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# Safety rules

## Standard safety precautions

Be informed and notify personnel of the laws in force regulating safety, and provide documentation available for consultation.

- Keep working areas as clean as possible.
- Ensure that working areas are provided with emergency boxes. They must be clearly visible and always contain adequate sanitary equipment.
- Fire extinguishers must be properly identified and always be clear of obstructions. Their efficiency must be checked on a regular basis and personnel must be trained on proper interventions and priorities.
- Keep all emergency exits free of obstructions and clearly marked.
- Smoking in working areas subject to fire danger must be strictly prohibited.

## Prevention of injury

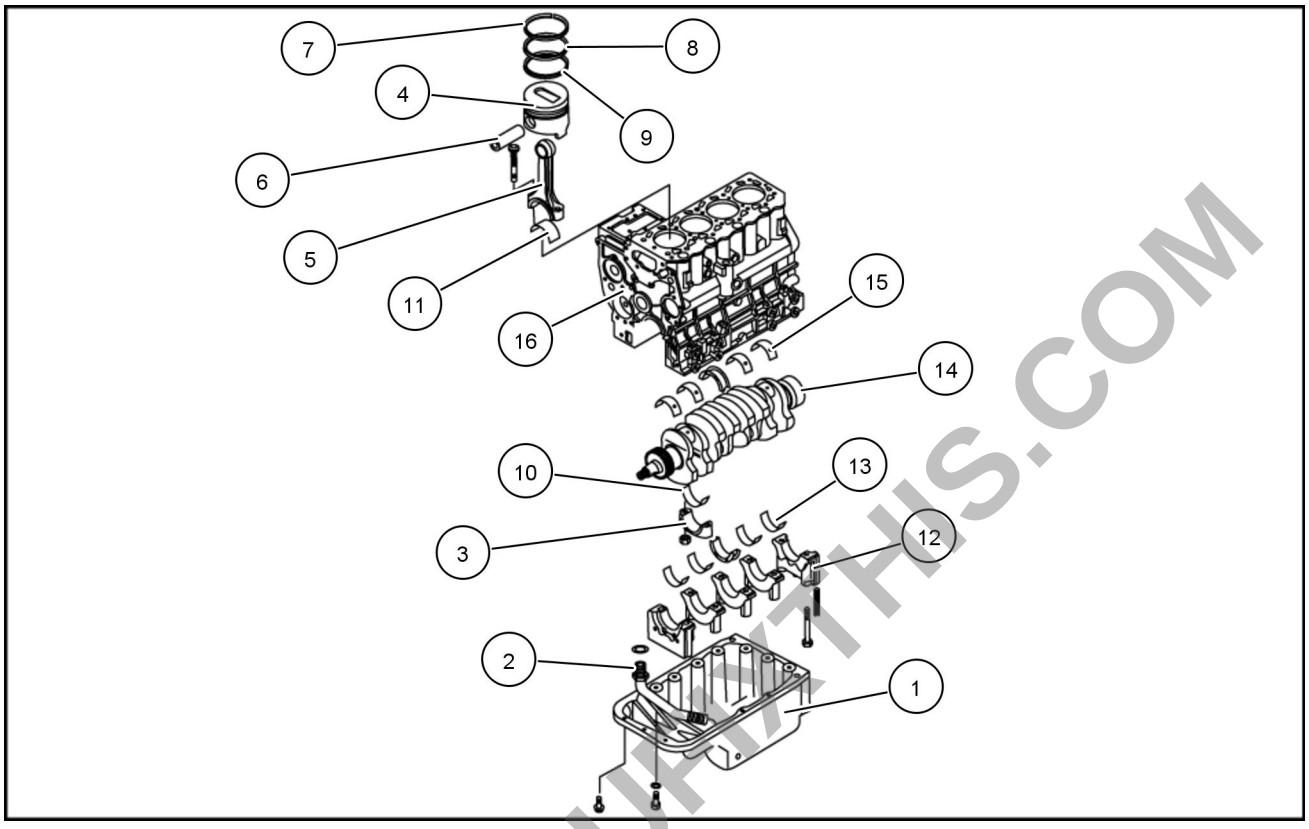
- Wear suitable work attire and safety glasses with no jewelry such as rings and chains when working close to engines and equipment in motion.
- Wear safety gloves and goggles when performing the following operations:
  - Topping off or changing lubrication oils.
  - Using compressed air or liquids at a pressure greater than **2 bar** (**29 psi**).
- Wear a safety helmet when working close to hanging loads or equipment working at head level.
- Always wear safety shoes and fitting clothes.
- Use protection cream for hands.
- Change wet clothes as soon as possible.
- In the presence of voltages exceeding **48 - 60 V**, verify the efficiency of the ground and mass electrical connections. Ensure that hands and feet are dry and use isolating foot boards. Workers should be properly trained to work with electricity.
- Do not smoke or start an open flame close to batteries and any fuel material.
- Place soiled rags with oil, diesel fuel or solvents in specially provided anti-fire containers.
- Do not use any tool or equipment for any use other than what it was originally intended for. Serious injury may occur.
- If running an engine indoors, make sure there is a sufficient exhaust fan in use to eliminate exhaust fumes.

