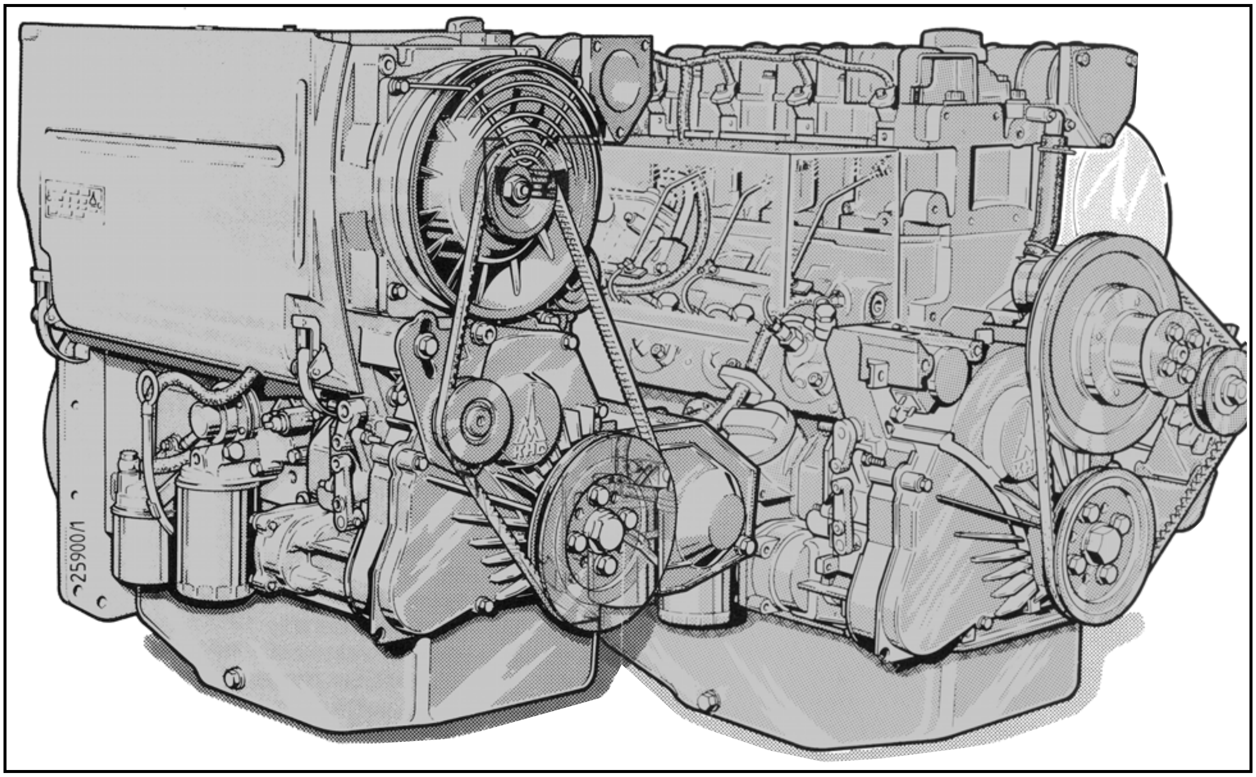


Engine Service Training 1011 / 1011F / 2011

Part Number: 999 0512

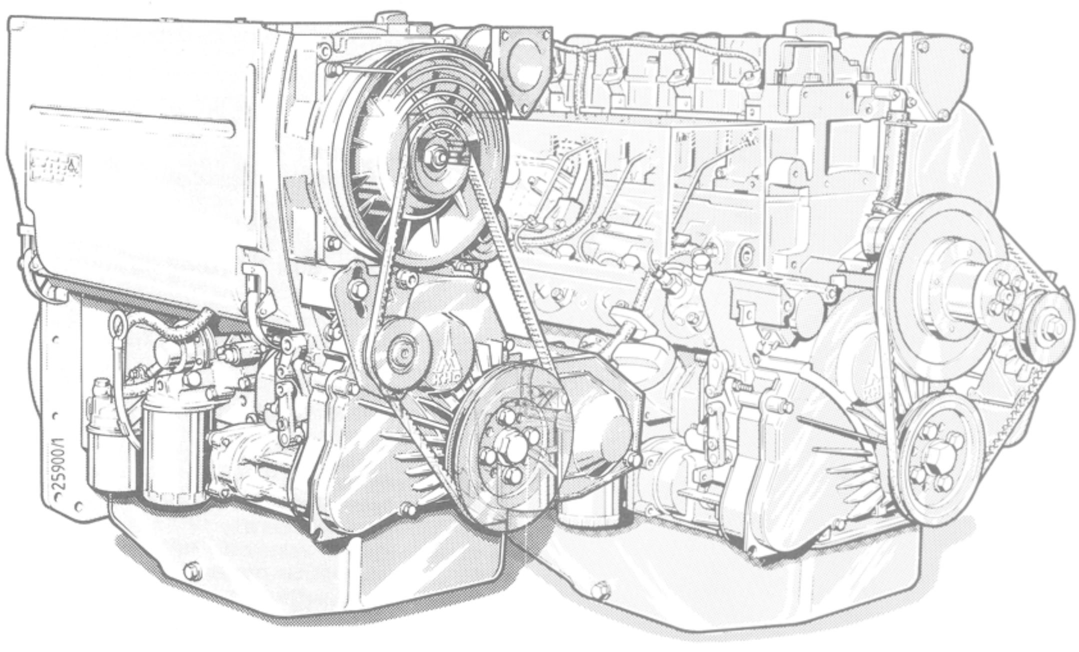
DEUTZ CORPORATION
Product Support
Training Center Atlanta

TITLE: **1011/F/2011**

INTRODUCTION

INDEX

Part Number: 999 0512



DC11/01/02

ENGINE FAMILY B/FL 1011E

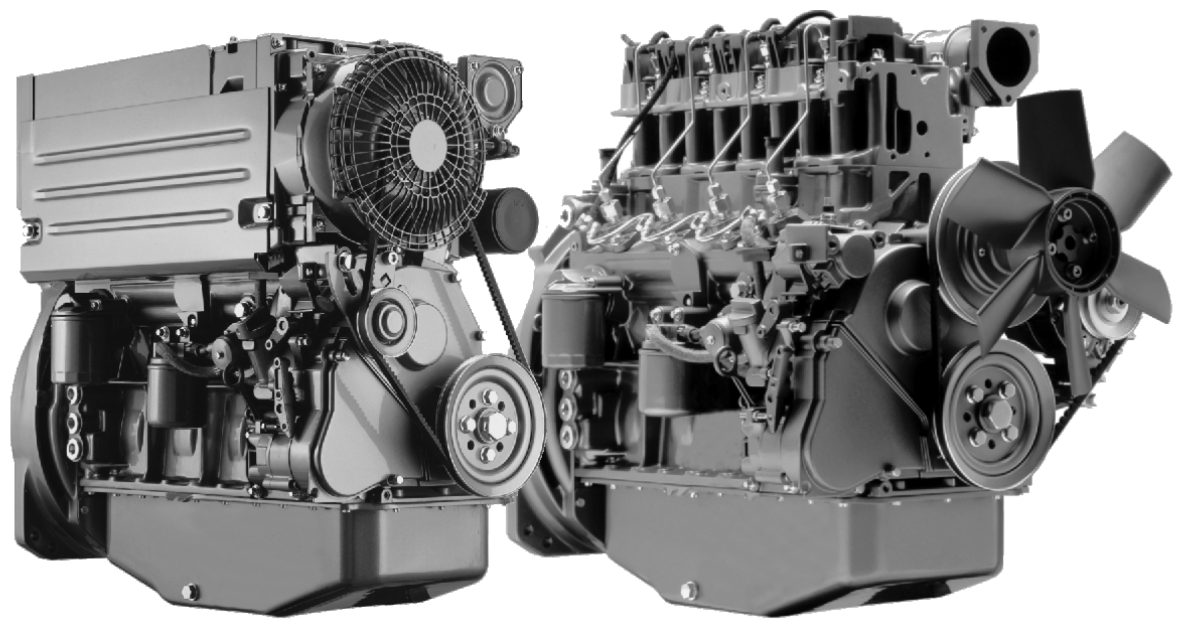
DC11/01/02

F2 - 4L1011, BF4L1011, F3L1011E

1. Available in naturally aspirated 2, 3 and 4 cylinder versions
2. Also available in turbo 4 cylinder version
3. kw from 11 to 53; speed range 1500 to 3600rpm
4. 91mm bore, 105mm stroke

The 1011 and 2011 engines are oil cooled. The engines are available with integrated ore external cooling systems. All cylinders are machined in the crankcase and not sleeved. Connecting rods and crankshafts are casted components.

Grey cast iron crankcase, acoustically optimized
Cast iron cylinder head
Direct injection
Single injection pumps
Camshaft toothed belt driven
3-Ring aluminum piston
Piston cooling with spray nozzles



DC11/01/03

ENGINE FAMILY B/F/L/M 1011F

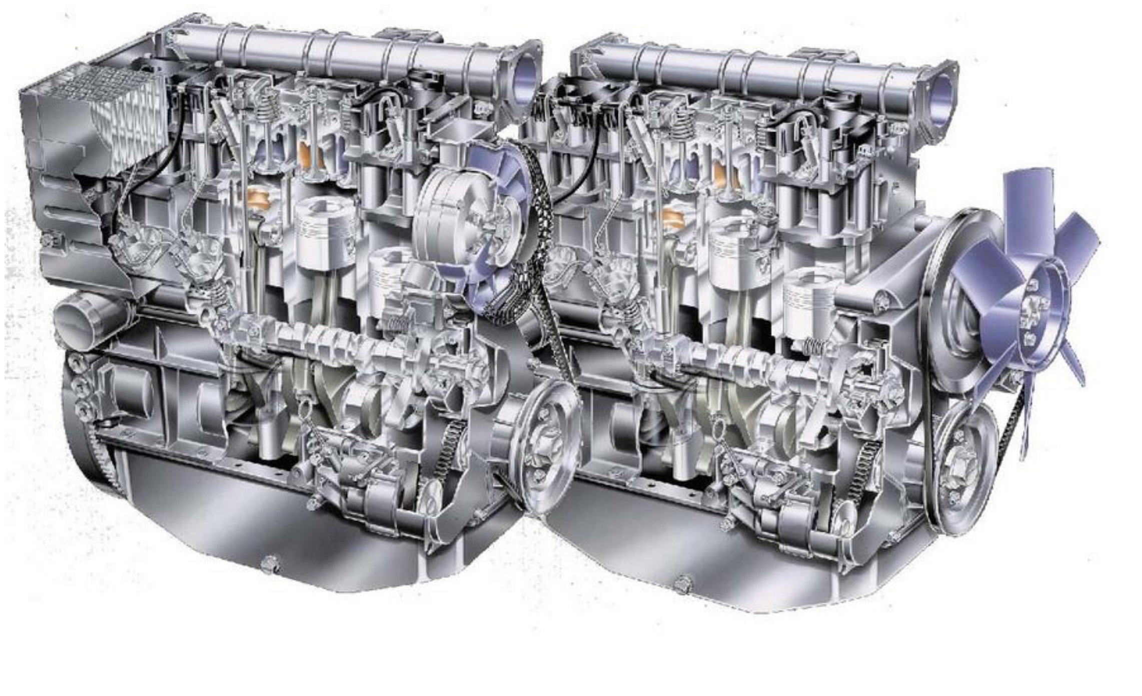
DC11/01/03

1. "F" engines with 12% output increase

The production of the F1011F engine series started in March of 1995.
The power output of the 1011F increased by 5% to 16 - 55.5 kW (21.75 - 75.5 HP). This was achieved by releasing the special output rating of the engine.
The power output of the FM1011F was increased by 12%, due to lengthening the engines piston stroke from 105 mm to 112 mm. The power output rate is 17.7 - 61.0 kW (24 - 83HP). FM engines are available in 3 cylinder and 4 cylinder NA, only the 4 cylinder engine is TC.

The following major components were changed:

1. CRANKCASE
2. CYLINDER HEAD
3. LUBE OIL PUMP
4. COOLING CIRCUIT
5. FUEL INJECTION SYSTEM



DC11/01/04

ENGINE FAMILY B/F/LM 2011

DC11/01/04

Bore (94mm / 3.7inch) and stroke (112mm / 4.4inch) dimensions are the same within the engine Family

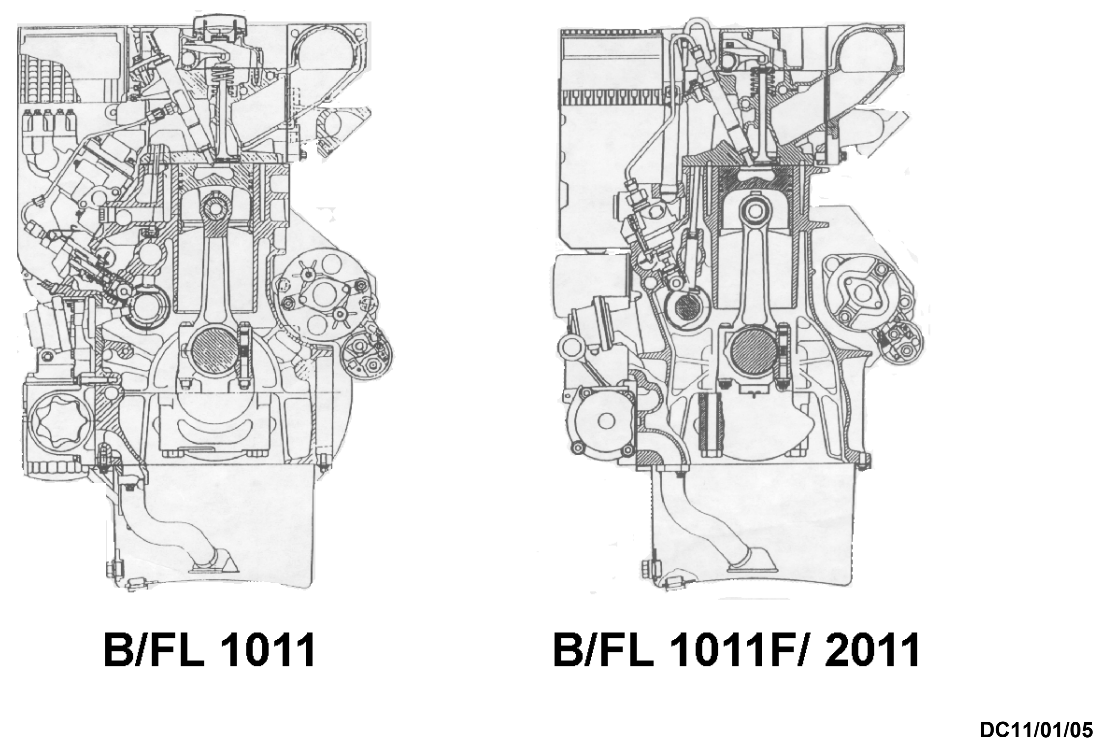
FL 2011 2-, 3- and 4 cylinder
Power out put
12 kW-47.8 kW (16.1-64.1 HP)
Maximum rated speed 2800 1/min

FM 2011 2-, 3- and 4 cylinder
Power out put
12.5 kW-48.5 kW (16.8-65.0HP)
Maximum rated speed 2800 1/min

BFL 2011 3 and 4 cylinder only.
Power out put
24.7 kW-58.1 kW (33.1-77.9 HP)
Maximum rated speed 2800 1/min

BFM 2011 3 and 4 cylinder only.
Power out put
24.5 kW-65 kW (32.9-87.2 HP)
Maximum rated speed 2800 1/min

Integrated or conventional cooling system
Oil cooled
Grey cast iron crankcase, acoustically optimized
Cast iron cylinder head



DESIGN COMPARISON

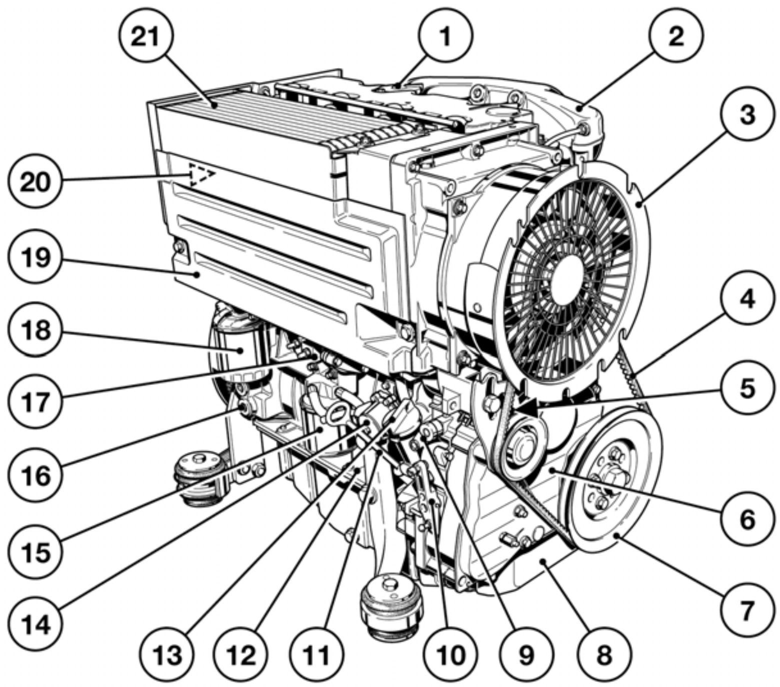
DC11/01/05

1. 17% Weight reduction

The following design changes have been implemented:

1 Lube oil system
2 Oil and fuel filter position
3 Oil dip stick location
4 Fuel Injection pump position
5 Starter solenoid position downward

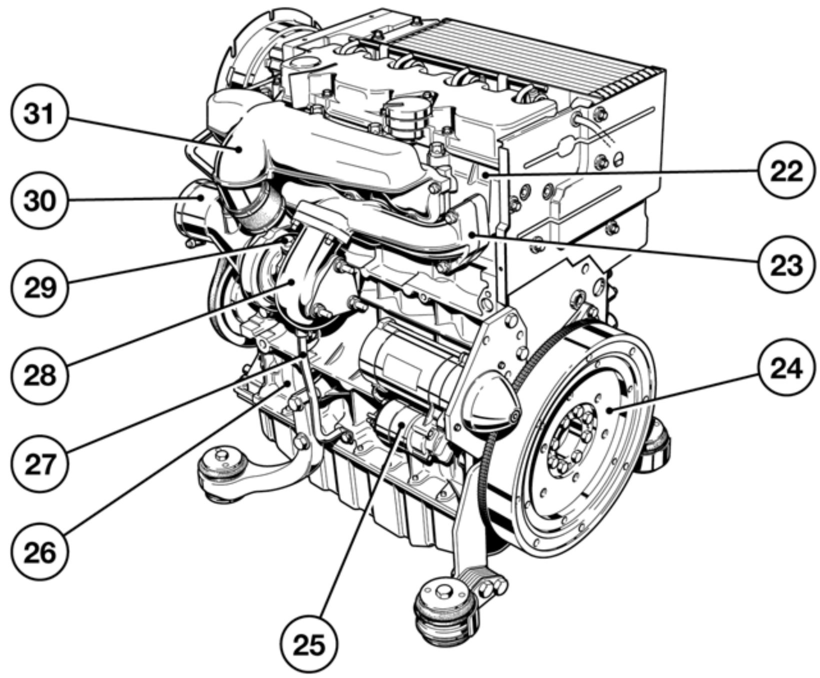
Most of the weight has been removed from the crankcase, yet the installation dimensions have been maintained.



B/FL1011F/2011 (FREE END)

DC11/01/06

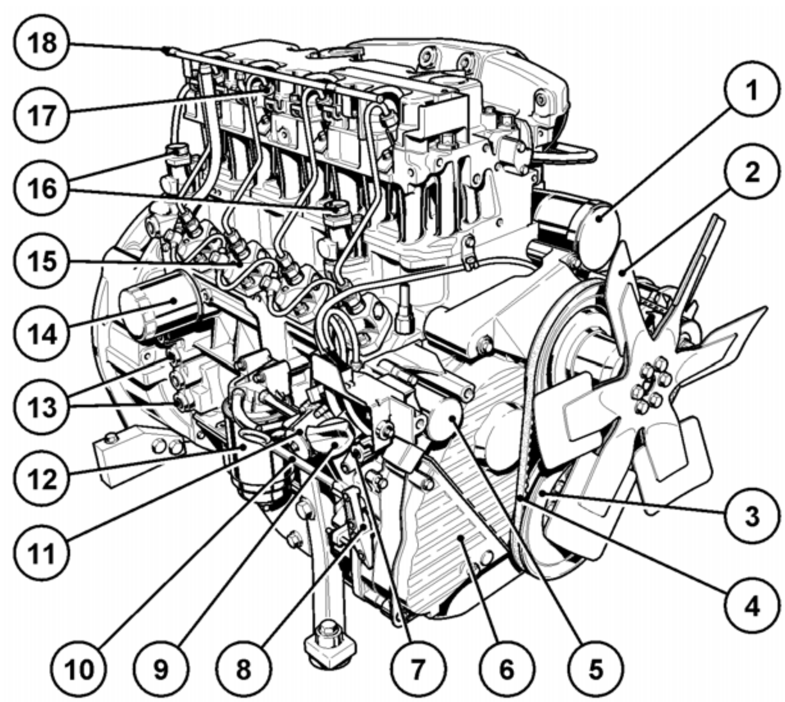
1	Crankcase breather	12	Crankcase
2	Charge air manifold	13	Oil filling socket
3	Cooling fan (with integrated alternator)	14	Fuel feed pump
4	V-belt	15	Fuel filter
5	Solenoid (start / stop)	16	Cab heat connections
6	Wheel box cover	17	Aneroid (LDA)
7	V-belt pulley	18	Lube oil filter
8	Oil pan	19	Removable air cowling
9	Shutdown lever	20	Injection pumps
10	Speed control lever	21	Oil cooler
11	Oil dipstick		



B/FL1011F/2011 (DRIVING END)

DC11/01/07

22	Cylinder head	27	Return line from ETC (lube oil)
23	Exhaust manifold	28	Exhaust turbocharger, ETC
24	Flywheel with ring gear	29	Feed line to ETC (lube oil)
25	Starter	30	Intake socket
26	Crankcase	31	Charge air line

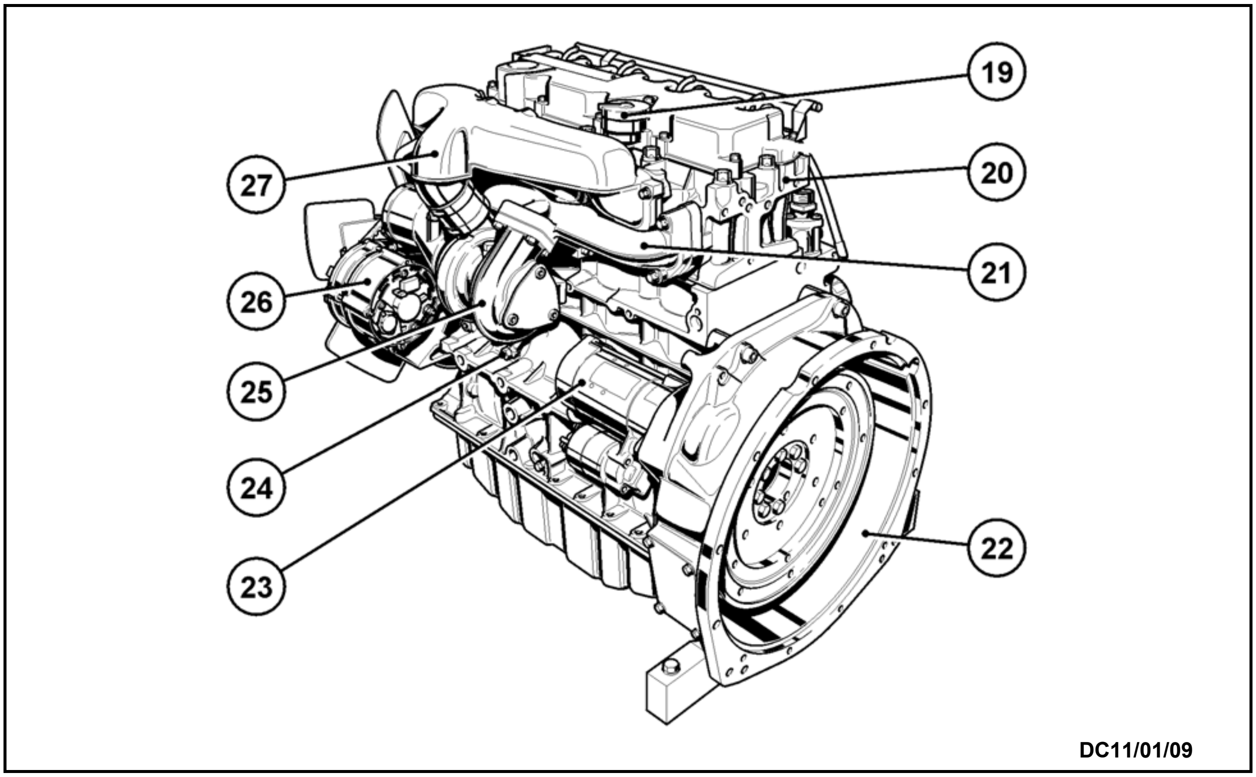


DC11/01/08

B/FM1011F/2011 (FREE END)

DC11/01/08

1 Intake manifold
2 Fan
3 V-belt pulley
4 V-belt
5 Solenoid (start / stop)
6 Gear train cover
7 Shutdown lever
8 Speed control lever
9 Oil filling socket
10 Oil dipstick
11 Fuel feed pump
12 Fuel filter
13 Cab heat connections
14 Lube oil filter
15 Injection pumps
16 Oil cooler connection
17 Injectors
18 Fuel return line



B/FM1011F/2011 (Driving End)

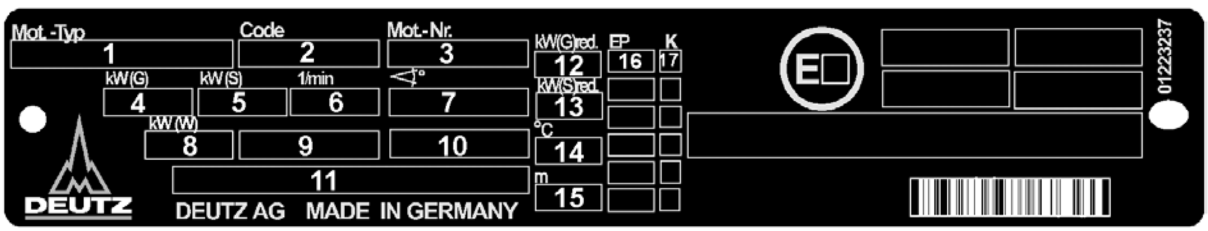
DC11/01/09

19	Crankcase breather	24	Lube oil supply line (exhaust turbo charger)
20	Cylinder head	25	Exhaust turbocharger (ETC)
21	Exhaust manifold	26	Alternator
22	Flywheel housing	27	Charge air manifold
23	Starter		

DC11/01/010

DC11/01/010

ENGINE IDENTIFICATIONS
INDEX



Dc11011

DC11/02/02

NAME PLATE

DC11/02/02

1. Engine Type
2. Engine Certification
3. Engine Serial Number
4. Total Power Output / Blower disengaged
5. Total Power Output / Blower engaged
6. Rated engine Speed
7. Fuel Injection Timing
8. Additional Power Absorption

9/10 Free Space for Information
11 ISO Power Indication
12 Power reduction kW (G)
13 Power reduction kW (s)
14 Power reduction kW (Temperature)
15 Power reduction kW (Altitude)

For internal combustion engines, the power is always indicated with reference to a standard (ISO). These standards specify the engines power output settings as indicated on the nameplate.
The performance of the engine is essentially influenced by the environmental conditions at its working site. Such as temperature and density of combustion air and cooling air. (14 and 15)

1	Engine type e.g.:	BF4M 2011
2	Code:	For engines certification according EPA
3	Engine number:	Serial number of engine
4	kW (G) [1)]	"Total power" (T-power), fan not running.

T-power as per ISO standard (The engine is equipped with a controlled blower. The indication on the name plate is the total power output including power absorption of the cooling blower. During total power output, the blower is

not engaged or running at maximum slippage.)

5	kW (S)	"Continuous power" (C-power), fan continuous running

C-power as per ISO standard (The engine can be equipped with a controlled or rigid driven cooling blower. The indication on the name plate is the engines power output when the cooling blower is ***fully*** engaged.)

6	1/min [3)]	Rated speed of the engine.
7	) °	Commencement of injection in ° C/A.
8	kW (W)	Effective power absorption (fan/blower)

Indication for power absorption of cooling fan for additional cooling, when a transmission oil cooler, charge air cooler (intercooler) is installed.

9+10		Free space (for additional information).
11		Abbreviation of ISO power indication. Indication of the standard and/or acceptance regulation taken as a basis to determine the engines performance. To all performance standards, the following reference stan dard conditions apply:

Ambient air pressure,	total:	100 kPa
	dry:	99 kPa
Ambient air temperature	:	298 K (25 °C)

12	kW (G) red. [2)]	Reduced "total power" for the ambient conditions prevailing at the place of installation / on site. (see 14/15)
13	kW (S) red. [2)]	Reduced "continuous power" for the ambient conditions prevailing at the place of installation / on site. (see 14/15)
14	Ambient air temperature in °C [2)]	Ambient conditions at the place of installation
15	Altitude above sea level in m[2)]	Ambient conditions at the place of installation
16		Not applicable for series 2011
17	K	Piston classification

[1)] The letter S or G according to Deutz Standard H 0172 defines the value of the net brake power in kW on the nameplate.

[2)] Increasing air temperature and lower air pressure result in a reduced air density and a reduction in the amount of oxygen. Lower oxygen content and lower density have negative effects on the engine's combustion process and cooling. The result is a power loss and higher component temperatures.

If, for a longer time, an engine is operated at clearly less favourable ambient conditions, premature wear must be expected due to thermal overload.

Therefore, upon extended operation or stationary operation under unfavourable ambient conditions, the power output must be reduced by lowering the fuel injection rate as specified in power reduction tables. When reducing the power, it must be distinguished between the applications (stationary or non-stationary or transient engine operation) and between naturally aspirated and turbo charged engines.

To establish the power reduction
a) the rated power indicated on the nameplate and
b) the ambient conditions at the location of installation must be taken as a basis.

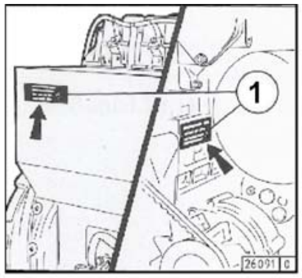
1. Altitude in metres above sea level
2. Air temperature in ° Celsius *)

*) *The air temperature is defined as "normal maximal day temperature"; this is the average value of the highest day temperature of the last years in the hottest month.*

Rated speed, as indicated on the name plate, is the speed at which the engine develops its highest or rated power output. The engines high idle no load speed can be 3-14% higher than the rated speed. The difference between rated and high idle no load sped and is called ***DROOP.***

Generator application:	***1800*** rpm	+ ***4 %*** =	***1872*** High idle rpm
Industrial application:	***2300*** rpm	+ ***7 %*** =	***2461*** High idle rpm
Automotive application:	***2500*** rpm	+ ***12%*** =	***2800*** High idle rpm

1



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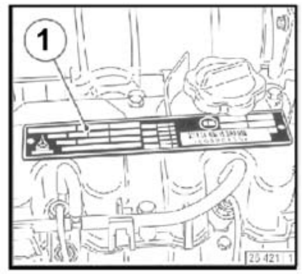

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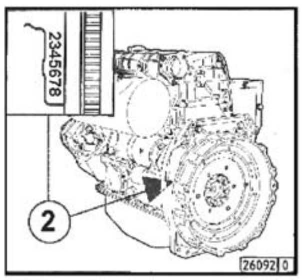

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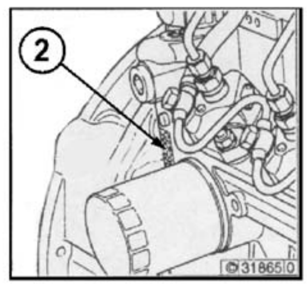


DC11/02/05

NAME PLATE / SERIAL NUMBER LOCATION

DC11/02/05

Illustration 1

	1 Name Plate Location on Cowling Cover
ENGINE:	BFL1011; FL1011; BFL1011F; FL1011F, BFL1011E; FL1011E
	1 Name Plate Location on crankcase
ENGINE:	BFL1011E; FL1011E; BFM1011F; FM1011F

Illustration 2

	1 Name Plate Location on Rocker Cover
ENGINE:	BFM1011F; FM1011F; BFL2011;FL2011; BFM2011; FL2011;

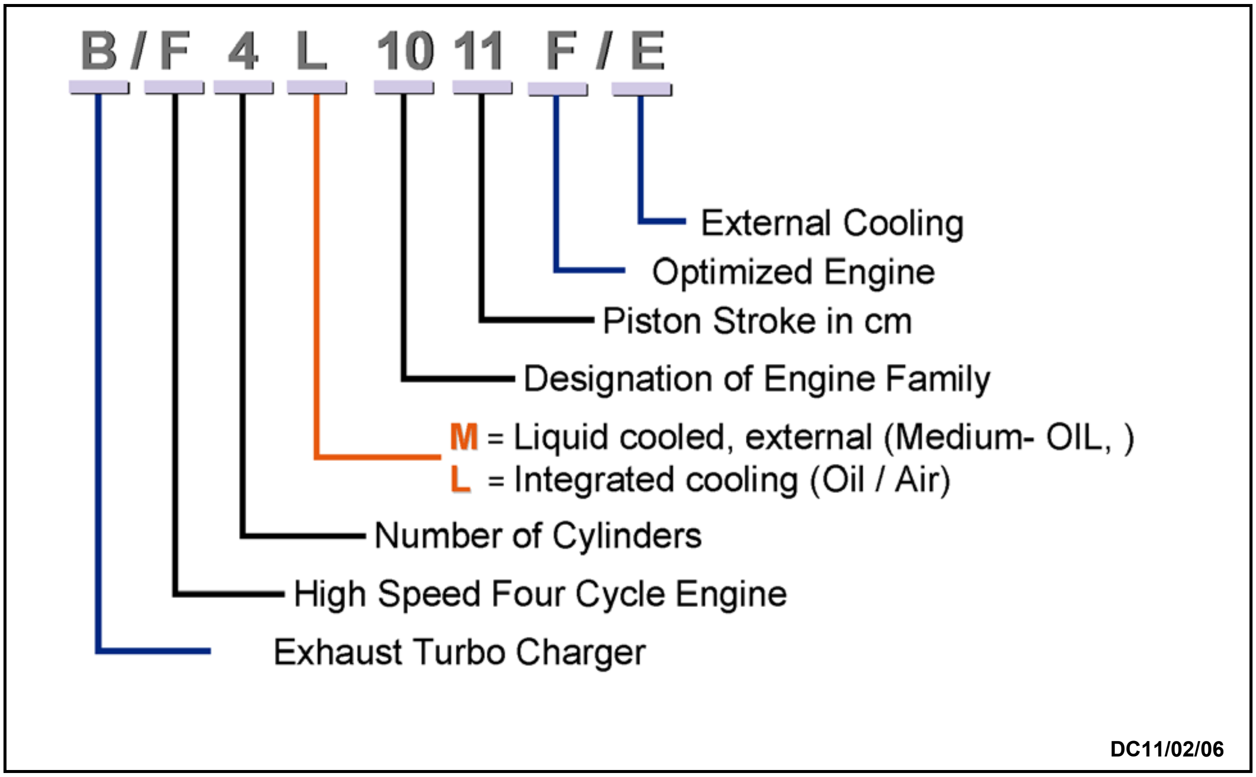
Illustration 3

	2 Engine Serial Number in Crankcase
ENGINE:	BFL1011; FL1011; BFL1011F; FL1011F, BFL1011E; FL1011E

Illustration 4 ([1])

	2 Engine Serial Number in Crankcase
ENGINE:	BFL1011F; FL1011F, BFL1011E; FL1011E; BFM2011;FL2011

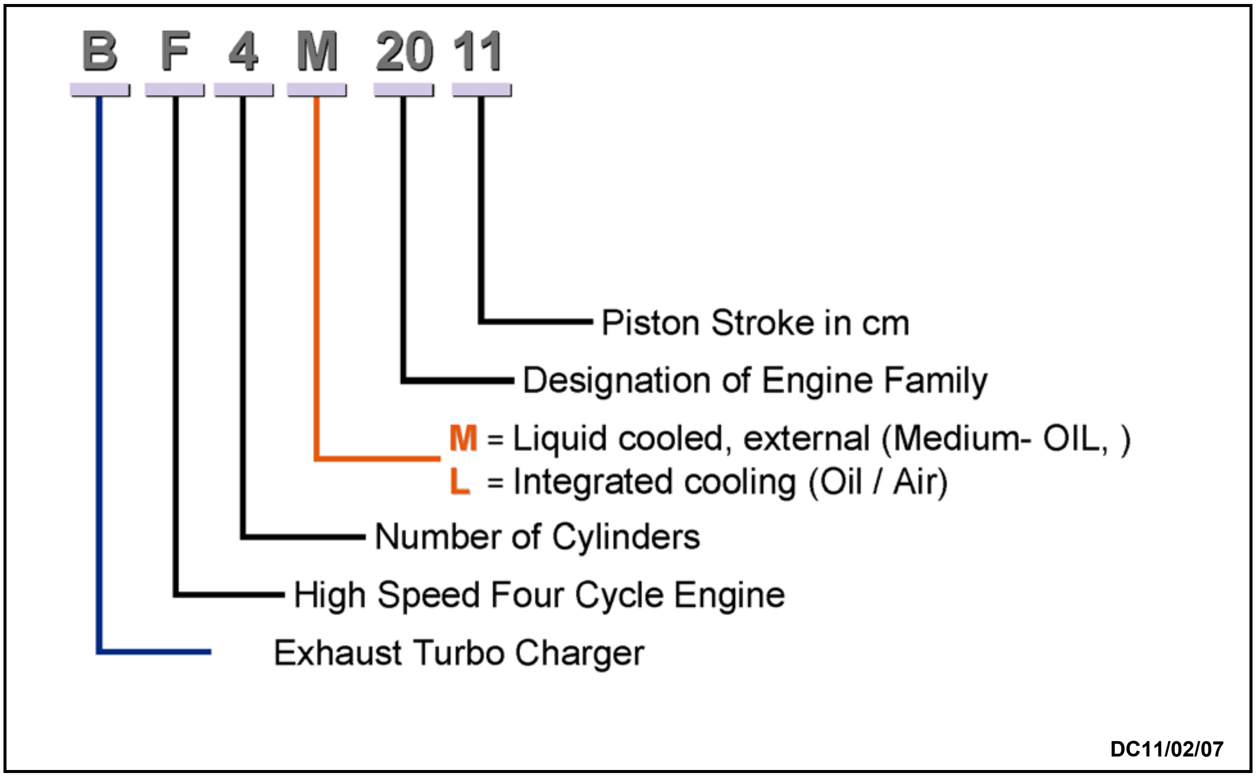
[1]) Since March 2001 the engine serial number has been engraved into the crankcase at the location as is it shown in illustration **4**



Engine designation

DC11/02/06

The example shows a combination of engine designation arrangements. This arrangement can be found on technical documentation or specification sheets.
Example:
B ***slash*** F indicates that the information in the document is either for a turbo charged (B) engine ***and / or*** for a naturally aspirated (F) engine.
The information as shown in the above illustration ***will not*** appear on any name plate.
Turbo charging is designated with the letter "B" as a prefix, the "B" is derived from the name of the inventor of the charger, A. R. Büchi.
The method of engine cooling is defined by the letters M and L.
M = MEDIUM— a mixture of water and glycol or, as in the case of 1011/2011, engine lubricating OIL.
L = LUFT (AIR)— in case of the 1011/ 2011 the engines designated with the letter L , they have an integrated cooling system and the ***cylinder head is AIR cooled.***
By improving or optimizing an engine, it will be identified with the letter **F**. Any further optimization will change the engine family designation number.
Example : **10**11 to **20**11
The letter E indicates that the engine is externally cooled. The engine has a remote mounted radiator or heat exchanger. The cooling fan can be engine, electrically or hydraulically driven. The engine ***cylinder head is OIL cooled.***



Engine designation

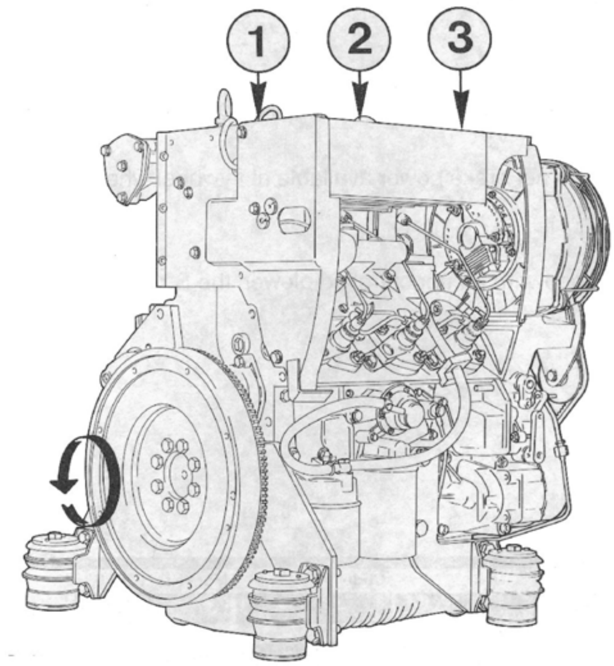
DC11/02/07

Model number as show in the illustration appears on engine name plate.

As specified, the engine is:
Turbo charged, high speed, four cycle, liquid cooled engine with 112mm (11.2cm) piston stroke.

M indicates that the engine is equipped with an external cooling system and the cylinder head is oil cooled.

With the increased power output, the external cooling system must be utilized to be able to handle the increased cooling demand.



DC11/02/08

ENGINE ROTATION / CYLINDER NUMBERING

DC11/02/08

1. Engine Identification beginning at the Flywheel End
2. Engine Rotation—Counter clock wise

The cylinders are numbered beginning at the flywheel.

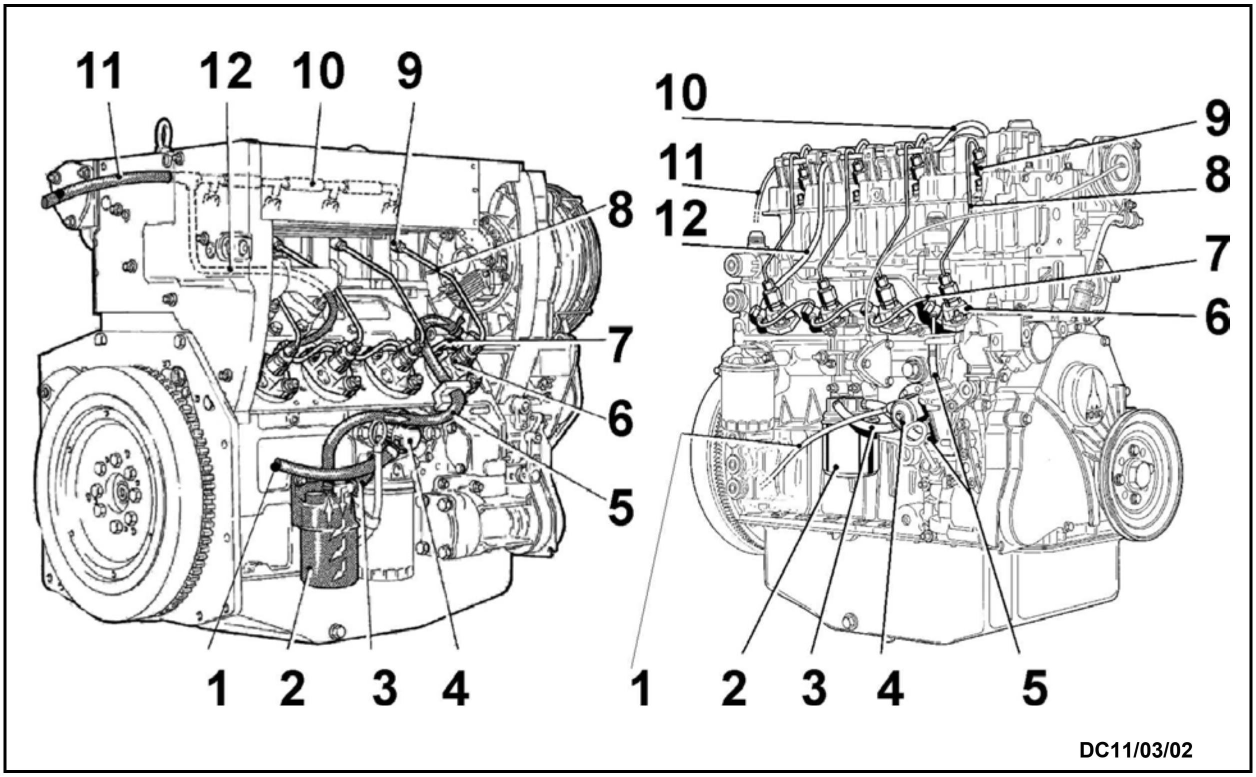
Facing the flywheel, the rotation of the engine is counter-clockwise.

Firing order:	2 cylinders 2011:	1 - 2
	3 cylinders 2011:	1 - 2 - 3
	4 cylinders 2011:	1 - 3 - 4 - 2

When performing engine disassembly, assembly or failure analysis it is very helpfull to be consistent in numbering the engine components. Also components might differ in form or shape with the location in the engine.

