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Safety rules

Personal safety



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible death or injury.

Throughout this manual and on machine decals, you will find the signal words DANGER, WARNING, and CAUTION followed by special instructions. These precautions are intended for the personal safety of you and those working with you.

Read and understand all the safety messages in this manual before you operate or service the machine.

⚠ DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury. The color associated with DANGER is RED.

⚠ WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury. The color associated with WARNING is ORANGE.

⚠ CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. The color associated with CAUTION is YELLOW.

FAILURE TO FOLLOW DANGER, WARNING, AND CAUTION MESSAGES COULD RESULT IN DEATH OR SERIOUS INJURY.

Machine safety

NOTICE: *Notice indicates a situation which, if not avoided, could result in machine or property damage. The color associated with Notice is BLUE.*

Throughout this manual you will find the signal word Notice followed by special instructions to prevent machine or property damage. The word Notice is used to address practices not related to personal safety.

Information

NOTE: *Note indicates additional information which clarifies steps, procedures, or other information in this manual.*

Throughout this manual you will find the word Note followed by additional information about a step, procedure, or other information in the manual. The word Note is not intended to address personal safety or property damage.

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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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Engine - General specification

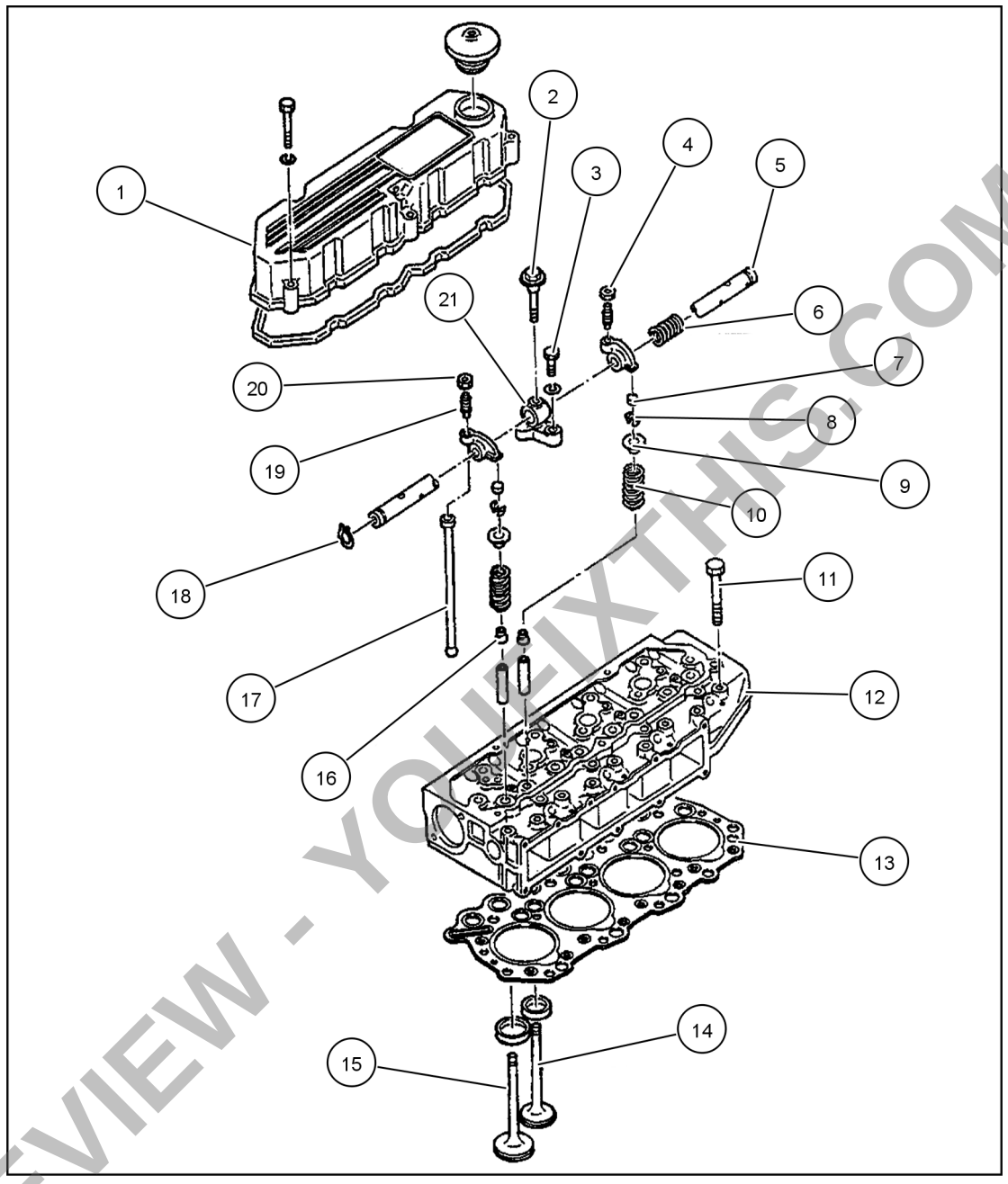
Engine Model		S4Q-Y161GT	S4Q2-Y161GT
General	Type	In-line, water-cooled, 4-stroke cycle	
	Firing order	1-3-4-2	
	Compression ratio	22:1	
	Combustion chamber, type	Swirl	
	Weight (dry), kg (lb)	245 (540)	
	Number of cylinders	4	
	bore x stroke, mm (in)	88 x 95 (3.46 x 3.74)	88 x 103 (3.46 x 4.06)
	Displacement, liter (cu in)	2.311 (141)	2.505 (153)
Maximum permissible working angles for oil pickup level in oil pan, longitudinal and lateral		30°	
Fuel system	Injection pump, type	Doowon rotary	
	Injection nozzle, type	Bosch throttle	
	Fuel filter, type	Spin-on	
Lubrication system	Type	Force feed	
	Oil filter, type	Spin-on cartridge of paper-element	
	Capacity, liter (U.S. gal.)	Oil pan: 7 (1.8) approx. Crankcase: 8 (2.1) approx.	
Cooling system	Type	Radiator	
	Capacity (water jacket), liter (U.S. gal)	3.7 (0.98)	
Electrical system	Starter, V—kW	12—2.2	
	Alternator, V—A	12—50	
	Battery recommended, V—Ah	12—80D26R	

