ENGINE

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ENGINE MECHANICAL

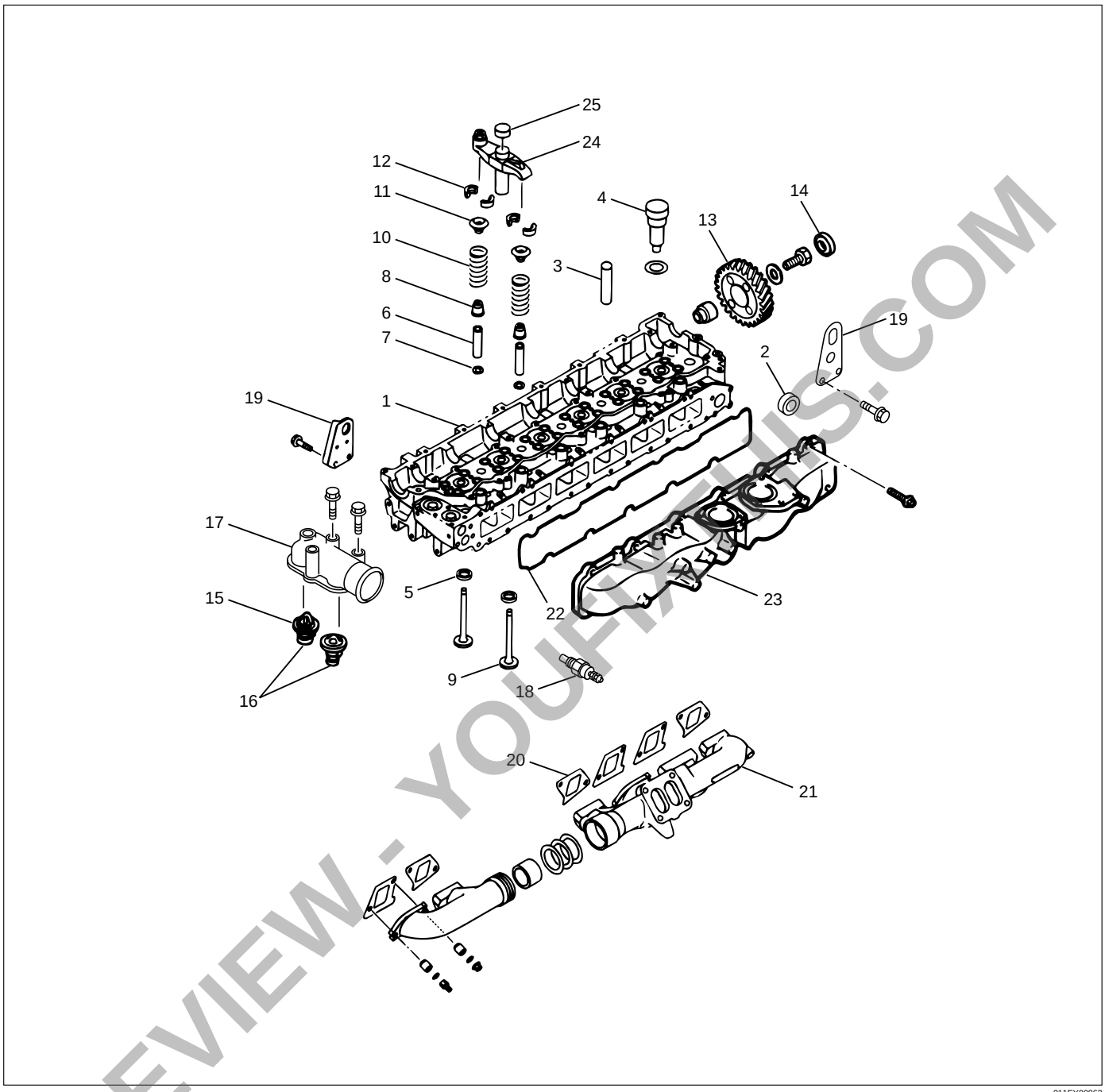
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Disassembly



