
Perkins 400 Series

Models 403C-11, 403C-15, 404C-22 and 404C-22T

WORKSHOP MANUAL

- | | |
|-----------------|---|
| 403C-11 | Three cylinder naturally aspirated diesel engine |
| 403C-15 | Three cylinder naturally aspirated diesel engine |
| 404C-22 | Four cylinder naturally aspirated diesel engine |
| 404C-22T | Four cylinder turbo charged diesel engine |

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PACE

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General information

Introduction

This workshop manual has been written to provide assistance for technicians who service and overhaul the Perkins 403C-11, 403C-15, 404C-22 and the 404C-22T engine. The assumption is made that the engine is removed from the application.

The engine conforms with USA EPA/CARB and EC emissions legislation for agricultural and industrial applications.

Where the information applies only to certain engine types, this is indicated in the text.

Special tools are available and listed in chapter 16. POWERPART recommended consumable products are listed in this chapter. There is a reference to the relevant special tools and consumable products at the beginning of each operation.

Danger is indicated in the text by two methods:

Warning! *This indicates that there is a possible danger to the person.*

Caution: *This indicates that there is a possible danger to the engine.*

Note: Is used where the information is important, but there is not a danger.

Warning! *Read and remember the "Safety precautions". They are given for your protection and must be used at all times.*

Generally, if new joints are to be fitted, it is accepted that the faces for the joint will be cleaned, as this is normal workshop practice. Also, it is understood that during assembly and inspection, all parts are to be thoroughly cleaned and lubricated, and where present, burrs and scale are to be removed.

All open ports of high-precision components e.g. fuel injection equipment must be covered until assembly, to prevent the entry of foreign matter.

When either the "left" or the "right" side of the engine is referred to, it is when viewed from the flywheel end.

When fitting setscrews or studs into holes that enter oil, coolant or air passages, a suitable sealant should be used to prevent leakage.

Micro encapsulated anaerobic sealant (M.E.A.S.) has been applied to the threads instead of jointing compounds or other sealants when the fasteners are fitted in through holes into oil or coolant passages. The identification of these fasteners, as supplied, is by the colour of the sealant.

With M.E.A.S. sealed studs, the sealed end must be fitted into the component. The threaded holes must have a 1,59 mm (0.0625 in) 45° chamfer to ensure that the M.E.A.S. sealant is not removed when the new fasteners are fitted. If the fasteners have to be removed and fitted again, the threads must be cleaned and a suitable sealant used.

Safety precautions

These safety precautions are important. You must refer also to the local regulations in the country of use. Some items only refer to specific applications

- Only use these engines in the type of application for which they have been designed.
- Do not change the specification of the engine.
- Do not smoke when you put fuel in the tank.
- Clean away fuel which has been spilt. Material which has been contaminated by fuel must be moved to a safe place.
- Do not put diesel fuel in the tank during engine operation (unless it is absolutely necessary).
- Do not add lubricating oil, or adjust the engine while it runs (unless you have had the correct training; even then extreme care must be used to prevent injury).
- Do not make adjustments that you do not understand.
- Ensure that the engine does not run in a location where it can cause a concentration of toxic emissions.
- Other persons must be kept at a safe distance while the engine or auxiliary equipment is in operation.
- Do not permit loose clothing or long hair near moving parts.
- Keep away from moving parts during engine operation. **Warning!** Some moving parts cannot be seen clearly while the engine runs.
- Do not operate the engine if a safety guard has been removed.
- Do not remove the filler cap or any component of the cooling system while the engine is hot and while the coolant is under pressure, because dangerous hot coolant can be discharged.
- Do not allow sparks or fire near the batteries (especially when the batteries are on charge) because the gases from the electrolyte are highly flammable. The battery fluid is dangerous to the skin and especially to the eyes.
- Disconnect the battery terminals before a repair is made to the electrical system.
- Only one person must control the engine.
- Ensure that the engine is operated only from the control panel or from the operators position.
- If your skin comes into contact with high-pressure fuel, obtain medical assistance immediately.
- Diesel fuel and lubricating oil (especially used lubricating oil) can damage the skin of certain persons. Protect your hands with gloves or a special solution to protect the skin.
- Do not wear clothing which is contaminated by lubricating oil. Do not put material which is contaminated with oil into the pockets of clothing.
- Discard used lubricating oil in accordance with local regulations to prevent contamination.
- Ensure that the control lever of the transmission drive is in the "out-of-drive" position before the engine is started.
- Use extreme care if emergency repairs must be made in adverse conditions.
- The combustible material of some components of the engine (for example certain seals) can become extremely dangerous if it is burned. Never allow this burnt material to come into contact with the skin or with the eyes.
- Always use a safety cage to protect the operator when a component is to be pressure tested in a container of water. Fit safety wires to secure the plugs which seal the hose connections of a component which is to be pressure tested.
- Do not allow compressed air to contact your skin. If compressed air enters your skin, obtain medical help immediately.
- Turbochargers operate at high speed and at high temperatures. Keep fingers, tools and debris away from the inlet and outlet ports of the turbocharger and prevent contact with hot surfaces.
- Do not clean an engine while it runs or while it is hot. If cold cleaning fluids are applied to a hot engine, certain components on the engine could be damaged.
- Fit only genuine Perkins parts.

Viton seals**Warnings!**

- *Some seals used in engines and in components fitted to engines are made of Viton. Viton is used by many manufactures and is a safe material under normal conditions of operation. If Viton is burned, a product of this burnt material is an acid which is extremely dangerous. Never allow this burnt material to come into contact with the skin or with the eyes. If it is necessary to come into contact with components which have been burnt, ensure that the precautions which follow are used:*
- *Ensure that the components have cooled.*
- *Use Neoprene gloves and discard the gloves safely after use.*
- *Wash the area with calcium hydroxide solution and then with clean water.*
- *Disposal of components and gloves which are contaminated must be in accordance with local regulations.*

If there is contamination of the skin or eyes, wash the affected area with a continuous supply of clean water or with calcium hydroxide solution for 15 - 60 minutes. **Obtain immediate medical attention.**

Safety cautions when an engine is cleaned

Care should be taken, when an engine is cleaned with a high pressure cleaning system.

Cautions:

- *Do not wash an engine while it runs or while it is hot. If cold cleaning fluids are applied to a hot engine, certain components on the engine could be damaged.*
- *Leave the engine to cool for at least one hour and disconnect the battery connections before cleaning.*
- *Do not wash any part of the fuel injection pump (FIP), cold start device, electrical shut off solenoid (ESOS) or electrical connectors.*
- *Ensure that the alternator, starter motor and any other electrical components are shielded and not directly cleaned by the high pressure cleaning system.*

If these cautions are ignored, the engine or certain components could be damaged, fail to operate and also make the manufacturer's warranty invalid.

POWERPART recommended consumable products

Perkins have made available the products recommended below in order to assist in the correct operation, service and maintenance of your engine and your machine. The instructions for the use of each product are given on the outside of each container. These products are available from your Perkins distributor.

POWERPART Antifreeze

Protects the cooling system against frost and corrosion.

Part number 21825166.

POWERPART Easy Flush

Cleans the cooling system.

Part number 21825001.

POWERPART Gasket and flange sealant

To seal flat faces of components where no joint is used. Especially suitable for aluminium components.

Part number 21820518.

POWERPART Gasket remover

An aerosol for the removal of sealants and adhesives.

Part number 21820116.

POWERPART Griptite

To improve the grip of worn tools and fasteners.

Part number 21820129.

POWERPART Hydraulic threadseal

To retain and seal pipe connections with fine threads. Especially suitable for hydraulic and pneumatic systems.

Part number 21820121.

POWERPART Industrial grade super glue

Instant adhesive designed for metals, plastics and rubbers.

Part number 21820125.

POWERPART Lay-Up 1

A diesel fuel additive for protection against corrosion.

Part number 1772204.

POWERPART Lay-Up 2

Protects the inside of the engine and of other closed systems.

Part number 1762811.

POWERPART Lay-Up 3

Protects outside metal parts.

Part number 1734115.

POWERPART Metal repair putty

Designed for external repair of metal and plastic.

Part number 21820126.

POWERPART Pipe sealant and sealant primer

To retain and seal pipe connections with coarse threads. Pressure systems can be used immediately.

Part number 21820122.

POWERPART Radiator stop leak

For the repair of radiator leaks.

Part number 21820127.

POWERPART Retainer (high strength)

To retain components which have an interference fit. Currently Loctite 638.

Part number 21820638.

POWERPART Safety cleaner

General cleaner in an aerosol container.

Part number 21820128.

POWERPART Silicone adhesive

An RTV silicone adhesive for application where low pressure tests occur before the adhesive sets. Used for sealing flange where oil resistance is needed and movement of the joint occurs.

Part number 21826038.

POWERPART Silicone RTV sealing and jointing compound

Silicone rubber sealant which prevents leakage through gaps. Currently Hylosil.

Part number 1861108.

POWERPART Stud and bearing lock

To provide a heavy duty seal to components that have a light interference fit.

Part number 21820119 or 21820120.

POWERPART Threadlock and nutlock

To retain small fasteners where easy removal is necessary.

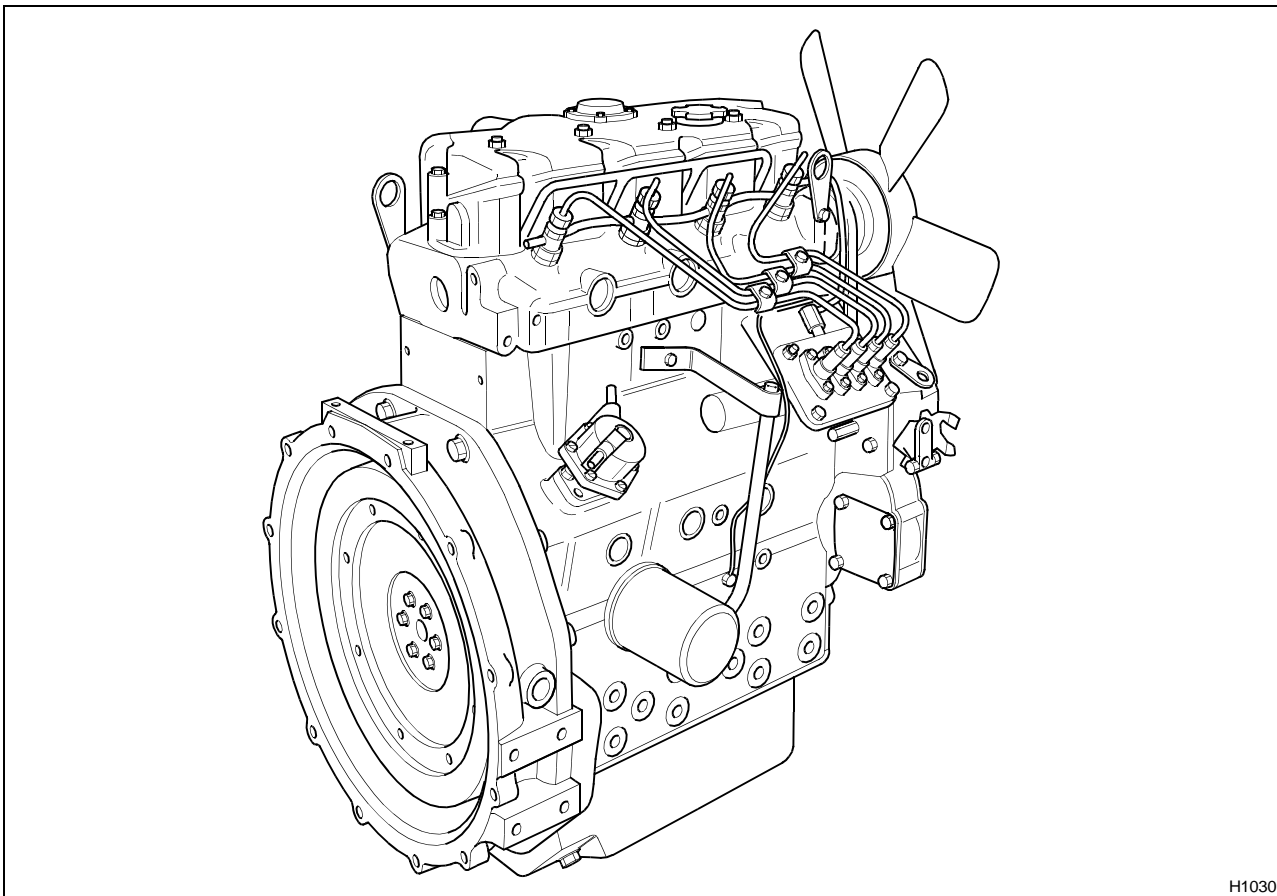
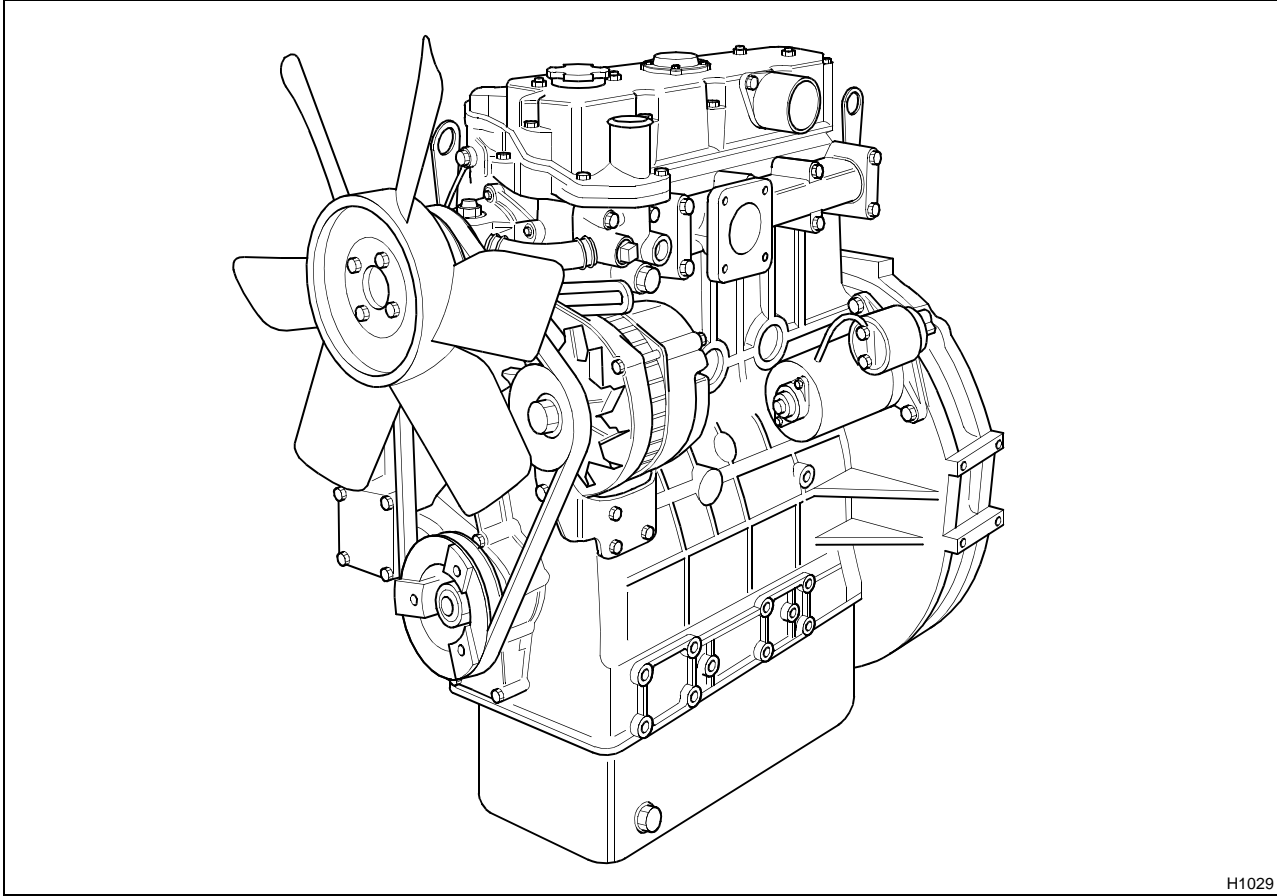
Part number 21820117 or 21820118.

POWERPART Universal jointing compound

Universal jointing compound which seals joints. Currently Hylomar.

Part number 1861117.

Engine views



Engine identification

Engine build lists numbering system

The standard engine build list numbering code is defined as follows:

Code	I	II	III	IV	V
Example	HP	TBA	U	000001	D

Code I Engine build code

Code	HH	HL	HP	HR
Engine	403C-11	403C-15	404C-22	404C-22T

Code II engine build list

The build list increases numerically for both OEMS and distributors.

Code III country of manufacture

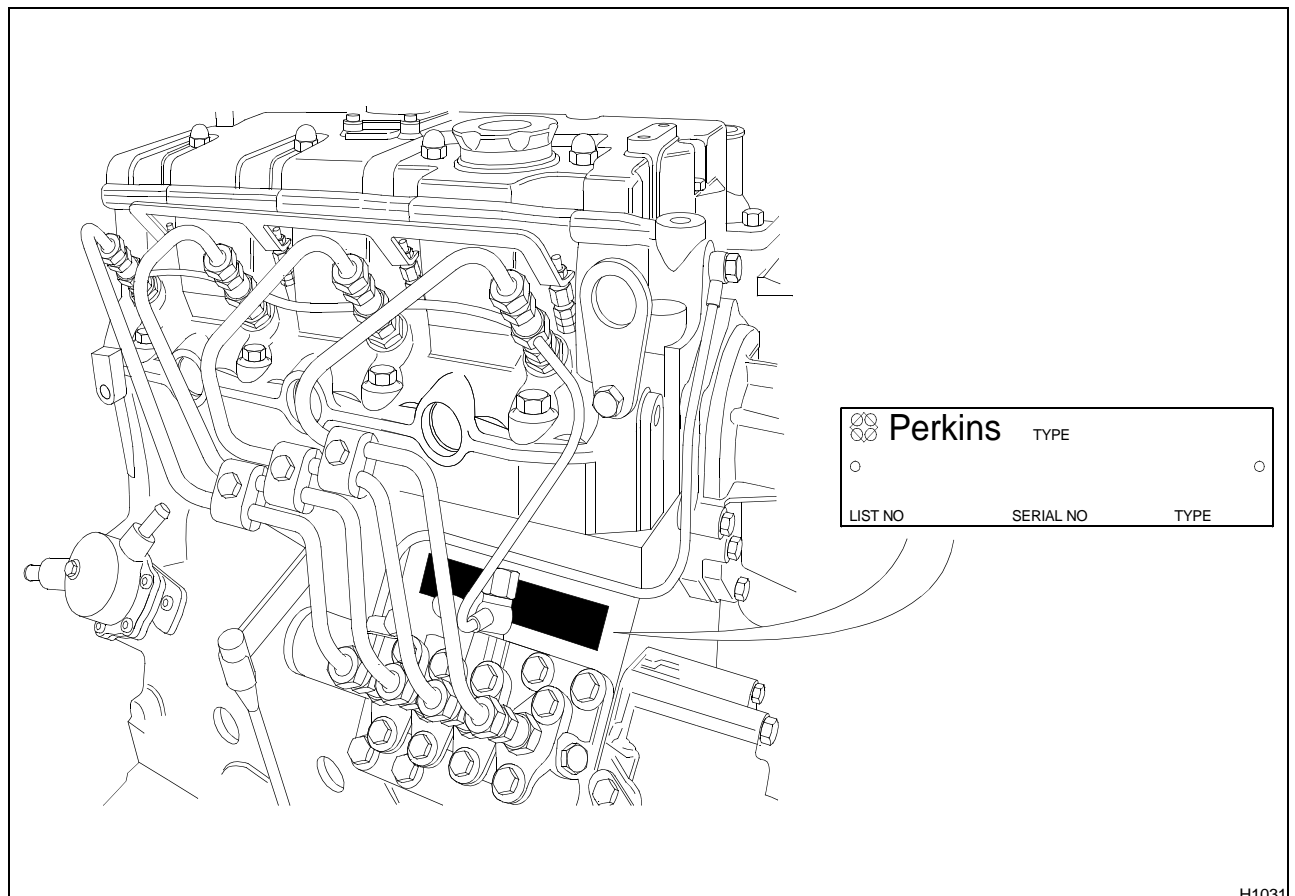
Code	J	U
Country of manufacture	Made in Japan	Made in U.K.

Code IV engine serial number

Individual serial number commencing with 000001 increasing numerically.

Code V year of manufacture

Code	H	J
Year	2001	2002



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Engine lift equipment

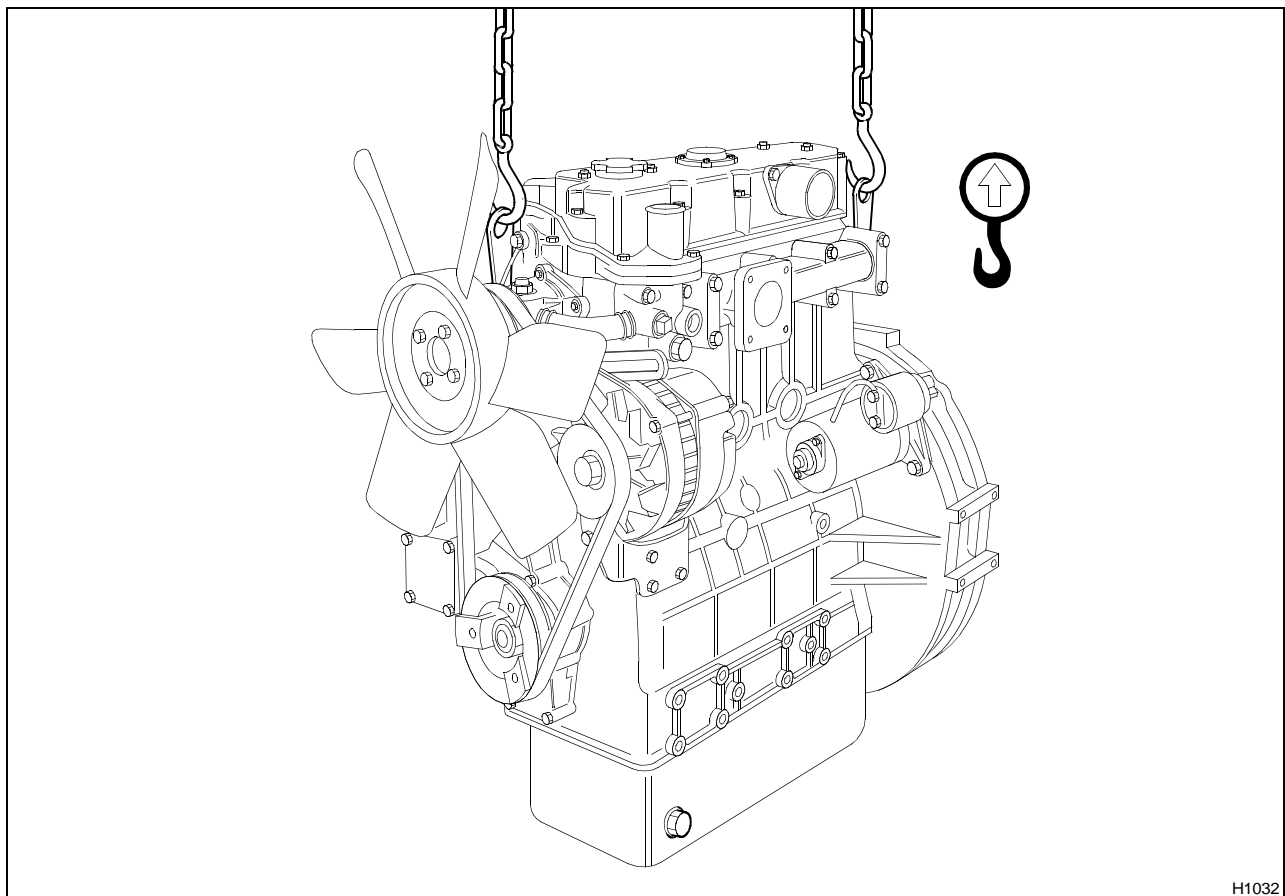
Recommended torque: lifting eye bolts

Engine	Nm (lbf ft) kgf m
All models	26 (19) 2,6

Maximum engine weights

Engine	Engine specification	Maximum engine weights (dry) ⁽¹⁾
403C-11	Long flywheel housing specification	114 kg
	Short flywheel housing specification	96 kg
	Backplate specification	87 kg
403C-15	Long flywheel housing specification	176 kg
	Short flywheel housing specification	154 kg
	Backplate specification	150 kg
404C-22	Long flywheel housing specification	220 kg
	Short flywheel housing specification	196 kg
	Backplate specification	184 kg
404C-22T	Long flywheel housing specification	230 kg
	Short flywheel housing specification	206 kg
	Backplate specification	194 kg

(1) Engine may alter with final specification.



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2

Specifications

Basic engine data

Engine model	403C-11	403C-15	404C-22	404C-22T
Engine build code	HH	HL	HP	HR
Number of cylinders	3	3	4	4
Cylinder arrangement	Vertical in line			
Cycle	Four stroke			
Direction of rotation	Clockwise from the front			
Induction system	Naturally aspirated			Turbo charged
Combustion system	Indirect injection			
Nominal bore	77 mm (3.03 in)	84 mm (3.3 in)		
Stroke	81 mm (3.19 in)	90 mm (3.5 in)	100 mm (3.9 in)	
Compression ratio	23: 1	22.5: 1	23.3: 1	
Cubic capacity	1,131 litres (69 in ³)	1,496 litres (91 in ³)	2,216 litres (135.2 in ³)	
Firing order	1, 2, 3	1, 2, 3	1, 3, 4, 2	
Valve tip clearance (cold)				
Inlet	0,2 mm (0.0078 in)			
Exhaust	0,2 mm (0.0078 in)			
Governor	Mechanical all speed			
Fuel injection	Cassette type fuel injection pump			
Electrical system	12 Volt			
Lubricating oil pressure relief valve	304 - 500 kPa	262 - 359 kPa	352 - 448 kPa	
Lubricating oil pressure switch located on top cover	49,0 kPa	29,4 kPa		
Lubricating oil pressure switch located on cylinder block oil rail	49,0 kPa	98,0 kPa		

Standard torques

Most of the torque tensions on the engine are standard. Special torque tensions are listed in the separate specific torque tables. The standard torque tensions listed in the tables below can be used when a specific torque is not necessary.

The torque tensions below apply to components lubricated lightly with clean engine oil before they are fitted.

Standard torques for setscrews and nuts

Thread size	Strength	Coarse thread				Fine thread			
		Pitch mm	Torque	Torque	Torque	Pitch mm	Torque	Torque	Torque
			Nm	lbf ft	kgf m		Nm	lbf ft	kgf m
M 4	8.8 11T	0,7	3 4	2 3	0,3 0,4	-	-	-	-
M5	8.8 11T	0,8	6 8	4 6	0,6 0,8	-	-	-	-
M6	8.8 11T	1,0	10 14	7 10	1,0 1,4	-	-	-	-
M8	8.8 11T	1,25	26 32	19 24	2,7 3,3	1,0	30 35	22 26	3,0 3,6
M10	8.8 11T	1,5	50 62	37 46	5,1 6,3	1,25	56 66	41 49	5,7 6,7
M12	8.8 11T	1,75	75 104	55 77	7,6 10,6	1,25	84 113	62 83	8,6 11,5
M14	8.8 11T	2,0	118 157	87 116	12,0 16,0	1,5	132 167	97 123	13,5 17,0
M16	8.8 11T	2,0	167 230	123 170	17,0 23,4	1,5	175 245	129 181	17,8 25,0

Bolt strength	Examples of applicable material
8.8 11T	S45C SCM435

Special torques

	Torque Nm (lbf ft) kgf m
Angleich	5 (3.6) 0,5
Atomiser	64 (47.2) 6,4
Atomiser pipes	23 (16.9) 2,3
Blanking plug rear of cylinder block	7 (5.1) 0,7
Crankshaft carrier to block	27 (19.9) 2,7
Connecting rod nuts	52 (38.3) 5,2
Crankshaft nut	303 (223.5) 30,3
Crankshaft sub assembly	52 (38.3) 5,2
Exhaust manifold	25 (18.4) 2,5
Flywheel	74 (54.5) 7,4
Fuel injection pump	15 (11) 1,5
Fuel injection pump leak off rail	7 (5.1) 0,7
Glow plug	18 (13.2) 1,8
Head setscrew	101 (74.5) 10,3
Leak off rail	27 (19.9) 2,7
Lift pump banjo	12 (8.8) 1,2
Lift pump mounting setscrew	6 (4.4) 0,6
Oil pipe	12 (8.8) 1,2
Oil strainer	10 (7.3) 1,0
Relief valve	64 (47.2) 6,4
Timing case	10 (7.3) 1,0
Rocker assembly nuts	33 (24.3) 3,3
Rocker cover	14 (10.3) 1,4
Electrical shut off solenoid	18 (13.2) 1,8
Sump drain plug	35 (25.8) 3,5
Temperature switch	27 (19.9) 2,7
Thermostat setscrew	14 (10.3) 1,4

Compression test data

Many factors affect compression pressures, the battery, starter motor condition, ambient conditions and the type of gauge used can give a wide variation of results for a given engine.

Standard value	To be repaired
>2940 kPa (426.6 lbf / in ²) @ 250 rpm	<2450 kPa (355.5 lbf / in ²) @ 250 rpm

Compression tests should only be used to compare between cylinders of an engine. If one or more cylinders vary by more than 350 kPa (50 lbf / in²) then those cylinders may be faulty.

Compression tests should not be the only method used to show the condition of an engine, but they should be used together with other symptoms and tests.

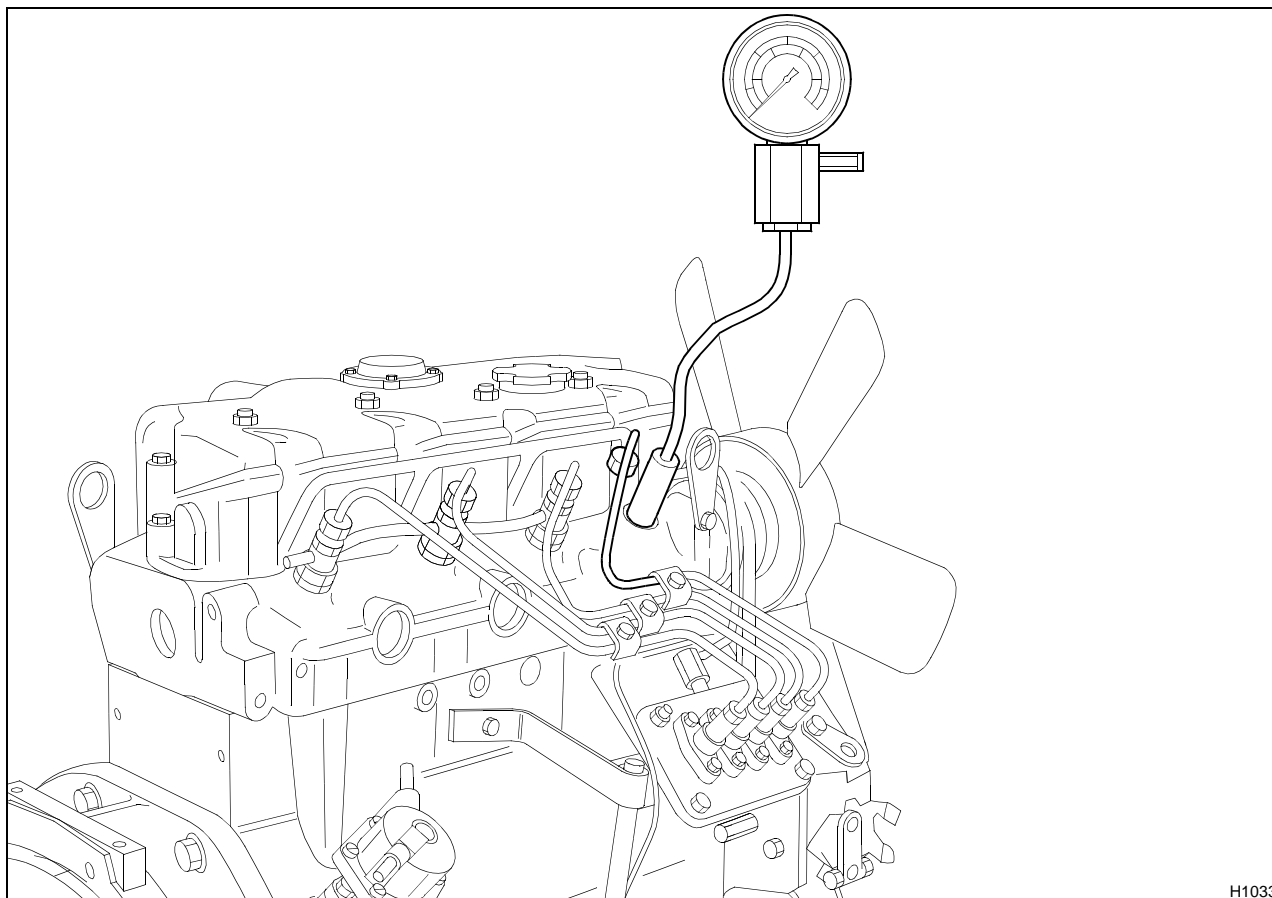
How to do a compression test

Note: Before the compression test, ensure that the battery is in good condition and fully charged. Also ensure the starter motor is in good condition.

- 1 Ensure that the valve tip clearances are set correctly.
- 2 Remove the atomisers, see Operation 11-1.
- 3 Fit a suitable gauge into the atomiser hole of the cylinder to be tested.
- 4 Disconnect the stop solenoid or put the stop solenoid in the no fuel position. Operate the starter motor and record the pressure indicated on the gauge.

Caution: Do not remove the stop solenoid as this will allow the engine to start.

- 5 Repeat for each cylinder.



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3

Cylinder head assembly

Rocker cover and inlet manifold

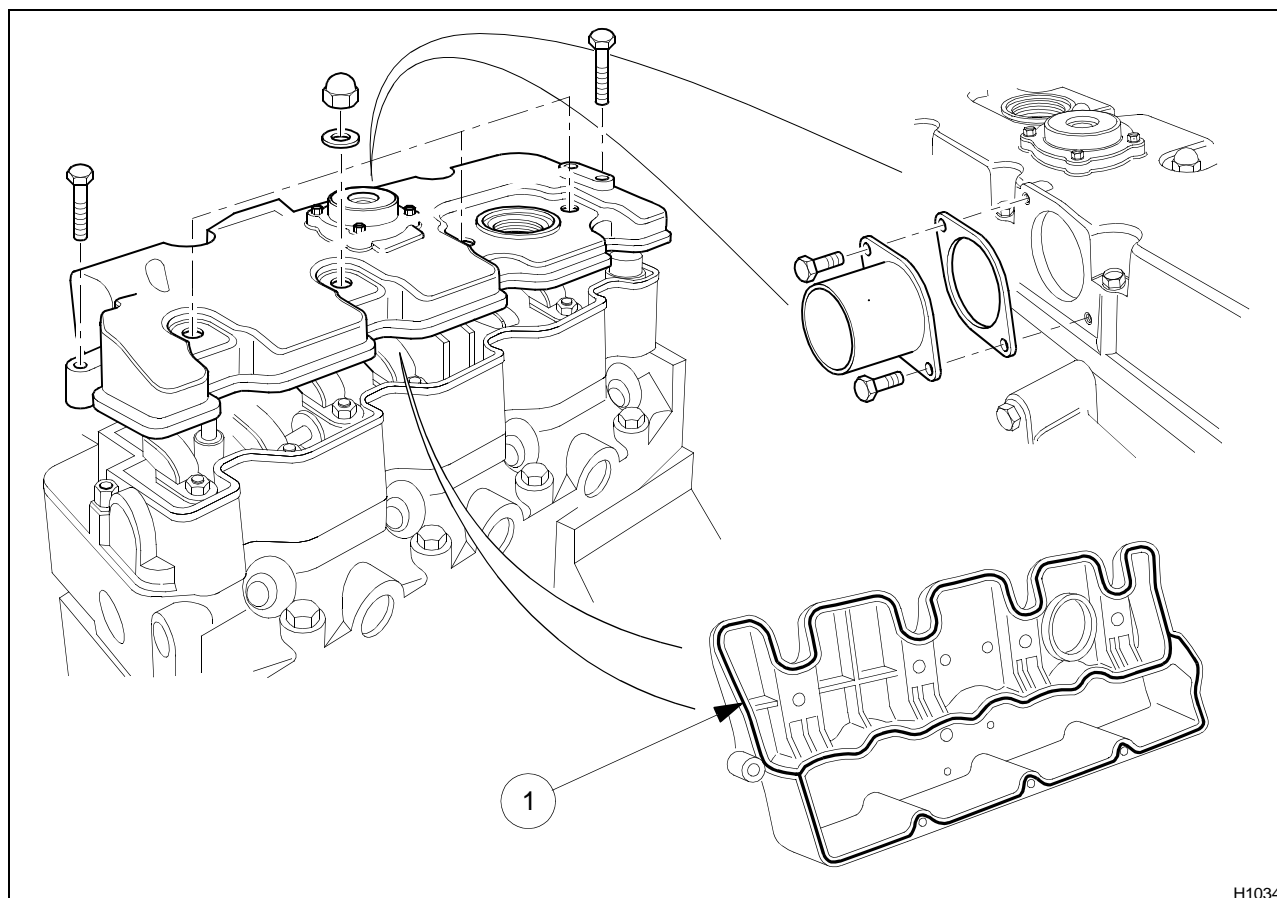
To remove and to fit

Operation 3-1

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Cap nut	11 (8.1) 1,1
	Setscrew	11 (8.1) 1,1
403C-15 404C-22 404C-22T	Cap nut	14 (10.3) 1,4
	Setscrew	14 (10.3) 1,4

Notes:

- An 'O' ring (1) is fitted in the groove in the rocker cover.
- Inspect the 'O' ring and renew if necessary.



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Rocker assembly

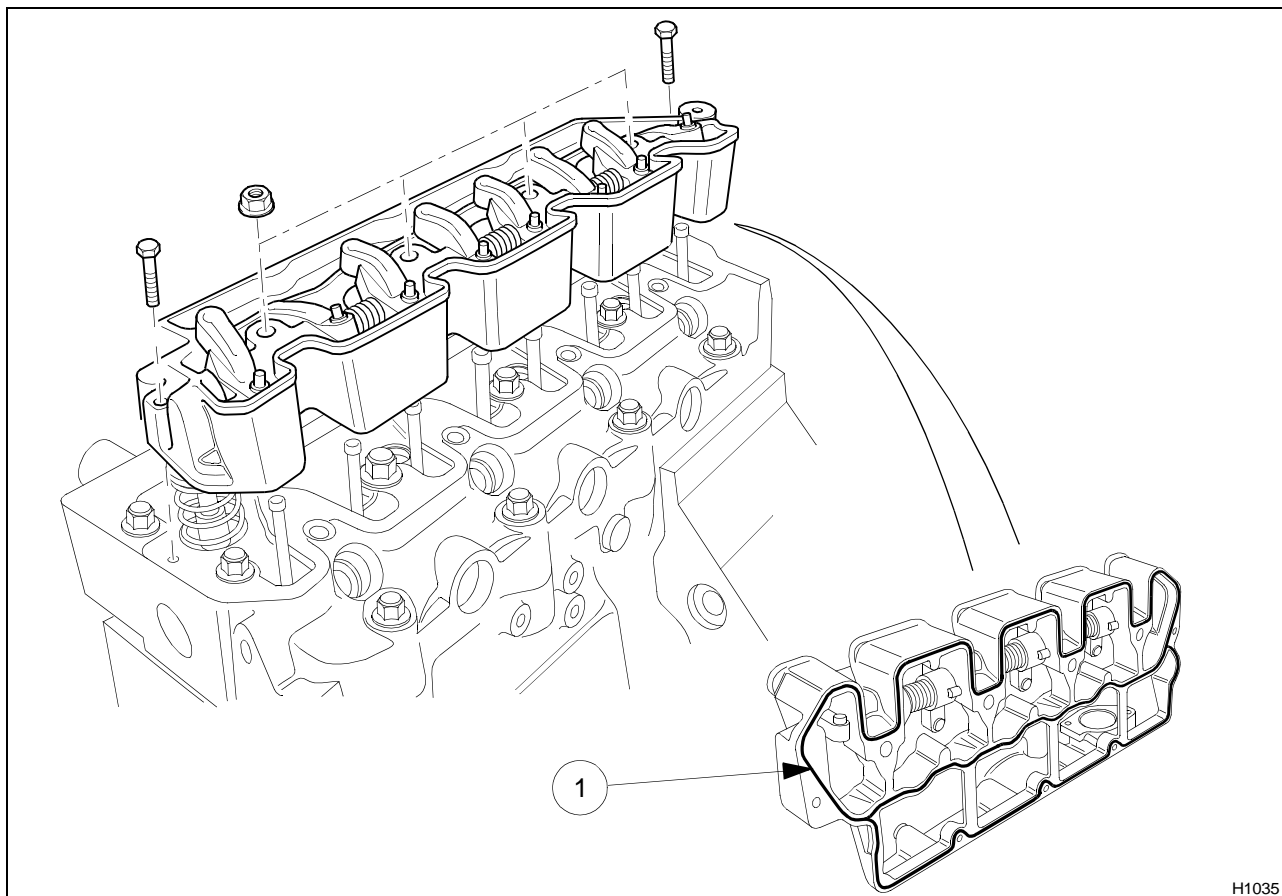
To remove and to fit

Operation 3-2

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Rocker assembly nuts	23 (17.0) 2,3
403C-15 404C-22 404C-22T	Rocker assembly nuts	33 (24.3) 3,3

Caution: Ensure that the valve stem caps are on the valve stems and the pushrods are located in the rockers after assembly.

Note: An 'O' ring (1) is fitted in the groove in the rocker assembly.



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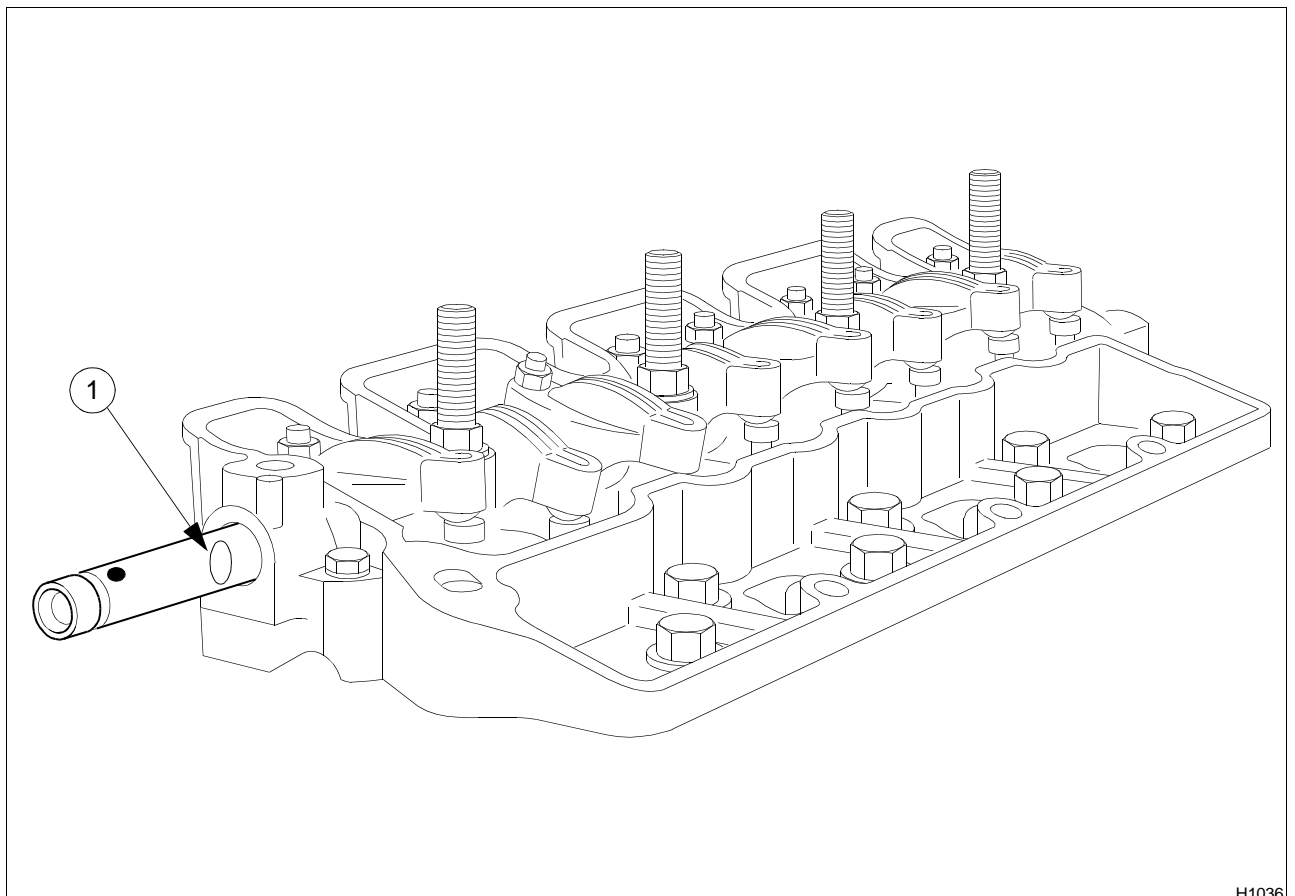
To dismantle and to assemble

Operation 3-3

Engine	Torque Nm (lbf ft) kgf m	
All models	Tappet adjustment nut	14 (10.3) 1,4

Use a suitable puller to extract the rocker shaft.

Note: Remember the position of the recess (1) for assembly.



