S SERIES EURO V

Application to vehicles

FICE3481

Technical and Repair manual

OPERATION

In this injection system, the pressure regulator, located upstream from the high-pressure pump, governs the flow of fuel needed in the low-pressure system. Afterwards, the high-pressure pump correctly supplies the hydraulic accumulator.

This solution, pressurizing solely the necessary fuel, improves the energy efficiency and limits heating the fuel in the system. The relief valve fitted on the high-pressure pump has the function of keeping the pressure, at the pressure regulator inlet, constant at 5 bars; irrespective of the efficiency of the fuel filter and of the system upstream. The action of the relief valve causes an increase in the flow of fuel in the high-pressure pump cooling circuit.

The high-pressure pump continually keeps the fuel at the working pressure, irrespective of the timing and the cylinder that is to receive the injection and accumulates it in a duct common to all the electro-injectors.

At the electro-injector inlet, there is therefore always fuel at the injection pressure calculated by the electronic control unit.

When the solenoid valve of an electro-injector is energized by the electronic control unit, fuel taken straight from the hydraulic accumulator gets injected into the relevant cylinder.

The hydraulic system is made out of a low-pressure fuel recirculation circuit and a high-pressure circuit.

The high-pressure circuit is composed of the following pipes:

- pipe connecting the high-pressure pump outlet to the Rail;
- hydraulic accumulator;
- pipes supplying the electro-injectors.

The low-pressure circuit is composed of the following pipes:

- fuel intake pipe from the tank to the pre-filter;
- pipes supplying the mechanical supply pump and the pre-filter;
- pipes supplying the high-pressure pump via the fuel filter.

The fuel system is also fitted with the fuel exhaust circuit and the electric injectors.

According to the high performance of this hydraulic system, for reasons of safety it is necessary to:

- avoid connecting high-pressure pipe fittings with approximate tightening;
- avoid disconnecting the high-pressure pipes with the engine running (NEVER try bleeding, which is both pointless and dangerous).

The integrity of the low-pressure circuit is also essential for the system to work properly; it is therefore necessary to avoid all manipulation and modifications and act only in the event of leakage.

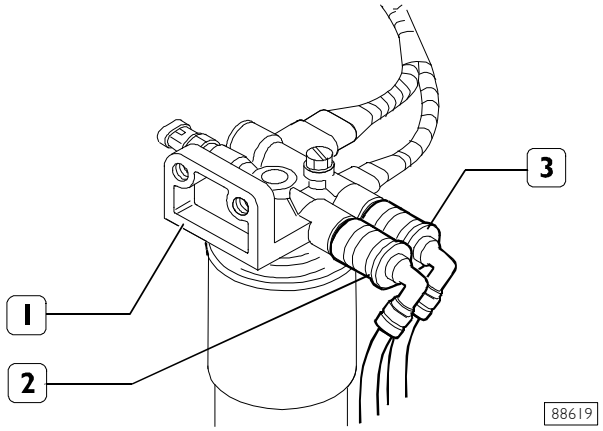
HYDRAULIC SYSTEM

The hydraulic system is composed of:

- tank
- fuel pre-filter
- electric supply pump
- fuel filter
- high pressure supply pump with supply pump built inpressure regulator
- manifold (rail)
- electro-injectors
- supply pipes and fuel recirculation

