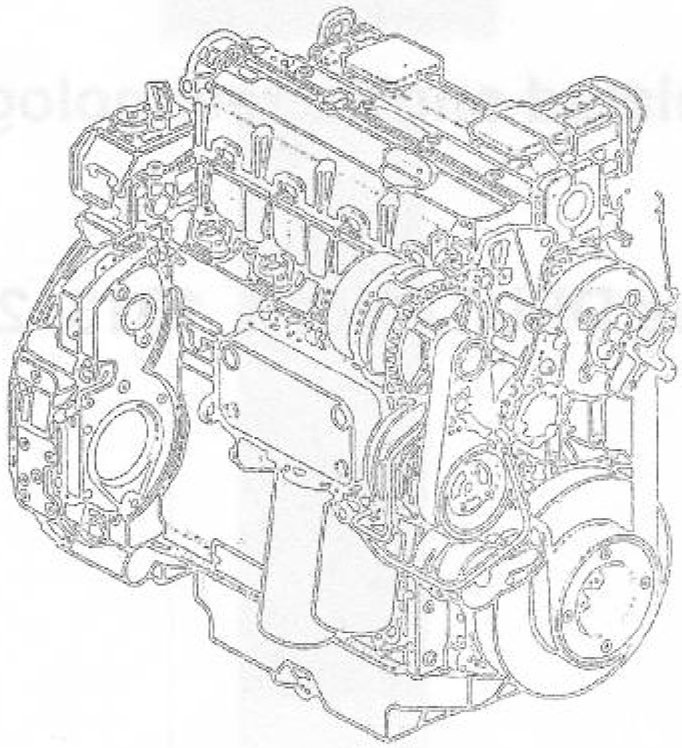
Service Training



Engine Series

DEUTZ 1012, 1013, 2012

DEUTZ

DEUTZ

Course-attendant trainee documentation for service training

Product-related engine technology

engine series DEUTZ 1012, 1013, 2012

Property of:

Attention:

This course attendant trainee documentation is conducive for effective explanation and illustration about the contruction and function of engine, components and systems. The contents of figures are only according to the date of printing actual documentation and are not subject to be updated.

Obligatory upon operation, maintenance and repair are only the engineering data and intructions of the actual technical printed material such as operation manuals, work-shop manuals, adjusting- and repair-instructions, technical circulars and service bulletins.

Table of Contents

1. Engine plan

1.1 Technical data

BFM 2012

	BF4M 2012 BF4M 2012 C	BF6M 2012 C
Number of cylinders / arrangement	4 in line	6 in line
Bore [mm]	101	98 / 101
Stroke [mm]	126	
Engine swept volume [ltrs.]	4.04	5.7 / 6.06
Working cycle / combustion system	Four-stroke diesel with direct injection and exhaust turbocharging. (BF4/6M 2012 C with charge air cooling)	
Firing order	1 - 3 - 4 - 2	1 - 5 - 3 - 6 - 2 - 4
Direction of rotation	When facing flywheel: counter-clockwise	
Rated speed [min^{-1}]	See engine nameplate	
Power [kW]	See engine nameplate	
Valve clearance: inlet / exhaust [mm]	0.3 / 0.5	
Commencement of delivery	See engine nameplate	
Nozzle opening pressure [bar]	220^{+8}	
Lubrication	Forced-feed circulation lubrication	
Min. oil pressure [bar], at low idling and with warmed-up engine (120°C oil temperature)	0.8	
Type of cooling	Liquid-cooled with integrated oil cooler.	
Coolant volume [ltrs.] (only engine volume)	approx. 4.7	approx. 6
Thermostat begins to open at: [°C] fully opened at: [°C]	83 95	

BFM 1012

	BF4M 1012, E BF4M 1012, EC	BF6M 1012, E BF6M 1012, EC
Number of cylinders / arrangement	4 in line	6 in line
Bore [mm]	94	
Stroke [mm]	115	
Displacement [ltrs.]	3.2	4.8
Working cycle / combustion system	Four-stroke diesel with direct injection and exhaust turbocharging.	
Firing order	1 - 3 - 4 - 2	1 - 5 - 3 - 6 - 2 - 4
Direction of rotation	When facing flywheel: counter-clockwise	
Rated speed [min^{-1}]	See engine nameplate	
Power [kW]	See engine nameplate	
Valve clearance: inlet / exhaust [mm]	0.3 / 0.5	
Commencement of delivery	See engine nameplate	
Injector opening pressure [bar]	250^{+8}	
Lubrication	Forced-feed circulation lubrication	
Min. oil pressure [bar], at low idling and with warmed-up engine (120°C oil temperature)	0.8	
Type of cooling	Liquid-cooled with integrated oil cooler.	
Coolant volume [approx. ltrs.] 1012 1012 C (only engine volume) 1012 E,C	9.3 10.0 5.6	12.2 13.6 7.3
Thermostat begins to open at: [°C] fully opened at: [°C]	83 95	

BFM 1013

	BF4M 1013, E BF4M 1013, EC	BF6M 1013, E BF6M 1013, EC
Number of cylinders / arrangement	4 in line	6 in line
Bore [mm]	108	
Stroke [mm]	130	
Displacement [ltrs.]	4.8	7.1
Working cycle / combustion system	Four-stroke diesel with direct injection and exhaust turbocharging.	
Firing order	1 - 3 - 4 - 2	1 - 5 - 3 - 6 - 2 - 4
Direction of rotation	When facing flywheel: counter-clockwise	
Rated speed [min^{-1}]	See engine nameplate	
Power [kW]	See engine nameplate	
Valve clearance: inlet / exhaust [mm]	0.3 / 0.5	
Commencement of delivery	See engine nameplate	
Injector opening pressure [bar]	275^{+8}	
Lubrication	Forced-feed circulation lubrication	
Min. oil pressure [bar], at low idling and with warmed-up engine (120°C oil temperature)	0.8	
Type of cooling	Liquid-cooled with integrated oil cooler.	
Coolant volume [approx. ltrs.] 1013 1013 C 1013 CP (only engine volume) 1013 E,C	12.1 13.6 - 7.2	16.3 17.8 18.4 9.8
Thermostat begins to open at: [°C] fully opened at: [°C]	83 95	

1.2 Engine view 2012

Service side 2012

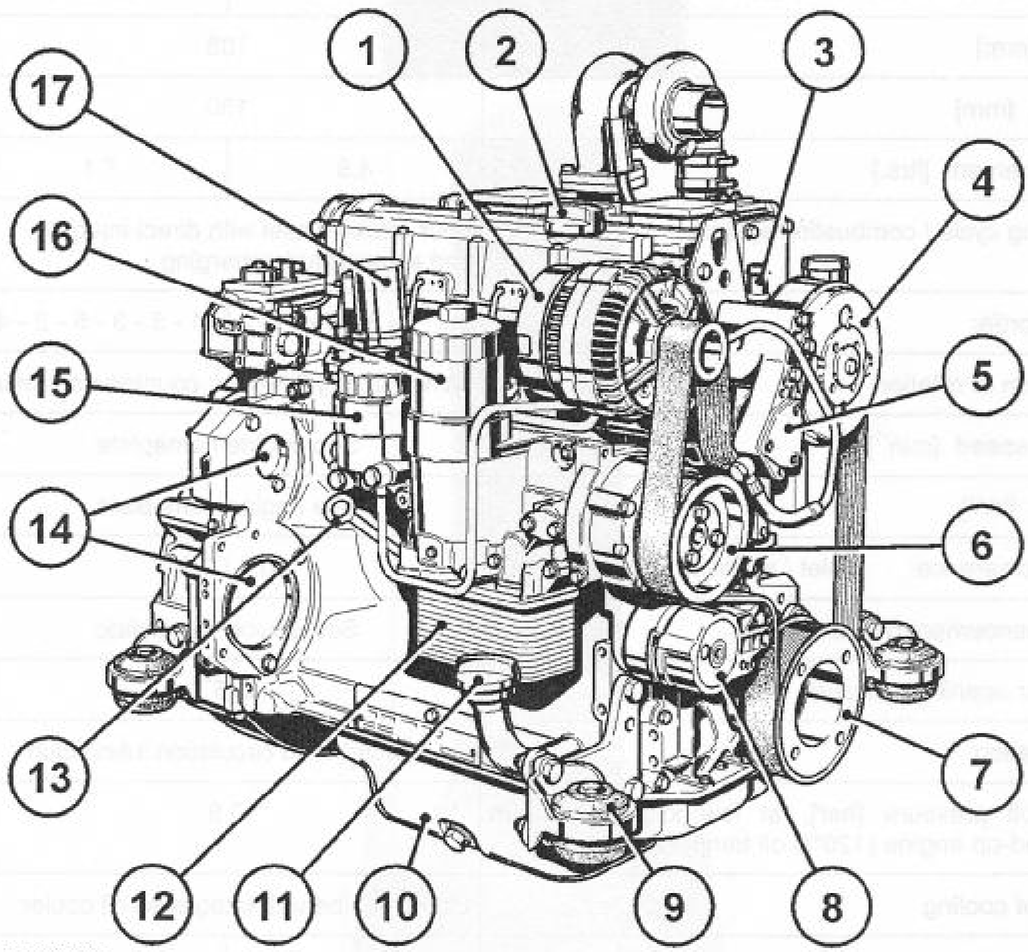


Bild 2012-0001

1 - Alternator
2 - Oil filler
3 - Coolant connection compensation line
4 - Fan pulley
5 - Fuel pump
6 - Coolant pump
7 - Poly-V-pulley with vibration damper
8 - Poly-V-belt tension pulley
9 - Engine mounting
10 - Oil pan
11 - Oil filler neck
12 - Oil cooler with filter bracket
13 - Oil dipstick
14 - PTOs for mounting hydraulic pumps for air compressor
15 - Fuel filter
16 - Oil filter
17 - Shutdown solenoid (de-energized for shutdown)

Starter side 2012

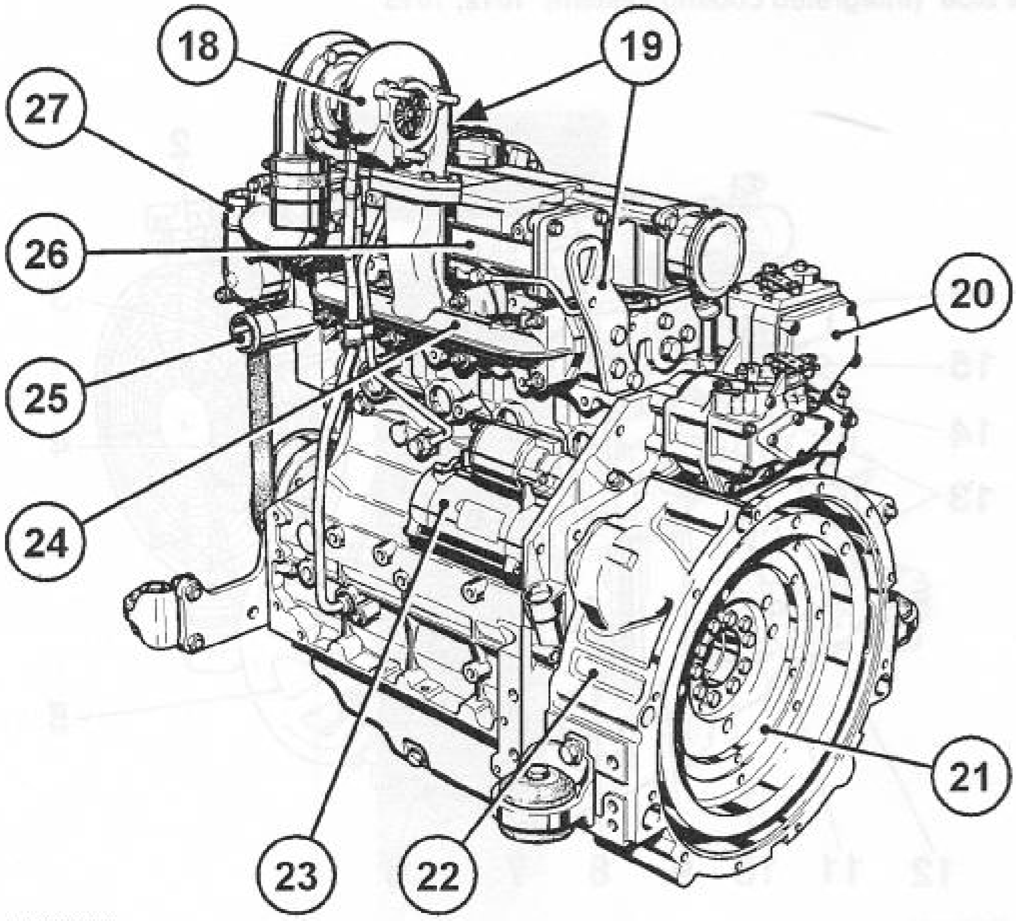


Bild 2012-0002

18 - Exhaust turbocharger
19 - Engine lifting eye
20 - Governor
21 - Flywheel
22 - SAE housing
23 - Starter motor
24 - Exhaust manifold
25 - Coolant inlet
26 - Air intake manifold
27 - Coolant outlet socket with thermostat

1.3 Engine view 1012, 1013

Service side (Integrated cooling system) 1012, 1013

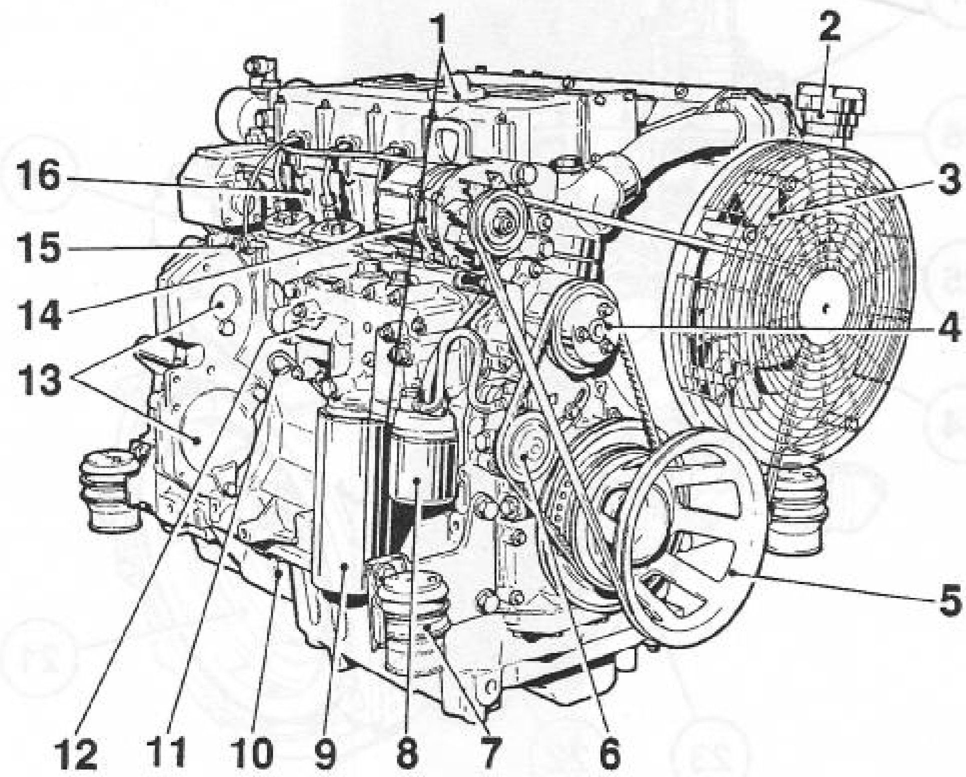


Bild 1012-C001

1- Oil filler neck
2- Coolant filler
3- Cooling fan
4- Coolant pump
5- V-belt-pulley
6- Fuel pump
7- Engine mounting
8- Fuel filter
9 - Lube oil filter
10 - Oil pan
11 - Dipstick
12 - Lube oil cooler
13 - PTOs for mounting hydraulic pumps and air compressor
14 - Alternator
15 - Leak-off fuel line with pressure holding valve
16 - Cylinder head

Starter side (Integrated cooling system) 1012, 1013

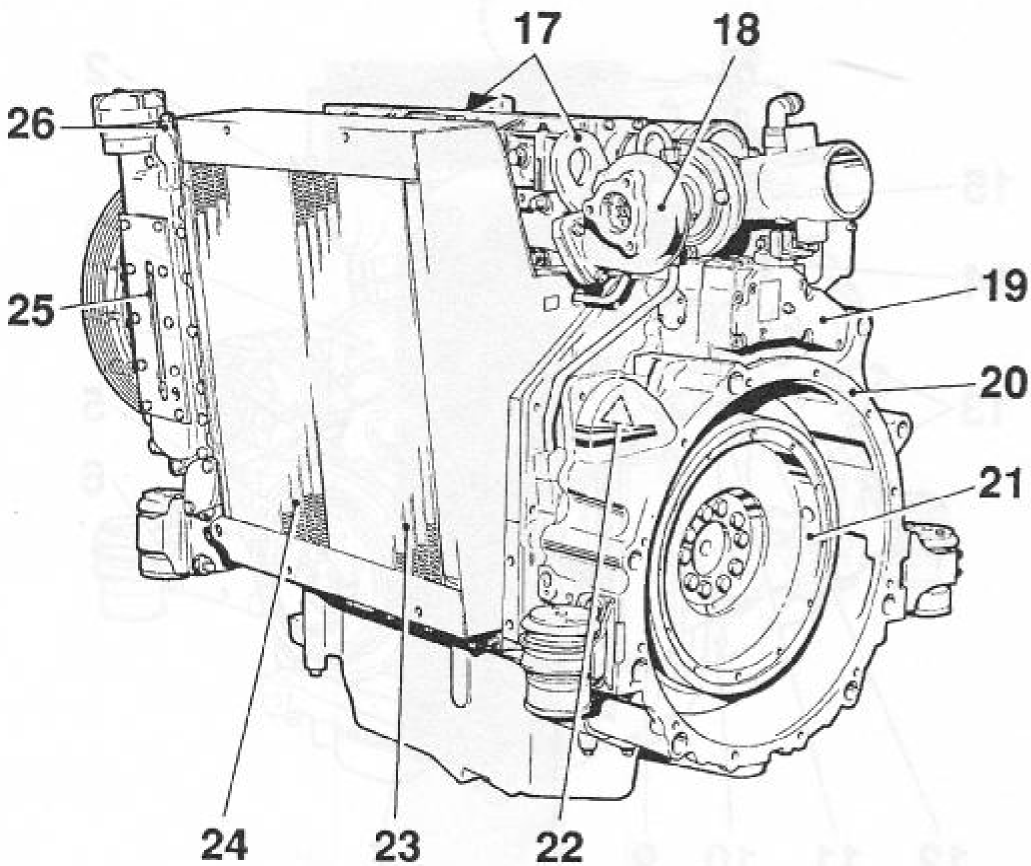


Bild 1012-0002

17 - Lifting points
18 - Exhaust turbocharger
19 - Governor
20 - Adapter housing
21 - Flywheel
22 - Starter motor
23 - Hydraulic oil cooler
24 - Coolant heat exchanger
25 - Coolant level gauge
26 - Pressure relief valve, 1.5 bar

Service side (External cooling system) 1012, 1013

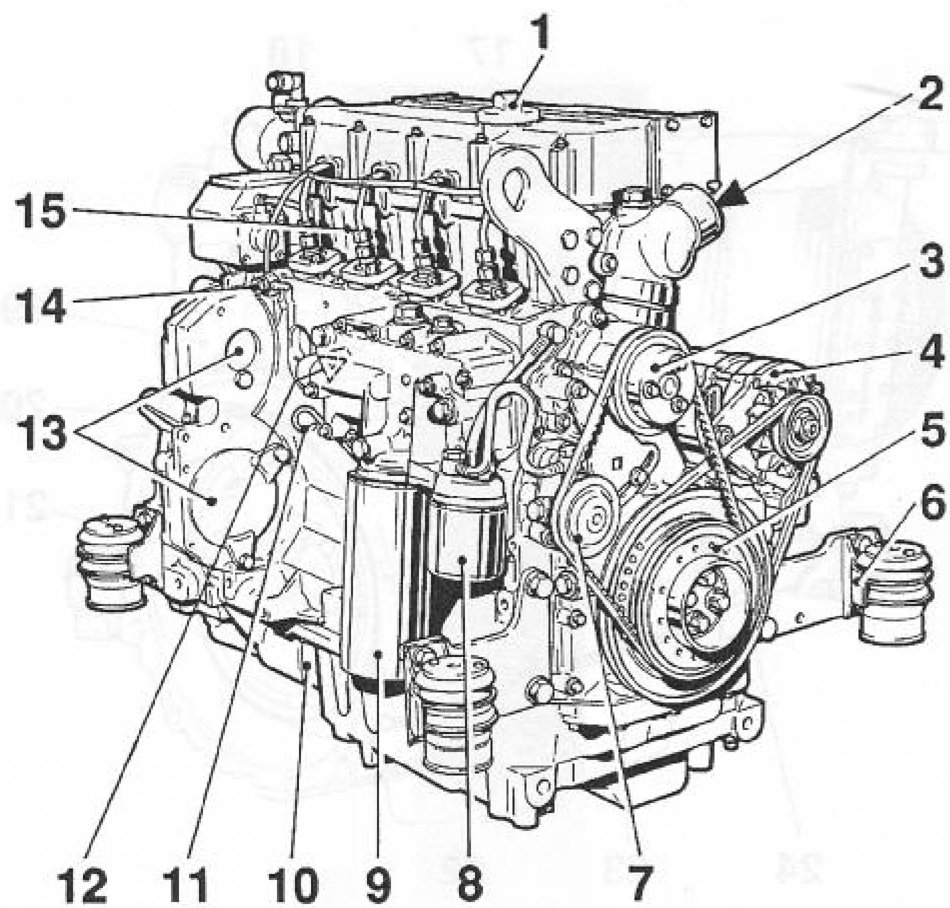


Bild 1012-0003

1- Oil filler
2- Coolant inlet
3- Coolant pump
4- Alternator
5- V-belt-pulley
6- Engine mounting
7- Fuel pump
8- Fuel filter
9- Lube oil filter
10- Oil pan
11- Dipstick
12- Lube oil cooler
13- PTOs for mounting hydraulic pumps and air compressor
14- Leak-off fuel line with pressure holding valve
15- Cylinder head

Starter side (External cooling system) 1012, 1013

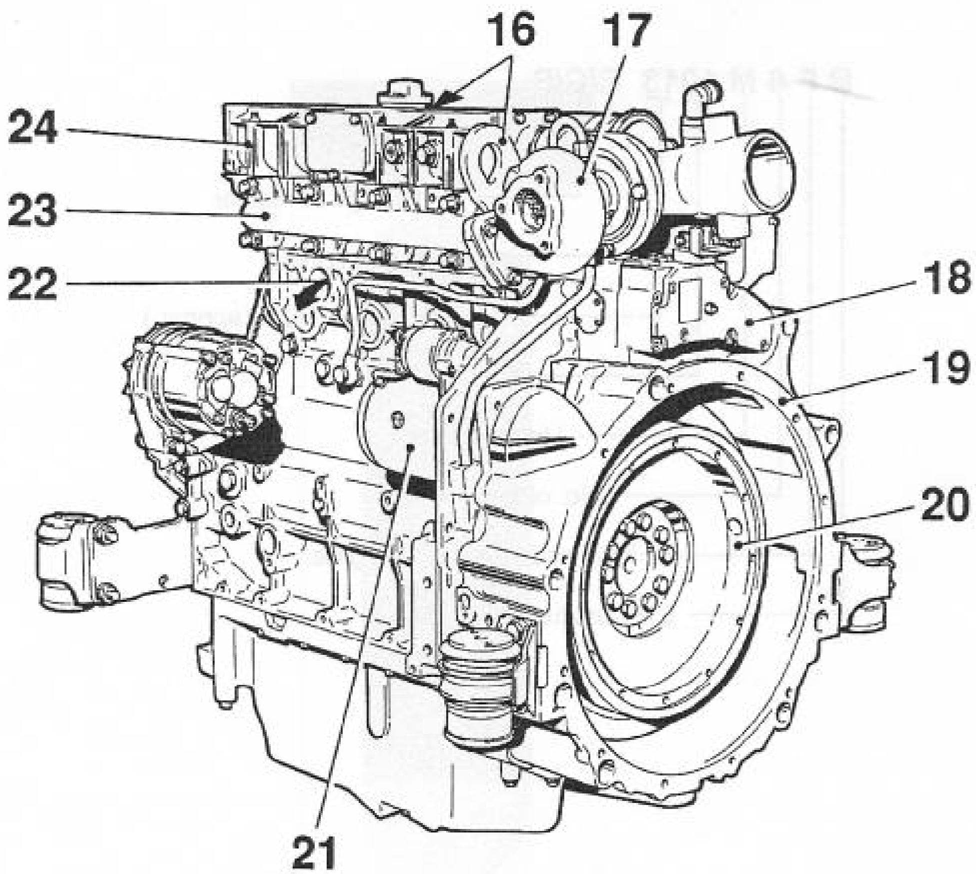
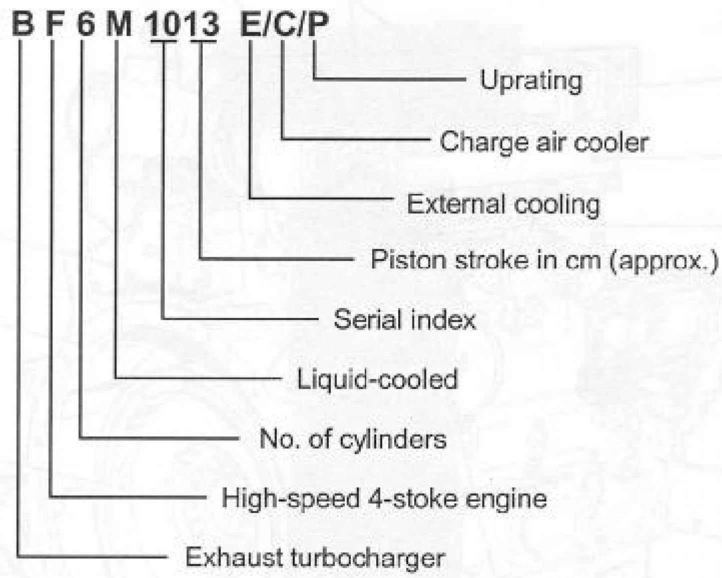


Bild 1012-0004

16 - Lifting points
17 - Exhaust turbocharger
18 - Governor
19 - Adapter housing
20 - Flywheel
21 - Starter motor
22 - Coolant outlet to heat exchanger
23 - Exhaust manifold
24 - Air intake manifold

1.4 Model designation



1.5 Nameplate and engine serial number

The nameplate (C) is affixed on the service side (right-hand side) of the engine. The engine serial number is stamped on the nameplate (C) and on the crankcase side.

