CURSOR
EURO 4 ENGINES

Vehicle application

C78

C78 ENT C

C10

C10 ENT C

C13

C13 ENT C

Technical and Repair manual

This publication describes the characteristics, data and correct methods for repair operations on each component of the vehicle.

If the instructions provided are followed and the specified equipment is used, correct repair operations in the programmed time will be ensured, safeguarding against possible accidents.

Before starting to perform whatever type of repair, ensure that all accident prevention equipment is available and efficient.

All protections specified by safety regulations, i.e.: goggles, helmet, gloves, boot, etc. must be checked and worn.

All machining, lifting and conveying equipment should be inspected before use.

The data contained in this publication was correct at the time of going to press but due to possible modifications made by the Manufacturer for reasons of a technical or commercial nature or for adaptation to the legal requirements of the different countries, some changes may have occurred.

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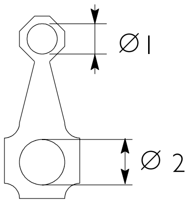
CURSOR EURO 4 ENGINES

SPECIAL REMARKS

The subjects usually dealt with in each section are:
Technical data table, Driving torques, Equipment, Diagnostic, Removal and Fitting in place, Repair operations.
Where possible, the same sequence of procedures has been followed for easy reference.
Diagrams and symbols have been widely used to give a clearer and more immediate illustration of the subject being dealt with, (see next page) instead of giving descriptions of some operations or procedures.

Example



∅ 1 = housing for connecting rod small end bush

∅ 2 = housing for connecting rod bearings

Tighten to torque
Tighten to torque + angular value

Graph and symbols

	Removal Disconnection
	Refitting Connection
	Removal Disassembly
	Fitting in place Assembly
	Tighten to torque
	Tighten to torque + angle value
	Press or caulk
	Regulation Adjustment
⚠	Warning Note
	Visual inspection Fitting position check
	Measurement Value to find Check
	Equipment
	Surface for machining Machine finish
	Interference Strained assembly
	Thickness Clearance
	Lubrication Damp Grease
	Sealant Adhesive
	Air bleeding

	Intake
	Exhaust
	Operation
ϱ	Compression ratio
	Tolerance Weight difference
	Rolling torque
IVECO PARTS	Replacement Original spare parts
	Rotation
	Angle Angular value
	Preload
	Number of revolutions
	Temperature
bar	Pressure
>	Oversized Higher than.... Maximum, peak
<	Undersized Less than.... Minimum
	Selection Classes Oversizing
	Temperature < 0 °C Cold Winter
	Temperature > 0 °C Hot Summer

Part 1
F2B CURSOR EURO 4 ENGINES

PREFACE TO USER'S GUIDELINE MANUAL

Section 1 describes the F2B engine illustrating its features and working in general.

Section 2 describes the type of fuel feed.

Section 3 relates to the specific duty and is divided in four separate parts:

1. Mechanical part, related to the engine overhaul, limited to those components with different characteristics based on the relating specific duty.
2. Electrical part, concerning wiring harness, electrical and electronic equipment with different characteristics based on the relating specific duty.
3. Maintenance planning and specific overhaul.
4. Troubleshooting part dedicated to the operators who, being entitled to provide technical assistance, shall have simple and direct instructions to identify the cause of the major inconveniences.

Sections 4 and 5 illustrate the overhaul operations of the engine overhaul on stand and the necessary equipment to execute such operations.
The appendix reports general safety prescriptions to be followed by all operators whether being in-charge of installation or maintenance, in order to avoid serious injury.

