Perkins 100 Series

Models 102-05, 103-07, 103-10, 103-13, 103-15, 104-19, 104-22

WORKSHOP MANUAL

102-05 **Two cylinder diesel engines**

103-07 **Three cylinder diesel engines**
103-10
103-13
103-15

104-19 **Four cylinder diesel engines**
104-22

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PACE

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General information

Introduction

This Workshop Manual has been written to provide the trained technician with enough information to service and overhaul all of the latest Perkins 100 Series engines. It has been compiled for use in conjunction with normal workshop practice and information contained in current service bulletins. Certain accepted practices have been purposely omitted in order to avoid repetition. For overhaul procedures the assumption is made that the engine is removed from the application.

How to use this manual

This manual is illustration based and is divided into 16 chapters. The illustrations in each chapter follow the sequence for the complete dismantle of a particular assembly or component. Assembly is achieved by the use of the illustrations in reverse order from the rear of the chapter. In assembly and inspection, all parts are to be thoroughly cleaned, lubricated, and where present, burrs and scale to be removed. Any open ports of high precision components, e.g. fuel injection equipment that are exposed when dismantled, must be blanked off until assembly, to prevent the ingress of foreign matter.

Where the information applies to certain types of engine only, this is indicated in the illustrations. When set screws are fitted in "through" holes into the cylinder block, a suitable sealant should be used. In this manual, when the "left" or "right" of the engine is referred to, it is that side of the engine when viewed from the flywheel end.

Special tools have been made available and a list of these is given in Chapter 16. At the start of each operation reference to the relevant special tools is made.

POWERPART consumable products are listed on page 5. At the start of each operation reference to the necessary consumable products is made.

Data and dimensions are provided as part of each operation and also in Chapter 2.

Always use the full engine number to order new parts.

Read and remember the "Safety precautions" on page 2. They are given for your protection and must be used at all times.

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.

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 any 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 absolutely necessary).
- Do not clean, add lubricating oil, or adjust the engine during operation (unless you have had the correct training; even then extreme caution must be used to prevent injury).
- Do not make any adjustments you do not understand.
- Ensure 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 whilst the engine and auxiliary equipment is in operation. Do not permit loose clothing or long hair near parts which move.
- Keep away from moving parts during engine operation.

Warning! *Some parts cannot be seen clearly while the engine is running.*

- Do not run the engine with any safety guards removed.
- Do not remove the filler cap or any component of the cooling system whilst the engine is hot and while the coolant is under pressure, because dangerous hot coolant can be discharged.
- Do not use salt water in the fresh water cooling system or any other coolant which can cause corrosion.
- Do not allow sparks or fire near the batteries (especially during charging), as the gases from the electrolyte are highly flammable. The battery fluid can burn and is also dangerous to the skin and especially the eyes.
- Disconnect the battery terminals before you make a repair to the electrical system.
- Only one person must be in control of the engine. Ensure the engine is only operated from the control panel or operator's position.
- If your skin comes into contact with high pressure fuel, get medical assistance immediately.
- Diesel fuel and used engine oils can cause skin damage to some persons. Use protection on the hands (gloves or special protection solutions).
- Do not move equipment unless the brakes are in good condition.
- Do not use ether or other starting fluids to start these engines.
- 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 a safe place to prevent contamination.
- Use extreme care if emergency repairs must be made in adverse conditions.
- The combustible material of some components of the engine can be extremely dangerous if burnt. Never let this material come into contact with skin or the eyes. Refer to "Viton seals" on page 11.
- Do not allow compressed air to contact the skin. If compressed air enters the skin seek medical help immediately.
- 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 clean an engine whilst it is running. If cold cleaning fluids are applied to a hot engine, certain components on the engine may be damaged.

Continued

- Ensure that the control lever of the transmission drive is in the "out of drive" position before the engine is started.
- Read and use the instructions relevant to "Engine lift equipment" on page 10.
- Do not use more than 50% anti freeze concentration by volume at high ambients, otherwise engine damage will result.
- Fit only genuine Perkins Parts.

Engine preservation

Introduction

The recommendations indicated below are designed to prevent damage to the engine when it is withdrawn from service for a prolonged period. Use these procedures after the engine is withdrawn from service. The instructions for the use of POWERPART products are given on the outside of each container.

Procedure

1 Completely clean the outside of the engine.

2 When a preservative fuel is to be used, drain the fuel system and fill it with the preservative fuel. POWERPART Lay-Up 1 can be added to the normal fuel to change it to a preservative fuel. If preservative fuel is not used, the system can be completely filled with normal fuel but the fuel must be drained and discarded at the end of the storage period together with the fuel filter canister.

3 Operate the engine until it is warm. Then correct leakages of fuel, lubricating oil or air. Stop the engine and drain the lubricating oil from the sump.

4 Renew the canister of the lubricating oil filter.

5 Fill the sump to the full mark with new and clean lubricating oil and add POWERPART Lay-up 2 to the oil to protect the engine against corrosion. If POWERPART Lay-Up 2 is not available, use a correct preservative fluid instead of the lubricating oil. If a preservative fluid is used, this must be drained and the lubricating oil sump must be filled to the correct level with normal lubricating oil at the end of the storage period.

6 Drain the coolant circuit, In order to protect the cooling system against corrosion, fill it with an approved antifreeze mixture because this gives protection against corrosion.

Caution: *Certain corrosion inhibitor mixtures could cause damage to some engine components. It is recommended that you consult the Perkins Service Department, Peterborough.*

7 Operate the engine for a short period in order to circulate the lubricating oil and the coolant in the engine.

8 Disconnect the battery. Then put the battery into safe storage in a fully charged condition. Before the battery is put into storage, protect its terminals against corrosion. POWERPART Lay-Up 3 can be used on the terminals.

9 Clean the engine breather pipe (if one is fitted) and seal the end of the pipe.

10 Remove the atomisers and spray POWERPART Lay-Up 2 for one to two seconds into each cylinder bore with the piston at BDC.

Slowly turn the crankshaft one revolution and then fit the atomisers, complete with new seat washers.

11 Remove the air filter. Then, if necessary, remove the pipe installed between the air filter and the induction manifold. Release the cap screws and remove the rocker cover. Spray POWERPART Lay-Up 2 around the rocker shaft assembly and into the induction ports in the cylinder head, as indicated on the container label. Fit the rocker cover. Seal the manifold with waterproof tape.

12 Remove the exhaust pipe. Spray POWERPART Lay-Up 2 into the exhaust manifold. Seal the manifold with waterproof tape.

13 Seal the vent pipe of the fuel tank or the fuel filler cap with waterproof tape.

14 Remove the alternator drive belt and put it into storage.

15 In order to prevent corrosion, spray the engine with POWERPART Lay-Up 3. Do not spray the area inside the alternator cooling fan.

Caution: *After a period in storage, but before the engine is started, operate the starter motor with the stop switch held in the "STOP" position until oil pressure is indicated. Oil pressure is indicated when the low pressure warning light is extinguished. If a solenoid stop control is used on the fuel injection pump, it must be disconnected for this operation.*

If the engine protection is done correctly according to the above recommendations, no corrosion damage will normally occur. Perkins are not responsible for damage which may occur when an engine is in storage after a period in service.

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 Anti-freeze

Protects the cooling system against frost and corrosion (1 litre).

Part number 21825166.

POWERPART Easyflush

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 other closed systems.

Part number 1762811.

POWERPART Lay-up 3

Protects outside metal parts.

Part number 1734115.

POWERPART Repel

Dries damp equipment and gives protection against corrosion. Passes through dirt and corrosion to lubricate and to assist removal of components.

Part number 21825164.

POWERPART Platelock

For tight fitted metal surfaces. Suitable for metal plated surfaces and stainless steel.

Part number 21826039.

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 that have an interference fit.

Part number 21820638.

POWERPART Red rubber grease

Provides lubrication for the fitting “O” rings.

Part number 21820221.

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 that prevents leakage through gaps.

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 that seals joints.

Part number 1861117.

Engine I.D. location

The engine identification plate (A1) is located on the front right side of the engine, just above the fuel injection pump.

It consists of the following:

Abbreviations and codes

Engine build list (parts list) numbering system

The standard engine parts list numbering code system is defined as follows:

Code	I	II	III	IV	V
Example	KE	30260	U	000001	D

Code I Engine Build Code

Engine	Build code	Engine	Build code
102 - 05	KN	103 - 15	KE
103 - 07	KL	104 - 19	KF
103 - 10	KD	104 - 22	KR
103 - 13	KH		

Code II Engine parts list

Parts list increases numerically for both OEMS and distributors.

Code III Country of manufacture

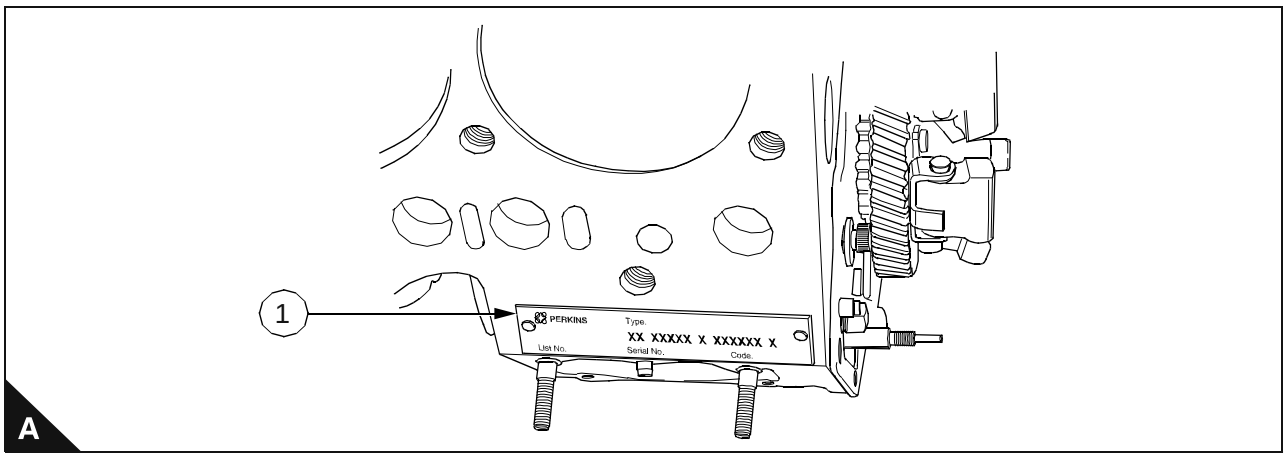
Code	Country of manufacture
J	Made in Japan
U	Made in U.K.

Code IV Engine serial number

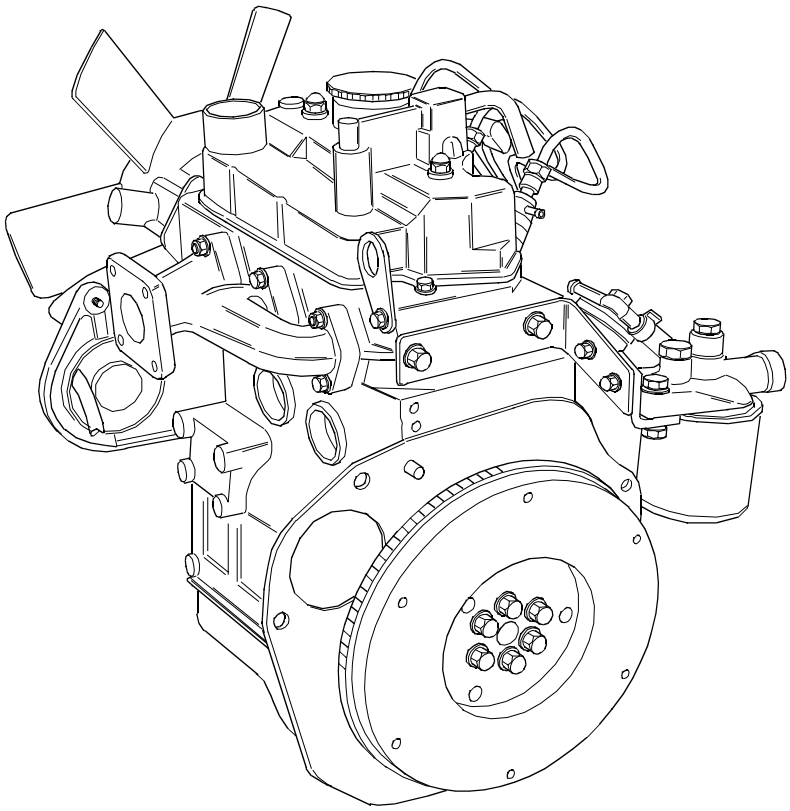
Individual engine serial number commencing with 000001 increasing numerically.

Code V Year of Manufacture

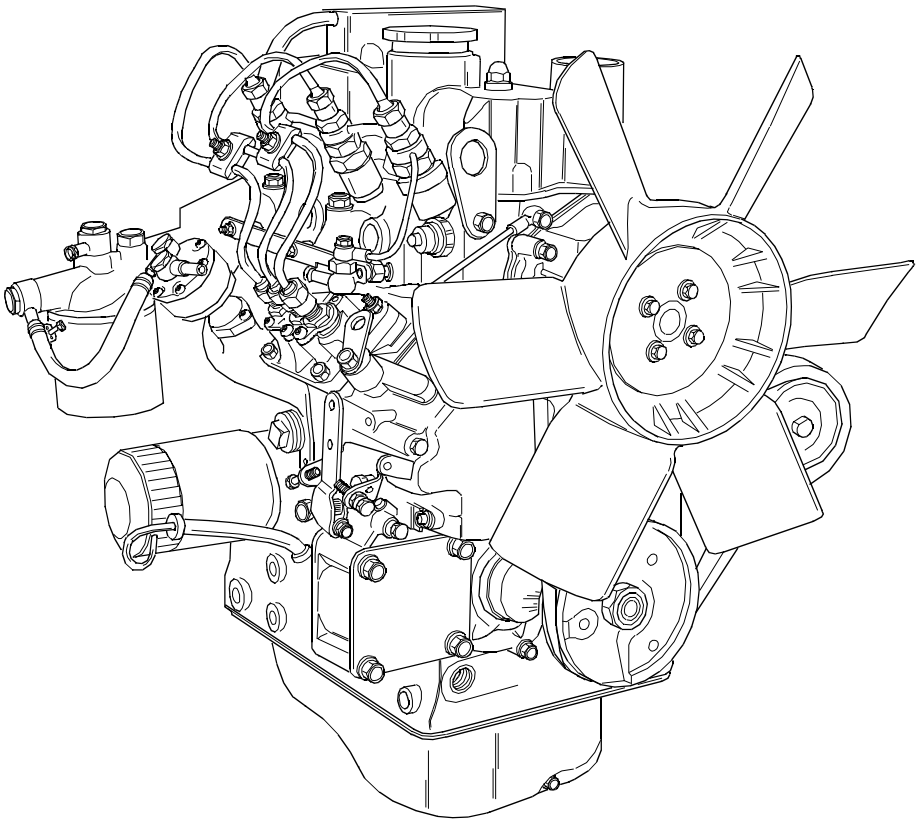
Code	Year	Code	Year	Code	Year	Code	Year	Code	Year
M	1985	T	1989	Y	1994	E	01/01/99 31/03/99	J	2002
N	1986	U	1990	A	1995	F	01/04/99 31/12/99	K	2003
O	not used	V	1991	B	1996	G	2000	L	2004
P	1987	W	1992	C	1997	H	2001		
Q/S	1988	X	1993	D	1998	I	not used‘		



Engine views - 3 cylinder front and rear

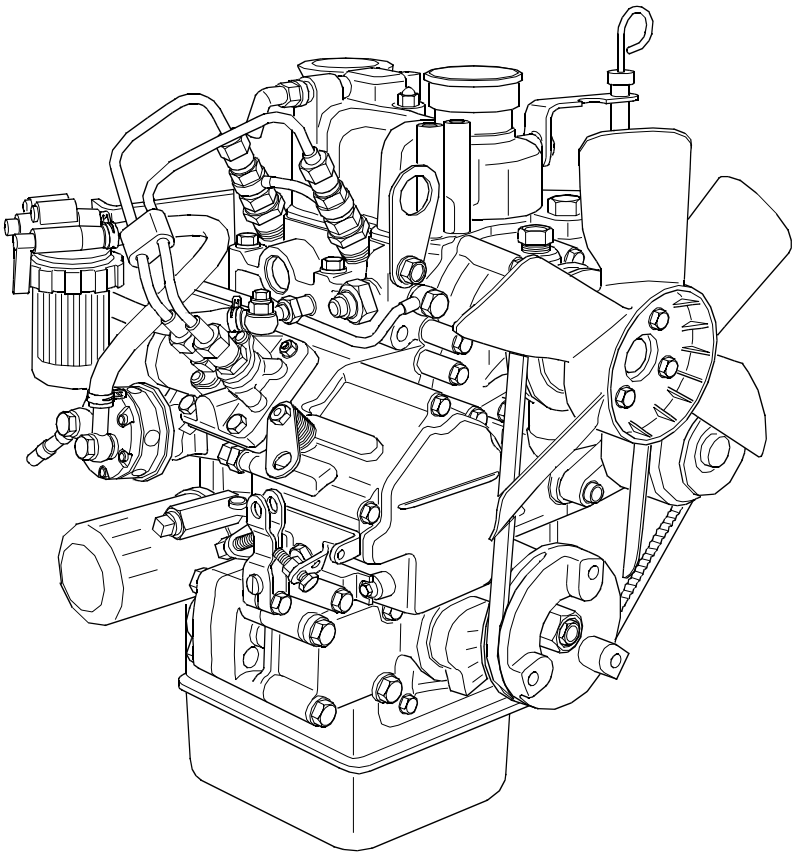


A

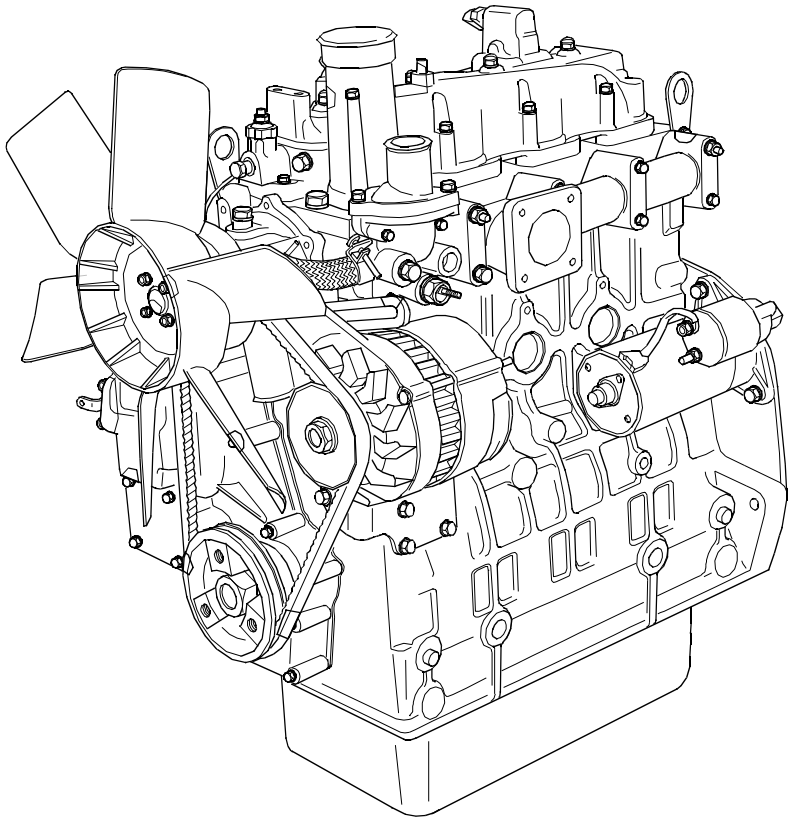


B

Engine views - 2 cylinder front and 4 cylinder front



A



B

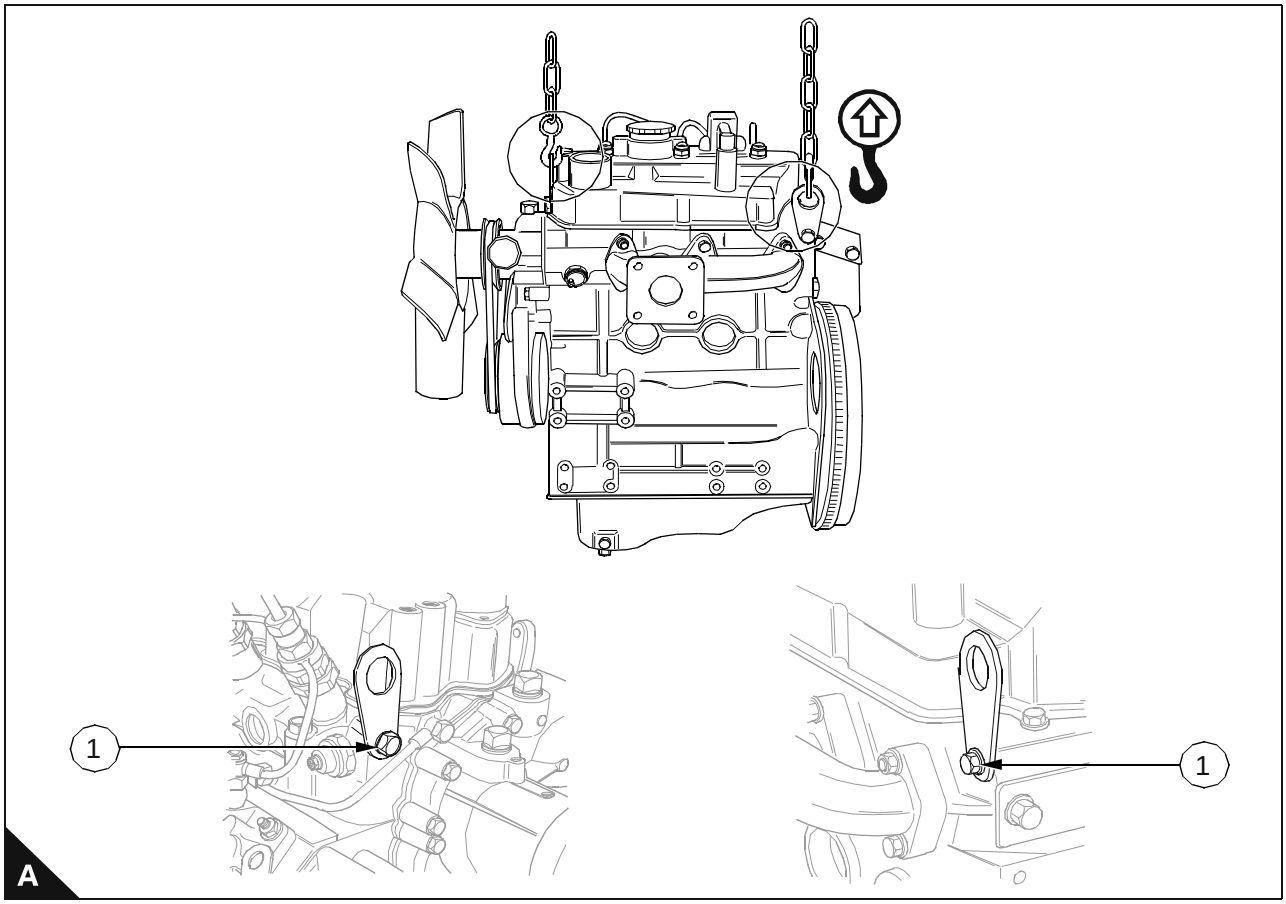
Engine lift equipment

Special requirements

Torque Nm (lbf ft) kgf m	
Lifting hook bolts (A1)	26 (19) 2,6

Maximum engine weights (dry) with flywheel and housing fitted

Engine model	102-05	103-07	103-10	103-13	103-15	104-19	104-22
Engine build code	KN	KL	KD	KH	KE	KF	KR
Max engine weight	79 kg	87 kg	111 kg	164 kg	176 kg	207 kg	220 kg



Viton seals

Some seals used in engines and in components fitted to engines are made of Viton.

Viton is used by many manufacturers 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.

Warning! *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 the use of a high pressure hose.

*Cautions***:**

- *Do not wash an engine while the engines runs or if 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), glow plugs, 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 of the engine could be damaged, fail to operate and also make the manufacturer's warranty invalid.

Engines that conform to Emissions Levels

Engines that are fitted with an emissions label on the timing case conform to stage 1 emissions legislation and, for certain service procedures, additional information is included to ensure that the engine remains emissions approved.

Compression test data

Tests have shown that many factors affect compression pressures. Battery, starter motor condition, ambient conditions and the type of gauge used can give a wide variation of results for a given engine.

Engine model	Pressure kPa (lbf/in²)	
	Standard	To be repaired
102-05, 103-07, 103-10, 103-13	>2940 (426.6) @ 200 rev/min	<2450 (355.5)
103-15, 104-19, 104-22	>2940 (426.6) @ 250 rev/min	<2450 (355.5)

A compression test 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.

A compression test should not be the only method used to show the condition of an engine, but it 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 that it is fully charged. Also ensure that the starter motor is in good condition.

1 To ensure that the engine cannot start, disconnect the engine stop solenoid or ensure the engine stop control is in the ‘stop’ position.

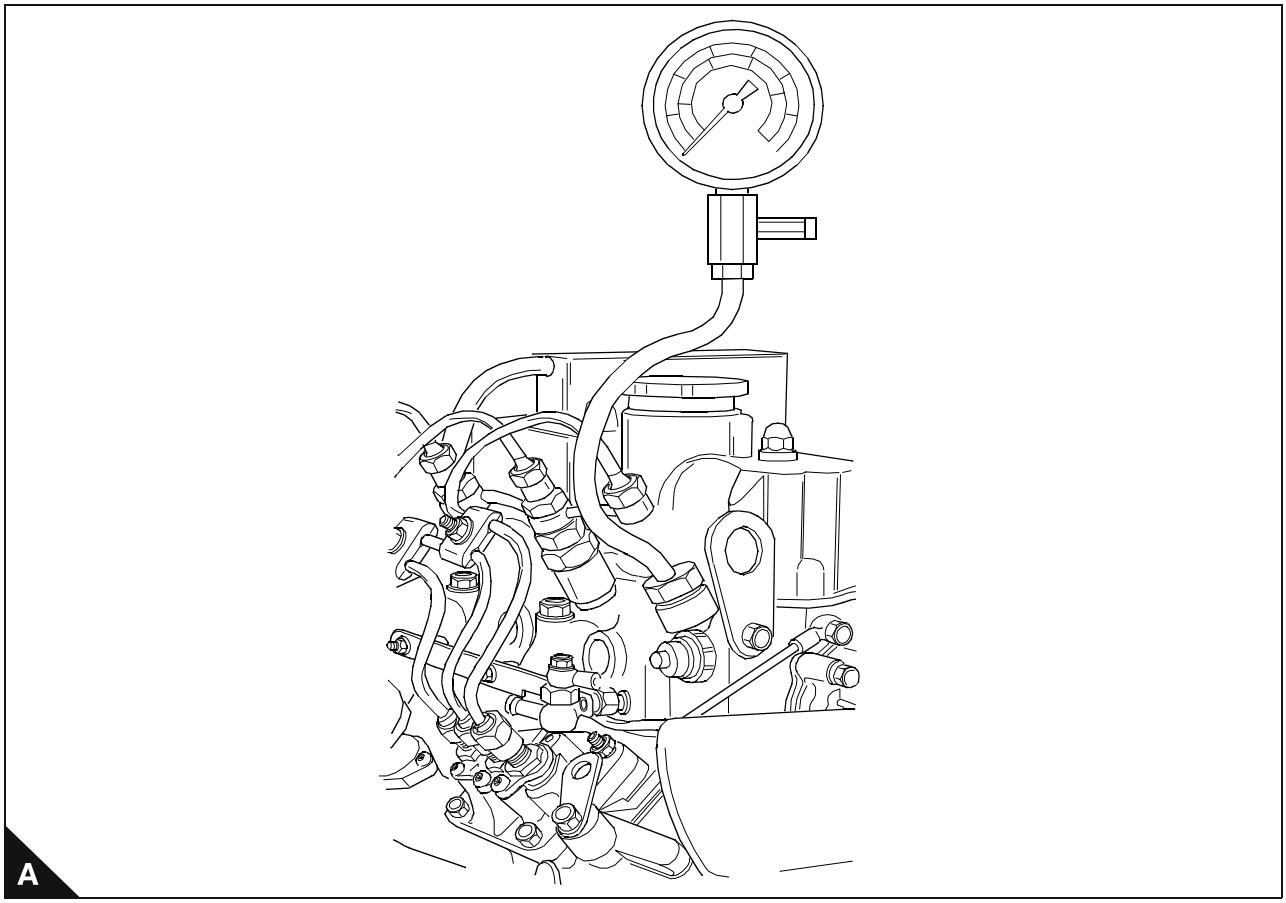
2 Ensure that the valve tip clearances are set correctly.

3 Remove the atomisers.

4 Fit a suitable gauge into the atomiser hole of the cylinder to be tested.

5 Operate the starter motor and record the pressure indicated on the gauge.

6 Repeat for each cylinder.



2

Specifications

Basic engine data

Engine model	102-05	103-07	103-10	103-13	103-15	104-19	104-22
Engine build code	KN	KL	KD	KH	KE	KF	KR
Number of cylinders	2	3	3	3	3	4	4
Cylinder arrangement and cycle	Vertical in line, four stroke cycle						
Direction of rotation	Clockwise, viewed from front						
Induction system	Naturally aspirated						
Combustion system	IDI special swirl						
Nominal bore	67 mm (2.6 in)	67 mm (2.6 in)	75 mm (2.9 in)	84 mm (3.3 in)	84 mm (3.3 in)	84 mm (3.3 in)	84 mm (3.3 in)
Stroke	64 mm (2.5 in)	64 mm (2.5 in)	72 mm (2.8 in)	80 mm (3.1 in)	90 mm (3.5 in)	90 mm (3.5 in)	100 mm (3.9 in)
Compression ratio	24:1	24:1	23:1	22:1	22.5:1	22:1	22:1
Cubic capacity	0,451 ltrs. (27.5 in^3)	0,676 ltrs. (41.2 in^3)	0,954 ltrs. (58.2 in^3)	1,330 ltrs. (81.1 in^3)	1,496 ltrs. (91.2 in^3)	1,995 ltrs. (121.7 in^3)	2,216 ltrs. (135.2 in^3)
Firing order	1, 2	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 3, 4, 2	1, 3, 4, 2
Oil pressure relief	262-359 KPa						352-448 KPa
Oil pressure switch	29,6 KPa						
Valve tip clearance (cold)							
-Inlet	0,2 mm (0.0078 in)						
-Exhaust	0,2 mm (0.0078 in)						
Electrical system	12 volt						
Governor	Mechanical all speed						
Fuel injection	Cassette type fuel injection system						

Thread Sealant

When setscrews or studs are fitted into holes which are tapped through the cylinder block, a suitable sealant must be used to prevent leakage.

Micro encapsulated anaerobic sealant (M.E.A.S) fasteners have been introduced 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 a red, blue, or other colour sealant around the fastener threads.

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

Note: New setscrews have sealant applied by the manufacturer to the first 13,0 mm (0.50 in) of the threads. If the setscrews are to be used again, clean the old sealant from the male and female threads and apply new sealant, (Powerpart Threadlock and Nutlock) to the setscrews.

Recommended torque tensions

Most of the torques on the engine are standard. Torques specific to individual operations are listed in the relevant operation. The standard torques listed in the tables below can be used when a specific torque is not necessary.

Note: The torques below apply to components lubricated lightly with clean engine oil before they are fitted.

Standard torques for setscrews, studs and nuts

Thread size	Bolt Strength	Coarse Screw Thread				Fine Screw Thread			
		Pitch (mm)	Torque (Nm)	Torque (lbf ft)	Torque (kgf m)	Pitch (mm)	Torque (Nm)	Torque (lbf ft)	Torque (kgf m)
M4	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 20,5

Examples of applicable material

Bolt Strength	Example
8.8 11T	S45C SCM435

Data and dimensions

Note: The information in this Workshop Manual is given as a guide for personnel engaged on engine overhauls. The dimensions which are shown are those which are mainly used in production.

Injection timing

Engine build list	Engine type	Injection timing
KN30305, KN30306 KN30308, KN30309	102-05	25.5° ± 1°
KN30304, KN30327	102-05	27.5° ± 1°
KL30317, KL30318 KL30319, KL30320 KL30323, KL30324 KL30325, KL30326	103-07	17.0° ± 1°
KD30238, KD30239 KD30240	103-10	23.0° ± 1°
KD30241, KD30242 KD30247, KD30248	103-10	22.5° ± 1°
KD30245, KD30246	103-10	18.5° ± 1°
KH30255, KH30256 KH30273	103-13	22.5° ± 1°
KE30260, KE30261 KE30274	103-15	22.5° ± 1°
KE30262, KE30263	103-15	16.0° ± 1°
KF30265, KF30266 KF30276	104-19	21.5° ± 1°
KR30334, KR30335	104-22	16.0° ± 1°
KR30331, KR30332 KR30333	104-22	20.0° ± 1°

Note: OEM build lists can be found on the relevant service bulletin. If the timing is incorrect refer to "Fuel injection pump timing" on page 85.

Cylinder bore dimensions

Engine model/Block specification	Bore dimension mm (in)	
	Standard	Service limit
102-05, 103-07		
New Block	67,000 - 67,019 (2.63780 - 2.63854)	67,2 (2.646)
1st oversize bore 0,5 mm (0.2 in)	67,500 - 67,519 (2.65750 - 2.65822)	67,7 (2.666)
2nd oversize bore 1,0 mm (0.4 in)	68,000 - 68,019 (2.67720 - 2.67791)	68,2 (2.685)
103-10		
New Block	75,000 - 75,019 (2.95280 - 2.95350)	75,2 (2.961)
1st oversize bore 0,5 mm (0.2 in)	75,500 - 75,519 (2.97244 - 2.97318)	75,7 (2.981)
2nd oversize bore 1,0 mm (0.4 in)	76,000 - 76,019 (2.99212 - 2.99287)	76,2 (2.999)
103-13, 103-15, 104-19, 104-22		
New Block	84,000 - 84,019 (3.30710 - 3.30783)	84,2 (3.315)
1st oversize bore 0,5 mm (0.2 in)	84,500 - 84,519 (3.32677 - 3.32751)	84,7 (3.335)
2nd oversize bore 1,0 mm (0.4 in)	85,000 - 85,019 (3.34650 - 3.34719)	85,2 (3.354)

Caution: *When service limits are exceeded following a second oversize bore operation, the block* ***must*** *be renewed.*

Piston and piston ring dimensions

Piston

If the outer surface of the piston is excessively damaged (cracked, scored, or it shows signs of being burnt etc.) it must be renewed.

Piston skirt

1 Check the larger diameter of the piston skirt (10 mm from bottom) with reference to the following tables.

102-05, 103-07, 103-10, 103-13

Piston size	Diameter mm (in)		
	102-05, 103-07	103-10	103-13
Standard	66,9375 - 66,9525 (2.6353- 2.6359)	74,9325 - 74,9475 (2.950100 - 2.950690)	83,948 - 83,963 (3.30503 - 3.30562)
0,5 mm oversize	67,4375 - 67,4525 (2.6550 - 2.6556)	75,4325 - 75,4475 (2.969780 - 2.970370)	84,448 - 84,463 (3.32472 - 3.32531)
1,0 mm oversize	Not applicable	75,9325 - 75,9475 (2.989463 - 2.990060)	84,948 - 84,963 (3.34440 - 3.34499)

103-15, 104-19, 104-22

Piston size	Diameter mm (in)	
	103-15, 104-19	104-22
Standard	83,948 - 83,963 (3.30503 - 3.30567)	83,948 - 83,963 (3.30503 - 3.30562)
0,5 mm oversize	84,448 - 84,463 (3.32472 - 3.32531)	84,448 - 84,463 (3.32472 - 3.32531)
1,0 mm oversize	84,948 - 84,963 (3.34440 - 3.34499)	84,948 - 84,963 (3.34440 - 3.34499)

2 Check inside diameter (thrust direction) of the cylinder.

Engine model	Diameter mm (in)	
	Standard	Service limit
102-05, 103-07	66,9375 - 66,9525 (2.6353 - 2.6359)	66,7 (2.626)
103-10	74,9325 - 74,9475 (2.950100 - 2.950690)	74,7 (2.941)
103-13, 103-15, 104-19, 104-22	83,948 - 83,963 (3.30503 - 3.30562)	83,7 (3.295)

3 Calculate the clearance between the cylinder and piston. If this clearance is more than standard, or the piston diameter is less than the service limit, renew the piston.

Engine model	Clearance mm (in)	
	Standard	Service limit
102-05, 103-07	0,048 - 0,082 (0.00189 - 0.00323)	0,25 (0.010)
103-10	0,0525 - 0,0865 (0.002070 - 0.003406)	0,25 (0.010)
103-13, 103-15, 104-19, 104-22	0,038 - 0,072 (0.00150 - 0.00283)	0,25 (0.010)

Oversized piston

When the cylinder is oversized, ensure that the correct oversized piston and piston ring set is used.

Note: Ring sets are available for all pistons listed above.

Gudgeon pin

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

Engine model	Diameter mm (in)	
	Standard	Service limit
102-05, 103-07	18,998 - 19,002 (0.74795 - 0.74811)	18,98 (0.7472)
103-10	20,998 - 21,002 (0.82669 - 0.82685)	20,98 (0.8259)
103-13	24,996 - 25,00 (0.98410 - 0.98425)	24,98 (0.9835)
103-15	27,996 - 28,000 (1.10220 - 1.10240)	27,98 (1.1016)
104-19	27,996 - 28,000 (1.10220 - 1.10240)	27,98 (1.1016)
104-22	27,996 - 28,000 (1.10220 - 1.10240)	27,98 (1.1016)

2 Check the clearance between gudgeon pin hole and gudgeon pin. Check the inside diameter of the gudgeon pin hole and the outside diameter of the gudgeon pin, and calculate the clearance between them. If the clearance is more than the service limit, renew the piston and gudgeon pin.

Engine model	Clearance mm (in)	
	Standard	Service limit
102-05, 103-07, 103-10	-0,004 to +0,004 (-0.00016 to +0.00016)	0,02 (0.0008)
103-13, 103-15, 104-19, 104-22	-0,001 to +0,007 (-0.00040 to +0.00030)	0,02 (0.0008)

Crankshaft deflection

1 Support the crankshaft with a V-block.

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 correction or replacement of the crankshaft is needed.

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

4 If measured diameter is less than the service limit, correct by grinding and use undersized bearings and bush.

Crankshaft inspection

1 Check the oil seal contact face for damage or wear.

2 Check oil holes for blockage.

3 Check crankshaft journal (A4) and 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

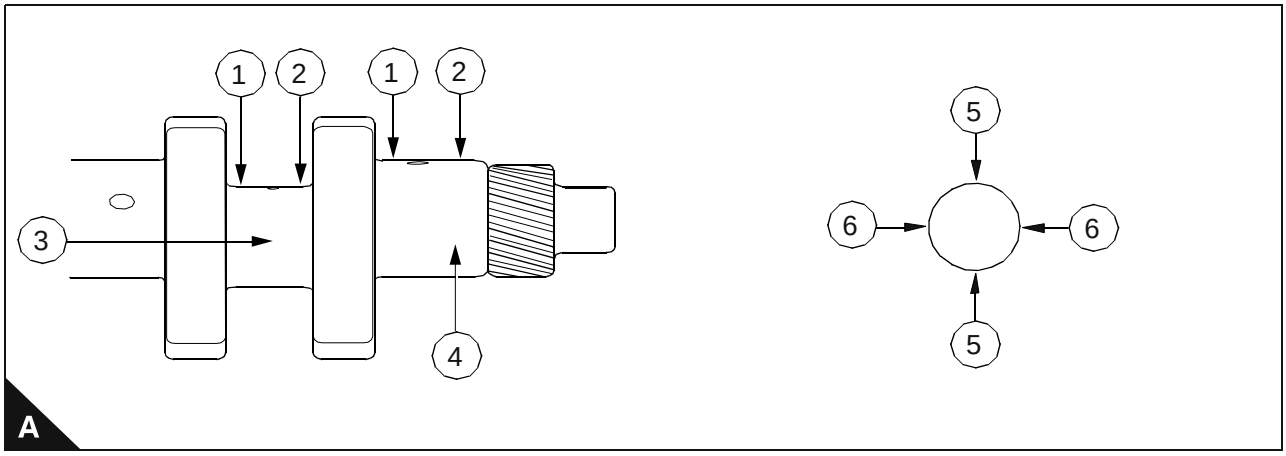
When grinding the crankshaft, work with the following specifications:

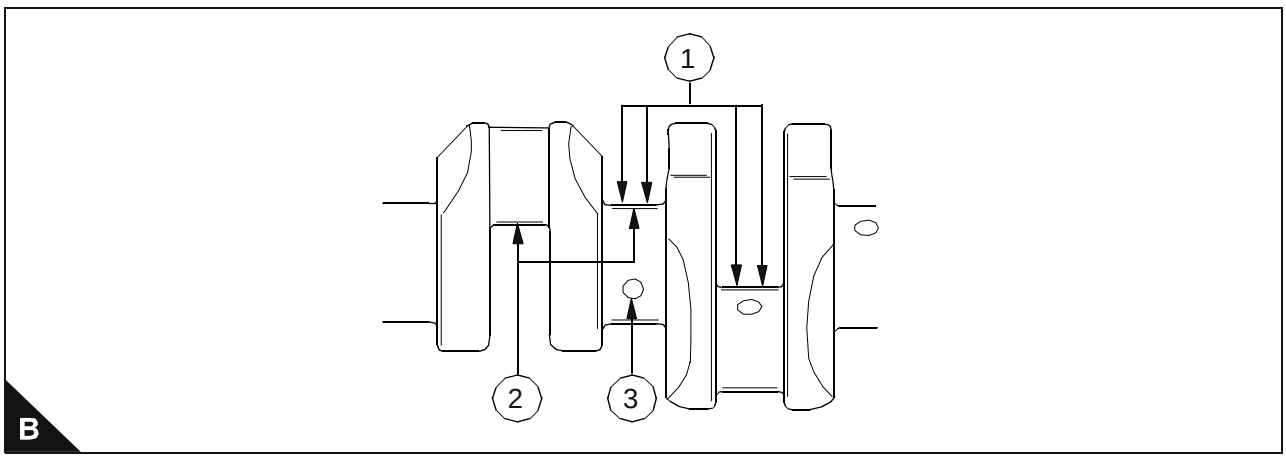
Radius at pin/journal (B1): 3 mm ± 0,2 mm (0.118 in ± 0.0078 in).

Finish precision (B2): 1.6Z

Radius around oil hole (B3): 2 mm (0.0787 in) maximum/5 mm (0.196 in) minimum.

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





Crankshaft journal diameters

Engine model/Journal type	Journal No.	Diameter mm (in)	
		Standard	Service limit
102-05			
Standard	1	42,964 - 42,975 (1.69150 - 1.69193)	42,90 (1.689)
	2	45,948 - 45,959 (1.80897 - 1.80941)	45,90 (1.807)
Undersize 0,25 mm (0.01 in)	1	42,714 - 42,725 (1.68165 - 1.68210)	42,65 (1.679)
	2	45,698 - 45,709 (1.79913 - 1.79960)	45,65 (1.797)
Undersize 0,50 mm (0.02 in)	1	42,464 - 42,475 (1.67181 - 1.67224)	42,40 (1.669) **(1)**
	2	45,448 - 45,459 (1.78930 - 1.78972)	45,40 (1.787) **(1)**
103-07			
Standard	1, 2	42,964 - 42,975 (1.69150 - 1.69193)	42,90 (1.689)
	3	45,948 - 45,959 (1.80897 - 1.80941)	45,90 (1.807)
Undersize 0,25 mm (0.01 in)	1, 2	42,714 - 42,725 (1.68165 - 1.68210)	42,65 (1.679)
	3	45,698 - 45,709 (1.79913 - 1.79960)	45,65 (1.797)
Undersize 0,50 mm (0.02 in)	1, 2	42,464 - 42,475 (1.67181 - 1.67224)	42,40 (1.669) **(1)**
	3	45,448 - 45,459 (1.78930 - 1.78972)	45,40 (1.787) **(1)**
103-10			
Standard	1, 2, 3	45,964 - 45,975 (1.80960 - 1.81004)	45,90 (1.807)
Undersize 0,25 mm (0.01 in)	1, 2, 3	45,714 - 45,725 (1.79980 - 1.80020)	45,65 (1.797)
Undersize 0,50 mm (0.02 in)	1, 2, 3	45,464 - 45,475 (1.78992 - 1.79035)	45,40 (1.787) **(1)**
103-13			
Standard	1, 2, 3	57,957 - 57,970 (2.28177 - 2.28228)	57,9 (2.280)
Undersize 0,25 mm (0.01 in)	1, 2, 3	57,707 - 57,720 (2.27192 - 2.27244)	57,6 (2.268)
Undersize 0,50 mm (0.02 in)	1, 2, 3	57,457 - 57,470 (2.26210 - 2.26260)	57,4 (2.260) **(1)**
103-15			
Standard	1, 2, 3	67,957 - 67,970 (2.67550 - 2.67597)	67,90 (2.6732)
Undersize 0,25 mm (0.01 in)	1, 2, 3	67,707 - 67,720 (2.66563 - 2.66614)	67,65 (2.6634)
Undersize 0,50 mm (0.02 in)	1, 2, 3	67,457 - 67,470 (2.65579 - 2.65630)	67,40 (2.6535) **(1)**
104-19, 104-22			
Standard	1, 2, 3, 4	67,957 - 67,970 (2.67550 - 2.67597)	67,90 (2.6732)
Undersize 0,25 mm (0.01 in)	1, 2, 3, 4	67,707 - 67,720 (2.66563 - 2.66614)	67,65 (2.6634)
Undersize 0,50 mm (0.02 in)	1, 2, 3, 4	67,457 - 67,470 (2.65579 - 2.65630)	67,40 (2.6535) **(1)**

(1) If the diameter is less than this value, the crankshaft must be renewed.

Crankshaft pin diameters

Engine model/Pin type	Diameter mm (in)	
	Standard	Service limit
102-05, 103-07		
Standard	34,964 - 34,975 (1.37653 - 1.37697)	34,90 (1.374)
Undersize 0,25 mm (0.01 in)	34,714 - 34,725 (1.36669 - 1.36712)	34,65 (1.364)
Undersize 0,50 mm (0.02 in)	34,464 - 34,475 (1.35685 - 1.35728)	34,40 (1.354) **(1)**
103-10		
Standard	38,964 - 38,975 (1.53401 - 1.53445)	38,90 (1.531)
Undersize 0,25 mm (0.01 in)	38,714 - 38,725 (1.52417 - 1.52460)	38,65 (1.5216)
Undersize 0,50 mm (0.02 in)	38,464 - 38,475 (1.51433 - 1.51476)	38,40 (1.5118) **(1)**
103-13		
Standard	43,964 - 43,975 (1.73090 - 1.73130)	43,90 (1.728)
Undersize 0,25 mm (0.01 in)	43,714 - 43,725 (1.72102 - 1.72145)	43,65 (1.719)
Undersize 0,50 mm (0.02 in)	43,464 - 43,475 (1.71120 - 1.71161)	43,40 (1.709) **(1)**
103-15, 104-19, 104-22		
Standard	51,964 - 51,975 (2.04582 - 2.04626)	51,90 (2.0433)
Undersize 0,25 mm (0.01 in)	51,714 - 51,725 (2.03598 - 2.03641)	51,65 (2.0335)
Undersize 0,50 mm (0.02 in)	51,464 - 51,475 (2.02614 - 2.02660)	51,40 (2.0236) **(1)**

(1) If the diameter is less than this value, the crankshaft must be renewed.

Bearing holder

Centre bearing

1 Remove the bearing holder and check it for stepped wear and other damage. If it is excessively damaged renew.

2 Using the Plastigauge ®, measure the oil clearance between the crankshaft centre journal and the bearing. If the oil clearance is more than the service limit, renew the bearing or grind the crankshaft centre journal and use an undersize bearing.

Engine model/Journal No.	Clearance mm (in)	
	Standard	Service limit
102-05		
No. 1	0,035 - 0,088 (0.00140 - 0.00350)	0,20 (0.0078)
No. 2	0,039 - 0,092 (0.00154 - 0.00362)	0,20 (0.0078)
103-07		
No. 1, 2	0,035 - 0,088 (0.00140 - 0.00350)	0,20 (0.0078)
No. 3	0,039 - 0,092 (0.00154 - 0.00362)	0,20 (0.0078)
103-10		
No. 1, 2, 3	0,039 - 0,092 (0.00154 - 0.00362)	0,20 (0.0078)
103-13, 103-15		
No. 1, 2, 3	0,044 - 0,102 (0.00173 - 0.00401)	0,20 (0.0078)
104-19, 104-22		
No. 1, 2, 3, 4	0,044 - 0,102 (0.00173 - 0.00401)	0,20 (0.0078)

Undersize bearing shell chart

Engine model/Bearing size	Journal No.	Crankshaft centre journal diameter mm (in)
102-05		
Standard	1	42,964 - 42,975 (1.69150 - 1.69193)
	2	45,948 - 45,959 (1.80897 - 1.80941)
Undersize 0,25 mm (0.01 in)	1	42,714 - 42,725 (1.68165 - 1.68210)
	2	45,698 - 45,709 (1.79913 - 1.79956)
Undersize 0,50 mm (0.02 in)	1	42,464 - 42,475 (1.67181 - 1.67224)
	2	45,448 - 45,459 (1.78930 - 1.78972)
103-07		
Standard	1, 2	42,964 - 42,975 (1.69150 - 1.69193)
	3	45,948 - 45,959 (1.80897 - 1.80941)
Undersize 0,25 mm (0.01 in)	1, 2	42,714 - 42,725 (1.68165 - 1.68210)
	3	45,698 - 45,709 (1.79913 - 1.79956)
Undersize 0,50 mm (0.02 in)	1, 2	42,464 - 42,475 (1.67181 - 1.67224)
	3	45,448 - 45,459 (1.78930 - 1.78972)
103-10		
Standard	1, 2, 3	45,964 - 45,975 (1.80960 - 1.81004)
Undersize 0,25 mm (0.01 in)	1, 2, 3	45,714 - 45,725 (1.79976 - 1.80019)
Undersize 0,50 mm (0.02 in)	1, 2, 3	45,464 - 45,475 (1.78992 - 1.79035)
103-13		
Standard	1, 2, 3	57,957 - 57,970 (2.28177 - 2.28228)
Undersize 0,25 mm (0.01 in)	1, 2, 3	57,707 - 57,720 (2.27192 - 2.27244)
Undersize 0,50 mm (0.02 in)	1, 2, 3	57,457 - 57,470 (2.26210 - 2.26260)
103-15		
Standard	1, 2, 3	67,957 - 67,970 (2.67550 - 2.67597)
Undersize 0,25 mm (0.01 in)	1, 2, 3	67,707 - 67,720 (2.66563 - 2.66614)
Undersize 0,50 mm (0.02 in)	1, 2, 3	67,457 - 67,470 (2.65579 - 2.65630)
104-19, 104-22		
Standard	1, 2, 3, 4	67,957 - 67,970 (2.67550 - 2.67597)
Undersize 0,25 mm (0.01 in)	1, 2, 3, 4	67,707 - 67,720 (2.66563 - 2.66614)
Undersize 0,50 mm (0.02 in)	1, 2, 3, 4	67,457 - 67,470 (2.65579 - 2.65630)

Crankshaft bearing bush

1 Check the bearing (bush) for damage or poor contact. If found to be defective, renew.

2 Using a cylinder gauge and micrometer, measure the clearance between the bearing (bush) and the crankshaft journal (B).

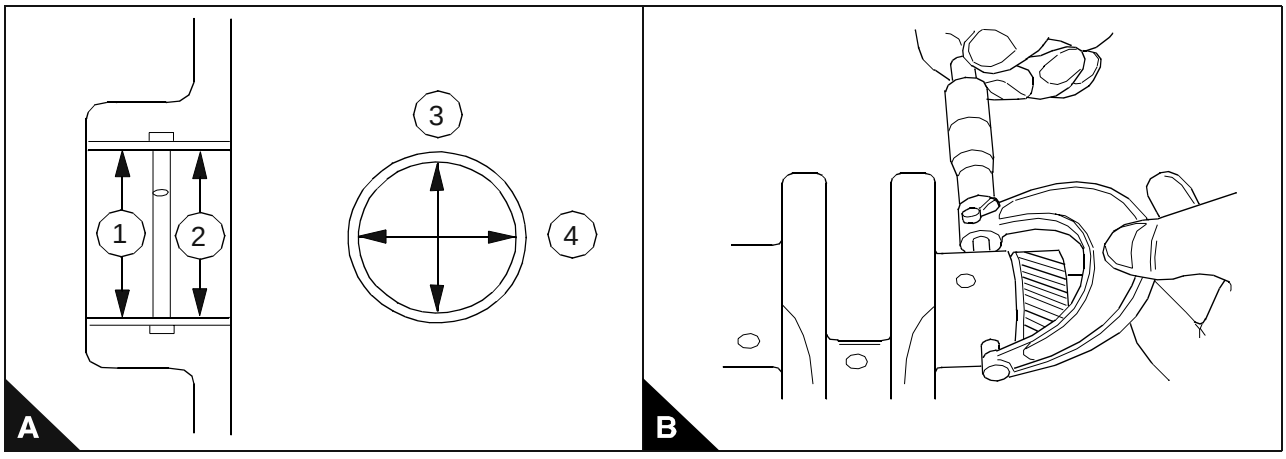
3 Measure inside diameters at positions (A1) and (A2). At each position measure in both directions (A3) and (A4) as shown. The oil clearance can be obtained by subtracting this value from the maximum crankshaft journal diameter.

Engine model	Clearance mm (in)	
	Standard	Service limit
102-05, 103-07	0,035 - 0,102 (0.00140 - 0.00401)	0,20 (0.0078)
103-10	0,039 - 0,106 (0.00154 - 0.00420)	0,20 (0.0078)
103-13, 103-15, 104-19, 104-22	0,044 - 0,116 (0.00173 - 0.00456)	0,20 (0.0078)

4 If the oil clearance exceeds the service limit renew the bearing (bush), or grind the crankshaft journal to the required specifications. In this case use an undersize bearing (bush).