## During maintenance

- Never open the filler cap of the cooling system when the engine is hot. High temperature liquid at operating pressure could result in serious danger and risk of burn. Wait until the temperature decreases under **50 °C** (**122 °F**).
- Never add coolant to an overheated engine and use only appropriate liquids.
- Always work when the engine is turned off. Certain circumstances require maintenance on a running engine. Be aware of all the risks involved with such an operation.
- Always use adequate and safe containers for engine fluids and used oil.
- Keep engine clean of any spilled fluids such as oil, diesel fuel, and or chemical solvents.
- Use of solvents or detergents during maintenance may emit toxic vapors. Always keep working areas aerated. Wear a safety mask if necessary.
- Do not leave soiled rags that may contain any flammable substances close to the engine.
- Always use caution when starting an engine after any work has been performed. Be prepared to cut off intake air in case of engine runaway.
- Never disconnect the batteries while the engine is running.


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# Engine - Exploded view




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**(1)** Oil pan
**(2)** Oil pickup tube
**(3)** Connecting rod cap
**(4)** Piston
**(5)** Connecting rod
**(6)** Piston pin
**(7)** No. 1 compression ring
**(8)** No. 2 compression ring
**(9)** Oil ring
**(10)** Lower connecting rod bearing
**(11)** Upper connecting rod bearing
**(12)** Main bearing cap
**(13)** Lower main bearing
**(14)** Crankshaft
**(15)** Upper main bearing
**(16)** Cylinder block

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# Torque - Minimum tightening torques for normal assembly

## METRIC NON-FLANGED HARDWARE

| NOM. SIZE | CLASS 8.8 BOLT and CLASS 8 NUT | | CLASS 10.9 BOLT and CLASS 10 NUT | | LOCKNUT CL.8 W/CL8.8 BOLT | LOCKNUT CL.10 W/CL10.9 BOLT |
|---|---|---|---|---|---|---|
| | UNPLATED | PLATED W/ZnCr | UNPLATED | PLATED W/ZnCr | | |
| M4 | 2.2 N·m (19 lb in) | 2.9 N·m (26 lb in) | 3.2 N·m (28 lb in) | 4.2 N·m (37 lb in) | 2 N·m (18 lb in) | 2.9 N·m (26 lb in) |
| M5 | 4.5 N·m (40 lb in) | 5.9 N·m (52 lb in) | 6.4 N·m (57 lb in) | 8.5 N·m (75 lb in) | 4 N·m (36 lb in) | 5.8 N·m (51 lb in) |
| M6 | 7.5 N·m (66 lb in) | 10 N·m (89 lb in) | 11 N·m (96 lb in) | 15 N·m (128 lb in) | 6.8 N·m (60 lb in) | 10 N·m (89 lb in) |
| M8 | 18 N·m (163 lb in) | 25 N·m (217 lb in) | 26 N·m (234 lb in) | 35 N·m (311 lb in) | 17 N·m (151 lb in) | 24 N·m (212 lb in) |
| M10 | 37 N·m (27 lb ft) | 49 N·m (36 lb ft) | 52 N·m (38 lb ft) | 70 N·m (51 lb ft) | 33 N·m (25 lb ft) | 48 N·m (35 lb ft) |
| M12 | 64 N·m (47 lb ft) | 85 N·m (63 lb ft) | 91 N·m (67 lb ft) | 121 N·m (90 lb ft) | 58 N·m (43 lb ft) | 83 N·m (61 lb ft) |
| M16 | 158 N·m (116 lb ft) | 210 N·m (155 lb ft) | 225 N·m (166 lb ft) | 301 N·m (222 lb ft) | 143 N·m (106 lb ft) | 205 N·m (151 lb ft) |
| M20 | 319 N·m (235 lb ft) | 425 N·m (313 lb ft) | 440 N·m (325 lb ft) | 587 N·m (433 lb ft) | 290 N·m (214 lb ft) | 400 N·m (295 lb ft) |
| M24 | 551 N·m (410 lb ft) | 735 N·m (500 lb ft) | 762 N·m (560 lb ft) | 1016 N·m (750 lb ft) | 501 N·m (370 lb ft) | 693 N·m (510 lb ft) |

