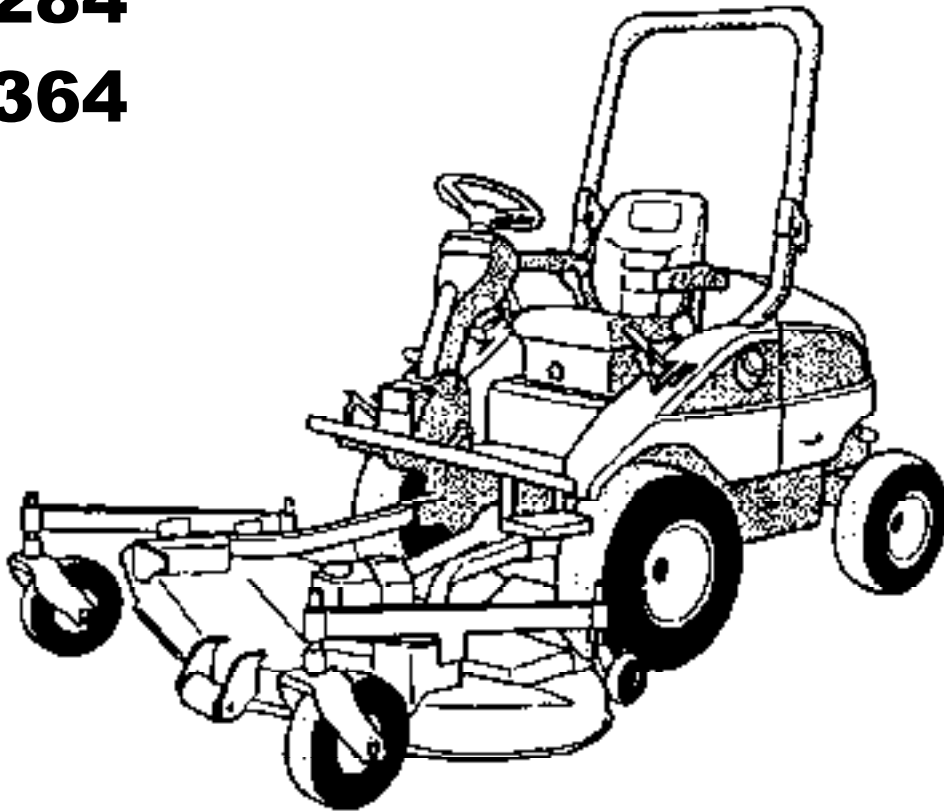


SHIBAURA

FRONT MOWER

CM284

CM364



WORKSHOP MANUAL



Introduction

Shibaura developed a front mower incorporating new technology for more improved passenger mowing garden tractor.

This manual describes the structure, functions, maintenance and service of models CM284 and CM364 so that their functions are fully exhibited in actual operation.

Please read this carefully to promote sales and service, to improve the service techniques and guide users for proper operation of Shibaura tractors.

Figures or other conditions in this manual may be changed without notice in order to improve the performance or for other objects.

**Ishikawajima-Shibaura Machinery Co., Ltd.
Tractor Division
Quality Assurance Department**

INDEX

Chapter 1. GENERAL	3	Chapter 6. REAR AXLE ASSEMBLY	149
1-1 Specifications & Performances	4	1. DESCRIPTION AND OPERATION	150
1-2 Precautions Before Servicing	5	2. REAR AXLE REMOVAL	151
1-3 Basic Understanding on Servicing	5	3. INSTALLATION	151
Chapter 2. ENGINE	7	4. DISASSEMBLY	152
2-1 Engine Removal	8	5. INSPECTION	154
2-2 Disassembly, Inspection and Reassembly	9	6. ASSEMBLY	155
1. Disassembly	9	7. INSTALLATION	156
2. Disassembly, Inspection and Reassembly of Engine Main Parts	13	Chapter 7. HYDRAULIC LIFT SYSTEM	157
3. Engine Reassembly	36	1. DESCRIPTION AND OPERATION	158
2-3 Electrical Units	46	2. OIL FLOW	159
1. Alternator	46	3. OVERHAUL	162
2. Starting Motor	53	Chapter 8. IMPLEMENT DRIVE	167
3. Glow Plug	68	1. DESCRIPTION AND OPERATION	168
4. Thermometer and Thermosensor	69	2. POWER FLOW	169
5. Buzzer Alarm Warning System	70	3. AUTOMATICALLY PTO DISENGAGE SYSTEM	171
6. Oil Pressure Switch	71	4. ADJUSTMENT AND SPECIFICATION	172
7. Engine Stop Solenoid	72	Chapter 9. MAINTENANCE	
8. Fusible Link	72	STANDARDS TABLE	173
9. Wiring Harness	72	Maintenance Standards Table	174
2-4 Trouble Shooting	73	Chapter 10. ELECTRICAL SYSTEM	177
2-5 Engine Maintenance Standard Table	75	1. DESCRIPTION	178
Chapter 3. TRANSMISSION AND BRAKE	83	2. COMPONENT LOCATION AND FUNCTION	178
1. DESCRIPTION AND OPERATION	84	3. FUNCTION INSPECTION AND ADJUSTMENT	181
2. TRANSMISSION UNIT	88	Chapter 11. MOWER	207
1) Removal	88	11-1 Sectional Vier: FM60SD	208
2) Front Transmission Unit	93	11-2 Specifications	209
3) Rear Transmission Unit	101	11-3 Disassembly	210
4) PTO Clutch Unit	105	11-4 Reassembly and Adjustment	216
5) Front Wheel Shaft and Brake Unit	108		
6) Two Way Clutch Unit	110		
7) Differential Gear Unit	111		
Chapter 4. HST SYSTEM	117		
1. OIL FLOW	118		
2. HST UNIT REMOVAL	121		
3. PRECAUTIONS BEFORE DISASSEMBLY	124		
4. DISASSEMBLY	124		
5. INSPECTION	125		
6. REASSEMBLY	126		
7. ASSEMBLY	126		
8. ADJUSTMENT	128		
9. TROUBLE SHOOTING AND SPECIFICATIONS	132		
Chapter 5. POWER STEERING	135		
1. OIL FLOW	136		
2. CONTROL VALVE ASSEMBLY	141		
3. POWER STEERING CYLINDER	145		
4. PIPING	146		
5. TROUBLE SHOOTING	147		

Chapter 1. GENERAL

1-1 Specifications & Performances

Model		CM284	CM364	
Engine	Model	J843	N843L	
	Type	Water-Cooled 4-Cycle Vertical Diesel Engine		
	Number of Cylinders	3		
	Total Stroke Volume	1330 cc	1662 cc	
	Maximum Output	20.8 kW (28 HP)/2700 rpm	26 kW (35 PS)/2700 rpm	
	Compression Ratio	22.5 : 1		
	Fuel	Diesel Fuel Oil		
	Starting Method	By Starting Motor		
Maine Body	Overall Length	2415 mm		
	Overall Height	1390 mm		
	Overall Width	1220 mm (narrow), 1370 mm (wide)		
	Weight	730 kg	750 kg	
	Tire	Front Wheel	23 × 10.5 – 12	
		Rear Wheel	20 × 8.00 – 10	
	No. of Running Speeds	2 Forward Speeds, 2 Reverse Speeds (Continuously variable speed)		
	Transmission System	L/H Switching, All Hydraulic Continuously Variable Speed (HST)		
	Brake	Wet Disc Brake		
	Lift Control Valve Relief Set Pressure	9.8 MPa {100 kgf/cm ² }		
	Relief Set Pressure/ Steering	5.88 – 6.56 MPa {60 – 67 kgf/cm ² }/ Full Hydraulic Power Steering		
	Running Speed	Forward: L	0 – 10.0 km/h	
		Forward: H	0 – 17.2 km/h	
Reverse: L		60 – 70 % of Forward Speed		
Reverse: H		60 – 70 % of Forward Speed		
Capacity	Fuel Tank	50.5 ℓ		
	Engine Oil	4.6 ℓ (Including oil filter)	5.6 ℓ (Including oil filter)	
	Transmission Gear Oil	Front 20 ℓ, Rear 2.3 ℓ		
	Cooling Water	5.1 ℓ	5.3 ℓ	
Electric Units	Battery	75 D 26 L		
	Starting Motor	12 V – 1.7 kW	12 V – 2.0 kW	
	Alternator	12 V – 40 A		
	Head Light	23 W		
	Monitor Lamp	3 W		
	Dash Panel Lamp	2 W		
	Light Switch Lamp	1.4 W		

1-2 Precautions Before Servicing




1. Have the tractor washed clean and have the oil, fuel, and cooling water drained out as would be required by the work to be performed.
2. Service shop should always be kept clean to prevent dust from rising and should be well lighted.
3. The disassembled parts shall have the oil and grease washed off and arranged on a stand separated by groups.
4. Clothing, service tools and equipments shall be checked to ensure safety in performing the operations.

1-3 Basic Understanding on Servicing

1. Engine, transmission, and hydraulic apparatus have been specially manufactured to high accuracy so that care shall be exercised to maintain them in clean state and not to do any unnecessary disassembly.
2. Defective parts due to wear and other causes shall be discarded and new parts ordered with the tractor model, serial No., code No., and part name clearly defined. (Keep the defective parts on hand to enable showing it to the customer.)
3. When assembling, it is essential to have oil applied to all moving parts so that they will be provided with initial oil film until normal lubrication takes place.
4. Unless specially instructed, bolts and nuts shall be tightened by proper tools to the proper tightening torque.

GENERAL METRIC BOLT TORQUE SPECIFICATION TABLE
USE THE FOLLOWING TORQUES WHEN SPECIAL TORQUES ARE NOT GIVEN

NOTE : These values apply to fasteners as received from supplier, dry, or when lubricated with normal engine oil. They do not apply if special graphited or molly disulphide grasses or other extreme pressure lubricants are used.

Bolt Size	Grade No.	Coarse Thread		Fine Thread	
		Pitch (mm)	Newton Meters	Pitch (mm)	Newton-Meters
M6	4T 	1.0	4.9 – 6.9	–	–
	7T 		8.3 – 11.3		
	10T 		11.7 – 15.7		
M8	4T	1.25	12.7 – 16.7	1.0	15.2 – 20.1
	7T		22.6 – 28.4		26.5 – 34.3
	10T		28.5 – 36.3		30.4 – 40.2
M10	4T	1.5	25.5 – 33.3	1.25	28.4 – 36.2
	7T		44.1 – 55.9		49.0 – 62.8
	10T		54.0 – 69.6		57.9 – 73.5
M12	4T	1.75	37.3 – 47.1	1.25	43.1 – 54.9
	7T		65.7 – 83.4		74.5 – 94.1
	10T		92.2 – 116		99.0 – 127
M14	4T	2.0	62.8 – 80.4	1.5	69.6 – 87.3
	7T		104 – 131		117 – 148
	11T		139 – 175		147 – 186
M16	4T	2.0	86.3 – 110	1.5	91.2 – 115
	7T		149 – 184		157 – 192
	11T		206 – 255		221 – 270
M18	4T	2.0	114 – 141	1.5	131 – 163
	7T		196 – 235		230 – 279
	11T		275 – 333		299 – 368
M20	4T	2.5	144 – 179	1.5	172 – 211
	7T		240 – 289		275 – 333
	11T		363 – 441		397 – 485

Chapter 2. ENGINE

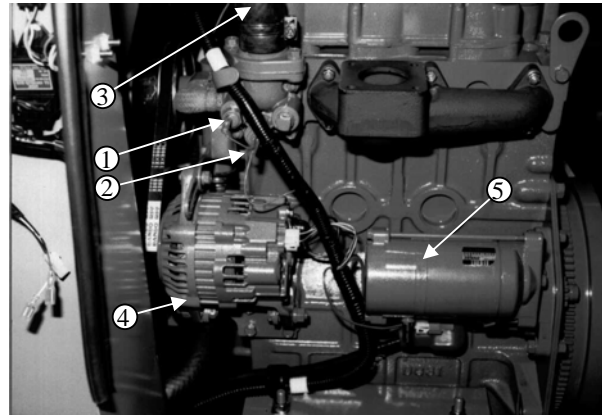
NOTE:

Due to Pollutant Regulations, some of parts relating to Engine exhaust are not available for spares as an individual part.

Engine Model	Tractor Model
J843	CM284
N843L	CM364

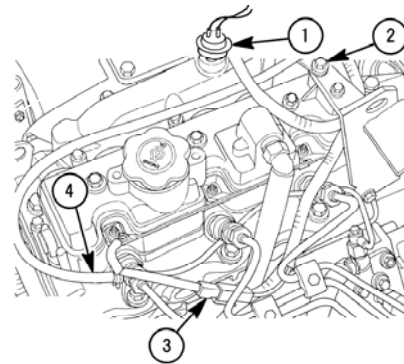
2-1 Engine Removal

- 1) If necessary, remove bolts and nuts and the bonnet.
- 2) Remove the muffler and stay from the engine.
- 3) Disconnect the wiring from the air cleaner clogging sensor.
- 4) Disconnect the wiring from the water temperature sensor and water temperature switch.
- 5) Remove the radiator hoses from the engine.
- 6) Disconnect the wiring from the alternator.
- 7) Disconnect the wiring from the starting motor.
- 8) Remove the bolt and ground wire from the cylinder head.
- 9) Disconnect the fuel return hose from the fuel return pipe.



002X

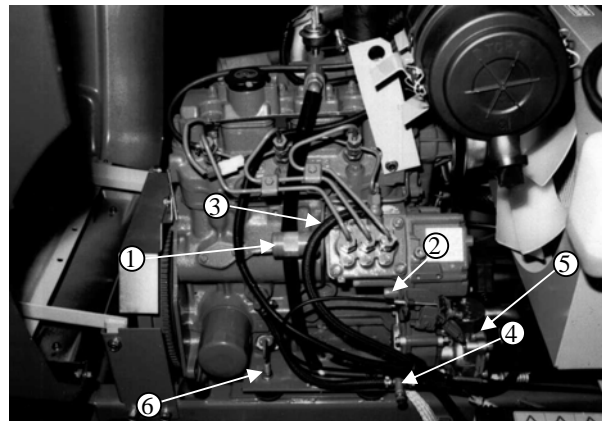
- | | |
|----------------------------|------------------|
| ① Water temperature switch | ④ Alternator |
| ② Water temperature sensor | ⑤ Starting motor |
| ③ Radiator hose | |



003X

- | | |
|-------------------------------|-----------------------|
| ① Air cleaner clogging sensor | ③ Glow plug connector |
| ② Ground wire | ④ Fuel return hose |

- 10) Disconnect the wiring from the engine oil pressure switch.
- 11) Disconnect the wiring from the glow plug connector.
- 12) Disconnect the wiring from the engine stop solenoid.
- 13) Disconnect the fuel pipe from the injection pump.
- 14) Remove the accelerator wire from the engine.
- 15) Disconnect the drain hose from the drain cock.
- 16) Disconnect the oil hoses from the hydraulic oil pump.
- 17) Remove the engine attaching nuts and hoist the engine from the frame.

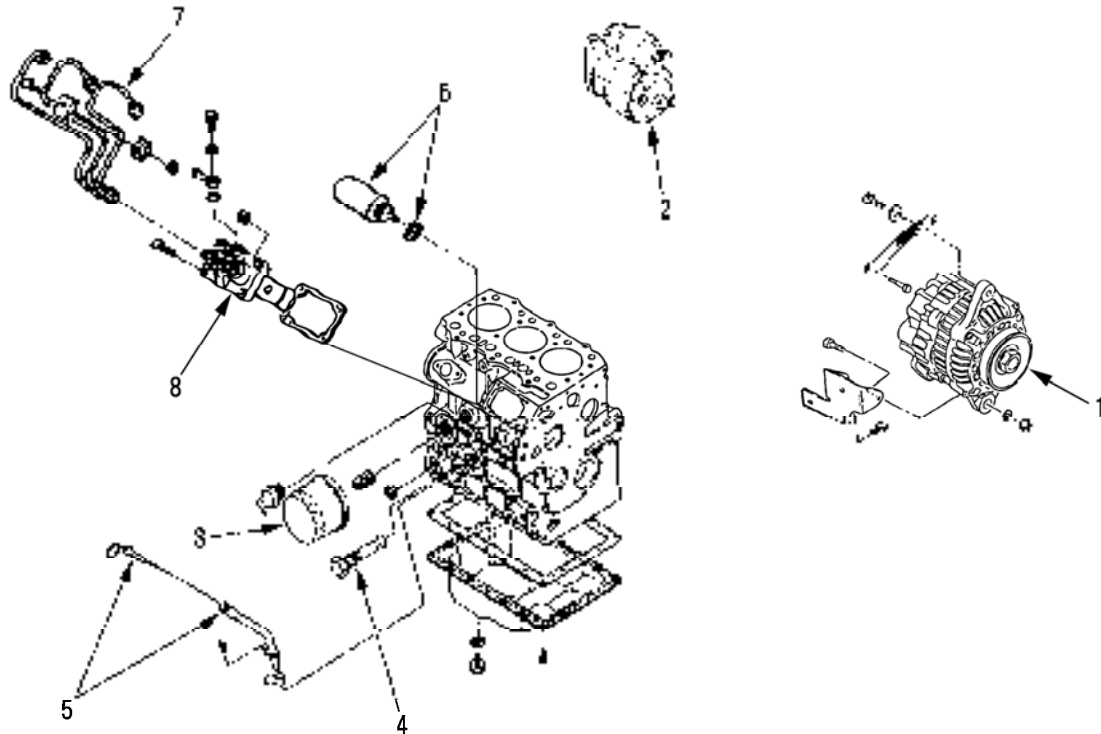


004X

- | | |
|------------------------|------------------------|
| ① Engine stop solenoid | ⑤ Hydraulic oil pump |
| ② Accelerator wire | ⑥ Engine attaching nut |
| ③ Fuel hose | |
| ④ Drain cock | |

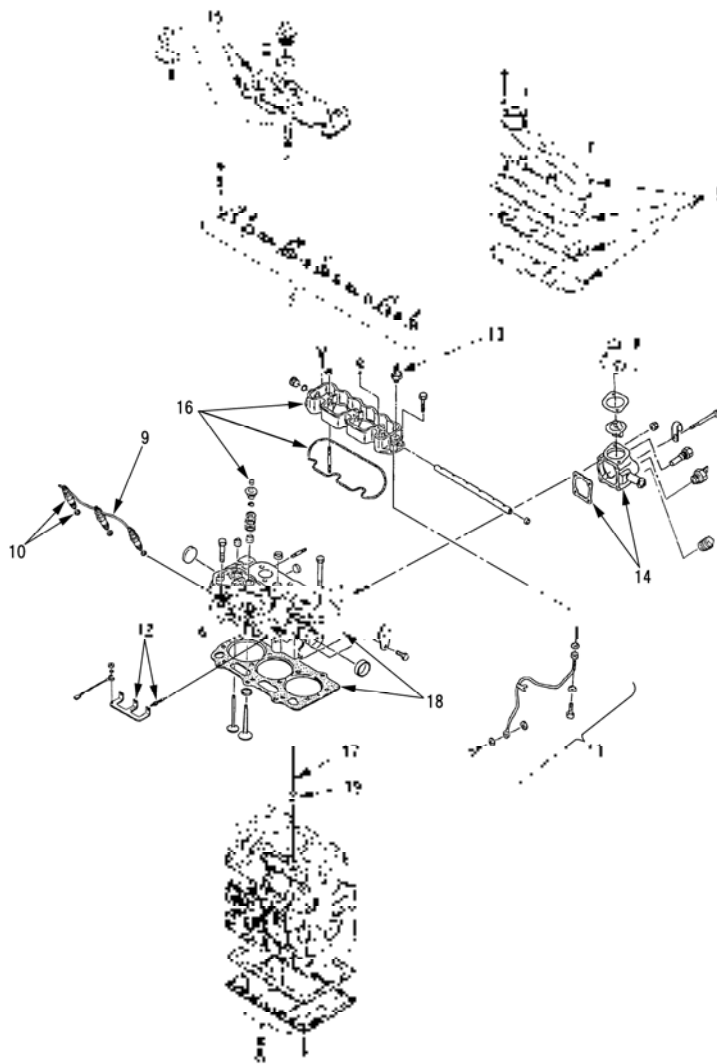
2-2 Disassembly, Inspection and Reassembly

1. Disassembly



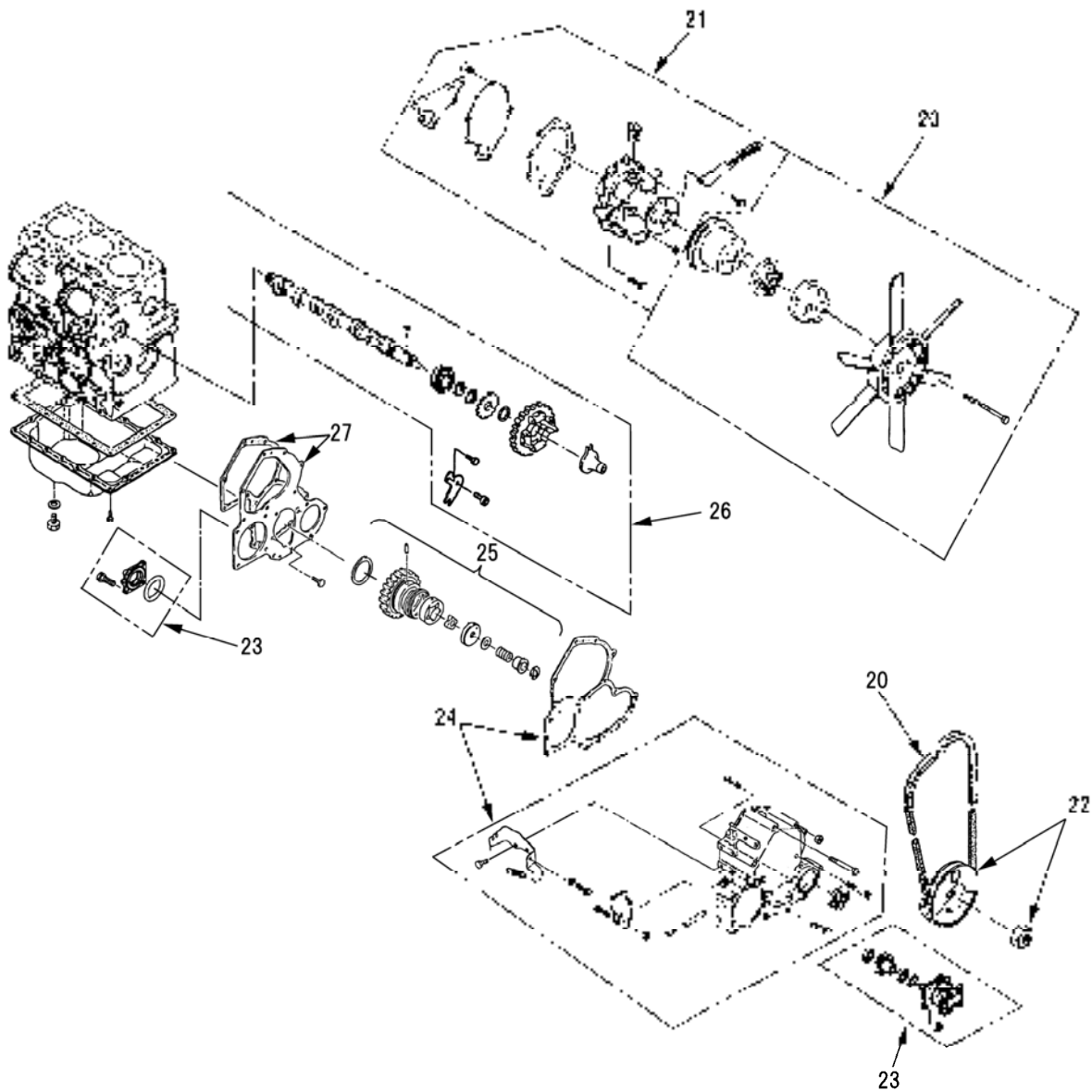
005X

Order	Disassemble Parts Name
1	Alternator
2	Starting motor
3	Oil filter
4	Relief valve
5	Oil level gauge · Gauge guide
6	Engine stop solenoid · Seal washer
7	Injection pipe
8	Injection pump NOTE: 1. Remove the injection pipes and engine stop solenoid before remove the injection pump. 2. Raise the injection pump and disconnect the governor link from the control rack by remove the snap pin. 3. Injection timing has been adjusted by the shims between injection pump and cylinder block. Take note of their thickness and number when removing the injection pump.