5 To renew the crankshaft journal (bush), use a press to install.

Engine model/Bush size	Crankshaft journal O.D. finished size mm (in)
102-05, 103-07	
Standard	42,964 - 42,975 (1.69150 - 1.69193)
Undersize 0,25 mm (0.01 in)	42,714 - 45,725 (1.68165 - 1.68210)
Undersize 0,50 mm (0.02 in)	42,464 - 42,475 (1.67181 - 1.67224)
103-10	
Standard	45,964 - 45,975 (1.80960 - 1.81004)
Undersize 0,25 mm (0.01 in)	45,714 - 45,725 (1.79980 - 1.80020)
Undersize 0,50 mm (0.02 in)	45,464 - 45,475 (1.78992 - 1.79035)
103-13	
Standard	57,957 - 57,970 (2.28177 - 2.28228)
Undersize 0,25 mm (0.01 in)	57,707 - 57,720 (2.27192 - 2.27244)
Undersize 0,50 mm (0.02 in)	57,457 - 57,470 (2.26210 - 2.26260)
103-15, 104-19, 104-22	
Standard	67,957 - 67,970 (2.67550 - 2.67597)
Undersize 0,25 mm (0.01 in)	67,707 - 67,720 (2.66563 - 2.66614)
Undersize 0,50 mm (0.02 in)	67,457 - 67,470 (2.65579 - 2.65630)



3

Cylinder head assembly

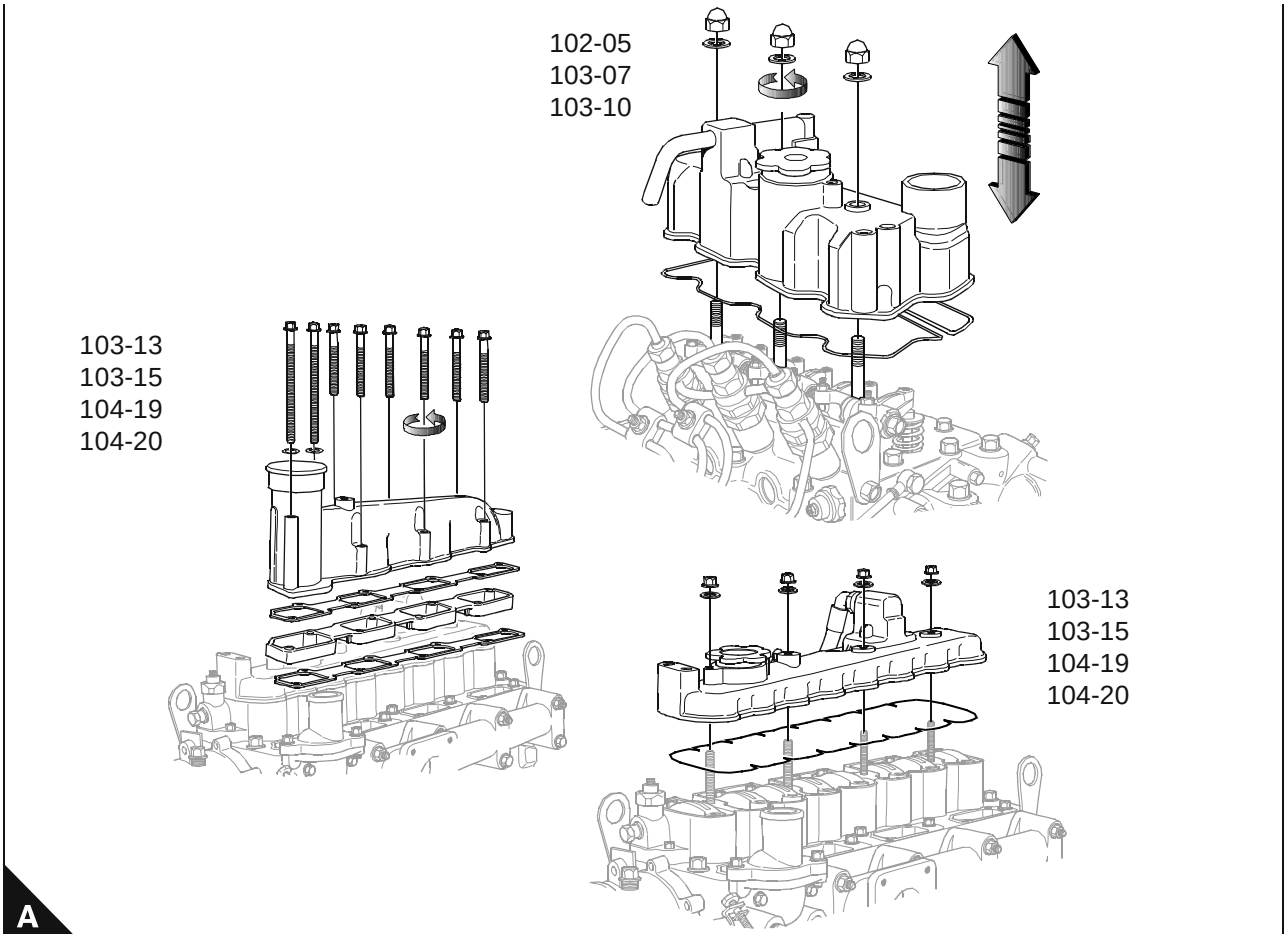
Rocker cover and inlet manifold

To remove and to fit **Operation 3-1**

Special requirements

Torque Nm (lbf ft) kgf m	
102-05, 103-07, 103-10	11 (8) 1,1
103-13, 103-15	10 (7) 1,0
104-19, 104-22	14 (10) 1,4

Note: Inspect the joint, renew if necessary.



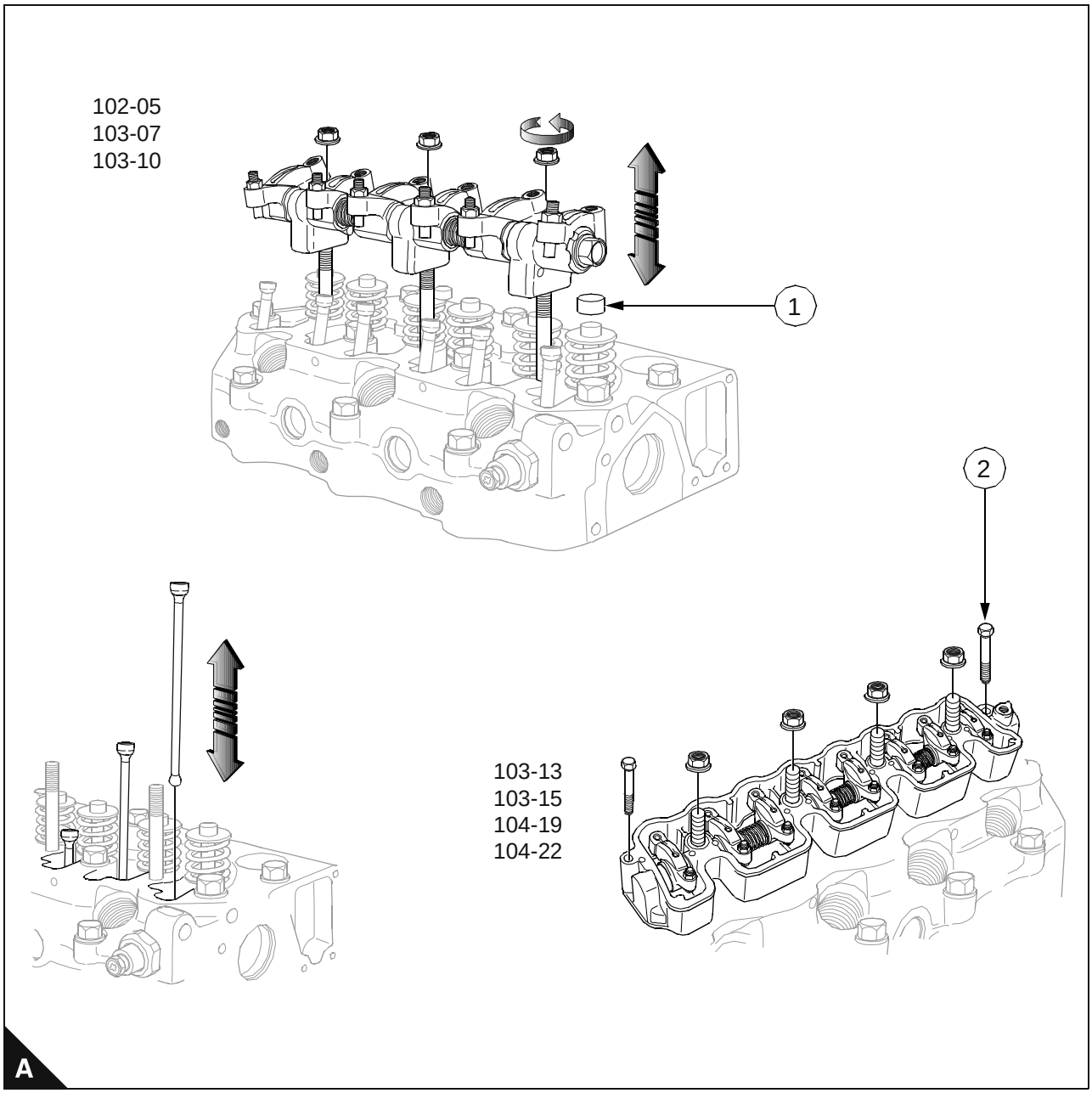
Rocker assembly

To remove and to fit **Operation 3-2**

Special requirements

Torque Nm (lbf ft) kgf m	
102-05, 103-07, 103-10	23 (17) 2,3
103-13, 103-15	23 (17) 2,3
104-19, 104-22	33 (24) 3,3
Bolts (A2)	6 (4) 0,6

Note: Ensure that the valve stem caps (A1) remain on the valve stems.

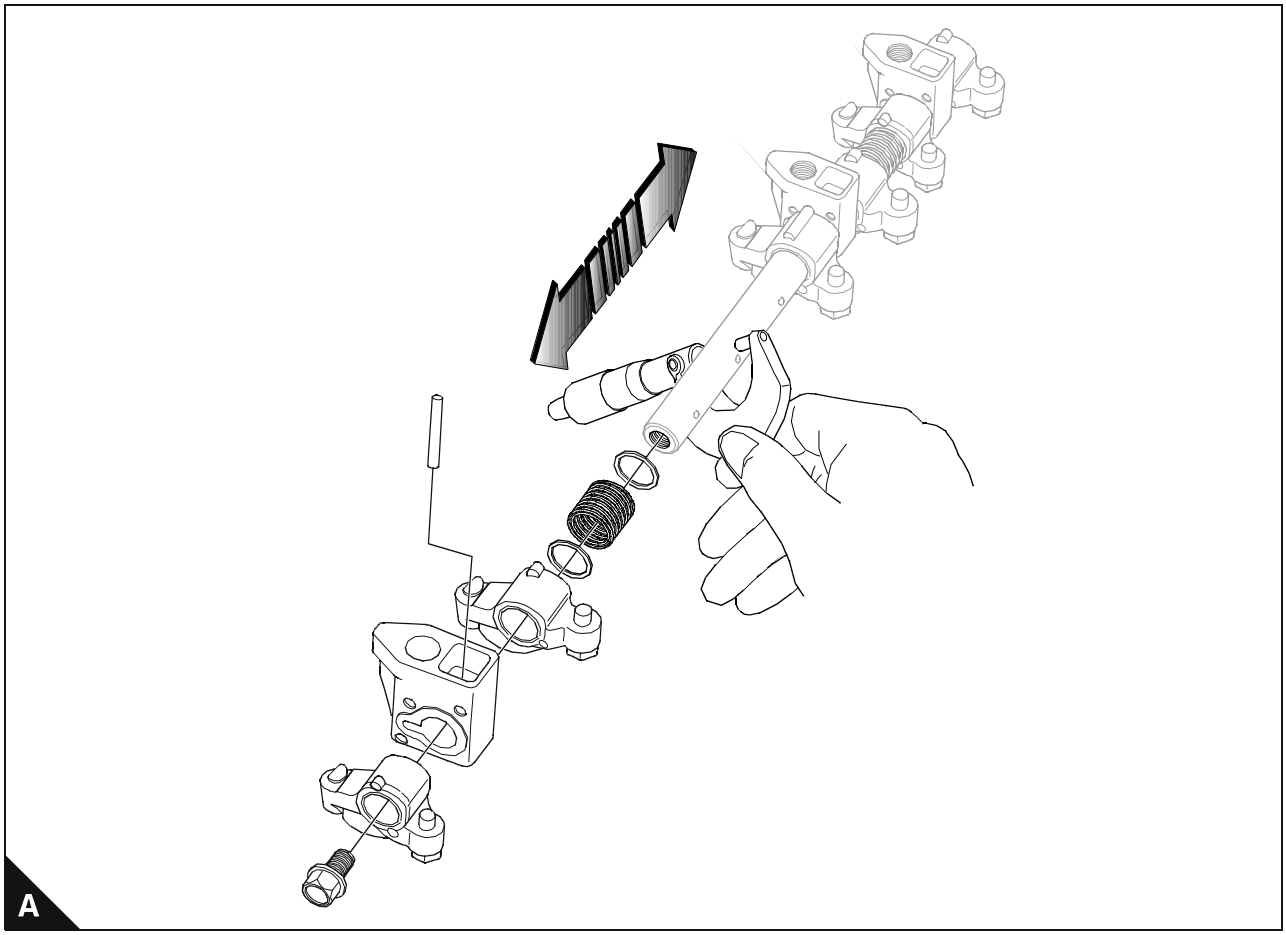


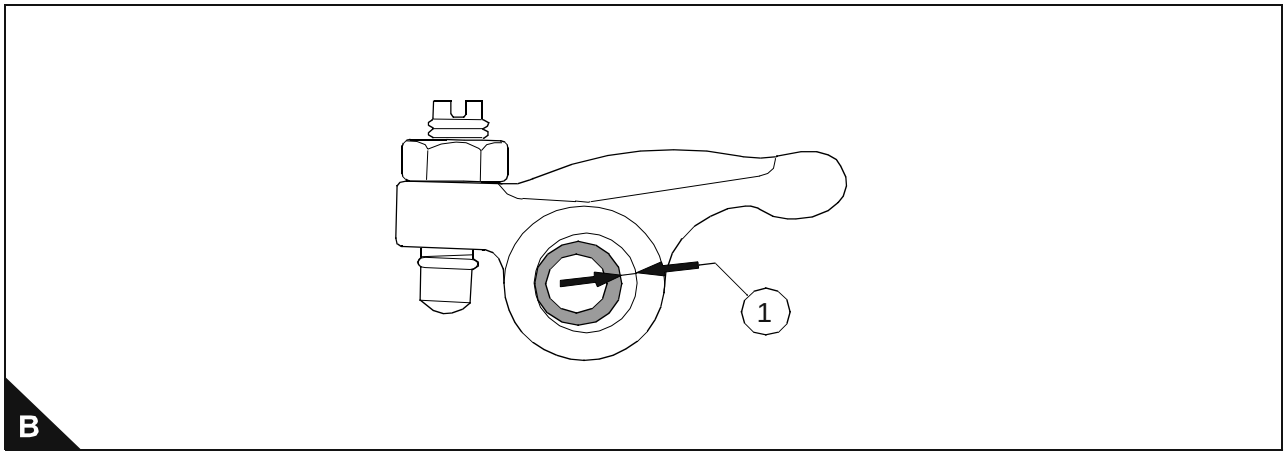
Rocker shaft (102-05, 103-07, 103-10)

To dismantle, to inspect and to assemble **Operation 3-3**

Special requirements

Diameter (A) mm (in)		Clearance (B1) mm (in)	
Standard	**Service limit**	**Standard**	**Service limit**
11,65 - 11,67 (0.4587 - 0.4595)	11,57 (0.4555) max	0,032 - 0,068 (0.00126 - 0.00268)	0,2 (0.008) max





Rocker shaft (103-13, 103-15, 104-19, 104-22)

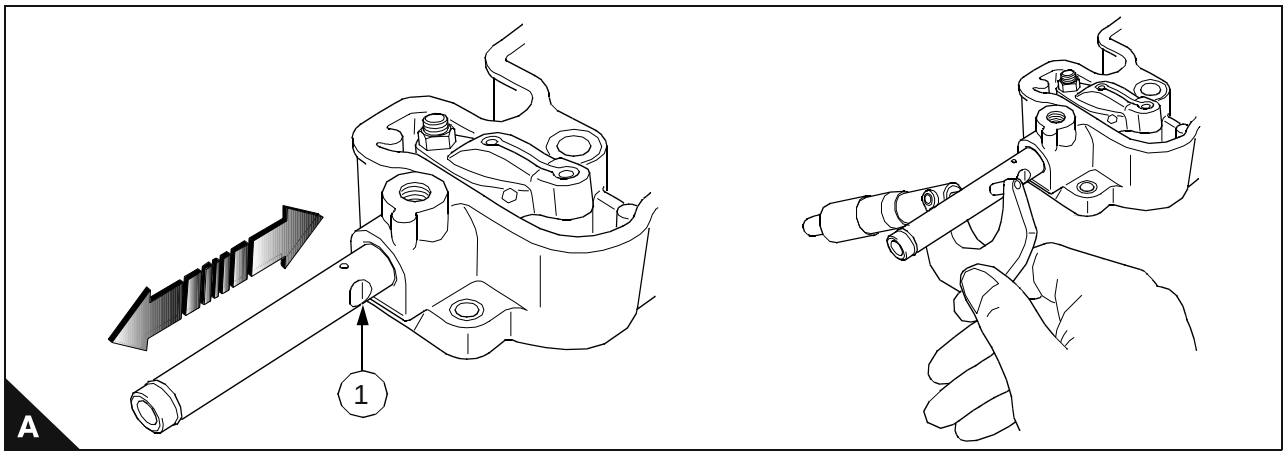
To dismantle, to inspect and to assemble **Operation 3-4**

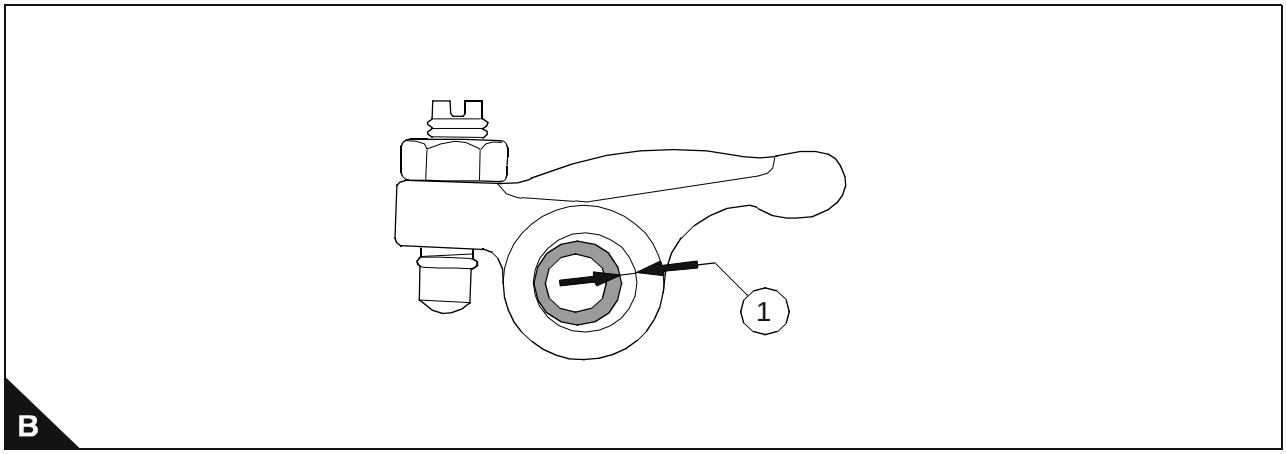
Special requirements

Engine model	Diameter (A) mm (in)	
	Standard	Service limit
103-13, 103-15	11,65 - 11,67 (0.4587 - 0.4595)	11,57 (0.4555) max
104-19, 104-22	14,95 - 14,97 (0.5886 - 0.5894)	14,87 (0.5854) max

Engine model	Clearance (B1) mm (in)	
	Standard	Service limit
103-13, 103-15	0,032 - 0,068 (0.00126 - 0.00268)	0,2 (0.008) max
104-19, 104-22	0,030 - 0,093 (0.00120 - 0.00366)	0,2 (0.008) max

Note: Be aware of the position of the shaft location recess (A1).





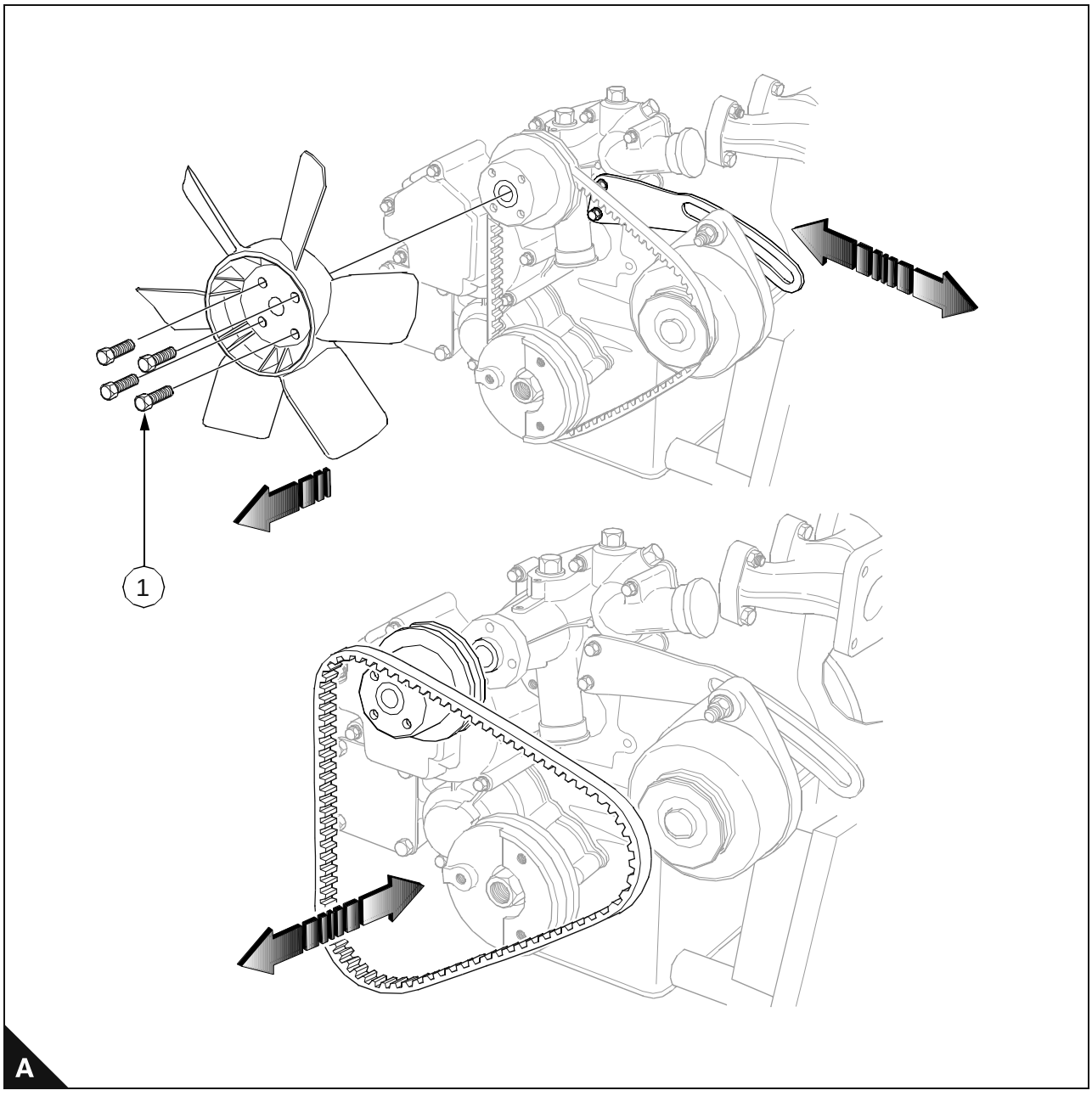
Fan and mounting

To remove — Operation 3-5

Special requirements

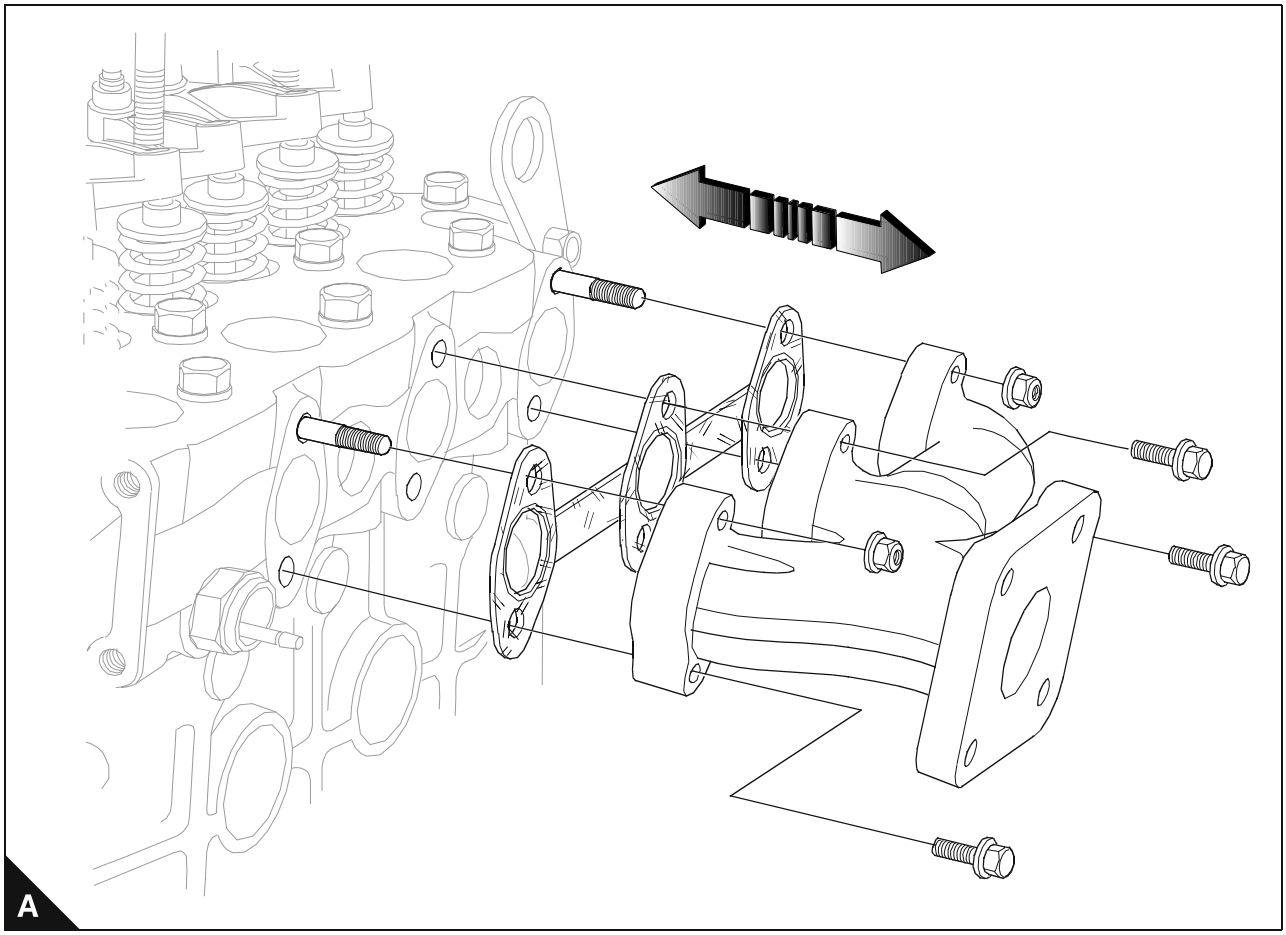
Tension Nm (lbf ft) kgf m	
Bolts (A1)	11 (8) 1,1

To fit and tension the fan belt refer to Operation 12-1.



Exhaust manifold and gasket

To remove and to fit **Operation 3-6**



Fuel injection pipes / fuel return pipes

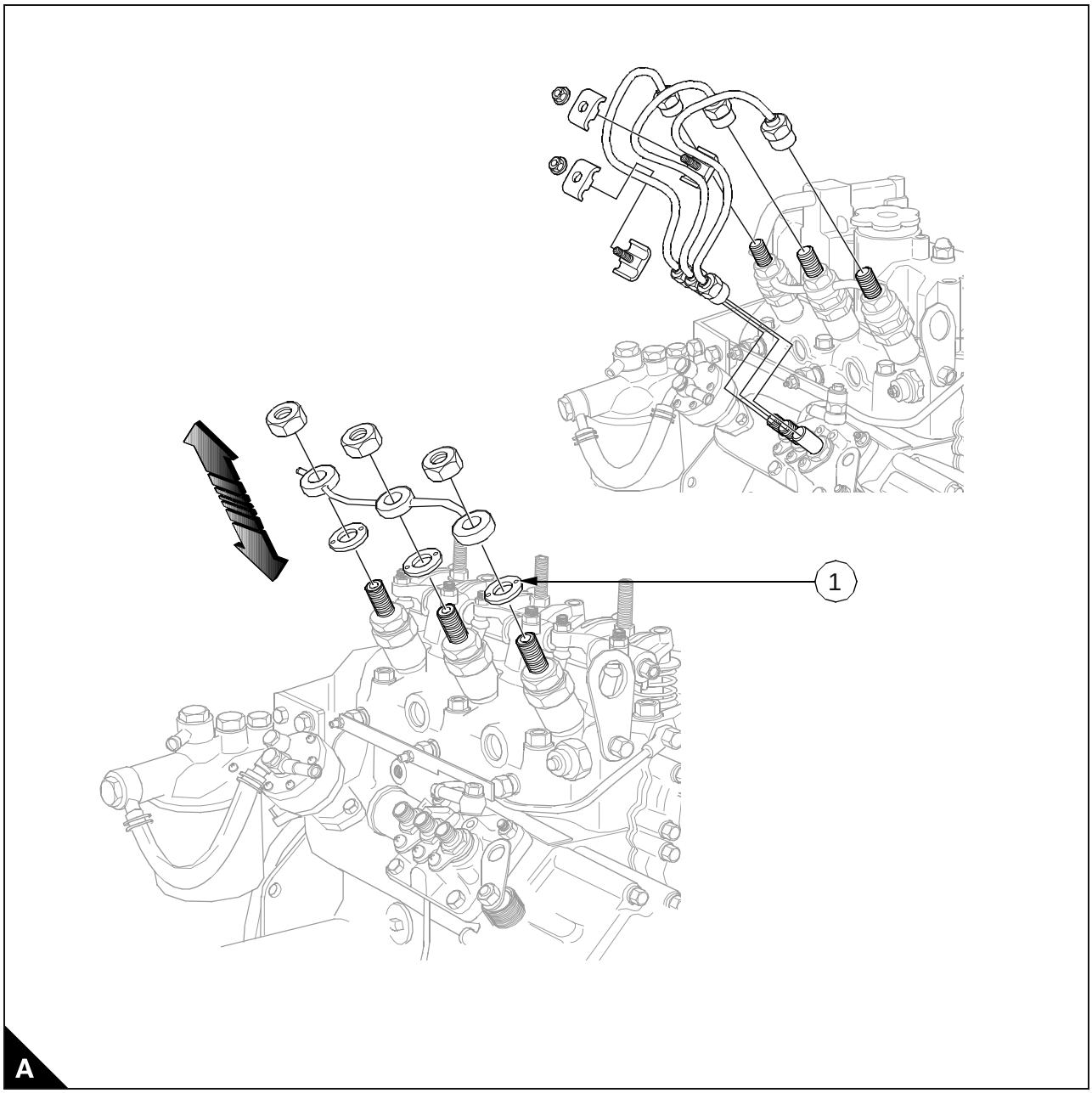
To remove and to fit **Operation 3-7**

Special requirements

Torque Nm (lbf ft) kgf m	
102-05, 103-07, 103-10	22 (16) 2,2
103-13, 103-15, 104-19, 104-22	20 (15) 2,0

Notes:

- Be aware of holes in washers (A1).
- For emissions approved engines. It is essential that the fuel adjustment screw is not altered from the original setting.
- For emissions approved engines. The maximum No Load Speed must be checked after assembly.



Oil pipes

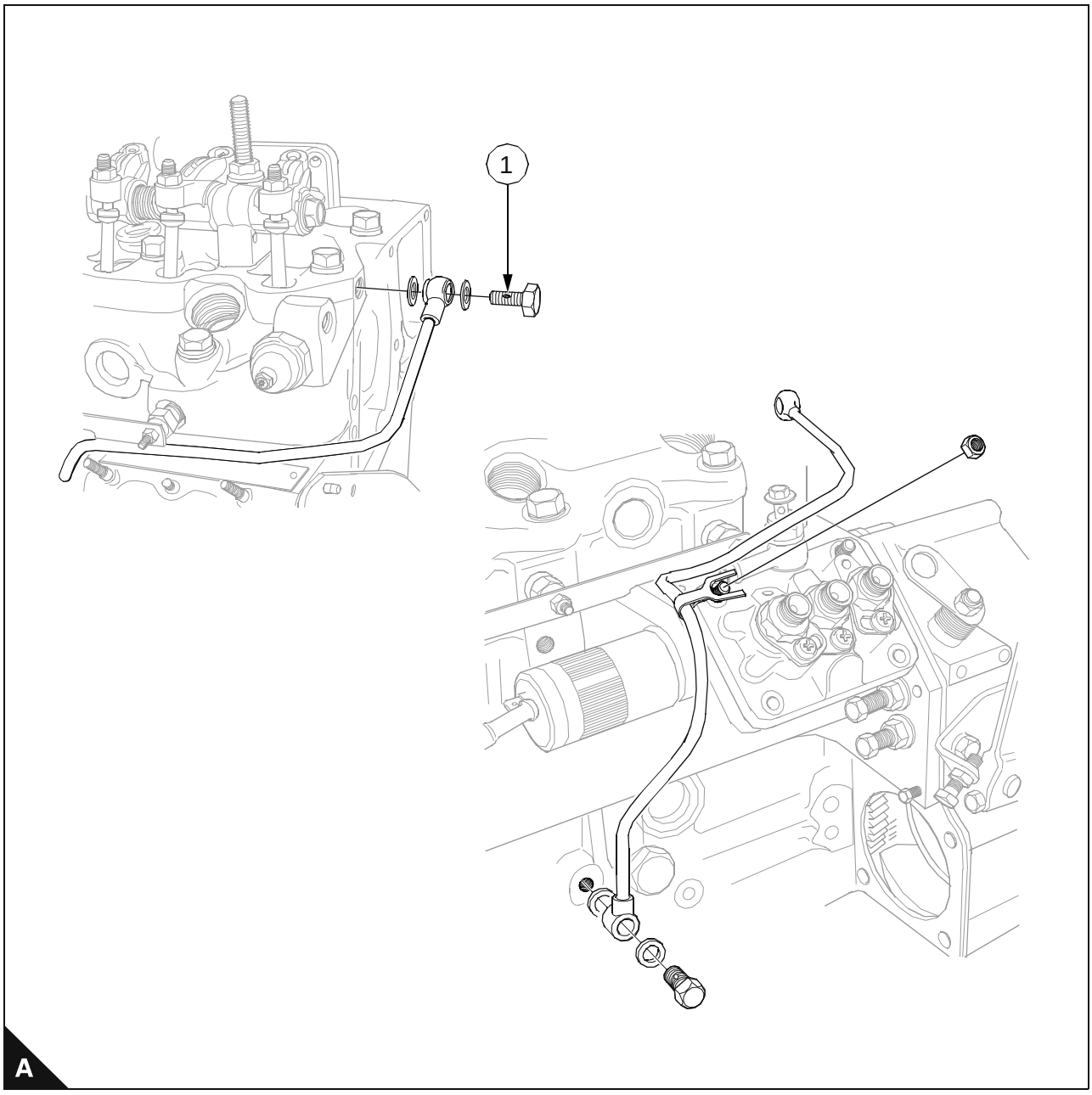
To remove and to fit **Operation 3-8**

Special requirements

Torque Nm (lbf ft) kgf m	
102-05, 103-07, 103-10	11 (8) 1,1
103-13, 103-15, 104-19, 104-22	12 (9) 1,2

Notes:

- Be aware of the oil restriction in the *banjo* bolts (A1).
- The diagram below shows a typical arrangement only.



To remove and to fit — **Operation 3-9**

Special requirements

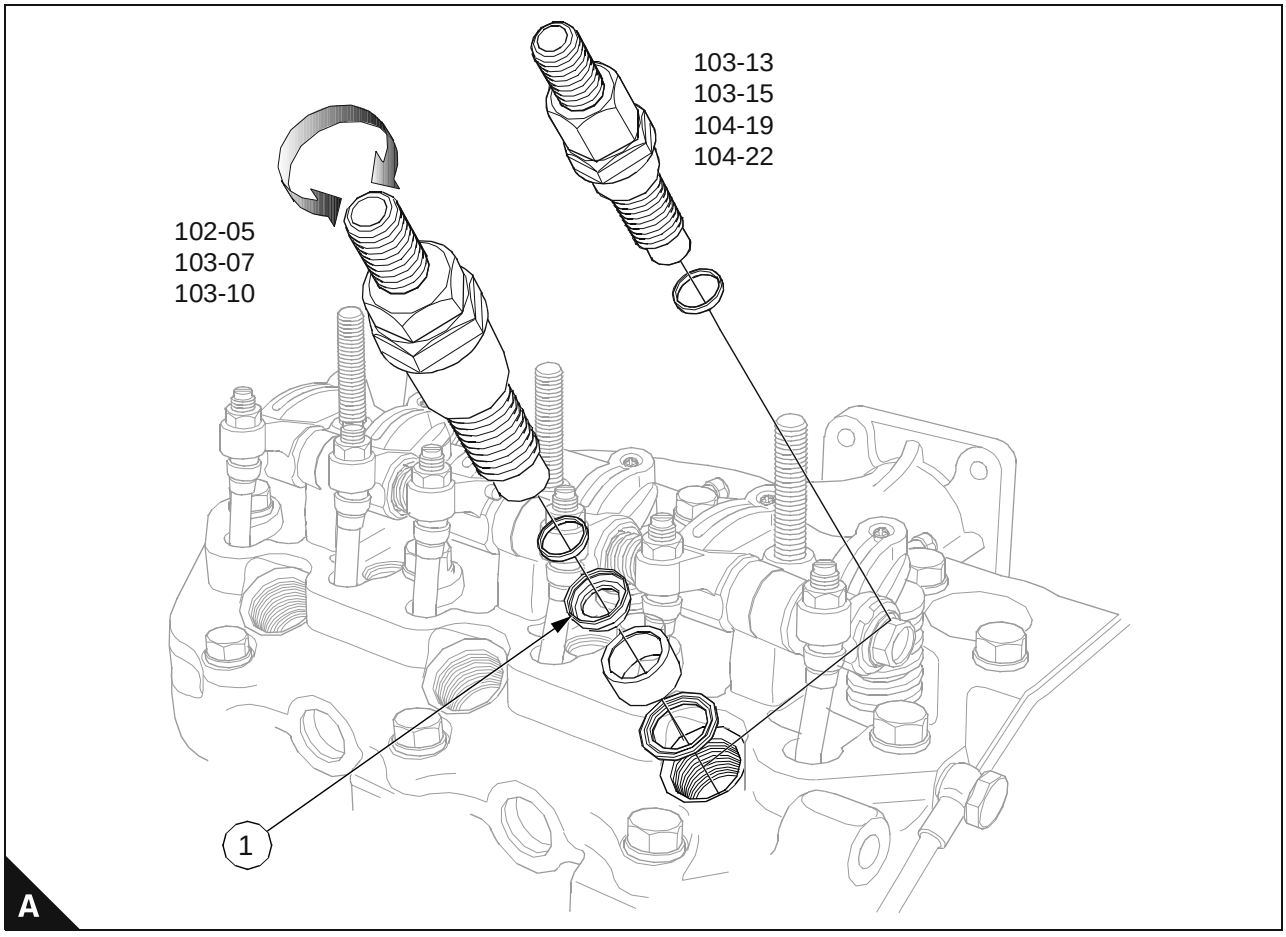
Torque Nm (lbf ft) kgf m		Test Pressure kgf/cm² (lbf/in²) ats	
102-05, 103-07	64 (47) 6,5	102-05, 103-07	120 (1707) 116
103-10	81 (60) 8,2	103-10	120 (1707) 116
103-13, 103-15, 104-19, 104-22	64 (47) 6,5	103-13, 103-15, 104-19, 104-22	150 (2133) 145

***Cautions*:**

- *Deep sockets should always be used during this procedure.*
- *Connections should be blanked off until assembly.*

Notes:

- Item (A1) is used on 103-10 engines only.
- For emissions approved engines. It is essential that the fuel adjustment screw is not altered from the original setting.
- For emissions approved engines. The maximum No Load Speed must be checked after assembly.



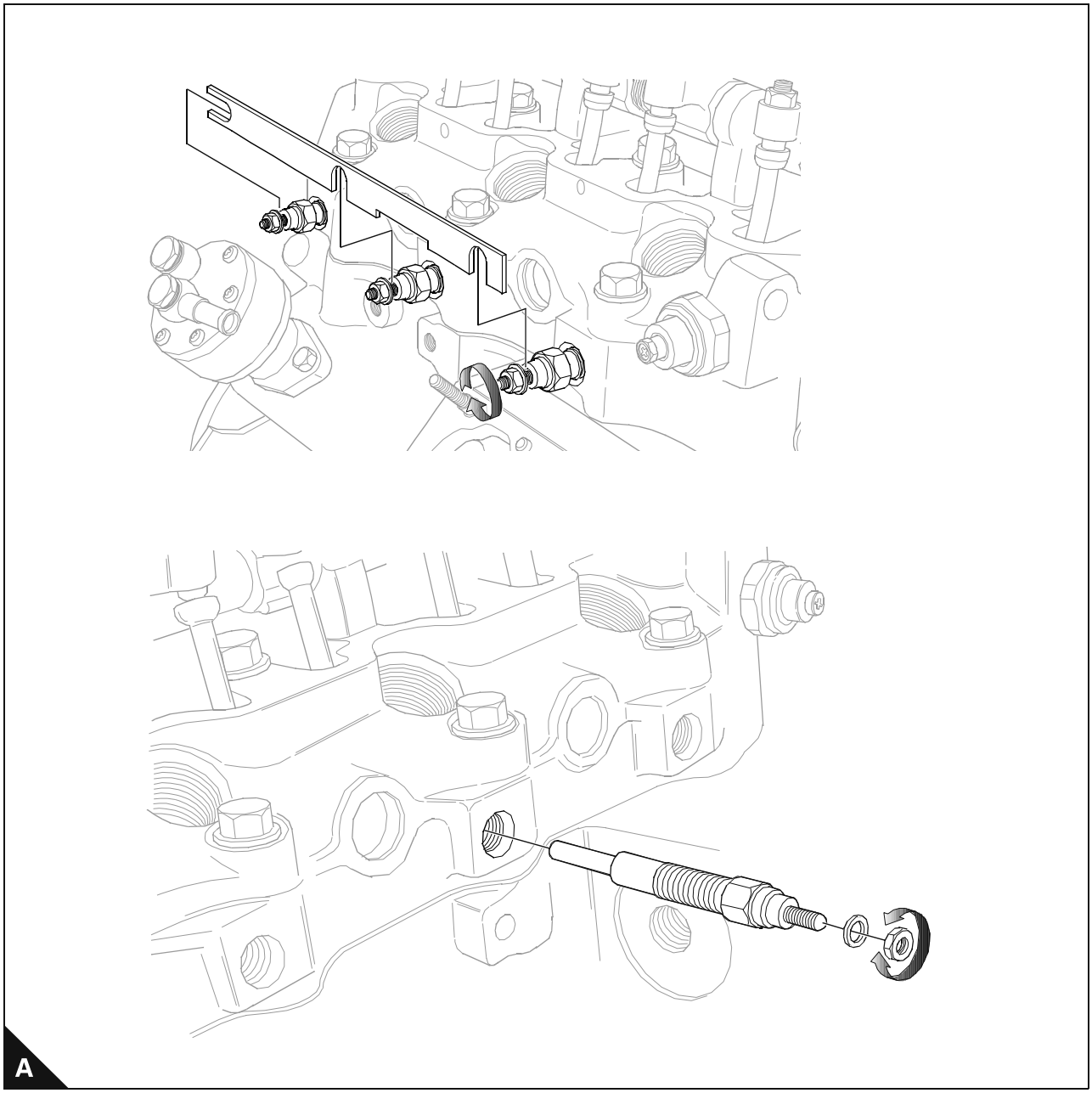
Busbar / glowplugs

To remove and to fit **Operation 3-10**

Special requirements

Torque Nm (lbf ft) kgf m	
Glowplugs	17 (12) 1,7
Contacts	17 (12) 1,7

Note: The diagram below shows a typical arrangement only.



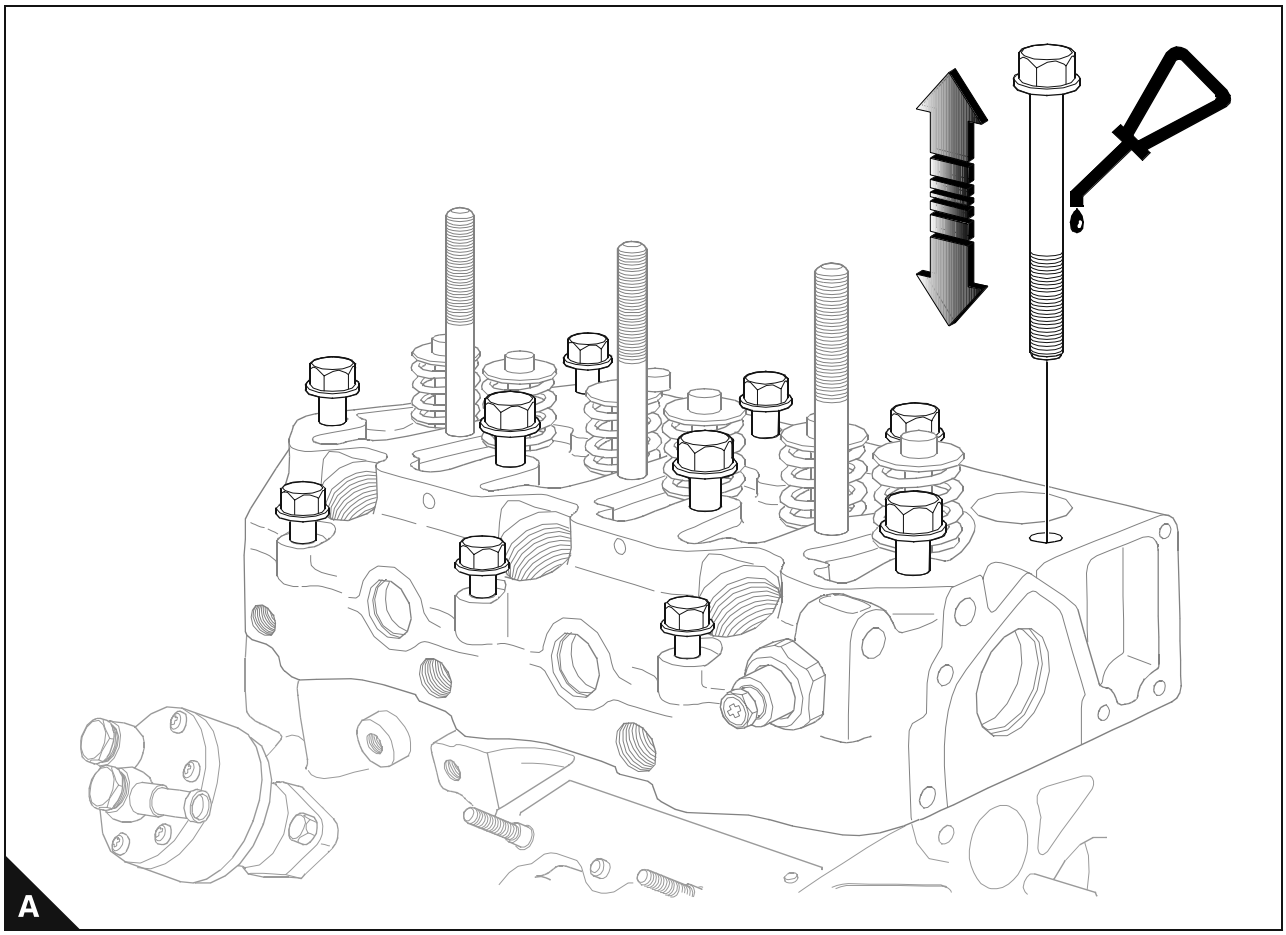
Head bolts

To remove and to fit — Operation 3-11

For recommended torques and tightening sequences refer to Operation 3-14.

Notes:

- Lubricate bolts with engine lubricating oil.
- For emissions approved engines. It is essential that the fuel adjustment screw is not altered from the original setting.
- For emissions approved engines. The maximum No Load Speed must be checked after assembly.



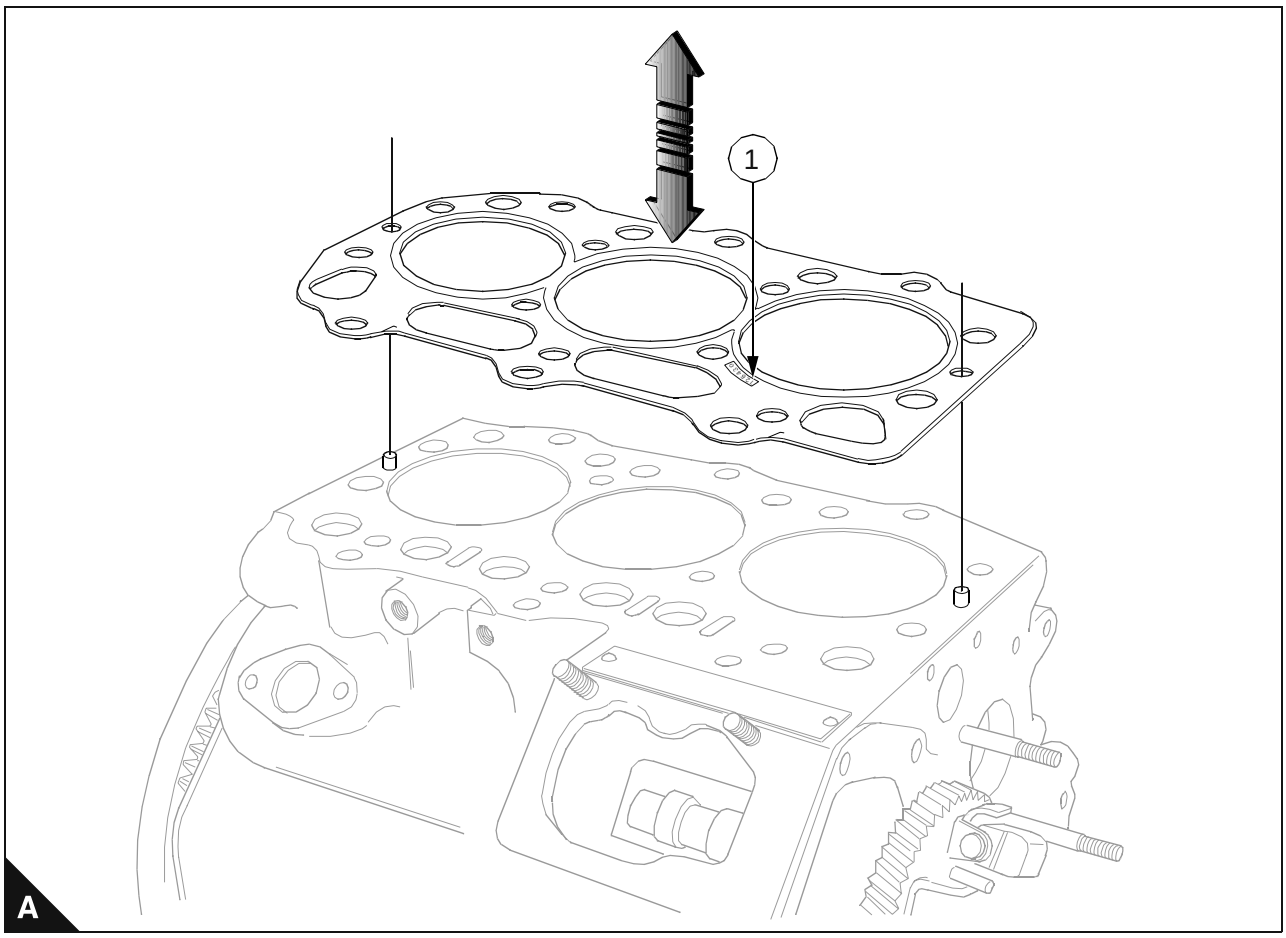
Cylinder head gasket

To remove and to fit **Operation 3-12**

Align gasket on dowels, gasket must only be assembled with markings (A1) facing up.

Notes:

- Always fit dry.
- For emissions approved engines. If the cylinder block, crankshaft, connecting rods or pistons are changed, the piston height must be checked and the correct thickness gasket used, refer to operation 3-13.



To select the correct thickness of cylinder head gasket **Operation 3-13**

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.

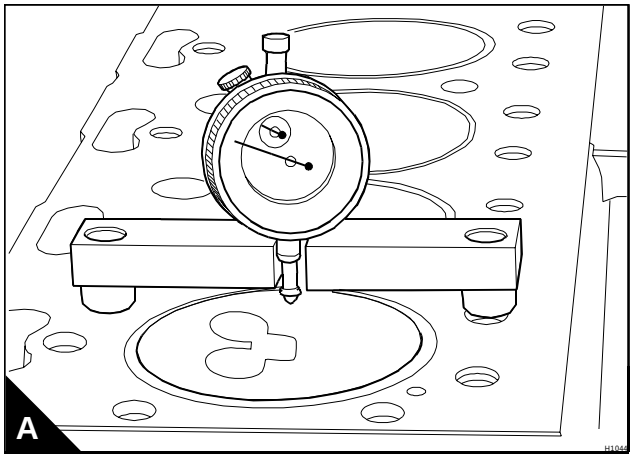
4 Rotate the crankshaft to ensure that the piston is at the highest position and make a note of the gauge indication.

