GENERAL

TO THE USER

This Workshop Manual is intended to assist with workshop operations and repair work.

Citius series engines (types 44, 49, 66, 74 and 84) are generally of the same construction, so the same repair instructions will usually apply to various engine types. The differences between the various engine types, which affect repair work, are mentioned in the technical data and repair instructions. All measurements are in millimetres and valid when the temperature of the parts is +20°C, unless otherwise stated.

Before starting any repair work, please read the safety instructions at the beginning of this book. Make sure that you have all the necessary tools, parts and accessories to hand. The special tools mentioned in the work instructions are not all essential, but they speed up and facilitate the work and contribute to successful execution of the work. An engine which has undergone repairs must be run in just like a new one.

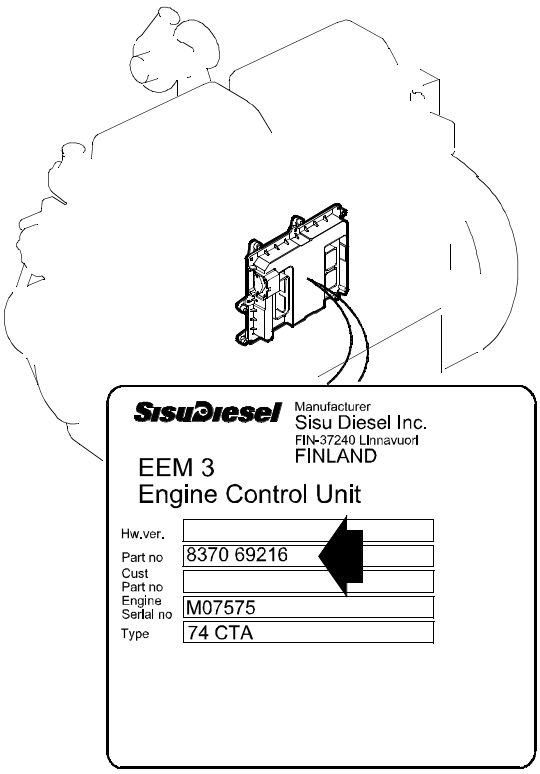
Should the engine require work not described in this manual, please consult your local agent or the Service Department of Sisu Diesel Inc., Linnavuori, Finland. To facilitate consulting, find out the following facts about the engine before contacting us:

- engine type
- engine number
- model or equipment
- hours operated or kilometres driven.

This Workshop Manual does not cover the regular service procedure as this is explained in the Citius series Instruction Manual.

MARKING OF THE EEM 3 CONTROL UNIT

The model specification is indicated on the type plate of the EEM 3 control unit. This specification must always be stated when ordering a control unit or requesting adjusted settings.



Note! The engine meets EU97/68/EC Stage IIIA and EPA 40 CFR 89 Tier 3 emission requirements.

Do not fit any components on the engine other than those originally intended for it. The use of parts other than original SisuDiesel spare parts will invalidate the responsibility of Sisu Diesel Inc. with respect to the fulfilment of the emission requirements.

LIFTING THE ENGINE

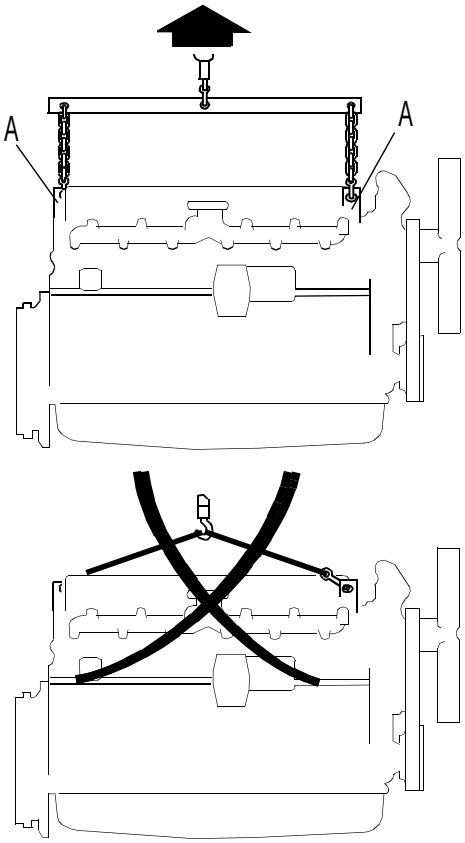
Safe lifting of the engine can be done using a lifting device with which the lifting force is applied vertically to the lifting ears.

Weight of engine

Engine type	Weight kg *)
44	345
49	345
66	515
74	525
84	650

*) Dry weight without flywheel and electrics

A = Engine lifting ears



The upper part has a wedge-shaped bearing location, in which the piston pin bearing bushing is fitted with a press fit.
The piston is made of a eutectic aluminium alloy. In the upper face of the piston there is a combustion chamber. The shape of the chamber is intended to maximise the mixture of air and fuel. The upper ring location is formed in a cast iron ring, which is cast in the piston. In addition, the piston is graphite-coated to ensure correct running-in.

