F32 SERIES
EU/2002/88/CE

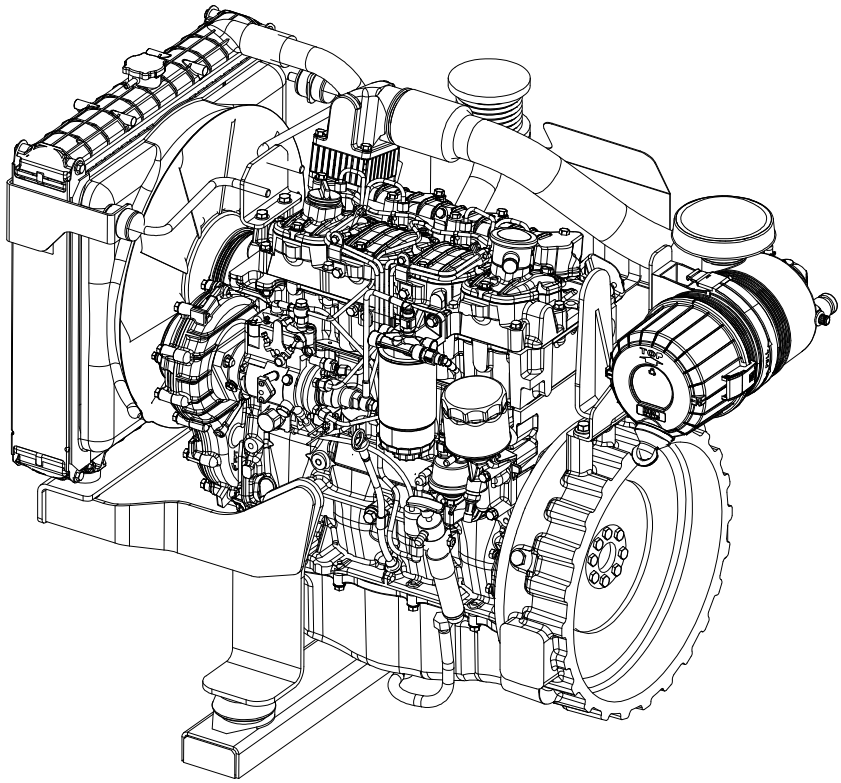
G-Drive application

F32AM1A

Technical and Repair manual

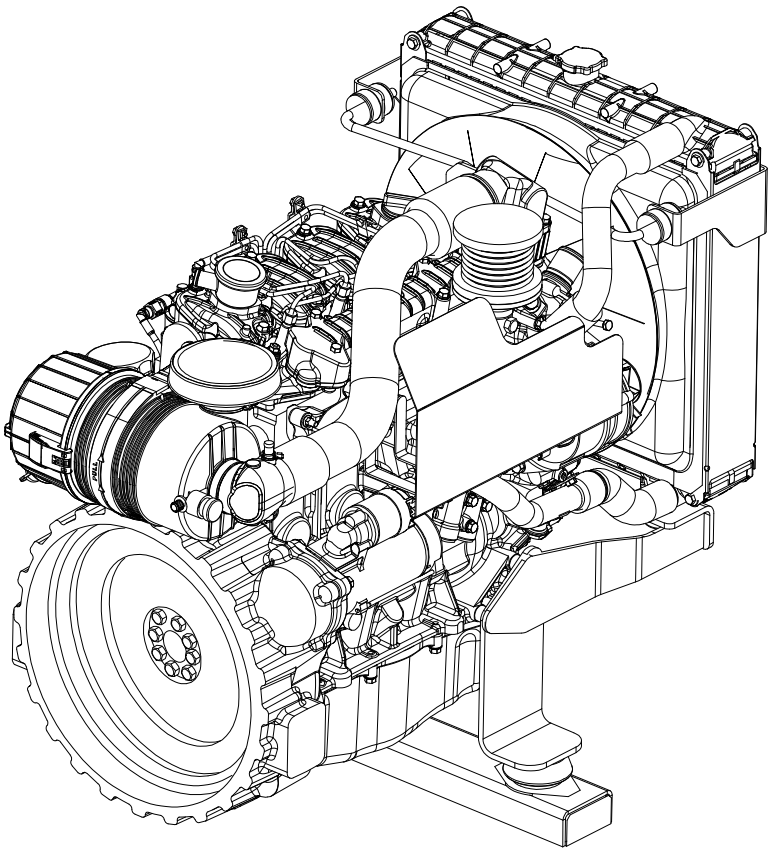
ENGINE VIEWS (for F5CE0405A*B001 engines)

Figure 1



139814

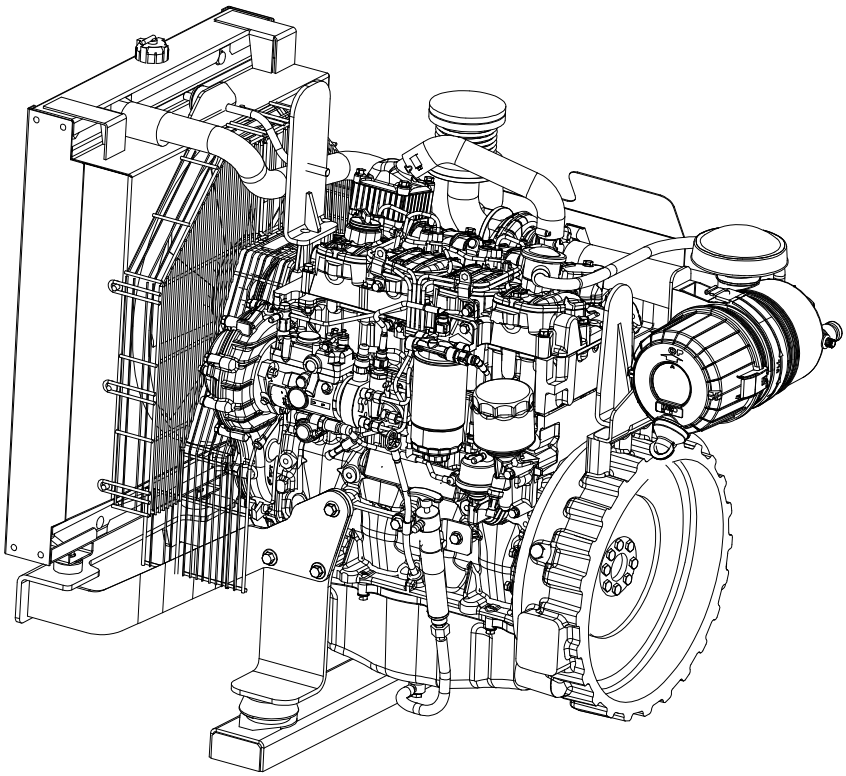
Figure 2



139815

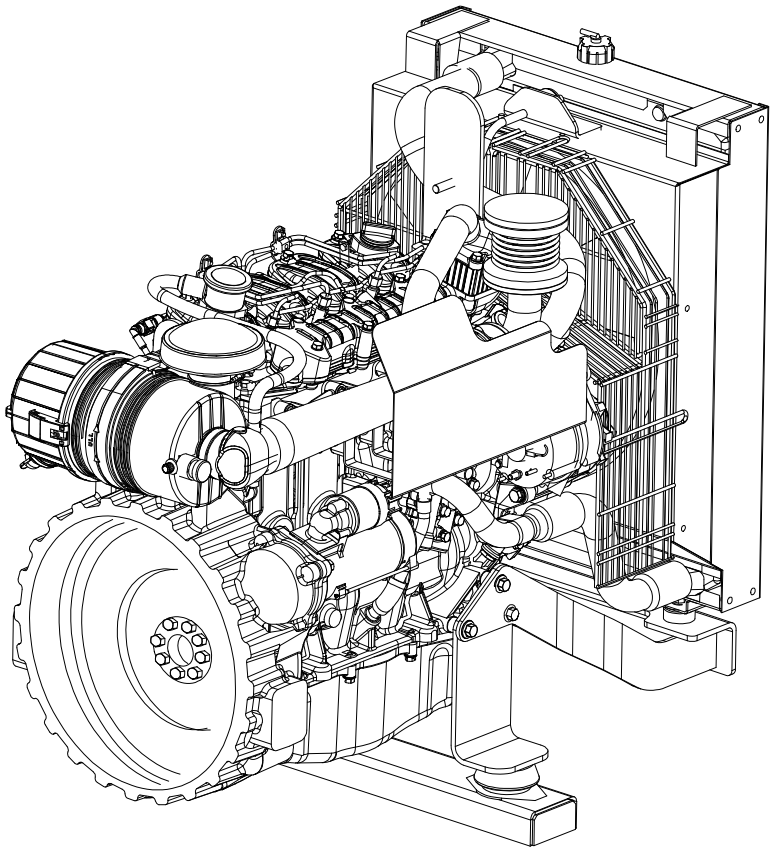
ENGINE VIEWS (for F5CE0455A*B001 engines)

Figure 3



139810

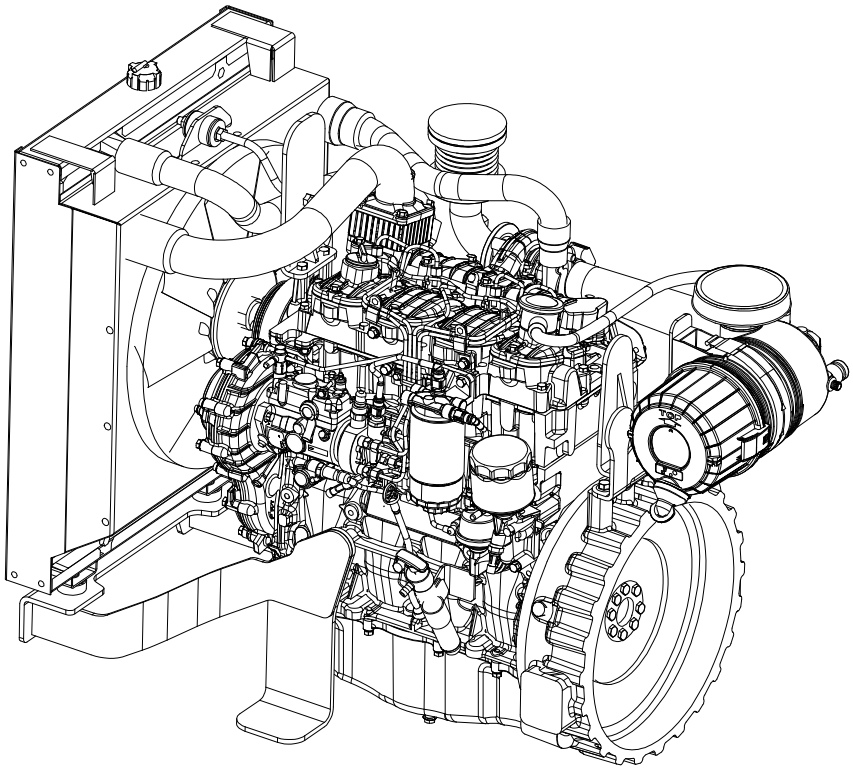
Figure 4



139811

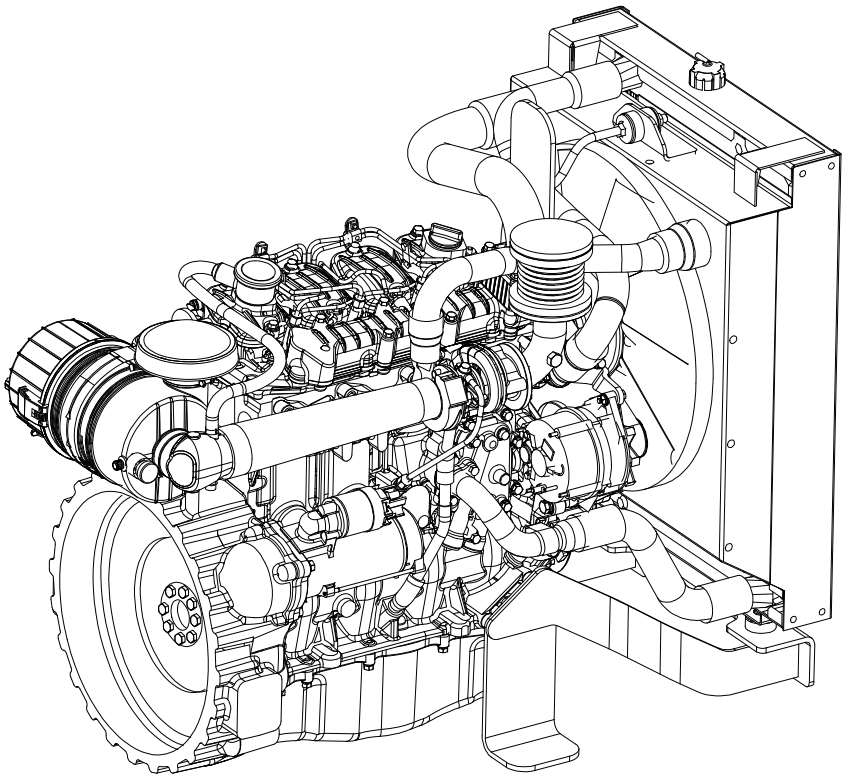
ENGINE VIEWS (for F5CE0485A*B001 engines)

Figure 5



139813

Figure 6



139812

ENGINE LUBRICATION SYSTEM

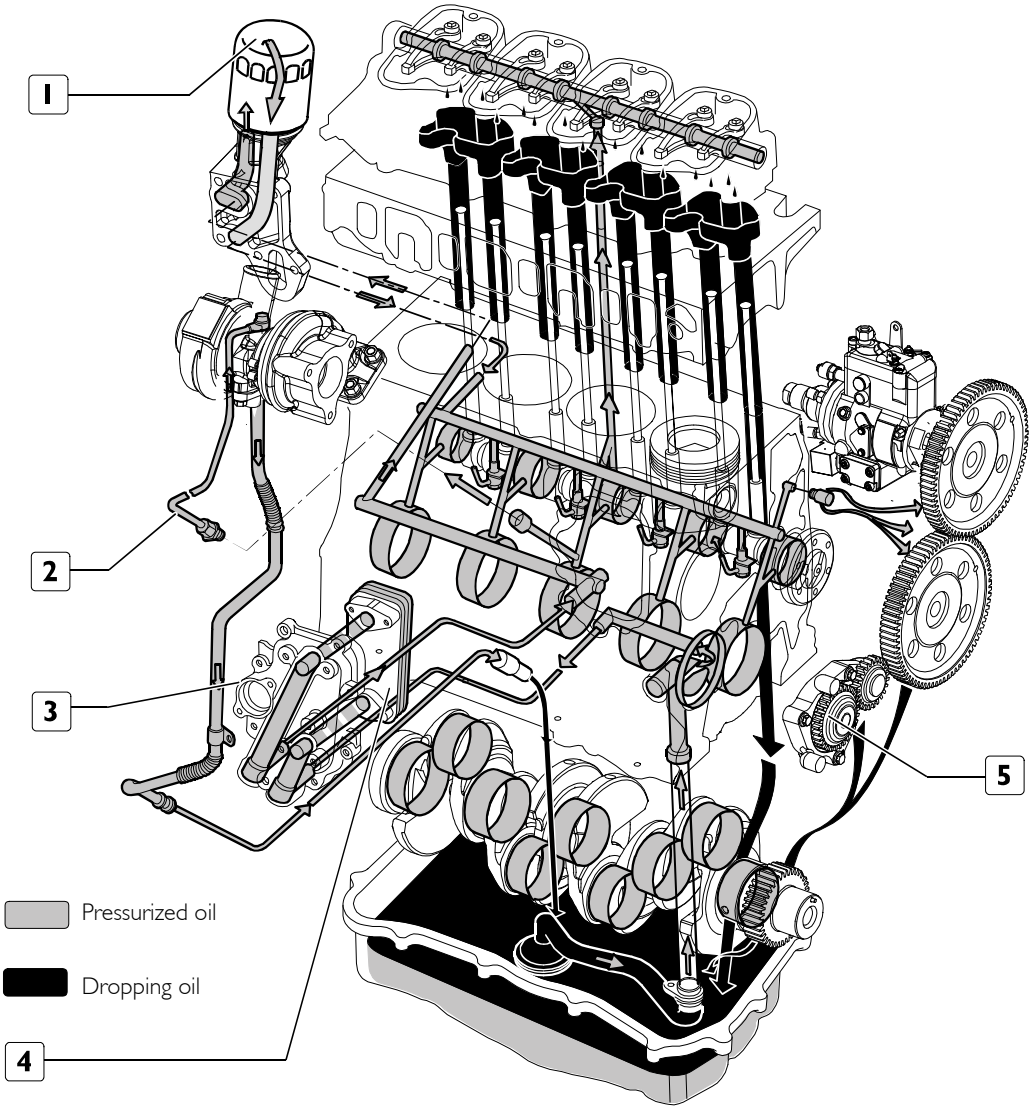
Forced circulation lubrication is controlled by the rotor oil pump housed in the front part of the engine basement and driven by the toothed gear splined on the shank of the engine drive shaft.

From the oil pan, the lubrication oil is distributed to the engine drive shaft, the camshaft and the valve control.

The lubrication system also comprises the heat exchanger, he centrifugal blower for the versions with turbosupercharger and eventually the compressor if the compressed air system is also fitted.

All the above mentioned components vary depending on their use and therefore will be illustrated in the specific section.

Figure 7



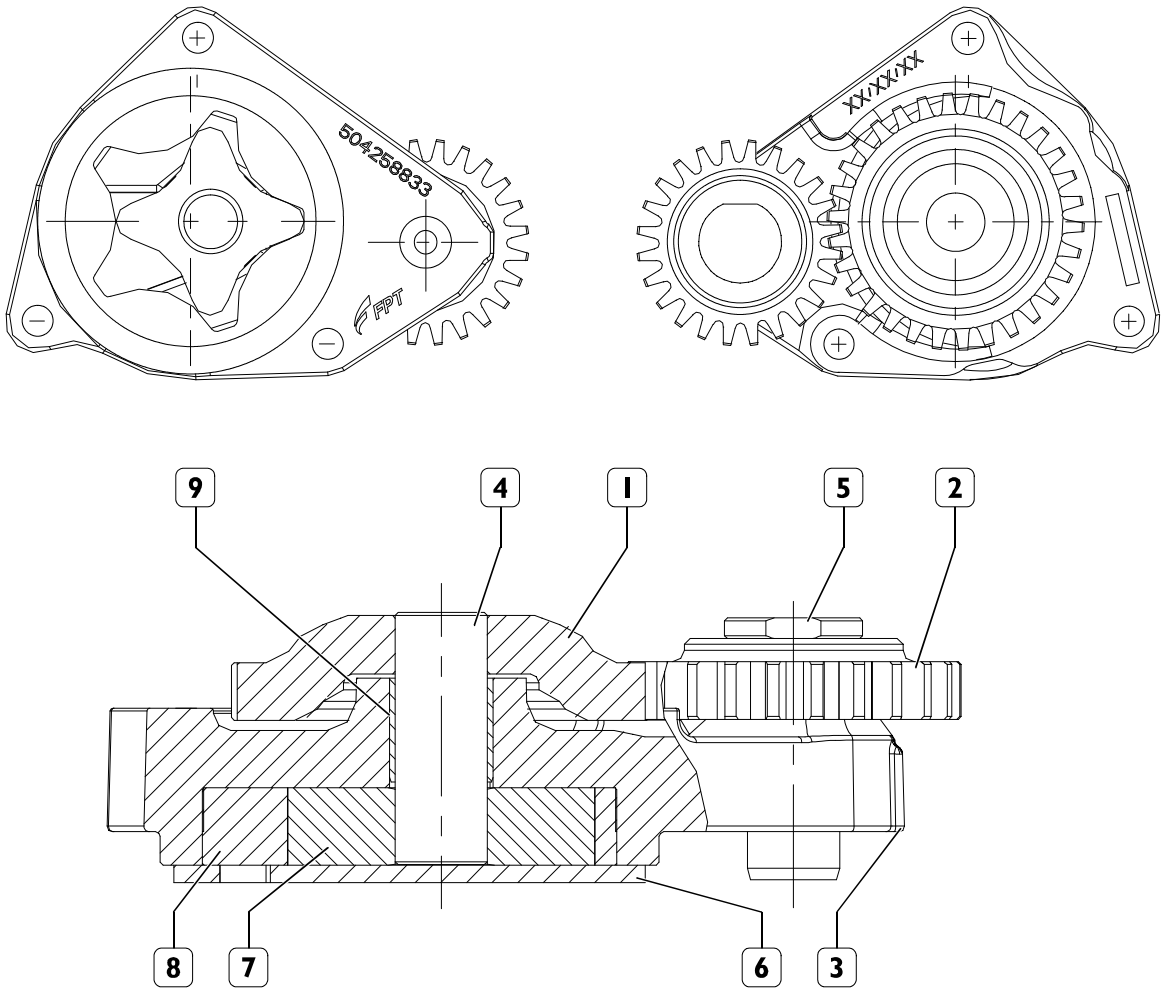
139772

LUBRICATION SYSTEM DIAGRAM

1. Oil filter - 2. Turbosupercharger lubrication feed pipe (if fitted) - 3. Heat exchanging unit - 4. Heat exchanger - 5. Oil pump

Oil pump

Figure 8

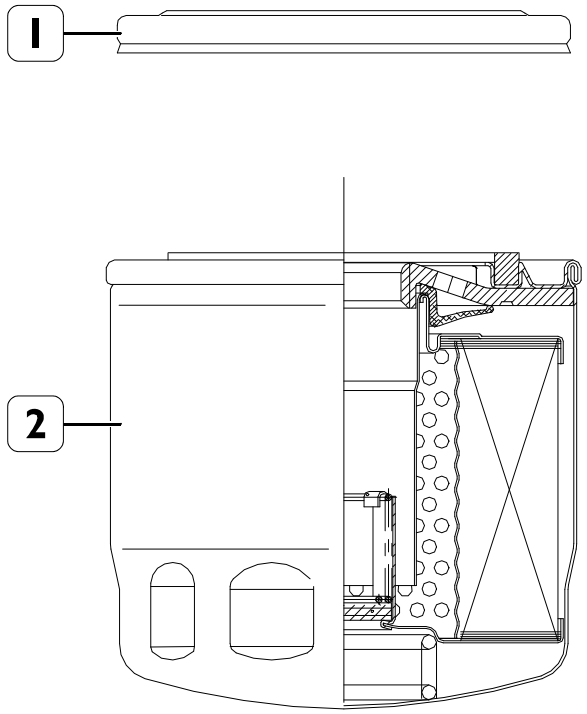


PUMP SPECIFICATIONS	
Rotating speed	750 rpm - 4200 rpm
Feed pressure	2 Bar - 4 Bar
Rated flow	12.2 l/min - 75.9 l/min
Oil type	SAE 20/30
Max. oil temperature	80 °C

1. Main gear - 2. Secondary gear - 3. Pump unit - 4. Drive shaft - 5. Secondary shaft - 6. Cover - 7. Internal rotor - 8. External rotor - 9. Bush.

Engine oil filter

Figure 9

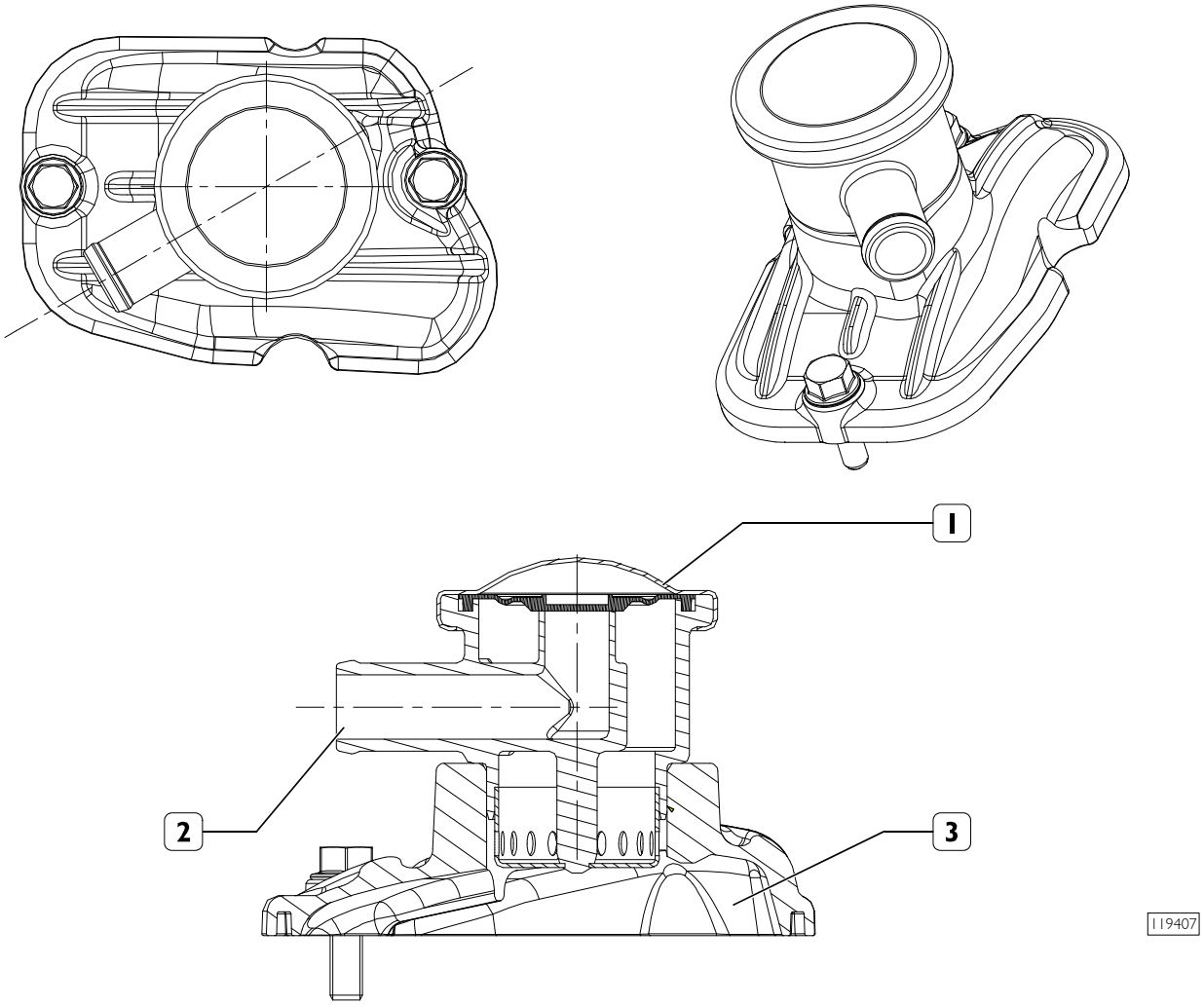


1. Protective cover - 2. Cartridge

Booster pressure:	20 bar (ISO 4548/3)
Dynamic pressure:	0-15 bar (1Hz) > 50,000 cycles (ISO 4548/5)
Operating temperature:	-40 / + 140 °C
Torque wrench setting:	30 ± 3 Nm
Maximum flow:	50 l/min.
Load loss at the end of life cycle:	2.5 bar
Accumulation:	> 15 gr with 2.5 bar load loss (ISO 16889)

ENGINE OIL VAPOUR RECIRCULATION

Figure 10



1. Valve - 2. Breather - 3. Tappet cover

On the tappet cover (3) there is a valve (1) having the duty to cause condensation of oil vapours making them drop by gravity on the underlying tappet cover (3).

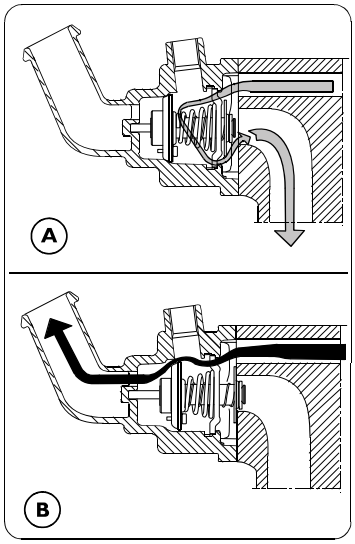
The remaining non condensed vapours will be duly conveyed through the breather (2), for instance by suction (appropriate connection must be provided by the outfitter).

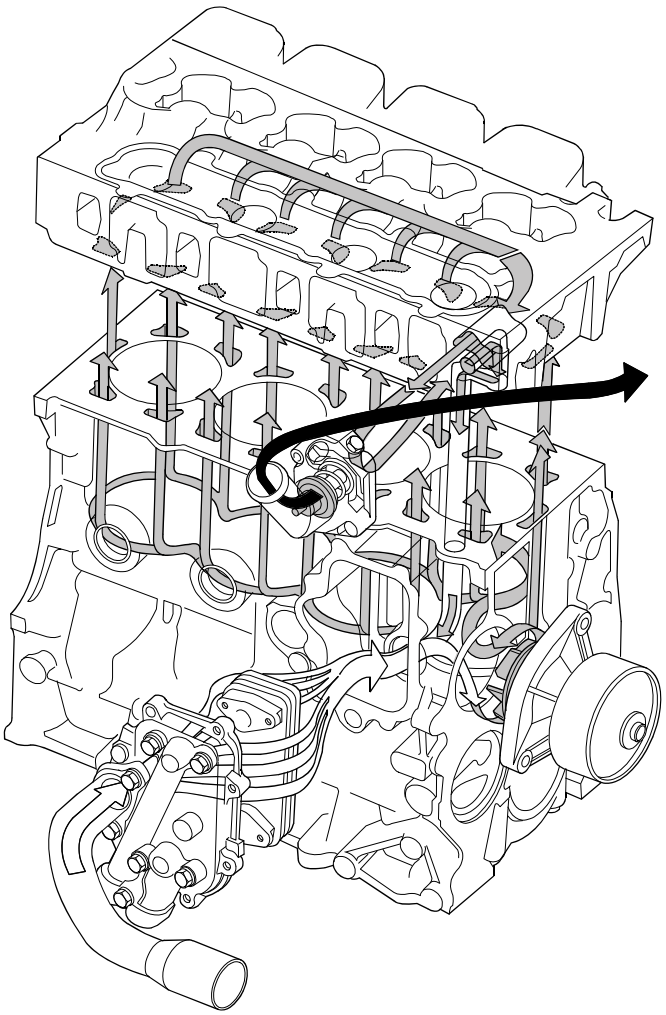
ENGINE COOLING SYSTEM

The closed circuit forced circulation engine cooling system is composed of the following parts:

- ❑ expansion tank: position, form and dimensions may vary depending on the engine fitting;
- ❑ radiator dissipating the heat absorbed by the engine cooling liquid. This component's position and dimensions may vary depending on the outfit;
- ❑ fan increasing the radiator's cooling power. This component may vary depending on the specific engine fitting;
- ❑ heat exchanger cooling the lubricant oil. This component may vary depending on the specific engine fitting;
- ❑ centrifugal water pump positioned in the front part of the engine basement;
- ❑ thermostat controlling cooling liquid circulation.

Figure 11





A Closed thermostat
B Open thermostat

Water inflow

Engine cooling water

Water outflow from thermostat

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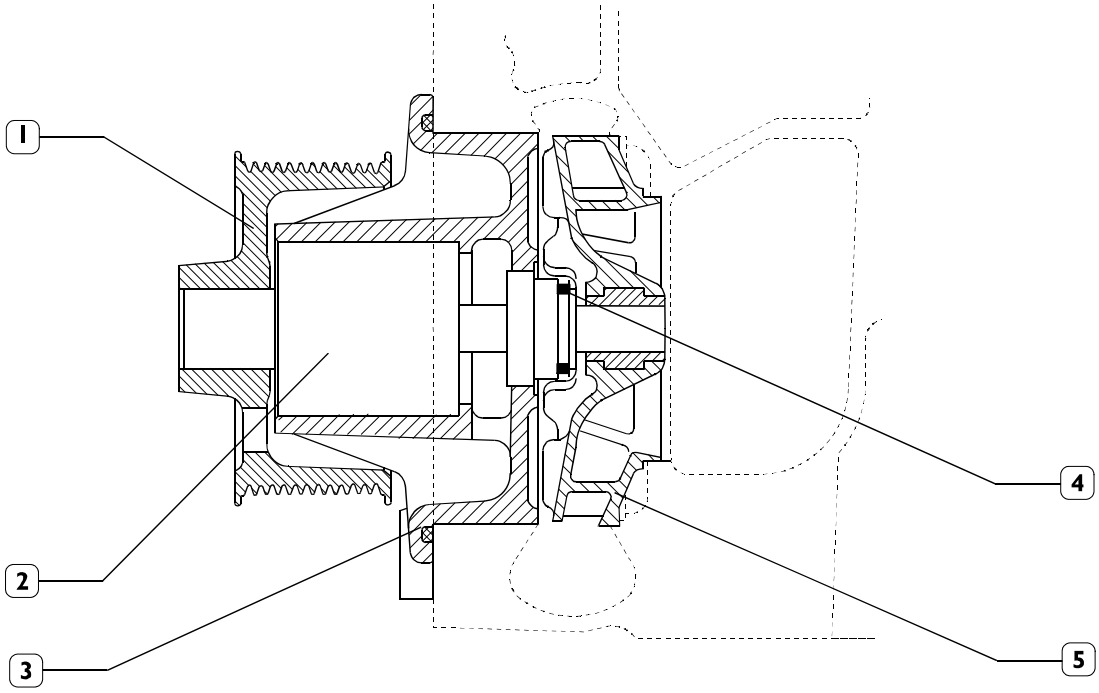
ENGINE COOLING SYSTEM DIAGRAM

WATER PUMP

Figure 12



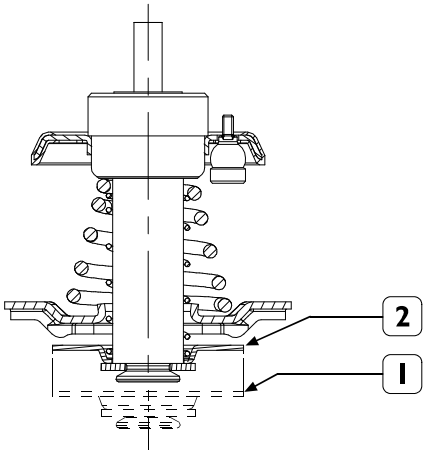
WATER PUMP SECTION

1. Hub - 2. Shaft with bearing - 3. Pump unit - 4. Sheath - 5. Impeller.

The water pump is a centrifugal blade turbine type pump. The pump's bearing (2) is connected to the impeller's shaft as a whole. Water tight between the pump unit (3) and the shaft (2) is ensured by the sheath (4).

THERMOSTAT

Figure 13



THERMOSTAT DIAGRAM

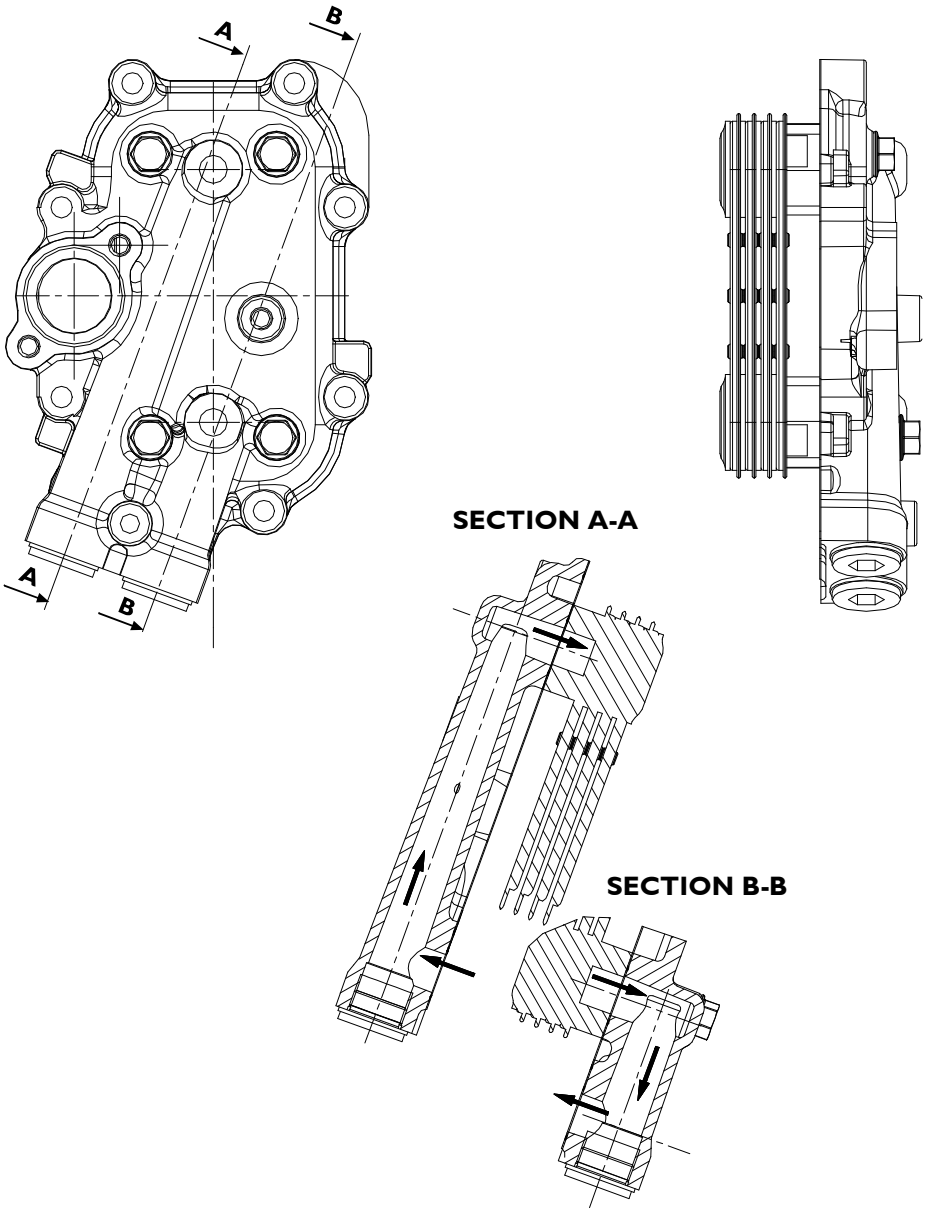
Working system

When the engine is cool, water output from the front part of the cylinder head flows into an inlet containing the thermostat, which cuts out water circulation to the radiator. This way, water circulation will only be possible in the pump-engine circuit, insofar allowing engine heat-up quickly. The thermostat valve starts opening at nearly 80 °C, allowing water circulation into the radiator and also obstructing direct return towards the engine. Check the thermostat efficiency and replace it in case of doubtful functioning.

1. Stroke starts at 79° ± 2 °C
2. 7 mm stroke at 94°±2 °C

HEAT EXCHANGER

Figure 14



The heat exchanger within the engine cooling system has the duty to control the engine oil temperature, reducing it by absorbing heat throughout the engine cooling liquid.

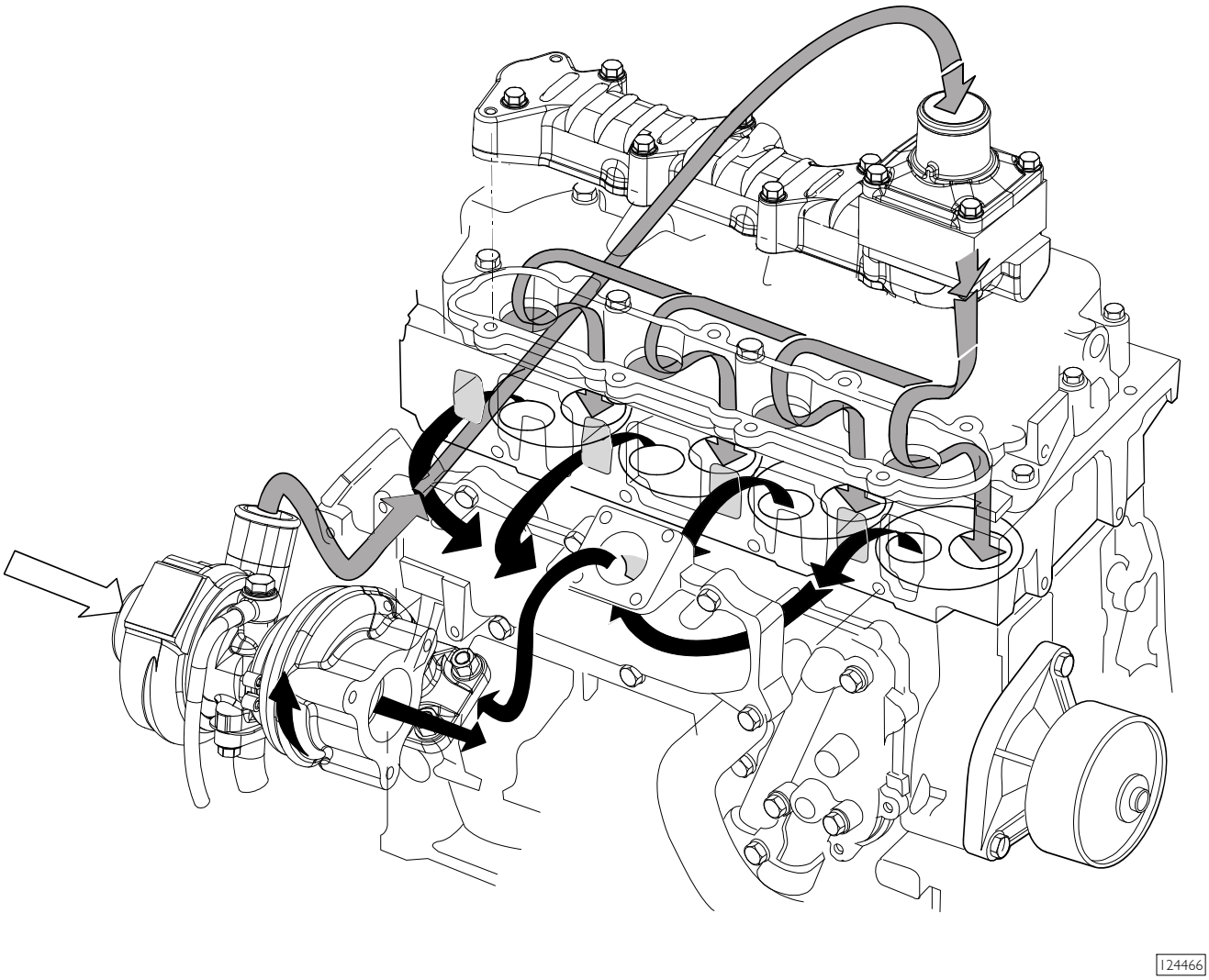
BOOSTING

For engines F5CE0455A*B001, F5CE0485A*B001

The boosting system is composed of the following parts:

- ❑ Air filter;
- ❑ Turbosupercharger.
- ❑ An "intercooler" radiator (if fitted).

Figure 15



SECTION 2

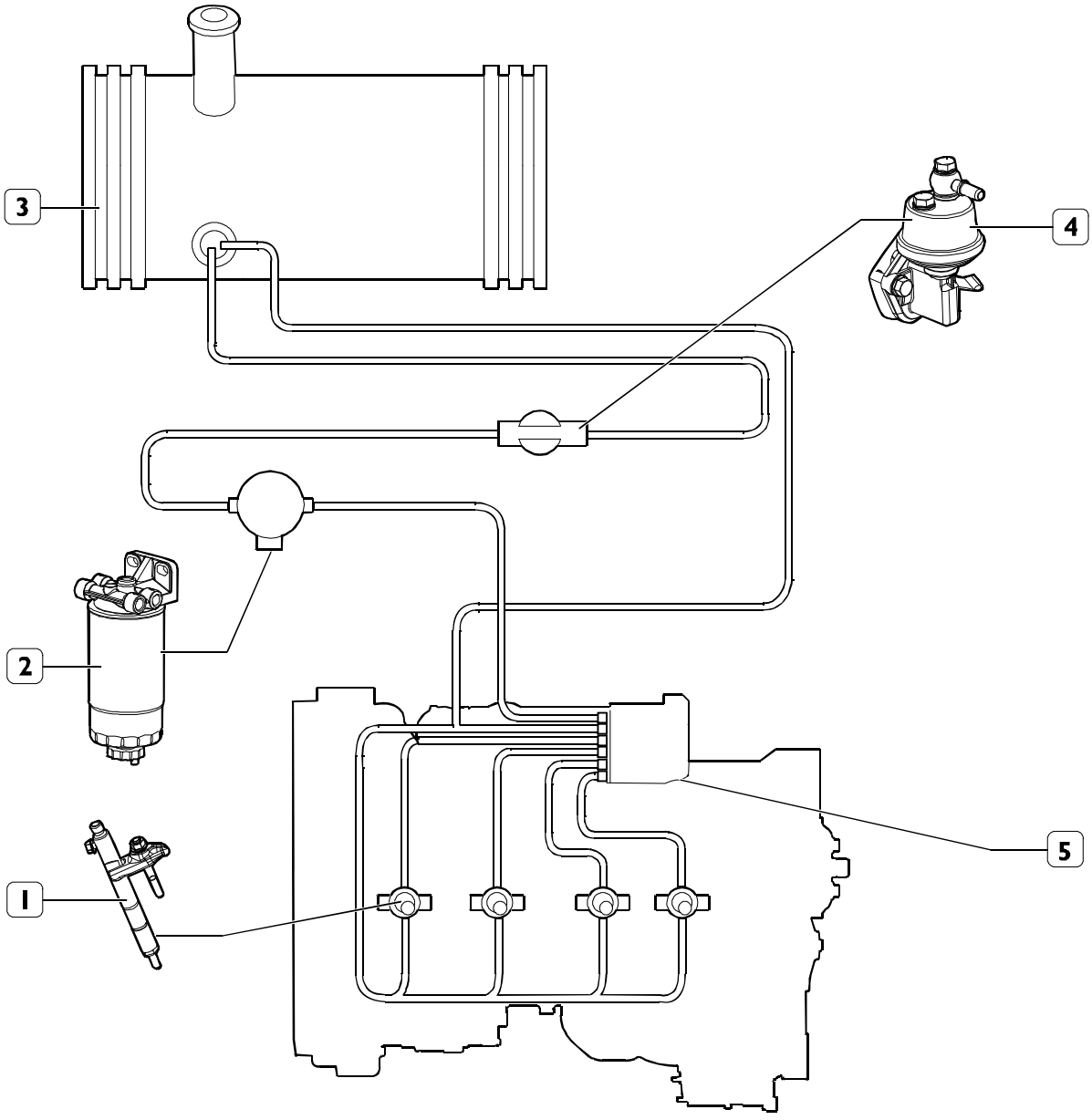
Supply

SUPPLY

The engine supply system consists of the following components:

- ❑ Fuel tank (aboard the vehicle)
- ❑ Fuel delivery and return pipes
- ❑ Fuel pre-filter (if fitted, it is placed nearby the engine on the vehicle's chassis)
- ❑ Priming pump, fitted on the engine and driver by the engine camshaft
- ❑ Fuel filter (its position on the engine may vary depending on the outfit and use)
- ❑ Supply rotary pump
- ❑ Injector feed pipe (from the fuel supply pump to the fuel injectors)
- ❑ Injectors

Figure 1

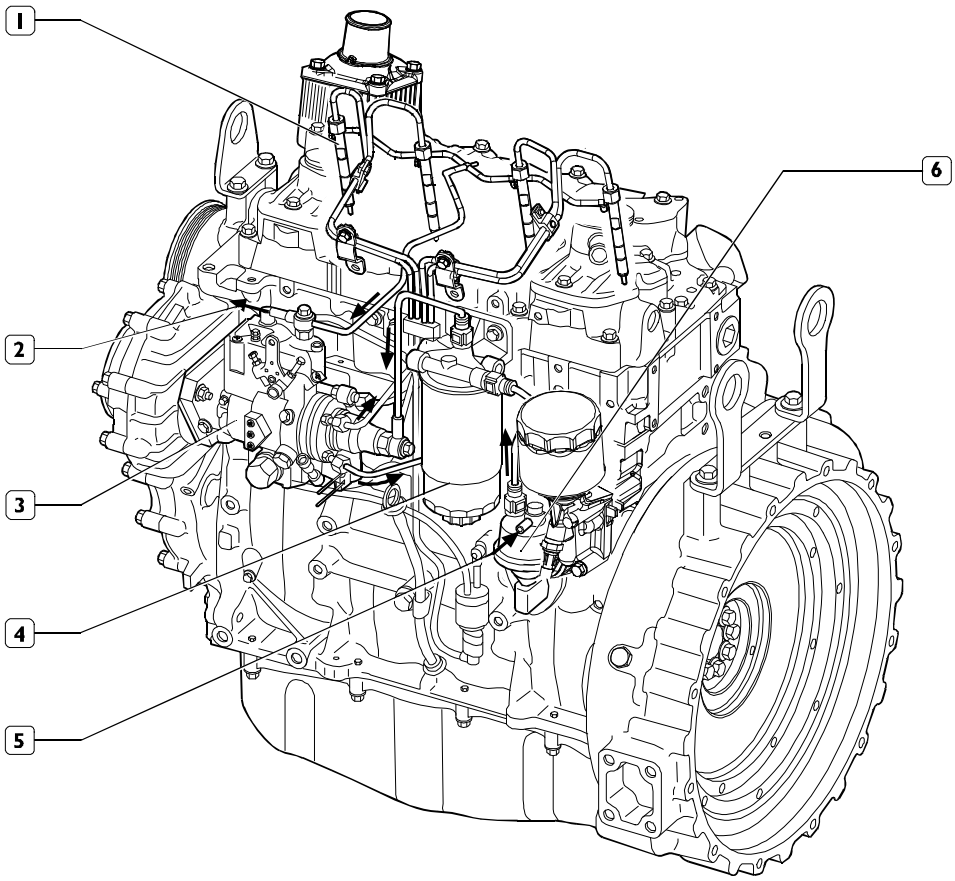


SUPPLY SYSTEM DIAGRAM

1. Injectors - 2. Fuel filter - 3. Tank - 4. Supply rotary pump - 5. Ignition pump.

PIPE LAYOUT

Figure 2



Working system description

The fuel (5) is primed from the fuel tank from the priming pump (6). The latter is fitted on the engine basement and is driven by the engine camshaft.