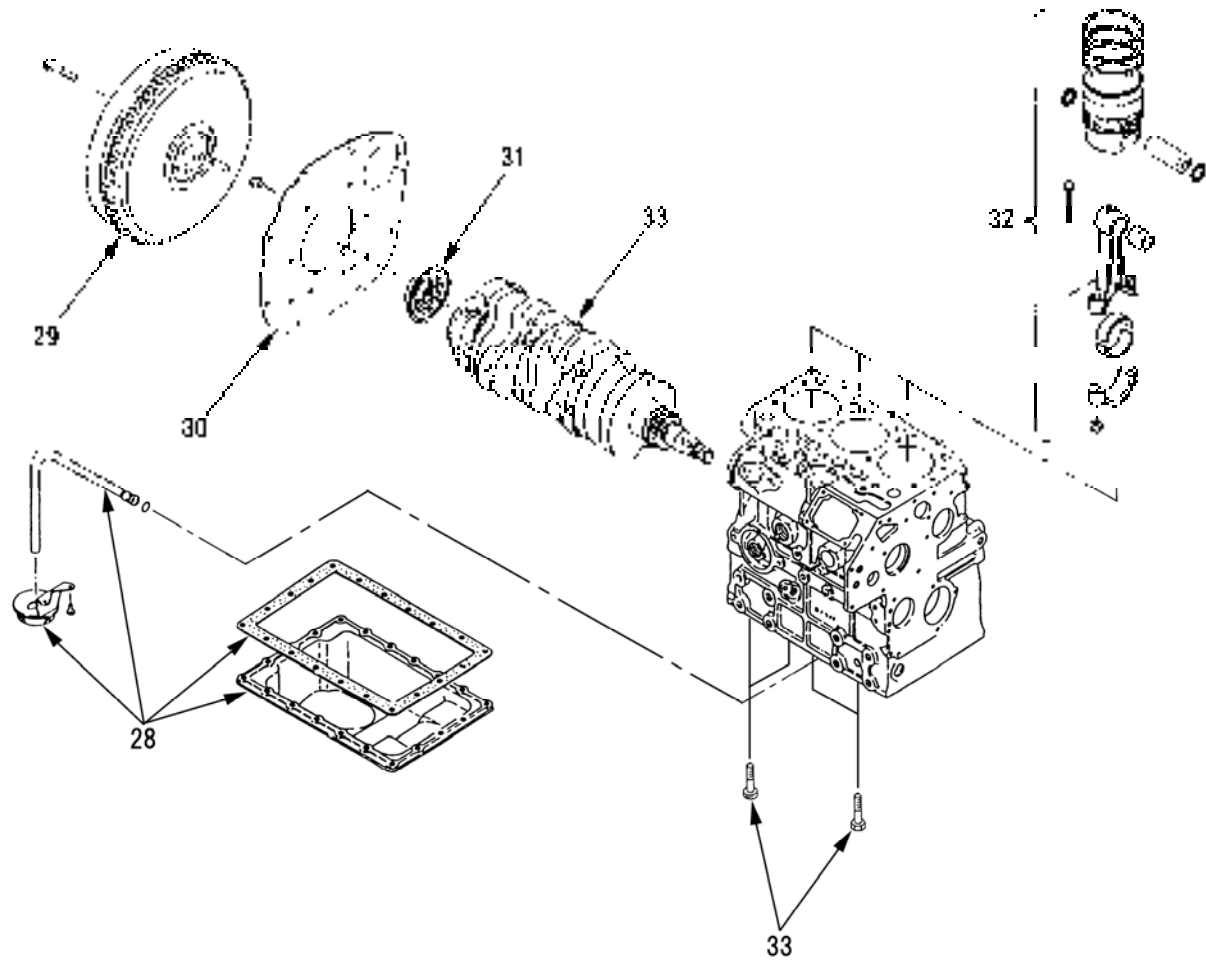
006X

Order	Disassemble Parts Name
9	Return pipe
10	Injection nozzle · Gasket
11	Oil transfer pipe · Eye bolt · Seal washer
12	Connector · Glow plug
13	Oil pressure switch
14	Thermostat case · Gasket
15	Head cover · O-Ring · Intake manifold · Spacer
16	Rocker arm assembly · O-Ring · Cap NOTE: Remove the caps from intake valves and exhaust valves.
17	Push rod
18	Cylinder head assembly · Head gasket NOTE: 1. Untighten the cylinder head bolts in several steps and remove the cylinder head assembly.
19	Tappet



007X

Order	Disassemble Pats Name
20	V-belt · Cooling fan · Fan holder · Fan pulley
21	Water pump assembly · Gasket
22	Crankshaft pulley
23	Hydraulic oil pump, Cover, Drain cock.
24	Timing gear case assembly · Gasket NOTE: Remove the engine stop solenoid and injection pump assembly at first.
25	Idle gear · Oil pump assembly
26	Cam shaft assembly · Plate NOTE: Remove the bolts and plate at first, and draw out the cam shaft assembly.
27	Front plate · Gasket



008X

Order	Disassemble Parts Name
28	Oil pan · Gasket · Suction filter · Suction pipe
29	Fly wheel
30	Rear plate
31	Oil seal
32	Piston and connecting rod assembly NOTE: 1. Before extracting piston, remove the carbon deposit from the TDC in the cylinder. 2. Place the connecting rod, cap and bearing removed in order of the cylinders.
33	Crank shaft and bearing holder assembly NOTE: Remove the four bolts, and draw out the crank shaft and bearing holder assembly as a set.

2. Disassembly, Inspection and Reassembly of Engine Main Parts

★ Cautions before start

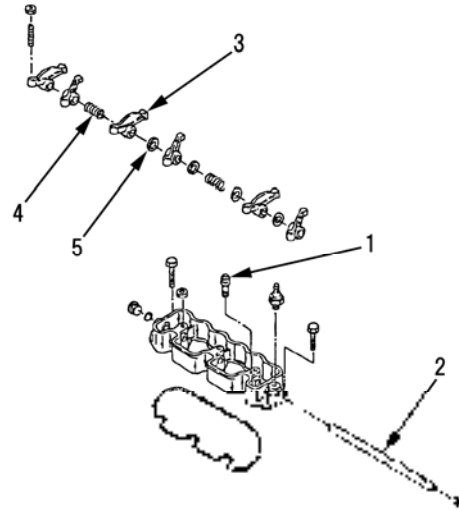
- 1) Check the cylinder block and cylinder head for wear, leakage and damage.
- 2) Remove deposit in oil holes of each part with air and check for clogging.
- 3) Wash each part well to remove dust, contaminated oil, carbon, and other foreign matter.
- 4) Remove carbon deposite on the piston, cylinder head, valves, etc. carefully not to damage parts. (Great care is necessary specifically for aluminum alloy parts.)
- 5) Valves, pistons, connecting rods, metals and other parts which are to be combined as specified should be attached match marks beforehand to prevent confusion.

1) Rocker arm ass'y

Disassembly

- (1) Extract the screw from the rocker arm bracket.
- (2) Screw in a M8 bolt from the front side of the rocker arm bracket and extract the rocker arm shaft.
- (3) Take out the spring and rocker arm from the rocker arm bracket.

1. Screw
2. Rocker arm shaft
3. Rocker arm
4. Spring
5. Shim



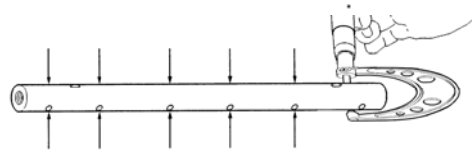
009X

Inspection and service

(1) Rocker arm shaft

Measure the outside diameter of the rocker arm shaft with a micrometer and replace if the result is below the service limit.

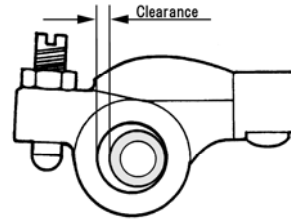
Rocker arm shaft diameter (∅)		
	Standard assembling value	Service limit
J843	11.65 – 11.67	11.57
N843L	14.95 – 14.97	14.87



010X

(2) Clearance between rocker arm and rocker arm shaft

- a. Measure the rocker arm bore.
- b. Measure the clearance between the rocker arm and rocker arm shaft, and replace if the service limit is exceeded.



Clearance between rocker arm and rocker arm shaft (mm)	
Standard assembling value	Service limit
0.032 – 0.068	0.2

011X

(3) Inspection of rocker arm

Check the valve cap-contact surface for uneven wear and streaks. Correct the curved surface with an oil stone or grinder correctly if insignificant.

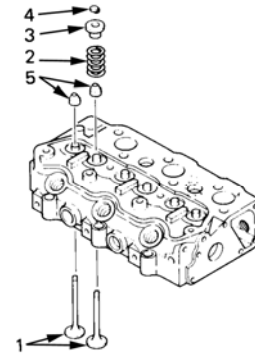
Reassembly

Reassembly parts reversely to disassembly.

2) Cylinder head ass'y

Disassembly

- (1) Compress the valve spring with a valve spring replacer and remove the valve cotter, retainer, spring and valve.
- (2) Remove the valve guide seal, if required.



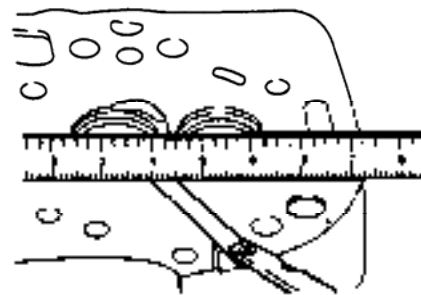
1. Valve
2. Spring
3. Retainer
4. Valve cotter
5. Valve guide seal

013X

Inspection and service

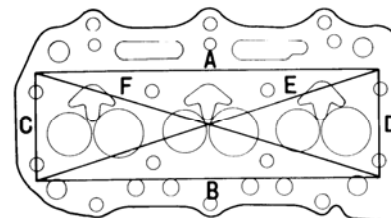
(1) Distortion of cylinder head bottom surface.

Apply a straight edge to the bottom surface of the cylinder head, and insert a thickness gauge at 6 points from A to F in the right figure and measure distortion. If the distortion exceeds the repair value, correct with surface grinder or the like.



014X

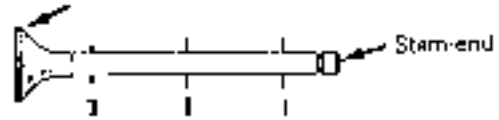
Distortion at cylinder head bottom surface (mm)	
Standard assembling value	Repair value
Less than 0.05	0.12



015X

(2) Intake and exhaust valves and valve guide

- a. Check the head and stem of each valve and replace if burnout, wear or deformation is remarkable.
- b. Measure the outside diameter at the position I, II, and III on the valve stem with a micrometer and replace if the result is less than the service limit.



016X

Valve stem diameter (mm)			
Intake valve		Exhaust valve	
Standard assembling value	Service limit	Standard assembling value	Service limit
6.955 – 6.97	6.89	6.94 – 6.95	6.84

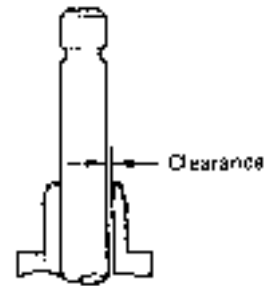
- c. Replace a valve if its head thickness is less than service limit.



017X

Valve head thickness (mm)	
Standard assembling value	Service limit
0.775 – 1.075	0.5

- d. Replace the valve if the clearance between the stem and guide exceeds the service limit.

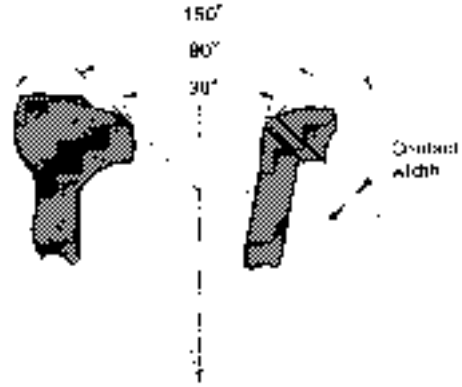


018X

Clearance between valve stem and valve guide (mm)			
Intake valve		Exhaust valve	
Standard assembling value	Service limit	Standard assembling value	Service limit
0.03 – 0.06	0.2	0.045 – 0.075	0.25

(3) Valve seat

- a. Since the valve seat is corrected according to the valve guide, be sure to check the valve guide for wear condition first before correcting the seat.
- b. Correct the seat using a seat cutter of 15°, 45° and 75° so that the contact width is the standard assembling value.

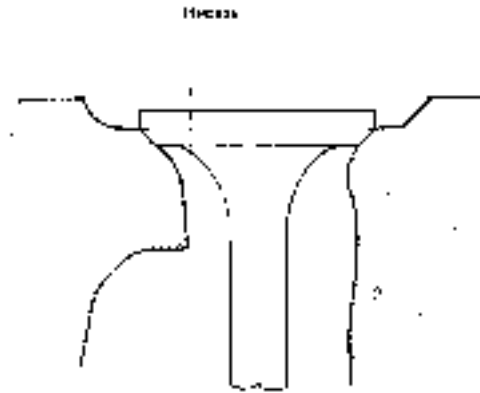


019X

Valve seat contact width (mm)		Repair value
Standard assembling value		
Intake	1.66 – 1.87	2.5
Exhaust	1.66 – 1.73	

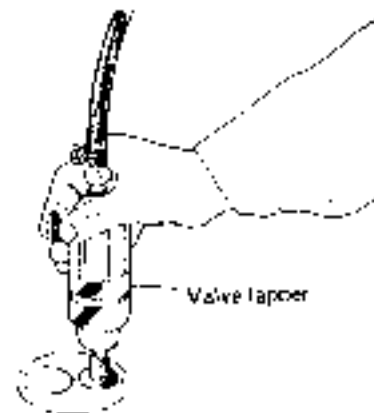
- c. When the seat recess exceeds the service limit, replace the valve seat or valve.

Valve seat recess (mm)	
Standard assembling value	Service limit
0.85 – 1.15	1.8



020X

- d. Coat the valve seat surface with compound and lap the contact surface turning the valve.
- e. Check that the valve contact surface is within the standard value and the contact position is even.



021X

(4) Valve spring

- a. Check the valve spring visually for damage.
- b. Measure the squareness of the spring using a square on a surface plate and replace if the service limit is exceeded.
- c. Check the free length and spring force with a spring tester and replace if the service limit is exceeded.

	Standard assembling value	Service limit
Squareness (mm)	1.2	2
Free length (mm)	35	33.5
Spring force (when compressed to 30.4 mm)	8.1	7



022X

(5) Inspection of combustion chamber

Check and clean the inside of the combustion chamber.

Reassembly

Reassemble parts in the order reverse to disassembly taking care for the following points.

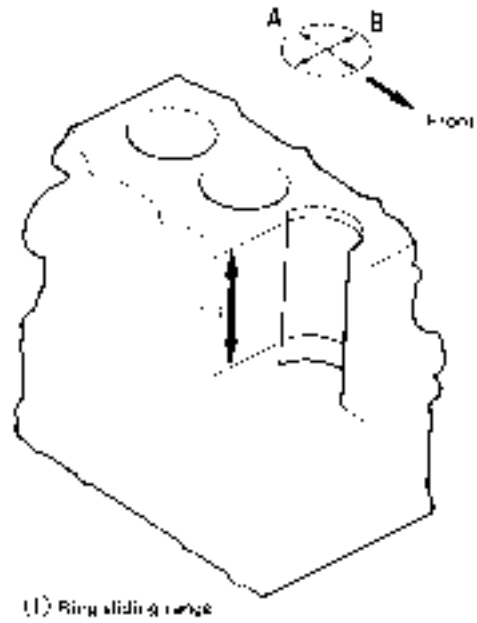
- (1) When assembling the valve, spring, retainer and cotter, be careful not to damage the valve guide seal.
- (2) Tighten the glow plug with the tightening torque of 14.7 – 19.6 N·m {1.5 – 2.0 kgf·m}.

3) Cylinder block

Inspection and service

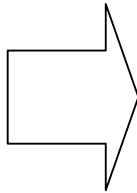
- (1) Check for crack, damage and distortion on the top of the block in the same way as in the cylinder head.
- (2) Measurement of cylinder bore
 - a. There should be apparent scratches, rust, corrosion, etc. on the cylinder bore.
 - b. Measure the cylinder bore at the top, center and bottom respectively in the crankshaft direction (A) and the direction at right angle to it (B). If the repair value is exceeded, replace engine long block assembly.

Distortion on cylinder block top surface (mm)	
Standard assembling value	Repair value
Less than 0.05	More than 0.12



122V

Model	Standard assembling value	Repair value
J843 · N843L	$\phi 84 - \phi 84.019$	More than $\phi 84.2$

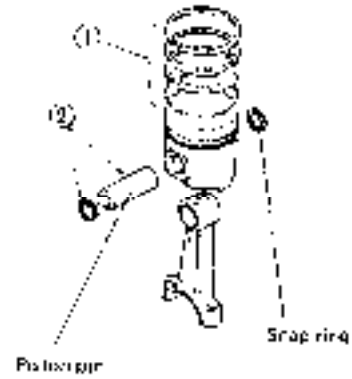


Replace engine long block assembly.

4) Piston and piston ring

Disassembly

- (1) Remove the piston ring using a piston ring tool.
- (2) Remove the snap ring and extract the piston pin.



Inspection

(1) Piston

- a. Check the piston for crack, streak and burnout on the outside surface and replace if remarkable.
- b. Measure the longer diameter at 10 mm above the lower end of the piston skirt and bore of the cylinder in the thrust direction, calculate the clearance, and replace if the repair value is exceeded.

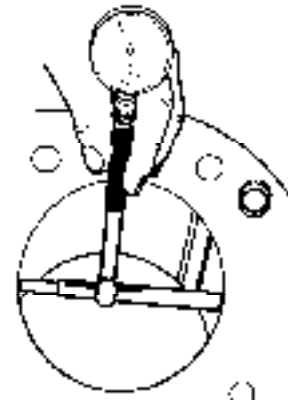
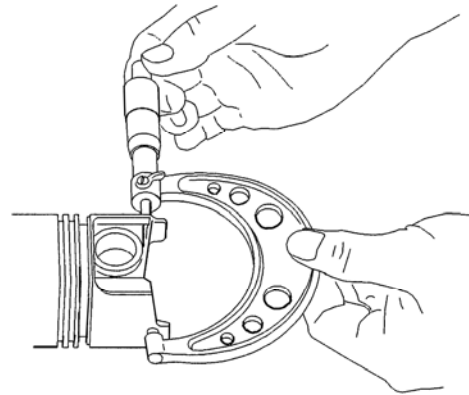
Clearance between cylinder and piston (mm)		
Model	Standard assembling value	Service limit
J843·N843L	0.0375 – 0.0715	0.25

Piston skirt bottom longer dia. (mm)		
Model	Standard assembling value	Service limit
J843·N843L	φ 83.9475 – 83.96	φ 83.7

Model	Piston size	Skirt bottom longer dia.
J843	S.T.D	83.9475 – 83.9625
N843L	S.T.D	83.9475 – 83.9625

- d. Measure the piston pin hole diameter and piston pin outside diameter and replace if the clearance exceeds the service limit.

Clearance between piston pin hole and piston pin (mm)	
Standard assembling value	Service limit
-0.001 – +0.007	0.02



024X

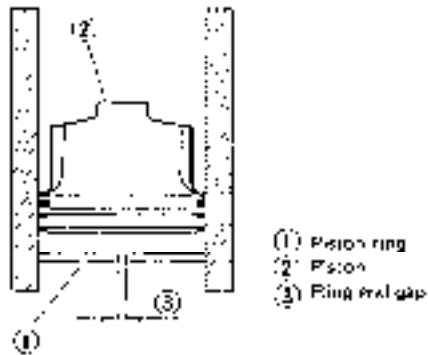
025X

026X

(2) Piston ring

- a. Replace worn out or damaged piston ring, if any.
- b. Insert a ring at a right angle to the least worn out skirt of a cylinder, measure the clearance of ring end gap with a thickness gauge and replace if the end gap exceeds the service limit.

Piston ring end gap (mm)		
	Standard assembling value	Service limit
Top ring	0.2 – 0.35	1.0
Second ring	0.2 – 0.4	1.0
Oil ring	0.2 – 0.8	1.2



027X

- c. Measure the clearance between the piston ring groove and ring and replace if the service limit is exceeded.

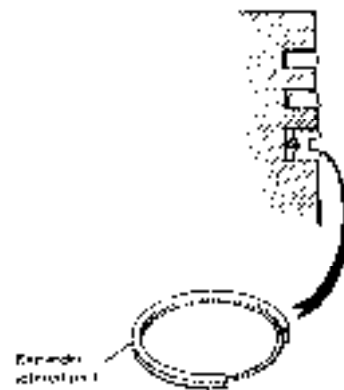
Clearance between piston ring groove and ring (mm)		
	Standard assembling value	Service limit
Top ring	0.07 – 0.11	More than 0.25
Second ring	0.04 – 0.08	More than 0.25
Oil ring	0.03 – 0.13	More than 0.25

- d. Piston and piston ring kits of the following part No. is available.

Model	Piston ring size	Part code No.
J843	S.T.D.	115107840
N843L	S.T.D.	115107290

Piston/piston ring kit		
Model	Size	Part code No.
J843	S.T.D.	115017390
N843L	S.T.D.	115017310

- e. Piston ring installing procedure
Install the piston ring to the piston as shown in the right figure.