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
103-10	0,45 to 0,55 mm	1,1 mm
	0,56 to 0,65 mm	1,2 mm
	0,66 to 0,75 mm	1,3 mm
103-13 103-15	0,60 to 0,70 mm	1,3 mm
	0,71 to 0,80 mm	1,4 mm
104-19	0,50 to 0,60 mm	1,2 mm
	0,61 to 0,70 mm	1,3 mm
Engine	**Protrusion below cylinder block top face**	**Gasket thickness**
102-05	-0,30 to -0,15 mm	0,5 mm
	-0,16 to +0,05 mm	0,6 mm
103-07	-0,40 to -0,25 mm	0,4 mm
	-0,26 to -0,15 mm	0,5 mm
104-22	-0,45 to -0,30 mm	0,4 mm
	-0,29 to -0,20 mm	0,5 mm



Head bolts - all variants

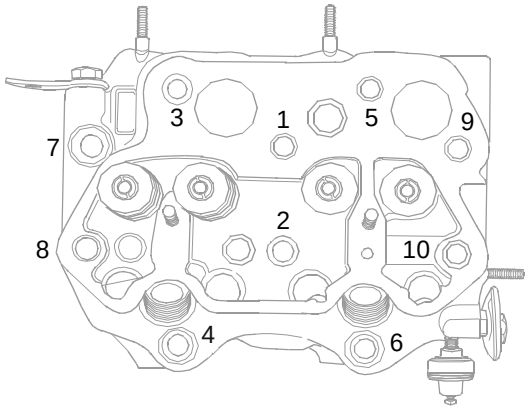
Tightening sequence **Operation 3-14**

Special requirements

Torque Nm (lbf ft) kgf m			
102-05, 103-07	37 (27) 3,7	103-13, 103-15, 104-19, 104-22	100 (74) 10,2
103-10	51 (38) 5,2		

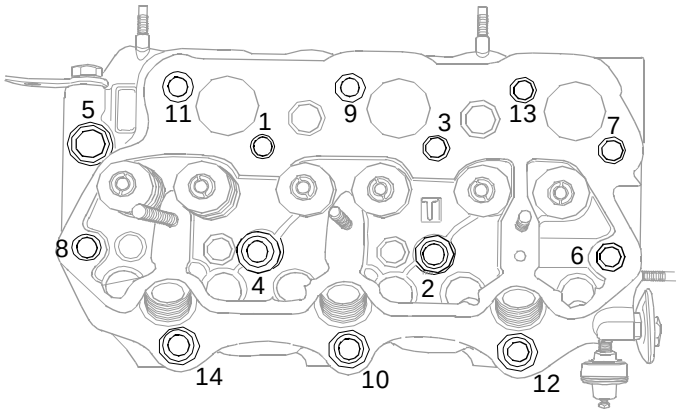
Note: All torques should be rechecked after tightening. Item (C1) is present on 104-19 models only.

102-05



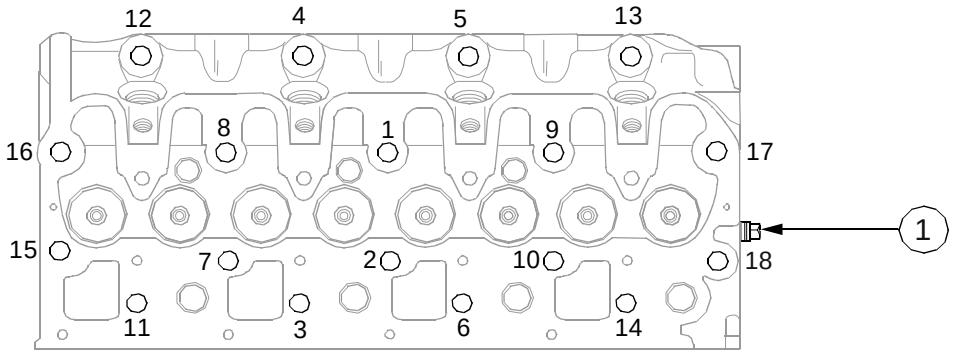
A

103-07
103-10
103-13
103-15



B

104-19
104-22



C

Valve and valve springs

To remove and to fit **Operation 3-15**

Special requirements

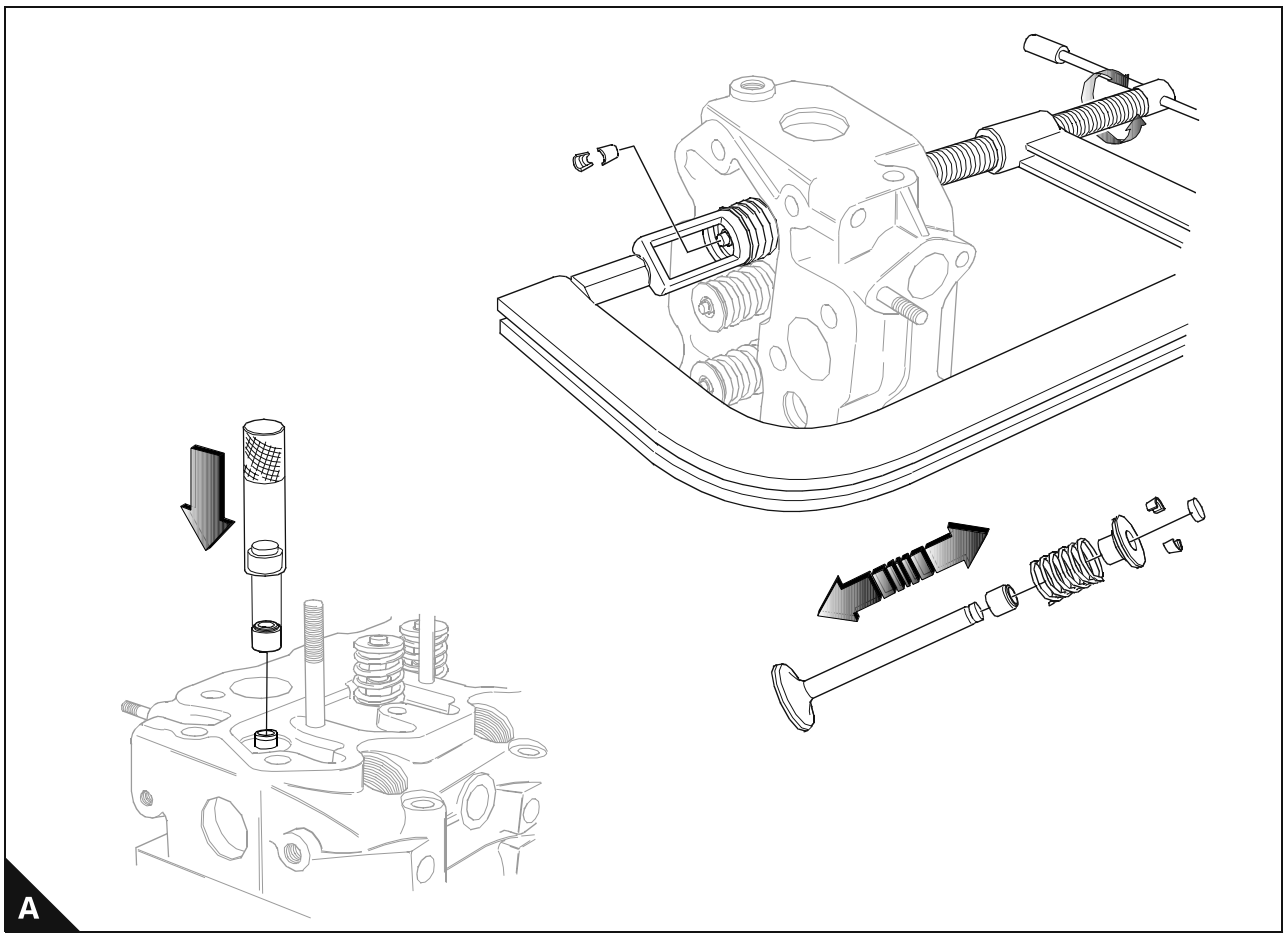
Special tools			
Description	**Part number**	**Description**	**Part number**
Valve spring remover	21825663	Stem seal replacer - 103-10, 103-13, 103-15, 104-19, 104-22	21825623
Stem seal replacer - 102-05, 103-07	21825622		

Caution: *Always wear safety glasses.*

Inlet and exhaust seals are different on 103-10 and above:

Inlet: Silver garter spring.

Exhaust: Black garter spring with small "EX" inscribed on garter.



Valve spring

To inspect **Operation 3-16**

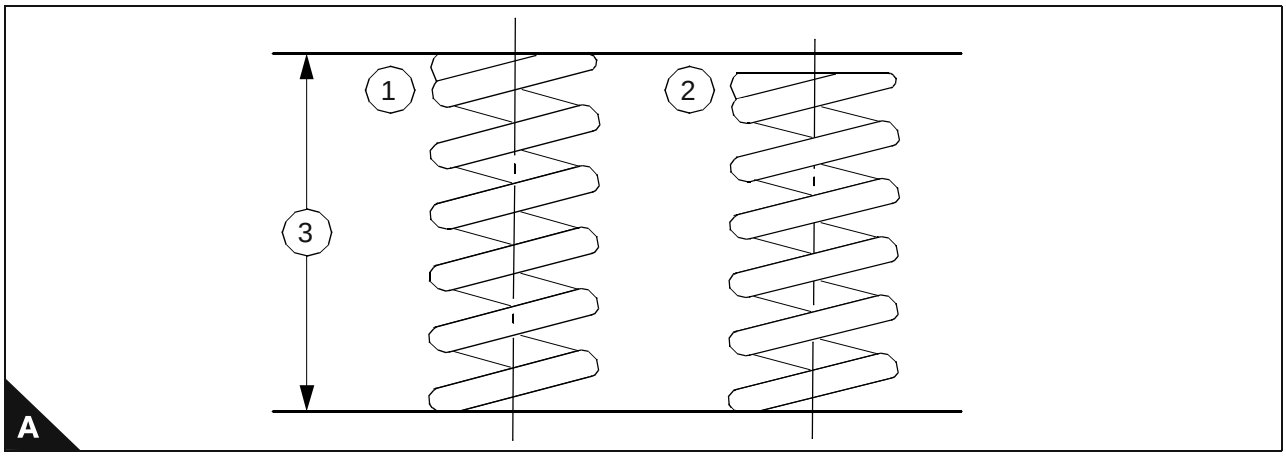
Special requirements

Engine model	Free length (A3) mm (in)	
	Standard	Service limit
102-05, 103-07	33,0 (1.299)	31,5 (1.240)
103-10, 103-13, 103-15, 104-19, 104-22	35,0 (1.378)	33,5 (1.319)

Engine model	Spring rate when compressed to 30,4 mm (1.197 in) N (lbf) kgf	
	Standard	Service limit
102-05, 103-07	68 (15.2) 6,9	59 (13.2) 6,0
103-10, 103-13, 103-15, 104-19, 104-22	79 (17.9) 8,1	69 (15.4) 7,0

1 Visually inspect the valve spring for damage. A new spring (A1) and a worn spring (A2) are shown.

2 Using a spring tester, check spring force and free length. Renew if found to be beyond the service limit.



Valve stem diameter and thickness of valve head

To inspect **Operation 3-17**

Valve head thickness

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

Thickness (A1) mm (in)	
Standard	**Service limit**
0,925 - 1,075 (0.03642 - 0.04232)	0,5 (0,020) max

Valve stem diameter

Check the valve stem for excessive wear or damage. If found to be excessively worn or damaged, renew the valve.

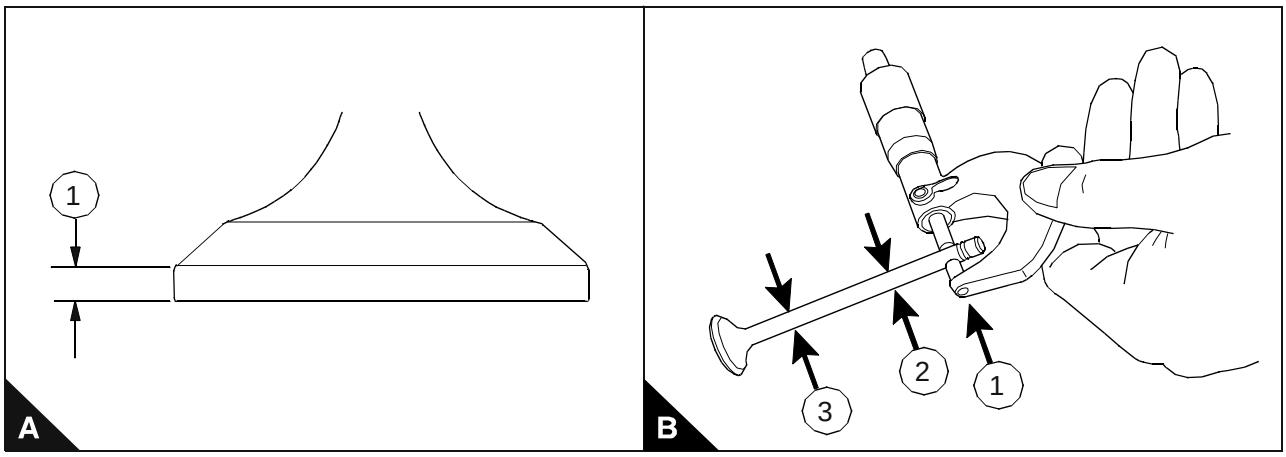
Check the valve stem diameters at positions (B1), (B2) and (B3) with a micrometer. If the diameter is less than the service limit, renew the valve.

Intake valve

Engine model	Diameter mm (in)	
	Standard	**Service limit**
102-05, 103-07	5,960 - 5,975 (0.23464 - 0.23524)	5,9 (0.232)
103-10, 103-13, 103-15, 104-19, 104-22	6,955 - 6,970 (0.27382 - 0.27441)	6,89 (0.271)

Exhaust valve

Engine model	Diameter mm (in)	
	Standard	**Service limit**
102-05, 103-07	5,940 - 5,955 (0.23386 - 0.23445)	5,9 (0.232)
103-10, 103-13, 103-15, 104-19, 104-22	6,940 - 6,950 (0.27323 - 0.27362)	6,84 (0.269)



Valve guide clearance

To inspect **Operation 3-18**

Check the clearance between the valve and valve-guide.

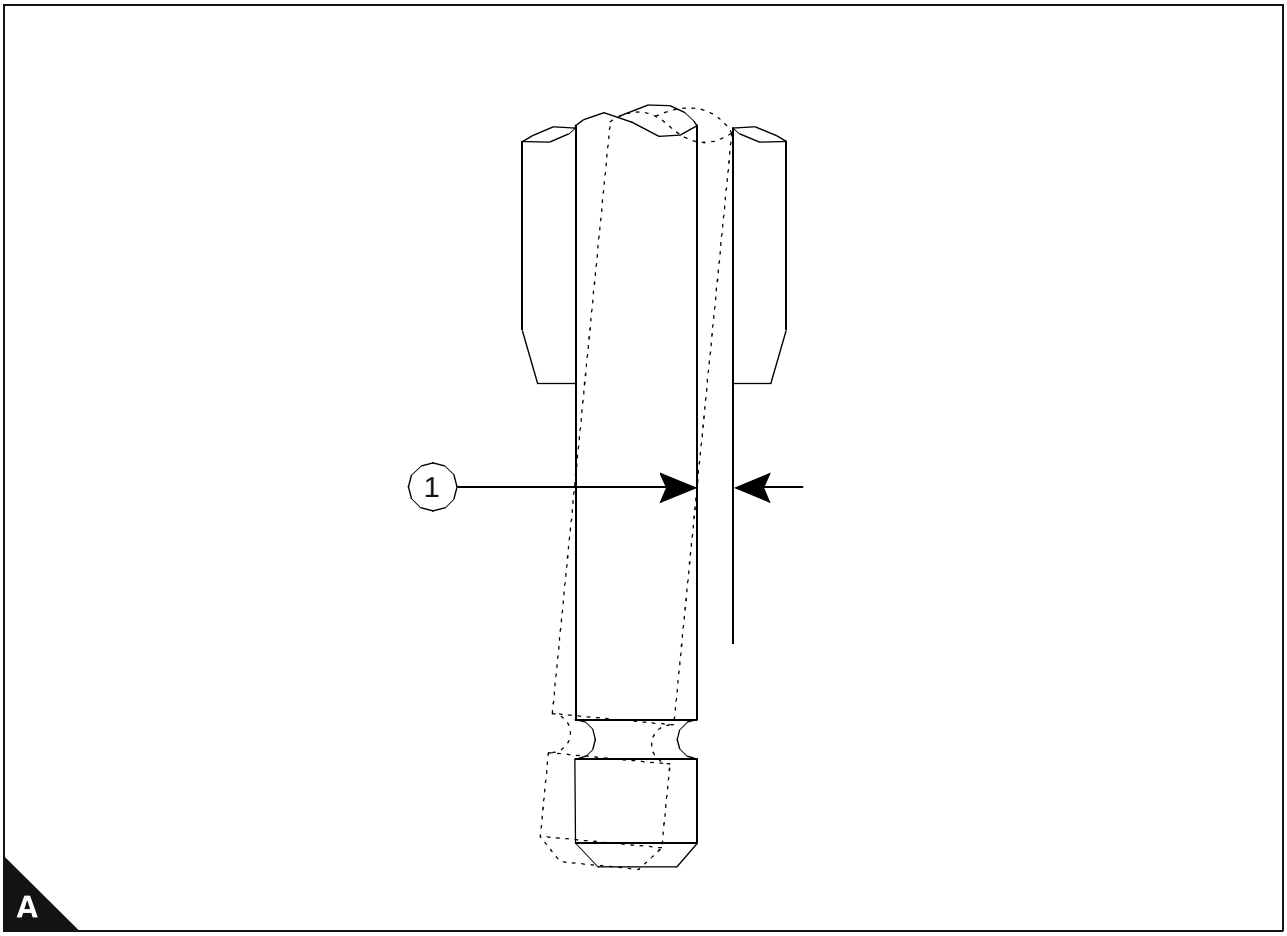
If the clearance exceeds the service limit, renew the cylinder head.

Intake valve

Engine model	Clearance (A1) mm (in)	
	Standard	Service limit
102-05, 103-07, 103-10	0,025 - 0,052 (0.001 - 0.002)	0,2 (0.008) max
103-13, 103-15, 104-19, 104-22	0,03 - 0,06 (0.0012 - 0.0024)	0,2 (0.008) max

Exhaust valve

Engine model	Clearance (A1) mm (in)	
	Standard	Service limit
102-05, 103-07, 103-10	0,045 - 0,072 (0.0018 - 0.0028)	0,25 (0.010) max
103-13, 103-15, 104-19, 104-22	0,05 - 0,075 (0.002 - 0.003)	0,25 (0.010) max

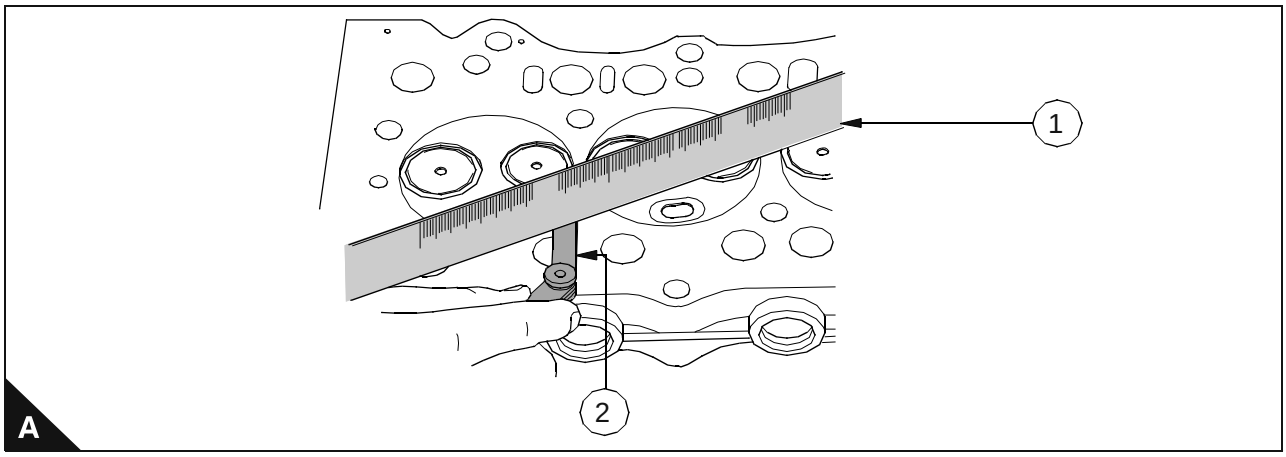


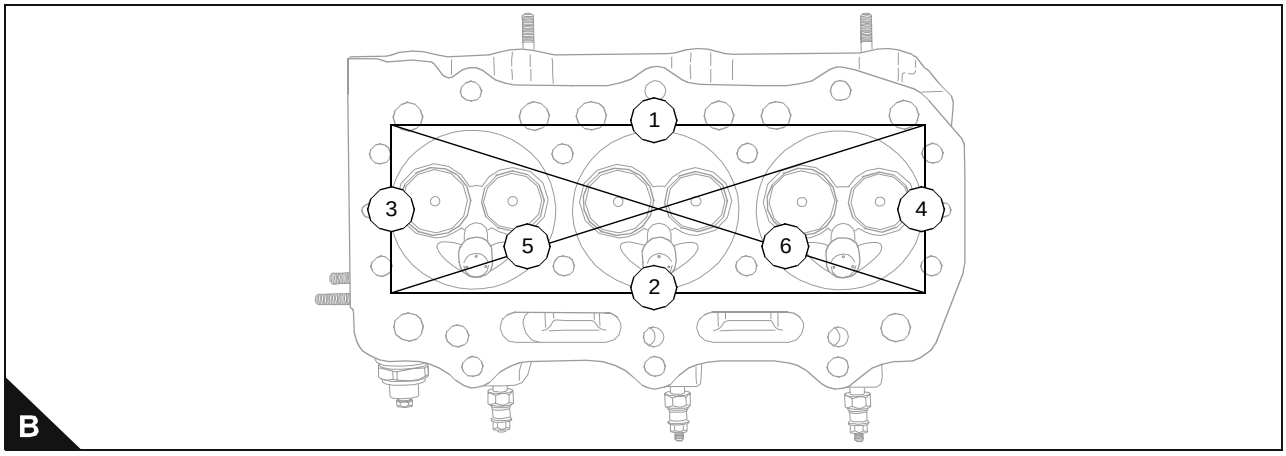
To check the distortion of the lower face — Operation 3-19

Special requirements

Maximum machine limit mm (in)		
Distortion	**Max service limit**	**Max regrind**
0,05 (0.002) OR LESS	0,12 (0.005)	0,15 (0.006)

Using a straight edge (A1) and feeler gauge (A2) check the six positions (lines B1 to B6) for distortion. Do not machine beyond the maximum limit.





Valve seat width

To correct **Operation 3-20**

If the contact width (B1) of the valve seat is more than service limit, check wear condition of the valve guide first.

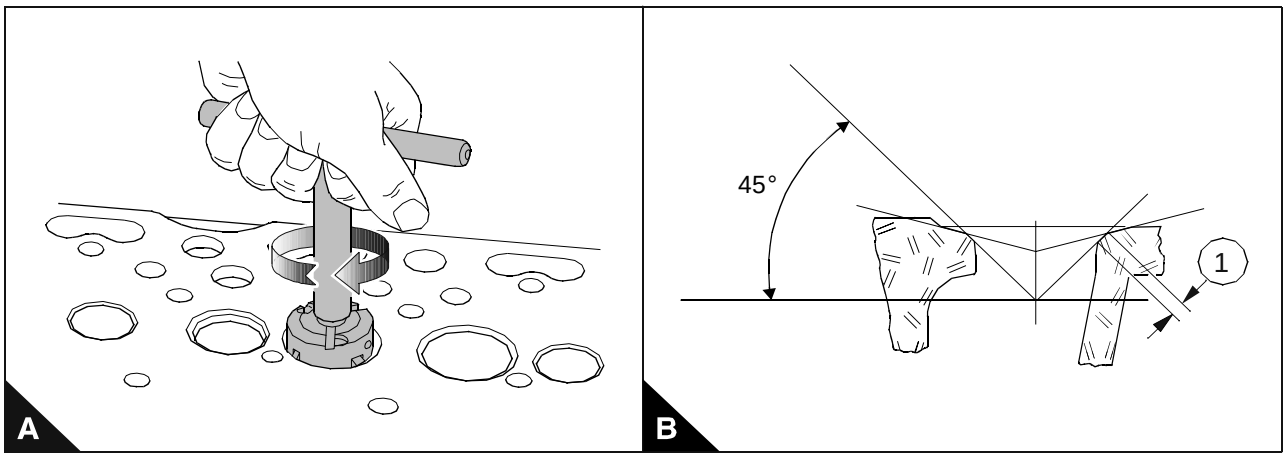
Using a seat cutter of 45° correct the seat.

Intake valve

Engine model	Clearance mm (in)	
	Standard	Service limit
102-05, 103-07	1,59 - 1,80 (0.0626 - 0.0709)	2,5 (0,098) max
103-10	1,70 - 2,10 (0.0670 - 0.0830)	2,5 (0,098) max
103-13, 103-15	1,66 - 1,87 (0.0653 - 0.0736)	2,5 (0,098) max
104-19, 104-22	1,50 - 2,00 (0.0591 - 0.0790)	2,5 (0,098) max

Exhaust valve

Engine model	Clearance mm (in)	
	Standard	Service limit
102-05, 103-07	1,59 - 1,80 (0.0626 - 0.0709)	2,5 (0,098) max
103-10	1,70 - 2,10 (0.0670 - 0.0830)	2,5 (0,098) max
103-13, 103-15	1,66 - 1,73 (0.0653 - 0.0681)	2,5 (0,098) max
104-19, 104-22	1,94 - 2,16 (0.0764 - 0.0850)	2,5 (0,098) max



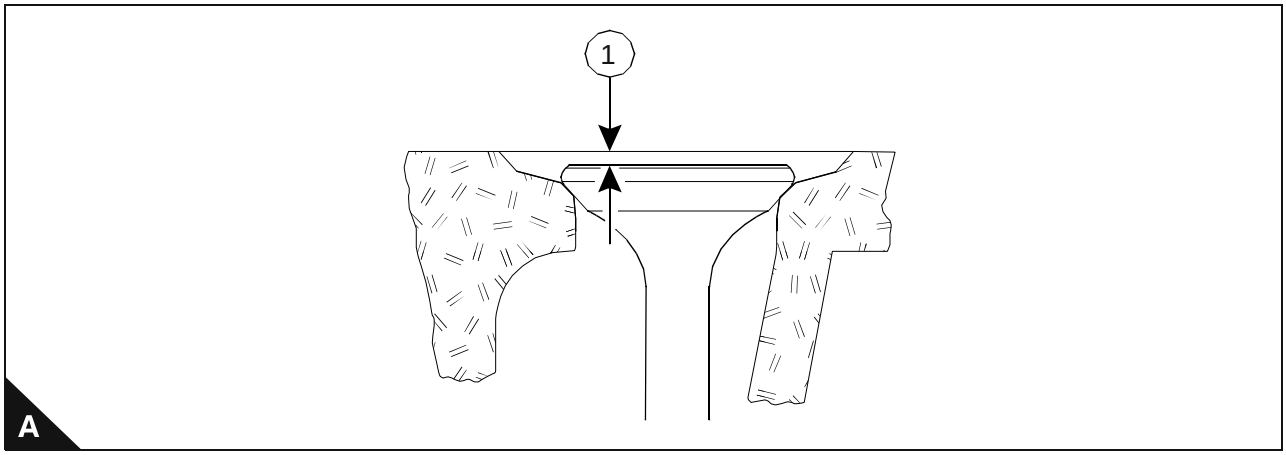
Valve depth

To correct **Operation 3-21**

Special requirements

Engine model	Depth (A1) mm (in)	
	Standard	Service limit
102-05, 103-07	0,70 - 0,90 (0.0276 - 0.0354)	1,8 (0.071) max
103-10	0,85 - 1,15 (0.0335 - 0.0453)	1,8 (0.071) max
103-13, 103-15	0,85 - 1,15 (0.0335 - 0.0453)	1,8 (0.071) max
104-19, 104-22	0,65 - 0,95 (0.0256 - 0.0374)	1,8 (0.071) max

Rectify if the depth is more than the service limit.

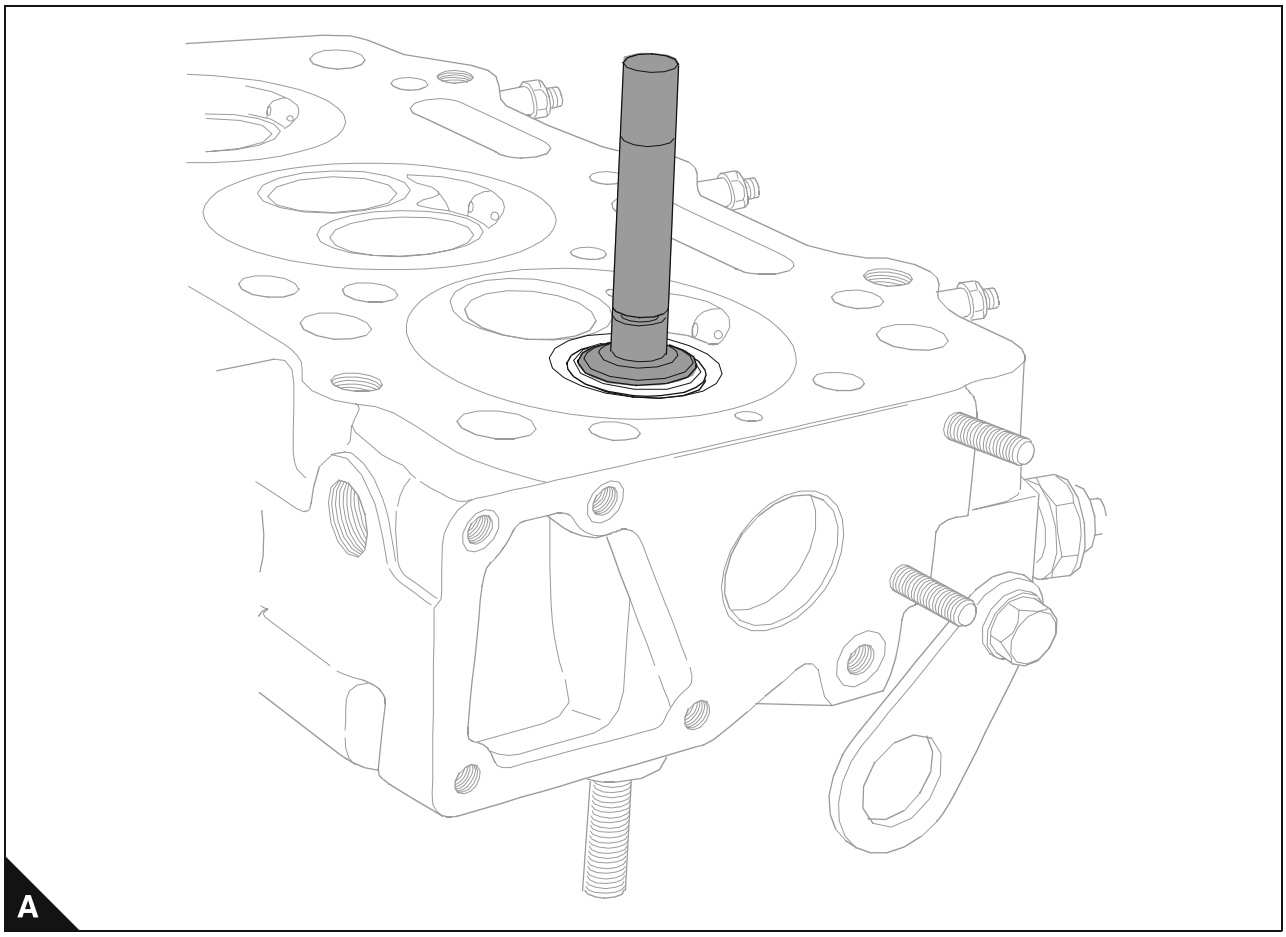


Valve seat contact face

Lapping **Operation 3-22**

Correct valve seat contact using a valve lapping tool and lapping compound.

Note: When using a new cylinder head, obtain correct seat contact width and seat recess using the seat cutter, then carry out a final lap.



Valve tip clearance

To check **Operation 3-23**

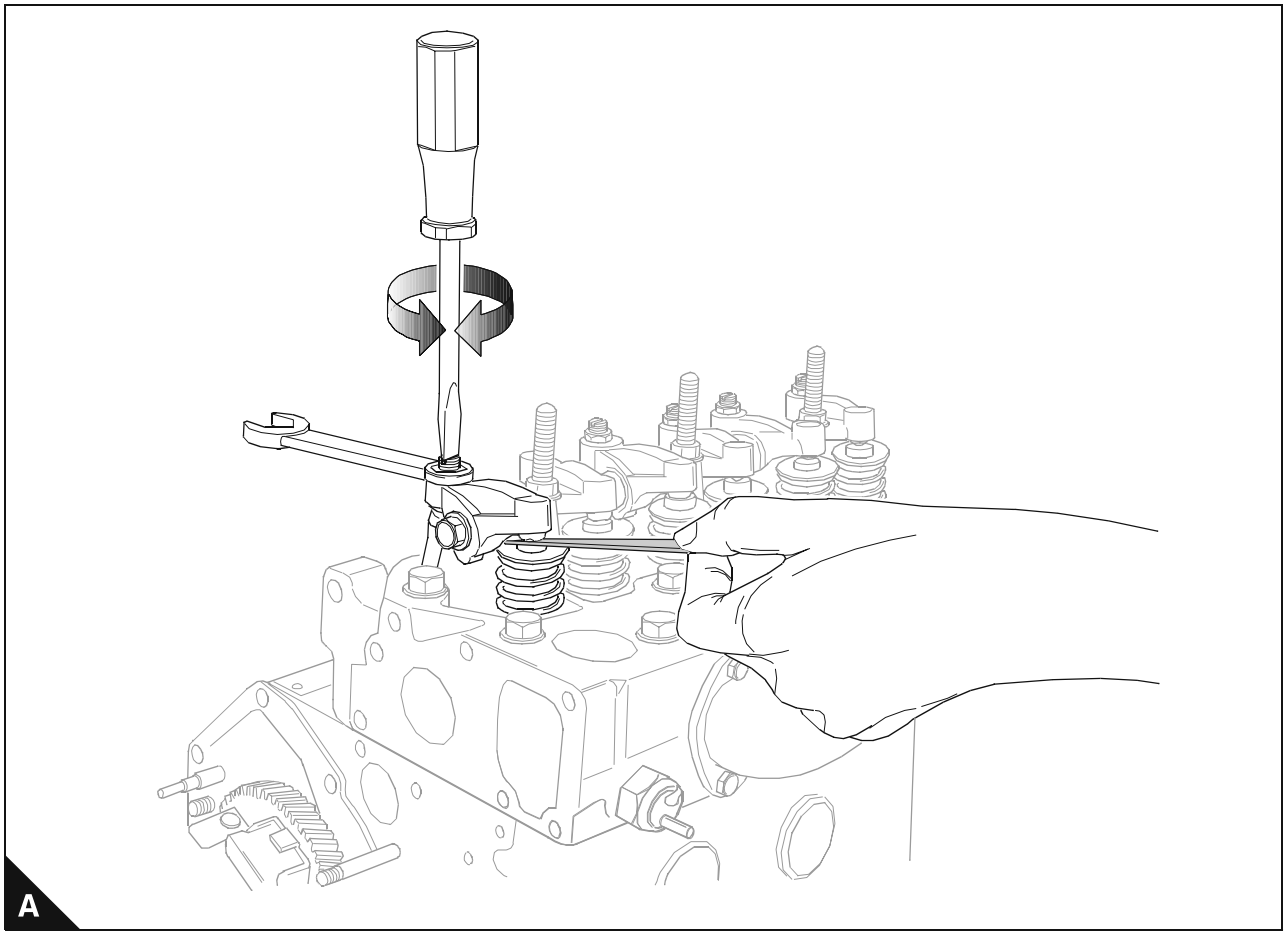
The valve sequence is viewed from the front of the engine.

Rotate the crankshaft clockwise when viewed from the front.

Adjust the clearance of both intake and exhaust valves to 0,2 mm (0.0078 in).

Note: Always adjust when the engine is cold.

Engine model	Valve overlap	Adjust valves
2 Cylinder engines	No.1 Cyl	3 and 4
	No.2 Cyl	1 and 2
3 Cylinder engines	No.1 Cyl	3 and 6
	No.2 Cyl	2 and 5
	No.3 Cyl	1 and 4
4 Cylinder engines	No.4 Cyl	1 and 2
	No.2 Cyl	5 and 6
	No.1 Cyl	7 and 8
	No.3 Cyl	3 and 4



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4

Piston and connecting rod assemblies

Big end bearing and cap

To remove and to fit **Operation 4-1**

Special requirements

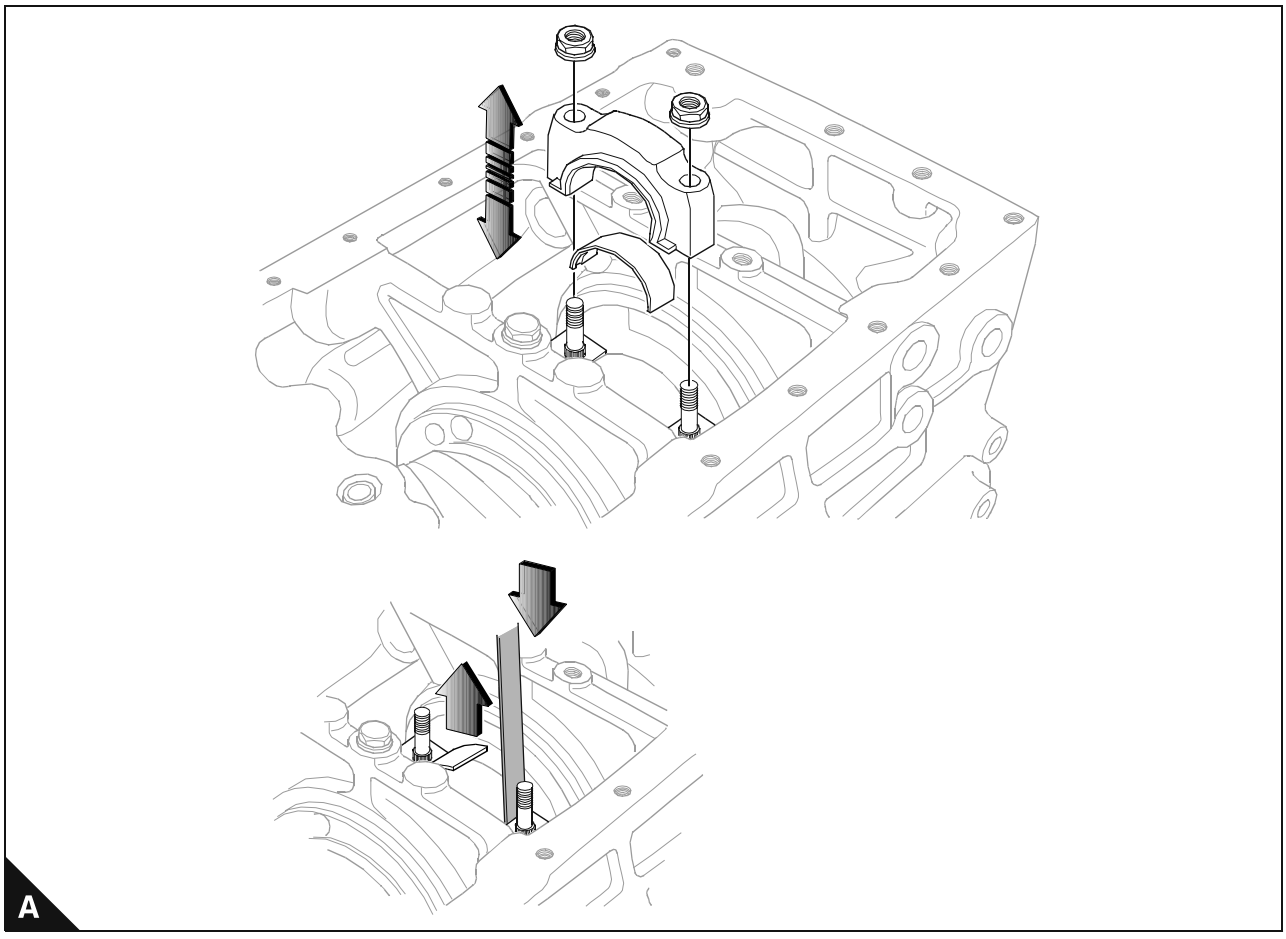
Torque Nm (lbf ft) kgf m		Clearance mm (in)	
102-05, 103-07	23 (17) 2,3	**Standard**	**Service limit**
103-10	32 (24) 3,2	0,1 - 0,3 (0.004 - 0.012)	0,7 (0.276)
103-13, 103-15, 104-19, 104-22	52 (38) 5,3		

Ensure that when the connecting rods are fitted an axial play (clearance) is provided.

During assembly apply a thin layer of clean engine lubricating oil to the crank pins with.

Notes:

- Identify each rod/piston/cylinder pair on disassembly.
- For emissions approved engines. The fuel adjustment screws must not be altered from the original settings.
- For emissions approved engines. The maximum No Load Speed must be checked after assembly.
- If new connecting rods are fitted, see Operation 3-13.

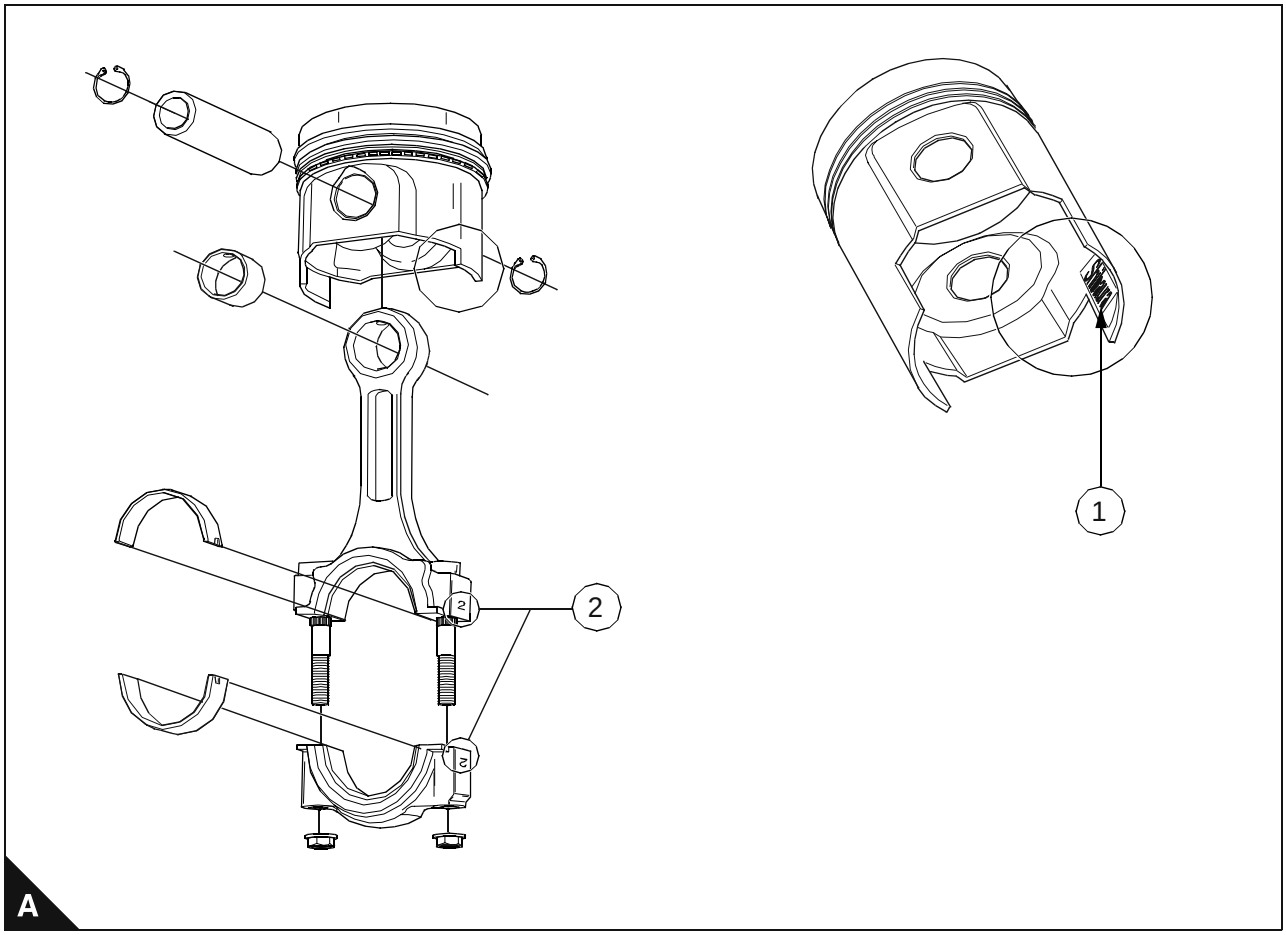


Piston and connecting rod

To dismantle and to assemble **Operation 4-2**

Align Shibaura logo (A1) with stamped number on con rod.

Align numbers to match (A2).



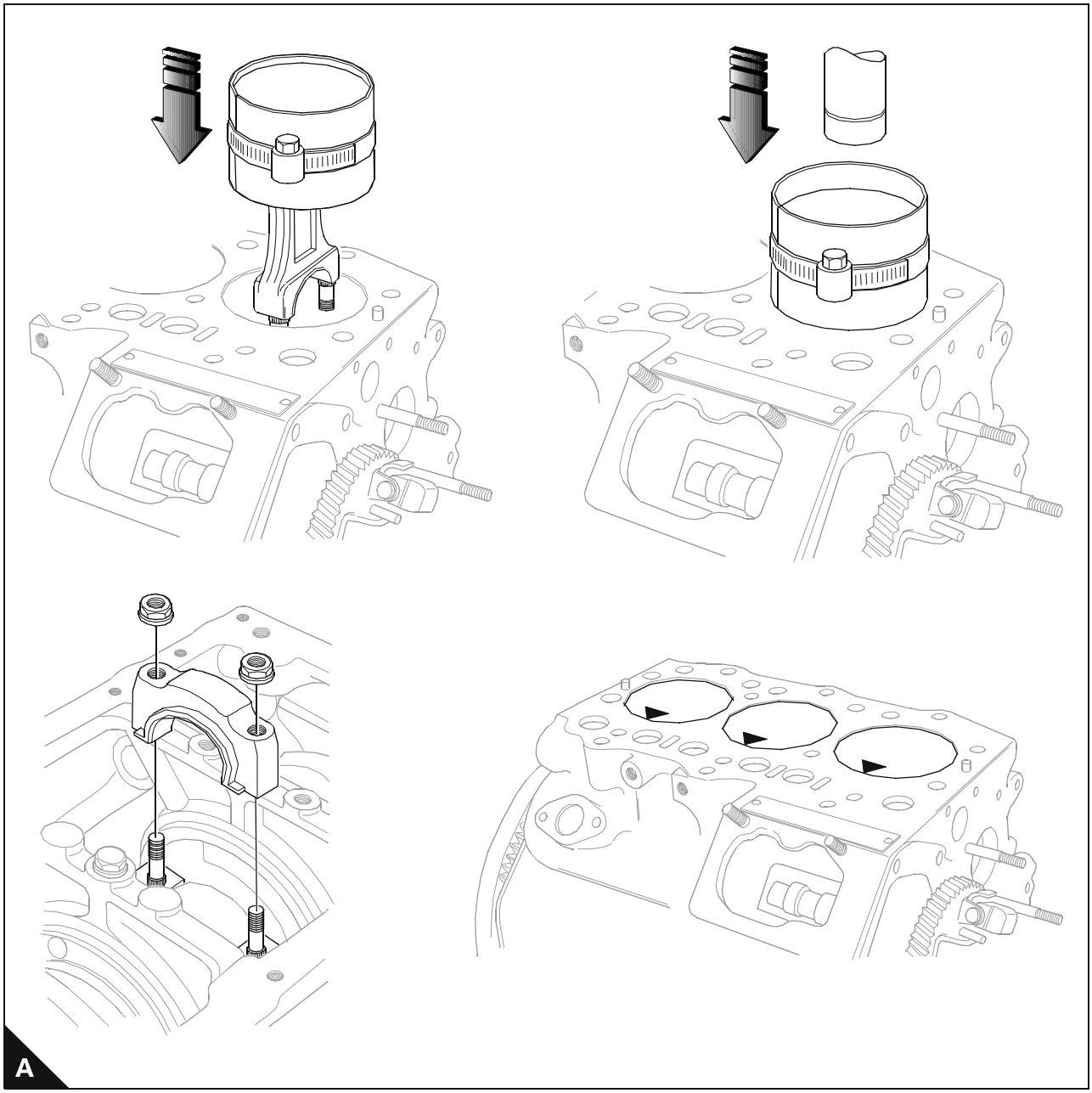
To fit Operation 4-3

Special requirements

Torque Nm (lbf ft) kgf m			
102-05, 103-07	23 (17) 2,3	103-13, 103-15, 104-19, 104-22	52 (38) 5,3
103-10	32 (24) 3,2		

For positioning of connecting rod assembly refer to Operation 4-2.

Note: Pistons must be fitted with Shibaura name toward the fuel injection pump.

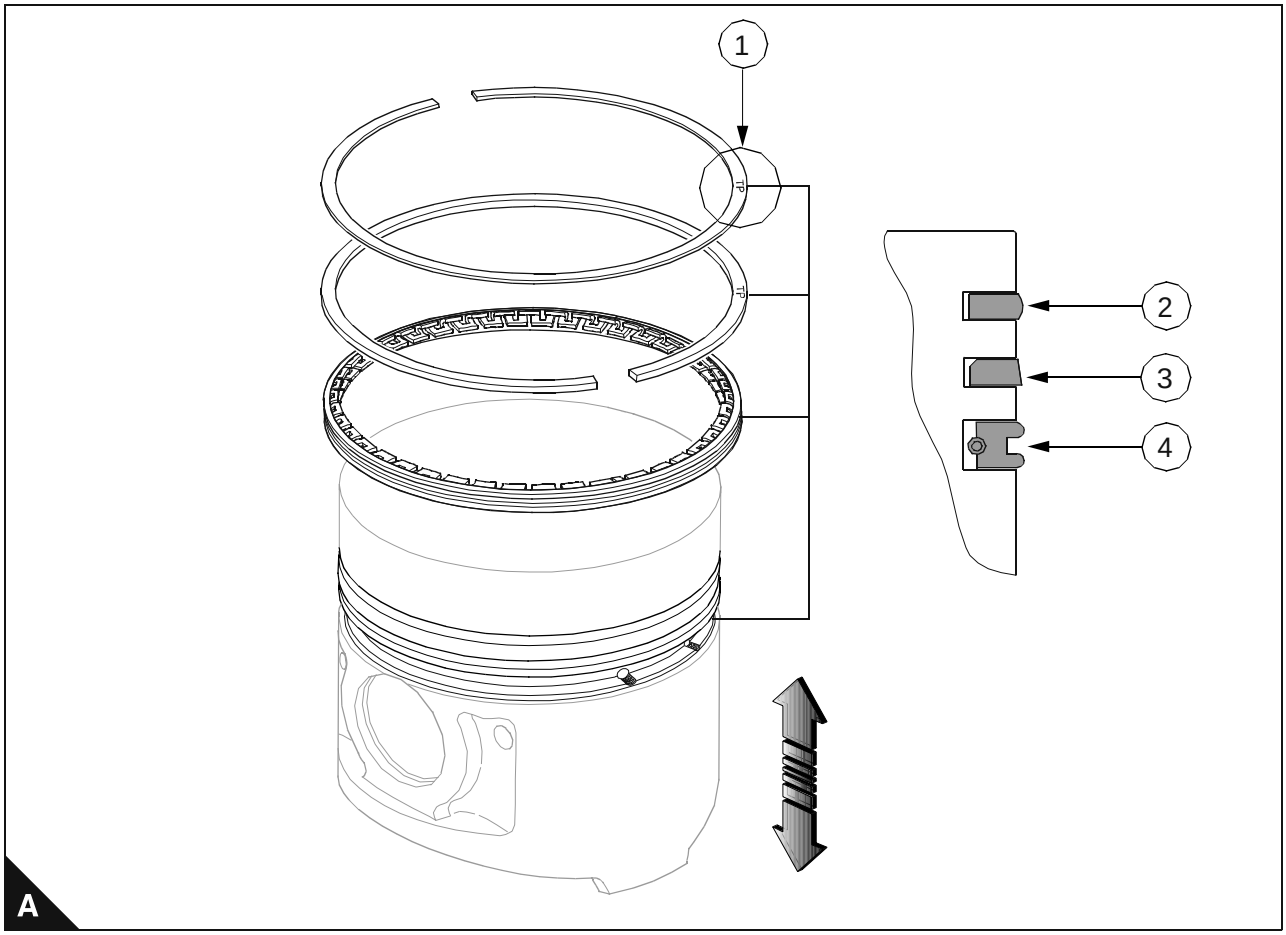


Piston and piston ring

To inspect — Operation 4-4

Any letters or marks on a surface of a ring (A1) will always be to the upper face.

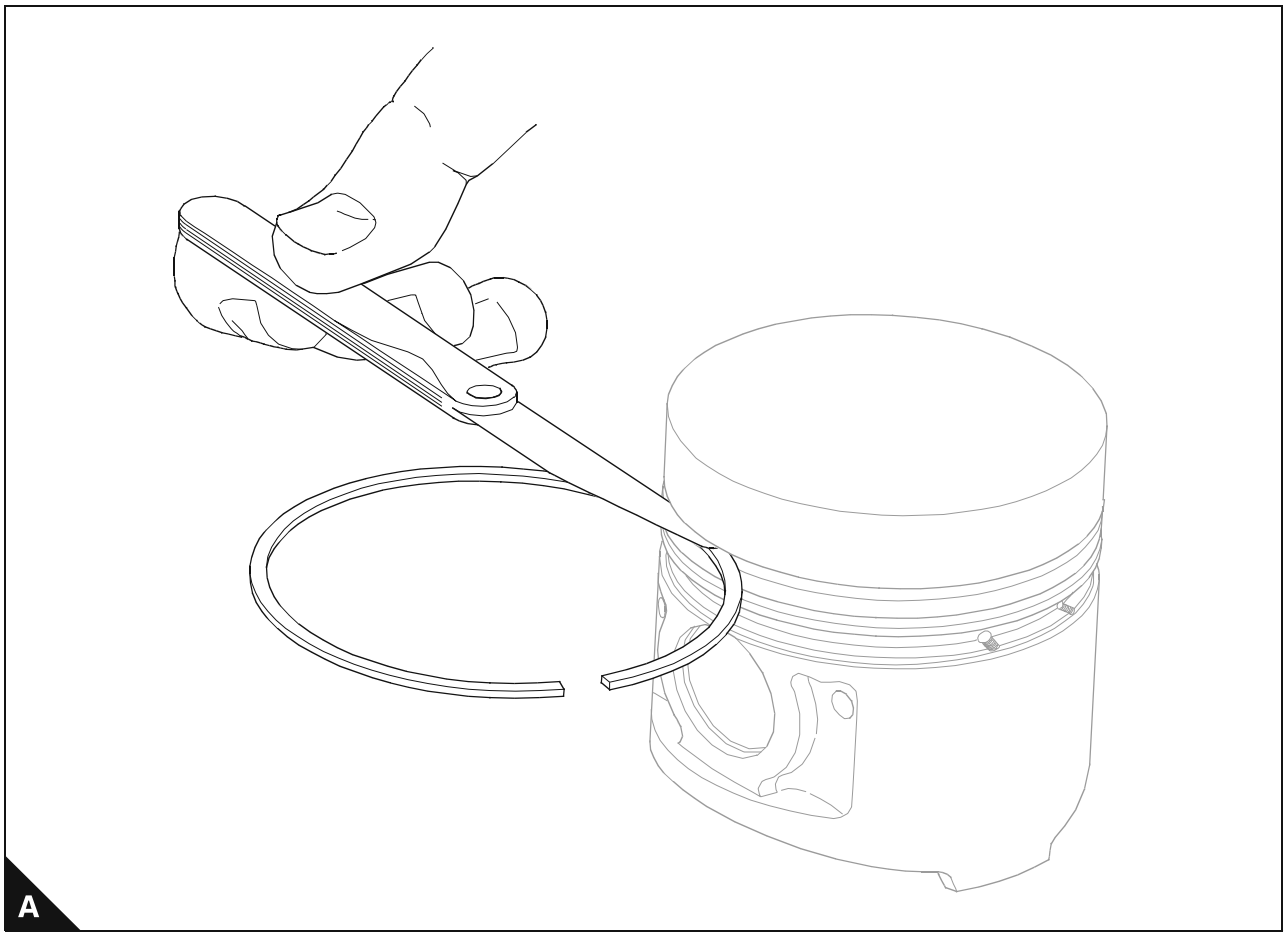
The piston profile shows the No.1 ring (A2), No.2 ring (A3) and the oil scraper ring (A4).