The engine model (A) and engine serial number (B) must be indicated when ordering spare parts.

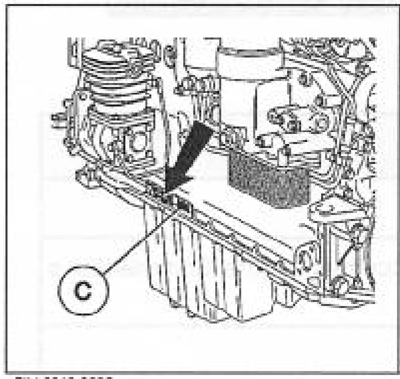


Bild 2013-0005

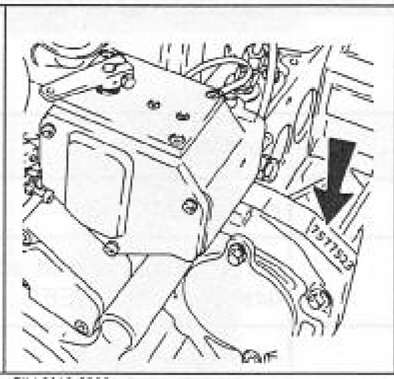


Bild 2013-0006

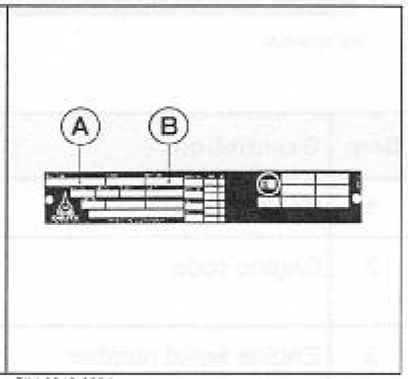


Bild 2013-0004

1.6 Cylinder numbering

- The cylinders are numbered, beginning at the flywheel end.
- The direction of engine rotation is counter-clockwise when facing the flywheel.
- Firing order: BF4M 1012, 1013, 2012: 1 - 3 - 4 - 2
  BF6M 1012, 1013, 2012: 1 - 5 - 3 - 6 - 2 - 4

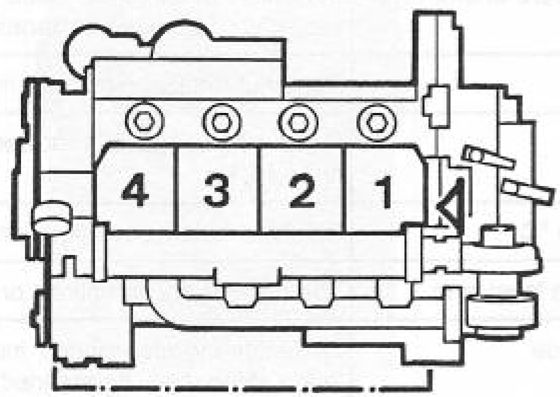


Bild 2013-0007

1.7 Description of nameplate

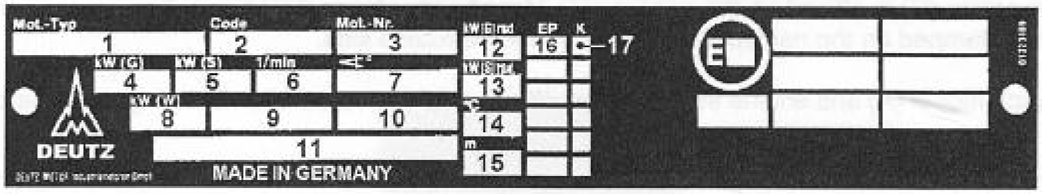


Bild 2013-0008

Item	Description	Remark
1	Engine model	e.g. BF6M 2012 C
2	Engine code	For engines certified according to the Commission's directives 88/195/EEC.
3	Engine serial number	-
4	kW (G) میزان قدرت موتور بدون فن	G-power (total power), fan is not running.
5	kW (S)	S-power (continuous power), fan is fully running.
6	min^{-1}	Rated engine speed.
7	Commencement of delivery and camshaft type	COD in ° C/A. Letter for camshaft type.
8	kW (W)	Fan/blower power requirement (eff. deduction) as integral part of site power.
9,10		Not assigned.
11	Indication of standard and/or regulation	Indication of standard used during acceptance test procedure for power declaration.
12	kW (G) red.	Reduced "total power", on-site conditions,items14,15.
13	kW (S) red.	Reduced "continuous power", on-site conditions items 14,15.
14	Air temperature in °C	For the ambient conditions on site.
15	Altitude above sea level in m	For the ambient conditions on site.
16	Injection pump code	Code for cylinder-related indication of pump installation dimension determined during production (beginning from top with cylinder #1).

2. Design structure

2.1 Cylinder

The engines of the 1012, 1013, 2012 series are available with different crankcase versions, all of which are made of high-alloy grey cast iron.

The BFM 1012 and BFM 2012 have a crankcase with integrated cylinder liners (1), i.e. crankcase and liners form one casting.

The entire BFM 1013 series is provided with wet liners (3).

Cylinder repair

In case of damage, the cylinders of the 1012 and 2012 series are repaired by installing slip-fit liners (2).

On the 1013 engines the wet liners (3) are replaced by new ones. In this case the sealing surfaces of the O-ring seals must be wetted with oil before being inserted.

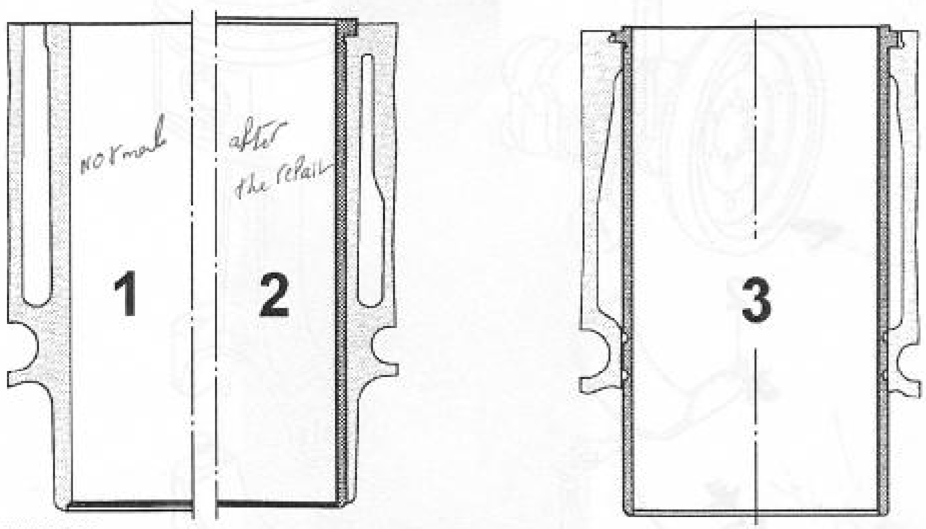


Bild 1012-0010

2.2 Crankshaft assembly

2.2.1 Connecting rod

The connecting rod of forged steel is fitted at the big end bearing bore with a balance weight (1) in order to compensate the manufacturing tolerances with regard to weight and position of the center of gravity.

The number markings (A) on the big end eye and the bearing cap must be on one side and identical.

Locating lugs (2) are provided in the lower and upper bearing shells to prevent the bearing shells from rotating in their seat; these lugs engage in adequately shaped grooves in the big end eye and big end bearing cap.

The piston must be so installed that the flywheel symbol (B) on the piston top faces the flywheel.

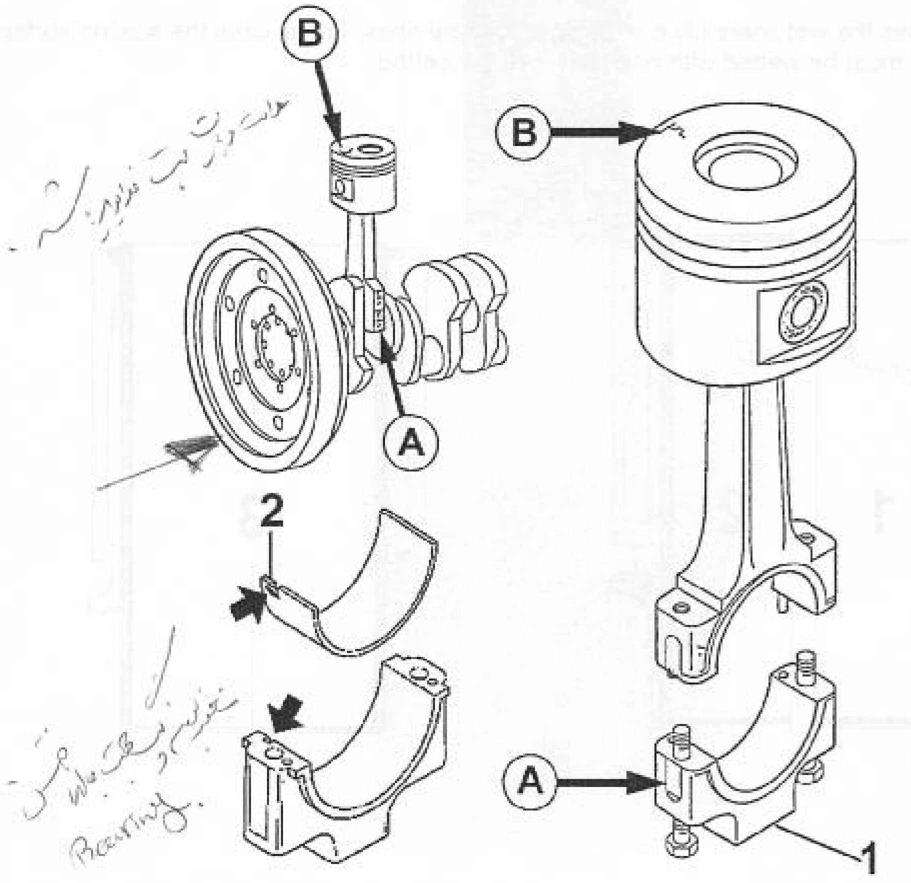


Bild 2013-0010

2.2.2 Piston

The pistons of the 1012, 1013, 2012 series are made of a special aluminium alloy.

The piston must be so installed that the flywheel symbol (1) on the piston top faces the flywheel.

The pistons are equipped with 3 piston rings. The 1st ring has a ring carrier (2) of cast iron.

The cross section of the 1st piston ring is asymmetrical (trapezoidal ring).

The cross section of the 2nd piston ring is conical (compression ring). When installing the piston, the TOP mark at the ring gap must point upwards.

The 3rd ring is the bevelled-edge oil control ring with hose spring (oil scraper ring).

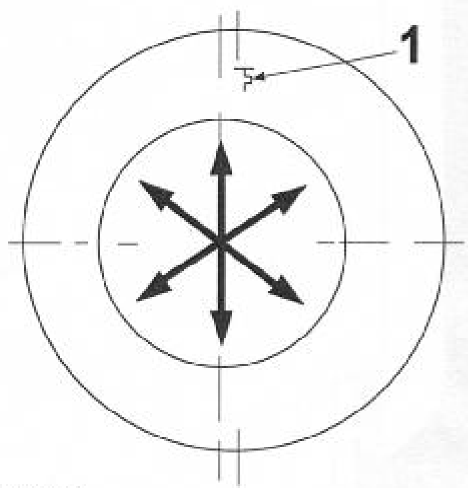


Bild 2012-0012

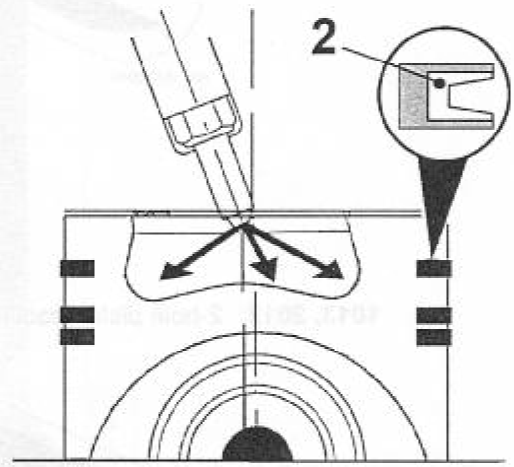


Bild 2012-0013

1013 5
1020 6

2.2.3 Piston cooling

The piston is cooled by spraying lube oil against the inside of the piston top.

The piston cooling nozzles made of plastic are fitted in the main bearing pedestals. An adjustment of the nozzle is not necessary.

1012: 1-hole piston cooling nozzle

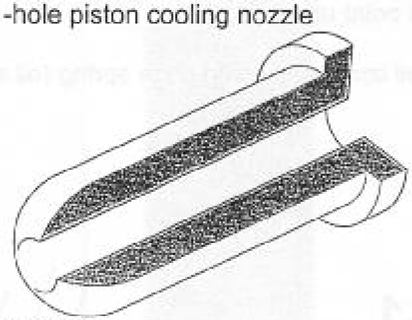
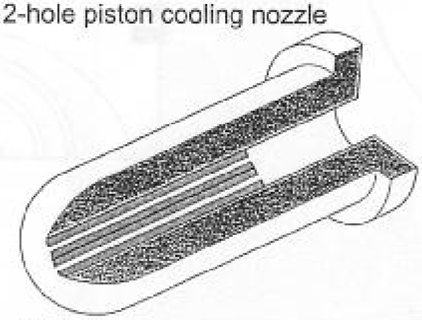


Bild 1012-0014

1013, 2012: 2-hole piston cooling nozzle



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2.2.4 Crankshaft

The forged crankshaft of these engine series is provided with integrated balance weights. The drive gear for the timing gears and the flywheel flange are shrunk on.

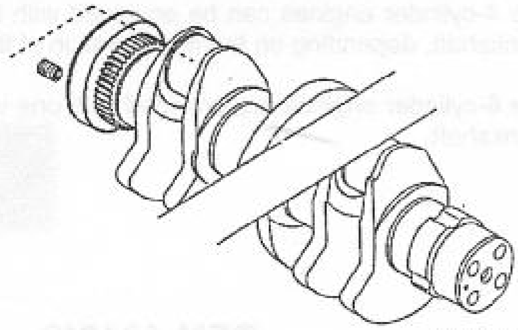


Bild 2013-0013

The material microstructure of the fillet radii on the bearing journals is strengthened by rolling.

Remachining of the fillet radii is therefore not permissible.

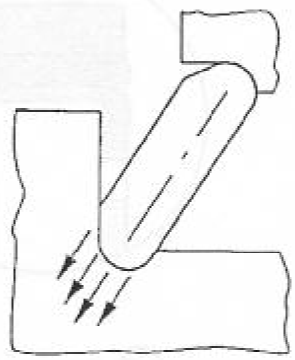


Bild 2013-0014

In case of repair, there is available one undersize of 0.25 mm (referred to the diameter) for the crankpins and main bearing journals.

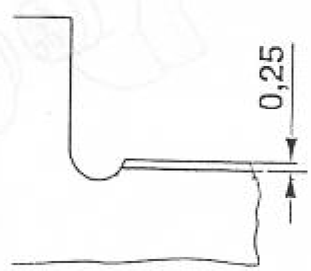


Bild 2013-0015

The thrust bearing face can only be remachined once (oversize: 0.4 mm, 0.2 mm each side).

Thrust bearing clearance of the crankshaft in installed condition: 0.1 to 0.28 mm.

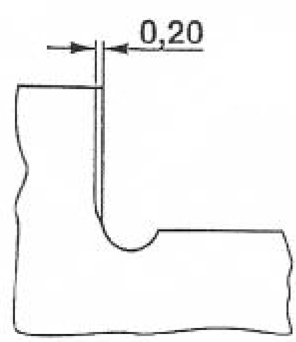


Bild 2013-0016

2.2.5 Torsional vibration damper

The 4-cylinder engines can be equipped with torsional vibration dampers of different type for the crankshaft, depending on the configuration of the PTOs and their moments of inertia.

The 6-cylinder engines are provided with one vibration damper as standard because of the longer crankshaft.

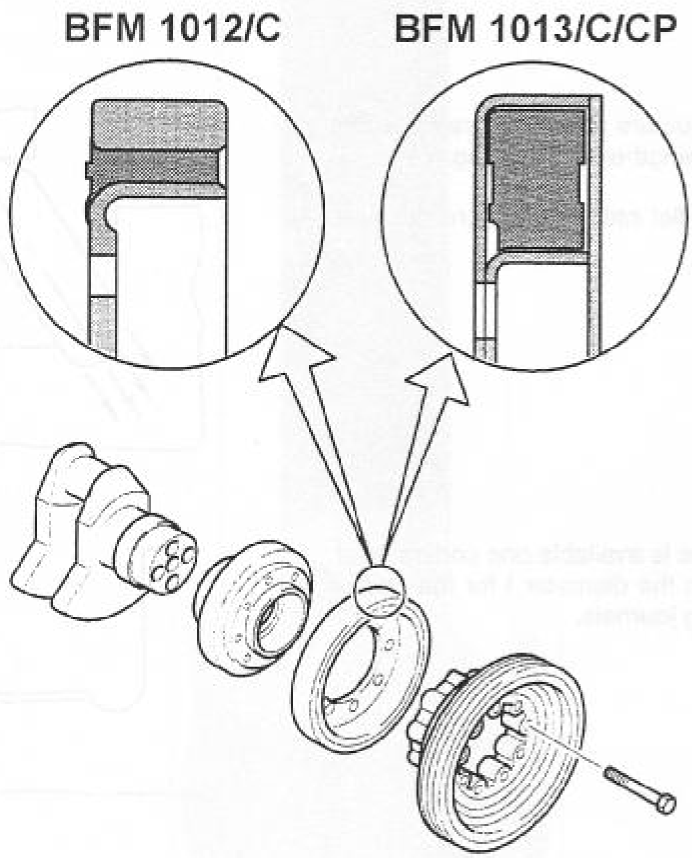


Bild 1012-0020

2.3 Mass balancing gear (MAG)

2.3.1 Function of mass balancing gear

Inertia forces of 2nd order are developed by 4-cylinder in-line engines, i.e. a force is released twice per engine revolution in vertical direction (Z direction). Furthermore, a breakdown torque (alternating torque) occurs due to the alternating torques around the crankshaft axis.

These forces must be compensated by a mass balancing gear in the case of rigidly mounted engines.

With the 1012 and 2012 series, the balancing shafts are mounted on two bearings, integrated in the crank-case and driven by the crankshaft gear and the camshaft drive via idler gears.

The two counter-rotating balancing shafts, which rotate at twice the engine speed, fully balance the inertia forces of 2nd order in vertical direction (Z direction).

The breakdown torque occurring around the crankshaft X axis is partially balanced due to the vertical offset 'e' of the two balancing shafts.

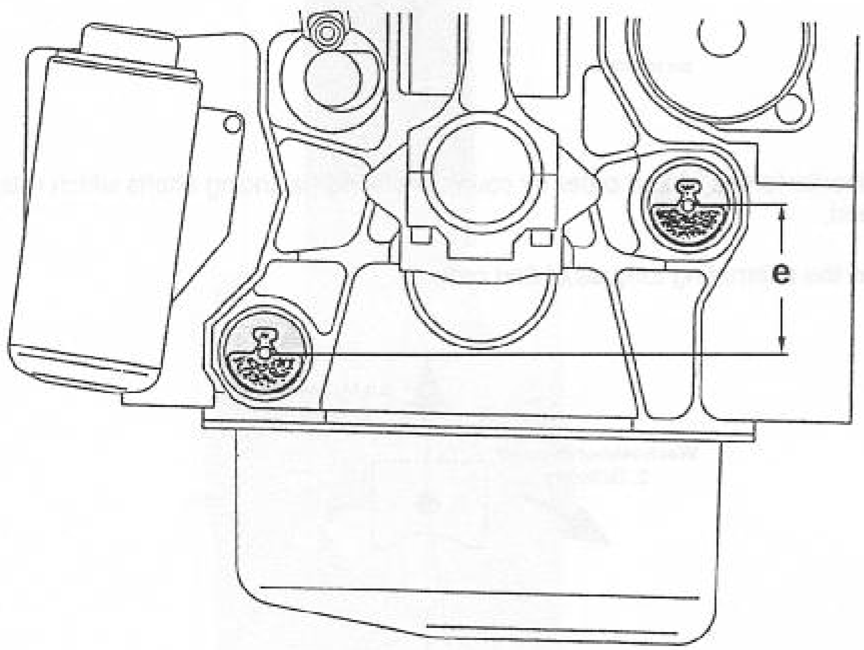


Bild 2013-3017

2.3.2 Design structure of mass balancing gear

Without mass balancing gear no balancing of the inertia force of 2nd order in Z direction and the breakdown torque around the crankshaft longitudinal axis.

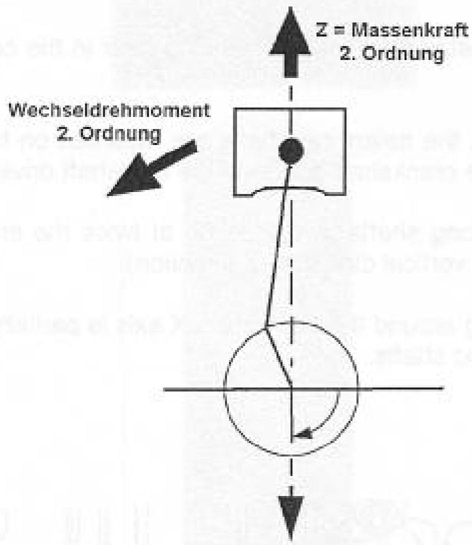


Bild 2013-0018

Elimination of inertia forces of 2nd order by counter-rotating balancing shafts which rotate at twice the engine speed.

No influence on the alternating torques of 2nd order.

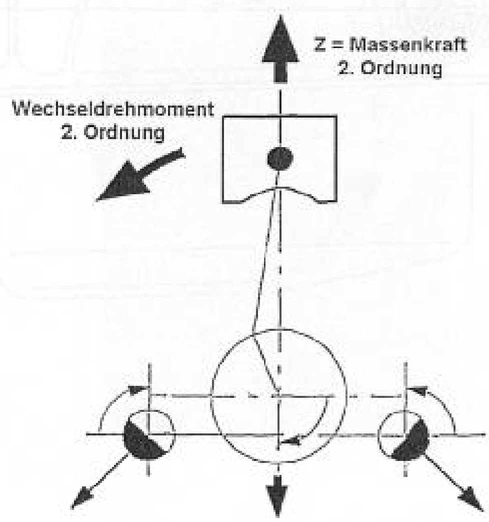


Bild 2013-0019

Elimination of inertia forces of 2nd order by counter-rotating balancing shafts which rotate at twice the engine speed.

Partial elimination of alternating torques of 2nd order due to vertically offset arrangement of balancing shafts (e), depending on engine speed.

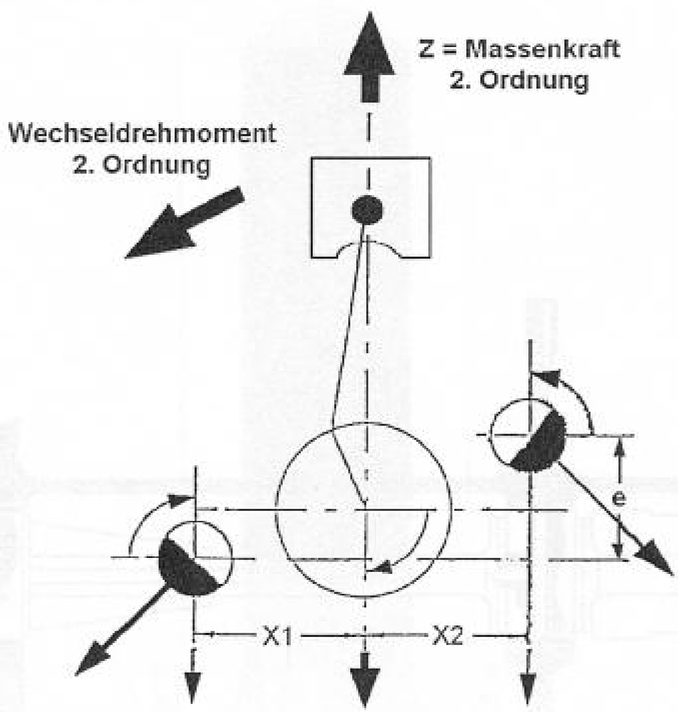


Bild 2013-0020

2.3.3 Installation of mass balancing shafts

The shafts are mounted with the **balance weights** pointing **downward** towards the oil pan, with the 1st cylinder in its firing TDC position.