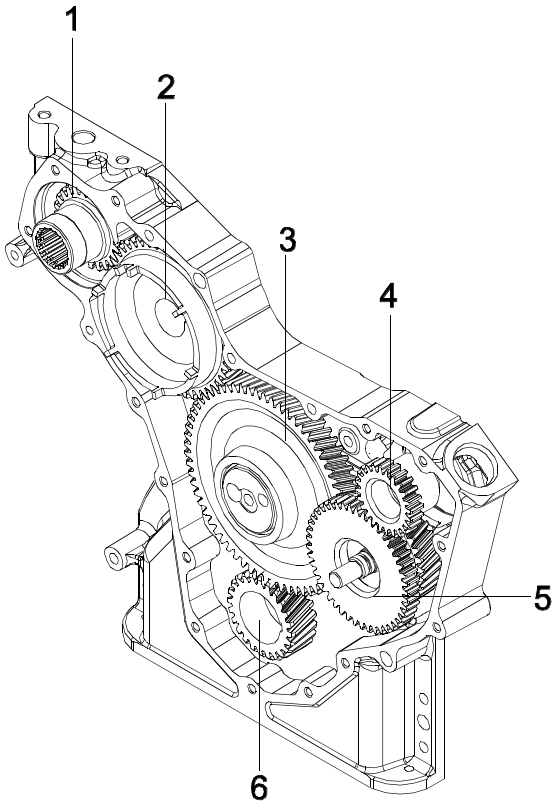
The piston has three rings. The upper molybdenum-coated ring has a wedge-shaped cross-section. On some slightly supercharged engines the upper ring is right-angled. The middle ring is tapered and it fits into its groove. The taper takes up the clearance. The oil control ring is spring-loaded and it has a two-stage, chromed scraping edge.
Some four-cylinder engines are equipped with a balancer unit. The eccentric weights, which rotate at twice the engine speed, even out the vibration forces exerted by the movement of the pistons and the crank mechanism.

Timing Gears

44-, 49-, 66- and 74-Engines

The timing gear drives the camshaft, high-pressure pump and oil pump. The timing gear train consists of hardened, helically cut gear wheels. The gear of the high-pressure pump is spur-geared and it is driven by a double idler gear. The gears are encased by the timing gear casing, which is fitted to the front of the engine.

If the engine is equipped with a hydraulic pump, it is driven via a gear or a separate drive unit.
The idler gear is supported with a bearing sleeve / ball bearing (66- and 74-engines) on the shaft on the front face of the cylinder block. Two different dimensions of gear and shaft are used.



Timing gear parts

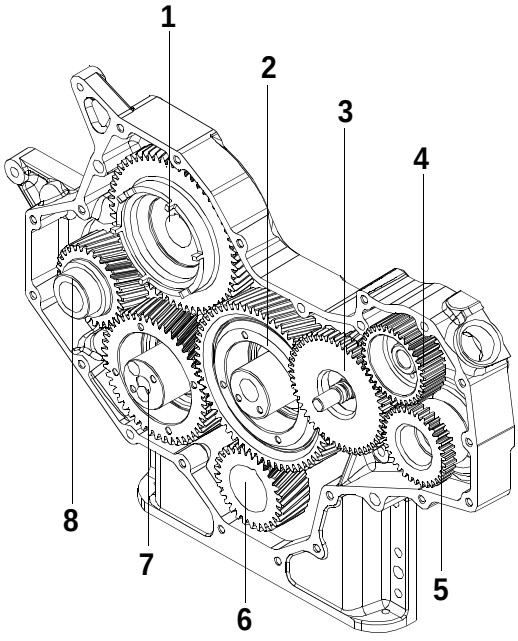
1. P.T.O. gear	2. Camshaft gear
3. Idler gear	4. High-pressure pump gear
5. Double idler gear	6. Crankshaft gear

84-Engines

There are two main types of timing gear assembly: narrow and broad timing gear casing.

The timing gear drives the camshaft, high-pressure pump, oil pump and coolant pump. The timing gear train consists of hardened, helically cut gear wheels. The gears of the high-pressure pump and coolant pump are spur-geared and they are driven by a double idler gear. The gears are encased by the timing gear casing, which is fitted to the front of the engine.
If the engine is equipped with the broad timing gear casing, there is a separate drive unit for a hydraulic pump or a compressor. The drive unit is driven via a small idler gear.

The idler gear is supported with a bevelled ball bearing on the shaft on the front face of the cylinder block.



Timing gear parts

1. Camshaft gear	2. Idler gear
3. Double idler gear	4. Coolant pump gear
5. High-pressure pump gear	6. Crankshaft gear
7. Small idler gear	8. P.T.O. gear

Cam lift:
2V engines:
- inlet valve . . . . . 7.38 mm
- exhaust valve . . . . . 8.28 mm
4V engines:
- inlet valve . . . . . 6.18 mm
- exhaust valve . . . . . 7.70 mm
Width of cam, 2V engines . . . . . 17.70...18.30 mm
Width of cam, 4V engines . . . . . 19.70...20.30 mm
Camshaft max. permissible deflection (total indicator reading). . . . . 0.03 mm

Crankshaft

44-, 49-, 66- and 74-Engines

Crankpin diameter:
- standard . . . . . 67.981...68.000 mm
- 1st undersize 0.25 mm . . . . . 67.731...67.750 mm
- 2nd undersize 0.50 mm . . . . . 67.481...67.500 mm
- 3rd undersize 1.00 mm . . . . . 66.981...67.000 mm
- 4th undersize 1.50 mm . . . . . 66.481...66.500 mm
Crankpin length . . . . . 40.000...40.160 mm
Main bearing journal diameter (44-, 49- and 66-engines):
- standard . . . . . 84.985...85.020 mm
- 1st undersize 0.25 mm . . . . . 84.735...84.770 mm
- 2nd undersize 0.50mm . . . . . 84.485...84.520 mm
- 3rd undersize 1.00 mm . . . . . 83.985...84.020 mm
- 4th undersize 1.50 mm . . . . . 83.485...83.520 mm
Main bearing housing diameter (in cylinder block) . . . . . 91.000...91.025 mm
Main bearing journal diameter (74-engines):
- standard . . . . . 89.985...90.020 mm
- 1st undersize 0.25 mm . . . . . 89.735...89.770 mm
- 2nd undersize 0.50 mm . . . . . 89.485...89.520 mm
- 3rd undersize 1.00 mm . . . . . 88.985...89.020 mm
- 4th undersize 1.50 mm . . . . . 88.485...88.520 mm
Main bearing housing diameter (in cylinder block) . . . . . 96.000...96.025 mm
Main bearing shell thickness:
- standard . . . . . 2.955...2.965 mm
- 1st undersize 0.25 mm . . . . . 3.080...3.090 mm
- 2nd undersize 0.50 mm . . . . . 3.205...3.215 mm
- 3rd undersize 1.00 mm . . . . . 3.455...3.465 mm
- 4th undersize 1.50 mm . . . . . 3.705...3.715 mm
- bearing 8361 40950 (see instruction 5 B) . . . . . 3.705...3.715 mm
Main bearing clearance . . . . . 0.050...0.127 mm
Length of thrust bearing journal (journal nearest to flywheel):
- standard (2 standard thrust plates) . . . . . 45.000...45.080 mm
- 1st oversize (one std and one 0.1 mm overthick thrust plate) . . . . . 45.100...45.180 mm
- 2nd oversize (one std and one 0.2 mm overthick thrust plate) . . . . . 45.200...45.280 mm
- 3rd oversize (one 0.1 mm and one 0.2 mm overthick thrust plate). . . . . 45.300...45.380 mm
- 4th oversize (two 0.2 mm overthick thrust plates). . . . . 45.400...45.480 mm