ENGINE FUEL SYSTEM

INDEX



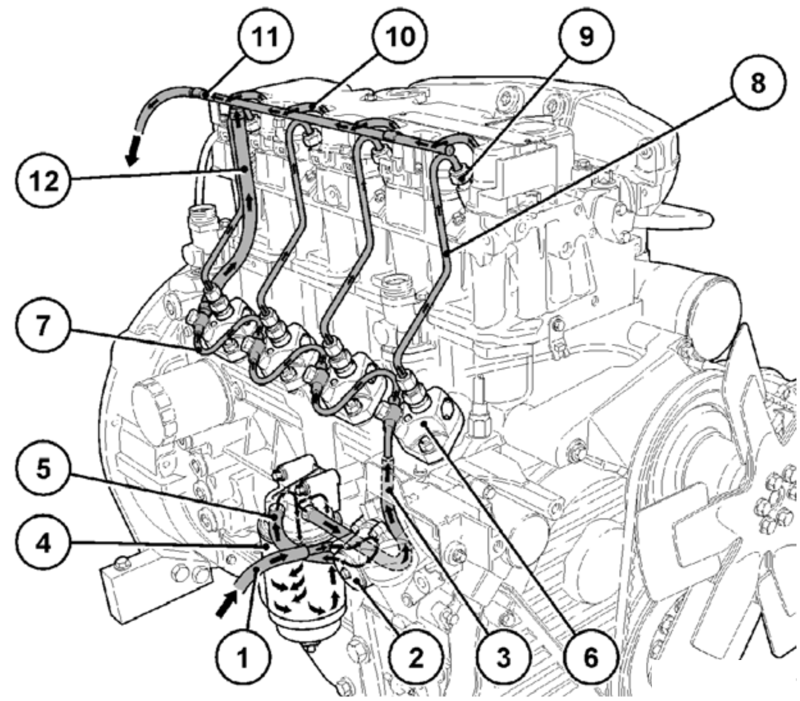
1011 / 1011F FUEL SYSTEM

DC11/03/02

Fuel System Components

1— Fuel line from tank to fuel lift pump
2— Fuel filter
3— Fuel line from lift pump to filter
4— Fuel lift pump
5— Fuel line from filter to fuel supply gallery
6— Fuel injection pump
7— Fuel supply gallery
8— Fuel injection lines
9— Injectors
10— Leak off line
11— Return line to fuel tank
12— Fuel overflow line

Because of the operating temperatures of the engine, the material of hose sections (11) and the "T" fittings in between them, become porous and brittle and the assembly will leak. The fittings and hoses must be inspected at the 1000 Hr maintenance intervals and if required being replaced . When rubber sections have been removed from the barbed fittings of the fuel injectors or barbed "T" fittings, the internal surface of the hoses might be damaged and might leak. Therefore, any time the hoses have been removed , they should be replaced.



DC11/03/03

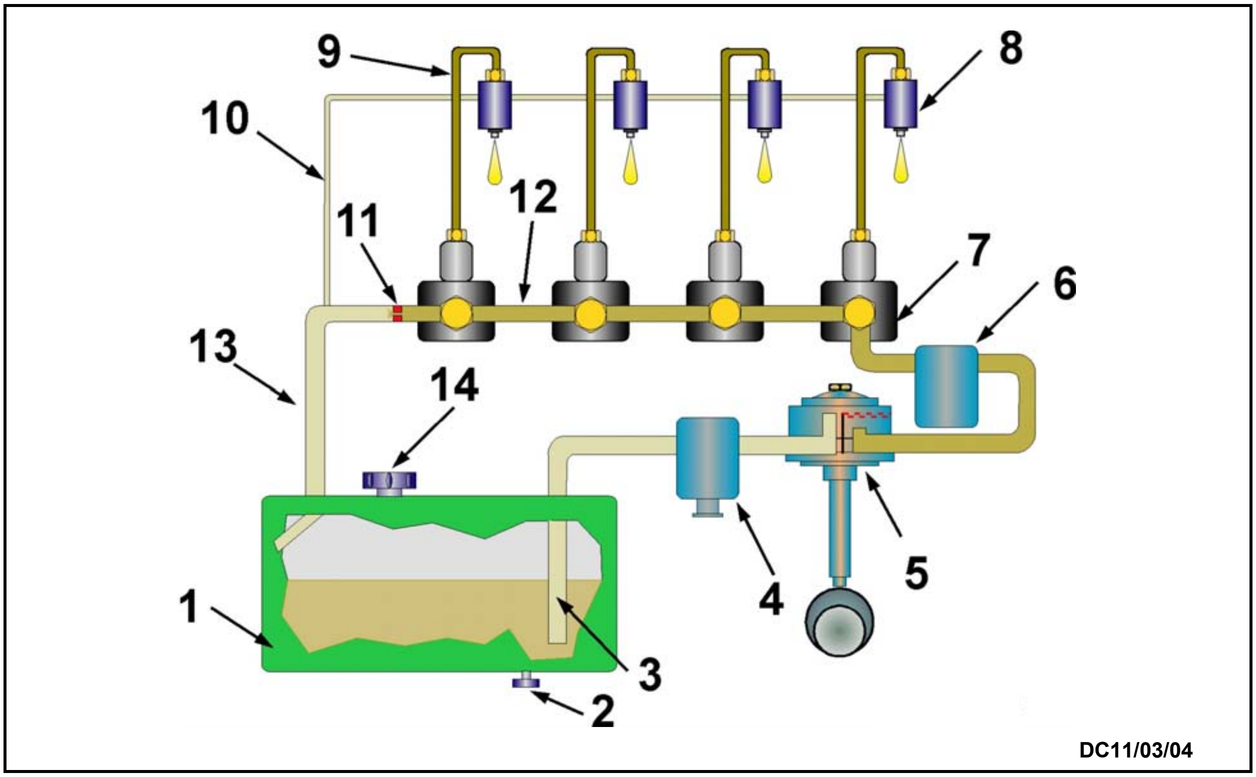
2011 FUEL SYSTEM

DC11/03/03

Fuel System Components

1— Fuel line from tank to fuel feed pump
2— Fuel feed pump
3— Fuel line from feed pump to fuel filter
4— Fuel filter
5— Fuel line from fuel filter to fuel supply gallery
6— Injection pumps
7— Fuel supply gallery
8— Fuel injection lines
9— Injectors
10— Injector return line
11— Fuel return line to tank
12— Fuel overflow line

The 2011 engine has a steel injector leak-off line. The overflow line from the fuel supply line is connected to the leak-off line via screw fitting. The connections from the fuel injectors to the leak-off line are made off short rubber hoses.



Fuel flow

DC11/03/04

1	Fuel Tank	8	Fuel Injector
2	Drain Plug	9	Injection Line
3	Suction Pipe	10	Leak-off Line
4	Pre-Filter (recommended)	11	Orifice
5	Fuel Lift Pump	12	Fuel Supply Gallery
6	Fuel Fine Filter	13	Fuel Return Line
7	Fuel Injection Pump	14	Filler Cap

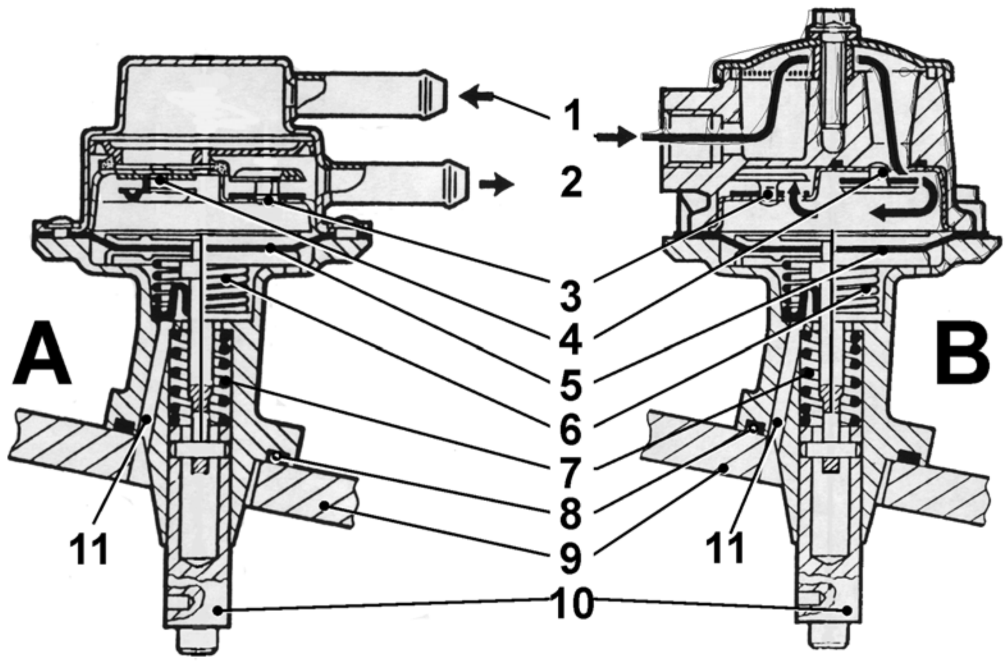
The FL1011/ 2011 fuel system is self-bleeding through the fuel return orifice.

The fuel is drawn from the fuel tank(1) by the lift pump (5) and is transferred to the fine filter (6). Deutz highly recommends to install a pre-filter (4) in the fuel system.
From the fuel filter the fuel is pushed under low pressure into the main gallery (12) of the single fuel injection pumps. The gallery in this case is a metal pipe connecting the individual pumps with each other. The gallery is equipped with an orifice (11) at the end where it connects to the fuel return line (13). This permits the operator to start the engine immediately after fuel filter change since this system is self bleeding.
With the injection pump galleries full of fuel, this fuel is then pumped at high pressure through the fuel injectors (8) into the combustion chambers.
The leak-off-fuel of the injectors returns to the tank.

The ***FUEL RETURN*** line in the 1011/ F / 2011 fuel systems are not to be immersed in fuel anymore. The return line should end shortly after entering the tank and above the maximum fuel level and it should be bend away from the suction line. To prevent aeration of the fuel in the fuel tank, the leak-off fuel should be guided against the tank wall.

When the filter element before or after the fuel lift pump becomes contaminated and the fuel flow is restricted, this will not cause the engine to shut down.
The plungers in the fuel injection pumps will draw fuel its least flow resistance into the fuel system.
With the return line immersed into the fuel, the fuel injection pumps will draw fuel via return line and inject it into the combustion chamber and the engine keeps on running. The neglected filter maintenance causes the unfiltered fuel to enter the injection pumps and will lead to excessive injection pump wear.

The revised fuel system will prevent this.



FUEL LIFT PUMP

DC11/03/06

"A" B/FL1011/E Lift Pump **"B" B/F/L/M1011F/2011 Lift Pump**

1. **Fuel "IN"**
2. **Fuel "OUT"**
3. **Flapper Valve "OUT"**
4. **Flapper Valve "IN"**
5. **Diaphragm**
6. **Diaphragm Spring**
7. **Plunger Spring**
8. **"O" Ring**
9. **Crank Case**
10. **Pump Plunger**
11. **Pump Ventilation**

Fuel transfer pump driven by cam lobe on engine's camshaft

A gravity-fed fuel system has a fuel tank placed above the fuel injection system.

The force-fed system allows the fuel tank to be located at a level below the fuel injection system. However, a fuel lift pump is required to raise the fuel from the tank to the fuel injection pump.

The transfer pump is of the diaphragm (**5**) type and is mounted to the crankcase (**9**).

The pump is sealed to the crankcase with an “O”-ring (**8**).

The pump is driven by an excenter on the engines camshaft.

When the engine turns, the excenter pushes the plunger (**10**) up (or inward the pump). The diaphragm is being lifted by the diaphragm spring (**6**) and pushing the fuel through the flapper valve (**3**) toward the injection pumps. In case of fuel flow restriction on the pressure side of the fuel system, spring (**6**) will push the diaphragm only as the spring force permits. This will protect the diaphragm (**5**) from rupturing. The plunger will continue its mechanical travel through a center hole in the diaphragm. The chamber underneath is sealed with a special shaft seal (**12**). The diaphragm breathes through a breather passage (**11**) into the crankcase.
When the pumping stroke is completed, the plunger is following the excenter down, starting the suction stroke.

At the same time, the flapper valve (**3**) on the delivery side will close, thus preventing the fuel from being pumped back into the fuel tank

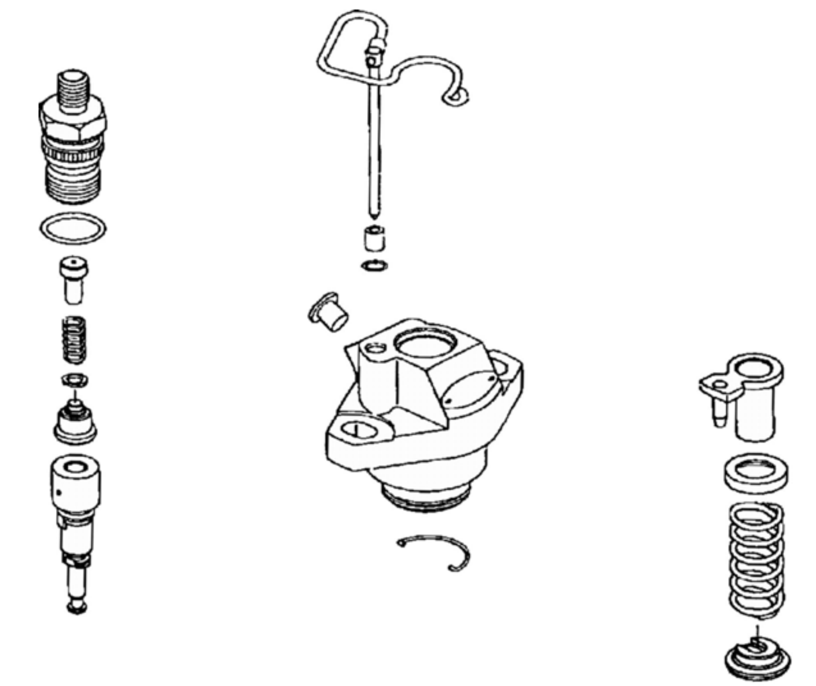
The flapper valve (**4**) opens to allow fuel to be sucked in by the diaphragm, that is pulled downward by the plunger (**10**) and its spring (**7**) .

At the end of the suction stroke, the whole pumping process will start all over again.

The B/FL1011 fuel lift pump **“A”** does not have a fuel filter or strainer installed. Therefore, it is recommended to install a filter, strainer or water separator, between the fuel tank and transfer pump. This prevents contaminants or water being drawn in by the lift pump, damaging the fuel injection pumps and / or fuel injectors.

The B/FL1011F / 2011 fuel lift pump **“B”** is equipped with a pre-filter, therefore preventive maintenance can be performed on these pumps.

The 1011F and 2011 lift pumps can not be installed on the older 1011 engine.



BOSCH FUEL INJECTION PUMP

DC11/03/08

1. Individual injection pumps (1 per cylinder)

The injection pumps have three functions:
1 Pressurize fuel
2 Time delivery
3 Meter fuel quantity

Individual pumps are driven by the engine's camshaft. The PFE-pump does not have its own roller tappet. The roller tappet is riding as a separate part on the engine's camshaft. The pump is flange mounted to the crankcase.
OMAP and BOSCH pumps were used in the 1011 engines and can not be intermixed, both pumps have a different stroke and plunger diameter. When installing BOSCH pumps insted of OMAPpumps, the engine's camshaft must be changed. The new camshaft fits into the existing camshaft drive.

ALL 1011F and 2011 ENGINES have BOSCH injection pumps.

FUEL INJECTION PUMP INSTALLATION

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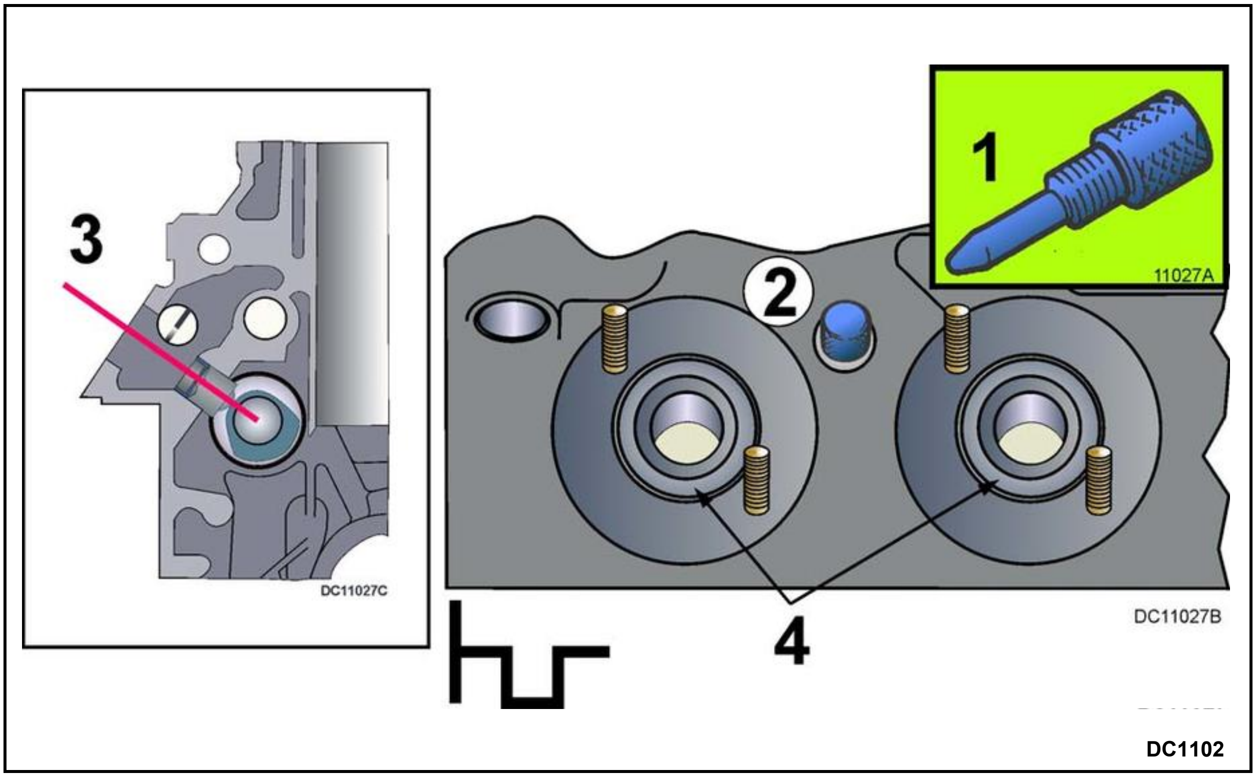


FL1011 Injection Pump Mounting Ports

DC11/04/02

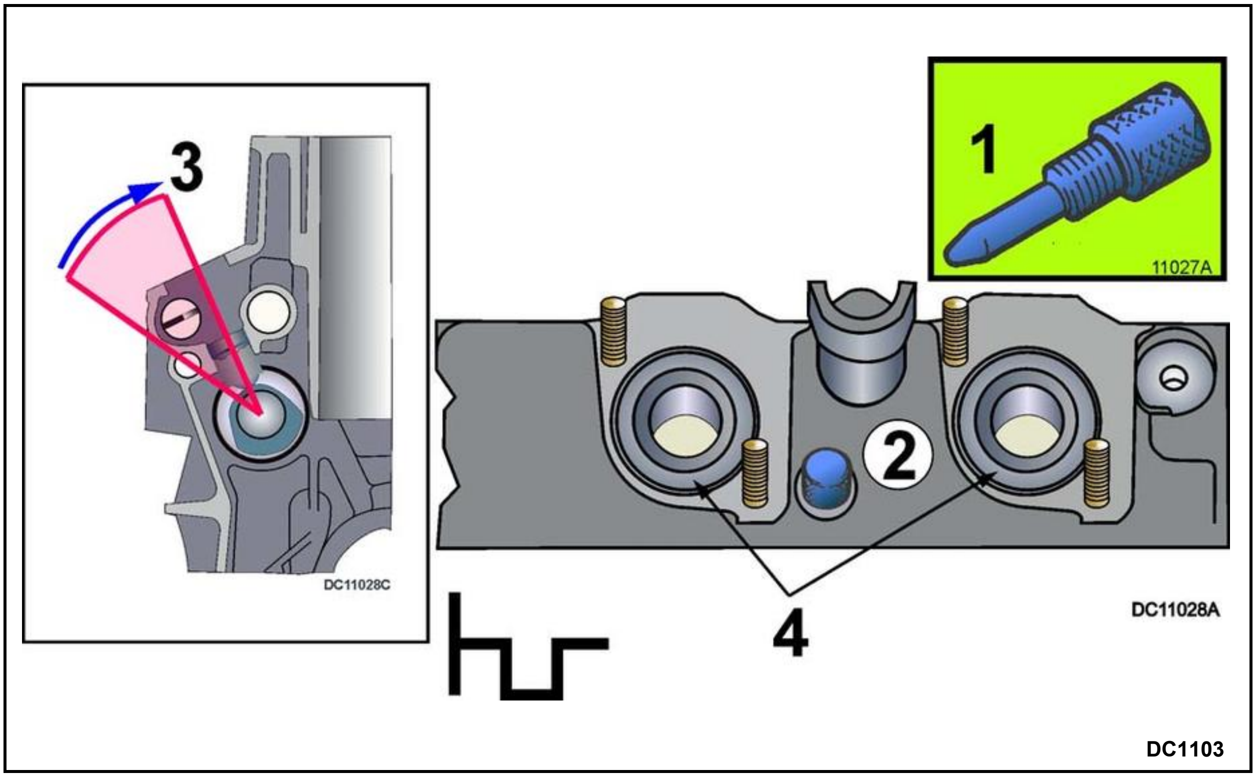
= Symbol for Flywheel and Crankshaft

The following special tool is required to perform the fuel injection pump installation procedure:

1. FUEL RACK LOCKING PIN

For easy and simplified installation of the single fuel injection pumps, just move the fuel control rack into a position where the locating hole in the rack and the hole in the crankcase align.

Remove screw plug that is installed in the crankcase (at location 2) and install fuel rack locking pin (1).
On the **B/FL1011/E** the location 2 is located between fuel injection pumps **1** and **2** (4).
The location of the fuel control rack is between the fuel injection pump and cylinder head (see illustration 3).



F/L/M1011/F/2011 Injection Pump Mounting Ports

DC11/04/03

= Symbol for Flywheel and Crankshaft

The following special tool is required to perform the fuel injection pump installation procedure:

1. FUEL RACK LOCKING PIN

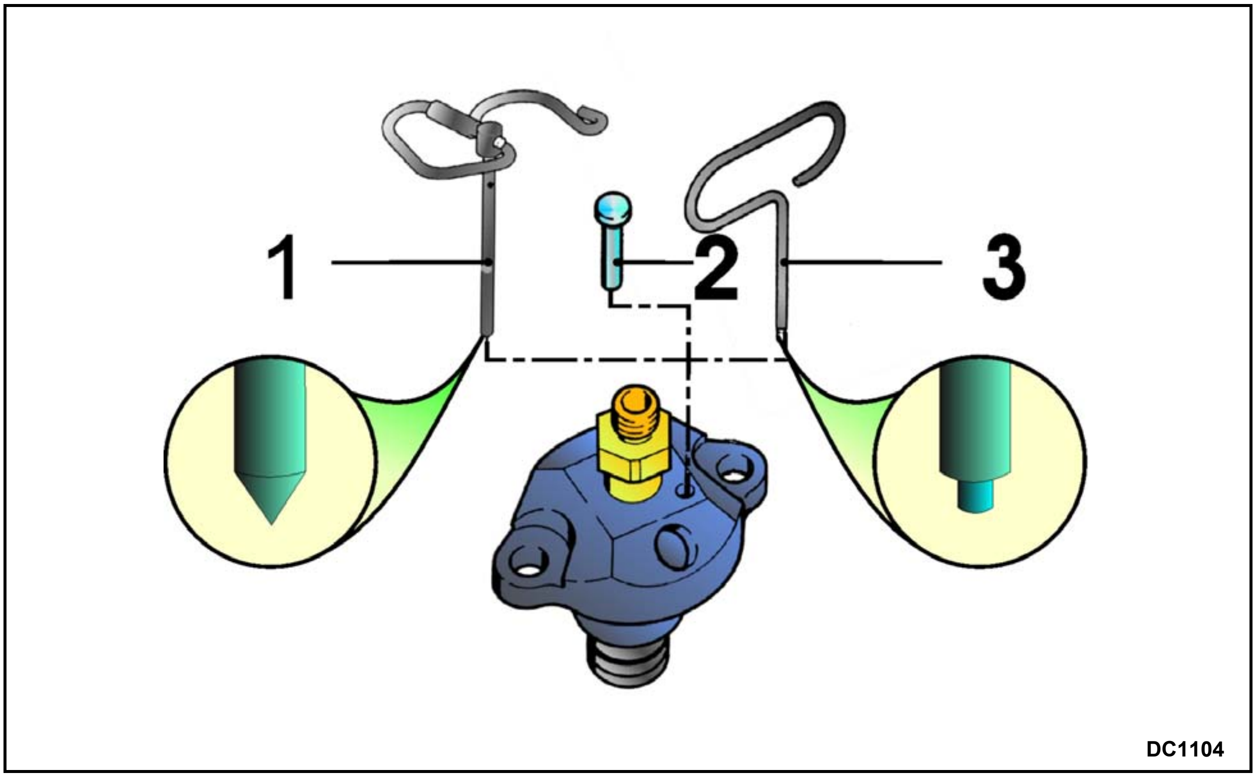
For easy and simplified installation of the single fuel injection pumps, just move the fuel control rack into a position where the locating hole in the rack and the hole in the crankcase align.

The Location of the screw plug has changed further to the outer edge of the crankcase. On the **B/F/L/M1011F/2011** the location 2 is located between the last injection pump and the one before (4).

Remove screw plug that is installed in the crankcase (at location 2) and install fuel rack locking pin (1).

The angle of the fuel injection pump has changed to a steeper angle compared to the 1011 engine (see illustration 3). With this, the fuel injection pump is now located between fuel control rack and the cylinder head.

Since the control rack on the 1011F and 2011 still works in the same direction as the 1011 (flywheel STOP ; blower START) , the position of the guide pin on the metering sleeve has been changed by almost 180^0. Therefore, a 1011 fuel injection pump cannot be used in a 1011F or 2011 engine.



1011/2011 LOCKING PINS

DC11/04/04

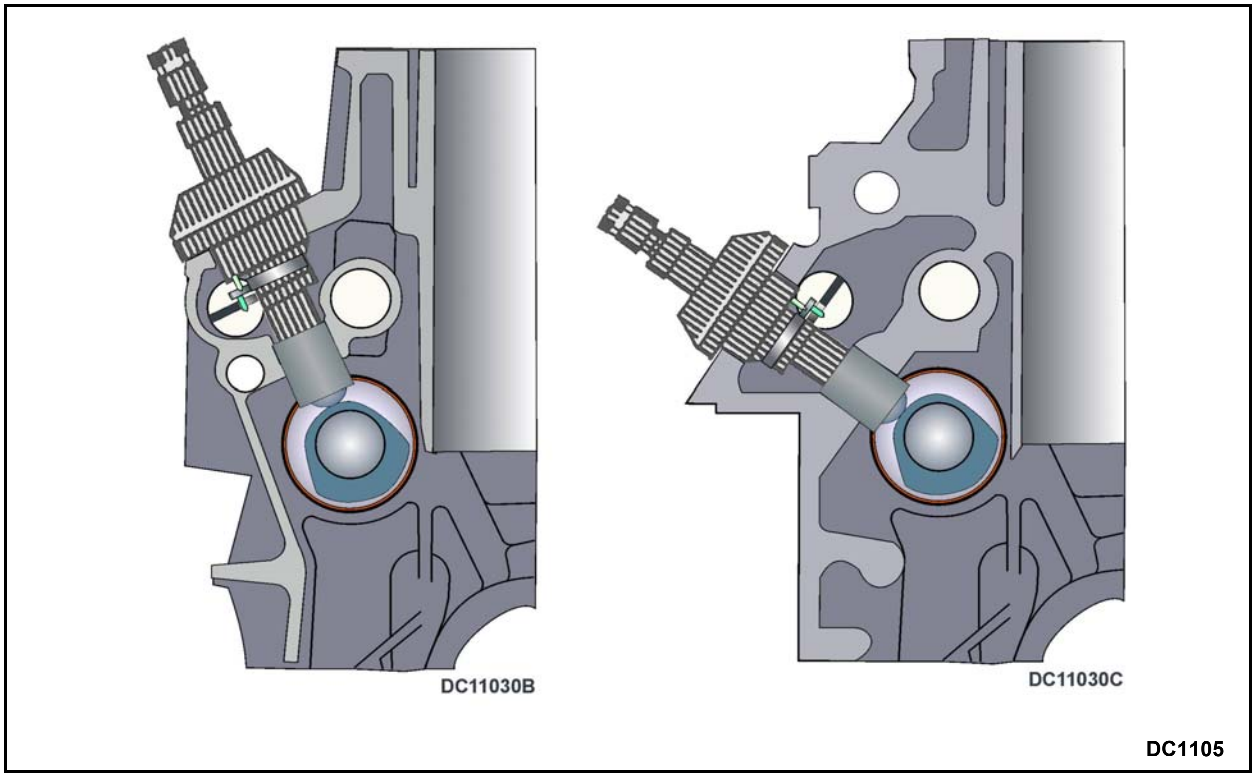
1 Bosch Locking Pin
2 Sealing Pin
3 Omap Locking Pin

- Before installing any injection pump, the lever of the metering sleeve must be locked down using one of the special tools item # **1** or **3** (locking pin). Special attention must be paid to the Injection pump OMAP or BOSCH
- After pump installation, the locking pin must be removed and replaced with the sealing pin (item **2**)
-

Before installing the fuel injection pump, the lever of the metering sleeve must be locked down with item # **1** or **3**. This aligns the pin of metering sleeve lever with the corresponding slot in the fuel control rack.

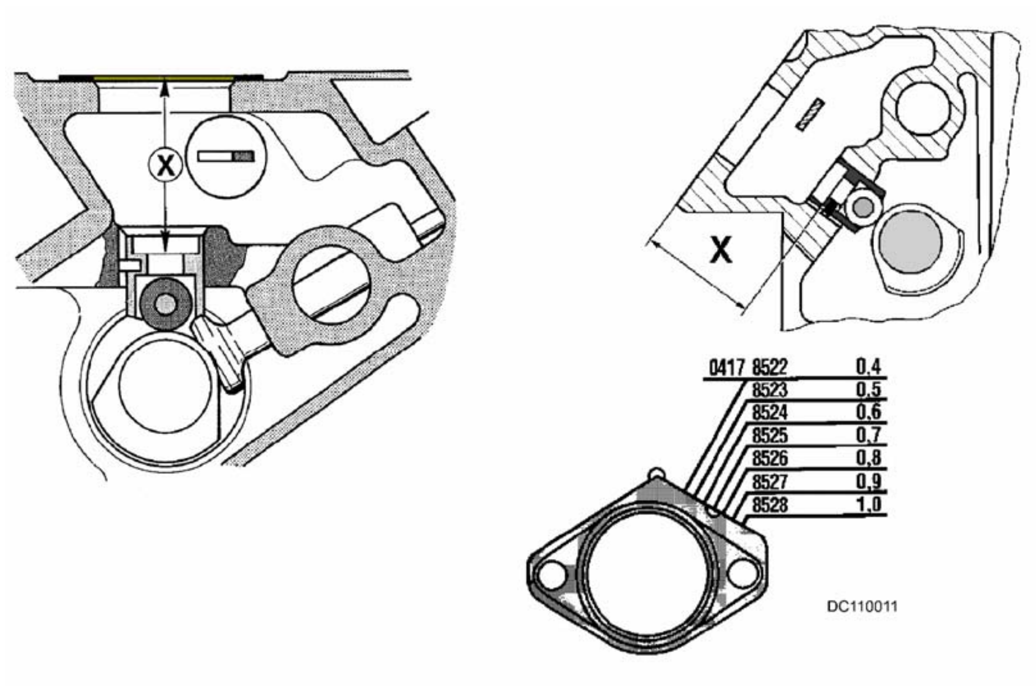
After pump installation, the locking pin must be removed and be replaced with a sealing pin #2.

NOTE 1: The locking pin for the BOSCH Injection pump is tapered.
NOTE 2: The installation depth for the **non EPA approved** engines is listed in the Workshop manual. The installation depth for the **EPA approved** engines is listed in **service bulletin # 145 dated April 20, 1999.**



FUEL INJECTION PUMP INSTALLATION

DC11/04/05



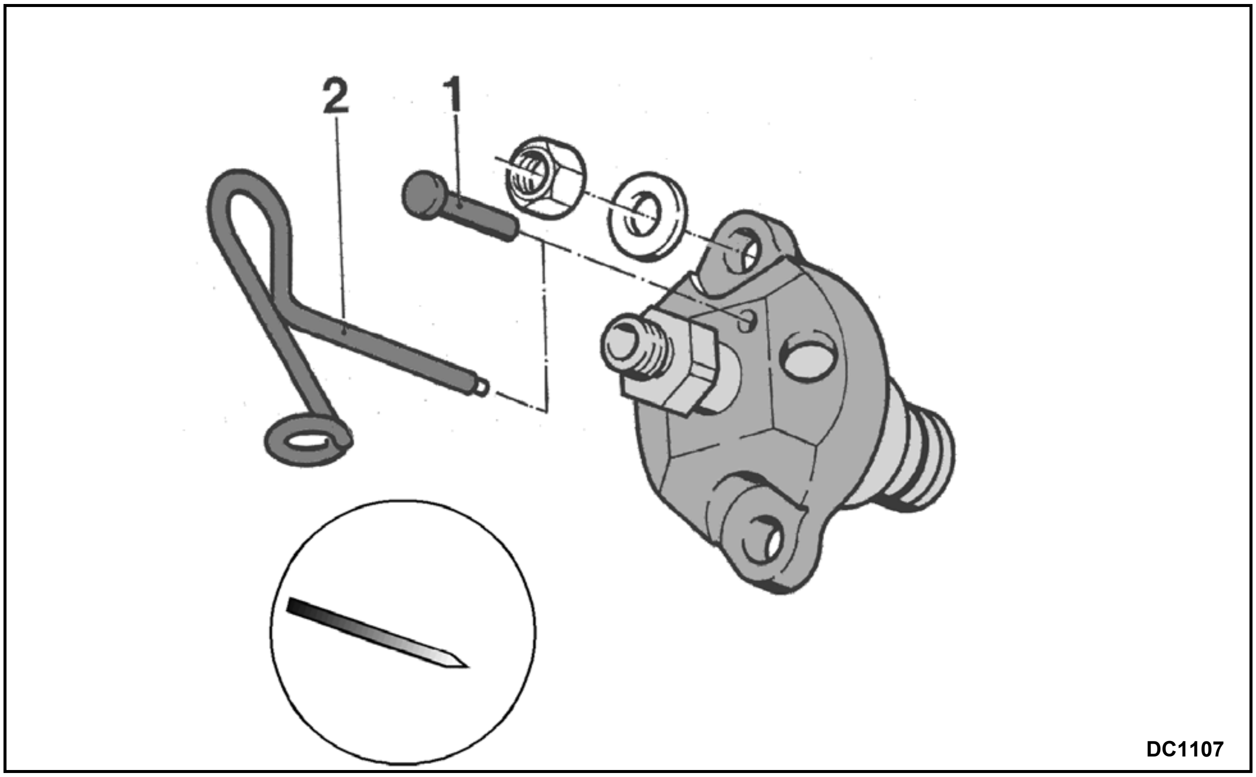
DC1106

FL1011 Injection Pump Mounting Depth

DC11/04/06

1. Distance X must be adjusted to specification, with the roller tappet on the base circle of the camshaft

Check engine specification data for correct depth.
Turn camshaft in rotating direction until the base circle of the cam lobe is facing upwards.
Insert roller tappets. Hold firmly, they may fall down into the oil pan.
In this position the roller tapped is at BOTTOM DEAD CENTER.
On the B/FL 1011 engine, apply a sealing gasket over the studs to the sealing surface of the crankcase. On the 1011F engine, this procedure has been omitted.
Measure the depth from the crankcase sealing surface down to the contact surface of the tappet. (Including gasket on the 1011 and without gasket on the 1011F engine)
Compare the measured depth with the specified data and adjust accordingly, i.e. adding or removing shims.
This dimension does not only determine the pre-stroke of the plunger, it also establishes port closure of the plunger and barrel assembly, i.e. fuel injection begins
The FM and the 1011F engine has different shims. Seven different shim sizes are available. The thickness of the shim is identified by notches in different locations on the gasket. See the workshop manual for specific details.
The shims can also be used on the B/FL1011 engines, no paper gasket is required.



FL1011 Injection Pump

DC11/04/07

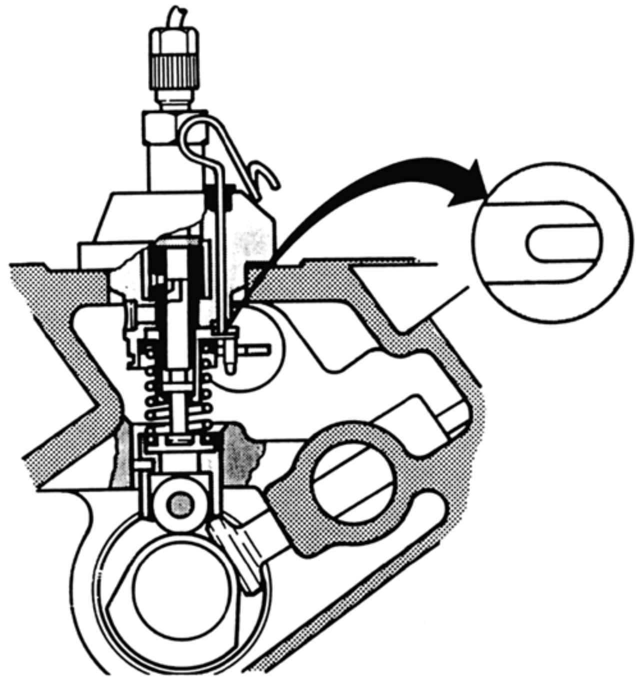
1. Sealing pin
2. Locking pin

1. Before installing the injection pump, you must first lock down the gear segment using the special tool item #2 (locking pin)
2. After pump installation, the locking pin must be removed and replaced with the sealing pin (item 1)

Before installing the fuel injection pump, the gear segment must be locked down with item #2. This aligns the pin of the gear segment with the corresponding slot in the fuel control rack.

After pump installation, the locking pin must be removed and be replaced with a sealing pin #1.

NOTE 1: The locking pin for the BOSCH Injection pump is tapered.
NOTE 2: The installation depth on the non EPA engines is listed in the shop repair manual. The installation depth for the EPA approved engines is listed in service bulletin # 145 dated April 20, 1999.



FL1011 Installing Injection Pump

DC11/04/08

1. With the control rack locked and the gear segment of the injection pump locked, the pin on the gear segment will perfectly align with a slot in the control rack.

NOTE: The fuel injection pumps in the FM and F engines have been rotated by1800 i. e. the metering sleeve lever is directed towards to the outside of the crankcase, whereas the 1011 pumps have the metering sleeve lever towards the inside of the engine.

Slip the fuel injection pump over the studs into its mounting hole and tighten to specification.

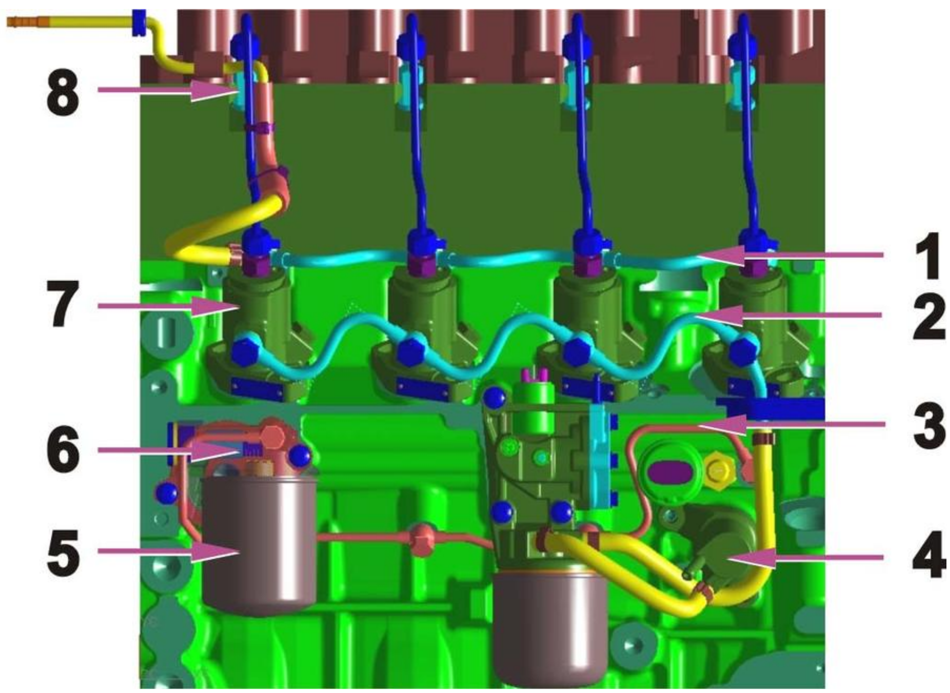
After all the pumps are installed, remove the fuel rack locking pin and make sure that the fuel rack is moving freely.

DC11/04/09

DC11/04/09

FUEL INJECTION PUMP INSTALLATION

INDEX



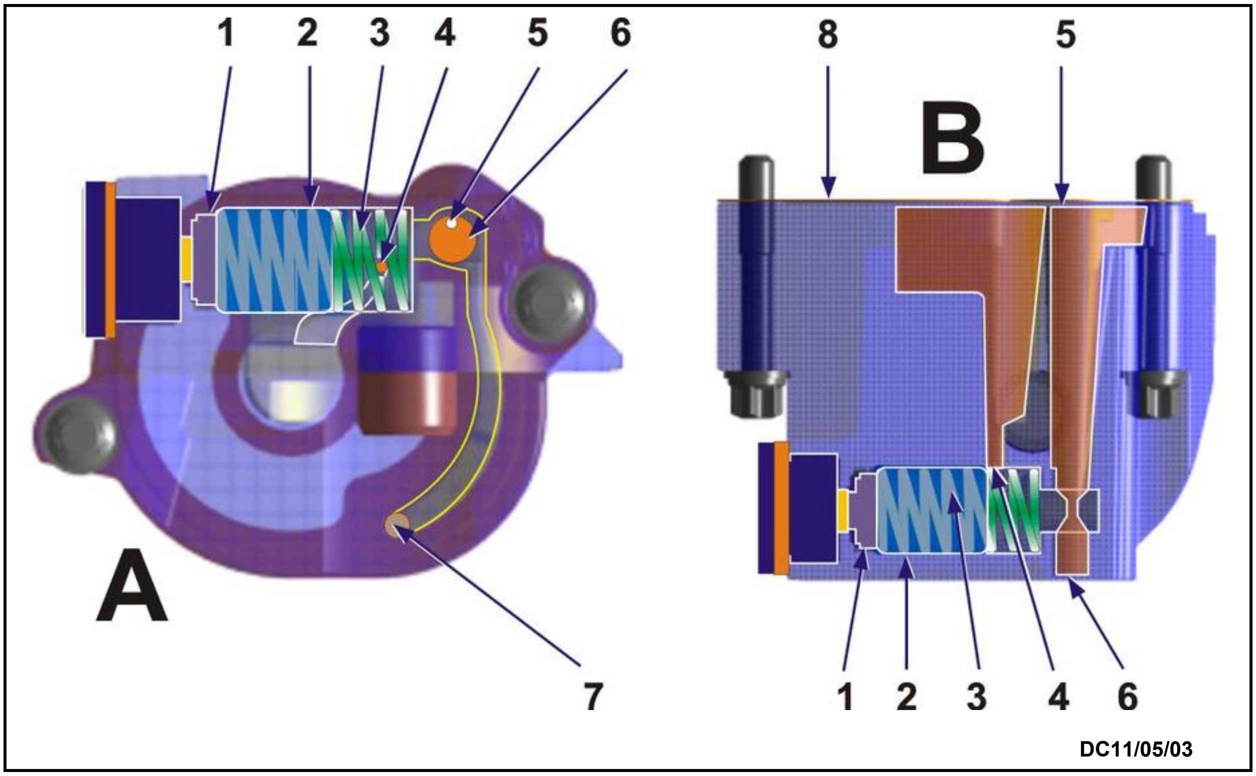
DC11/05/02

MOTORPAL INJECTION SYSTEM

DC11/05/02

1	FUEL RETURN LINE	5	LUBE OIL FILTER
2	FUEL SUPPLY LINE	6	LUBE OILFILTER BRACKET
3	LUBE OIL SUPPLY LINE	7	FUEL INJECTION PUMP
4	FUEL LIFT PUMP	8	FUEL INJECTOR

To eliminate white smoke during the starting process, the engines of the 2011 series are equipped with ***Hydraulic Fuel Injection Pump Tappets.***
Since the 2004 production of the 2011 engine series, the engines are equipped with ***Motorpal Fuel Injection Pumps*** (**7**). The diesel fuel is supplied by a ***Motorpal Piston Type*** lift pump (**4**) to the injection pumps via fuel supply line (**2**). The excess diesel fuel returns through the fuel return line (**1**) back into the fuel tank. The diesel fuel is delivered under high pressure through the high pressure fuel line and a ***Leakless Fuel Injector*** (**8**) into the combustion chamber.
The lube oil filter bracket (6) houses a thermostat that controls the lube oil supply to the hydraulic fuel injection pump tappets via supply line (**3**).