They are precisely located by pins (special tool). These pins are screwed into the existing bores provided in the crankcase.

After installation of the balancing shafts the pins must be screwed out again and the threaded bores plugged with a screw.

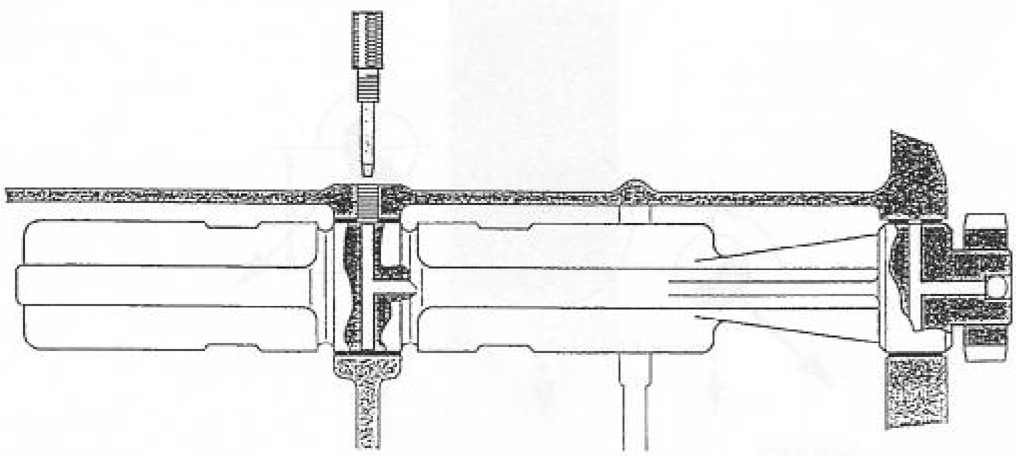


Bild 2013-0021

NOTES

2.4 Cylinder head

2.4.1 Design structure

The cylinder heads of the 1012, 1013, 2012 engine series are made of grey cast iron and designed as block-type heads. The combustion air enters vertically and the exhaust air is discharged laterally. Inlet and outlet are located on one side of the cylinder head.

2.4.2 Valves

The engines are provided with one inlet and one exhaust valve per cylinder. The valve guides are shrunk in the cylinder head. The valve seat inserts are made of high-quality steel and are also shrunk in the cylinder head.

The valves are turned by eccentric actuation through the rocker arms. The new compressed cone connection permits easy turning of the valve despite stress load.

Attention: The valve springs of the **1012** and **2012** have a **special installation** direction. The colored mark on the spring must show to the bottom.

The valve springs of the **1013** have **no special installation** direction.

Rocker arm lubrication is integrated in the lube oil circuit. The oil is supplied via tappets and push-rods.

Valve seat angle: inlet: 30° exhaust: 45°

2.4.3 Valve clearance adjustment

The valve clearance must be checked and adjusted at specified intervals (see operation manual). To do this, the engine oil temperature must be < 80 °C.
Valve clearance: Inlet 0.3 mm Outlet 0.5 mm

Adjustment:

- Remove rocker cover.
- Turn crankshaft until both valves in cylinder 1 overlap (exhaust valve about to close, inlet valve about to open).
- Adjust clearance of valves marked in black in figure 1012-0021. Mark respective rocker arm with chalk to show that adjustment has been done.

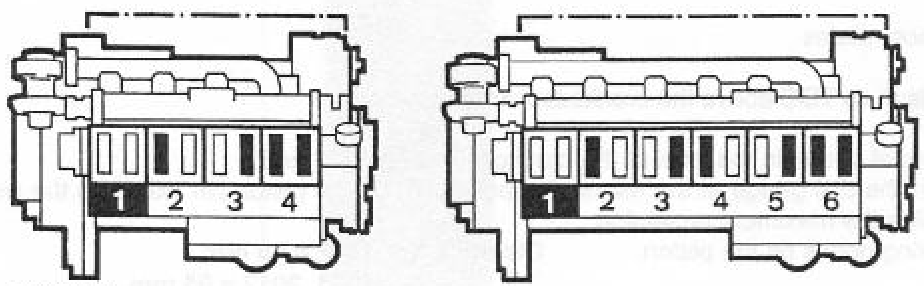


Bild 1012-0021

- Turn crankshaft one full revolution (360°). Now adjust clearance of valves marked black in figure 1012-0022.

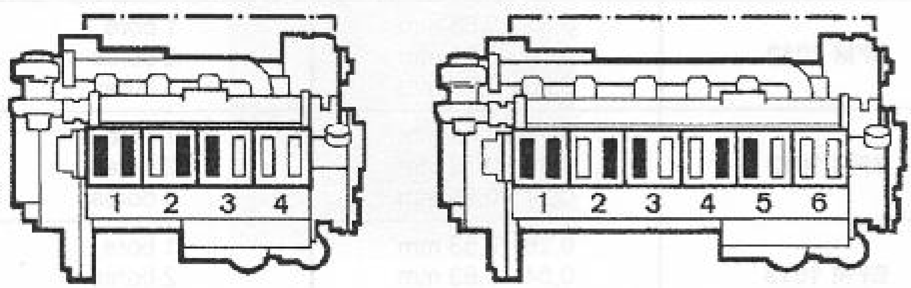


Bild 1012-0022

2.4.4 Determining cylinder head gasket

The thickness of the cylinder head gasket is responsible for the correct piston crown clearance of the engine. The piston crown clearance (0.65 mm) essentially influences the combustion and thus:

Power
Fuel consumption
Exhaust emission

The piston crown clearance is adjusted by determining the piston projection and the thickness of the cylinder head gasket.

Measuring piston projection

A dial gauge with a fixture is needed to measure the piston projection.

The fixture comprises:

1 - Dial gauge
2 - Bridge
3 - Two spacer plates

The piston is in its TDC above the crankcase surface.

A Set the dial gauge in the level of the crankcase surface to "zero".
B Position the dial gauge at the measuring points (C) on the piston pin axis onto the piston and determine the maximum projection.
C Measuring points on the piston. **Distance X: 1012 = 90 mm,**
1013, 2012 = 95 mm

This measurement is performed on each piston. The maximum determined piston projection determines the thickness of the cylinder head gasket (see table). There are 3 different gasket thicknesses identified by bores (4):

1 bore = 1,2 mm; 2 bores = 1,3 mm; 3 bores = 1,4 mm.

	Piston projection	Identification of cylinder head gasket
BFM 2012	0,33 - 0,55 mm 0.56 - 0,65 mm 0,66 - 0,76 mm	1 bore 2 bores 3 bores
BFM 1012	0,43 - 0,63 mm 0,64 - 0,73 mm 0,74 - 0,85 mm	1 bore 2 bores 3 bores
BFM 1013	0,28 - 0,53 mm 0,54 - 0,63 mm 0,64 - 0,75 mm	1 bore 2 bores 3 bores

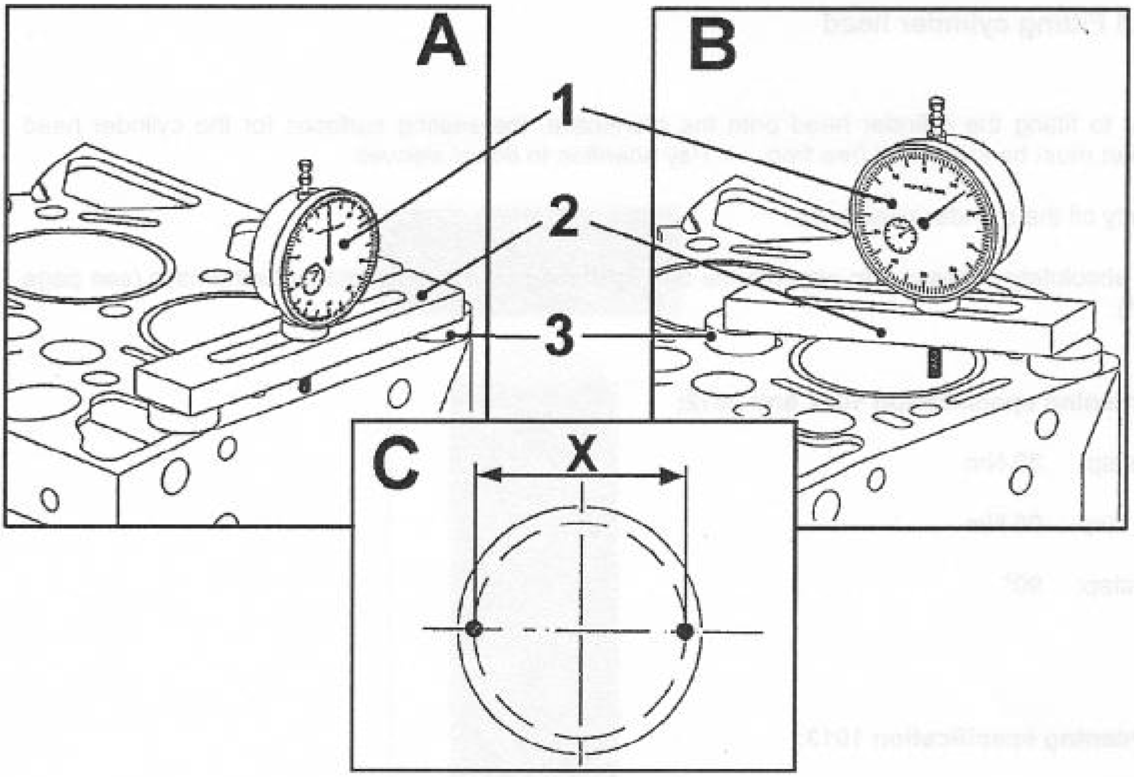


Bild 1012-0025

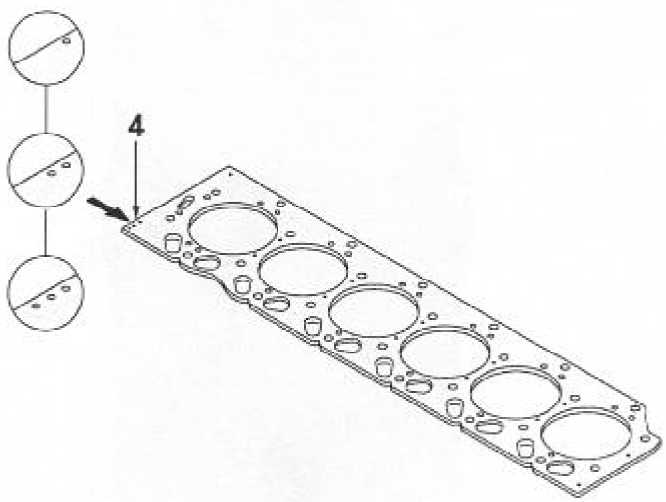


Bild 2013-0026

2.4.5 Fitting cylinder head

Prior to fitting the cylinder head onto the crankcase, the sealing surfaces for the cylinder head gasket must be clean and free from oil. Pay attention to dowel sleeves.

Lightly oil the cylinder head bolts.

It is absolutely necessary to observe the bolt tightening order in the adjacent schematic (see page 2-17).

Tightening specification 1012 and 2012:

1st step: 30 Nm

2nd step: 80 Nm

3rd step: 90°

Tightening specification 1013:

1st step: 50 Nm

2nd step: 130 Nm

3rd step: 90°

Tightening order for 4-cylinder engine

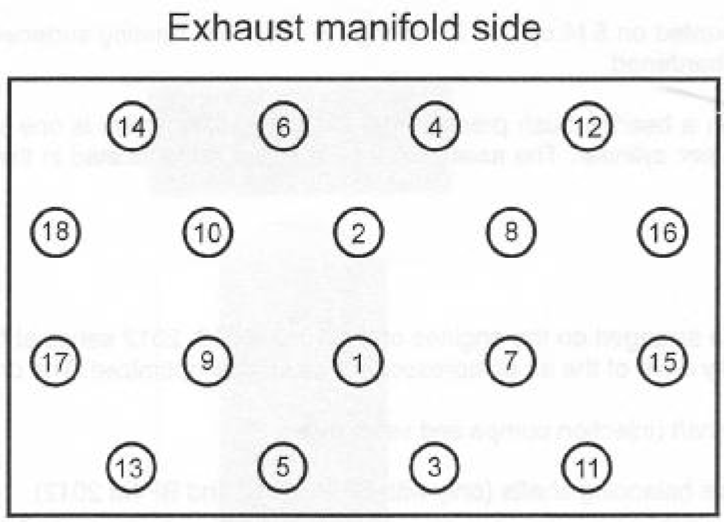


Bild 2013-0027

Tightening order for 6-cylinder engine

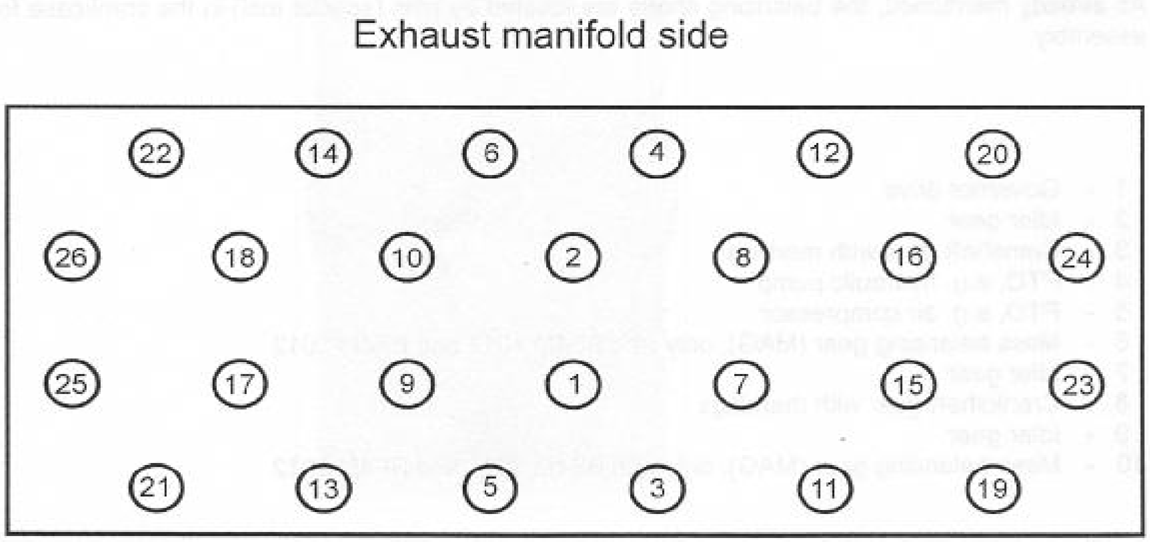


Bild 2013-0028

2.5 Camshaft and timing gears

Camshaft

The camshaft is mounted on 5 (4 cyl.) or 7 bearings (6 cyl.). The running surfaces of bearings and cams are induction-hardened.

Each bearing runs in a bearing bush pressed into the crankcase. There is one inlet, exhaust and injection pump cam per cylinder. The axial stop for the camshaft is located in the timing chest cover.

Timing gears

The timing gears are arranged on the engines of the 1012, 1013, 2012 series at flywheel end. The gears for the auxiliary drive of the air compressor are clearance-optimized. The drive:

Camshaft (injection pumps and valve gear)

2 mass balancing shafts (only with BF4M 1012 and BF4M 2012)

Governor

1st PTO (hydraulic pumps)

2nd PTO (air compressor)

Crankshaft flange and camshaft gear are marked for setting the engine timing.
Marking on the crankshaft flange in the tooth gap.
Marking on the camshaft gear on the tooth.

As already mentioned, the balancing shafts are located by pins (special tool) in the crankcase for assembly.

1 - Governor drive
2 - Idler gear
3 - Camshaft gear with marking
4 - PTO, e.g. hydraulic pump
5 - PTO, e.g. air compressor
6 - Mass balancing gear (MAG), only with BF4M 1012 and BF4M 2012
7 - Idler gear
8 - Crankshaft gear with markings
9 - Idler gear
10 - Mass balancing gear (MAG), only with BF4M 1012 and BF4M 2012

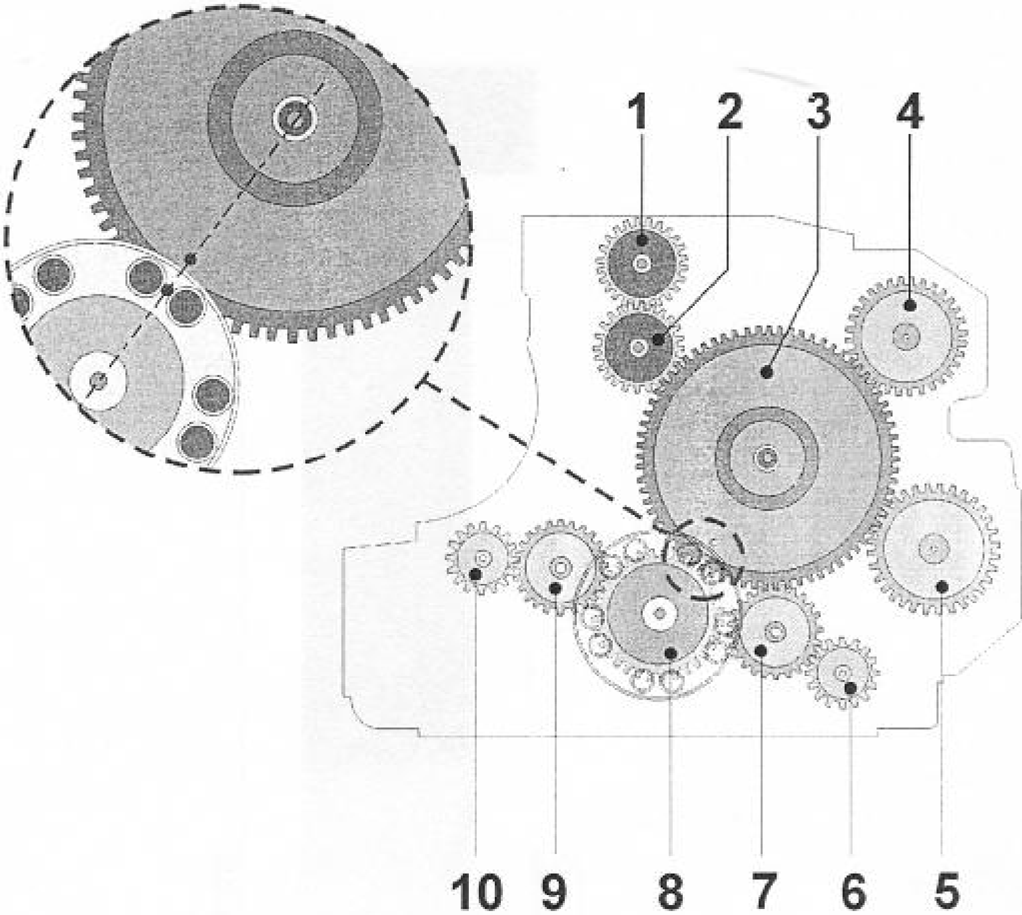


Bild 2013-0029

NOTES

3. Lubrication system

3.1 Lube oil circuit

3.1.1 BFM 2012

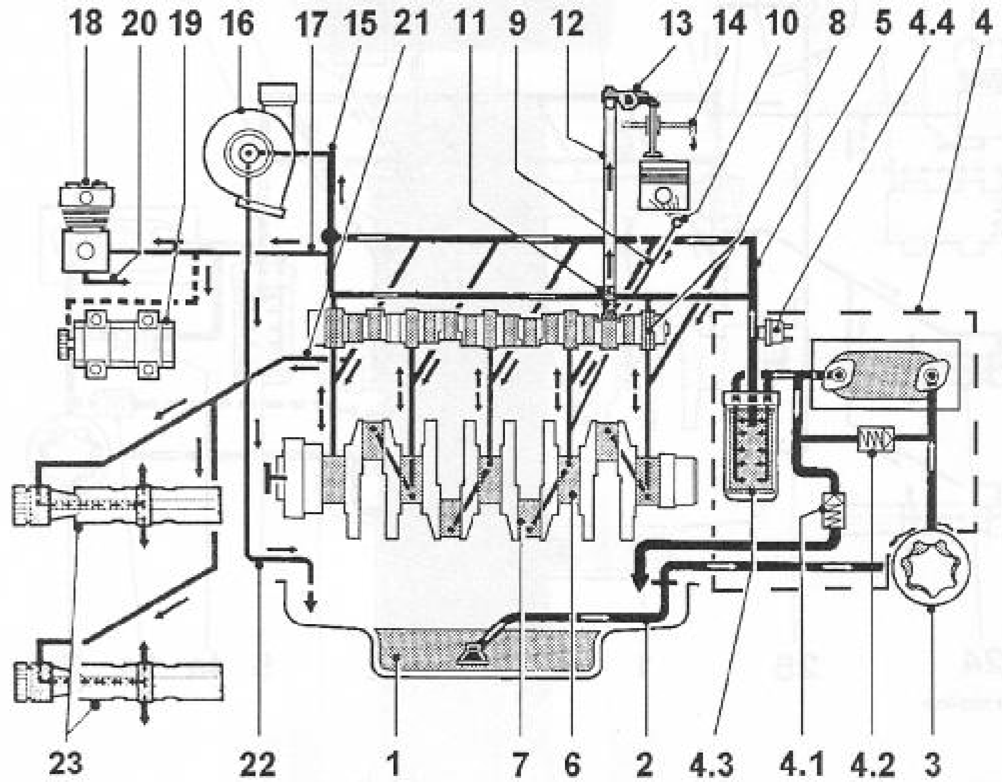


Bild 2012-0030

1 - Oil pan
2 - Intake pipe
3 - Lube oil pump
4 - Lube oil cooler housing
 4.1 - Press.reg. valve; 4 ±0.4 bar
 4.2 - Cooler bypass valve; 2.1 ±0,35 bar
 4.3 - Lube oil filter with bypass valve; 2.5 ±0,5 bar
 4.4 - Oil pressure sensor
5 - Main oil gallery
6 - Crankshaft bearing
7 - Big end bearing
8 - Camshaft bearing
9 - Bore for piston cooling spray nozzle
10 - Spray nozzle for piston cooling
11 - Tappet control bore for lubrication of rocker arms
12 - Pushrod, oil supply for rocker arm
13 - Rocker arm
14 - Return line to oil pan
15 - Oil line to exhaust turbocharger
16 - Exhaust turbocharger
17 - Oil line to compressor or to hydraulic pump
18 - Compressor
19 - Hydraulic pump
20 - Return line
21 - Return to oil pan
22 - Return line from turbocharger
23 - Mass balancing shafts

3.1.2 BF4M 1012

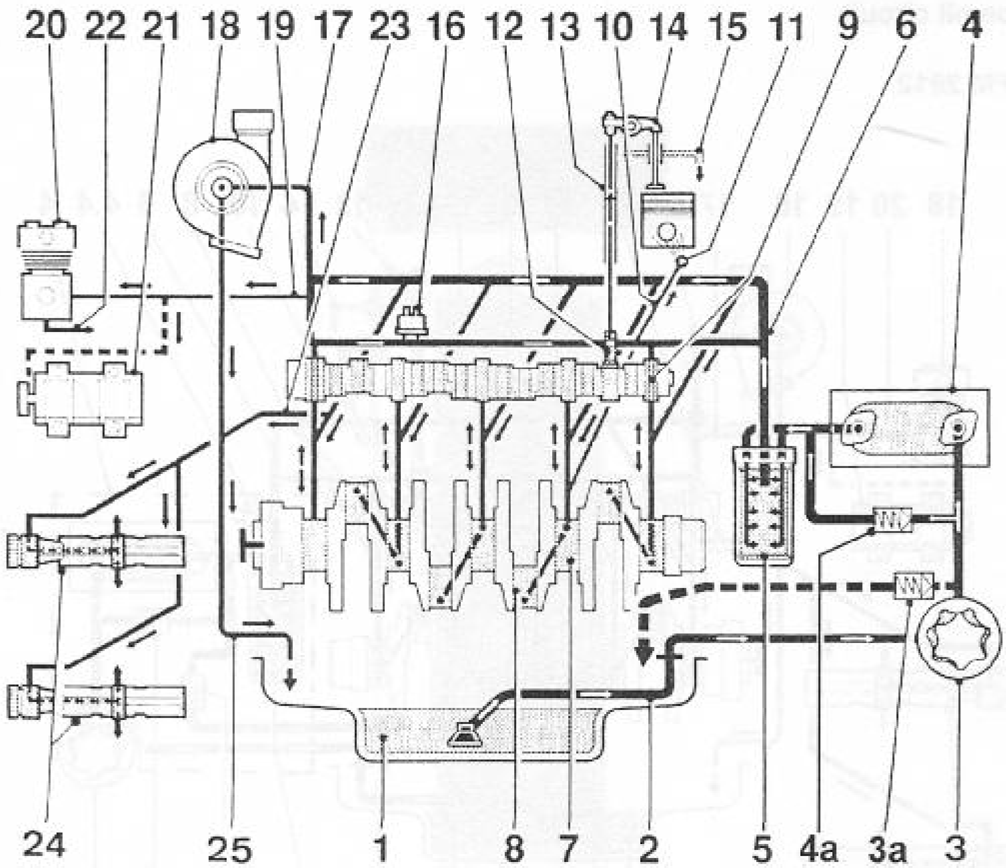


Bild 1012-0030

1 - Oil pan
2 - Intake pipe
3 - Lube oil pump
   3a - Press.reg. valve; 6 ±0.75 bar
4 - Lube oil cooler
   4a - Cooler bypass valve; 1.45 ±0,3 bar
5 - Lube oil filter
6 - Main oil gallery
7 - Crankshaft bearing
8 - Big end bearing
9 - Camshaft bearing
10 - Bore for piston cooling spray nozzle
11 - Piston cooling nozzle
12 - Tappet control bore for lubrication of rocker arms
13 - Pushrod
14 - Rocker arm
15 - Return line to oil pan
16 - Oil sensor
17 - Oil line to exhaust turbocharger
18 - Exhaust turbocharger
19 - Oil line to compressor or to hydraulic pump
20 - Compressor
21 - Hydraulic pump
22 - Return line
23 - Line to mass balancing gear (2x)
24 - Mass balancing shafts
25 - Return line from turbocharger