Other crankshaft journals cannot be ground longer.
Crankshaft end float . . . . . 0.100...0.380 mm
Max. permissible ovality and other deformity of crankpins or journals . . . . 0.03 mm
Crankshaft unbalance . . . . . 1.0 Ncm max.

Balancing unit ring gear location, diameter (44- and 49-engines). . . . . 150.220...150.260 mm
Balancing unit ring gear I.D. (44- and 49-engines) . . . . . 150.000...150.040 mm
Number of teeth on trigger wheel 60-2

Lubricating System

Oil pressure at normal running temperature:
- at idling speed (min.) . . . . . 1.0 bar
- at running speed . . . . . 2.5...5.0 bar
Oil pressure regulating valve (44-, 49-engines):
Free length of oil pressure valve spring . . . . . 48.2...51.8 mm
Assembly length / load of oil pressure valve spring . . . . . 28.5 mm / 89 N
Oil pressure regulating valve (66-, 74- and 84-engines):
Free length of oil pressure valve spring (identification = yellow dot) . . . . . 49.3...50.8 mm
Assembly length / load of oil pressure valve spring . . . . . 28.5 mm / 127 N
Oil filter by-pass valve opens at a pressure difference of . . . . . 2 ± 0.5 bar

Oil Pump

44- and 49- Engines

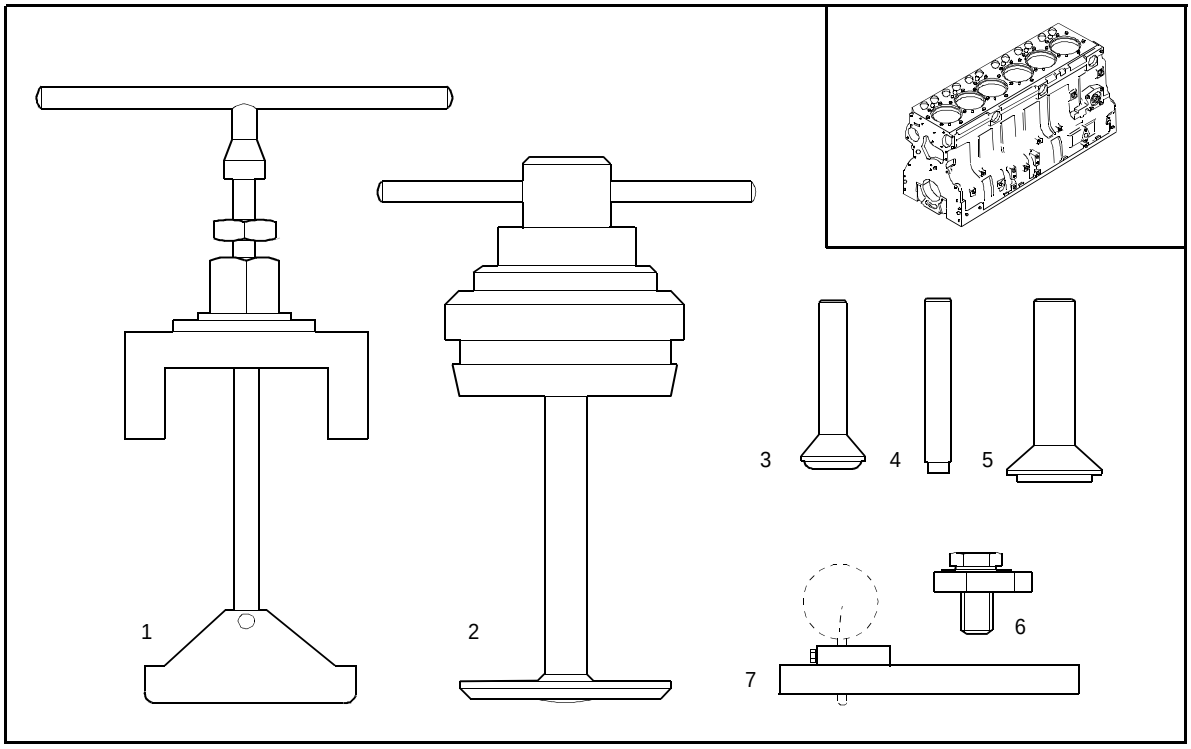
Backlash between gears when crankshaft lies firmly against the lower side of the main bearings:
- crankshaft gear-lubricating oil pump gear . . . . . 0.05...0.25 mm
- between the pump gears . . . . . 0.16...0.26 mm
Diameter of drive shaft at bearings for body and cover . . . . . 17.966...17.984 mm
Diameter of shaft holes on body and cover . . . . . 18.000...18.018 mm
Diameter of gear wheel hole . . . . . 18.060...18.078 mm
Fixed shaft, diameter . . . . . 18.028...18.039 mm
Protrusion of fixed shaft end below pump body face . . . . . 0.5...1.0 mm
Thickness of cover gasket . . . . . 0.06...0.08 mm
Outside diameter of gear . . . . . 43.486...43.525 mm
Housing diameter . . . . . 43.650...43.750 mm
Thickness of gears . . . . . 24.000...24.027 mm
End play of gears . . . . . 0.03...0.11 mm
Depth of housing . . . . . 24.000...24.043 mm