Fuel pipes

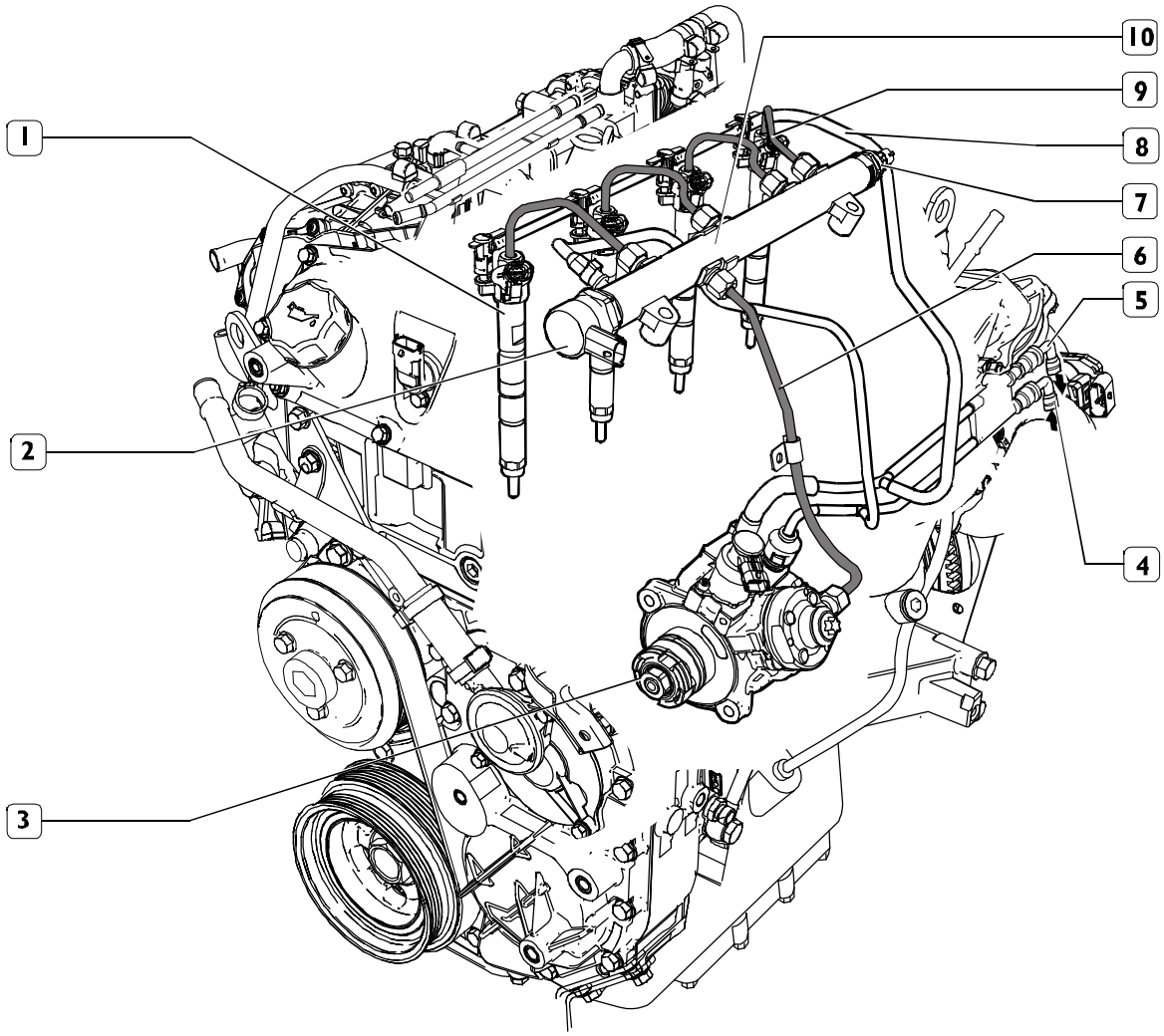
Figure 1



1. Fuel filter mounting - 2. High-pressure pump supply pipe quick-coupling fitting – 3. Supply pipe quick-coupling fitting.

If disconnecting the fuel pipes (2-3) from the mounting (1), it is necessary, when refitting, to make sure their fittings are perfectly clean. This is to avoid an imperfect seal and fuel getting out.

Figure 2



High pressure fuel pipes

Low pressure fuel recirculation pipes

FUEL FEED AND CIRCULATION SYSTEM

1. Electric injector - 2. Pressure regulating valve (DRV) - 3. CP4.1 high-pressure pump - 4. Fuel delivery pipe to the high-pressure pump - 5. Fuel return pipe to the tank - 6. High-pressure fuel delivery pipe to the hydraulic accumulator (rail) - 7 Pressure sensor - 8. Injector fuel exhaust pipe - 9. High-pressure fuel delivery pipe to the electric injectors - 10. Hydraulic accumulator (rail)

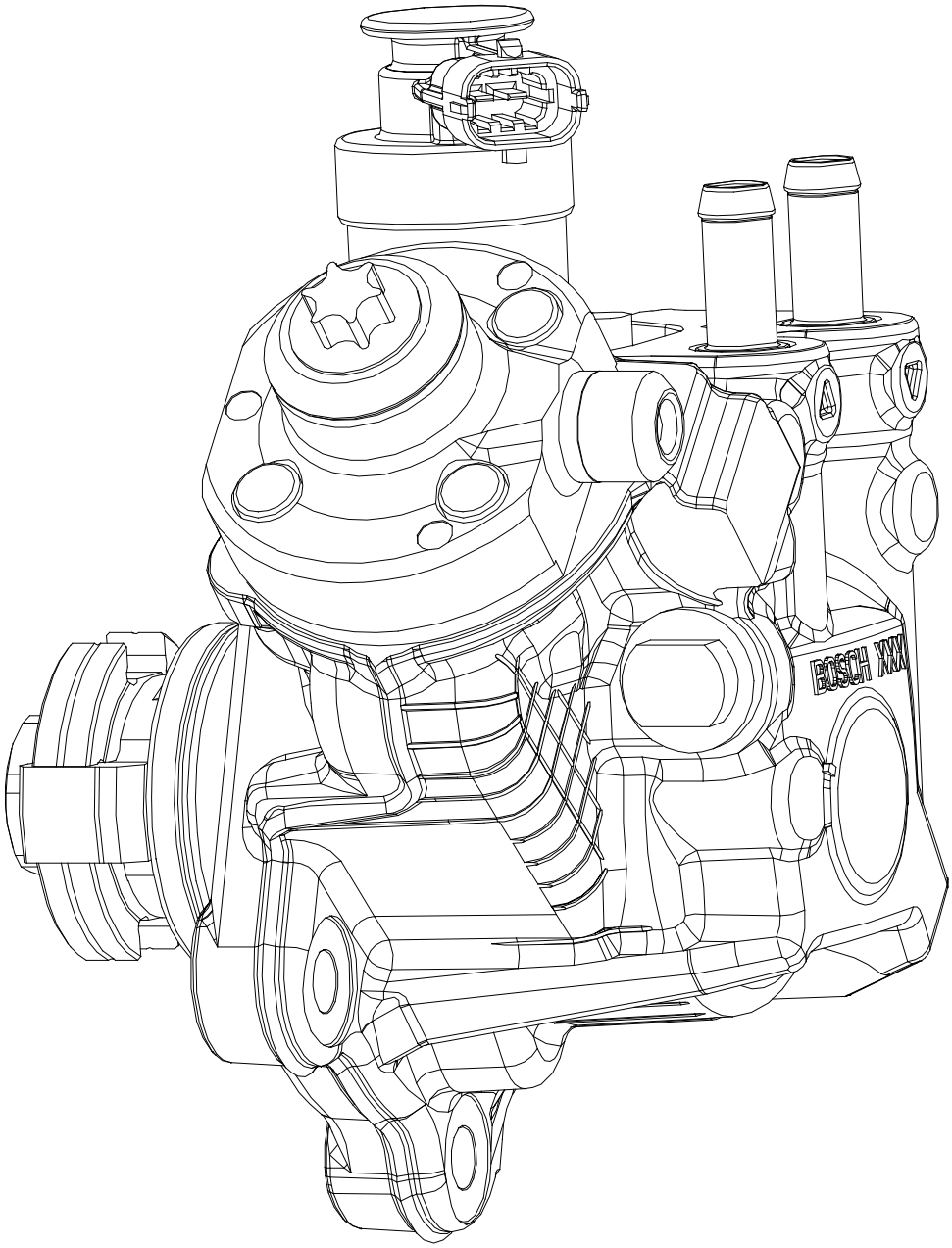
Check valve characteristics

opening pressure $0.5^{+0.05}_{-0.1}$ bar

differential pressure less than 0.2 bar at 120 litres/h of fuel.