Throughout the filter (4), fuel is conveyed to the transfer pump, which is placed inside the supply rotary pump (3), which is a turbine blade pump type. The supply rotary pump duty is to increase the fuel pressure based on the increase of engine revolutions' number.

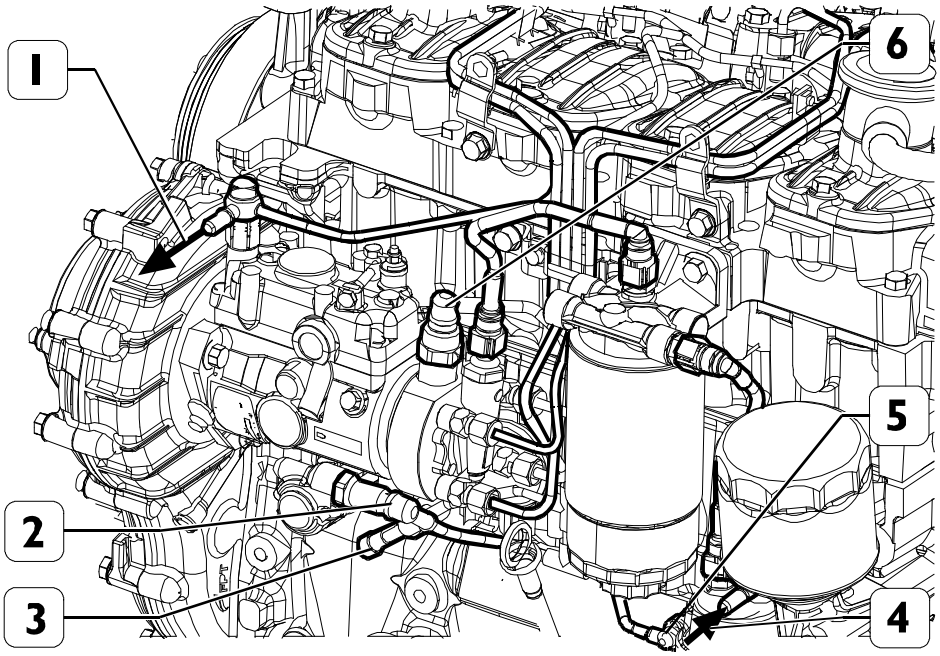
Then, the fuel reaches the valve controlling fuel pressure within the supply pump.

The distributor piston further increases such pressure and delivers the fuel to the injectors (1) throughout the delivery pipe fitting.

The fuel leak (2) from the injectors is recovered and sent back to the fuel tank.

DELPHI SUPPLY PUMP

Figure 3



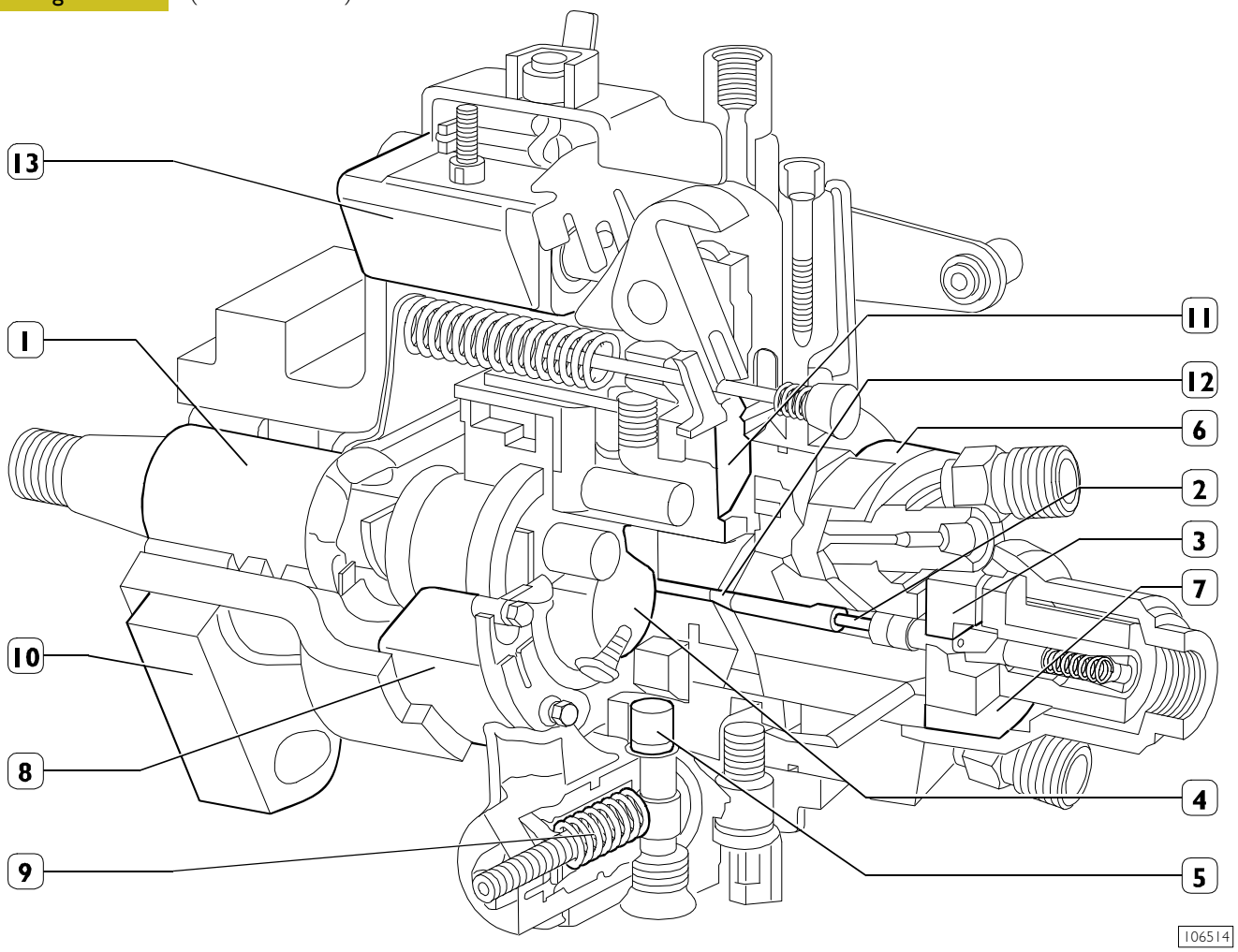
119417

1. Fuel outlet - 2. Motor stop solenoid - 3. Pump stop connection - 4. Fuel inlet- 5. Water temperature sensor for KSB - 6. Electromagnet on KSB

STANADYNE SUPPLY PUMP

The rotary type pump is driven by a gear mating the camshaft's one.

Figure 4 (Demonstrative)



1. Propeller shaft - 2. Timing gear rotor - 3. Transfer pump vanes - 4. Pumping pistons (4) - 5. Cam inner ring - 6. Hydraulic head - 7. Pressure regulator assembly - 8. Regulator - 9. Automatic advance - 10. Seat - 11. Metering valve - 12. Delivery valve - 13. Electric power supply cut-off solenoid.

Description of operation

The main rotation components are the propeller shaft (1), timing gear rotor (2), transfer pump vanes (3) and the regulator (8). Referring to Figure 4, the propeller shaft engages the timing gear rotor inside the hydraulic head.

The four pistons are actuated towards each other simultaneously by the internal ring of the cam via the rollers and sliding blocks that are conveyed in the holes on the end portion of the rotor.

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

The transfer pump on the rear of the rotor is the positive displacement type and is closed inside the end plug. The end plug also contains the inlet filter screen and the pressure regulator of the transfer pump. The top of the regulator assembly is pressed against the timing gear rotor and forms an end seal for the transfer pump.

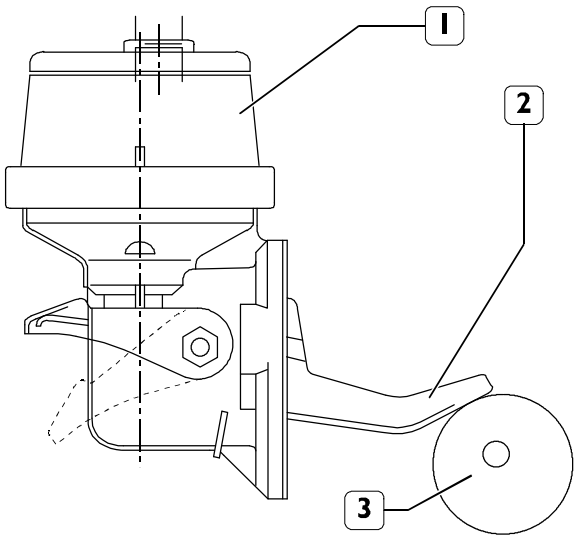
The timing gear rotor contains two inlet ports, a single axial hole and a discharge port serving all the outlets to the injection lines.

The hydraulic head contains the hole in which the rotor turns, the hole of the metering valve, inlet opening and the unions for the delivery outlet. The high pressure injection lines that are connected to the injectors are secured to the above-mentioned outlet unions.

PRIMING PUMP

The priming pump duty is to prime the fuel from the tank and convey it to the fuel supply pump. It is fitted on the engine basement and driven by the engine camshaft.

Figure 5



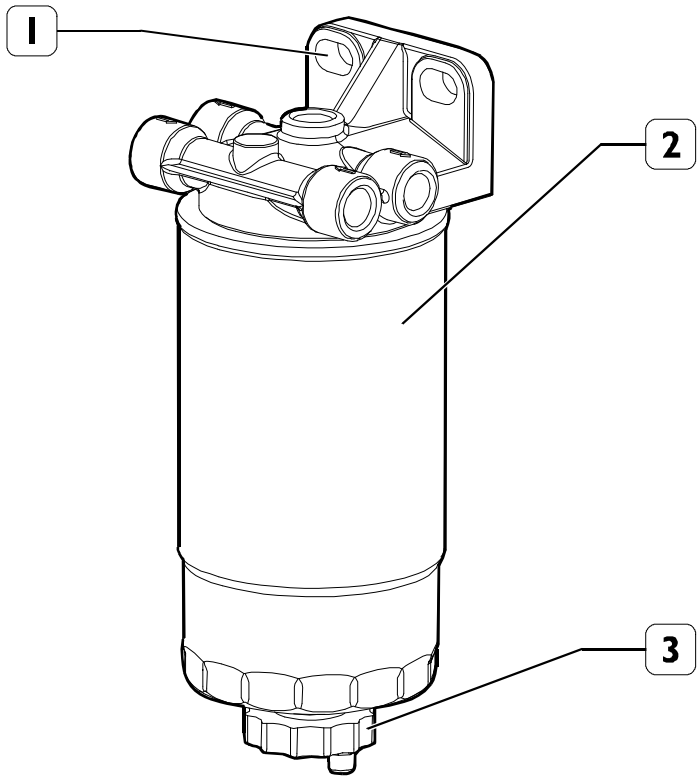
1. Pump - 2. Control lever - 3. Camshaft.

FUEL FILTER

The filter is placed nearby the supply pump and the priming pump. Its duty is to retain impurities and separate water from the fuel in which it is contained.

At the bottom of the filtering cartridge there may be a water drainage device (3).

Figure 6

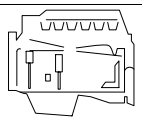
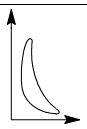
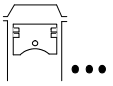
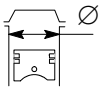
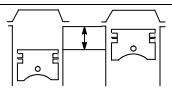
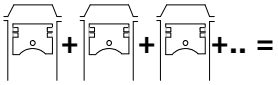
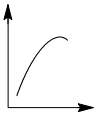


1. Fuel filter support - 2. Cartridge filter- 3. Water drainage device

SECTION 3

G-Drive application

MAIN SPECIFICATIONS

			F5CE0405A*B001	F5CE0455A*B001	F5CE0485A*B001
	Type				
	Cycle		Diesel 4 strokes		
	Feeding		Drawn in	Turbocharged	Turbocharged - intercooler
	Injection		Direct		
	N. of cylinders		4 on-line		
	Diameter	mm	99		
	Stroke	mm	104		
	Total displacement	cm^3	3200		
	Compression ratio		17 ± 0.5 : 1		
	Max. power	kW (HP)	32 (44)	42 (57)	52 (71)
		rpm	1500		
	Max. power	Nm (kgm)	204 (21)	267 (27)	331 (34)
		rpm	1500		
	Loadless engine idling	rpm	-		
	Loadless engine peak	rpm	1750 ± 50		
	COOLING Water pump control **Thermostat** - start of opening	 °C	 Liquid Through belt 79 ± 2		
 SAE 15W40 T2 URANIA LD7	**OIL SUPPLY** Total quantity 1st filling MIN level (engine off) MAX level (engine off)	 l (kg) l (kg) l (kg)	 10.5 (9.2) 7.5 (6.6) 9.5 (8.4)		

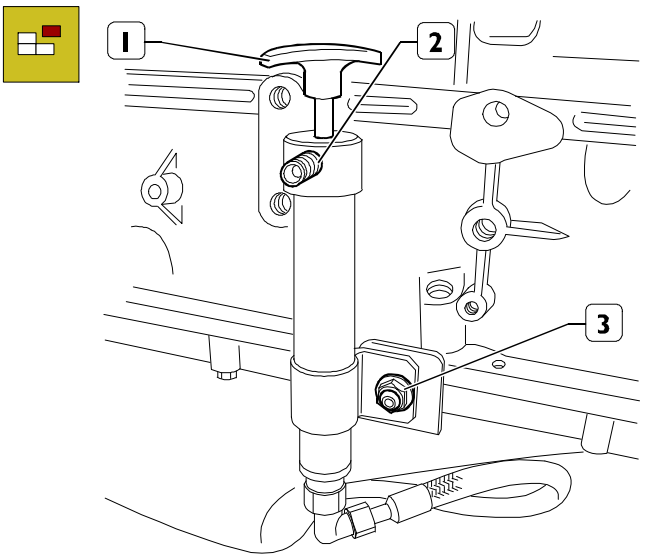
NOTE Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by FPT.
Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turns based on which the engine has been designed.

PART ONE -

MECHANICAL COMPONENTS

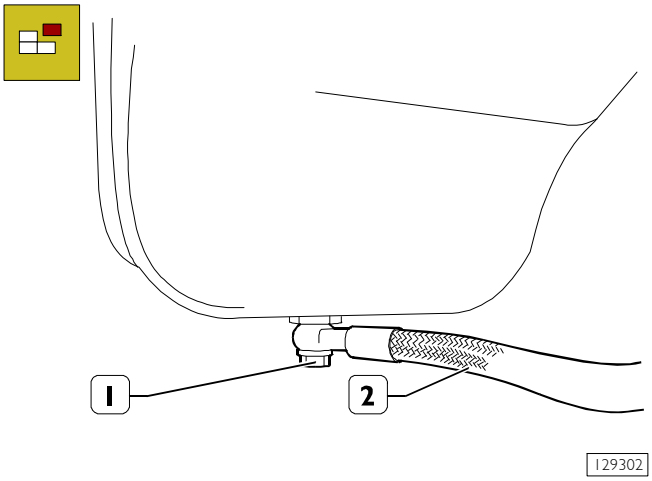
PREPARING THE ENGINE FOR OVERHAUL ON THE BENCH

Figure 7 (Demonstrative)



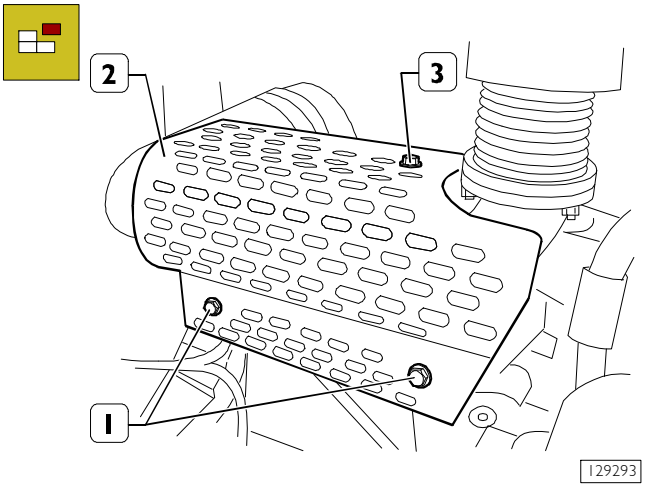
- ❑ Extract the dipstick and the filler plug to facilitate the lubrication oil flow.
- ❑ Connect the special pipe for draining the pump (2) fitted in the engine to the outside.
- ❑ Remove the oil in the engine oil sump using the drainage pump (1).
- ❑ Remove the pump adjusting the nut (3).

Figure 8 (Demonstrative)



- ❑ Disconnect the pipe (2) and remove it, adjusting the bolt (1).

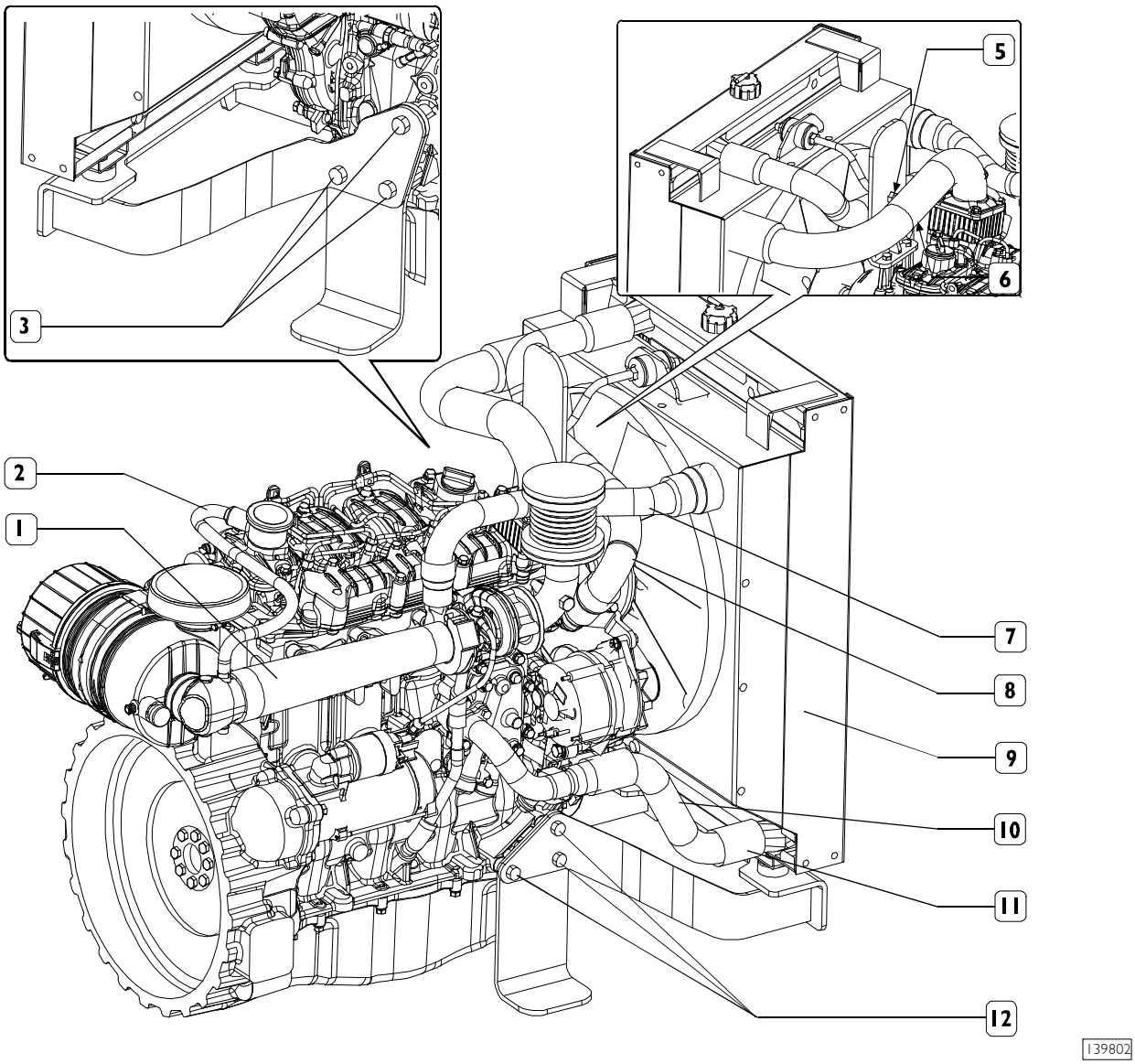
Figure 9 (Demonstrative)



- ❑ If present, remove the turbine guard grille (2), adjusting the bolts (1) and (3).
- ❑ Then remove the mounting brackets.

F5CE0485 engine

Figure 10



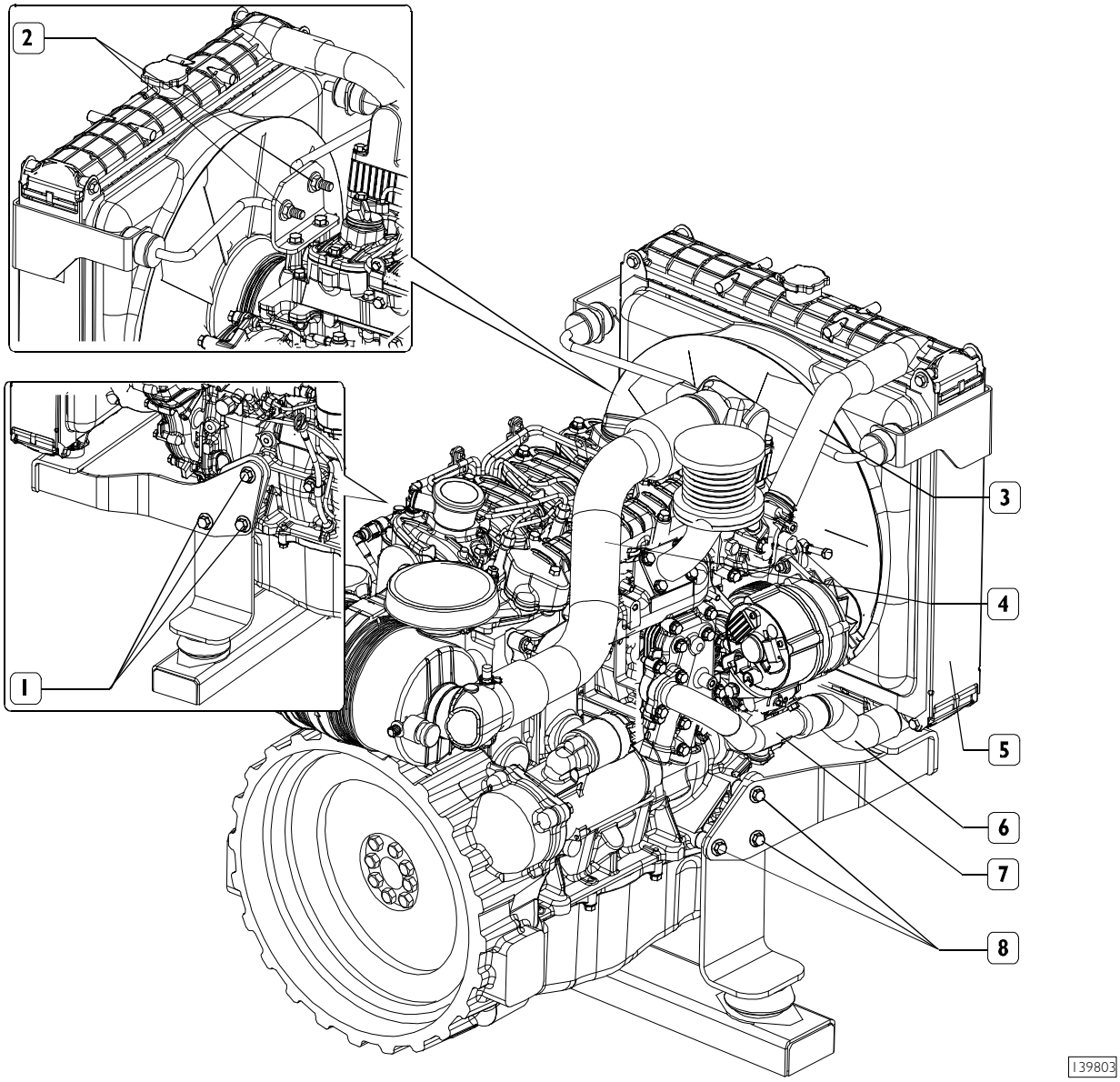
F5CE0485 ENGINE

Place a container under the sleeve (11) to recover the refrigerant.

- ❑ slacken off the collars and remove the water hose (10);
- ❑ slacken off the collars and remove the hoses (1) and (7) from the turbocharger;
- ❑ slacken off the collar and remove the water hose (8);
- ❑ slacken off the collars and remove the air hose (4);
- ❑ remove the oil vapour recirculation hose (2);
- ❑ undo the nut (5) securing the linkage to the engine;
- ❑ undo the bolts (3) and (12) securing the bracket to the engine;
- ❑ remove the radiator assembly from the engine (9).

F5CE0405 engine

Figure 11



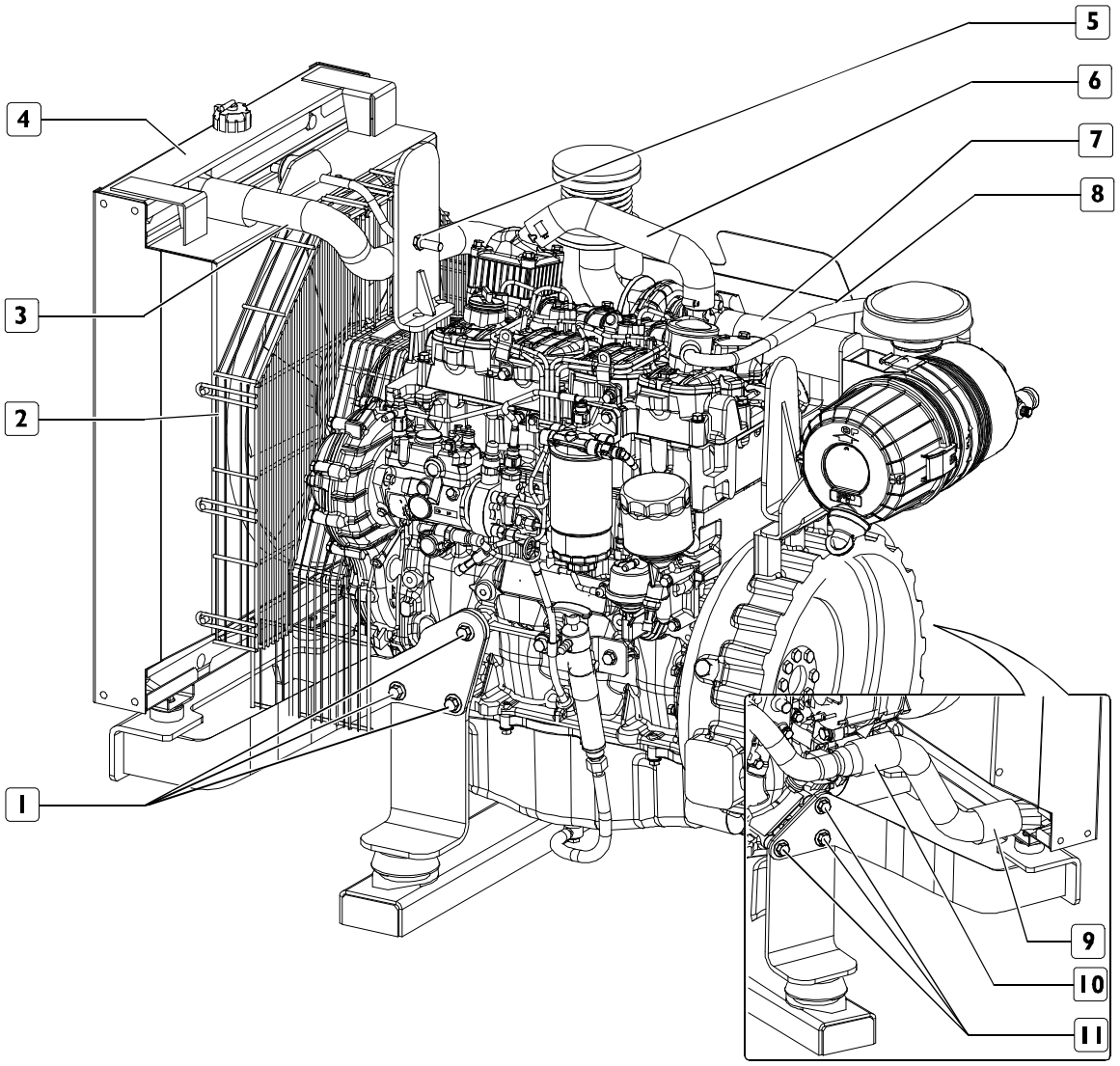
F5CE0405 ENGINE

Place a container under sleeve (6) to recover the coolant.

- ❑ slacken off its collars and remove water hose (7);
- ❑ slacken off its collar and remove water hose (3);
- ❑ slacken off its collars and remove air hose (4);
- ❑ slacken off nuts (2) securing the linkage to the engine;
- ❑ slacken off bolts (1) and (8) securing the brackets to the engine;
- ❑ remove the radiator assembly from the engine (5).

F5CE0455 engine

Figure 12

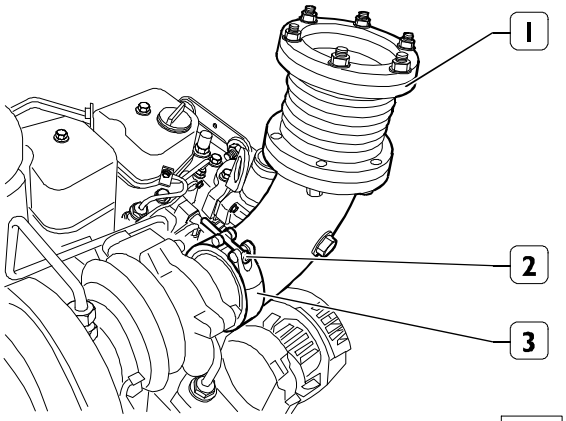


F5CE0455 ENGINE

Place a container under sleeve (9) to recover the coolant.

- ❑ slacken off its collars and remove water hose (10);
- ❑ slacken off their collars and remove pipes (6) and (7) from the turbocharger;
- ❑ slacken off its collar and remove water hose (3);
- ❑ remove the oil vapour recirculation hose (8);
- ❑ undo nut (5) securing the linkage to the engine;
- ❑ remove the guard (2);
- ❑ slacken off bolts (1) and (11) securing the brackets to the engine;
- ❑ remove the radiator assembly (4) from the engine.

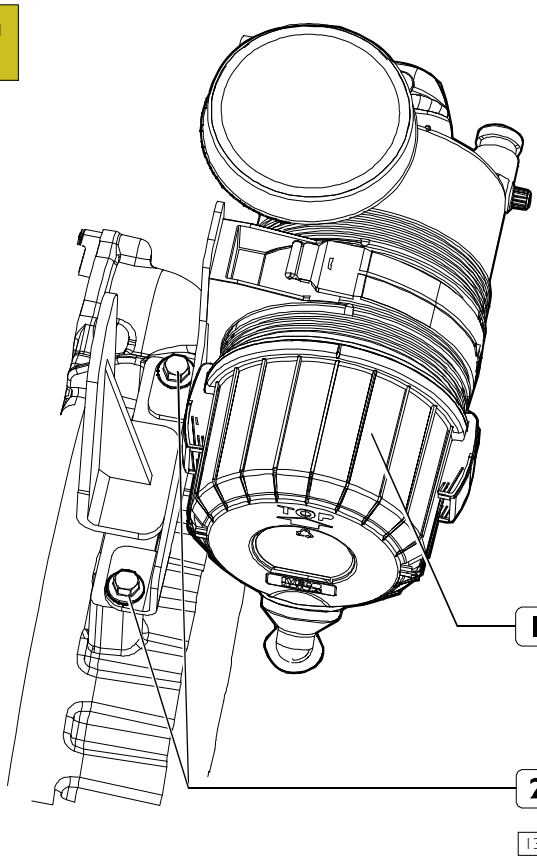
Figure 13 (Demonstrative)



❑ Disconnect the drainage pipe (1) from the system, adjusting the bolt (2) to open the band (3).

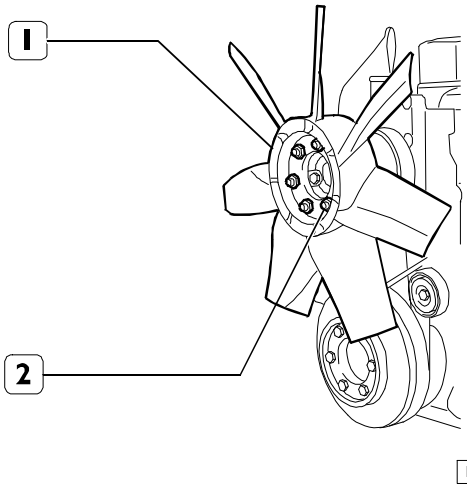
NOTE The shape and the size of the drainage pipe vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out.
The procedures described can, however, be applied.

Figure 14



❑ Undo the bolts (2) securing the bracket to the engine and remove the air filter complete with mounting.

Figure 15 (Demonstrative)



❑ Remove the fan (1), complete with spacer, adjusting the bolts (2).

NOTE The shape and the size of the fan vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out.
The procedures described can, however, be applied.

ENGINE DISASSEMBLY ON BENCH

NOTE Engine disassembly operations to remove the engine from the vehicle are described in the specific section. Engine disassembly operations, as well as engine overhaul, must be executed by qualified engineers only, duly provided with the specific tools required.

NOTE Depending on the appliance, some units may have different position on the engine.

NOTE Before fitting the engine on the rotary stand 99322205, disassemble the parts which may interfere with the bracket 99361043 assembly. Depending on the appliance, it may be necessary to remove the starter and the oil filter.

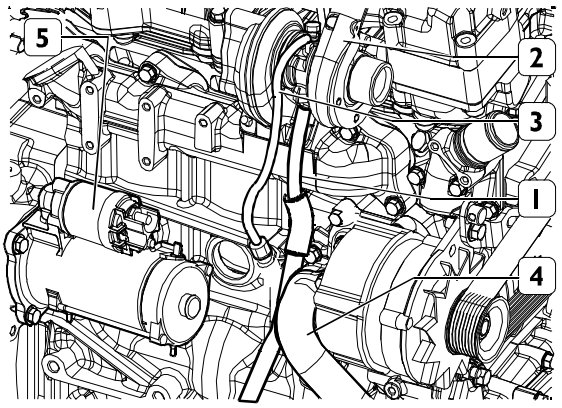
- ❑ Drain the engine oil from the oil pan collecting it in a suitable container.

Warning! Avoid skin contact with the engine oil: in case of contact wash your skin with running water.

The engine oil is highly polluting: waste disposal must be executed complying with the laws and regulations in force.

- ❑ Remove the electric wiring from the injection pump.

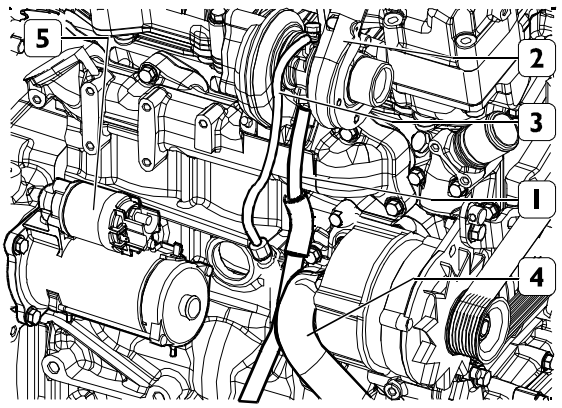
Figure 1



124496

- ❑ Remove oil delivery pipe connected to the turbocharger (3) and t the oil return pipe (1) (if present).
- ❑ Remove the turbocharger unit (2).
- ❑ Duly hold the starter (5), unscrew the fastening screws and remove the starter.
- ❑ Remove the water hose (4).

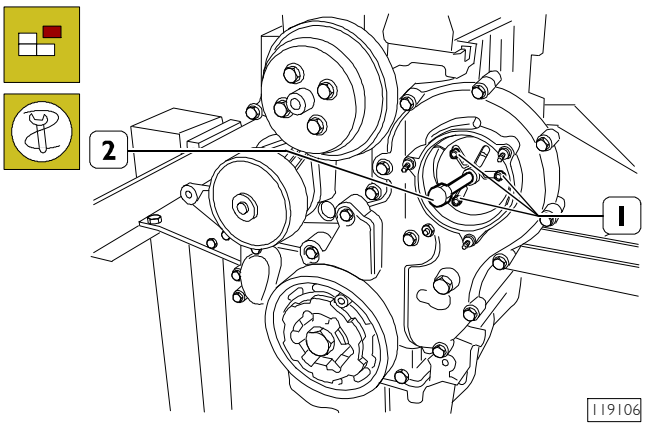
Figure 2



124469

- ❑ Remove the L.D.A. pipe. Remove the fast clutch fuel pipes from the priming pump to the filter (3) and from the filter to the ignition pump (1), then fit the specially provided caps to the pipes, the pumps and the filter. Unscrew the screws (2), fastening the fuel ignition pipes and remove them.

Figure 3

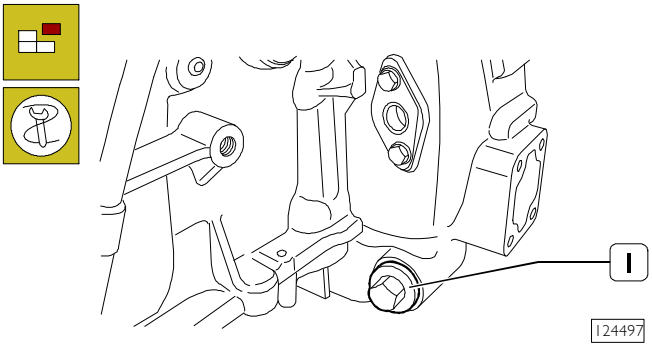


❑ Unscrew the pump fastening screws on the rear part of the gear cover. To disassemble the pump, fit tool 99340025 to the pump wheel and fix it with the three screws (1).
Using the specially provided wrench, slowly tighten the screw (2) holding the rear part of the pump removing the pump completely.

NOTE Before pump disassembly, use the speciallyprovided tool (99360612), lock the engine into thepposition corresponding to T.D.C. for cylinder 1. Now block with the specific system the pump shaft; this way the pump should be timed, so that when refitting (if no maintenance intervention is required on it) no adjustment is necessary.

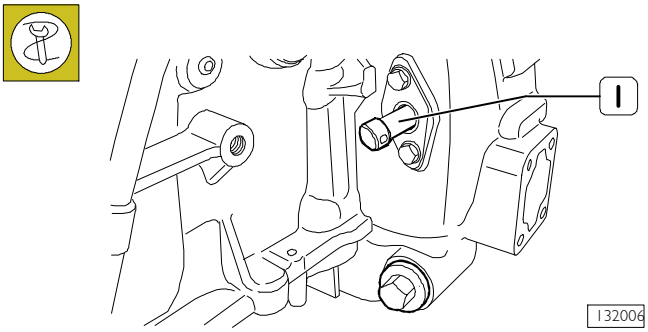
Cylinder 1 T.D.C. search

Figure 4



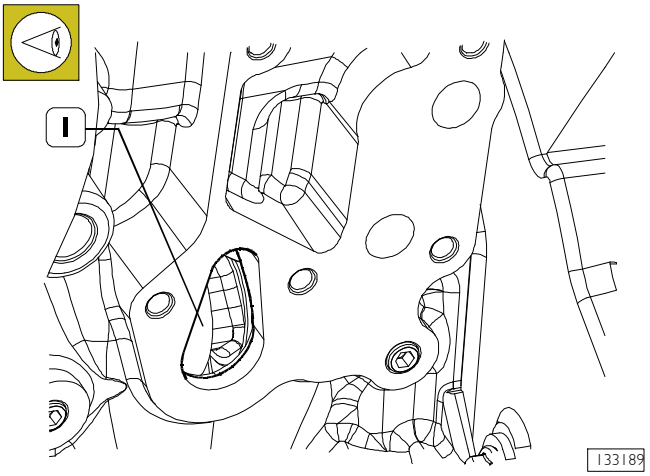
❑ Fit tool (1) 99360330 to flywheel housing to rotate the flywheel (must be used with a suitable wrench).

Figure 5



❑ Loosen the screws of the plate in which tool 99360612 (1) is to be fitted.

Figure 6



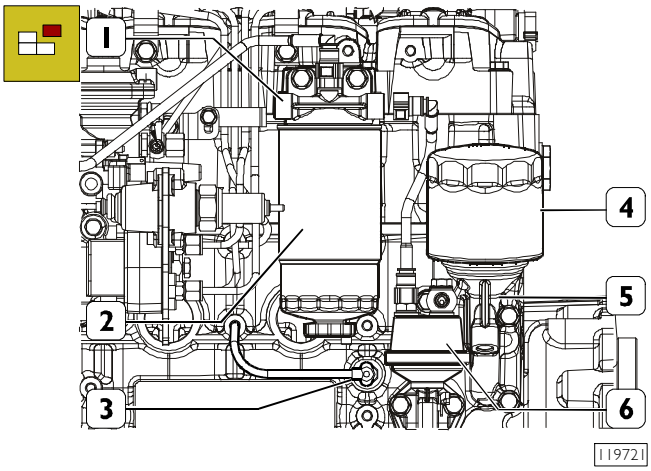
Position the engine drive shaft at T.D.C. of cylinder 1 rotating the flywheel until achieving the following conditions:

❑ the notch (1) is visible from the inspection hole;

❑ tool 99360612 should be fitted through the carter into the port on the flywheel.

Remove tools and tighten the previously loosened plate screws.

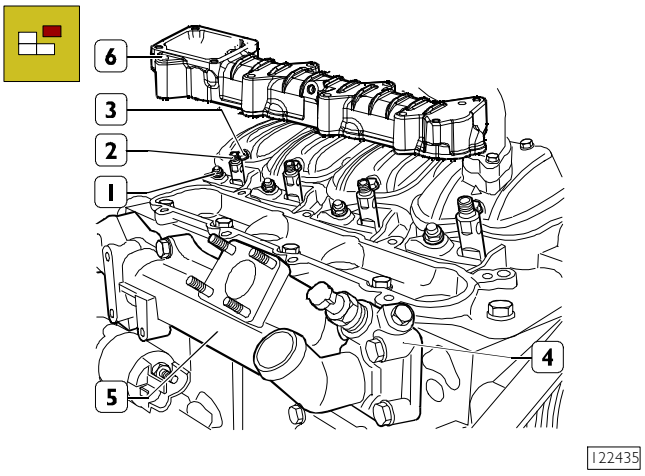
Figure 7



- ❑ Place a container under the diesel fuel filter and unscrew the condense drainage faucet under said filter; completely drain the diesel fuel container therein.
- ❑ Disassemble the diesel fuel filter (2), the filter support (1), the priming pump (6), the oil filter (4), the oil filter support (5), and the KSB water sensor (3).

Warning! The oil filter contains a certain quantity of engine oil.
Collect the engine oil and dispose it complying with the applicable laws and regulations in force.

Figure 8

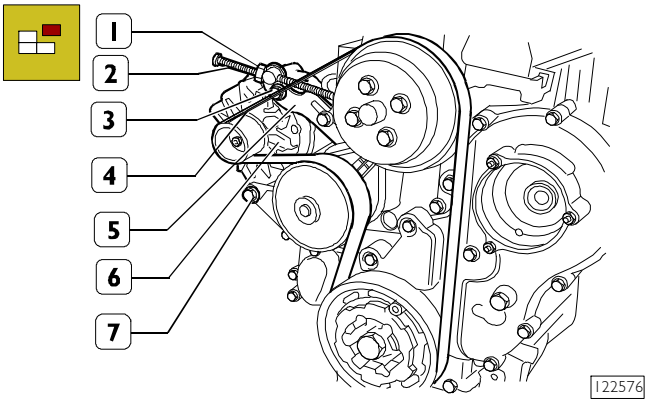


- ❑ Unscrew the injector support fastening screws (1), disassemble the injector supports and remove the injectors (2).
- ❑ Loosen the screws (3) and remove the tappet covers.
- ❑ Remove the intake manifold (6).
- ❑ Remove the thermostat unit (4) and the exhaust manifold (5).

NOTE On the central cover there is a lubrication oil vapour blow-by valve.

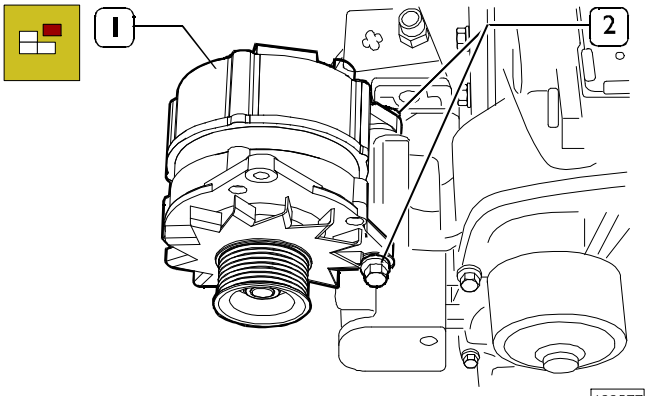
All the gaskets must always be replaced in phase of assembly.

Figure 9



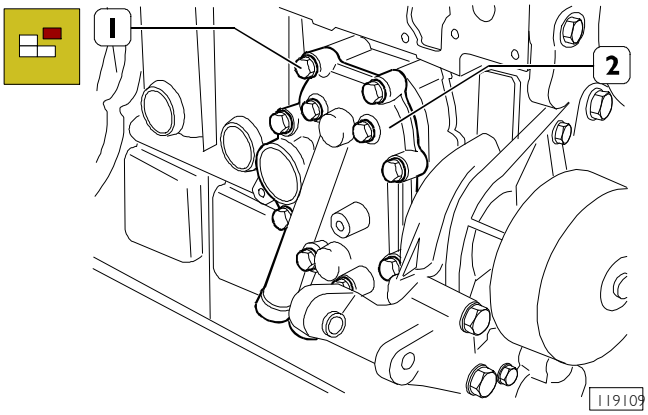
- ❑ Loosen the screw (7) and the relevant screw nut on the belt tensioning bracket (1).
- ❑ Loosen the screw (7) in order to withdraw the belt (4).
- ❑ Remove the fan, the fan support spacer and the belt.
- ❑ Remove the belt tensioning bracket (5).
- ❑ Disassemble the pulleys and the guide rollers.

Figure 10



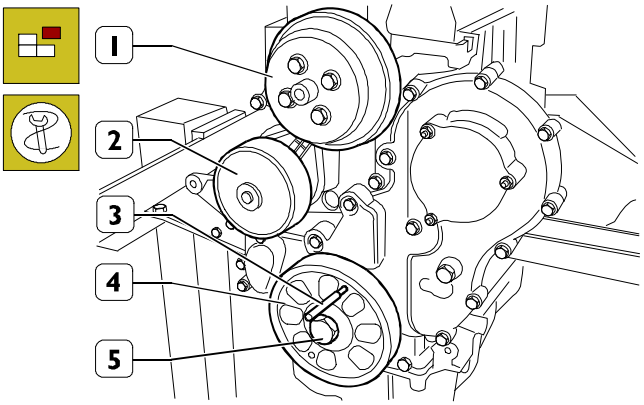
- ❑ Duly hold the alternator (1) and detach it from its support loosening the screw (2): recover nut and washer.