66-, 74- and 84-Engines

Backlash between gears when crankshaft lies firmly against the lower side of the main bearings:
- crankshaft gear-lubricating oil pump gear . . . . . 0.05...0.25 mm
- between the pump gears . . . . . 0.16...0.26 mm
Diameter of drive shaft at bearings for body and cover . . . . . 17.966...17.984 mm
Diameter of drive shaft bearing hole on body and cover . . . . . 18.000...18.018 mm
Inner diameter of bearing for gear wheel which rotates on fixed shaft . . . . 18.000...18.018 mm
Diameter of fixed shaft at gear wheel . . . . . 17.966...17.984 mm
Fixed shaft in pump body, diameter . . . . . 20.035...20.048 mm
Protrusion of fixed shaft end below pump body face . . . . . 0.5 mm
Thickness of cover gasket . . . . . 0.06...0.08 mm
Outer diameter of gear wheels . . . . . 55.824...55.870 mm
Housing diameter . . . . . 56.000...56.120 mm
Thickness of gears . . . . . 32.000...32.027 mm
End play of gears . . . . . 0.03...0.11 mm
Depth of housing . . . . . 32.000...32.043 mm

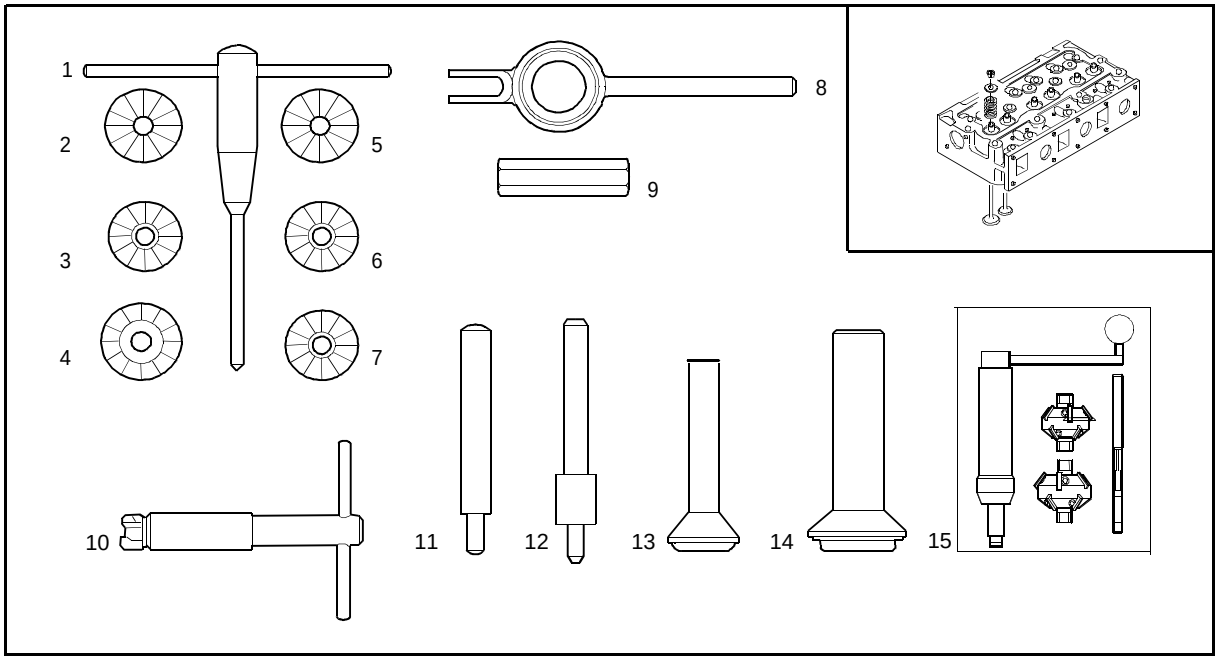
SPECIAL TOOLS

Cylinder Block



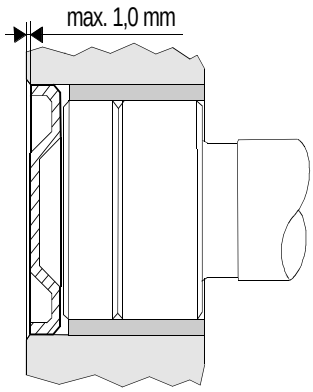
Ref.	Description	Order no.	44	49	66	74	84
1	Puller for cylinder liner	9051 73100	x	x	x	x	
		9104 51500					x
2	Milling cutter for cylinder liner seat	9101 65600	x	x	x	x	
		9104 52000					x
-	Spare cutting blade for milling cutter	9045 87600	x	x	x	x	x
3	Drift for 40 mm cup plug	9052 46620	x	x	x	x	x
4	Drift for 16 mm cup plug	9052 46650	x	x	x	x	x
5	Drift for fitting camshaft cup plug	9025 87400	x	x	x	x	x
6	Press tool for cylinder liner	9101 66300	x	x	x	x	x
7	Holder for dial gauge	9025 79200	x	x	x	x	x

