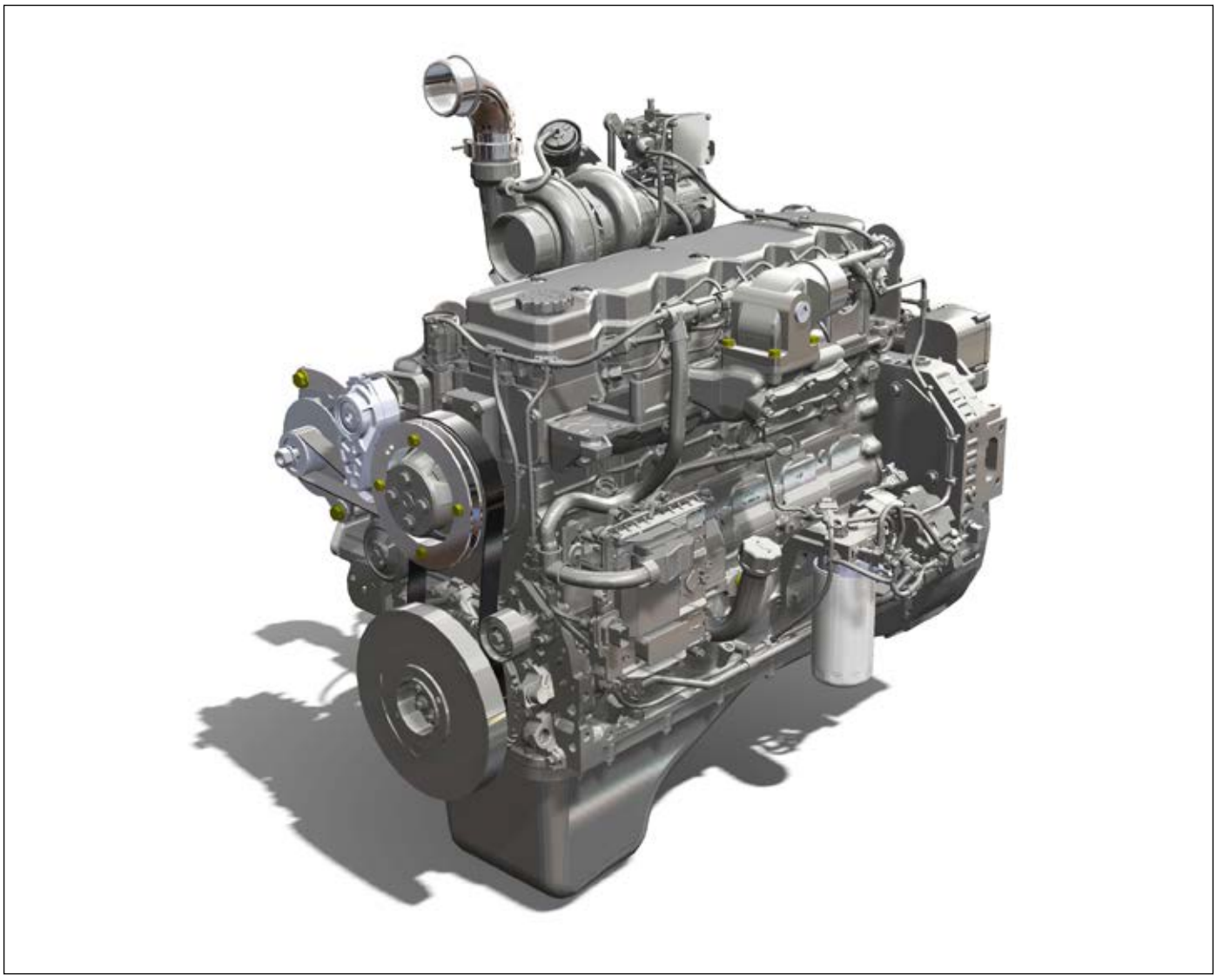
Tigercat®

Tigercat FPT N67 Tier 4f ENGINE
SERVICE AND REPAIR MANUAL



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OPTIONAL ELECTRICAL AND MECHANICAL PARTS INSTALLATIONS

Assemblies shall be modified and equipped with additions - and their accessories shall be fitted - in accordance with the assembling directives issued by FPT.
It is reminded that, especially about the electric system, several electric sockets are provided for as series (or optional) sockets in order to simplify and normalise the electrical intervention that is care of preparation personnel.

It is absolutely forbidden to make modifications or connections to electric central units wiring harnesses; in particular, the data interconnection line between central units (CAN line) is to be considered inviolable.

CONVERSIONS BETWEEN THE MAIN UNITS OF MEASUREMENT OF THE INTERNATIONAL SYSTEM AND MOST USED DERIVED QUANTITIES

Power

1 kW	=	1.36 CV
1 kW	=	1.34 hp
1 CV	=	0.735 kW
1 CV	=	0.986 hp
1 hp	=	0.746 kW
1 hp	=	1.014 CV

NOTE The unit CV is converted into hp for simplicity according to a 1:1 ratio
1 hp = 1 CV.

Torque

1 Nm	=	0.1019 kgm
1 kgm	=	9.81 Nm

Revolutions per time unit

1 rpm	=	0.1047 rad/s
1 rad/s	=	9.55 rpm

Pressure

1 bar	=	1.02 kg/cm^2
1 kg/cm^2	=	0.981 bar
1 bar	=	10^5 Pa

NOTE Where accuracy is not particularly needed:

- ❑ Nm unit is for the sake of simplicity converted into kgm according to ratio 10:1

  1 kgm = 10 Nm;

- ❑ bar unit is for the sake of simplicity converted into kg/cm^2 according to ratio 1:1

  1 kg/cm^2 = 1 bar.

Temperature

0 °C = 273.15 K
0 °F = 255.37 K
0 °C = 32 °F (the conversion factor between Celsius and Fahrenheit is 1:1.8)

TECHNICAL CODE

Themodel number is assigned by themanufacturer; it is used to identify themain characteristics of the engine, and to characterize its application and power output level. It is stamped on the side of the crank-case close to oil filter.

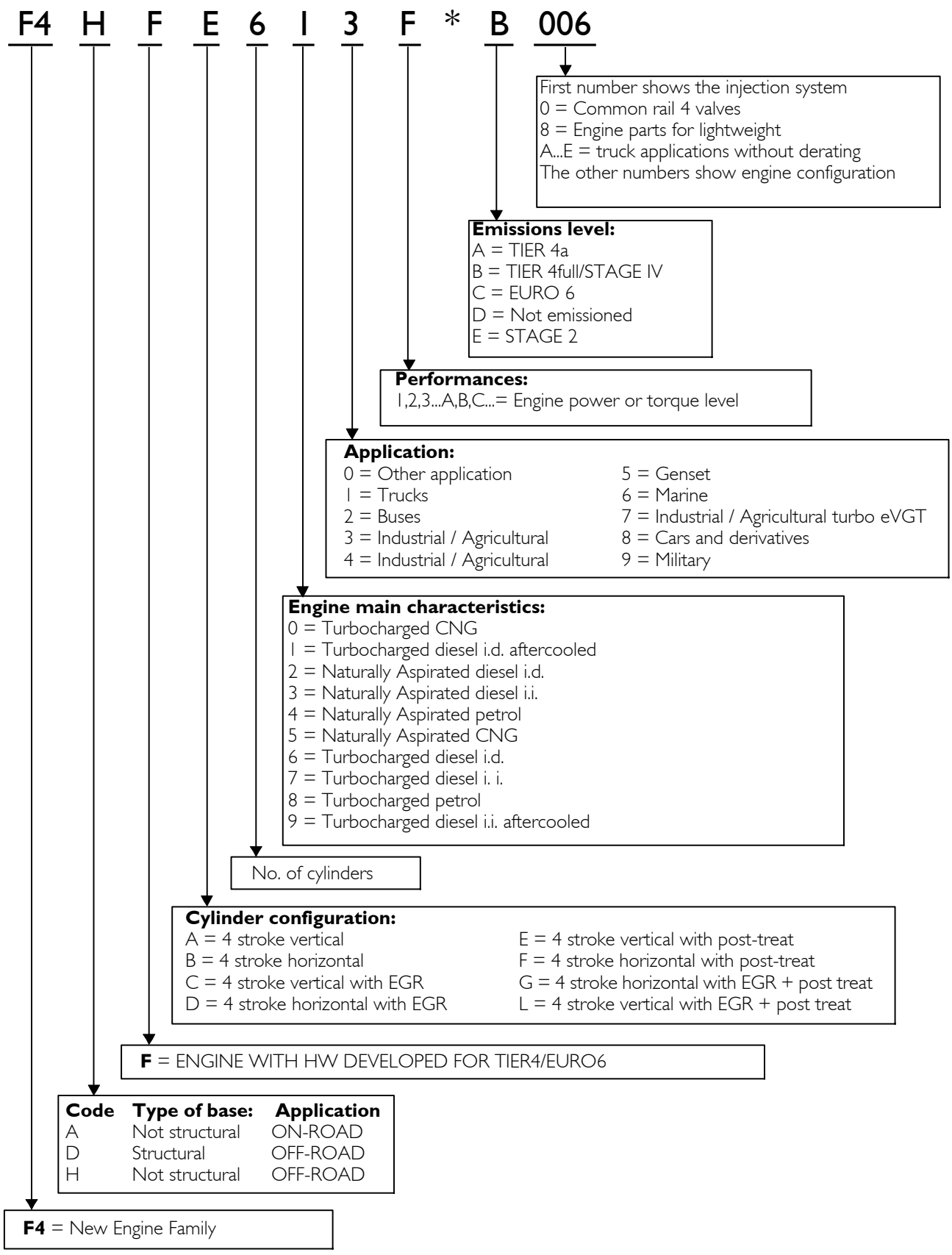
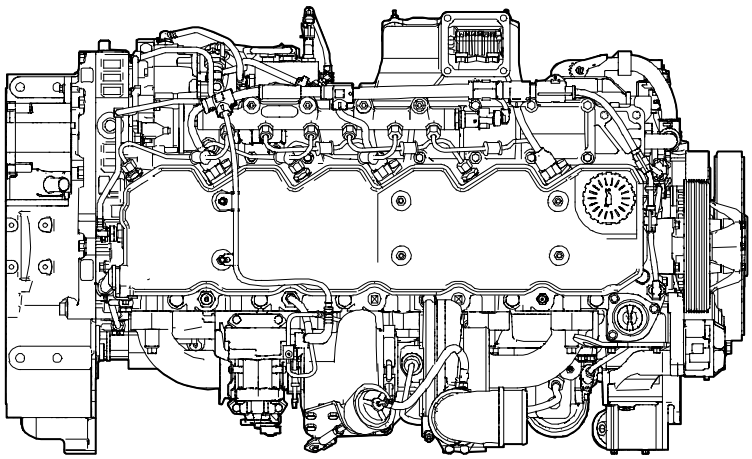