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Legend

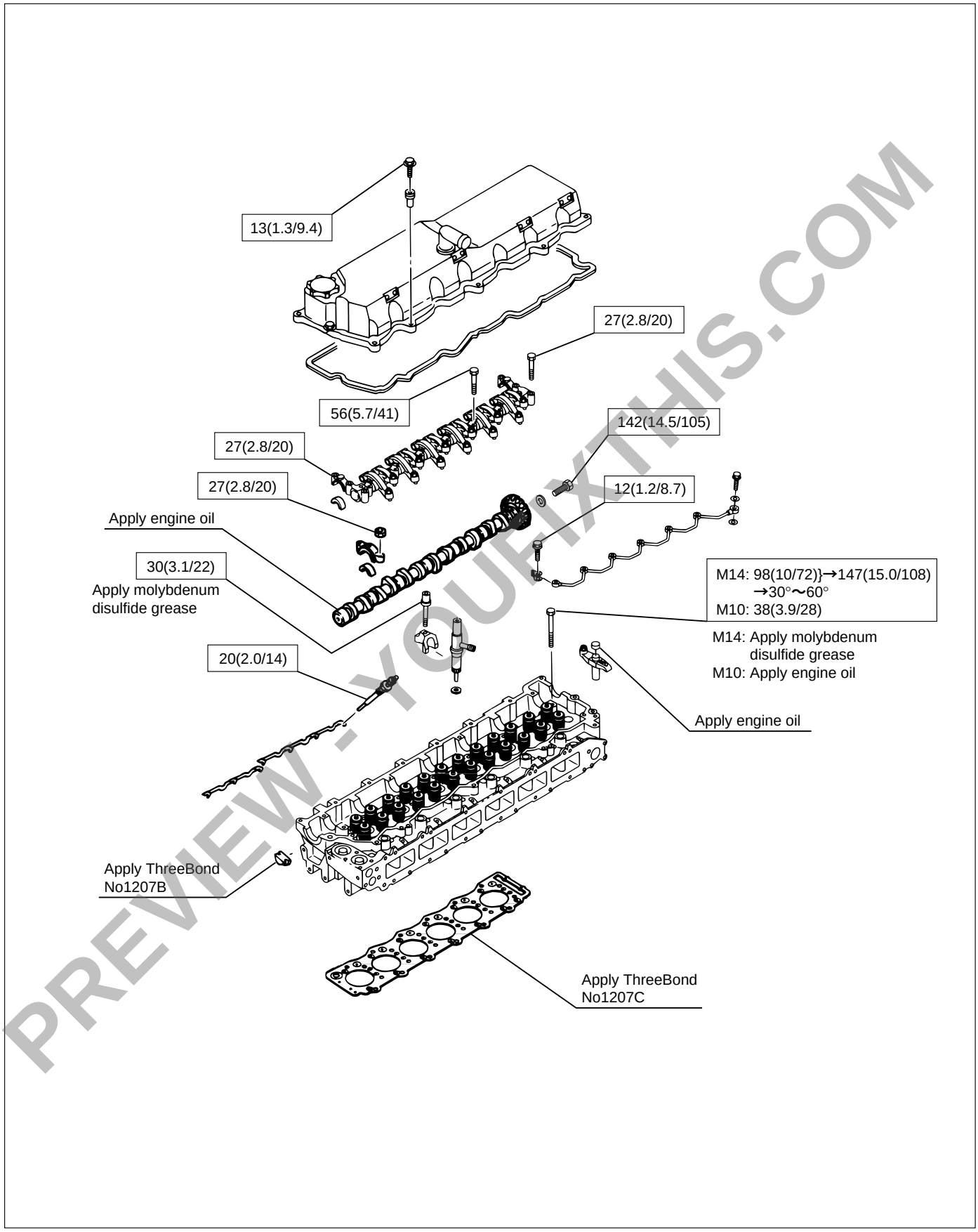
(1) Cylinder head cover
(2) Oil seal
(3) Bridge guide
(4) Nozzle sleeve
(5) Valve seat insert
(6) Valve guide
(7) Lower spring seat
(8) Valve stem seal
(9) Valve
(10) Valve spring
(11) Upper spring seat
(12) Split collar
(13) Idler gear C
(14) Idler gear cover
(15) Gasket
(16) Thermostat
(17) Water outlet pipe
(18) Overheat warning switch
(19) Hanger
(20) Gasket
(21) Exhaust manifold
(22) Gasket
(23) Inlet cover
(24) Bridge
(25) Bridge cap

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Cylinder Head

N·m (kgf·m/lb ft)



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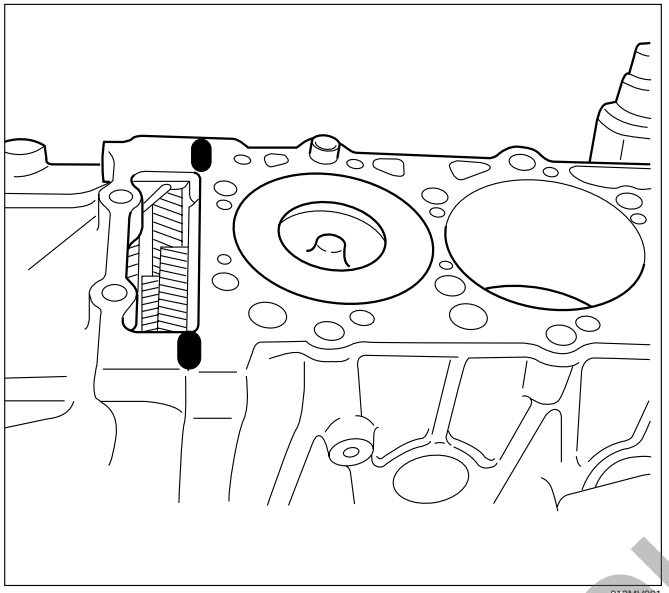
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Installation

1. Install the new cylinder head gasket.
   - Clean the cylinder block surface and remove sealant residue.
   - Apply ThreeBond No. 1207C or equivalent to the cylinder block and the timing gearcase fitting faces.