UPDATING

Section	Description	Page	Date of revision

SECTION 1

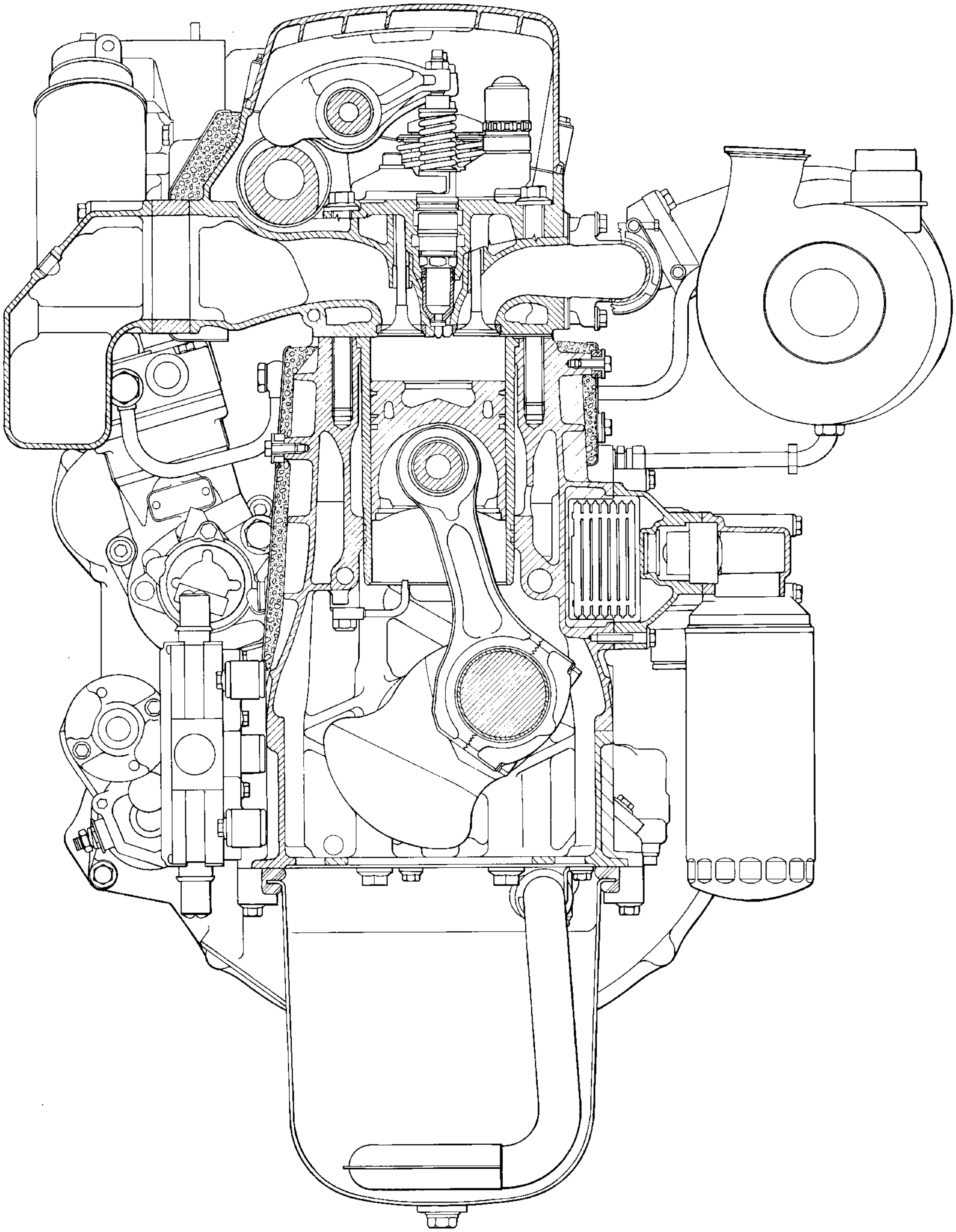
General specifications

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F2BE3681C	C78 ENT C
F2BE3681B	C78 ENT C
F2BE3681A	C78 ENT C

