FPT N67 TM4 Бриз Моторс Technical repair manual

G_Drive application

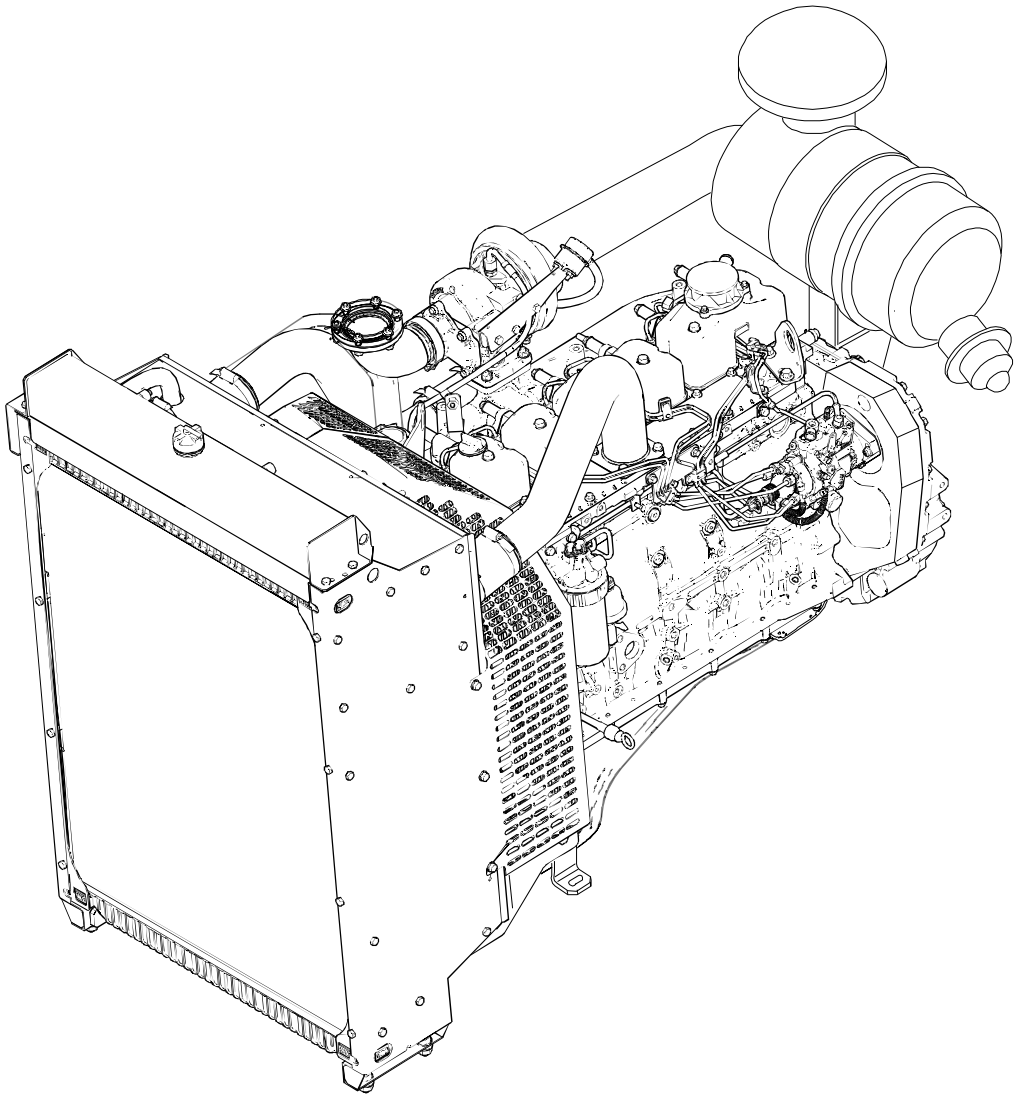
N67

F4GE0685A*B601

Technical repair manual

ISO F4GE0685A*B601 VIEW

Figure 1



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The F4GE0685A*B601 is a six-cylinder in-line engine with turbocharger with two valves per cylinder; it belongs to the NEF series and operates according to a four-stroke diesel cycle.

The engine supply system is based on the direct injection of the fuel by means of a mechanical rotary pump.

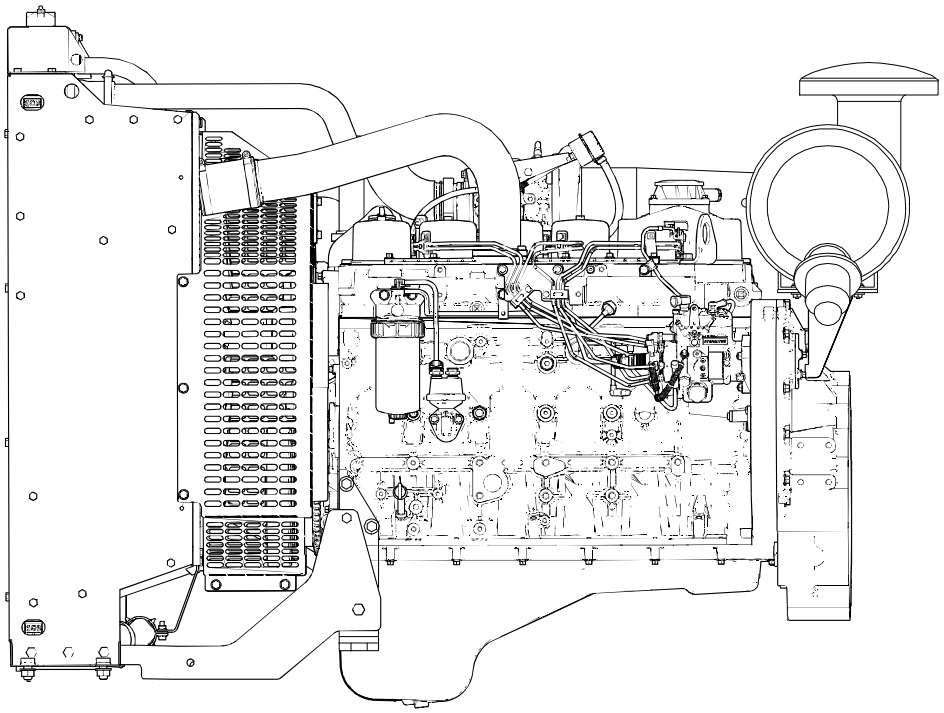
With the "dual speed" mode, you can switch between 1500 rpm to 1800 rpm, varying the operating frequency from 50 Hz to 60 Hz.

The camshaft and the fuel injection pump are timed with the crankshaft via the timing gear train.

The intake and exhaust valves are timed with the camshaft tappets, the push rods and the rocker arm assembly.

F4GE0685A*B601 ENGINE VIEWS

Figure 2



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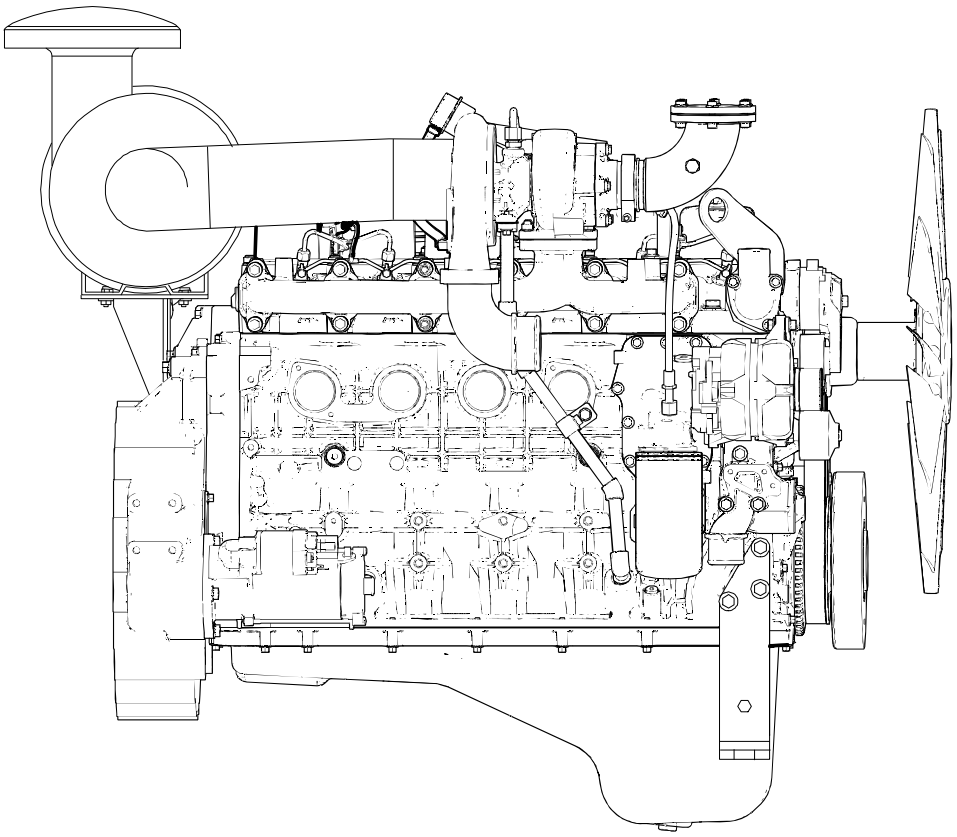
LEFT SIDE VIEW

Figure 3



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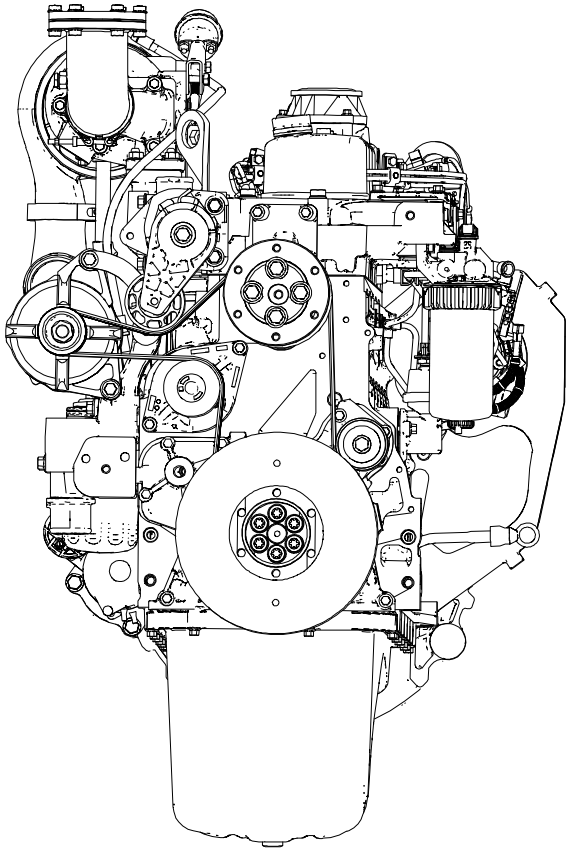
RIGHT SIDE VIEW

Figure 4



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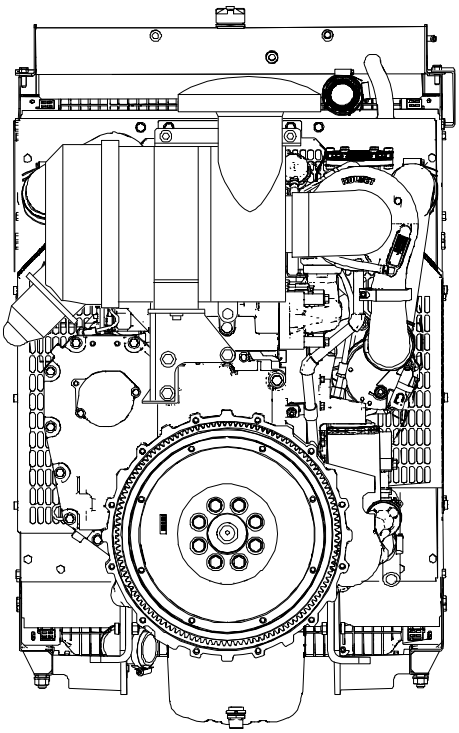
FRONT VIEW

Figure 5



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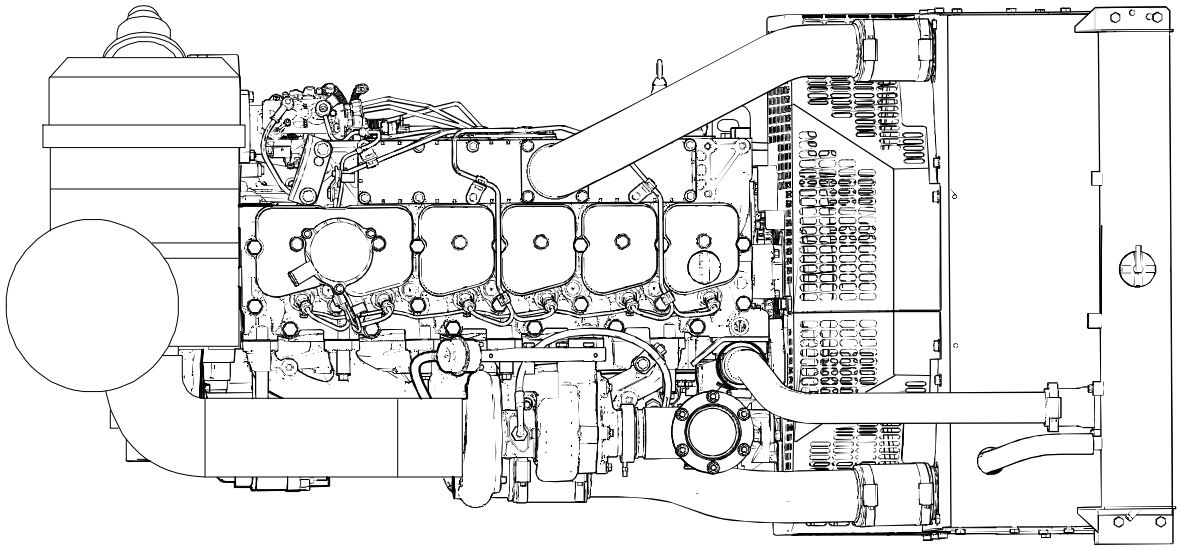
REAR VIEW

Figure 6



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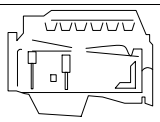
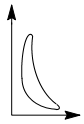
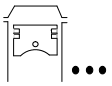
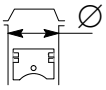
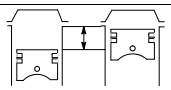
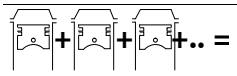
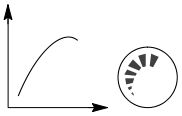
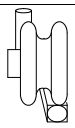
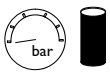
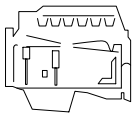
TOP SIDE VIEW

MAIN ENGINE SPECIFICATIONS

	Type		**F4GE0685A*B601**	
	Cycle		Diesel 4-stroke	
	Air supply		Supercharged with turbocharger + intercooler	
	Injection		Direct injection with rotary pump	
	Number of cylinders		6, in line	
	Bore	mm	104	
	Stroke	mm	132	
	Total displacement	cm^3	6728	
	Compression ratio		17.5 : 1	
	Prime Power Stand-by	kWm kWm rpm (Hz)	149.7 165 1,500 (50)	- - 1,800 (60)
	Low idle speed	rpm (Hz)	1,500 (50)	- (60)
	Low idle speed	rpm (Hz)	1,570 (50)	- (60)
	**TURBOCHARGING** Turbocharger type		Turbocharger with intercooler HOLSET HX35W	
	**LUBRICATION** Oil pressure with engine warmed up: - at idling speed bar @ rpm - at maximum speed bar @ rpm		Forced by means of rotary pump, pressure relief valve and oil filter 2 @ 750 4 @ 4,200	
	COOLING Water pump drive: **Thermostat**: - opening start - max. opening	 °C °C	Liquid By means of ancillary belt 78.6 ± 1.9 96	

NOTE The data, specifications and performance figures are only valid if the fitter complies with all the installation instructions provided by FPT.
Furthermore, the fitted appliances must always be in compliance with the torque, power and engine speed for which the engine was designed.

	Type		**F4GE0685A*B601**
	CAPACITIES		
	Cooling circuit (1)	Litres	engine (4) 10.5 G-Drive (5) 25.5
	Lubrication circuit (2) (3)	Litres (kg)	17.2 (15.8)
	Periodic replacement:		
	sump at minimum level		8 (7.4)
	sump at maximum level		12 (11)
	Fuel tank	Litres	-

(1) Use a 50% mixture of water and PARAFLU 11 or the equivalent corresponding to the specification SAE J1034.

(2) Use lubricants which comply with the international specifications ACEA E5-E7 (high power engines).
The oil used is considered to be acceptable until a quantity equalling 0.1% of fuel consumption is reached.

(3) The quantities indicated refer to the first refuel only and are relative to the engine, oil sump and filter.

(4) The quantities indicated only refer to the engine in its standard configuration.

(5) The quantities indicated refer to the total capacity of the G-Drive including the engine capacity, the radiator and the pipes.

Filling from drums or tanks can cause contamination of the diesel, with the consequent risk of damaging the injection system; if necessary, perform suitable filtration or sedimentation of the impurities before refuelling.

NOTE The data, specifications and performance figures are only valid if the fitter complies with all the installation instructions provided by FPT.

Furthermore, the fitted appliances must always be in compliance with the torque, power and engine speed for which the engine was designed.

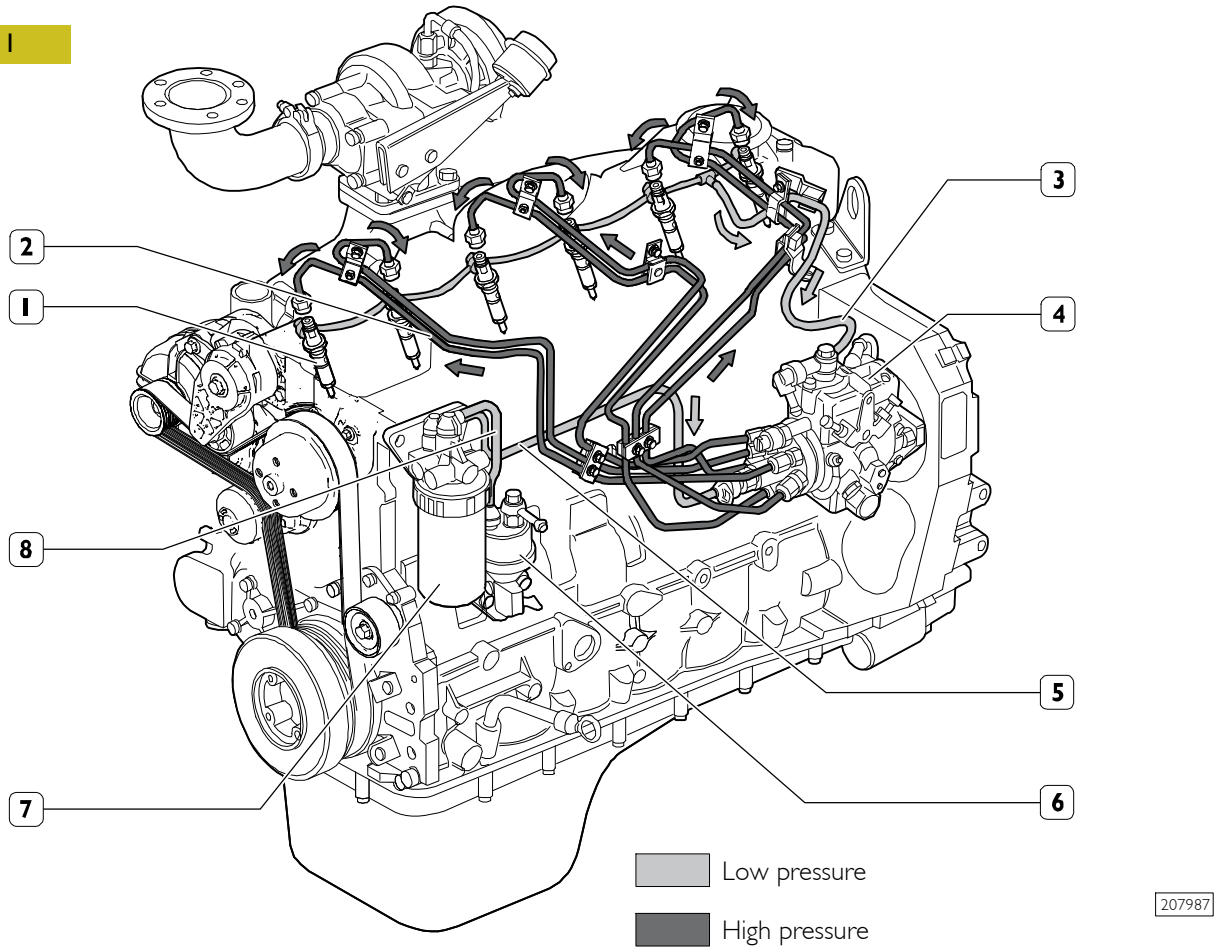
SUPPLY SYSTEM

General information

The fuel supply system is composed of:

- ❑ Fuel tank
- ❑ Pipes delivering and returning fuel to the tank
- ❑ Fuel suction pump
- ❑ Fuel filter
- ❑ Mechanical rotary fuel injection pump
- ❑ Injector supply pipes
- ❑ Mechanical injectors
- ❑ Pipes returning fuel from injectors

Figure 1



1. Mechanical injectors - 2. Injector supply pipes - 3. Pipe returning fuel from injectors - 4. Mechanical rotary fuel injection pump - 5. Fuel line from the filter to the supply pump - 6. Fuel suction pump - 7. Fuel filter - 8. Fuel line from the suction pump to the filter.

Operation description

The fuel is sucked into the fuel tank by means of the priming pump. This is located on the engine crankcase and is controlled by the camshaft.

The fuel is conveyed through the filter to the inlet coupling in communications with the suction chamber of the transfer pump.

The transfer pump is positioned inside the supply pump and is of the blade type; its purpose is to increase the fuel pressure depending on the increase of the number of revolutions.

The fuel therefore reaches the valve which regulates the pressure inside the supply pump.

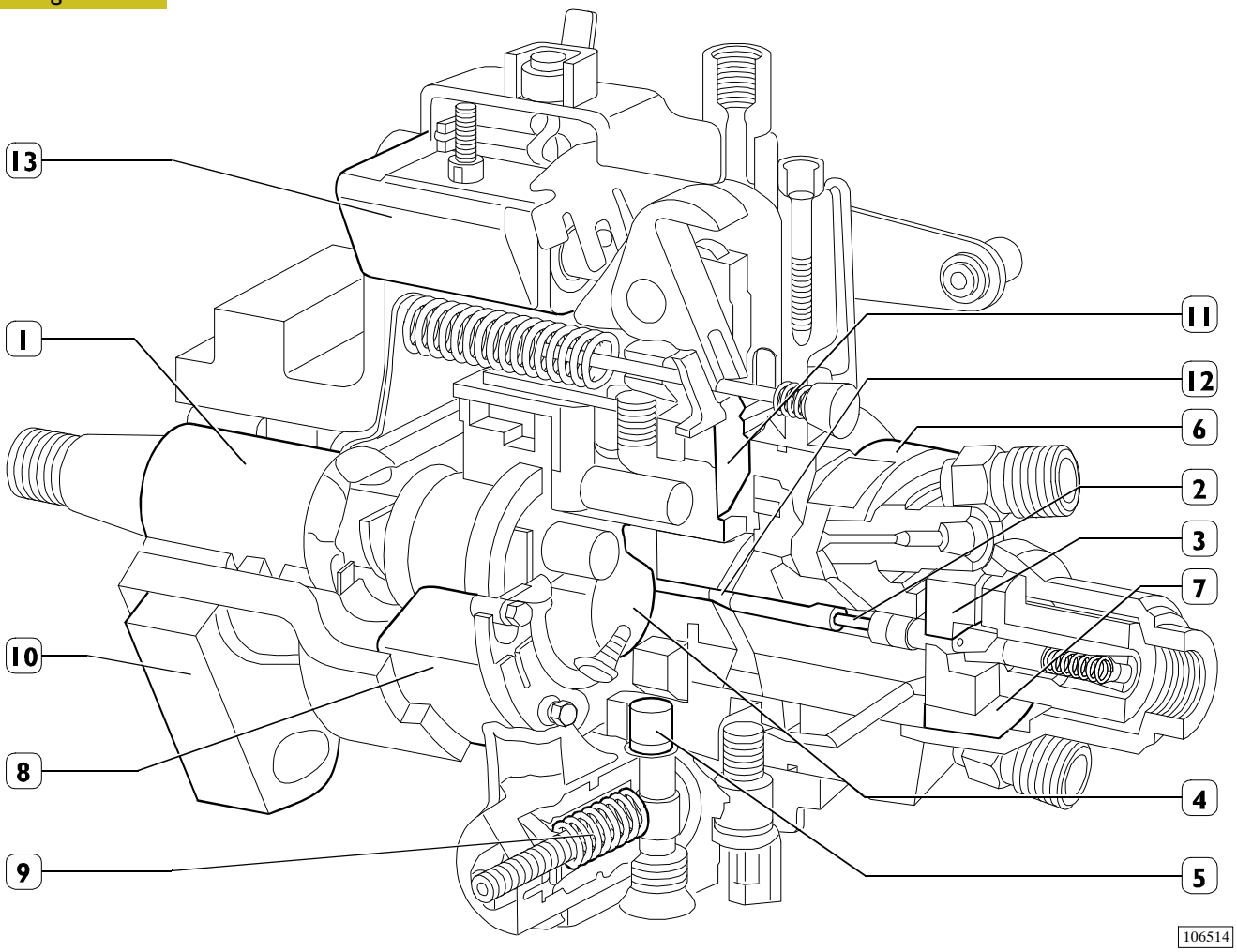
The distributor piston further increases this pressure and sends it through the fuel delivery coupling to the injectors.

The fuel which leaks from the injectors is recovered and sent to the tank again.

FEED PUMP

The STANADYNE DB4 CCW mechanical rotary fuel injection pump is driven by a gear coupled to the camshaft.

Figure 2



1. Propeller shaft - 2. Distribution rotor - 3. Transfer pump vanes - 4. Pumping pistons - 5. Cam internal ring - 6. Hydraulic head - 7. Pressure regulator unit - 8. Regulator - 9. Automatic advance - 10. Seat - 11. Metering valve - 12. Delivery valve - 13. Electric power shut-off solenoid valve.

Operation description

The main rotation components are the propeller shaft (1), the distribution rotor (2), the transfer pump vanes (3) and the regulator (8). The propeller shaft engages the distribution rotor inside the hydraulic head (6).

The four pistons are engaged towards each other simultaneously by the cam inner ring through the rollers and the sliding blocks that are transported into the holes located on the end of the rotor.

The number of cam lobes is equal to the number of engine cylinders.

The transfer pump positioned no the rear part of the rotor is positive cylinder type and is closed within the end plug. The end plug also contains the screen of the intake filter and pressure regulator (7) of the transfer pump. The upper part of the regulator unit is pressed against the distribution rotor and forms a final seal for the transfer pump.

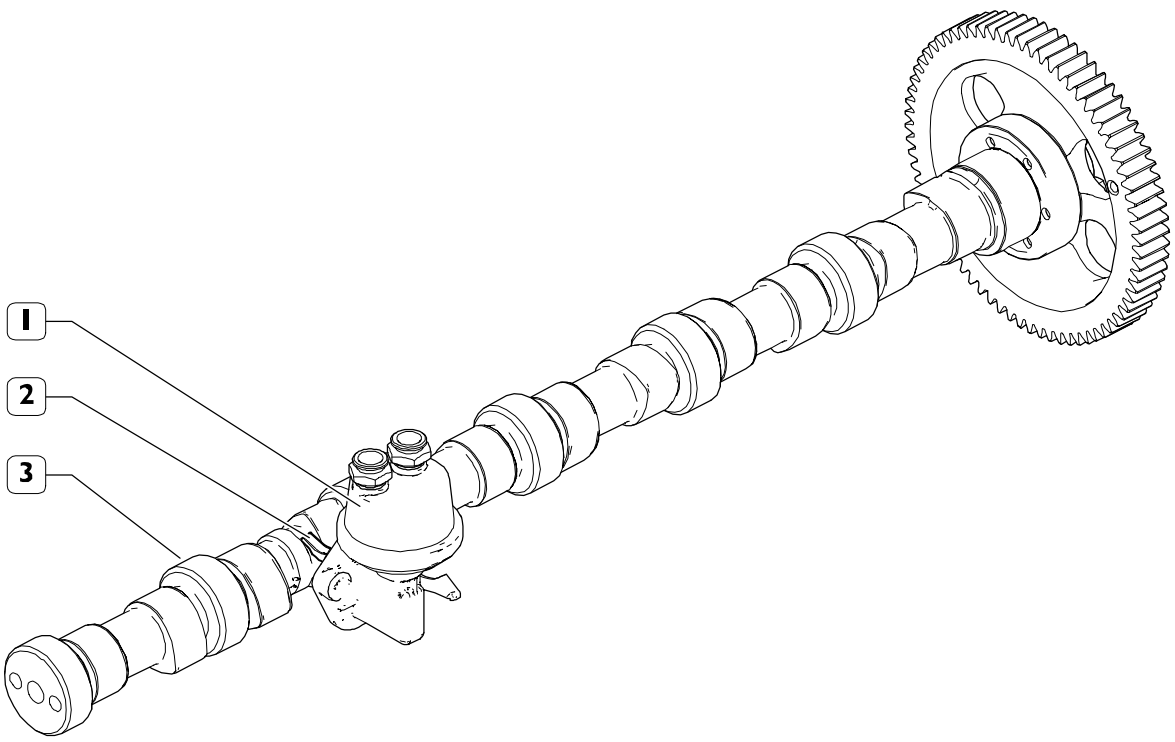
The distribution rotor (2) contains two loading doors, a single axial hole and a loading door for all outlets towards the injection line.

The hydraulic head (6) contains the hole in which the rotor turns, the hole of the metering valve (11), loading opening and the couplings for exhaust delivery. The high pressure injection lines connected to the injectors are fixed to the above mentioned exhaust couplings.

PRIMING PUMP

The fuel suction pump, mounted on the engine crankcase and powered by the camshaft, has the function of conveying the fuel in the tank to the injection pump.

Figure 3



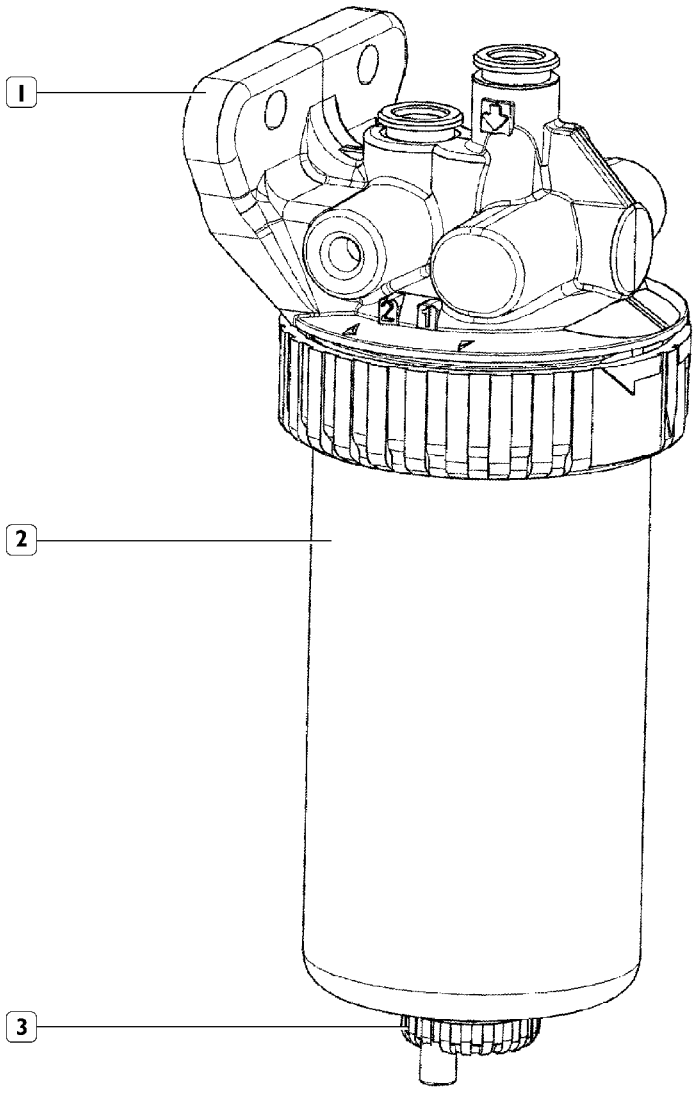
1. Fuel suction pump - 2. Control lever - 3. Camshaft.

FUEL FILTER

The filter is positioned near the feed pump and the priming pump, and has the function of retaining impurities and separating the water contained in the fuel.

At the base of the filter cartridge, there is a water bleed screw through which it is possible to drain it from time to time; a heater and temperature sensor can be placed on the support for the uses that require it (use in cold climates).

Figure 4



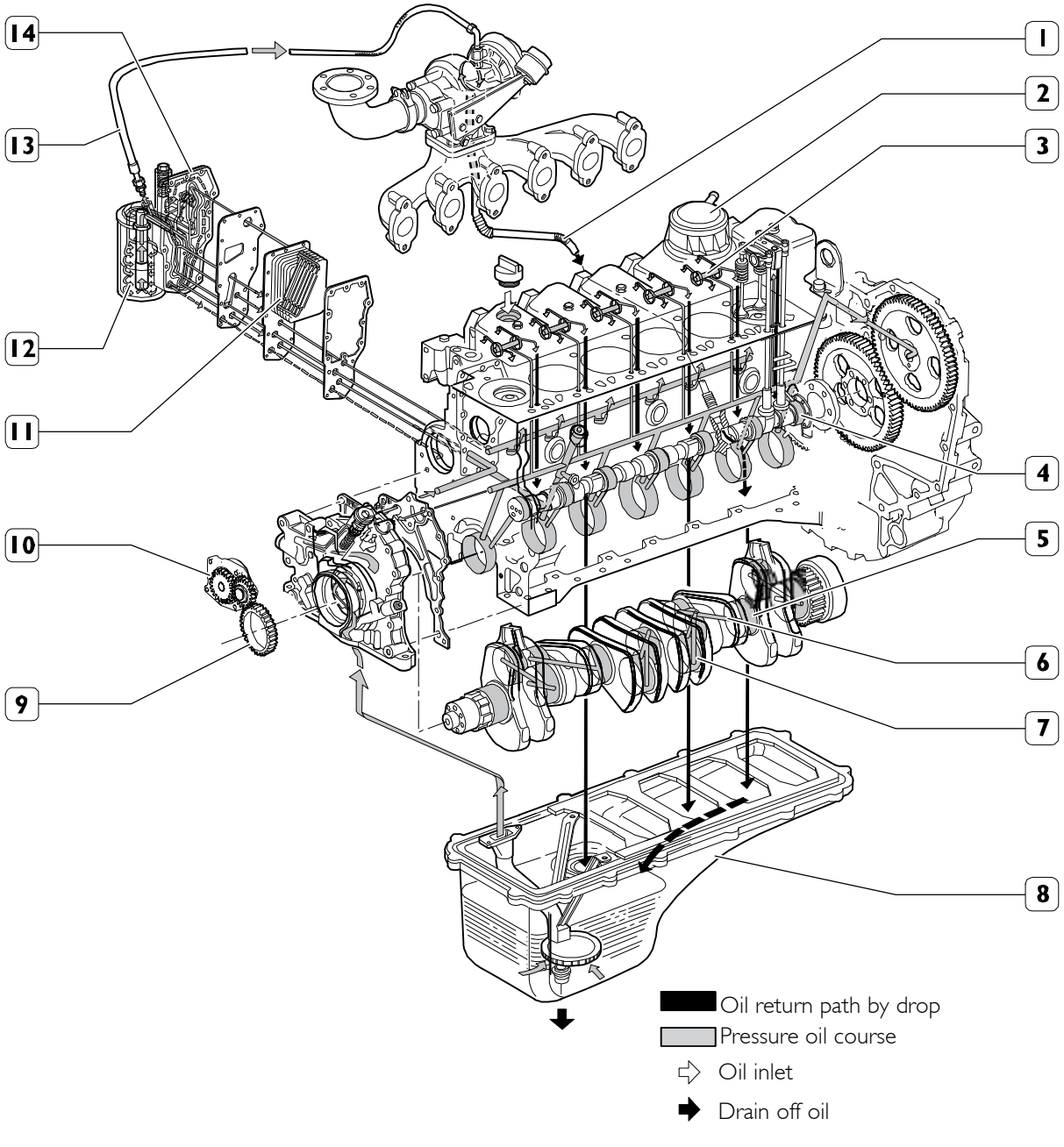
1. Fuel filter support - 2. Filtering cartridge - 3. Water bleed screw.

LUBRICATION CIRCUIT

The lubrication circuit of the engine includes a rotary oil pump, an oil filter, a heat exchanger, an oil pressure control valve and a by-pass valve.

From the lubricant sump, after being cooled in the heat exchanger and filtered in the oil filter, it is sent to the crankshaft, the camshaft, the control valves and the turbocharger.

Figure 5



1. Turbocharger lubrication oil discharge pipe - 2. Regulation valve (blow-by) - 3. Rocker arm shaft hole - 4. Camshaft bush - 5. Main half-bearings - 6. Crankshaft transverse channels - 7. Connecting rod half-bearings - 8. Oil sump - 9. Oil pump control gear set on crankshaft - 10. Rotary oil pump - 11. Heat exchanger lubricant oil / coolant - 12. Oil filter - 13. Turbocharger lubrication oil delivery pipe - 14. Oil filter support.

Operation description

The forced circulation lubrication is produced by the rotary oil pump, housed in the front part of the crankcase and driven by a spur gear fitted to the stub of the crankshaft.

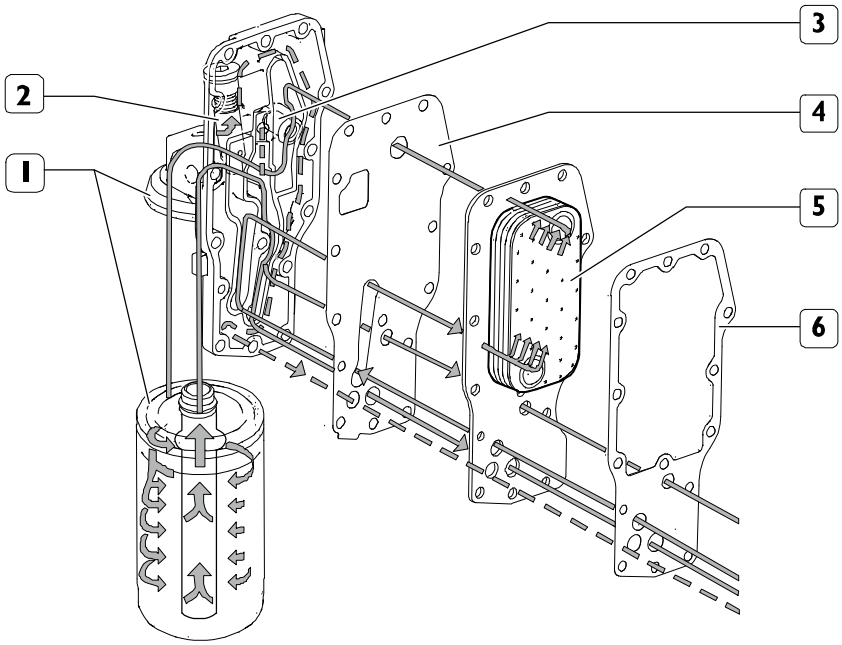
The pump draws oil from the sump through a filter and the suction pipe and pushes it up to the heat exchanger and filter. The oil then flows into the main pipe holding the entire length of the block and delivers oil to the conduits that allow the lubrication of the camshaft, rocker arm shafts and main half-bearings. The oil flows from the main half-bearings through transverse ducts to the connecting rod half-bearings into the crankshaft between the main pins and the connecting rod pins. The oil also feeds the diffusing openings for cooling the pistons. The oil spray lubricates the underside of the piston, keeping the crown cold, and the plug and the relative bushing, through the hole in the top. The oil running through the rocker arm shafts and lubricates the single rocker arms drips from the rocker arms to lubricate the adjusting screws, push rods and camshaft tappets.

Turbocharger lubrication

The turbocharger and supports are lubricated by means of oil circulating in the engine. The lubricant, drawn just after the oil filter, is pumped through the delivery pump to the turbocharger and returns by gravity to the oil sump through the exhaust pipe.

LUBRICANT HEAT EXCHANGER

Figure 6



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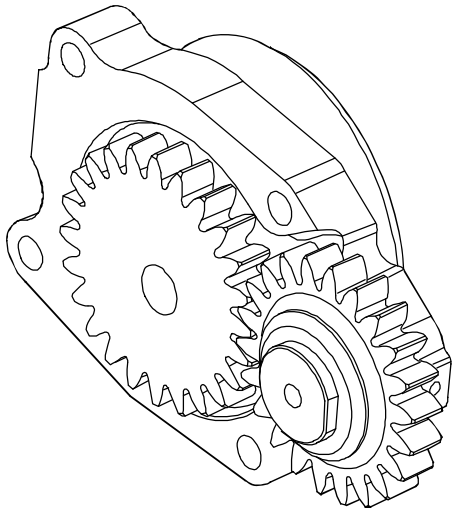
1. Oil filter support - 2. Lubricant pressure control valve - 3. By-pass valve to cut off clogged oil filter - 4. Internal heat exchanger gasket - 5. Heat exchanger lubricant oil / coolant - 6. Gasket between heat exchanger and crankcase

OIL PUMP

Housed in the front of the crankcase, the oil pump is a rotary pump commanded by a spur gear fitted to the stub of the crankshaft.

Figure 7



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NOTE The oil pump shall not be overhauled. If faults are found, replace it.

OIL SUMP

The oil sump (1) is elastically fixed to the engine block by an aluminium plate (3).

The gasket (2) in a rubber "C" section, fitted to the profile attached to the oil sump, improves the seal and reduces noise.

This type of gasket may be replaced only in case of deterioration or breakage and not necessarily at every removal.

Figure 8

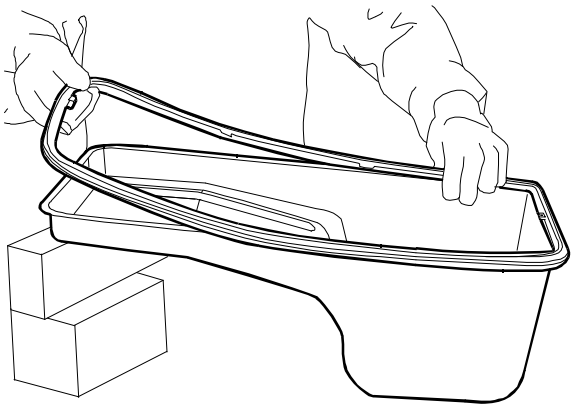

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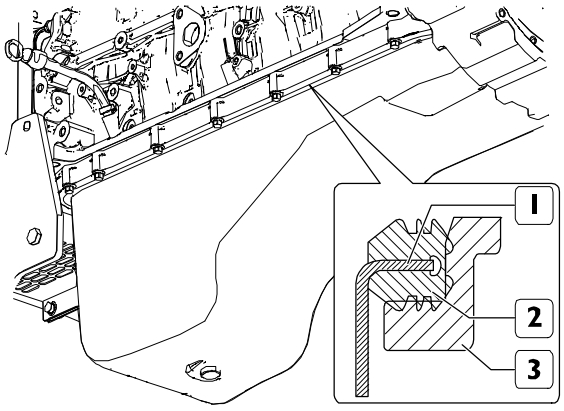
Figure 9



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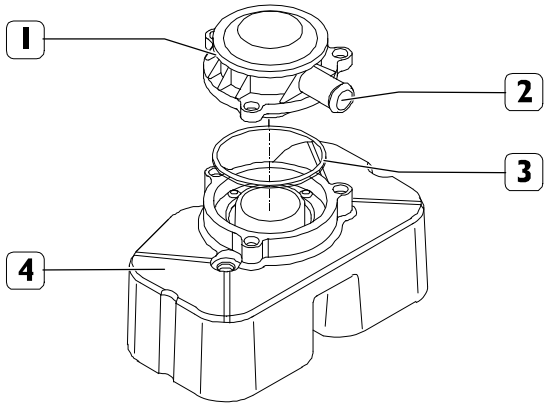
OIL VAPOUR RECYCLING

While the engine is running, part of the gas produced by combustion leaks out of the piston gaskets into the sump and mixes with the oil vapour it contains. This mix rises up in the cylinder head and is conveyed to the blow-by filter (1) fitted on the top of the cover (4) of cylinder tappets 5-6. The device is equipped with a membrane that allows the partial separation of oil vapours and condensation, causing the oil to fall by gravity for recovery.

The remaining uncondensed vapours are emitted into the air intake circuit through the breather (2) for combustion.

Figure 10



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1. Regulation valve (blow-by) - 2 . Oil vapour breather (at intake) - 3. Gasket - 4. Tappet cover for cylinders 5-6

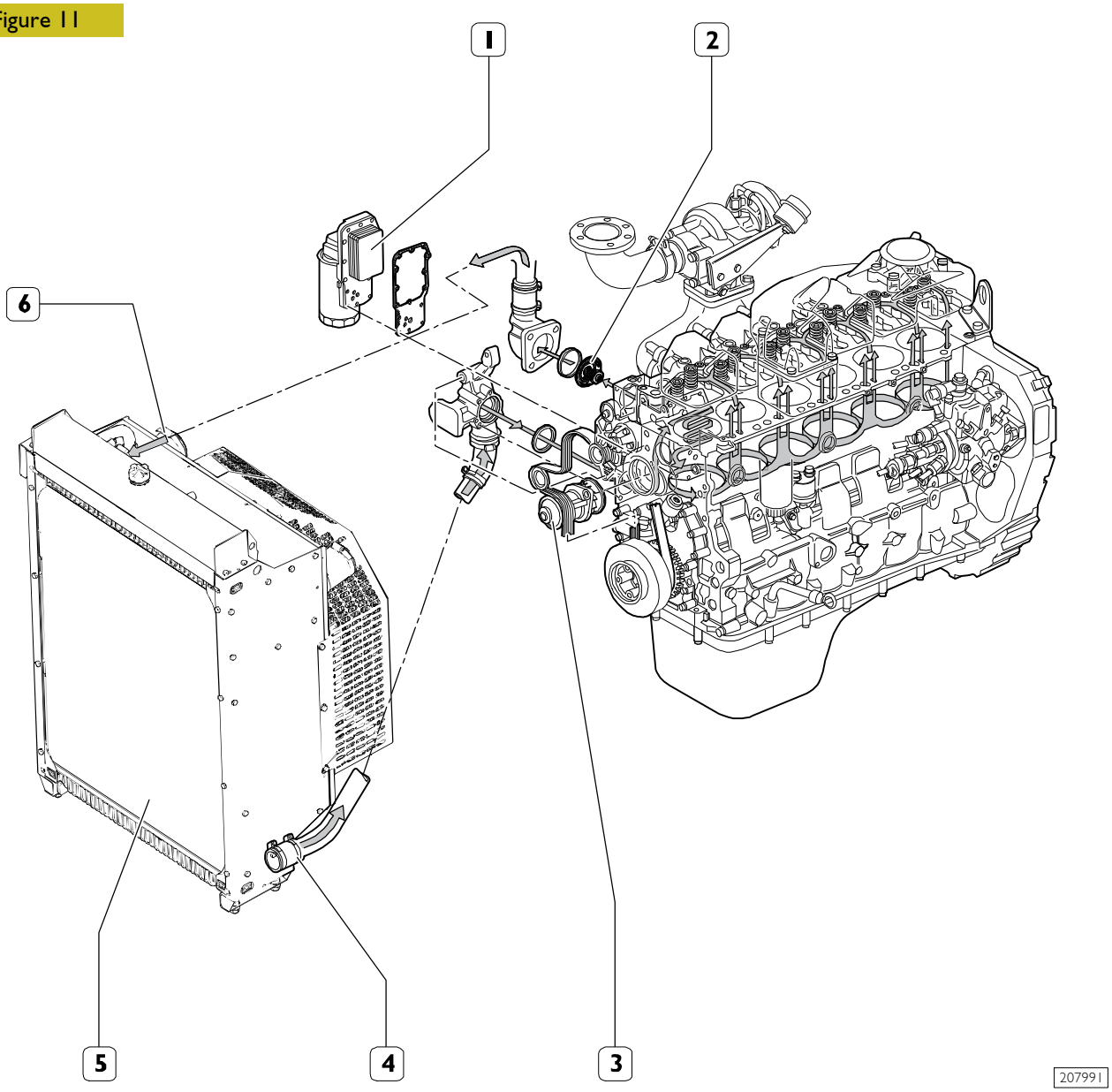
COOLING CIRCUIT

The engine cooling system, of the closed-loop forced-circulation type, is composed of the following components:

- ❑ expansion tank: the position, shape and dimensions can change depending on the engine outfitting.
- ❑ radiator, for dissipating the heat taken from the engine by the coolant. This component can also change depending on the outfitting both in terms of position and dimensions.
- ❑ viscostatic fan with the function of increasing the dissipating power of the radiator: this is also part of the specific outfitting for the engine.
- ❑ heat exchanger to cool the lubricant oil: this is also part of the specific outfitting for the engine.
- ❑ centrifugal water pump set in the front part of the engine block;
- ❑ thermostat to control coolant circulation.

The circuit can also extend to the compressor if the construction provides for its presence.

Figure 11



COOLING SYSTEM DIAGRAM

1. Heat exchanger lubricant oil / coolant - 2. Thermostat to regulate temperature - 3. Water pump - 4. Engine coolant inlet pipe (from the radiator) - 5. Radiator - 6. Engine coolant outlet pipe (to the radiator)

Operation description

The coolant, put into circulation by the water pump, flows around the plates of the oil heat exchanger. From here, it goes into the coolant chamber, around the cylinder liners, to the inside of the cylinder head. In the cylinder head, the coolant runs towards the front end of the channels, around the intake and exhaust openings, to the valve seats and the injectors, and exits through the temperature regulation body where the cooling circuit thermostat is located.

While heating, the thermostat is closed, for which the coolant is sent through the by-pass circuit to the intake side of the water pump. The coolant continues to circulate through the block, the cylinder head and the water pump so as to ensure a quick and uniform heating time.

Once the engine has reached operating temperature, the thermostat opens and allows the coolant to run through the upper radiator hose to the expansion vessel. The coolant circulates through the radiator, dissipating heat, and exits through the lower sleeve; then it is sent to the suction side of the water pump. The coolant continues to flow through the engine and the radiator circuit until the temperature drops below the opening temperature of the thermostat.

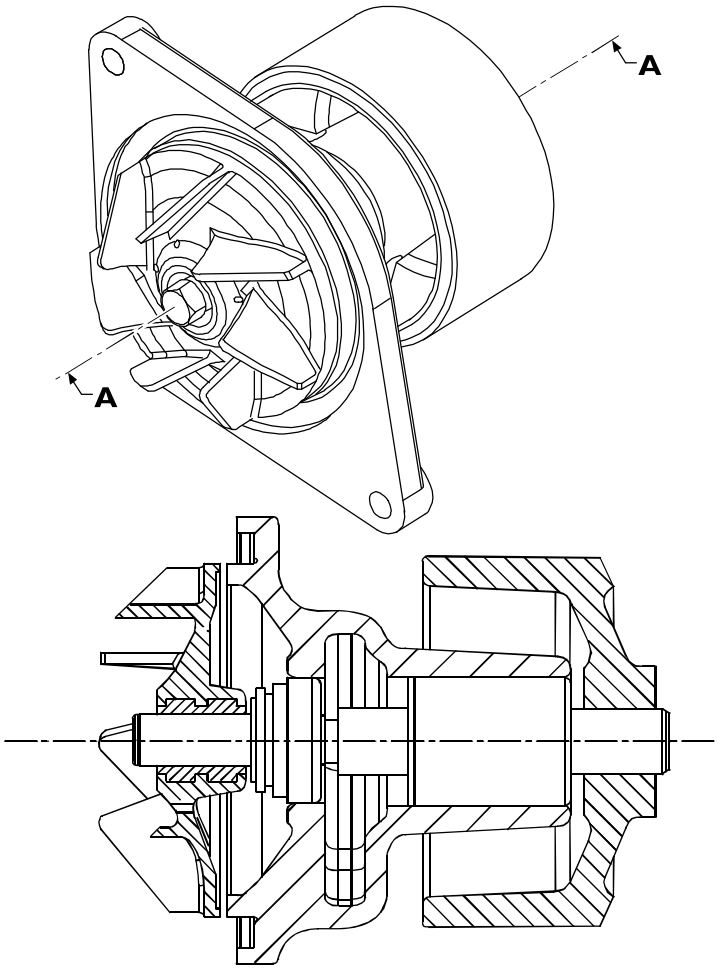
WATER PUMP

The water pump, located in a hollow obtained in the crankcase, is centrifugal and driven by a poly-V belt.

The almost complete absence of external pipes, sleeves and clamps, eliminates several connections, reducing possible sources of leakage. A thermostat regulates the engine temperature.

The coolant (water and Paraflu 11 at 50%) also circulates in the oil heat exchanger.

Figure 12



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Sect. A - A

NOTE Check that the pump casing shows no sign of cracking or water leakage; replace the water pump assembly if it does.

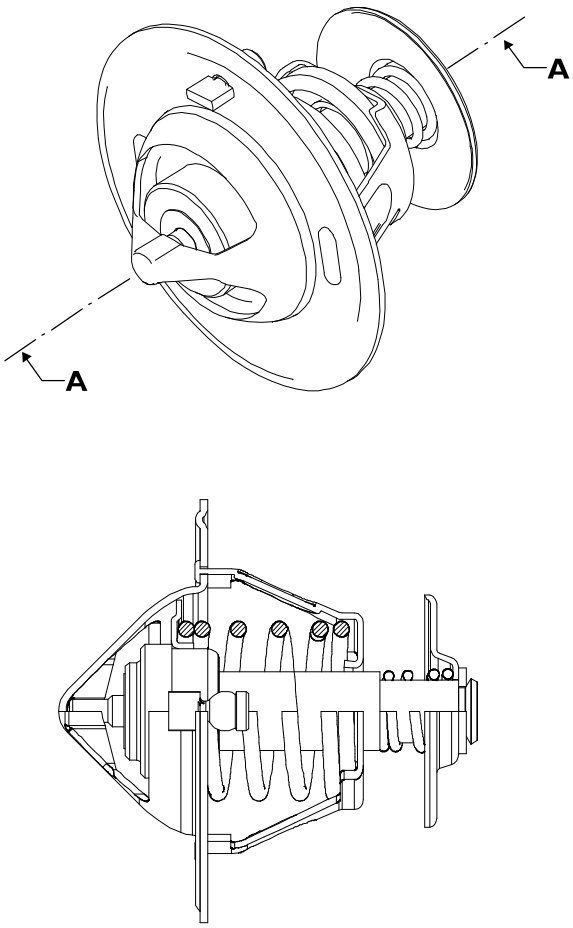
THERMOSTAT

The thermostat, located in the cylinder head, is of the by-pass type and doesn't need regulations. If there are doubts as to its proper functioning, replace it.

The coolant temperature sensor is also fitted into the cylinder head.

Start of opening:	78.6 °C± 1.9
Maximum opening:	96 °C @ min 7.5 mm ÷ Max 9 mm
Water flow rate:	Max 6 L/h @ 1 bar
Operating temperature field:	-40 ÷ +135 °C

Figure 13



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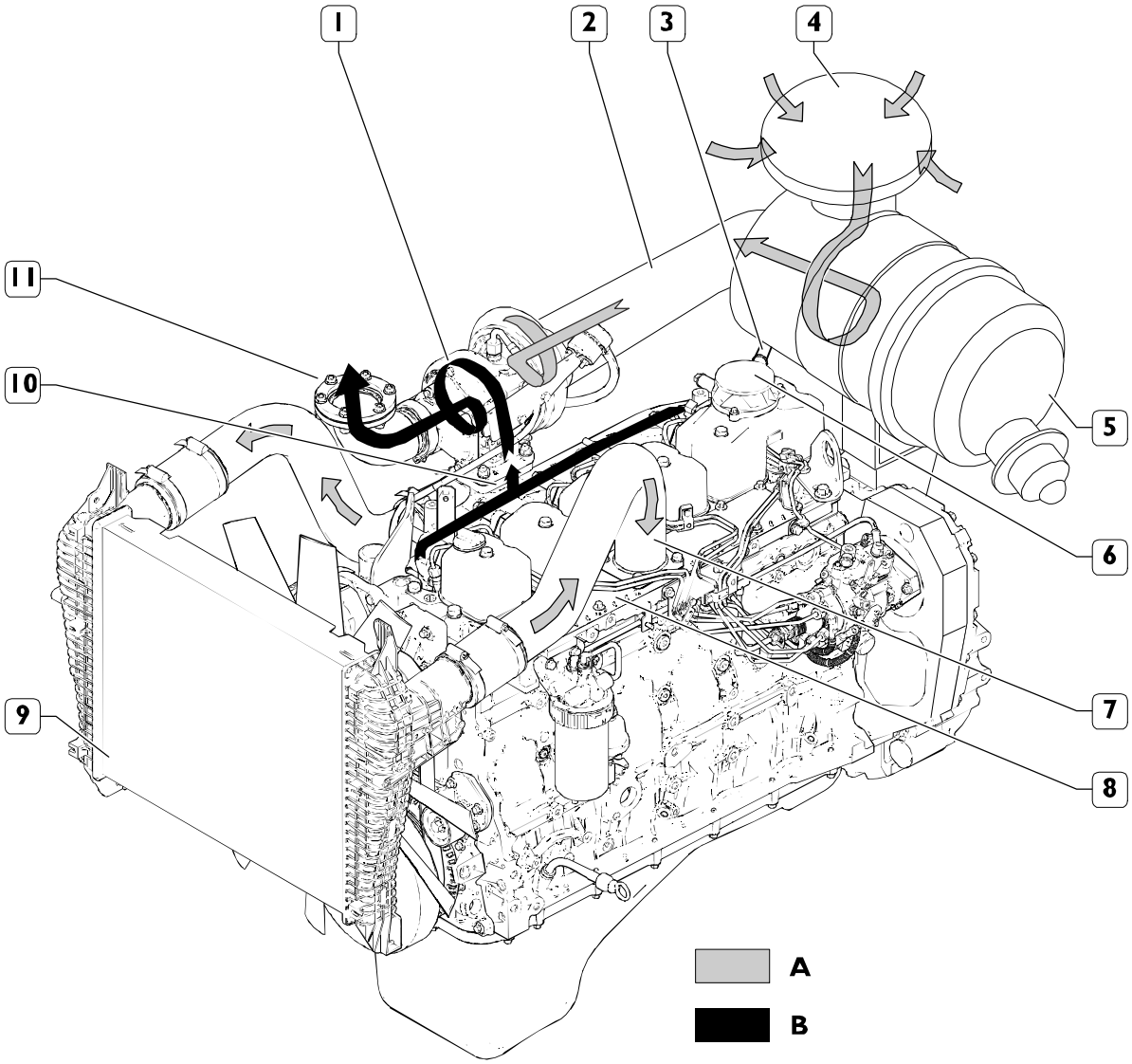
Sect. A - A

INTAKE AND EXHAUST SYSTEM

Figure 14



A. Intake air flow - B. Exhaust gas flow

1. Turbocharger - 2. Combustive air intake duct to turbocharger - 3. Oil vapour breather pipe - 4. External air socket - 5. Air filter - 6. Regulation valve (blow-by) - 7. Combustive air intake duct to engine - 8. Intake manifold - 9. Intercooler - 10. Exhaust manifold - 11. Exhaust gas outlet duct from turbocharger

Operation description

The engine intake system recalls external air through the air socket and filters it through the primary and secondary (safety) dry cartridges contained in the air filter. The filtered air runs through the entry hose to the turbocharger.

The filtered and compressed (hot) air exits the turbocharger and is sent through the intercooler.

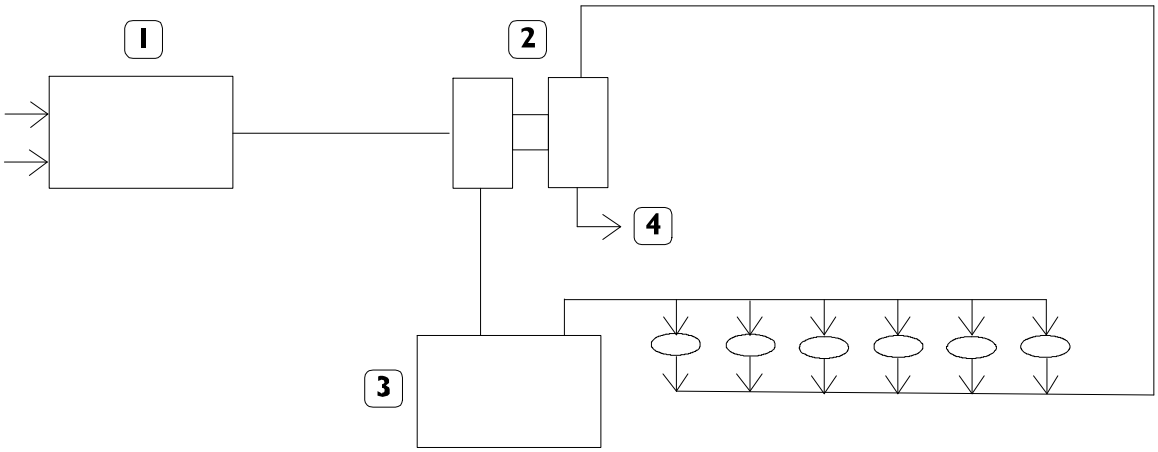
The cold compressed air exits the intercooler and reaches the intake manifold.

The exhaust manifold collects the fuel gases coming from the cylinders and conveys them directly to the turbocharger to activate it, to then expel them through the exhaust manifold of the turbocharger.

TURBOCHARGING

The adoption of turbocharging makes it possible to increase the power developed by the engine by emitting, at each cycle, a quantity of combustive air greater than what the engine would have been able to intake naturally through the alternating motion of the pistons. A greater quantity of air emitted into the combustion chamber makes it possible to completely burn a higher quantity of fuel, so as to respect the optimal stoichiometric ratio.

Figure 15



212626

TURBOCHARGER

The turbocharger (2) consists of a rotating turbine, set in rotation by the exhaust gases during operation of the engine, and a rotating compressor keyed by a shaft connecting the turbine. The compressor, driven by the turbine, compresses the air sucked through the air filter (1).

The hot compressed air leaving the turbocharger (2) is sent to the intercooler (3) to be cooled.

The cold compressed air leaving the intercooler (3) is sent directly to the cylinders, through the intake manifold.

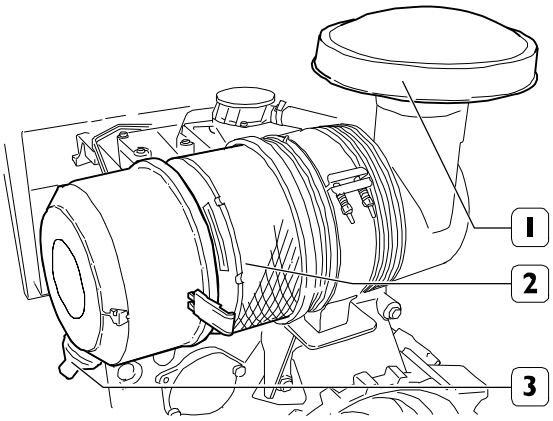
The turbocharger (2) is equipped with a regulation valve that partializes the exit of exhaust gas depending on the supercharge pressure downstream of the compressor, sending part of it directly to the exhaust pipe (4).

AIR FILTER

By means of the aspiration created by the engine, the outside air flows through the air socket (1) and the centrifugal movement is imparted at high speed by the wings aimed at the filter.

The larger particles of dust and dirt are separated from the air and collected in the condensate discharge valve (3). The suctioned air then passes through the primary (2) and possibly the secondary (safety) filter elements before being fed into the engine. If present, the secondary filter (safety) ensures that unfiltered air does not enter into the engine even if the primary filter should fail.