LUBE OIL FILTER BRACKET (HYDRAULIC TAPPET)

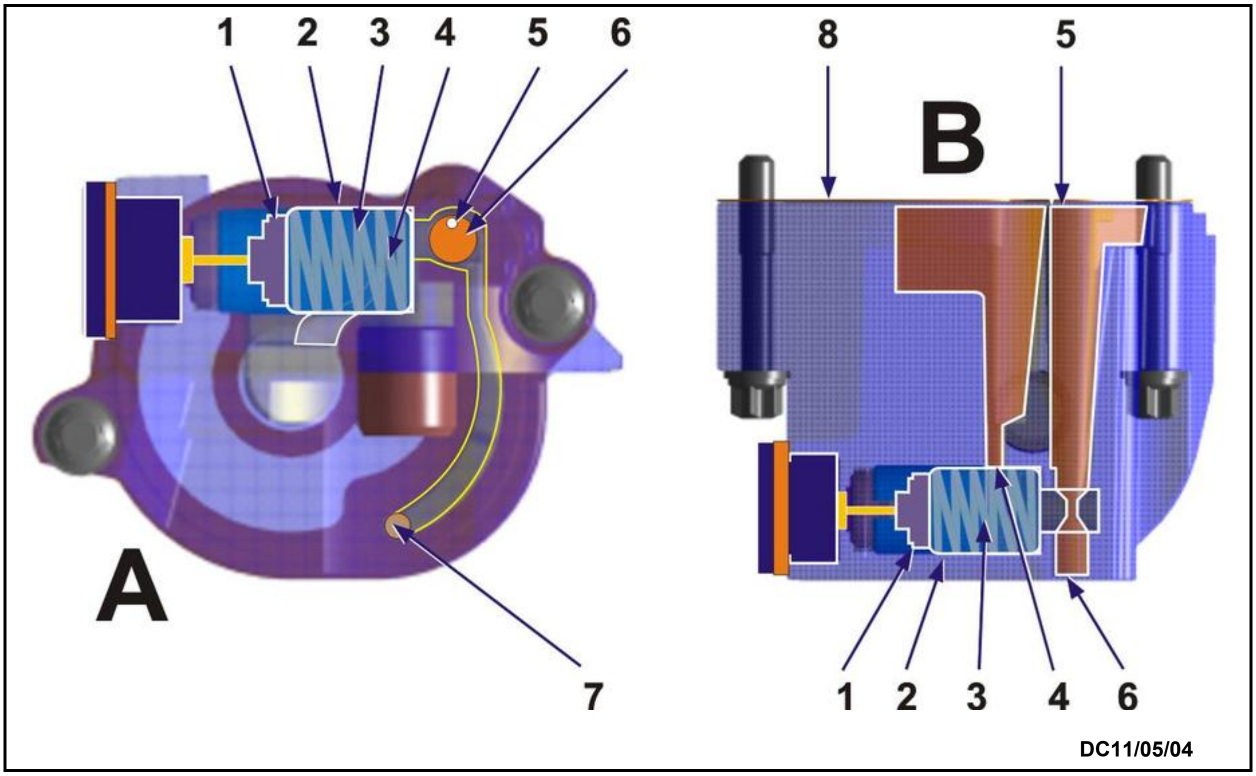
DC11/05/03

A FILTER BRACKET "*FRONT*" VIEW
B FILTER BRACKET "*TOP*" VIEW

1	**THERMOSTATE**	**5**	**ORIFICE**
2	**CONTROL PISTON**	**6**	**EXTERNAL OIL LINE CONNECTION**
3	**SPRING**	**7**	**#1 TAPPET OIL SUPPLY**
4	**OIL SUPPLY PORT**	**8**	**GASKET**

Principle of the Fuel Injection Advancement.

A thermostat (**1**) has been arranged in the oil filter bracket. With the engine cold, the control piston (**2**) is being pushed by a spring (**3**) into its rest position. With the engine starting and running, engine lube oil is being supplied under pressure through the oil supply port (**4**) into the external oil supply line (**6**) and the number one tappet supply (**7**).



LUBE OIL FILTER BRACKET (HYDRAULIC TAPPET)

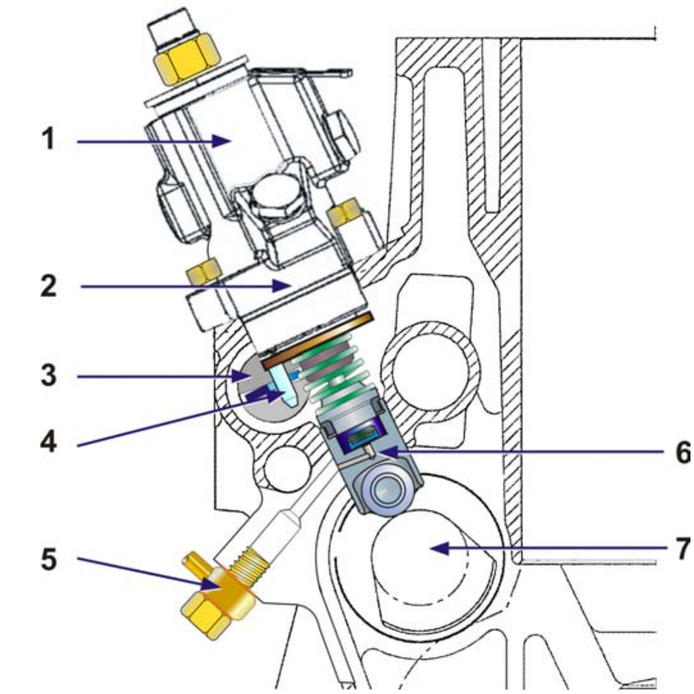
DC11/05/04

A FILTER BRACKET "*FRONT*" VIEW
B FILTER BRACKET "*TOP*" VIEW

1	**THERMOSTATE**	**5**	**ORIFICE**
2	**CONTROL PISTON**	**6**	**EXTERNAL OIL LINE CONNECTION**
3	**SPRING**	**7**	**#1 TAPPET OIL SUPPLY**
4	**OIL SUPPLY PORT**	**8**	**GASKET**

Principle of the Fuel Injection Advancement.

After the engine lube oil temperature has risen, the control piston (**2**) will be moved by the thermostat (**1**). The shift will close the oil supply port (**4**) to the external oil line (**6**). The oil pressure in the hydraulic tapped system will drop. The oil will return via orifice (**3**) into oil circuit.

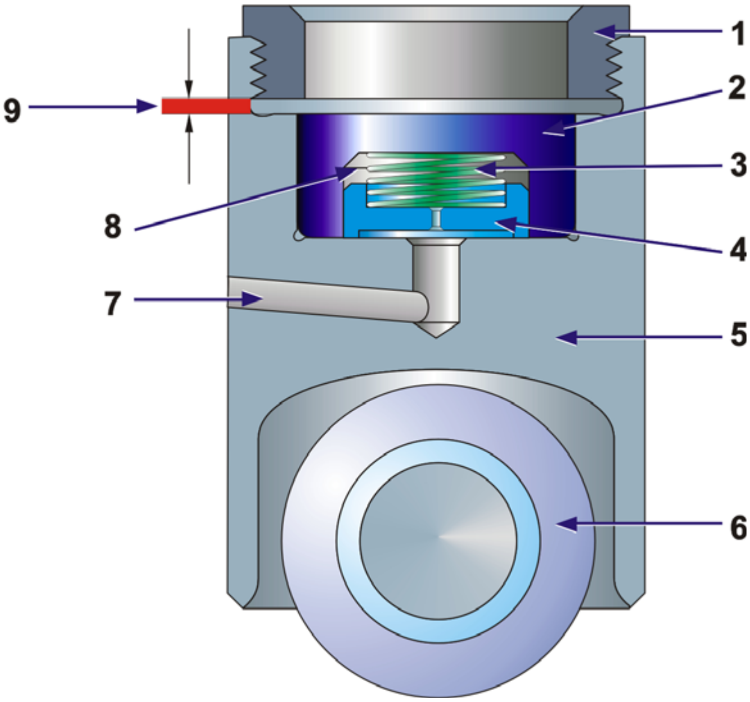


FUEL INJECTION PUMP ARRANGEMENT

DC11/05/05

1	FUEL INJECTION PUMP	5	OIL SUPPLY GALLERY
2	GASKET	6	HYDRAULIC PUMP TAPPET
3	FUEL CONTROL RACK	7	CAMSHAFT
4	PIN (METERING SLEEVE)		

Lube oil is supplied to piston arrangement in the hydraulic pump tappet (**6**), when the tappet is on the base circle of the camshaft (**7**).



HYDRAULIC ROLLER TAPPET (FUEL INJECTION PUMP)

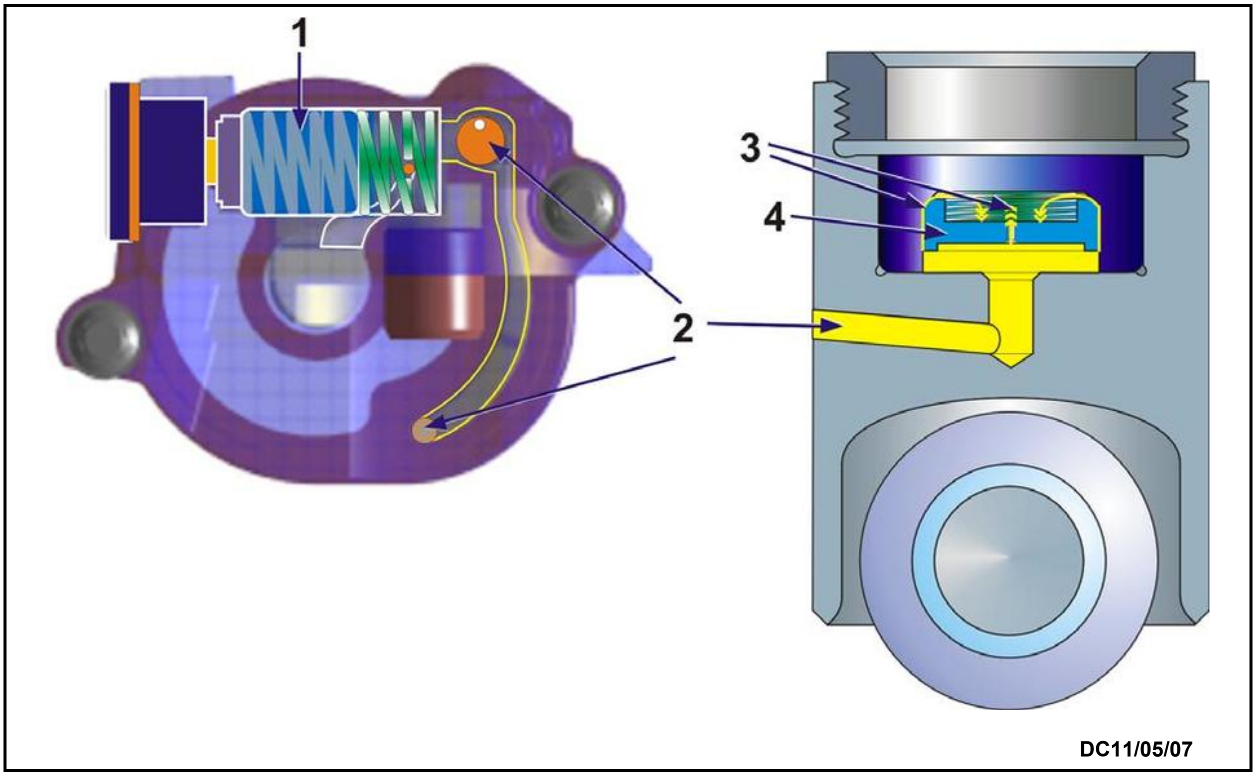
DC11/05/06

1	RETAINING NUT	6	ROLLER/SHAFT/BUSHING ASSEMBLY
2	WORKING PISTON	7	OIL SUPPLY GALLERY
3	SPRING	8	PRESSURE CHAMBER
4	SERVO PISTON	9	PISTON CLEARANCE
5	TAPPET BODY		

The cross section shows the various components in the ***Hydraulic Fuel Injection Pump Roller Tappet.***

The roller assembly (**6**) exists of a shaft, **sliding bushing** and roller.
The oil supply gallery (**7**) is exposed to the engine oil circuit when the roller tappet is on the base circle of the camshaft.
The piston clearance (**9)** allows the working piston to move 1 mm upwards in direction timing advance. The total travel of 1 mm is approximately 6° crank angle.

NOTE:
The working piston (**2**) in this graphic is in its base position located by the return spring force of the fuel injection pump.



HYDRAULIC ACTION 1

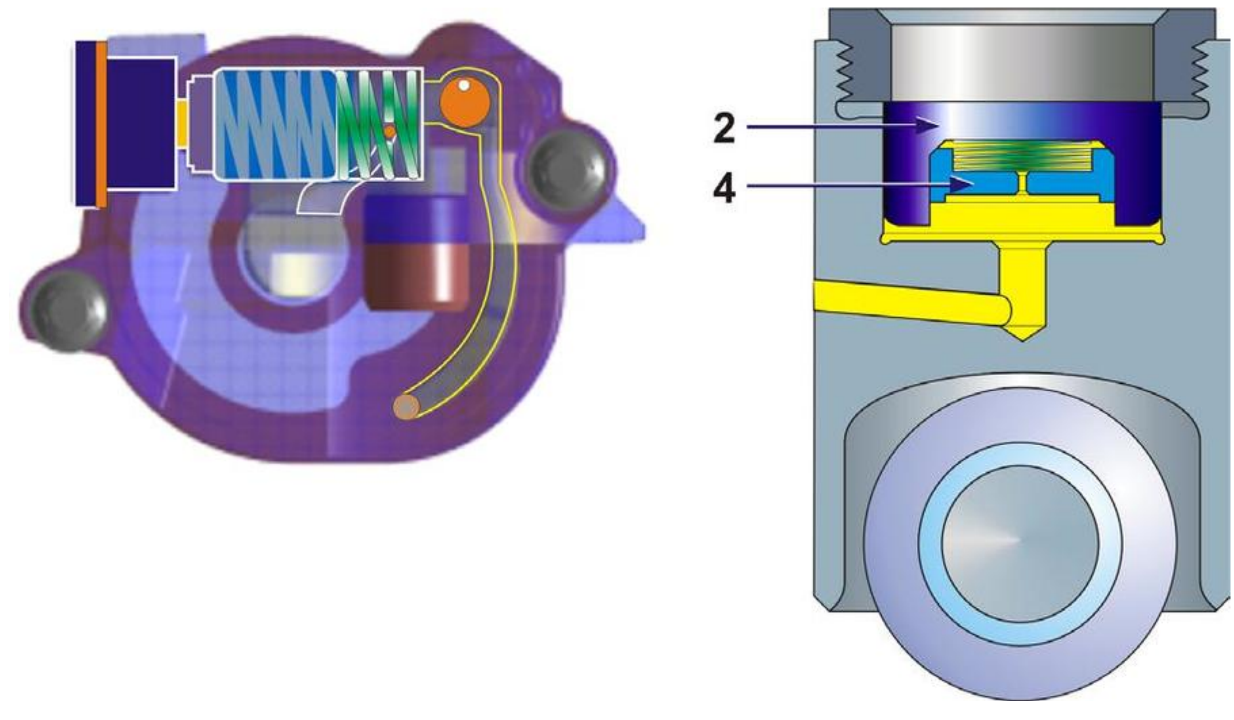
DC11/05/07

With the engine oil cold, the control piston (**1**) is in its rest position. The oil is being transferred through the oil supply line (**2**) to the roller tappet in the crankcase.

The servo piston (**4**) is lifted by the oil pressure against the working piston. The spring force is overcome by the increasing oil pressure.

At the same time, oil enters the chamber on top of the servo piston through the 0.2 mm orifice and the clearance (**3**) between servo piston and working piston. During this procedure no pressure equalization on top and below the servo piston is achieved yet.

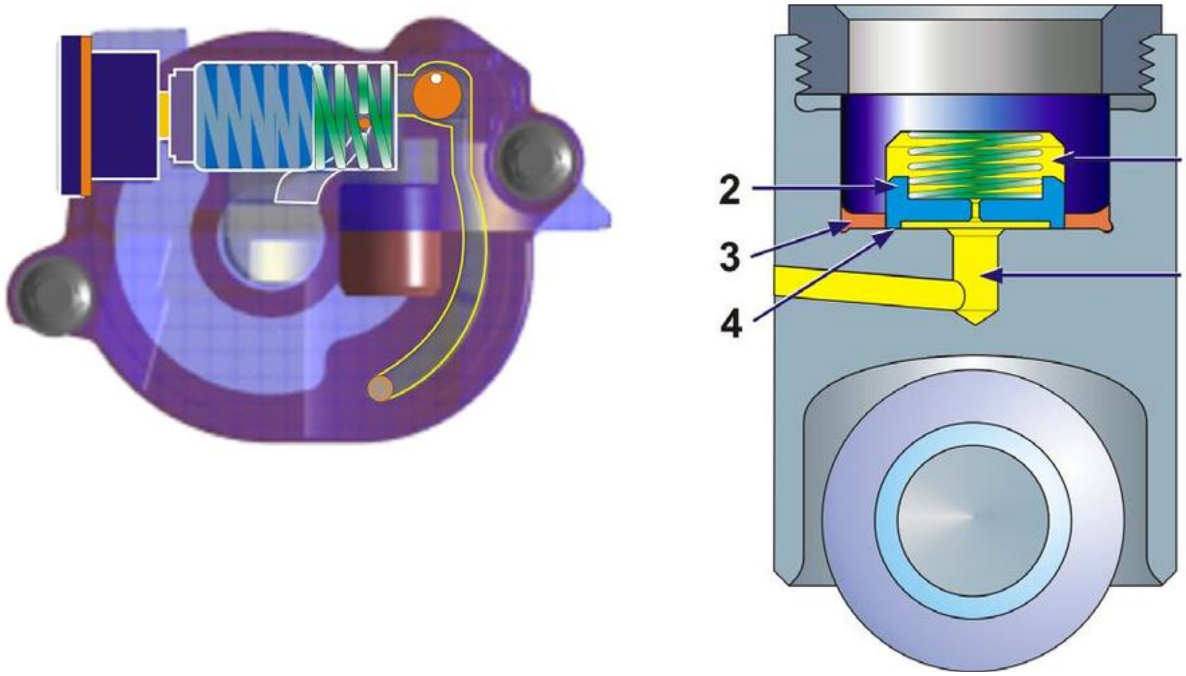
NOTE:
The working piston (**2**) in this graphic is in its base position located by the return spring force of the fuel injection pump.



HYDRAULIC ACTION 2

DC11/05/08

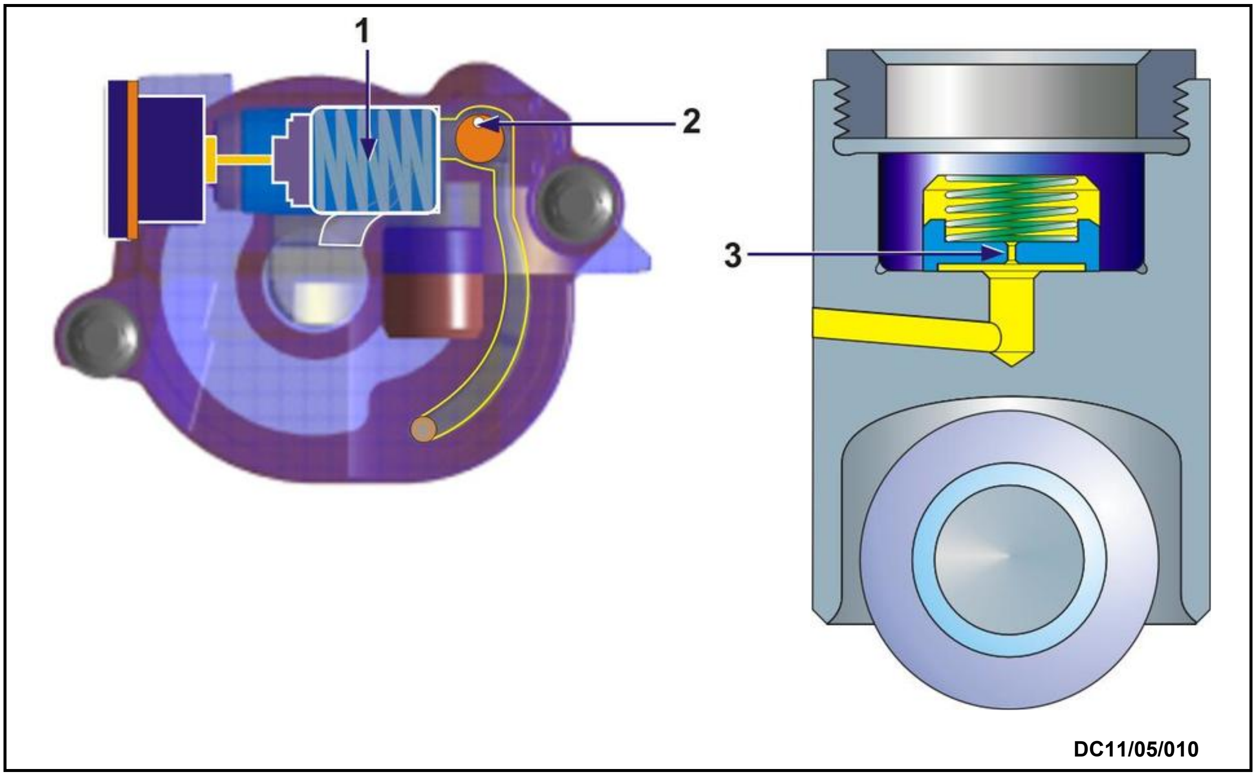
The servo piston (**4**) lifts the working piston (**5**) up against the retaining nut. The hydraulic force acting against the larger surface of the working piston achieves this movement.



HYDRAULIC ACTION 3

DC11/05/09

When the oil pressure (**1**) is equal above and below the servo piston (**2**), the spring force is grater and pushes the servo piston down. With this the oil flow is stopped against the working piston since the servo piston seals off (**4**) the oil supply. At the same time a high pressure chamber (**3**) has been created.



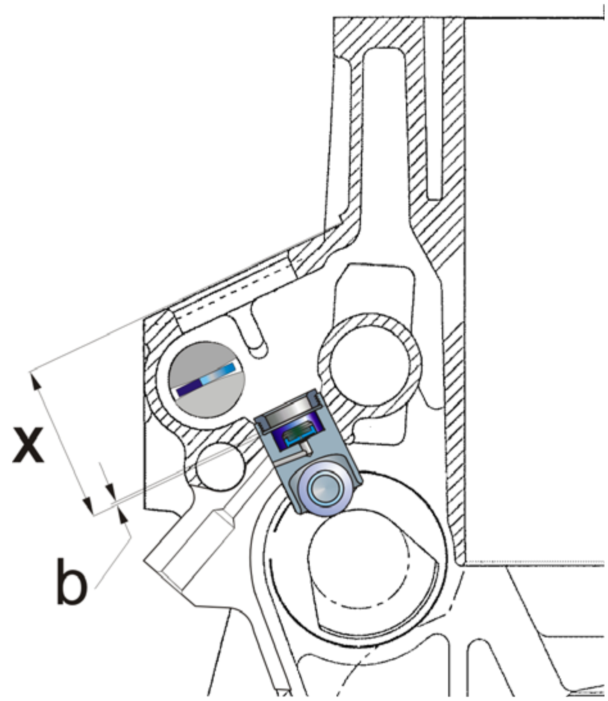
HYDRAULIC BASIC ACTION

DC11/05/010

At a lube oil temperature between 60° and 65° C the control piston (**1**) in the oil filter bracket will close the oil supply port and turns off the oil supply to the injection pump roller tappet. The oil pressure in the system will be reduced. The pressure reduction will be initiated by a 1 mm orifice (**2**) in the filter bracket gasket. The oil underneath the working piston will flow through the 0,2 mm passage (**3**) in the servo piston back into the crankcase. The working piston is pushed down into its base position by the return spring force of the fuel injection pump and the plunger in the fuel injection pump will return to its static port closure setting.

If the passage (**3**) in the servo piston is blocked, the advancement of the port closure will not be delayed. The return of the fuel injection pump plunger to the static timing will be delayed, since the oil will return only through the mechanical tolerances between servo and working piston.

In this situation it takes approximately 5 minutes for the advanced timing to return to static timing.



DC11/05/011

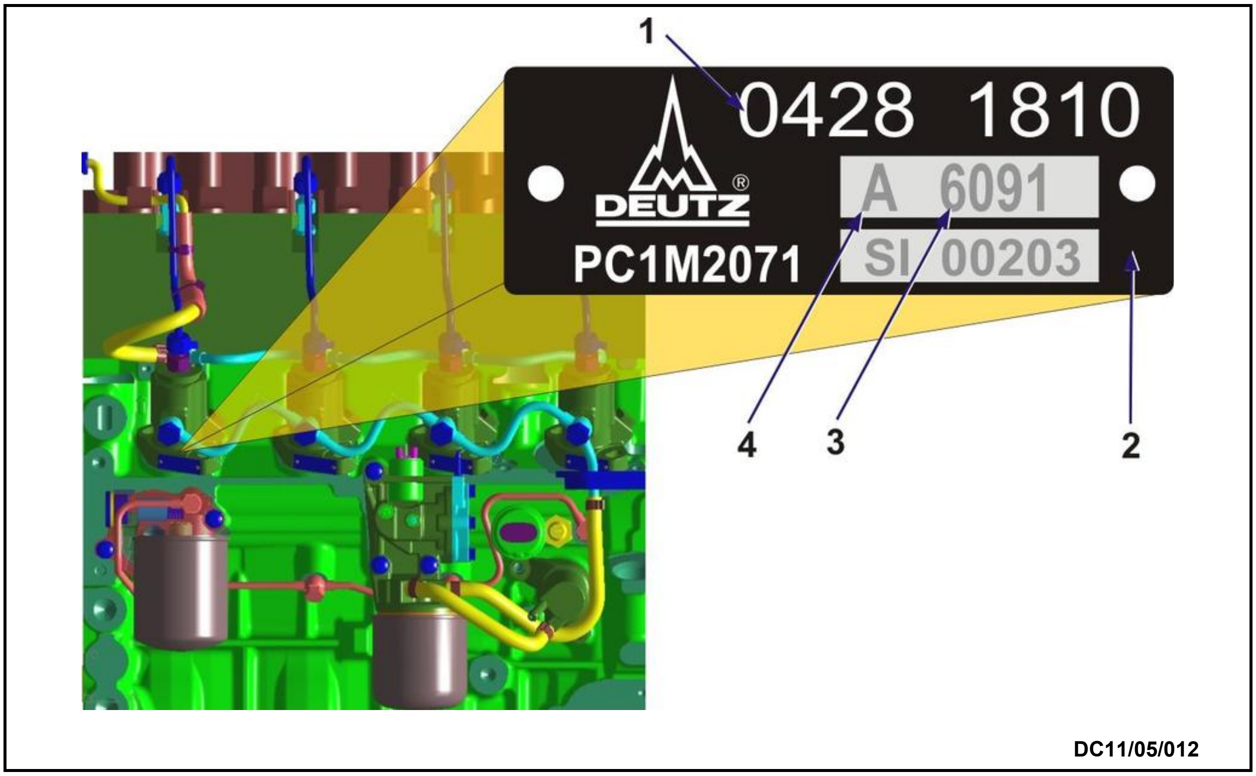
MEASURING INSTALLATION DEPTH

DC11/05/011

X = Installation depth with the roller tappet on the base circle of the camshaft.
B = Piston clearance between servo and working piston.

The following procedure applies for 2011 engines with Motorpal injection pumps

Turn camshaft in rotating direction until the base circle of the cam lobe is facing upwards. Insert roller tappets.
In this position the roller tapped is at BOTTOM DEAD CENTER.
Measure the depth from the crankcase sealing surface down to the contact surface of the working piston (without gasket). The working piston must be pushed down (**b**) in the pressure chamber as far as it will move.
Record measured dimension.



INJECTION PUMP NAME PLATE

DC11/05/012

1 Deutz part number for the Motorpal fuel injection pump.

2 The name plates are colored on the Motorpal fuel injection pumps.
Four different colors are being used to identify the usage in a specific engine.

BLACK	=	Naturally aspirated engines without white smoke kit.
GREEN	=	Turbo charged engines without white smoke kit.
RED	=	Naturally aspirated engines with white smoke kit
BLUE	=	Turbo charged engines without white smoke kit

3 This number on the name plate determines the dimension of the port closure of the fuel injection pump plunger after a specified pre-stroke. This number must be divided by 100 .

4 The Motorpal fuel injection pumps have four different calibration identification letters A; B; C; D. The calibration is the ***LOW IDLE*** injection rate calibration. An engine must be equipped with pumps with the same calibration letters.

Motorpal Fuel Injection Pump Identification

Engines with Hydraulic Fuel Injection Pump Tappets (White Smoke Kit)

Naturally aspirated engines

Fuel Injection Pump Type:	PC 1M 9F 2074
Pump Name Plate:	Blue
Pump Dimension:	52,2
Deutz Part Number:	0428 6448
Pre-Stroke:	5,0

Turbo charged engines

Fuel Injection Pump Type:	PC 1M 9F 2075
Pump Name Plate:	Red
Pump Dimension:	52,2
Deutz Part Number:	0428 6450
Pre-Stroke:	4,3

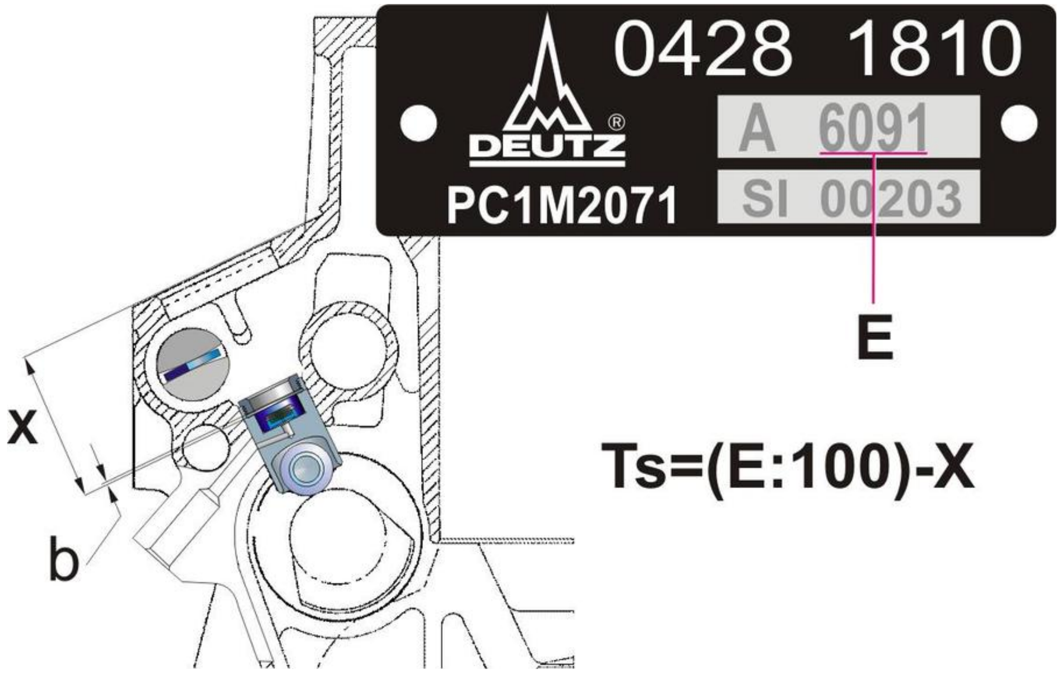
Engines with Solid Fuel Injection Pump Tappets (Without White Smoke Kit)

Naturally aspirated engines

Fuel Injection Pump Type:	PC 1M 9F 2071
Pump Name Plate:	Black
Pump Dimension:	60,9
Pump Dimension:	0428 1810
Pre-Stroke:	5,0

Turbo charged engines

Fuel Injection Pump Type:	PC 1M 9F 2073
Pump Name Plate:	Green
Pump Dimension:	60,9
Pump Dimension:	0428 1814
Pre-Stroke:	4,3



DC11/05/014

SHIM CALCULATION

DC11/05/014

Ts CALCULATED SHIM THICKNESS
X MEASURED INSTALLATION DEPTH
E PORT CLOSURE DIMENSION

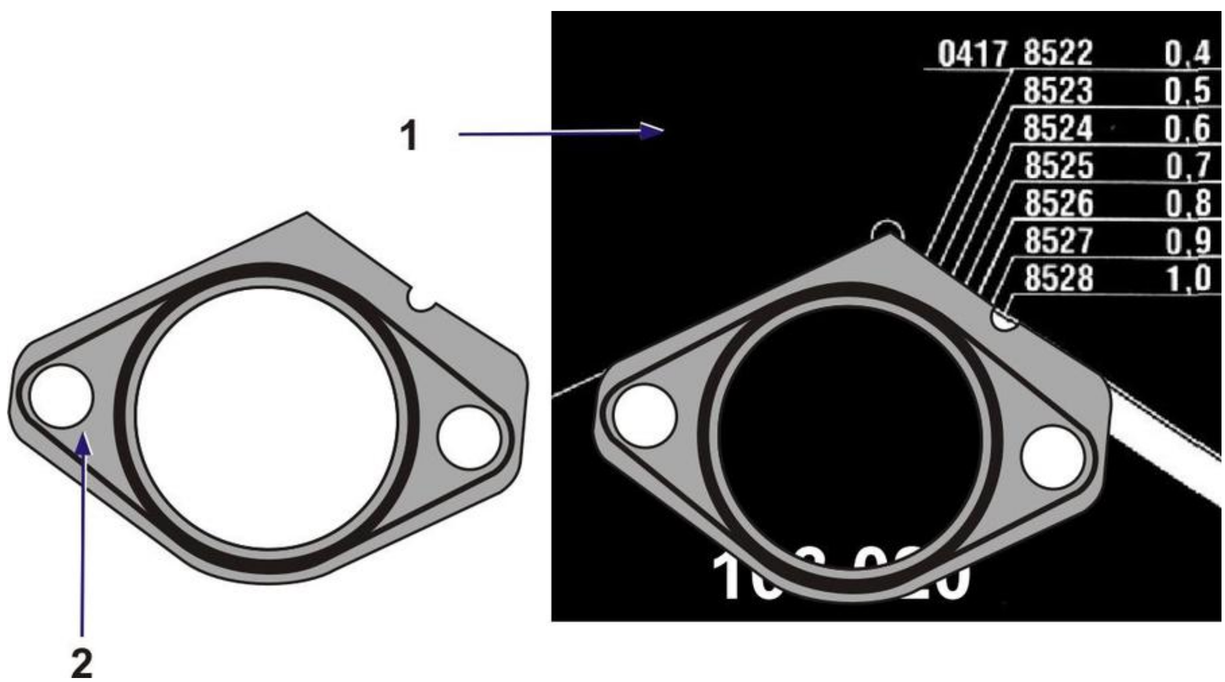
The shim thickness is calculated as follows:

Ts=(E:100)-X

E=6091:100
E=60,91

Ts=60,91-59,91

Ts=1,00 mm



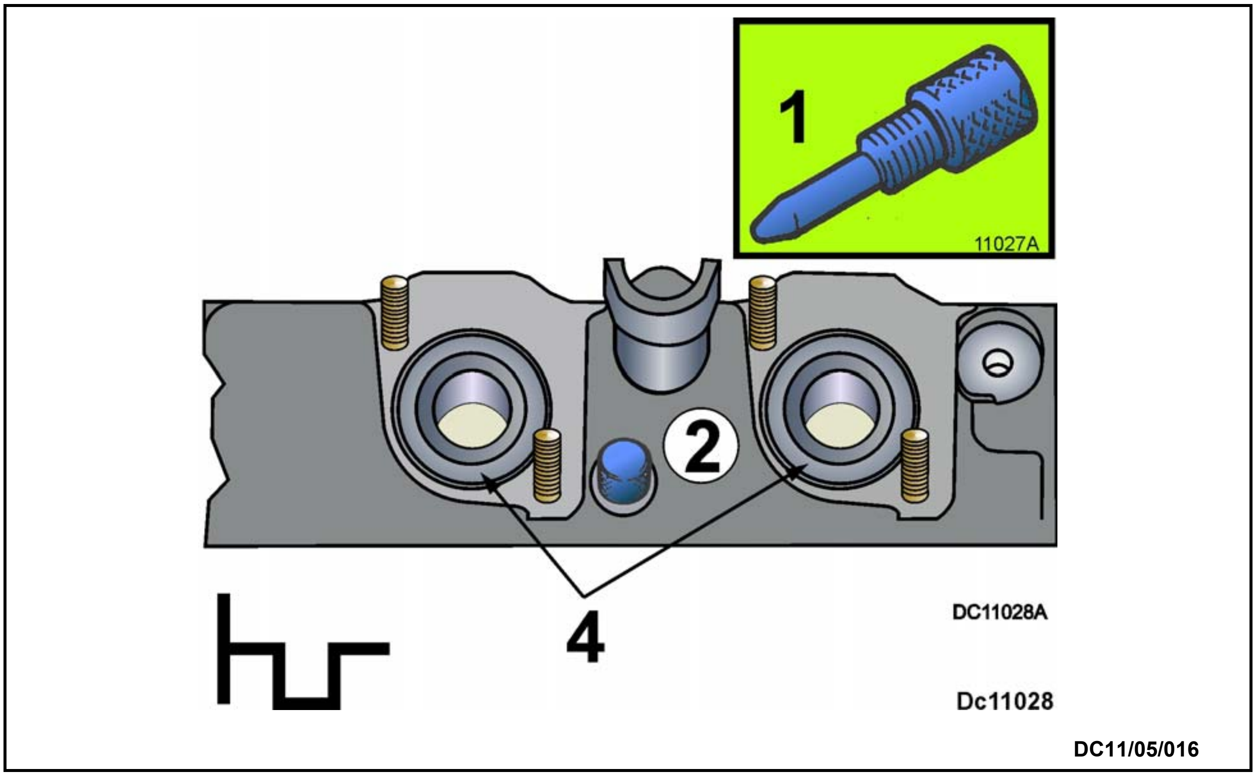
DC11/05/015

SHIM SELECTION

DC11/05/015

1 SPECIAL TOOL PART NUMBER O30 1257
2 SHIM

The calculated shim thickness establishes the exact closure of the fuel supply port in the plunger and barrel assembly, i.e. fuel injection begin.
Seven different shim sizes are available. The thickness of the shim is identified by notches in different locations on the shim. The shim is coated with a gasket material which seals the injection pump against the crankcase.
In the previous example, the shim as 1,00 mm thick.
Place the shim in the tem plate, the “half moon” cut out indicates the shim thickness.
The special tool indicates the part number for the shim.



FUEL RACK LOCKING

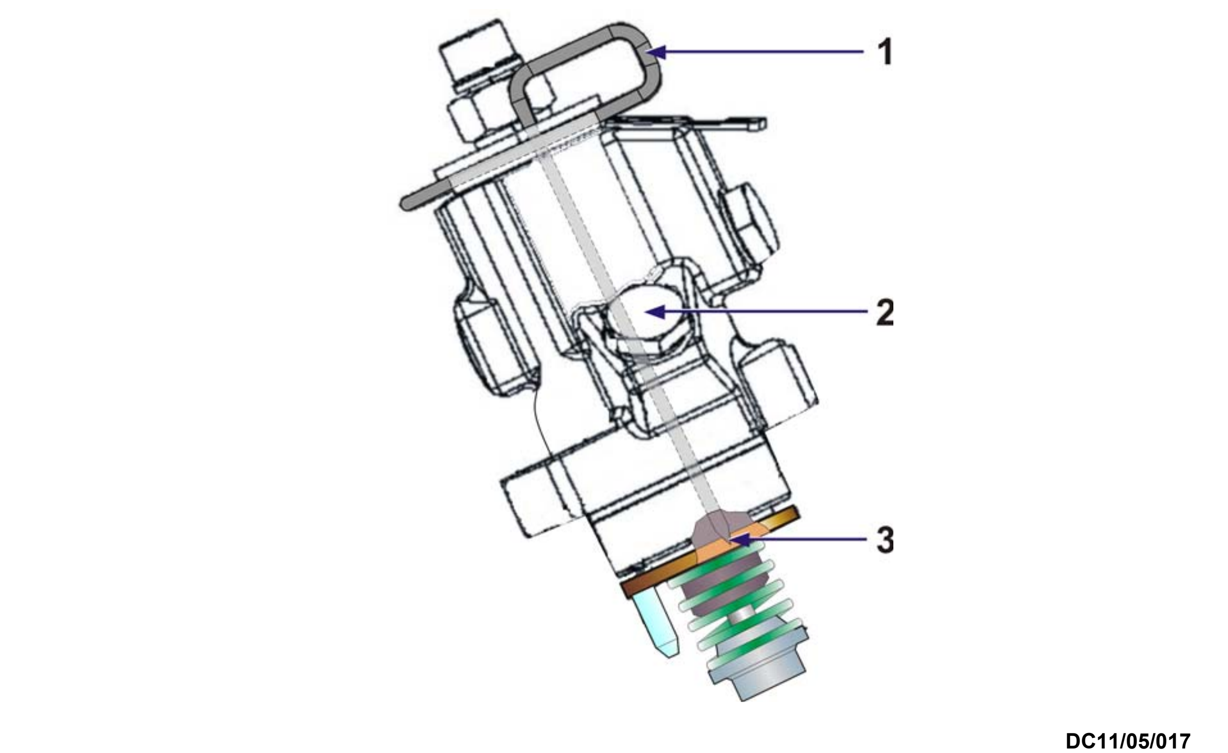
DC11/05/016

= SYMBOL FOR FLYWHEEL AND CRANKSHAFT

1 FUEL RACK LOCKING PIN

For easy and simplified installation of the single fuel injection pumps, remove screw plug that is installed in the crankcase (at location 2) just move the fuel control rack into a position where the locating hole in the rack and the hole in the crankcase align. Install fuel rack locking pin (**1**).

On the **B/F/L/M 2011** the location **2** is located between the last injection pump and the one before (**4**).

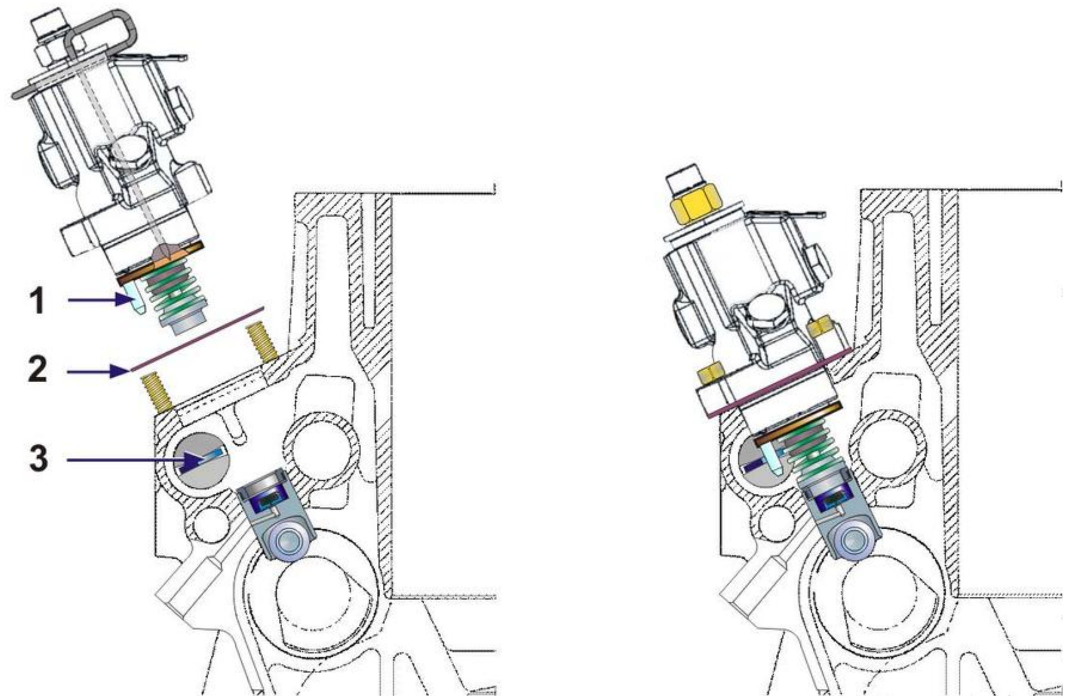


METERING SLEEVE LOCKING

DC11/05/017

1 LOCKING PIN DEUTZ PART NUMBER 030 0016
2 SCREW PLUG
3 DISK WITH LOCKING POSITION

Before installing the fuel injection pump, the gear segment must be locked down with a special tool (**1**). This aligns the pin of the gear segment with the corresponding slot in the fuel control rack.
Remove the screw plug (**2**) with its copper washer from the injection pump.
Insert locking pin (**1**) into the opening at the top of the pump. The pin and the disk of the gear segment are visible through the opening where the screw plug (**2**) was previously removed.
Rotate the disk until an indent becomes visible. Push the locking pin with its tapered tip into the tapered indent in the disk (**3**). The gear segment of the injection pump is locked in the installation position.
After pump installation, the locking pin must be removed and be replaced with a sealing pin.



DC11/05/018

FUEL INJECTION PUMP INSTALLATION.

DC11/05/018

With the control rack locked and the gear segment of the injection pump locked, the pin (**1**) on the gear segment will perfectly align with a slot in the control rack (**3**).

Slide the shim (**2**) over the mounting studs

Slip the fuel injection pump over the studs into its mounting hole and tighten to specification.

After all the pumps are installed, remove the fuel rack locking pin and make sure a sealing pin is installed.

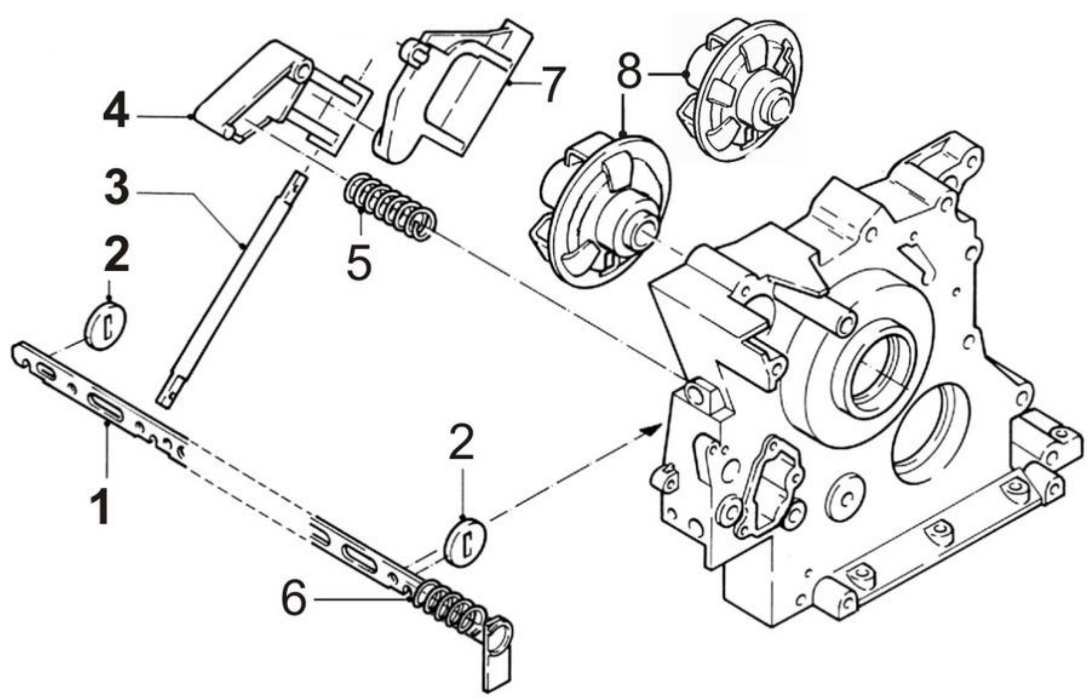
The fuel control rack must move freely after pump installation.