Figure 11



- ❑ Place a container under the heat exchanger (2) to collect the cooling liquid contained therein.
- ❑ Loosen the screws (1) and disassemble the heat exchanger unit (2).

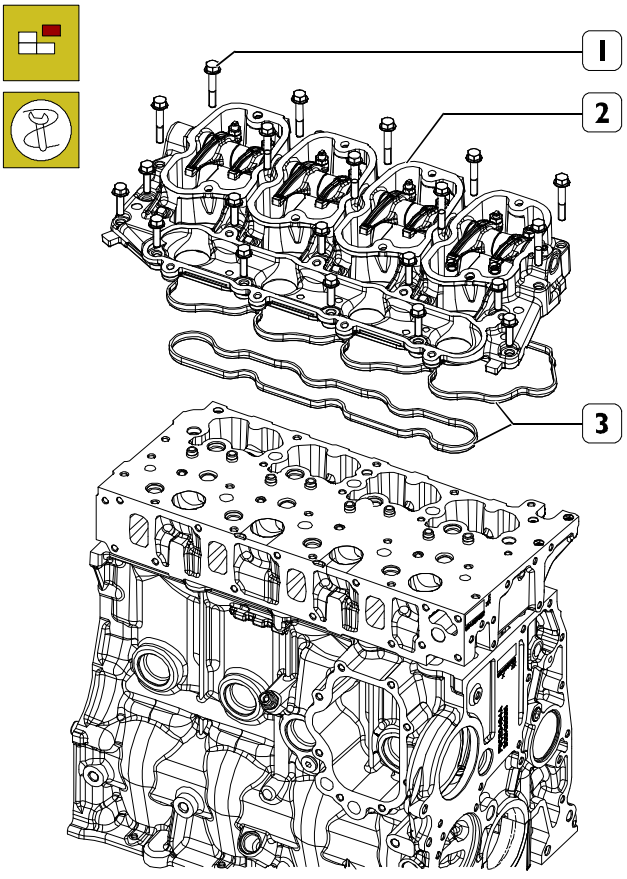
Figure 12



125127

- ❑ Remove the electromagnetic joint support (1) and the water pump (2).
- ❑ Loosen the screw (5) and remove the pulley (4), using a pin (3).

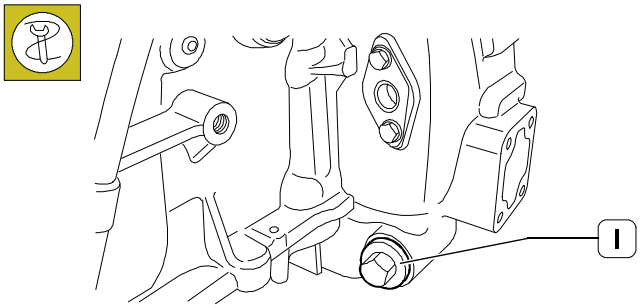
Figure 13



119111

- ❑ Loosen the fastening screws (1), remove the overhead holding the whole rocker arm unit (2) and recover the two gaskets (3).

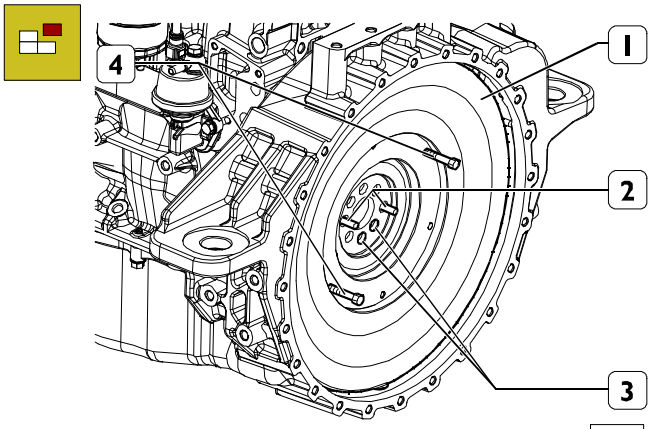
Figure 14



124497

- ❑ Fit tool (1) 99360330 to the flywheel box and, using a wrench, lock the flywheel rotation.
- ❑ Loosen the screws fastening the flywheel to the engine drive shaft.

Figure 15

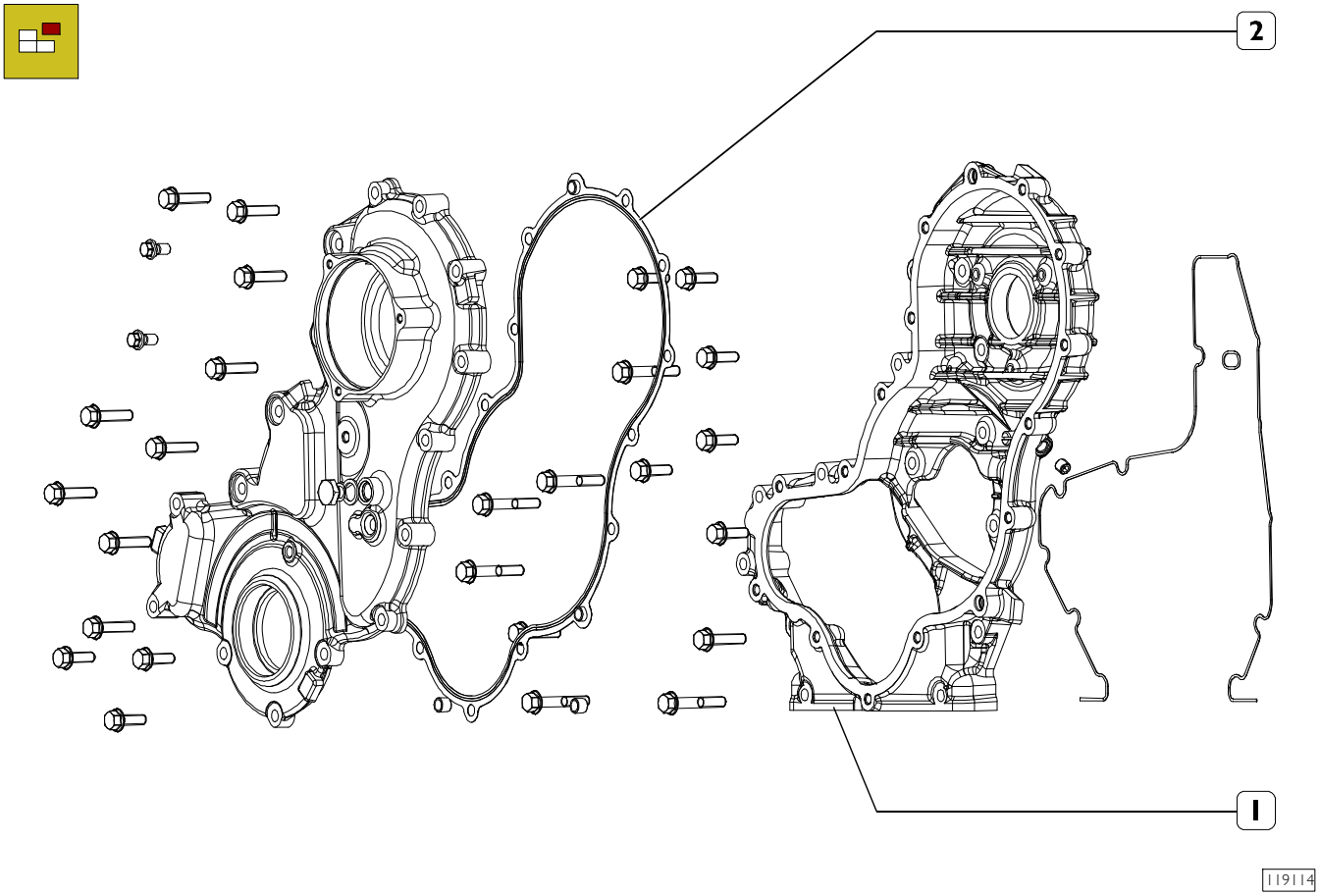


119113

- ❑ Screw two medium length screws in the ports (4), in order to secure the flywheel with a sling.
- ❑ By means of two guide pins (2) previously screwed in the engine drive shaft ports (3), guide the flywheel withdrawal throughout a hoist.
- ❑ Withdraw the flywheel casing grommet.
- ❑ Withdraw the grommet of the timing gearcase.

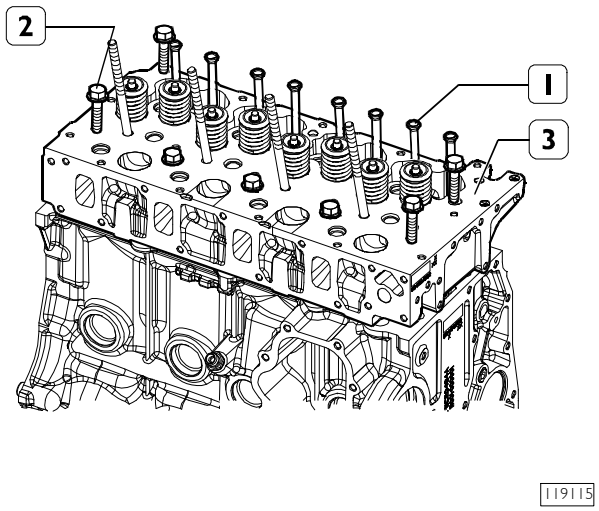
Timing gearcase

Figure 16



❑ Remove the rear part (1), of the timing gearcase cover.

Figure 17

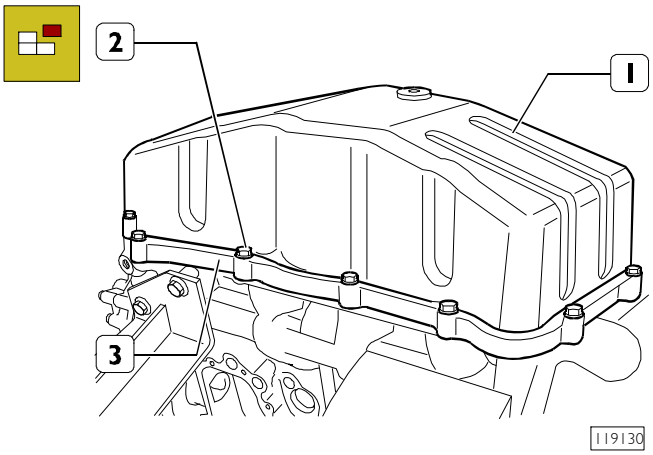


❑ Remove the tappet rods (1).

❑ Disassemble the cylinder head;
loosen the cylinder head (3) fastening screws (2);
hook the brackets with metal ropes and, throughout a hoister, detach the cylinder head with valves from the basement.

❑ Remove the cylinder head gasket.

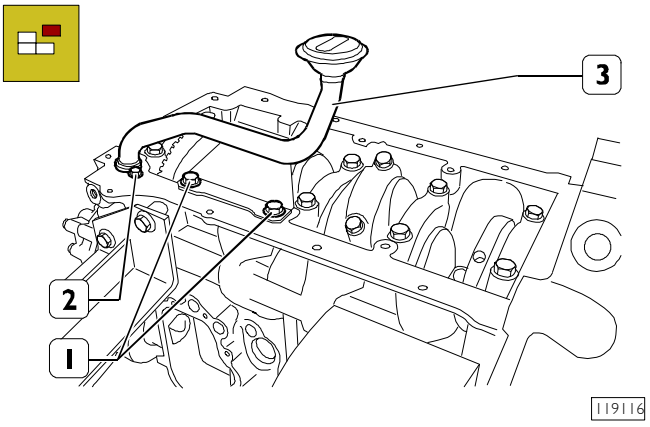
Figure 18



- ❑ Turn the engine upside down.
- ❑ Loosen the screws (2), disassemble the plate (3) and remove the oil pan (1).

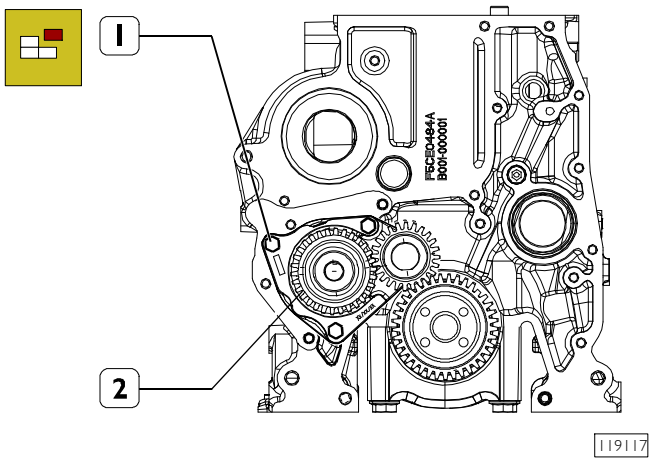
NOTE The shape and dimensions of the oil pan and the suction rose may vary depending on the engine appliance. Hence, the figures provide a general indication of the operation to be executed. Yet, the herein description of the procedures is exhaustive and applicable.

Figure 19



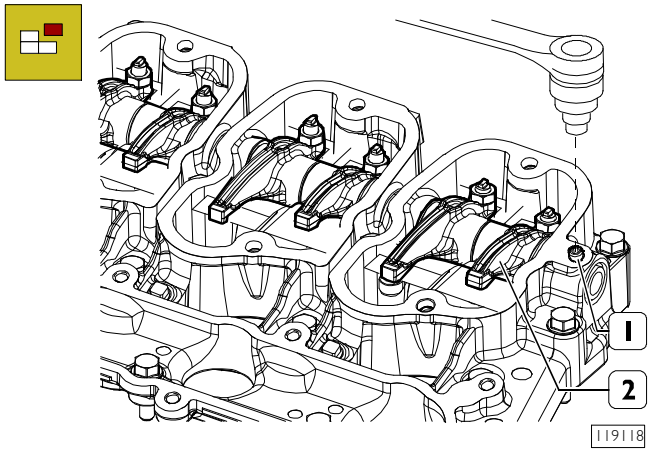
- ❑ Loosen the suction rose support fastening screws (1).
- ❑ Loosen the suction rose (3) fastening screws (3) and then remove the suction rose.

Figure 20



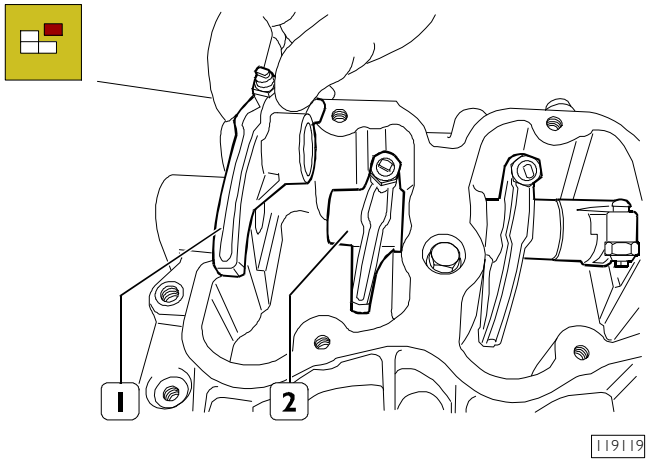
- ❑ Loosen the screws (1) and remove the oil pump (2).

Figure 21



- ❑ Loosen the rocker arm fastening screw (1) from the disassembled rocker arm holding unit and then remove the rocker arm.

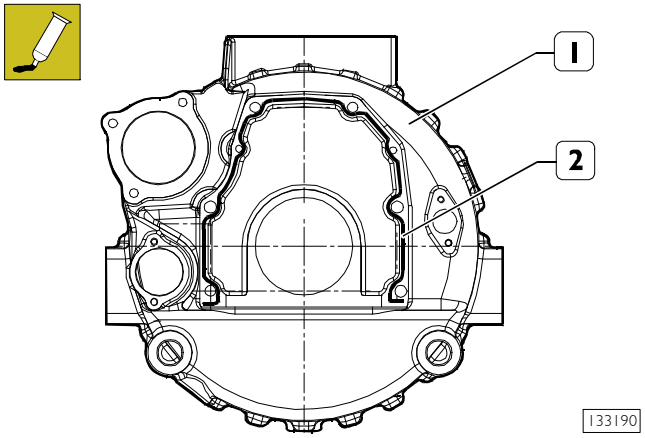
Figure 22



- ❑ Withdraw the rocker arm (1) from one side recovering the equalizers (2) from the other.

Rear side component assembly

Figure 23



SCHEME FOR THE APPLIANCE OF LOCTITE 5999 SEALER ON THE TIMING GEARCASE

❑ Accurately clean the timing gearcase (1) and the engine basement.

It is absolutely necessary to clean the surface to be sealed in order to obtain perfect tightness.

Apply LOCTITE 5999 sealer on the gearcase in order to form a sealing bead of a few mm.

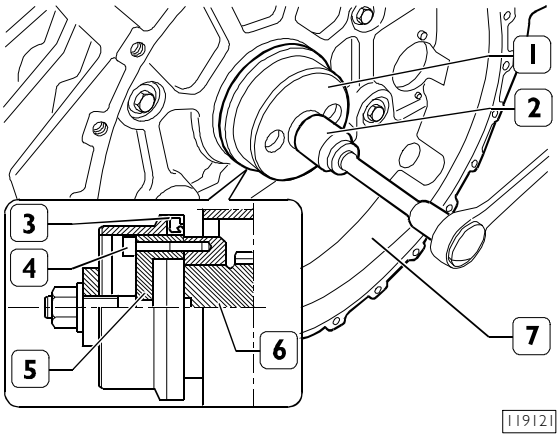
The sealing bead must be homogeneous (no lumps), free of air bubbles, thinner areas and gaps.

Any imperfection must be corrected as soon as possible.

Avoid the excess of sealer: too much sealing material would leak and pour out on both sides of the joint parts and, as a consequence, obstruct the passage of the lubricant.

After having applied the sealer, the parts must be joined within 10 minutes.

Figure 24

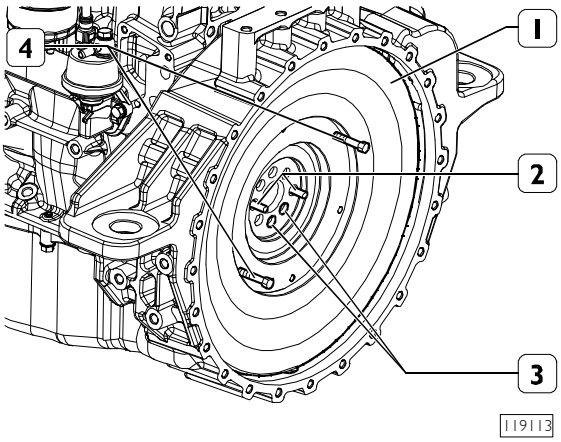


❑ Fit the specific tool 99346259 (5) to the rear shank (6) of the engine drive shaft, fix it with the screws (4) and spline the new grommet (3) thereon.

❑ Position part (1) on part (5), tighten the screw nut (2) until the grommet has been fitted (3) into the flywheel casing (7).

Flywheel assembly

Figure 25



❑ Screw two hooks or eyebolts on the flywheel (1) through the ports (4).

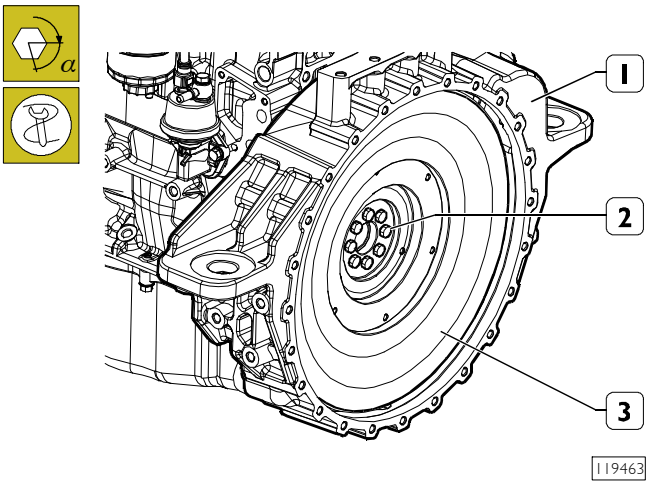
❑ By means of a hoister, draw the flywheel up to its housing inside the casing.

NOTE The flywheel has a reference dowel that couples with the relevant seat on the box.

❑ Screw two pins (2) of appropriate length into the shaft's ports (3) and, using them as a guide, duly fit the engine flywheel (1) into its casing.

❑ Tighten the screws fastening the engine flywheel to the engine drive shaft. Fit the tool 99360330 to the flywheel casing in order to lock the engine flywheel rotation.

Figure 26



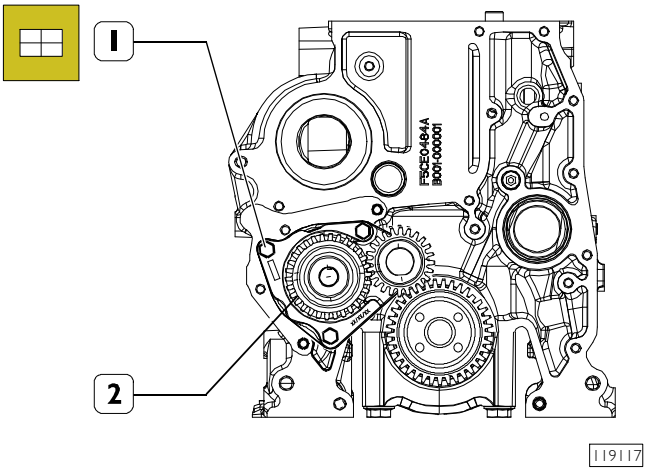
Tighten the engine flywheel (2) fastening screws (1) in two steps:

- ❑ Step 1: 30 ± 1.5 Nm torque setting;
- ❑ Step 2: 90° angular fastening.

NOTE Angular fastening must be executed using tool 99395216.
Before assembly, always check that the port threads and the screws show no trace of wear and dirt.

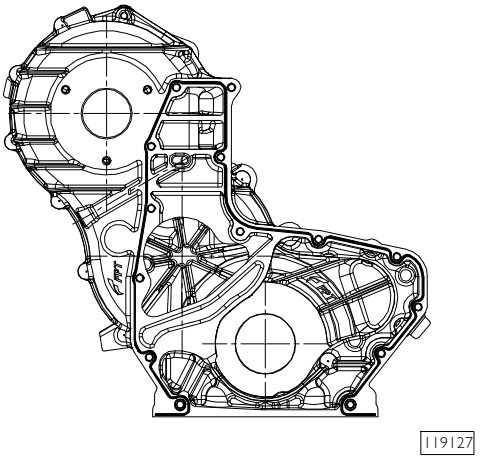
Front side component installation

Figure 27



- ❑ Assemble the oil pump (2).
- ❑ Tighten the fastening screws (1) to the prescribed torque wrench.

Figure 28



SCHEME FOR THE APPLIANCE OF LOCTITE 5999 SEALER

NOTE It is absolutely necessary to clean the surface to be sealed in order to obtain perfect tightness.

Apply LOCTITE 5999 sealer on the gearcase in order to form a sealing bead of a few mm.

The sealing bead must be homogeneous (no lumps), free of air bubbles, thinner areas and gaps.

Any imperfection must be corrected as soon as possible.

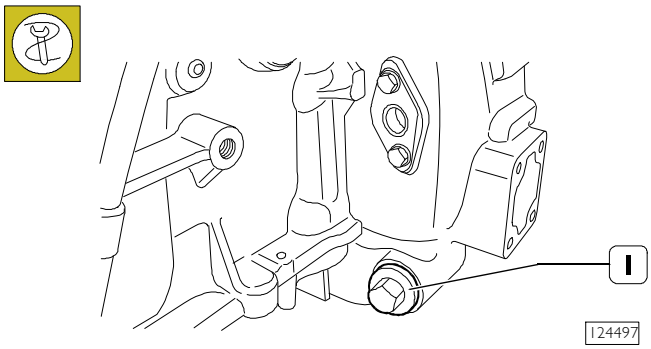
Avoid the excess of sealer: too much sealing material would leak and pour out on both sides of the joint parts and, as a consequence, obstruct the passage of the lubricant.

After having applied the sealer, the parts must be joined within 10 minutes.

- ❑ Assemble the front case (1) and tighten the fastening screws to the prescribed torque wrench.

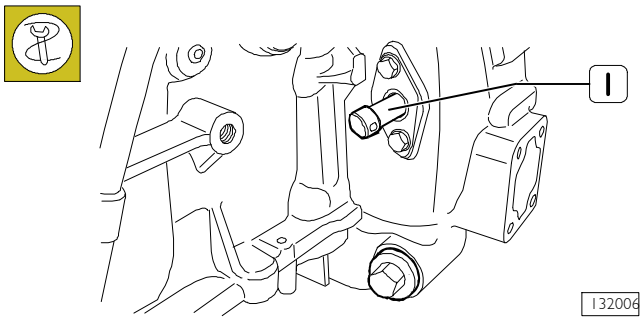
Timing

Figure 29



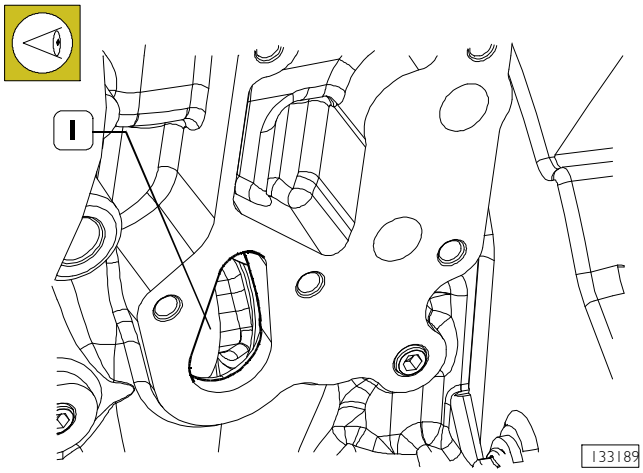
❑ Fit tool (1) 99360330 to flywheel housing to rotate the flywheel (must be used with a suitable wrench).

Figure 30



❑ Loosen the screws of the plate in which tool 99360612 (1) is to be fitted.

Figure 31



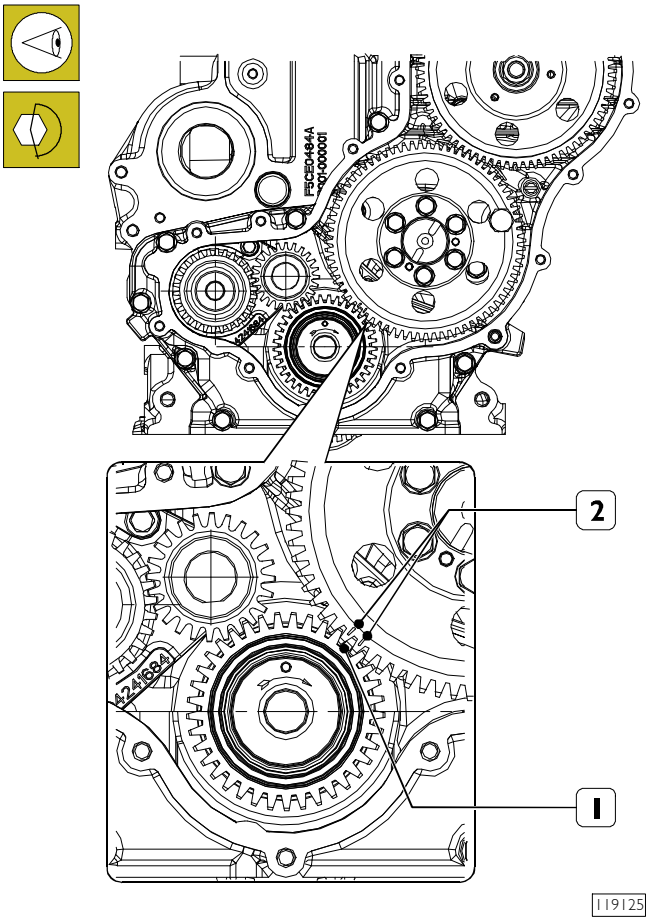
Position the engine drive shaft at T.D.C. of cylinder 1 rotating the flywheel until achieving the following conditions:

❑ the notch (1) is visible from the inspection hole;

❑ tool 99360612 should be fitted through the carter into the port on the flywheel.

Remove tools and tighten the previously loosened plate screws.

Figure 32



❑ Seize the 45° bevel tooth (1) of the engine drive shaft gear with the timing gear tooth marked with two notches (2), as shown in the figure.

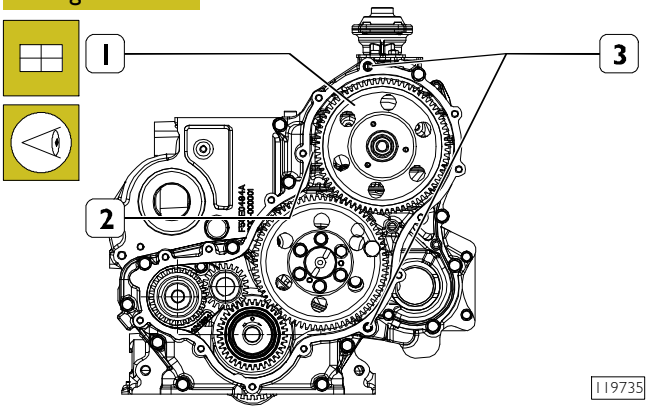
❑ Rotate the camshaft keeping the timing gear fix until the camshaft's pin fits into the relevant housing within the timing gear.

❑ Screw the screws of the transmission gear without fully tightening them.

❑ With magnetic base comparator, check the clearance among the engine shaft gear and the cam shaft gear: it must be 0.068 ÷ 0.168 mm.

❑ Screw the fastening screws (1) of the transmission gear.

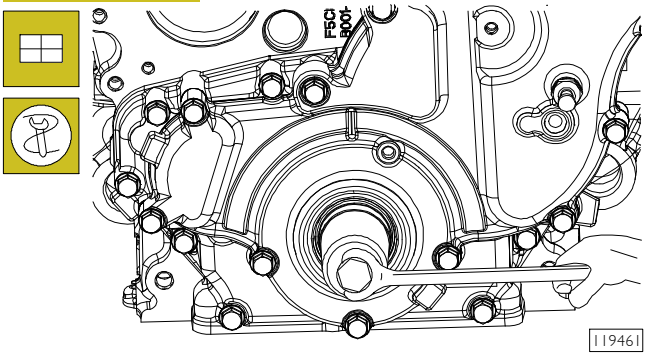
Figure 33



- ❑ Fit the ignition pump cogwheel (1) into its housing.
- ❑ Fit the pre-set ignition pump into its housing on the engine, inserting the shaft into the gear hole.
- ❑ Tighten the three screw nuts on the rear part of the timing gearcase and the front cover fixing the shaft to the gear.
- ❑ Unblock the pump with magnetic base comparator, check the clearance among the engine shaft gear and the oil pump gear: it must be 0.068 ÷ 0.168 mm.
- ❑ Fit the new gasket using the centring pins (2) on the casing for its correct positioning.
- ❑ Fit the casing's cover using the centring pins (2) to correctly position it and then tighten the fastening screws to the prescribed torque wrench.
- ❑ Unlock the fly-wheel

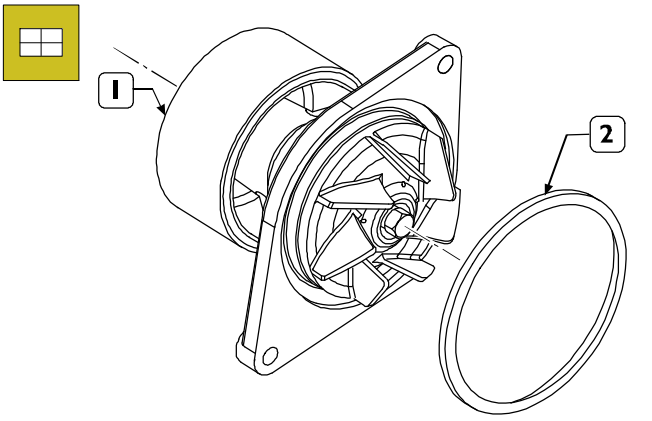
NOTE To carry out the correct ignition pump assembly, proceed as shown in the specific section.

Figure 34



- ❑ Fit the inner part of tool 99346258 to the front shank of the engine drive shaft. Make sure that the engine drive shaft pin is correctly fitted into the tool spline in order to avoid damaging it. Fix it with the screw (1) and spline the new grommet thereon.
- ❑ Place the outer section of the tool on the previously fitted one, tighten the screw nut (2) until completely fitting the grommet (3) into the casing.

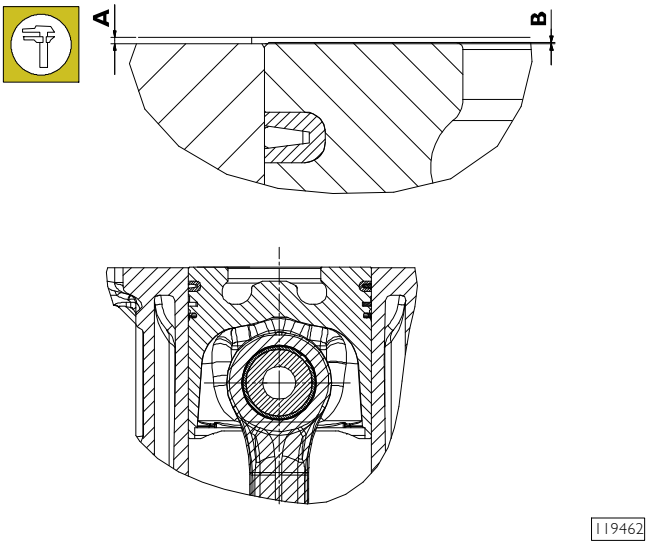
Figure 35



- ❑ Fit a new grommet (2) to the water pump (1).
- ❑ Assemble the water pump (1).
- ❑ Tighten the fastening screws to the prescribed torque wrench.

Piston projection measurement

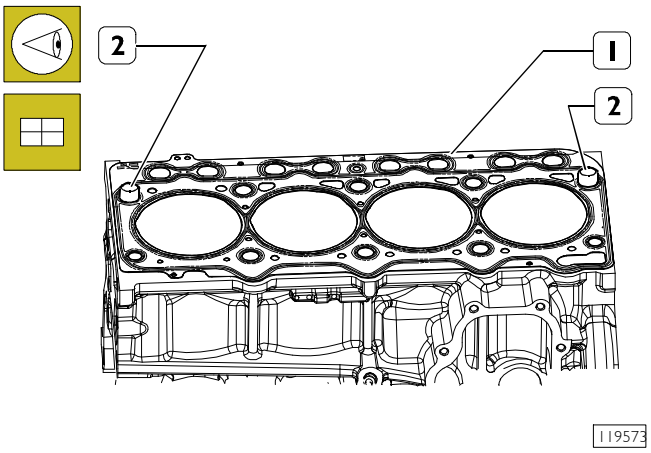
Figure 36



Piston projection from basement A (mm)	Engine gasket thickness B
	Thickness (mm)
From 0.07 to 0.07	0.80
From 0.08 to 0.22	0.70

- ❑ Measure the piston projection and refer to the table above to select the appropriate thickness of the sheath.

Figure 37



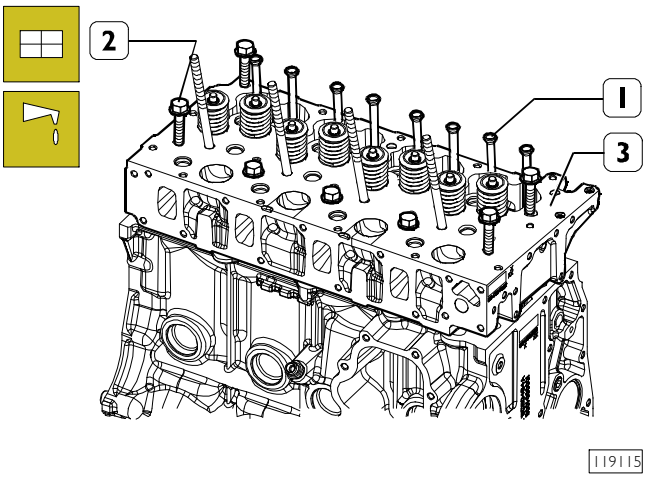
❑ Fit the gasket (1) on the basement centring it taking the pins (2) as a reference. The gasket's thickness must be selected based on the piston projection in respect to the upper plan of the basement.

NOTE Check that the block's laying plan is clean.

Do not grease the gasket. It is recommended to keep the gasket inside its wrapping until it has to be fitted.

The fitting direction is univocal and defined by the centring pins on the basement, which must match with the ports on the gasket.

Figure 38



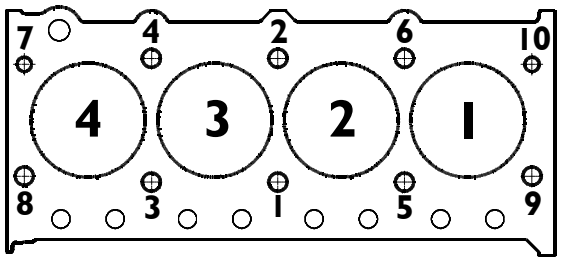
NOTE Always use new screws for assembly.

❑ Lubricate the head fastening screws (2) and tighten them to the prescribed torque wrench.

❑ Place the head (3) on the block taking the centring pins as a reference.

NOTE The head screws should be tightened in a precise order.
There follows the locking sequence and the torques to be applied for each type of screw.

Figure 39



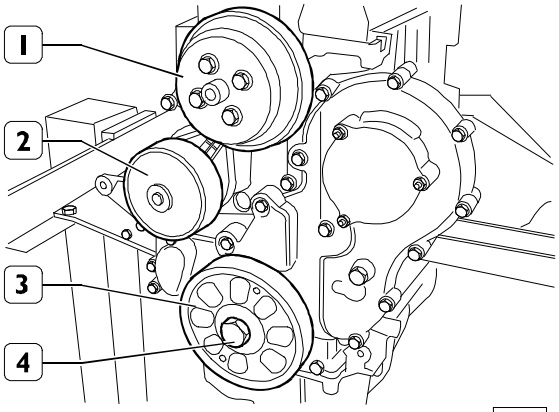
133184

HEAD SCREW LOCKING ORDER

Screws 1,2,3,4,5,6: M15x1,5 6g x193
Screws 7,8,9,10: M12 x1,5 6g x165

- ❑ Lubricate the screws;
- ❑ Tighten the screws with a torque wrench following the locking order described above:
  - M15 Screws: torque 130±6,5 Nm;
  - M12 Screws: torque 65±3,25 Nm;
- ❑ Tighten the screws further with a torque wrench following the locking order described above:
  - M15 Screws: 90°;
  - M12 Screws: 90°;
- ❑ Wait a few minutes for settling;
- ❑ Then apply the final angular closing following the locking order described above:
  - M15 Screws: 70°;
  - M12 Screws: 60°.

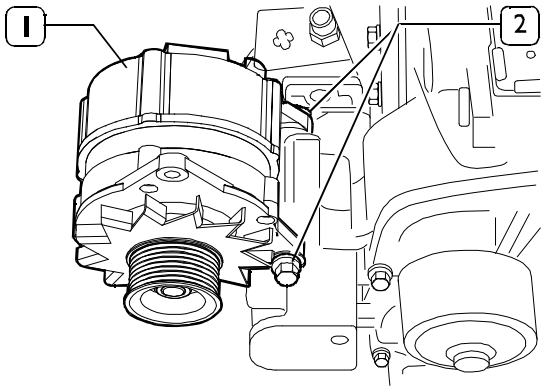
Figure 40



125128

- ❑ Reassemble the electromagnetic joint support (1).
- ❑ Reassemble the pulley (2).
- ❑ Reassemble the pulley (3), tighten the fastening screw (4) to the prescribed torque setting.
- ❑ Reassemble the heat exchanger reminding to replace the old gasket with a new one; tighten the fastening screws to the prescribed torque setting.

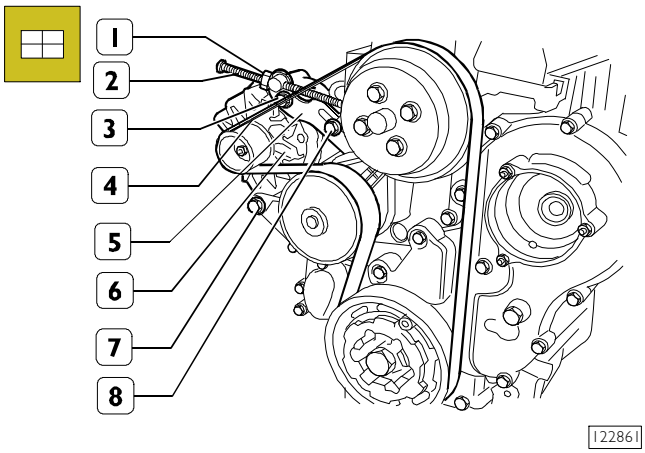
Figure 41



133577

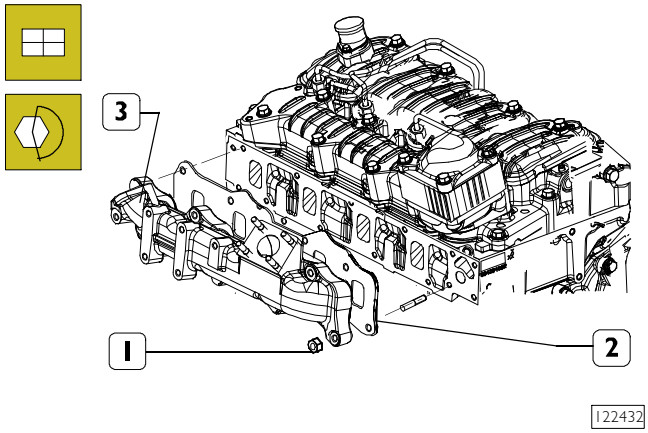
- ❑ Put the alternator back in place (1).
- ❑ Screw up without tightening (2).

Figure 42



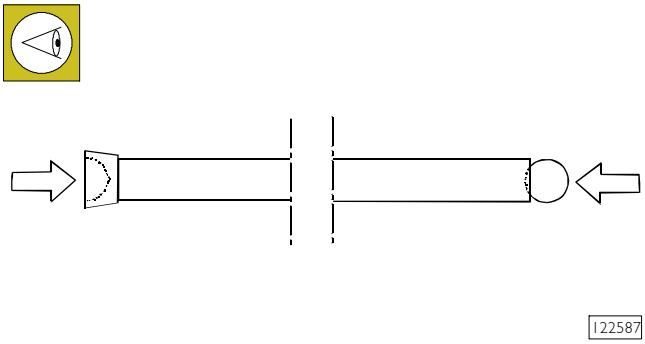
- ❑ Fit the drive belt (4) on the pulley and the guide rollers.
- ❑ Refit the fan support spacer and the fan, and tighten the screws to the prescribed torque.
- ❑ Tension drive belt (4) tightening screw (2) until screw (8) reaches the end of the channel in which bracket (5) is seated. Tighten nut (1) and screw (8).
- ❑ Tighten the screw (3) and the screw nut (7) fastening the alternator (6) to the support.

Figure 43



- ❑ Fit the exhaust collector (3) with a new gasket (2) and tighten the fastening screws (1) to the prescribed torque setting.

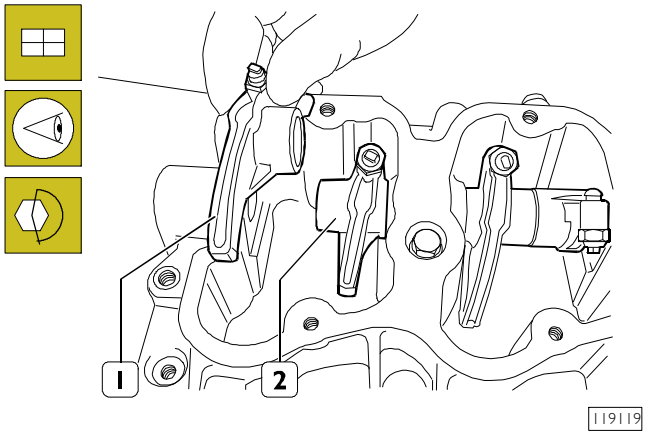
Figure 44



Before reassembly, check that the rocker arm rods must not be deformed; there must be no trace of wear or seizure on the spherical housings of the rocker arm adjusting screws as well as on the tappets (pointers); otherwise these parts must be replaced. The suction valve rods are identical and therefore interchangeable.

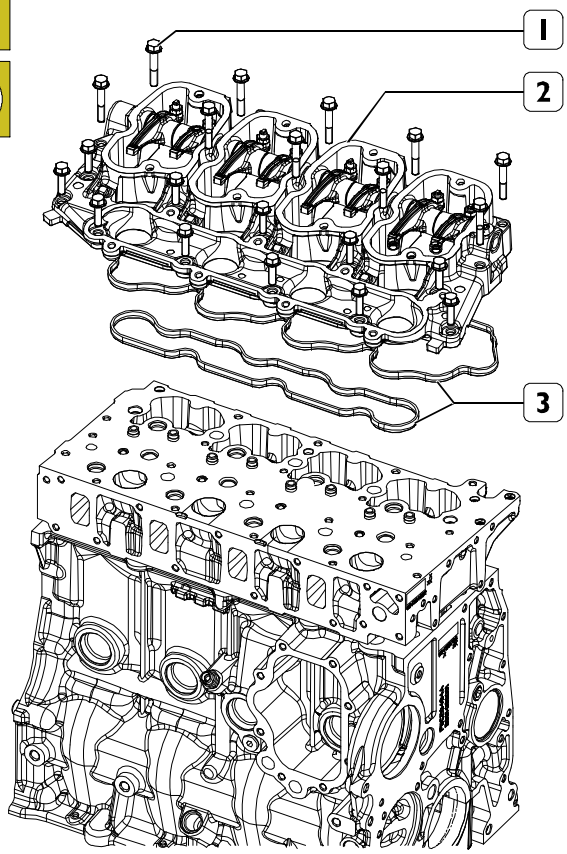
- ❑ Fit the control rods in their housing.

Figure 45



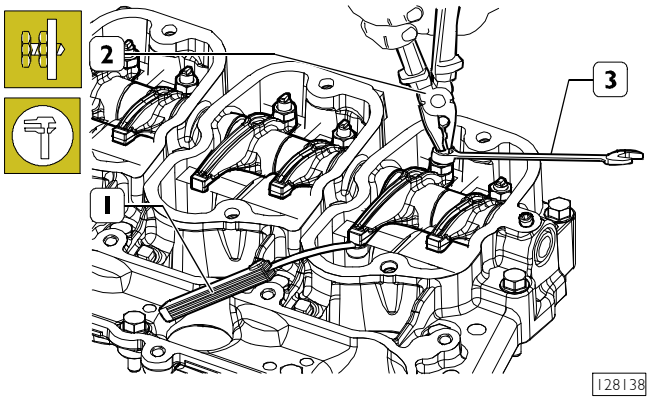
- ❑ Fit the rocker arm positioning the equalizer couples: the suction equalizer first (short rod) and then the exhaust equalizer (long rod) (2).
- ❑ Tighten the fastening screw (1).

Figure 46



- ❑ Replace the gaskets (3), reassemble the rocker arm holding case (2) and tighten the fastening screws to the prescribed torque setting.
- ❑ After having completed the assembly, check that the rocker arms are correctly positioned on the valves and the tappet control rods.

Figure 47



Rotate the engine drive shaft, balance the valves of cylinder 1 and adjust the valves identified by star symbol, as indicated in the following table:

Cylinder n°	1	2	3	4
Suction	-	-	*	*
Exhaust	-	*	-	*

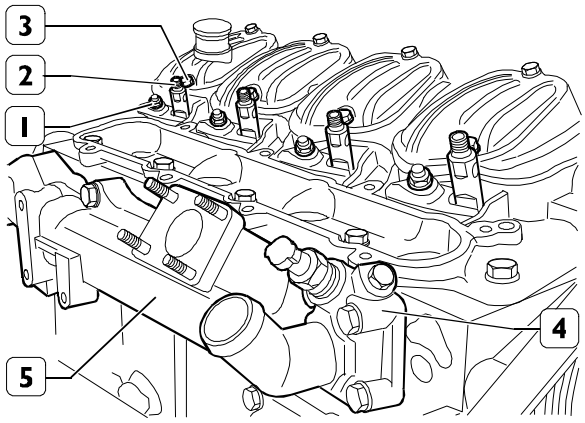
Rotate the engine drive shaft., balance the valves of cylinder 4 and adjust the valves identified by star symbol, as indicated in the following table:

Cylinder n°	1	2	3	4
Suction	*	*	-	-
Exhaust	*	-	*	-

Adjust the clearance between the rockers and valves using a pair of pliers (2), a wrench (3) and a feeler gauge (1).