High pressure pump CP4.1 description

Figure 3



126023

Pump with one radial plunger controlled via a gear by the timing belt; it needs no timing.

The pump is lubricated and cooled by the fuel.

The operating pressure is controlled as follows:

- ❑ electronically by a solenoid valve located on the pump casing and controlled by the ECU;
- ❑ by a regulator valve (DRV) mounted on the hydraulic accumulator (Rail).

Fuel supply is provided by a transfer pump. This is built into the fuel level indicator located in the fuel tank incorporated into the fuel intake assembly (GAC) together with the fuel level signalling device located in the fuel tank.

NOTE The high-pressure pump cannot be overhauled; therefore, it must not be removed or tampered with. Only the following repairs are permitted: replacing the drive gear and the pressure regulator.

Pressure control valve

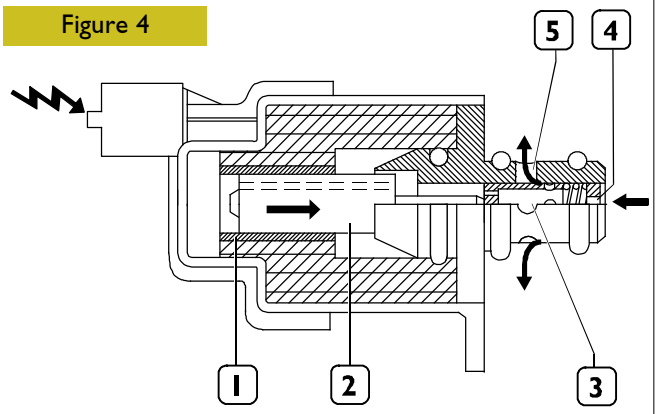
The fuel pressure regulator is mounted on the low-pressure circuit of the CP4 pump. The pressure regulator modulates the amount of fuel sent to the high-pressure circuit according to the commands received directly from the engine control unit. The pressure regulator is mainly composed of the following components:

- connector
- casing
- solenoid
- pre-load spring
- shutter cylinder.

When there is no signal, the pressure regulator is normally open, therefore with the pump providing maximum delivery. The engine control unit, via the PWM (Pulse Width Modulation) signal, modulates the change in fuel flow rate in the high-pressure circuit by partially closing or opening the sections of passage of the fuel in the low-pressure circuit.

Operation

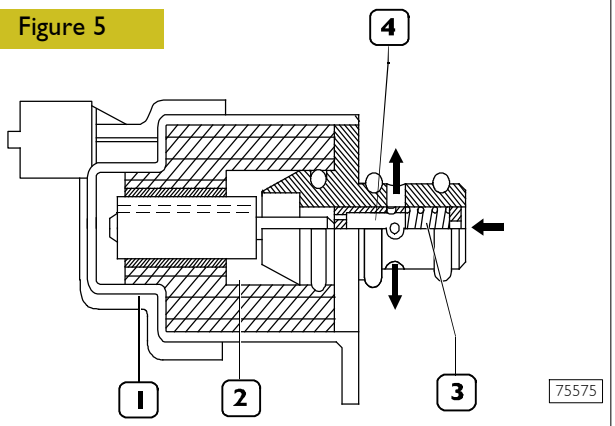
Figure 4



1. Solenoid - 2. Magnetic core - 3. Shutter cylinder - 4. Fuel inlet - 5. Fuel outlet.

When the engine control unit governs the pressure regulator (via PWM signal), the solenoid (1) is energized that, in its turn, generates the movement of the magnetic core (2). The shift of the core causes the shutter cylinder (3) to move axially, choking the flow of fuel.

Figure 5

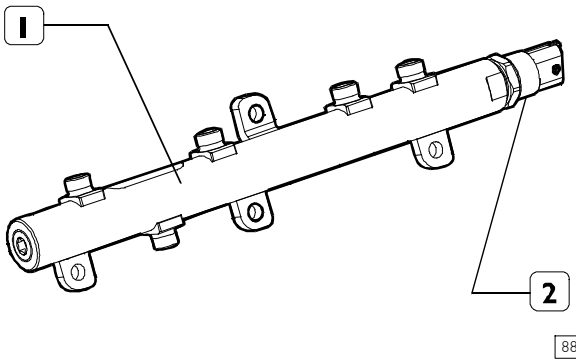


1. Solenoid - 2. Magnetic core - 3. Pre-load spring - 4. Shutter cylinder.

When the solenoid (1) is not energized, the magnetic core is pushed into the rest position by the pre-load spring (3). In this condition, the shutter cylinder (4) is in such a position as to offer the fuel the greatest section of passage.

Hydraulic accumulator (rail)

Figure 6



The hydraulic accumulator is fitted on the cylinder head on the suction side.

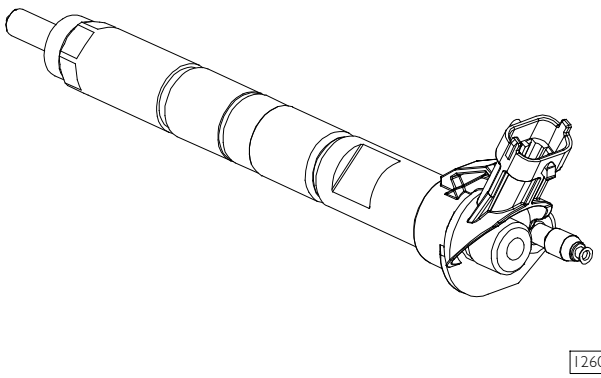
With its volume of approximately 8.8 cm^3 it dampens the pressure ripples of the fuel due to:

- the operation of the high-pressure pump;
- the opening of the electro-injectors.