DC11/05/019

HYDRAULIC ACTION 1

DC11/05/019

MECHANICAL SPEED GOVERNOR
INDEX

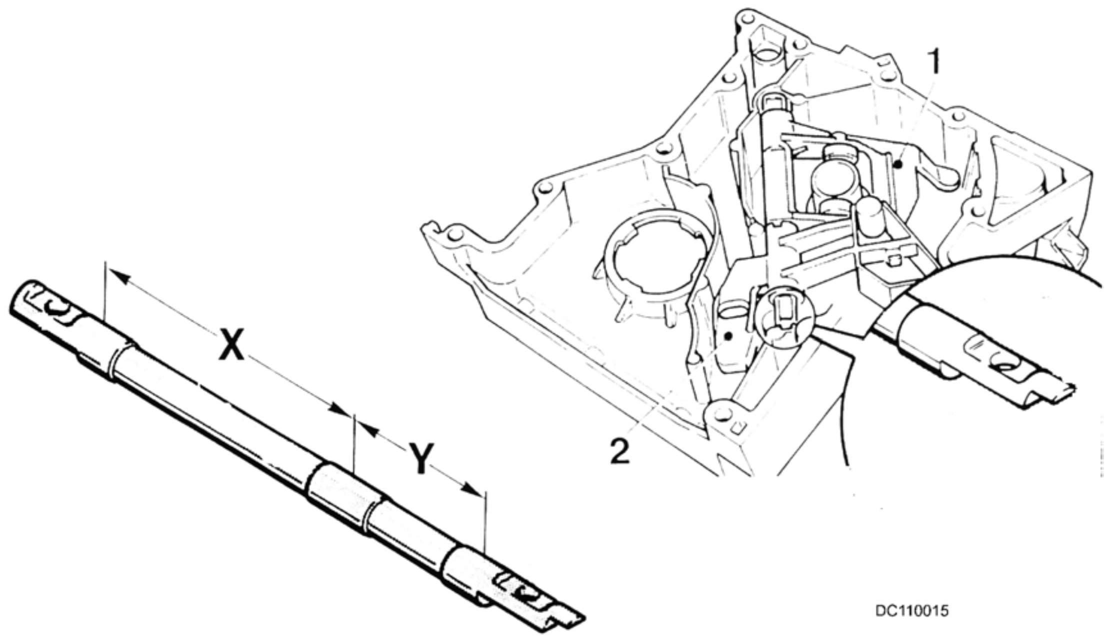


FL1011 Governor

DC11/06/02

1. FUEL CONTROL RACK
2. CONTROL RACK GUIDE
3. GOVERNOR SHAFT
4. TENSIONING LEVER
5. MAIN GOVERNOR SPRING
6. EXCESS FUEL SPRING
7. ROLLER LEVER
8. FLYWEIGHT ASSEMBLY

The flyweight assembly has changed from 6 (light) to 3 (heavy) flyweights on the FM and F engines.



DC11/06/03

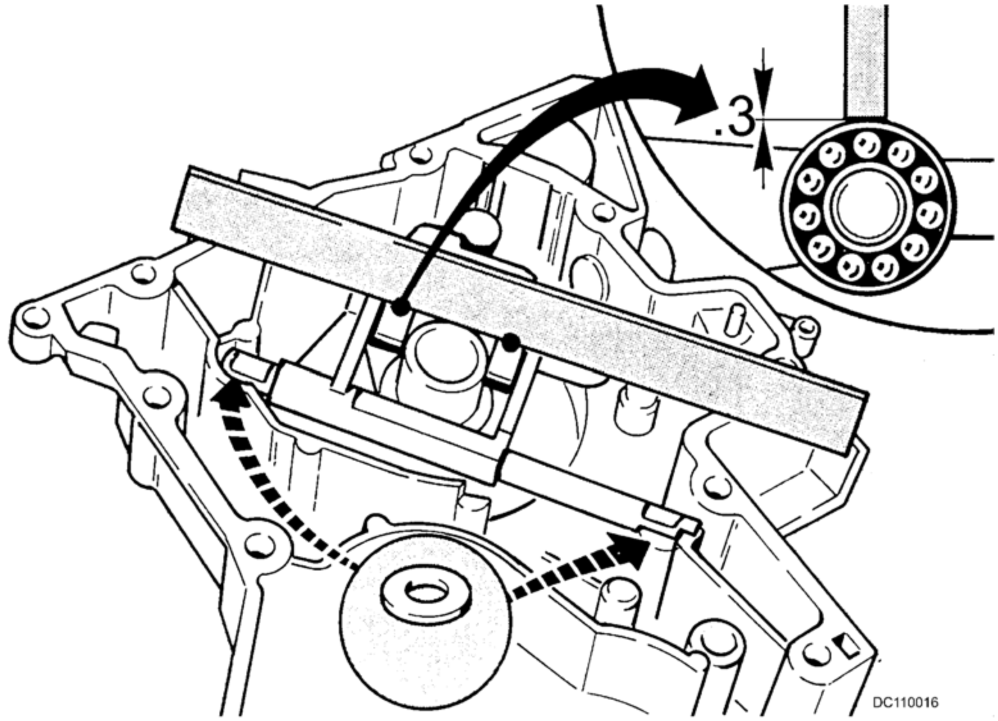
Governor Shaft installation

DC11/06/03

1. Shaft fits only one way

The tensioning lever and roller lever are mounted on the same shaft. Attention has to be paid to the correct location of the levers on the shaft.

Roller lever "1" must be installed on the shaft in location "X", the tensioning lever "2" next to it in location "Y". The governor subassembly must be installed in the front cover as highlighted. This is the ONLY way to install the governor shaft.

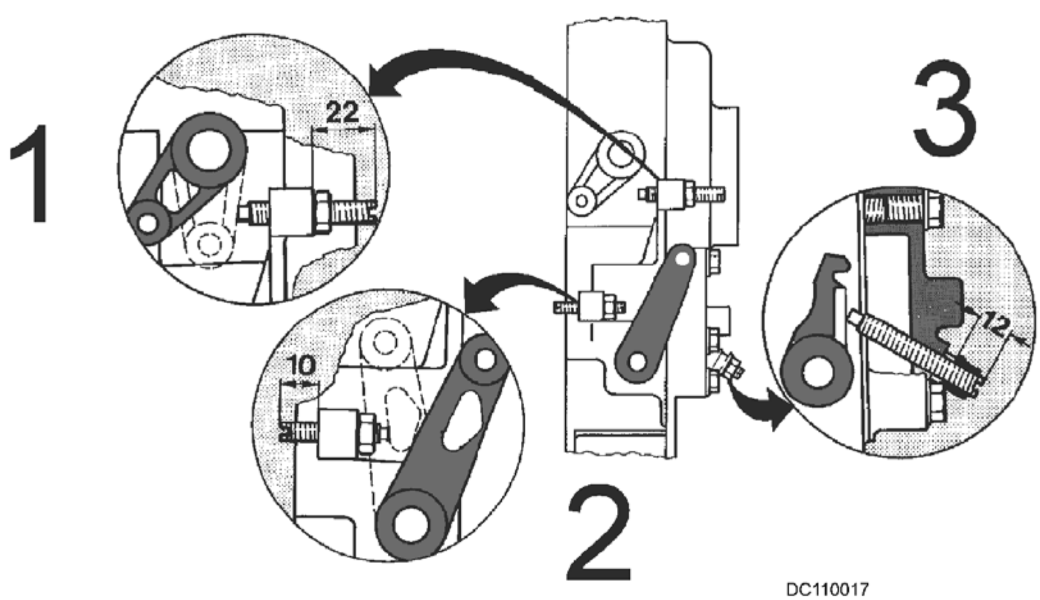


DC11/06/04

DC11/06/04

1. Important for trouble-free operation

To prevent governor hunting and uneven wear, the roller bearings have to be leveled and aligned with the front cover sealing surface. The bearings can be adjusted in height by adjusting the shaft ends using 0.5mm, max. 0.7mm adjusting shims. A maximum tolerance between roller bearing and straight edge of 0.3mm is permissible.



DC11/06/05

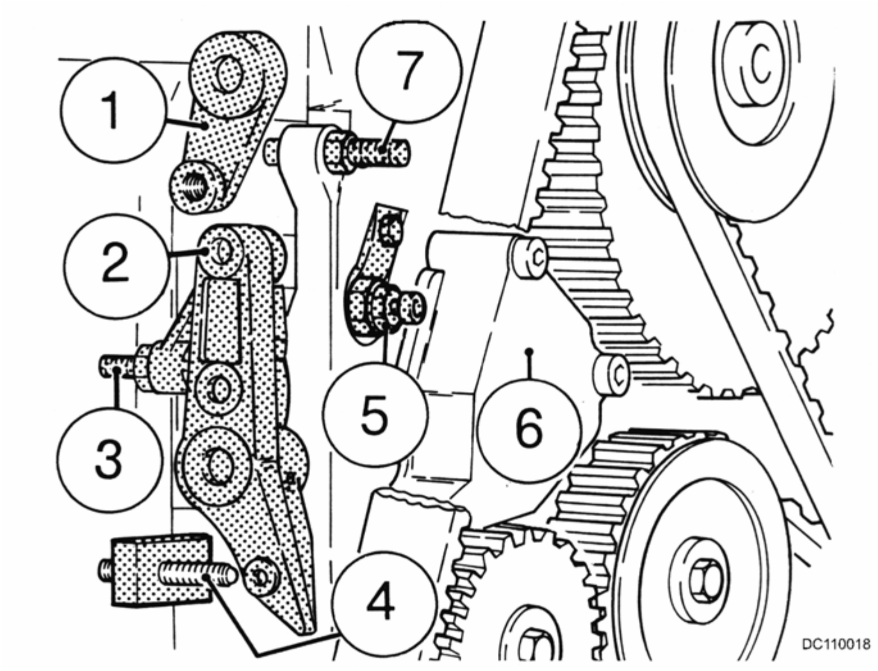
DC11/06/05

1. Shut-off stop adjustment
2. Low idle adjustment
3. High idle adjustment

All components stay in the cover when it is removed. All governor settings will remain intact when the cover is reinstalled. A quick run-down of the external levers and adjustment screws.

1 The shut-down lever and shut-down stop screw
2 The speed control lever with low idle speed adjustment screw "
3 The maximum speed adjustment screw:

The measurements shown are safety settings to prevent the engine from over speeding after mechanical work was performed at the governor.



DC11/06/06

DC11/06/06

A. Design change
B. High idle adjustment externally now

1. **Shut-off lever**
2. **Speed control lever**
3. **Low idle adjustment screw**
4. **High idle adjustment screw**
5. **Torque & full load control device**
6. **Cover**
7. **Stop set screw**

The governor speed control lever was changed so that both the high and low idle stop adjustment screws are easily accessible for easy adjustment.

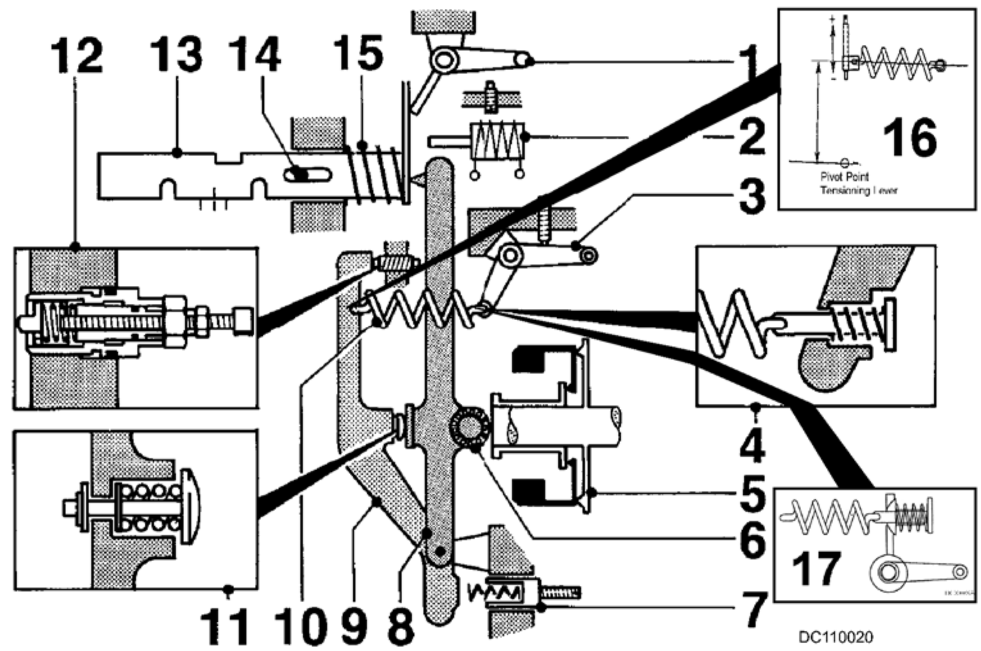
Please note that there are five different governor spring speed ranges on the FL1011. they are: up to 1500, 1501 - 1800, 1801 - 2500, 2501 - 300, and 3600 rpm gen set. These speed ranges are full load rated speeds. If the full load rated speed is moved outside the original speed range by the high idle adjustment, the governor spring must be changed to that of the new speed range. The governor spring "rated speed" is the highest full load speed that can be set with that spring, i.e. 1500, 1800, 2500, 3000, 3600rpm.
The stop lever now has an internal spring which holds the lever in the run position.

This eliminates the need to block the stop lever in the run position when engine shut-down is accomplished exclusively via the integral shut-down solenoid.

The new levers are now current production.

With the introduction of the external speed adjustment "high idle", the internal adjustment screw in the front cover will be eliminated.

Please note the low idle rpm tolerance downward must not exceed 750 rpm as the possibility exists that below that speed the governor spring may unhook itself.



DC11/06/08

. Shut-off lever
2. Shut-off solenoid
3. Speed control lever
4. Low idle spring
5. Flyweight assembly
6. Ball bearings
7. High idle spring
8. Roller lever
9. Tensioning lever
10. Main governor spring
11. Spring
12. Torque capsule, full load adjustment
13. Fuel control rack
14. Fuel rack locating pin
15. Excess fuel spring
16. Droop adjustment
17. 2 Frequency governor

The governor assembly has not changed. All options remain for the FM an F engine.
The mechanical governor assembly is built into the engine's front cover. With this diagram it can be seen that the centrifugal forces cause the flyweights attached to the front of the engine's camshaft to fly outward. This moves a governor guide sleeve toward your left in the diagram. Mainspring force opposes centrifugal force by transmitting the mainspring force through the tensioning lever and roller lever. The governor's guide sleeve is held in position to the right until centrifugal force exceeds mainspring force.
When centrifugal force is greater than mainspring force, the governor sleeve moves left pushing the top of the roller lever left. The control rack to a lower injection rate

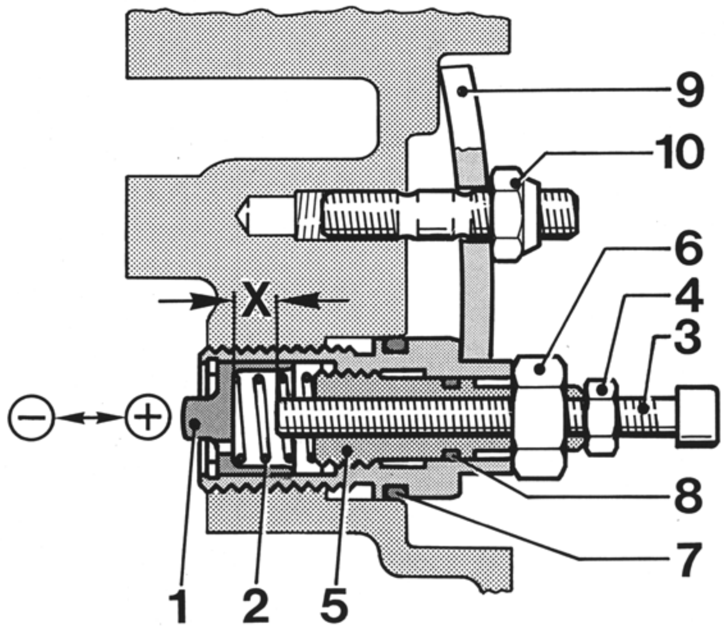
When centrifugal force is greater than mainspring force, the governor sleeve moves left pushing the top of the roller lever left. The control rack to a lower injection rate position, toward the left. When mainspring force is greater than centrifugal force, the control rack will move to a higher injection rate position, toward the right with a little help from the starting spring. The mainspring tension is adjusted by changing the position of the throttle lever. A shut-off lever is also provided. As it can be seen in the diagram, when it is pivoted down, the lever mechanically positions the control rack to the zero fuel delivery position.

But in most cases, a shut-down solenoid will be utilized to electrically shut down the engine.

When installing the shut-down solenoid, hold the shut-off lever in the shut-down position. After installation, electrically energize and de-energize the solenoid to make sure it functions properly and that the control rack is free to move.

Item 4; 7; 11; 12 are options that can be installed as required.
Item 16 is a production part and part of the tensioning lever. The mechanism cannot be adjusted from the outside of the engine.

Item 17 is a different governor assembly, and cannot be installed afterwards. The assembly is only available with the front cover.

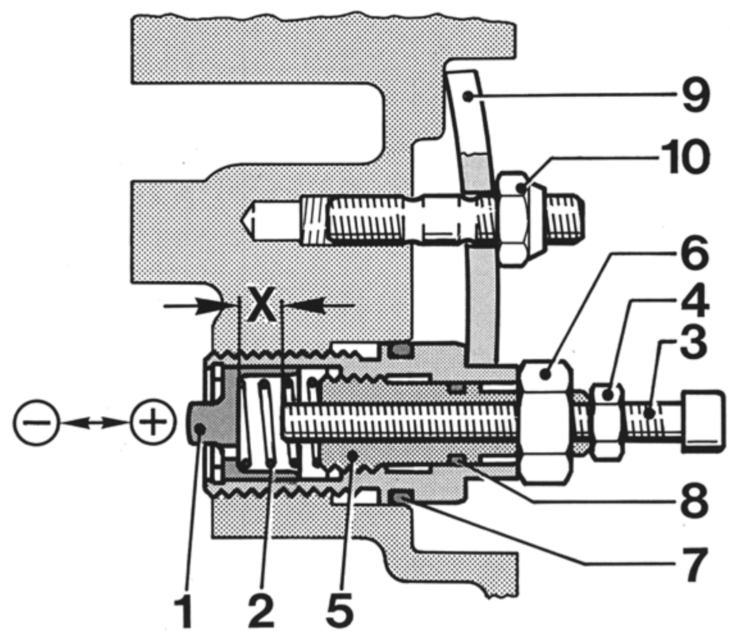


DC11/06/010

DC11/06/010

1. Pressure capsule
2 Torque spring
3 Torque set screw
4 Lock nut (for item 3)
5. Torque spring tensioner
6. Lock nut (for item 5)
7. O-ring
8. O-ring
9. Clamping plate
10. Self locking nut

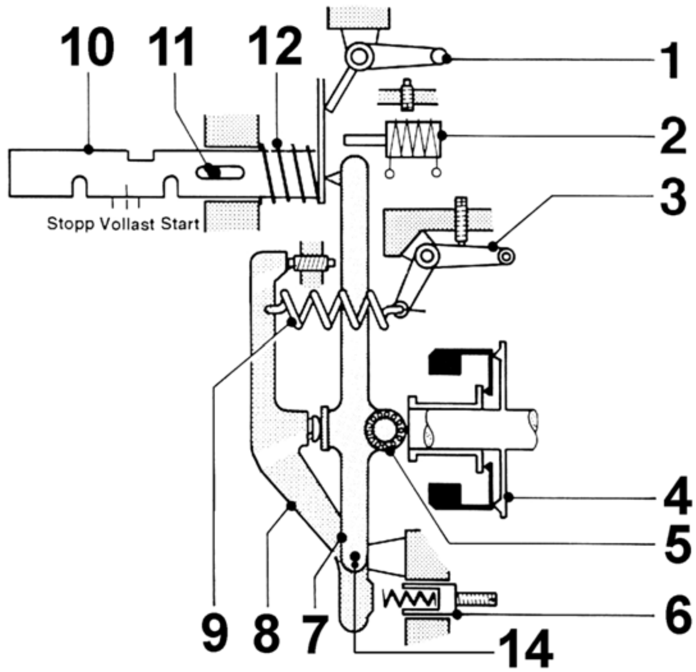
The tensioning lever works in conjunction with the torque capsule. By tensioning the main governor spring, the torque spring 2 will be compressed (loaded). This load has to be added to the governor forces. The additional load increases the total governor flyweight forces to move the fuel control rack into a lesser fuel injection rate position.
Remember: higher spring force: more fuel
higher flyweight force: less fuel
The maximum fuel setting can be changed by turning the complete capsule "in" or "out". Remove plastic seal, loosen locking nut 10 and remove clamping plate 9. To reduce the fuel injection rate (lowering power output), turn the capsule "in" (-) using lock nut 6. Using the same nut, turn the capsule "out" (+), the fuel injection rate will be increased (higher power output). Since the torque capsule does not come as an assembly, follow the assembly procedure, pre-setting and tightening specification in the workshop manual.



DC11/06/011

DC11/06/011

Changing maximum torque setting can be achieved by loosening lock nut 4 and adjusting torque set screw 3 in accordance with the application's power requirement. Set screw 3 controls the movement "X" of the pressure capsule 1. Setting the beginning of the torque rise, loosen the lock nut 6 and change the load of the torque spring 2 with the torque spring tensioner 5. The torque rise is influenced by the torque spring characteristic. For torque pre-setting and tightening specifications, check the workshop manual.



DC11/06/012

TORQUE CONTROL FUNCTION

DC11/06/012

1 SHUT DOWN LEVER
2 SHUT DOWN SOLENOID
3 SPEED CONTROL LEVER
4 FLY WEIGHT ASSEMBLY
5 ROLLER BEARING
6 HIGH IDLE BUFFER SPRING
7 ROLLER LEVER
8 TENSIONING LEVER
9 MAIN GOVERNOR SPRING
10 FUEL CONTROL RACK
11 FUEL RACK LOCATING PIN
12 START FUEL SPRING
13 STARING AID SPRING
14 GOVERNOR SHAFT

TORQUE CONTROL FUNCTION

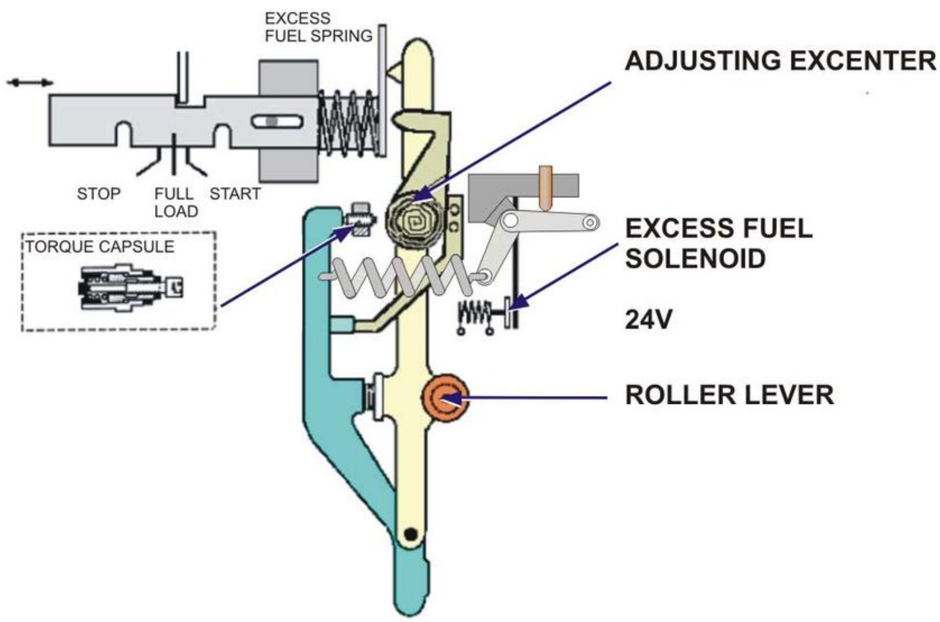
With decreasing engine speed the volumetric efficiency increases. Maintaining the same fuel injection rate, the engine has more oxygen than fuel for combustion available. With the function of a torque capsule the presents of the additional oxygen can be used to inject more diesel fuel into the combustion chamber.

This process is called **“Positive”** torque control.

POSITIVE TORQUE CONTROL FUNCTION.

When an additional load is applied to the engine, the engine speed will decrease. With this, the force of the flyweight assembly (**4**) against the roller lever (**7**) will reduce. The force of the main governor spring (**9**) increases against the torque capsule via the tensioning lever (**8**). The adjusted torque travel of the torque capsule can be used to its full advantage.

The force of the main governor spring (**9**) is able to move the roller lever (**7**) into a higher fuel injection rate with the force of tensioning lever (**8**).



TORQUE FUNCTION

DC11/06/013

Some fuel injection system work exactly the opposite way.
With decreasing engine speed, the fuel injection rate increases. More diesel fuel is being injected than oxygen is available in the combustion chamber.
The engine will smoke black.
In such cases the injected fuel amount has to be reduced.
To achieve this, the function of a **"Negative"** torque control is being used.

NEGATIVE TORQUE CONTROL FUNCTION.
In the governor housing is a shaft installed with eccentrically adjustment. The adjustment excenter is accessible from the out side of the housing. Internally of the housing, a bell crank is mounted to the shaft. The bell crank has no solid connection to the tensioning lever.
When the engine speed decreases, as explained in the example on the previous page, the governor acts against a positive torque control.
When an additional load is applied to the engine, the engine speed will decrease. With this, the force of the flyweight assembly against the roller lever will reduce. The force of the main governor spring increases against the torque capsule via the tensioning lever. The force of the main governor spring is able to move the roller lever into a higher fuel injection rate with the force of tensioning lever. The bell crank reverses the movement and pushes the fuel control rack into a lesser fuel injection rate.

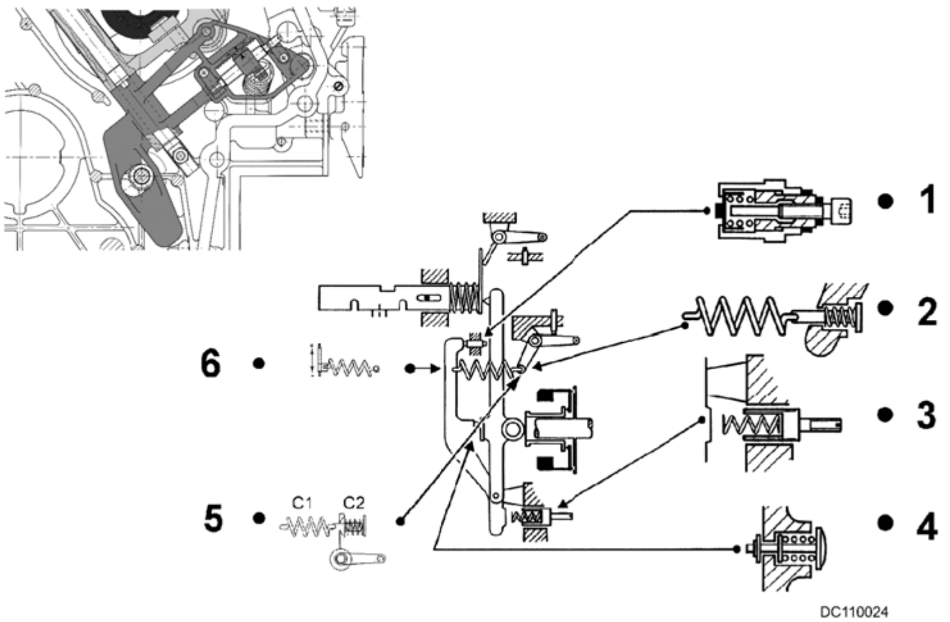
TORQUE FUNCTION continued

De-activating bell crank (negative torque control)

During the starting process, the fuel control rack is moved into excess fuel or start position with the aid of the excess fuel spring.

To prevent the bell crank acting against the fuel rack movement, the bell crank is physically moved out of function.

This is achieved with an electric solenoid which is energized via terminal 50 (or starting terminal) on the starter switch . The electric solenoid pushes the bell crank away from the tensioning lever.



DC11/06/015

DC11/06/015

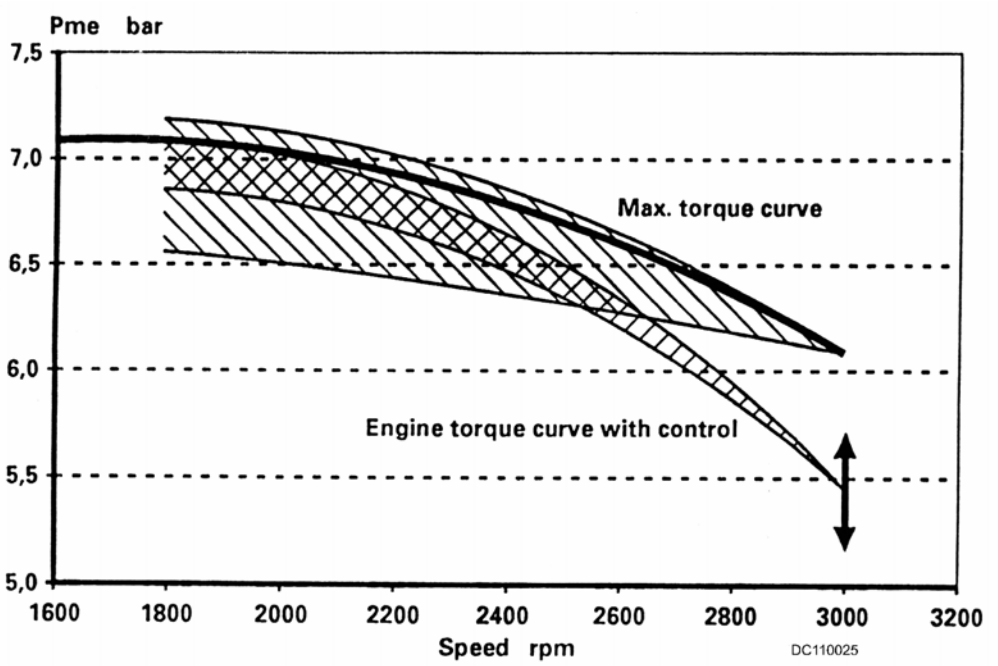
1. TORQUE CAPSULE
2. LOW IDLE BUFFER SPRING
3. HIGH IDLE BUFFER SPRING
4. EXCESS FUEL SPRING (COMPRESSOR APL.)
5. 2 FREQUENCY SPRING ASSEMBLY
6. DROOP ADJUSTMENT

(subjects 1-4 are explained on the following pages)

The 2 Frequency governor is only available mounted in its front cover, and can be ordered only as a complete sub-assembly.
With the secondary spring C2, at a operating speed of 1500 1/min, the main governor spring C1 reacts so slow (stiff) that it could be considered as a “solid” rod. The spring C2 acts as the governor spring.

At 1800 1/min the spring C2 is completely compressed and the main spring C1 will govern the engine.

For this application only one spring (yellow-white) is required, and the speed droop runs between 4-5%.
The droop adjustment screw is specified for the 2 frequency governor only. Its function is to make necessary droop corrections for 1500 or 1800 1 /min only. The set screw is accessible through the filler neck.

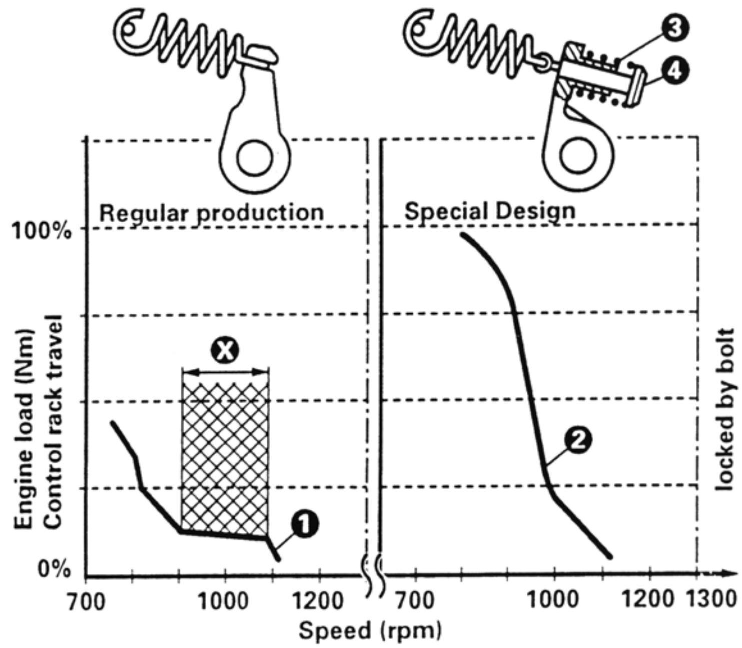


DC11/06/016

DC11/06/016

Torque curve

1. Torque setting, using a torque capsule
2. Individual torque curve adjustments for specific application characteristics is already done during engine acceptance test

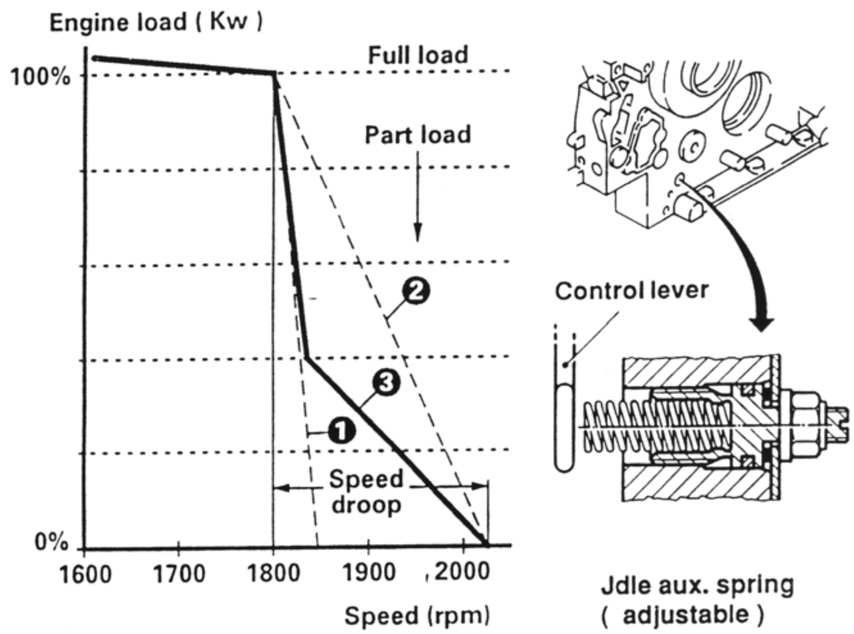


DC11/06/017

DC11/06/017

Low idle buffer spring

1. If little or no speed instability is acceptable at low idle, break-away curve (1) with possible instability range (x)
2. With additional buffer spring (3)
   - more acting spring coils
   - smoother spring characteristics stable break-away curve (2)
3. Above 1300 rpm buffer spring inoperative

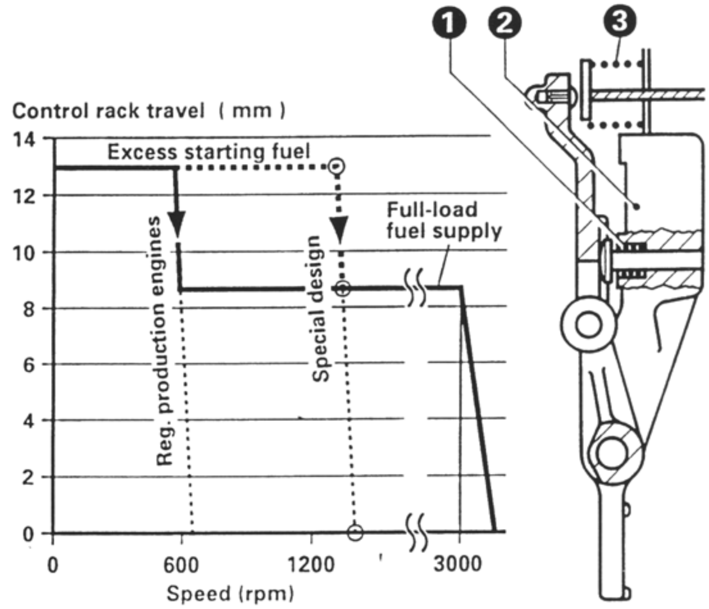


DC11/06/018

DC11/06/018

High idle buffer spring

1. On engines with low speed droop (difference between rated speed and high idle no load speed) as per break-away curve (1), the governor tends to hunt due to load changes (load - no load)
2. Break-away curve (2) with higher speed droop, stable governing characteristics - not suitable, however, for all applications (e.g. generator sets)
3. Break-away curve (3) - low speed droop in main operating range, stabilization due to high idle buffer spring at load changes



DC11/06/019

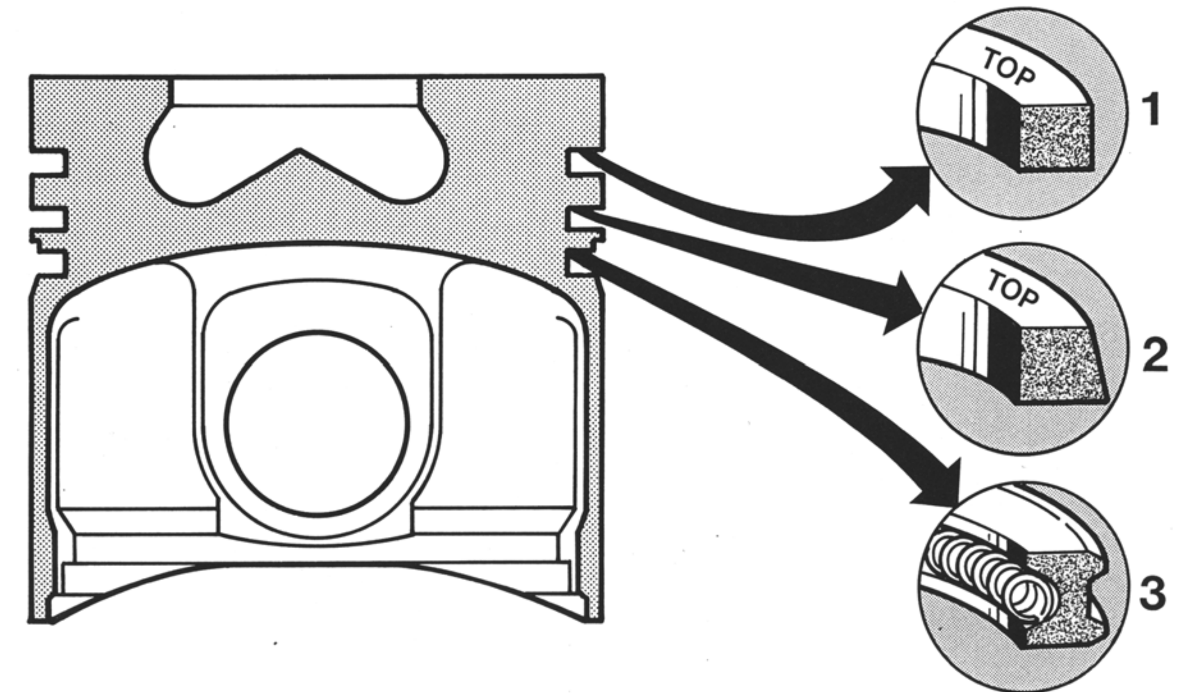
DC11/06/019

Excess starting fuel

1. Screw type compressors apply a specific parasitic load to the engine after start up until the engine reaches maximum rated speed
2. With this additional load, only with excess fuel is it possible for the engine to run up to rated speed
3. With an excess fuel spring (1) installed in governor lever (2), the fuel control rack is held in excess fuel up to 1400rpm
4. On regular production engines, excess fuel is cut off with start spring (3) at 600rpm

DC11/06/020

DC11/06/020



Piston (Naturally Aspirated)

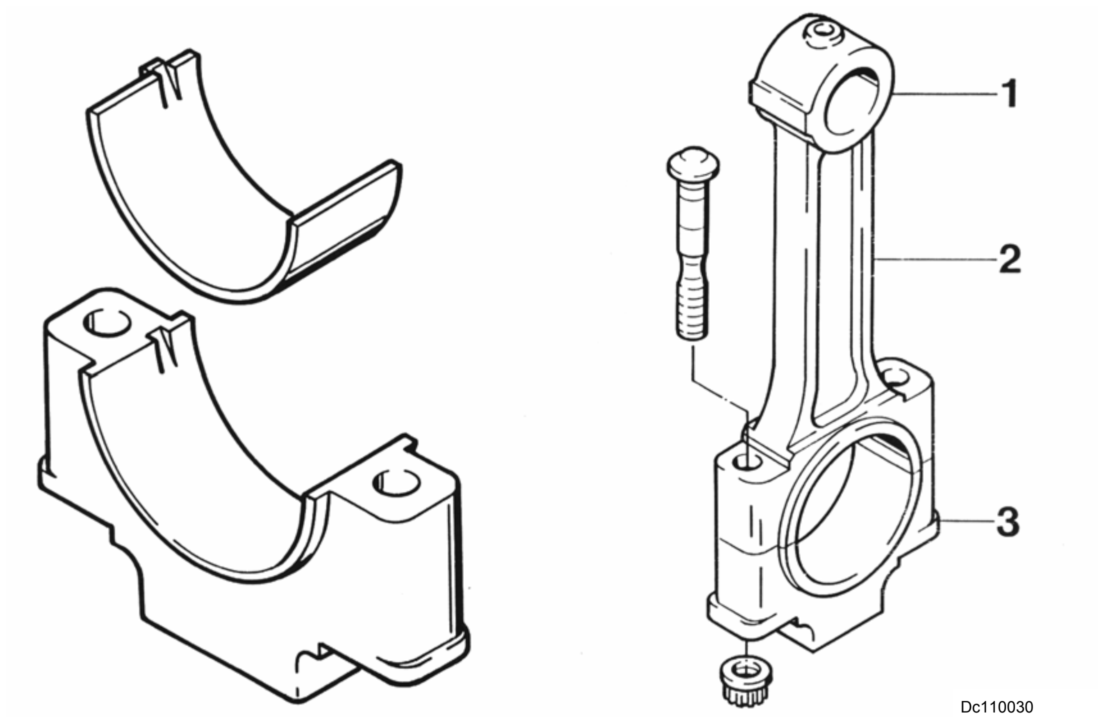
DC110029

1. Rectangular chrome ring
2. Compression ring (marked "top", towards combustion chamber)
3. Oil control ring

The piston is an aluminum casting. Since the combustion system is a direct injection system, the combustion bowl is cast into the piston. The entrance diameter of the combustion bowl was reduced compared to the bottom of the bowl. The design is for naturally aspirated engines only. The bowl is off-center in relation to the crankshaft center line. The piston is equipped with three piston rings.

1. rectangular chrome ring
2. compression ring (marked "top" towards combustion chamber)
3. oil control ring

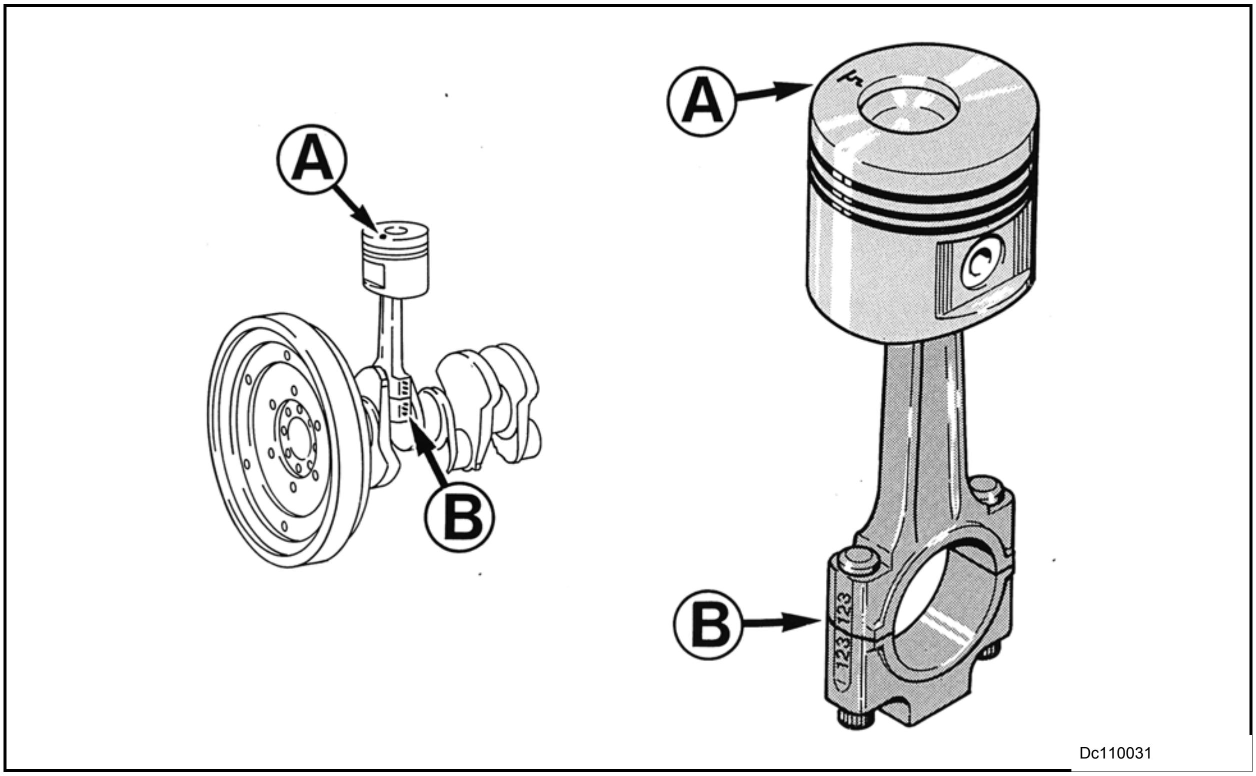
The rings are installed into the ring grooves machined into the aluminum casting, there is no steel ring land cast into the piston. The rings are not interchangeable with turbo-charged piston rings.