3.1.3 BF6M 1012

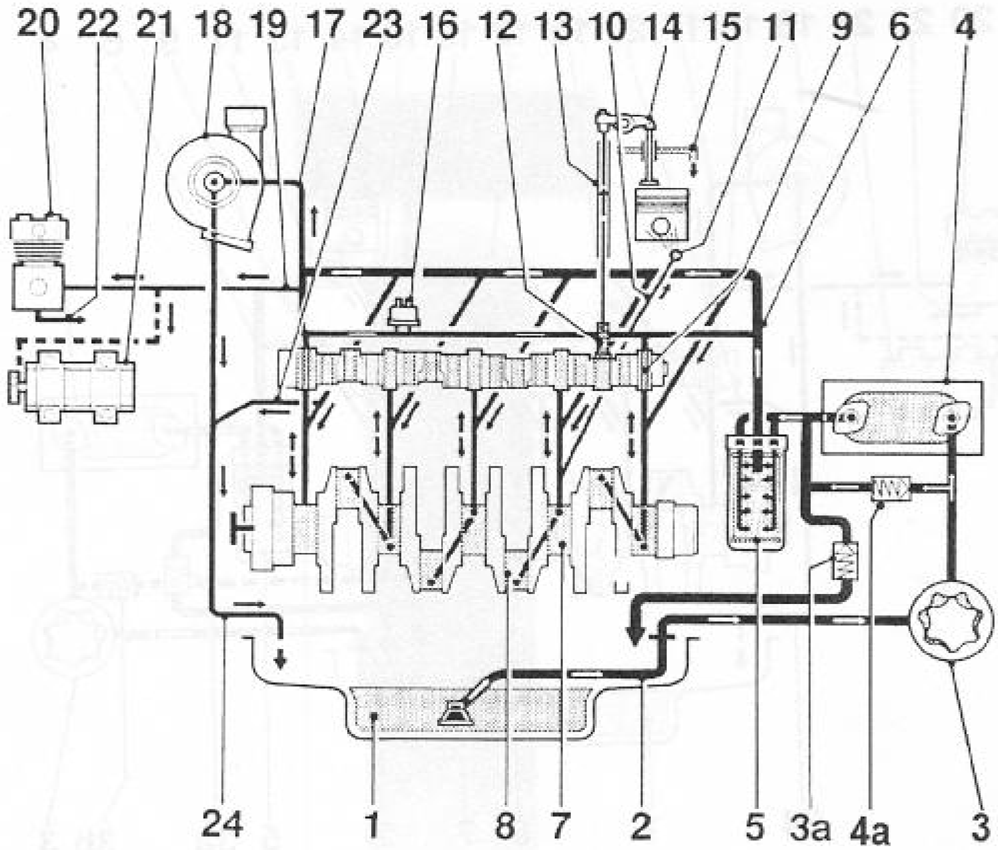


Bild 1012-0031

1 - Oil pan
2 - Intake pipe
3 - Lube oil pump
   3a - Press.reg. valve; 4 ±0.5 bar
4 - Lube oil cooler
   4a - Cooler bypass valve; 1.45 ±0,3 bar
5 - Lube oil filter
6 - Main oil gallery
7 - Crankshaft bearing
8 - Big end bearing
9 - Camshaft bearing
10 - Bore for piston cooling spray nozzle
11 - Piston cooling nozzle
12 - Tappet control bore for lubrication of rocker arms
13 - Pushrod
14 - Rocker arm
15 - Return line to oil pan
16 - Oil sensor
17 - Oil line to exhaust turbocharger
18 - Exhaust turbocharger
19 - Oil line to compressor or to hydraulic pump
20 - Compressor
21 - Hydraulic pump
22 - Return line
23 - Return line to oil pan
24 - Return line from turbocharger

3.1.4 BF4M 1013, BF6M 1013

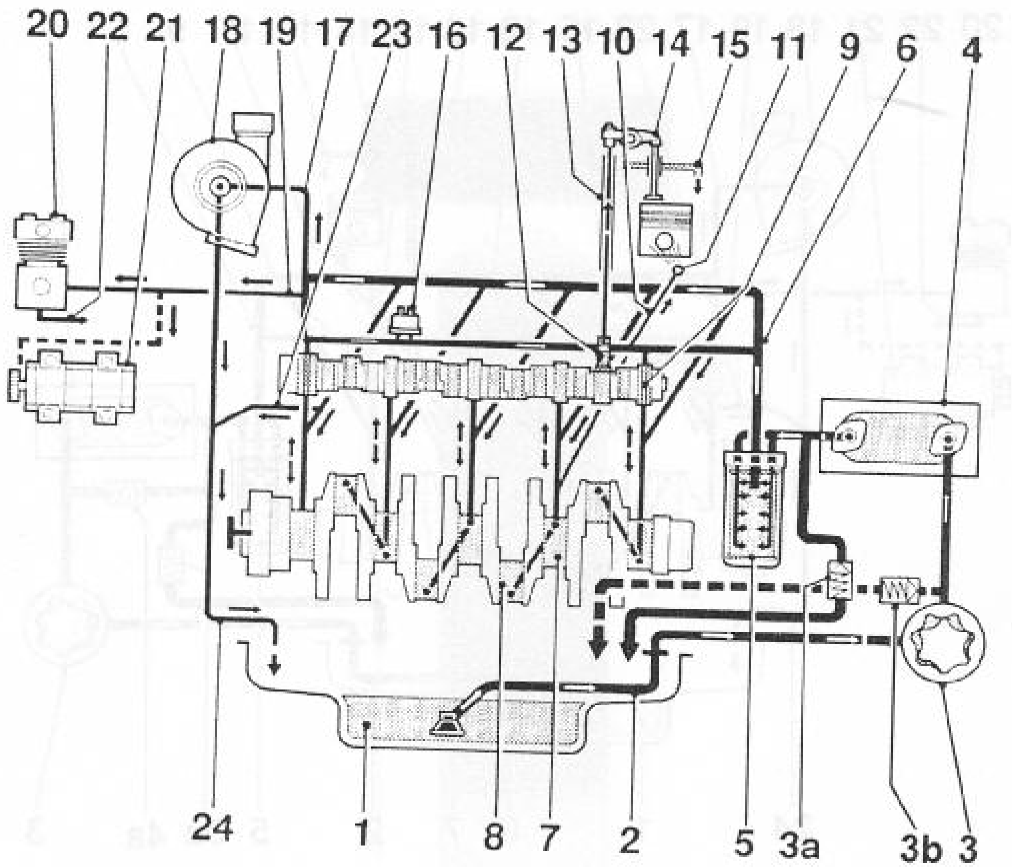


Bild 1012-0032

1 - Oil pan
2 - Intake pipe
3 - Lube oil pump
   3a - Press.reg. valve; 4 ±0.5 bar
   3b - Pressure-relief valve; 10 ±1 bar
4 - Lube oil cooler
5 - Lube oil filter
6 - Main oil gallery
7 - Crankshaft bearing
8 - Big end bearing
9 - Camshaft bearing
10 - Bore for piston cooling spray nozzle
11 - Piston cooling nozzle
12 - Tappet control bore for lubrication of rocker arms
13 - Pushrod
14 - Rocker arm
15 - Return line to oil pan
16 - Oil sensor
17 - Oil line to exhaust turbocharger
18 - Exhaust turbocharger
19 - Oil line to compressor or to hydraulic pump
20 - Compressor
21 - Hydraulic pump
22 - Return line
23 - Return line to oil pan
24 - Return line from turbocharger

3.2 2 Wiring diagram, lube oil circuit

3.2.1 BFM 2012

Item	Description	Remark
1	Lube oil pump	Rotary pump; Volume flow at n = 2500 min^{-1}: BF4M 2012 = 65 l/min BF6M 2012 = 90 l/min
2	Oil cooler	
3	Bypass valve oil cooler	Opening pressure: p = 2.1 ±0.35 bar
4	Oil filter	With bypass valve (5)
5	Bypass valve oil filter	Opening pressure: p = 2.5 ±0.5 bar
6	Pressure regulating valve	Opening pressure: p = 4.0 ±0.4 bar
7	Exhaust turbocharger	

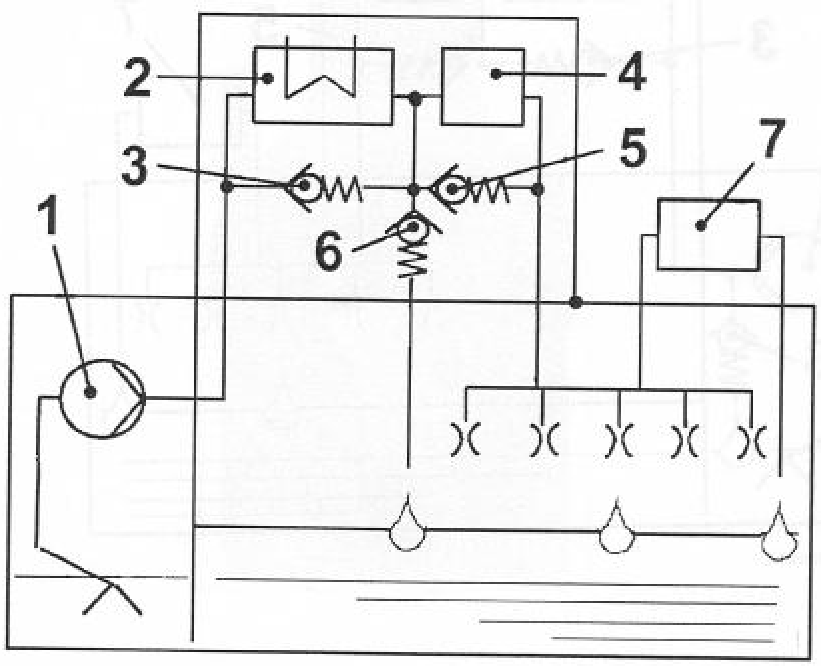


Bild 2013-0031

3.2.2 BF4M 1012

Item	Description	Remark
1	Lube oil pump	Rotary pump; Volume flow at n = 2500 min^{-1}: BF4M 1012 = 50 l/min
2	Oil cooler	With bypass valve (3)
3	Bypass valve oil cooler	Opening pressure: p = 1.5 ±0.2 bar
4	Oil filter	With bypass valve (5)
5	Bypass valve oil filter	Opening pressure: p = 2.5 ±0.5 bar
6	Pressure regulating valve	Opening pressure: p = 6.0 ±0.75 bar
7	Exhaust turbocharger	

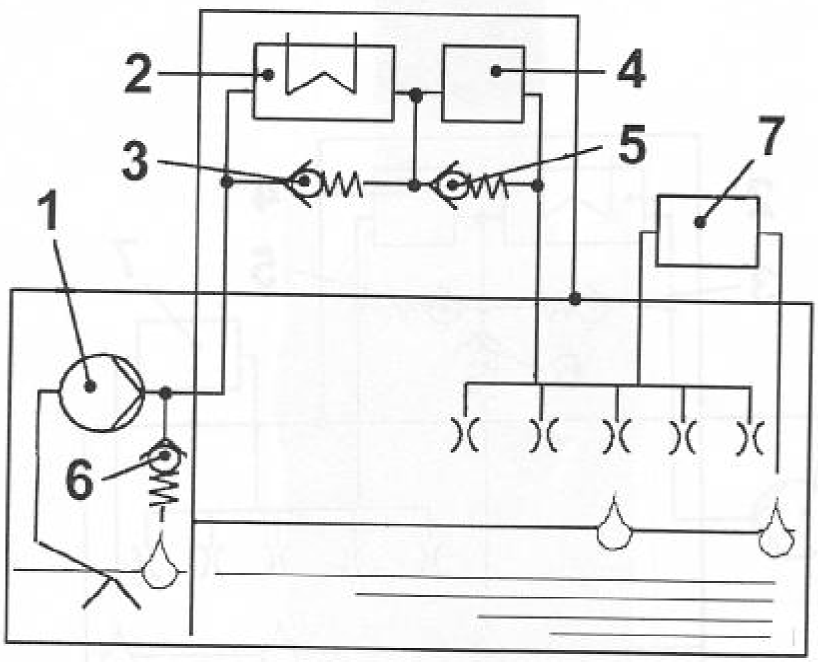


Bild 1012-0033

3.2.3 BF6M 1012 (Industie and tractors)

Item	Description	Remark
1	Lube oil pump	Rotary pump; Volume flow at n = 2500 min^{-1}: BF6M 1012 = 75 l/min
2	Oil cooler	With bypass valve (3)
3	Bypass valve oil cooler	Opening pressure: p = 1.5 ±0.2 bar
4	Oil filter	With bypass valve (5)
5	Bypass valve oil filter	Opening pressure: p = 2.5 ±0.5 bar
6	Pressure regulating valve	Opening pressure: p = 4.0 ±0.4 bar
7	Exhaust turbocharger	

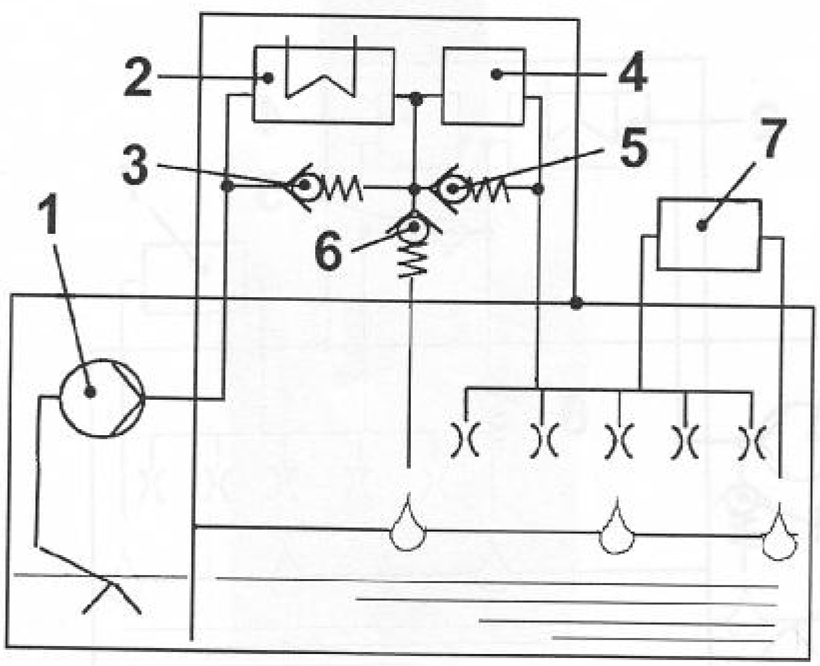


Bild 2013-0031

3.2.4 BF4M 1013, BF6M 1013

Item	Description	Remark
1	Lube oil pump	Rotary pump; Volume flow at n = 2500 min^{-1}: BF4M 1013 = 50 l/min BF6M 1013 = 75 l/min BF6M 1013 CP = 90 l/min
2	Oil cooler	
3	Pressure-relief valve	Opening pressure: p = 10 ±1 bar
4	Oil filter	With bypass valve (5)
5	Bypass valve oil filter	Opening pressure: p = 2.5 ±0.5 bar
6	Pressure regulating valve	Opening pressure: p = 4.0 ±0.4 bar
7	Exhaust turbocharger	

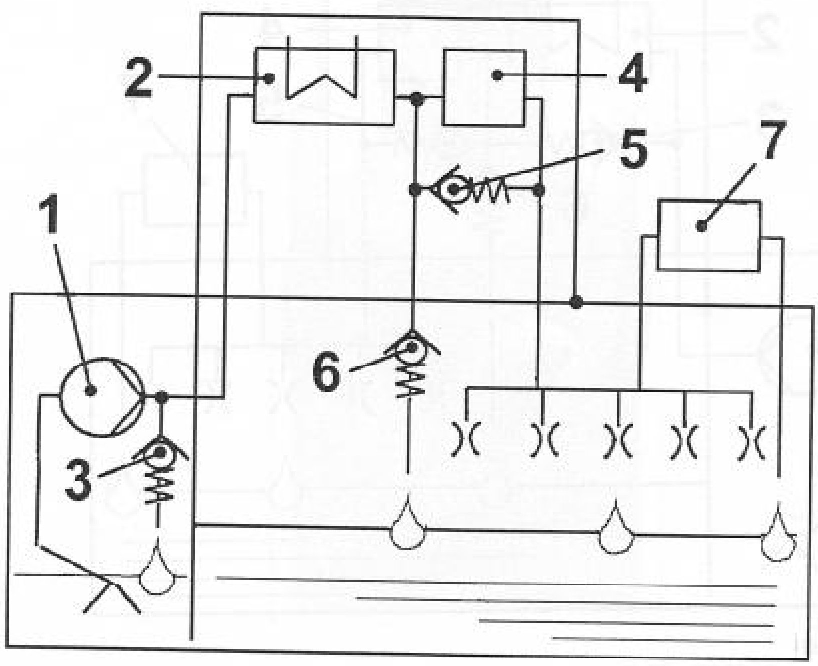


Bild 1012-0036

NOTES

3.3 Lube oil ducts

The engines of the BFM 1012, 1013, 2012 series are provided with forced-feed circulation lubrication with lube oil cooler and lube oil filter arranged in full flow.

The lube oil is supplied by the lube oil pump through the oil cooler to the oil filter. Both components are mounted to the lube oil cooler housing which is flanged to the crankcase. Downstream of the filter the lube oil flows into the main oil gallery and secondary oil gallery. From here the oil is ducted to the lubricating points.

The main oil gallery supplies:

Crankshaft
Camshaft
Valve tappets
Roller tappets

The secondary oil gallery supplies:

Exhaust turbocharger
Compressor

1 From oil filter
2 Main oil gallery
3 Oil duct to crankshaft
4 Oil duct to camshaft
5 Seondary oil gallery

I Crankshaft bearing
II Camshaft bearing
III Fuel rack guide
IV Mass balancing shaft bearing (only BF4M 1012 and BF4M 2012)

Lubrication of the rockers is effected via the tappets and the pushrods.

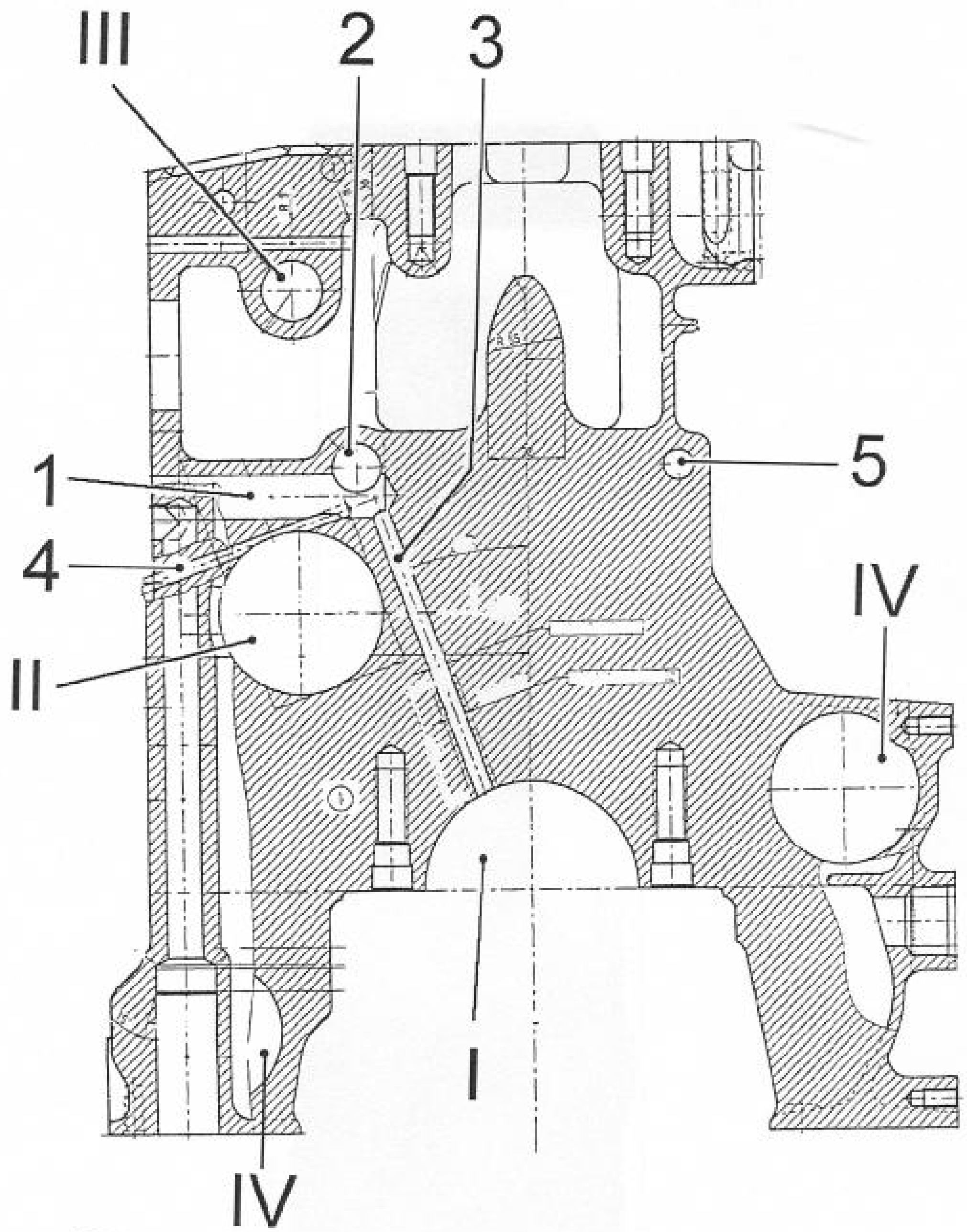


Bild 2013-0032

NOTES

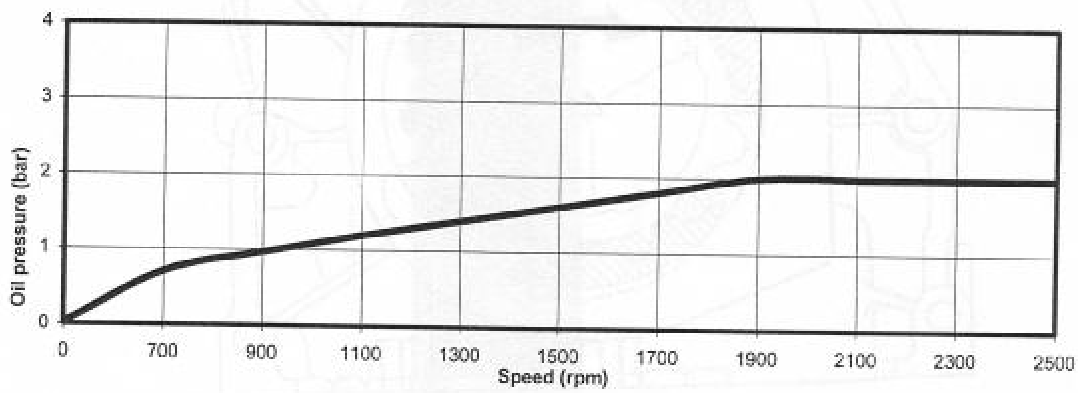
3.4 Lube oil pump 1012,1013 and 2012

The lube oil pump is designed as rotary pump and installed in the front cover. The inner rotor (1) is seated on the crankshaft and is driven by same.

Its driver contour (4) has no 120° partition, i.e. the rotor can only be slid onto the crankshaft in a specific position.

The pumps of BF4M 1012, BF6M 1012, BF4M 1013, BF6M 1013, BF4M 2012 and BF6M 2012 feature different volume flows. This is attributable to deviating rotor widths (see tables).

Minimum oil pressure at 120°C oil temperature, measured at oil filter bracket.