Item	Nominal size	Assembly standard	Repair limit	Service limit	Remarks
Maximum speed, (no-load)	Vary according to specifications				Adjust governor setting
Minimum speed, (no-load)					
Compression pressure, kPa (psi)	**2940 kPa** (**427 psi**) at 150 t0 200 rpm		**2550 kPa** (**370 psi**)		Oil and water temp. **20 - 30 °C** (**68 - 86 °F**)
Engine oil pressure, kPa, (psi)	**196 - 392 kPa** (**28 - 57 psi**) at rated rpm		**147 kPa** (**21.3 psi**)		Oil temperature **70 - 90 °C** (**158 - 194 °F**)
	98 kPa (**14.2 psi**), minimum at low idle speed		**49 kPa** (**7 psi**)		
Valve timing	Inlet valves open: 30° B.T.D.C Inlet valves close: 50° A.T.D.C. Exhaust valves open: 74° B.T.D.C. Exhaust valves close: 30° A.T.D.C. ±3° (crank angle)				
Valve clearance (cold)		**0.25 mm** (**0.098 in**)			Both inlet and exhaust valves

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Cylinder head - Exploded view



70106728A 1

(1) Rocker cover
(2) Bolt (long)
(3) Bolt (short)
(4) Exhaust valve rocker arm
(5) Rocker shaft
(6) Rocker shaft spring
(7) Valve cap
(8) Valve retainer
(9) Valve cotters
(10) Valve spring
(11) Cylinder head bolt
(12) Cylinder head
(13) Cylinder head gasket
(14) Valve (exhaust)
(15) Valve (inlet)
(16) Valve stem seal
(17) Valve push rod
(18) Snap ring
(19) Inlet valve rocker arm
(20) Adjusting screw
(21) Rocker shaft brackets