Clearance shall be as follows:
- intake valves 0.25 ± 0.05 mm
- exhaust valves 0.50 ± 0.05 mm.

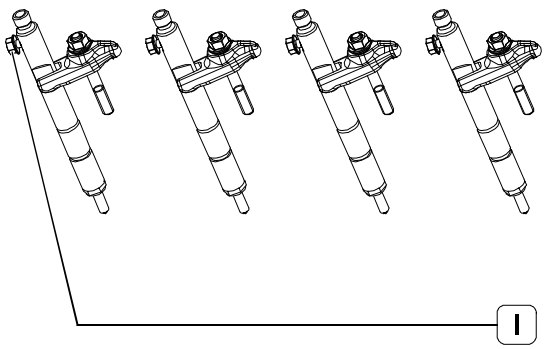
Figure 48



120020

❑ Reassemble the injectors (2) replacing the grommets. Tighten the fastening screws(1) to the prescribed torque setting.

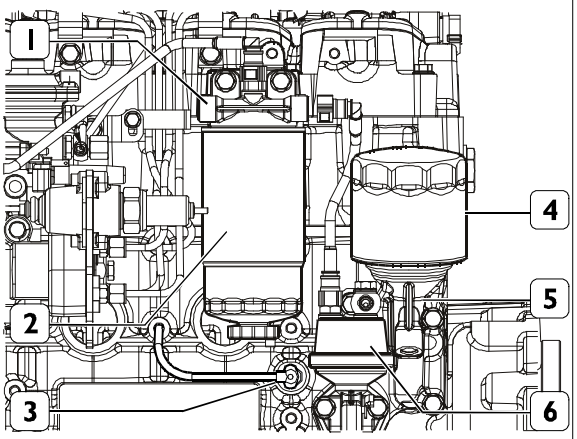
Figure 49



119128

❑ Make the holes (1) for fuel exhaust all face the same direction.

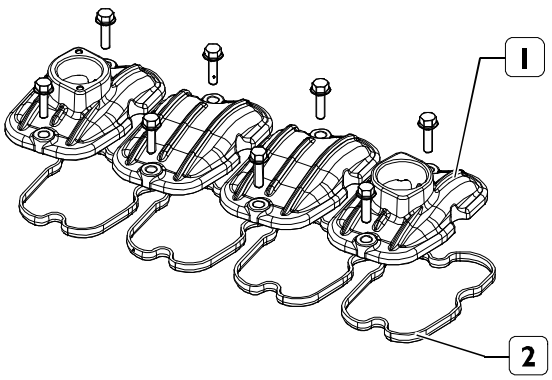
Figure 50



119721

❑ Reassemble the KSB water temperature sensor (6), the oil filter support (5), the priming pump (3), the diesel fuel filter support (2), the fuel filter (1) and the oil filter (4).

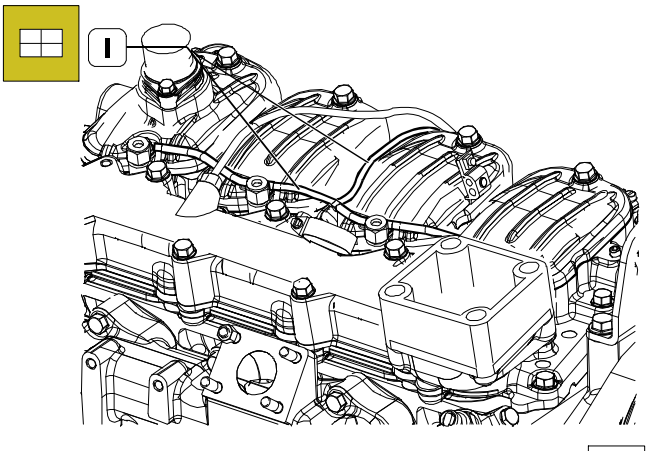
Figure 51



119905

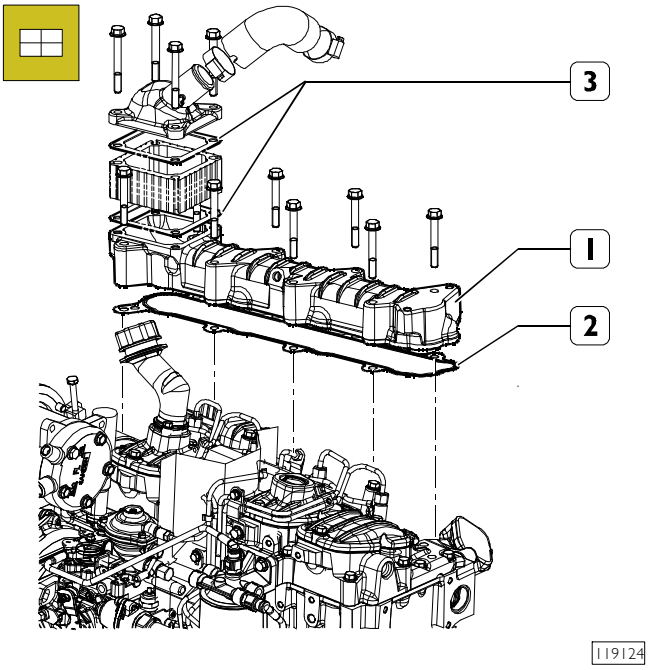
❑ Fit the head covers (1) replacing the gaskets (2).

Figure 52



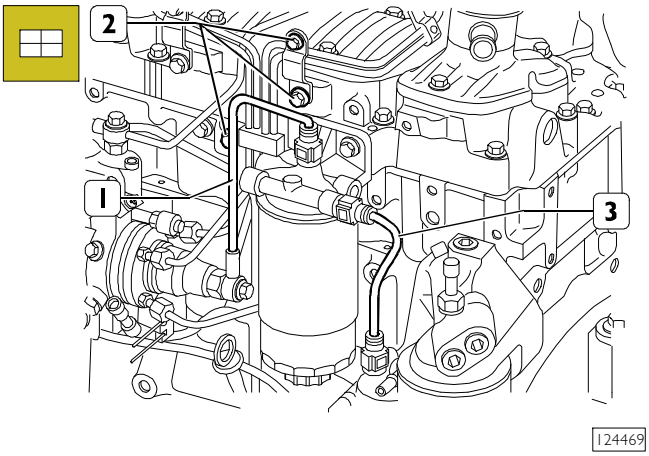
❑ Reassemble the fuel exhaust pipes (1).

Figure 53



❑ Reassemble the whole intake manifold (1) replacing the gasket (2) and (3).

Figure 54

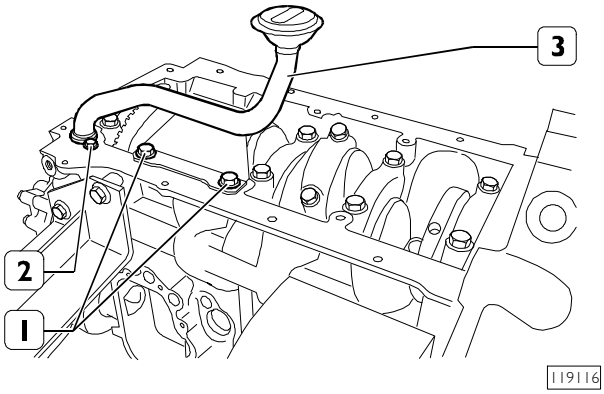


❑ Reassemble the pipe from the pump to the injector and tighten the brackets' fastening screws (2).

❑ Reassemble the pipe from the pump to the fuel filter (1) and from the fuel filter to the priming pump (3).

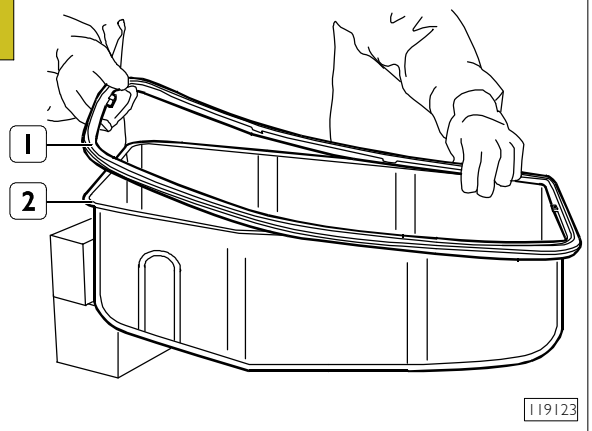
❑ Reassemble the L.D.A. pipe.

Figure 55



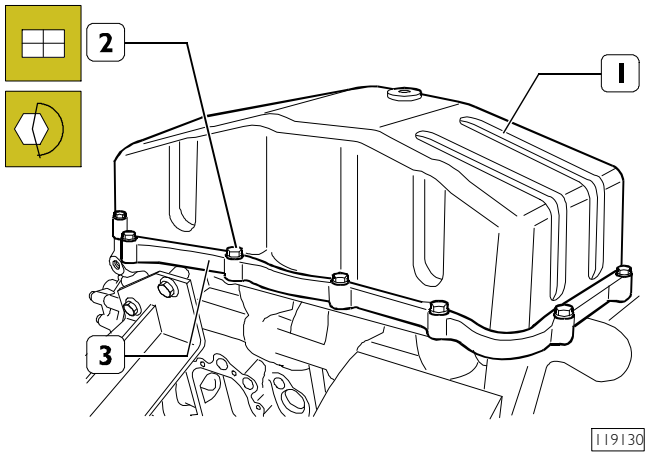
❑ Reassemble the suction rose tightening the support fastening screws (1) and the screw fixing the suction rose (2) to the prescribed torque setting.

Figure 56



❑ Fit the new gasket (1) to the oil pan (2).

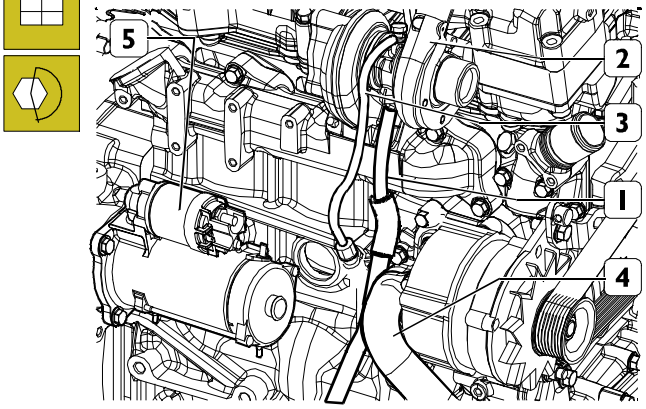
Figure 57



❑ Assemble the oil pan (1) and fit the plate thereon (3). Tighten the fastening screws (2) to the prescribed torque setting.

NOTE Before assembly, check that the port threads and the gaskets show no trace of wear or dirt.

Figure 58



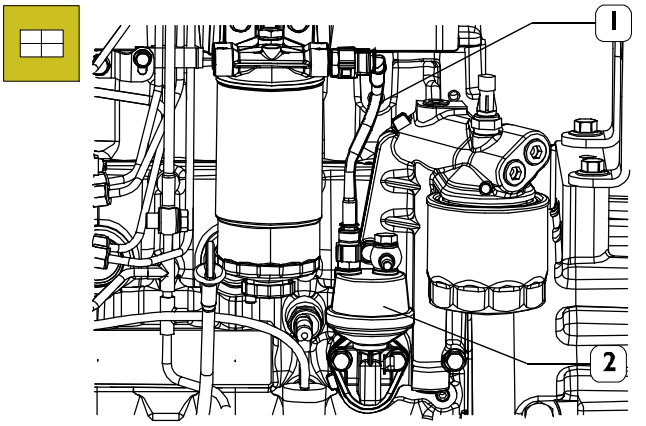
❑ Reassemble the turbocharger (2) unit (xxxxtrad.).

❑ Reassemble the pipe (4) and fit the clip in the correct housing.

❑ Reassemble the oil delivery pipe (3) and the return pipe (1) (if present).

❑ Refit the starter (5) and tighten the fastening screws to the prescribed torque setting.

Figure 59



❑ Disconnect the fuel filter pipe (1) and act on the priming pump (2) drainage lever.

❑ Continue drainage until fuel discharge is completed.

❑ Connect the pipe (1) to the filter.

Checks and inspections

The following checks must be executed after the engine fitting on vehicle.

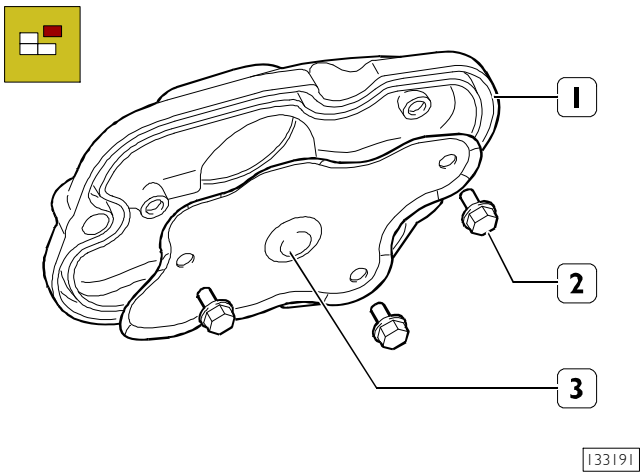
Check that the liquid refuelling or top up has been provided to the correct levels prescribed.

Start the engine, keep it running at a number of rev./-min. slightly over idling and wait until the cooling liquid temperature reaches the value prescribed for thermostat valve opening and then provide checking the following:

- ❑ check there is no water leak from the manifolds connecting the engine cooling circuit pipes and the cabin interior heating pipes, eventually further tightening the O-rings.
- ❑ Carefully check the fuel filter pipe fittings.
- ❑ Check there is no oil leakage from cylinder head and cover, oil pan and basement, heat exchanger oil filter and relevant housings in between the various lubrication circuit pipes.
- ❑ Check there is no fuel leakage from the fuel pipes.
- ❑ Check there is no air leak from the pneumatic pipes (if fitted).
- ❑ Check that the warning lights on the instrument panel and equipment disconnected upon engine disconnection efficiently work.
- ❑ Check and carefully bleed the engine cooling system throughout reiterated drainage.

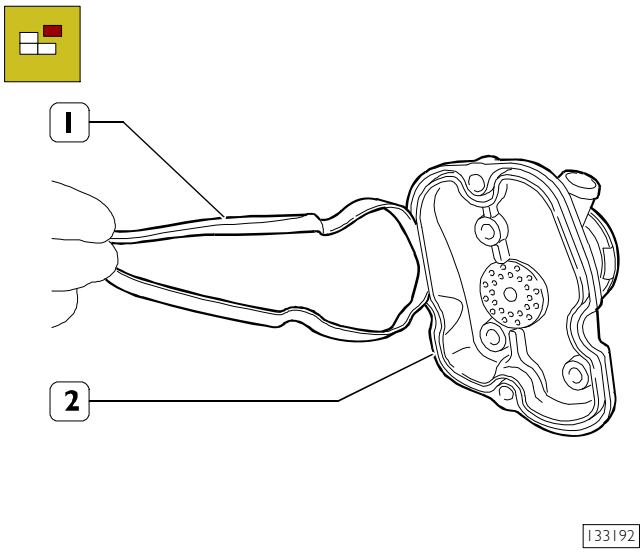
Rocker cover blow-by removal and refitting

Figure 60



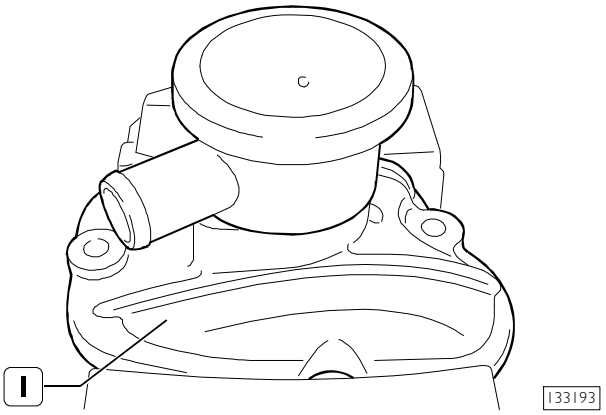
❑ Unscrew the screws (2) from the tappets cover (1) with the blow-by filter and remove the plate guard (3).

Figure 61



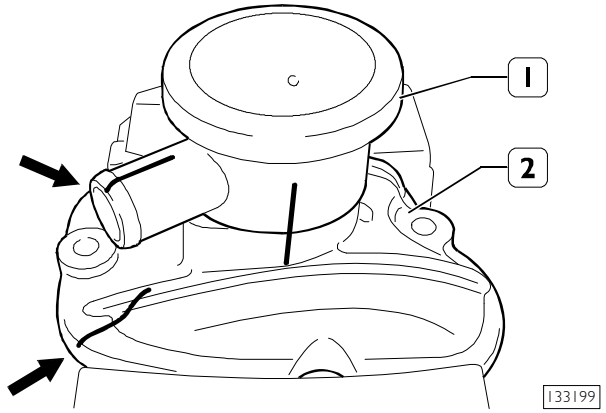
❑ Remove the gasket (1) from the rocker cover (2).

Figure 62



❑ Secure the rocker cover (1) in a vice.

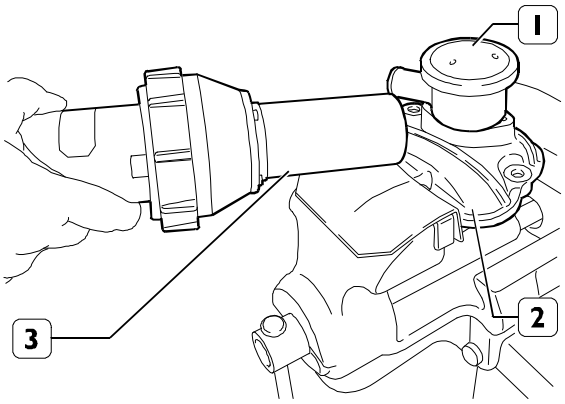
Figure 63



❑ Mark the relative position (as pointed out by the arrows) among the blow by (1) and the rocker cover (2).

NOTE In case of replacement of the blow-by unit (1) it is important to mark the cover (2) for the correct positioning of the blow-by pipe (1).

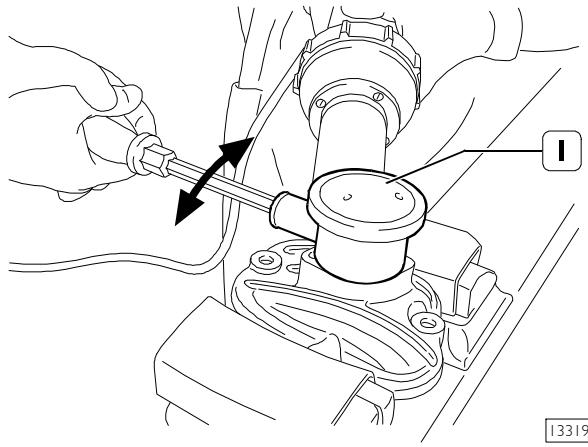
Figure 64



To remove the blow-by (1) from the rocker cover (2) it is necessary to free the elements from the hold of the sealant.

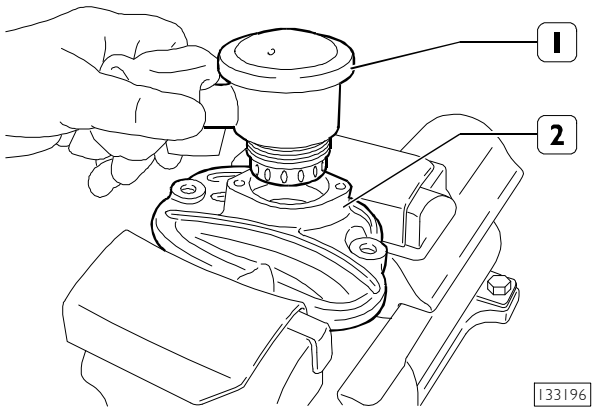
❑ With special hot air device (3) heat the concerned area between blow-by and cover.

Figure 65



❑ Inserting a screwdriver in the blow-by pipe (1) try to rotate the blow-by alternatively in both clockwise and counterclockwise directions (1) up to when it makes free from the hold of the sealant.

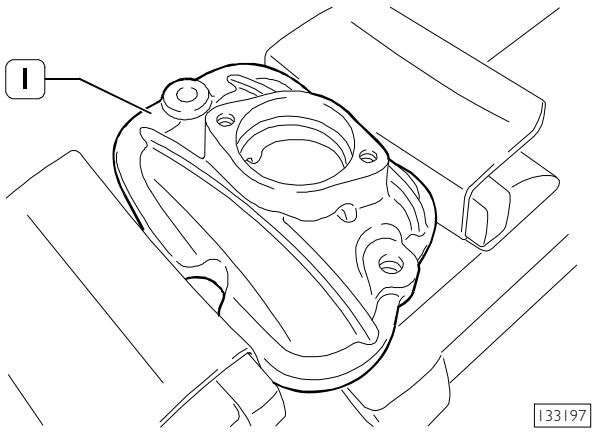
Figure 66



❑ Remove the blow-by (1) from the rocker cover (2).

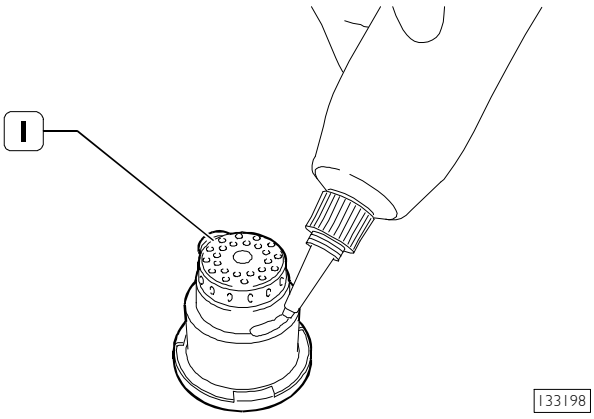
Handle with suitable protections; hot parts.

Figure 67



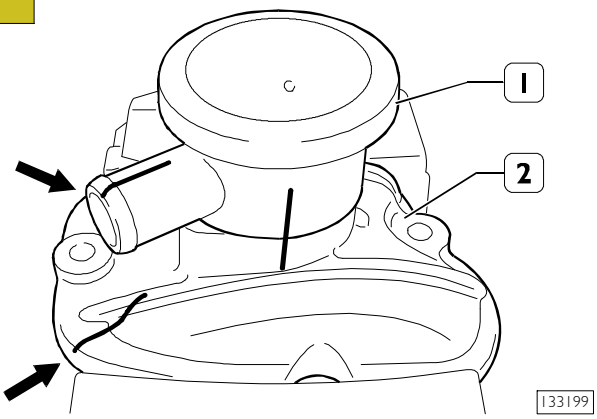
❑ Clean the blow-by seat on the rocker cover (1) from possible traces of sealant.

Figure 68



❑ Apply a regular layer of LOCTITE 510 all around the blow-by body (1).

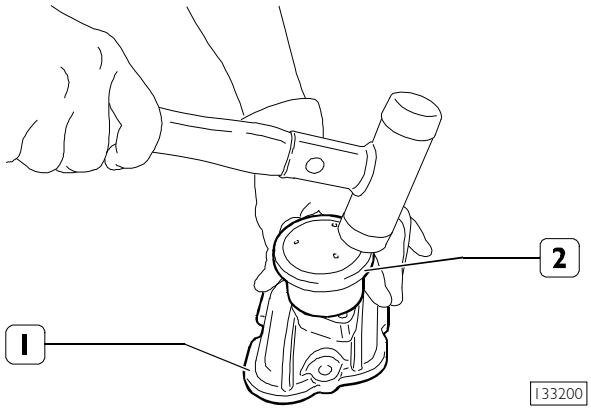
Figure 69



❑ Fit the blow-by (1) on the rocker cover (2) having care to position the exit hole (1) in the correct direction.

NOTE The position of the blow-by exit hole can vary according to the specific applications of the engine. A wrong positioning of the blow-by body (1) on the cover (2) may, therefore, result in difficult while refitting the engine aboard specific applications.

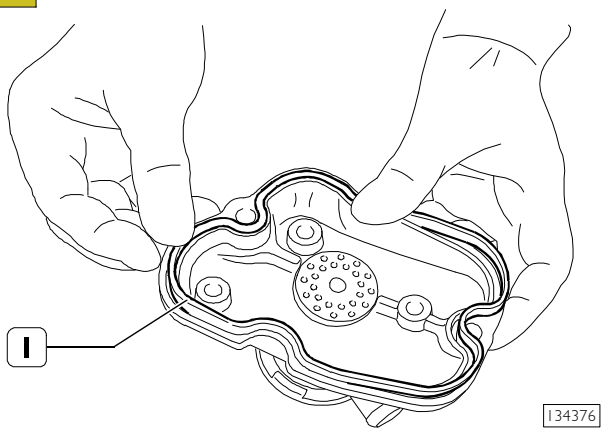
Figure 70



❑ Lean the complete cover assembly on a stiff surface.

❑ By means of a plastic hammer make sure that the blow-by (2) goes completely inside its seat on the rocker cover (1).

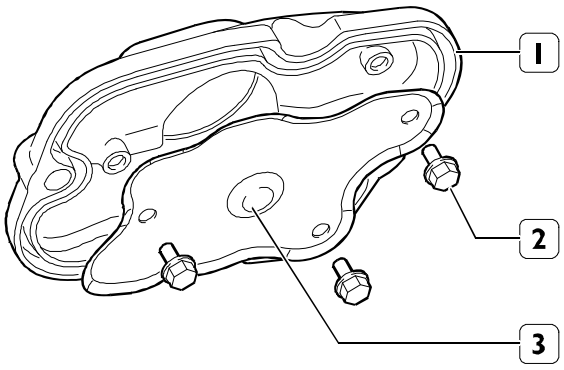
Figure 71



❑ Position a new gasket (1) in its seat on the rocker cover.

NOTE The position of the gasket in the seat is univocal.

Figure 72



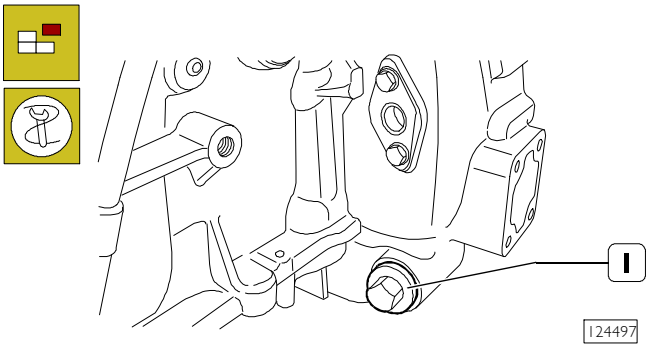
❑ Refit the plate (3) on the tappets cover (1) with the blow-by filter and tighten the M5x10 screws (2).

Rotary feed pump disassembly and assembly procedure

NOTE This procedure prescribes that:

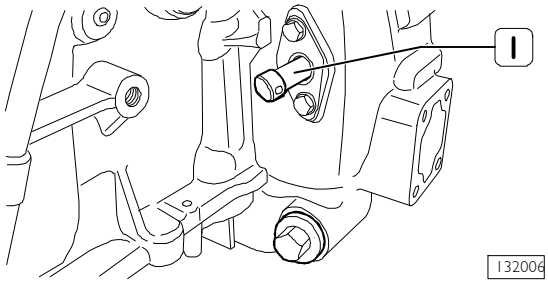
- ❑ the fuel pipes (from the pumping elements to the injectors, recovering blow-by from the injectors to the pump and the supply from the priming pump) have all been removed;
- ❑ the electrical connections have been disconnected.
- ❑ Accelerator cable shall be disconnected.

Figure 73



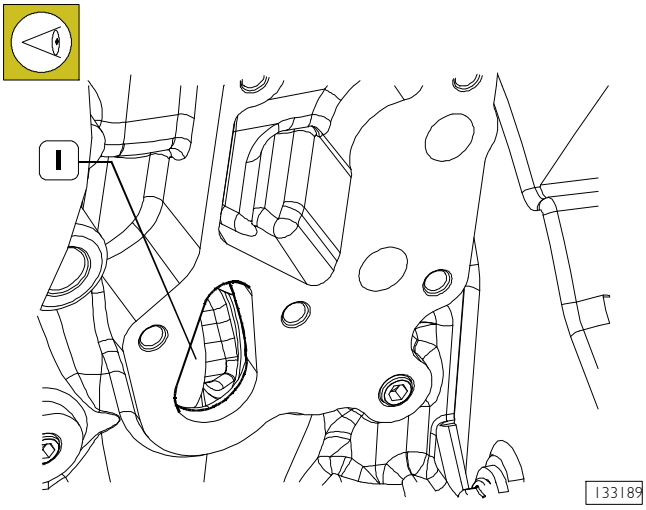
- ❑ Fit tool (1) 99360330 to flywheel housing to rotate the flywheel (must be used with a suitable wrench).

Figure 74



- ❑ Loosen the screws of the plate in which tool 99360612 (1) is to be fitted.

Figure 75

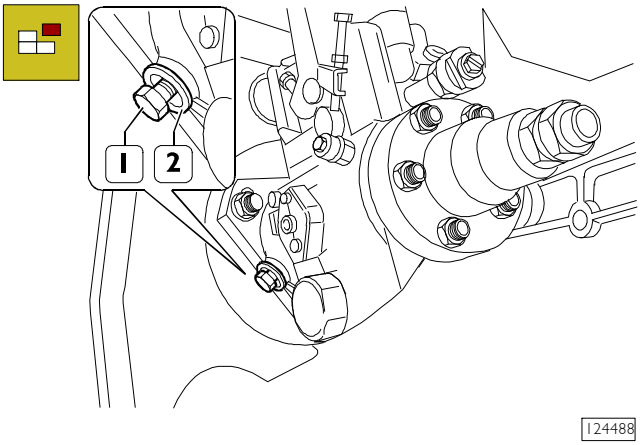


Position the engine drive shaft at T.D.C. of cylinder 1 rotating the flywheel until achieving the following conditions:

- ❑ the notch (1) is visible from the inspection hole;
- ❑ tool 99360612 should be fitted through the carter into the port on the flywheel.

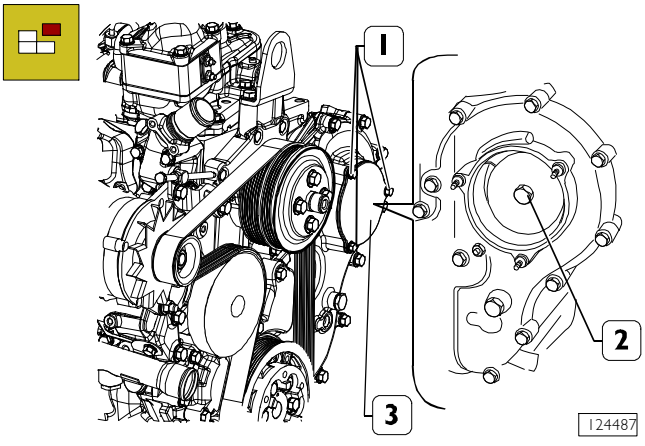
STANADYNE Pump

Figure 76



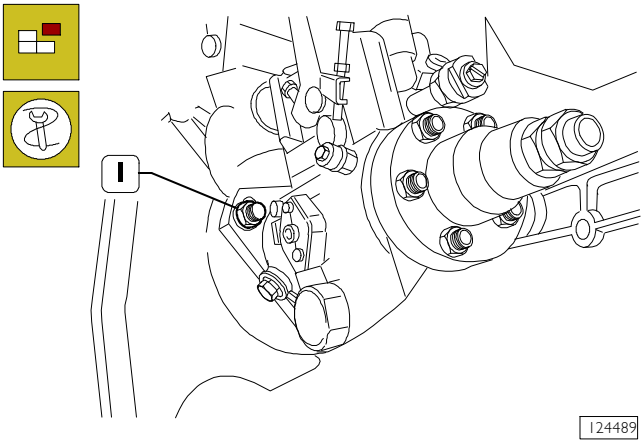
- ❑ Partially unlock pump shaft retaining screw (1) and move spacer with slot (2) in area with lager size hole for complete screw passage.
- ❑ Lock applying a torque ranging between 11.9 and 12.4 Nm retaining screw (1) till reaching spacer, thus locking pump shaft rotation.

Figure 77



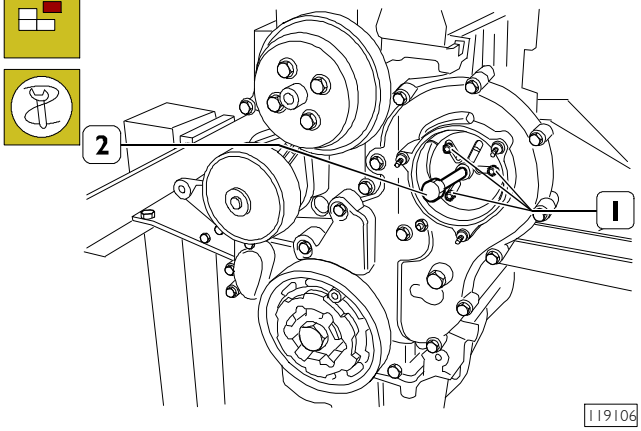
- ❑ From timing side, remove the cover (3) loosening the screws (1) in order to have access to the union fixing nut (2) to the pump driving gear.
- ❑ Loosen the fixing nut (2) and remove the relating washer.

Figure 78



- ❑ From the pump side, loosen the fixing nuts (1) without removing them in order to enable moving the pump backwards using 99340025 extractor.

Figure 79

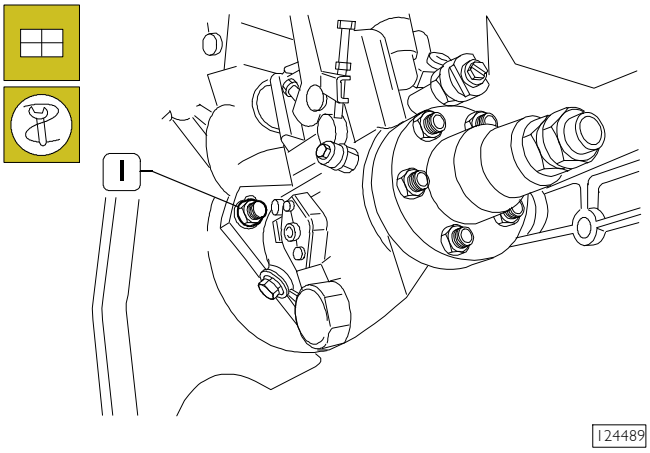


- ❑ Assemble the 99340025 (2) extractor throughout the three threaded ports (1) and withdraw the gear from the pump shaft.
- ❑ Properly hold the feed pump and loosen completely the fixing nuts.
- ❑ Withdraw the pump from the studs, together with the gasket.

When the supply pump is to be assembled on the engine the P.M.S. conditions at compression end stage cylinder No. 1 must be carried out.

NOTE Hold the pump driving gear to avoid interference or crawling during timing gear rotation.

Figure 80

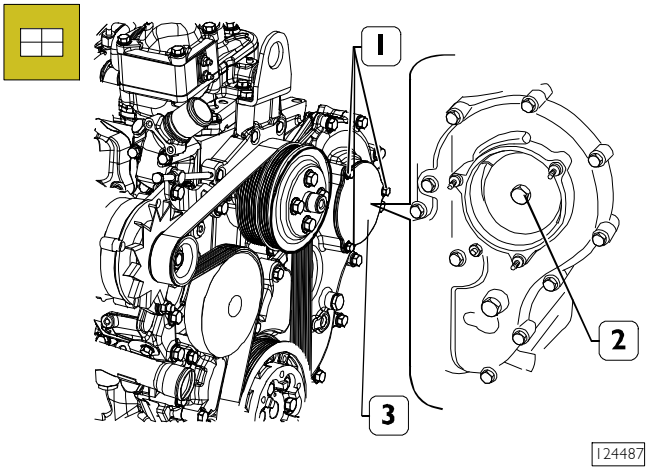


When installing supplì pump on engine, cylinder no.1 must be at P.M.S. end of compression phase.

- ❑ Assemble the pump pre-set in its housing on the engine, fitting the shaft into the gear port (not provided with wrench).
- ❑ Tighten the fixing nuts (1) locking the pump flange in the slot centre.

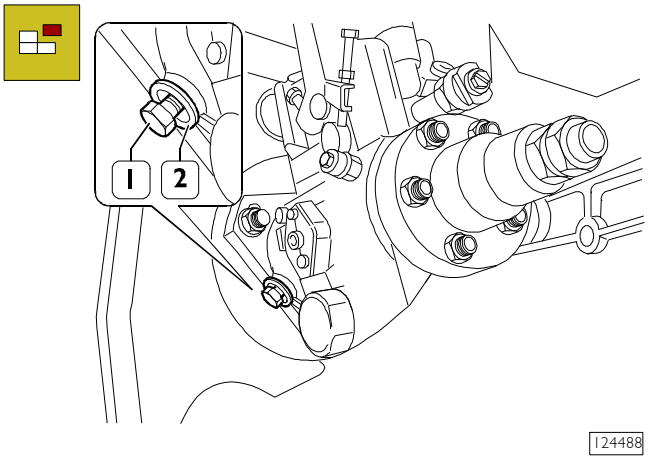
NOTE The gasket removed during pump disassembly shall not be utilised again.
Always use original spare parts.

Figure 81



- ❑ On the timing side, throughout the specially appointed port, fit the washer and screw up the fixing nut (2) to the pump shaft. Lock the nut to the 190-203 Nm couple.
- ❑ Assemble the cover (3) including gasket and tighten the screws (1).

Figure 82

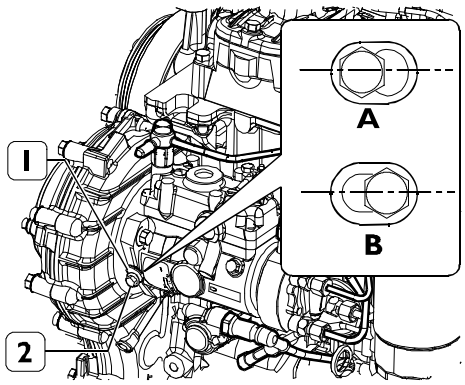


- ❑ Svitare, senza rimuovere, la vite (1) di bloccaggio rotazione dell'alberino della pompa e spostare il distanziale con asola nella zona del foro di dimenzioni minori. Avvitare fino a battuta la vite bloccando il suddetto distanziale: in questo modo l'alberino della pompa di alimentazione è libero di ruotare.
- ❑ Disassemble the flywheel rotation/locking tool 99360330.
- ❑ Connect all the pipes (from the pumping elements to the injectors, recovering blow-by from the injectors to the pump and the supply from the priming pump).
- ❑ Connect the electrical connections.

NOTE In case pump removal has been carried out while the engine was assembled, connect acceleration cable.

DELPHI Pump

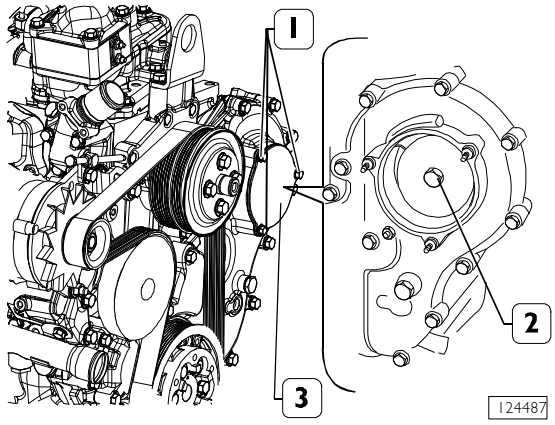
Figure 83



139777

- ❑ Unscrew the side screw that locks the pump shaft partially (2) and move spacer (1) from position (A) to position (B).
- ❑ Tighten the lateral screw (2) blocking rotation of the pump shaft.

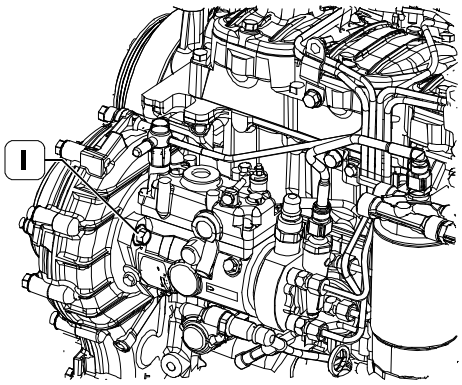
Figure 84



124487

- ❑ From timing side, remove the cover (3) loosening the screws (1) in order to have access to the union fixing nut (2) to the pump driving gear.
- ❑ Loosen the fixing nut (2) and remove the relating washer.

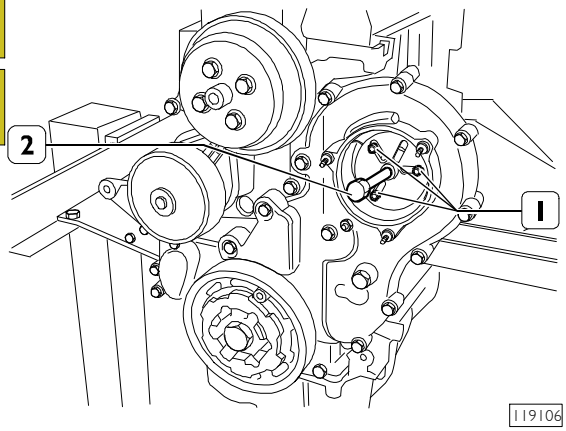
Figure 85



139778

- ❑ From the pump side, loosen the fixing nuts (1) without removing them in order to enable moving the pump backwards using 99340025 extractor.

Figure 86



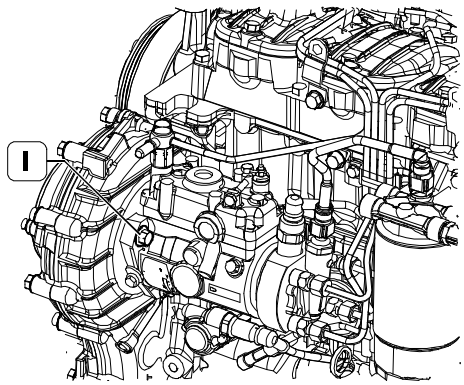
119106

- ❑ Assemble the 99340025 (2) extractor throughout the three threaded ports (1) and withdraw the gear from the pump shaft.
- ❑ Properly hold the feed pump and loosen completely the fixing nuts.
- ❑ Withdraw the pump from the studs, together with the gasket.

When the supply pump is to be assembled on the engine the P.M.S. conditions at compression end stage cylinder No. 1 must be carried out.

NOTE Hold the pump driving gear to avoid interference or crawling during timing gear rotation.

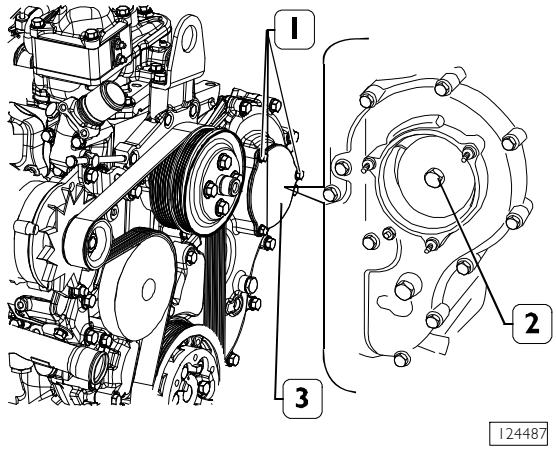
Figure 87



- ❑ Assemble the pump pre-set in its housing on the engine, fitting the shaft into the gear port (not provided with wrench).
- ❑ Tighten the fixing nuts (1) locking the pump flange in the slot centre.

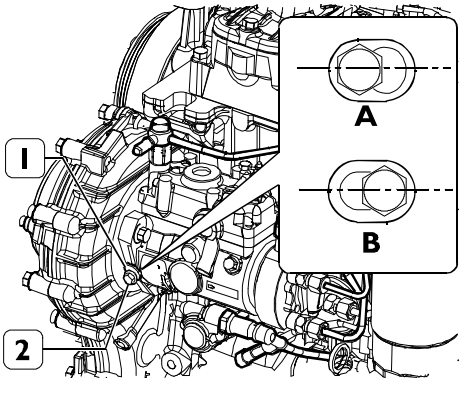
NOTE The gasket removed during pump disassembly shall not be utilised again.
Always use original spare parts.

Figure 88



- ❑ On the timing side, throughout the specially appointed port, fit the washer and screw up the fixing nut (2) to the pump shaft. Lock the nut to the prescribed pair.

Figure 89



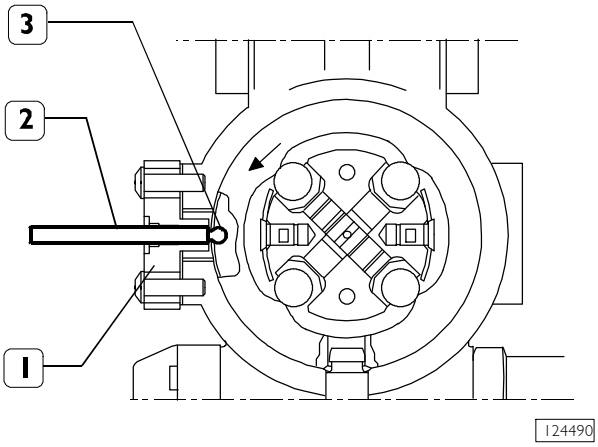
- ❑ Unscrew the side screw that locks the pump shaft partially (2) and move spacer (1) from position (B) to position (A). Tighten screw so that it locks spacer: in this way the supply pump shaft will be able to rotate freely.
- ❑ Assemble the cover (3, Figure 88) including gasket and tighten the screws (1, Figure 88).
- ❑ Tighten the previously loosened plate screws.
- ❑ Connect all pipelines (from pumping elements to injectors, bleeding recovery pipes from injectors to pump, LDA pipeline and feed provided by priming pump).
- ❑ Connect electrical connections to electro-magnets on the hydraulic head and on KSB.

NOTE If the pump has been removed with the engine mounted, connect the accelerator cable, if present in the application.

Installation of rear components with reduced distribution

STANADYNE

Figure 90



1. Slot on the hub of the hydraulic rotor - 2. Synchronization pin 99365196 - 3. Plate.

The synchronization pin 99365196 (2) has been designed for use in the event of the rotor shaft being inadvertently released.
The correct synchronization of the pump with the engine is obtained when the synchronization pin 99365196 (2), fitted in the hole on the plate (3), enters the slot (1) on the exterior of the hydraulic rotor hub.

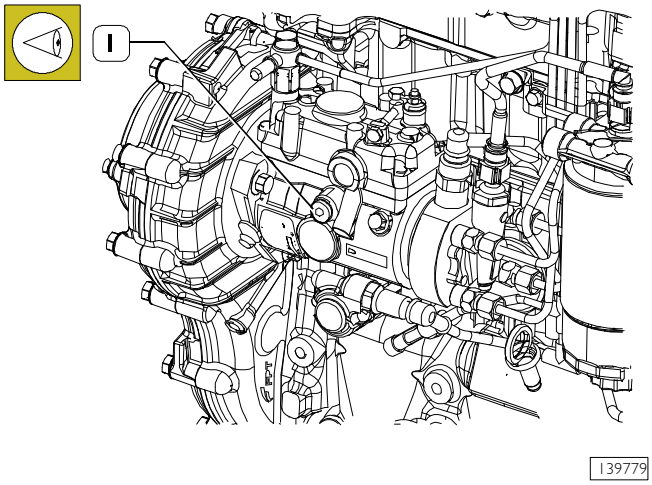
Therefore:

- ❑ Remove the screw cap (3) at the centre of the plate.
- ❑ Insert the synchronization pin (1) 99365196 in the hole on the plate (3). The synchronization position is obtained when the synchronization pin (2) enters the slot on the hydraulic rotor hub.
- ❑ Lock the control shaft in the correct position by means of the screw (1, Figure 7).
- ❑ Remove the synchronization pin and fit the screw cap of the plate (3). Tighten the cap using a torque of 2.3 ÷ 3.4 Nm.

NOTE Support the pump gear to prevent interference or sticking when the timing system gears turn.