Figure 16

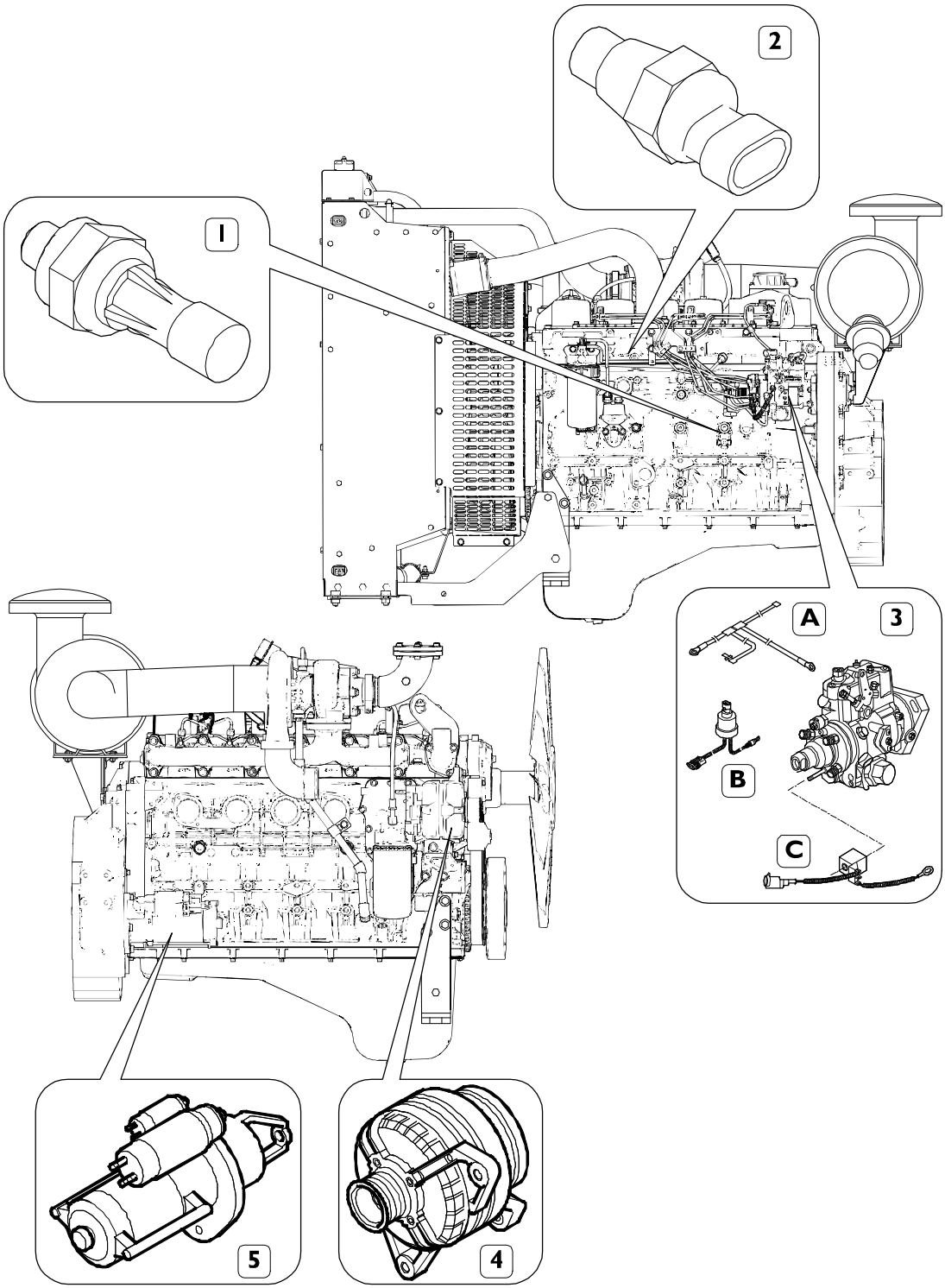


207993

1. External air socket - 2. Filter element (primary) - 3. Condensate exhaust valve

LOCATION OF ELECTRICAL COMPONENTS ON THE ENGINE

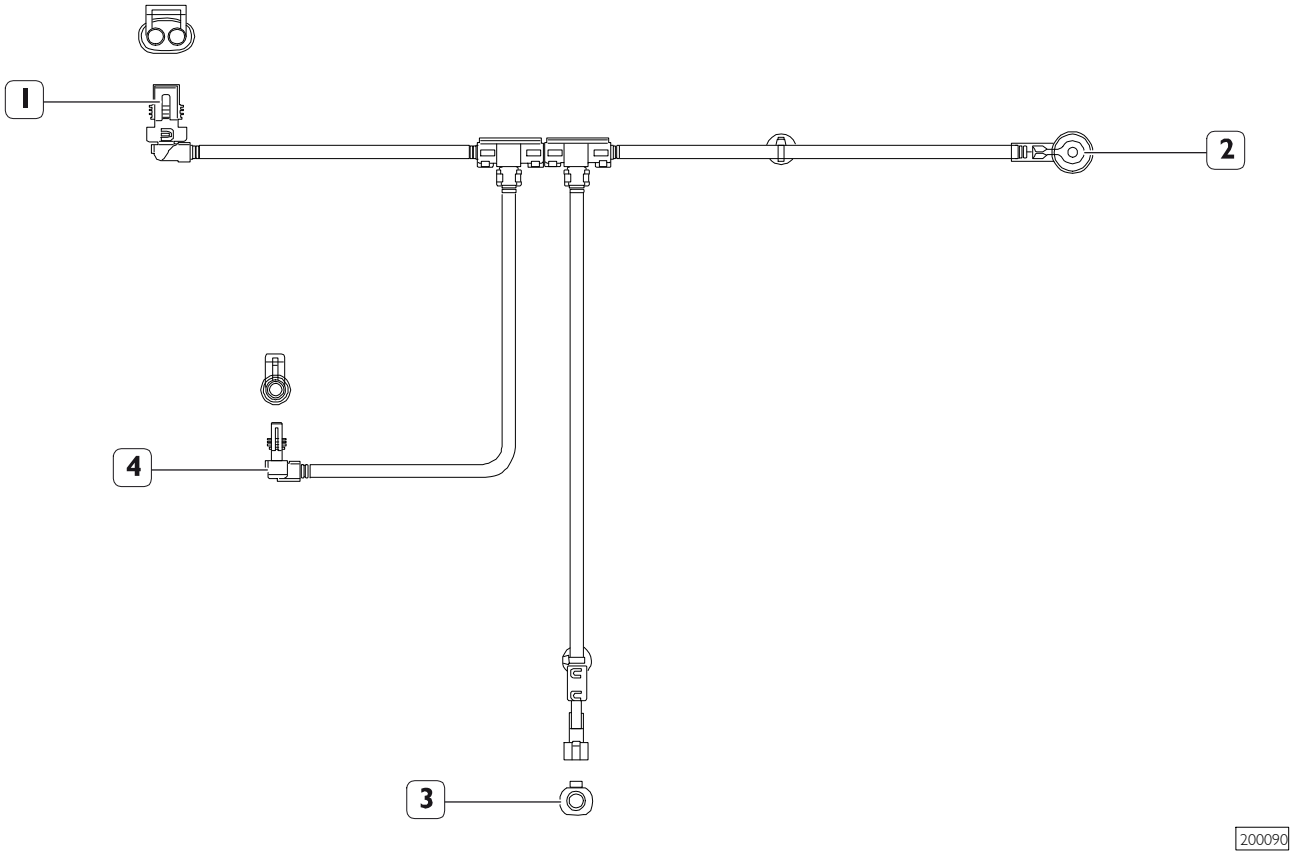
Figure 1



1. Lubricant oil pressure sensor; - 2. Coolant temperature sensor for KSB ignition timing regulator; -
3. (A) KSB connection cable - Stanadyne pump (B) Timer (where provided); (C) CSA. - 4. Alternator. - 5. Starter;

KSB connection cable - Stanadyne pump

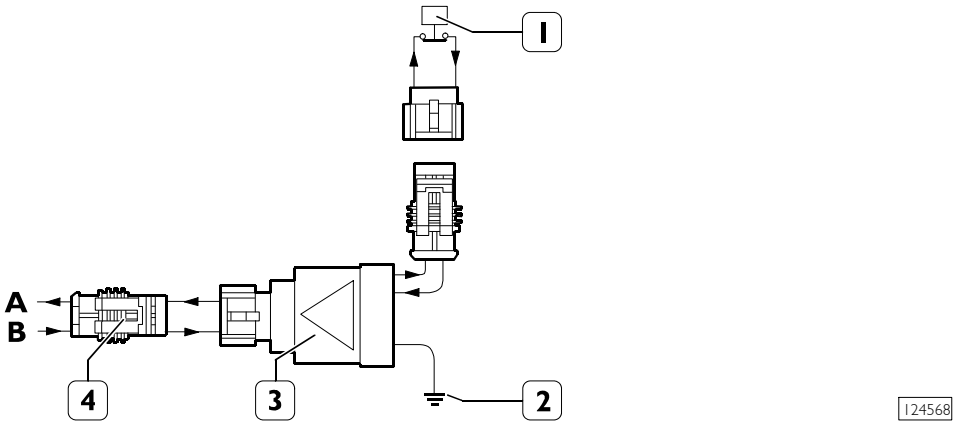
Figure 2



1. Air sensor- 2. Electrostop - 3. Interface - 4. KSB Signal

Timer (if present)

Figure 3



1. Air sensor (TAK) - 2. Engine ground - 3. Timer 35±5 - 4. KSB cable - Stanadyne pump
A. Output 12V advance electromagnet - B. Input +15 12V (from CSA)

Once the engine is started, it is brought to operating speed immediately (without transition). The KSB would not work with the ending hot, causing a high amount of "white" smoke, the timer which activates it intervenes for about 30-40 seconds, eliminating the ignition smoke.

Starter motor

Figure 4

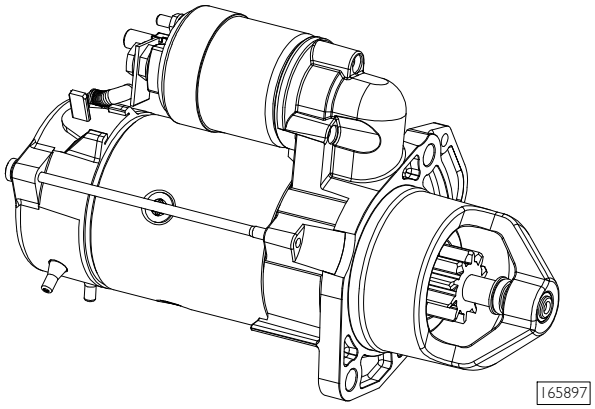
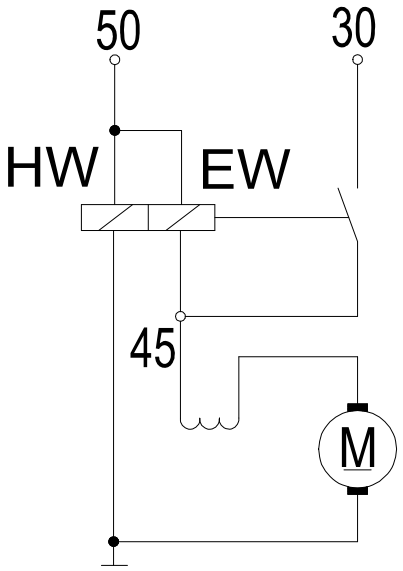


Figure 5



The starter motor runs the engine, gaining its inertia and friction, and bringing it to a certain number of revolutions such as to initiate the formation of the mixture required for combustion and then the autonomous movement of the engine.

The movement is transmitted by a DC electric motor, powered by the battery, via an engagement pinion which rotates the sprocket formed on the engine flywheel.

Due to a free wheel engagement, the pinion turns off when the main engine rotates faster than the starter motor.

A relay energized by the current of the starter motor engages the pinion by means of a fork.

The starter motor included is a translation type and starts by means of the pinion, with relay housed directly above the starter motor.

Ignition is usually controlled via the ignition switch on the control panel and provides a positive voltage to the relay located on the starter motor.

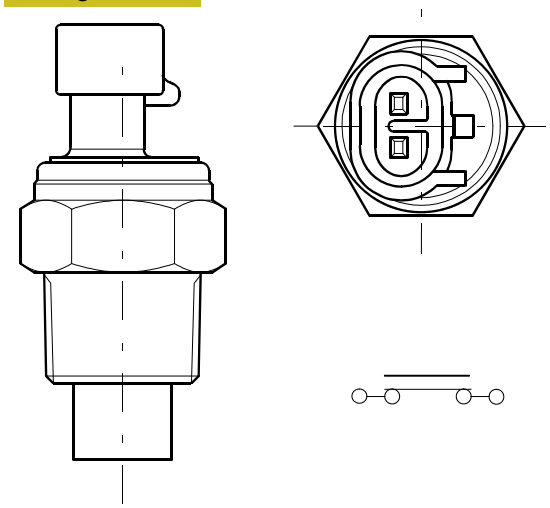
Characteristics:

BOSCH HX87-M 12V 3.2kW

Battery capacity:	min. 55 Ah - Max. 176 Ah
Exhaust current (EN 50342):	min. 420 A - Max. 1320 A

Coolant temperature sensor for KSB ignition timing regulator

Figure 6



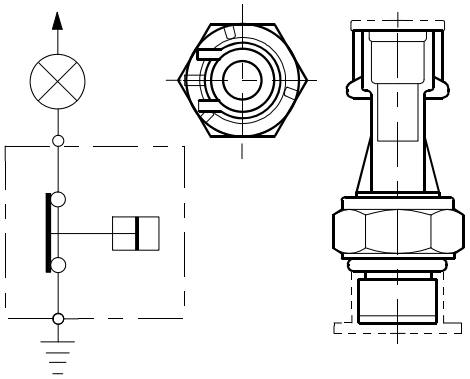
It is mounted on the engine head on the left side of the engine.

Characteristics:

Operating voltage:	12 ÷ 24 V
Electric load:	2.5 A (inductive)
	5.0 A (resistive)
Calibration:	30±3 °C Opening of contacts with temperature rising
	20±3 °C Closer of contacts with temperature lowering

Lubricant oil pressure sensor

Figure 7



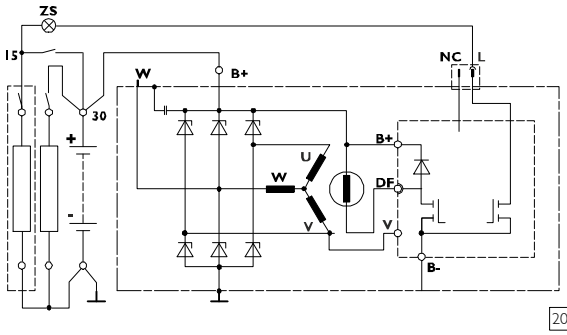
It is mounted on the crankcase on the left side of the engine.

Characteristics:

Operating voltage:	12 ÷ 24 V
Contact closure with pressure decreasing:	0.6 bar
Contact opening with pressure rising:	0.9 bar

Alternator

Figure 8



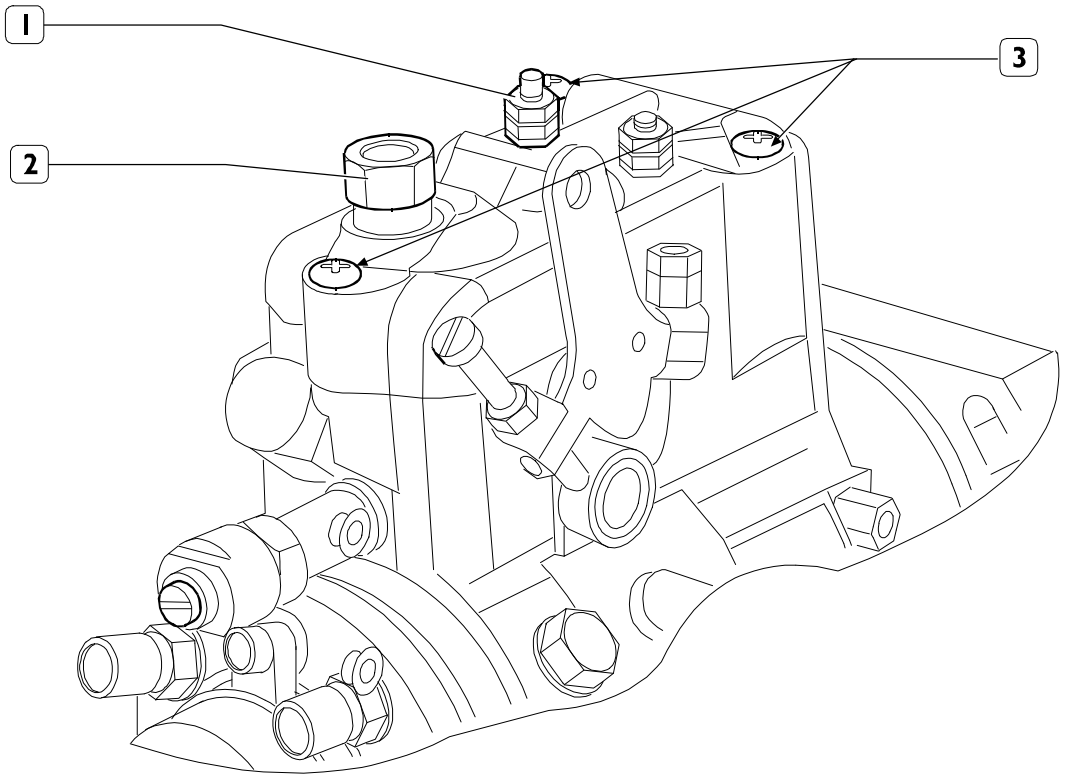
It is frontally located on the right-hand side of the engine and is controlled by the auxiliary assembly belt.

Characteristics:

Working voltage:	12 V
Current strength:	90A (a 6000 rpm)
Absorption in stand-by:	≤1mA
Direction of rotation:	Clockwise

PROCEDURE FOR ASSEMBLY OF "ADC100" ELECTRONIC ACTUATOR ON STANADYNE SERIES "D" INJECTION PUMP

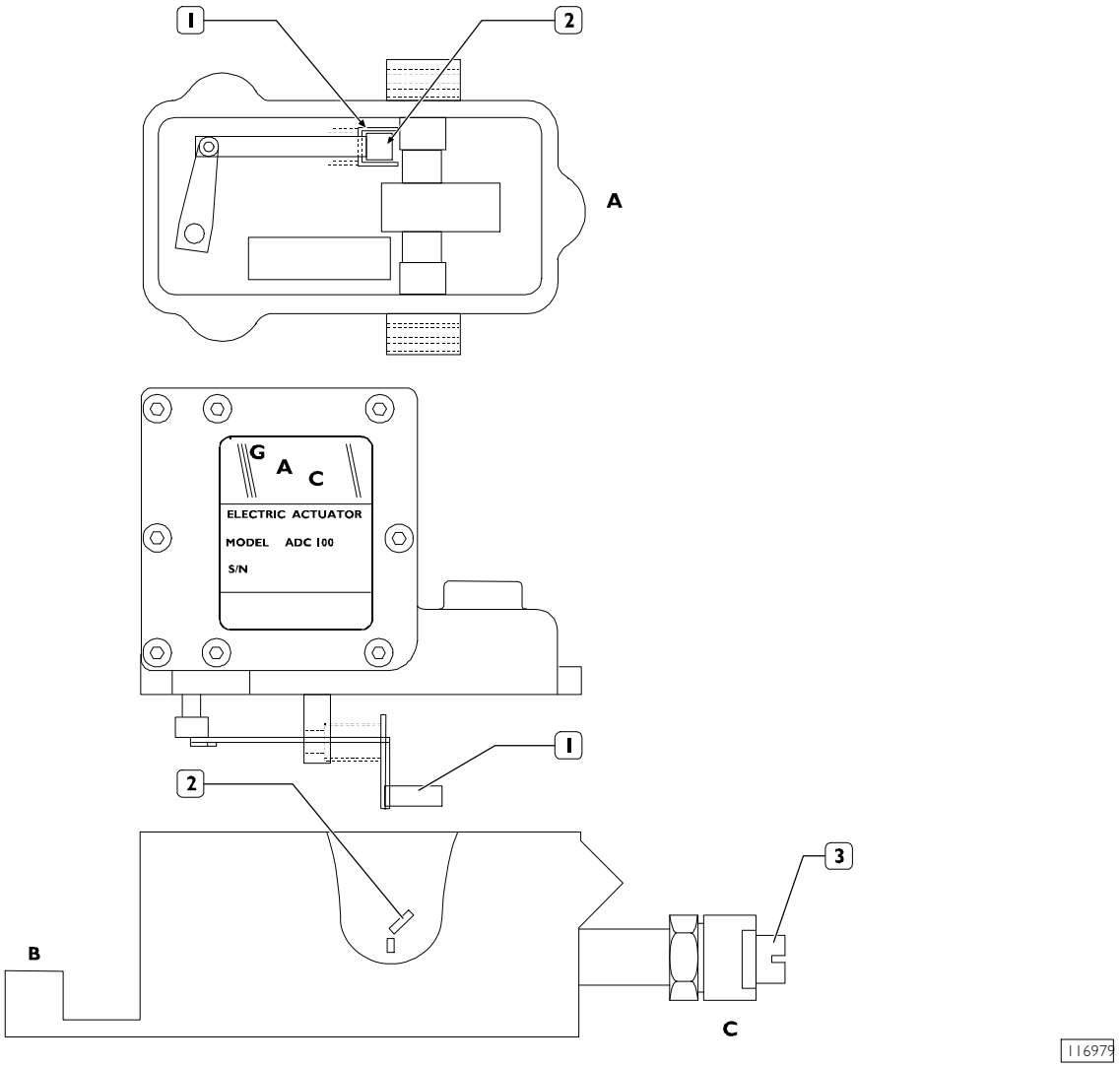
Figure 9



Before removing the Injection Pump cover and then replacing the electronic actuator, the pump exterior must be cleaned with solvents if needed. This prevents contamination to the inside of the pump.

- ❑ Disconnect the stop solenoid valve wire from the terminal (1) on the pump cover ensuring that it is isolated.
- ❑ Remove the fuel return pipe from the fitting (2).
- ❑ Remove the three screws (3) from the pump cover. The screws will be replaced with the screws supplied with the ADC100 actuator.
- ❑ Remove the injection pump cover making sure that no dirt gets into the inside of the pump.
- ❑ Remove the fuel return pipe fitting (2) and the gasket from the injection pump cover. Keep the fitting (2) and the gasket as they have to be fitted on the electronic actuator.

Figure 10



A. View from the top of the open injection pump - B. In front (guard side) - G Behind (injector side)
I. Electronic actuator "U" hook - 2. Injection pump lever - 3. Droop adjustment screw

Actuator assembly

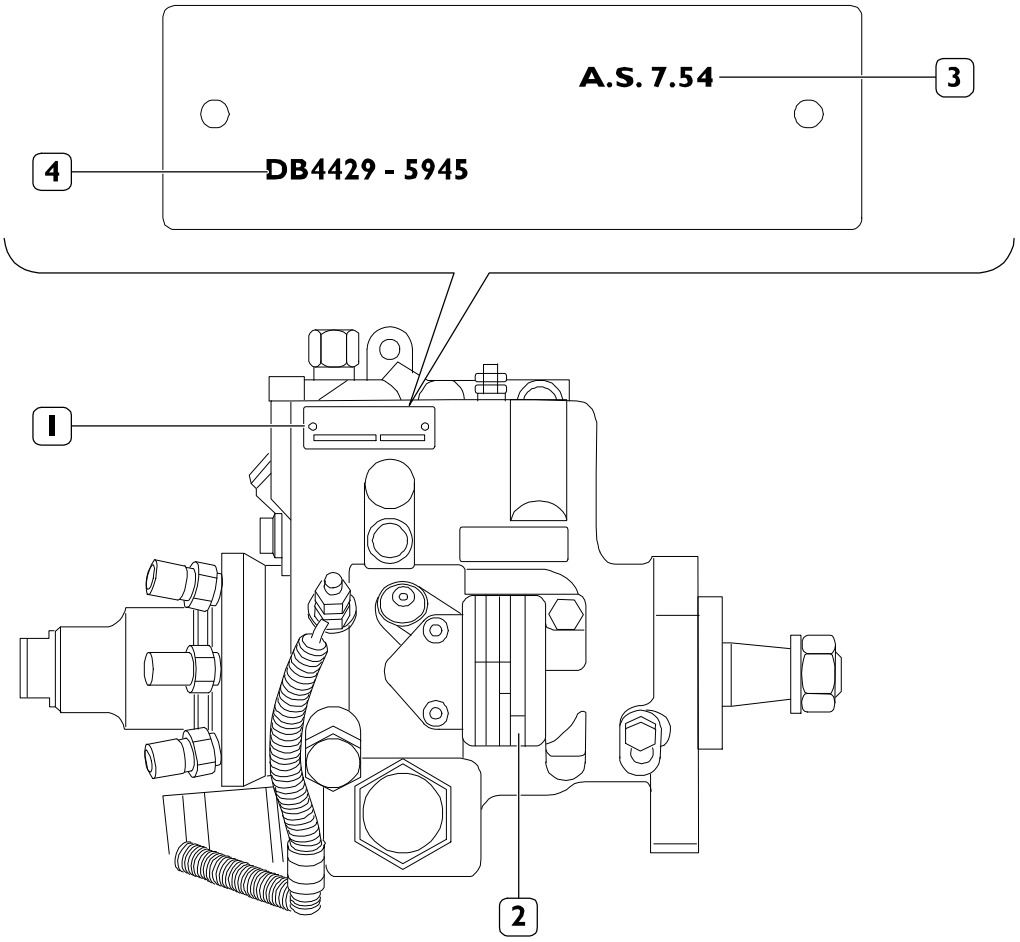
- ❑ Refit the fuel return pipe fitting and the original pump cover gasket on the ADC100 electronic actuator.
- ❑ Position the electronic actuator on the injection pump with the higher part inclined slightly upwards.
- ❑ Let the electronic actuator slide towards the rear of the pump (injector side) until the "U" hook (1) of the actuator engages with the injection pump lever (2). After engagement, align the holes between the pump and the electronic actuator.

NOTE Incorrect coupling between the actuator hook () and the injection pump lever (2) can cause the engine to experience overspeed conditions.

- ❑ Tighten the ADC100 actuator to the injection pump using the screws supplied with the actuator.
- ❑ Reconnect the fuel return pipe to the fitting on the actuator.

SWITCHING FROM 50 Hz TO 60 Hz FOR NEF ENGINES WITH STANADYNE PUMP

Figure 11



Based on the specific operational requirements of the engine, it is possible to vary the adjustment of the Stanadyne pump so as to obtain a different operating frequency:

- 1500 rpm / 50 Hz
- 1800 rpm / 60 Hz

The procedures needed in order to carry out the following adjustments will be described:

- Switching from 50 Hz to 60 Hz and vice versa.
- Stabilisation of rotation speed.

NOTE If only the Stanadyne (2) identification plate is present, this means that the injection pump is calibrated at 50 Hz.

In the event of a factory modification of calibration from 50 Hz to 60 Hz, FPT applies an identification plate (1).

The FPT plate (1) will show:

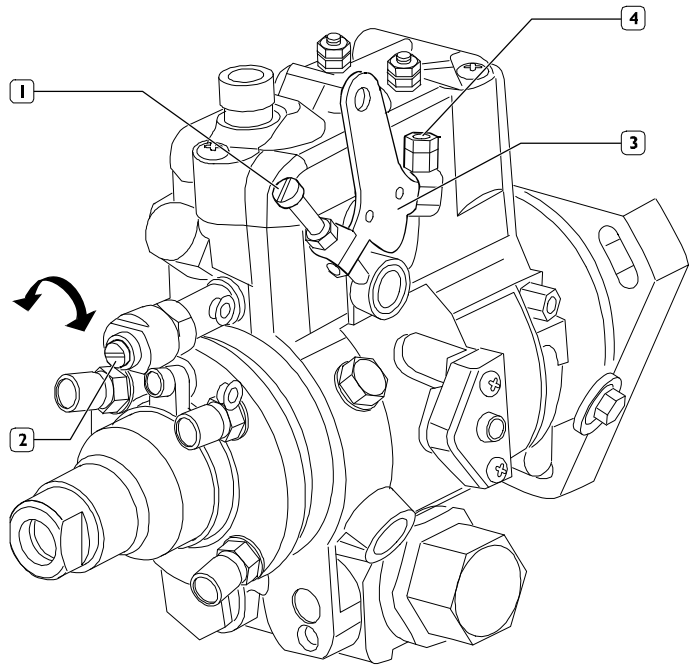
- the injection pump model (4);
- an identification code (3) for the specific application for injection pump calibration, for example: A.S. 7.54 identifies calibration at 1800 rpm - 60 Hz.

Switching from 50 Hz to 60 Hz

To switch from 50 Hz to 60 Hz first of all:

- identify the injection pump code on the Stanadyne identification plate (2).

Figure 12



116975

Injection pump type (Stanadyne identification plate)	Screw turns at 50 Hz from end of travel position (clockwise)	Screw turns at 60 Hz from end of travel position (clockwise)	Difference in turns from 50 Hz to 60 Hz (clockwise)
DB 4629 - 5927	2	6	4
DB 4629 - 5932	2	9	7
DB 4629 - 5944	2.5	8.5	6
DB 4429 - 5945	3	6	3
DB 4429 - 5954	2	8.5	6.5
DB 4427 - 5955	3	9	6

❑ Act on the droop setting (2) adjustment screw by turning it clockwise by the number of turns indicated in the table from its current position.

NOTE In case of doubt, it is always possible to unscrew the droop setting adjusting screw (2) anticlockwise to end of stroke - but do not force beyond this point to avoid damaging the adjustment system.

At this stage, and always with reference to the table in the figure, turn the droop setting screw (2) clockwise by the number of turns indicated for the 60 Hz setting from the end of stroke position.

❑ Once the engine is started, you need to operate on the adjusting screws on maximum (1) and idle (4) so as to block the accelerator lever (3) into this position to obtain the desired speed, taking into account the drop in frequency in the passage of the engine from empty to full (about 2 Hz).

If, for example, an engine with an injection pump having code DB 4429 - 5945 originally calibrated at 50 Hz is to be changed to 60 Hz, simply act on the droop setting adjustment screw (2) by turning it 3 turns clockwise from its current position, start the engine, loosen the max. speed adjustment screw and accelerate using the accelerator pedal, until the load rotation regime is 62 Hz (1860 rpm).

❑ Then adjust the minimum speed screw (4) to block the accelerator lever in the new position and block both adjustment screws using the specific counternuts (1 e 4) tightening torque 3.5 ÷ 4 Nm).

NOTE The min. speed adjustment screw (4) does not allow minimum setting in the "classic" sense of the term, since the injection pump governor sets a higher rotation speed given that the injection pump is used in a power assembly application.

Switching from 60 Hz to 50 Hz

To change the regime from 60 Hz to 50 Hz, proceed as indicated above, remembering to turn the droop setting adjustment screw (2, Figure 12), turns anticlockwise 3 times from its position for operation at 60 Hz.

Stabilisation of rotation speed

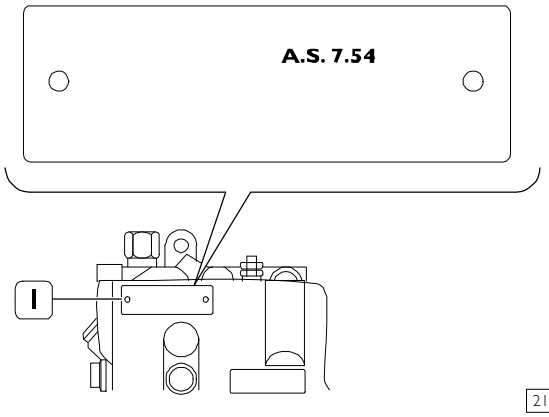
In the event of rotation speed instability, act on the droop setting adjustment screw (2, Figure 12) by turning it slightly clockwise / anticlockwise until the engine rotation speed stabilises.

NOTE Attention! Some engines cannot undergo the passage from 50 Hz to 60 Hz and vice versa, since they need a specific injection pump to operate at the requested speeds.

Refer to "Service Information" SI 1911 to verify which engines cannot undergo the passage from 50 Hz to 60 HZ and vice versa.

Identification plate

Figure 13

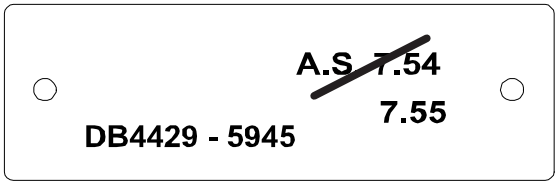


214938

If the FPT plate is not present because the engine with injection pump is calibrated at 50 Hz, fit the plate in position (1), with markings as shown in the figure.

Blank identification plates can be ordered through our Spare Parts Service.

Figure 14



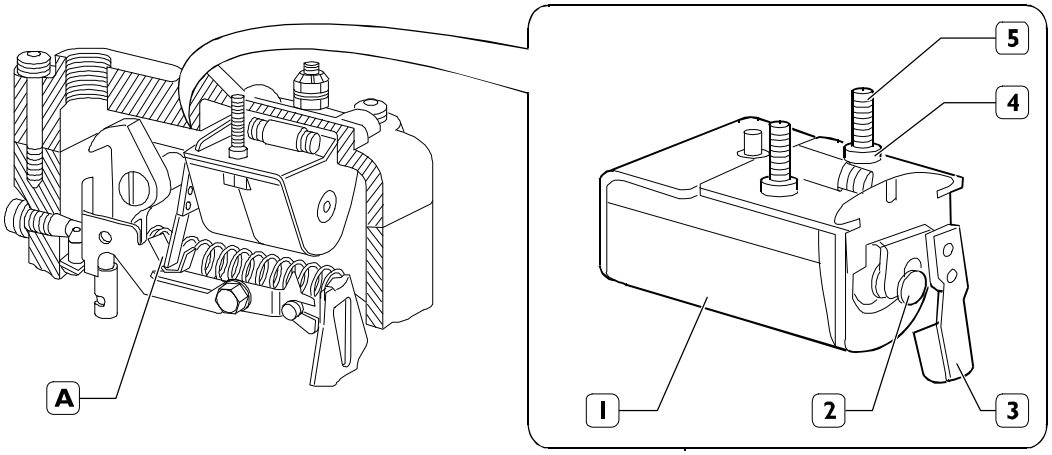
214939

If the FPT plate is already present on the injection pump, mark the new identification suffix for the new calibration and cancel the identification of the previous calibration, as shown in the figure.

REPLACING ELECTROSTOP AND COLD ADVANCE SOLENOID ON STANADYNE PUMP

Figure 15

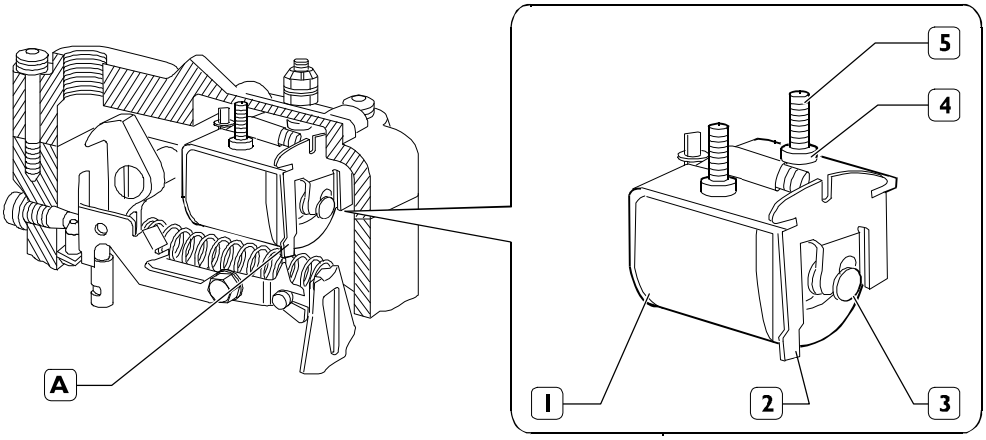
ETR



116980

A. Position of the electrostop arm - 1. Encapsulated coil - 2. Electrostop mobile core - 3. Electrostop arm - 4. Insulator - 5. Solenoid terminals

ETSO



116981

A. Position of the electrostop arm - 1. Encapsulated coil - 2. Electrostop arm - 3. Electrostop mobile core 4. Insulator - 5. Solenoid terminals

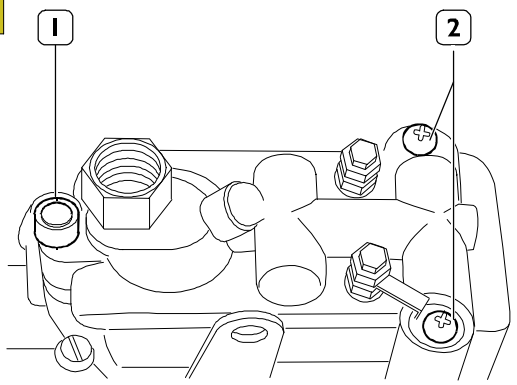
Two types of electrostops can be used on Stanadyne injection pumps:

- ETR (Energize To Run - stop in dexcitation)
- ETSO (Energize To Stop - stop in excitation).

In the figure, please note the different assembly position of the electrostop according to the ETR - ETSO functions.

Electrostop replacement

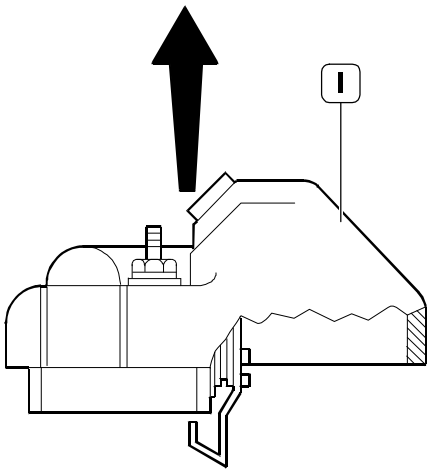
Figure 16



To replace the electrostop, remove the injection pump cover loosening and removing the three fastening screws (1 and 2) of the cover and the relative washers.

NOTE The screw (1) has a seal which can be broken in order for it to be removed.

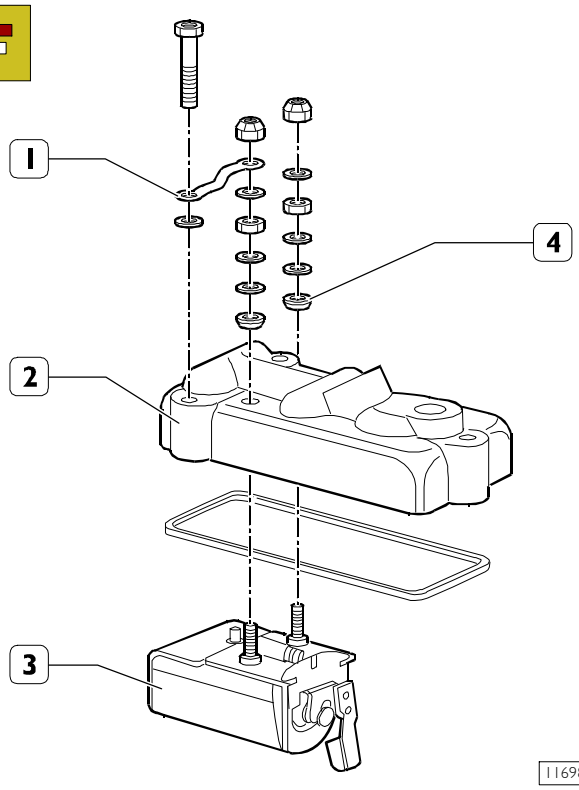
Figure 17



Remove the entire cover of the electrostop (1), pulling it upwards perpendicularly to the injection pump.

Be careful that nothing falls into the injection pump.

Figure 18



Remove the electrostop (3) from the cover (2).

NOTE Since the ends of the component are electrically isolated from the cover, make sure to remember the assembling order of the nuts, of the washers and of the components, for the electrical connection of the electrostop ends; one end is earthed through an appropriate element (1).

Pay attention to the position of the isolating element (4).

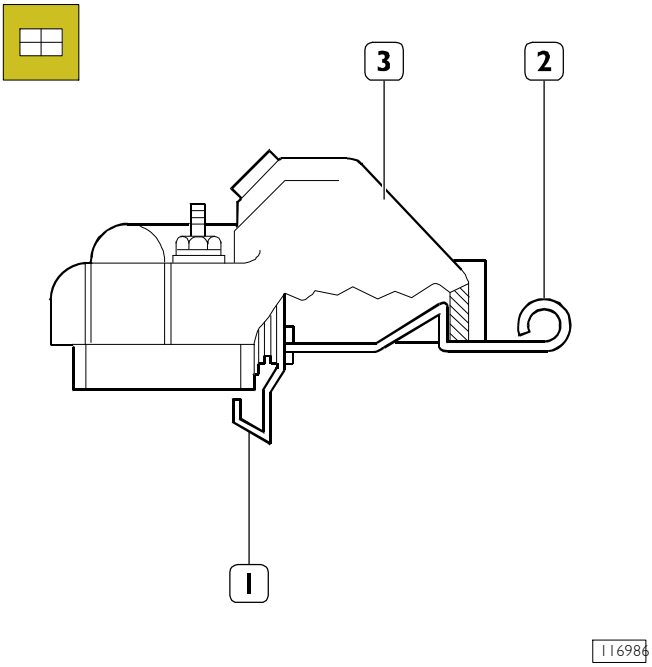
Fit the new electrostop on the injection pump cover using the specific kit:

- ❑ 12V-ETR
- ❑ 24V-ETR
- ❑ 12V-ETSO
- ❑ 24V-ETSO

In addition to the electrostop indicated, the kit contains all that is required for its assembling.

The nuts securing the electrostop (3) to the cover (2) must be tightened to a torque of 1.1 ÷ 1.7 Nm.

Figure 19



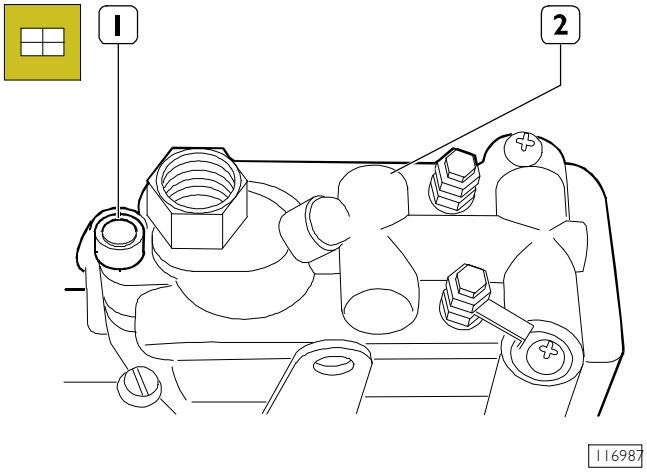
In the electrostop ETR kit there is the joint tool (1) which must be used to position the electrostop arm (2) correctly and to reassemble the cover on the injection pump.

NOTE This tool (1) allows to keep the arm of the electrostop (2) in the excitation position, allowing the correct assembling of the cover and avoiding dangerous overrevving when the engine is started.

Once the cover is put on the assembling seat and the relative screws are pointed on the injection pump, rotate the joint tool (1) and then pull it carefully from underneath the cover (3), making sure not to move or damage the gasket of the cover.

Then tighten the screws to a tightening torque of 4.0 ÷ 5.1 Nm, making sure not to damage the connection earthed element of the electrostop end.

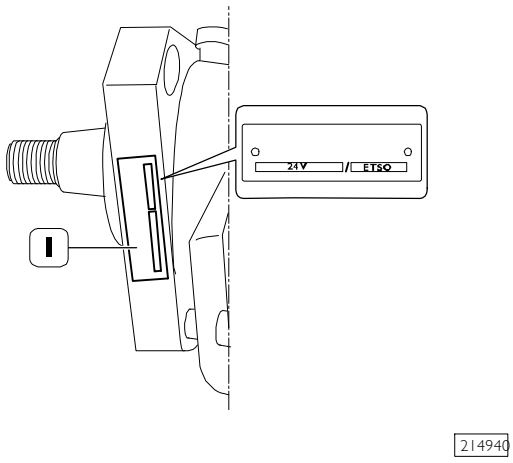
Figure 20



The repositioning of the cover (2) must be done repeating the operations described for removal but in the reverse order, making sure that it corresponds perfectly to the assembling seat without forcing it (obviously for the ETR version, the cover of the pump will correspond to the assembling seat only after the joint tool has been removed).

NOTE A blue seal is included in the kit which has to be positioned on the screw (1), after the cover reassembling operations (2): when new, the seal is not blue.

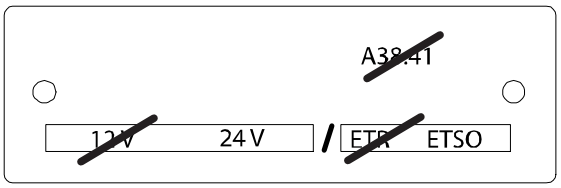
Figure 21



If the original electrostop is to be replaced and its characteristics modified (different voltage, ETR instead of ETSO), an identification plate (1) must be applied in the indicated area.

The plate must be stamped (1) as shown in detail in the figure.

Figure 22



21494

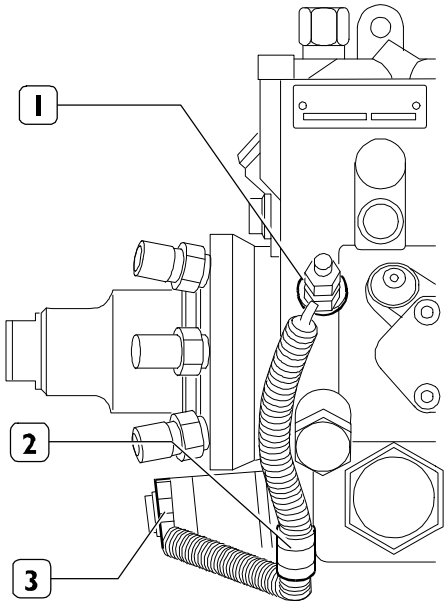
In some cases the plate may already be present.

If the plate is already present, the old identification elements must be cancelled and the new ones marked as shown in the example in the figure.

The electrostop and the cold advance solenoid on this injection pump must have the same operating voltage, therefore in the event of a modification in the engine operating voltage, they must both be replaced.

Cold advance solenoid replacement

Figure 23

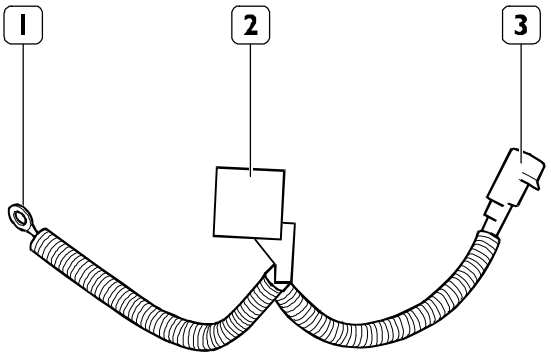


116990

Disconnect the connector from the temperature sensor on the engine, and then remove the fastening nut of the socket clamp (2) and the nut (1) of the cable assembly end, in order to release the cold advance solenoid cables.

Remove the fastening nut (3) from the electromagnet and remove the component from its seat.

Figure 24



116991

Insert the connection cable socket (1) in the cable assembly end and screw in the nut (1, Figure 23) tightening it to a torque of 5.7÷6.8 Nm.

Position the socket clamp (2, Figure 23) and screw in the fastening nut tightening it to a torque of 7.9÷9.0 Nm.

Position the electromagnet in its seat and screw in the self--locking fastening nut, supplied with the replacement kit, tightening it to a torque of 5.1÷5.7 Nm.

NOTE The operating voltage of the device is easy to find by looking at the colours of the power supply wires of the solenoid:

- BLACK for the 12V device
- RED: for the 24V device

The electrostop and the cold advance solenoid on this injection pump must have the same operating voltage, therefore in the event of a modification in the engine operating voltage, they must both be replaced.

SCHEDULED MAINTENANCE

Introduction

To ensure best operating conditions, on the following pages are indicated the checks, tests and adjustments which shall be carried out on the different parts at the established time.

The frequencies of the maintenance operations are indicative since the engine use and its characteristics are essential to evaluate replacements and checks.

Not only it is permitted, but we also suggest that the staff in charge of maintenance should also perform those checking and maintenance operations which do not fall among those listed below, but are recommended by good-practices and particular conditions of use of the engine.

Furthermore, in case of clear malfunctioning of the engine, for example excessive grade of smoke of exhaust gases, high temperature of the coolant or low oil pressure, prompt measures must be taken to verify the causes of the defect.

Operators are also reminded that any maintenance operation, even the easiest one, is to be performed in compliance with accident--prevention laws for the safety of the staff in charge of maintenance.

Checks and scheduled maintenance procedures

Checks to be made during periods of use	Frequency
Check the engine lubricant oil level	Daily
Check engine coolant level	Daily
Check the cleanliness of the heat exchanger (radiator)	Daily
Inspection of the exhaust duct/s	Daily
Air filter Inspection	Monthly (2)
Check tightening and cleanliness of battery clamps	Six-months
Check electrolyte level of the batteries	Six-months
Check condition of the blow-by filter	Six-months

Periodical maintenance	Frequency
Engine lubricant oil change	800 hours (3) (4)
Changing the oil filter	800 hours (3) (4) (5)
Changing the fuel filter	600 hours (1) (4) (5)
Drain the water from the fuel filter	150 hours (1)
Drainage/suction of water, condensation and impurities from the fuel tank/s	150 hours (1)
Change blow-by filter	900 hours
Replace engine coolant	1200 hours / 2 years
Change air filter	1200 hours / 2 years (2)

Unscheduled maintenance	Frequency
Change ancillary belt	1200 hours / 3 years
Clean the heat exchanger (radiator)	1200 hours
Visual turbocharger inspection	1200 hours
Injector calibration	1800 hours
Adjustment of valve/rocker arm clearance	3000 hours

1) Maximum period relating to the use of high quality fuel, (specification EN 590); which is reduced in the event of fuel contamination and alarm signals caused by filter clogging and/or the presence of water in the filter. The filter clogging signal indicates that the filter must be replaced. If the warning light of water present in the filter does not go off after drainage, then the filter must be replaced.
2) The frequency depends on the ambient conditions and product efficiency/wear. After long periods of engine inactivity, perform the check before starting the engine. The filter clogging signal indicates that the filter must be replaced.
3) The intervals are applicable for lubricants which meet the international standards ACEA E5 E7 (high power engines)
4) To be performed every year even if the specified operating hours interval has not been reached.
5) Only use filters with the following specifications:
   - degree of filtering < 12 μm
   - filtering efficiency 99.5% (ß > 200).

NOTE Checks, inspections and changes are indicative and must integrate those specifications foreseen for vehicles equipped with an NEF engine.

The data are only valid if the fitter observes all the installation regulations provided by FPT.

REQUIREMENTS

In the event in which fuel is used with a sulphur percentage greater than 0.5 %, or oils are used which do not meet the specifications in the section 1 - GENERAL INFORMATION, then the replacement frequencies of the engine oil, engine oil filter and blow-by filter must be halved, or suitably adjusted, in accordance with the use and operating conditions of the engine; please consult the personnel in charge of maintenance operations for appropriate advice.

- ❑ Do not disconnect the battery supply while the engine is running.
- ❑ Do not perform arc welding near the engine without first removing its electrical wiring.
- ❑ After all maintenance operations that require disconnecting the batteries, make sure that the terminals have been well secured on the poles.
- ❑ Do not use a battery charger to start the engine.
- ❑ Do not paint the devices, components and electrical connectors of the engine equipment.
- ❑ Electrically disconnect the battery/batteries before performing any electrical work.
- ❑ Contact the manufacturer before installing electronic equipment.

Do not perform any operation that would change the calibration of the injection pump.
It was adjusted during the engine test phase and based on its destination.

Extraordinary interventions - daily checks

Before starting, it is recommended to carry out a series of simple checks that can significantly help avoid problems, also of a series nature, while the engine is operating. These checks are usually performed by the vehicle operators and drivers.

- Checking the levels and checking for any leaks from the fuel, cooling and lubrication circuits.

- Informing maintenance personnel if any problems are found; top up if necessary.

After starting the engine and with the engine operating, perform the following checks and controls:

- Checking for any leaks from the fuel, cooling and lubrication circuits.

- Making sure there is no unusual noise or knocking during operation.

- Using the instruments to check the specified pressure, temperature values, etc.

- Visually checking the smoke (colour of the exhaust gas).

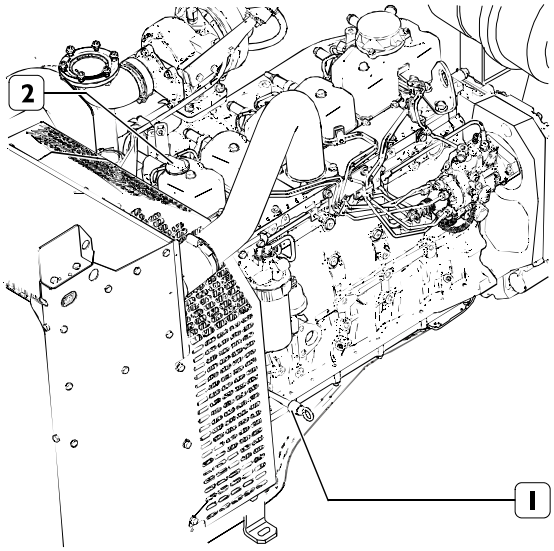
- Visually checking the level of the coolant in the expansion tank.

CHECKS TO BE MADE DURING PERIODS OF USE - HOW TO PROCEED

Check the engine lubricant oil level

Only proceed when the engine is not turning and is at low temperature in order not to run the risk of burns.

Figure 1



- ❑ Use the oil dipstick (1) to check that the lubricant oil level is between the "Min" and "Max" limits.
- ❑ If the level is insufficient, it is necessary to top up with lubricant oil which meets the international specifications ACEA E5 (high power engines), as indicated in the section 1 - GENERAL INFORMATION: remove the lubricant oil cap (2) and pour engine lubricant oil through the hole.
- ❑ Use the oil dipstick (1) to check that the lubricant oil level does not exceed the "Max" limit.

Make sure that the oil dipstick is fully inserted and that the oil filler cap is fully tightened in a clockwise direction.

Check engine coolant level

Only proceed when the engine is not turning, and is at low temperature, so as not to run the risk of burns.

- ❑ Remove the pressurization cap from the expansion tank.
- ❑ Visually check that the coolant in the expansion tank is above the minimum level.
- ❑ If necessary, top up the expansion tank with a mixture of 50% water and PARAFLU 11, as contained in the section 1 - GENERAL INFORMATION. Do not fill the expansion tank to the brim.
- ❑ 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

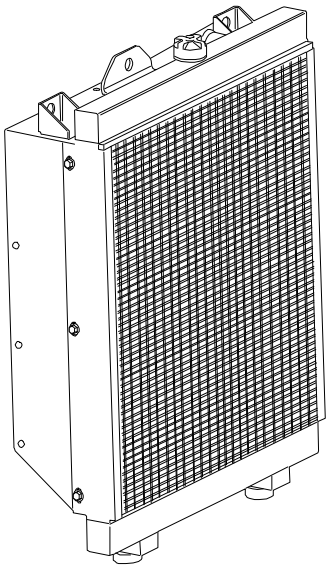
if frequent coolant top-ups are necessary, the cooling circuit must be diagnosed.

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.

Check the cleanliness of the heat exchanger (radiator)

Figure 2



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Check that the air intake surfaces of the radiators are free of impurities (dust, mud, straw etc.).

Clean them if necessary using compressed air or steam.

When using compressed air, it is required to use suitable personal protections for hands, face and eyes.

Inspection of the exhaust duct/s

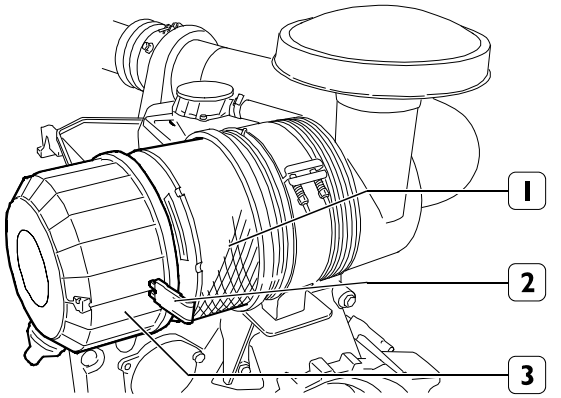
Visually check that the exhaust gas / exhaust system is not obstructed or damaged.

- ❑ Make sure that there is no risk of harmful fumes in the environment where the engine is being worked on.

Air filter Inspection

Only proceed when the engine is not turning over.

Figure 3



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- ❑ Remove the cover (3) of the air filter after having undone the two quick release catches (2).
- ❑ Remove the filtering element (1); make sure that dust does not enter the sleeve during this operation.
- ❑ Make sure there are no impurities. Otherwise, clean the filter element according to the instructions provided below.
- ❑ Blow dehumidified compressed air on the filtering element, working from the inside outward (maximum pressure 200 kPa).
- ❑ Check the condition of the air filter before refitting it. Replace it if broken or torn.
- ❑ Check the condition of the gasket at its base.
- ❑ Position the filter element (1) in its seat.
- ❑ Replace the cover (3) of the air filter and lock it using the two quick release catches (2).

Do not use detergents or diesel to clean the air filter. Never strike the filter element with tools.

The imprecise assembly of the air filter may result in the intake of unfiltered air and therefore cause serious damage to the engine.

Check tightening and cleanliness of battery clamps

Check that the battery terminals and cable clamps are clean, well tightened and protected by Vaseline.

In the event of dirty cable clamps and battery terminals:

- ❑ Loosen the nut and remove the terminal from the negative terminal (marked with a "-").
- ❑ Loosen the nut and remove the terminal from the positive terminal (marked with a "+").
- ❑ Use a metal brush or fine grade sand paper to clean the cable terminals and the battery terminals until they are shiny.
- ❑ Smear the cable terminals with Vaseline and insert them onto the battery terminals making sure that the positive pole is connected first, followed by the negative pole, and then tighten each terminal.

Check the cables and clamps for signs of wear and corrosion; replace them if in poor condition.

Visually check the condition of the battery: the terminals must not show signs of deterioration and the body must not be damaged, otherwise they should be replaced.

Wear protective glasses and gloves.

Check electrolyte level of the batteries

The batteries used are of reduced maintenance type. Therefore, under normal conditions of use, no top up of the electrolyte is required. However, the routine checking of the electrolyte level is recommended. Proceed after positioning the batteries on a horizontal surface.

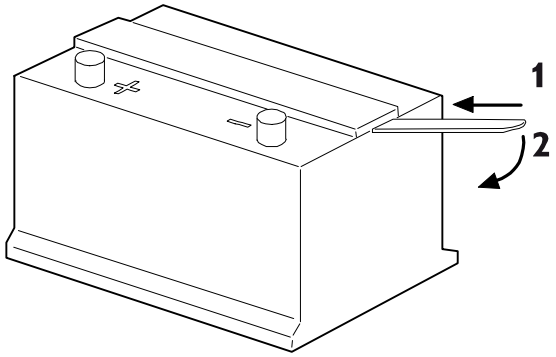
- ❑ Visually check that the electrolyte level is between the "Min" and "Max" reference marks on the batteries; in the absence of any reference marks, make sure the liquid covers the lead plates contained in the elements by approx. 5 mm.
- ❑ Only use distilled water to top up the elements whose level is below the minimum.
- ❑ If the battery has to be recharged, contact a specialised workshop.

A specialised workshop should be contacted if all the battery elements need topping up with a considerable quantity of distilled water and the diagnostics of the battery recharging system's efficiency should be performed.

The batteries contain sulphuric acid which is highly caustic and corrosive; during the top up operations protective glasses and gloves must be worn, as well as an apron to protect clothing. If possible, have this check performed by qualified personnel.

During the checks do not smoke or allow naked flames near the batteries. Ensure that the work area is suitably ventilated.

Figure 4



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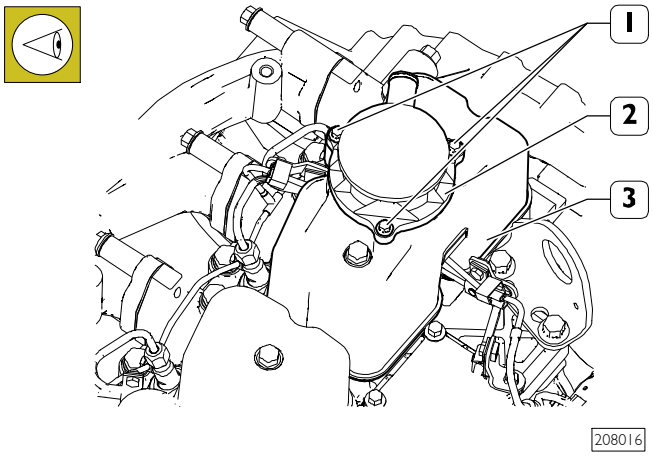
Some batteries have a single cover for the inspection plugs. To access the elements, use a lever as shown in the figure.

Check condition of the blow-by filter

Only proceed when the engine is not turning over.

Figure 5



Disconnect the oil vapour recovery piping from the blow-by filter (2).

Remove the screws (1) and remove the blow-by filter (2) from the tappet cover of cylinders 5-6 (3); Recover the sealing gasket.

Verify that the blow-by filter (2) is not clogged; Otherwise replace it.

Clean the contact surface carefully.

Install the sealing gasket and fit the blow-by filter (2) on the cylinder tappet cover 5-6 (3).

Tighten the screws (1) to the torque specified in the table.

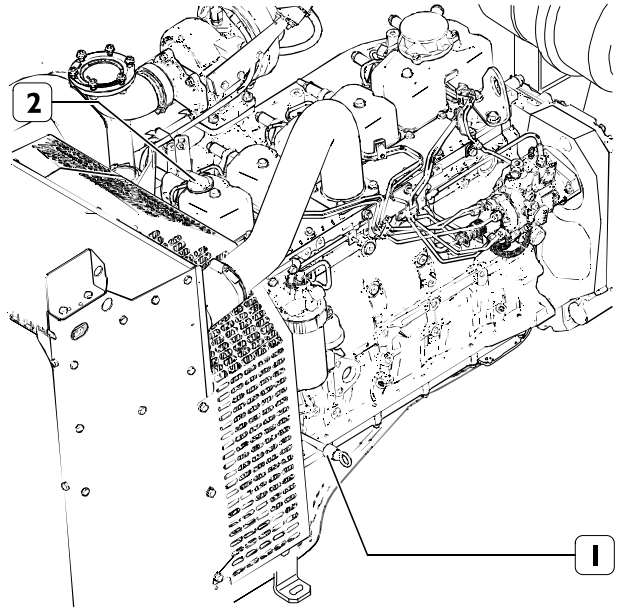
Ref.	N.	Description	Tightening torques
(1)	3	M6x1x20	10±2 Nm

PERIODIC MAINTENANCE - HOW TO PROCEED

Engine lubricant oil change

Only proceed when the engine is not turning and is at low temperature so as not to run the risk of burns.

Figure 6



Make sure that the oil dipstick is fully inserted and that the oil filler cap is fully tightened in a clockwise direction.

- ❑ Place a suitable container for collecting the spent oil under the oil sump next to the lubricant oil drain plug.
- ❑ Unscrew the lubricant oil drain plug; afterwards extract the oil level dipstick (1) and remove the lubricant oil cap (2) to assist the flow of the engine lubricant oil.
- ❑ Wait until the oil sump has completely emptied, then retighten the lubricant oil drain plug.
- ❑ Proceed with the refilling operation through the hole situated on the tappet cover of cylinder no. 1, using lubricant oil that meets the international standards ACEA E5-E7 (high power engines), as indicated in the section Section 1 - GENERAL INFORMATION.
- ❑ Use the oil dipstick (1) to check that the lubricant oil level does not exceed the "Max" limit.
- ❑ Retighten the lubricant oil cap (2).
- ❑ Together with the replacement of the engine lubricant oil it is necessary to replace the oil filter (see paragraph OIL FILTER REPLACEMENT).

Eliminate the consumables and any materials in contact with them (for example, filters) in accordance with current regulations.

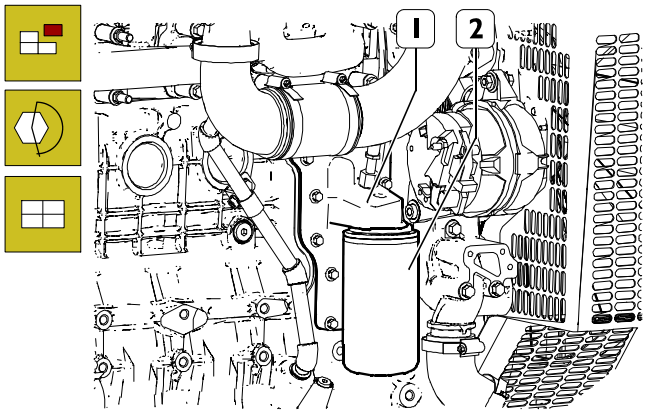
Oil filter change

Only use filters with the following specifications

- ❑ degree of filtering < 12 µm
- ❑ filtering efficiency 99.5% (ß > 200).

Only proceed when the engine is not turning and is at low temperature so as not to run the risk of burns.

Figure 7



- ❑ Proceed with the emptying of the spent oil (as described in paragraph ENGINE LUBRICANT OIL CHANGE).
- ❑ Place a container for collecting the spent oil under the filter support (1).
- ❑ Remove the filter (2) using tool 99360076 by unscrewing it from its relative support.
- ❑ Replace the filter element and the O-ring seal contained inside the filter (2).
- ❑ Carefully clean the surfaces of the support (1) in contact with the O-ring seal.
- ❑ Smear the O-ring seal of the new filter with oil.
- ❑ Tighten the new filter (2) onto the support (1) to the torque specified in the table.

Ref.	N.	Description	Tightening torques
(2)	1	M27x2	20±2 Nm

Eliminate the consumables and any materials in contact with them (for example, filters) in accordance with current regulations.

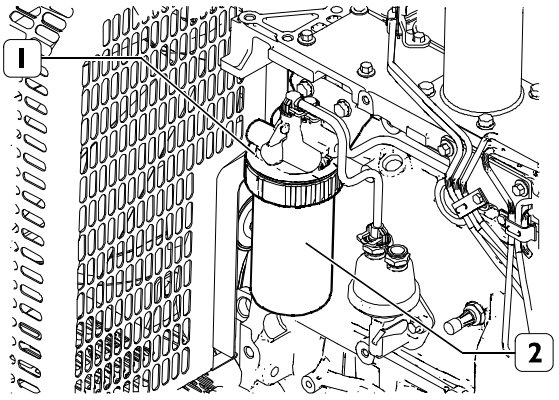
Fuel filter change

Only use filters with the following specifications:

- ❑ degree of filtering < 12µm
- ❑ filtering efficiency 99.5% (ß > 200).

Only proceed when the engine is not turning and is at low temperature so as not to run the risk of burns.

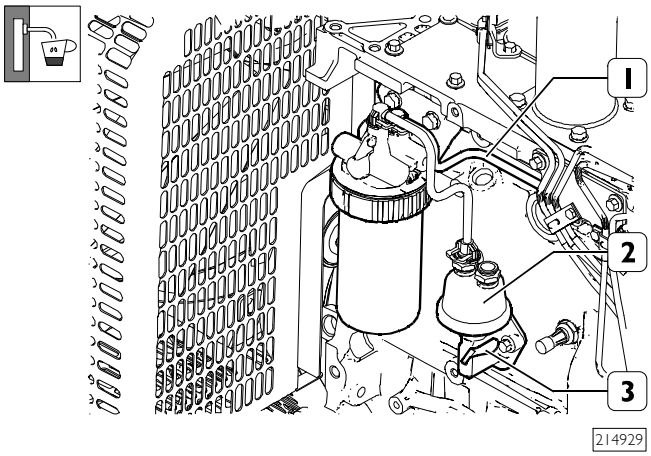
Figure 8



- ❑ Place a container for collecting the diesel under the filter support (1).
- ❑ Remove the filter (2) using tool 99360076 by unscrewing it from its relative support.
- ❑ Replace the filter element and the O-ring seal contained inside the filter (2).
- ❑ Carefully clean the surfaces of the support (1) in contact with the O-ring seal.
- ❑ Smear the O-ring seal of the new filter with oil.
- ❑ Screw the new filter (2) onto the support (1) and tighten it to the torque specified in the table.

Ref.	N.	Description	Tightening torques
(2)	1	-	20±2 Nm

Figure 9



Residual air bleeding procedure:

- ❑ Loosen the fuel outlet fitting (1) located on the top of the filter.
- ❑ Make sure that the discharge of diesel does not soil the ancillary belt and does not leak into the surroundings.
- ❑ Move the lever (3) of the fuel priming pump (2) to the diesel outlet without residual air.
- ❑ Correctly tighten the previously loosened coupling.
- ❑ Start the engine and let it run idle for a few minutes to remove any residual air.

Do not fill the new fuel filter before placing it on the support in order to prevent harmful impurities from entering the fuel circuit and the injection system.

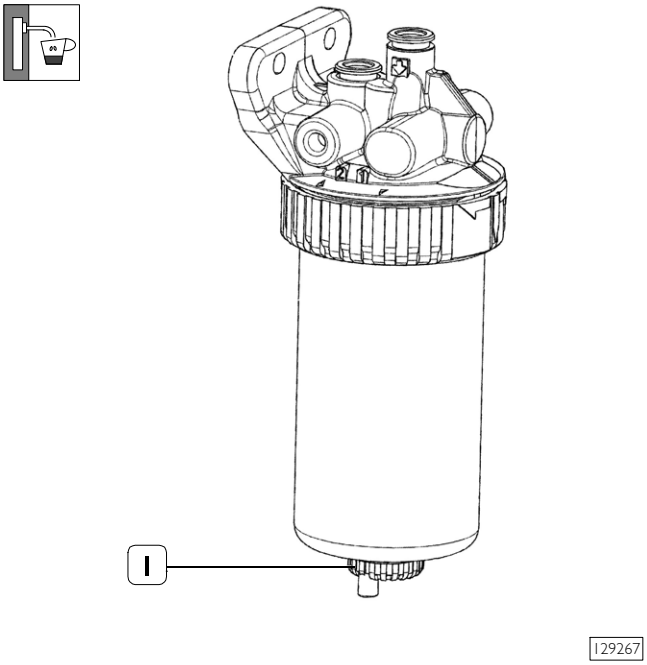
Eliminate the consumables and any materials in contact with them (for example, filters) in accordance with current regulations.

Drain the water from the fuel filter

In the case of a high risk of refuelling with fuel polluted with foreign agents and water, the following check should be performed at each refuelling.

Only proceed when the engine is not turning over.

Figure 10



- ❑ Place a container for collecting liquids under the fuel filter.
- ❑ Unscrew the valve plug (1) located at the bottom of the filter; in some versions, the plug includes the water in diesel sensor.
- ❑ Drain the liquid until only "diesel" is released.
- ❑ Fully retighten the plug manually.
- ❑ Dispose of the drained liquids according to the applicable regulations in force.

Drainage/suction of water, condensation and impurities from the fuel tank/s

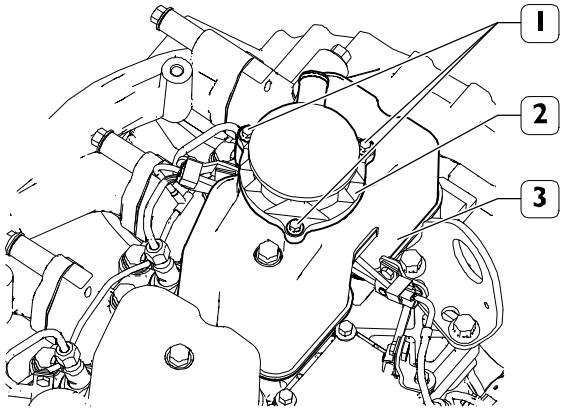
Perform the drainage/suction of water, condensation and impurities from the fuel tank/s by following the instructions contained in the manual supplied by the tank manufacturer.

Proceed as necessary based on the structure or location of the tank: engines that operate in adverse environments and conditions and/or that are refuelled using drums or jerry cans, require more attention when cleaning the tank.

Change blow-by filter

Only proceed when the engine is not turning over.

Figure 11



Disconnect the oil vapour recovery piping from the blow-by filter (2).

Remove the screws (1) and remove the blow-by filter (2) from the tappet cover of cylinders 5-6 (3).

Clean the contact surface carefully.

Install a new sealing gasket and fit the blow-by filter (2) on the cylinder tappet cover 5-6 (3).

Tighten the screws (1) to the torque specified in the table.

Ref.	N.	Description	Tightening torques
(1)	3	M6x1x20	10±2 Nm

Change the 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 PARAFLU 11, as contained in the section 1-GENERAL INFORMATION. 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.