Figure 15



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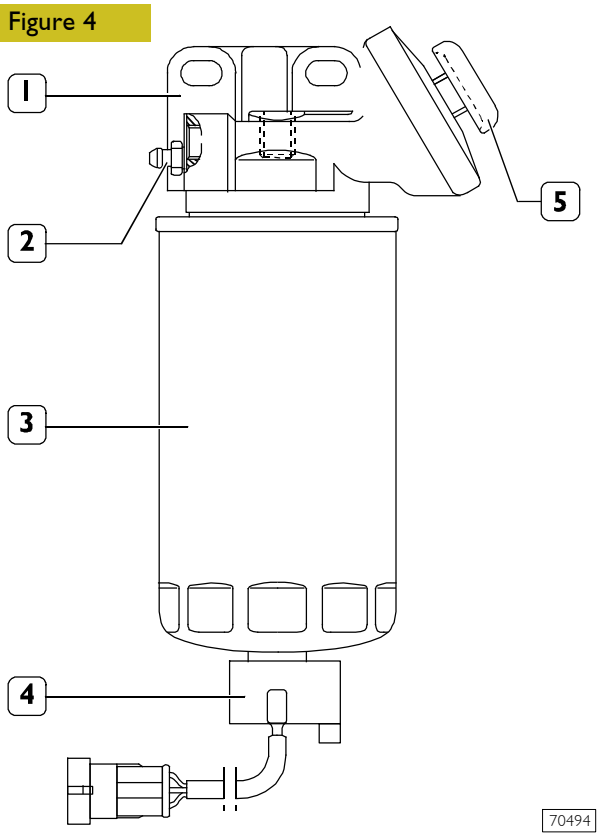
TOP VIEW

FUEL SUPPLY SYSTEM COMPONENTS

Fuel prefilter

Figure 4



The fuel filter is of the high water separation type, is assembled on the vehicle chassis, and has the sensor (4) for detecting water in fuel placed on the cartridge (3) base.

Manual priming pump (5) and air bleeding screw (2) from system are located on filter support.

The presence of condensate into filter is signalled by sensor (4) when a warning light on the instrument panel is lit.

If the warning light is on, it is necessary to immediately operate to remove its cause; the common rail system components are quickly damaged by the presence of water or impurities in the fuel.

Fuel filter

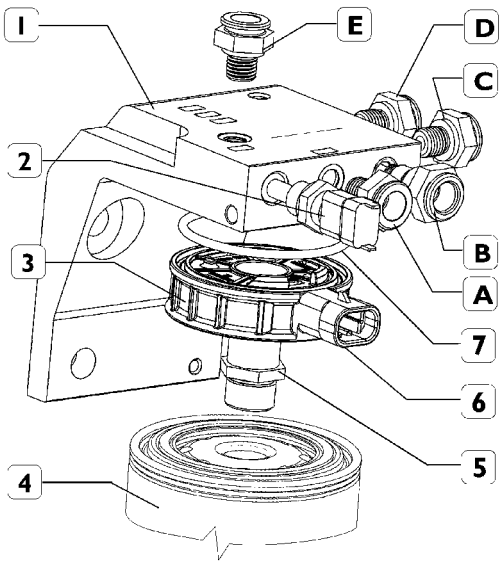
It is located on engine block in the circuit between feed pump and high pressure pump (CP3).

On the support there are located: fuel temperature sensor and heater resistances.

Fuel temperature, signalled by relating sensor to EDC17CV41 central unit, enables a very accurate calculation of the flow rate of fuel to be injected into the cylinders.

The electric heater is activated when the fuel temperature is less than 0 °C and deactivated when the fuel temperature exceeds 5 °C.

Figure 5



1. Fuel filter support - 2. Fuel temperature sensor - 3. Electric fuel heater - 4. Fuel filter - 5. Adapter - 6. Heater connector - 7. Gasket

Fuel filter connections:

A. Outlet connection to high-pressure pump

B. Outlet connection for fuel discharge to the tank

C. Inlet connection for fuel discharge from high pressure pump

D. Inlet connection for fuel discharge from common rail and injectors

E. Inlet connection from mechanical supply pump

LUBRICATION

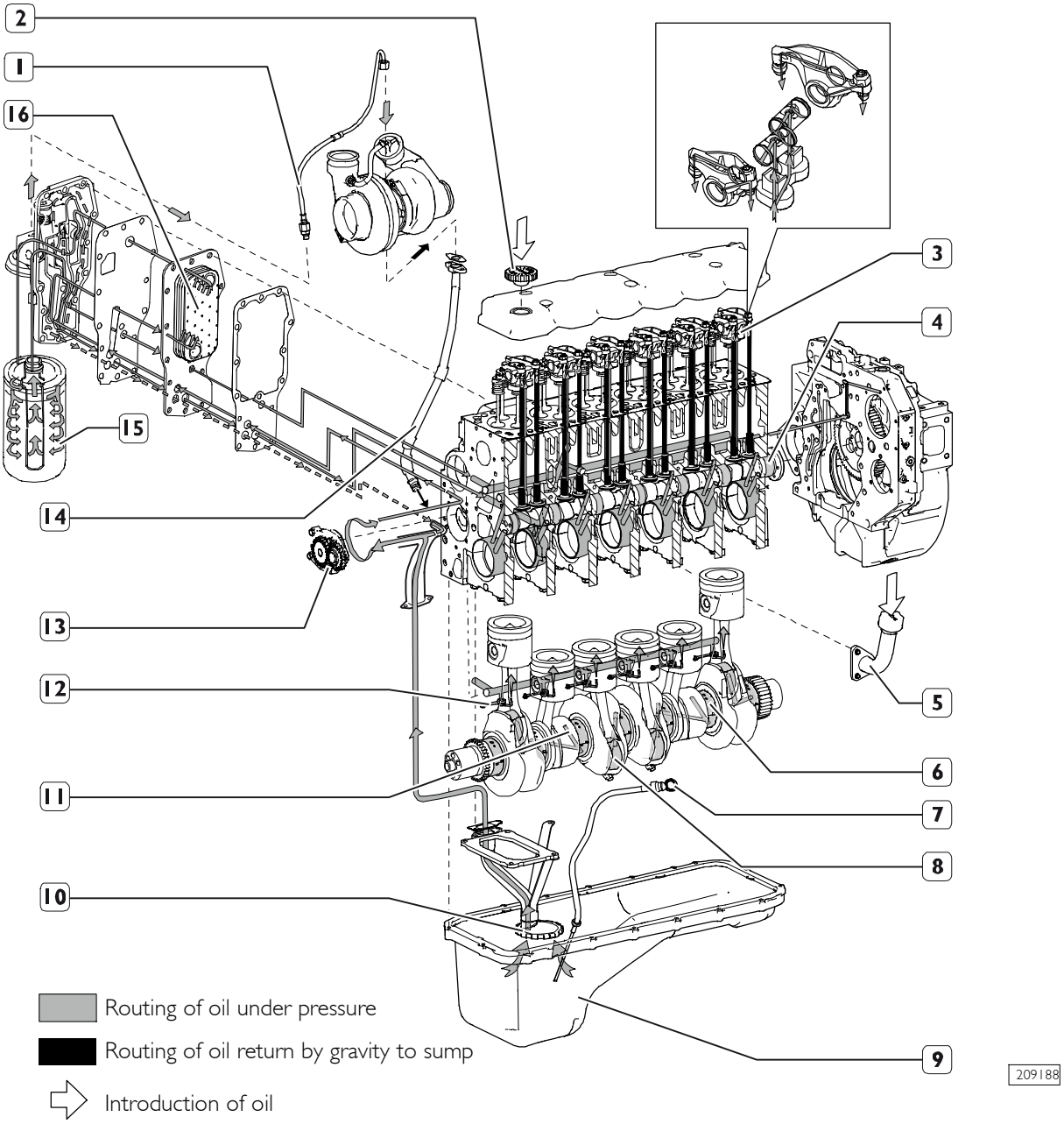
Lubrication by forced circulation is achieved through oil rotary expansion pump, placed in the front part of the basement, driven by the straight-tooth gear splined to the shaft's bar hold.