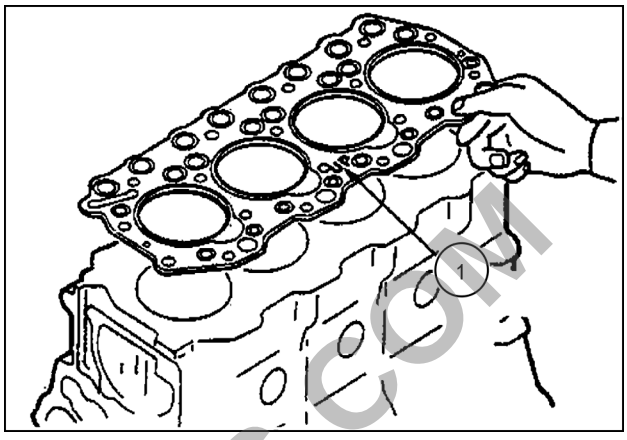
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Cylinder head - Install

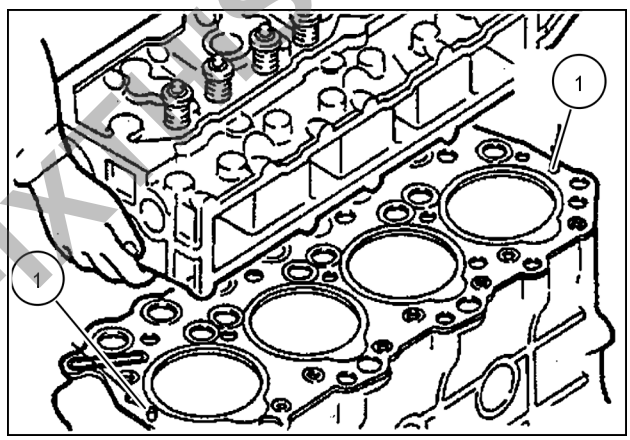
1. Clean the surface of cylinder head and the crankcase.
2. Align the holes in the new gasket **(1)** with the locating dowels and place the gasket on the crankcase.

NOTE: *The gasket is marked with "UP" which indicates the orientation of the gasket.*



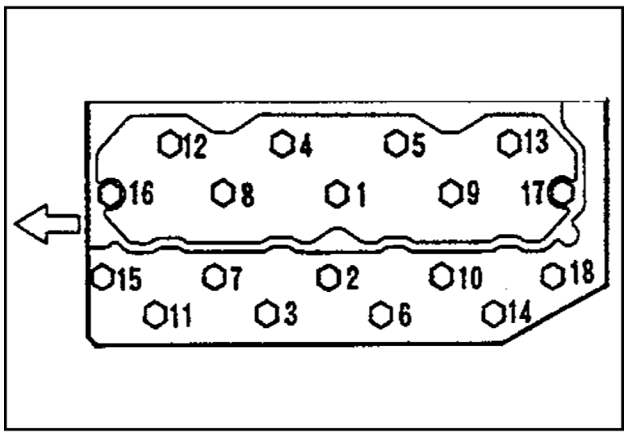
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3. Align the holes in the cylinder head with the locating dowels **(1)** and place the cylinder head on the crankcase.



70106760 2

4. Use the sequence diagram shown in the figure to torque the cylinder head bolts in the following stages:
   A. **61 - 68 N·m** (**45 - 50 lb ft**)
   B. **113 - 123 N·m** (**83 - 91 lb ft**)



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Fuel injection system - Testing - Knocking

NOTE: *Knocking is when the diesel engine rotates producing unique combustion noise (diesel knock) due to its combustion system. This knock noise is normal unless it is especially loud.*

NOTICE: *Check items before troubleshooting*
(1) Clogging of air cleaner element
(2) Use of poor quality fuel (low cetane number fuel such as kerosene)

