

W844-2

For Models: L844D, M844K2, M844W2, M844LK2,
M844LW2, NL844K2, NL844LK2, NL844W2,
NL844LW2, M20CR2, and M20CRW2

WORKSHOP MANUAL

Marine Generators | Marine Diesel Engines | Land-Based Generators



LUGGER





— CALIFORNIA —
Proposition 65 Warning:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

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Printed in U.S.A.
PART NO.: W844-2 01/06



WORKSHOP MANUAL

for Models

**L844D, M844K2, M844W2, M844LK2, M844LW2, NL844K2,
NL844LK2, NL844W2, NL844LW2, M20CR2, & M20CRW2**

Alaska Diesel Electric reserves the right to carry out any design modifications and, for this reason, some of the contents of this manual may not apply to your engine. If further information is needed, we suggest that you contact an authorized dealer or the ADE factory.

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INTRODUCTION

SAFETY RULES



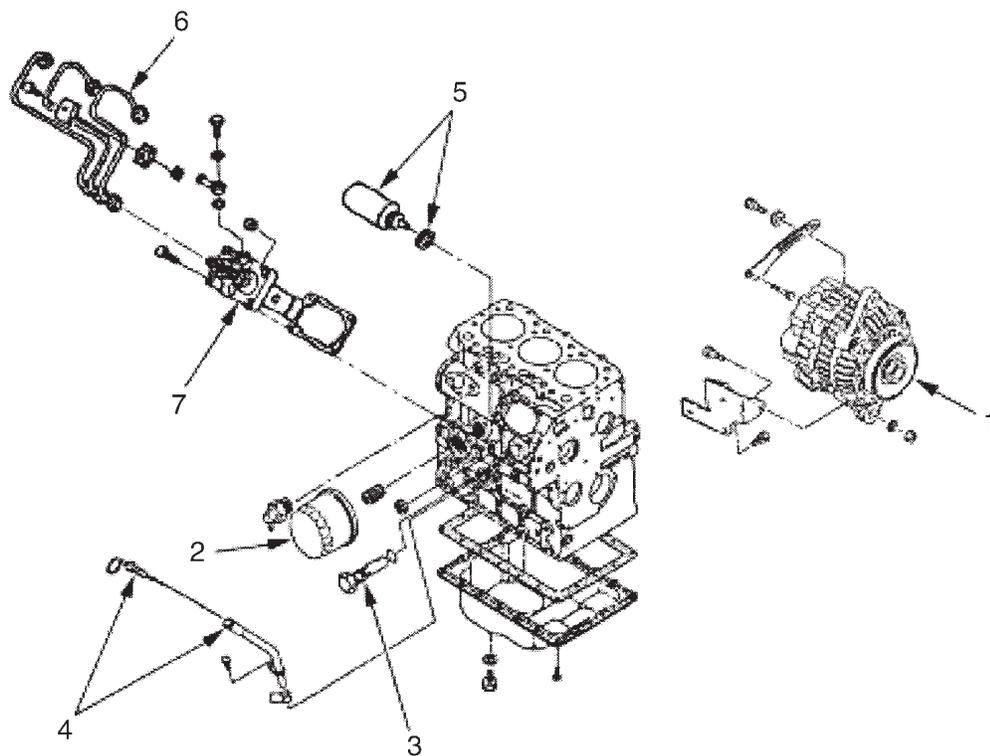
CAUTION: Accident reports show that careless use of engines causes a high percentage of accidents. You can avoid accidents by observing these safety rules. Study these rules carefully and enforce them on the job.

- Never leave engine without proper security.
- Turn the coolant tank cap slowly to relieve pressure before removing. Add coolant only when the engine is stopped and cool.
- Mount a fire extinguisher near engine.
- Always disconnect the battery ground strap before making adjustments.
- Operate engines in properly ventilated areas.
- Keep trash and other objects away from engine.
- Escaping fluids under pressure can penetrate your skin. Use a piece of cardboard or wood, not your hands, to search for leaks.
- Avoid wearing loose clothing without a belt when working around engines.
- Do not oil or grease engine while it is running.
- Use caution in handling fuel. Never refuel a hot or running engine. Do not smoke while filling fuel tank or servicing fuel system.
- Keep your hands, feet, hair and clothing away from power-driven parts.
- Check for any loose electrical connections or faulty wiring.
- Engines should be operated only by knowledgeable, qualified personnel.
- Look completely around engine to make sure that everything is clear and clean before starting.
- Do not operate an engine that isn't in proper working order. If an unsafe operating condition is noted, tag the set and control panel so others will also know about the problem.
- Provide first aid kits.
- Do not disassemble parts or engine except for what is needed to be worked on - as initially the engine was put together with precision that could prove to be hard to duplicate.
- Apply oil to moving parts during reassembly to form an oil film to fill up the gap before regular lubrication occurs.



CAUTION: This symbol is used throughout this book to alert you to possible danger areas. Please take special notice of these sections.

Engine Overall Disassembly



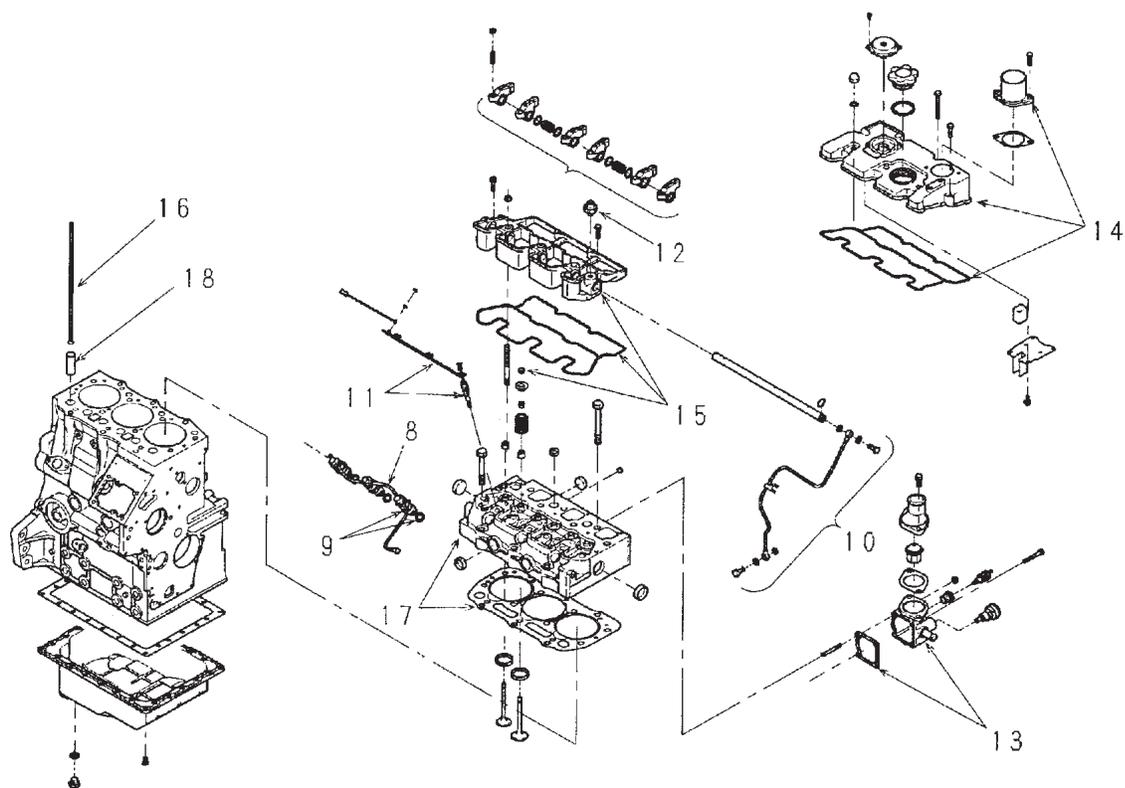
W844cylblockwithalt

SEQUENCE	PART	DISASSEMBLY ESSENTIALS
----------	------	------------------------

- | | |
|---|-----------------------------------|
| 1 | Alternator |
| 2 | Oil Filter |
| 3 | Relief Valve |
| 4 | Dipstick |
| 5 | Engine stop solenoid, seal washer |
| 6 | Injection pipe |
| 7 | Injection pump assembly |

Remove the injection lines and stop solenoid before removing the injection pump.
 Raise the injection pump and disconnect the governor link from the control rack by removing the snap pin.
 The injection timing has been adjusted by the shims between the injection pump and cylinder block; note the thickness and number when removing the injection pump.

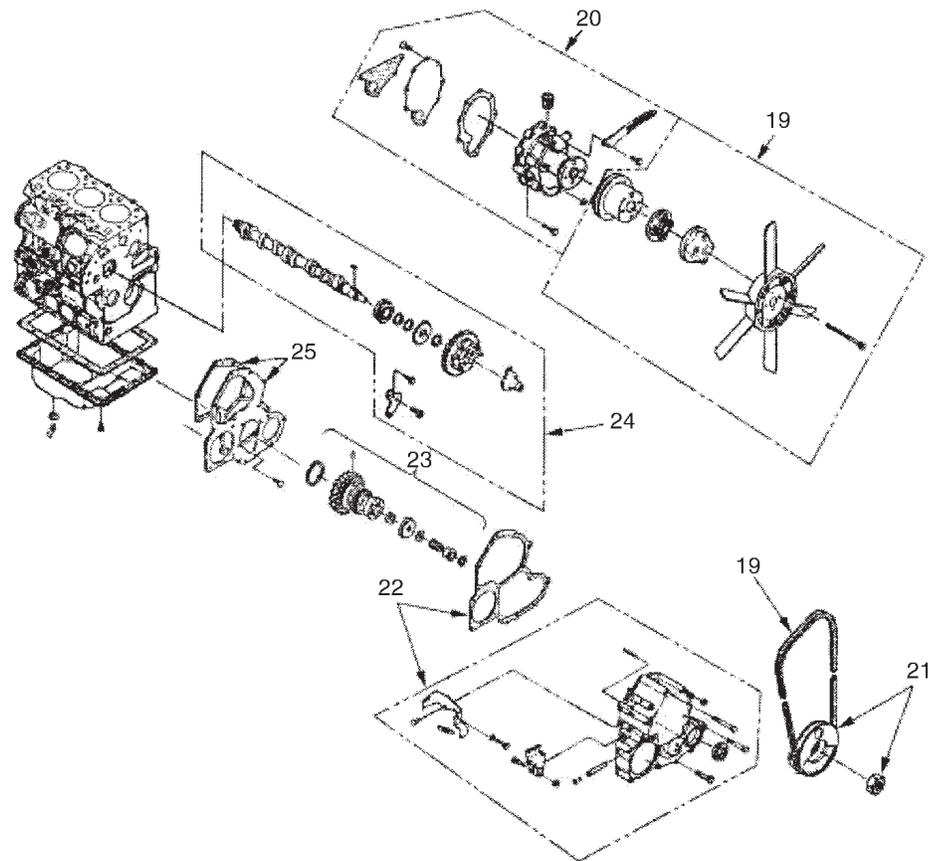
Engine Overall Disassembly



W844blockwithrockercover

SEQ.	PART	DISASSEMBLY ESSENTIALS
8	Return pipe	<p>Remove the caps from intake valves and exhaust valves.</p> <p>Loosen the cylinder head bolts in several steps and remove the cylinder head assembly.</p>
9	Injection nozzle, gasket	
10	Oil transfer tube, banjo bolt, seal washer	
11	Connector, glow plugs	
12	Oil pressure switch	
13	Thermostat housing, gasket	
14	Rocker arm cover, o-ring, intake manifold, spacer	
15	Rocker arm assembly, o-ring, cap	
16	Push rod	
17	Cylinder head, head gasket	
18	Tappet	

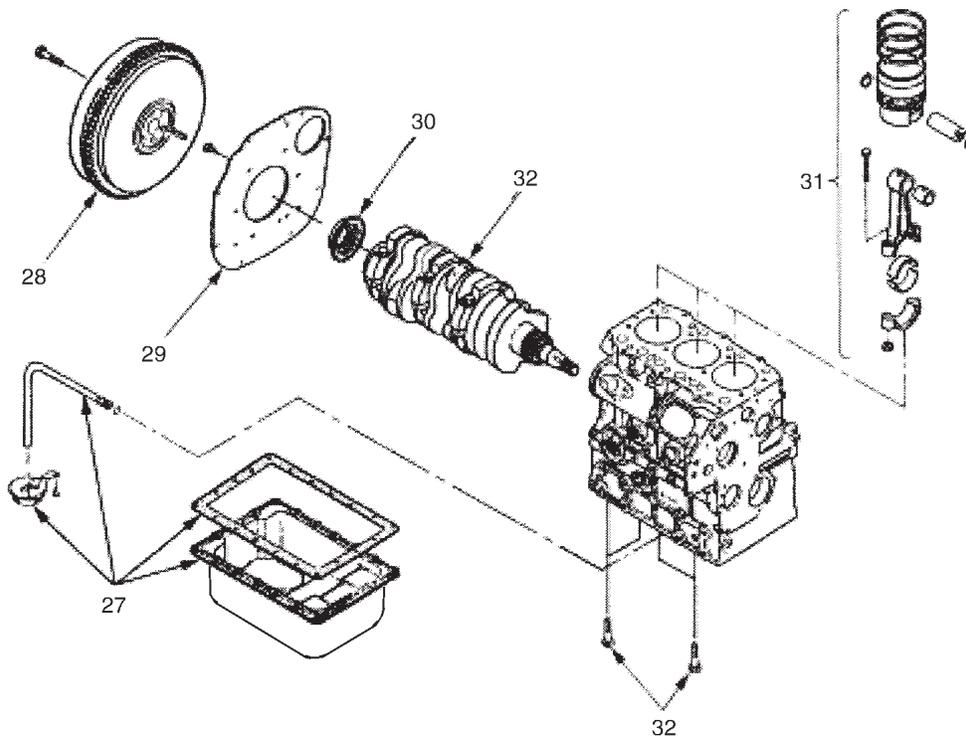
Engine Overall Disassembly



W844v belt&fan

SEQ.	PART	DISASSEMBLY ESSENTIALS
19	V-belt, cooling fan, fan housing, fan pulley	<p>First remove the injection pump assembly and the stop solenoid. Remove the bolts and plate first and pull out the camshaft assembly.</p>
20	Water pump assembly, gasket	
21	Crankshaft pulley	
22	Timing gear case assembly, gasket	
23	Idle gear, oil pump assembly	
24	Cam shaft assembly, plate	
25	Front plate, gasket	

Engine Overall Disassembly



W844blockwithcrankshaft

SEQ.	PART	DISASSEMBLY ESSENTIALS
27	Oil pan, gasket, intake filter, intake pipe	<p>Remove the carbon deposit from the top of the cylinder before taking out the piston.</p> <p>Keep the connecting rod, cap, and bearing in the order of the cylinders as they are removed.</p> <p>Take out the bolts for the bearing holders and remove the crankshaft and bearing holder as a set.</p>
28	Flywheel	
29	Rear plate	
30	Oil seal	
31	Piston and connecting rod assembly	
32	Crankshaft and bearing holder assembly	

Engine Main Parts Inspection

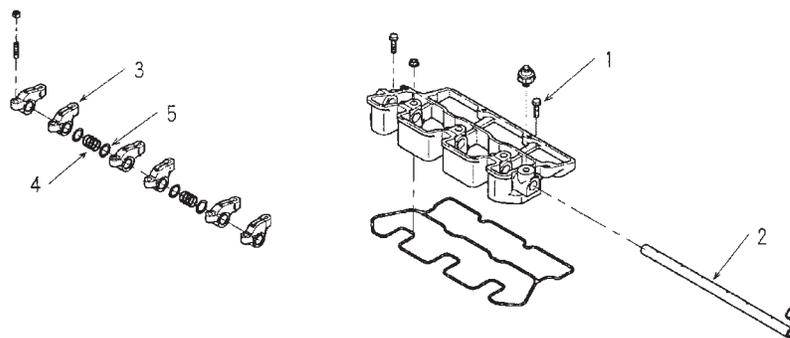
Notes before assembly:

1. Check for wear and leakage on the cylinder block and the cylinder head.
2. Check for clogs in oil holes on parts and remove deposits with air.
3. Wash each part completely to remove contaminants, oil, carbon, etc...
4. For the piston, cylinder, and valves take care in removing deposits (aluminum alloy parts need extra care).
5. Valves, pistons, connecting rods, metals, and other parts that are to be put back together should be marked with their matches so that they can be re-fitted with greater ease.