On the hydraulic accumulator (1) there is the fuel pressure sensor (2).

ELECTRO-INJECTORS

Figure 7



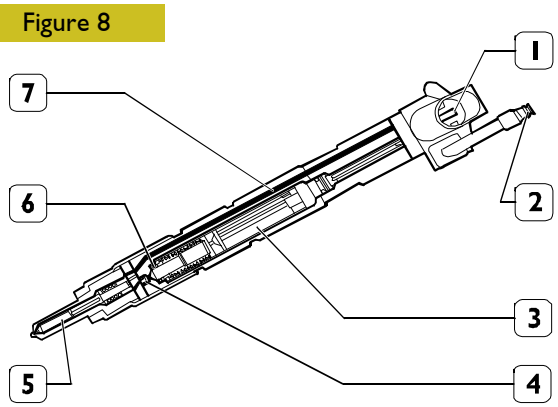
The piezoelectric injectors are located on the engine head and receive the fuel under pressure from the rail. They operate both the high pressure fuel supply and recirculation under atmospheric pressure of the excess fuel that has not been injected.

The following are installed on the injector head :

- ❑ a central access pipe for fuel under high pressure;
- ❑ a lateral pipe for the recirculation of fuel under low pressure with built-in throttle;
- ❑ the site for the electric connector that receives commands from the control unit.

The electronic control unit controls the piezoelectric actuator inside the injector.
The piezoelectric actuator, due to reduced switching times, enables a very fast reaction to the commands sent from the engine control unit, making injection capacity more flexible and increasing the number of injections per cycle.

Figure 8



1. Electrical connection - 2. Connection for fuel return flow - 3. Encapsuled piezoelectric actuator - 4. Control valve - 5. Nozzle - 6. Hydraulic amplifier - 7. High pressure line

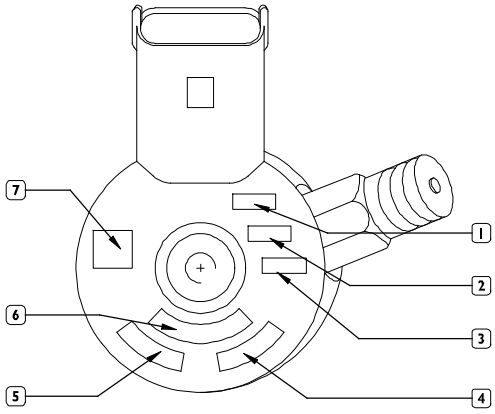
Operation

When the piezoelectric actuator (3) is reached by an electrical load, commanded by the control unit, it increases its length. The movement, amplified by the hydraulic amplifier (6), act mechanically on the control valve (4) and it allows therefore the injection of the fuel present in the high pressure duct (7). While stopping the electrical load, the actuator reacts elastically and again assumes its initial length.The springs add their contribution, winning the pressures that act in balancing on the whole surface of the components.
The fuel in excess is than recirculated in the fuel circuit through the duct (2).

REPLACEMENT OF INJECTORS ON VEHICLE

Electro-injector reprogramming

Figure 9



1. Production plant code - 2. IMA Matrix code - 3. Uncoded IMA code - 4. Bosch spare part No. - 5. Date of production - 6. Serial No. - 7. Production line code - 8. Iveco spare part No.

The electro-injectors are no longer divided into classes: Min (01) - Med (02) - Max (03), so that deviations from the design flow rates are measured, at the final testing phase, by the manufacturer for each injector and stamped with the IMA code (Injector Menge Abgleichung) on the injector magnet. At the engine production facility, the I.M.A. code is read in line by an automated reading station, converted into bar code, printed on the engine identification label and applied to the engine.
In the vehicle factory, the EDC 17 ECU is programmed at the end of the line by automatically reading the engine label.

Figure 10

numero	codice OCR iniettore
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

numero	codice OCR iniettore
A	A
B	B
C	C
D	D
E	E
F	F
G	G
H	H
I	I
J	J
K	K
L	L
M	M
N	N
O	O

numero	codice OCR iniettore
P	P
Q	Q
R	R
S	S
T	T
U	U
V	V
W	W
Y	Y
Z	Z

Conversion table of OCR characters into ARIAL font

105067

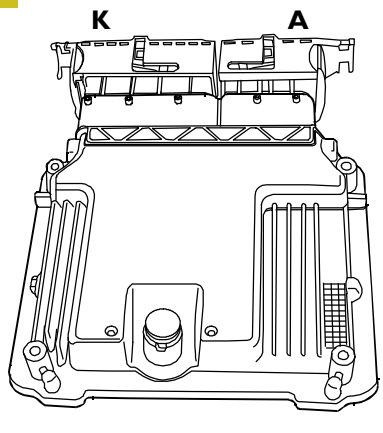
At the assistance centre the uncoded IMA code is required (3, Figure 9) for the ECU replacement and reprogramming procedure.
The table shows the conversion of OCR characters into Arial fonts.
When electro-injectors on engine mounted on vehicle require replacing, follow the instructions provided below:

- ❑ in cases where electro-injectors are removed and do not need to be replaced, their individual positions need to be noted in order to later re-install them in their original positions; this is done to avoid having to reprogram the ECU;
- ❑ after replacing one or more injectors, the ECU requires reprogramming;
- ❑ before installing a new electro-injector, note the IMA code stamped on the injector, as it becomes difficult to read the code once the injector is in position;
- ❑ in the event the ECU is replaced, program the new ECU with the IMA codes of the electro-injectors installed on the engine and copy the correction coefficients (ZFC) of the replaced ECU; if this is not possible, they must be reset and auto-configuration process must be restarted.