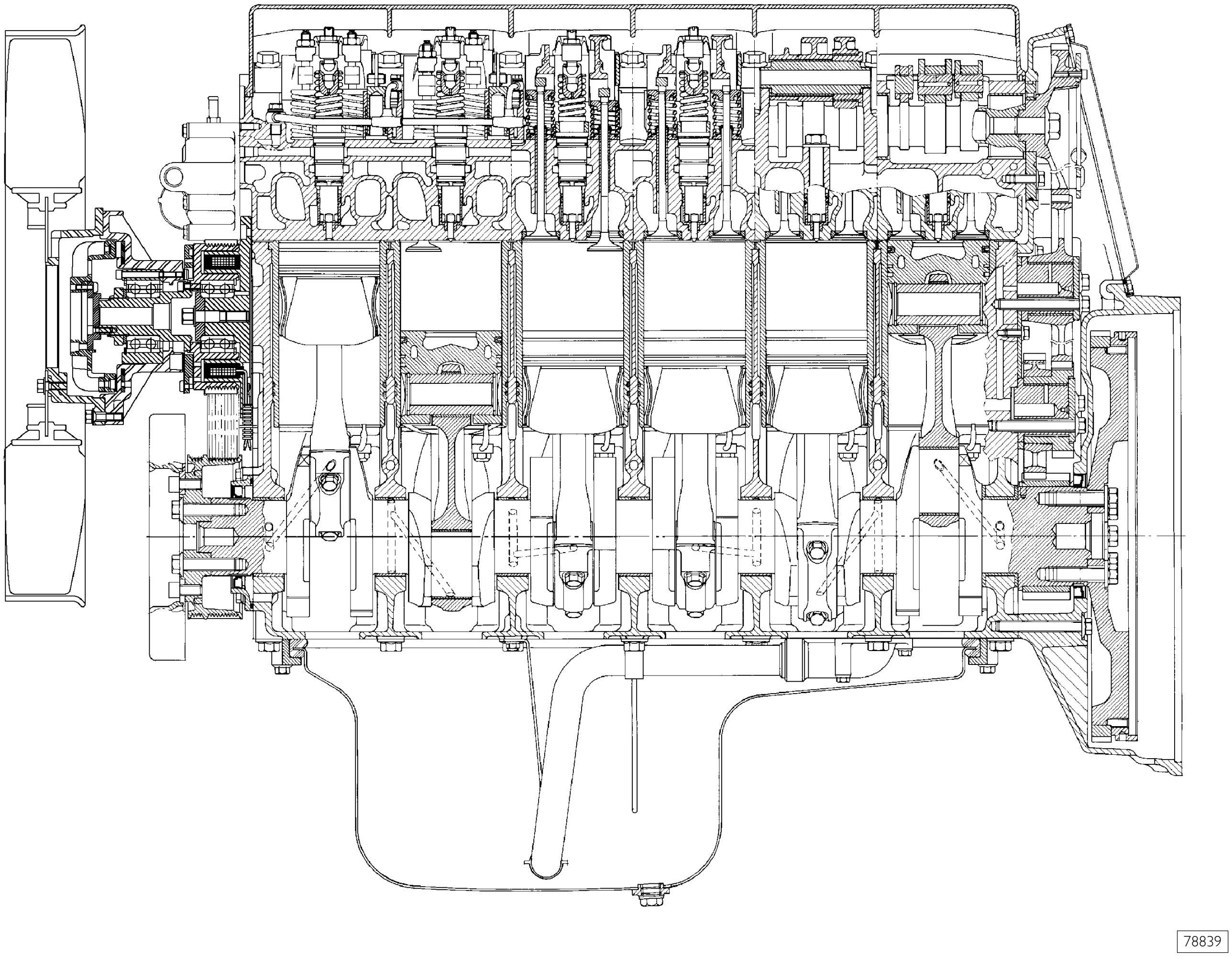
ENGINE SECTIONS

Figure 1



ENGINE - CROSS SECTION

Figure 2

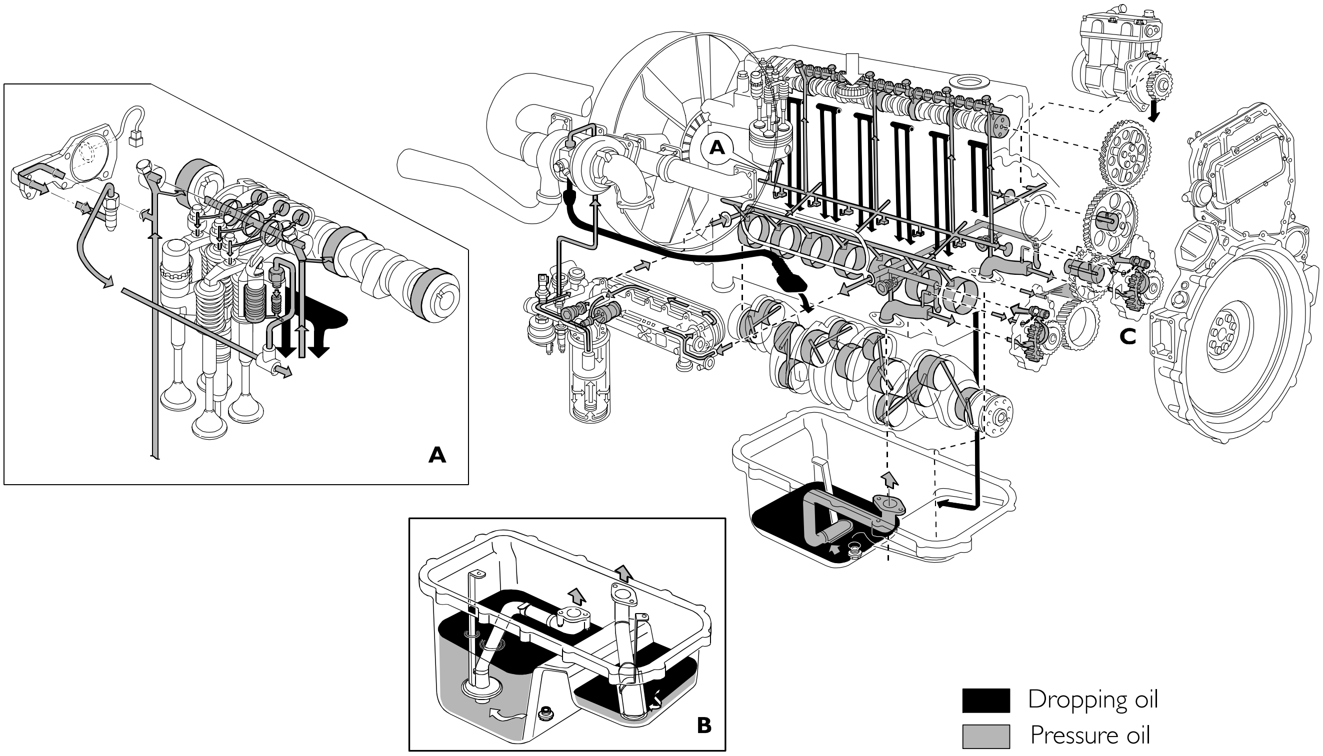


ENGINE - LONGITUDINAL SECTION

LUBRICATION

Engine lubrication is obtained with a gear pump driven by the crankshaft via gears.
A heat exchanger governs the temperature of the lubricating oil.
The oil filter, signalling sensors and safety valves are installed in the intercooler.