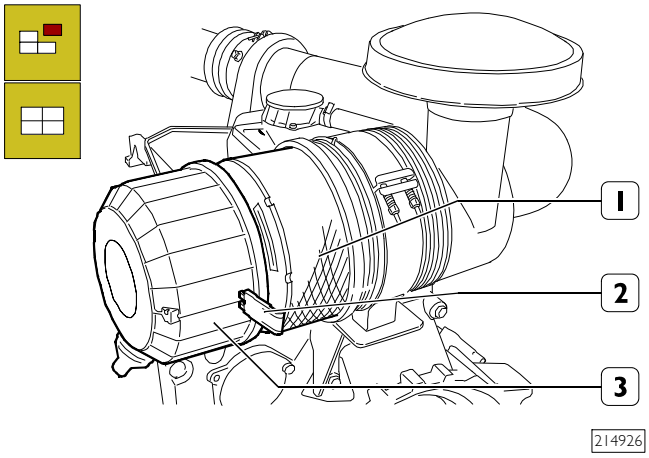
The failure to observe the aforesaid procedure does not guarantee the presence of the correct quantity of coolant in the engine.

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.

Change air filter

Only proceed when the engine is not turning over.

Figure 12



- ❑ Remove the cover (3) of the air filter after having undone the two quick release catches (2).
- ❑ Remove the filtering element (1); make sure that dust does not enter the sleeve during this operation.
- ❑ Replace the filter element and the relative gasket at its base.
- ❑ Position the filter element (1) in its seat.
- ❑ Replace the cover (3) of the air filter and lock it using the two quick release catches (2).

Do not use detergents or diesel to clean the air filter. Never strike the filter element with tools.

The imprecise assembly of the air filter may result in the intake of unfiltered air and therefore cause serious damage to the engine.

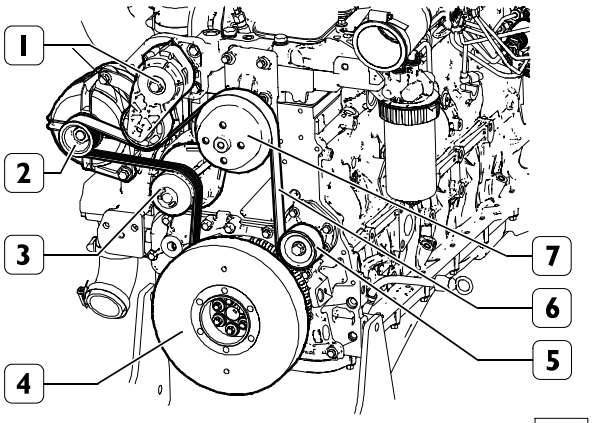
UNSCHEDULED MAINTENANCE - HOW TO PROCEED

Change ancillary belt

When the engine is off, but still hot, the belt may start to move without warning. Wait for the engine temperature to decrease to prevent serious danger of an accident.

Only proceed when the engine is not turning and is at low temperature so as not to run the risk of burns.

Figure 13



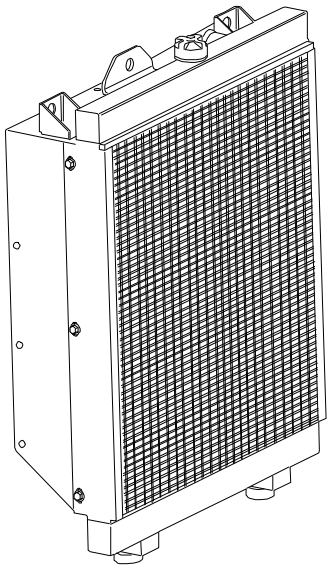
- ❑ Remove the protective grille and the fan together with spacer by acting on the relative fasteners as described in section 5.
- ❑ Act on the automatic belt tensioner (1) and remove the auxiliary device drive belt (6).
- ❑ Act on the automatic belt tensioner (1) and force fit the new auxiliary device drive belt (6).
- ❑ Check that the belt (6) is inserted correctly inside the alternator pulley (2); also check that the water pump pulley (3), the crankshaft pulley with damper (4), the guide pulley (5) and the fan pulley (7) are inserted correctly.
- ❑ Fully rotate the crankshaft twice to ensure that the new auxiliary device drive belt (6) has been correctly fitted.
- ❑ Reposition the fan together with spacer in its seat and the protective grilles and tighten the relative fasteners.

Replace the ancillary belt if it shows signs of abrasions, cracks or tears or if it is soiled with oil or fuel.

Clean the heat exchanger (radiator)

The surfaces of the heat exchanger (radiator) come into contact with external air and may be subjected to deposits and impurities (dust, mud, straw, etc.). Clean them if necessary using compressed air or steam.

Figure 14



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When using compressed air, it is required to use suitable personal protections for hands, face and eyes.

Visual turbocharger inspection

Only proceed when the engine is not turning over. Visually check that the turbine and compressor impellers and the relative inlet and outlet ducts are not obstructed or damaged, otherwise replace them.

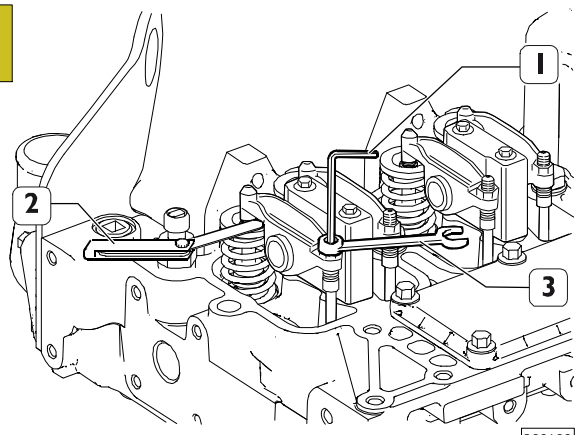
Injector calibration

The injectors require periodic cleaning and calibration of the exact injection pressure, by adding or replacing the shim washers inserted under the spring; check the injection pressure by using a hand operated pump equipped with a pressure gauge which, operated by the lever, enables the injector calibration pressure to be obtained and which is displayed on the pump pressure gauge at the moment in which diesel delivery occurs. During the test it is also possible to note whether the direction of the jet is correct and whether the injectors show any signs of fuel leakage. Clean the injectors using a metal brush to remove the carbon deposits from the nozzle tips.

Remove and refit the injectors as described in the procedure "REMOVING/REFITTING INJECTORS" in Section 5.

Adjust valve/rocker arm clearance

Figure 15



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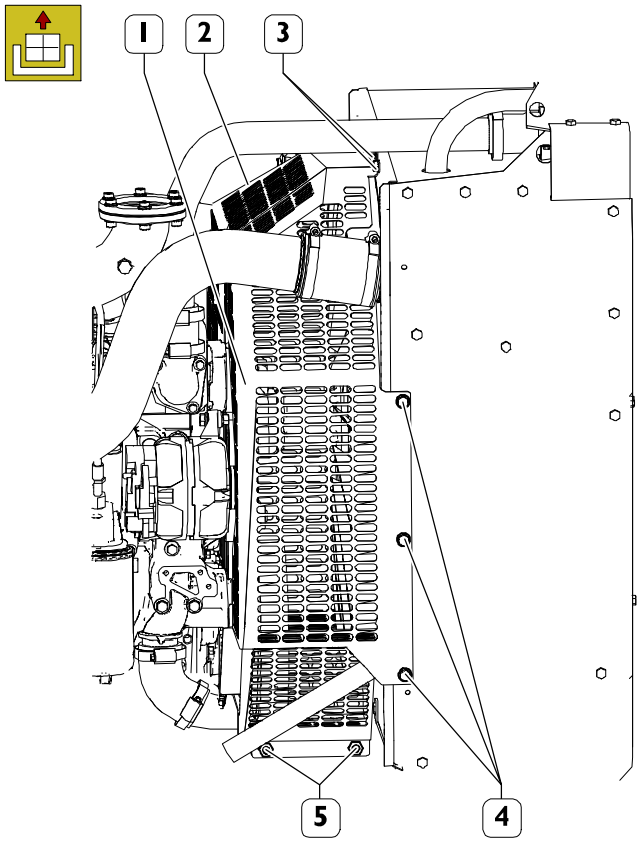
The adjustment of the clearance between the rocker arms and the intake and exhaust valve control rods must be strictly carried out using an Allen wrench (1), box-end wrench (3) and a feeler gauge (2).

Make the adjustment as described in the paragraph "rocker arm clearance adjustment" in Section 5.

PROTECTIVE GRILLE REMOVAL - REFITTING

Removal

Figure 1



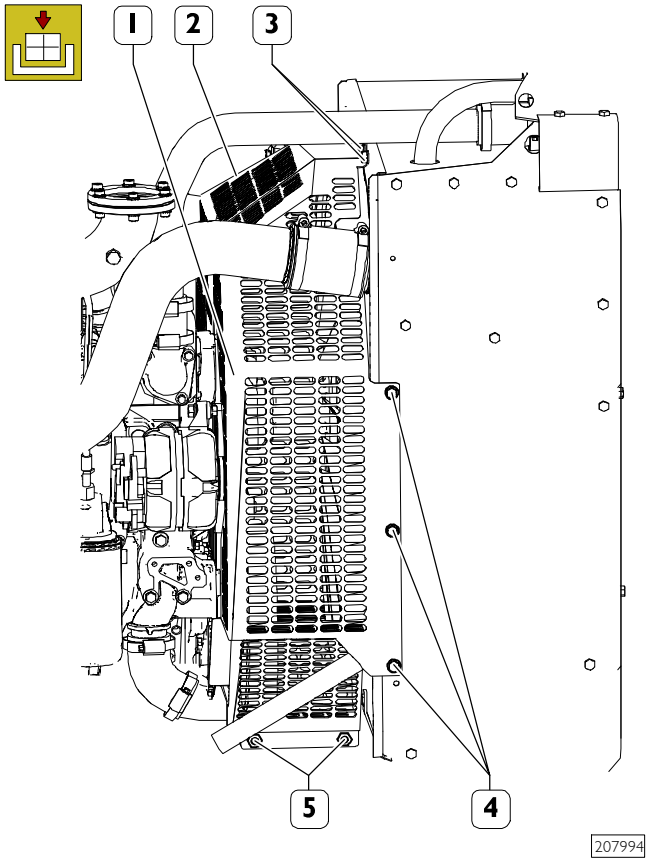
Remove the fan protection grilles (1) and (2) by performing the following operations:

- ❑ unscrew the upper screws (3);
- ❑ unscrew the lower screws (5);
- ❑ unscrew the side screws (4) from both sides;
- ❑ laterally remove the fan protection grilles (1) and (2).

Ref.	N.	Description
(3)	2	M8x1.25x20
(4)	6	M8x1.25x20
(5)	2	M8x1.25x20

Refitting

Figure 2



Laterally install the fan protection grilles (1) and (2).

Screw the upper screws (3), the lower screws (5) and the side screws (4);

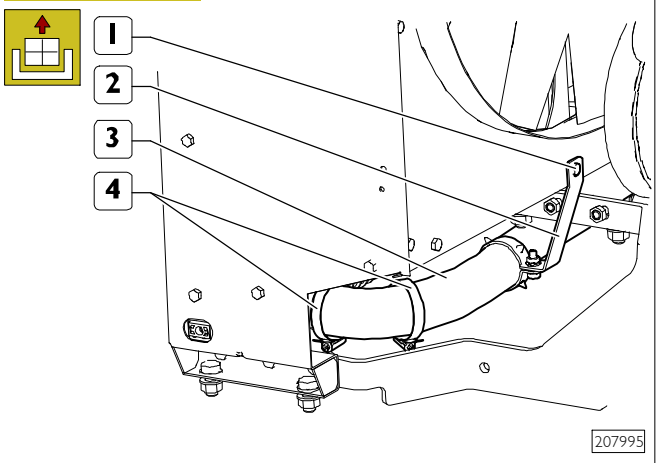
Ref.	N.	Description	Tightening torques
(3)	2	M8x1.25x20	-
(4)	6	M8x1.25x20	-
(5)	2	M8x1.25x20	-

RADIATOR ASSEMBLY REMOVAL - REFITTING

Remove the protection grilles as described in the procedure "PROTECTION GRILL REMOVAL - REFITTING".

Removal

Figure 3

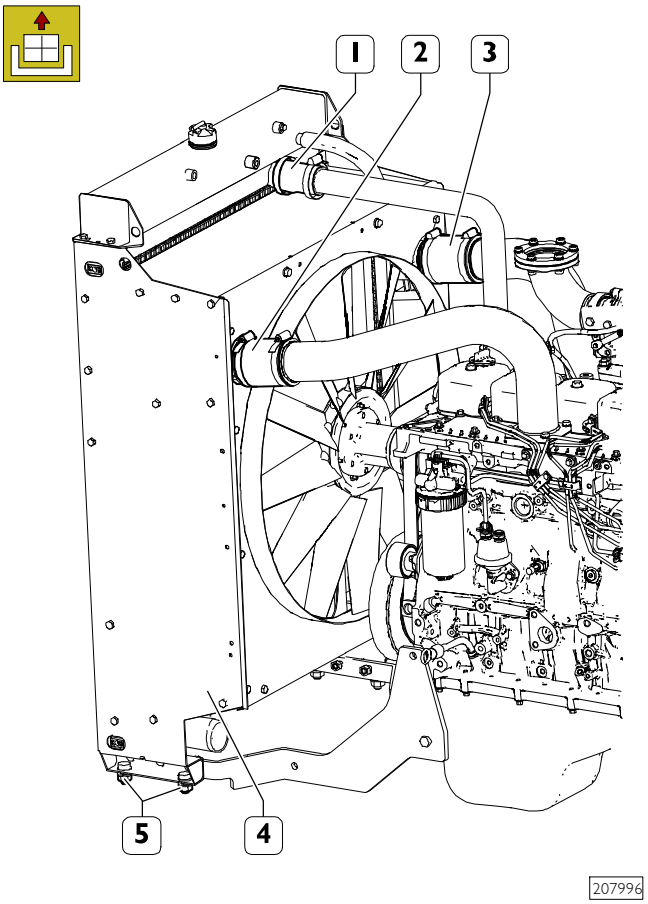


Position a suitable container under the pipes (3) to recover coolant.

Disconnect the sleeve (3) of the lower coolant pipe using its clamp (4).

Remove the screw (1) and remove the bracket (2) from the radiator assembly.

Figure 4



Disconnect the sleeve (1) of the upper coolant pipe from the radiator assembly (4) by loosening its clamp.

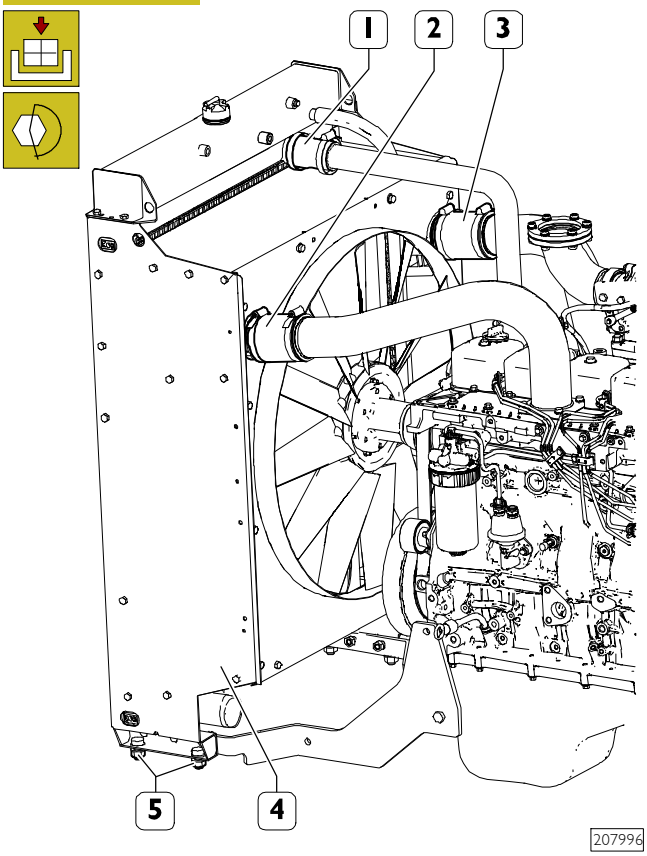
Disconnect the sleeves (2) and (3) of the intercooler pipes from the radiator assembly (4) by loosening their clamps.

Remove the bracket fastening screws (5) from the radiator assembly (4) and slide the radiator assembly forward.

Ref.	N.	Description
(5)	4	M14x30

Refitting

Figure 5



NOTE Before installing the radiator assembly, check the state of wear of the rubber sleeves. Replace the sleeves in question if found to be excessively worn.

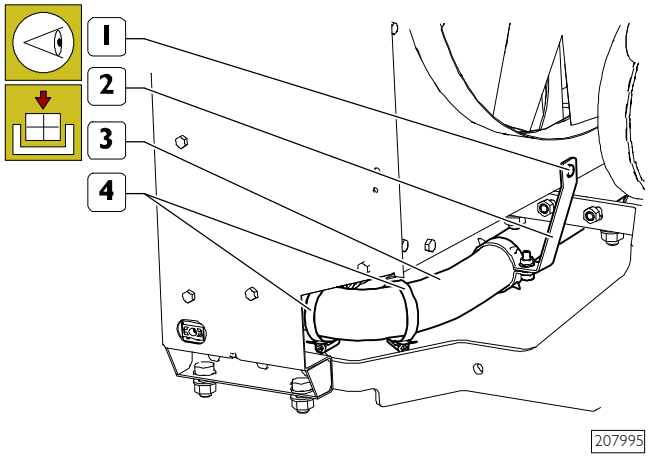
Install the radiator assembly (4) on the brackets, paying attention to any interferences with the fan, and tighten the screws (5) on both sides.

Ref.	N.	Description	Tightening torques
(5)	4	M14x30	-

Connect the sleeves (2) and (3) of the intercooler pipes and tighten their clamps.

Connect the sleeve (1) of the upper pipes of the coolant circuit and tighten the clamp.

Figure 6



NOTE Check the state of wear of the rubber sleeve. Replace the sleeve if found to be excessively worn.

Connect the sleeve (3) of the lower pipes of the coolant circuit and tighten the clamp (4).

Position the bracket (2) and fix it to the radiator assembly using the screw (1), tightening it to the torque specified in the table.

Refill the cooling system with coolant.

Refit the fan protection grilles as described in the procedure "PROTECTION GRILL REMOVAL - REFITTING".

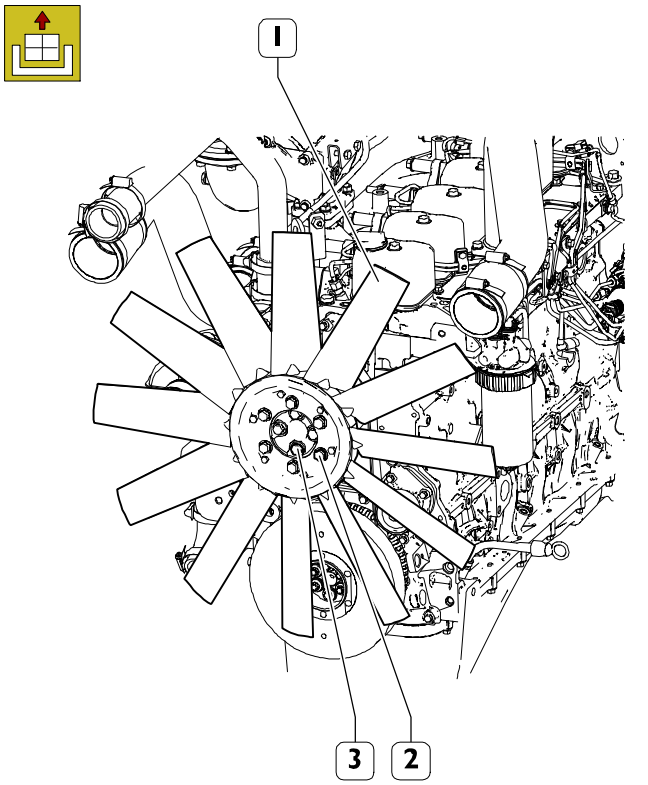
FAN REMOVAL - REFITTING

Remove the protection grilles as described in the procedure "PROTECTION GRILL REMOVAL - REFITTING".

Remove the radiator assembly as described in the procedure "RADIATOR ASSEMBLY REMOVAL - REFITTING".

Removal

Figure 7



Unscrew the screws (2) and remove the fan (1).

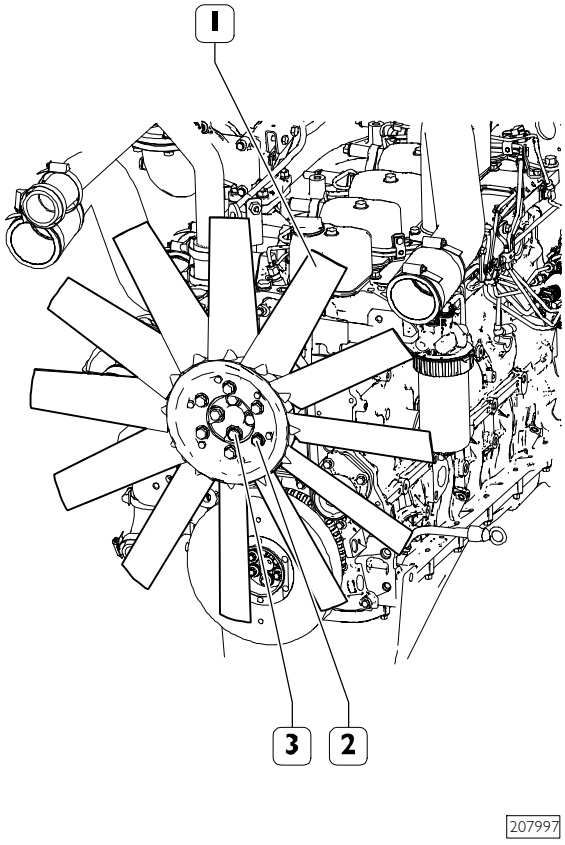
Ref.	N.	Description
(2)	6	M10x1.5x30

NOTE To remove the fan (1) with the spacer, remove the belt and unscrew the internal screws (3).

Ref.	N.	Description
(3)	4	M10x1.5x110

Refitting

Figure 8



Fit the fan (1) on the spacer and tighten the external screws (2).

Ref.	N.	Description	Tightening torques
(2)	6	M10x1.5x30	35 ± 5 Nm

If removing the fan (1) together with the spacer, fit the fan onto the spacer and tighten the screws (3). Key the belt onto the fan pulley.

Ref.	N.	Description	Tightening torques
(3)	4	M10x1.5x110	43 ± 6 Nm

Refit the radiator assembly as described in the procedure "RADIATOR ASSEMBLY REMOVAL - REFITTING".

Refit the protection grilles as described in the procedure "PROTECTION GRILL REMOVAL - REFITTING".

ANCILLARY BELT REMOVAL-REFITTING

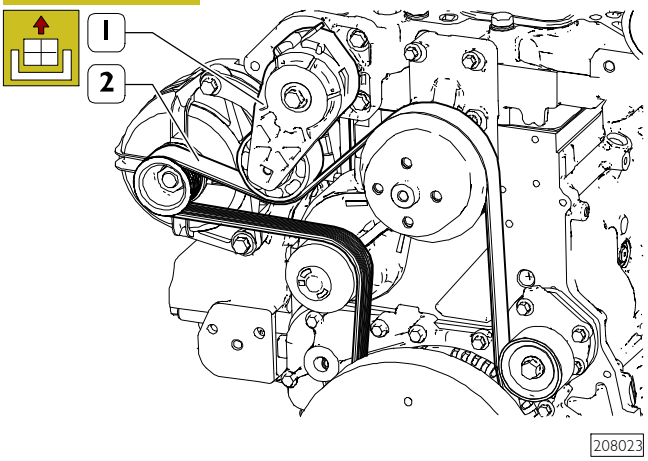
Remove the protection grilles as described in the procedure "PROTECTION GRILL REMOVAL - REFITTING".

Remove the radiator assembly as described in the procedure "RADIATOR ASSEMBLY REMOVAL - REFITTING".

Remove the fan as described in the procedure "FAN REMOVAL - REFITTING".

Removal

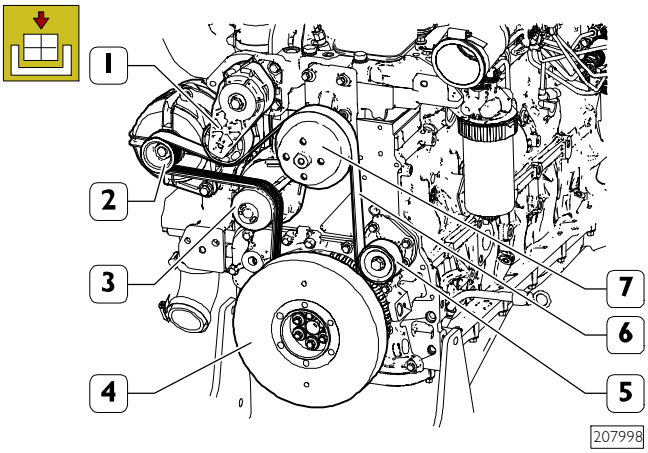
Figure 9



Act on the automatic belt tensioner (1) and remove the auxiliary device drive belt (2).

Refitting

Figure 10



NOTE If refitting the belt that was previously removed, carefully examine it for cuts or signs of giving way.

Act on the automatic belt tensioner (1) key the auxiliary belt (6).

Verify that the belt is correctly inserted in the alternator pulley (2), water pump pulley (3), crankshaft pulley (4),the guide pulley (5) and the fan pulley (7).

Refit the fan as described in the procedure "FAN REMOVAL - REFITTING".

Refit the radiator assembly as described in the procedure "RADIATOR ASSEMBLY REMOVAL - REFITTING".

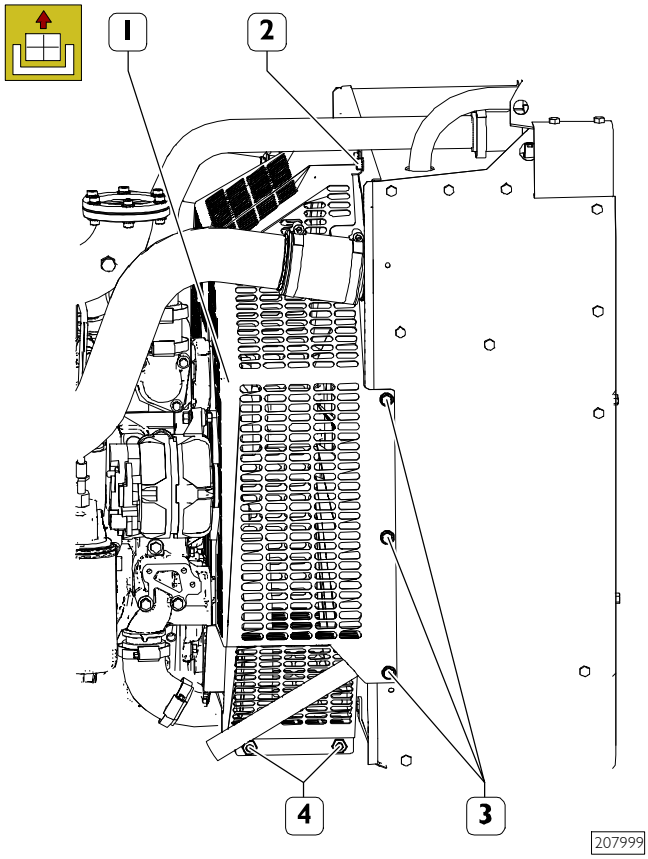
Refit the protection grilles as described in the procedure "PROTECTION GRILL REMOVAL - REFITTING".

ALTERNATOR REMOVAL/REFITTING

Removal

Disconnect the electrical connections of the alternator.

Figure 11

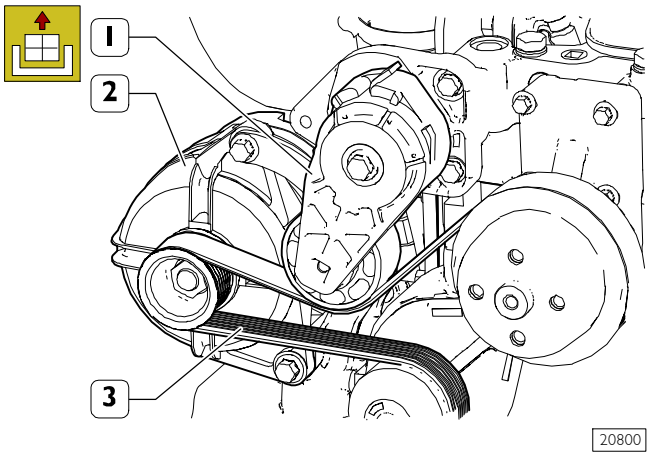


Remove the alternator pulley protection grille (1) by performing the following operations:

- ❑ unscrew the upper screw (2);
- ❑ unscrew the lower screws (4);
- ❑ unscrew the side screws (3);
- ❑ laterally remove the grille (1).

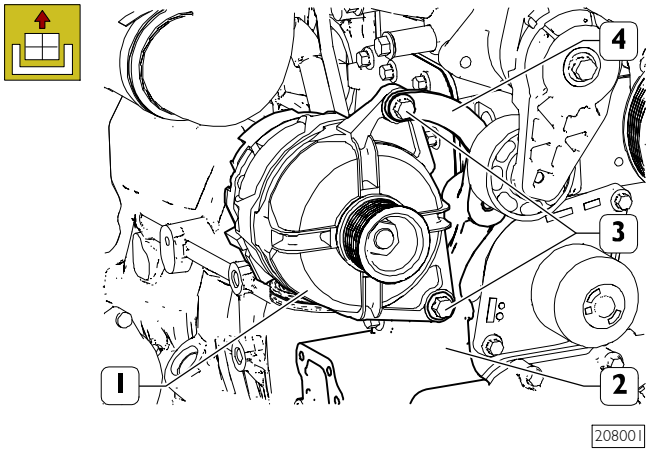
Ref.	N.	Description
(2)	1	M8x1.25x20
(3)	3	M8x1.25x20
(4)	2	M8x1.25x20

Figure 12



Act on the automatic belt tensioner (1) and remove the belt (3) from the alternator pulley (2).

Figure 13



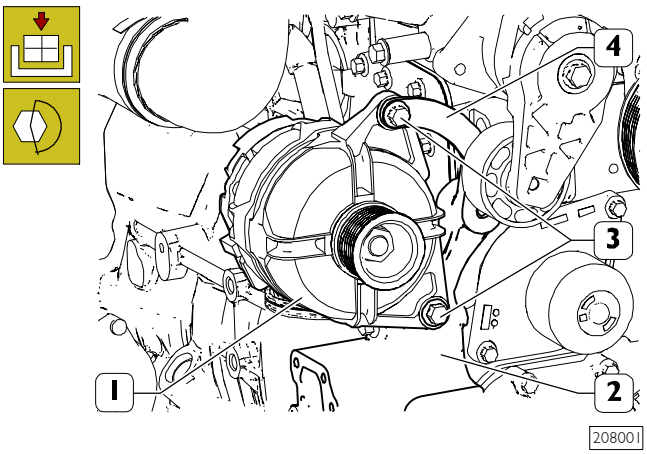
Unscrew the screw (3) fixing the alternator (1) to the support (2) and the screw (4) from the bracket (5).

Remove the alternator (1) from the support (2).

Ref.	N.	Description
(3)	2	M10x1.5

Refitting

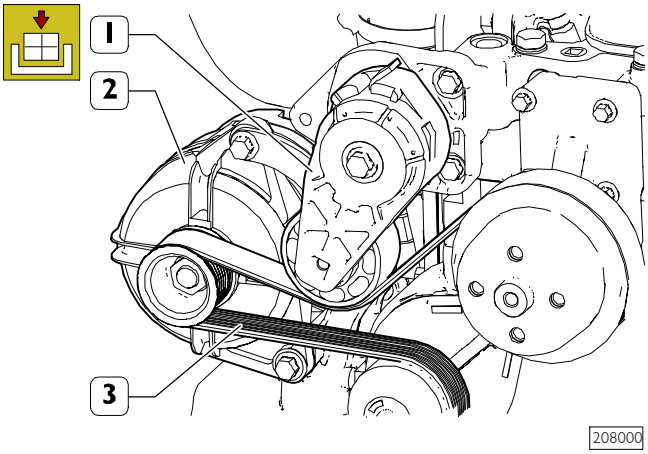
Figure 14



Fit the alternator (1) onto the support (2).

Screw the screw (3) fixing the alternator (1) to the support (2) and the screw (4) from the bracket (5).

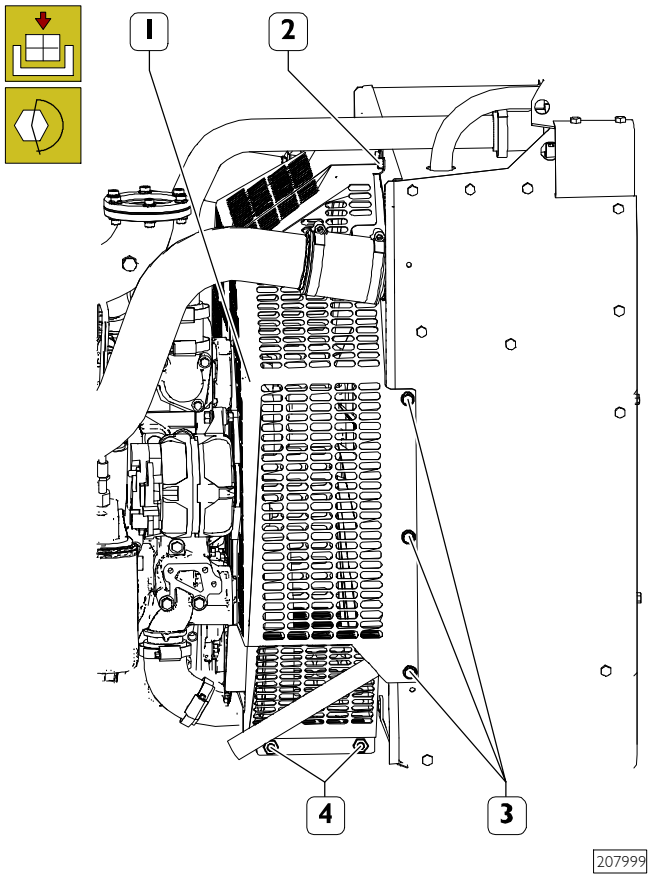
Figure 15



Act on the automatic belt tensioner (1) and put the belt (3) onto the alternator pulley (2).

Ref.	N.	Description	Tightening torques
(3)	2	M10x1.5	43 ± 6 Nm

Figure 16



Fit the alternator pulley protection grille (1) and tighten the upper screw (2), the lower screws (4) and the side screws (3).

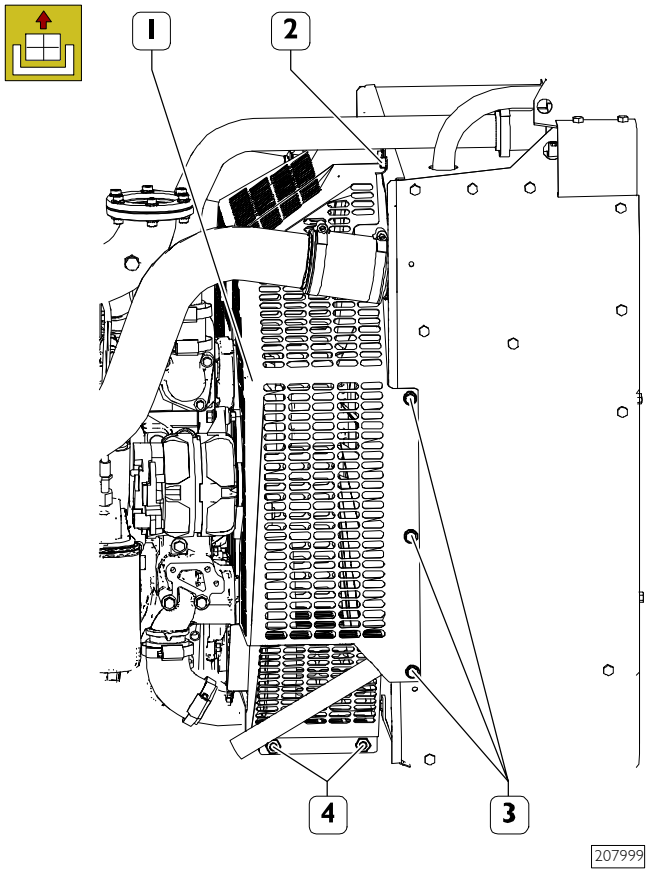
Ref.	N.	Description	Tightening torques
(2)	1	M8x1.25x20	-
(3)	3	M8x1.25x20	-
(4)	2	M8x1.25x20	-

WATER PUMP REMOVAL/REFITTING

Removal

Position a suitable container to collect any coolant which may leak out.

Figure 17

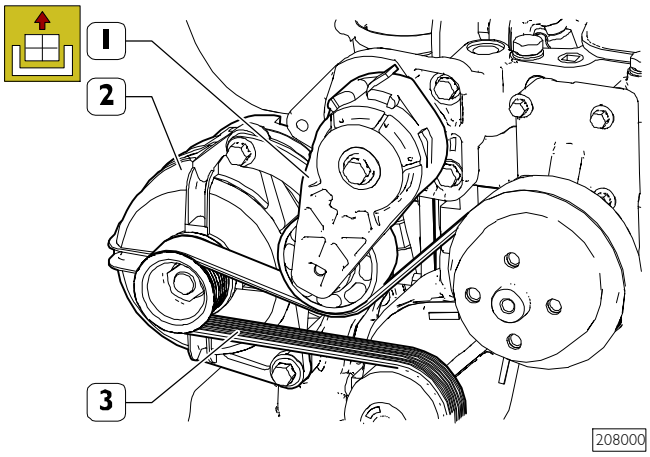


Remove the alternator pulley protection grille (1) by performing the following operations:

- ❑ unscrew the upper screw (2);
- ❑ unscrew the lower screws (4);
- ❑ unscrew the side screws (3);
- ❑ laterally remove the grille (1).

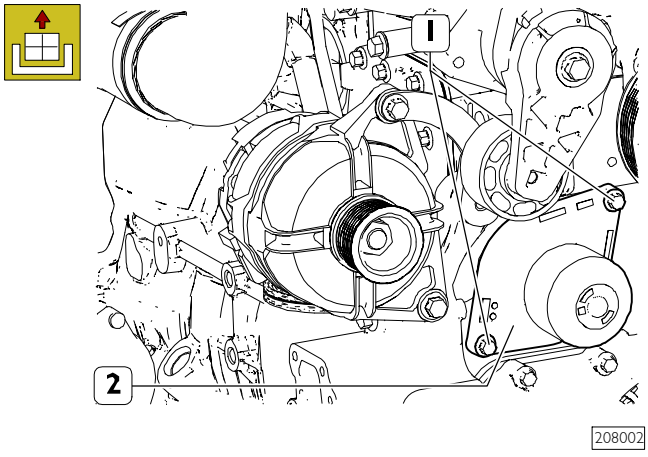
Ref.	N.	Description
(2)	1	M8x1.25x20
(3)	3	M8x1.25x20
(4)	2	M8x1.25x20

Figure 18



Act on the automatic belt tensioner (1) and remove the belt (3) from the alternator pulley (2).

Figure 19

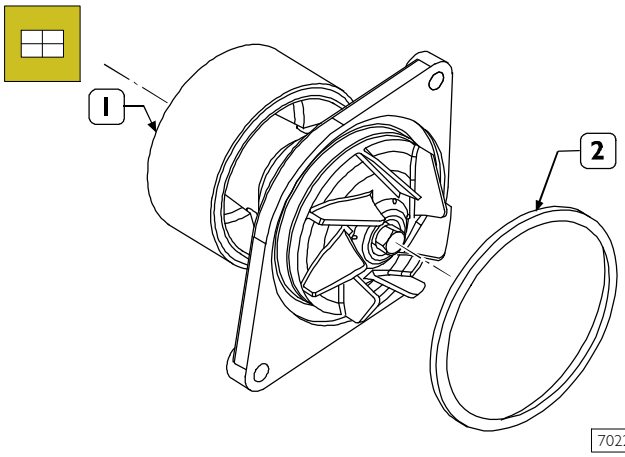


Unscrew the screws (1) and remove the water pump (2) together with the seal ring.

Ref.	N.	Description
(1)	2	M8x1.25

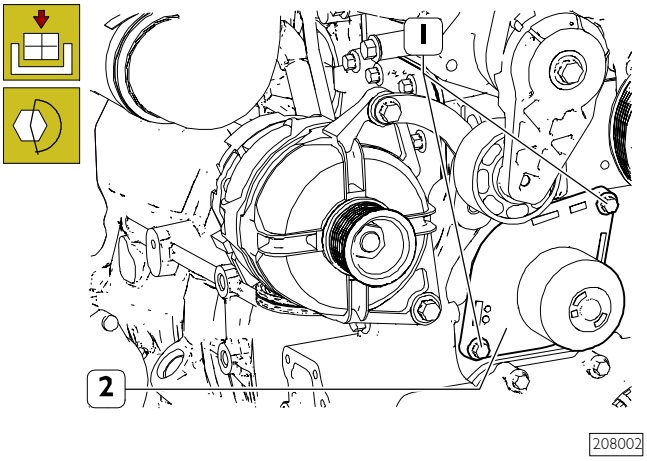
Refitting

Figure 20



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

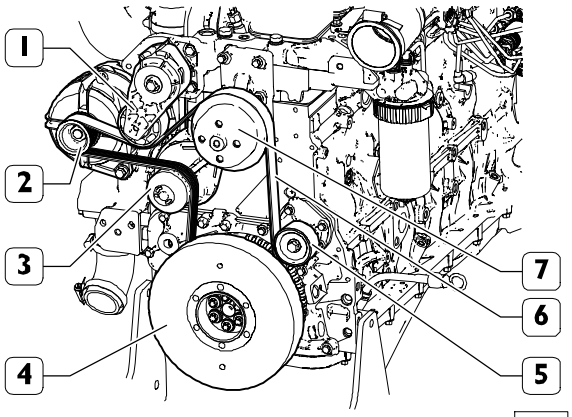
Figure 21



Fit the water pump (2) together with the new seal ring, tighten the screws (1) and tighten them to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(1)	2	M8x1.25	24 ±4 Nm

Figure 22

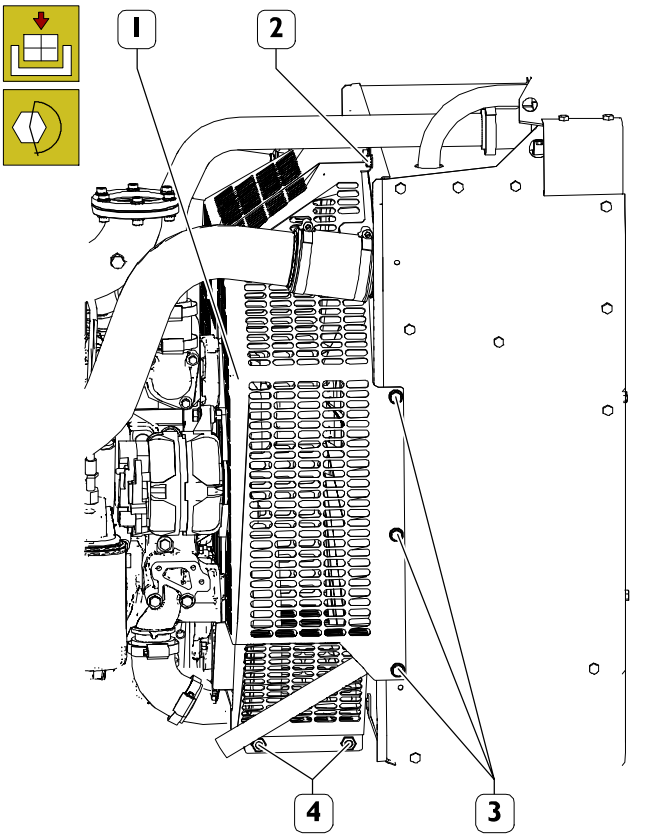


Position the belt (6) onto the water pump pulley (3) as shown in the figure.

Using a suitable tool, act on the automatic tensioner (1) and fit the auxiliary drive belt (6) onto the alternator pulley (2).

Verify correct insertion of the belt inside the crankshaft pulley (4) the guide pulley (5) and the fan pulley (7).

Figure 23



707999

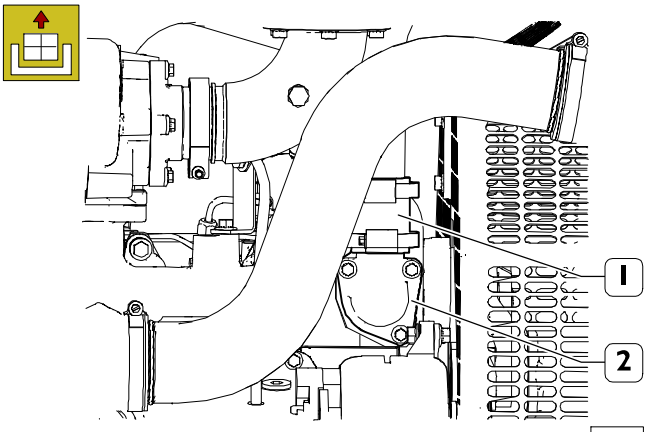
Fit the alternator pulley protection grille (1) and tighten the upper screw (2), the lower screws (4) and the side screws (3).

Ref.	N.	Description	Tightening torques
(2)	1	M8x1.25x20	-
(3)	3	M8x1.25xx20	-
(4)	2	M8x1.25xx20	-

REMOVAL/REFITTING OF THERMOSTAT

Removal

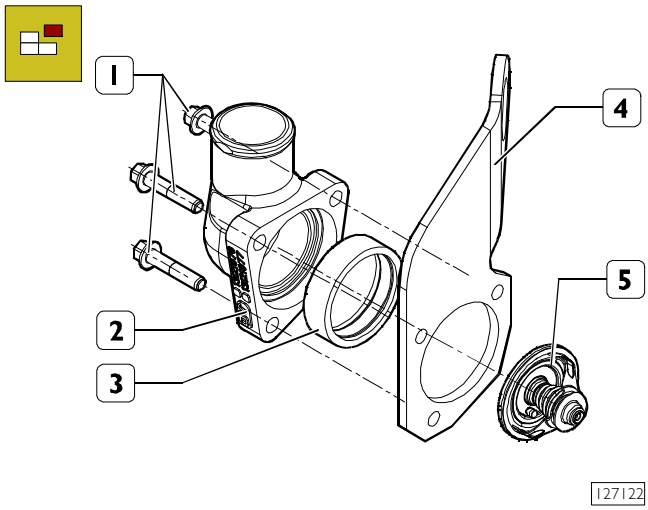
Figure 24



208004

Loosen the clamp and disconnect the sleeve (1) from the thermostat body (2).

Figure 25



127122

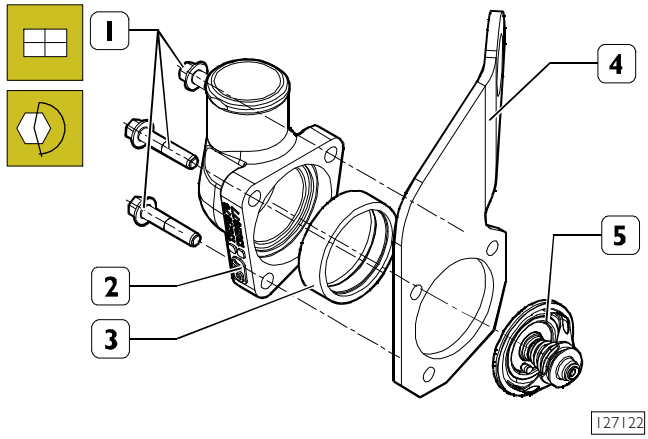
- ❑ Unscrew the fastening screws (1) and remove the thermostat body (2) together with the bracket (4); recover the gasket (3) and the thermostat (5).
- ❑ Fit the bracket into the original position and fasten it with the screws of the thermostat body.

Ref.	N.	Description
(1)	3	M8x1.25

Refitting

NOTE The seal must always be replaced with a new one.

Figure 26

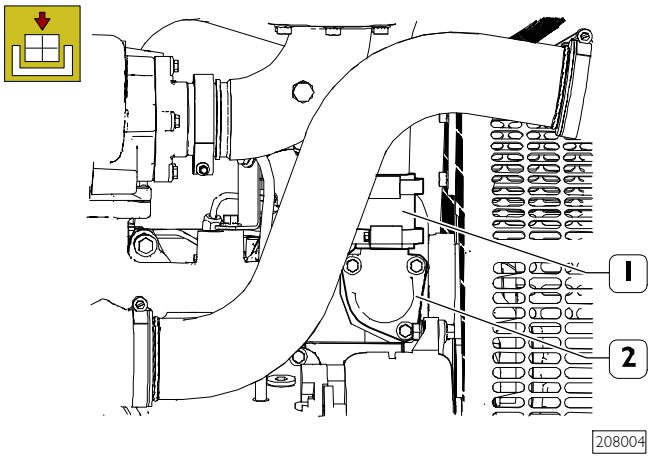


127122

- ❑ Fit the thermostat body (2), complete with thermostat (5) and gasket (3).
- ❑ Screw the screws (1) fastening the thermostat body (2) to the cylinder head, then tighten them to the torque specified in the table.

Ref.	N.	Description	Tightening torques
(1)	3	M8x1.25	-

Figure 27



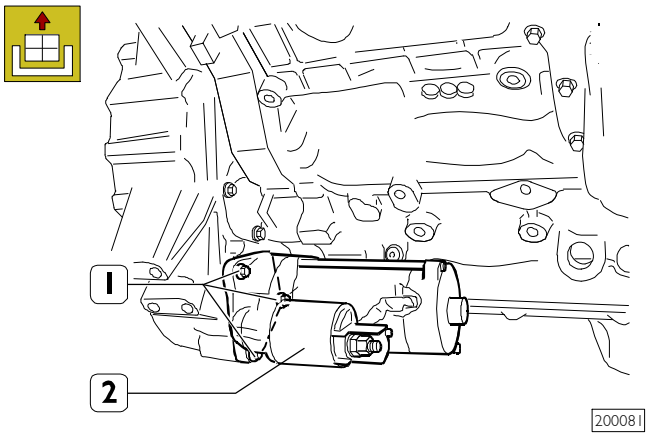
Connect the sleeve (1) to the thermostat body (2) and tighten its clamp.

STARTER MOTOR REMOVAL/REFITTING

Removal

Disconnect the electrical connections of the starter motor.

Figure 28

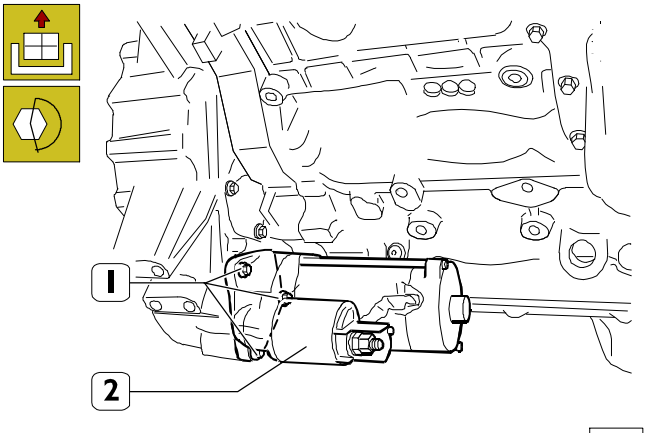


Unscrew the screws (1) and remove the starter (2).

Ref.	N.	Description
(1)	3	M10x1.5x30

Refitting

Figure 29



❑ Remove the electric starter motor (2), by unscrewing the three fastening screws (1).

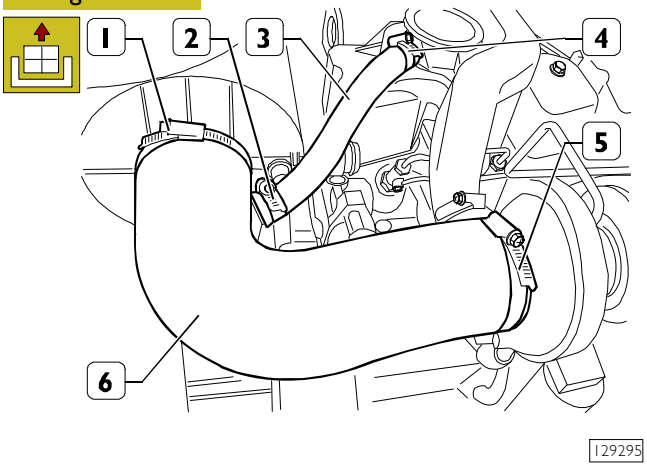
Fit the starter motor (1) and tighten the screws (2) to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(1)	3	M10x1.5x30	43 ±6 Nm

AIR FILTER REMOVAL - REFITTING

Removal

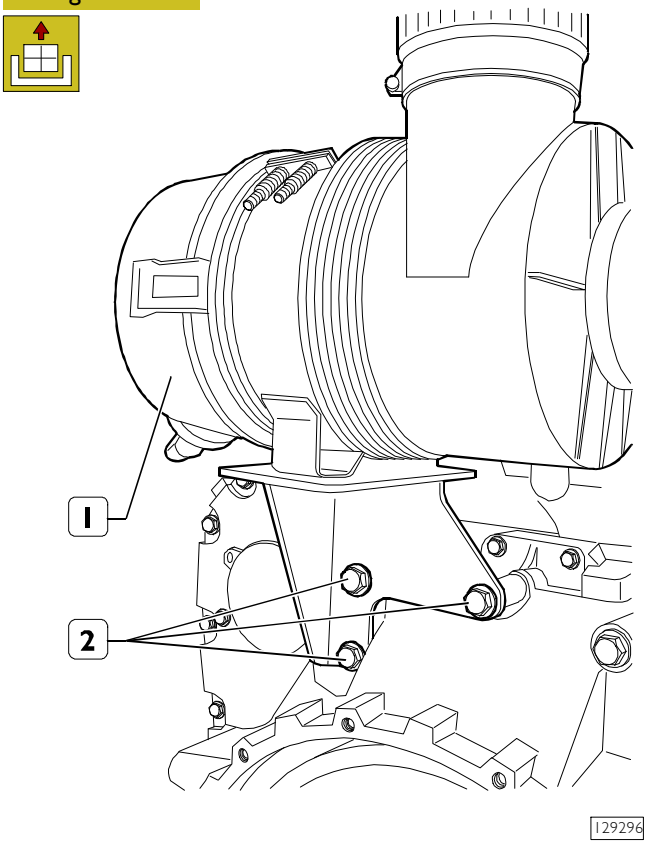
Figure 30



❑ Disconnect and remove the oil vapour recovery pipes (3), acting on the relative clamps (2) and (4).

❑ Disconnect and remove the air intake pipes (6), acting on the relative clamps (1) and (5).

Figure 31

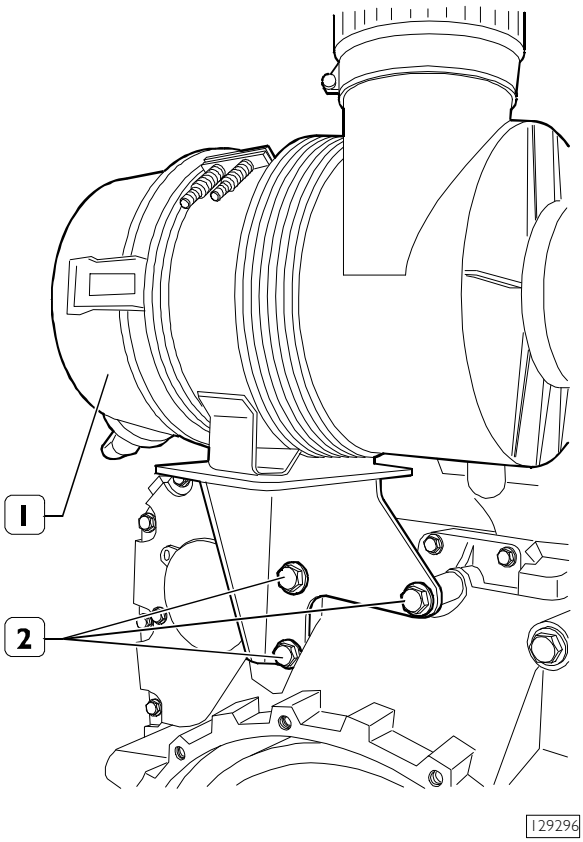


❑ Remove the air filter (1) by unscrewing the screws (2) and remove it from its seat together with the support.

Ref.	N.	Description
(2)	3	M12x1.75

Refitting

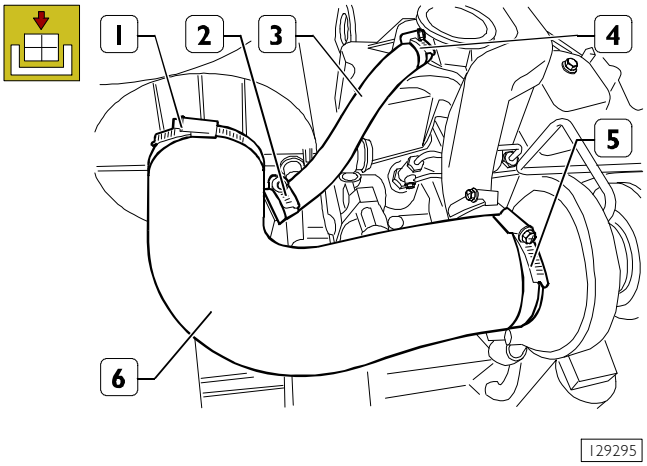
Figure 32



❑ Fit the air filter together with the support (1) and tighten the screws (2) to the prescribed torque.

Ref.	N.	Description	Tightening torques
(2)	3	M12x1,75	85 ±10 Nm

Figure 33



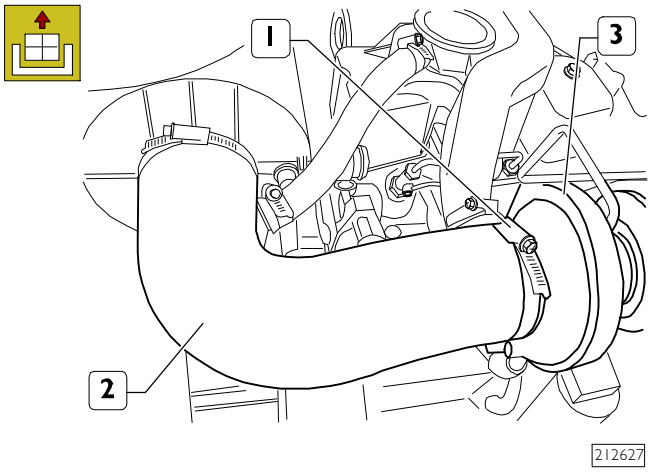
❑ Connect the air intake pipes (6), closing their clamps (1) and (5)

❑ Connect the oil vapour recovery pipes (3), closing their clamps (2) and (4).

TURBOCHARGER REMOVAL/REFITTING

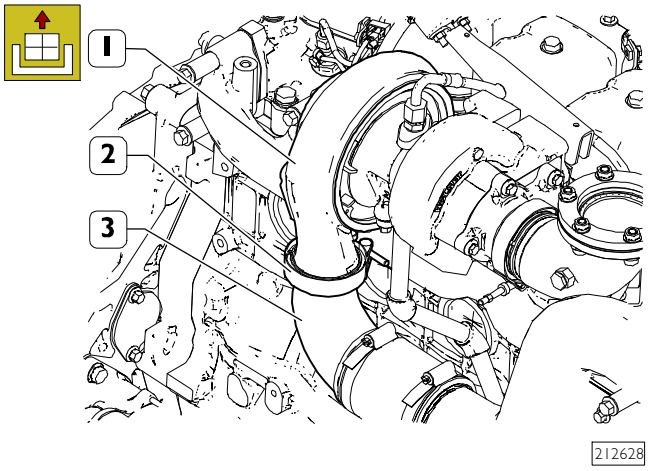
Removal

Figure 34



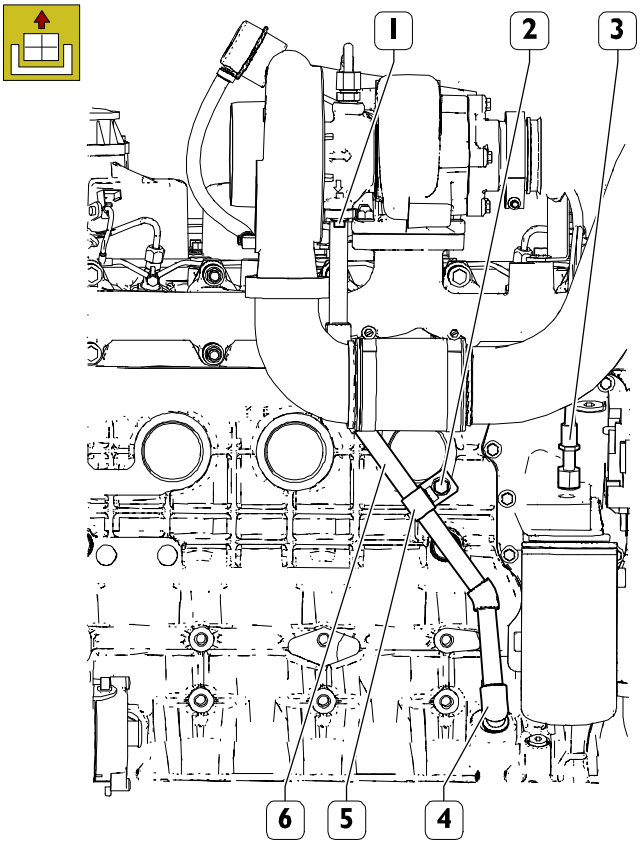
Loosen the clamp (1) and disconnect the air filter pipe (2) from the turbocharger (3).

Figure 35



Loosen the clamp (2) and disconnect the intercooler air delivery pipe (3) from the turbocharger (1).

Figure 36



- ❑ Remove the lubrication oil discharge pipe (6) from the turbocharger by proceeding as follows:
- ❑ Unscrew the two screws (1) in the lower part of the turbocharger;

Ref.	N.	Description
(1)	2	M8x1.25

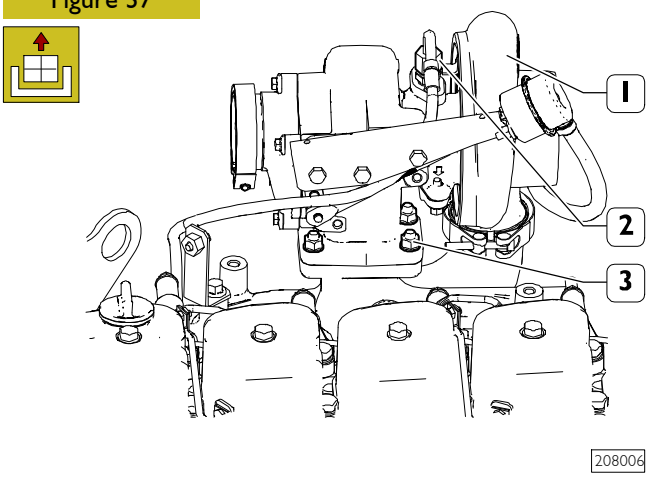
- ❑ Unscrew the screws (2) that retain the piping (6) to the block by means of the fastening collar (5);

Ref.	N.	Description
(2)	1	M8x1.25x16

- ❑ Remove the coupling (4) from the block;
- ❑ Plug the ends of the pipes and the exhaust valve of the turbocharger.

Unscrew the fitting and disconnect the lubrication pipe (3) from the upper part of the heat exchanger.

Figure 37



Unscrew the fitting (2) and disconnect the lubricant pipe from the turbocharger (1).

Ref.	N.	Description
(2)	1	M16

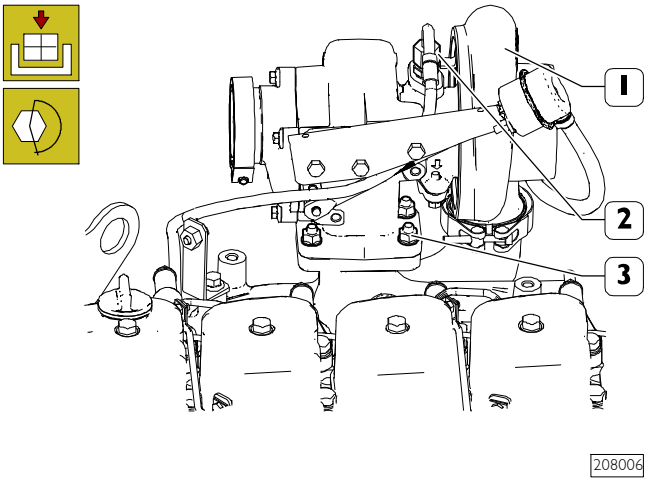
Remove the nuts (3) fastening the turbocharger (1) to the exhaust manifold.

Ref.	N.	Description
(3)	4	M10x1.5

Remove the turbocharger (1) and recover the gasket.

Refitting

Figure 38



Support the turbocharger (1) and position it on the exhaust manifold after having fitted a new gasket.

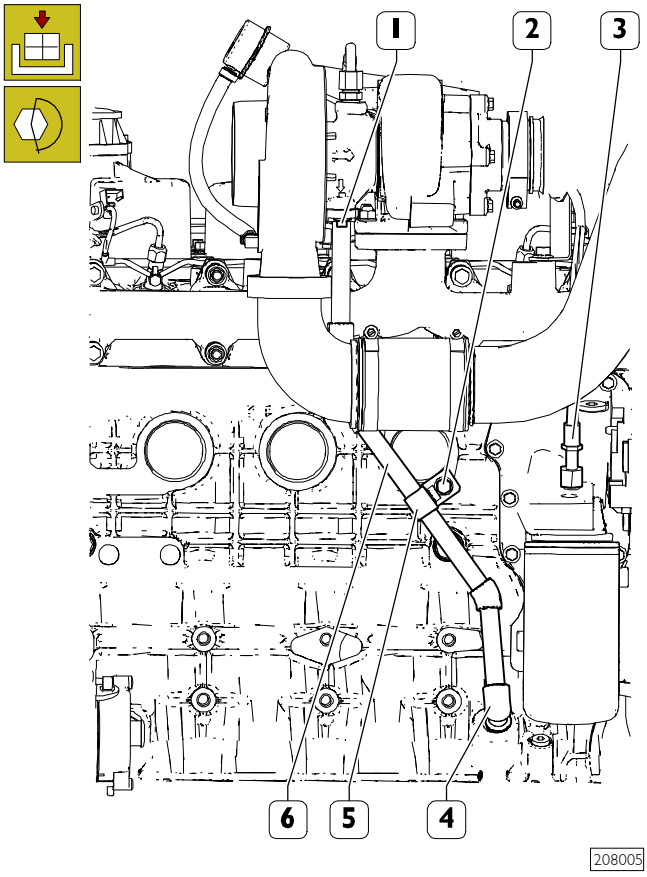
Tighten the nuts (3) fastening the turbocharger (1) to the exhaust manifold.

Ref.	N.	Description	Tightening torques
(3)	4	M10x1.5	-

Fit the lubrication pipe coming from the heat exchanger and tighten the coupling (2) to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(2)	1	M16	36 ±5 Nm

Figure 39



Refit the lubrication oil discharge pipe (6) from the turbocharger by proceeding as follows:

❑ Fit new sealing rings and insert the coupling (4) in the crankcase;

❑ Insert and screw the fastening screws (1) in the lower part of the turbocharger, then tighten to the torque indicated in the table;

Ref.	N.	Description	Tightening torques
(1)	2	M8x1.25	-

❑ Tighten the screw (2) that keeps the pipes (6) in position on the block by means of the fastening collar (5).

Ref.	N.	Description	Tightening torques
(2)	1	M8x1.25x16	-

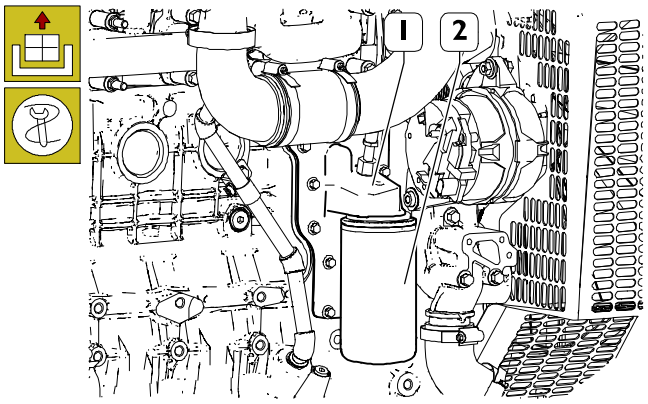
❑ Connect the lubrication pipe (3) to the upper part of the heat exchanger and tighten the coupling to the torque indicated in the table

Ref.	N.	Description	Tightening torques
(3)	1	M16	36 ±5 Nm

OIL FILTER REMOVAL - REFITTING

Removal

Figure 40

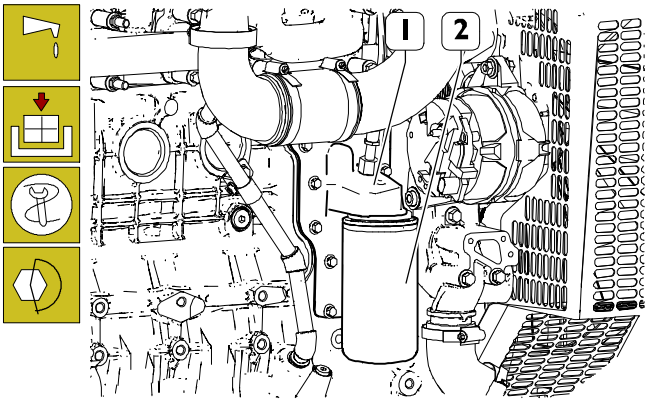


❑ Using tool 99360076, remove the oil filter (2) and its gasket, unscrewing it from the support (1).