Connecting Rod Assembly

DC110030

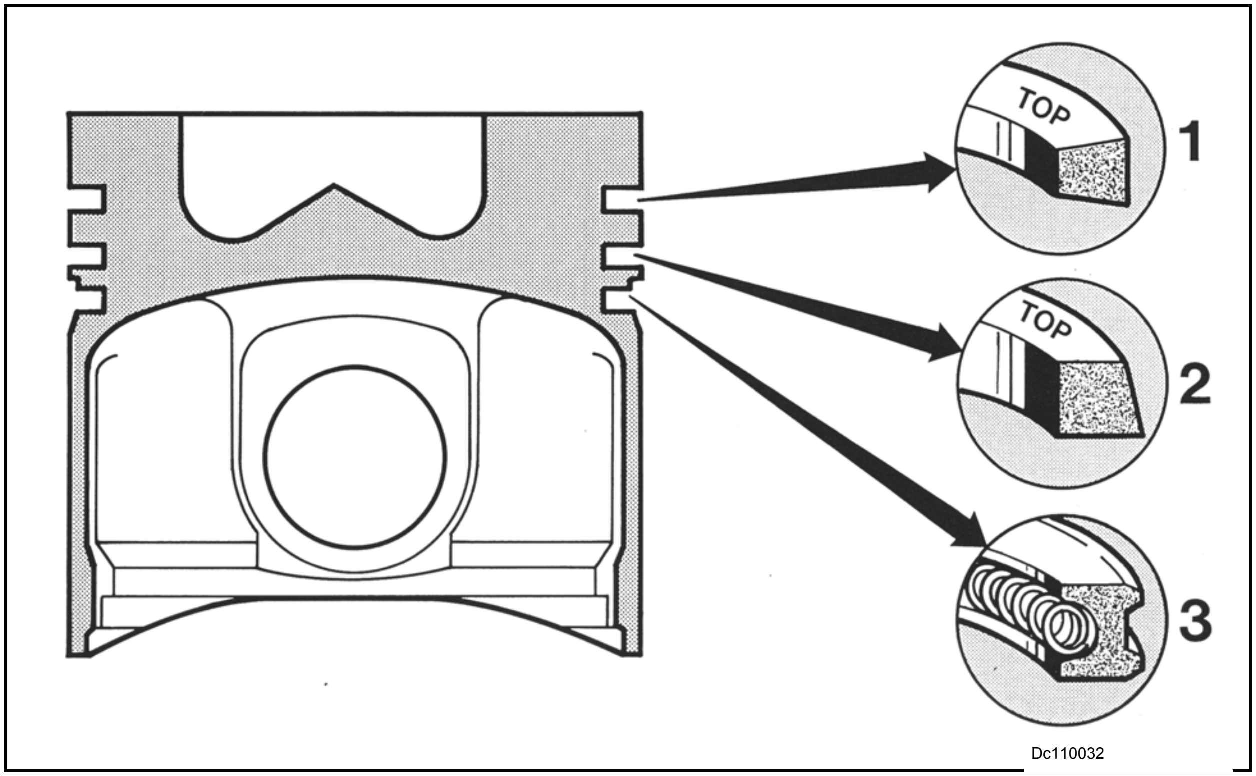
The connecting rod is a forged part. It has at its piston pin bore hole an excess metal portion. This portion can be machined to be within weight and balancing tolerances of the connecting rod. The connecting rod cap is split in a 90° angle from the rod. The connecting rod cap is notched to locate the crank journal bearings. The assembly is held together with a con rod bolt and nut. The nut can only be tightened with a 12 point drive socket.



Connecting Rod/Piston Installation

DC110031

The connecting rod and cap have an identification number "B" which is identical on both parts. When installed on the crank journal, the numbers must be towards the fuel injection pump side. The installation direction of the piston is symbolized with a flywheel and crankshaft. See "A", the piston should be installed so the flywheel symbol on the piston crown is facing direction flywheel. At the same time,the smaller portion of the piston crown, off set piston bowl, must be towards the fuel injection pump side.



Piston (Turbo-charged)

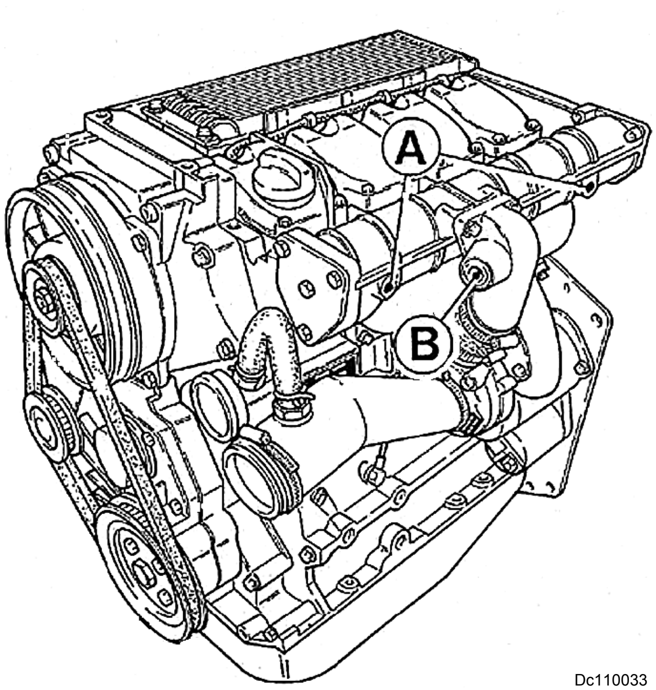
DC110032

1. Trapezoidal chrome ring
2. Compression ring (marked "TOP" towards combustion chamber)
3. Oil control ring, chromed

The piston is an aluminum casting. The entrance diameter of the combustion bowl is as wide as the bottom of the bowl, compared to the naturally aspirated piston. The piston is equipped with three piston rings.

The rings are installed into machined ring grooves. No steel ring land is cast into the piston. The piston rings are not interchangeable with naturally aspirated piston rings. Check engine specification for dimensional differences.

i.e.	TB rings	NA rings
1.	3mm height	2mm height
2.	2.5mm	2mm
3.	3.5mm	3mm

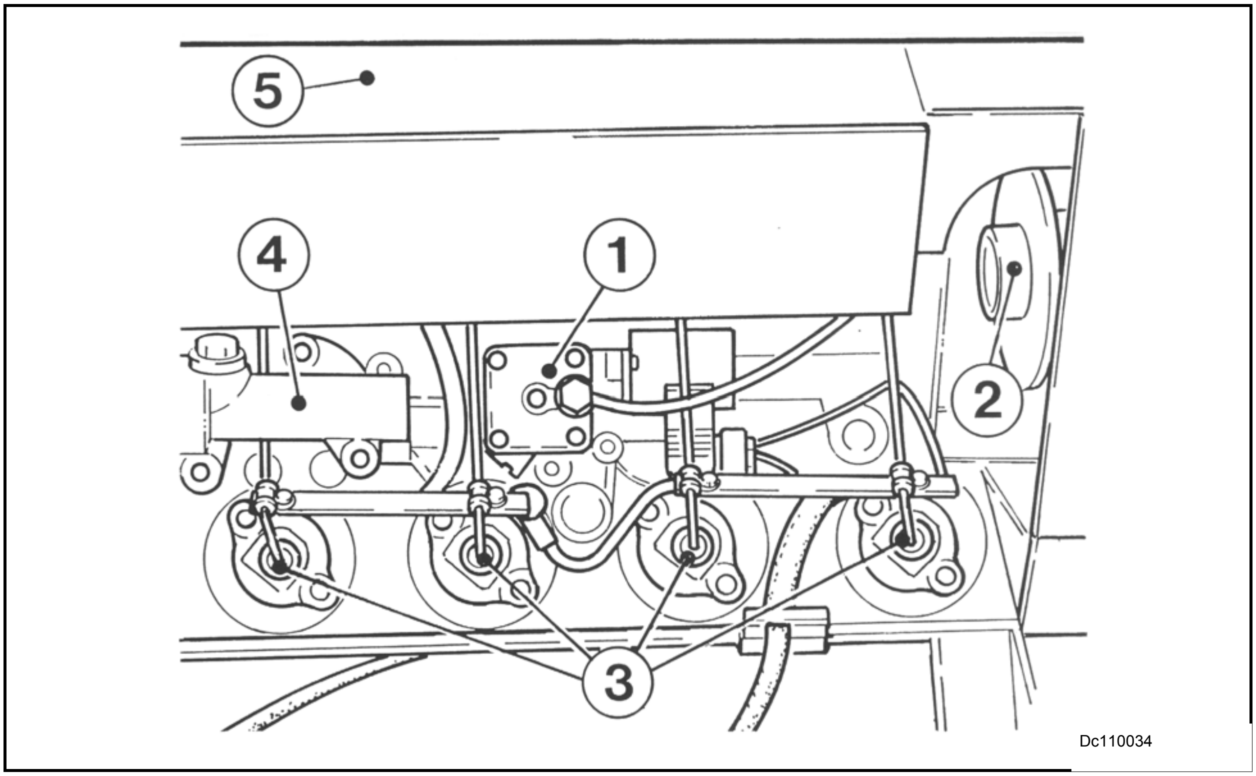


BF4L1011

DC110033

1.Charge air manifold	4. Compressor
2.Exhaust manifold	5. Crankcase breather
3.Exhaust gas turbine	6. Lube oil supply

The turbo-charged engine power output is limited at 53kW. The rated speed range is from 1500-2800rpm. Generator sets run up to 3000rpm. The compression ratio is established at 17 : 1.



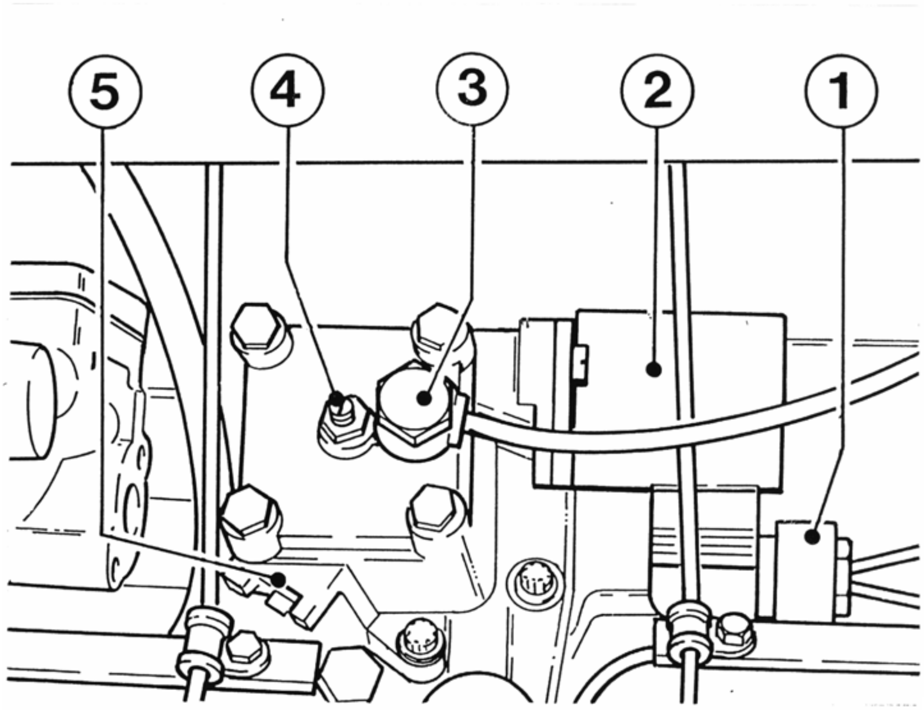
Aneroid

DC110034

1. Aneroid
2. Alternator
3. Fuel injection pumps
4. Thermostat housing
5. Oil cooler

To prevent black smoke emission during acceleration of the engine.

An aneroid can be installed as an option.

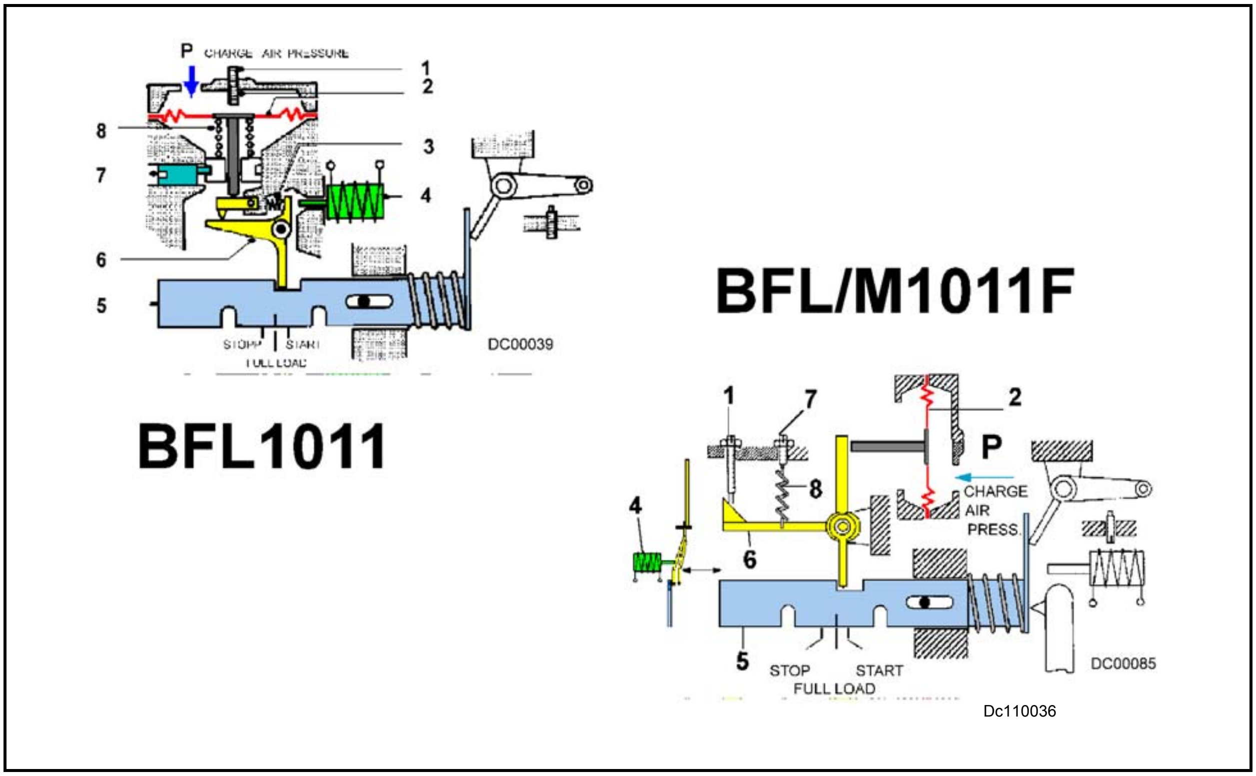


ANEROID FUNCTION

DC110035

1 .Excess fuel solenoid plug
2. Excess fuel solenoid
3. Charge air supply
4. Fuel limiting screw
5. Spring tension screw

To prevent black exhaust emission during sudden load changes, from low load to fuel load, the governor of the engine is equipped with a charge air operated full load stop. The aneroid is mounted to the crankcase and is engaged into the fuel control rack.



Aneroid Function

DC110036

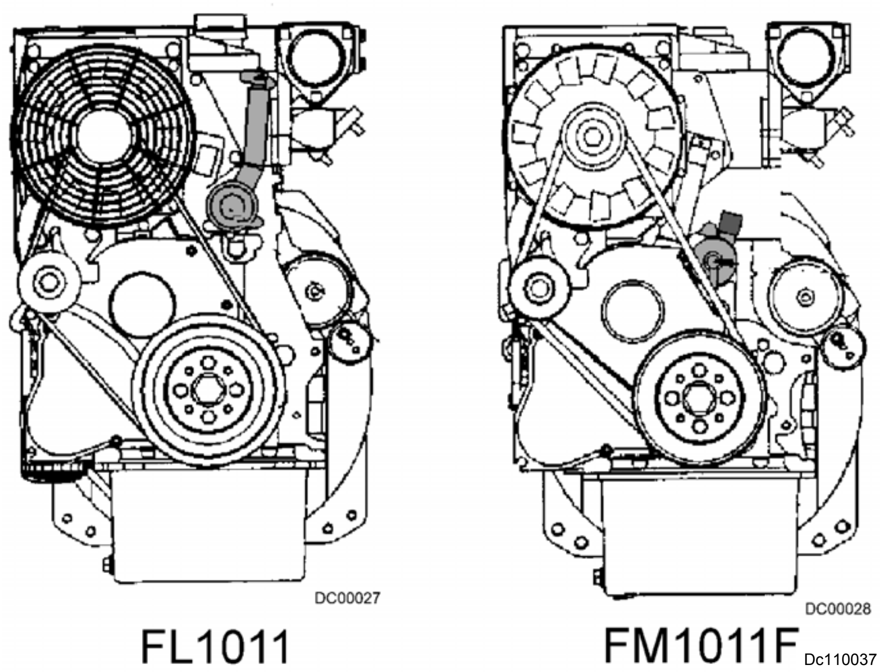
1.	Fuel limiting screw	6.	Bell crank
2.	Diaphragm	7.	Spring tension screw
3.	Return spring	8.	Spring
4.	Excess fuel solenoid	P	Charge air pressure
5.	Fuel control rack		

Charge air manifold pressure "P" is applied to the diaphragm 2. At that moment the spring 8 is compressed according to the pressure applied. With this, the bell crank 6 allows the fuel control rack to move in direction excess fuel. The amount of movement is controlled by the boost pressure applied to the diaphragm 2.

To inject excess fuel during engine start-up, the aneroid is bypassed by energizing the excess fuel solenoid. The plunger of the solenoid 4 pushes against the bell crank 6 and the fuel control rack moves into start position.

With the spring tensioning screw 7 the aneroid can be adjusted to determine at which boost pressure the bell crank is activated to release the fuel rack in direction excess fuel. This set screw is not sealed. Set screw 1 controls some of the fuel setting, therefore the setting can only be done on a dynamometer. The set screw is sealed and must not be altered by unauthorized personnel

NOTE: The FM1011F engines excess fuel solenoid is not connected to a timer anymore. By the end of the starting process, the solenoid is de energized and the spring blade bell crank is sliding on the fuel rack until the governor moves the rack into a position where the bell crank slides back into its slot in the fuel control rack.

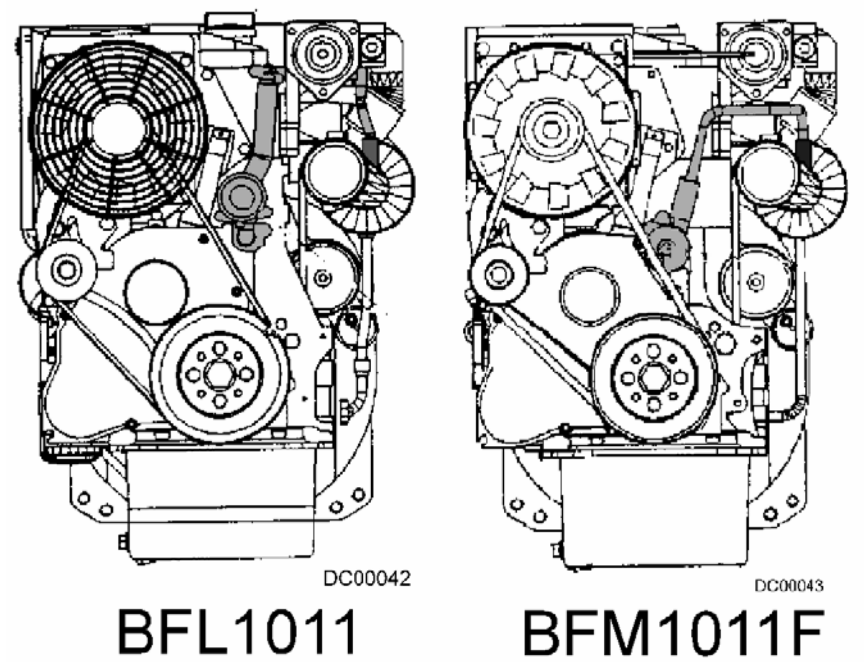


Breather Connections

DC110037

FL1011 Crankcase Breather external
On the naturally aspirated engine, the crankcase breather valve is mounted to the crankcase. A rubber hose connects the valve to the cylinder head. A gallery is machined into the cylinder head to which the valve is connected. Holes are drilled from the intake ports into that gallery for the oil fumes to escape. The drillings are of different sizes. The size difference ensures even oil fume distribution and lubrication to the intake vales

FM1011F Crankcase Breather internal
On the naturally aspirated engine, the crankcase breather valve is mounted to the crankcase. The connection between valve and cylinder head is internal. The oil fume distribution in the cylinder head works the same way as the FL1011. The opening on the breather box to the outside is being closed off



Breather Connections

DC110038

BFL1011 Crankcase Breather External to the Cylinder Head.

BFM1011F Crankcase Breather External To Turbocharger Inlet.

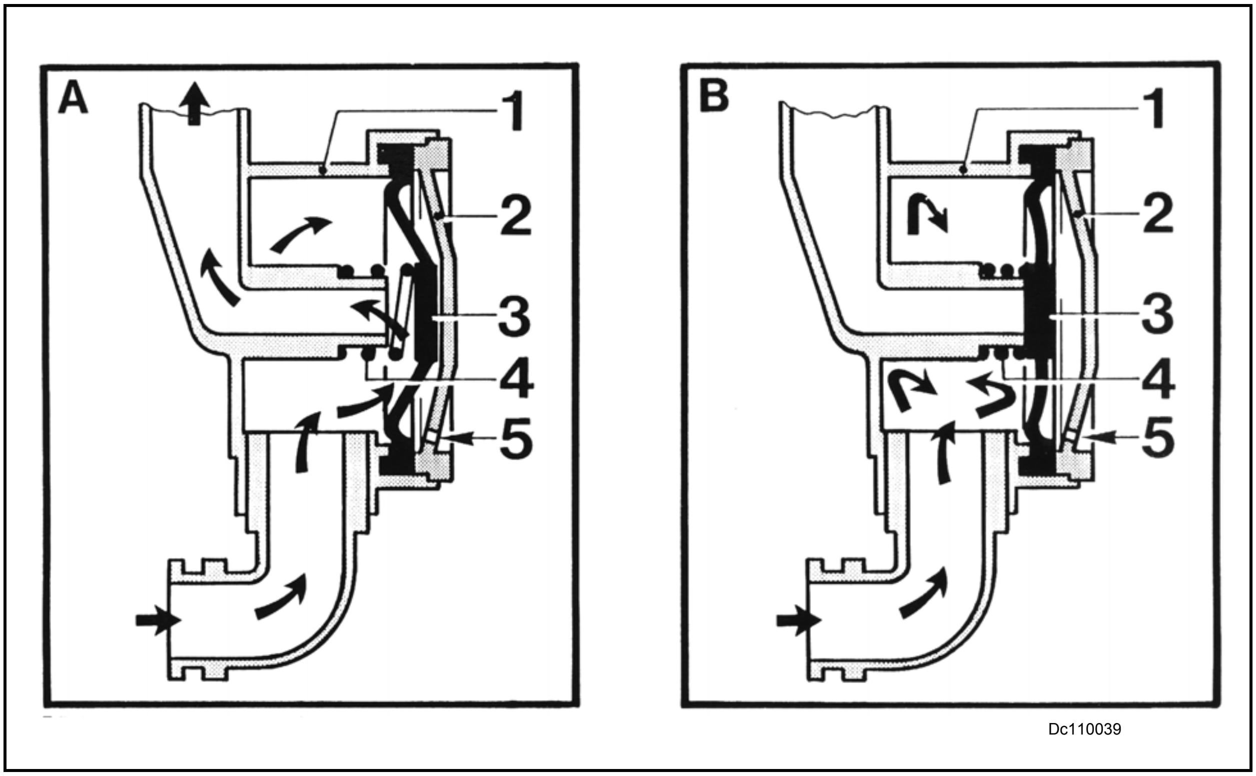
BFL1011

On previous turbocharged engines, the valve is connected via rubber hose to the intake pipe on the compressor side of the turbocharger.

The newer engines have the valve connected to the cylinder head the same way as on naturally aspirated engines except that a gallery in the intake manifold, but not connected or open to the suction part of the manifold, transfers the crankcase pressure into the intake pipe. The connection between manifold and cylinder head is sealed with an o-ring. The fumes enter the air intake system in front of the turbo charger.

BFL1011F

On the turbo charged “F” engine, the rubber cap is removed (naturally aspirated) and a pipe connection is made directly to the air manifold in front of the turbo charger. The fumes are not routed through the cylinder head as in the naturally aspirated engine.



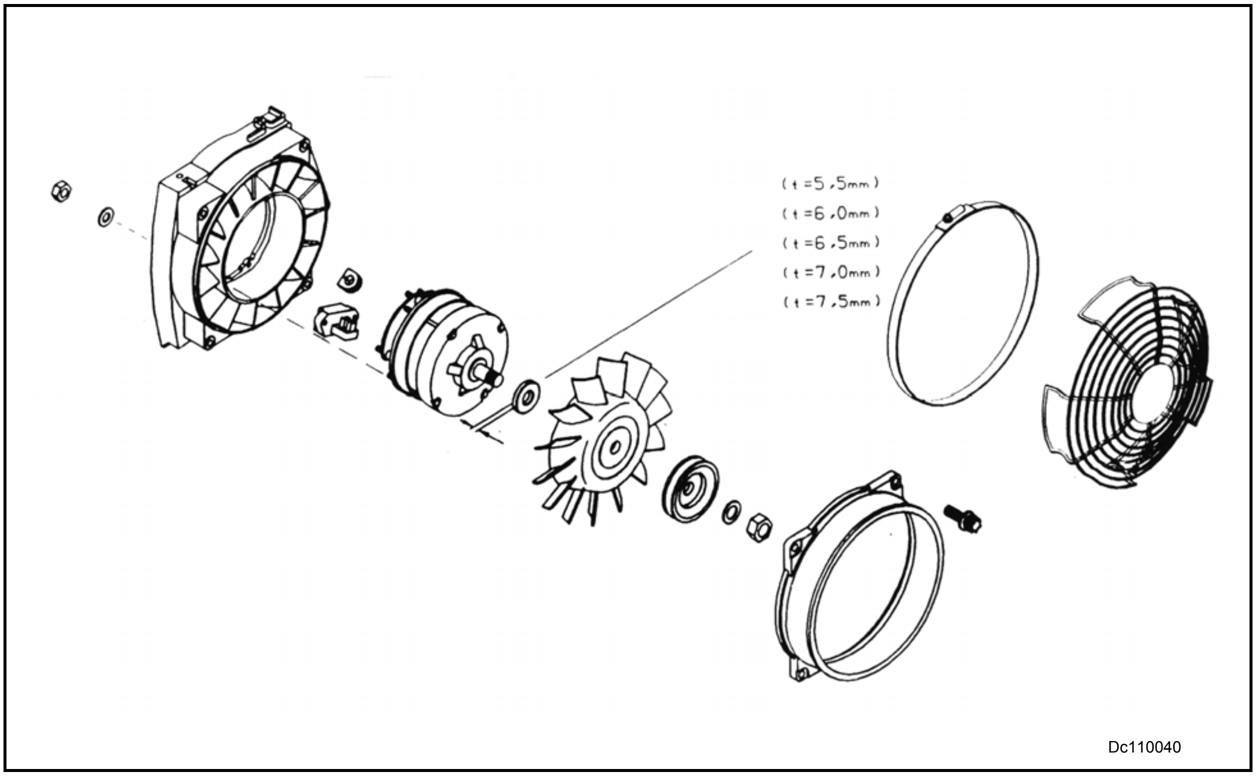
FL1011 Crankcase Ventilation

DC110039

A - Ventilation System Open
B - Ventilation System Closed

1. Valve housing
2. Housing cover
3. Diaphragm
4. Diaphragm spring
5. Vent hole

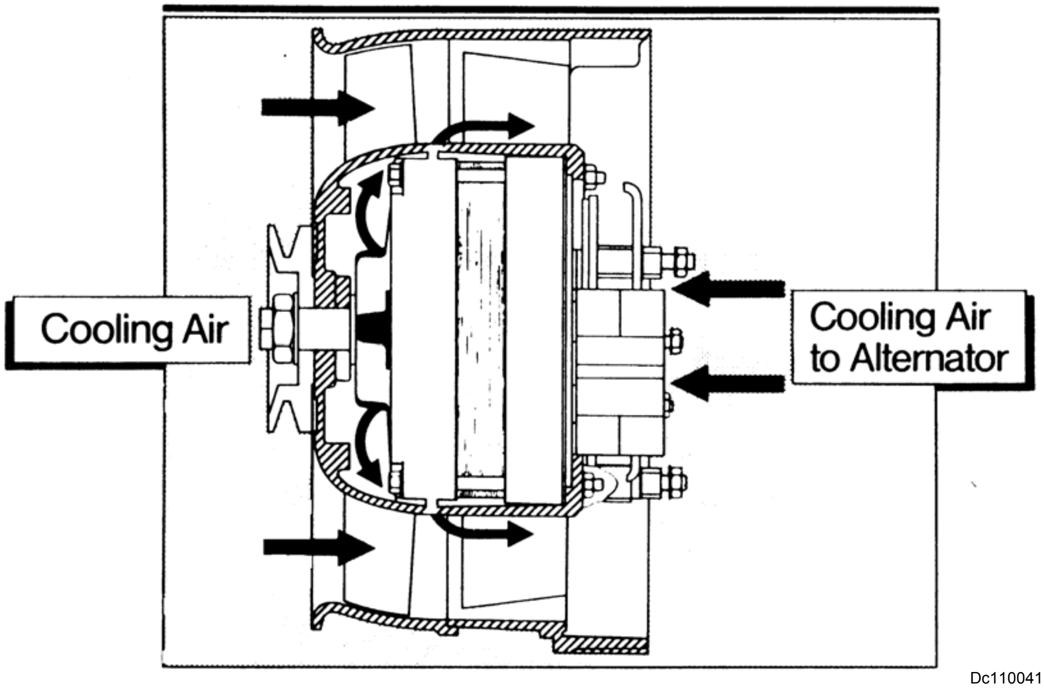
The crankcase breather valve controls the combustion blow-by gasses in the crankcase. Due to environmental protection regulations, the gasses are fed into the intake manifold and mix with the combustion air. The vacuum (suction) created in the manifold is working on the diaphragm 3 against the spring 4 (fig. A). The crankcase pressure is regulated at 4mbar (0.06 psi). The oil fumes from the crankcase lubricate the valve seats on both, naturally aspirated and turbo-charged, engines. When the vacuum increases, the diaphragm closes the connection to the intake manifold (fig. B). It is very important to keep the venthole 5 clean to assure trouble-free function. (The venthole was relocated to the back side at the top of the breather housing).
When the engine is operating under full load, the crankcase pressure increases to a point where the breather valve stays open, and the oil fumes are being constantly drawn out of the crankcase.



FL1011 Cooling Blower/Alternator

DC110040

The axial cooling blower is belt driven by the crankshaft pulley. This blower design differs from the other Deutz air blower in a way that the fan is in front of the stator. This configuration was chosen for optimum engine efficiency, i.e. fuel consumption, power absorption, etc. The uneven blade spacing results in blower noise values that contribute only little to the overall engine noise level.



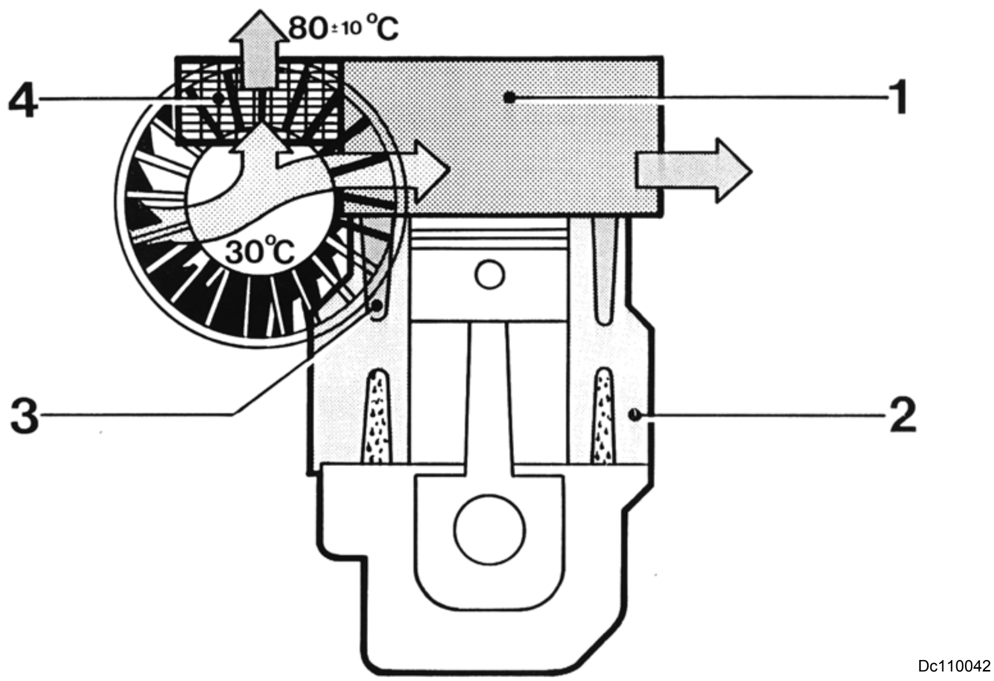
Alternator Cooling

DC110041

The alternator, installed in the stator, has the blower mounted to its shaft. This blower/ alternator assembly is V-belt driven, as already mentioned above. Part of the cooling air flow is redirected by 180° before it enters the alternator. With this sudden change in direction, dirt particles are ejected from the air and clean cooling air enters the alternator, thus providing long performance of the alternator.

A V-belt failure would cause the alternator to stop. With this, an alarm would alert the operator or a shut-down device would shut the engine down to protect it from major damage.

Show video.

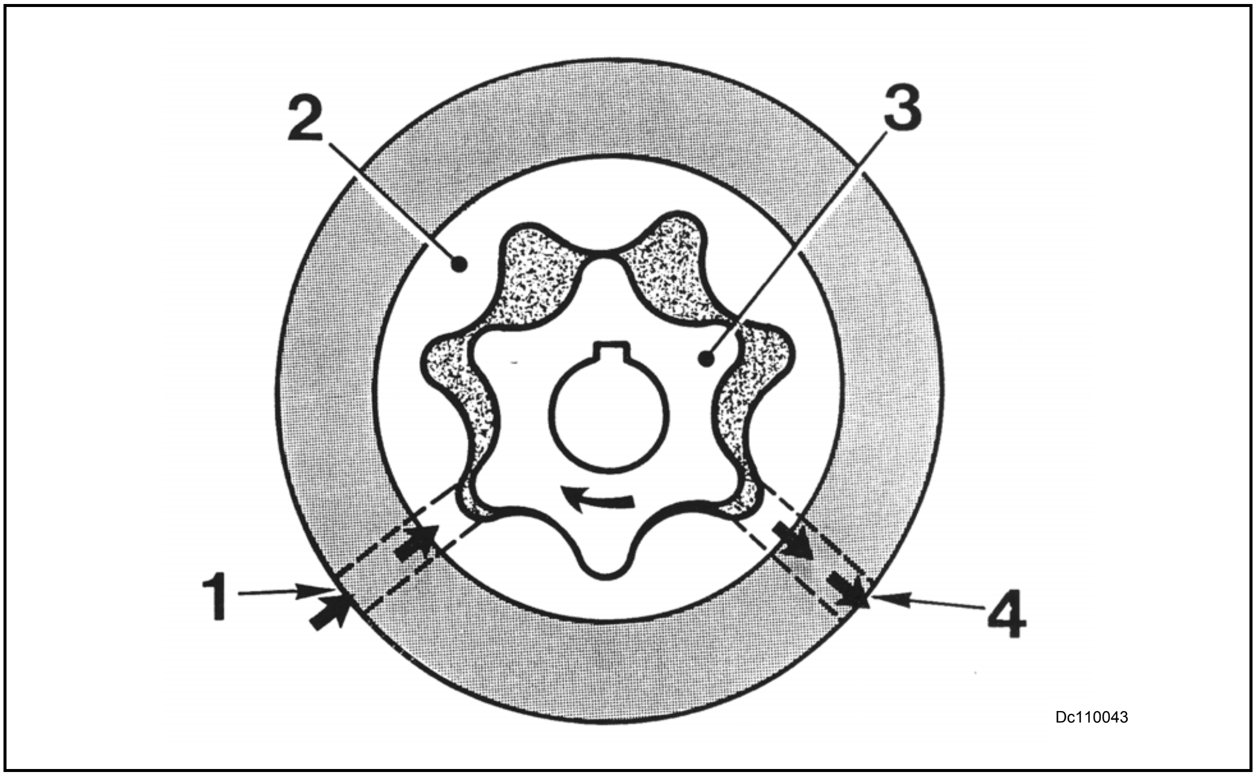


FL1011 Cooling Air Flow

DC110042

1. Air cooled cylinder head
2. Crankcase
3. Upper cylinder cooling channels
4. Oil cooler

A "hybrid" cooling system was developed to cope with the higher heat transfer to the lube oil. The finned cast iron cylinder head 1 is cooled by the air, supplied by a belt driven cooling blower. The cylinders are integrated in the crankcase and cooled by engine oil. The upper portion is cooled by force-fed oil via a separate oil circuit into the cooling channel 3. The lower segment of the cylinders is cooled by splash oil. At a temperature of 95°C the engine oil is routed through the cooler.

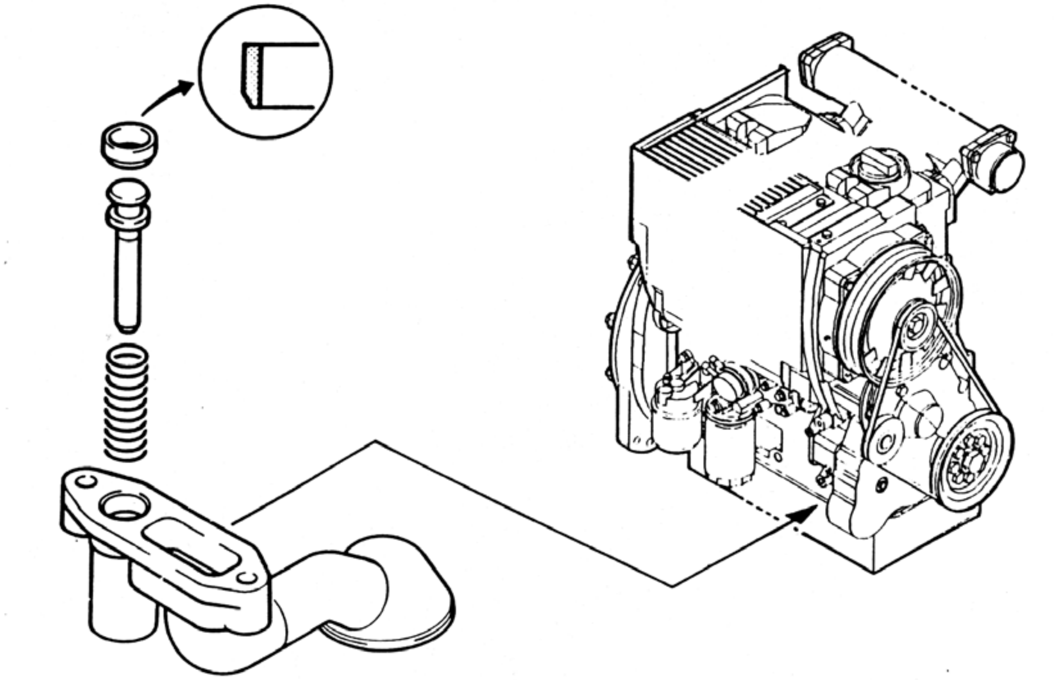


FL1011 Lube Oil Pump

DC110043

1. Oil entrance (suction)
2. Rotor ring
3. Rotor
4. Oil exit (pressure)

The rotor pump which is a variation of the internal gear pump is relatively simple in design. A rotor 3 turns inside a rotor ring 2. In operation, the inner rotor is driven inside the rotor ring. The rotor has one lobe less than the ring, so that one lobe is engaged with the outer ring at any time. This allows the lobes of the rotor to slide over the lobes of the ring to seal the system to prevent oil from backing up. Oil is drained in through port 1 and pushed out under pressure through port 4.



FL1011 Suction Pipe
Oil Pick-Up Tube With Pressure Relief Valve

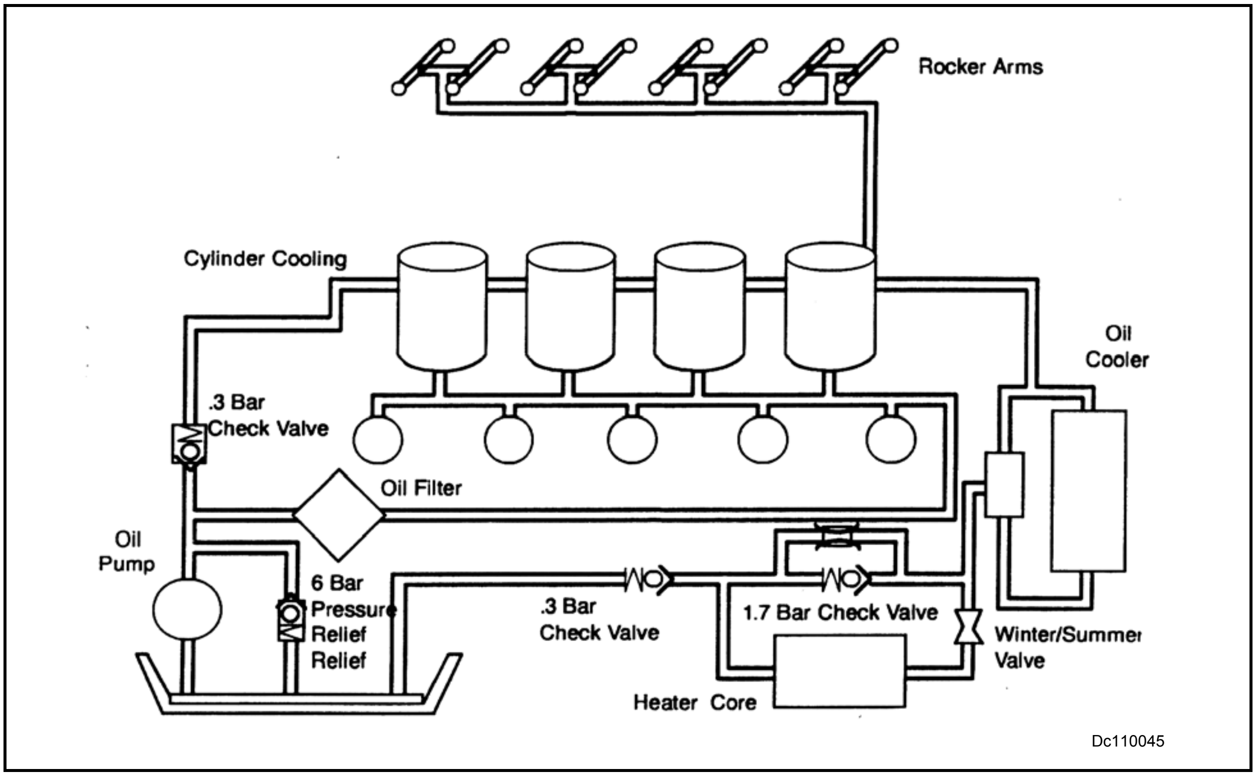
DC110044

1. Suction pipe is mounted to crankcase
2. Pressure relief valve incorporated in suction pipe base

Oil pressure relief valves
The oil pressure relief valve maintains the correct pressure in the lubrication system regardless of the engine speed or the temperature of the oil (4-6 bar/58-87psi).
Most oil pumps can push out more oil than needed for engine lubrication. At idling speeds, or on older engines, this is no problem. But what happens to the excess oil when the engine is new and operating properly?
This is where the pressure relief valve does its job. When the oil pressure exceeds the valve setting, the valve opens and returns the excess oil to the crankcase.

The regulating valve is usually connected to the main oil gallery through passages in the block. However, it may be a part of the oil pump.

On the 1011 engines the suction pipe is mounted to the crankcase. The mounting base incorporates the pressure relief valve. Special attention must be paid when installing the valve seat.



FL1011 Lube Oil Cooling System

DC110045

1. Air – oil cooled

Use video for demonstration.