Lube oil pump BFM 2012

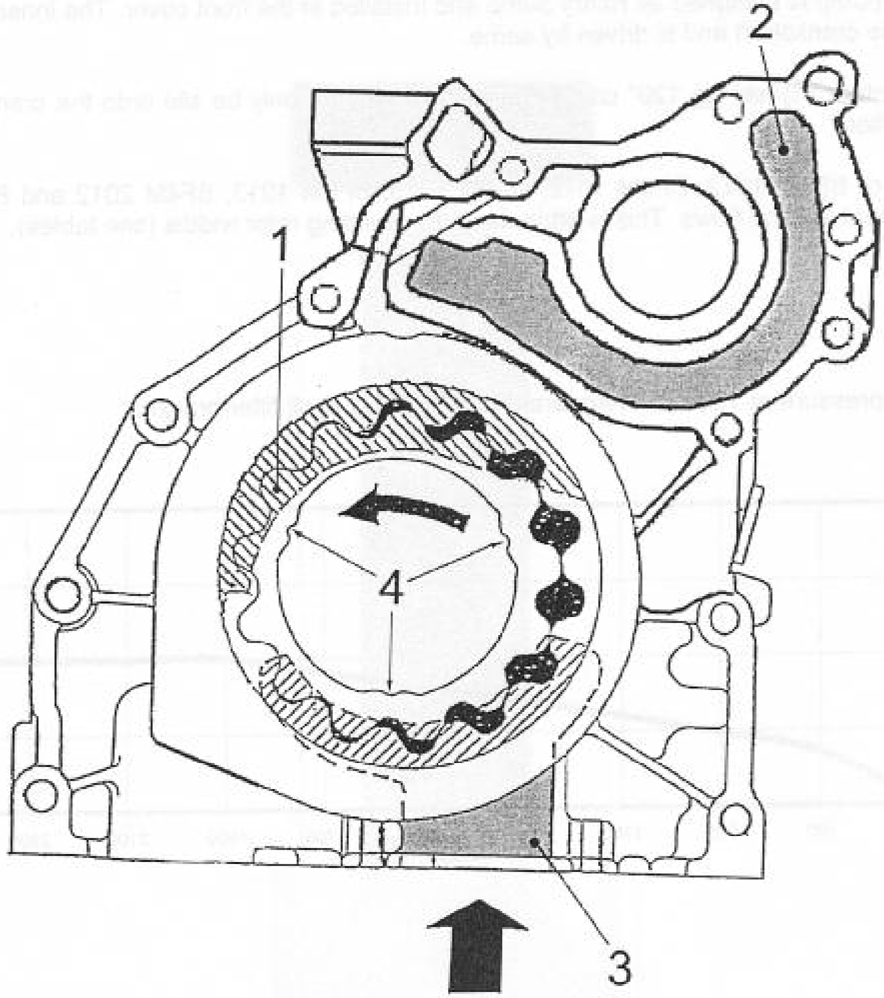


Bild 2013-0333

2 - Delivery chamber towards crankcase
3 - Suction chamber

	BF4M 2012	BF6M 2012
Rotor width (mm)	12,3	16,5
Volume flow (l/min) at $n_{2500\ min-1}$	65	90

Lube oil pump BFM 1012 and BFM 1013

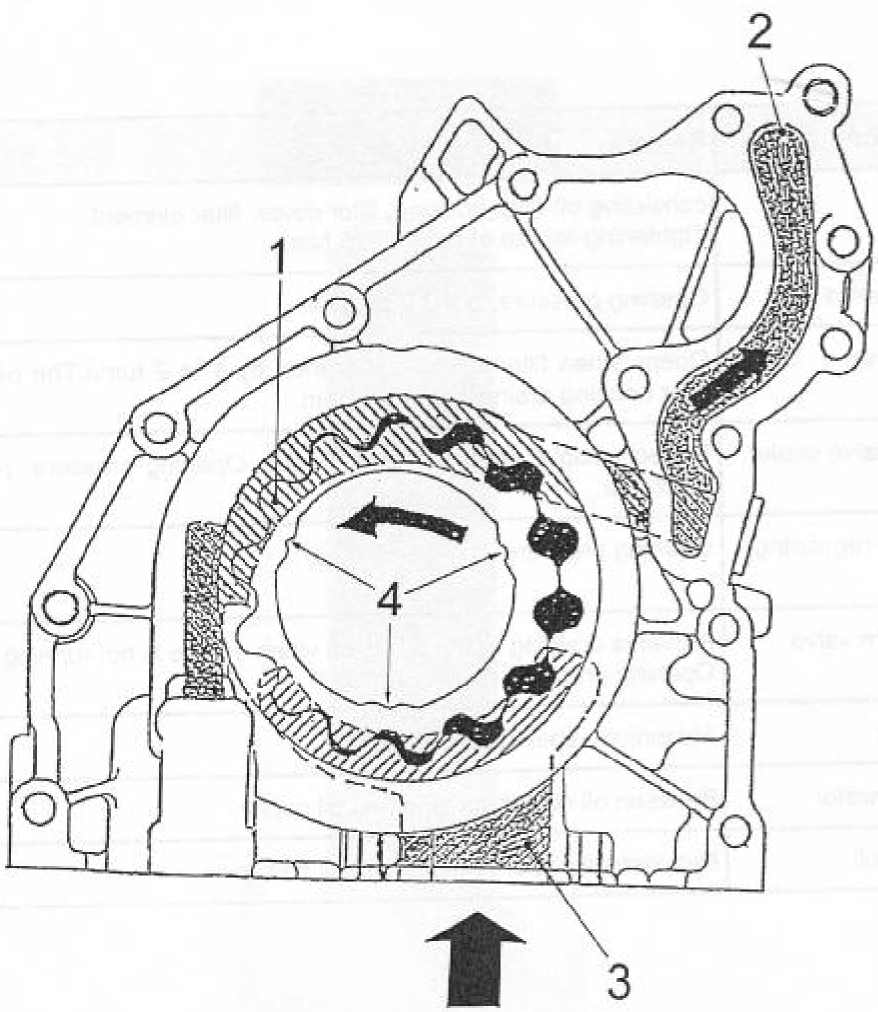


Bild 1012-0037

2 - Delivery chamber towards crankcase
3 - Suction chamber

	BF4M 1012	BF6M 1012	BF4M 1013	BF6M 1013	BF6M 1013 CP
Rotor width (mm)	9,5	13,5	8,7	12,5	14,5
Volume flow (l/min) at $n_{2500\ min^{-1}}$	50	75	50	75	90

3. Lube oil cooler housing BFM 2012

The oil cooler housing incorporates the oil cooler, the oil filter and the pressure relief valve of the lube oil circuit.

Item	Description	Remark
1	Oil filter	consisting of: filter housing, filter cover, filter element. Tightening torque of cover = 25 Nm.
2	Bypass valve filter	Opening pressure: p = 2.5 ±0.5 bar.
3	Drain valve	Opens when filter cover is loosened by 1 to 2 turns.The oil in the filter housing drains into the oil pan.
4	Bypass valve cooler	Protects cooler from pressure peaks. Opening pressure: p = 2.1 ±0.35 bar.
5	Pressure regulating valve	Opening pressure: p = 4.0 ±0.4 bar.
6	Non-return valve	Prevents draining of the oil circuit when engine is not running. Opening pressure max. 0.12 bar.
7	Oil cooler	Aluminium shell-type cooler
8	Passage water	Between oil cooler housing and oil cooler
9	Passage oil	Between oil cooler housing and oil cooler

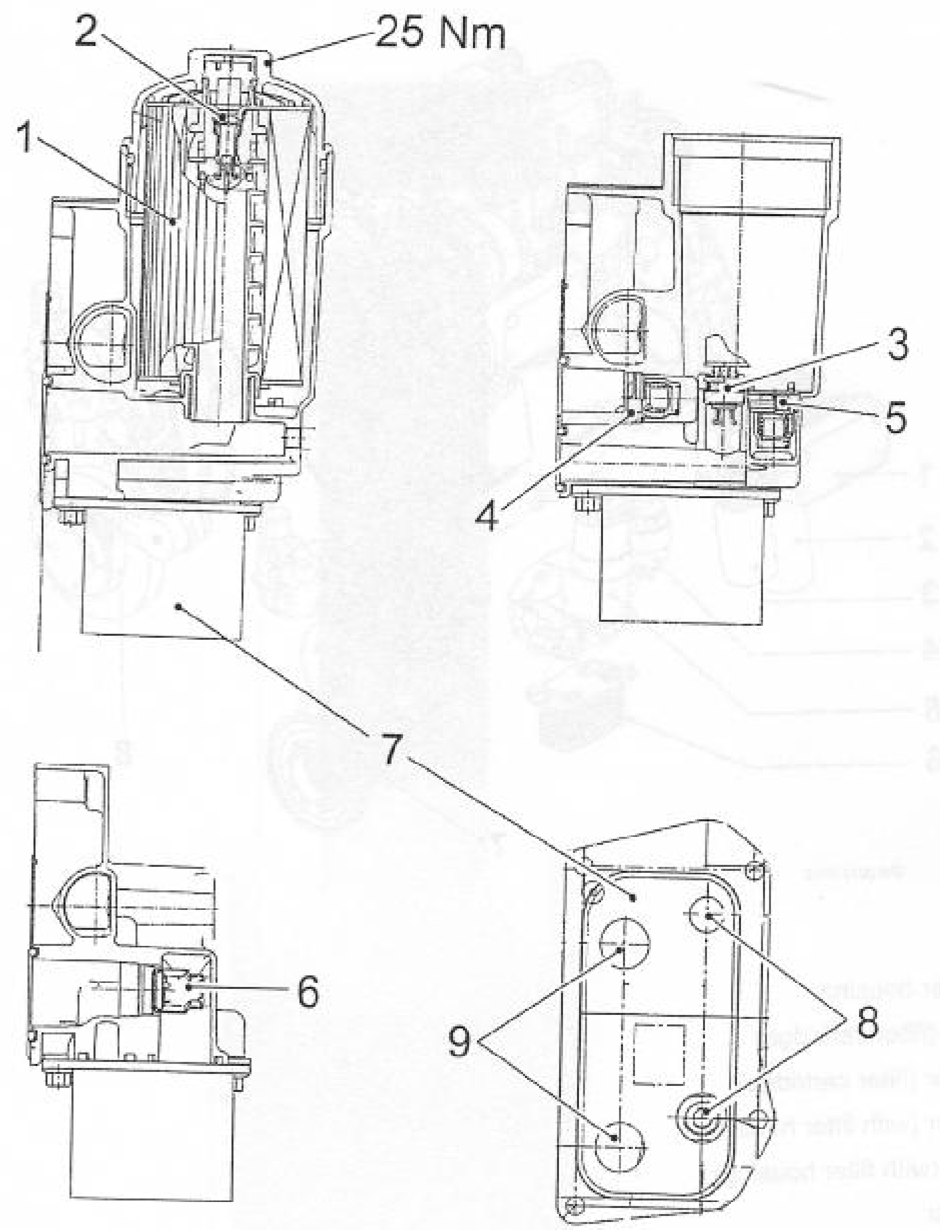


Bild 2013-0034

3.6 Lube oil filter- and cooler versions BFM 2012

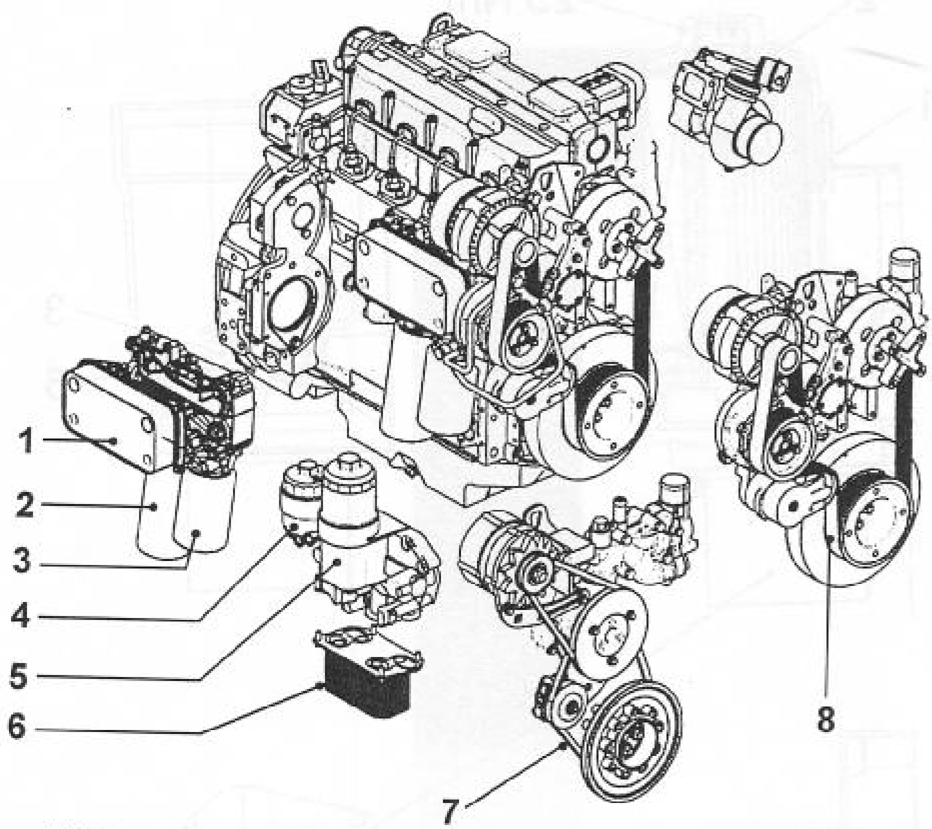


Bild 2012-0072

1 – Oil cooler housing

2 – Oil filter (filter cartridge)

3 – Fuel filter (filter cartridge)

4 – Fuel filter (with filter housing)

5 – Oil filter (with filter housing)

6 – Oil cooler

7 – V-belt version

8 – Poly-V-belt version

4. Fuel system

The engines of the 1012, 1013 and 2012 series operate according to the direct injection principle.

The piston bowl has a small amount of eccentricity to the piston axis. The fuel is injected via single injection pumps. The maximum injection pressure reaches up to 1200 bar (1012) and and 1350 bar (1013, 2012). This results in good exhaust emission values which meet the requirements of EURO I to III.

1012 engine series:

- 5 - hole nozzle
- Compression 17.5 : 1
- Max. injection pressure 1500 bar

5 hole

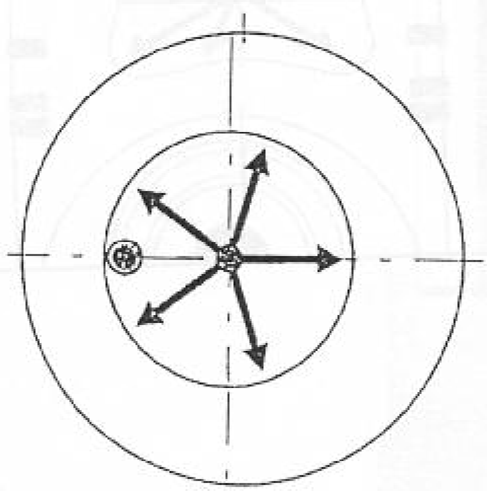


Bild 1012-040

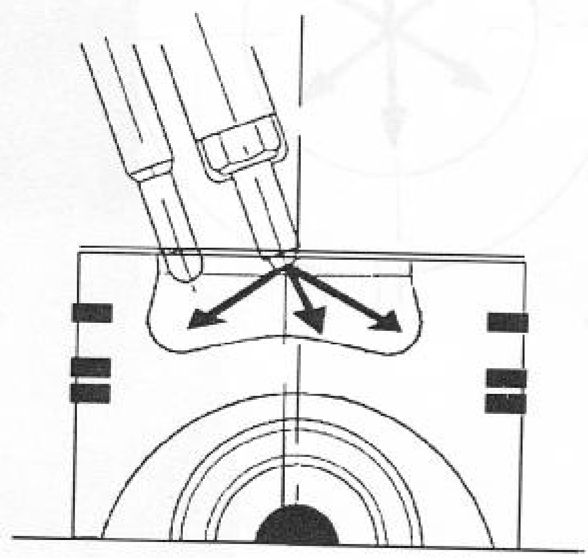


Bild 1012-0041

1013 and 2012 engine series:

- 6 - hole nozzle
- Compression 19 : 1
- Max. injection pressure 1350 bar

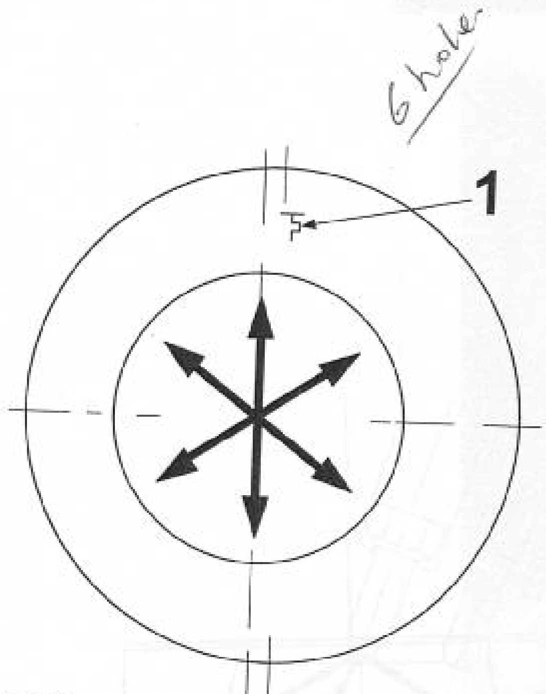


Bild 2012-0040

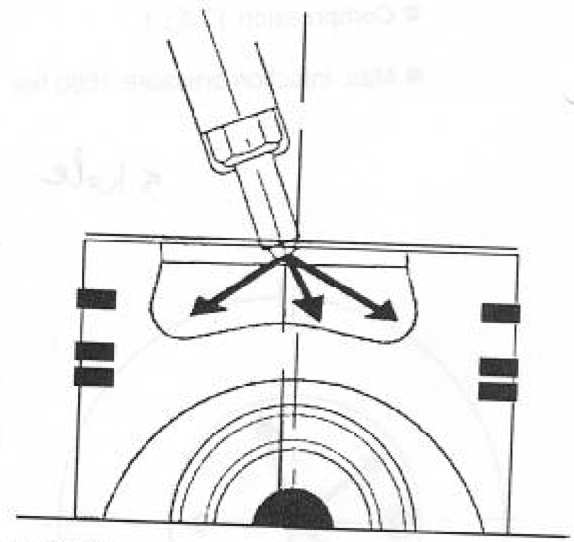


Bild 2012-0041

4.1 Design structure

4.1.1 BFM 2012

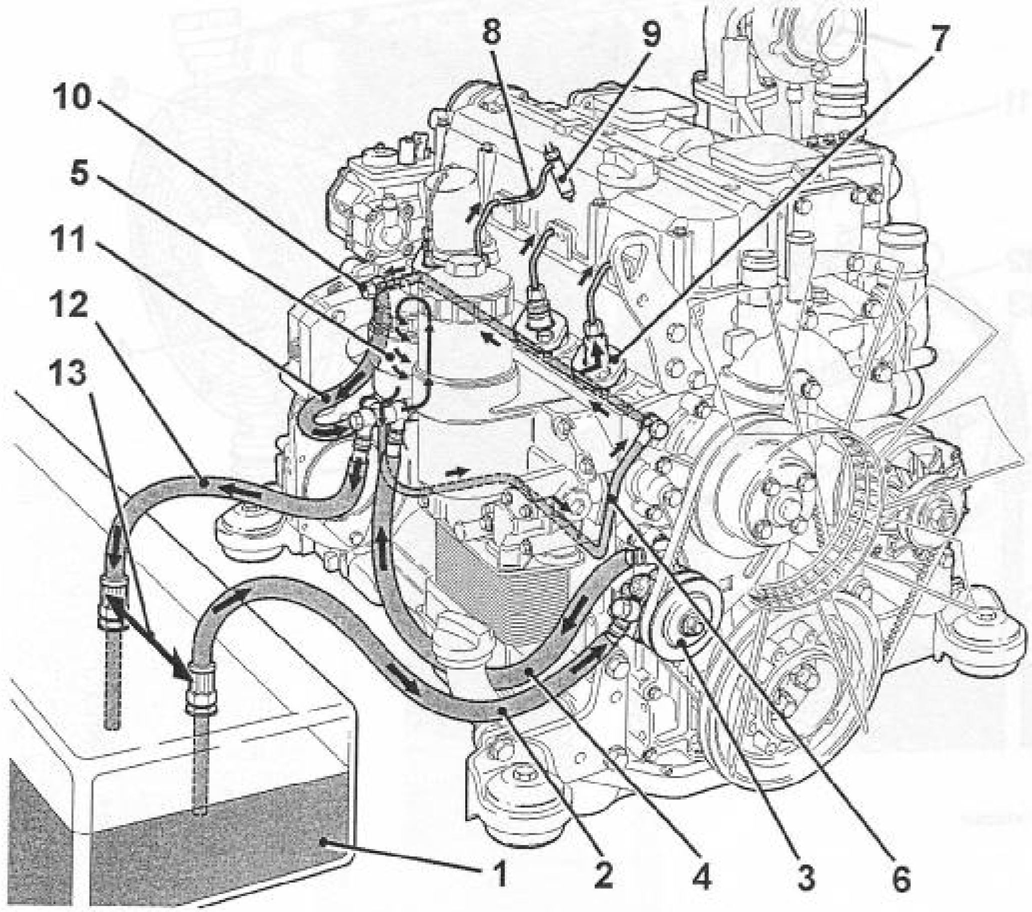


Bild 2012-0042

1. Fuel tank
2. Line to fuel pump
3. Fuel pump
4. Line to fuel filter
5. Fuel filter
6. Line to single injection pumps
7. Single injection pump
8. Line to injector
9. Injector
10. Pressure holding valve, (5 bar)
11. Return line to fuel filter housing
12. Return line to fuel tank
13. Minimum distance 300 mm

The fuel is delivered by the fuel feed pump (3) from the tank (1) via the filter (5) to the supply duct of the single injection pumps integrated in the crankcase.

From the single injection pumps the fuel is supplied through the injection lines (8) to the injectors (9). At the end of the supply duct is fitted the pressure holding valve (10), 5 bar.

4.1.2 BFM 1012, 1013

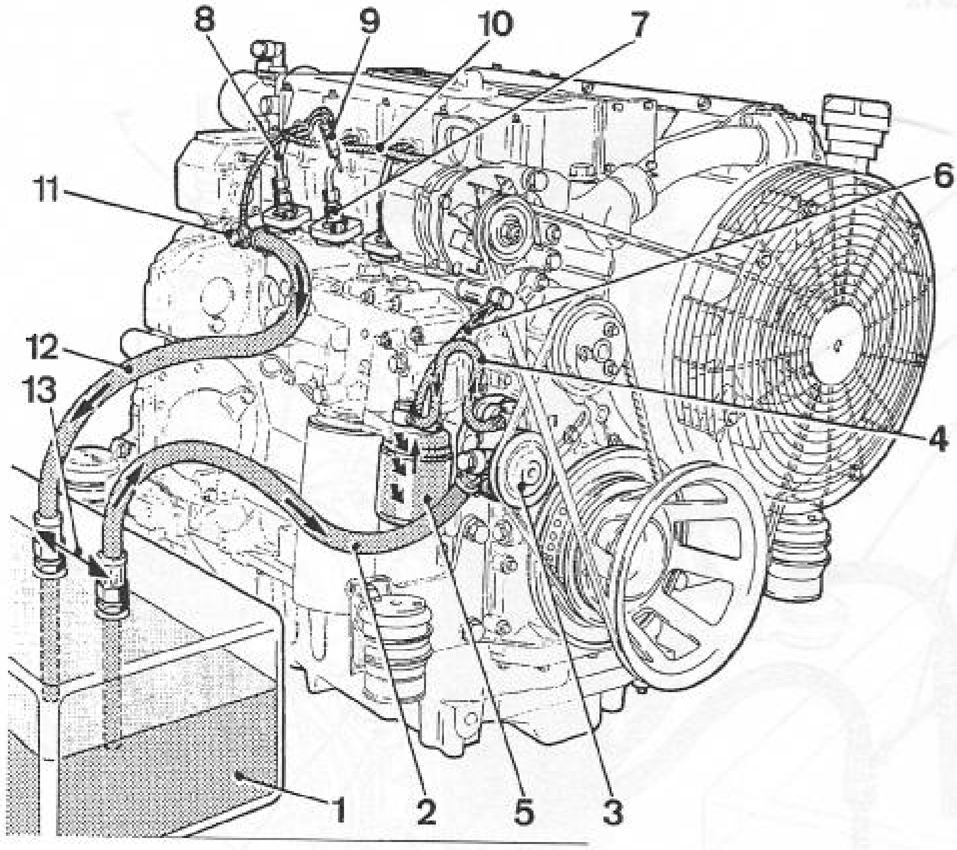


Bild 1012-0042

1 Fuel tank
2 Line to fuel pump
3 Fuel pump
4 Line to fuel filter
5 Fuel filter
6 Line to single injection pumps
7 Single injection pump
8 Line to injector
9 Injector
10 Fuel-leakage line
11 Pressure holding valve
12 Return line to fuel tank
13 Minimum distance 300 mm

The fuel is delivered by the fuel feed pump (3) from the tank (1) via the filter (5) to the supply duct of the single injection pumps integrated in the crankcase.

From the single injection pumps the fuel is supplied through the injection lines (8) to the injectors (9). At the end of the supply duct is fitted the pressure holding valve (11).

4.2 Fuel feed pump

The fuel feed pump is designed as rotary pump which is driven via the Poly-V-belt.

The pump is provided with a two-way valve (item 1 $P_{op.}$ 6 ±0.5 bar, item 2 $P_{op.}$: 0.5 bar).

The overpressure relief valve (1) is designed as plunger valve and opens at 5.5 bar. This valve simultaneously limits the system pressure to 9.5 bar.