A) Rocker Arm Assembly Disassembly and Inspection

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

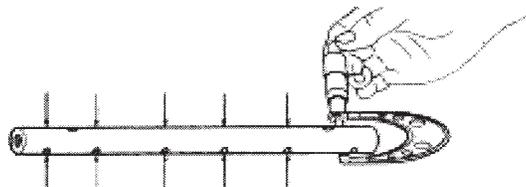
Screw in a M8 bolt at the front end of the rocker arm shaft and take out the rocker arm shaft.
Take out the spring, shim, and rocker arm from the rocker arm bracket.



inspec.pg1a

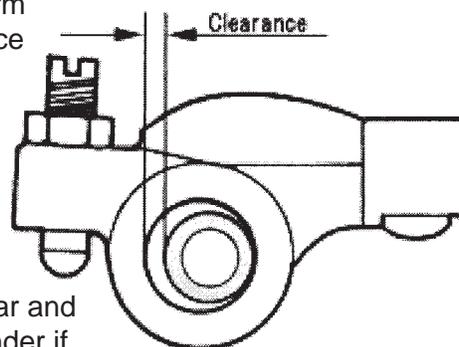
- 1 Using a micrometer, check outside diameter of the rocker arm shaft. If the shaft wear exceeds the service limit shown, replace it.

Wear of rocker arm shaft \varnothing (mm)	
Standard assembly value	Service limit
14.95 - 14.97	14.87



- 2 Measure the inside diameter of the rocker arm. Calculate the clearance between the rocker arm and rocker arm shaft. If the clearance is past the service limit replace the part.

Clearance between rocker arm and rocker arm shaft (mm)	
Standard assembly value	Service limit
0.032 - 0.068	More than 0.2



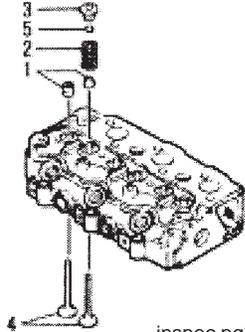
- 3 Check the valve cap-contact surface for uneven wear and streaks. Smooth the surface with an oilstone or grinder if needed.

inspec.pg1b

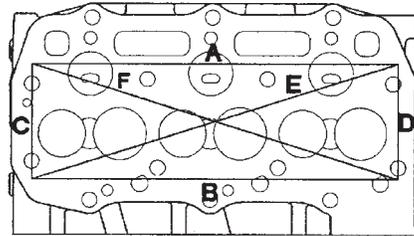
Engine Main Parts Inspection

B) Cylinder Head Assembly

- 1 Valve guide seal
- 2 Spring
- 3 Retainer
- 4 Valve
- 5 Valve keeper



Using a valve spring replacer, compress the valve spring to remove the valve keeper, retainer, spring, and valve. Then remove the valve guide seal.



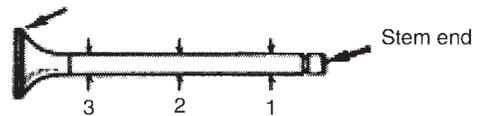
inspec.pg2a

inspec.pg2b

- To measure the distortion of the cylinder head bottom surface; apply a straight edge to the bottom surface of the cylinder head and insert a gauge to measure thickness at 6 points from A to F as shown above. If the distortion measured exceeds the repair value as shown below, smooth with a surface grinder or something similar.

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

- Valve guide and stem:
Inspect the head and stem of each valve and replace if damaged or badly worn.
Measure the outside diameter at 1,2,3 positions (figure at right) with a micrometer and replace if the result is less than the service limit as seen in the below table.

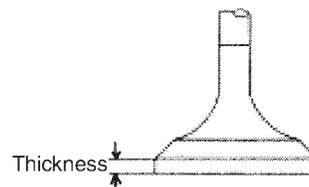


inspec.pg2c

Wear of valve stem \varnothing (mm)			
Intake Valve		Exhaust Valve	
Standard assembly value	Service Limit	Standard assembly value	Service Limit
6.955-6.97	6.89	6.94-6.95	6.84

- Valve head:
If the head thickness is less than the service limit below, replace.

Valve head thickness (mm)	
Standard assembly value	Service Limit
0.8-1.1	Less than 0.5



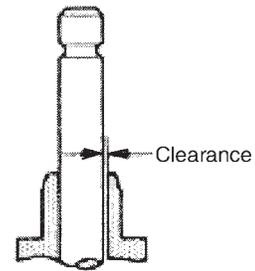
inspec.pg2d

Engine Main Parts Inspection

4. Valve Guide and Valve:

If the clearance between the valve stem and guide exceeds the service limit, replace the valve.

Clearance between valve stem and guide			
Intake Valve		Exhaust Valve	
Standard assembly value	Service Limit	Standard assembly value	Service Limit
0.03-0.06	More than 0.2	0.045-0.075	More than 0.25

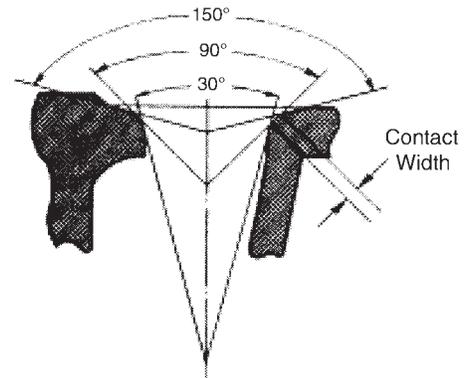


W844stem&guide

5. Valve Seat:

Check the valve guide first for wear condition before correcting the valve seat as the valve seat is corrected according to the valve guide. Use seat cutter of 15°, 45°, and 75° to correct the seat to the standard assembling values.

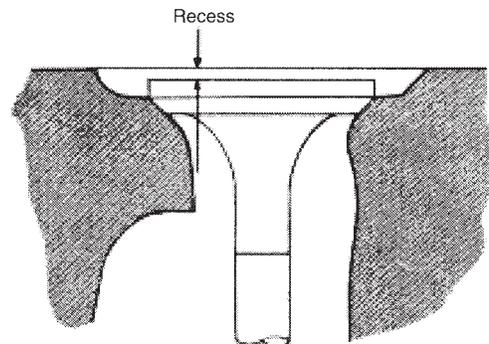
Valve Seat Contact Width (mm)		
	Standard assembly value	Repair value
Intake	1.77-1.19	2.5
Exhaust	1.87-2.09	2.5



W844valveseatwidth

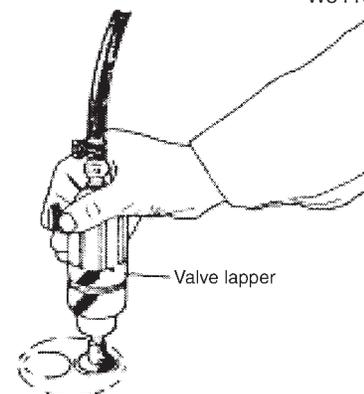
6. Replace the cylinder head if the seat recess exceeds the service limit.

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



W844valveseatrecess

7. To correct the valve seat, coat the valve seat with compound and lap the contact surface turning the valve. Make sure the valve contact surface is within the standard value and the contact position is even. If the cylinder head is replaced with a new one, adjust the seat contact width and seat recess to the specified values (see above tables) with a seat cutter before lapping.



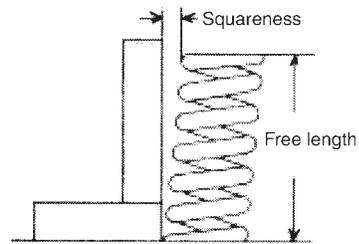
W844valvelapper

Engine Main Parts Inspection

8. Valve Spring

Check the valve spring for damage.

Measure the squareness of the spring using a square on a surface plate and if the surface limit is exceeded, replace the spring. Check the free length and spring force with a spring tester and replace the spring if the service limit is exceeded.



W844spring

	Standard assembly value	Service Limit
Squareness (mm)	1.2	2
Free Length	35	33.5
Spring force (compressed to 30.4 mm)	79.8 N (8.1 kgf)	68.6 N (7 kgf)

Reassembly

Reassemble the components in the reverse order to that previously discussed.

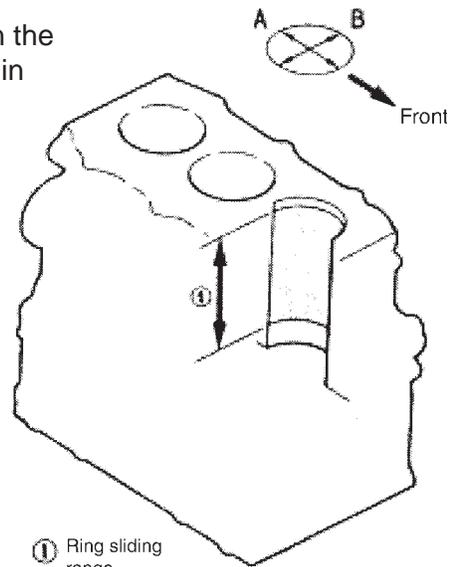
Take care to not damage the valve guide seal when assembling the valve spring, retainer, and cotter.

Tighten the glow plugs to:
15-20 N•m (1.5~2.0 kgf•m)

C. Cylinder Block

Check for cracks and damage on the top of the block just like on the cylinder head. There should be no scratches, rust, or corrosion in the cylinder bore. Measure the cylinder bore at the top, center, and the bottom in the crankshaft direction (A on figure to the right) and also right angle to it (B).

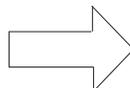
Replace the engine long block if the repair value is exceeded.



W844ringslide

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

Cylinder bore diameter (mm)	
Standard assembly value	Repair value
84 - 84.019	84.2

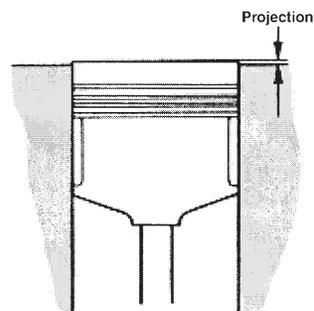


Replace with long block assembly

Engine Main Parts Inspection

D. Piston and Piston Ring

To disassemble - use a piston ring tool to remove the piston ring. Then remove the snap ring and extract the piston pin.



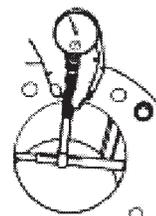
W844piston

1. Inspection of the Piston:

Check the outside of the piston for cracks, streaks, or burnouts, replace if needed.

Measure the bore of the cylinder in the thrust direction, and measure the longer diameter 10 mm above the lower end of the piston skirt. Calculate the clearance and replace if it exceeds the repair value.

Also measure the piston pin hole diameter and piston pin outside diameter, replace if the clearance exceeds the service limit.

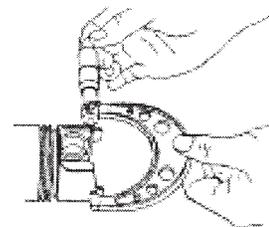


W844bore

Clearance between cylinder and piston (mm)	
Standard assembly value	Service limit
0.0375- 0.0715	0.25

Piston skirt bottom longer diameter ϕ (mm)	
Standard assembly value	Service limit
83.948- 83.963	83.7

Clearance between piston pin hole and piston pin (mm)	
Standard assembly value	Service limit
-0.001~ + 0.011	0.02

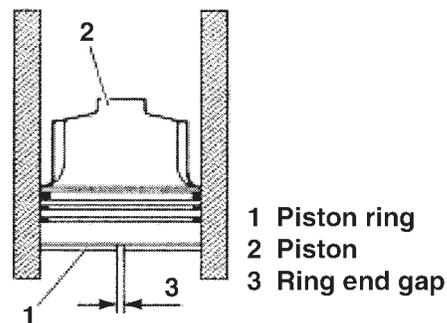


2. Inspection of the Piston ring:

Replace worn out or damaged piston rings.

3. To measure the clearance of the piston, insert a ring at a right angle to the least worn out skirt of a cylinder and measure the clearance of the ring end gap with a thickness gauge. Replace it if the end gap exceeds the service limit.