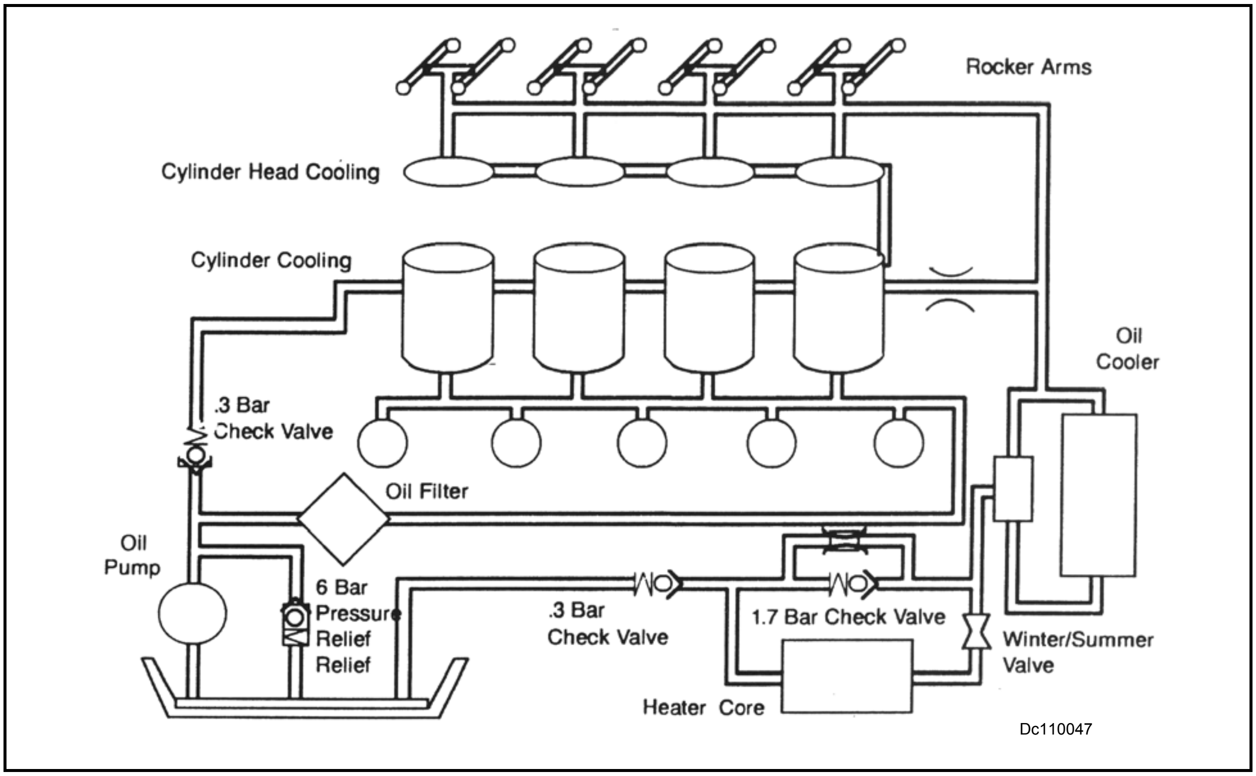
The lube oil system not only supplies oil to lubricate all moving parts in the engine, it also removes more or less heat. The oil is also functioning as a coolant. This function has been utilized to its maximum on the 1011 engine. The oil flow is divided in the main oil gallery: approx. flows into the lubricating system, passing a full flow oil filter. The remaining of the oil flows to the cylinder cooling system via thermostat through the oil cooler back to the sump. The lube oil pump is installed externally. The oil is picked up in the oil pan and fed into the lubricating oil circuit. When a pressure of approx. 0.3 bar is reached, a check valve opens to allow the oil to flow into the cooling oil circuit. This ensures that the oil flows to the lube oil circuit first before it enters the cooling system. The pressure relief valve opens when the oil pressure exceeds 6 bar. The excess oil flows back into the oil pan.
Once the oil enters the cooling oil circuit, it flows in a specific pattern around the cylinders from the flywheel end to the front end. As the oil leaves the cylinder cooling channels, a small portion continues up to a passage in the cylinder head gasket and flows to lubricate the rocker arm assemblies. The remainder of the cooling oil flows into a diverter valve assembly where it encounters an oil thermostat.

DC110045

At temperatures below 95°C, the thermostat allows the oil to bypass the oil cooler. When the temperature is higher than 95°C, the thermostat shifts causing the oil to flow through the oil cooler. Engines are also available without an oil thermostat. In those cases oil continuously flows to a heater control valve. There are of course two settings...summer and winter. In its summer position, oil is blocked from flowing through the valve. The pressure in the cooling circuit will exceed 1.7 bar causing a check valve to open to allow the oil to bypass the heater core. The oil continues its flow and opens a .3 bar check valve within the diverter valve assembly and returns to the engine's oil sump. This .3 bar check valve serves to hold oil in the cooling circuit when the engine is shut down.

When the oil control valve is placed in its winter position, oil flows through the heater core where restriction to oil flow is less than 1.7bar. Oil then flows out of the heater core, opens the .3 bar check valve and returns to the oil sump.

The sump design allows up to 30° inclination in all directions.

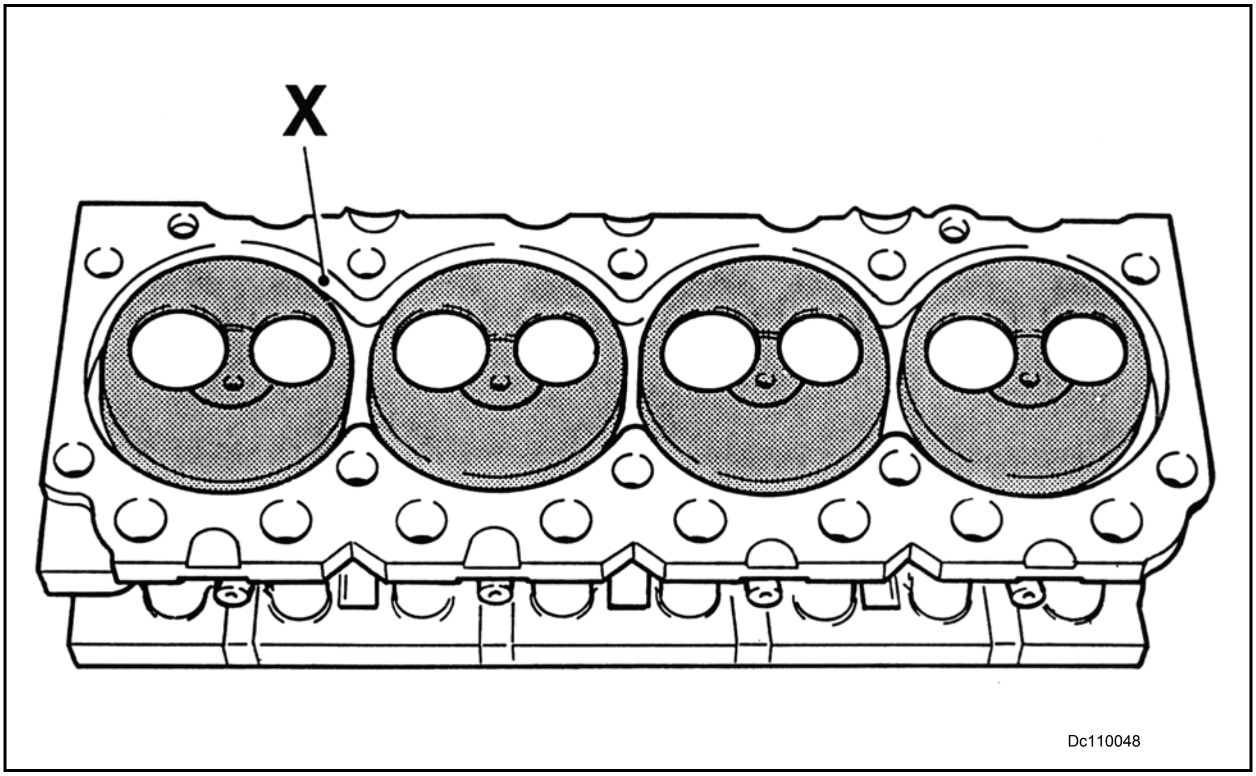


FL1011E Lube Oil Cooling System

DC110047

1. E = oil cooled only

Oil flow in the "E" option engine is slightly different. As the schematic shows, an orifice is placed in the crankcase restricting the oil's ability to flow into the diverter valve assembly. This increases the oil volume flow into the engine's oil-cooled cylinder head. The oil flows into circular grooves cast into the cylinder head and the flows up toward the rocker arm. There the circuit meets with an oil gallery drilled into the cylinder head allowing the majority of the cylinder head oil to return to the oil cooler circuit. The oil that does not return continues its flow to and lubricates the rocker arm assemblies. It returns to the sump by way of drain back castings in the cylinder head.



FL 1011 E Engine
Special Features

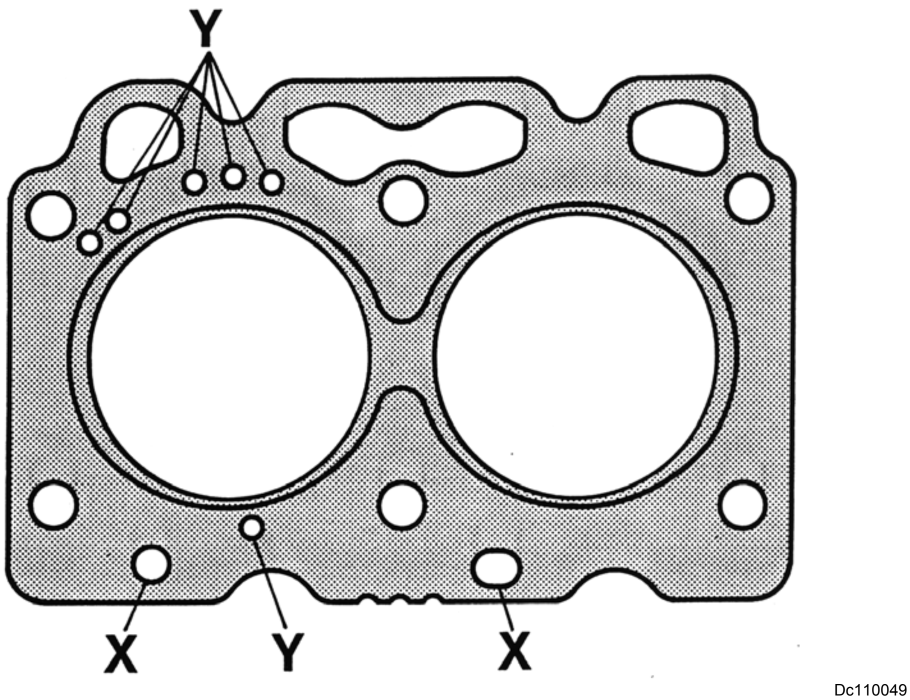
DC110048

X = Cooling channel

The FL1011E engine is provided with an external cooling system, with the lube oil being used as coolant.
The following components are different from the FL1011 model with the integrated cooling system:

oil cooled block type cylinder head
crankshaft mounted fan*
external mounted alternator
additional orifice in crankcase

*The crankshaft mounted fan is a basic design feature with a heat exchanger (radiator) mounted in front of it. Application related options are remote mounted heat exchanger with an electrically or hydraulically driven cooling fan.

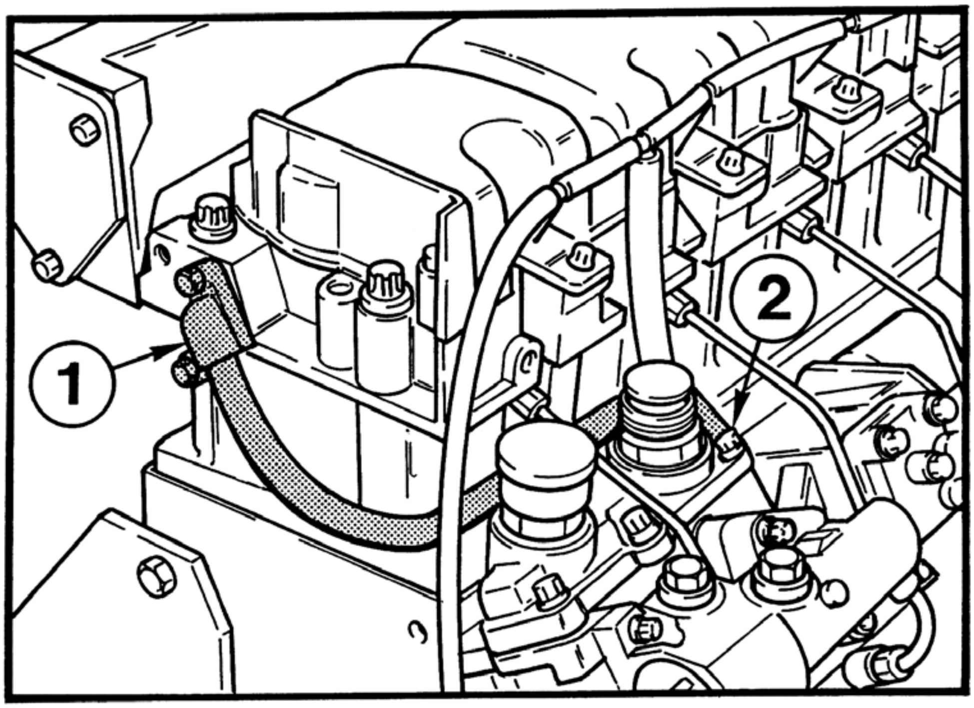


Cylinder Head Gasket FL 1011 E

DC110049

Y = Oil supply holes
X = Dowel holes

The oil supply openings are located at the last cylinder unit (i.e. 2, 3, 4) in the cylinder head gasket. An orifice installed in the crankcase restricts the oil return to the crankcase; therefore oil is being forced into the cylinder head for cooling and lubrication of the rocker arms. The selection of the gasket is the same procedure as for the 1011 engine with integrated cooling system.

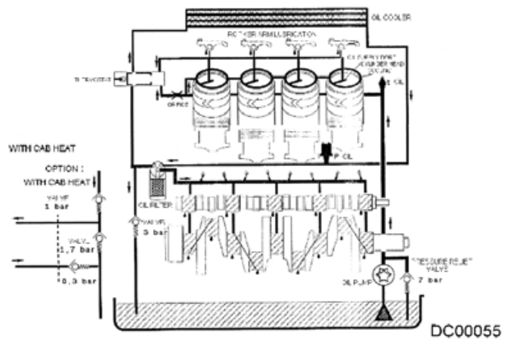


Cooling Oil Return FL 1011 E

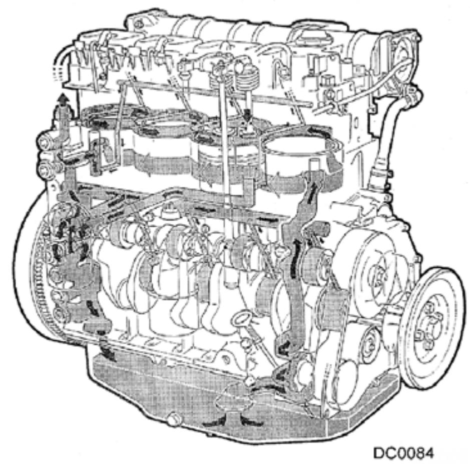
DC110050

1. Oil return line
2. Thermostat housing

The cooling oil flows from the cylinder cooling system into the cooling channels of the block type cylinder head. The oil return is provided by an oil return line 1, mounted to the cylinder head at the flywheel end. The oil drains through the thermostat housing 2 back into the crankcase or into the cooling system.



DC00055



DC0084

Dc110051

FM1011F LUBE OIL CIRCUIT

DC110051

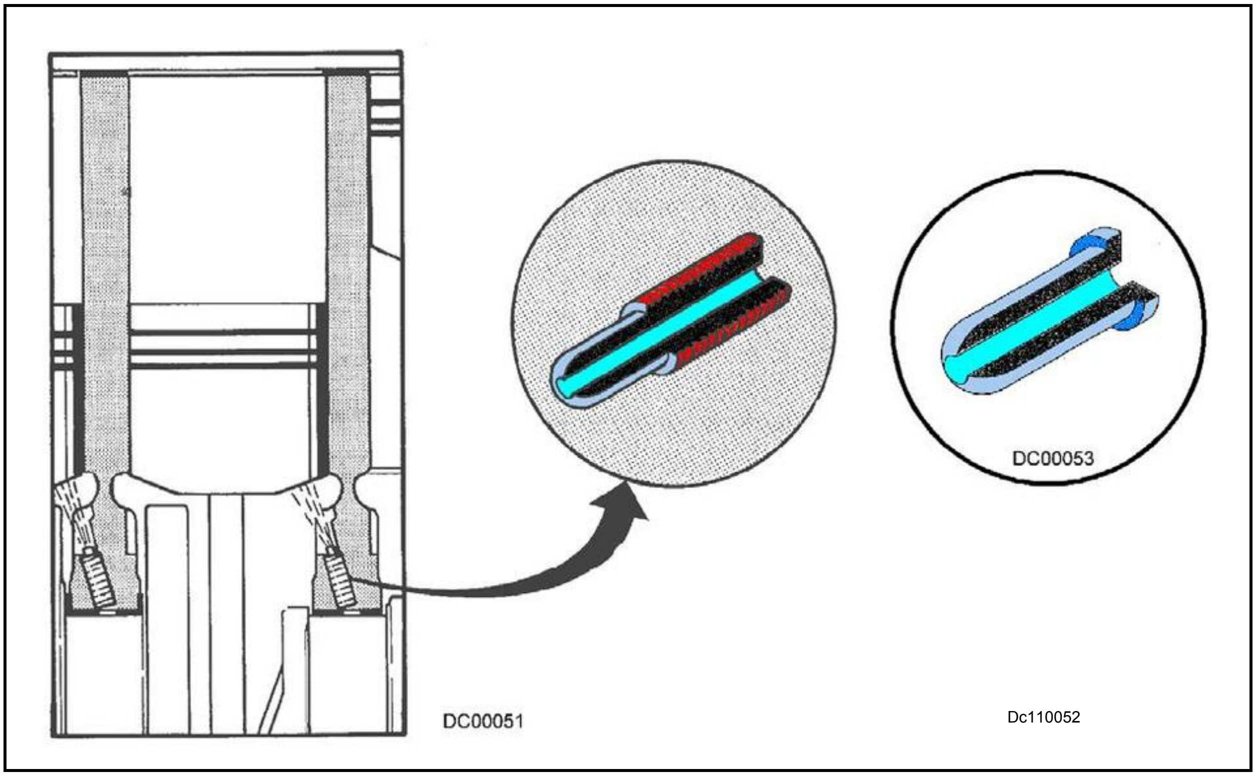
The lube oil is drawn by the external lube oil pump from the oil sump and forced into the cooling circuit. The pump is equipped with a 7 bar pressure relieve valve. The oil is being returned to the oil sump and not to the suction side of the lube oil pump.

FILLING PROCESS OF OIL COOLER

With the engine cold and the thermostat closed, the oil returning from the cooling system is forced through the lube oil filter into the lubricating system. At the same time, the return oil flow from the cylinders is restricted by an orifice, this forces the oil through on oil supply passage into the cylinder head. This oil cools the cylinder head and lubricates the rocker arms. Some of the oil returns via oil gallery into the thermostat housing, some of the oil runs off through the cylinder head and crankcase back into the oil sump. Oil flowing through the lube oil filter is also divided to flow into the engine oil cooler .The thermostat is closed and the oil cannot flow through the oil cooler until the thermostat shifts..

LUBE OIL FLOW

After the thermostat has shifted, the lube oil flows through the cooler and filter into the lube oil circuit. At the end of the oil circuit, a 3 bar pressure valve maintains an even oil pressure in the engine.



FL1011 Piston Cooling Nozzle

DC110052

aturally aspirated engine – 1 nozzle per cylinder
2. High performance/turbo engine – 2 nozzles per cylinder

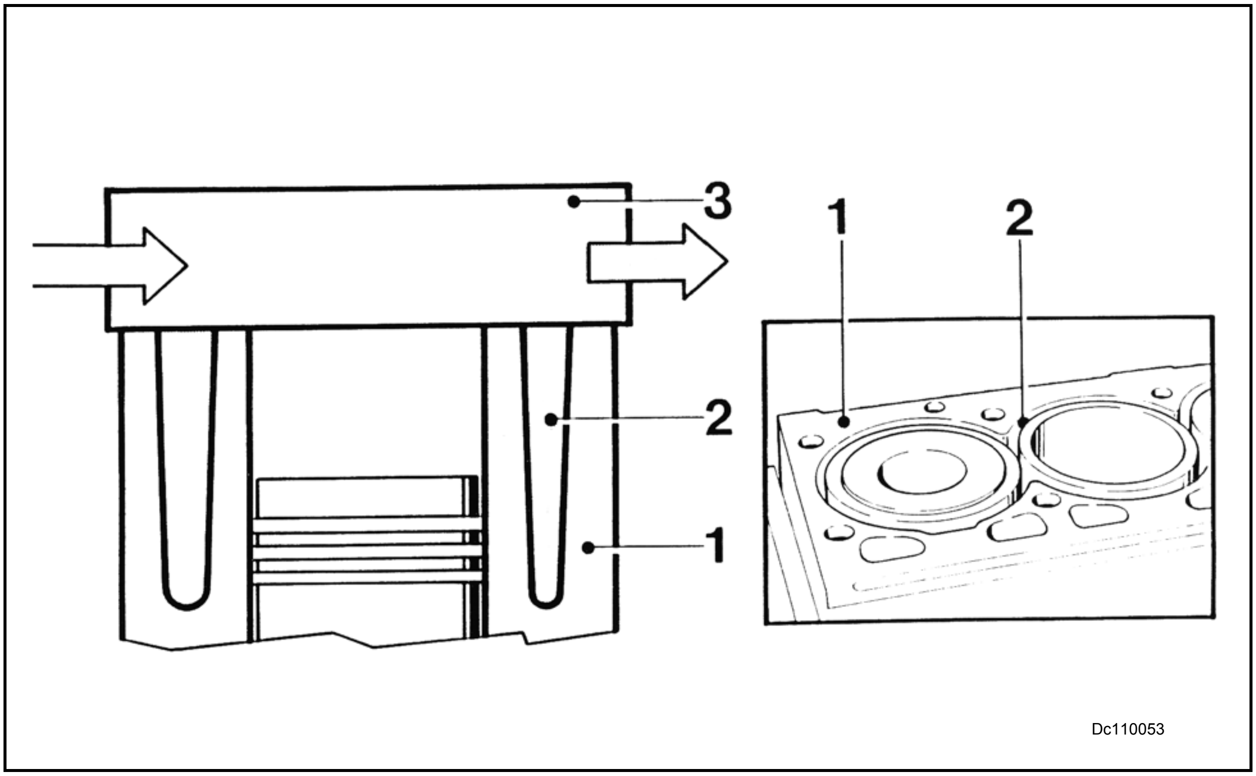
In the past, the performance of the Deutz engines has been increased considerably as a result of the improved combustion methods and of the turbo-charging.

Under these circumstances, additional cooling of the pistons is required. Naturally aspirated engines have one cooling nozzle whereas a more intensive cooling is necessary for turbo-charged engines. These engines and some engines for special applications have two cooling nozzles (uprated output). The nozzles are installed into

the oil supply gallery that feeds oil to the crankshaft main bearings. As shown, the nozzles are hollow and do not have spring-loaded valves. The method of the piston cooling is splash cooling, i.e. oil is sprayed onto the bottom of the piston crown.

FL 1011	1 Cooling nozzle per cylinder	Screw type 1992/ > Slip type
BFL 1011	2 Cooling nozzles per cylinder	Screw type 1992/ > Slip type
BF/L/M1011/F	2 Cooling nozzles per cylinder	Slip type

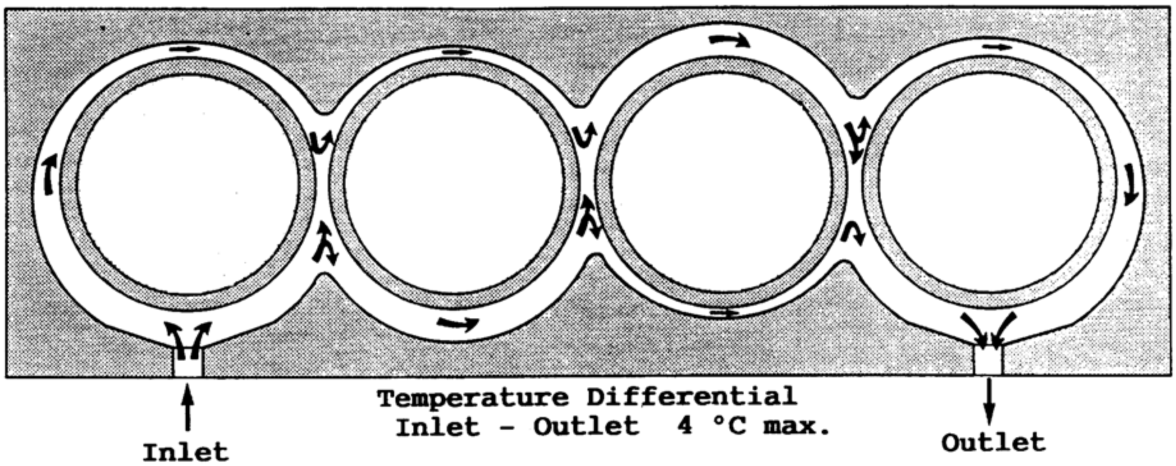
The slip type nozzle is helt in place by the bearing shell.



FL1011 Crankcase

DC110053

1. Crankcase
2. Pressure channel
3. Cylinder head



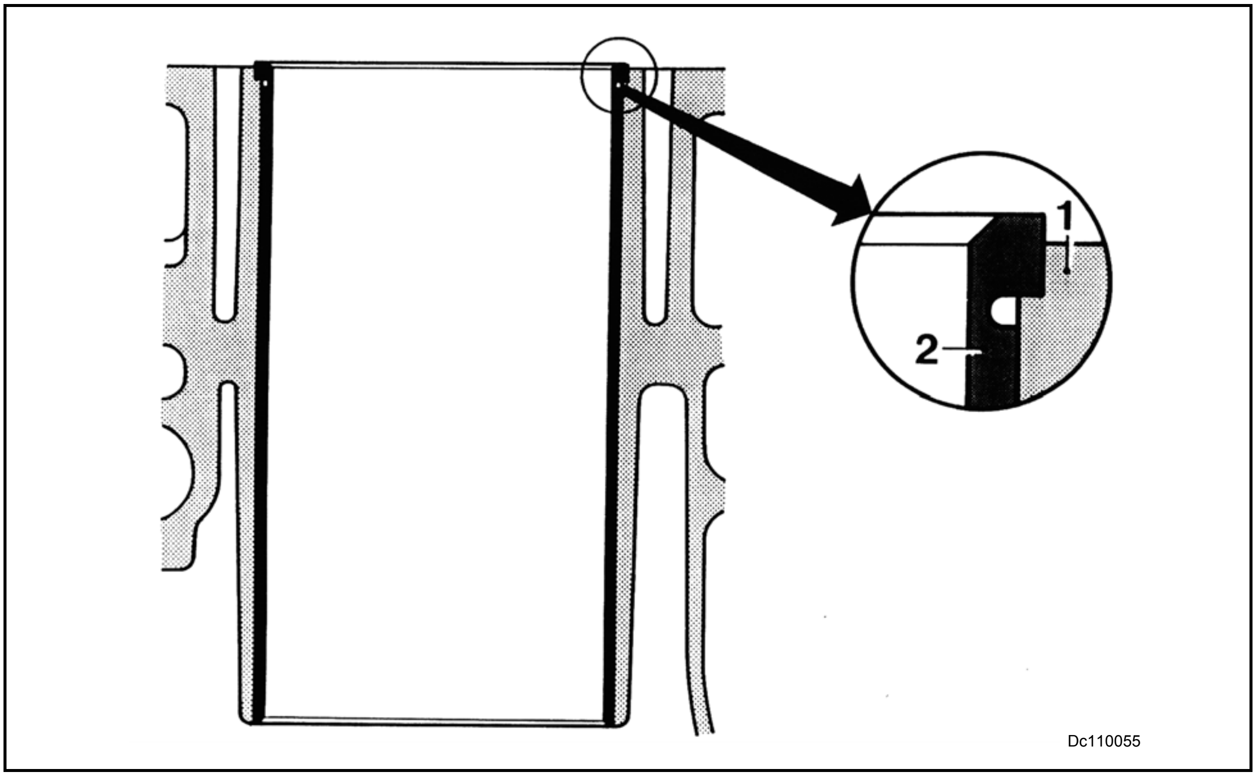
Cooling Oil Flow Around Cylinders

DC110054

1. Oil flow direction = flywheel blower

The cooling system's oil flows longitudinally through the crankcase around the cylinders. The optimized oil flow ensures that the temperature differential between outlet and inlet does not exceed 4K at engine rated conditions, hence providing an even cooling of all cylinders.

The off-set position of the oil cooling area ensures a homogeneous oil circulation around the cylinders for an adequate heat transfer, eliminating the danger of thermal deformations. This is an important factor that contributes to low oil consumption (less than 0.3% of the fuel consumption) and low cylinder wear. This design concept, for which a patent has been applied, provides sufficient oil flow velocities around each and every cylinder.

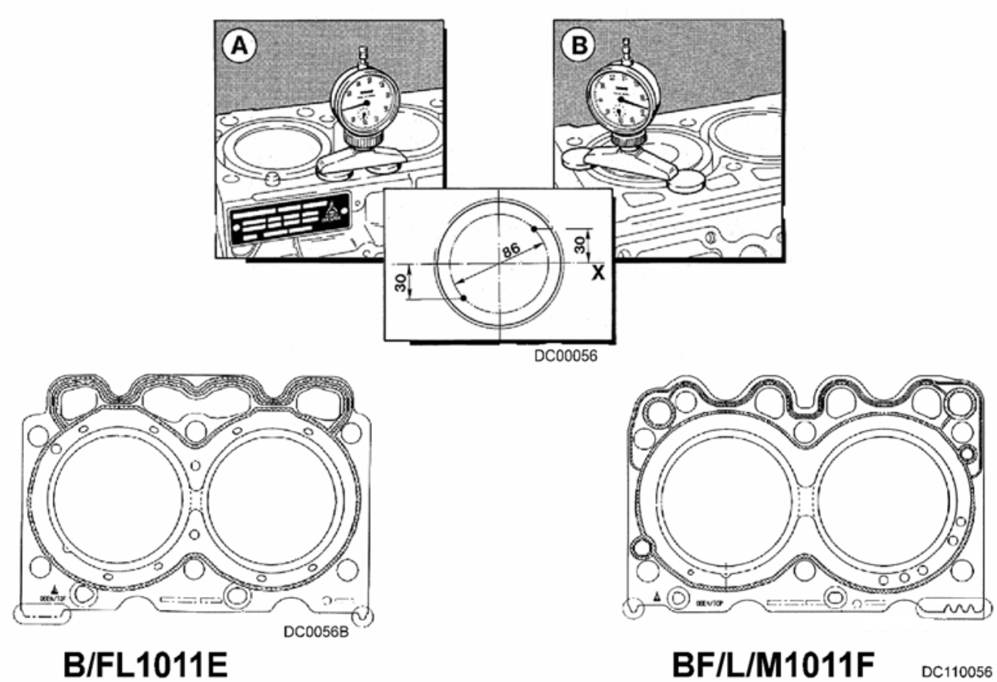


Cylinder Repair

DC110055

In case of cylinder damage, the engine can be repaired by installing a dry-type slip-fit sleeve. The repair procedure cannot be performed in the equipment, the engine has to be removed from it. The damaged cylinder bore needs to be opened up to accept the dry sleeve 2. A recess 1 is machined into the crankcase to locate and seat the sleeve. The collar of the cylinder protrudes from the crankcase deck. The protrusion is required for tight cylinder fit and secure cylinder head gasket sealing. A machining of the installed sleeve is not necessary, since it has been honed to its specified dimensions.

The machining procedure can be obtained from the manual # .0297 7442.



Dc110056

Piston Crown Clearance
Cylinder Head Gasket

DC110056

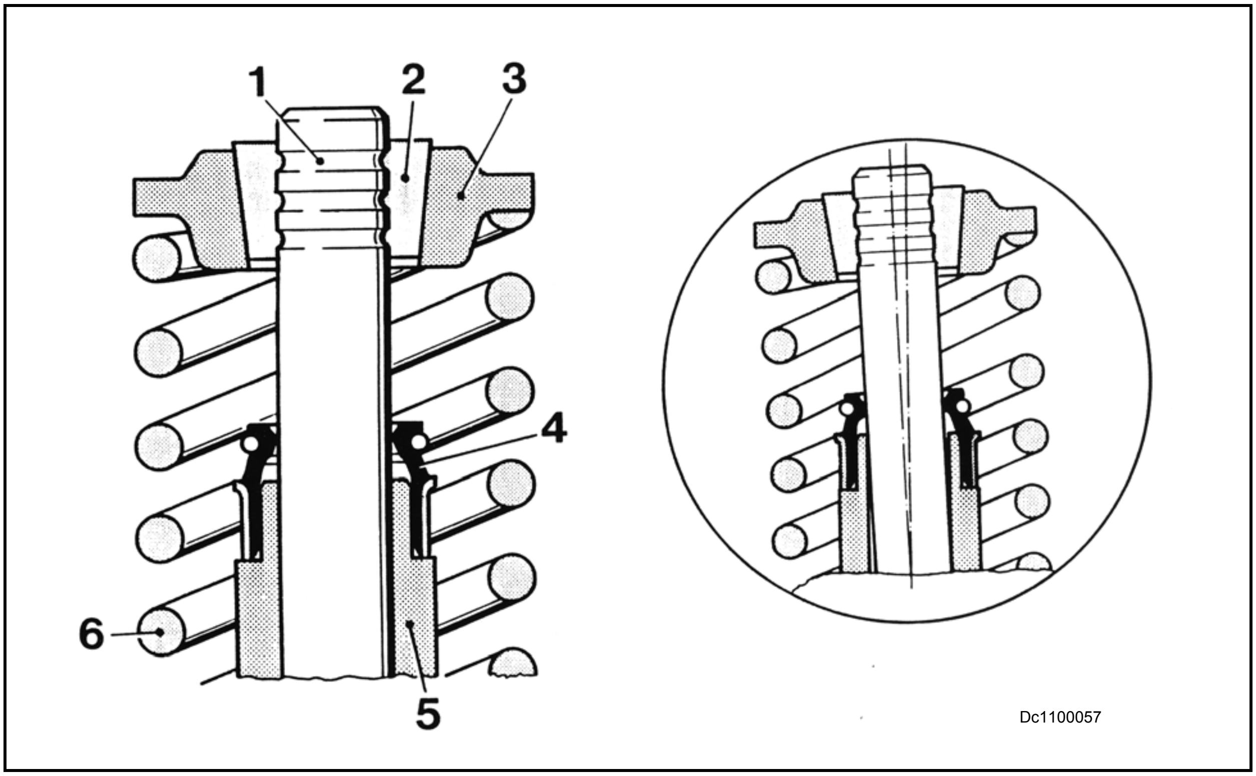
1. Three sizes cylinder head gaskets available
2. Three sizes piston height available

The exact setting of the piston crown clearance is important for optimum power output, fuel consumption and exhaust emission. Figure A shows "zeroing" the dial gauge on the crankcase top surface. Figure B shows the piston protrusion. The center picture shows the measuring location. To adjust the cylinder head height, three different gasket thicknesses are available. Over a period of time the cylinder head gaskets have changed in material and design. Each gasket is provided with a "TAB" or "TABS" for identification. If the piston crown clearance cannot be set with the existing gaskets, pistons with different piston crown heights (A, B, C) are available. Check the workshop manual for protrusion specification and head gasket selection.

Gasket Identification:

B/FL1011/E	Notches up until 1994 from that date on Tabs at the BLOWER END
B/FL/M1011F	Tabs at the FLYWHEEL END

Note: The one tab at each end of the gasket, opposite the gasket identification, aligns it at the assembly line. (Robot) Use video tape for demonstration



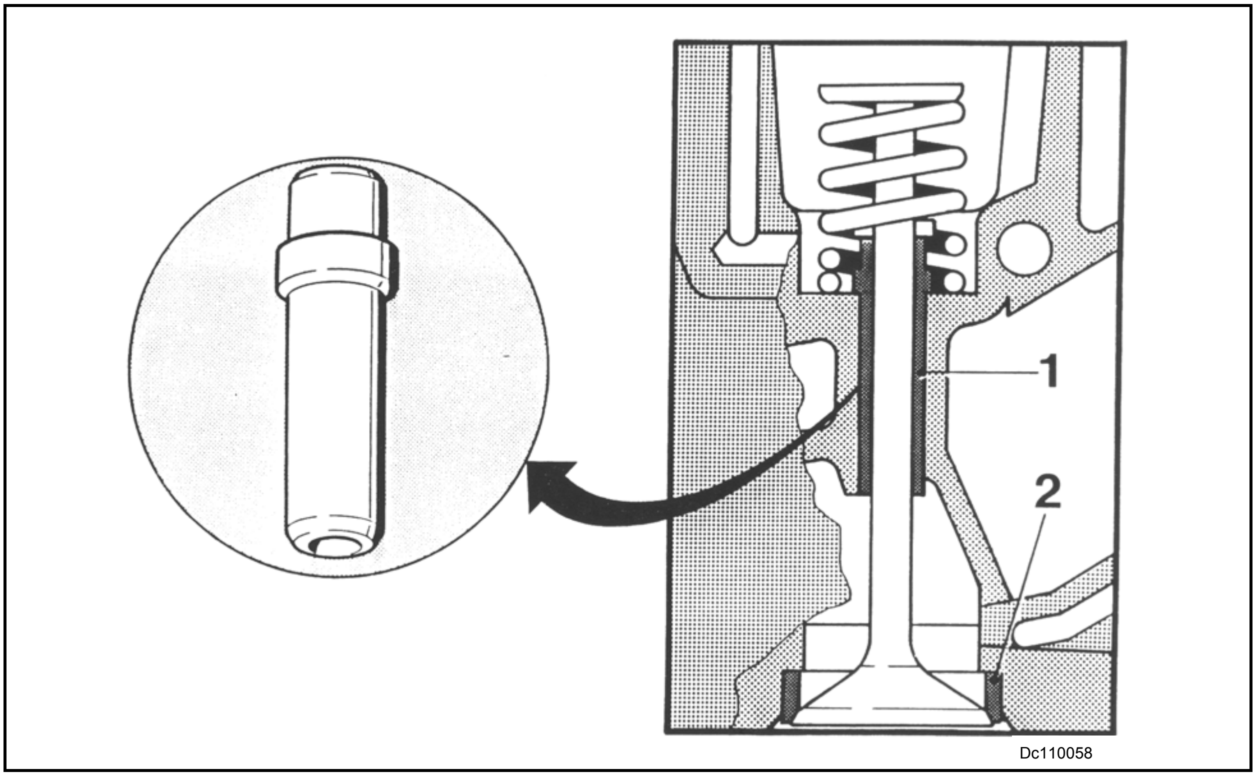
FL1011 Valve Train Components

DC110057

1.Valve stem
2.Valve keeper
3.Spring seat

4. Valve seal
5. Valve guide
6. Valve spring

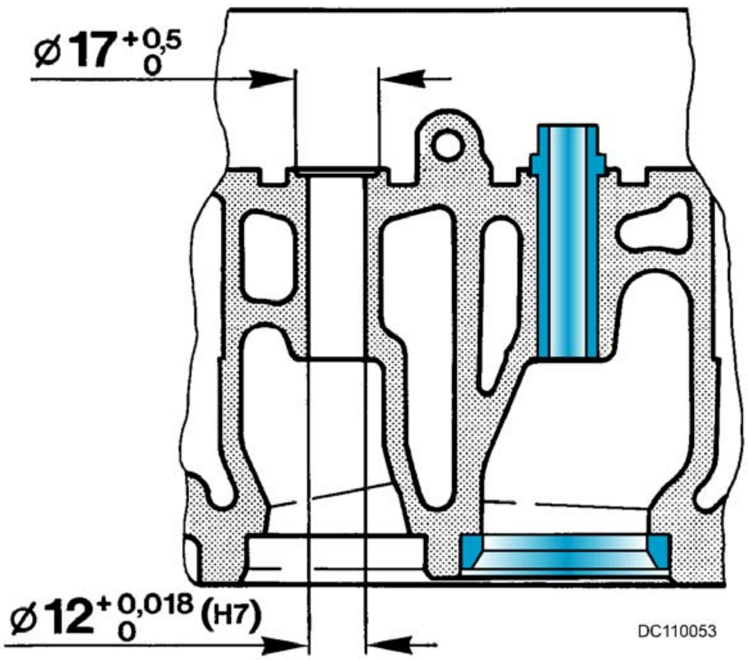
As shown on the exploded view, even with some valve stem/valve guide wear, due to the valve stem seal, engine oil entering the combustion system has been minimized.



FL1011 Cylinder Head Components

DC110058

1. Valve guide - on new engines a guide is not installed in the head, a bore is simply drilled. The guide is for replacement only.
2. Valve seat



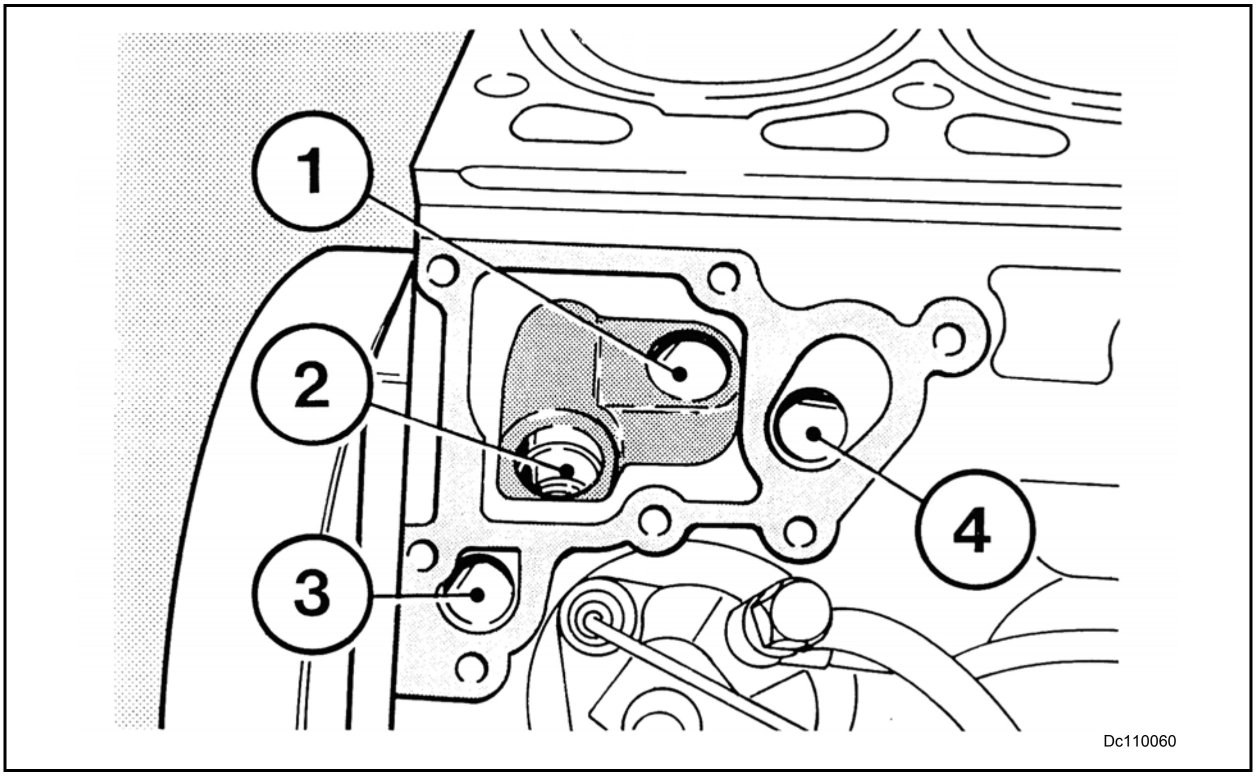
Valve Guide/Valve Seat Insert Replacement

DC110059

The valve guides are machined into the cylinder head. In case of excessive guide wear, the bore can be opened up to specification and a valve guide insert can be pressed in. The valve seats are inserts and can be replaced as such. To install these components, the cylinder head does not need to be heated up. The seat angle on the seat inserts and the valves is as follows:

Naturally aspirated engines:	Intake 45°/exhaust 45°
Turbo-charged engines:	Intake 30°/exhaust 45°

Illustation is shown in Student Hand Book in section
Piston Selection / Head Gasket Selection page 9



Thermostat Housing Location

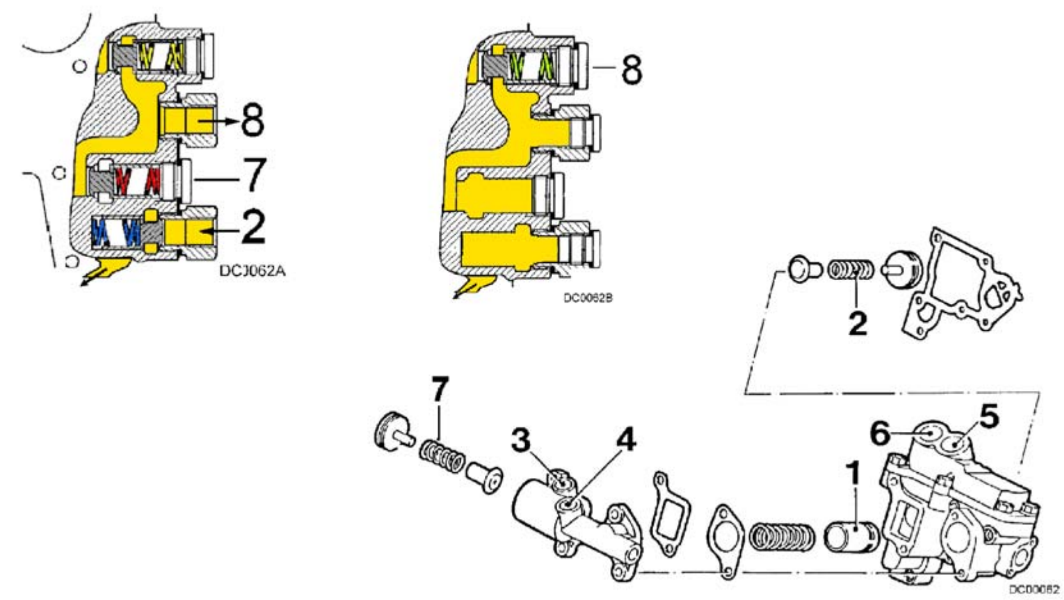
DC110060

1. Cylinder cooling supply
2. Main oil supply
3. Oil return to pan
4. Cylinder cooling oil return

The thermostat housing is mounted to the crankcase on the right side of the engine, above the fuel injection pump 1. Depending on application, the housing design can be for cab heat requirement or for industrial use. The openings in the crankcase determine the oil flow as follows:

1.Cylinder cooling supply
2. Main oil supply
3. Oil return to pan
4. Cylinder cooling oil return

With the engine oil temperature below 95°C the oil flows from gallery 2 into gallery 1 and returns from gallery 4 back to the oil pan via closed thermostat and gallery 3. When the oil temperature exceeds 95°C the oil flows from gallery 4 via oil cooler back into the oil pan through gallery 3.