From the pan, the lubrication oil flows to the driving shaft, to the camshaft and to the valve drive.

Lubrication involves the heat exchanger as well, the turbo-blower and the eventual compressor for any eventual compressed air system.

All these components may often vary according to the specific duty and will therefore be examined in the specific section.

Figure 20



LUBRICATION SYSTEM LAYOUT

1. Turbocharger lubrication oil delivery pipe - 2. Lubricant oil filler cap - 3. Rocker arm shaft hole - 4. Camshaft bush - 5. Lubricant oil filler cap - 6. Main half-bearings - 7. Oil level dipstick - 8. Connecting rod half-bearings - 9. Oil sump - 10. Oil suction - 11. Crankshaft transverse channels - 12. Piston cooling nozzles - 13. Rotary oil pump - 14. Turbocharger lubrication oil discharge pipe - 15. Oil filter - 16. Heat exchanger lubricant oil / coolant

NOTE Verifying an anomalous operation of the engine, due to the booster system, it is recommended, before performing controls on the turbocharger, to check the efficiency of the sealing gaskets and the fixing of the connection sleeves, making sure of clogging absence inside intake sleeves, air cleaner or inside radiators. If the turbocharger damage is due to a lack of lubrication, check that the oil circulation pipes are not broken or obstructed, in such case replace them or eliminate the trouble.

Bearing end play check

Position the tracer point of the magnetic-base dial gauge on the turbocharger shaft end and set to zero the dial gauge.

Move the turbocharger shaft axially and check that the clearance is not higher than the prescribed value.

Replace the turbocharger if a different value is found.

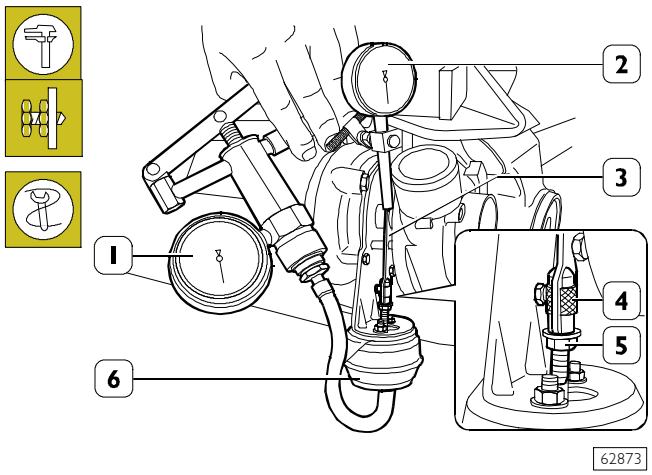
Waste gate

The turbocharger is fitted with a pressure regulation valve, mounted on the exhaust manifold before the turbine and controlled by a pneumatic actuator, connected via a pipe to the intake manifold.

Its job is to limit the quantity of exhaust gas acting on the turbine by sending part of it directly into the exhaust pipe when the boost pressure downstream of the compressor reaches the maximum value set.

Check and adjustment

Figure 34



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Cover the air, exhaust gas and lubrication oil inlets and outlets.

Carry out an accurate external cleaning of the turbocharger, using the anticorrosive and antioxidant solution and perform the check on the actuator (6).

Clamp the turbocharger in a vice.

Disconnect the pipe of the actuator (6) and apply to the actuator union, the pipe of pump 99367121 (1).

Apply the magnetic-base dial gauge (2) on the exhaust gas inlet flange in the turbine.

Position the tracer point of the gauge (2) on the tie rod (3) end and set to zero the gauge (2).

Through the pump (1) let in compressed air, in the actuator (6), at the prescribed pressure and make sure that such value is kept constant for the whole check time, otherwise replace the actuator (6).

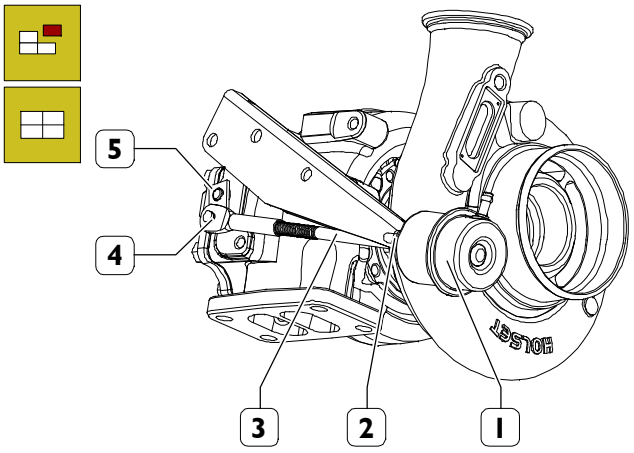
In the above-mentioned conditions, the tie rod must have carried out the prescribe stroke.

NOTE During the operation, beat slightly the actuator (6) in order to eliminate possible sticking of the actuator internal spring.

If a different value is found, loosen the nut (5) and operate properly the knurled ring nut (4).

Actuator replacement

Figure 35



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Remove the elastic clip (4) and withdraw the tie rod (3) from the lever (5).

Remove the nuts (2) and remove the actuator (1) from the supporting bracket. Fit the new actuator following the removal operations in reverse order and fitting a new clip (4), tighten the nuts (2) to 5.6 – 6.8 Nm torque.

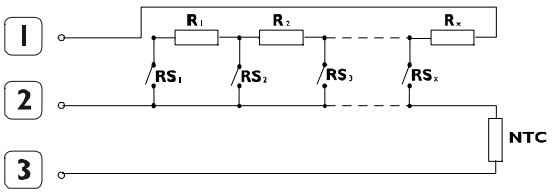
Check and adjust the actuator (1), if required, as described in the relevant chapter.

Then, paint the nut (6) with safety paint.

Before refitting the turbocharger on engine, fill the central body with engine oil.

Electrical connections:

Figure 44



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Ref.	Description
1	Level
2	Common ground
3	NTC signal (temperature)

ATS SYSTEM MAINTENANCE PLANNING

The general checking/inspection intervals which must be carried out on the ATS system components are as follows.

The frequency of the maintenance operations is just an indication since the use of the engine is the main characteristic to determine and evaluate replacements and checks.

It is not only allowed but recommended that the staff in charge of the maintenance should also carry out the necessary maintenance and controlling operations even if not being included in the ones listed here below but that may be suggested by common sense and by the specific conditions in which the engine is run.

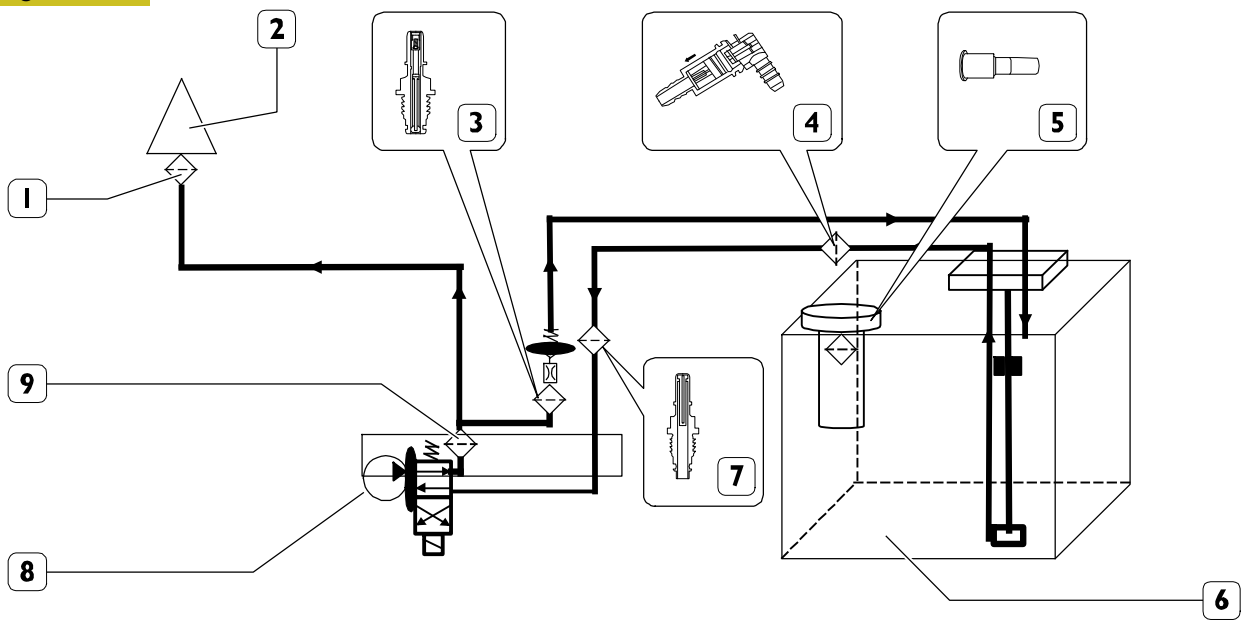
In case of evident system malfunction immediately intervene in order to find the causes.