028X

(3) Piston pin

Measure the outside diameter of the piston pin and replace if the service limit is exceeded.

Piston pin outside dia. (φ)		
Model	Standard assembling value	Service limit
J843	24.996 – 25.0	24.98
N843L	27.996 – 28.0	27.98

5) Connecting rod

Inspection

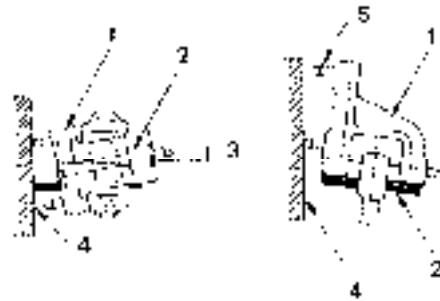
- (1) Check for torsion, parallelism and damage.
Measure the torsion and parallelism using a connecting rod aligner and correct or replace if the repair value is exceeded.

1. Gauge
2. Piston pin
3. Torsion
4. Flat part of aligner
5. Pin

- (2) Measure the bore of the connecting rod small end bush and replace if the clearance to the piston pin exceeds the service limit.

- (3) Install the connecting rod to the crankshaft, measure the axial play and replace the connecting rod if the service limit is exceeded.

Torsion and parallelism of connecting rod (mm)		
	Standard assembling value	Repair value
Torsion (per 100 mm)	Less than 0.08	More than 0.2
Parallelism (per 100 mm)	Less than 0.05	More than 0.15



029X

Clearance between bush and piston pin (mm)	
Standard assembling value	Service limit
0.010 – 0.025	More than 0.08

Axial play of connecting rod and crank pin (mm)	
Standard assembling value	Service limit
0.1 – 0.3	More than 0.7



6) Connecting rod metal

Inspection

- (1) Check the metal and if peeling, melting, uneven wear, improper contact or other damage is noticed, replace the metal.
- (2) Measure the oil clearance of the crank pin and metal using plasti-gauge.
- a. Remove oil dust or other foreign matter stuck to the metal and crank pin.
 - b. Cut plasti-gauge to the length same as the metal width and place it on the crank pin in parallel with the crankshaft avoiding the oil hole.
 - c. Install the connecting rod metal and connecting rod cap and tighten with the specified tightening torque.

Tightening torque	49 – 53.9 N·m {5.0 – 5.5 kgf·m}
-------------------	--

NOTE: Never turn the connecting rod at this time.

Clearance between crank pin and connecting rod metal (oil clearance) (mm)		
	Standard assembling value	Service limit
J843	0.035 – 0.083	0.2
N843L	0.035 – 0.085	0.2
	 <p>Set a plasti-gauge.</p>	 <p>Measure the oil clearance</p>
	030X	031X

- d. Remove the connecting rod cap and measure the plasti-gauge width with the scale printed on the gauge envelope.

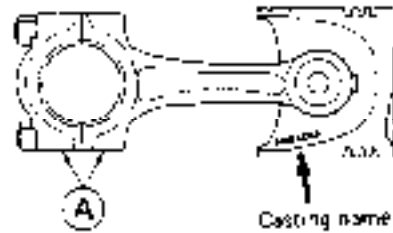
NOTE: Measure the widest part of the plasti-gauge.

- (3) If the oil clearance exceeds the service limit according to the result of the measurement, replace the metal.

Models	Metal size	Metal code No.	Crankshaft pin outside dia. Finishing dimension (ϕ)
J843	S.T.D.	198517180	43.964 – 43.975
N843L	S.T.D.	198517250	51.964 – 51.975

Reassembly (piston and connecting rod)

- (1) Heat the piston to about 100°C with a piston heater or the like and install it aligning the SHIBAURA mark in the piston and match mark at (A) of the connecting rod.
- (2) Care should be taken to the figure match mark at (A) of the connecting rod.
- (3) Install the piston ring to the piston facing the stamp at the end surface of the ring end gap upward.
- (4) When the connecting rod or piston and piston pin are replaced, weight variation among cylinders with the rod, piston and piston ring installed should be within 10 g.



032X

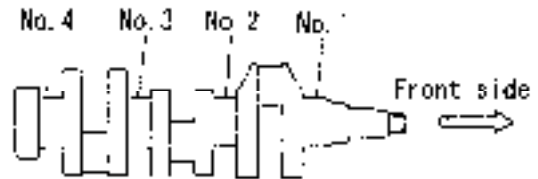
7) Bearing holder

Disassembly and inspection

Center bearing (metal)

- (1) Remove the bearing holder, and replace the metal if peeling, melting, uneven wear, or improper contact is noticed.
- (2) Measure the oil clearance of the crankshaft center journal and metal using a plasti-gauge.
- (3) If the oil clearance exceeds the service limit according to the result of the measurement, replace the metal or/and crank shaft.

Clearance between crankshaft center journal and metal (oil clearance) (mm)		
Models	Standard assembling value	Service limit
J843 N843L	No.2, 3 and 4	0.044 – 0.116
		0.2



033X

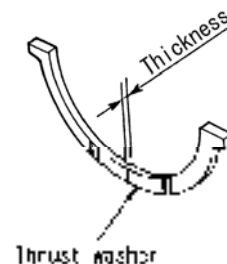
Metal size	Metal code No.	
	J843	N843L
S.T.D.	198517210 (Upper)	198517230 (Upper)
	198517200 (Lower)	198517240 (Lower)

Journal size	Finished dimensions of crankshaft journal (ϕ)	
	J843	N843L
S.T.D.	57.957 – 57.970	67.957 – 67.970

Thrust washer

Check the thrust washer and replace if wear, improper contact, seizure, or other damage is noticed, or thickness exceeds the service limit.

Thrust washer thickness (mm)	
Standard assembling value	Service limit
2.95 – 3.0	Less than 2.8



034X

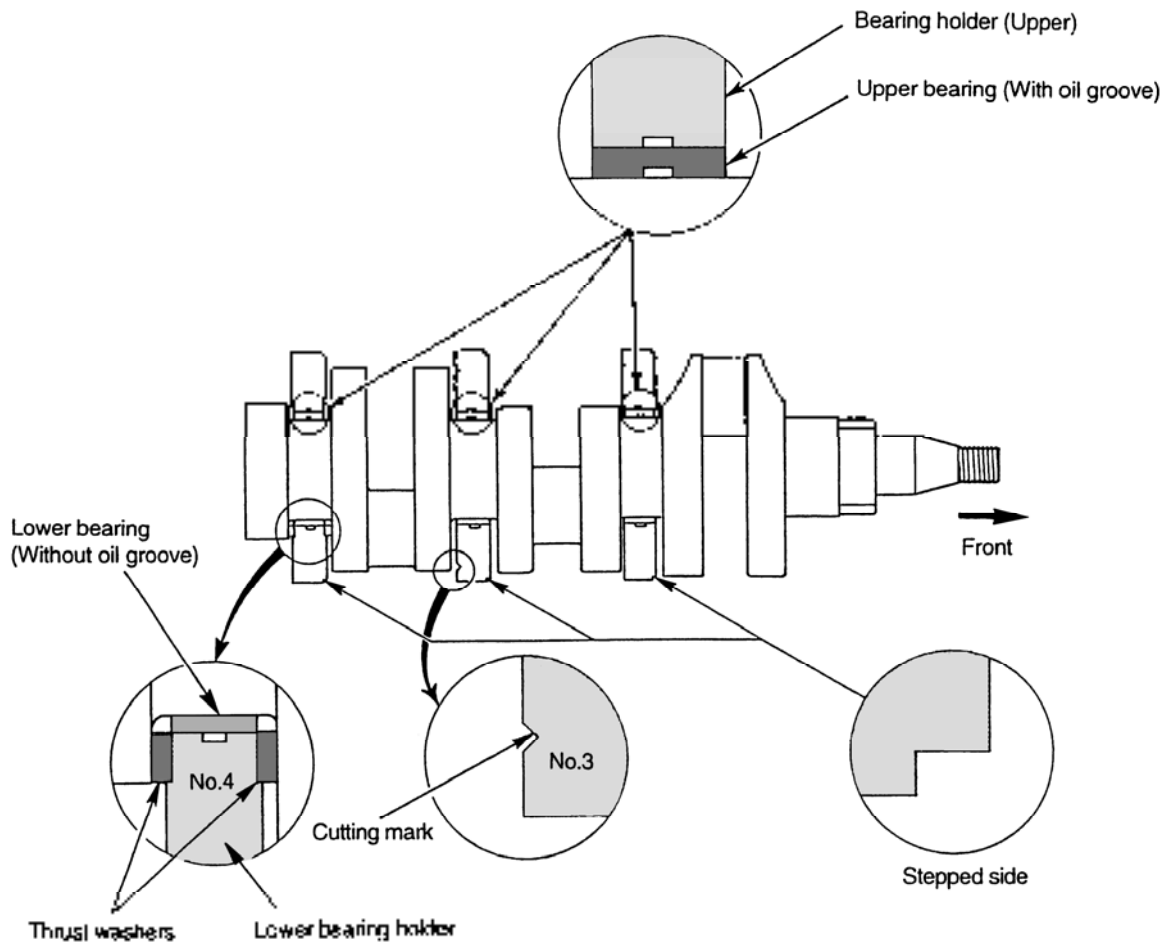
Reassembly

- (1) Install the metal with oil groove to the upper bearing holder and the metal without oil groove to the lower bearing holder
- (2) With the stepped area of the bearing holder facing the front side, install the bearing holder to be fitted with thrust washer on the flywheel side and the bearing holder with identification cutting mark at the center.

Bearing holder tightening torque	49 – 53.9 N·m {5 – 5.5 kgf·m}
----------------------------------	--

- (3) Install the thrust washer facing the oil groove towards the crankshaft thrust surface.

NOTE: Be sure to confirm that the oil hole of the bearing holder and that of the cylinder block are in the same direction.

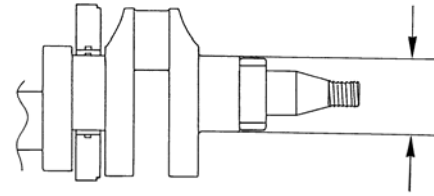


035X

8) Crankshaft bearing (bush)

Inspection

- (1) Check the bearing (bush) and replace if peeling, melting, uneven wear, improper contact, or other damage is notice.
- (2) Measure the oil clearance of the bearing (bush) and crankshaft journal using a cylinder gauge and micrometer.
- (3) If the oil clearance exceeds the service limit according to the result of measurement, replace the bearing (bush) or/and crank shaft.



036X



037X

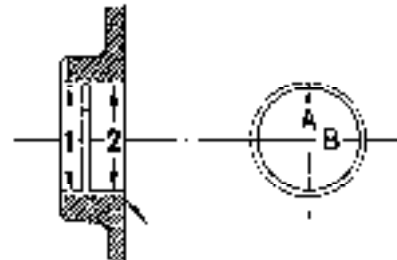
Clearance between crankshaft journal and bearing (bush) (oil clearance) (mm)	
Standard assembling value	Service limit
0.044 – 0.116	0.2

Bush size	Bush code No.	
S.T.D.	J843	N843L
	198517190	198517220

Bush size	Crankshaft journal outside dia. Finishing dimension (ϕ)	
S.T.D.	J843	N843L
	57.957 – 57.970	67.957 – 67.970

NOTE:

1. Measure the dimensions in the A and B directions at the position 1 and 2 in the right figure avoiding the oil hole of the bearing (bush) and calculate difference from the maximum value of the crankshaft journal (oil clearance).
2. When replacing the bush, push it up using a press or the like. At this time, align the oil holes and push it up until the bush end surface becomes level with the outside machined surface of the cylinder block (see the arrow mark in the right figure).



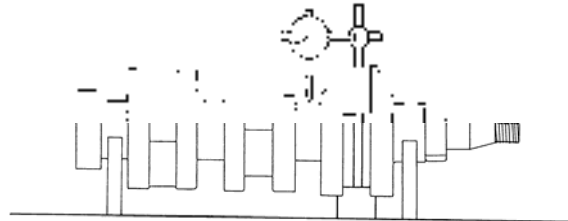
038X

9) Crankshaft

Inspection

- (1) To measure run-out of the crankshaft, support the crankshaft using a V block as shown in the right figure, apply a dial gauge to the crankshaft center journal, read the indication on the dial gauge rotating the shaft one turn gently. If the service value is exceeded, correct or replace.
- (2) Check the crankshaft oil seal for damage or wear on the contact surface and oil hole clogging.

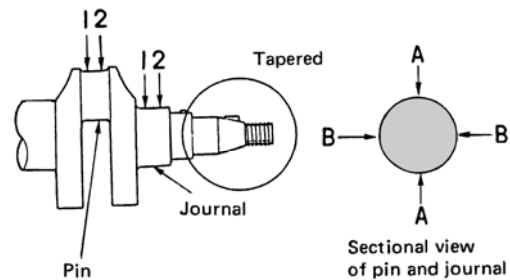
Crankshaft run-out (mm)	
Standard assembling value	Service limit
Less than 0.03	0.06



039X

- (3) Check the crankshaft journal and pin for damage, irregular wear (ellipticity, conicalness) and shaft diameter. If the service limit is exceeded, replace the bearing (bush) and/or crankshaft. Measure the dimensions of the journal and pin in the AA and BB directions at the position 1 and 2 avoiding the oil holes.

Irregular wear limit of crankshaft journal and pin
0.05 mm



040X

Model J843				
Journal and pin size	Shaft dia. at crankshaft journal (ϕ)		Shaft dia. at crankshaft pin (ϕ)	
S.T.D.	Outside dia. finishing dimension	Repair value	Outside dia. finishing dimension	Repair value
	57.957 – 67.970	Less than 57.90	43.964 – 43.975	43.90

Model N843L				
Journal and pin size	Shaft dia. at crankshaft journal (ϕ)		Shaft dia. at crankshaft pin (ϕ)	
S.T.D.	Outside dia. finishing dimension	Repair value	Outside dia. finishing dimension	Repair value
	67.957 – 67.970	Less than 67.90	51.964 – 51.975	Less than 51.90

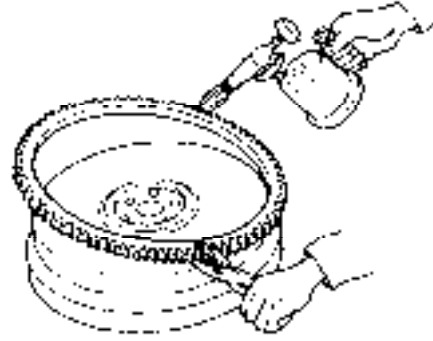
* Replace the crankshaft if diameter is below the repair value.

10) Flywheel and ring gear

Inspection

Check the ring gear and replace if damage or remarkable wear is noticed.

When the wear is limited to a small area, remove the ring gear, turn it about 90 degrees and shrinkage-fit to reuse it. To shrinkage-fit the ring gear, heat it to 120 – 150°C to allow it to expand.



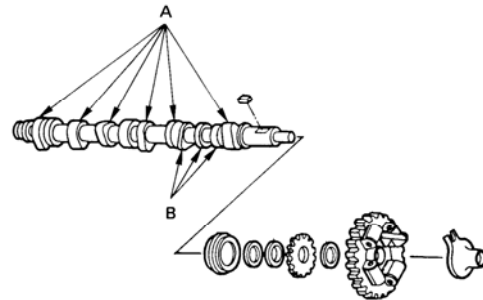
042X

11) Cam shaft ass'y

Inspection

- (1) Check the journal and cam for wear and damage and replace if the service limit is exceeded.
- (2) Correct insignificant uneven wear or scars on the cam surface using oil stone or the like.

A. Height of intake/exhaust valve cams (mm)	
Standard assembling value	Service limit
34.441 – 34.5076	34.1
B. Height of injection pump cams (mm)	
Standard assembling value	Service limit
42.99 – 43.01	42.8



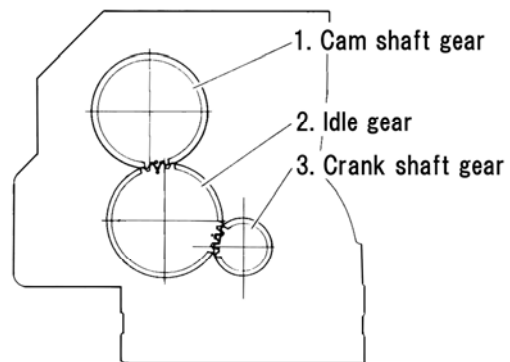
043X

12) Timing gear

Inspection

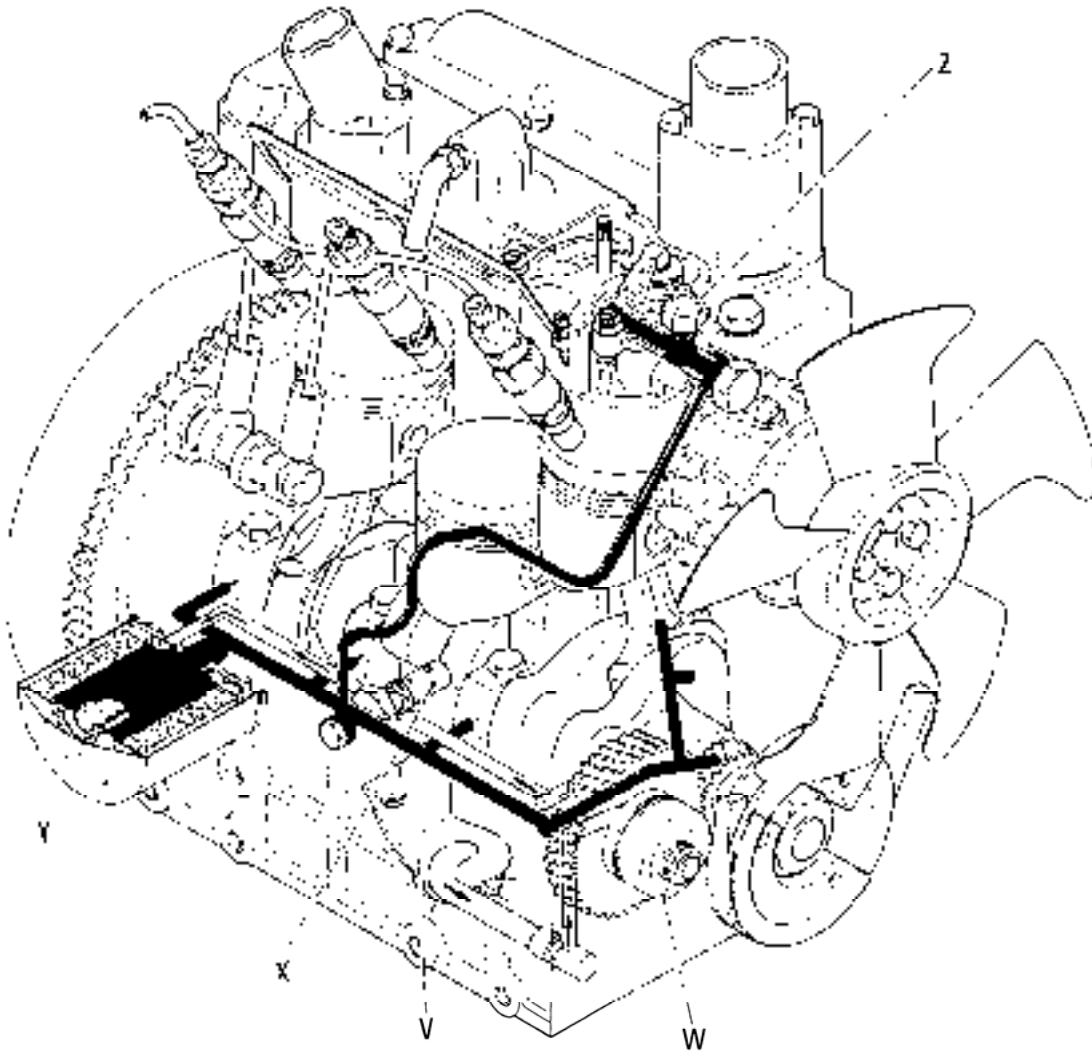
- (1) If pitting or remarkable wear is observed on the tooth face of gears, replace the gear.
- (2) Measure the backlash of gears and replace if the service limit is exceeded.

Timing gear backlash (mm)	
Standard assembling value	Service limit
0.08	More than 0.25



044X

13) Oil flow



- V :Suction filter
- W:Oil pump
- X :Relief valve
- Y :Oil filter
- Z :Oil pressure switch

045X

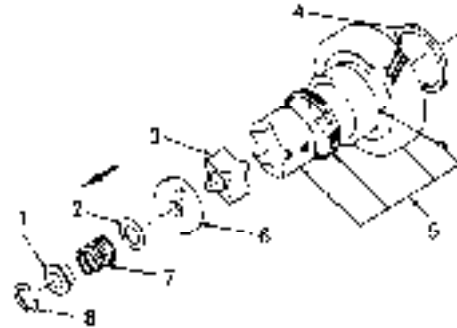
14) Oil pump

Disassembly

Removal from engine

- (1) Remove the snap ring.
- (2) Take out the collar, spring and shim.
- (3) Take out the idle gear, vane, and oil pump cover together.
- (4) Extract the rotor and thrust washer.
- (5) Extract the oil pump cover from the idle gear.

- | | |
|------------------|--------------------|
| 1. Collar | 5. Idle gear and v |
| 2. Shim | 6. Oil pump cover |
| 3. Rotor | 7. Spring |
| 4. Thrust washer | 8. Snap ring |



046X

Inspection and reassembly

- (1) Check the oil pump cover, rotor and vane and replace if worn out or damaged remarkably.
- (2) Check the clearance between the rotor and vane and replace if the service limit (0.25 mm) is exceeded.
- (3) Reassemble in the order reverse to disassembly.
 - a. Install the crankshaft gear and idle gear aligning the match mark.
 - b. Adjust the side clearance of the rotor and vane to **0.1 – 0.15 mm**. (Refer to Fig. 071X.)

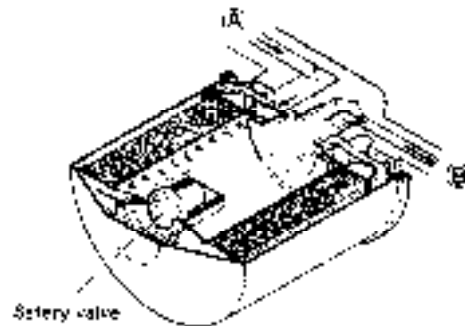


047X

15) Oil filter

Structure and Functions

- (1) The cartridge type oil filter is excellent in filtering performance.
- (2) Since it is of the full-flow type, when the filter is clogged, the safety valve is opened to allow the oil to flow, preventing seizure or other troubles.
- (3) The oil fed under pressure with the oil pump enters (A), is filtered by the element, and supplied to each part from (B).
When the element is clogged, the oil is supplied to each part without passing through the element.