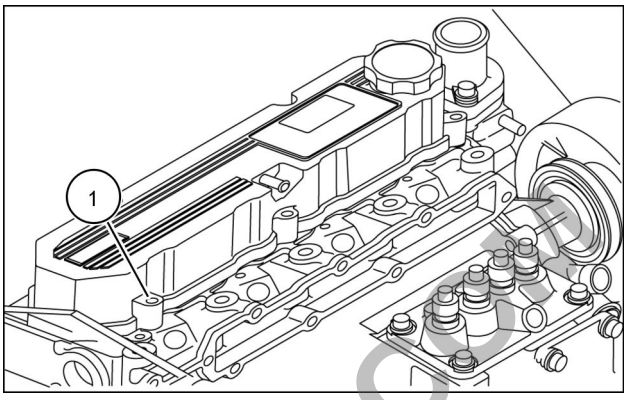
***NOTE:*** *M4 through M8 hardware torque specifications are shown in pound-inches. M10 through M24 hardware torque specifications are shown in pound-feet.*

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# Valve cover - Remove

1. Remove the bolts **(1)** that are securing the valve cover to the cylinder head.




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# Engine - Problem solving

**OPERATION**

In most cases, the engine should be overhauled when the compression pressure of the engine becomes low. An increase in engine oil consumption and blow-by gas are also considered to evaluate the engine condition. Besides, such symptoms as a decrease in output, increase in fuel consumption, decrease in oil pressure, difficulty of engine starting and increase in noise are also considered for judging the overhaul timing, although those symptoms are often affected by other causes, and are not always effective to judge the overhaul timing. Decreased compression pressure shows a variety of symptoms and engine conditions, thus making it difficult to accurately determine when the engine needs an overhaul. The engine can exhibit these conditions in various combinations. Some of these problems are directly caused by worn engine parts, while others are not. Phenomena described in items **(2)** and **(6)** will result from improper fuel injection volume, fuel injection timing, worn plunger, faulty nozzles and also faulty conditions of electrical devices such as battery and starter. The most valid reason to overhaul an engine is a decrease in compression pressure due to worn cylinder liners and pistons, as described in item **(4)**. In addition to this item, it is reasonable to take other problems into consideration for making the total judgement.

**TROUBLESHOOTING**

The following shows typical problems caused by reduced compression pressure.

1. Decreased output power
2. Increased fuel consumption
3. Increased engine oil consumption
4. Increased blow-by gas through the breather due to worn cylinder liners and piston rings (Visually check the blow-by amount)
5. Increased gas leakage due to poor seating of inlet and exhaust valves
6. Difficulty in starting
7. Increased noise from engine parts
8. Abnormal exhaust color after warm-up operation

***NOTE:*** *Refer to* ***Engine - Check (10.001)*** *for the proper procedure to check cylinder compression.*

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# Engine - General specification

| Engine model | S4L (Y361GT, Y362GT, Y363GT) |
|---|---|
| - Type | Water cooled, 4-stroke cycle diesel |
| - No. of cylinders | 4 |
| - Combustion type | Swirl chamber |
| - Valve mechanism | Overhead valve type |
| - Cylinder bore x stroke | **78 mm** x **78.5 mm** ( **3.07 in** x **3.09 in**) |
| - Total displacement | **1.50 l** (**91.55 in³**) |
| - Compression ratio | 22:1 |
| - Fuel used | JIS K2204, Diesel fuel or its equivalent (ASTM diesel fuel oil No. 2-D) |
| - Firing order | 1 - 3 - 4 - 2 |
| - Direction of rotation | Counterclockwise as viewed from flywheel side |
| - Length | **688 mm** (**27.07 in**) |
| - Width | **461 mm** (**18.15 in**)<br>**476 mm** (**18.74 in**) - Y363GT |
| - Height | **613 mm** (**24.13 in**) |
| - Dry weight | Approximately **165 kg** (**364 lb**) |

