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

Publication TPD 1377E, Issue 3

The information is correct at the time of print.
Published in March 2002 by Technical Publications.

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1

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 10.
- 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 9.
- 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, refer to "How to drain the cooling system" on page 23. In order to protect the cooling system against corrosion, fill it with an approved antifreeze mixture because this gives protection against corrosion, refer to "Coolant specification" on page 41.

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 (refer to illustration A under "How to start a cold engine with the fuelled starting aid" on page 17) 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.

Part number 1 litre 21825166.

POWERPART Easyflush

Cleans the cooling system.

Part number 21825001.

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 Chisel

Allows easy removal of old gaskets and joints.

Part number 21825163.

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 Threadlock (pipe)

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

Part number 21820575.

POWERPART Platelock

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

Part number 21826039.

POWERPART Silicone gasket sealant

Silicone adhesive used for sealing where oil or water resistance is needed.

Part number 21826046.

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

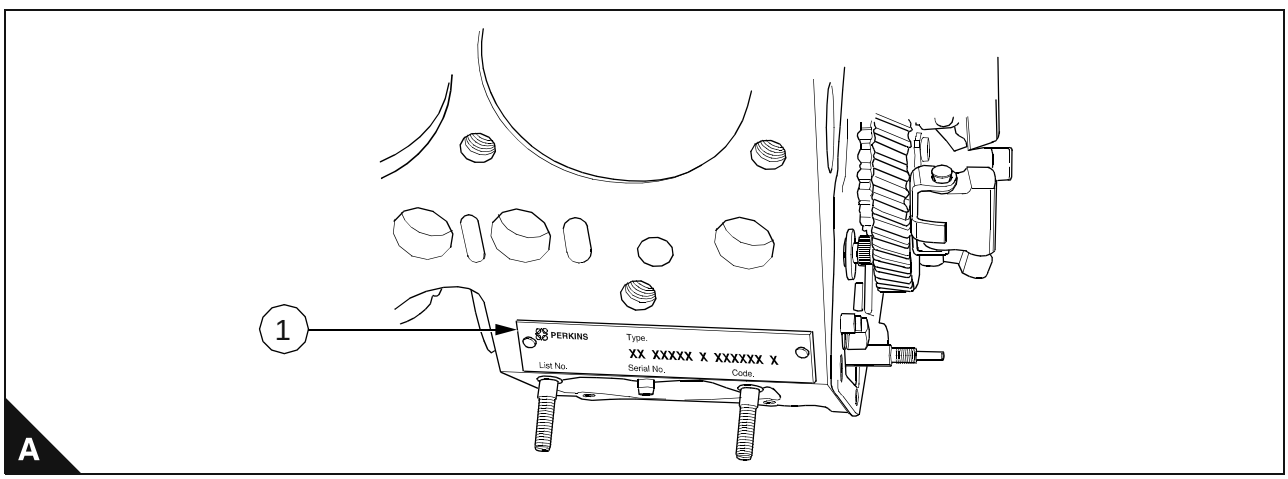
Code	Country of manufacture
J	Made in Japan
U	Made in U.K.

Code IV Engine serial number

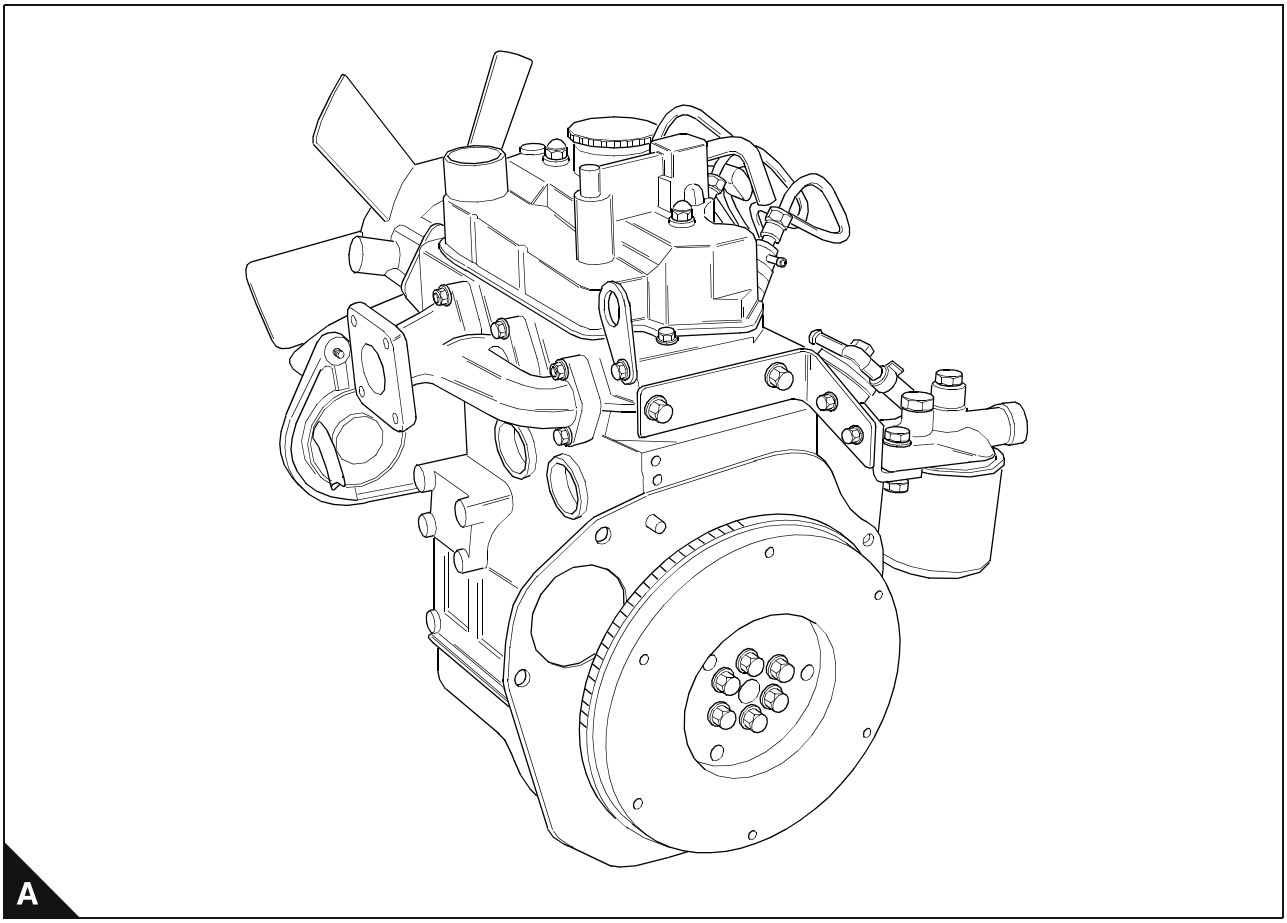
Individual engine serial number commencing with 000001 increasing numerically.

Code V Year of Manufacture

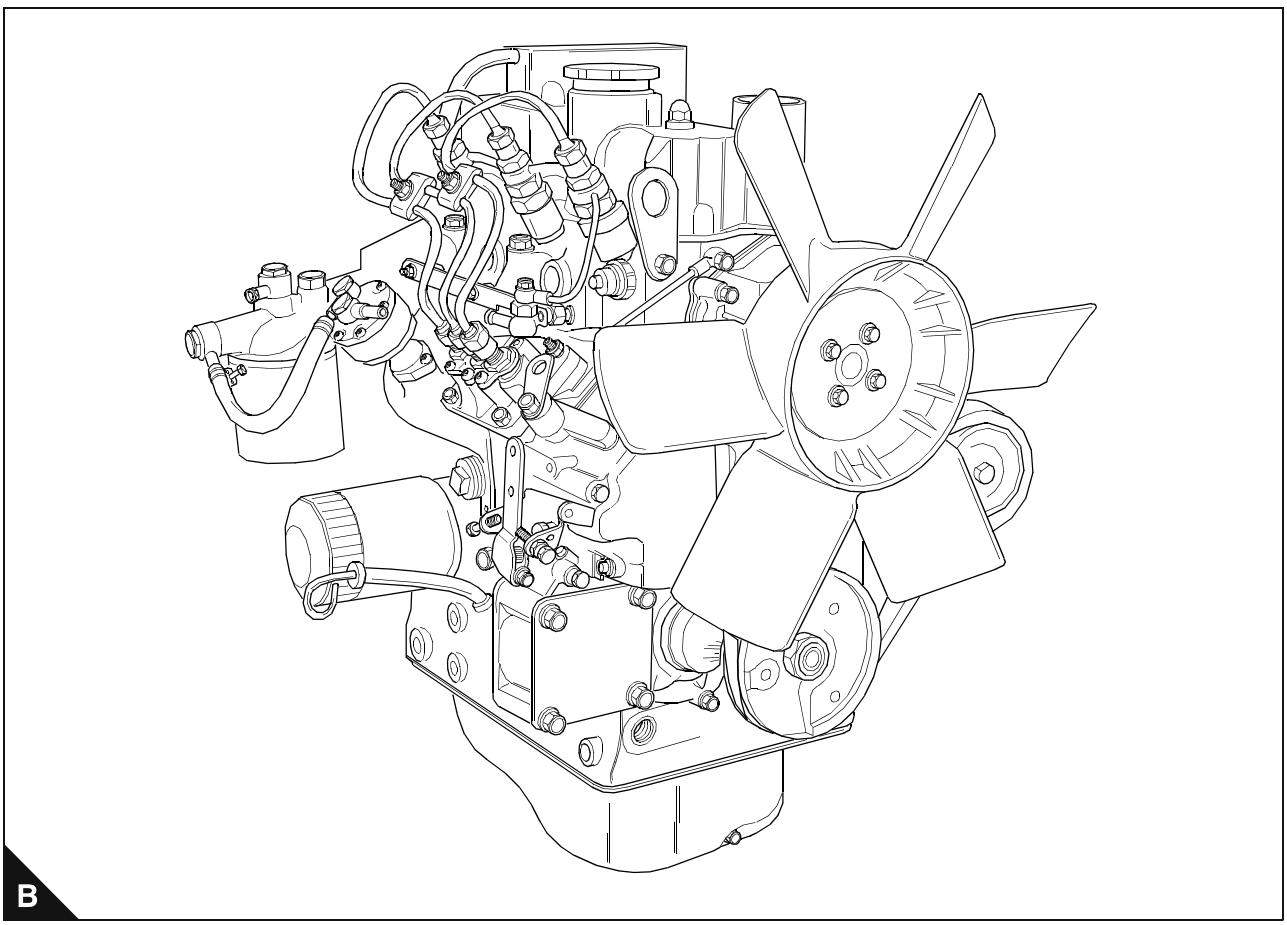
Code	Year	Code	Year	Code	Year	Code	Year	Code	Year
M	1985	Q/S	1988	W	1992	B	1996	F	2000
N	1986	T	1989	X	1993	C	1997	G	2001
O	not used	U	1990	Y	1994	D	1998	H	2002
P	1987	V	1991	A	1995	E	1999		



Engine views - 3 cylinder front and rear

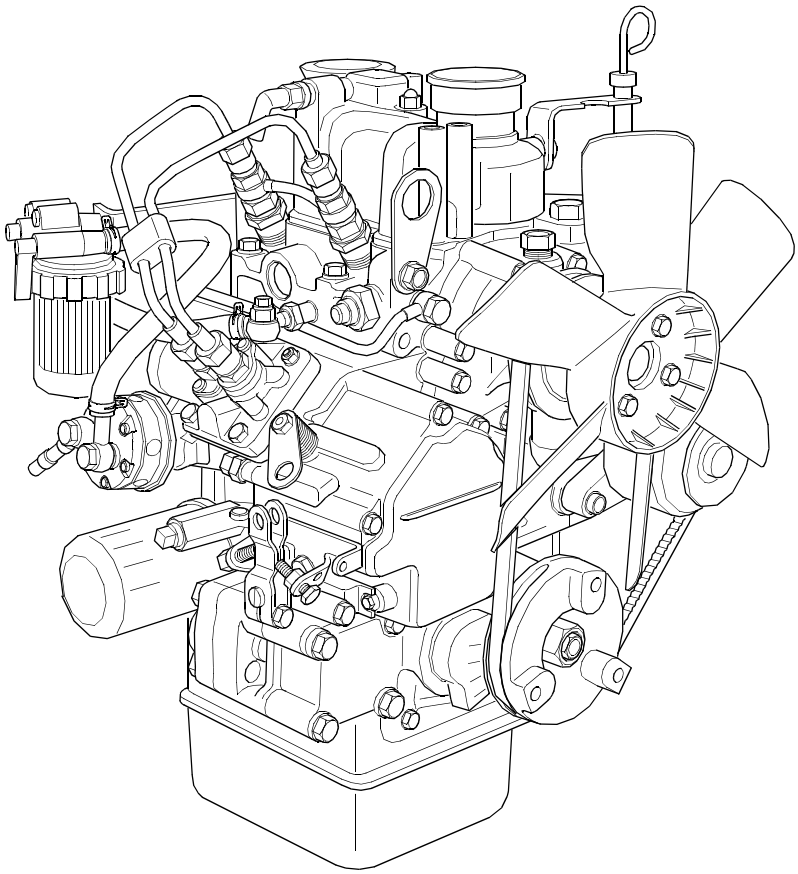


A

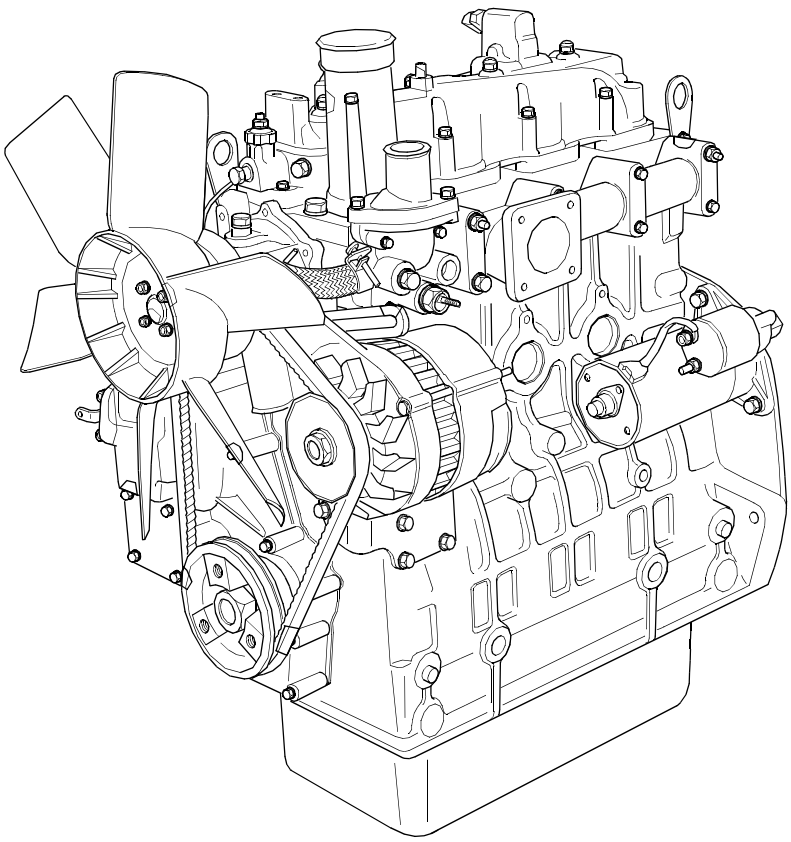


B

Engine views - 2 cylinder front and 4 cylinder front



A



B

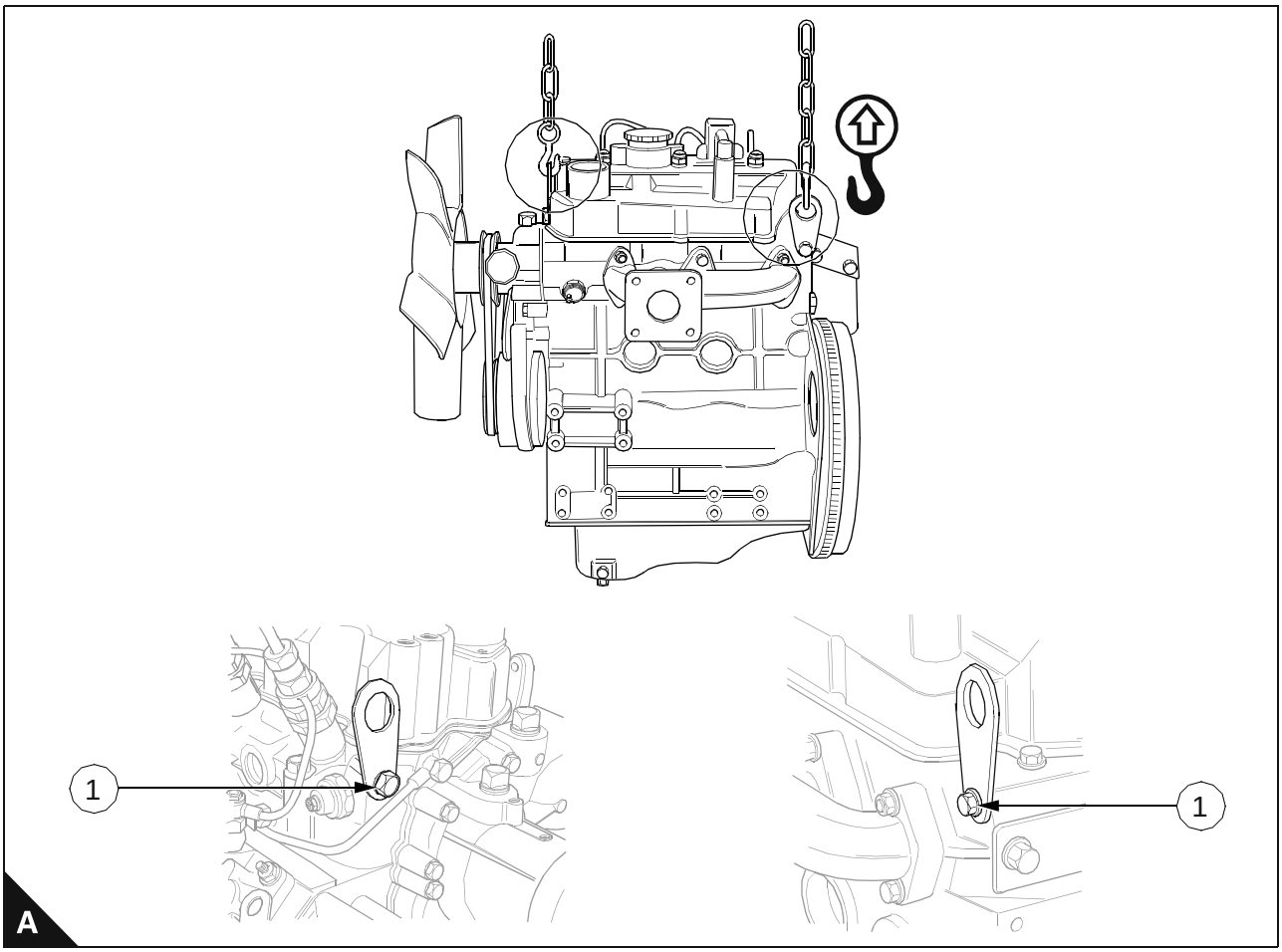
Engine lift equipment

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.*

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.

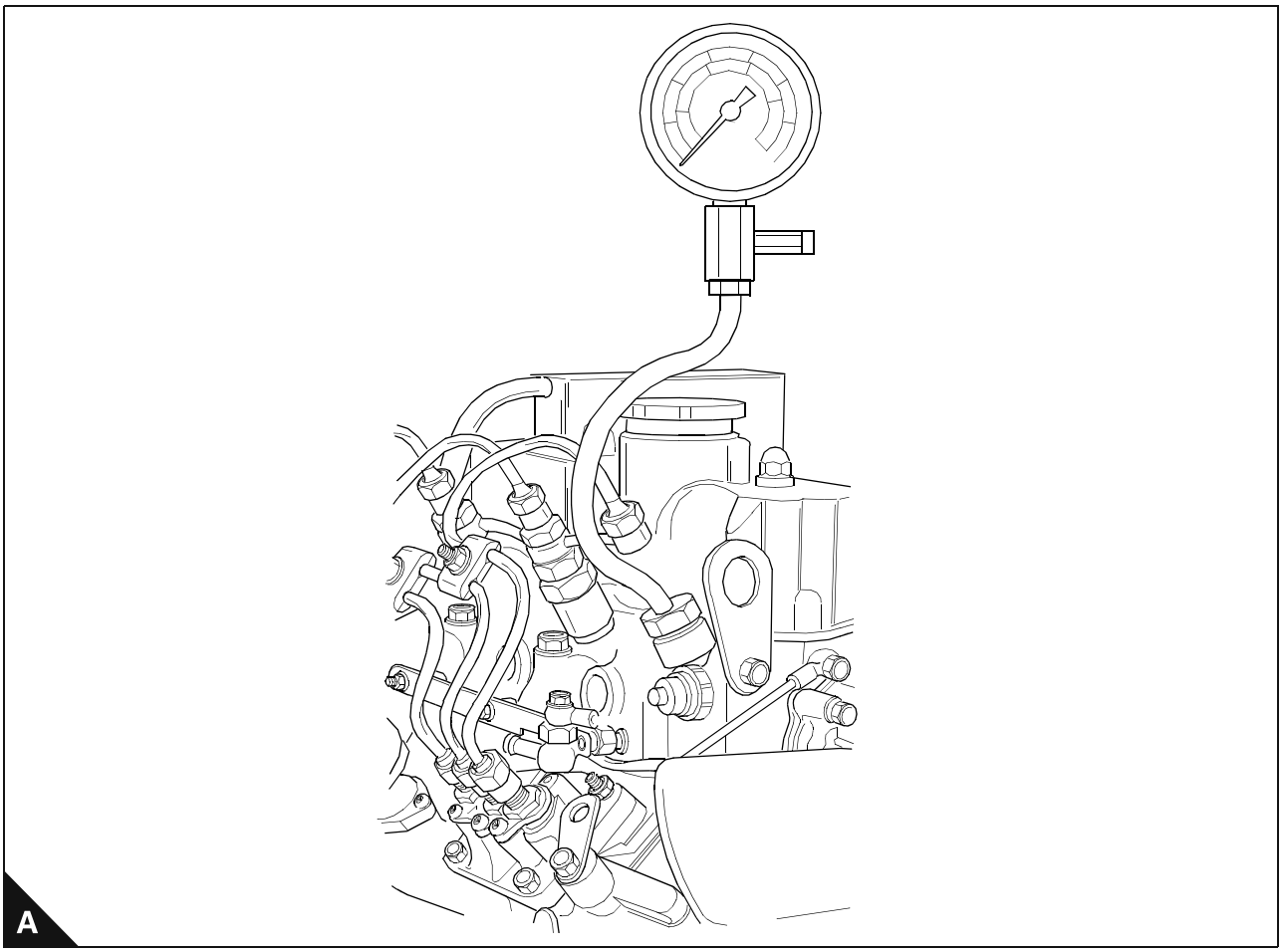
3 Remove the atomisers.

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

Note: .

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

6 Repeat for each cylinder.



A

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						

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 79.

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 0,5 mm (0.2 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 0,5 mm (0.2 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 0,5 mm (0.2 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

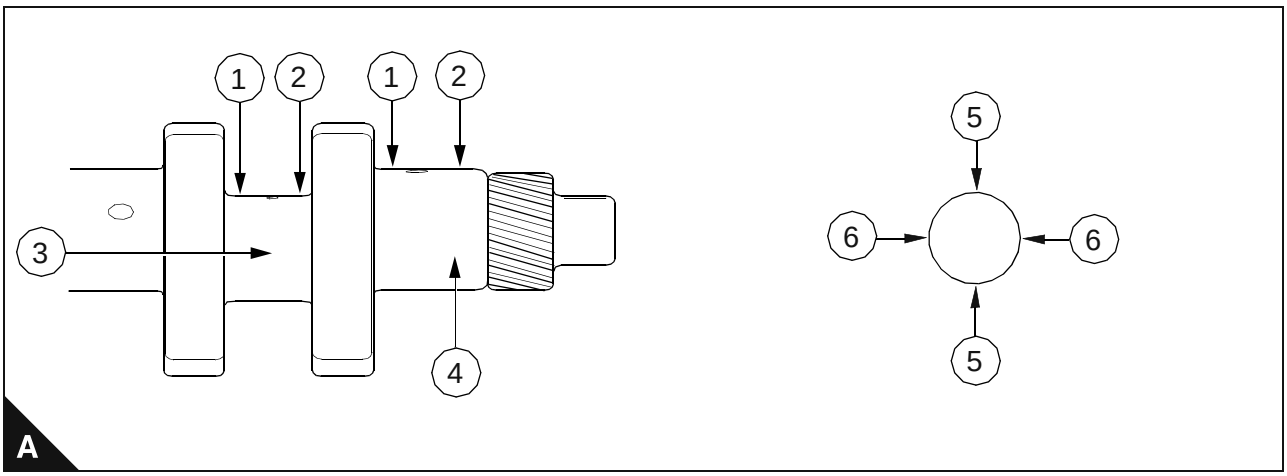
When grinding the crankshaft, work with the following specifications:

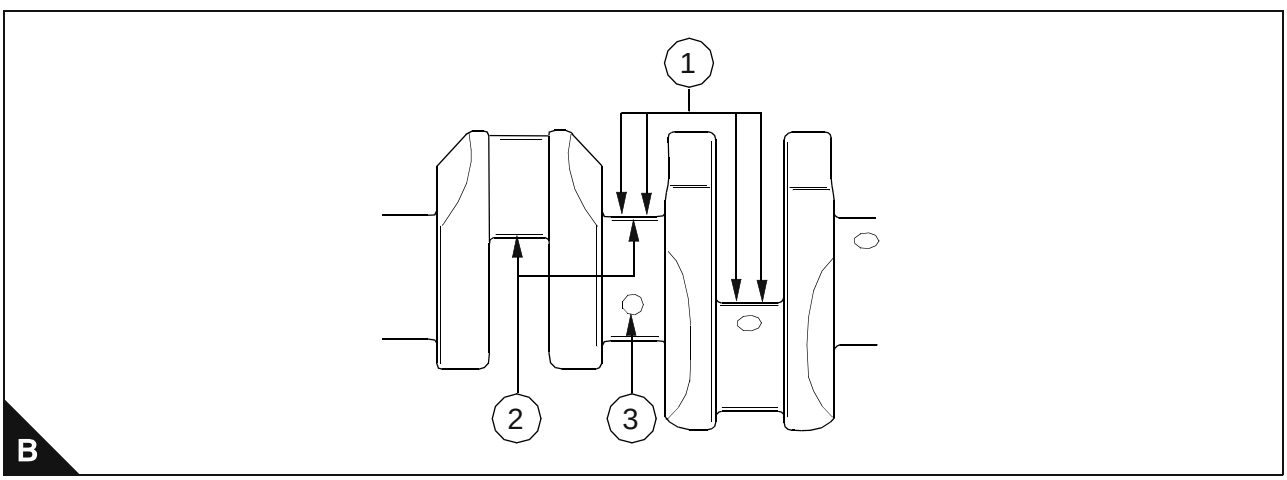
Radius at pin/journal (B1): 3 mm ± 0,2 mm (0.118 in ± 0.0078 in).

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.

Crankshaft 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).

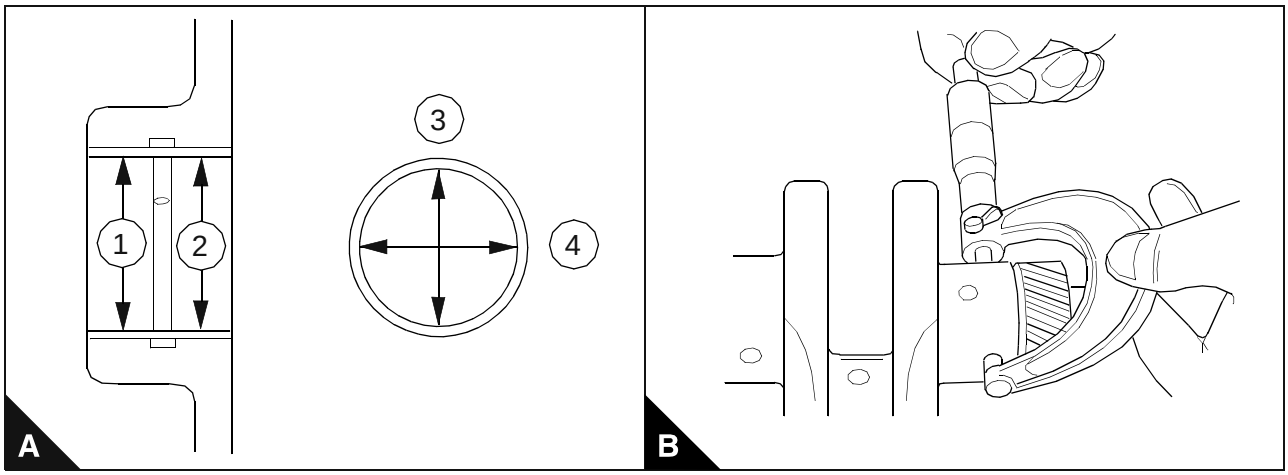
3 Measure inside diameters at positions (A1) and (A2). At each position measure in both directions (A3) and (A4) as shown. The oil clearance can be obtained by subtracting this value from the maximum crankshaft journal diameter.

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

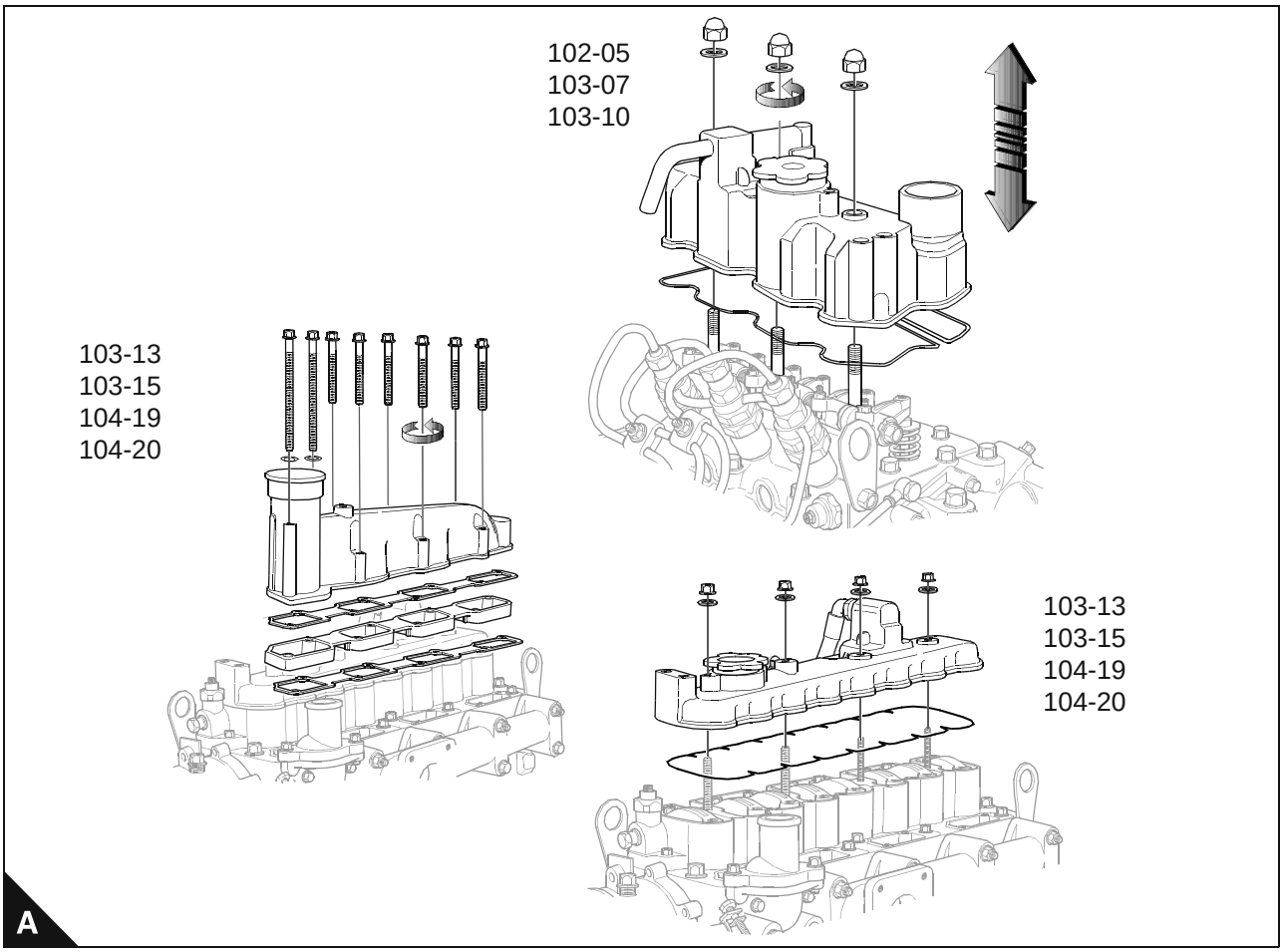
Rocker cover and inlet manifold

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.



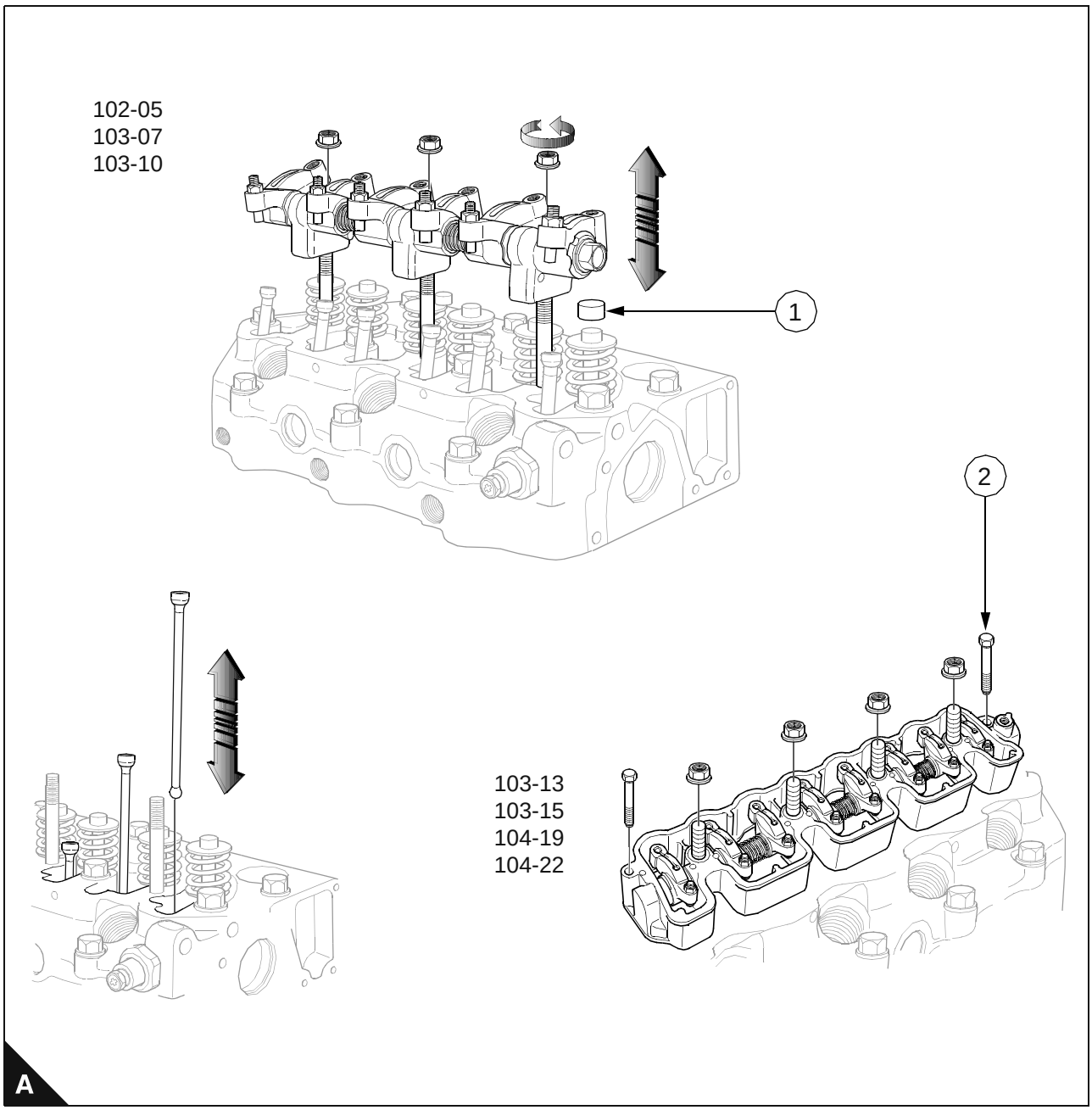
Rocker assembly

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.

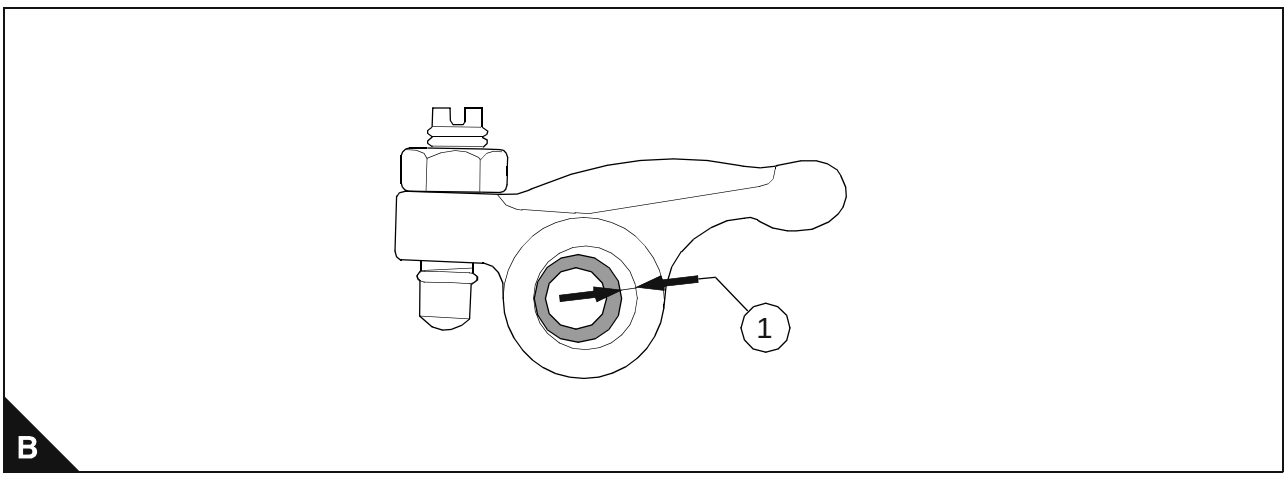


Rocker shaft (102-05, 103-07, 103-10)

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)

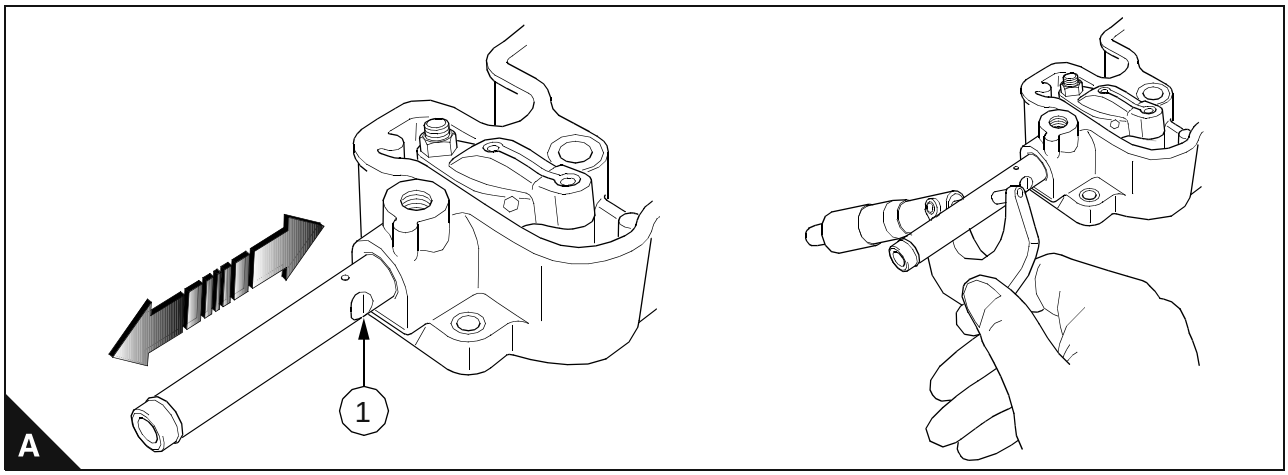
To dismantle, to inspect and to assemble **Operation 3-4**

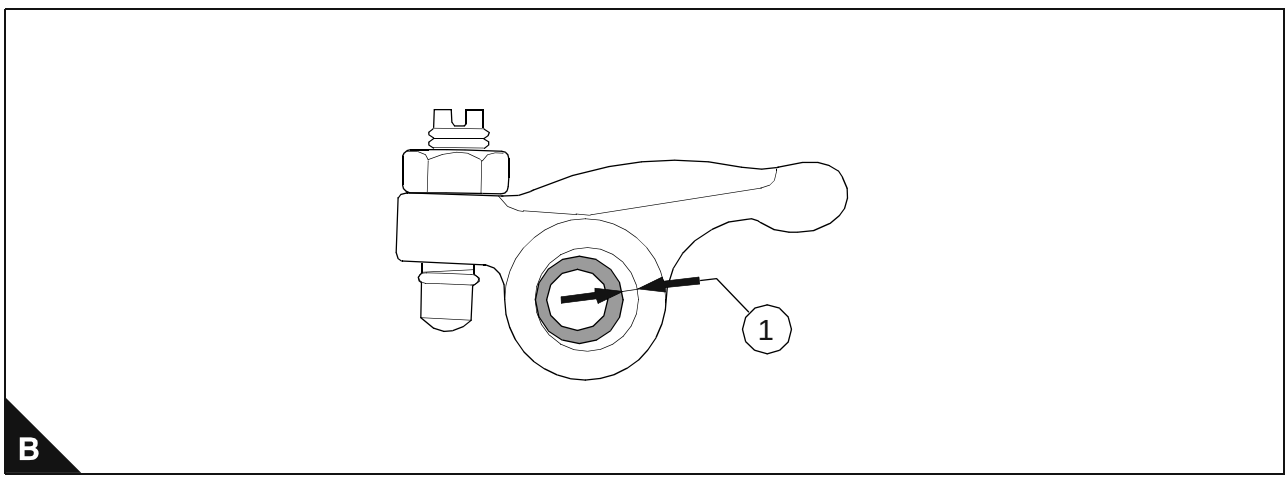
Special requirements

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).