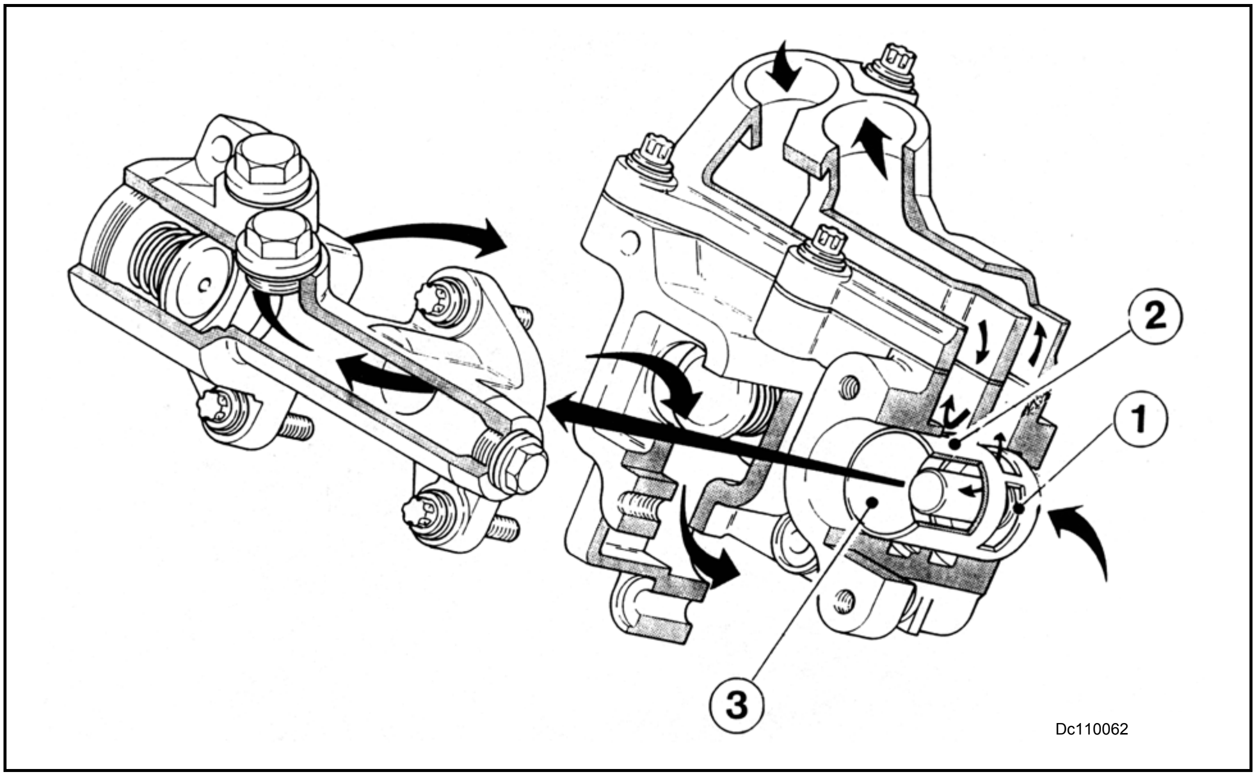


FL1011 / FL / M1011F Diverter Valve Assembly

DC110061

1. Thermostat
2. Pressure valve (0.3 bar)
3. Cab heat supply
4. Cab heat return
5. Cooler return
6. Cooler supply
7. Pressure valve (1.7 bar)
8. Pressure valve (1.0 bar) with cab heat
Pressure valve (3.0 bar) without cab heat

On the FL/M1011F engine the temperature control and the oil flow control valves are integrated into the crankcase. The thermostat is always installed. Its opening temperature is 95 C (203 F).
Different valve arraignments can be installed into the engine
1.) **WITH cab heat provision.** 2.) **WITHOUT cab heat provision**.
1.) When i**nstalling cab heat** provision, attention has to be paid to the installation direction of the valves and the color coding of the pressure springs. The vale in location 8 has to be installed with its valve seat inward, and the 1 bar spring (color code: yellow) on top of it. Location 7, install valve with its seat inward and the 1.7 bar spring(color code: red) on top of it. In location 2, the 0.3bar spring (color code: blue) has to be installed first followed by the valve, with its valve stem inwards. All screw plugs must be tightened to specification.
2.) When assembling an engine **without cab heat**, only the thermostat, position 1 and the pressure vale in position 8 need to be installed. The valve seat faces inward and the 3 bar spring(color code: green) is to be installed on top. All other openings are to be closed with

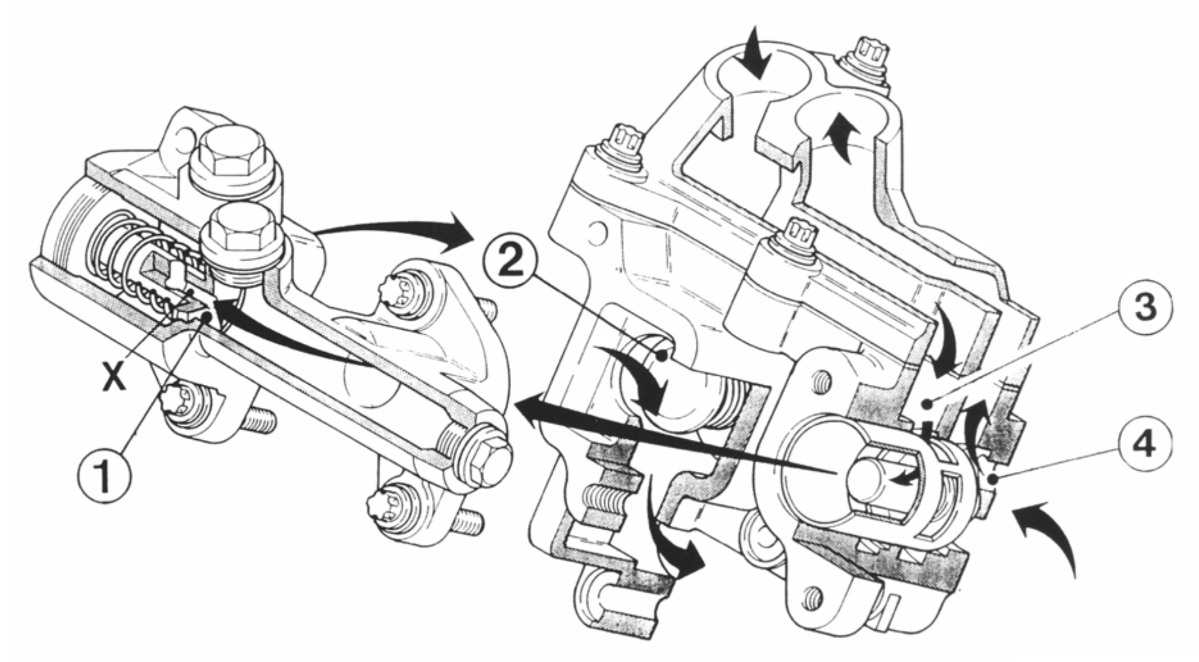


FL1011 Thermostat Housing/Oil Flow

DC110062

Thermostat closed

With the thermostat closed (oil temperature below 95°C), the oil flows through the thermostat at location 1 towards the oil cooler. Since passage 2 is closed, the oil flow is blocked. Therefore, the actual flow passes through the inner passage 3 of the thermostat into the oil pan.

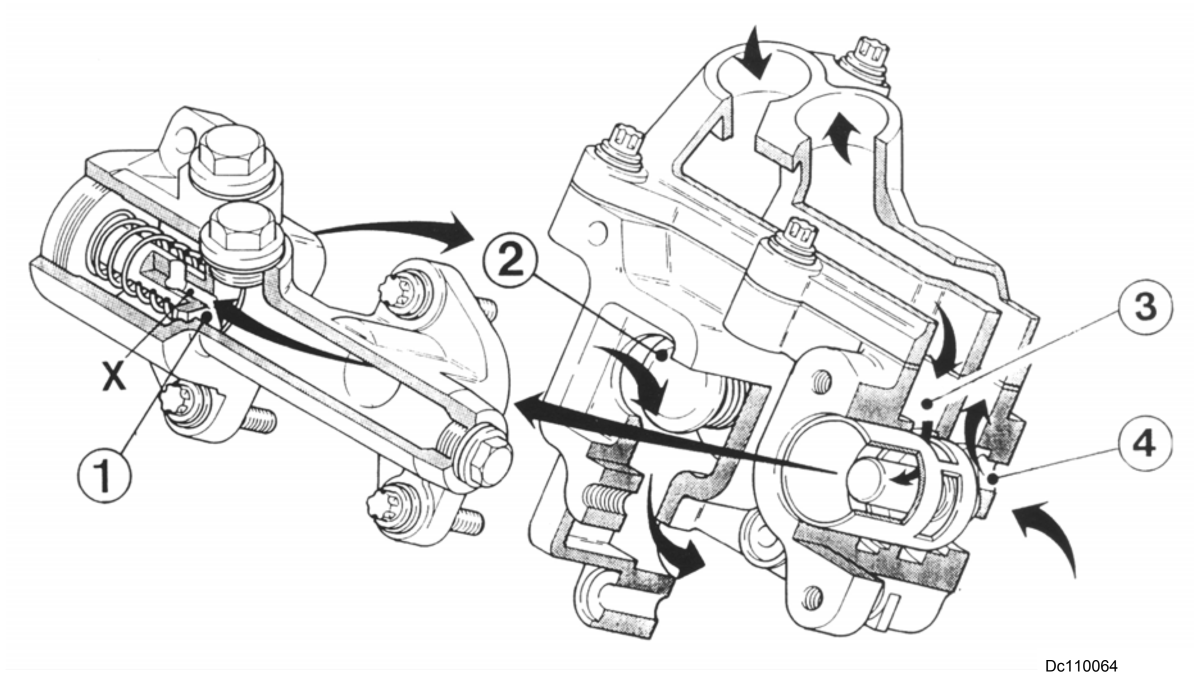


Thermostat Housing/Oil Flow

DC110063

Thermostat open

With the thermostat open (oil temperature above 95°C), the passages oil cooler supply and return are open. The oil enters the housing at location 4 and flows through the oil cooler. It returns into the oil pan via passage 3 and the inner part of the thermostat

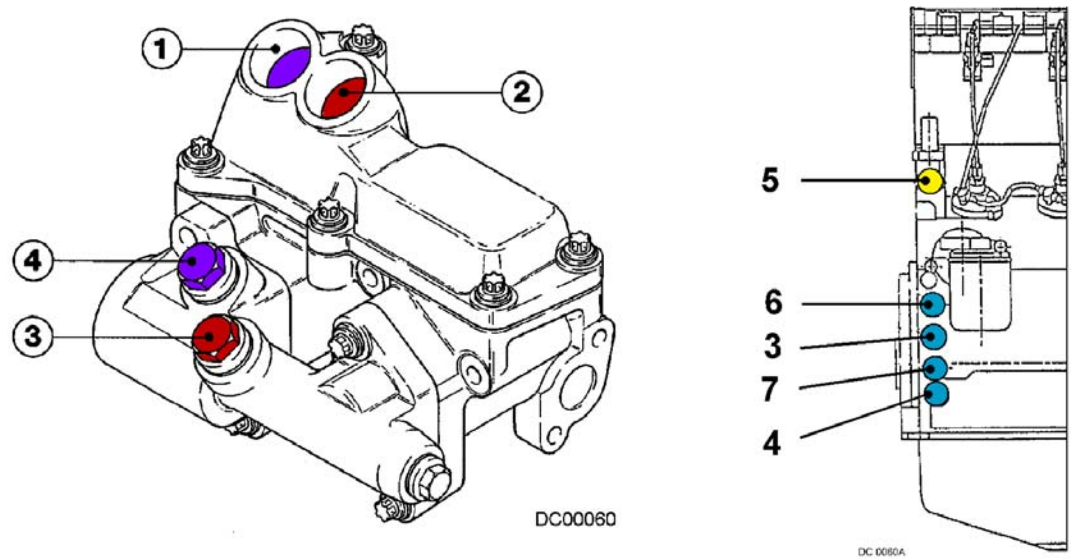


Thermostat Housing

DC110064

Thermostat open
Pressure regulating valves

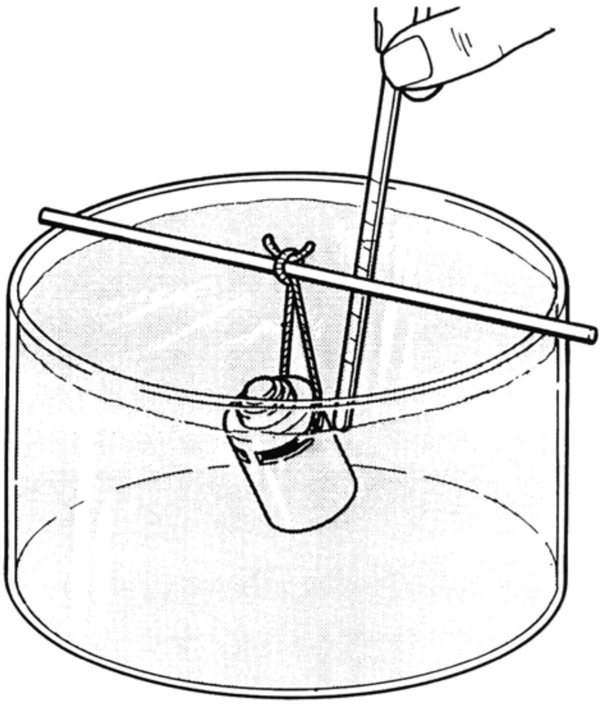
The valve at position 1 opens up at an oil pressure of 1.7 bar. This valve provides an adequate oil flow to the heater core at low engine rpm and pressure regulation at high rpm. An orifice "X" has been incorporated into the valve as a safety feature. In case of a closed heating circuit or a closed valve 1, an oil flow will be maintained to prevent engine overheat due to blockage of oil flow. The hole size of the orifice is 2.5mm dia. for naturally aspirated and 4mm dia. for turbo-charged engines. Valve 2 closes at 0.3 bar oil pressure to prevent the cooling system from draining empty when the engine is not running



Thermostat Housing
Heat Exchanger Connections

DC110065

1. Oil cooler return
2. Oil cooler supply
3. Heat exchanger supply
4. Heat exchanger return
5. Thermostat
6. Valve
   1bar with cab heat
   3bar without cab heat
7. Valve 3bar



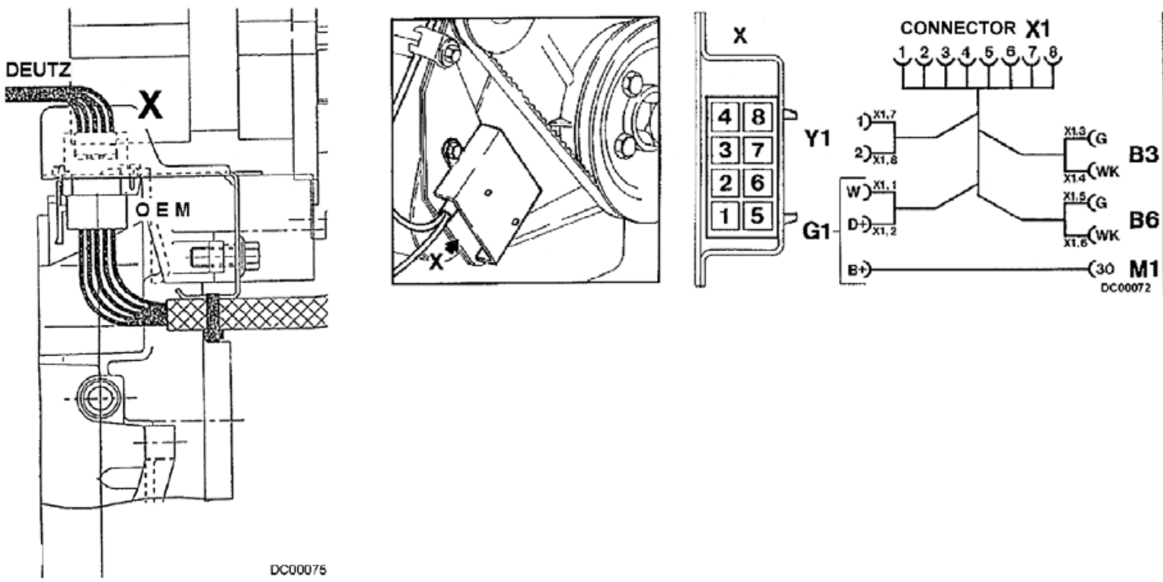
FL1011 Thermostat

DC110066

1. Opening temperature 95° C (203° F)

The thermostat provides automatic control of engine temperature at the correct level. This is necessary to get the best performance from an engine.
Only a small part of the engine's cooling capacity is required under the light loads, even during warm weather.
During warm-up, the thermostat remains closed.
The thermostat is designed to open at a temperature of 95°C, thus keeping the engine oil temperature to this minimum level in all load and speed conditions of the engine. In this way, the thermostat has also proved most effective in controlling HC emissions at low loads and oil dilution.
Test the thermostat as follows:

1. Suspend the thermostat and a thermometer in a container of oil. Do not let them rest against the sides or bottom.
2. Heat and stir the oil.
3. The thermostat should begin to open at a temperature as specified. It should be fully open at 30°C above the specified temperature.
4. Remove the thermostat and observe its closing action.
5. If the thermostat is defective, discard it.



Dc110067

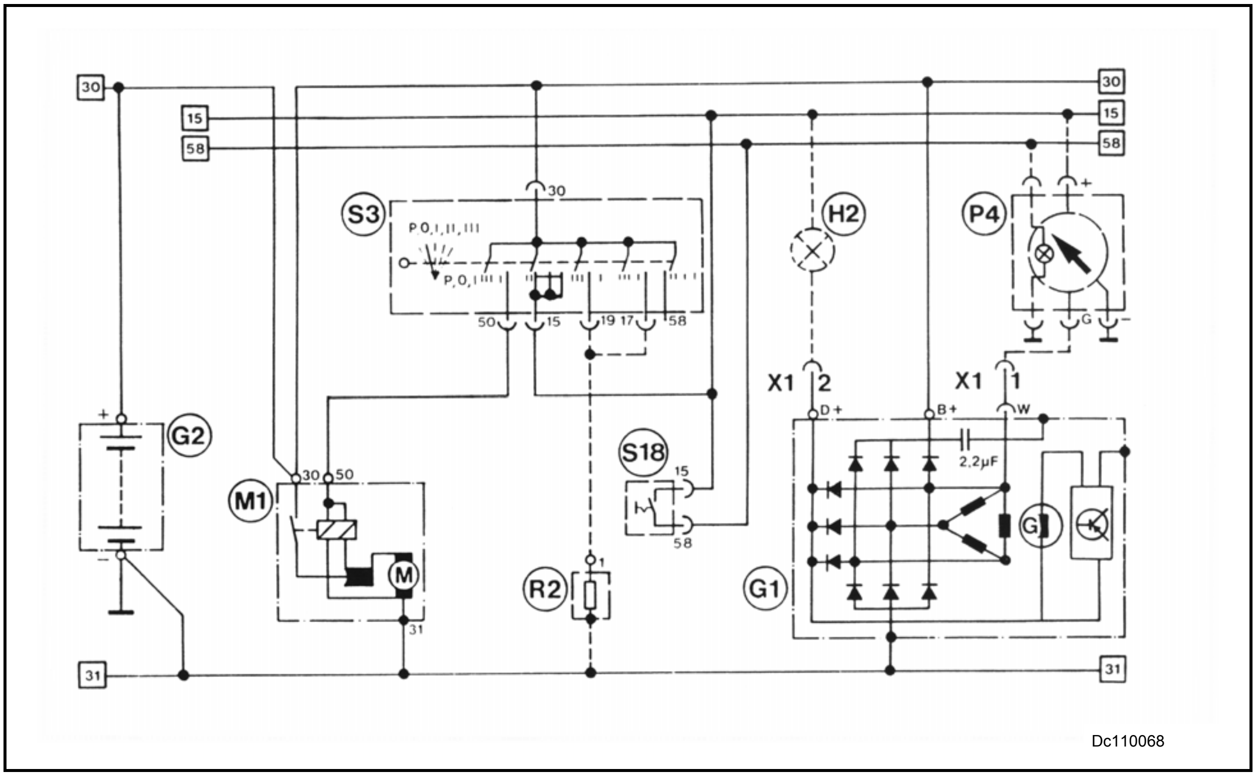
Wiring Harness

DC110067

X	receptacle	B3	engine oil temperature
X1	harness plugs	B6	engine oil pressure
Y1	solenoid	M1	starter motor

G1 alternator

The connector X on the FL/M1011/F has been relocated to the upper part of the engine near the cooling blower. The size of the connector has changed, yet the wire identification is identical to the 1011 harness



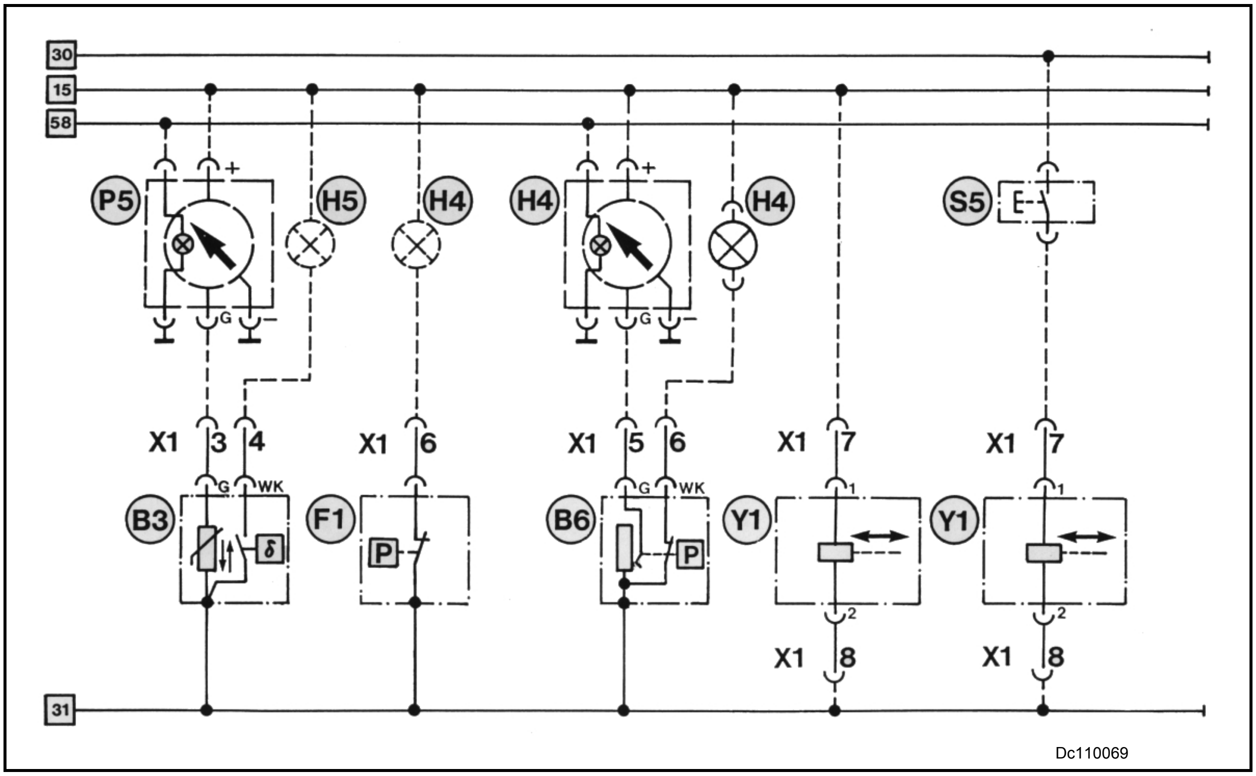
Wiring Schematic FL1011/E

DC110068

Starting circuit:

G2	battery	S18	panel light switch
M1	starter	G1	alternator
S3	starter switch	H2	charging light
R2	glow plug	P4	tachometer

The FL1011/E engines are equipped with a wiring harness and its schematic is laid out as shown on the overhead transparency.



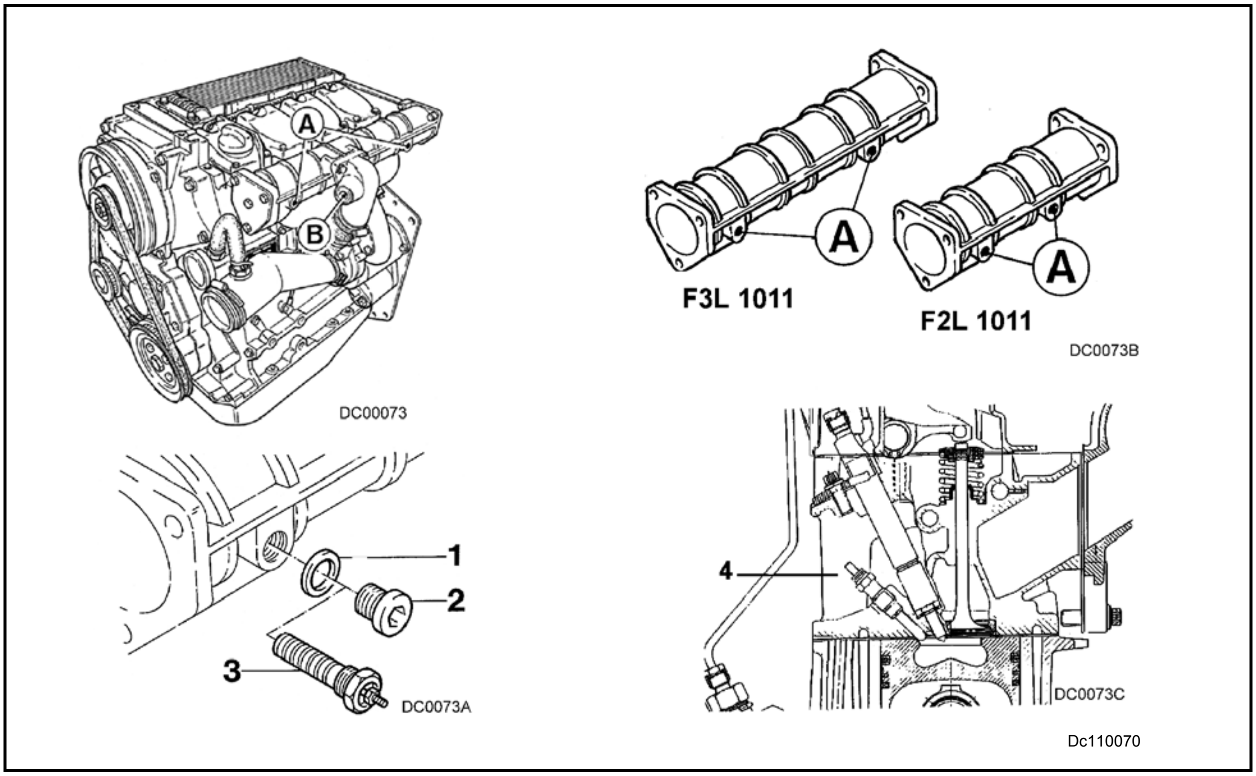
Wiring Schematic FL/M1011/F/E

DC110069

Warning/shut-off circuit

P5	Temperature gauge, oil	Y3	Solenoid, excess fuel
H5	Warning light, high oil temp.	H4	Warning light, oil pressure
H4	Warning light, oil pressure	S5	Push-button, engine stop
F1	Oil pressure switch	Y1	Solenoid, energ. to run/ energ. to stop
P1	Pressure gauge, oil	K20	Timing relay

BF4L1011 engines that operate with variable speed may be equipped with an aneroid (charge pressure dependent fuel stop). To allow the fuel rack to move in the excess fuel position during starting, an electric solenoid is also installed.
Remember! No more timing relay for turbo charged engines.
Note: The wiring schematic has not changed, only the size of the connector X1.



Cold Starting Aid

DC110070

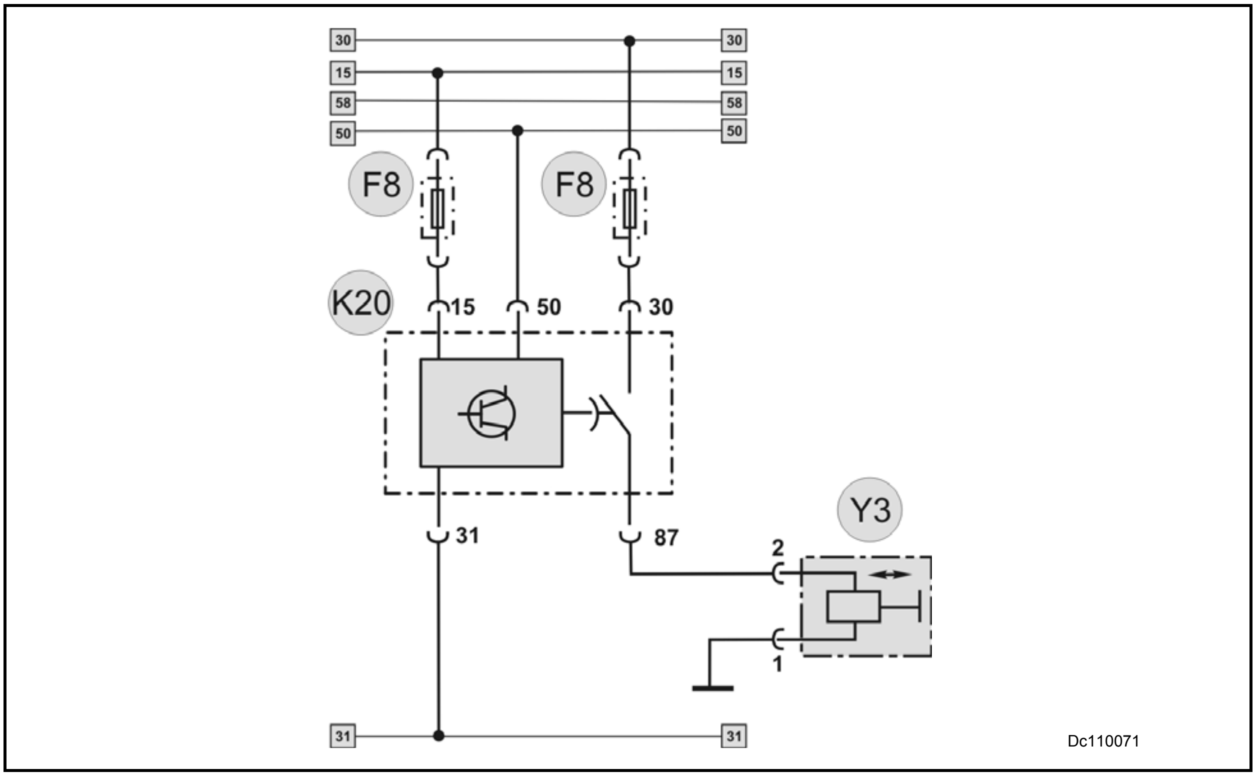
A FL1011
B BF4L1011

1.	Sealing washer	3.	Glow plug (Spiral)
2.	Plug	4.	Glow plug (Pentype)

Deutz offers starting aid kits optional, to be able to start the engines at much lower ambient temperatures.
The FL1011 engines can be equipped with spiral type pre-heat plug.
The energized glow plug will heat up the combustion air during the starting process.
This is to make sure that the ignition temperature is achieved to self-ignite the injected diesel fuel.
For the FL/M1011F several options of cold start aids are available

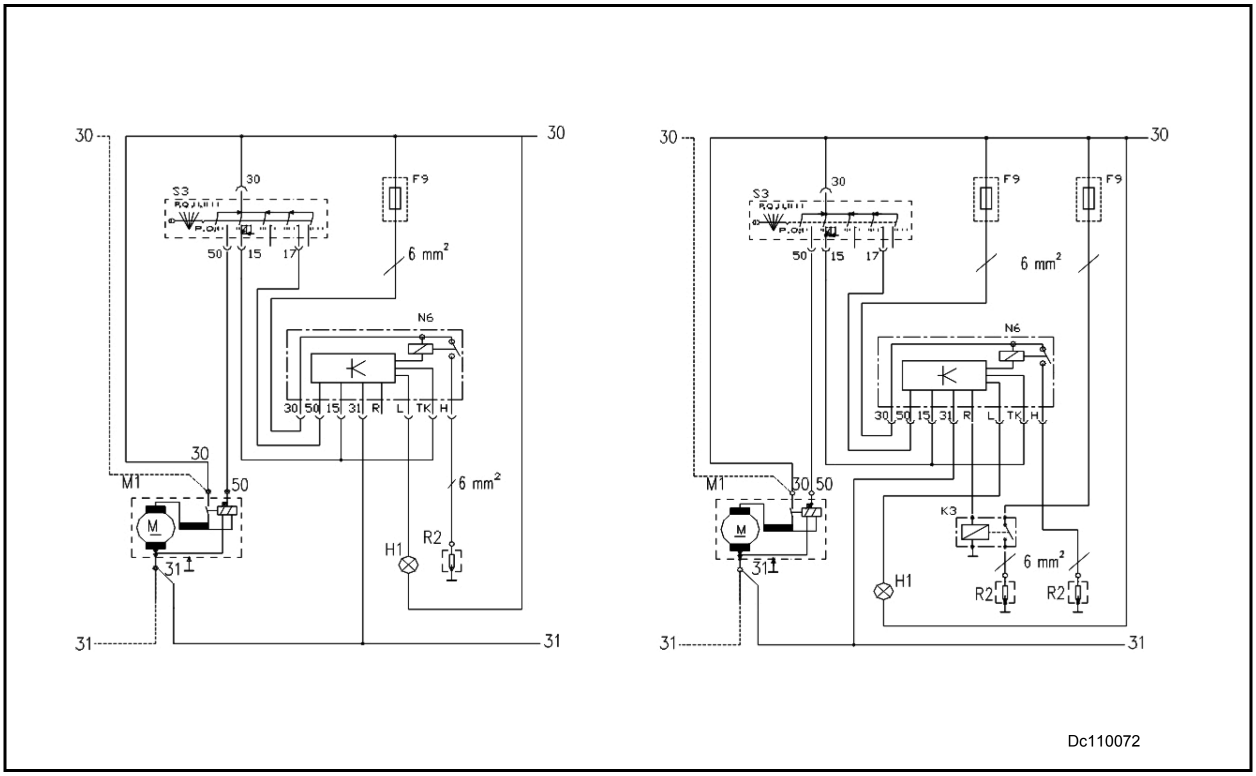
1. down to minus 100 C NA
2. down to minus 150 C 1 x Spiral glow plug (Standard engine)
3. down to minus 200 C 1 x Spiral glow plug (Standard engine) 2 x Spiral glow plugs (Optimised engine)
4. down to minus 300 C Pen type glow plug (Standatd engine) Pen type glow plug + 2 x Spiral plugs (Optim.engine)

All exhaust optimized engines must have a temperature control unit installed. Both the glow plugs and the contol unts are available for 12 and 24 volt.

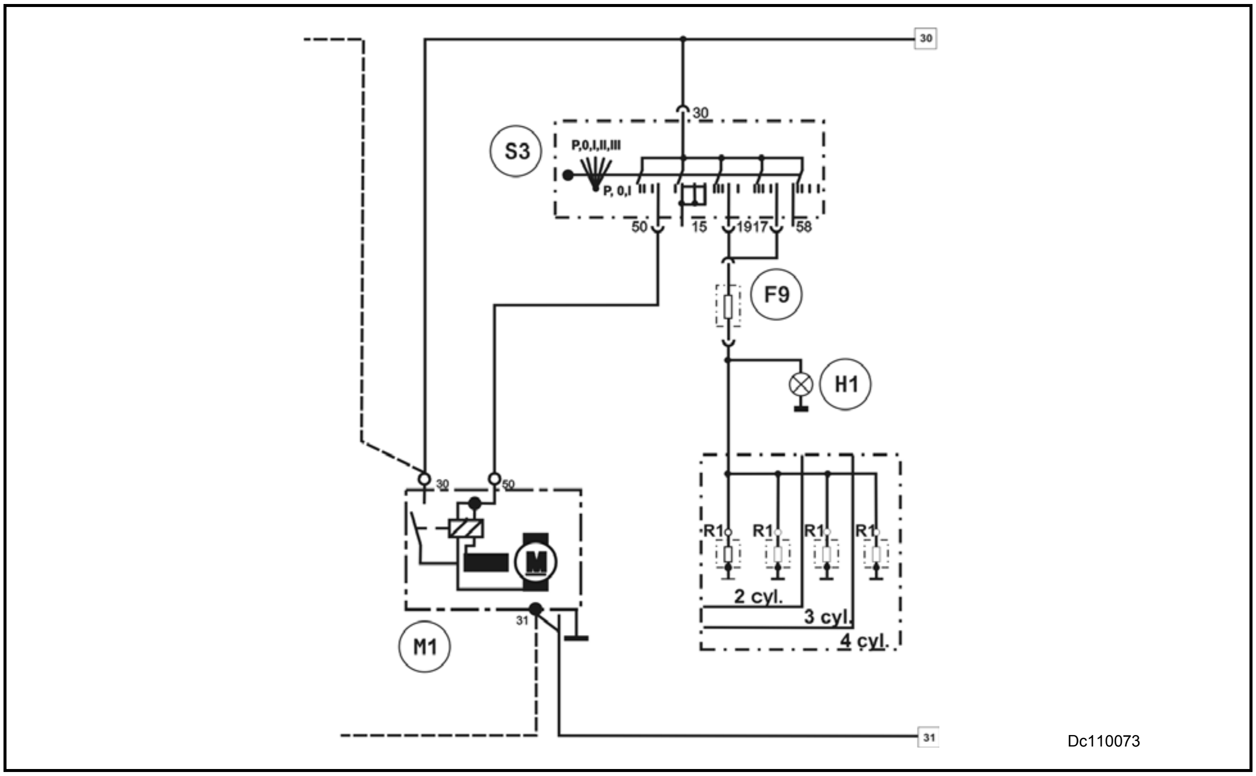


Cold Starting Aid

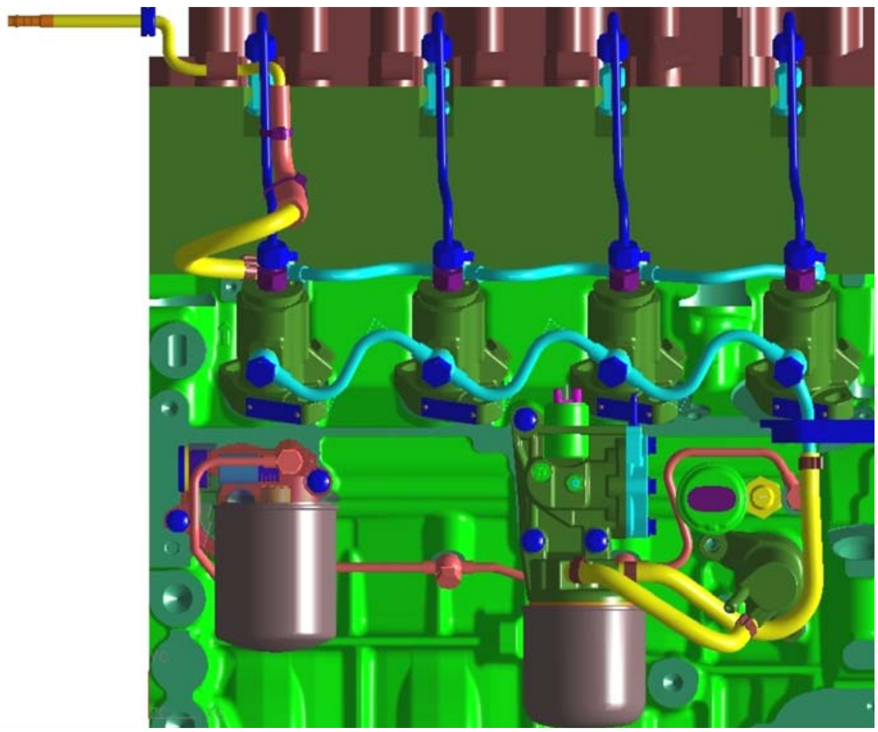
To ensure that the fuel rack stays in the excess fuel position for a given time period and to allow the engine speed to increase under load, a 10 second electric relay is loosely shipped from the factory which can be mounted and wired to the instrument panel.



Cold Starting Aid



Cold Starting Aid



2011 FUEL INJECTION SYSTEM

Engine Service Training

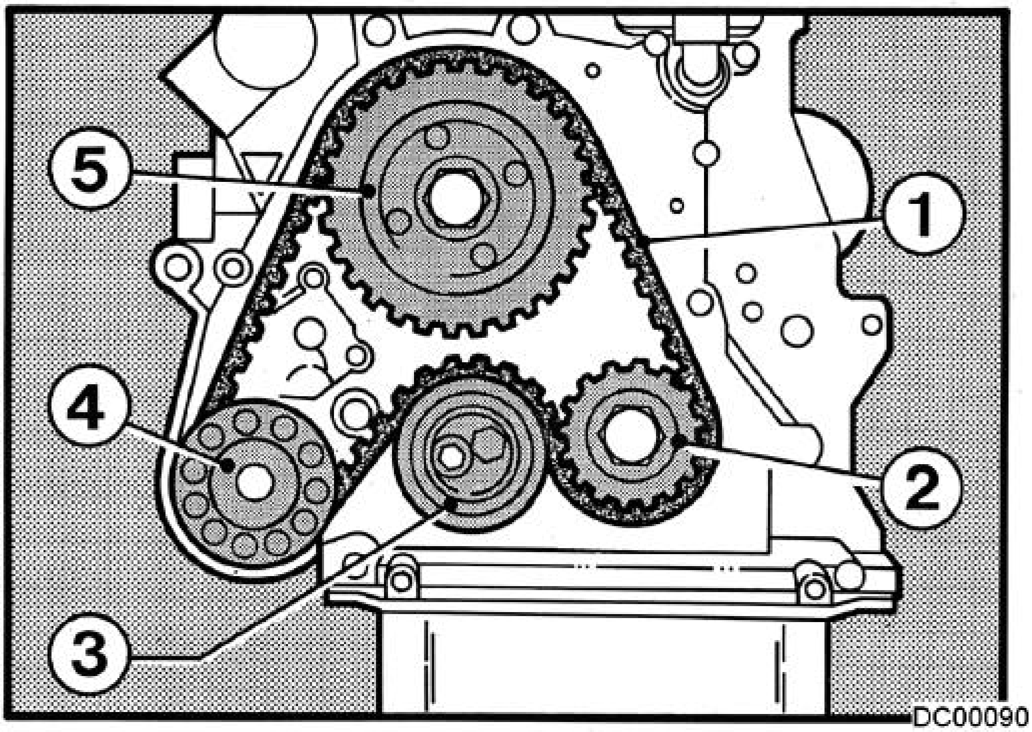
Tooth Belt Installation 1011/1011F

BELT REPLACEMENT
AT SPECIFIED MAINTENANCE INTERVAL

Part Number: 030

DEUTZ CORP.
Product Support
Training Center Atlanta

Title: Belt Maintenance 1011
By: D. Hensel
Date: April 2004
Revision : 2



B/FL 1011/E Drive Train

1. Toothed belt
2. Crankshaft gear
3. Tensioning pulley
4. Oil Pump
5. Camshaft Gear

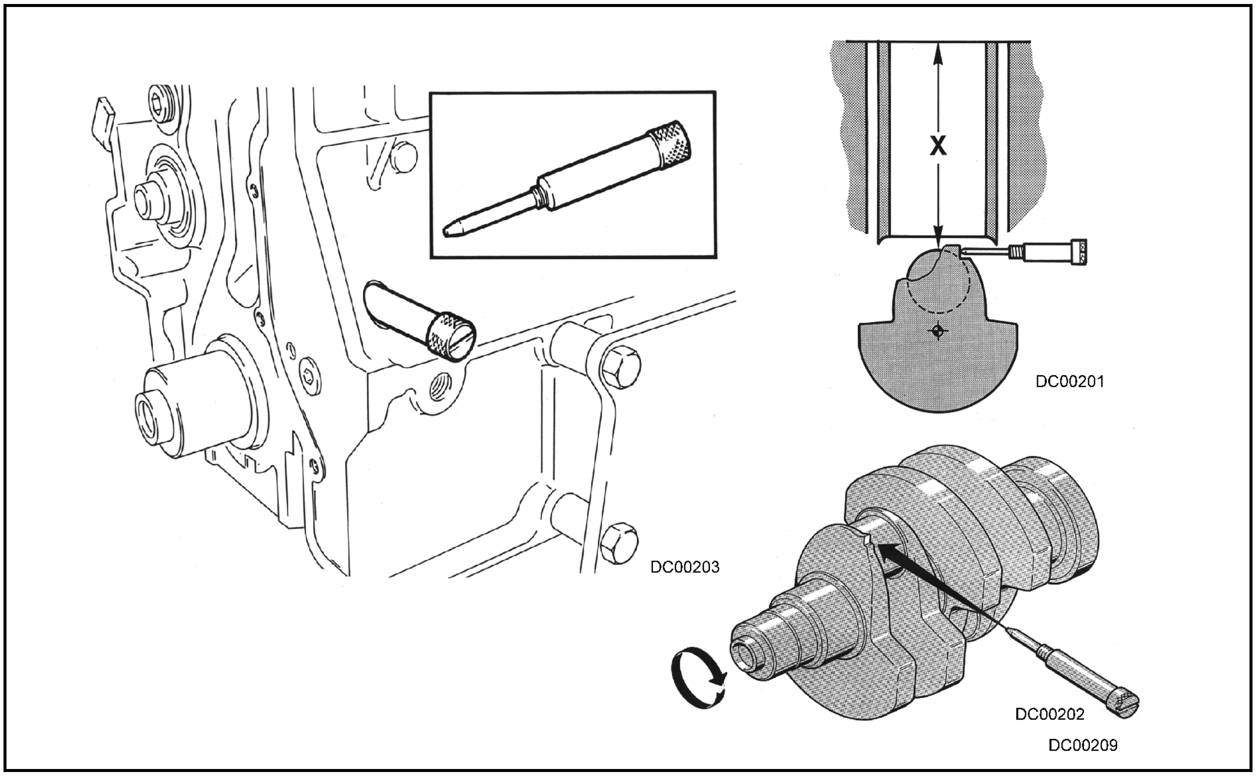
The belt (1) is located at the blower end of the engine. It is driven by the crankshaft (2) and driving the camshaft (5) and the externally mounted engine oil pump (4). It is tensioned by the tensioning pulley (3).