N°	Test Point	Expected Result	Other Result (Possible Cause)
1	**Check** Is the fuel injection timing normal (fuel injection timing is early)?	**Result** Yes **Action** Go to test **2**	**Result** No **Action** Adjust fuel injection timing
2	**Check** Are fuel injection nozzles normal (drop in injection-valve opening pressure and faulty)?	**Result** Yes **Action** Go to test **3**	**Result** No **Action** Examine fuel injection nozzles
3	**Check** Is the compression pressure in cylinders normal?	**Result** Yes **Action** Go to test **4**	**Result** No **Action** Inspecting valves, pistons, piston rings and cylinder head gasket
4	**Check** Is the fuel injection pump normal (variations in injection amount)?	**Result** Yes **Action** Generation of mechanical noise (wear of and damage to main working parts)	**Result** No **Action** Replace or repair fuel injection pump

Fuel injection system - Testing - Excessive black smoke

NOTICE: *Check items before troubleshooting*

(1) Clogging of air cleaner element
(2) Use of poor quality fuel
(3) Overload

N°	Test Point	Expected Result	Other Result (Possible Cause)
1	**Check** Is the smoke set amount of the fuel injection pump normal?	**Result** Yes **Action** Go to test **2**	**Result** No **Action** Adjust smoke set
2	**Check** Is the engine correctly adjusted (valve clearance excessive, fuel injection timing out of order)?	**Result** Yes **Action** Go to test **3**	**Result** No **Action** Adjust engine
3	**Check** Are fuel injection nozzles normal (spray state, injection-valve opening pressure too high)?	**Result** Yes **Action** Go to test **4**	**Result** No **Action** Inspect fuel injection nozzles
4	**Check** Is the compression pressure normal?	**Result** Yes **Action** Inspect fuel injection pump	**Result** No **Action** Inspect valves, cylinder head gasket, pistons and piston rings

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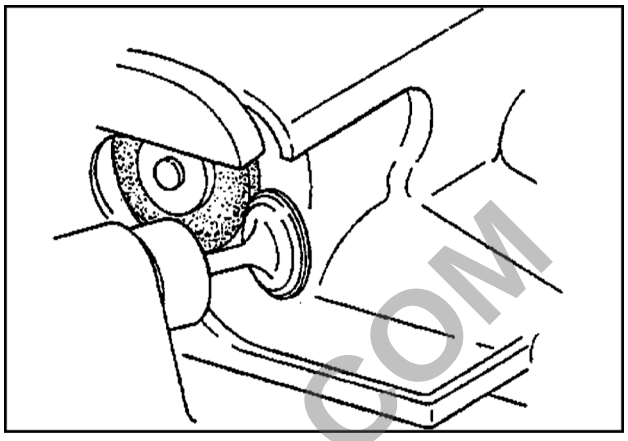
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Resurfacing valves

1. If the valve face is badly worn, resurface the valve with a valve resurfacer.

NOTE: *Set the valve ref rat an angle of 30°.*
The valves have a satellite facing. This facing will be gone if the valve margin is less than the service limit. If the valve margin seems to be less than the service limit, when ground, replace the valve.

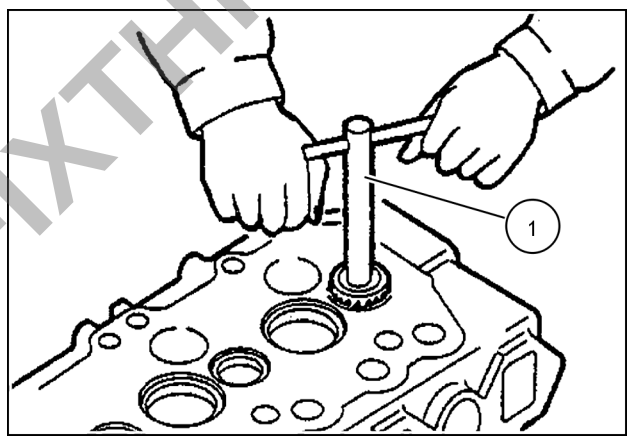


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Refacing valve seats

1. Using a valve seat cutter or a valve seat grinder **(1)**, cut the valve seat. After cutting, grind the seat with a sandpaper of #400 grade or so inserted between the cutter and valve seat.

