

Document Title: Adjusting operation	Function Group: 210	Information Type: Service Information	Date: 2014/4/10
Profile:			

Adjusting operation

Perform adjusting operation as follows after the maintenance job :

- Supply the fuel oil, lubricating oil and coolant.

CAUTION

Check the levels of the lubricating oil and coolant again after test running (for about 5 minutes) and add as required.

- Start the engine, and carry out idling at a low revolution (from 700 to 900 rpm) for a few minutes.
- Run in the engine for about five minutes at the rated revolution (no-load). Check for coolant, fuel or oil leaks and existence of abnormal vibration or noise. Also check the oil pressure, coolant temperature and exhaust gas color.
- Adjust the no-load minimum and maximum revolutions according to the specifications.

Long storage

Observe the following instructions when the engine is to be stored for a long period without operation :

- Always drain cooling water in a cold season or before a long storage. (This is unnecessary when antifreeze is used.)

CAUTION

Negligence of water draining will cause the water remaining inside the engine to freeze and expanded, damaging the engine cooling system components.

- Coolant draining procedure
 1. Remove the radiator cap.
 2. Loosen the draining cock under the radiator to drain coolant.
 3. Loosen the drain cock on the side of the engine block to drain coolant.
 4. After draining coolant, tighten the radiator cap and drain plug and cocks.
- Remove all mud, dust, oil deposits and thoroughly clean the engine and attached components.
- Perform the nearest periodic inspection before the storage.
- Drain or fill the fuel oil fully to prevent condensation in the fuel tank.
- Disconnect the battery cable from the battery negative terminal.
- Cover the silencer, air cleaner and electric parts with PVC cover to prevent water and dust from depositing or entrance.
- Select a well-ventilated location without moisture and dust for storage.
- Perform battery recharging once a month during storage to compensate for self-discharge.

Document Title: Compression inspection	Function Group: pressure 210	Information Type: Service Information	Date: 2014/4/10
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Compression pressure inspection

Compression pressure drop is one of major causes of increasing blowby gas (lubricating oil contamination or increased lubricating oil consumption as a resultant phenomenon) or starting failure. The compression pressure is affected by the following factors :

1. Degree of clearance between piston and cylinder
2. Degree of clearance at intake/exhaust valve seat
3. Gas leak from nozzle gasket or cylinder head gasket

In other words, the pressure drops due to increased parts wear and reduced durability resulting from long use of the engine. A pressure drop may also be caused by scratched cylinder or piston by dust entrance from the dirty air cleaner element or worn or broken piston ring. Measure the compression pressure to diagnose presence of any abnormality in the engine.

Compression pressure measurement method

1. After warming up the engine remove the fuel injection nozzle from the cylinder to be measured.
2. Before installing the compression gauge, cut off the fuel supply by the adjusting lever and check if fuel comes out while rotating the flywheel manually.
3. Install the compression gauge and compression gauge adapter at the cylinder to be measured.

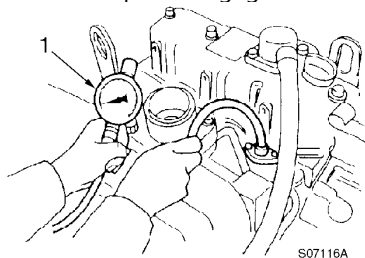


Figure 1
Measuring the compression pressure

1. Compression gauge



Do not forget to install a gasket at the tip end of the adapter.

4. Install the compression gage and compression gage adapter at the cylinder to be measured.
5. Crank the engine by the starting motor until the compression gage reading is stabilized.

Standard compression pressure

- Standard : 35 ± 1 kgf/cm² (497 $\pm$ 14.2 psi)
- Limit : 27 kgf/cm² (383.4 psi)
- Difference among cylinders : 2 ~ 3 kgf/cm² (28.4 ~ 42.6 psi)

Engine speed and compression pressure

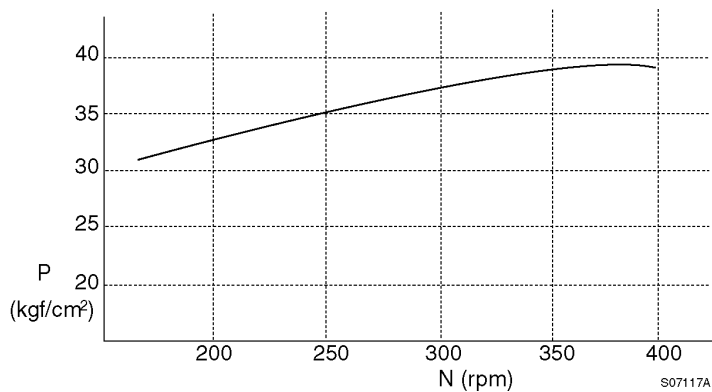


Figure 2
Engine speed and compression pressure

- P : Compression pressure
- N : Engine speed

Check items

When the measured compression pressure is below the limit value, inspect each part by referring to the table below.