Figure 3



B. Engine oil sump (auxiliary oil pump version)

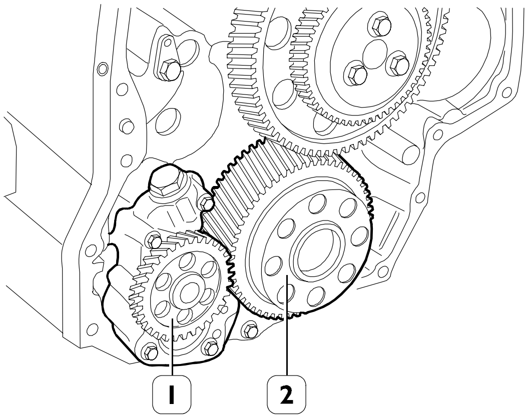
C. Auxiliary oil pump

86930

LUBRICATION CIRCUIT

Oil pump

Figure 4



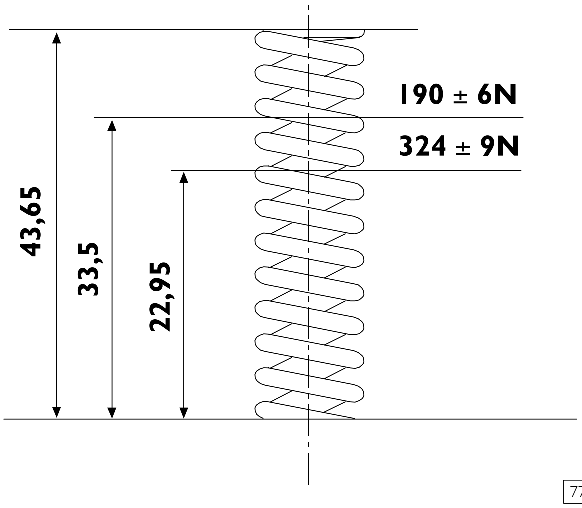
60560

The oil pump (1) cannot be overhauled. On finding any damage, replace the oil pump assembly.

See under the relevant heading for replacing the gear (2) of the crankshaft.

Overpressure valve

Figure 6



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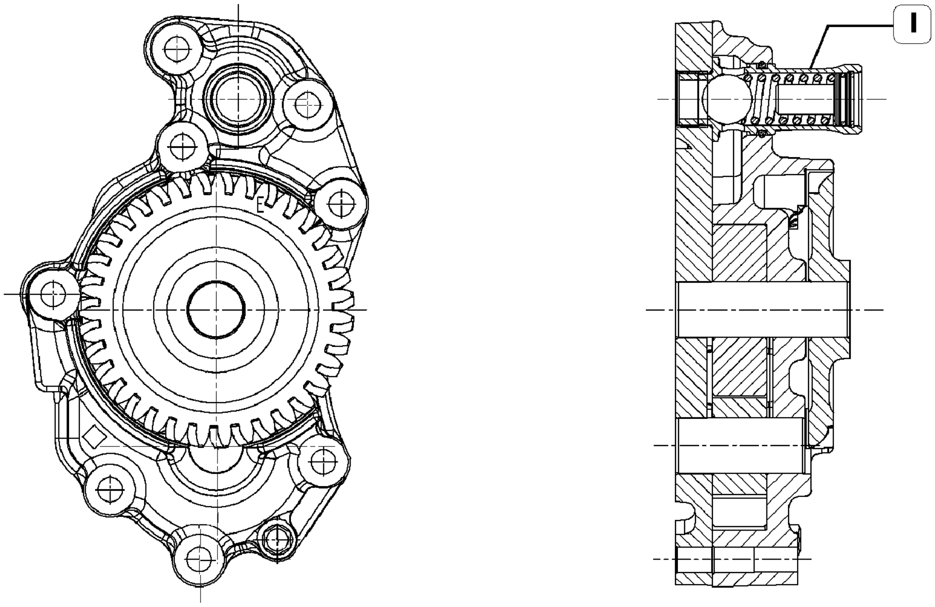
MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

Figure 5



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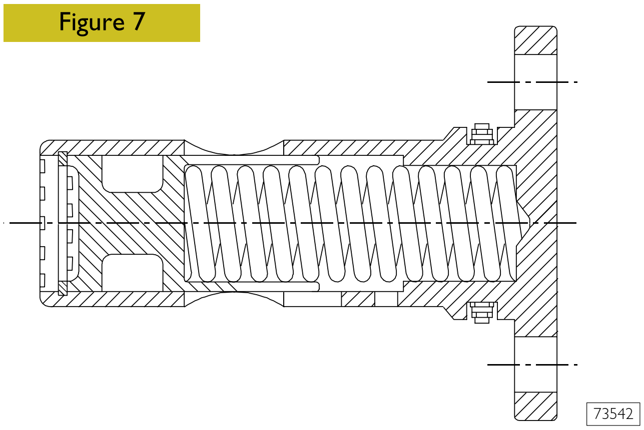
OIL PUMP CROSS-SECTION
1. Overpressure valve – Start of opening pressure 10.1 ± 0.7 bars