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To inspect

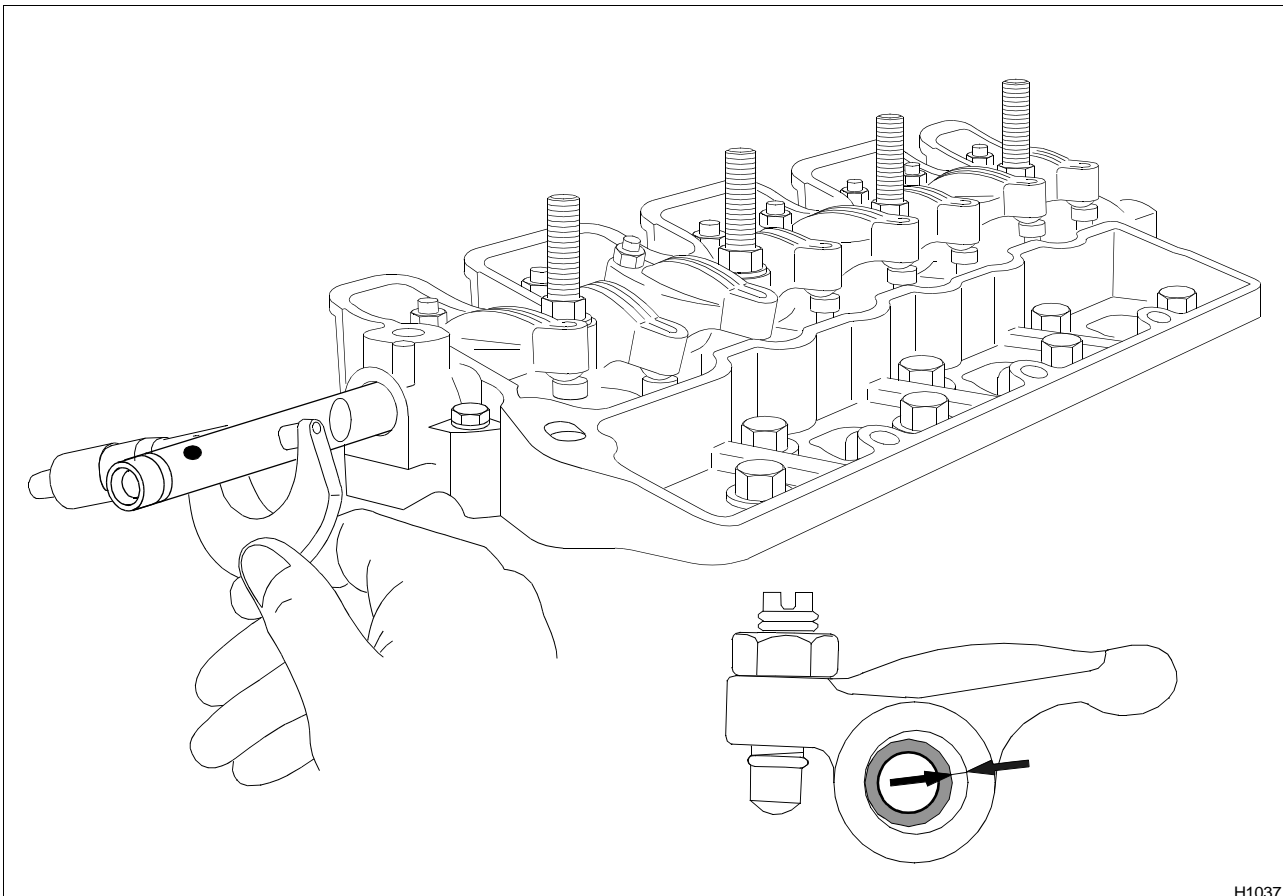
Operation 3-4

Rockershaft diameter

Engine	Diameter mm (in)	
	Standard	Service limit
403C-11 403C-15	11,65 - 11,67 (0.4587 - 0.4595)	11,57 (0.4555)
404C-22 404C-22T	14,95 - 14,97 (0.5886 - 0.5894)	14,87 (0.5854)

Rocker shaft to rocker lever clearance

Engine	Clearance mm (in)	
	Standard	Service limit
403C-11 403C-15	0,032 - 0,068 (0.00126 - 0.00268)	0,2 (0.008)
404C-22 404C-22T	0,030 - 0,093 (0.00120 - 0.00366)	0,2 (0.008)



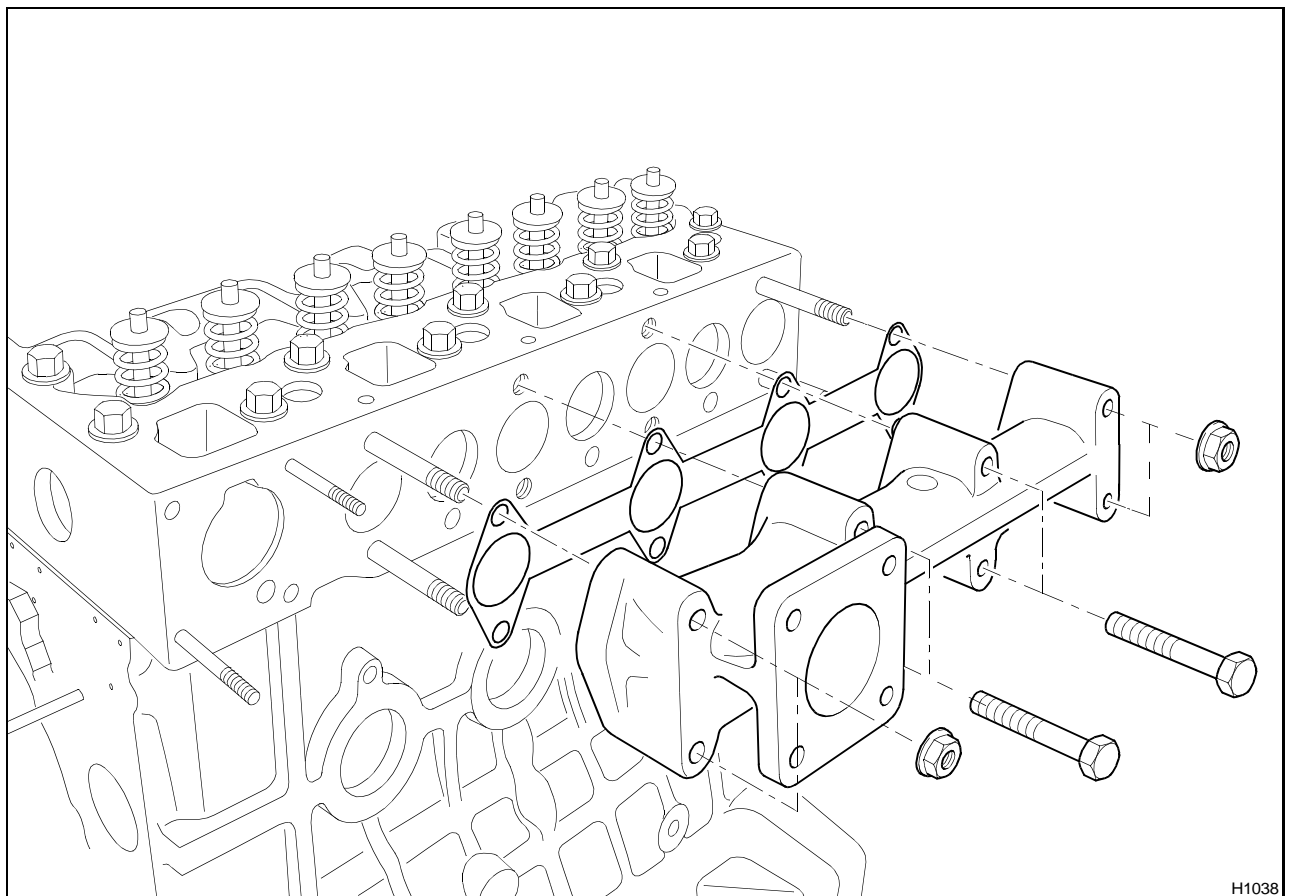
H1037

Exhaust manifold and gasket

To remove and to fit

Operation 3-5

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Setscrew	9,8 (7.2) 0,9
	Nuts	9,8 (7.2) 0,9
403C-15	Setscrew	25 (18.4) 2,5
404C-22	Nuts	25 (18.4) 2,5
404C-22T		



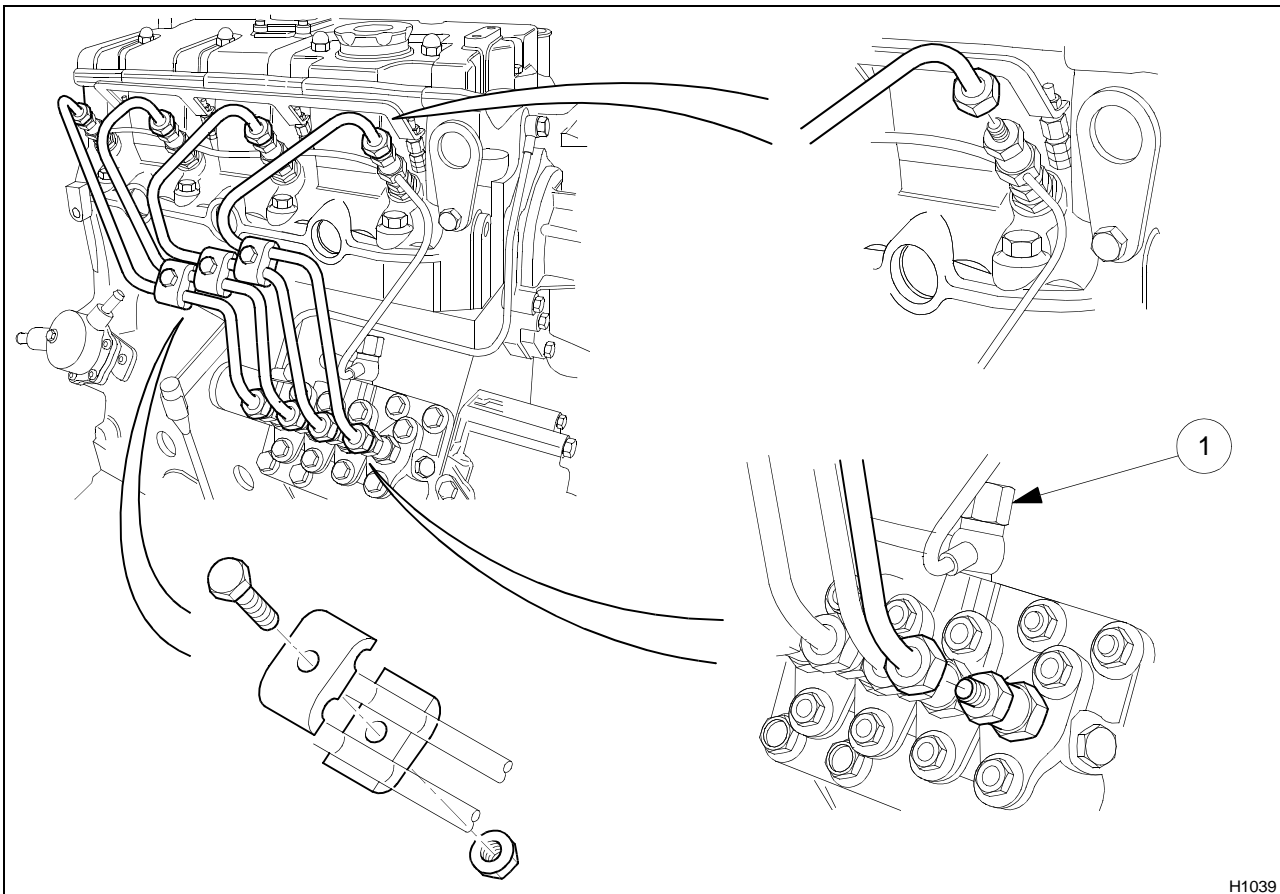
H1038

Fuel injection pipes / fuel return pipes

To remove and to fit

Operation 3-6

Engine	Torque Nm (lbf ft) kgf m	
All models	Fuel injection pipe	23 (16.9) 2,3
	Banjo bolt (1)	2,5 (3.2) 0,25

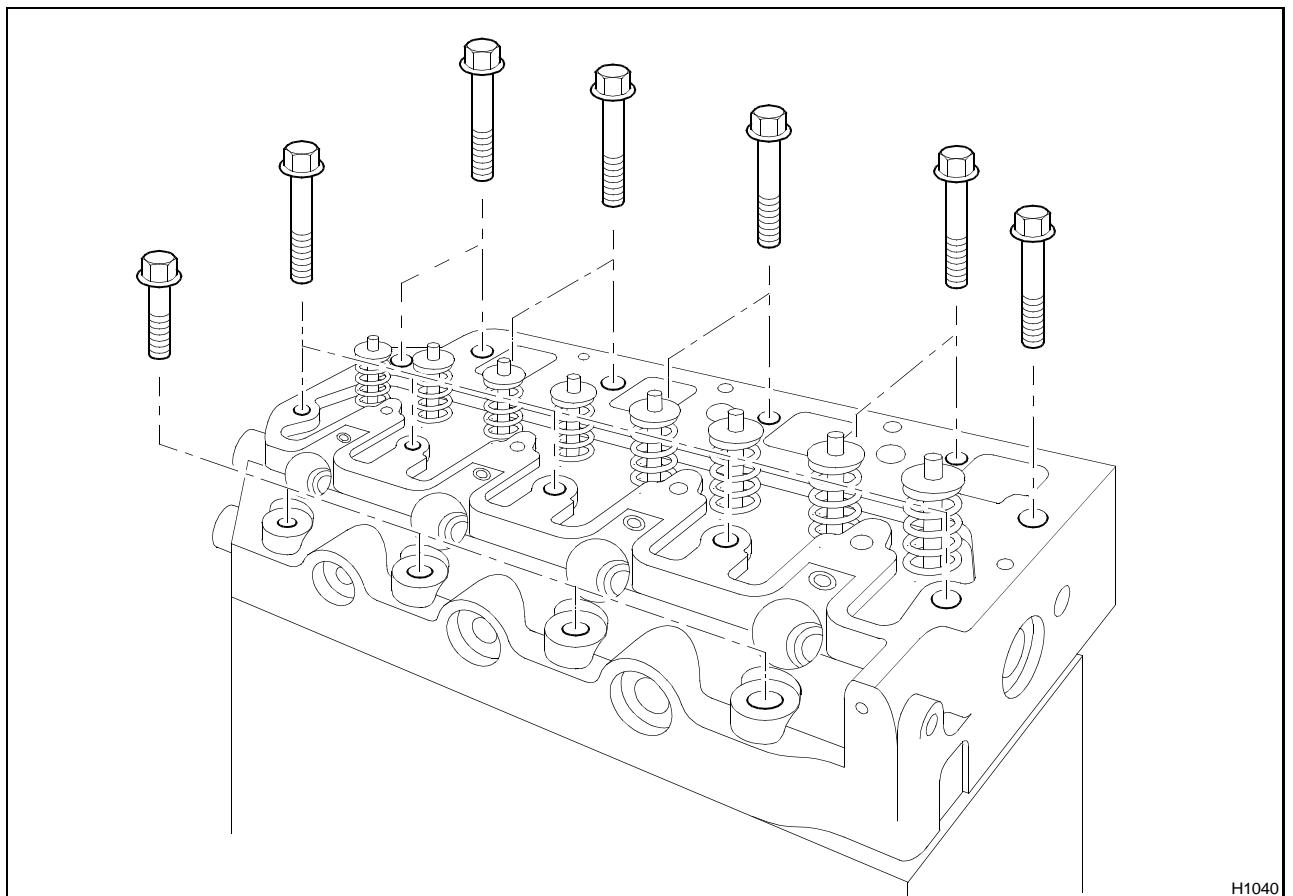


Cylinder head setscrews

To remove and to fit

Operation 3-7

Note: If it is necessary to replace the cylinder head the fuel adjustment screw must not be altered from the original setting. The maximum no load speed must be checked after assembly.



H1040

Cylinder head

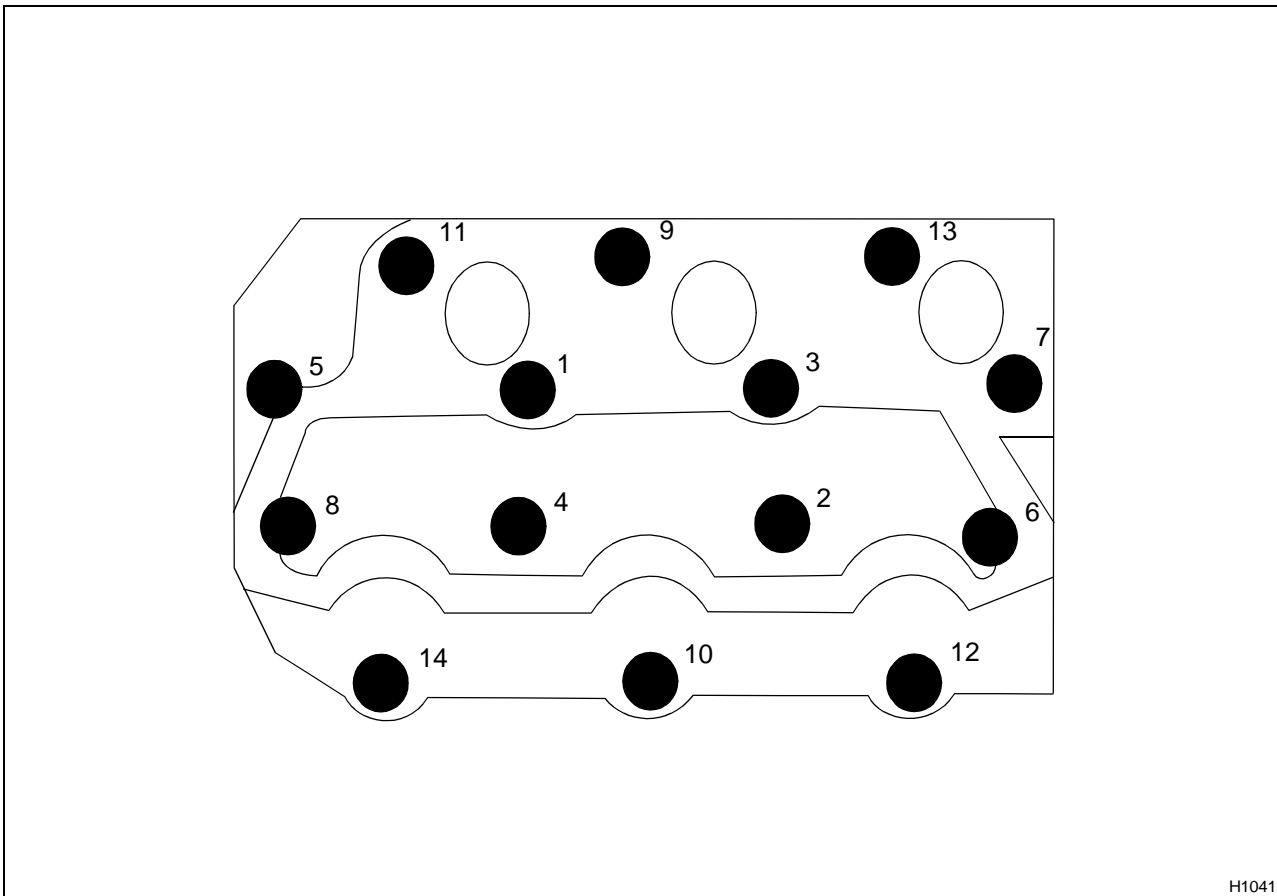
Tightening sequence 403C-11 and 403C-15

Operation 3-8

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Cylinder head setscrews	51 (37.6) 5,2
403C-15	Cylinder head setscrews	101 (74.5) 10,3

Notes:

- All torques should be checked again after tightening.
- On assembly lubricate cylinder head setscrews with clean oil.



H1041

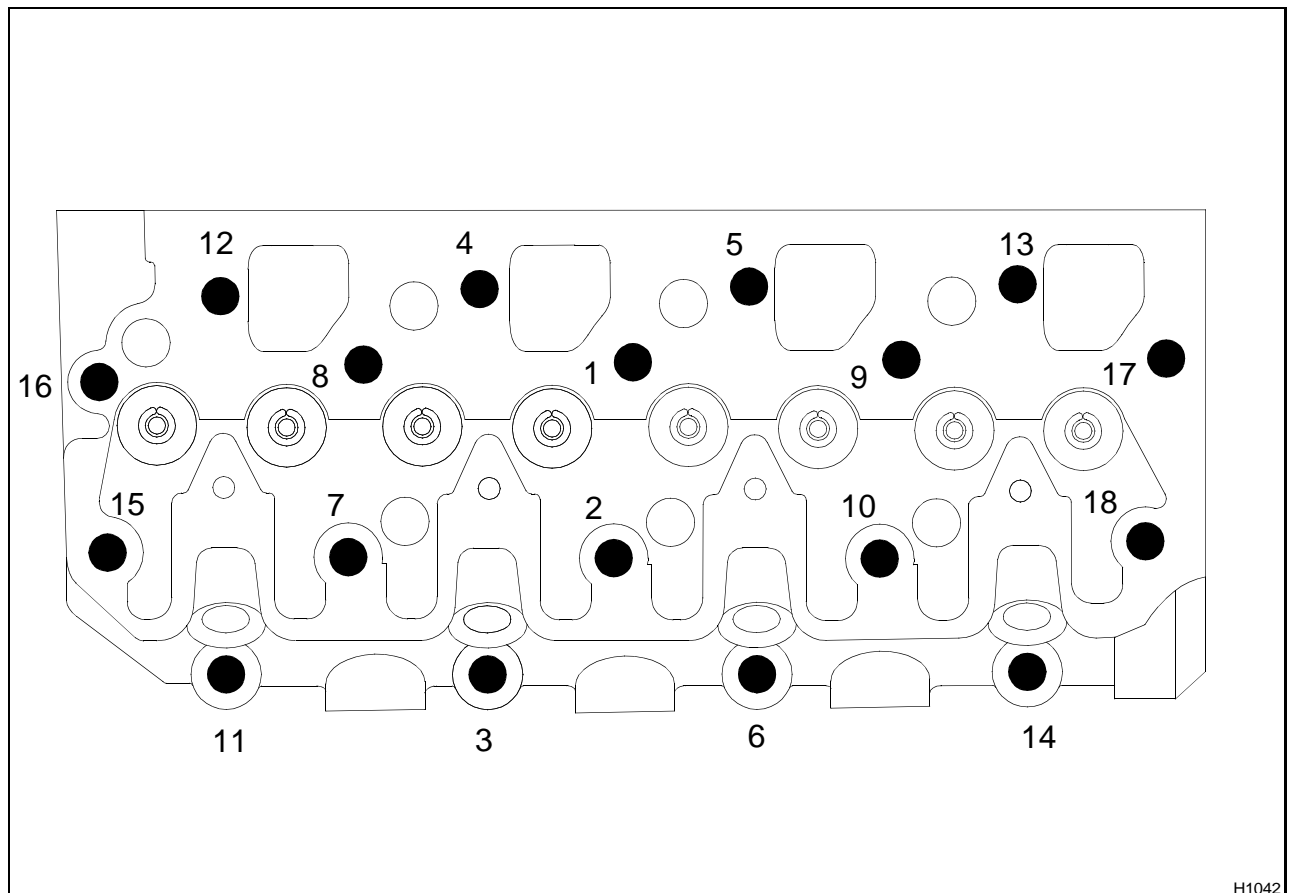
Tightening sequence 404C-22 and 404C-22T

Operation 3-9

Engine	Torque Nm (lbf ft) kgf m	
404C-22 404C-22T	Cylinder head setscrews	101 (74.5) 10,3

Notes:

- All torques should be checked again after tightening.
- On assembly lubricate cylinder head setscrews with clean oil.



H1042

Cylinder head gasket

To remove and to fit

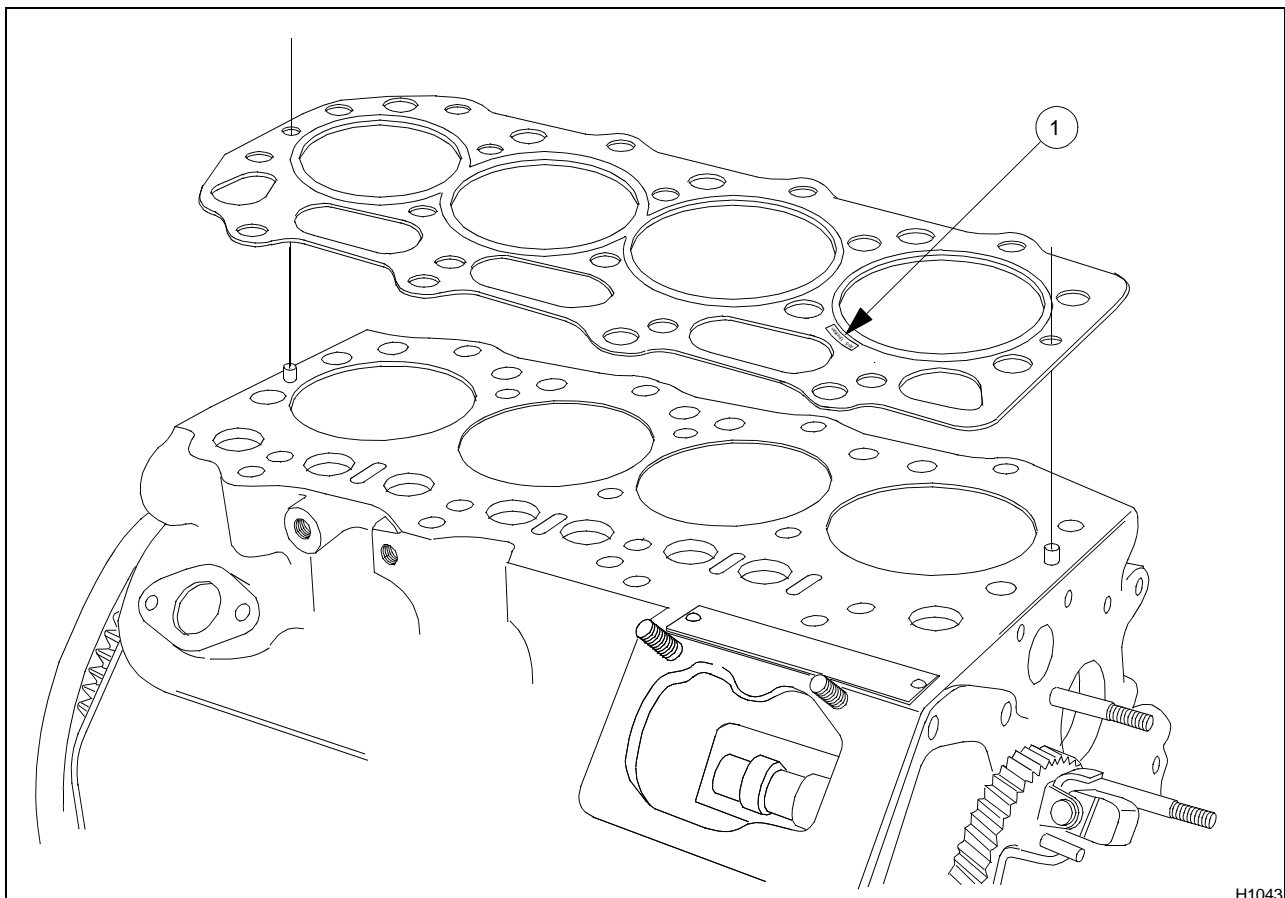
Operation 3-10

Align the gasket on the dowels in the cylinder block.

Cautions:

- *The gasket must only be fitted with the markings (1) facing up.*
- *When fitting a new gasket it must be replaced with a gasket of the same thickness as originally fitted. The gasket thickness can be identified by the part number that is stamped on the gasket.*
- *The correct piston height must be maintained to prevent damage to the pistons and valves and ensure that the engine conforms to emission legislation.*

Note: Always fit dry.



H1043

To select the correct thickness of cylinder head gasket

Operation 3-11

Caution: If the correct piston height above or below the cylinder block is not obtained, damage to the engine can occur. The difference between the highest and the lowest piston height must not exceed 0.1 mm.

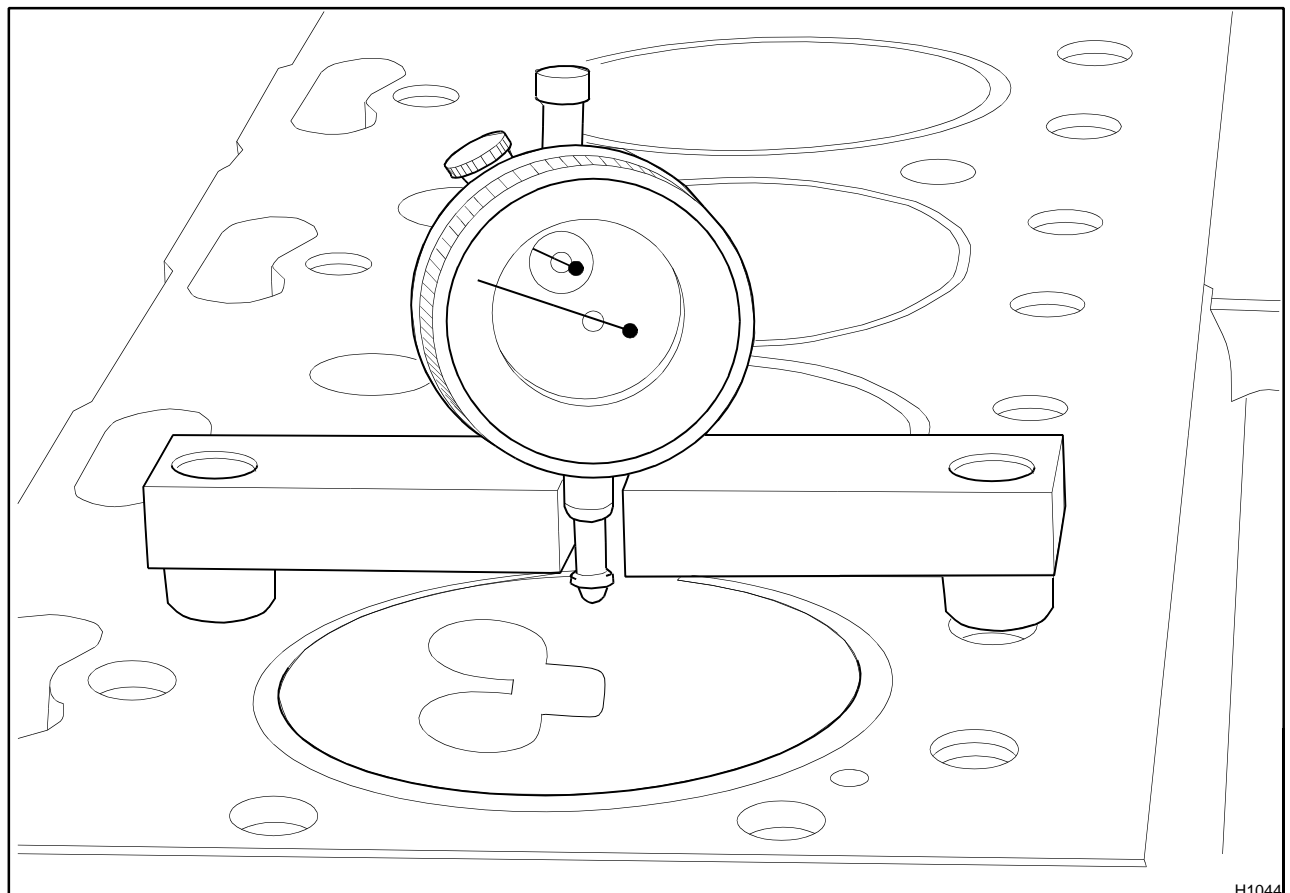
- 1 Put the piston height tool (A) on the face of the **cylinder block** and rotate the gauge dial to the zero position.
- 2 Rotate the crankshaft until the piston crown is approximately at top dead centre (TDC).
- 3 Carefully put the tool over the top of the piston with the plunger of the gauge in contact with the piston above the axis of the gudgeon pin.
- 4 Rotate the crankshaft to ensure that the piston is at the highest position and make a note of the gauge indication.

Notes:

- If the cylinder block, crankshaft, connecting rods or pistons are changed the piston height will have to be checked and the correct thickness gasket used.
- If the original piston is used, ensure that it is assembled to the correct connecting rod and is used in the original cylinder.

Cylinder head gasket selection

Engine	Protrusion above cylinder block top face	Gasket thickness
403C-11	0,55 to 0,64	1,2 mm
	0,65 to 0,75	1,3 mm
403C-15	0,60 to 0,69	1,3 mm
	0,70 to 0,79	1,4 mm
Engine	Protrusion below cylinder block top face	Gasket thickness
404C-22	-0,45 to -0,30	0,4 mm
404C-22T	-0,29 to -0,20	0,5 mm



H1044

Valve and valve spring

To remove and to fit

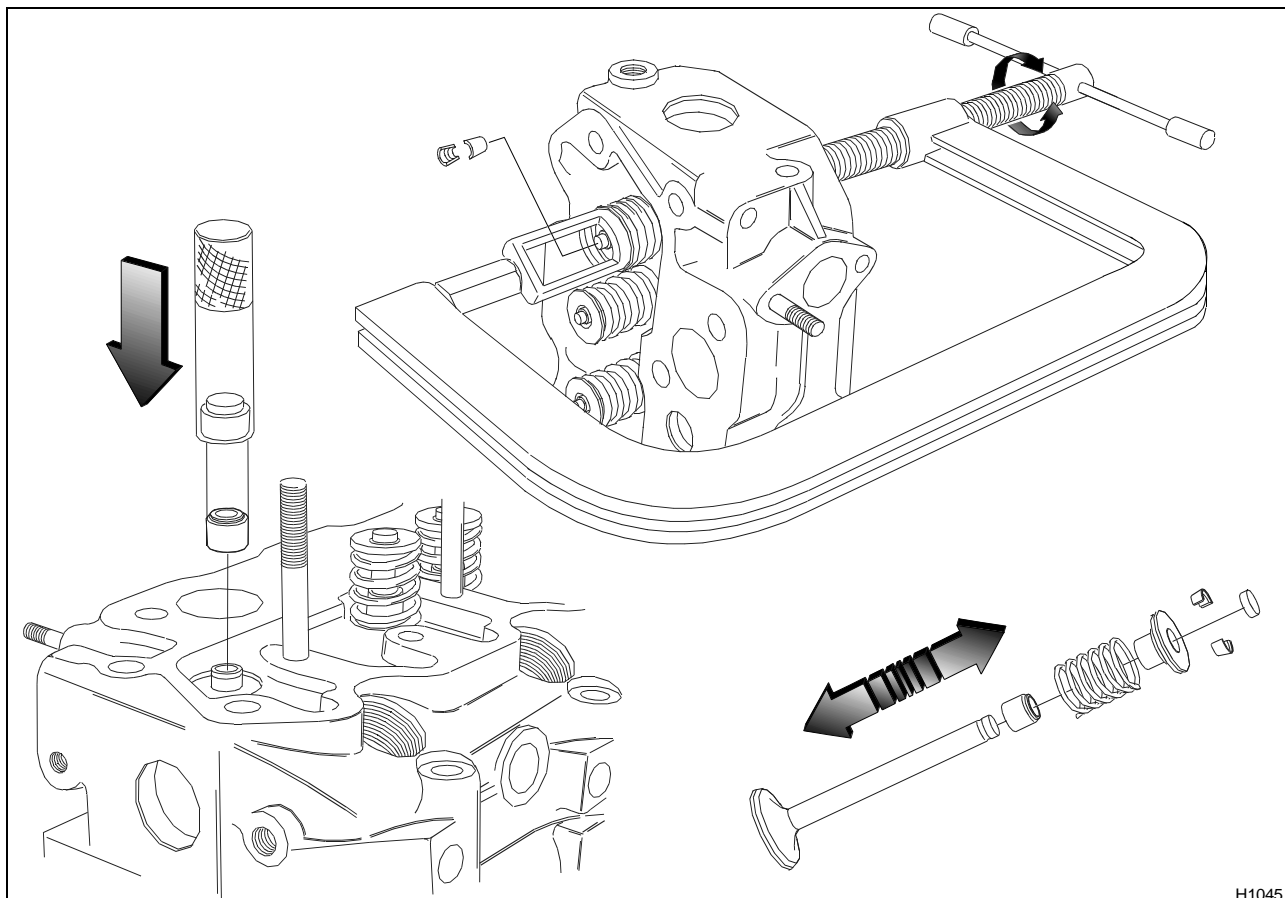
Operation 3-12

Special tools	
Description	Part number
Valve spring remover	21825663
Valve stem seal replacer	21825623

Notes:

- The oil seal for the inlet valve stem is identified by a silver garter spring.
- The oil seal for the exhaust valve stem is identified by a black garter spring (not shown) with the letters "EX" on the garter.

Warning! Safety glasses must be worn for this operation.



H1045

To inspect - valve spring

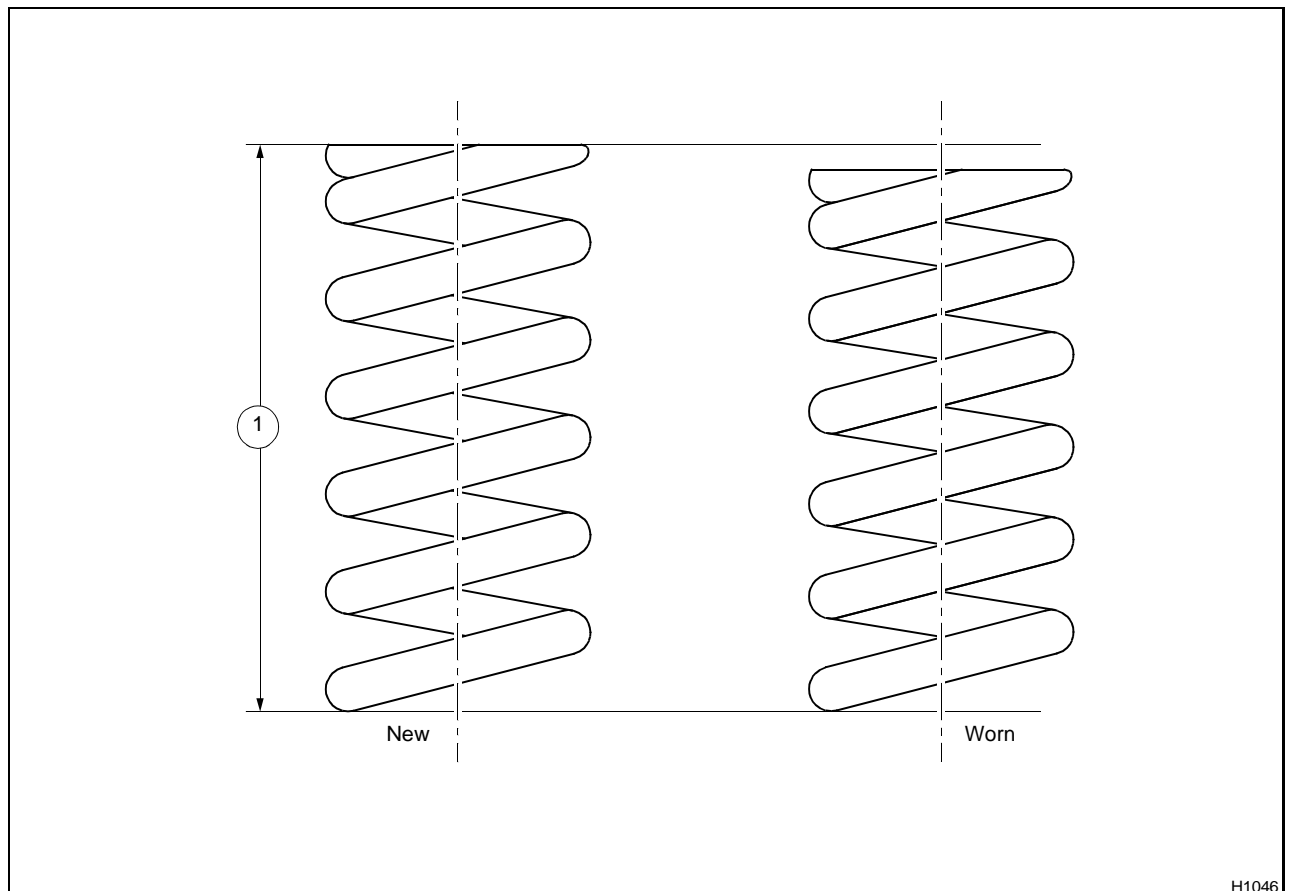
Operation 3-13

Visually inspect the valve spring for damage.

Use a spring tester to check spring force and free length. Renew the spring if it is outside the service limit.

Engine	Free length (1) mm (in)	
	Standard	Service limit
All models	35,0 (1.378)	33,5 (1.319)

Engine	Spring rate when compressed to 30,4 mm (1.197 in) N (lbf) kgf	
	Standard	Service limit
All models	79 (17.8) 8,1	68,6 (15.4) 7,0



H1046

To inspect - valve stem and thickness of valve head

Operation 3-14

Use a micrometer to check the valve stem diameters at positions 1, 2 and 3, if less than the service limit, renew. Check the valve stem for wear or damage, if outside the service limit, renew.

Inlet valve

Engine	Diameter mm (in)	
	Standard	Service limit
All models	6,955 - 6,970 (0.27382 - 0.27441)	6,89 (0.271)

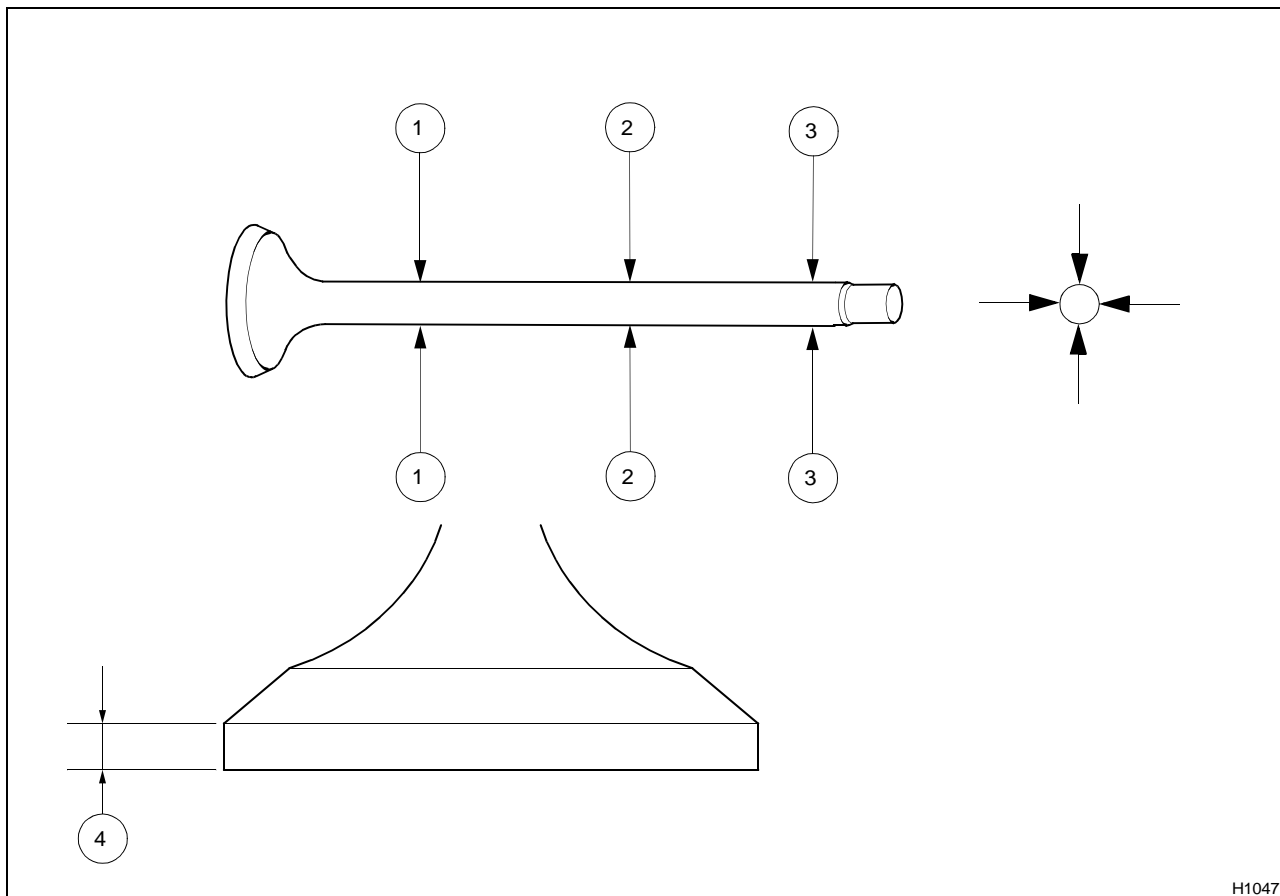
Exhaust valve

Engine	Diameter mm (in)	
	Standard	Service limit
All models	6,940 - 6,950 (0.27323 - 0.27362)	6,84 (0.269)

Valve head thickness

Engine	Thickness mm (in)	
	Standard	Service limit
All models	0,925 - 1,075 (0.03642 - 0.04232)	0,5 (0.020)

If the valve head thickness (4) is less than the service limit, renew the valve.



H1047

Cylinder head to valve stem clearance

To inspect

Operation 3-15

Check the clearance (3) between the valve stem and the cylinder head. If the clearance is greater than the service limit, the valves must be checked for wear, see Operation 3-14, If the valves are within service limits, renew the cylinder head.

- 1 Put a new valve in the valve guide.
- 2 Put a dial test indicator with a magnetic base (1) onto the face of the cylinder head.
- 3 With the valve lifted 15,0 mm (0.6 in) and the gauge (2) in contact with the edge of the valve head, move the valve radially away from the gauge. With the head in this position, set the gauge to '0'.
- 4 Move the valve radially across the axis of the cylinder head towards the gauge. Make a note of the reading on the gauge if the reading is greater than the service limit, renew the cylinder head.

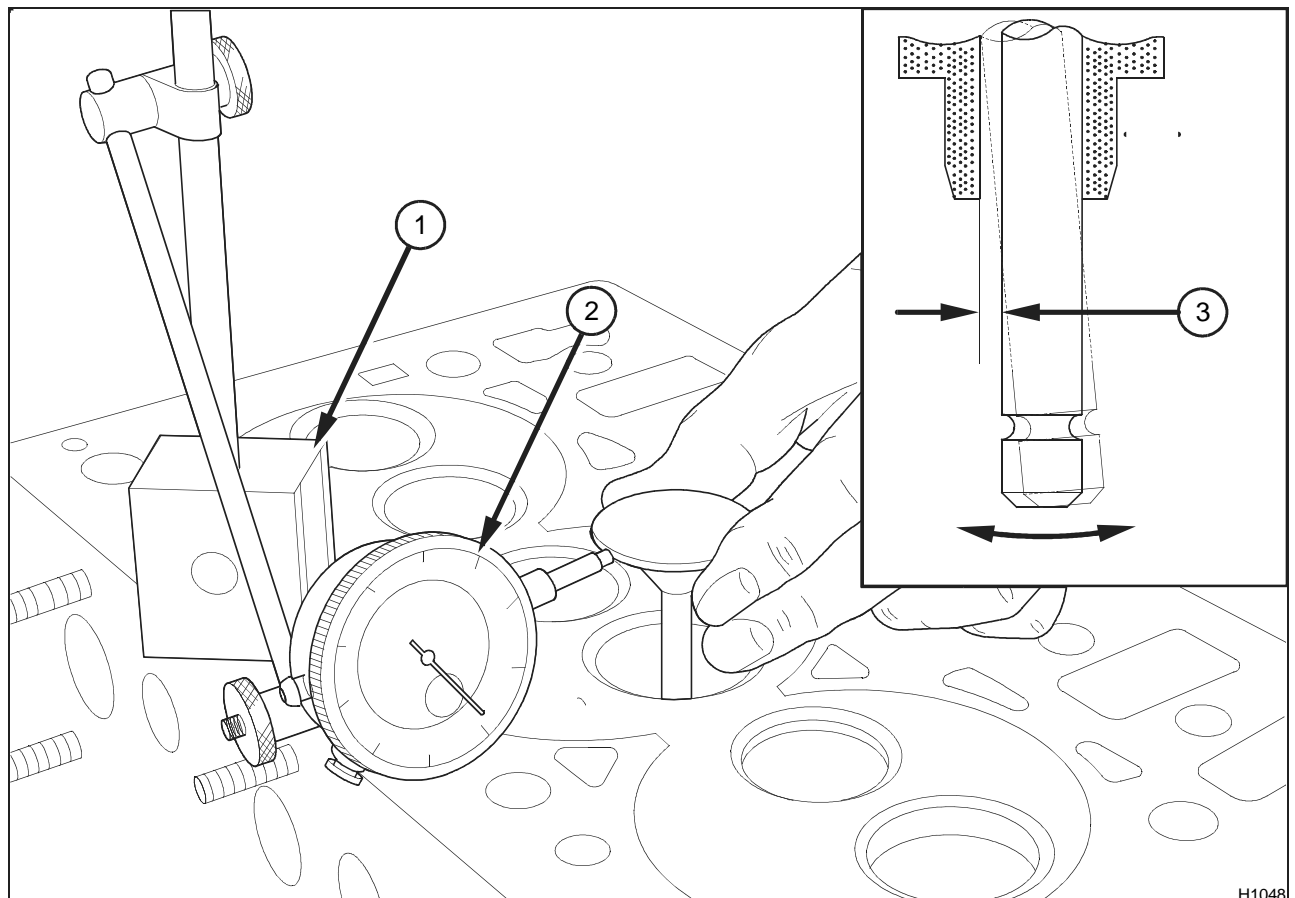
Maximum permissible clearances with a valve lift of 15 mm (0.6 in).

Inlet valve

Engine	Clearance mm (in) standard	Service limit
403C-11	0,025 - 0,052 (0.0010 - 0.0020)	0,2 (0.008)
403C-15, 404C-22 and 404C-22T	0,030 - 0,060 (0.0012 - 0.0024)	0,2 (0.008)

Exhaust valve

Engine	Clearance mm (in) standard	Service limit
403C-11	0,045 - 0,072 (0.0020 - 0.0030)	0,25 (0.010)
403C-15, 404C-22 and 404C-22T	0,050 - 0,075 (0.0020 - 0.0030)	0,25 (0.010)



H1048

Cylinder head

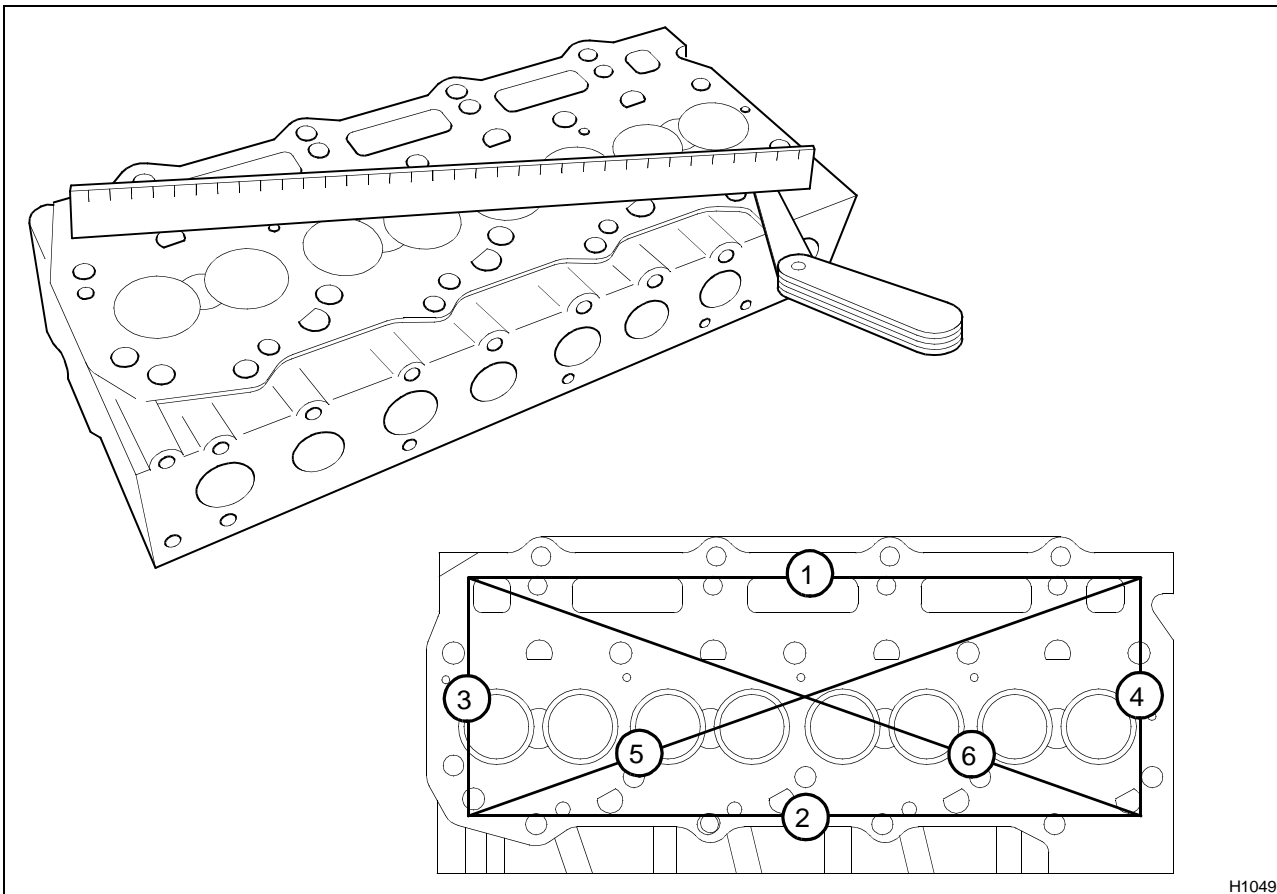
To inspect

Operation 3-16

Maximum regrind limit mm (in)		
Distortion	Maximum service limit	Maximum regrind
0,05 (0.002) or less	0,12 (0.005)	0,15 (0.006)

Use a straight edge and feeler gauge to check the six positions for distortion.

Caution: Do not grind beyond the maximum limit.



H1049

Valve seat width

To inspect and to correct

Operation 3-17

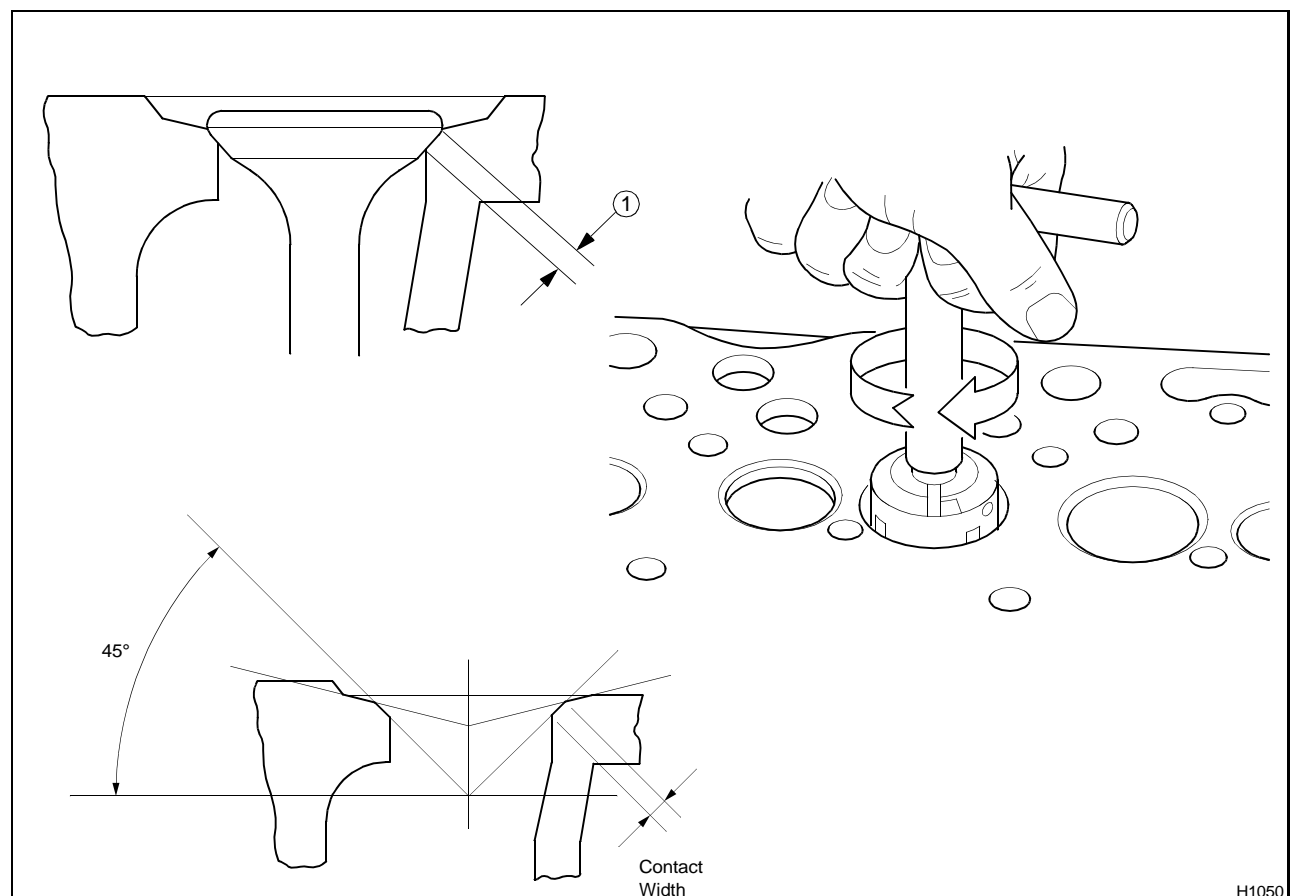
Special tools	
Description	Part number
Valve seat cutter	27610030

Engine	Inlet valve		Exhaust valve	
	Clearance mm (in)		Clearance mm (in)	
	Standard	Service limit	Standard	Service limit
403C-11	1,70 - 2,10 (0.0670 - 0.0830)	2,5 (0.098)	1,70 - 2,10 (0.0670 - 0.0830)	2,5 (0.098)
403C-15	1,66 - 1,87 (0.0653 - 0.0736)	2,5 (0.098)	1,66 - 1,73 (0.0653 - 0.0681)	2,5 (0.098)
404C-22 404C-22T	1,50 - 2,00 (0.0591 - 0.0790)	2,5 (0.098)	1,94 - 2,16 (0.0764 - 0.0850)	2,5 (0.098)

If the contact face (1) of the valve seat is more than the service limit, check the valve stem for wear, see Operation 3-14 and the cylinder head to valve stem clearance, see Operation 3-15. If greater than the service limit, use a seat cutter of 45° to correct the seat.

If the valve stem clearance exceeds the service limit, renew the valve.

If the bore in the cylinder head for the valves is worn, replace the cylinder head. If the valve seat in the cylinder head is damaged or worn, cut a new seat if the valve depth will remain within tolerance.