The bypass valve (2) is a ball valve. When the fuel lines have run empty, the fuel system can be primed with a hand pump. This prevents an excessive engine starting procedure. (starter protection).

Note:
Do not reduce the line cross section and connection to fuel feed pump (see installation directions), as this may result in engine power loss.

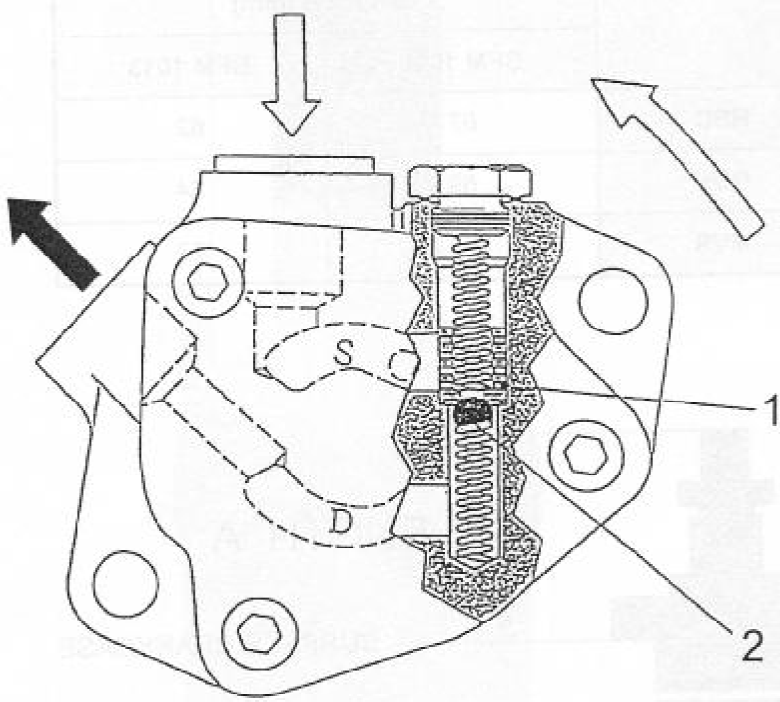


Bild 2013-0043

4.3 Injection system

The engines of the the 1012, 1013, 2012 series are provided with BOSCH single injection pumps. In combination with a high hydraulic stiffness due to extremely short injection lines, very high injection pressures are realized with this concept. This again forms the basis for achieving low exhaust emission values together with low fuel consumption figures.

Different demands of optimization of a diesel engine request different lay outs of the injection equipment. For that reason the injection pumps of the **1012/1013** series have different relief valves, which have an influence on the installation height of the pumps and the length of the injection pipes.

Injection pumps with the following relief valves are used:

RSD = Return-flow restrictor and constant-volume valve

RDV = Return-flow restrictor valve

MVS = Injection pump for Solenoid (Magnet) -Valve-System (MVS)

	Length A [mm]	
	BFM 1012	**BFM 1013**
RSD	67	62
RDV	59	54
MVS	-	77

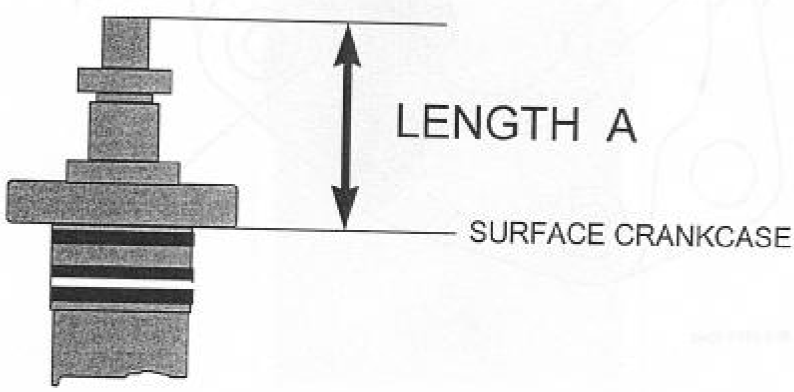


Bild 1012-0043

The different injection pipes resulting from the different pump dimensions are colour-marked. The pipe itself and the two cap nuts on the pipe are chromium-plated either in „silver" or „gold". The following table shows the colour combinations of the injection pipes.

	Length „A" [mm]	Injection pipe	Nut Injection pump	Nut Injector
BFM 1012	59	Silber	Silber	Silber
	67	Silber	Gold	Gold
BFM 1013	54	Gold	Silber	Silber
	54*1)	Gold	Gold	Silber
	62	Gold	Gold	Gold
	77	Gold	Silber	Gold

*1) Inner diameter of this pipe is 2.25 mm (all other pipes: 1.8 mm).

The pressure holding valve (page 4-2, item 11) determines the fuel supply pressure of the engine. There are two pressure holding valves for the supply pressures of 1.8 bar and 5 bar.

Supply pressure 1.8 bar for RSD injection pumps.

Supply pressure 5.0 bar for RDV injection pumps.

The 5.0 bar pressure holding valve is identified by 6 notches in the hexagon of the bolt. The 1.8 bar pressure holding valve has no notches in the hexagon.

4.3.1 Commencement of delivery

The setting of the commencement of delivery (COD) influences:

- fuel consumption,
- power and
- exhaust emissions
  of the engine.

With the 1012, 1013 and 2012 engine series, the commencement of delivery is set without tolerance. It is indicated in C/A degrees BTDC of the piston (see nameplate) and is dependent on application, power and speed setting respectively optimization of the engine.

The single injection pump (1) is in COD position when the plunger (7) is just closing the fuel inlet port (8) in the plunger barrel (8).

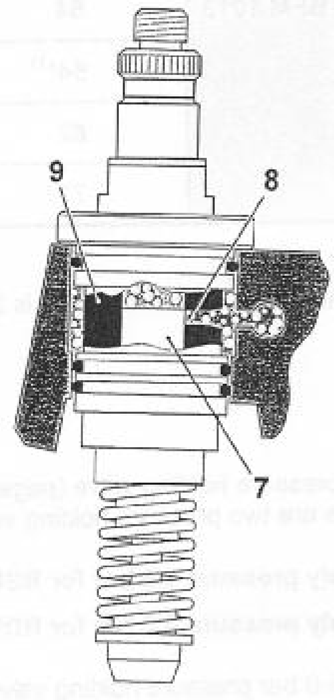


Bild 2013-0044

On engines with in-line injection pumps the crankshaft assembly is turned in COD position and the closing of the fuel inlet port in the injection pump plunger is determined with a high-pressure pump. Any occurring tolerances are compensated at the coupling of the injection pump drive, with the injection pump camshaft being turned to COD position relative to the stationary crankshaft assembly.

This method for setting the commencement of delivery is not applicable in the case of the BFM 1012, 1013 and 2012 as the injection pump cams are fitted on the engine camshaft (6).

The commencement of delivery is therefore set according to a new method, with the conventional method being subdivided into length measurements of individual components and arithmetic steps.

The permissible manufacturing tolerances of the following components are determined and eliminated with the shim (4):

- Crankcase (3),
- Camshaft (6),
- Roller tappet (5) and
- Injection pump (1).

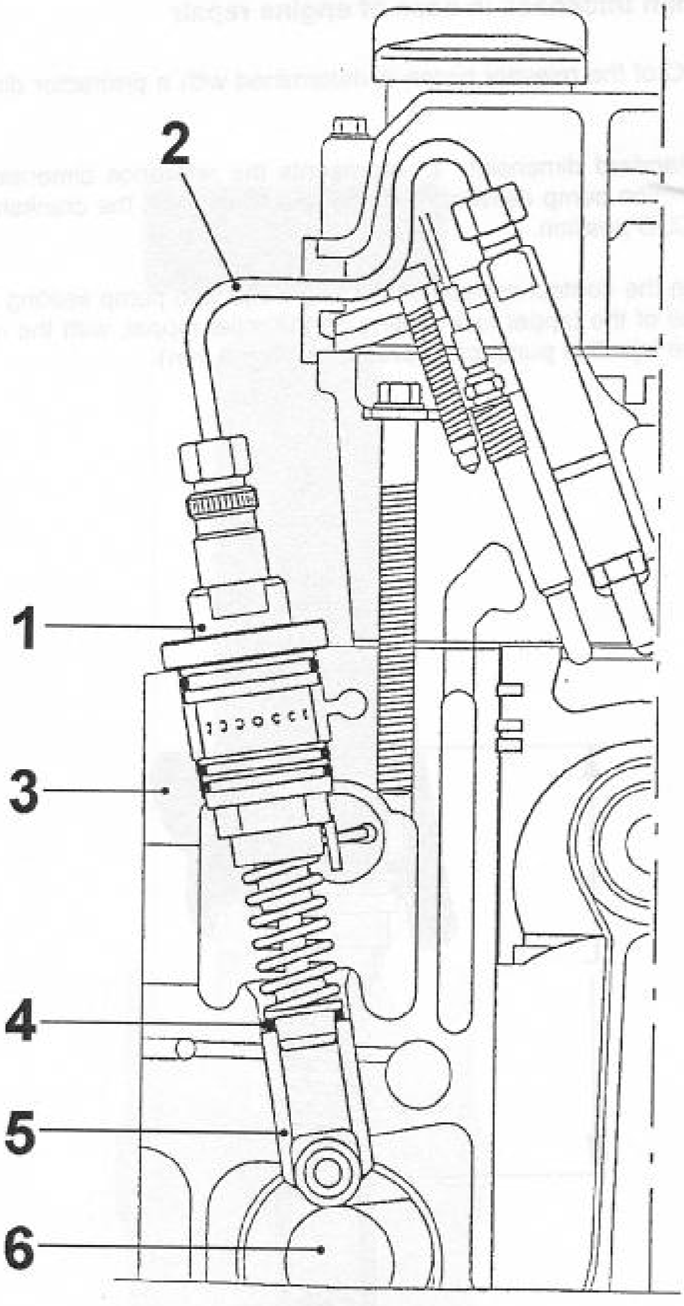


Bild 2012-0045

4.4 Determining shim thickness in case of engine repair

To begin with, the TDC of the relevant piston is determined with a protractor disc fitted to the flywheel.

The injection pump standard dimension "L" represents the reference dimension for setting the commencement of injection pump delivery. It is required to connect the crankshaft assembly and the injection pump in COD position.

It is measured between the contact surface of the single injection pump seating on the crankcase and the contact surface of the tappet foot seating on the roller tappet, with the roller tappet being on the base circle of the injection pump cam (prestroke Vh = 0 mm).

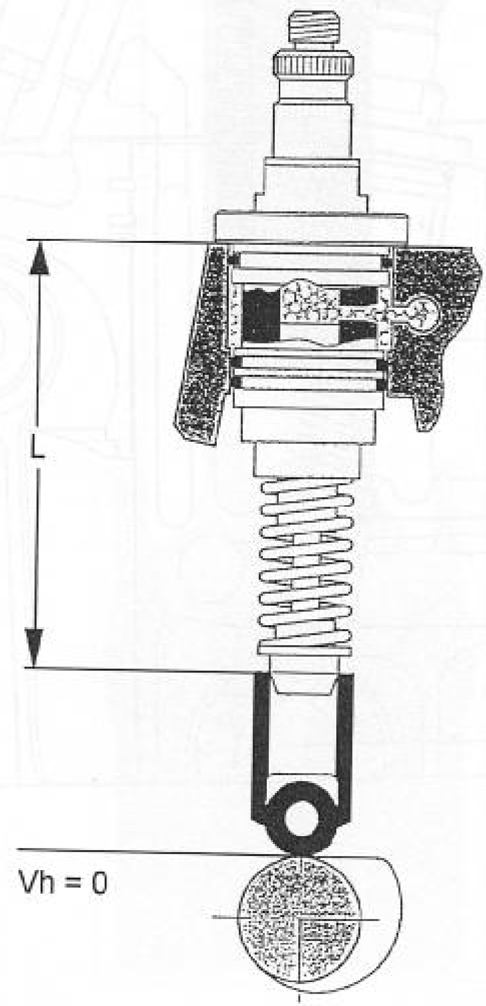


Bild 2013-0046

For determining the standard dimension (L), a special tool is used which consists of three individual components:

Hollow cylinder (1) with standard gauge for BFM 2012 : L_e = **124 mm.**

for BFM 1012 : **Le = 124 mm or 126 mm**

for BFM 1013 : **Le = 150 mm**

Depth gauge (2) with clamping device for the dial gauge.

Dial gauge (3).

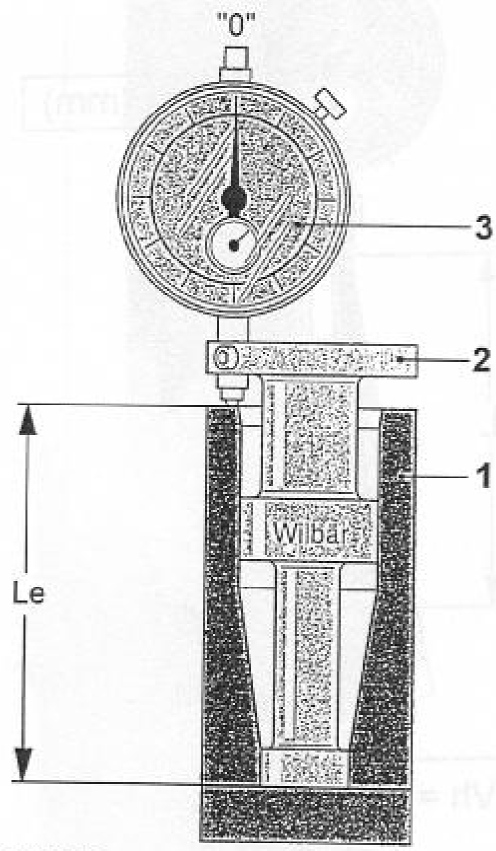


Bild 2013-0047

After completed basic setting the special depth gauge is inserted in the injection pump seat to be gauged and the dial gauge readings (X,Y) are taken. When adding the standard measure (Le) to the reading, the standard dimension (L) has been determined and will be noted down.

$$L = Le + X + Y \text{ (mm)}$$

Important: During this measurement the roller tappet must be positioned on the base circle of the camshaft!

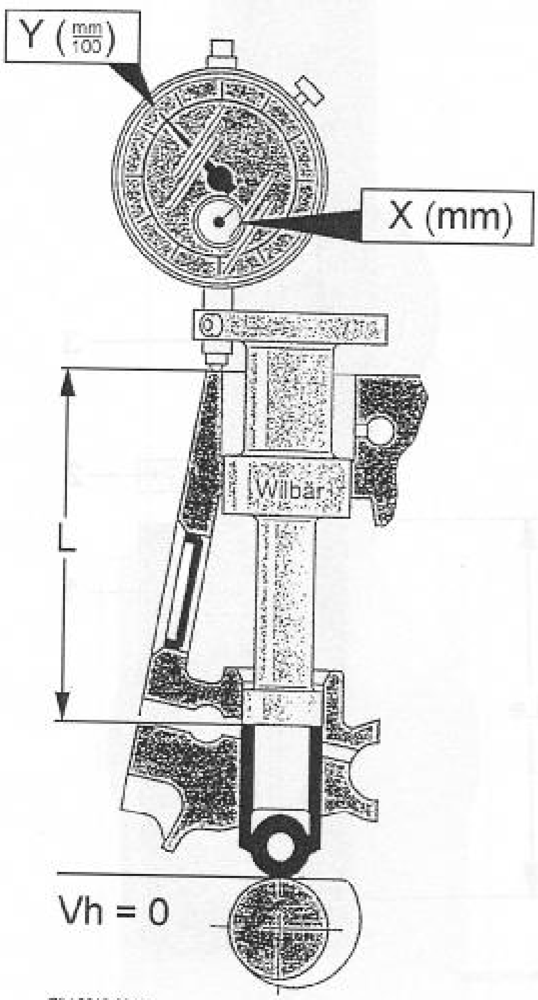


Bild 2013-0048

After the standard dimension (L) has been determined, the gauge fitted in the crankcase is set to zero position, with the roller tappet positioned on the camshaft base circle.

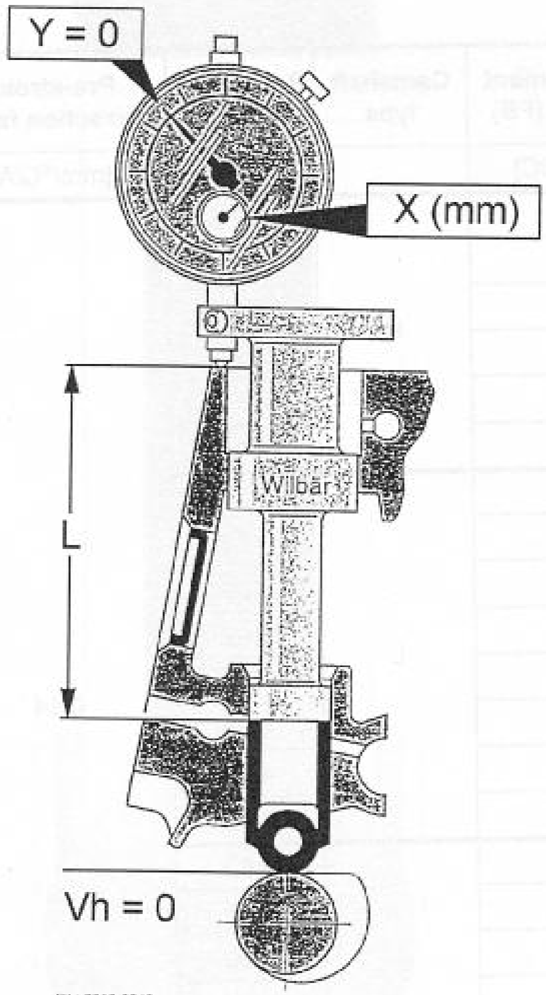


Bild 2013-0049

4.4.1 Table for commencement of delivery, pre-stroke, basic dimension Lo

From the following table the "Vh" value is determined for the pre-stroke according to the commencement of delivery to be set - see nameplate. It is determined depending on engine type and installed camshaft.

Table for BFM 2012

Engine type	Commencement of delivery (FB)	Camshaft type	Pre-stroke (Vh)	Pre-stroke correction factor	Standard dimension (Lo) injection pump
	[°C/A BTDC]		[mm]	[mm/°C/A]	[mm]
BFM 2012	0,0	K	4,80	0,14	117,5
	1,0		4,62		
	2,0		4,44		
	3,0		4,27		
	4,0		4,11		
	5,0		3,95		
	2,0	L	5,14		
	3,0		4,97		
	4,0		4,80		
	5,0		4,62		
	6,0		4,44		
	7,0		4,26		
	8,0		4,11		
	9,0		3,95		
	1,0	H	5,52		
	2,0		5,36		
	3,0		5,20		
	4,0		5,05		
	5,0		4,89		
	6,0		4,73		
	7,0		4,58		
	8,0		4,43		

Tabelle 1

Note: Commencement of delivery and camshaft type are indicated on the nameplate.

Table for BFM 1012 and BFM 1013

Engine type	Commencement of delivery (FB) [°C/A BTDC]	Camshaft type	Pre-stroke (Vh) [mm]	Pre-stroke correction factor [mm/°C/A]	Standard dimension (Lo) injection pump [mm]
BFM 1012	6,0	C	5,16	0,14	119
	7,0		4,98		
	8,0		4,80		
	9,0		4,63		
	10,0		4,47		
	11,0		4,30		
	12,0		4,15		
	13,0		4,00		
BFM 1012	3,0	F	4,80	0,14	117,5
	4,0		4,63		
	5,0		4,47		
	6,0		4,30		
	7,0		4,15		
	8,0		4,00		
BFM 1013	5,0	A	6,32	0,14	143
	6,0		6,11		
	7,0		5,90		
	8,0		5,70		
	9,0		5,50		
	10,0		5,31		
BFM 1013	4,0	B	5,70	0,14	143
	4,5		5,60		
	5,0		5,50		
	5,5		5,40		
	6,0		5,31		
	7,0		5,10		
	8,0		4,90		

Tabelle 2

Note: Commencement of delivery and camshaft type are indicated on the nameplate.

The crankshaft is turned in direction of engine rotation until the dial gauge precisely indicates the "Vh" value given in the table. The crankshaft assembly is now in commencement of delivery position for the cylinder to be set. On the fitted protractor disc (exact TDC position of the piston had to be determined before), the actual commencement of delivery "FB_{actual}" is now compared with commencement of delivery "$Fb_{nom.}$". Each deviation is corrected.

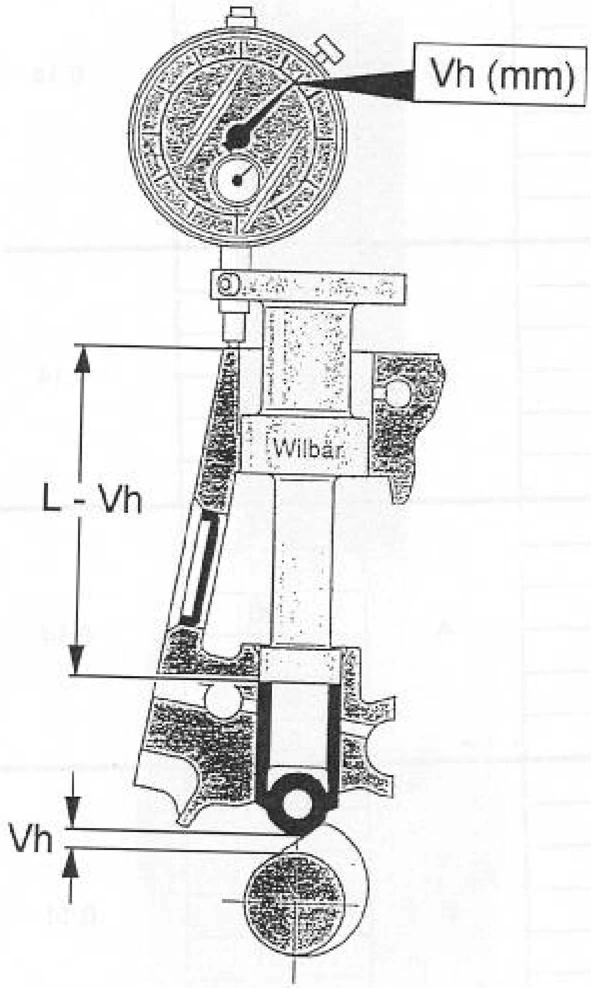


Bild 2013-0050

The injection pump is brought into commencement of delivery position by means of a computation method.

During the manufacturing process of the injection pump the closing of the fuel inlet port is determined with the high-pressure method.

In this position - commencement of delivery position of the injection pump plunger - the distance is measured between pump contact surface and tappet foot contact surface.

This length is called L_{Fb} as the injection pump must be compressed to this length in order to arrive at its com-mencement of delivery position.

Due to manufacturing tolerances this length varies from pump to pump.

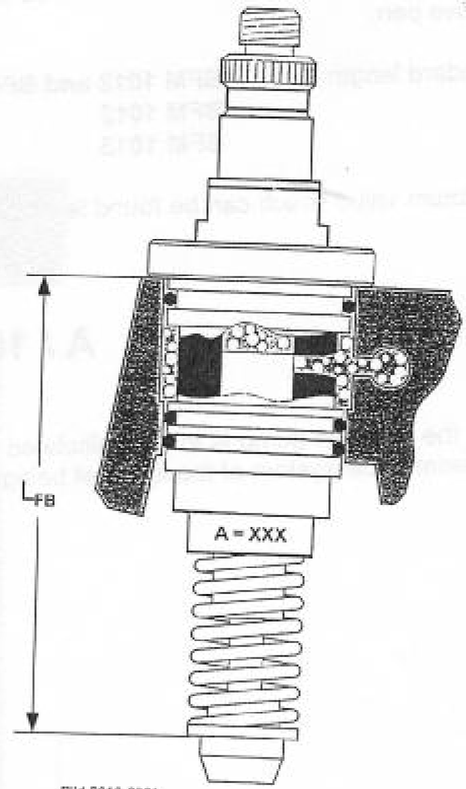


Bild 2013-0051

During the engine development phase it was found out that the length L_{Fb} is always only some hundreds of a millimeter longer than a certain standard dimension Lo of the pump.

Those hundreds of a millimeter which must be added to Lo in order to obtain L_{Fb} are called A/100.

$$L_{Fb} = L_o + A / 100$$

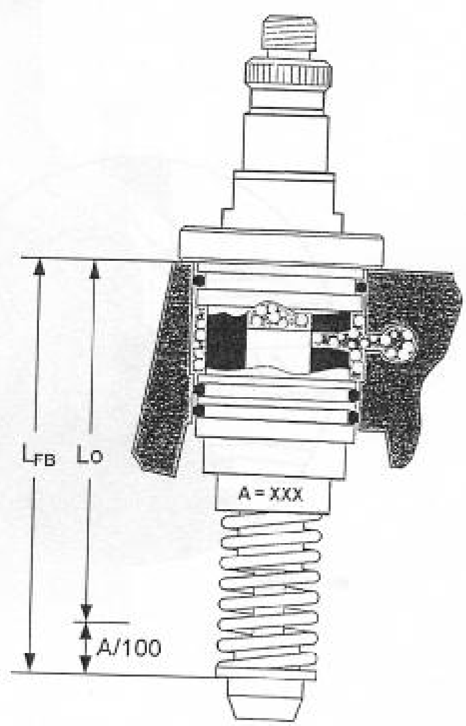


Bild 2013-0052

These hundreds of a millimeter are measured and written on the pump body by means of an electrosensitive pen.