To measure piston ring clearance **Operation 4-5**

By use of feeler gauges, measure the clearance between the piston ring groove and ring. If the clearance exceeds the service limit, renew the piston and rings.

102-05, 103-07, 103-10			103-13, 103-15, 104-19, 104-22		
Clearance mm (in)			Clearance mm (in)		
Piston ring	**Standard**	**Service limit**	**Piston ring**	**Standard**	**Service limit**
No. 01 ring	0,06 - 0,1 (0.0024 - 0.0039)	0,25 (0.0098)	No. 01 ring	0,07 - 0,11 (0.0028 - 0.0043)	0,25 (0.0098)
No. 02 ring	0,05 - 0,09 (0.0020 - 0.0035)	0,25 (0.0098)	No. 02 ring	0,04 - 0,08 (0.0016 - 0.0032)	0,25 (0.0098)
Oil control ring	0,02 - 0,06 (0.0008 - 0.0024)	0,15 (0.0059)	Oil control ring	0,02 - 0,06 (0.0008 - 0.0024)	0,15 (0.0059)



Piston ring and block

To inspect **Operation 4-6**

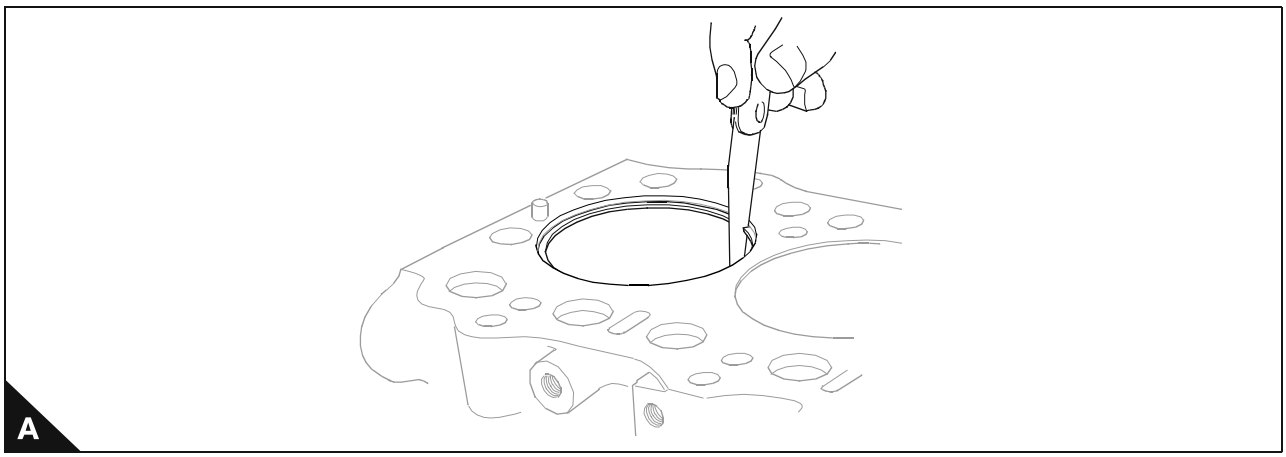
Note: If the piston ring is worn or damaged, renew it.

Piston ring gap

Insert the rings into the cylinder at right angles to the cylinder bore and measure the gaps with a feeler gauge. If the gap is more than the service limit, renew the ring.

102-05, 103-07			103-10		
Gap mm (in)			Gap mm (in)		
Piston ring	**Standard**	**Service limit**	**Piston ring**	**Standard**	**Service limit**
No. 01 ring	0,13 - 0,25 (0.0051 - 0.0100)	1,0 (0.040)	No. 01 ring	0,15 - 0,27 (0.0059 - 0.0106)	1,0 (0.040)
No. 02 ring	0,10 - 0,22 (0.0040 - 0.0087)	1,0 (0.040)	No. 02 ring	0,12 - 0,24 (0.0047 - 0.0094)	1,0 (0.040)
Oil control ring	0,10 - 0,30 (0.0040 - 0.0120)	1,0 (0.040)	Oil control ring	0,20 - 0,35 (0.0079 - 0.0138)	1,0 (0.040)

103-13, 103-15, 104-19, 104-22		
Gap mm (in)		
Piston ring	**Standard**	**Service limit**
No. 01 ring	0,20 - 0,35 (0.0079 - 0.0138)	1,0 (0.040)
No. 02 ring	0,20 - 0,40 (0.0079 - 0.0158)	1,0 (0.040)
Oil control ring	0,20 - 0,40 (0.0079 - 0.0158)	1,0 (0.040)



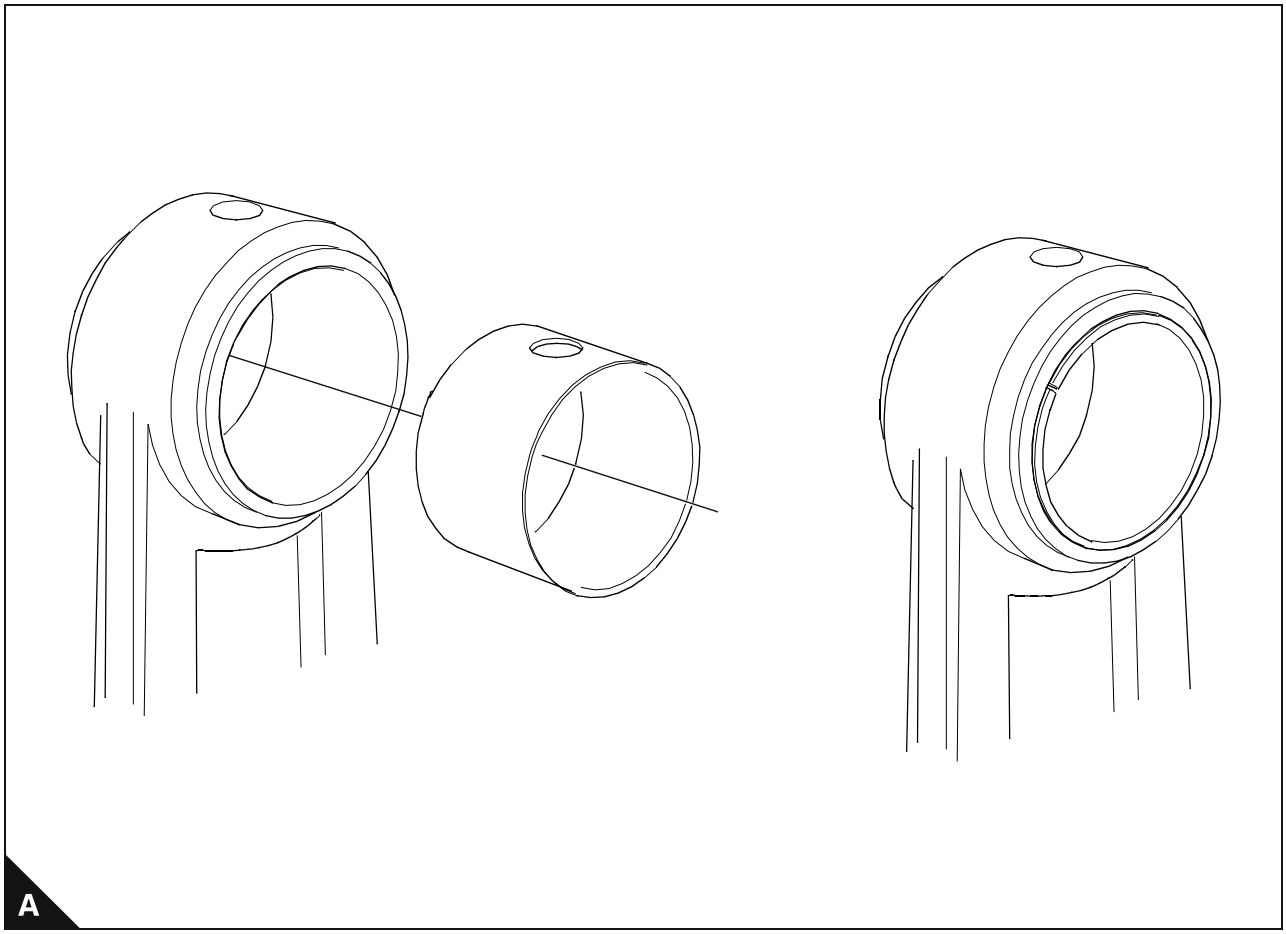
Small end bush

To remove and to fit **Operation 4-7**

Special requirements

Engine model	Clearance mm (in)	
	Standard	Service limit
102-05, 103-07	0,013 - 0,028 (0.00051 - 0.00110)	0,1 (0.004)
103-10	0,008 - 0,023 (0.00031 - 0.00091)	0,1 (0.004)
103-13, 103-15, 104-19, 104-22	0,010 - 0,025 (0.00040 - 0.00099)	0,1 (0.004)

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

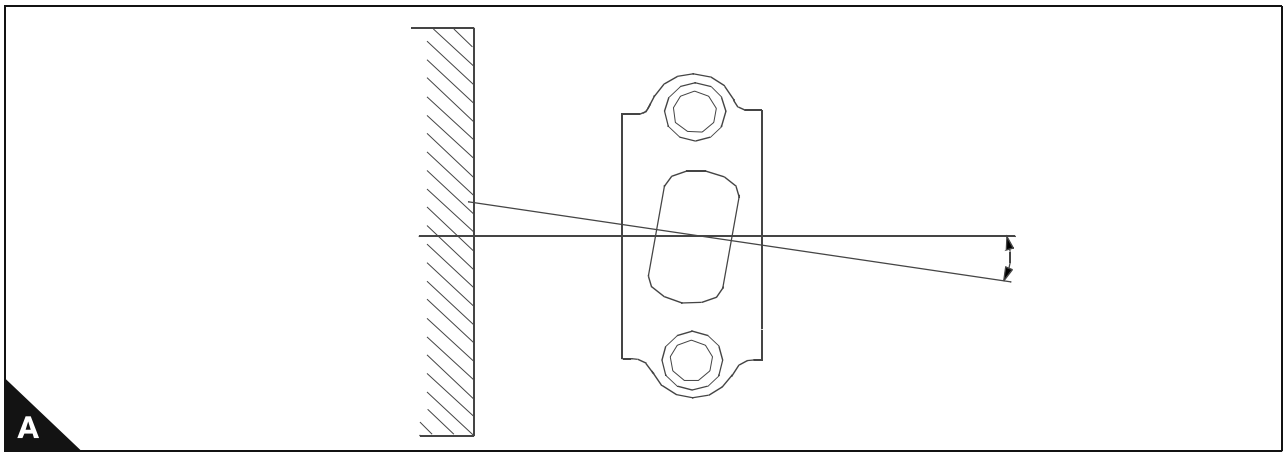


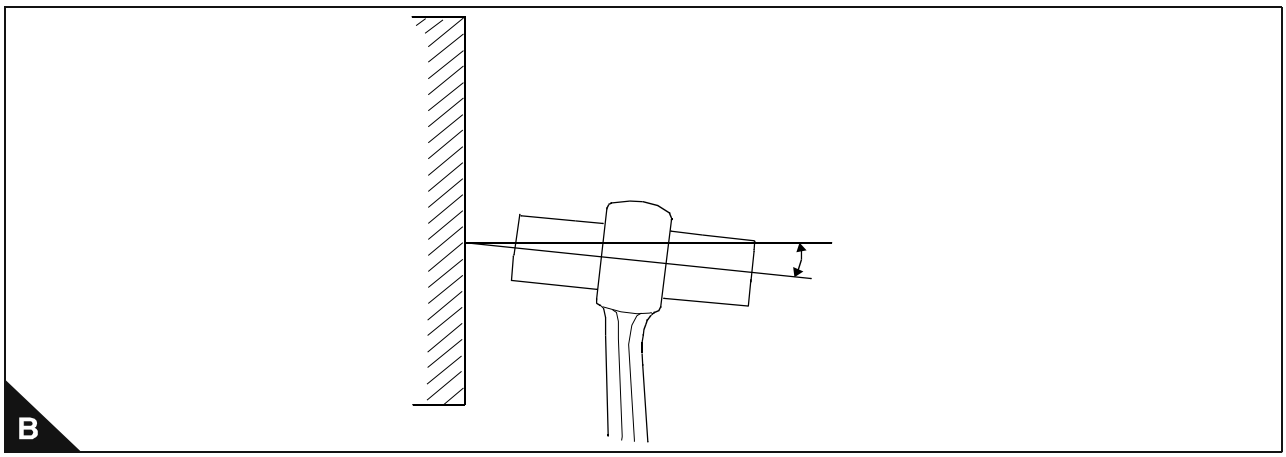
Connecting rod

To inspect **Operation 4-8**

Special requirements

Dimension mm (in)		
	Standard	**Service limit**
Distortion for 100 (3.937)	Less than 0,08 (0.0031)	0,20 (0.0079) max
Parallel for 100 (3.937)	Less than 0,05 (0.0020)	0,15 (0.0059) max





5

Crankshaft assembly

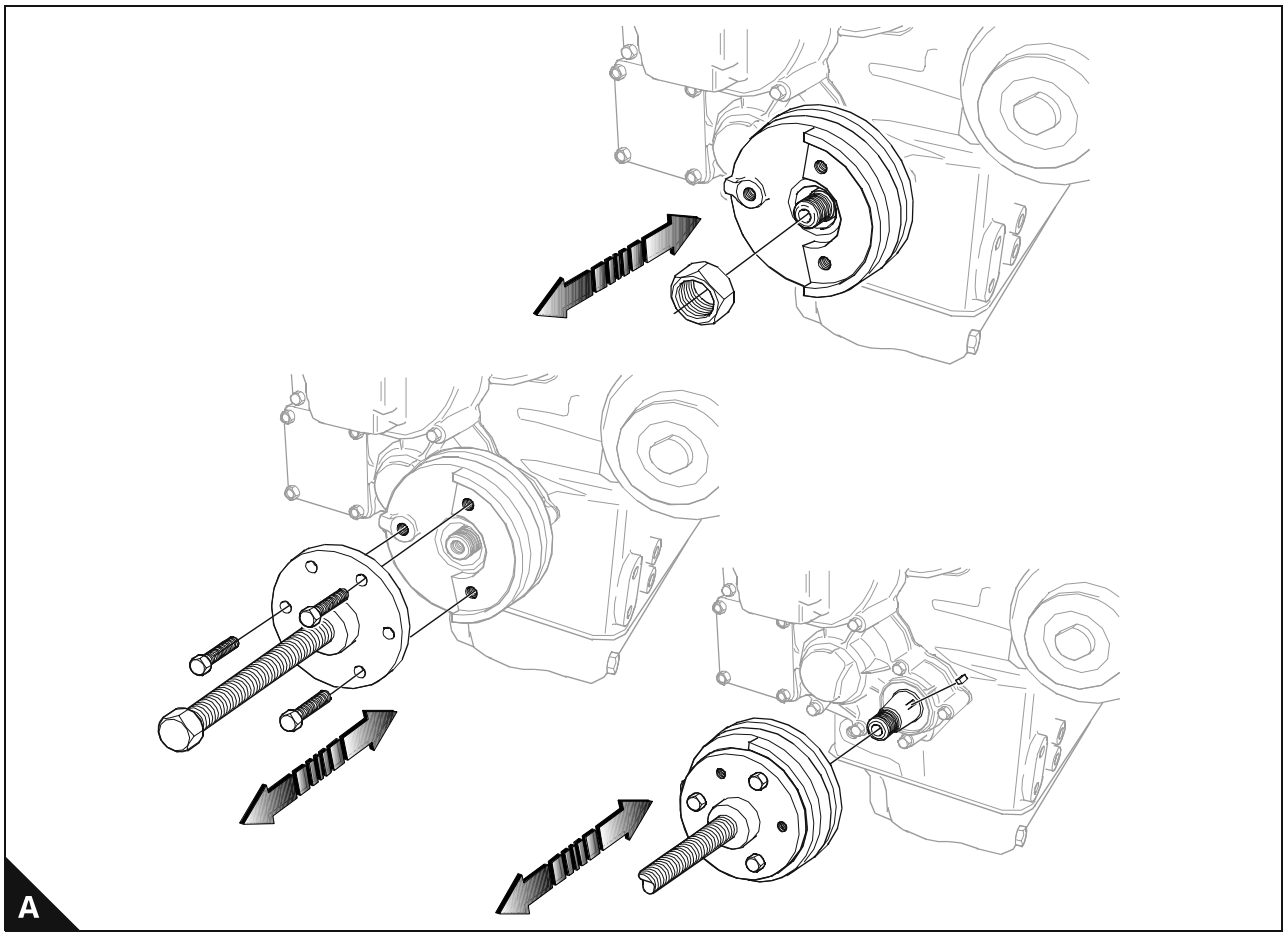
Crankshaft pulley

To remove and to fit **Operation 5-1**

Special requirements

Special tools		Torque Nm (lbf ft) kgf m	
Description	**Part number**	102-05, 103-07	93 (69) 9,5
Crankshaft pulley remover	21825619	103-10	123 (91) 12,5
		103-13, 103-15, 104-19, 104-22	304 (224) 31

Note: Store the key (A1) in a safe place until assembly.



Flywheel, backplate and oil seal

To remove and to fit — Operation 5-2

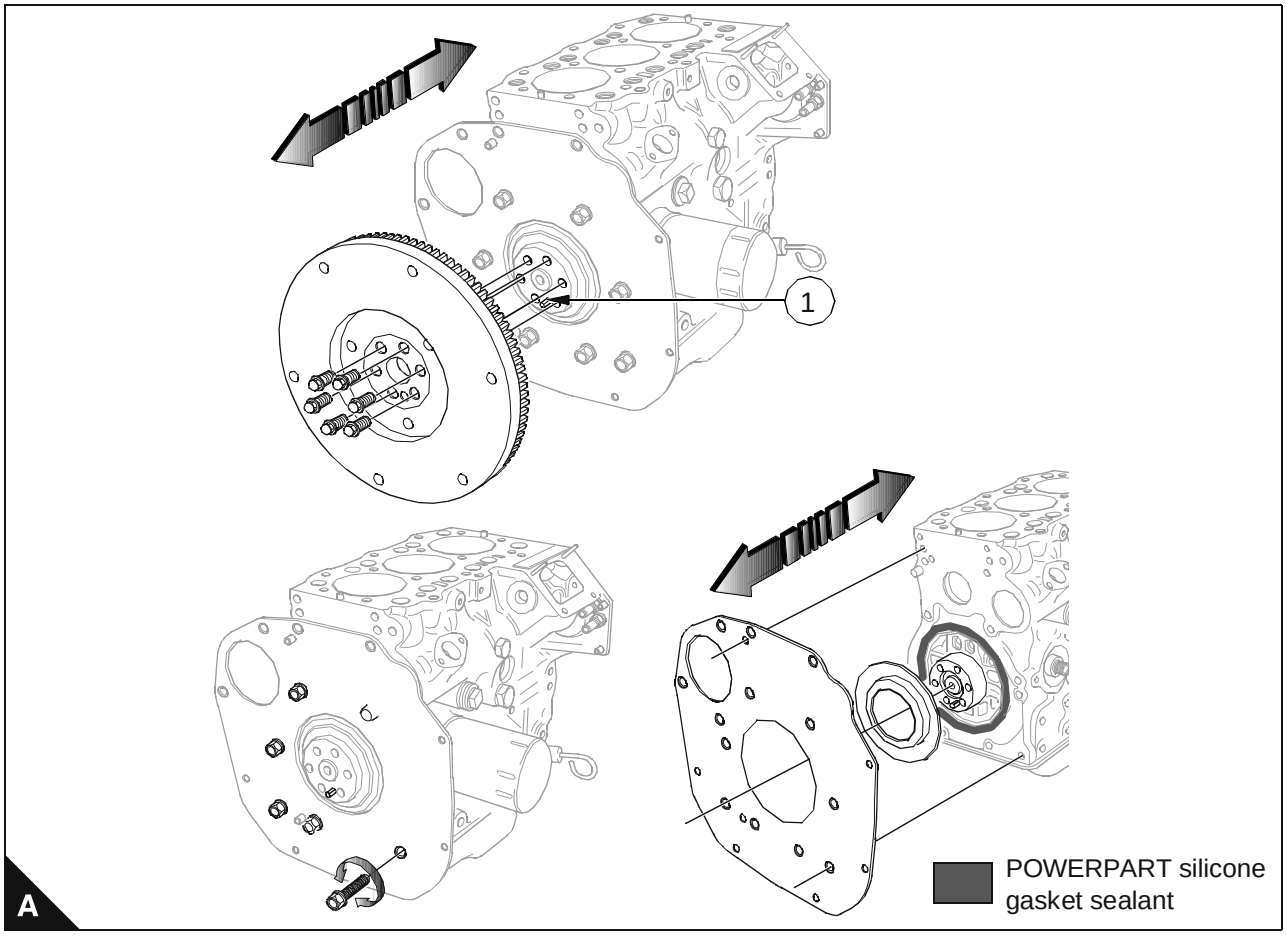
Special requirements

POWERPART products	
Description	**Part number**
Silicone RTV sealing and jointing compound	1861108

Flywheel setscrews : Torque Nm (lbf ft) kgf m		Backplate setscrews : Torque Nm (lbf ft) kgf m	
102-05, 103-07	73 (54) 7,4	102-05, 103-07	15 (11) 1,5
103-10	73 (54) 7,4	103-10	50 (37) 5,1
103-13, 103-15, 104-19, 104-22	73 (54) 7,4	103-13, 103-15, 104-19, 104-22	15 (11) 1,5

Notes:

- To remove and fit the flywheel, see Operation 13-1.
- On assembly, apply Powerpart silicone RTV sealing and jointing compound to the block (around screw holes) before the backplate is fitted.
- 103-10, 103-13 and 103-15 engines only: Remember the position of the dowel (A1).



Crankshaft retainer setscrews and crankshaft

To remove and to fit **Operation 5-3**

Special requirements

Hex hole setscrews (A1) : Torque Nm (lbf ft) kgf m		Hex setscrews (A2) : Torque Nm (lbf ft) kgf m	
102-05, 103-07, 103-10	27 (20) 2,7	102-05, 103-07, 103-10	27 (20) 2,7
103-13, 103-15, 104-19, 104-22	27 (20) 2,7	103-13, 103-15, 104-19, 104-22	51 (38) 5,2

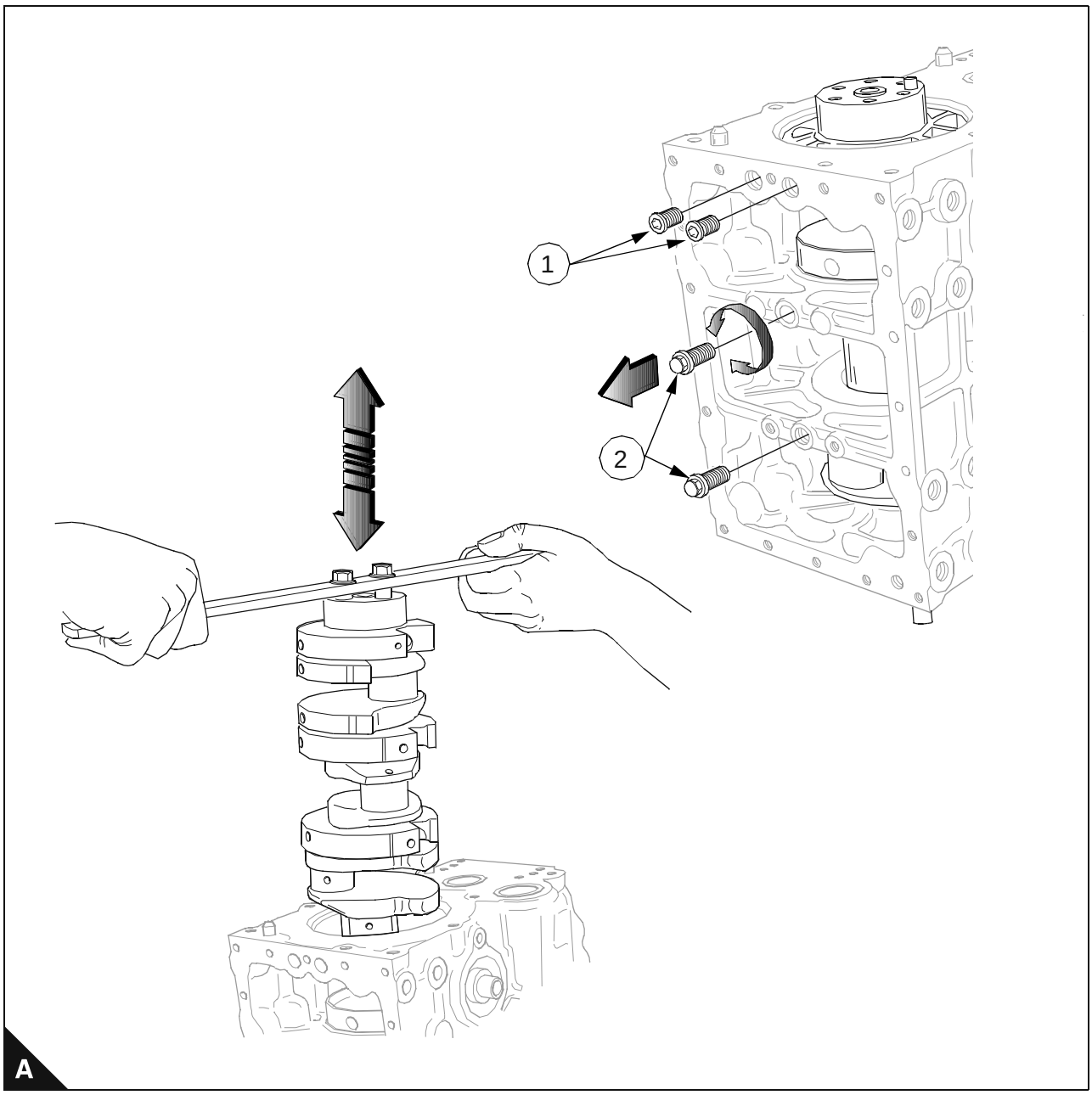
Check that the oil ways of the bearings match up with the oil ways in the block.

Caution: *Before removal and fitting of the crankshaft ensure that the pressure relief valve has been removed.*

Notes:

- For emissions approved engines. The fuel adjustment screw must not be altered from the original setting.
- The maximum No Load Speed must be checked after assembly.
- If a new crankshaft is fitted, see Operation 3-13.

Continued


1
2
A

Bearing clearance

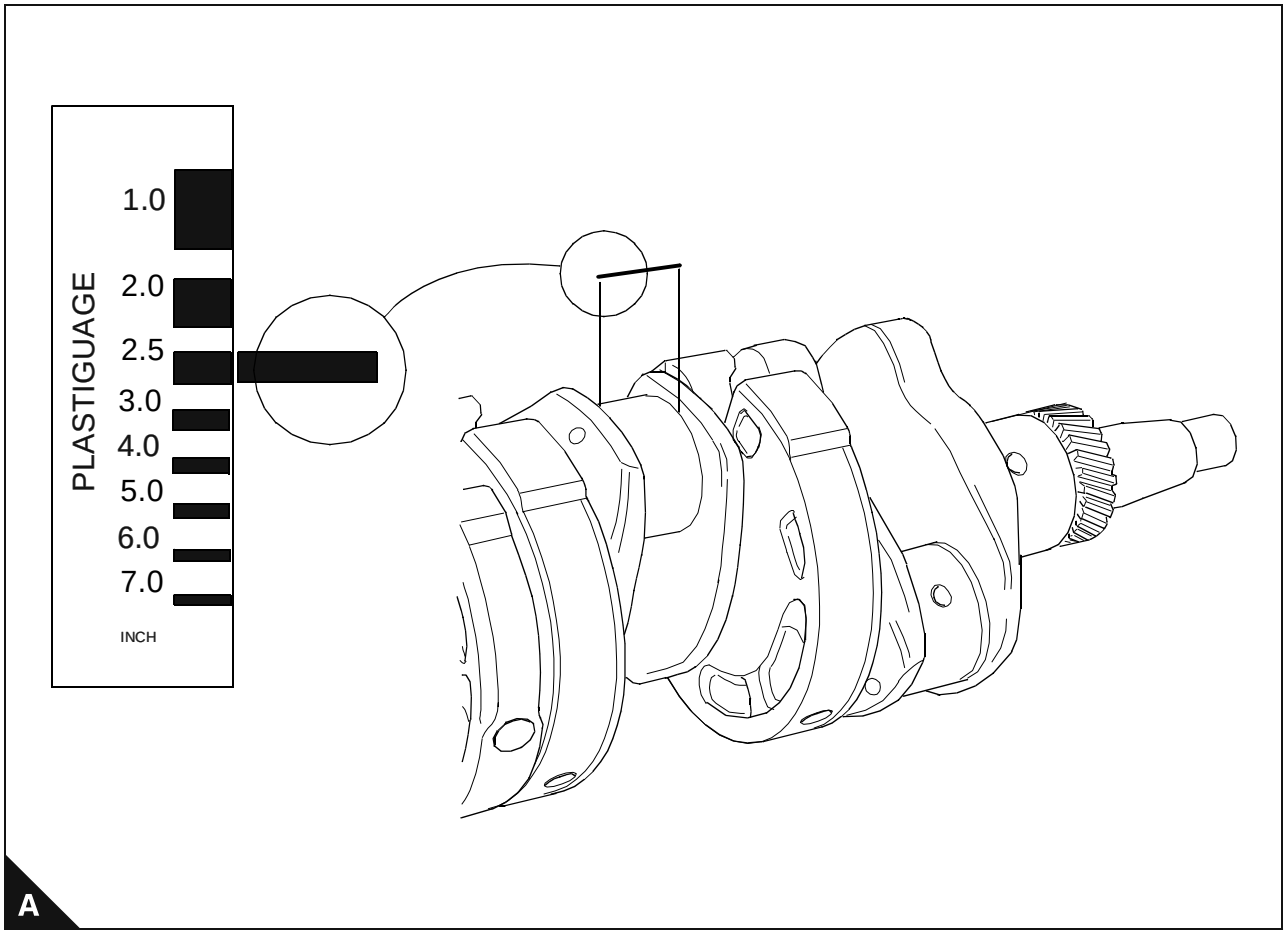
To check **Operation 5-4**

Special requirements

Engine model	Clearance mm (in)	
	Standard	Service limit
102-05, 103-07	0,031 - 0,079 (0.00122 - 0.00311)	0,20 (0.0079)
103-10	0,035 - 0,083 (0.00138 - 0.00327)	0,20 (0.0079)
103-13, 103-15, 104-19, 104-22	0,035 - 0,085 (0.00138 - 0.00335)	0,20 (0.0079)

Use Plastigauge® to check the bearing clearance.

Tighten the main bearings to the torque settings given in Operation 5-5 for two and three cylinder engines or Operation 5-6 for four cylinder engines.



Main bearings

To dismantle and to assemble (two and three cylinder engines) **Operation 5-5**

Special requirements

Torque Nm (lbf ft) kgf m		Bearing holder (Aluminium) : Thickness mm (in)	
		Standard	Service limit
102-05, 103-07, 103-10 Aluminium Bearings	22 (16) 2,2	21,85 - 21,95 (0.8602 - 0.8641)	21,6 (0.8503)
102-05, 103-07, 103-10 Cast Iron Bearings	27 (19.9) 2,7	N/A	N/A

Engine model	End Float : Clearance mm (in)	
	Standard	Service limit
102-05, 103-07	0,10 - 0,30 (0.0040 - 0.0120)	0,50 (0.0197)
103-10	0,05 - 0,30 (0.0020 - 0.0120)	0,50 (0.0197)

1 Identify position of bearing carriers on shaft.

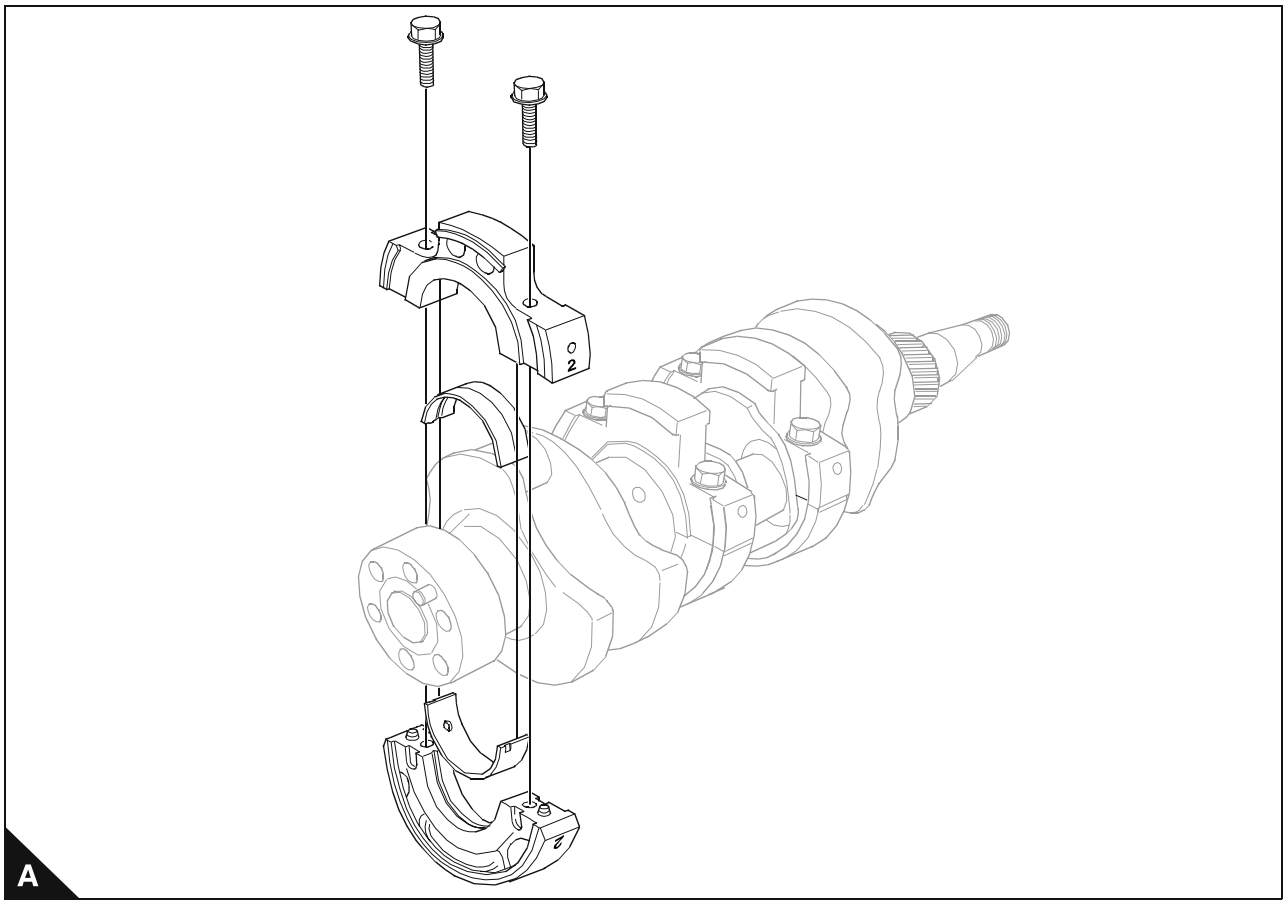
2 Install bearing carriers on the crankshaft ensuring oil holes align with feed holes in cylinder block.

3 Check end float.

4 Check number 2 bearing holder on 102-05 engines and number 3 bearing holder on 103-07 and 103-10 engines for wear, poor contact, look burnt or other defects. Defective bearing holders must be renewed.

Notes:

- For emissions approved engines. The fuel adjustment screw must not be altered from the original setting.
- The maximum No Load Speed must be checked after assembly.



To dismantle and to assemble (four cylinder engines) **Operation 5-6**

Special requirements

Torque Nm (lbf ft) kgf m	
103-13, 103-15, 104-19, 104-22	51 (38) 5,2

End float : Clearance mm (in)		Thrust washer : Thickness mm (in)	
Standard	**Service limit**	**Standard**	**Service limit**
0,10 - 0,40 (0.0040 - 0.0160)	0,50 (0.0197) max	2,95 - 3,00 (0.1161 - 0.1181)	2,80 (0.1102) max

1 Identify position of bearing carriers on shaft.

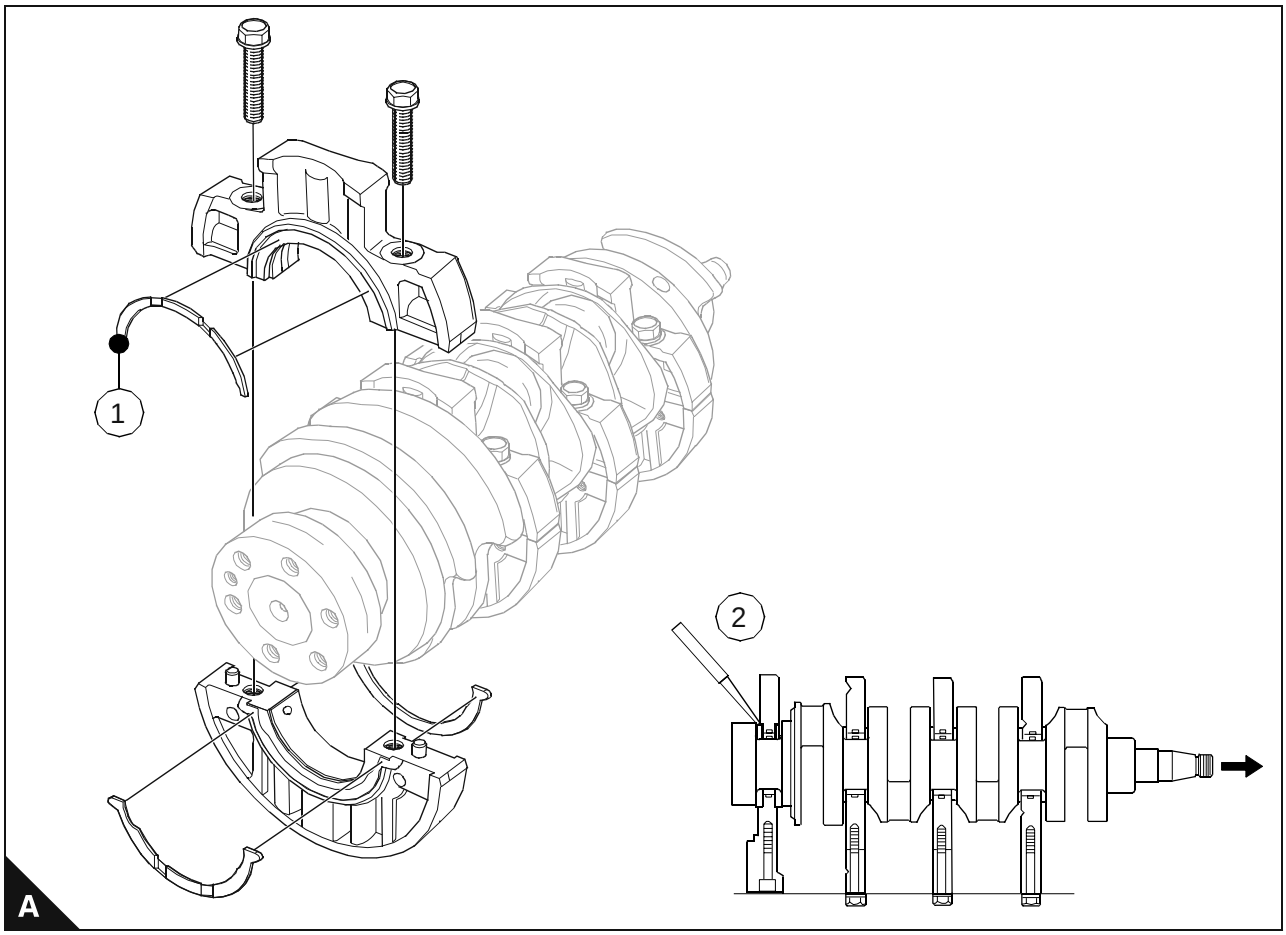
2 Install bearing carriers on shaft ensuring oil holes align with feed holes in cylinder block.

3 Check end float clearance (A2).

Note: Ensure that the thrust washers are aligned correctly, and are fitted with their oil grooves towards the crankshaft.

4 Check the thrust washers for wear, poor contact, look burnt, or have any other defects. Defective washers must be renewed.

Note: Item (A1) is only used on 104-19 and 104-22 engines.



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6

Timing case and drive assembly

Fuel injection pump

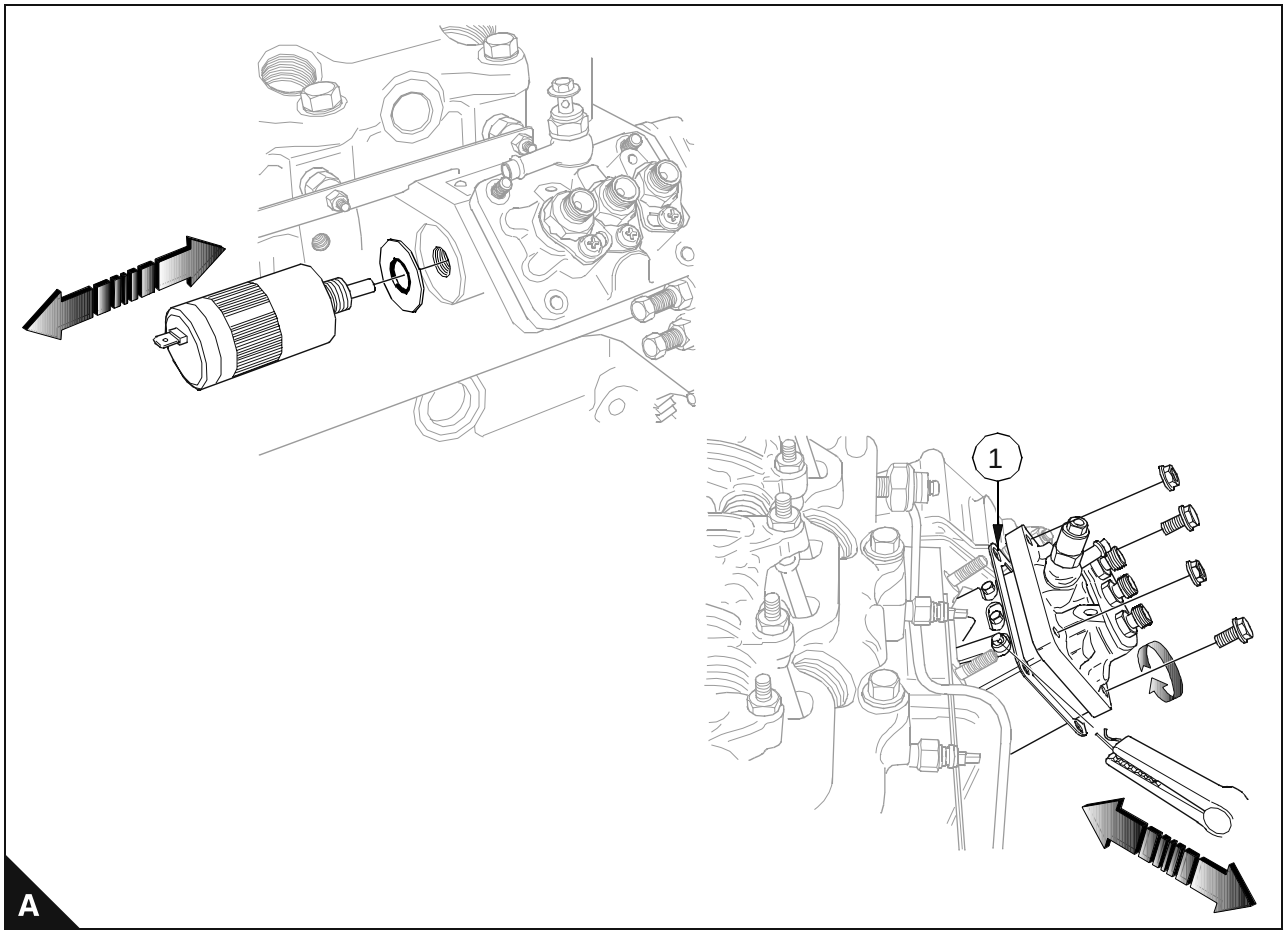
To remove and to fit **Operation 6-1**

Special requirements

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

When the shim (A1) is not required, assemble using a 0,5 mm bead of silicone sealant.

Note: Blank off the connections of the fuel injection pump until assembly.



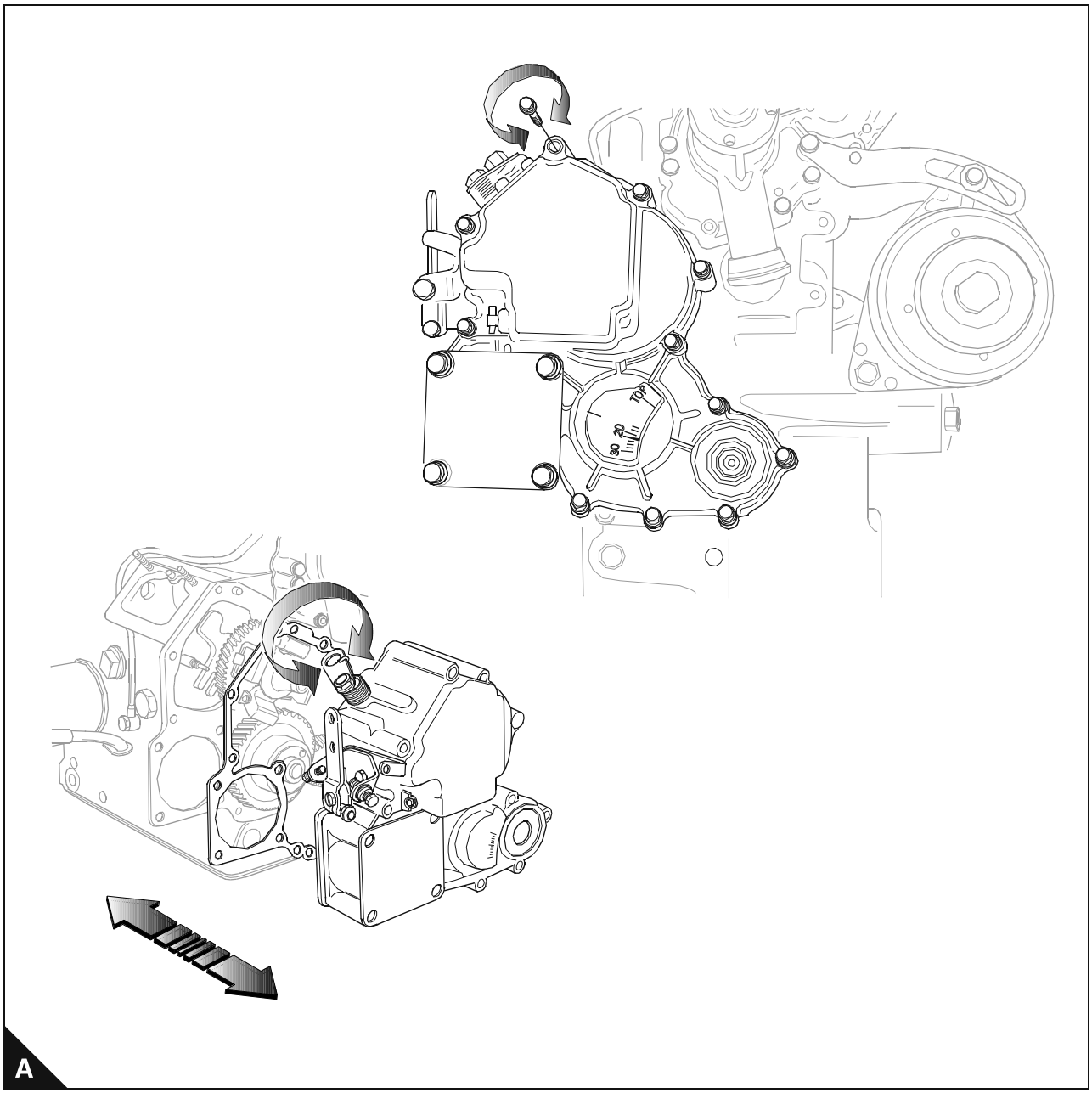
Timing cover

To remove and to fit — Operation 6-2

For crankshaft pulley removal refer to Operation 5-1.

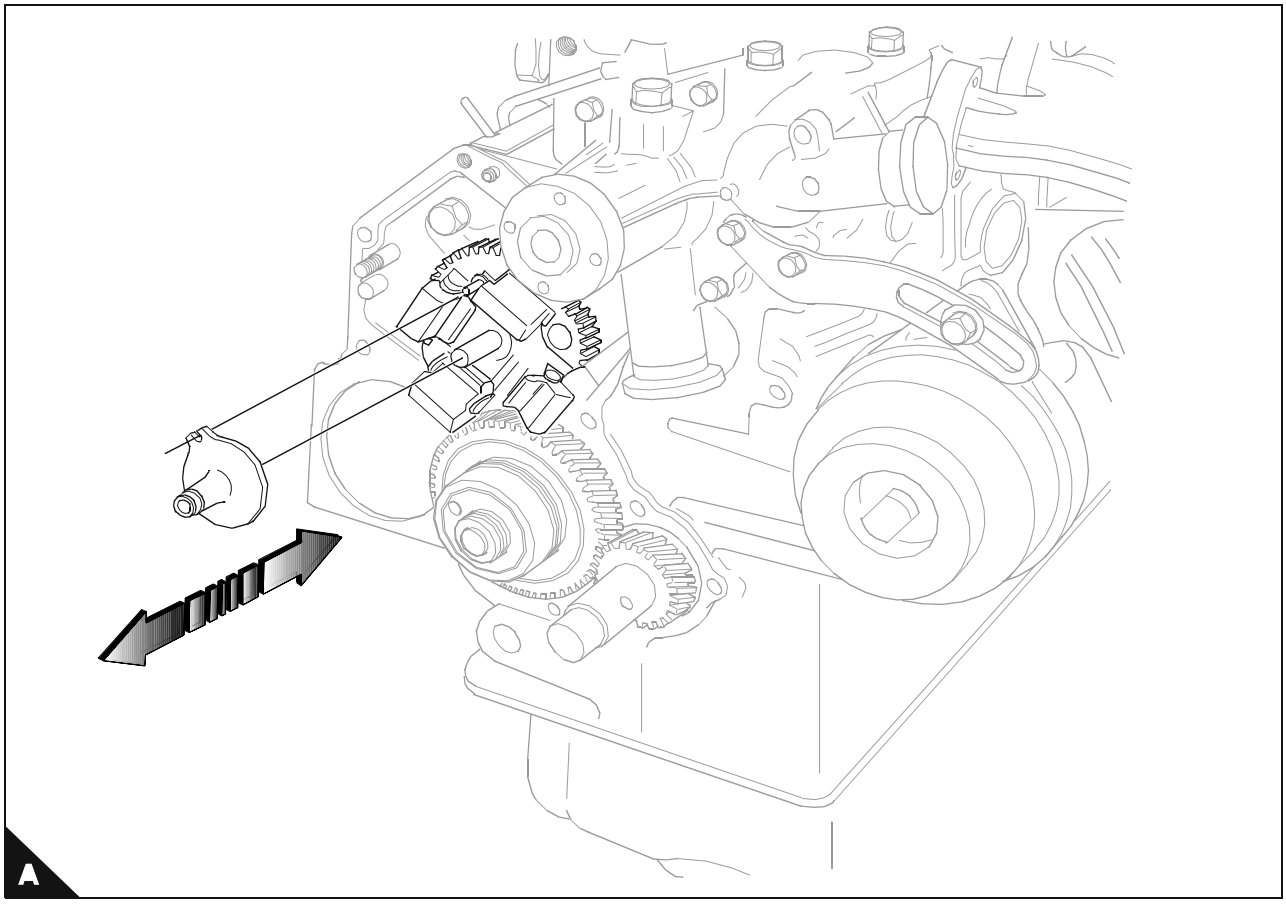
Notes:

- Make sure that the governor springs are correctly attached before the timing cover is fitted, see Operation 6-14.
- On assembly hold arm clockwise.
- After fitting the timing cover, look through the ESOS mounting holeand check that the linkage moves correctly when the throttle lever on the fuel injection pump is operated.
- For emissions approved engines. The fuel adjustment screw should not be altered from original setting.
- The Maximum No Load Speed must be checked after assembly.
- If a new timing case is fitted, a new emissions label must be fitted.