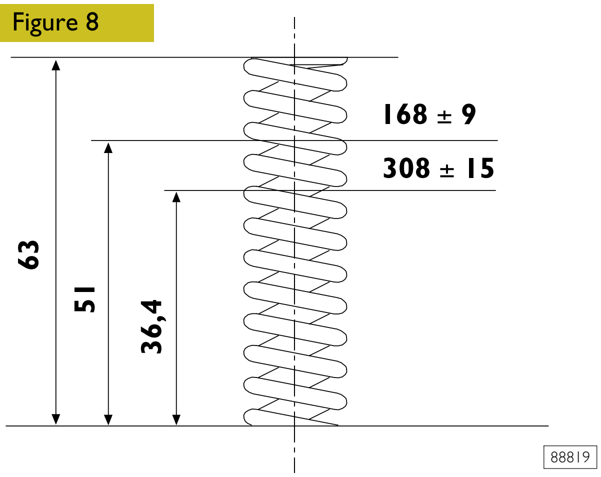
Oil pressure control valve

Figure 7



The oil pressure control valve is located on the left-hand side of the crankcase.
Start of opening pressure 5 bars.

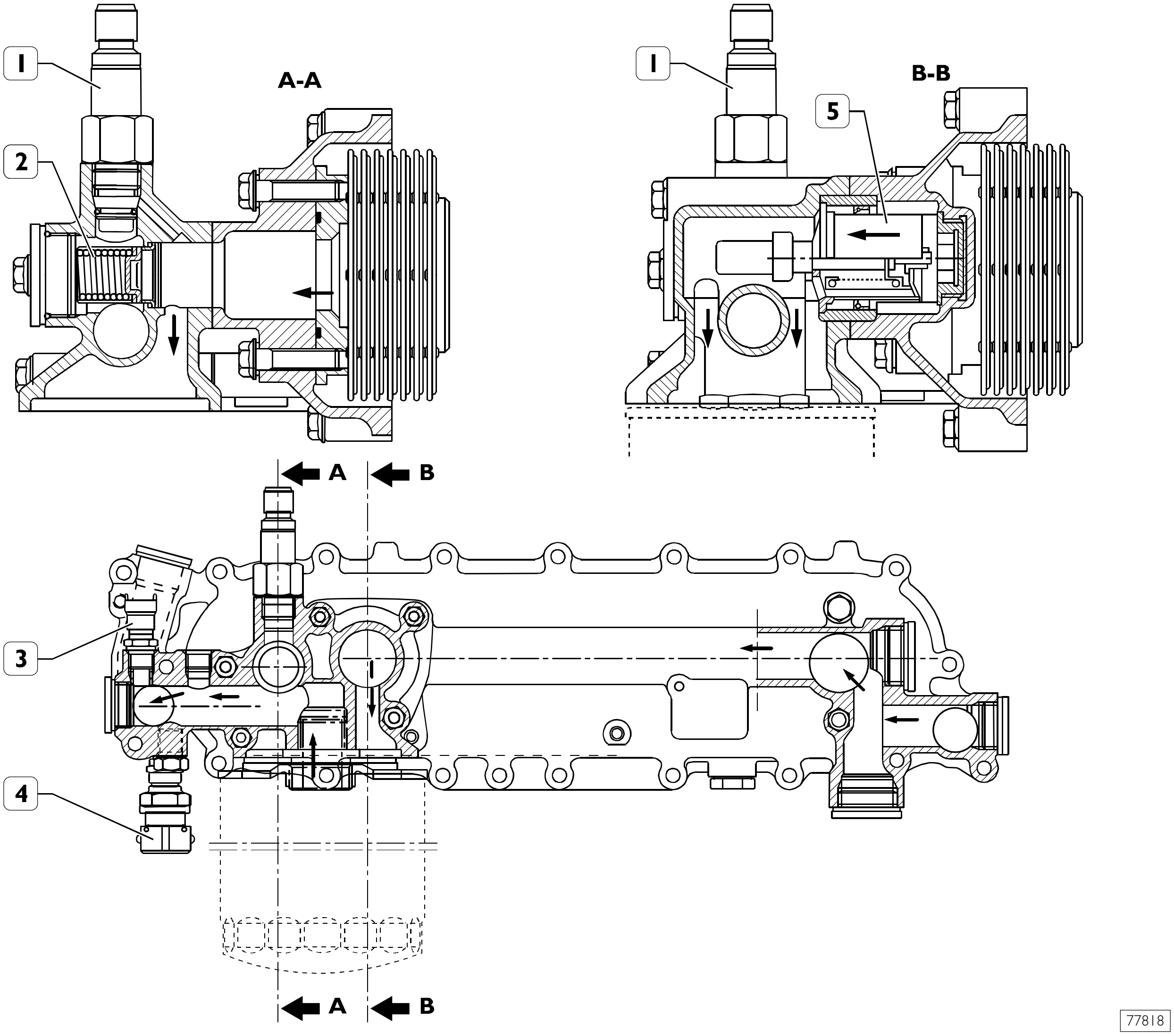
Figure 8



MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

Heat exchanger

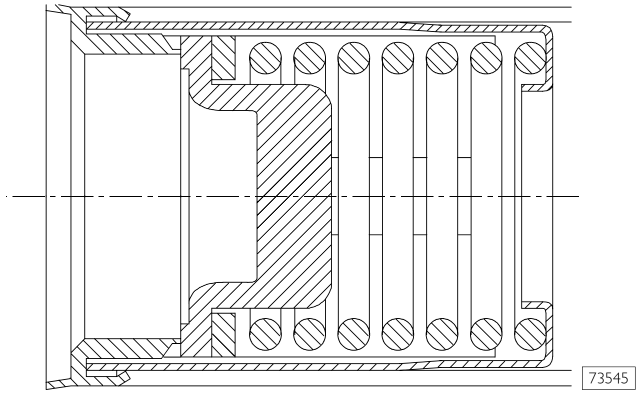
Figure 9



HEAT EXCHANGER
The following elements are fitted on the intercooler: 1. Transmitter for low pressure warning lamp - 2. By-pass valve - 3. Oil temperature sensor - 4. Oil pressure sensor for single gauge - 5. Heat valve. Number of intercooler elements: 7

By-pass valve inside the filter support/heat exchanger assembly

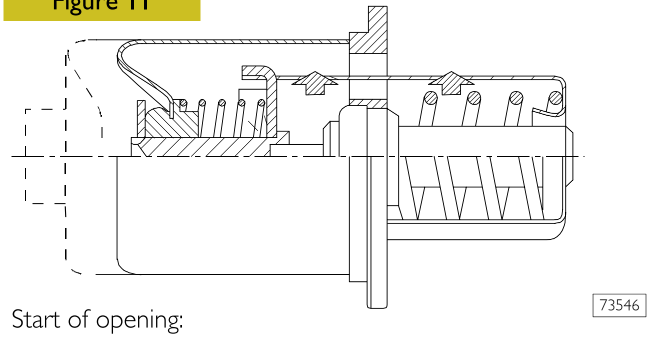
Figure 10