Piston ring end gap (mm)		
	Standard assembly value	Service limit
Top Ring	0.2- 0.35	1.0
Second Ring	0.20- 0.40	1.0
Oil Ring	0.25- 0.50	1.2



W844pistonringgap

Engine Main Parts Inspection

D. Piston and Piston Ring continued

4. Measure the clearance between the piston ring groove and ring and replace it if the service limit is exceeded.

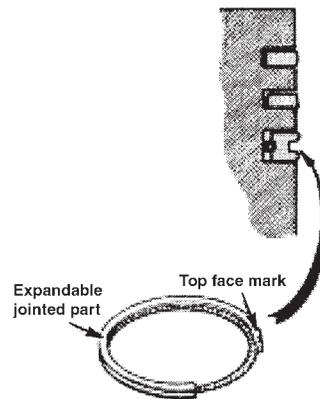
Clearance between piston ring groove and ring (mm)		
	Standard assembly value	Service limit
Top Ring	0.07- 0.11	0.25
Second Ring	0.04- 0.08	0.25
Oil Ring	0.02- 0.06	0.25

5. Install the piston ring to the piston as shown in the figure on the right.

Inspection of the Piston Pin

- a. Measure the outside diameter of the piston pin and replace if the service limit as shown below is exceeded.

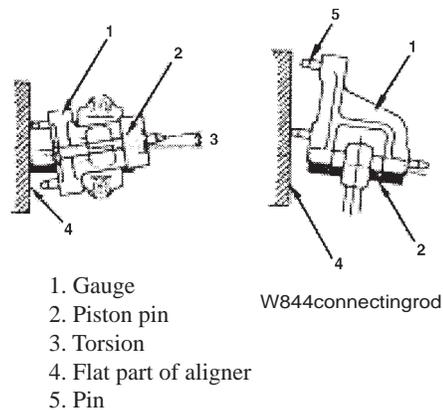
Piston outside diameter \varnothing (mm)	
Standard assembly value	Service limit
27.994 - 28.0	27.97



E. Connecting Rod

1. Check the rod for torsion, parallelism, and possible damage. Using a connecting rod aligner, measure the torsion and parallelism. Replace or correct the rod if the repair value is exceeded.

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



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 it if the clearance to the piston pin exceeds the service limit.
 3. Measure the axial play after re-attaching the connecting rod to the crankshaft, replace the connecting rod if the service limit is exceeded.

Clearance between bush and piston pin (mm)	
Standard assembly value	Service limit
0.010 - 0.027	More than 0.08

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

Engine Main Parts Inspection

Connecting Rod Metal

1. Check the metal and replace it if peeling, melting, or other damage is noticed.
2. Use the plasti-gauge and measure the oil clearance of the crank pin and metal. Remove any foreign matter or oil dust stuck to the metal or crank pin. Cut the plasti-gauge to the same length as the metal width and put it on the crank pin parallel with the crankshaft, avoiding the oil hole. Install the connecting rod metal and connecting rod cap and tighten to below specified torque.

Note: Do not turn the connecting rod.

Tightening torque: 49 - 54 N•m (5.0 - 5.5 kgf•m) [36 - 39.8 ft.•lb.]

3. Remove the connecting rod cap and measure the plasti-gauge width, the widest part of the plasti-gauge, with the scale printed on the gauge envelope.

If the oil clearance exceeds the service limit, replace the metal.

Reassembly of the Piston and Connecting Rod

1. Heat the piston to about 100°C with a piston heater and install while aligning the SHIBAURA mark in the piston and match mark at "A" of the connecting rod (as seen on right figure), using care at the match marks.
2. Install the piston ring to the piston facing the stamp up towards the end surface of the ring end gap.

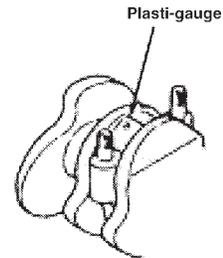
F. Bearing Holder

1. Remove the center bearing holder and replace the metal if peeling, melting, improper contact, or other damage is noticed. Replace the thrust washer also if any damage is noticed or if the thickness exceeds the service limit.
2. Measure the oil clearance with a plasti-gauge, of the crankshaft center journal and metal. If the oil clearance exceeds the service limit, replace the metal and/ or the crankshaft.

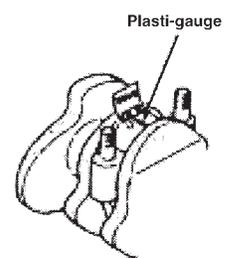
Crankshaft center journal finishing ϕ (mm):

67.957 - 67.970

Clearance between crank pin and connecting rod metal (Oil clearance) (mm)	
Standard assembly value	Service limit
0.035 - 0.085	0.2

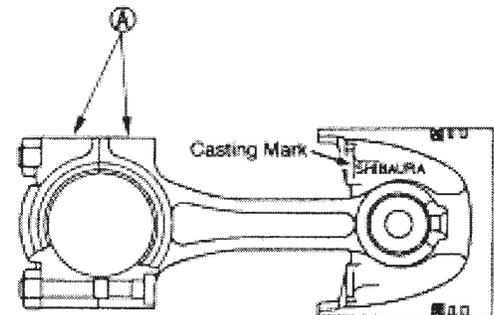


Set a plasti-gauge



Measure the oil clearance

Crankshaft pin outside ϕ
Finishing dimension ϕ (mm)
51.964 - 51.975



W844piston-connrod

Clearance between crankshaft center journal and metal (oil clearance) (mm)	
Standard Assembly value	Service limit
0.044- 0.102	0.2

Rear bearing holder thickness (mm)	
Standard Assembly value	Service limit
2.95- 3.00	2.8

Engine Main Parts Inspection

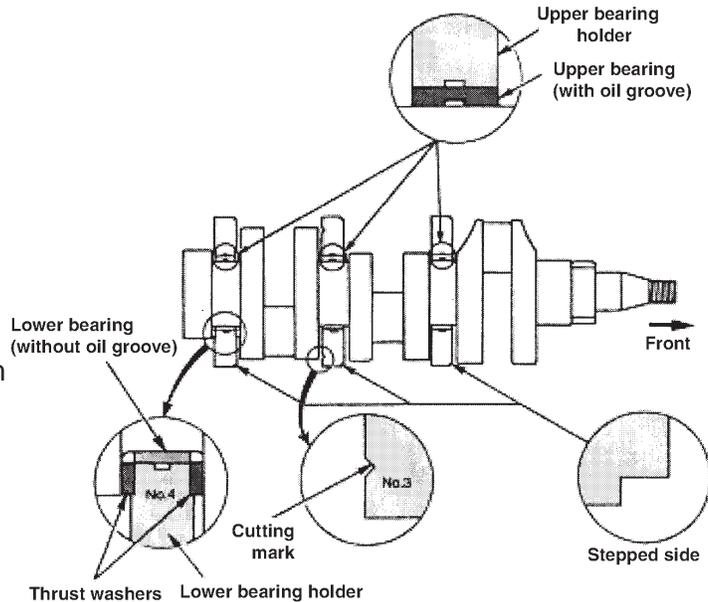
F. Bearing Holder, Thrust Washer (continued)

1. Re-assemble the bearing holder with the identification cutting mark at the center and the bearing holder with the thrust washer at the flywheel side, facing the stepped side towards the front. Install the thrust washer facing the oil groove to the crankshaft thrust surface.

Bearing Holder Tightening Torque: 49- 54 N•m
(5.0 - 5.5 kgf•m) [36 - 39.8 ft.•lbs.]

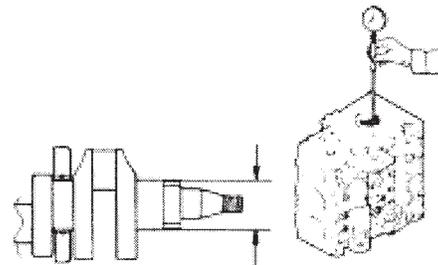
Install the metal with the oil groove to the upper side and the one without the oil groove to the lower side.

Note: Be sure that the oil holes of the bearing holder and and cylinder block are aligned.



G. Crankshaft Bearing

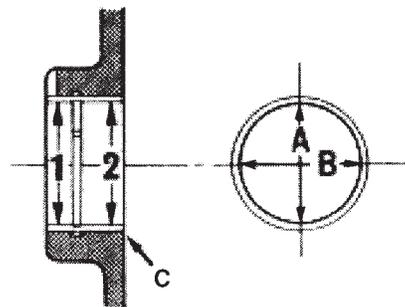
1. Check the bearing and if peeling, melting, improper contact, or other damage is noticed, replace the bearing.
2. Using a cylinder gauge and a micrometer, measure the oil clearance of the bearing and the crankshaft journal. If the oil clearance exceeds the service limit, replace the bearing and/ or the crankshaft.



Clearance between crankshaft journal and bearing (Oil clearance) (mm)	
Standard assembly value	Service limit
0.044 - 0.116	0.2

3. Measure the dimensions in the A and B directions at the positions 1 and 2 (at figure at right) making sure to avoid the oil hole of the bearing. Calculate the difference from the maximum value of the crankshaft journal, the oil clearance.

4. To replace the bearing, push it up using a press or something similar. Align the oil holes and push it up until the bearing end surface becomes level with the outside machined surface of the cylinder block (C on fig. at right).

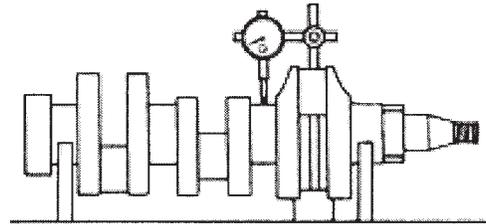


Crankshaft journal outside diameter finishing dimension \varnothing (mm): 67.957 - 67.970

Engine Main Parts Inspection

H. Crankshaft

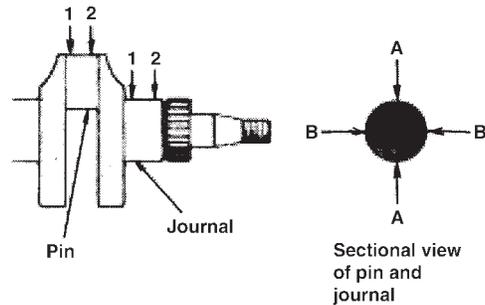
1. Measure the run-out of the crankshaft by first supporting the crankshaft with a V block (as shown in figure on right). Put a dial gauge in the crankshaft center journal and read the dial gauge while rotating the shaft one turn, gently. If the service limit is exceeded, repair or replace the crankshaft.



W844crankshaftmeas

2. Check the crankshaft oil seal for damage or wear on the contact surfaces, and check for clogging in the oil hole.

3. Check the crankshaft journal and pin for damage, excessive wear, and shaft diameter. If the service limit is exceeded, replace the bearing and/ or the crankshaft. Measure in the AA and BB directions (in figure on right) of the journal and pin at the 1 and 2 position. Avoid the oil holes.



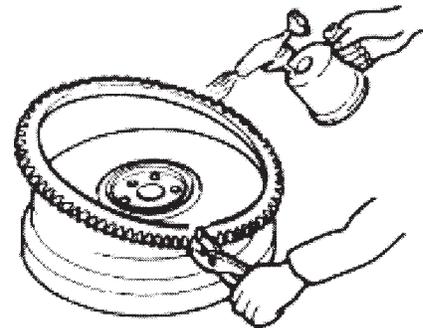
W844crankshaftmeas

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

Irregular Wear limit of Crankshaft Journal and Pin \varnothing (mm)		
More than 0.05		
Shaft diameter at Crankshaft Journal \varnothing (mm)		
Outside dia. finishing dimension		Repair value
Std.	67.957 - 67.970	67.9
Shaft diameter at Crankshaft Pin \varnothing (mm)		
Outside dia. finishing dimension		Repair value
Std.	51.964- 51.975	51.90

I. Flywheel and Ring Gear

1. Inspect the ring gear and replace it if it is damaged or excessive wear is noticed. If the wear is limited to a small area, remove the ring gear and turn it 90° and heat-shrink it to re-use it. To shrink-fit the ring gear heat it to 120° - 150° C to allow for expansion.

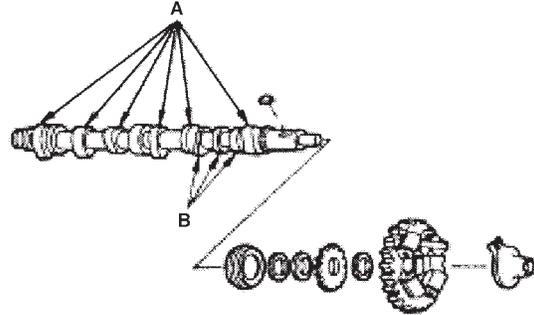


W844ringgear

Engine Main Parts Inspection

J. Camshaft Assembly

1. Inspect the journal and cam for wear and damage and replace it if the service limit is exceeded. Correct slight wear or scars on the cam surface using oil stone or something similar.

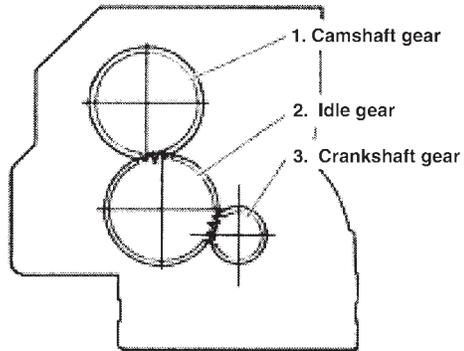


W844camshaft

(A) Height of intake/exhaust valve cams (mm)	
Standard assembly value	Service limit
34.453 - 34.508	34.1
(B) Height of injection pump cams (mm)	
Standard assembly value	Service limit
42.94 - 43.06	42.8

K. Timing Gear

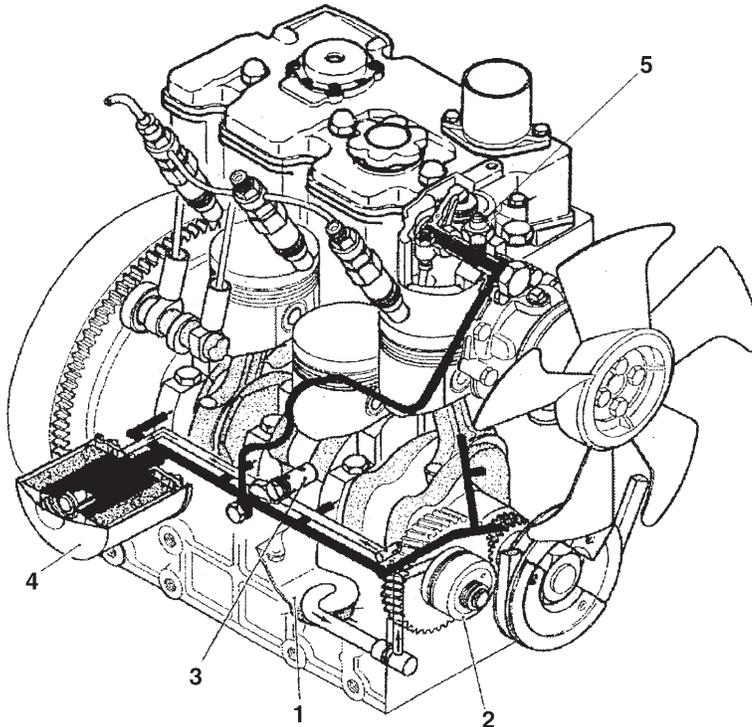
1. Replace the gears if excessive wear or pitting is seen on the tooth face of the gears. Measure the backlash of the gears and replace them if the service limit is exceeded.