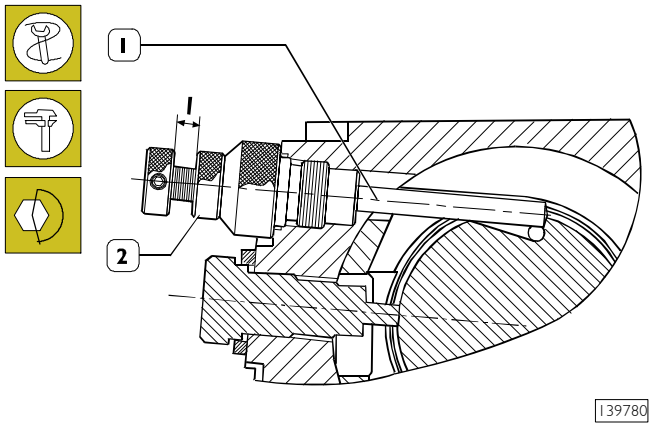
DELPHI

Figure 91



- ❑ Set the engine as follows: cylinder 1 at TDC in compression, injection pump inserted in seating with bolts slackened off.
- ❑ Remove plug (1);

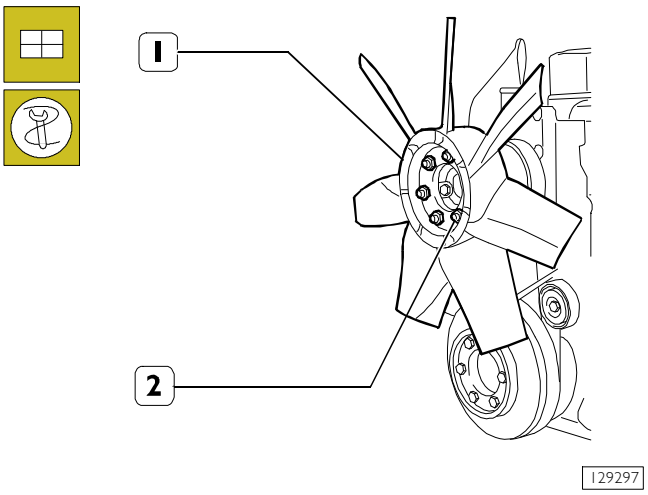
Figure 92



- ❑ Fit tool 99365197(1), using the shorter timing pin, and screw it fully home;
- ❑ Undo counternut (2) until it is snug against the pump.
- ❑ Measure distance "l".
- ❑ Distance "l" must be equal to the value stamped on the plug, within a tolerance of ±0.09 mm. E.g.: if the value stamped on the plug is 5.64 mm, measured distance "l" must be in the range 5.55 mm to 5.73 mm.
- ❑ If "l" is smaller, turn the pump clockwise, if it is greater, turn the pump counterclockwise.
- ❑ Repeat the procedure (measurement and adjustment) until measured distance "l" is in the prescribed range.
- ❑ Secure the pump in place by torquing the nuts.
- ❑ Fit the plug to the pump.

ENGINE COMPLETION

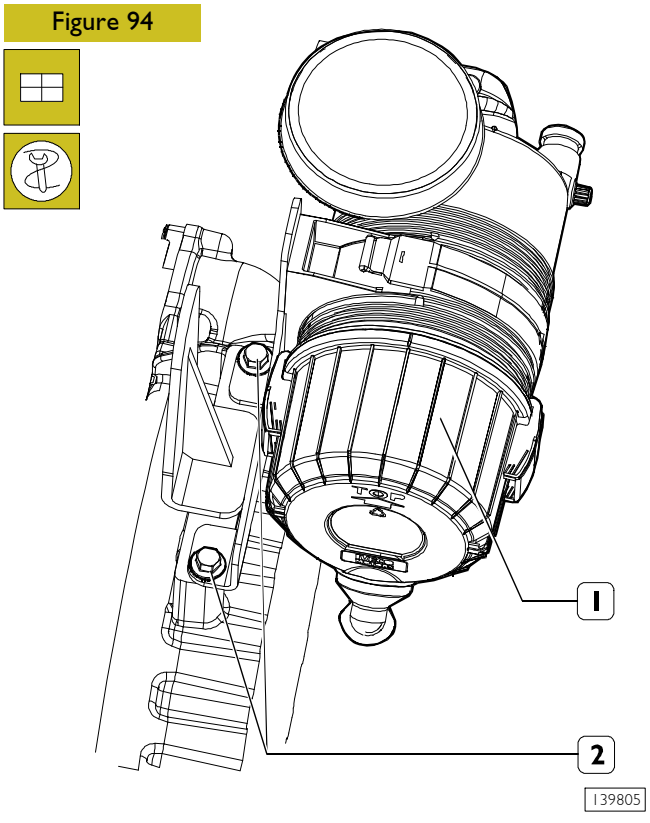
Figure 93 (Demonstrative)



❑ Refit the fan (1), complete with spacer and tighten the bolts (2) to the recommended torque.

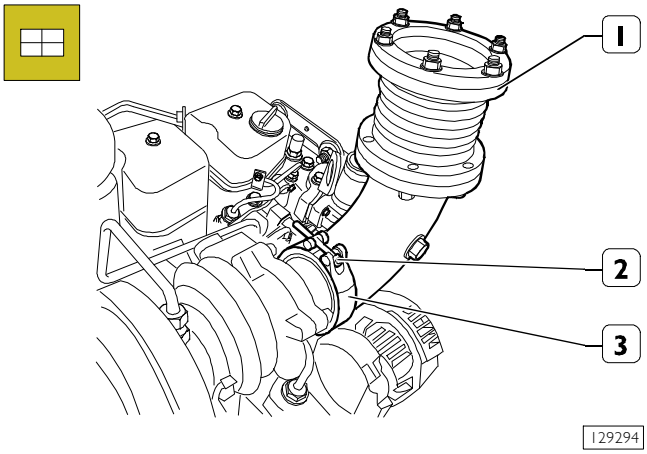
NOTE The shape and the size of the drainage pipe vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out.
The procedures described can, however, be applied.

Figure 94



❑ Fit the air filter complete with mounting (1) and tighten the bolts (2) to the recommended torque.

Figure 95 (Demonstrative)

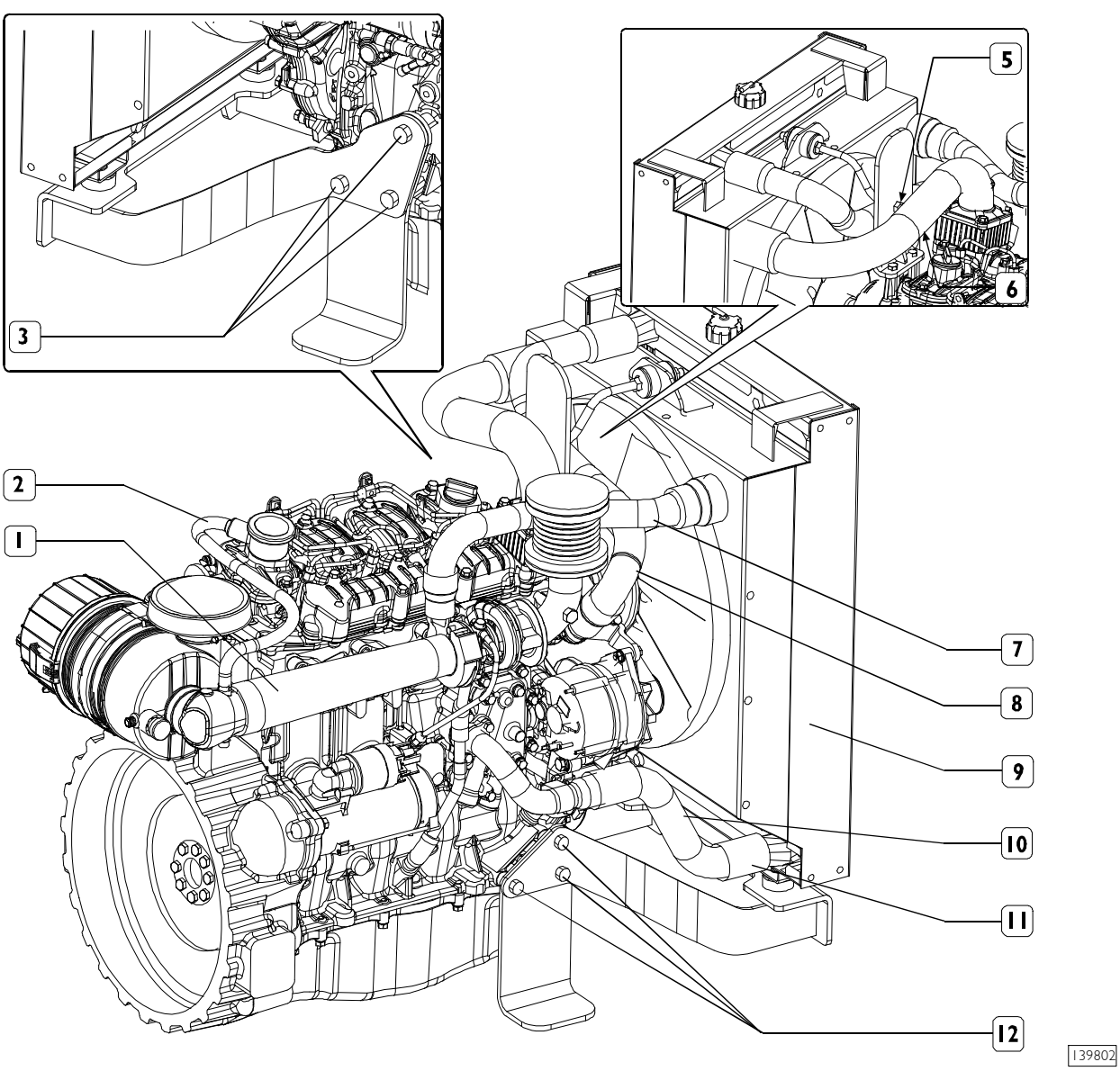


❑ Connect the drainage pipe (1) tightening the bolt (2) to close the band (3).

NOTE The shape and the size of the drainage pipe vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out.
The procedures described can, however, be applied.

F5CE0485 engine

Figure 96

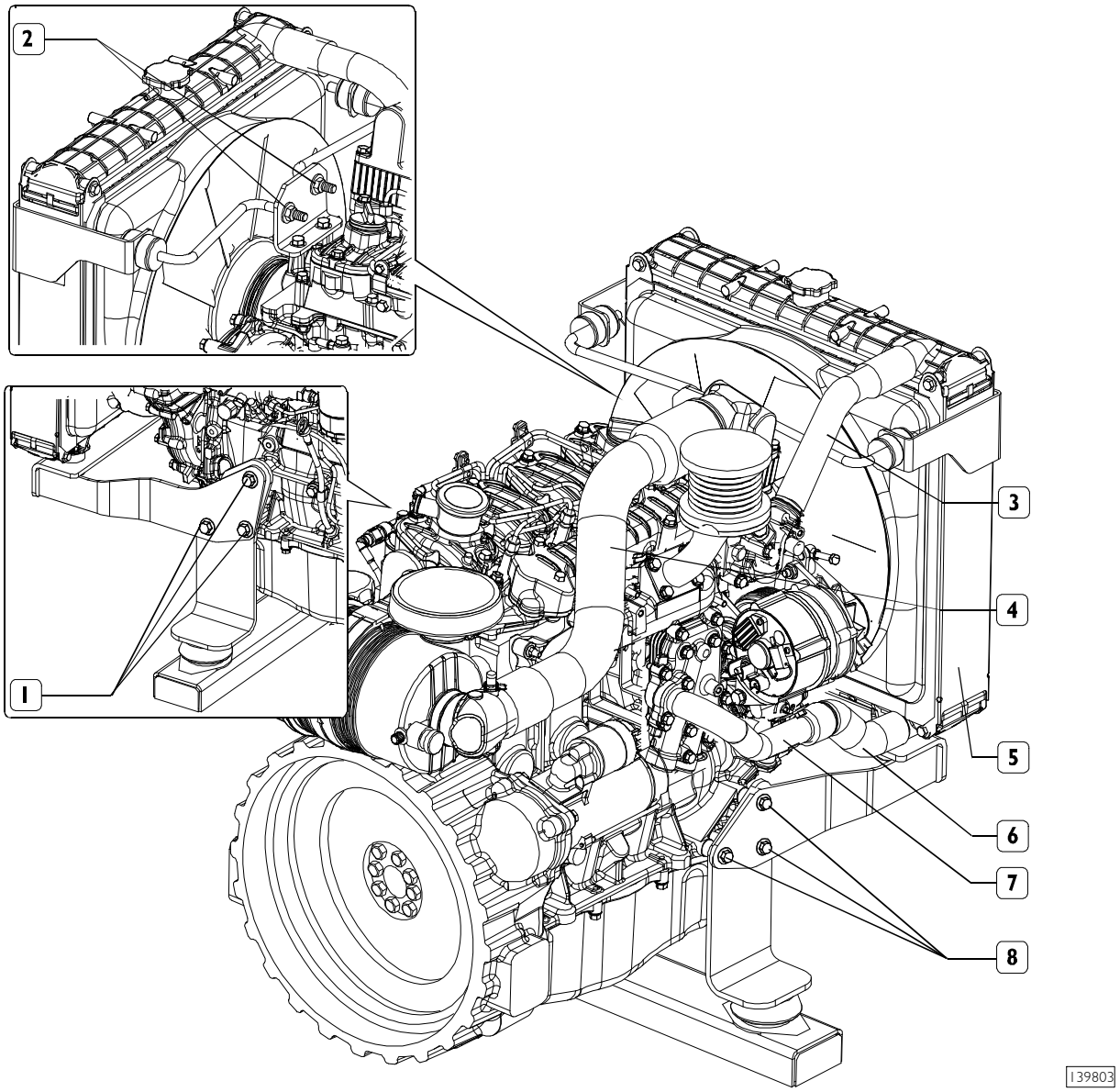


F5CE0485 ENGINE

- ❑ locate the radiator assembly (9) on the engine.
- ❑ tighten down bolts (3) and (12) securing the brackets to the engine;
- ❑ tighten down nuts (5) securing the linkage to the engine;
- ❑ fit the oil vapour recirculation hose (2);
- ❑ fit the air hose (4) and tighten down its collars;
- ❑ fit the water hose (8) and tighten down its collars;
- ❑ fit turbocharger pipes (1) and (7) and tighten down their collars;
- ❑ fit the water hose (10) complete with sleeve (11) and tighten down its collars;
- ❑ charge the cooling circuit with coolant.

F5CE0405 engine

Figure 97

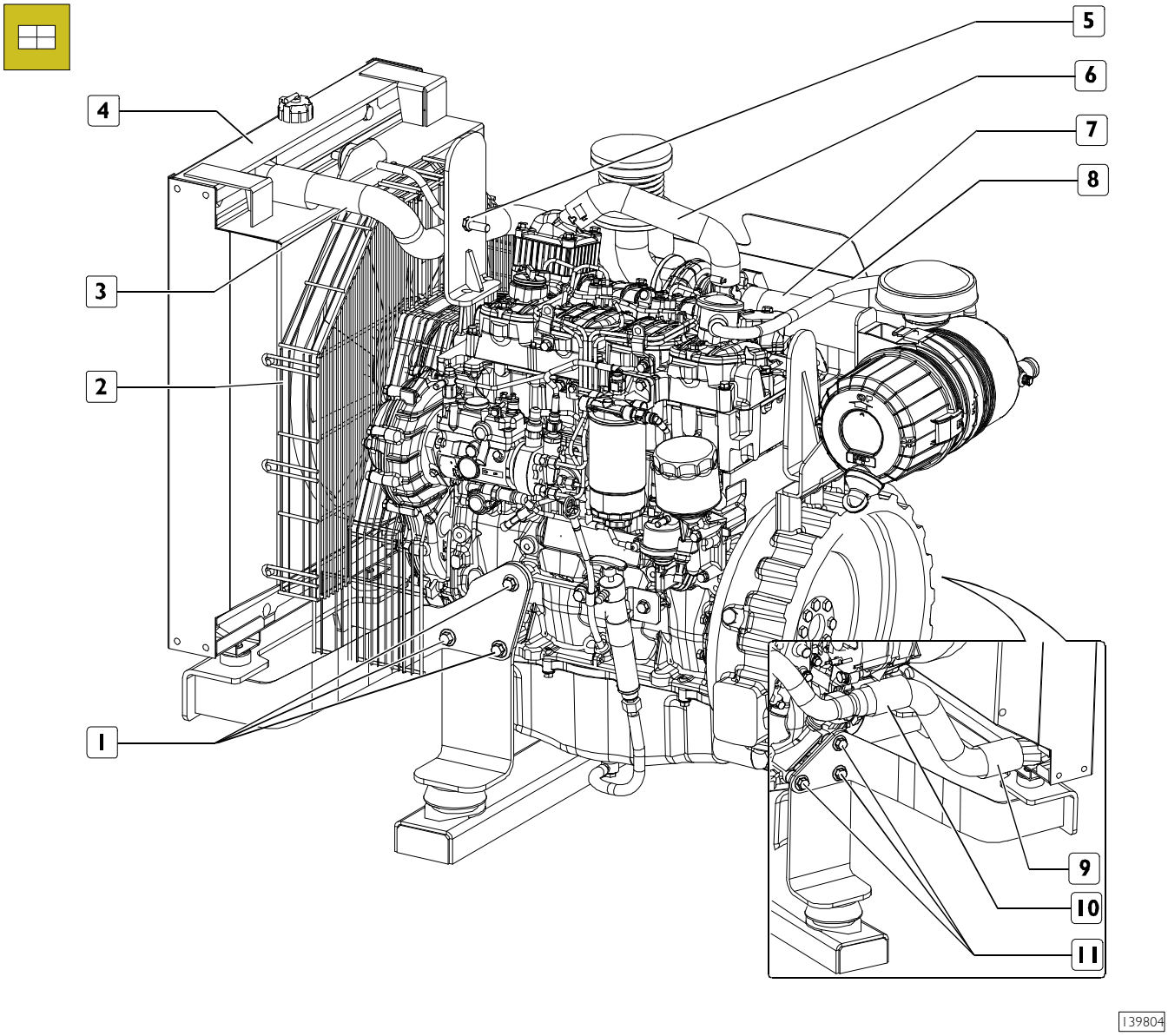


F5CE0405 ENGINE

- ❑ locate the radiator assembly (5) on the engine.
- ❑ tighten down bolts (1) and (8) securing the brackets to the engine;
- ❑ tighten down nuts (2) securing the linkage to the engine;
- ❑ fit the air hose (4) and tighten down its collars;
- ❑ fit the water hose (3) and tighten down its collars;
- ❑ fit the air hose (7) complete with sleeve (6);
- ❑ charge the cooling circuit with coolant.

F5CE0455 engine

Figure 98

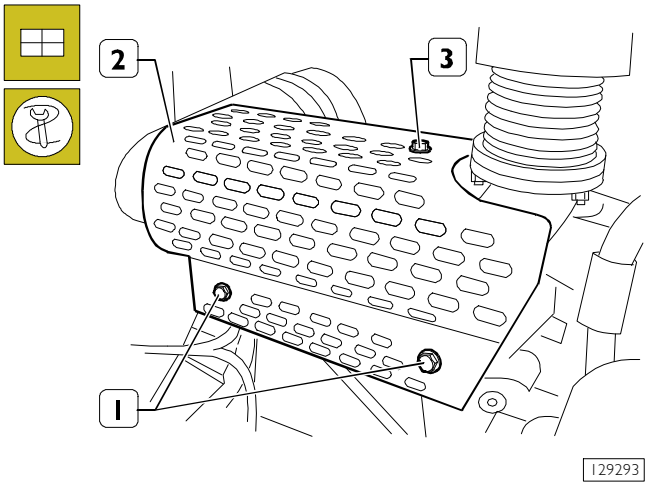


F5CE0455 ENGINE

- ❑ locate the radiator assembly (4) on the engine;
- ❑ tighten down bolts (1) and (11) securing the brackets to the engine;
- ❑ fit guard (2);
- ❑ tighten down nuts (5) securing the linkage to the engine;
- ❑ fit the oil vapour recirculation hose (8);
- ❑ fit the water hose (3) and tighten down its collars;
- ❑ fit turbocharger pipes (6) and (7) and tighten down their collars;
- ❑ fit the water hose (10) complete with sleeve (9) and tighten down its collars;
- ❑ charge the cooling circuit with coolant.

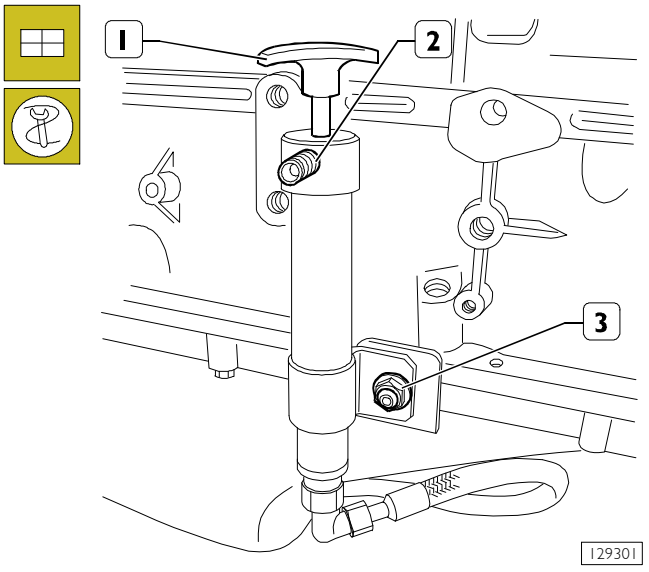
Refitting engine to radiator

Figure 99 (Demonstrative)



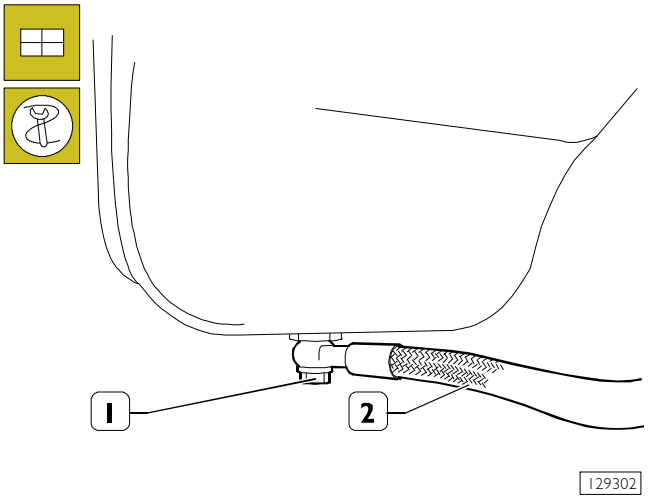
- ❑ If present, refit the turbine guard grille (2), restoring the mounting brackets and adjusting the bolts (1) and (3).
- ❑ Refit the radiator assembly on the crankcase, paying attention to any interference with the fan and tighten the fixing bolts on both sides to the recommended torque.

Figure 100 (Demonstrative)



- ❑ Reposition the dipstick and the oil filler plug;
- ❑ Refit the pump tightening the nut (3) to the recommended torque.

Figure 101 (Demonstrative)



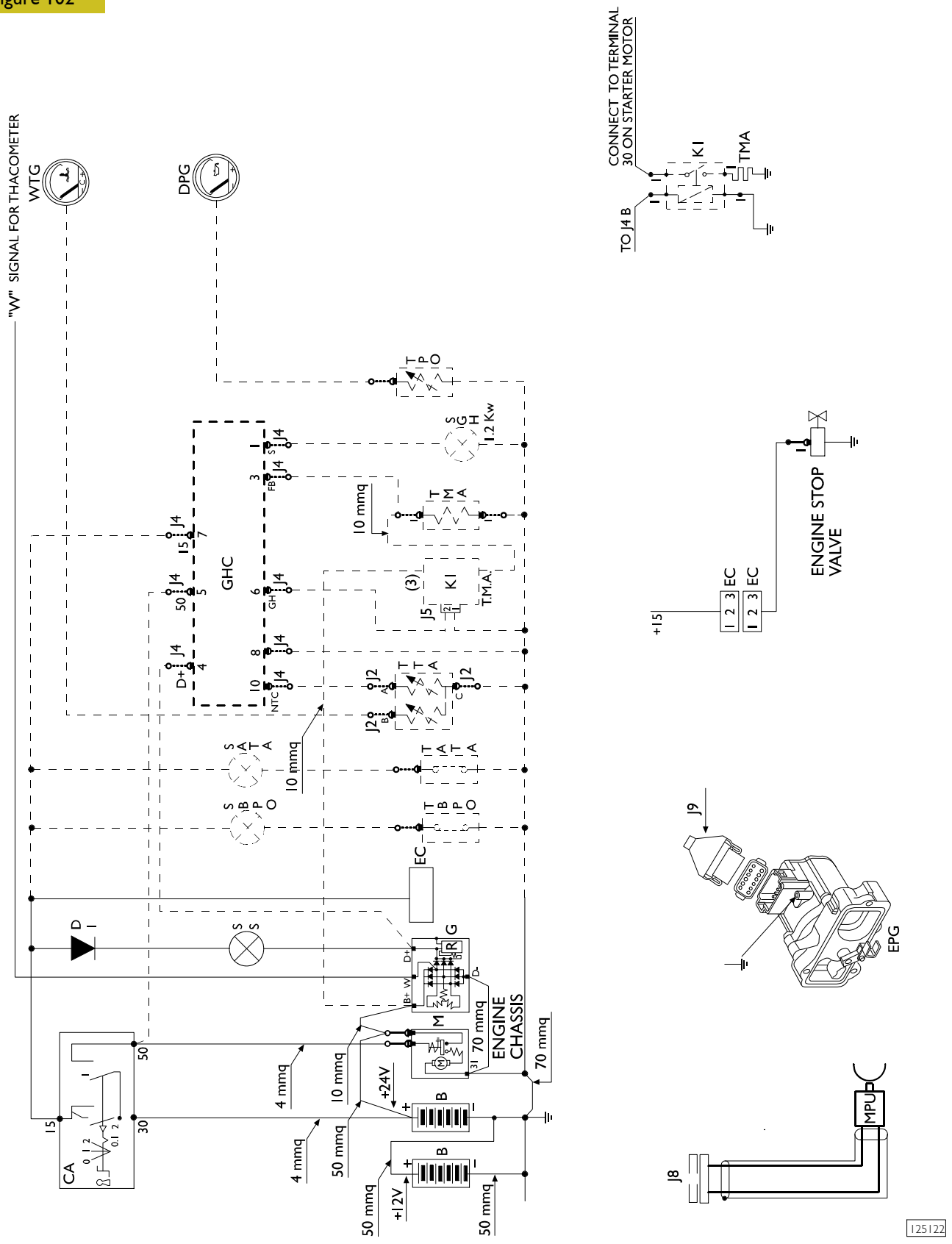
- ❑ Refit the pipe (2), tightening the bolt (1) to the recommended torque.

PART TWO -

ELECTRICAL EQUIPMENT

PRINCIPLE ELECTRICAL DIAGRAM (for F5CE0405A*B001 engines)

Figure 102



NOTE The part of the drawing shown with the broken lines is optional.
Unless otherwise specified, use cables with a section of 1 mm^2.

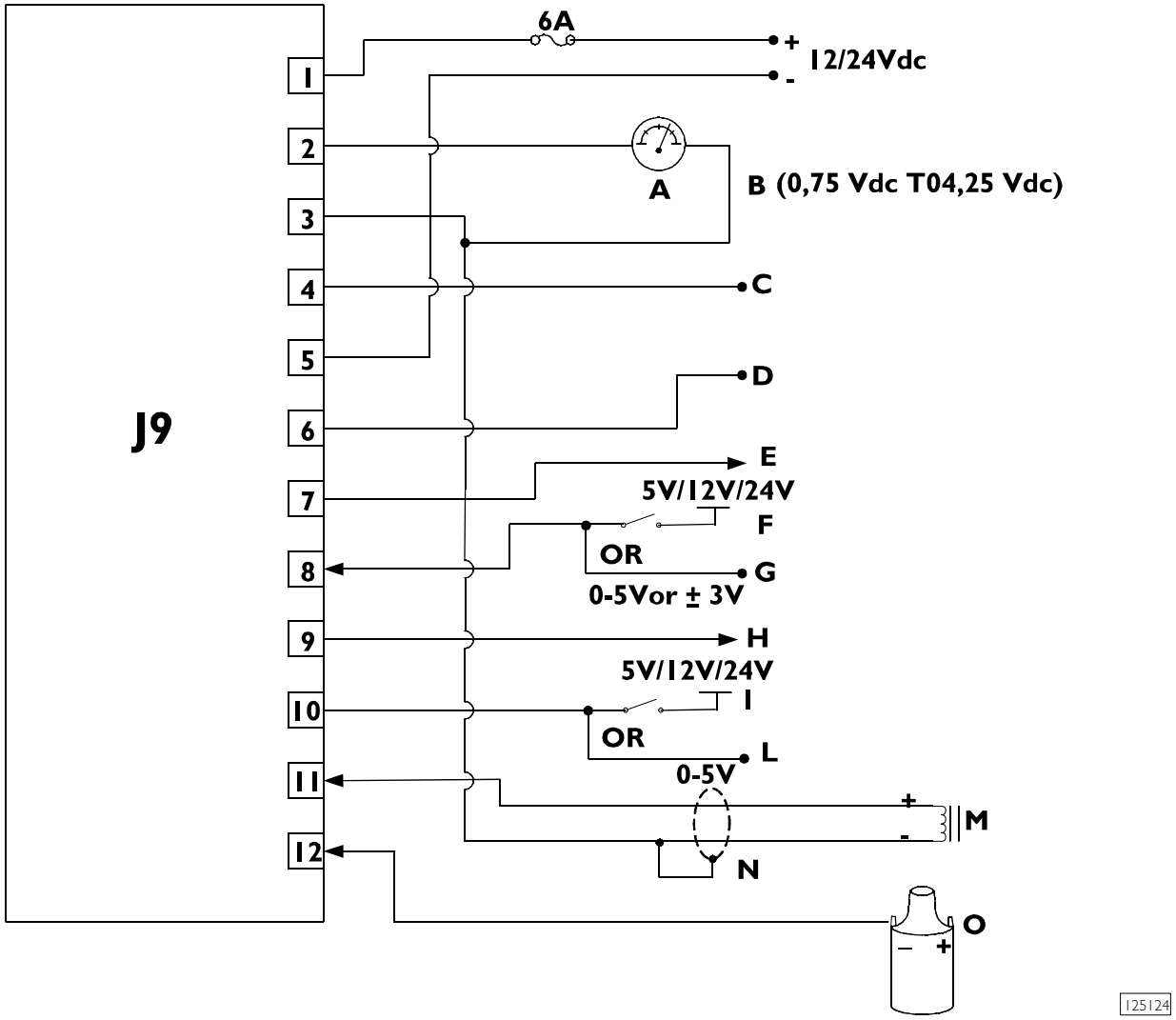
Key to components

B	Battery
M	Starter motor
G	Battery charger alternator
TPO	Engine oil pressure switch
TBPO	Low engine oil level pressure switch
TTA	Engine water temperature transmitter
TATA	High engine water temperature thermostat
CA	Ignition switch
EC	Electrical fuel cut-off
EPG	Electronic speed control
KB	Cold advance
SATA	High water temperature alarm warning light
SBPO	Oil low temperature alarm warning light
SGH	"Cold start" indicator light
SS	Battery charge alarm warning light
TAK	KSB water sensor
TMA	Thermostat (heater)
GHC	Pre-post heating control unit
D1	6A Diode
WTG	Water temperature gauge
OPG	Oil pressure gauge
MPU	Pulse transmitter

NOTE Maximum power of all indicator lights is 3W.

Diagram of electrical connections to electronic speed governor (EPG)

Figure 103



A. Voltmeter - B. Throttle position - C. AUX3 input/serial communication - D. AUX4 input/serial communication - E. Sensor power supply - F. AUX1 discrete input - G. AUX1 analogic input - H. Status detection output - I. AUX2 discrete input - L. AUX2 analogic input - M. Variable reluctance speed sensor (MPU) - N. Braided wire - O. Ignition coil.

For C, D, F, G, I, L references:

NOTE Reference all discrete and analog inputs to PIN 3 (Signal GND). To prevent electrical noise emissions from interfering with the AUX input signals, it is recommended that wiring to auxiliary (AUX) inputs not be routed within 150mm of any high voltage ignition leads.

For C, D references:

NOTE AUX 3 and AUX 4 can also be configured as discrete or analog inputs in a similar manner as AUX 1 and AUX 2, but are not functional while serial communications are connected.
Use WOODWARD KIT 8923-1061 to connet a computer for use with the SERVICE TOOL.
When configured as an analog input, the full scale range is 0-5V.

For N reference:

NOTE All shield ties are to be no longer than 2" between the cable and ground.

For O reference:

NOTE If using ignition speed input option, connect PIN 12 of the "L"Series speed control to the negative terminal of the ignition coil. The ignition system common must be referenced to the "L" series speed control ground (PIN 3 or PIN 5).

For M,O references:

NOTE Speed input is accomplished by using either the MPU or the ignition input. Do not connect wires to both inputs simultaneously.

For E reference:

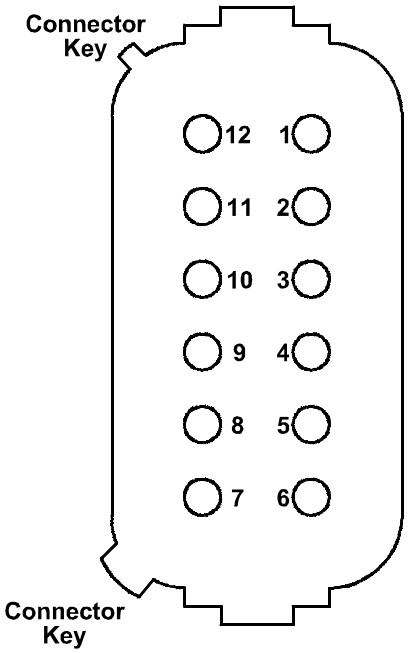
NOTE The 5V output is provided for powering external sensors. Rated at 10mA max.

For H reference:

NOTE Low-side drive output designed to drive a relay, lamp, or other status indicator maximum current allowed through the coil or lamp is 500mA. Maximum voltage allowed at this terminal is 32Vdc.

J9 connector PIN-OUT

Figure 104



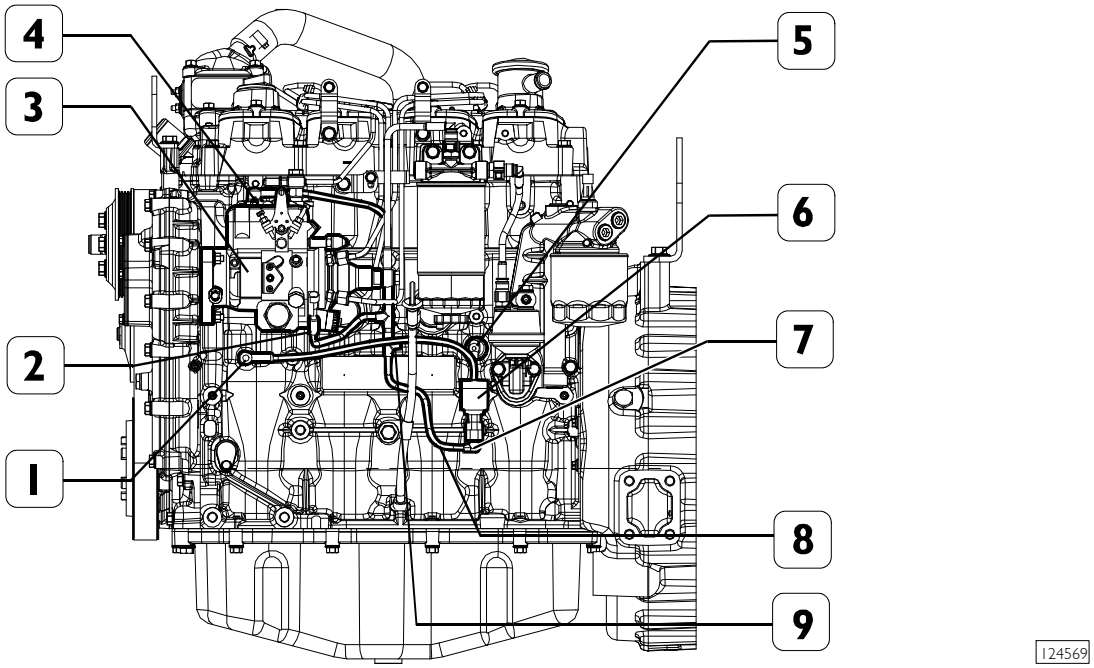
Connector as viewed looking into speed control

PIN PIN	Description
1	+12V/24 Vdc input powe
2	Throttle position sensor signal output
3	PWM/AUX ground
4	AUX3/PC input (with specific software)
5	Ground for the 12 V/24 V input power
6	AUX4/PC input (with specific software)
7	5V output for external sensors (10 mA MAX)
8	AUX1 input
9	Relay driver output
10	AUX2 input
11	MPU speed signal input
12	Ignition speed signal input

ELECTRICAL COMPONENTS

Location of KSB - Stanadyne pump cable components

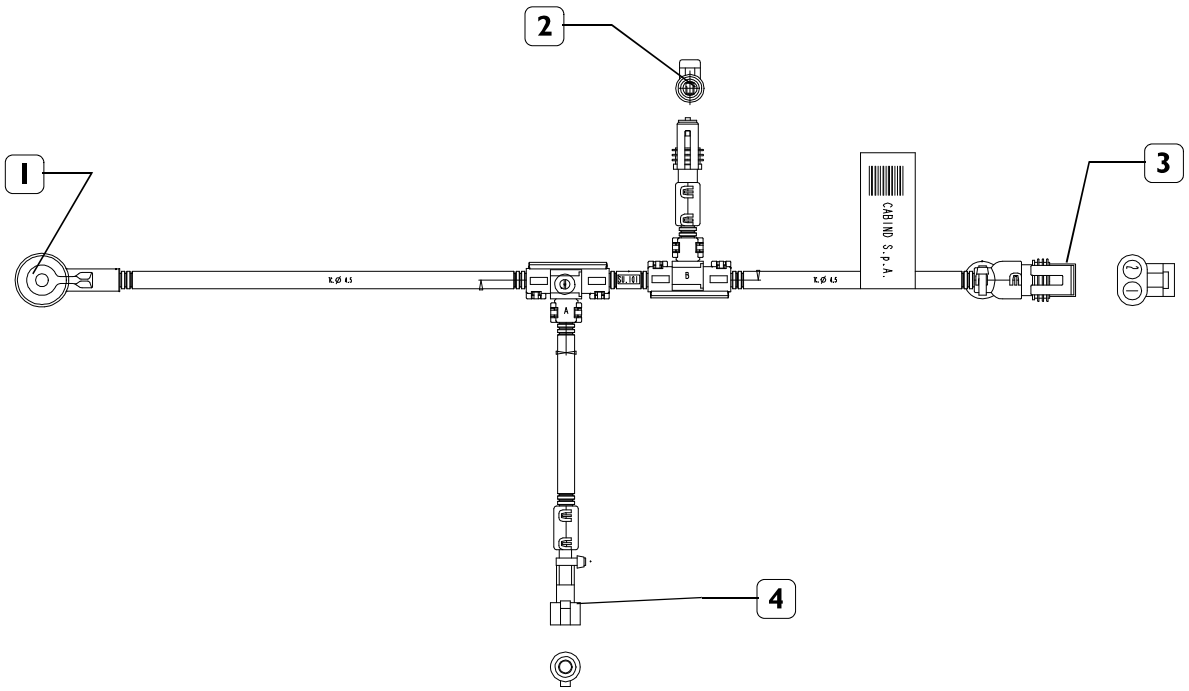
Figure 105



1. Ground - 2. KSB - 3. Stanadyne pump - 4. Electrostop - 5. Sensor (TAK) - 6. 24V Timer - 7. Timer connector - 8. KSB cable - 9. CSA connector (24V power supply).

KSB - Stanadyne pump connection cable

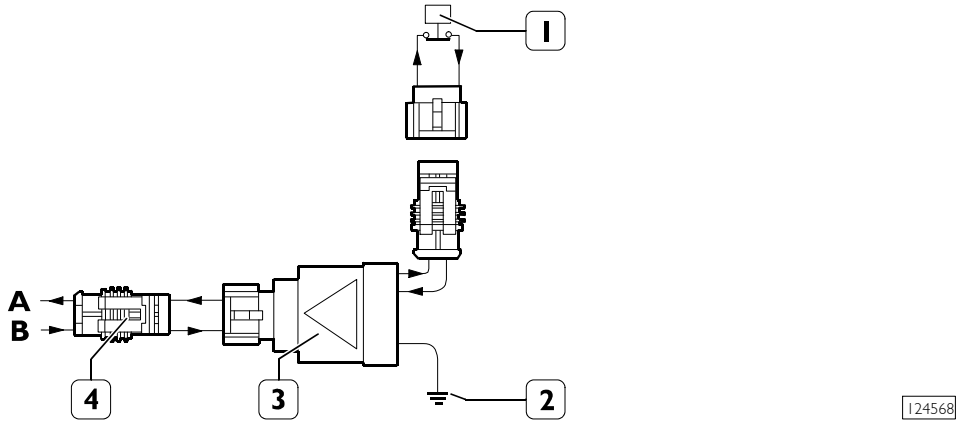
Figure 106



1. Electrostop - 2. CSA - 3. 24V Timer - 4. KSB

Timer (for F5CE0405A*B001 engines)

Figure 107

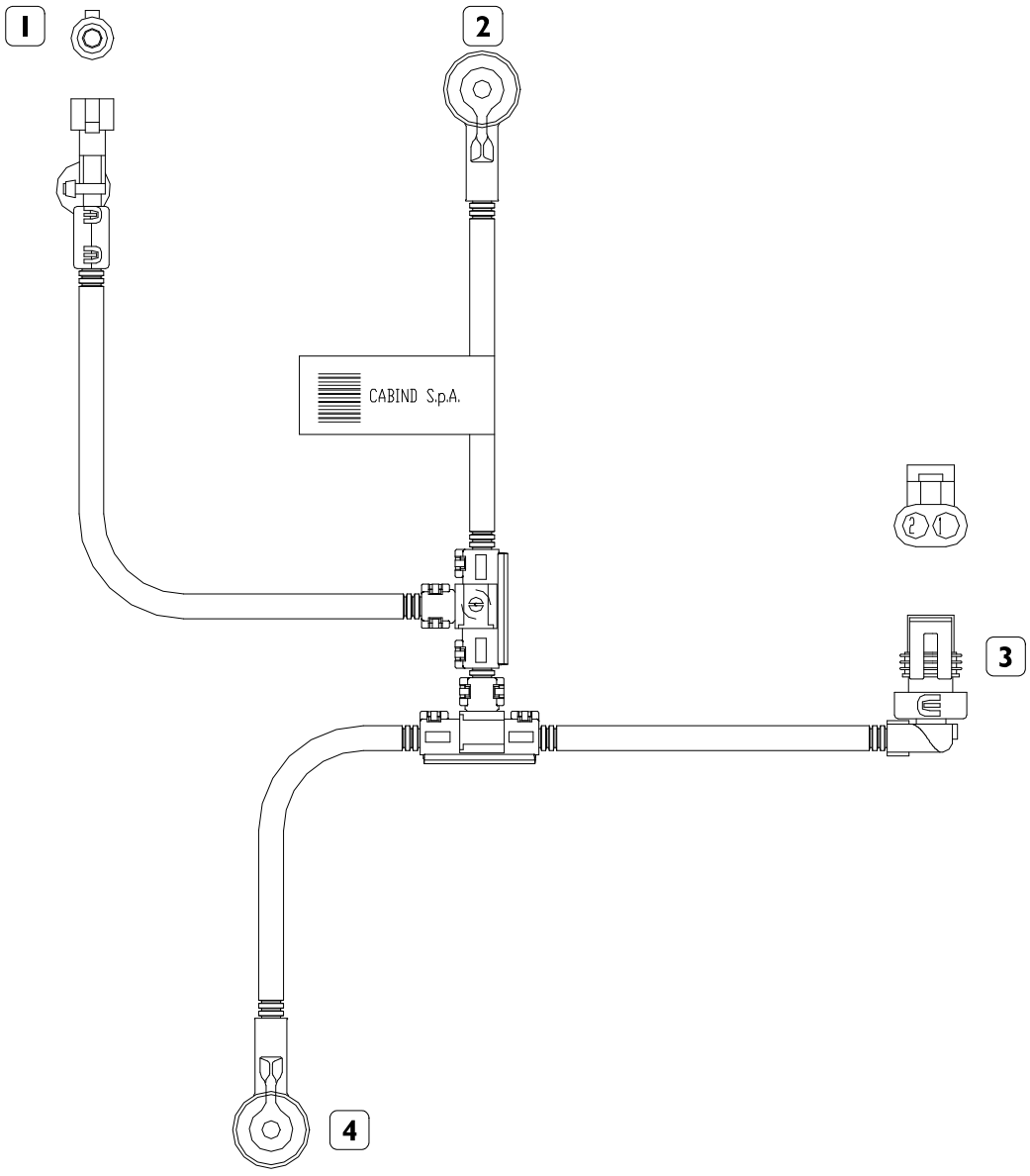


1. Sensor (TAK) - 2. Engine ground - 3. 24V Timer - 4. KSB-Stanadyne pump cable
A. Electrostop 24V output - B. 24V input (from CSA)

After ignition, the engine is immediately taken (without a transient state) to top speed, 1500 rpm. The KSB would not work with the engine warm, and would cause a high level of "white" smoke; the timer then starts it for 30 seconds, eliminating the ignition smoke.