Cylinder Head and Valve Mechanism



Ref.	Description	Order no.	44	49	66	74	84
1	T-handle for valve seat milling cutter	9101 66100	x	x	x	x	x
2	Milling cutter for facing exhaust valve seat	9101 71100	x	x	x	x	x
3	Milling cutter for exhaust valve seat	9101 65502	x	x	x	x	x
4	Inner milling cutter for exhaust valve seat	9101 65503	x	x	x	x	x
5	Milling cutter for facing inlet valve seat	9101 75800	x	x	x	x	x
6	Milling cutter for inlet valve seat	9101 65505	x	x	x	x	x
7	Inner milling cutter for inlet valve seat	9101 65506	x	x	x	x	x
8	Lever for compressing valve spring	9101 66200	x	x	x	x	x
9	Counter nut for lever above	9052 47200	x	x	x	x	x
10	Milling tool for injector seat, 2V engines	9120 85600	x	x	x	x	
	Milling tool for injector seat, 4V engines	9120 85400	x	x	x	x	x
11	Drift for removing valve guide, 2V engines	9101 65800	x	x	x	x	
	Drift for removing valve guide 4V engines	9120 85300	x	x	x	x	x
12	Drift for fitting valve guide, 2V engines	9101 65900	x	x	x	x	
	Drift for fitting valve guide, 4V engines	9120 85000	x	x	x	x	x
13	Drift for 36 mm cup plug	9052 46660	x	x	x	x	x
14	Drift for 45 mm cup plug	9103 94800			x	x	x
15	Milling cutter kit for valve seat, 4V engines	8370 62635	x	x	x	x	x

1.5. Fitting Plug at Camshaft Rear End



1. Clean the seat for the plug.

2. Apply sealing compound to the contact surface of the plug.

3. Drive in the plug with fitting drift 9025 87400.

Note! Do not drive in the plug too far because it will affect the camshaft end float

1.6. Oversize Bushings for Camshaft

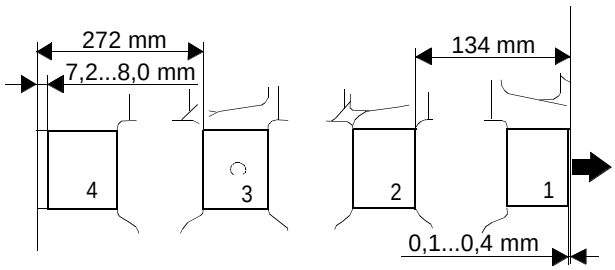
44- and 49-Engines

If the location of the camshaft bushing (front bearing) is damaged, a bushing with a **0.4 mm** oversize outer diameter can be fitted. Bushings are available even for other camshaft bearings which do not normally have bushings. Order numbers and machining dimensions for the bushing locations are shown in the figure.

Observe the position of the bushing oil holes. It is unnecessary to ream the bushings after fitting.

Order numbers of the oversize camshaft bushings and hole diameters for the bushings, 44-engines. Numbering begins from the front end of the engine.

Order no.	Hole Diameter
1. 8368 66036	56.02...56.05 mm
2. 8368 52460	55.42...55.45 mm
3. 8368 52460	55.42...55.45 mm
4. 8368 52461	55.64...55.67 mm



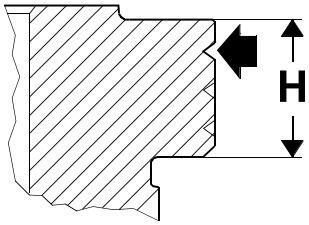
66-, 74- and 84-Engines

Order numbers of the oversize camshaft bushings and hole diameters for the bushings. Numbering begins from the front end of the engine. Installing places are the same as with the standard bushings. See the previously page.

Order no.	Hole Diameter
1. 8368 66036	56.02...56.05 mm
2. 8368 52466	55.62...55.65 mm
3. 8368 52460	55.42...55.45 mm
4. 8368 52466	55.62...55.65 mm
5. 8368 52467	55.84…55.87 mm

84-Engines

Order no.	H	Marking grooves pcs
8368 67048	$9.03^{+0.02}$	- (std.)
8368 67050	$9.08^{+0.02}$	1
8368 67051	$9.13^{+0.02}$	2
8368 67052	$9.23^{+0.02}$	3



Cylinder liners with oversize flanges (higher flanges) are marked with grooves on the outer circumference as follows:

1st oversize, 0.05 mm = 1 marking groove
2nd oversize, 0.10 mm = 2 marking grooves
3rd oversize, 0.20 mm = 3 marking grooves

Note! Recess depth is adjusted with a cylinder liner recess cutter 9101 65600 or 9104 52000 (84-engines).

7. If the liner height of a cylinder liner is not the same all the way round, the cylinder liner flange and the cylinder block recess depth should be checked. Cylinder liners with warped flanges should be discarded.

8. Fit the O-rings into the grooves in the cylinder liner. For 84-engines, fit the O-rings into the grooves in the cylinder block. Fit the green O-ring (A) into the lowest groove. Lubricate the O-rings with a liquid soap (not with engine oil).

Note! Stretch the O-rings as little as possible when fitting them. Max. permissible stretch is 6%.

9. Press the cylinder liners into the cylinder block. It should be easy to press them fully home. Make sure that the liners do not rise up after fitting.

3. CYLINDER HEAD, 2V ENGINES

3.1. Removing Cylinder Head

1. Disconnect current from the main switch.

2. Clean the engine externally and drain the coolant. Disconnect the coolant hoses from the cylinder head and the thermostat housing.

3. Remove the suction hoses between the turbocharger and the air filter and between the turbocharger and the inlet manifold.

4. Disconnect the turbocharger pressure and return oil pipes.

5. Disconnect the wires from the intake air heater and injectors.

6. Remove the injector leak-off fuel pipe and the high-pressure pipes. Remove the injectors. Fit blanking-off caps on all open connections.

Note! Do not open high-pressure pipe connectors on the fuel system when the engine is running. Wait at least 30 sec. after the engine has stopped. If the jet of high-pressure fuel comes into contact with your skin, the fuel will penetrate the skin causing severe injuries.