Compression pressure check items

Item	Cause	Corrective action
Air cleaner element	Clogged element Broken element Defect at element seal portion	Clean the element Replace the element
Valve clearance	Excessive or no clearance	Adjust the valve clearance
Valve timing	Incorrect valve clearance	Adjust the valve clearance
Cylinder head gasket	Gas leak from gasket	Replace gasket Retighten the cylinder head screws to the specified torque
Inlet/exhaust valve Valve seat	Gas leak due to worn valve seat or foreign matter Sticking valve	Lap the valve seat Replace the inlet/exhaust valve
Piston Piston ring Cylinder	Gas leak due to scoring or wear	Perform honing or boring/honing and use an oversized part

Document Title: Cylinder head, disassembly/assembly	Function Group: 2111	Information Type: Service Information	Date: 2014/4/10
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Cylinder head, disassembly/assembly

Disassemble in the order of the numbers shown in the illustration. (service point)

1. Remove the alternator assembly. (service point 1)
2. Remove the fan, pulley and V-belt.
3. Remove the thermostat case. (service point 2)
4. Remove the fuel filter and fuel oil piping. (service point 3)
5. Remove the oil level gauge assembly.
6. Remove the oil filter. (service point 4)
7. Remove the fuel injection pipes. (service point 5)
8. Remove the intake manifold assembly.
9. Remove the exhaust manifold assembly.
10. Remove the rocker cover.
11. Remove the rocker shaft assembly, push rods and valve caps. (service point 6)
12. Remove the cylinder head assembly and head gasket. (service point 7)
13. Remove the fuel injection valves and fuel return pipe. (service point 8)
14. Remove the intake/exhaust valves, stem seals and valve springs. (service point 9)
15. Remove the rocker arms from the rocker shaft.

For assembly, reverse the procedure.

Service points

Point 1

Disassemble :

- Loosen the mounting screw while supporting the alternator.

CAUTION

Do not tilt the alternator toward the cylinder block in a haste since it may damage the alternator or pinch a finger.

Reassemble :

- The belt deflection shall be between 10 ~ 15 mm (7 ~ 9 mm for a new belt).

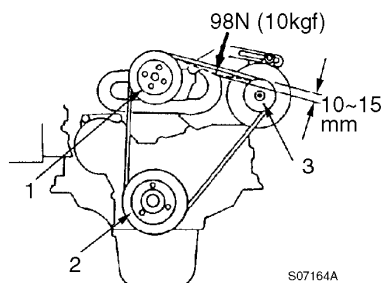


Figure 1
V-belt tension

1. Cooling water pump
2. Crankshaft pulley
3. Alternator

- Replace the belt with a new one if cracked, worn or damaged.
- Carefully prevent the belt from being smeared with oil or grease.

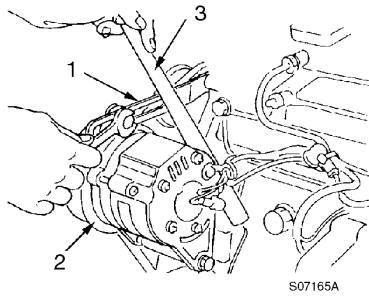


Figure 2
Tension adjustment

1. Adjuster
2. Alternator
3. Adjust the V-belt tension by inserting a bar

Point 2

Reassemble :

- Check the thermostat function.

Point 3

Reassemble :

- Replace the fuel filter element with a new one.

Disassemble :

- Cover the fuel pipe opening with tape to prevent intrusion of foreign matter.

Point 4

Reassemble :

- Replace the oil filter with a new one.
- After fully tightening the filter manually, retighten it with a filter wrench by 3/4 turn.

Point 5

Disassemble :

- Cover the fuel injection pipe and pump inlets and outlets with tape or the like to prevent intrusion of foreign matter.

Point 6

Disassemble :

- Keep the removed push rods by attaching tags showing corresponding cylinder numbers.

Reassemble :

- Always apply oil to the contact portions of the push rods and valve clearance adjusting screws.

Point 7

Disassemble :

- Loosen the cylinder head screws in two steps in the illustrated order.