Replacement

- (1) Replace the oil filter every 200 hours of operation.
- (2) Coat the filter mounting surface with oil and tighten the filter by hand.
- (3) Do not reuse the filter if it is removed once.

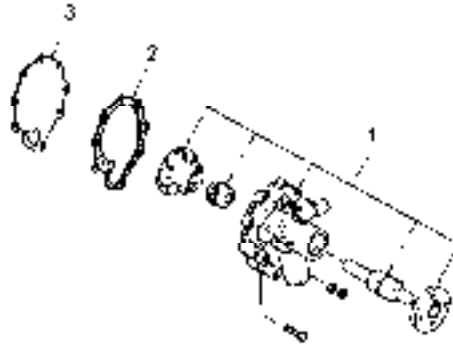
048X

16) Water pump ass'y

Disassembly

- (1) Remove the set plate gasket.

NOTE: The pump main body is aluminum die cast and should be replaced as ass'y if subjected to water leakage or other troubles.



049X

1. Water pump ass'y
2. Gasket
3. Set plate

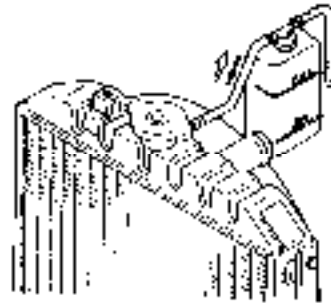
17) Radiator and reserve tank

Specifications and structure

Structure

Radiator cap of the pressure type (closing-up type) is employed for better cooling efficiency. When the cooling water temperature in the radiator rises (pressure also increases), the pressure valve is pushed open to release excessive pressure (cooling water) from the overflow pipe (white arrow) and the water is stored in the reserve tank.

When the cooling water temperature in the radiator decrease and the internal pressure becomes negative, the cooling water in the reserve tank is returned into the radiator. (black arrow)



050X

Specifications	
Fin type	Corrugated
Cooling water volume	5.1 ℓ (J843), 5.3 ℓ (N843L)
Pressure valve starting pressure	0.75 – 1.05 kgf/cm ²
Negative pressure valve starting pressure	Less than 0.05 kgf/cm ²
Heat radiation volume	28,400 kcal/h

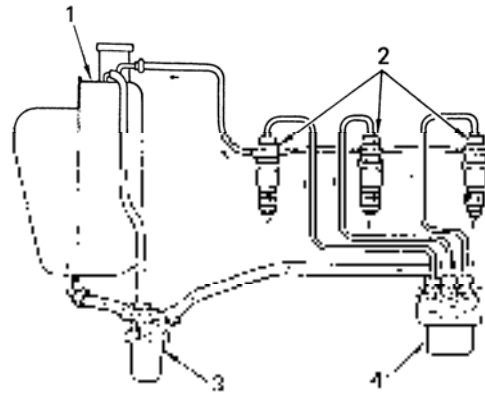
Inspection

- a. Check the radiator, pipe, and reserve tank for water leakage and repair or correct if any.
- b. Check the radiator fin and remove dust, mud, or other foreign matter clogging in the air passage, if any.
- c. Check the pressure valve and negative pressure valve of the radiator cap for valve opening pressure and sealing condition. Replace of defective.
- d. Check the radiator hose and replace if damaged or aged.
- e. If the net is clogged, remove and clean.
- f. The cooling water level in the reserve tank should be always between FULL and LOW.

18) Fuel filter

Fuel passage

The fuel flows as shown in the figure from the tank, pressurized by the injection pump to high pressure, and fed to the nozzle and injected to the combustion chamber. The fuel after lubricating the nozzle needle is returned to the tank through the overflow pipe.



- | | |
|----------------------|-------------------|
| 1. Tank | 4. Injection pump |
| 2. Nozzle and holder | 5. Fuel pump |
| 3. Fuel filter | |

051X

Inspection

If water, dust, or other foreign matter is observed in the transparent plastic case, clean and replace the filter if necessary.

Disassembly and reassembly

- (1) Remove the filter turning the filter ring nut.

NOTE: Take care to the O-Ring fitted between the ring nut and filter body, coat with grease before tightening.

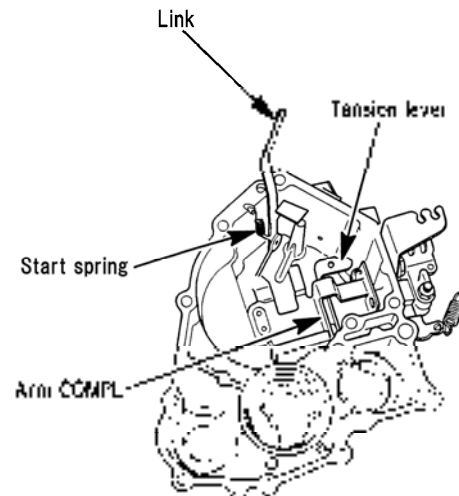
- (2) Apply the grease to the element attaching place of the filter body, and install the element by hand.

19) Governor

Structure and functions

Governor

This governor is a mechanical all-speed governor. It is installed in the gear case. The fly weight ass'y is installed to the cam shaft and its movement is transmitted to the control rack of the injection pump through the slider control lever link. The spring which controls the movement of the fly weight is hitched to the arm COMPL and tension lever. The spring tension is changed by changing the governor lever so as to control the engine speed.



052X

20) Injection pump

Specification

Engine Model	Part Code No.	Manufacturer and Injection Pump Type
J843	131017700	BOSCH AUTOMOTIVE SYSTEM CORPORATION 104134 – 3050
N843L	131017770	BOSCH AUTOMOTIVE SYSTEM CORPORATION 104135 – 3050

Disassembly, Inspection and Reassembly

- (1) Disassembly, inspection, and reassembly of injection pump. If the trouble has been verified to be in the injection pump, do not disassemble other than at shop specializing in this operation.

Trouble-shooting

Trouble	Possible Cause	Check or Remedy
1. Engine does start.	(1) Fuel Shortage or air mixed in. (2) Defective engine stop solenoid.	(1) Replenish fuel, check air entering part, bleed air (2) Check and replace the electric system
2. Engine starts but will not stop at once.	(1) Filter or pipes clogged. (2) Air mixed in. (3) Fuel tank filter cap air breathe clogged. (4) Short-circuit or disconnected wire of electric system of engine stop solenoid.	(1) Replace or clean out. (2) Check fuel pipe and connections. (3) Wash (4) Inspect and repair.
3. Engine output unstable	(1) Air mixed in. (2) Water mixed in fuel.	(1) Check fuel pipe and connections. (2) Replace fuel, replace filter.
NOTE: Due to possibilities of other troubles, refer to 2 – 5 Trouble Shooting		

21) Nozzle and holder

Specifications

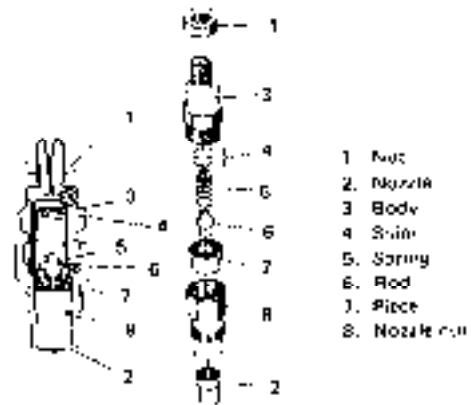
Model	J843 (CM284)	N843L (CM364)	Model	J843 (CM284)	N843 (CM364)
Part code No.	131406440	131406360	Needle valve dia.	$\phi 4$	
Ass'y No.	105148 - 1210	105148 - 1170	Pintle dia.	$\phi 1$	
			Valve opening	11.76 MPa {120 kgf/cm ² }	14.7 MPa {150 kgf/cm ² }
Nozzle holder	105078 - 0100		Injection angle	4°	
Nozzle	105007 - 1170 (NP-DN4PDN117)		Nozzle type	Throttle type	

Structure and functions

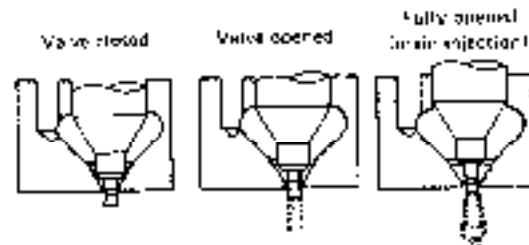
The nozzle is finished super-precisely to inject the fuel which is fed from the injection pump under pressure to the combustion room in good condition. Components as shown in the right figure are incorporated.

The fuel is fed under pressure from the oil hole of the nozzle holder main body to the nozzle body. When the pressure exceeds the specified value, it pushes the spring, injected from the nozzle, and at the same time lubricates and cools the nozzle and nozzle body.

The oil leaking at this time is returned to the tank by the return pipe.



053X



054X

Disassembly and inspection

- (1) Place the nozzle holder (body) in a vice and disassemble turning the nozzle nut.

NOTE: Take care not to allow the needle valve to drop when removing the nozzle.

- (2) Wash the nozzle and needle valve and check for seizure and sticking of the nozzle and fuel leakage on the seat surface. Correct fuel leakage of the seat by lapping.
- (3) Check the distance piece upper and lower contact areas and correct to be stuck closely.
- (4) Check the push rod for wear on the nozzle needle valve contact surface and check the spring seat for crack.

Reassembly and adjustment

- (1) When assembling a new nozzle ass'y, heat light oil to 50 – 60°C and remove the rust preventive oil in it. Slide the body and needle valve to ensure that they slide lightly.
- (2) Invert the body, place the shim, spring, rod, piece and nozzle on it in this order, cover the nozzle nut and tighten.
- (3) After assembly, check for the nozzle injection pressure.
 - a. Adjust by the adjusting washer (shim) so that the injection is started at 11.76 MPa {120 kgf/cm²} on Model J843 and 14.7 Mpa {150 kgf/cm²} on Model N843L using a nozzle tester.
 - b. The pressure increases or decreases about 0.98 MPa {10 kgf/cm²} by a washer of 0.1 mm.
- (4) Injection condition
 - a. Small drops should not be mixed in the spray.
 - b. The oil should be injected describing a cone by straight lines toward the center line of the nozzle.
 - c. Place white paper at about 30 cm from the nozzle and confirm that the spray is approximately circular when injected.
 - d. Keep the oil pressure lower by 1.96 MPa {20 kgf/cm²} than the specified value 11.76 MPa {120 kgf/cm²} on Model J843 and 14.7 Mpa {150 kgf/cm²} on Model N843L and check that the test oil does not drop form the nozzle end.



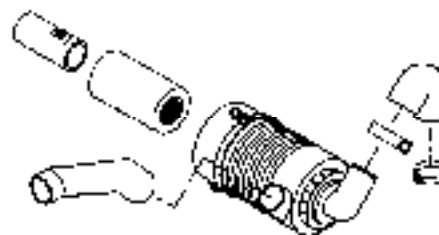
1. Gasket
2. Nozzle nut
Tightening torque: 3 - 5 kgf-m
3. Nozzle
4. Piece
5. Rod
6. Spring
7. Shim
8. Body
9. Nut
Tightening torque: 3 - 4 kgf-m

055X

22) Air Cleaner

Structure and functions

- (1) The air cleaner is connected to the cylinder with the air cleaner hose.
- (2) The air cleaner is of the cyclone type incorporating filter element and removes dust from the intake air.



035X

Inspection and replacement

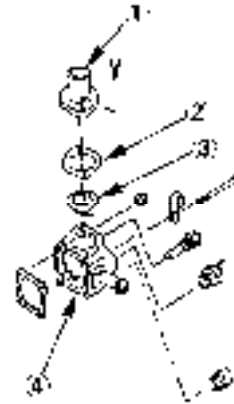
- (1) Take out the element every **100 – 200 hours** and blow compressed air (less than **7kgf/cm²**) from the inside and clean. (Clean the dust deposit on the dust pan also.)
- (2) If soot or oil has stuck to the element, immerse it in neutral detergent for about **15 minutes** and then wash by shaking several times. Rinse in clean water sufficiently and dry naturally.
- (3) When the air cleaner is used in dust place, clean it earlier.
- (4) After cleaning 6 times or once every year, replace the element with new one.
- (5) After completion of cleaning, apply light from the inside of the element. It should be replaced with new one if puncture, pin hole, and especially thinner part is observed or if the gasket is broken.
- (6) Do not use the element before drying completely.

23) Thermostat

Disassembly

- (1) Remove the bolt fixing the thermostat cover from the thermostat case.
- (2) Remove the thermostat and gasket from the thermostat case.

1. Thermostat cover
2. Gasket
3. Thermostat
4. Thermostat case



057X

Specifications and inspection

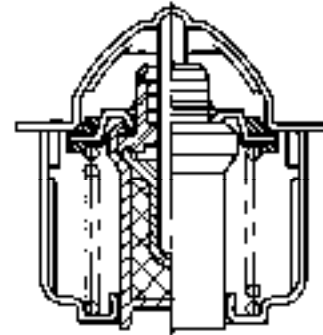
Thermostat

Replace if the valve is opened even only slightly at normal temperature.

Immerse the thermostat in water, increase the water temperature gradually and check the valve opening temperature and valve lift.

Specifications

Type	Wax pellet
Opening temperature	80° – 84°C
Full-opening temperature	95°C
Valve lift (at water temperature 95°C)	8.0 mm



058X

NOTE: 3 to 5 minutes are required until the valve is operated.

3. Engine Reassembly

★ Cautions before assembly

- 1) Wash parts to be installed. (Especially wash oil passage, bearing, piston and cylinder bore carefully.)
- 2) Coat the sliding and rotating parts of the cylinder bore, piston, bearing and other parts with new oil before installing.
- 3) Replace the gaskets with new ones. If necessary, use liquid packing to prevent oil leakage.
- 4) Do not tighten bolts and nuts for aluminum alloy parts excessively. Tighten them with specified torque.

Reassembly

1. Relief valve assembly with O-Ring.

Relief valve tightening torque.

Relief valve tightening torque	
59 – 69 N·m {6.0 – 7.0 kgf·m}	

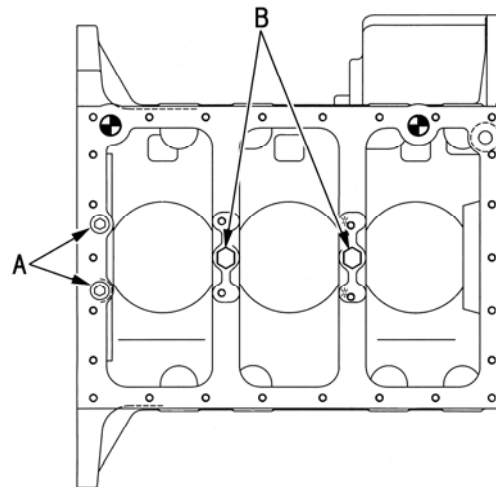
2. Crank shaft and bearing holder assembly

Cylinder block to bearing holder tightening torque

Bolts fixing bearing holder		
A	Hexagon socket head bolt	25 – 29 N·m {2.5 – 3.0 kgf·m}
B	Hexagon bolt	49 – 54 N·m {5.0 – 5.5 kgf·m}

NOTE:

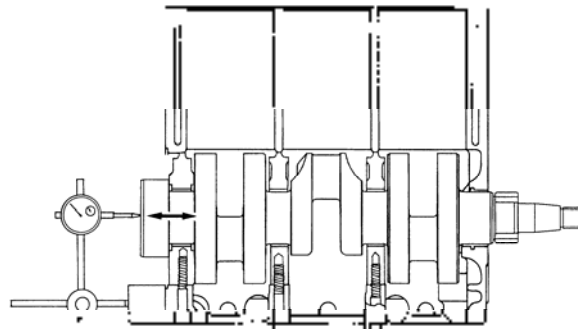
1. Take care not to damage the bush in the cylinder block by the crank shaft gear when install the crank shaft and bearing holder assembly.
2. Install the two hexagon socket head bolts for the fly wheel side bearing holder.



059X

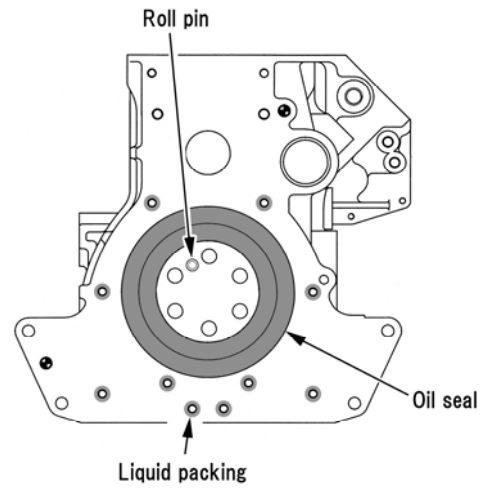
3. Measure the end play of crank shaft.

Crankshaft end play	
Standard value	0.1 – 0.4 mm
Service limit	0.5 mm



060X

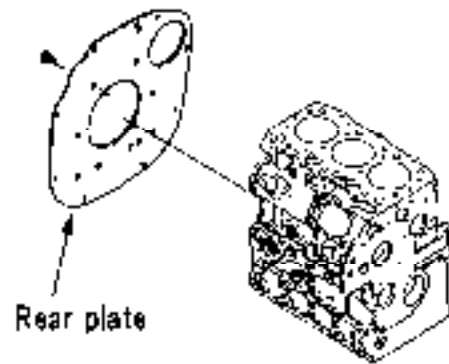
3. Oil seal



4. Rear plate

NOTE: Apply the liquid gasket to around the M8 screw holes for rear plate.

Rear plate tightening torque:
22.6 – 28.4 N·m {2.3 – 2.9 kgf·m}

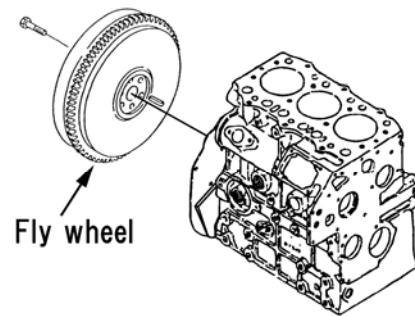


061X

5. Fly wheel

Align the hole to the roll pin on the crankshaft.

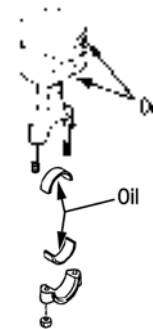
Fly wheel tightening torque
69 – 78 N·m {7.0 – 8.0 kgf·m}



062X

6. Piston and connecting rod assembly

- ① Coat the metal surface, piston and piston ring with engine oil.



063X

064X

- ② Turn the ring to allow the oil to ensure the ring groove sufficiently, and set the ring end gaps at 90° respectively avoiding piston pin direction and the direction at a right angle to the piston pin.
- ③ Insert the ring facing the connecting rod figure match mark toward the injection pump side, using ring pliers.

NOTE: Place the smallest connecting rod figure match mark to the front side so that the figures increase gradually.

- ④ Tighten the connecting rod cap with the specified torque and check for the axial play.

Connecting rod tightening torque
49 – 54 N·m {5.0 – 5.5 kgf·m}

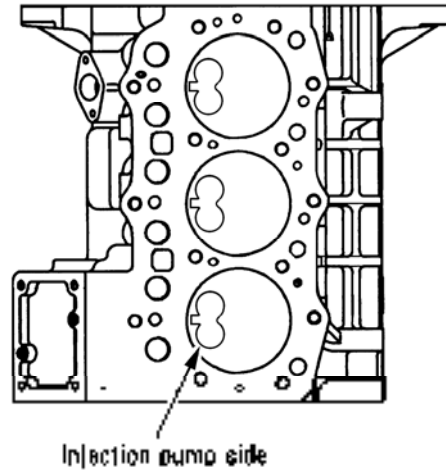
NOTE:

1. After tightening, confirm that the crankshaft moves lightly.
2. The connecting rod should move 0.1 – 0.3 mm in the axial direction.

7. Suction pipe · Suction filter

- ① Fit an O-Ring to the suction pipe and insert the suction pipe to the cylinder block.
- ② Place the suction pipe end into the suction filter and fix the suction filter.

Suction filter tightening torque
9 – 13 N·m {0.9 – 1.3 kgf·m}



065X

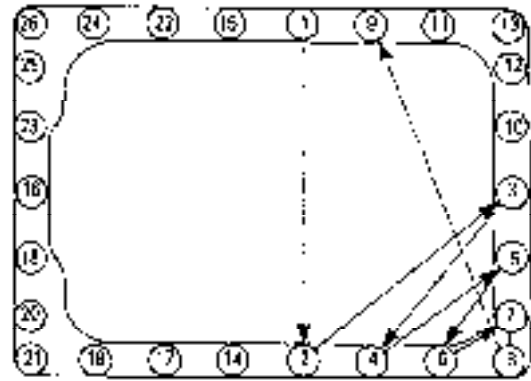


066X

8. Oil pan

Start tightening the bolts of the oil pan from the center, then tighten the opposing bolt on opposite side on the diagonal and specified torque.

Bolt tightening torque
10 – 12.7 N·m {1.0 – 1.3 kgf·m}



Tightening Order

067X

9. Oil level gauge · Gauge guide

Install the oil level gauge and gauge guide using 2 O-Rings.

10. Front plate

Install the front plate together with the gasket.

11. Cam shaft ass'y · Tachometer shaft · Plate

- ① Install the tachometer shaft.
- ② Install the cam shaft ass'y (taking care to the bearing).
- ③ Fix the tachometer shaft and cam shaft ass'y with the plate.

Plate tightening torque
9 – 13 N·m {0.9 – 1.3 kgf·m}



068X

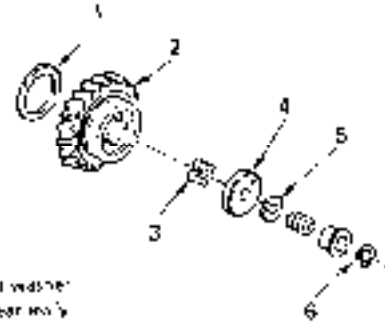
NOTE: Install the timing gear case taking care so that the slider is not dislocated from the guide pin.

12. Idle gear · Oil pump ass'y

- ① Install a thrust washer to the idle gear shaft.
- ② Install the idle gear ass'y.
- ③ Align the match marks of the idle gear, crankshaft gear and cam shaft gear and install it to the idle gear shaft.
- ④ Install the rotor.
- ⑤ Install the oil pump cover, shim, spring and collar and fix with a snap ring.

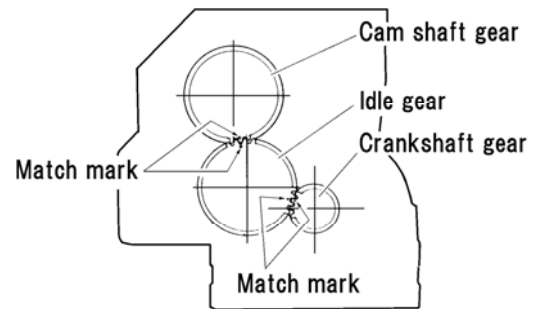
NOTE:

1. Coat the rotor and vane both sides with grease before installing them.
2. Never turn the crankshaft until the timing gear case is installed.
3. Turn the oil pump cover clockwise and counterclockwise, fix the hole at the center of the spring pin inserting hole moving distance, and then install the gear case.