| Engine model | S4L2 (Y361GT, Y362GT, Y363GT, Y364GT) |
|---|---|
| - Type | Water cooled, 4-stroke cycle diesel |
| - No. of cylinders | 4 |
| - Combustion type | Swirl chamber |
| - Valve mechanism | Overhead valve type |
| - Cylinder bore x stroke | **78 mm** x **92 mm** ( **3.07 in** x **3.62 in**) |
| - Total displacement | **1.758 l** (**107.29 in³**) |
| - Compression ratio | 22:1 |
| - Fuel used | JIS K2204, Diesel fuel or its equivalent (ASTM diesel fuel oil No. 2-D) |
| - Firing order | 1 - 3 - 4 - 2 |
| - Direction of rotation | Counterclockwise as viewed from flywheel side |
| - Length | **688 mm** (**27.07 in**)<br>**672 mm** (**26.46 in**) - Y363GT |
| - Width | **461 mm** (**18.15 in**)<br>**476 mm** (**18.74 in**) - Y363GT, Y364GT |
| - Height | **613 mm** (**24.13 in**) |
| - Dry weight | Approximately **165 kg** (**364 lb**) |

| Inspection point | Nominal | Standard | Limit | Remark |
|---|---|---|---|---|
| Maximum rotation speed (rated rotation speed used as reference) | Varies depending on specification of destination | | | |
| Minimum rotation speed | Varies depending on specification of destination | | | |
| Compression ratio @ **290 RPM** | | **29 bar** (**421 psi**) or above | **26 bar** (**377 psi**) or less | When oil and water temperatures at **20 - 30 °C** (**68 - 86 °F**) |
| Valve timing<br>Intake<br>- Open<br>- Close<br>Exhaust<br>- Open<br>- Close | | <br><br>BTDC **15 °**<br>ABDC **41 °**<br><br>BBDC **54 °**<br>ATDC **10 °** | | With **2 mm** (**0.079 in**) clearance on valve side, when cold. Values are only for checking valve timing and are different from the actual ones. |
| Rocker arm<br>Rocker arm inside diameter | **18.9 mm** (**0.744 in**) | **18.910 - 18.930 mm** (**0.7445 - 0.7453 in**) | | |


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# Engine - Testing - Compression pressure

***NOTE:*** *Be sure to measure the compression pressure for all the cylinders. It is not a good practice to measure the compression pressure for only one cylinder, and presume the compression for the remaining cylinder.*

***NOTE:*** *Be sure to check engine speed when measuring the compression pressure, as pressure varies with engine speed.*

***NOTE:*** *Measuring the compression pressure at regular intervals is important to obtain correct data.*

***NOTE:*** *When measuring the compression pressure for cylinders one by one, do not remove other fuel injection nozzles for their positions, except for the one being measured.*

| N° | Test Point | Expected Result | Other Result (Possible Cause) |
|---|---|---|---|
| 1 | **Check**<br>Compression pressure. Refer to **Engine - Check - Compression pressure (10.001)** for the proper procedure. | **Result**<br>With the engine speed at **290 RPM**, the compression pressure should be between **26 - 29 bar** (**377 - 421 psi**). There should be no more than **3 bar** (**42 psi**) difference between cylinders. | **Action**<br>If the compression pressure is not within the expected result, overhaul the engine. |