7. Remove the inlet and exhaust manifolds and the thermostat housing.

Note! It is possible to remove the cylinder head even though these parts are attached to the head.

8. Remove the valve cover.

9. Remove the rocker arm mechanism and the push rods.

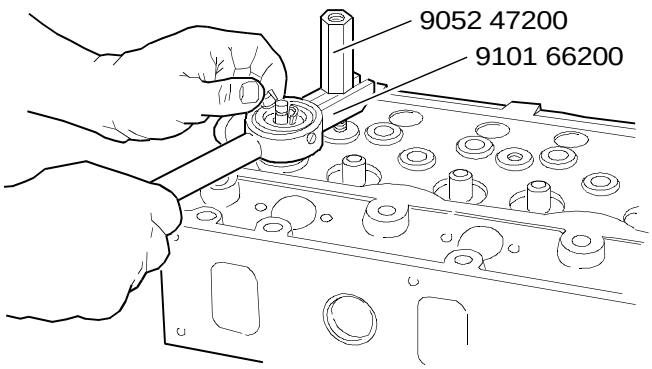
10. Loosen all the cylinder head bolts first by a 1/4 turn, then loosen them fully and remove. Remove the cylinder head.

3.2. Removing Valves

Ensure that valves which are to be re-used are marked, so that they can be re-fitted in their original locations.

1. Install the counter screw 9052 47200 for the valve spring installing tool in the rocker arm cover bolt. On 33-, 66-, 74- and 84-engines there is no screw stud on the valves for the centre cylinder. A bolt of suitable length should be used instead.

2. Compress the valve springs using lever 9101 66200. Remove the valve cotters, spring guide and spring. Remove the valves.



2. Screw the cylinder head stud bolts into the cylinder block to a torque of **30 Nm**. Fit the valve tappets if removed.

3. Check that the sealing surfaces are clean and fit the cylinder head gasket(s) and the cylinder head(s). Ensure that on the six cylinder engines both cylinder heads are parallel by lightly fastening the exhaust manifold before tightening the cylinder head bolts (the exhaust manifold can become damaged if the heads are not parallel). Clean, lubricate and fit the bolts.

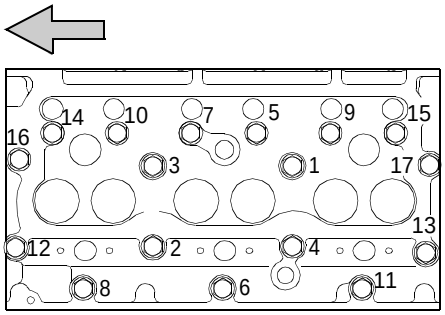
4. The pictures show the correct tightening order of the cylinder head bolts. The order is also marked on the cylinder heads.

5. Tighten the cylinder head bolts progressively as follows:

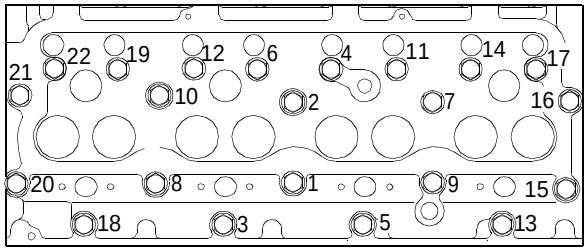
    1. First tighten to **80 Nm**
    2. Tighten by **90°**
    3. Tighten again by **90°**.

6. Adjust the valve clearances (see instruction **5.3.**).

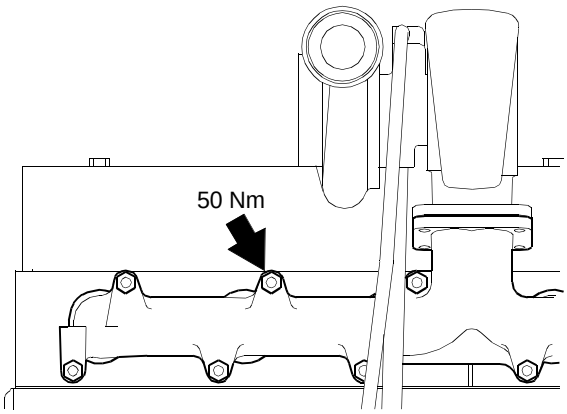
Note! After this the cylinder head does not need retightening.



66, 74, 84



44, 49



Tighten the exhaust manifold nuts to **50 Nm**. **Do not overtighten!**

6. VALVE MECHANISM, 4V ENGINES

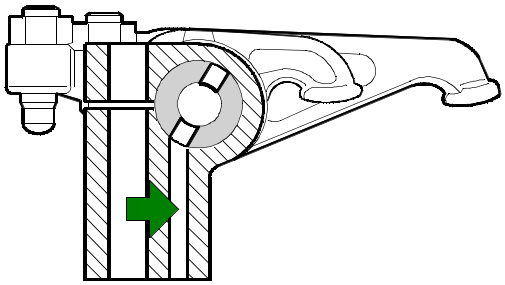
For removing, checking or reconditioning the 4V engine valve mechanism, follow the instructions for the 2V engine as shown in section 5. The following are repair instructions for 4V valve mechanisms which differ from the 2V valve mechanism.