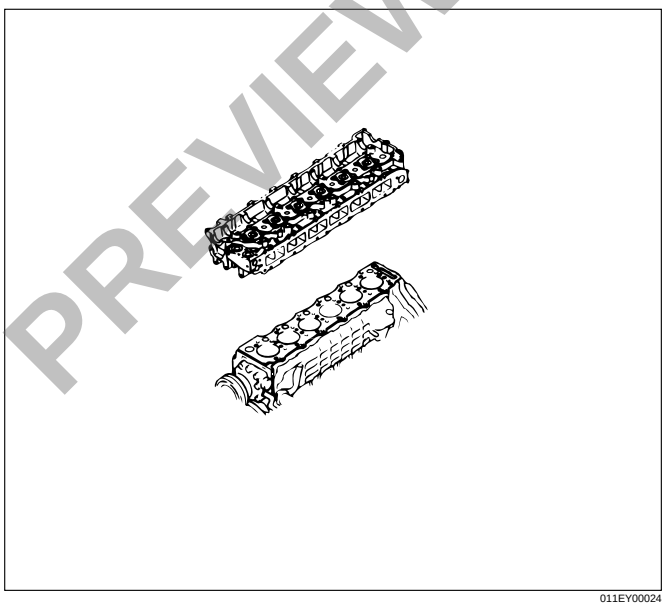
     The sealant must be 2.0 mm (0.08 in) thick and 3.0 mm (0.12 in.) wide.

     The sealant must not obstruct the cylinder oil port.



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   - Install the new cylinder head gasket to the cylinder block.
2. Install the cylinder head assembly over the locating dowel pins.
   - Carefully place the cylinder head on the cylinder head gasket.



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   - Apply molybdeum disulfide grease to the cylinder head bolts (M14) threads and setting faces.
   - Apply engine oil to the cylinder head bolts (M10) (Number (1) to (26)) threads and setting faces.
   - Tighten the M14 cylinder head bolts in three steps using the angular tightening method.

     Follow the tightening order shown in the illustration.
   - Tighten the M10 (Number (27) to (28)) cylinder head bolts to the specified torque.

NOTE: Cylinder head bolts can be reused 6 times before replacement.
Replace if any doubt exists.

M14 bolt

Torque:

1st step 98 N·m (10 kgm/72 lbft)

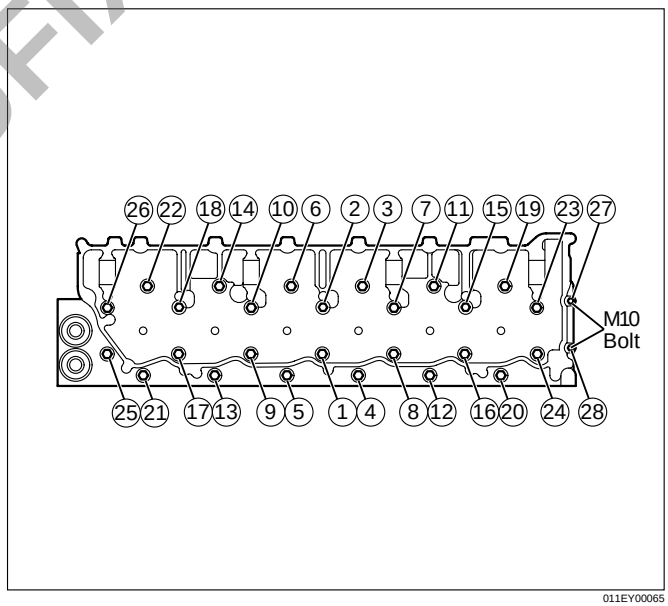
2nd step 147 N·m (15 kgm/108 lbft)

3rd step 30 – 60 deg.

M10 bolt

Torque: 38 N·m (3.9 kgm/28 lbft)

NOTE: Cover the timing gear hole with a clear cloth to prevent the entry of foreign material.