The use of a toothed belt, instead of gears, has two main advantages: flexibility of selecting the camshaft location and low noise emission. A reinforced plastic cover protects the drive train.

When replacing the toothed belt on an engine that is still assembled, it is not necessary to remove the rocker brackets or the fuel injection pumps.

<u>Do not remove toothed belt until specified later in the procedure.</u>

The following special tools are required:
1 set locking pins P/N 030 1093
1 tension measuring gauge P/N 030 1095
1 wrench; camshaft gear clamping washer P/N 030 1129

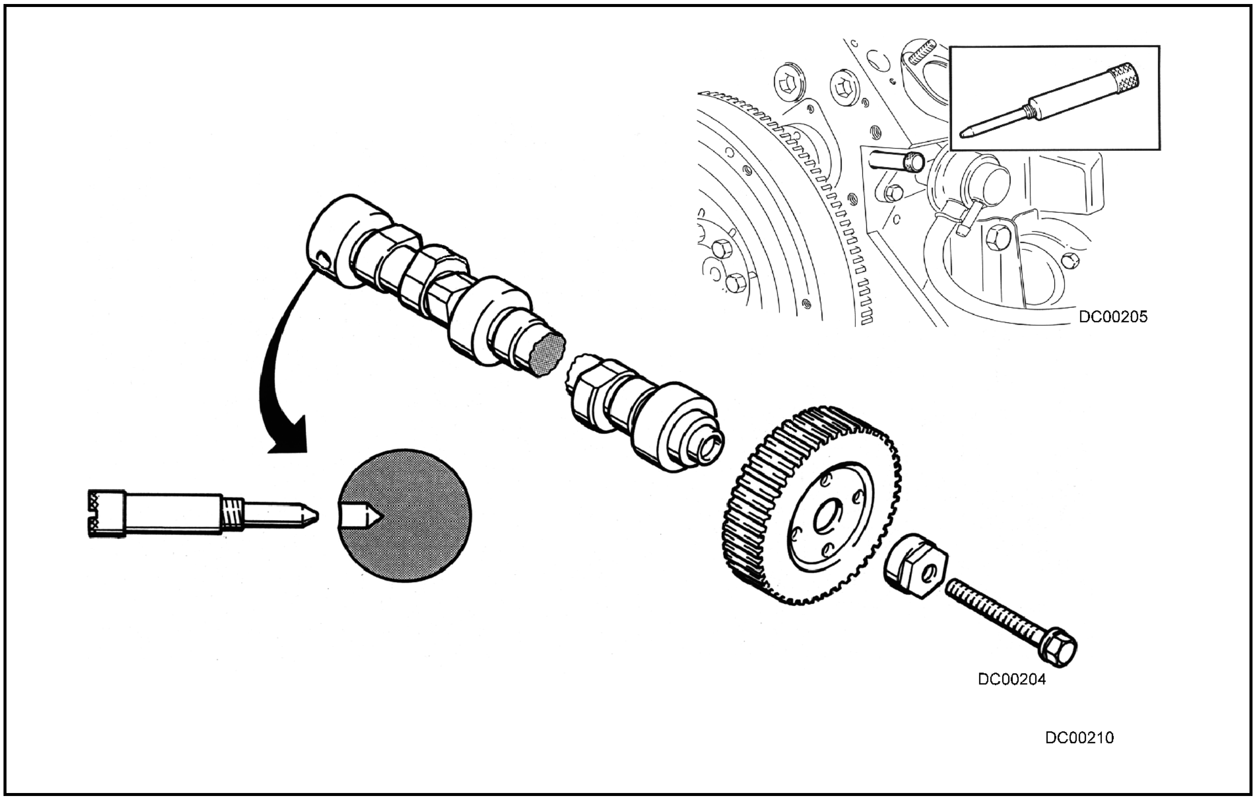


Camshaft Locking Position

It is necessary to time the crankshaft to the camshaft. This determines the fuel injection timing and valve timing. For this procedure, the crankshaft and camshaft have to be locked into a pre-determined position.

Remove the hex head screw plug from the crankcase located on the left side at the blower end right above the crankcase rim. Turn the crankshaft in rotating direction.

While shining light through the screw plug hole, a machined surface on the crank journal web becomes visible, when turning the crankshaft. Insert the locking pin (special tool) and tighten. Slowly turn crankshaft in rotating direction until it contacts the pin.



Crankshaft Locking Position

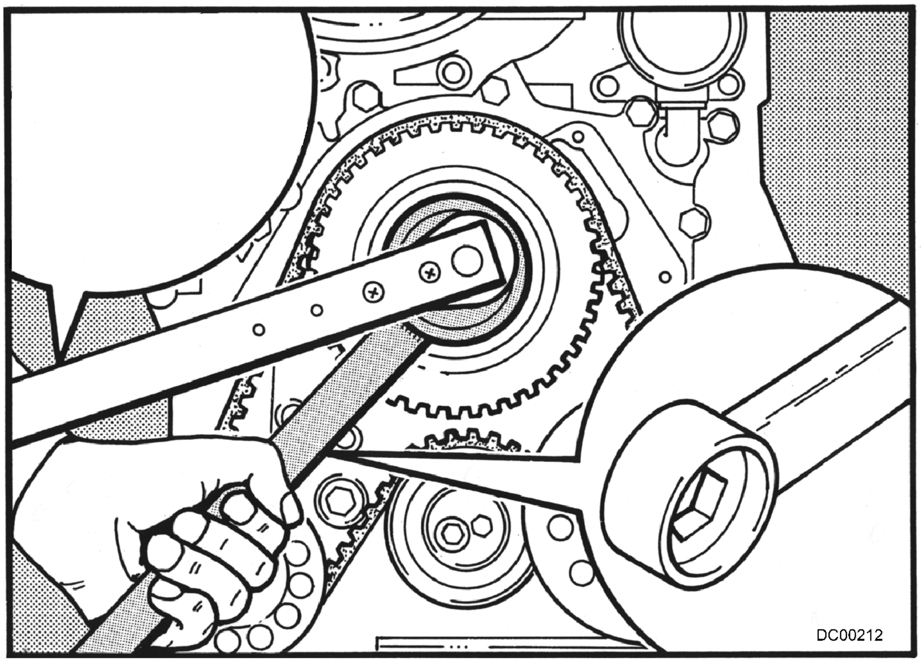
To be able to lock the camshaft in its correct position, remove the screw plug at the right side of the crankcase nearest the flywheel end.

Shining light through the opening of the crankcase, camshaft journal #1 can be seen, and the locating hole becomes visible. It might also be necessary to move the shaft in axial direction to align the locating hole with the bore in the crankcase.

Insert the locking pin and turn it in until it bottoms out against the crankcase.

Both camshaft and crankshaft are timed to each other.

Remove toothed belt and tensioning pulley.

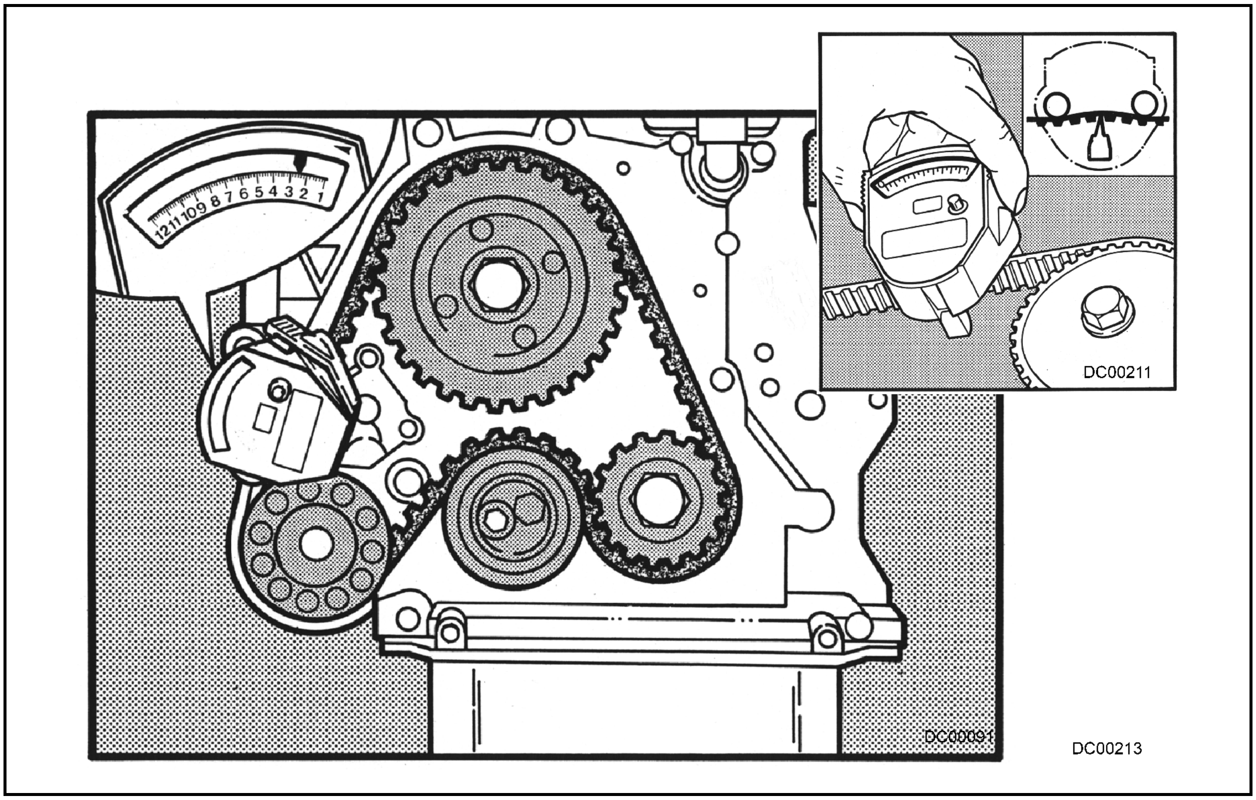


Camshaft Locking Position

Once the camshaft is locked in position, loosen the center bolt that holds the camshaft gear in place.

For safety reasons, use the Deutz special tool to hold the gear clamping washer.

If required, remove gear assembly and clean all parts from oil. All contact surfaces **must** be free of oil and completely **dry**.



Toothed Belt Installation

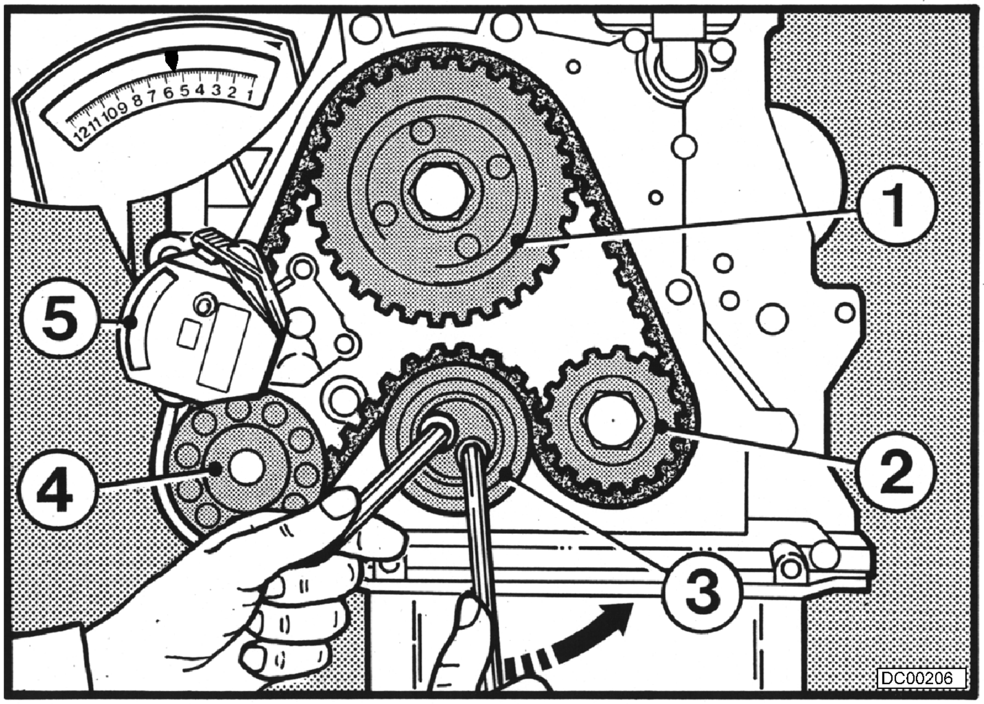
Install new tensioning pulley and rotate it that the opening for the allen wrench is located towards the oil sump sealing surface. Fit toothed belt to all gears. Pay special attention to the equal spacing between all the gears. Equally space the belt around its assembly, i.e. measure the distance from the crankcase surface to the edge of the belt. The spacing should measure 8 - 9 mm.

Note: Make sure the crankshaft is resting securely against the locking pin.

Slide tension measuring gauge onto the toothed belt. The procedure should be as follows:

Press the two levers of the gauge together. Push in the button on the gauge and hold. Release the two levers. The measuring device is now tensioned and locked. The belt tension should be measured between camshaft gear and oil pump gear. Slide the instrument onto the belt and make sure that the rollers are flush with the edge and the tensioning finger is between two teeth of the belt.

Press the levers of the gauge together which releases the lock. The gauge is now secure and tight on the belt.



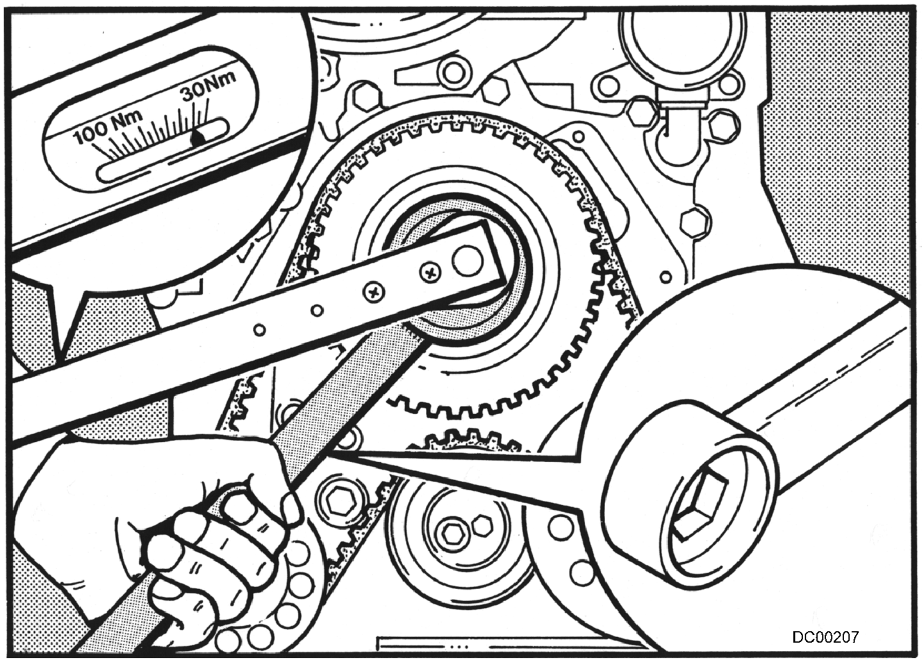
Toothed Belt Tensioning

1. Camshaft gear
2. Crankshaft gear
3. Tensioning pulley
4. Oil pump drive
5. Tensioning measuring gauge

Note: Make sure the belt tensioning device is not touching any engine components, e.g. pump gear, cam gear.

Pre-tension toothed belt. Turn tensioning pulley with the aid of an allen wrench **counter-clockwise**. Turn until a scale reading of 3.0-3.5 is achieved.

Tighten the tensioning pulley bolt with 45-49 Nm.



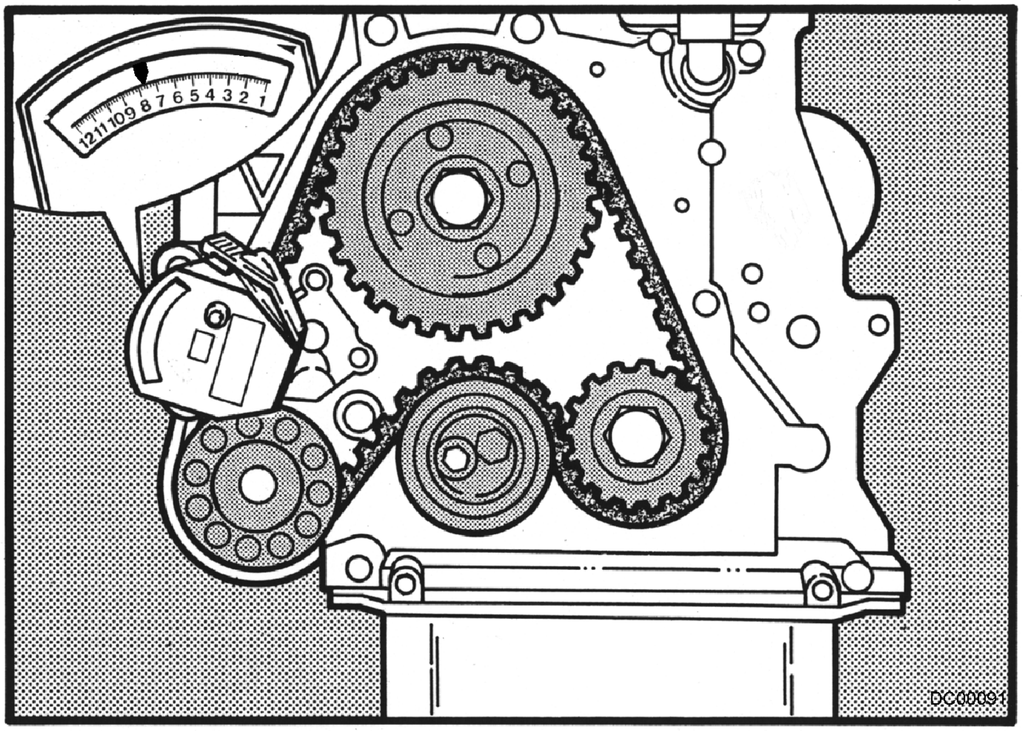
Toothed Belt Tensioning

Hold camshaft gear clamping washer with special tool. Pre-load camshaft bolt with 30 Nm.

Note: Pay special attention to the bolt grade.

Tighten the camshaft bolt as follows:
1. Bolt grade 10.9 tighten to 150°
2. Bolt grade 12.9 tighten to 210°

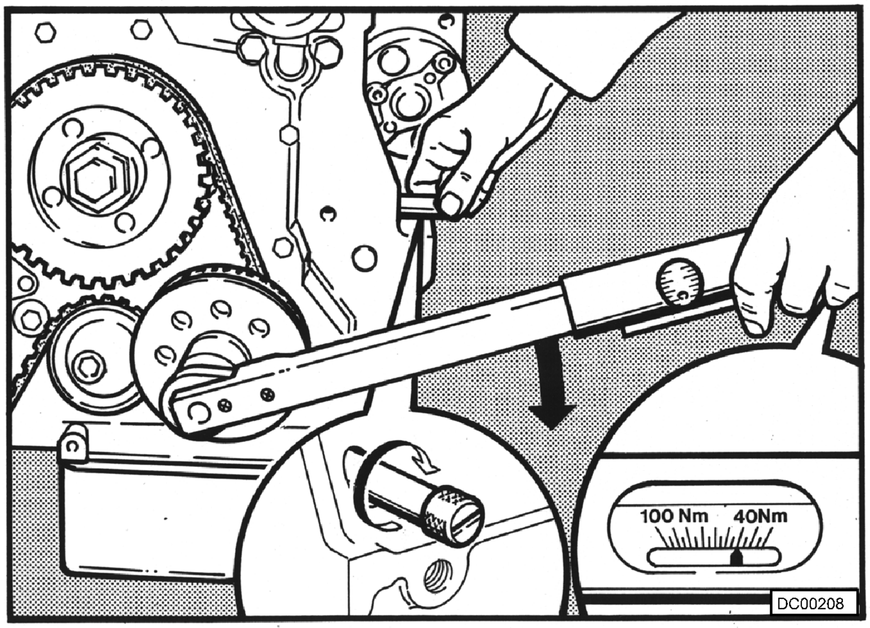
Remove adjusting pins from crankshaft and camshaft. Remove also tension measuring gauge.



Toothed Belt Tensioning Check

Turn **crankshaft** in rotating direction through **four** complete rotations. Reinstall tension measuring gauge as described earlier. A reading of 6.5 - 9.5 should be obtained. If the scale reading is not obtained, re-adjust the belt tension, following the previous procedure.

Note: A toothed belt, that has been in operation , **must not** be reused.



Valve Timing Check

It is necessary that the hex head screw plugs are removed.

Install **camshaft** locking pin and turn it into the crankcase as far as it will go. Attach a torque wrench to the central crankshaft bolt. Apply a torque of 40 Nm in the direction of crankshaft rotation. Do not hold the load, slowly release it and remove the torque wrench. Turn the **crankshaft** locking pin into the crankcase until it makes slight contact with the crankshaft. Mark the position of the locking pin. The timing is correct when the pin still can be turned in for ¾ or 2¼ turns until it bottoms out. If the pin cannot be turned in that far or the pin bottoms out before it contacts the crankshaft, perform the previous installation procedure. If the checks are within specification, remove both locking pins. Close the holes with the screw plugs, applying new copper seals.

Reassemble engine.

Engine Service Training

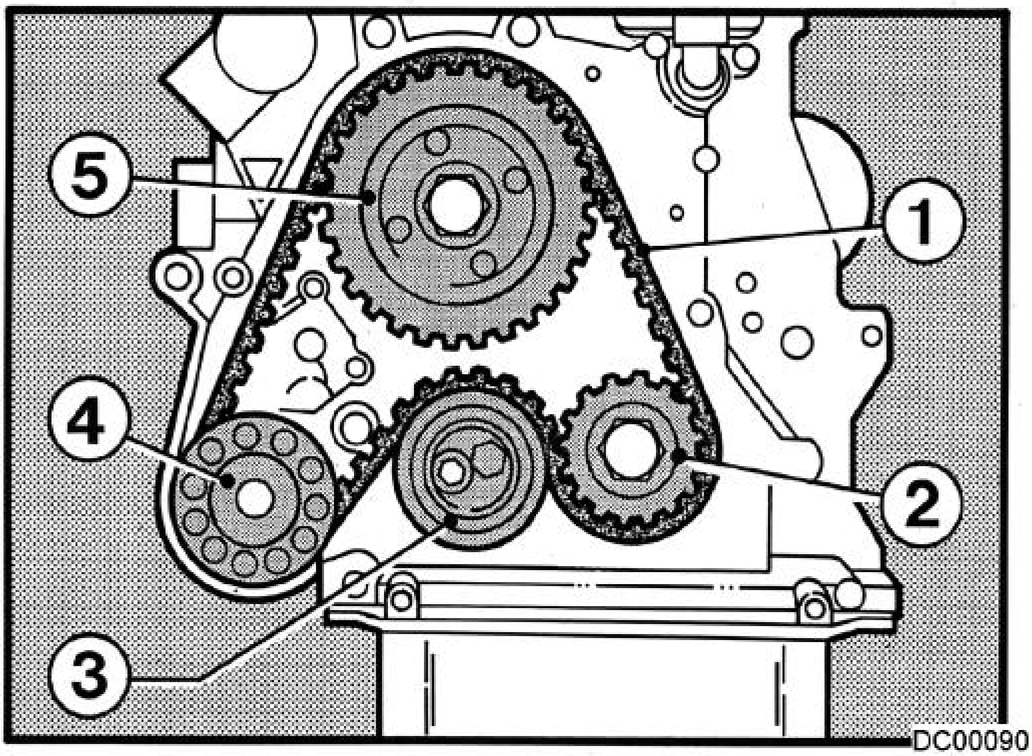
Tooth Belt Installation 1011/1011F

BELT REPLACEMENT
AT ENGINE OVERHAUL

Part Number: 030

DEUTZ CORP.
Product Support
Training Center Atlanta

Title: Engine Overhaul 1011
By: D. Hensel
Date: April 2004
Revision : 2



B/FL 1011/E Drive Train

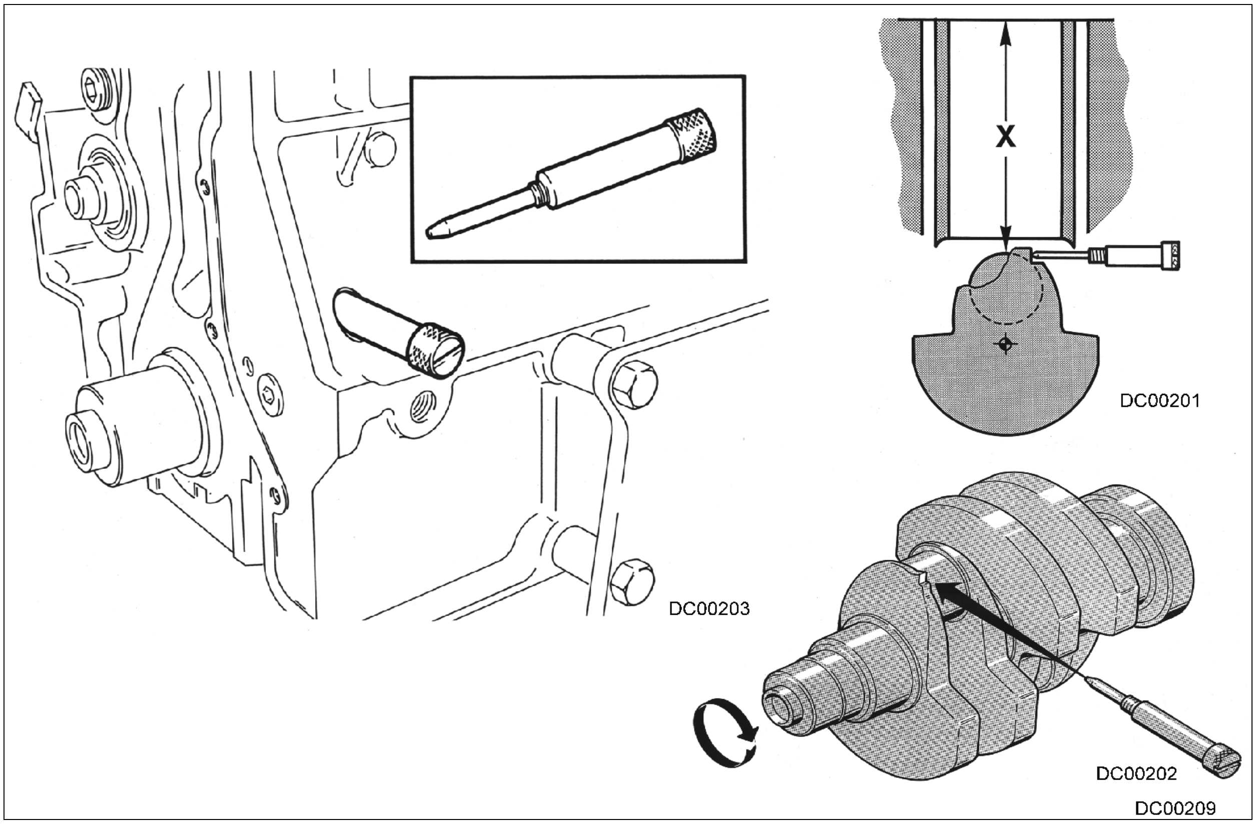
1. Toothed belt
2. Crankshaft gear
3. Belt tensioner
4. Oil pump
5. Camshaft gear

The belt (1) is located at the blower end of the engine. It is driven by the crankshaft (2) and driving the camshaft (5) and the externally mounted engine oil pump (4). It is tensioned by the tensioning pulley (3).

The use of a toothed belt, instead of gears, has two main advantages: flexibility of selecting the camshaft location and low noise emission.

A reinforced plastic cover protects the drive train.

The following special tools are required:
1 set locking pins P/N 030 1093
1 tension measuring gauge P/N 030 1095
1 wrench; camshaft gear clamping washer P/N 030 1129



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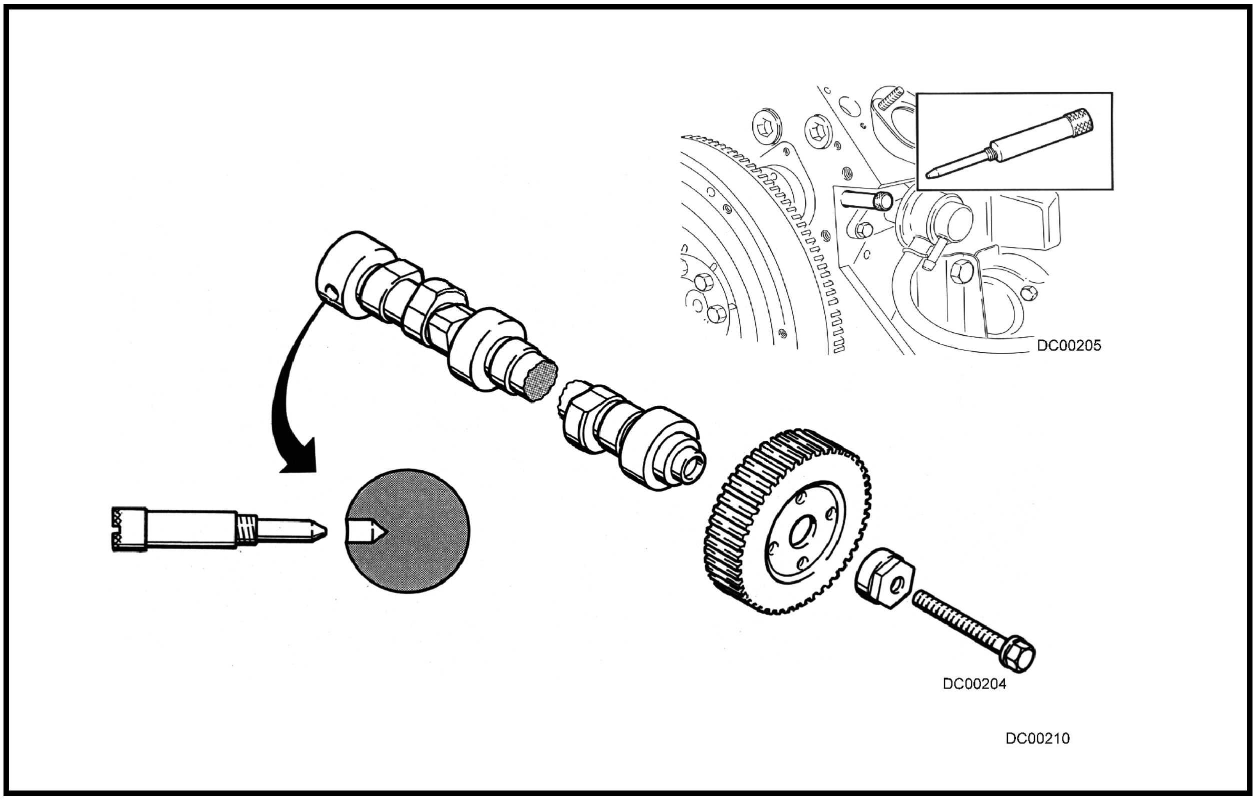

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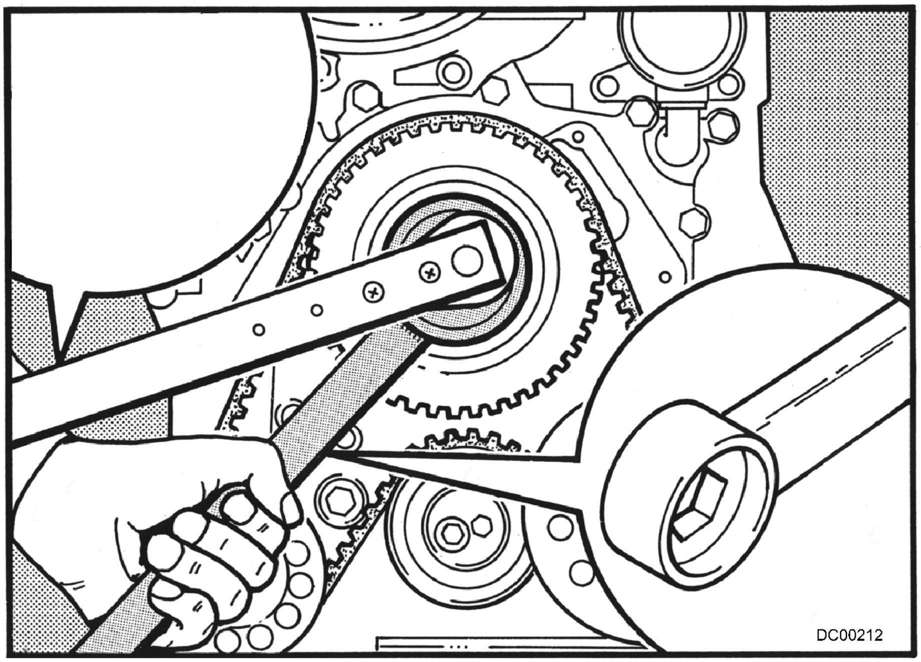
Both camshaft and crankshaft are timed to each other.



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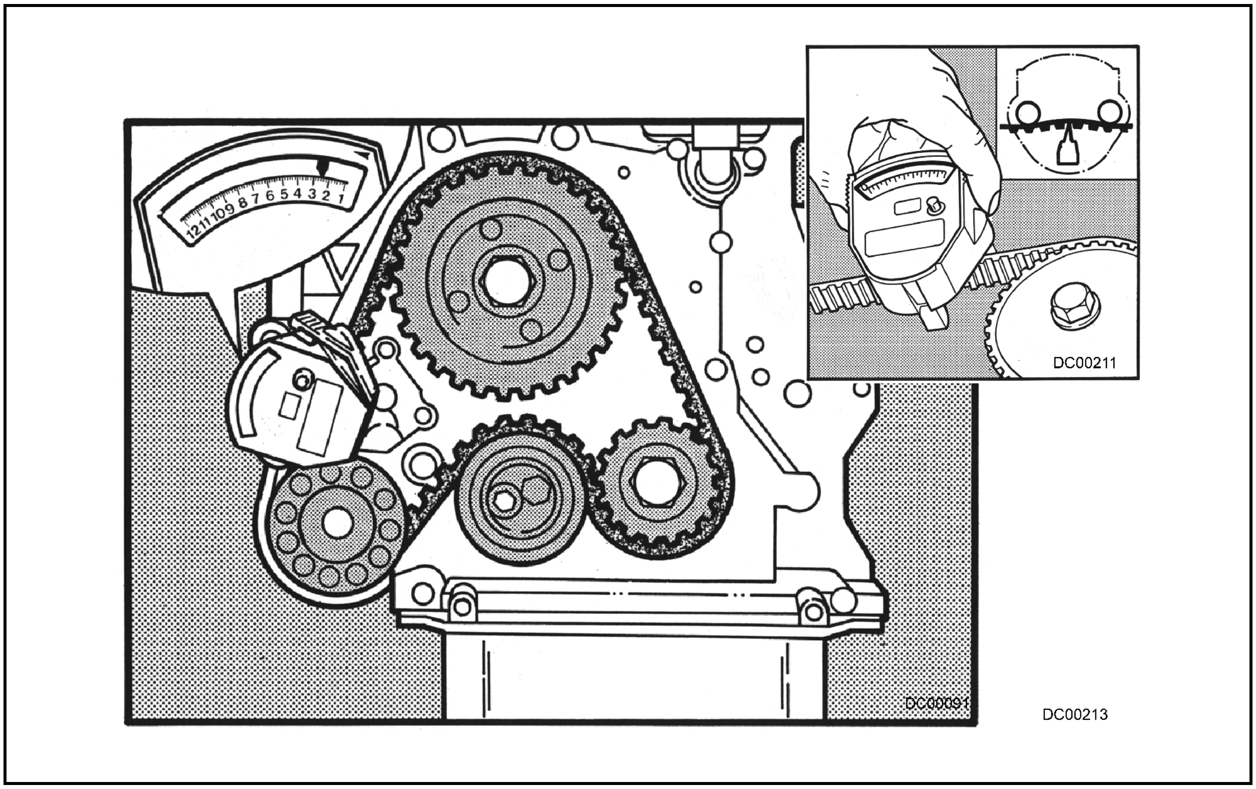

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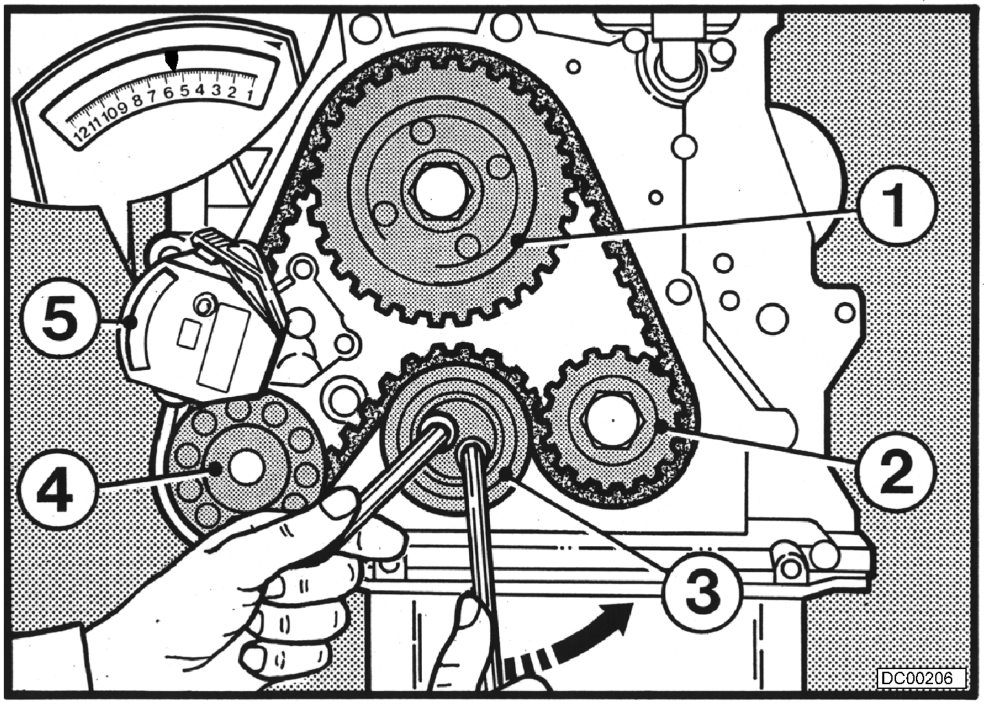

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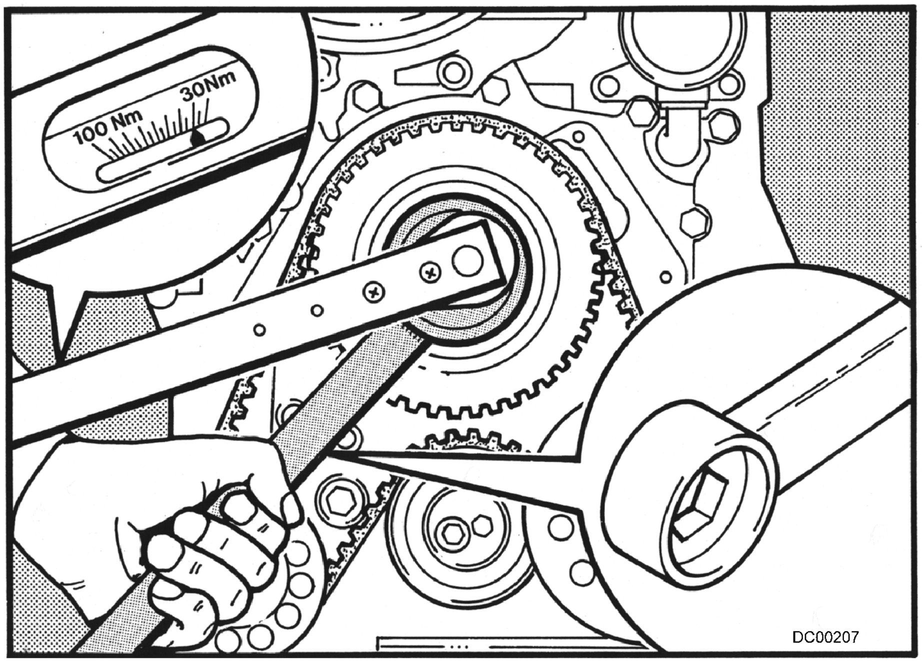

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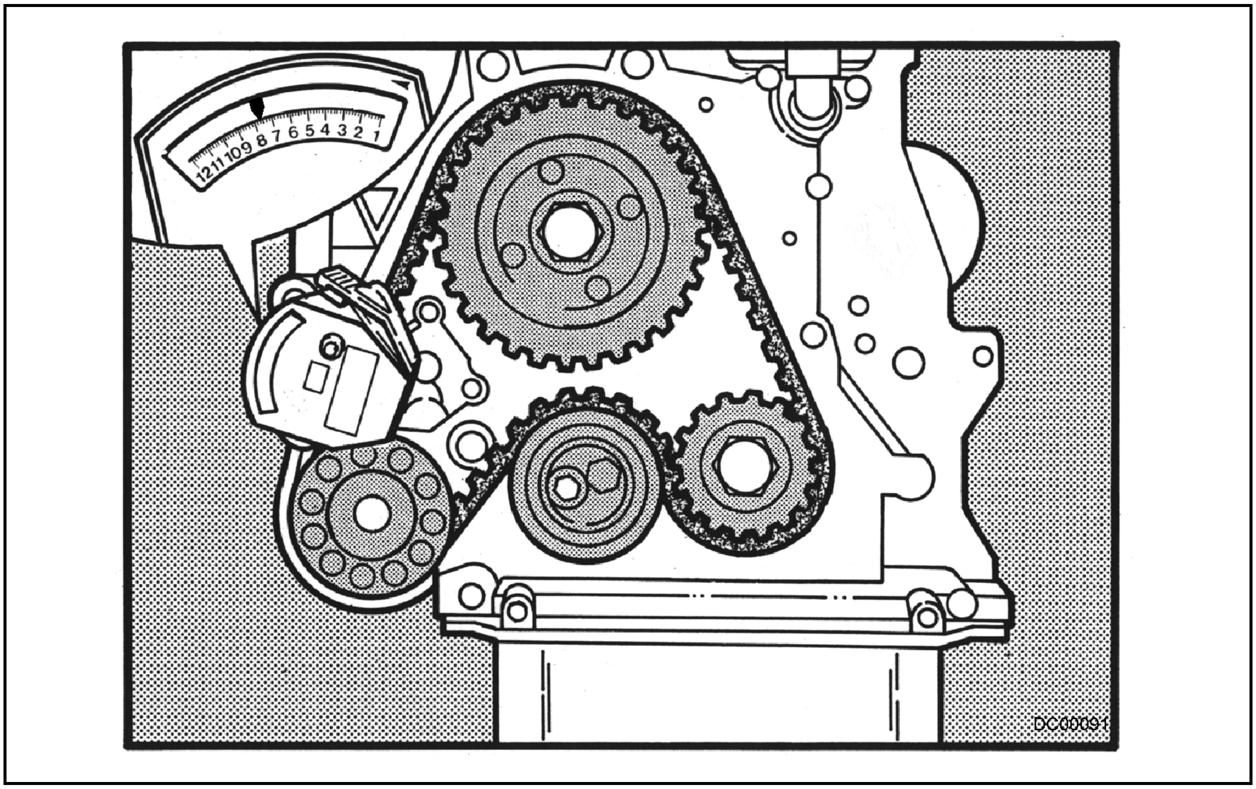

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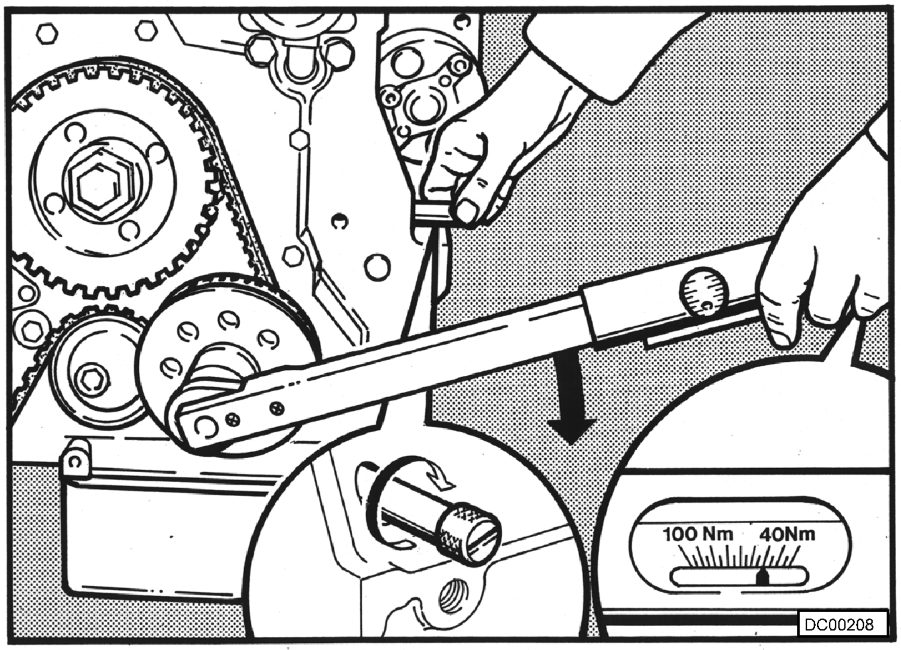

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Reassemble engine.