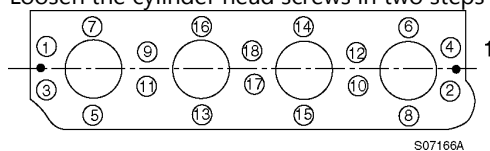


Figure 3
Head screw disassembly order

1. Fan side

- Place the cylinder head assembly on card board to prevent any damage to the combustion face.

Reassemble :

- Replace the head gasket with a new one.
- Uniformly install the head screws manually after applying oil on the threads and seat portions.

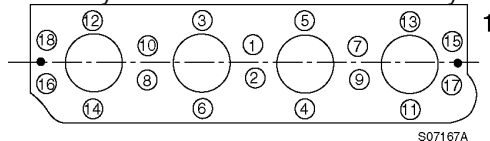


Figure 4
Head screw tightening order

1. Fan side

- They shall be tightened in two steps in the reverse of the order for disassembly.
- Tightening torque :

- First step : 5 ~ 6 kgf·m (36.1 ~ 43.3 lbf·ft)
- Second step : 10.5 ~ 11.5 kgf·m (75.8 ~ 83.0 lbf·ft)

Point 8

Disassemble :

- Carefully remove the fuel injection valve so as not to leave the tip end protector from being left inside the cylinder.

Reassemble :

- Replace the fuel injection valve protector with a new one.

Point 9

Disassemble :

- When removing each inlet/exhaust valve from the cylinder head, use a valve spring compressor and compress the valve spring and remove the valve cotter.



Figure 5
Valve spring compressor

- Keep each removed inlet/exhaust valve after attaching a tag showing the corresponding cylinder number.
- If cotter burr is seen at the shaft of each inlet/exhaust valve stem, remove it with an oil stone and extract the valve from the cylinder head.

Reassemble :

- Replace the stem seal with a new one when an intake/exhaust valve is disassembled.
- Carefully install each valve after oil application so as not to damage the stem seal.
- Different stem seals are provided for the intake and exhaust valves. Do not confuse them since those for exhaust valves are marked with yellow paint.
- After assembling the intake/exhaust valve, stem seal, valve spring, seat, and cotter, tap the head of the valve stem lightly for settling.
- Do not forget to install the valve cap.

Document Title: Cylinder head, parts inspection and measurement	Function Group: 2111	Information Type: Service Information	Date: 2014/4/10
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Cylinder head, parts inspection and measurement

Cylinder head

Clean the cylinder head, mainly the combustion surface, valve seats and intake/exhaust ports, remove carbon deposit and bonding agent, and check the surface state.

- Appearance check
Check mainly discoloration and crack.
If crack is suspected, perform dye check.
- Combustion surface distortion Apply a straight-edge in two diagonal directions and on four sides of the cylinder head, and measure distortion with a feeler gage

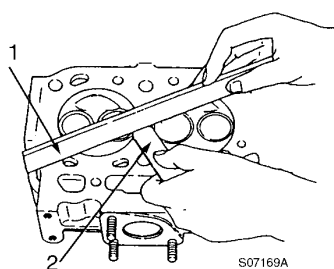


Figure 1

Distortion at combustion surface

1. Straight edge
2. Feeler gauge

Combustion surface distortion, unit : mm (in)

	Standard	Limit
Distortion	0.05 (0.002) or less	0.15 (0.0059)

- Valve sink
Measure with the valve inserted to the cylinder head.

Combustion surface distortion, unit : mm (in)

		Standard	Limit
Valve sink	Inlet	0.5 ~ 0.7 (0.0197 ~ 0.0276)	1.0 (0.0394)
	Exhaust	0.6 ~ 0.8 (0.0236 ~ 0.0315)	1.1 (0.0433)

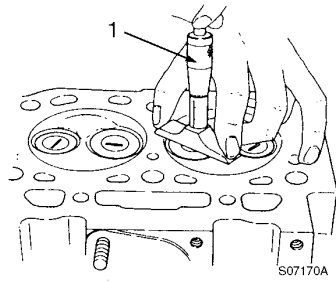


Figure 2
Valve sink

1. Depth micrometer

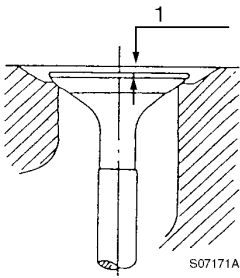


Figure 3
Valve sink depth

1. Valve sinking depth
- Seat width

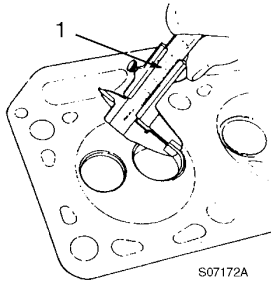


Figure 4
Valve seat width

1. Vernier callipers

Valve seat width, unit : mm (in)