Slider

To remove and to fit **Operation 6-3**



Camshaft retainer plate

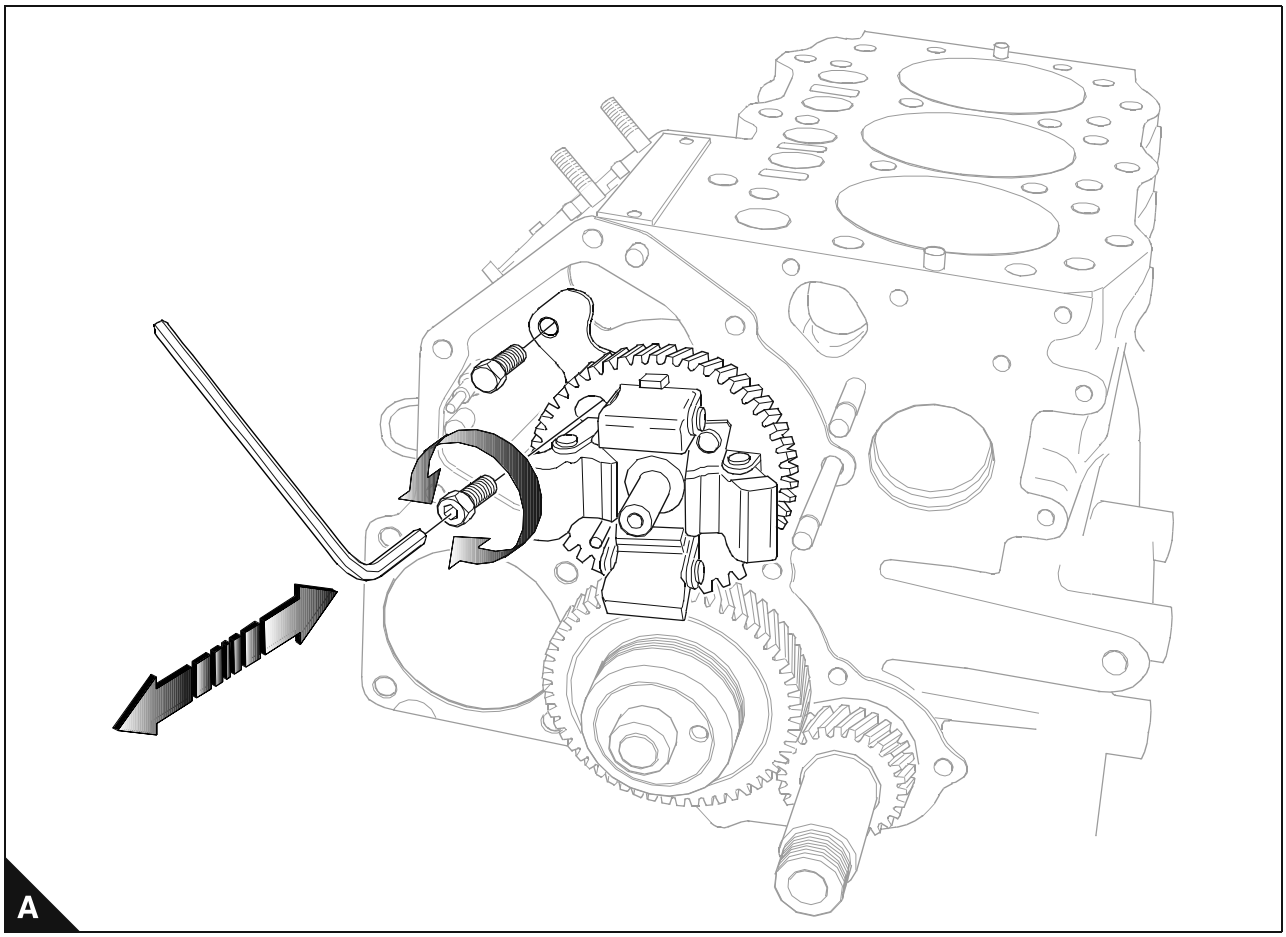
To remove and to fit **Operation 6-4**

Special requirements

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

Notes:

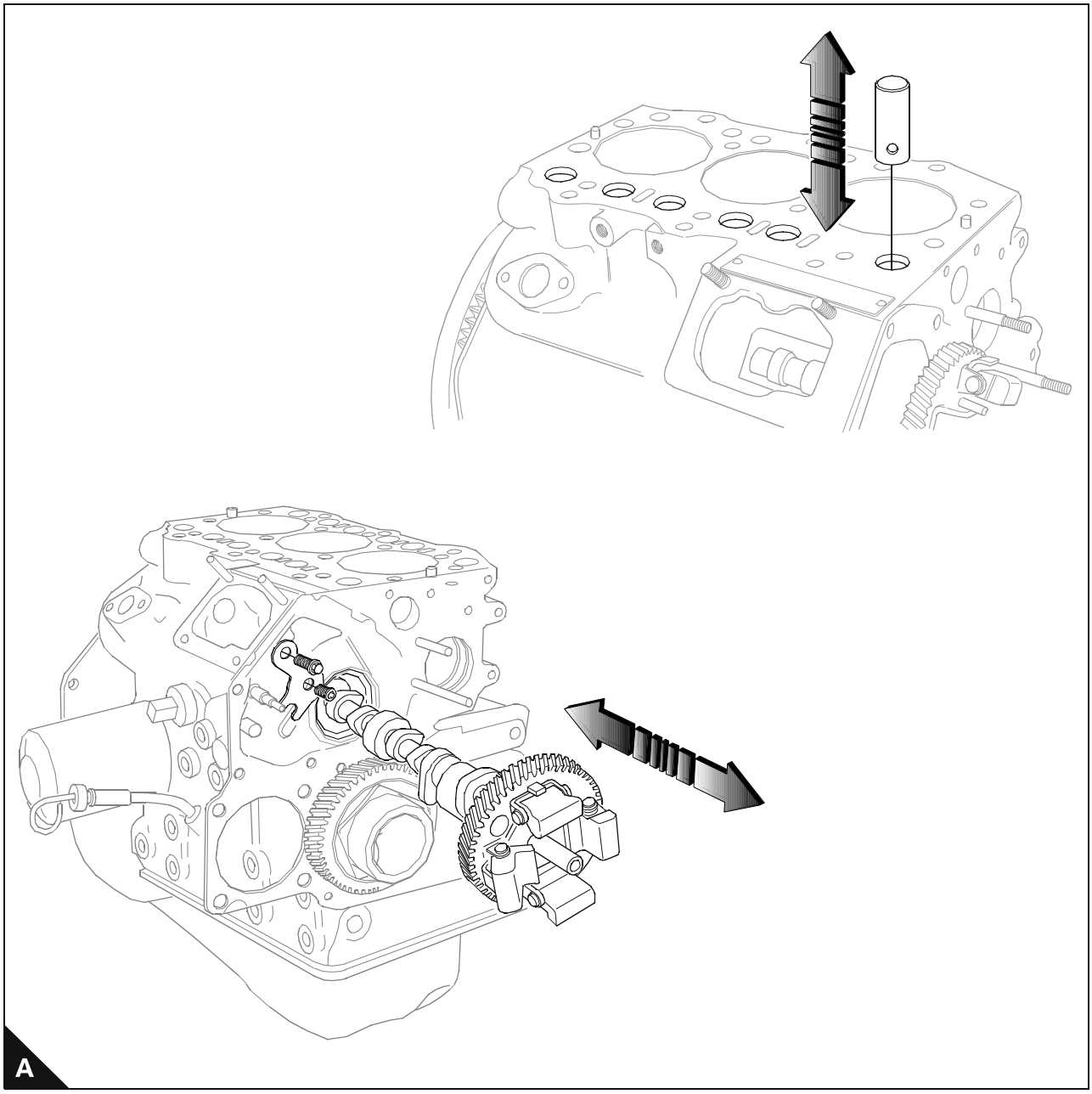
- For emissions approved engines. The fuel adjustment screw must not be altered from the original setting.
- The maximum No Load Speed must be checked after assembly.



Camshaft and cam followers

To remove **Operation 6-5**

Caution: *Remove fuel lift pump and all the cam followers before removing the camshaft.*



To fit **Operation 6-6**

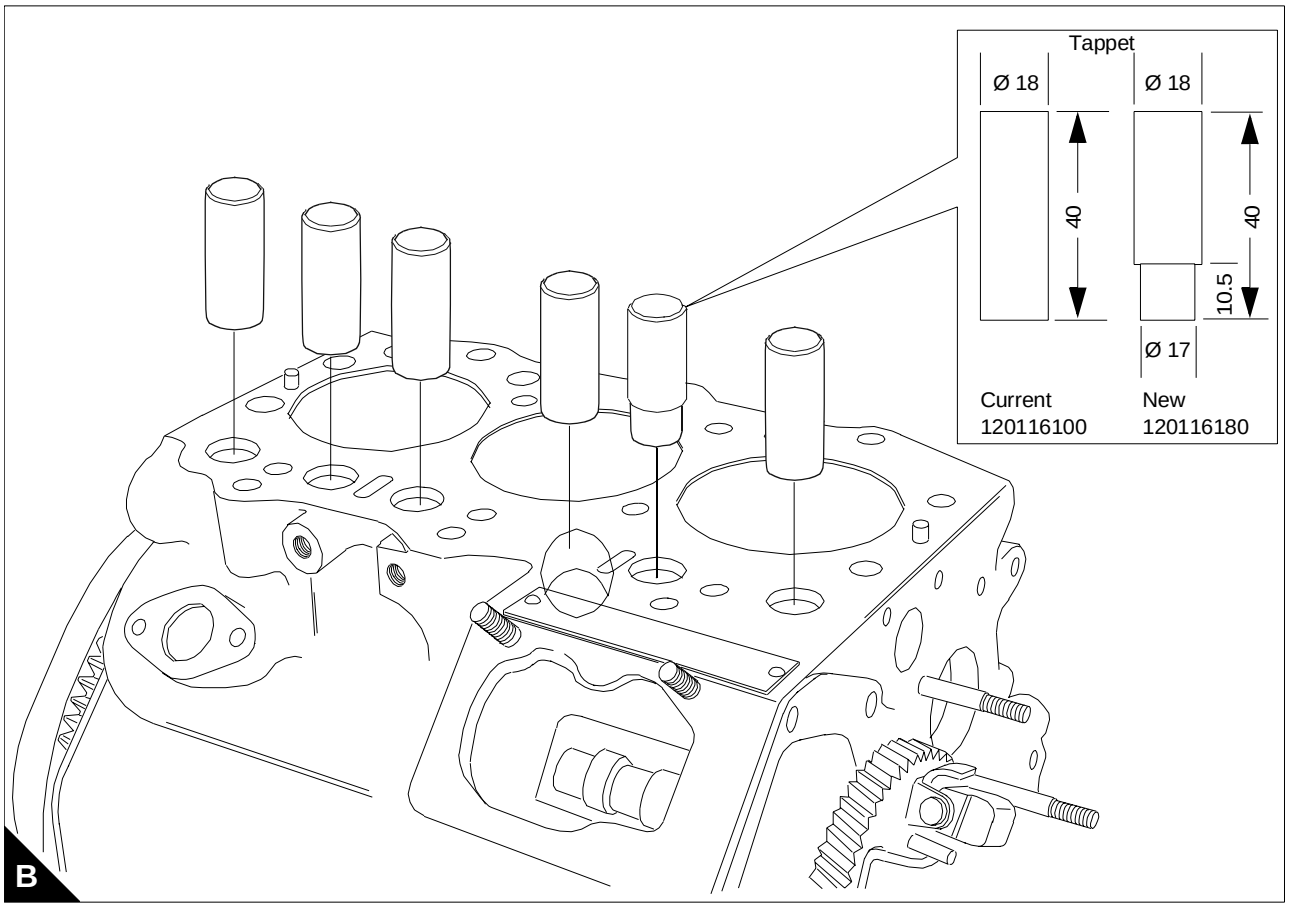
***Cautions*:**

- *The new camshaft is not interchangeable with the old camshaft.*
- *If a new camshaft is fitted, new cam followers of the correct type must be fitted as well.*

From engine serial number 333367J the camshaft and the cam followers fitted to the 103-07 engine have changed.

The width of the injection cams for N°2 and N°3 cylinders have been increased by 0,5 mm.

To prevent interference with the wider injection cam on the camshaft, the diameter of the tappet end of the exhaust cam follower for N°1 cylinder has been decreased by 1,0 mm to 17 mm.



Camshaft assembly

To inspect **Operation 6-7**

Cam height (intake and exhaust cams) (A1)

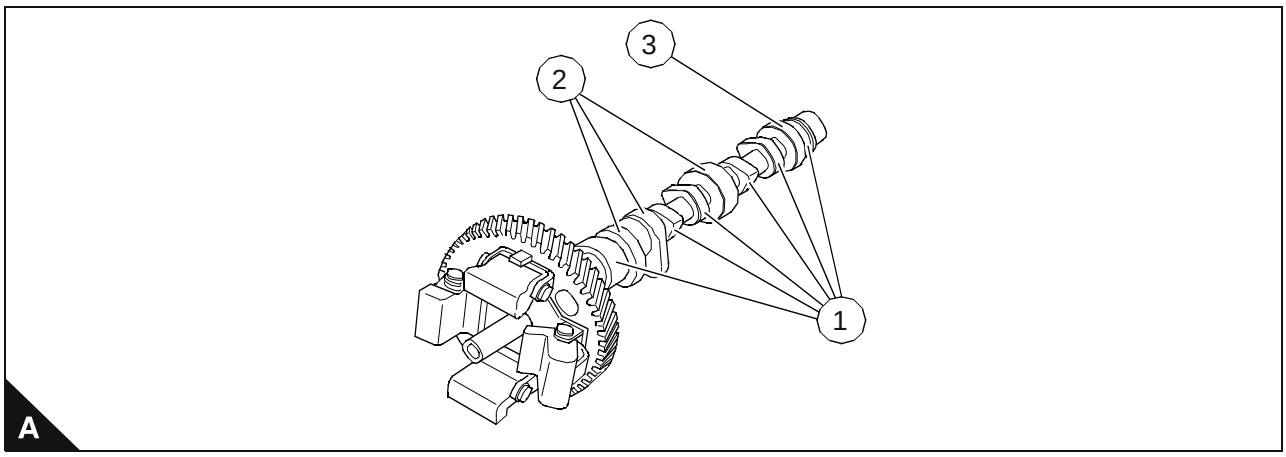
Engine model	Height mm (in)	
	Standard	Service limit
102-05, 103-07	26,565 - 26,620 (1.04590 - 1.04803)	26,1 (1.028)
103-10	26,445 - 26,500 (1.04114 - 1.04330)	26,1 (1.028)
103-13, 103-15, 104-19, 104-22	34,065 - 34,120 (1.34114 - 1.34330)	33,7 (1.327)

Height of cam for injection pump (A2)

Engine model	Height mm (in)	
	Standard	Service limit
102-05, 103-07	34,480 - 34,520 (1.3575 - 1.3591)	34,3 (1.351)
103-10	33,940 - 34,060 (1.3362 - 1.34094)	33,8 (1.331)
103-13, 103-15, 104-19, 104-22	41,940 - 42,060 (1.65120 - 1.65590)	41,8 (1.645)

Height of cam for fuel feed pump (A3)

Engine model	Height mm (in)	
	Standard	Service limit
102-05, 103-07, 103-10	27,900 - 28,000 (1.09842 - 1.10236)	27,0 (1.063)
103-13, 103-15, 104-19, 104-22	31,900 - 32,000 (1.25590 - 1.25984)	30,0 (1.181)

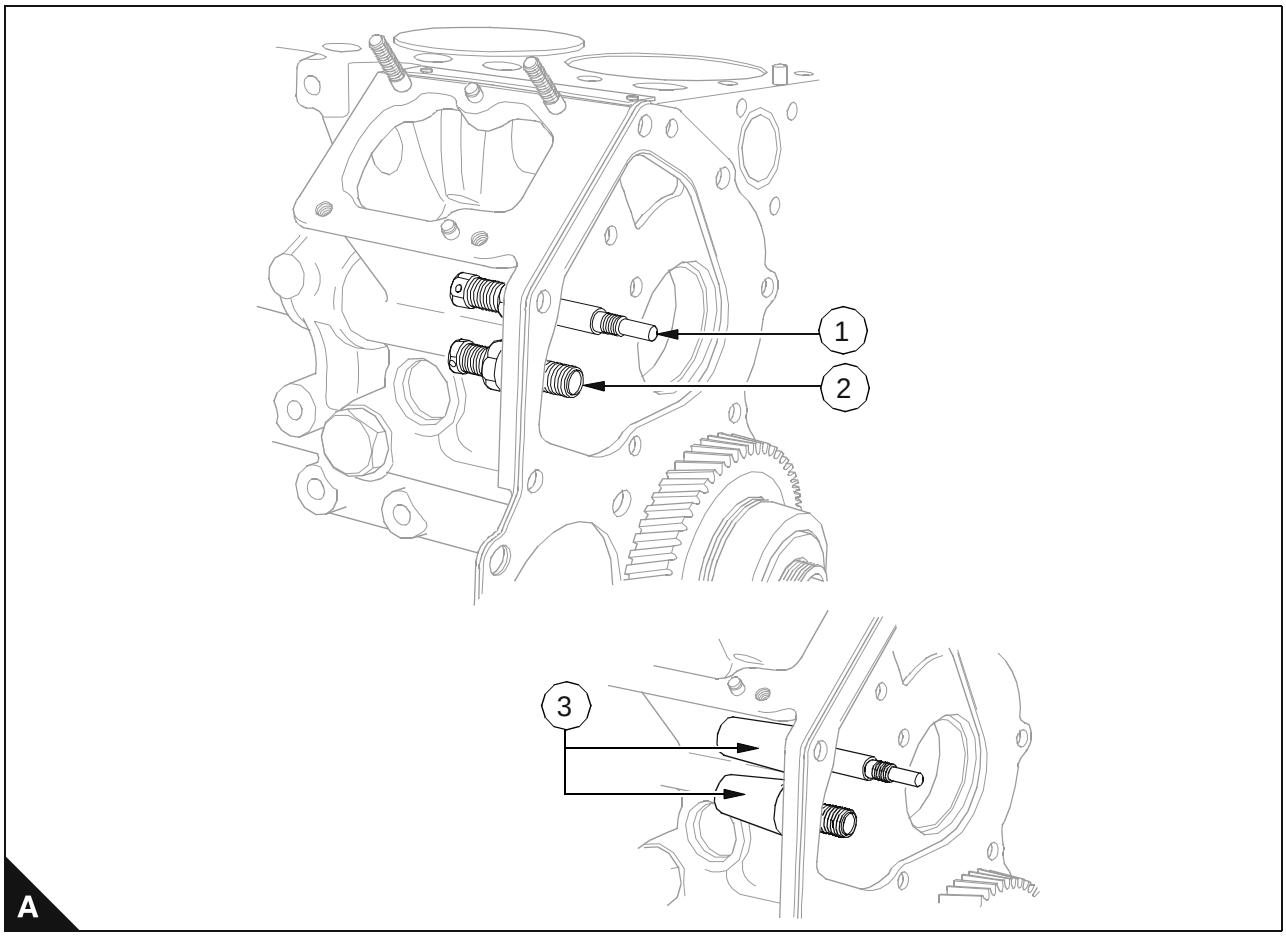


Max fuel screw and max speed screw

To locate **Operation 6-8**

Notes:

- The max fuel screw (A1) and max speed screw (A2) should not be adjusted by the operator.
- An anti tamper device (A3) may be fitted. Where this device is present, see Operation 6-9.
- If adjustment of the maximum fuel screw or the no load speed is necessary, the adjustment must be done on an engine test facility by personnel approved by Perkins Engines Company Ltd.



To remove and to fit **Operation 6-9**

A requirement of emissions legislation is that access to adjustments (A1, A2) that affect the engine's exhaust emissions is limited to personnel approved by Perkins Engines Company Ltd.

The fuel adjustment screw (B2) and maximum speed adjustment (B5) are affected. The fuel adjustment screw has a tamper resistant body (B1) fitted over the screw and the maximum speed adjustment is protected by a tamper evident plastic cap (B4).

To remove the tamper resistant body

1 Strike the tamper resistant device metal body (B1) with a suitable cold chisel approximately 10-15 mm from the cylinder block flange. This will deform the body against the screw lock nut. This operation is necessary until the metal tube cannot freely rotate around the fuel adjustment screw.

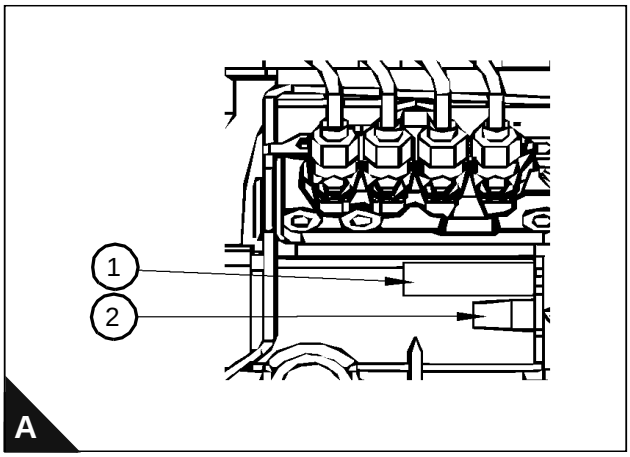
2 Rotate the metal body and the fuel adjustment screw together using a pair of pliers at the D-plug (B3) end of the tube.

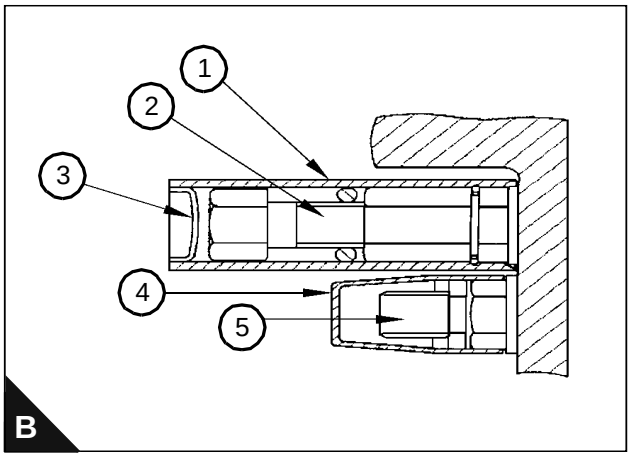
3 Remove the fuel adjustment screw (B2) as a single assembly completely from the cylinder block.

As the removal procedure for the original fuel adjustment screw and tamper resistant device body will cause permanent damage to both these items, replacements must be obtained from PDC Irlam.

To re-fit a new fuel screw and service tamper resistant body

1 The fuel adjustment screw assembly (B2) may vary according to the engine build code. The appropriate replacement must be obtained from PDC Irlam.





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A special service version of the tamper evident body (D) must be fitted when a new fuel screw is fitted. A kit part number U5MK0619 is available from PDC. This kit will be supplied only to permitted personnel and must not be supplied to end users. A groove (D4) around the circumference of the tamper evident body is used to identify it as a service part.

2 Fit the fuel adjustment screw assembly (C3) to the engine ensuring that there is a metal snap ring (C1) located in the lock nut groove and a o-ring (C2) fitted.

3 On a suitable calibrated test facility, reset the engine performance parameters to the certified specification indicated on the engine's emissions control information label mounted on the timing case.

4 Having set the full load fuel delivery to the certified specification and ensuring the lock nut is correctly tightened, insert the D-plug (D2) into the service tamper resistant body (D3) at the opposite end of the internal groove (D1). Fit the new service tamper resistant body assembly (D) over the fuel adjustment screw.

5 Tap on the tube until the internal groove (D1) in the body engages over the metal snap ring (C1) in the lock nut.

To remove and re-fit the tamper evident maximum engine speed cap

The maximum speed adjustment has a plastic cap (B4) fitted by Perkins. The length of this fitted cap will be either 22mm or 30mm in length depending on the original protrusion of the maximum speed adjustment screw (B5). The cap is pressed by hand onto the adjustment screw and an internal lip locates into a groove on the lock nut.

1 Remove the plastic cap (B4) from the maximum speed bolt (B5) with a suitable lever, taking care not to damage the seal between the cylinder block and the locknut.

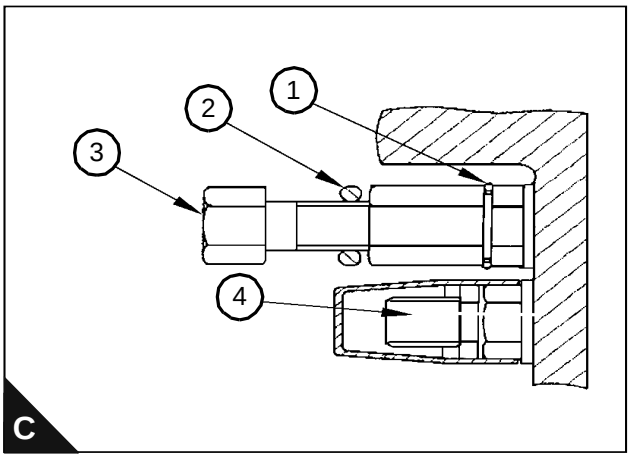
2 Make the necessary adjustment to maximum (no load) engine speed by rotating bolt clockwise to reduce speed and anti-clockwise to increase speed with the engine throttle lever fully open.

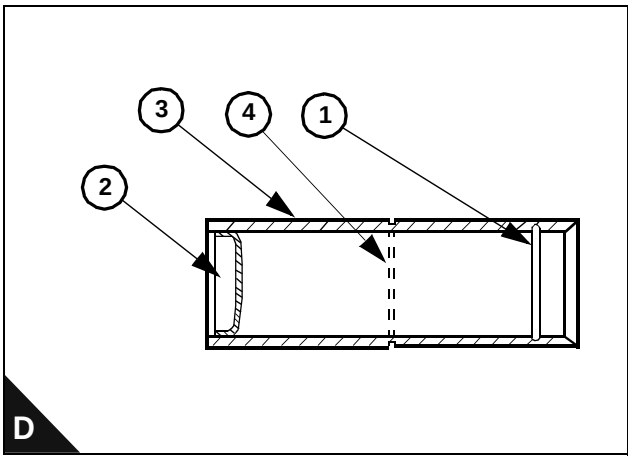
Note: The only permitted adjustment to the maximum engine speed is to correct the speed in accordance with the high idle speed shown on the emissions compliance label mounted on the engine timing case.

3 After adjustment to within the certified maximum speed range, a new service cap of the appropriate length can be obtained from PDC Irlam. The replacement service cap will be red in colour part number 131276440 - 30mm length or 131276450 - 22 mm length. This cap will be supplied only to permitted personnel and must not be supplied to end users.

4 Hand press the replacement service cap onto maximum speed bolt (C4) lock nut.

A warranty claim will not be accepted if it can be seen that an adjustment to the maximum engine speed setting (B5) or the fuel adjustment screw (B2) has been made by personnel not approved by Perkins.





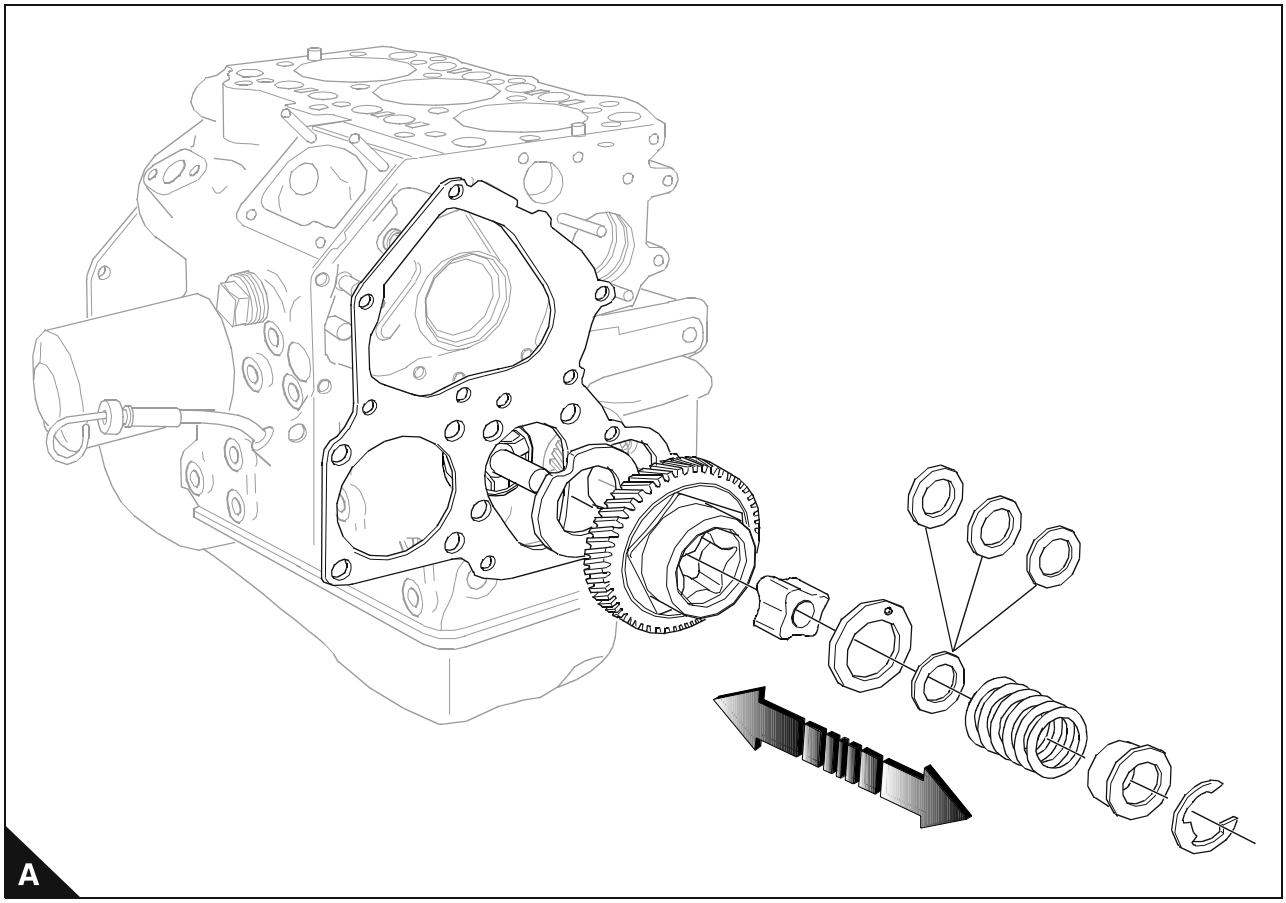
Idler gear and oil pump

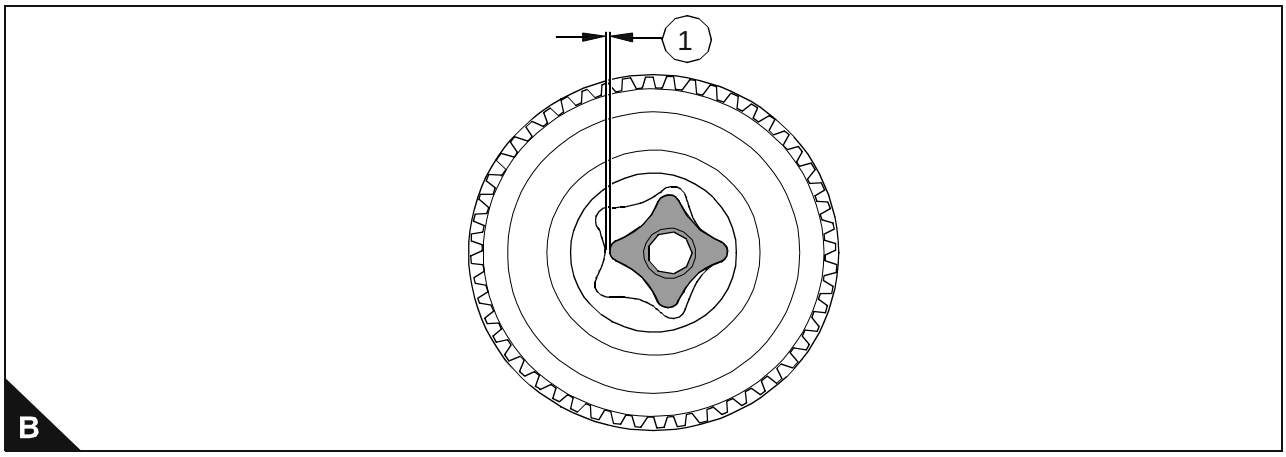
To remove and to fit **Operation 6-10**

Special requirements

Clearance (B1) mm (in)	
Standard	**Service limit**
0,01 - 0,15 (0.0004 - 0.0060)	0,25 (0.0098) max

Extra shims may be required to achieve the standard clearance. To check the end float refer to Operation 6-13.





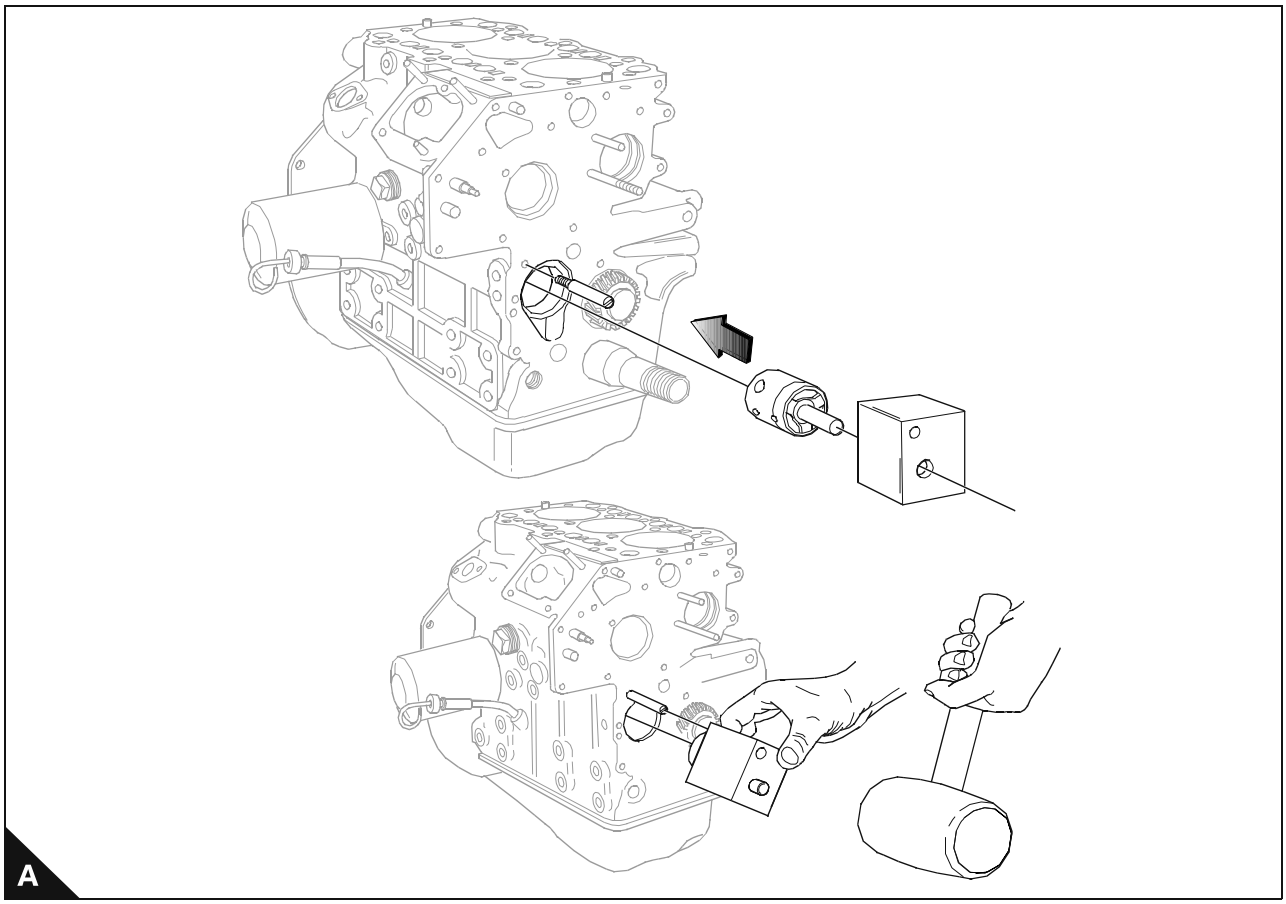
Idler hub

To fit **Operation 6-11**

Special requirements

Special tools	
Description	**Part number**
Idler hub assembly tool - 102-05, 103-07	21825624
Idler hub assembly tool - 103-10	21825625
Idler hub assembly tool - 103-13, 103-15, 104-19, 104-22	21825626

Caution: *If the idler hub is removed, it must be renewed.*



Gear teeth backlash

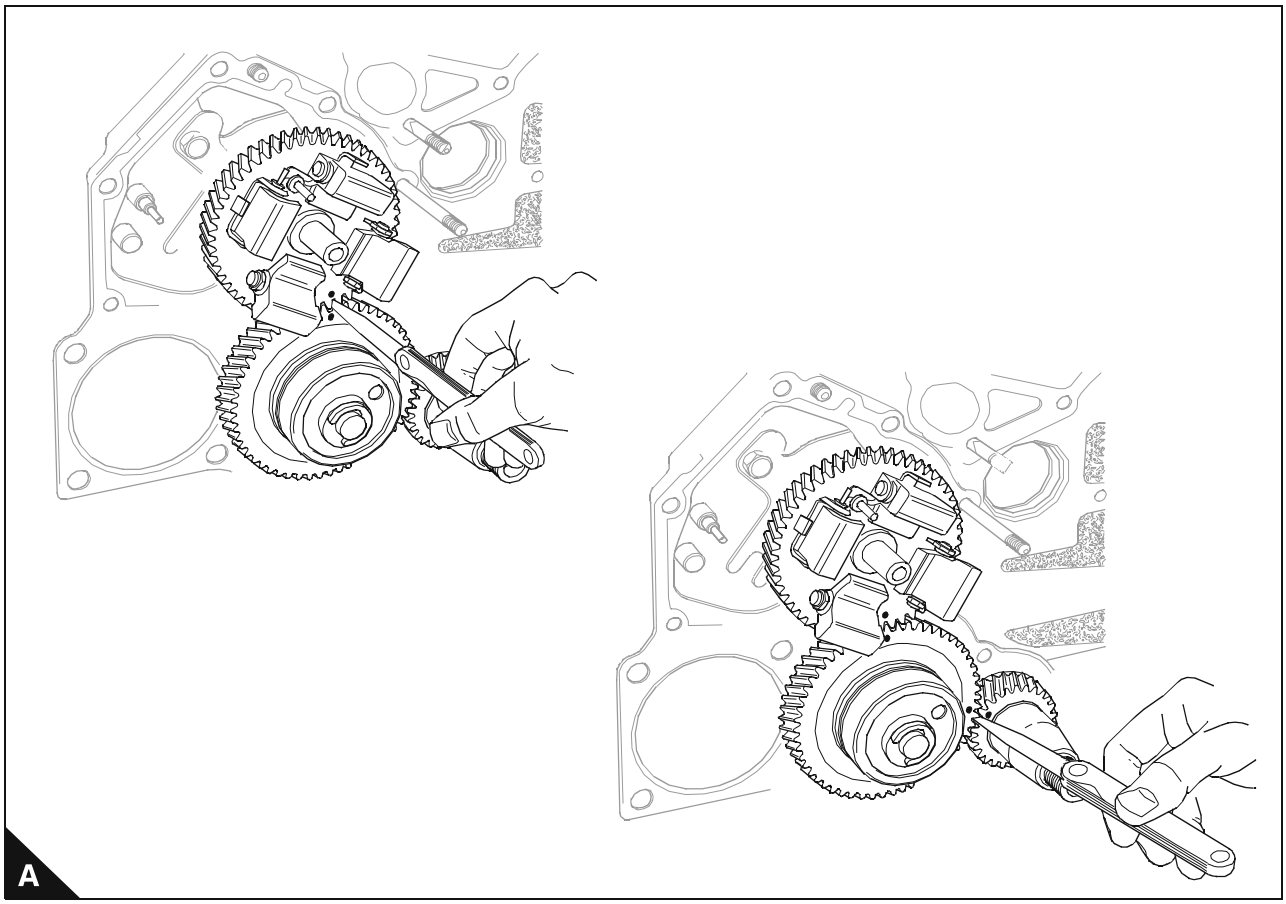
To check backlash **Operation 6-12**

Special requirements

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

1 Align the set marks.

2 Measure the clearance with a feeler gauge.



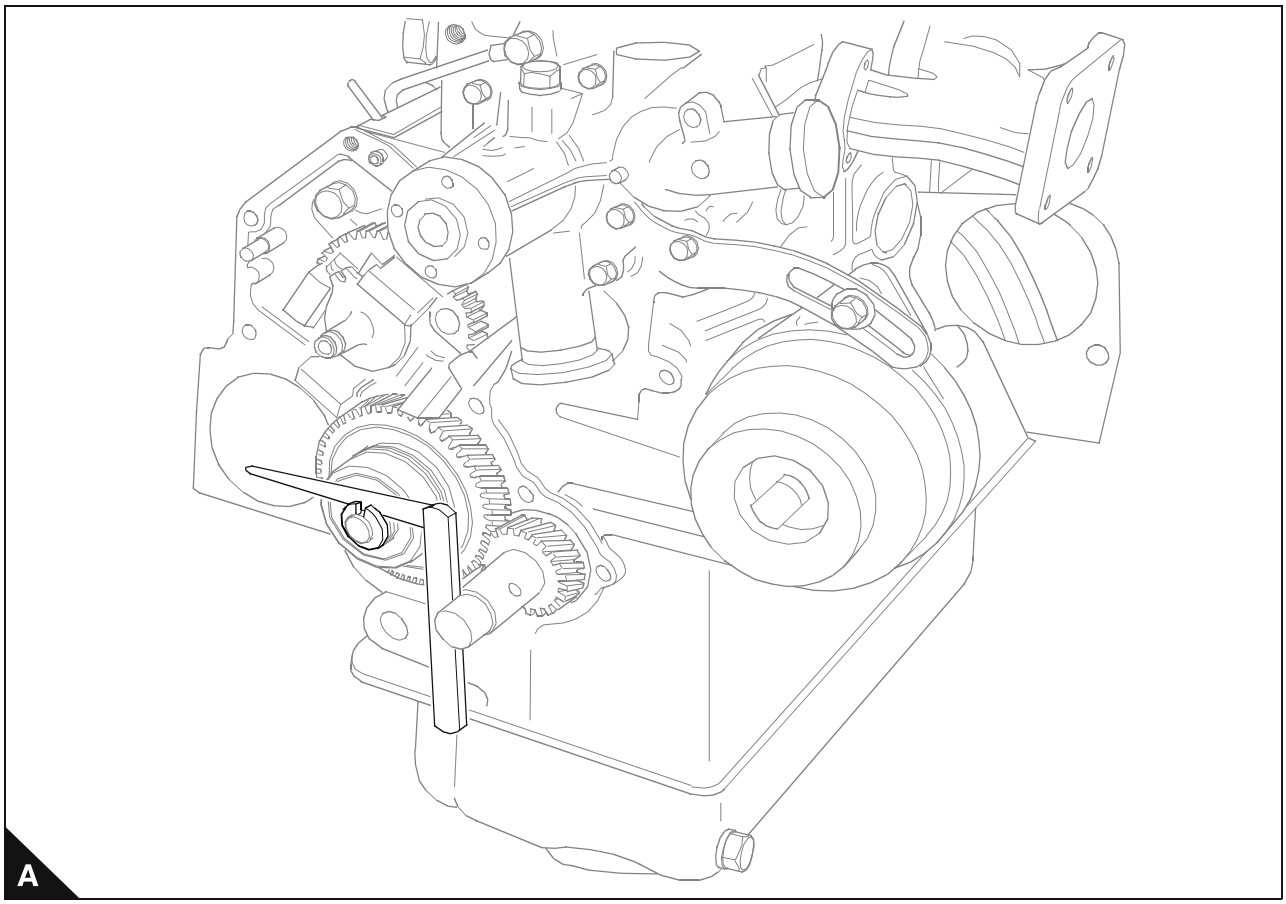
Oil pump end float

To check **Operation 6-13**

Special requirements

Clearance mm (in)	
Standard	**Service limit**
0,10 - 0,15 (0.0040 - 0.0060)	0,20 (0.0079)

Use a feeler gauge to check the end float clearance of the oil pump. Adjust with 0,1. 0,15. 0,2. and 0,5 mm shims.



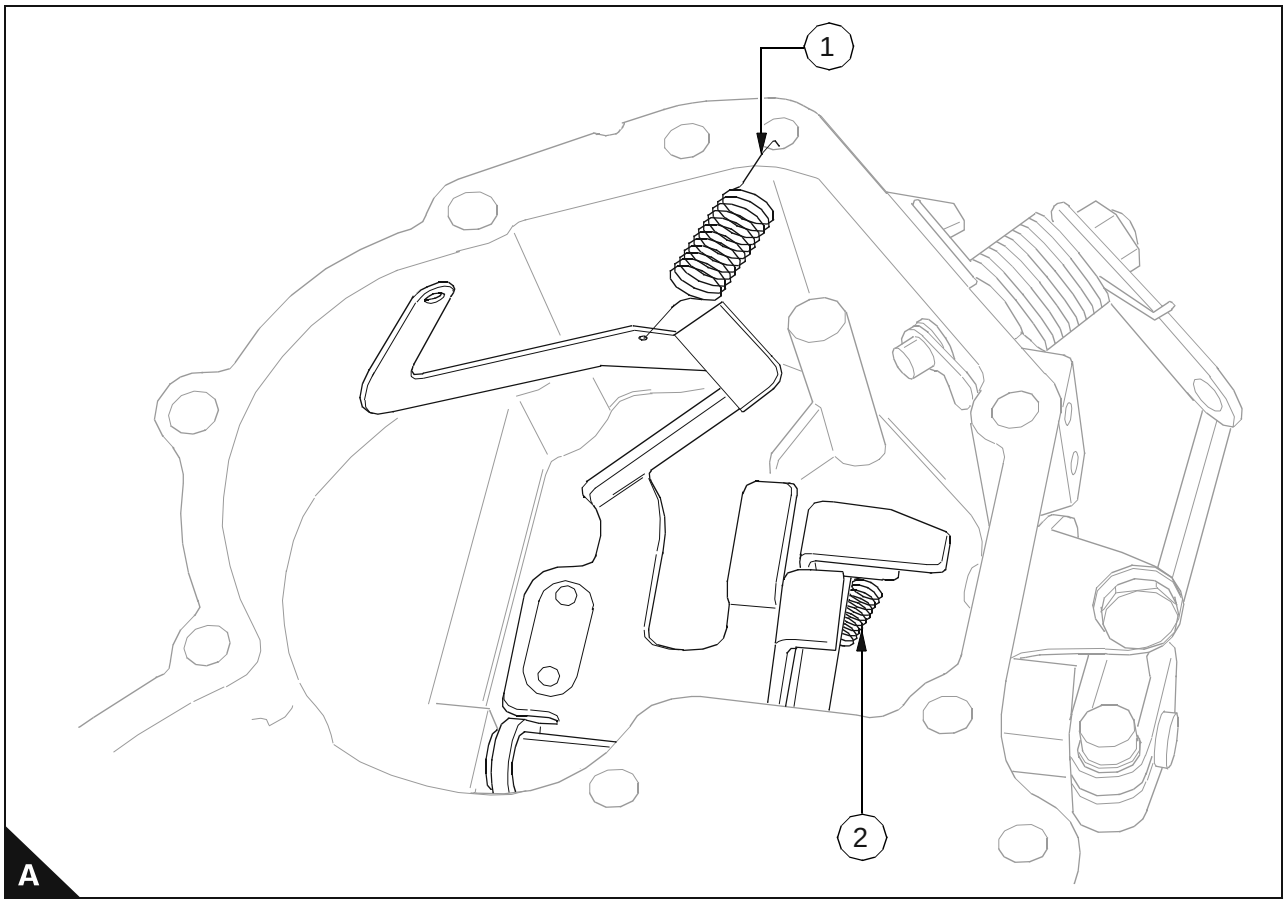
Governor spring

To locate and to check — Operation 6-14

The main governor springs are colour coded to assist with identification. The colour code is as follows:

Part Number	Description	Colour Code
198217580	Main Spring	Black
198217570	Main Spring	Purple
198217320	Main Spring	Yellow - green
198217110	Main Spring	Silver

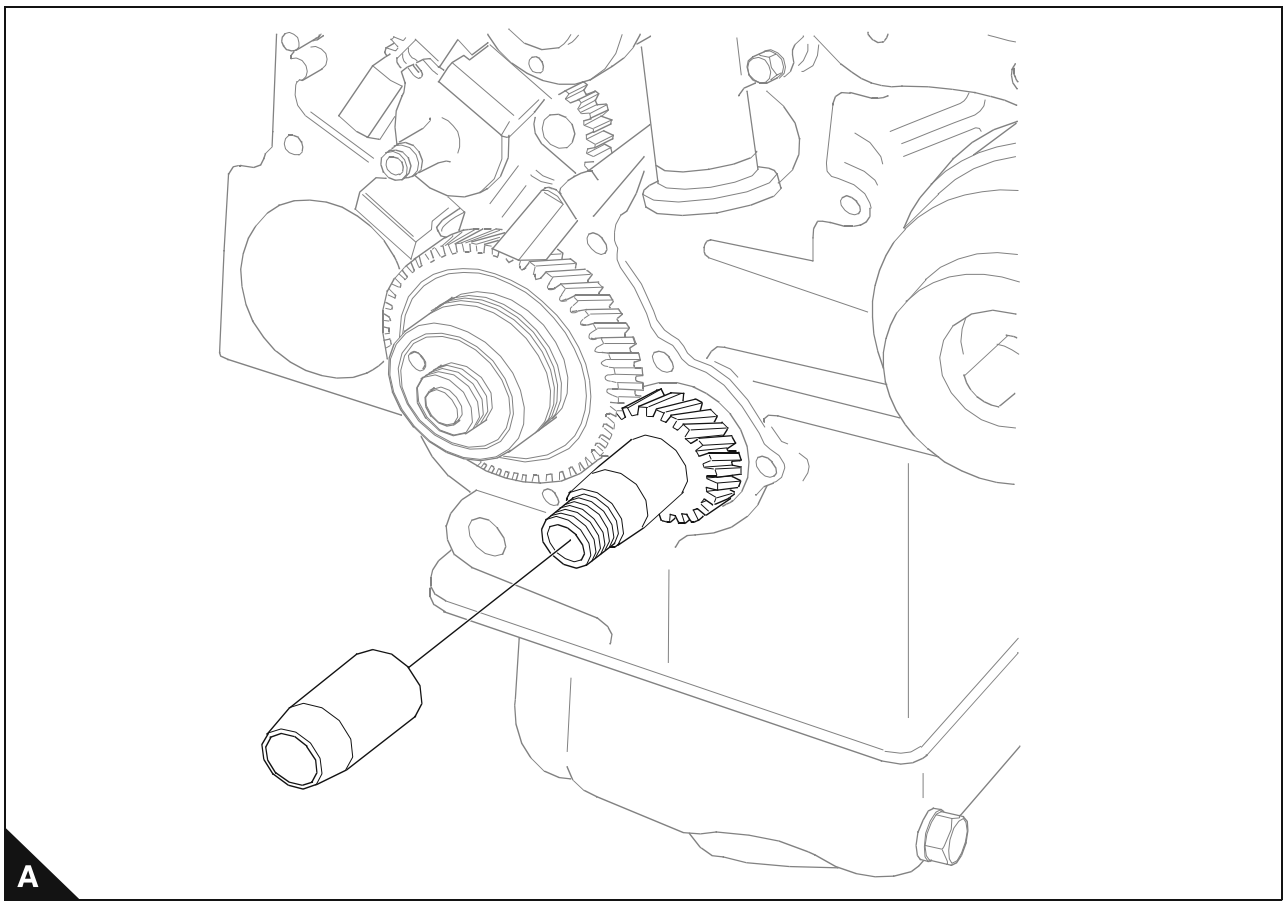
Note: Remember the locations of the start spring (A1) and the governor spring (A2).



Oil seal protector

To fit **Operation 6-15**

Note: Fit the oil seal protector before the timing cover is fitted.



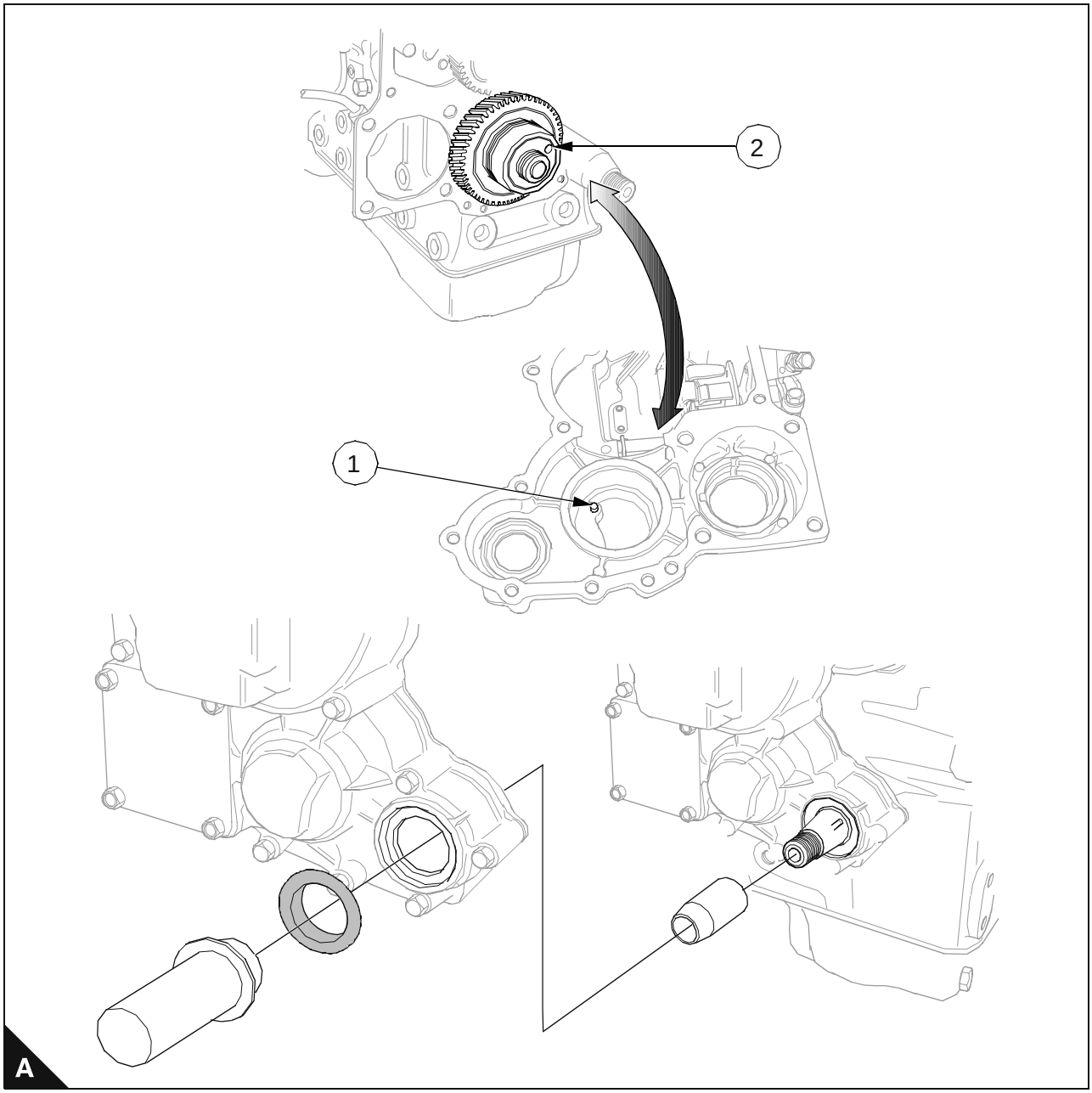
Timing cover

To fit — Operation 6-16

1 Ensure the oil pin (A1) locates in the hole (A2) in the idler gear.

2 Remove the oil seal protector after the timing cover is fitted. Fit the key onto the crankshaft nose, refer to Operation 5-1.