W844gears

Timing Gear Backlash (mm)	
Standard assembly value	Service limit
0.08	More than 0.25

Oil Flow



1. Suction Filter
2. Oil Pump
3. Relief Valve
4. Oil Filter
5. Oil Pressure Switch

Engine Main Parts Inspection

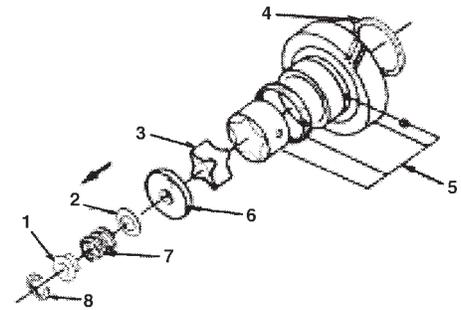
L. Oil Pump

1. Remove the oil pump from the engine and then remove the snap ring and take out the collar, spring, and shim. Take out the idler gear, the vane, and the oil pump together. Then take out the rotor and thrust washer and extract the oil pump cover from the idler gear.

2. Inspect the oil pump cover, rotor, and vane and replace them if they are worn out or excessively damaged.

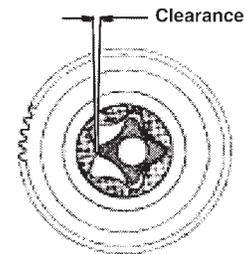
3. Measure the clearance between the rotor and vane and replace the parts if the service limit (0.25 mm) is exceeded.

4. Re-assemble the pump in the reverse order as the dis-assembly. Install the crankshaft gear and idle gear while aligning the match mark. Adjust the side clearance of the rotor and vane to 0.1 - 0.15 mm. (See the oil flow on page 16.)



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

W844oilpump



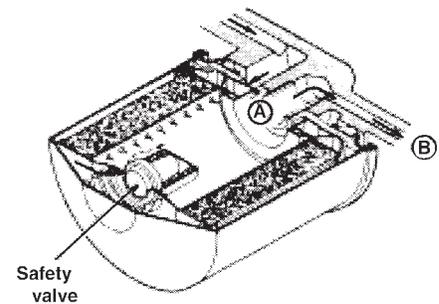
W844pumpcover

M. Oil Filter

1. This cartridge type oil filter is of the full-flow type when the filter is clogged the safety valve opens to allow the oil to flow, to prevent seizure of the parts.

2. The oil is fed under pressure with the oil pump (A on figure at right) filtered by the element and supplied to each part (B). If the element gets clogged, oil is supplied to each part without passing through the element.

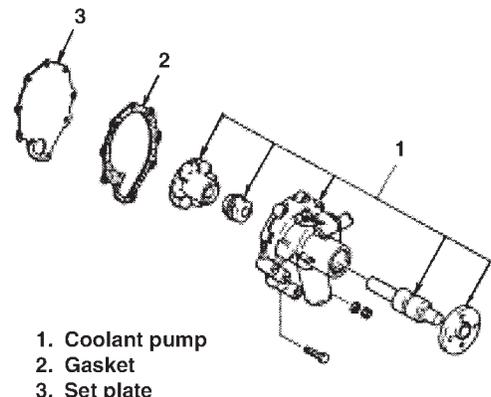
3. Replace the oil filter every 250 hours of operation. Coat the filter mounting surface with oil and tighten the filter by hand. Do not reuse the filter if it is removed once.



W844oilfilter

N. Coolant Pump

1. When dis-assembling, remove the set plate gasket. The pump main body is aluminum die cast and should be replaced as an assembly if water leakage occurred or some such thing. Re-assemble in reverse order as it was taken apart.



- | |
|-----------------|
| 1. Coolant pump |
| 2. Gasket |
| 3. Set plate |

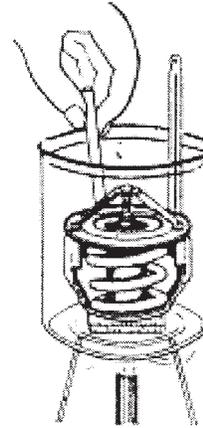
W844coolantpump

Engine Main Parts Inspection

O. Thermostat

1. If the valve on the thermostat is open even just slightly at normal temperature, replace it.
2. To check the thermostat, immerse it in water and increase the water temperature gradually while checking the valve opening temperature and valve lift. Three to five minutes are required until the valve operates. Re-install if it checks out fine.

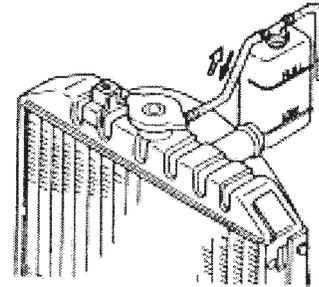
Type	Wax Pellet
Opening Temperature	80° - 84°C
Full-opening Temperature	95°C
Valve Lift	8.0 mm



W844thermostat

P. Radiator

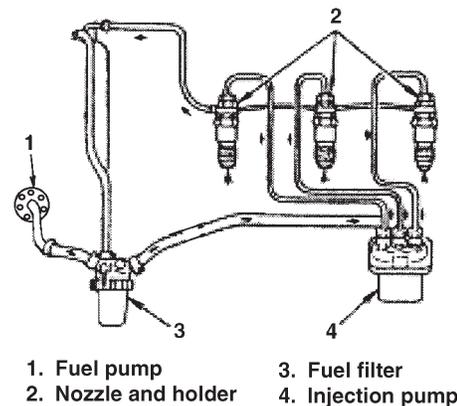
1. Inspect the radiator, pipes, and reserve tank for leakage and repair if necessary.
2. Check the radiator fins for dust or mud possibly clogging the air passage, and remove.
3. Check the pressure valve and negative pressure valve of the radiator cap for the opening pressure and sealing condition. Replace if they are defective.
4. Inspect the radiator hose and replace if damaged.
5. Remove and clean the net if it is clogged.
6. Make sure the cooling water level in the reserve tank is between “full” and “low”.



W844radiator

Q. Fuel Filter

The fuel passes through (as shown in the figure at right), pressurized to a high pressure by the injection pump and fed to the nozzle and then injected to the combustion chamber. The fuel pipe takes the fuel to lubricate the nozzle needle. If after inspection of the fuel filter, any water, dust, or foreign material is found in the transparent plastic case - clean and replace filter if needed. Remove the filter by turning the filter ring nut counter clockwise. Be sure to coat the o-ring between the ring nut and main body with grease. Also coat the element where it mounts to the main body with grease and install by hand.



W844fuelpassage

Engine Main Parts Inspection

R. Injection Pump

If the injection pump needs to be serviced, do not disassemble it - take it to an authorized injection pump repair shop. No separate service parts are available for the fuel injection pump.

Troubleshooting (check Troubleshooting section for other possibilities):

Trouble	Possible Cause	Solution
Engine does not start.	Fuel shortage or air mixed in.	Replenish fuel, check air entering part, bleed air out. Check and possibly replace the electric system.
Engine starts but does not stop right away.	Filter or pipes clogged. Air mixed in. Stop solenoid wires damaged or disconnected.	Replace or clean out. Check fuel pipe and connections. Inspect and repair.
Engine output unstable	Air mixed in. Water mixed in fuel.	Check fuel pipe and connections. Change fuel, replace filter.

Engine Main Parts Inspection

S. Nozzle and Holder

Pintle diameter	ø 1
Valve Opening	15.2 - 16.2 MPa
Nozzle Holder	(155 - 165 kgf/ cm ²)
Nozzle Type:	Throttle
Injection Angle	4°
Needle Valve Diameter	ø 4

Functions:

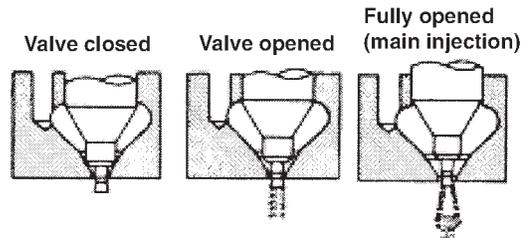
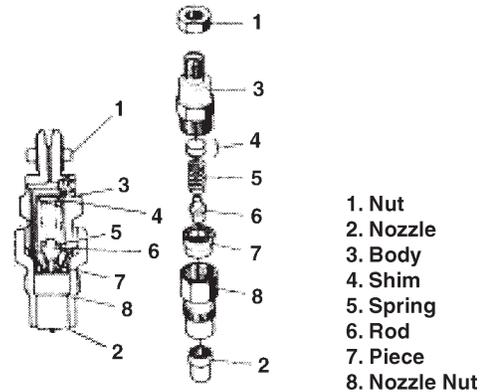
1. The nozzle is precisely machined to inject the fuel under pressure from the injection pump to the combustion chamber. Components of the part are shown at right.

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, the spring is pushed, injected from the nozzle, and at the same time lubricates the nozzle and nozzle body, and cools them.

The extra oil is taken away by the return pipe.

To disassemble, place the nozzle holder in a vice and turn the nozzle nut. **Take care to not allow the needle valve to drop when the nozzle is removed.**

1. Wash the nozzle and needle valve and look for the nozzle sticking or fuel leakage on the seat surface. Lap the seat surface if fuel is found.
2. Check the contact areas on the upper and lower part of the distance piece (#7 on right figure) and make sure they stick very closely to their respective parts.
3. Inspect the push rod for wear on the nozzle needle valve contact surface, and check the spring seat for cracks.

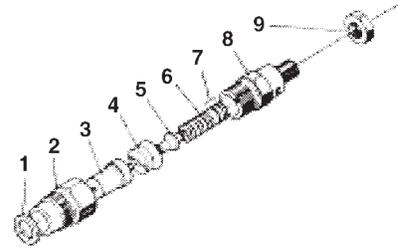


W844nozzle

Engine Main Parts Inspection

S. Nozzle and Holder (continued)

1. When putting together a new nozzle assemble, heat light oil to 50-60°C and remove the rust preventative oil. Make sure the body and needle valve slide lightly.
2. Invert the body and assemble the shim, spring, rod, piece, and nozzle on in the order as seen on right. Cover the nozzle nut and tighten.
3. Check the nozzle injection pressure after assembly. With the adjusting washer ,or shim, adjust the injection so that it starts at 15.7 MPa (160 kgf/cm²), using a nozzle tester. The pressure increases or decreases about 0.98 MPa (10 kgf/cm²) with a washer of 0.1 mm.
4. When inspecting the injection condition, make sure small drops are not mixed in the spray. The oil should be injected so that it looks like a cone on white paper with straight lines going towards the center of the nozzle. Put a white sheet of paper about 30 cm from the nozzle and make sure the injection spray is basically circular.
Make sure the oil pressure is lower by 1.96 MPa (20 kgf/ cm²) than the specified value - 15.7 Mpa (160 kgf/ cm²) and check that the test oil does not drop from the nozzle end.



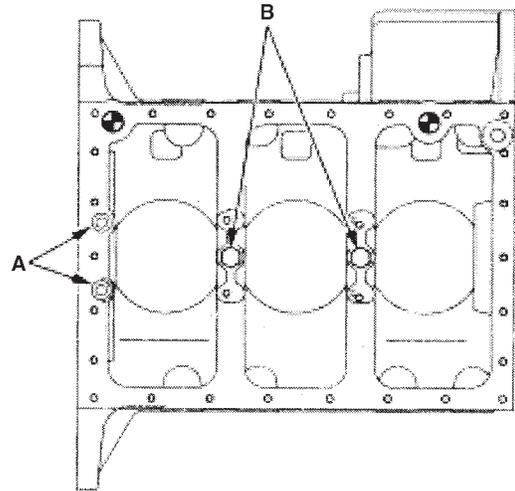
1. Gasket
2. Nozzle Nut
(Tightening torque: 3~5 kgf•m)
3. Nozzle
4. Piece
5. Rod
6. Spring
7. Shim
8. Body
9. Nut
(Tightening torque: 3~4 kgf•m)

W844injnozzle

Engine Reassembly

Important notes before assembly:

- First wash the parts that are going to be reinstalled. (Be sure to wash the oil passage, bearing, piston, and cylinder bore carefully.)
- Coat the sliding and rotating parts of the cylinder bore, piston, bearing, and other moving parts with new oil before installing them.
- Replace the gaskets with new ones. Use liquid packing if necessary to prevent oil leakage.
- Do not excessively over tighten nuts and bolts for aluminum alloy parts. Tighten fasteners with the specified torque.



W844cylblockbolts

1. Relief Valve with O-ring Assembly

Relief valve tightening torque:

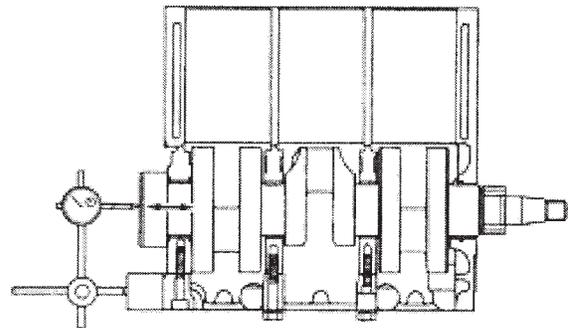
59 - 69 N•m (6.0 - 7.0 kgf•m) [43.5 - 50.8 ft.•lbs.]

2. Crankshaft and Bearing Holder Assembly

Cylinder block to bearing holder tightening torque:

Bolts holding bearing holder		
A	Hexagon socket head bolt	25-29 N•m (2.5-3.0 kgf•m) [18.4-21.4 ft.•lbs]
B	Hexagon bolt	49-54 N•m (5.0-5.5 kgf•m) [36-39.8 ft.•lbs.]

Be sure not to damage the bushing in the cylinder block by the crankshaft gear when installing the crankshaft and bearing holder assembly. Install the two hexagon socket head bolts for the flywheel side bearing holder.