Valve depth

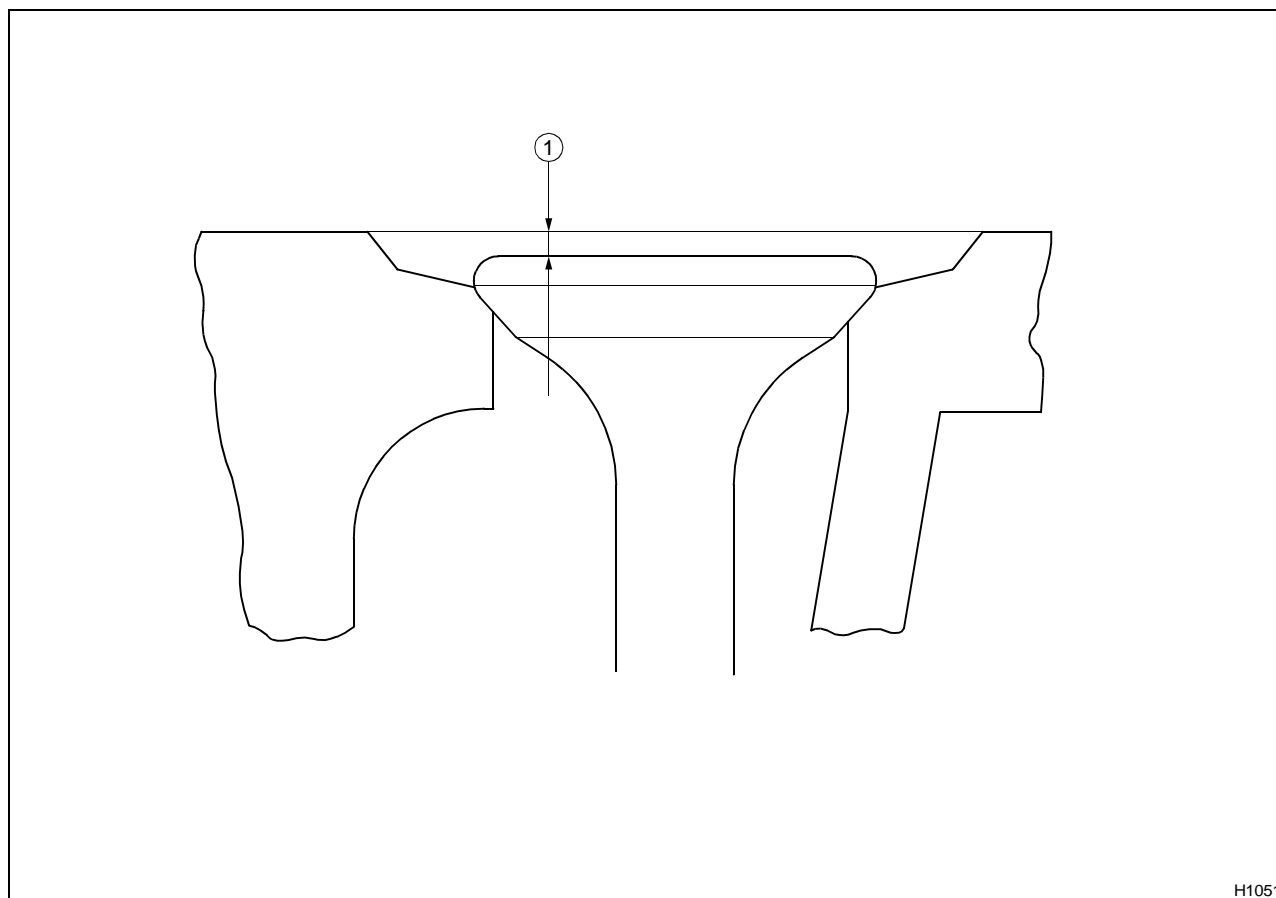
To check

Operation 3-18

If the valve depth (1) is greater than the service limit, use a new valve to check the valve depth.

If the depth still exceeds the service limit, renew the cylinder head. If the depth is within the service limit renew the valves.

Engine	Depth mm (in)		
	Inlet standard	Exhaust standard	Service limit
403C-11	0,65 - 0,95 (0.0256 - 0.0374)	0,85 - 1,15 (0.0335 - 0.0453)	1,8 (0.071)
403C-15	0,85 - 1,15 (0.0335 - 0.0453)	0,85 - 1,15 (0.0335 - 0.0453)	1,8 (0.071)
404C-22 404C-22T	0,65 - 0,95 (0.0256 - 0.0374)	0,65 - 0,95 (0.0256 - 0.0374)	1,8 (0.071)

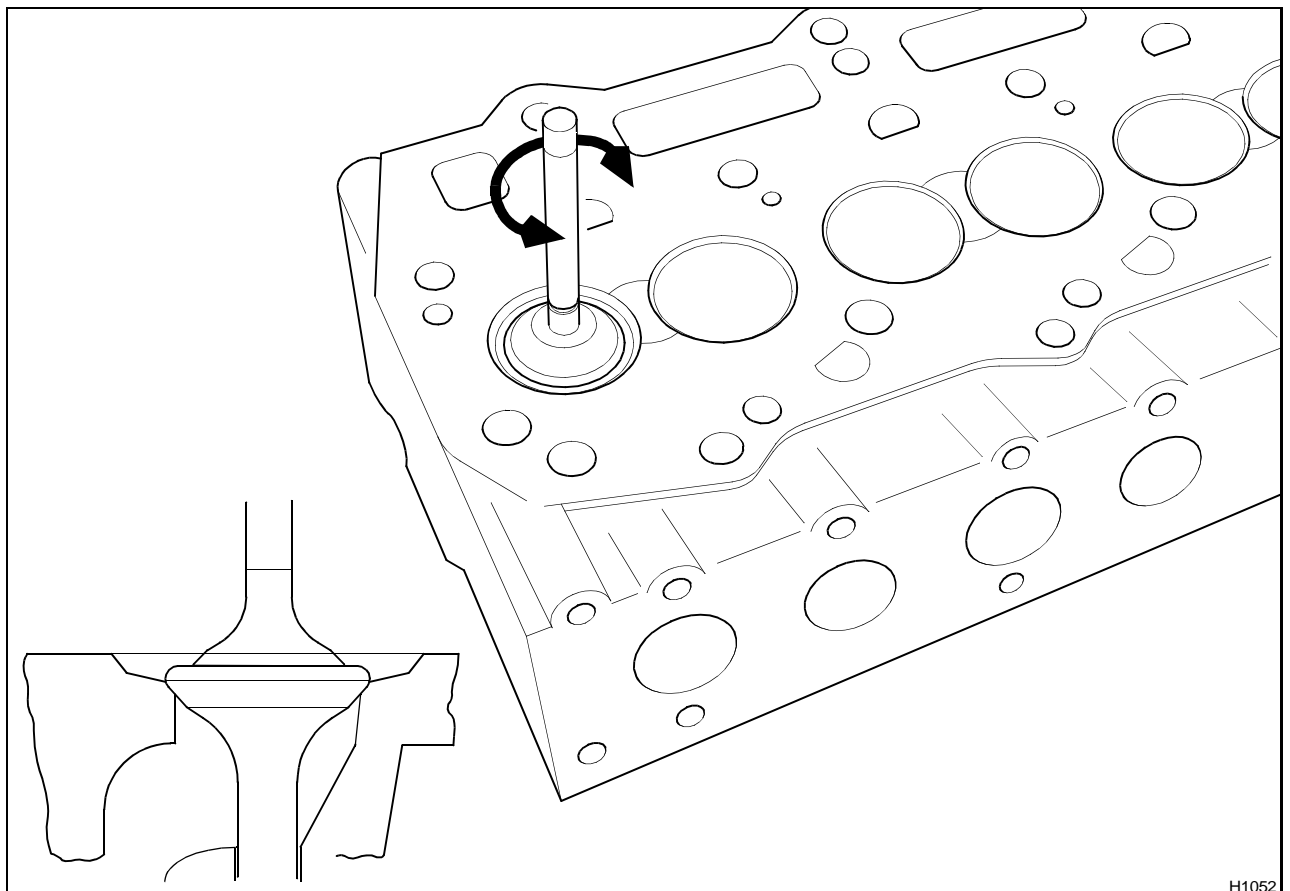


H1051

To lap the contact face of the valve seat

Operation 3-19

Use the valve seat cutter to obtain the correct seat contact width and seat recess on a new cylinder head, use a valve lapping tool and lapping compound to finish.



H1052

Valve tip clearance

To check and to adjust

Operation 3-20

The valve adjustment sequence is viewed from the front of the engine.

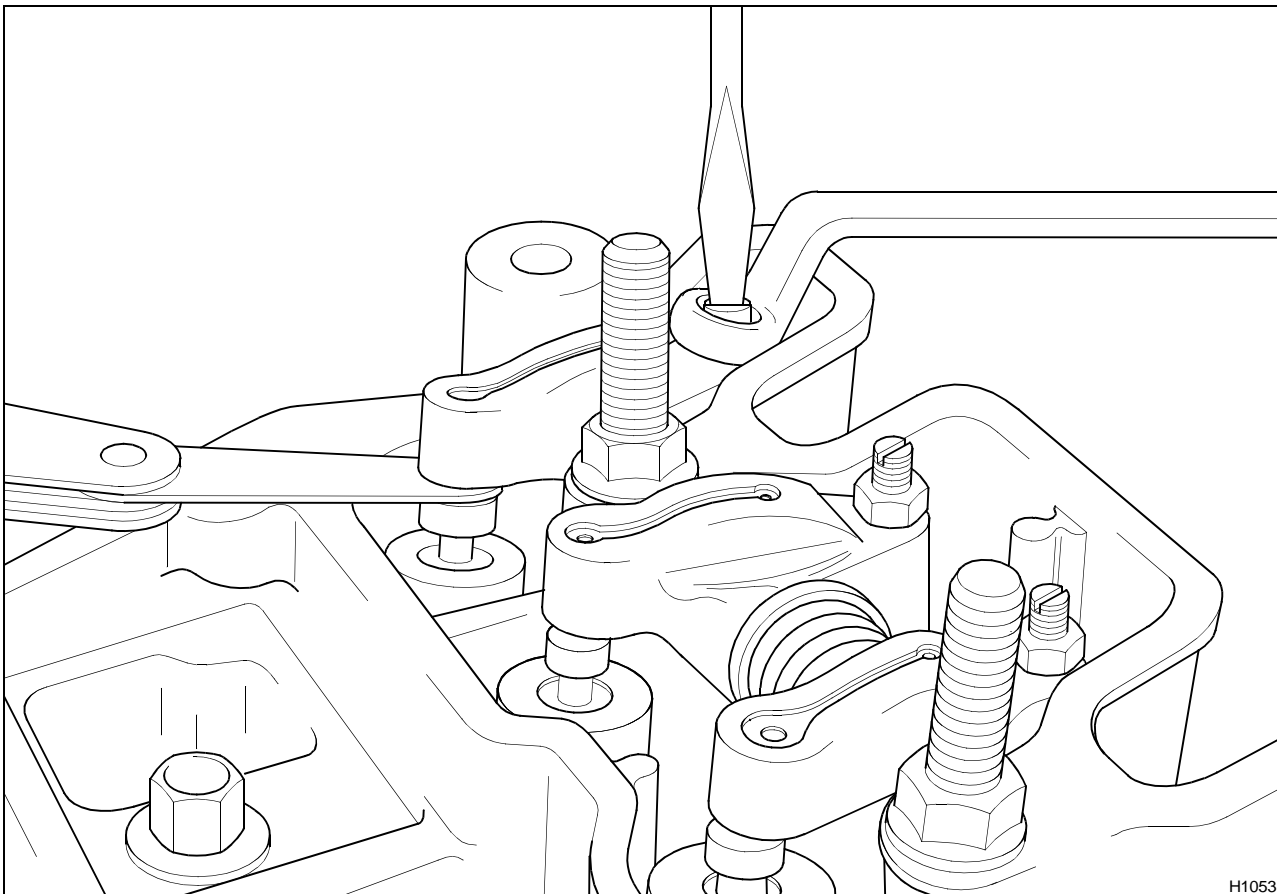
Rotate the crankshaft clockwise when viewed from the front.

Caution: Only adjust the valve clearances when the engine is cold.

Engine	Valve overlap	Adjust valves
403C-11 403C-15	No. 1 Cylinder	3 and 6
	No. 2 Cylinder	2 and 5
	No. 3 Cylinder	1 and 4
404C-22 404C-22T	No. 4 Cylinder	1 and 2
	No. 2 Cylinder	5 and 6
	No. 1 Cylinder	7 and 8
	No. 3 Cylinder	3 and 4

Valve tip clearance (cold)	
Inlet	0,2 mm (0.0078 in)
Exhaust	0,2 mm (0.0078 in)

Torque Nm (lbf ft) kgf m	
Tappet adjustment nut	14 (10.3) 1,4



H1053

4

Piston and connecting rod assemblies

Big end bearing and cap

To remove and to fit

Operation 4-1

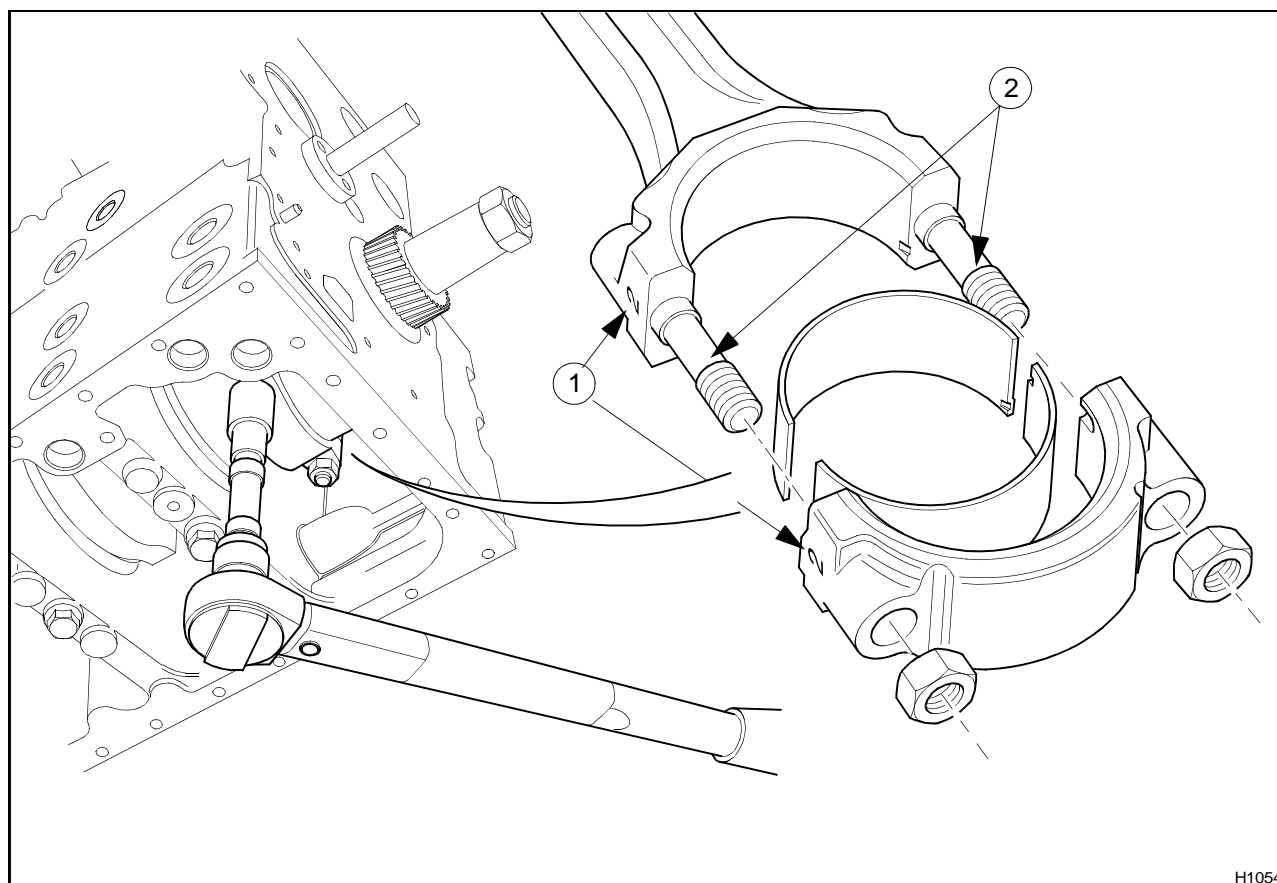
Engine	Torque Nm (lbf ft) kgf m	
403C-11	Nut	32 (23.6) 3,3
403C-15, 404C-22 and 404C-22T	Nut	52 (38.3) 5,2

Standard clearance	Service limit
0,1 - 0,3 mm (0.004 - 0.012 in)	0,7 mm (0.276 in)

Caution: Ensure that the connecting rod bolts (2) do not damage the crankshaft when the connecting rod is removed or fitted.

Notes:

- The connecting rods and caps are numbered matched pairs and must be kept together when removed from the engine. The numbers (1) must be aligned when assembled.
- The piston and connecting rods are matched to a cylinder, record the position of each connecting rod and piston for correct assembly. After the connecting rods are fitted check for axial movement.
- The fuel adjustment screw must not be altered from the original setting. The maximum no load speed must be checked after assembly.



H1054

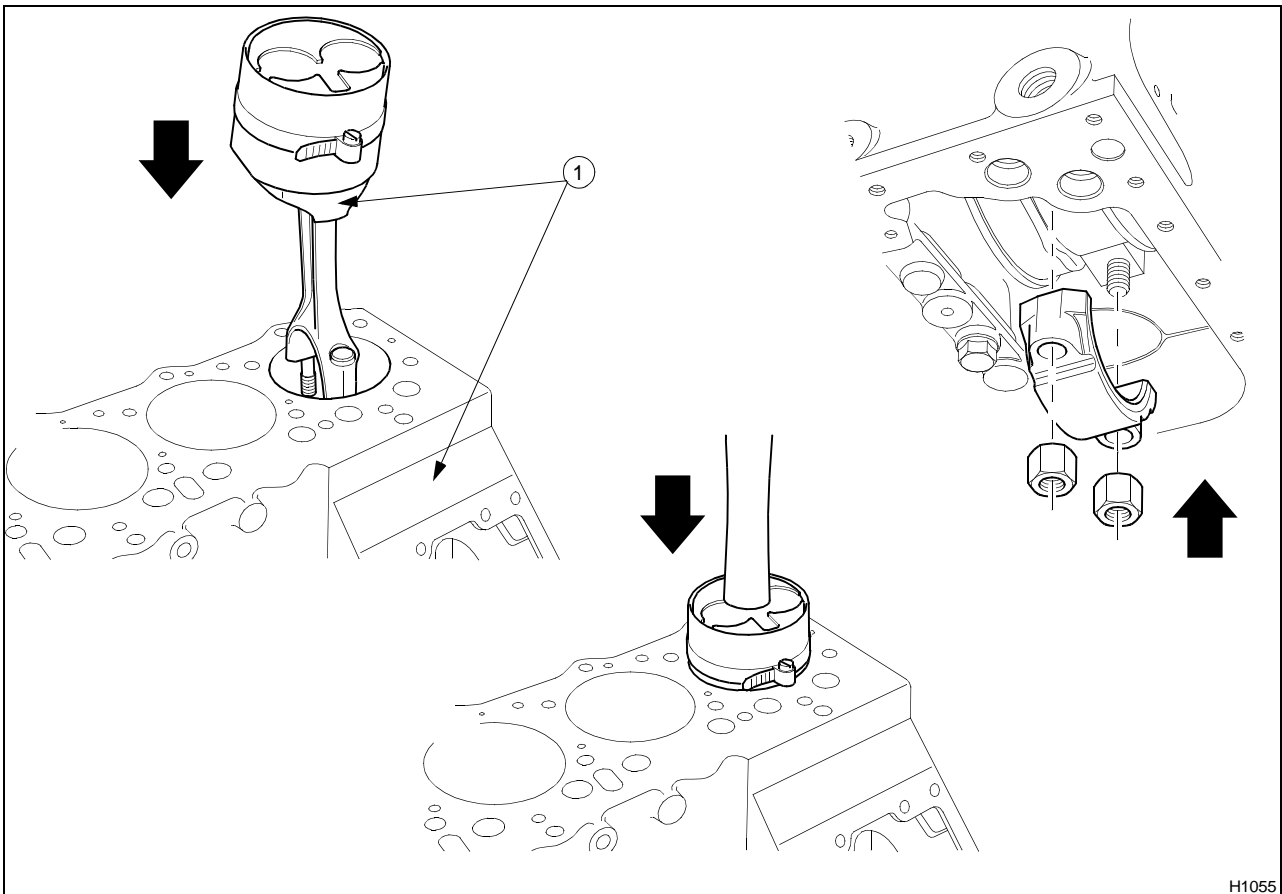
Piston and connecting rod

To remove and to fit

Operation 4-2

The Shibaura name on the inside of the piston must be facing the fuel pump on assembly.

To assemble the connecting rod assembly, see page 35.

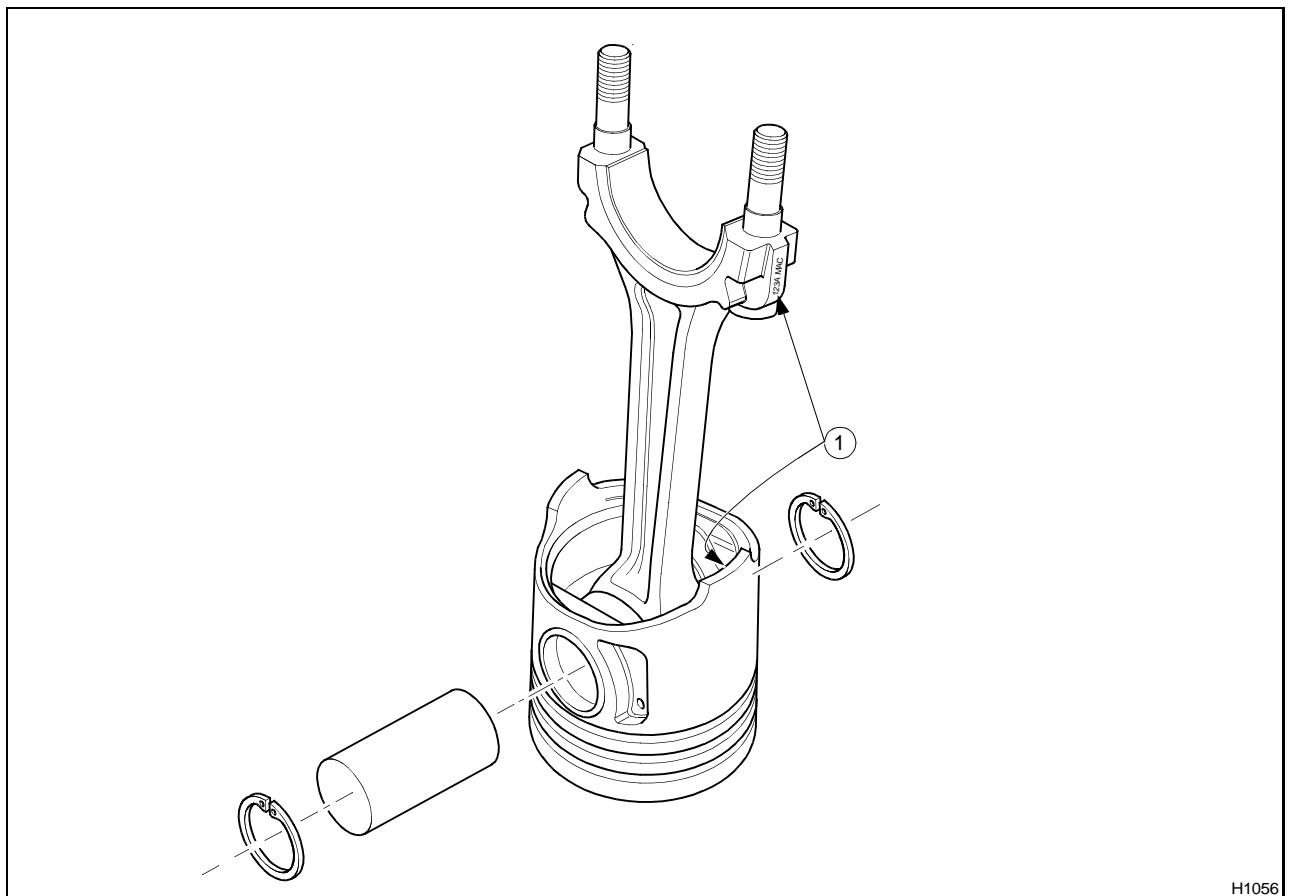


To dismantle and to assemble

Operation 4-3

The Shibaura (1) name (inside of the piston) must be aligned with the stamped number on the connecting rod (1).

The numbers stamped on the connecting rods and caps must be the same and aligned.



H1056

Piston rings

To fit

Operation 4-4

Any letters or markings on the surface of the ring will always be positioned on the top face (facing upwards). Use a suitable piston ring expander to fit the piston rings.

1 Fit the spring of the oil control ring (6) in the bottom groove of the piston with the latch pin (1) inside both ends of the spring. Fit the oil control ring (4) over the spring (6). Ensure that the ring gap is at 180° to the latch pin.

2 Fit the second ring (3) with the taper face into the second groove, with the word "TOP" towards the top of the piston.

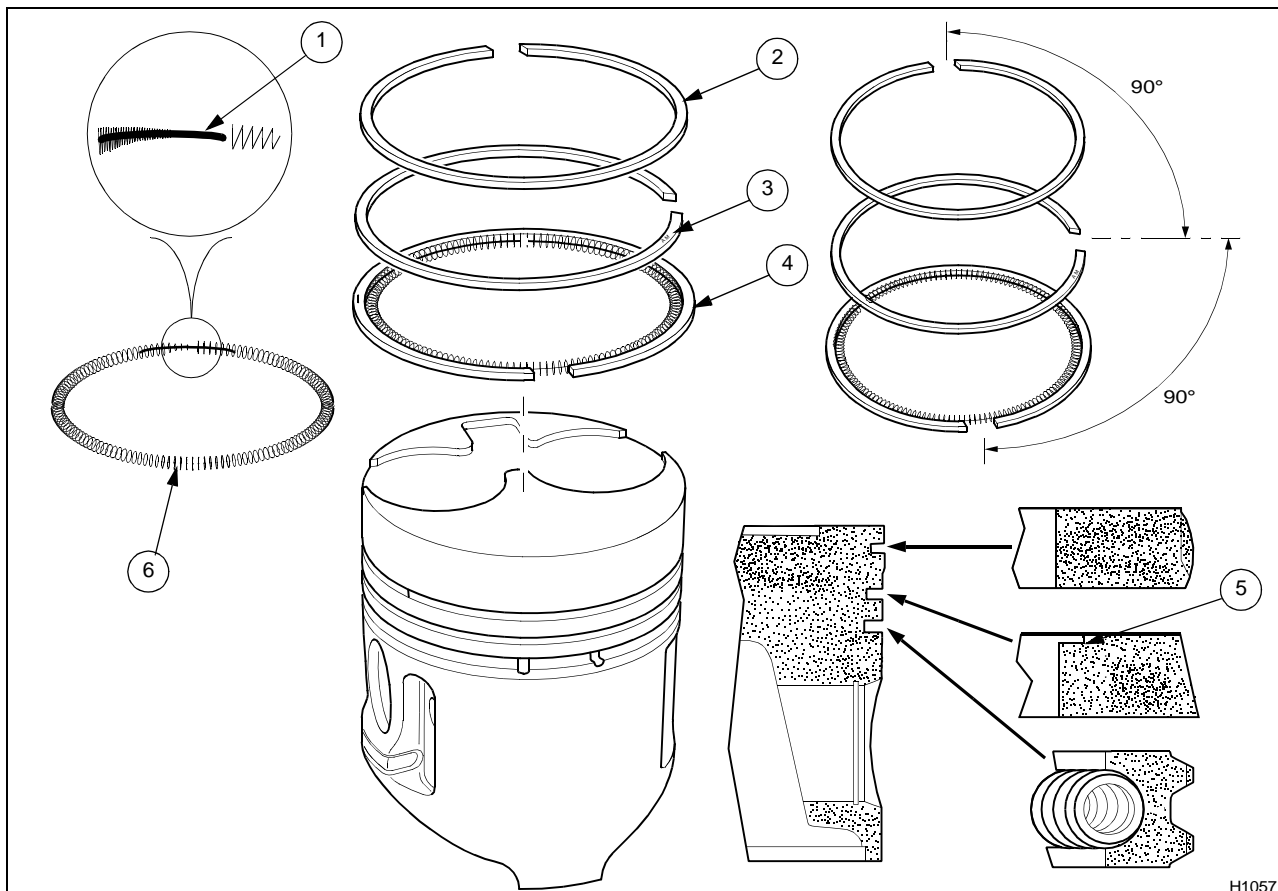
New second rings have a green identification mark which must be on the left of the ring gap when the ring is fitted and the piston is upright.

The second ring has a step (5) at the top inside edge of the tapered face.

3 Fit the top ring (2) with the word 'TOP' towards the top of the piston.

New top rings have a red identification mark which must be on the left of the ring gap when the ring is fitted and the piston is upright.

4 Ensure that the ring gaps are 90° apart.



H1057

To measure the piston ring clearance

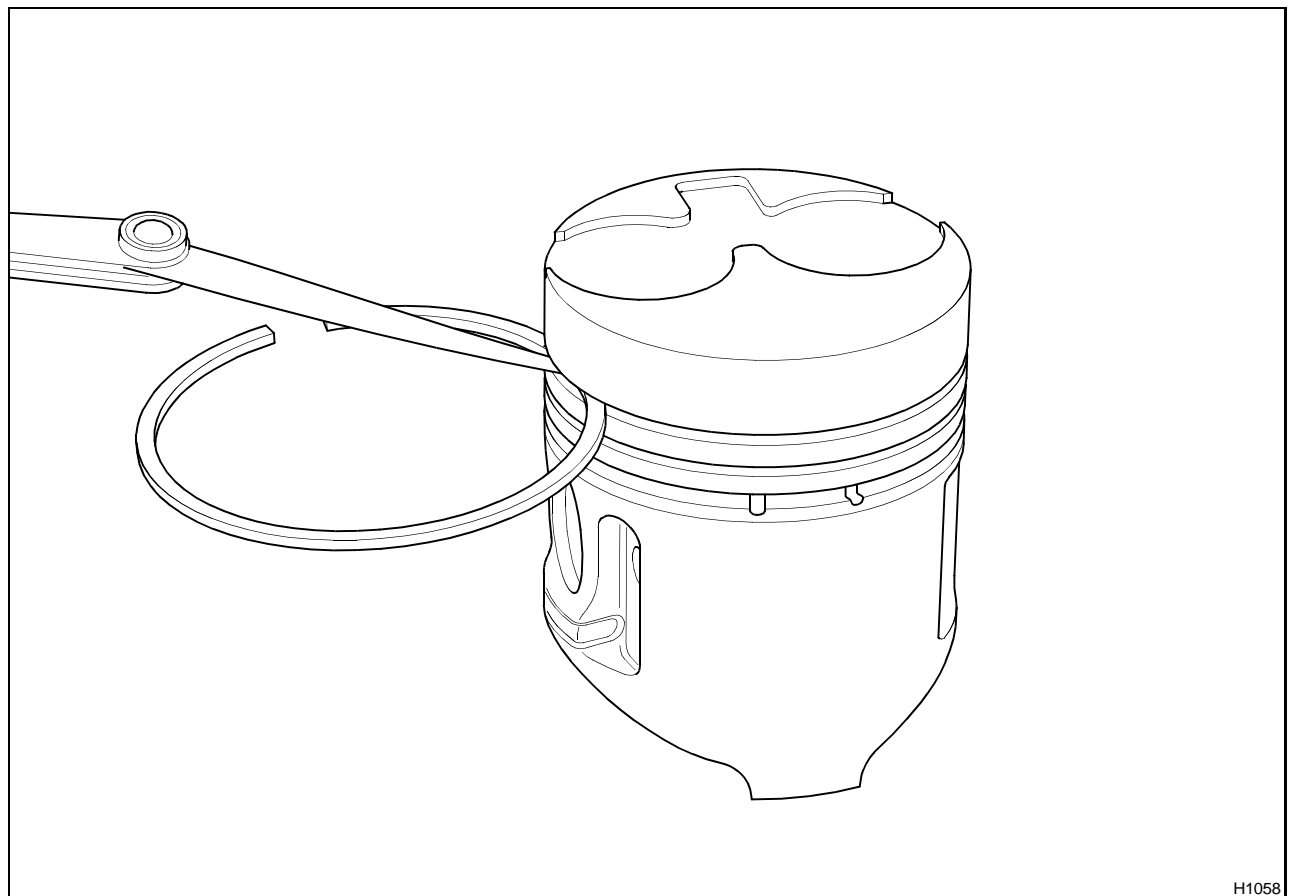
Operation 4-5

Use a feeler gauge to measure the clearance between the piston ring groove and the piston ring. If the clearance is greater than the service limit, use a new piston ring and check the clearance again.

If the clearance is within the service limit with a new piston ring, renew the piston rings. If the clearance is outside the service limit with a new piston ring, renew the piston.

Note: The number 1 piston ring of the 404C-22T is of the 'keystone' design, therefore it is difficult to measure the wear due to it's position in the piston ring groove. When either number 2 ring or the oil control ring is outside the service limit renew all rings.

Engine	Torque Nm (lbf ft) kgf m	Standard	Service limit
403C-11	Number 1 ring	0,06 - 0,10 mm (0.0024 - 0.0039 in)	0,25 (0.0098 in)
	Number 2 ring	0,05 - 0,09 mm (0.0020 - 0.0035 in)	0,25 (0.0098 in)
	Oil control ring	0,02 - 0,06 mm (0.0008 - 0.0024 in)	0,15 (0.0059 in)
403C-15 404C-22	Number 1 ring	0,07 - 0,11 mm (0.0028 - 0.0043 in)	0,25 (0.0098 in)
	Number 2 ring	0,04 - 0,08 mm (0.0016 - 0.0032 in)	0,25 (0.0098 in)
	Oil control ring	0,02 - 0,06 mm (0.0008 - 0.0024 in)	0,15 (0.0059 in)
404C-22T	Number 2 ring	0,04 - 0,08 mm (0.0016 - 0.0032 in)	0,25 (0.0098 in)
	Oil control ring	0,02 - 0,06 mm (0.0008 - 0.0024 in)	0,15 (0.0059 in)



H1058

To measure the piston ring gap

Operation 4-6

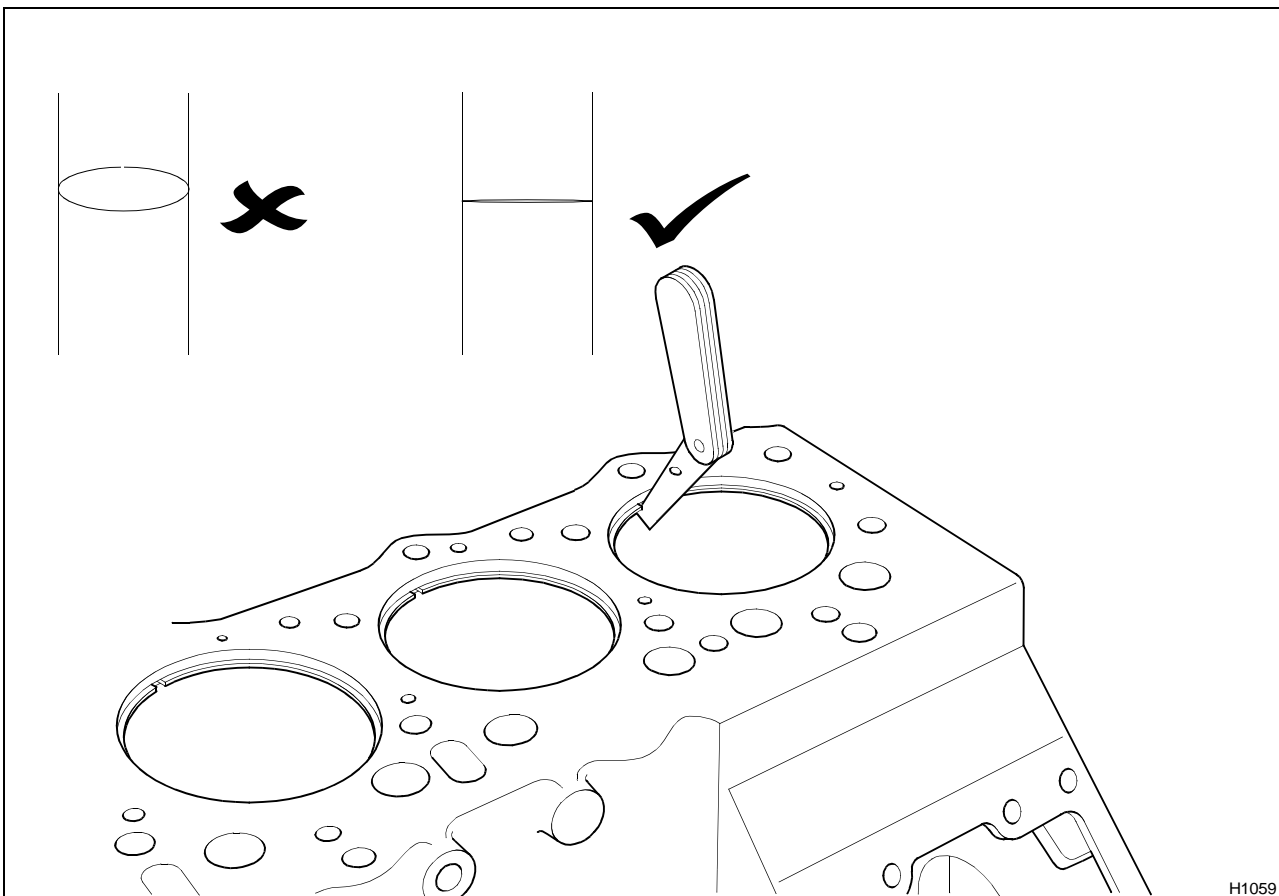
If the piston ring is worn or damaged, renew.

Piston ring gap

Clean the carbon from the top of the cylinder bore.

Insert the ring into the cylinder at right angles to the cylinder block and measure the gap with a feeler gauge. If the gap is greater than the service limit, renew the piston ring.

Engine	Ring number	Standard	Service limit
403C11	Number 1 ring	0,15 - 0,27 mm (0.0059 - 0.0106 in)	1,0 mm (0.039 in)
	Number 2 ring	0,12 - 0,24 mm (0.0047 - 0.0094 in)	1,0 mm (0.039 in)
	Oil control ring	0,20 - 0,35 mm (0.0079 - 0.0138 in)	1,0 mm (0.039 in)
403C-15	Number 1 ring	0,20 - 0,35 mm (0.0079 - 0.0138 in)	1,0 mm (0.039 in)
404C-22	Number 2 ring	0,20 - 0,40 mm (0.0079 - 0.0158 in)	1,0 mm (0.039 in)
404C-22T	Oil control ring	0,20 - 0,40 mm (0.0079 - 0.0158 in)	1,0 mm (0.039 in)



Piston and connecting rod assemblies

To dismantle and to assemble

Operation 4-7**Gudgeon pin**

Check the outside diameter of the gudgeon pin. If it is less than the service limit, renew the gudgeon pin.

Engine	Outside diameter	Service limit
403C-11	20,996 - 21,002 mm (0.82660 - 0.82680 in)	20,98 mm (0.8260 in)
403C-15 404C-22 404C-22T	27,996 - 28,000 mm (1.10220 - 1.10240 in)	27,98 mm (1.1016 in)

Engine	Standard clearance	Service limit
403C-11	-0,004 - +0,004 mm (-0.00016 - +0.00016 in)	0,02 mm (0.0008 in)
403C15 404C-22 404C-22T	-0,001 - +0,007 mm (-0.00040 - +0.00030 in)	0,02 mm (0.0008 in)

Piston and piston ring

To inspect

Operation 4-8

Piston

If the outer surface of the piston is damaged (cracked, scored, burning etc) renew.

Piston skirt

Check the larger diameter of the piston skirt (10 mm from bottom).

Check the inside diameter (thrust direction) of the cylinder. Calculate the clearance between the cylinder and the piston. If the clearance is more than the service limit, or piston diameter is less than service limit, renew the piston

Engine	Cylinder diameter	Service limit
403C-11	76,932 - 76,947 mm (3.02880 - 3.02940 in)	76,7 mm (3.020 in)
403C-15 404C-22 404C-22T	83,948 - 83,963 mm (3.30503 - 3.30562 in)	83,7 mm (3.295 in)

Engine	Clearance between piston and cylinder	Service limit
403C-11	0,0525 - 0,0865 mm (0.00210 - 0.00340 in)	0,25 mm (0.010 in)
403C-15 404C-22 404C-22T	0,0380 - 0,0720 mm (0.00150 - 0.00283 in)	0,25 mm (0.010 in)

Connecting rod

To inspect

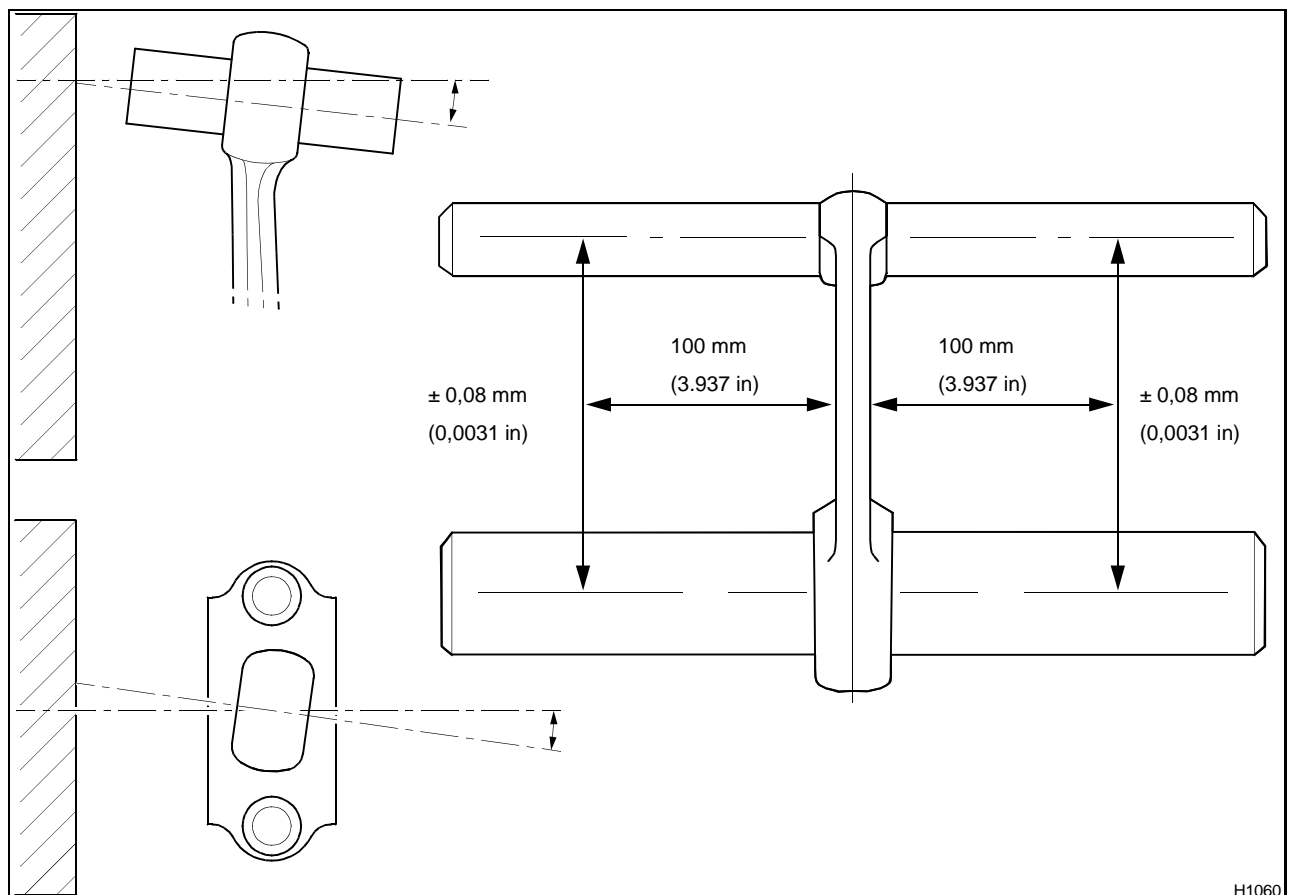
Operation 4-9

Engine	Standard		Service limit
All models	Distortion for 100 mm (3.937 in)	< 0,08 mm (0.0031 in)	0,20 mm (0.0079 in)
	Parallel for 100 mm (3.937 in)	< 0,05 mm (0.0020 in)	0,15 mm (0.0059 in)

The large and small end bores must be parallel with each other within the limits of $\pm 0,31$ mm (0.008 in) measured 100 mm (3.397 in) each side of the connecting rods axis on a test mandrel.

Check the small end bush for wear or for other damage and renew it if necessary.

Check the fit of the gudgeon pin in the small end bush and check the gudgeon pin for wear.



H1060

Connecting rod bearing clearance

To check

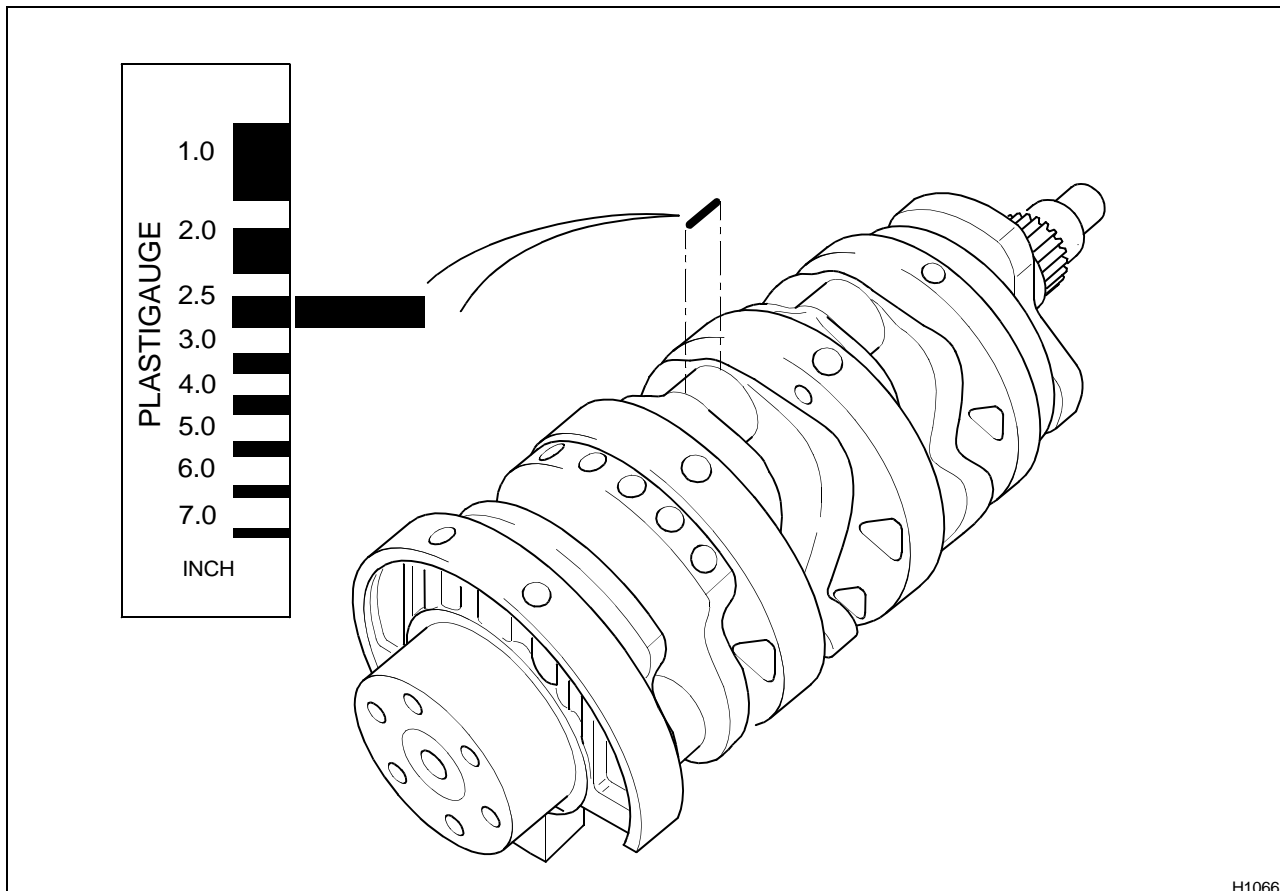
Operation 4-10

To check the clearance between the crankshaft bearing journal and the bearing cap.

- 1 Clean the bearing surfaces and the exposed half of the crankshaft journal.
- 2 Fit the bearing caps and tighten the bearing cap to torque.
- 3 Remove the bearing cap of the clearance to be checked.
- 4 Place a piece of Plastigauge ® across the full width of the bearing surface on the crankshaft journal, fit the bearing cap and tighten the bearing cap setscrew to the specified torque.
- 5 Remove the bearing cap but **do not move** the Plastigauge ®.
- 6 Use the Plastigauge ® envelope to measure the widest point of the Plastigauge ®. This reading indicates the bearing clearance in thousandths of an inch.
- 7 If the bearing clearance is not within the specifications the crankshaft must be reground and undersize bearings fitted.

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Bearing carrier setscrew	23 (16.9) 2,3
403C-15, 404C-22 and 404C-22T	Bearing carrier setscrew	52 (38.3) 5,2

Engine	Journals	Standard clearance	Service limit
403C-11	1 and 2	0,039 - 0,092 mm (0.00150 - 0.00360 in)	0,20 mm (0.0079 in)
	3	0,029 - 0,082 mm (0.00110 - 0.00320 in)	0,20 mm (0.0079 in)
403C-15, 404C-22 and 404C-22T	All	0,035 - 0,085 mm (0.00138 - 0.00335 in)	0,20 mm (0.0079 in)



H1066

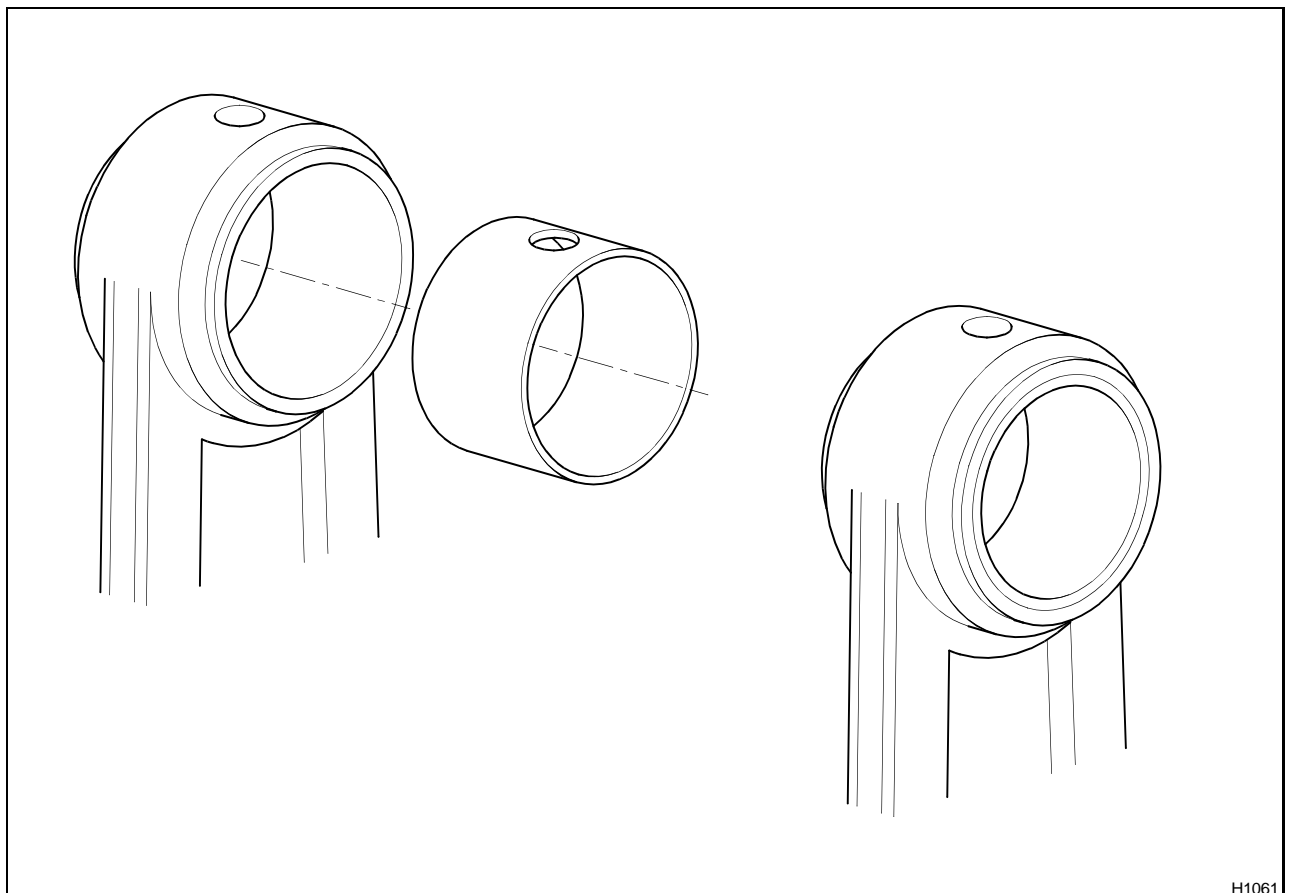
Small end bush

To remove and to fit

Operation 4-11

Calculate the clearance between the small end bush and the gudgeon pin. If the clearance is greater than the service limit, renew the bush.