Attention, the oil filter contains approximately 1 kg of engine oil.
Collect and dispose of the engine oil according to applicable laws.

Refitting

Figure 41



Moisten the sealing ring and position it on the oil filter (2).

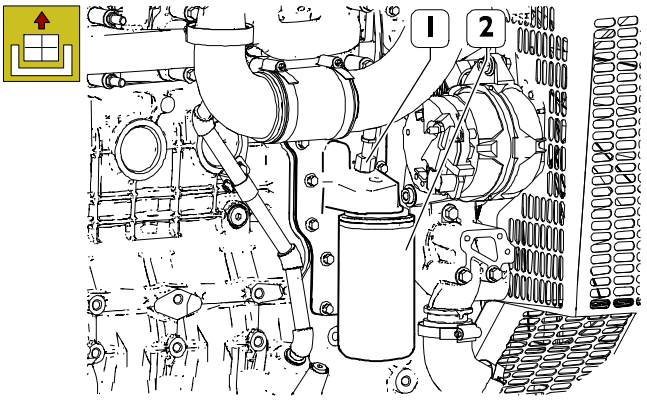
Manually screw the oil filter (2) onto the mount (1) of the heat exchanger until it clicks, then use tool 99360076 to further tighten it to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(2)	1	M27x2	20 ±2 Nm

HEAT EXCHANGER REMOVAL/REFITTING

Removal

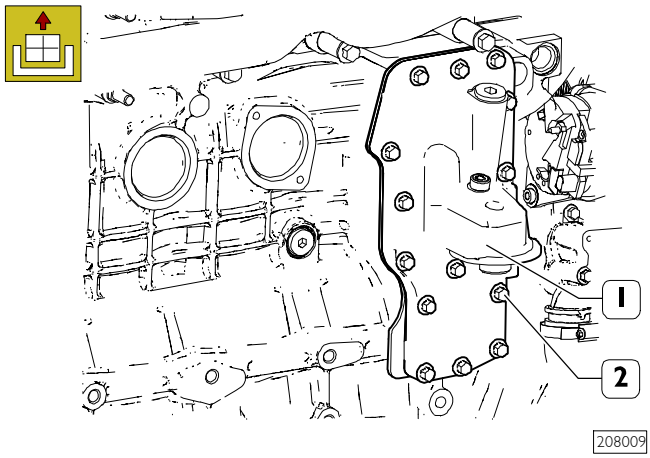
Figure 42



Unscrew the fitting (1) and disconnect the lubricant oil pipe from the turbocharger.

Remove the oil filter (2) according to the operations described in the procedure "OIL FILTER REMOVAL - REFITTING".

Figure 43

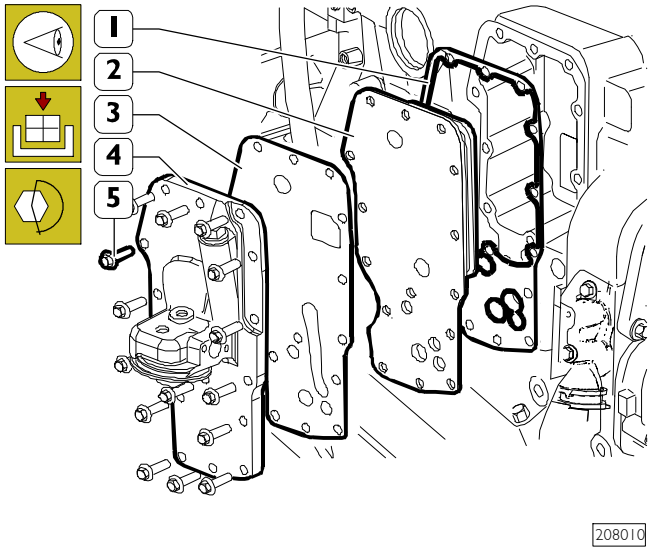


Remove the screws (2) and remove the oil filter/heat exchanger support (1), the intermediate plate and the corresponding gaskets.

Ref.	N.	Description
(2)	15	M8x1.25x35

Refitting

Figure 44



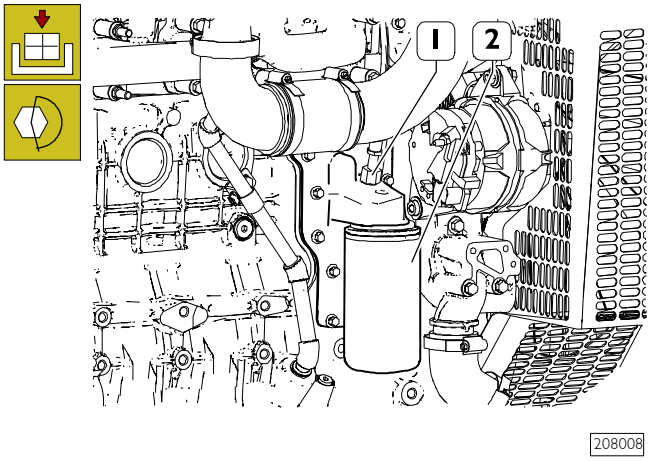
NOTE Before each assembly operation, check that the thread on the holes and the screws shows no sign of wear or dirt.

Fit on the crankcase: a new gasket (1), the heat exchanger (2) a new gasket (3) and the oil filter support (4).

❑ Screw in the screws (5) fastening the heat exchanger (2), then tighten them to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(5)	15	M8x1.25x35	26 ±4 Nm

Figure 45



Connect the lubrication pipe (1) to the upper part of the heat exchanger and tighten the coupling to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(1)	1	M16	36 ±5 Nm

Fit the oil filter (2) according to the operations described in the procedure "OIL FILTER REMOVAL - REFITTING".

OIL SUMP REMOVAL/REFITTING

Removal

NOTE Position a suitable container below the sump to collect the oil as it drains out of the drain plug.

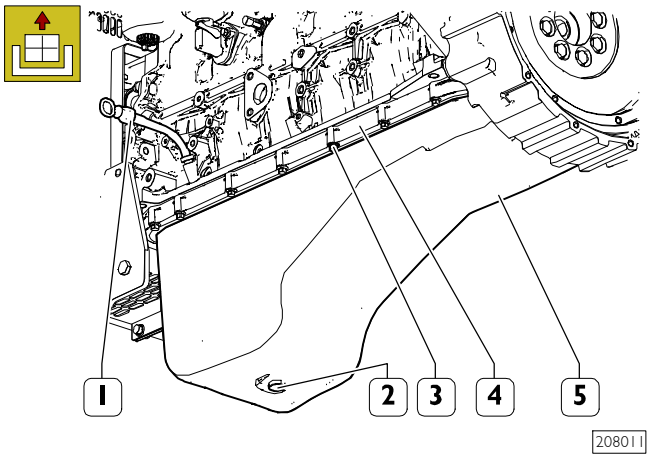
The engine oil is highly pollutant and noxious.

In case of contact with skin, wash thoroughly with water and detergent.

Suitably protect skin and eyes; proceed in accordance with accident prevention standards.

Suitably dispose of the residuals and in accordance with regulations.

Figure 46



To assist in the flow of engine oil, pull out the oil dipstick (1) and remove the filling plug on the rocker arm cover of cylinder No. 1.

NOTE It is recommended that the oil is drained while hot.

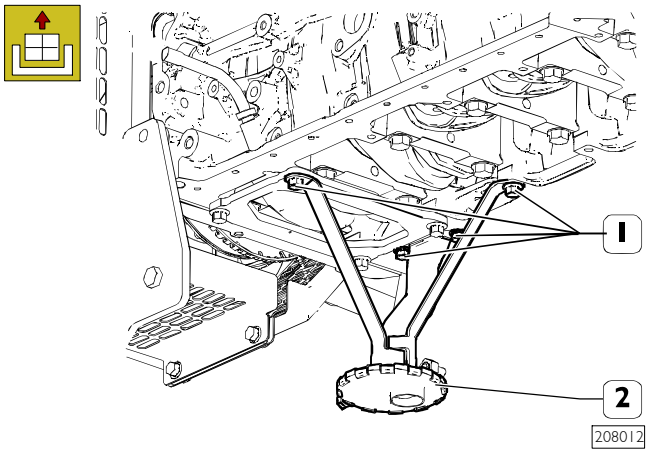
Unscrew the drain plug (2) so that all of the oil present in the oil sump (5) flows out;

Ref.	N.	Description
(2)	1	M22x1.5

Remove the screws (3), disassemble the frame (4) and disconnect the oil sump (5).

Ref.	N.	Description
(3)	18	M8x1.25

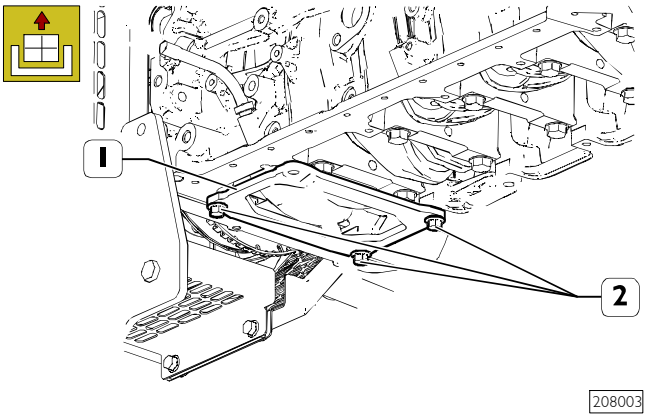
Figure 47



Remove the screws (1) and disassemble the oil suction strainer (2).

Ref.	N.	Description
(1)	2	M8x1.25
(1)	2	M10x1.5

Figure 48

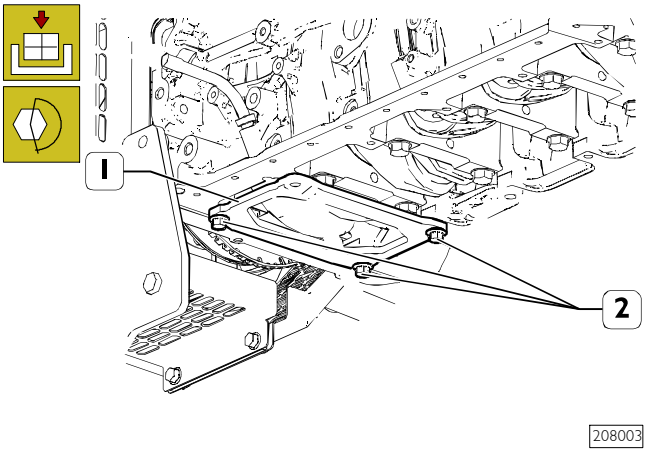


Remove screws (2) and disassemble the stiffening plate (1).

Ref.	N.	Description
(2)	3	M10x1.5

Refitting

Figure 49

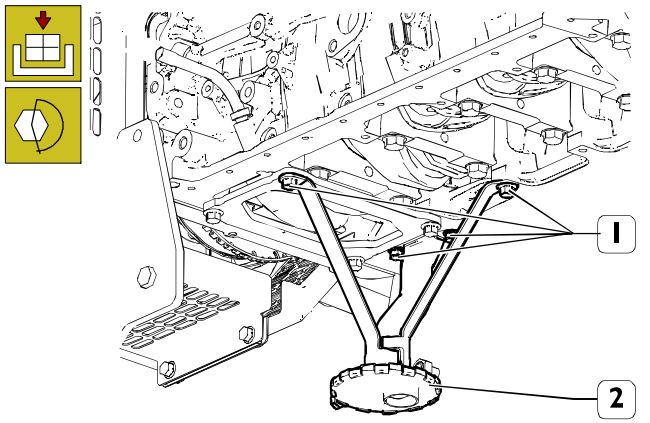


Refit the hardening plate (1) on the crankcase.

Screw the fastening screws (2) of the plate (1) and tighten them to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(2)	3	M10x1.5	43 ±5 Nm

Figure 50



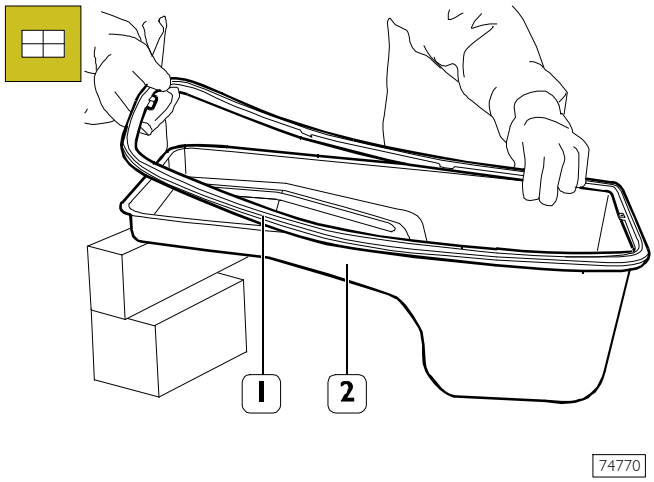
Refit the strainer (2) complete with gasket and bracket to the crankcase.

Screw the fastening screws (1) of the strainer (2) and tighten them to the torque indicated in the table.

Screw the other fastening screws (1) of the brackets and tighten them to the torque indicated in the table.

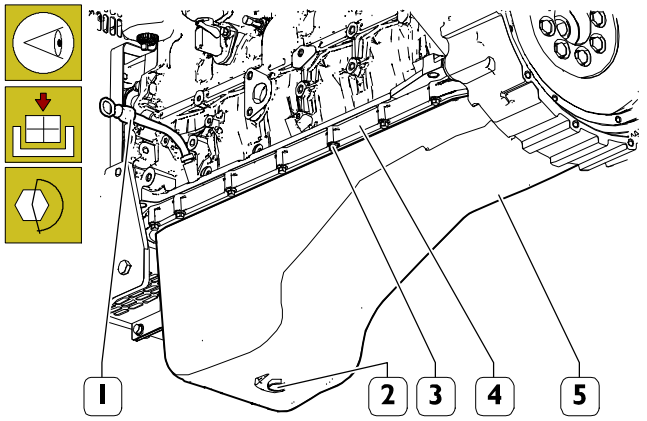
Ref.	N.	Description	Tightening torques
(1)	2	M8x1.25	24 ±4 Nm
(1)	2	M10x1.5	43 ±5 Nm

Figure 51



❑ Set the new gasket (1) on the oil sump (2).

Figure 52



NOTE Before each assembly operation, check that the thread on the holes and the screws shows no sign of wear or dirt.

Fit the oil sump (5) and apply the plate (4) to it.

Screw the fastening screws (3) of the oil sump (5) and tighten them to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(3)	18	M8x1.25	24 ±4 Nm

Fit the drain plug (2) and tighten to the torque indicated in the table

Ref.	N.	Description	Tightening torques
(2)	1	M22x1.5	40 ±10 Nm

NOTE Only use recommended oils or oils with the properties required for proper engine operation.

If topping up, do not mix oils with different properties.

Failure to observe these standards will invalidate the service warranties.

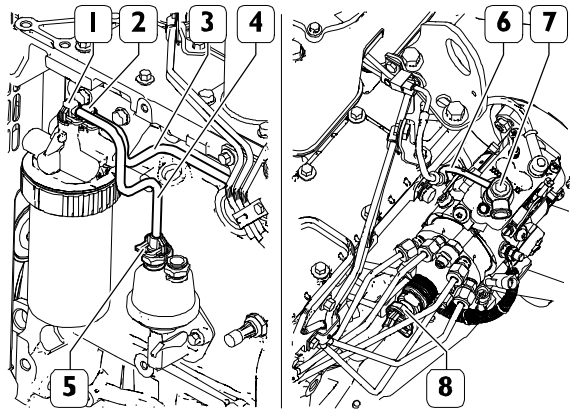
Through the filler cap, introduce the oil in the specified quantity and quality prescribed.

Check the level with the dipstick (1) until obtaining a filling near the maximum level notch shown on the dipstick.

LOW PRESSURE PIPES REMOVAL - REFITTING

Removal

Figure 53



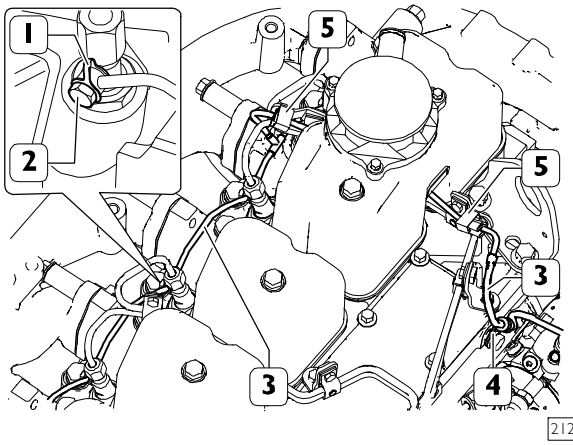
Disconnect the couplings (1) and (2) from the fuel filter support.

Disconnect the coupling (5) from the priming pump and remove the pipes (4).

Disconnect the coupling (8) from the feed pump and remove the pipe (3).

Unscrew the coupling (7) to disconnect the pipe (6) from the feed pump.

Figure 54



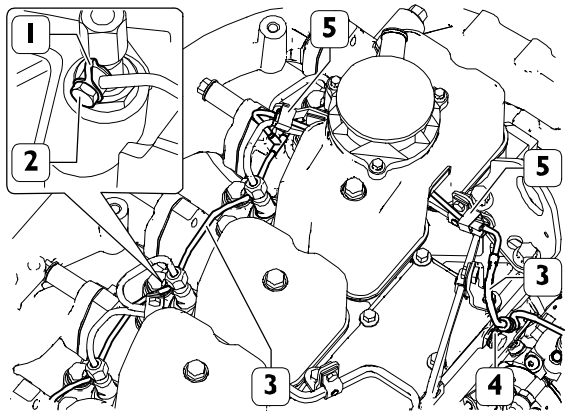
Remove the screws (2) and their gaskets (1), and remove the fuel exhaust pipes (3) from the injectors.

Remove screws (4) and (5) of the brackets.

Take out the pipes (3).

Refitting

Figure 55

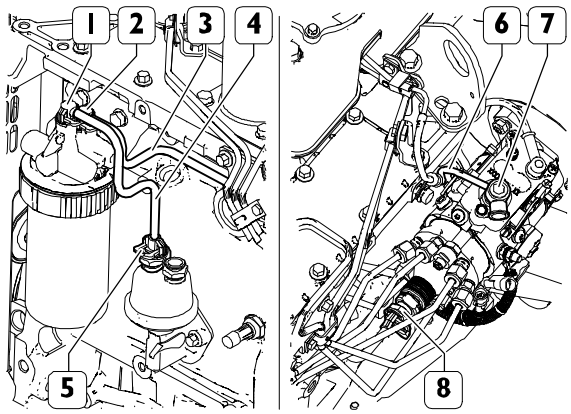


Install the fuel exhaust pipes (3) on the injectors.

Use new gaskets (1) and tighten the screws (2).

Install the clamps (4) and (5) and lock them with their screws.

Figure 56



Connect the pipe (6) to the feed pump and tighten the coupling (7).

Connect the pipe (3) to the feed pump by means of the coupling (8).

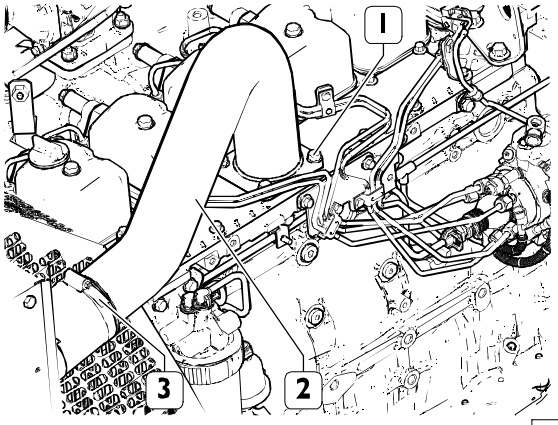
Connect the pipe (4) to the priming pump by means of the coupling (5).

Connect the pipes (3) and (4) to the fuel filter support using couplings (1) and (2).

HIGH PRESSURE PIPES REMOVAL - REFITTING

Removal

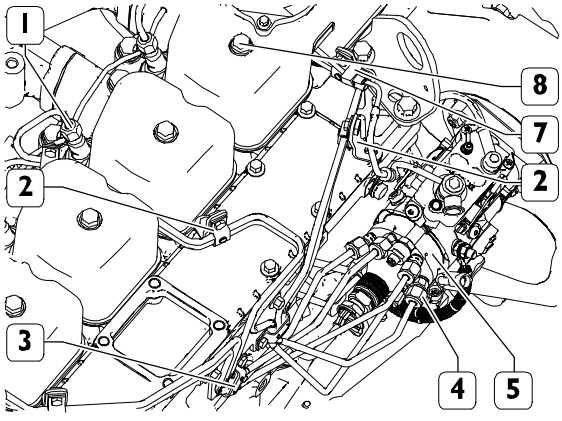
Figure 57



Unscrew the screws (1) fastening the pipe (2) to the intake manifold.

Loosen the collar (3) and remove the pipe (2).

Figure 58



Unscrew the couplings (1) and disconnect the high pressure pipes from the injectors.

Unscrew the couplings (4) and disconnect the high pressure pipes from the feed pump (5).

Remove the brackets (2), (3) and (7).

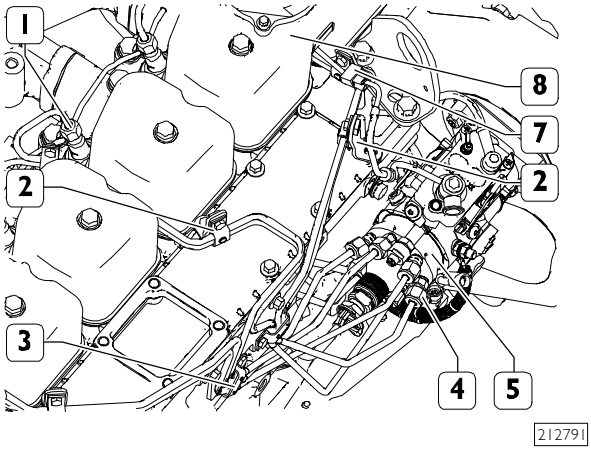
Unscrew the screws (8) and remove the tappet cover of cylinders 5-6.

Ref.	N.	Description
(8)	2	M8x1.25

Remove the high pressure pipes from the engine.

Refitting

Figure 59



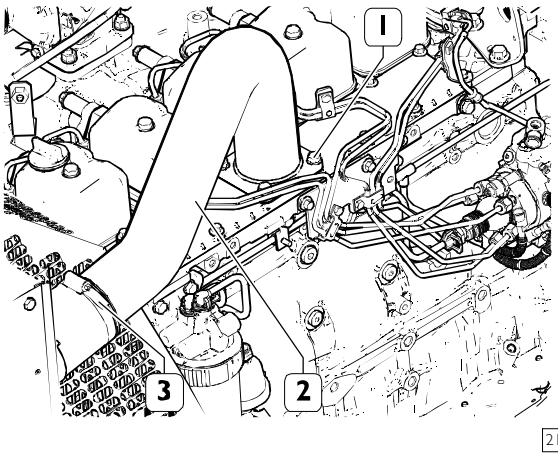
Install the high pressure pipes on the engine and fit the cover (8) of cylinder tappets 5-6.

Connect the high pressure pipes to the feed pump (5) and tighten the couplings (4).

Unscrew the couplings (1) and connect the high pressure pies to the injectors and tighten the couplings (1).

Install clamps (2), (3) and (7) to fasten the pipes to the engine.

Figure 60



Insert the upper end of the pipe (2) into the intercooler outlet sleeve.

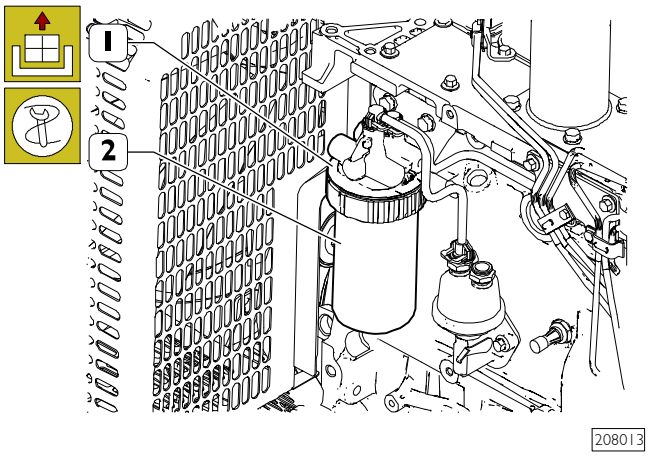
Install the lower end of the pipe (2) onto the intake manifold and tighten the screws (1).

Tighten the clamp (3) fastening the pipe (2).

FUEL FILTER REMOVAL - REFITTING

Removal

Figure 61

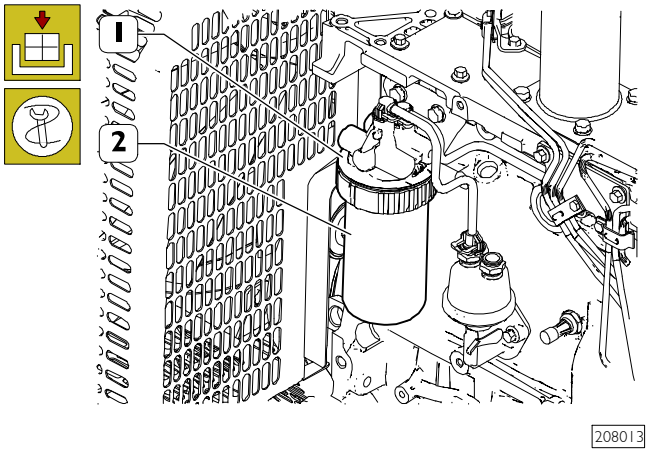


Place a suitable container under the diesel filter and unscrew the condensate bleed cock, positioned under the filter itself, to completely drain the diesel inside.

Using tool 99360076, unscrew the fuel filter (2) from the support (1) and remove it.

Refitting

Figure 62



NOTE The filter must be previously filled with fuel to facilitate supply system bleeding operations.

Manually screw in the fuel filter (2) on the support (1) and then screw in further by another 3/4 turn. Check that tightening is to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(2)	1	-	20 ±2 Nm

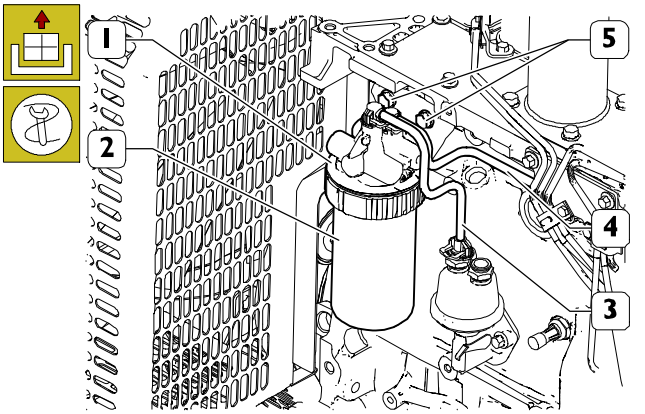
Bleed the supply system as described in the paragraph "Supply system bleeding procedure".

FUEL FILTER HOUSING REMOVAL-REFITTING

Removal

Position a suitable container to collect any fuel which may leak out.

Figure 63



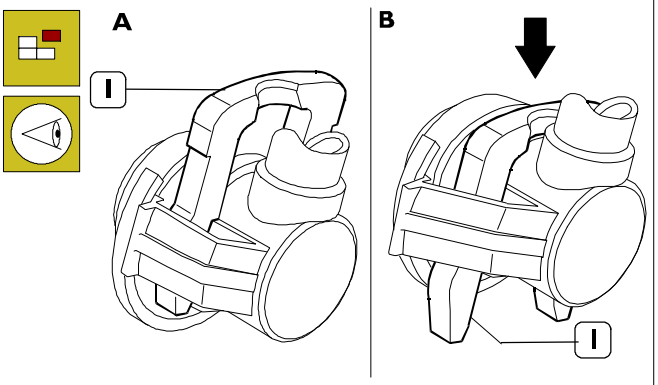
Remove the fuel filter (2) as described in the relevant section.

Disconnect the fuel pipes (3 and 4, respectively) from the priming pump to the filter support, and remove the feed pump from the latter.

Unscrew the fastening screws (5) and remove the support (1) from the cylinder head.

Ref.	N.	Description
(5)	2	M10x1.5

Figure 64

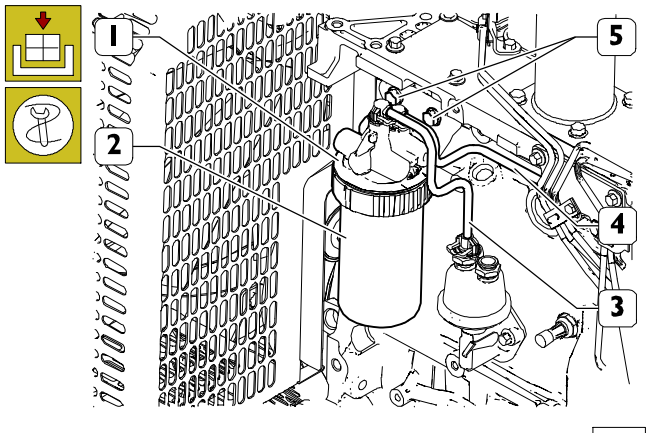


NOTE To disconnect lower pressure fuel pipes from their couplings, press clip (1) as shown in figure B.

After disconnecting the pipe, bring the clip (1) back to the locking position in figure **A**, to prevent it from deforming.

Refitting

Figure 65

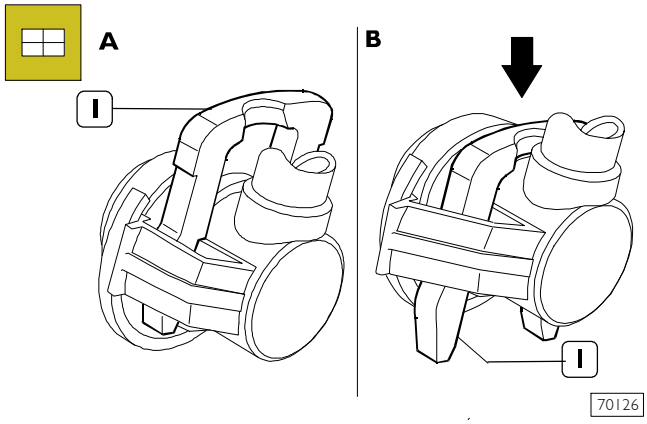


Mount the fuel filter support (1) and tighten the screws (5).

Ref.	N.	Description	Tightening torques
(5)	2	M10x1.5	-

Connect the fuel pipes (3 and 4, respectively) from the priming pump to the support (1), and remove the feed pump from the latter.

Figure 66



NOTE To connect lower pressure fuel pipes from their couplings, press clip (1) as shown in figure **B**.

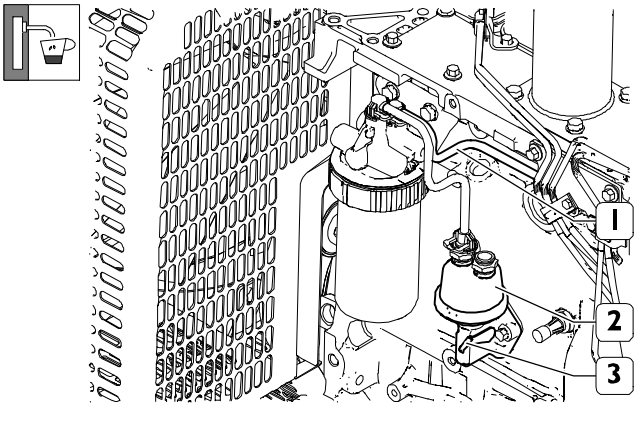
After disconnecting the pipe, bring the clip (1) back to the locking position in figure **A**.

Fit the fuel filter as described in the relevant section.

Bleed the supply system as described in the paragraph "Supply system bleeding procedure".

Supply system bleeding procedure

Figure 67

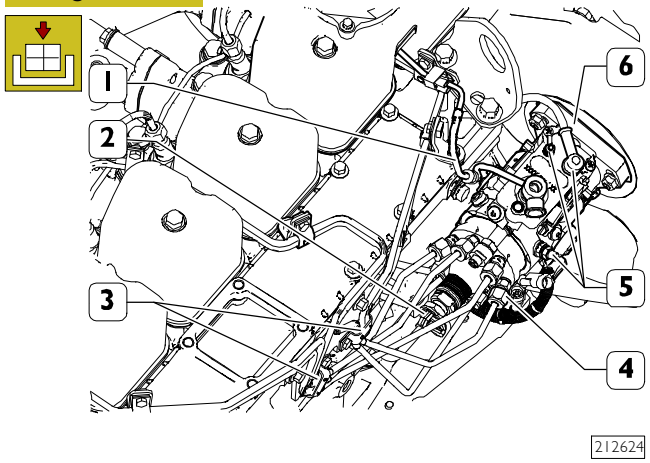


- ❑ Disconnect the fuel pipe (1) from the filter and repeatedly move the bleed lever (3) of the priming pump (2).
- ❑ Continue the operation until fuel comes out.
- ❑ Connect the pipe (1) to the filter.

PROCEDURE FOR FEED PUMP REMOVAL/REFITTING

Preliminary operations

Figure 68



Disconnect fuel delivery pipes (4) from the fuel pump (6).

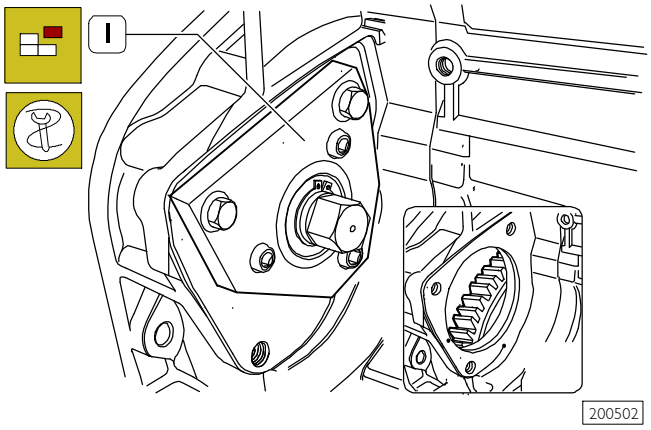
Disconnect the injector leak recovery pipe (1).

Disconnect the supply pipe (2) coming from the priming pump.

Disconnect electrical connections (5).

Remove the brackets (3) to facilitate the removal of the feed pump (6).

Figure 69



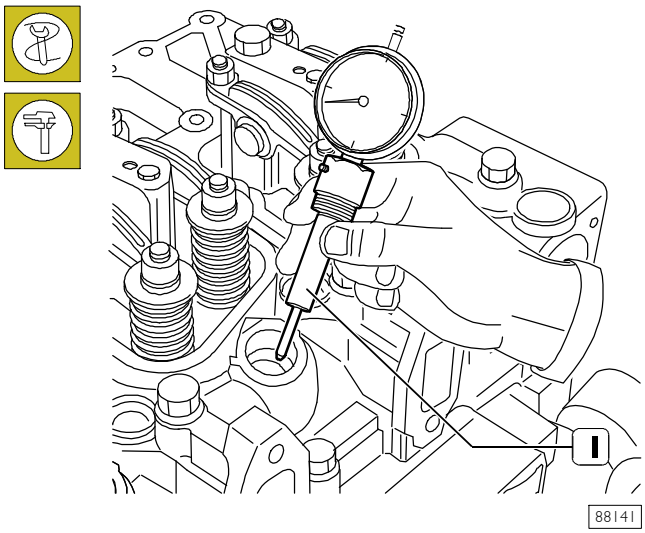
Remove the starter motor from the flywheel housing as described in the relative procedure and fit tool 99360221 (1) in order to rotate the flywheel. If it is necessary to replace the feed pump, this spare is supplied preset.

If however the pump needs to be disassembled and refitted without having undergone any repair interventions, preset it while it is still fitted on the engine and only then remove it.

The following procedure refers to the second possibility as this is the more complex one.

Identifying top dead centre with tool (99395097) - False injector

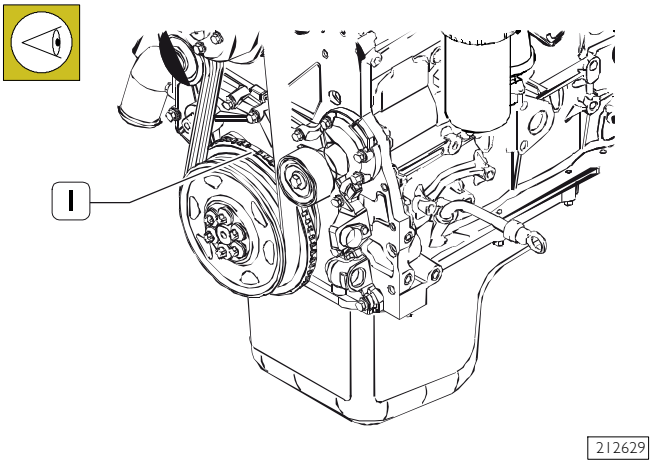
Figure 70



To identify the 1° cylinder top dead centre position at the end of the compression stroke, remove the rocker arm cover of the 1° cylinder, remove the 1° injector and position the tool (1). Pre-load the dial gauge 99395604.

The required condition is obtained by turning the crankshaft appropriately until the maximum value appears on the dial gauge and making sure that the intake and exhaust valves are both closed.

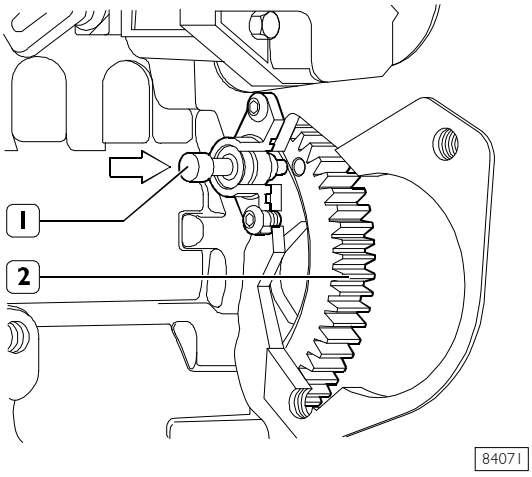
Figure 71



❑ Make sure that the non-drilled part (1) of the phonic wheel is positioned at the top along its vertical axis.

Identifying top dead centre at end of compression stroke for first cylinder using timing system lock pin (99360616)

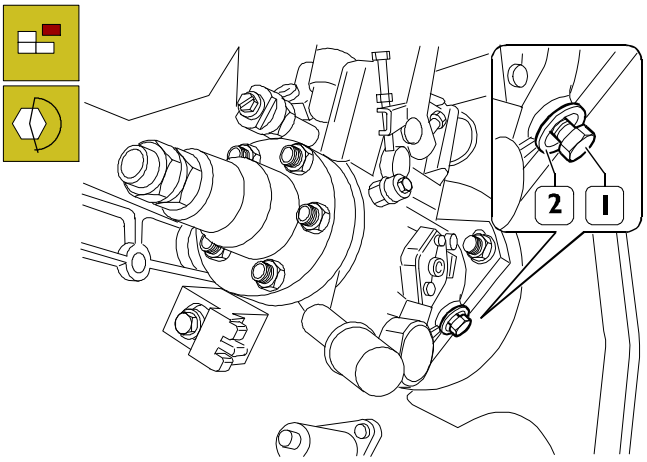
Figure 72



Turn the flywheel until when pressing pin 99360616(1), the latter does not lock the gear (2) obtaining the TDC of the 1° cylinder.

Removal

Figure 73



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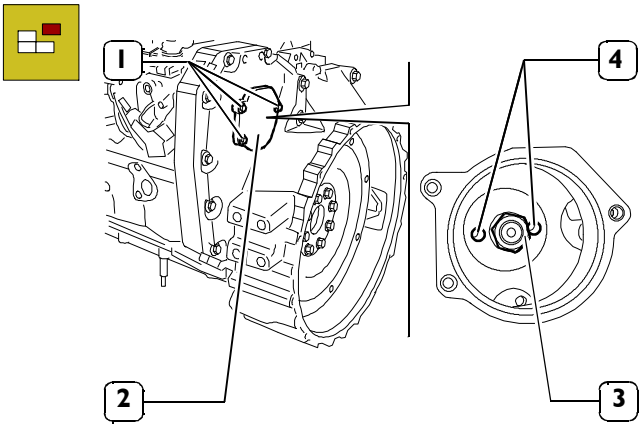
❑ Partially unscrew the screw (1) locking the pump spindle and move the spacer with the slot (2) to the largest part of the hole to allow the screw to fit in completely.

❑ Apply a torque of between 11.9 and 12.4 Nm to tighten the locking screw (1) flush with the spacer locking the pump spindle rotation.

Figure 74



75693

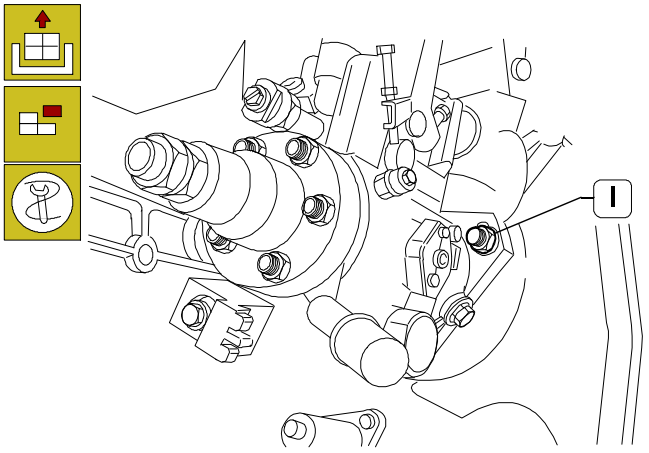
❑ On the timing gear side, remove the small cover (2) unscrewing the screws (1) so as to access the nut (3) securing the pump drive gear.

Ref.	N.	Description
(1)	3	M8x1.25

❑ Unscrew the nut (3) and recover the relative washer.

Ref.	N.	Description
(3)	1	M14x1.5

Figure 75



106658

❑ From the side of the pump, loosen the fastening nuts (1) without removing them in order to allow the pump to move backwards when the extractor 99340035 operates.

Ref.	N.	Description
(1)	3	M8x1.25

❑ Fit the extractor 99340035 using the two threaded holes (4, Figure 74) and detach the gear from the pump spindle.

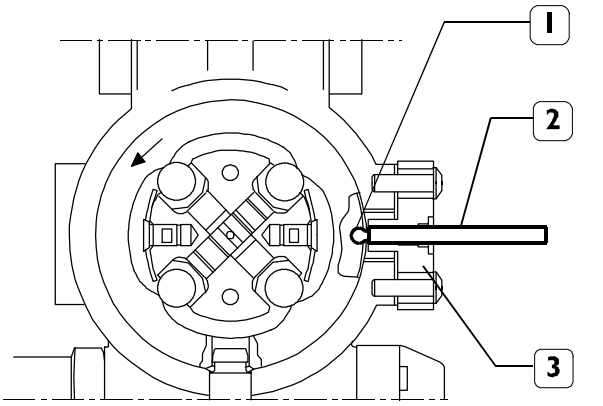
❑ Suitably support the feed pump and unscrew the fastening nuts (1) completely.

❑ Take the pump off the studs together with the gasket.

NOTE Support the pump drive gear to prevent interference or sticking when the timing gears rotate.

Check correct setting of rotating feed pump

Figure 76



1. Slot on hydraulic rotor hub - 2. Synchronisation pin 99365196 - 3. Plate.

The synchronisation pin 99365196 (2) has been designed for use in the event that the rotor shaft has been accidentally released.

The correct pump/engine synchronisation is obtained when synchronisation pin 99365196 (2), inserted into the hole in the plate (3), engages in the slot (1) on the outside of the hydraulic rotor hub.

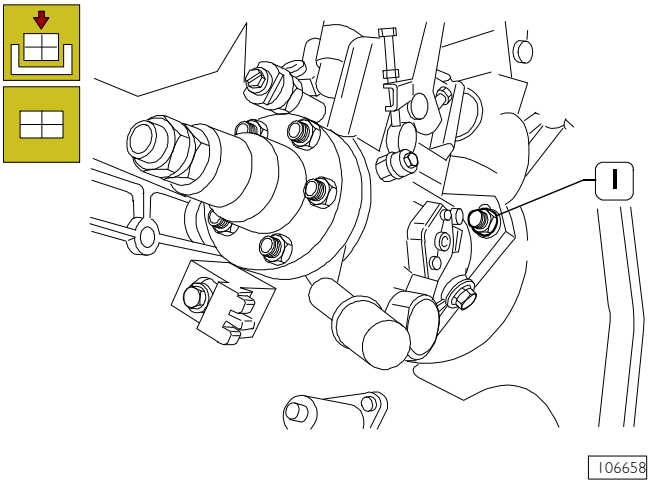
Therefore:

- ❑ Remove the screw plug (3) at the centre of the plate.
- ❑ Insert synchronisation pin (1) 99365196 into the hole in the plate (3). The synchronized position is obtained when the synchronisation pin (2) is inserted in the slot on the hydraulic rotor hub.
- ❑ Lock the drive shaft in the correct position using the screw (1, Figure 73).
- ❑ Remove the synchronisation pin and fit the screw plug of the plate (3). Tighten the plug to a torque of 2.3 ÷ 3.4 Nm.

NOTE Support the pump drive gear to prevent interference or sticking when the timing gears rotate.

Refitting

Figure 77



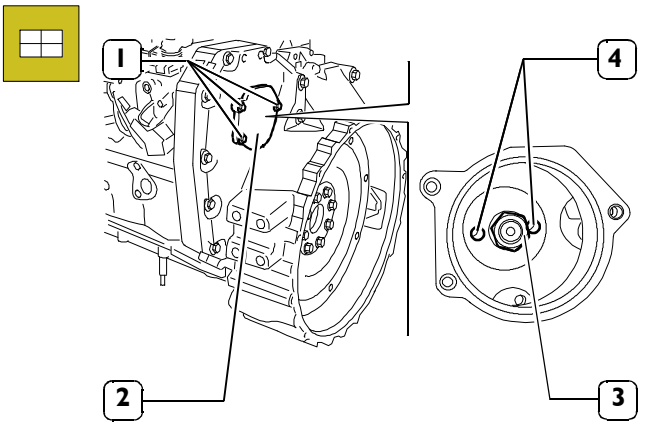
When fitting the feed pump on the engine, the conditions of the T.D.C at the cylinder No. 1 at the end of the compression stroke must be met.

- ❑ Fit the preset pump into its seat on the engine, fitting the shaft into the hole of the gear (without key).
- ❑ Screw the nuts (1) fastening the fuel pump by positioning the flange in the centre slot, then tighten the nuts (1) to the torque specified in the table.

Ref.	N.	Description	Tightening torques
(1)	3	M8x1.25	24 ±4 Nm

NOTE The gasket removed during pump disassembly must not be reused. Always use original spare parts.

Figure 78



75693

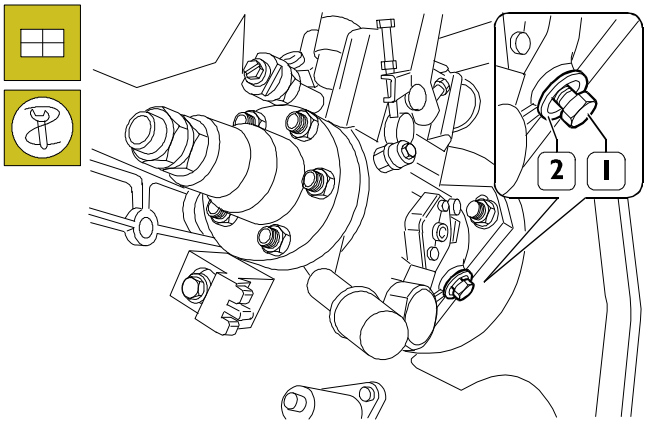
- ❑ On the timing gear side, fit the washer through the specific hole and screw in the nut (3) on the pump spindle, then tighten to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(3)	1	M14x1.5	90 ±5 Nm

- ❑ Fit the cover (2) together with the gasket and screw the two screws (1) and tighten them to the torque indicated in the table

Ref.	N.	Description	Tightening torques
(1)	3	M8x1.25	24 ±4 Nm

Figure 79



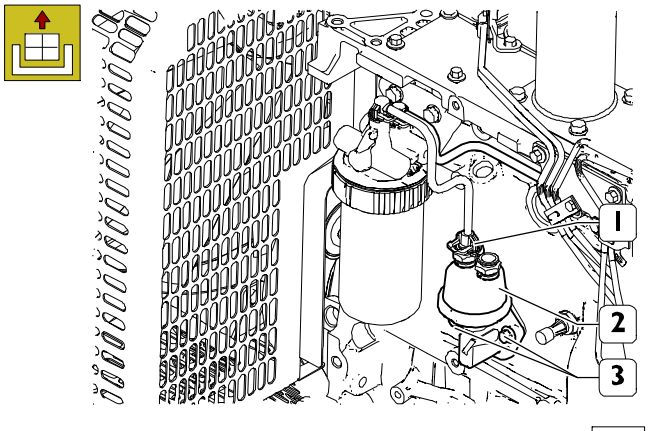
106659

- ❑ Undo but do not remove screw (1) locking the rotation of the pump spindle and move the spacer with slot into the small part of the hole. Snugly tighten the screw to lock the foregoing spacer: in this way, the feed pump spindle is free to rotate.
- ❑ Remove flywheel rotating tool 99360221; place the starter motor in its seat.
- ❑ Connect all the pipes (the pipe from the pumps to the injectors, the leak recovery pipe from the injectors to the pump, and the feed supply pipe from the priming pump).
- ❑ Connect the electrical connections.

PROCEDURE FOR PRIMING PUMP REMOVAL/REFITTING

Removal

Figure 80

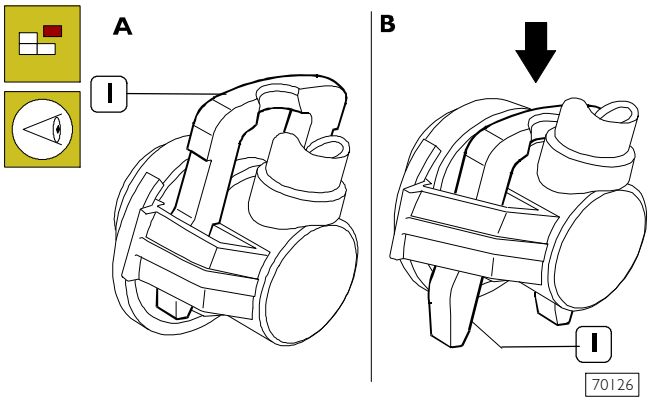


From the priming pump (2), use the clip (1) to disconnect the collection pipe from the priming pump (2) with the fuel filter.

Unscrew the screws (3) and remove the priming pump (2).

Ref.	N.	Description
(3)	2	M8x1.25

Figure 81

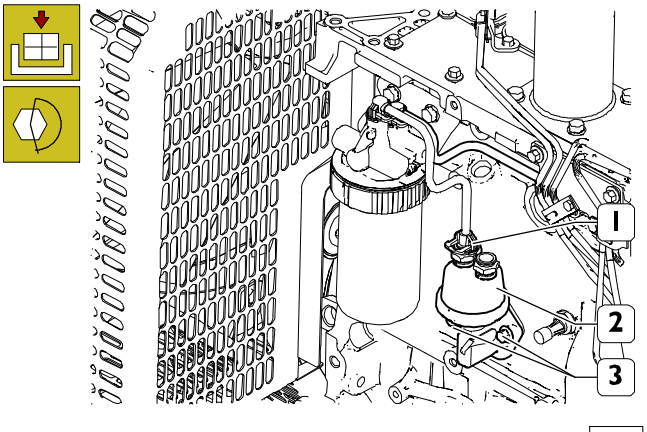


NOTE To disconnect lower pressure fuel pipes from their couplings, press clip (1) as shown in figure **B**.

After disconnecting the pipe, bring the clip (1) back to the locking position in figure **A**, to prevent it from deforming.

Refitting

Figure 82

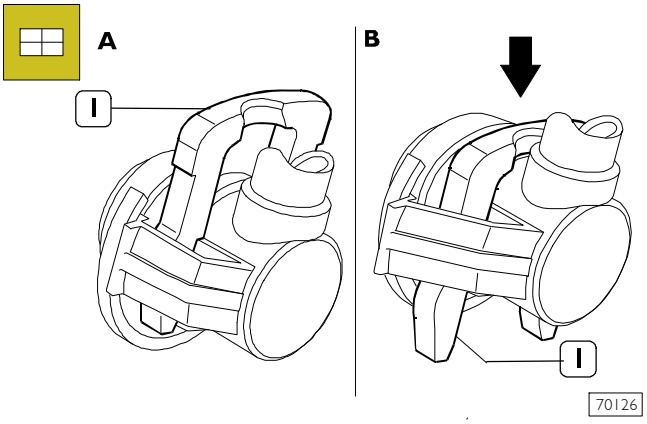


Refit the fuel priming pump (2) together with the new gasket and tighten the screws (3) to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(3)	2	M8x1.25	24 ±4 Nm

Connect the pipe connecting the priming pump with the fuel filter support and lock it with the clip (1).

Figure 83



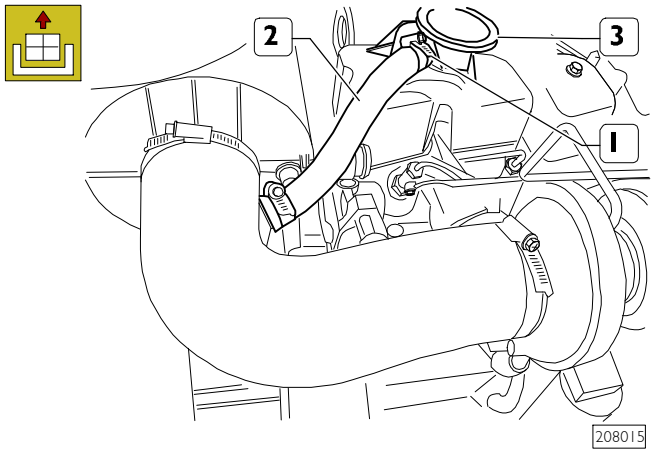
NOTE To connect lower pressure fuel pipes from their couplings, press clip (1) as shown in figure **B**.

After disconnecting the pipe, bring the clip (1) back to the locking position in figure **A**.

BLOW-BY REMOVAL/REFITTING

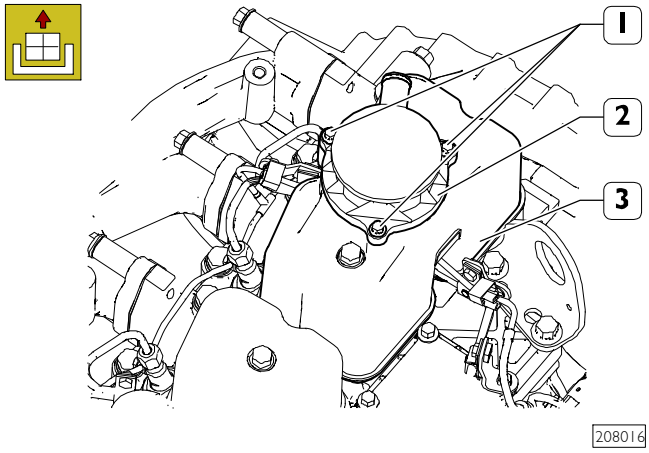
Removal

Figure 84



Loosen the clamp (1) and disconnect the oil vapour recovery pipe (2) from the blow-by unit (3).

Figure 85

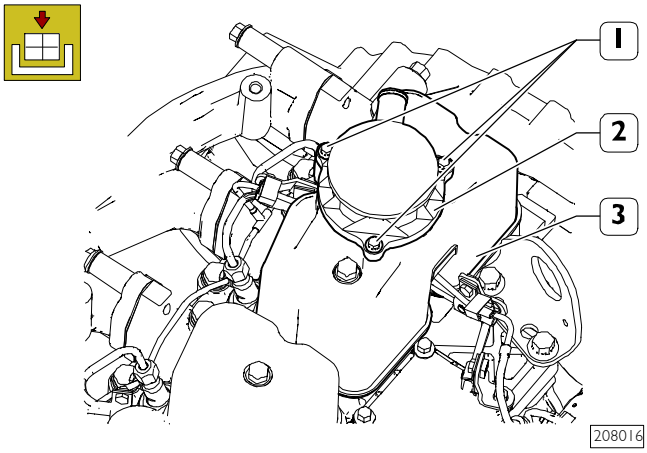


Unscrew the screws (1) and remove the blow-by unit (2) from the tappet cover (3).

Ref.	N.	Description
(1)	3	M6x1x20

Refitting

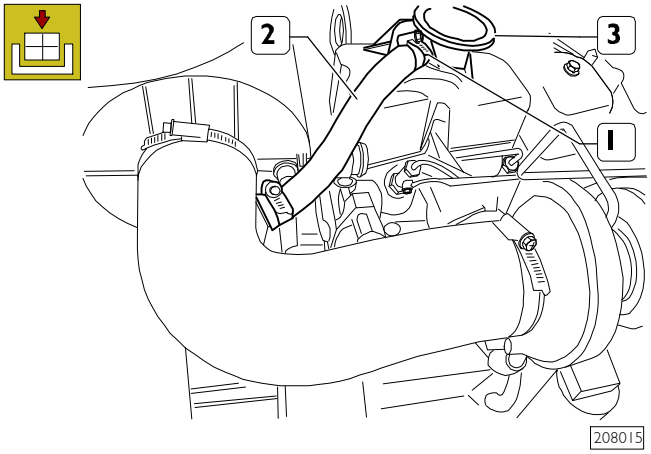
Figure 86



Install the blow-by unit (2) on the tappet cover (3) and tighten the screws (1) to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(1)	3	M6x1x20	10 ±2 Nm

Figure 87

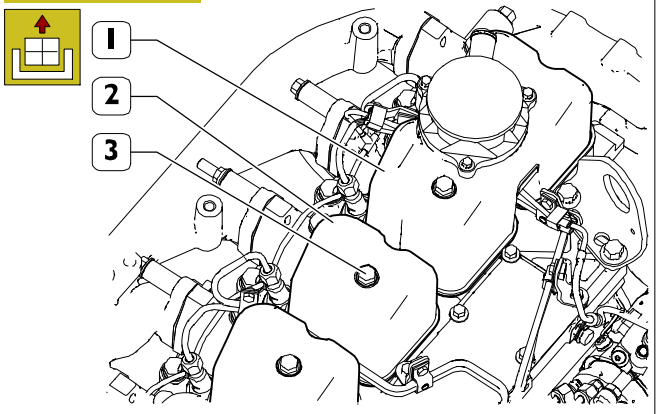


Connect the oil vapour recovery pipe (2) to the blow-by unit (3) and tighten the clamp (1).

TAPPET COVER REMOVAL-REFITTING

Removal

Figure 88



Unscrew the screw (3) and remove the tappet cover (2) with its gaskets.

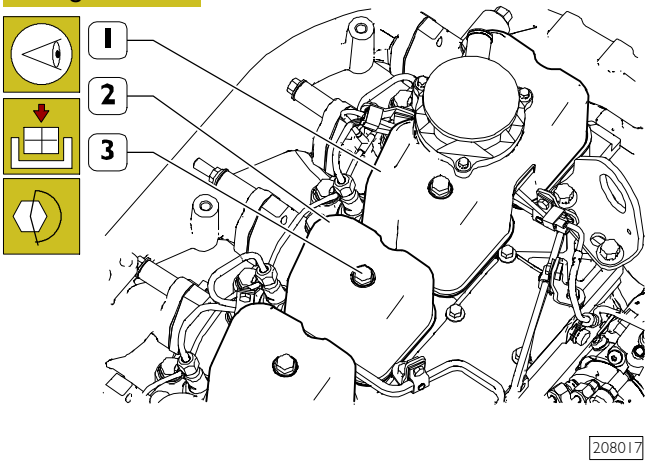
Ref.	N.	Description
(3)	-	M8x1.25

Before removing the tappet cover (1) of cylinders 5-6, it is necessary to remove the pipe connecting the air filter to the blow-by filter.

If replacing the cover (1), remove the blow-by filter from the cover by following the operations described in the procedure "BLOW-BY REMOVAL - REFITTING".

Refitting

Figure 89



NOTE Always put in new gaskets. Check the threading of the fastening screws: there should be no signs of wear or build-up of dirt.

The seal plugs must not show any deformations. Otherwise, replace with new parts.

Fit the tappet covers (1) and (2) with their respective gaskets.

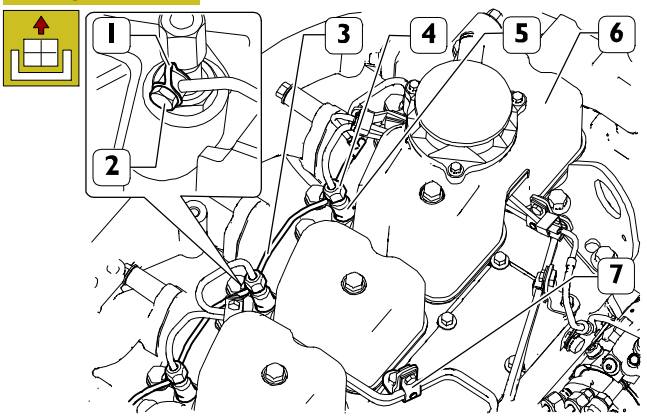
Insert the sealing plugs, then tighten the fastening screws (3) for the tappet covers (1) and (2) to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(3)	-	M8x1.25	24 ±4 Nm

INJECTOR REMOVAL - REFITTING

Removal

Figure 90



208019

Unscrew the unions (4) and remove the fuel pipes (5) from the injectors.

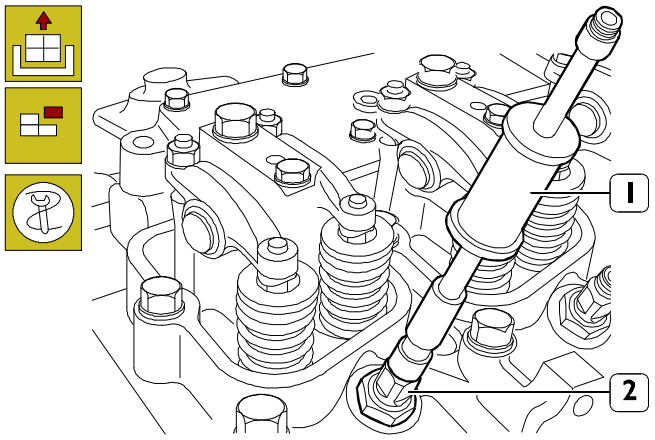
Ref.	N.	Description
(4)	6	M14x1.5

Remove the screws (2) and gaskets (1) to remove the fuel exhaust pipes (3) from the injectors (5).

Ref.	N.	Description
(2)	6	-

NOTE To facilitate access to the injectors (5), remove the clamps (7) retaining the fuel pipes and if necessary, the tappet cover (6) for cylinders 5-6 as described in the procedure "TAPPET COVER REMOVAL - REFITTING".

Figure 91



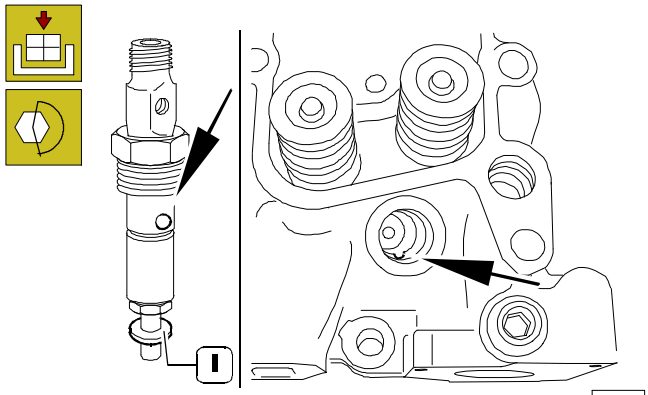
84082

❑ Unscrew and remove the injectors (2), using tool 99340205 (1), and extract them from the cylinder head.

Ref.	N.	Description
(4)	6	M24x1.5

Refitting

Figure 92



75707

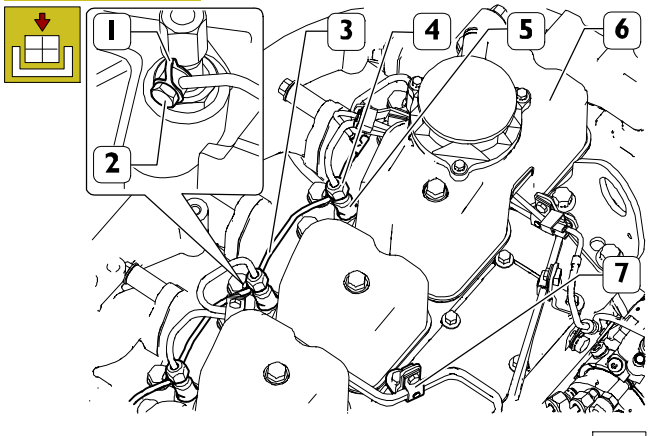
NOTE If compression in the cylinders is to be checked, using tool 99360344, leave the injector disassembled and carry out the procedure described in the section "Procedure for checking compression in the cylinders using tool 99360344" Section 6.

❑ Insert new gaskets (1) and fit the injectors into the cylinder heads, tightening them to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(-)	6	M24x1.5	44 ±4 Nm

NOTE While carrying out injector assembly operations, check that the ball on the injector is at the engine head seat.

Figure 93



208019

Install the fuel exhaust pipes (3) on the injectors (5) and fix them to the injector using the screws (2) with the new gaskets (1).

Ref.	N.	Description	Tightening torques
(2)	6	-	-

Screw the couplings (4) to refit the fuel pipes going from the injectors (5).

Ref.	N.	Description	Tightening torques
(4)	6	M14x1.5	37 ±3 Nm

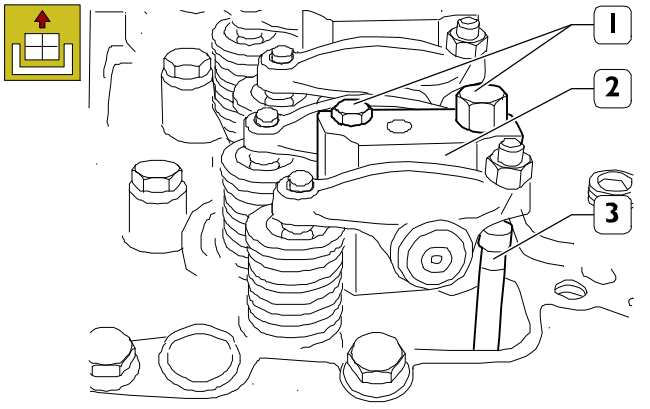
Fit the clamps (7) retaining the fuel pipes and if necessary, the tappet cover (6) for cylinders 5-6 as described in the procedure "TAPPET COVER REMOVAL - REFITTING".

ROCKER ARM ASSEMBLY REMOVAL-REFITTING

Remove the tappet covers as described in the procedure "TAPPET COVER REMOVAL - REFITTING".

Removal

Figure 94



208020

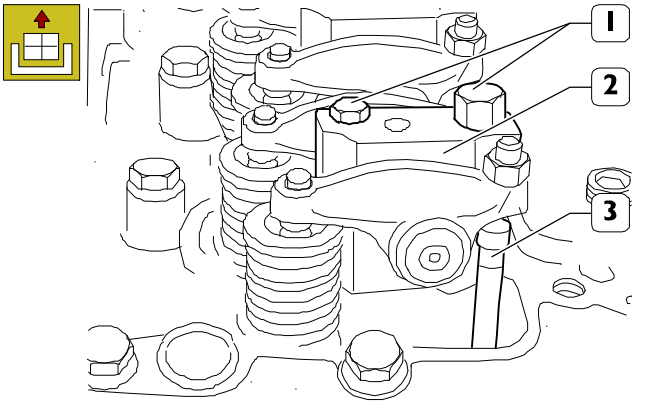
unscrew the fastening screws (1) and disassemble the mount (2) together with the rocker arms; remove the push rods (3).