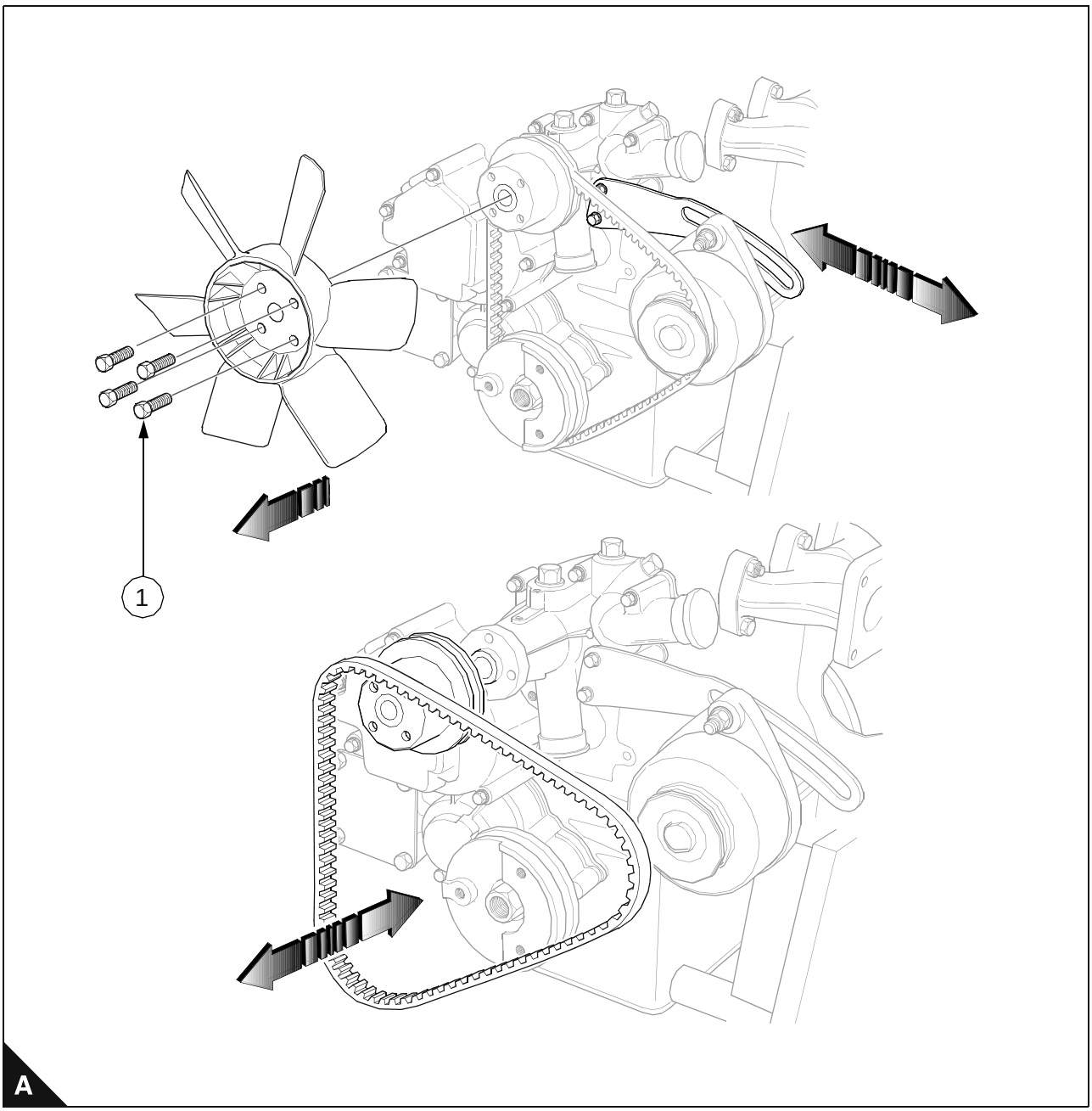
Fan and mounting

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.



Coolant pump

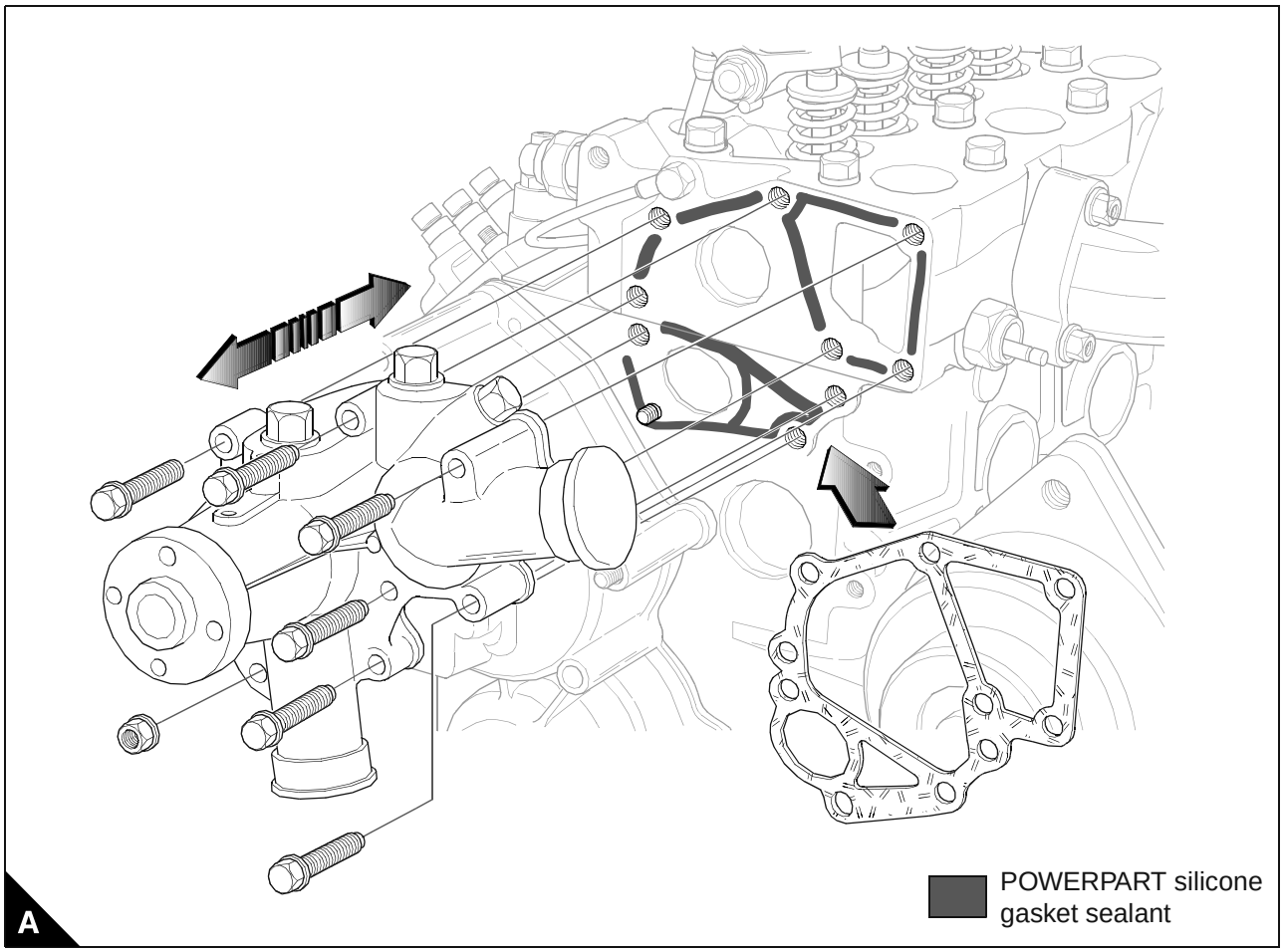
To remove and to fit **Operation 3-6**

Special requirements

POWERPART products	
Description	**Part number**
Silicone gasket sealant	21826046

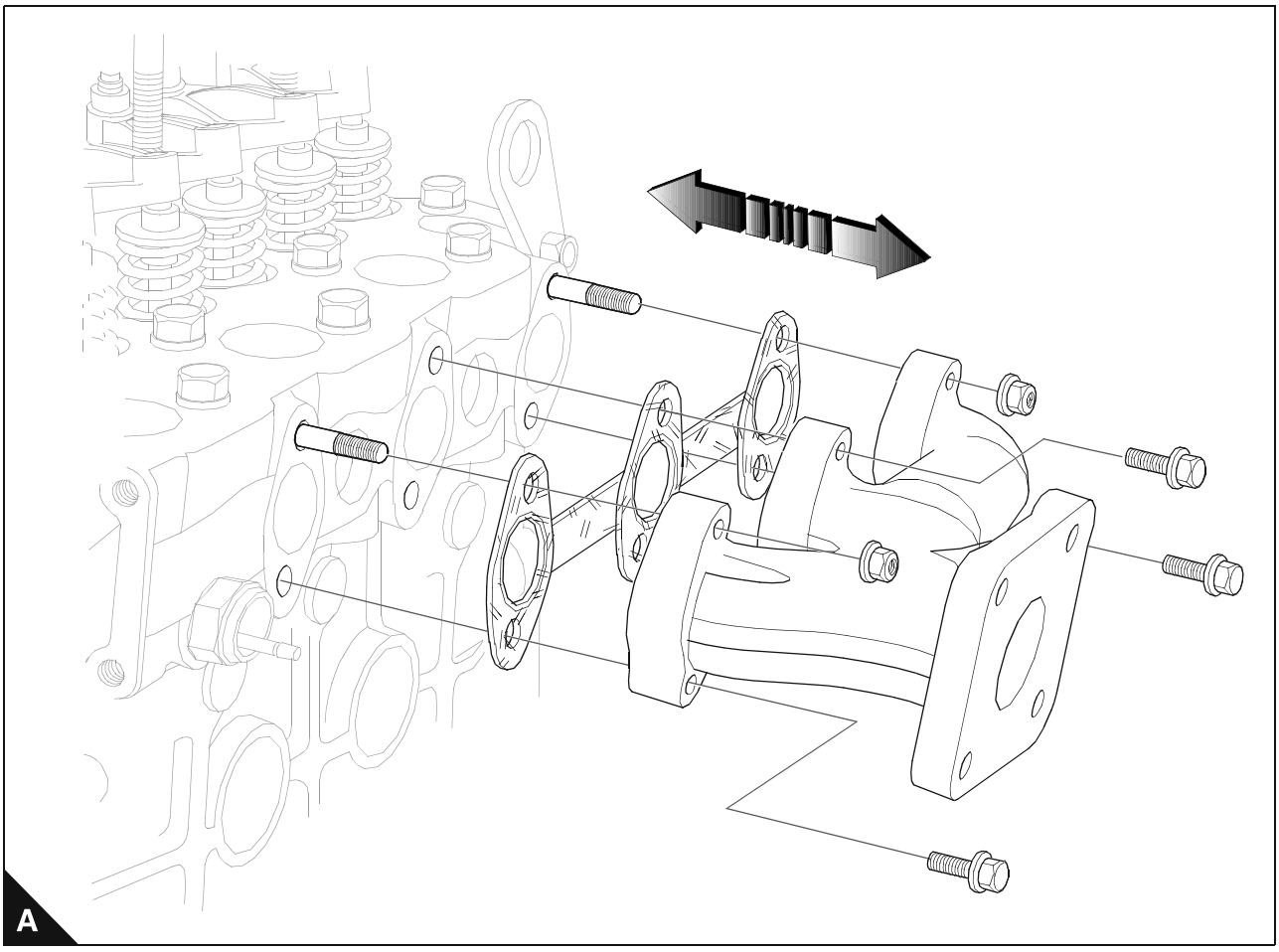
Notes:

- When fitting use Powerpart silicone gasket sealant for 102-05, 103-07 and 103-10 engines.
- The diagram below shows a typical coolant pump arrangement only.



Exhaust manifold and gasket

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



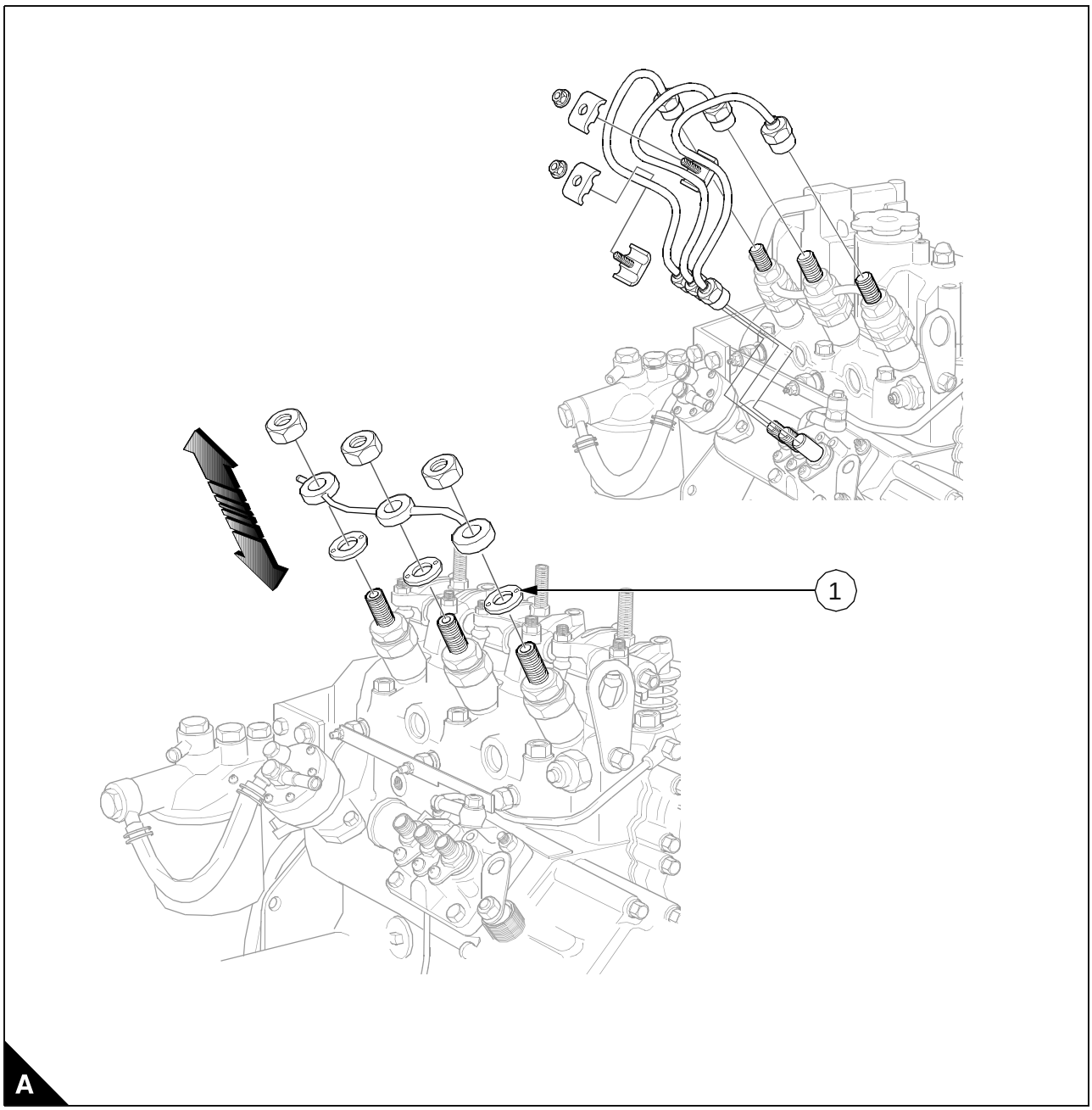
Fuel injection pipes / fuel return pipes

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

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

Note: Be aware of holes in washers (A1).



Oil pipes

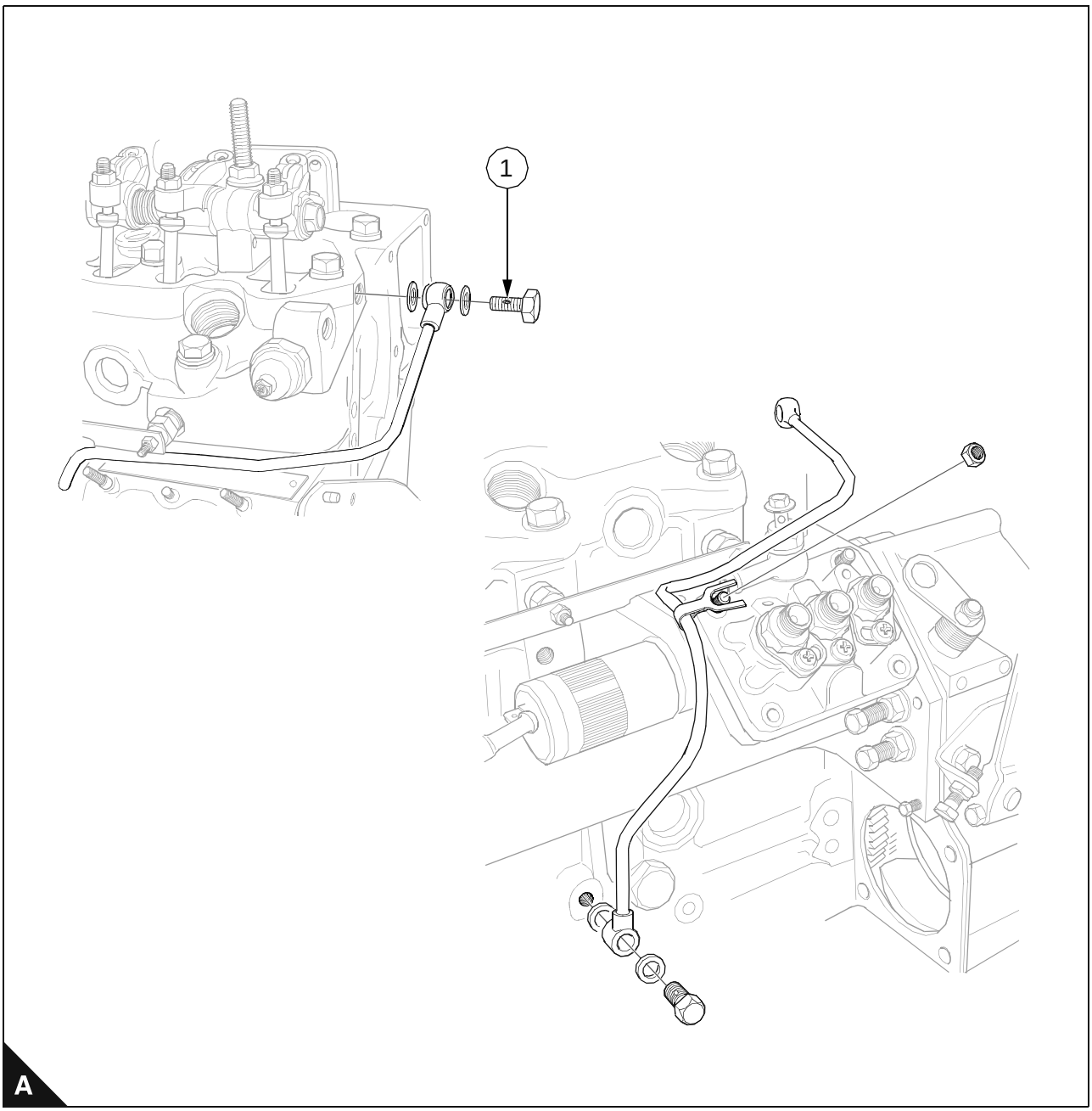
To remove and to fit **Operation 3-9**

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.



Atomisers

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

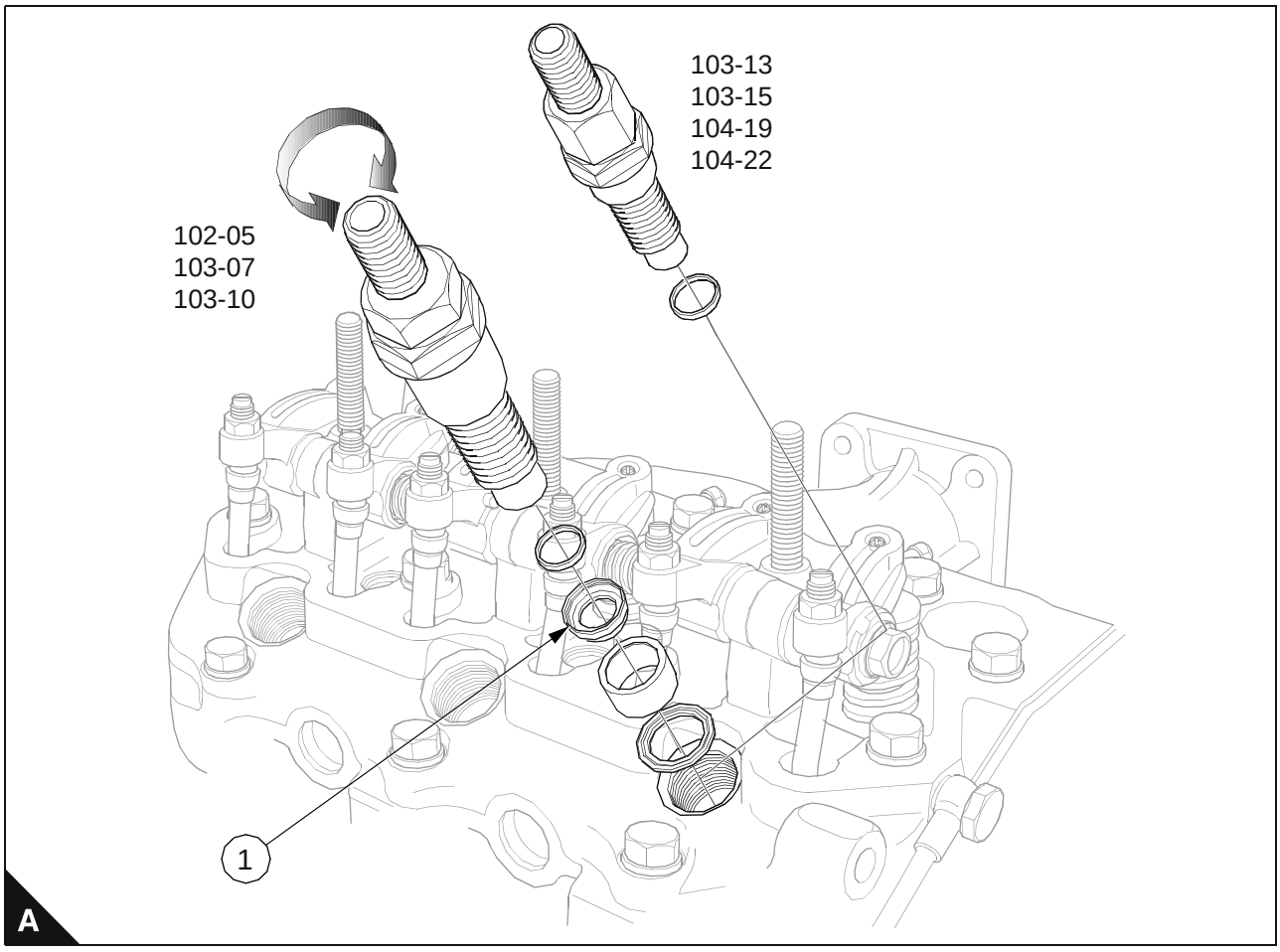
Special requirements

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.*

Note: Item (A1) is used on 103-10 engines only.



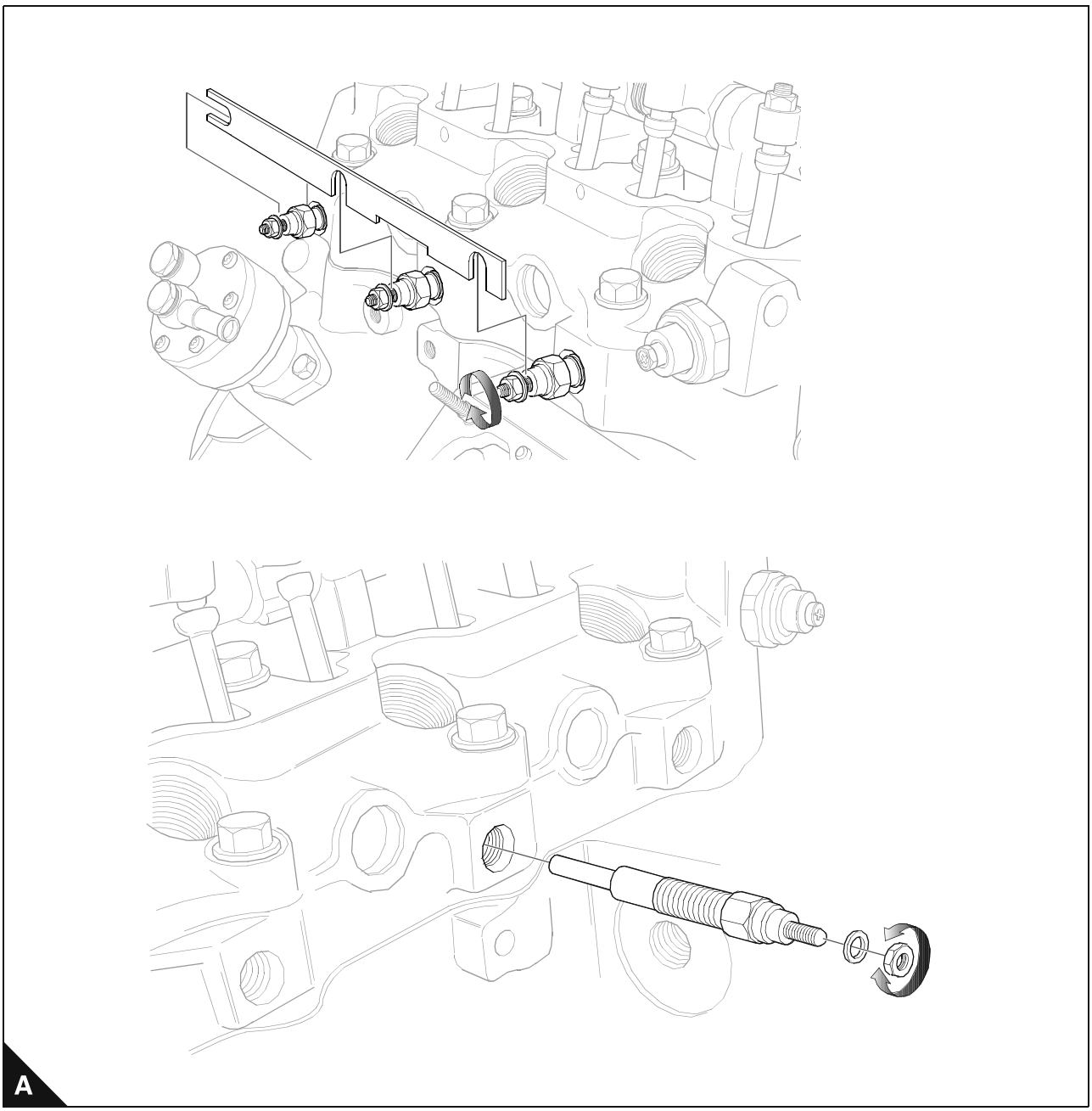
Busbar / glowplugs

To remove and to fit **Operation 3-11**

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.

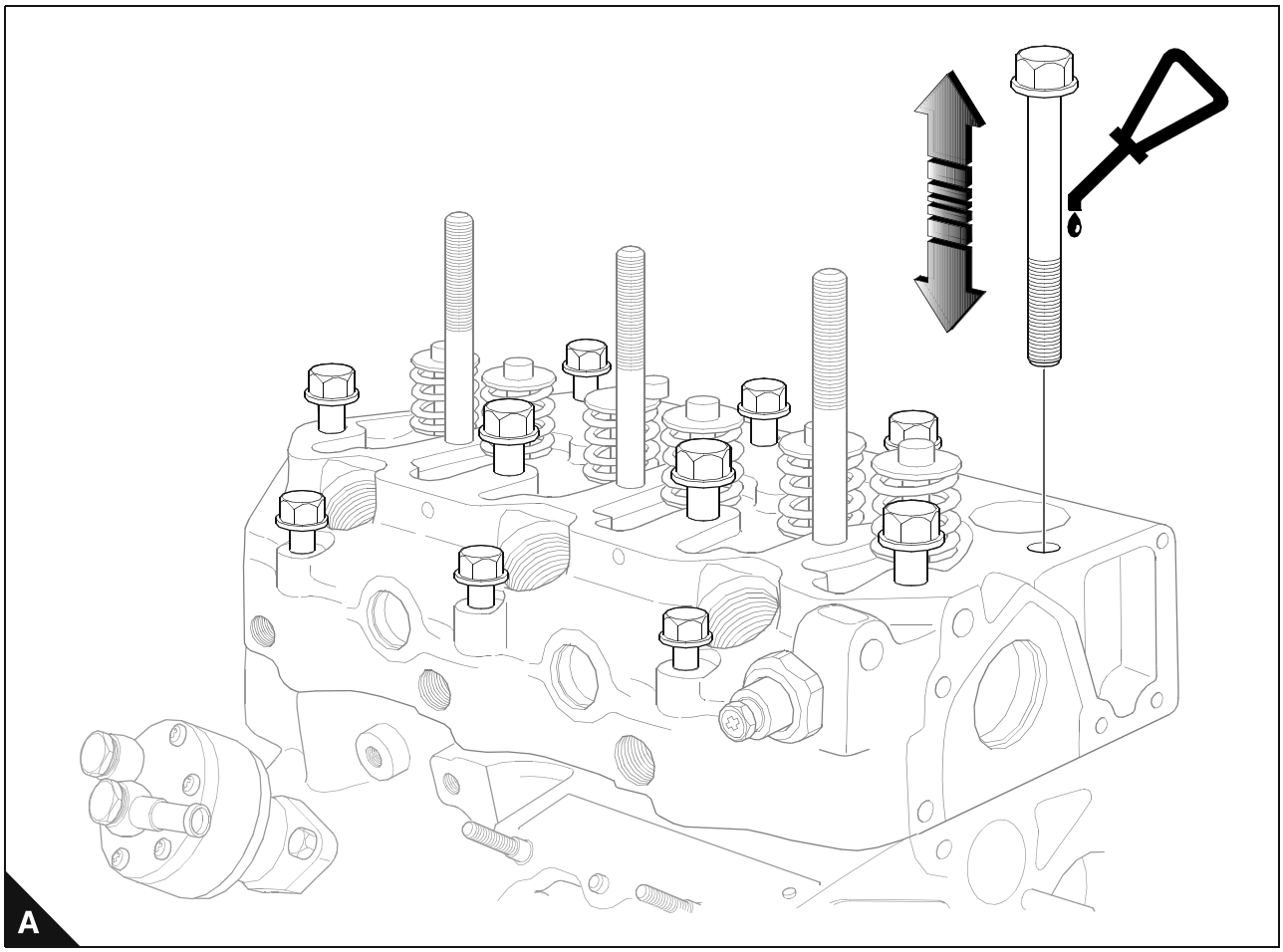


Cylinder head bolts

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

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

Note: Lubricate bolts with engine lubricating oil.

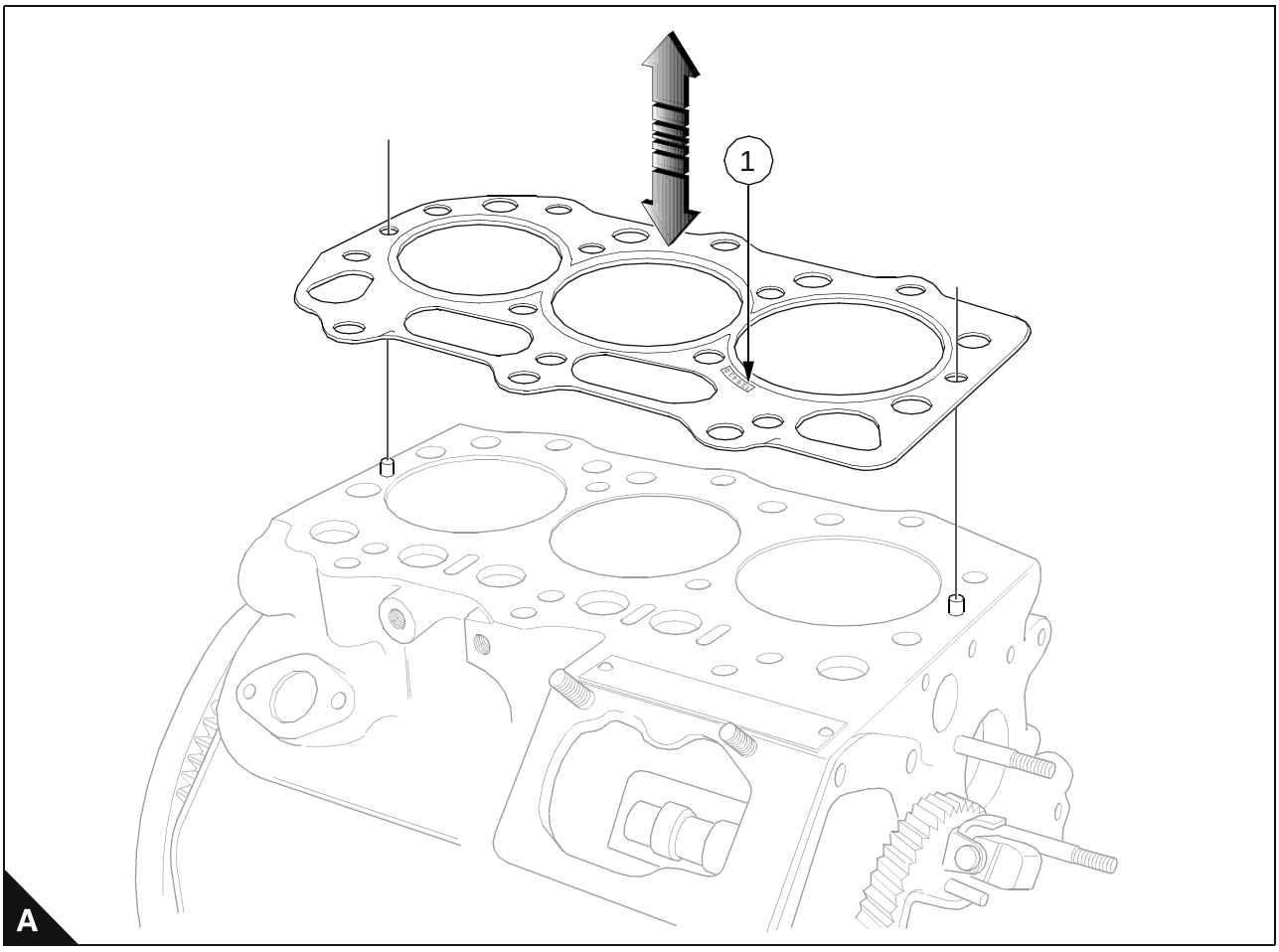


Cylinder head gasket

To remove and to fit **Operation 3-13**

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

Note: Always fit dry.



Head bolts - all variants

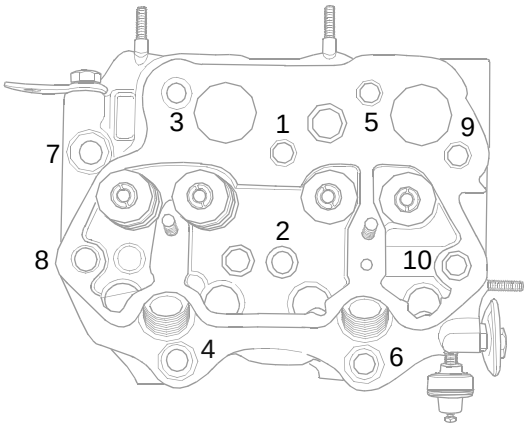
Tightening sequence **Operation 3-14**

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		

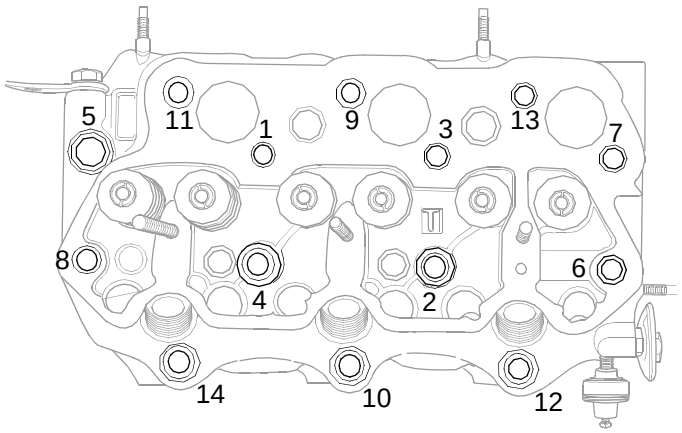
Note: All torques should be rechecked after tightening. Item (C1) is present on 104-19 models only.

102-05



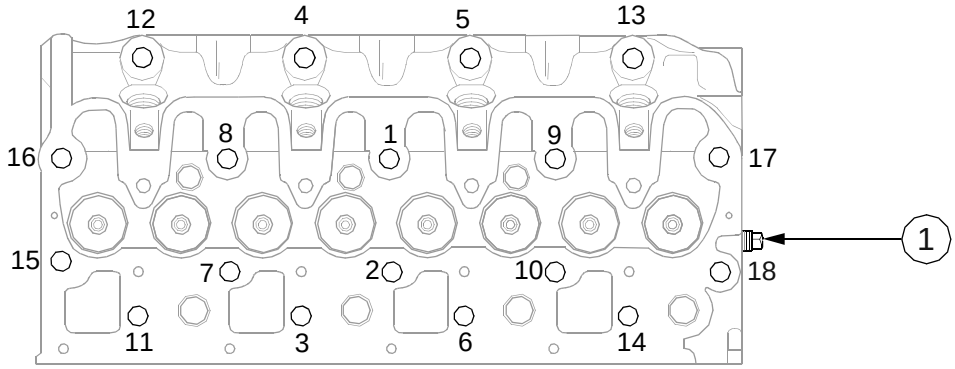
A

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



B

104-19
104-22



C

To remove and to fit — Operation 3-15

Special requirements

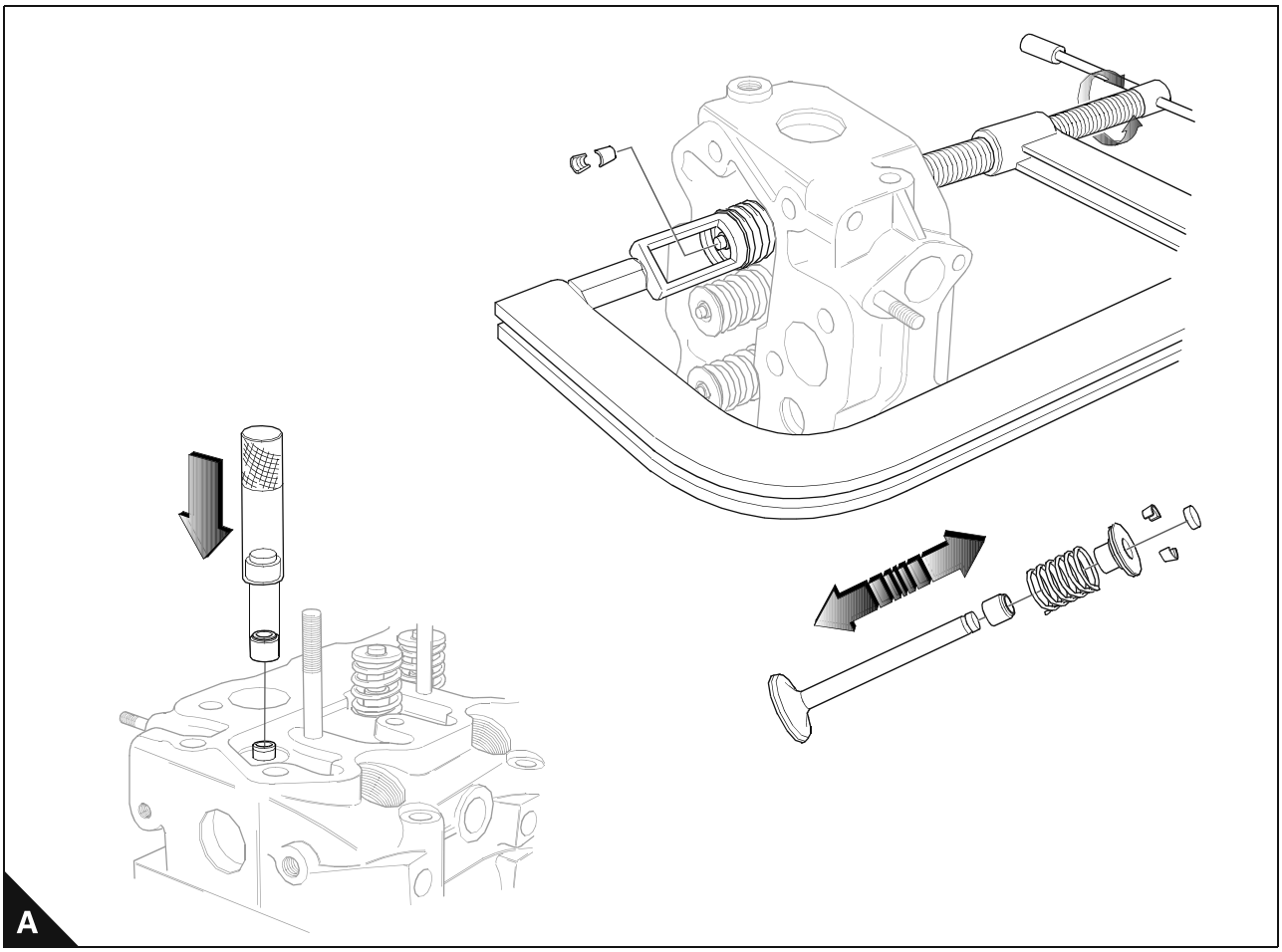
Special tools			
Description	**Part number**	**Description**	**Part number**
Valve spring remover	21825663	Stem seal replacer - 103-10, 103-13, 103-15, 104-19, 104-22	21825623
Stem seal replacer - 102-05, 103-07	21825622		

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**

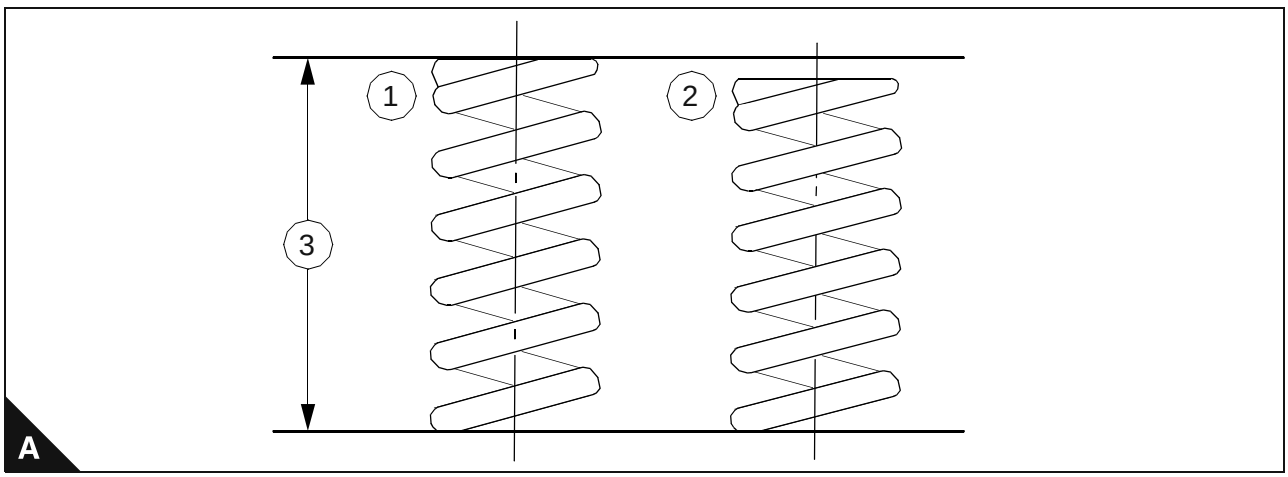
Special requirements

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.