		Standard	Limit
Seat width	Inlet	1.3 (0.0512)	2.0 (0.0787)
	Exhaust	2.2 (0.0866)	3.0 (0.1181)

- Seat contact
Apply a thin coat of bluing on the valve seat. Insert the valve in the cylinder and push it against the seat to check seat contact.
Standard : Continuous contact all around

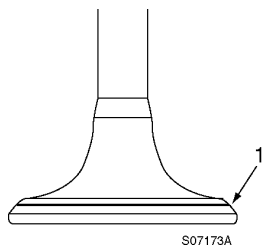


Figure 5
Valve seat contact

1. Seat
 - Valve guide
Mainly check damage and wear on the inside wall. Apply supply part number 129150–11810 when replacing the part.

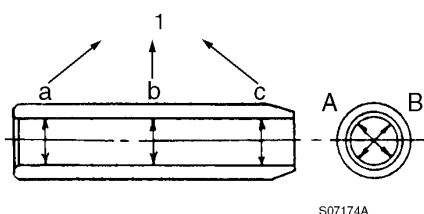


Figure 6
Valve guide inside diameter

1. Measuring positions

Valve guide inside diameter, unit : mm (in)

		Standard	Limit
Inlet valve	Stem outside diameter	7.965 ~ 7.980 (0.3136 ~ 0.3142)	7.915 (0.3116)
	Guide inner diameter	8.015 ~ 8.030 (0.3156 ~ 0.3161)	8.100 (0.3189)
	Clearance	0.035 ~ 0.065 (0.0014 ~ 0.0026)	0.185 (0.0073)
Exhaust valve	Stem outside diameter	7.955 ~ 7.970 (0.3132 ~ 0.3138)	7.905 (0.3112)
	Guide inner diameter	8.015 ~ 8.030 (0.3156 ~ 0.3161)	8.100 (0.3189)
	Clearance	0.045 ~ 0.075 (0.0018 ~ 0.0030)	0.195 (0.0077)

- Inlet/exhaust valve
Mainly clean and check damage and wear at the valve stem and seat.
- Seat contact : See above.
- Stem outside diameter : See above.

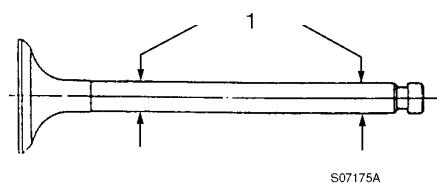


Figure 7
Valve stem outside diameter

- 1. Measuring positions
- Valve head thickness

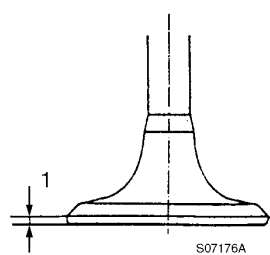


Figure 8
Valve head thickness

- 1. Thickness

Valve head thickness, unit : mm (in)

	Standard	Limit
Inlet	1.71 (0.0673)	1.00 (0.0394)
Exhaust	1.65 (0.0650)	1.00 (0.0394)

- Valve stem bend
 Limit : 0.01 mm (0.0004 in)
- Overall length

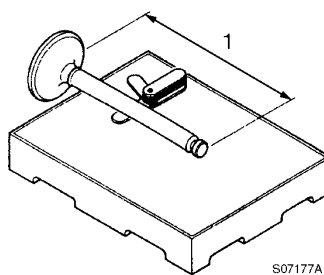


Figure 9
Valve bend and length

- 1. Length

Valve overall length, unit : mm (in)

	Standard	Limit
Inlet	115 (4.53)	114.5 (4.50)
Exhaust	115 (4.53)	114.5 (4.50)

- Valve spring
 Mainly inspect damage and corrosion.