3 To fit the crankshaft pulley refer to Operation 5-1.



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7

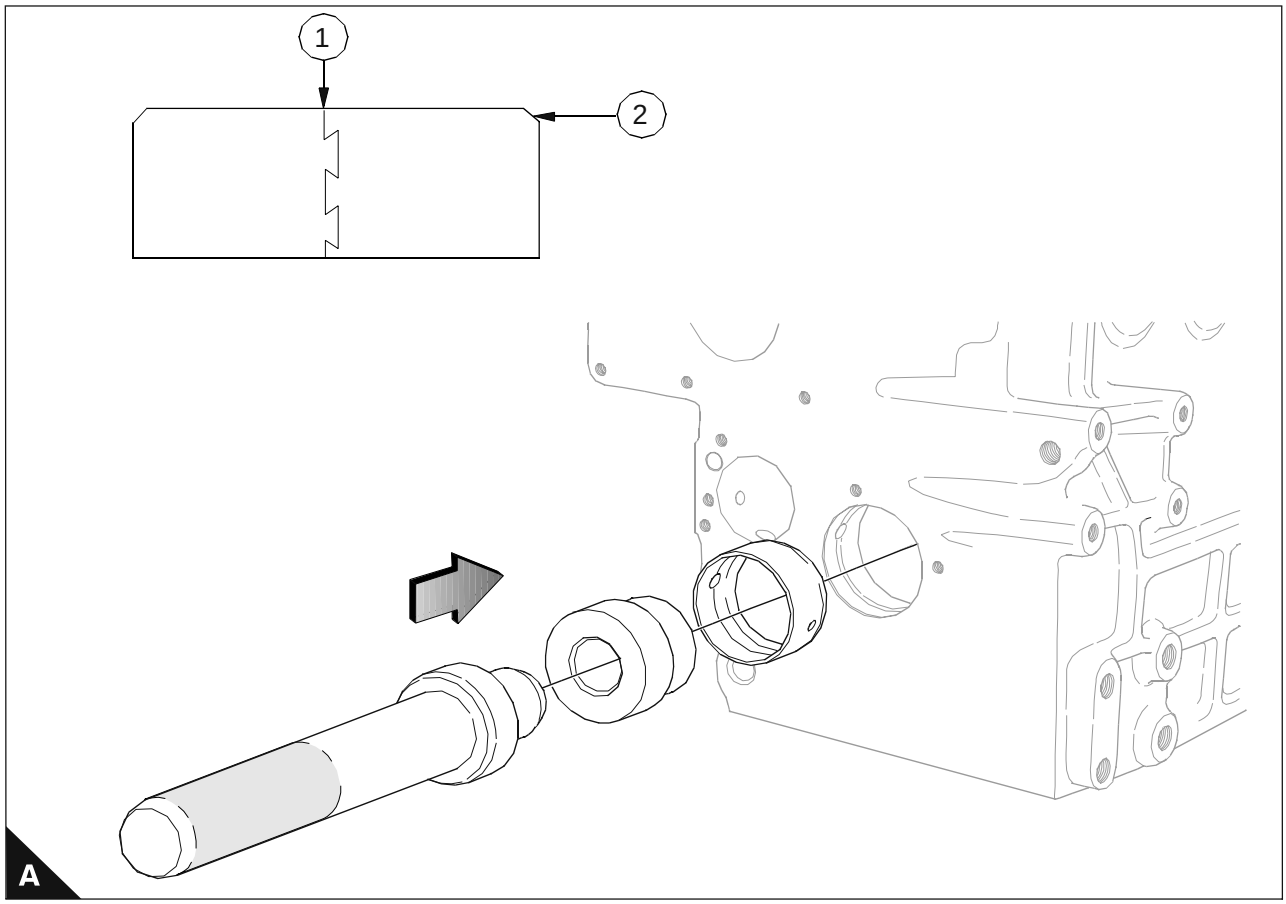
Cylinder block assembly

Front bush

To fit **Operation 7-1**

The bush must be fitted with the chamfered side (A2) into the block first, with the joint (A1) uppermost. To remove, use the tool from the inside of the cylinder block.

Note: Make sure that the oil way in the bush is aligned with the oil way in the block.



Cylinder block top face

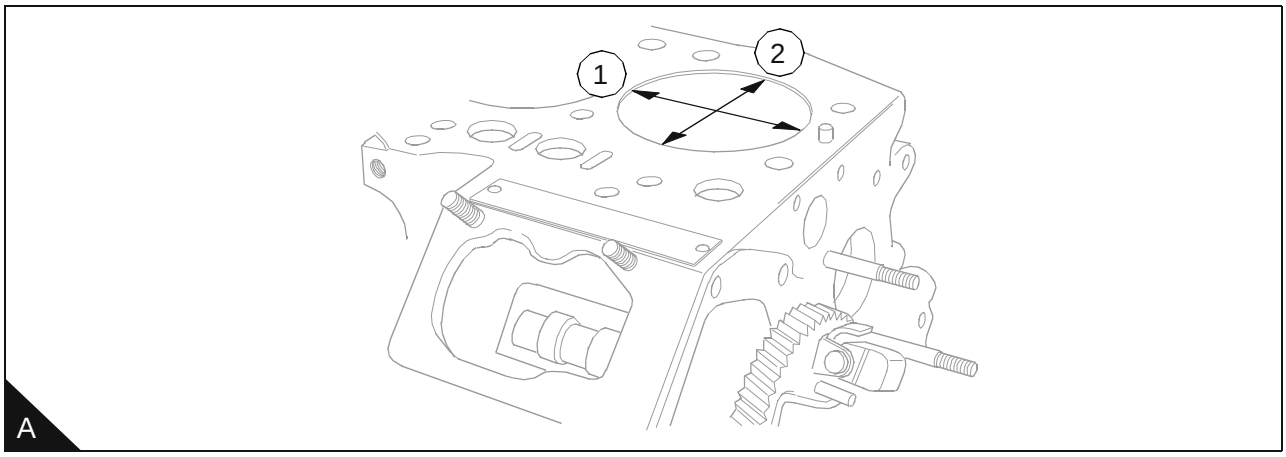
To inspect — Operation 7-2

Inspect the cylinder block top face for cracks, damage and distortion in the same way as for the cylinder head, refer to Operation 3-19.

If outside limit, renew the cylinder block.

Distortion mm (in)	
Standard	**Service limit**
Less than 0,05 (0.002)	0,12 (0.005)

Note: For emissions approved engines. If a new cylinder block is fitted, the engine should be tested on an engine test brake and the fuel adjustment screw set. This procedures is only done by a Perkins approved dealer. This will ensure that the engine will conform with emissions legislation.



8

Engine timing

Fuel injection pump timing

To check timing **Operation 8-1**

Special requirements

Special tools		Torque Nm (lbf ft) kgf m	
Description	**Part number**		
Fuel pump spill pipe	21825680	Delivery valve holder	42 (31) 4,2

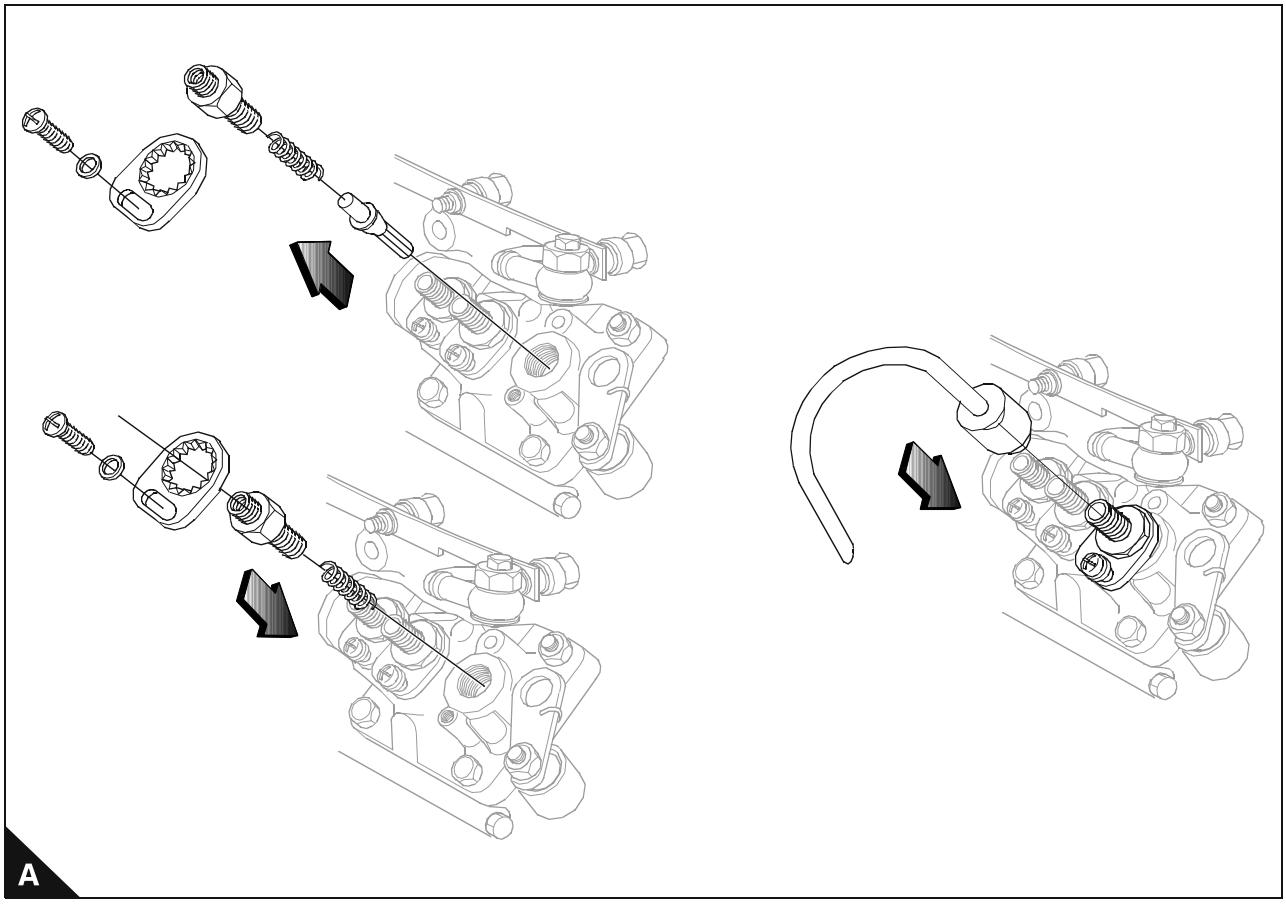
1 Set the piston for number 1 cylinder to TDC on the compression stroke. Turn the crankshaft counter-clockwise a quarter of a revolution.

2 Disconnect or remove the ESOS, HP pipes and LP fuel inlet pipes from pump (A).

3 Ensure the throttle lever is held in the maximum fuel position after the procedure.

4 Remove the delivery valve holder for number 1 cylinder and remove the delivery valve. Store the delivery valve in appropriate clean fuel until assembly.

Note: The fuel pump may need to be moved to an upright position to remove and to fit the delivery valves.



Continued

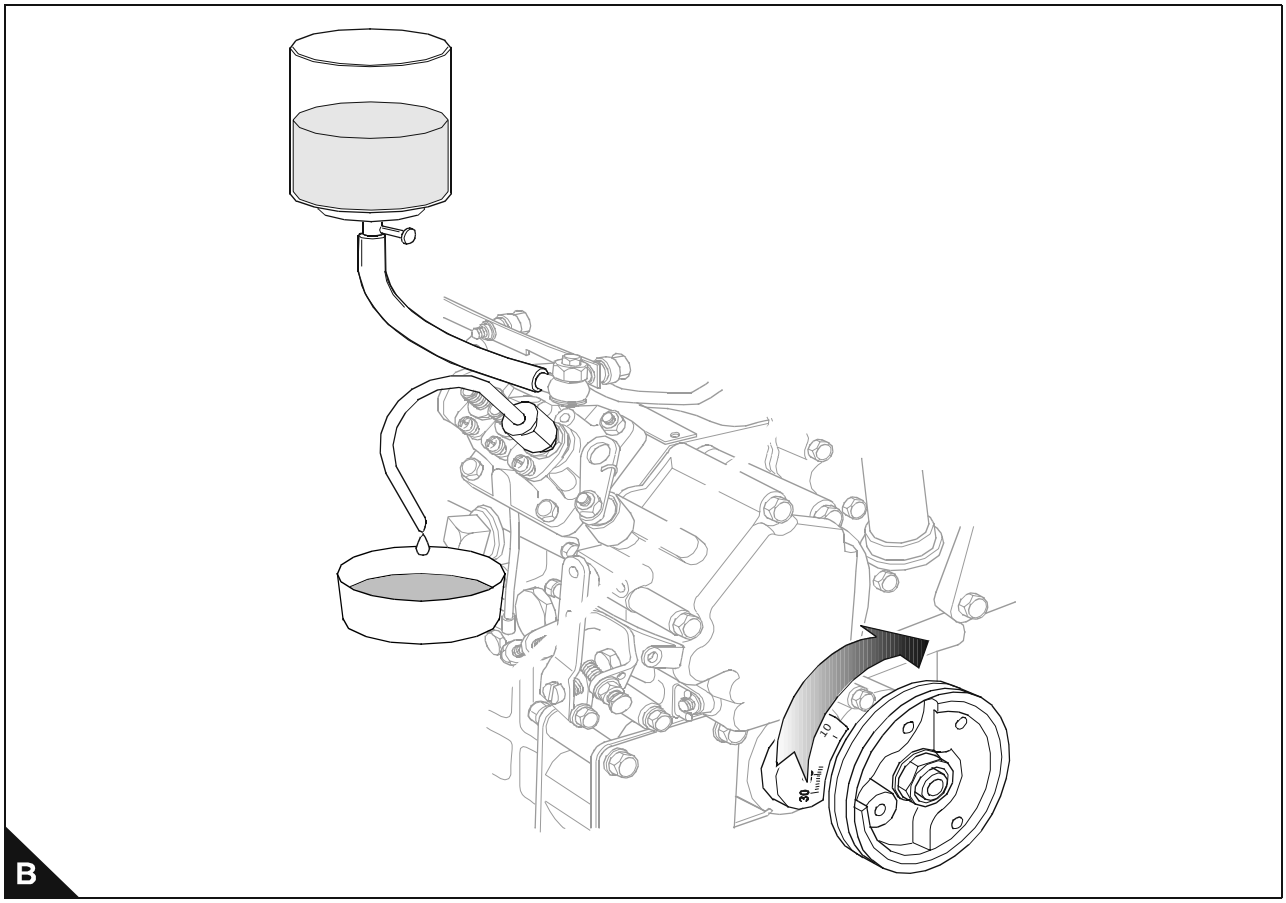
5 Connect a suitable tank, which has a tap and contains 0,2 litres (¼ pint) of clean fuel, to the pump inlet.

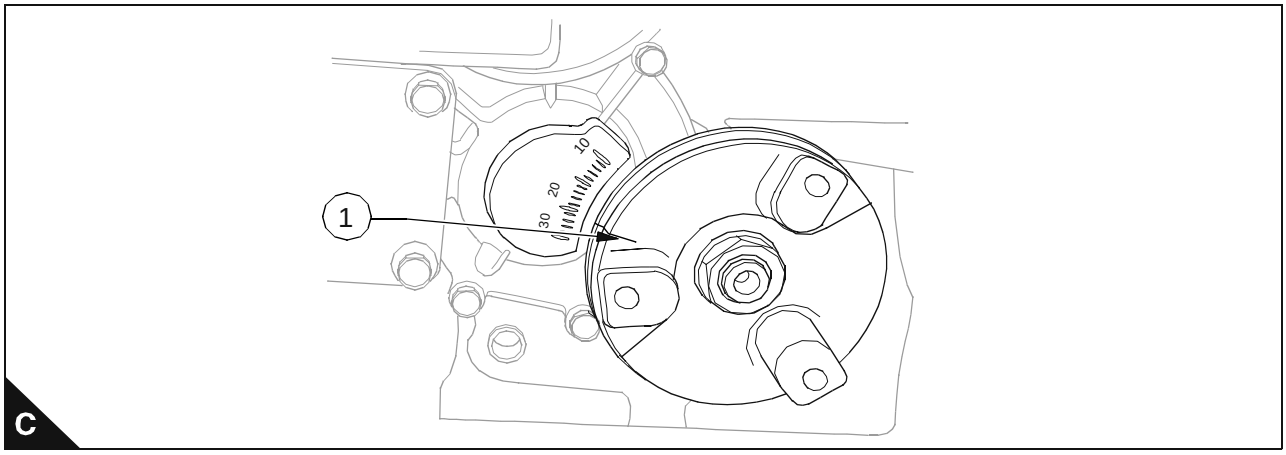
6 Connect the fuel pump spill pipe to the delivery valve holder for number 1 cylinder. Put a suitable waste fuel container below the pipe neck and open the tap, if correctly set fuel should flow (B).

Note: The outlet from the tank should be approximately 152 mm (6 in) above the pump.

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

8 Use the value shown by the timing mark (C1) with the injection timing tables given in "Injection timing" on page 15.





Continued

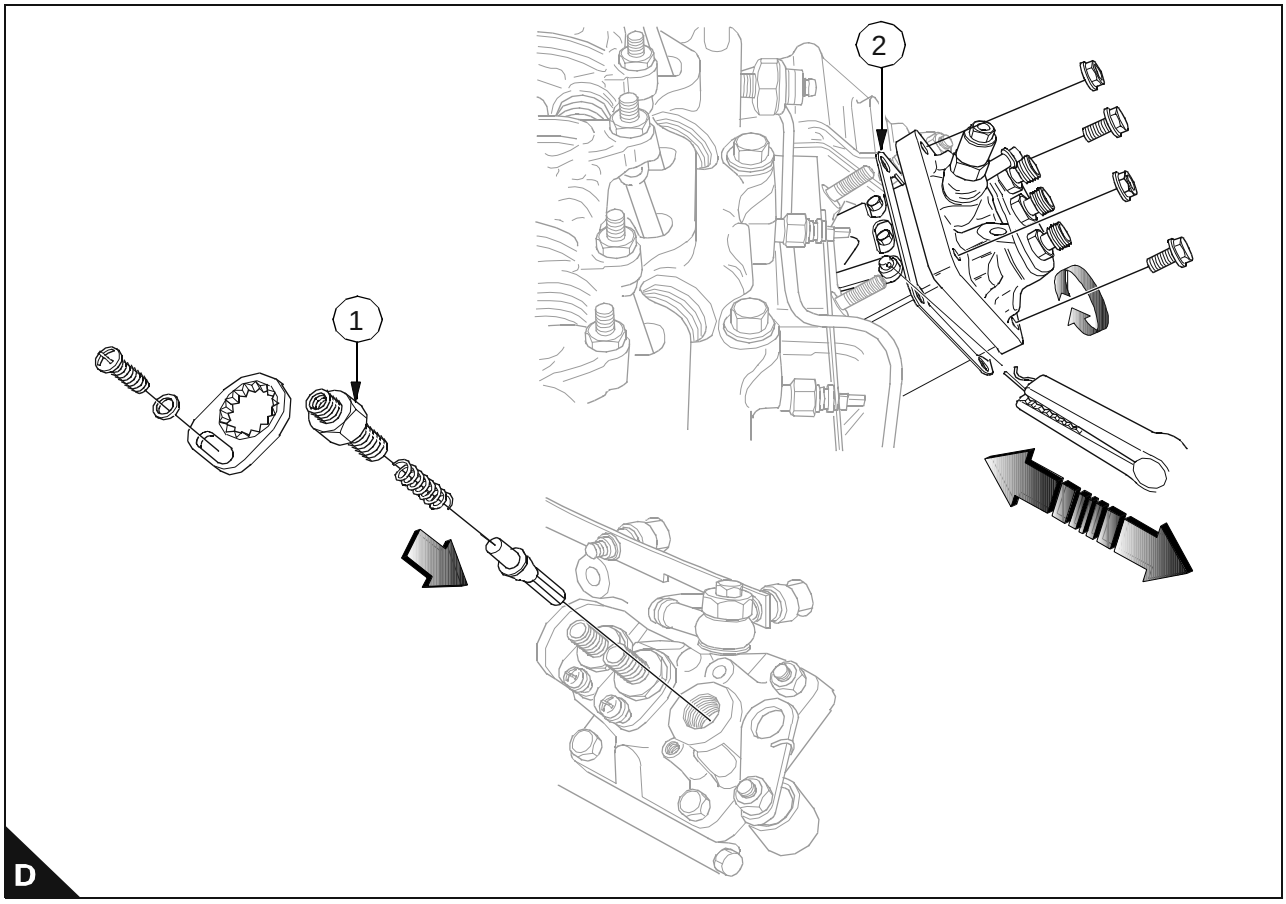
9 If engine timing is incorrect adjust the thickness of shim (D2) to correct.

Note: If the shim thickness is adjusted by 0,1 mm, the timing will alter by approximately one degree. An increase in the number of shims will retard the timing, but if the number of shims are decreased this will advance the timing.

10 Fit the delivery valve.

Notes:

- Ensure that the delivery valve holder (D1) is tightened to the specified torque.
- For emissions approved engines. If it is necessary to change the fuel injection pump, the fuel delivery must be reset on a suitable test dynamometer with the new pump. The procedure above, on injection pump timing explains how to change the timing.
- When changing the timing, it is important that this procedure is done before the engine is tested on a suitable dynamometer.



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Aspiration system

Breather system

To clean and renew — Operation 9-1

Cautions:

- *Failure to change a damaged, blocked or restricted engine breather hose may cause a back pressure in the crankcase, causing premature failure of the rear engine oil seal.*
- *Do not start an engine that is found to have a damaged, blocked or restricted breather hose, starting the engine may cause damage to the rear engine oil seal.*

Special requirements

POWERPART products	
Description	**Part number**
Platelock	21826039
Threadlock	21820119 or 21820118

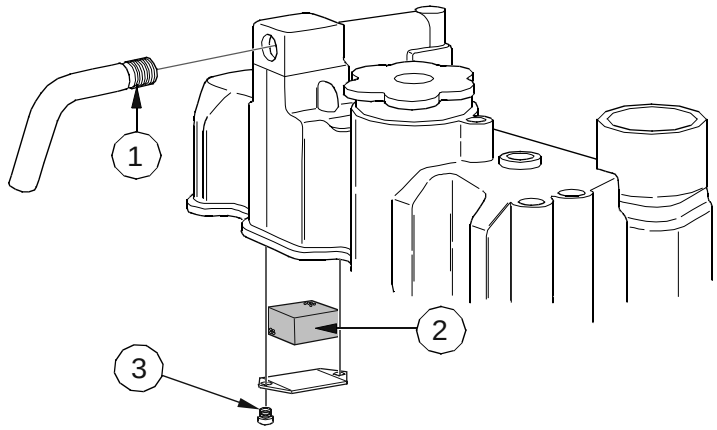
Clean the breather gauze (A2/B2) with suitable cleaning solvent. If damaged renew.

If the engine breather pipe (A1/B1) is damaged, blocked or restricted, it must be renewed.

On assembly, apply Powerpart Platelock to the threaded area on the breather pipes (A1/B1).

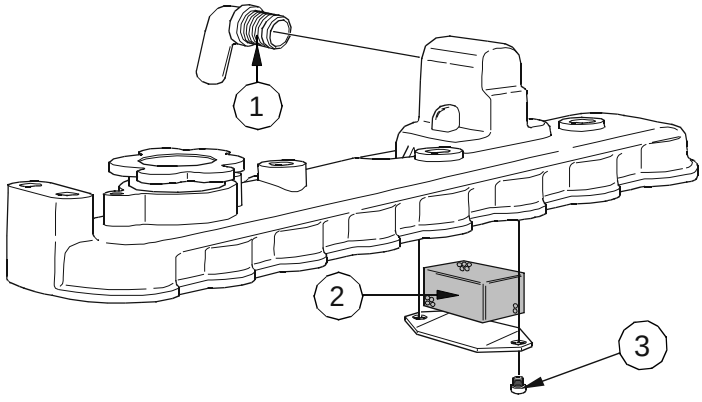
On assembly, apply Powerpart Threadlock to the threaded area on the setscrew (A3/B3).

102-05
103-07
103-10



A

103-13
103-15
104-19
104-22



B

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10

Lubrication system

Oil filter canister

To remove and to fit **Operation 10-1**

1 Remove the filter canister with a strap wrench or a similar tool and then discard the canister.

2 Clean the seal face of the filter head.

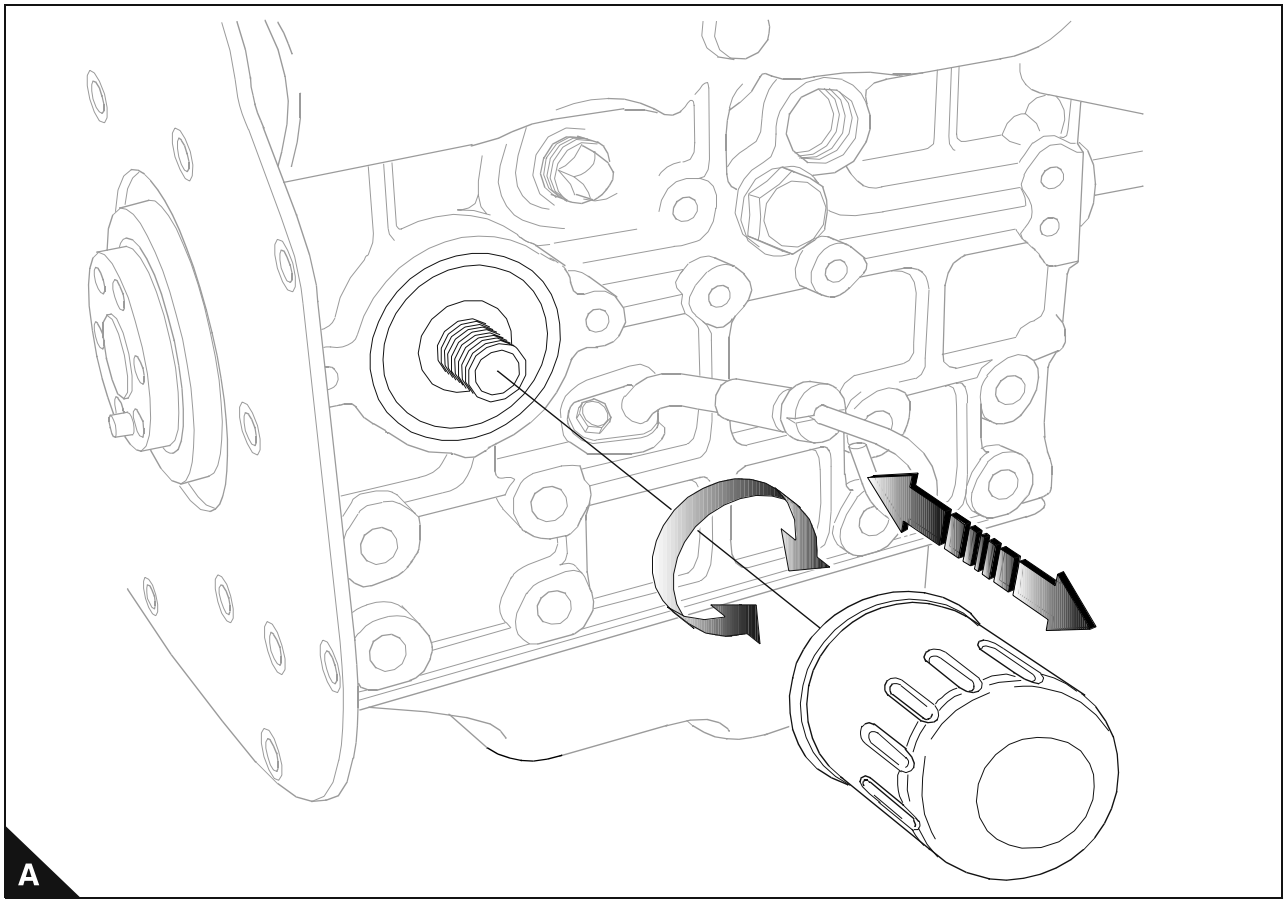
3 Lubricate the seal of the new canister with clean engine oil before assembly.

4 Install the new canister and tighten it by hand only. Do not use a strap wrench.

5 Tighten the canister by a further ½ to ¾ of a turn by hand only.

6 After the lubricating oil has been added to the sump, operate the engine and check for leakage from the filter. When the engine has cooled, check the oil level on the dipstick and add oil to the sump, as necessary.

Caution: *Do not use a strap wrench to tighten the filter canister.*



Pressure relief valve

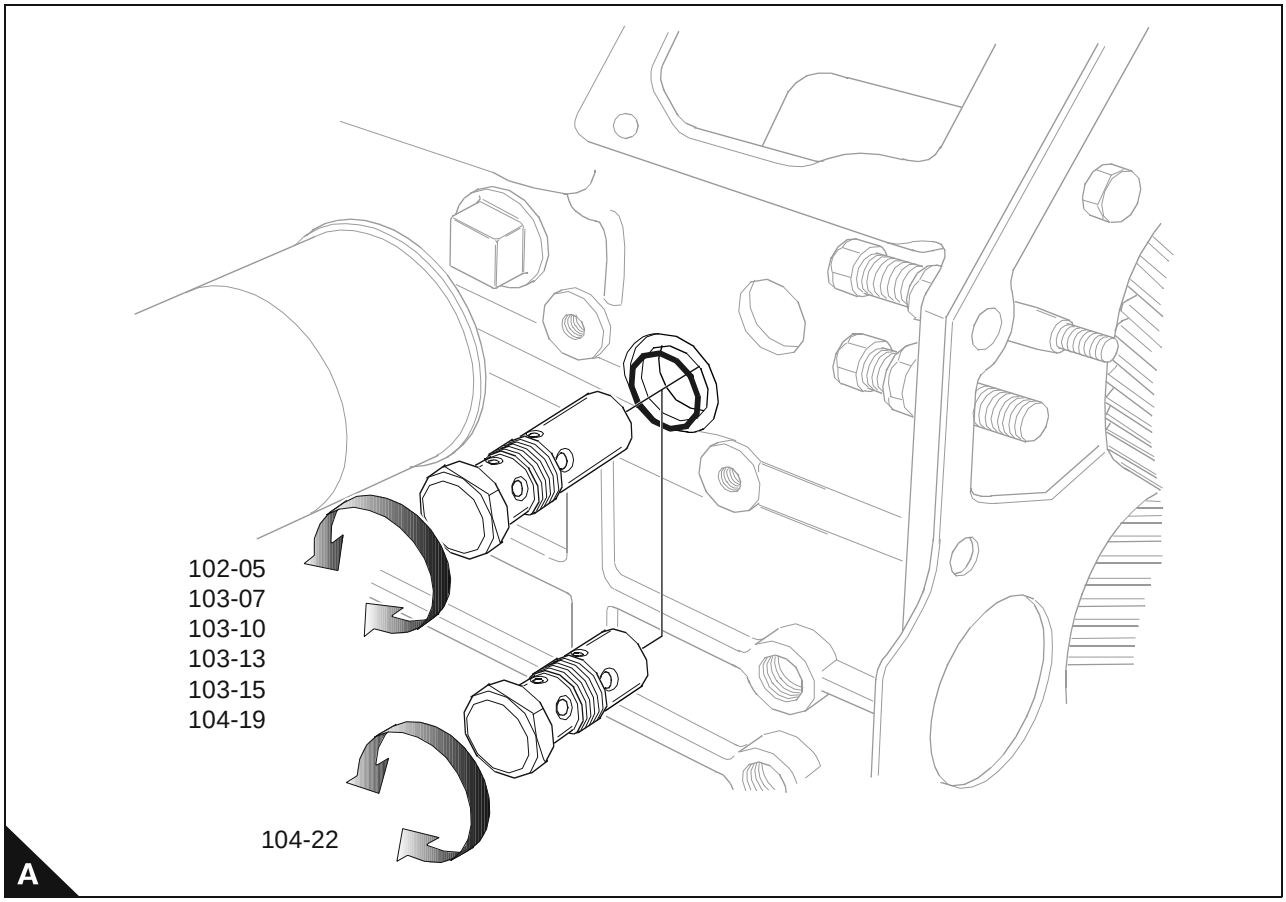
To remove and to fit **Operation 10-2**

Special requirements

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

Renew the 'O' ring 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.*



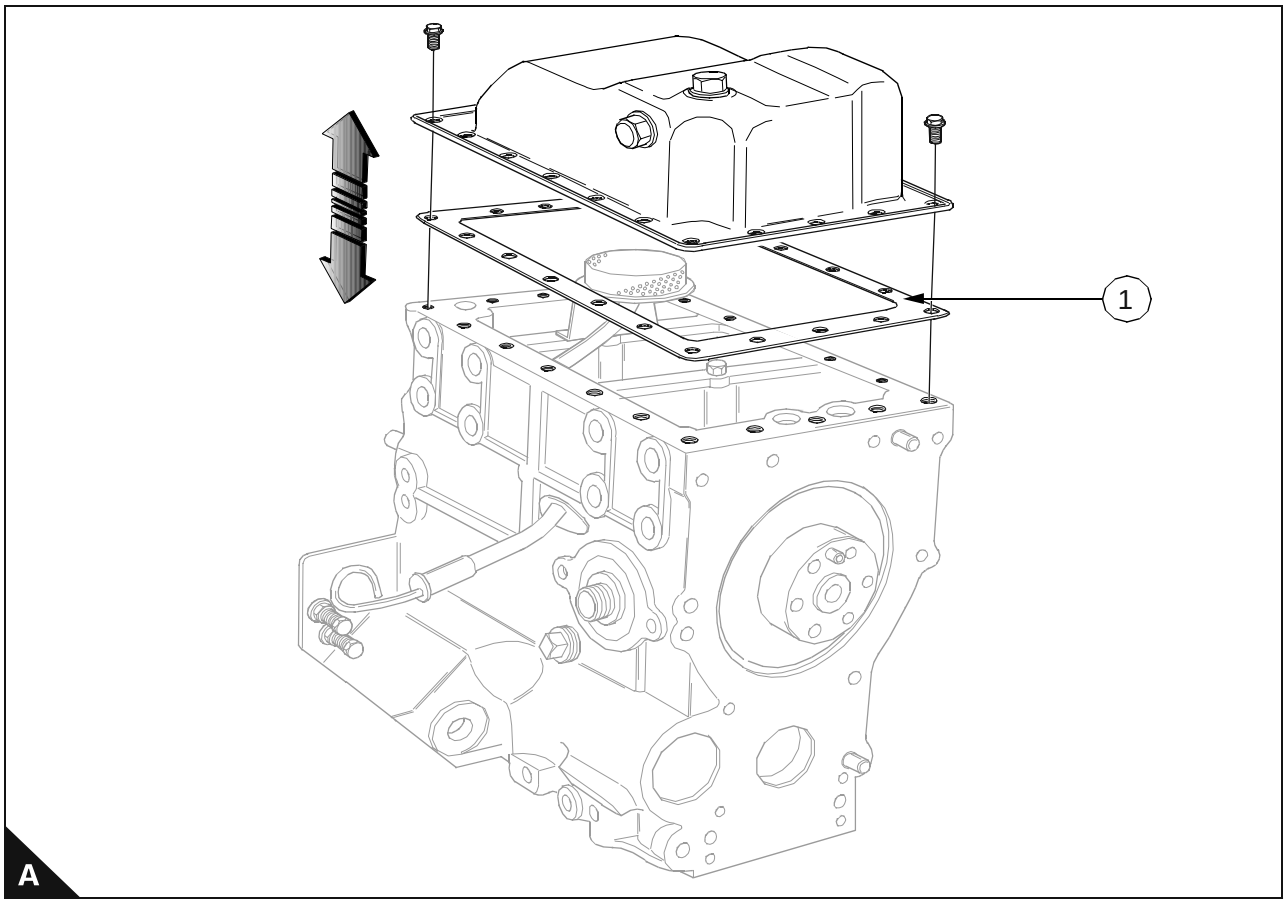
Lubricating oil sump

To remove and to fit **Operation 10-3**

Special requirements

Torque Nm (lbf ft) kgf m	
Sump setscrews	11 (8) 1,1

Note: When the sump is fitted renew the joint (A1).



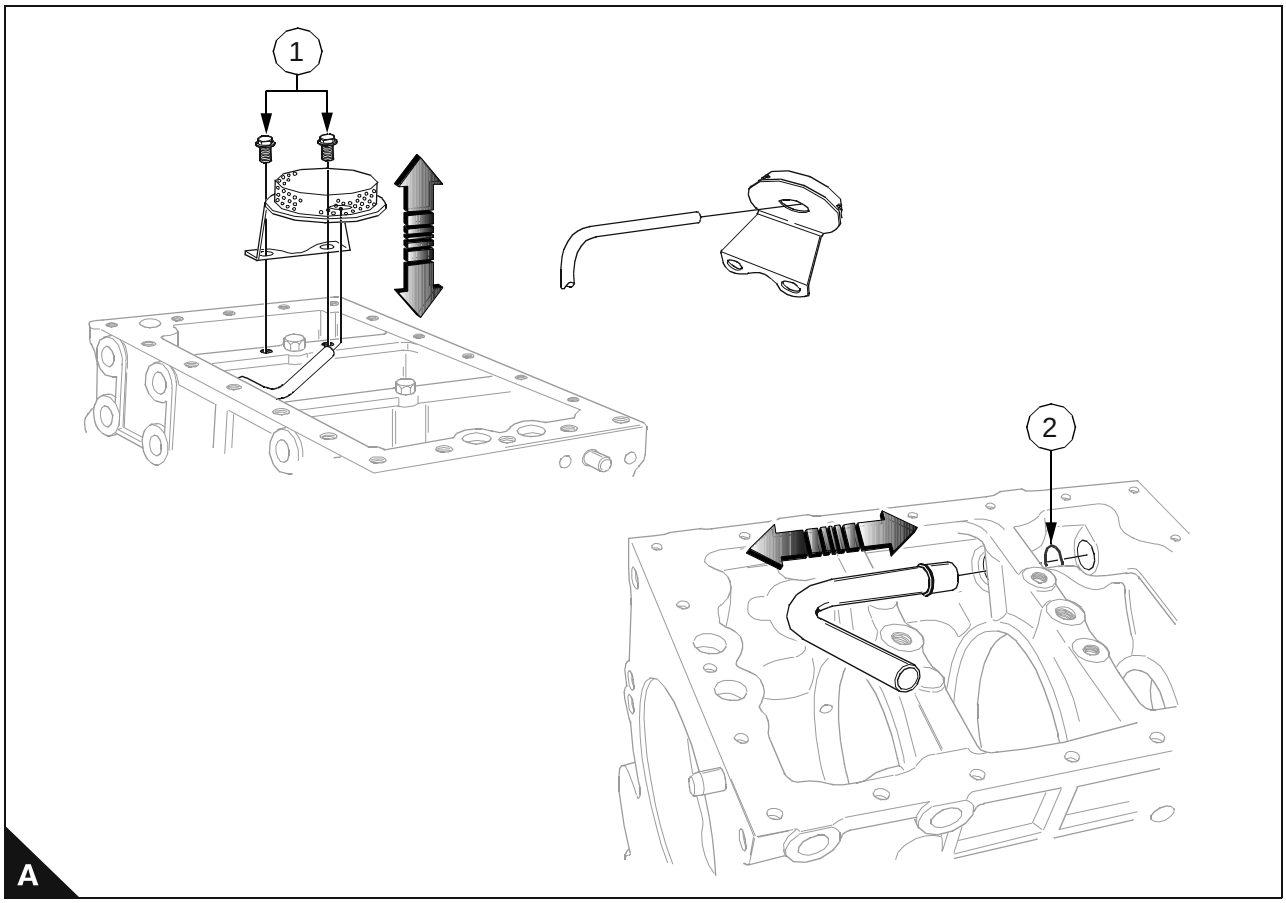
Strainer and suction pipe

To remove and to fit **Operation 10-4**

Special requirements

Torque Nm (lbf ft) kgf m	
Filter setscrews (A1)	11 (8) 1,1

Note: On assembly renew the 'O' ring (A2).

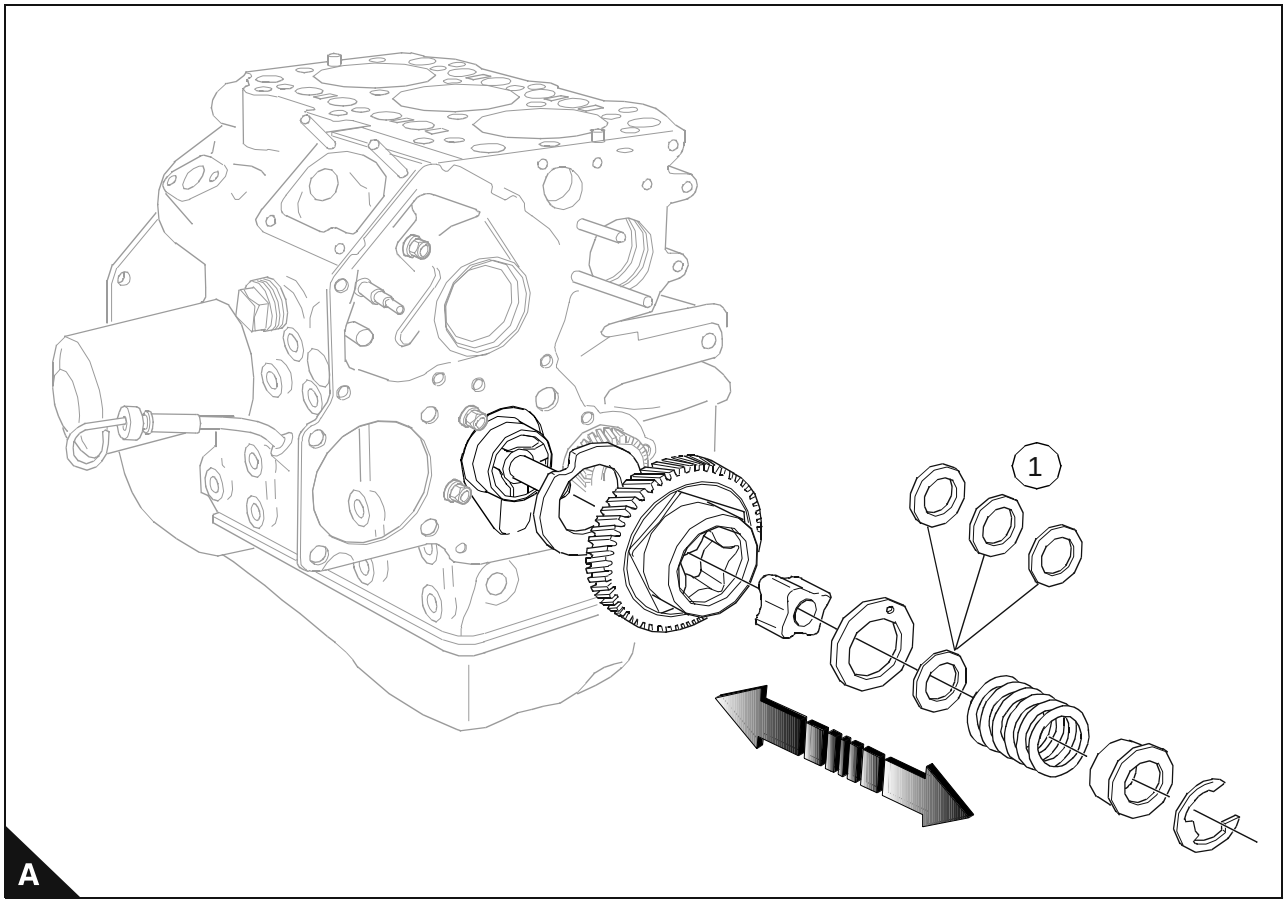


Lubricating oil pump

To remove, to fit and to inspect **Operation 10-5**

For the tolerances see "Idler gear and oil pump" on page 75 and "Oil pump end float" on page 78.

Note: Extra shims (A1) may be needed to achieve the standard clearance.



Oil pressure switch

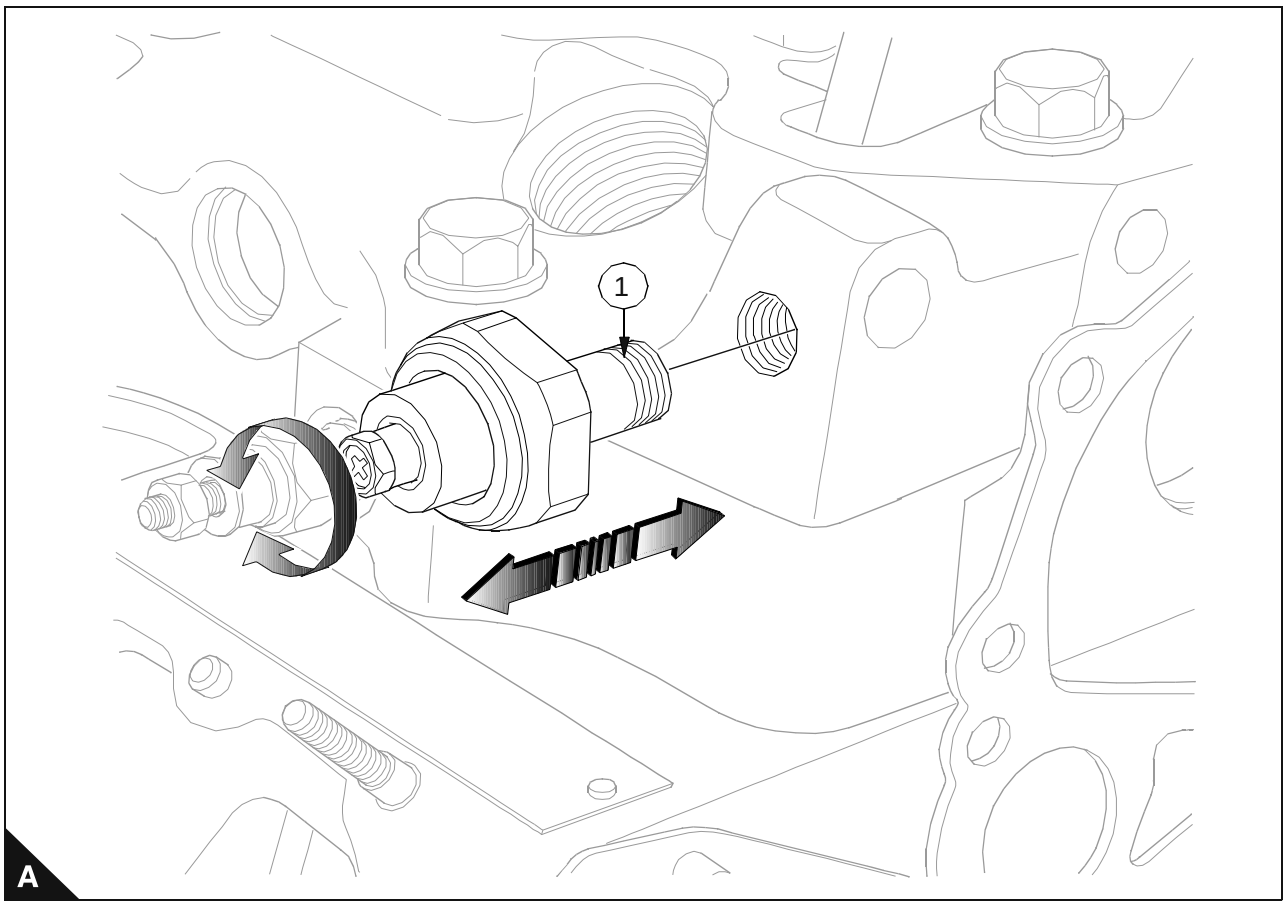
To remove and to fit **Operation 10-6**

Special requirements

POWERPART products		Torque Nm (lbf ft) kgf m	
Description	**Part number**		
Platelock	21826039	Oil pressure switch	11 (8) 1,1

Powerpart Platelock must be applied to the thread (A1) when the oil pressure switch is fitted to the cylinder block.

Oil pressure switch range of operation 19,3 - 39,3 KPa (2.8-5.7 lbf/in²).



11

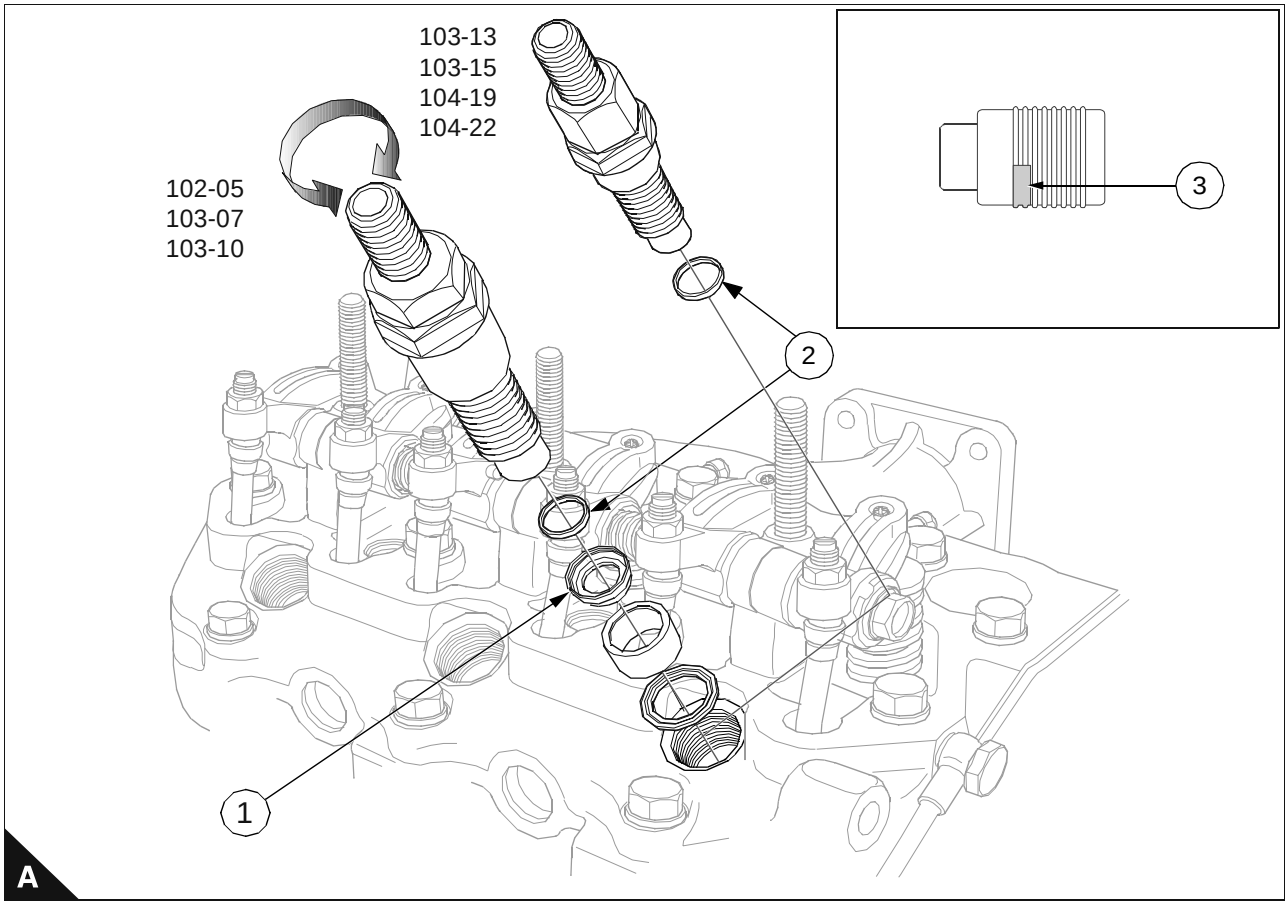
Fuel system

Atomisers

To remove **Operation 11-1**

***Cautions*:**

- *Deep sockets should always be used for this procedure.*
- *Connections should be blanked off until assembly.*



To fit **Operation 11-2**

Special requirements

Torque Nm (lbf ft) kgf m		Test pressures kgf/cm² (lbf/in²) ats	
102-05, 103-07	64 (47) 6,5	102-05, 103-07	120 (1707) 116
103-10	81 (60) 8,2	103-10	120 (1707) 116
103-13, 103-15, 104-19, 104-22	64 (47) 6,5	103-13, 103-15, 104-19, 104-22	150 (2133) 145

1 Clean and dry the male and female threads of the atomiser and the cylinder head.

2 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 (A3).

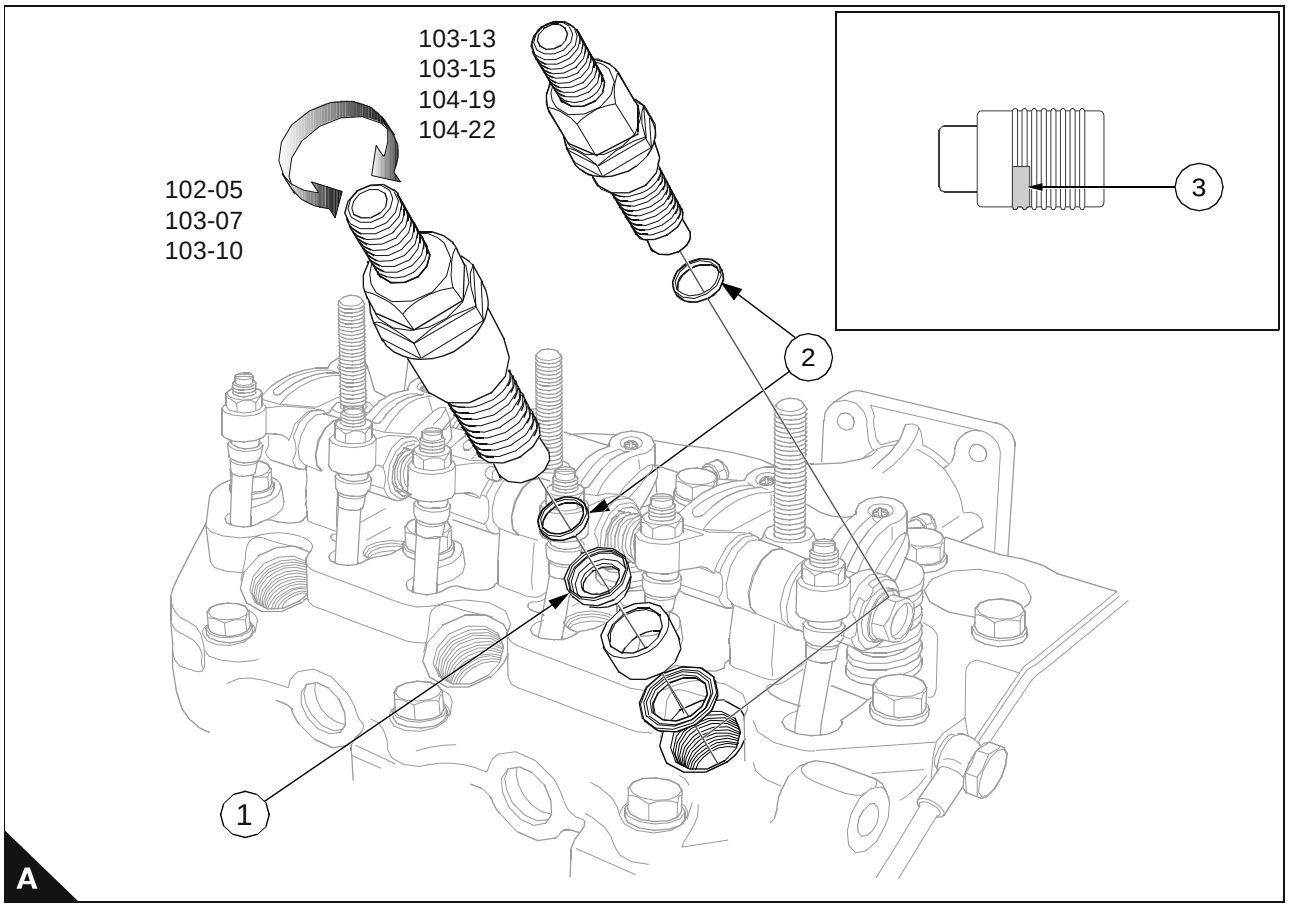
Engine serial numbers KR-----924551F to KR-----926370F require two nozzle washers (A2) fitted when servicing any of the above engine serial numbers.