NOTE: *Do not cut or grind the valve seat more than is necessary for resurfacing.*
If the seat width seems to be greater than the service limit when resurfaced, replace the valve seat.



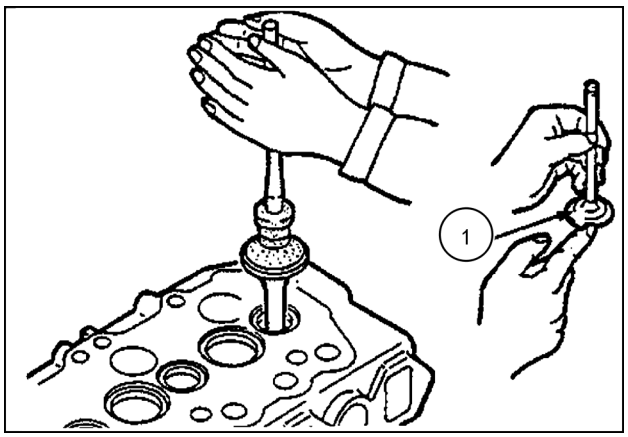
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Lapping valves

1. After resurfacing or replacing the valves and/or valve seats, be sure to lap the valve in the valve seat.
2. Put a small amount of lapping compound **(1)** on the valve face.

NOTE: *Do not put the lapping compound on the valve stem. Use a compound of 120 to 150 mesh for initial lapping and a compound of finer than 200 mesh for finish lapping. Lapping valve*
Mixing the compound with a small amount of engine oil will facilitate putting the compound on the valve face.

3. Using a lapping tool, hold the valve against the seat and rotate it only a part of a turn, then raise the valve off the seat, rotating it to a new position. Then press the valve against the seat for another part of a turn. Repeat this operation until the compound wears and loses its cutting property.
4. Wash the valve and valve seat with dry cleaning solvent.
5. Put engine oil on the valve seat and lap the valve in the seat.
6. Check the valve face for contact with the seat.