Whilst the engine is running, the EDC 17 ECU performs a number of tests on the electro-injectors' minimum flow rate.
In certain conditions (overrun: vehicle deceleration with pedal released) an increasing (very small) quantity of fuel starting from zero is injected and its effect on engine rotation smoothness is observed. Injection start threshold is detected and stored by the ECU.
This auto-configuration process is carried out on each single cylinder.
Therefore, replacing an electro-injector requires that the ECU be reprogrammed, entering the IMA codes of the new electro-injectors and resetting the correction factors (ZFC) of the cylinder concerned.
Replacing all electro-injectors makes it necessary to reset all the correction coefficients (ZFC) of each single electro-injector.
The correction coefficients (ZCF) can be zeroed using the FPT. diagnostic tool, by reprogramming the ECU and performing the sensor replacement procedure provided by the diagnostic tool.

ELECTRIC/ELECTRONIC COMPONENTS
Electronic control unit EDC 17

Figure 11



PERSPECTIVE VIEW
A. Engine side injection cable connector - K. Bonnet/cab cable connector.

The control unit is of the "flash EPROM" type, i.e. it can be reprogrammed from the outside without acting on its hardware.

The control unit processes the signals from the sensors by applying software algorithms, and also controls the actuators (in particular, the electric injectors and the pressure regulator).

The control unit records, in the memory non-labile area, the information on the engine parameters originally set or acquired during engine operation.

The injection control unit incorporates the absolute pressure sensor, in order to further improve the injection system control.

The control unit is fitted to the left side of the engine compartment and is connected to the vehicle wiring by means of two connectors:

- 60-pole connector "**A**" for the components available on the engine;
- 94-pole connector "**K**" for the components on the vehicle.

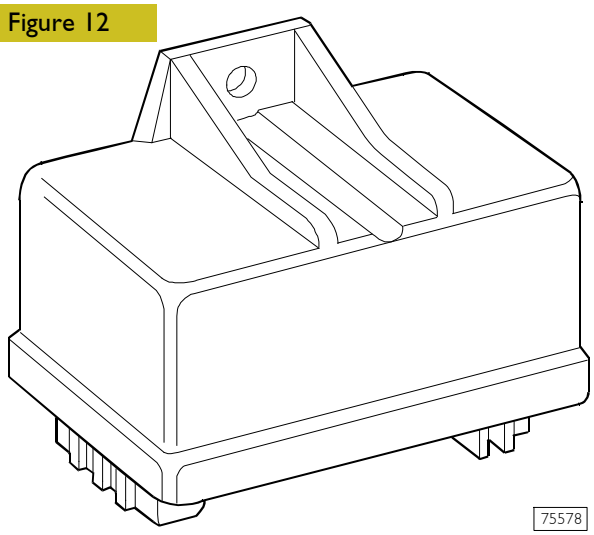
In addition to controlling the system functions described in the respective charter, the electronic control unit is interfaced with the other electronic systems found on the vehicle, such as ABS - EBD, cruise control, speed limiter, EGR, preheating plugs.
On the vehicles equipped with D.P.F. catalyst, the control unit also controls the catalyst regeneration system. In this case, after any of the operations below is carried out:

- replacing one or several injectors,
- replacing all the injectors,
- replacing the air flow meter,
- replacing the hydraulic accumulator pressure sensor (common rail),
- replacing the EDC 17 control unit;
- changing the engine oil,
- replacing the D.P.F. catalyst,
- replacing the filter differential pressure (Δp) sensor,
- replacing any significant component as regards emission levels,
- performing forced regeneration,

the control unit shall be programmed again by means of the DAIMLER E-Tester tool, and the replacement procedure for the concerned component shall be performed, in accordance with the indications of the diagnosis instruments.

Glow plug electronic control unit

Figure 12



The engine control unit, in the phase of:

- starting
- after-starting

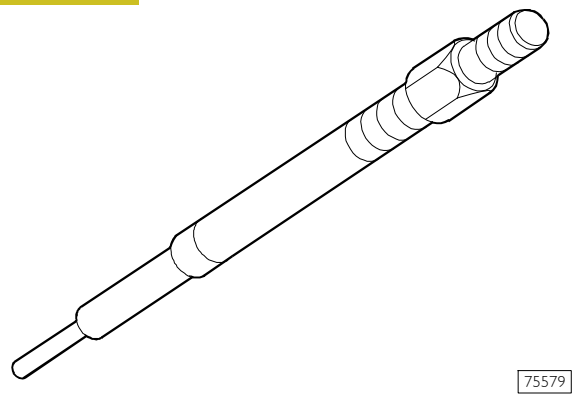
times the operation of the glow plug control unit according to the engine temperature.

The spark plug control takes place through the spark plug pre-warming control unit according to the engine temperature under the direct control of the engine control unit EDC 16.

The pre-heating control unit contains an "intelligent" contactor that sends feedback to the control unit that is thus informed about any fault with the pre-heating control unit or shorting to earth of the glow plugs.

Glow plugs

Figure 13



CONTROL VALUES

With a constant supply voltage of 11 V:

- max. current drawn	18 A
- in 5 sec.	11 ±1.5 A
- in 30 sec.	6 ±0.9 A
- temperature after 7 sec.	850°C
- tightening torque	8-10 Nm

Engine speed sensor

It is an inductive sensor and is positioned on the phonic wheel fitted on the front end of the drive shaft
It generates the signals resulting from the magnetic flow lines which close through the teeth of the phonic wheel.
Tooth number 58.
The electronic control unit uses this signal to measure the speed of rotation of the engine, its angular position and to operate the electronic rev counter.
If this signal fails the rev counter will not work.

Camshaft timing sensor

It is an inductive sensor and is positioned on the camshaft gear of the suction valves.
It generates the signals resulting from the magnetic flow lines which close through a slot on the gear itself.
The signal generated by this sensor is used by the electronic control unit as a redundant signal to measure the different engine speeds.