Engine	Clearance mm (in)	Service limit mm (in)
403C-11	0,010 - 0,025 (0.00040 - 0.00099)	0.08 (0.0031)
403C-15 404C-22 404C-22T	0,010 - 0,025 (0.00040 - 0.00099)	0,10 (0.0040)



H1061

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5

Crankshaft assembly

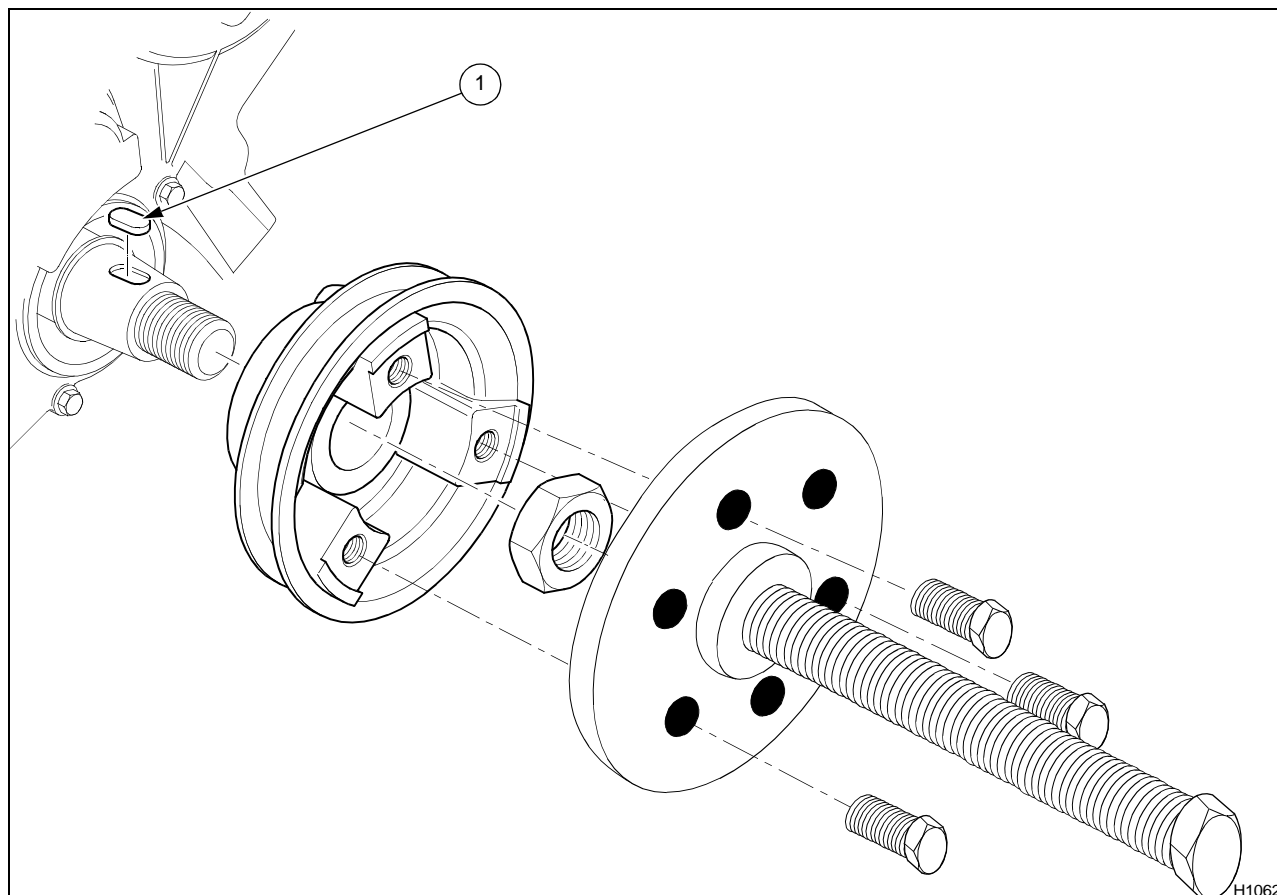
Crankshaft pulley

To remove and to fit

Operation 5-1

Engine	Torque Nm (lbf ft) kgf m		Special tools	Part number
403C-11	Crankshaft nut	123 (90.7) 12,5	Crankshaft pulley remover	21825619
403C-15	Crankshaft nut	304 (224.2) 30,9		
404C-22 404C-22T				

Note: Store the key (1) in a safe place until assembly.



Crankshaft retaining bolts and crankshaft

To remove and to fit

Operation 5-2

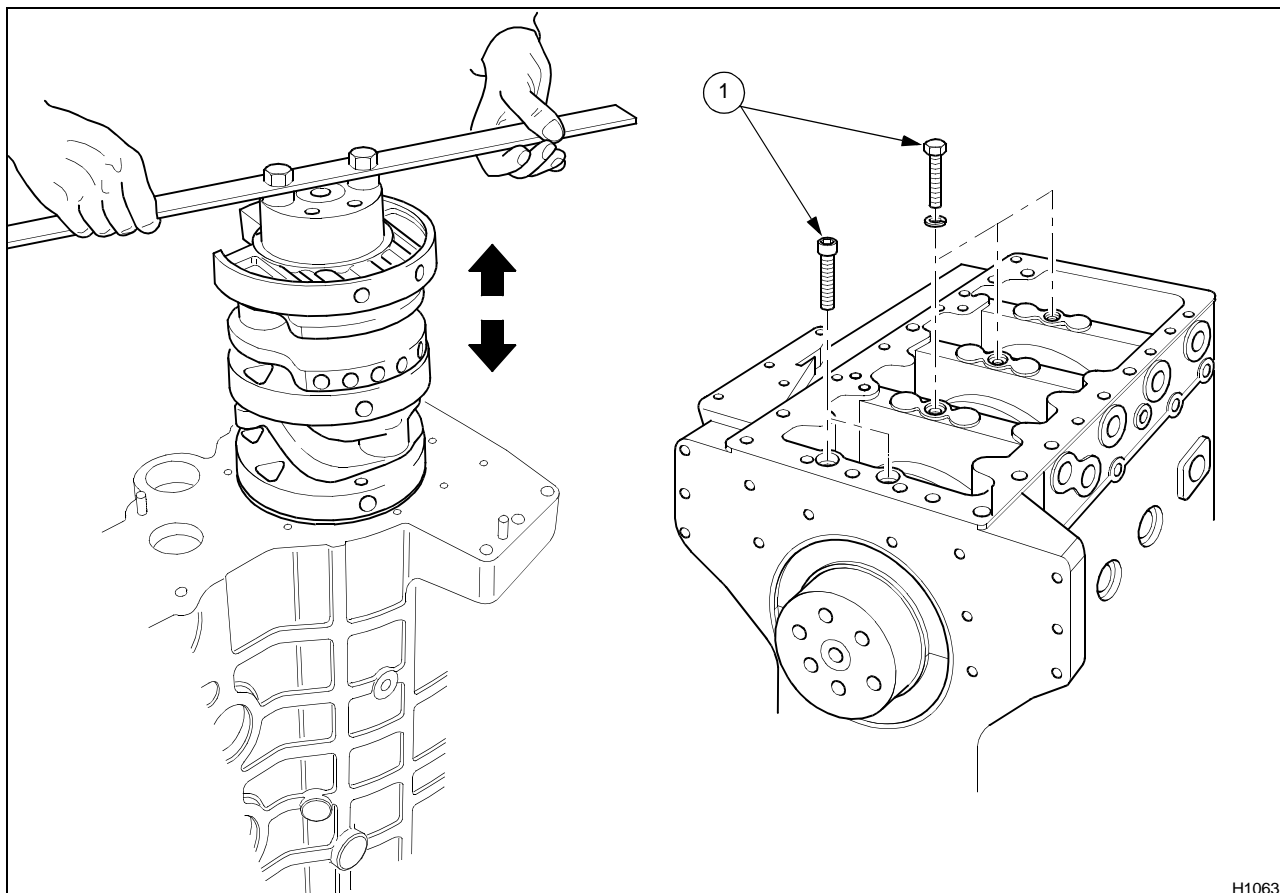
Engine	Torque Nm (lbf ft) kgf m	
403C-11	Crankshaft bearing holder setscrew	27 (19.9) 2,7
	Crankshaft bearing holder to block (allen screws)	27 (19.9) 2,7
403C-15	Crankshaft bearing holder setscrew	52 (38.3) 5,2
404C-22 404C-22T	Crankshaft bearing holder to block (allen screws)	27 (19.9) 2,7

Cautions:

- Ensure that the lubricating oil pressure relief valve has been removed before the crankshaft is removed or fitted.
- Ensure that the oil ways in the bearings align with the oil ways in the cylinder block.

Remove the bearing holder setscrews (1) and lift the crankshaft assembly out vertically.

Note: If the crankshaft or crankshaft bearings are replaced the fuel adjustment screw must not be altered from the original setting. The maximum no load speed must be checked after assembly.



H1063

Crankshaft

To inspect for deflection

Operation 5-3

- 1 Support the crankshaft on V-blocks.
- 2 Position a dial gauge on the crankshaft centre journal, and turn the crankshaft gradually by one full turn.
- 3 If the gauge reading is more than the service limit, renew or regrind the crankshaft.

Engine	Deflection mm (in)	
	Standard	Service limit
All models	0,03 or less (0.011)	0,06 (0.0023)

- 4 When the measured diameter is less than the service limit, regrind and use undersized bearings and bushes.

Crankshaft inspection

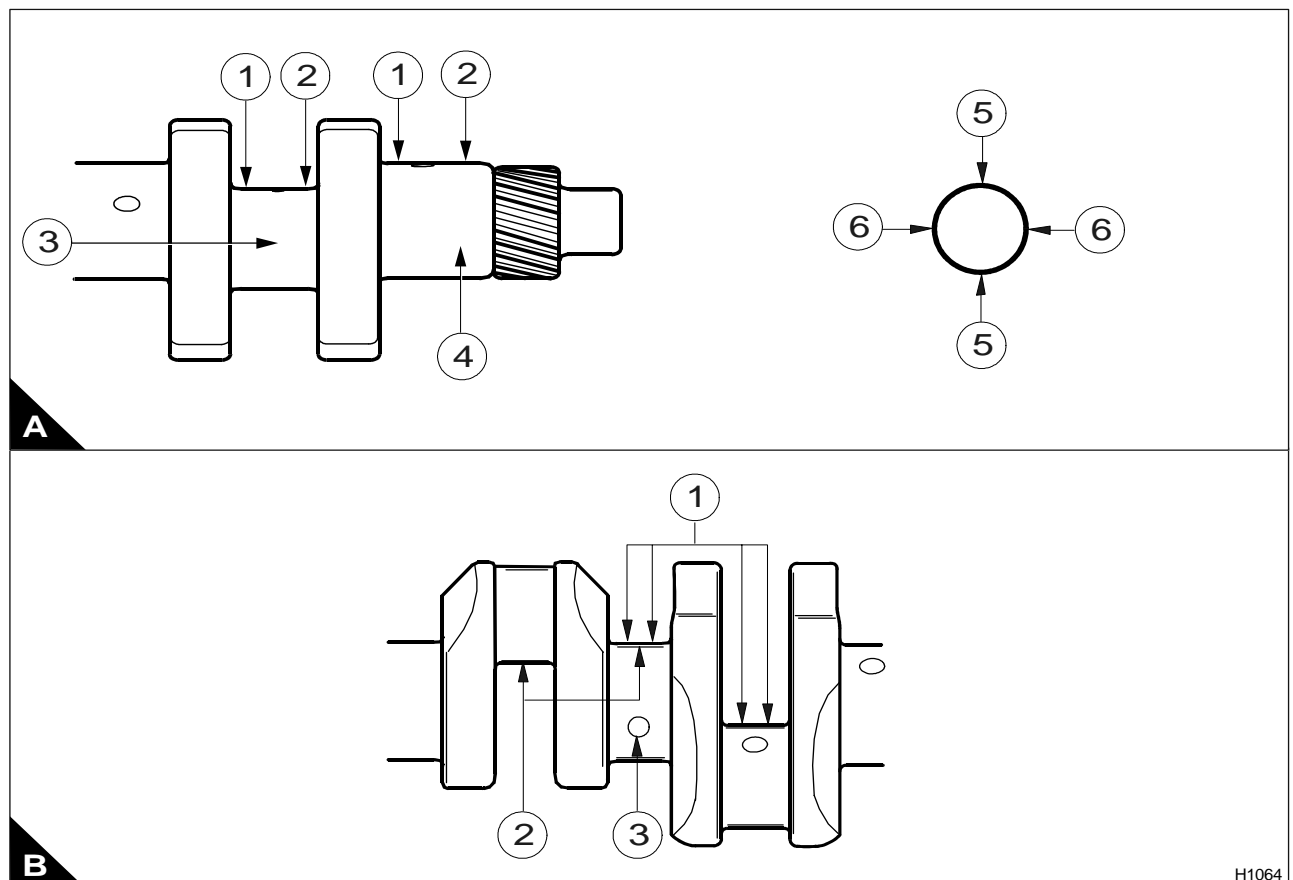
- 1 Check the oil seal contact face for damage or wear.
- 2 Check oil holes for clogging.
- 3 Check crankshaft journal (A4) and crank pin (A3) for stepped wear. Take measurements of diameters (A5-A5) and (A6-A6) at positions (A1) and (A2). If the maximum difference between the measurements (stepped wear) is more than the service limit of 0,05 mm (0.0019 in) then correction is required.

Grinding specification

When grinding the crankshaft, work with the following specifications:

Radius at pin / journal (B1)	3 mm (0.118 in) \pm 0,2 mm (\pm 0.0078 in)
Finish precision (B2)	1.6Z ($\nabla \nabla \blacktriangledown$)
Radius around oil hole (B3)	2 mm (0.787 in) maximum / 5 mm (0.196 in) minimum

Note: Use No. 400 emery cloth for final polishing.



H1064

Crankshaft journal diameter

Engine	Size	Standard diameter	Service limit
403C-11	Standard	47,964 - 47,975 mm (1.88830 - 1.88880 in)	47,90 mm (1.8860 in)
	Undersize 0,25 mm (0.01 in)	47,714 - 47,725 mm (1.87850 - 1.87890 in)	47,65 mm (1.8750 in)
	Undersize 0,50 mm (0.02 in)	47,464 - 47,475 mm (1.86870 - 1.86910 in)	47,40 mm (1.8660 in)
403C-15 404C-22 404C-22T	Standard	67,957 - 67,970 mm (2.67550 - 2.67597 in)	67,90 mm (2.6732 in)
	Undersize 0,25 mm (0.01 in)	67,707 - 67,720 mm (2.66563 - 2.66614 in)	67,65 mm (2.6634 in)
	Undersize 0,50 mm (0.02 in)	67,457 - 67,470 mm (2.65579 - 2.65630 in)	67,40 mm (2.6535 in) *

Crankshaft pin diameter

Engine	Size	Standard diameter	Service limit
403C-11	Standard	40,964 - 40,975 mm (1.61280 - 1.61320 in)	40,90 mm (1.6102 in)
	Undersize 0,25 mm (0.01 in)	40,714 - 40,725 mm (1.60290 - 1.60330 in)	40,65 mm (1.6003 in)
	Undersize 0,50 mm (0.02 in)	40,464 - 40,475 mm (1.59310 - 1.59350 in)	40,40 mm (1.5905 in)
403C-15 404C-22 404C-22T	Standard	51,964 - 51,975 mm (2.04582 - 2.04626 in)	51,90 mm (2.0433 in)
	Undersize 0,25 mm (0.01 in)	51,714 - 51,725 mm (2.03598 - 2.03641 in)	51,65 mm (2.0335 in)
	Undersize 0,50 mm (0.02 in)	51,464 - 51,475 mm (2.02614 - 2.02660 in)	51,40 mm (2.0236 in) *

Note: If the diameter is less than the maximum undersize service limit (*), the crankshaft must be renewed.

Main bearings

To dismantle and to assemble

Operation 5-4

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Bearing holder setscrew	23 (16.9) 2,3
403C-15, 404C-22 and 404C-22T	Bearing holder setscrew	52 (38.3) 5,2

End float

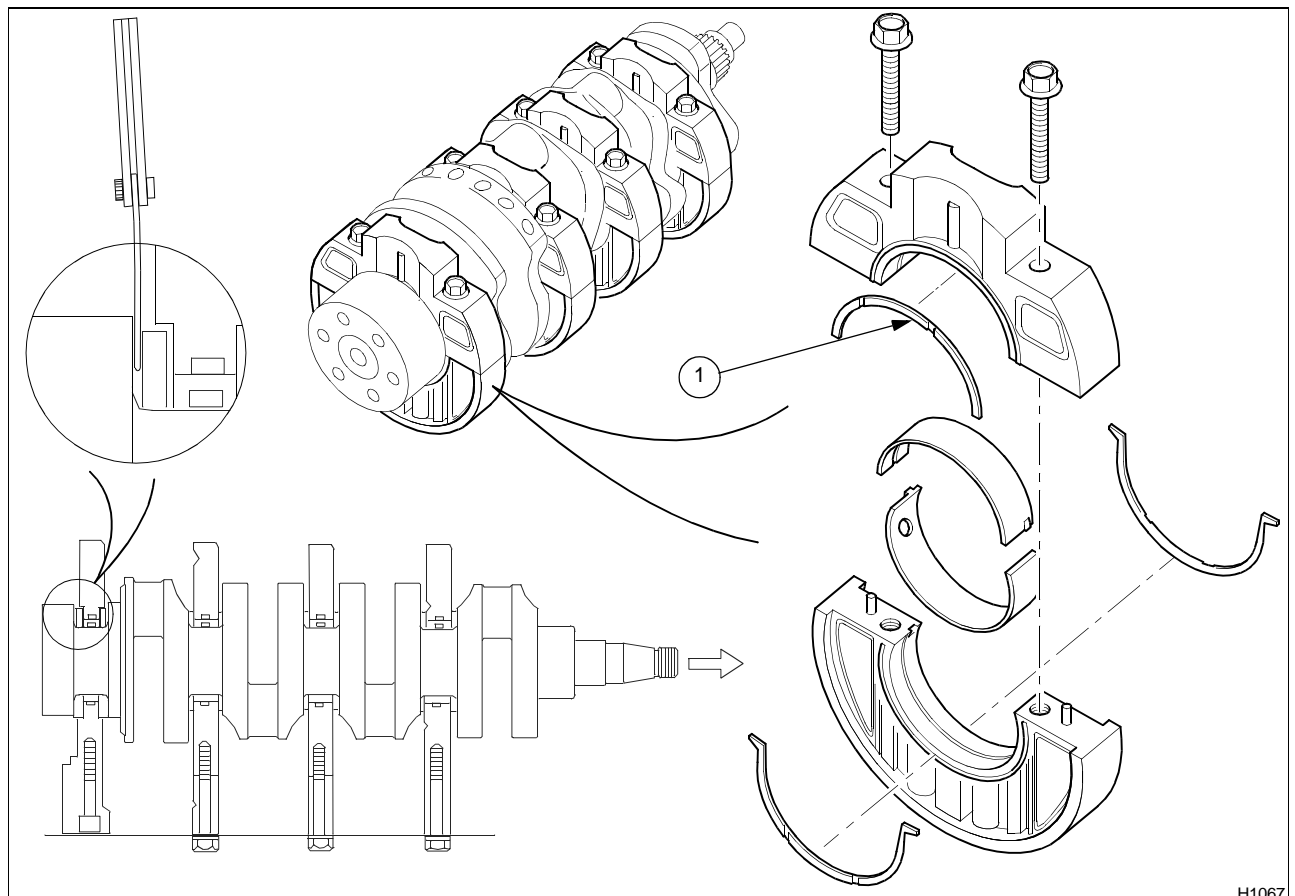
If the end float is greater than the service limit check the thrust washers for wear.

Note: Item (1) only used on 404C-22 and 404C-22T.

Engine	Standard clearance	Service limit
403C-11	0,10 - 0,30 mm (0.0040 - 0.0120 in)	0,50 mm (0.0197 in)
403C-15, 404C-22 and 404C-22T	0,10 - 0,40 mm (0.0040 - 0.0160 in)	0,50 mm (0.0197 in)

Engine	Thrust washer thickness	Service limit
403C-11	21,85 - 21,95 mm (0.8602 - 0.8641 in)	21,6 mm (0.8503 in)
403C-15, 404C-22 and 404C-22T	2,95 - 3,00 mm (0.1161 - 0.1181 in)	2,80 mm (0.1102 in)

- 1 Identify the location of bearing carriers on the crankshaft and mark before removal.
 - 2 Install bearing carriers on the crankshaft, ensure that the lubricating oil holes align with the feed holes in the cylinder block.
 - 3 Check end float clearance.
- Note:** Ensure that the thrust washers are aligned correctly, fitted with their oil grooves towards the crankshaft.
- 4 Check the thrust washers for wear, poor contact or damage, if damaged renew.



H1067

Bearing holder

Centre bearing

- 1 Remove the bearing holder and inspect for peeling, melting, stepped wear and damage. If it is damaged renew.
- 2 Use Plastigauge ® to measure the oil clearance (see Operation 4-10) between the crankshaft centre journal and the bearing. If the oil clearance is greater than the service limit, renew the bearings or regrind the centre journal and use undersize bearings.

Engine	Standard oil clearance	Service limit
403C-11	0,039 - 0,106 mm (0.00153 - 0.00401 in)	0,20 mm (0.0078 in)
403C-15 404C-22 404C-22T	0,044 - 0,102 mm (0.00150 - 0.00420 in)	0,20 mm (0.0078 in)

Engine / Bearing size mm (in)	Journal	Centre crankshaft diameter mm (in)
403C-11		
Standard	1, 2	47,965 - 47,975 (1.88830 - 1.88880)
	3	47,954 - 47,965 (1.88800 - 1.88840)
Undersize 0,25 (0.01)	1, 2	47,714 - 47,725 (1.87850 - 1.87890)
	3	47,704 - 47,715 (1.87810 - 1.87850)
Undersize 0,50 (0.02)	1, 2	47,464 - 47,475 (1.86870 - 1.86910)
	3	47,454 - 47,465 (1.86250 - 1.86870)
403C-15		
Standard	1, 2, 3	67,957 - 67,970 (2.67550 - 2.67597)
Undersize 0,25 (0.01)	1, 2, 3	67,707 - 67,720 (2.66563 - 2.66614)
Undersize 0,50 (0.02)	1, 2, 3	67,457 - 67,470 (2.65579 - 2.65630)
404C-22 and 404C-22T		
Standard	1, 2, 3, 4	67,957 - 67,970 (2.67550 - 2.67597)
Undersize 0,25 (0.01)	1, 2, 3, 4	67,707 - 67,720 (2.66563 - 2.66614)
Undersize 0,50 (0.02)	1, 2, 3, 4	67,457 - 67,470 (2.65579 - 2.65630)

6

Timing case and drive assembly

Timing cover

To remove

Operation 6-1

Engine	Special tools	
	Description	Part number
403C-11	Front oil seal protector	21825620
403C-15, 404C-22 and 404C-22T	Front oil seal protector	21825621

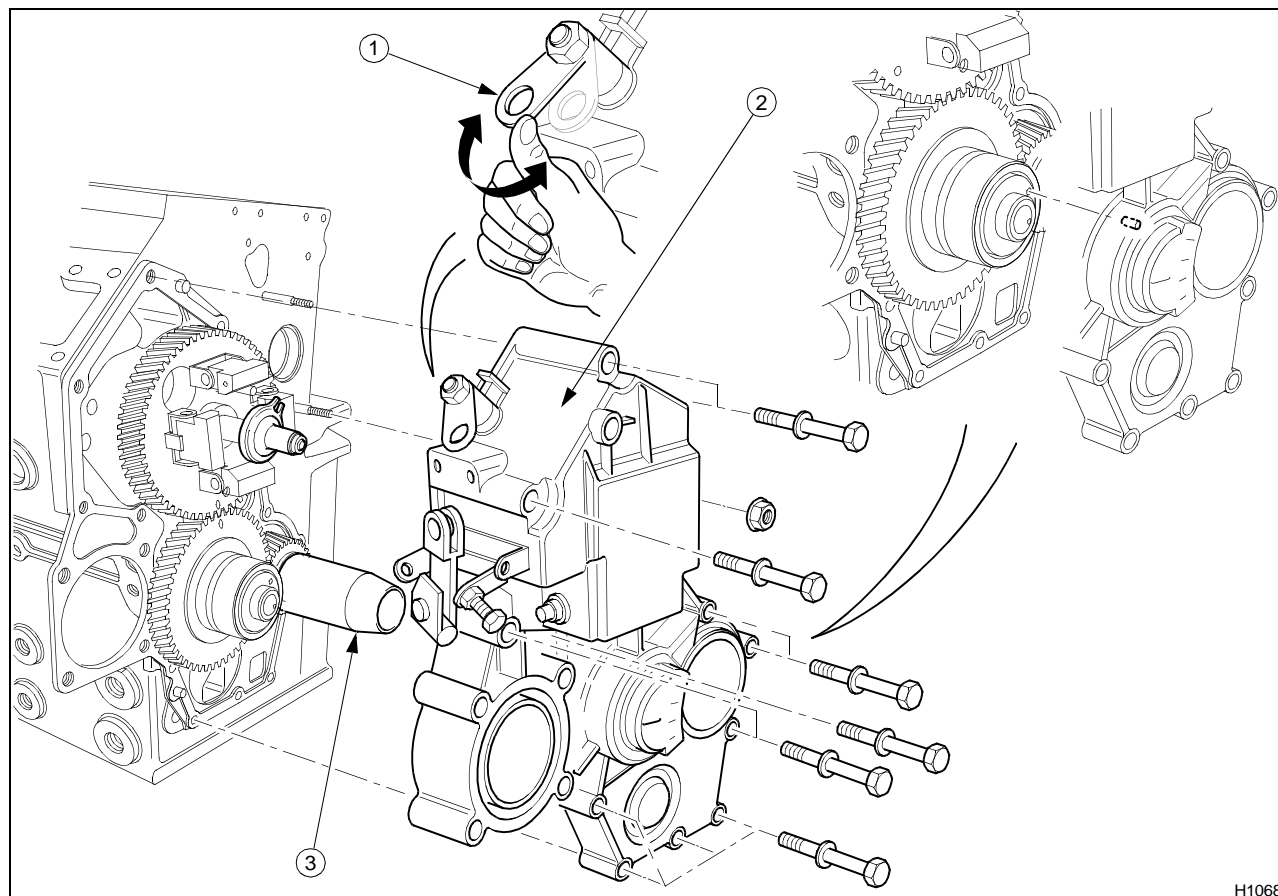
Cautions:

- If the timing case assembly or internal governor components are replaced the fuel adjustment screw should not be adjusted. The maximum no load speed should be checked after assembly.
- The fuel injection pump, see Operation 11-3 and the keyway in the crankshaft must be removed before the timing case is removed.
- Ensure that the stop lever arm (1) is held clockwise in tension for removal and assembly.

Note: If the timing case is renewed, a new emission label must be fitted as shown (2).

1 To remove the PTO cover, see Operation 6-9.

2 To remove and to fit the crankshaft pulley, see Operation 5-1.



H1068

To fit

Operation 6-2

Engine	Special tools	
	Description	Part number
403C-11	Front oil seal protector	21825620
403C-15 404C-22 404C-22T	Front oil seal protector	21825621

To fit

1 The fuel injection pump, see Operation 11-3 and the keyway in the crankshaft must be removed before the timing case is fitted. Fit the front oil seal protector.

2 To fit the PTO cover, see Operation 6-9.

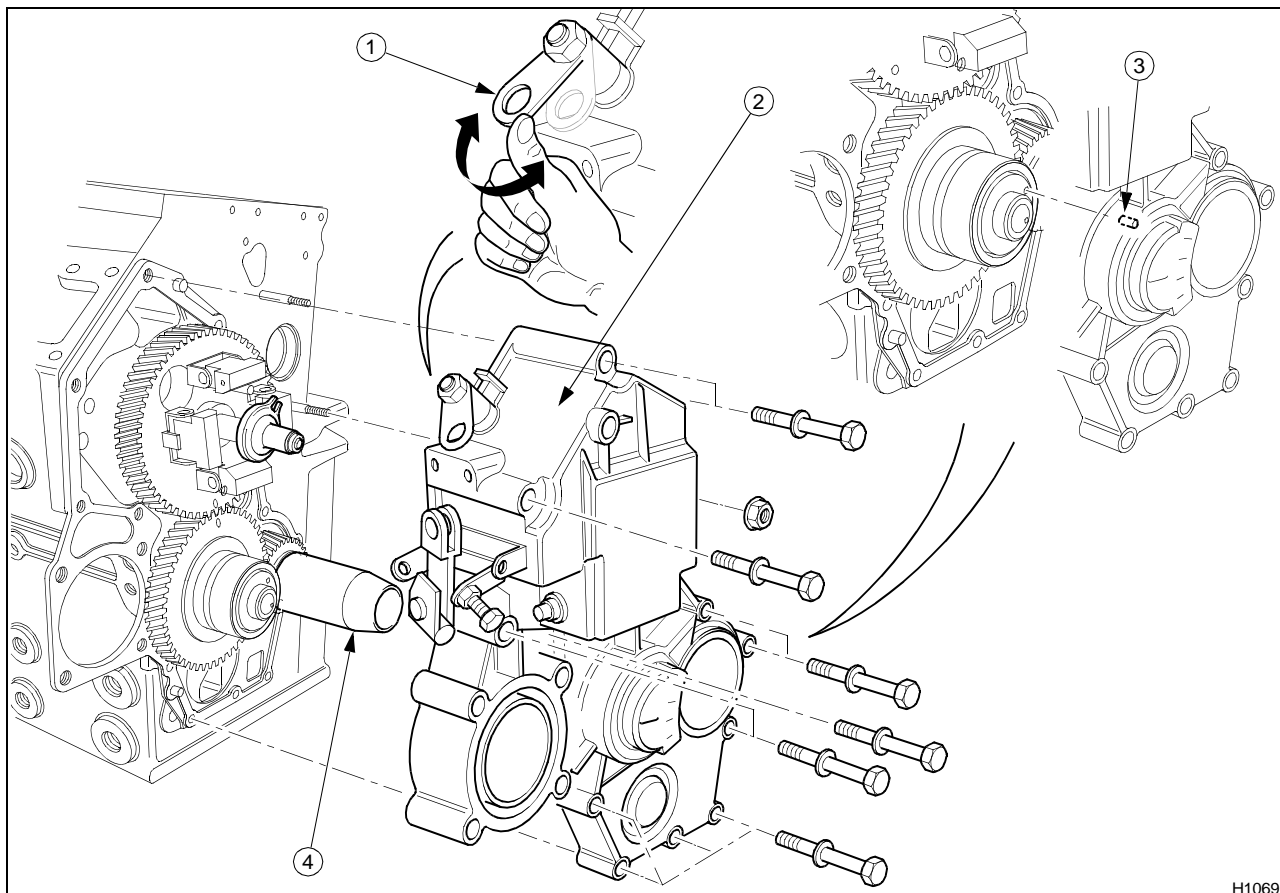
3 Ensure the oil pin (3) locates in the hole in the idler gear and that the stop lever arm (1) is held clockwise in tension for removal and assembly.

4 Remove the oil seal protector (4) after fitting the timing cover. Fit the key into the key way in the crankshaft nose.

5 To fit the crankshaft pulley, see Operation 5-1.

Note: If the timing case is renewed, a new emission label must be fitted as shown (2).

Caution: If the timing case assembly or internal governor components are replaced the fuel adjustment screw should not be adjusted. The maximum no load speed should be checked after assembly.



H1069

Angleich

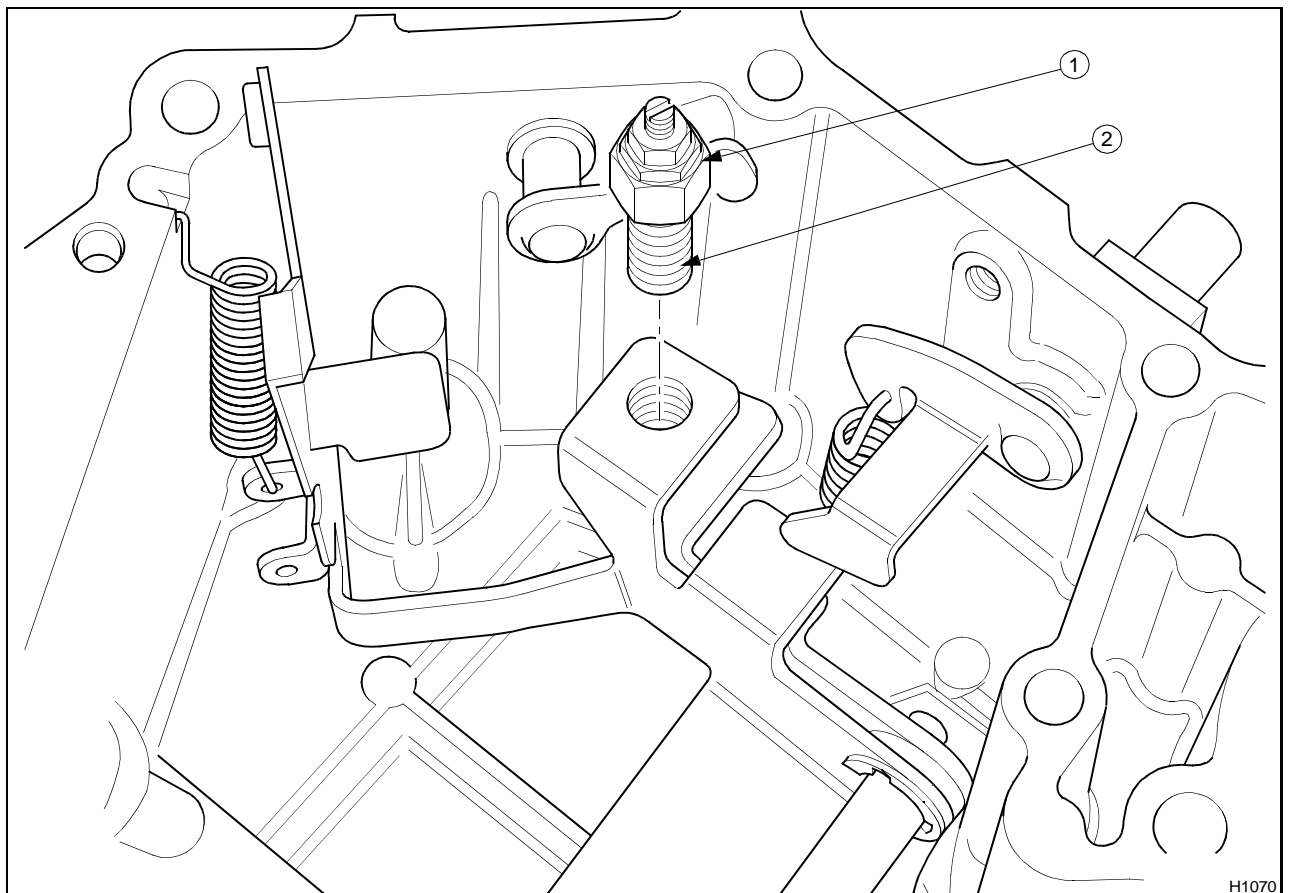
To remove and to fit

Operation 6-3

Engine	Torque Nm (lbf ft) kgf m	
403C-15, 404C-22 404C-22T	Angleich (1)	5 (3.6) 0,5

Notes:

- The internal setting for the Angleich must not be altered.
- Apply a little Loctite 275 to threads (2) before assembly.
- The Angleich is not fitted to the 403C-11 engine.



H1070

Slider

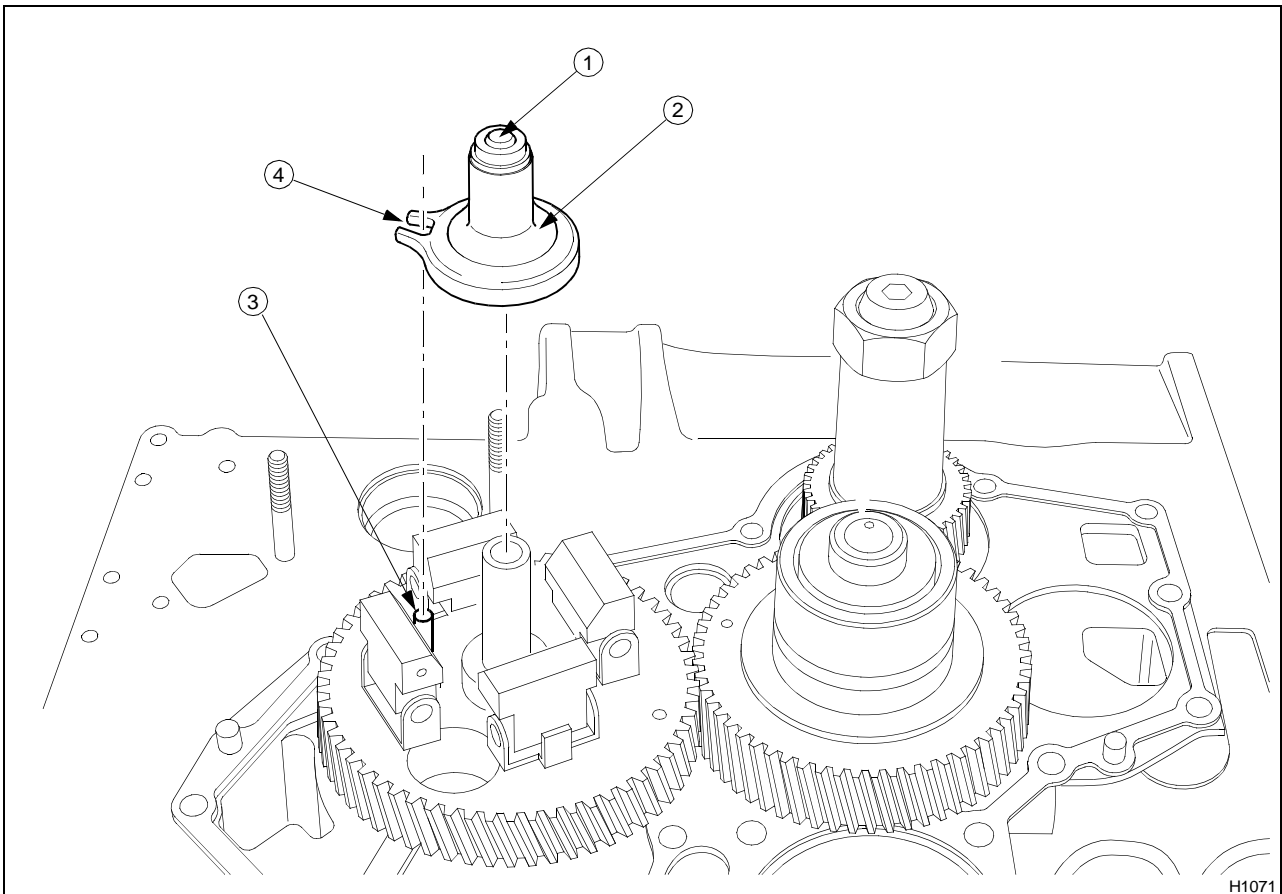
To remove and to fit

Operation 6-4

The slider (2) must be fitted with the slot (4) held captive by the pin (3).

When fitting the timing case care must be taken to ensure correct alignment of the slider contact (1) with the governor lever.

Caution: *Incorrect alignment of the slider (2) on the pin (3) may result in the loss of engine speed control.*



Camshaft retaining plate

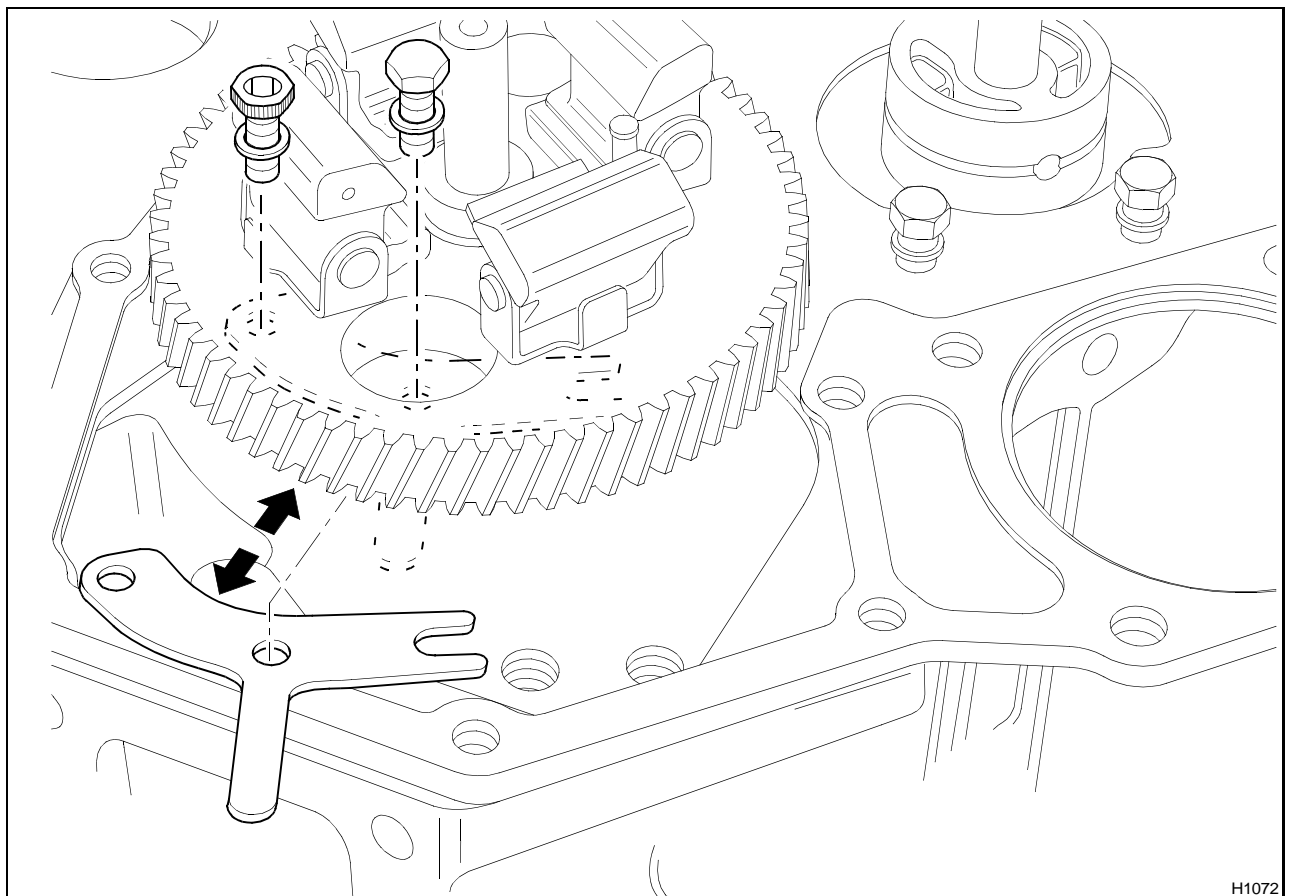
To remove and to fit

Operation 6-5

Engine	Torque Nm (lbf ft) kgf m	
All models	Camshaft retainer plate setscrews	11 (8) 1,1

The camshaft retainer plate is fitted between the cylinder block and the camshaft gear. The camshaft retainer plate is fastened by either two setscrews or a setscrew and an allen screw.

Note: If the camshaft assembly is replaced the fuel adjustment screw must not be altered from the original setting. The maximum no load speed must be checked after assembly.



H1072

Camshaft and tappets

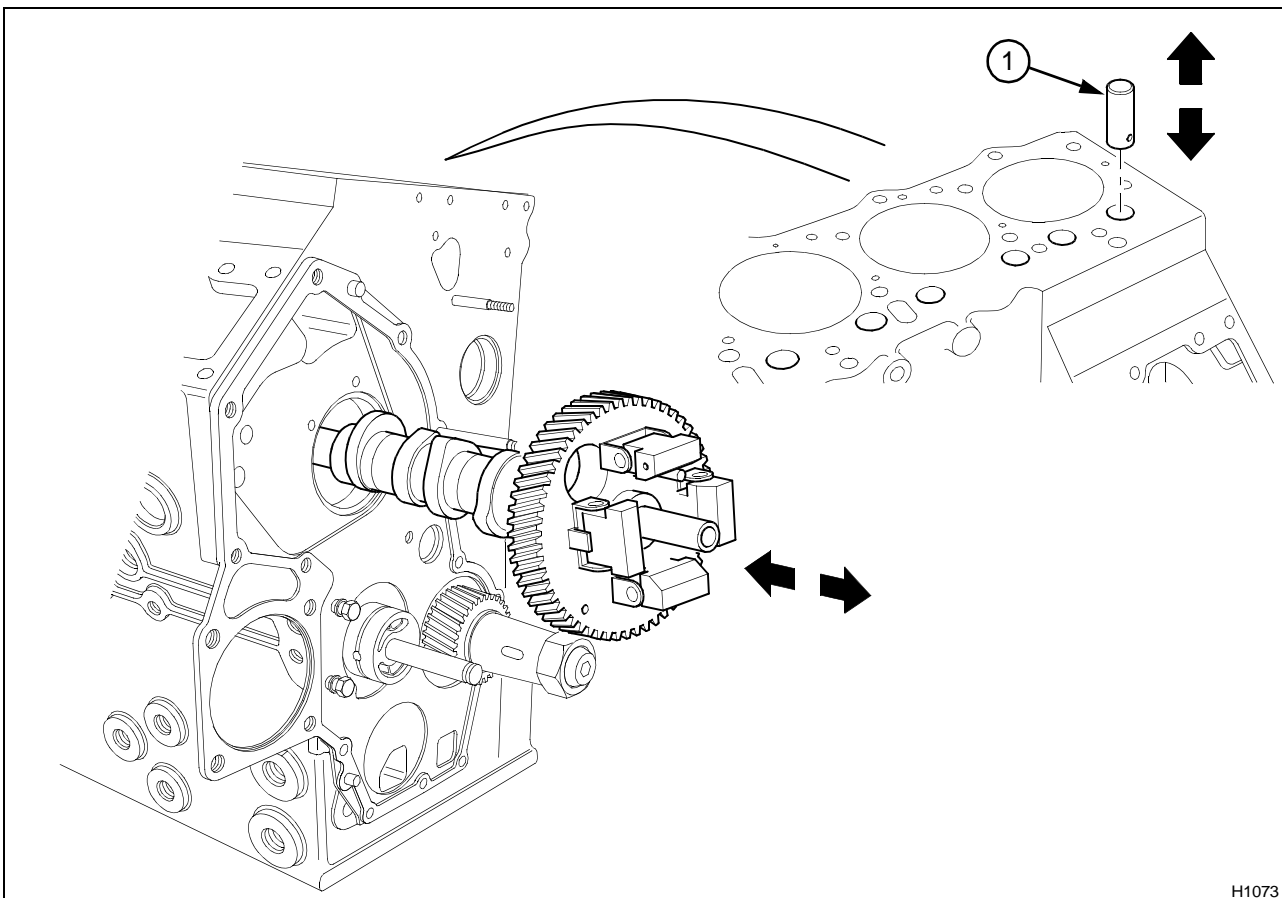
To remove and to fit

Operation 6-6

Caution: Remove the lift pump see Operation 11-2 and the fuel injection pump see Operation 11-3 before removing the camshaft.

Note: If the camshaft assembly is replaced the fuel adjustment screw must not be altered from the original setting. The maximum no load speed must be checked after assembly.

Lubricate the tappets with clean lubricating oil before assembly.



H1073

Camshaft assembly

To inspect

Operation 6-7

Height of cam for inlet and exhaust valves (1).

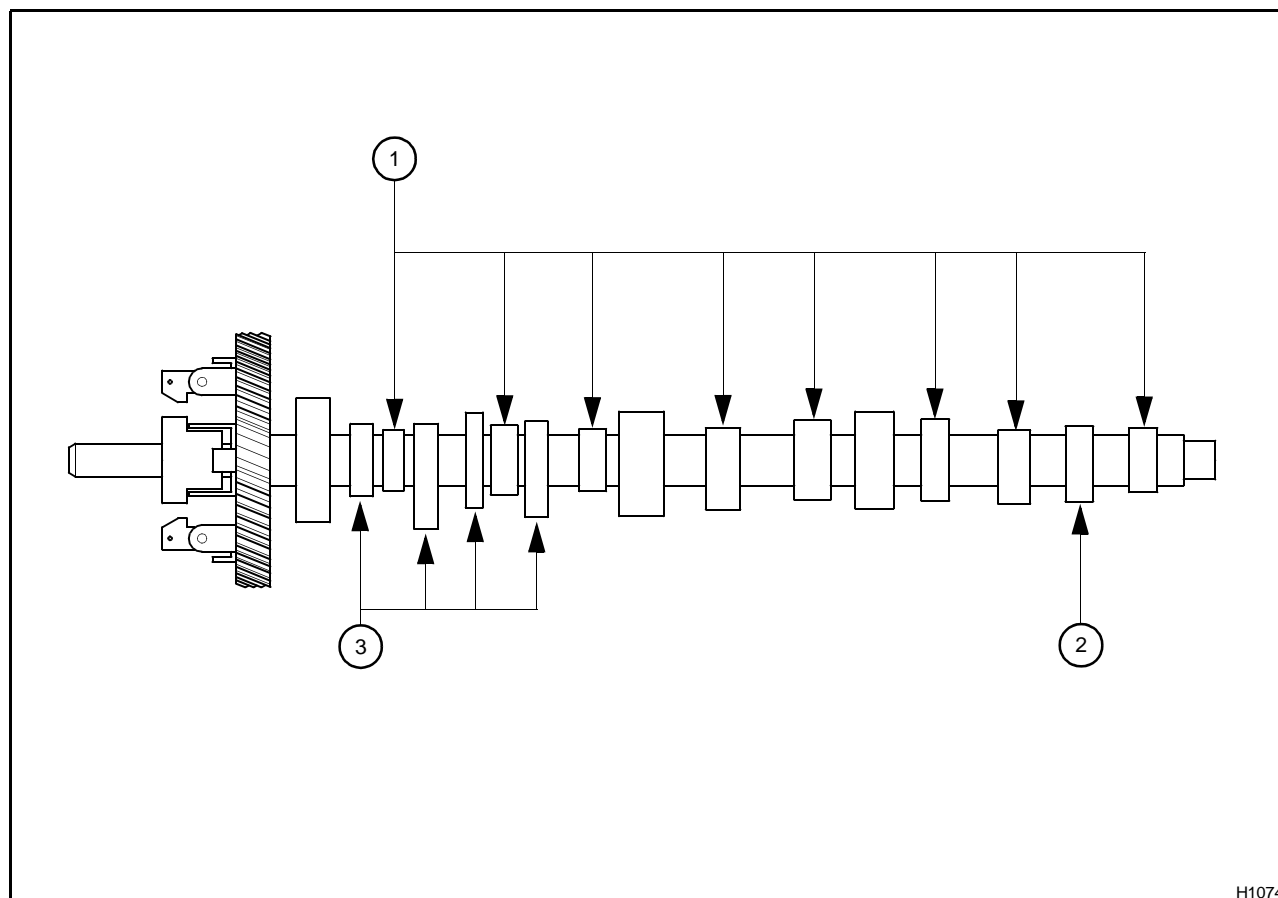
Engine	Height mm (in)	
	Standard	Service limit
403C-11	26,955 - 27,010 (1.06120 - 1.06340)	26,5 (1.0276)
403C-15, 404C-22 and 404C-22T	34,065 - 34,120 (1.34114 - 1.34330)	33,7 (1.3270)

Height of cam for fuel feed pump (2).

Engine	Height mm (in)	
	Standard	Service limit
403C-11	27.900 - 28,000 (1.09842 - 1.10240)	27,0 (1.0630)
403C-15, 404C-22 and 404C-22T	31,900 - 32,000 (1.25590 - 1.25984)	30,0 (1.1810)

Height of cam for fuel injection pump (3).