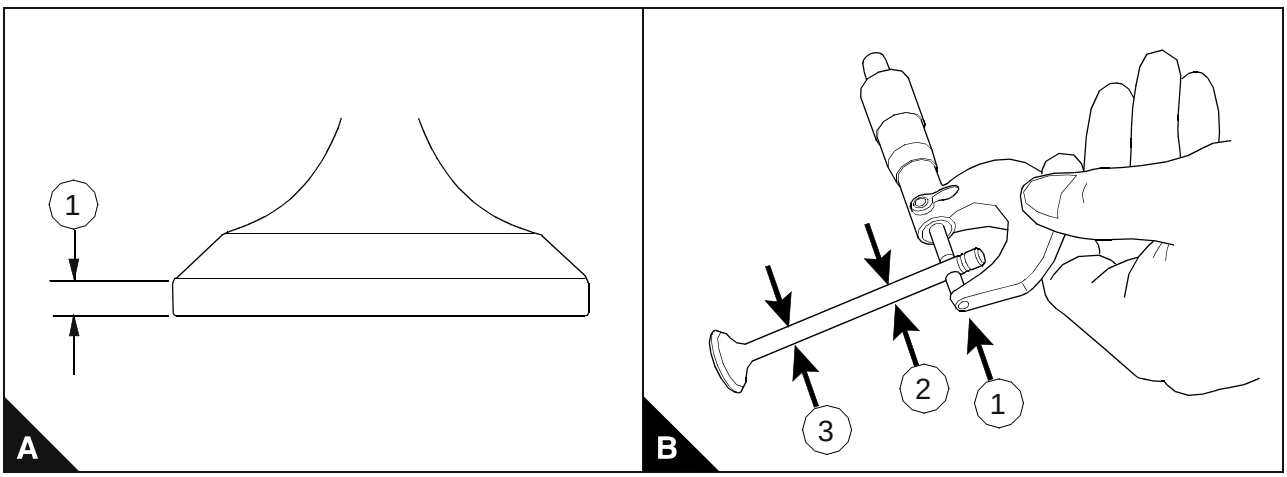
Check the valve stem diameters at positions (B1), (B2) and (B3) with a micrometer. If the diameter is less than the service limit, renew the valve.

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.

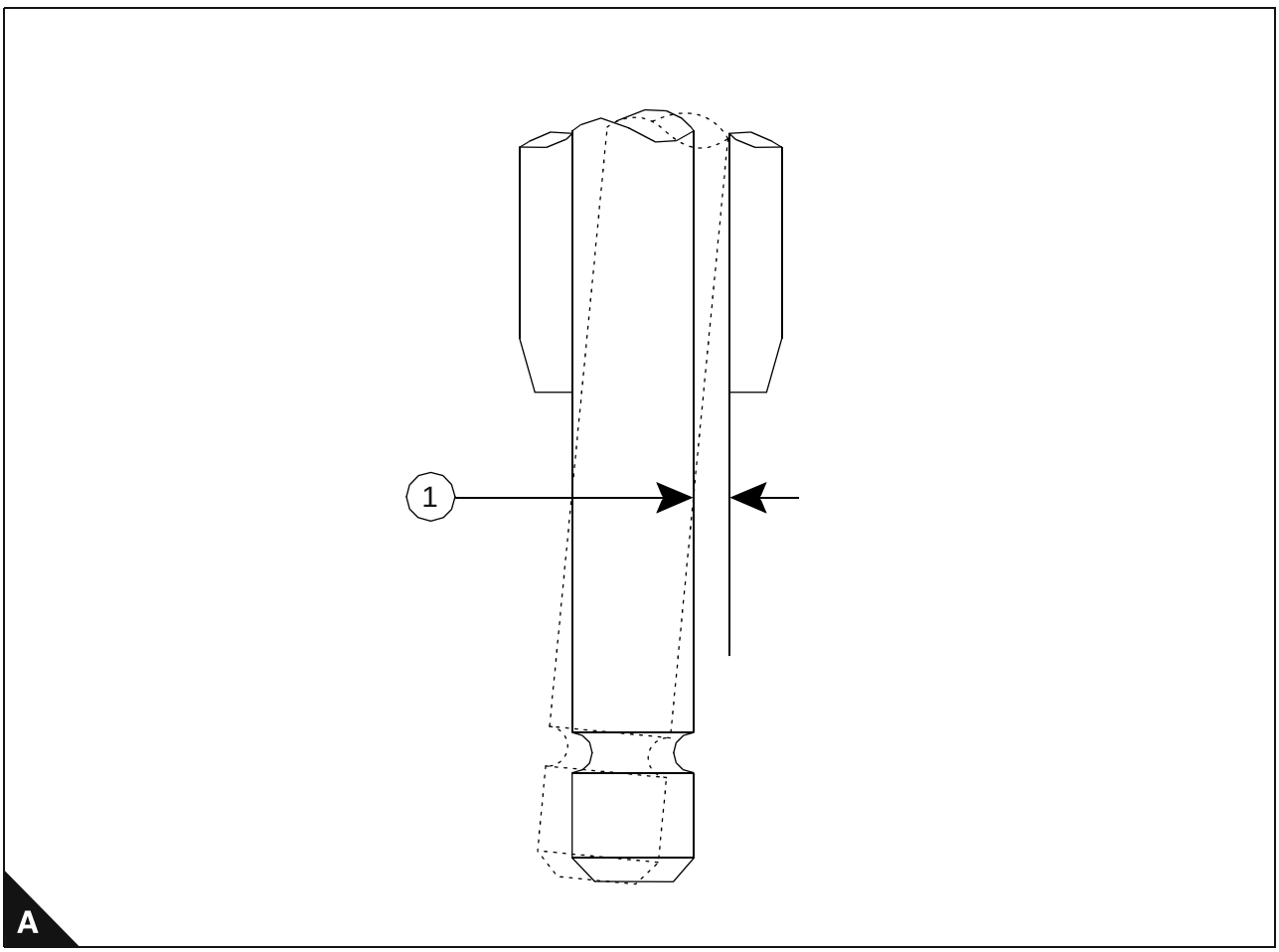
If the clearance exceeds the service limit, renew the cylinder head.

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

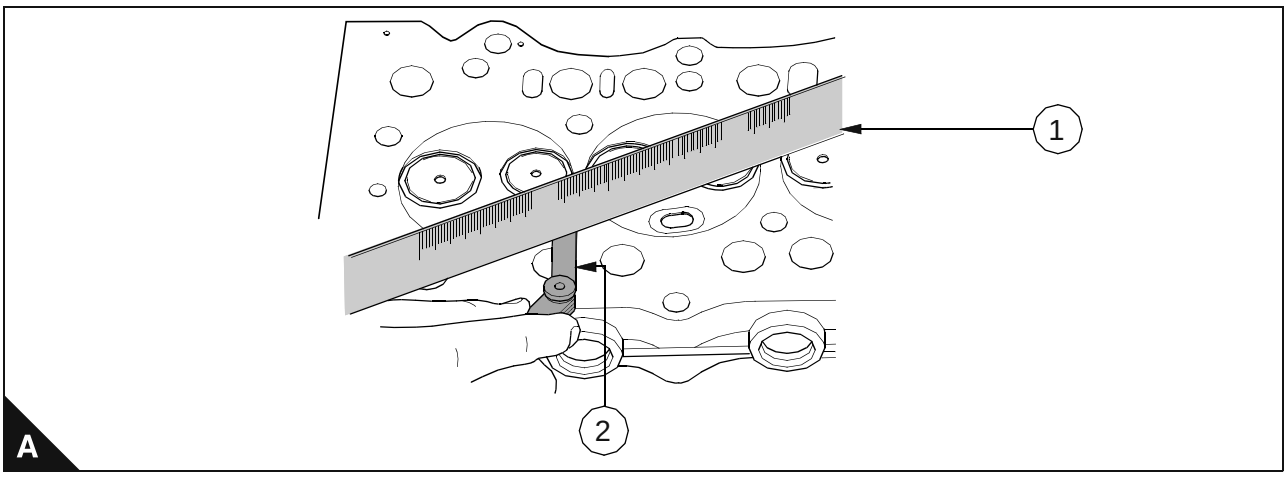


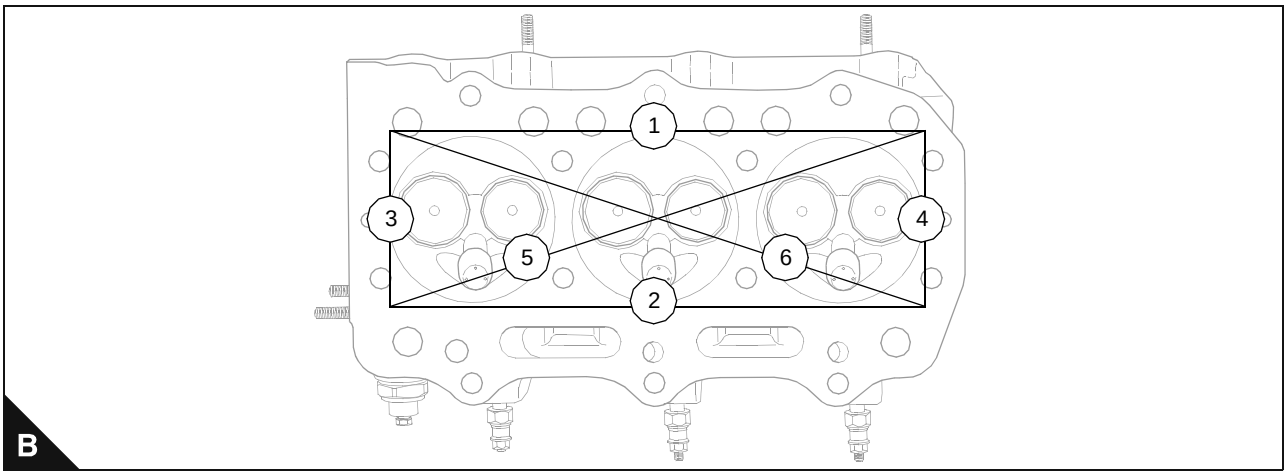
To check the distortion of the lower face — Operation 3-19

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.

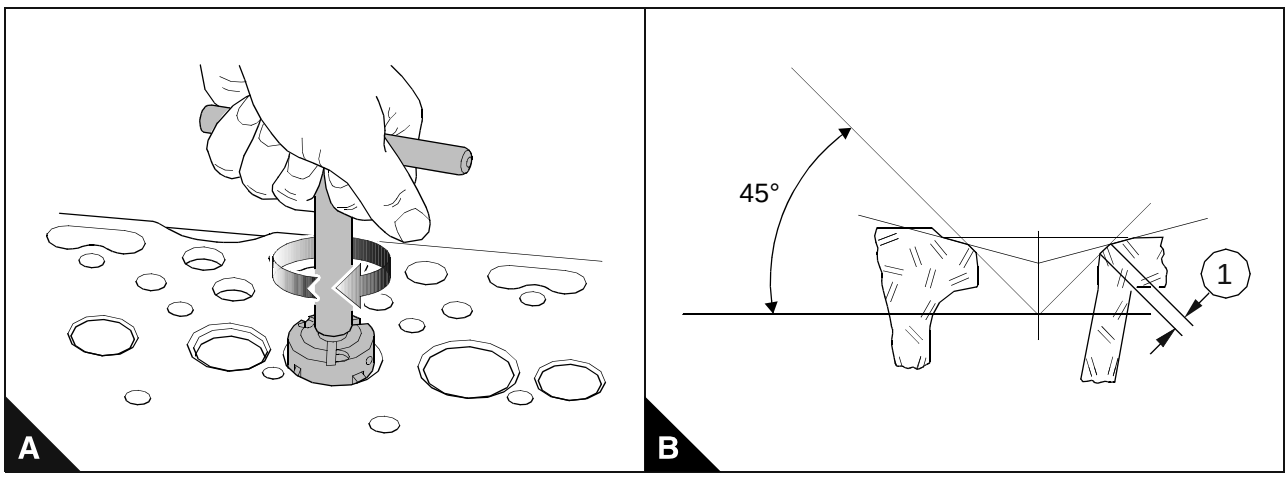
Using a seat cutter of 45° correct the seat.

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



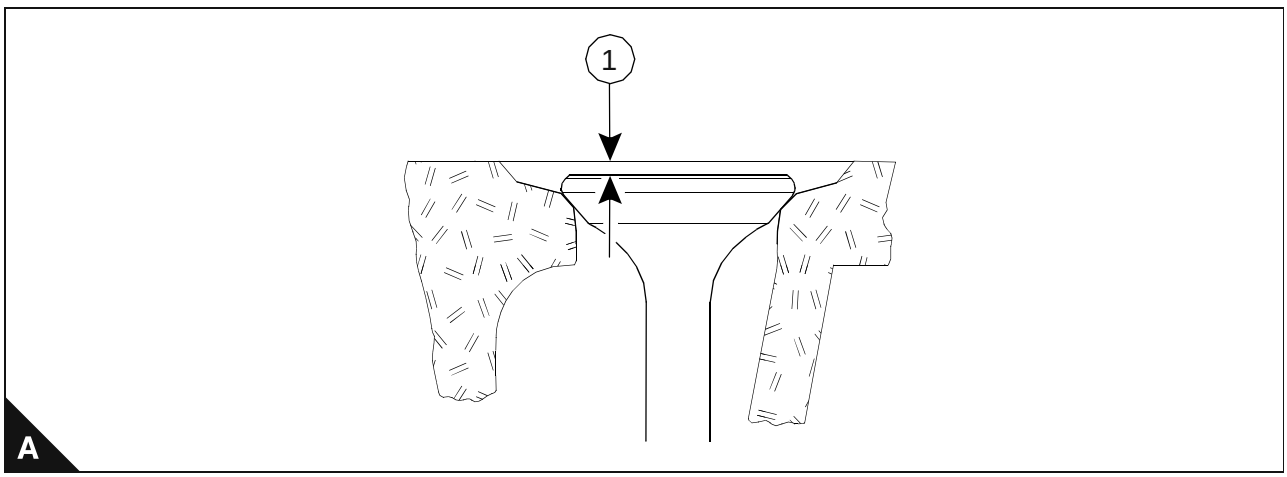
Valve depth

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.

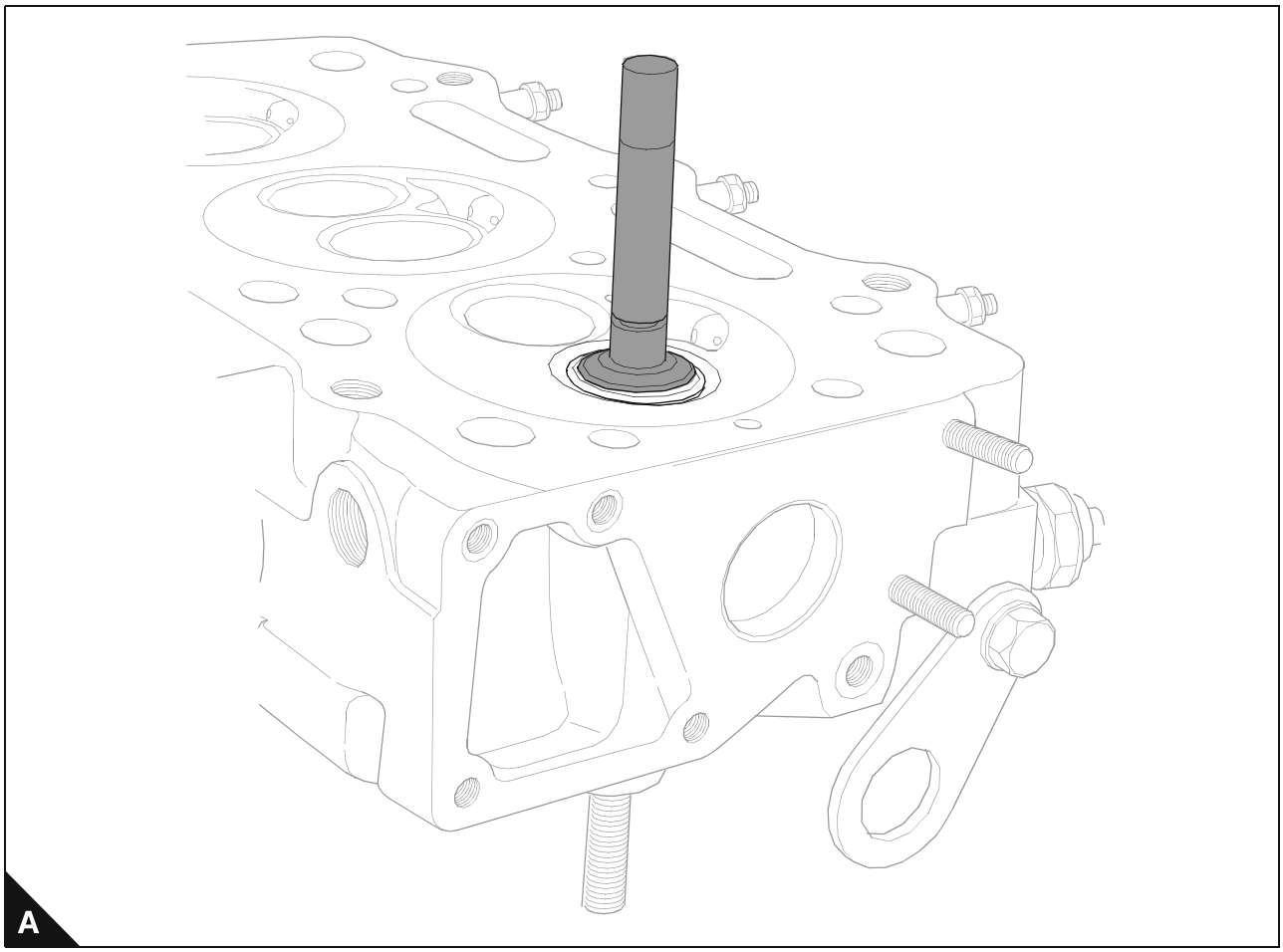


Valve seat contact face

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**

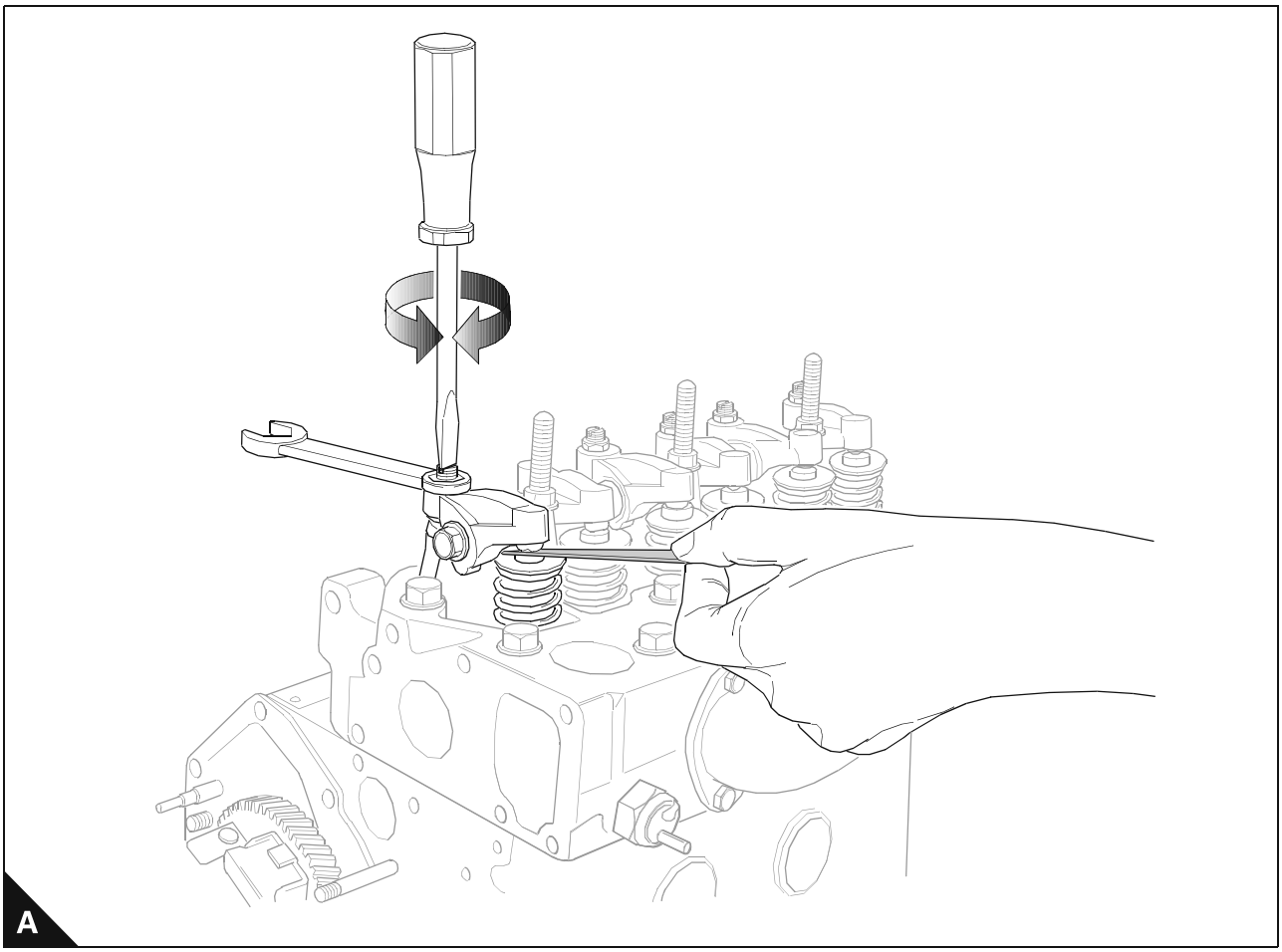
The valve sequence is viewed from the front of the engine.

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**

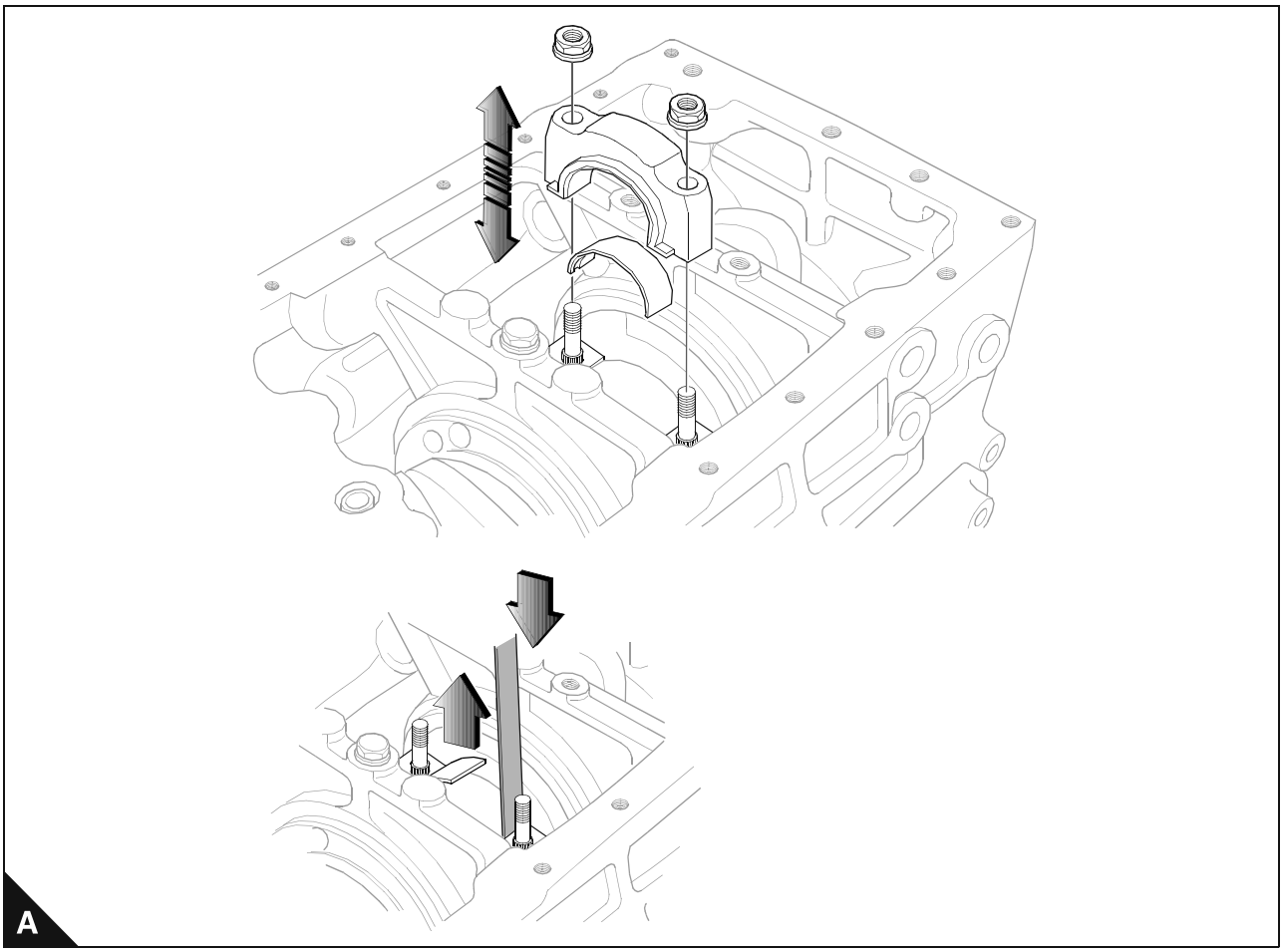
Special requirements

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.

Note: Identify each rod/piston/cylinder pair on disassembly.

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

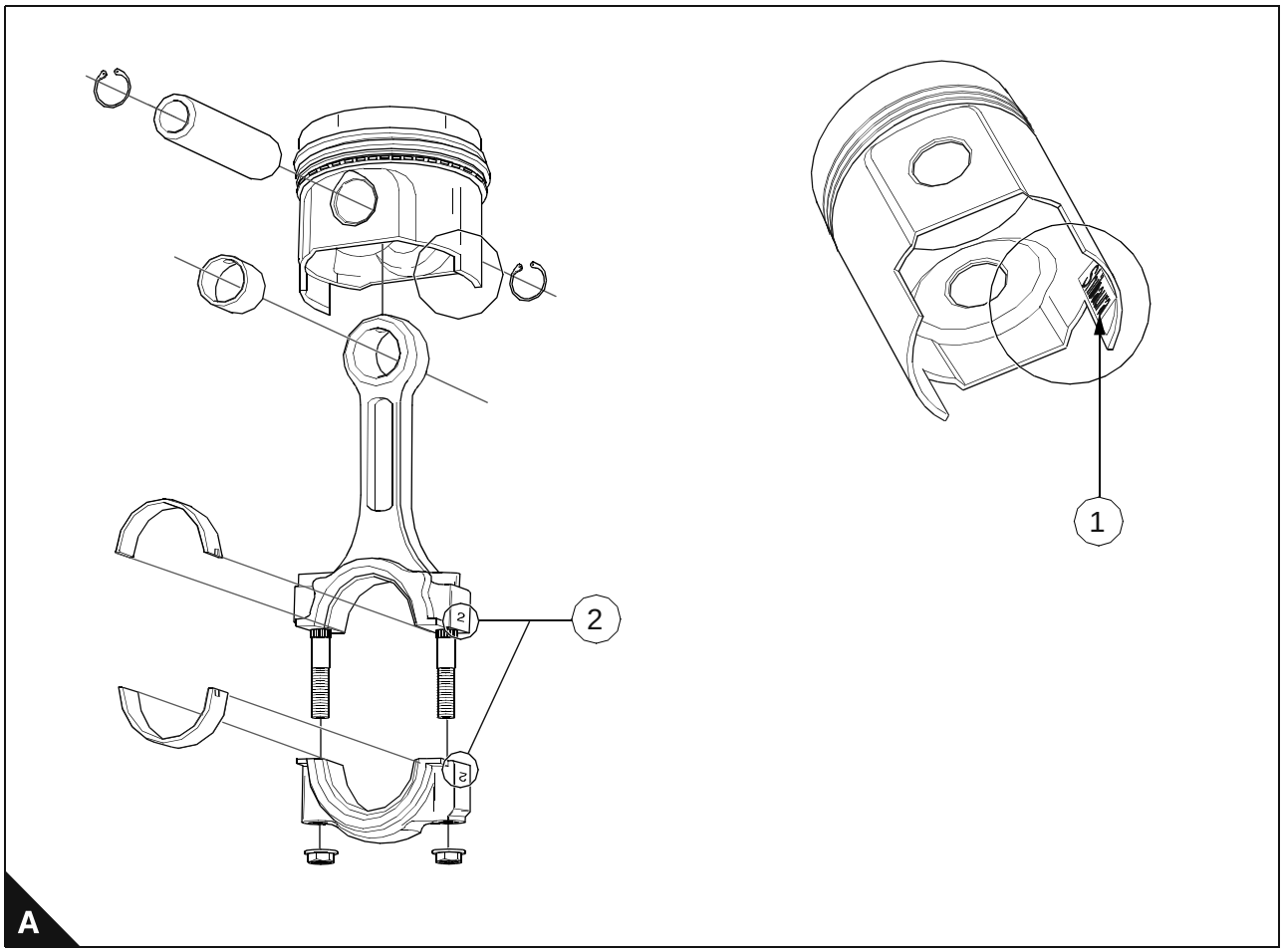


Piston and connecting rod

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

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

Align numbers to match (A2).



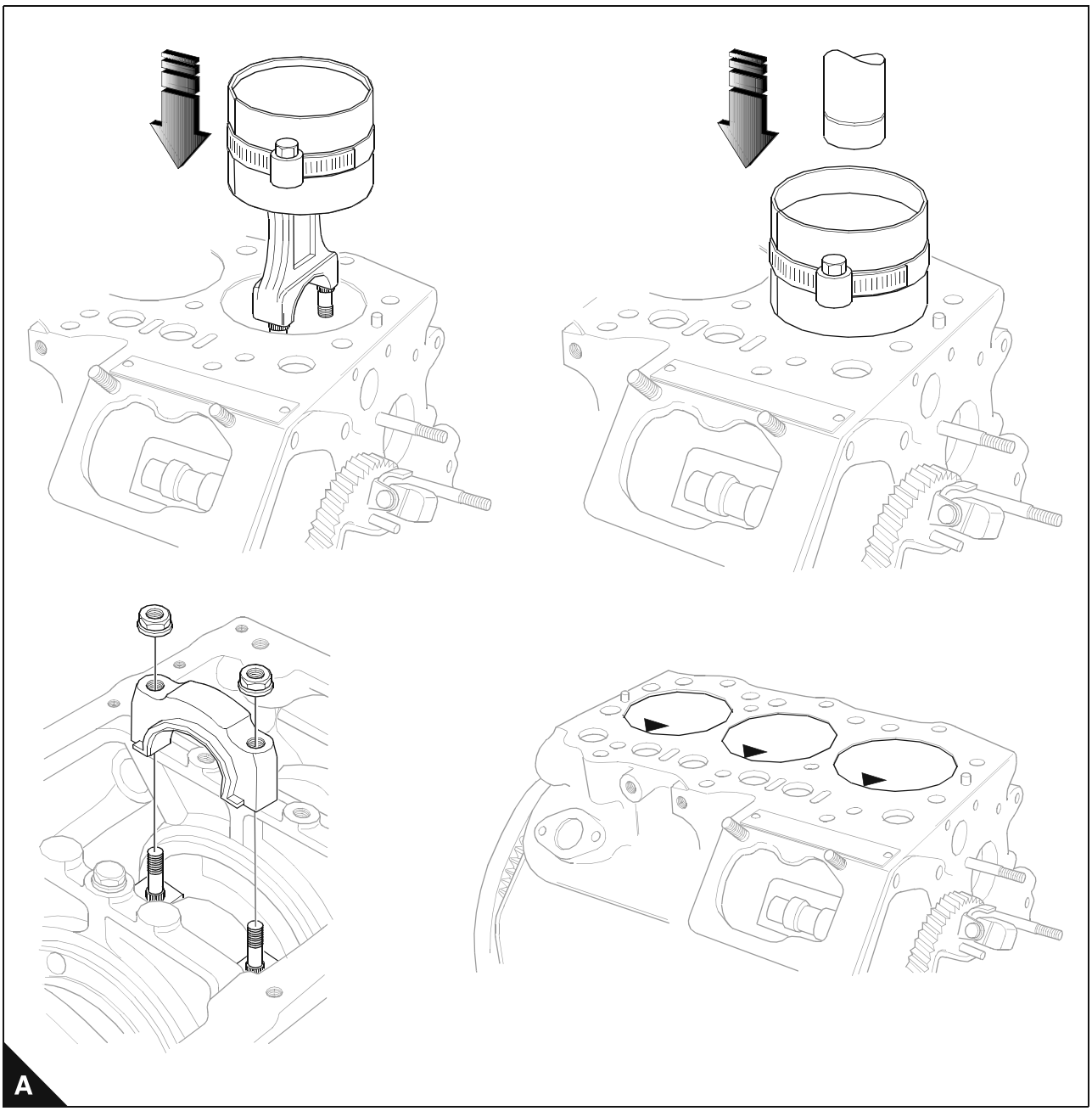
To fit **Operation 4-3**

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.

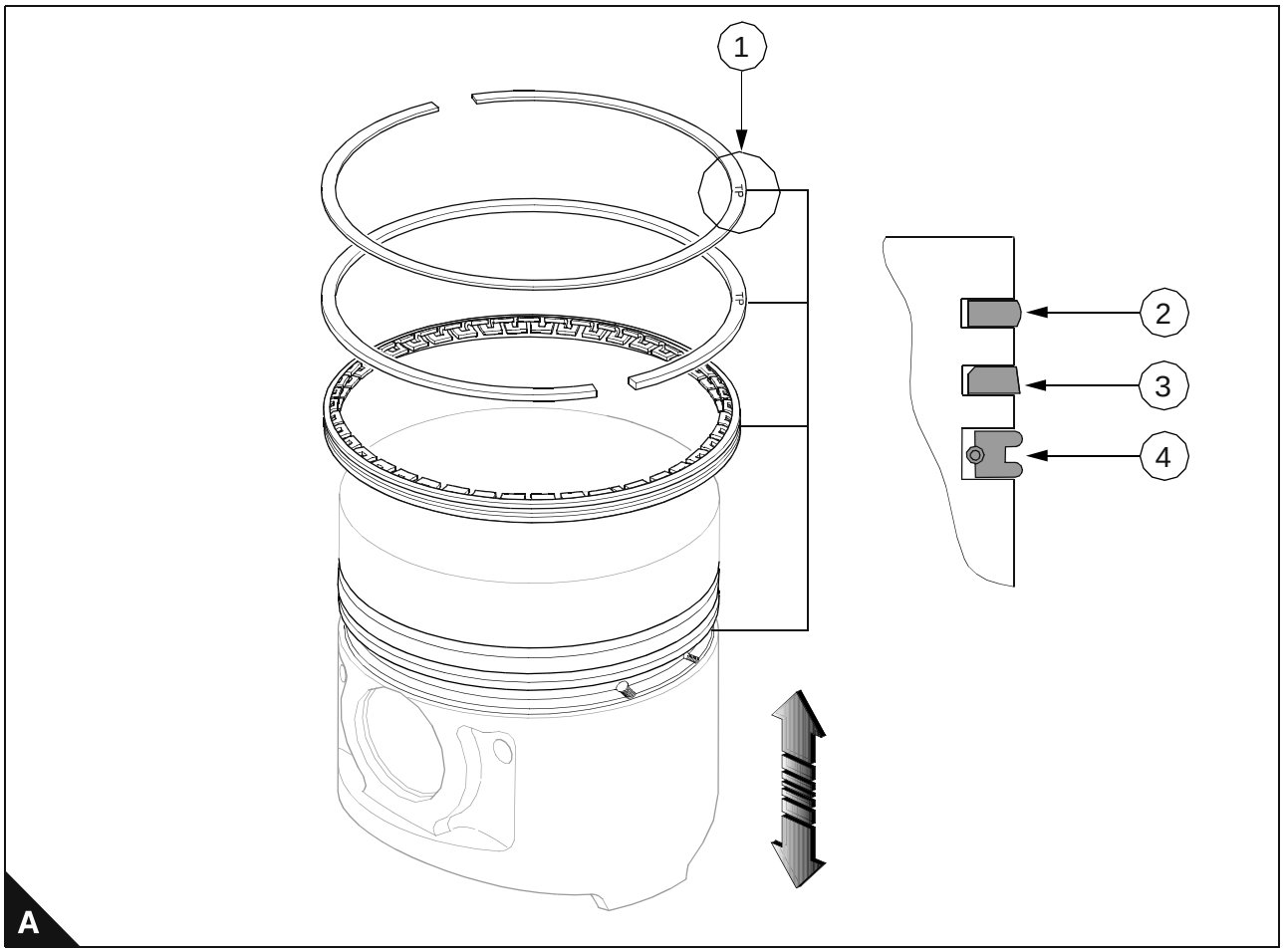


Piston and piston ring

To inspect **Operation 4-4**

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

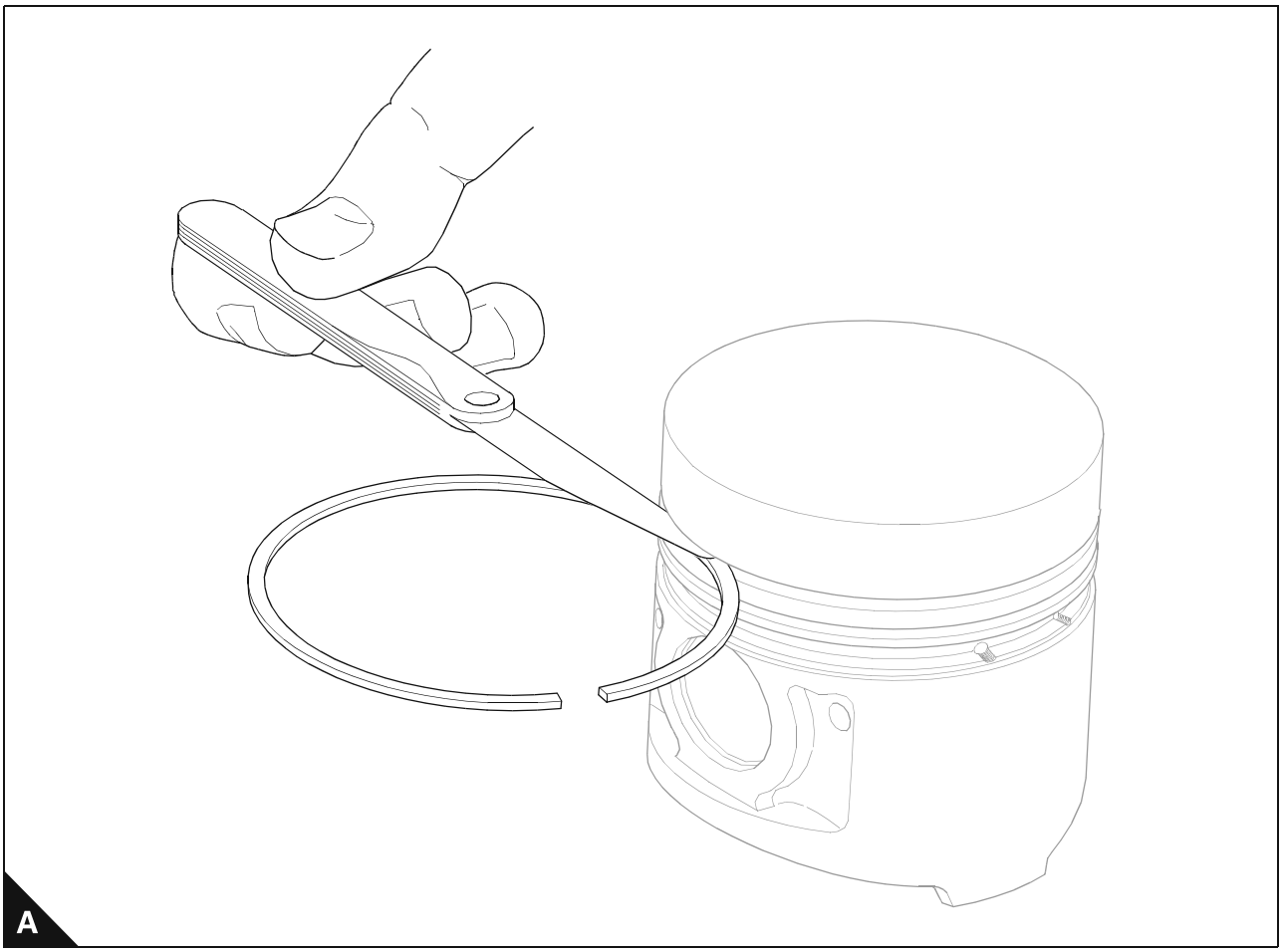
The piston profile shows the No.1 ring (A2), No.2 ring (A3) and the oil scraper ring (A4).



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)



A

Piston ring and block

To inspect **Operation 4-6**

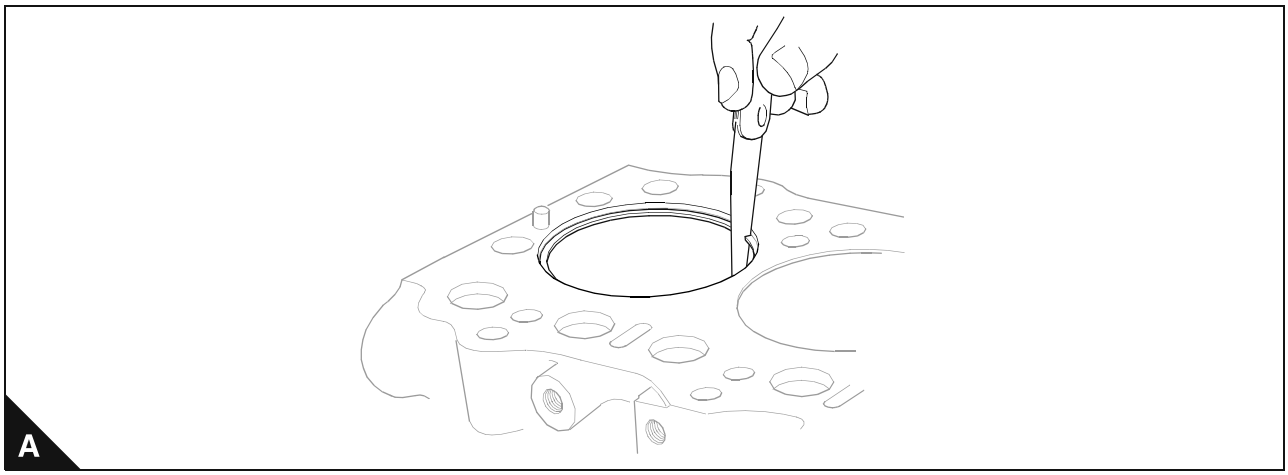
Note: If the piston ring is worn or damaged, renew it.