6.1. Reconditioning Valve Mechanism

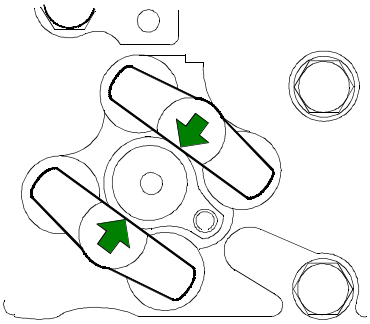
1. Notice the length difference between the push rods in different engine types. See the schedule as follows:

Engine	Total Length of Push Rod, mm	Order Number of Push Rod
44-/49-/66-/74- 2V engines	237...238.3	8366 55867
44-/49-/66-/74- 4V engines	245...246.3	8370 70119
84- 4V engines	286...287.3	8370 69014

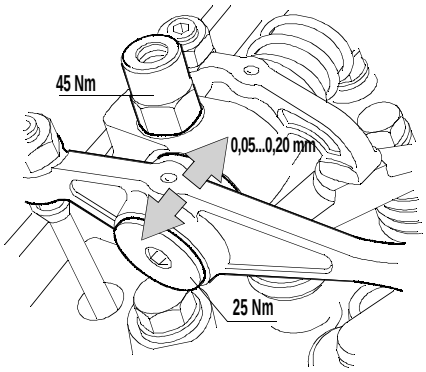
2. Check the diameter of the rocker arm bore, **25.000...25.021 mm**. Change the worn or damaged rocker arm.



3. Fit the plug to the other end of the rocker arm shaft. Lubricate the shaft and fit various parts in the correct order. Notice the correct position of the brackets and the shaft. Fit the other end plug and tighten the plugs to 25 Nm.



4. Fit the connecting parts onto the valves in position as shown in the pictures.

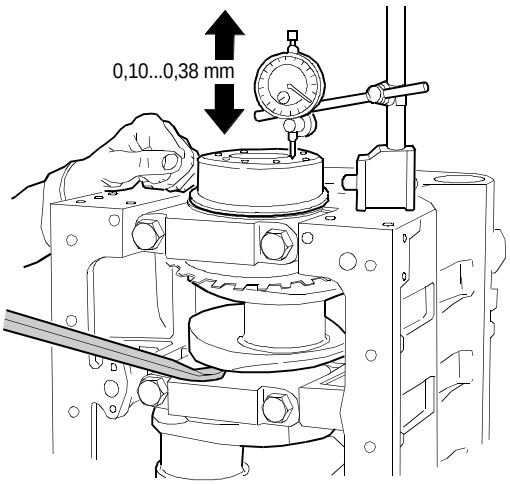


5. Fix the valve mechanism and ensure the right end clearance, **0.05...0.20 mm**, for the levers at the end. Tighten the mechanism screw and nuts to a torque of **45 Nm**.

6.2. Checking and Adjusting Valve Clearances

The valve clearance, which can be adjusted on a hot or cold engine, is **0.35 mm** for both inlet and exhaust valves. The clearance is adjusted when the respective piston is at T.D.C. in the compression stroke. The valves for the different cylinders are adjusted in the same sequence as the order of injection.

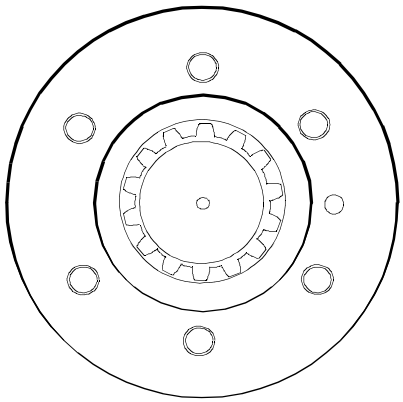
5. Check that the crankshaft can rotate without binding. Check the end float using a dial gauge. The correct end float is **0.10...0.38 mm**. If the end float is too large, oversize thrust bearings should be fitted.



Note! Bearing shells should never be reamed or machined in any other way, nor should the sides of the bearing caps be filed.

7.5. Crankshaft Hub Piece

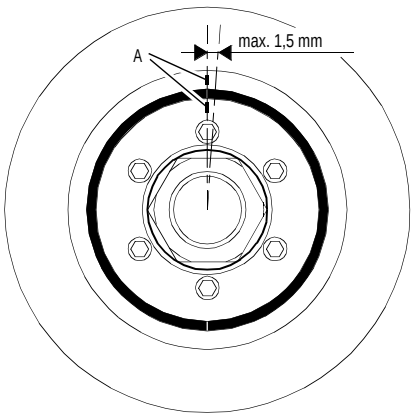
Check hub piece functionality, especially the sealing surface. If the sealing surface is worn out, see the instruction 11.3. point 9. In Citius series Common Rail engines, the crankshaft pulley does not have any timing or installation marks. There is no specific position for the crankshaft hub piece.



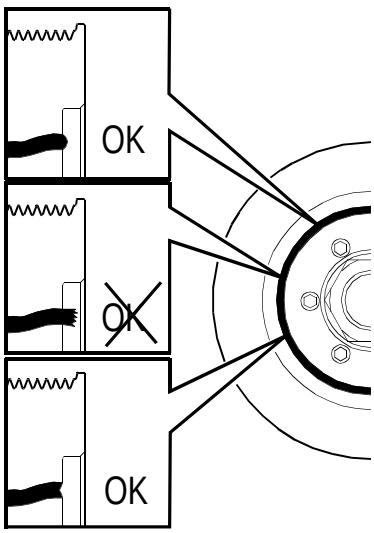
7.6. Checking Element of the Rubber Damper

44-, 49- and 66-Engines

1. Check the alignment marks (A) on both sides of the rubber element. If the difference is more than **1.5 mm**, change the damper for a new one.