KSB - DELPHI pump connection cable

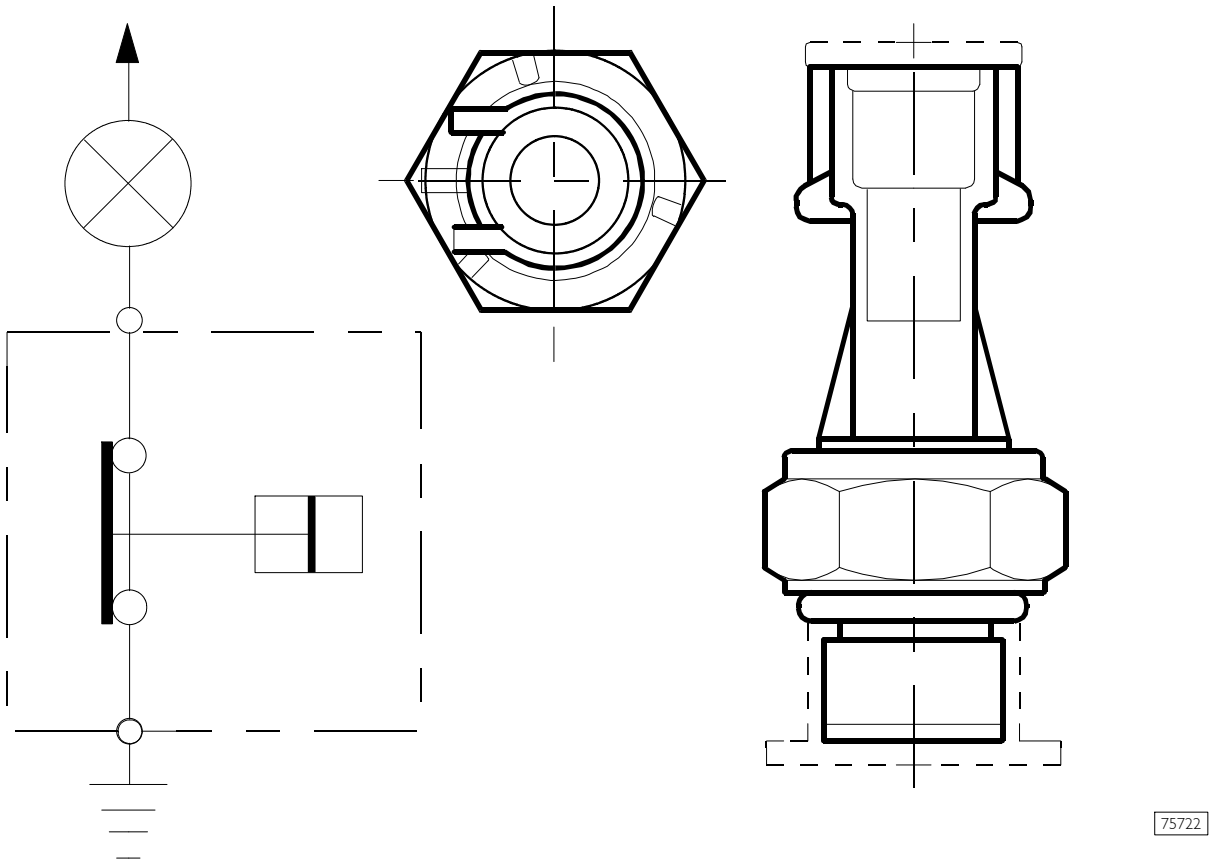
Figure 108



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

Oil pressure switch

Figure 109

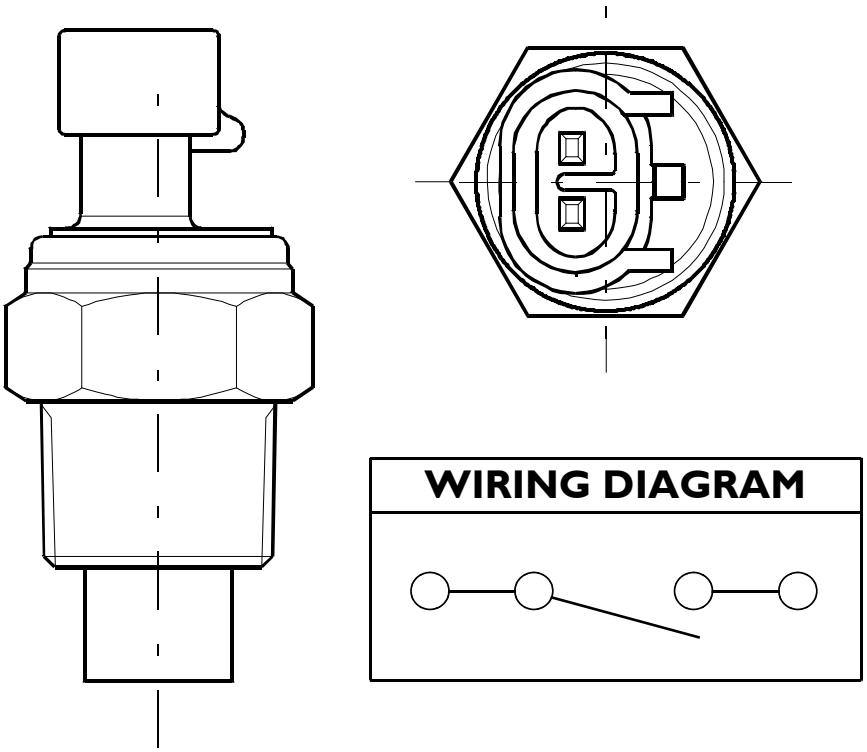


Characteristics

Voltage:	12 ÷ 24 V
Contact closure with decreasing pressure:	0.6 bar
Contact opening with increasing pressure:	0.9 bar

Cooling liquid temperature sensor for KSB (for F5CE0455-F5CE0485 engines)

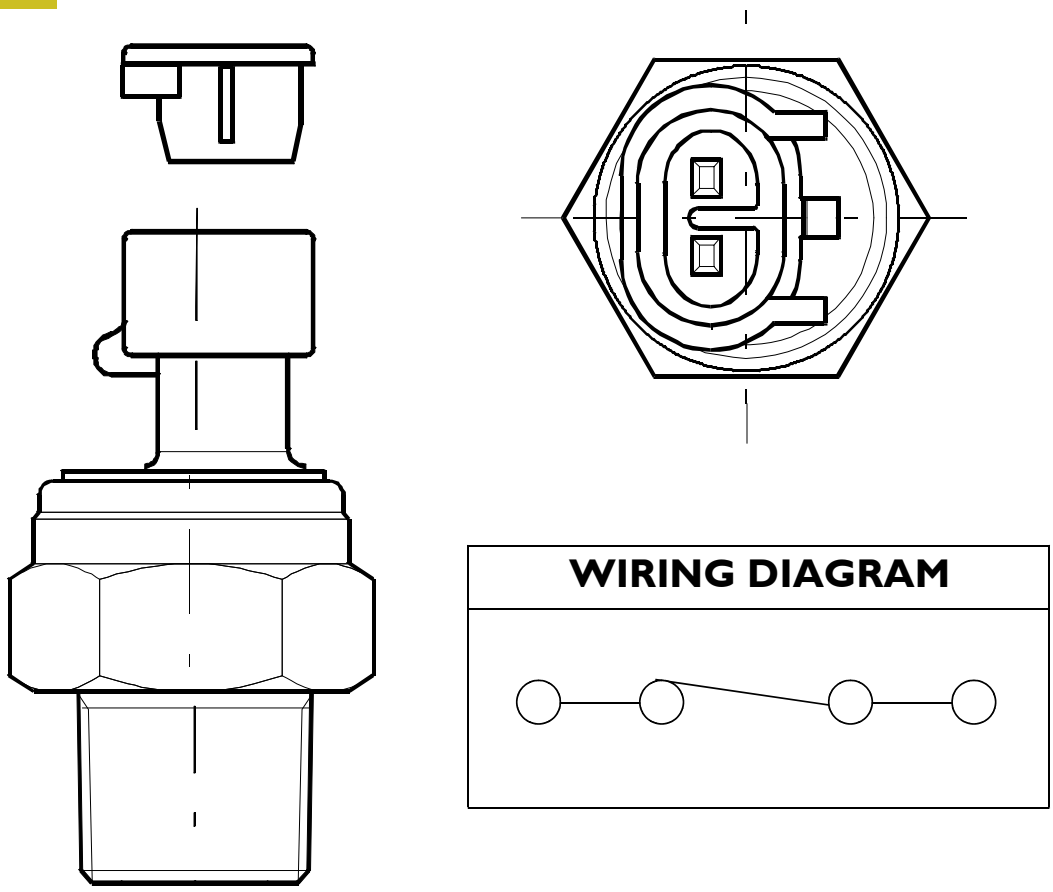
Figure 110



Characteristics	
Contact closing temperature	65 ± 5 °C
Maximum load on contacts	Max 15A

Cooling liquid temperature sensor for KSB (for F5CE0405 engines)

Figure 111

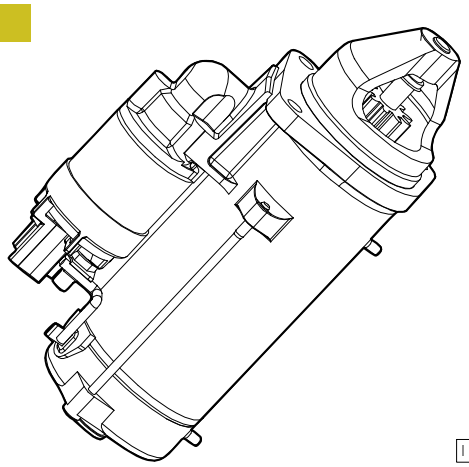


Characteristics.	
Contact closing temperature	20 ± 5 °C
Maximum load on contacts	15A

Starter

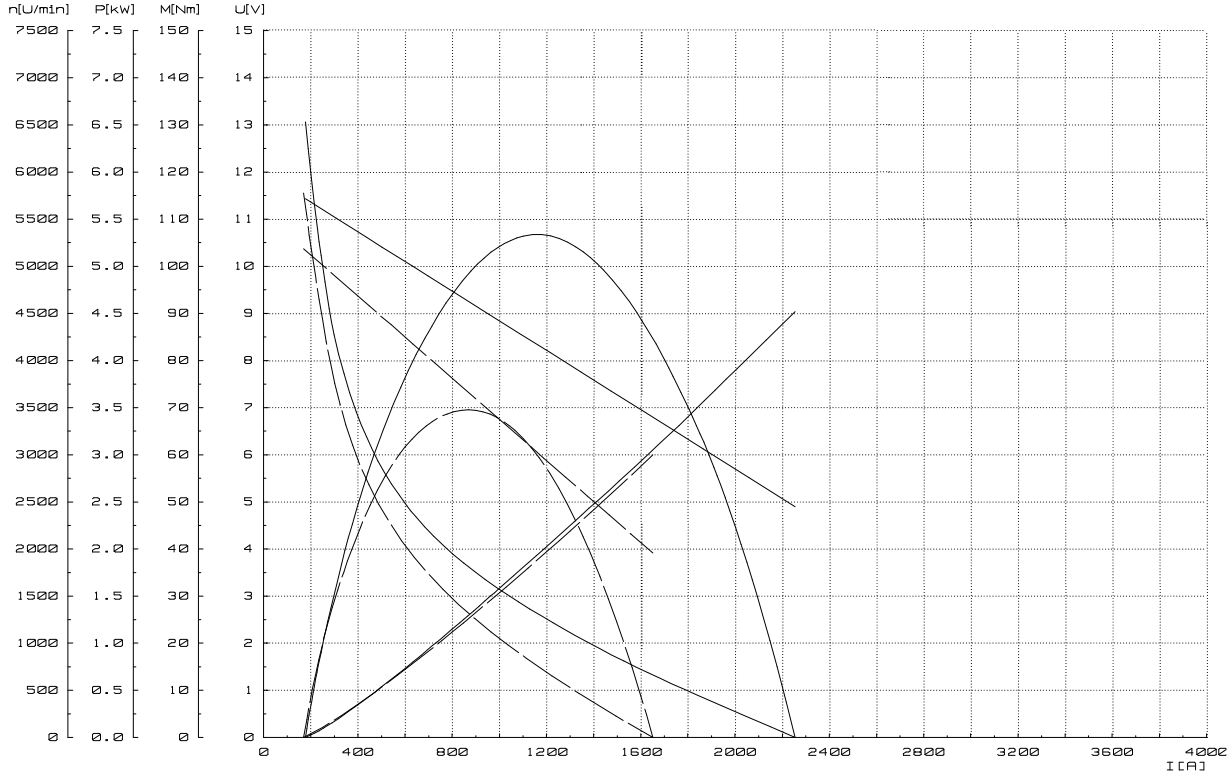
Manufacturer	BOSCH
Electrical system	12 V
Rated output	3 kW

Figure 112



119464

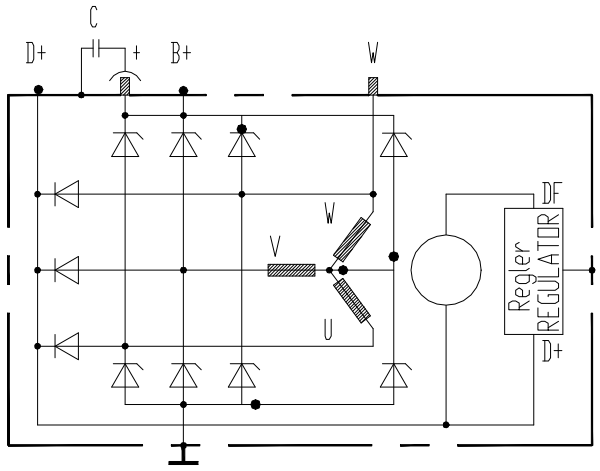
Figure 113



139807

BOSCH 14V Alternator (for F5CE0485 - F5CE0455 engines)

Figure 114



139808

WIRING DIAGRAM

Specifications for use

Vehicle electric system rated voltage: 12 V
Suitable for coupling with battery of any capacity
It must work with the battery connected.

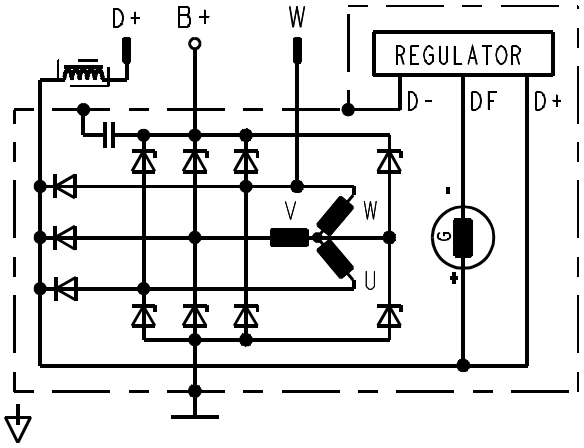
Connection with inverted polarity is not allowed.

Operating specifications

Rated voltage	14 V
Rated current delivery	95A at 6.000 rpm
Drive side direction of rotation	clockwise
Maximum continuous speed	≤13.500 min^{-1}

Ikra Alternator (for F5CE0405 engines)

Figure 115



122578

WIRING DIAGRAM

Specifications for use

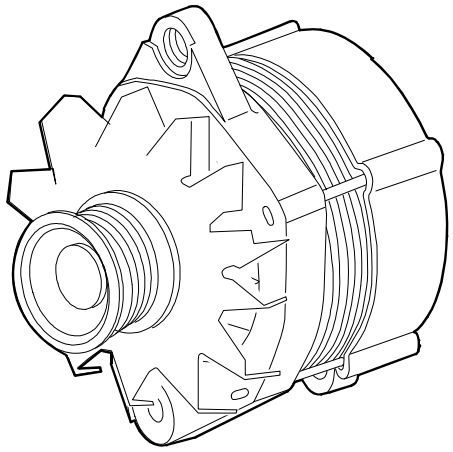
Vehicle electric system rated voltage: 12 V
Suitable for coupling with battery of any capacity
It must work with the battery connected.

Connection with inverted polarity is not allowed.

Operating specifications

Rated voltage	14 V
Rated current delivery	120A at 6.000 rpm
Drive side direction of rotation	clockwise
Maximum continuous speed	≤13.500 min^{-1}

Figure 116



88317

PART THREE - TROUBLESHOOTING

FAILURE	POSSIBLE ROOT CAUSE	RECOMMENDED TESTS OR REMEDY	NOTES
The engine does not start	Discharged of damaged battery	Check the battery and recharge it. Replace the battery if necessary	
	Battery terminal connections corroded or loose	Clean, check and tighten the battery terminal screw nuts. Replace the terminals and the screw nuts if excessively corroded.	
	Incorrect timing of the ignition pump	Check the ignition pump timing.	Apply to FPT Technical Service.
	Deposits or water presence in the fuel tank	Disconnect the pipes and clean them with compressed air jet. Disassemble the ignition pump and clean it. Eliminate any presence of water in the fuel tank and refuel.	Always bleed the supply system.
	Insufficient fuel reserve	Refuel	
	No supply	Overhaul or replace the supply or transfer pumps	
	Air bubbles in the fuel pumps or in the ignition pump	Check the pipes to ascertain the cause of air presence and the supply pump. Eliminate any air from the ignition pump interior loosing the specially provided cap and manually operating the supply pump.	
	Defective starter	Repair or replace the starter	

FAILURE	POSSIBLE ROOT CAUSE	RECOMMENDED TESTS OR REMEDY	NOTES
The engine does not start at low temperatures	Supply system obstruction by formation of paraffin crystals due to the use of unsuitable fuel.	Change the existing fuel with other fuel suitable for low temperatures. Replace the fuel filter.	
	K.S.B. device for cold spark lead change is incorrectly working.	Overhaul or replace the supply pump.	Apply to FPT Technical Service
The engine stops	Idle too low.	Adjust the idle level throughout the adjusting screw.	
	Ignition pump irregular delivery	Regulate delivery.	Apply to FPT Technical Service
	Impurities or presence of water in the fuel pipes.	Disconnect the pipes and clean them with compressed air jet. Disassemble the ignition pump and clean it. Eliminate any presence of water in the fuel tank and refuel.	Always bleed the supply system.
	Fuel filter clogged.	Disassemble and replace the fuel filter if necessary.	
	Presence of air in the supply and ignition systems.	Check the pipes for cracks or loose pipe fittings. Replace the worn parts. Eliminate air any air from inside the pipes and then bleed the ignition pump and the fuel filter loosing the specially provided caps and manually operating the priming pump.	
	Ignition pump controls broken.	Replace the ignition pump.	
	Incorrect slack between camshaft and tappets.	Adjust the slack replacing the adjusting plates.	
	Burnt, corroded or cracked.	Replace the valves, overhaul or replace the valve housings on the cylinder head.	

FAILURE	POSSIBLE ROOT CAUSE	RECOMMENDED TESTS OR REMEDY	NOTES
The engine excessively heats up	Defective water pump.	Check the whole unit and replace it if necessary; replace the sheath.	
	Defective thermostat.	Replace the thermostat.	
	Incrustation within the various cooling liquid passages of the cylinder head and unit.	Accurate washing is necessary. Follow the instructions prescribed for the specific incrustation removal product to be used.	
	Insufficient tension of the water pump drive belt.	Check the belt tensioning and adjust it.	In case of appliances equipped with automatic tensioning device, check that the device is correctly working.
	Cooling liquid level too low.	Top up the radiator cooling liquid to the level required.	
	Incorrect engine timing.	Check timing.	
	Ignition pump incorrect calibration (too high or too low)	Adjust the pump delivery on bench. Ignition must be set up according to the prescribed delivery.	Apply to FPT Technical Service
	Obstructed air filter.	Clean the air filter and replace it if necessary.	
Insufficient engine power and irregular functioning	Ignition pump incorrect timing.	Check timing and proceed setting up the ignition pump correctly.	
Insufficient engine power and irregular functioning	Defective spark lead automatic changing device.	Test the ignition pump functioning on bench. If the values detected to not comply with the prescribed ones, replace the changing device spring.	Apply to FPT Technical Service
	K.S.B. automatic spark lead changing device failure.	Adjust or replace the ignition pump.	
	Piston excessive wear.	Proceed with engine overhaul and replacement of worn parts.	
	Incorrect speed regulator calibration.	Check the regulator and calibrate it.	Apply to FPT Technical Service

FAILURE	POSSIBLE ROOT CAUSE	RECOMMENDED TESTS OR REMEDY	NOTES
Insufficient engine power and irregular functioning	Partial nozzle obstruction or defective injectors.	Clean the nozzles throughout the specially provided equipment and overhaul the injectors.	
	Impurities or presence of water in the supply and ignition systems.	Accurate cleaning is necessary as well as refuelling.	Always bleed the supply system.
	Incorrect slack between camshaft and tappets.	Check the slack and adjust it.	
	Defective turbocharger.	Replace the whole unit.	
	Obstructed air filter.	Clean the air filter or replace it.	
	Defective L.D.A. device.	Check that the membrane is not perforated and that the counter spring is appropriate and correctly loaded (test on bench). Check the pressure within the intake manifold is correct in relation to the engine speed at full load.	Apply to FPT Technical Service
	Incorrect adjustment of the tie rods connecting the accelerator pedal and the regulator's lever.	Adjust the tie rods in order to be able to take the control lever to maximum delivery position.	
Anomalous engine strokes	Defective injectors.	Replace the injectors.	
	Obstructed fuel pipes.	Disassemble the pipes, clean them and replace those that are seriously dented.	
	Ignition pump incorrect setting.	Correct the pump setting so that ignition may be carried out according to the prescribed spark lead angle.	Apply to FPT Technical Service

FAILURE	POSSIBLE ROOT CAUSE	RECOMMENDED TESTS OR REMEDY	NOTES
Anomalous engine strokes	Engine strokes cause excessive slack of one or more crankshaft bearings or big end bearings or excessive shoulder slack.	Grind the engine drive shaft pins and fit undersize bearings. Replace the thrust bearing half rings.	
	Unbalanced engine drive shaft.	Check the engine drive shaft alignment.	
	Loose flywheel fastening screws.	Replace the loose screws and tighten them to the prescribed torque setting.	
	Connecting rod misalignment.	Replace the connecting rod.	
	Noisy piston pins for excessive slack of piston hubs and connecting rod bush. Loose bushes in their housing on the connecting rod.	Replace the piston pin and/or the piston and the connecting rod bush.	
	Noisy timing	Adjust the slack between camshaft and tappet and check there are no broken springs. Furthermore, check that the slack between valve stems and valve guides as well as tappets an relevant seat.	
Anomalous engine fumes. Black or dark grey fumes.	Excessive pump maximum delivery.	Disconnect the pump and adjust its delivery referring to the calibration table of the screw nuts.	Apply to FPT Technical Service
	Defective or incorrectly adjusted K.S.B. device.	Adjust the ignition pump or replace it.	Apply to FPT Technical Service
	The ignition pump is excessively delayed (or spark lead changing device is defective).	Correct setting, check the spark lead changing device.	

FAILURE	POSSIBLE ROOT CAUSE	RECOMMENDED TESTS OR REMEDY	NOTES
Anomalous engine fumes. Black or dark grey fumes	Ignition pump spark lead is excessive.	Correct the adjustment.	
	The nozzles (or some of them) are partially or totally obstructed.	Replace the injectors with a series or new injectors or, as an alternative, clean and recondition the original ones using the specific equipment.	
	Clogged or deteriorated air filter.	Clean or replace the air filter.	
	Loss of compression within the engine due to: worn or stuck snap rings; worn cylinder barrel; deteriorated or incorrectly calibrated valves.	Overhaul the engine or limit the inspection to the parts of interest.	
	Unsuitable injectors' type, different type of injectors or incorrectly calibrated injectors.	Replace the injectors.	
	Incorrect ignition pipe internal diameter, dented pipe ends due to repeated locking.	Check the conditions of the pipe ends or pipe fittings and eventually replace the pipes.	
Blue, blue-grey and whitish grey fumes.	Excessive spark lead.	Adjust the pump setting.	Apply to FPT Technical Service
	K.S.B. automatic cold spark lead device is not malfunctioning.	Calibrate the ignition pipe or replace the K.S.B. unit.	Apply to FPT Technical Service
	Defective injectors.	Replace the injectors.	
	Oil leakage from the piston rings caused by worn or stuck rings or barrels worn inside.	Overhaul the engine	
	Engine oil leaking through the intake valve guides, due to worn guides or valve stems.	Recondition the cylinder head.	
	Engine is too cold (thermostat is not working or defective)	Replace the thermostat.	

PART FOUR -

MAINTENANCE PLANNING

SCHEDULED MAINTENANCE
Servicing Plan

Engine lubrication frequency has been calculated presuming the use of fuel with content of Sulphur < 0.5%. WARNING! In case of use of fuel containing a percentage of Sulphur e > 0.5 %, the engine oil replacement interval must be halved.

Use engine oil SAE 15W40 T2 - URANIA LD7

Overhaul and/or basic maintenance

Checks and regular servicing		Frequency (hours)
1.	Engine visual inspection	Daily
2.	Check for presence of water in the fuel filter or pre-filter	Daily
3.	Check engine oil level	Daily
4.	Check air filter	Daily
5.	Check cooling liquid level	Daily
6.	Check battery	Every six months
7.	Change the cooling liquid	Every 2 years or 1200 hours
8.	Check the wear conditions of the alternator's belt and of the water pump	300 (2)
9.	Change engine oil	500
10.	Replace engine oil filter	500
11.	Replace fuel filter	600 (1) (3)
12.	Tappet check and adjustment	1000
13.	Replace fuel pre-filter	1000 (1)
14.	Check turbo-compressor and clean it if necessary	1200
15.	Replace the alternator's belt and the water pump	1200
16.	Replace air filter	1200 (2)
17.	Ignition pump overhaul	3000

1) Using fuel complying with EN590 Standard

(2) Depending on appliance

(3) Using filters with filtering degree < 12 μ and β > 200 μ filtering efficiency

Checks not included in maintenance planning-daily checks

It is a good habit to execute, before engine start, a series of simple checks that might represent a valid warranty to avoid inconveniences, even serious, during engine running. Such checks are usually up to the operators and to the vehicle's drivers.

- Level controls and checks of any eventual leakage from the fuel, cooling and lubricating circuits.
- Notify the maintenance if any inconvenience is detected of if any filling is necessary.

After engine start and while engine is running, proceed with the following checks and controls:

- check presence of any eventual leakage from the fuel, cooling and lubricating circuits.
- Verify absence of noise or unusual rattle during engine working.
- Verify, using the vehicle devices, the prescribed pressure temperature and other parameters.
- Visual check of fumes (colour of exhaust emissions)
- Visual check of cooling liquid level, in the expansion tank.

MAINTENANCE PROCEDURES

Daily operations

1. Visually inspect engine

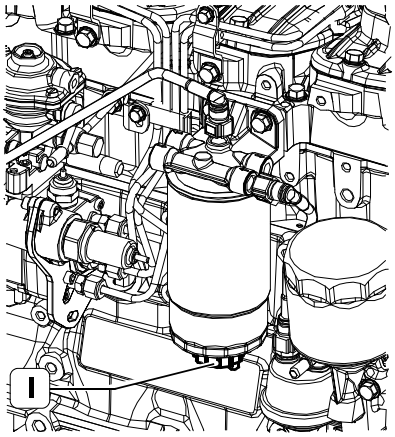
Carefully check the seal of the engine components and the fluid hoses.
Tighten down mounting collars and replace damaged hoses if you discover any leakages.
Change any worn parts.

2. Check of water presence within fuel filter or pre-filter

The components of the system can be damaged very quickly in presence of water or impurity within the fuel.

Timely proceed operating on the pre-filter (not available on the engine block) to carry out the drainage of the water within the feed circuit.

Figure 117



127699

Fuel filter is equipped with pump tap-valve (1) to drain the water eventually mixed with fuel.

Place a container underneath the filter and slightly loosen the screw. Drain the water eventually contained in the filter's bottom.

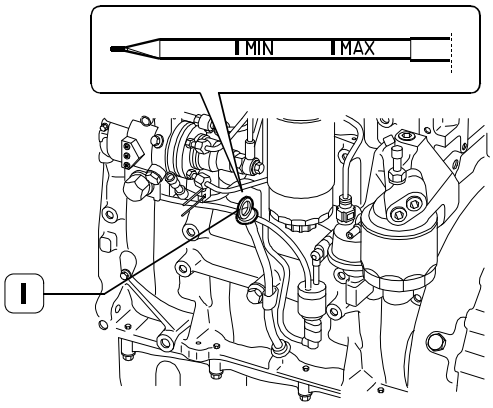
Lock the tap (1) (max 0.5 Nm locking couple) as soon as fuel starts bleeding.

3. Engine oil level check

The check must be executed when the engine is disconnected and possibly cool.

The check can be made using the specially provided flexible rod (1).

Figure 118



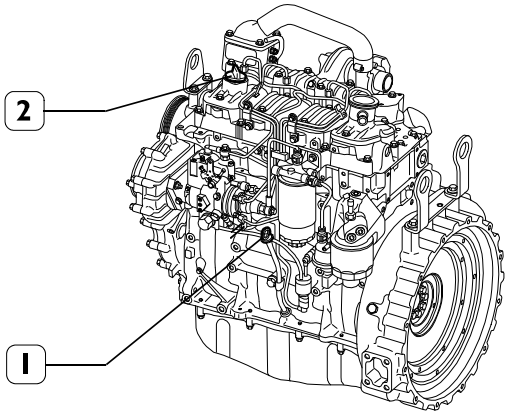
124570

Draw off the rod (1) from its slot and check that the level is within the etched tags of minimum and maximum level.

Whether it should be difficult to make the evaluation, proceed cleaning the rod using a clean cloth with no rag grinding and put it back in its slot. Draw it off again and check the level.

In case the level results being close to the tag showing minimum level, provide filling lubrication of the engine's components.

Figure 119



124571

To provide filling, operate through the upper top (2) or through the lateral top (1).

Some applications are equipped with a level transmitter alerting dashboard instruments in case of insufficient lubrication oil within the pan.

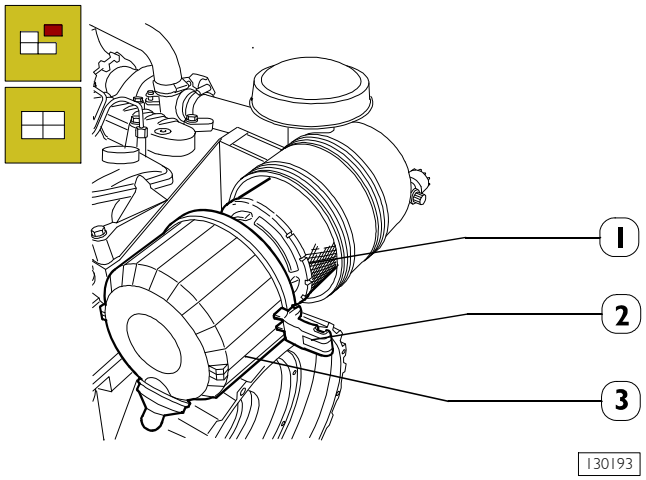
The engine oil is highly polluting and harmful.
In case of contact with the skin, rinse well with water and detergent.

Adequately protect the skin and the eyes, operate in full compliance with safety regulations.

Disposal must be carried out properly, and in full compliance with the law and regulations in force.

4. Air filter control

Figure 120



130193

Only proceed with the engine stopped.

- ❑ Remove the filter cover (3) after first unscrewing the locking handle (2).
- ❑ Remove the external cartridge (1). During this operation, take care to ensure that no dust get into the sleeve.
- ❑ Check that there is no dirt. If there is, clean the filter element as indicated below.
- ❑ Blow dry compressed air through the filter element, from the inside outward (maximum pressure 200 kPa). Do not use detergents; do not use diesel.
- ❑ Never use tools to beat the filter element, and check its condition before replacing it.
- ❑ Replace the filter if any breakages or tears are found.
- ❑ Check that the gasket at its base is in good condition.
- ❑ Reassemble by repeating the above operations in reverse order.

NOTE Take care to ensure that the parts are reassembled correctly. Imperfect assembly might result in unfiltered air being sucked into the engine, causing serious damage.

5. Check of cooling liquid level

Due to the high temperatures achieved by the system, do not operate immediately after the engine's disconnection, but wait for the time deemed necessary for the cooling.
Protect the eyes and the skin from any eventual high pressure jet of cooling liquid.

- ❑ Make sure that, with a cold engine, the liquid level in the cooler is such as to cover all the internal elements of the cooler.
- ❑ If necessary, top up with clean water. Do not use distilled water.

NOTE If the refill operations occur frequently a diagnosis of the cooling circuit is necessary.

In the event that the heat exchanger is available on the vehicle, refill it if necessary, paying attention that the fluid does not saturate the internal volume of the exchanger in order to enable any increase in volume of the fluid caused by the temperature increase.

6. Check battery

Every six months

Place the batteries on a level surface, then proceed as follows.

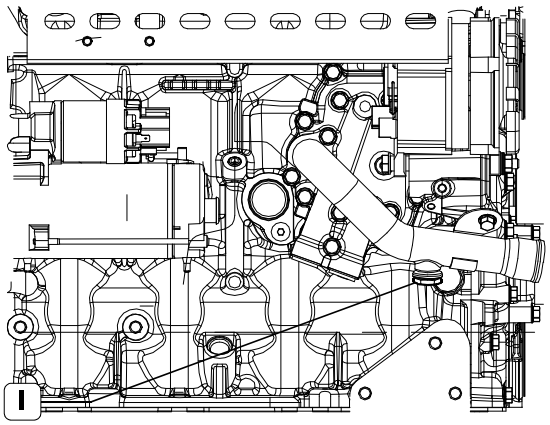
- ❑ Visually check that the fluid level is between the "Min" and "Max" limits; in the absence of references, check that the fluid covers the Lead plates inside the elements by approximately 5 mm.
- ❑ If necessary, top up with distilled water only those elements in which the level is below minimum.
- ❑ Have the efficiency of the battery recharging system tested if a voltage of less than 11 V (for 12 V rated systems) or 22 V (for 24 V rated systems) is detected with the engine running.
- ❑ On this occasion, make sure that the terminals and clamps are clean, properly locked and protected by Vaseline grease.

- ❑ The batteries contain sulphuric acid, which is extremely caustic and corrosive; always wear protective gloves and goggles when topping them up. Whenever possible it is recommended that this control be carried out by specialised personnel.
- ❑ Do not smoke or use live flames near the batteries during controls, and make sure that the room you are working in is adequately ventilated.

Every 2 years or 1200 hours

7. Change coolant

Figure 121



Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.

- ❑ Provide suitable containers to ensure that no coolant is dispersed into the environment.
- ❑ Undo nut (1) and wait for the fluid to drain out completely. When empty, repair the circuit making sure that the hoses are perfectly sealed.
- ❑ Fill up the circuit.
- ❑ Refill the engine and the heat exchanger until complete top up.
- ❑ With the filler cap open, start the engine and keep it idling for nearly one minute. This phase facilitates the cooling liquid air bleed.
- ❑ Stop the engine and top up again.

Every 300 hours

8. Check of belt's tear and wear status

Carefully verify the belt's surface in order to detect any sign of incision, crack, excessive wear in correspondence of toothing; check end and surface grinding.

Danger: if the engine is switched off but is still hot, unexpected motion of the belt may occur.

Wait for engine temperature cooling as a precaution in order to avoid serious danger injury.

Every 500 hours

9. -10. Oilmotor and filter replacement

Warning: We recommend to wear proper protections because of high motor service temperature.

The motor oil reaches very high temperature: you must always wear protection gloves.

Due to the several applications, the pan shape and the oil quantity can change slightly. However, the following operations are valid for all applications.

We recommend to carry out the oil drainage when the motor is hot.

- ❑ Place a proper container for the oil collecting under the pan connected with the drain plug.
- ❑ Unscrew the plug and then take out the control dipsick and the inserting plug to ease the downflow of the lubrication oil.

The oil motor is very pollutant and harmful.

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

Protect properly skin and eyes: operate according to safety rules.

Dispose of the residual properly following the rules.

- ❑ After the complete drainage, screw the plug and carry out the clean oil filling.

Use only the recommended oil or oil having the requested features for the corrrect motor functioning.

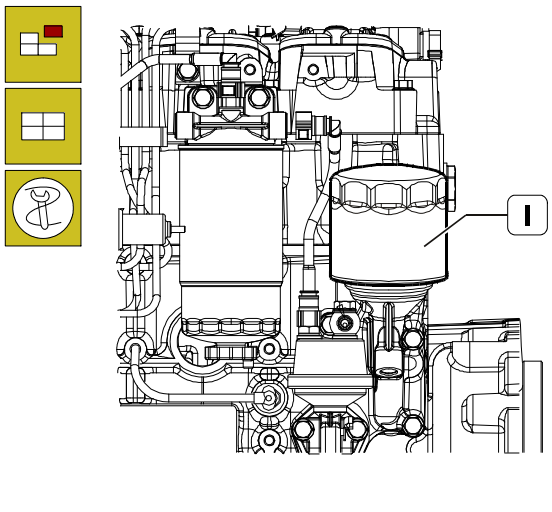
In case of topping up, don't mix oils having different features.

If you don't comply with theses rules, the service warranty is no more valid.

- ❑ Check the level through the dipsick until when the filling is next to the maximum level notch indicated on the dipsick.

Whereas you replace the lubrication oil, it is necessary to replace the filter.

Figure 122



- ❑ The filter is composed by a support and a filtering cartridge. For the cartridge replacement use the 9936076-tool.

Warning: the oil filter contains inside a quantity of oil of about 1 kg.

Place properly a container for the liquid.

Warning: avoid the contact of skin with the motor oil: in case of contact wash the skin with running water.

The motor oil is very pollutant: it must be disposed of according to the rules.

- ❑ Replace the filtering cartidge (1) with a new one and screw manually until when the gasket, previously moistened by smearing with oil, is in contact with the support.
- ❑ Tigthen by means of the 99360076-tool and lock related nuts at predefined torque 30 ± 3 Nm.
- ❑ Operate the motor for some minutes and check the level through the dipsick again. If it is necessary, carry out a topping up to compensate the quantity of oil used for the filling of the filtering cartridge.

Every 600 hours

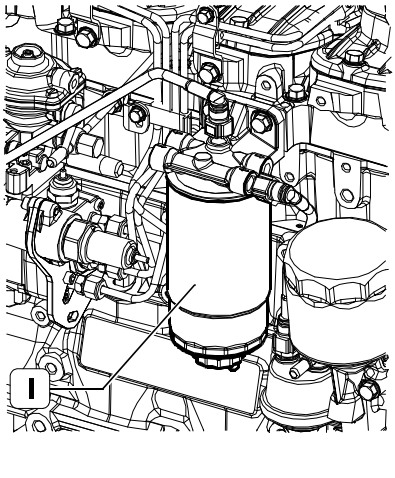
11. Fuel filter replacement

During this operation don't smoke and don't use free flames.

Avoid to breathe the vapors coming from filter.

After filters replacement the supply equipment deaeration must be carried out.

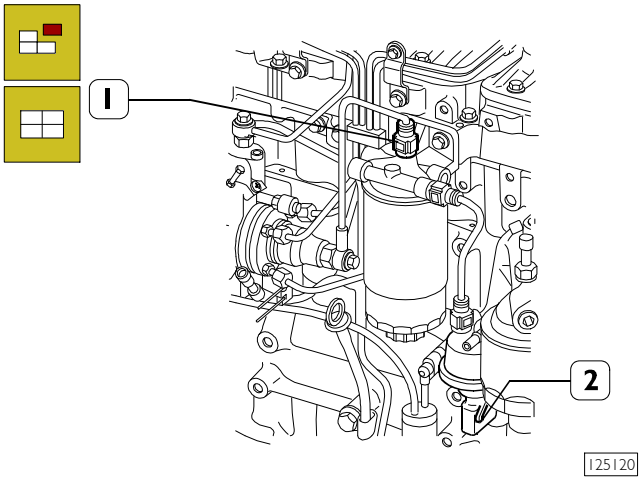
Figure 123



- ❑ Drain the fuel inside the filter by operating the water release tap. Collect the fuel in a container without impurities.
- ❑ Unscrew the cartridge (1) by using the 99360076-tool.
- ❑ Collect the eventual fuel inside the filtering cartridge.
- ❑ Clean the gasket seat on the support and oil slightly the gasket on the new filtering cartridge.
- ❑ Screw manually the new filtering cartdrige until when the gasket is completely on its seat.
- ❑ Tigthen through the 99360076-tool at 25 ± 2.5 Nm torque.

Bleeding procedure:

Figure 124



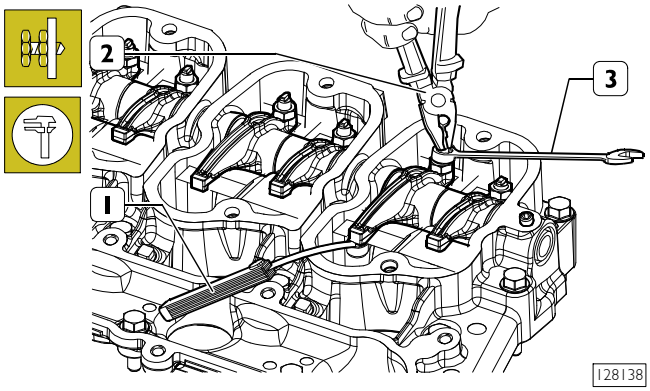
- ❑ Loosen the fuel outlet manifold, located on the upper part of the filter (1).
- ❑ Make sure that any diesel coming out will not dirty the auxiliary member drive belt or be dispersed into the environment.
- ❑ Use the pre-filter hand pump until the diesel coming out is free from any residual air or perform the same operation using the mechanical feed pump (2).
- ❑ Lock the manifold loosened as above to the required torque.
- ❑ Dispose of any diesel expelled during the above operation in accordance with the law.
- ❑ Start the engine and run it at minimum speed for a few minutes to eliminate any residual air.

NOTE Should it be necessary to accelerate the bleeding phase, the hand pump can be used during start-up.

Every 1000 hours

12. Check and adjust tappets clearance

Figure 125



Adjust the clearance between the rockers and valves using a pair of pliers (2), a wrench (3) and a feeler gauge (1).

Clearance shall be as follows:
- intake valves 0.25 ± 0.05 mm
- exhaust valves 0.50 ± 0.05 mm.

Rotate the engine drive shaft, balance the valves of cylinder 1 and adjust the valves identified by star symbol, as indicated in the following table:

Cylinder n°	1	2	3	4
Suction	-	-	*	*
Exhaust	-	*	-	*

Rotate the engine drive shaft., balance the valves of cylinder 4 and adjust the valves identified by star symbol, as indicated in the following table:

Cylinder n°	1	2	3	4
Suction	*	*	-	-
Exhaust	*	-	*	-

13. Change fuel prefilter

Every 1200 hours

14. Check/clean turbocharger

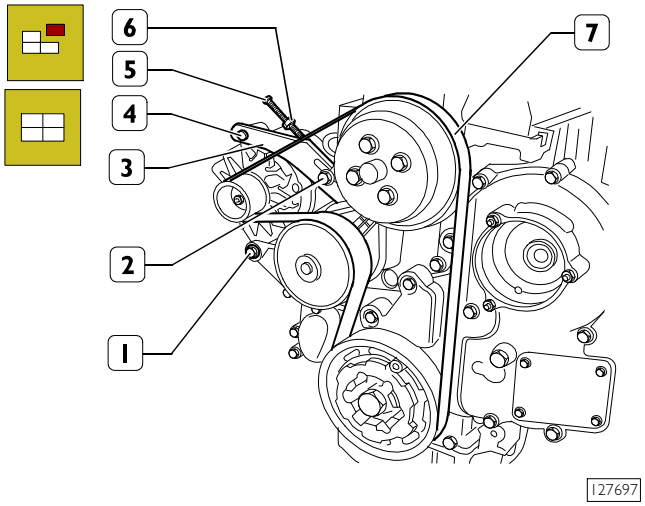
Visually inspect the turbocharger and clean it carefully with compressed air if dirty.

15. Alternator belt replacement

Warning: with switched off motor (but still hot) the belt can operate without advance notice.

Wait for the motor temperature lowering to avoid very serious accidents.

Figure 126



- ❑ Loosen screw (4) and the relevant nut on belt stretching bracket (3).
- ❑ Loosen the screws (1, 2, 5) and the screw nut (6) in order to withdraw the belt (7).
- ❑ Fit the new belt (7) on the pulleys and guide rollers.
- ❑ Tighten the driving belt (7) screwing up screw (5) until the screw (2) reaches the end of the groove which is on the bracket (3). Tighten the nut (6) and the screw (1).
- ❑ Tighten the screw (4) and the bolt (1) that fixes the alternator to the support.

16. Change air filter

Follow the instructions given in point 4.

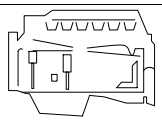
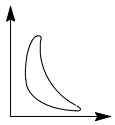
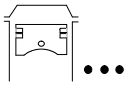
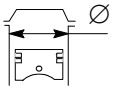
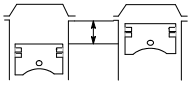
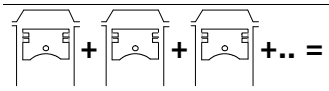
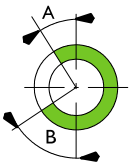
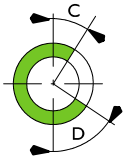
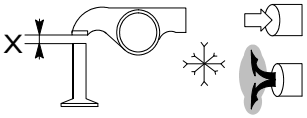
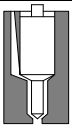
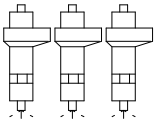
Every 3000 hours

17. Overhaul injection pump

SECTION 4

Mechanical overhaul

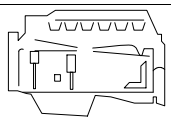
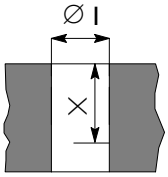
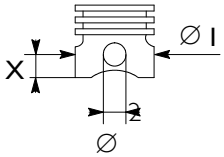
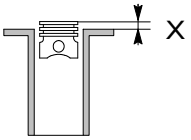
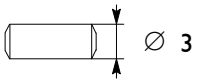
GENERAL SPECIFICATIONS

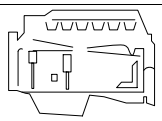
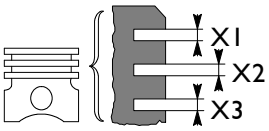
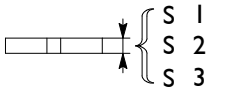
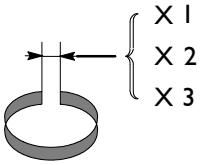
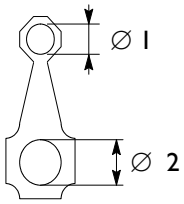
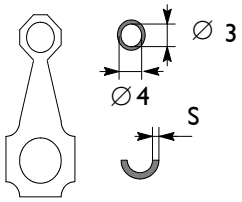
	Type		F5CE0405A*B001	F5CE0455A*B001 F5CE0485A*B001
	Cycle		Diesel * 4 strokes	
	Power		See the specifications reported in Section 3	
	Injection		Direct	
	Number of cylinders		4	
	Bore	mm	99	
	Stroke	mm	104	
	Total displacement	cm^3	3200	
	**TIMING** start before T.D.C. A end after B.D.C. B		19° ± 30' 37° ± 30'	
	start before B.D.C. D end after T.D.C. C		61° ± 30' 21° ± 30'	
	Checking timing X	mm mm	0.25 ± 0.05 0.50 ± 0.05	
	FUEL FEED Injection Type:	rotary	STANADYNE	DELPHI DPGE
	Nozzle type		STANADYNE	DELPHI
	Injection sequence		1 - 3 - 4 - 2	

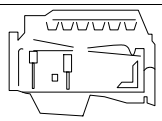
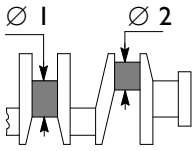
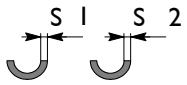
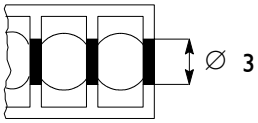
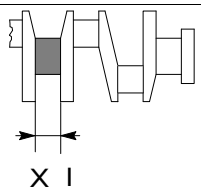
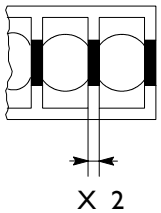
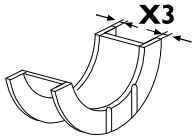
* Use STANDARD fuel compliant to the EN 590

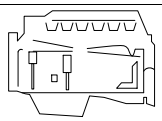
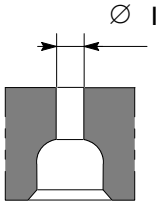
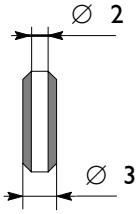
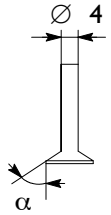
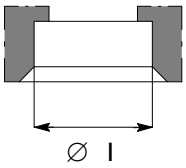
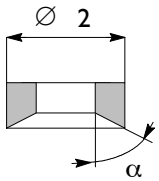
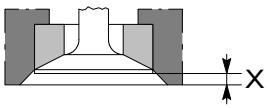
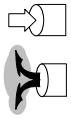
NOTE EN 590 specifications distinguish different classes of diesel fuel, identifying the characteristics of those best suited to low temperatures.
It is entirely up to the Oil companies to comply with these regulations, which foresee that fuels suited to the climactic and geographic conditions of the various Countries be distributed.