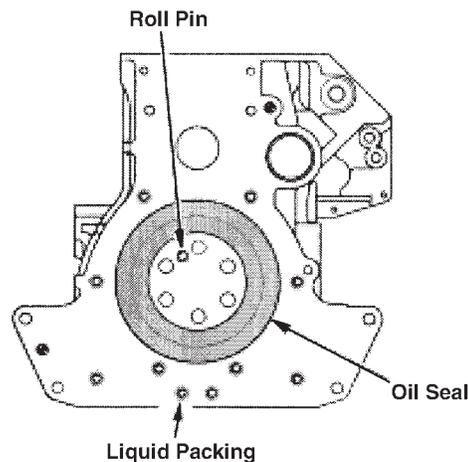


W844crankshaftendplay

Measure the endplay of the crankshaft.

Crankshaft End Play	
Standard assembly value	Service limit
01. - 0.3 mm	0.5 mm

Oil seal assembly - see figure at right.



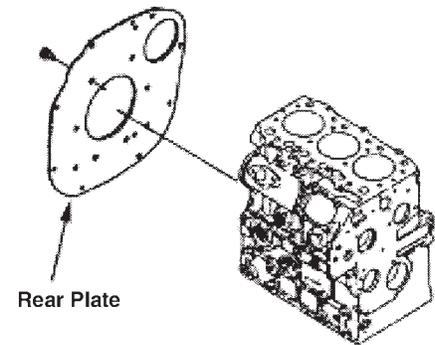
W844oilseal

Engine Reassembly

Rear Plate

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

Rear plate tightening torque:
23 - 28 N•m (2.3 - 2.9 kgf•m) [17- 20.6 ft•lbs.]

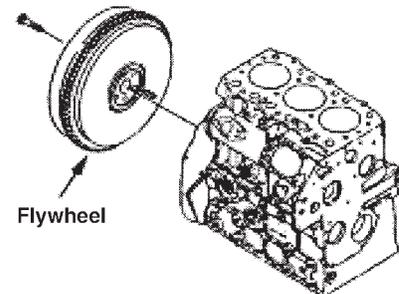


W844rearplate

Flywheel

Align the hole to the roll pin on the crankshaft.

Flywheel tightening torque:
69 - 78 N•m (7.0 - 8.0 kgf•m) [50.8- 57.5 ft•lbs.]



Piston and Connecting Rod Assembly

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

Turn the ring so that the oil coats the ring groove.

Set the ring end gaps to 90° respectively, and avoiding the piston pin direction and right angles to the piston pin.

Insert the ring so that it faces the match mark on the connecting rod towards the injection pump side, using ring pliers.

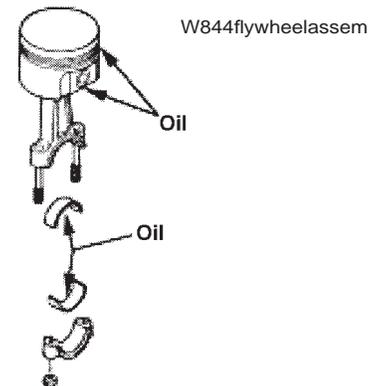
Place the smallest connecting rod figure match mark to the front side so that the figures increase gradually.

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

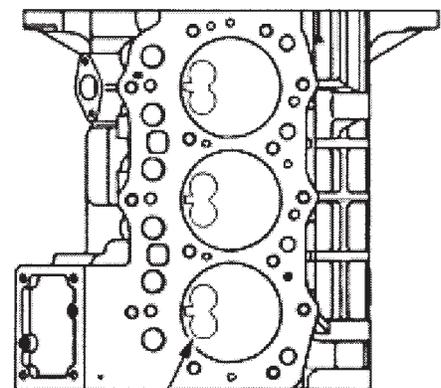
Connecting Rod tightening torque:
49 - 54 N•m (5.0 - 5.5 kgf•m) [36- 39.8 ft•lbs.]

After tightening to torque, make sure that the crankshaft moves lightly.

The connecting rod should move 0.1 - 0.3 mm towards the axial direction.



W844pistonoil



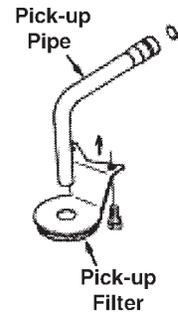
Injection pump side

W844injumpsided

Engine Reassembly

Pick-up Pipe and Filter

Insert the pick-up pipe to the cylinder block with an o-ring fitted to the pick-up.
 Then place the pick-up end into the filter and attach.
 Suction Filter tightening torque:
 9 - 13 N•m (0.9 - 1.3 kgf•m) [6.6- 9.6 ft.•lbs.]

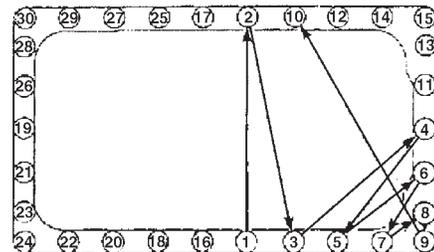


W844suctionfilter

Oil Pan

Tighten the bolts of the oil pan from the center out, tightening the opposite bolts on the diagonal next.

Bolt tightening torque:
 10 - 13 N•m (1.0 - 1.3 kgf•m) [7.4- 9.6 ft.•lbs.]



W844boltorder

Dipstick

Install the dipstick and guide with two o-rings.

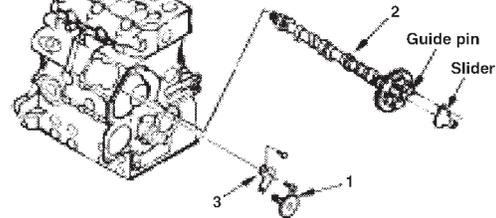
Front Plate

Install a gasket with the front plate.

Camshaft Assembly, Tachometer Shaft Plate

Install the tachometer shaft.
 Then install the camshaft assembly, being careful of the bearing. Put the plate on to fix the tachometer shaft and camshaft.

Plate tightening torque:
 9 - 13 N•m (0.9 - 1.3 kgf•m) [6.6- 9.6 ft.•lbs.]



W844slider

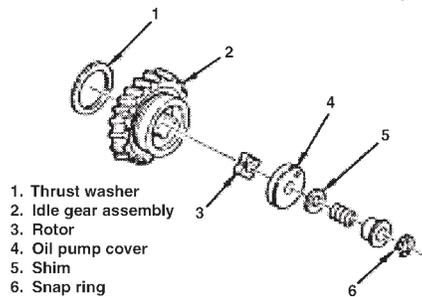
Be sure that the slider is not dislocated from the guide pin while installing the timing gear case.

Idle Gear, Oil Pump Assembly

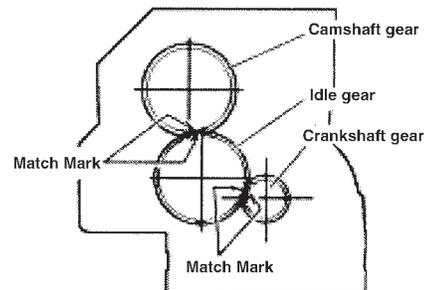
Put a thrust washer on the idle gear shaft and then install the idle gear assembly.
 Align the match marks of the idle gear, crankshaft gear, and camshaft gear and install it to the idle gear shaft. Then install the rotor.

Install the oil pump cover, shim, spring, and collar and fix them with a snap ring.

*Notes: Coat both sides of the rotor and vane with grease before installation.
 Do not turn the crankshaft until the timing gear case is installed. Turn the oil pump cover both ways until the hole at the center of the spring pin is in the center of the moving distance and then install the gear case.*



W844oilpumpassem



W844matchmarks

Engine Reassembly

Pick-up Pipe and Filter (continued)

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

Timing Gear Case, Cover

Loosen the lock nut and take out the low idle set bolt. Install the start spring between the timing gear case and governor link.

Insert the link into the cylinder block hole while turning the governor lever clockwise and holding it, then install the timing gear case.

Reinstall the low idle set bolt and secure the lock nut. Finally, install the covers.

Crankshaft Pulley

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

Crankshaft pulley tightening torque:
274 - 333 N•m (28 - 34 kgf•m) [202- 245 ft.•lbs.]

Injection Pump Assembly

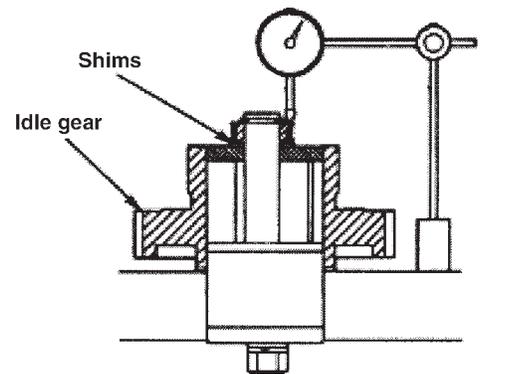
Place the shim back, which had been removed at disassembly, and link up the control rack of the injection pump, fasten with the snap pin. Tighten the injection pump down with the bolts and nuts.

Injection pump tightening torque:
13 - 17 N•m (1.3 - 1.7 kgf•m) [9.6- 12.5 ft.•lbs.]

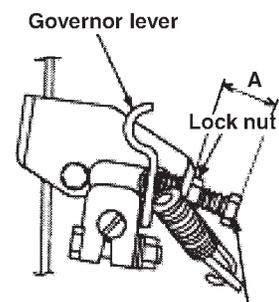
Injection Timing Adjusting Shim	
Thickness (mm)	Part #
0.2	131437490
0.3	131437500
0.4	131437510
0.5	131437520
0.5	131437530

Notes: Use liquid packing, coated on, if a shim is not required.

The injection timing varies about 2° with 0.3 mm of shims. When you need an adjustment with shims more than 1.0 mm, use a 0.5 mm shim with beading and a 0.5 mm shim without beading.

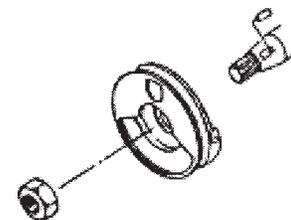


W844shims

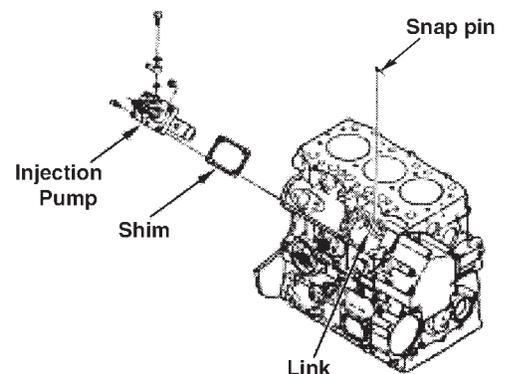


Low idle adjusting bolt

W844governorlever



W844nut



W844snappin

Engine Reassembly

Oil Filter

Put a small quantity of oil on the mounting surface and tighten by hand.

Engine Stop Solenoid

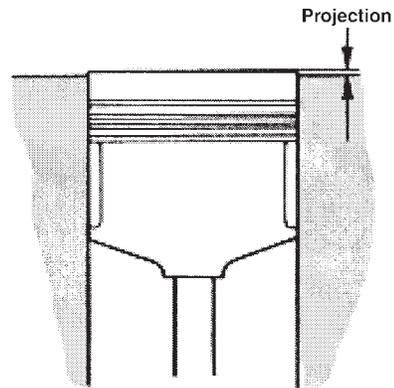
Tighten the engine stop solenoid with pliers, lightly.

Cylinder Head Assembly

Rotate the crankshaft to get the piston to Top Dead Center (TDC) and then measure the projection or depression from the face of the cylinder block with a depth gauge or dial gauge.

Note: Measure while pushing down the piston lightly by hand.

Use the cylinder with the largest projection or depression (844LW2 models) distance among the cylinders as reference. The variation among all the cylinders should be within 0.1 mm in measured value.



W844piston

Select a head gasket based on the measured values below.

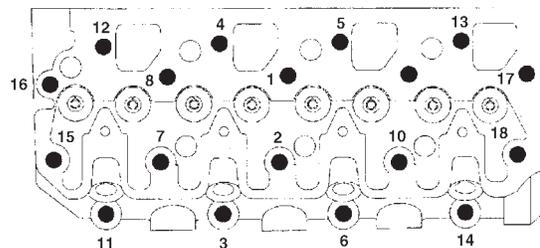
Engine Model.	Measured Value (mm)	Head Gasket Part #	Thickness when tightened
844W2	0.5 - 0.6	111147510	t = 1.2
	0.6 - 0.7	111147520	t = 1.3
844LW2	-0.3 to -0.45	111147580	t = 0.4
844LW2	-0.2 to -0.3	111145790	t = 0.5

Tighten the cylinder head bolts in the order shown at right, in several steps. Tighten down with the below specified torque.

Cylinder head tightening torque:
98 - 103 N•m (10 - 10.5 kgf•m) [72.2- 76 ft.•lbs.]

Be careful of the spring pin which positions the cylinder head assembly.
Coat the threads with grease that contains disulfide molybdenum.

Tightening order



W844cylhead

Engine Reassembly

Rocker Arm Assembly, Caps, Pushrods

Install the caps to the valve stem ends. (#1 of figure at right).

Then install the push rod and rocker arm assembly. (#2)

Rocker arm assembly tightening torque:
27 - 39 N•m (2.8 - 4.0 kgf•m) [20- 28.8 ft.•lbs.]

Valve Clearance Adjustment

Loosen the intake and exhaust valve nut and adjust the valve clearance to 0.2 mm by turning the adjustment screws.

Adjust the valve clearance when the engine is cold. Be sure the tappet is in the lowest position before making the adjustment. To do this - put the piston at TDC on the compression stroke with both valves closed.

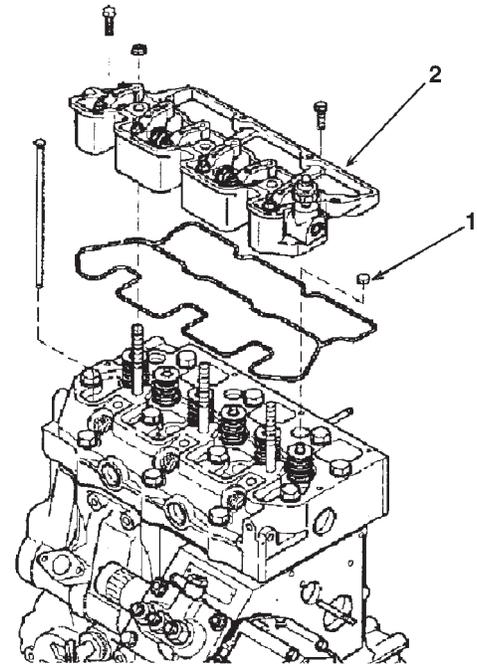
Lock nut tightening torque:
12 -16 N•m (1.2 - 1.6 kgf•m) [8.6- 11.8 ft.•lbs.]