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| Inspection point | Nominal | Standard | Limit | Remark |
|---|---|---|---|---|
| Rocker shaft outside diameter | **18.9 mm** (**0.744 in**) | **18.880 - 18.930 mm** (**0.7433 - 0.7453 in**) | | |
| Clearance between rocker arm and rocker shaft (oil clearance) | | **0.012 - 0.050 mm** (**0.0005 - 0.0020 in**) | **0.200 mm** (**0.0079 in**) | Replace rocker arm |
| Valve | | | | |
| Valve stem outside diameter | | | | |
| - Intake | **6.6 mm** (**0.260 in**) | **6.565 - 6.580 mm** (**0.2585 - 0.2591 in**) | **6.500 mm** (**0.2559 in**) | |
| - Exhaust | **6.6 mm** (**0.260 in**) | **6.530 - 6.550 mm** (**0.2571 - 0.2579 in**) | **6.500 mm** (**0.2559 in**) | |
| Valve guide inside diameter | | | | |
| - Intake | **6.6 mm** (**0.260 in**) | **6.600 - 6.615 mm** (**0.2598 - 0.2604 in**) | | |
| - Exhaust | **6.6 mm** (**0.260 in**) | **6.600 - 6.615 mm** (**0.2598 - 0.2604 in**) | | |
| Clearance between valve guide and valve stem | | | | |
| - Intake | | **0.020 - 0.050 mm** (**0.0008 - 0.0020 in**) | **0.100 mm** (**0.0039 in**) | Replace valve and valve guide |
| - Exhaust | | **0.050 - 0.085 mm** (**0.0020 - 0.0033 in**) | **0.150 mm** (**0.0059 in**) | |
| Valve seat angle | **45 °** | | | |
| Valve sinkage | **0 mm** (**0.00 in**) | **0.25 - 0.75 mm** (**0.0098 - 0.0295 in**) | **1.50 mm** (**0.0591 in**) | |
| Valve head width | **1.6 mm** (**0.063 in**) | **1.30 - 1.80 mm** (**0.0512 - 0.0709 in**) | **2.50 mm** (**0.0984 in**) | |
| Valve margin | **1.5 mm** (**0.059 in**) | **1.35 - 1.65 mm** (**0.0531 - 0.0650 in**) | **0.50 mm** (**0.0197 in**) | |
| Valve guide mounting length | **10 mm** (**0.39 in**) | **9.5 - 10.5 mm** (**0.374 - 0.413 in**) | | |
| Valve spring | | | | |
| Free length | | **47 mm** (**1.85 in**) | **46 mm** (**1.81 in**) | |
| Length @ **131 - 145 N** (**29 - 33 lb**) | | **39.0 mm** (**1.535 in**) | **-15 %** | |
| Length @ **279 - 309 N** (**63 - 69 lb**) | | **30.1 mm** (**1.185 in**) | **-15 %** | |
| Push rod runout | | **0.3 mm** (**0.012 in**) | | Replace |
| Cylinder head distortion | | **0.05 mm** (**0.0020 in**) | **0.10 mm** (**0.0039 in**) | |
| Cylinder | | | | |
| Cylinder block distortion (Deck) | | **0.05 mm** (**0.0020 in**) or less | **0.10 mm** (**0.0039 in**) | Repair |
| Inside diameter | **78 mm** (**3.071 in**) | **78 mm** (**3.071 in**) | **78.2 mm** (**3.079 in**) | Repair to oversize or replace |
| Cylindericity | | **0.01 mm** (**0.0004 in**) or less | | |
| Piston | | | | |


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# Engine - Service instruction General Troubleshooting Information

***NOTICE:*** *For fuel injection pump, the injection quantity of each cylinder can be measured only with a pump tester. Do not adjust or disassemble the fuel injection pump even during troubleshooting unless absolutely necessary.*

***NOTICE:*** *To inspect the combustion state of each cylinder, loosen the fuel injection pipe of any cylinder to stop injection, and compare the extent of a drop in the engine speed with that of other cylinders.*

1. Symptoms of the diesel engine often occur in combination of various problems, Therefore it is often very difficult to determine the defect from a problem.
   Similar symptoms can be caused by the fuel injection pump, fuel injection nozzles and compression pressure. It is necessary to conduct a careful study to determine the cause.
   From the reason above, troubleshooting described in this manual is summarized as items which are more likely to cause problems or items easy to inspect.
2. The diesel engine has the following characteristics from its structure and combustion system. It is necessary to fully understand these characteristics before performing troubleshooting.
   - The engine produces unique combustion noise (diesel knock) in the normal condition.
   - The engine discharges slight black smoke at heavy load.
   - High compression and high torque cause vibration on a single unit of the engine.
   - Slight hunting is caused during acceleration and deceleration.