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Troubleshooting

1. Hard starting

Condition	Possible Cause	Correction
Starter motor does not turn over	Loose battery cable terminals Poor battery connections due to rusting	Clean and/or retighten the battery cable terminals
	Battery discharged or weak	Recharge or replace the battery
	Fusible link shorted	Replace the fusible link
	Defective starter switch or starter relay	Replace the starter switch or starter relay
	Defective magnetic switch of starter motor or starter relay	Repair or replace the magnetic switch or starter relay
	Defective starter motor	Repair or replace the starter motor
Starter motor operates but engine does not turn over	Loose battery cable terminals Poor battery connections due to rusting	Clean and/or retighten the battery cable terminals
	Battery discharged or weak	Recharge or replace the battery
	Loose fan belt	Adjust the fan belt tension
	Defective starter motor pinion gear	Replace pinion gear
	Defective magnetic switch of the starter motor	Repair or replace the magnetic switch
	Worn starter motor Weak brush spring	Replace the brush and /or brush spring
	Piston,crank bearing seizure,or other damage	Repair or replace the related parts
Engine turns over but does not start	Air in the fuel system	Bleed air from the fuel system
	Defective engine stop mechanism	Replace the engine stop mechanism
	Control wire improperly adjusted	Adjust the control wire
	Fuel tank is empty	Fill the fuel tank
	Clogged or damaged fuel lines	Repair or replace the fuel lines
	Loose fuel line connections	Retighten the fuel line connections
	Clogged fuel filter element	Replace the fuel filter element or cartridge
	Fuel feed pump strainer is clogged	Clean the fuel pump strainer
	Defective feed pump	Repair or replace the feed pump
	Poor return of the engine stop button	Completely return the engine stop button
	Use of the wrong fuel	Use the recommended fuel
	Water particles in the fuel	Change fuel
	Air in the injection pump	Bleed air from the fuel system
	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
	Improper injection pump control rack operation	Repair or replace the injection pump control rack
	Injection pump plunger worn or stuck	Replace the injection pump plunger assembly
	Injection pump camshaft seizure or other damage	Replace the injection pump camshaft

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Main Data and Specifications

ITEMS	6HK1
Engine type	Four cycle, water cooled, in-line, overhead camshaft direct injection
Combustion chamber	Open type in piston crown
Cylinder liner	Dry
Timing drive system	Gear drive
No. of cylinders – bore × stroke mm (in)	6 – 115 × 125 (4.53 × 4.92)
No. of piston rings	Four rings (Compression rings: 3, Oil ring: 1)
Total piston displacement L (cid)	7.790 (475.4)
Compression ratio (to 1)	17.3
Compression pressure at 200 min^{-1} MPa (kg/cm^2/psi)	3.24 (33/469) or more
Engine dimensions* mm (in)	1,332 × 995 × 1,143 (52.4 × 39.2 × 45.0)
Engine weight (Dry)*	kg (lb) 650 (1,433)
Fuel injection order	1 – 5 – 3 – 6 – 2 – 4
Fuel injection timing (TDC)* deg	9
Specified fuel type	SAE No.2 diesel fuel
Idling speed* min^{-1}	1000
Valve clearances Intake mm (in)	0.40 (0.016)
Exhaust mm (in)	0.40 (0.016)
Intake valves Open at (BTDC) deg	15
Close at (ABDC) deg	44
Exhaust valves Open at (BBDC) deg	58
Close at (ATDC) deg	11
Injection pump	Bosch, in-line P-Type
Governor type*	Mechanical
Injection nozzles	Multi-hole
Injection nozzle opening pressure MPa (kg/cm^2/psi)	1st stage: 18.1 (185/2630) 2nd stage: 22.1 (225/3200)
Main fuel filter	Paper element
Lubrication system	
Lubrication method	Full flow pressure circulation
Specified engine oil (API grade)	CD
Oil pressure (at oil gallery) kPa (kg/cm^2/psi)/min^{-1}	290 – 490 (3.0 – 5.0/43–71)/2000 Condition: SAE 30 API CD grade engine oil at an oil temperature of 80°C (176°F)
Oil pump type	Gear (Timing gear drive)

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ITEMS	SERVICE STANDARD	SERVICE LIMIT
Rocker Arm Shaft and Rocker Arm		
Rocker Arm Shaft Run-Out mm (in)		0.30 (0.012)
Rocker Arm Shaft Outside Diameter mm (in)	21.979 – 22.000 (0.865 – 0.866)	21.85 (0.860)
Rocker Arm Inside Diameter mm (in)	22.010 – 22.035 (0.867 – 0.868)	
Rocker Arm Shaft and Rocker Arm Clearance mm (in)	0.010 – 0.056 (0.0004 – 0.0022)	0.20 (0.008)
Rocker Arm Pin and Roller Clearance mm (in)	0.068 – 0.099 (0.0027 – 0.0039)	0.50 (0.02)
Valve Cap Worn mm (in)		0.10 (0.004)
Camshaft		
Camshaft Journal Diameter mm (in)	39.950 – 39.975 (1.5728 – 1.5738)	39.85 (1.5689)
Cam Lobe Height Intake mm (in)	7.851 (0.3091)	7.351 (0.2894)
Exhaust mm (in)	9.540 (0.3756)	9.040 (0.3559)
Camshaft Run-Out mm (in)	0.025 (0.001)	0.05 (0.002)
Camshaft Bearing Inside Diameter mm (in)	40.00 – 40.037 (1.575 – 1.576)	
Camshaft Bearing Clearance mm (in)	0.025 – 0.087 (0.001 – 0.003)	0.15 (0.006)
Crankshaft		
Crankshaft End Play mm (in)	0.040 – 0.205 (0.0026 – 0.008)	0.54 (0.021)
Crankshaft Run-Out mm (in)	0.06 (0.002) or less	0.45 (0.016)
Crankshaft Journal Diameter	See section 6A crankshaft journal diameter in this manual.	
Crankshaft Journal and Bearing Clearance mm (in)		
No. 4 Bearing	0.093 – 0.124 (0.00366 – 0.00488)	0.14 (0.0055)
Other Bearings	0.063 – 0.094 (0.00248 – 0.00370)	0.14 (0.0055)
Crankshaft Journal and Crankpin Uneven Wear mm (in)		0.05 (0.0020)