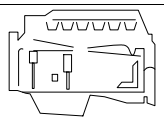
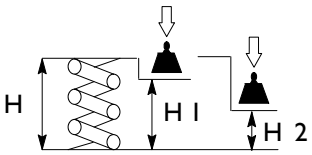
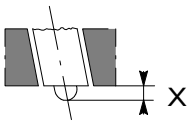
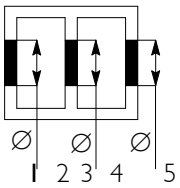
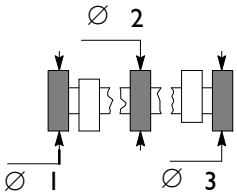
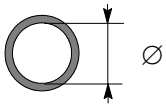
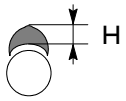
DATA - ASSEMBLY SLACKS

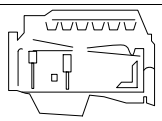
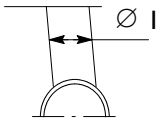
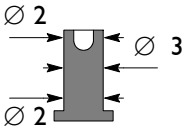
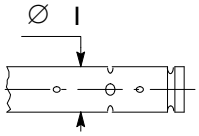
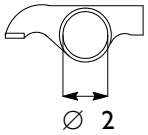
	Type	4 CYLINDERS
CYLINDER UNIT AND CRANKSHAFT COMPONENTS		mm
	Cylinder barrels ⌓ Ø1 > Ø1	99 to 99.02 0.4
	Spare pistons type: Size X Outside diameter Ø 1 Pin housing Ø 2	 10 98.908 to 98.918 36.003 to 36.009
	Piston – cylinder barrels	0.082 to 0.112
	Piston diameter Ø 1	0.4
	Piston protrusion X	-0.22 ÷ +0.07
	Piston pin Ø 3	35.996 to 35.999
	Piston pin – pin housing	0.004 to 0.013

	Type	4 CYLINDERS
CYLINDER UNIT AND CRANKSHAFT COMPONENTS		**mm**
	Split ring slots X1*	2.21
	X 2	2.05 to 2.07
	X 3	2.54 to 2.56
	* theoretical measurement on a Ø of $96^{-0.25}$ mm	
	Split rings S 1*	2.068 to 2.097
	S 2	1.970 to 1.990
	S 3	2.470 to 2.490
	*measured at 1.5 mm from external Ø	
	Split rings - slots 1	-
	2	0.060 to 0.100
	3	0.050 to 0.090
	Split rings	0.4
	Split ring end opening in cylinder barrel:	
	X 1	0.20 to 0.35
	X 2	0.60 to 0.80
	X 3	0.30 to 0.60
	Crankshaft bearing bush seat Ø 1	39.460 to 39.49
	Big end bearing seat X	67.833 to 67.841
	0	67.842 to 67.848
	Crankshaft bearing bush diameter	
	Internal Ø 4	36.010 to 36.020
	Ø 3	39.570 to 39.595
	Crankshaft half bearings Red	1.875 to 1.884
	Blue	1.883 to 1.892
	Green	1.891 to 1.900
	Piston pin – bush	0.011 to 0.024
	Big end half bearings	0.254; 0.508

	Type	4 CYLINDERS
CYLINDER UNIT AND CRANKSHAFT COMPONENTS		**mm**
	Crankshaft bearing pins No. 1-2-3-4 Ø 1 No. 5 Ø 1 Big end bearing pins Ø 2	 76.182 to 76.208 83.182 to 83.208 64.015 to 64.038
	Crankshaft half bearings S 1 Big end half bearings S 2	2.165 to 2.174 1.877 to 1.883
	Crankshaft supports No. 1-2-3-4 Ø 3 No. 5 Ø3	 80.588 to 80.614 87.588 to 87.614
	Half bearings – Journals No. 1-2-3-4 No. 5	 0.064 to 0.095 0.059 to 0.100
	Half bearings - Crankpins	0.033 to 0.041
	Main half bearings Big end half bearings	0.127; 0.254; 0.508
	Crankshaft pin for shoulder X 1	31.85 to 32.150
	Crankshaft support for shoulder X 2	32.50 to 32.55
	Shoulder half-rings X 3	2.51 to 2.56
	Engine drive shaft shoulder	0.095 to 0.270

	Type		4 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM			**mm**
	Valve guide seats on cylinder head	Ø 1	12.960 to 12.995
	Valve guides	Ø 2 Ø 3	0.023 to 8.038 12.950 to 12.985
	Valves:  	Ø 4 α Ø 4 α	7.985 to 8.000 60° 30' ± 0° 10' 7.985 to 8.000 60° 30' ± 0° 10'
	Valve stem and guide		0.040 to 0.053
	Valve seat on cylinder head  	Ø1 Ø1	39.987 to 40.013 43.787 to 43.813
	Valve seat outside diameter; valve seat angle on cylinder head:  	Ø 2 α Ø 2 α	40.063 to 40.088 60° ± 1° 40.863 to 43.88 60° ± 1°
	Recessing of valve  	X X	0.3 to 0.7 0.3 to 0.7
	Between valve seat and head 		0.050 to 0.101 0.050 to 0.101
	Valve seats		-

	Type		4 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM			**mm**
	Valve spring height: free spring under a load equal to: 270 N 528 N	 H H1 H2	 44.6 34 23.8
	Injector protrusion	X	1.7 to 2.35
	Seat for camshaft no. 1 bushes (flywheel side) Camshaft housings No. 2-3-4 No. 1-5		59.222 to 59.248 50.069 to 50.119 40.069 to 40.119
	Camshaft supporting pins 1 2 ⇒ 4 5	 Ø	53.995 to 54.045 39.975 to 40.025 49.975 to 50.025 53.995 to 54.045
	Bush inside diameter	Ø 5	54.083 to 54.147
	Bushes and journals		0.038 to 0.162
	Cam lift:  	 H H	 5.511 6.213

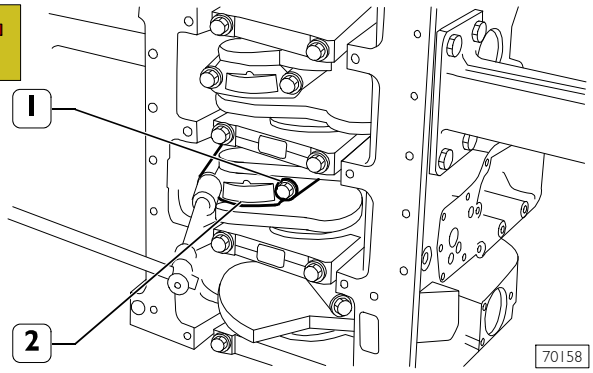
	Type		4 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM			**mm**
	Tappet cap housing on block	Ø 1	15,000 ÷ 15,018
	Tappet cap outside diameter:	Ø 2 Ø 3	15.924 to 15.954 15.960 to 15.975
	Between tappets and housings		0.03 to 0.068
	Tappets		-
	Rocker shaft	Ø 1	18.979 to 19.000
	Rockers	Ø 2	19.020 to 19.033
	Between rockers and shaft		0.020 to 0.054

ENGINE OVERHAUL
ENGINE DISASSEMBLY ON BENCH

To execute the operations described here following, it is necessary to fit the engine on the rotary stand after having removed all the appliance's specific components (see Section 3 of the herein manual).

This section illustrates all the more important procedures of engine bock overhaul.

Figure 1

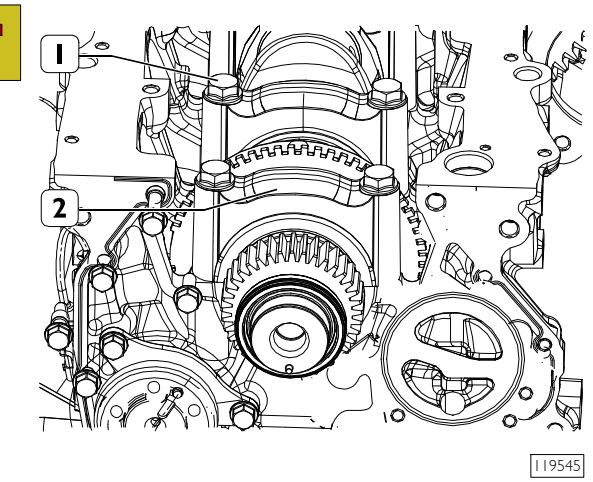


Loosen the screws(1) fastening the connecting rod caps (2) and remove the fastening the connecting rod caps.

Withdraw the pistons with the connecting rods from the upper part of the crankcase.

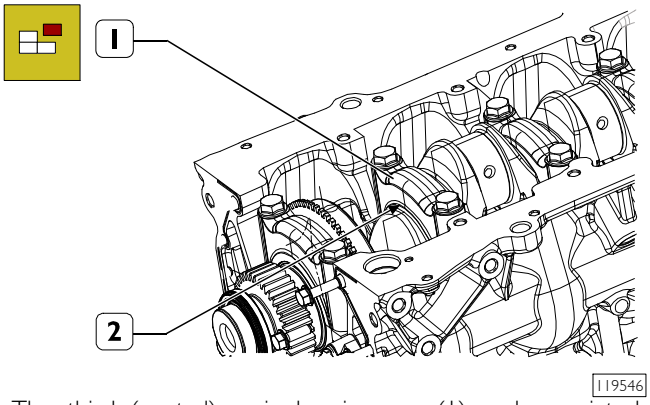
NOTE Keep the half bearings in their respective housings since, in case of reuse after the overhaul, they will have to be reassembled in the same position.

Figure 2



Loosen the screws (1) and disassemble the crankshaft bearing caps (2).

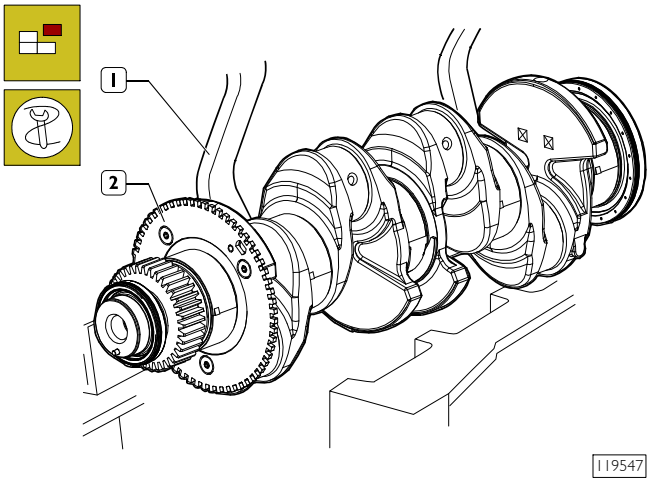
Figure 3



The third (central) main bearing cap (1) and associated support have a bearing-half (2) equipped with thrust.

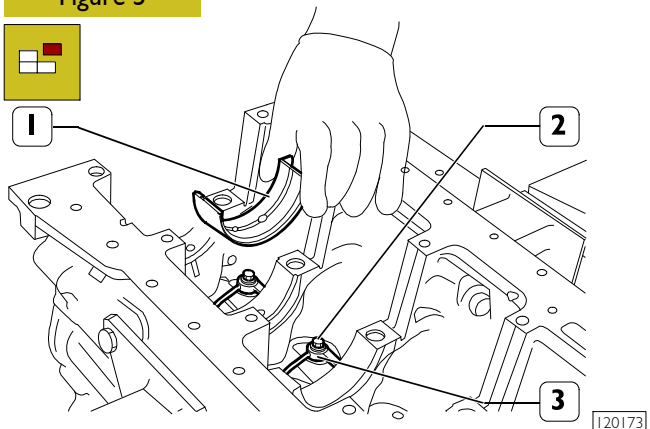
NOTE Note down the assembly position of the upper and lower half bearings since, in case of reuse after the overhaul, they will have to be reassembled in the same position.

Figure 4



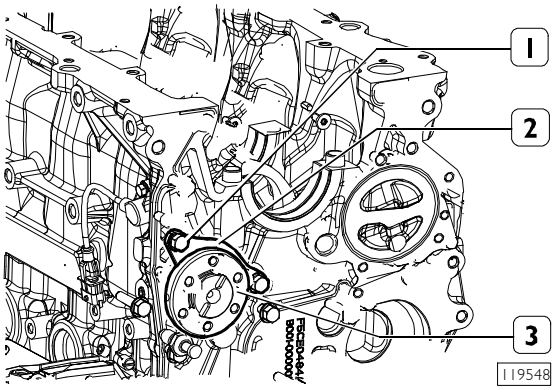
Using tool 99360500 (1) and a hoister, remove the engine drive shaft (2) from the crankcase.

Figure 5



Disassemble the crankshaft half bearings (1).
Loosen the fastening screws (2) and disassemble the oil nozzles (3).

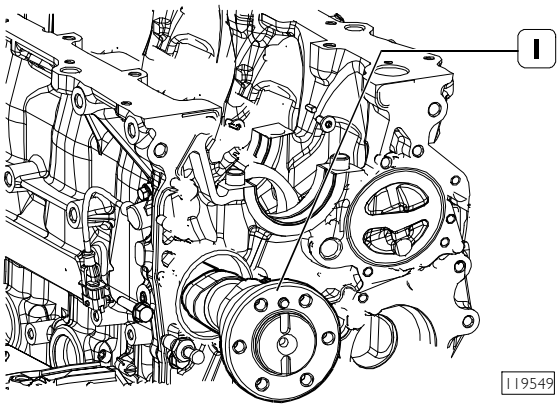
Figure 6



Loosen the fastening screws (1) and disassemble the camshaft (3) holding plate (2).

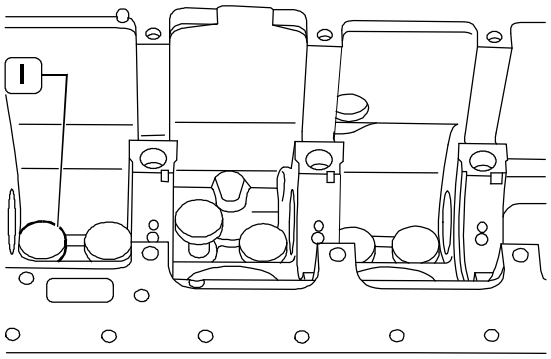
NOTE Note down the plate assembly position (2).

Figure 7



Carefully withdraw the camshaft (1) from the engine bock.

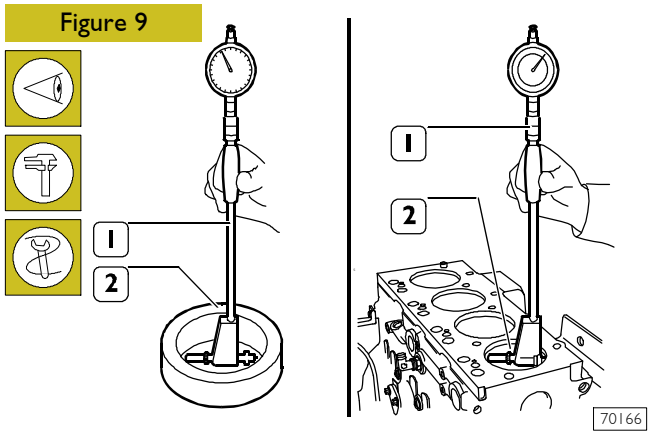
Figure 8



Withdraw the tappets (1) from the engine bock.

REPAIRS
CYLINDER UNIT
Checks and measurements

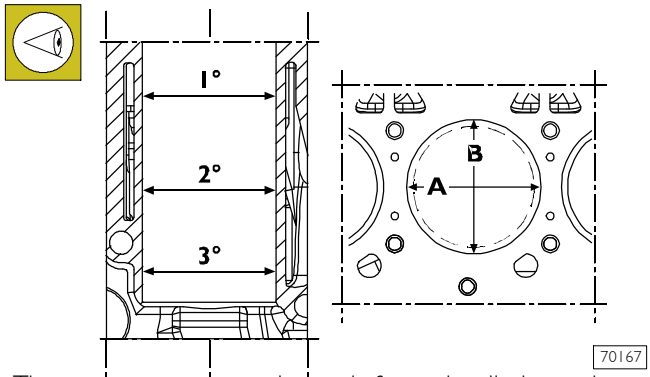
Figure 9



Once completed the engine disassembly, carefully clean the cylinder-crankcase units.
Use suitable eyebolts to handle the cylinder unit. Carefully check the crankcase has for cracks. Check the conditions of the processing caps: replace them if oxidized or in case their tight is doubtful. Check the surface of the cylinder barrels: there must be no trace of meshing, scratches, oval or conical shaping and excessive wear.
Cylinder barrel inner diameter check to detect any oval or conical shaping or wear shall be executed throughout the bore meter (1) equipped with comparator, which must be previously be reset on the ring calliper (2) of the cylinder barrel diameter.

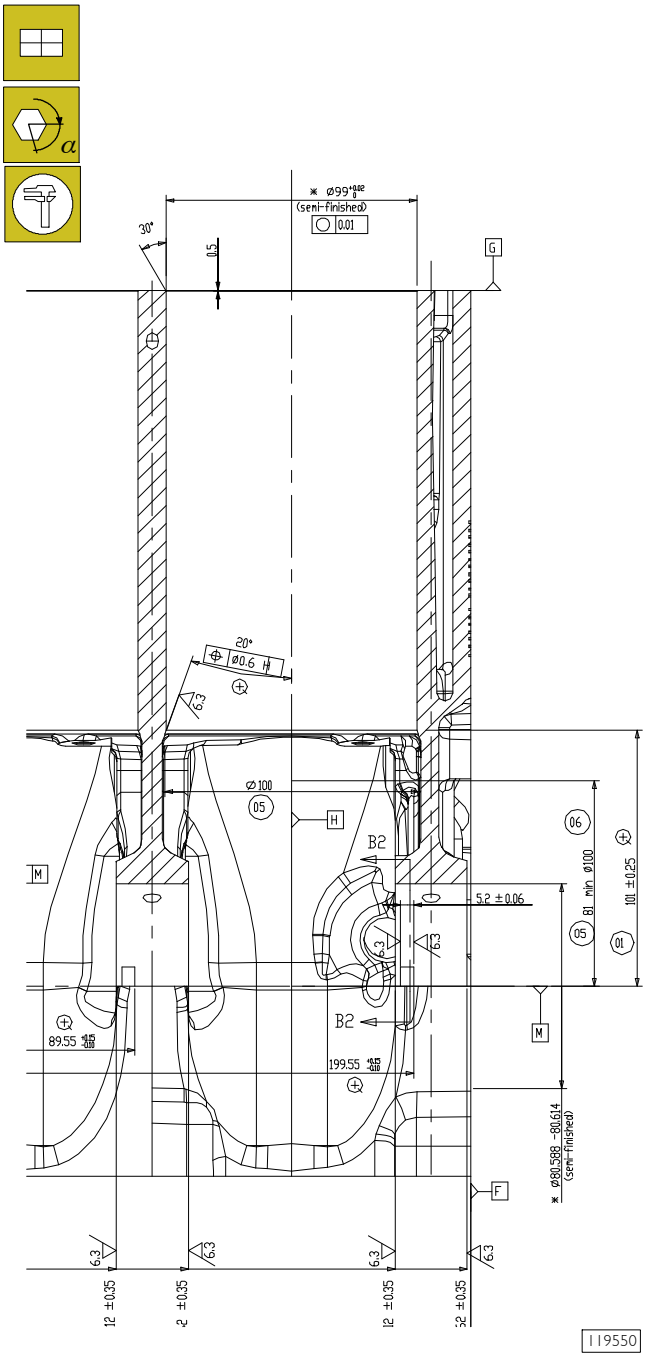
NOTE If the ring calliper is unavailable, use a micrometer for reset.

Figure 10



The measurements must be made for each cylinder, at three different heights from the barrel and on two perpendicular planes: one parallel to the engine longitudinal axle (A) and the other perpendicularly (B). Generally, maximum wear is detected on the perpendicular plane (B) and with the first measurement.
If oval or conical shaping or wear is detected, proceed boring and grinding the cylinder barrels. Cylinder barrel grinding must be executed based on the spare pistons' diameter plus 0.4 mm of the rated value and at the prescribed assembly slack.

Figure 11



NOTE In case of grinding, all the barrels must result having the same oversize (0.4 mm).

Check the crankshaft bearing seats proceeding as follows:

- ❑ fit the crankshaft bearing caps on the supports without bearings;
- ❑ tighten the fastening screws to the prescribed torque setting;
- ❑ with a suitable comparator, check that the inner barrel diameter corresponds to the prescribed value.

If the detected value is higher, replace the crankcase.

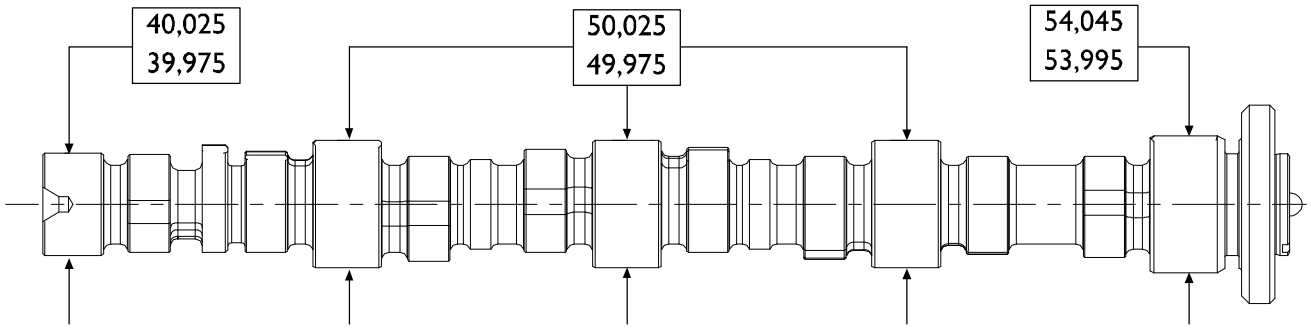
Checking head base surface on cylinder unit

After having detected any deformed areas, grind the head base surface using a grinding machine.

Planarity error must not exceed 0.075 mm. Check the conditions of the cylinder unit processing caps: replace them if oxidized or in case their tight is doubtful.

TIMING SYSTEM
Camshaft

Figure 12



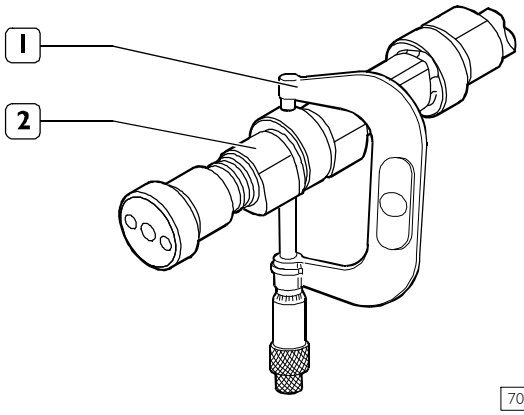
MAIN DATA ABOUT CAMSHAFT PINS

The surface of the camshaft pins and of cams must be extremely smooth. In case any trace of meshing or scratches are detected, replace the shaft and the relevant bushes.

Checking cam lift and pin alignment

Place the camshaft on footstocks and, throughout a centesimal comparator placed on the central support, check that the radial oscillation does not exceed 0.015 mm otherwise replace the shaft.

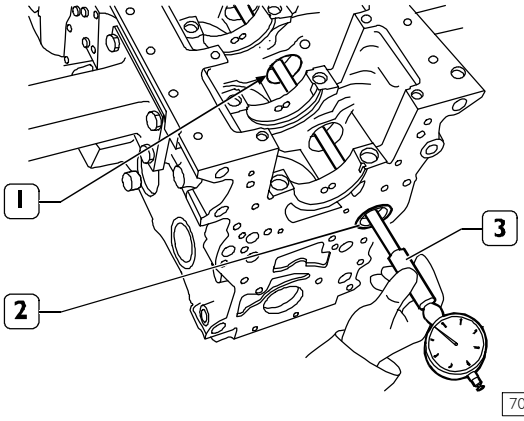
Figure 13



Using a micrometer (1), check the diameter of the camshaft (2) supporting pins on the two perpendicular axles.

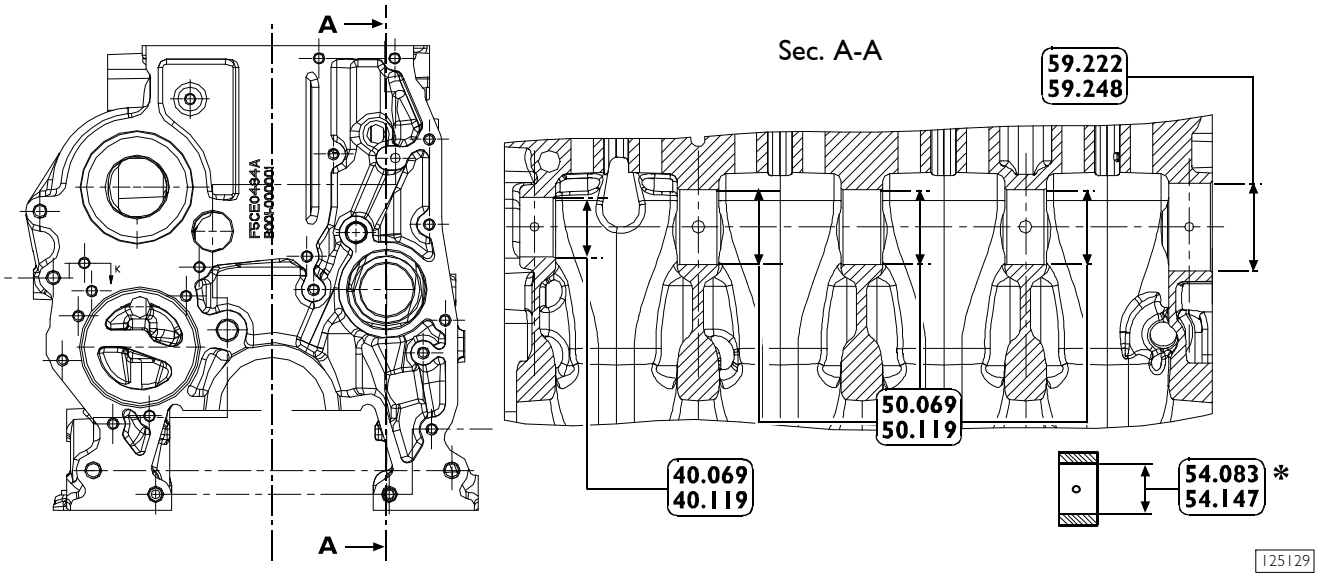
BUSH

Figure 14



The front camshaft bush (2) must be thrust in the respective seat.
There must be no trace of meshing or wear in the inner surface.
Using a bore meter (3) measure the front adiameter of the camshaft bush (2).
Measurements must be made on two perpendicular axles.

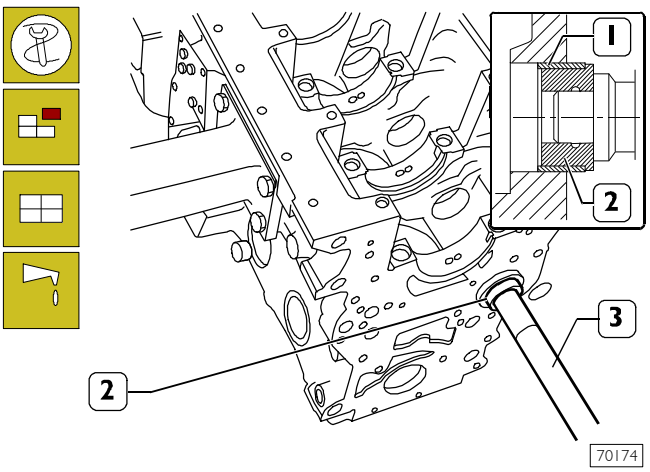
Figure 15



MAIN DATA OF THE CAMSHAFT BUSH AND RELEVANT SEAT
* Quota to obtain after bush fixing.

Bush replacement

Figure 16

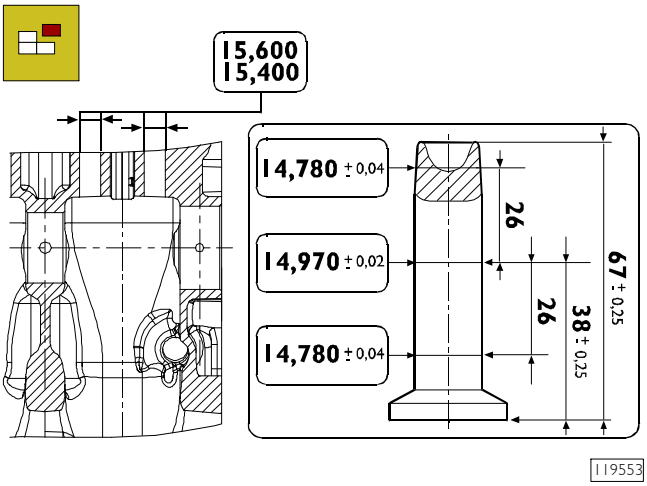


Use the beater 99360362 (2) and handgrip 99370006 (3) to disassemble and replace the bush (1).

NOTE In phase of assembly, the bush (1) must be oriented making the lubrication ports coincide with those on the crankcase.

Tappets

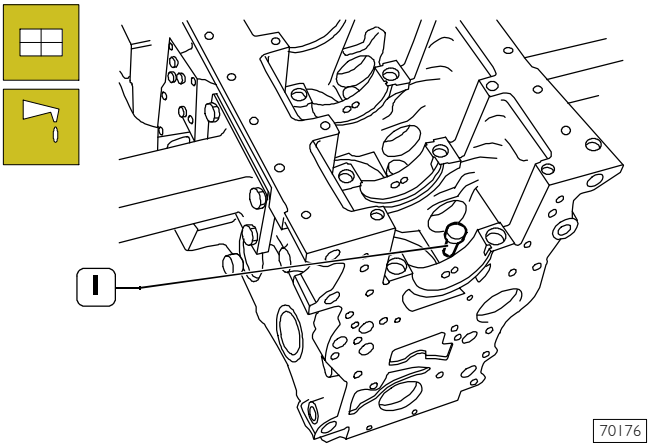
Figure 17



TAPPET AND RELEVANT SEAT ON CRANKCASE MAIN DATA

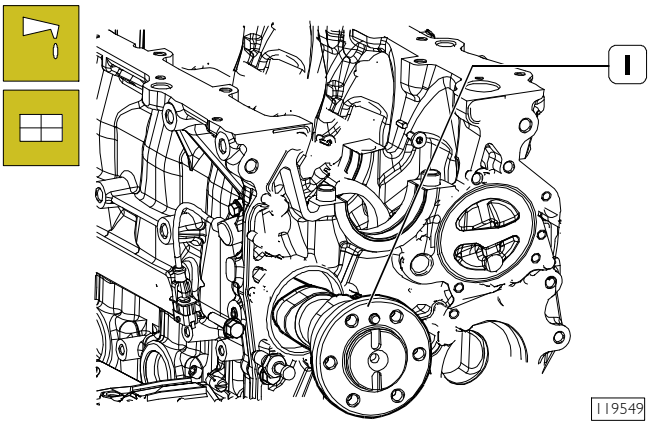
Tappet - camshaft assembly

Figure 18



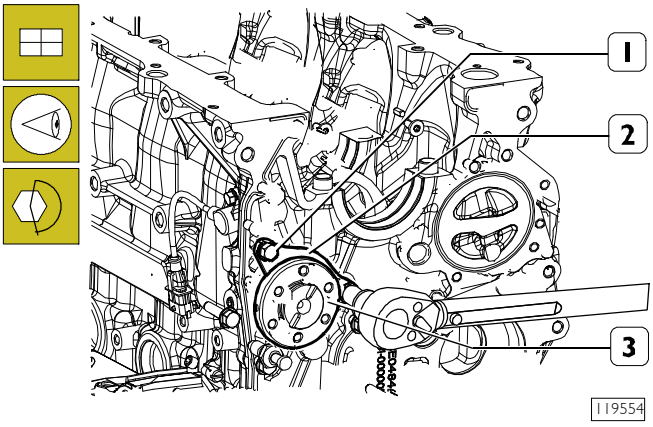
Lubricate the tappets (1) and fit them into the relevant seats on within the crankcase.

Figure 19



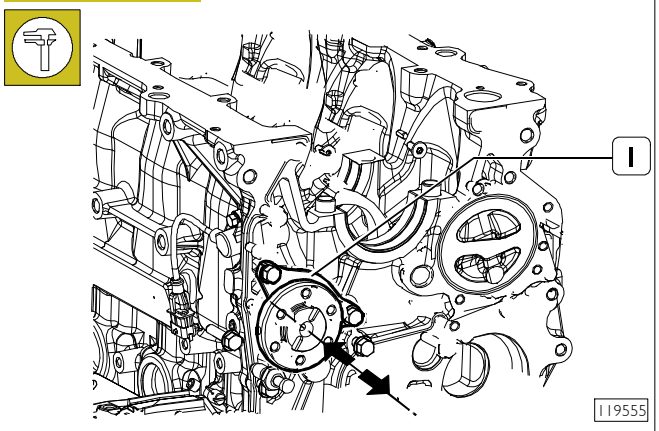
Lubricate the camshaft supporting bush and assemble the camshaft (1) paying attention, during the aforesaid operation, not to damage the bush or the shaft's seats

Figure 20



Position the camshaft (3) holding plate (1) with the slot towards the upper side of the crankcase and the marking towards the operator; tighten the fastening screws (2) to the prescribed torque setting.

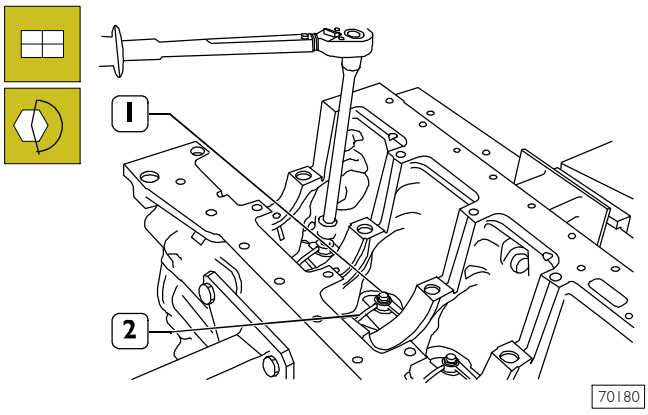
Figure 21



Check the camshaft axial shaft (1).

The prescribed value is 0.23 ± 0.1 3 mm.

Figure 22

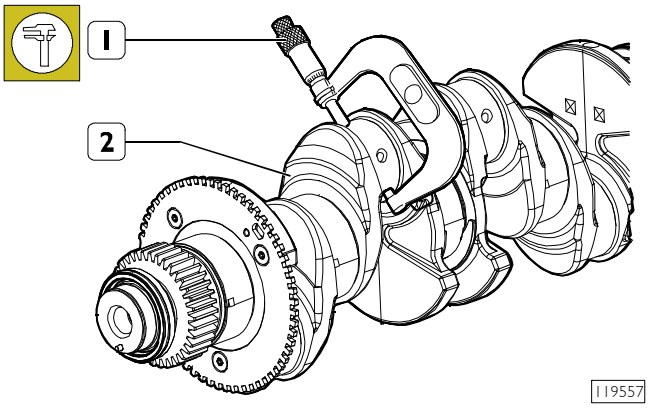


Fit the nozzles (2) and tighten the fastening screws (1) to the prescribed torque setting.

ENGINE DRIVE SHAFT

Measurement of main journals and crankshaft bearing pins

Figure 23



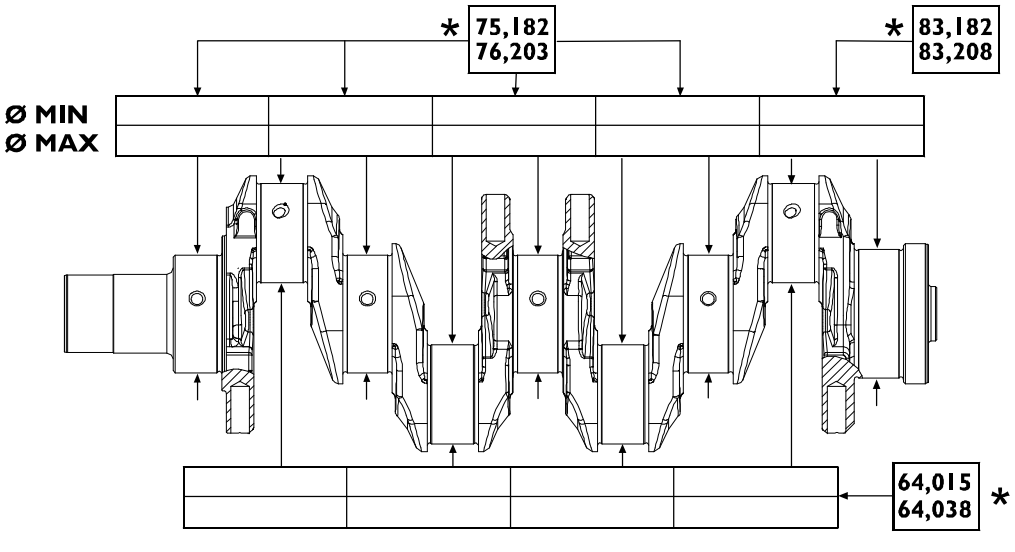
In case meshing, scratches or excessive oval shaping is detected on the main journals and crankshaft bearing pins, it is necessary to grind the pins. Before proceeding with pin (2) grinding, measure the shaft pins by means of a micrometer (1) in order to establish to which diameter the pins must be reduced.

NOTE Itis recommended to note down the values detected in a prospect.
See Figure 24.

Undersize classes are: 0.254 - 0.508 mm.

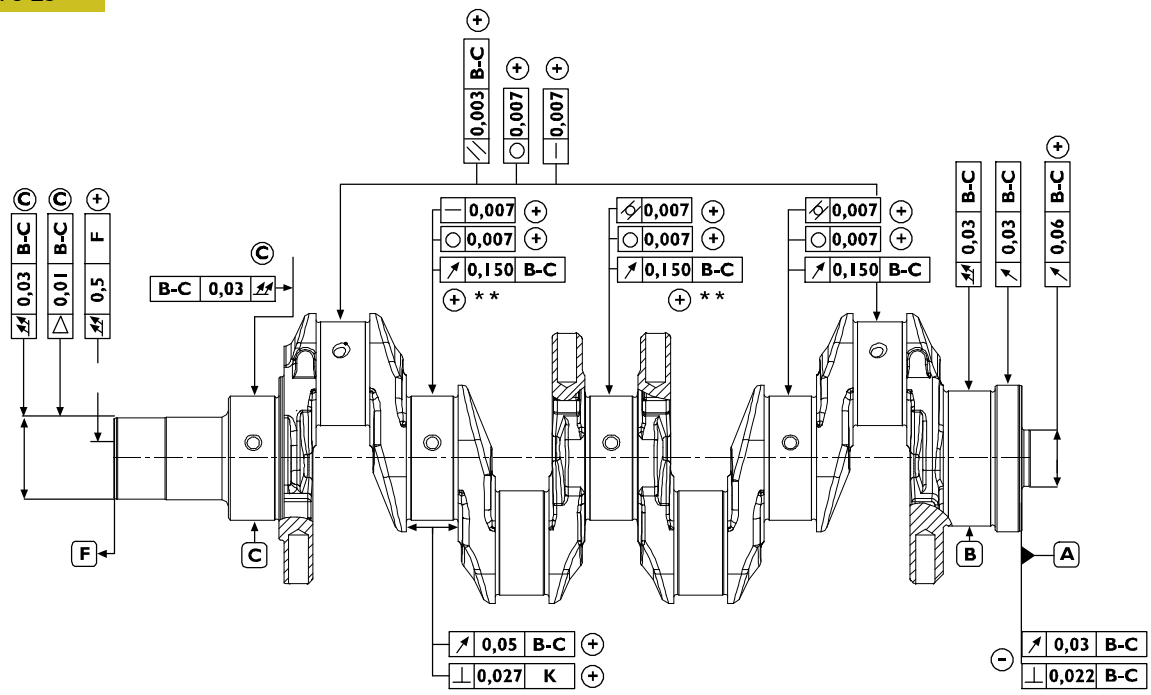
NOTE The main journals and crankshaft bearing pins must always be grinded to the same undersize classes in order not to alter the shaft's balance.

Figure 24



PROSPECT REPORTING MEASUREMENT VALUES OF
THE ENGINE DRIVE SHAFT MAIN JOURNALS AND CRANKSHAFT BEARING PINS
* Rated value

Figure 25

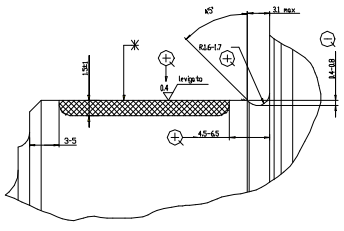


ENGINE DRIVE SHAFT MAIN TOLERANCES

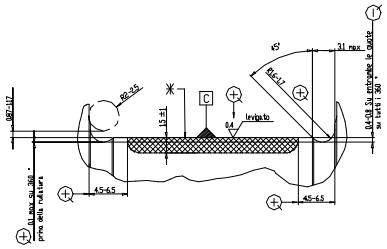
TOLERANCES	TOLERANCE CHARACTERISTIC	GRAPHIC SYMBOL
SHAPE	Roundness	○
	Cilindricity	/○/
DIRECTION	Parallelism	//
	Verticality	⊥
	Straightness	—
POSITION	Concentricity or coaxiality	⌾
OSCILLATION	Circular oscillation	↗
	Total oscillation	⌰

LEVELS OF IMPORTANCE FOR PRODUCT CHARACTERISTICS	GRAPHIC SYMBOL
CRITICAL	©
IMPORTANT	⊕
SECONDARY	⊖

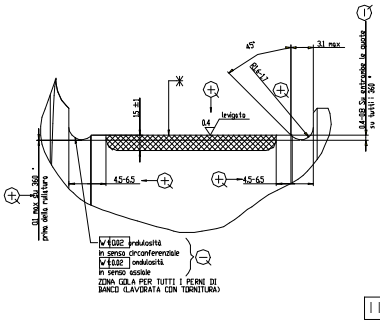
TIMING SIDE BENCH



INTERMEDIATE BENCHES

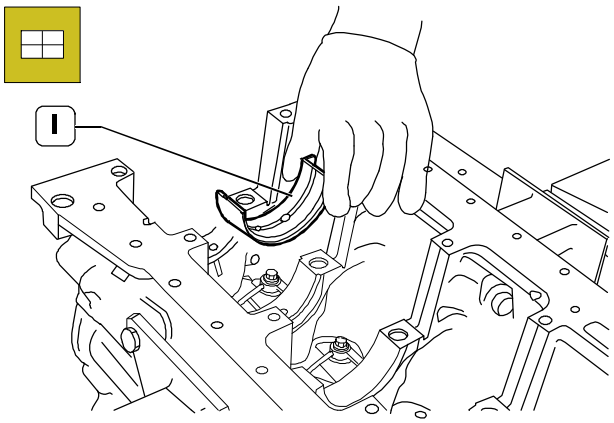


FIRST BENCH ON FRONT SIDE



Crankshaft bearing assembly

Figure 26



NOTE If it is not necessary to replace the crankshaft bearings, these shall be reassembled in the same order and position they were before disassembly.

The spare crankshaft bearings (1) have undersize internal diameter of 0.254 - 0.508 mm.

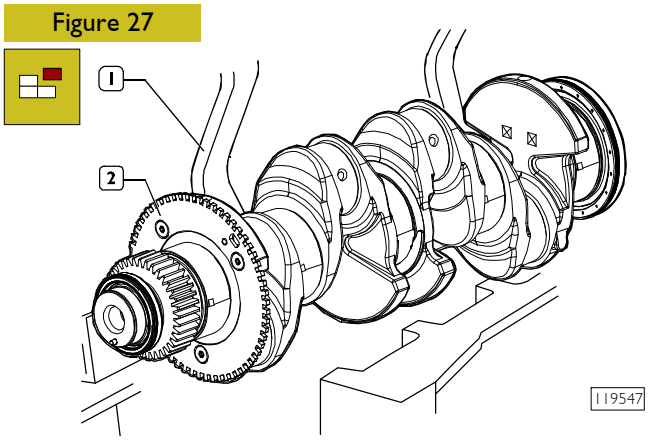
NOTE Do not try to adapt the bearings.

Carefully clean the crankshaft half bearings (1) having lubrication port and fit them in their respective seats.

The penultimate crankshaft half bearing (1) is provided with shoulder half rings.

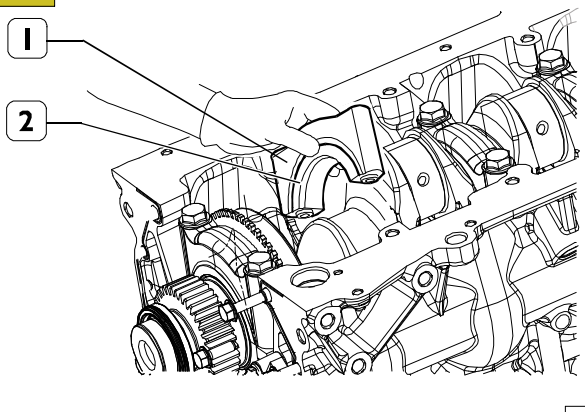
Crankshaft assembly

Figure 27



Assemble the engine drive shaft (2).

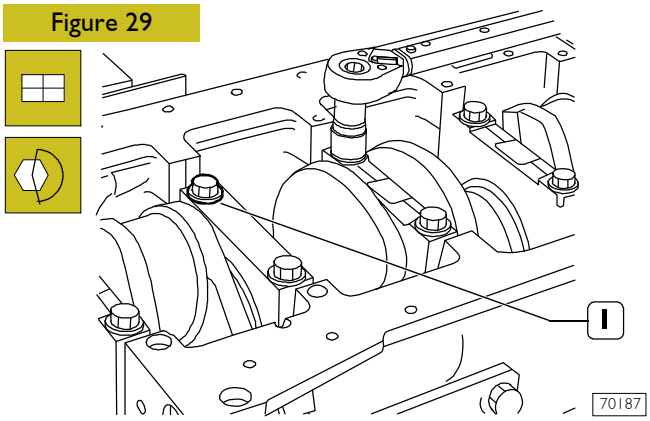
Figure 28



- ❑ carefully clean the parts and eliminate any oil residuals;
- ❑ ffit the caps (1) and the half bearings (2) on the relevant supports.

NOTE Always use new screws in phase of assembly.

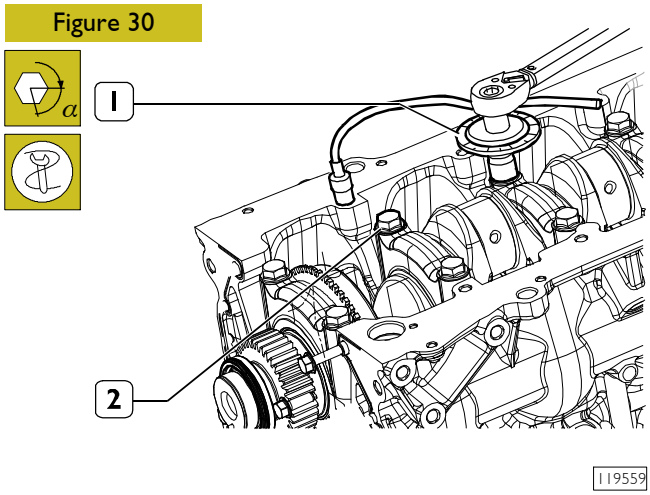
Figure 29



Tighten the pre-lubricated screws (1) and tighten them in three subsequent phases:

- ❑ 1st phase with torque wrench setting at 50 ± 2.5 Nm.
- ❑ 2nd with torque wrench setting at 80 ± 4 Nm.

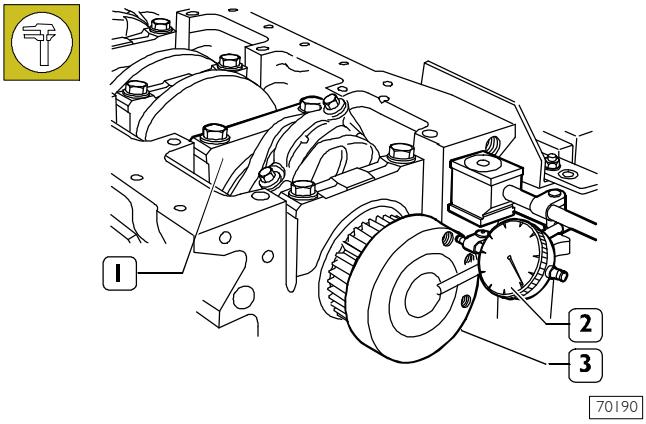
Figure 30



- ❑ 3rd phase using tool 99395216 (1) fitted as shown in the figure and further tighten the screws (2) by 90° angle.

Checking output shaft shoulder clearance

Figure 31

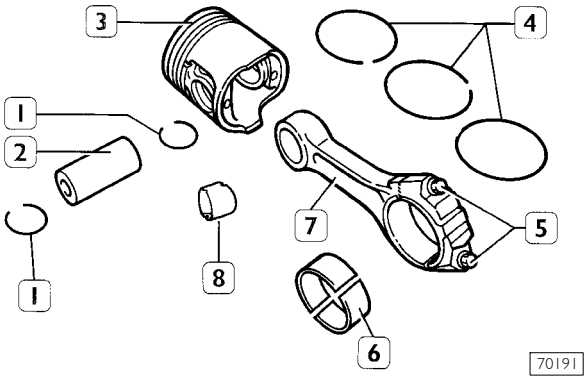


The check of the shoulder clearance is performed with a magnetic based comparator (2) placed on the engine shaft (3) as indicated in the figure.

If the clearance is above the one prescribed replace the semi-crankshaft bearings of the thrust hold rear support next to the last (1) and check again the clearance between the engine shaft pins and the semi-crankshaft bearings.

CONNECTING ROD – PISTON ASSEMBLY

Figure 32

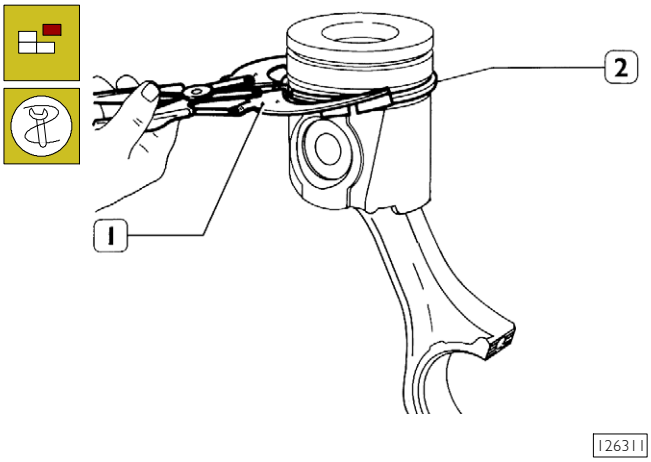


CONNECTING ROD-PISTON UNIT COMPONENTS

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

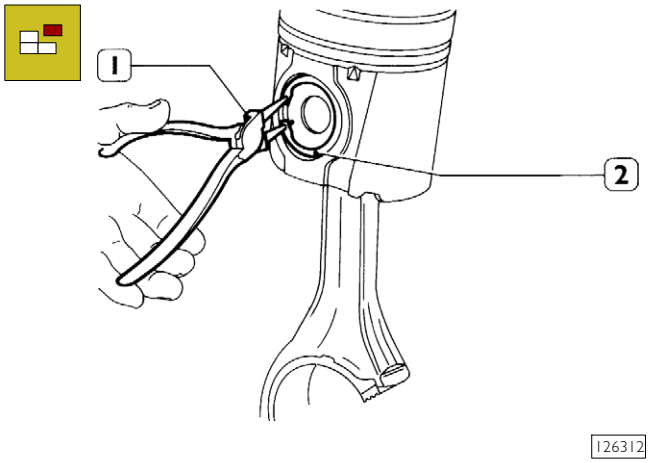
NOTE The spare pistons are supplied with standard dimensions or oversize by 0.4 mm.