All 104-22 engines built from engine serial number KR-----926371F require one nozzle washer (A2) fitted when servicing.

If a new cylinder head is fitted on engine serial numbers KR-----924551F to KR-----926370F then only one nozzle washer (A2) is fitted.

Notes:

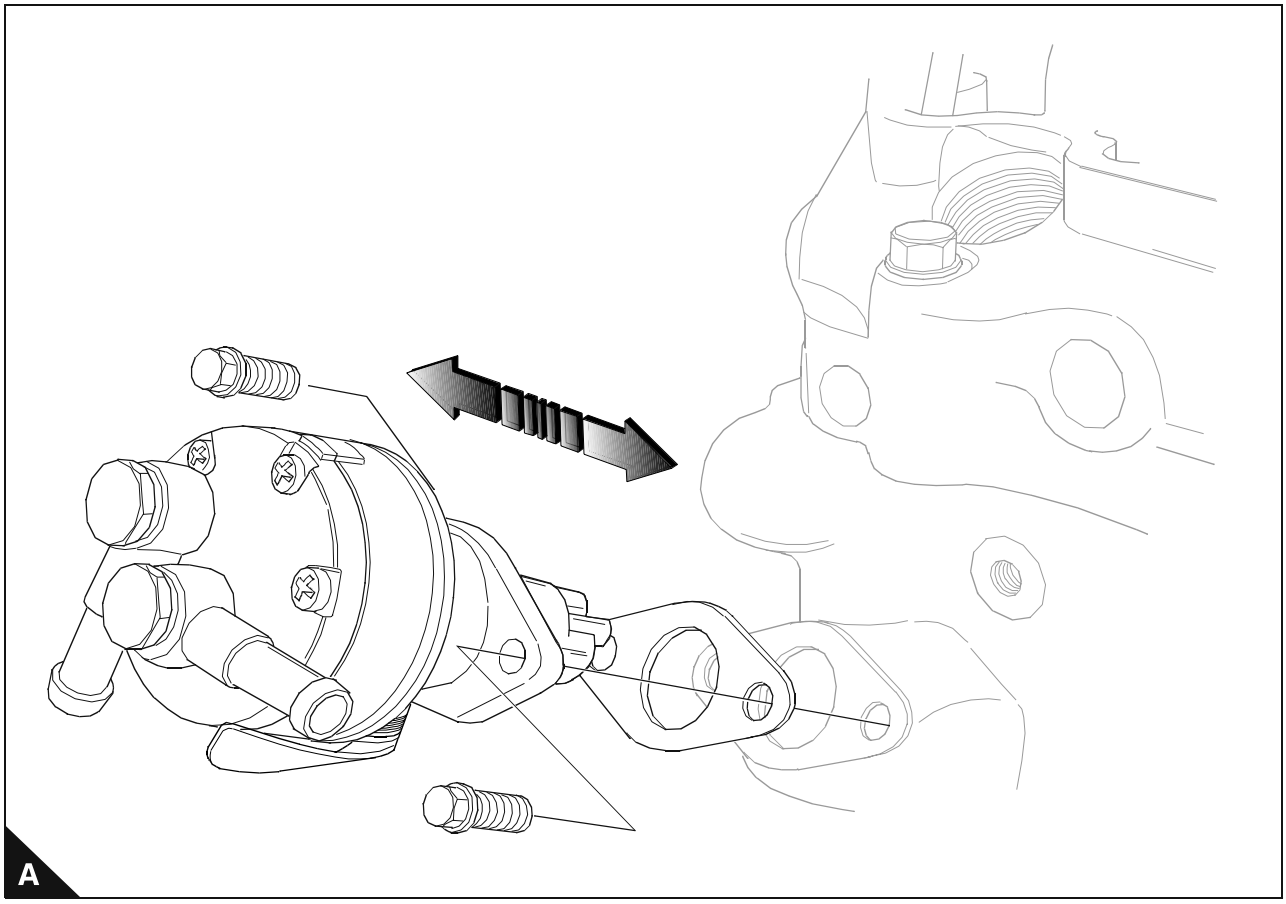
- Item (A1) is used on 103-10 engine only.
- Item (A2) is part number 131426200.



Fuel lift pump

To remove and to fit early fuel lift pump **Operation 11-3**

Note: Camshaft eccentric must be in the maximum lift position for the priming lever to operate correctly.



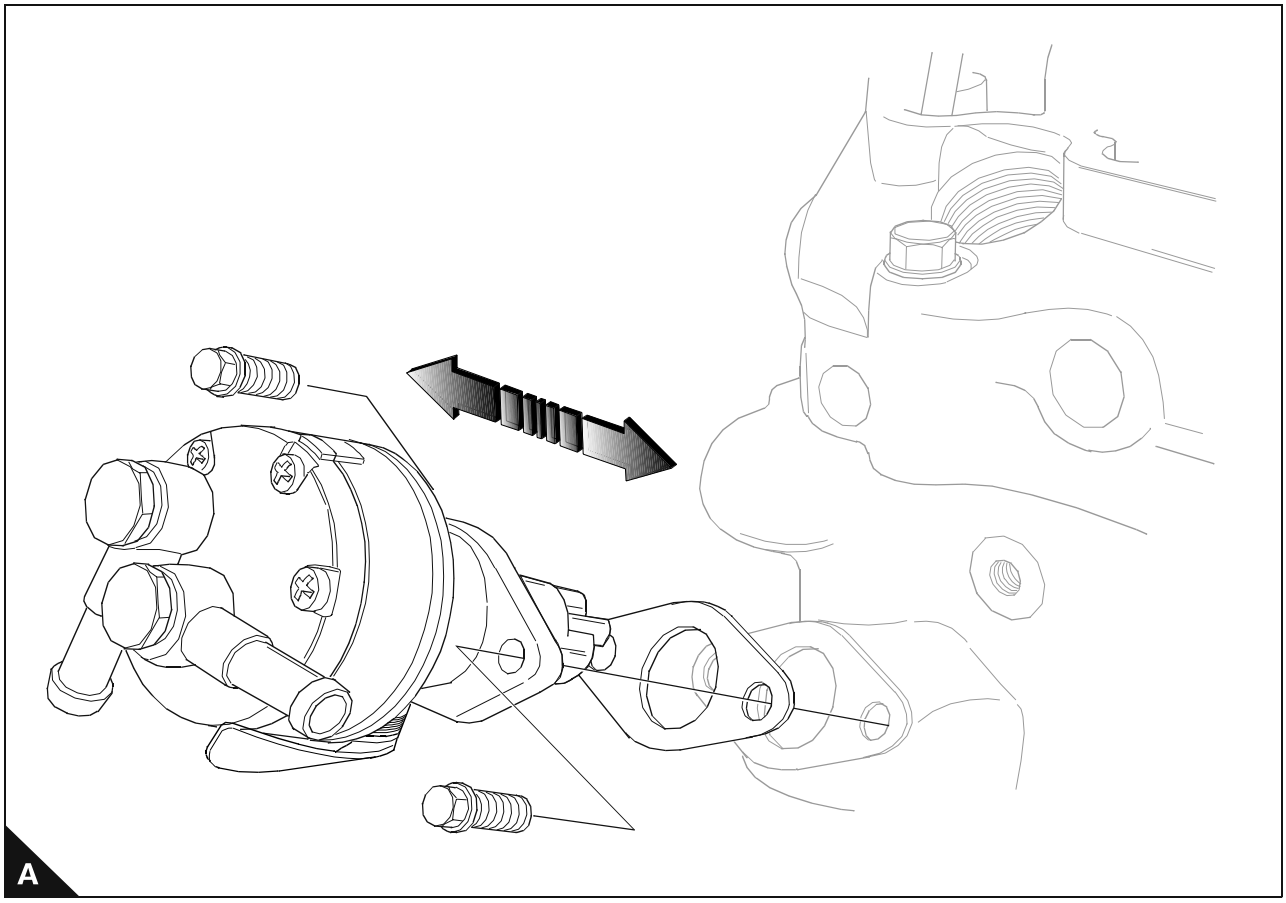
To remove and to fit the latest fuel lift pump **Operation 11-4**

Engine	Torque Nm (lbf ft) kgf m	
All models	Lift pump setscrew	6 (4.4) 0,6
	Lift pump inlet adjusting bolt (A1)	2,5 (1.8) 0,25

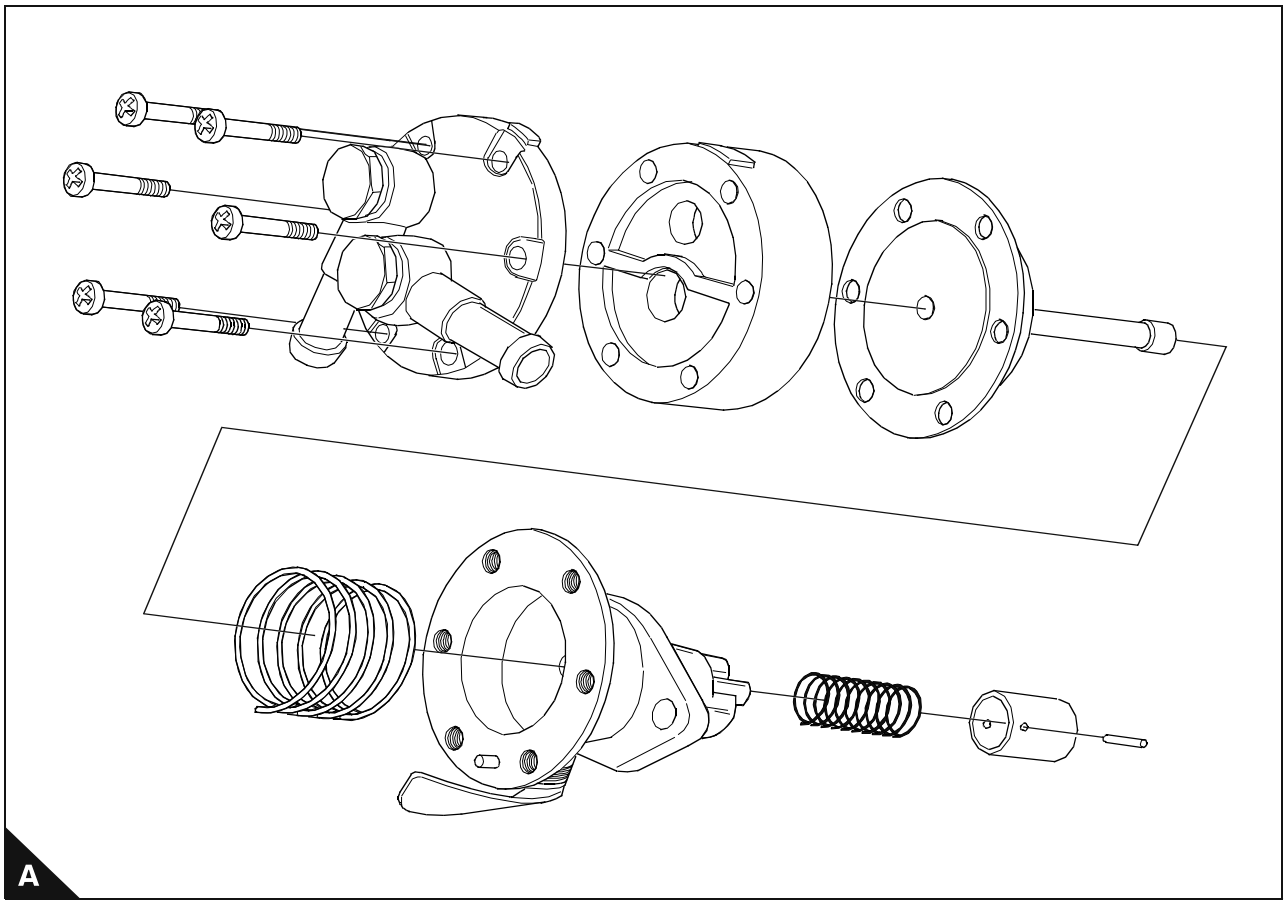
The fuel inlet for the fuel lift pump can rotate 360° and is adjustable in 15° increments.

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.

Note: Camshaft eccentric must be in the minimum lift position for the priming lever to operate correctly.



To dismantle and to assemble the early fuel lift pump **Operation 11-5**



Fuel injection pump

To remove and to fit **Operation 11-6**

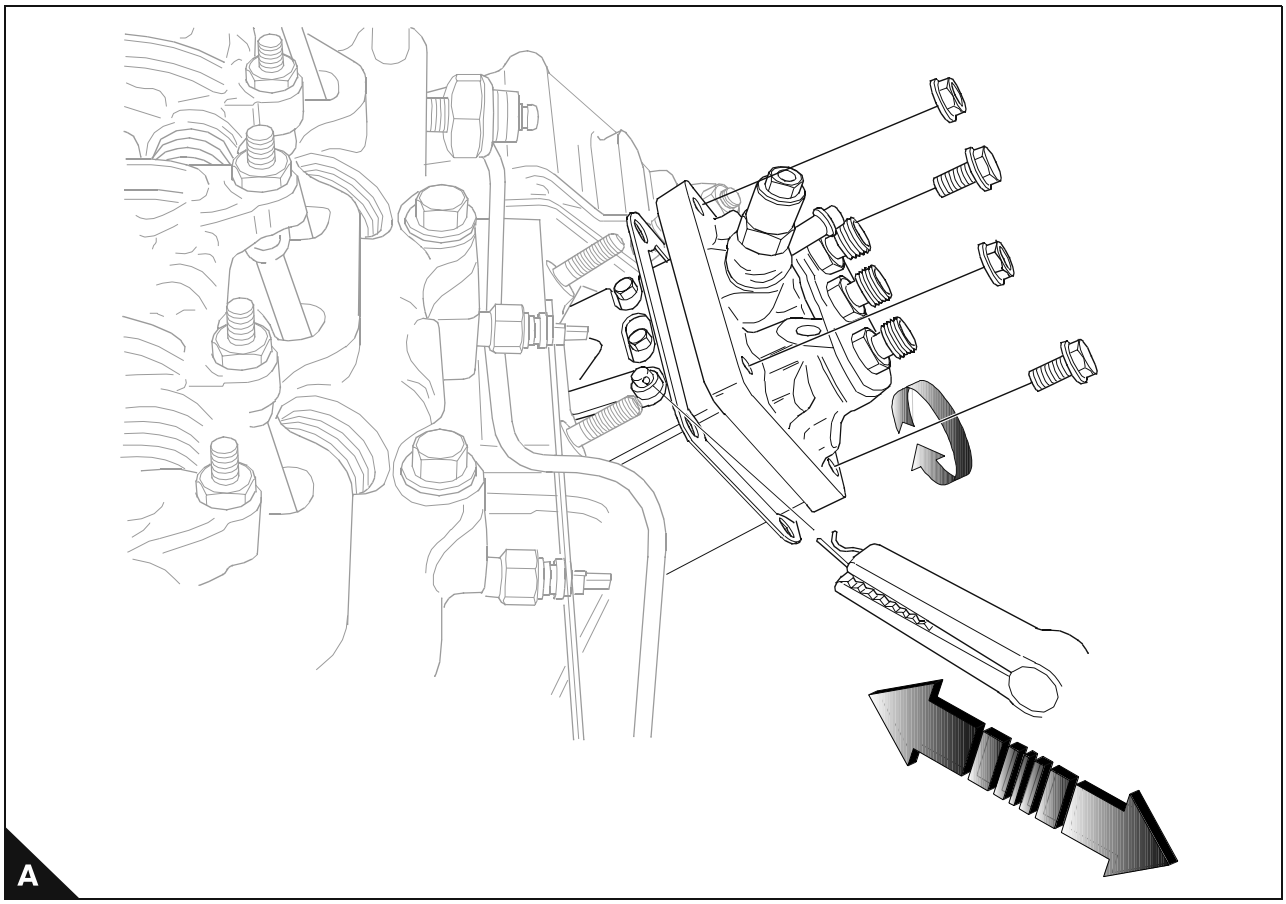
Special requirements

Torque Nm (lbf ft) kgf m	
102-05, 103-07	11 (8) 1,1
103-10	6 (4.4) 0,6
103-13, 103-15, 104-19, 104-22	15 (11) 1,5

Caution: *Connections should be blanked off until assembly.*

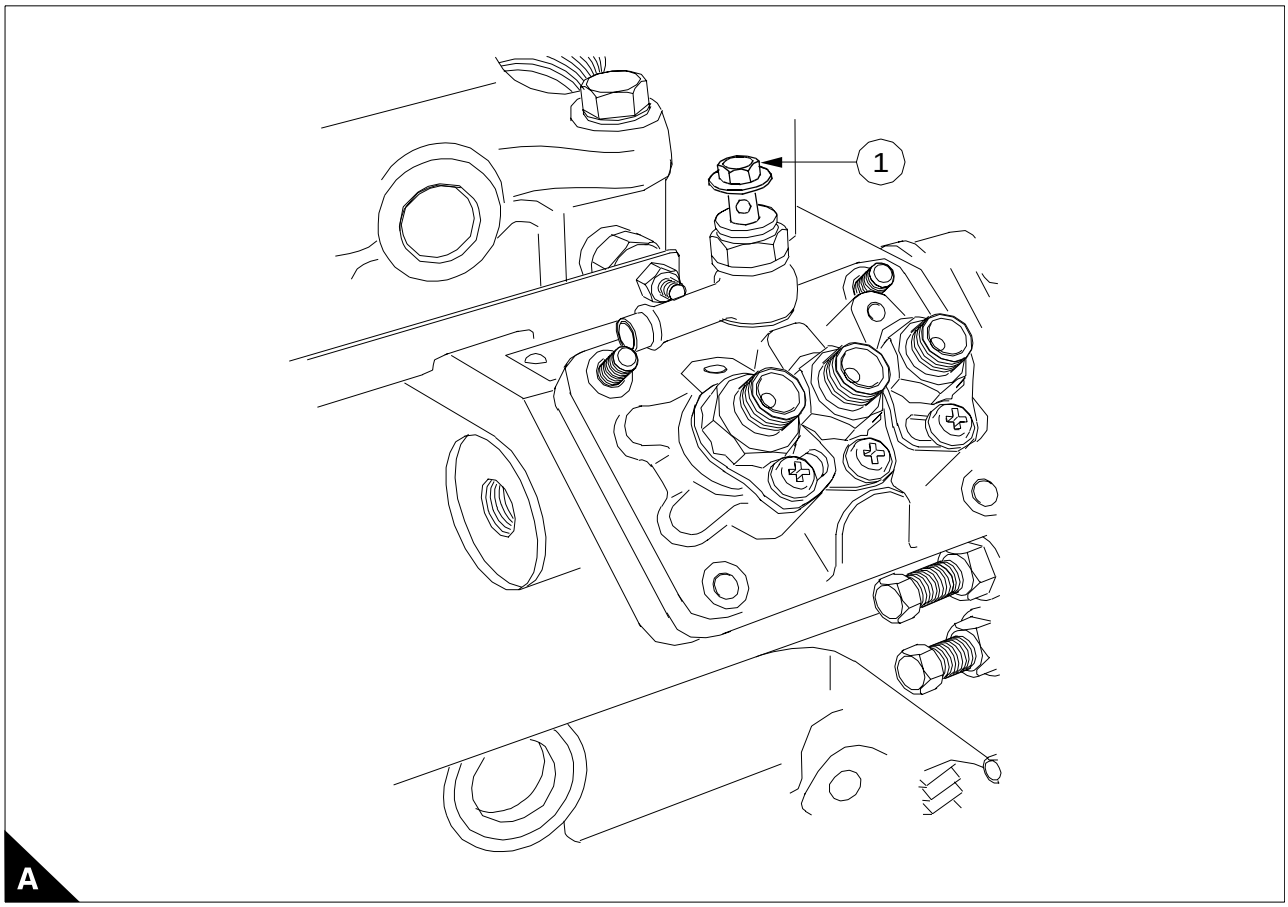
Notes:

- For emissions approved engines. If a new fuel injection pump is fitted, shims of the same thickness as the originals and a pump with the same part number must be fitted.
- For emissions approved engines. If the fuel injection pump is put back, 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.



Banjo Bolt **Operation 11-7**

The torque setting for the banjo bolt (A1), fitted to the fuel injection pump, for the 103-10 engines (KD) is 20,0 Nm (14.75 lbf ft) 2,04 kgf m. The torque setting for all other engines is 7,0 Nm (5.16 lbf ft) 0,71 kgf m.



Vent points

To eliminate air from the fuel system **Operation 11-8**

To vent the 100 series fuel system

1 Identify the location of fuel lift pump (A3).

2 Locate the vent screw on top of the fuel filter (A2) and loosen off.

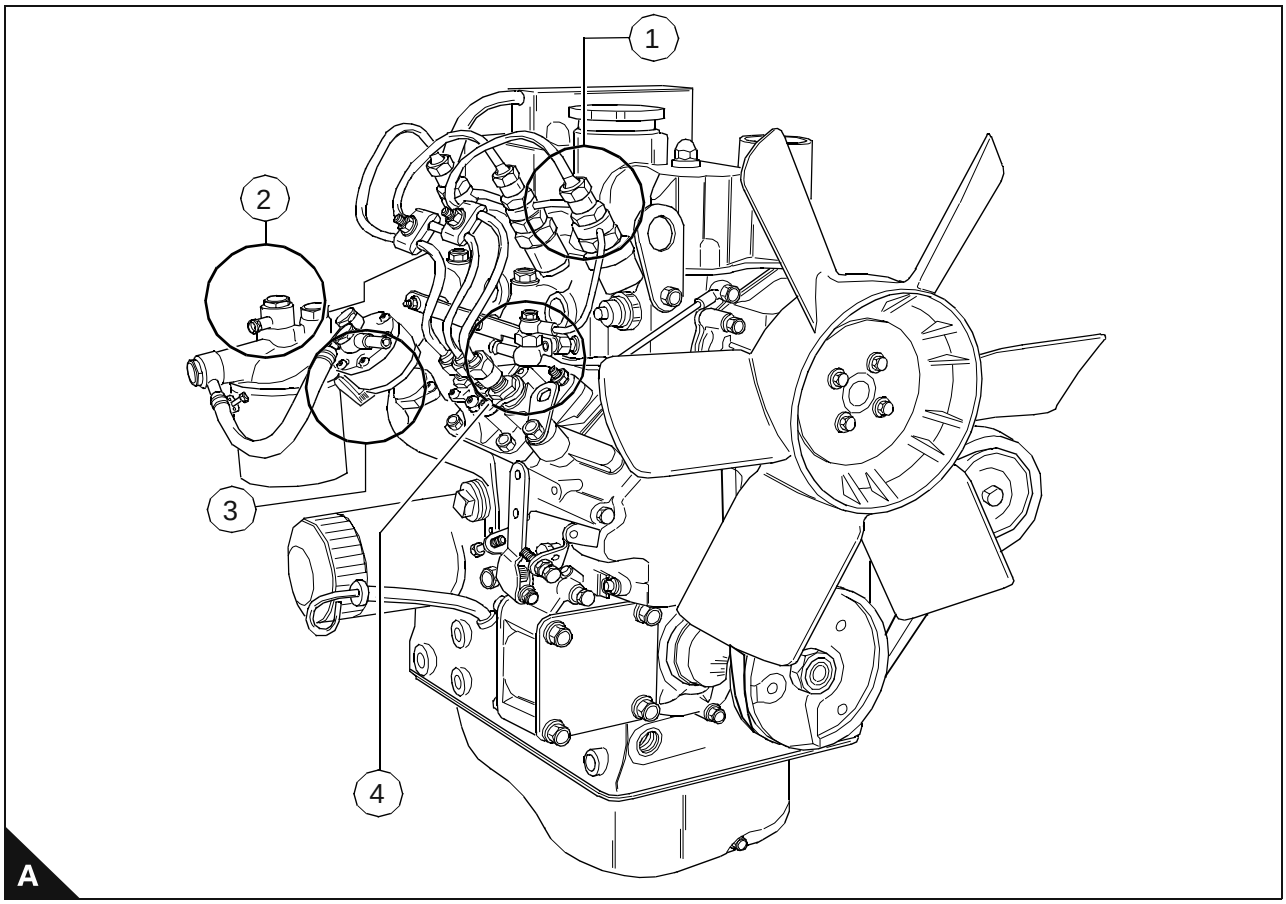
3 Operate the hand primer on lift pump until air free fuel flows. Tighten the vent screw.

4 Identify the vent screw on the fuel injection pump (A4) and loosen off. Operate the hand primer until air free fuel flows. Tighten the vent screw.

5 Identify the fuel pipes from fuel injection pump to the atomiser (A1) and loosen them all off at the atomiser end. Operate the starter motor until fuel flows from the injector pipes. Tighten all pipe connections.

The engine is now ready to start.

Caution: *When the starter motor is operated, do not exceed continuous rotation for more than 15 second periods. Wait for 30 seconds between periods of turning if fuel does not flow on initial rotation.*



12

Cooling system

Fan and mounting

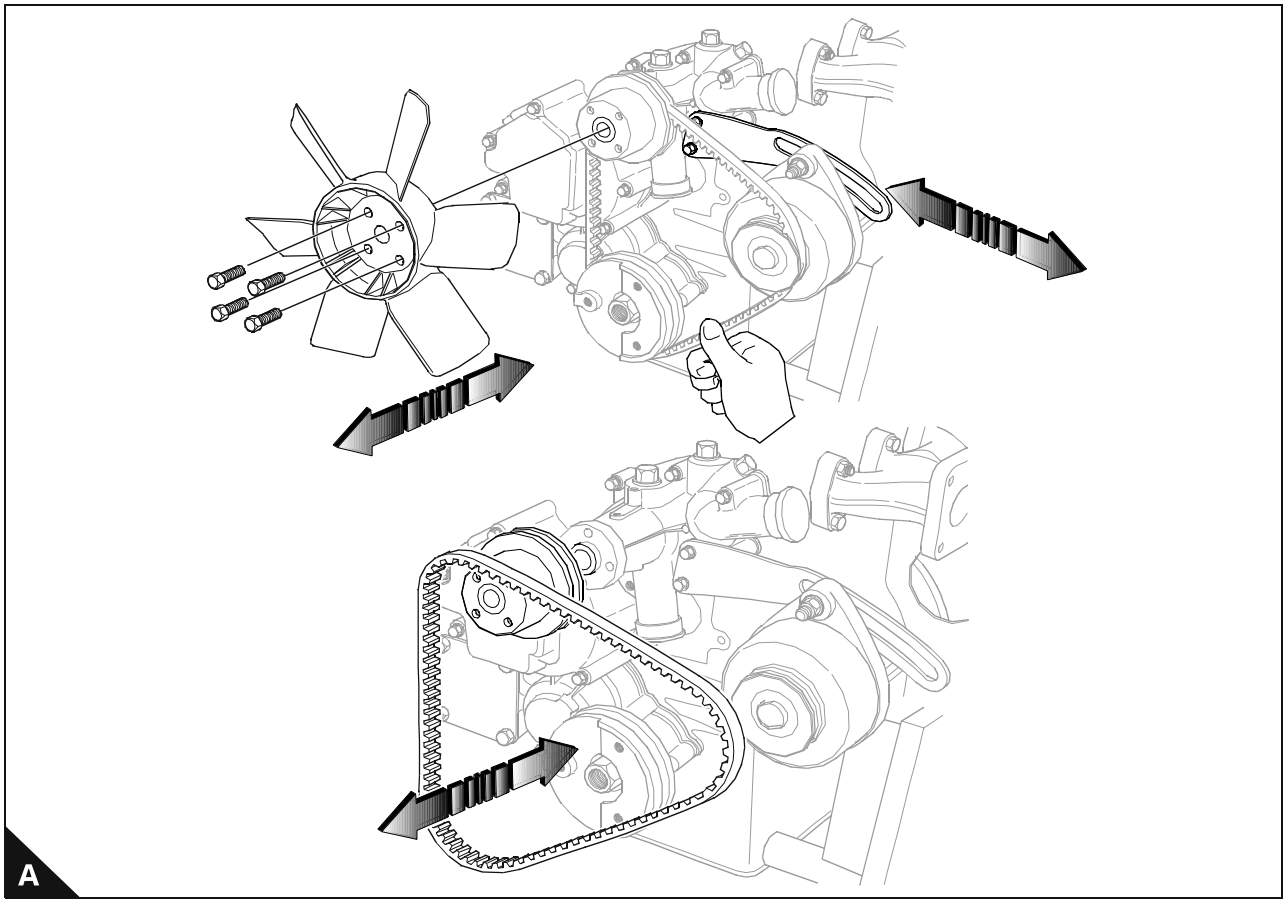
To remove and to fit **Operation 12-1**

Special requirements

Torque Nm (lbf ft) kgf m	
Setscrews	11 (8) 1,1

Depress the fan belt at the centre between the crankshaft pulley and the alternator pulley with a finger force of 49 N (11 lbf) 5 kgf, approximately. The belt deflection is shown in the table below:

Engine type	Belt deflection
102-05, 103-07	4 mm Approx.
103-10	5 mm Approx.
103-13, 103-15, 104-19	6 mm Approx.
104-22	7 mm Approx.



Coolant pump

To remove and to fit — Operation 12-2

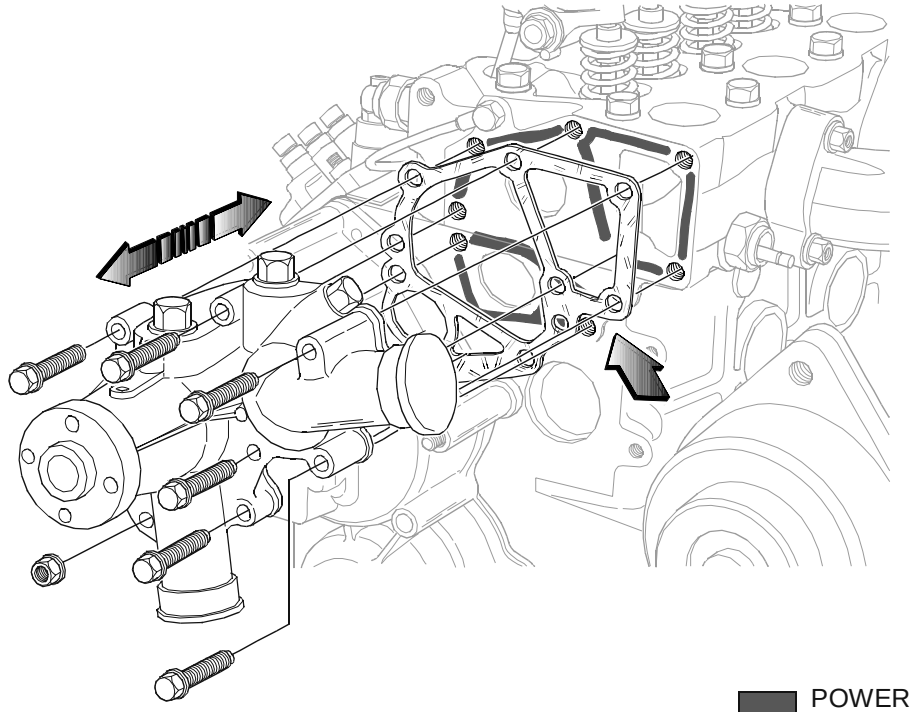
Special requirements

POWERPART products	
Description	**Part number**
Silicone RTV sealing and jointing compound	1861108

Notes:

- On assembly apply Powerpart silicone RTV sealing and jointing compound to the cylinder block of 102-05, 103-07 and 103-10 engines.
- A small amount of leakage of coolant across the surface of the face seal in the coolant pump is normal. Its purpose is to provide lubrication for the seal. There is a hole in the coolant pump body to allow coolant to drain. Small amounts of coolant might be seen intermittently from the drain hole during the engine operation cycle.
- Signs of a coolant through the drain hole are not an indication that the pump is faulty. Coolant stains or intermittent drops of coolant from the hole, indicate normal operation of the pump.

102-05
103-07
103-10

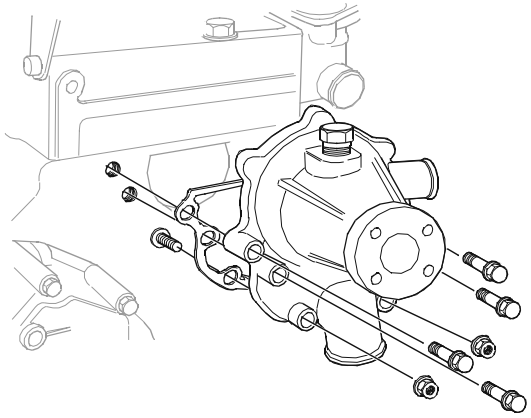


POWERPART silicone gasket sealant

A

Continued

103-13
103-15
104-19
104-22



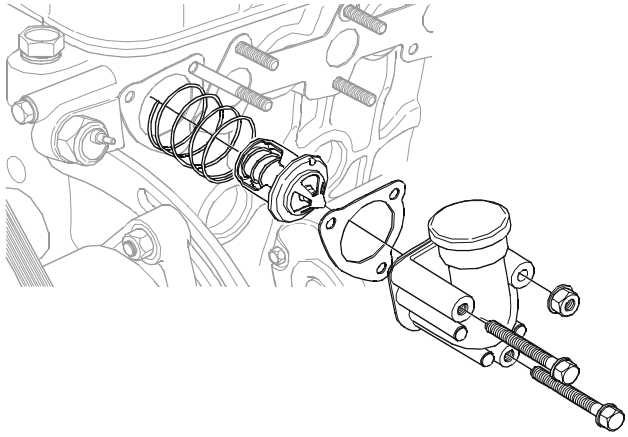
B

Thermostat

To remove and to fit **Operation 12-3**

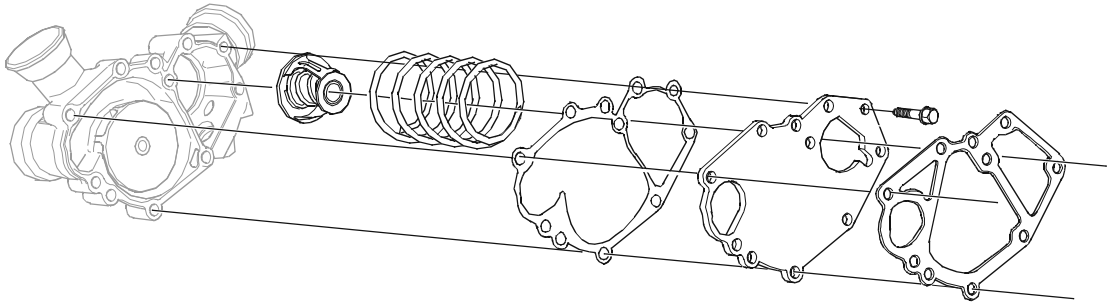
Note: The vent hole on the thermostat must be fitted in the "12 o'clock" position.

102-05
103-07



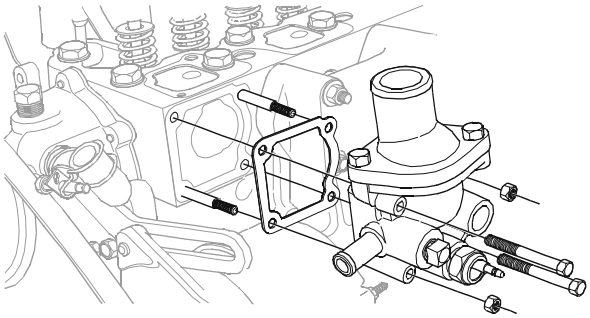
A

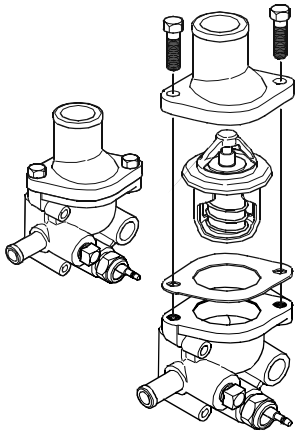
103-10



B

103-13
103-15
104-19
104-22





C

Special requirements

Engine model (wax pellet type thermostat)	Temperature when valve starts to open °C (°F)	Temperature when fully open °C (°F)
102-05, 103-07	73 to 77 (163.4 to 170.6)	87 (188.6)
103-10, 103-13, 103-15, 104-19, 104-22	80 to 84 (176 to 183.2)	95 (203)

Renew the thermostat if the valve is:

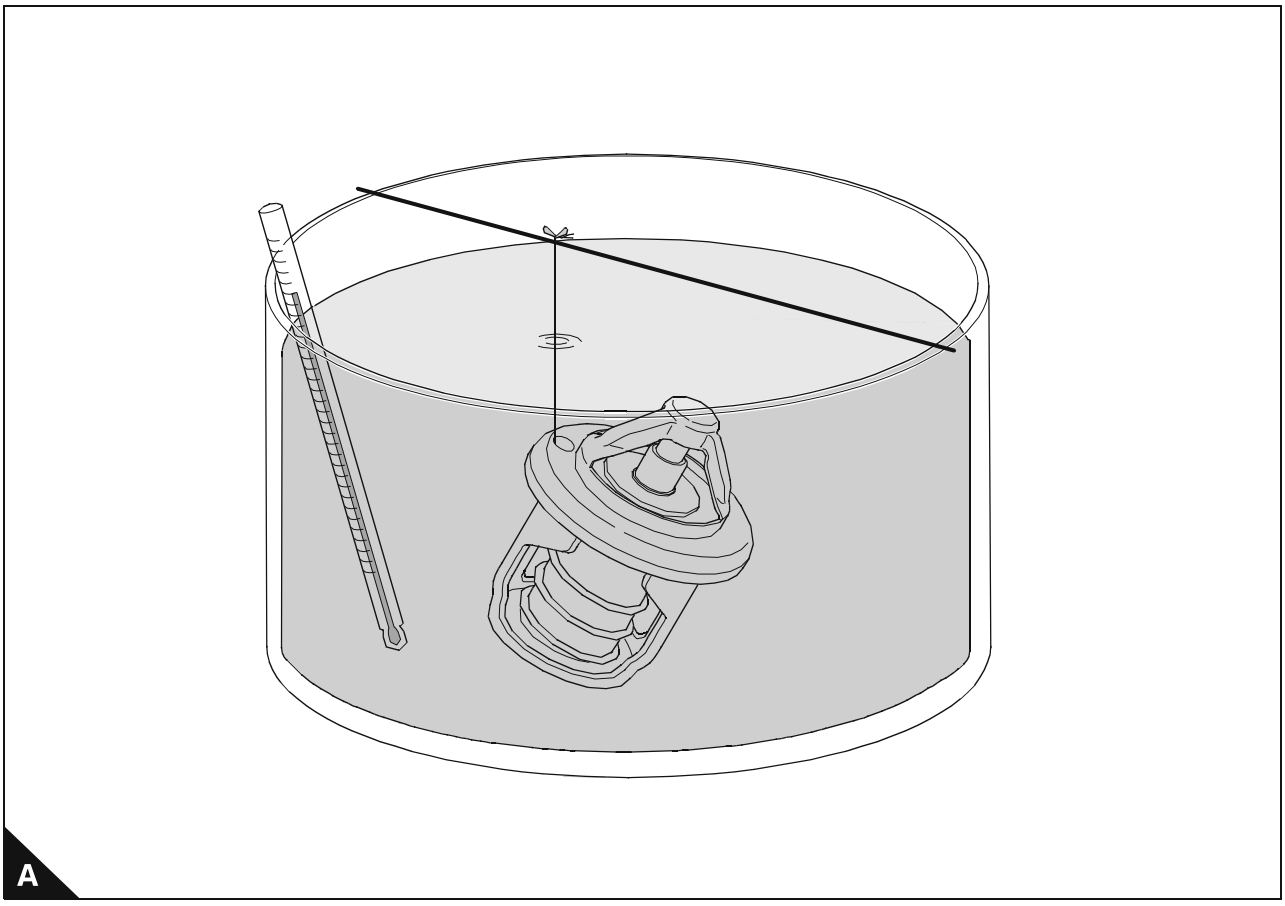
- Open at ambient temperature.
- Closed at the fully open temperature.

1 Place the thermostat into the water.

2 Increase the water temperature gradually and record the water temperature when the valve starts to open and the temperature when the valve is fully open. The standard values are given in the table.

Notes:

- The "Start to open" temperature will be stamped on the thermostat.
- 3 to 5 minutes will be required before the valve starts to open.



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13

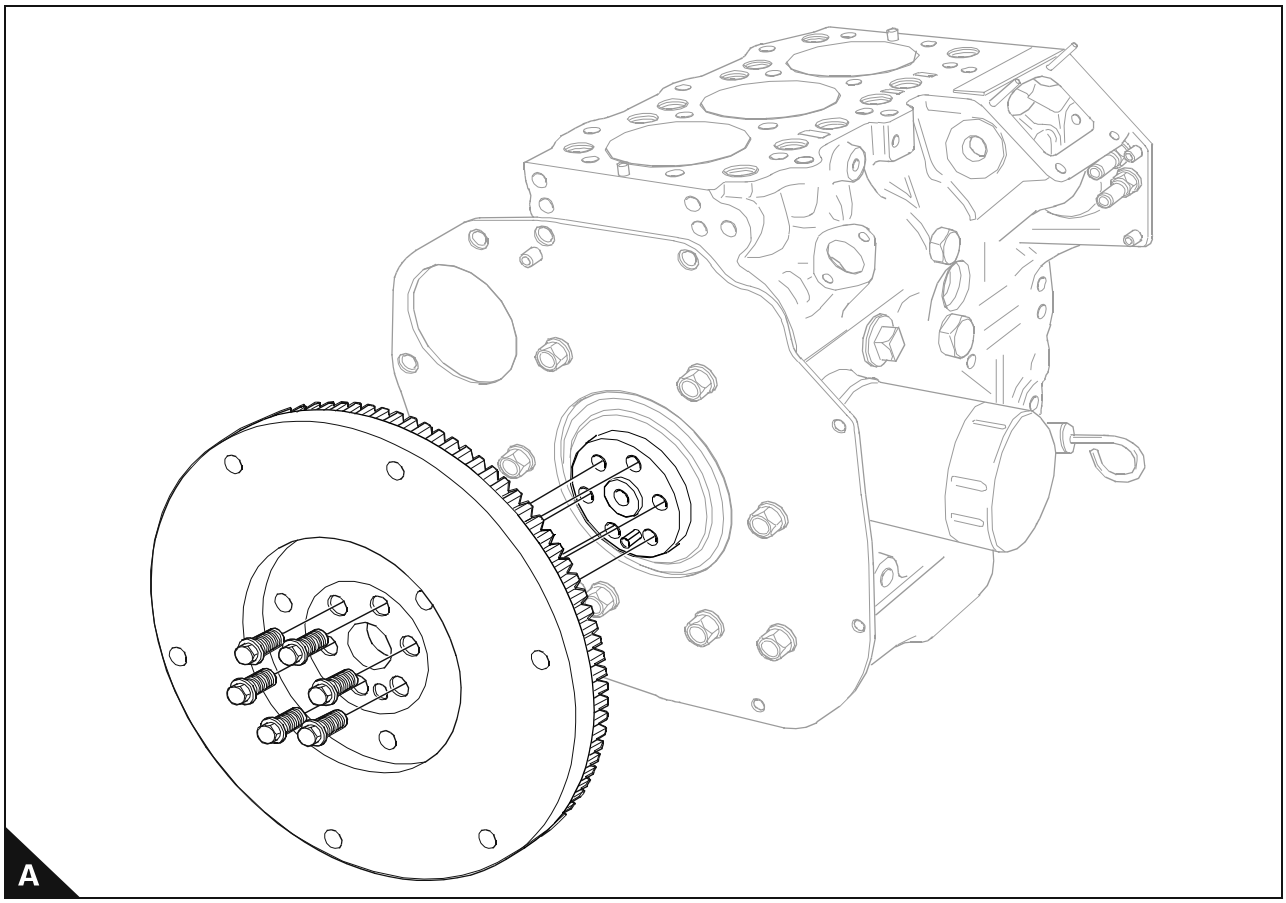
Flywheel and housing

Flywheel

To remove and to fit **Operation 13-1**

Special requirements

Torque Nm (lbf ft) kgf m	
Flywheel setscrews	73 (54) 7,4

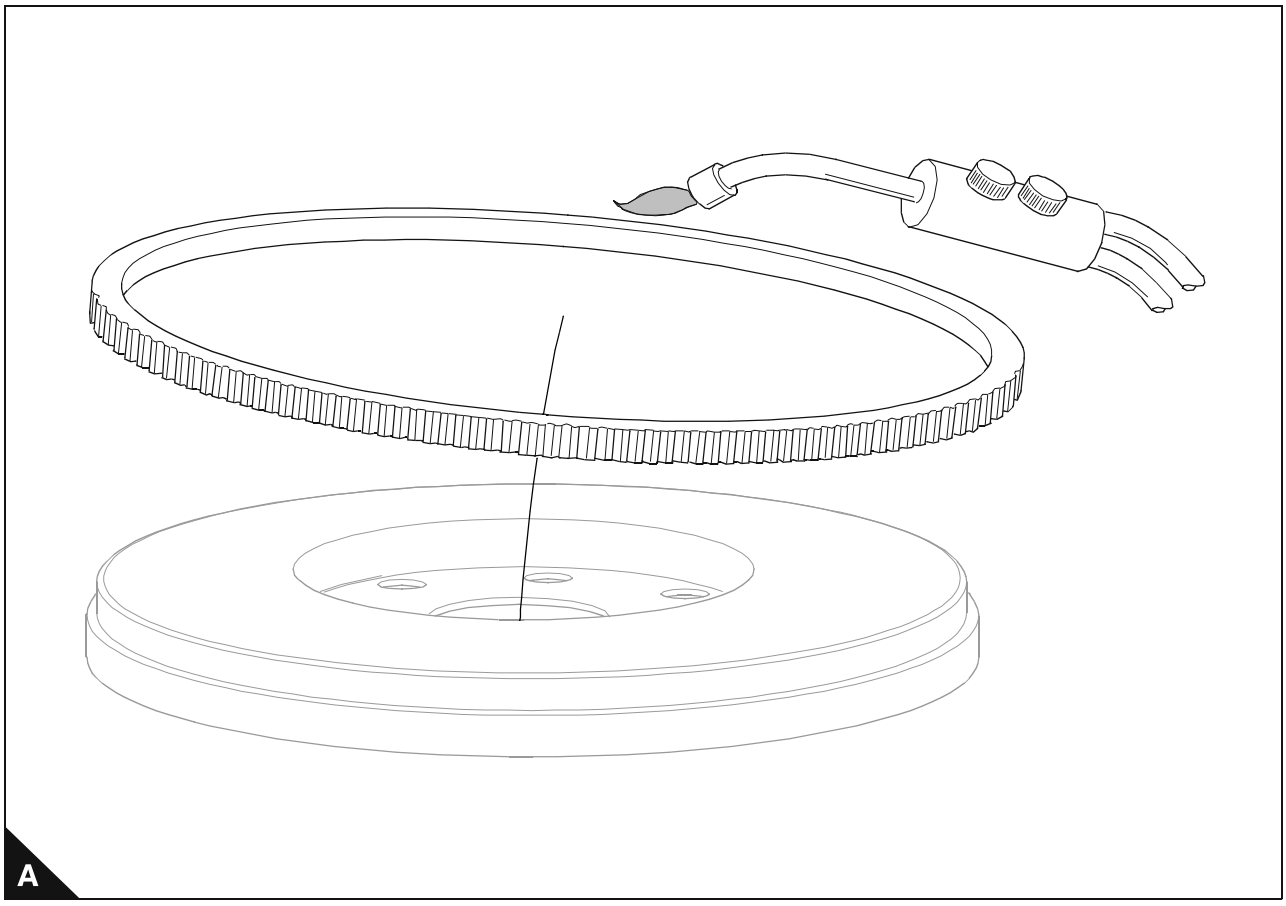


To inspect **Operation 13-2**

If the ring gear is excessively damaged or worn, renew.

When wear is not excessive remove ring gear and reinstall 90° from original position. To install, preheat the ring gear to 120 °C to 150 °C.

Caution: *Heat evenly, do not locally overheat.*



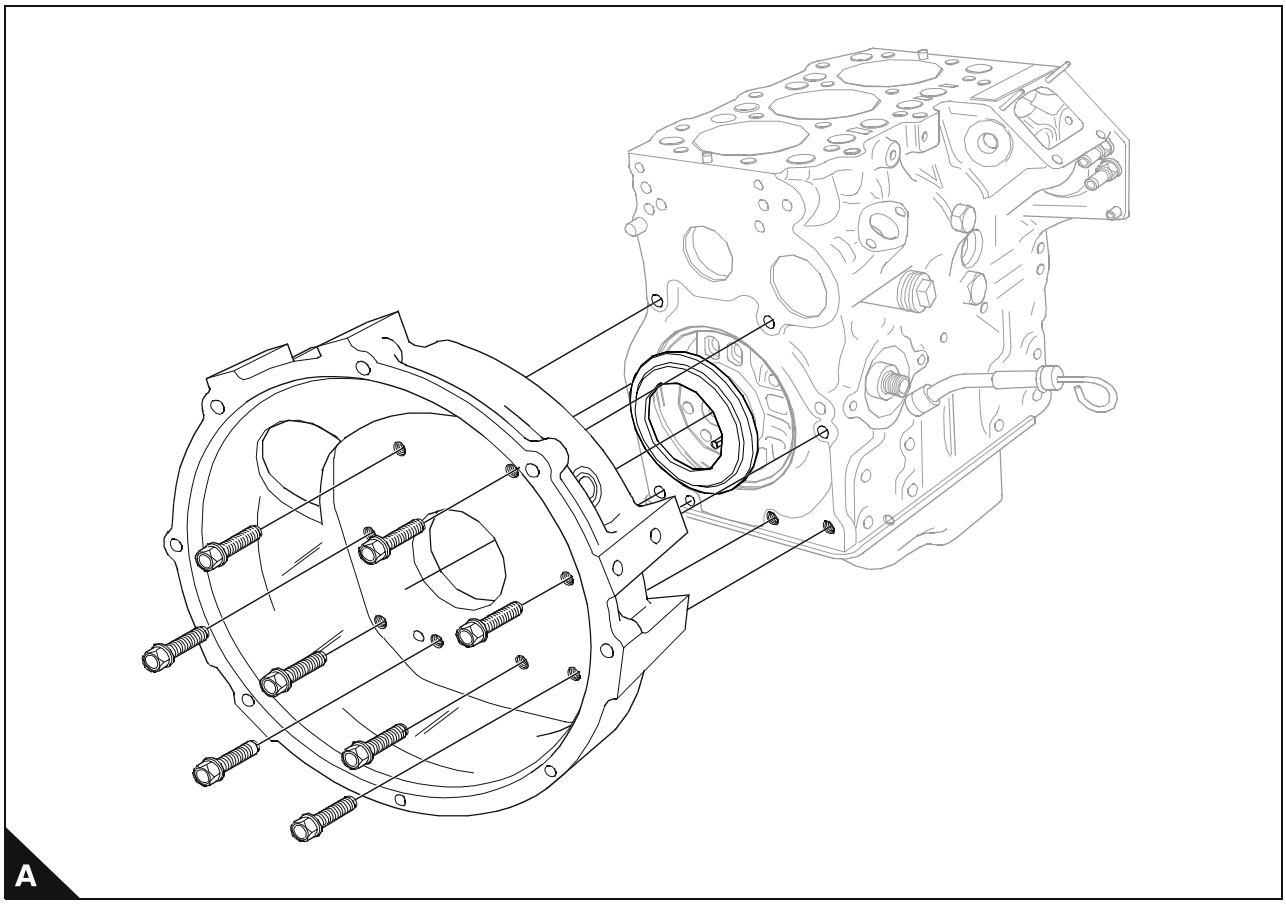
Flywheel housing (if fitted)

To remove and to fit — Operation 13-3

Special requirements

Torque Nm (lbf ft) kgf m	
102-05, 103-07	15 (11) 1,5
103-10	50 (37) 5,1
103-13, 103-15, 104-19, 104-22	25 (18) 2,6

Note: Only 104-22 engines have the backplate and housing fitted together.