Oil Pressure Switch

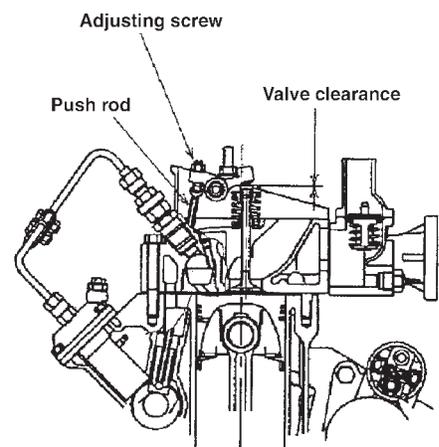
Oil pressure switch tightening torque:
10 -12 N•m (1.0 - 1.2 kgf•m) [7.4- 8.6 ft.•lbs.]

Oil Pipe

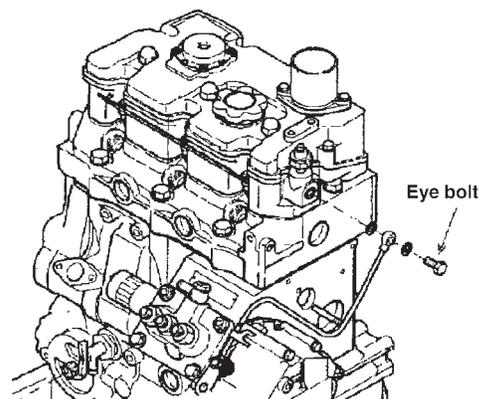
Eye bolt (M8) tightening torque:
10 -13 N•m (1.0 - 1.3 kgf•m) [7.4- 9.6 ft.•lbs.]



W844pushrod



W844valveclear

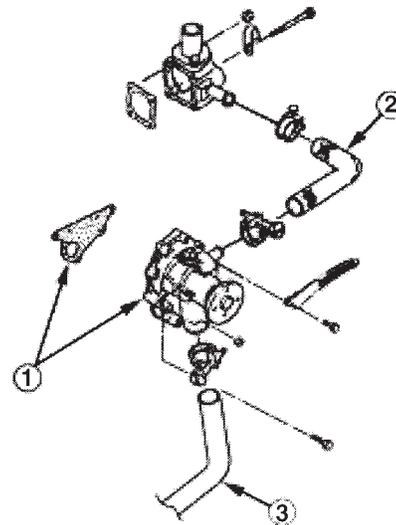


W844eyebolt

Engine Reassembly

Water Pump Assembly, Bypass Hose

Put together and tighten the gasket and water pump assembly. (#1 at right). Connect the thermostat case and water pump case with the bypass hose (#2 at right). Install the radiator hose (#3).



W844bypass hose

Head Cover, Filler Pipe

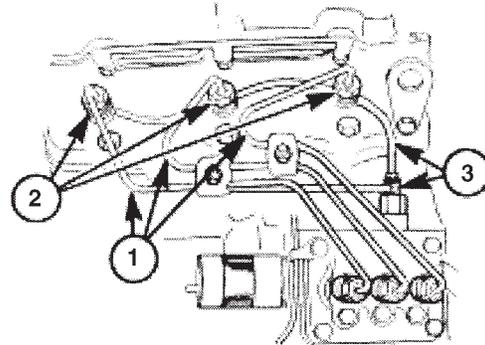
Tighten down the head cover and filler pipe evenly, while being careful of the o-ring.

Head cover tightening torque:
12 - 16 N•m (1.2 - 1.6 kgf•m) [8.6- 11.8 ft.•lbs.]

Nozzle and Holder Assembly

Tighten the nozzle and holder assembly to the specified torque using a nozzle holder socket wrench.

Nozzle and holder tightening torque:
59 - 69 N•m (6 - 7 kgf•m) [43.5- 50.9 ft.•lbs.]



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

W844nozzleholder

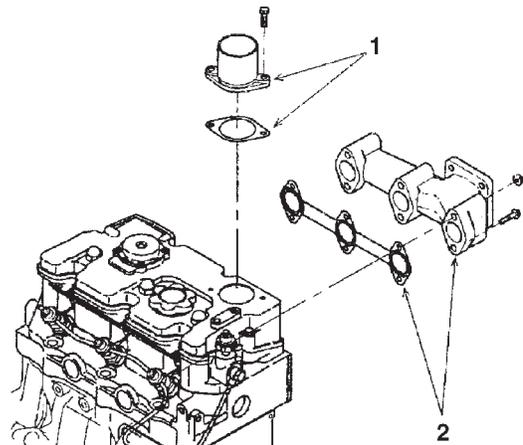
Return Pipe Assembly, Injection Pipe

Return pipe tightening torque:
29 - 30 N•m (3.0 - 4.0 kgf•m) [21.4- 22.1 ft.•lbs.]

Injection pipe tightening torque:
23 - 36 N•m (2.3- 3.7 kgf•m) [17- 26.6 ft.•lbs.]

Intake Manifold, Spacer, Exhaust Manifold

First install the gasket, then the spacer, then the intake manifold gasket, and then the exhaust manifold.

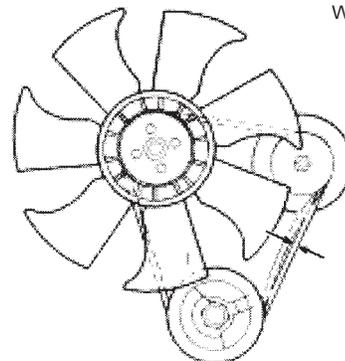


W844spacer

Alternator, V-belt, Fan Pulley, Cooling Fan

Install the alternator, then the fan pulley, and the cooling fan, and then the V-belt. Adjust the belt tension with the alternator so that the belt is deflected 5 - 10 mm in the middle point between the crankshaft pulley and alternator pull when depressed with a finger (about 5 kgf) and tighten.

Cooling fan tightening torque:
9 - 13 N•m (0.9 - 1.3 kgf•m) [6.6- 9.6 ft.•lbs.]



W844fan

Removal and Inspection

**Caution:**

Be sure to disconnect the negative (-) battery cable from the battery before starting any work on the electrical system. Electrical shock or damage to engine components could result could occur if this is not done. Some testing requires 12 volt power, extra care should be taken in these cases.

Fuel Shut-off Solenoid

The fuel shutoff solenoid is located on the right side of the engine, threaded into the rear of the fuel injection pump (#1 on picture at right). The shutoff solenoid contains a spring loaded plunger that pushes the control rack of the injection pump to the shut-off position (closed) when the solenoid is not energized. When the key switch is turned “On” or to “Start”, the safety stop relay closes to complete the circuit that energizes the solenoid. This then retracts the plunger from the injection pump and the control rack of the injection pump allows the engine to start.

To remove the solenoid, first disconnect the negative (-) battery cable from the battery.

Then disconnect the wiring harness lead from the fuel shutoff solenoid.

Carefully remove the fuel shutoff solenoid from the engine with a pair of pliers.

After removal, discard the sealing washer (#1 at right).

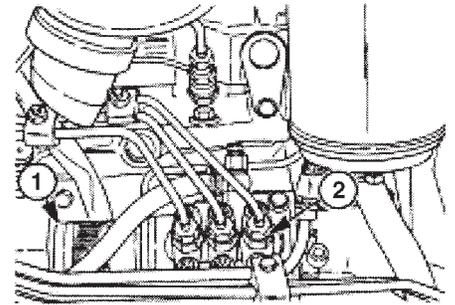
To test the solenoid; measure the protrusion distance (“A” on figure at right) on the solenoid. The distance should measure between 25.5 - 26.4 mm. If the distance is not within those perimeters, the solenoid is defective and needs to be replaced.

Note: Be sure the paint is removed from the solenoid body when connecting the 12 volt power supply to the solenoid body, or power will not be transferred to the solenoid.

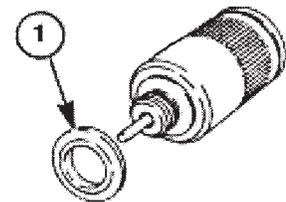
Use jumper wires to connect the positive (+) terminal of a 12 volt power supply to the solenoid lead (#1 on right figure). Connect the negative terminal of the 12 volt power supply to the solenoid body (#2). The plunger should retract into the solenoid body (#3).

Measure the protrusion distance (“B” on right), it should be between 11.5 - 14.5 mm. If the distance is not within those perimeters or the plunger does not retract, the solenoid should be replaced.

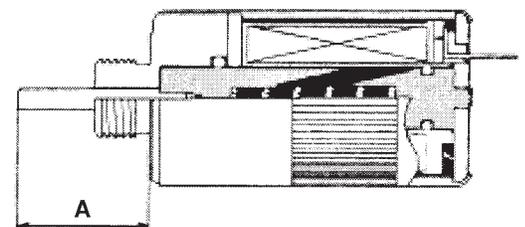
Reassembly in reverse of the above disassembly and install a new sealing washer on the solenoid.



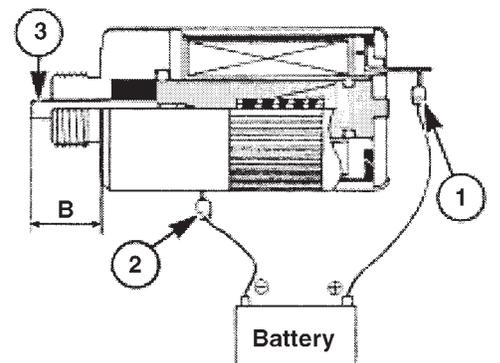
W844fuelshutoff



W844sealingwasher



W844sealingwasher



W844battery

Removal and Inspection

Glow Plugs

The glow plugs are located on the right side of the engine cylinder head, next to the fuel injectors. (#1 on figure at right). The glow plugs preheat the air going to the pre-combustion chamber which helps in the starting of the engine when it's cold.

To remove the glow plugs for testing, first disconnect the negative (-) battery cable from the battery. Then remove the 3 nuts (#1 at right) and washers attaching the electrode bar (#2) to the glow plugs. Then remove the glow plugs from the engine cylinder head.

To test the glow plug, first clean the carbon from the sheath end of the glow plug, but do not test resistance using the glow plug sheath.

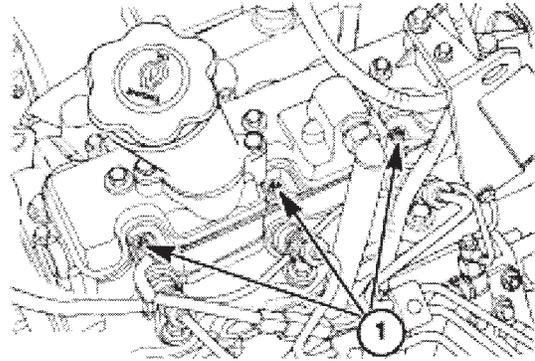
Using an ohmmeter, touch one test probe to the glow plug electrode. Touch the other test probe to the glow plug body. A normal reading is 1.0 ohms, maximum, for a standard glow plug. If the resistance measured is too high, the glow plug needs to be replaced.

To reinstall the glow plugs, thread the glow plugs into the engine cylinder head. Torque each glow plug to 15 - 20 N•m (1.5 ~ 2.0 kgf•m) [11- 14.7 ft.•lbs.]. Then install the electrode bar and put the washers on the glow plugs, and secure with the three nuts. Finally, connect the negative (-) battery cable back on the battery.

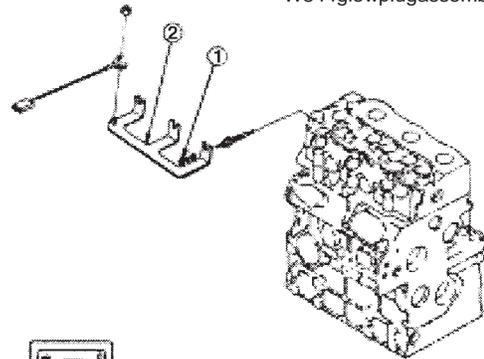
Oil Pressure Switch

The oil pressure switch (#1) is located on the front top of the cylinder head. The oil pressure switch closes (completes the circuit) when the oil pressure of the engine is less than 29.4 kPa. When this happens, an indicator light on the instrument panel should go on. The oil pressure switch is closed before the engine is started and opens after starting. If the switch does not work after starting, the oil level in the engine may be too low or there might be a problem with the oil pump.

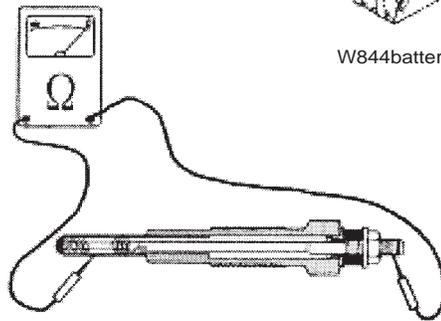
To test the oil pressure switch, use an ohmmeter and touch one lead to the pressure switch terminal (#1 at right) and the other lead to the threads of the switch body (#2). There should be little or no resistance on the ohmmeter, indicating continuity in the switch. If there is no continuity the switch needs to be replaced.



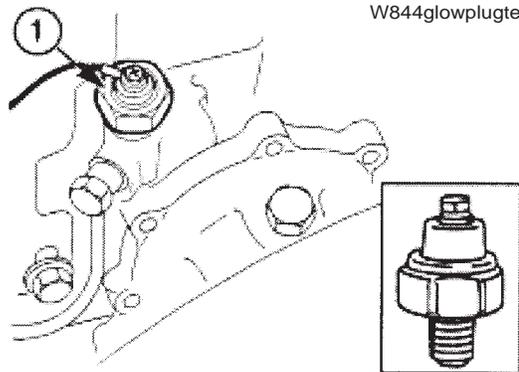
W844glowplugassemb



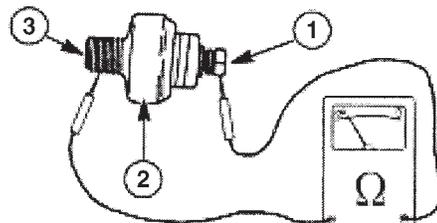
W844battery cable



W844glowplugtest



W844oilpressure1



W844oilpressure2

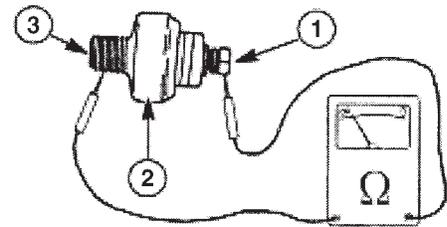
Removal and Inspection**Oil Pressure Switch (continued)**

While the test leads are connected to the switch, pressurize the switch at the port (#3 at right) with low pressure, 69~ 138 kPa (0.7~ 1.4 kgf/c m²) compressed air.