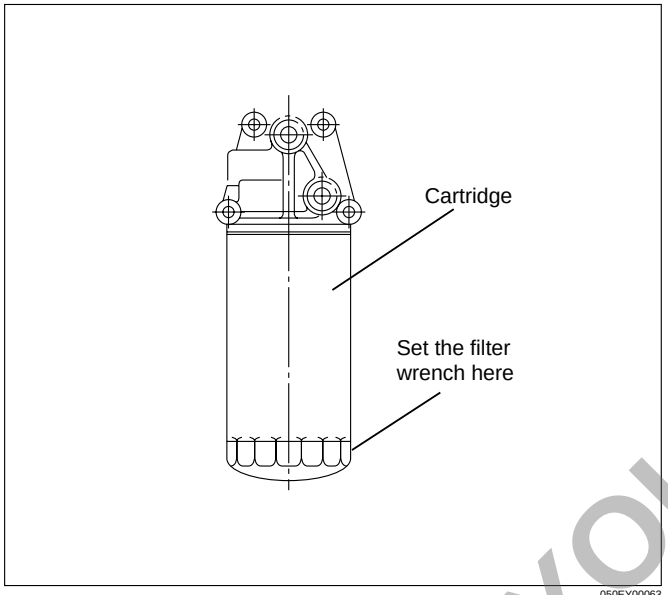
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Lubrication System

Oil filter replacement

1. Set a filter wrench to the cartridge and remove the oil filter.
   Discard the used cartridge.
2. Before installing the new oil filter, apply engine oil to the gasket of the cartridge.
3. Turn the oil filter until the filter gasket comes in contact with its sealed face.
4. Use the filter wrench to turn in the oil filter an additional one full turn.

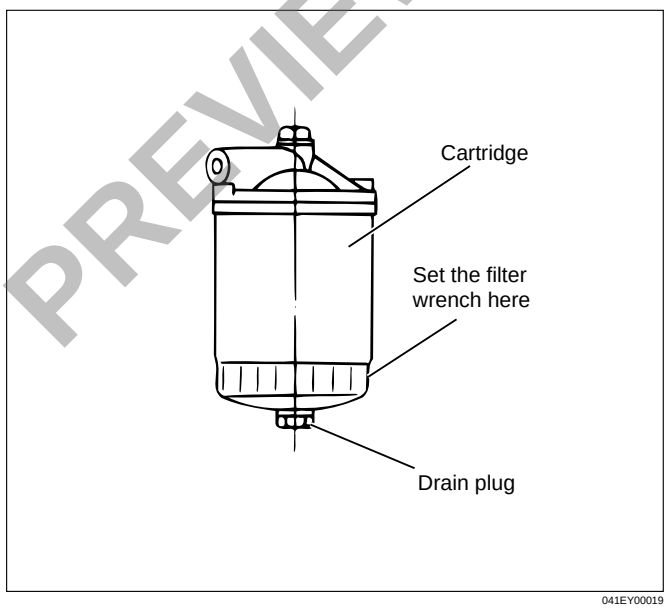


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Fuel System

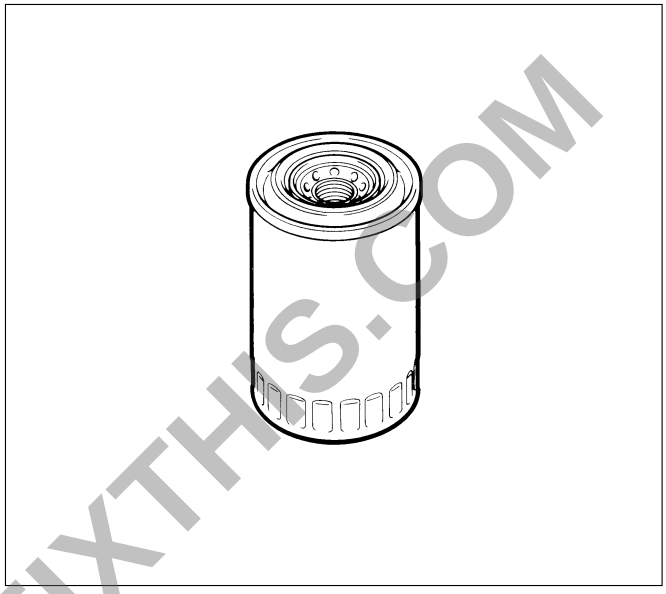
Fuel filter replacement procedure

1. Use a filter wrench to remove the cartridge.
   Discard the used cartridge.



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2. Before installing a new fuel filter, apply fuel to the gasket of the cartridge.
3. Turn the fuel filter until the filter gasket comes in contact with the sealed face.
4. Use the filter wrench to turn in the fuel filter an additional 2/3 of a turn.