We wish to remind that each maintenance operation, even the most simple must be performed in compliance with the accident prevention standards for the safety of maintenance personnel in charge.

Component	Function	Service-Requirement
Tank Neck Filter (300 or 100* μm)	Protect tank during filling	No regular service planned (Cleaning, if required)
SM Pre-Filter (100 or 70* μm)	Protect SM from dirt coming from tank	Cleaning @ every oil change interval
SM Inlet-Filter (100 μm)	Protect SM during 1st start-up	No regular service planned (Replacement, if required)
SM Main-Filter	Protect DM	Change every 3,600 hours or 2 years (whichever occurs first)
SM Backflow-Filter (100 μm)	Protect throttle in backflow connector from dirt coming from pressure line or dirt introduced during change of SM Main-Filter	No regular service planned (Replacement, if required)
Dosing Valve Filter (36 μm)	Protect DM during 1st start-up	Cannot be serviced

* for application working in dusty environment only.

Figure 67



FILTER LOCATION

1. Dosing valve filter - 2. Dosing module - 3. SM Backflow-Filter - 4. SM Pre-Filter - 5. Tank pre-filter - 6. AdBlue tank - 7. SM Inlet-Filter - 8. Supply module - 9. SM main filter.

Pin	Cable colour	Signal	Component
73	B	O_P_SVL11	Injector 1 "low", Bank 1, Cylinder 1
74	R	O_P_SVL12	Injector 2 "low", Bank 1, Cylinder 3
75	G	O_P_SVL13	Injector 3 "low", Bank 1, Cylinder 2
76	-	-	Free
77	-	-	Free
78	-	-	Free
79	-	-	Free
80	-	-	Free
81	-	-	Free
82	-	-	Free
83	GN	O_T_MEU	Fuel high pressure pump metering unit:
84	-	-	Free
85	-	-	Free
86	RG	I_A_AN05	Boost pressure and air temperature sensor: pressure signal
87	-	-	Free
88	-	-	Free
89	-	-	Free
90	BV	G_R_AN05	Boost pressure and air temperature sensor: ground analog input 5
91	-	-	Free
92	-	-	Free
93	-	-	Free
94	-	-	Free
95	-	-	Free
96	-	-	Free

Camshaft timing segment speed sensor

The timing sensor generates signals obtained from a magnetic flux field closing through the holes in the timing gear on the camshaft.
The signal generated by this sensor is utilized by the electronic control unit as an injection phase signal.
Although it is similar to the flywheel sensor, these two devices are NOT interchangeable because of the different external shape.
The timing sensor is connected to the control unit on pins 67A - 68A. The sensor impedance is ~900 Ω.

Figure 11

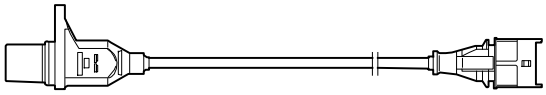


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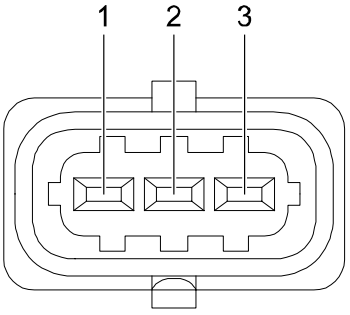
Figure 12



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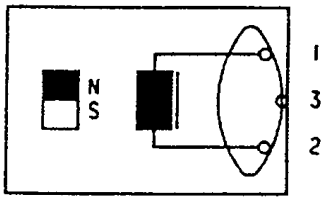
Connector



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Wiring diagram

Ref.	Description	ECU Pin
1	Ground	67A
2	NTC	68A
3	Shield	69A

SECTION 4

Scheduled maintenance

Page

SCHEDULED MAINTENANCE 3

- ❑ Recovery 3
- ❑ Regular maintenance and inspection planning . 3
- ❑ Checks not included in maintenance planning-daily checks 4

MAINTENANCE PROCEDURES 5

- ❑ Checks (in periods of use) 5
- ❑ Planned maintenance 7
- ❑ Unscheduled maintenance 10

Change engine coolant

- ❑ Only proceed when the engine is not turning, and is at low temperature, so as not to run the risk of burns.
- ❑ Place a container for collecting coolant under the heat exchanger (radiator).
- ❑ Remove the pressurization cap from the expansion tank.
- ❑ Loosen the retaining elements and remove the sleeves connecting the engine cooling circuit to the heat exchanger.
- ❑ Drain the coolant from the heat exchanger (radiator) and wait until it is completely empty.
- ❑ Once emptied, refit the cooling circuit making sure the sleeves are perfectly sealed.
- ❑ Refill the engine and the heat exchanger until the cooling circuit has been completely refilled using a mixture of 50% water and Actifull OT, as contained in the section REFILLING. Do not fill the expansion tank to the brim.
- ❑ With the coolant cap open, start the engine and let it idle for approx. one minute. This helps to completely bleed the air contained in the cooling circuit.
- ❑ Stop the engine and top up with more coolant, if necessary.
- ❑ When the engine is cold, make sure that the coolant in the expansion tank is a few centimetres below the filling hole.
- ❑ In the event of an externally located level indicator as regards the heat exchangers, proceed with the top up operation by making sure that the coolant does not overfill the internal volume of the exchanger in order to allow the expansion of coolant volume during increases in temperature.

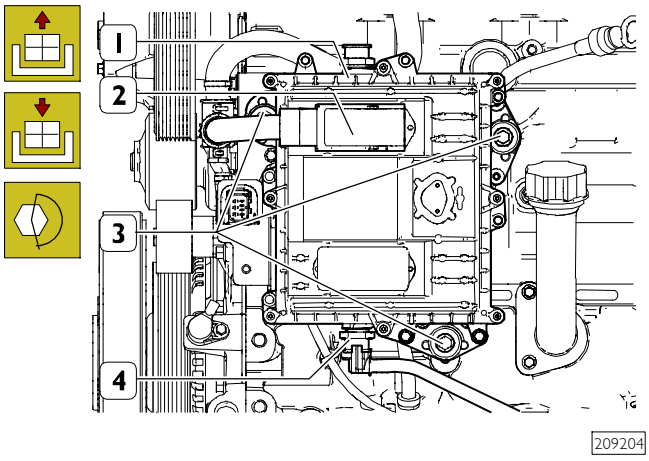
The failure to observe the aforesaid procedure does not guarantee the presence of the correct quantity of coolant in the engine.

When the engine is hot, pressure builds up in the cooling circuits which may eject hot liquid violently, resulting in a risk of burns. Open the filler cap of the coolant tank only if necessary and only when the engine is cold.

ENGINE CONTROL UNIT REMOVAL AND INSTALLATION

Removal

Figure 12



Disconnect the engine cable (2) from the ECU (1), as described in the relative section.

Position a suitable container to catch any fuel.

Disconnect the retainer and remove the low pressure fuel pipe from fuel pre-filter to the engine control unit heat exchanger.

Disconnect the retainer (4) and remove the low pressure fuel pipe from the engine control unit heat exchanger to to mechanical pump, as described in the relative section.

Unscrew the supporting screws (3), and remove the ECU (1), including the heat exchanger.

Ref.	No.	Description
(3)	3	M8x1.25

Installation

Fit the ECU (1) including the heat exchanger on the crankcase and tighten the supporting screws (3) to the prescribed torque.

Connect the low pressure fuel pipe from the mechanical pump to the engine control unit heat exchanger by means of the retainer (4), as described in the relative procedure.

Connect the low pressure fuel pipe from fuel pre-filter to the engine control unit heat exchanger by means of the retainer.

Connect the engine cable (2) to the ECU (1), as described in the relative section.

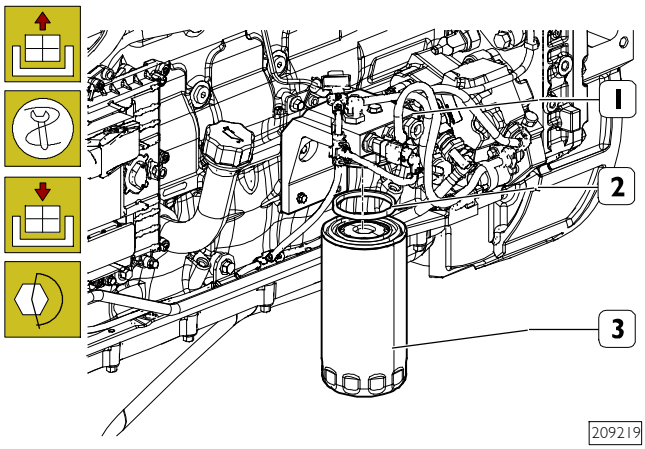
Ref.	No.	Description	Tightening torques
(3)	3	M8x1.25	24 ± 4 Nm

NOTE Replacing the elastic support elements is recommended.

FUEL FILTER REMOVAL AND INSTALLATION

Removal

Figure 13



Place a container for collecting the diesel under the filter support (1).

Unscrew and remove the filter (3) from its relative support (1) by tool 99360076.

Ref.	No.	Description
(3)	1	20x1.5

Installation

Moisten the sealing gasket (2) of the fuel filter (3) with a thin layer of oil.