Do not use high pressure compressed air as this may damage the oil pressure switch. This is not a calibrated test, the purpose is to see if the switch contacts open with pressure.

The ohmmeter should indicate high resistance while the air pressure is going to the pressure port (no continuity). If there appears to be continuity, the switch needs to be replaced.

To reinstall the oil pressure switch - put it back into the cylinder head and tighten to 14.7~ 19.6 N•m (1.5~ 2.0 kgf•m) [10.8- 14.5 ft.•lbs]. Install the ring terminal onto the oil pressure switch, and secure the terminal with the retaining screw (#2).



W844oilpressure2

Removal and Inspection

Alternator Maintenance Chart

A007TO3877 (Mitsubishi)		
Nominal output		12 volt 40 Amp
Polarity		Negative ground
Weight		3.7 kg (8.2 lb.)
Rotational direction (viewed from pulley)		Clockwise
Load Char. (cold)	Terminal voltage	13.5 volts
	Current	min. 30 amps
	Revolutions	2500 RPM
Brush Length	Original	18.5 mm (0.728")
	Limit	5.0 mm (0.2")
Brush spring tension	Original	470~ 590g. (1.036~ 1.300 lb.)
	Limit	270 g. (0.60 lb.)
Bearing	Rear side	ECSC8
	Front side	6303DDG
Slip Ring o/w wear	To be repaired	0.05 mm (.002")
	Allowable limit	0.2 mm (0.08")
Slip ring surface condition		If dirty or damaged - correct with emery cloth.
Rotor shaft bending	To be repaired	0.07 mm (.0028")
Field coil resistance		2.8 ohms at 5000 RPM
Adjusting voltage		14.4~ 15.0 volts at 5000 RPM

Troubleshooting

Problem	Parts	Cause	Solution
No charging	Wiring, ammeter	Possible disconnection, short circuit, loose connection.	Repair.
	Alternator	Disconnection of coils, ground short circuit. Defective rectifier.	
	Regulator	Disconnection of RF resistor. Defective regulator.	Replace. Replace.
Weak charging	Wiring	Possible disconnection, short circuit, loose connection.	Repair.
	Alternator	Possible loose belt, rotor coil short, stator coil short, defective rectifier, insufficient contact of brush, stained slip ring.	Repair or Replace.
	Regulator	Defective regulator.	Replace.
	Battery	Defective battery.	Replace.
Over charging	Battery	Internal short circuit.	Replace.
	Regulator	Defective regulator.	Replace.
Unstable charging current	Wiring	Disconnection or wire broken.	Replace.
	Alternator	Drive belt loose. Rotor coil short, wire broken, or stator coil short, wire broken. Brush not contacting, or stained brush and slip ring. Possible broken brush and spring, or insufficient contact of terminals.	Repair or Replace.
	Regulator	Defective regulator.	Replace.
Abnormal noise of alternator	Alternator	Alternator installed incorrectly. Defective bearing. Rotor core and stator core in contact. Defective diode. Stator coil short.	Repair or Replace.

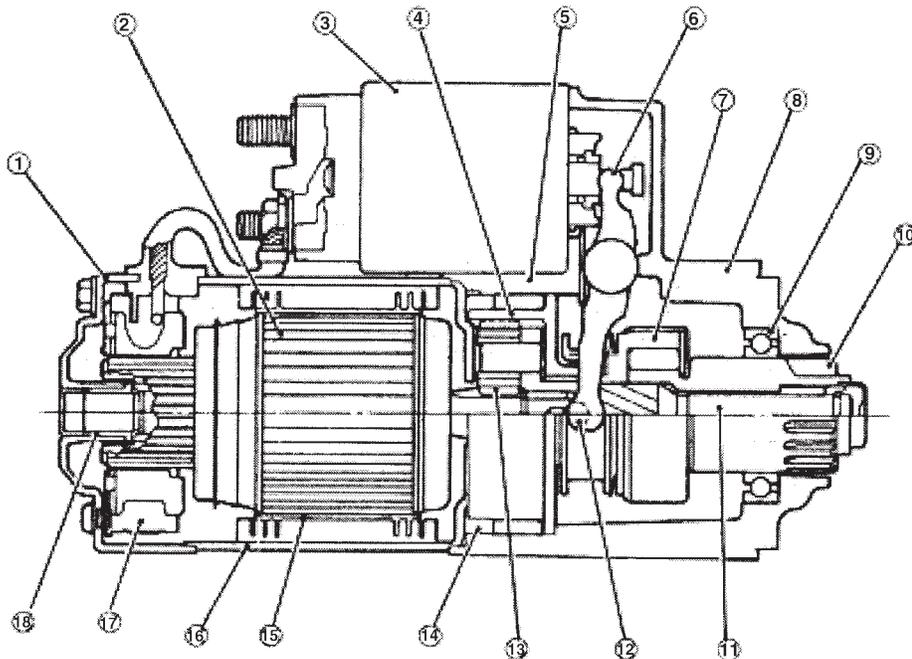
W844slipring2

Removal and Inspection

Starter

This starter (Part #185086551) has a reduction mechanism with a planetary gearing system and permanent magnets for magnetic field induction. Its reduction internal gear is comprised of three planetary gears, gear shafts (with an over-running clutch fitted by a spline) and an armature shaft gear. The structure is different from a direct drive type of starter, but the electrical wiring is the same between the two types.

The magnetic field is produced by six permanent magnets, which are mounted in the starter yoke and positioned according to polarity. These are permanently attached to the yoke and cannot be removed.



W844benchalt

- | | | |
|------------------------|---------------------|--------------------|
| 1. Rear bracket | 8. Front bracket | 15. Magnets |
| 2. Armature | 9. Bearing | 16. Yoke |
| 3. Switch | 10. Pinion | 17. Brushes |
| 4. Internal gear | 11. Gear shaft | 18. Sleeve bearing |
| 5. Lever packing | 12. Ball | |
| 6. Lever | 13. Planetary gears | |
| 7. Over-running clutch | 14. Rubber cover | |

Removal and Inspection

Starter (continued)

Before disassembling the starter - be sure to put match marks both at the switch and yoke (or two locations) so that mistakes can be avoided at reassembly.

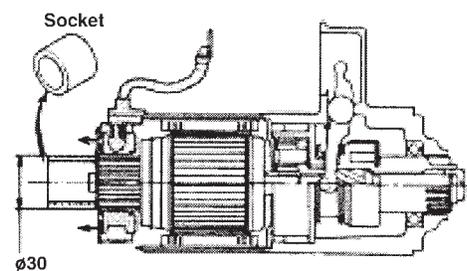
Be sure not to clamp the yoke in a vise or hit it with a hammer while repairing it as this could damage the permanent magnets or dent the yoke.

To disassemble the starter - first remove the terminal nut (#1 on figure below) and disconnect the connecting wire (#2). Then remove the screws (#3) that secure the switch and remove the switch and plunger (#4).

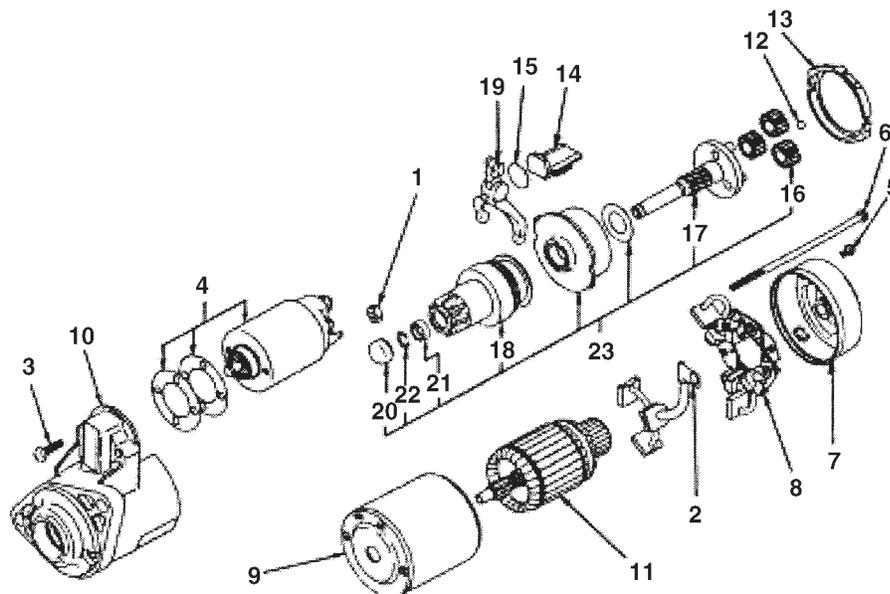
Remove the brush holder screws (#5) and through bolts (#6). Remove the rear bracket (#7), but do not remove the brush holder (#8).

Install a socket (of outer diameter 30 mm) on the armature commutator (see figure at right). Then slide the brush holder (#8) onto the socket. Leave the socket in position in the brush holder for inspection and reassembly.

Slide the yoke (#9) away from the front bracket (#10). Remove the armature (#11) and ball (#12). Do not lose the ball when removing the armature.



W844startersock



W844starterassemb

Removal and Inspection

Starter (continued)

Remove the rubber cover (#13 starter assembly facing page) from planetary gear assembly (#23) and remove lever packing (#14) and plate (#15).

Remove planetary gears (#16), then remove the gear shaft/ overrunning clutch assembly (#18) and lever (#19) as a unit from the front bracket (#10).

To remove the overrunning clutch (#18), first remove the plastic cap (#20). If the cap is cracked or otherwise damaged, it should be replaced for reassembly. Slide a piece of pipe of suitable size over the shaft against the stop ring (#21). Then tap the pipe with a hammer to remove the stop ring and expose the snap ring (#22). Remove the pipe from the shaft.

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 should be replaced for reassembly.

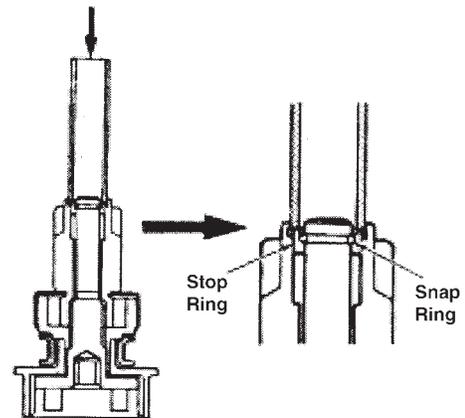
Inspect the armature with a growler tester; inspect the armature coil for short-circuit. If there is a short-circuit, replace the armature.

Inspect the armature coil for ground with a circuit tester. Replace the armature if it is grounded. Inspect the commutator for wear. If it is below the limit, replace the armature. Also inspect the commutator for insulator depth, correct if below the limit. Check the gear teeth for wear or damage and replace the armature if needed.

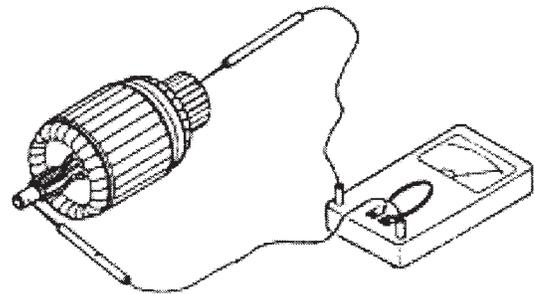
Check the permanent magnets for cracks, damage, and whether or not they are loose. Replace the yoke assembly if necessary.

Check the brushes for wear. Replace the brushes if below the limits specified. Check the brush spring pressure to make sure the brush moves smoothly in the brush holder.

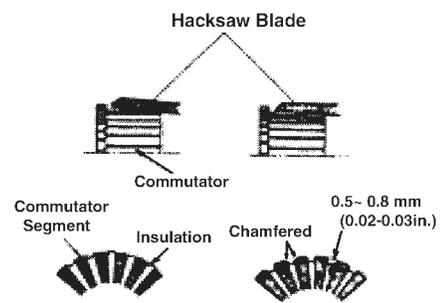
To check the brush holder assembly for grounds, touch one probe of a circuit tester to the holder plate and the other probe to each of the insulated holders. Replace the brush holder assembly if any continuity is noted.



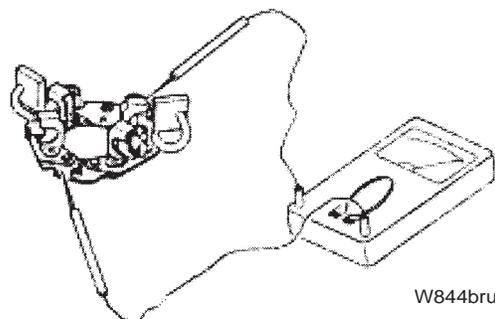
W844snapring



W844armature



W844commutator



W844brushes

Removal and Inspection

Starter (continued)

To inspect the over-running clutch and pinion gear, rotate the pinion while holding the clutch housing. The pinion should rotate smoothly in one direction (not necessarily easily) but should not rotate in the opposite direction. If the clutch is not functioning properly, replace it. If the pinion gear is worn or burred, replace that.

Note: The over-running clutch should not be cleaned with grease dissolving solvents since these would dissolve the lubricant in the clutch mechanism.

Replace the front bracket as an assembly, including the ball bearing, if the bearing rotates ragged or noisily.

If the bearing is worn badly on the rear bracket, replace the rear bracket as an assembly, including the sleeve bearing.

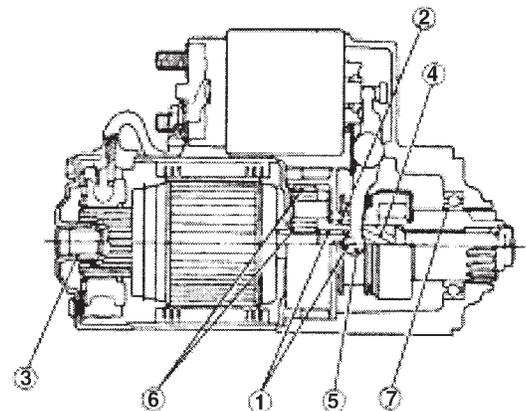
Replace the gears on the planetary and internal gears if the teeth are badly worn.