Valve spring, unit : mm (in)

	Standard	Limit
Free length	47.5 (1.87)	—
Inclination	—	1.2 (0.047)

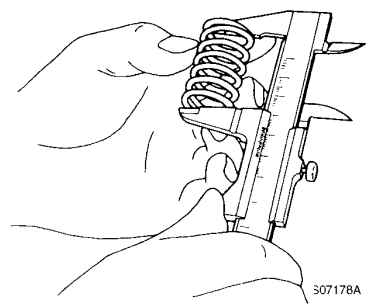


Figure 10
Valve spring free length

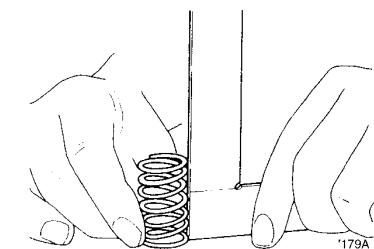


Figure 11
Valve spring inclination

- Valve rocker arm
Mainly inspect valve head cap contact surface, inside surface defects and wear. Slight surface defects shall be corrected with an oilstone

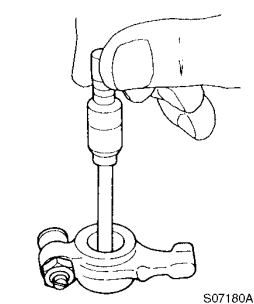


Figure 12
Rocker arm hole diameter

Rocker arm hole diameter, unit : mm (in)

	Standard	Limit
Arm hole diameter	18.50~18.52 (0.7283~0.7291)	18.57 (0.7311)
Shaft outside diameter	18.47~18.49 (0.7272~0.7280)	18.44 (0.7260)
Clearance	0.01~0.05 (0.0004~0.0020)	0.13 (0.005)

- Valve rocker arm shaft
Mainly inspect seizure and wear at the surface in sliding contact with the arm. The rocker shaft diameter shall be as specified in above.

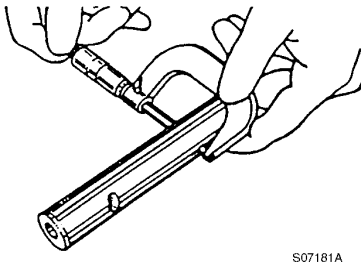


Figure 13
Rocker shaft outside diameter

- Push rod
Mainly inspect the surface in contact with the tappet and adjusting screw. Slight defects shall be corrected with an oilstone. Bend limit : 0.03 mm (0.0012 in) or less

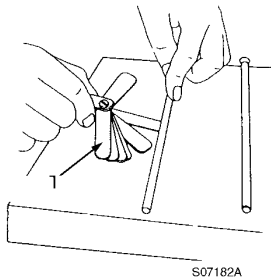


Figure 14
Push rod bend

1. Thickness gauge
- Valve clearance adjusting screw
Mainly inspect the surface in contact with the push rod. Slight defects shall be corrected with an oilstone.
 - Rocker arm spring Mainly inspect surface defects and corrosion.

Valve seat correction



Always check the oil clearance between the valve and valve guide before correcting the valve seat. If it exceeds the limit, replace the valve or valve guide first to make the clearance satisfy the standard. After correction, wash the valve and the cylinder head sufficiently with diesel oil to remove all grinding powder or compound.

- If the seat surface is slightly roughened : perform (A) and (B) following.
- If the seat is heavily roughened but the width is almost normal, correct with a seat grinder or seat cutter first. Then perform lapping (A) and (B) following.

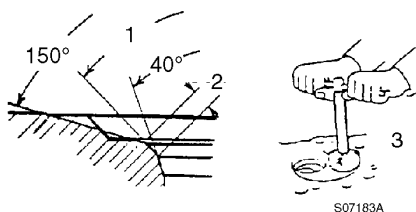


Figure 15
Cylinder head correction angle

1. Seat angle
2. Seat width
3. Seat cutter

Seat cutter angle, unit : degree

	Inlet	Exhaust
Seat cutting angle	120	90

- If the seat is heavily roughened and the width is much enlarged, grind the seat inner surface with a seat grinder whose center angle is 40 then grind the seat outer surface with a grinder whose center angle is 150° to make the seat width match the standard. Then perform seat correction as described above, and then carry out lapping (A) and (B) below.

Grinding wheel angle, unit : degree

	θ1	θ2
Grinding wheel angle	40	150

- (A) : Lap the valve and seat with a mixture of valve compound and engine oil.
(B) : Lap with engine oil only.

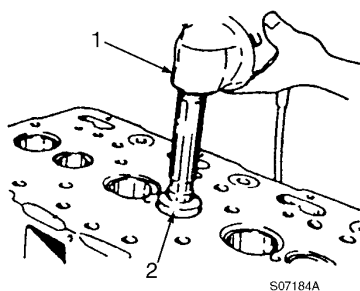


Figure 16
Seat grinder

1. Grinder
2. Grindstone



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