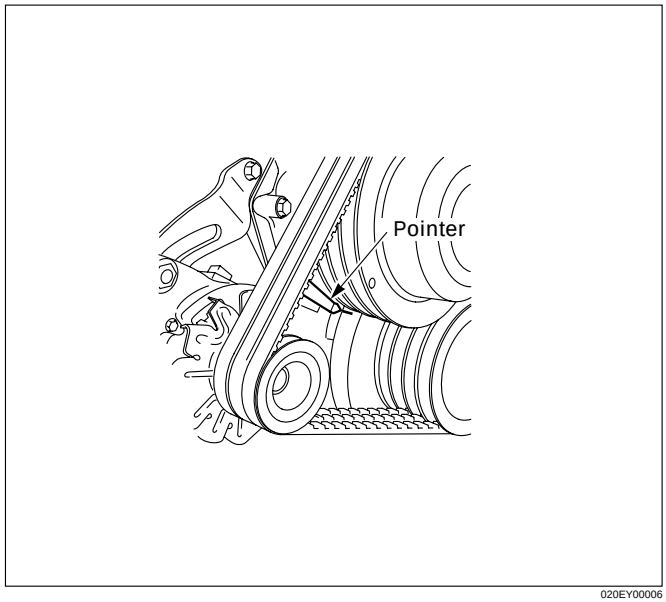


NOTE: Be careful not to spill the fuel remaining in the fuel filter when the filter is removed. After changing the fuel filter element, conduct fuel air bleeding and check for fuel leaks.

Injection Timing Adjustment

Injection Timing Inspection

1. Disconnect the negative battery cable.
2. Rotate the crankshaft in the normal direction of engine rotation to align the injection timing mark on the damper with the timing pointer on the front cover.
   - Injection Timing (Static-TDC): 9 degree



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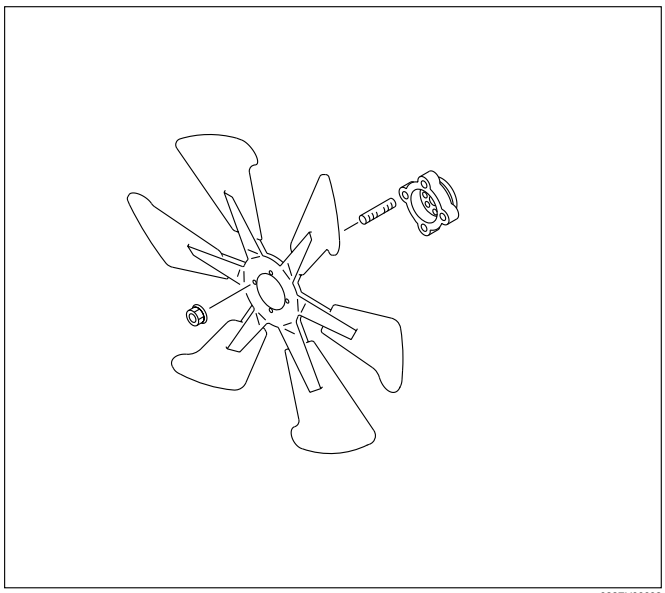
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6J	Engine Induction

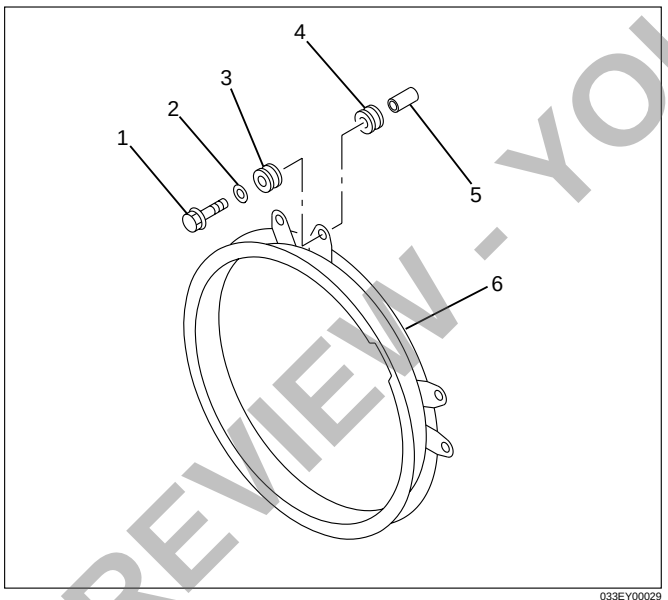
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10. Install the cooling fan.
    Tighten the fixing nuts to the specified torque.
    Torque: 39 N·m (4.0 kgm/29 lbft)