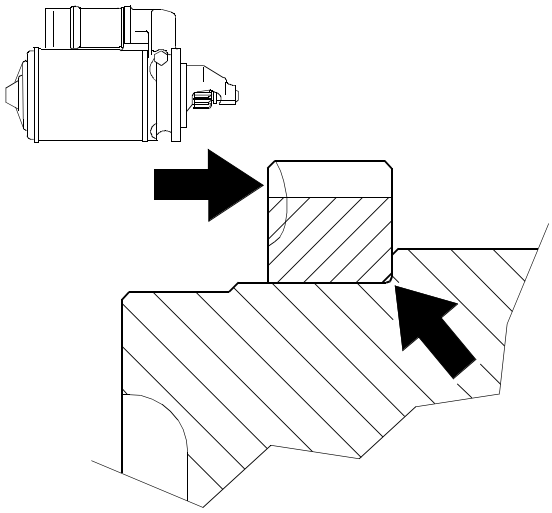


2. Also check the condition of the rubber element. If rubber pieces have been loosened from the element, rubber has been pressed to a depth of more than **3.5 mm** or the outer circumference is slack or it moves in the direction of the shaft, change the damper.



10. FLYWHEEL

10.1. Changing Starter Ring Gear on Flywheel



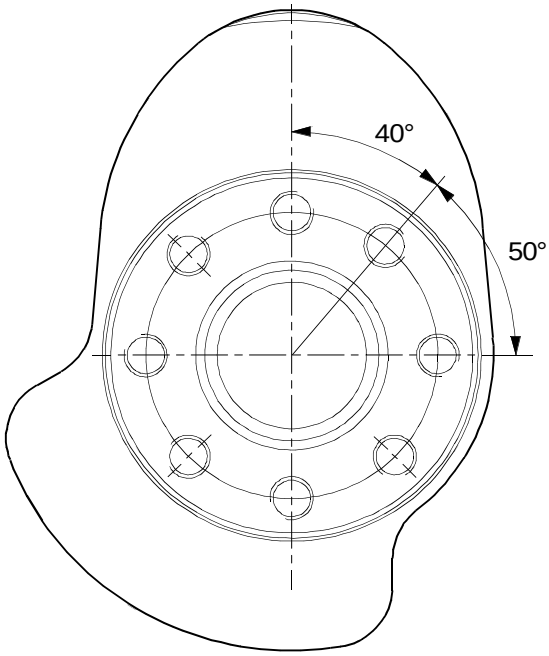
If the ring gear is worn, replace it with a new one. The ring gear cannot be turned around because its teeth are chamfered and hardened on the starter motor side.

1. Remove the old starter ring by tapping it at various points with a drift. Clean the flywheel contact face with a steel-wire brush.

2. Warm the ring gear to a temperature of **150...200°C**. Fit the ring gear with the inner diameter chamfering turned against the flywheel and the teeth chamfering against the starter motor.

3. Allow the ring gear to cool freely without using any coolant.

10.2. Fitting Flywheel



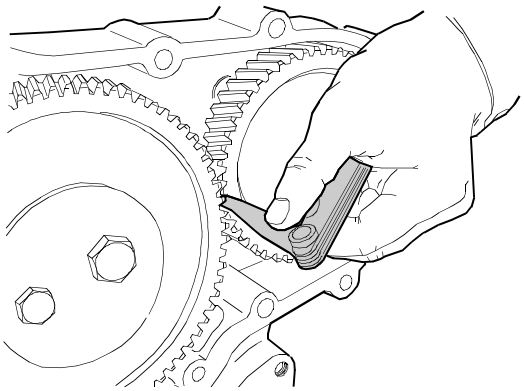
1. Clean the contact surfaces on the crankshaft rear flange and on the flywheel.

2. Fasten the flywheel to the crankshaft rear end. Suitable studs (2 pcs) can be used as guide pins, and screwed into the flywheel fixing bolt holes.

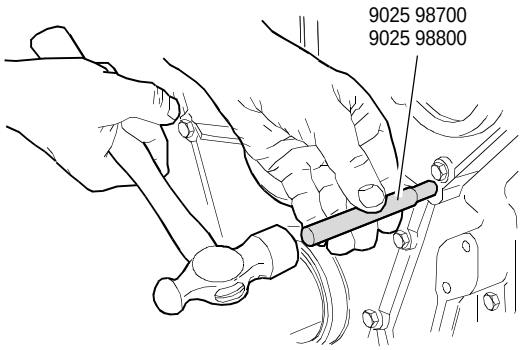
Note! In 84-engines, the flywheel fixing bolt holes are unsymmetrical.

3. Tighten the flywheel retaining screws evenly to a torque of **150 Nm** (**200 Nm**, 84-engines).

7. Check the tooth backlash, which should be **0.05...0.25 mm.**

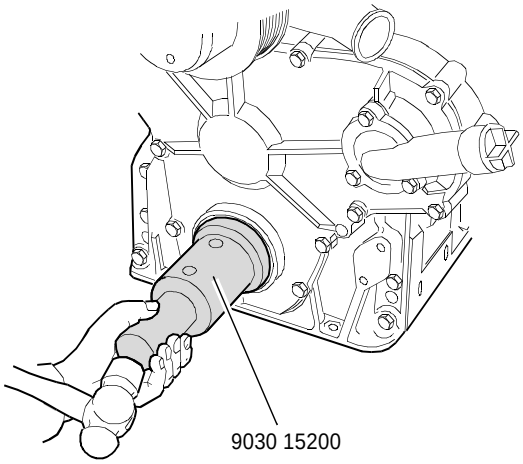


8. Fit the oil deflector ring on the crankshaft and fit the timing gear casing cover using a sealant. Drive in the tension pins with drifts 9025 98700 and 9025 98800 respectively (the tubular pin round the screw stud). Tighten nuts and bolts.



9. Fit the protective plate into the seal location and fit the crankshaft front seal with special tool 9030 15200.

Note! If the hub piece is worn out at the sealing surface, a 3 mm spacer ring, order number 8353 28899, can be fitted in front of the crankshaft rear oil seal.



10. Lubricate both the seal and sealing surfaces and fit the crankshaft hub (with belt pulley).

11. Lubricate the crankshaft nut threads. Tighten the nut to **600 Nm** on 44- and 49-engines and **1000 Nm** on 66-engines.

12. Fit the other removed parts.