LUBRICATION

General

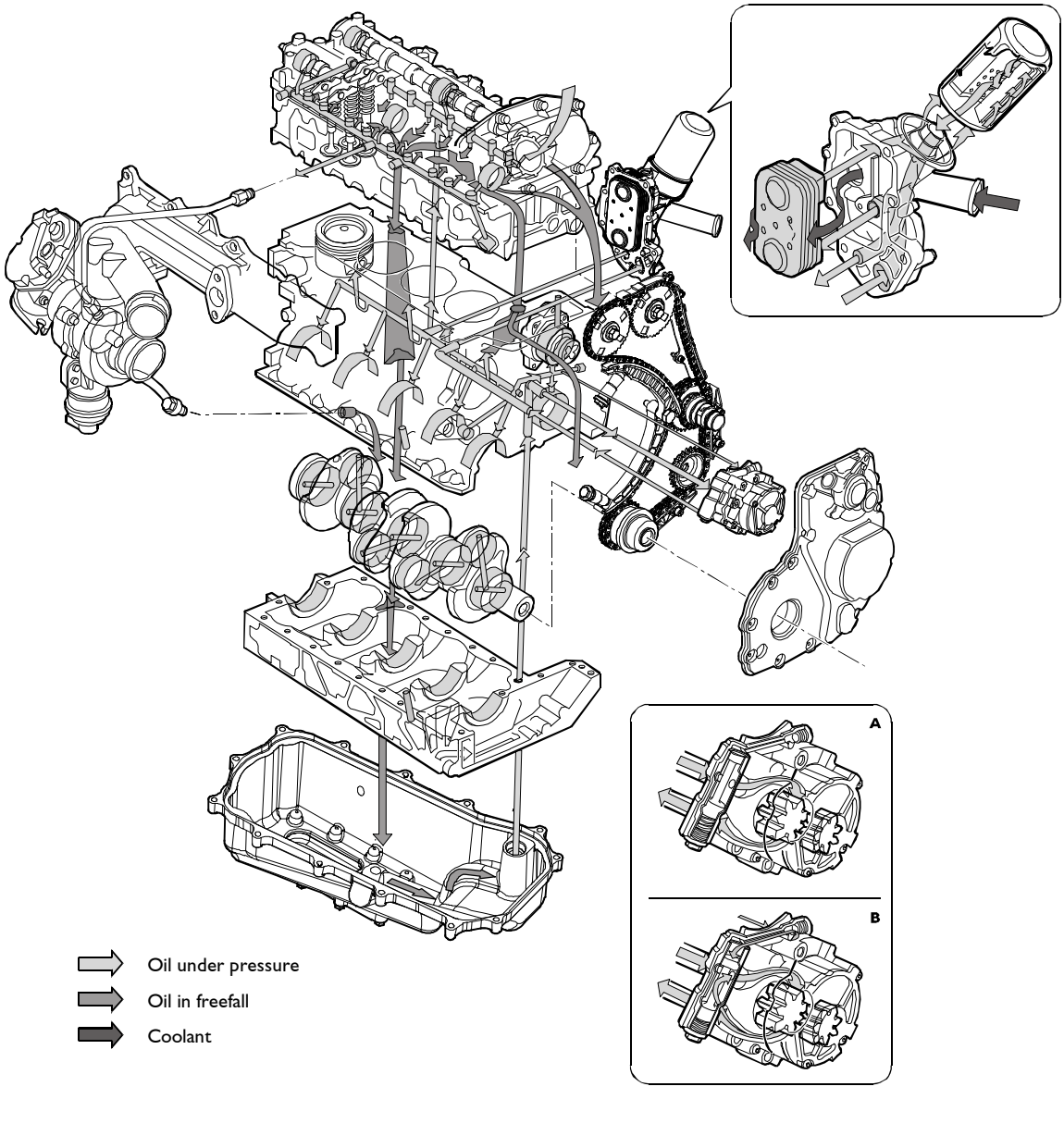
The engine is lubricated by forced circulation performed by the following parts:

- a gear oil pump with built-in depressor (GPOD);
- a pressure relief valve integrated in the oil pump;
- a heat exchanger made up of five elements;
- A double filtration oil filter with built-in safety valve.

Operation (see Figure 14)

Engine oil is drawn up from the sump by the oil pump via the suction strainer and delivered under pressure to the heat exchanger where it is cooled.
The oil continues through the oil filter and goes to lubricate the relevant parts through ducts or pipes.
At the end of the lubrication cycle, the oil returns to the sump by gravity. The oil filter can be excluded by the safety valve built into it if it gets clogged.
In addition, the lubricating oil feeds the chain hydraulic tightening devices for the control of the auxiliary elements and the timing system and the hydraulic tappet.

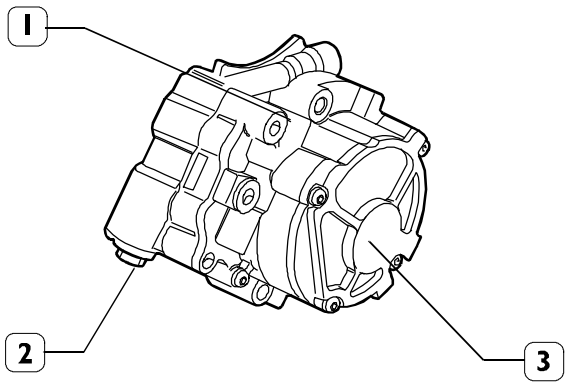
Figure 14



A. Pressure regulating valve closed - B. Pressure regulating valve open.

OIL PUMP/DEPRESSOR UNIT

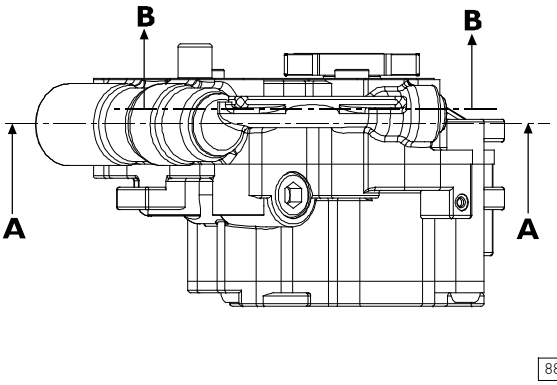
Figure 15



1. Oil pump - 2. Oil pressure adjusting valve - 3. Depressor.

NOTE Should the unit be faulty, not due to the oil pressure adjusting valve, change the whole unit.