Engine	Height mm (in)	
	Standard	Service limit
403C-11	39,900 - 40,100 (1.57090 - 1.57870)	39,8 (1.5669)
403C-15, 404C-22 and 404C-22T	41,940 - 42,060 (1.65120 - 1.65590)	41,8 (1.6450)



H1074

Maximum fuel screw and maximum speed screw

Location

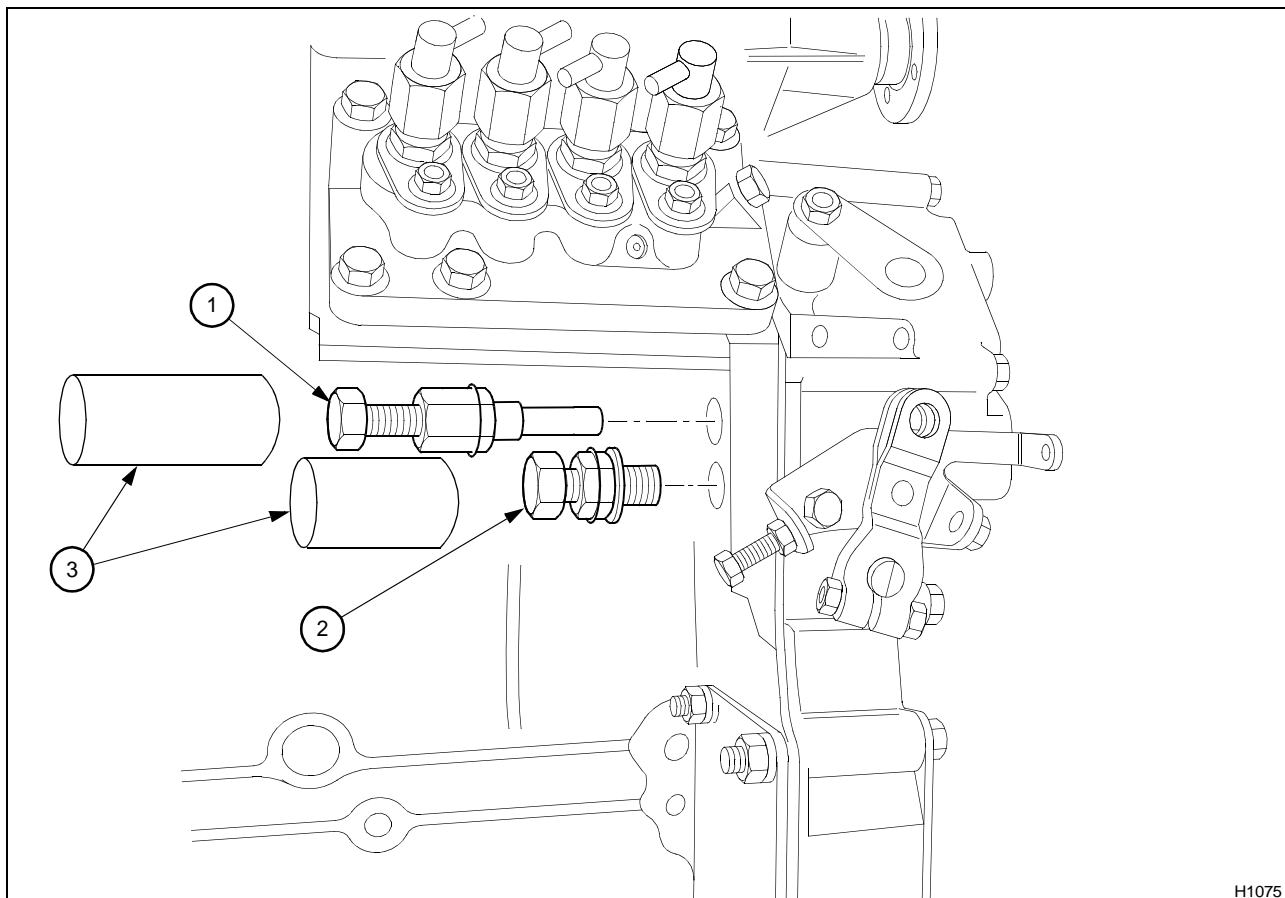
Operation 6-8

Engine	Torque Nm (lbf ft) kgf m	
All models	Maximum fuel screw lock nut	14 (10.3) 1,4
	Maximum speed screw lock nut	14 (10.3) 1,4

Caution: The fuel adjustment setscrew must be set correctly for the engine to comply with emissions legislation. This must only be carried out by an approved Perkins distributor.

Notes:

- The maximum fuel setscrew (1) and the maximum speed setscrew (2) **must not** be adjusted by the operator.
- Under certain circumstances it may be necessary to remove the anti tamper device for the maximum fuel setscrew. This must only be carried out by an approved Perkins distributor.
- Any adjustment to the maximum fuel screw will require an engine test brake, and also a check of maximum no load speed to confirm the settings.



H1075

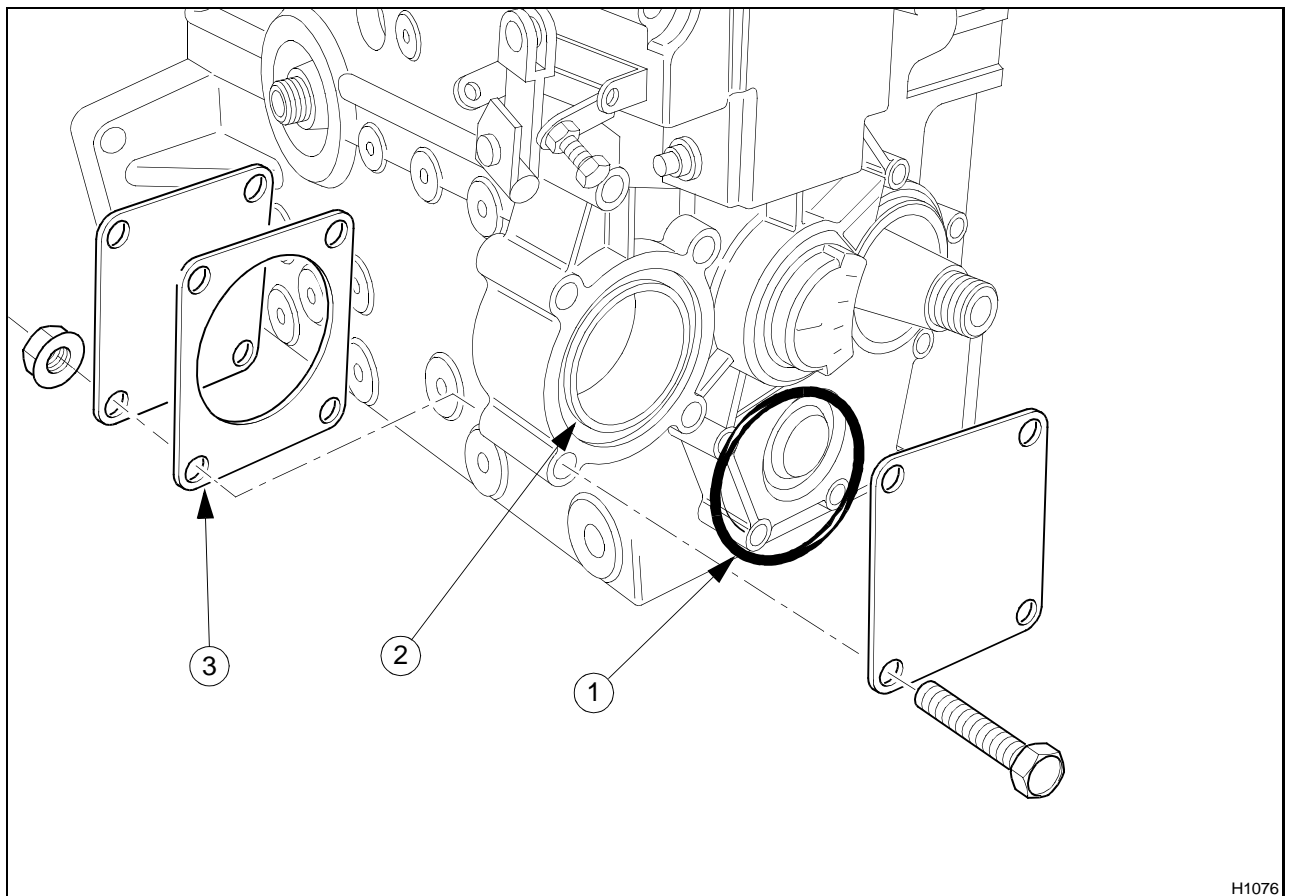
Front oil seal and PTO cover

To remove and to fit

Operation 6-9

An 'O' ring (1) is fitted in the groove (2) on the front of the timing case.

A joint (3) is used on the rear of the timing case PTO cover.



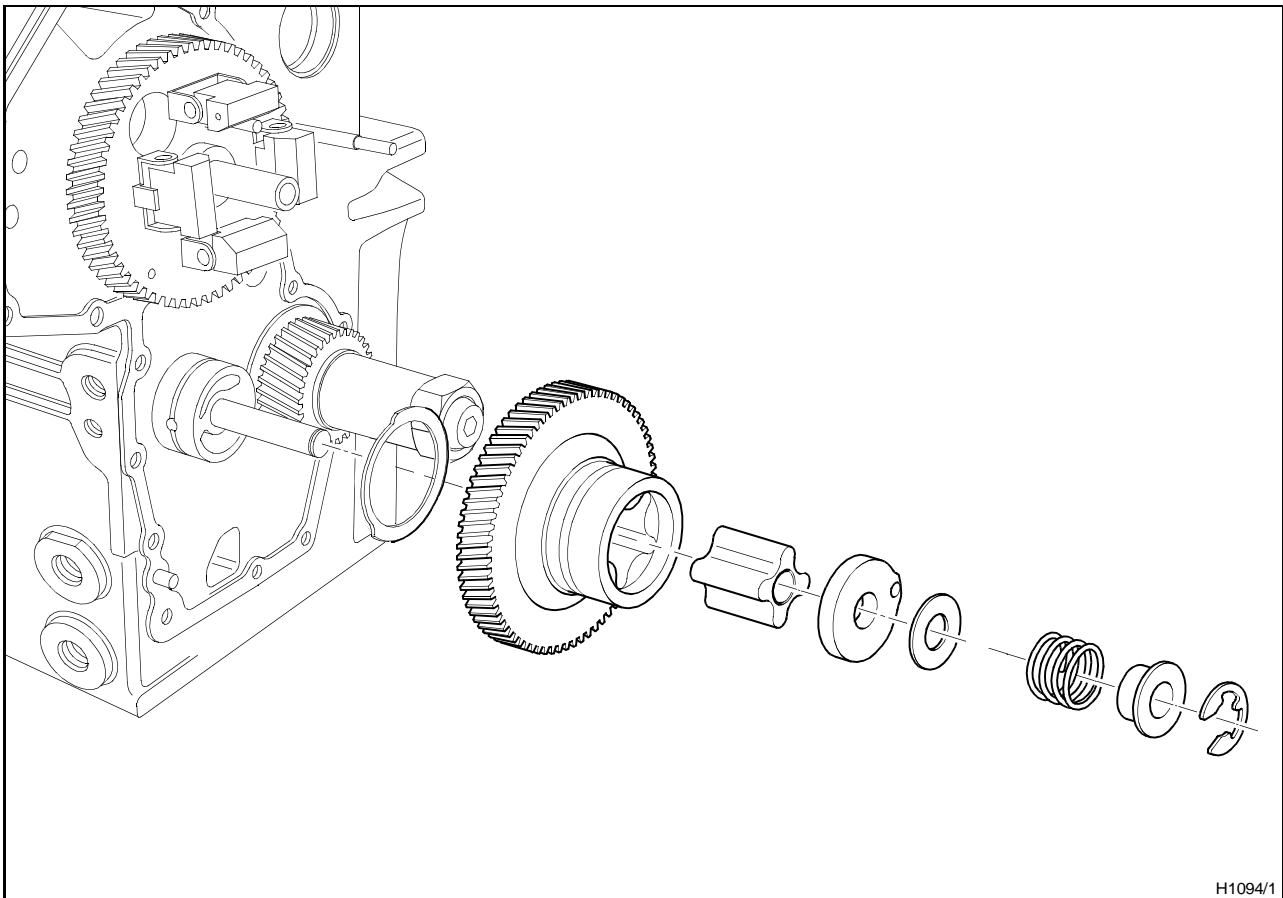
H1076

Idler gear and oil pump

To remove and to fit

Operation 6-10

To check the end float, see Operation 6-13.



H1094/1

Idler hub

To remove and to fit

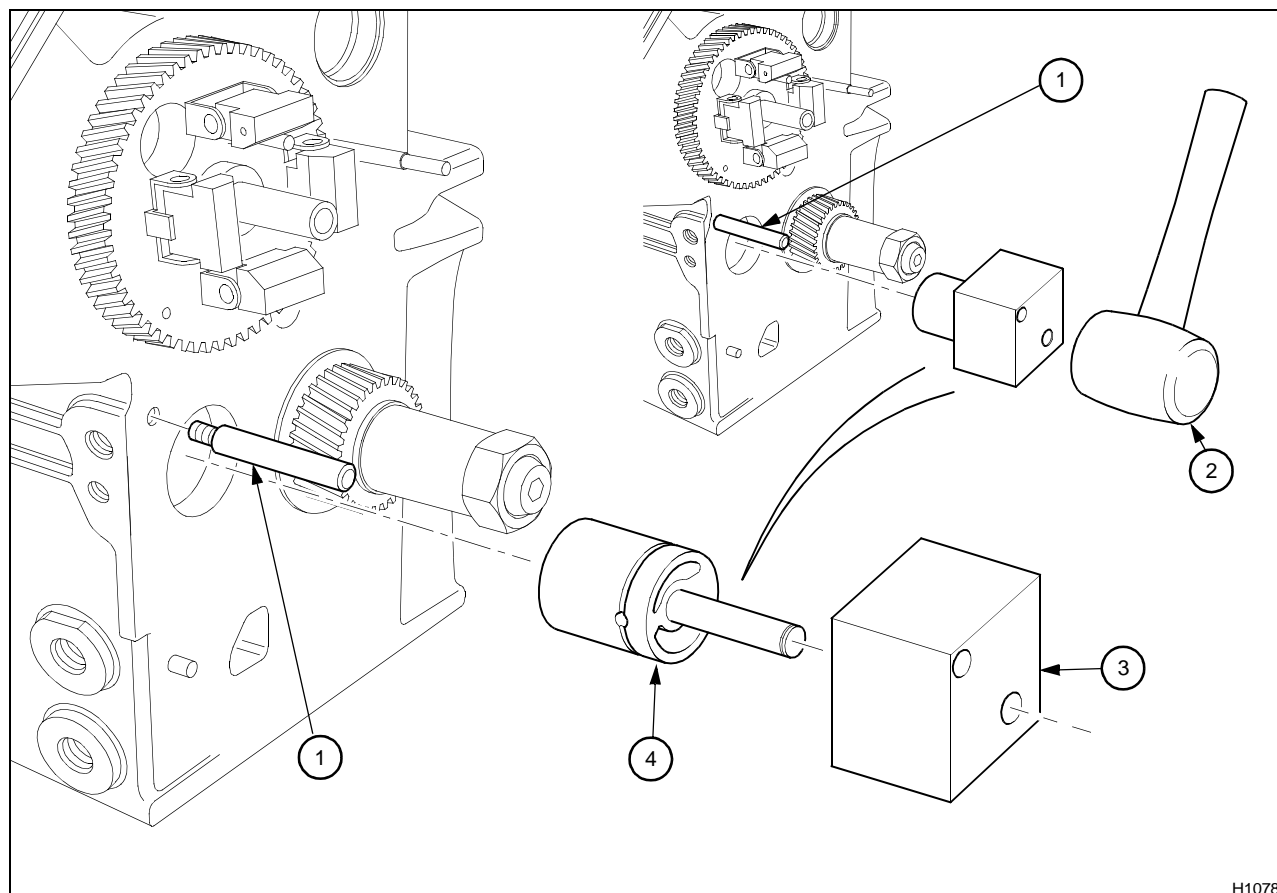
Operation 6-11

To remove the lubricating oil pump idler hub the crankshaft must be removed. The oil pump idler hub can then be removed with a suitable drift and hammer from the inside of the engine block.

- 1 Fit the location pin (1) into the block.
- 2 Place the idler hub (4) into the idler hub tool (3) and fit on the location pin (1).
- 3 Using the hammer (2) hit the idler hub tool until the hub is fitted.

Engine	Special tools	
	Description	Part number
403C-11	Idler hub fitting tool	21825625
403C-15 404C-22 404C-22T	Idler hub fitting tool	21825626

Caution: Always fit a new idler gear hub, do not fit the old hub, as it may be damaged when removed.



H1078

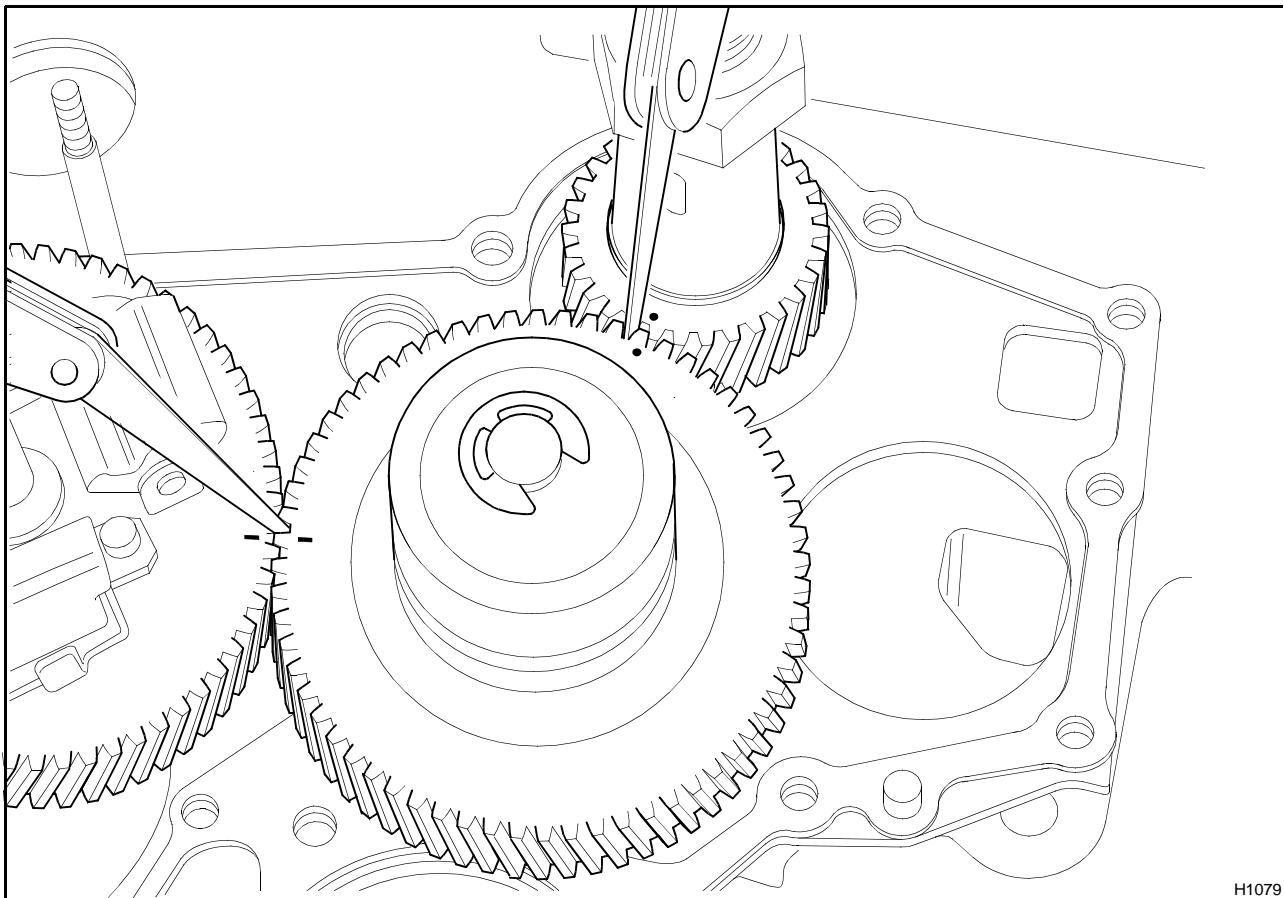
Gear teeth backlash

To check

Operation 6-12

Engine	Timing gear tolerances mm (in)	
	Standard	Service limit
All models	0,08 (0.0032)	0,25 (0.0098)

Measure the clearances one at a time with a feeler gauge at each of the locations shown. If the measurement is outside the service limit fit new gears.



H1079

Oil pump end float

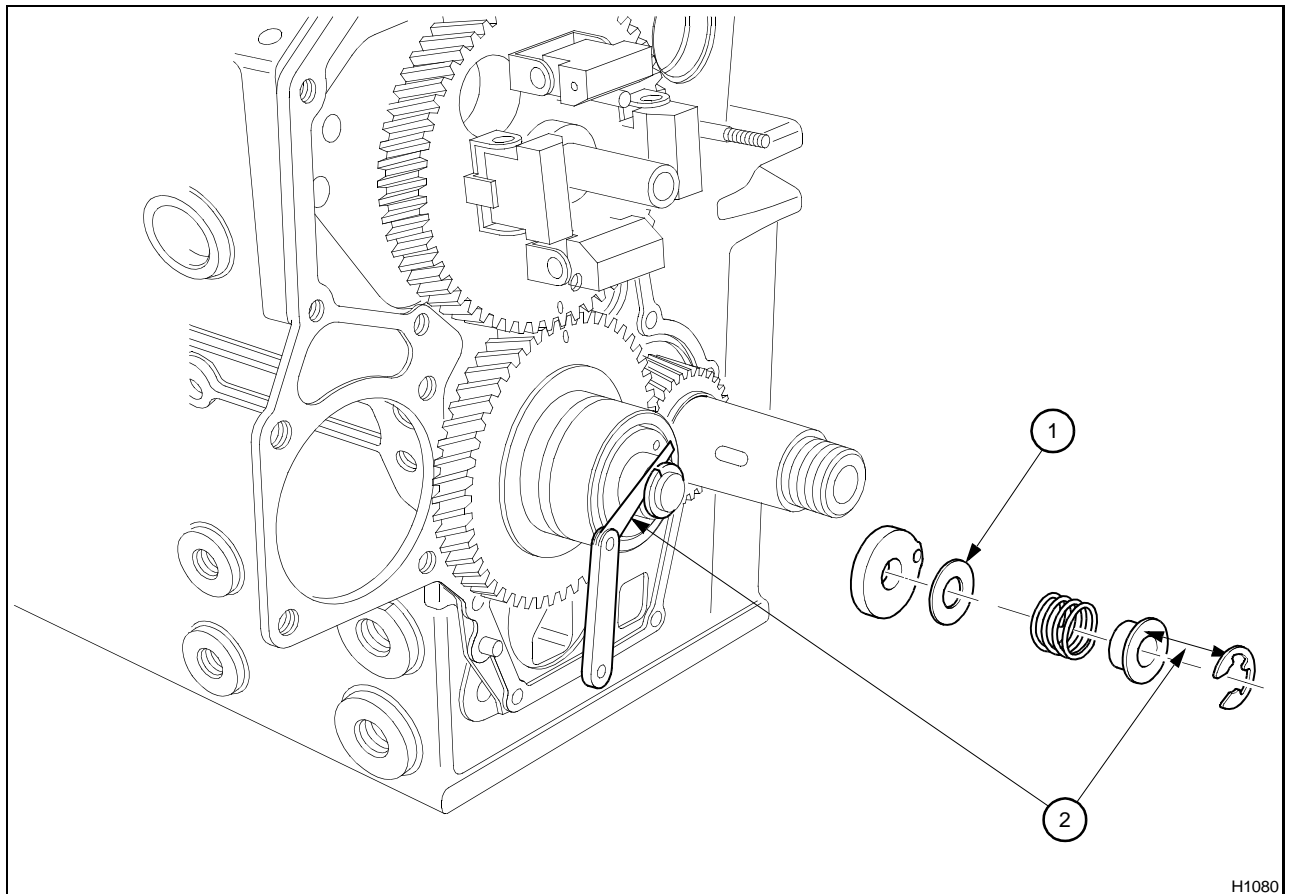
To check and adjust

Operation 6-13

Use a feeler gauge to check the oil pump end float (2).

Adjust with 0,1 - 0,15 - 0,2 and 0,5 mm shims (1).

Engine	Standard clearance mm (in)	Service limit mm (in)
All models	0,10 - 0,15 (0.0040 - 0.0060)	0,20 (0.0079)



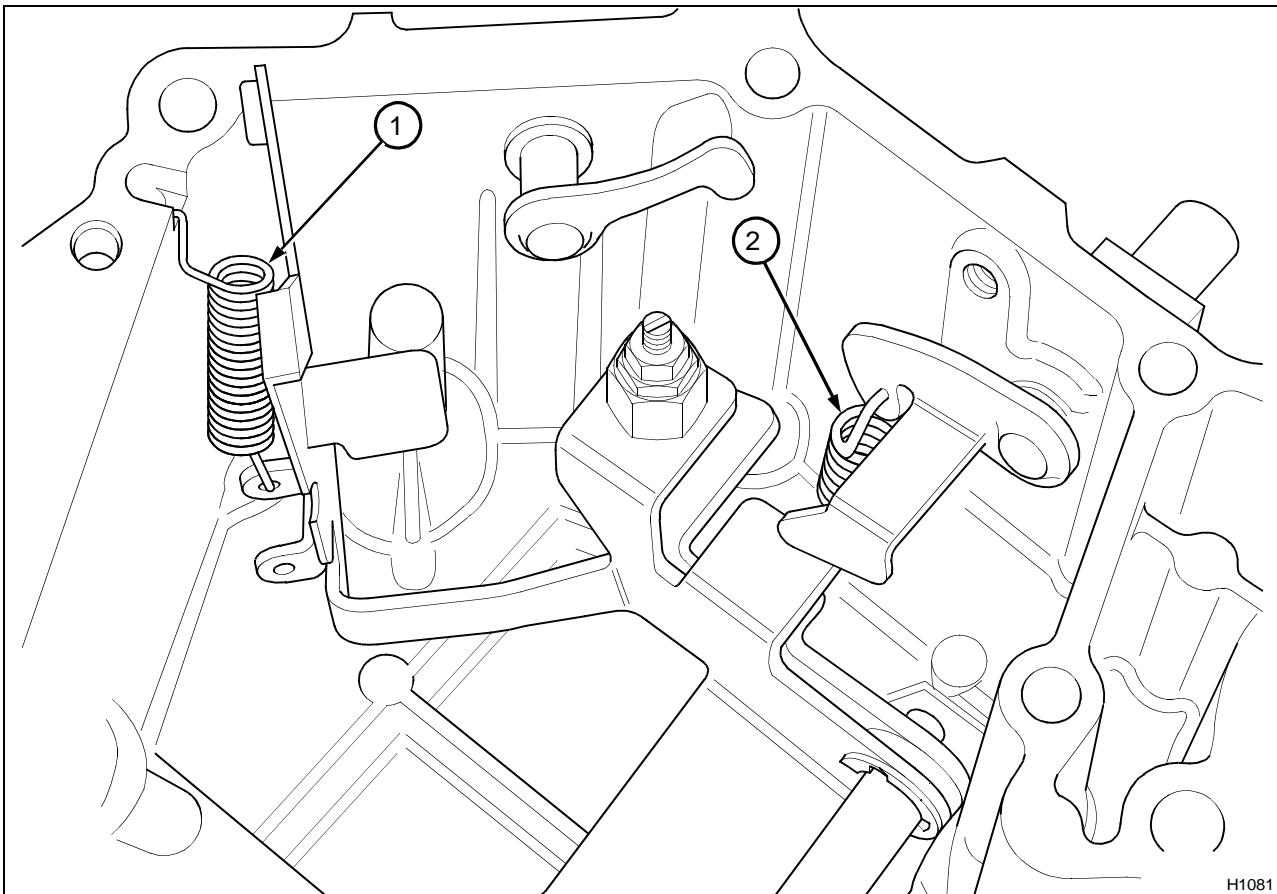
H1080

Governor springs

To inspect

Operation 6-14

The diagram shows the correct position for the start spring (1) and the governor spring (2).



H1081

7

Cylinder block assembly

Front crankshaft bush

To remove and to fit

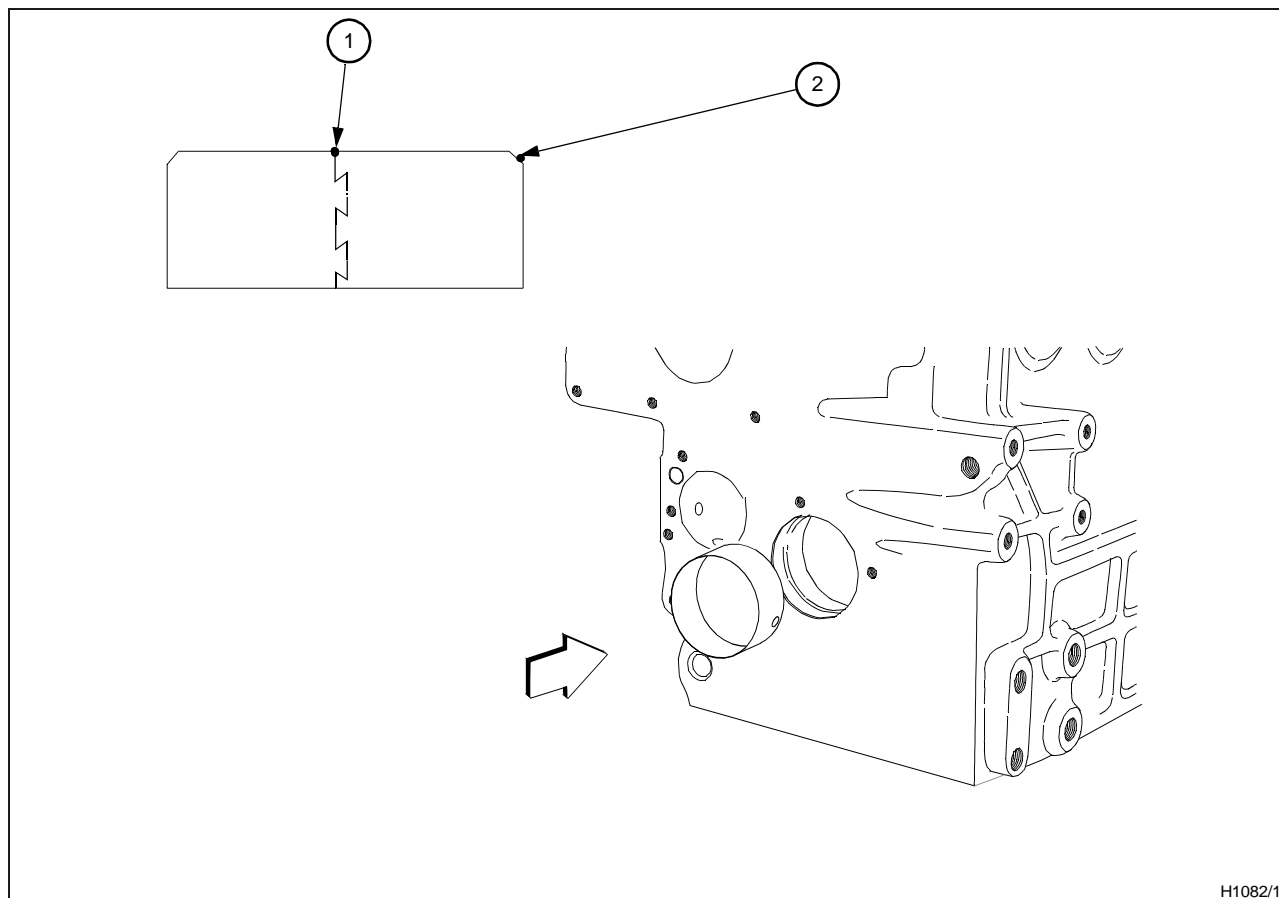
Operation 7-1

Caution: Ensure that the lubrication oil hole in the bush, aligns with the oil gallery in the block.

To remove the bush use a suitable drift and hammer from the inside of the block.

Use a suitable press to fit the crankshaft bush.

Note: The bush must be fitted with the chamfered side (2) towards the cylinder block, with the join (1) at the top.



H1082/1

To inspect

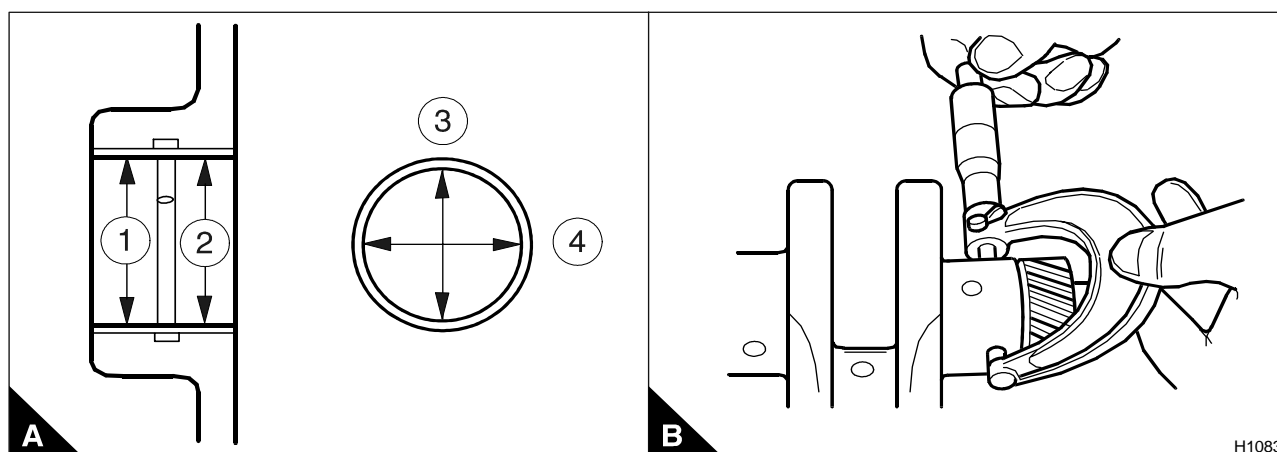
Operation 7-2

- 1 Check the bush for damage, wear and contact. If damaged, worn or poor contact renew the bush.
- 2 Using a cylinder gauge and a micrometer, measure the bush (A) and the crankshaft journal (B) to calculate the clearance.
- 3 Measure the inside diameters at positions (A1) and (A2) at each position measure in both directions (A3) and (A4) as shown. The oil clearance is the difference between the larger value and the maximum crankshaft journal diameter.

Engine	Standard oil clearance	Service limit
403C-11	0,039 - 0,106 mm (0.00150 - 0.00420 in)	0,20 mm (0.0078 in)
403C-15 404C-22 404C-22T	0,044 - 0,116 mm (0.00173 - 0.00456 in)	0,20 mm (0.0078 in)

- 4 If the oil clearance exceeds the service limit, renew the bush, or regrind the crankshaft journal and use an undersize bush.

	Bush size	Crankshaft journal O.D finished size
403C-11	Standard	47,964 - 47,975 mm (1.88830 - 1.88880 in)
	0,25 mm (0.01 in)	47,714 - 47,725 mm (1.87850 - 1.87890 in)
	0,50 mm (0.02 in)	47,464 - 47,475 mm (1.86870 - 1.86910 in)
403C-15 404C-22 404C-22T	Standard	67,957 - 67,970 mm (2.67550 - 2.67597 in)
	0,25 mm (0.01 in)	67,707 - 67,720 mm (2.66563 - 2.66614 in)
	0,50 mm (0.02 in)	67,457 - 67,470 mm (2.65579 - 2.65630 in)



H1083

Cylinder block top face

To inspect

Operation 7-3

Inspect the cylinder block top face for cracks, damage and warping in the same way as for the cylinder head, see Operation 3-16.

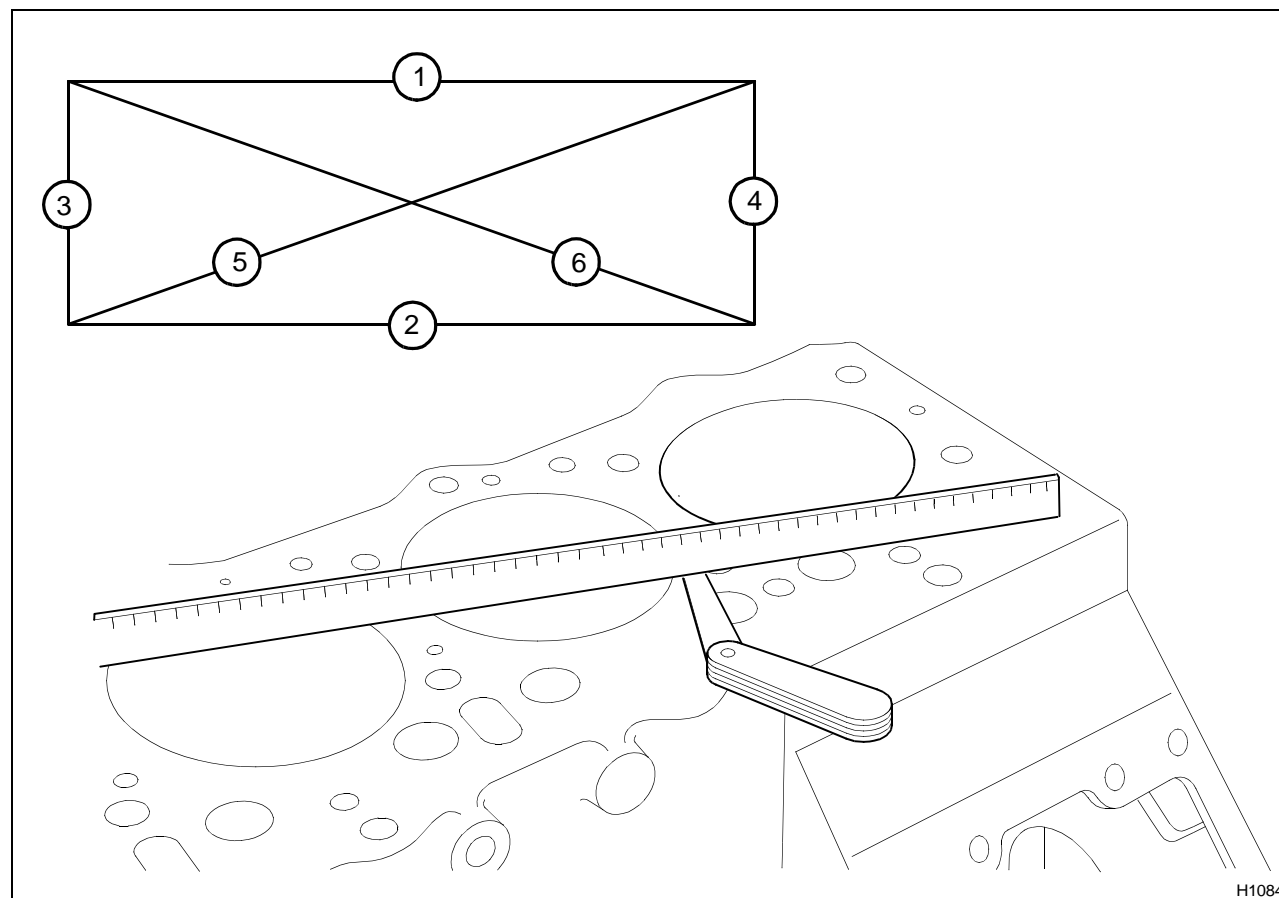
If outside service limit, renew the cylinder block.

Caution: The fuel adjustment screw must be set by an approved Perkins dealer to ensure that the engine will comply with emissions legislation.

If the cylinder block is renewed, the engine must be tested on an engine test brake and the fuel adjustment screw set.

If a suitable engine test brake is not available, a long engine is available as a service part.

Engine	Standard value	Service limit
All models	Less than 0,05 mm (0.002 in)	0,12 mm (0.005 in)



H1084

Cylinder bore

To inspect

Operation 7-4

- 1 Visually inspect cylinder bore. There should be no scoring or corrosion.
- 2 Measure the cylinder bore using a cylinder gauge at the upper, middle and lower areas (piston ring contact area) in the direction of the crankshaft (1) and at the right angle to the crankshaft (2).
- 3 The upper area in the cylinder block is where the top ring is in contact with the cylinder bore when the piston is at T.D.C. (approximately 10 mm below the cylinder block top face). The lower area is where the oil control ring is in contact with the cylinder bore when the piston is at B. D. C. (about 100 mm from the top face).

Caution: The 400 Series range of engines must not be flexi honed.

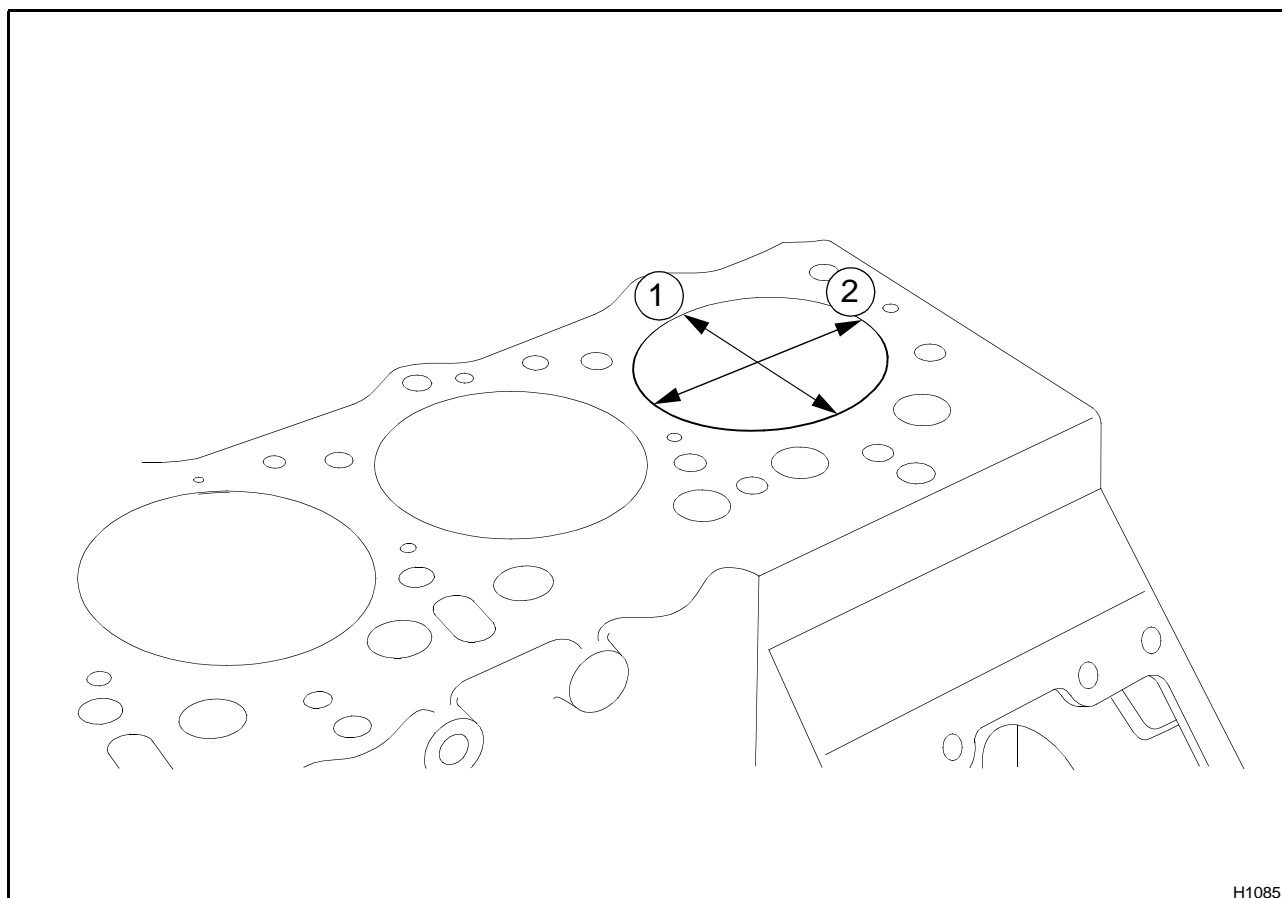
If the bore diameter is larger than the service limit for the engine model listed below, renew the cylinder block with a long engine.

Caution: The fuel adjustment screw must be set by an approved Perkins dealer to ensure that the engine will comply with emissions legislation.

If the cylinder block is renewed, the engine should be tested on an engine test brake and the fuel adjustment screw set.

If a suitable engine test brake is not available, a long engine is available as a service part.

Engine	Bore diameter new cylinder block	Service limit
403C-11	77,000 - 77,019 mm (3.03100 - 3.03200 in)	77,200 mm (3.03900 in)
403C-15 404C-22 404C-22T	84,000 - 84,019 mm (3.30710 - 3.30783 in)	84,200 mm (3.31500 in)



H1085

8

Engine timing

Injection timing

Operation 8-1

Engine	Maximum rated engine speed rev/min	Injection timing (BTDC)
403C-11 Gen-set	1500	18° ± 1°
403C-11 Gen-set	1800	18° ± 1°
403C-11 Gen-set	3000	23° ± 1°
403C-11 Gen-set	3600	22° ± 1°
403C-11 Industrial	2200	23° ± 1°
403C-11 Industrial	2400	23° ± 1°
403C-11 Industrial	2600	23° ± 1°
403C-11 Industrial	2800	23° ± 1°
403C-11 Industrial	3000	23° ± 1°
403C-15 Gen-set	1500	14° ± 1°
403C-15 Gen-set	1800	14° ± 1°
403C-15 Gen-set	3000	20° ± 1°
403C-15 Gen-set	3600	20° ± 1°
403C-15 Industrial	2200	22° ± 1°
403C-15 Industrial	2400	22° ± 1°
403C-15 Industrial	2600	22° ± 1°
403C-15 Industrial	2800	20° ± 1°
403C-15 Industrial	3000	20° ± 1°
404C-22 Gen-set	1500	12° ± 1°
404C-22 Gen-set	1800	12° ± 1°
404C-22 Gen-set	3000	18° ± 1°
404C-22 Industrial	2200	18° ± 1°
404C-22 Industrial	2400	18° ± 1°
404C-22 Industrial	2600	20° ± 1°
404C-22 Industrial	2800	20° ± 1°
404C-22 Industrial	3000	20° ± 1°
404C-22T Industrial	2800	18° ± 1°

If the fuel injection pump is replaced or renewed, the same shim thickness as originally fitted should be used. The fuel adjustment screw must not be adjusted from the original setting. The maximum no load speed must be checked after assembly.

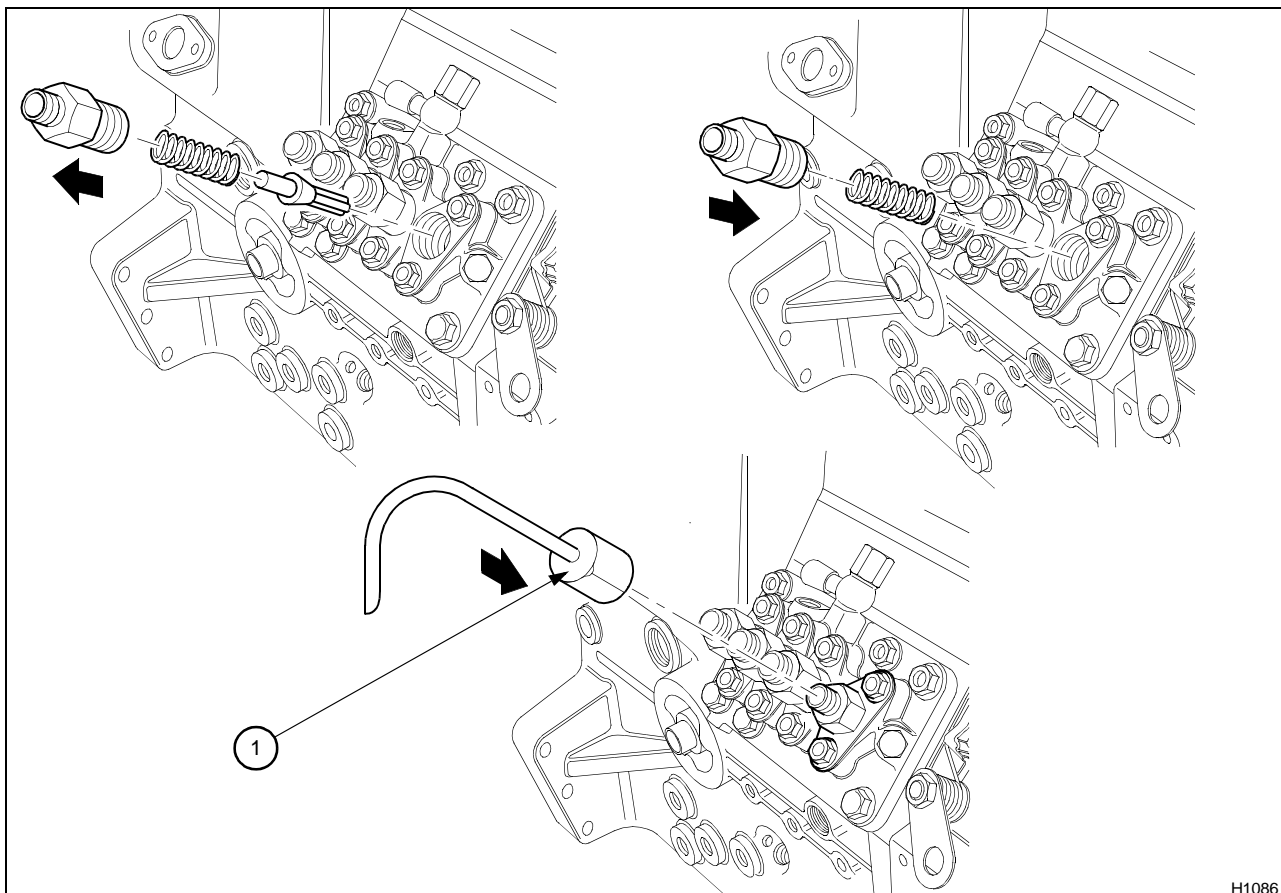
No service parts are available for the 400 Series fuel injection pump.

To check the timing of the fuel injection pump

Operation 8-2

Engine	Special tools	Part number
All models	Spill pipe	21825680

- 1 Set the piston for number one cylinder to TDC on the compression stroke. Turn the crankshaft counter clockwise a quarter of a revolution.
 - 2 Remove the ESOS, high pressure fuel pipes and low pressure fuel pipes from the fuel injection pump.
 - 3 Ensure that the fuel pump rack is in the maximum fuel position.
 - 4 Remove the delivery valve holder for number 1 cylinder and remove the delivery valve. Store the delivery valve in clean fuel until assembly.
- Note:** The fuel pump may have to be removed to an upright position to remove and to fit the delivery valves.
- 5 Connect the fuel pump spill pipe (1) to the delivery valve holder for number 1 cylinder.

Continued

H1086

6 Connect a suitable clean fuel reservoir (1), which has a tap and contains approximately 0,2 litres (¼ pint) of clean fuel, to the fuel injection pump inlet.

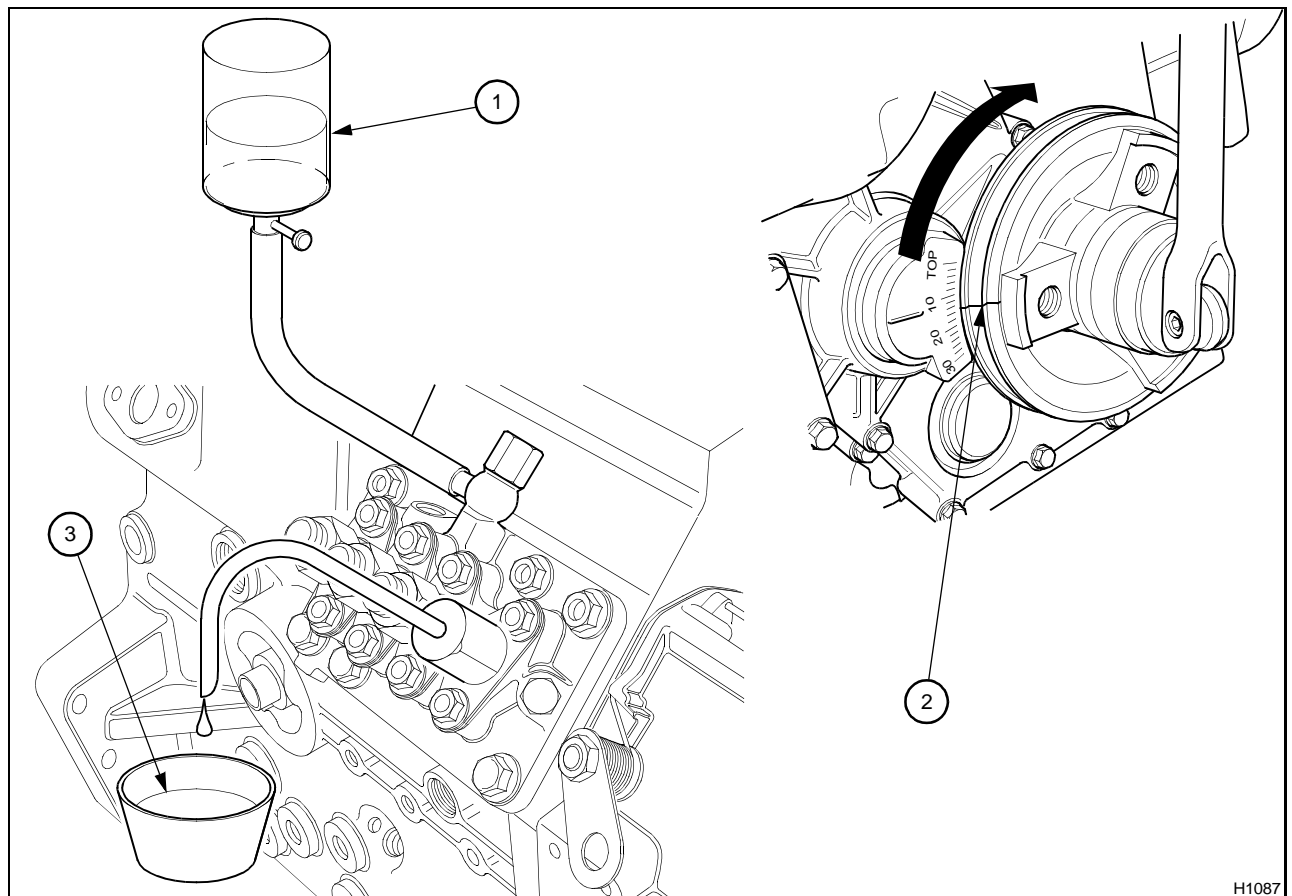
7 Put a suitable waste fuel (3) container below the pipe neck and open the tap, if set correctly the fuel should flow.