The standard length is:		
	BFM 1012 and BFM 2012:	Lo = 117,5 mm,
	BFM 1012	: Lo = 119,0 mm,
	BFM 1013	: Lo = 143,0 mm,

The minimum value which can be found is zero. A pump will be scrapped if its L_{Fb} value drops below Lo.

$$A / 100 \geq 0$$

Now that the injection pump is in the calculated arithmetical COD position, it can now be brought into the geometrical system of the flywheel being also in COD position.

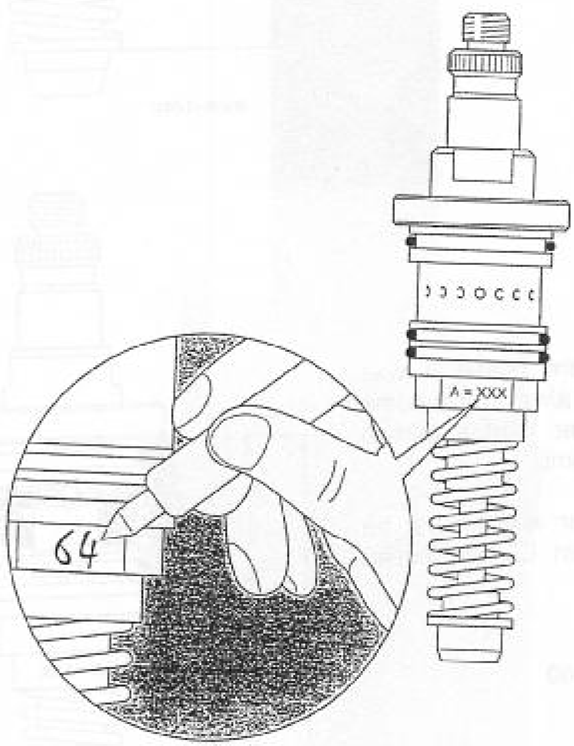


Bild 2013-0053

The injection pump is now frictionally and rigidly connected with the crankshaft assembly in commencement of delivery positon by inserting a shim (Z) of calibrated thickness. The illustration shows that there exists according to the computation :

$$(L - Vh) - (L_O + A/100)$$

a distance (T_S) between injection pump tappet foot and roller tappet. This distance must be compensated by the shim (Z) to be determined by computation. Injection pump and crankshaft assembly are thus rigidly connected in commencement of delivery position.

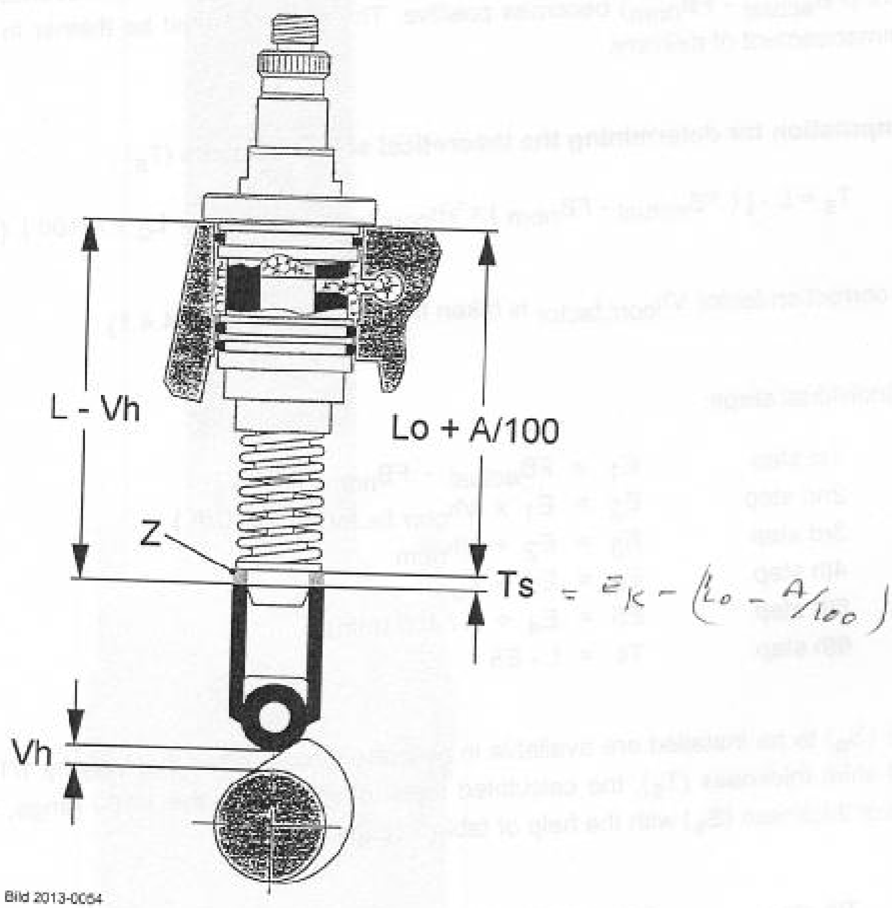


Bild 2013-0054

The described commencement of delivery correction in case "FB_{actual}" deviates from "FB_{nom}" is considered in the computation of L - Vh.

Corrected commencement of delivery =

$$Vh + (FB_{actual} - FB_{nom}) \times \text{corretion factor } (Vh_{corr.factor}) \text{ (mm)}$$

If $FB_{actual} < FB_{nom}$, i.e. commencement of delivery is retarded, the value in brackets ($FB_{actual} - FB_{nom}$) becomes negative. Thus the shim (Z) must be thicker in order to advance the commencement of delivery.

If $FB_{actual} > FB_{nom}$, i.e. the commencement of delivery is too much advanced, the value in brackets ($FB_{actual} - FB_{nom}$) becomes positive. The shim (Z) must be thinner in order to retard the commencement of delivery.

Computation for determining the theoretical shim thickness (T_S) :

$$T_S = L - [(FB_{actual} - FB_{nom}) \times Vh_{corr.factor} + Vh_{nom} + L_o + A/100] \text{ (mm)}$$

The correction factor $Vh_{corr.factor}$ is taken from table 1 (chapter 4.4.1).

The individual steps:

1st step	$E_1 = FB_{actual} - FB_{nom}$ (°C/A)
2nd step	$E_2 = E_1 \times Vh_{corr.factor}$ (mm/°C/A)
3rd step	$E_3 = E_2 + Vh_{nom}$
4th step	$E_4 = E_3 + L_o$
5th step	$E5 = E_4 + A / 100$ (mm)
6th step	$Ts = L - E5$

Shims (S_S) to be installed are available in calibrated thicknesses that vary by 1/10 mm. The theoretical shim thickness (T_S), the calculated result of which is in the 1/100 range, is converted into the shim thickness (S_S) with the help of table 2 (page 4-21).

7th step	The actual shim thickness (S_S) is determined with the help of table 2 (page 4-21).

4.4.2 Table for determining shim thickness

Theor. thickness (T_S) [mm]	Shim thickness (S_S) [mm]	Theor. thickness (T_S) [mm]	Shim thickness (S_S) [mm]
0,95 - 1,049	1,0	3,05 - 3,149	3,1
1,05 - 1,149	1,1	3,15 - 3,249	3,2
1,15 - 1,249	1,2	3,25 - 3,349	3,3
1,25 - 1,349	1,3	3,35 - 3,449	3,4
1,35 - 1,449	1,4	3,45 - 3,549	3,5
1,45 - 1,549	1,5	3,55 - 3,649	3,6
1,55 - 1,649	1,6	3,65 - 3,749	3,7
1,65 - 1,749	1,7	3,75 - 3,849	3,8
1,75 - 1,849	1,8	3,85 - 3,949	3,9
1,85 - 1,949	1,9	3,95 - 4,049	4,0
1,95 - 2,049	2,0	4,05 - 4,149	4,1
2,05 - 2,149	2,1	4,15 - 4,249	4,2
2,15 - 2,249	2,2	4,25 - 4,349	4,3
2,25 - 2,349	2,3	4,35 - 4,449	4,4
2,35 - 2,449	2,4	4,45 - 4,549	4,5
2,45 - 2,549	2,5	4,55 - 4,649	4,6
2,55 - 2,649	2,6	4,65 - 4,749	4,7
2,65 - 2,749	2,7	4,75 - 4,849	4,8
2,75 - 2,849	2,8	4,85 - 4,949	4,9
2,85 - 2,949	2,9	4,95 - 5,049	5,0
2,95 - 3,049	3,0		

Tabelle 1

NOTES

4.5 Determining shim thickness for replacement of injection pumps (EP Code)

For replacement of the injection pumps without any modification on the crankshaft assembly the setting of the commencement of delivery to be redetermined is simplified. A code for the injection pump of each cylinder is given on the nameplate under the column **EP**.

With the help of the EP code the corrected installation dimension (E_K) is taken from table 3. This installation dimension corresponds to L - Vh, with the FB tolerances having been considered already.

The new shim (T_S) is determined with the following equation:

$$T_s = E_K - (Lo + A/100) \ \text{(mm)}$$

E_K = corrected injection pump dimension in mm determined with EP code from nameplate and from tables chapter 4.5.1.

Lo = **117,5 mm** (BFM 2012)
Lo = **117,5 mm or 119 mm** (BFM 1012)
Lo = **143,0 mm** (BFM 1013)

A/100 = in mm, to be taken from new injection pump.

4.5.1 Tables EP-Code

BFM 1012 and BFM 2012, Lo = 117,5 mm

E_K (mm)	EP Code	E_K (mm)	EP Code	E_K (mm)	EP Code	E_K (mm)	EP Code
119,250 119,275 119,300 119,325 119,350	230 231 232 233 234	119,875 119,900 119,925 119,950 119,975	255 256 257 258 259	120,500 120,525 120,550 120,575 120,600	280 281 282 283 284	121,125 121,150 121,175 121,200 121,225	305 306 307 308 309
119,375 119,400 119,425 119,450 119,475	235 236 237 238 239	120,000 120,025 120,050 120,075 120,100	260 261 262 263 264	120,625 120,650 120,675 120,700 120,725	285 286 287 288 289	121,250 121,275 121,300 121,325 121,350	310 311 312 313 314
119,500 119,525 119,550 119,575 119,600	240 241 242 243 244	120,125 120,150 120,175 120,200 120,225	265 266 267 268 269	120,750 120,775 120,800 120,825 120,850	290 291 292 293 294		
119,625 119,650 119,675 119,700 119,725	245 246 247 248 249	120,250 120,275 120,300 120,325 120,350	270 271 272 273 274	120,875 120,900 120,925 120,950 120,975	295 296 297 298 299		
119,750 119,775 119,800 119,825 119,850	250 251 252 253 254	120,375 120,400 120,425 120,450 120,475	275 276 277 278 279	121,000 121,025 121,050 121,075 121,100	300 301 302 303 304		

Tabelle 1

BFM 1012, Lo = 119 mm

E_K [mm]	EP-Code	E_K [mm]	EP-Code	E_K [mm]	EP-Code	E_K [mm]	EP-Code
120,750 120,775 120,800 120,825	131 132 133 134	121,350 121,375 121,400 121,425 121,450	155 156 157 158 159	121,975 122,000 122,025 122,050 122,075	180 181 182 183 184	122,600 122,625 122,650 122,675 122,700	205 206 207 208 209
120,850 120,875 120,900 120,925 120,950	135 136 137 138 139	121,475 121,500 121,525 121,550 121,575	160 161 162 163 164	122,100 122,125 122,150 122,175 122,200	185 186 187 188 189	122,725 122,750 122,775 122,800 122,825	210 211 212 213 214
120,975 121,000 121,025 121,050 121,075	140 141 142 143 144	121,600 121,625 121,650 121,675 121,700	165 166 167 168 169	122,225 122,250 122,275 122,300 122,325	190 191 192 193 194	122,850	215
121,100 121,125 121,150 121,175 121,200	145 146 147 148 149	121,725 121,750 121,775 121,800 121,825	170 171 172 173 174	122,350 122,375 122,400 122,425 122,450	195 196 197 198 199		
121,225 121,250 121,275 121,300 121,325	150 151 152 153 154	121,850 121,875 121,900 121,925 121,950	175 176 177 178 179	122,475 122,500 122,525 122,550 122,575	200 201 202 203 204		

Tabelle 2

BFM 1013, Lo = 143 mm

E_K [mm]	EP-Code	E_K [mm]	EP-Code	E_K [mm]	EP-Code	E_K [mm]	EP-Code
		145,850 145,875 145,900 145,925 145,950	355 356 357 358 359	146,475 146,500 146,525 146,550 146,575	380 381 382 383 384	147,100 147,125 147,150 147,175 147,200	405 406 407 408 409
145,350 145,375 145,400 145,425 145,450	335 336 337 338 339	145,975 146,000 146,025 146,050 146,075	360 361 362 363 364	146,600 146,625 146,650 146,675 146,700	385 386 387 388 389	147,225 147,250 147,275 147,300 147,325	410 411 412 413 414
145,475 145,500 145,525 145,550 145,575	340 341 342 343 344	146,100 146,125 146,150 146,175 146,200	365 366 367 368 369	146,725 146,750 146,775 146,800 146,825	390 391 392 393 394	147,350 147,375 147,400 147,425 147,450	415 416 417 418 419
145,600 145,625 145,650 145,675 145,700	345 346 347 348 349	146,225 146,250 146,275 146,300 146,325	370 371 372 373 374	146,850 146,875 146,900 146,925 146,950	395 396 397 398 399		
145,725 145,750 145,775 145,800 145,825	350 351 352 353 354	146,350 146,375 146,400 146,425 146,450	375 376 377 378 379	146,975 147,000 147,025 147,050 147,075	400 401 402 403 404		

Tabelle 3

4.6 Fuel rack travel

With removed governor, the fuel rack (4) is pressed by the compression spring (3) always into the excess starting fuel position (1).

With non-fitted single injection pumps, the free fuel rack travel must be 17 +0.5 mm at a minimum.

With fitted single injection pumps, the fuel rack travel (Y) must be 16.8 mm at a minimum.

The recess dimension (X) between fuel rack in stop position and the contact surface of the governor on the timing chest cover must be between 0.3 - 1.3 mm.

Note: It is absolutely necessary to measure and indicate the recess dimension (X), together with the engine serial number, when replacing the governor.

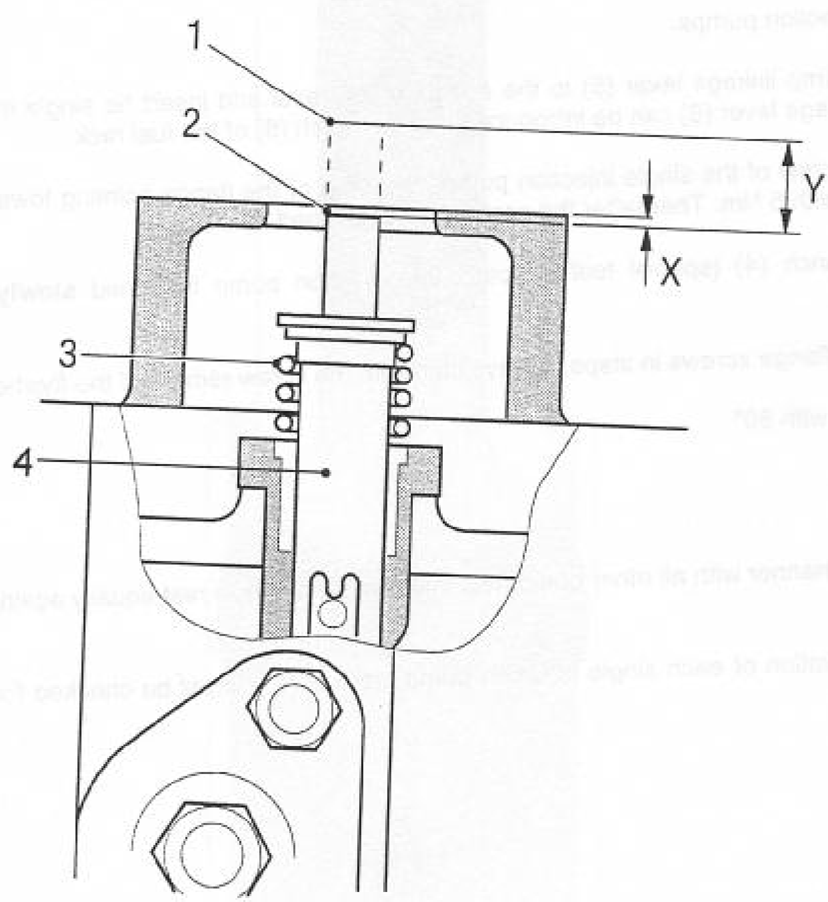


Bild 2013-0055

4.7 Installation of injection pumps in the crankcase

To obtain uniform delivery of the injection pumps, all of them must be installed in a specific position.

With mounted governor - in case of replacement

The injection pump fuel rack is brought in stop position with a special tool inserted into the receiving bore of the shutdown solenoid.

With removed governor - in case of repair

The injection pump fuel rack is brought in stop position with a locking device (1) (special tool No. 100 800) which is fastened to the receiving face of the governor.

The roller tappet of every injection pump must be turned to the camshaft base circle.

Oil O-rings of the injection pumps.

Turn the injection pump linkage lever (5) to the middle of its travel and insert he single injection pump so that the linkage lever (5) can be introduced into the notch (6) of the fuel rack.

Preload the flange screw of the single injection pump - chamfer of the flange pointing towards injection pump body - with 5 Nm. Thereafter the screws are slackened by 60°.

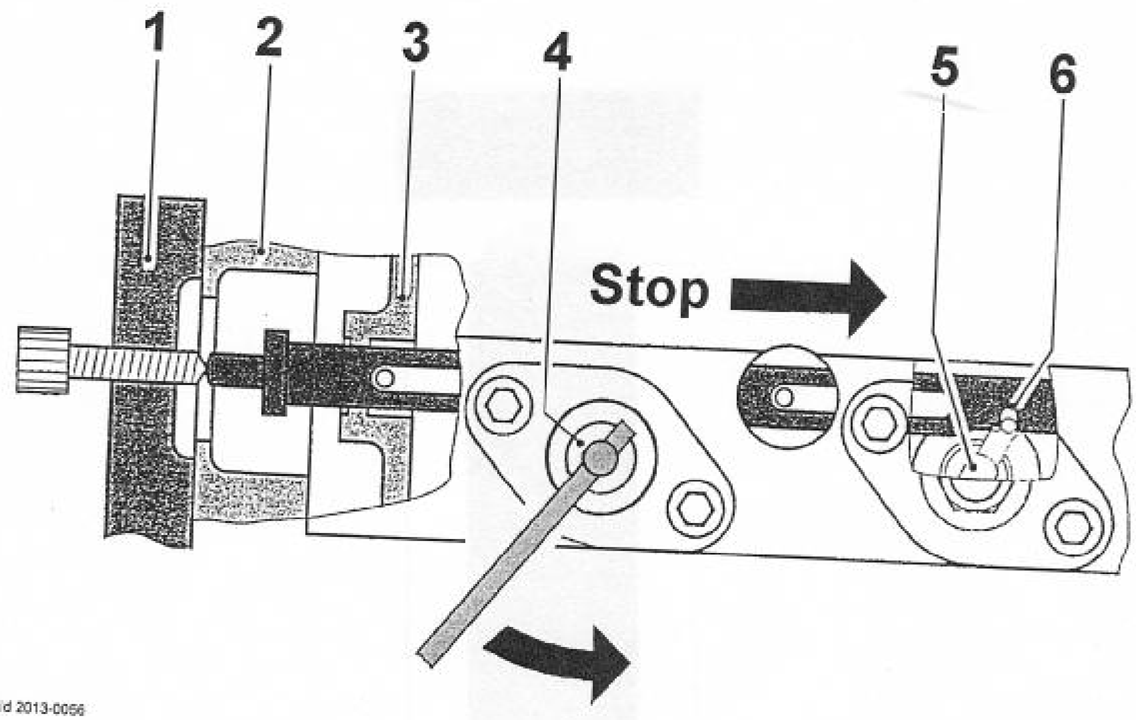
With a serrated wrench (4) (special tool adapter) the injection pump is turned **slowly anti-clockwise** until stop.

Thereafter tighten all flange screws in steps. Always start with the screw remote of the flywheel.

tighten with 60°
7 Nm
10 Nm
30 Nm

Proceed in the same manner with all other pumps. All injection pumps now rest equally against the fuel rack notches.

Note: After installation of each single injection pump the fuel rack must be checked for free movability.



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NOTES

5. Governor

The governors of the 1012, 1013 and 2012 series engines are mechanical variable-speed governors with centrifugal measuring element of M/s Heinzmann.

All governor settings may only be conducted by trained specialists on a specifically laid out governor test bench.

5.1 Governor, external view

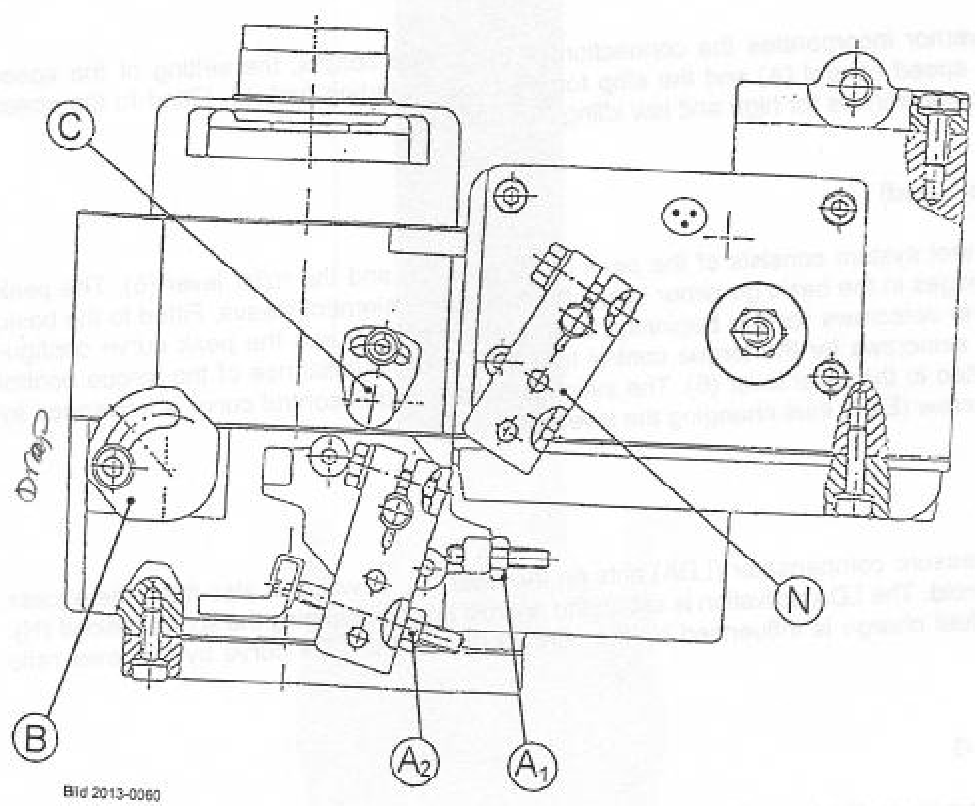

Bild 2013-0060

C - Beginning of torque control
B - Speed droop
A_1 - High idling
A_2 - Low idling
N - STOP lever

5.2 Design structure and function

The entire governor consists of the basic governor, the torque control and the manifold-pressure compensator (LDA). These individual systems form the common governor output signal, the control rod travel (Yr).

Basic governor (brown)

The engine-driven centrifugal measuring element acts via two levers (1) and (2) directly on the fuel rack (3). The governor springs are installed in the flyweights which open with increasing speed and move the fuel rack via levers (1) and (2) in direction of less fuel. The fuel rack movement in direction of full load is initiated by the excess starting fuel spring (4). It keeps the fuel rack always in the maximum position released by the governor. There exists no form-fit mechanical connection between governor and fuel rack.

The basic governor incorporates the connection of the torque control, the setting of the speed droop (B), the speed control (A) and the stop for the excess starting fuel (L). Fitted to the speed control are the stop screws for high and low idling (A_1) and (A_2).

Torque control (red)

The torque control system consists of the peak curve lever (5) and the roller lever (6). The peak curve lever engages in the basic governor below the measuring element sleeve. Fitted to the basic governor are the setscrews for the beginning of torque control (C) and the peak curve configuration (D). The setscrews for the torque control travel (E) and the initial rise of the torque control curve (F) are fitted to the roller lever (6). The initial rise of the torque control curve is influenced by displacing the screw (E-F), thus changing the lever ratio.

LDA (blue)

The manifold-pressure compensator (LDA) acts on the lever (7), to which is also fitted the excess starting fuel solenoid. The LDA activation is set on the aneroid box by changing the spring preload (H). The NA-based fuel charge is influenced by the screw (J) and the LDA curve by the lever ratio K/total length.

Full-load stop G

The full-load stop acts on the lever (7).

Mechanical STOP N

The manual stop lever (N) displaces the lever (8), which is firmly connected with the basic governor, in direction of zero fuel delivery.

Excess starting fuel solenoid O

The excess starting fuel solenoid pulls screw (M) through lever (7) from lever (8). This way the LDA stop becomes ineffective.

System connection (green)

The levers (7) and (8) ensure that the torque control and LDA systems act together with the basic governor on the fuel rack. The integration of all adjustment possibilities outside the systems is effected via levers 1,2,7 and 8. Lever (7) transmits the fuel rack travel via screw (M) onto lever (8) being firmly connected with the fuel rack.