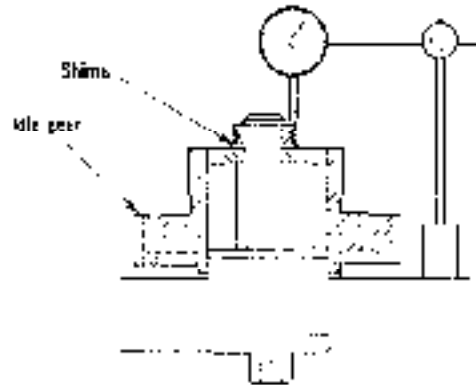
1. Thrust washer
2. Idle gear ass'y
3. Rotor
4. Oil pump cover
5. Shim
6. Snap ring

069X



070X

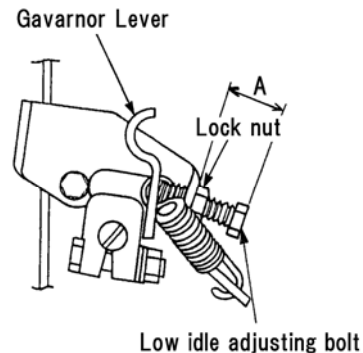
- ⑥ Adjust the shims so that the oil pump, rotor and vane side clearance is **0.1 – 0.15 mm**.



071X

13. Timing gear case · Cover

- ① Untighten the lock nut and remove the low idle set bolt.
- ② Install the start spring between the timing gear case and governor link.
- ③ Inserting the link into the cylinder block hole while turn the governor lever to clockwise and hold it, and then install the timing gear case.
- ④ Reinstall the low idle set bolt and secure the lock nut.
- ⑤ Install the covers.



072X

14. Crankshaft pulley

Fit the key to the crankshaft, install the crankshaft pulley, and tighten with the nut.

Crankshaft pulley tightening torque

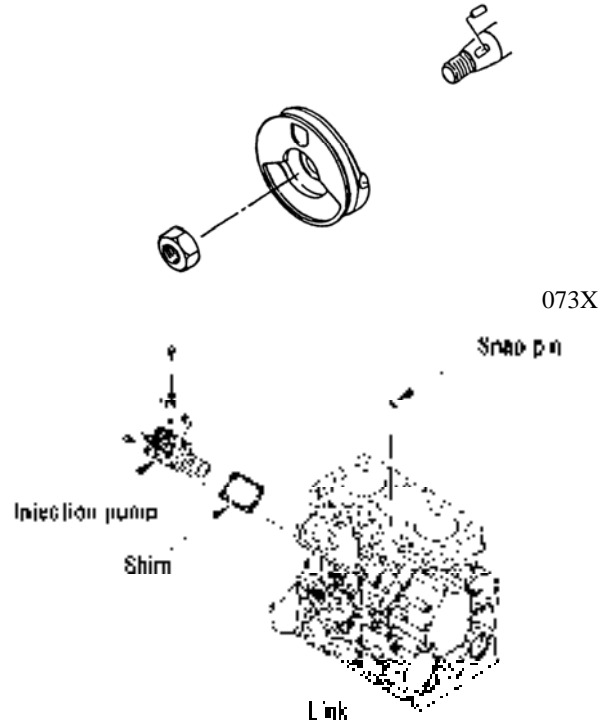
274 – 333 N·m {28 – 34 kgf·m}

15. Injection pump assembly

- ① Fit the shim which has been removed at the time of disassembly, connect the control rack of the injection pump and link, and fix with the snap pin.
- ② Tighten the injection pump with bolts and nut.

Injection pump tightening torque

13 – 17 N·m {1.3 – 1.7 kgf·m}



16. Injection timing adjustment

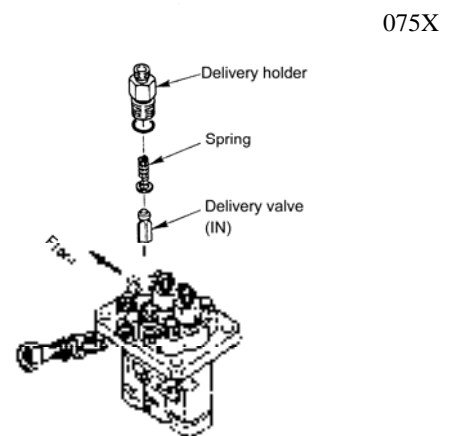
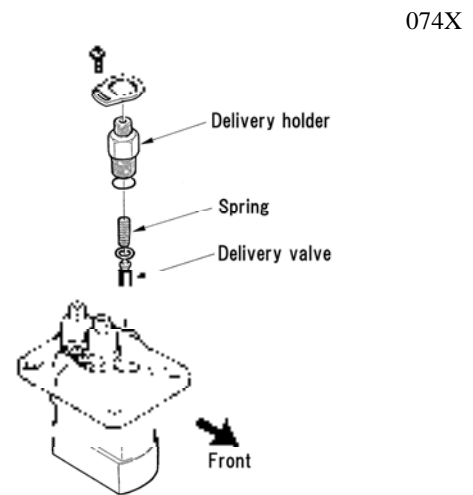
Usually the injection timing is adjusted properly by the step of the order 15.

When the injection pump, cam shaft assembly or cylinder block is replaced, adjust the injection timing in the following procedure.

- ① Install the injection pump inserting a shim of 0.5 mm in thickness according to the procedure of order 15.
- ② Remove the delivery valve holder on the injection pump front side (radiator side).
- ③ Extract the delivery valve (IN) and install the spring and delivery holder.

NOTE: When installing the delivery holder, adjust the delivery valve (OUT) to the correct position with a wire.

- ④ Move the governor lever in the fuel increasing direction and flow the fuel near 25° before compression TDC of the No. 1 piston (front side) and then the fuel flows out of the delivery valve holder.
- ⑤ Turn the crankshaft gently clockwise from the condition of above ④, and then the fuel flowing out of the delivery holder stops. Read the piston position before TDC at this time. If it is late more than 18° decrease the shim thickness and if earlier more than 20° increase the shim thickness.



076X

Injection timing adjusting shim	
Thickness (mm)	Part code
	J843-N843L
0.2	131437540
0.3	131437550
0.4	131437560
0.5	131437570
0.5	*131437580
* Without beading	

NOTE:

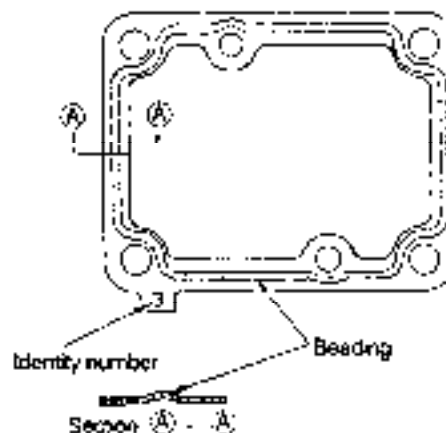
1. When shim is not required, coat liquid parking before installing.
2. The injection timing varies about 2° with 0.3 mm of shims.
3. Mix assemble a shim (0.5 mm) with beading and a shim (0.5 mm) without beading when you need adjusting shims more than 1.0 mm.

- ⑥ Install the delivery valve (IN)

Delivery holder tightening torque
39.2 – 44.1 N·m {4.0 – 4.5 kgf·m}

Injection timing (before TDC)	18 – 20°
Piston displacement (before TDC)	
J843	2.594 – 3.187 mm
N843L	3.195 – 3.932 mm

Crankshaft angle	Model	
	J843	N843L
17°	2.320	2.854
18°	2.594	3.195
19°	2.884	3.554
20°	3.187	3.932
21°	3.505	4.328
22°	3.837	4.741



077X

17. Drive gear ass'y (for hydraulic pump) · Hydraulic pump ass'y

Install the drive gear ass'y to the hydraulic pump and then install it to the gear case..

18. Oil filter

Coat the mounting surface with a small quantity of oil and tighten by hand.

19. Engine stop solenoid

Tighten the engine stop solenoid lightly with pliers.

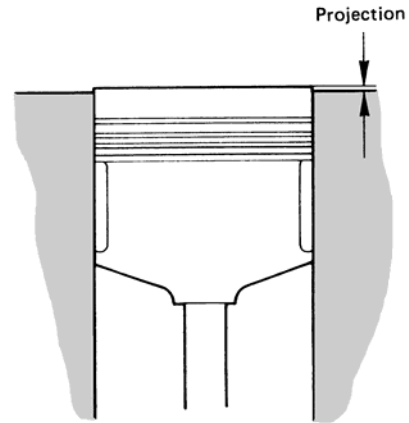
20. Cylinder head ass'y

- ① Set the piston at the TDC and measure the injection beyond the cylinder block with a depth gauge or dial gauge.

NOTE:

1. Measure holding the piston lightly by hand.
2. Use the cylinder with the largest projection distance among the 3 cylinders as the reference. The variation of the projection should be within 0.1 mm.

- ② Select a head gasket according to the measured value.



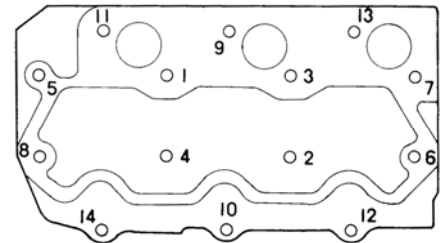
078X

Measured value (mm)	Head gasket part code No.	Thickness when tightened
More than 0.6 – under 0.7	111147490	t = 1.3
More than 0.7 – less than 0.8	111147500	t = 1.4

NOTE: Four smallest digits of the part code No. are stamped on the top surface of the head gasket.

- ③ Tighten the cylinder head in several steps in the order as shown in the right figure and tighten with the specified torque finally.

Cylinder head tightening torque
98 – 103 N·m {10 – 10.5 kgf·m}



079X

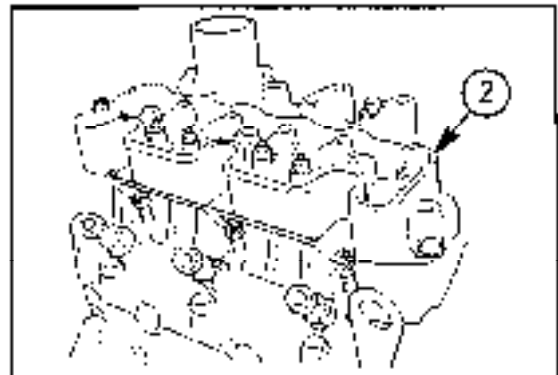
NOTE:

1. Take care to the spring pin which positions the cylinder head ass'y.
2. Coat the thread with grease containing disulfide molybdenum.

21. Cap · Push rod · Rocker arm ass'y

- ① Install the cap to the valve stem end.
- ② Install the push rod and rocker arm ass'y.

Rocker arm ass'y tightening torque	
J843	20 – 25 N·m {2.0 – 2.5 kgf·m}
N843L	27 – 39 N·m {2.8 – 4.0 kgf·m}



080X

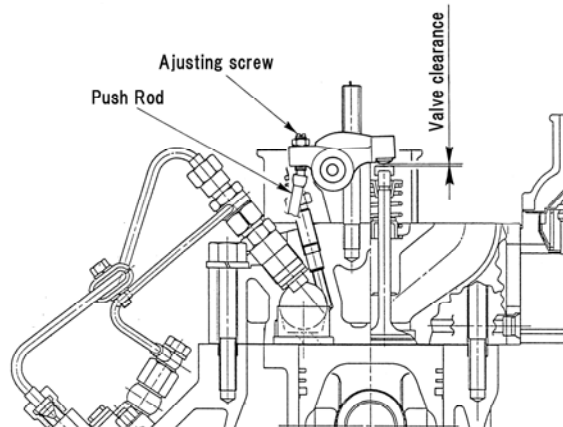
22. Valve clearance adjustment

Untighten the nut of the intake and exhaust valves and adjust the clearance to 0.2 mm.

NOTE:

1. Adjust the valve clearance while cold.
2. Set the No. 1 cylinder at the compression TDC, adjust the valve clearance of the No. 1 intake and exhaust valves, and No. 2 exhaust valve, turn the crankshaft 240° counterclockwise when viewed from the front side, and adjust the No. 2 intake, and No. 3 intake and exhaust valves.

Lock nut tightening torque
11.8 – 15.7 N·m {1.2 – 1.6 kgf·m}



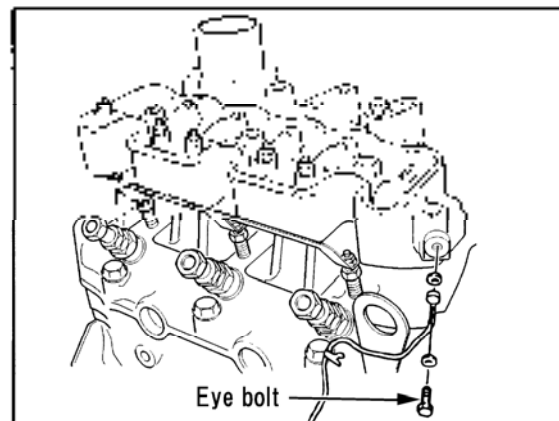
081X

23. Oil pressure switch

Oil pressure switch tightening torque
15 – 20 N·m {1.5 – 2.0 kgf·m}

24. Oil pipe

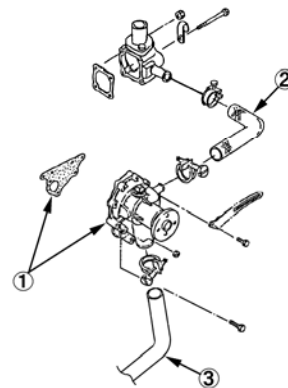
Eye bolt tightening torque	
M8	10 – 13 N·m {1.0 – 1.3 kgf·m}



082X

25. Water pump ass'y · Bypass hose

- ① Install and tighten the gasket and water pump ass'y.
- ② Connect the thermostat case and water pump case with bypass hose.
- ③ Install the radiator hose.



26. Connector

083X

27. Head cover · Filler pipe

Tighten the head cover and filler pipe evenly taking care to the O-ring.

Head cover tightening torque	
J843	8 – 12 N·m {0.8 – 1.2 kgf·m}
N843L	12 – 16 N·m {1.2 – 1.6 kgf·m}

28. Nozzle and holder ass'y

Tighten the nozzle and holder ass'y with specified torque using a nozzle holder socket.

Nozzle and holder tightening torque
59 – 69 N·m {6 – 7 kgf·m}



1. Injection pipe
2. Nozzle and holder
3. Return pipe

29. Return pipe COMPL · Injection pipe

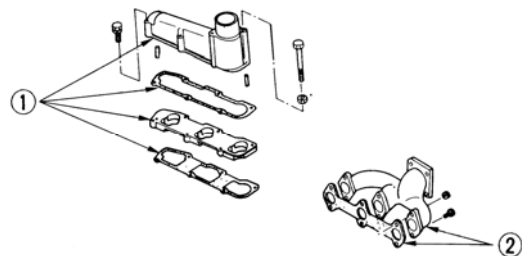
Install the return pipe and then injection pipe.

Injection pipe tightening torque
15 – 25 N·m {1.5 – 2.5 kgf·m}

085X

30. Intake manifold · Spacer · Exhaust manifold

- ① Install the gasket, spacer, gasket, and intake manifold in this order.
- ② Install the exhaust manifold.



086X

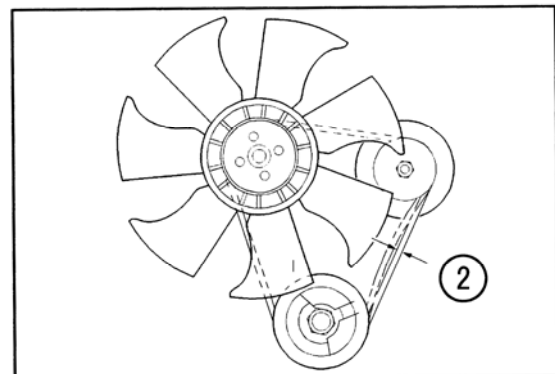
31. Alternator

Install the alternator taking care to the direction of the adjusting plate.

32. V belt · Fan pulley · Cooling fan

- ① Install the fan pulley and cooling fan and then V belt.
- ② Adjust the belt tension with the alternator so that it is deflected 5 – 10 mm at the middle point between the crankshaft pulley and alternator pulley when depressed by a finger (about 5 kgf) and tighten.

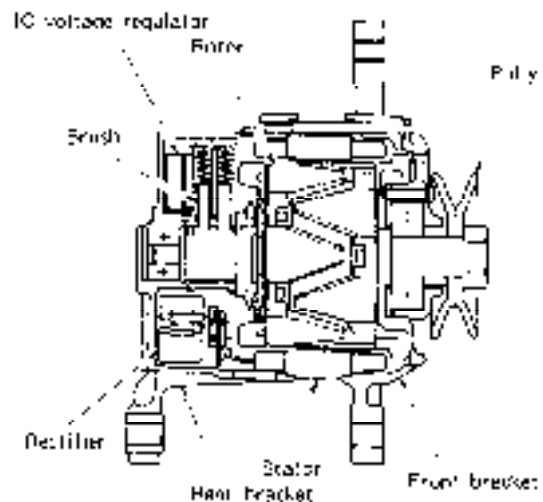
Cooling fan tightening torque
9 – 13 N·m {0.9 – 1.3 kgf·m}



087X

2-3 Electrical Units

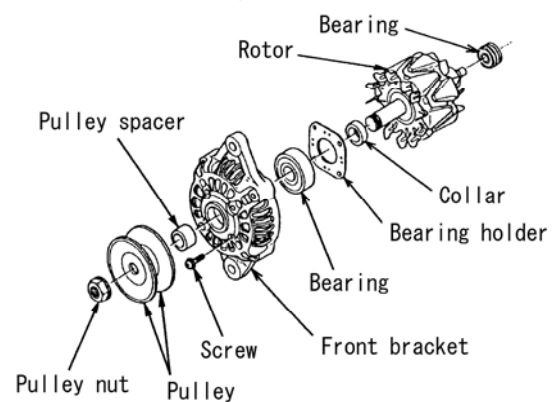
1. Alternator (No. 185046320 – A007T03877)



1) Disassembly

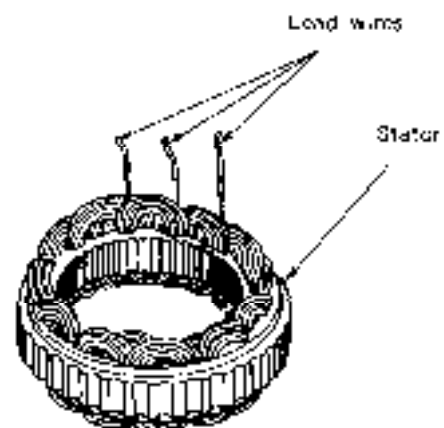
- ① Make both brackets and the stator with a scribe mark for assembly.
- ② Remove the four through bolts. Pry between the stator and front bracket with blade of a screw driver. Carefully separate the front bracket, pulley and rotor assembly away from the stator and rear bracket assembly.
- ③ Place the rotor in a vice with soft jaws and remove the pulley nut, washer, pulley spacer and front bracket from the rotor.

088X



089X

- ④ Unsolder three stator leads and remove the stator.
- ⑤ Remove the voltage regulator assembly and rectifier assembly as a set.

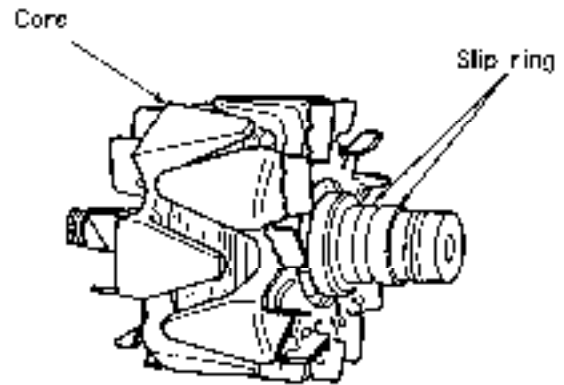


090X

2) Inspection of parts

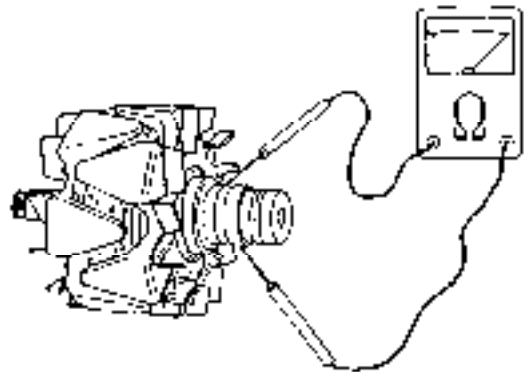
(1) Rotor

- ① Inspection of slip ring surface.
Correct stain or scratches on the slip ring surface with a sand paper of about 400 – 600 #.
A badly roughened slip ring or a slip ring worn down beyond the service limit should be replaced.



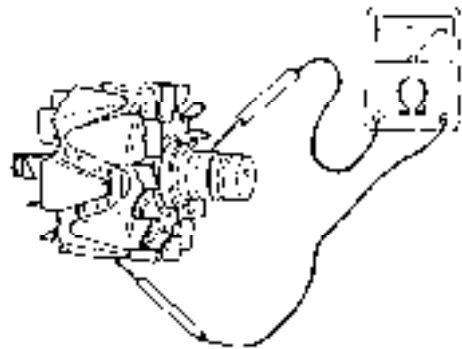
- ② Check for continuity between both the slip rings. If there is no continuity, the field coil is defective.
Replace the rotor assembly.

091X



- ③ Check for continuity between the slip ring and shaft (or core).
If there is continuity, it means that the coil or slip ring is grounded.
Replace the rotor assembly.

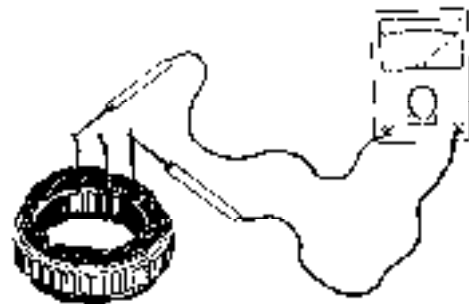
092X



(2) Stator

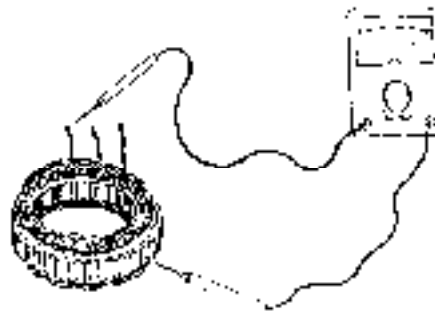
- ① Check for continuity between the leads of the stator coil.
If there is no continuity, the stator coil is defective.
Replace the stator assembly.