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)



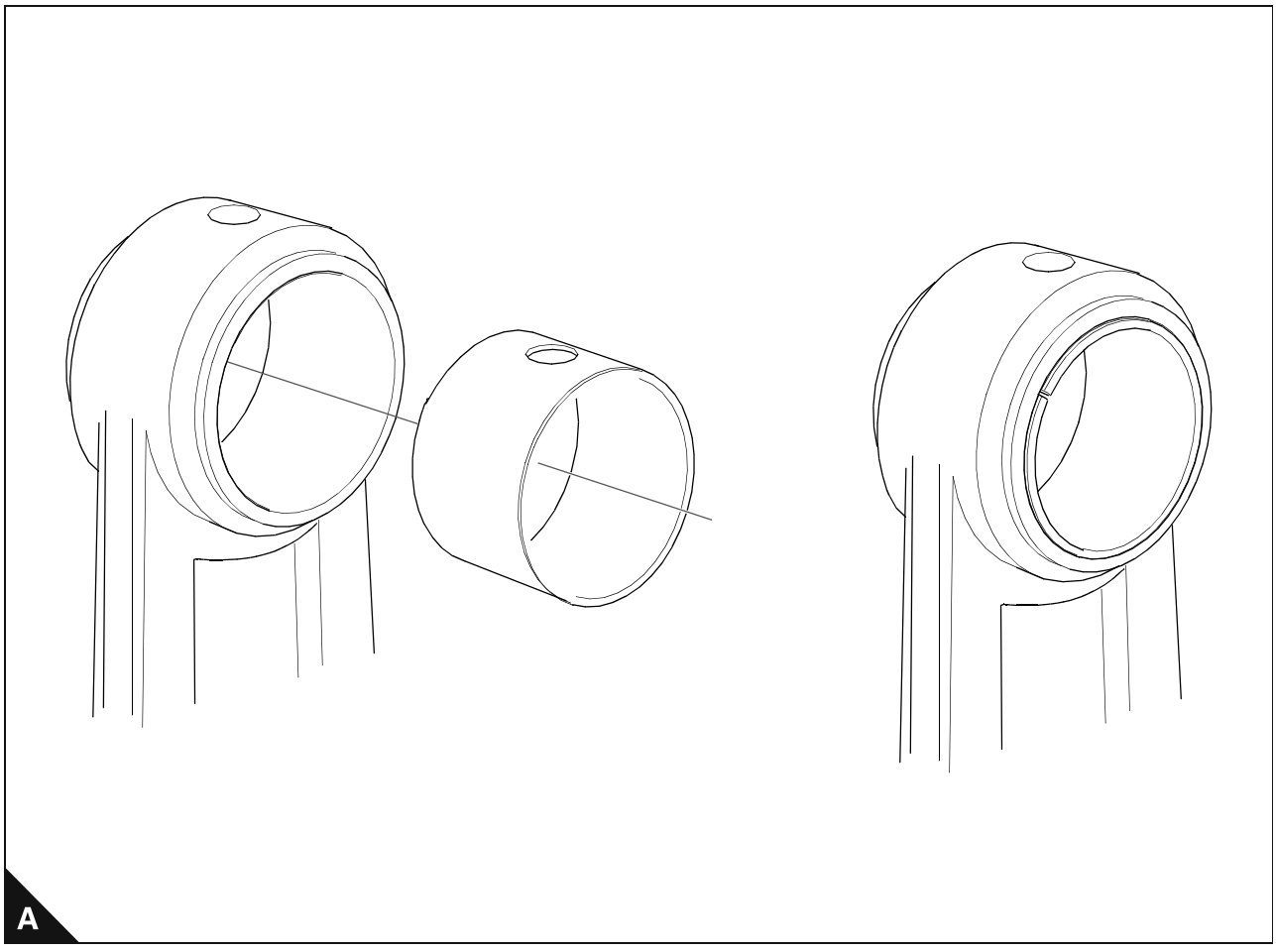
Small end bush

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.

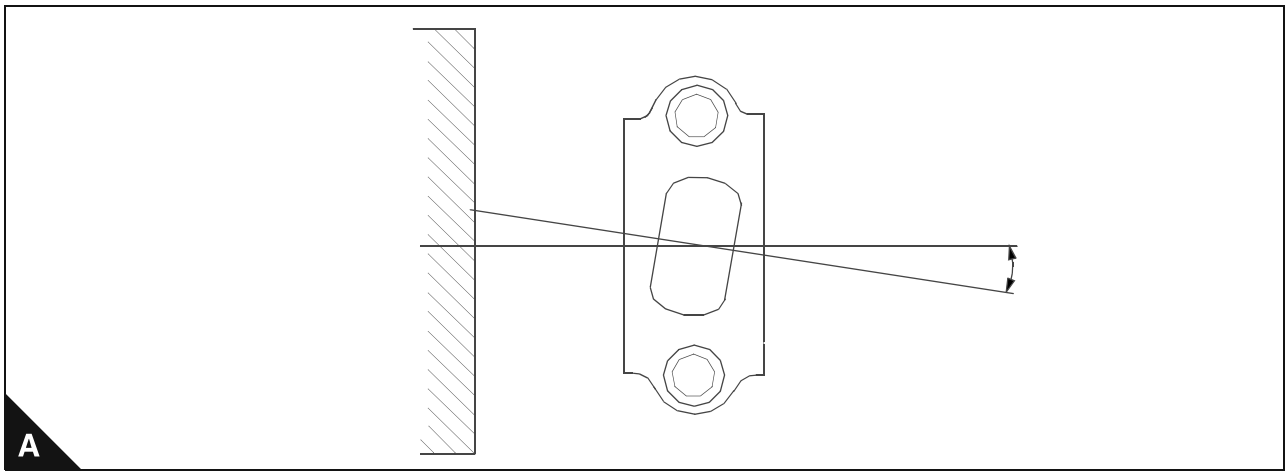


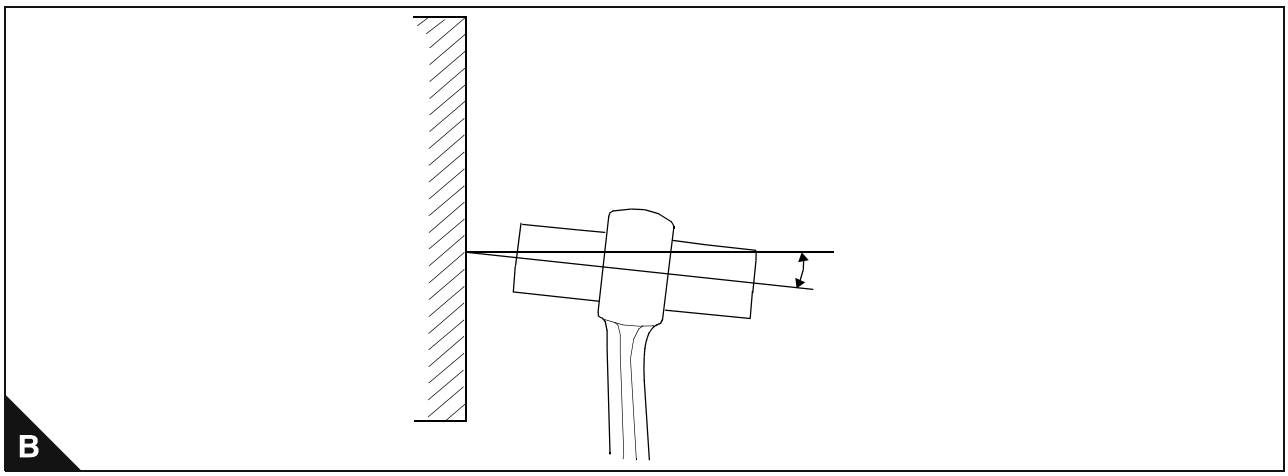
Connecting rod

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

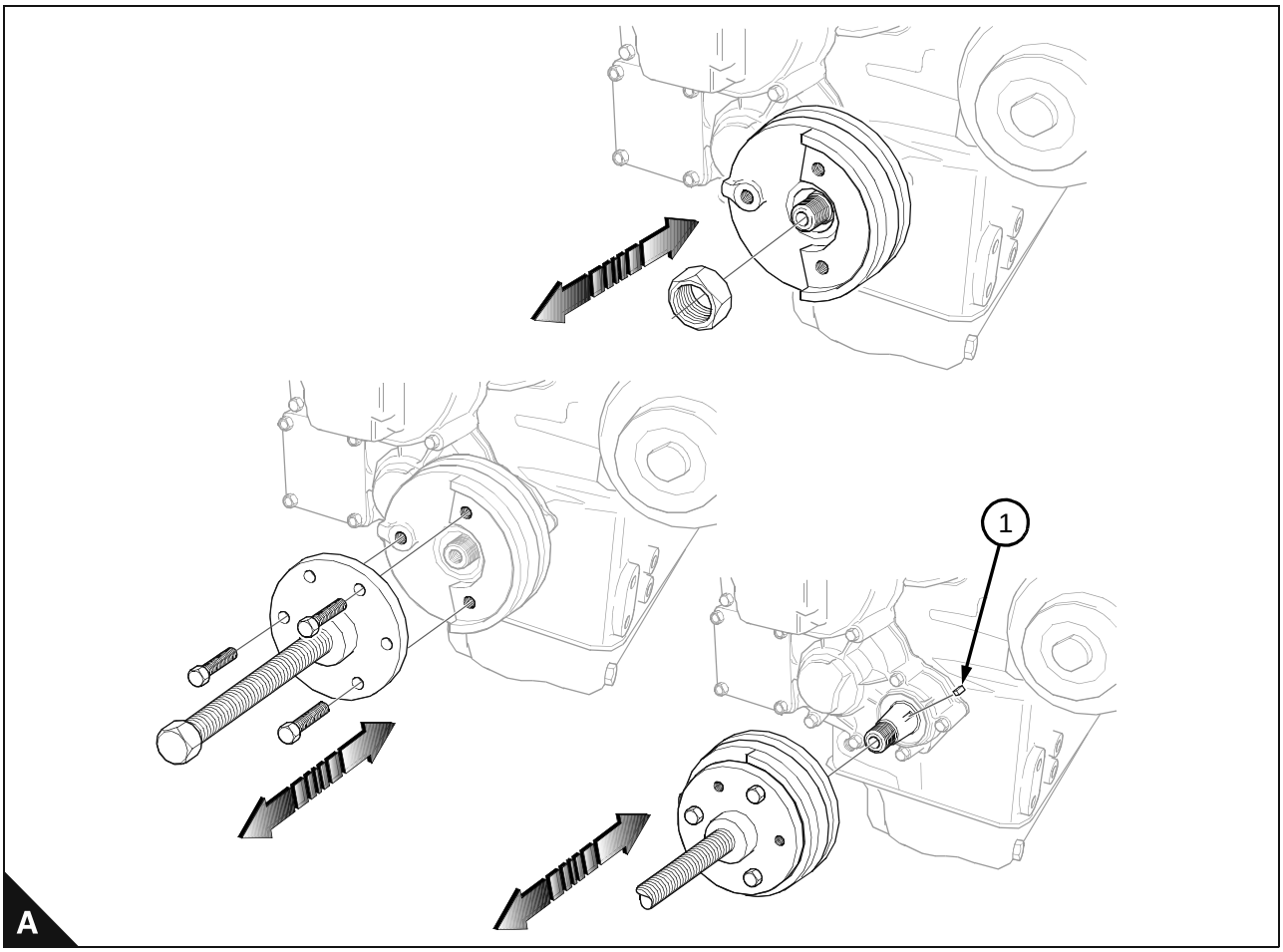
Crankshaft pulley

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**

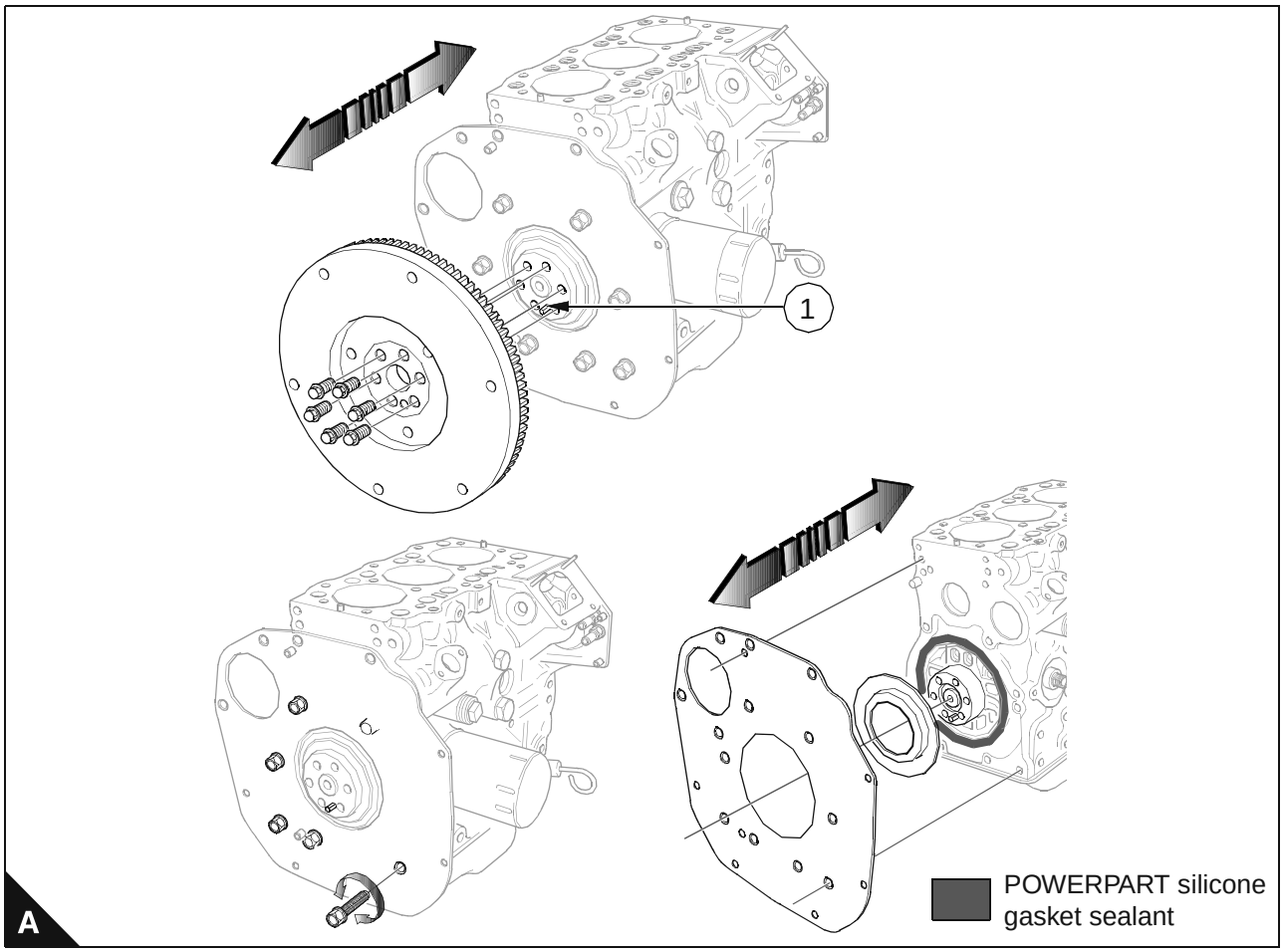
Special requirements

POWERPART products	
Description	**Part number**
Silicone gasket sealant	21826046

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:

- On assembly use Powerpart silicone gasket sealant.
- Apply liquid sealer to the block (around screw holes) before the backplate is fitted.
- Remember the position of the dowel (A1).



Crankshaft retainer setscrews and crankshaft

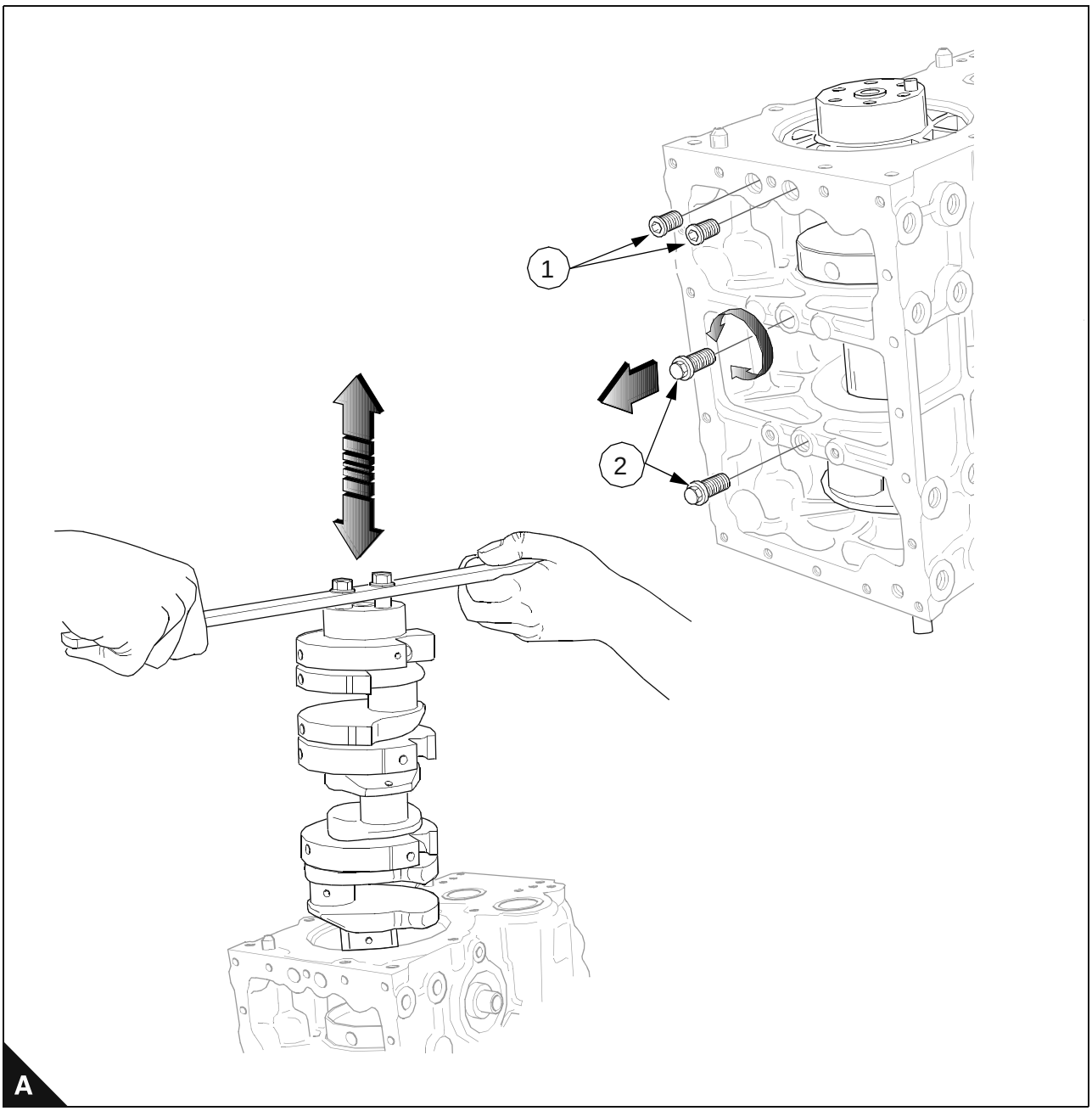
To remove and to fit **Operation 5-3**

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.*



Bearing clearance

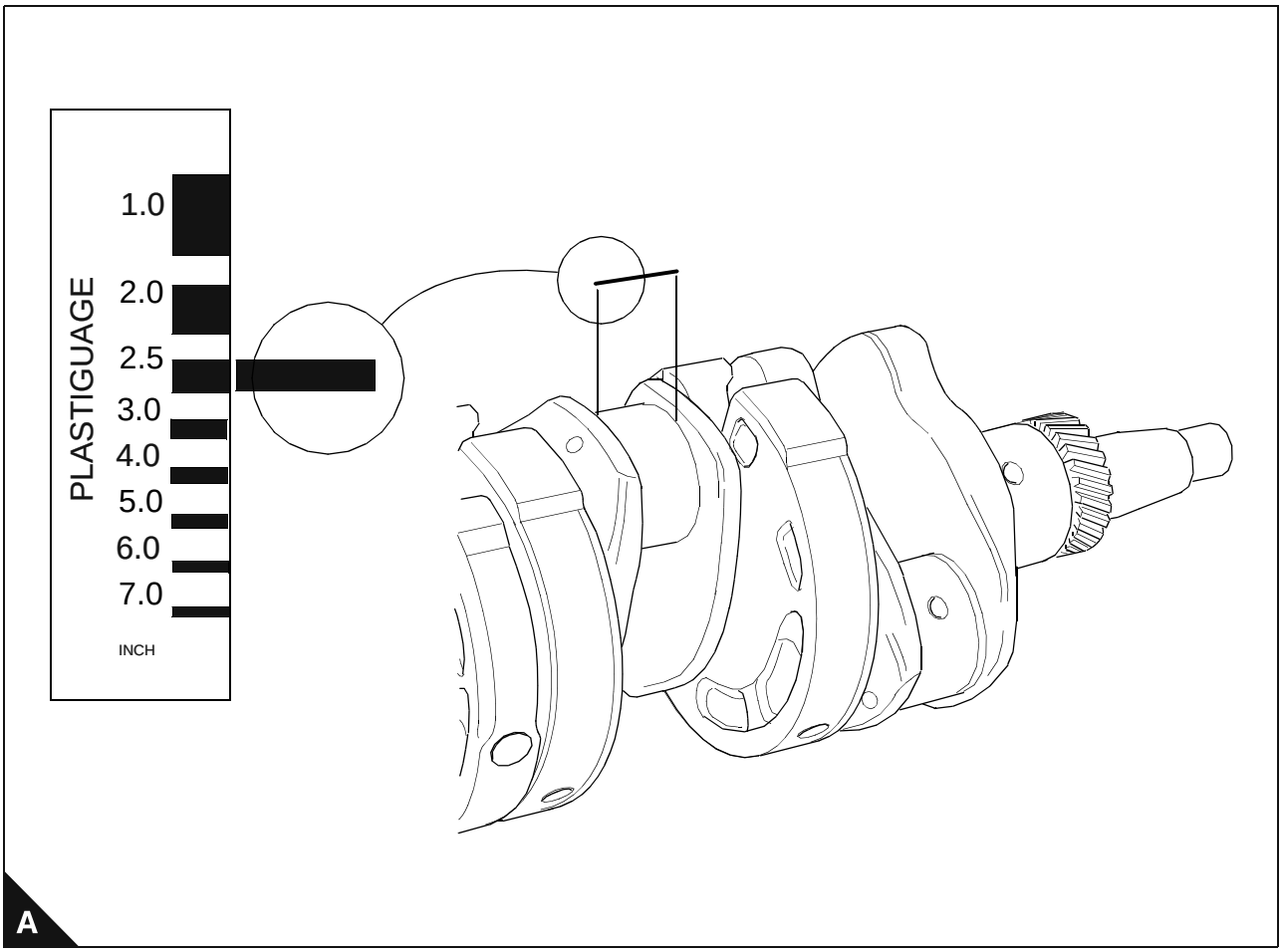
To check **Operation 5-4**

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	22 (16) 2,2	21,85 - 21,95 (0.8602 - 0.8641)	21,6 (0.8503)

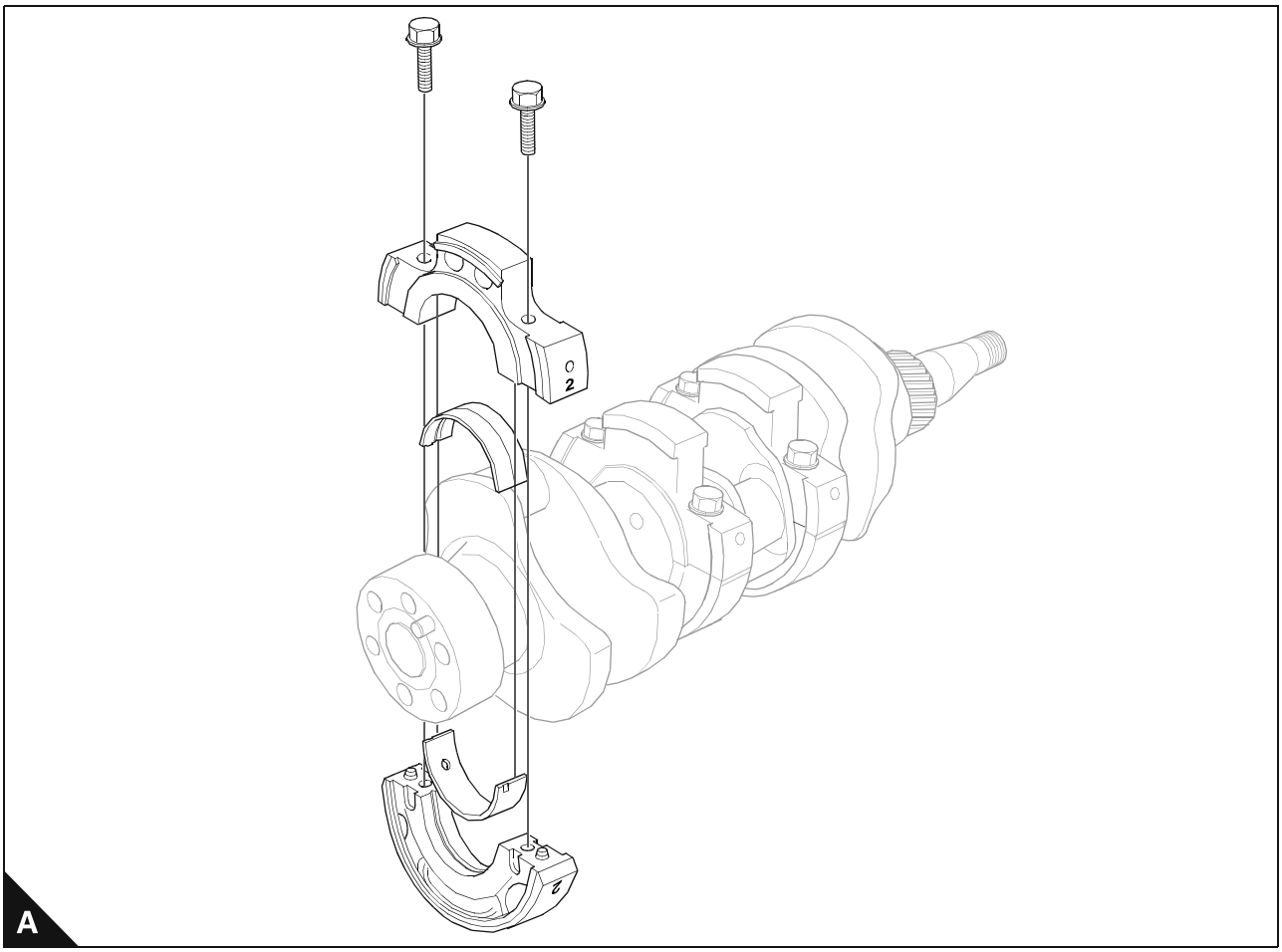
Engine model	End Float : Clearance mm (in)	
	Standard	Service limit
102-05, 103-07	0,10 - 0,30 (0.0040 - 0.0120)	0,50 (0.0197)
103-10	0,05 - 0,30 (0.0020 - 0.0120)	0,50 (0.0197)

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.



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.

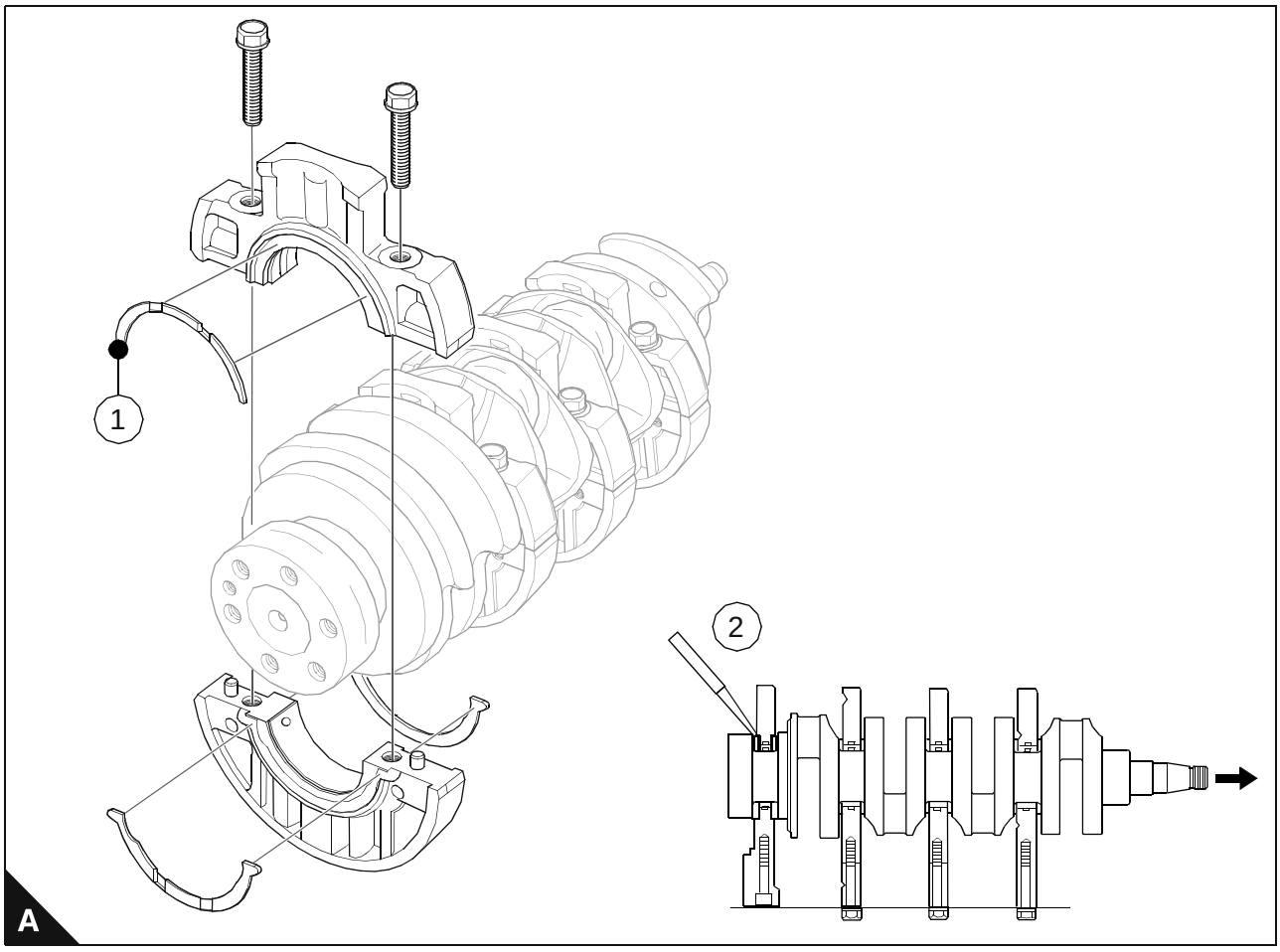
2 Install bearing carriers on shaft ensuring oil holes align with feed holes in cylinder block.

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.



6

Timing case and drive assembly

Fuel injection pump

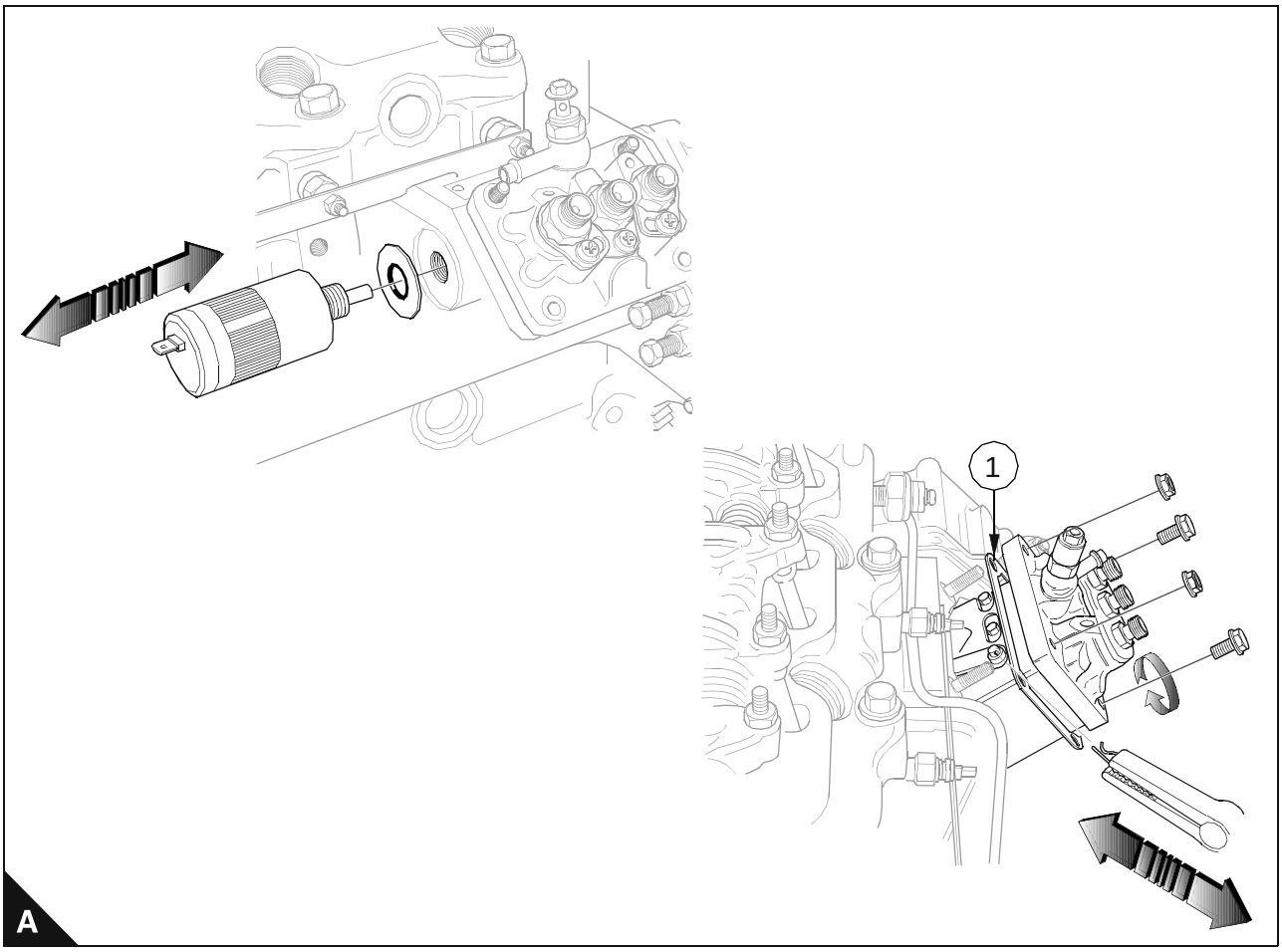
To remove and to fit **Operation 6-1**

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.

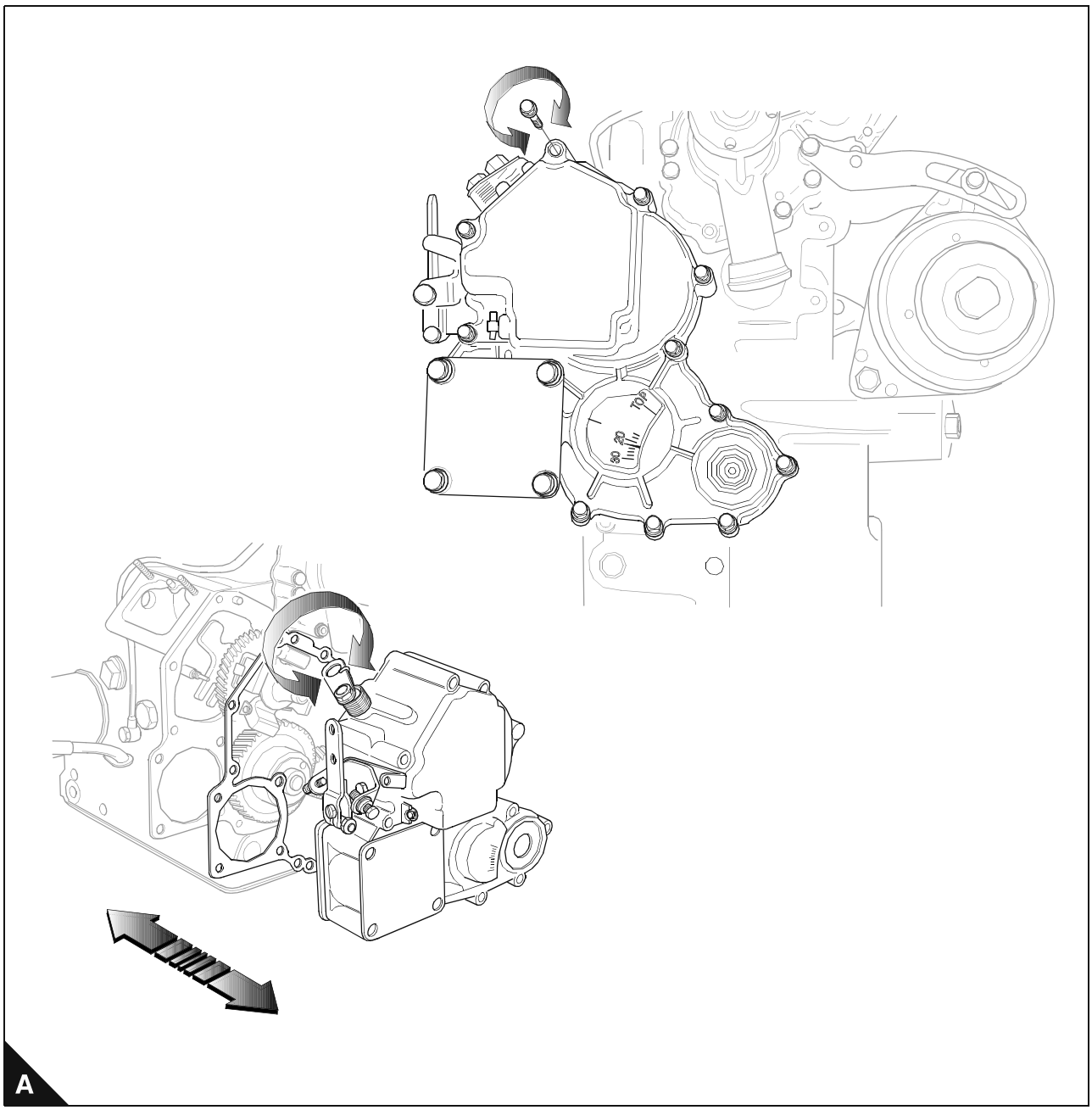


Timing cover

To remove and to fit **Operation 6-2**

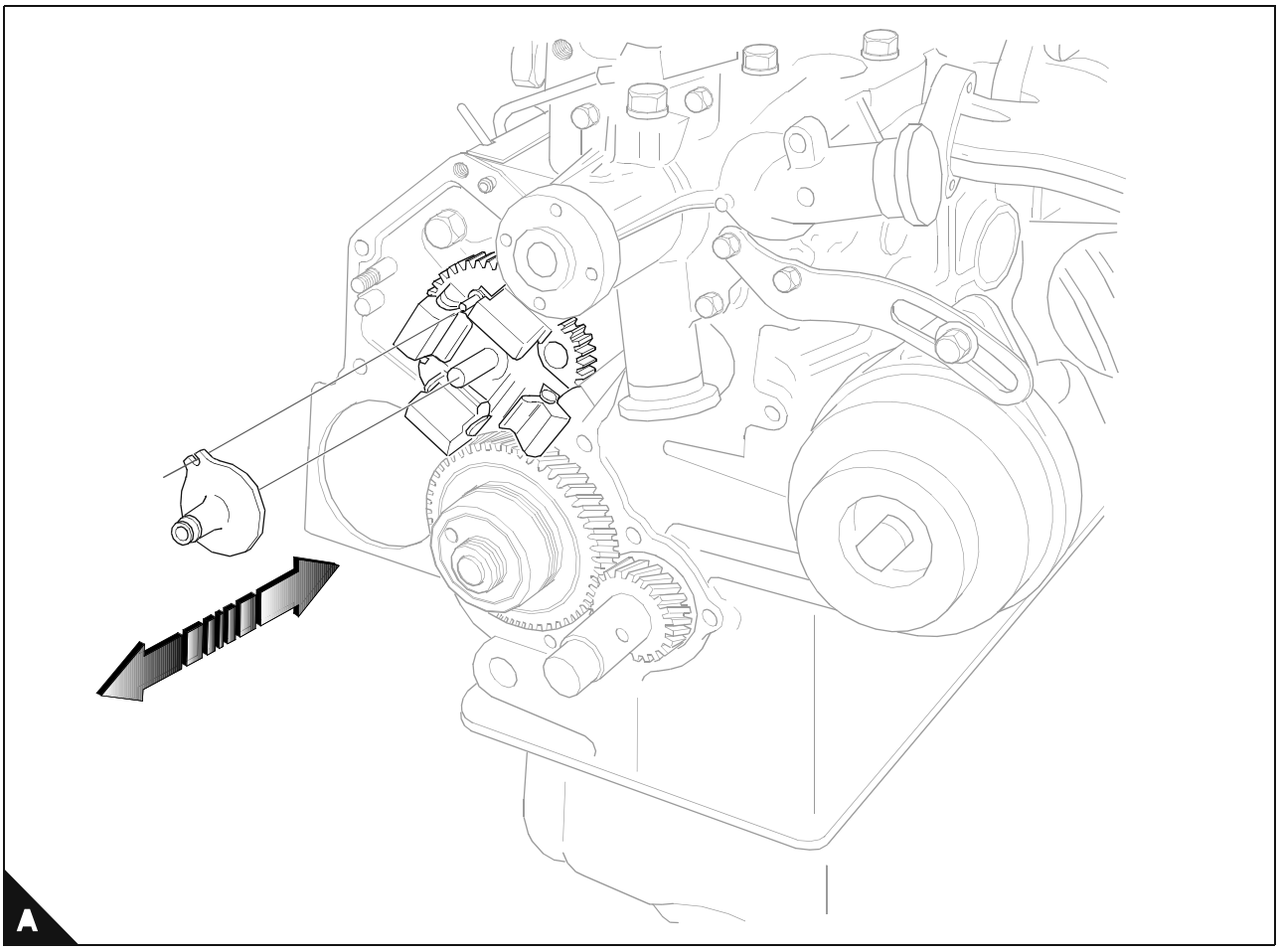
For crankshaft pulley removal refer to Operation 5-1.

Note: On assembly hold arm clockwise.