Figure 16



SECTIONS OF OIL PUMP/DEPRESSOR UNIT

1. Oil input pipe from cylinder block - 2. Oil suction pipe - 3. Oil pressure adjusting valve - 4. Oil delivery pipe - 5. Depressor air suction pipe - 6. Depressor oil suction pipe.

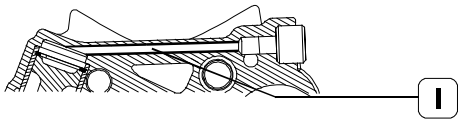
Oil pump

Characteristic data

transmission ratio	1	
displacement	23.52	cm^3
pumping diameter	49.5	mm
number of teeth	7	
height	16	mm
oil pump minimum speed	780	rpm
oil pump max. speed	3500	rpm
oil pump over-revs	4200	rpm
oil pump forced over-revs	4900	rpm
speed	3500	rpm
torque	-	Nm
power draw (calc.)	-	W

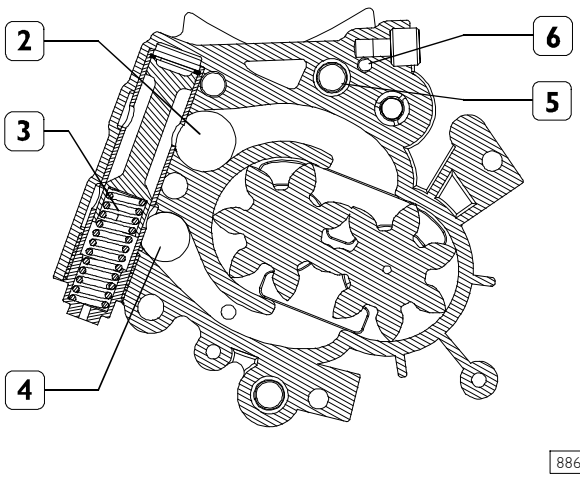
Oil temperature: 100°C – closed recirculation – max. outlet pressure 5 bars	
engine speed rpm (oil pump speed – rpm) 780 (862)	capacity (l/min)
3500 (4485)	

Figure 17



SECTION B-B

Figure 18



SECTION A-A

Vacuum pump

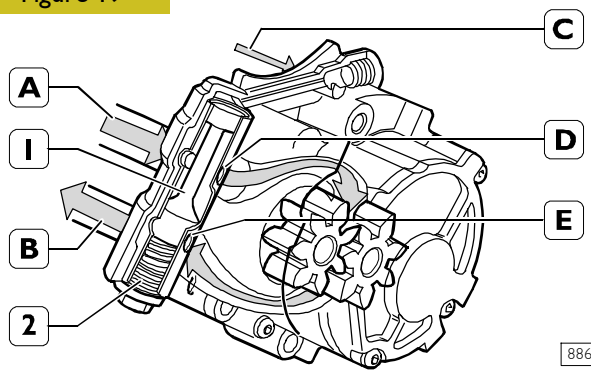
The vacuum pump (2, Figure 15), with radial blades, is also incorporated in the GPOD (1, Figure 16). It is driven directly by the oil pump.

transmission ratio	1	
displacement	150	cm^3
volume to drain	4.5	litres
chamber diameter	65	mm
rotor diameter	45.5	mm
cam	7.5	mm
number of blades	3	
height	34	mm
vacuum pump minimum speed	780	rpm
vacuum pump max. speed	3500	rpm
vacuum pump over-revs	4200	rpm
vacuum pump forced over-revs	4900	rpm
theoretical flow rate at minimum (air)	-	l/min
actual flow rate at minimum (air) – at atmospheric pressure	-	l/min
Theoretical speed at max. speed – (air)	-	l/min
Actual flow rate at max. speed – (air) at atmospheric pressure	-	l/min
measured power draw (maximum)		
speed	3500	rpm
torque	-	Nm
power draw (calc.)	-	W

Oil temperature: 100°C – engine speed 780 rpm (pump speed 994 rpm)			
tank (litres)	vacuum (bar)	0.5	0.8
4.5	time (sec)	4.5	12.5
9		9.5	26.0

Oil pressure adjusting valve

Figure 19



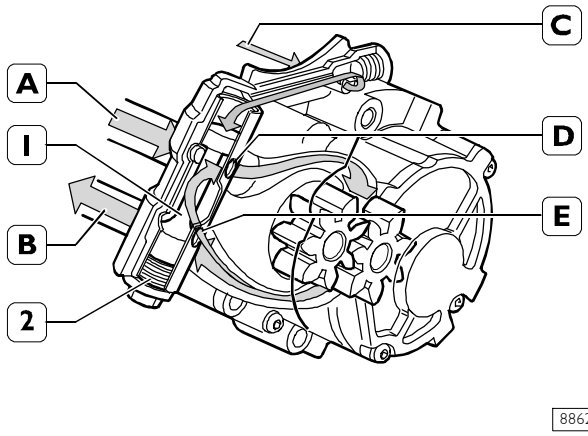
1. Oil input pipe from cylinder block - 2. Oil suction pipe - 3. Oil pressure adjusting valve - 4. Oil delivery pipe - 5. Depressor air suction pipe - 6. Depressor oil suction pipe.

Pressure at opening start: 4.4 bar

Description of oil pressure adjusting valve closed

If in pipe **C** the oil pressure is below 4.4 bar, the valve (1) closes the holes **D** - **E**.