Set screws Z and S

Screw (Z) fulfills two functions. Firstly, to adapt the measuring element with its tolerances to the fuel rack travel. Secondly, to realize different break-away characteristics with different break-away speeds and governor spring versions.

Screw (S) is called safety screw. It limits the absolute maximum speed if the break-away system does no longer function for any reason whatsoever.

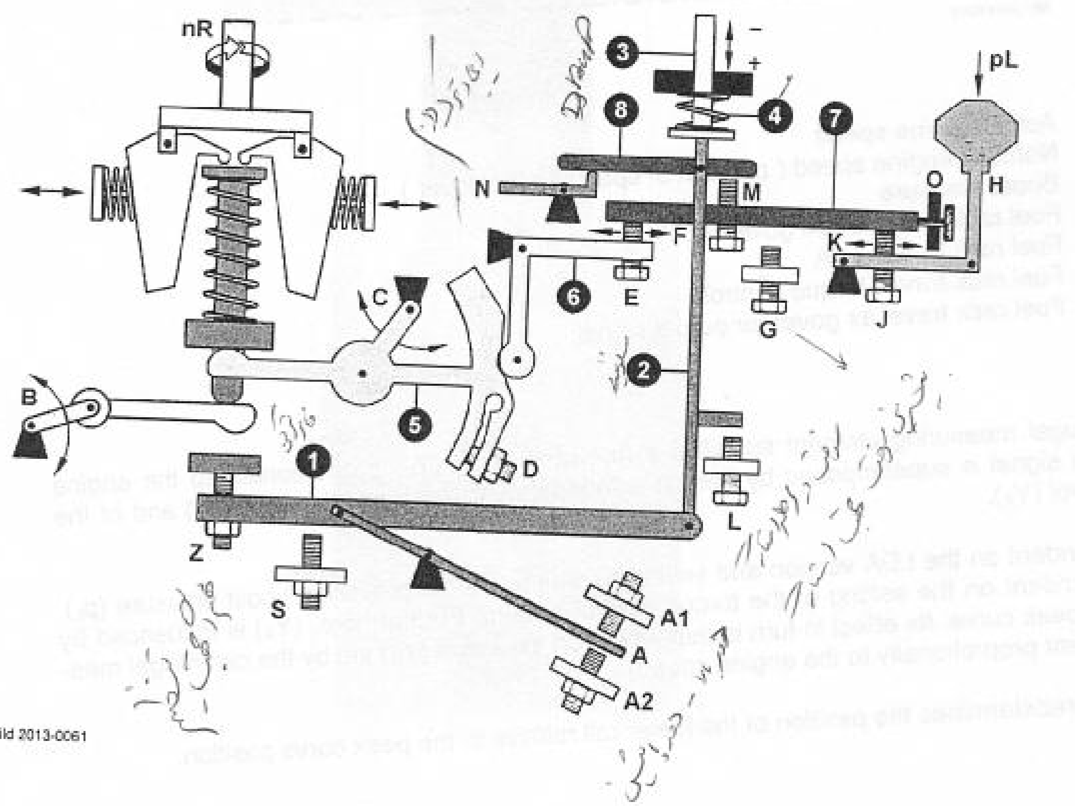

Bild 2013-0061

5.3 Block diagram of the control loop

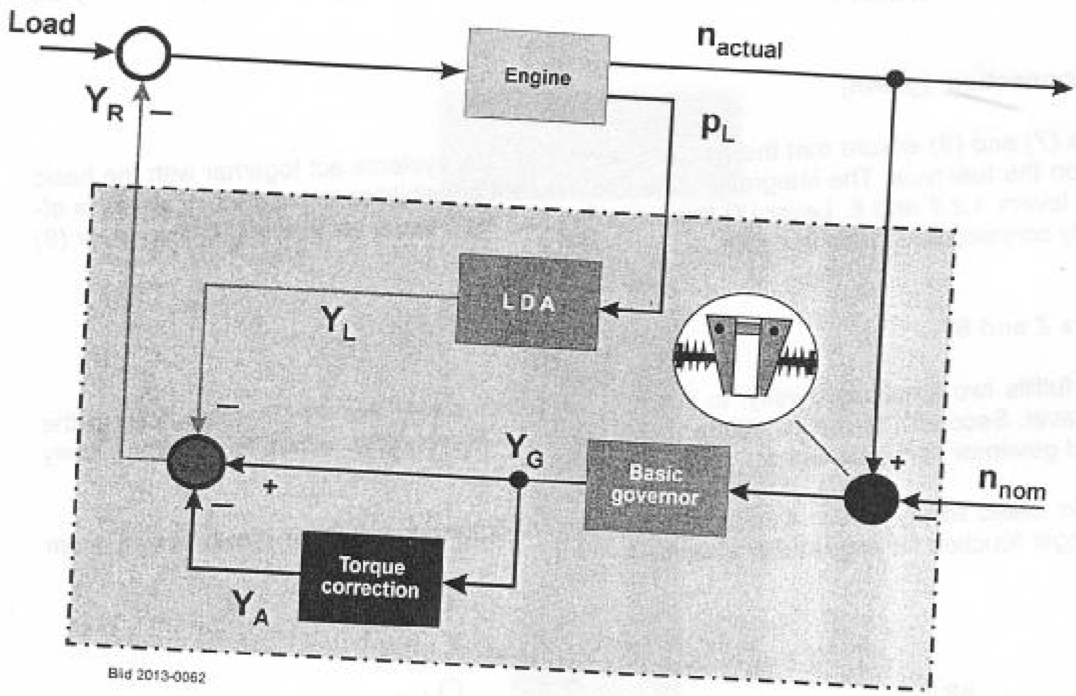

Bild 2013-0062

n_{actual}	Actual engine speed
n_{nom}	Nominal engine speed (position of speed control lever)
p_L	Boost pressure
Y_G	Fuel rack travel, basic governor
Y_L	Fuel rack travel, LDA
Y_A	Fuel rack travel, torque control
Y_R	Fuel rack travel as governor output signal

The centrifugal measuring element specifies a fuel rack travel (Y_G) proportionally to the engine speed. This signal is superimposed by the system-dependent signals of the LDA (Y_L) and of the torque control (Y_A).

(Y_L) is dependent on the LDA version and setting as well as on the prevailing boost pressure (p_L). (Y_A) is dependent on the setting of the torque control system. Furthermore, (Y_A) is influenced by the applied peak curve. Its effect in turn is dependent on the travel (Y_G) set by the centrifugal measuring element proprotionally to the engine speed).

That travel predetermines the position of the feeler roll relative to the peak curve position.

6. Coolant system

6.1 Coolant circuit 2012

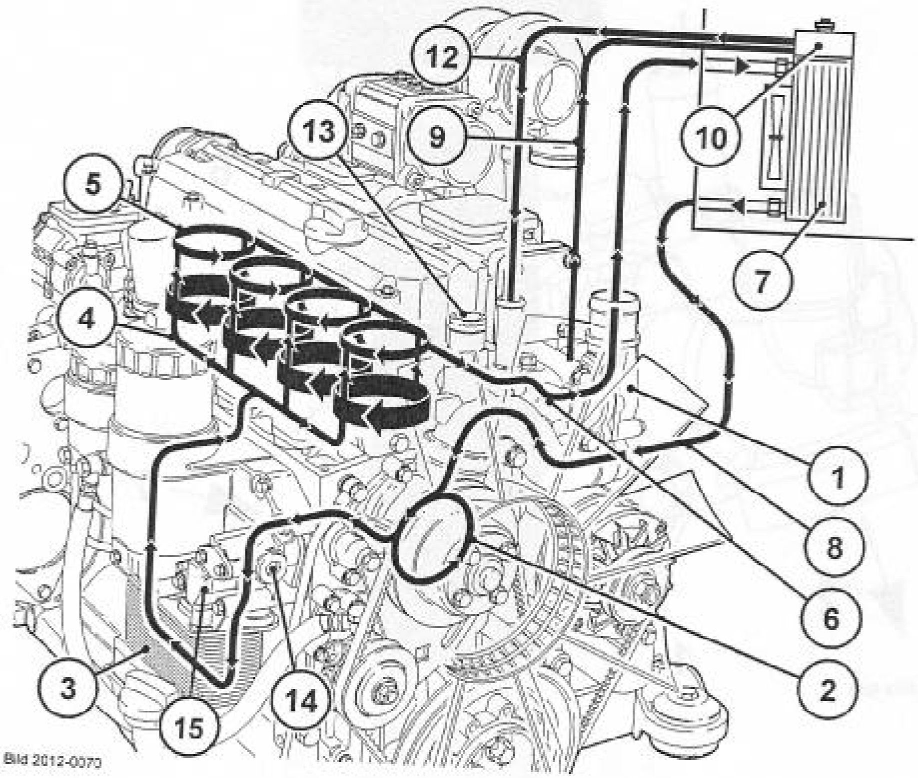

Bild 2012-0070

1 - Thermostat housing
2 - Coolant pump
3 - Lube oil cooler
4 - Cylinder cooling
5 - Cylinder head cooling
6 - Line from engine to radiator (7)
7 - Radiator (7)
8 - Line from radiator to engine
9 - Bleeder line to expansion tank (10)
10 - Expansion tank
12 - Expansion line to coolant pump (2)
13 - Coolant return from heater
14 - Coolant supply to heater (V-belt version, M26x1.5)
15 - Coolant supply to heater (Poly-V-belt version, M18x1.5)

6.1.1 Thermostat housing BFM 2012

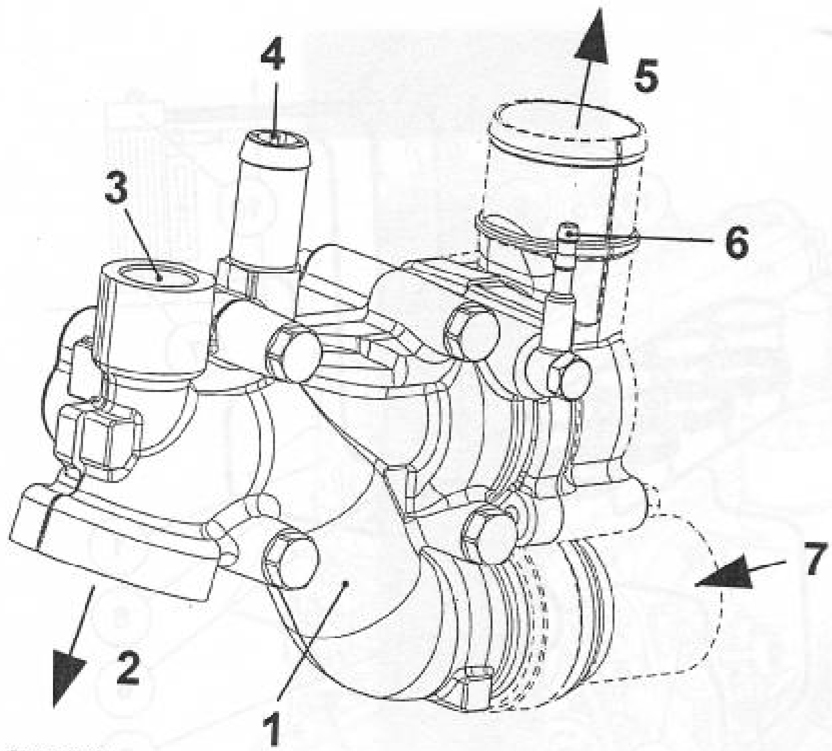

Bild 2012-0071

1 – Thermostat housing
2 – To the coolant pump
3 – From the cab heater
4 – Expansion line
5 – To the Radiator
6 – Bleeder line
7 – From the Radiator

6.1.2 Draining cooling system

Draining

For draining the cooling system undo screw at the LH side of the crankcase and catch coolant in a suitable container and dispose of.

Thereafter tighten screw again.

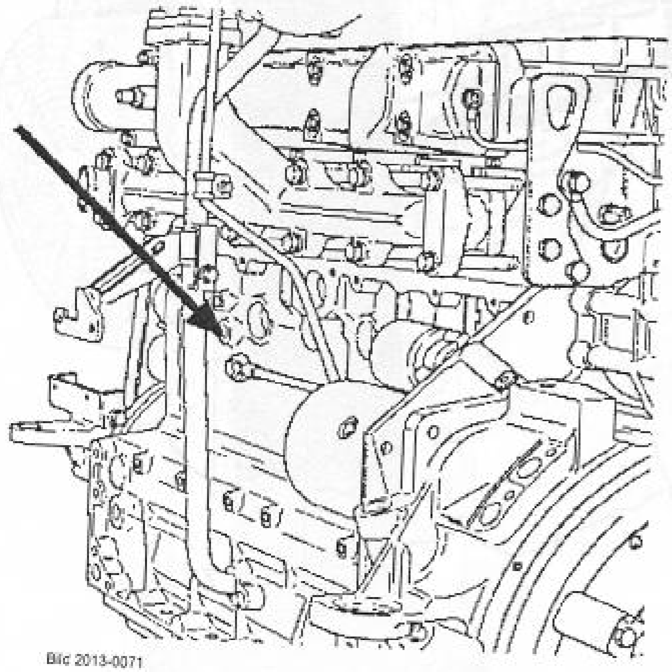

Bild 2013-0071

6.2 Coolant circuit 1012, 1013 (Integrated cooling system)

The BFM 1012/1013 engine series are available with two different cooling systems: Integrated and external cooling system.

6.2.1 Coolant circuit

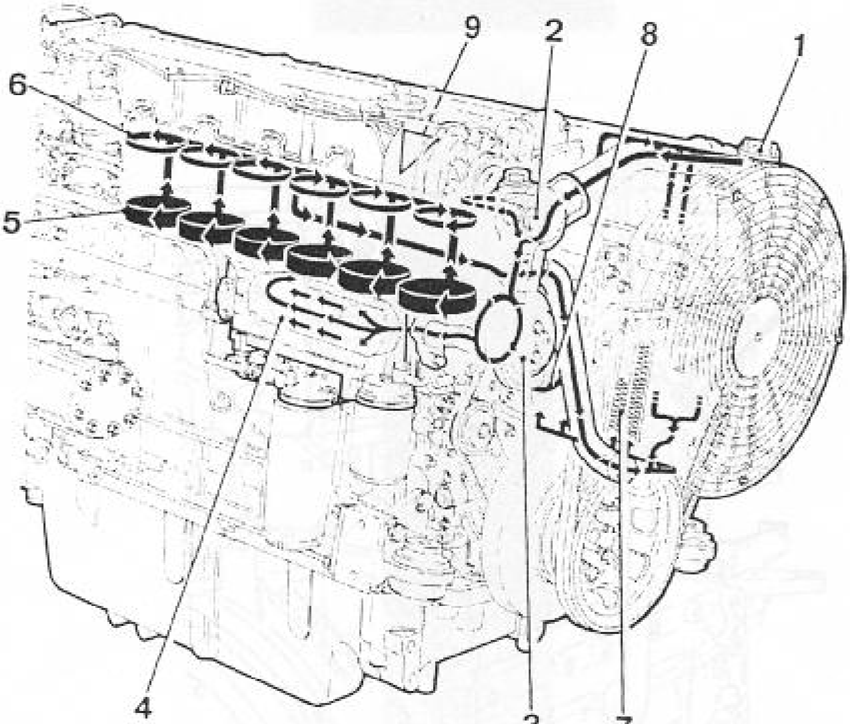

Bild 1012-0070

1 - Coolant filler
2 - Thermostat housing
3 - Coolant pump
4 - Lube oil cooler
5 - Cylinder cooling
6 - Cylinder head cooling
7 - Cooler (radiator)
8 - Compensator line from expansion tank to coolant pump
9 - Bleeder line from cylinder head to expansion tank

6.2.2 Design structure

In the case of the integrated cooling system, blower and expansion tank form one unit. The radiator (heat exchanger) is mounted to the expansion tank.

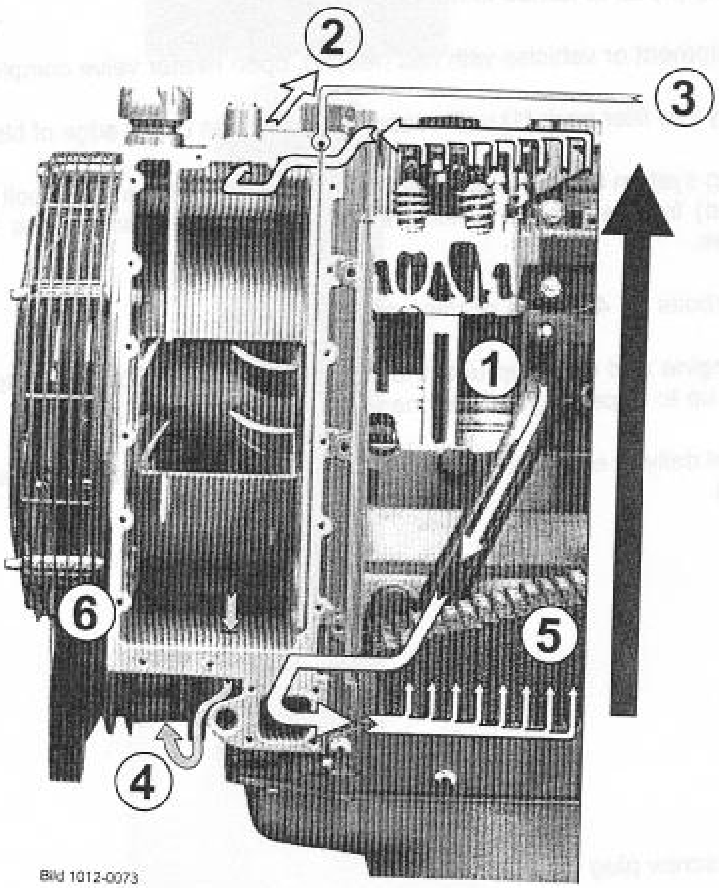

Bild 1012-0073

1 - Return line from engine to radiator (5).

2 - Coolant supply from radiator (5) via thermostat housing to coolant pump.

3 - Bleeder line from cylinder head to expansion tank (6).

4 - Compensating line from expansion tank (6) to pump suction side.

5 - Radiator (heat exchanger), direction of flow from bottom to top.

6 - Blower with expansion tank.

6.2.3 Filling

- Slacken bleeder screw (3) and turn out approx. 5 mm.
- Turn out bleeder screw (4) completely.
- Turn out screw plug (5) up to turned-in nut (approx. 10 mm).
- In the case of equipment or vehicles with cab heating, open heater valve completely.
- Pour coolant slowly into filler neck (1) until coolant level reaches upper edge of bleeder neck (2).
- The engine cooling system is bled during the filling procedure via the banjo bolt (3) (bleeder line from cylinder head) from which the coolant must drip out at the end of the filling procedure without any bubbles.
- Tighten all screws/bolts (3, 4, 5) and position cap (6) in place.
- Thereafter start engine and warm up until thermostat has opened. Check coolant level (7) and refill, if necessary, up to upper edge of filler neck.
- Check coolant level daily or every 10 hours on the cold engine. It must be above the mark „KALT - COLD" (7).

6.2.4 Draining

- Position tray under screw plug (5).
- Screw off cap (6) of filler neck (1).
- Slacken bleeder screws (3 and 4).
- Turn out screw plug (5) completely. Drain coolant.

Note: In the case of equipment and vehicles with cab heating, open heater valve completely.

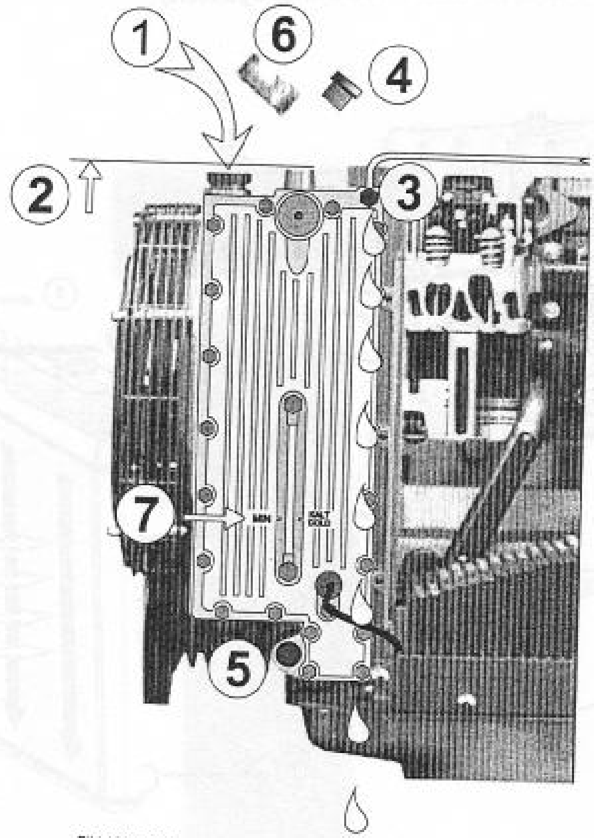

Bild 1012-0074

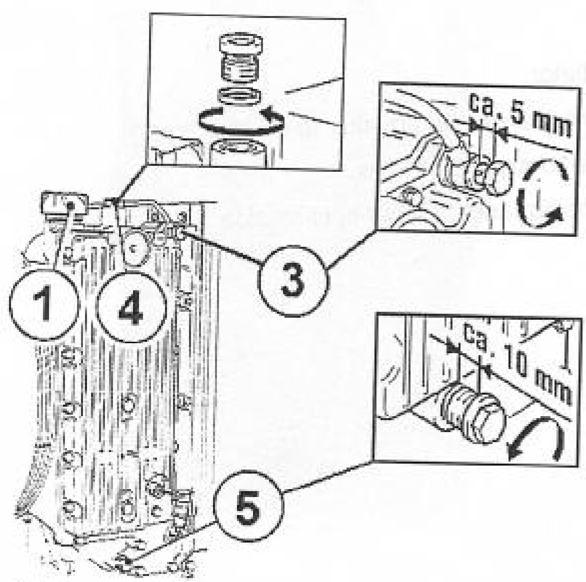

Bild 1012-0075

6.3 Coolant circuit 1012, 1013 (External cooling system)

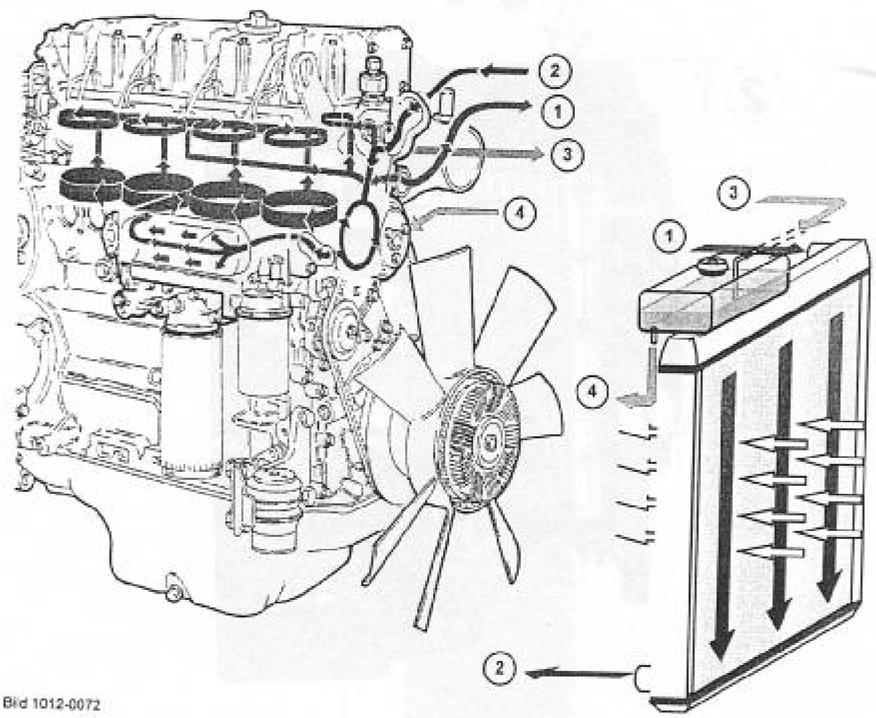

Bild 1012-0072

1 - Return line from engine to radiator.

2 - Coolant supply from radiator via thermostat housing to coolant pump.

3 - Bleeder line from cylinder head to expansion tank.

4 - Compensating line from expansion tank to pump suction side.

6.4 Coolant

Liquid-cooled engines are to be filled with a treated coolant as otherwise serious engine damage can occur as a result of freezing, cavitation and corrosion.

The water used must meet the following requirements:

Water quality		min.	max.
ph value at 20 °C		6.5	8.5
Chloride ion content	(mg/dm^3)	-	100
Sulfate ion content	(mg/dm^3)	-	100
Total hardness	(°dGH)	3	12

The coolant is prepared by adding a cooling system conditioner to the cooling water. A cooling system conditioner which is free from nitrite, amine and phosphate is available in 5-liter containers from DEUTZ Service through the spare parts service. The suitability of other cooling system conditioners should be expressly confirmed by DEUTZ Service.

The concentration of the cooling system conditioner must not fall below or exceed the following values:

Cooling system conditioner	Protection against freezing down to °C
max. 45 %	-35°C
40 %	-28°C
min. 35 %	-22°C

The concentration of the coolant is checked with commercially available testers.

Cooling system conditioners must be disposed of in accordance with anti-pollution regulations.

NOTES