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# Valves - Service instruction - Lapping

***NOTE:*** *Always lap the valve against the valve seat after refacing the valve seat or after replacing the valve.*

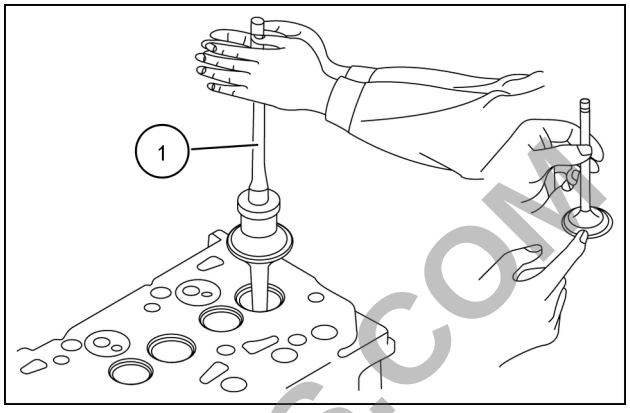
1. Apply a thin coat of lapping compound evenly to the valve face.

***NOTE:*** *Do not allow the compound to adhere to the valve stem.*

***NOTE:*** *The compound spreads more evenly if the it is mixed with a small amount of engine oil.*

***NOTE:*** *Use medium grain compound (125 - 150 mesh) for initial lapping, then use a fine grain compound (200 mesh) for finishing.*

2. Use a valve lapper **(1)** for lapping. Tap the valve against the valve seat while rotating the valve little by little.
3. Wash off the compound using diesel fuel.
4. Coat the contact surface of the valve with engine oil, then use 200 mesh compound to finish lapping..
5. Apply a thin lead-free coloring paste on the valve seat face. Tap the valve against the valve seat using a valve lapper to check for contact condition.



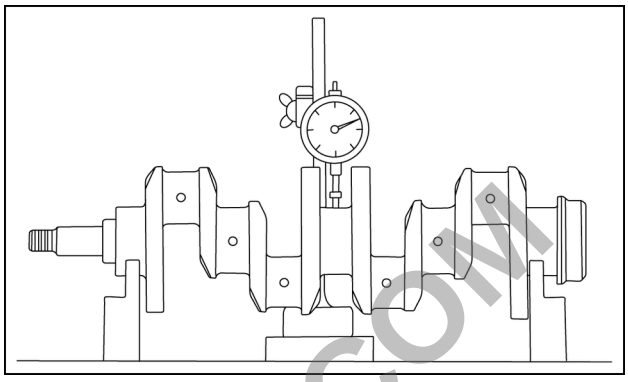

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# Crankshaft - Measure - Runout

1. Support the crankshaft at the front and rear journals with V-blocks.
2. Measure the crankshaft runout at the center journal using a dial gauge.
3. Grind the crankshaft to repair if the runout slightly deviated from the standard.
4. Straighten the crankshaft using a press if the runout exceeds the standard considerably, but is within the limit.
5. Replace the crankshaft if the limit is exceeded.
6. Inspect the crankshaft for cracks and other harmful damage using the magnetic particle method if it has been repaired by grinding or pressing.



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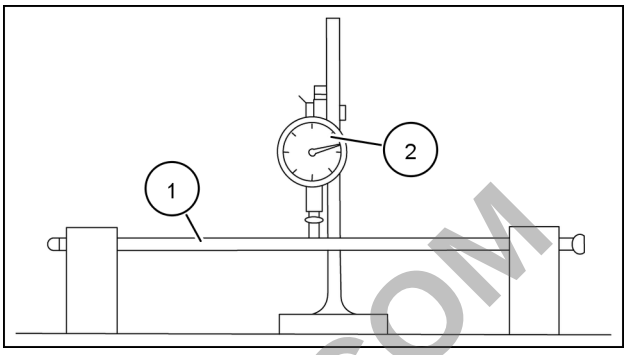
| Measurement | Standard | Limit |
|---|---|---|
| Crankshaft runout | **0.025 mm** (**0.0010 in**) or less | **0.050 mm** (**0.0020 in**) |

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# Camshaft Push rod - Measure

1. Measure the runout of the push rod **(1)** using a dial gauge **(2)**. The measurement should be **0.3 mm** (**0.012 in**) or less.
2. Replace the push rod if the limit is exceeded.