093X



094X

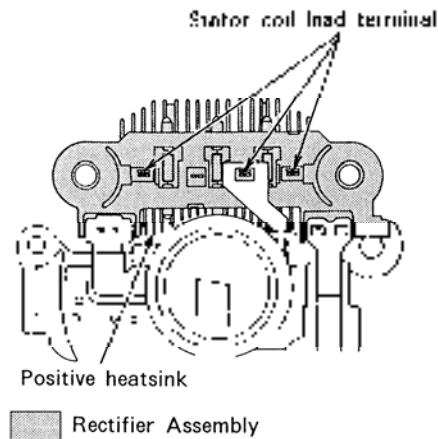
- ② Check for continuity between any stator lead and stator core.
If there is continuity, it means that the coil is grounded.
Replace the stator assembly.



(3) Rectifier Assembly

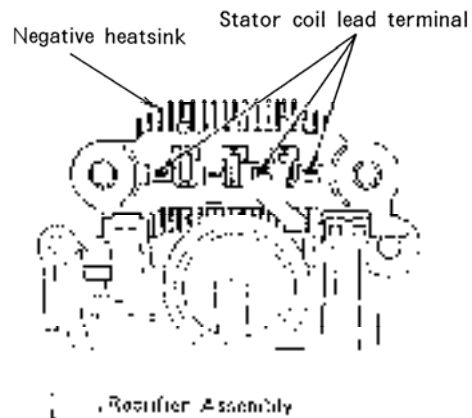
095X

- ① Positive Heatsink
Check for continuity between the positive (+) heat sink and stator coil lead connection terminal with a circuit tester.
If there is continuity in both directions, the diode is short-circuited.
Replace the rectifier assembly.



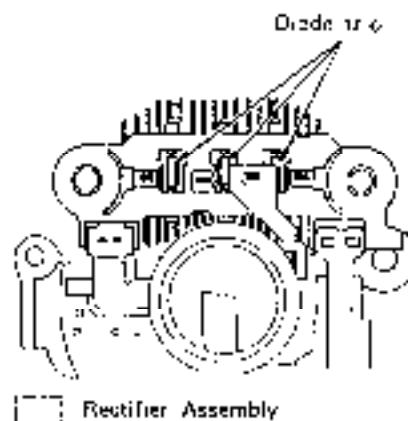
096X

- ② Negative Heatsink
Check for continuity between the negative (-) heat sink and stator coil lead connection terminal with a circuit tester.
If there is continuity in both directions, the diode is short-circuited.
Replace the rectifier assembly.



097X

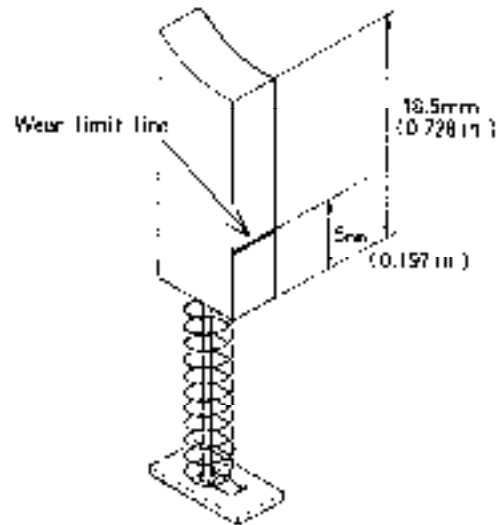
- ③ Diode Trio
Using a circuit tester, check the three small diodes for continuity in both directions.
If there is either continuity or an open circuit in both directions, the diode is defective.
Replace the rectifier assembly.



098X

④ Brush and Brush spring

- a. Check the length of the brush.
A brush worn down to the wear limit line should be replaced.
- b. Check the brush spring pressure and make sure the brush moves smoothly in the brush holder.



099X

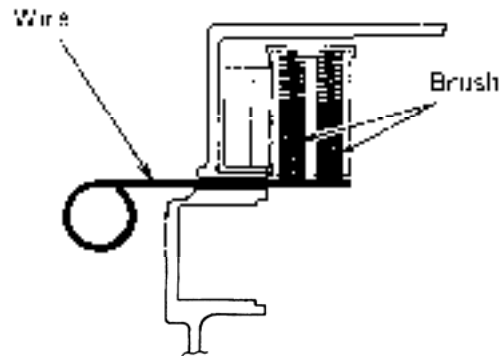
3) Reassembly

Reverse the disassembly procedure except for the following:

- (1) Installing rotor.
Push brushes into brush holder, insert a wire to hold them in raised position before install the rectifier and regulator assembly.
Install rotor and remove wire.

NOTE: Since rear bearing and rear bracket fitting is tight, heat the bearing box in the rear bracket to 50 – 60°C {122 – 140°F} before installing rotor.

- (2) Lubrication to bearing box for bearing with resin band, grease should not be applied.
Remove oils completely if found on the bearing box in the rear bracket.

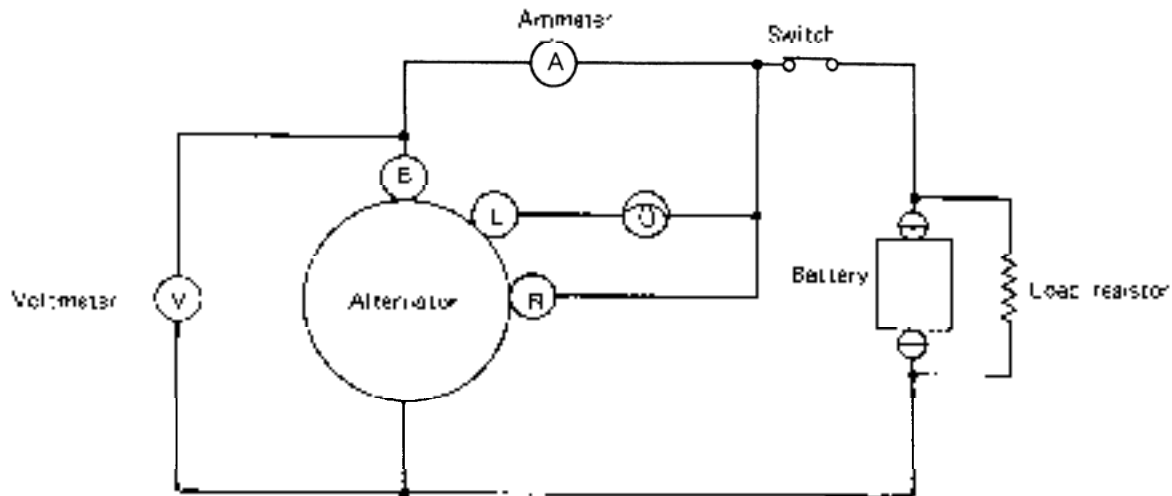


100X

4) Bench Check

To check the alternator on a test bench, proceed as follows:

- (1) Make connection as shown in the Figure 101X except leave the load resistor disconnected.
- (2) Slowly increase the alternator speed and observe the voltage.
- (3) If the voltage is uncontrolled with speed and increases above 15.5 V, check the alternator.
- (4) If voltage is below 15.5 V, connect the load resistor as shown in the Figure 101X.
- (5) Operate the alternator at 2500 rpm and adjust the load resistor as required to obtain maximum output.
- (6) Measure the output current. The output must be within the limits shown in the section on "Service Specifications".
If the output is less than specified value the alternator should be disassembled and checked.



101X

5) Precautions

- (1) Reversed battery connections will damage the alternator and/or wiring.
- (2) When connecting a booster battery, make certain to connect negative battery terminals together and positive battery terminals together.
- (3) When a fast charger is used to charge the battery, the equipment battery cables should be disconnected.
- (4) Grounding of the alternator output terminal will damage the alternator and/or circuit.
- (5) Do not connect a load of over 1A to the terminal "L".
- (6) If the alternator is operated with the terminal L and B short-circuited, it may damage the diode trio.

6) Service Specifications

Item	Model Name	A007T03877 (MITSUBISHI)
Nominal output	(V-A)	12 – 40
Polarity		Negative ground
Weight	(kg)	Approx. 3.7 {8.2 lb}
Rotational direction (Viewed from the pulley)		Clockwise
Load characteristics (cold)	Terminal voltage	(V) 13.5
	Current	(A) Min. 30
	Revolution number	(rpm) 2500
Brush length	Original	(mm) 18.5
	Limit	(mm) 5.0
Brush spring tension	Original	(N) 4.6 – 5.8 {470 – 590 gf}
	Limit	(N) 2.6 {270gf}
Bearing	Rear side	ECSC8
	Front side	6303DDG
Slip ring diameter	Original	(mm) 22.7
	Limit	(mm) 22.1
Slip ring diameter eccentric wear	To be repaired	(mm) 0.05
	Allowable limit	(mm) 0.2
Slip rings surface condition		If dirty or damaged correct with emery cloth.
Rotor shaft bending	To be repaired	(mm) 0.07
Field coil resistance	(Ω /at 20°C)	2.8
Adjusting voltage	(V)(at 5000 rpm)	14.4 – 15.0

7) Fault Finding

Trouble	Parts	Cause	Remedy
No charging	Wiring, ammeter	Disconnection, short circuit, loosened connection	Correct
	Alternator	Disconnection of coils, earth, short circuit	Replace
		Defective rectifier	Replace
		Disconnection of RF resistor	Replace
Regulator	Defective regulator	Replace	
Insufficient charging	Wiring	Disconnection, short circuit, loosened connection	Correct
	Alternator	Loosened alternator bolt	Correct
		Layer short of rotor coil	Replace
		Layer short of stator coil	Replace
		Defective rectifier	Replace
		Insufficient contact of brush, stained slip ring	Correct
	Regulator	Defective regulator	Replace
Battery	Defective battery	Replace	
Over charge	Battery	Internal short circuit	Replace
	Regulator	Defective regulator	Replace
Unstable charging current	Wiring	Disconnection or breakage of wire	Replace
	Alternator	Slackened alternator drive belt	Replace
		Short of rotor coil, breakage of wire	Replace
		Shortage of stator coil, breakage of wire	Replace
		Insufficient contact of brush, stained brush and slip ring	Correct
		Broken brush and spring	Replace
		Insufficient contact of terminals	Correct
	Regulator	Defective regulator	Replace
Abnormal noise of alternator	Alternator	Incorrect installation of alternator	Correct
		Defective bearing.	Replace
		Rotor core and stator core in contact	Correct
		Defective diode	Replace
		Short of stator coil	Replace

2. Starting Motor (For Engine Model J843:CM284) (No. 185086551 1.7kW)

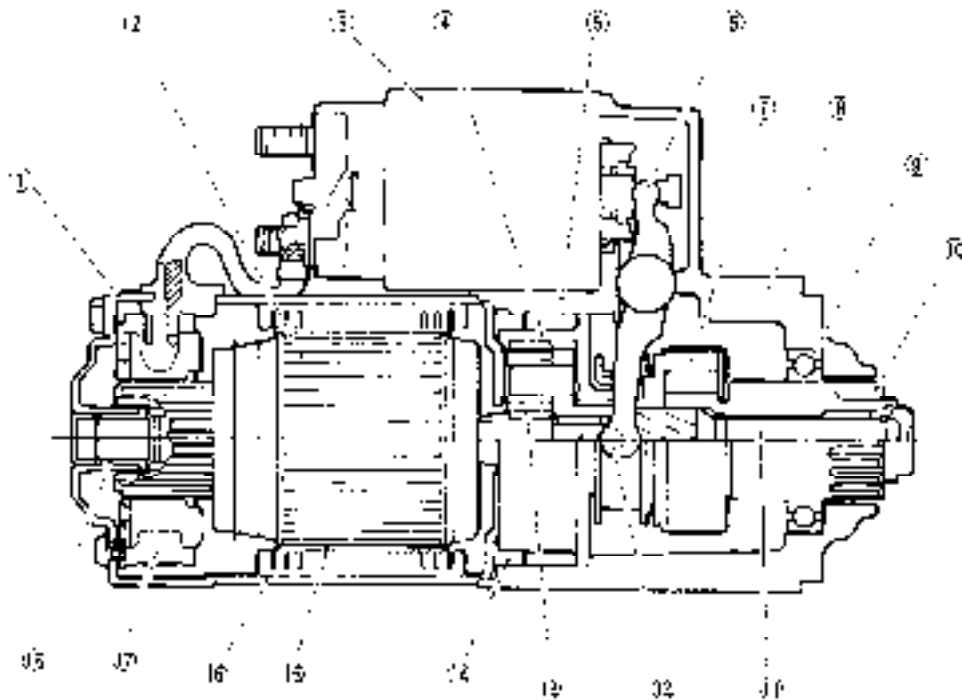
1) Structure

This starter features a reduction mechanism of planetary gearing system and permanent magnets for magnetic field induction.

Its reduction mechanism comprises internal gear, three planetary gears, gear shafts (with overrunning clutch fitted by spline) and armature shaft gear.

The structure is different from that of direct drive type, but the electrical wiring is the same between two types.

The magnetic field is produced by six permanent magnets. The magnets are mounted in the yoke and positioned according to polarity. They are permanently attached to the yoke and are not removable.



- | | | |
|-----------------|----------------------|-------------------|
| ① Rear Bracket | ⑦ Overrunning Clutch | ⑬ Planetary Gears |
| ② Armature | ⑧ Front Bracket | ⑭ Rubber Cover |
| ③ Switch | ⑨ Bearing | ⑮ Magnets |
| ④ Internal Gear | ⑩ Pinion | ⑯ Yoke |
| ⑤ Lever Packing | ⑪ Gear Shaft | ⑰ Brushes |
| ⑥ Lever | ⑫ Ball | ⑱ Sleeve Bearing |

102X

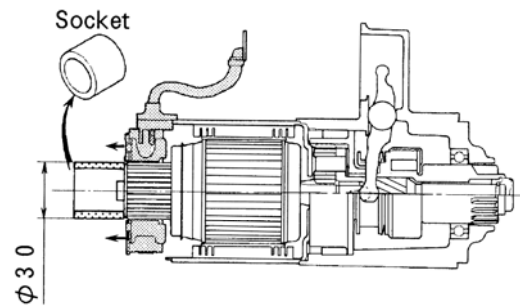
2) Disassembly

Reference Figure 104X

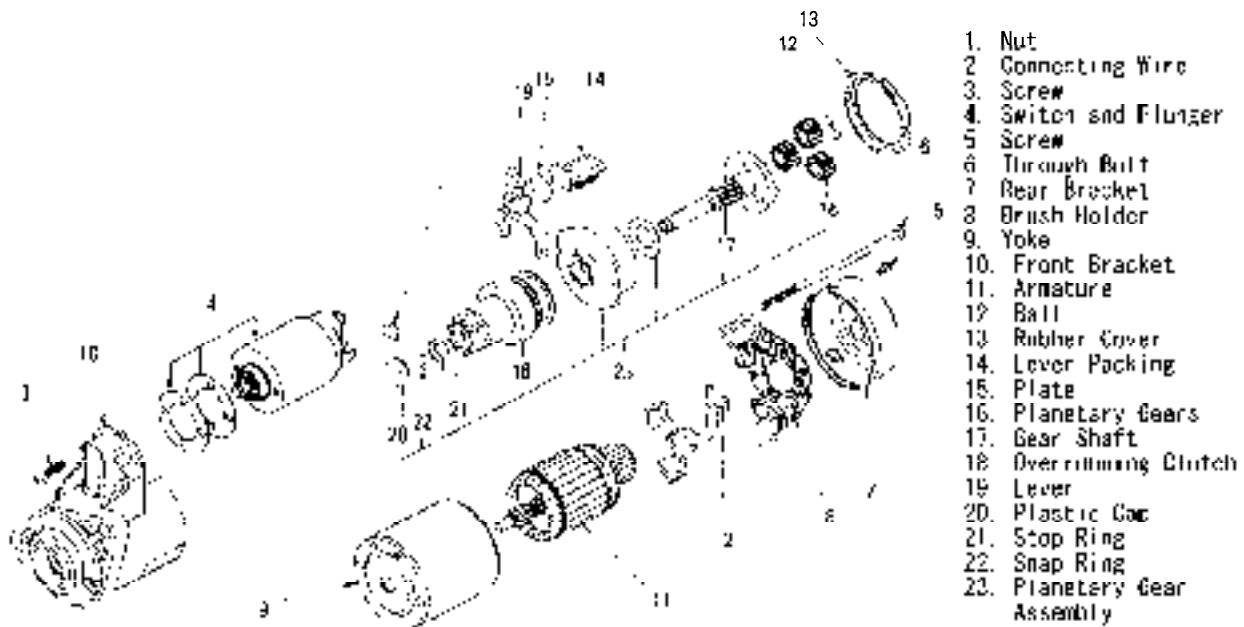
NOTE:

1. Before disassembling starter, be sure to put match marks at two locations (switch and yoke) so that any possible mistake can be avoided.
2. Do not clamp yoke in a vise or strike it with a hammer during repair operations. Permanent magnets attached to yoke could be broken and yoke dented or deformed if mishandled.

- ① Remove switch terminal nut (1) and disconnect connecting wire (2).
Remove screws (3) securing switch and remove switch and plunger (4).
- ② Remove brush holder securing screws (5) and through bolts (6).
Remove rear bracket (7) but do not remove brush holder (8).
- ③ Install a socket (outer diameter 30mm) on the armature commutator, see Figure 103X.
Then slide the brush holder (8) onto the socket. Leave the socket in position in the brush holder for inspection and reassembly.

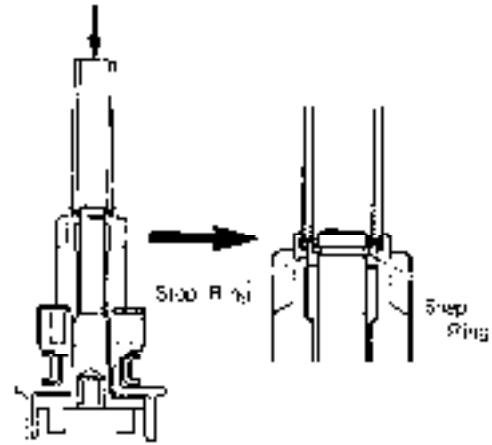


103X



104X

- ④ Slide yoke (9) away from front bracket (10).
- ⑤ Remove armature (11) and ball (12).
Do not lose ball when removing the armature.
- ⑥ Remove rubber cover (13) from planetary gear assembly (23) and remove lever packing (14) and plate (15).
- ⑦ Remove planetary gears (16).
Remove gear shaft/overrunning clutch assembly (18) and lever (19) as a unit from front bracket (10).
- ⑧ To remove overrunning clutch (18).
 - a. Remove plastic cap (20). If the cap is too badly distorted or cracked, it will be necessary to use a new one on reassembly.
 - b. Slide a piece of pipe of suitable size over shaft against stop ring (21).
Then tap the pipe with a hammer to remove the stop ring and expose snap ring (22).
Remove the pipe from the shaft.
 - c. Remove the snap ring and the stop ring and separate the over running clutch (18) from the gear shaft (17).
If the snap ring is distorted, it will be necessary to use a new one on reassembly.

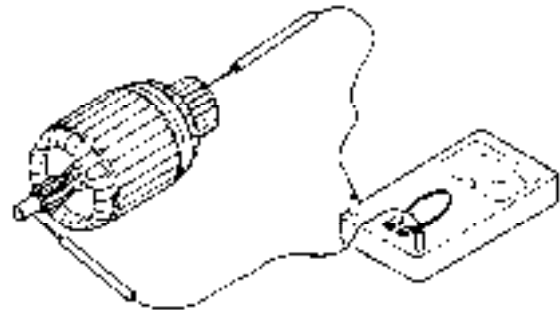


105X

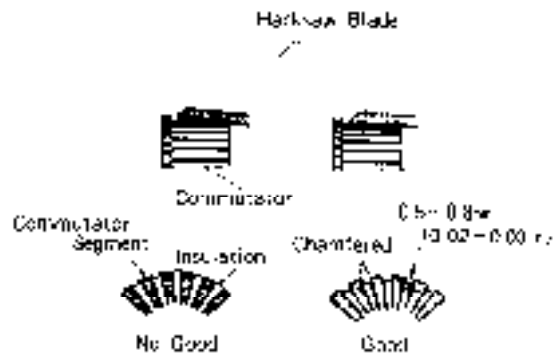
3) Inspections

(1) Armature

- ① Inspect the armature coil for short-circuit with a growler tester.
Replace armature if shorted.
- ② Inspect armature coil for ground with a circuit tester.
Replace grounded armature.
- ③ Inspect commutator for wear. If below the limit, replace armature.
- ④ Inspect commutator for insulator depth.
Correct if below the limit.
- ⑤ Check gear teeth for wear or damage, and replace armature as necessary.



106X



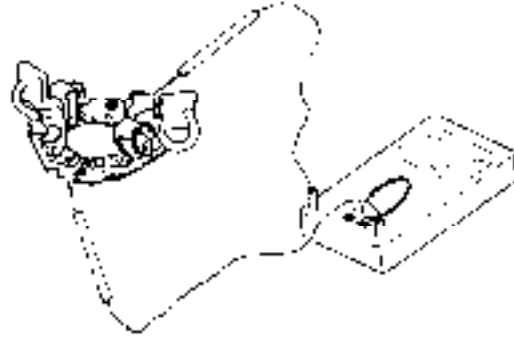
107X

(2) Permanent magnets

Check permanent magnets for crack, damage and looseness, replace yoke assembly as necessary.

(3) Brushes

- ① Check brushes for wear. Replace brushes if below the limit.
- ② Check brush spring pressure to make sure brush moves smoothly in brush holder.
- ③ To check brush holder assembly for grounds, touch one probe of a circuit tester to holder plate and the other probe to each of insulated holders. Replace brush holder assembly if any continuity is noted.



108X

(4) Over running clutch and pinion gear.

While holding clutch housing, rotate pinion.

Pinion should rotate smoothly in one direction (not necessarily easily), but should not rotate in opposite direction. If the clutch does not function properly, replace it. If pinion gear is worn or burred, replace it.

NOTE: Overrunning clutch should not be cleaned with grease dissolving solvents, since these would dissolve the lubricant in the clutch mechanism.

(5) Front bracket

Replace front bracket as an assembly including ball bearing if the bearing fails to rotate smoothly or it is noisy.

(6) Rear bracket

Replace rear bracket as an assembly including sleeve bearing if the bearing is badly worn.

(7) Internal gear and planetary gears

Replace the gears if their teeth are badly.