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

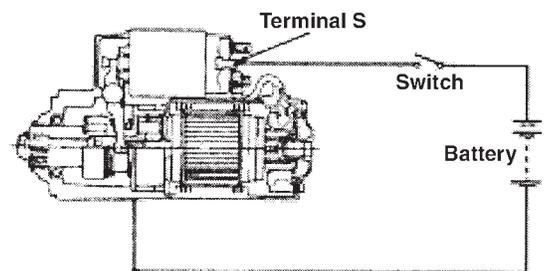
To reassembly the starter, reverse the disassembly steps and first apply grease to the following shown parts.

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 over-running clutch
6. Armature shaft gear, internal gear, and planetary gears
7. Sliding surfaces of pinion and front bearing

After completing the reassembly, check the pinion position to be sure that it is between 0.5 and 2.0 mm. To adjust the position - connect the starter to a battery and close the switch. This will shift the pinion into a ranking position.



W844starterarmature



W844terminalS

Removal and Inspection

Starter (continued)

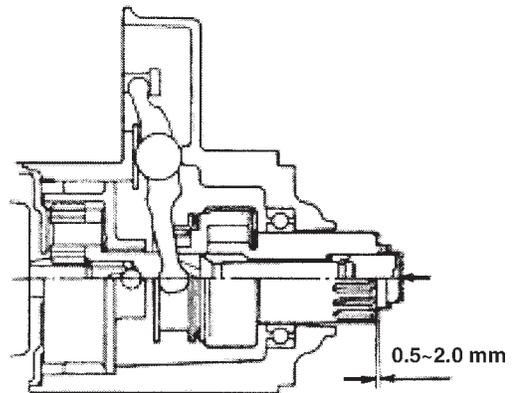
Push the pinion back by hand and measure the amount of the pinion movement as shown on right figure. If the measurement does not fall within the limit (0.5~2.0 mm), adjust by adding or removing shims which are located between the switch and the front bracket. (Adding shims decreases the amount of the movement.)

After adjusting the pinion position, do a non-load test circuit with a voltmeter and an ammeter.

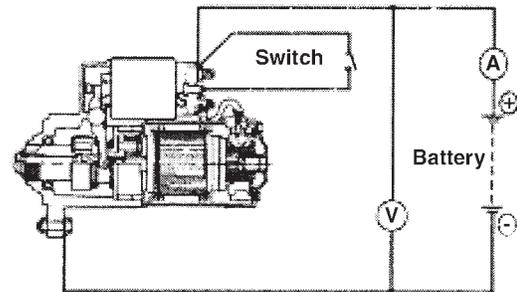
Use wires as thick as possible and tighten each terminal fully.

Close the switch and compare the RPM current and voltage readings with the service specifications.

Compare readings with inspection findings.



W844pinion



W844starter&battery

Starter Maintenance Chart

Item		Standard value or service limit
No-load Char.	Volts	11
	Amps	max. 110 amps
	RPM	2400 min.
Commutator	Outer diameter	29.4 mm
	Service Limit	28.8 mm
Brush	Length	17.5 mm
	Service Limit	10 mm
Brush Spring	Tension	22.5~ 32.5 N
	Service Limit	10 N
Pinion Movement (Pinion gap)		0.5~ 2.0 mm

Notes

Blank area for notes.

SECTION 5 – TROUBLESHOOTING

Troubleshooting, Starter

Problem	Parts	Cause	Solution
Pinion does not advance even when the key switch is on	Wiring	Possible disconnection, loose battery and switch terminals, bad contacts.	Correct and retighten.
	Key switch	Improper contact - no current flow.	Correct or replace contact.
	Starter	Helical spline of the pinion shaft is scored and prevents pinion from moving	Repair or replace.
	Magnet switch	Improper movement of the plunger of the magnet switch or disconnected wire or short circuit of the coil.	Repair or replace.
Motor rotation is not transmitted to the engine even though the pinion is engaged and the motor rotates.	Starter	Defective clutch. Broken reduction gear.	Replace. Replace.
The starting motor does not start even though the pinion is engaged with the ring gear.	Wiring	The wire connecting the battery and magnet switch disconnected or lead wire connecting magnet switch and motor loose.	Repair or tighten or replace the wire.
	Starter	Locked ball bearing.	Replace.
		Installed wrong.	Install correctly.
		Worn out brush, brush spring not contacting.	Replace.
		Stained commutator.	Repair.
	Magnet switch	Defective armature or field coil.	Repair or replace.
		Loose connections of the field coil and brush.	Retighten.
Battery	Broken holding coil. Bad contacts. Contact surface rough. Not charged.	Replace. Replace. Replace. Charge battery.	
Motor starts rotating before pinion is engaged with ring gear.	Starter	Improper sliding of pinion shaft	Replace.
		Worn out tooth top of pinion	Repair.
		Pinion pushing position incorrect	Replace.
	Engine	Worn out ring gear.	Replace.
Magnet switch	Defective magnet switch.	Replace.	

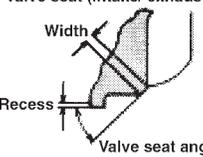
Troubleshooting, Engine

Problem	Cause	Solution
Engine does not start	Defective key switch. Battery not charged correctly. No fuel. Air in fuel system. Fuel injected improperly. Glow plug defective. Oil viscosity wrong. Clogged air cleaner. Cylinder compression off. Defective engine stop solenoid.	Correct contact points. Charge battery. Add fuel. Find where air is entering and correct. Injection pump trouble. Have repaired by authorized shop. Replace. Check and change oil. Clean. Check and correct each part. Check wiring, replace if need be.
Irregular engine speed	Air mixed in fuel system. Uneven fuel injection. Clogged fuel filter. Governor faulty.	Bleed air from fuel Injection pump faulty. Have repaired by authorized shop. Replace the filter. Check and adjust.
Engine stops during operation	No fuel. Clogged fuel filter. Air mixed in fuel system.	Fill up. Replace filter. Find where air is entering and fix.
Engine overheats	Insufficient coolant. Loose fan belt. Clogged radiator or radiator fins. Coolant passage clogged. Thermostat not functioning. Lubricating oil low. Load too high.	Add coolant, check for leaks. Clean and retighten. Clean the radiator and/or fins. Clean. Test and replace if needed. Fill. Reduce load.
Engine Exhaust white color	Too much engine oil. Low viscosity of engine oil.	Check and adjust quantity. Check and change if necessary.
Exhaust black or dark grey	Wrong fuel. Load too high. Clogged air cleaner.	Check and change. Reduce load. Clean element.
Improper charging	Fan belt loose. Wiring defective. Battery or alternator defective.	Correct belt tension. Check and repair. Replace.
Starting motor does not operate	Loose or disconnected wire. Battery voltage dropped. Safety switch defective. Fusible link wire disconnected.	Check and repair. Charge battery. Replace. Replace.

Troubleshooting, Engine

Problem	Cause	Solution
Oil pressure lamp does not go out	Engine oil low. Oil pressure switch defective. Lubricating system leaks oil. Oil filter clogged. Wiring short circuited between oil pressure lamp and main contact.	Fill to specified level. Replace the switch. Check and fix leaks. Replace with new one. Repair wiring.
Oil pressure lamp does not light up with the key switch turned on (while engine is stopped)	Lamp burned out. Disconnected wire between battery and oil pressure lamp.	Replace lamp. Repair.

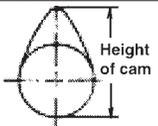
Engine Main Parts

Inspection Items	Standard Dimension	Standard Value	To be Repaired	Allowable Limit	Remarks
Cylinder Head					
Compression pressure of cylinder MPa (kgf/cm ²)		More than 2.94 (More than 30)	Less than 2.45 (Less than 25)		Engine 250 RPM
Cylinder head tightening torque N•m (kgf•m)		98-103 (10.0-10.5) [72.2-76 ft.•lbs.]			Coat threads with engine oil.
Distortion of cyl. head bottom surface		Less than 0.05	0.12		
Valve seat (Intake/ exhaust)		0.85 - 1.15	1.8		Valve sheet angle 45°
					
Width of valve seat	Intake	1.77 - 2.19	2.5		
	Exhaust	1.87 - 2.09	2.5		
Cylinder Block					
Cylinder bore diameter	ø84	ø84 - 84.019		ø84.2	
Cyl. block upper face distortion		Less than 0.05	0.12		
Piston					
Piston skirt bottom longer ø	ø83.955	ø83.948 - 83.963		ø83.7	
Clearance between cyl. and piston		0.038 - 0.072		0.25	at 20°C
Clearance between piston pin hole and piston pin		-0.001 - +0.011		0.02	
Piston pin outside dia.		ø27.994 - 28.0		ø27.97	
Clearance between small end bushing & piston pin		0.010 - 0.027		0.08	Oil Clearance
Piston ring end gap	Top	0.20 - 0.35		1.0 1.2	
	2nd	0.20 - 0.40			
	Oil	0.25 - 0.50			
Clearance between piston ring groove and ring	Top	0.07 - 0.11		0.25	
	2nd	0.04 - 0.08			
	Oil	0.02 - 0.06			
Ring width	Top	2			
	2nd	1.5			
	Oil	4			

Note: Units not specified are in mm.

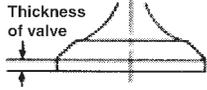
SECTION 6 – ENGINE MAINTENANCE STANDARDS

Engine Main Parts

Inspection Items	Standard Dimension	Standard Value	To be Repaired	Allowable Limit	Remarks
Connecting Rod					
Torsion between small and lg. end holes (per 100 mm)		Less than 0.08	More than 0.2		
Parallelism between sm. & lg. end holes (per 100 mm)		Less than 0.05	More than 0.15		
Axial play of connecting rod and crank pin		0.1 - 0.3		0.7	
Clearance between crank pin & connecting rod		0.035 - 0.085		0.2	Oil clearance
Connecting rod tightening torque N•m (kg•m)		49 - 54 (5.0 - 5.5) [36- 39.8 ft.•lbs.]			
Crankshaft					
Diameter of journal	ø68	ø67.957- 67970		ø67.4	
Diameter of crank pin	ø52	ø51.964- 51.975		ø51.4	
Main journal & crank pin	1.6Z				
Crankshaft run out		Less than 0.03	More than 0.06		
Axial play of crankshaft		0.1 - 0.3		0.5	
Thickness of thrust washer	3.0	2.95 - 3.00		2.8	
O.D. x I.D. of bushing (journal metal)	ø68 x 72				
Clearance between crankshaft jnl. & bearing		0.044 - 0.116		0.2	Oil clearance
I.D. x O.D. of center bearing	ø68 x 72				
Clearance between crankshaft & center bearing		0.044 - 0.102		0.2	
Camshaft					
	For intake/ Exhaust	34.453- 34.508		34.1	
	For inj. Pump	42.94- 43.06		42.8	
Camshaft run out		Less than 0.03	More than 0.1		
Cam gear backlash		0.08	0.25		
Valve					
Intake valve stem diameter	6.97	6.955- 6.97		6.89	
Exhaust valve stem ø	6.95	6.94- 6.95		6.84	

Note: Units not specified are in mm.

Engine Main Parts

Inspection Items	Standard Dimension	Standard Value	To be Repaired	Allowable Limit	Remarks
Valve					
Clearance between valve stem and valve guide	Inlet	0.03- 0.06		More than 0.2	
	Exh.	0.045- 0.075		More than 0.25	
 Thickness of valve	1.0	0.8- 1.1		0.5	
Valve clearance intake/exh.		0.2	0.5		
 Valve Spring	Spring Force N (kgf)	79.8 (8.1)		68.6 (7)	
	Free length	35		33.5	
	Squareness	Less than 1.2		2.0	
Push rod length	177.8	177.6 - 178.0			
Push rod outer diameter	ø6.3				
Rocker arm shaft wear	ø14.96	ø14.95- 14.97		ø14.87	
Clearance between rocker arm and shaft		0.032- 0.068		0.2	Oil clearance
Oil pump Discharge rate: (L/min) Engine speed: 2500 RPM Discharge pressure: 294-490 kPa (3-5 kgf/c m ²) Oil temp: 50°C-80°C (SAE30)		16.2			
Oil pressure switch operating pressure kPa(kgf/cm ²)	29.4 (0.3)	19.6- 39.2 (0.2- 0.4)			
Relief pressure kPa(kgf/cm ²)		245- 343 (2.5-3.5)			
Oil Capacity (L)	8.2				With filter change +0.5L
Tip clearance (rotor-to-vane)		0.1- 0.15		0.25	
Side clearance (rotor-to-cover)		0.1- 0.15		0.2	
Injection Pump					
Injection timing before TDC		13 - 15°			
Piston displacement before TDC	844	1.510- 2.005			
	844L	1.677- 2.228			
Nozzle: 105007-1170					
Inj. pressure MPa (kgf/cm ²)	15.7 (160)	15.2- 16.2 (155-165)			

Note: Units not specified are in mm.

SECTION 6 – ENGINE MAINTENANCE STANDARDS
Engine Main Parts

Inspection Items	Standard Dimension	Standard Value	To be Repaired	Allowable Limit	Remarks
Angle of injection direction	4°				
Nozzle and holder tightening torque N•m (kgf•m)		59 - 69 (6 - 7)			with cylinder head installed
Cooling System					
Coolant water volume (L)	5.0				Reserve tank 0.6L
Thermostat open temp.	82°C				
Thermostat full-open temp.	95°C				
V belt (fan) loose (load at center 5 kg)		5 - 10			
Starter					
No. of teeth of pinion gear: 11 Magnetic shifting of pinion					
Wear of commutator diameter	ø29.4		ø28.8		
Stepped wear of commutator		0.05		0.2	
Bending allowance of armature shaft		0.05	More than 0.08		
Length of brush	17.5			9	
Spring force of brush N (kgf)		22.5- 32.5 (2.3 - 3.3)		Less than 8.8 (0.9)	
Alternator, 12 volt 40 amp					
Outside diameter of slip ring		22.7		22.1	
Length of brush		18.5		5.0	
Pulley tightening torque N•m (kgf•m)		58 - 79 (5.95- 8.05)			

Note: Units not specified are in mm.



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