Figure 33



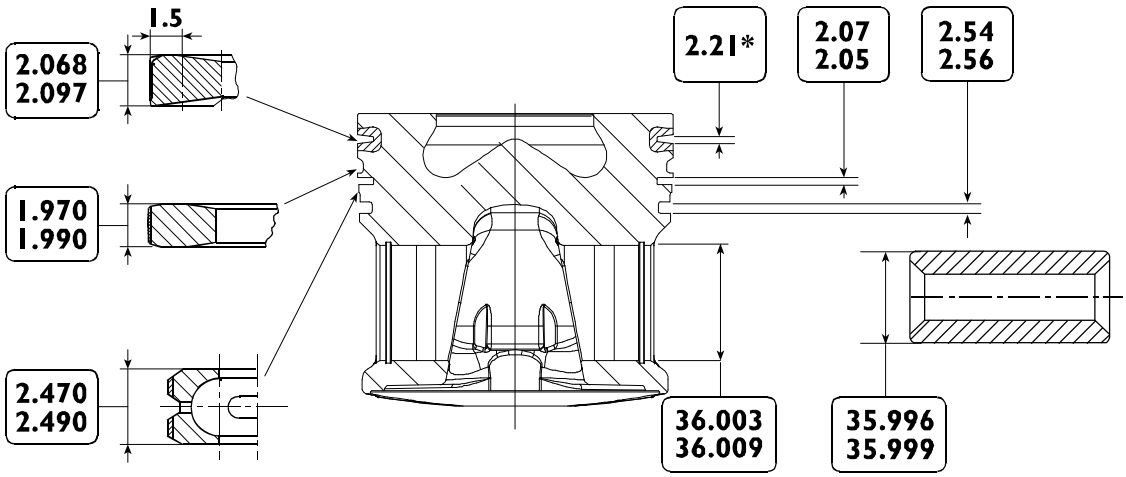
Using pincers 99360183 (1), remove the snap rings (2) from the piston.

Figure 34



Remove the piston pin (2) grommet using the round tippedpliers (1).

Figure 35

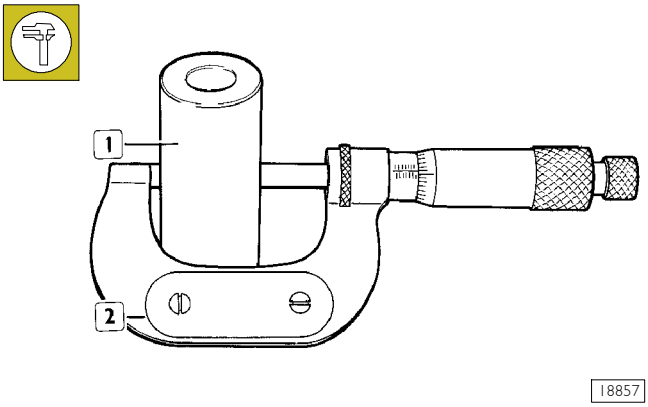


MAIN DATA OF THE PISTON, PINS AND SNAP RINGS

* Quota detected on Ø 96 mm.

Piston pins

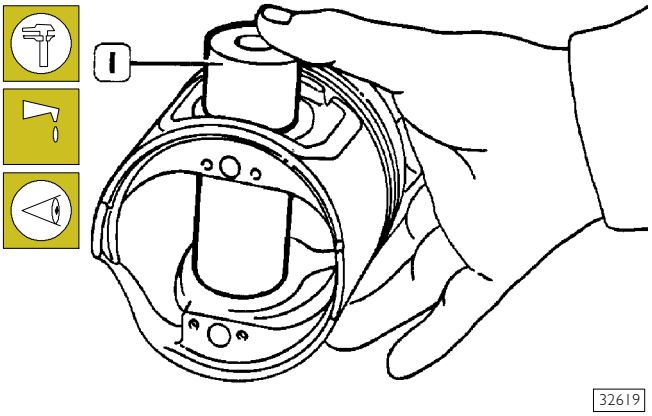
Figure 36



Measurement of the piston pin diameter (1) throughout a micrometer (2).

Conditions for the correct coupling of pins and pistons

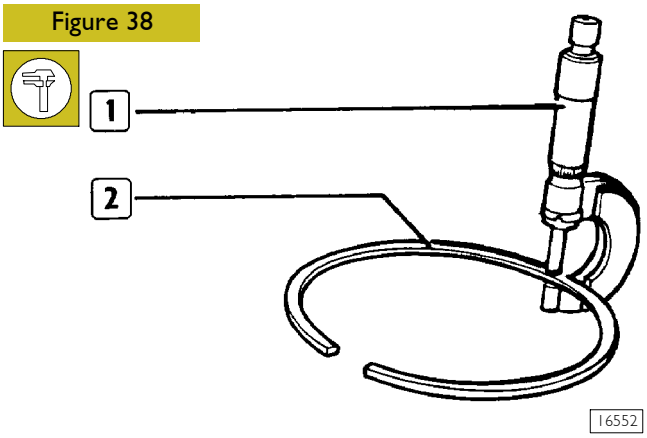
Figure 37



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

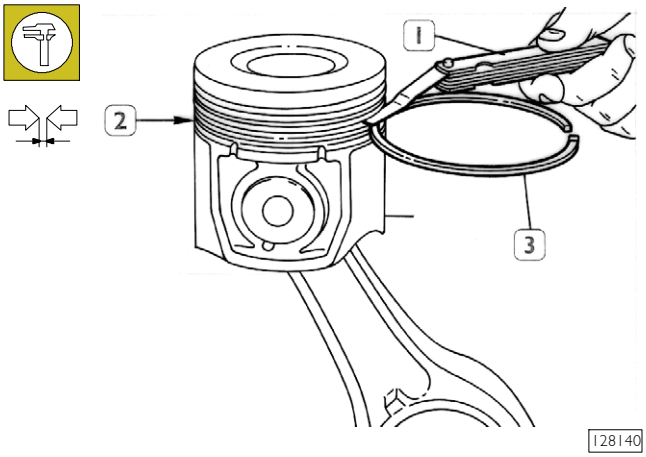
Split rings

Figure 38



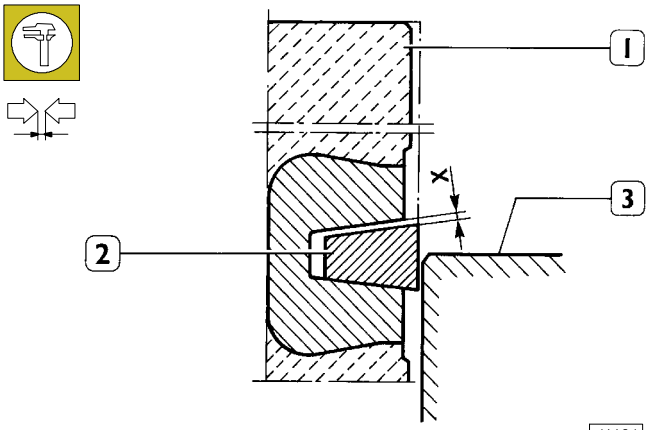
Check the thickness of the grommets (2) throughout a micrometer (1).

Figure 39



Check the slack between the grommets (3) of the 2nd and 3rd slots and relevant housing on the piston (2) using calliper and gauges (1).

Figure 40

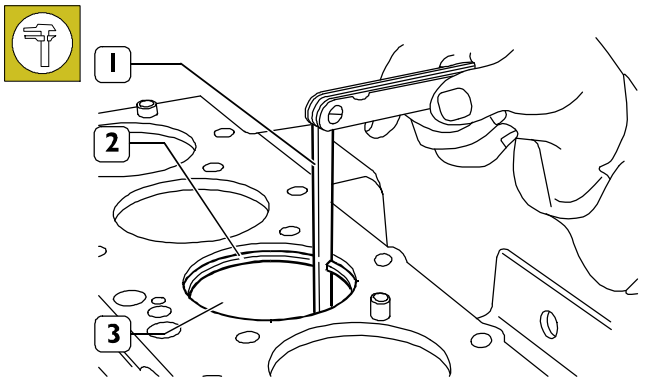


SCHEME FOR THE MEASUREMENT OF SLACK BETWEEN THE FIRST PISTON SLOT AND THE TRAPEZOIDAL GROMMET

Due to the particular for of the first grommet, having trapezoidal section, the slack between said grommet and the slot must be measured as follows: the piston (1) must be projected from the crankcase so that nearly half of the grommet (2) in question comes out of the cylinder barrel (3).

In this position, using a gauge calliper, measure the slack (X) between grommet and slot: the slack must comply with the prescribed value.

Figure 41



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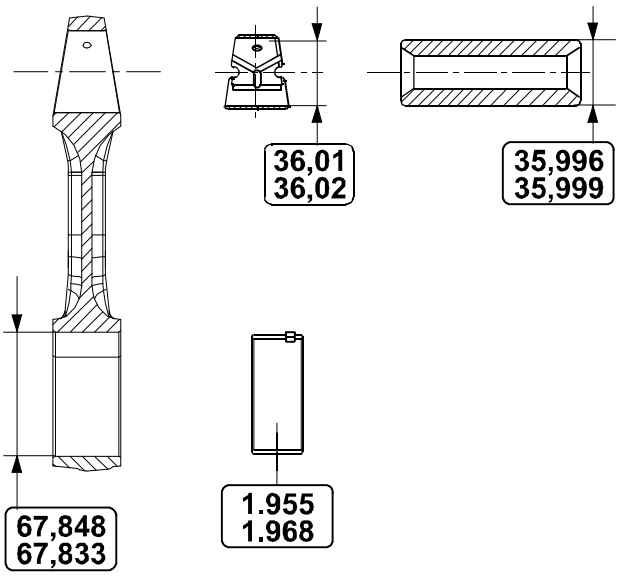
Measurement of slack between the snap ring ends (2) fitted into the cylinder barrel (3) throughout gauge calliper (1).

Connecting rods

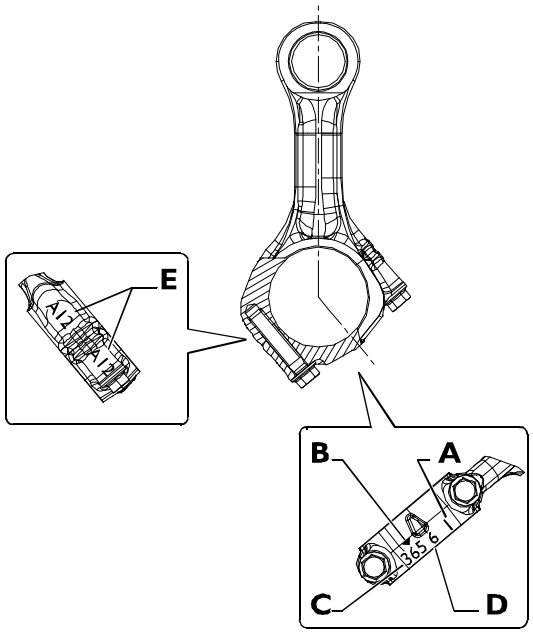
Figure 42



119562

NOTE The connecting rod-connecting rod cap surfaces are knurled to ensure better coupling. Therefore, it is recommended not to remove the knurling.

Figure 43



119563

A. Class of weight - B. Part number - C. Date of production (DD/MM) - D. Date of production (year) - E. Marking for connecting rod-cap coupling.

NOTE In phase of assembly, ensure that all the connecting rods belong to the same manufacturer and class of weight.

Bushes

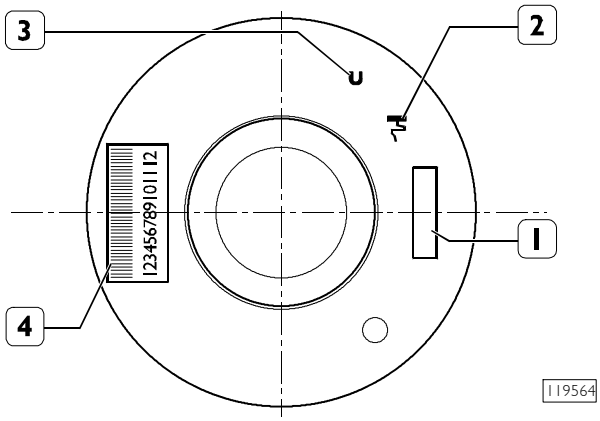
Check that the connecting rod shoe bush is not loose and that there is no trace of meshing or scratches otherwise replace it.

Disassembly and reassembly must be executed using a suitable beater.

When fixing it, make sure that the ports for oil passage on the bush and on the connecting rod coincide. Throughout a boring machine, bore the bush in order to obtain the prescribed diameter.

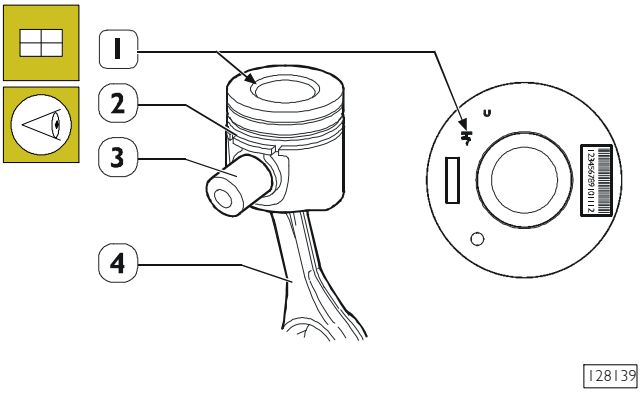
Connecting rod-piston unit assembly
Connecting rod-piston coupling

Figure 44



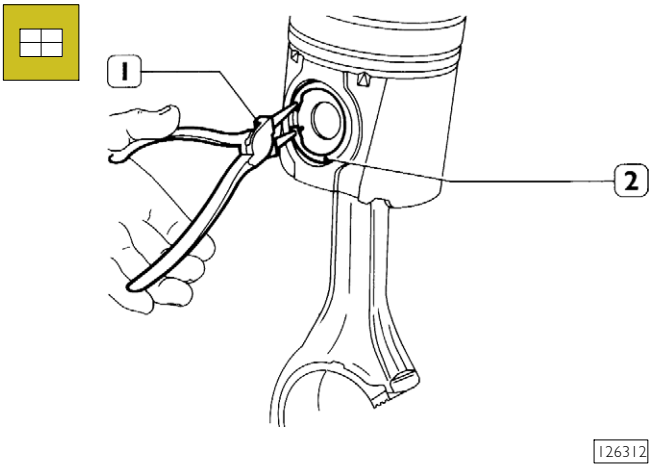
The following references are marked on the piston crown:
1. Spare part number and modification number;
2. Symbol indicating the installation mark for the piston inside the cylinder liner; it should be turned towards the flywheel side (the symbol (2) may be represented as illustrated in the figure or with an arrow, in accordance with production requirements);
3. Stamping proving 1st slot insert inspection;
4. Date of manufacture

Figure 45



Throughout the pin (3), connect the piston (2) to the connecting rod (4) following the indication of the reference arrow (1) to correctly fixing the piston (2) into the cylinder barrel, also taking into consideration the numbers (5) printed on the connecting rod (4), as shown in the figure.

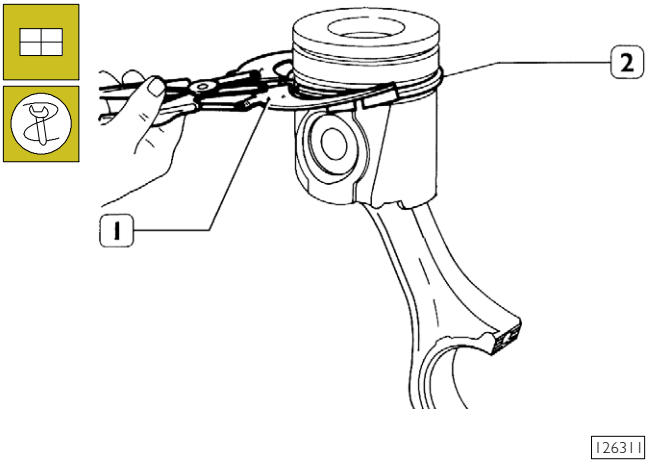
Figure 46



Fit the pin snap rings (2).

Snap ring assembly

Figure 47

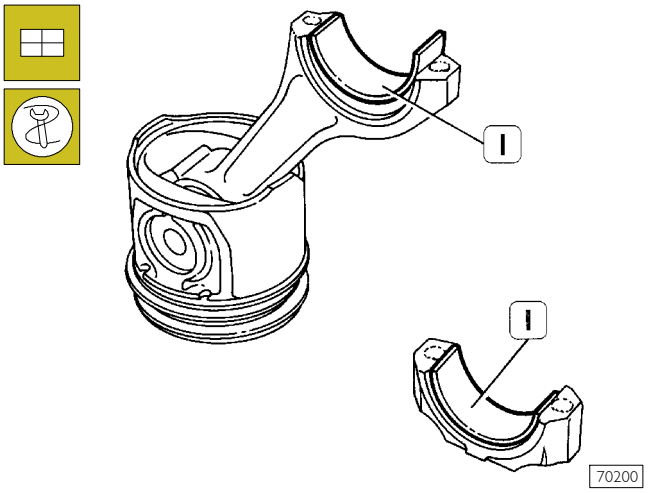


Use the pincers 99360183 (1) to fit the snap fasteners (2) to the piston.
The snap rings must be fitted with "TOP" marking upwards. Furthermore, ring opening must be misaligned by 120°.

NOTE The spare snap rings are available in the following sizes:

- standard;
- oversize by 0.4 mm.

Figure 48

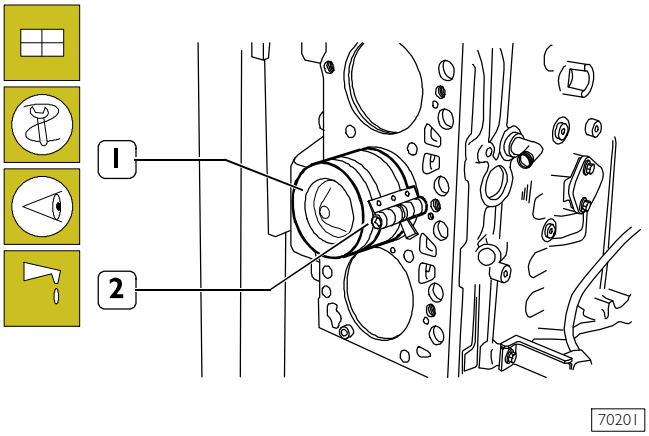


Fit the half bearings (1) on the connecting rod and cap.

NOTE If it is not necessary to replace the big end bearings, reassemble the existing ones in the same order and position they were before disassembly.
Do not adapt the half bearings.

Fitting connecting rod-piston assembly into cylinder barrels

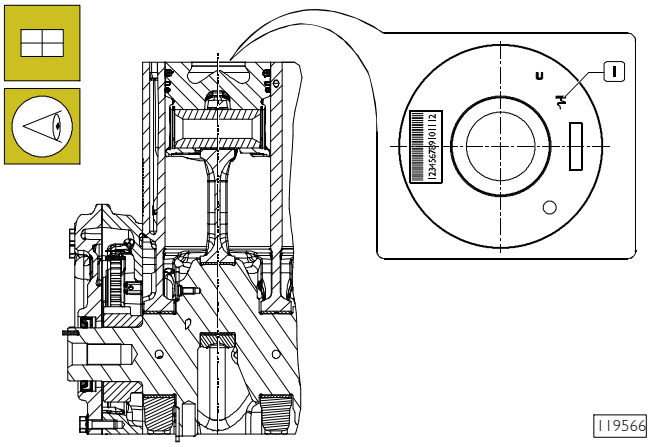
Figure 49



Lubricate the pistons, the snap pins and the cylinder barrel interior.
Using the band 99360605 (2), fit the connecting rod-piston unit (1) into the cylinder barrel, checking that :

- ❑ the number of each connecting rod corresponds to the coupling cap number.

Figure 50



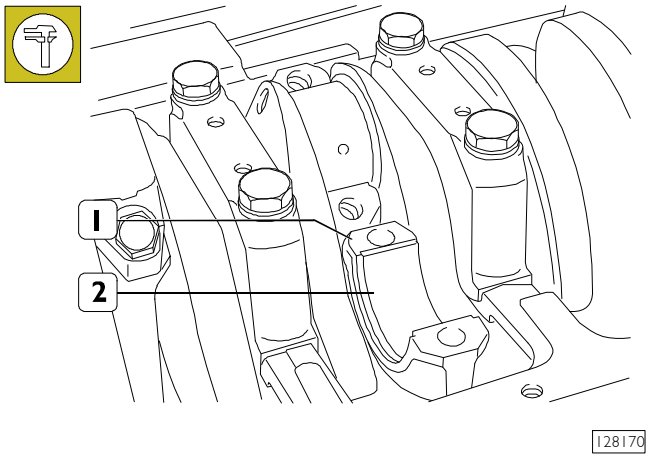
SCHEME FOR CORRECTLY FIXING THE CONNECTING ROD-PISTON UNIT INTO THE HOLLOW

- ❑ The snap rings' openings must be misaligned by 120°;
- ❑ all the connecting rod/piston units must have the same weight;
- ❑ the engine drive shaft sign (1) printed on the piston crown must be turned towards the flywheel while the notch on the piston shield must match the oil nozzles' position.

The connecting rod must not collide with the cylinder wall.

Connecting rod caps fitting

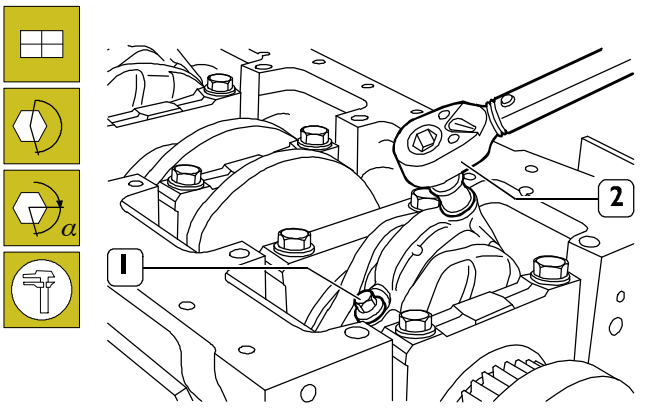
Figure 51



- ❑ carefully clean the parts eliminating any oil residuals;
- ❑ fit the connecting rod caps (1) and the relevant half bearings (2).

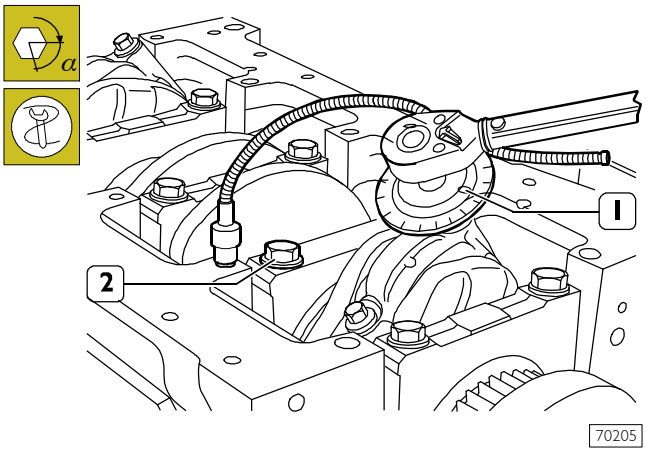
NOTE Always use new screws in phase of assembly.

Figure 52



❑ lubricate the fastening screws (1) with engine oil and tighten them to the prescribed torque setting (50 ± 2.5 Nm) using a torque wrench.

Figure 53



❑ fit the tool 99395216 (1) to the socket wrench and then further tighten the screws (2) by 70°.

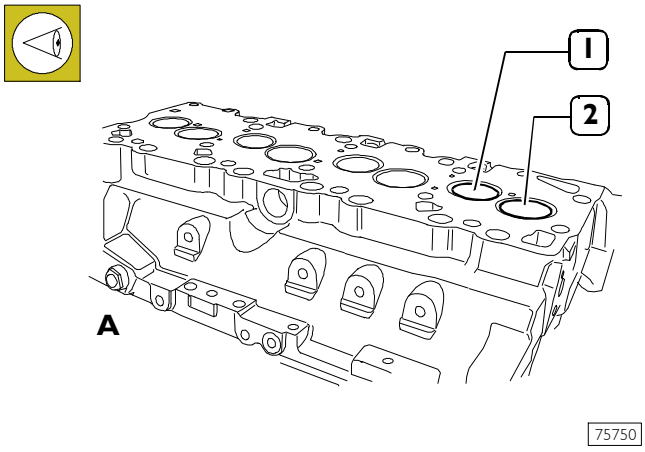
Check manually that the connecting rods are slidingaxially on the output shaft pins.

Piston projection check

NOTE See page 21 of Section 3.

CYLINDER HEAD
Valve disassembly

Figure 54

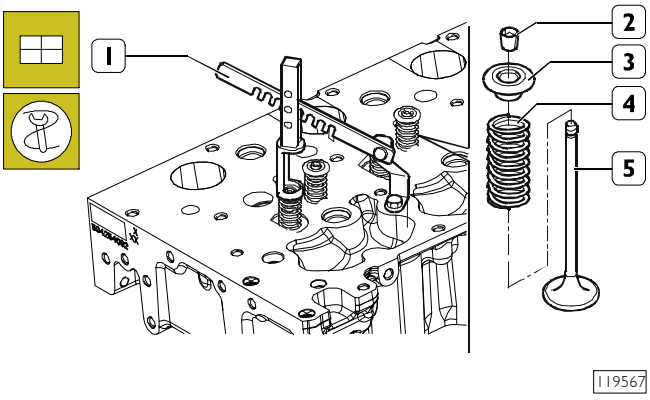


The intake valves (1) and exhaust valves (2) have different head diameter.

NOTE Number the valves before removing them from the cylinder head in order to be able to reassemble them in the same order in case replacement is not necessary.

A = intake side

Figure 55

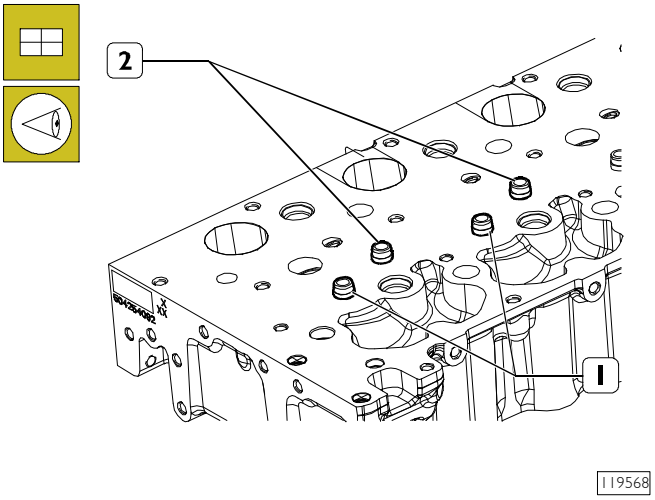


Valve disassembly must be executed using tool 99360268 (1) to slightly press the plate (3) so that, compressing the spring (4), it is possible to remove the half cone (2). Then remove the plate (3) and the spring (4).

Repeat the operation in correspondence of each valve.

Turn the cylinder head upside down and withdraw the valves (5).

Figure 56



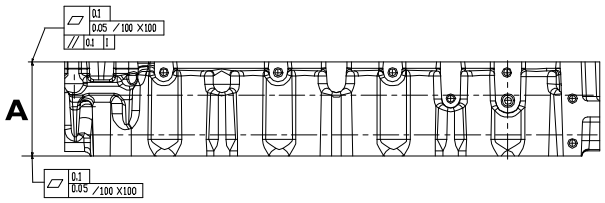
Remove the grommets (1 and 2) from their valve guides.

Cylinder head base surface check

Any deformation detected on the whole length of the cylinder head must not exceed 0.20 mm.

In case higher value is detected, grind the cylinder head in order to obtain the prescribed value. Refer to the main specifications reported here following and follow the instructions accompanying the figures below.

Figure 57

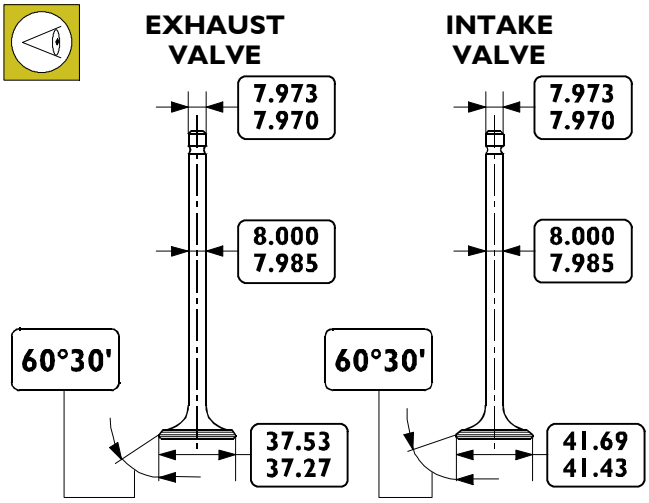


119591

A rated thickness of the cylinder head is 90 ± 0.1 mm.

VALVES

Figure 58

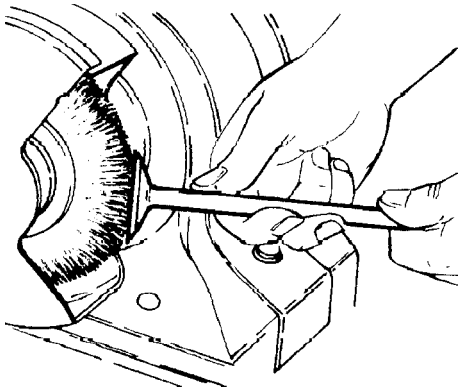


119569

INTAKE AND EXHAUST VALVE MAIN DATA

Valve scaling, checking and grinding

Figure 59



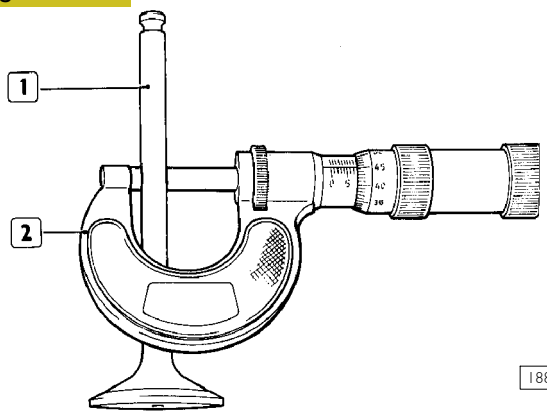
18625

Eliminate carbon deposits from the valves using the specially provided metal brush.

Check the valves for meshing, cracks or burns.

If necessary, grind the valve seats removing as less material as possible.

Figure 60

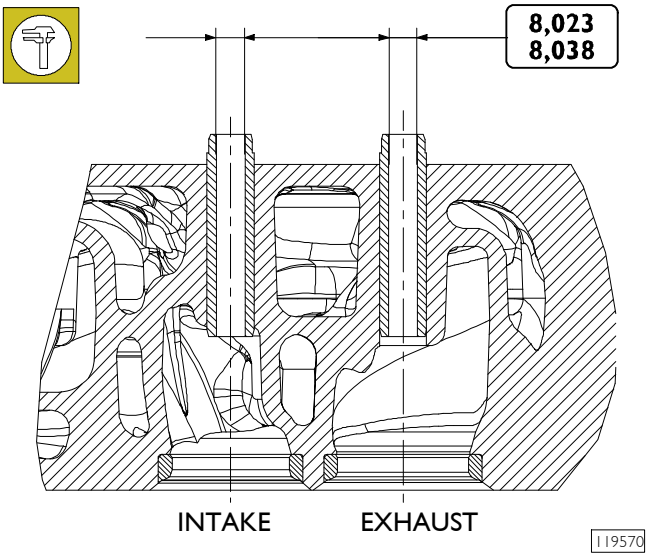


18882

Using a micrometer (2) measure the valve stem (1): the prescribed value is 7.985 to 8.000 mm.

VALVE GUIDE

Figure 61



Using a bore meter, measure the valve guide inner diameters, which must correspond to the values reported in the figure below.

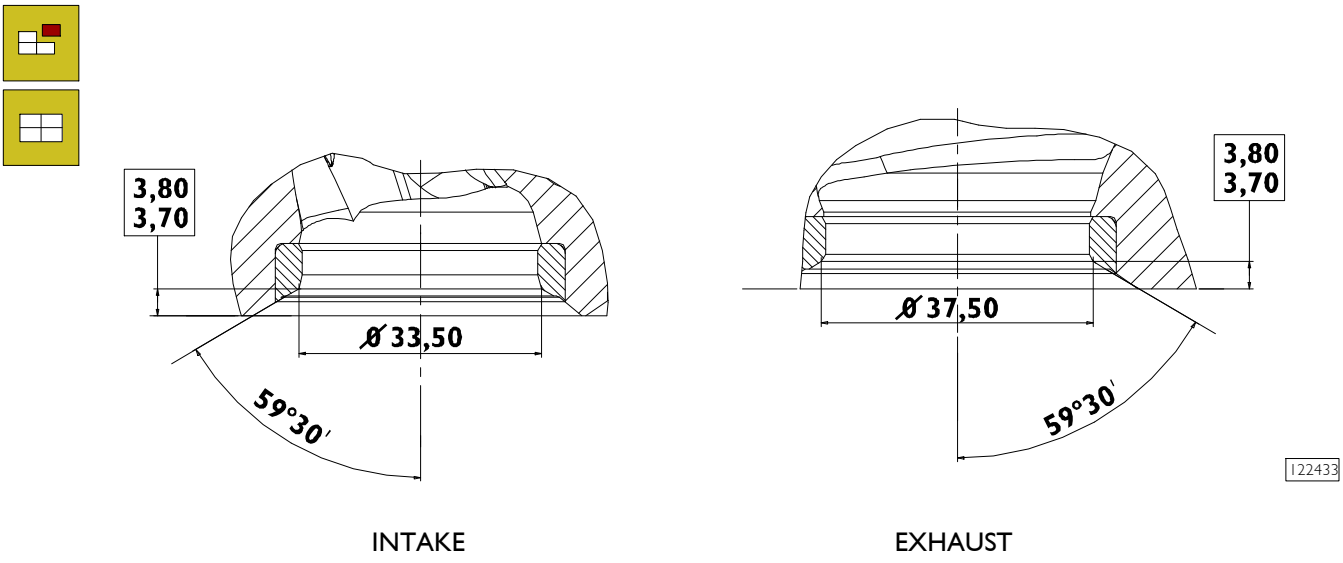
Valve guide replacement

Valve guide assembly and disassembly is performed with beater 99360288.

Insert the valve guide in the cylinder head so that they stick out from it for 8.1 ÷ 8.9 mm.

VALVE SEATS

Figure 62



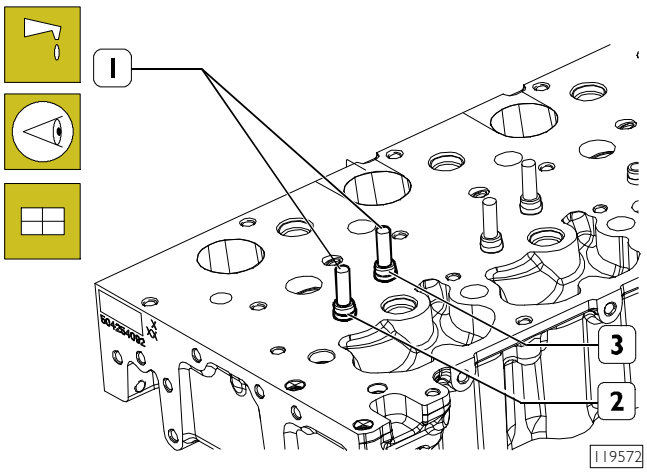
VALVE SEAT SPECIFICATIONS

If the valve seat are damaged replace them with the spare ones included in the supply. With the tools and being careful not to indent the cylinder heads, remove as much material as possible form the valve seats until removal from cylinder head is possible by means of a punch.

Heat cylinder head up to 80° ÷ 100°C and with the beater assemble the new valve seats previously cooled in them.

CYLINDER HEAD ASSEMBLY

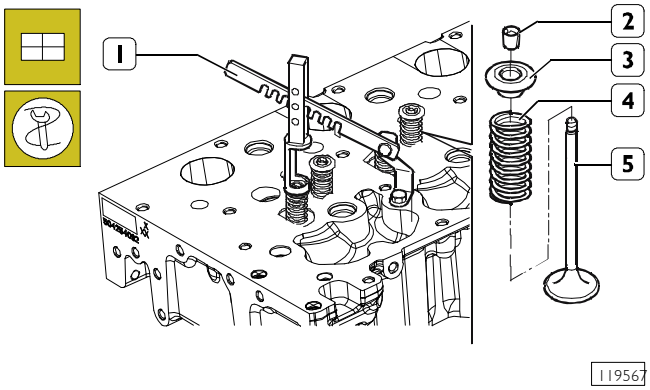
Figure 63



Lubricate the valve stems (1) and fit them in the relevant valve guides in the same position they were before disassembly.

Fit the grommets (2 and 3) to the valve guide using tool 99360292.

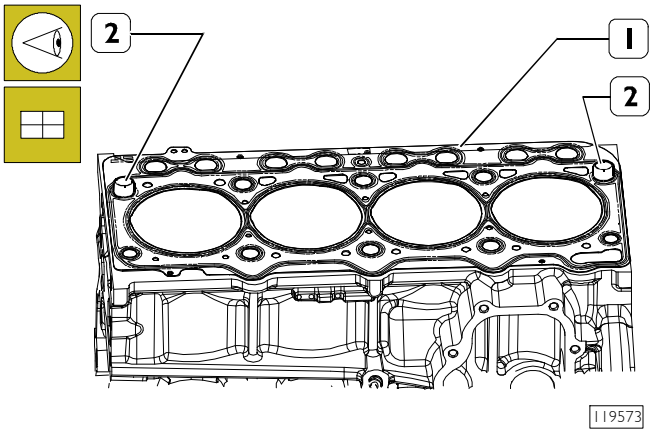
Figure 64



Place the spring (4) and the upper plate (3) on the cylinder head. Using tool 99360268 (1), compress the spring (4) and constrain the parts to the valve (5) throughout the half cones (2).

Cylinder head reassembly

Figure 65



Check that the cylinder head and crankshaft coupling surfaces are clean.
Do not foul the cylinder head gasket.
Fit the gasket (1) on the crankshaft in the correct centred position, taking the pins as reference (2).

TORQUE SETTING

PART			TORQUE	
				kgm
	Motor vent cover fastening	(M6x1 6g x 18)	10 ± 1	1 ± 0.1
Oil Pan Unit	Threaded cap with O-ring		50 ± 5	5 ± 0.5
	Oil pan spacer fastening	(M8x1.25 6g x 35)	25 ± 2.5	2.5 ± 0.25
Engine bock	Crankshaft caps - pre-tightening - tightening - angle tightening		50 ± 2.5 80 ± 4 80° 90°	5 ± 0.25 8 ± 0.4
	Piston cooling nozzle		18 ± 1.8	1,8 ± 0.18
	3/8" conical threaded cap		40 ± 4	4 ± 0.5
	1/8" conical threaded cap		15 ± 1.5	0.7 ± 0.15
	Water drainage cap		25 ± 2.5	2.5 ± 0.25
	Oil turbo delivery pipe fixing		40 ± 4	4 ± 0.4
Timing gearcase	Conical threaded cap		15 ± 1.5	0.7 ± 0.15
	Gear cooling nozze		15 ± 1.5	0.7 ± 0.15
	Cover fastening	(M8x1.25 6g x 25)	25 ± 2.5	2.5 ± 0.25
	Cover fastening	(M8x1.25 6g x 35)	25 ± 2.5	2.5 ± 0.25
	Cover fastening	(M8x1.25 6g x 16.5)	25 ± 2.5	2.5 ± 0.25
	Gearcase fastening	(M8x1.25 6g x 22.5)	25 ± 2.5	2.5 ± 0.25
	Gearcase fastening	(M8x1.25 6g x 25)	25 ± 2.5	2.5 ± 0.25
	Gearcase fastening	(M8x1.25 6g x 35)	25 ± 2.5	2.5 ± 0.25
	Gearcase fastening	(M8x1.25 6g x 50)	25 ± 2.5	2.5 ± 0.25
Flywheel case	Case fastening	(M8x1.25 6g x 25)	35 ± 3.5	2.5 ± 0.25
	Case fastening	(M12x 1.75 6g x 30)	110 ± 11	11 ± 1.1
	Case fastening	(M12x 1.75 6g x 40)	110 ± 11	11 ± 1.1
	Case fastening	(M12x 1.75 6g x 50)	110 ± 11	11 ± 1.1
	Plate fastening		25 ± 2.5	2.5 ± 0.25
Cylinder head	Cylinder head fastening First phase Second phase Third phase	(M15x 1.5 6g x 193)	130 ± 6.5 90° 70°	13 ± 0.65
	Cylinder head fastening First phase Second phase Third phase	(M12x 1.5 6g x 165)	65 ± 3.25 90° 60°	6 ± 0.325
	Exhaust manifold stud bolt		20 ± 2	2 ± 0.2
Overhead	Rocker arm dowel		25 ± 2.5	2.5 ± 0.25
	Overhead fastening	(M8x1.25 6g x 30)	27 ± 2.7	2.7 ± 0.27
	Overhead fastening	(M8x1.25 6g x 50)	27 ± 2.7	2.7 ± 0.27
	Threaded cap		20 ± 2	2 ± 0.2
	Valve adjusting nut		20 ± 2	2.5 ± 0.25
	Inspection cover fastening		25 ± 2.5	2.5 ± 0.25

PART			TORQUE	
Intake manifold	Intake manifold fastening	(M8x1 .25 6g x 60)	32 ± 3.2	3.2 ± 0.32
	Intake manifold fastening	(M8x1.25 6g x 55)	32 ± 3.2	3.2 ± 0.32
	Throw fastening to intake manifold		27 ± 2.7	2.7 ± 0.27
Exhaust manifol	Exhaust manifold fastening		30 ± 3	3.0 ± 0.3
	Turbo-blower stud screw		18 ± 1.8	1.8 ± 0.18
	Engine drive shaft pulley fastening		350 ± 17.5	35 ± 1.75
Connecting rod	Connecting rod cap fastening - pre-tightening - angle tightening		50 ± 2.5	5 ± 0.25 70°
	Phonic wheel fixing		15 ± 1.5	1.5 ± 0.15
Flywheel	Flywheel fastening - pre-tightening - angle tightening		30 ± 1.5	3 ± 0.15 90°
Timing	Thrust block fastening		25 ± 2.5	2.5 ± 0.25
	Gear fastening		36 ± 3.6	3.6 ± 0.36
Injectors	Injector stud screw fastening		20 ± 2	2 ± 0.2
	Injector fastening nut - tightening		28 ± 2.8	2.8 ± 0.28
	Engine cable fastening		25 ± 2.5	2.5 ± 0.25
Fuel filter	Union fixing to support		28 ± 2.8	2.8 ± 0.28
	Fuel filter fastening		25 ± 2.5	2.5 ± 0.25
Supply pump	Supply pump fastening		25 ± 2.5	2.5 ± 0.25
	Inlet		25 ± 2.5	2.5 ± 0.25
	Fast clutch		25 ± 2.5	2.5 ± 0.25
Injector scar	Injector fastening		6 ± 0.6	0.6 ± 0.06
	Pump fastening		25 ± 2.5	2.5 ± 0.25
Turbo blower	Collector fastening screw nuts		28 ± 2.8	2.8 ± 0.28
	Oil delivery inlet fixing		25 ± 2.5	2.5 ± 0.25
	Delivery pipe fastening screw nut		28 ± 2.8	2.8 ± 0.28
	Exhaust pipe fixing to heat exchanger		25 ± 2.5	2.5 ± 0.25
	Exhaust pipe fixing to turbo		15 ± 1.5	1.5 ± 0.15
Cooling pipe	Water pipe fixing to the heat exchanger		25 ± 2.5	2.5 ± 0.25
	Water pipe fixing to the support		25 ± 2.5	2.5 ± 0.25
External EGR	Hear exchanger to valve body fixing		25 ± 2.5	2.5 ± 0.25
	Heat exchanger to elbow fixing		25 ± 2.5	2.5 ± 0.25
	EGR fastening to intake manifold		25 ± 2.5	2.5 ± 0.25
	Valves to body fixing		10 ± 1	1 ± 0.1
	Fixing to manifold		25 ± 2.5	2.5 ± 0.25
	Threaded union		75 ± 7.5	7.5 ± 0.75

PART			TORQUE	
				kgm
Oil level check	Oil pressure control valve fastening		28 ± 2.8	2.8 ± 0.28
	Oil level dipstick fastening		35 ± 3.5	3.5 ± 0.35
Suction rose	Flange fastening to block		10 ± 1	1 ± 0.1
	Stirrup fastening to block		25 ± 2.5	2.5 ± 0.25
Oil filter body	Cartridge union		45 ± 4.5	4.5 ± 0.45
	Oil filter fastening		25 ± 2.5	2.5 ± 0.25
	Oil filter cartridge fastening		30 ± 3	3 ± 0.3
	Oil pump fixing - pre-tightening - tightening		 15 ± 1.5 35 ± 3.5	 1.5 ± 0.15 3.5 ± 0.35
Heat exchanger	Threaded caps		45 ± 4.5	4.5 ± 0.45
	Exchanger unit fixing		25 ± 2.5	2.5 ± 0.25
	Heat exchanger fastening		25 ± 2.5	2.5 ± 0.25
Temperature regulator	Thermostat unit fixing		25 ± 2.5	2.5 ± 0.25
	Bleed vent fixing		40 ± 4	4 ± 0.4
	Water pump fastening		25 ± 2.5	2.5 ± 0.25
Fan support	Bearing fixing		40 ± 4	4.0 ± 0.4
	Fan support fixing		25 ± 2.5	2.5 ± 0.4
	Pulley fixing		40 ± 4	4.0 ± 0.4
	Control outlet rear cover fastening		25 ± 2.5	2.5 ± 0.25
Alternator group	Support fastening to block	(M10x1.5 6g x 50-60)	50 ± 5	5 ± 0.5
	Alternator fastening (screw + nut)		50 ± 5	5 ± 0.5
	Push rod fixing		50 ± 5	5 ± 0.5
	Alternator push rod fixing (screw + nut)		50 ± 5	5 ± 0.5
	Support fastening to block	(M10x1.5 6g x 35)	50 ± 5	5 ± 0.5
Manoeuvre hook	Front hook fastening		50 ± 5	5 ± 0.5
	Rear hook fastening		70 ± 7	7 ± 0.7
LDA	Manifold side pipe fastening		15 ± 1.5	1.5 ± 0.15
	Pump side pipe fastening		15 ± 1.5	1.5 ± 0.15

PART		TORQUE	
			kgm
Sensors F5CE0455/0485	Time impulse transmitter fastening	10 ± 1	1 ± 0.1
	Oil pressure sensor fastening	28 ± 2.8	2.8 ± 0.28
	Thermometric switch fastening	36 ± 3.6	3.6 ± 0.36
	Water temperature sensor fastening	45 ± 4.5	4.5 ± 0.45
	Conical threaded cap	45 ± 4.5	4.5 ± 0.45
	Support fastening	45 ± 4.5	4.5 ± 0.45
	Air pressure sensor fastening	25 ± 2.5	2.5 ± 0.25
Injection pump	Gear to pump retaining nut - pre serraggio - pre-tightening	 18 ± 1.8 90 ± 9	 1.8 ± 0.18 9 ± 0.9
	Stud bolt for injection pump	10 ± 1	1 ± 0.1
	Fuel pump retaining nut	25 ± 2.5	2.5 ± 0.25
High pressure	Fastening to pump and injector	10 ± 1	1 ± 0.1
	Pipe fastening screws	10 ± 1	1 ± 0.1