Figure 20

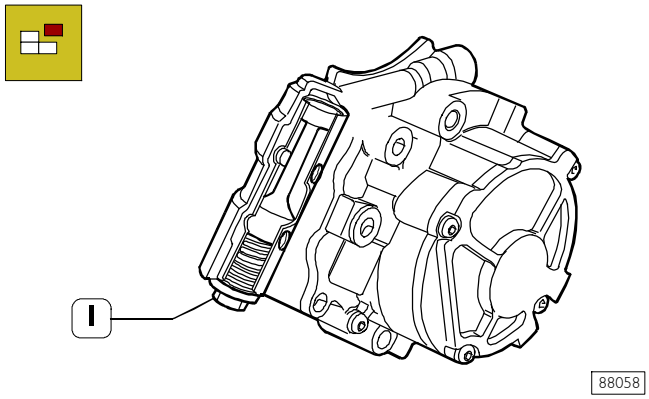


Oil pressure adjusting valve open

If in pipe **C** the oil pressure is equal or above 4.4 bar, the valve (1), as a result of the pressure itself, wins through the spring reaction (2) and goes down, thus opening communication between the delivery pipe **A** and the suction pipe **B**, through draining holes **D**-**E**, and therefore the pressure drops.
When the pressure falls below 4.4 bar, the spring (2) takes the valve (1) to the initial position of closed valve.

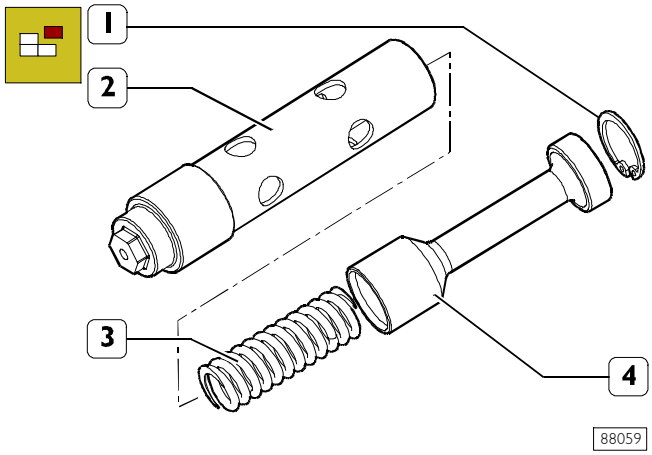
Disassembly

Figure 21



Use the suitable wrench to remove the oil pressure adjusting valve (1) from the oil pump.

Figure 22

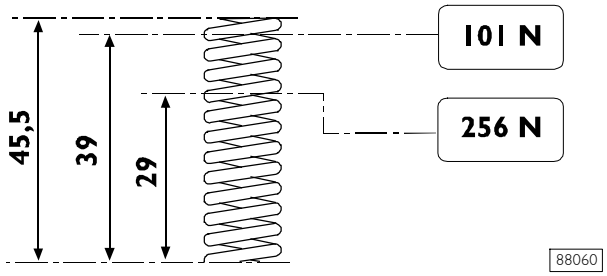


PARTS COMPRISING THE OIL PRESSURE CONTROL VALVE

1. Split ring - 2. Valve - 3. Spring - 4. Valve casing.

Use the suitable pliers to remove the snap ring (1), take off the valve (4) and the spring (3) from the valve body (2).

Figure 23



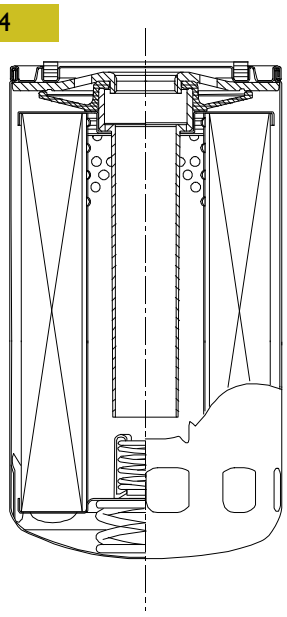
MAIN DATA OF THE OIL PRESSURE CONTROL VALVE SPRING

Assembly

For refitting, reverse the removal operations.

OIL FILTER

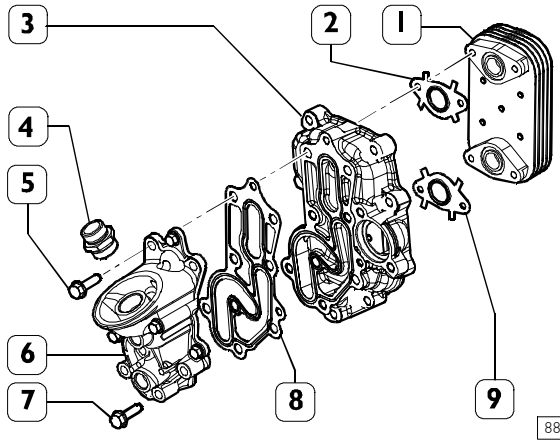
Figure 24



Oil filter with built in by-pass valve - differential opening pressure 2.5 ± 0.2 bar.

HEAT EXCHANGER

Figure 25



HEAT EXCHANGER COMPONENT DETAILS

1. Heat exchanger made up of five elements - 2. Gasket - 3. Box - 4. Pipe union - 5. Screw - 6. Oil filter support - 7. Screw - 8. Heat exchanger box - 9. Gasket.

Disassembly

Remove the screws (5) and take off the heat exchanger (1) from the box (3) with the gasket (8).
Remove the screws (7) and take off the oil filter support (6) from the box (3).

Assembly

For refitting, reverse the removal operations and observe the following warnings.
Clean accurately the heat exchanger (1).
Always change the gaskets (2, 9 and 8). Apply LOCTITE 577 on the threading of the pipe union (4) (if removed), drive it in the support (1) and tighten it to the prescribed torque.
Tighten the screws to the prescribed torque.

Thank you so much for reading.

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