Note: The fuel reservoir should be approximately 152 mm (6 in) above the fuel injection pump.

8 Turn the crankshaft slowly until the fuel flow reduces to a drop which falls every 7 - 10 seconds. This is then the timing point.

9 Use the value shown by the timing mark (2) with the injection timing tables on page 69.

Continued



H1087

10 If the engine timing is incorrect adjust the thickness of the fuel injection pump shim.

Note: Changing the fuel injection pump shim by 0,1 mm will change the timing by approximately one degree. Thicker shims will retard the timing and thinner shims will advance the timing.

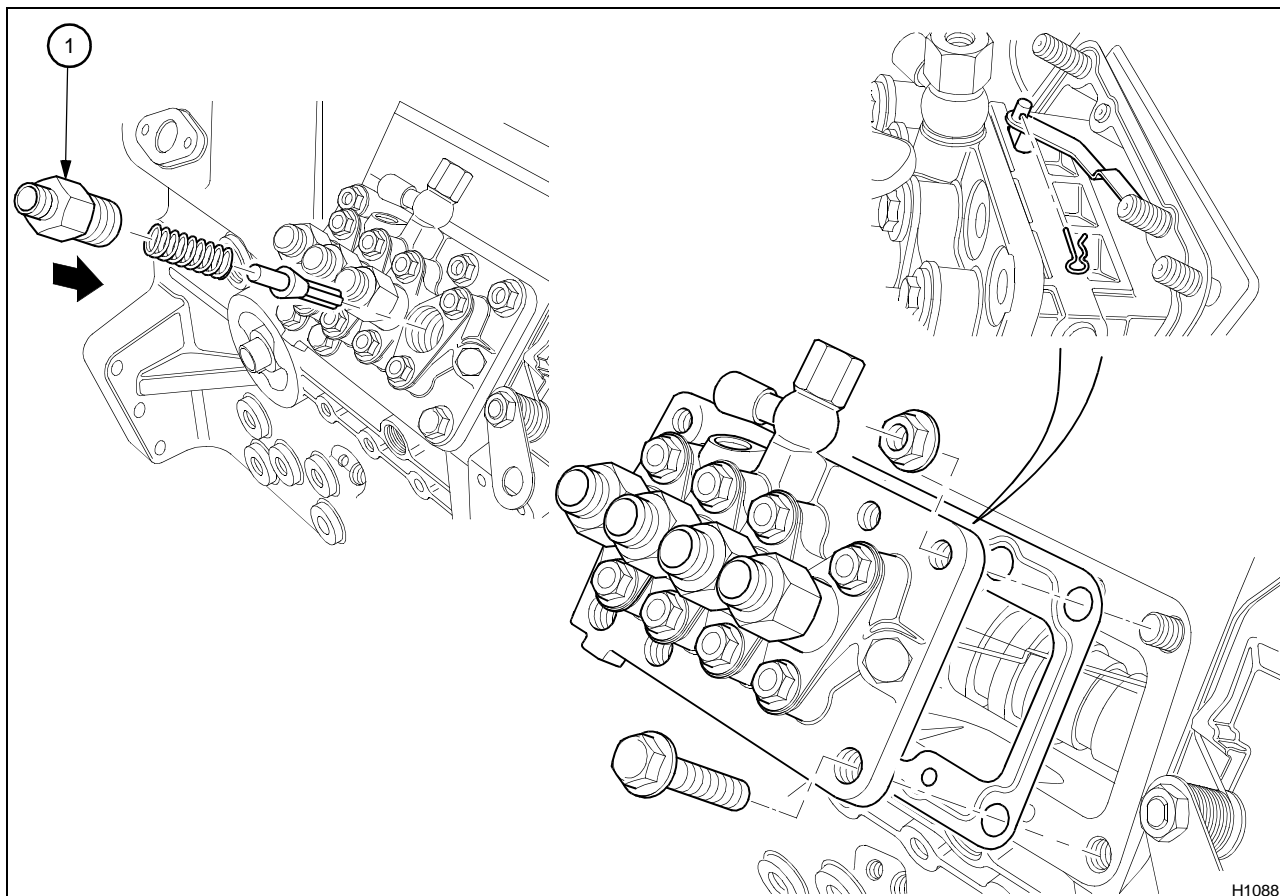
11 Fit the delivery valve (1) and tighten the delivery valve holder.

Caution: The maximum no load speed must be set by an approved Perkins distributor.

12 The engine must be tested on an engine test brake to check the maximum no load speed and engine settings after assembly.

Note: There are no service parts available for the 400 Series fuel injection pump.

Engine	Torque Nm (lbf ft) kgf m	
All models	Delivery valve holder	42 (31.0) 4,2



9

Aspiration system

Breather system

Closed circuit, naturally aspirated - to clean and to renew

Operation 9-1

To clean the engine breather assembly

The breather assembly should be renewed every 2000 hours.

Caution: Ensure that the components of the breather assembly are fitted in their correct position (1 - 6). If they are incorrectly fitted, the engine may be damaged.

1 Release the four setscrews (2) and remove the breather cover (1), the spring (6) and the diaphragm assembly (4).

Caution: It is important that the area around the vent hole (3) is clean.

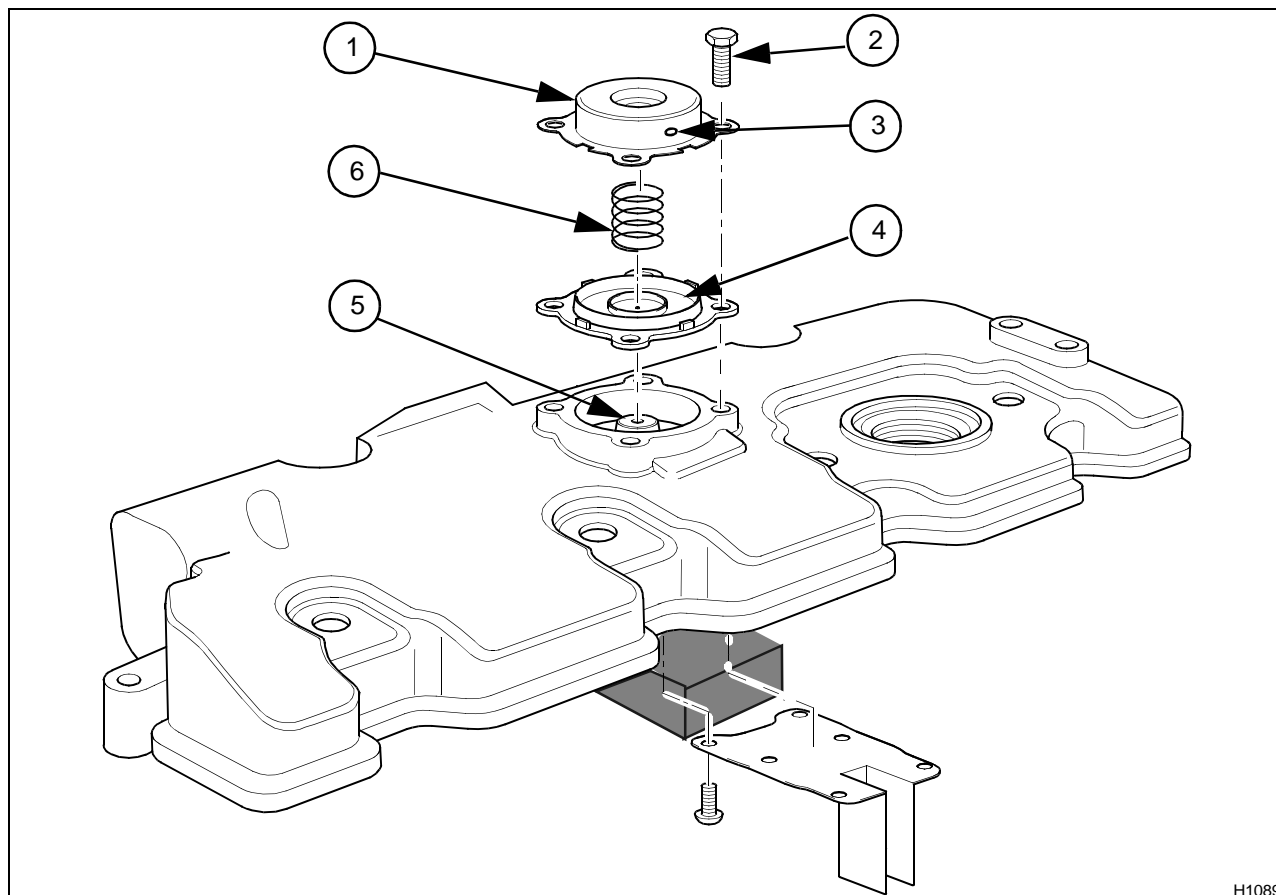
2 Clean the breather cavity (5) in the rocker cover.

3 Clean the breather in clean diesel fuel

4 Fit the breather assembly into the cavity in the rocker cover, ensuring that the breather cover, diaphragm and spring are assembled correctly and that the vent hole (3) faces towards the flywheel.

Tighten the four setscrews.

Clean the breather only with a clean diesel fuel. If the breather is damaged or the diaphragm perforated, renew the breather.



H1089

To clean the engine breather assembly

The breather assembly should be renewed every 2000 hours.

Caution: Ensure that the components of the breather assembly are fitted in their correct position (1 - 7). If they are incorrectly fitted, the engine may be damaged.

1 Release the four setscrews (2) and remove the breather cover (1), the spring (7), the diaphragm assembly (4) and the adaptor (6).

Caution: It is important that the area around the vent hole (3) is clean.

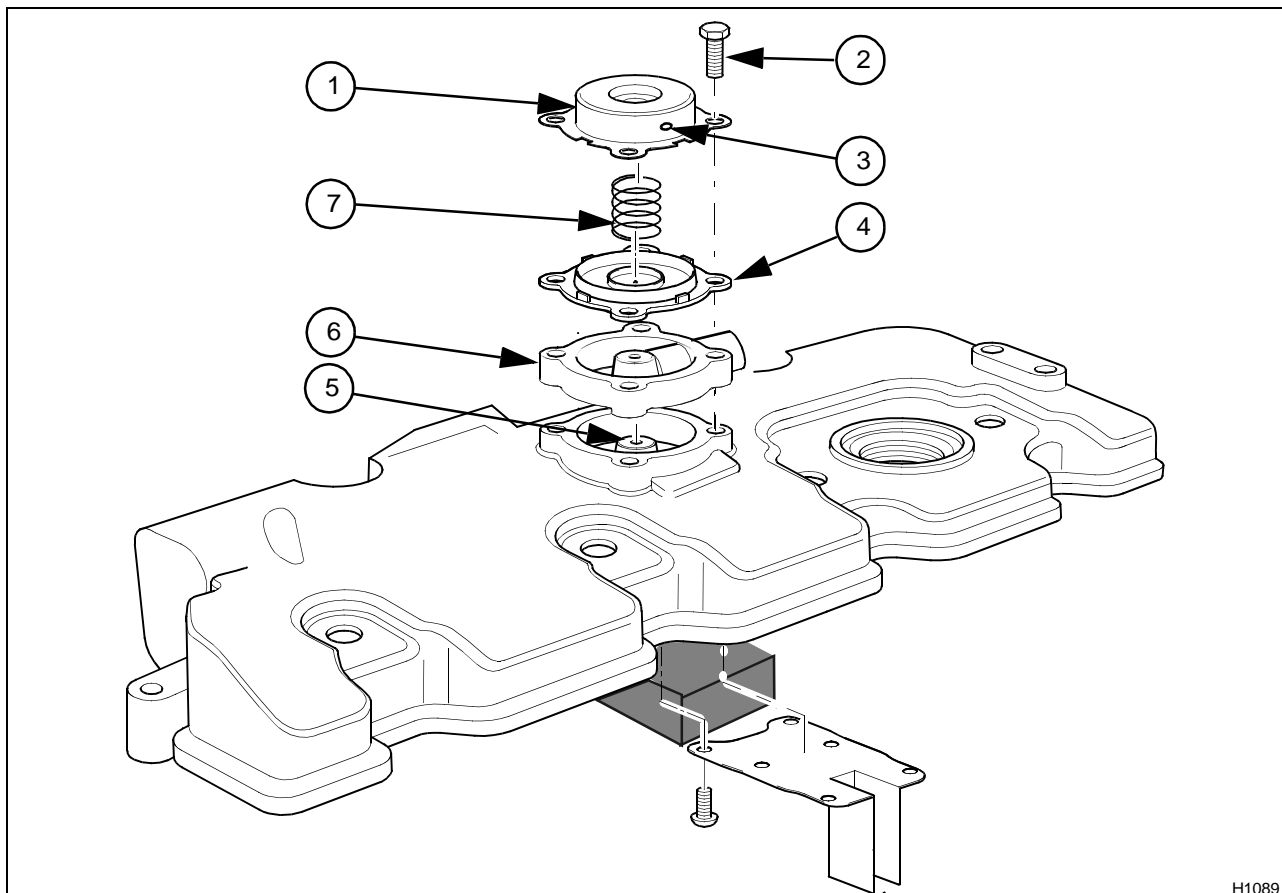
2 Clean the breather cavity (5) in the rocker cover.

3 Clean the breather in clean diesel fuel.

4 Fit the breather assembly into the cavity in the rocker cover, ensuring that the breather cover, diaphragm and spring are assembled correctly and that the vent hole (3) faces towards the flywheel.

Tighten the four setscrews.

Clean the breather only with a clean diesel fuel. If the breather is damaged or the diaphragm perforated, renew the breather.



H1089

Turbocharger

To remove and to fit

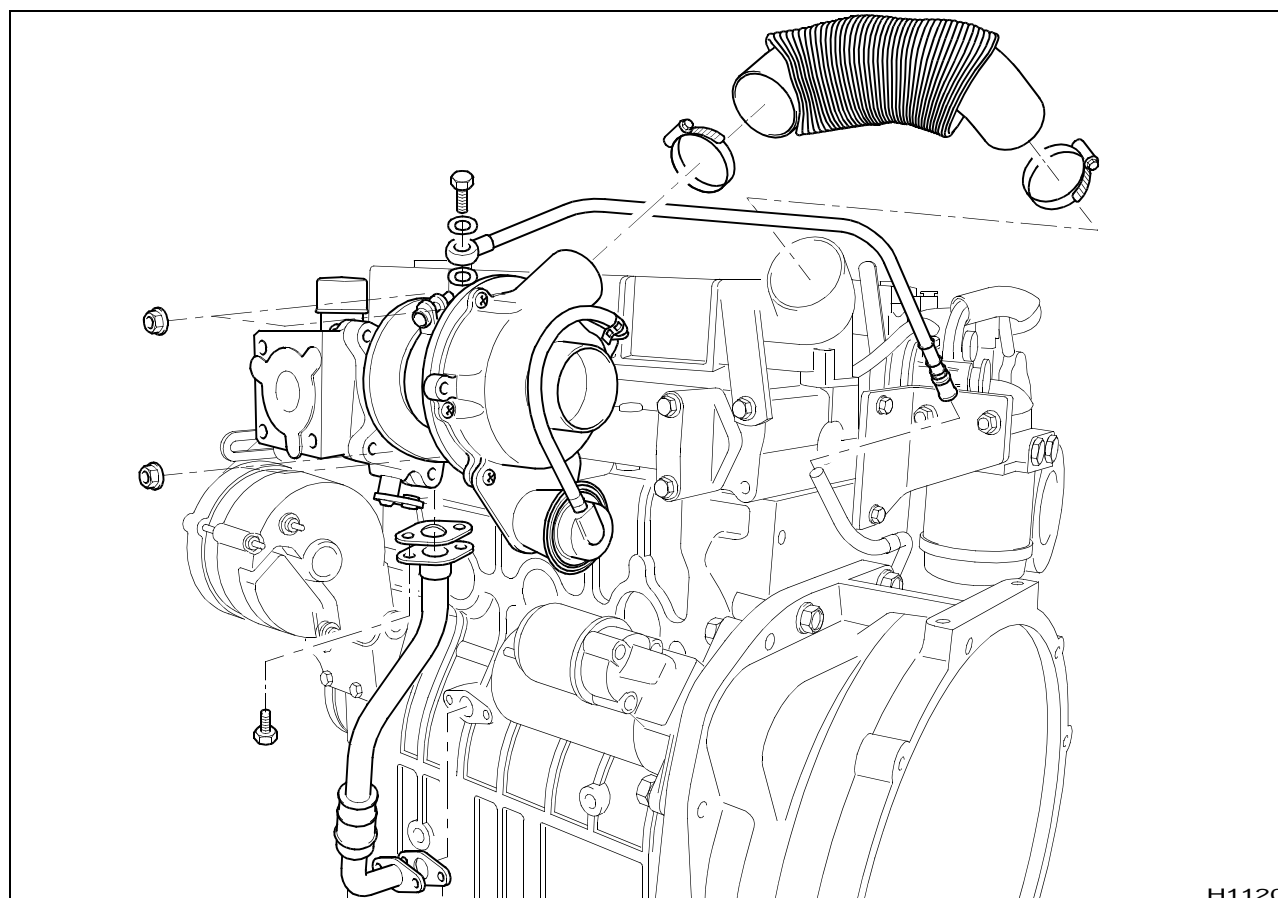
Operation 9-3

Engine	Torque Nm (lbf ft) kgf m	
404C-22T	Turbocharger to manifold nuts	25 (18.4) 2.5
	Elbow securing set screws	32,4 (23.9) 3,3
	Oil feed pipe banjo bolt to turbocharger	20 (14.8) 2,0
	Oil drain pipe set screws	10 (7.3) 1,0
	Oil feed pipe set screws to cylinder block	

The turbocharger is fitted only to the 404C-22T engine.

Caution: The bearing housing of the turbocharger must be lubricated with clean engine oil on assembly.

Note: There is an 'O' ring fitted between the oil feed pipe for the turbocharger and the cylinder block.



H1120

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10

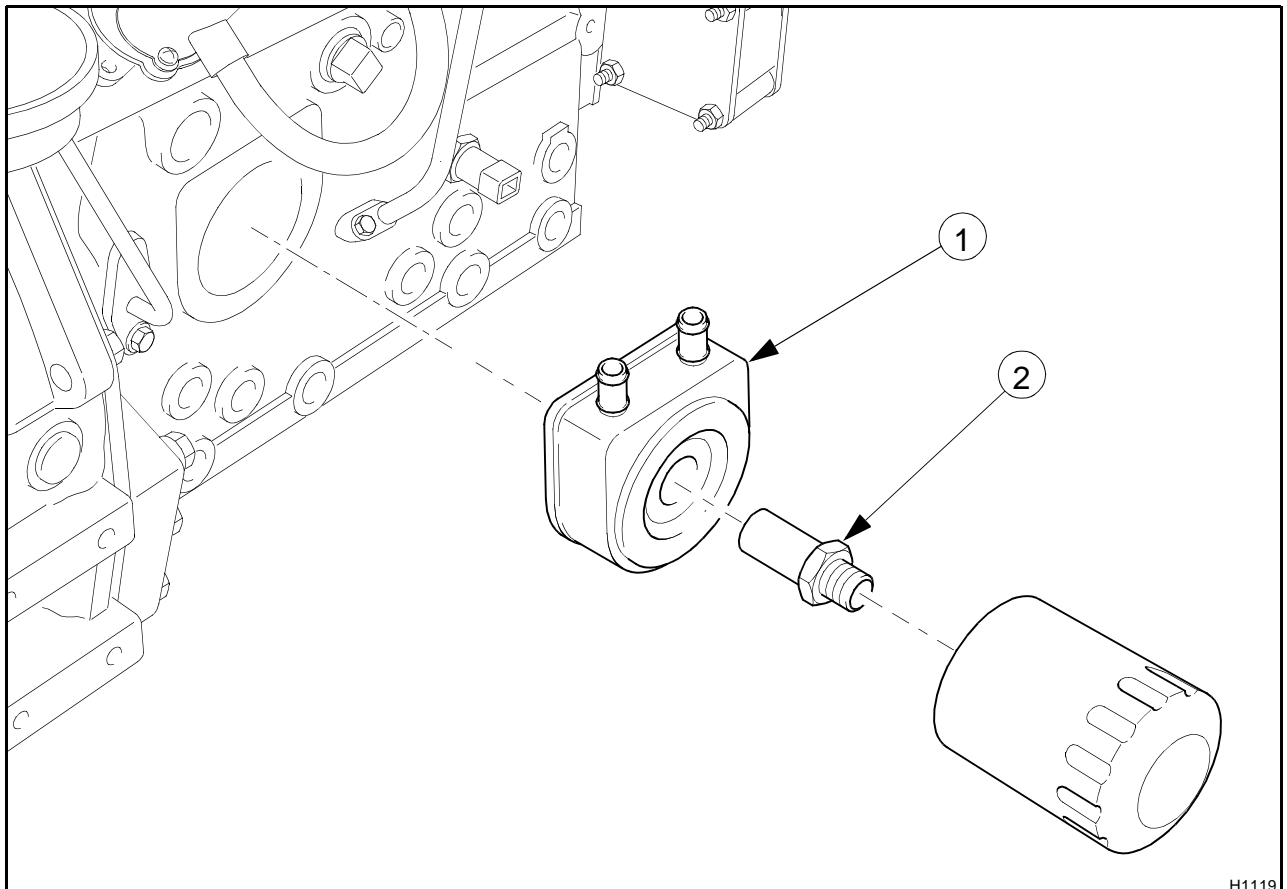
Lubrication system

Lubricating oil canister

To fit

Operation 10-1

- 1 Lubricate the seal with clean engine oil before assembly.
 - 2 Tighten by hand until the seal contacts the mounting face of the block.
 - 3 Tighten the canister by a further $\frac{1}{2}$ to $\frac{3}{4}$ of a turn by hand only.
- Note:** Do not overtighten oil filter.
- 4 The modine cooler (1) and fastener (2) are fitted only to the 404C-22T.



H1119

Pressure relief valve

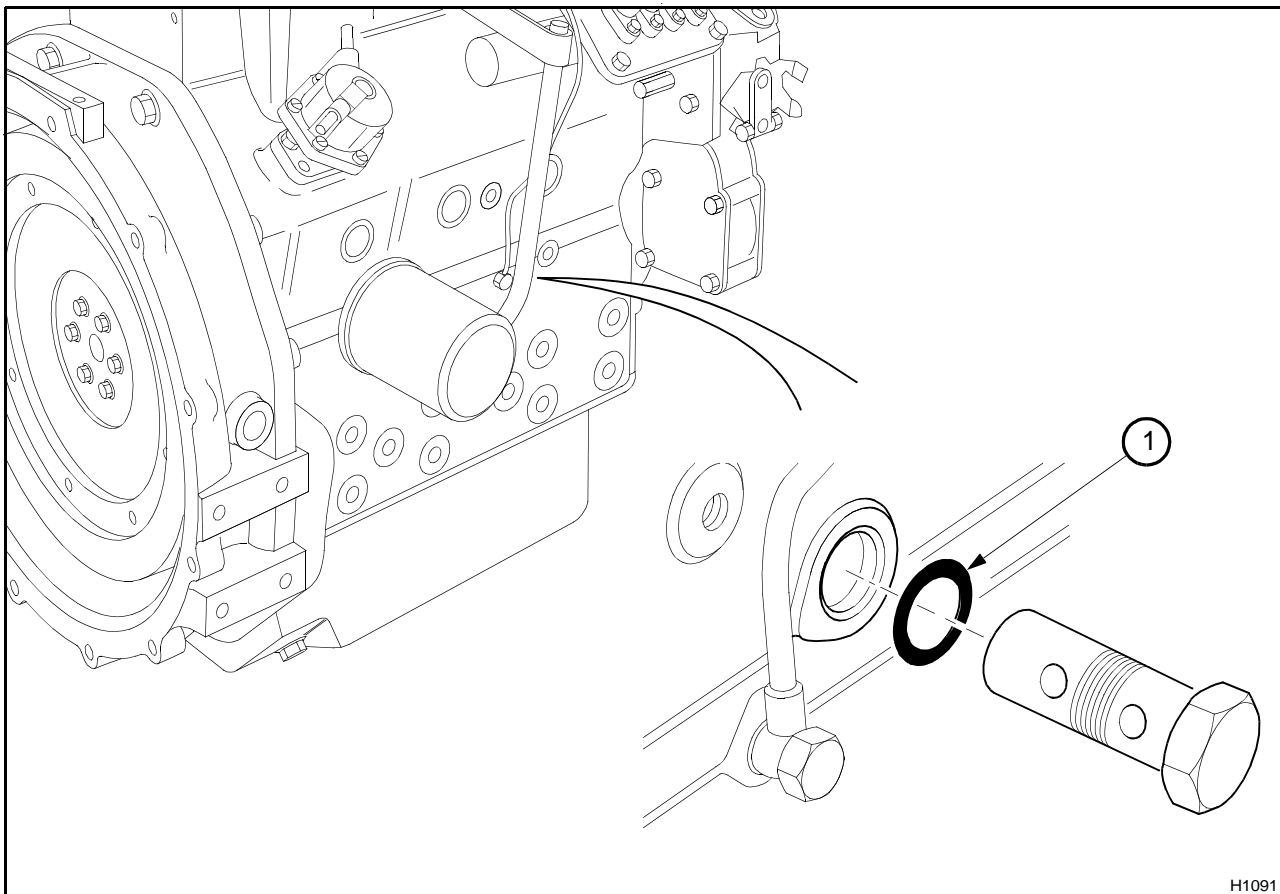
To remove and to fit

Operation 10-2

Engine	Torque Nm (lbf ft) kgf m	
All models	Pressure relief valve	64 (47) 6,5

Renew the 'O' ring (1) when the pressure relief valve is fitted to the cylinder block.

Caution: When the crankshaft is removed or fitted the pressure relief valve must be removed first.



H1091

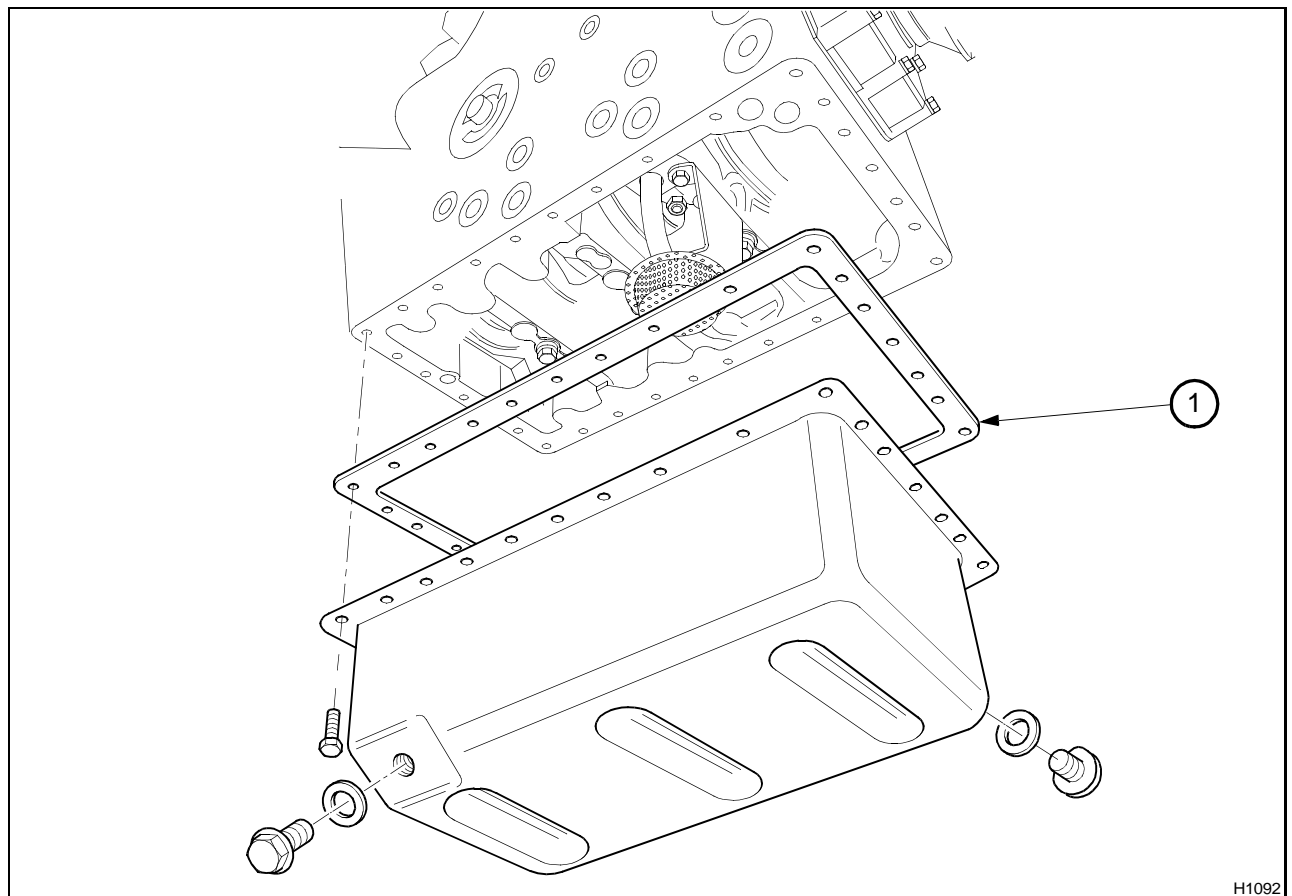
Lubricating oil sump

To remove and to fit

Operation 10-3

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Sump setscrews	6 (4.4) 0,6
	Sump drain plug	35 (25.8) 3,5
403C-15 404C-22 404C-22T	Sump setscrews	11 (8) 1,1
	Sump drain plug	35 (25.8) 3,5

Note: When the sump is fitted renew the joint (1).



H1092

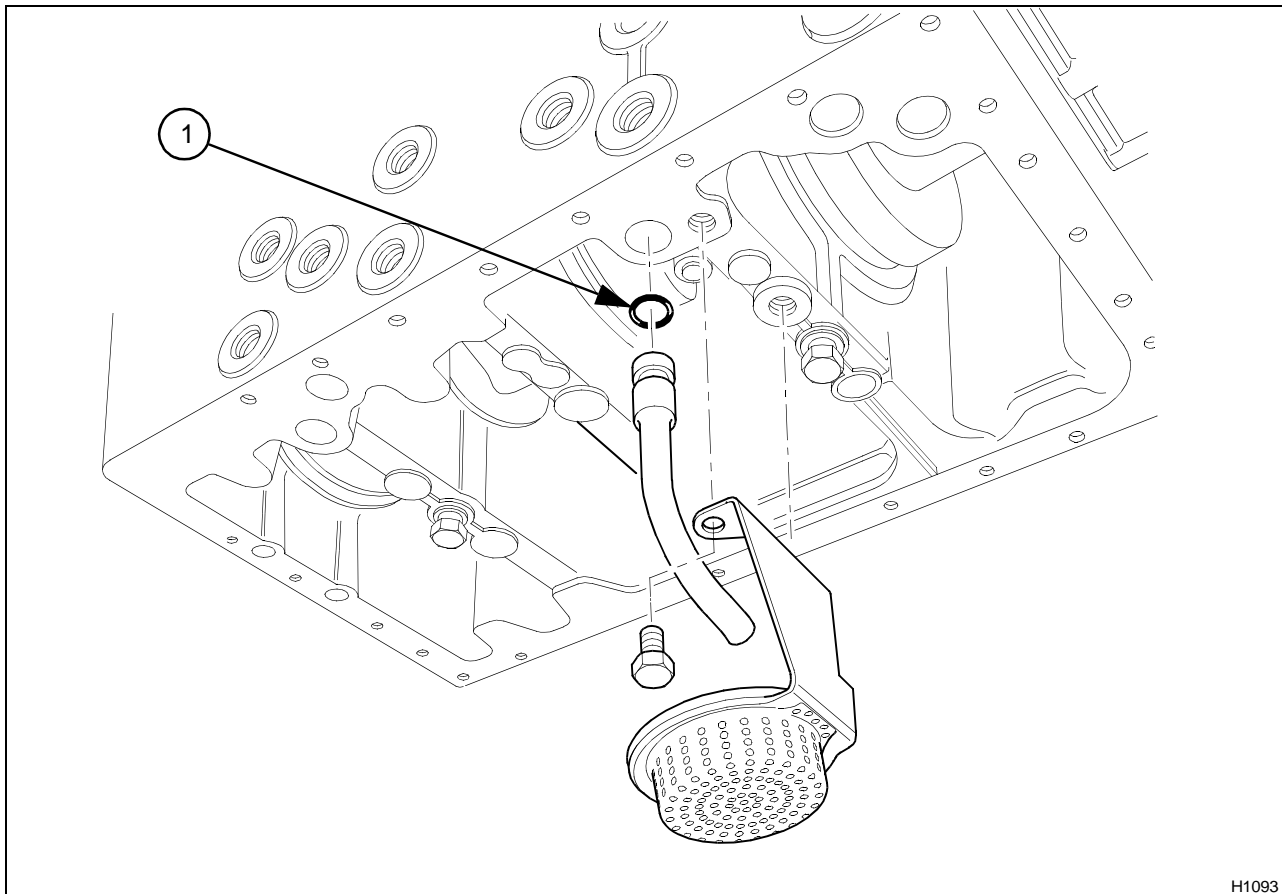
Lubricating oil strainer and suction pipe

To remove and to fit

Operation 10-4

Engine	Torque Nm (lbf ft) kgf m	
All models	Suction strainer setscrews	11 (8) 1,1

Renew the "O" ring (1) before the suction pipe is fitted.



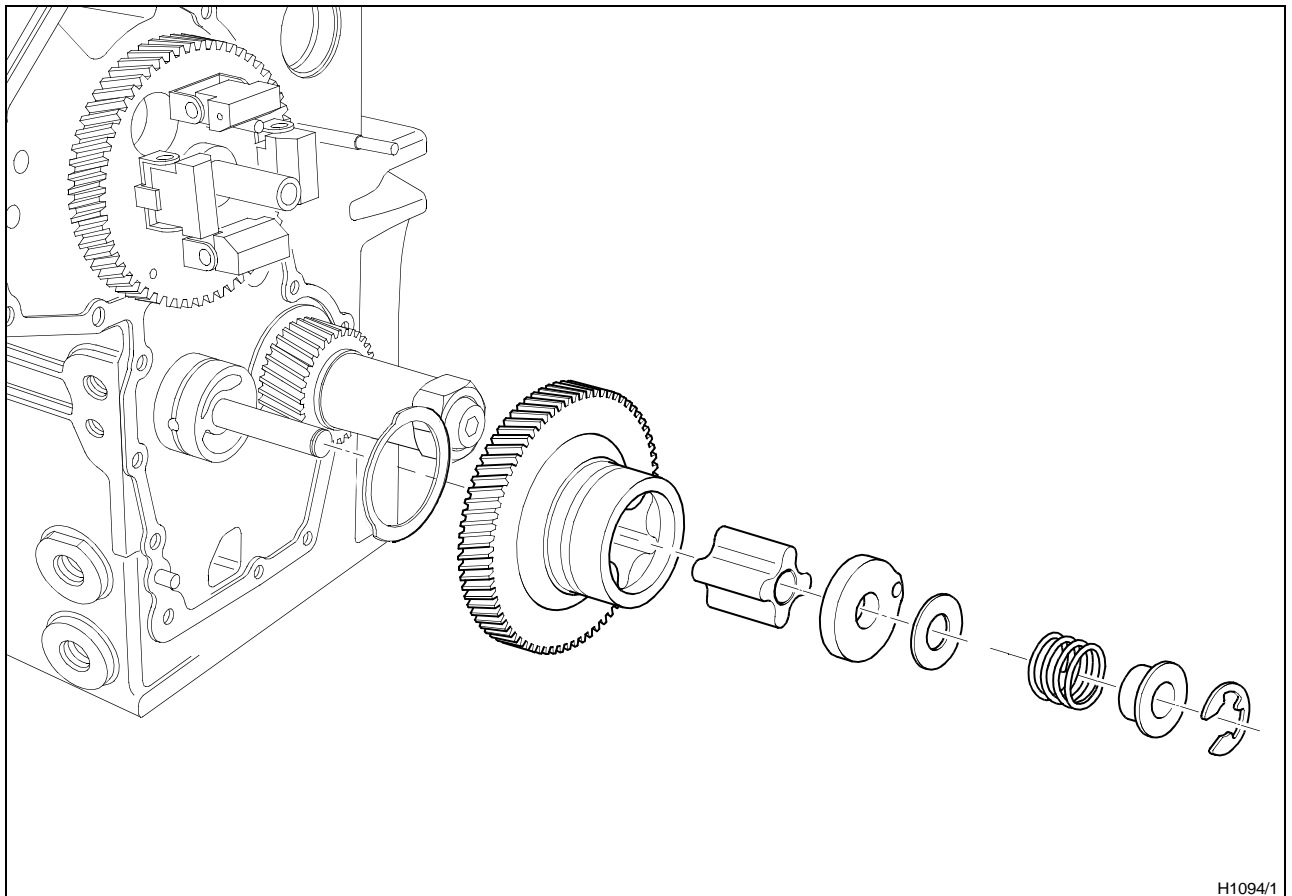
H1093

Lubricating oil pump

To remove and to fit

Operation 10-5

To check the end float, see Operation 6-13.



H1094/1

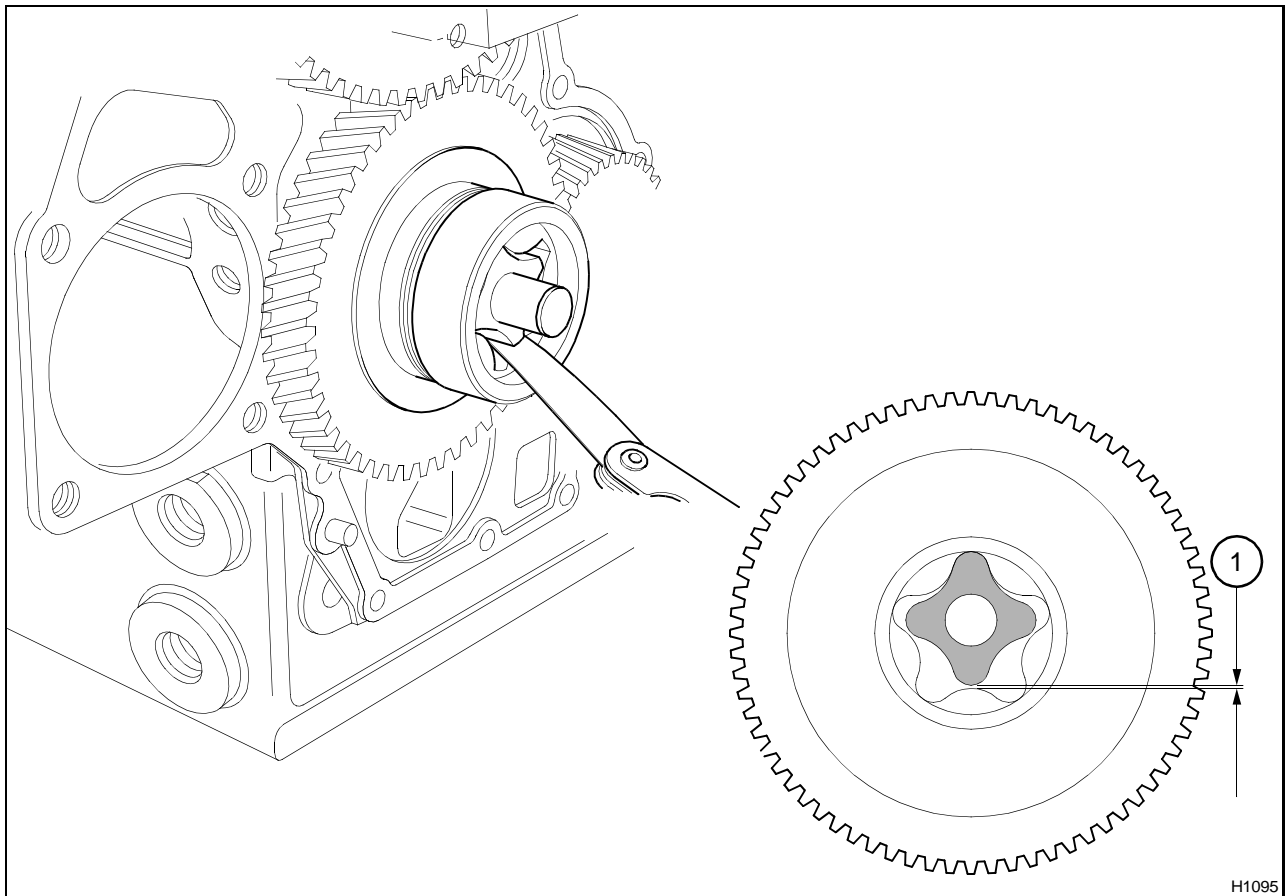
Rotor tip clearance

To inspect

Operation 10-6

Engine	Clearance standard limit	Service limit
All models	0,01 - 0,15 mm (0.0004 - 0.0060 in)	0,25 mm (0.0098 in)

Inner rotor to outer rotor (1).



H1095

Oil pressure switch

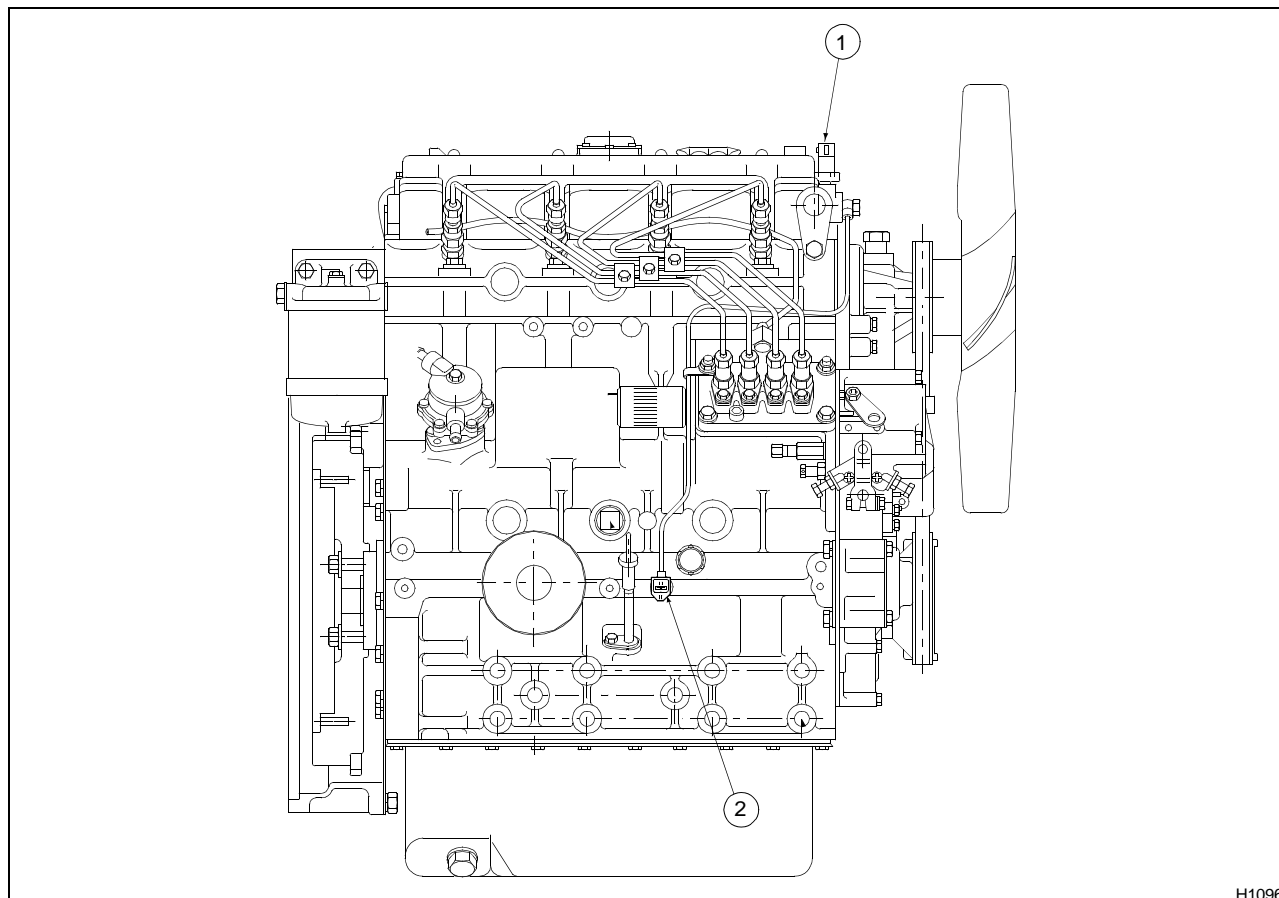
To remove and to fit

Operation 10-7

Engine	Torque Nm (lbf ft) kgf m	
All models	Oil pressure switch	10 (7.3) 1,0

The lubricating oil pressure switch can be found in two positions.

- 1 If fitted on the top cover, the switch (1) is brown in colour and rated to 0,3 kgf/cm² (4.27 lbf/in²).
- 2 If fitted on the cylinder block, the switch (2) is blue in colour and rated to 1,0 kgf/cm² (14.22 lbf/in²).



H1096

Lubricating oil pipes

To remove and to fit

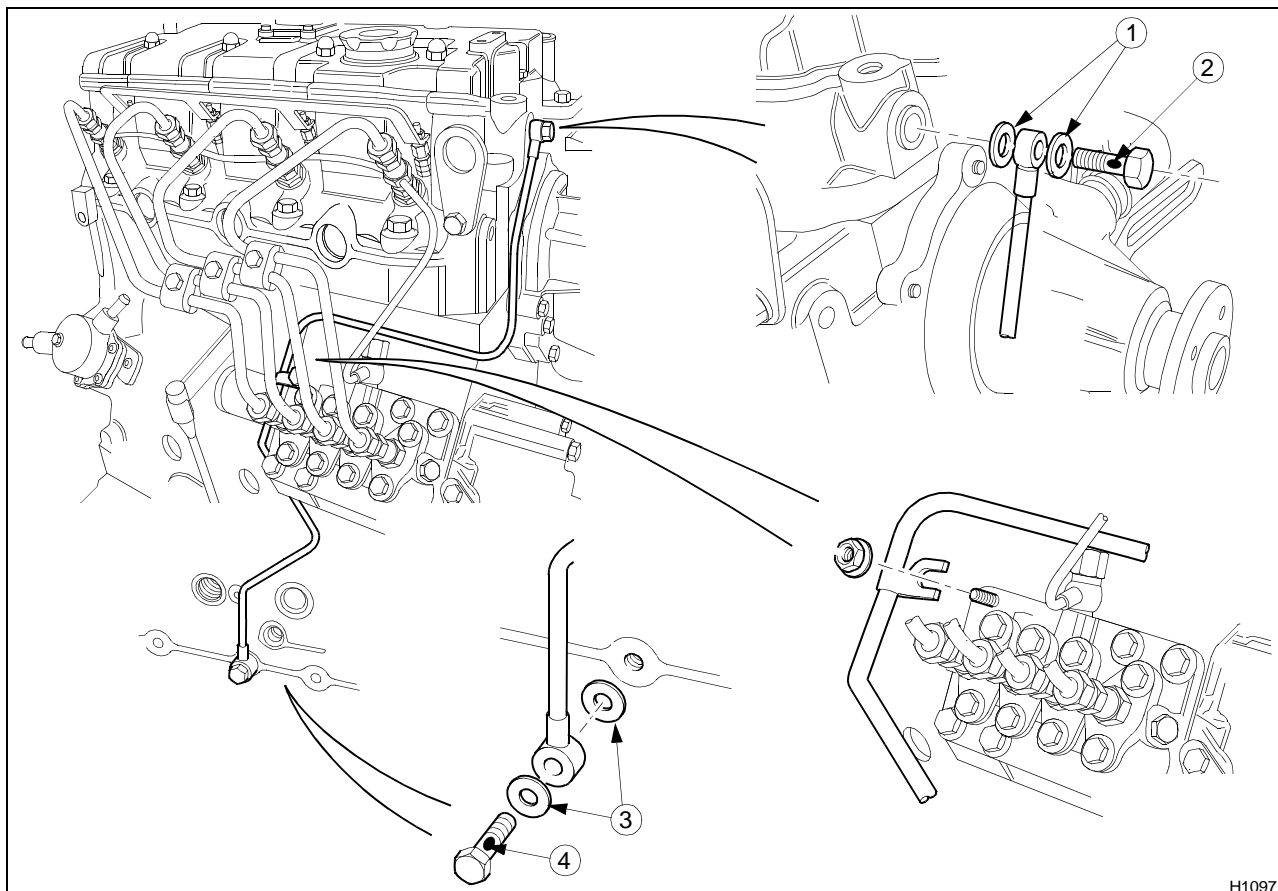
Operation 10-8

Engine	Torque Nm (lbf ft) kgf m	
All models	Banjo bolt	12 (8.8) 1,2

Note: The lubricating oil flow through the banjo bolt (2 and 4) is restricted.

Check the pipe for leaks and damage.

When fitting use new washers (1) and (3).



H1097

11

Fuel system

Atomisers

To remove and to fit

Operation 11-1

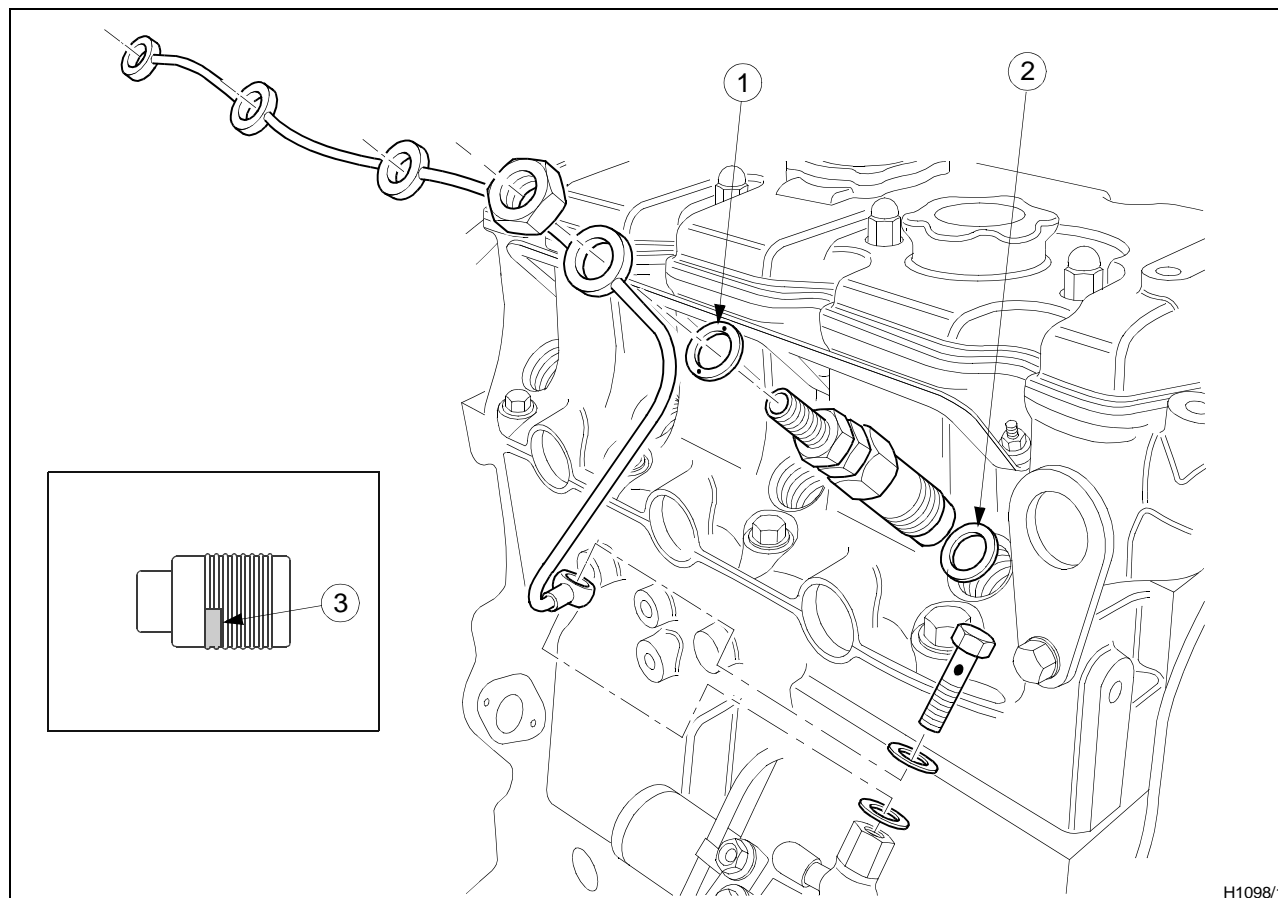
Engine	Torque Nm (lbf ft) kgf m		Test pressure kgf/cm ² (lbf/in ²) ats
All models	Atomiser	64 (47) 6,5	150 (2133) 145
	Atomiser high-pressure pipes	23 (16.9) 2,3	
	Nut - leak off-rail	27 (19.9) 2,7	

Cautions:

- Use only deep sockets for this operation.
- Connections should be blanked off until assembly.
- Washer (1) has two small holes 180° apart.
- Discard old washer (2), on assembly fit new nozzle washer.