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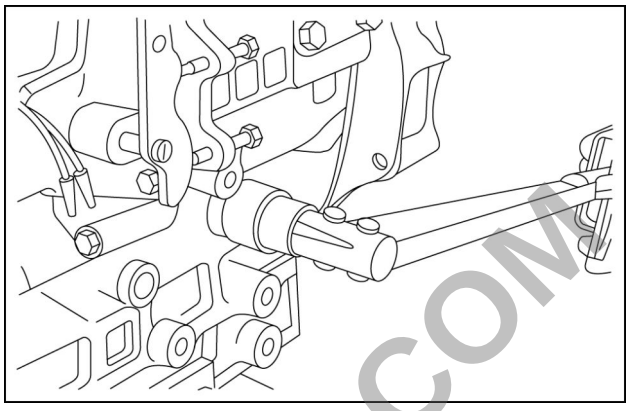
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# Engine oil filter Bypass valve - Install

1. Install the relief valve to the cylinder head side face, and tighten it to **44.1 - 53.9 N·m** (**32.5 - 39.8 lb ft**).



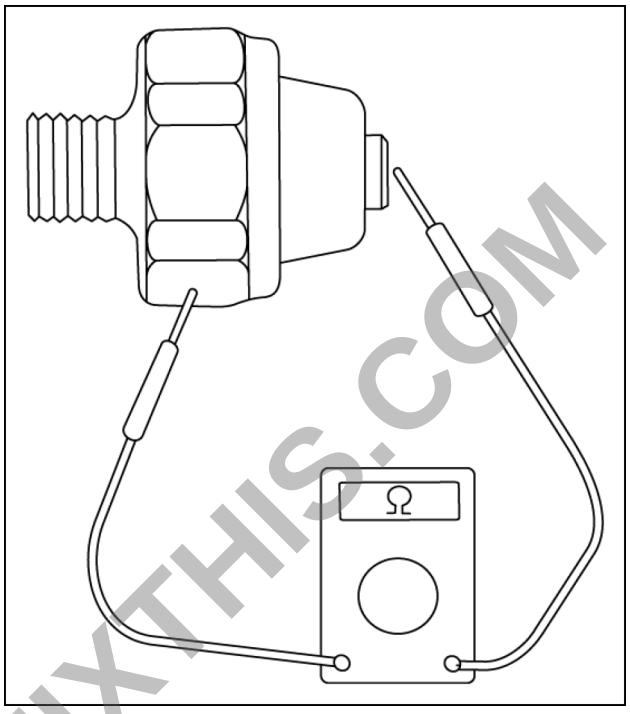
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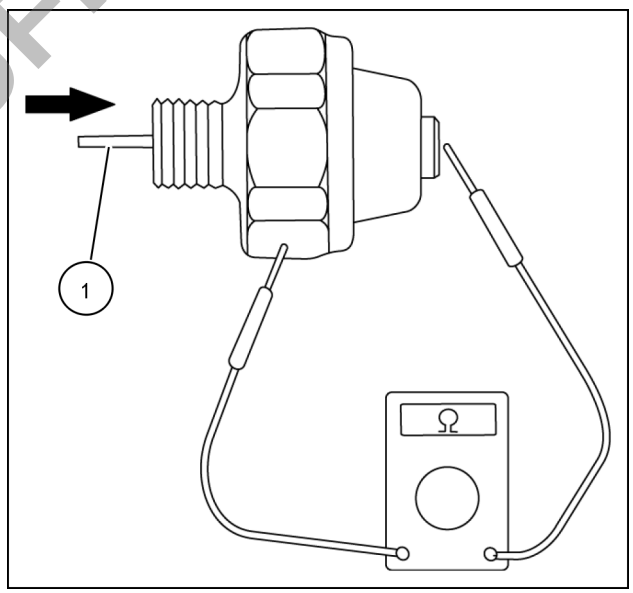
# Engine oil pressure sensor - Inspect

1. Connect a tester (ohm range) between the terminal and body to check for continuity. The switch is normal if there is continuity between them. If there is no continuity, replace the switch.



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2. Insert a thin rod **(1)** from the oil hole and lightly push it. The switch is normal if there is no continuity between them. If there is continuity when the rod is pushed in, replace the switch.
3. When air pressure of **0.48 bar** (**7 psi**) is applied from the oil hole and there is no continuity, the switch is normal. Also check for air leaks. If there are air leaks, the diaphragm is damaged. Replace the switch.




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