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14

Electrical equipment

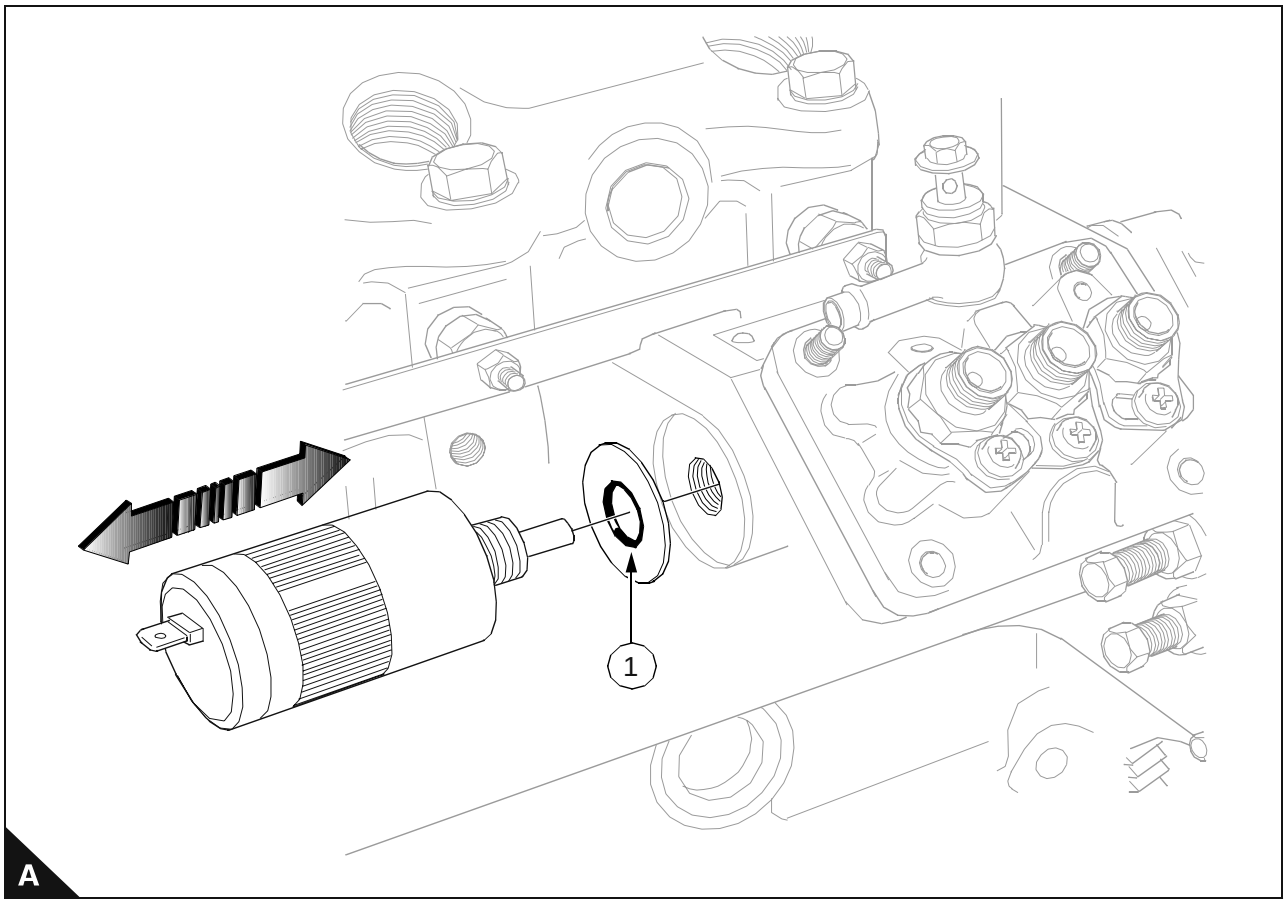
Electrical shut off solenoid (ESOS)

To remove and to fit **Operation 14-1**

Special requirements

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

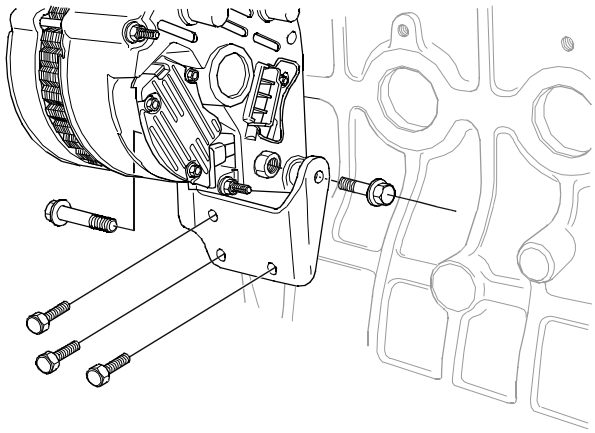
Note: Remember the location of special washer (A1).



Alternator

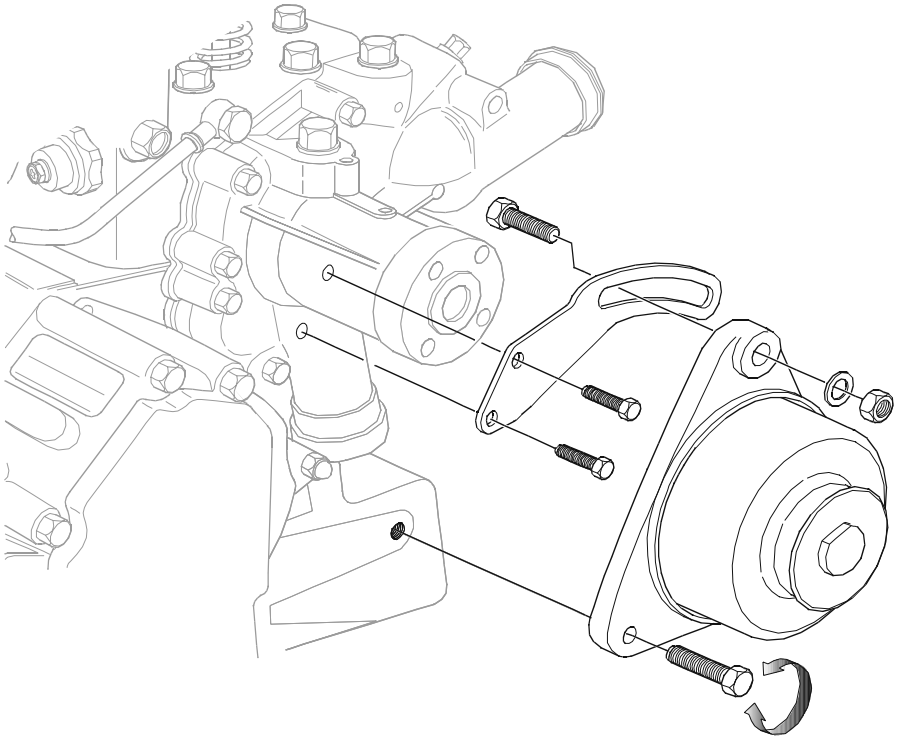
To remove and to fit **Operation 14-2**

103-13
103-15
104-19
104-22



A

102-05
103-07
103-10



B

Alternator Testing **Operation 14-3**

To avoid the return of parts that are not faulty, follow this procedure for all suspected failures. This will isolate the problem between either the alternator or the main electrical system.

Check that all connections to the alternator are secure and free from contamination. If the alternator is earthed using the engine block check that there is a good connection between the alternator, the earth connection and the engine block. If the alternator mounting bracket is of the black painted type, the bracket should be removed from the engine block and the paint removed from the mounting surfaces between the alternator, the mounting bracket and the engine block.

If the machine tachometer is not operating, check the security of the 'W' terminal (A3, B3).

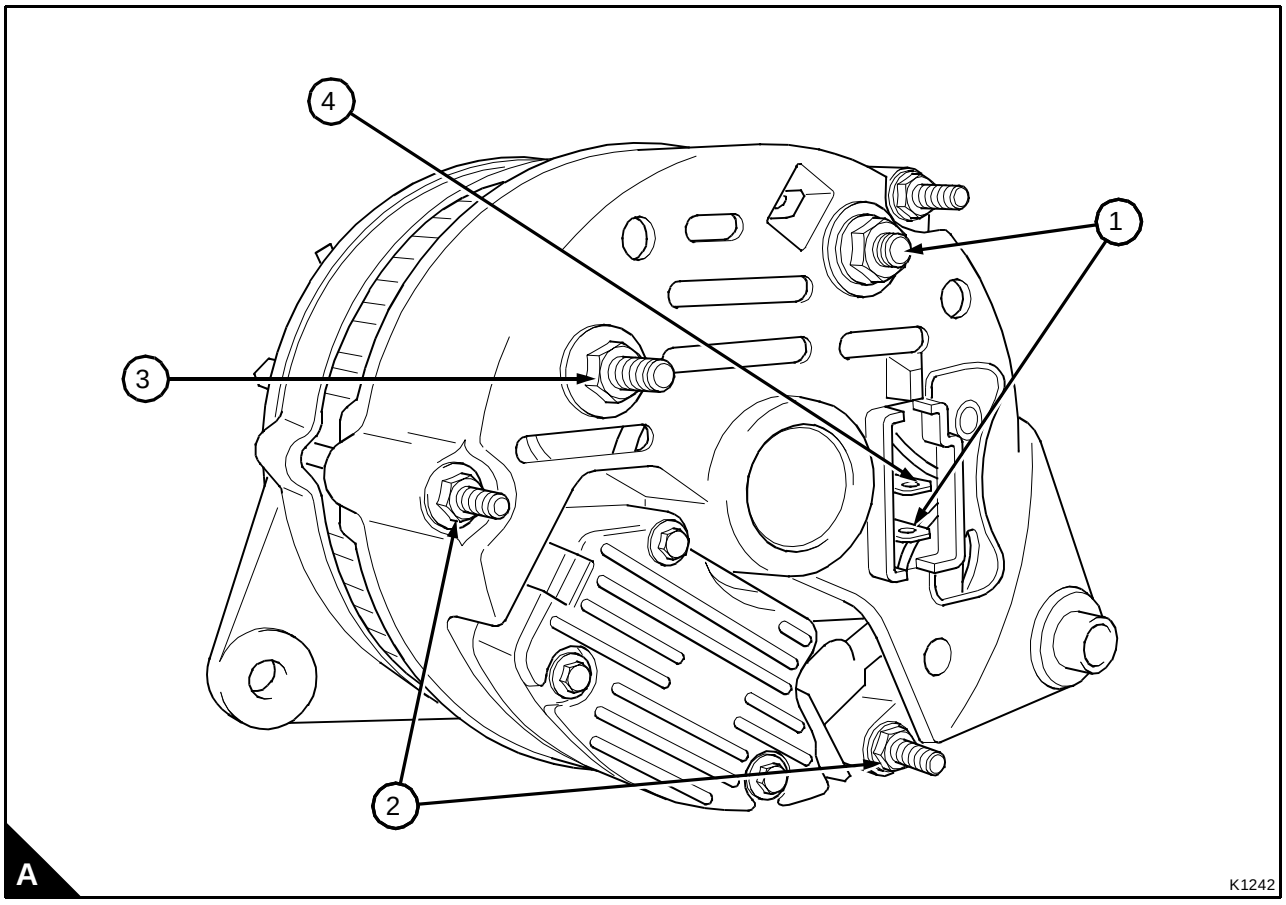
If the alternator is excessively contaminated by dust or dirt, use an airline and compressed air applied to the vent holes on the alternator.

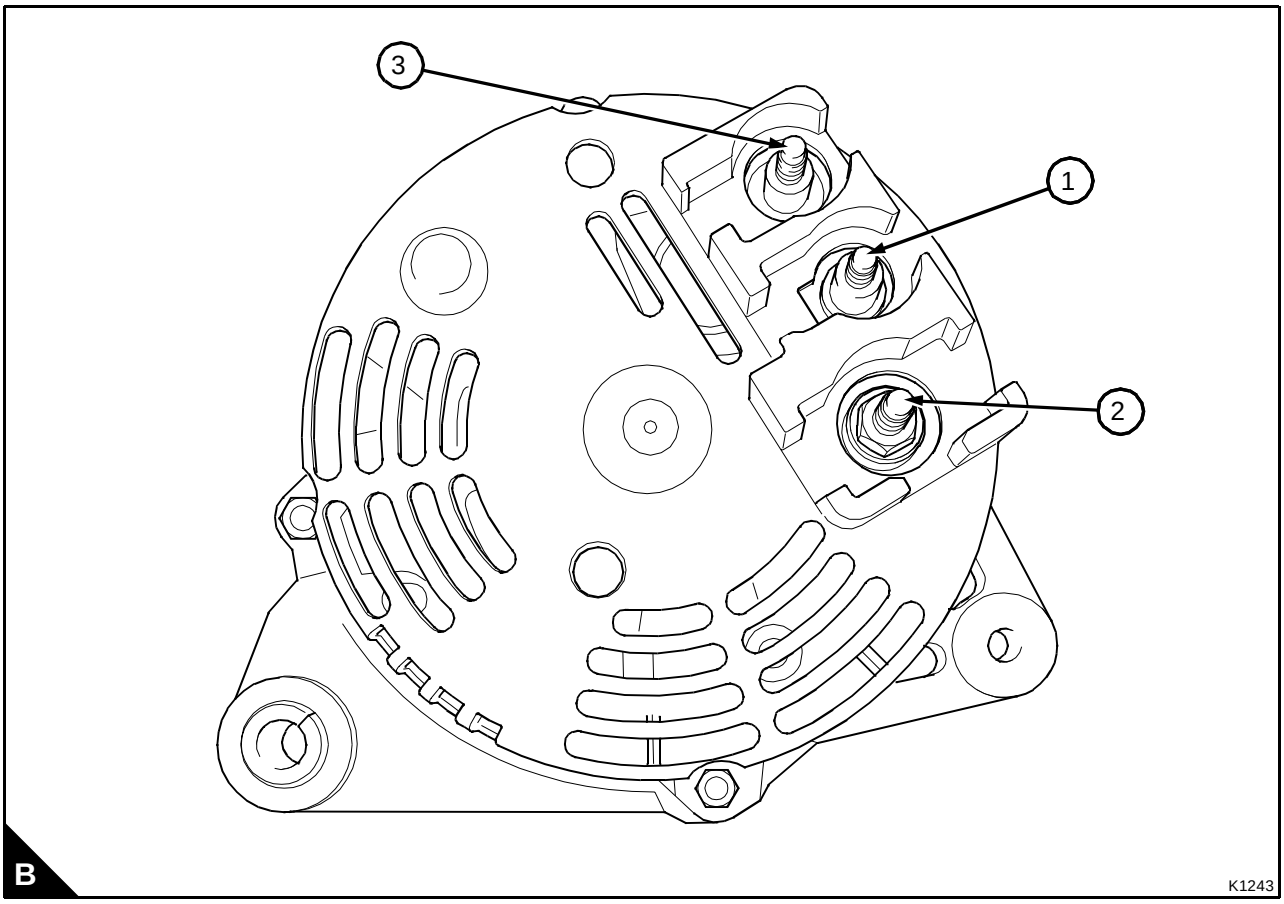
If the ignition warning lamp is illuminated, check the phase wiring (A4, B1).

Check the alternator charging voltage with a volt meter between the alternator +Ve (A1, B2) and the alternator earth terminal (A2) when the engine is operating at idle, with the minimal electrical load. The voltage should be between 13.6 and 14.7 volts, if it is outside this range then the alternator is faulty.

Notes:

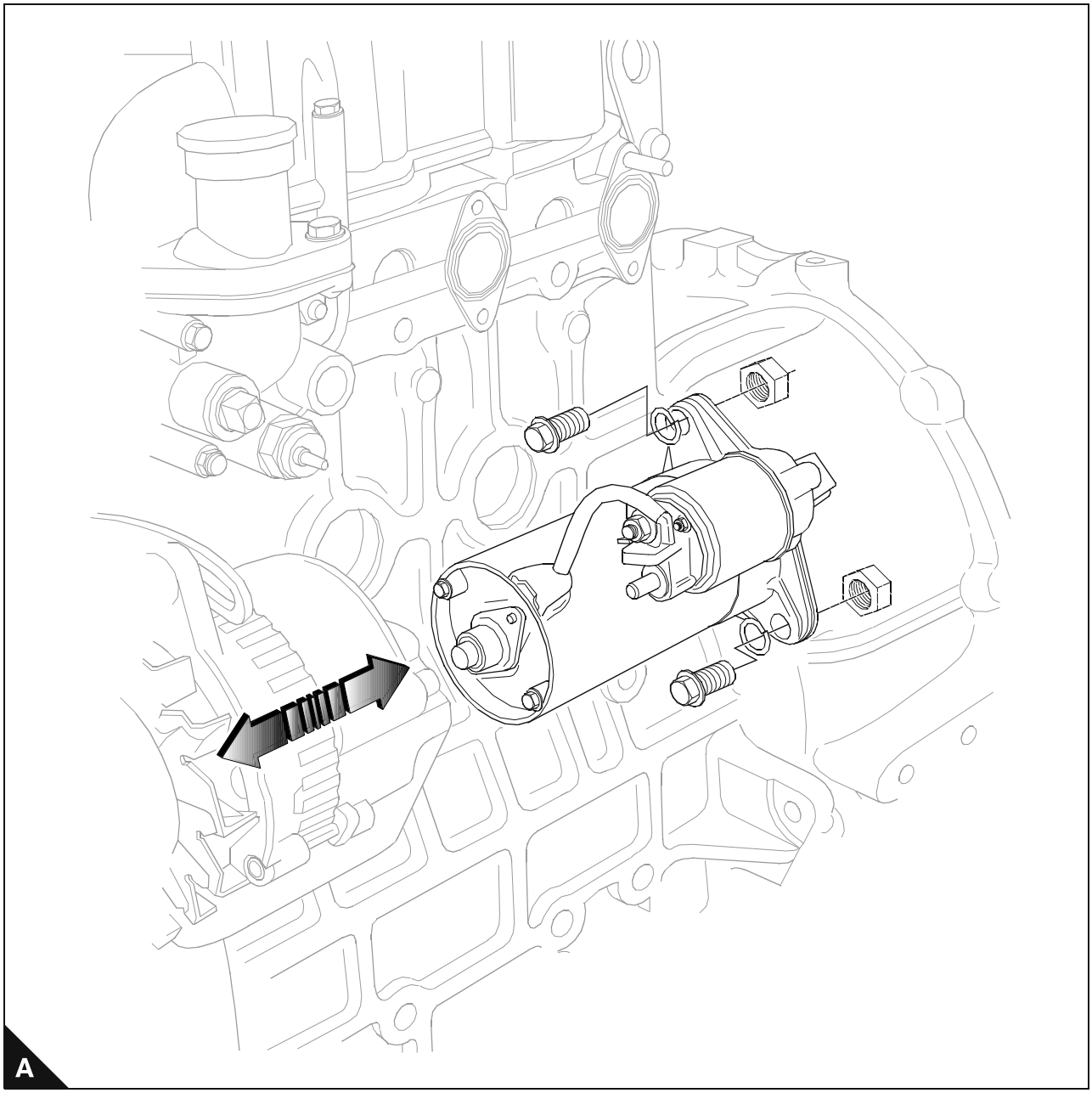
- Graphic A - External fan type.
- Graphic B - Internal fan type.




3
1
2
B
K1243

Starter motor

To remove and to fit **Operation 14-4**



Starter Motor Testing **Operation 14-5**

Before removing a suspect faulty starter motor, check the security of all of the electrical connections on the starter motor.

To test the starter motor use:

- 12 volt fully charged battery (A5).
- Two heavy duty cables with suitable clips.
- One small lead with an in-line switch capacity of 5 amperes minimum. The switch (A1) should be of the push to make type.

Secure the starter motor in a vice.

Connect the leads as shown in the diagram (A2, A3, A4), there should be no operation of the starter motor. If there is any smoke, buzzing or sparking from the starter motor, it is faulty.

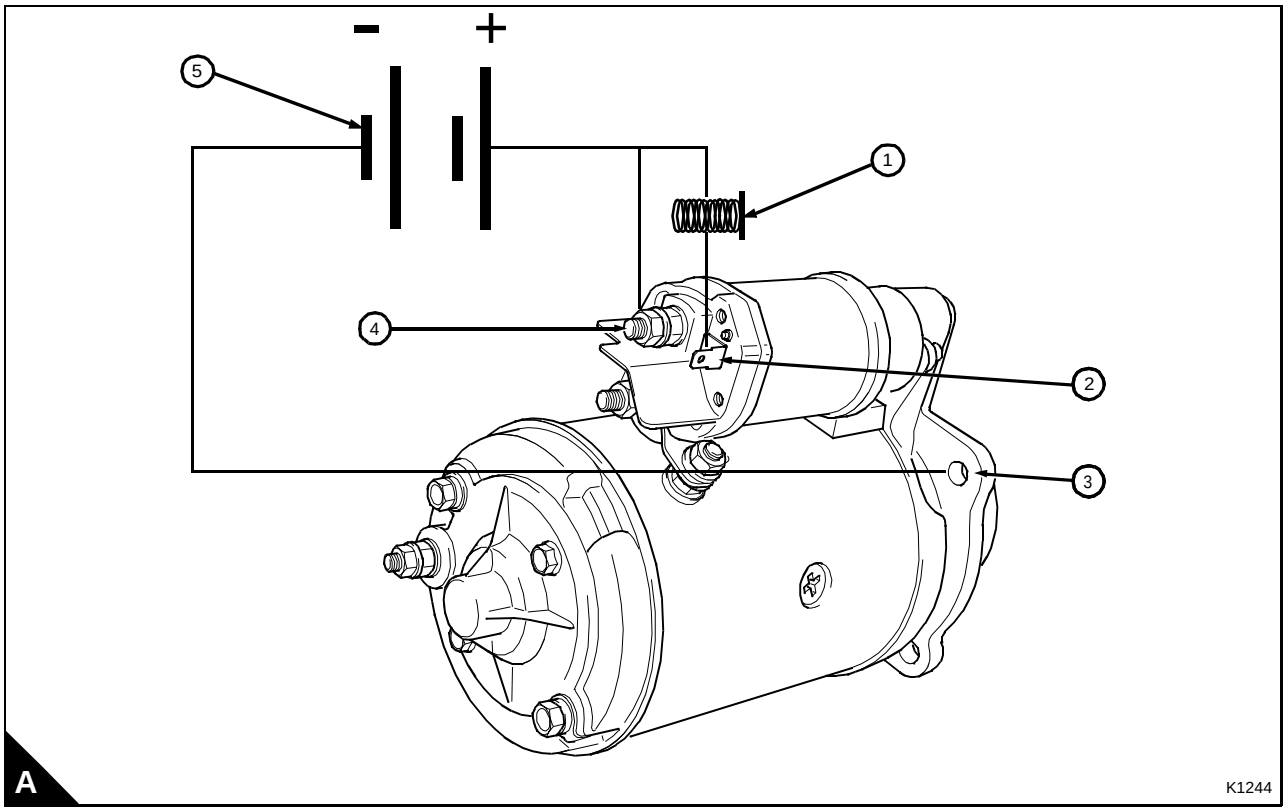
Operate the switch and the solenoid should operate, moving the pinion forward to engage the starter. The starter motor pinion will then rotate. Releasing the switch will allow the pinion to retract and stop rotating.

If there is any abnormal noise, such as knocking, electrical buzzing, smoke, the starter does not operate, or the pinion does not move forward or backward, or the pinion does not rotate, the starter motor is faulty.

If the starter motor operates correctly then the machine electrical system is faulty.

- A1 - Lead with push button switch.
- A2 - Lucar connector for ignition switch.
- A3 - Starter earth connection 8.0 - 8.5 Nm
- A4 - Solenoid connection 5.6 - 6.2 Nm.
- A5 - 12 volt battery.

Note: The starter motor earth (A3) should be connected directly to B- or via another earth. This should not be used as the main engine earth.



Wiring diagram 14 and 15 amp alternator - 102-05, 103-07, 103-10

Circuit	Cable number	Circuit current	Maximum circuit resistance	Maximum circuit volt drop	Remarks
Alternator charging	4, 7, 8, 9, 13	14 amp (2 cyl) 15 amp (3 cyl)	0.036 Ù (2 cyl) 0.033 Ù (3 cyl)	0.5 Volt	See Glow Plugs Circuit
Starter motor solenoid	4, 5, 6	15.75 amp	0.04 Ù	0.63 Volt	See Glow Plugs Circuit
STD glow plugs (via glow signal)	4, 5, 10, 11, 12	(Peak max) 26 amp (2 cyl) 39 amp (3 cyl)	0.0192 Ù (2 cyl) 0.0128 Ù (3 cyl)	0.5 Volt	

Wiring diagram maximum circuit resistance

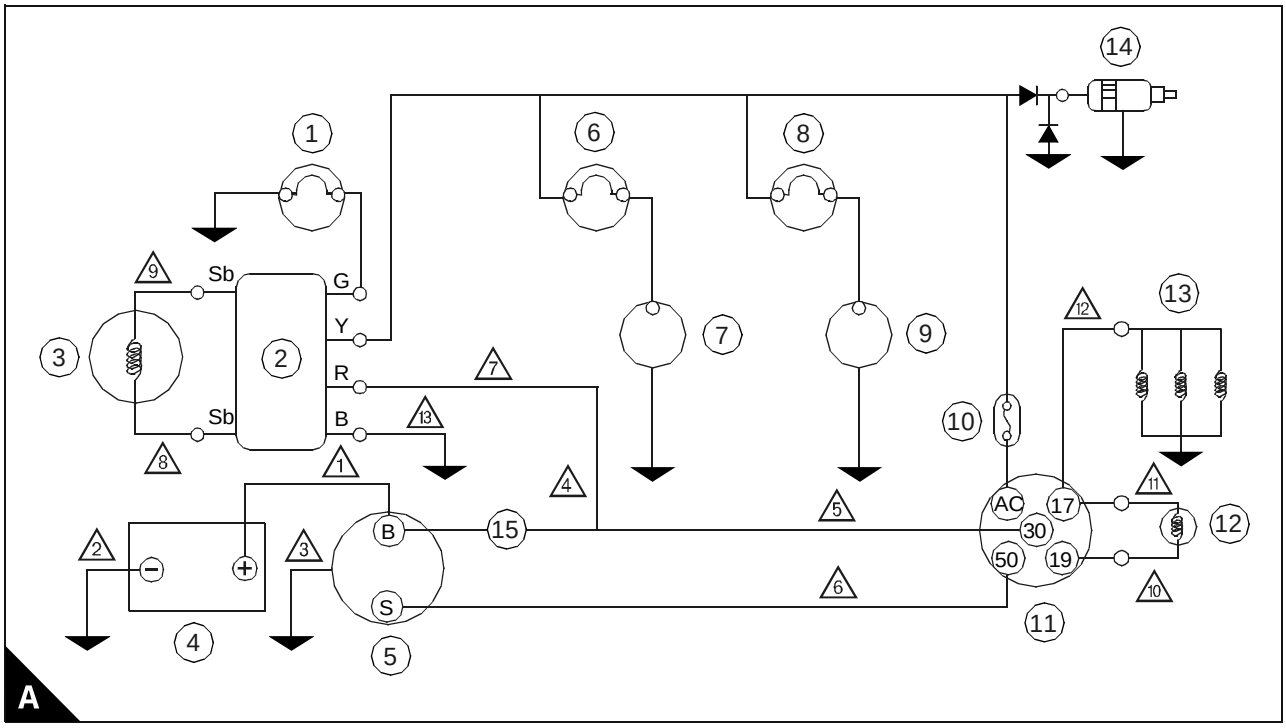
The resistance of battery cables 1, 2 and 3 must not exceed 0.0018 Ù.

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

(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 - 103-10 (when fitted with optional alternator)

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

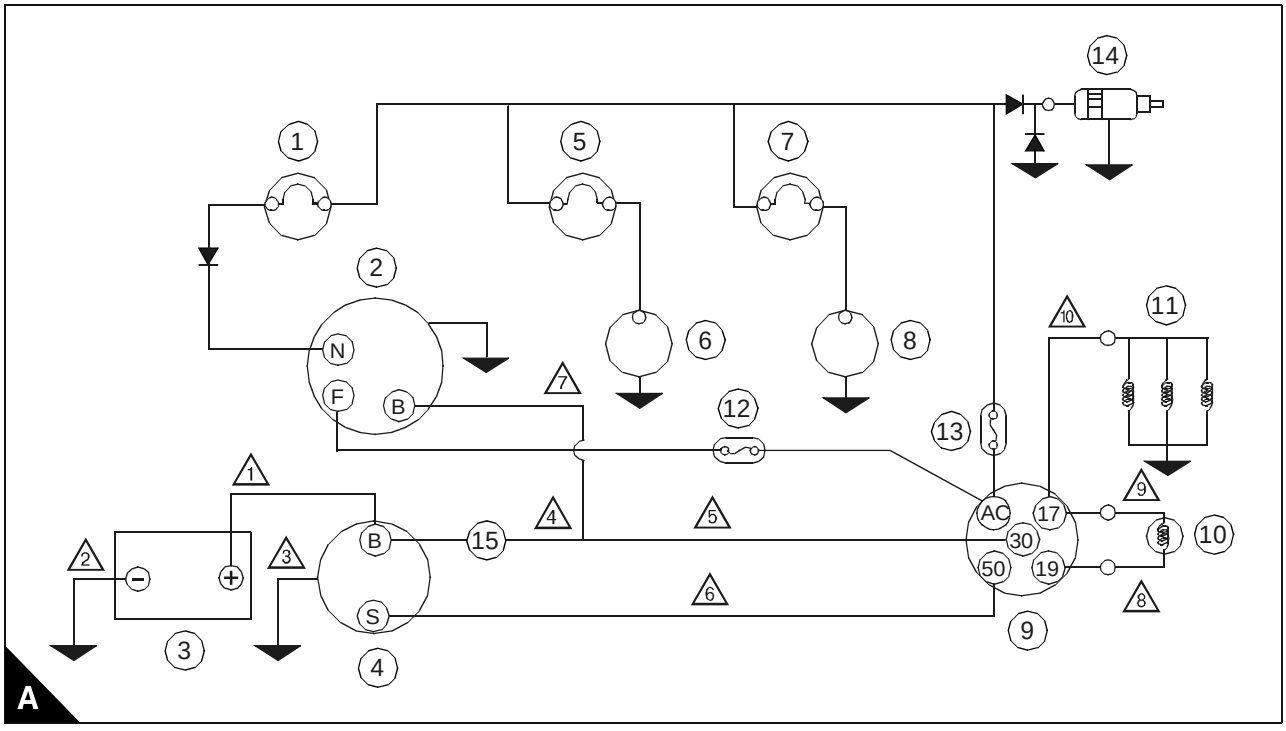
Wiring diagram maximum circuit resistance

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

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

(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 - 103-15, 104-19, 104-22

Circuit	Cable number	Circuit current	Maximum circuit resistance	Maximum circuit volt drop	Remarks
Alternator charging	4 7 11	55 amp	0.009 Ù	0.5 Volt	See Glow Plugs Circuit
Starter motor solenoid	4 5 6	15.75 amp	0.04 Ù	0.63 Volt	See Glow Plugs Circuit
STD glow plugs (via glow signal)	4 5 8 9 10	(Peak max) 39 amp (3 cyl) 52 amp (4 cyl)	0.0128 Ù (3 cyl)s 0.0096 Ù (4 cyl)s	0.5 Volt	

Wiring diagram maximum circuit resistance

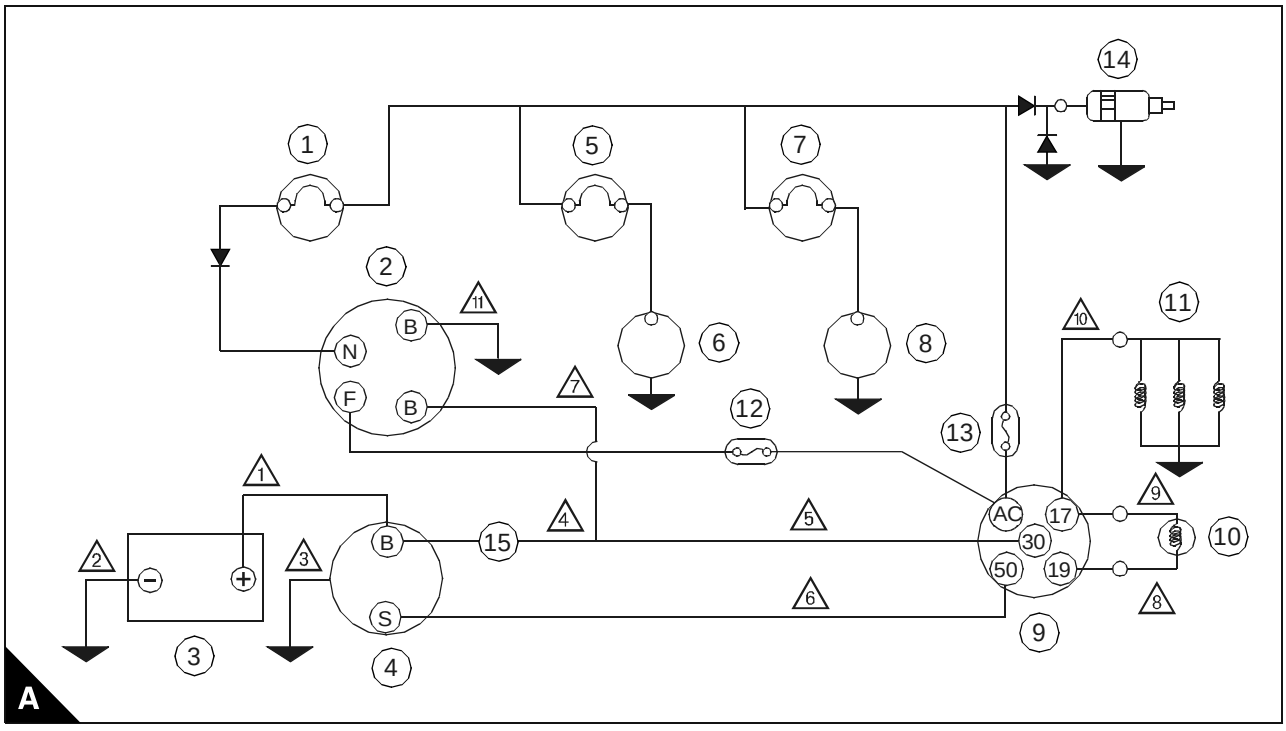
The resistance of battery cables 1, 2 and 3 must not exceed 0.0018 Ù.

Note: Maximum cable size for 375 lucar terminals on the alternator is 65/0,3 mm (4,5 mm^2) therefore twin cables are required at the connection to the alternator.

1 Alternator warning lamp
2 Alternator
3 Battery
4 Starter motor
5 Oil pressure warning lamp
6 Oil pressure switch **(1)**
7 Water temperature warning lamp
8 Thermostat switch
9 Key switch
10 Glow signal
11 Glow plugs
12 Fuse
13 Solenoid switch
14 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 40 amp alternator - 103-13

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

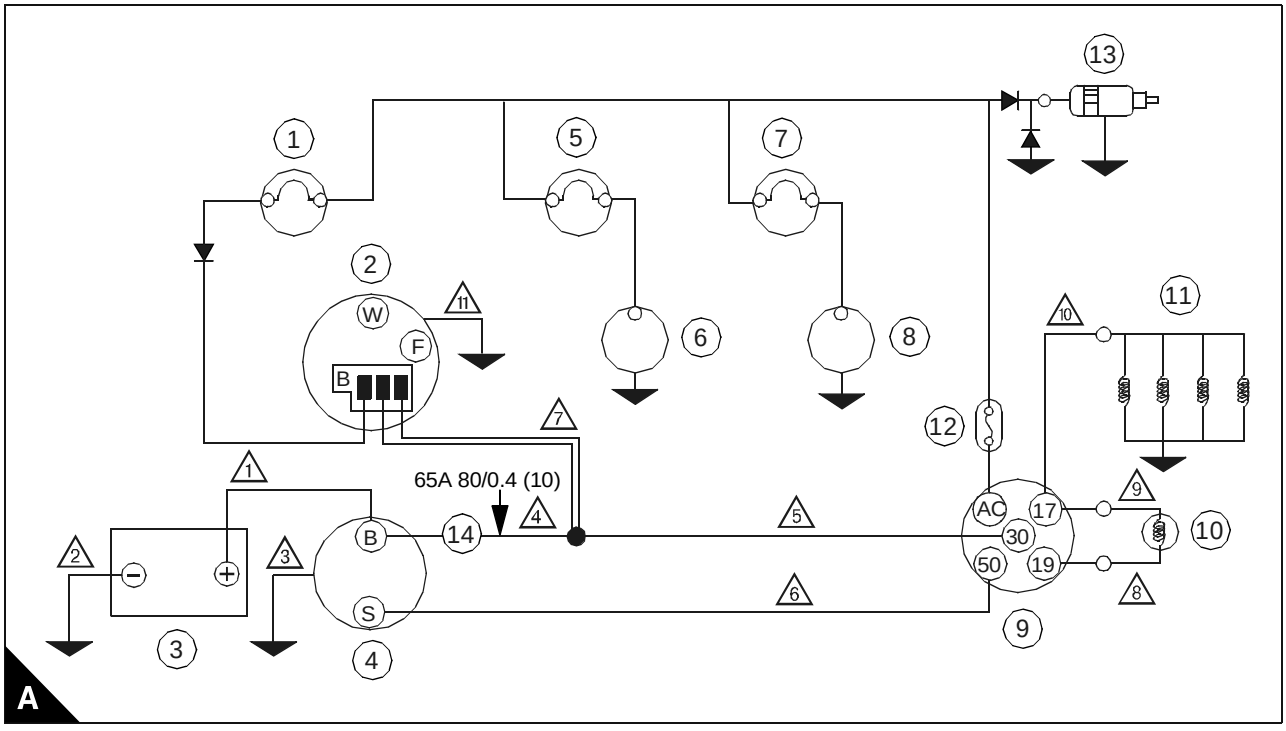
Wiring diagram maximum circuit resistance

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

1 Alternator warning lamp
2 Alternator
3 Battery
4 Starter motor
5 Oil pressure warning lamp
6 Oil pressure switch **(1)**
7 Water temperature warning lamp
8 Thermostat switch
9 Key switch
10 Glow signal
11 Glow plugs
12 Fuse
13 Fuse
14 Solenoid switch
15 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)**.



Auto shutdown wiring diagram

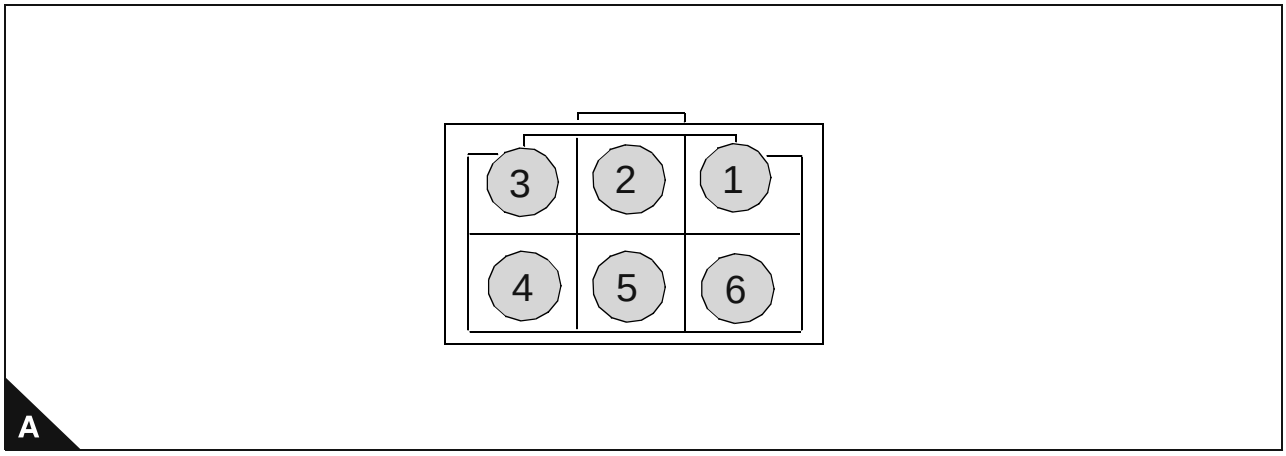
55 Amp alternator charge lamp

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 the 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	Water Temperature Switch
6	Black	Ground (earth)



Auto shutdown wiring diagram 14 and 15 amp alternator - 102-05, 103-07, 103-10

Auto 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

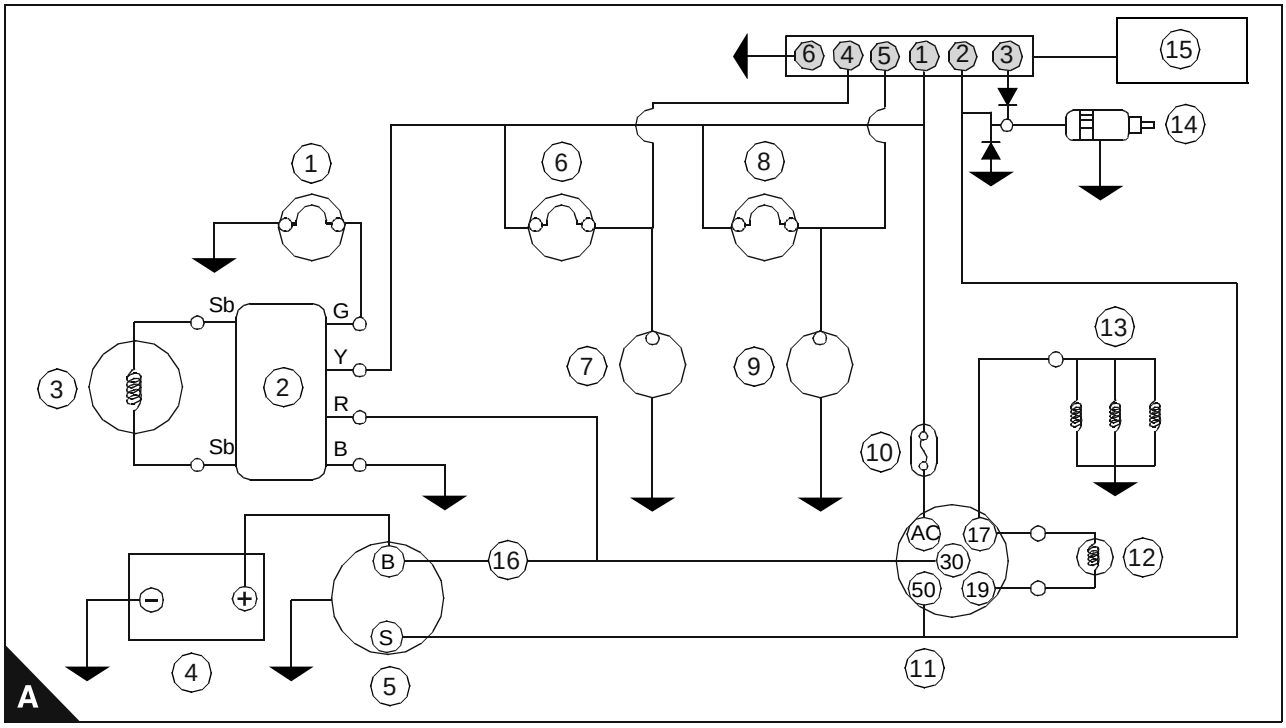
Water temperature switch: If the water temperature exceeds 105 °C ± 4 °C.

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

1 Alternator warning lamp
2 Regulator
3 Alternator
4 Battery
5 Starter motor
6 Oil pressure warning lamp
7 Oil pressure switch **(1)**
8 Water temperature warning lamp
9 Thermostat switch
10 Fuse
11 Key switch
12 Glow signal
13 Glow plugs
14 Solenoid switch
15 Auto shutdown device
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)**.



Auto shutdown wiring diagram 40 amp alternator - 103-10 (when fitted with optional alternator)

Auto 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

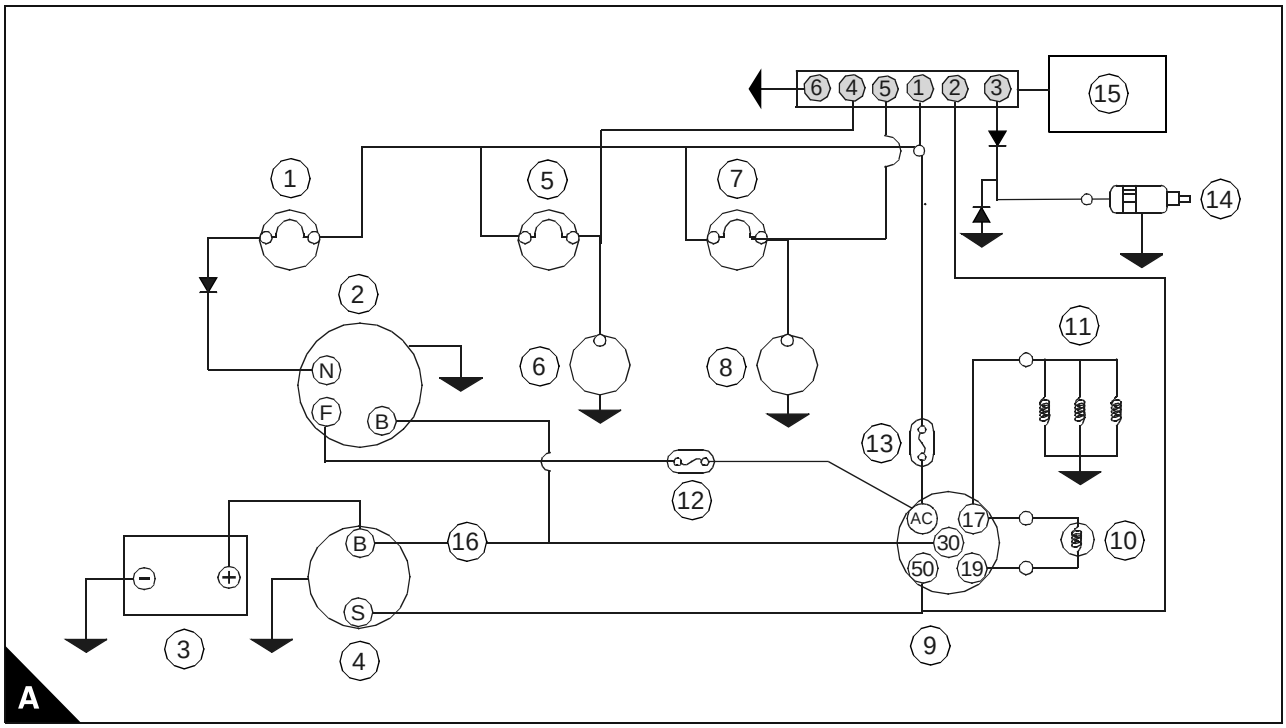
Water temperature switch: If the water temperature exceeds 105 °C ± 4 °C.

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

1 Alternator warning lamp
2 Alternator
3 Battery
4 Starter motor
5 Oil pressure warning lamp
6 Oil pressure switch **(1)**
7 Water temperature warning lamp
8 Thermostat switch
9 Key switch
10 Glow signal
11 Glow plugs
12 Fuse
13 Fuse
14 Solenoid switch
15 Auto shutdown device
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)**.



Auto shutdown wiring diagram 40 amp alternator - 103-13

Auto 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

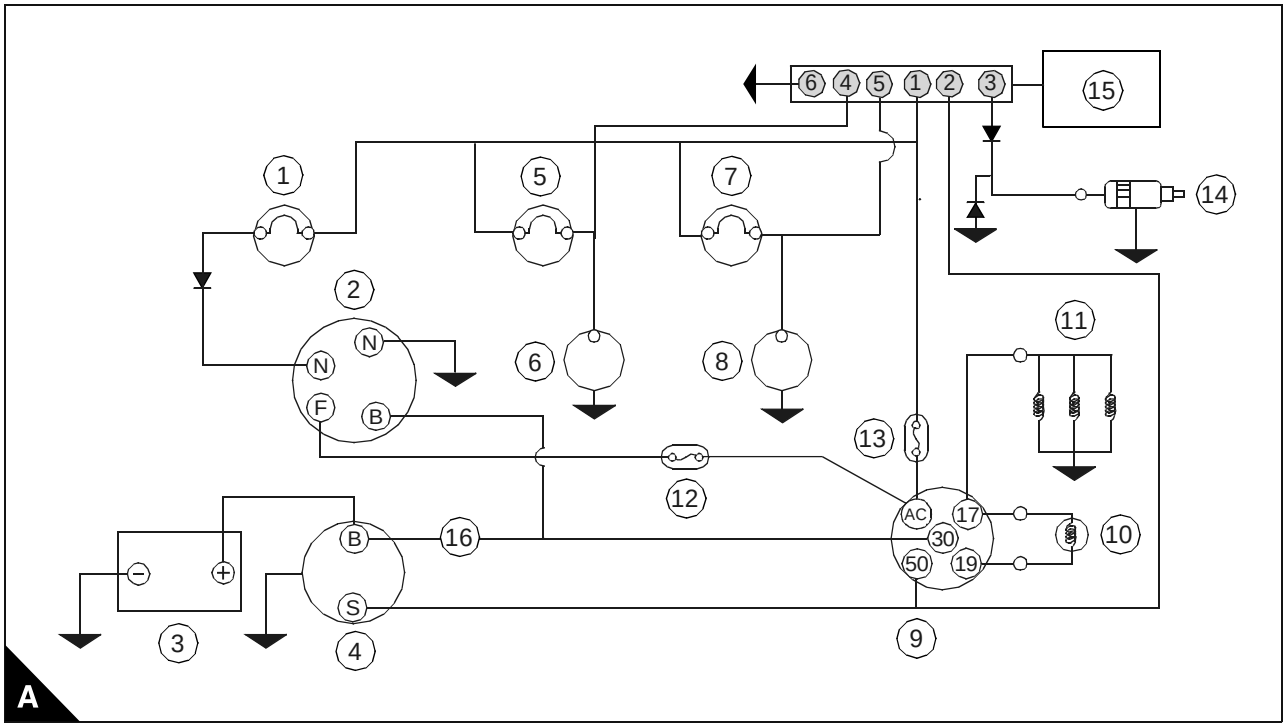
Water temperature switch: If the water temperature exceeds 105 °C ± 4 °C.

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

1 Alternator warning lamp
2 Alternator
3 Battery
4 Starter motor
5 Oil pressure warning lamp
6 Oil pressure switch **(1)**
7 Water temperature warning lamp
8 Thermostat switch
9 Key switch
10 Glow signal
11 Glow plugs
12 Fuse
13 Fuse
14 Solenoid switch
15 Auto shutdown device
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)**.



Auto shutdown wiring diagram 40 amp alternator - 103-15, 104-19, 104-22

Auto 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

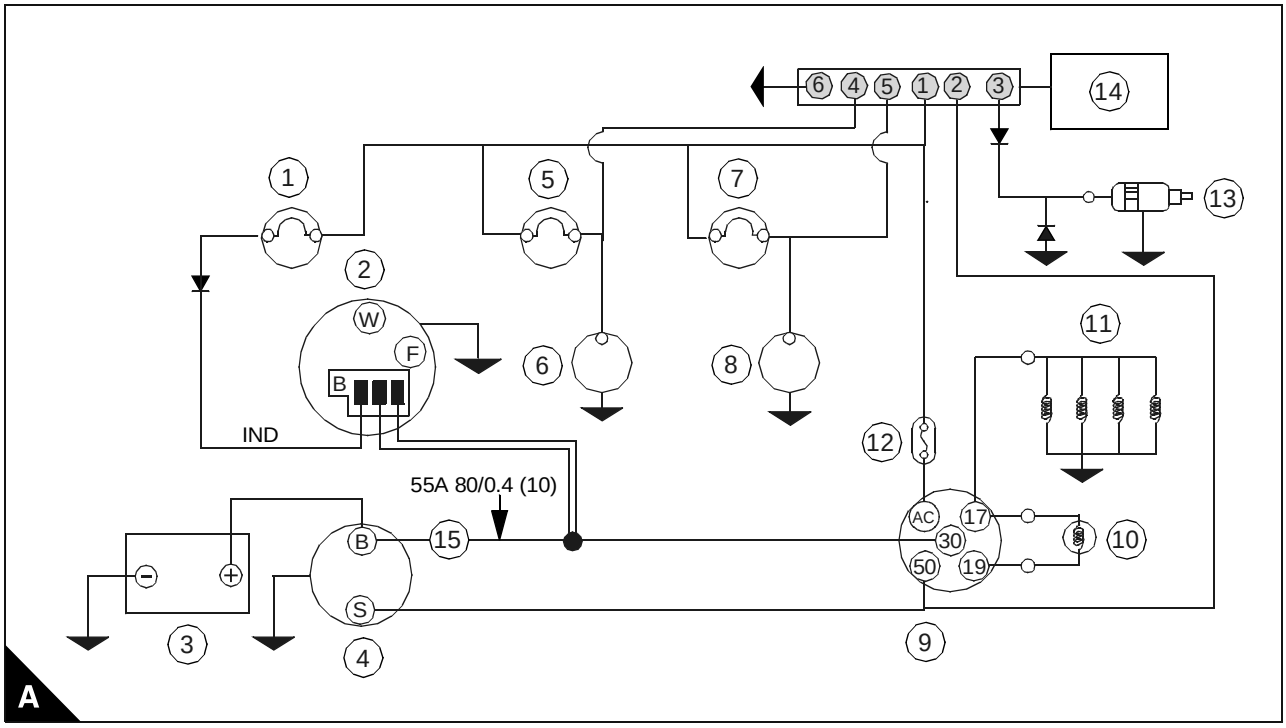
Water temperature switch: If the water temperature exceeds 105 °C ± 4 °C.

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

1 Alternator warning lamp
2 Alternator
3 Battery
4 Starter motor
5 Oil pressure warning lamp
6 Oil pressure switch **(1)**
7 Water temperature warning lamp
8 Thermostat switch
9 Key switch
10 Glow signal
11 Glow plugs
12 Fuse
13 Solenoid switch
14 Auto shutdown device
15 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)**.



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15

Auxiliary equipment

Radiator Anti-Vibration mountings

A new radiator mounting (part number 2638D017) has been introduced from engine serial number KD-----141489H for 103-10 engines, and from engine serial number KE\KF\KR-----954917H for 103-15, 104-19, and 104-22 engines.

Caution: *New mountings should not be mixed with older mountings. The new mounting is identified with a yellow mark, the old mounting is identified with an orange mark. If it is necessary to replace any of the three radiator anti-vibration mountings, then all three should be replaced at the same time using the new specification mounting.*

Note: All mountings supplied via Perkins Parts Distribution Centre (PDC), Irlam, England will be to the latest specification.

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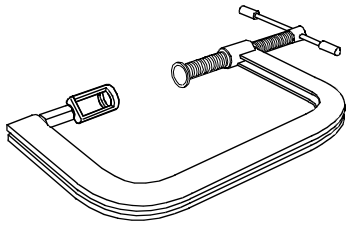
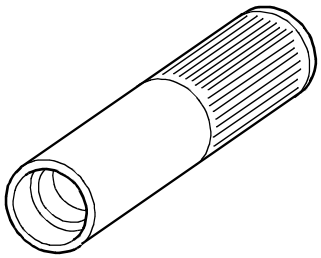
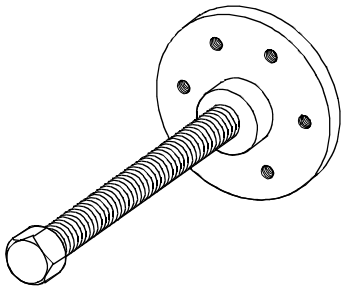
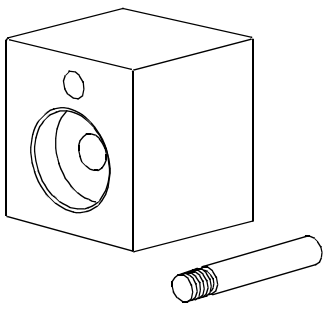
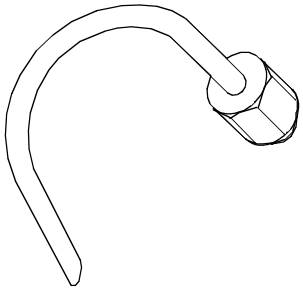
Special tools

Special tools list

These tools are available through your nearest Perkins Dealer/Distributor.

Description	Illustration
Valve spring remover Part number 21825663	
Valve stem seal replacer 102-05, 103-07: Part number 21825622 103-10, 103-13, 103-15, 104-19, 104-22: Part number 21825623	
Crankshaft pulley remover Part number 21825619	
Idler hub assembly tool 102-05, 103-07: Part number 21825624 103-10: Part number 21825625 103-13, 103-15, 104-19, 104-22: Part number 21825626	

Description	Illustration
Fuel pump spill pipe Part number: 21825680	
Front oil seal protector 102-05, 103-07, 103-10: Part number 21825620 103-13, 103-15, 104-19, 104-22: Part number 21825621