Ref.	N.	Description
(1)	6	M8x1.25
(1)	6	M12x1.75x180

Repeat the operation for the remaining rocker arm mounts.

Refitting

Figure 95



208020

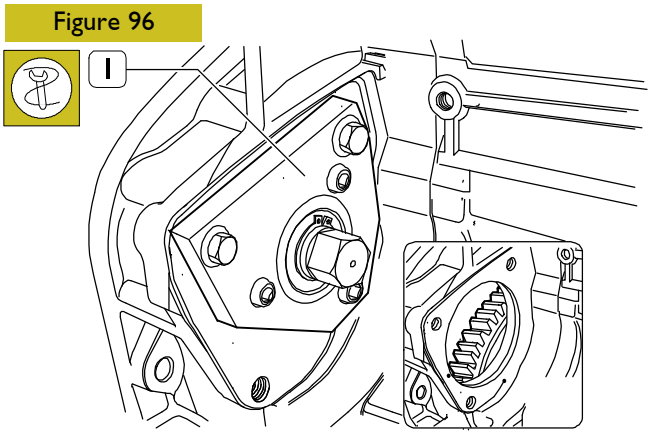
Place the push rods (3) in their seats.

Fit the mount (2) together with the rocker arms on the cylinder head and tighten the screws (1) to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(1)	6	M8x1.25	24 ±3 Nm
(1)	6	M12x1.75x180 1st phase 2nd phase 3rd phase	70±5 Nm 90° 90°

Setting rocker free play

Figure 96



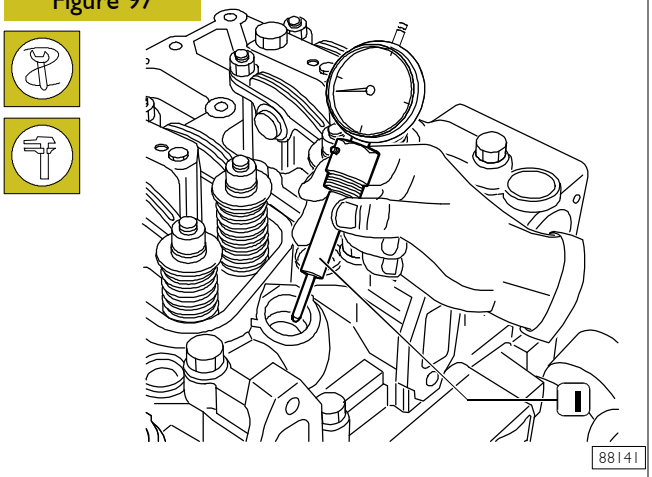
200502

Remove the starter motor as described in the procedure "STARTER MOTOR REMOVAL - REFITTING".

❑ Fit tool 99360221 (1) to rotate the flywheel with the help of a wrench.

Identifying top dead centre with tool (99395097) □ False injector

Figure 97

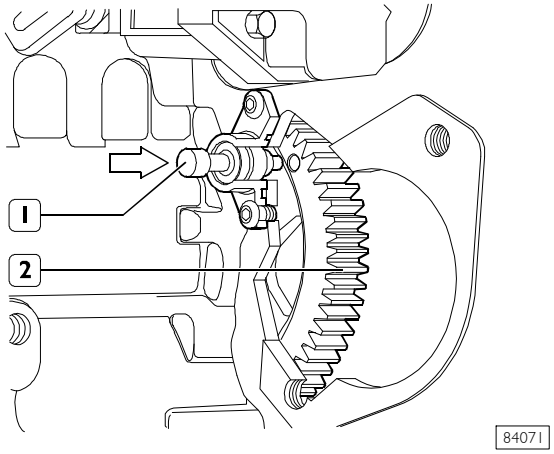


To identify the 1° cylinder top dead centre position at the end of the compression stroke, remove the rocker arm cover of the 1° cylinder, remove the 1° injector and position tool 99395097 (1). Pre-load the dial gauge 99395604.

The required condition is obtained by turning the crankshaft appropriately until the maximum value appears on the dial gauge and making sure that the intake and exhaust valves are both closed.

Identifying top dead centre at end of compression stroke for first cylinder using timing system lock pin (99360616)

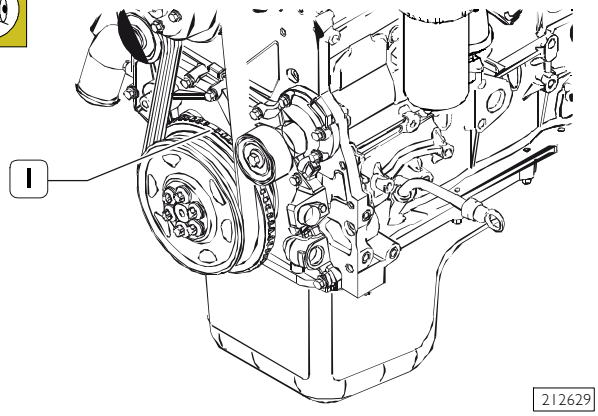
Figure 98



Identifying the 1st cylinder top dead centre position at the end of the compression stroke:

- ❑ remove the cylinder rocker arm cover;
- ❑ turn the flywheel until, when pressing lock pin 99360616 (1), the pin does not lock the gear (2);
- ❑ make sure that the intake and exhaust valves of the 1st cylinder are both closed and not balanced

Figure 99

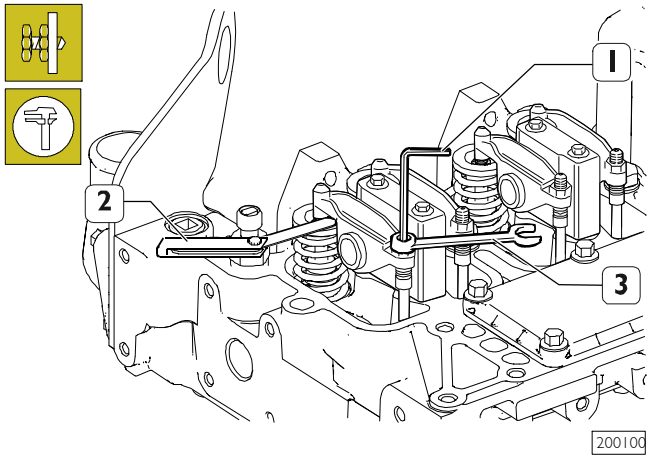


- ❑ Also make sure that the non-drilled part (1) of the tone wheel is positioned at the top along its vertical axis (condition with cylinder n.1 at TDC) and the valves of cylinder n. 6 are balanced. If cylinder n.1 is balanced, turn the engine by 1 revolution to bring it into the required condition.
- ❑ Adjust the 1st cylinder valve clearance as indicated in the relative paragraph.
- ❑ At this point, appropriately turn the crankshaft as shown in the Table to adjust the rocker arm clearance of the other cylinders.

FIRING ORDER: 1 - 5 - 3 - 6 - 2 - 4

Start and rotation crankshaft	Rocker arm clearance adjustment intake and exhaust valves - cylinder n°
Cyl n.1 at TDC	1
Turn 120°	5
Turn 120°	3
Turn 120°	6
Turn 120°	2
Turn 120°	4

Figure 100



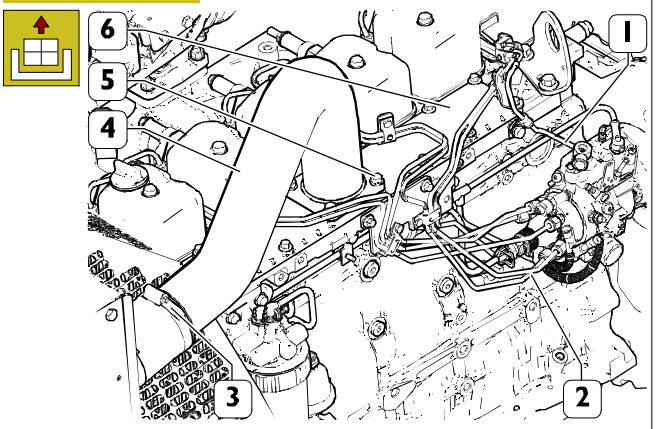
Adjust the clearance between the rocker arms and valves using an Allen wrench (1), a box wrench (3) and feeler gauge (2). The clearance is:

- intake valve 0.25 ± 0.05 mm
- exhaust valves 0.50 ± 0.05 mm.

INTAKE MANIFOLD REMOVAL/REFITTING

Removal

Figure 101



Remove the low pressure pipe (1) as described in the procedure "LOW PRESSURE PIPE REMOVAL - REFITTING".

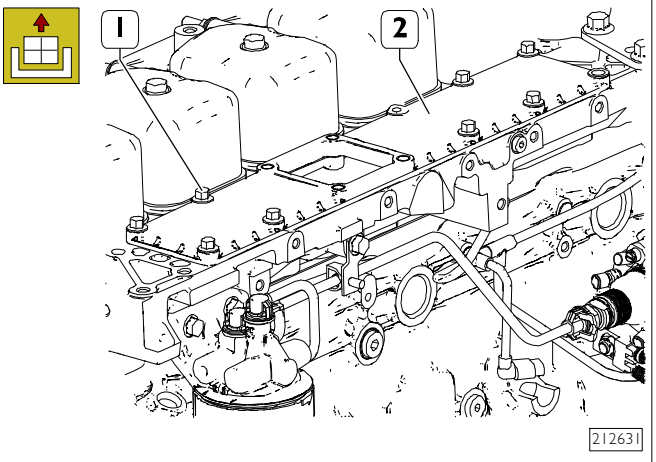
Remove the high pressure pipe (2) as described in the procedure "HIGH PRESSURE PIPE REMOVAL - REFITTING".

Loosen the clamp (3) of the pipe (4) connecting the intercooler to the intake manifold.

Unscrew the screws (5) that fasten the pipe (4) and remove it from the intake manifold (6).

Ref.	N.	Description
(5)	4	M8x1.25

Figure 102

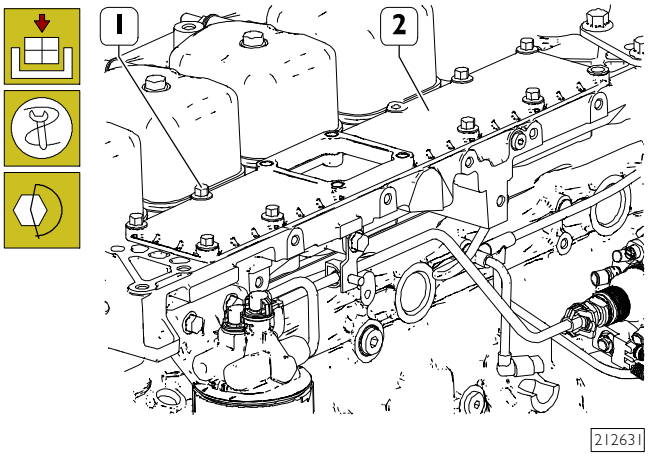


Unscrew the screws (1) fastening the intake manifold (2) and remove it from the cylinder head.

Ref.	N.	Description
(1)	10	M8x1.25

Refitting

Figure 103



NOTE Check the correct positioning of the intake manifold (2); The shortest part, with regard to fitting the pipe coming from the intercooler, should be facing the front part of the engine.

Apply a sufficient layer of LOCTITE 5999 on the mating surface of the intake manifold (2).

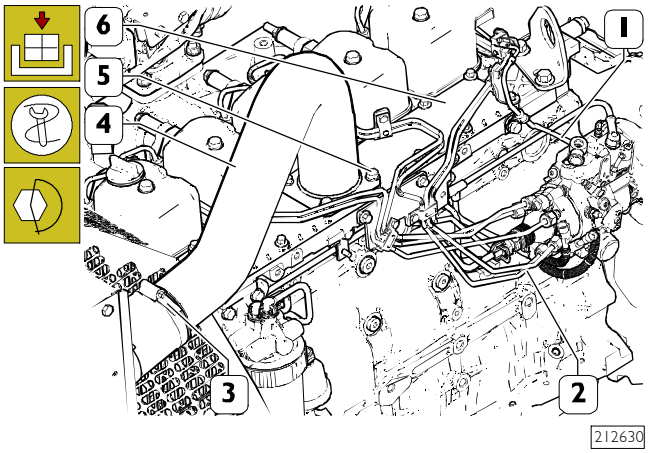
Fit the intake manifold (2) on the cylinder head.

NOTE Do not tighten the two screws used to fasten the fuel pipe support brackets.

Screw the screws (1) and tighten them to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(1)	10	M8x1.25	24 Nm

Figure 104



Fit the pipe (4) connecting the intercooler to the intake manifold (6) and tighten the screws (5) to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(5)	4	M8x1.25	24 Nm

Tighten the clamp (3) of the pipe sleeve (4).

Refit the high pressure pipe (2) as described in the procedure "HIGH PRESSURE PIPE REMOVAL - REFITTING".

Refit the low pressure pipe (1) as described in the procedure "LOW PRESSURE PIPE REMOVAL - REFITTING".

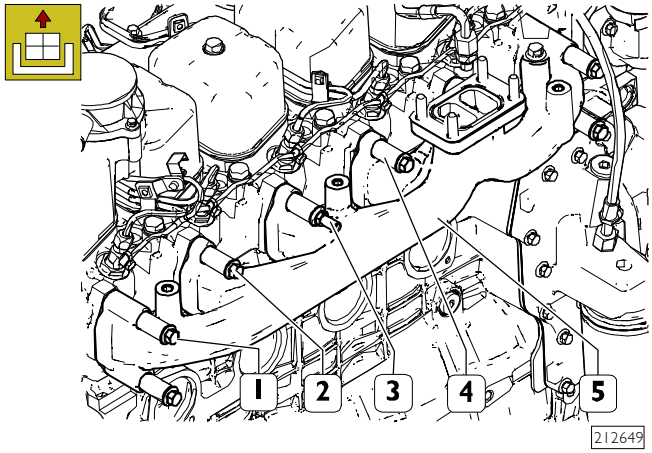
Bleed the feed circuit as described in the relative paragraph.

EXHAUST MANIFOLD REMOVAL/REFITTING

Removal

Remove the turbocharger as described in the procedure "TURBOCHARGER REMOVAL - REFITTING".

Figure 105

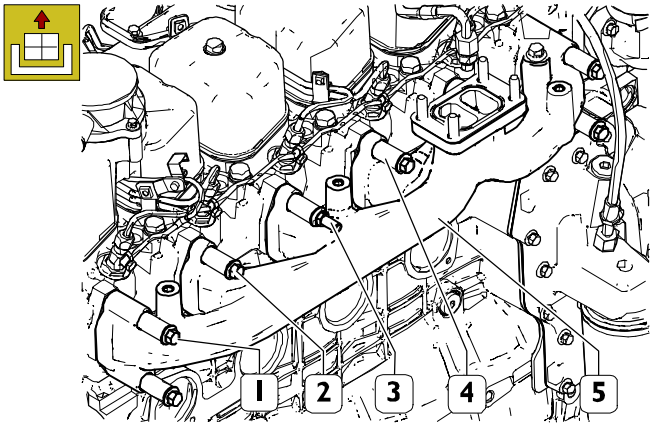


Unscrew the screws (1), (2) and (3) and remove the exhaust manifold (5). Recover the spacers (4).

Ref.	N.	Description
(1)	4	M8x1.5x95
(2)	6	M10x1.5x65
(3)	2	M8x1.5x65 (with threaded extension)

Refitting

Figure 106



Fit the intake manifold (5) on the cylinder head with the new gaskets.

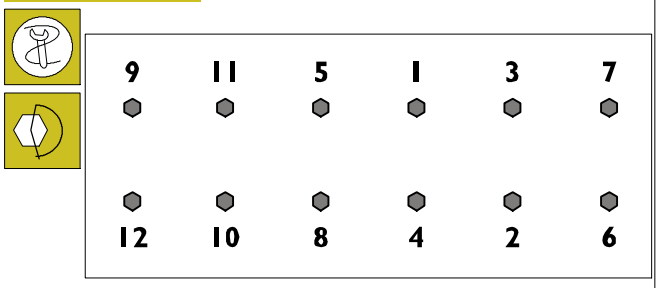
NOTE Always put in new gaskets.

NOTE There are three types fastening screws for the intake manifold:

Ref.	N.	Description
(1)	4	M8x1.5x95
(2)	6	M10x1.5x65
(3)	2	M8x1.5x65 (with threaded extension)

Insert the spacers (4) in the screws (1), (2) and (3) and screw them without tightening.

Figure 107



212651

Tighten the screws in the order shown in the diagram to the torque indicated in the table.

Ref.	N.	Description	Tightening torques
(6-7-9-12)	-	M8x1.5x95	55 ±3 Nm
(1-2-3-4-10-11)	-	M10x1.5x65	55 ±3 Nm
(5-8)	-	M8x1.5x65 (with threaded extension)	55 ±3 Nm

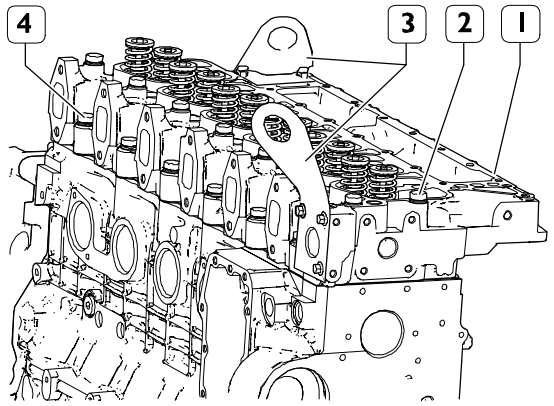
Refit the turbocharger as described in the procedure "TURBOCHARGER REMOVAL - REFITTING".

CYLINDER HEAD REMOVAL/REFITTING

Cylinder head removal

- ❑ Remove the radiator assembly as described in the procedure "RADIATOR ASSEMBLY REMOVAL - REFITTING" - Section 5.
- ❑ Remove the fan as described in the procedure "FAN REMOVAL - REFITTING" - Section 5.
- ❑ Remove the automatic belt tensioner and the fan pulley as described in the procedure "AUTOMATIC BELT TENSIONER-GUIDE PULLEY AND FAN PULLEY REMOVAL" - Section 6.
- ❑ Remove the fan mounts and the automatic belt tensioner as described in the procedure "FAN MOUNT AND AUTOMATIC BELT TENSIONER REMOVAL" - Section 6.
- ❑ Remove the low pressure pipe, only from the injector side, as described in the procedure "LOW PRESSURE PIPE REMOVAL - REFITTING" - Section 5.
- ❑ Remove the fuel filter support as described in the procedure "FUEL FILTER SUPPORT REMOVAL - REFITTING" - Section 5.
- ❑ Remove the high pressure pipe (5) as described in the procedure "HIGH PRESSURE FUEL PIPE REMOVAL - REFITTING".
- ❑ Remove the injectors as described in the procedure "INJECTOR REMOVAL - REFITTING" - Section 5.
- ❑ Remove the rocker arm assembly as described in the procedure "ROCKER ARM ASSEMBLY REMOVAL - REFITTING" - Section 5.
- ❑ Remove the intake manifold as described in the procedure "INTAKE MANIFOLD REMOVAL - REFITTING" - Section 5.
- ❑ Remove the thermostat as described in the procedure "THERMOSTAT REMOVAL - REFITTING" - Section 5.
- ❑ Remove the exhaust manifold as described in the procedure "EXHAUST MANIFOLD REMOVAL - REFITTING" - Section 5.

Figure 108



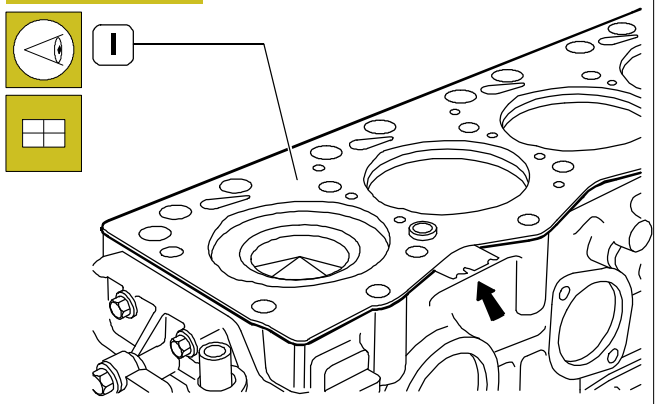
212623

Unscrew the cylinder head (1) fastening screws (2) Hook brackets (3) with metal ropes and with the aid of a hoister detach cylinder heads from the base.

Ref.	No.	Description
(4)	6	M12x70
(2)	7	M12x140
(2)	7	M12x180

Installing cylinder head

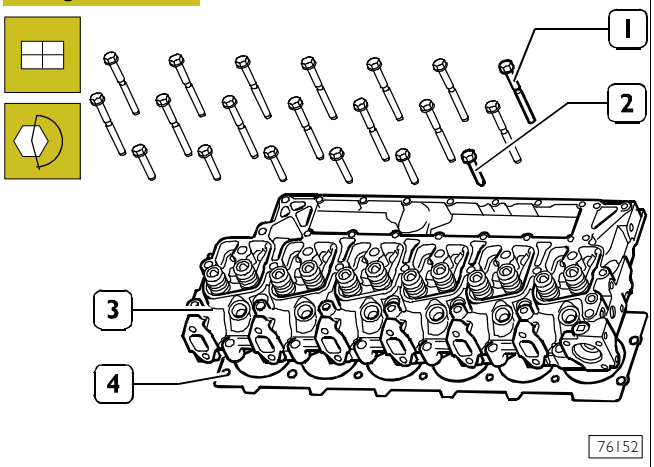
Figure 109



87759

Check that the mating surfaces of the cylinder head and crankcase are clean.
Keep the cylinder head gasket clean.
Position the cylinder head gasket (1) with the marking "ALTO" (1) facing the head.
The arrow shows the point where the gasket thickness is given.
The thickness of the gasket must be chosen according to the detected protrusion of the piston from the upper surface of the crankcase.

Figure 111

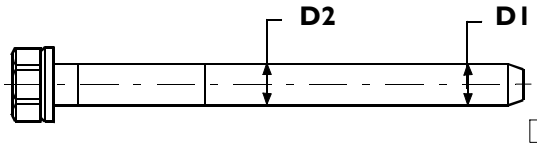


76152

NOTE Before re-using the retaining screws (1) and (2), measure the diameters D1 and D2 twice as shown in the figure:

if D1 - D2 < 0.1 mm the screw can be reused

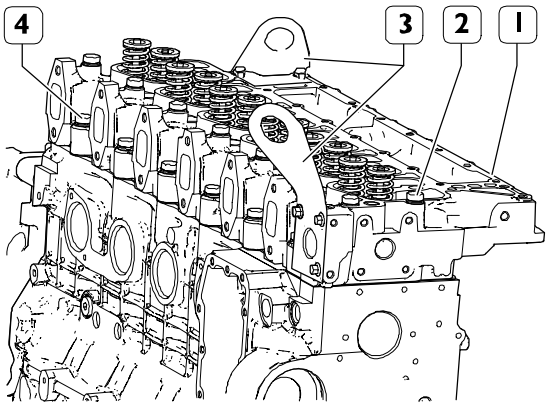
if D1 - D2 > 0.1mm the screw must be replaced



75703

Using a hoister, position the cylinder head (3) on the crankcase, being careful not to damage the gasket (4).

Figure 110

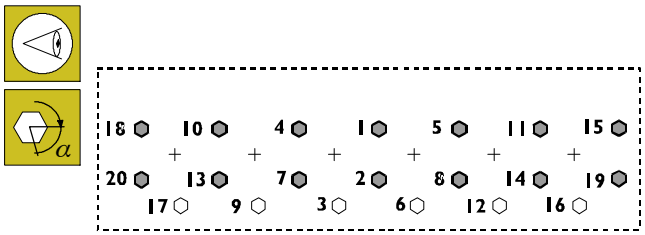


212623

Unhook the wire ropes from the lifting eyelets (3).

Screw the screws (2) and (4) fixing the cylinder head (1) in the same position found at removal, and tighten them to the torque values indicated in the table, in the sequence shown in the next figure.

Figure 112



76214

Ref.	No.	Description		Tightening torque
(4)	6	M12x70	1st step	50 Nm 90°
(2)	7	M12x140	1st phase 2nd phase	40 Nm 90° 90°
(2)	7	M12x180	1st phase 2nd phase	70 Nm 90° 90°

- ❑ Refit the exhaust manifold as described in the procedure "EXHAUST MANIFOLD REMOVAL - REFITTING" - Section 5.
- ❑ Refit the thermostat as described in the procedure "THERMOSTAT REMOVAL - REFITTING" - Section 5.
- ❑ Refit the intake manifold as described in the procedure "INTAKE MANIFOLD REMOVAL - REFITTING" - Section 5.
- ❑ Refit the rocker arm assembly as described in the procedure "ROCKER ARM ASSEMBLY REMOVAL - REFITTING" - Section 5.
- ❑ Refit the injectors as described in the procedure "INJECTOR REMOVAL - REFITTING" - Section 5.
- ❑ Refit the high pressure pipe (5) as described in the procedure "HIGH PRESSURE FUEL PIPE REMOVAL - REFITTING".
- ❑ Refit the fuel filter support as described in the procedure "FUEL FILTER SUPPORT REMOVAL - REFITTING" - Section 5.
- ❑ Refit the low pressure pipe, only from the injector side, as described in the procedure "LOW PRESSURE PIPE REMOVAL - REFITTING" - Section 5.
- ❑ Refit the fan mounts and the automatic belt tensioner as described in the procedure "Fan mount and automatic belt tensioner refitting" - Section 6.
- ❑ Refit the automatic belt tensioner and the fan pulley as described in the procedure "Automatic belt tensioned--guide pulley and fan pulley refitting" - Section 6.
- ❑ Refit the fan as described in the procedure "FAN REMOVAL - REFITTING" - Section 5.
- ❑ Refit the radiator assembly as described in the procedure "RADIATOR ASSEMBLY REMOVAL - REFITTING" - Section 5.

FITTING THE ENGINE ON THE ROTATING STAND

Preliminary operations

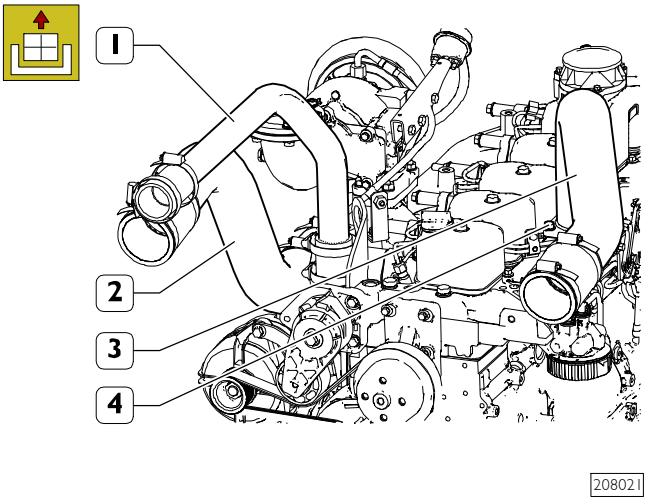
Remove the radiator assembly as described in the procedure "RADIATOR ASSEMBLY REMOVAL - REFITTING" - Section 5.

Remove the fan as described in the procedure "FAN REMOVAL - REFITTING" - Section 5.

Remove the air filter as described in the procedure "AIR FILTER REMOVAL - REFITTING" - Section 5.

Removal of radiator assembly pipes from engine

Figure 1



208021

Loosen the clamp and remove the coolant pipe (1) from the engine.

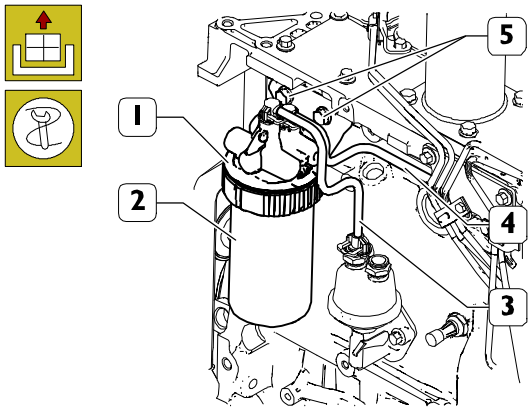
Loosen the clamp and remove the pipe (2) connecting the turbocharger to the intercooler.

Remove the screws (4) fixing the pipe (3) connecting the intercooler to the intake manifold and remove it from the engine.

Ref.	No.	Description
(4)	4	M8x1.25

Removal of fuel filter and support

Figure 2



214917

Place a suitable container under the diesel filter and unscrew the condensate bleed cock, positioned under the filter itself, to completely drain the diesel inside.

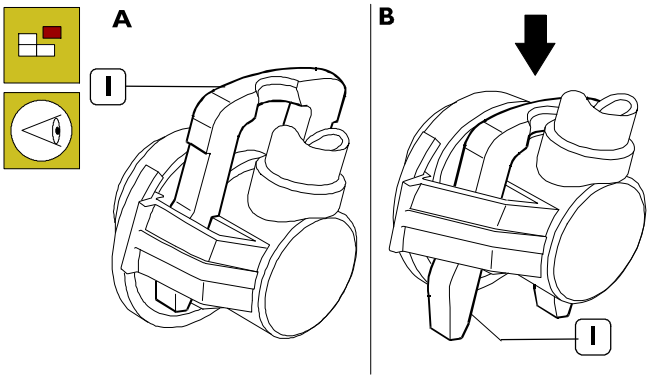
Using tool 99360076, unscrew the fuel filter (2) from the support (1) and remove it.

Disconnect the fuel pipes (3 and 4) respectively from the priming pump to the filter support, and from this one to the feed pump.

Unscrew the fastening screws (5) and remove the support (1) from the cylinder head.

Ref.	No.	Description
(5)	2	M10x1.5

Figure 3



70126

NOTE To disconnect lower pressure fuel pipes from their couplings, press clip (1) as shown in figure B.

After disconnecting the pipe, bring the clip (1) back to the locking position in figure A, to prevent it from deforming.

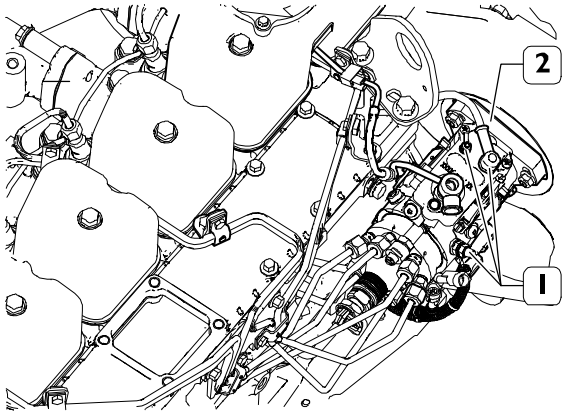
Removal of fuel pipes

Remove the low pressure pipe (5) as described in the procedure "LOW PRESSURE FUEL PIPE REMOVAL - REFITTING".

Remove the high pressure pipe (5) as described in the procedure "HIGH PRESSURE FUEL PIPE REMOVAL - REFITTING".

Removal of electrical connections

Figure 4

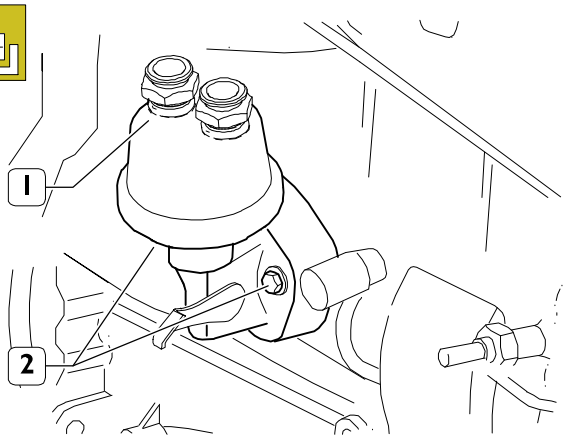


214918

Disconnect the electrical connections (1) from the fuel pump (2).

Priming pump removal

Figure 5



212625

Remove screws (2) and disconnect the priming pump (1) from the crankcase.

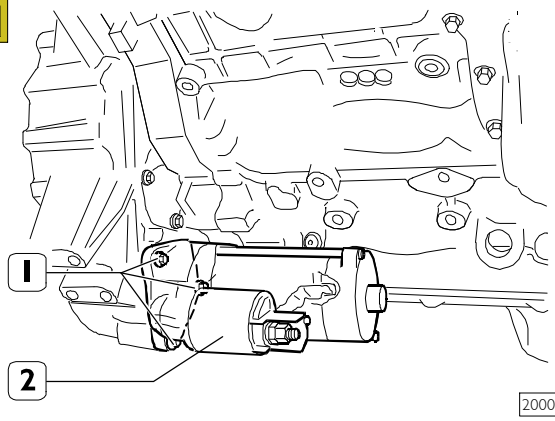
Ref.	No.	Description
(2)	2	M8x1.25

Removal of components hindering bracket assembly

Removal of starter motor

Disconnect the electrical connections of the starter motor.

Figure 6



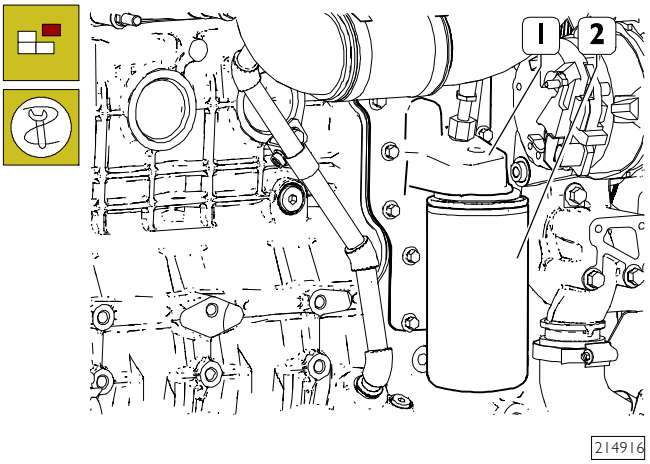
200081

Unscrew the screws (1) and remove the starter (2).

Ref.	No.	Description
(1)	3	M10x1.5

Removal of oil filter

Figure 7



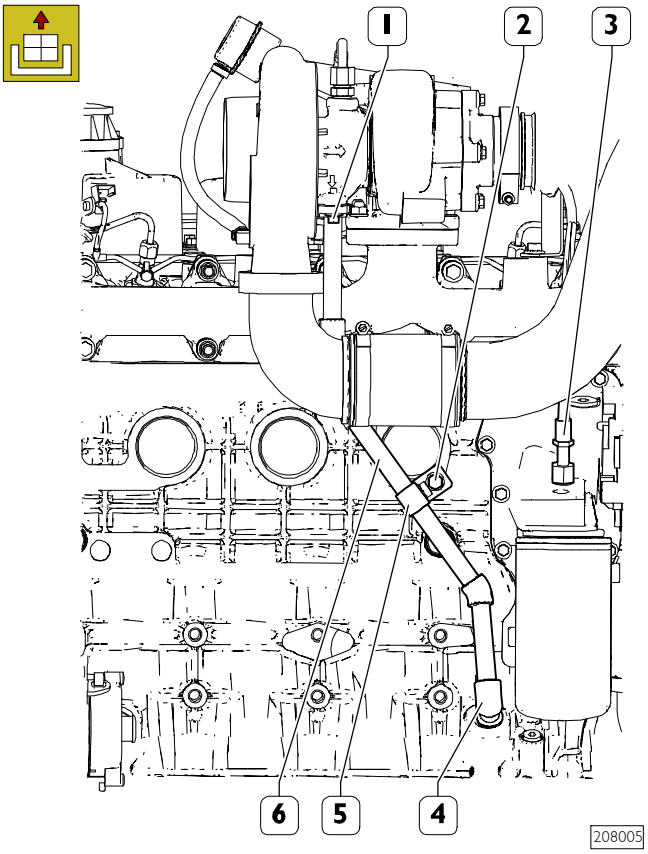
❑ Using tool 99360076, remove the oil filter (2) and its gasket (2), unscrewing it from the support (1).

Attention, the oil filter contains approximately 1 kg of engine oil.

Collect and dispose of the engine oil according to applicable laws.

Removal of turbocharger and turbocharger lubrication pipes

Figure 8



❑ Remove the lubrication oil discharge pipe (6) from the turbocharger by proceeding as follows:

❑ Unscrew the two screws (1) in the lower part of the turbocharger;

Ref.	No.	Description
(1)	2	M8x1.25

❑ Unscrew the screws (2) that retain the piping (6) to the block by means of the fastening collar (5);

Ref.	No.	Description
(2)	1	M8x1.25x16

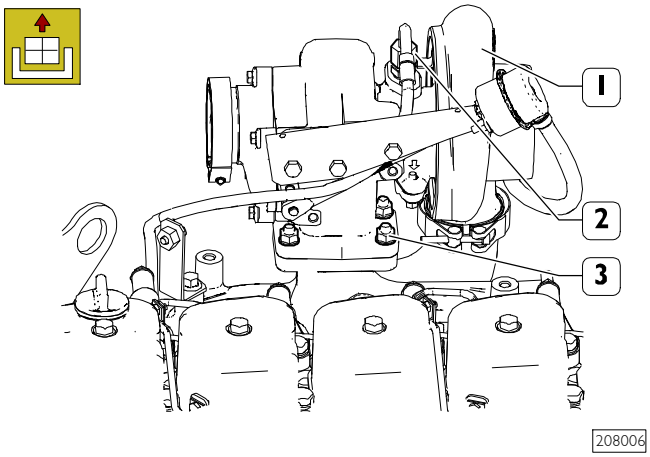
❑ Remove the coupling (4) from the block;

❑ Plug the ends of the pipes and the exhaust valve of the turbocharger.

Unscrew the fitting and disconnect the lubrication pipe (3) from the upper part of the heat exchanger.

Ref.	No.	Description
(3)	1	M16

Figure 9



Unscrew the fitting (2) and disconnect the lubricant pipe from the turbocharger (1).

Ref.	No.	Description
(2)	1	M16

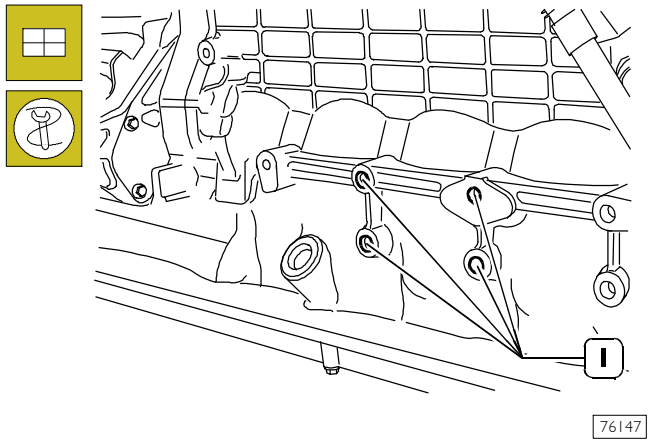
Remove the nuts (3) fastening the turbocharger (1) to the exhaust manifold.

Ref.	No.	Description
(3)	4	M10x1.5

Remove the turbocharger (1) and recover its gasket.

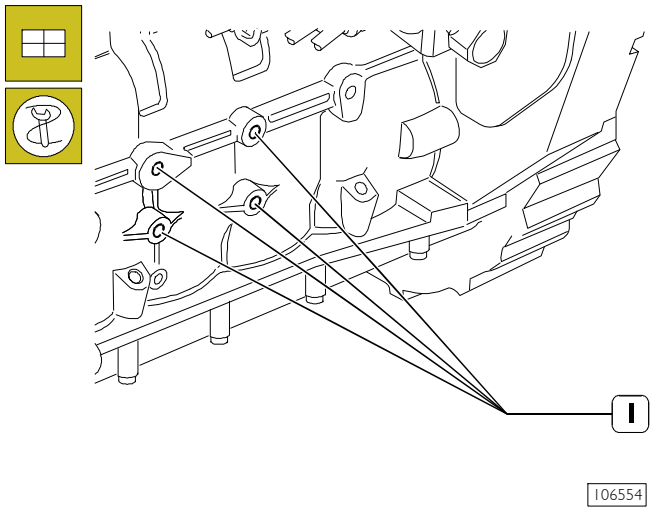
Fitting the engine on the rotating stand

Figure 10



❑ fit the support bracket 99361037 using the four threaded holes (1).

Figure 11

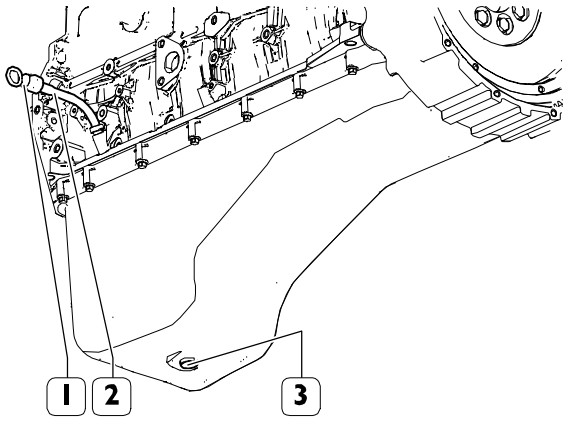


❑ connect the second bracket 99361037 using the threaded holes (1).

❑ Lift the engine with arm 99360595 and put it on the rotating stand 99322205.

Engine lubricant oil drainage

Figure 12



208022

Withdraw oil dipstick (1).

Unscrew the guide tube (2) and remove it from the block; plug the threaded hole to prevent the entrance of foreign bodies.

Refer to Section 1 "General Information"- for information on the quantity of oil in the oil sump

Collect and dispose of the engine oil according to applicable laws.

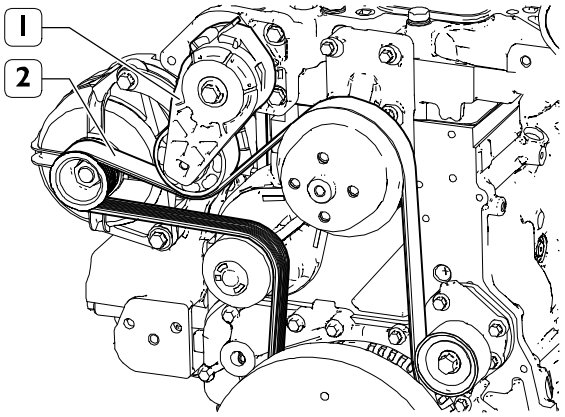
Drain the oil through the plug (3) located below the oil sump.

Ref.	No.	Description
(3)	1	M22x1.5

DISASSEMBLY OF ENGINE AT BENCH (COMPONENTS ON THE FRONT - PART 1)

Removal of auxiliary device drive belts

Figure 13

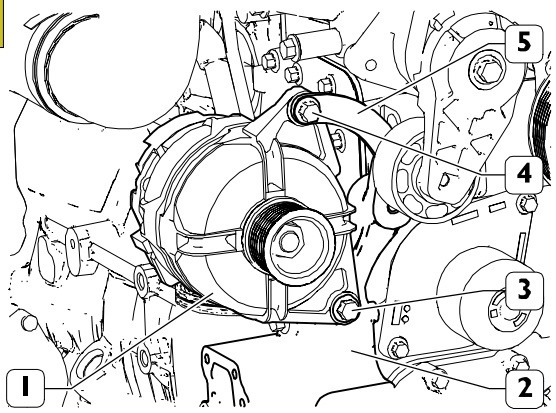


208023

Act on the automatic belt tensioner (1) and remove the auxiliary device drive belt (2).

Alternator removal

Figure 14



208001

Unscrew the screw (3) fixing the alternator (1) to the support (2) and the screw (4) from the bracket (5).

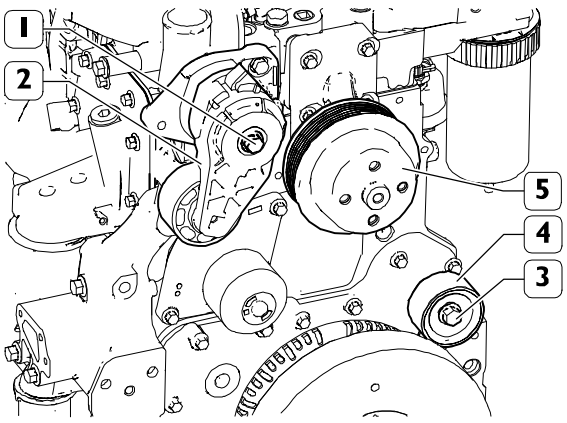
Remove the alternator (1) from the support (2).

Ref.	No.	Description
(3)	1	M10x1.5
(4)	1	M10x1.5

Unscrew the fastening screws and remove the bracket (5) from the alternator support.

Removal of automatic belt tensioner - fan pulley and fan control pulley

Figure 15



Undo the screw (1) and remove the automatic belt tensioner (2).

Ref.	No.	Description
(1)	1	M10x1.5x80

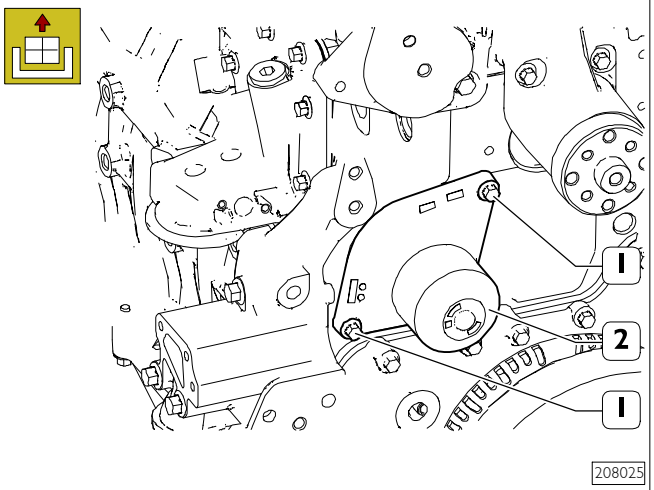
Unscrew the screw (3) and remove the guide pulley (4).

Ref.	No.	Description
(3)	1	M10x1.5

Remove the fan control pulley (5) from the support.

Removal of water pump

Figure 16

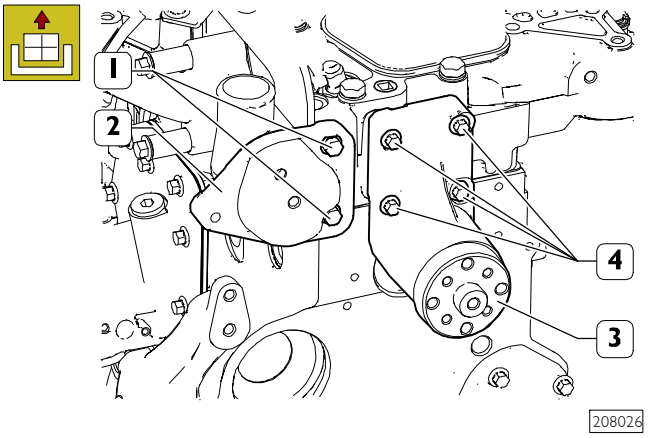


Unscrew the screws (1) and remove the water pump (2).

Ref.	No.	Description
(1)	2	M8x1.25

Removal of fan mounts and automatic belt tensioner

Figure 17



Unscrew the screws (4) and remove the fan mount (3).

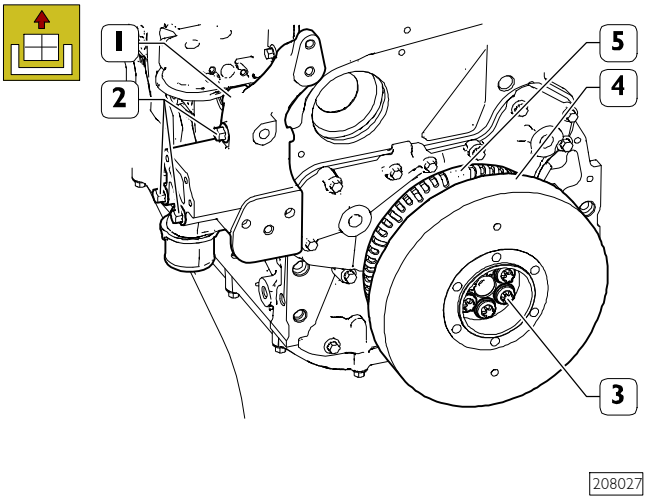
Ref.	No.	Description
(4)	4	M8x1.25

Unscrew the screws (1) and remove the automatic belt tensioner support (2).

Ref.	No.	Description
(1)	2	M8x1.25

Removal of alternator support - damper and crankshaft pulley

Figure 18



Unscrew the screws (2) and remove the alternator mount (1).

Ref.	No.	Description
(2)	2	M10x1.5x135
(2)	1	M10x1.5x70

Unscrew the screws (3) and pull out the damper (4) and the pulley (5) from the crank shaft.

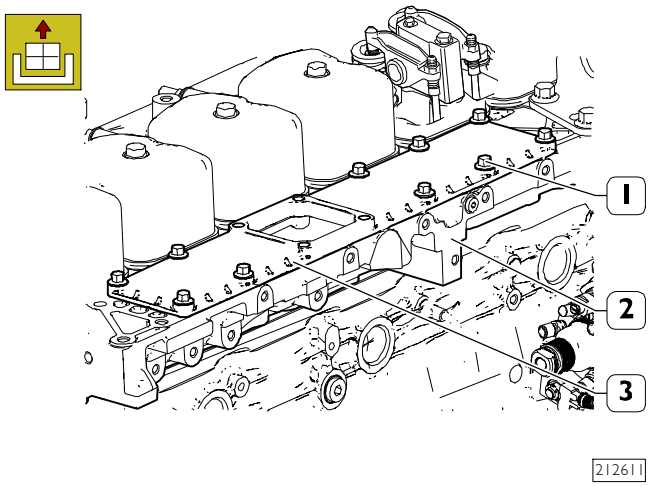
Ref.	No.	Description
(3)	6	M12x1.25

Recover the spacers between the pulley and the crankshaft.

DISASSEMBLY OF ENGINE AT BENCH (COMPONENTS AT THE TOP - PART 1)

Intake manifold removal

Figure 19

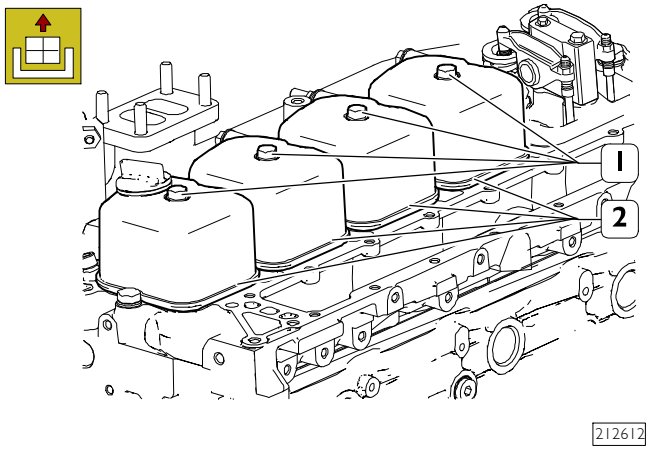


Unscrew the screws (1) fastening the intake manifold (3) and remove it from the cylinder head (2).

Ref.	No.	Description
(1)	10	M8x1.25x25

Tappet cover removal

Figure 20



Unscrew the screw (1) and remove the tappet cover (2) with its gaskets.

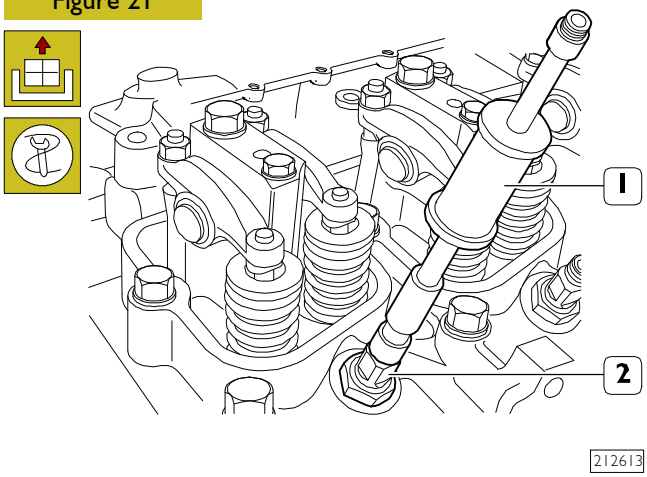
Ref.	No.	Description
(1)	4	M8x1.25

Repeat the operation for the remaining tappet covers.

NOTE The tappet cover for cylinders 5-6 was already removed for the removal of the fuel pipes.

Injector removal

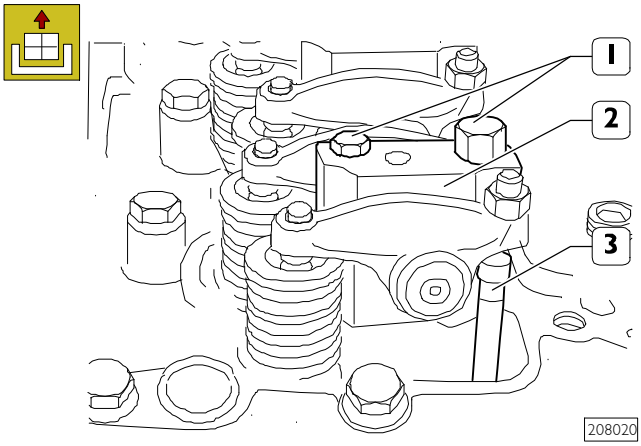
Figure 21



Remove the injectors (2) with tool 99340205 (1) and extract them from the cylinder head.

Rocker assembly removal

Figure 22



unscrew the fastening screws (1) and disassemble the mount (2) together with the rocker arms; remove the push rods (3).

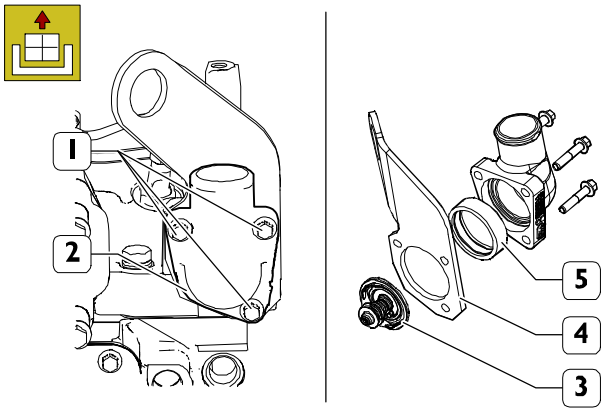
Ref.	No.	Description
(1)	6	M8x1.25X75
(1)	6	M12x1.75x180

Repeat the operation for the remaining rocker arm mounts.

DISASSEMBLY OF ENGINE AT BENCH (SIDE COMPONENTS)

Thermostat removal

Figure 23



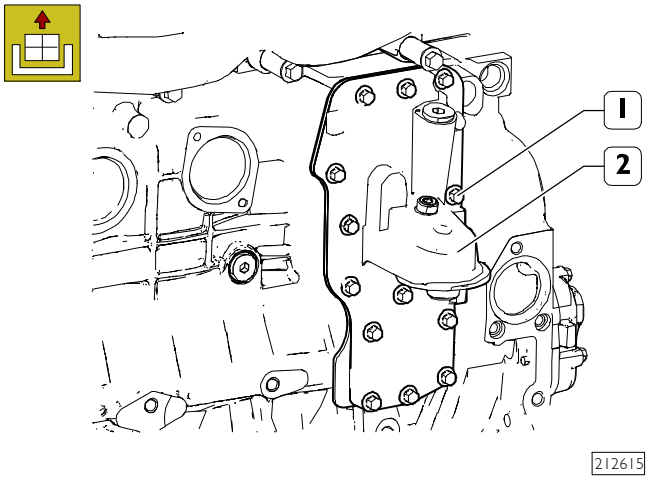
Unscrew the fastening screws (1) and remove the thermostat unit (2) together with the bracket (4); recover the gasket (5) and the thermostat (3).

Ref.	No.	Description
(1)	3	M8x1.25

Prior to removing the cylinder head, fit the bracket into the original position and fasten it with the screws of the thermostat body.

Removal of heat exchanger

Figure 24

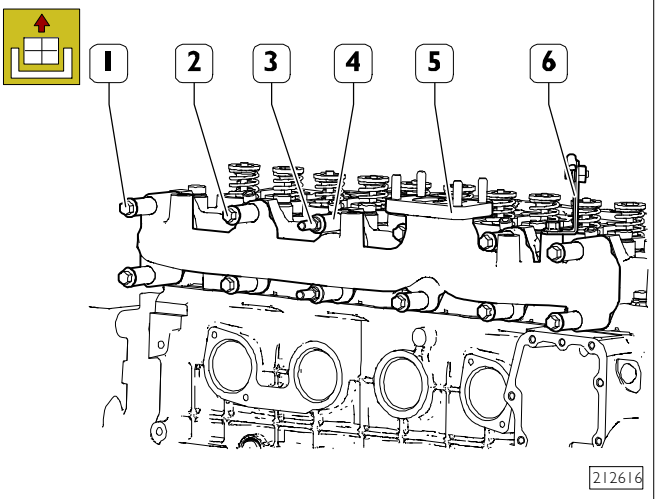


Unscrew the screws (1) and remove the oil filter/heat exchanger support (2), the intermediate plate and the corresponding gaskets.

Ref.	No.	Description
(1)	15	M8x1.25x35

Exhaust manifold removal

Figure 25



Unscrew the screws (1), (2) and (3) and remove the exhaust manifold (5). Recover the spacers (4).

Ref.	No.	Description
(1)	4	M8x1.5x95
(2)	6	M10x1.5x65
(3)	2	M8x1.5x65 (with threaded extension)

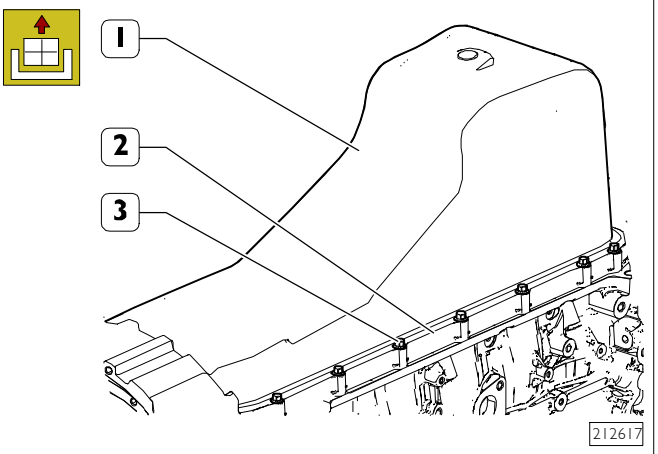
Unscrew the fastening screws and remove the bracket (6) from the cylinder head.

DISASSEMBLY OF ENGINE AT BENCH (COMPONENTS AT THE BOTTOM)

Turn the engine on the rotating stand.

Oil sump removal

Figure 26

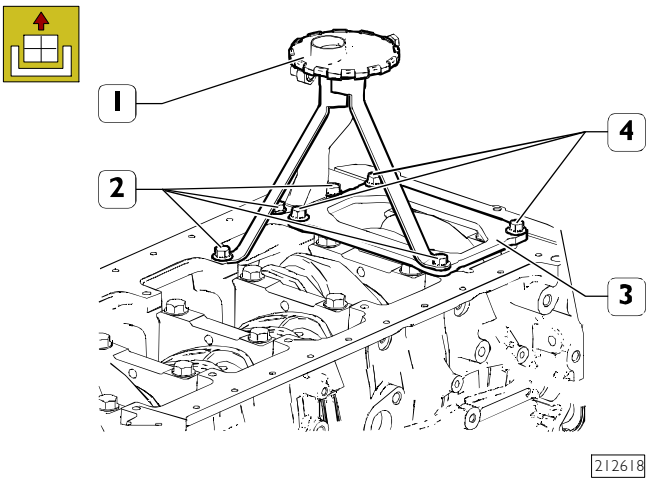


Remove the screws (3), disassemble the frame (2) and disconnect the oil sump (1).

Ref.	No.	Description
(3)	18	M8x1.25

Suction strainer removal

Figure 27



Remove the screws (2) and remove the oil suction strainer (1).

Ref.	No.	Description
(2)	2	M8x1.25
(2)	2	M10x1.5

Remove screws (4) and remove the stiffening plate (3).

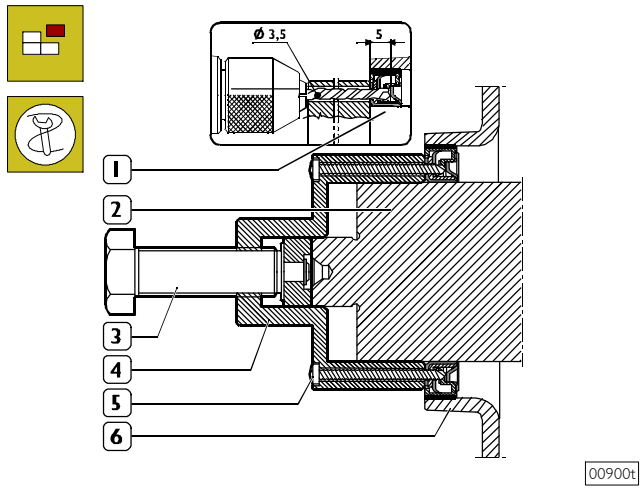
Ref.	No.	Description
(4)	3	M10x1.5

DISASSEMBLY OF ENGINE AT BENCH (COMPONENTS ON THE FRONT - PART 2)

Turn the engine on the rotating stand.

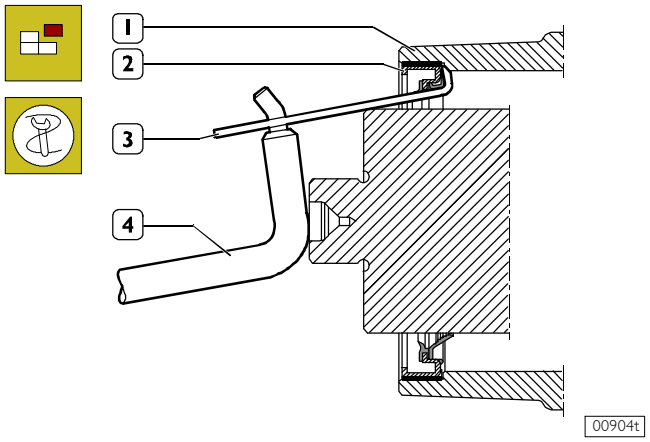
Removing the engine - front cover sealing ring

Figure 28



❑ Take out the crankshaft seal ring from the front cover. Use tool 99340055 (4) on the front tang (2) of the crankshaft. Through the guiding holes of the tool itself, drill the internal seal ring (1) with a bit (Ø 3.5 mm) to a depth of 5 mm. Secure the tool to the ring screwing in the 6 screws supplied.
Remove the ring (1) by screwing up the screw (3).

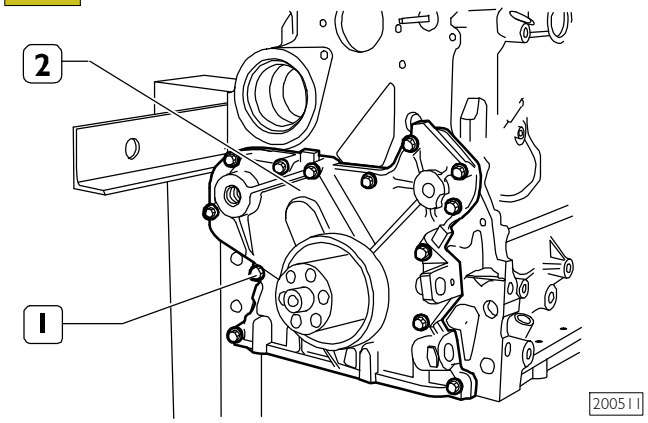
Figure 29



❑ Using the specific tie rod (3) of tool 99363204 and with the help of the lever (4), remove the external seal ring (2) from the front cover (1).

Front cover removal

Figure 30

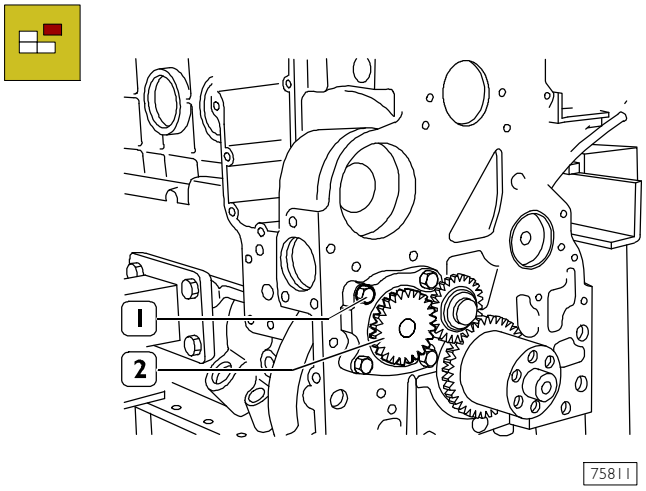


❑ Remove the fastening screws (1) and remove the front cover (2).

Ref.	No.	Description
(1)	13	M8x1.25

Oil pump removal

Figure 31



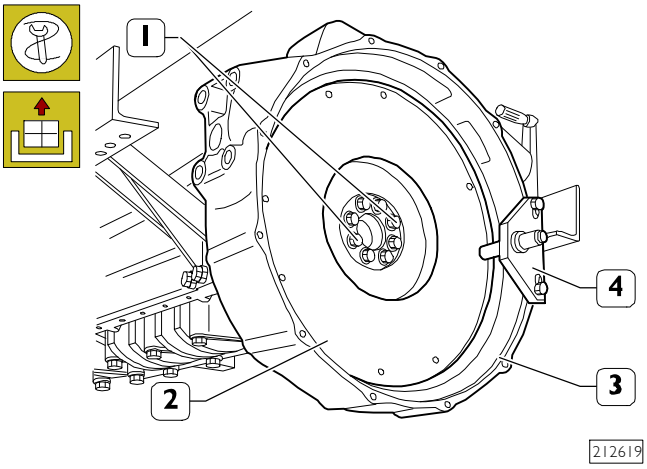
❑ Remove the screws (1) and disconnect the rotary oil pump (2).

Ref.	No.	Description
(1)	4	M8x1.25

DISASSEMBLY OF ENGINE AT BENCH (COMPONENTS AT THE REAR)

Removal of engine flywheel

Figure 32



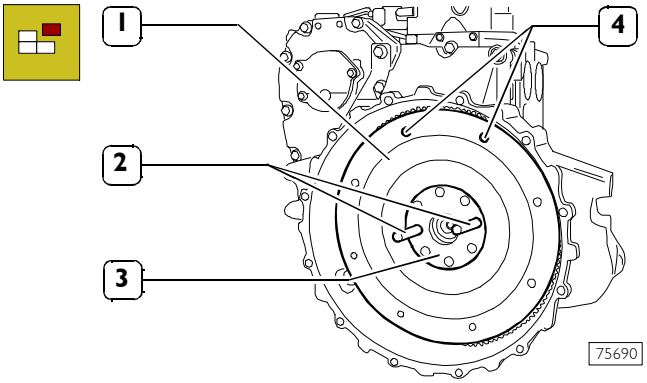
Apply the tool 99360351 (4) to the flywheel housing (3), to stop the flywheel (2) rotation.

Remove the two opposing screws (1) fastening the flywheel to the crankshaft.

Ref.	No.	Description
(1)	2	M12x1.25

In their place, insert the two extraction pins (see the following figure).

Figure 33



❑ Unscrew the remaining screws fixing the flywheel (1) to the crankshaft (3).

Ref.	No.	Description
-	6	M12x1.25

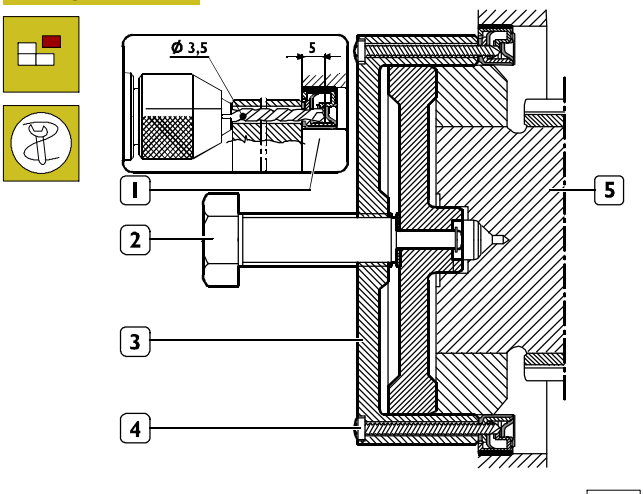
❑ Remove flywheel locking tool 99360351.

❑ Screw in two screws of average length into the holes (4) to sling the flywheel with a hoist.