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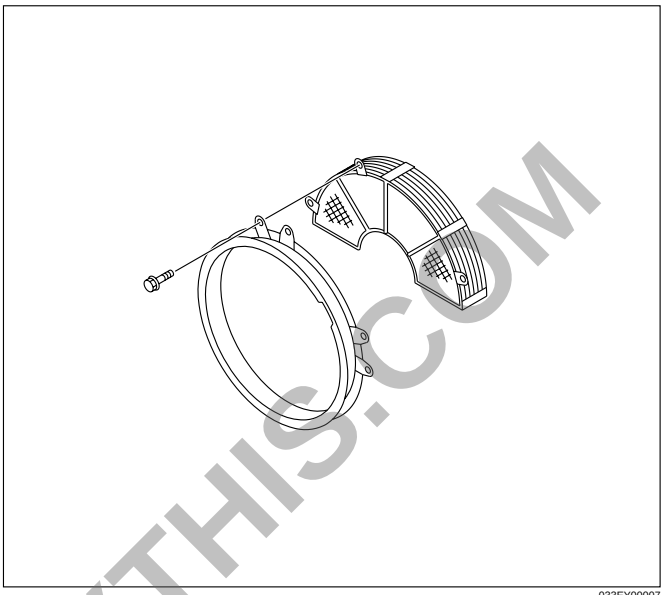
11. Install the fan guide.
    Tighten the fixing bolts to the specified torque.
    Torque: 30 N·m (3.1 kgm/22 lbft)



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Legend
(1) Bolt
(2) Washer
(3) Rubber mount
(4) Rubber mount
(5) Guide tube
(6) Fan guide

12. Install the fan guard.
    Tighten the fixing bolts to the specified torque.
    Torque: 40 N·m (4.1 kgm30 lbft)


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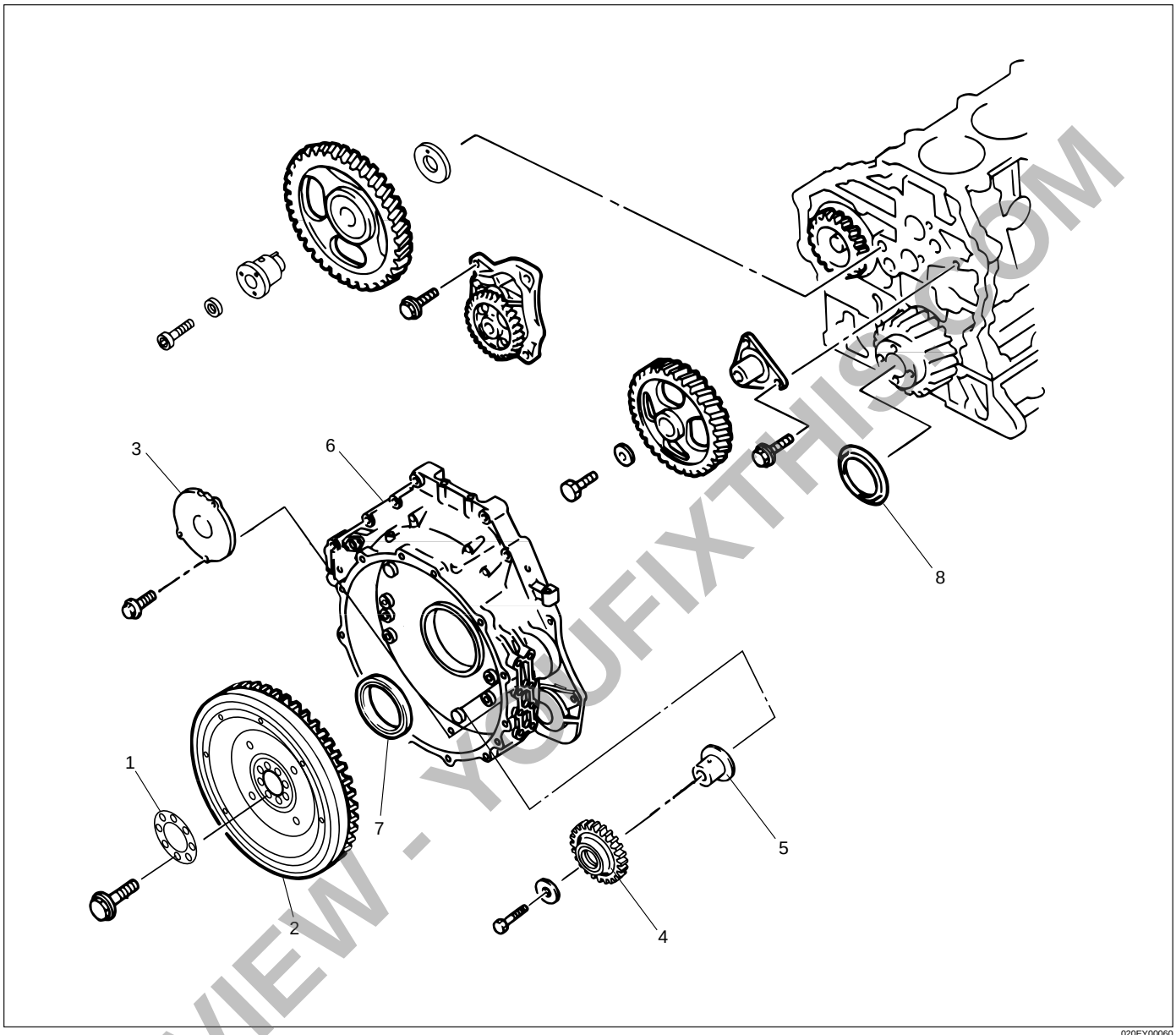
13. Adjust the fan tip clearance.
    Clearance: 7 - 13 mm (0.28 - 0.51 in)