Manually tighten the fuel filter (3) on the support (1) until it comes into contact with the gasket (2).

Additionally tighten the fuel filter (3) to the prescribed torque using a specific tool.

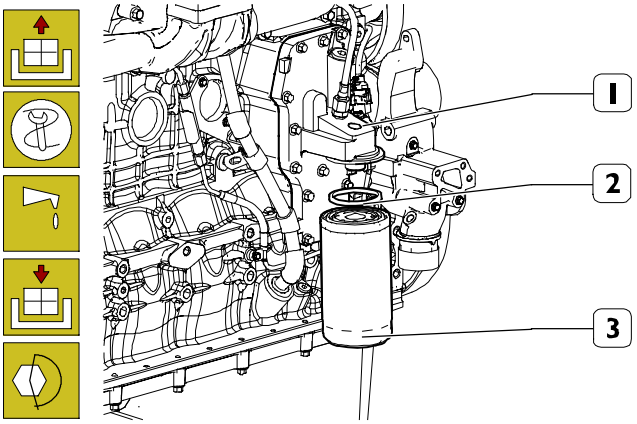
Ref.	No.	Description	Tightening torques
(3)	1	M20x1.5	20 ± 2 Nm

NOTE Pay attention to the electric fuel pre-heater (if installed) and the relative electrical connection.

ENGINE OIL FILTER REMOVAL AND INSTALLATION

Removal

Figure 43



Place a container for collecting the spent oil under the filter support (1).

Unscrew and remove the oil filter (3) from its relative support (1) by tool 99360076.

Ref.	No.	Description
(3)	1	M27x2

Installation

Moisten the sealing gasket (2) of the oil filter (3) with a thin layer of oil.

Manually tighten the oill filter (3) on the support (1) until it comes into contact with the gasket (2).

Additionally tighten the oil filter (3) to the prescribed torque using a specific tool.

Operate the engine for a few minutes and then check the level using the dipstick. If necessary, top up to compensate for the quantity of oil used to fill up the filtering cartridge.

Ref.	No.	Description	Tightening torques
(3)	1	M27x2	18 ± 2 Nm

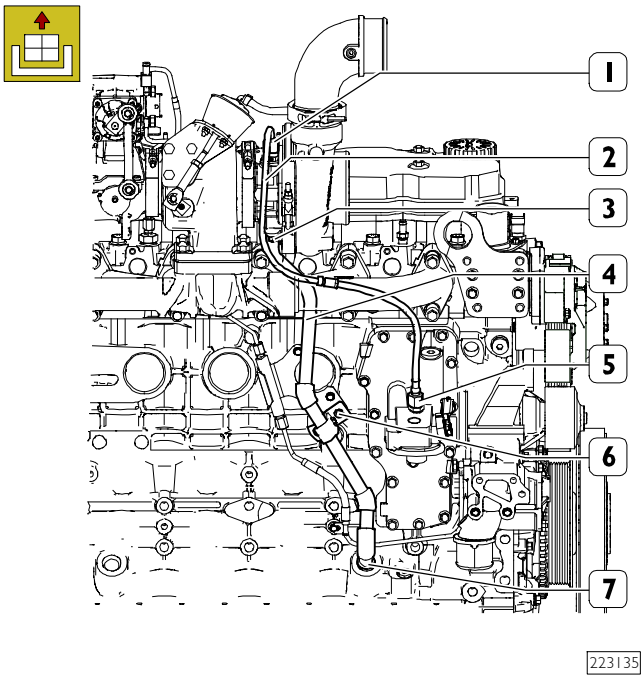
TURBOCHARGER REMOVAL AND INSTALLATION

Removal

Remove the engine oil filter as described in the relative procedure.

F4HFE613F*B006
F4HFE613F*B007

Figure 44



REMOVAL AND INSTALLATION ENGINE OIL HEAT EXCHANGER

Removal

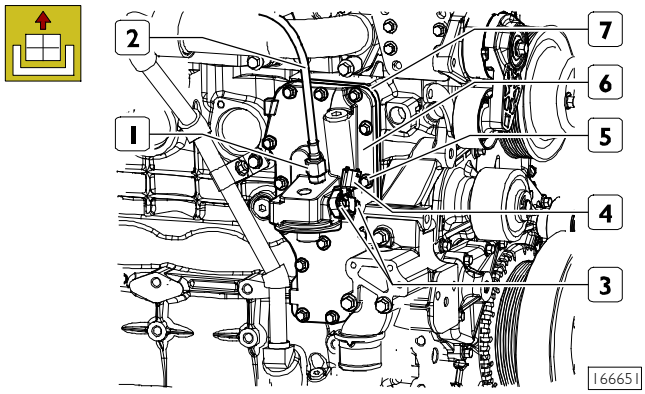
Remove the auxiliary components drive belt as described in the relative procedure.

Remove the alternator as described in the relative section.

Position a suitable container to catch any engine oil.

Remove the engine oil filter as described in the relative section.

Figure 73



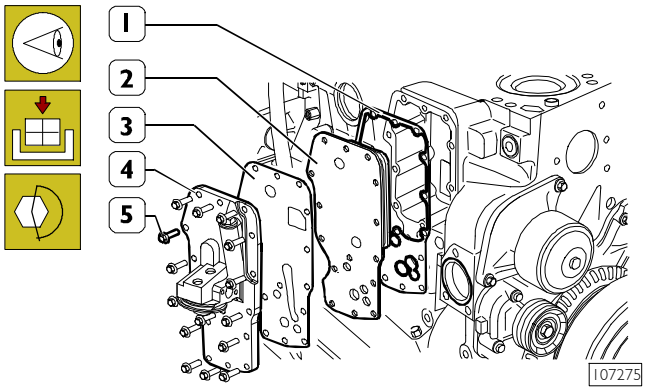
Unscrew the coupling (1) and remove the turbocharger oil delivery pipe (2).

Remove the screws (3) and the oil pressure / temperature sensor (4).

Remove the screws (5) and disassemble the oil filter / heat exchanger bracket (6), intermediate plate (6) and relative gaskets.

Installation

Figure 74

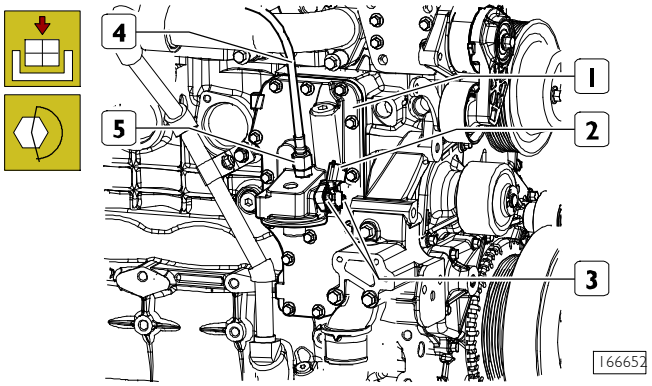


Fit the following on the engine block: a new gasket (1), the heat exchanger (2) a new gasket (3) and the oil filter bracket (4).

Tighten the screws (5) to the specified torque.

NOTE Always check that the threads on the screws and their holes do not show any signs of wear or traces of dirt before fitting.

Figure 75



Place the oil temperature/pressure sensor (2) in position on the bracket (1) with a new seal ring then screw in the retaining screws (3) and tighten them to the specified torque.

Install the oil delivery pipe (1), screwing on the coupling (2).

Install the engine oil filter as described in the relative section.

Install the alternator as described in the relative section.

Install the auxiliary components drive belt as described in the relative procedure.

Check the oil level with the dipstick: the level must be near the MAX mark on the dipstick.

If it is much below this level, top up with the necessary quantity.

OIL SUMP REMOVAL AND INSTALLATION

Removal

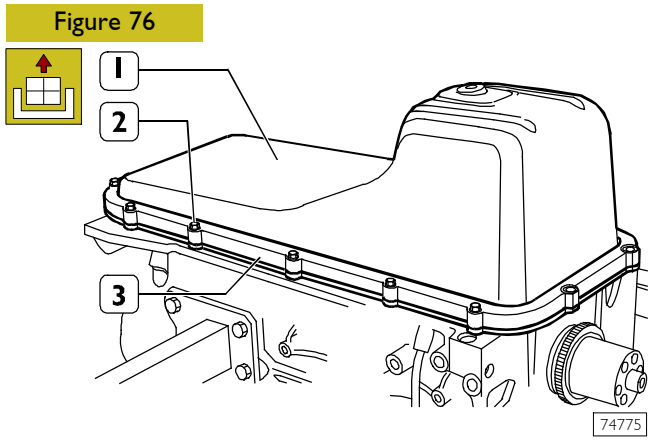
Place a suitable container under the oil sump drain plug to catch the oil.

Open the oil filler on the cylinder head and remove the dipstick to aid the flow of oil.

Unscrew the drain plug and let the oil in the sump drain completely.

NOTE It is recommended to drain the oil when the engine is hot.