❑ Using the two guide pins (2) previously screwed into the crankshaft holes (3) guide the engine flywheel (1) out with the help of the hoist.

Removing the engine - flywheel cover housing sealing ring

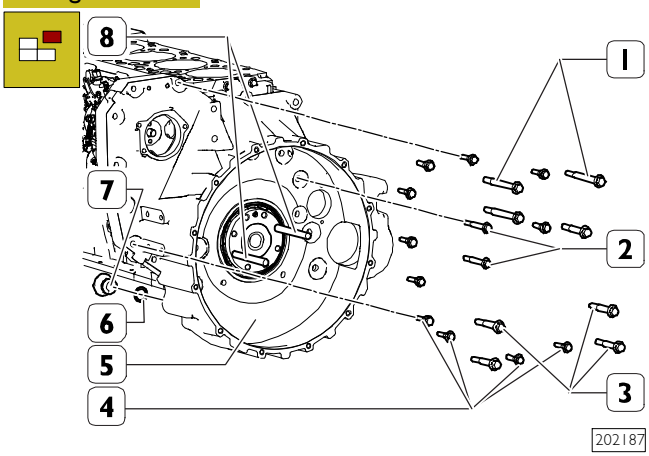
Figure 34



- ❑ Take out the flywheel housing seal ring applying tool 99340056 (3) onto the rear tang (5) of the crankshaft. Through the guiding holes of the tool itself, drill the internal seal ring with a bit (Ø 3.5 mm) to a depth of 5 mm.
- ❑ Secure tool 99340056 (3) to the ring (1) screwing in the 6 screws (4) supplied.
- ❑ Remove the ring (1) by screwing up the screw (2).
- ❑ Using an appropriate tie rod of tool 99363204 and a lever, take out the external seal ring from the flywheel housing

Removal of flywheel housing

Figure 35



Remove the flywheel housing:

- ❑ Unscrew the screws (1, 2, 3 and 4).
- ❑ Remove the male (7) and recover the gasket (6).
- ❑ Remove the 2 cable reference dowel pins (8).
- ❑ Remove the flywheel housing (5).

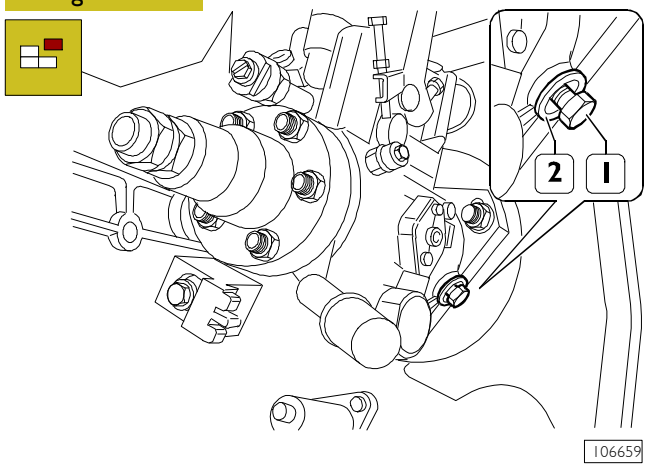
Ref.	No.	Screws description
(1)	3	Screw M12x1.75
(2)	2	Screw M8x20
(3)	5	Screw M10x1.5
(4)	11	Screw

NOTE Take note of the screw (1, 2, 3 and 4) assembling positions since they are of different sizes.

Removal of feed pump gear and feed pump

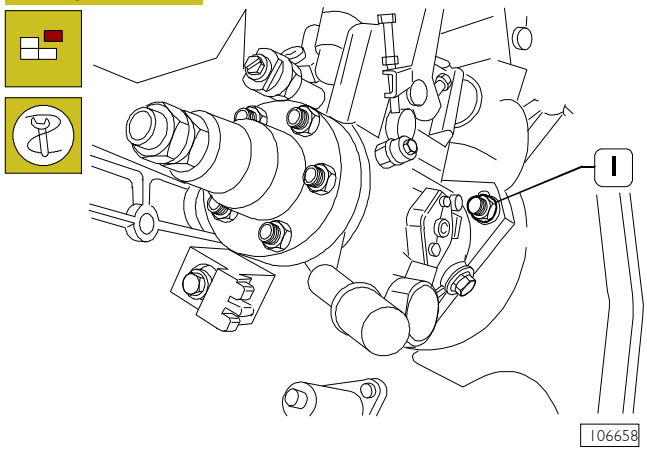
Verify that the position of the 1st cylinder is at the dead centre position after compression

Figure 36



- ❑ Partially unscrew the screw (1) locking the pump spindle and move the spacer with the slot (2) to the largest part of the hole to allow the screw to fit in completely.
- ❑ Apply a torque of between 11.9 and 12.4 Nm to tighten the locking screw (1) flush with the spacer locking the pump spindle rotation.

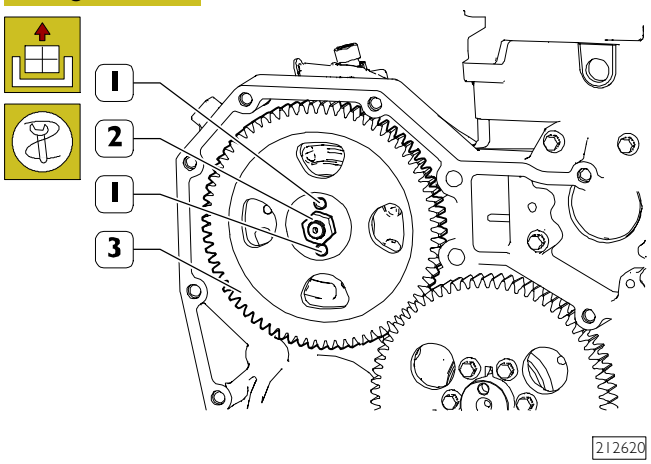
Figure 37



- ❑ From the side of the pump, loosen the fastening nuts (1) without removing them in order to allow the pump to move backwards when the extractor 99340035 operates.

Ref.	No.	Description
(1)	3	M8x1.25

Figure 38



Unscrew the nut (2) fastening the gear (3) to the feed pump and recover the respective washer.

Ref.	No.	Description
(2)	1	M14x1.5

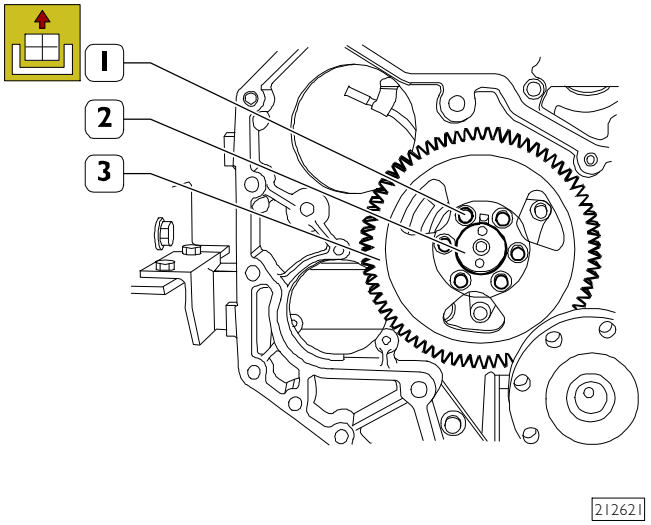
Fit the extractor 99340035 using the two threaded holes (1) and detach the gear (3) from the pump spindle.

Suitably support the feed pump and unscrew the fastening nuts completely.

Take the pump off the studs together with the gasket.

Removal of timing gear

Figure 39

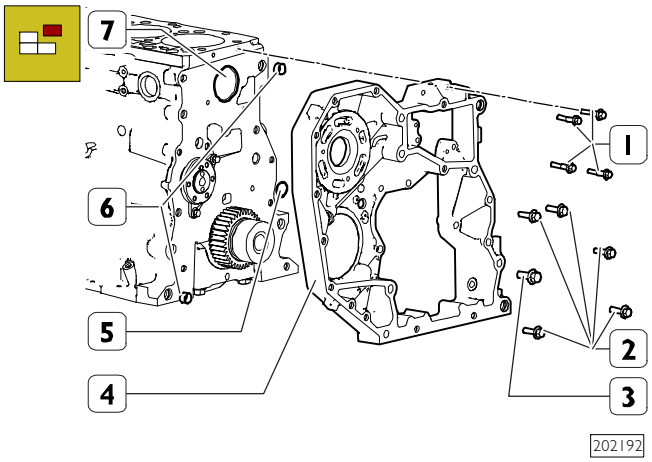


Unscrew the screws (1) and remove the gear (3) from the camshaft (2).

Ref.	No.	Description
(1)	6	M8x1.25

Removal of timing gear case

Figure 40



Remove the timing gear case:

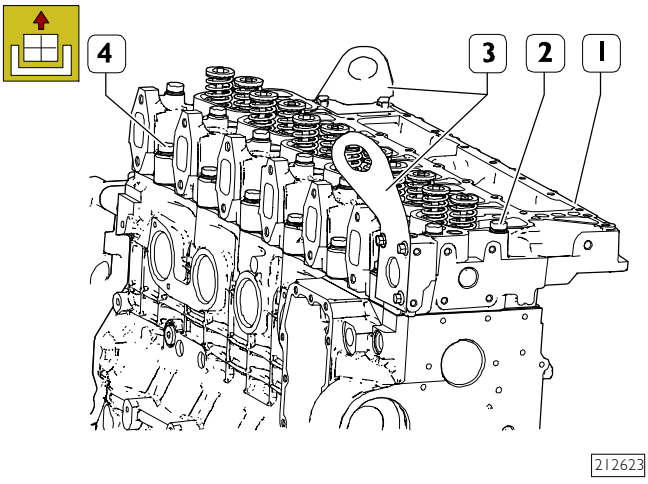
- ❑ Unscrew the screws (1, 2 and 3).
- ❑ Remove the timing gear case (4).
- ❑ Recover the gasket (5).
- ❑ Recover the cable reference dowel pins (6).
- ❑ Remove the core plug (7).

Ref.	No.	Screws description
(1)	4	Screw M8x1.25x40
(2)	5	Screw M10x1.5x30
(3)	1	Screw M12x1.75x30

DISASSEMBLY OF ENGINE AT BENCH (COMPONENTS AT THE TOP - PART 2)

Cylinder head removal

Figure 41



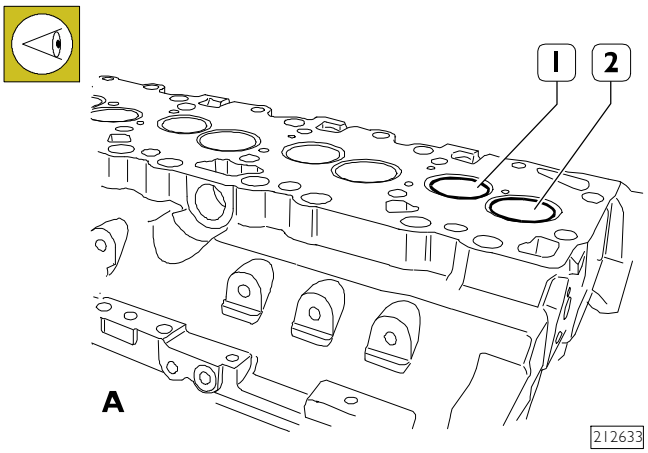
Unscrew the cylinder head (1) fastening screws (2) Hook brackets (3) with metal ropes and with the aid of a hoister detach cylinder heads from the base.

Ref.	No.	Description
(4)	6	M12x70
(2)	7	M12x140
(2)	7	M12x180

Remove the cylinder head gasket from the centring bushes.

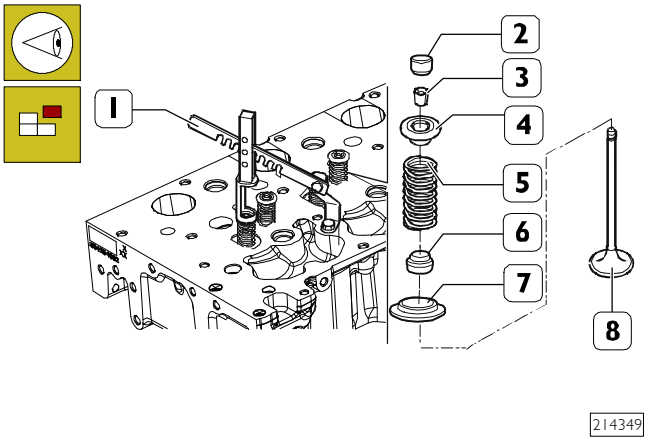
Valve removal

Figure 42



The intake (1) and exhaust (2) valves have a different diameter mushroom.

Figure 43



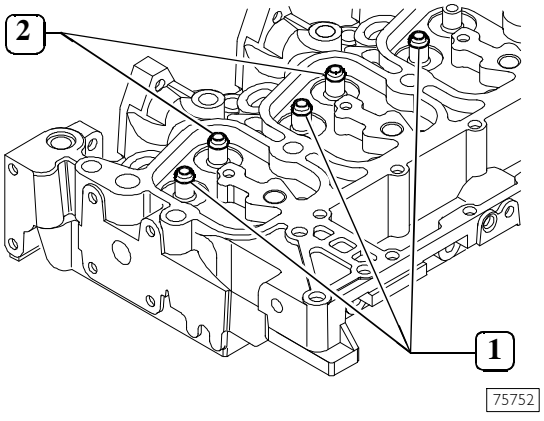
Remove the valve assembly:

NOTE Before removing the valves from the cylinder head, number them so that they can be re-installed in the same positions they were removed from if they are to be re-used.

A = exhaust side.

- ❑ Valve removal is carried out using tool 99360268 (1) and applying pressure on the plate (4) so that by compressing the spring (5), it is possible to remove the valve cap (2) and the cotters (3). Then remove: plate (4) and spring (5).
- ❑ Repeat this operation for all the valves.
- ❑ Upturn the cylinder head, remove the valve (8), the lower spring seat (7) and the oil seal (6).

Figure 44



Remove the sealing rings (1 and 2) from the relevant valve guides.

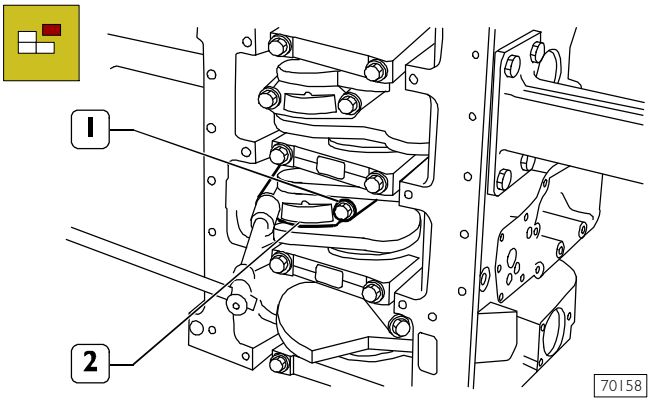
NOTE Sealing rings (1) for intake valves are yellow:

Sealing rings (2) for exhaust valves are green.

DISASSEMBLY OF ENGINE AT BENCH (CRANKCASE COMPONENTS)

Connecting rod cap removal

Figure 45



Remove the screws (1) fastening the connecting rod caps (2) and remove them.

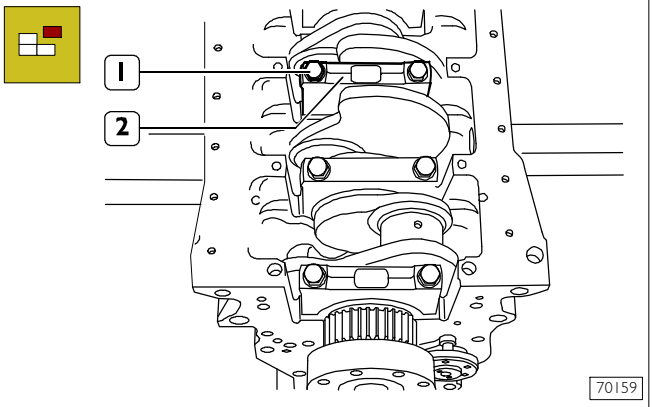
Ref.	No.	Description
(1)	12	M10x1.25

Withdraw the pistons including the connecting rods from the top of the engine block.

NOTE Keep the half-bearings in their housings since in case of use they shall be fitted in the same position found at removal.

Removal of main bearing caps

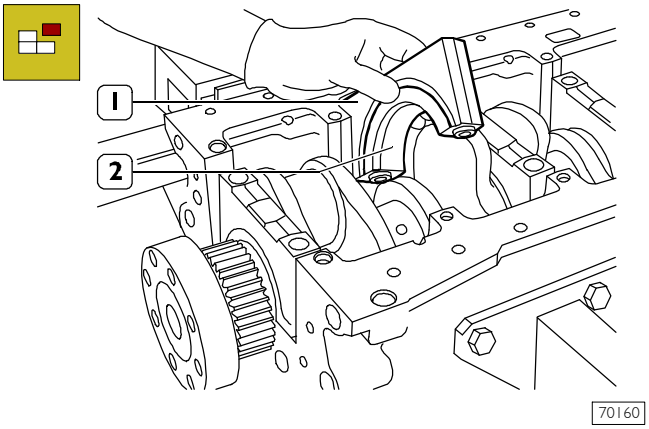
Figure 46



Remove the screws (1) and the main bearing caps (2).

Ref.	No.	Description
(1)	14	M12x1.5

Figure 47

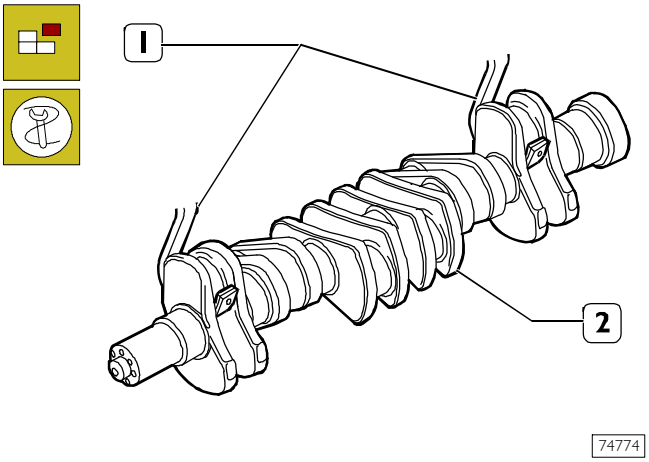


The second last main bearing cap (1) and the relevant support are fitted with shoulder half-bearing (2).

NOTE Take note of lower and upper half-bearing assembling positions since in case of reuse they shall be fitted in the same position found at removal.

Removal of crankshaft

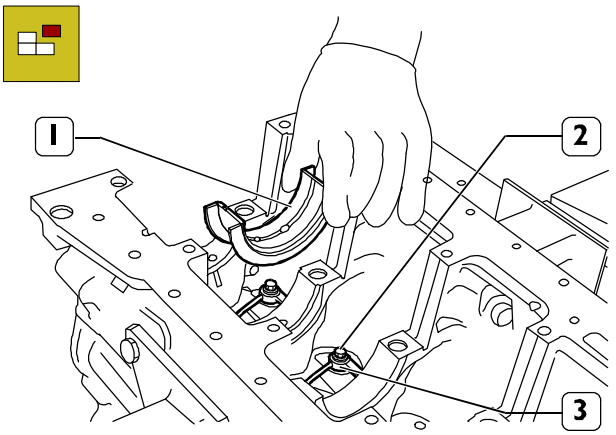
Figure 48



Use tool 99360500 (1) and hoist to remove the crankshaft (2) from the block.

Removal of main half-bearings and oil nozzles

Figure 49

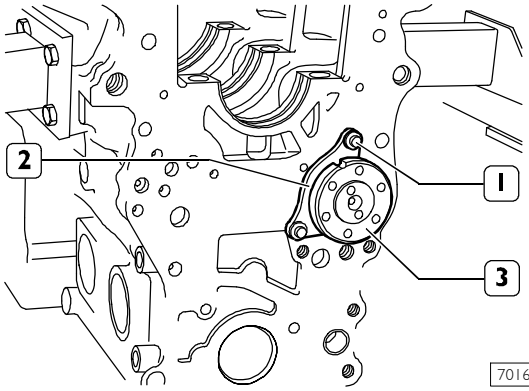


Remove the main half-bearings (1).
Remove the screws (2) and remove the oil nozzles (3).

Ref.	No.	Description
(2)	6	M8x1.25

Camshaft removal

Figure 50

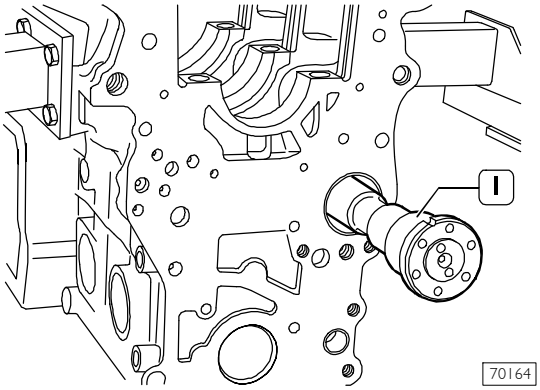


Remove the screws (1) and disconnect camshaft (3) side plate (2).

NOTE Take note of plate (2) assembling position.

Ref.	No.	Description
(1)	2	M8x1.25x16

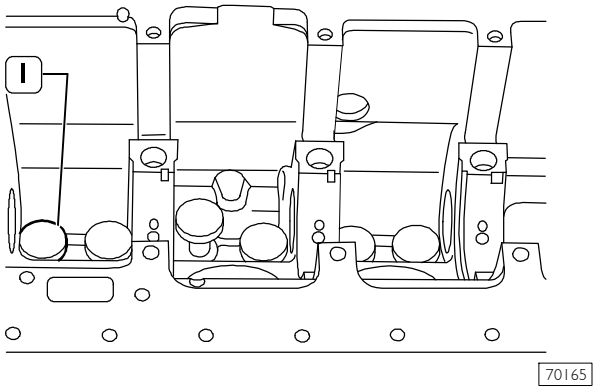
Figure 51



Withdraw carefully the camshaft (1) from the crankcase.

Tappet removal

Figure 52

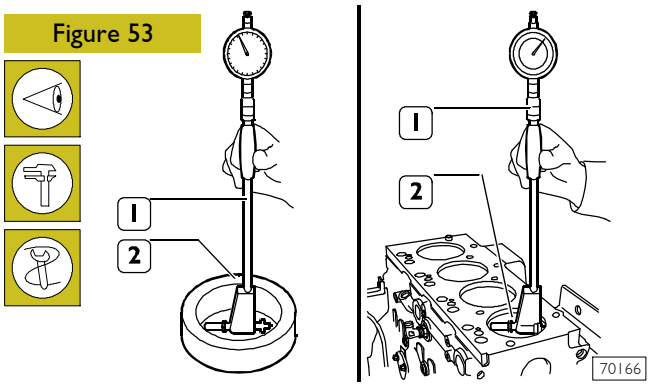


Withdraw the tappets (1) from the crankcase.

CHECKS

Cylinder block

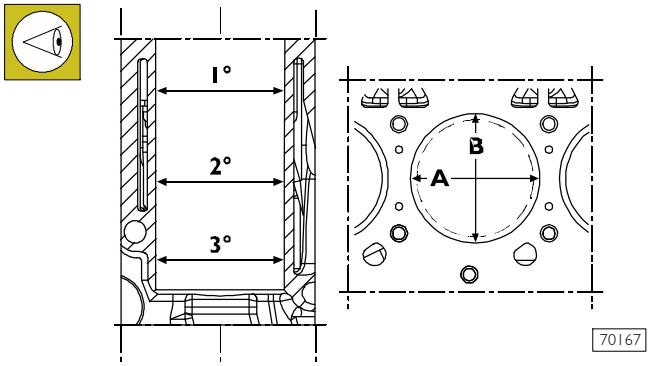
Figure 53



Once the engine is disassembled, thoroughly clean the cylinder--crankcase assembly.
Use the proper rings to handle the cylinder block.
Carefully inspect the crankcase for cracks.
Check the condition of casting hole plugs. If the caps are rusted, or if there is any doubt about the efficiency of the seal, replace them.
Inspect the surfaces of the cylinder liners; they should not be scored, seized, ovalised, conical or worn to excess.
The internal diameter of the cylinder liners is checked to ascertain the extent of ovalization, taper and wear, using the bore meter (1) fitted with a dial gauge previously reset on the ring gauge (2) of the diameter of the cylinder liner.

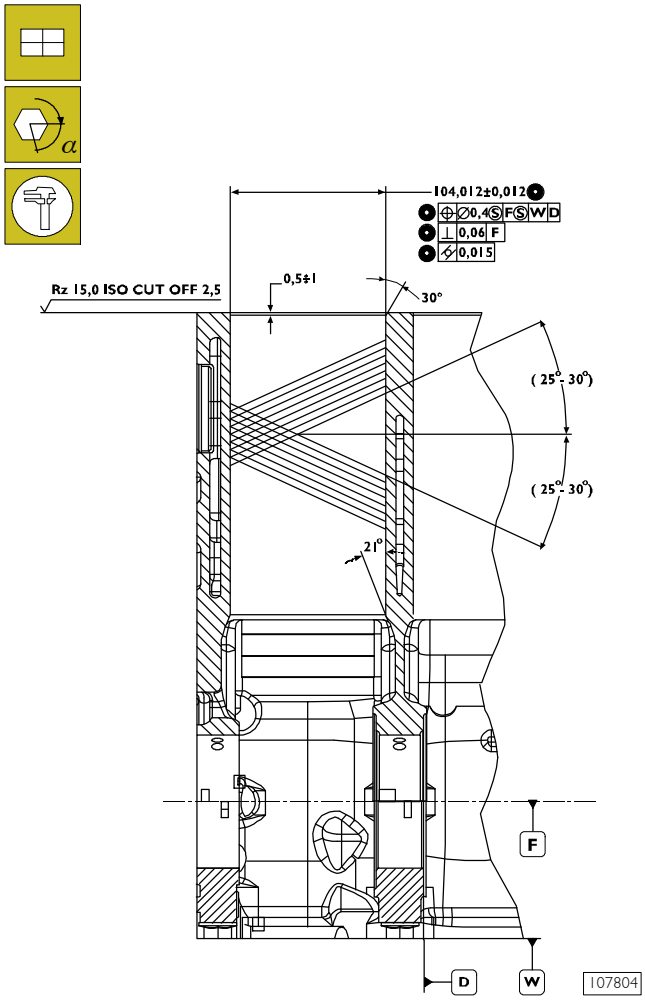
NOTE Should the ring gauge be not available, use a micrometer for zero-setting.

Figure 54



Measurements shall be performed on each cylinder, at three different heights in the bore and on two planes perpendicular with each other: one parallel to the longitudinal axis of the engine (A) and the other perpendicular to it (B); the greatest wear is usually found to be on this surface and during the first measurement. Should ovalization, taper or wear be found, bore and grind the cylinders. The refacing of the cylinder liners should be made in relation to the diameter of the pistons supplied as spare parts, which are oversized by 0.4 - 0.8 mm of the nominal value and to the prescribed assembly clearance.

Figure 55



NOTE In case of regrinding, all cylinders are to have the same oversize (0.4 - 0.8 mm).

Check main bearing housings as follows:

- ❑ fit the main bearings caps on the supports without bearings;
- ❑ tighten the fastening screws to the specified torque;
- ❑ use the proper internal gauge to check whether the housing diameter is falling within the specified value.

Replace if higher value is found.

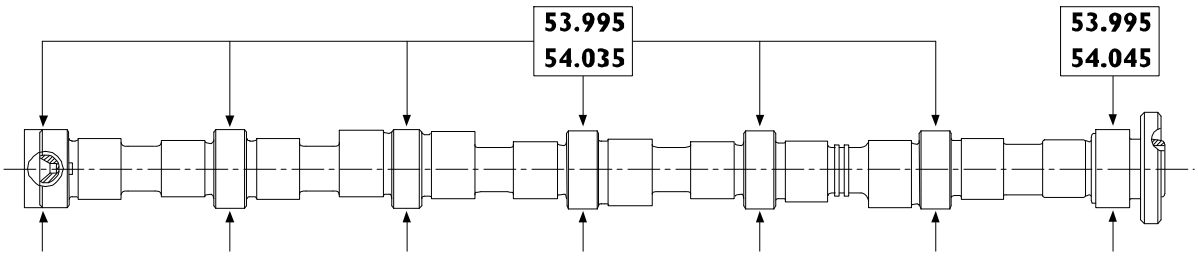
Checking cylinder block head contact surface

After establishing the areas of deformation, correct the contact surface with a grinding machine.
Planarity error shall not exceed 0.075 mm.
Check the state of the cylinder assembly machining plugs; if they are rusty or there is any doubt at all about their seal, replace them.

TIMING SYSTEM

Camshaft

Figure 56



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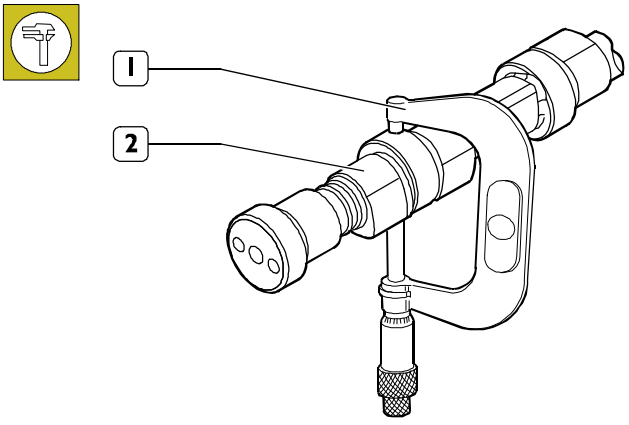
MAIN DATA ABOUT CAMSHAFT JOURNALS

The surfaces of the supporting pins of the shaft and those of the cams need to be extra smooth; if they show any signs of seizing or scoring, the shaft and the relevant bushings should be replaced.

Checking cam lift and journals alignment

Set the shaft on tailstocks and, using a dial gauge on the middle journal, check that the alignment error is no greater than 0.04 mm: change the shaft if it is any greater.

Figure 57



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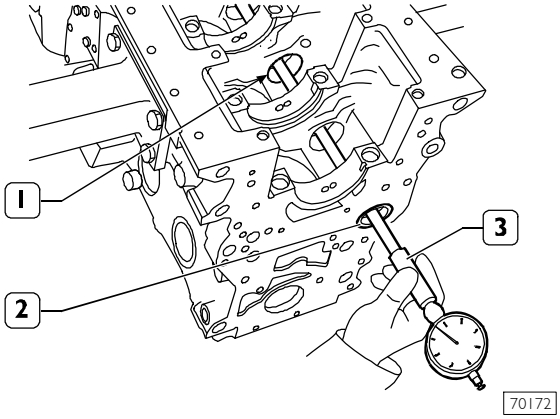
Check camshaft (2) journals diameter using micrometer (1) on two perpendicular axes.

Bushing check

Figure 58

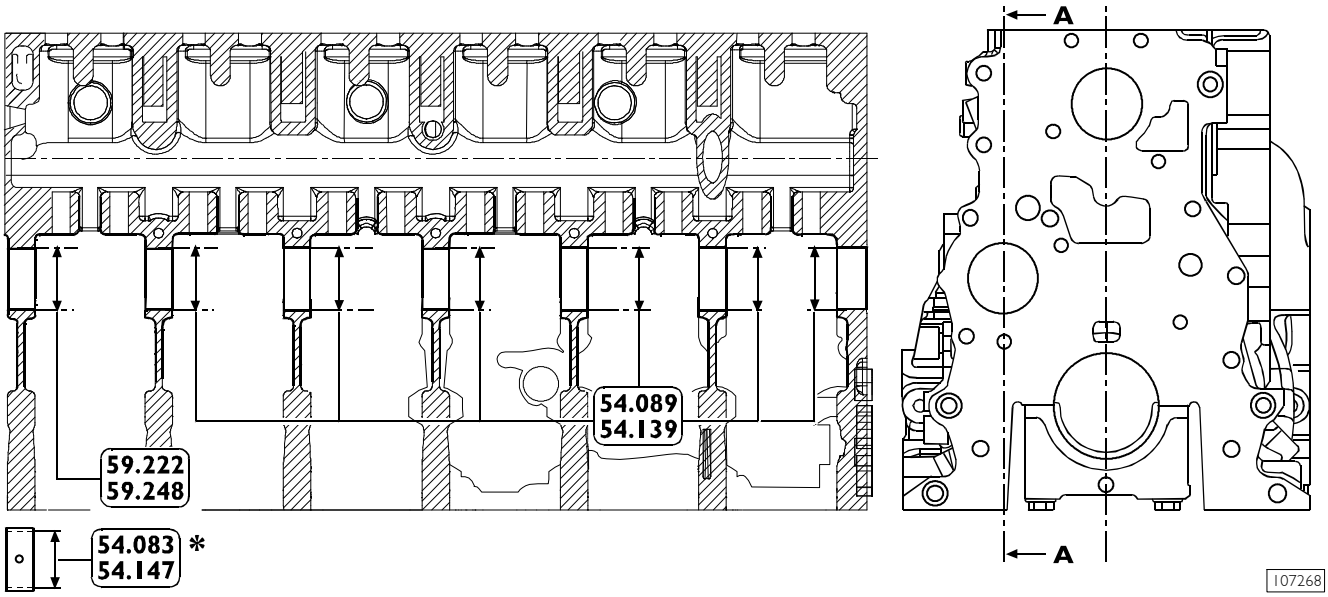


70172

The bushing (2) for camshaft must result to have been forced into its seat. Internal surfaces must not show seizing or wear. Measure the diameter of the bushing (2) and of the intermediate seats (1) of the camshaft with a bore gauge (3).

Measurements shall be performed on two perpendicular axes.

Figure 59



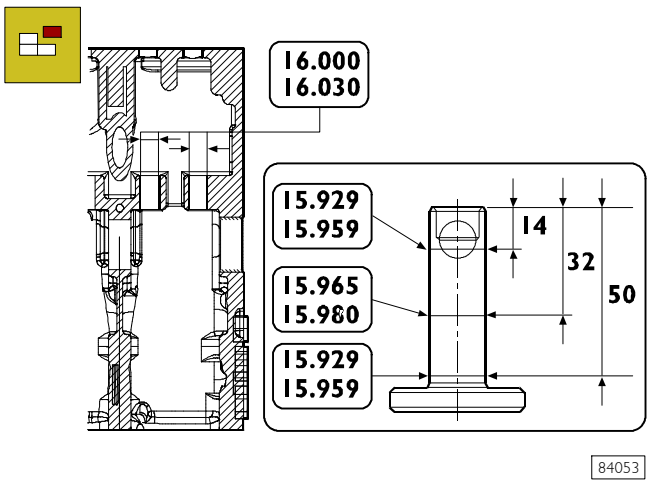
BUSHING MAIN DATA FOR CAMSHAFT AND RELATING SEAT

*Dimension to be obtained after driving the bushing.

Tappet check

Using a micrometer, check the diameter of the tappets on two perpendicular axles.

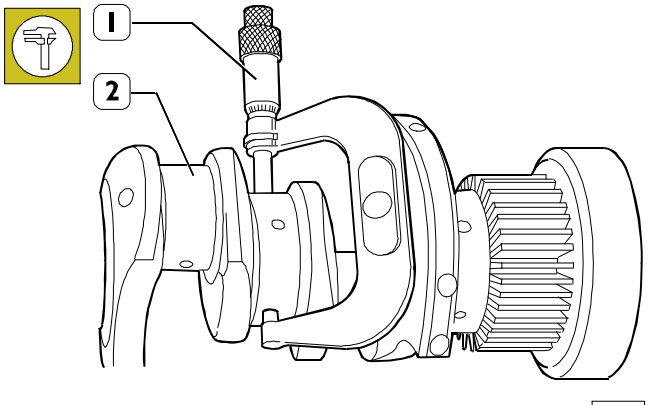
Figure 60



MAIN DATA CONCERNING THE TAPPETS AND THE RELEVANT HOUSINGS ON CRANKCASE

CRANKSHAFT
Measuring main journals and crank pins

Figure 61



If signs of seizure, scoring or excessive ovalization on main journals and crankpins are identified, it is necessary to regrind the pins. Before grinding the journals (2) measure them with a micrometer (1) to decide the final diameter to which the pins are to be ground.

NOTE It is advisable to enter readings in a table. See Figure 62

Undersize classes are of: 0.250 - 0.500 mm.

NOTE The main journals and crankpins must always be ground to the same undersize class.
Journals and crankpins undersize shall be marked on the side of the crank arm No.1.
For undersized crankpins, letter M.
Letter B for undersized main journals.
For undersized crankpins and main journals, letter MB.

Figure 62

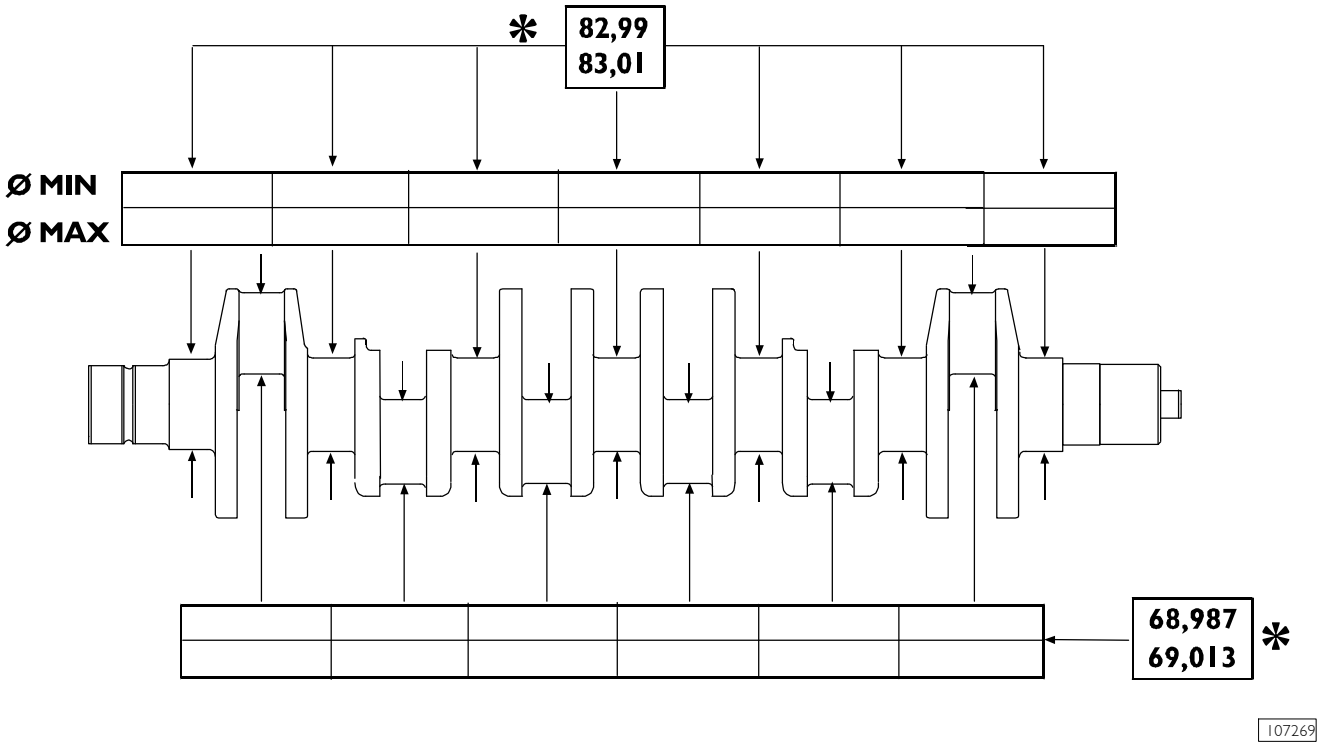
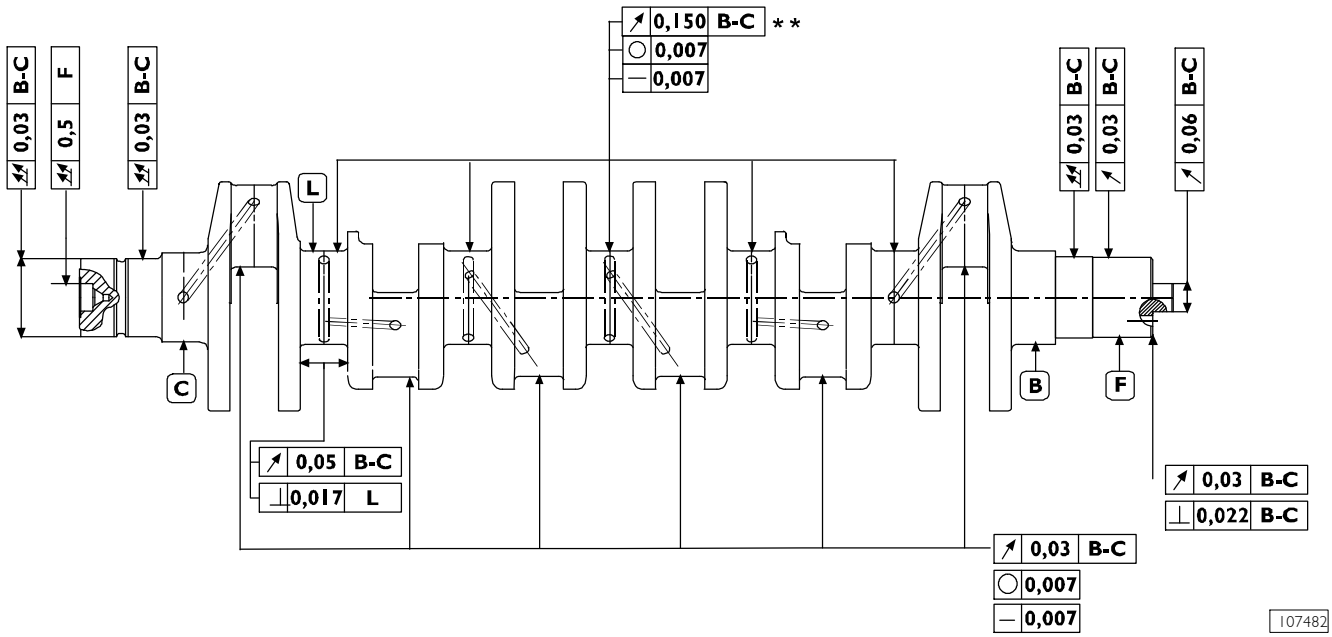


TABLE IN WHICH TO WRITE DOWN THE MEASURED VALUES FOR THE MAIN JOURNALS AND CRANKPINS

* Nominal value

Figure 63



* Measured on a radius greater than 45.5 mm

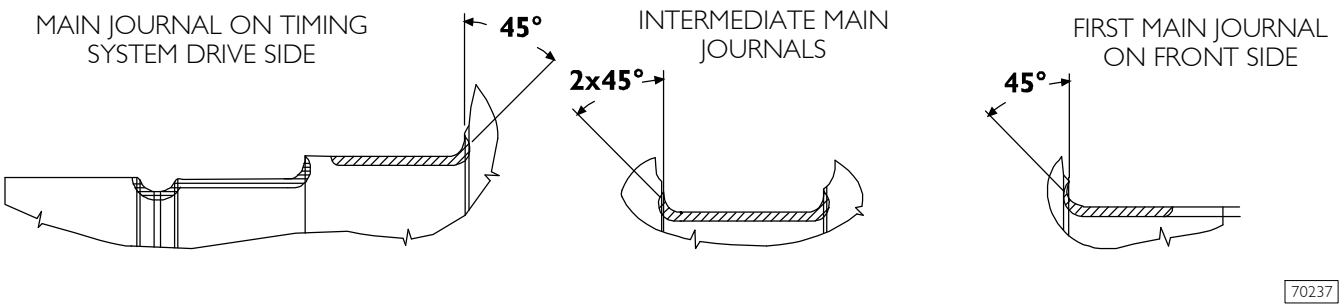
** ▯ 0.500 between adjacent main journals

MAIN CRANKSHAFT TOLERANCES

TOLERANCES	CHARACTERISTIC SUBJECT OF TOLERANCE	GRAPHIC SYMBOL
SHAPE	Circularity	○
	Cylindricity	/○/
ORIENTATION	Alignment	//
	Perpendicularity	⊥
	Straightness	—
POSITION	Concentricity or coaxiality	⌾
OSCILLATION	Circular oscillation	↗
	Total oscillation	⌰

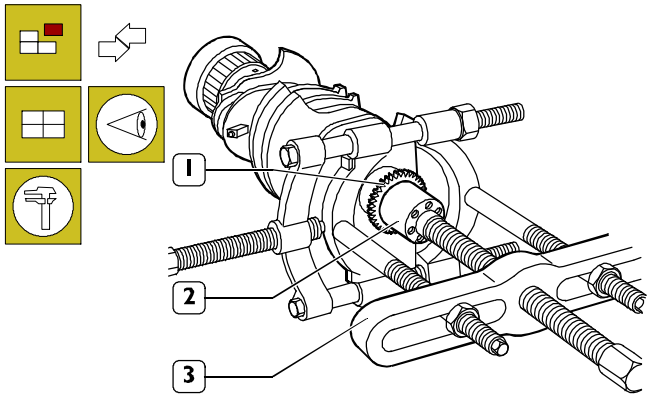
CLASS OF IMPORTANCE ASSIGNED TO PRODUCT CHARACTERISTICS	GRAPHIC SYMBOL
CRITICAL	©
IMPORTANT	▯
SECONDARY	▯

Figure 64



Checking/replace oil pump drive gear if necessary

Figure 65

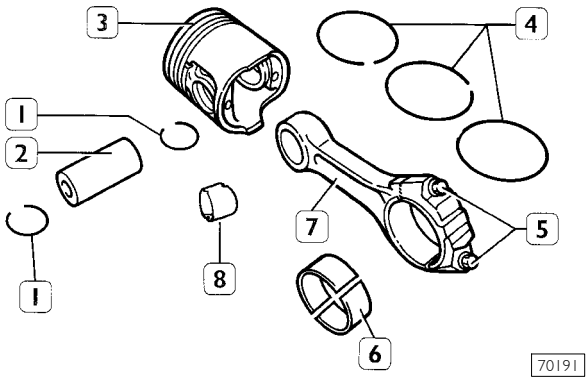


Check that gear toothing (1) is not damaged or worn, otherwise remove it using the proper puller (3).

When fitting the new gear, heat it to 180° C for 10 minutes in an oven, then key it to the crankshaft.

ROD-PISTON ASSEMBLY

Figure 66



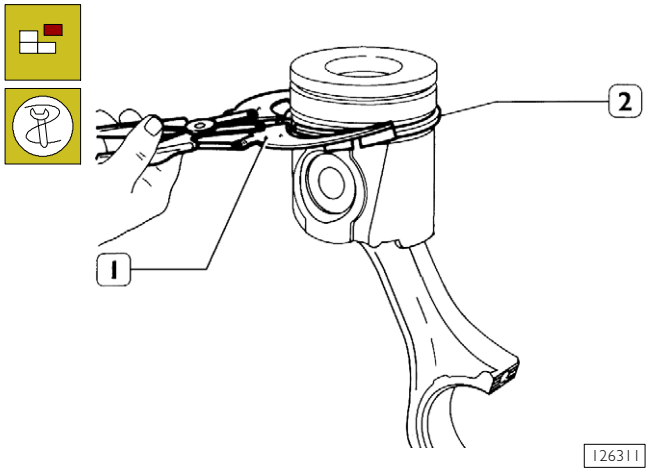
COMPONENT PARTS OF THE CONNECTING ROD PISTON ASSEMBLY

1. Retaining rings. - 2. Pin. - 3. Piston. - 4. Circlips. - 5. Screws - 6. Half-bearings. - 7. Connecting rod. - 8. Bush.

NOTE Pistons are supplied as STANDARD spares with 0.4 - 0.8 mm oversize.

Disassembly of elastic piston rings

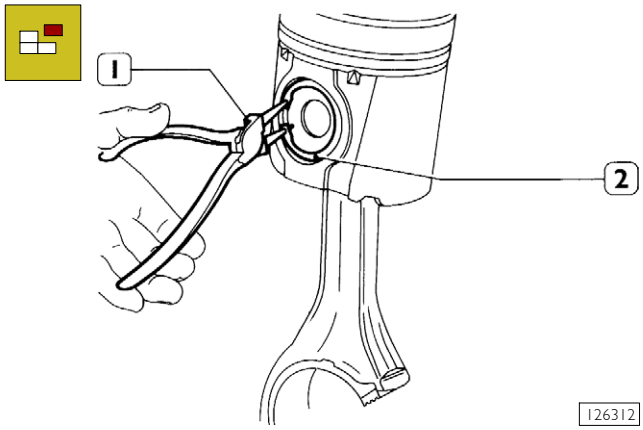
Figure 67



Remove the piston rings (2) using the tool 99360183 (1).

Disassembly of piston pin

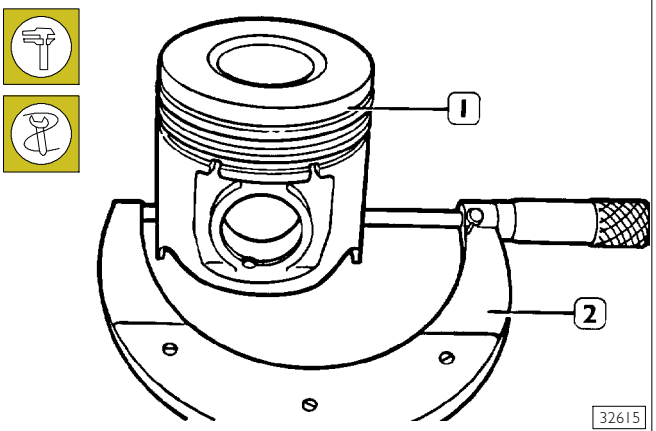
Figure 68



Remove the piston pin Seeger-rings (2) using round tipped pliers (1).

Measuring the piston diameter

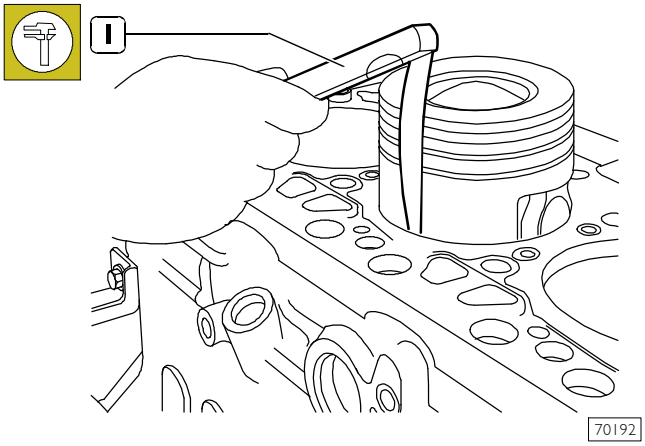
Figure 70



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

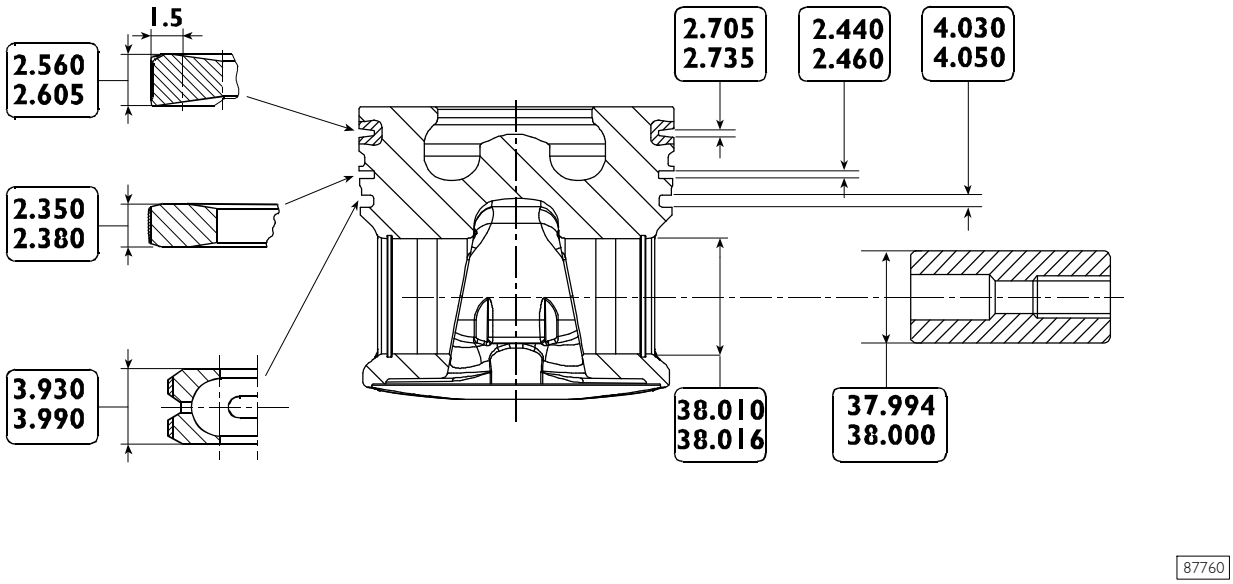
NOTE The diameter is to be measured at 12 mm from the piston skirt end.

Figure 69



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

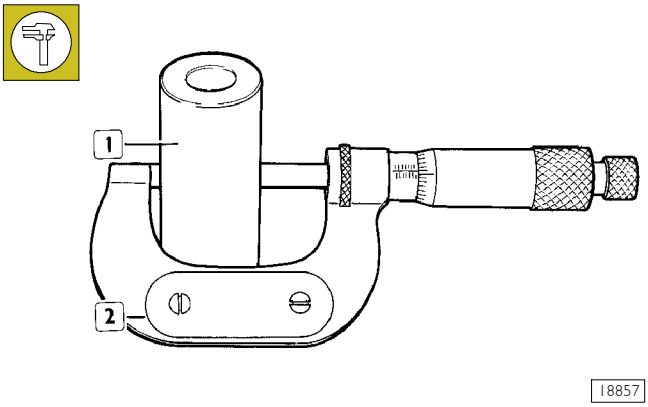
Figure 71



MAIN DATA OF THE PISTON, PINS AND PISTON RINGS

Gudgeon pins

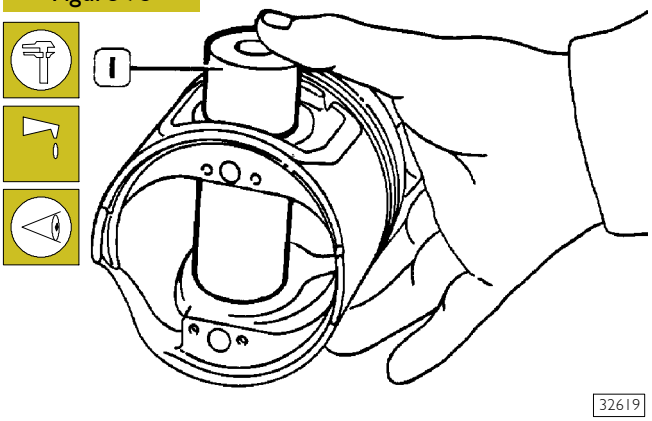
Figure 72



Measuring the diameter of the gudgeon pin (1) with a micrometer (2).

Conditions for correct pin / piston coupling

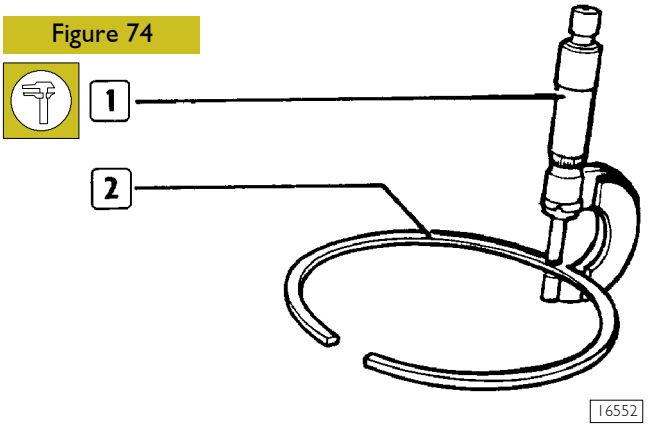
Figure 73



Use engine oil to lubricate the pin (1) and the corresponding seat on the piston hubs. Pin must be inserted in the piston with a light finger pressure and it should not come out by gravity.

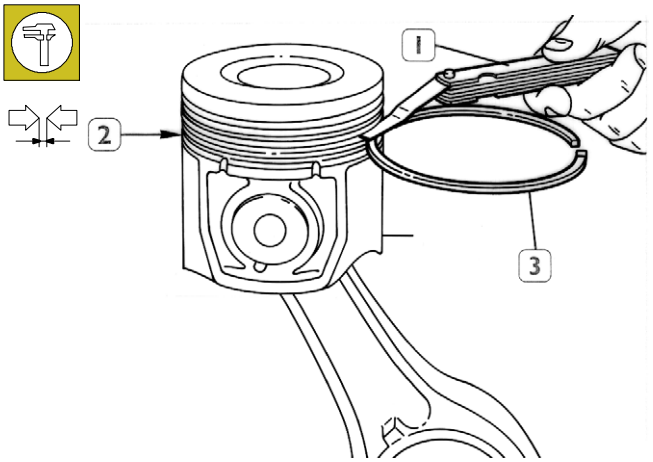
Piston rings

Figure 74



Check the thickness of the piston rings (2) with a micrometer (1).

Figure 75



Check the clearance between the seal rings (3) of the 2nd and 3rd slot and the relevant housings on the piston (2), using a feeler gauge (1).

Figure 76

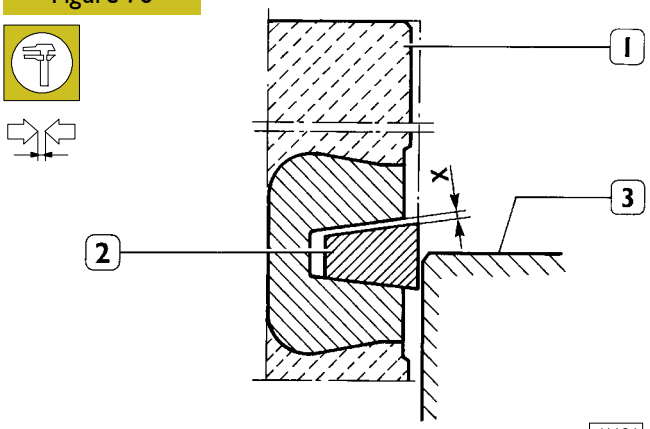
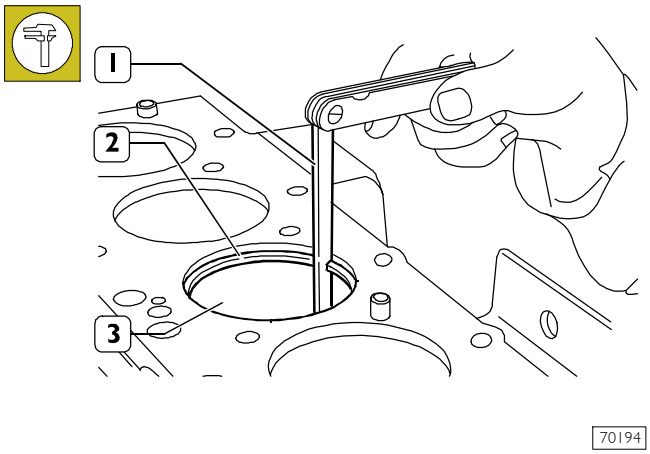


DIAGRAM FOR MEASURING THE CLEARANCE X BETWEEN THE FIRST PISTON SLOT AND THE TRAPEZOIDAL RING

Since the first piston ring section is trapezoidal, the clearance between the slot and the ring is to be measured as follows; make the piston (1) protrude from the engine block so that the ring (2) protrudes half-way from the cylinder liner (3).

In this position, use a feeler gauge to check the clearance (X) between the ring and the slot: this clearance must be as specified.

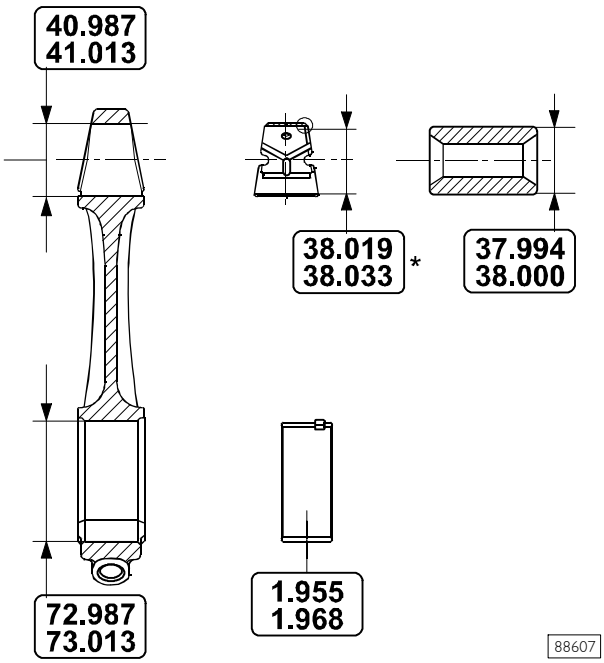
Figure 77



Use feeler gauge (1) to measure the clearance between the end of the circlip (2) fitted into the cylinder liner (3).

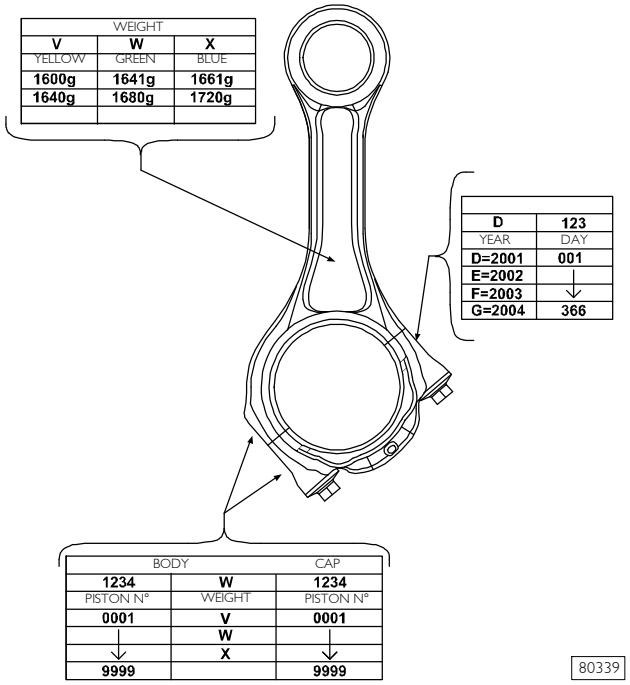
Connecting rods

Figure 78



NOTE The connecting rods have a determined fracture point and are supplied already fractured together with the screws fastening the caps; the connecting rod caps are not interchangeable because the profile of the fracture varies from component to component.

Figure 79 (Demonstrative)



NOTE Every connecting rod is marked as follows:

- ❑ On body and cap with a number showing their coupling and the corresponding cylinder. In case of replacement it is therefore necessary to mark the new connecting rod with the same numbers of the replaced one.
- ❑ On body with a letter showing the weight of the connecting rod assembled at production:
  - V, 1560 ÷ 1600 (marked yellow);
  - W, 1601 ÷ 1640 (marked green);
  - X, 1641 ÷ 1680 (marked blue);

Spare connecting rods are of the W class with green marking *.

Removal of material is not allowed.

Bushings

Check that the bushing in the small end has not come loose and shows no sign of seizure or scoring. Otherwise replace it.

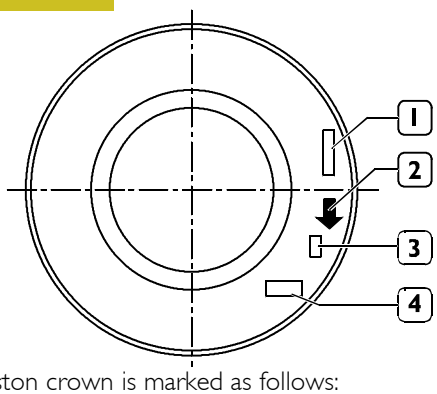
Removal and refitting shall be performed using the proper driver.

When refitting take care to make the oil holes on the bush coincide with those on the connecting rod small end. Ream the bush to obtain the specified diameter.

Connecting rod-piston refitting

Installing the connecting rod-piston assembly

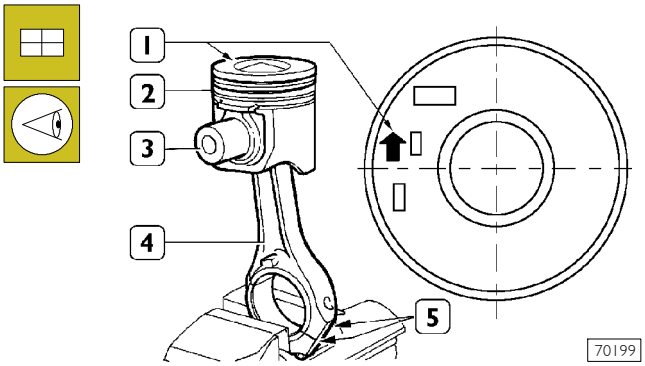
Figure 81



The piston crown is marked as follows:

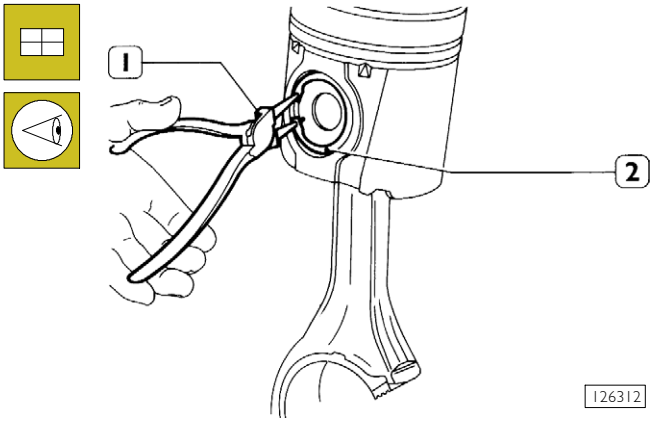
1. Part number and design modification number;
2. Arrow showing piston assembling direction into cylinder, this arrow shall face the front key of the engine block;
3. Marking showing 1st slot insert testing;
4. Manufacturing date.

Figure 82



Connect piston (2) to the connecting rod (4) with pin (3) so that the reference arrow (1) for fitting the piston (2) into the cylinder barrel and the numbers (5) stamped on the connecting rod (4) are read as shown in the figure.

Figure 80

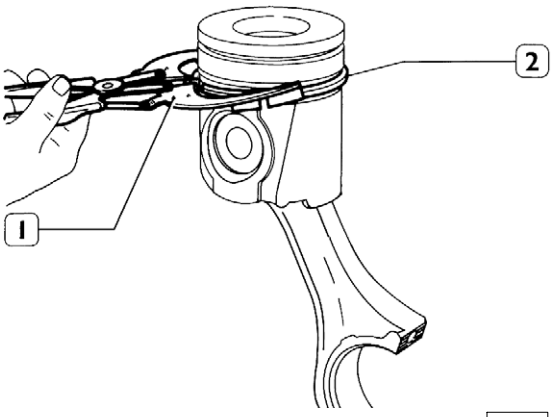


Using round-tipped pliers (1), insert the pin fitting Seeger rings (2).

Verify the correct insertion of the Seeger rings in their seats.

Fitting piston rings

Figure 83

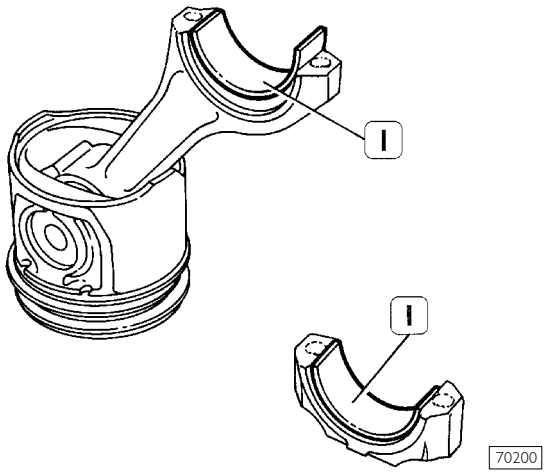


Use callipers 99360183 (1) to fit the circlip (2) on the piston. The circlips are to be fitted with the word "TOP" facing upwards and their openings displaced with each other by 120°.

NOTE Spare piston rings are supplied in the sizes below:

- standard;
- oversized by 0.4 - 0.8 mm.

Figure 84



Fit half bearings (1) on connecting rod and cap.