Slider

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

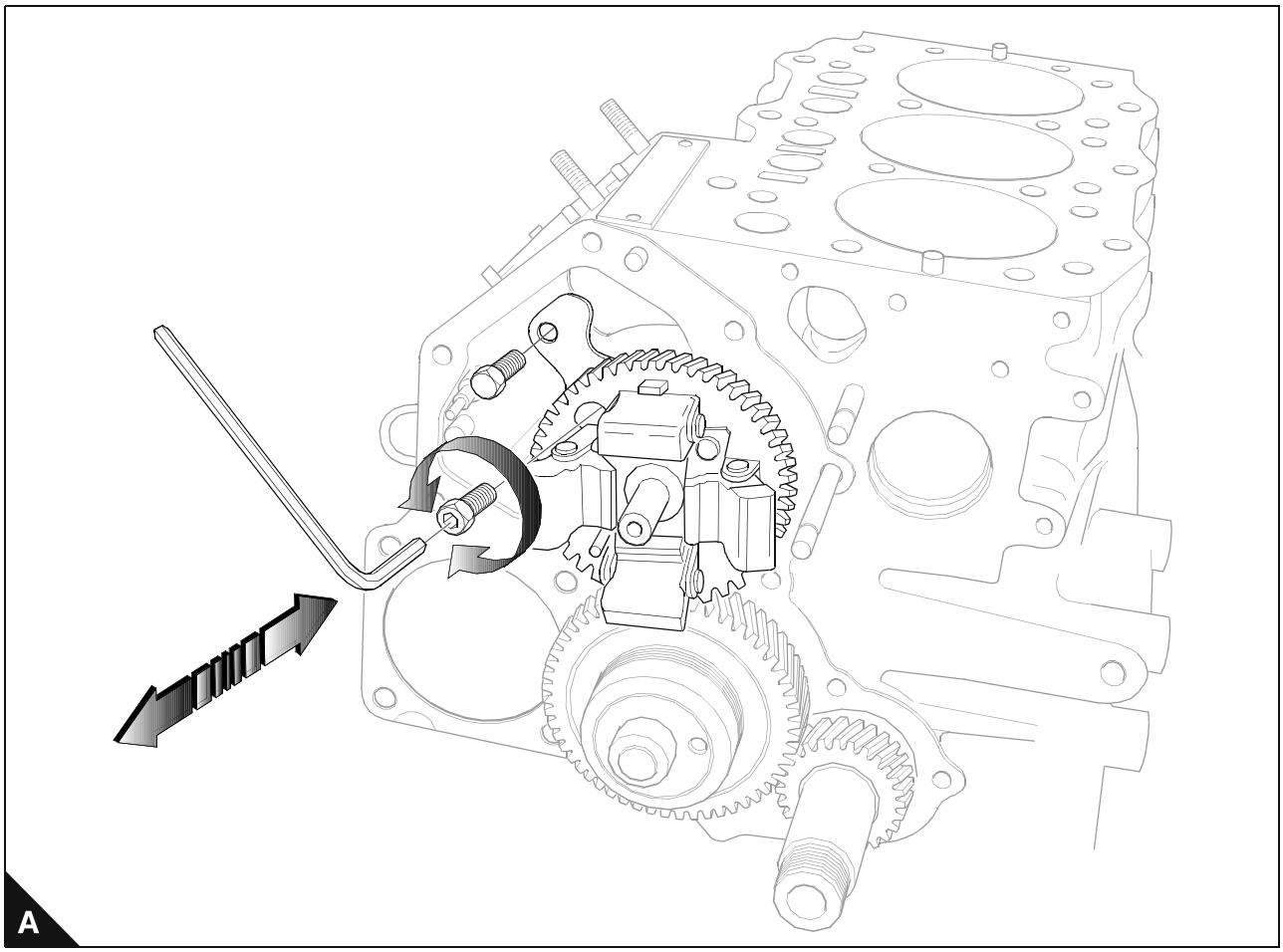


Camshaft retainer plate

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

Special requirements

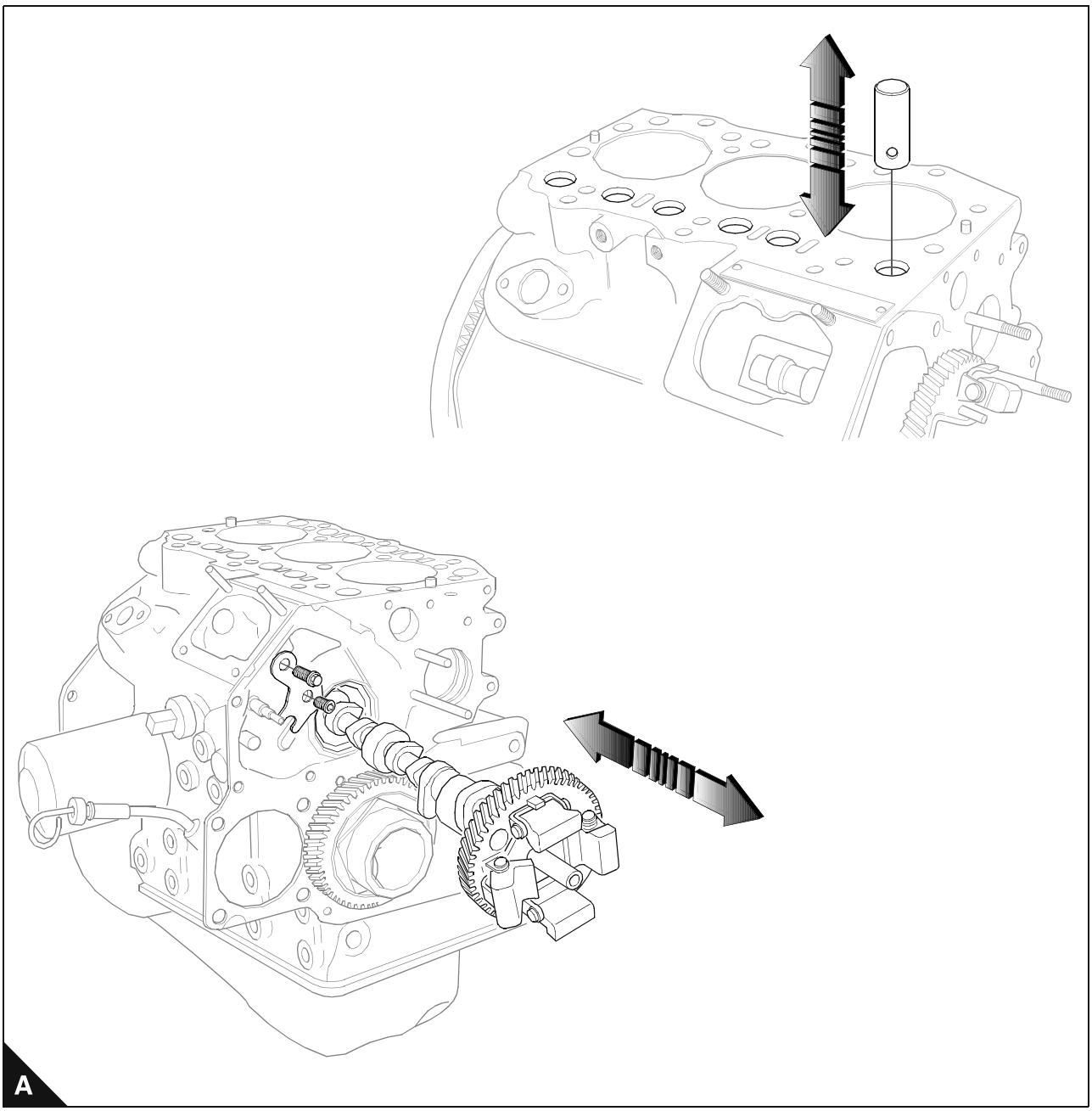
Torque Nm (lbf ft) kgf m	
Camshaft retainer plate setscrews	11 (8) 1,1



Camshaft and cam followers

To remove and to fit **Operation 6-5**

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



To inspect **Operation 6-6**

Cam height (intake and exhaust cams) (A1)

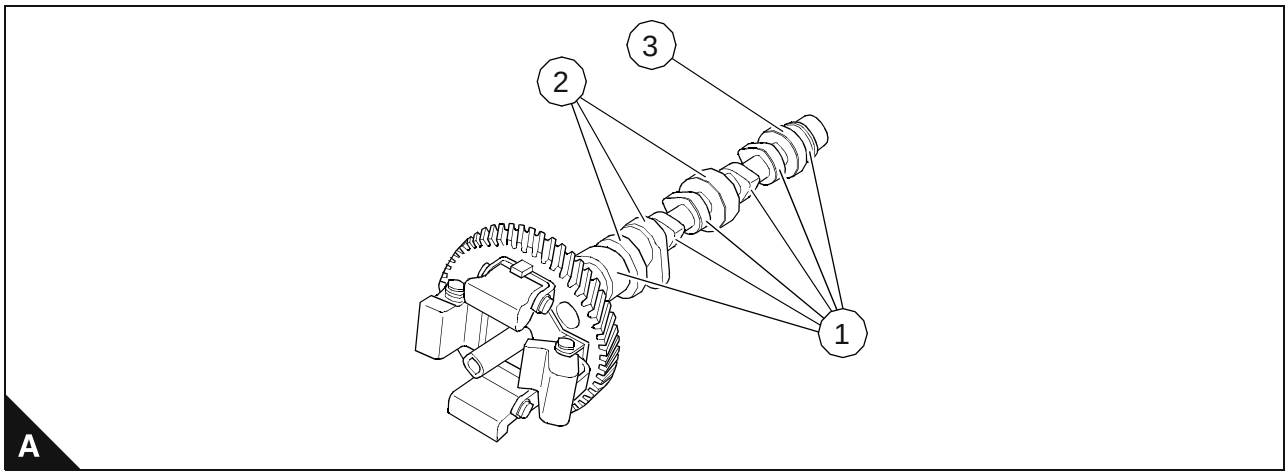
Engine model	Height mm (in)	
	Standard	Service limit
102-05, 103-07	26,565 - 26,620 (1.04590 - 1.04803)	26,1 (1.028)
103-10	26,445 - 26,500 (1.04114 - 1.04330)	26,1 (1.028)
103-13, 103-15, 104-19, 104-22	34,065 - 34,120 (1.34114 - 1.34330)	33,7 (1.327)

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)

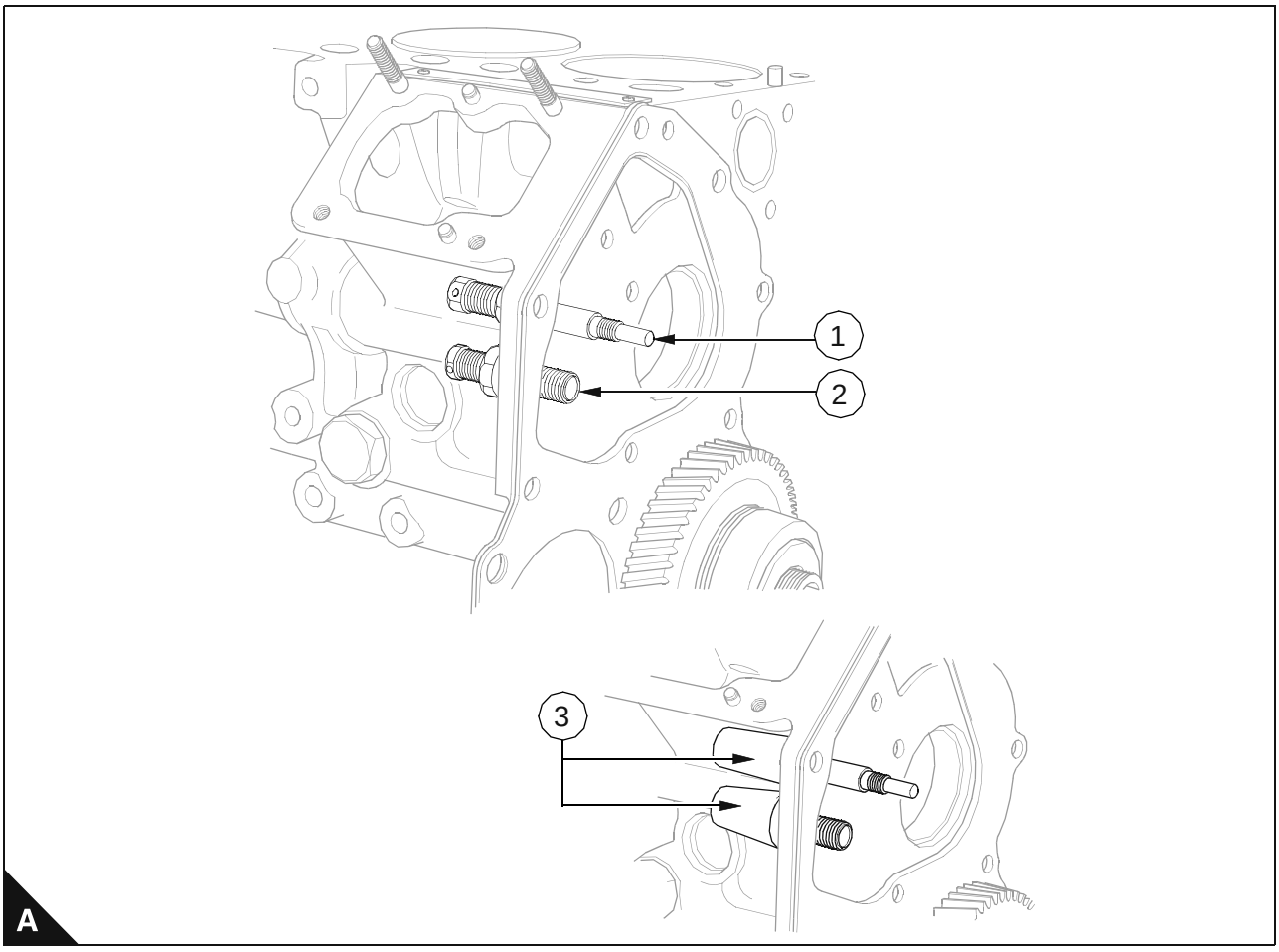


Max fuel screw and max speed screw

To locate **Operation 6-7**

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 contact the service department at Perkins.



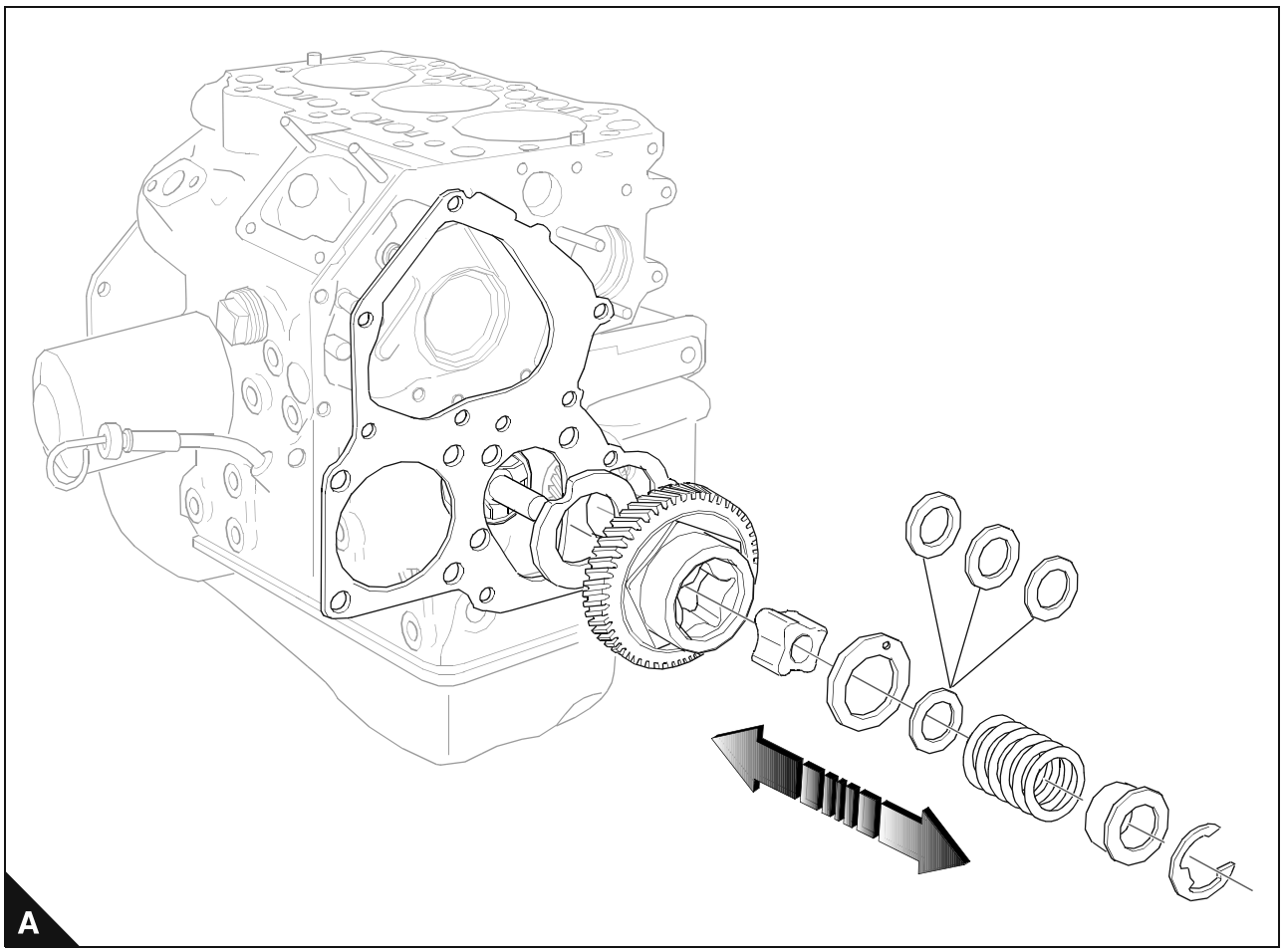
Idler gear and oil pump

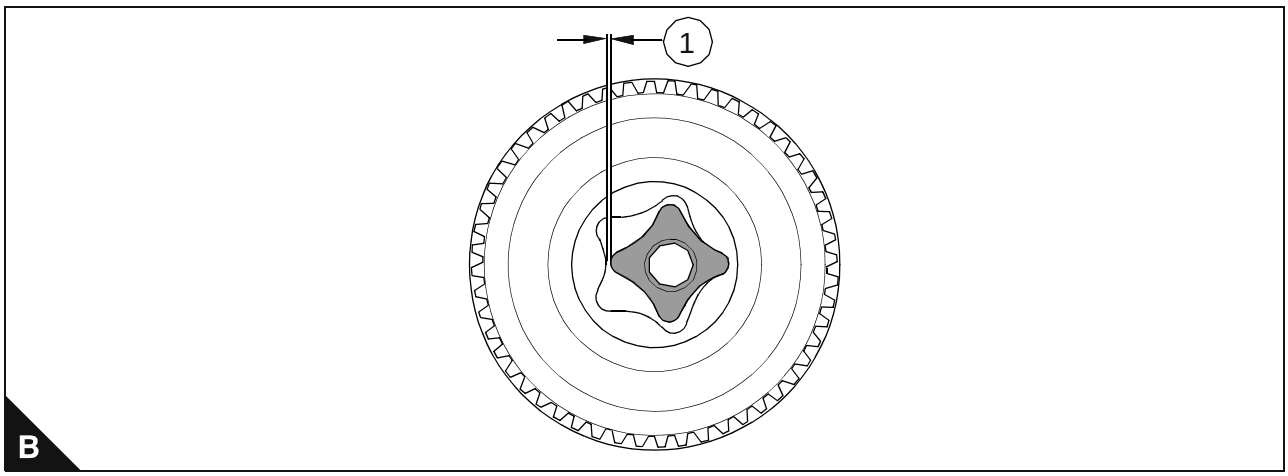
To remove and to fit **Operation 6-8**

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 6-11.





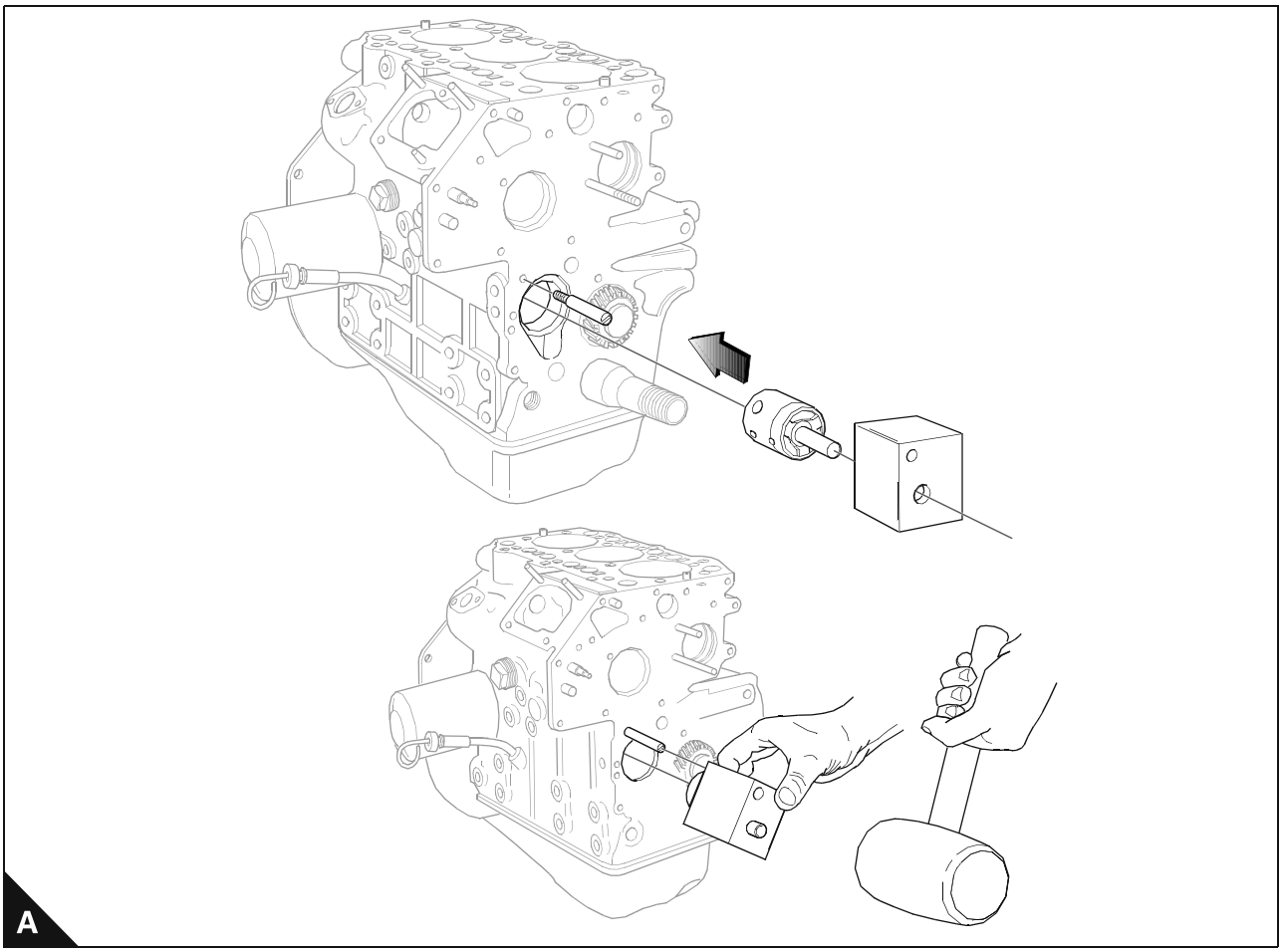
Idler hub

To fit **Operation 6-9**

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

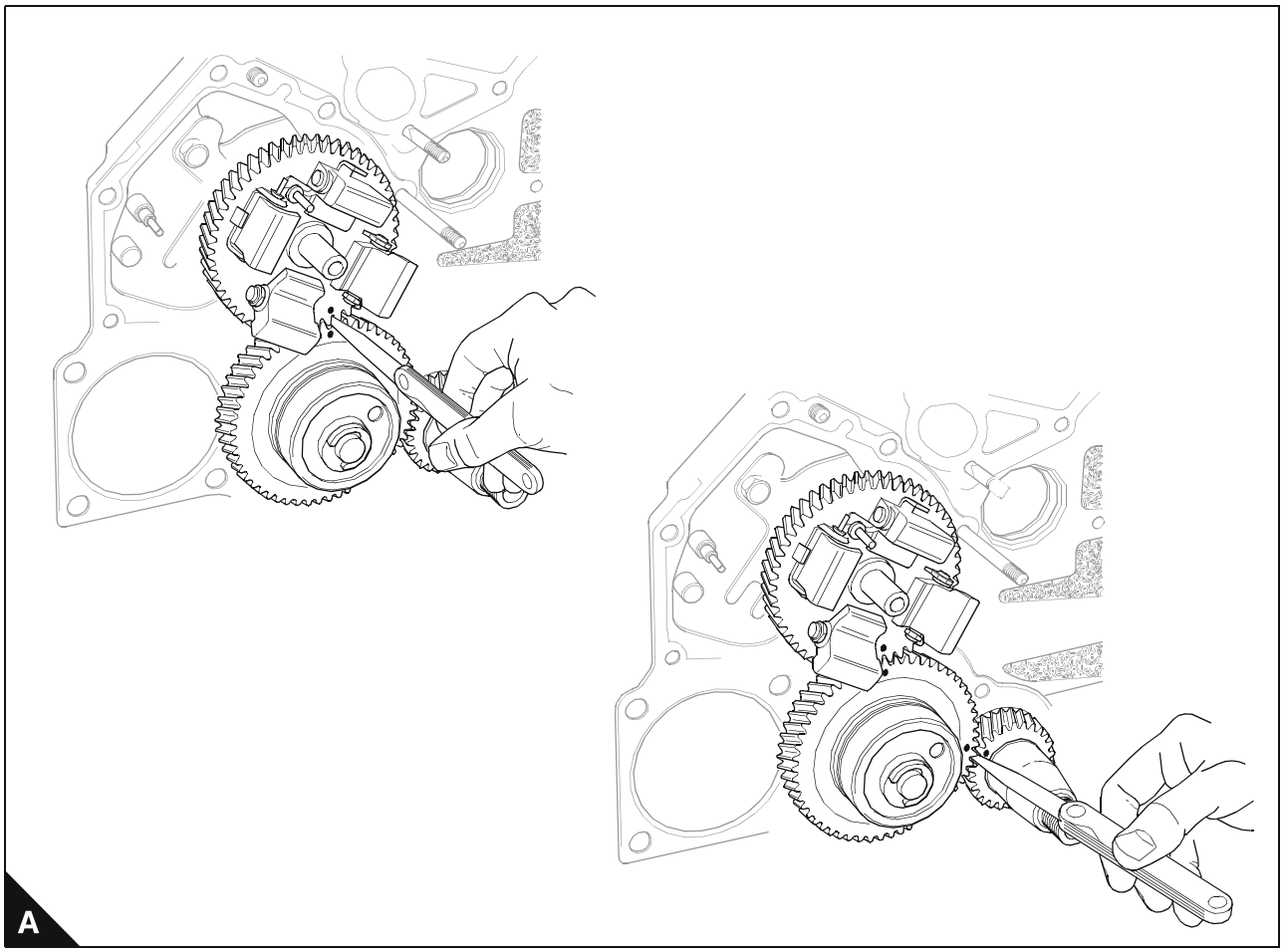
To check backlash **Operation 6-10**

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.



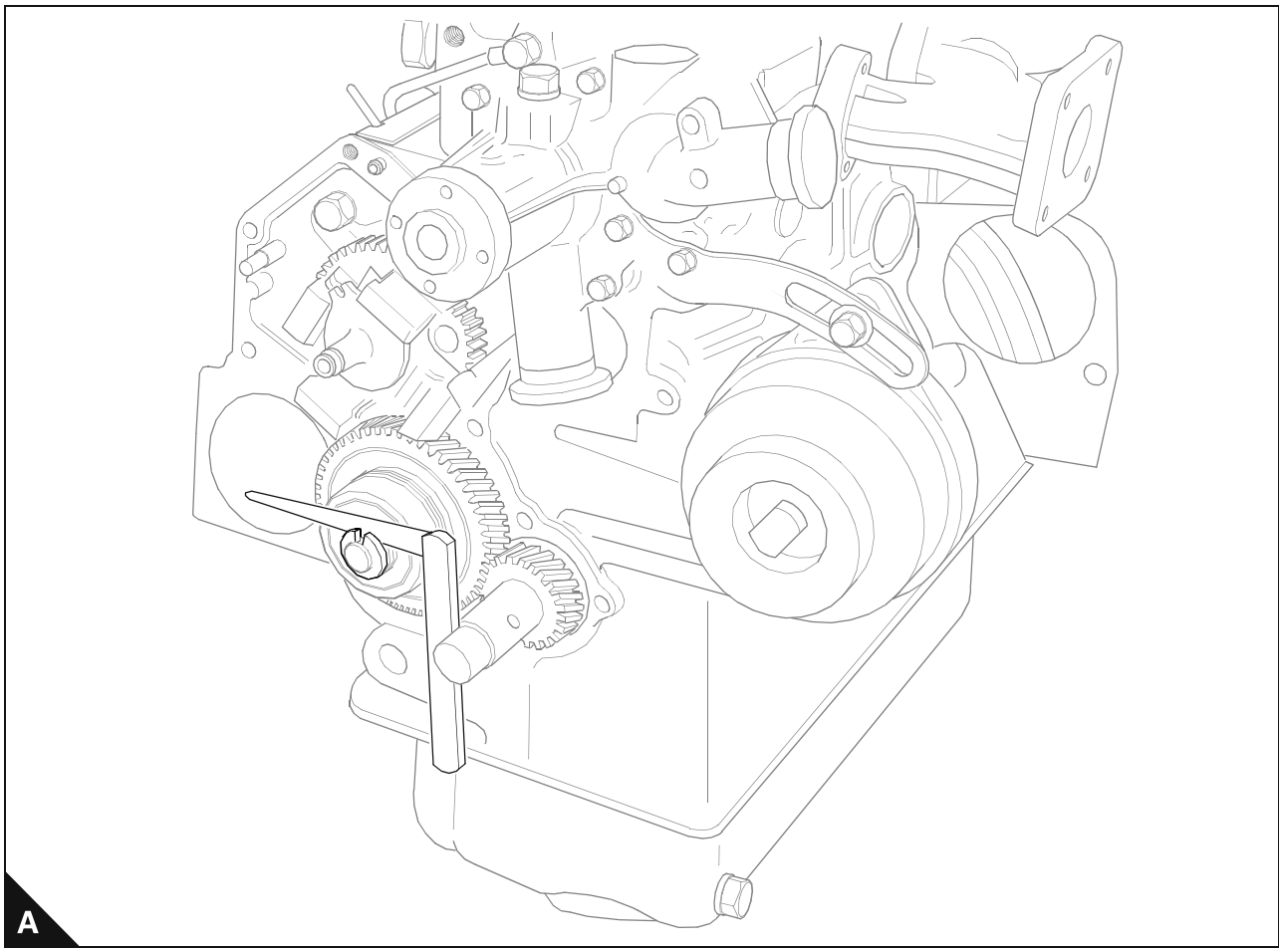
Oil pump end float

To check **Operation 6-11**

Special requirements

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

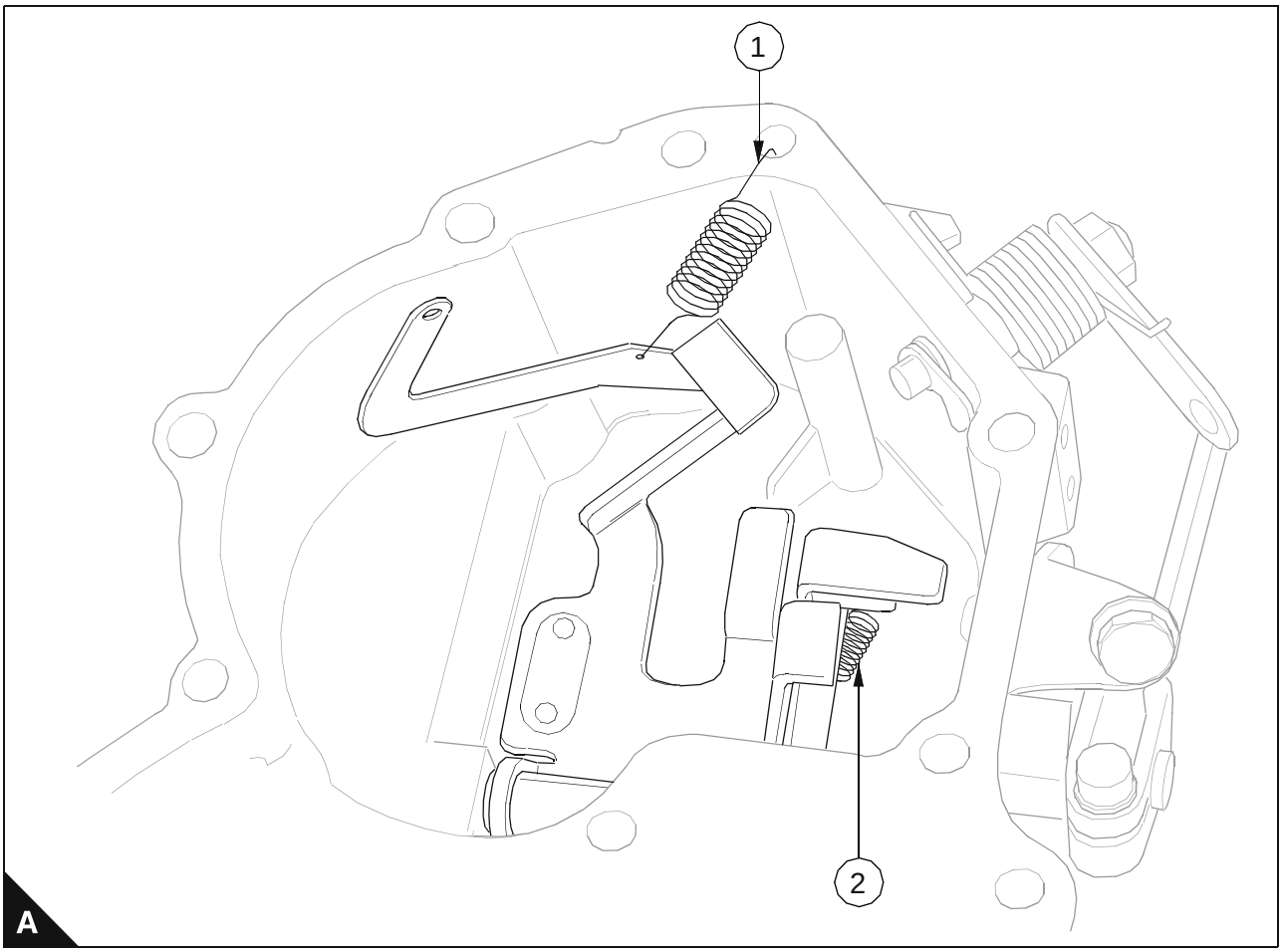
Use a feeler gauge to check the end float clearance of the oil pump . Adjust with 0,1, 0,15, 0,2, and 0,5 mm shims.



Governor spring

To locate and to check **Operation 6-12**

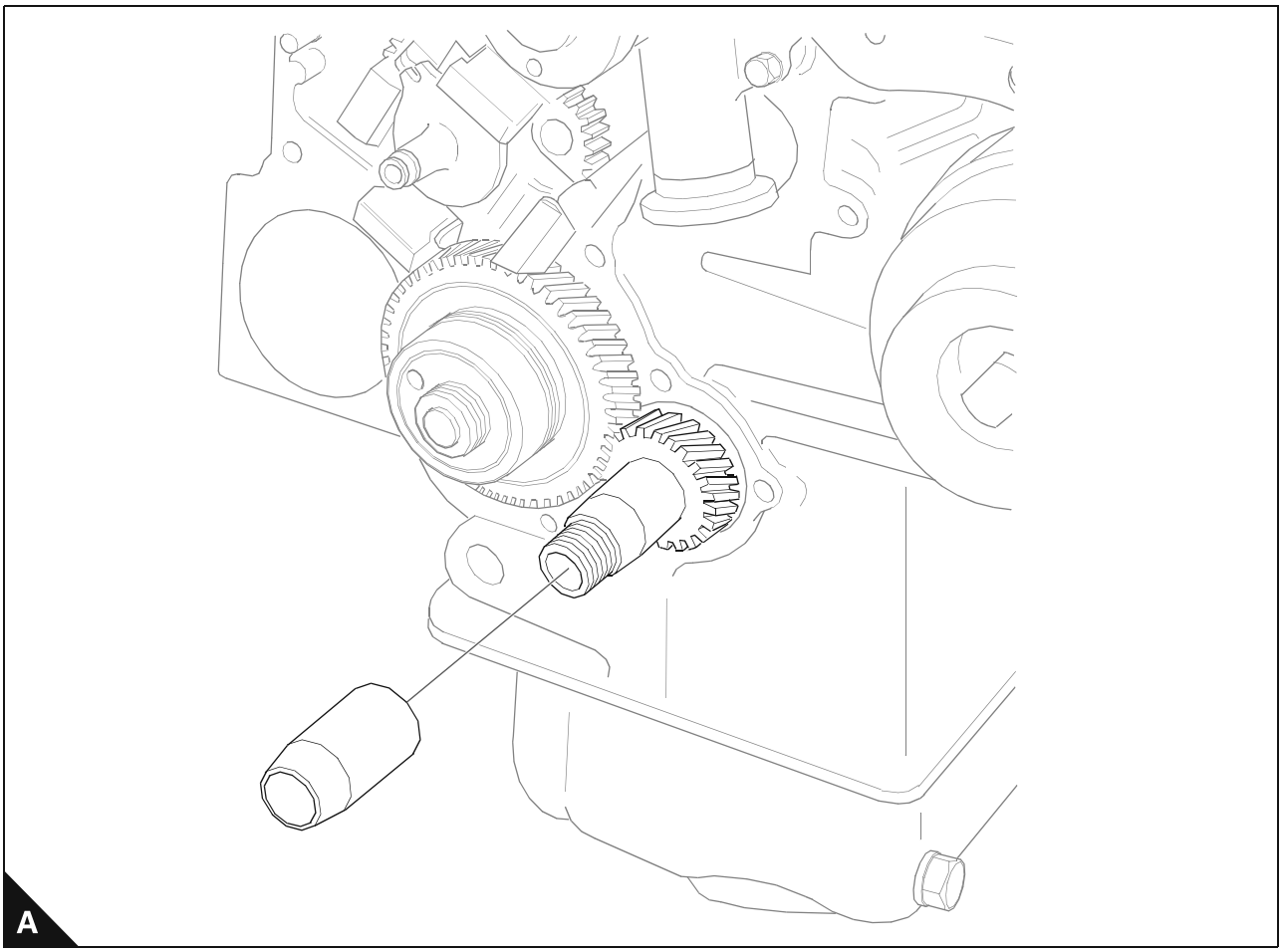
Note: Remember the locations of start spring (A1) and governor spring (A2).



Oil seal protector

To fit **Operation 6-13**

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



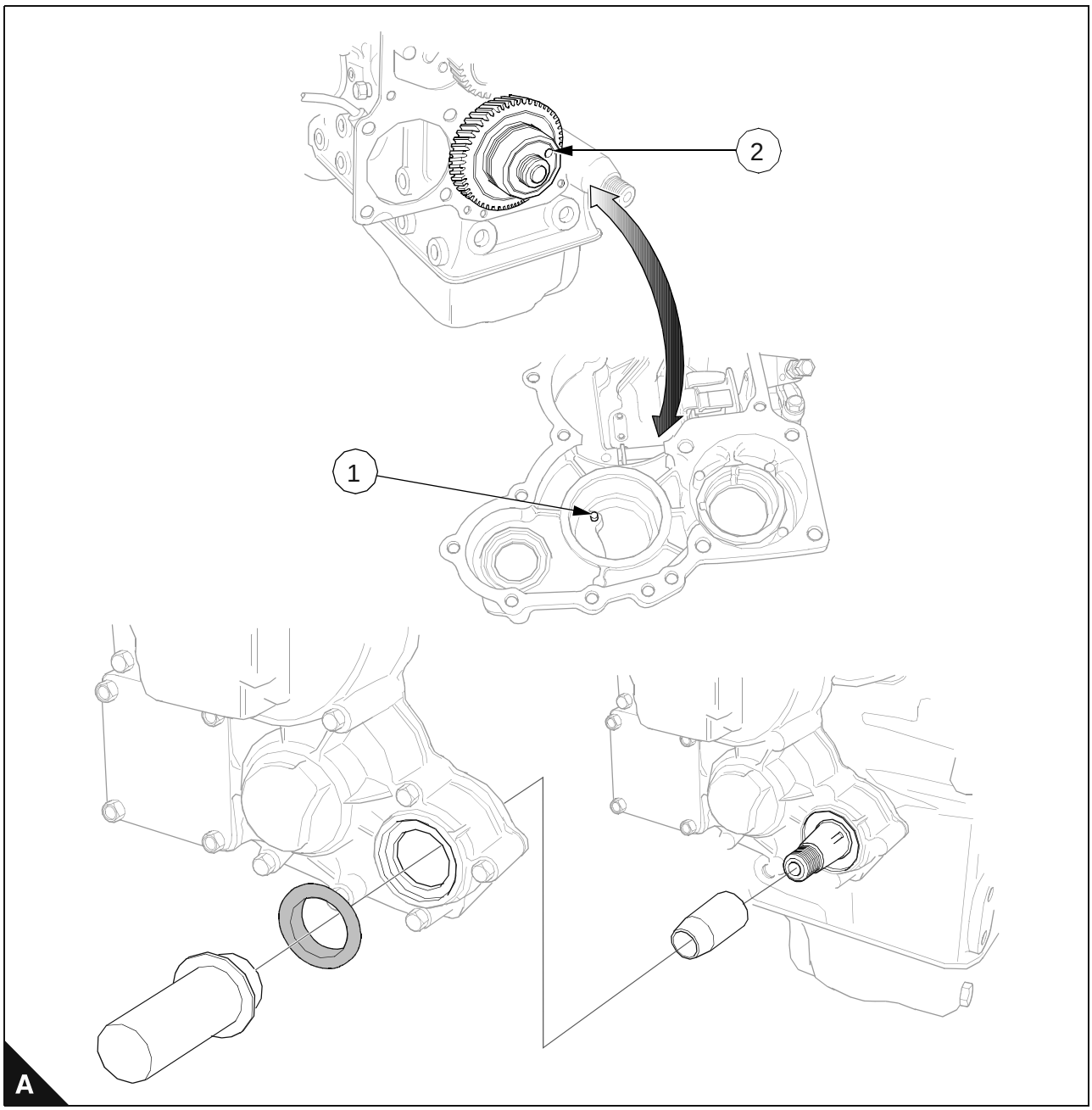
Timing cover

To fit **Operation 6-14**

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.