The valve quickly opens at a pressure of: 3 bars.

Thermostatic valve

Figure 11



Start of opening:

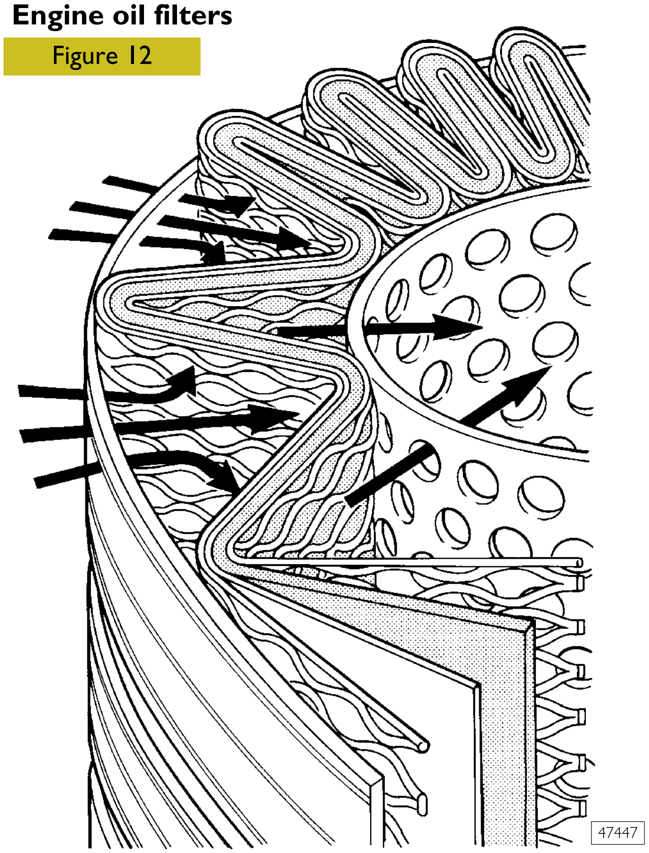
☐ travel 0.1 mm at a temperature of 82 ± 2°C.

End of opening:

☐ travel 8 mm at a temperature of 97°C.

Engine oil filters

Figure 12



This is a new generation of filters that permit much more thorough filtration as they are able to holder back a greater amount of particles of smaller dimensions than those held back by conventional filters with a paper filtering element.

These high-filtration devices, to date used only in industrial processes, make it possible to:

☐ reduce the wear of engine components over time;

☐ maintain the performance/specifications of the oil and thereby lengthen the time intervals between changes.