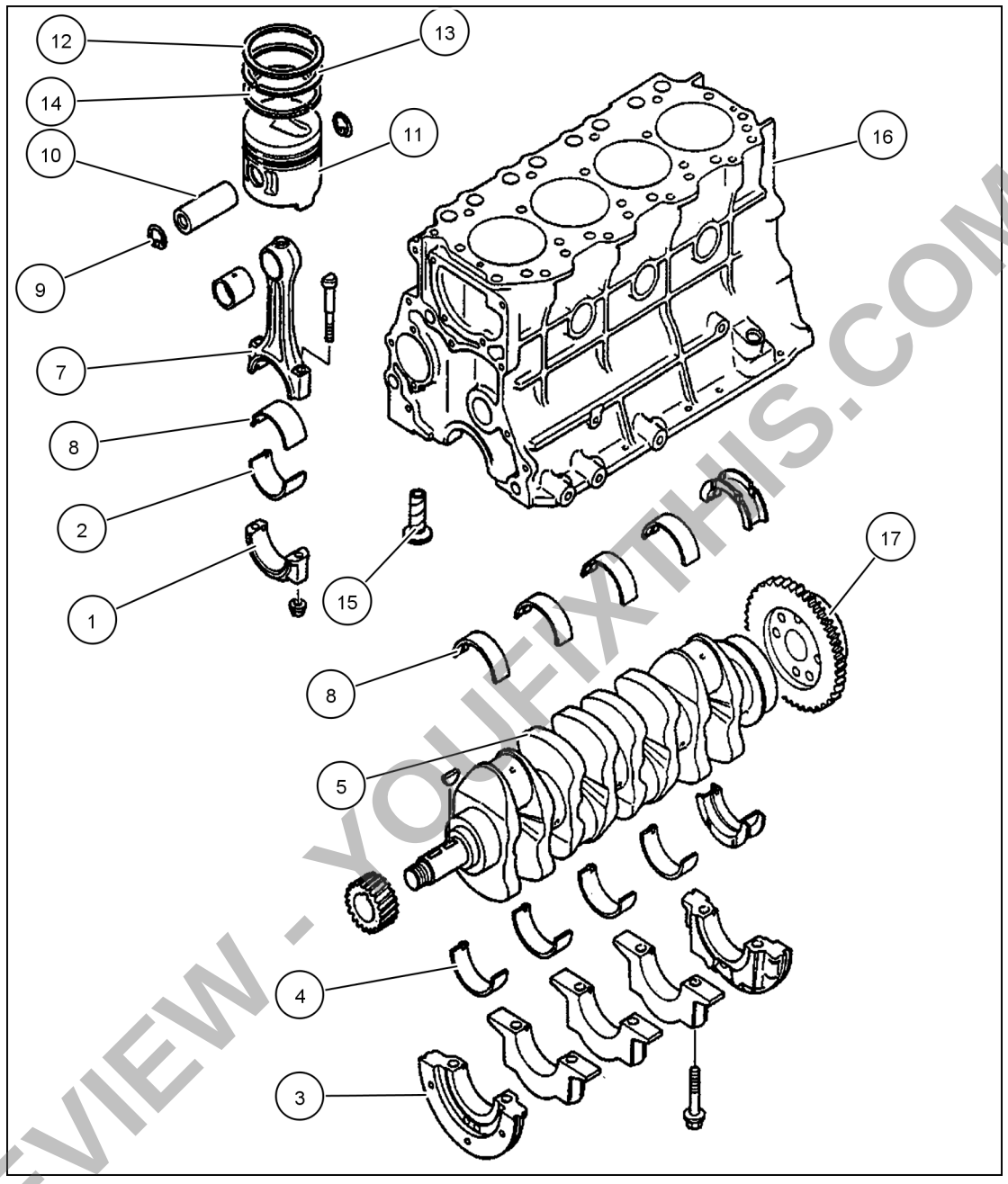


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Connecting rods and pistons - Exploded view



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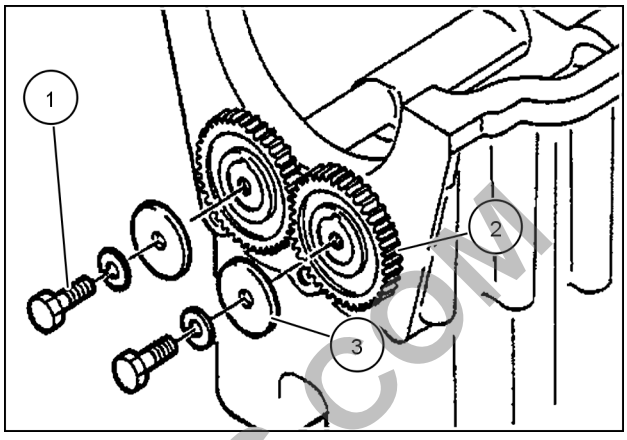
(1) Connecting rod cap
(2) Lower connecting rod bearing
(3) Main bearing cap
(4) Lower main bearing
(5) Crankshaft
(6) Upper main bearing
(7) Connecting rod
(8) Upper connecting rod bearing
(9) Snap ring
(10) Piston pin
(11) Piston
(12) Combustion ring
(13) Intermediate ring
(14) Oil control ring
(15) Tappet
(16) Crankcase
(17) Drive gear

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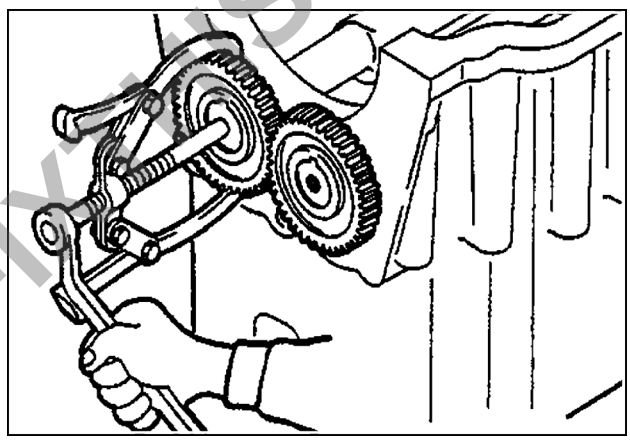
Balancer - Remove