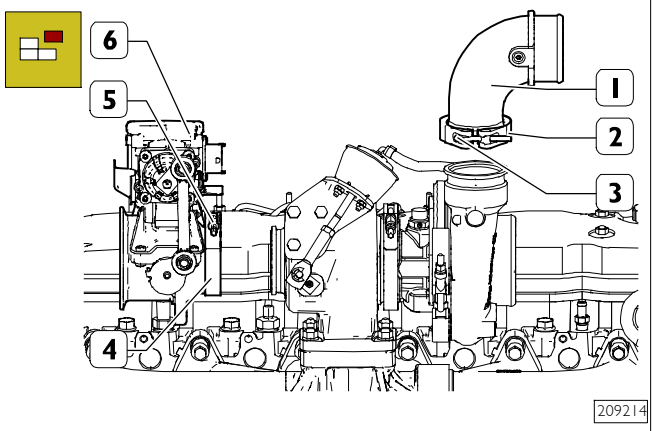
Figure 76



Undo the screws (2) then remove the plate (3) and oil sump (1), retaining the gasket.

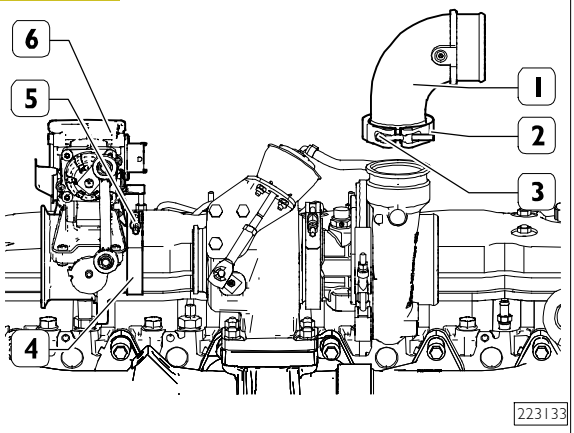
F4HFE613F*B006
F4HFE613F*B007

Figure 15



F4HFE613K*B010

Figure 16

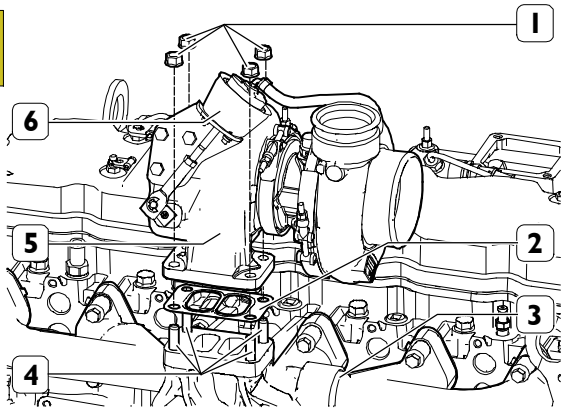


Unscrew the screws (3 and 5) and loosen the V-clamping collars (2 and 4) to remove both the compressed air turbocharger outlet (1) to intercooler and the motorized throttle valve (6).

Ref.	No.	Description
(3)	1	M6x1x55
(5)	1	M6x1x50

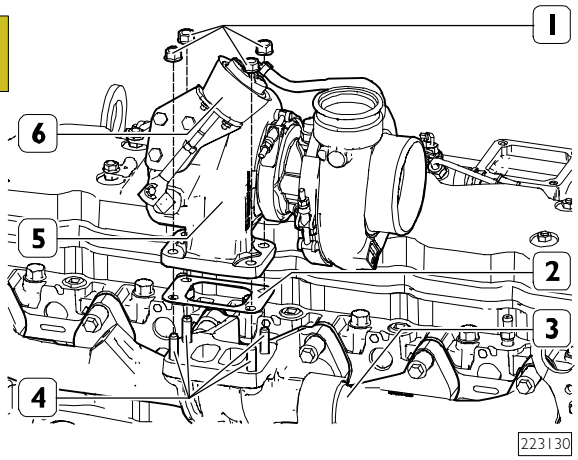
F4HFE613F*B006
F4HFE613F*B007

Figure 17



F4HFE613K*B010

Figure 18

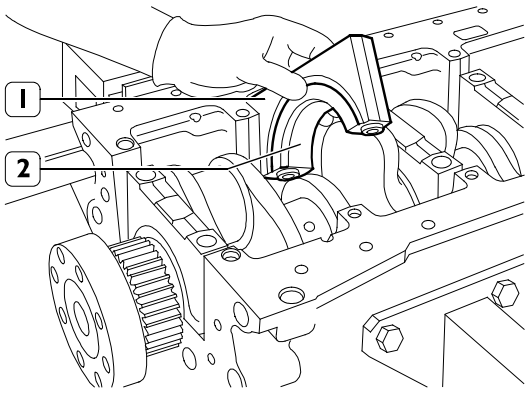


Unscrew the fastening nuts (1) and remove the turbocharger (5) together with the waste-gate valve (6), recovering the relevant gasket (2).

Unscrew the studs (4) from the exhaust manifold (3).

Ref.	No.	Description
(1)	4	M10
(4)	4	M10x1.5x42

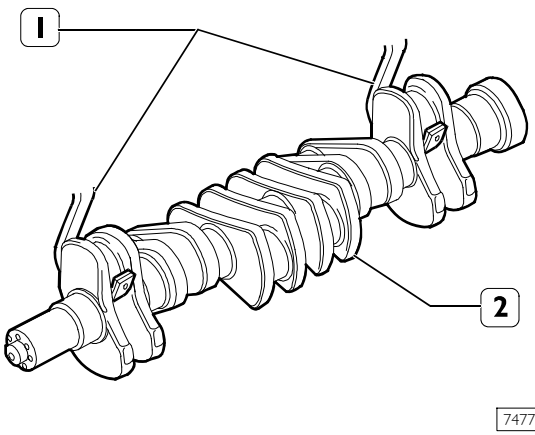
Figure 51



The second-last-main cap (1) and its relevant support have the half-bearing (2) equipped with shoulder.

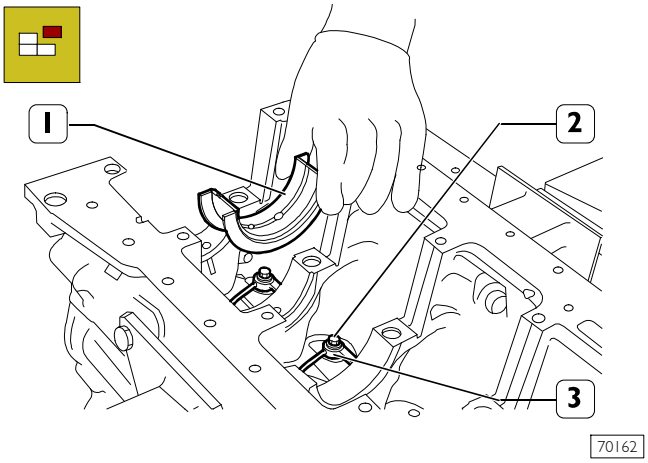
NOTE Write down the upper and lower half-bearing assembling position, in the event of use, they should be mounted in the position detected when disassembling.

Figure 52



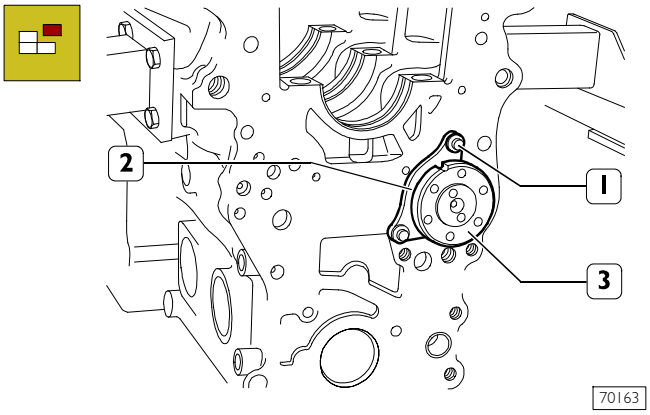
Remove the crankshaft (2) from the block by means of tool 99360500 (1) and hoister.

Figure 53



Remove the main half-bearings (1).
Remove the screws (2) and remove the oil nozzles (3).

Figure 54



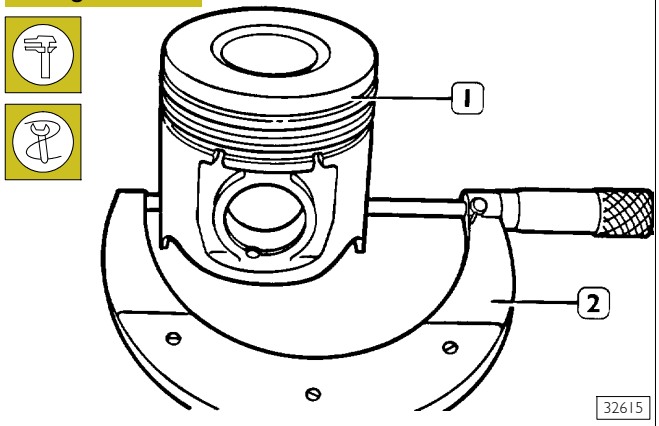
Remove the screws (1) and remove the camshaft (3) check plate (2)

NOTE Write down the plate (2) assembling position.