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Flywheel Housing

Removal



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Legend

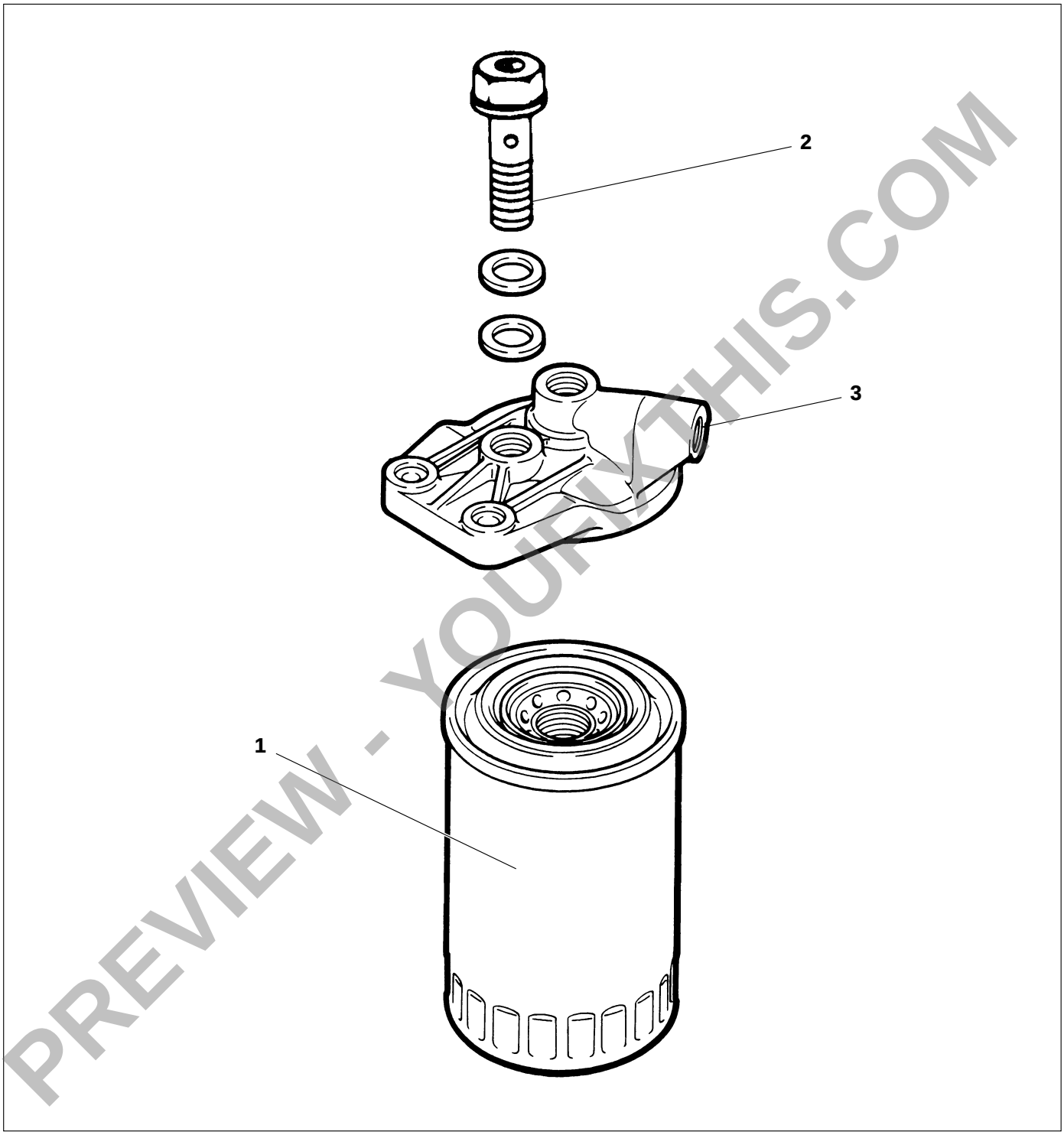
(1) Washer
(2) Flywheel
(3) Cover
(4) Idler gear D
(5) Idler gear shaft D
(6) Flywheel housing
(7) Oil seal
(8) Oil slinger

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Fuel Filter

Disassembly



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Legend

(1) Fuel filter
(2) Overflow valve
(3) Fuel filter body

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