7

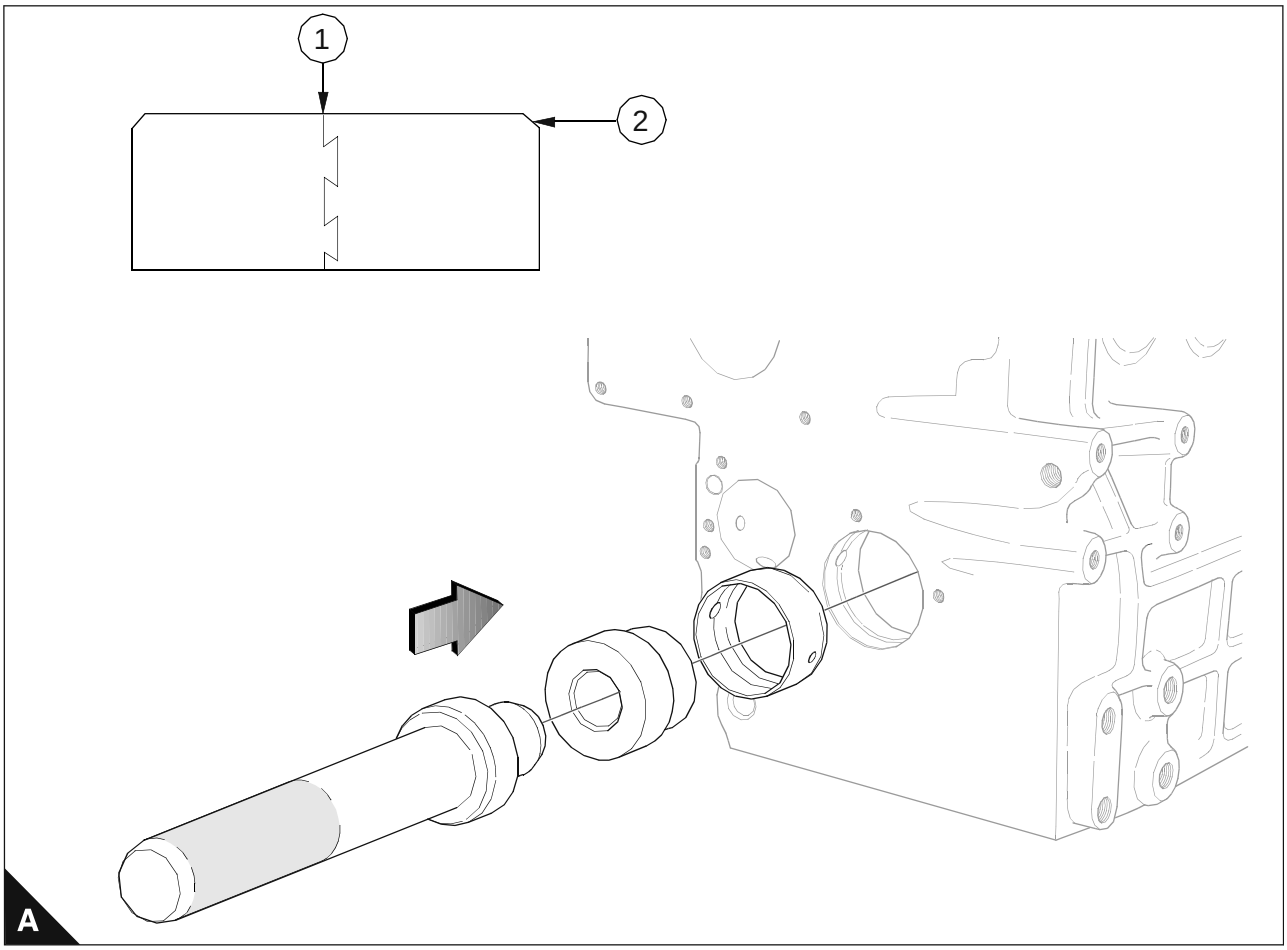
Cylinder block assembly

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)

Cylinder bore

1 Visually inspect cylinder bore. There should be no scratches, rust or corrosion.

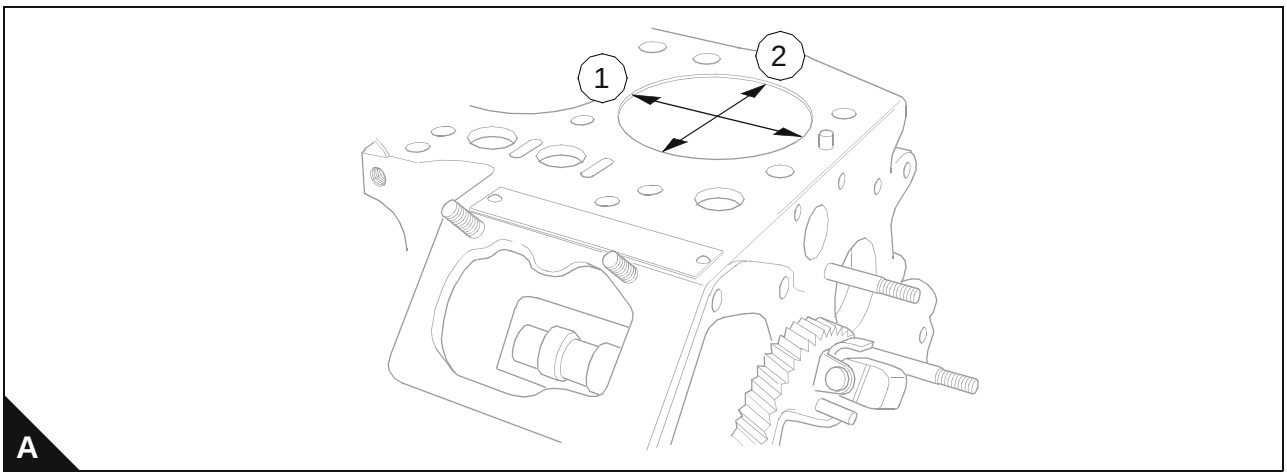
2 Measure the cylinder bore at the upper, middle and lower areas (piston ring contact area) in the direction of the crankshaft (A1) and at a right angle to the crankshaft (A2).

Note: The upper area described in the above is the position of the top ring when the piston is at T.D.C., (about 10 mm below the cylinder block top face). The lower area corresponds to the piston oil control ring when the piston is at B.D.C. (about 100 mm below the cylinder block top face).

3 Check the bore using a cylinder gauge.

4 If the bore is found to be outside the service limit, bore oversize to the dimension specified for your engine model in "Cylinder bore dimensions" on page 16.

Grinding stone size	100L x 4W
Speed	162 rev/min
Feed (shaft direction)	13 m/min
Gauge pressure	15 kg/cm² (5 kg/cm² - finish)
Finish stroke	9
Honing depth	0,04 mm (on diameter)
Cross hatch angle	40°
Surface roughness	2-4 microns



8

Engine timing

Fuel injection pump timing

To adjust 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.

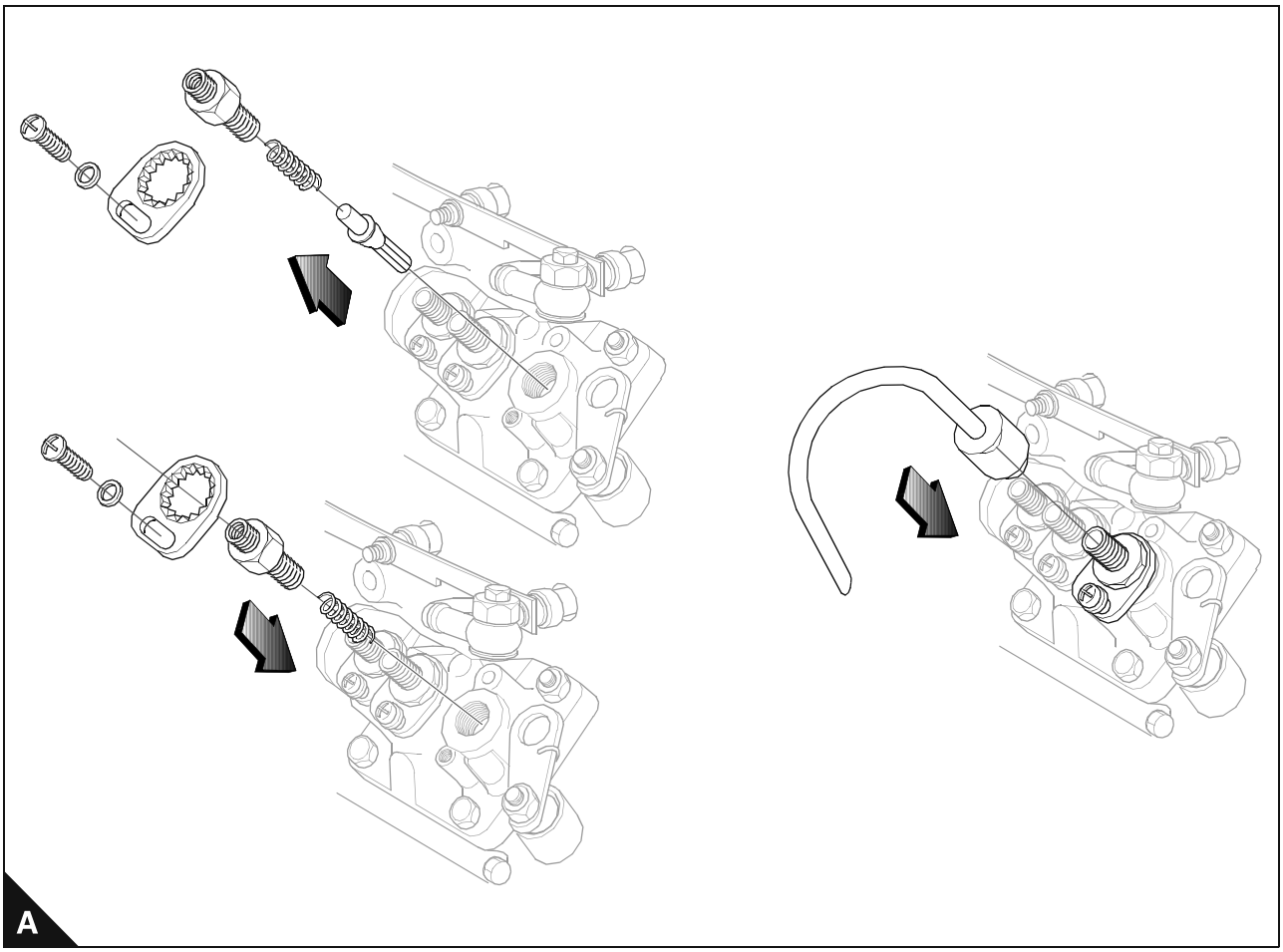
2 Disconnect or remove the ESOS, HP pipes and LP fuel inlet pipes from pump (A).

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.

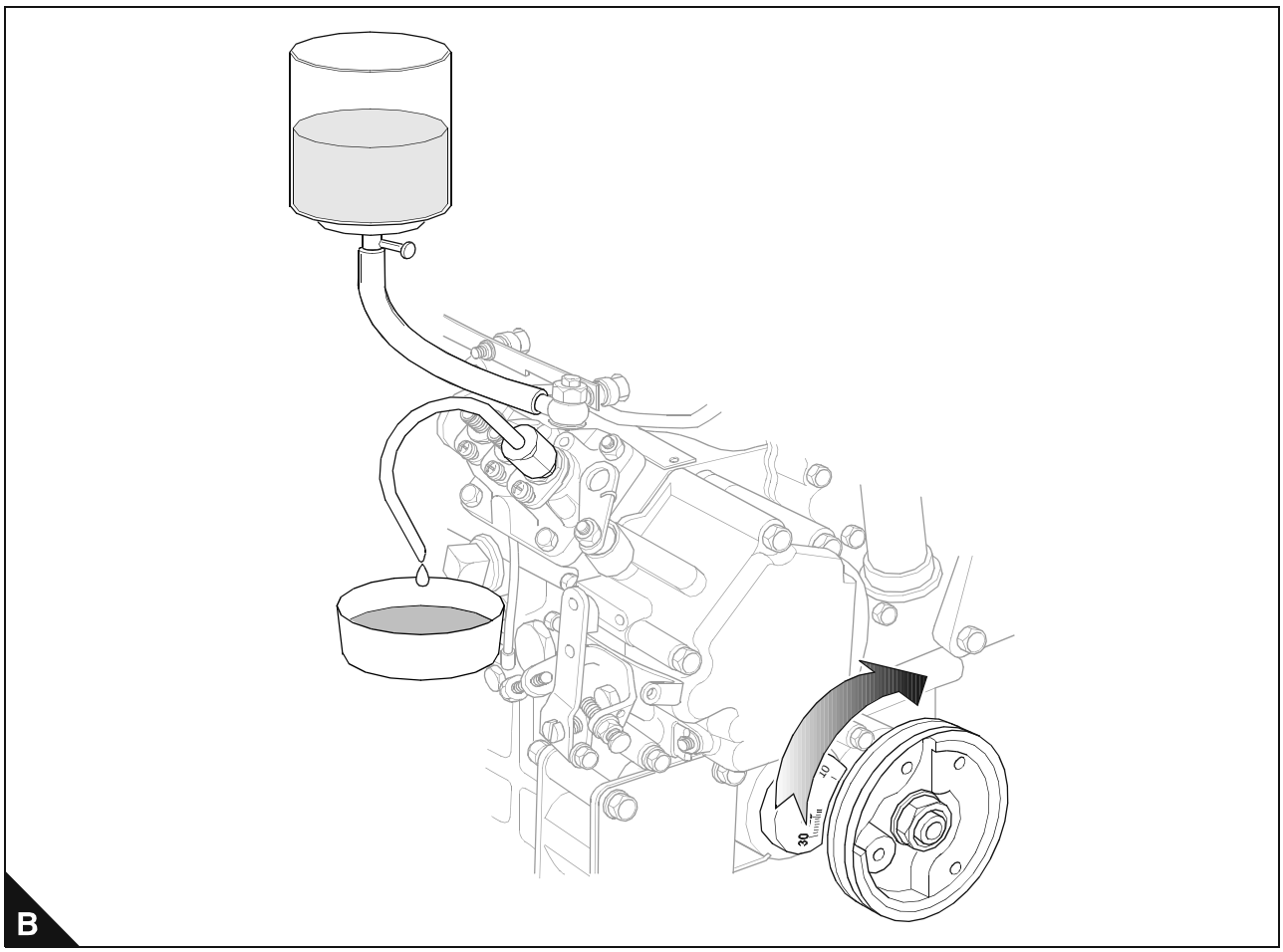
6 Connect the fuel pump spill pipe to the delivery valve holder for number 1 cylinder. Put a suitable waste fuel container below the pipe neck and open the tap, if correctly set fuel should flow (B).

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

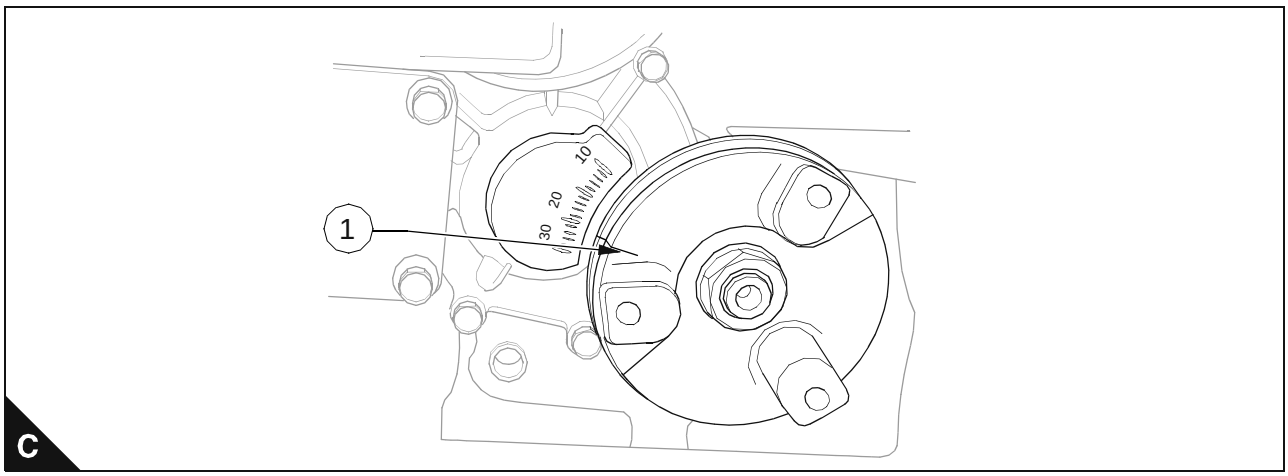
7 Turn the crankshaft slowly until the flow of fuel reduces to a drop which falls from pipe neck every 7-10 seconds. This is then the timing point.

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

Continued



B



C

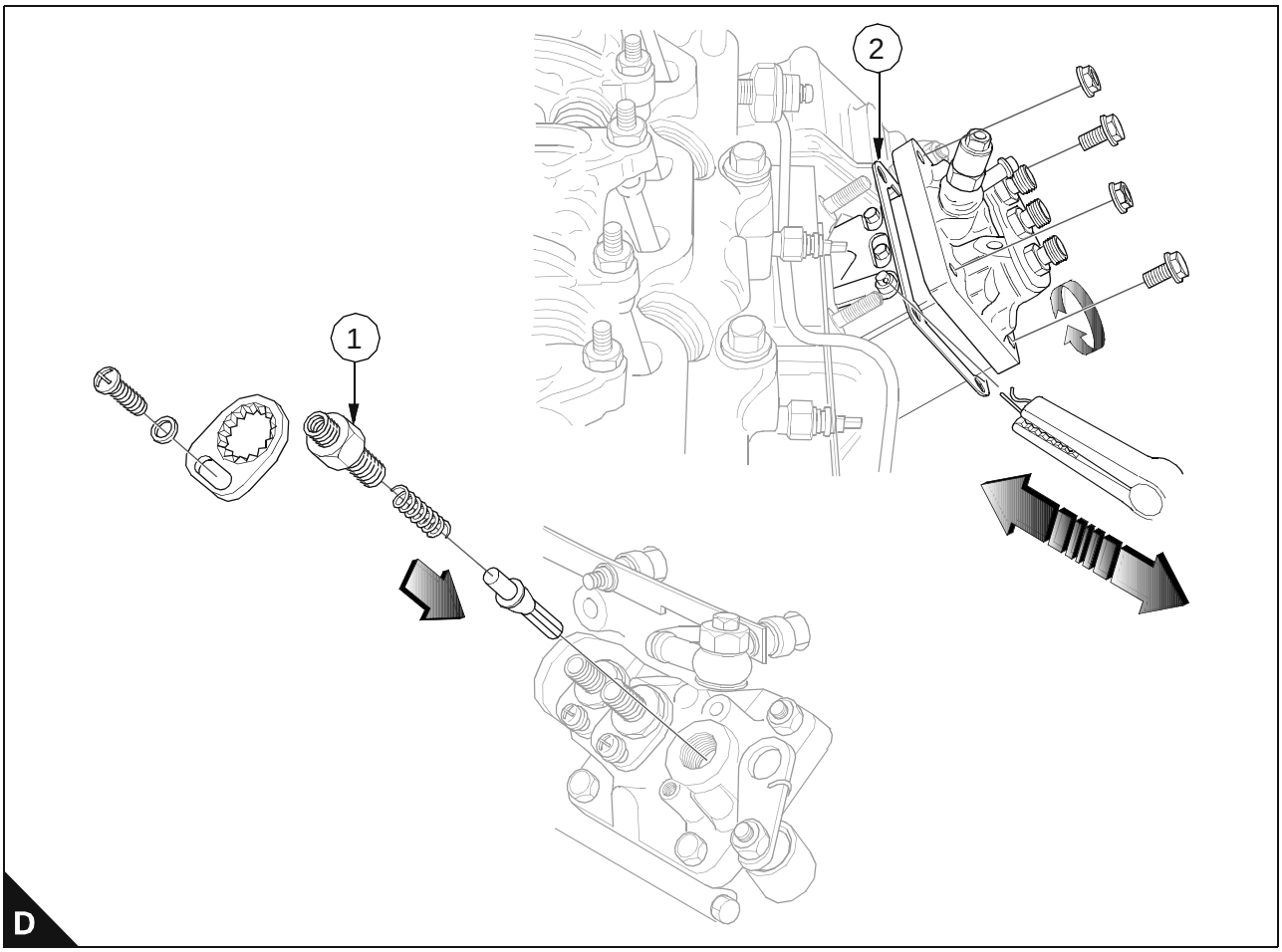
9 If engine timing is incorrect adjust the thickness of shim (D2) to correct.

Adjusting shim thickness (mm)	102-05	103-07, 103-10	103-13, 103-15	104-19, 104-22
	Part number	Part number	Part number	Part number
0,2	131437381	131437590	131437540	131437490
0,3	131437391	131437600	131437550	131437500
0,4	131437401	131437610	131437560	131437510
0,5	131437411	131437620	131437570	131437520

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.

Note: Ensure that the delivery valve holder (D1) is tightened to the specified torque.



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9

Aspiration system

Breather system

To clean and renew **Operation 9-1**

Special requirements

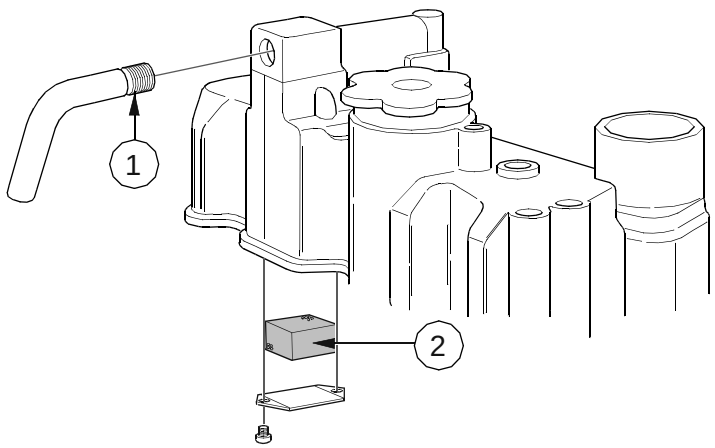
POWERPART products	
Description	**Part number**
Platelock	21826039

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

Ensure breather pipes (A1/B1) are not damaged or restricted.

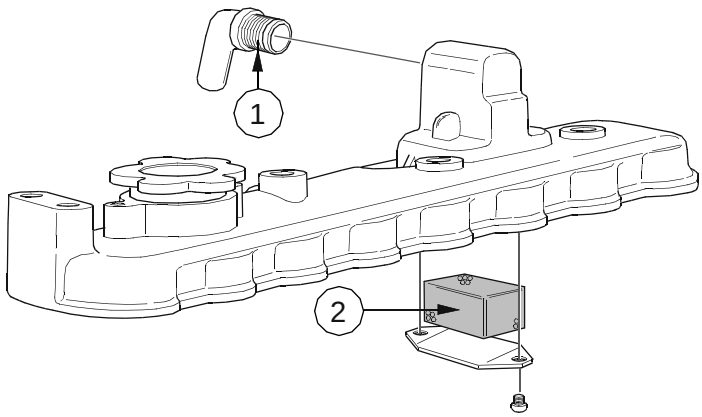
On assembly apply Powerpart Platelock to threaded area on breather pipes (A1/B1).

102-05
103-07
103-10



A

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



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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.

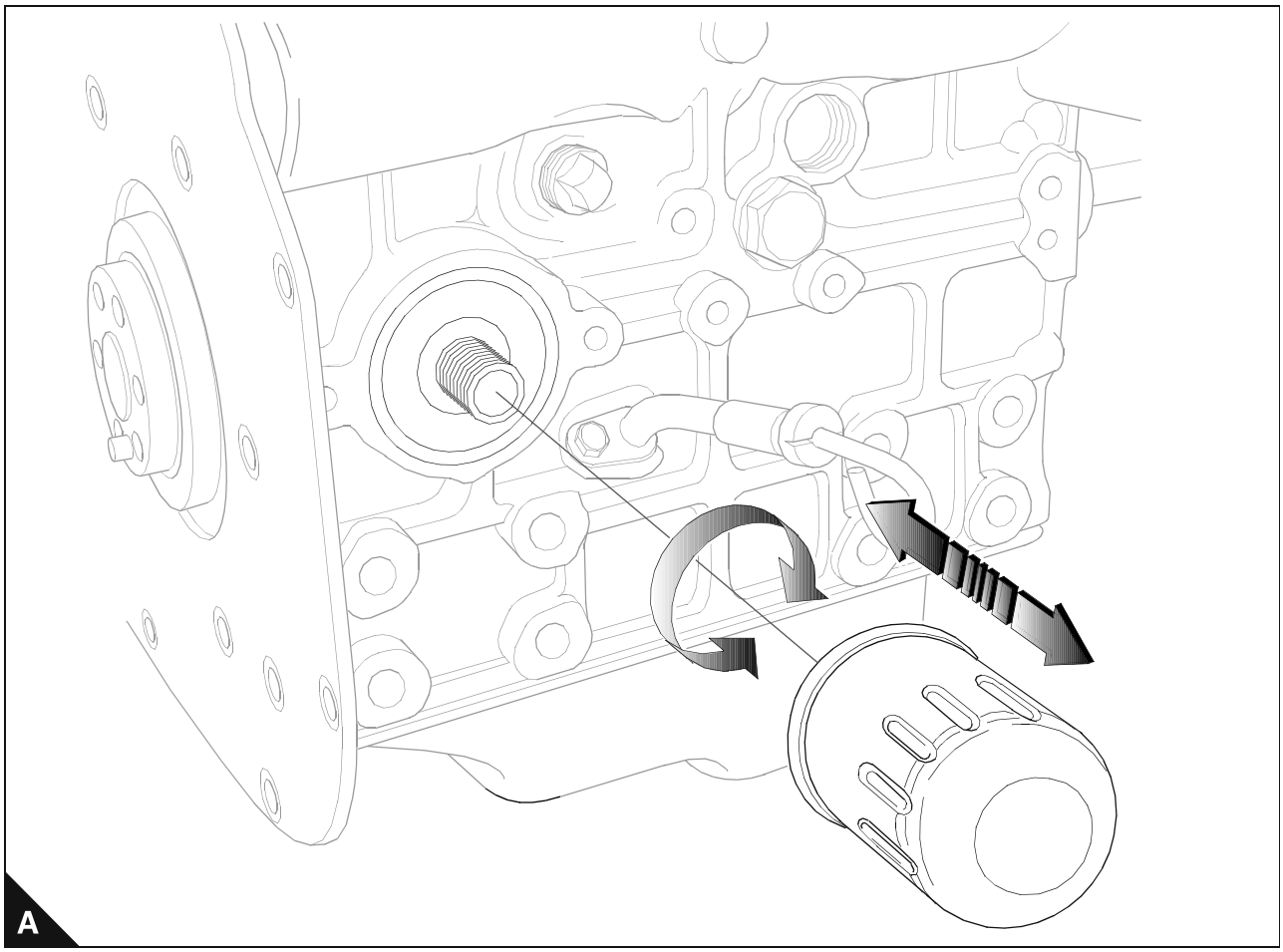
3 Lubricate the seal of the new canister with clean engine oil before assembly.

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

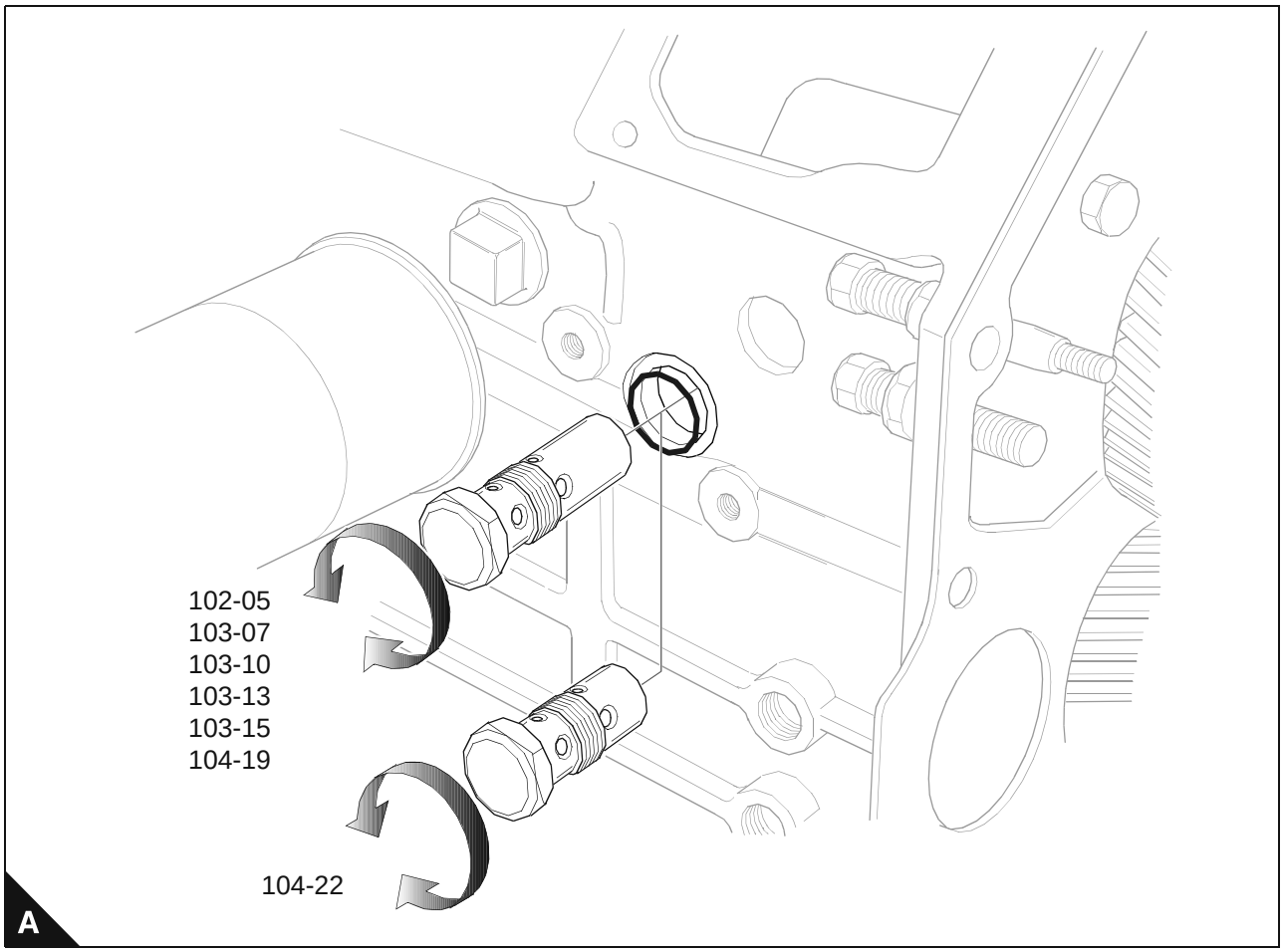
To remove and to fit **Operation 10-2**

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.*



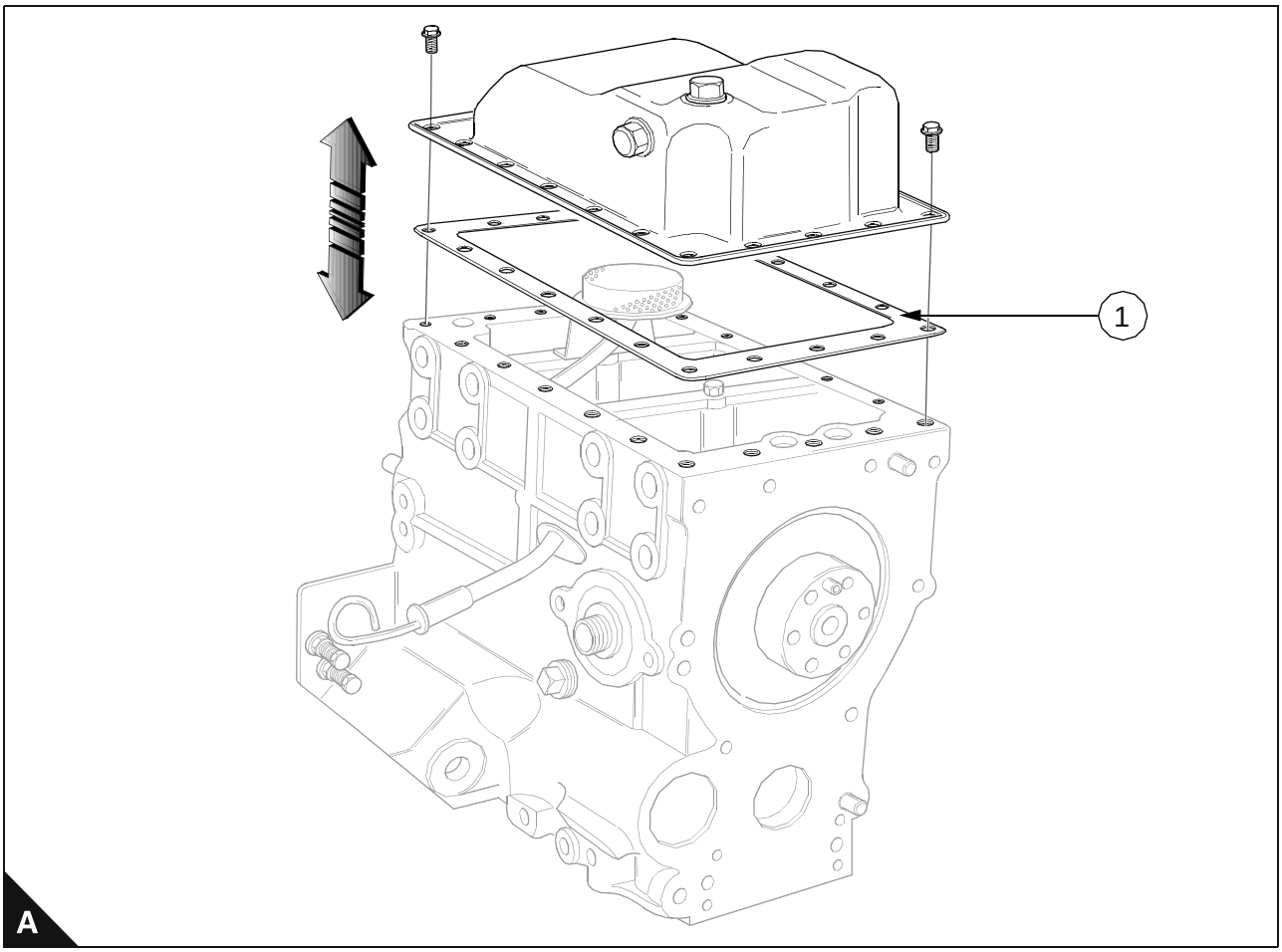
Lubricating oil sump

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).



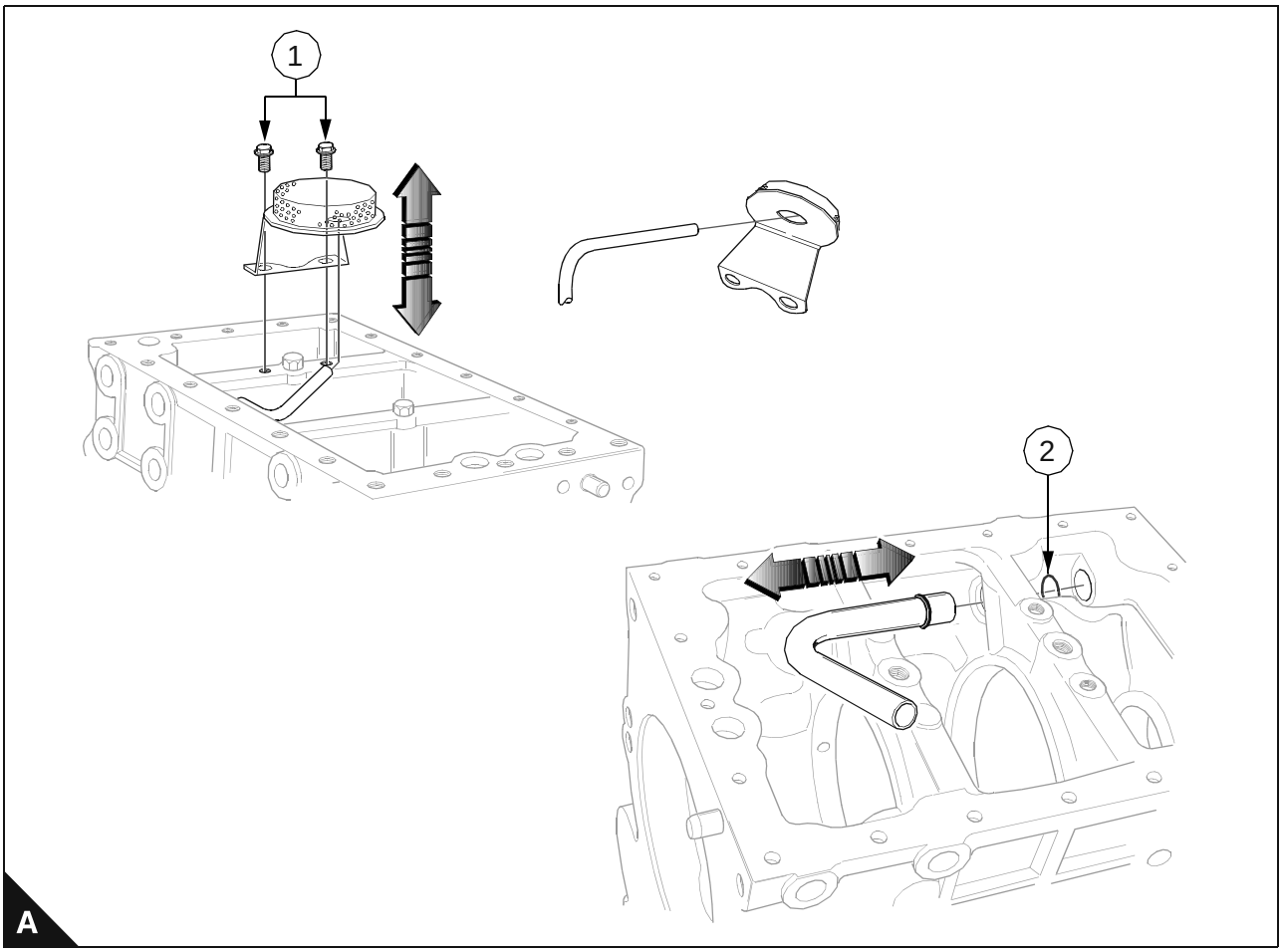
Strainer and suction pipe

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).

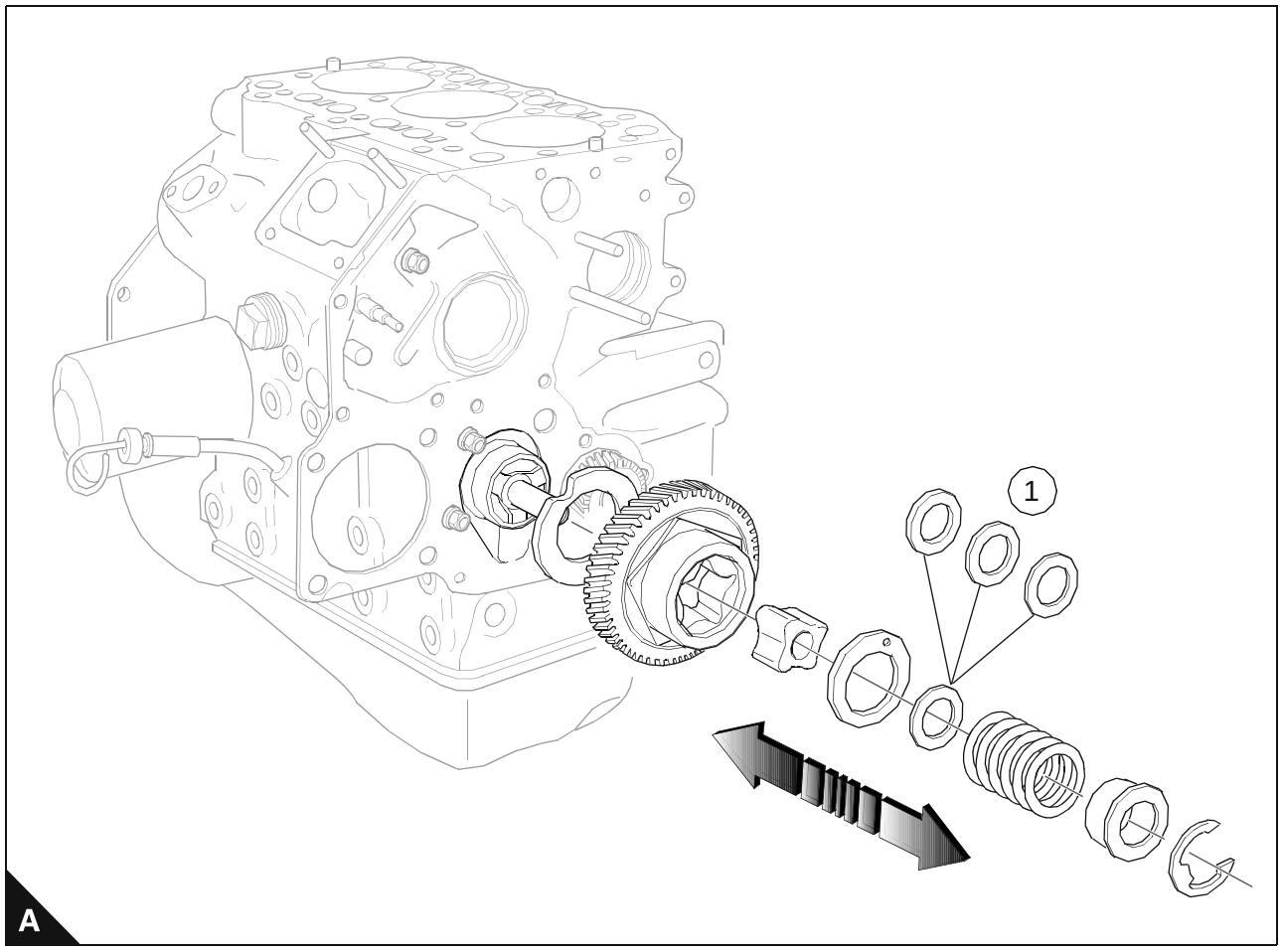


Lubricating oil pump

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

For the tolerances see "Idler gear and oil pump" on page 70 and "Oil pump end float" on page 73.