Pistons

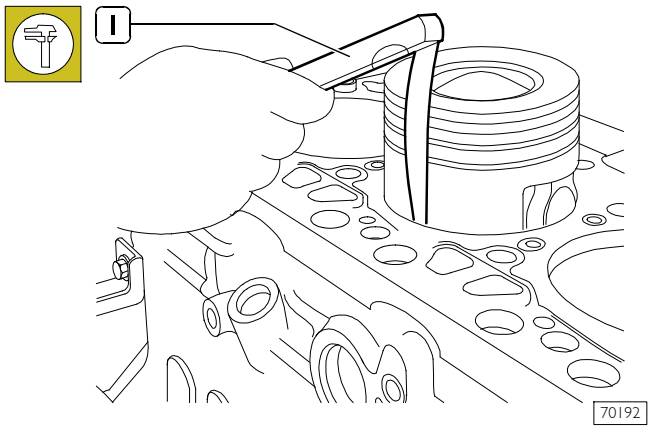
Measuring piston diameter

Figure 79



Using a micrometer (2), measure the diameter of the piston (1) to determine the assembly clearance.

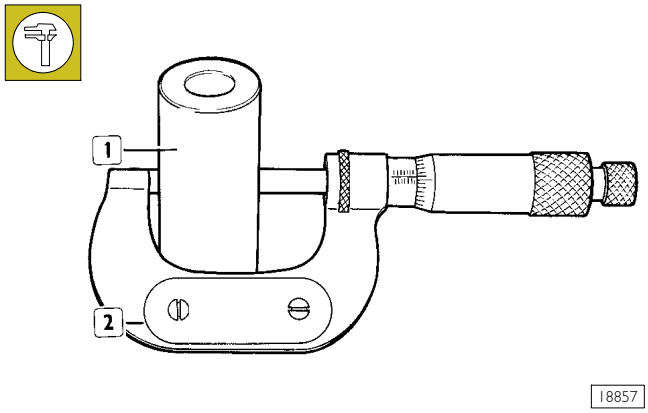
Figure 80



The clearance between the piston and the cylinder barrel can be checked also with a feeler gauge (1) as shown in the figure.

Gudgeon pins

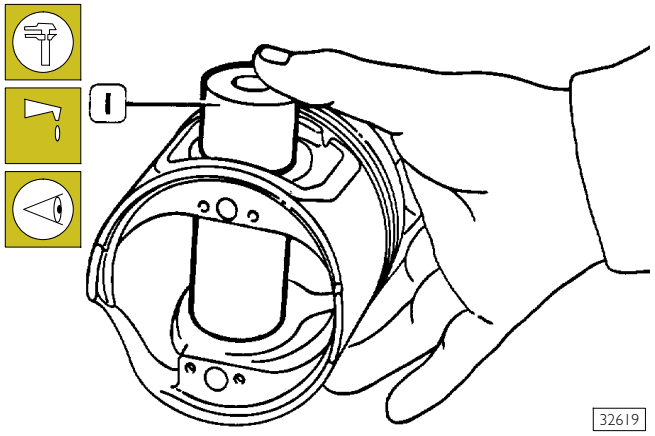
Figure 81



To measure the piston pin (1) diameter use the micrometer (2).

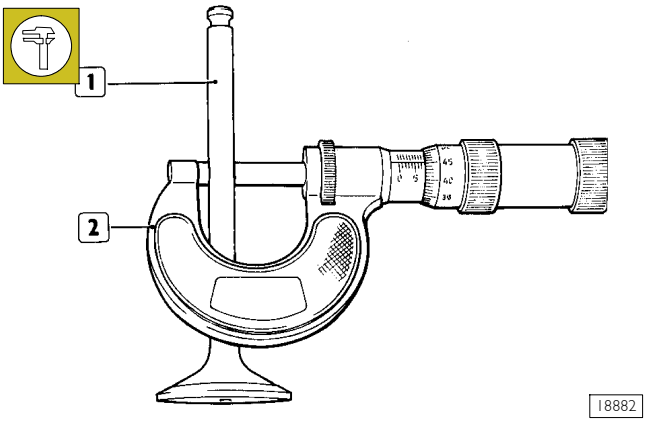
Conditions for proper pin-piston coupling

Figure 82



Lubricate the pin (1) and its seat on piston hubs with engine oil; the pin shall be fitted into the piston with a slight finger pressure and shall not be withdrawn by gravity.

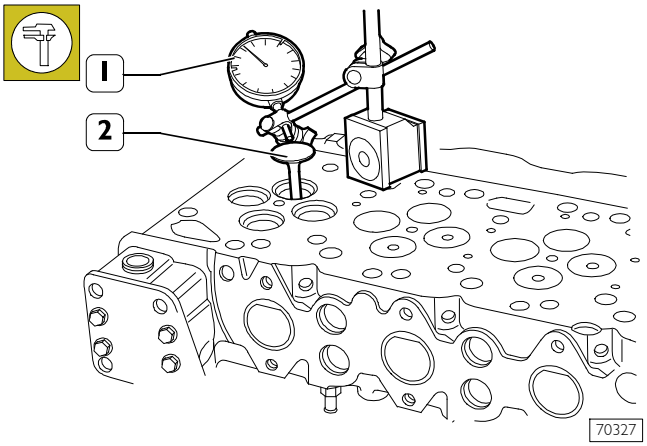
Figure 115



Check the valve stem (1) using a micrometer (2), it shall be 6.990 ± 7.010 mm.

Checking clearance between valve stem and valve guide and valve centering

Figure 116

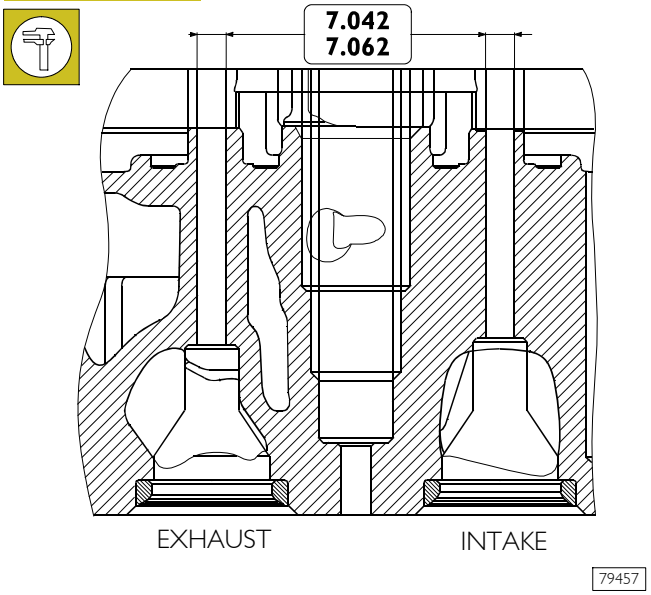


Use a magnetic base dial gauge (1) set as shown in the figure, the assembling clearance shall be 0.032 ± 0.072 mm.

Turn the valve (2) and check that the centering error is not exceeding 0.03 mm.

VALVE GUIDES

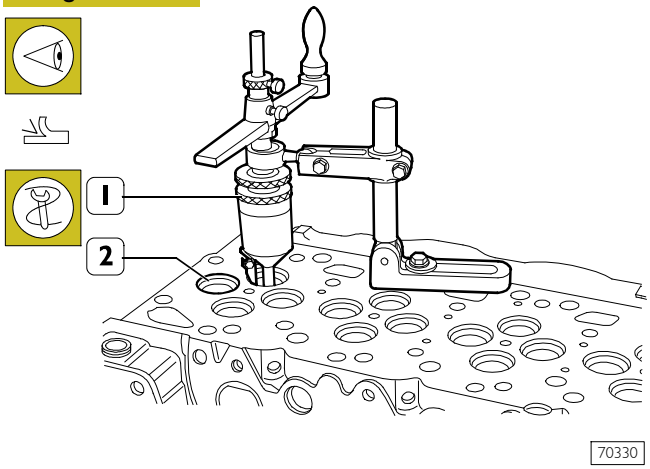
Figure 117



Use a bore dial gauge to measure the inside diameter of the valve guides, the read value shall comply with the value shown in the figure.

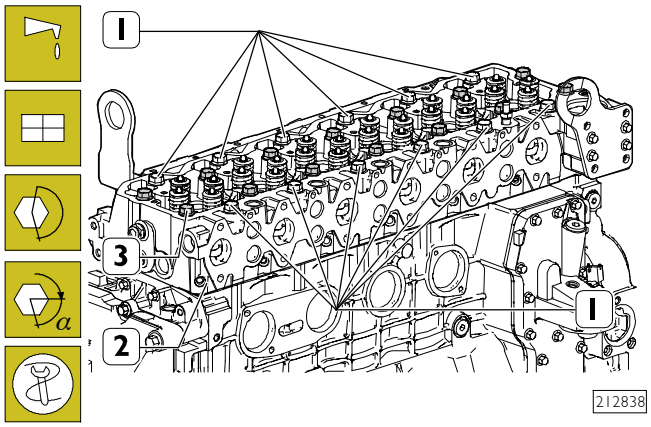
VALVE SEATS
Regrinding – replacing the valve seats

Figure 118



Check the valve seats (2). If slight scoring or burnout is found, regrind seats using tool (1) according to the angle values shown in Figure 119.

Figure 147



212838

After having correctly positioned the gasket on the crankcase, assemble the cylinder head (2) and tighten the fastening screws (1 and 3) in three phases, following order and mode shown in the figure below.