1. Remove the bolts **(1)** and washers **(3)** that secure the drive gears **(2)** to the balancer shafts.



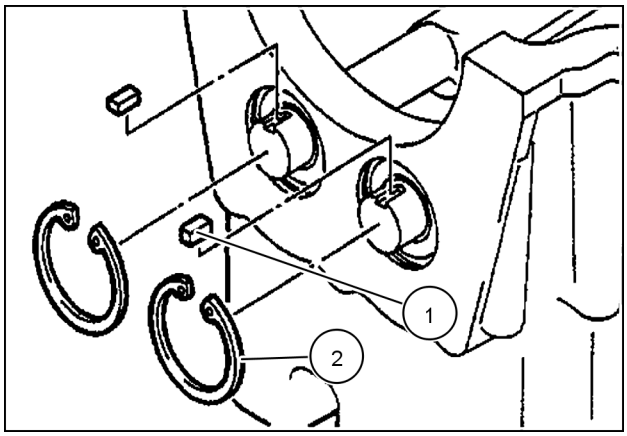
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2. Remove the gears from the balancer shafts with a gear puller.



70106788 2

3. Remove the keys **(1)** and snap rings **(2)** from the balancer shafts.



70106789 3

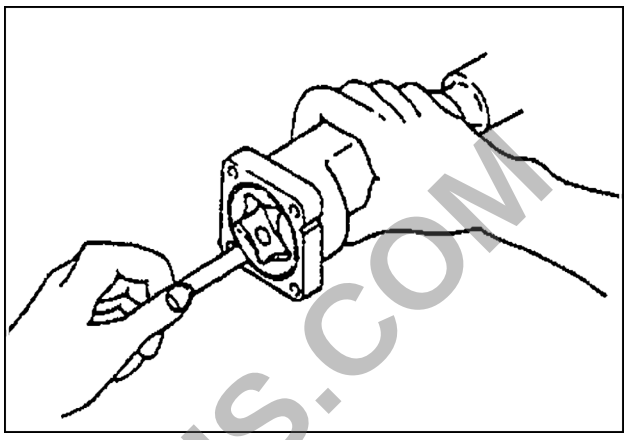
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Engine oil pump - Inspect

Clearance between outer rotor and inner rotor

1. Check the clearance with a feeler shown in the illustration. If the clearance exceeds the service limit, replace assembly.

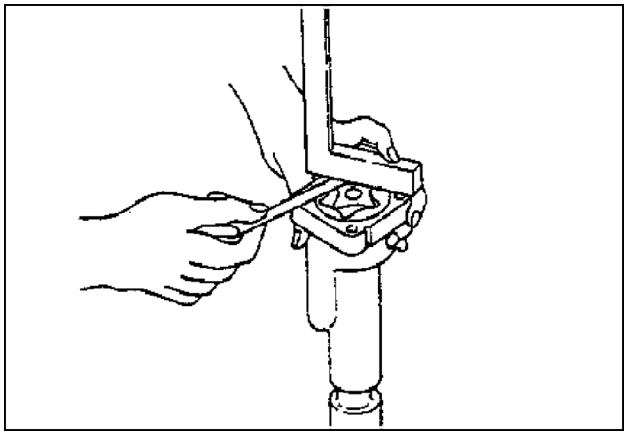


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Item	Assembly standard	Service limit
Clearance between outer rotor and inner rotor	**0.13 - 0.15 mm** (**0.0051 - 0.0059 in**)	**0.20 mm** (**0.0079 in**)

Clearance between rotors and cover

1. Check the clearance with a feeler gauge and straight edge, as shown in the illustration. If the clearance exceeds the service limit, replace the pump assembly.



70106916 2

Item	Assembly standard	Service limit
Clearance between rotors and cover	**0.04 - 0.09 mm** (**0.0016 - 0.0035 in**)	**0.15 mm** (**0.0059 in**)

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