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



Oil pressure switch

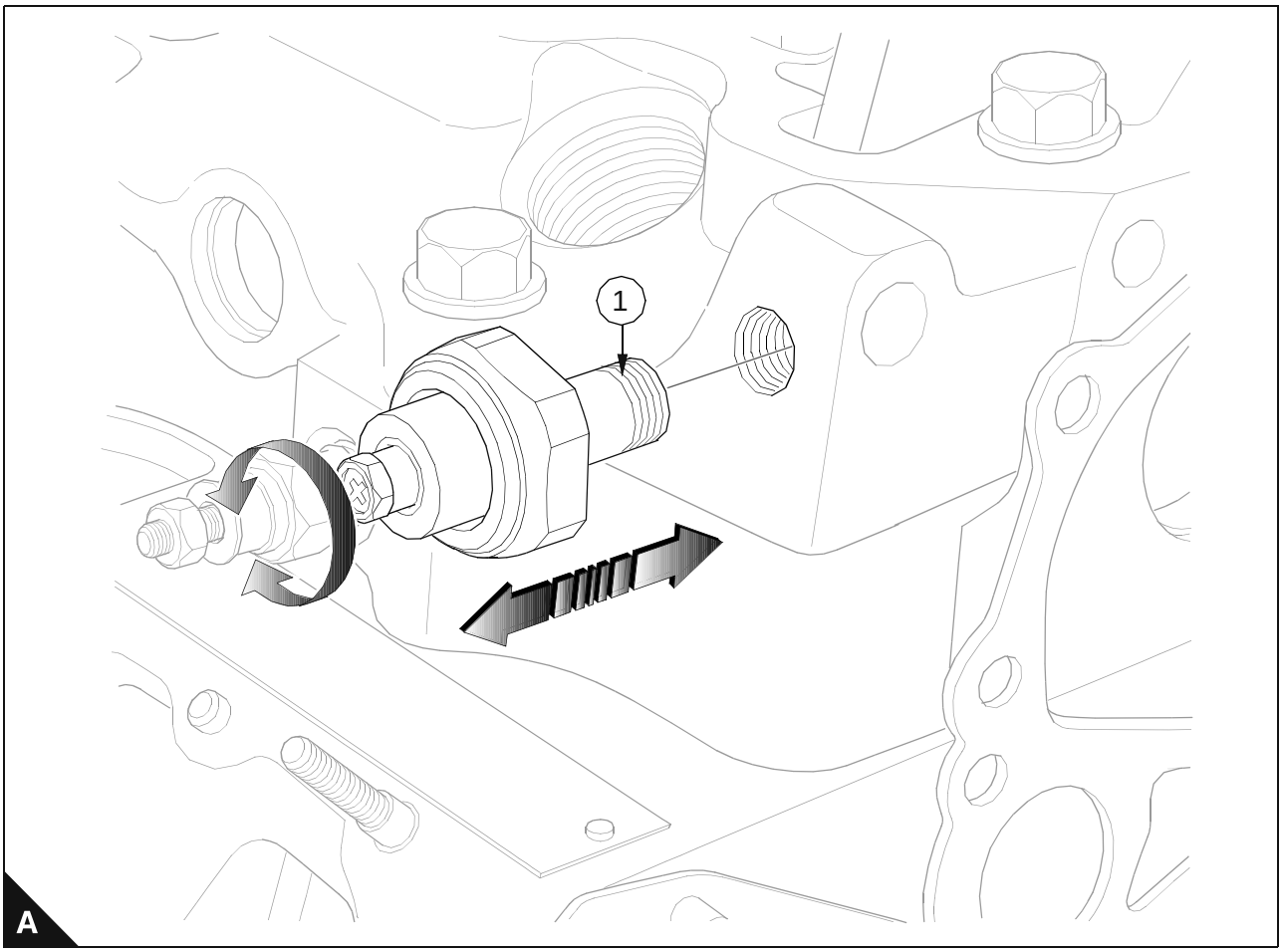
To remove and to fit **Operation 10-6**

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 and to fit **Operation 11-1**

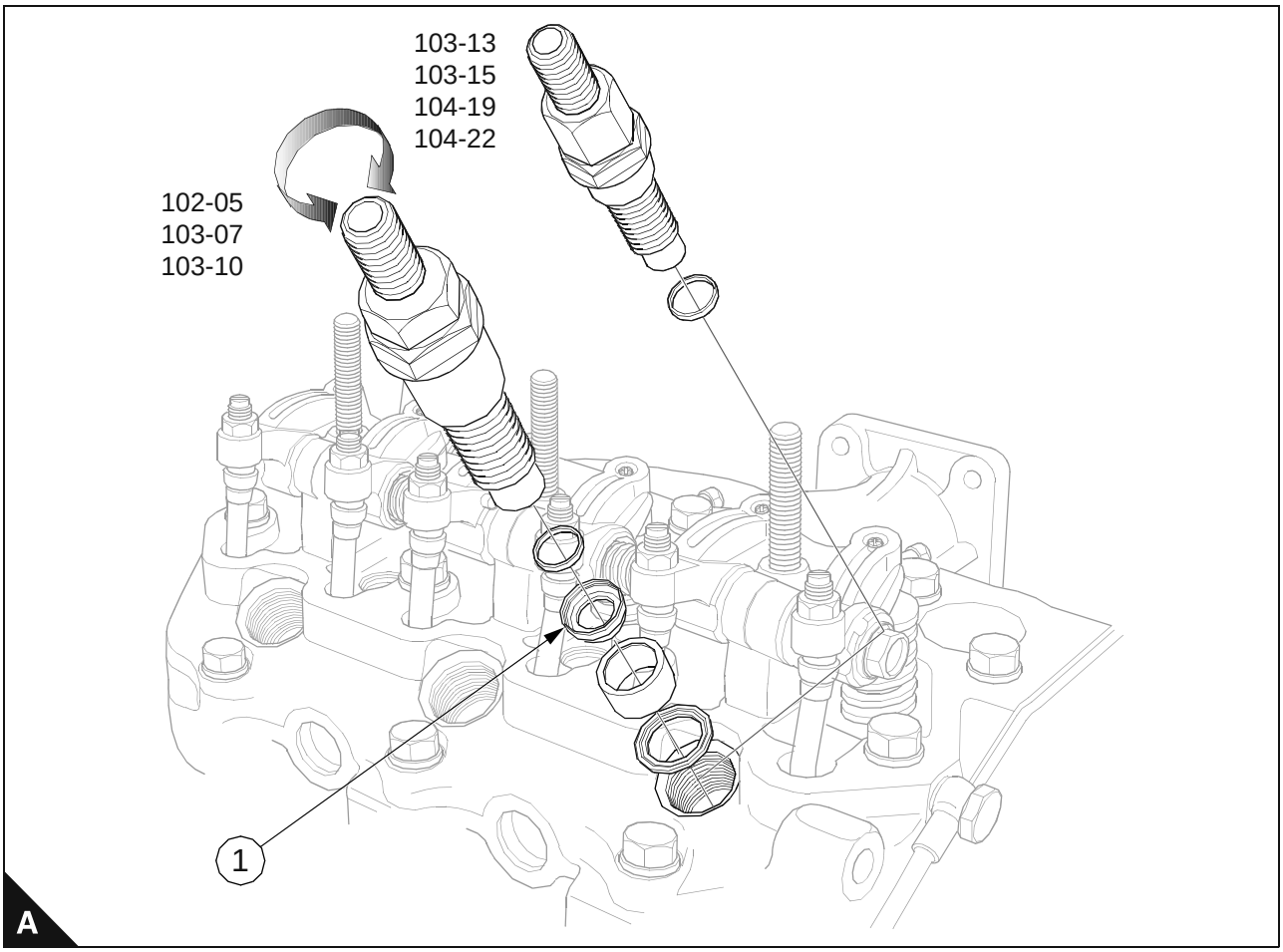
Special requirements

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

***Cautions*:**

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

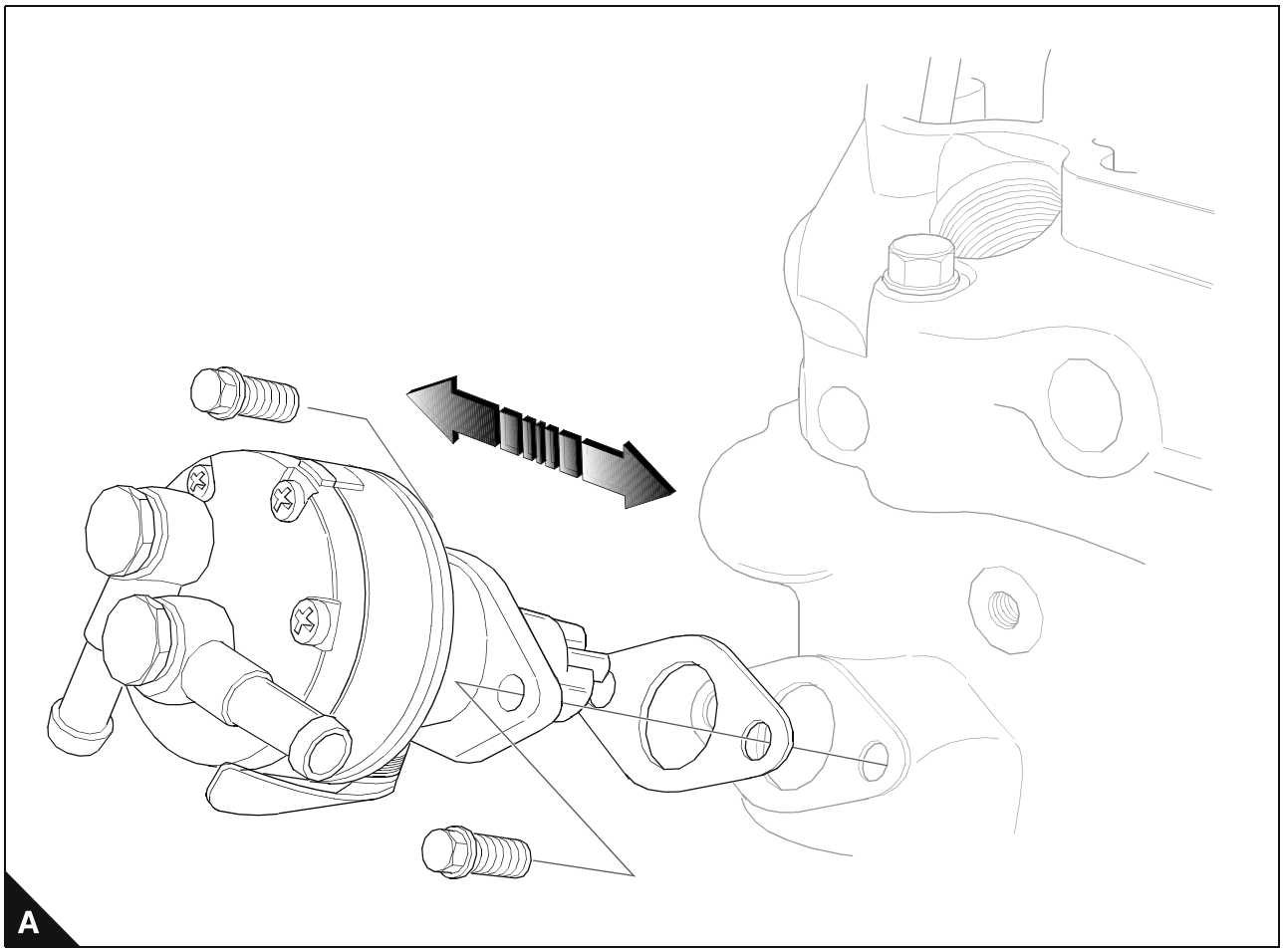
Note: Item (A1) is used on 103-10 engines only.

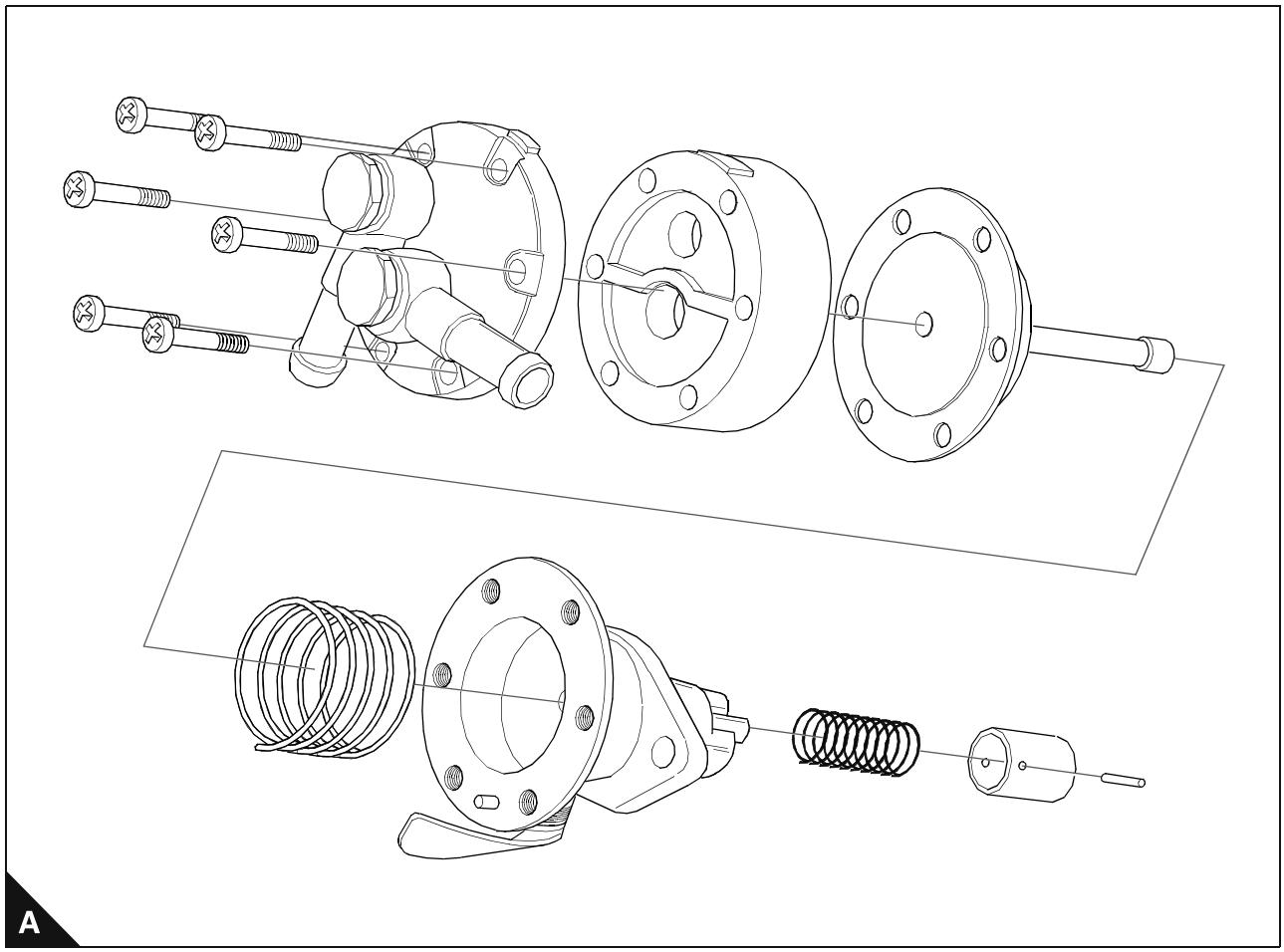


Fuel lift pump

To remove and to fit **Operation 11-2**

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





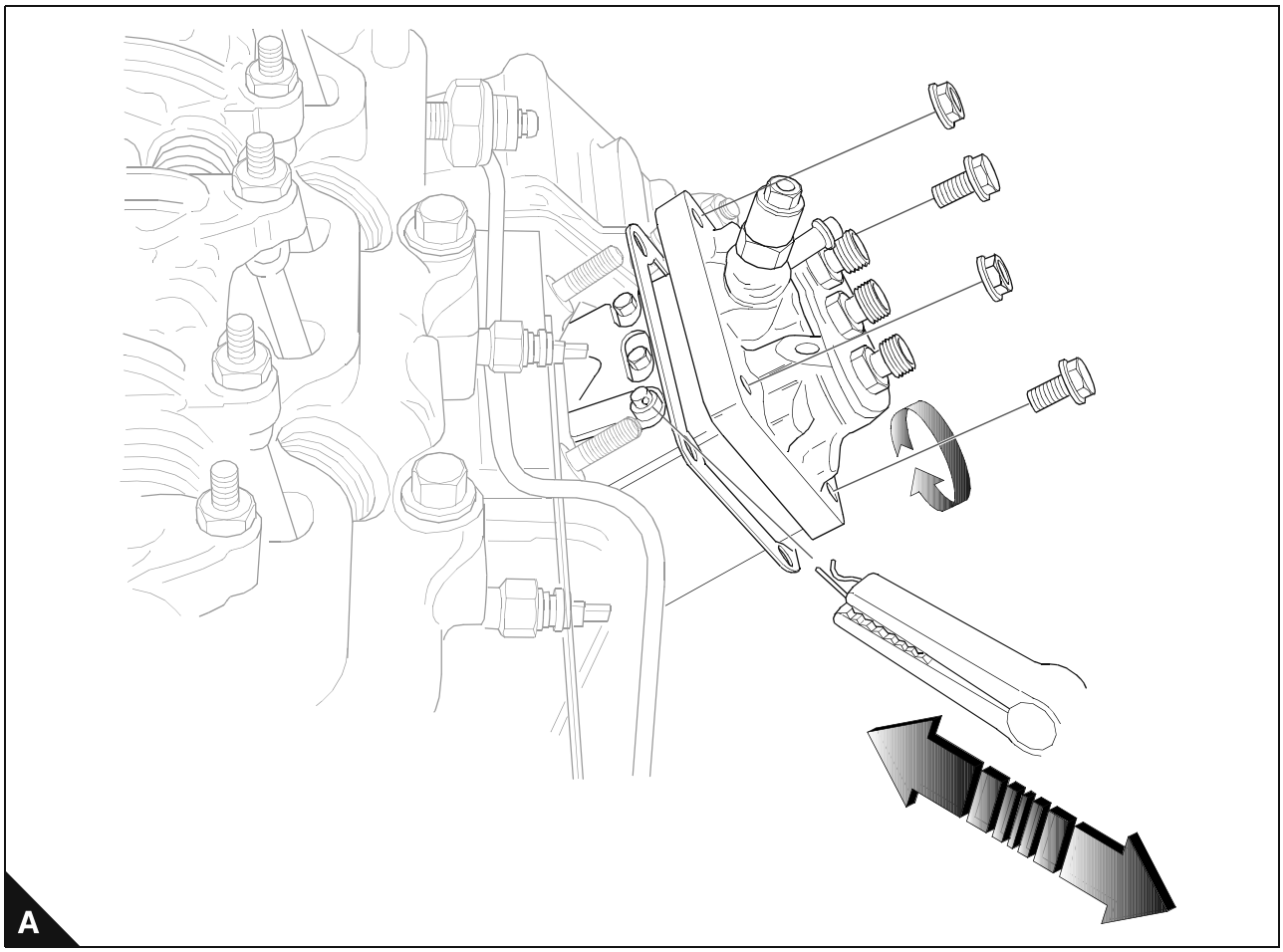
Fuel injection pump

To remove and to fit **Operation 11-4**

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.*



Vent points

To eliminate air from the fuel system **Operation 11-5**

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.

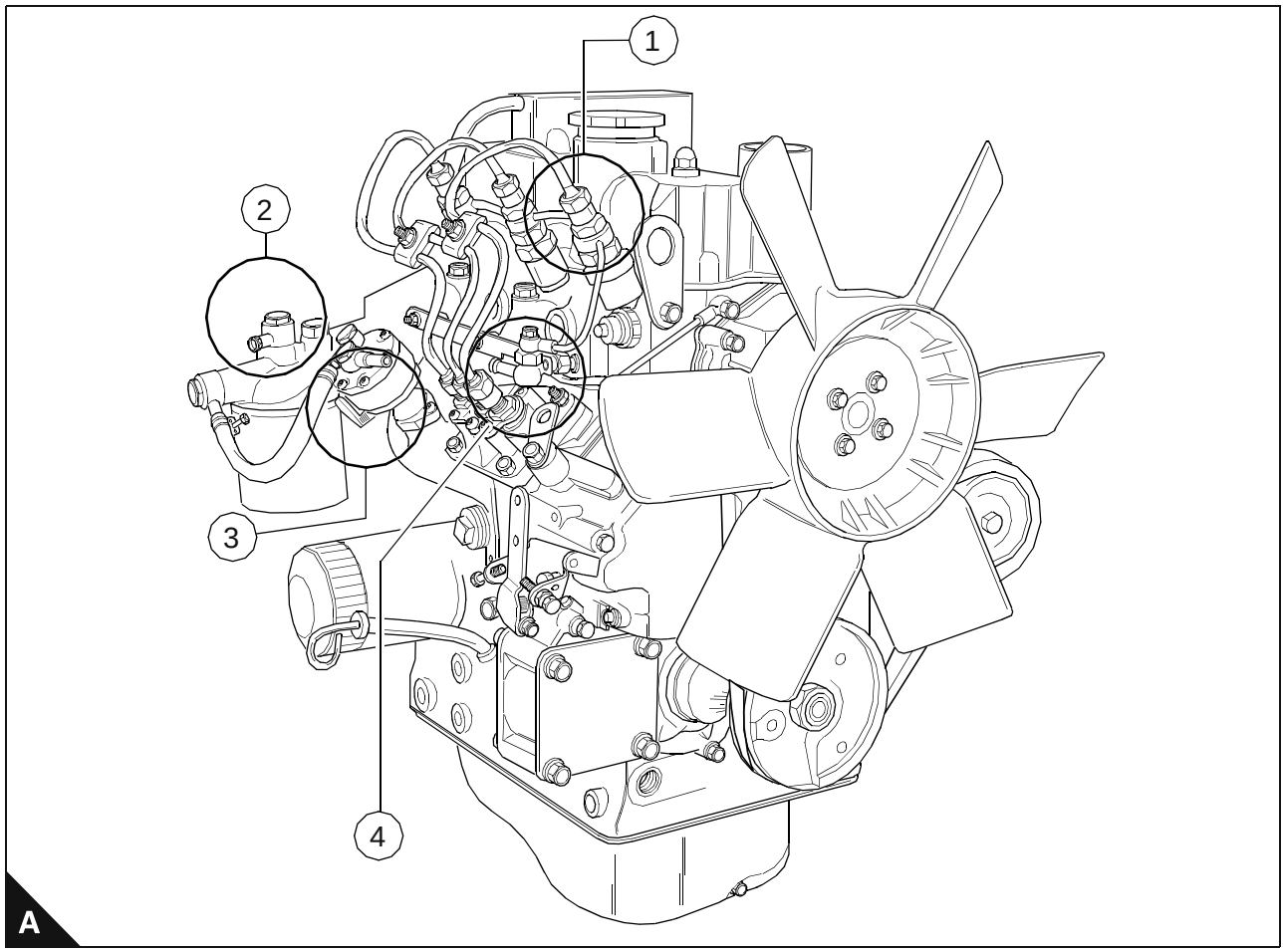
3 Operate the hand primer on lift pump until air free fuel flows. Tighten the vent screw.

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.*



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12

Cooling system

Fan and mounting

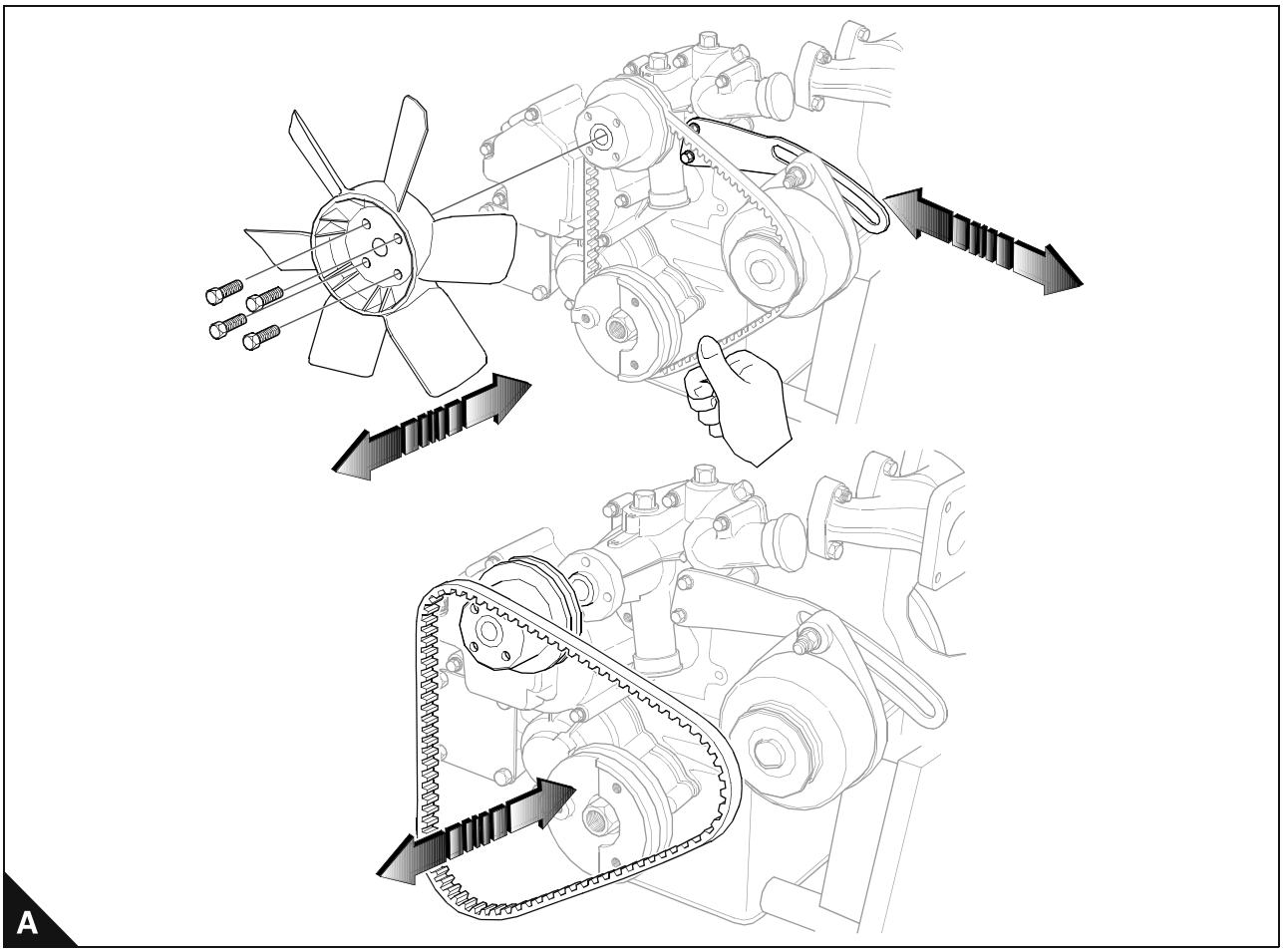
To remove and to fit **Operation 12-1**

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.



Water pump

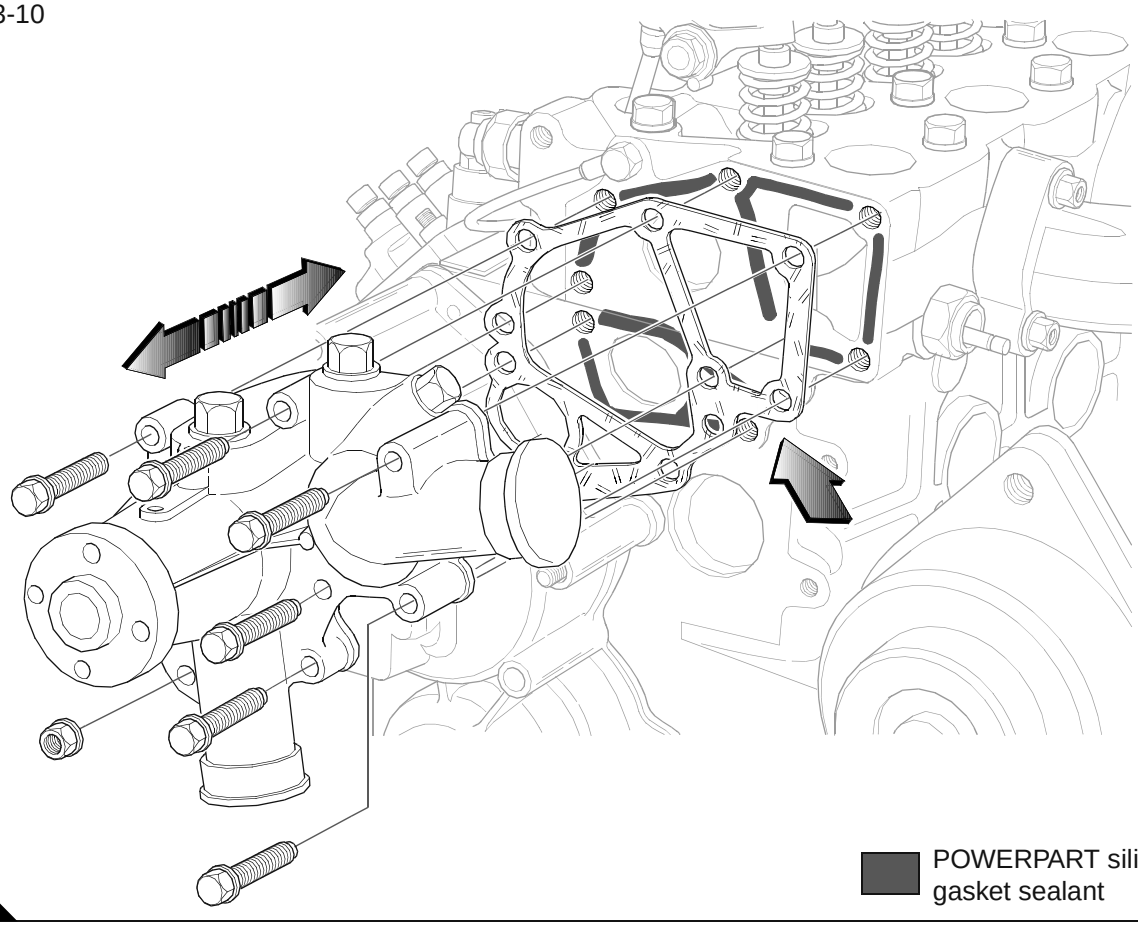
To remove and to fit **Operation 12-2**

Special requirements

POWERPART products	
Description	**Part number**
Silicone gasket sealant	21826046

Note: On assembly apply Powerpart silicone gasket sealant to cylinder block of 102-05, 103-07 and 103-10 engines.

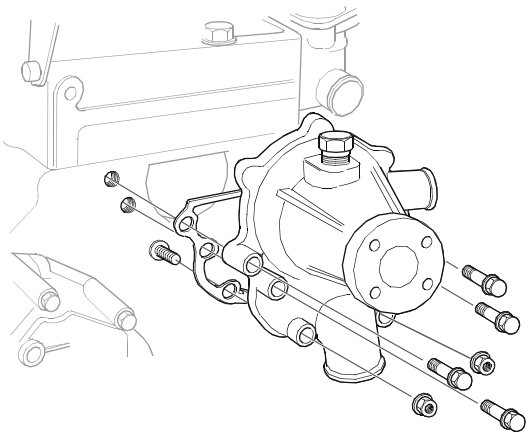
103-10



A

POWERPART silicone gasket sealant

102-05
103-07
103-13
103-15
104-19
104-22



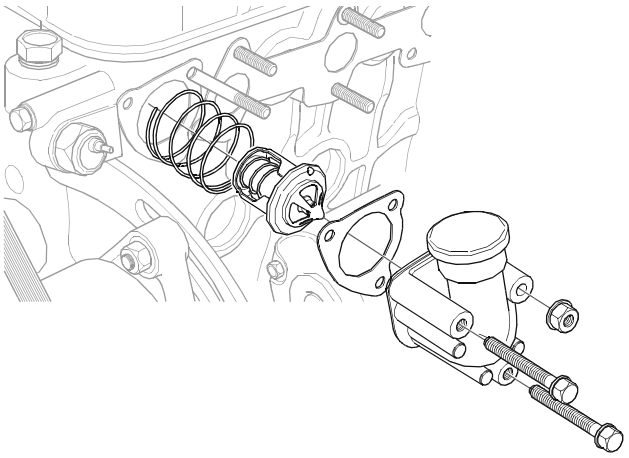
B

Thermostat

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

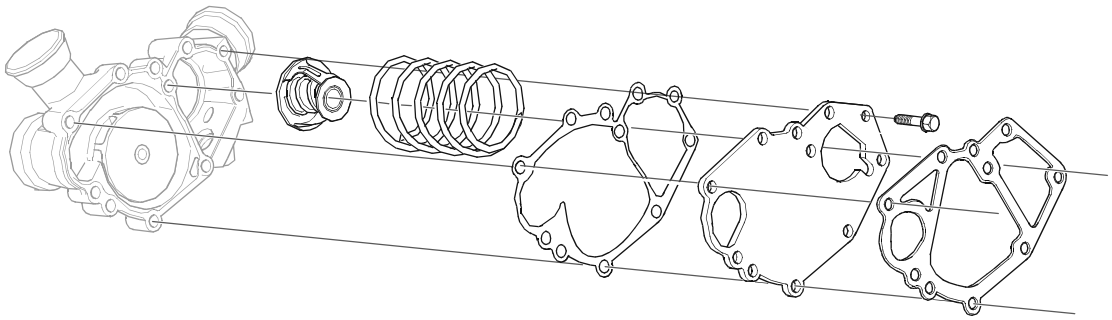
Note: The vent hole on the thermostat must be set to the "12 o'clock" position.

102-05
103-07



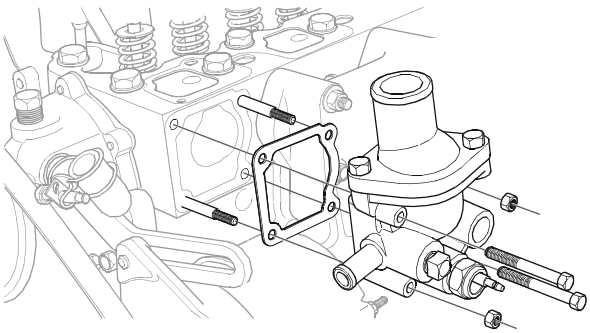
A

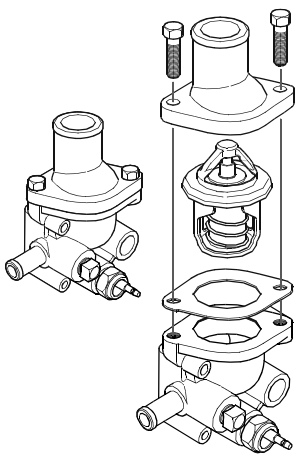
103-10



B

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





C

To test and inspect **Operation 12-4**

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:

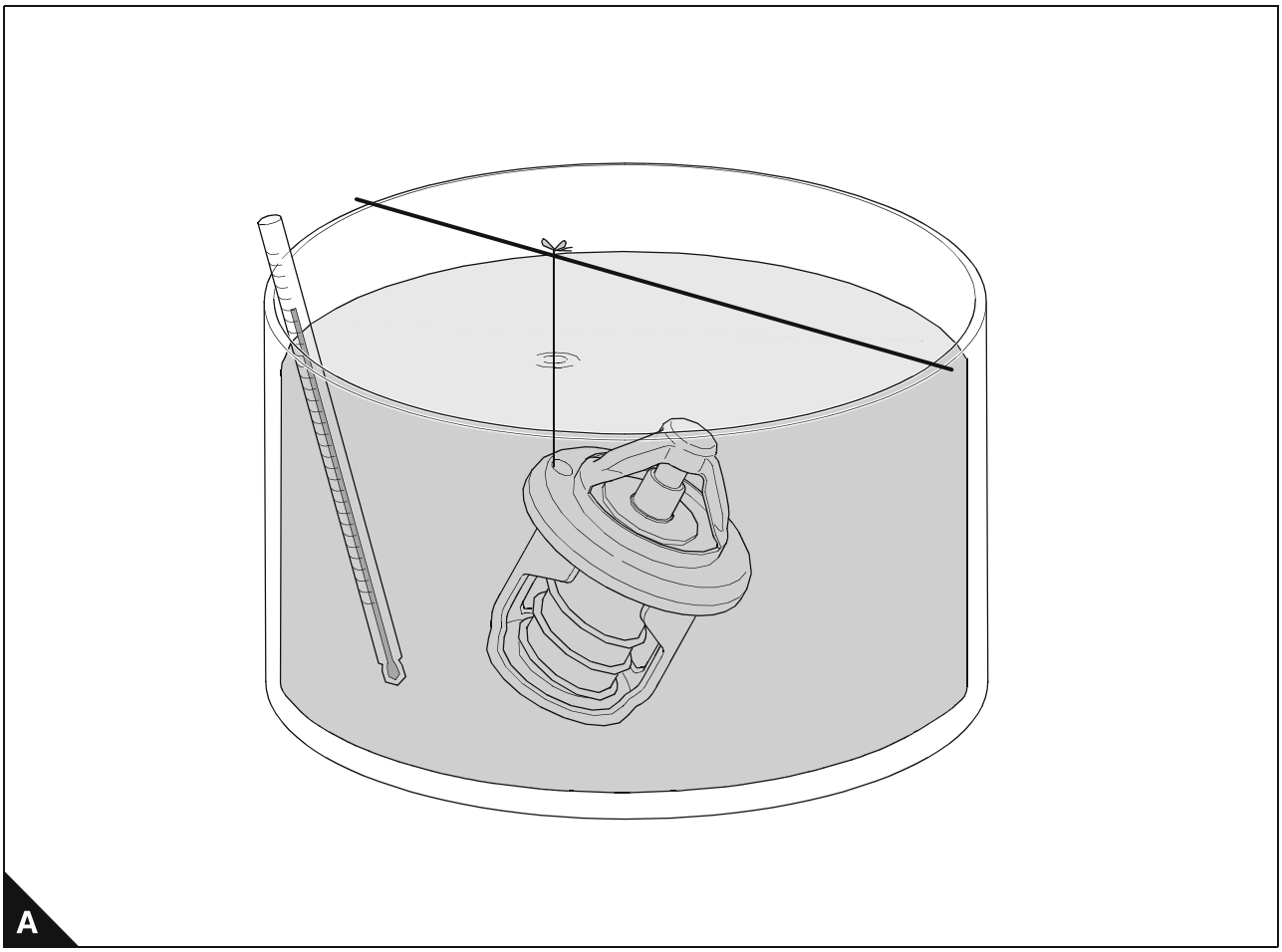
- Open at ambient temperature.
- Closed at the fully open temperature.

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.



A

13

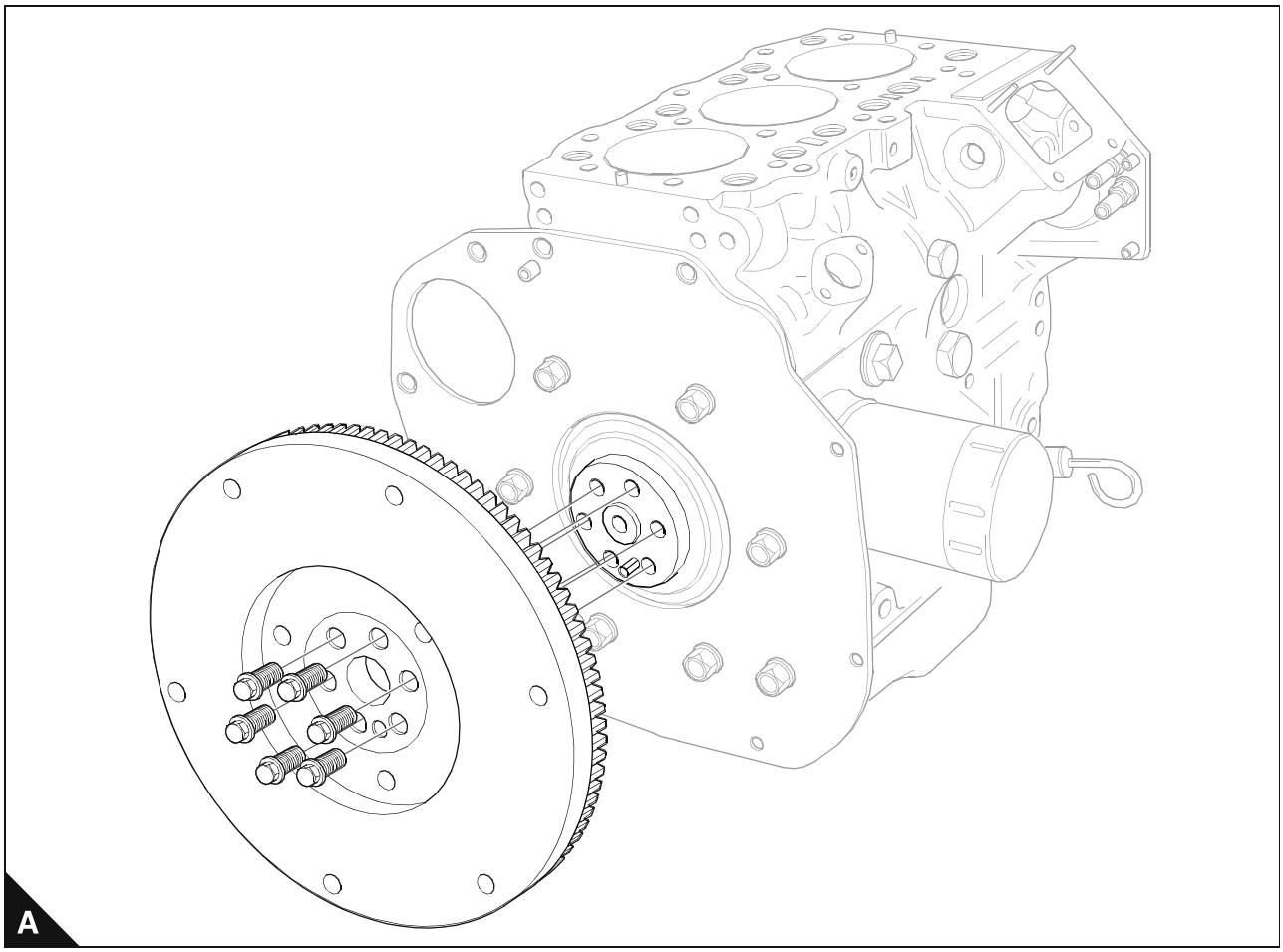
Flywheel and housing

Flywheel

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

Special requirements

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

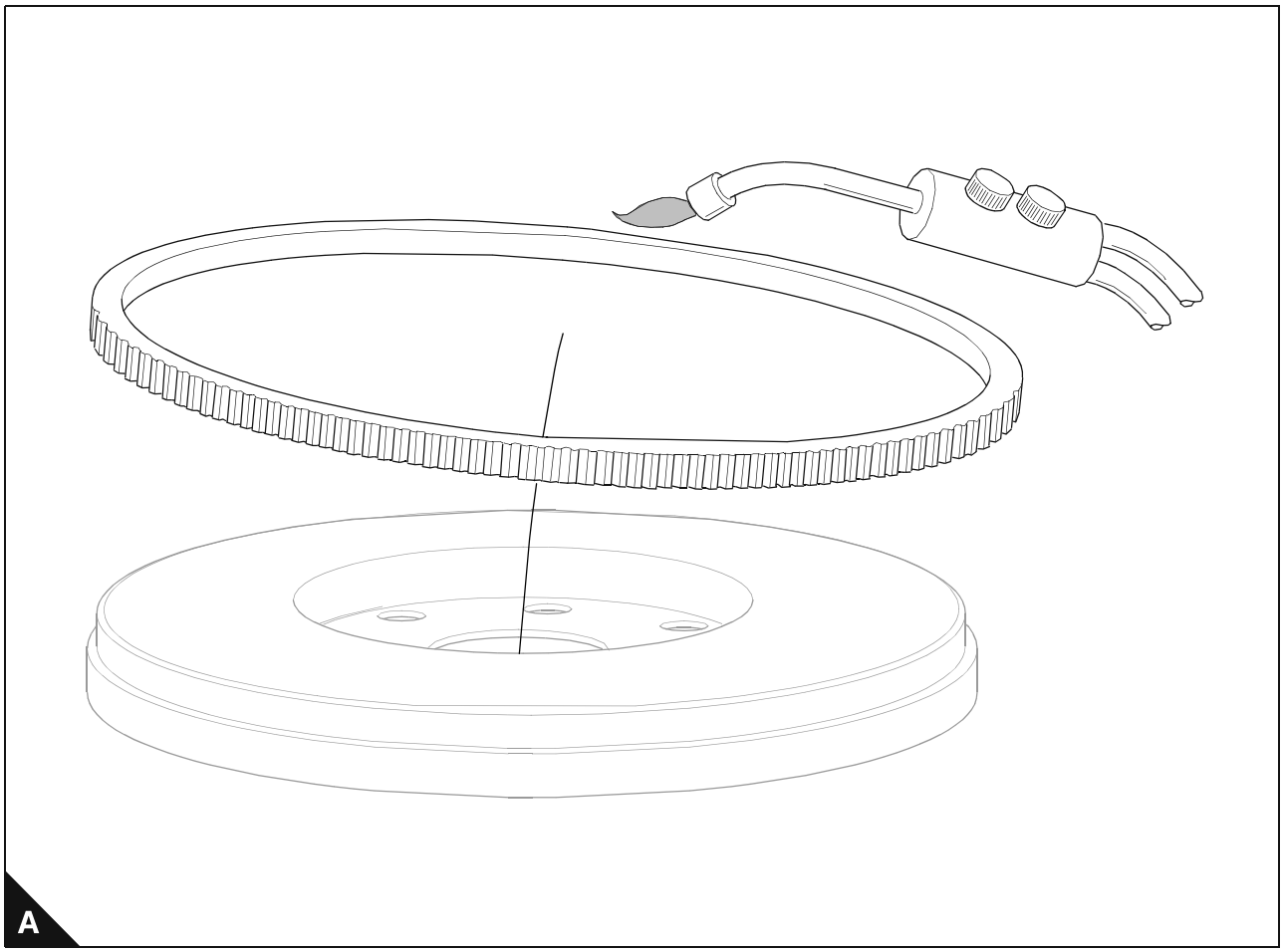


To inspect **Operation 13-2**

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.*



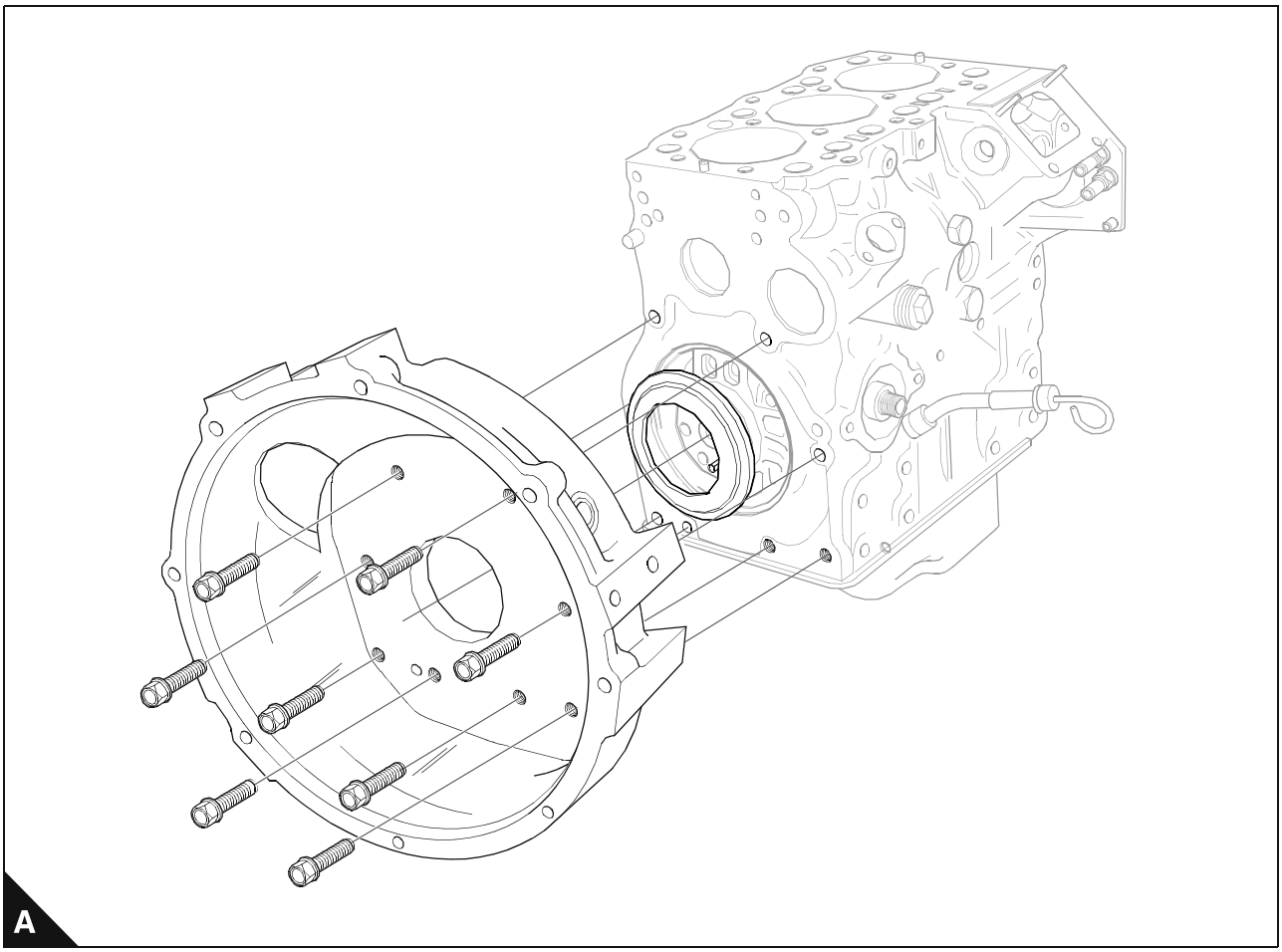
Flywheel housing (if fitted)