Note: If the atomisers or injection pipes are replaced it is essential that the fuel adjustment screw is not altered from the original settings. The maximum no load speed must be checked after assembly.

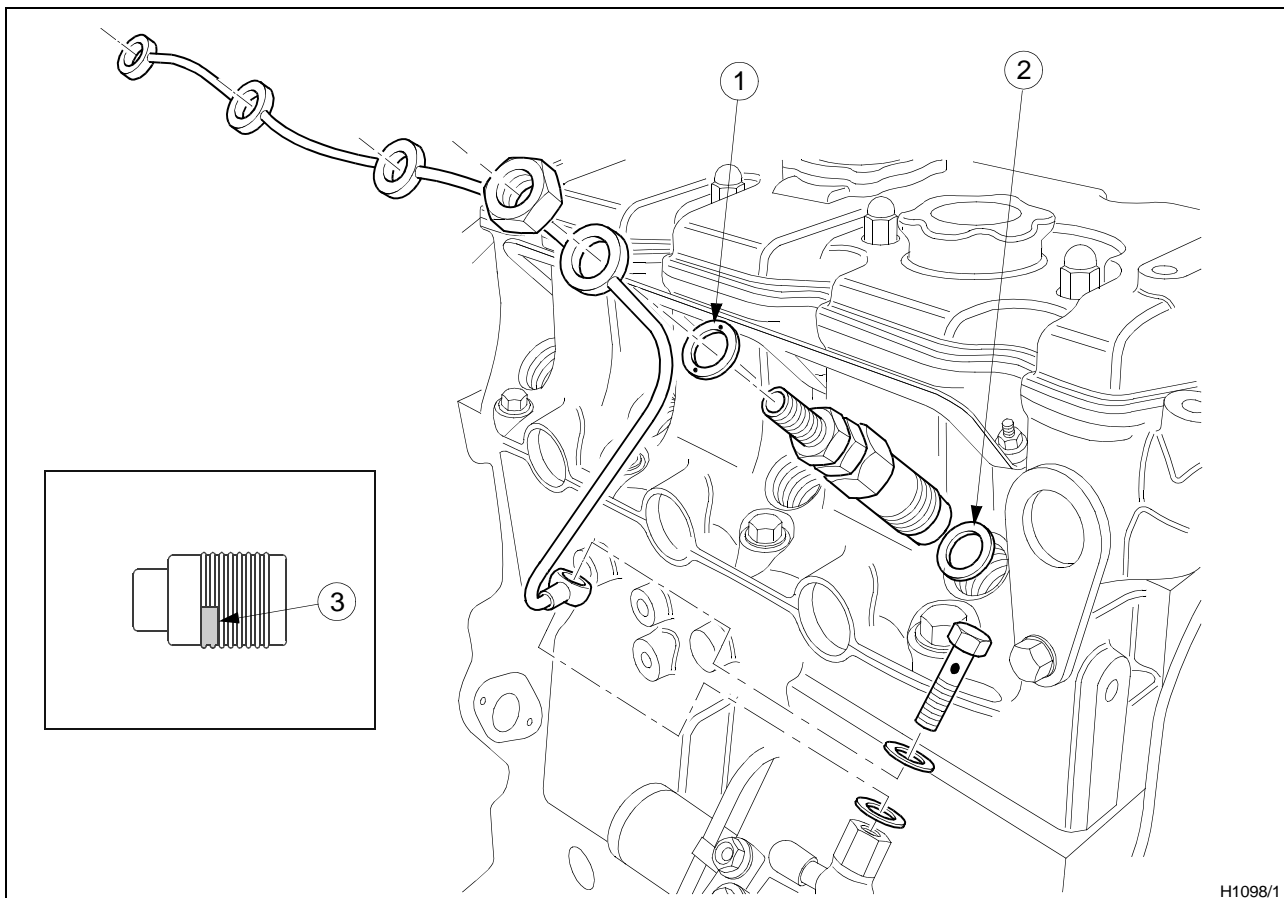
Continued



H1098/1

Before fitting the atomiser, clean and dry the male and female threads of the atomiser and the cylinder head.

Apply a 2 mm (0.08 in) bead of sealant POWERPART universal jointing compound, part number 1861117, to extend 6 mm (0.24 in) along the first two threads of the atomiser (3).



Fuel lift pump

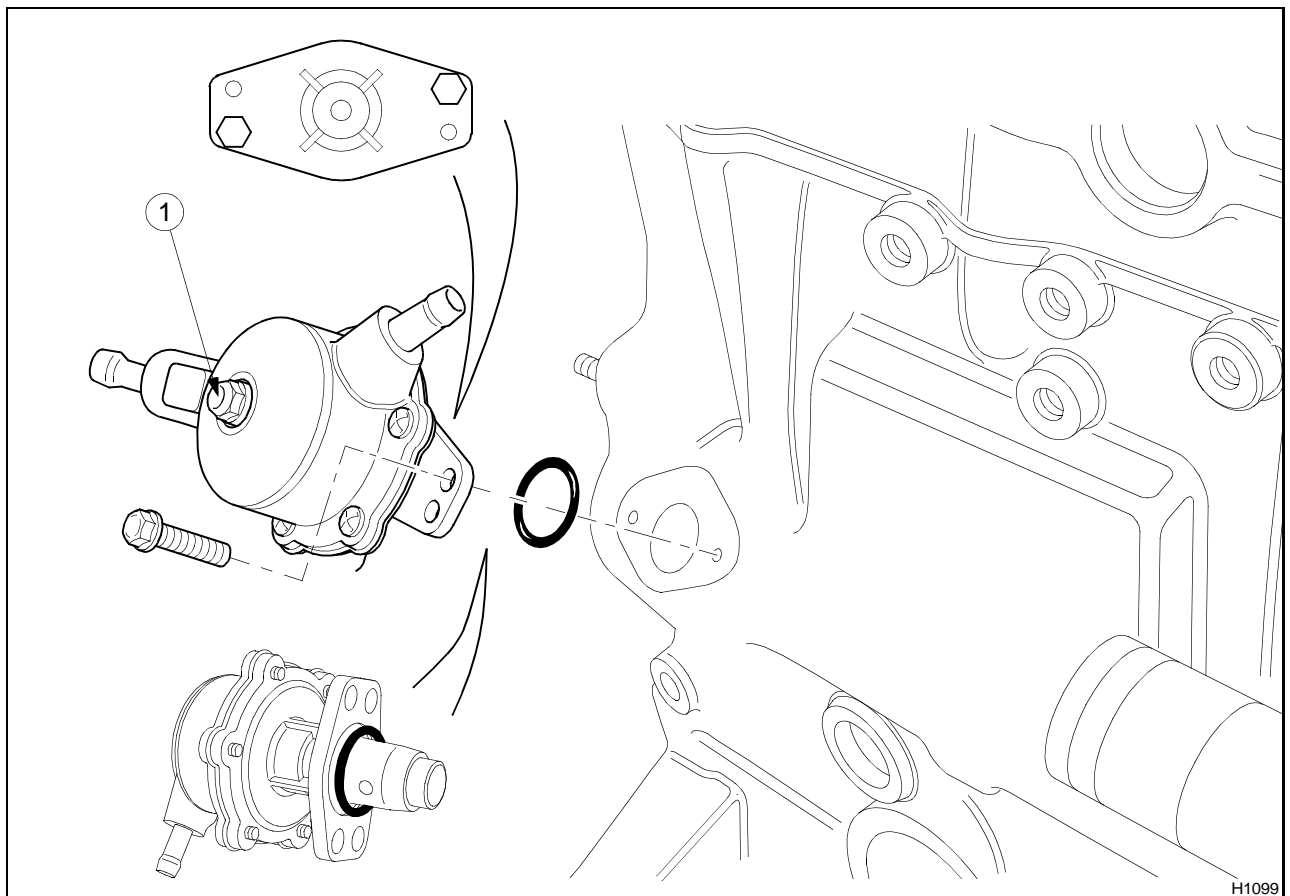
To remove and to fit

Operation 11-2

Engine	Torque Nm (lbf ft) kgf m	
All models	Lift pump setscrew	6 (4.4) 0,6
	Lift pump inlet adjusting bolt (1)	2,5 (1.8) 0,25

The fuel inlet for the fuel lift pump can rotate 360° and is adjustable in 15° increments.

The fuel lift pump flange has two sets of locating holes this allows the pump to be fitted in four positions for the outlet connection.



Fuel injection pump

To remove and to fit

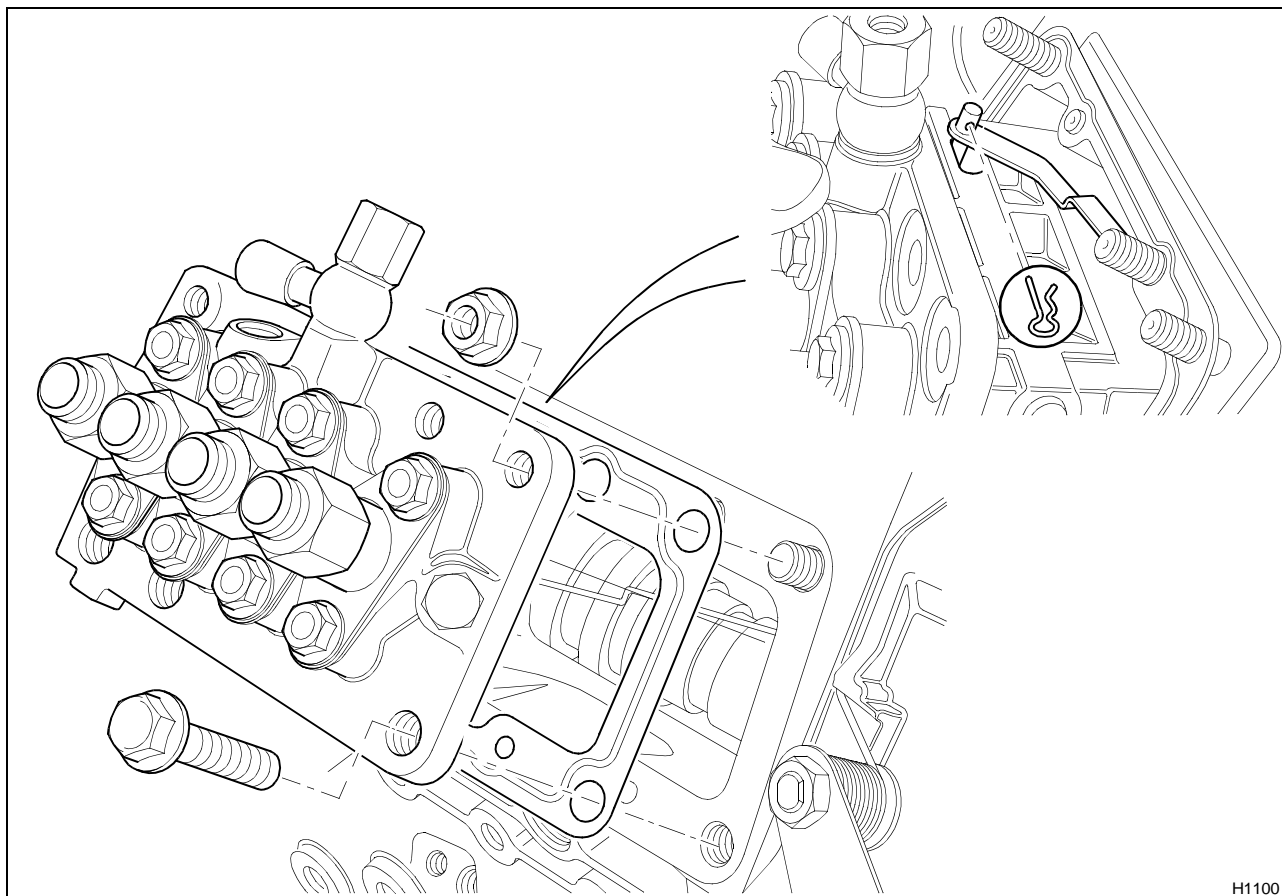
Operation 11-3

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Fuel injection pump fasteners	6 (4.4) 0,6
403C-15 404C-22 404C-22T	Fuel injection pump fasteners	15 (11) 1,5

Caution: Connections should be blanked off until assembly.

Notes:

- If the fuel injection pump is renewed, shims of the same thickness as originally fitted should be used.
- If a new fuel injection pump is fitted, it should be replaced with a fuel pump with the same part number as originally fitted.
- When the fuel injection pump is replaced it is essential that the fuel adjustment screw is not altered from the original setting. The maximum no load speed should be checked after assembly.



H1100

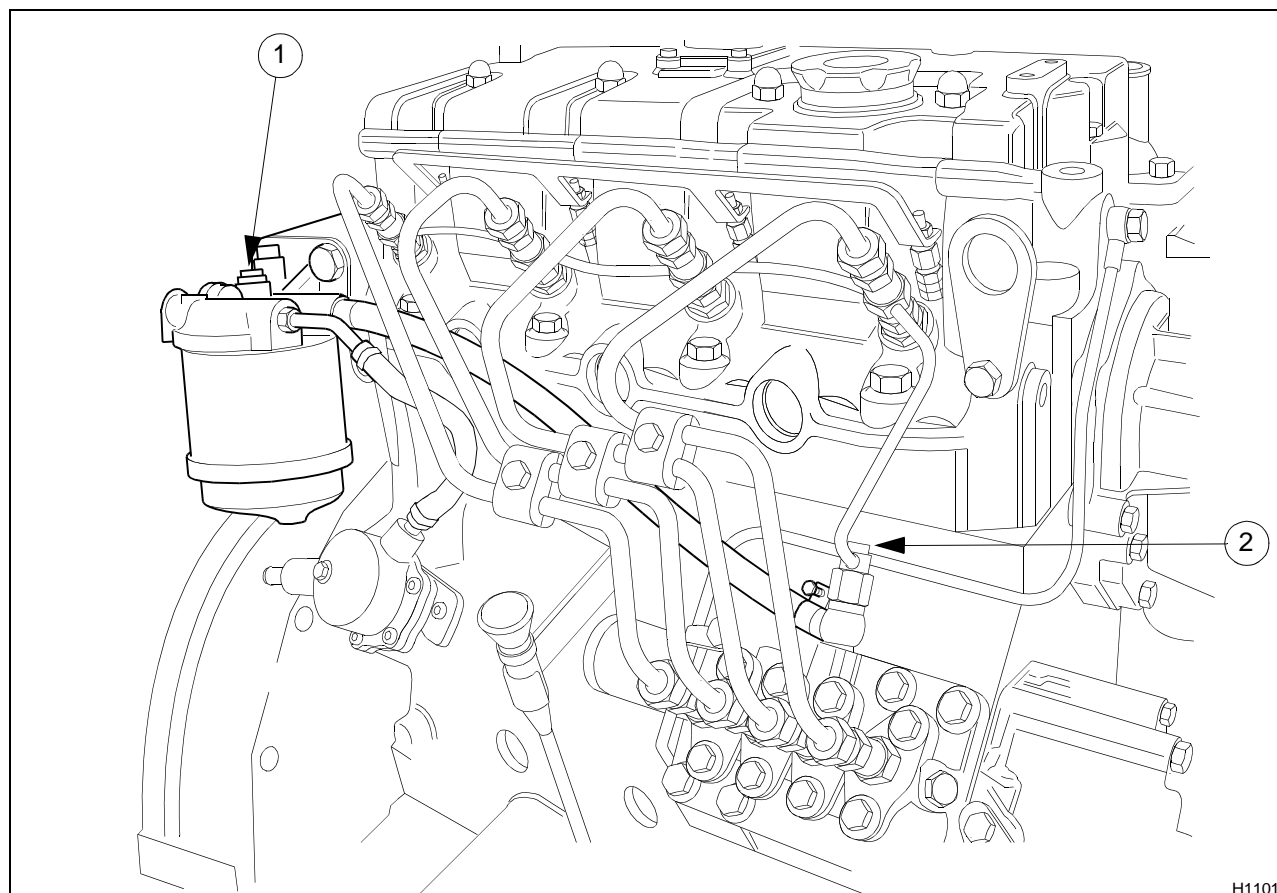
To eliminate air from the fuel system

Operation 11-4

- 1 Loosen the vent screw on the fuel filter (1).
- 2 Operate the hand primer until fuel, free of air, flows from the vent screw. Tighten the vent screw (1).
- 3 Loosen the vent screw on the fuel injection pump (2). Operate the hand primer until fuel, free of air, flows. Tighten the vent screw (2).
- 4 Attempt to start the engine using the starter motor for a maximum of 15 seconds, wait for 30 seconds before trying again.

Cautions:

- When using the starter motor, do not exceed continuous rotation of more than 15 seconds periods. If the engine does not run, on initial rotation, wait for 30 seconds and try again.
- Connections should be blanked off until assembly.



H1101

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12

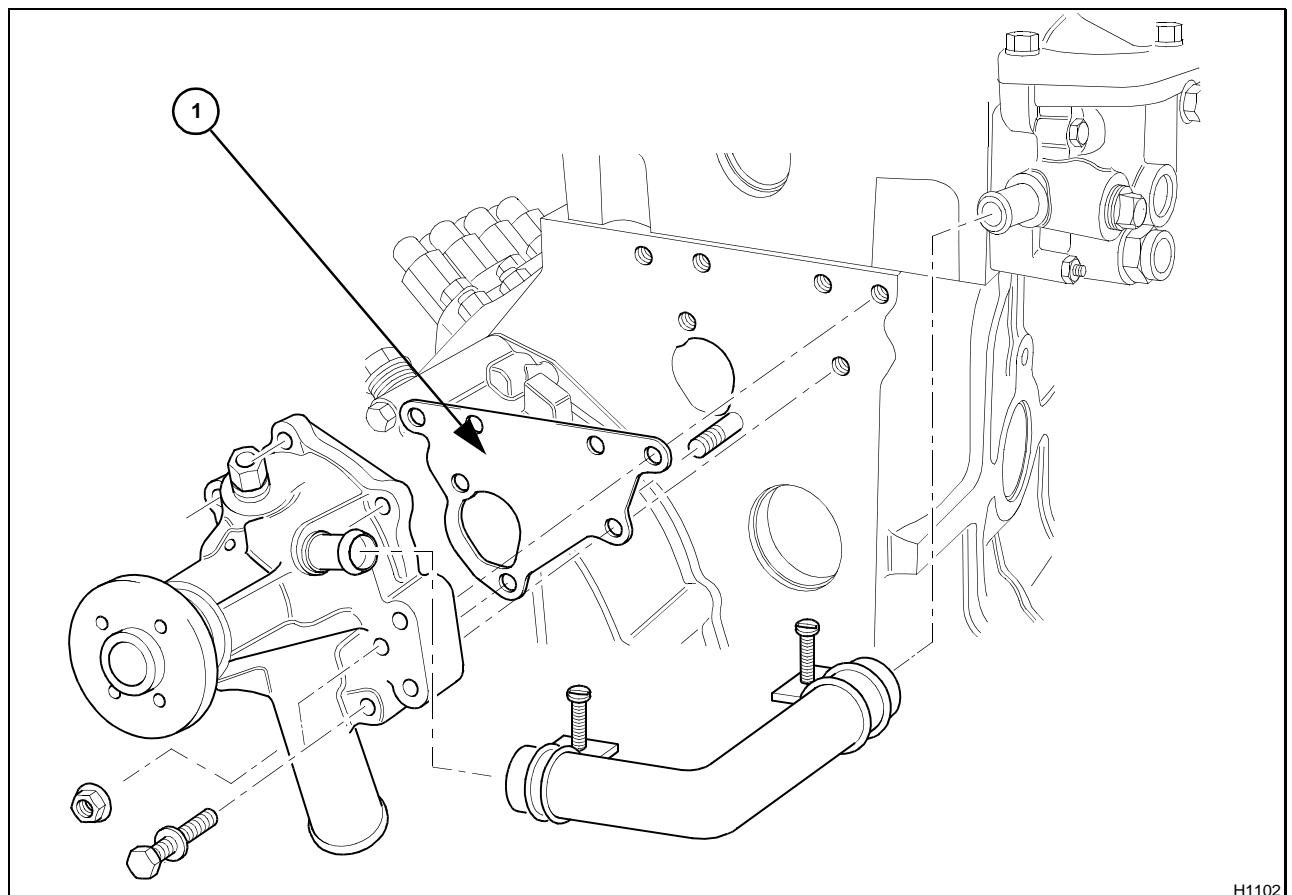
Cooling system

Coolant pump

To remove and to fit

Operation 12-1

Fit new joint (1) on assembly.

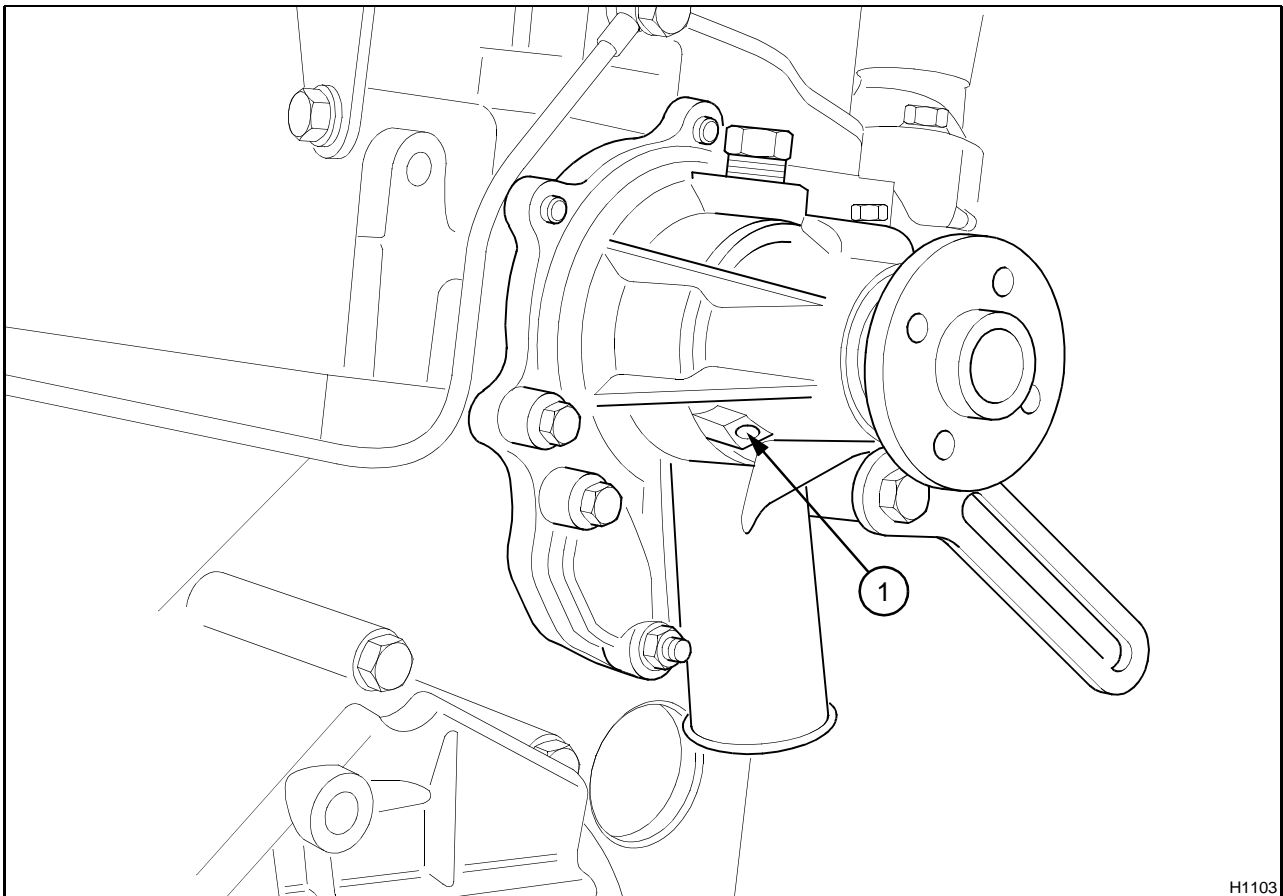


H1102

To inspect

Operation 12-2

Start the engine check the coolant pump tell-tale hole (1) for coolant leakage.



H1103

Fan and mounting

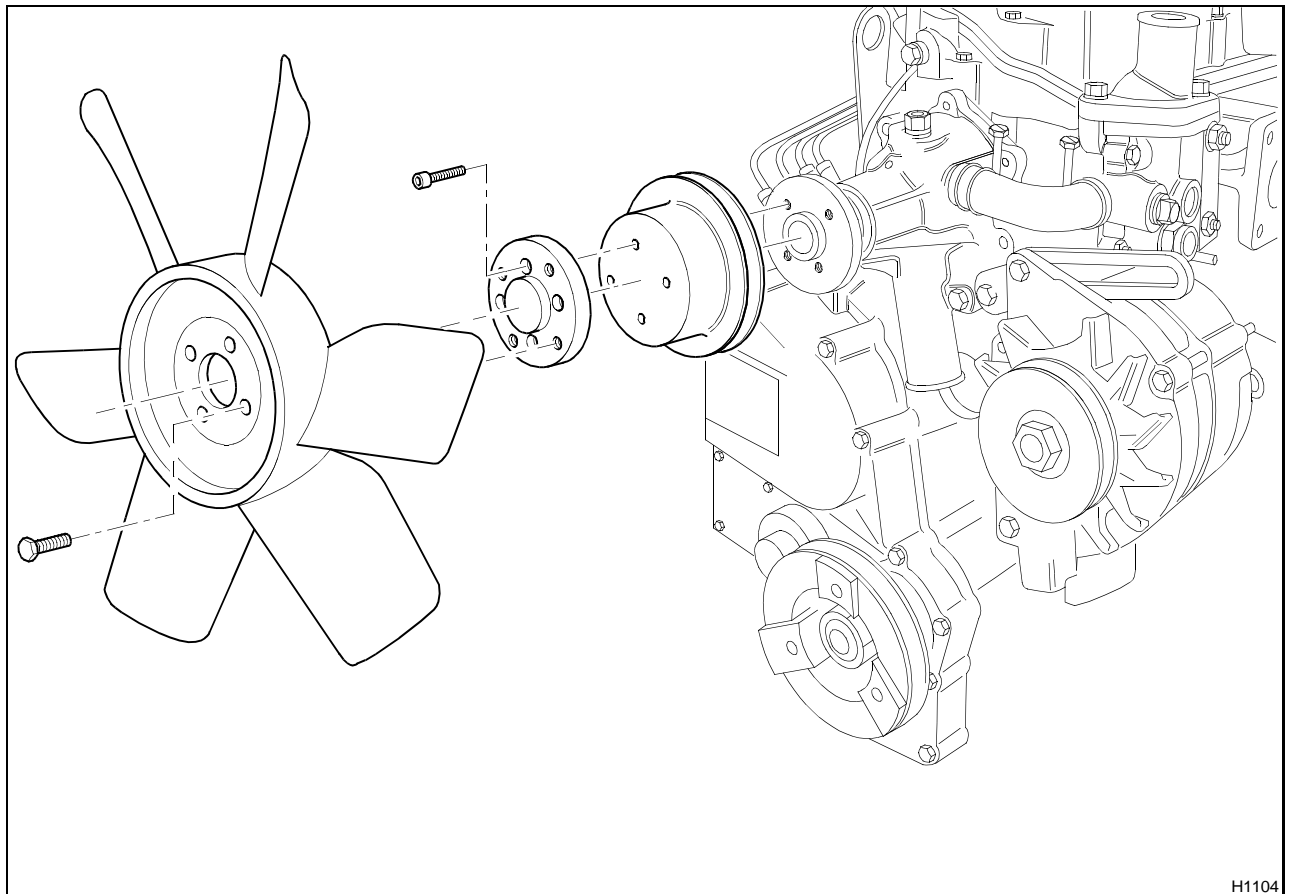
To remove and to fit

Operation 12-3

On assembly check the tension of the belt, see Operation 14-3.

To remove and to fit the alternator, see Operation 14-4

Engine	Torque Nm (lbf ft) kgf m	
All models	Setscrew	11 (8) 1,1
	Allen screw	11 (8) 1,1



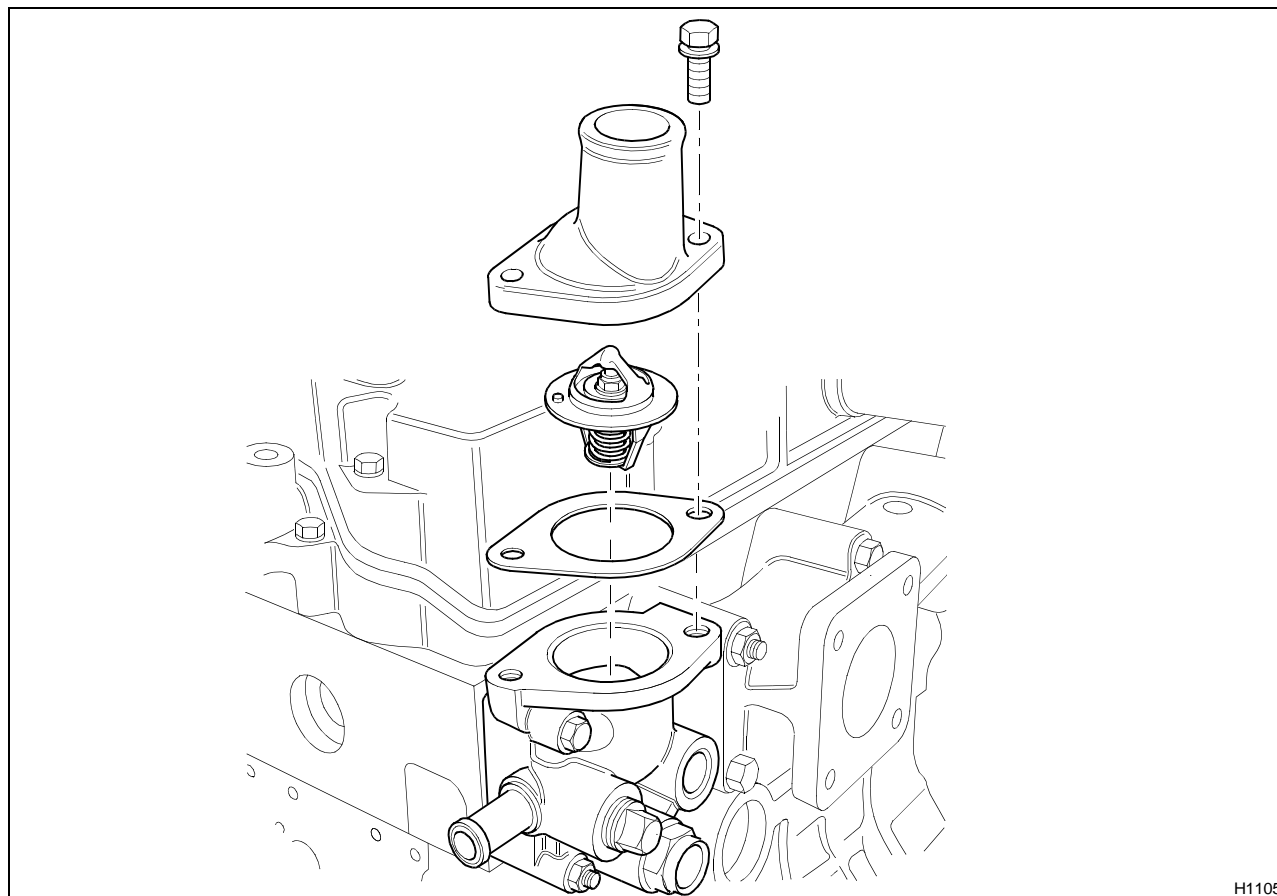
Thermostat

To remove and to fit

Operation 12-4

Engine	Torque Nm (lbf ft) kgf m	
All models	Setscrew	14 (10.3) 1,4

Caution: Ensure that the thermostat is correctly seated in the thermostat housing.

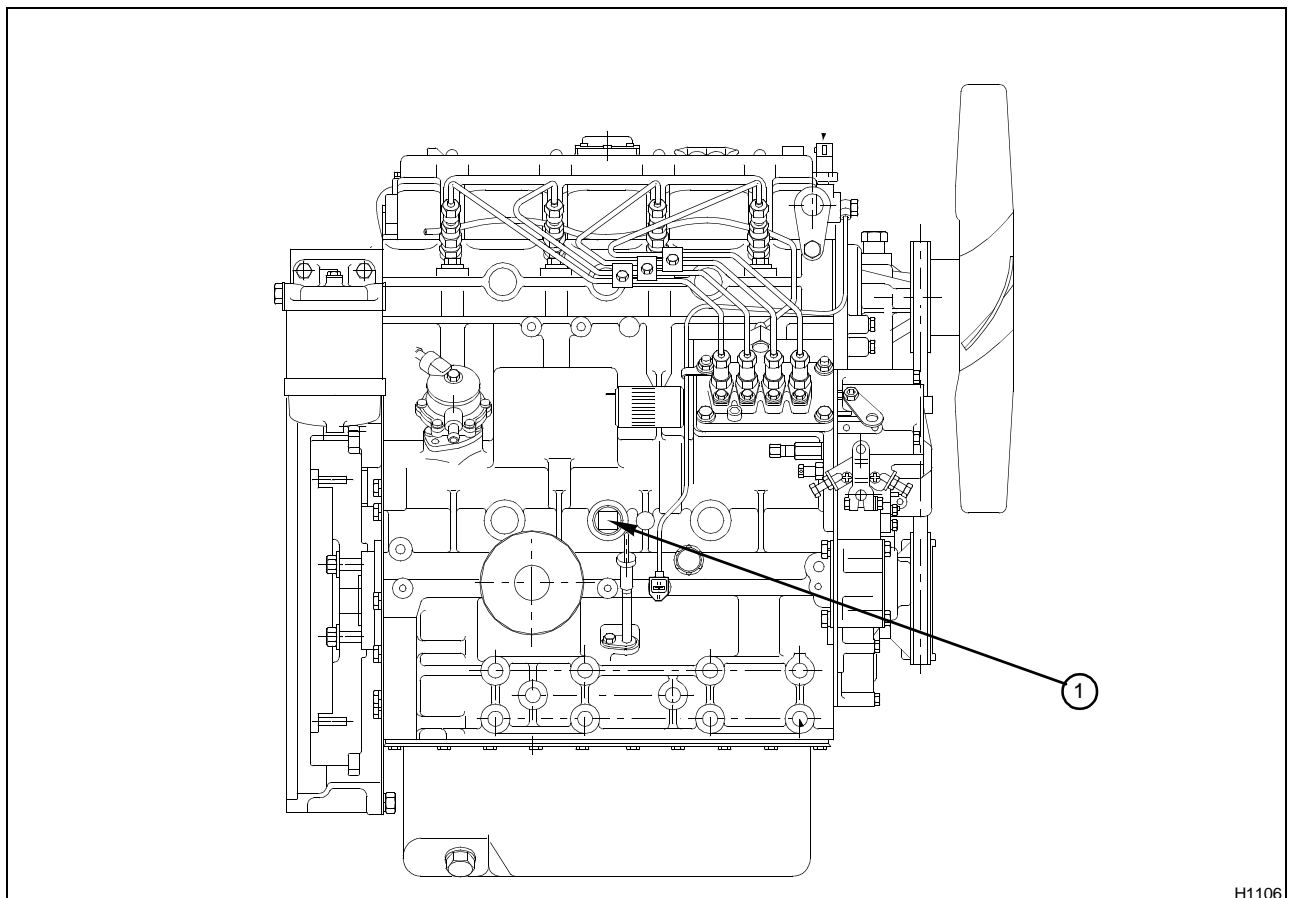


H1105

To drain the cylinder block

Operation 12-5

Engine	Torque Nm (lbf ft) kgf m	
All models	Cylinder block drain plug	30 (22,0) 3,0



H1106

To test and to inspect

Operation 12-6

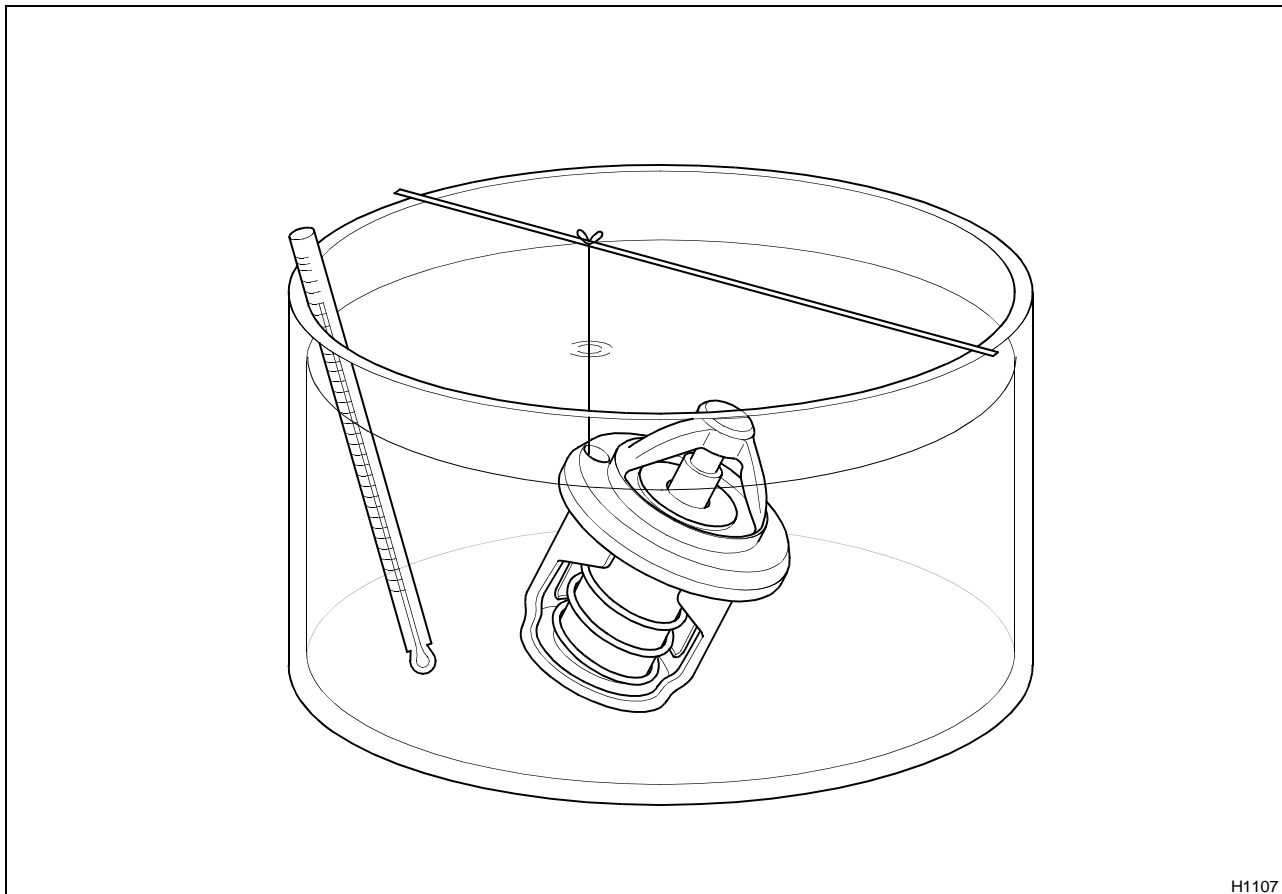
Visually inspect for damage, renew the thermostat if the valve is open at ambient temperature.

- 1 Put the thermostat into the water.
- 2 Raise the temperature of the water gradually.
- 3 Record the valve opening temperature and the valve lift.

Engine	Temperature when thermostat valve starts to open °C (°F)	Temperature when thermostat valve fully open °C (°F)
403C-11	75 (167)	87 (189)
403C-15 404C-22	80 to 84 (176 to 183.2)	95 (203)
404C-22T	71 (159.8)	82 (179.6)

Notes:

- The start to open temperature is stamped on the thermostat
- 3 to 5 minutes will be required before the valve starts to operate.



H1107

13

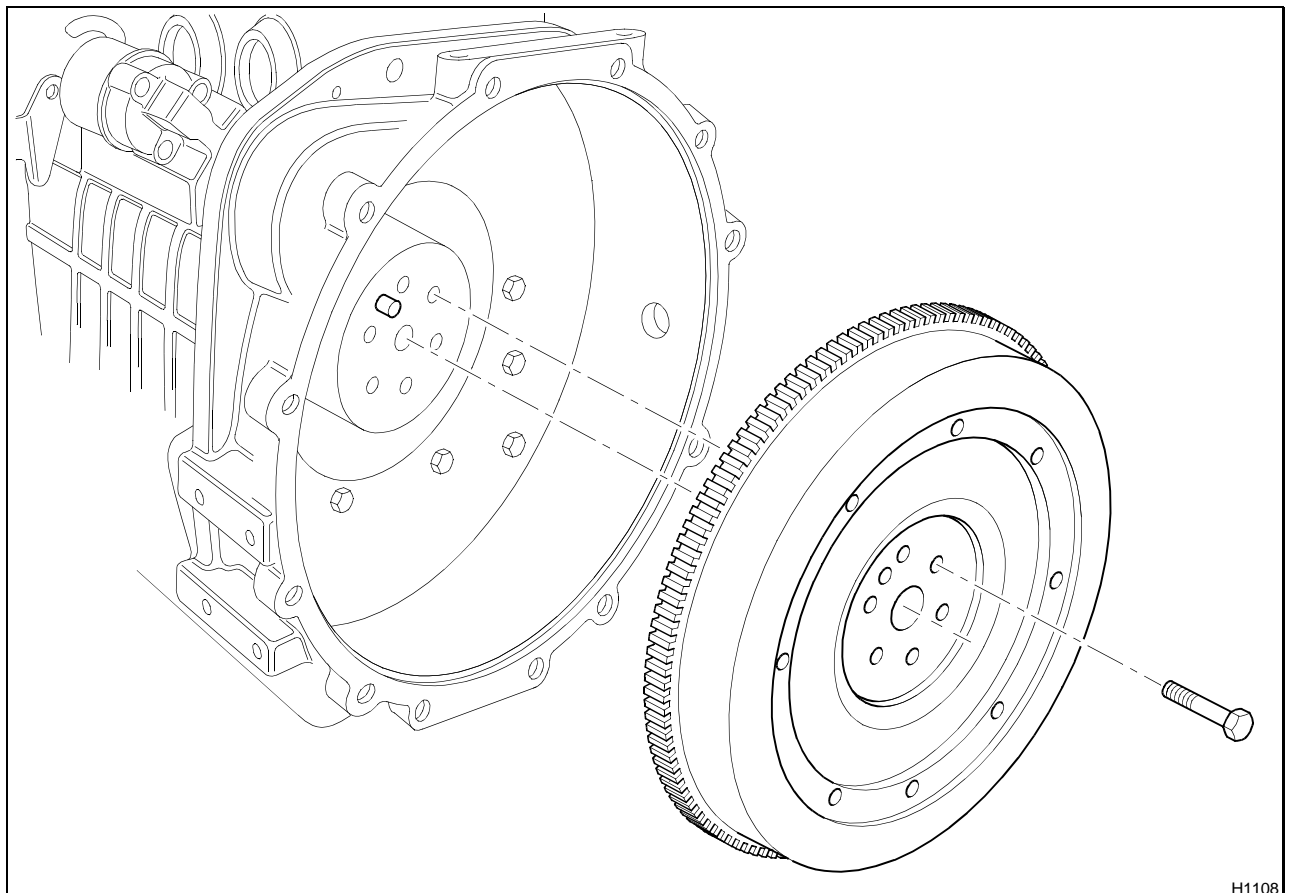
Flywheel and housing

Flywheel

To remove and to fit

Operation 13-1

Engine	Torque Nm (lbf ft) kgf m	
All models	Flywheel setscrew	74 (54.5) 7,4



H1108

To check for concentricity and alignment of the flywheel housing

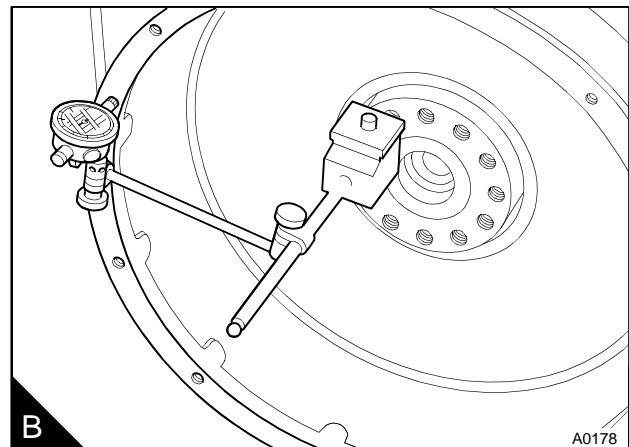
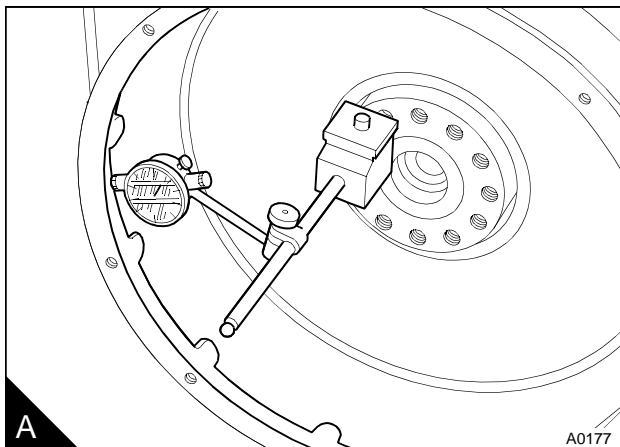
Operation 13-2

Check the housing concentricity with a dial test indicator (A). The run-out limit is given in the table below. If any adjustment is necessary, it must be made on the housing and the concentricity checked again.

Flywheel housing bore run-out	SAE 5 Flywheel housing	SAE 4 Flywheel housing
All models	0,20 mm (0.008 in)	0,23 mm (0.009 in)

Check the housing alignment (B). The maximum tolerance is given in the table below. Any necessary adjustment must be made on the housing and not on the cylinder block.

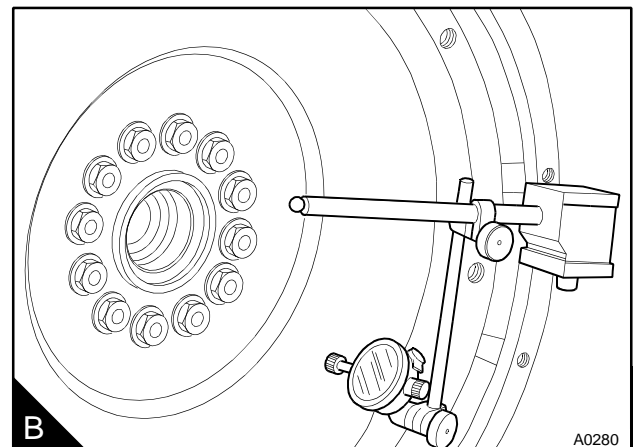
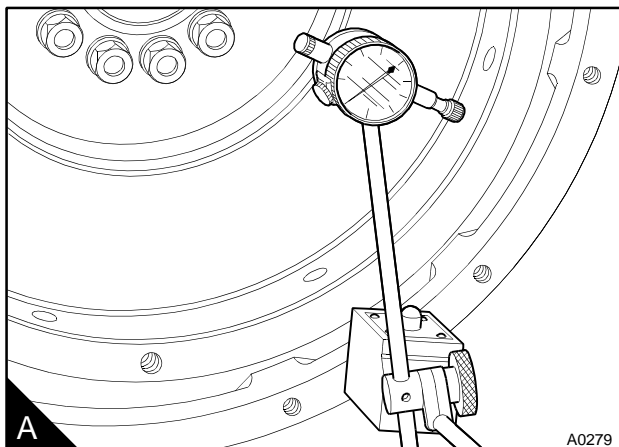
Flywheel face run-out	SAE 5 Flywheel housing	SAE 4 Flywheel housing
All models	0,20 mm (0.008 in)	0,23 mm (0.009 in)



To check for run-out of the flywheel and alignment of the flywheel face

Operation 13-3

- 1 Check the flywheel run-out with a dial test indicator (A). This must be less than 0,20 mm (0.008 in) total indicator reading.
- 2 Check the alignment of the flywheel face (B). During this check, keep the crankshaft pressed toward the front to remove the effect of crankshaft end-float.



Starter ring gear

To remove and to fit

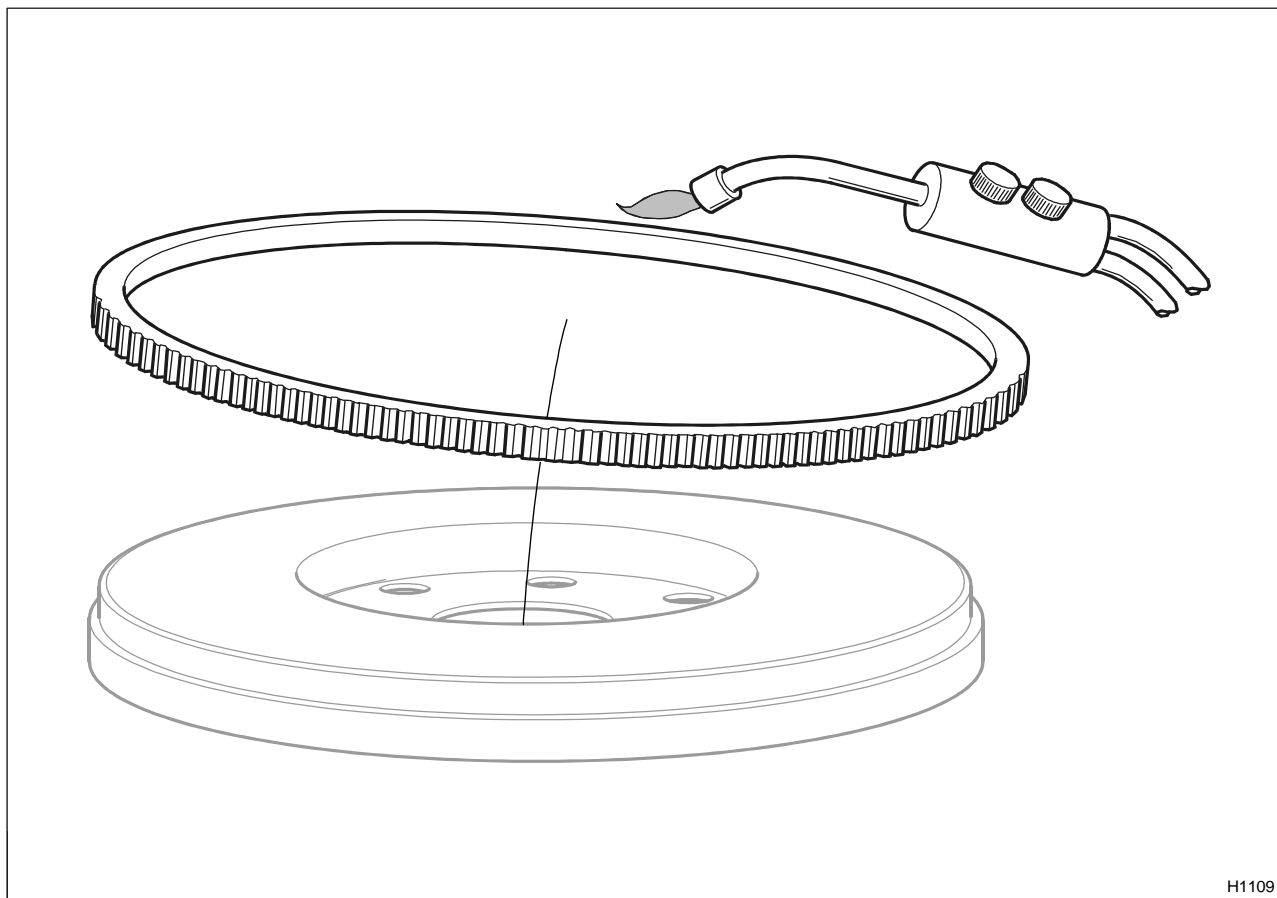
Operation 13-4

If the ring gear is excessively worn, renew.

When the wear is not excessive remove the ring gear and fit 90° from the original position.

To fit the ring gear heat to 120 °C to 150 °C (248 °F to 301°F).

Caution: Heat evenly, do not locally overheat.