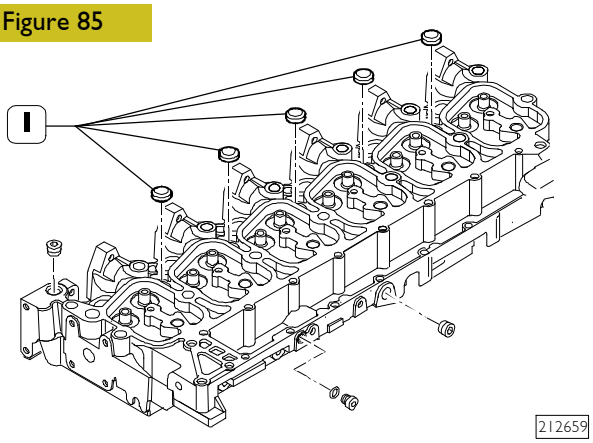
NOTE Not finding it necessary to replace the connecting rod bearings, you need to fit them back in exactly the same sequence and position as in removal.

Do not make any adjustment on the half-bearings.

CYLINDER HEAD

Cylinder head hydraulic seal check

Figure 85



Check the hydraulic seal using a suitable tool.

Pump in water heated to ~ 90°C at a pressure of 2 ÷ 3 bar.

Replace the cast hole plugs (1) if leaks are found, use the proper driver for their removal - refitting.

NOTE Before fitting the plugs, apply a layer of water--repellent sealant onto the seal surface.

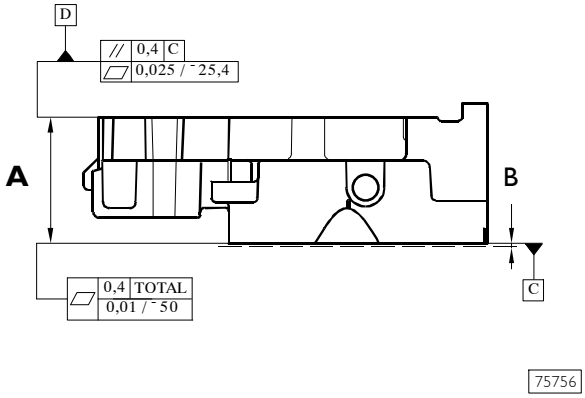
Replace the cylinder head if leaks are found.

Cylinder head contact surface check

Distortion found along the whole cylinder head shall not exceed 0.20 mm.

If measurement results exceed this value, regrind the cylinder head according to the values and instructions provided in the figure below.

Figure 86

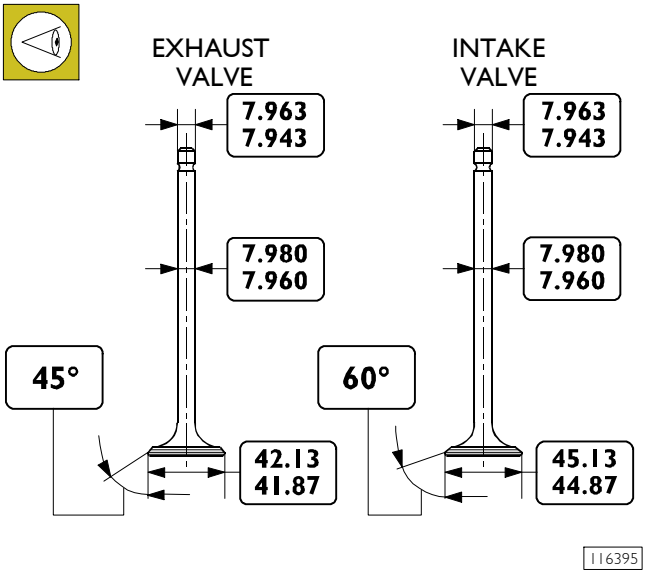


The rated thickness A for the cylinder head is 95 ± 0.25 mm, max. metal removal must not exceed thickness B by 0.13 mm.

NOTE After regrinding, check the valve recessing and if necessary regrind the valve seats to meet the prescribed valve recess.

VALVES

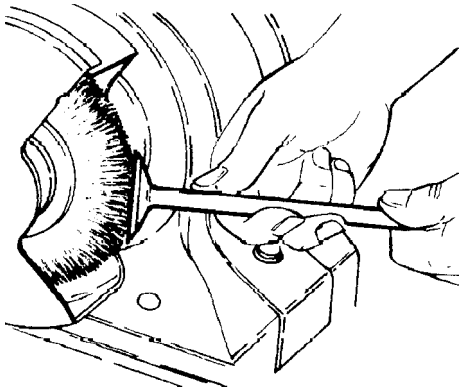
Figure 87



INTAKE AND EXHAUST VALVE MAIN DATA

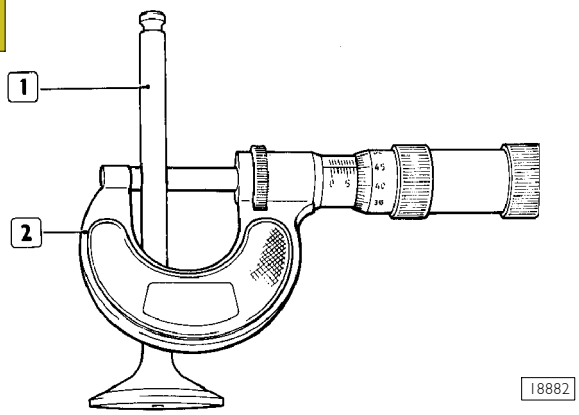
Valve descale, check and grind

Figure 88



Remove all carbon deposits from the valves using a wire brush.
Check that the valves show no signs of seizing, scoring or cracking.
Regrind the valve seats, if required, removing as little material as possible.

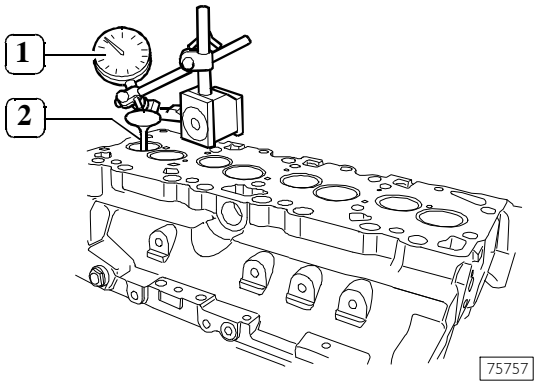
Figure 89



Use micrometer (2) to measure valve (1) stem: it must be 7.960 ÷ 7.980.

Checking clearance between valve stem and valve guide and centring valves

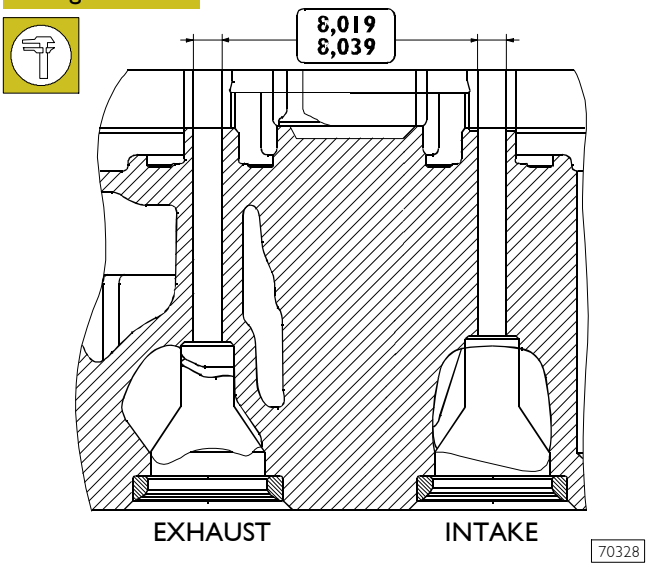
Figure 90



Use a magnetic-base dial gauge (1) set as shown, the assembling clearance must be 0.056 - 0.096 mm.
Making the valve (2) turn, check that the run out error is no greater than 0.03 mm.

VALVE GUIDES

Figure 91

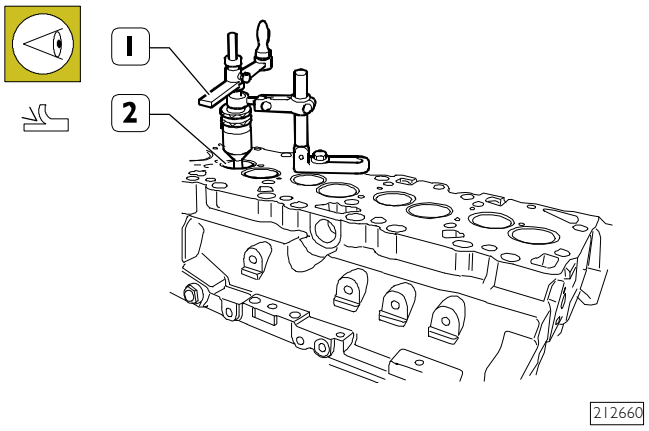


Use a bore gauge, measure the internal diameter of the valve guides; it must be equal to the value shown in the figure.

VALVE SEATS

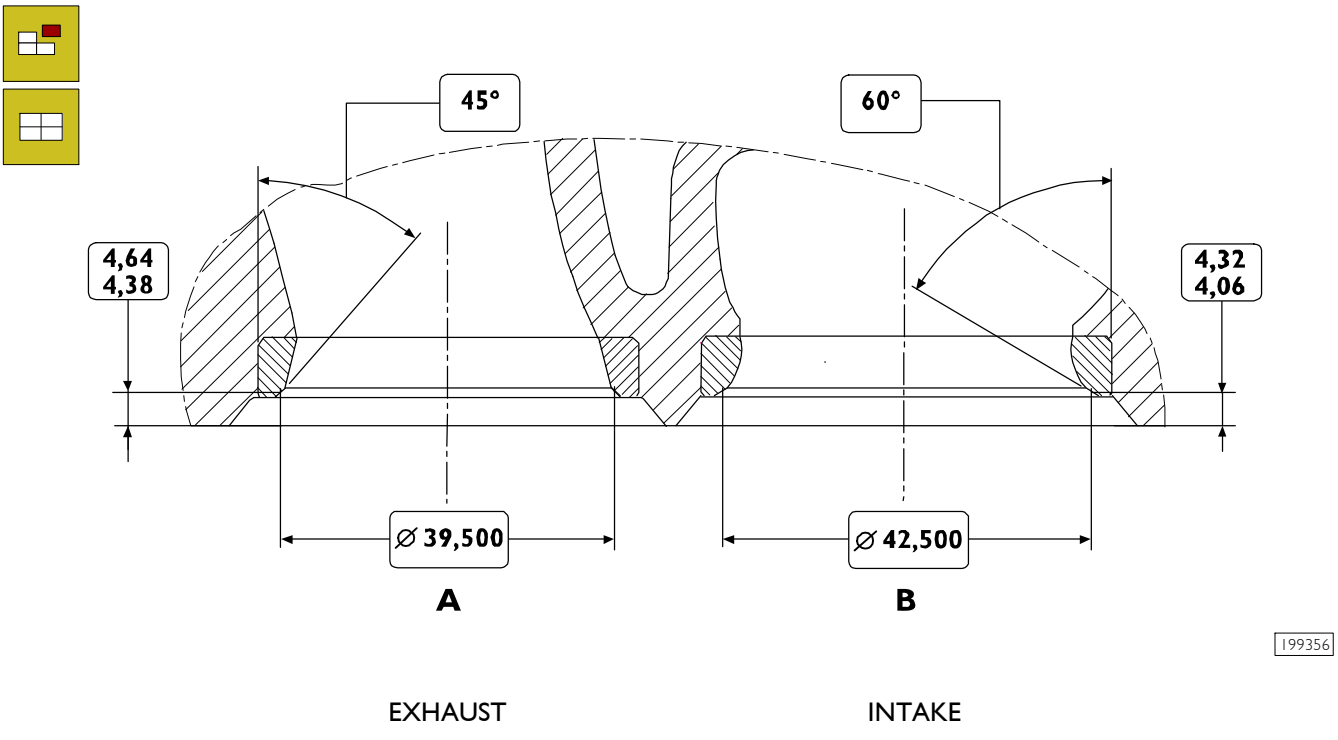
Regrinding - replacing the valve seats

Figure 92



Check the valve seats (2). If any scoring or burn marks are found, regrind with a suitable tool (1) according to the angles indicated in the following figure.

Figure 93



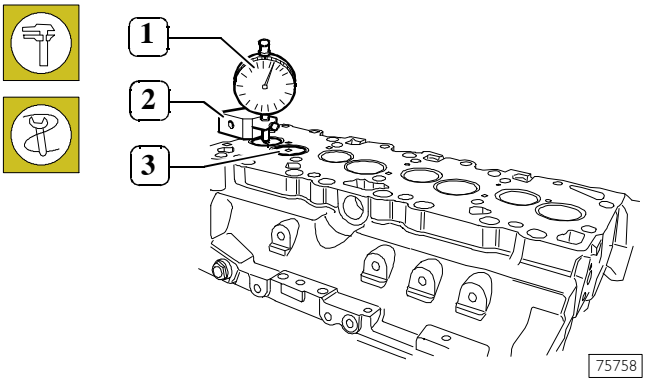
VALVE SEAT MAIN DATA

If valve seats cannot be restored just by regrinding, it is possible to replace them with spare seats. Using a specific tool and taking care not to nick the cylinder head, remove as much material as possible from the valve seats until they can be removed from the cylinder head with a punch.

Heat the cylinder head to 80 - 100°C and using a drift, fit the new valve seats which have already been cooled.

Then, using a suitable tool, regrind the valve seats to the values shown in the figure.

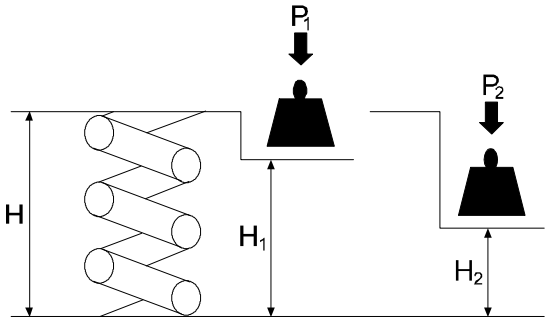
Figure 94



After regrinding, check that valve (3) recessing value is the specified one by using the stand 99370415 (2) and the dial gauge 99395603 (1).

VALVE SPRINGS

Figure 95



KEY DATA FOR CHECKING INTAKE AND EXHAUST VALVE SPRINGS

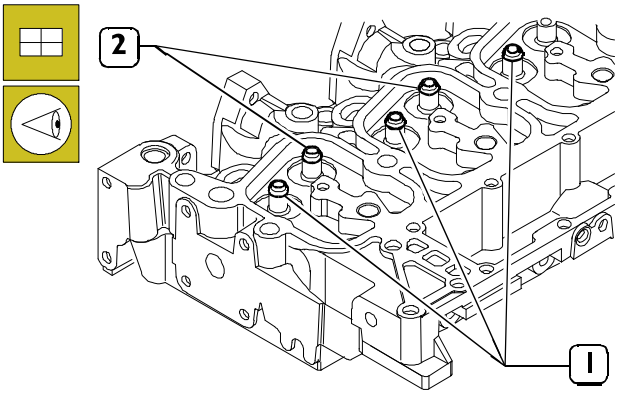
Before assembling, check the flexibility of the valve springs using the specific tool. Compare the elastic deformation and load data with those of the new springs shown in the following table.

Height		Under a load of
mm		N
H (free)	63.50/65.69*	0
H_1	49.02	329
H_2	38.20	641

* alternative assembling

Refitting valve assembly

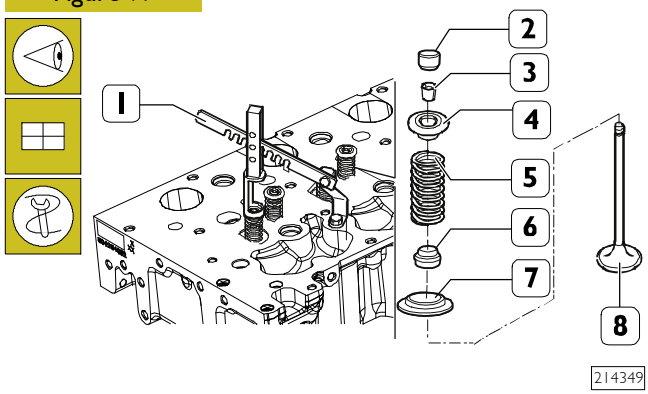
Figure 96



Fit the valve assembly:

- ❑ Fit the seal rings (1 and 2) on the relative valve guide.

Figure 97

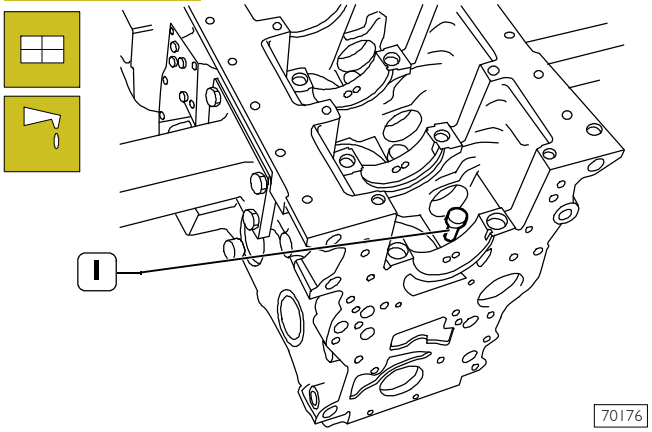


- ❑ Upturn the cylinder head and insert the oil seal (6), the spring seat (7) and the valve (8).
- ❑ Repeat this operation for all the valves.
- ❑ Upturn the cylinder head and insert the spring (5) and the plate (4).
- ❑ Valve assembly is carried out using tool 99360268 (1) and applying pressure on the plate (4) so that by compressing the spring (5), it is possible to insert the cotters (3) and the valve cap (2).

ENGINE ASSEMBLY AT BENCH (CRANKCASE COMPONENTS)

Refitting tappets

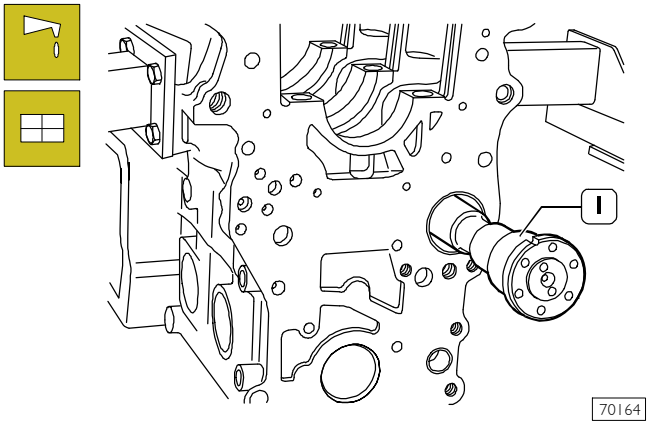
Figure 98



Lubricate the tappets (1) and fit them into the relevant housings on the crankcase.

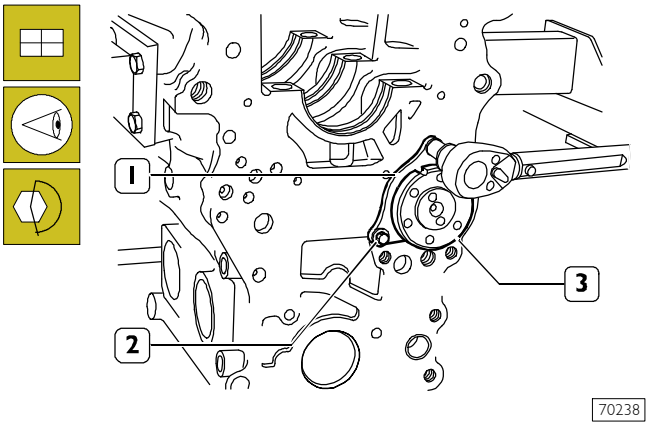
Camshaft refitting

Figure 99



Lubricate the camshaft support bushing and fit the camshaft (1) taking care not to damage the shaft support seats or bushing during this operation.

Figure 100

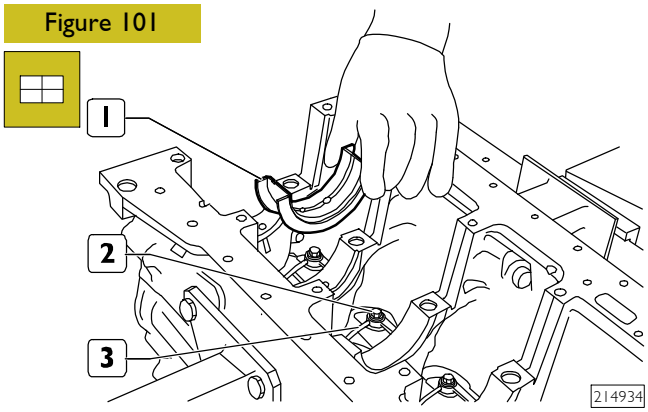


Position the camshaft (3) retaining plate (1) with the slot facing the top side of the crankcase and the marking facing the operator, tighten the screws (2) to the torque indicated in the table.

Ref.	No.	Description	Tightening torques
(2)	2	M8x1.25x16	24 ±4 Nm

Main bearings refitting

Figure 101



NOTE Refit the main bearings that have not been replaced, in the same position found at removal.

The main bearings (1) are supplied as spare parts undersized on the inner diameter by 0.25 - 0.50 - 0.75 - 1.00 mm.

NOTE Do not modify the bearings in any way.

Clean accurately the main half bearings (1) having the lubricating hole and fit them into their housings.

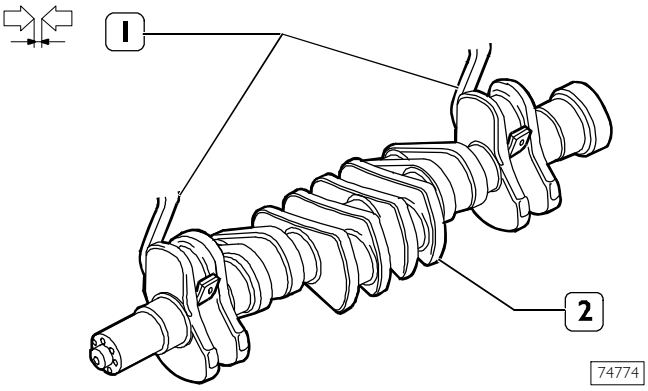
The second last main half bearing (1) is fitted with shoulder half rings.

Fit the nozzles (3) and tighten the screws (2) to the torque indicated in the table.

Ref.	No.	Description	Tightening torques
(2)	6	M8x1.25	15 ±3 Nm

Main journal assembly clearance measurement

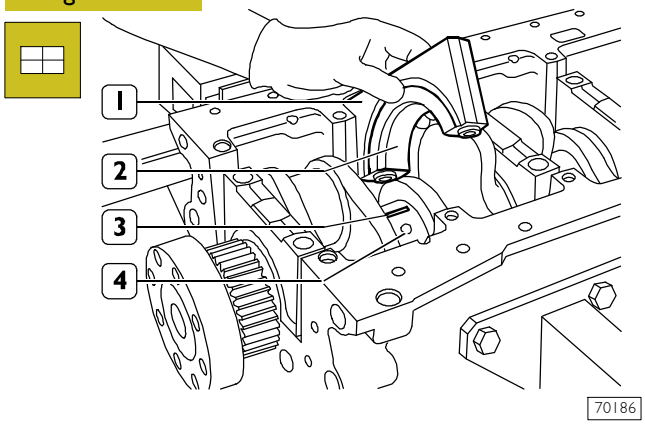
Figure 102



Install the crankshaft (2).

Check the clearance between the crankshaft journals and their bearings as follows:

Figure 103



- ❑ clean accurately the parts and remove any trace of oil;
- ❑ position a piece of calibrated wire (3) on the output shaft pins (4) so that it is parallel to the longitudinal axis;
- ❑ fit caps (1), including the half bearings (2) on the relevant supports.

NOTE Before re-using retaining screws take two measurements of the diameter as shown in the figure to identify diameters D1 and D2:
if D1 - D2 < 0.1 mm the screw can be reused

if D1 - D2 > 0.1mm the screw must be replaced

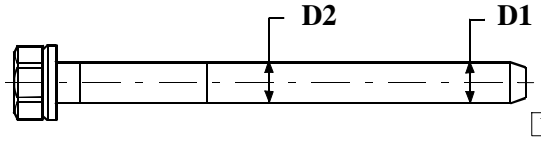
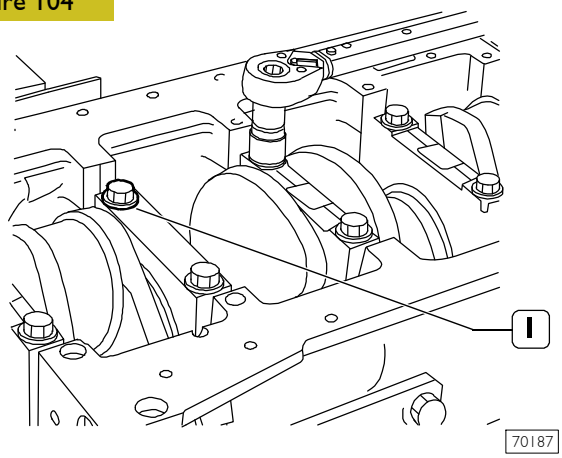


Figure 104



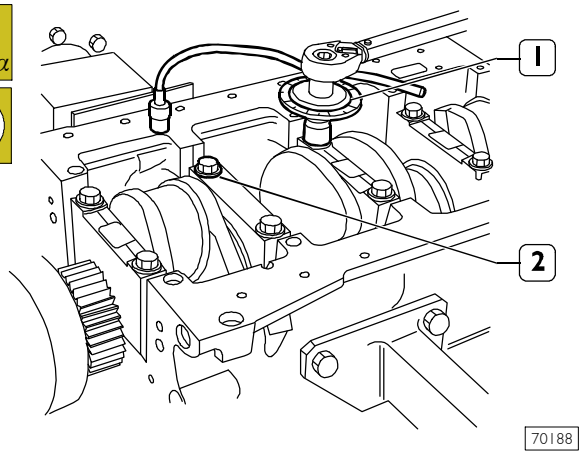
Screw in the pre-lubricated screws (1) in two phases:

- ❑ 1st phase with torque wrench;
- ❑ 2nd phase with tool 99395216.

Ref.	No.	Screws description	Tightening torques
(1)	14	Screw M12x1.5x120 1st phase 2nd phase	- 80 ± 6 Nm 90°

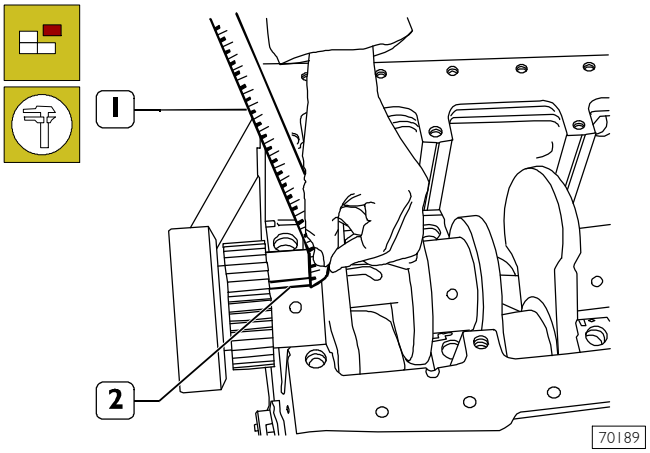
For the 2nd stage, apply tool 99395216 to the socket wrench as shown in the next figure.

Figure 105



Positioning of tool 99395216 (1) to close at an angle in the 2nd stage is shown in the previous table.

Figure 106



❑ Remove caps from supports.

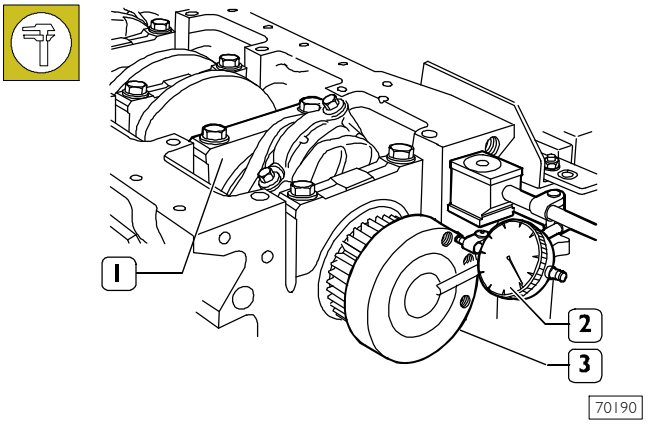
The clearance between the main bearings and journals is found by comparing the width of the calibrated wire (2) at the narrowest point with the scale on the envelope (1) containing the calibrated wire.

Numbers shown on the scale specify the clearance of coupling in millimetres.

If you find the clearance is not as required, replace the bearing shells and repeat the check; on obtaining the prescribed clearance, lubricate the main bearings and fit the supports permanently by tightening the fixing screws as described above.

Checking crankshaft end float

Figure 107

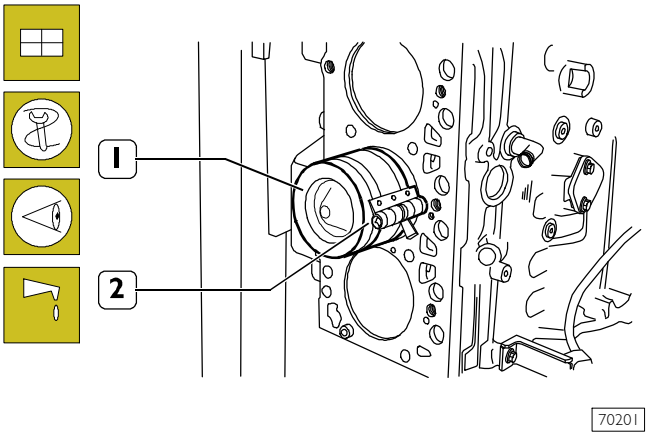


This check is performed by setting a magnetic-base dial gauge (2) on the output shaft (3) as shown in the figure, standard value is 0.068 ÷ 0.410 mm.

If higher value is found, replace main thrust half bearings of the second last rear support (1) and repeat the clearance check between crankshaft pins and main half bearings.

Fitting the connecting rod-piston assembly into the cylinder liners

Figure 108



Lubricate the pistons well, including the piston rings and the inside of the cylinder liners.
With the aid of 99360605 clamp (2), fit the connecting rod--piston assemblies (1) in the cylinder liners, checking that:

❑ the number of each connecting rod corresponds to the cap coupling number.

Figure 109

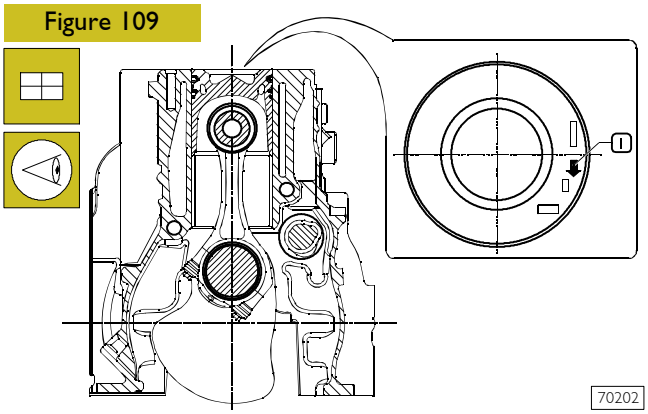


DIAGRAM FOR FITTING THE CONNECTING ROD-PISTON ASSEMBLY INTO CYLINDERS

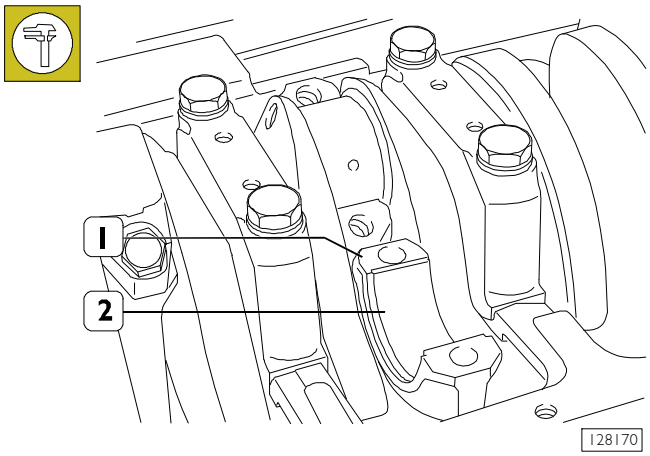
❑ the openings of the piston rings are offset by 120°;

❑ connecting rod-piston assemblies shall have the same weight;

❑ the arrow stamped on the piston crown shall be facing the front side of the engine block or the slot obtained on the piston skirt shall be corresponding to the oil nozzle position.

Crankpin assembly clearance measurement

Figure 110



Carry out the following operations to measure the clearance:

- ❑ carefully clean the parts and remove any trace of oil;
- ❑ fit the connecting rod caps (1) with the relevant half bearings (2).

NOTE Before re-using retaining screws take two measurements of the diameter as shown in the figure to identify diameters D1 and D2:
if D1 - D2 < 0.1 mm the screw can be reused

if D1 - D2 > 0.1mm the screw must be replaced

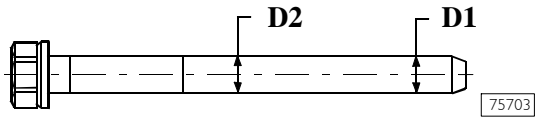
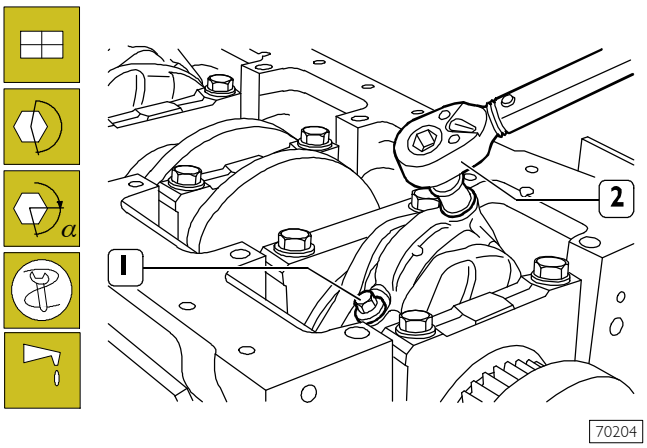


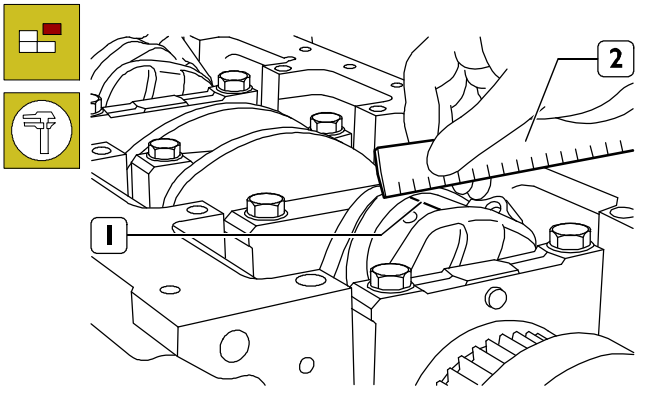
Figure 111



- ❑ Tighten the screws (1), pre-lubricated with engine oil, with a torque wrench (2) to the torque indicated in the table.
- ❑ For the 2nd phase, apply tool 99395216 (3) to the socket wrench.

Ref.	No.	Description	Tightening torque
(1)	12	M10x1.25 1st phase (with torque wrench) 2nd phase (with tool 99395216)	 60 ±5 Nm 60°

Figure 112

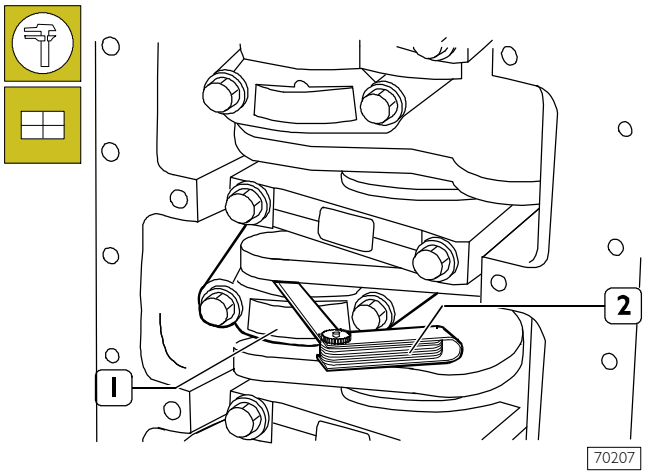


- ❑ Remove the cap and find the existing clearance by comparing the calibrated wire width (1) with the scale on the wire envelope (2).

If the clearance is not as prescribed, change the half bearings and repeat the check.

On obtaining the prescribed clearance, lubricate the connecting rod half bearings and fit them permanently by tightening the screws securing the connecting rod caps as described.

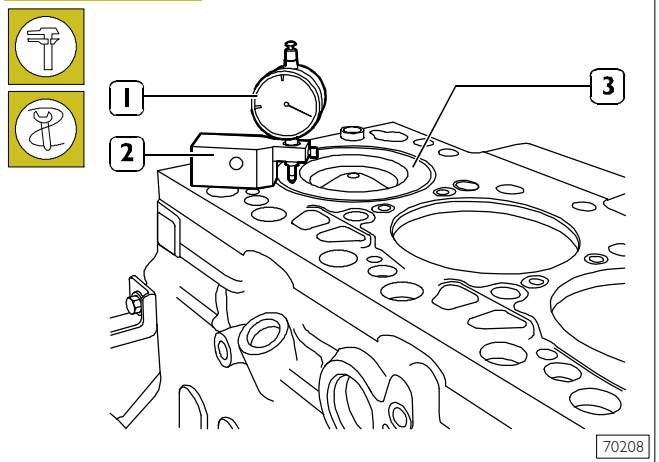
Figure 113



Manually check that the connecting rods (1) are sliding axially on the crankshaft pins and that their end float, measured with feeler gauge (2), is 0.250 - 0.275 mm.

Piston protrusion check

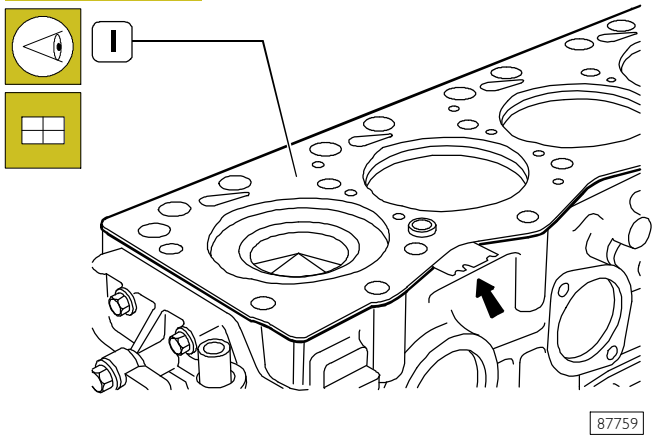
Figure 114



After fitting the connecting rod - piston assemblies, use the dial gauge 39395603 (1) fitted with base 99370415 (2) to check the protrusion of the pistons (3) at T.D.C. in relation to the top crankcase surface.

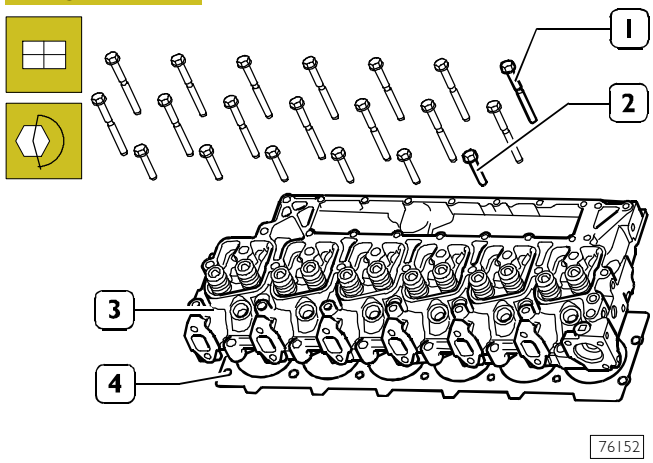
Protrusion must be 0.28 ÷ 0.52 mm.

Figure 115



Check that the mating surfaces of the cylinder head and crankcase are clean.
Keep the cylinder head gasket clean.
Position the cylinder head gasket (1) with the marking "ALTO" (1) facing the head.
The arrow shows the point where the gasket thickness is given.
The thickness of the gasket must be chosen according to the detected protrusion of the piston from the upper surface of the crankcase.

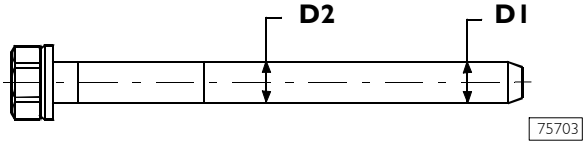
Figure 116



NOTE Before re-using the retaining screws (1) and (2), measure the diameters D1 and D2 twice as shown in the figure:

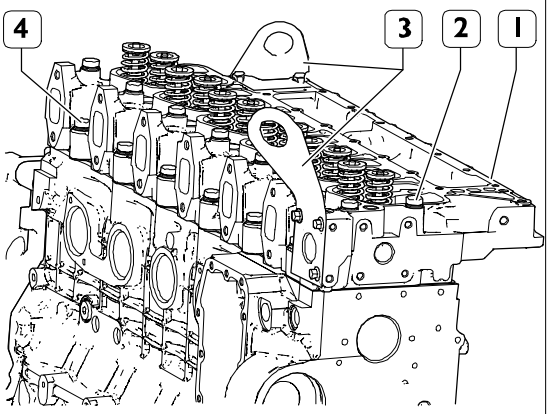
if D1 - D2 < 0.1 mm the screw can be reused

if D1 - D2 > 0.1mm the screw must be replaced



Using a hoister, position the cylinder head (3) on the crankcase, being careful not to damage the gasket (4).

Figure 117

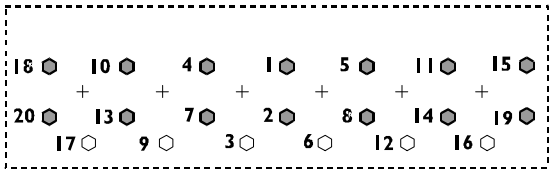


212623

Unhook the wire ropes from the lifting eyelets (3).

Screw the screws (2) and (4) fixing the cylinder head (1) in the same position found at removal, and tighten them to the torque values indicated below, in the sequence shown in the next figure.

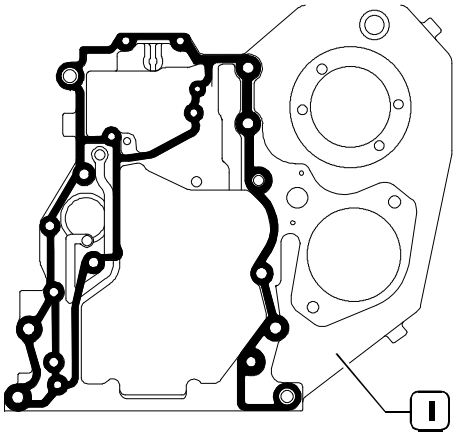
Figure 118



Ref.	No.	Description		Tightening torque
(4)	6	M12x70	1st phase 2nd phase	50 Nm 90°
(2)	7	M12x140	1st phase 2nd phase 3rdphase	40 Nm 90° 90°
(2)	7	M12x180	1st phase 2nd phase 3rdphase	70 Nm 90° 90°

Gear case refitting

Figure 119



75712

DIAGRAM OF AREA FOR APPLYING LOCTITE 5205 SEALANT ON THE GEAR HOUSING

❑ Carefully clean the timing gear case (1) and the crankcase.

Perfect seal is only obtained by cleaning accurately the surface to seal.

Smear the case with LOCTITE 5205 to obtain a bead of few mm diameter.

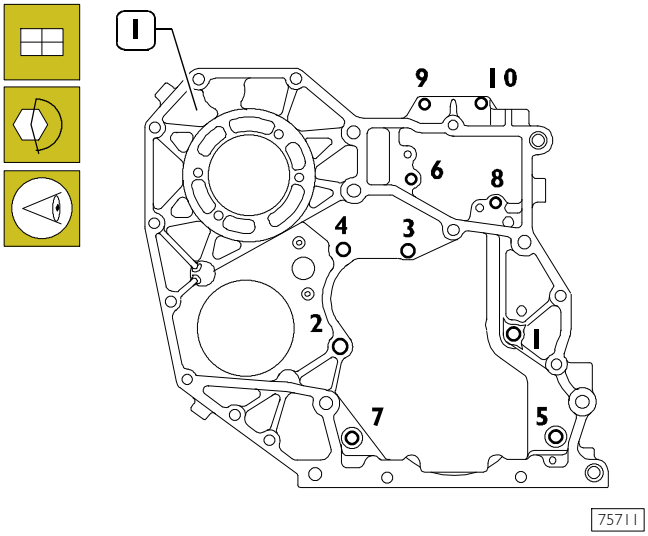
Application must be uniform (no lumps), without any air bubbles, thin areas or gaps.

Any flaws must be corrected in as short a time as possible.

Avoid using too much material to seal the joint. Excessive sealant could come out from joint sides and cause lubricant passage clogging.

The joints must be assembled within 10 minutes after applying the sealant.

Figure 120



75711

GEAR HOUSING FIXING SCREWS TIGHTENING SEQUENCE DIAGRAM

❑ Refit the case (1) to the engine block.

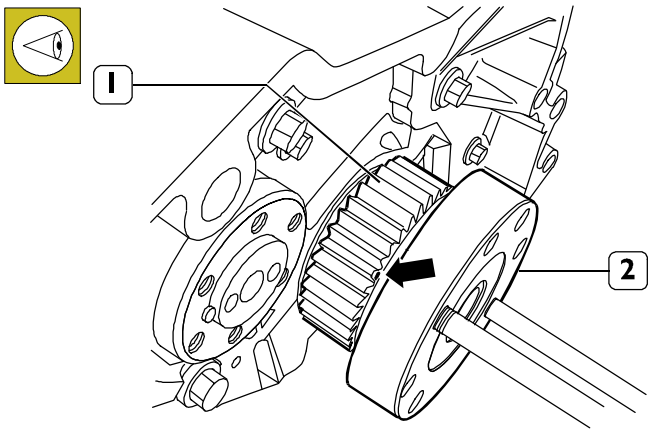
❑ Screw the ten fastening screws of the gear housing in the same position found at removal and tighten them to the torque indicated in the table, in the sequence shown in the figure.

Ref.	No.	Description	Tightening torques
2	1	M12x1.75x30	77 ±12 Nm
6,8,9, 10	4	M8x1.25x40	24 ±4 Nm
1,3,4, 5,7	5	M10x1.5x30	47 ±5 Nm

NOTE Before each assembly operation, check that the thread on the holes and the screws shows no sign of wear or dirt.

Camshaft gear refitting

Figure 121

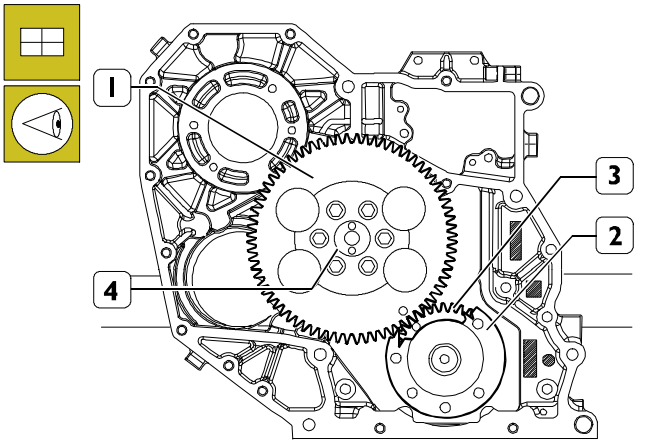


70211

❑ Use a felt-tip pen to highlight the drive gear tooth (1) fitted on the crankshaft (2) with a chamfer (▯) on its side for timing.

NOTE Screw in the two pins to facilitate crankshaft rotation.

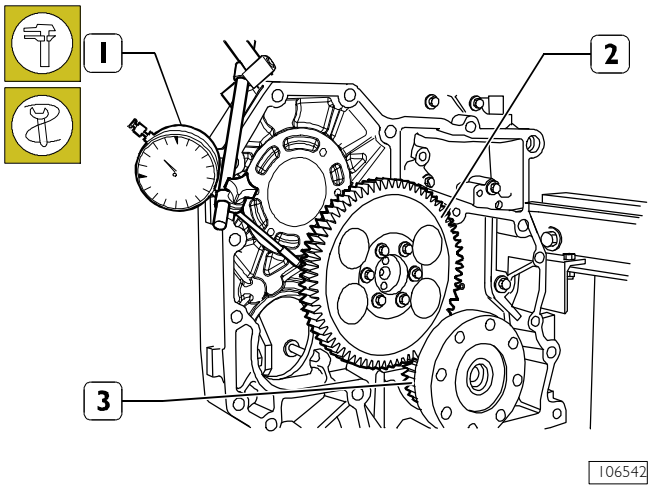
Figure 122



129300

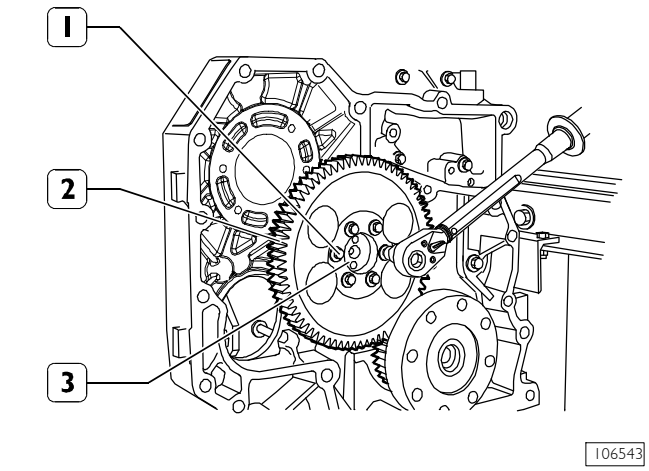
❑ When fitting the driven gear (1) on the camshaft (4), direct the crankshaft (2) so that the marks stamped on the two teeth of the driven gear (1) coincide with the bevel on the drive gear tooth (3).

Figure 123



❑ Set the dial gauge (1) on the timing gear (2) and check that the clearance between the gears (2) and (3) is between 0.076 ÷ 0.280 mm.

Figure 124

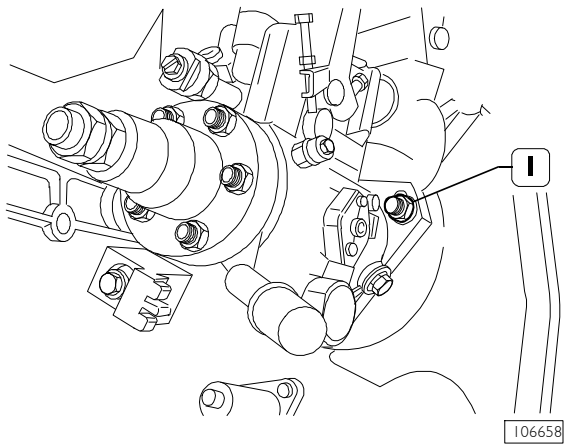


❑ Screw in the screws (1) securing the gear (2) to the camshaft (3) and tighten them to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(1)	6	M8x1.25	36 ±2 Nm

Refitting of feed pump gear and feed pump

Figure 125



When fitting the feed pump on the engine, the conditions of the T.D.C at the cylinder No. 1 at the end of the compression stroke must be met.

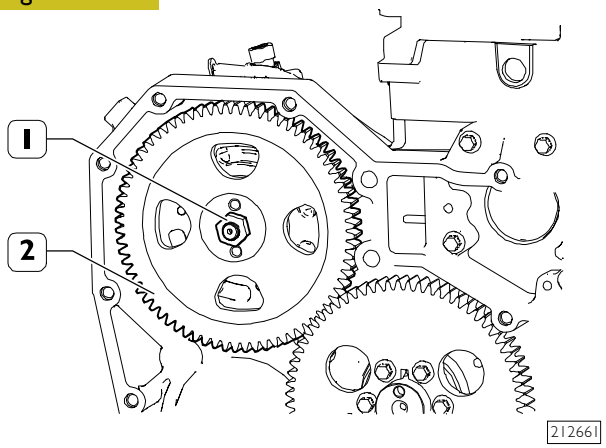
❑ Fit the preset pump into its seat on the engine, fitting the shaft into the hole of the gear (without key).

❑ Screw the nuts (1) fastening the fuel supply pump by locking the pump flange in the centre slot, then tighten to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(1)	3	M8x1.25	24 ±4 Nm

NOTE The gasket removed during pump disassembly must not be reused. Always use original spare parts.

Figure 126



Fit the command gear (2) on the feed pump spindle.

Insert the washer and screw the net (1) onto the pump spindle, then tighten it to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(1)	1	M14x1.5	90 ±5 Nm

Refitting engine flywheel housing

Figure 127

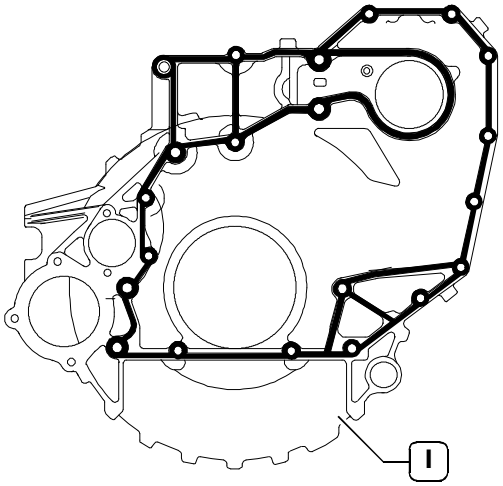


DIAGRAM OF AREA FOR APPLYING LOCTITE 5205 SEALANT ON THE FLYWHEEL COVER HOUSING

❑ Completely clean the flywheel cover housing (1) and the gear housing.

NOTE Perfect seal is only obtained by cleaning accurately the surface to seal.

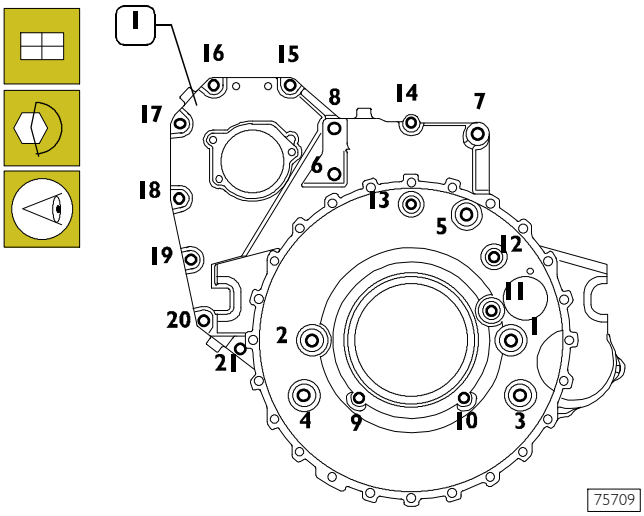
Smear the case with LOCTITE 5205 to obtain a bead of few mm diameter. Application must be uniform (no lumps), without any air bubbles, thin areas or gaps.

Any flaws must be corrected in as short a time as possible.

Avoid using too much material to seal the joint. Excessive sealant could come out from joint sides and cause lubricant passage clogging.

The joints must be assembled within 10 minutes after applying the sealant.

Figure 128



FLYWHEEL COVER HOUSING FIXING SCREWS TIGHTENING SEQUENCE DIAGRAM

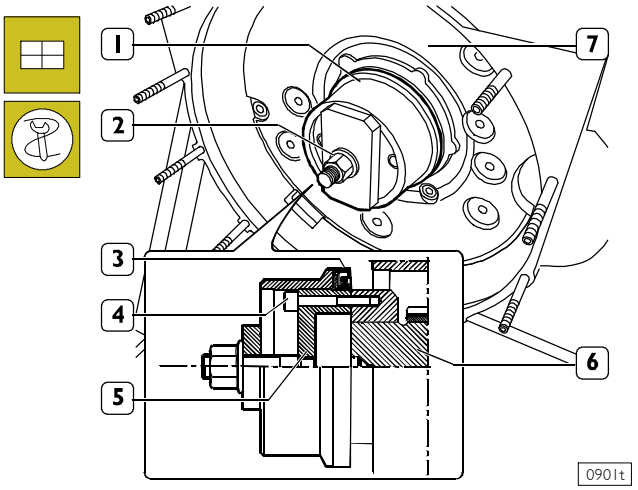
❑ Refit the housing (1) to the cylinder block and screw the fastening screws in the same position found at removal and tighten them to the following torque values in the sequence shown in the figure.

Ref.	No.	Description	Tightening torques
-	10	M12x1.75	85 ±10 Nm
-	11	M10x1.5	49 ±5 Nm

Before each assembly operation, check that the thread on the holes and the screws shows no sign of wear or dirt.

Refitting flywheel cover housing sealing ring

Figure 129

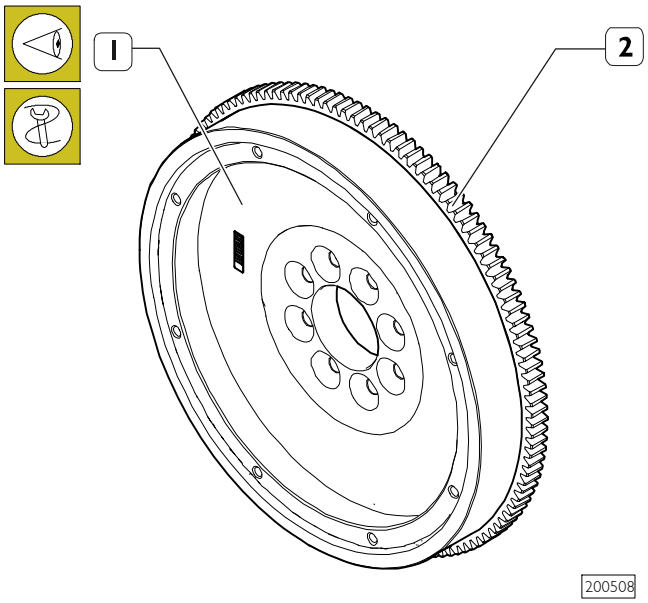


❑ Apply the tool 99346253 part (5) to the rear crankshaft tang (6), secure it by screws (4) and fit the new sealing ring (3).

❑ Position part (1) on part (5), screw nut (2) until completing sealing ring (3) fitting into flywheel housing (7).

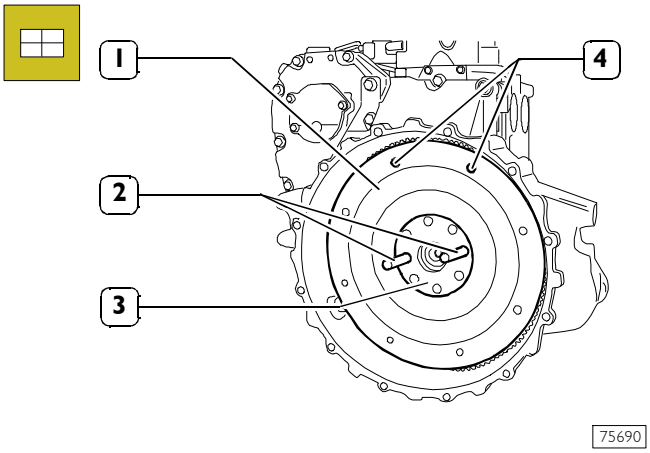
Refitting engine flywheel

Figure 130



❑ Check the condition of the ring gear teeth (2). If breakage or excessive wear of the teeth is found, remove the ring gear from the engine flywheel (1) using a general drift and fit the new one, previously heated to 150°C for 15 ÷ - 20 minutes; chamfering on ring gear inside diameter shall be facing the flywheel (1).

Figure 131

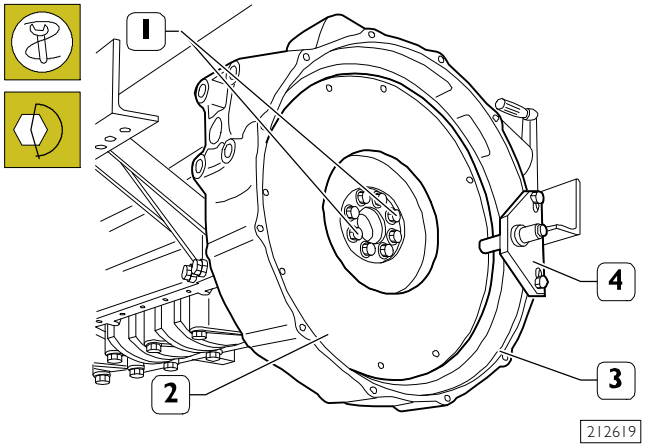


❑ Screw in two pull hooks or eyebolts in the flywheel (1) using the holes (4).

❑ Using a hoist, move the flywheel towards its seat inside the flywheel housing.

❑ Screw in two pins (2) of a suitable length into the shaft holes (3) and using them as a guide, fit the engine flywheel (1) positioning it correctly in the flywheel housing.

Figure 132



❑ Apply the tool 99360351 (4) to the flywheel housing (3), to stop the flywheel (2) rotation.

❑ Tighten the screws (1) securing the engine flywheel (2) to the torque.

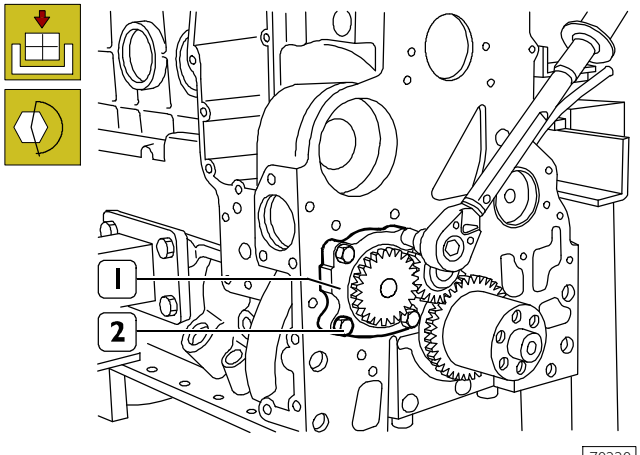
Ref.	No.	Description	Tightening torque
(1)	8	M12x1.25	50 ±5 Nm

NOTE Before each assembly operation, check that the thread on the holes and the screws shows no sign of wear or dirt.

ASSEMBLY OF ENGINE AT BENCH (COMPONENTS AT THE FRONT - PART 1)

Oil pump refitting

Figure 133



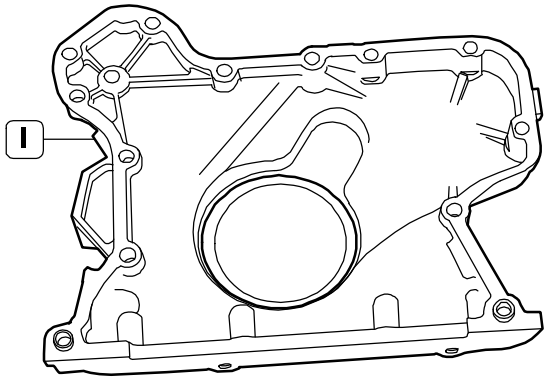
❑ Refit the mechanical rotor pump (1).

❑ Fit the fastening screws (2) and tighten them to the torque indicated in the table.

Ref.	No.	Description		Tightening torques
(2)	4	M8x1.25	1st phase 2nd phase	8 ±1 Nm 24 ±4 Nm

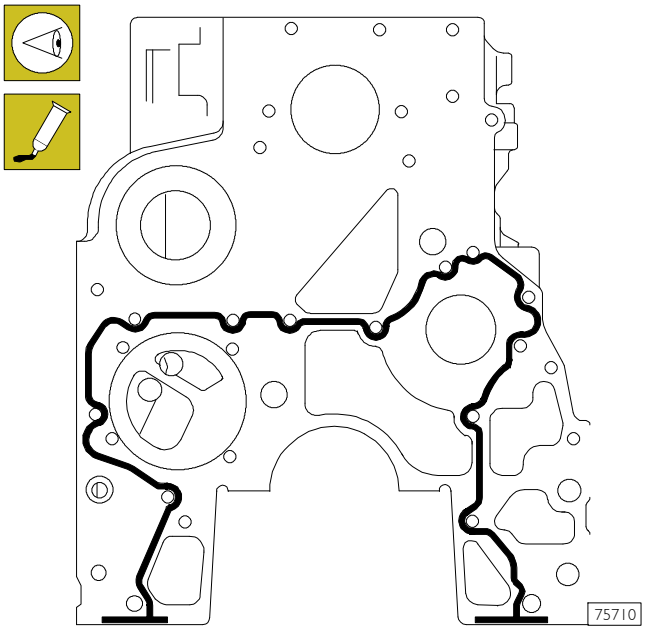
Front cover refitting

Figure 134



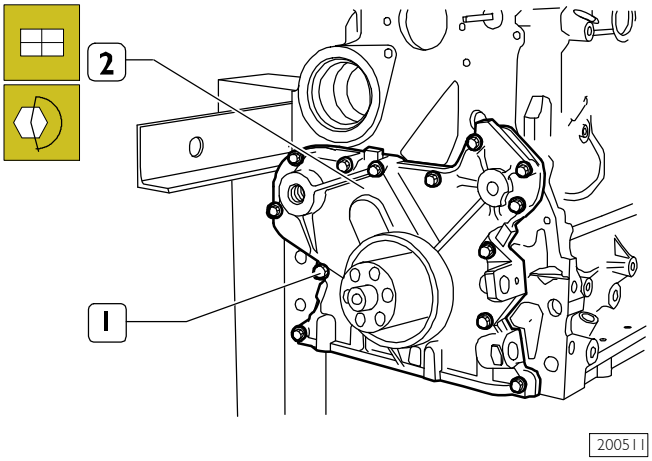
❑ Thoroughly clean the front cover (1) and the crankcase.

Figure 135



NOTE Perfect seal is only obtained by cleaning accurately the surface to seal.
Smear the case with LOCTITE 5205 to obtain a bead of few mm diameter.
Application must be uniform (no lumps), without any air bubbles, thin areas or gaps.
Any flaws must be corrected in as short a time as possible.
Avoid using too much material to seal the joint.
Excessive sealant could come out from joint sides and cause lubricant passage clogging.
The joints must be assembled within 10 minutes after applying the sealant.

Figure 136



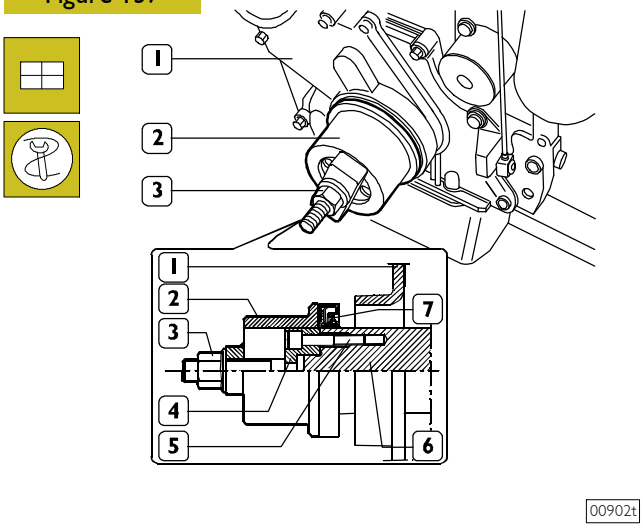
❑ Refit the front cover (2) to the crankcase.

❑ Screw the fastening screws of the plate (1) in the position they were in at disassembly, and tighten them to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(1)	13	M8x1.25	24 ±4 Nm

Refitting the engine - front cover sealing ring

Figure 137



❑ Apply tool 99346252 part (4) to the front crankshaft shaft (6), secure it by screws (5) and fit the new sealing ring (7).

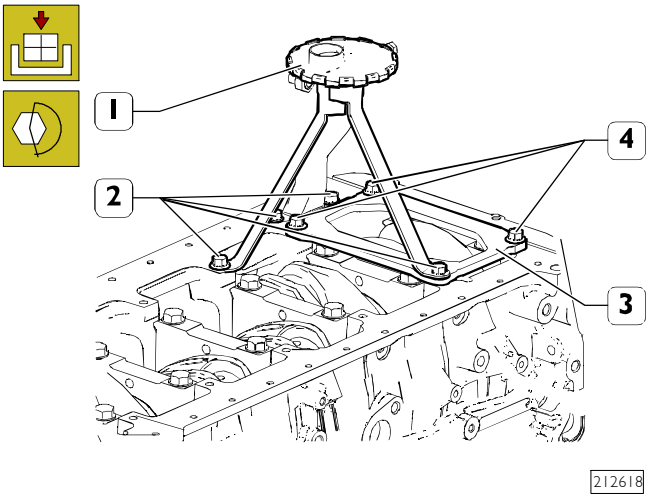
❑ Position part (2) on part (4); screw down the nut (3) to fit the seal (7) fully inside the front cover (1).