(8) Switch

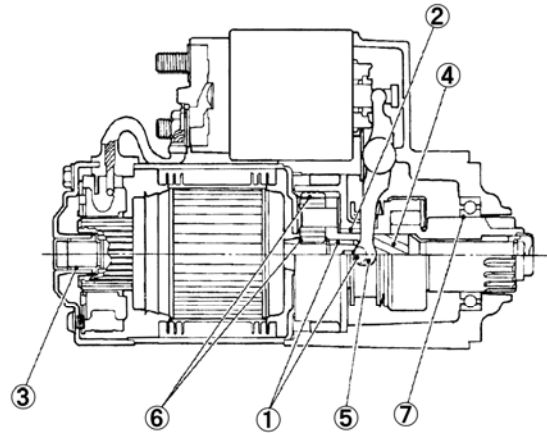
Check continuity between M terminal and body (ground).
Replace the switch if no continuity is noted.

4) Reassembly and Adjustment

To reassemble the starter, follow the reverse of disassembling procedure, and observe the following precautions:

(1) Apply grease to the following parts during assembly.

- ① Sleeve bearing and ball.
- ② Sleeve bearing in internal gear.
- ③ Sleeve bearing in rear bracket.
- ④ Gear shaft.
- ⑤ Sliding surface of lever and overrunning clutch.
- ⑥ Armature shaft gear, internal gear and planetary gears.
- ⑦ Sliding surfaces of pinion and front bearing.



109X

(2) Armature shaft end play

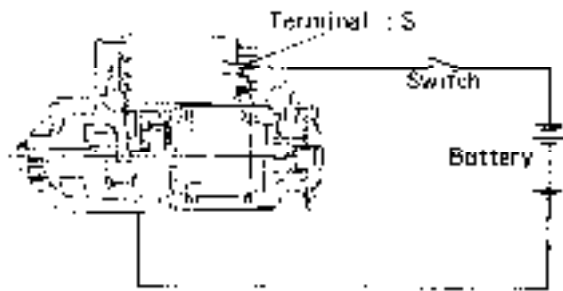
No adjustment.

(3) Pinion position adjustment.

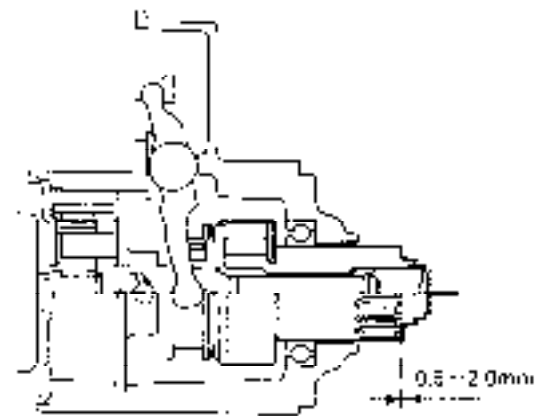
After completing reassembly, check pinion position to be sure that it is between 0.5 and 2.0 mm.

To adjust, proceed as follows:

- ① Connect the starter to a battery, as shown in Fig. 110X. Close switch. This will shift pinion into cranking position.
- ② Push pinion back by hand and measure the amount of the pinion movement as shown in Fig. 111X. If the amount does not fall within limit, adjust it by adding or removing shims which are located between switch and front bracket. Adding shims decreases the amount of the movement.



110X



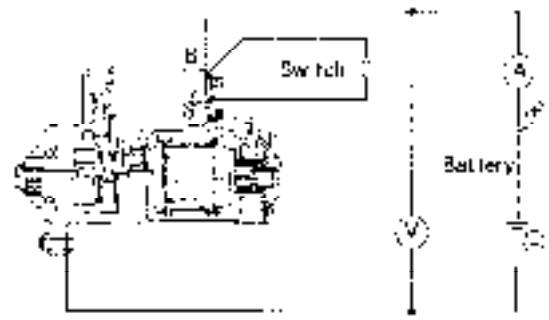
111X

5) Non-Load Test

- ① After adjusting pinion position, from a test circuit with a volt meter and an ammeter, as shown in Figure 112X.

NOTE: Use wires as thick as possible and tighten each terminal fully.

- ① Close the switch and compare the R.P.M., current and voltage readings with the Service Specifications.
- ② If any abnormality is noted, check it according to the inspections.



112X

6) Service Specifications

Item		Standard Value or Service Limit
No-load Characteristic	Volts	11
	Amps.	110 Max.
	RPM	2400/min.
Commutator	Outer Dia.	29.4 mm
	Service Limit	28.8 mm
Brush	Length	17.5 mm
	Service Limit	10 mm
Brush spring	Tention	22.5 – 32.5 N {2.3 – 3.3 kgf}
	Service Limit	10 N {1.02 kgf}
Pinion Movement (Pinion Gap)		0.5 – 2.0 mm
Part No.		185086551 (MITSUBISHI 1.7 kW)

7) Troubleshooting

(1) Pinion does not advance even though the key switch is turned ON.		
Unit	Cause	Remedy
Wiring	Disconnected wire, untightened battery and switch terminals, or improper contact of the inserting part.	Correct and retighten
Key switch	Improper contact preventing flow of current.	Correct or replace the contact part
Starting motor	Helical spline of the pinion shaft is scored and prevents the pinion from moving.	Replace or correct
Magnet switch	Improper movement of the plunger of the magnet switch or disconnected wire or short circuit of the coil.	Correct or replace

(2) Though the pinion is engaged and the motor rotates, the rotation is not transmitted to the engine.		
Unit	Cause	Remedy
Starting motor	Defective clutch. Broken reduction gear.	Replace Replace

(3) Though the pinion is engaged with the ring, the starting motor does not start.		
Unit	Cause	Remedy
Wiring	Disconnected wire, connecting the battery and magnet switch. Insufficient tightening of the lead wire connecting the magnet switch and motor.	Repair, retightening, or replace the wire.
Starting motor	Locked ball bearing. Improper installation. Worn out brush, improper contact of brush spring. Stained commutator. Defective armature or field coil. Insufficient tightening of connections of the field coil and brush.	Replace Install properly. Replace Correct Correct or replace Retighten
Magnet switch	Broken holding coil Improper contact of contact Roughened contact surface of contact	Replace Replace Replace
Battery	Discharged	Charge

(4) Motor starts rotating before the pinion is engaged with the ring gear.		
Unit	Cause	Remedy
Starting motor	Improper sliding of pinion shaft Worn out pinion tooth top Improper pinion pushing position	Replace Correct Replace
Engine	Worn out ring gear	Replace
Magnet switch	Defective magnet switch	Replace

Starting Motor (For Engine Model N843L:CM364)

1) Specifications and Performance

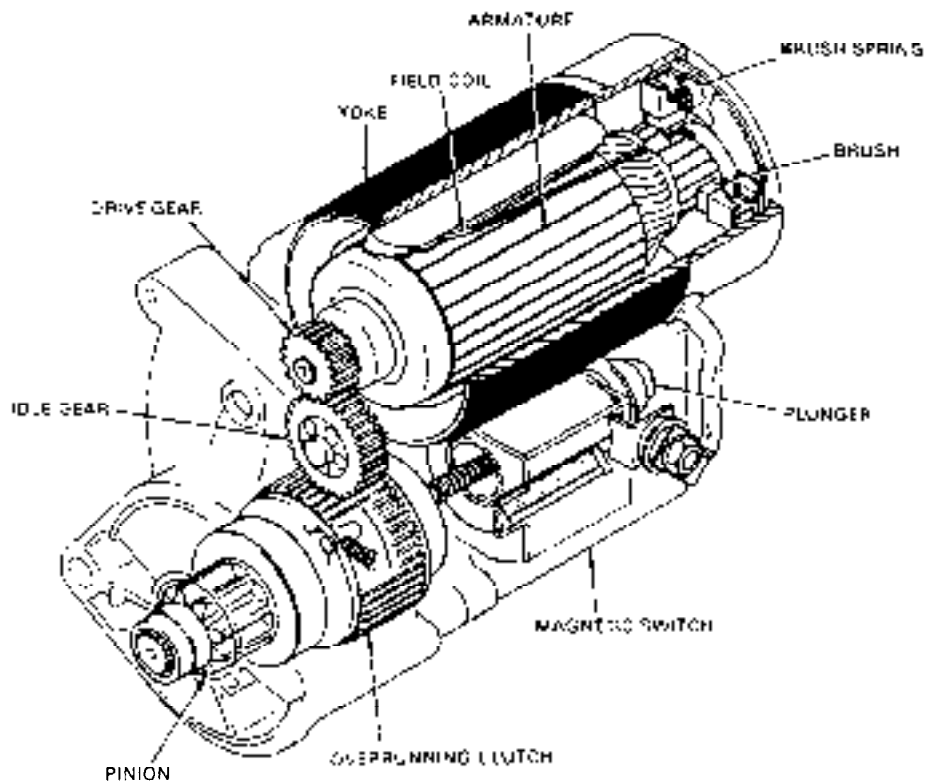
Part code No.	185086530	Pinion ejecting voltage (V)		Less than 8
Type	RA (228000-5121)	Unloaded	Terminal voltage (V)	11.5
Continuous operation (second)	30		Current (A)	Less than 100
Output (V-kW)	12 – 2.0		Speed (rpm)	More than 4000
Rotating direction (viewed from pinion)	Clockwise	Loaded	Terminal voltage (V)	7.6
Clutch type	Overrunning		Current (A)	Less than 400
Engaging type	Magnetic shift		Torque N·m {kgf·m}	More than 16.7 {1.7}

2) General Description

The newly developed reduction starter is a positive shift type starter and consists of the motor, reduction gear, overrunning clutch and pinion magnetic switch.

The magnetic switch and sliding pinion mechanism are arranged on the same axis as shown below.

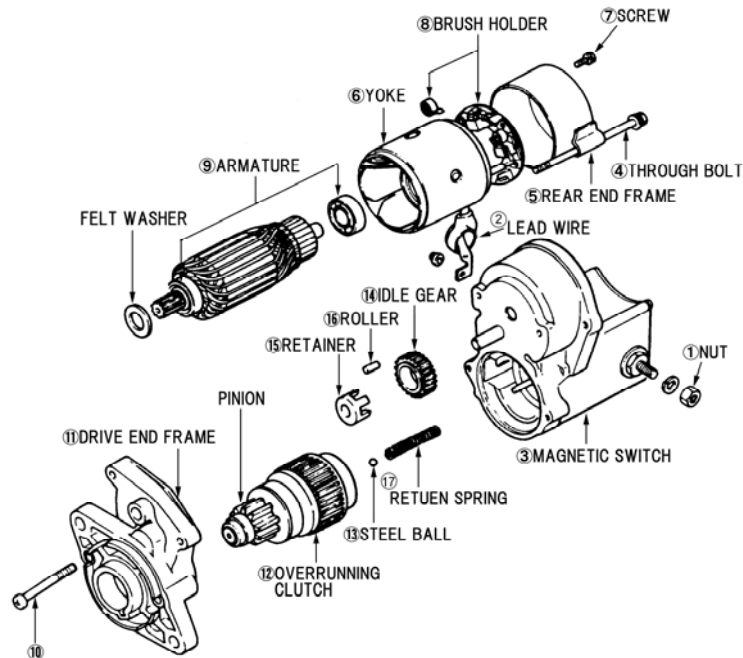
3) Structure



113X

4) Disassembly

Disassembly of yoke O.D. 76 mm type



114X

- (1) Remove the nut ① and disconnect the lead wire ② from the magnetic switch ③.
- (2) Remove the through bolts ④ from the rear end frame ⑤.
- (3) Remove the yoke ⑥ from the magnetic switch ③.
- (4) Remove the screw ⑦ from the rear end frame ⑤.
- (5) Remove the rear end frame ⑤ from the yoke ⑥.
- (6) Using the long-nose pliers, take off the brushes and pull out the brush holder ⑧.
- (7) Remove the armature ⑨ from the yoke ⑥.
- (8) Remove the screws ⑩ from the drive end frame ⑪.
- (9) Remove the drive end frame ⑪ from the magnetic switch ③.
- (10) Remove the over running clutch ⑫ from the drive end frame ⑪.

NOTE: If the pinion is installed on the drive end frame (externally attached to overrunning clutch shaft), it will be necessary to remove pinion prior to removing overrunning clutch.

- (11) Remove the steel ball from the overrunning clutch ⑫.
- (12) Remove the idle gear ⑭ from the drive end frame ⑪.
- (13) Remove the retainer ⑮ and rollers ⑯ from the drive end frame ⑪.
- (14) Remove the return spring ⑰ from the magnetic switch ③.

5) Inspection and Repair

Inspect the following items and repair or replace if necessary. Test method is as same as the conventional type.

- **Armature**

- Armature short circuit test
- Armature winding ground test
- Commutator run-out test
- Measurement of segment mica depth

- **Yoke**

- Field windings ground test
- Measurement of brush length

- **Brush holder**

- Check brush spring
- Brush holder insulation test

- **Overrunning clutch test**

6) Reassembly

Reverse the order of disassembly to reassemble the starter. However attention should be paid to the following operations.

(1) Lubrication

Before reassembling, apply the recommended grease as follows:

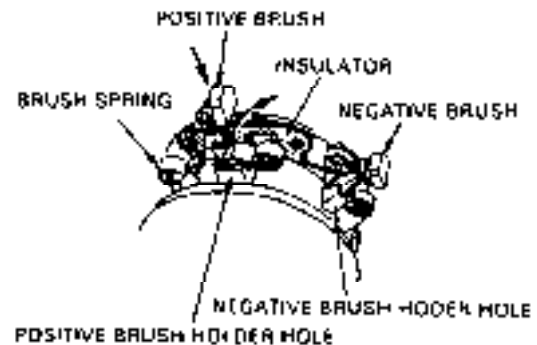
Nippondenso No. 50 grease or equivalent (Esso beacon 325)	<ul style="list-style-type: none"> • Retainer and rollers • Overrunning clutch • Steel ball • Return spring • Armature bearing • Felt washer
---	--

(2) Fixing torque

Item	Torque	N·m {kg·m}
Through blot	8.82 – 11.76	{0.9 – 1.2}
Drive end flame fixing screw	8.82 – 11.76	{0.9 – 1.2}
C-terminal nut	9.8 – 13.72	{1.0 – 1.4}

(3) Cautions for installation

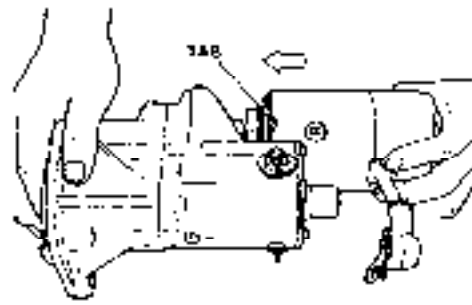
- Do not forget to assemble the steel ball and return spring
- Install the negative brush (brush holder side) to the brush holder negative hole (not insulated), and the positive brush (yoke side) to the brush holder positive hole (separated from plate with insulator). Then make sure that the positive brush lead wires are not grounded.
- When assembling the brush holder to the yoke, take care not to damage and get oil on it.



Installing the brush

115X

- When installing the rear end frame to the yoke, engage the tab on the rear end frame with the lead wire grommet.
- When installing the yoke to the magnetic switch, engage the tab on the yoke with the notch in the magnetic switch.
- Securely put the rubber boot over the C-terminal.



Installing the yoke

116X

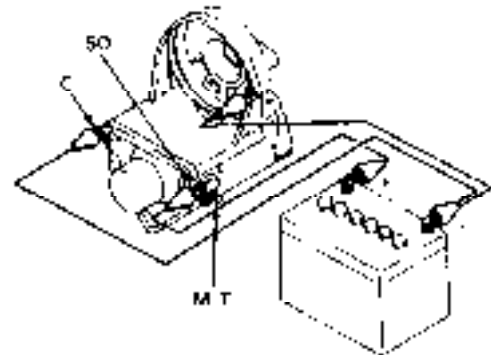
(4) Magnetic switch test

The following tests should be performed without the armature assembly.

NOTE: Each test should be performed a short time (3 to 5 sec.) to prevent the magnetic switch winding from burning. Each test should be performed with specified voltage is applied.

- **Pull-in test**

Connect the test leads as shown in Figure. When connecting terminal C and M. T are closed, the pinion should jump out.

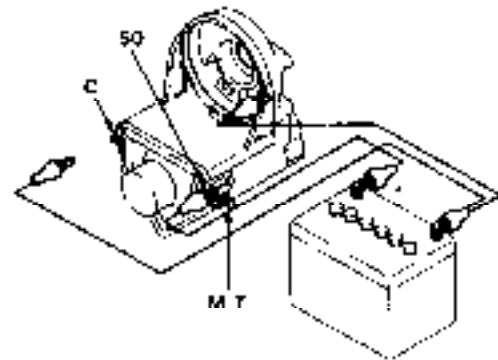


Pull-in test

117X

- **Hold-in test**

With the same condition as in the pull-in test, open the connecting terminal C. The pinion should remain in jumped out position.

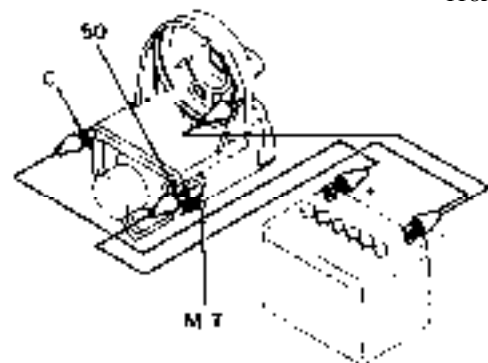


Hold-in test

118X

- **Return test**

With the same condition as in the hold in test, open the connecting terminal 50. The pinion should return immediately.



Return test

119X

7) Performance test

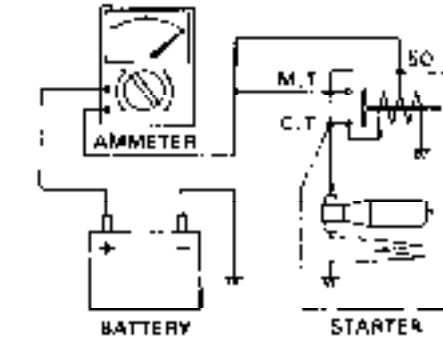
The following test should be carried out after reassembling the starter. If suitable equipment is not available, at least the No-load test should be carried out.

(1) No-load test

With the starter securely clamped in a vice, and using a battery and suitable ammeter, connect the positive lead of the battery, and the ammeter to the "50" terminal.

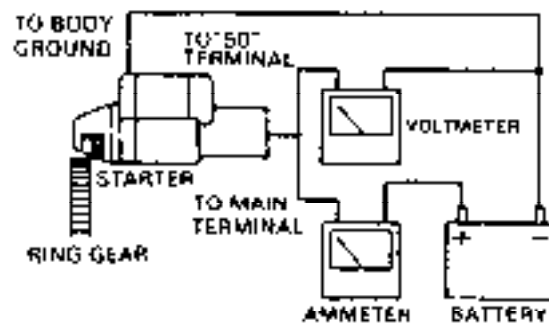
Connect the negative lead to the starter body.

The starter should show smooth and steady rotation immediately after jumping out of the pinion and should draw less than the specified current.



No-load test

120X



Lock and lock torque test

121X

(2) Load test

Read the ammeter and voltmeter when the specified torque is applied. The ammeter should indicate less than the specified current, and the tachometer should indicate more than the specified speed.

(3) Lock torque test

Read the torque meter and ammeter when the tachometer reading becomes 0 rpm after applying the load. The torque meter should indicate more than the specified torque and the ammeter should indicate less than the specified current.

8) Diagnosis and test for starting system

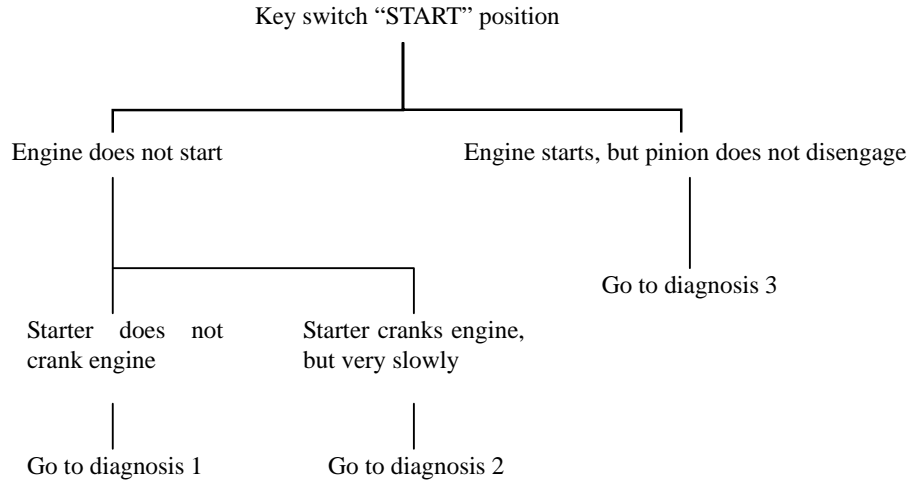
Use the diagnostic charts as a guide when you are repairing the starting system. Before diagnosis, be certain the battery is fully charged and inspect the starter and battery cables for clean and tight connections.

Precaution:

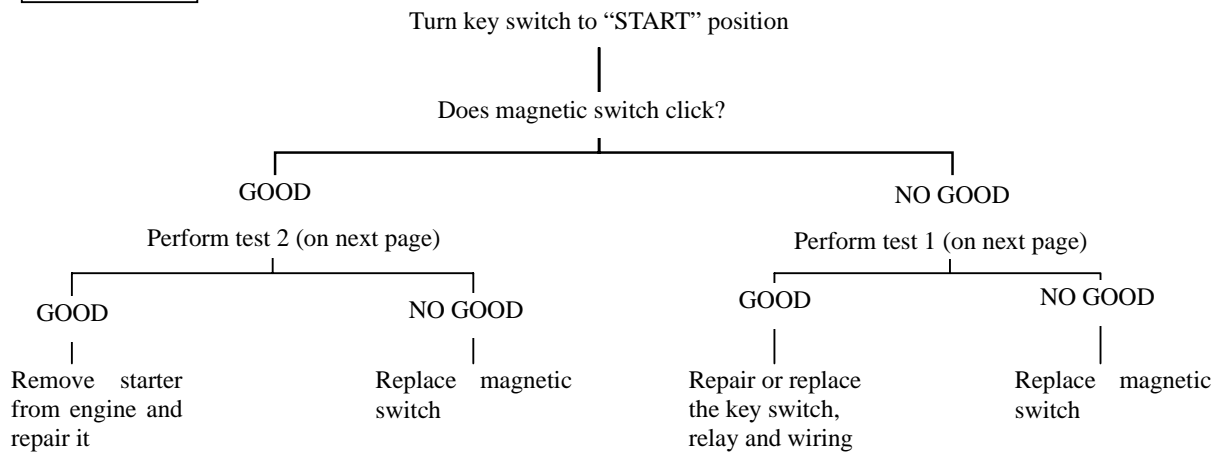
- Do not operate the starter longer than 30 seconds.
- Do not disconnect or short any lead wire while starter is operating.