Ref.	No.	Description	Tightening torques
(1)	12	M12x1.75x130 1st phase 2nd phase 3rd phase	 35 ± 5 Nm 90° 90°
(3)	14	M12x1.75x150 1st phase 2nd phase 3rd phase	 55 ± 5 Nm 90° 90°

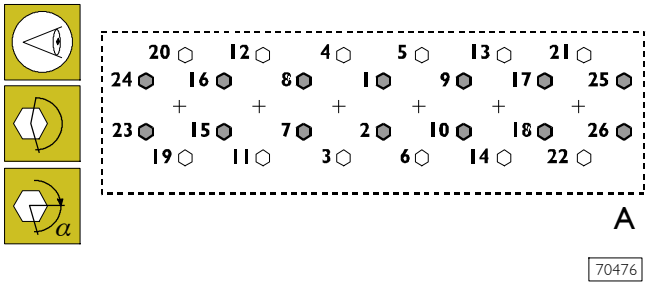
NOTE The screws (1 and 3) must be lubricated before being mounted on the cylinder head (2).

NOTE The screws (1 and 3) must be tightened following a "spiral" pattern starting in the middle and going outwards.

NOTE The angle tightening is carried out through tool 99395216.

NOTE Before any assembly operation always verify that the hole and screw threads have no evidence of wear or dirt.

Figure 148

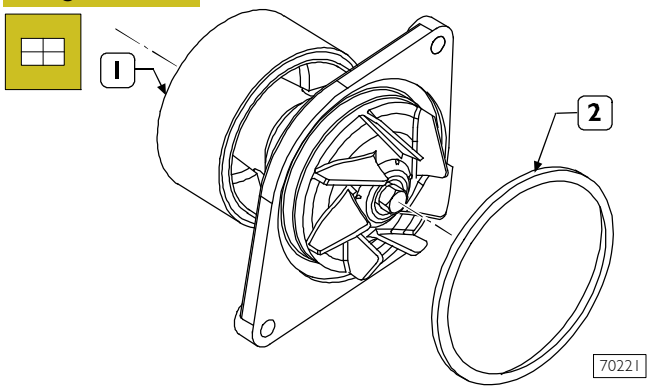


70476

Tightening order layout for cylinder head fastening screws.

A = Front side

Figure 149

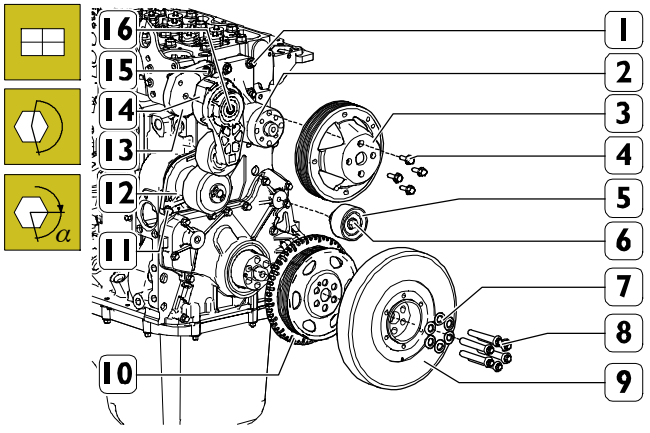


70221

Apply a new sealing ring (2) to the water pump (1).

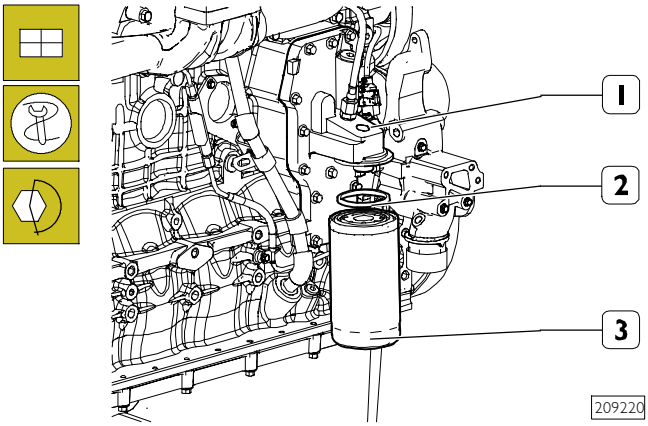
F4HFE613F*B006
F4HFE613F*B007

Figure 150



223136

Figure 185



Moisten the sealing gasket (2) of the oil filter (3) with a thin layer of oil.

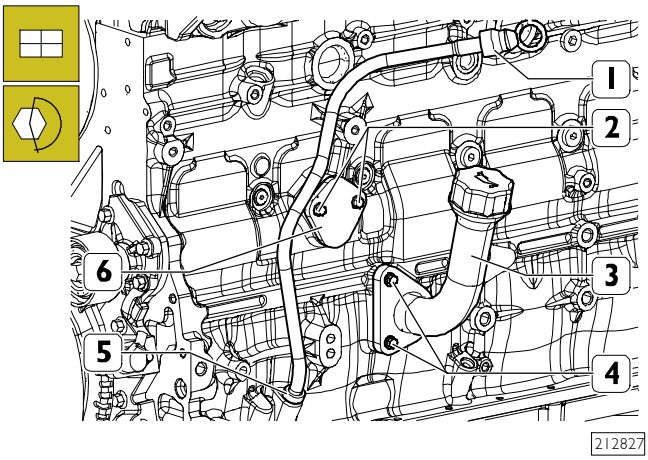
Manually tighten the oil filter (3) on the support (1) until it comes into contact with the gasket (2).

Additionally tighten the oil filter (3) to the prescribed torque using a specific tool.

Operate the engine for a few minutes and then check the level using the dipstick. If necessary, top up to compensate for the quantity of oil used to fill up the filtering cartridge.

Ref.	No.	Description	Tightening torques
(3)	1	M27x2	18 ± 2 Nm

Figure 186



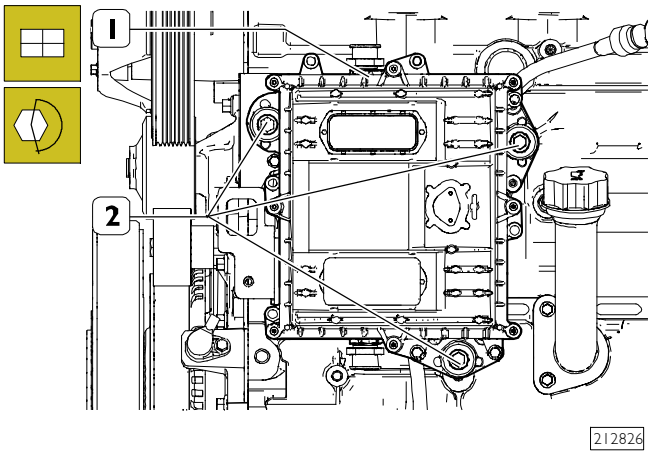
Install the oil dipstick pipe (1) and screw the hose coupling (5) into the engine block.

Fit the cover (6) together with the bracket supporting the oil dipstick pipe (1) and tighten the fastening screws (2) to the prescribed torque.

Install the oil filler pipe (3) with a new O-ring and tighten the fastening screws (4).

Ref.	No.	Description	Tightening torques
(2)	2	M8x1.25x20	24 ± 4 Nm
(4)	2	M12x1.75x25	80 ± 4 Nm

Figure 187

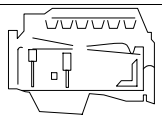
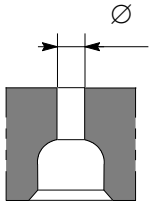
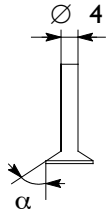
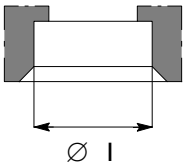
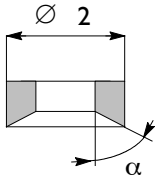
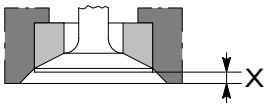
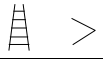


Fit the ECU (1), including the heat exchanger and tighten the supporting screws (2) to the prescribed torque.

In case the rubber buffers are cracked or excessively deformed, provide replacing them.

Install the low pressure fuel pipe from fuel pre-filter to the engine control unit heat exchanger and connect the retainer.

Ref.	No.	Description	Tightening torques
(2)	3	M8x1.25x45	14 Nm

	Type	F4HFE613		
		F*B006	F*B007	K*B010
CYLINDER HEAD – TIMING SYSTEM		mm		
	Valve guide seats on cylinder head Ø 1	7.042 ÷ 7.062		
	Valves:			
	Ø 4 α	6.990 ÷ 7.010 60° ± 0.25°		
	Ø 4 α	6.990 ÷ 7.010 45° ± 0.25°		
	Valve stem and guide	0.032 ÷ 0.072		
	Housing on head for valve seat:			
	Ø1	34.837 ÷ 34.863		
	Ø1	34.837 ÷ 34.863		
	Valve seat outside diameter; valve seat angle on cylinder head:			
	Ø 2 α	34.917 ÷ 34.931 60°		
	Ø 2 α	34.917 ÷ 34.931 45°		
	Sinking X	0.59 ÷ 1.11		
	X	0.96 ÷ 1.48		
	Between valve seat and head	0.054 ÷ 0.094		
		0.054 ÷ 0.094		
	Valve seats	-		