H1109

Backplate and rear oil seal

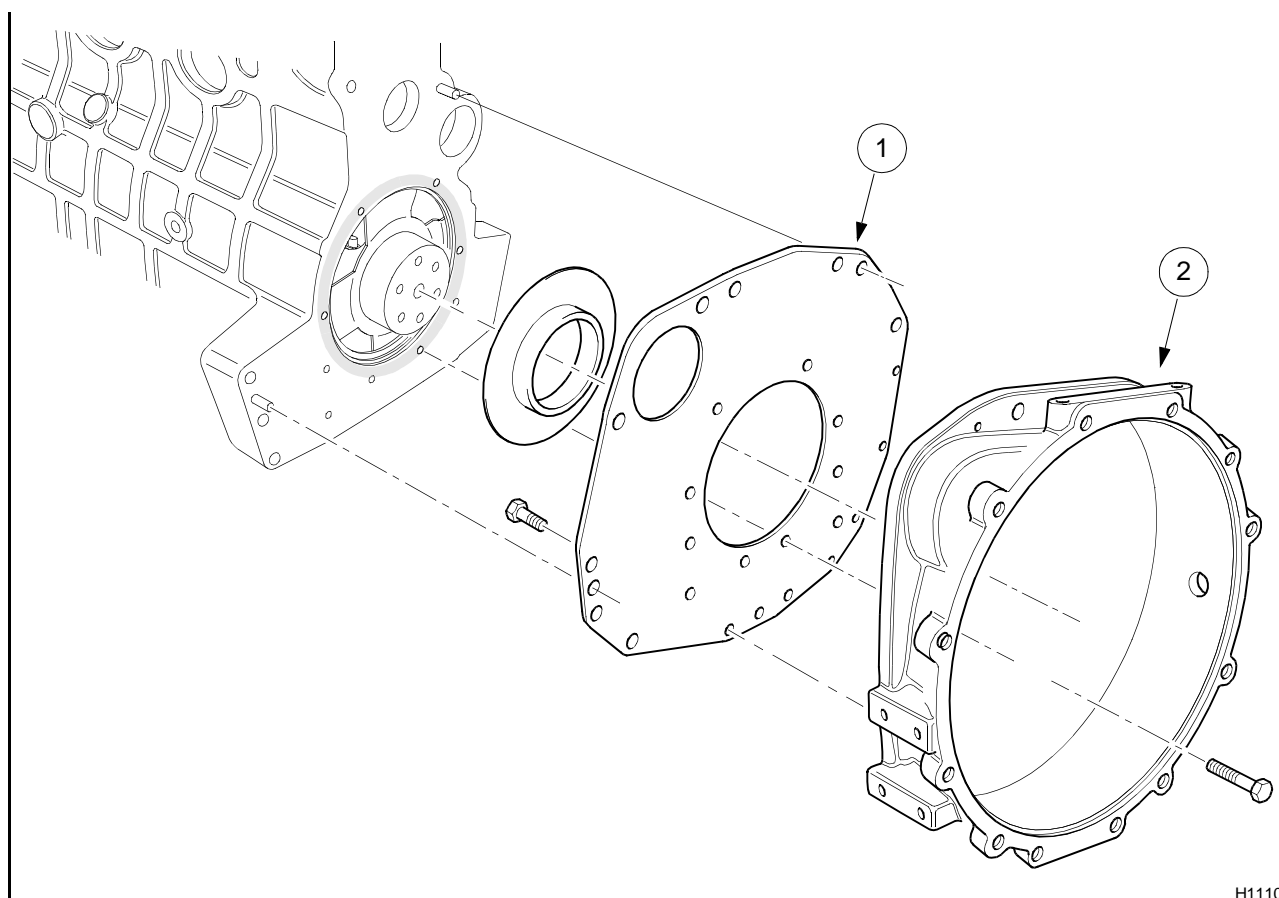
To remove and to fit

Operation 13-5

Only the 404C-22 engines / models have the backplate and the housing fitted together.

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Setscrew - backplate	50 (36.9) 5,1
	Setscrew - housing	50 (36.9) 5,1
403C-15	Setscrew - backplate	25 (18.8) 2,6
404C-22	Setscrew - housing	25 (18.8) 2,6
404C-22T		

Note: On assembly ensure that Powerpart silicone sealant is used between the cylinder block and the rear end oil seal.



H1110

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14

Electrical equipment

Electrical shut off solenoid

To remove and to fit

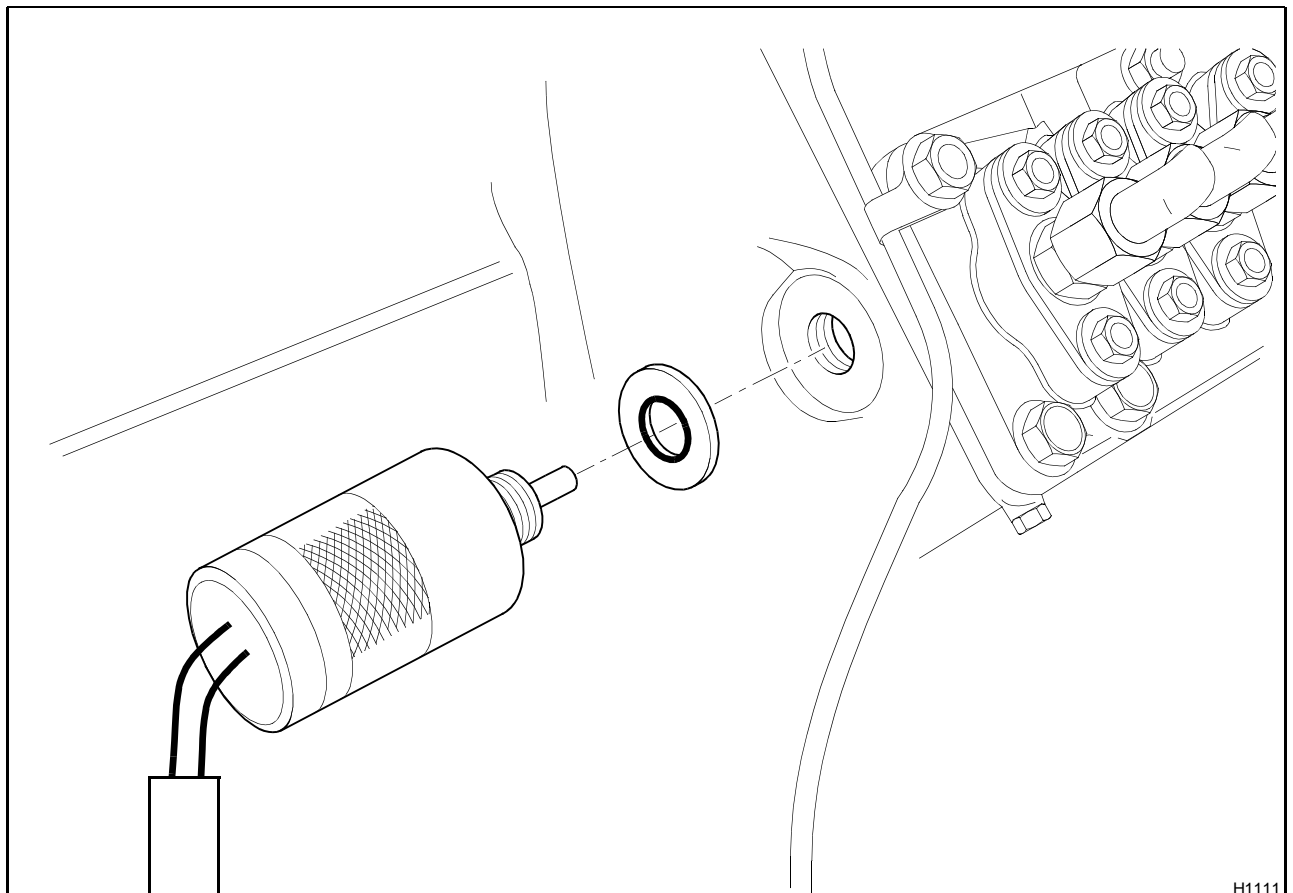
Operation 14-1

Special requirements

Engine	Torque Nm (lbf ft) kgf m	
All models	Solenoid	17 (12) 1,7

Notes:

- The washer is fitted with an integral "O" ring.
- Always use a new washer on assembly.



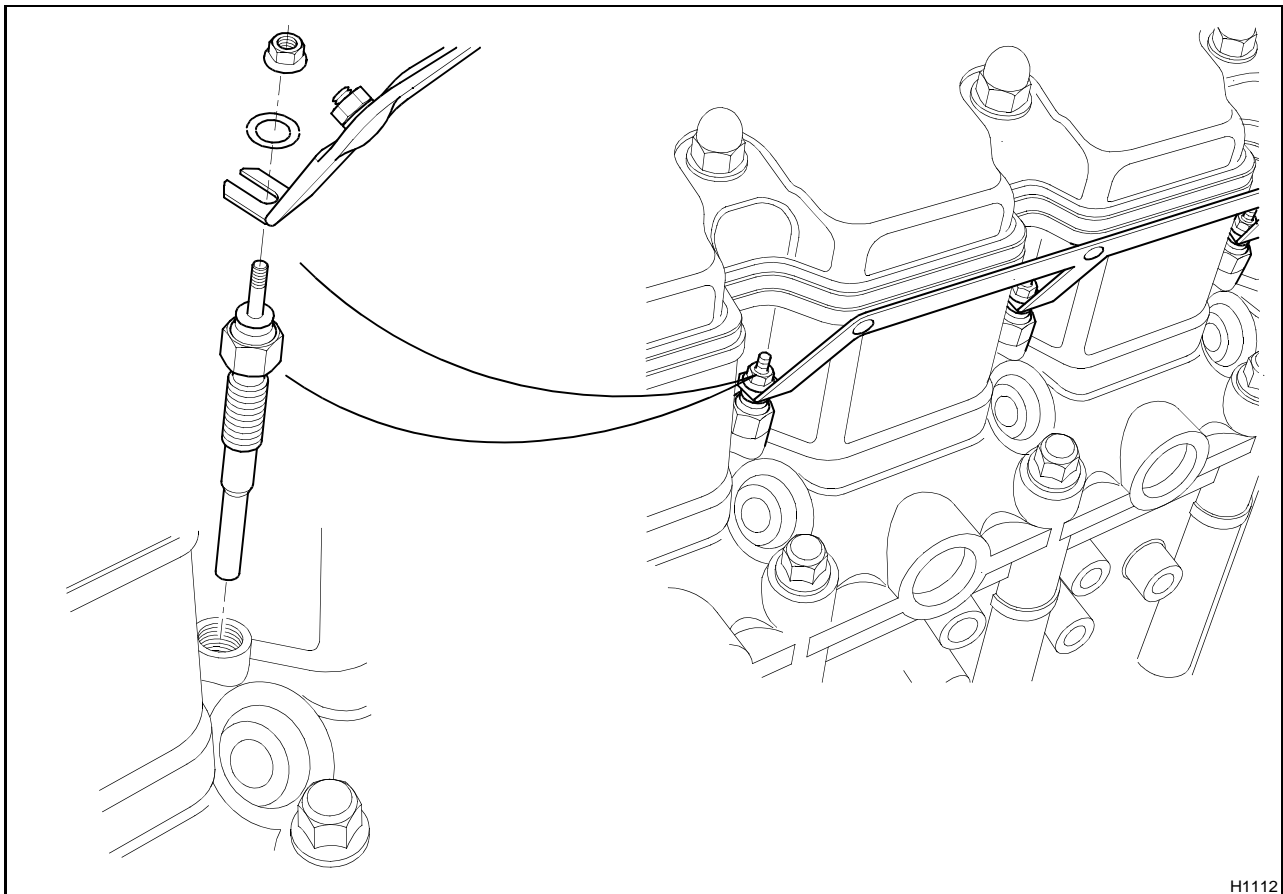
H1111

Bus-bar / glowplugs

To remove and to fit

Operation 14-2

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Glow plug	12 (8.9) 1,2
	Busbar nut	1,2 (0.9) 0,12
403C-15	Glow plug	18 (13) 1,8
404C-22 404C-22T	Busbar nut	1,2 (0.9) 0,12



H1112

Drive belt

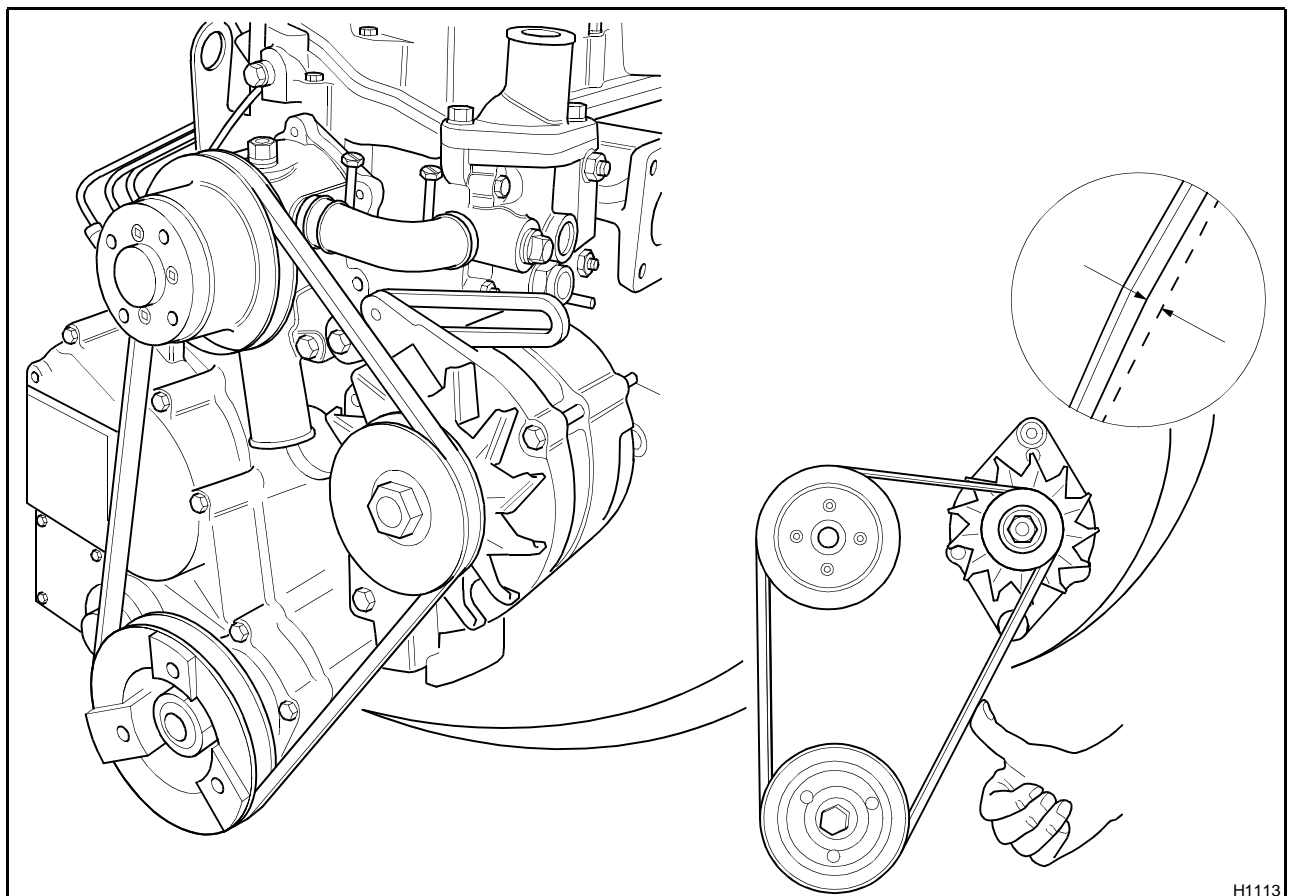
To inspect and to adjust

Operation 14-3

Press down the centre of the belt on the longest free length with a finger force of 49 Newtons, 11 lbf, 5 kgf approximately.

Engine	Deflection in mm (in)
403C-11	5 (0.19)
403C-15	6 (0.23)
404C-22 404C-22T	7 (0.27)

Check the belt for cracks or contamination by oil or grease.



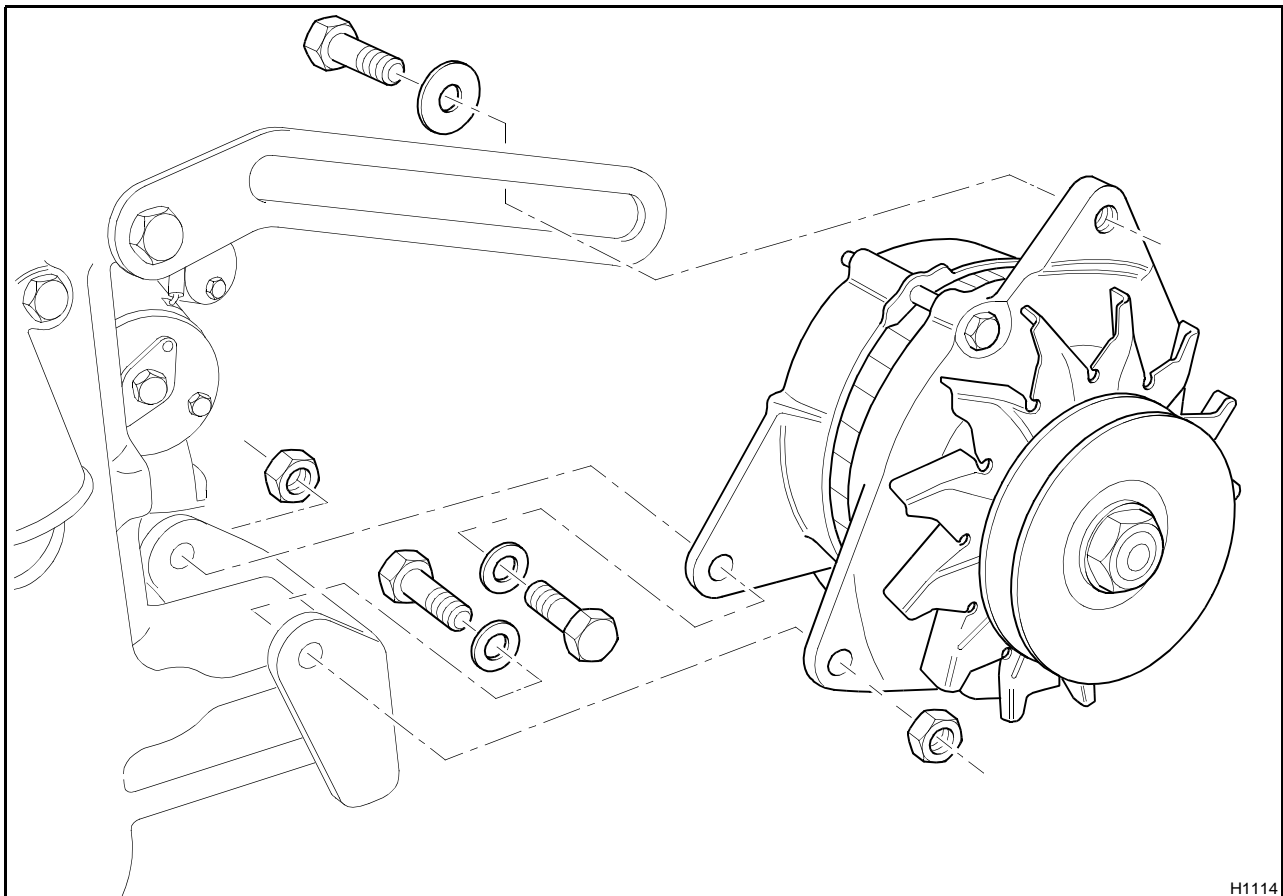
H1113

Alternator

To remove and to fit

Operation 14-4

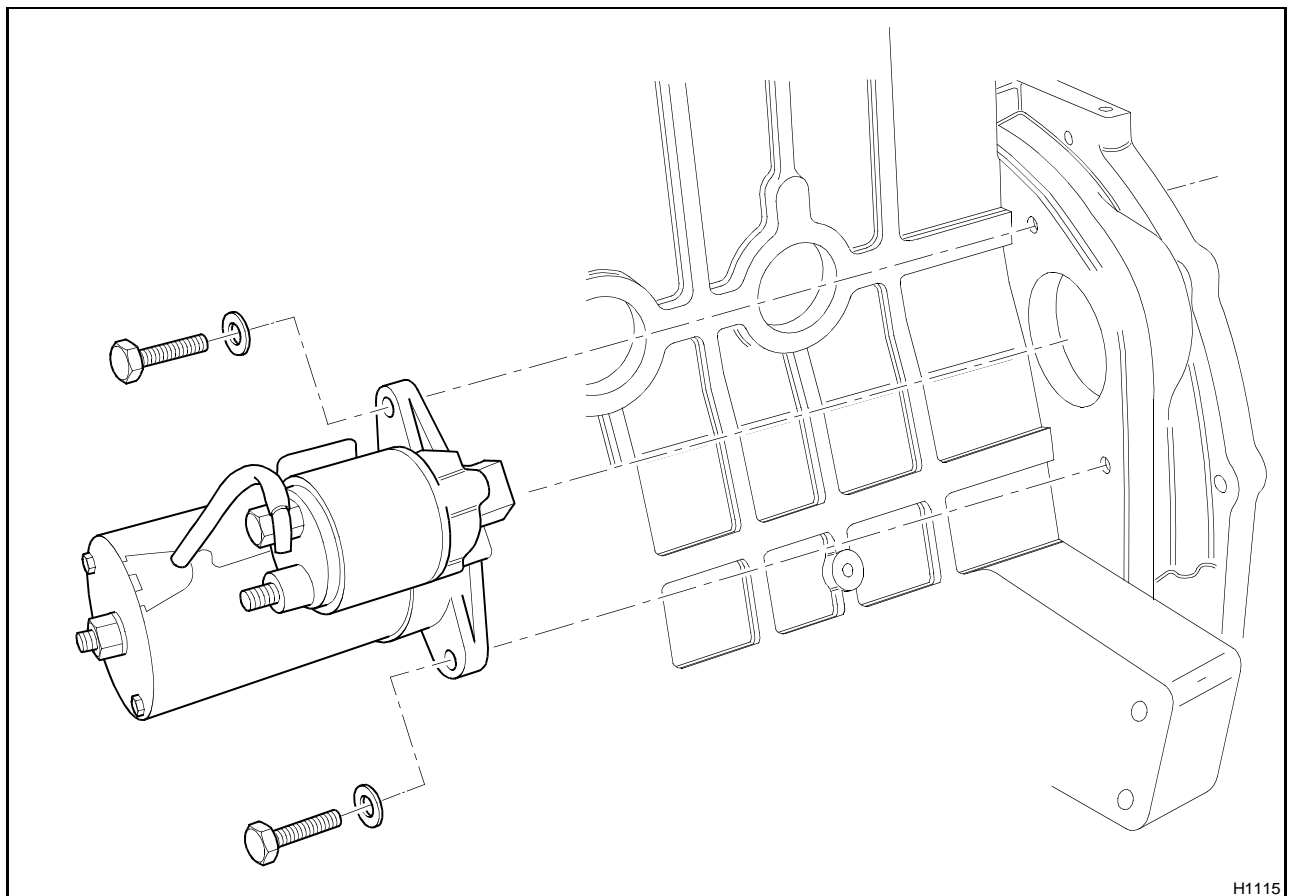
On assembly check the tension of the drive belt, see Operation 14-3.



H1114

Starter motor

To remove and to fit

Operation 14-5**Warning!** *The battery must be disconnected before the starter motor is removed.*

H1115

Wiring diagram 15 amp alternator - 403C-11

Circuit	Cable number	Circuit current	Maximum circuit resistance	Maximum circuit volt drop	Remarks
Alternator charging		14 amp (2 cyl) 15 amp (3 cyl)	0.036 Ω (2 cyl) 0.033 Ω (3 cyl)	0.5 Volt	See Glow Plugs Circuit
Starter motor solenoid		15.75 amp	0.04 Ω	0.63 Volt	See Glow Plugs Circuit
STD glow plugs (via glow signal)		(Peak max) 26 amp (2 cyl) 39 amp (3 cyl)	0.0192 Ω (2 cyl) 0.0128 Ω (3 cyl)	0.5 Volt	

Wiring diagram maximum circuit resistance

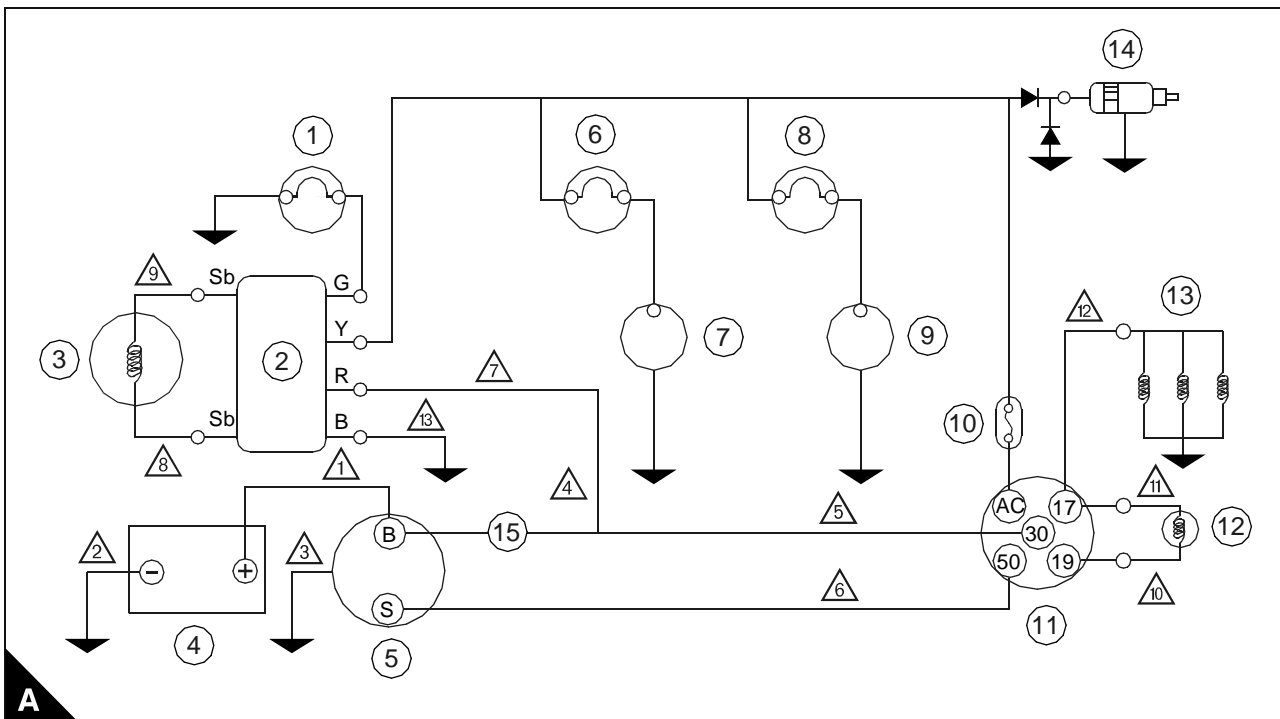
The resistance of battery cables 1, 2 and 3 must not exceed 0.0018 Ω.

Note: If a glow signal is not used - it is still necessary to connect terminal 19 and 17 on the switch.

- | | |
|--------------------------------------|---|
| 1 Alternator warning lamp | 9 Thermostat switch |
| 2 Regulator | 10 Fuse |
| 3 Alternator | 11 Key switch |
| 4 Battery | 12 Glow signal |
| 5 Starter motor | 13 Glow plugs |
| 6 Oil pressure warning lamp | 14 Solenoid switch |
| 7 Oil pressure switch ⁽¹⁾ | 15 A delayed fuse can be fitted if required |
| 8 Water temperature warning lamp | |

⁽¹⁾ Max current draw for standard oil pressure switch is 0.42 amps (5 Watt lamp max).

—|> = Diode. Capacity: Current 3 amp. Reverse Voltage: 600V. **(This is mandatory).**



Wiring diagram 40 amp alternator - 403C-11

Circuit	Cable number	Circuit current	Maximum circuit resistance	Maximum circuit volt drop	Remarks
Alternator charging	△4 △7 △11	40 amp	0.0125 Ωs	0.5 Volt	See Glow Plugs Circuit
Starter motor solenoid	△4 △5 △6	15.75 amp	0.04 Ωs	0.63 Volt	See Glow Plug Circuit
STD glow plugs (via glow signal)	△5 △8 △9 △10	(Peak max) 39 amp	0.0128 Ωs	0.5 Volt	

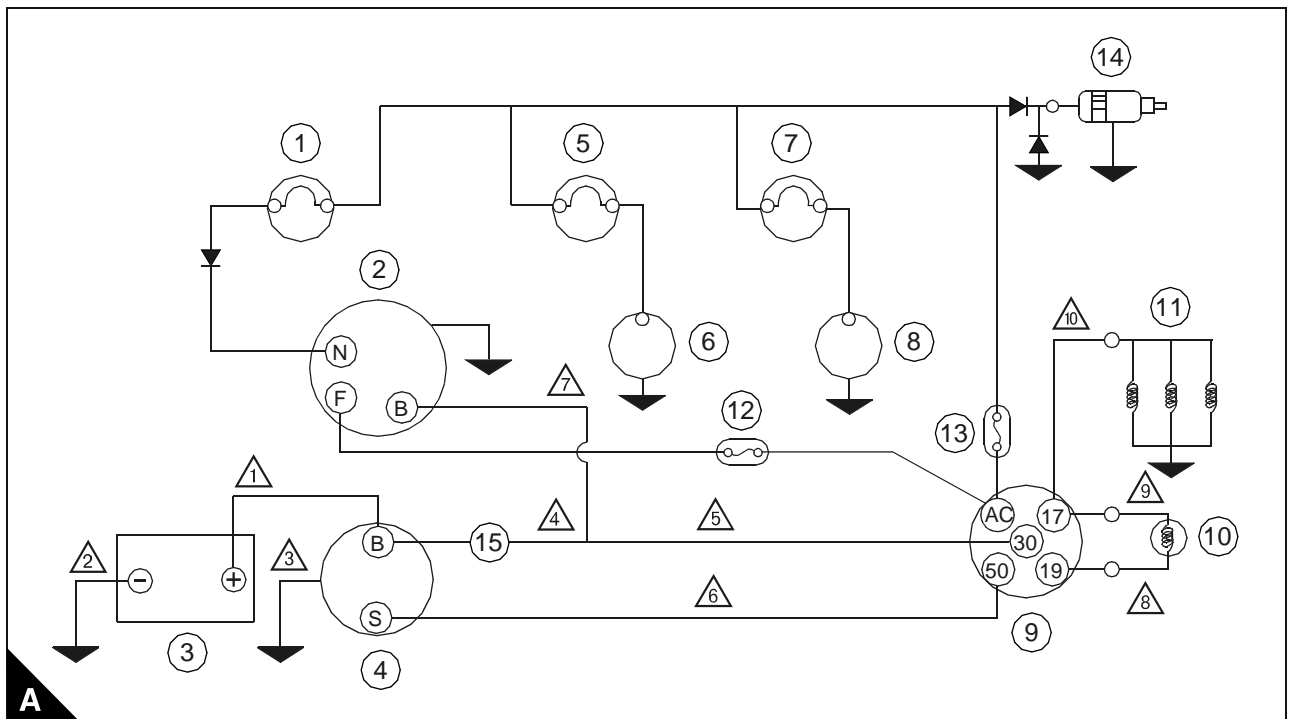
Wiring diagram maximum circuit resistance

The resistance of battery cables 1,2 and 3 must not exceed 0.0018 Ω.

- | | |
|----------------------------------|---|
| 1 Alternator warning lamp | 9 Key switch |
| 2 Alternator | 10 Glow signal |
| 3 Battery | 11 Glow plugs |
| 4 Starter motor | 12 Fuse |
| 5 Oil pressure warning lamp | 13 Fuse |
| 6 Oil pressure switch (1) | 14 Solenoid switch |
| 7 Water temperature warning lamp | 15 A delayed fuse can be fitted if required |
| 8 Thermostat switch | |

(1) Max current draw for standard oil pressure switch is 0.42 amps (5 Watt lamp max).

—▶— = Diode. Capacity: Current 3 amp. Reverse Voltage: 600V. **(This is mandatory).**



Wiring diagram 55 amp alternator 403C-15, 404C-22 and 404C-22T

Charging circuit

Circuit	Cable number	Circuit current	Maximum circuit resistance	Maximum circuit volt drop	Remarks
Alternator charging	4, 7, 11	55 Amps	0.0143 ohm	0.50 Volt	See glow plugs circuit
Starter motor solenoid	4, 5, 6	15.75 Amps	0.0400 ohm	0.63 Volt	See glow plugs circuit
STD glow plugs (via glow signal)	4, 5, 8, 9, 10	(Peak max) 52 Amps	0.0139 ohm	0.50 Volt	-

Caution: Diode capacity: current 3 amps, reverse voltage 600V this is **mandatory**.

Notes:

- Maximum cable size for 375 Lucar terminals on the alternator is 65/0,3 mm (4,5 mm²) therefore twin cables are required at connection to the alternator.
- Maximum current draw for standard oil pressure switch is 0.42 amps (5 Watts maximum bulb).
- A delay fuse can be fitted if necessary.

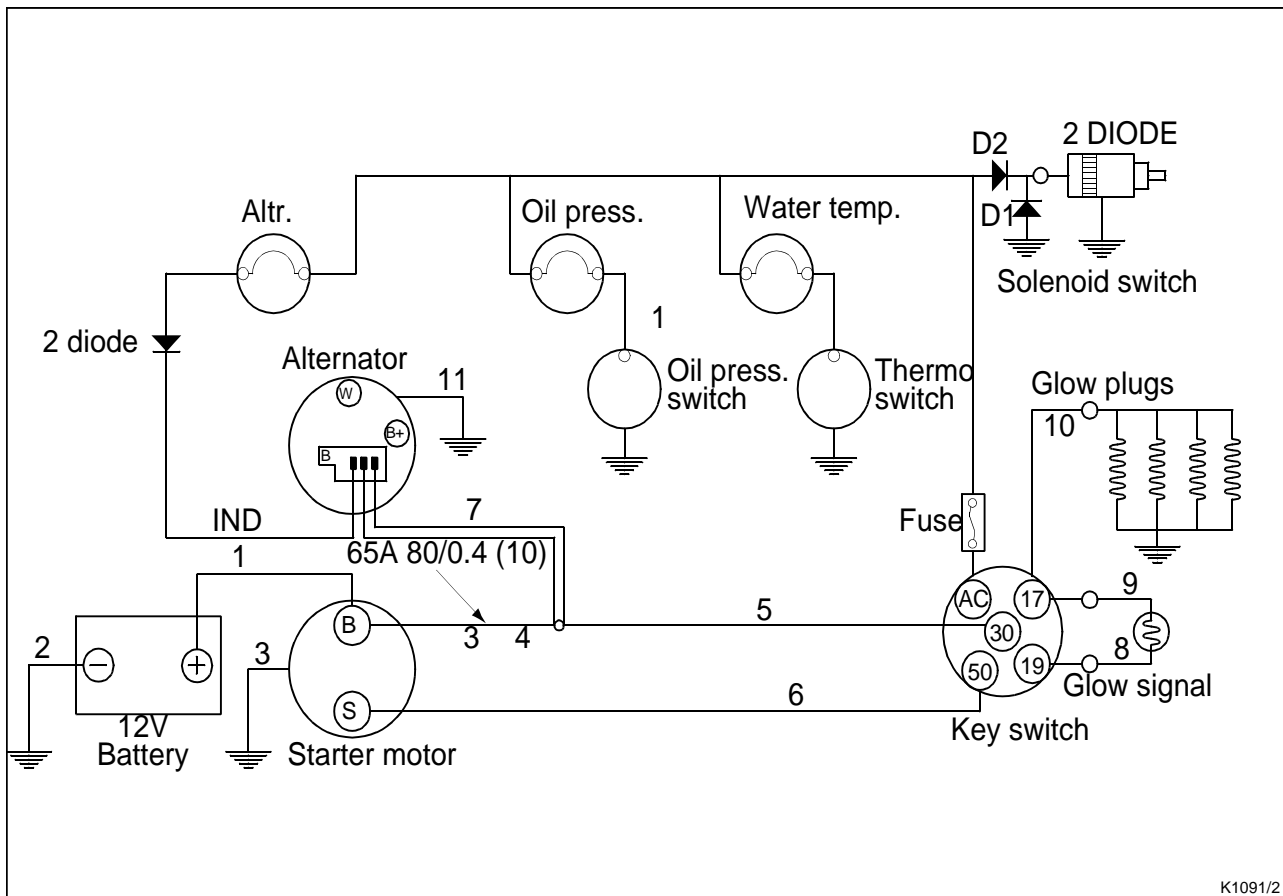
Alternator charge lamp, 55 amps

Alternator charge lamp rating: 12V - 2,2W at 850 rev/min.

When the engine is stopped the alternator charge lamp is illuminated via the battery. The light is extinguished when the engine is operated and the alternator is generating.

The use of a lower wattage bulb than the rating above will increase the speed at which the alternator will operate.

e.g. a charge lamp with a lower wattage bulb will have a rating of 12V - 1,2W at 1300 rev/min.



Automatic shutdown connector

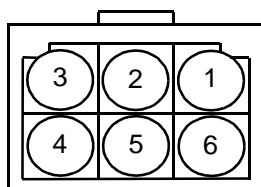
55 Amp alternator charge lamp

Note: Alternator charge lamp rating: 12V - 2.2W at 850 rev/min.

When the engine is at rest the alternator charge lamp is illuminated via the battery and it extinguishes when the alternator operates.

The use of a lower wattage bulb than the above will increase speed at which self excitation occurs upon initial run up, e.g. a charge lamp with a lower wattage bulb will have a rating of 12V - 1.2W at 1300 rev/min.

Pin number connector	Wire colour	Connection
1	Red	Key switch - AC
2	Orange	Key switch - 50
3	Red / Black	Solenoid
4	Brown	Oil pressure switch
5	Blue	Coolant temperature switch
6	Black	Ground (Earth)



Connector

H1116

Wiring diagram - automatic shutdown 15 amp alternator - 403C-11

Automatic shutdown operation conditions

If the conditions below last for more than 10 seconds during the start operation, the engine will shut down.

If the conditions below last for more than 2 seconds while the engine is operated, the engine will shut down.

Warning! There is no protection against low water levels.

Conditions

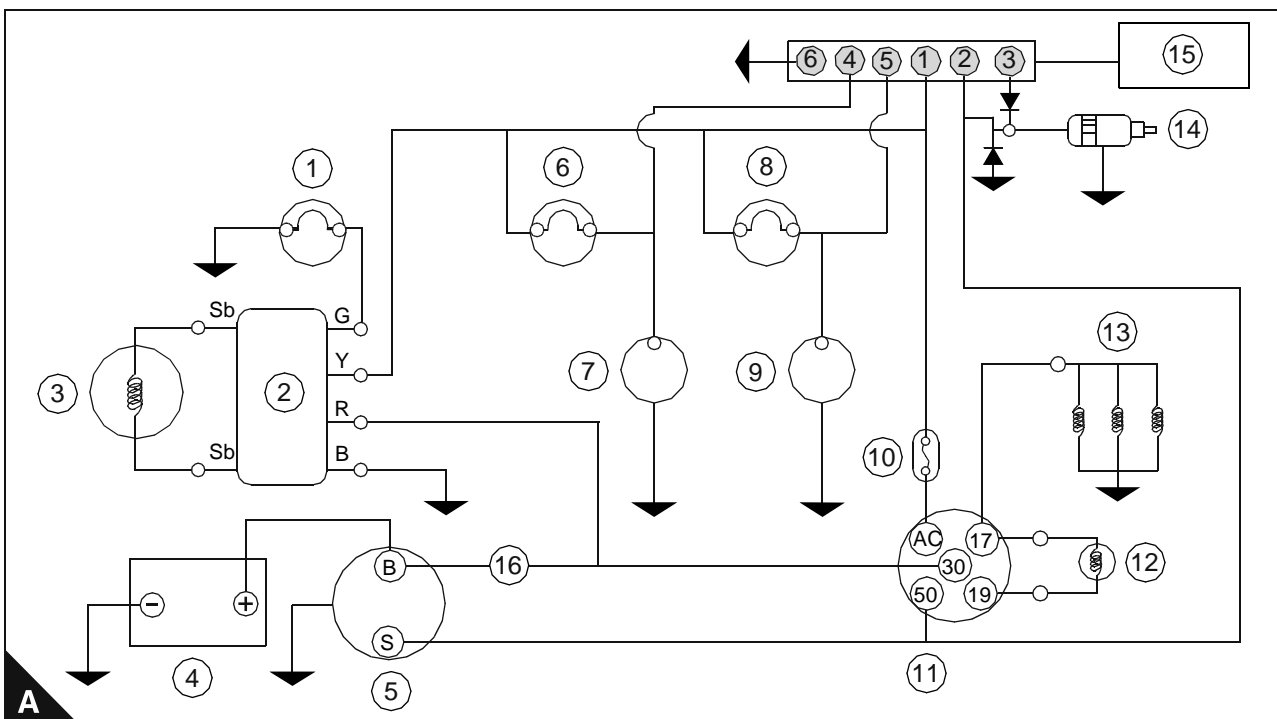
Water temperature switch: If the water temperature exceeds $105\text{ }^{\circ}\text{C} \pm 4\text{ }^{\circ}\text{C}$.

Oil Pressure Switch: If the oil pressure falls below $0,3\text{ kgf/cm}^2$ (4.27 lbf/in^2).

- | | |
|----------------------------------|--|
| 1 Alternator warning lamp | 9 Thermostat switch |
| 2 Regulator | 10 Fuse |
| 3 Alternator | 11 Key switch |
| 4 Battery | 12 Glow signal |
| 5 Starter motor | 13 Glow plugs |
| 6 Oil pressure warning lamp | 14 Solenoid switch |
| 7 Oil pressure switch (1) | 15 Automatic shutdown device |
| 8 Water temperature warning lamp | 16 A delayed fuse can be fitted if desired |

(1) Max current draw for standard oil pressure switch is 0.42 amps (5 Watt lamp max).

—|> = Diode. Capacity: Current 3 amp. Reverse Voltage: 600V. **(This is mandatory).**



Wiring diagram - automatic shutdown 40 amp alternator - 403C-11

Automatic shutdown operation symptoms

If the conditions below last for more than 10 seconds during the start operation, the engine will shut down.

If the conditions below last for more than 2 seconds while the engine is operated, the engine will shut down.

Warning! *There is no protection against low water levels.*

Conditions

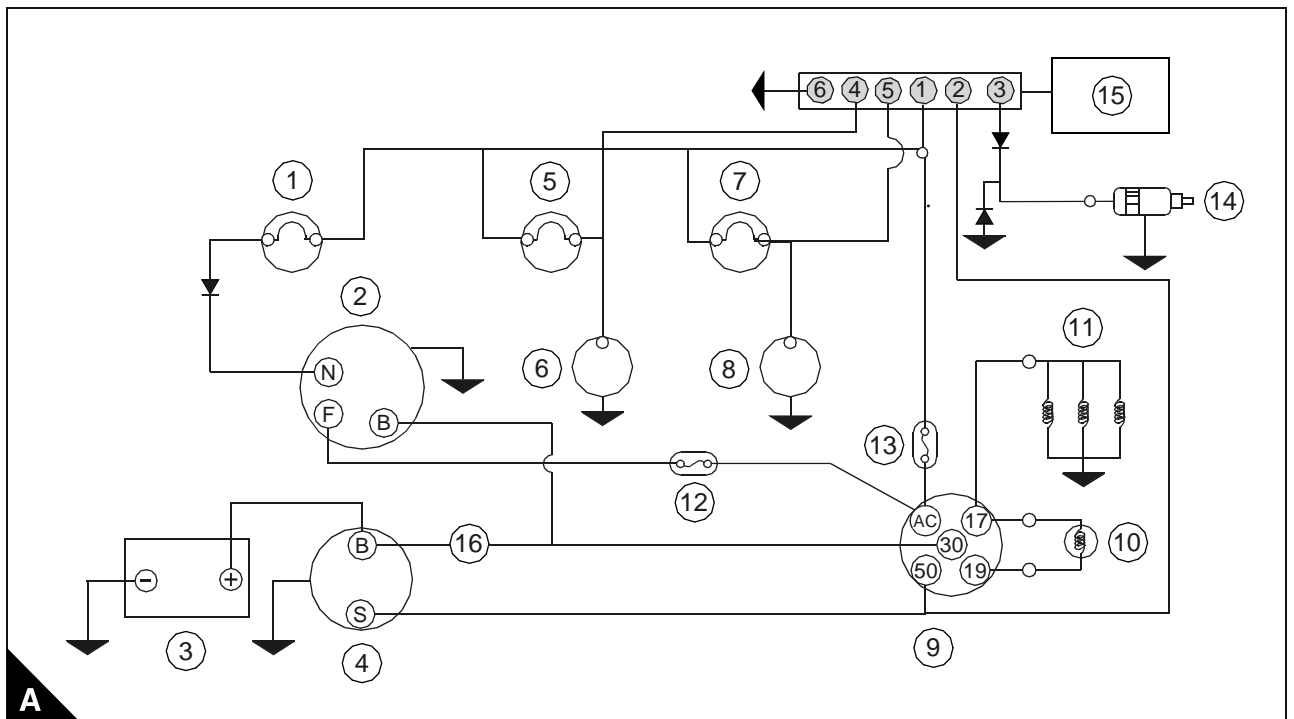
Water temperature switch: If the water temperature exceeds 105 °C ± 4 °C.

Oil Pressure Switch: If the oil pressure falls below 0,3 kgf/cm² (4.27 lbf/in²).

- | | |
|--------------------------------------|--|
| 1 Alternator warning lamp | 9 Key switch |
| 2 Alternator | 10 Glow signal |
| 3 Battery | 11 Glow plugs |
| 4 Starter motor | 12 Fuse |
| 5 Oil pressure warning lamp | 13 Fuse |
| 6 Oil pressure switch ⁽¹⁾ | 14 Solenoid switch |
| 7 Water temperature warning lamp | 15 Automatic shutdown device |
| 8 Thermostat switch | 16 A delayed fuse can be fitted if desired |

(1) Max current draw for standard oil pressure switch is 0.42 amps (5 Watt lamp max).

—▶ = Diode. Capacity: Current 3 amp. Reverse Voltage: 600V. **(This is mandatory).**



Wiring diagram - automatic shutdown 55 amp alternator 403C-15, 404C-22 and 404C-22T

Automatic shutdown operating conditions

If the conditions listed below continues for more than ten seconds while starting, or two seconds while the engine is being operated, the engine will shutdown.

If the water temperature exceeds 110 °C (230 °F) ± 3°C (5 °F)

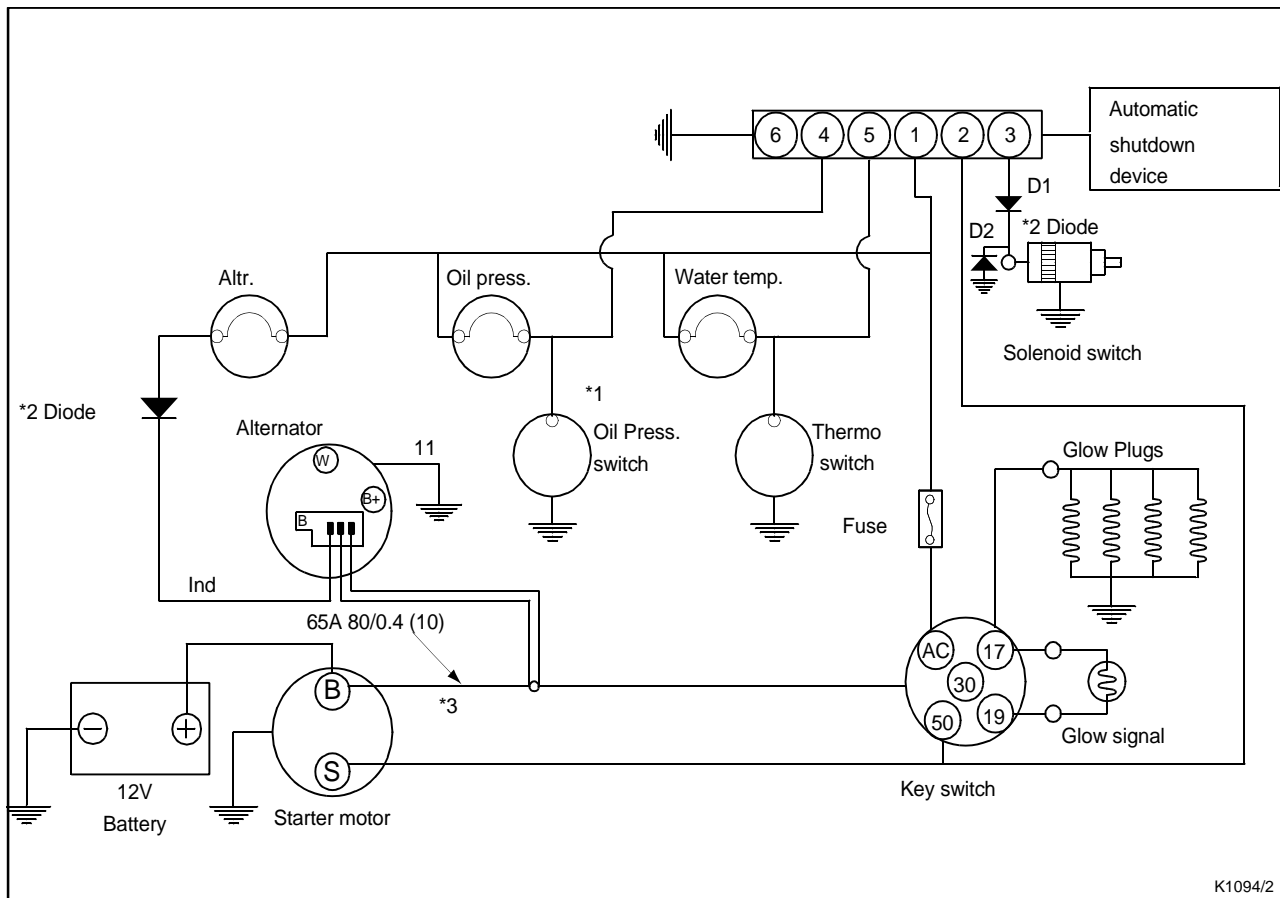
If the oil pressure falls below 0,3 kgf / cm² (4.27 lbf / in² top cover option) or 1,0 kgf / cm² (14.22 lbf / in² oil rail option).

Cautions:

- There is no automatic shutdown for low water levels.
- Diode capacity: current 3 amps, reverse voltage 600V, this is **mandatory**.

Notes:

- Maximum current draw for the standard oil pressure switch is 0.42 amps (5 Watts maximum bulb).
- A delay fuse can be fitted if necessary.



K1094/2

15

Auxiliary equipment

None fitted

Operation 15-1

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Special tools

Special tools list

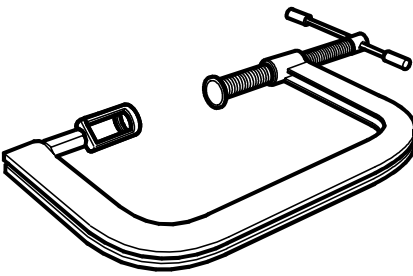
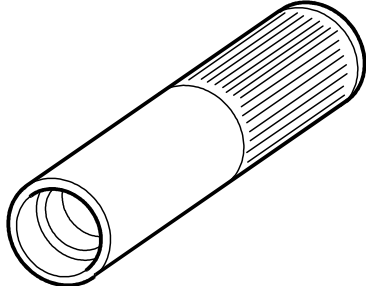
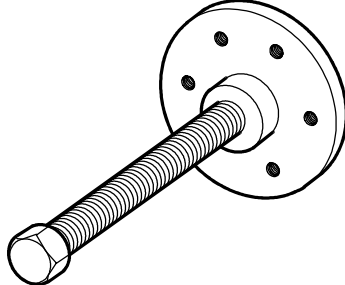
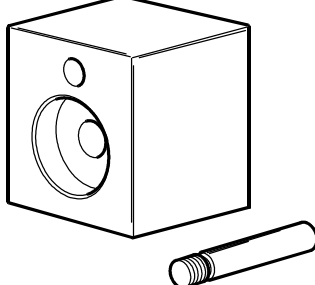
These tools are available locally through your Perkins distributor. If you cannot obtain the correct tool locally contact:

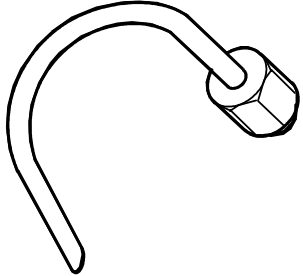
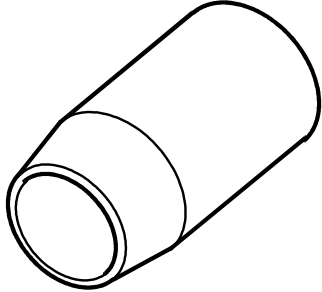
The Perkins Service Department, Peterborough, PE1 5NA, England, UK.

Tel. +44 1733583000

Fax +441733582240

Telex 32501 PERKEN G.

Description	Illustration
Valve spring remover Part number 21825663	
Valve stem seal replacer Part number 21825623	
Crankshaft pulley remover Part number 21825619	
Idler hub fitting tool 403C-11 part number 21825625 403C-15 and 404C-22 part number 21825626	

Description	Illustration
<p>Fuel pump spill pipe Part number 21825680</p>	
<p>Front oil seal protector 403C-11 part number 21825620 403C-15, 404C-22 part number 21825621</p>	
<p>Valve seat cutter Part number 27610030</p>	