(Continue)

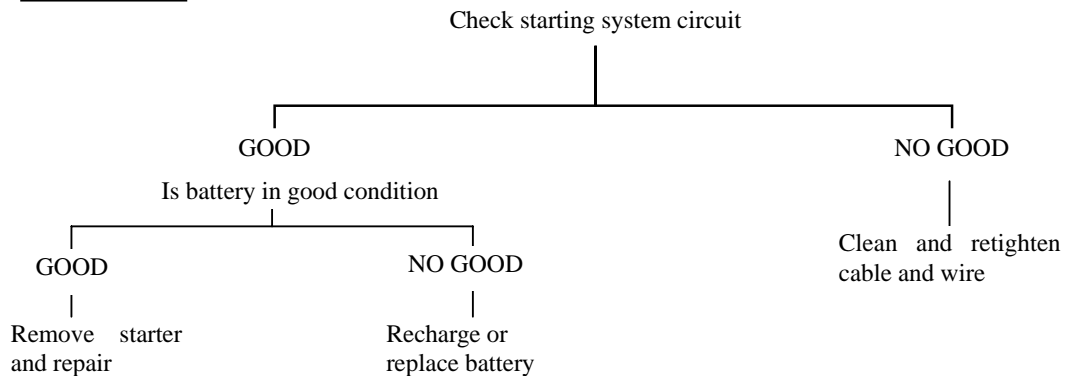
Diagnostic chart



Diagnosis 1

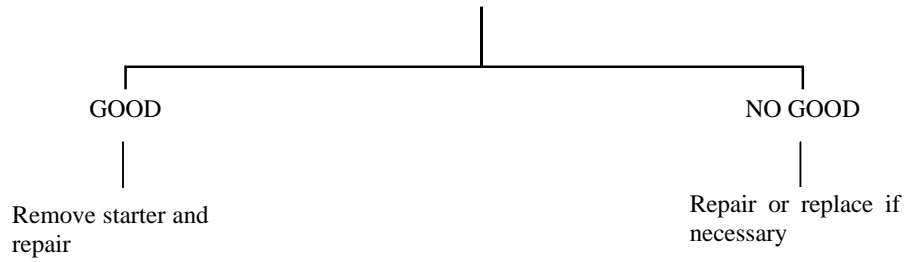


Diagnosis 2



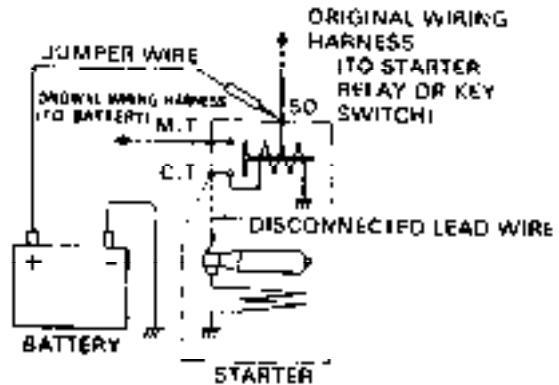
Diagnosis 3

Check the operation of starting switch and relay



TEST 1

- (1) Disconnect the cable from “C” terminal.
- (2) Connect a jumper wire to positive terminal of battery.
- (3) Briefly touch jumper wire to “50” terminal of magnetic switch.
If the magnetic switch operates, probable cause of starter failure is in the wiring, starting switch or relay.

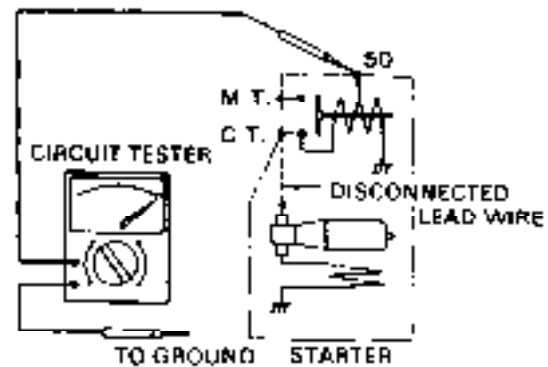


Test 1

TEST 2

122X

- (1) Disconnect the cables from C.T., M.T. and 50 terminal.
- (2) Using an ohmmeter, touch one probe to the “50” terminal and the other to the starter body.
There should be continuity.
If there is no continuity, the hold-in winding is open-circuited.
Replace the magnetic switch if open circuited.



Test 2

123X

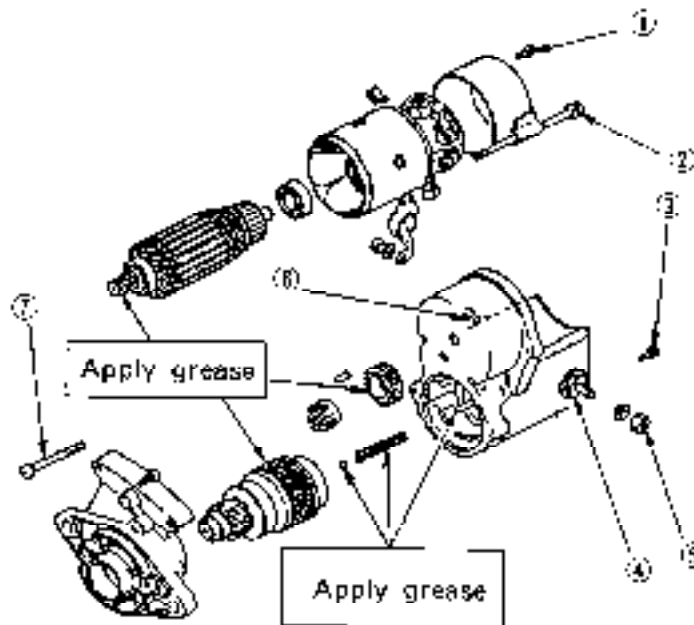
[Discrimination of starter terminals]

Each terminal can be discriminated as follows:

- M.T. Main terminal to which the main cable from battery is connected.
- C.T. C-terminal to which the lead wire from the yoke is connected.
- 50. 50-terminal to which the lead wire from the starting switch or starter relay is connected.

9) Service Specification

Part code No.		185086530	
Type		RA (228000-5121)	
Output (V-kW)		12 – 2.0	
Yoke outside diameter		Ø78	
Commutator outside diameter	Standard value	mm	35.0
	Repair value	mm	34.0
Commutator insulation depth	Standard value	mm	0.55 – 0.85
	Repair value	mm	0.2
Commutator irregular wear	Standard value	mm	0.02
	Repair value	mm	0.05
Brush length	Standard value	mm	15.0
	Repair value	mm	12.0
Tightening torque	N·m {kgf·cm}	① End frame bolt	2.94 – 4.7 {30 – 48}
		② Through bolt	8.82 – 11.76 {90 – 120}
		③ Magnetic switch cover bolt	3.63 – 4.6 {37 – 47}
		④ M terminal nut (Inside)	13.7 – 19.6 {140 – 200}
		⑤ M terminal nut (Outside)	5.88 – 9.8 {60 – 100}
		⑥ C terminal nut	9.8 – 13.7 {100 – 140}
		⑦ Housing bolt	8.82 – 11.76 {90 – 120}



124X

3. Glow Plug

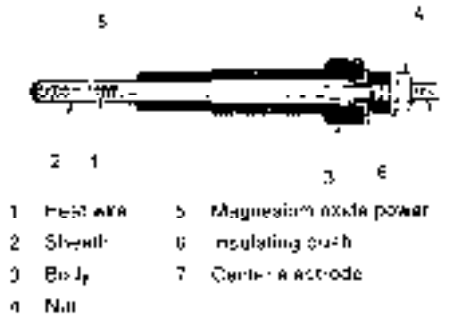
IQS super-high speed heating type glow plug is used for this tractor. Refer to paragraph 3-8, Electrical parts and accessories for the IQS system.

1) Specifications and structure

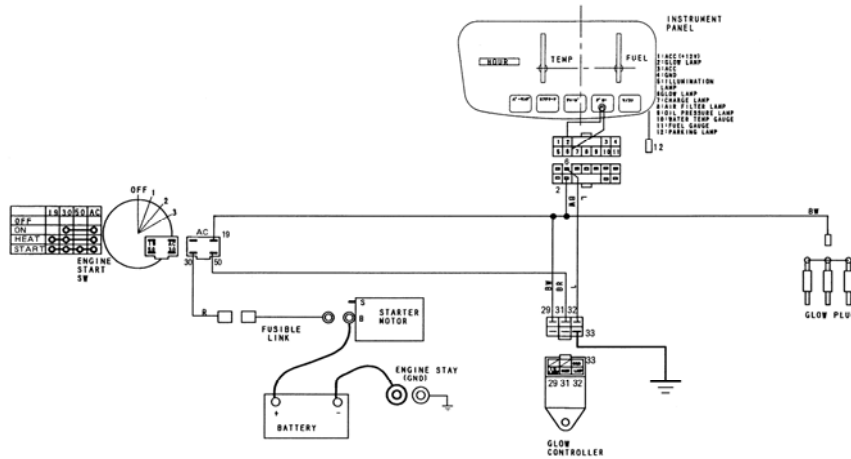
Part code No.	185366190	Rated voltage	12 V (DC)
Model	Y-70IRS	Standard resistance	0.8 Ω (At normal temperature)

The heat wire (heating unit) is enoused in the stainless steel sheath. Coiled thin heat wire is placed in sintered magnesium oxide powder.

One end of this heat wire is welded to the sheath end and another end is welded to the center electrode. By setting the key switch at the heat (H) and start (START) positions, power is supplied, heats the air in the combustion chamber and preheats the heat wire.



2) Circuit diagram



GLOW INDICATOR LAMP CIRCUIT

3) Inspection

- (1) Disconnect the connector.
- (2) Connect the circuit tester to the center electrode of the glow plug and cylinder head and measure the resistance.

Measured value	Judgment
At 0 Ω	Short-circuit
At ∞	Disconnected wire

125X

126X

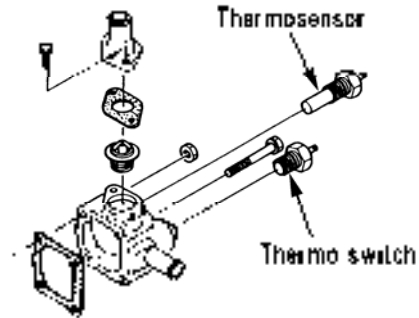
4. Thermometer and Thermosensor

1) Specifications (thermosensor) and structure

Part code No.	385720011
Operating range	50°C – 120°C
Standard resistance value (Ω) (The resistance rating is measure on the special circuit.)	$35^{\circ}\text{C} \rightarrow 670 \pm 80$ $80^{\circ}\text{C} \rightarrow 118 \pm 6$ $105^{\circ}\text{C} \rightarrow 54.5 \pm 2.7$ $115^{\circ}\text{C} \rightarrow 4.2 \pm 2.5$

Electric thermosensor composed of a receiver and transmitter is used for this tractor.

The receiver employs a thermister in which electric resistance varies according to temperature to increase the current flowing the circuit when the cooling water temperature rises and indicator of the receiver indicates the corresponding position.



127X

2) Inspection

(1) Thermosensor

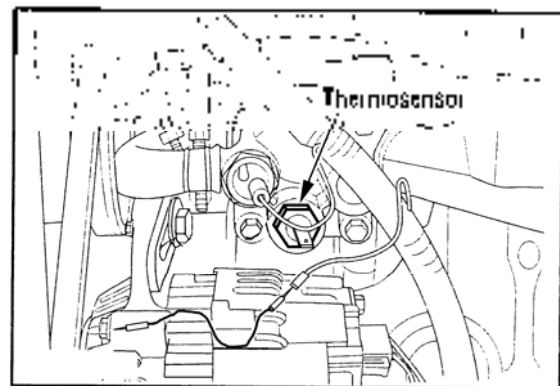
- Remove the thermosensor from the thermostat case.
- Connect a circuit tester to the thermosensor.
- Measure the resistance value at each temperature while heating with a heater.



128X

(2) Thermometer

- Disconnect the wiring from the themosensor.
- Turn the key switch to "ON" position. (No start the engine).
- Connect the wiring for thermosensor to ground.
- If the pointer for the thermometer moves to "C" to "H" after a while, the thermometer is normal. If the pointer does not move, the wiring or the thermometer is defective.



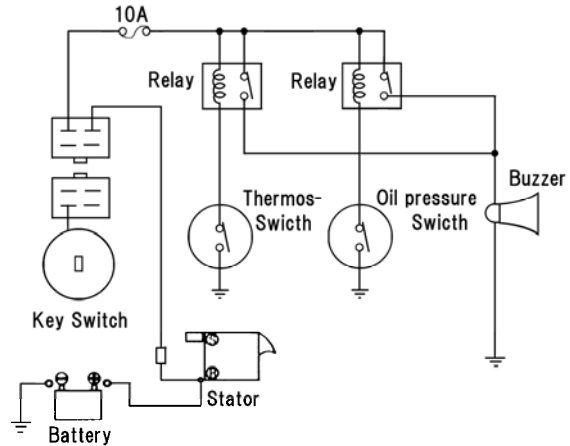
129X

5. Buzzer Alarm Warning System

The buzzer is alarmed when the engine is over heated and/or engine oil pressure is too lowered.

1) Over heat warning alarm system

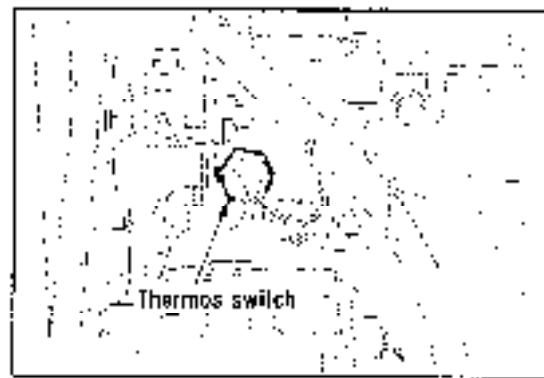
The thermos-switch is located on the thermostat case. Relay and buzzer are located on the fire wall compartment. The buzzer is alarmed with the thermos-switch and relay.



130X

The thermos switch is closed at 107°C to 113°C, and is opened at 103°C.

If buzzer is alarmed, clean the radiator front screen and radiator screen, and inspect the coolant quantity after coolant temperature become cold.

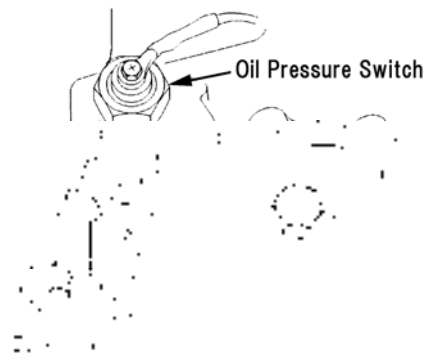


131X

(2) Engine oil pressure warning alarm system

The oil pressure switch is located on the cylinder head. Relay and buzzer are located on the fire wall compartment. The buzzer is alarmed with the oil pressure switch and relay. The switch is closed when oil pressure is low 0.29 MPa {0.3 kgf/cm²}.

If buzzer is alarmed, stop the engine and inspect the engine oil level.



132X

6. Oil Pressure Switch

Structure

This oil pressure switch is used to warn engine oil pressure. When the pressure increases more than specified, the oil pressure lamp lights up warning the trouble, Diaphragm and contact points are combined in the oil pressure switch.

- a. Oil pressure switch lamp lights up at pressure less than **0.2 – 0.4 kgf/cm²**.

7. Battery

1) Specifications

Model	CM284	75D26L	Electrolyte specific gravity (at 20°C)	1.28/When charged fully
	CM364			
Capacity		75 AH	Charging current	7A When charged normally

2) Specific gravity of electrolyte and charging condition

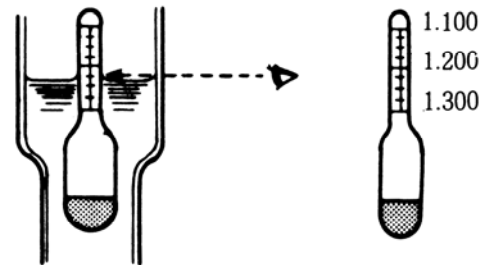
The specific gravity of electrolyte decreases approximately lineally in proportion to the discharged electricity of battery. By measuring the specific gravity of the electrolyte using a hydrometer, residual capacity of the battery can be known.

The specific gravity value measured by the hydrometer should be compensated with respect to temperature. The specific gravity of battery electrolyte is based on the temperature of 20°C. As the temperature varies 1°C, the specific gravity value increases or decreases 0.0007. Therefore measured values can be compensated by the following equation.

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

S_{20} — Specific gravity converted to the value at 20°C
 S_t — Measured specific gravity
 t — Electrolyte temperature in measured value

The right figure shows how to read the hydrometer and the table indicates relation between the specific gravity values and battery residual capacity.



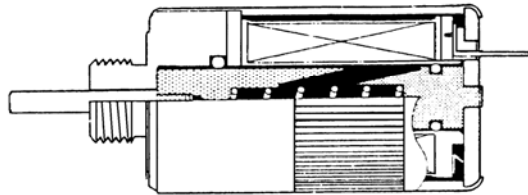
133X

Specific gravity (20°C)	Discharged electricity (%)	Residual capacity (%)
1.280	0	100
1.225	25	75
1.170	50	50
1.116	75	25
1.060	100	0

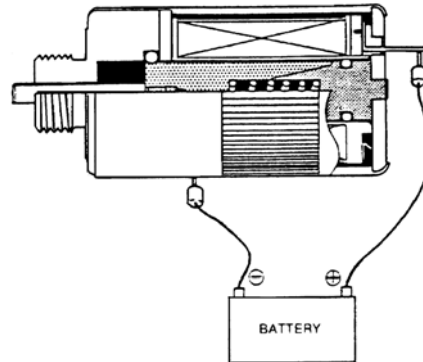
7. Engine Stop Solenoid

Inspection

Connect (+) side of the battery to the terminal of the engine stop solenoid and (-) side to the main body. If the plunger is sucked into the main body, the engine stop solenoid is normal.



134X



135X

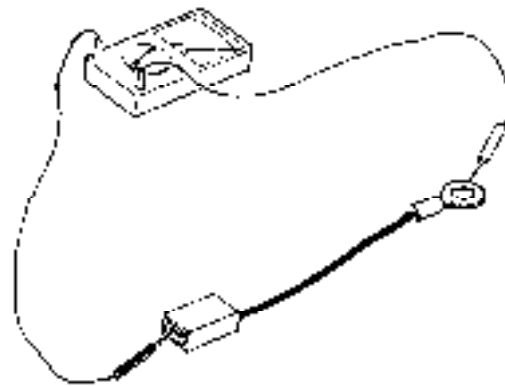
8. Fusible Link

Inspection

The fusible link is installed between the battery and fuse box to protect such parts that could not be protected by fuses or a circuit (starter circuit) to which large current flows instantaneously. Check the continuity with a circuit tester.

NOTE:

1. If a fusible link is burnt out again immediately after it is replaced, short circuit of the wiring can be considered as the reason. Check the wiring harness in such a case.
2. Never use a substitute wire or the like when the fusible link is burnt out.



136X

9. Wiring Harness

Inspection and service

- (1) Disconnect the negative cord of the battery when inspecting or servicing the wiring harness.
- (2) Check each wiring for damage of sheathing due to wiring or for some other reason, or looseness at the connecting parts at the time of its inspection or service. If there is some defective point, repair the insulation or replace the wiring harness. (The band becomes breakable when becoming old. Be sure to substitute in such a case.)
- (3) After completion of service for the tractor, etc., protect wiring at the plugging parts with vinyl tube, use clamping fixtures with vinyl cover, and check that the figures are not in direct contact with wiring. (Replace uncovered fixtures.) Especially check carefully where wiring may be caught between something.
- (4) Check very carefully where positive current flows constantly and confirm sheathing is free from troubles.
 - 1) Starting motor
 - 2) Alternator
 - 3) Key switch
- (5) After check, protect the wiring with corrugated tube or the like.

2-4 Trouble Shooting

Condition	Cause	Remedy
Engine does not start.	Defective key switch Insufficient charging or completely discharged battery. No fuel. Air mixed in the fuel system. Clogged fuel filter. Irregular or improper fuel supply. Defective glow plug. Improper viscosity of lubricating oil. Clogged air cleaner. Not compressed. Defective engine stop solenoid.	Connect or correct contact points properly. Charge. Replenish the fuel. Correct points allowing the air to enter the fuel. Replace the fuel filter. Trouble of injection pump. Have corrected in work specified by Nippon Denso. Replace. Check and change. Clean the air cleaner. Check and correct each part. Check or replace wiring.
Irregular engine speed	Air mixed in the fuel system. Uneven fuel injection. Clogged fuel filter. Trouble of speed governor. Improper function of engine main body.	Discharge air from the fuel. Trouble of injection pump. Have corrected or replaced in a work specified by Nippon Denso. Replace the fuel filter. Check and adjust. Overhaul, check and correct each part.
Engine stops during operation	No fuel in fuel tank. Clogged fuel filter. Air mixed in the fuel system. Improper functions of engine main body.	Replenish fuel. Replace the filter. Correct points to allow the air to enter the fuel system. Check and correct each part.
Engine overheat	Insufficient cooling water. Loosened or slipping fan belt. Failure of fan belt. Clogged radiator. Clogged radiator fin. Cooling water passage clogged with dust, fur, etc. Improper function of thermostat. Insufficient lubricating oil. Overload.	Replenish the cooling water, and check and repair water leaking points. Clean oil dust, etc. and retighten. Replace. Clean the radiator. Clean. Wash. Check and replace Replenish. Decrease the load.

Condition	Cause	Remedy
Improper color of engine exhaust	Too much engine oil. Too low viscosity of engine oil. Improper injection timing.	Check and adjust the quantity. Check and change. Too late. Correct.
Improper engine exhaust (black or dark gray)	Improper fuel. Excessive fuel injection. Improper function of engine main body. Overload. Clogged air cleaner.	Check and change. Check and adjust. Check a correct each part. Reduce the load. Clean the element.
Improper charging.	Loosened fan belt. Trouble in wiring of each part. Defective battery. Defective alternator.	Correct belt tension. Check and repair. Replace. Replace.
Starting motor does not operate.	Loosened or disconnected wiring of each part. Dropped battery voltage. Defective safety switch. Trouble in starting motor. Disconnected wire of fusible link.	Check and install or tighten. Charge the battery. Replace. Check and correct the starting motor. Replace.
Oil pressure lamp does not go out.	Insufficient engine oil. Trouble in oil pressure switch. Oil leakage from lubricating system. Clogged oil filter. Short circuit wiring between oil pressure lamp and mano contact.	Replenish to specified gauge level. Replace the switch. Check and retighten. Replace with new one. Repair.
Oil pressure lamp does not light up with the key switch turned ON. (While engine stops.)	Burnt out lamp. Disconnected wire between battery and oil pressure lamp.	Replace the lamp. Repair.