ASSEMBLY OF ENGINE AT BENCH (COMPONENTS AT THE BOTTOM)

Overturn the engine

Suction strainer refitting

Figure 138



- ❑ Reattach the stiffening plate (3) and the strainer (1) complete with gasket and bracket to the crankcase.
- ❑ Screw the fastening screws (2) of the strainer (1) to the crankcase and tighten them to the torque indicated in the table.

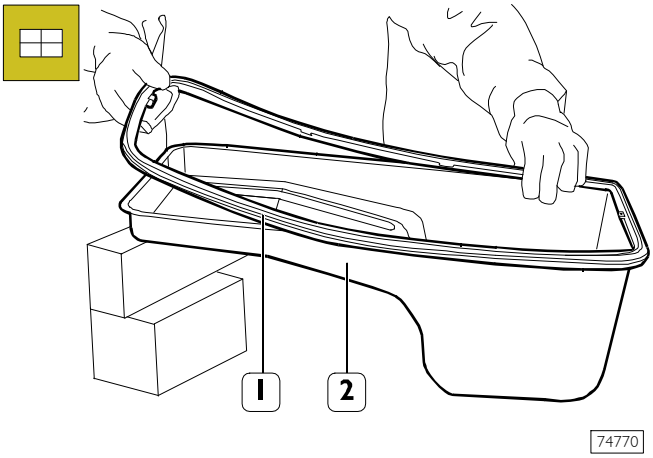
Ref.	No.	Description	Tightening torque
(2)	3	M8x1.25	24 ±4 Nm
(2)	1	M10x1.5	43±5 Nm

- ❑ Screw the four fastening screws (4M10x1.5) of the plate strainer (3) and tighten them to the torque indicated in the table

Ref.	No.	Description	Tightening torque
(4)	3	M10x1.5	43 ±5 Nm

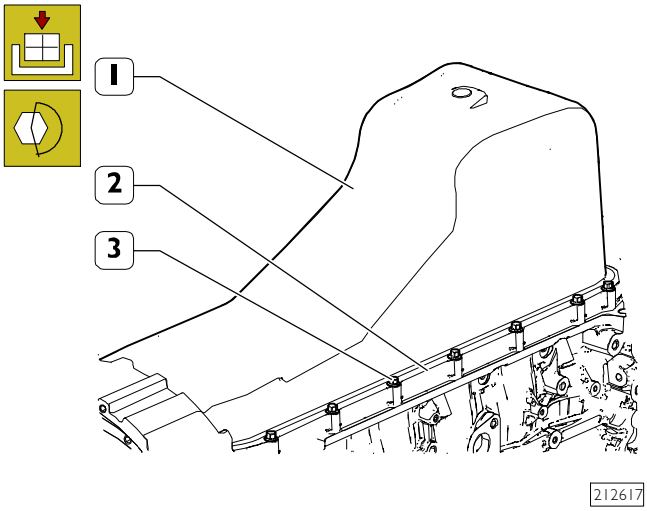
Oil sump refitting

Figure 139



- ❑ Set the new gasket (1) on the oil sump (2).

Figure 140



NOTE Before each assembly operation, check that the thread on the holes and the screws shows no sign of wear or dirt.

- ❑ Fit the oil sump (1) and apply the plate (2) to it.
- ❑ Screw the fastening screws (3) of the oil sump (1) and tighten them to the torque indicated in the table.

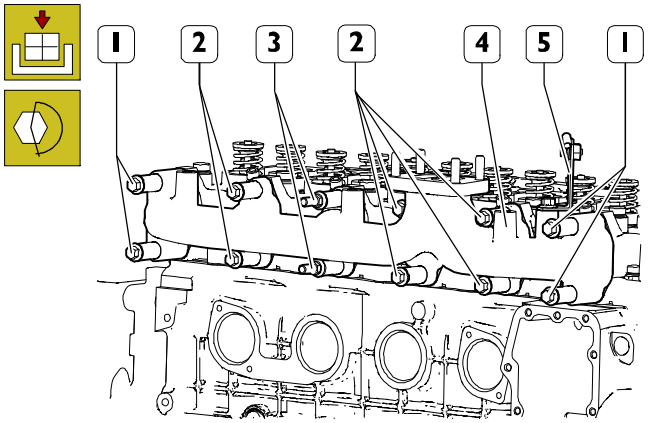
Ref.	No.	Description	Tightening torque
(3)	18	M8x1.25	24 ±4 Nm

ASSEMBLY OF ENGINE AT BENCH (SIDE COMPONENTS)

Overturn the engine.

Refitting exhaust manifold;

Figure 141



212664

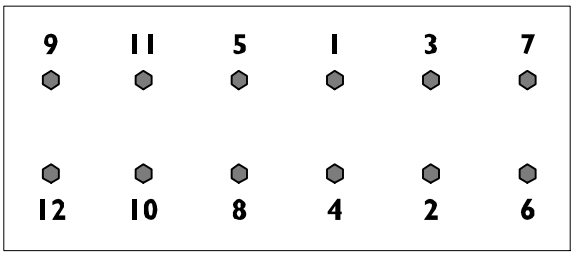
Mount the exhaust manifold (4) together with the gaskets.

Mount the bracket (5) on the exhaust manifold (4).

Screw in the screws (1), (2) and (3) fastening the exhaust manifold (4), with their respective spacers, to the cylinder head and tighten to the torque indicated in the table in the sequence shown in the next figure.

Ref.	No.	Description	Tightening torque
(1)	4	M10x1.5x95	55 ±3 Nm
(2)	6	M10x1.5x65	55 ±3 Nm
(3)	2	M10x1.5x65 (with external threading)	55 ±3 Nm

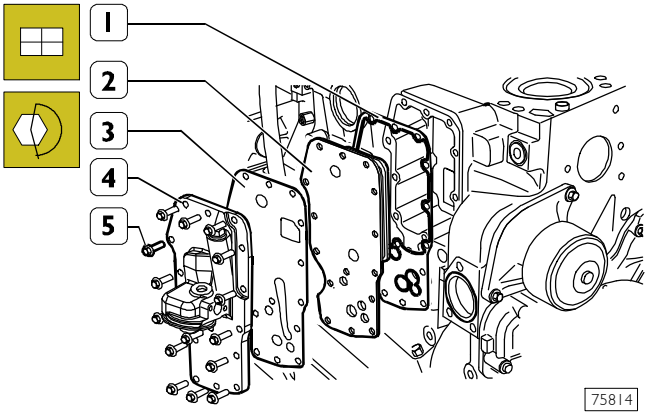
Figure 142



212651

Lubricant heat exchanger refitting

Figure 143



75814

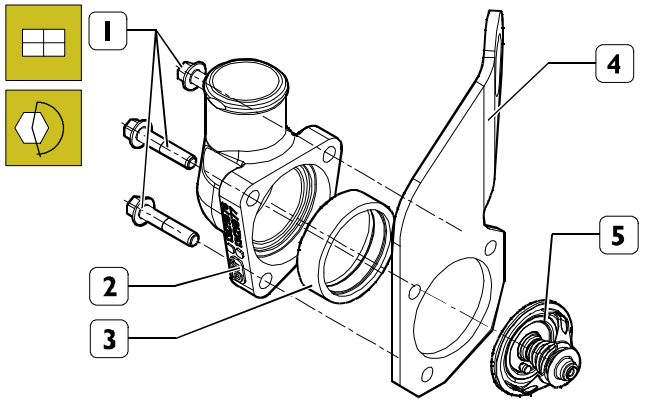
❑ Fit on the crankcase: a new gasket (1), the heat exchanger (2) a new gasket (3) and the oil filter support (4).

Ref.	No.	Description	Tightening torque
(5)	15	M8x1.25x35	26 ±4 Nm

NOTE Before each assembly operation, check that the thread on the holes and the screws shows no sign of wear or dirt.

Thermostat body refitting

Figure 144



127122

❑ Fit the thermostat body (2), complete with thermostat (5) and gasket (3).

❑ Screw the screws (1) fastening the thermostat body (2) to the cylinder head, then tighten them to the torque specified in the table.

Ref.	No.	Description	Tightening torque
(1)	3	M8x1.25	-

NOTE The screws (1) were used to fix the bracket (4).

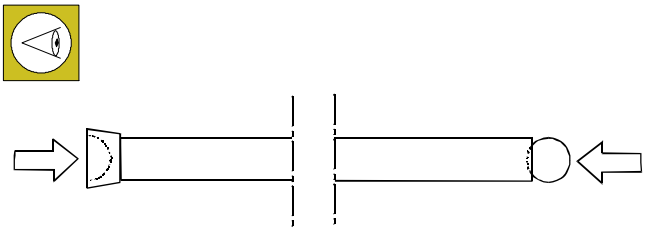
Remove the bracket and refit the parts from 1 to 5 as shown in the figure.

The gasket (3) must be new.

ASSEMBLY OF ENGINE AT BENCH (COMPONENTS AT THE TOP- PART 2)

Refitting rocker assembly

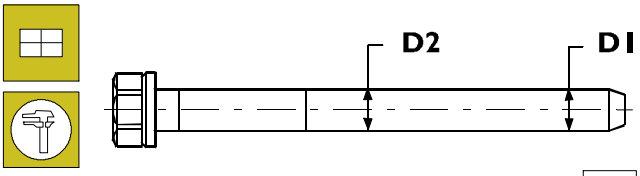
Figure 145



122587

Before assembly, check the rocker arm rods: there must be no sign of any deformation; the spherical seats for contact with the rocker arm adjusting screw and with the tappets (arrows) must show no trace of seizure or wear; if they do, replace them. Intake and exhaust valve control rods are identical and are therefore interchangeable.

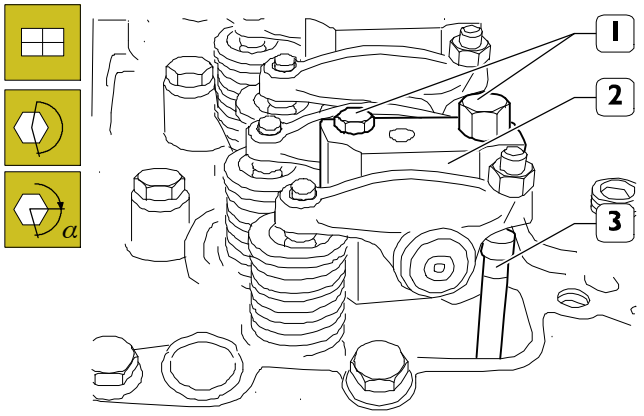
Figure 146



75703

- ❑ Insert the rocker arm assembly and the tappet cover rods. Before re-using the fastening screws take two measurements of the diameter as shown in the figure to identify diameters D1 and D2:
  if D1 - D2 < 0.1 mm the screw can be reused
  if D1 - D2 > 0.1mm the screw must be replaced

Figure 147



208020

- ❑ Fit the rocker arm support (2) onto the cylinder head.
- ❑ Ensure that the rocker arm rods (3) are correctly positioned in their seats.
- ❑ Screw the screws (1) fastening the rocker arm support (2) to the cylinder head, then tighten them to the torque specified in the table.

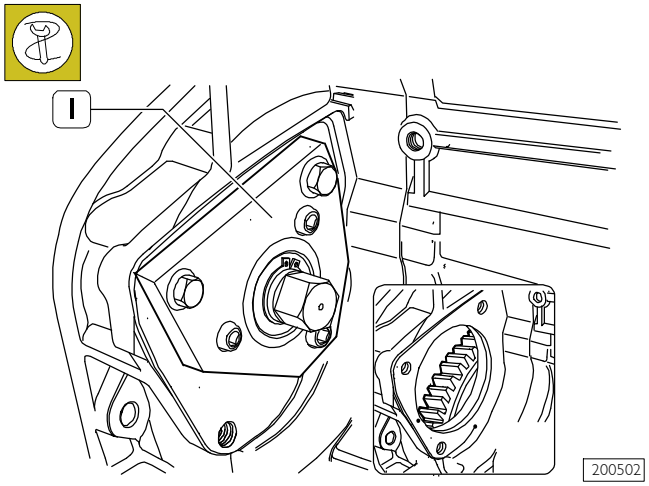
Ref.	No.	Description		Tightening torque
(1)	6	M8x1.25X75		24 ±3 Nm
(1)	6	M12x1.75x180	1st phase 2nd phase 3rd phase	70 ±5 Nm 90° 90°

NOTE NOTE The six screws 180 mm in length must be tightened in several phases until all of them are tightly closed, then rotate them 90°+90°.

Setting rocker free play

Preliminary operations

Figure 148

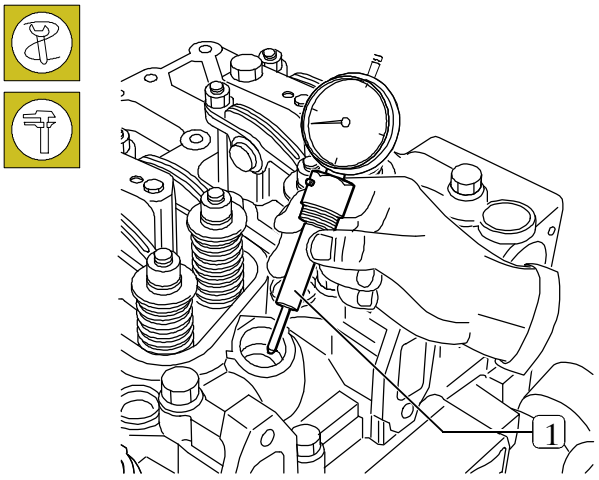


200502

- ❑ Fit tool 99360221 (1) to rotate the flywheel with the help of a wrench.

Identifying top dead centre with tool (99395097) - False injector

Figure 149



88141

Identifying the cylinder top dead centre position at the end of the compression stroke:

- ❑ position tool 99395097 (1) in the seat of the injector;
- ❑ preload dial gauge 99395604.

The required condition is obtained by turning the crankshaft appropriately until the maximum value is read on the dial gauge and making sure that the intake and exhaust valves of the relative cylinder are both closed and not balanced.

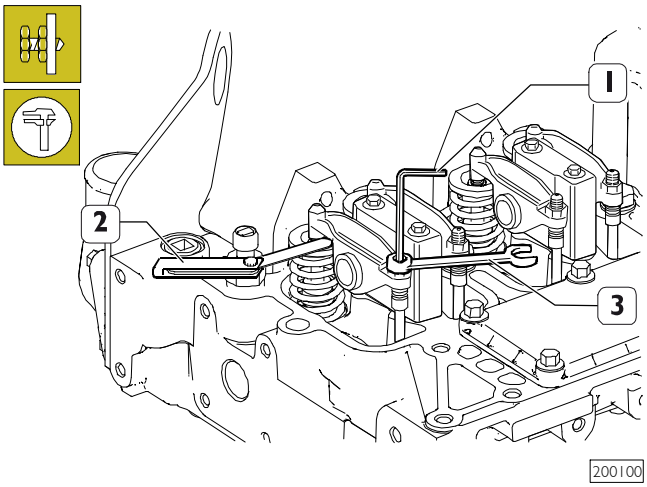
- ❑ Adjust the 1st cylinder valve clearance as described in the paragraph "Adjustment".
- ❑ At this point, appropriately turn the crankshaft as shown in the Table to adjust the rocker arm clearance of the other cylinders.

FIRING SEQUENCE 1-5-3-6-2-4

Crankshaft start and rotation	Rocker arm clearance adjustment intake and exhaust valves - cylinder No.
Cyl n.1 at TDC	1
Turn 120°	5
Turn 120°	3
Turn 120°	6
Turn 120°	2
Turn 120°	4

Adjustment

Figure 150



200100

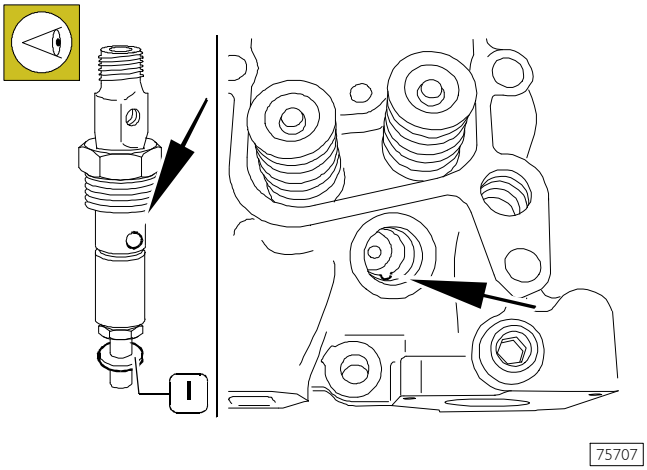
Adjust the clearance between the rocker arms and valves using an Allen wrench (1), a box wrench (3) and feeler gauge (2).

The clearance is:

- 0.25 ± 0.05 mm for the intake valve.
- exhaust valves 0.50 ± 0.05 mm.

Injector refitting

Figure 151



75707

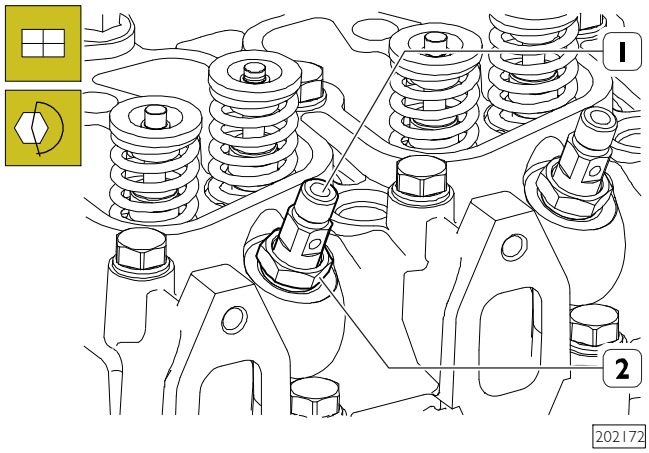
Assemble the injectors:

NOTE If compression in the cylinders is to be checked, using tool 99360344, leave the injector disassembled.

- ❑ Only assemble the injectors after having replaced the sealing gasket (1).

NOTE While carrying out injector assembly operations, check that the ball on the injector is at the engine head seat.

Figure 153

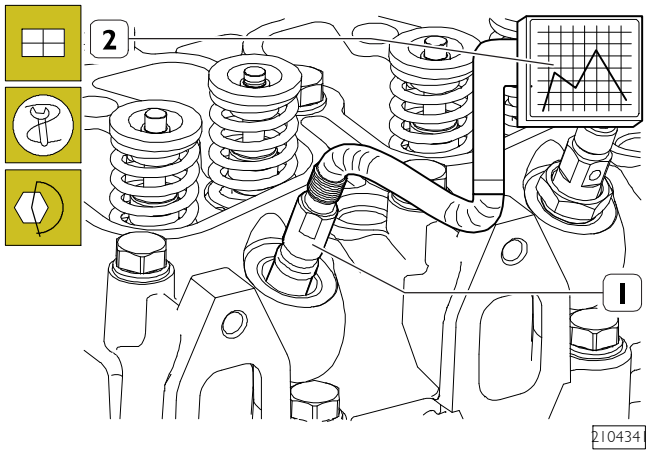


❑ Tighten the ring nut (2) securing the injectors (1).

Ref.	No.	Screws description	Tightening torques
(2)	6	Ring nut M24x1.5	44 ± 4 Nm

Procedure for checking compression in the cylinders using tool 99360344

Figure 152



❑ Fit tool 99360344 (1).

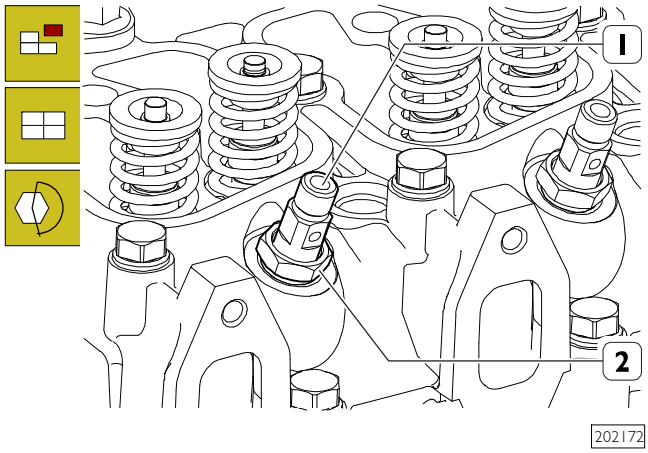
❑ Connect it to tool 99395382 (2).

❑ Manually actuate the engine flywheel in order to turn the engine.

❑ Tool 99395382 (2) traces the pressure trend inside the cylinder according to the combustion chamber.

Ref.	No.	Screws description	Tightening torques
(1)	1	Tool M24x1.5	60 ± 5 Nm

Figure 154

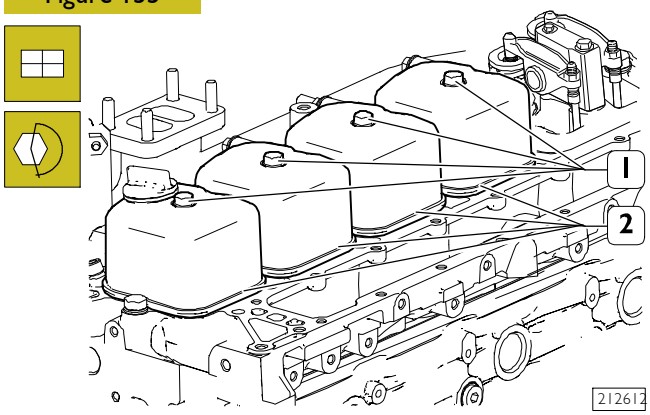


❑ Disassemble the tool 99360344.

❑ Tighten the ring nut (2) securing the injectors (1).

Refitting tappet cover

Figure 155



❑ Fit the four tappet covers (2) with their respective gaskets.

❑ Insert the sealing plugs, then tighten the four fastening screws (1) securing the tappet covers (2) to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(1)	4	M8x1.25	24 ±4 Nm

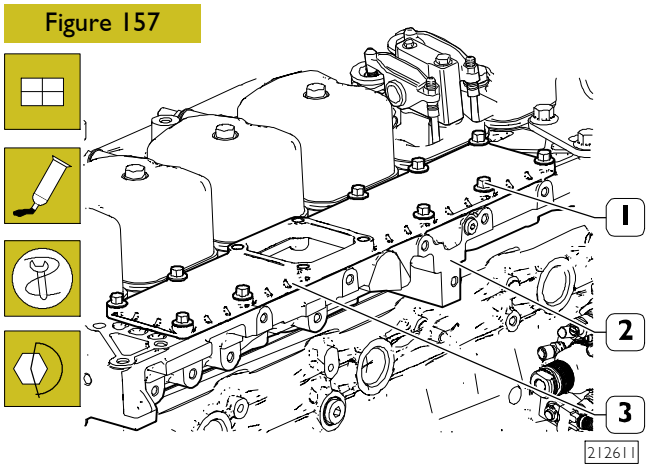
NOTE Always put in new gaskets.

Check the threading of the fastening screws: there should be no signs of wear or build-up of dirt.

The seal plugs must not show any deformations. Otherwise, replace with new parts.

NOTE The tappet cover for cylinders 5-6 will be fitted when the fuel pipes are refitted.

Figure 157



- ❑ Apply a bead of LOCTITE 5999 on the exhaust manifold plate mating surface (3).
- ❑ Fit the intake manifold plate (3) on the cylinder head (2) and screw the fastening screws (1) to the torque indicated in the table.

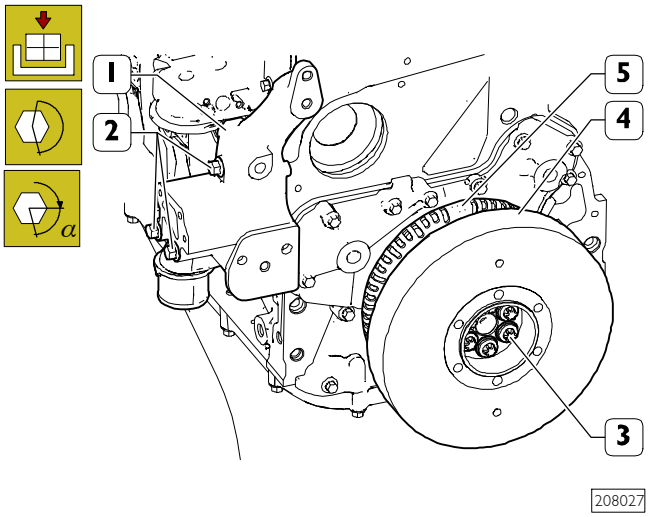
Ref.	No.	Description	Tightening torque
(1)	10	M8x1.25x25	24 Nm

NOTE Check that the intake manifold plate (3) is oriented correctly as shown in the figure (the shorter part near the air inlet hole must face the front end of the engine).

ASSEMBLY OF ENGINE AT BENCH (COMPONENTS AT THE FRONT - PART 2)

Refitting of alternator support - damper and crankshaft pulley

Figure 156



- ❑ Key the pulley (5) complete with spacer on the crankshaft.
- ❑ Install the damper (4) on the pulley (5).
- ❑ Fit the fastening screws (3) and tighten them to the torque indicated in the table.

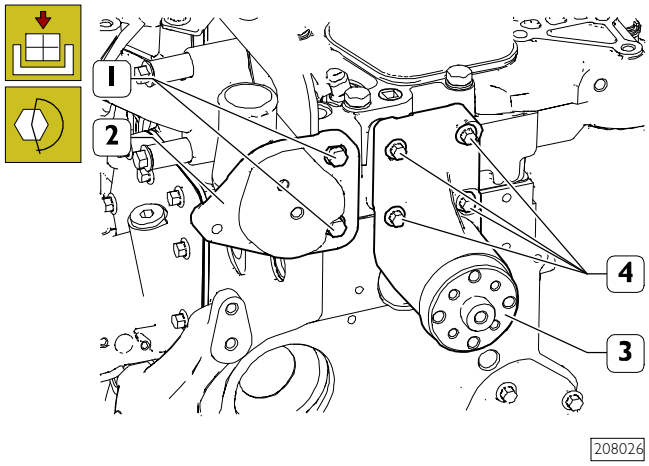
Ref.	No.	Description		Tightening torques
(3)	6	M12x1.25	1st phase 2nd phase	50 ±5 Nm 90°

- ❑ Install the alternator support (1)
- ❑ Fit the fastening screws (2) and tighten them to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(2)	2	M10x1.5x135	43 ±6 Nm
(2)	1	M10x1.5x70	43 ±6 Nm

Refitting the fan support and automatic belt tensioner support

Figure 158



- ❑ Install the fan mount (3).
- ❑ Fit the fastening screws (4) and tighten them to the torque indicated in the table.

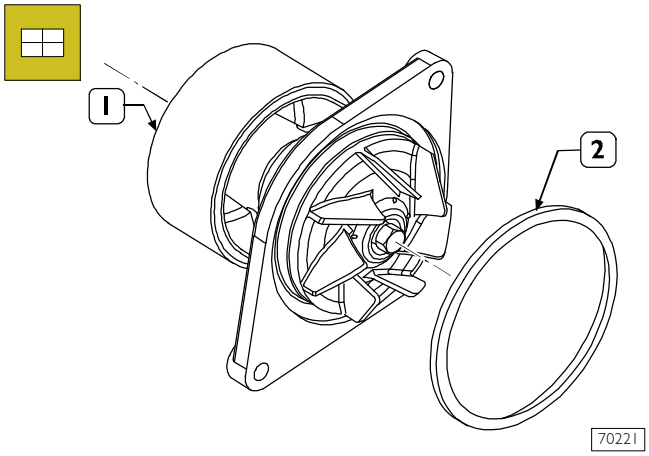
Ref.	No.	Description	Tightening torque
(4)	4	M8x1.25	-

- ❑ Install the automatic belt tensioner support (2).
- ❑ Fit the fastening screws (1) and tighten them to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(1)	2	M8x1.25	-

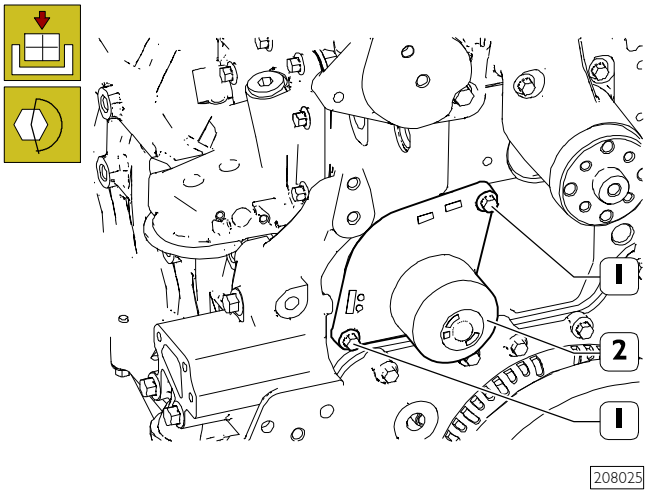
Refitting the water pump and alternator support bracket

Figure 159



- ❑ Apply a new seal ring (2) to the water pump (1).

Figure 160

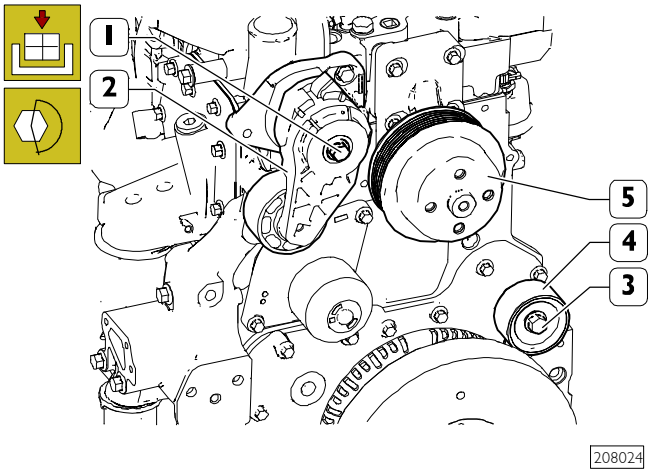


- ❑ Install the water pump (2).
- ❑ Fit the fastening screws (1) and tighten them to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(1)	2	M8x1.25	24 ±4 Nm

Refitting automatic belt tensioner - fan pulley and fan control pulley

Figure 161



- ❑ Install the fan control pulley (5) on the fan mount.
- ❑ Install the guide pulley (4); Fit the fastening screw (3) and tighten it to the torque indicated in the table.

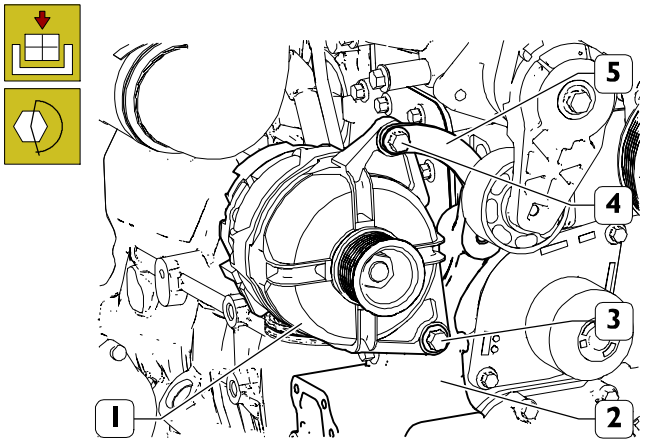
Ref.	No.	Description	Tightening torque
(3)	1	M10x1.5	45±5 Nm

❑ Install the automatic tensioner (2); Fit the fastening screw (1) and tighten it to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(1)	1	M10x1.5x80	-

Refitting alternator

Figure 162



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❑ Fit the bracket (5) on the alternator support (2) without locking the fastening screw.

❑ Fit the alternator (1) onto the support (2).

❑ Screw in the screws (4) fixing the bracket (5) to the alternator (1) without locking it.

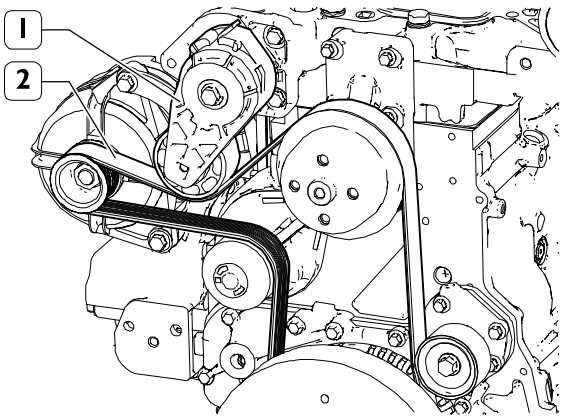
❑ Screw in the screws (3) fixing the alternator (1) to the support (2) without locking it.

❑ Tighten the fastening screws (3) and (4) to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(3)	1	M10x1.5	43±6 Nm
(4)	2	M10x1.5	43±6 Nm

Refitting auxiliary device drive belts

Figure 163



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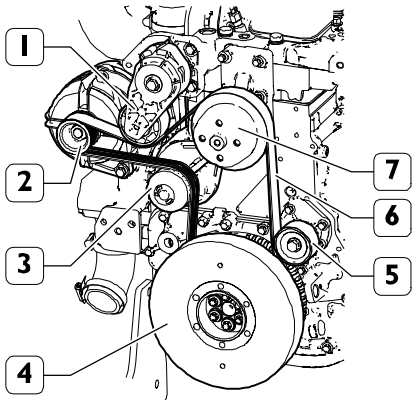
NOTE If refitting the belt that was previously removed, carefully examine it for cuts or signs of giving way.

❑ With a suitable tool, move the automatic tension belt (1) and put the auxiliary device drive belt (2) on the shoulders as indicated in the next figure Fully rotate the crankshaft to ensure that the new auxiliary device drive belt (2) has been correctly fitted.

Figure 164



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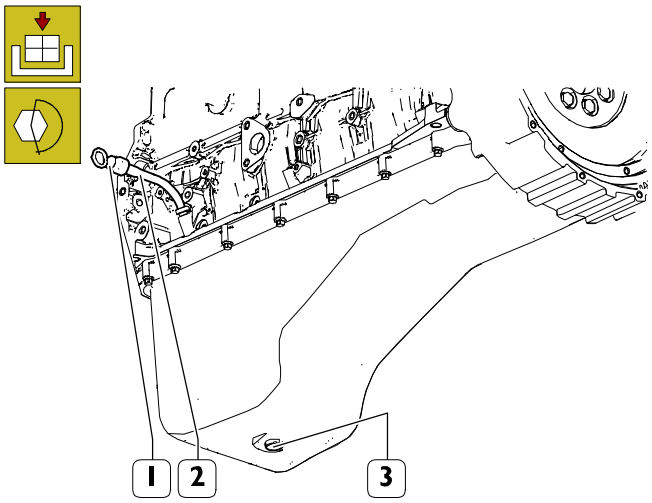
AUXILIARY DEVICE DRIVE BELT ASSEMBLY DIAGRAM
1. Automatic tensioner □ 2. Alternator pulley - 3. Water pump pulley - 4. Crankshaft pulley - 5. Guide pulley - 6. Auxiliary device drive belt - 7. Fan pulley

Refitting oil dipstick guide tube and oil sump plug

Figure 165



- ❑ Screw the oil dipstick (1) guide tube (2) to the crankcase.
- ❑ Screw in the oil drain plug (3) and tighten to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(3)	1	M22x1.5	40±10 Nm

Refill the engine oil as shown in Section 4 - Scheduled maintenance.

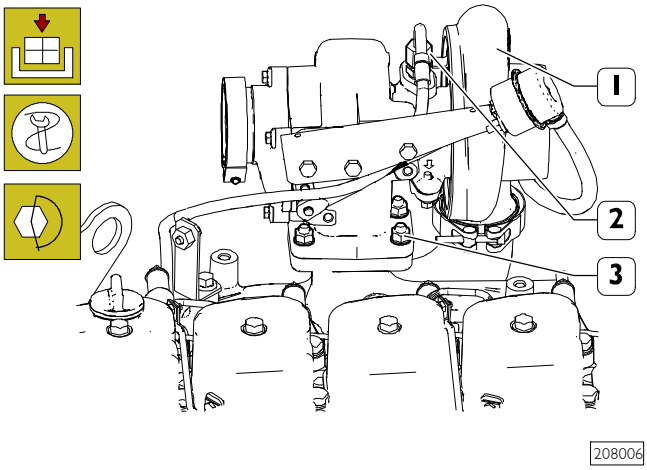
Removing the engine from the rotating stand

To complete the engine assembly operations, remove the rotating stand.

- ❑ Using the arm 99360595 support the engine and unscrew the screws securing the brackets to the rotating stand 99322205.
- ❑ Place the engine on a wooden support and remove the brackets 99361037 .

Refitting turbocharger and turbocharger lubrication pipes

Figure 166



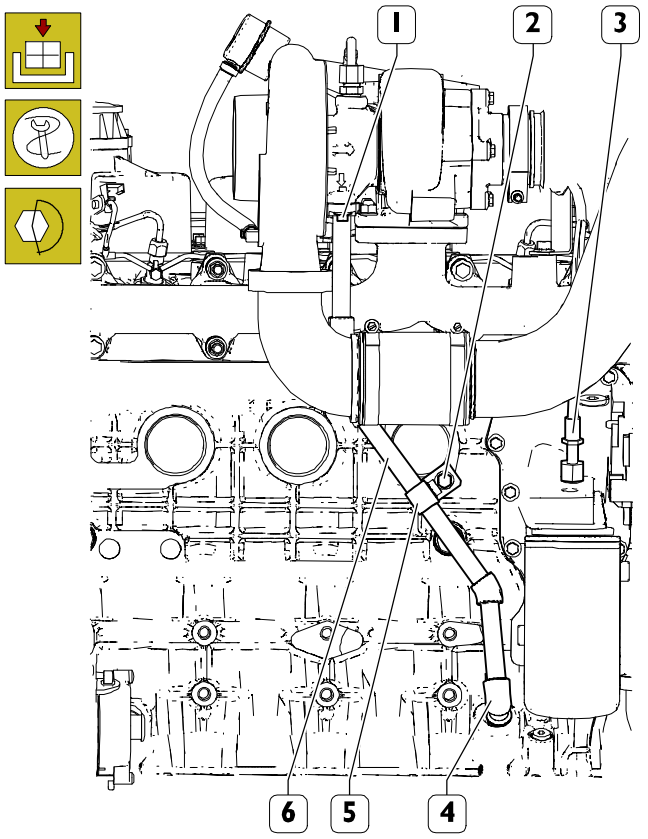
- ❑ Support the turbocharger (1) and position it on the exhaust manifold after having fitted a new gasket.
- ❑ Tighten the nuts (3) fastening the turbocharger (1) to the exhaust manifold and tighten them to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(3)	4	M10x1.5	-

- ❑ Screw the lubrication pipe coupling (2) onto the turbocharger (1) and tighten to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(2)	1	M16	36±5 Nm

Figure 167



Refit the lubrication oil discharge pipe (6) from the turbocharger by proceeding as follows:

- ❑ Fit new sealing rings and insert the coupling (4) in the crankcase;
- ❑ Screw the fastening screws (1) in the lower part of the turbocharger, then tighten to the torque indicated in the table;

Ref.	No.	Description	Tightening torque
(1)	2	M8x1.25	24 ±4 Nm

- ❑ Tighten the screw (2) that keeps the pipes (6) in position on the block by means of the fastening collar (5).

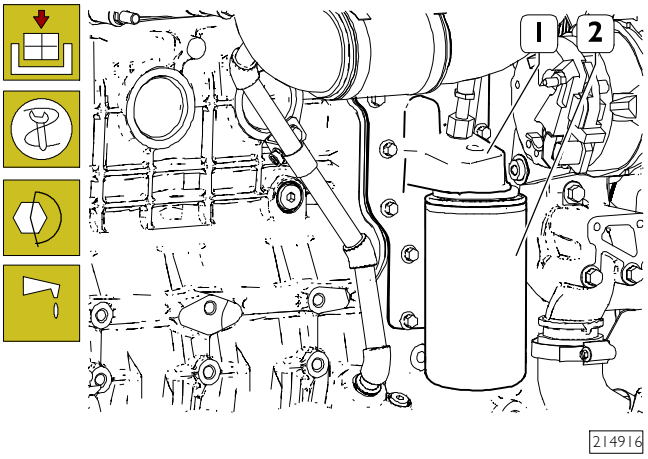
Ref.	No.	Description	Tightening torque
(2)	1	M8x1.25x16	24±4 Nm

- ❑ Screw the coupling (3) of the upper part of the heat exchanger and tighten the coupling to the torque indicated in the figure.

Ref.	No.	Description	Tightening torque
(3)	1	M16	36±5 Nm

Refitting oil filter

Figure 168



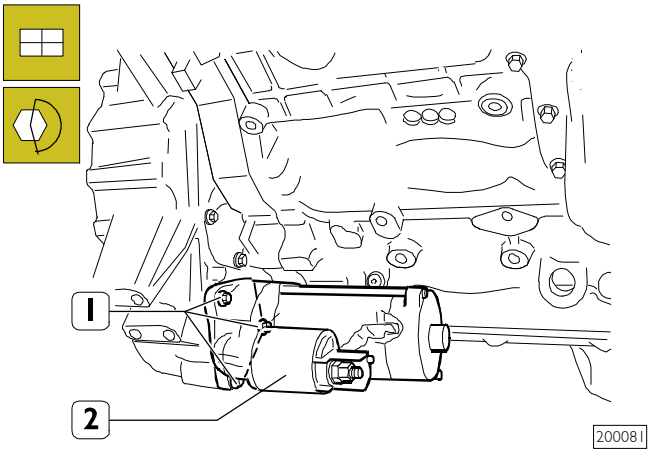
Moisten the sealing ring and position it on the oil filter (2).

- ❑ Manually screw the oil filter (2) onto the mount (1) of the heat exchanger until it clicks, then use tool 99360076 to further tighten it to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(2)	1	M27x2	20 ±2 Nm

Refitting electric starter motor

Figure 169

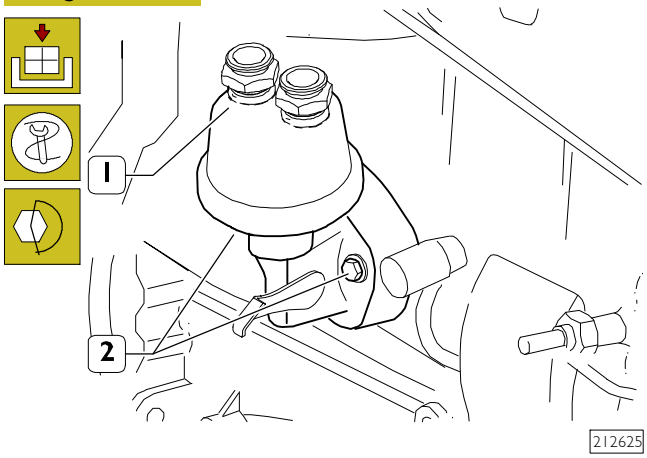


- ❑ Position and maintain the starter motor (1);
- ❑ Fit the fastening screws (2) and tighten them to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(2)	3	M10x1.5	43 ±6 Nm

Refitting priming pump

Figure 170



❑ Refit the fuel priming pump (1) together with the new gasket and tighten the screws (2) to the torque indicated in the table.

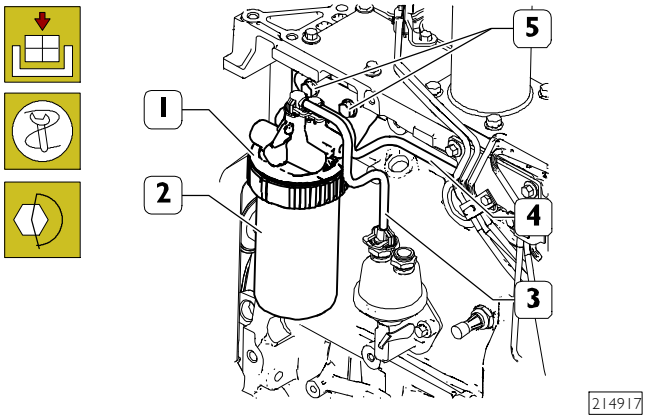
Ref.	No.	Description	Tightening torque
(2)	2	M8x1.25	24 ±4 Nm

Refit the low pressure pipe (5) as described in the procedure "LOW PRESSURE FUEL PIPE REMOVAL - REFITTING".

Refit the high pressure pipe as described in the procedure "HIGH PRESSURE FUEL PIPE REMOVAL - REFITTING" - Section 5.

Refitting fuel filter and pipes

Figure 171



Install the support (1) on the cylinder head and tighten the fastening screws (5).

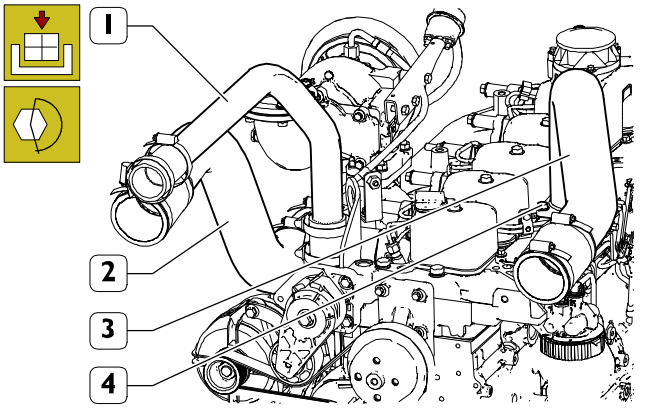
Ref.	No.	Description	Tightening torque
(5)	2	M10x1.5	-

Connect the pipes (3) and (4).

Using tool 99360076, fasten the fuel filter (2) from the support (1).

Refitting radiator assembly pipes to the engine

Figure 172



Fit the pipe (3) onto the intake manifold and tighten the screws (4) to the torque indicated in the table.

Ref.	No.	Description	Tightening torque
(4)	4	M8x1.25	24 Nm

Fit the pipe (2) onto the turbocharger and tighten the clamp.

Fit the coolant pipe (1) onto the engine and tighten the clamp.

ENGINE COMPLETION

❑ Refit the air filter as described in the procedure "AIR FILTER REMOVAL - REFITTING" - Section 5.

❑ Refit the fan as described in the procedure "FAN REMOVAL - REFITTING" - Section 5.

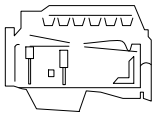
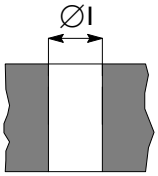
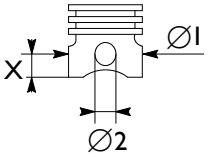
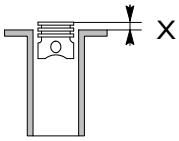
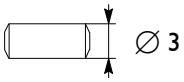
❑ Refit the radiator assembly as described in the procedure "RADIATOR ASSEMBLY REMOVAL - REFITTING" - Section 5.

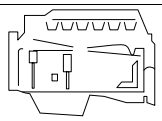
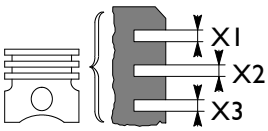
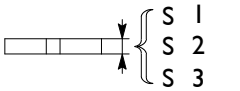
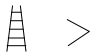
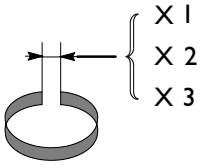
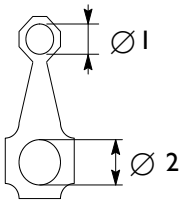
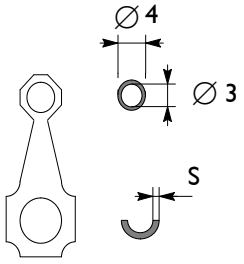
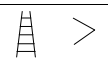
❑ Reconnect all the electrical connections to the feed pump and sensors.

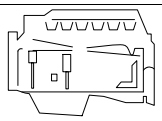
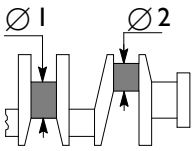
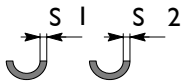
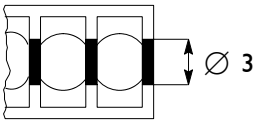
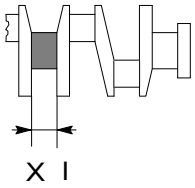
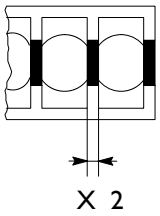
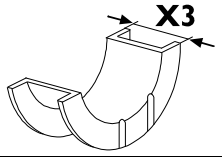
❑ Refill the cooling system with coolant.

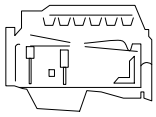
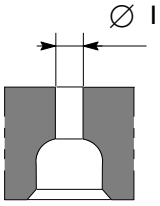
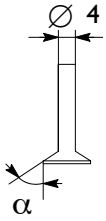
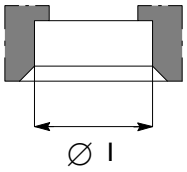
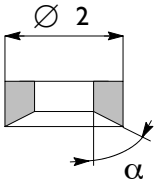
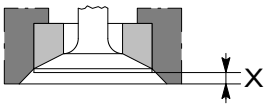
❑ Bleed the air from the 'supply system as described in the relevant paragraph.

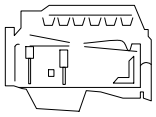
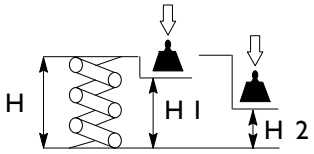
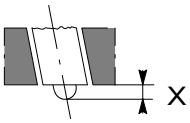
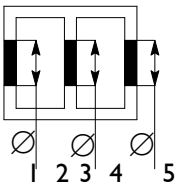
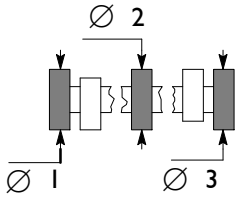
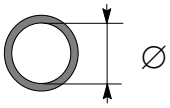
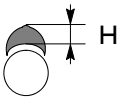
TECHNICAL SPECIFICATIONS AND ENGINE FITTING CLEARANCES

	Type	F4GE0685A*B601
CRANK GEAR AND CYLINDER ASSEMBLY DATA		mm
	Cylinder liners Ø1 > Ø1	104.000 ÷ 104.024 0.4 0.8
	Pistons Measuring point X Outer diameter Ø1 Pin housing Ø 2	55.9 103.714 ÷ 103.732 38.010 ÷ 38.016
	Piston - cylinder liners	0.268 ÷ 0.310
	Piston diameter Ø1	0.4 0.8
	Piston position from crankcase X	0.28 ÷ 0.52
	Piston pin Ø 3	37.994 ÷ 38.000
	Piston pin - pin seat	0.010 ÷ 0.022

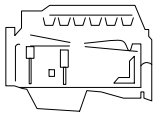
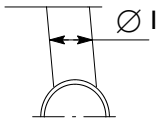
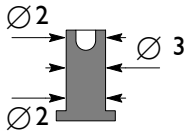
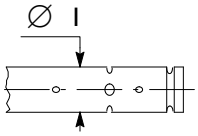
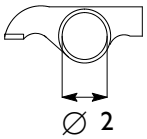
	Type	F4GE0685A*B601
CRANK GEAR AND CYLINDER ASSEMBLY DATA		mm
	Piston ring slots X1* X 2 X 3 * measured on a diameter of 101 mm	2.705 ÷ 2.735 2.440 ÷ 2.460 4.030 ÷ 4.050
	Circlips S 1* S 2 S 3 * measured on a diameter of 101 mm	2.560 ÷ 2.605 2.350 ÷ 2.380 3.970 ÷ 3.990
	Circlips - slots 1 2 3	0.099 ÷ 0.133 0.060 ÷ 0.110 0.040 ÷ 0.080
	Piston rings	0.4 0.8
	Piston ring end gap in cylinder liner: X 1 X 2 X 3	 0.30 ÷ 0.45 0.60 ÷ 0.80 0.30 ÷ 0.55
	Connecting rod small end bushing seat Ø1 Big end bearing housing Ø 2	40.987 ÷ 41.013 72.987 ÷ 73.013
	Diameter of External connecting rod small end bush Ø 4 Internal Ø 3 Half-bearings S	 40.987 ÷ 41.013 38.019 ÷ 38.033 1.955 ÷ 1.968
	Piston pin - bushing	0.019 ÷ 0.039
	Connecting rod half-bearings	0.250; 0.500

	Type	F4GE0685A*B601
CRANK GEAR AND CYLINDER ASSEMBLY DATA		mm
	Main journals Ø 1 Crankpins Ø 2	82.993 ÷ 83.013 68.987 ÷ 69.013
	Main half-bearings S 1 Connecting rod half-bearings S 2	2.456 ÷ 2.464 1.955 ÷ 1.968
	Main journals No. 1-7 Ø 3 No. 2-3-4-5-6 Ø 3	 87.982 ÷ 88.008 87.977 ÷ 88.013
	Half-bearings - Main journals n° 1-7 No. 2-3-4-5-6	0.041 ÷ 0.103 0.036 ÷ 0.108
	Half bearings - crankpins	0.038 ÷ 0.116
	Main half-bearings Connecting rod half-bearings	0.25 0.50 0.75 1.00
	Thrust main journal X 1 Main journals	37.475 ÷ 37.545 37.424 ÷ 37.576
	Main journal support for thrust X 2	32.180 ÷ 32.280
	Thrust half rings X 3	37.28 ÷ 37.38
	Crankshaft end play	0.095 ÷ 0.270

	Type	**F4GE0685A*B601**
CYLINDER HEAD - TIMING SYSTEM		**mm**
	Valve guide seats on cylinder head Ø 1	8.019 ÷ 8.039
	Valves: Ø 4 α	7.960 ÷ 7.980 60° ± 0° 7' 30''
	Ø 4 α	7.960 ÷ 7.980 45° ± 0° 10'
	Valve stem and related guide	0.039 ÷ 0.079
	Housing on head for valve seat: Ø1	46.987 ÷ 47.013
	Ø1	43.637 ÷ 43.663
	Valve seat outside diameter; valve seat angle on cylinder head: Ø 2 α	47.063 ÷ 47.089 60° ± 0.5°
	Ø 2 α	43.713 ÷ 43739 45° ± 0.5°
	X Recessing X	1.000 ÷ 1.520 1.000 ÷ 1.520
	Between valve seat and cylinder head	0.050 ÷ 0.102 0.050 ÷ 0.102
	Valve seats	-

	Type		**F4GE0685A*B601**
CYLINDER HEAD - TIMING SYSTEM			**mm**
	Valve spring height: free spring under a load of: 329 N 641 N	 H H1 H2	 63.50 / 65.69 * 49.02 38.20
	Injector protrusion	X	not adjustable
	Seat for camshaft timing system No. 1 (flywheel side) Camshaft seats n° 2-3-4-5-6-7		59.222 ÷ 59.248 54.089 ÷ 54.139
	Camshaft journal diameter: No. 2-3-4-5-6-7 No. 1 (flywheel side)	 Ø 2-3 Ø 1	 53.995 ÷ 54.035 53.995 ÷ 54.045
	Inside diameter of bushings	Ø	54.083 ÷ 54.147
	Bushings and supporting pins		0.038 ÷ 0.152
	Useful cam height:  	 H H	 11.02 10.74

* alternative assembling

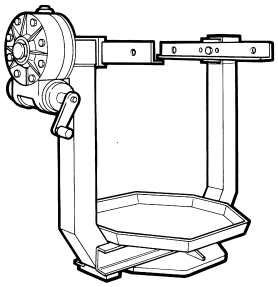
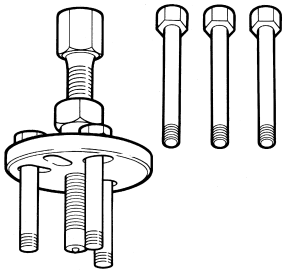
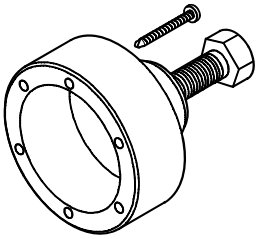
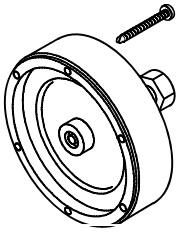
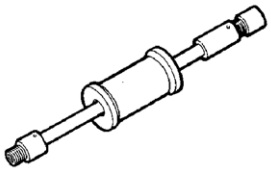
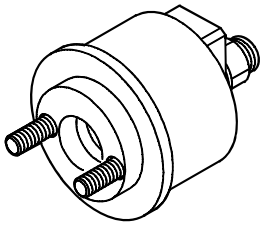
	Type	**F4GE0685A*B601**
CYLINDER HEAD - TIMING SYSTEM		**mm**
	Tappet washer seat in crankcase Ø 1	16.000 ÷ 16.030
	Tappet outside diameter: Ø 2 Ø 3	15.929 ÷ 15.959 15.965 ÷ 15.980
	Between tappets and seats	0.020 ÷ 0.065
	Tappets	-
	Rocker-arm shaft Ø 1	18.963 ÷ 18.975
	Rocker arms Ø 2	19.000 ÷ 19.026
	Between rockers and shaft	0.025 ÷ 0.063

TIGHTENING TORQUES

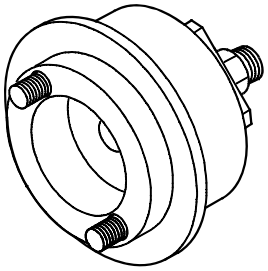
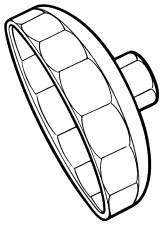
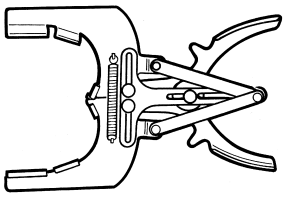
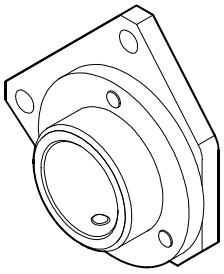
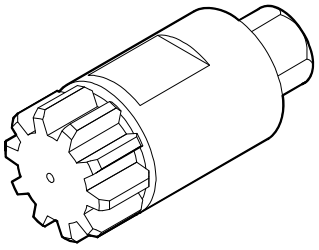
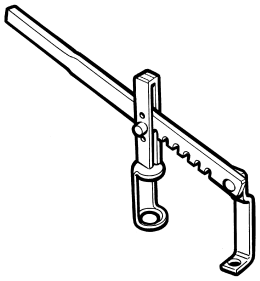
PART	Q.ty		TORQUE Nm	TORQUE kgm
Cooling nozzles (M8x1.25)	6		15 ± 3	1.5 ± 0.3
Main bearing caps (M12x1.5)	14	1st phase	80 ± 6	8.0 ± 0.6
		2nd step	90°	
Main bearing caps (M10x1.25)	12	1st phase	50 ± 5	5 ± 0.5
		2nd step	60°	
Gear housing				
(M12x1.75)	1		77 ± 12	7.7 ± 1.2
(M8x1.25)	4		24 ± 4	2.4 ± 0.4
(M10x1.5)	5		47 ± 5	4.7 ± 0.5
Camshaft gear set (M8x1.25)	6		36 ± 2	3.6 ± 0.2
Flywheel housing				
(M12x1.75)	8		85 ± 10	8.5 ± 1
(M10x1.5)	12		49 ± 5	4.9 ± 0.5
Engine flywheel (M12x1.25)	8		50 ± 5	5 ± 0.5
Oil pump (M8x1.25)	4	1st phase	8 ± 1	0.8 ± 0.1
		2nd phase	24 ± 4	2.4 ± 0.4
Water pump (M8x1.25)	2		24 ± 4	2.4 ± 0.4
Guide pulley (M10x1.5)	1		45 ± 5	4.5 ± 0.5
Fan hub (M10x1.5)	6		35 ± 5	3.5 ± 0.5
Fan control pulley (M10x1.5)	4		43 ± 6	4.3 ± 0.6
Strainer (M8x1.25)	2		24 ± 4	2.4 ± 0.4
Lower crankcase hardening plate (M10x1.5)	4		43 ± 5	4.3 ± 0.5
Oil sump (M8x1.25)	18		24 ± 4	2.4 ± 0.4
Oil sump drain plug (M22x1.5)	1		40 ± 10	4 ± 1
Front cover (M8x1.25)	13		24 ± 4	2.4 ± 0.4
Crankshaft pulley for damper (M10x1.25)			68 ± 7	6.8 ± 0.7
Damper on crankshaft (M12x1.25)	6	1st phase	50 ± 5	5 ± 0.5
		2nd step	90°	
Lubricant oil heat exchanger (M8x1.25)	15		26 ± 4	2.6 ± 0.4
Alternator support (M10x1.5)	3		43 ± 6	4.3 ± 0.6
Anchoring the alternator to its support (M10x1.5)	1		43 ± 6	4.3 ± 0.6
Fixing the alternator to the bracket (M10x1.5)	1		43 ± 6	4.3 ± 0.6
Cylinder head				
(M12x1.75x70)	26	1st phase	60 ± 5	6 ± 0.5
		2nd step	90°	
(M12x1.75x140)		1st phase	40 ± 5	4 ± 0.5
		2nd step	180°	
(M12x1.5x180)		1st phase	70 ± 5	7 ± 0.5
		2nd step	180°	

PART	Q.ty		TORQUE	
			Nm	kgm
Tappet adjuster nuts (M8x1.25)	6		24 ± 4	2.4 ± 0.4
Rocker arms support (M8x1.25)	6		24 ± 3	2.4 ± 0.3
(M12x1.75)	6	1st phase	70 ± 5	7 ± 0.5
		2nd step	90°	
		3rd phase	90°	
Fuel injector ring nuts (M24x1.5)	6		44 ± 4	4.4 ± 0.4
Thermostat body (M8x1.25)	3		-	-
Exhaust manifold (M10x1.5)	12		55 ± 3	5.5 ± 0.3
Intake manifold (M8x1.25)	10		24 ± 4	2.4 ± 0.4
Suction pump (M8x1.25)	2		24 ± 4	2.4 ± 0.4
Fastening the fuel filter support (M10x1.5)	2		-	-
Fuel filter	1		20 ± 2	2 ± 0.2
Tappet covers (M8x1.25)	6		24 ± 4	2.4 ± 0.4
Blow-by filter	3		10 ± 2	1 ± 0.2
Nut fastening the turbocharger to the exhaust manifold (M10x1.5)	4		-	-
Couplings for the turbocharger lubricant oil delivery pipes (M16)	2		36 ± 5	3.6 ± 0.5
Fastening the turbocharger lubricant oil exhaust pipes (M8x1.25)	1		-	-
Camshaft retaining plate (M8x1.25)	2		24 ± 4	2.4 ± 0.4
Fuel supply pump gear nut (M14x1.5)	1		90 ± 5	9 ± 0.5
Fuel supply pump gear nut (M8x1.25)	3		24 ± 4	2.4 ± 0.4
Cylinder head caps				
1/2"	3		24 ± 4	2.4 ± 0.4
3/4"	2		36 ± 5	3.6 ± 0.5
1/4"	1		12 ± 2	1.2 ± 0.2
Rear lifting hook (M12x1.75)	2		77 ± 12	7.7 ± 1.2
Plug for oil pressure regulation valve on filter support (M22x1.5)	1		80 ± 8	8 ± 0.8
Electric starter motor (M10x1.5)	3		43 ± 6	4.3 ± 0.6
Flywheel cover housing inspection cover (M8x1.25)	2		24 ± 4	2.4 ± 0.4
Oil filter (M27x2)	1		20 ± 2	2 ± 0.2

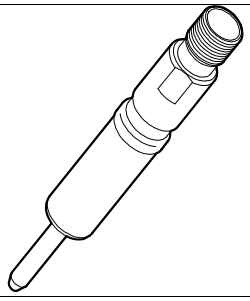
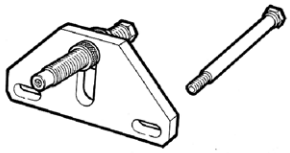
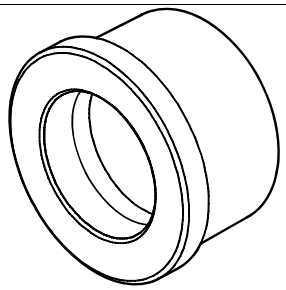
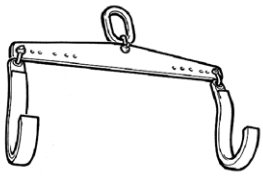
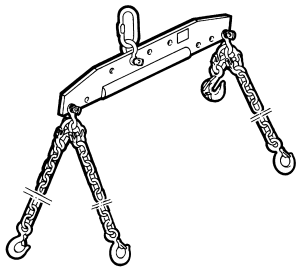
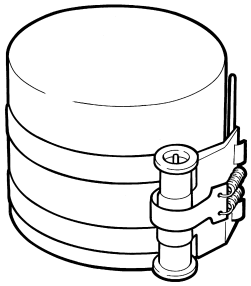
EQUIPMENT

TOOL No.		NAME
99322205		Revolving stand for overhauling units (capacity 1000 daN, torque 120 daNm)
99340035		Extractor for engine injection pump gear
99340055		Extraction tool for crankshaft front ring seal
99340056		Extraction tool for crankshaft rear gasket
99340205		Percussion extractor with parts for extraction
99346252		Key to fit crankshaft front gasket

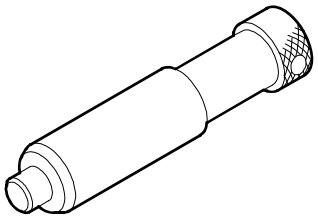
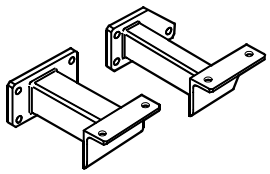
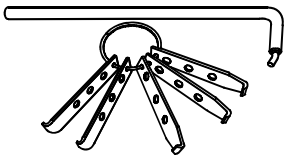
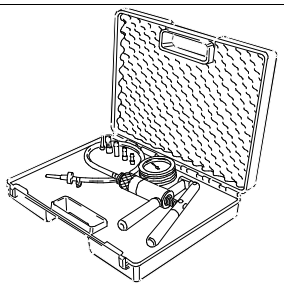
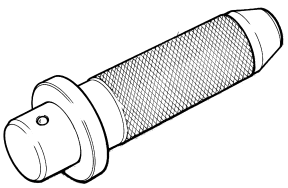
EQUIPMENT

TOOL No.		NAME
99346253		Key to fit crankshaft rear gasket
99360076		Tool to remove oil filter (engine)
99360183		Tool for piston ring removal and assembly (65-110mm)
99360221		Engine flywheel rotation tool (use with 99360222)
99360222		Pinion (use with 99360221)
99360268		Tool to take down and fit back engine valves

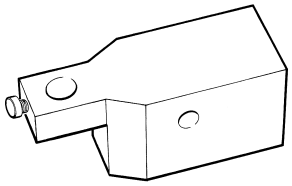
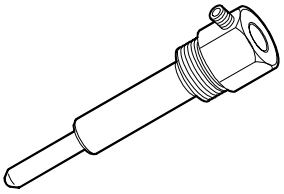
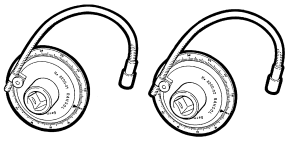
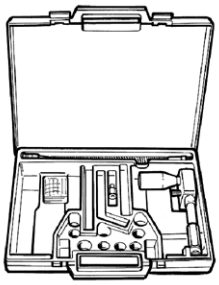
EQUIPMENT

TOOL No.		NAME
99360344		Coupling for compression control in cylinders (use with 99395682)
99360351		Tool to retain flywheel
99360362		Drift tool for removing/fitting camshaft bushes (to be used with 99370006)
99360500		Tool for lifting the crankshaft
99360595		Arm for removing and installing engine
99360605		Clamp for fitting piston into cylinder liners (60 ÷ 125 mm)

EQUIPMENT

TOOL No.		NAME
99360616		Tool for engine T.D.C. positioning
99361037		Brackets for fastening engine to 99322205 rotary stand
99363204		Tool to remove gaskets
99365196		Tool for positioning injection pump at delivery start
99367121		Manual pump for measuring pressure and vacuum
99370006		Handgrip for interchangeable drivers

EQUIPMENT

TOOL No.		NAME
99370415		Base of dial gauge for various measurements (use with 99395603)
99395097		Tool for top dead centre control (use with 99395604)
99395216		Pair of gauges for angular tightening with 1/2" and 3/4" square heads
99395603		Dial gauge (0 ÷ 5 mm)
99395604		Dial gauge (0 ÷ 10 mm)
99395682		Diesel engine cylinder compression test device