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

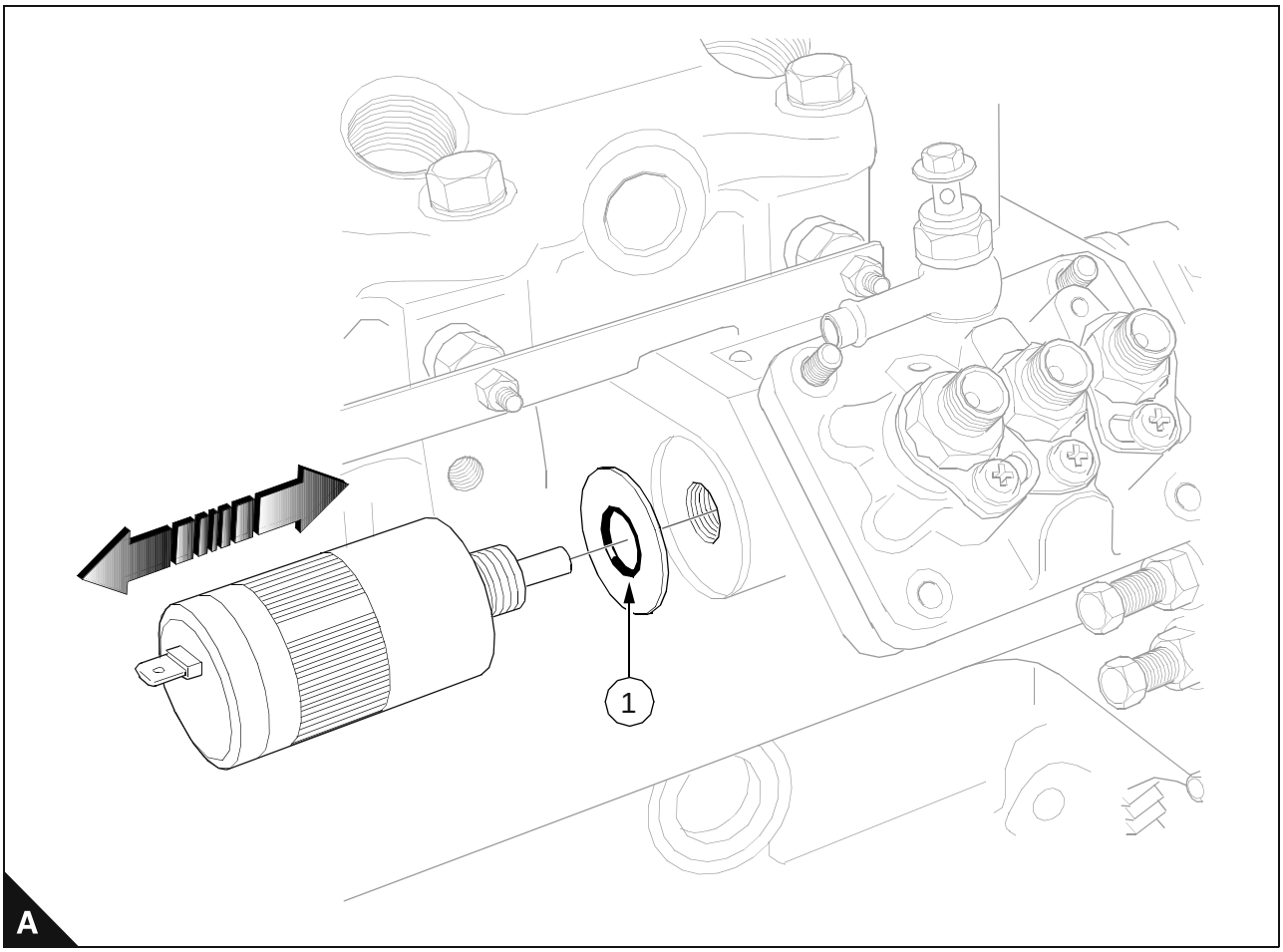
Electrical shut off solenoid (ESOS)

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

Special requirements

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

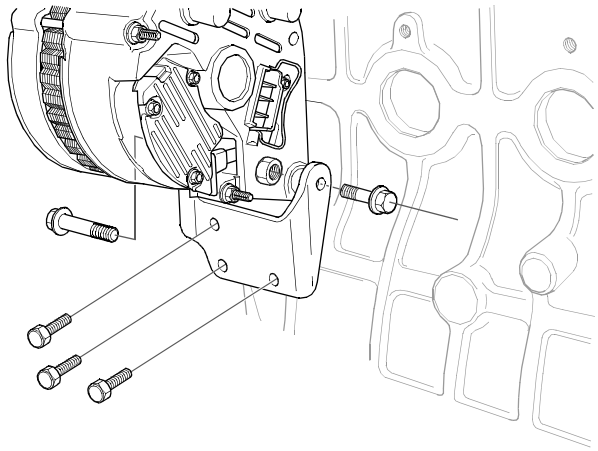
Note: Remember the location of special washer (A1).



Alternator

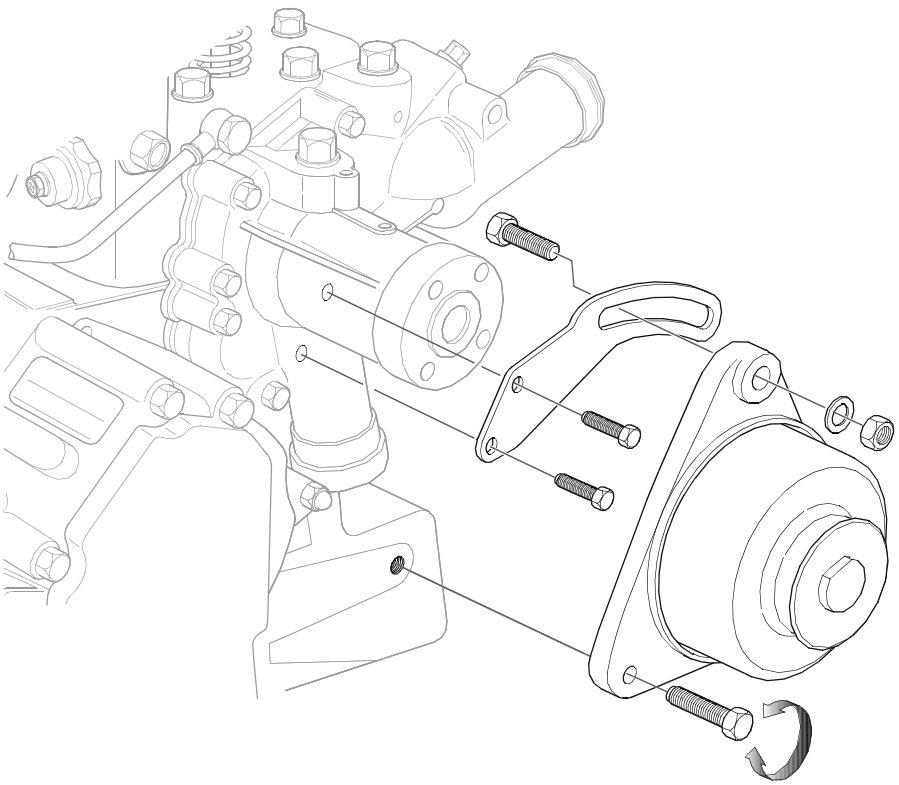
To remove and to fit **Operation 14-2**

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



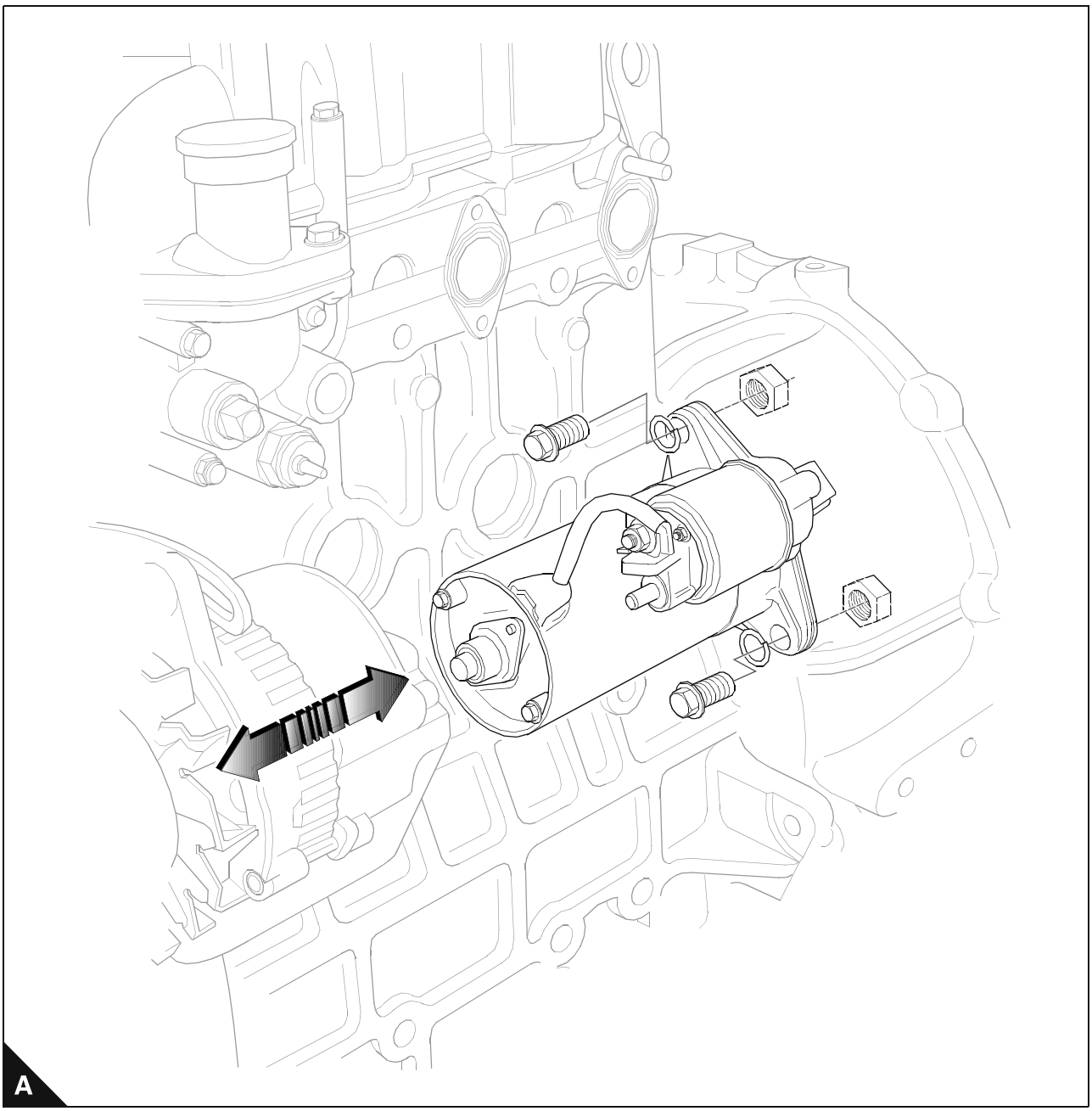
A

102-05
103-07
103-10



B

To remove and to fit **Operation 14-3**



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 Ω (2 cyl) 0.033 Ω (3 cyl)	0.5 Volt	See Glow Plugs Circuit
Starter motor solenoid	4, 5, 6	15.75 amp	0.04 Ω	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 Ω (2 cyl) 0.0128 Ω (3 cyl)	0.5 Volt	

Wiring diagram maximum circuit resistance

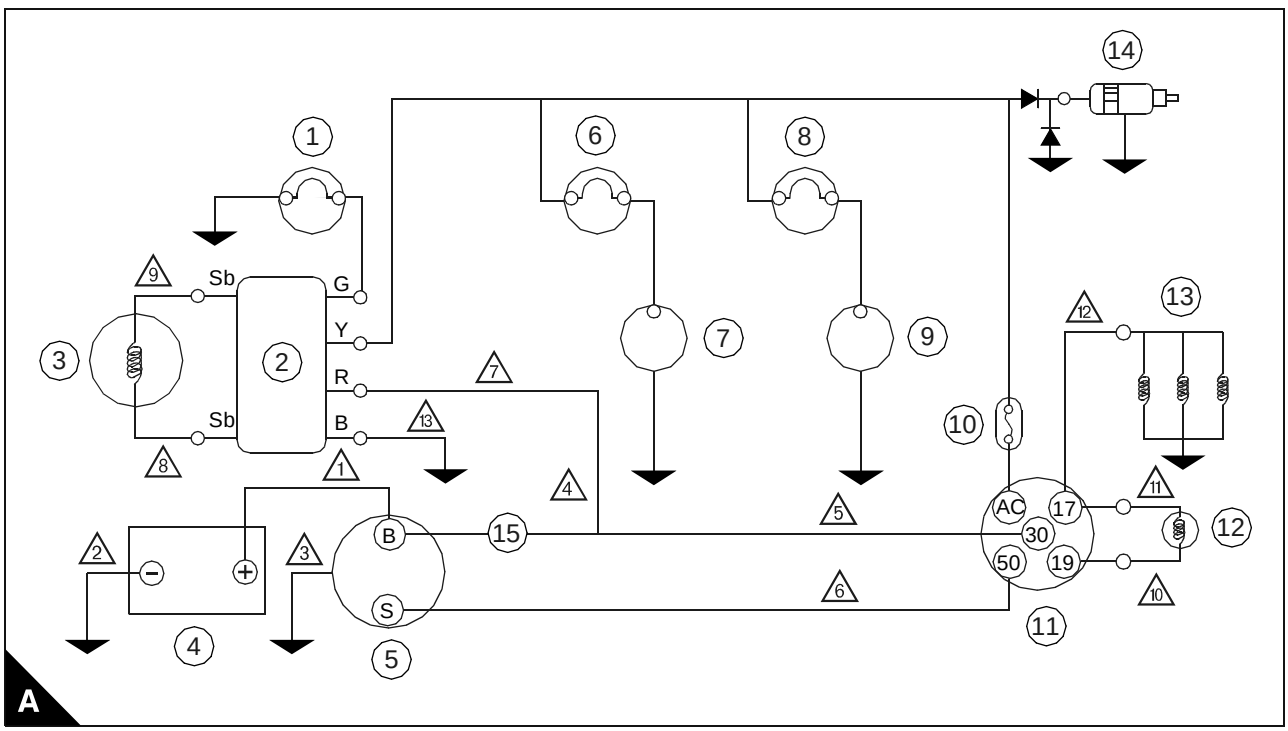
The resistance of battery cables 1, 2 and 3 must not exceed 0.0018 Ω.

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

1 Alternator warning lamp
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 Ωs	0.5 Volt	See Glow Plugs Circuit
Starter motor solenoid	4 5 6	15.75 amp	0.04 Ωs	0.63 Volt	See Glow Plug Circuit
STD glow plugs (via glow signal)	4 5 8 9 10	(Peak max) 39 amp	0.0128 Ωs	0.5 Volt	

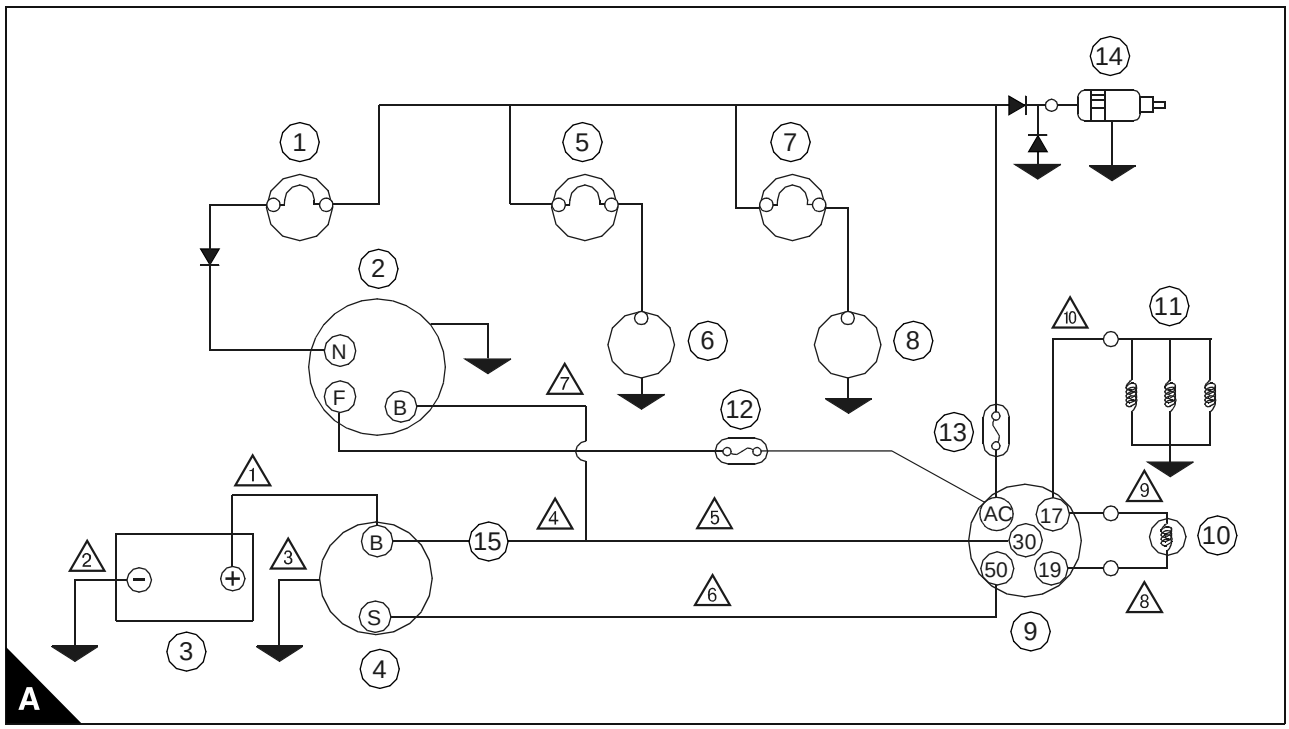
Wiring diagram maximum circuit resistance

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

1 Alternator warning lamp
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 Ω	0.5 Volt	See Glow Plugs Circuit
Starter motor solenoid	△4 △5 △6	15.75 amp	0.04 Ω	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 Ω (3 cyl)s 0.0096 Ω (4 cyl)s	0.5 Volt	

Wiring diagram maximum circuit resistance

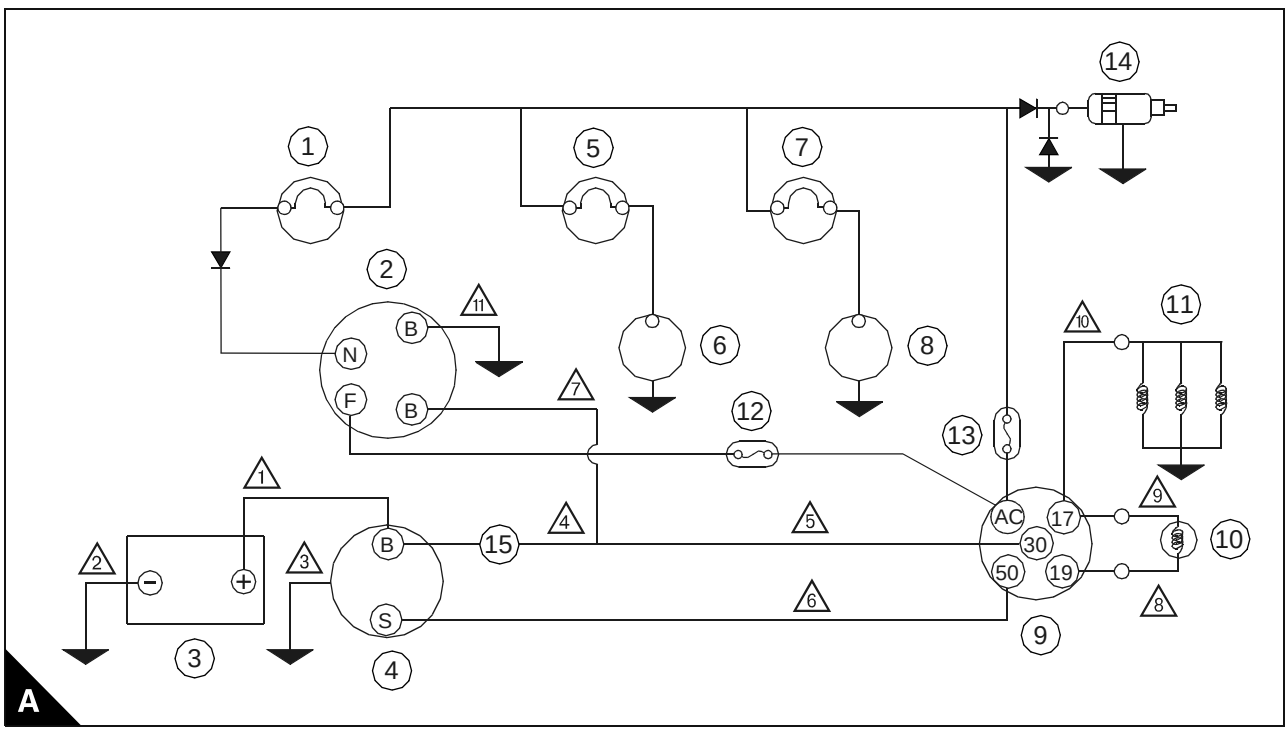
The resistance of battery cables 1, 2 and 3 must not exceed 0.0018 Ω.

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 Ω	0.5 Volt	See Glow Plugs Circuit
Starter motor solenoid	△4 △5 △6	15.75 amp	0.04 Ω	0.63 Volt	See Glow Plugs Circuit
STD glow plugs (via glow signal)	△4 △5 △8 △9 △10	(Peak max) 39 amp	0.0128 Ω	0.5 Volt	

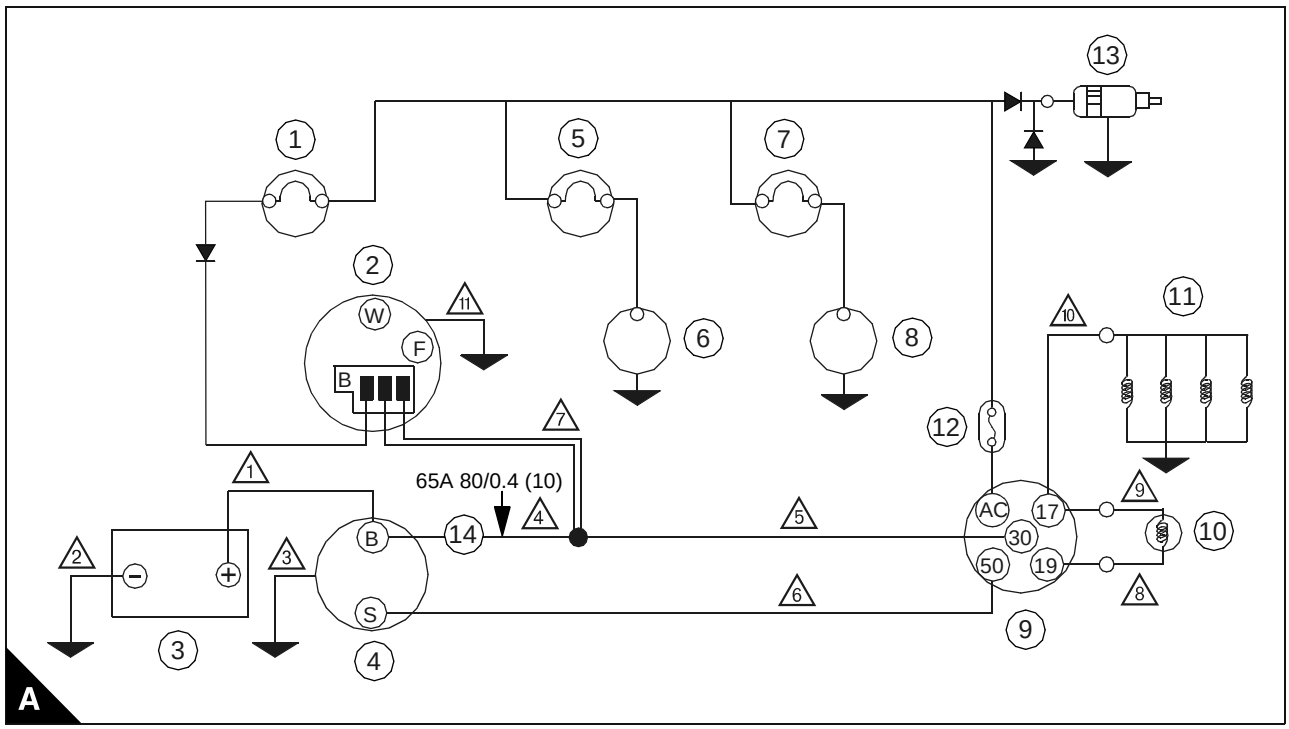
Wiring diagram maximum circuit resistance

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

1 Alternator warning lamp
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

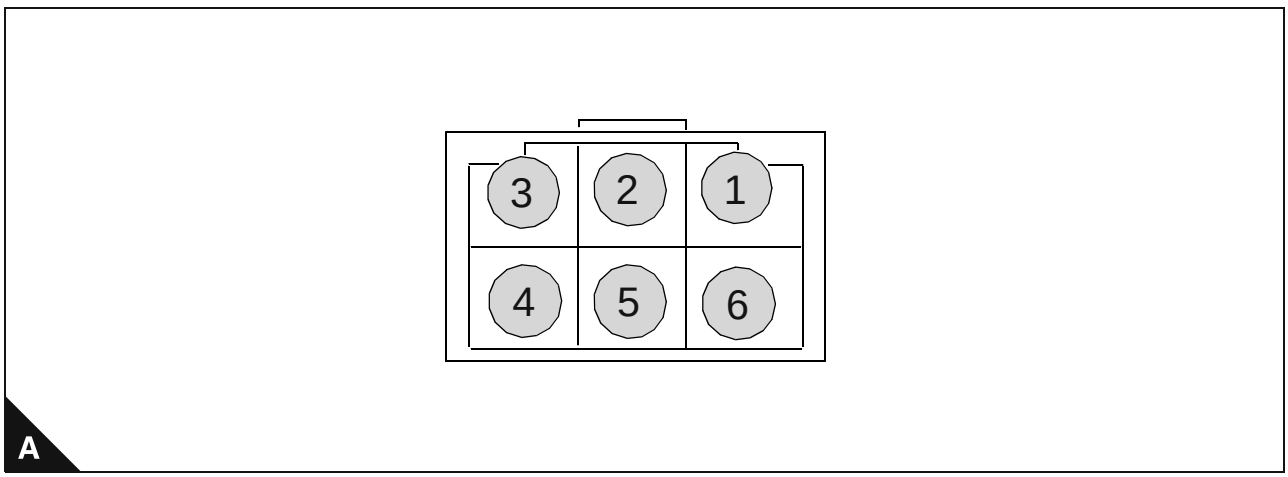
55 Amp alternator charge lamp

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 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

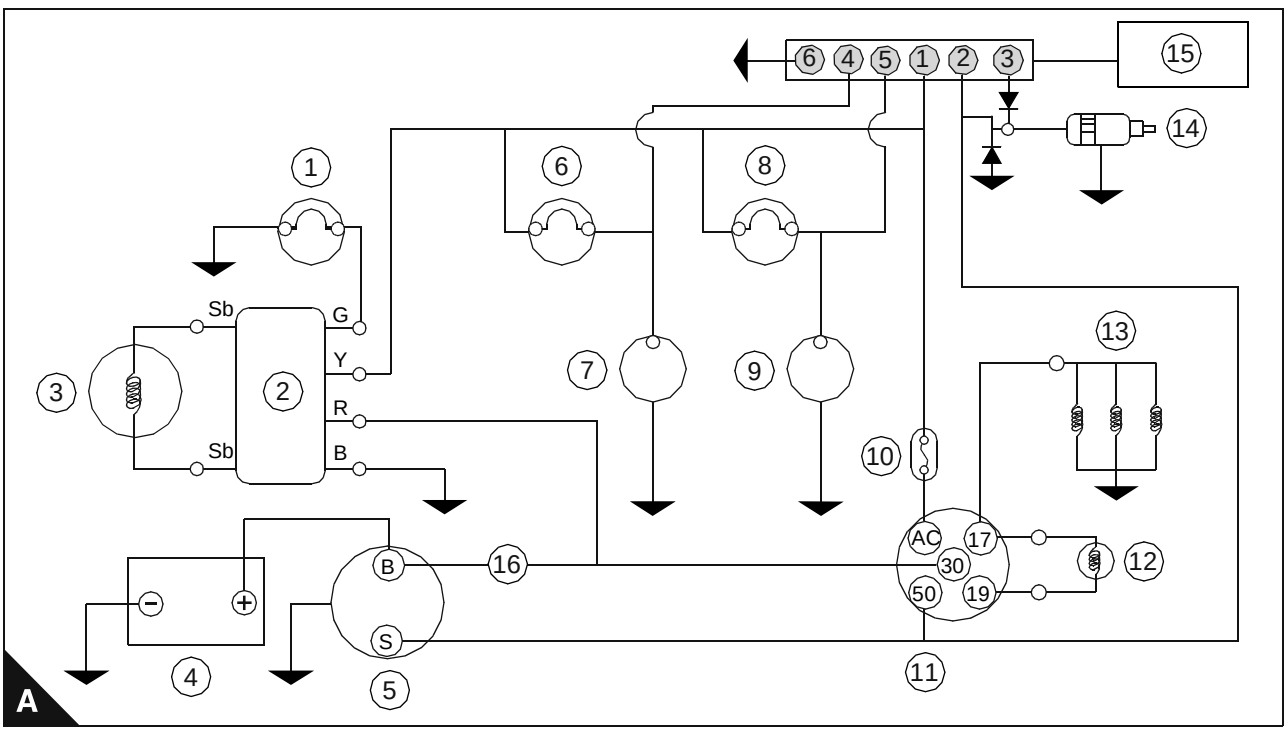
Water temperature switch: If the water temperature exceeds 105 °C ± 4 °C.

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

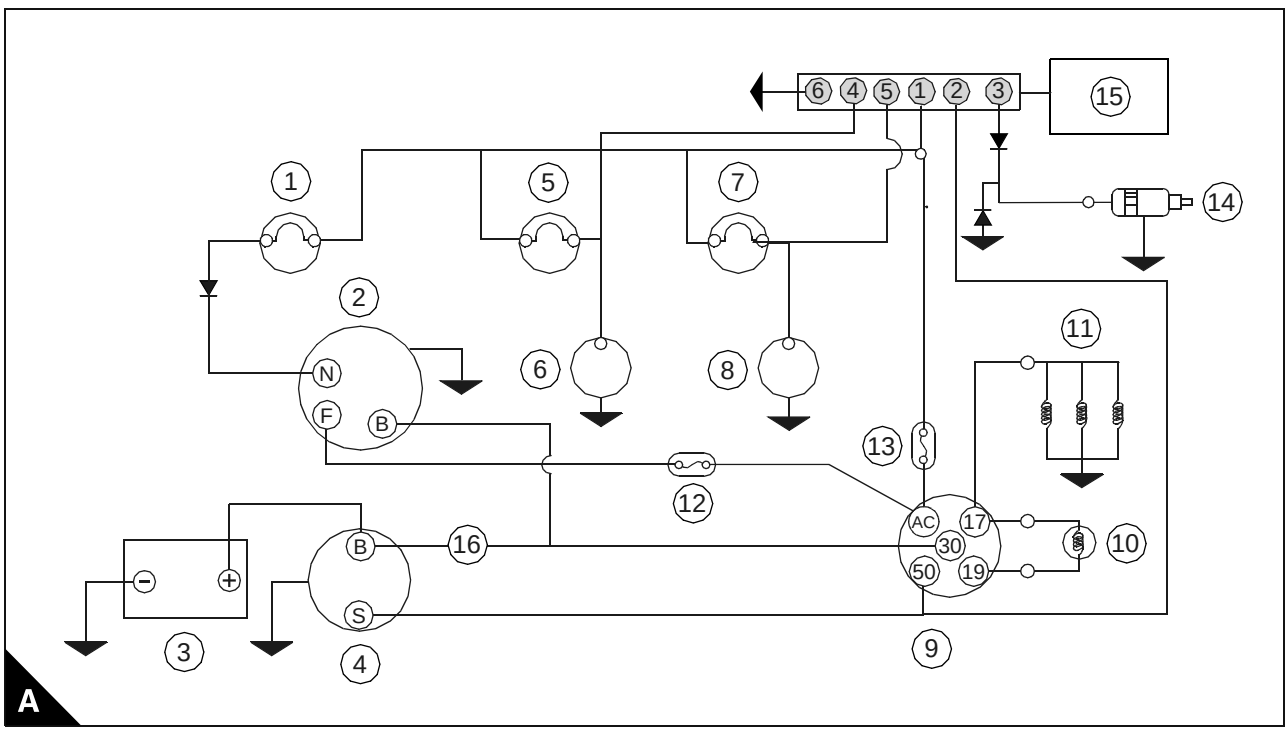
Water temperature switch: If the water temperature exceeds 105 °C ± 4 °C.

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

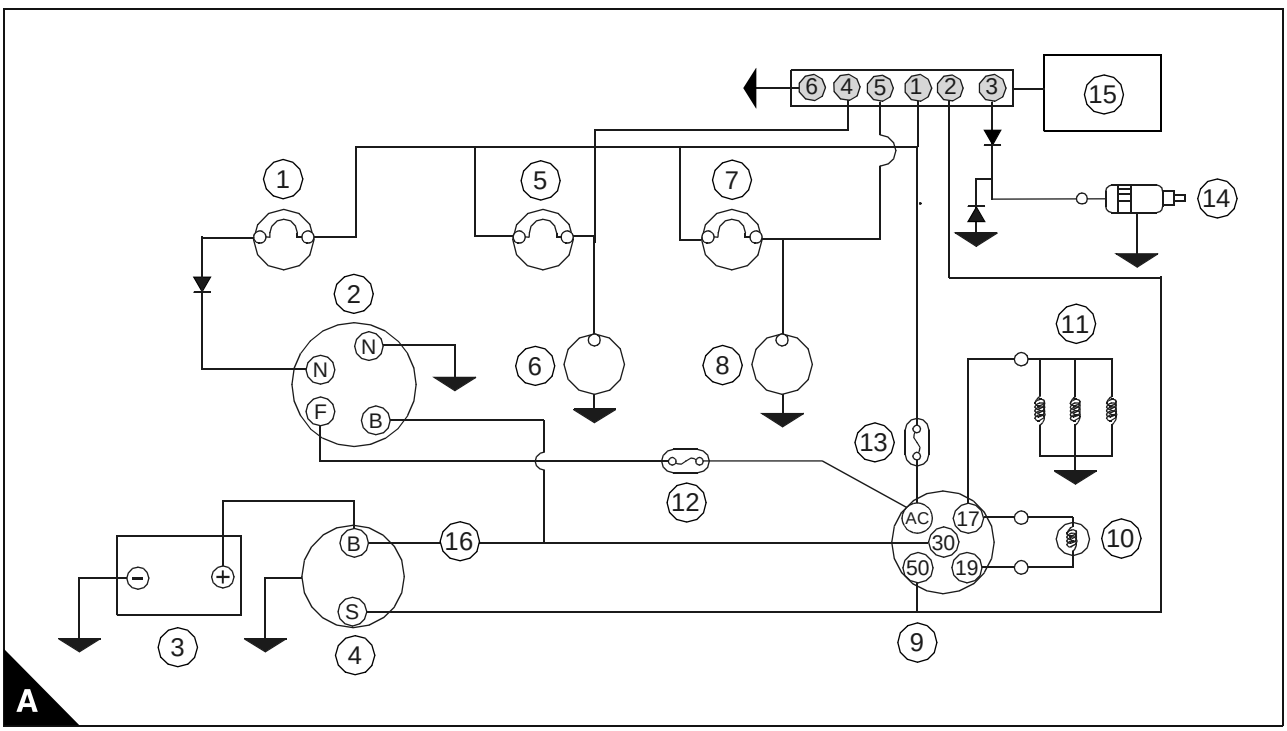
Water temperature switch: If the water temperature exceeds 105 °C ± 4 °C.

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

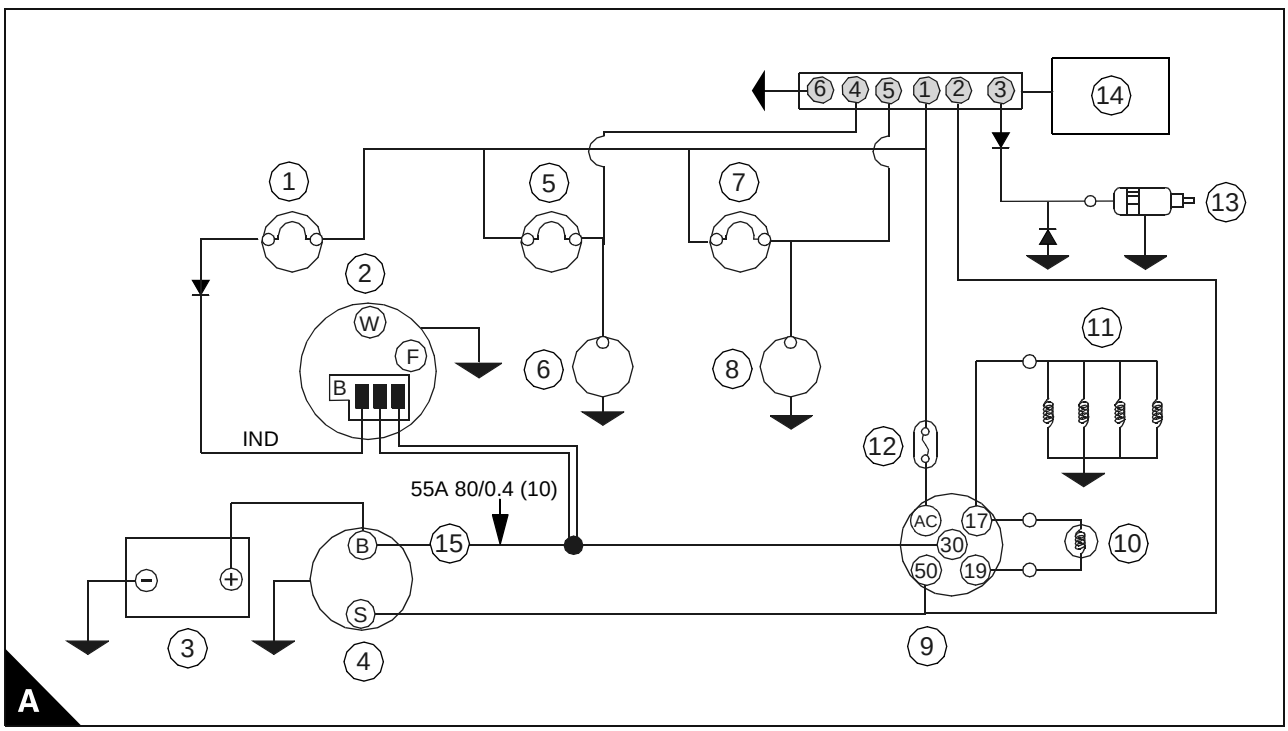
Water temperature switch: If the water temperature exceeds 105 °C ± 4 °C.

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)**.



15

Auxiliary equipment

Not available

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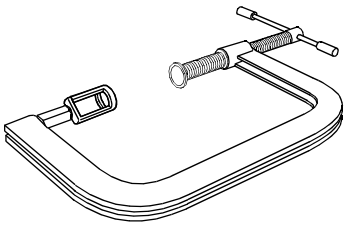
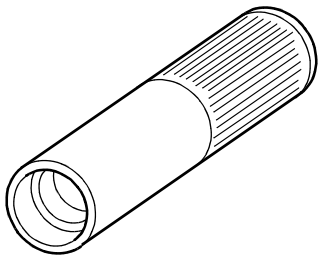
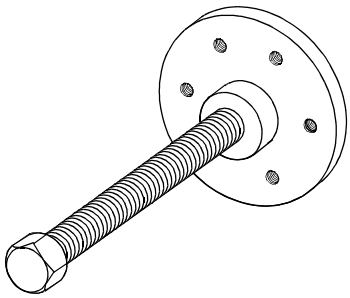
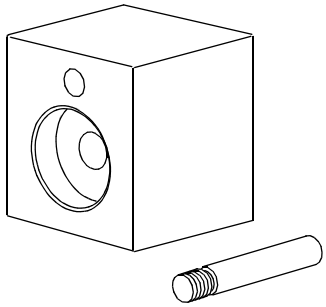
16

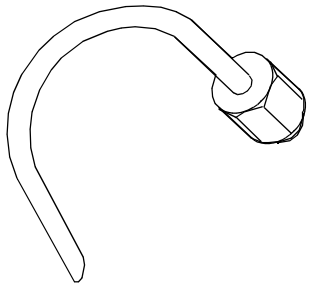
Special tools

Special tools list

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

The Perkins Service Department, Peterborough, PE1 5NA, England, UK. Tel +44 1733 583000, Fax +44 1733 582240, Telex 32501 PERKEN G.

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