External spiral winding

The filtering elements are closely wound by a spiral so that each fold is firmly anchored to the spiral with respect to the others. This produces a uniform use of the element even in the worst conditions such as cold starting with fluids with a high viscosity and peaks of flow. In addition, it ensures uniform distribution of the flow over the entire length of the filtering element, with consequent optimization of the loss of load and of its working life.

Mount upstream

To optimize flow distribution and the rigidity of the filtering element, this has an exclusive mount composed of a strong mesh made of nylon and an extremely strong synthetic material.

Filtering element

Composed of inert inorganic fibres bound with an exclusive resin to a structure with graded holes, the element is manufactured exclusively to precise procedures and strict quality control.

Mount downstream

A mount for the filtering element and a strong nylon mesh make it even stronger, which is especially helpful during cold starts and long periods of use. The performance of the filter remains constant and reliable throughout its working life and from one element to another, irrespective of the changes in working conditions.

Structural parts

The o-rings equipping the filtering element ensure a perfect seal between it and the container, eliminating by-pass risks and keeping filter performance constant. Strong corrosion-proof bottoms and a sturdy internal metal core complete the structure of the filtering element.

When mounting the filters, keep to the following rules:

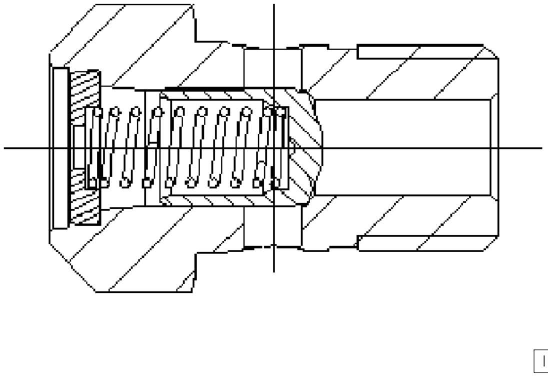
☐ Oil and fit new seals.

☐ Screw down the filters to bring the seals into contact with the supporting bases.

☐ Tighten the filter to a torque of 35÷40 Nm.

Valve integrated in piston cooling nozzle

Figure 13



The valve allows oil to enter only above the threshold pressure of 1.7 ± 0.2 bar. This permits filling the circuit and therefore lubricating the most stressed parts even when working at lower pressures.

COOLING

Description

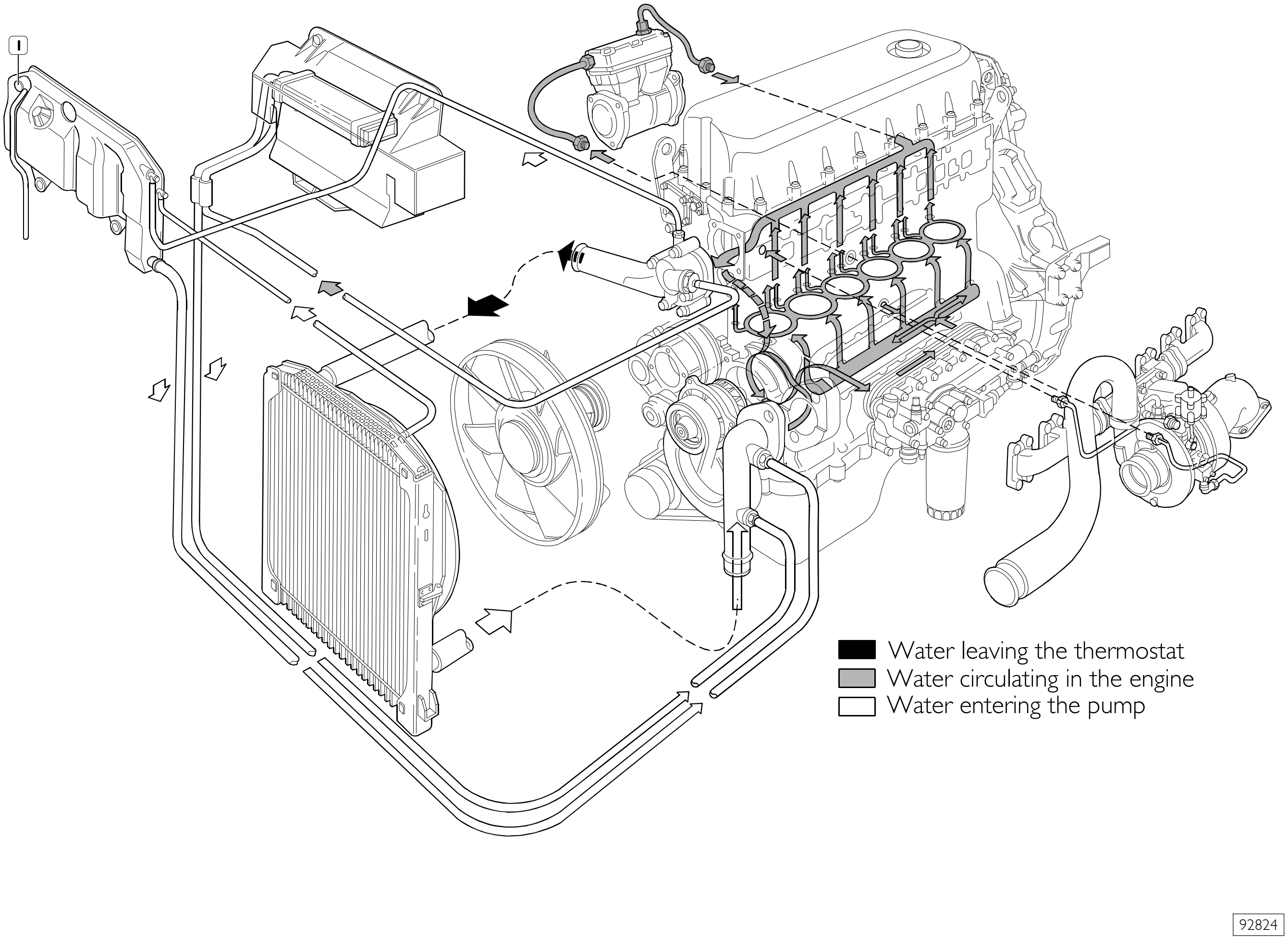
The engine cooling system is of the closed-circuit, forced circulation type.
It consists mainly of the following components:

- expansion tank, not supplied (by IVECO);
- a heat exchanger to cool down lubrication oil;
- a water pump with centrifugal system incorporated in the cylinder block;
- fan, not supplied;
- a 2-way thermostat controlling the coolant circulation.

Operation

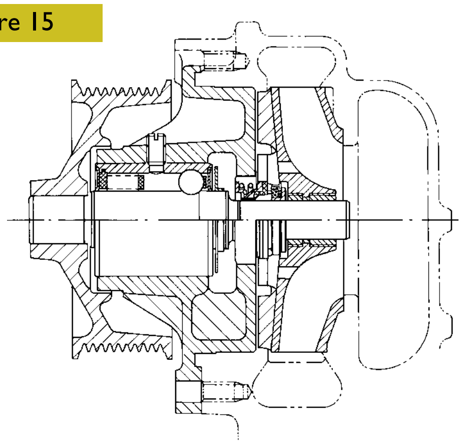
The water pump is actuated by the crankshaft through a poli-V belt and sends coolant to the cylinder block, especially to the cylinder head (bigger quantity). When the coolant temperature reaches and overcomes the operating temperature, the thermostat is opened and from here the coolant flows into the radiator and is cooled down by the fan.
The pressure inside the system, due to temperature change, is adequately controlled through the expansion vessel.

Figure 14



Water pump

Figure 15



WATER PUMP SECTION

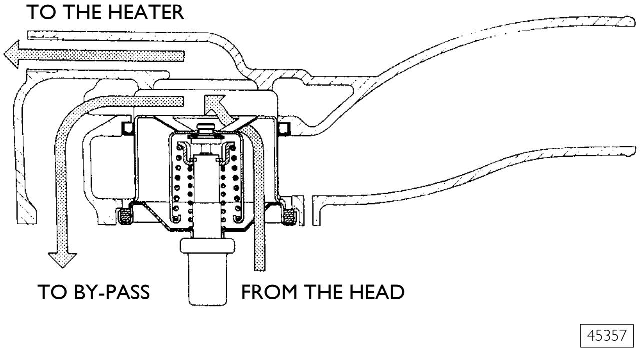
The water pump consists of: rotor, seal bearing and control pulley.

⚠ Make sure that the pump casing has no cracking or water leakage; otherwise, replace the entire pump.

Thermostat

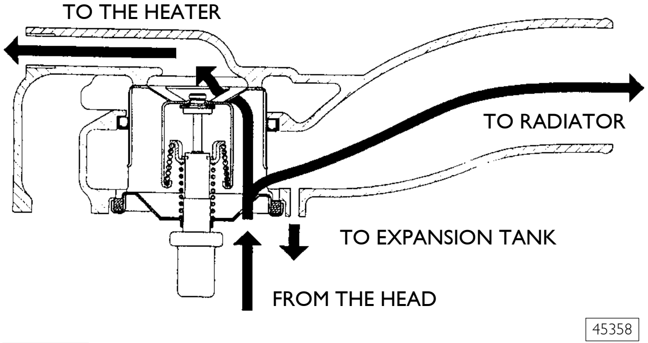
THERMOSTAT OPERATION VIEW

Figure 16



▨ Water circulating in the engine

Figure 17



■ Water issuing from thermostat

Check thermostat operation, in case of doubts, replace it.

Start of stroke temperature	84 °C ± 2 °C
Minimum stroke 15 mm at	94 °C ± 2 °C

TURBOCHARGING

The turbocharging system consists of:

- ☐ air filter;
- ☐ a variable geometry or a fixed geometry turbocharger;
- ☐ "intercooler" radiator.

Figure 18

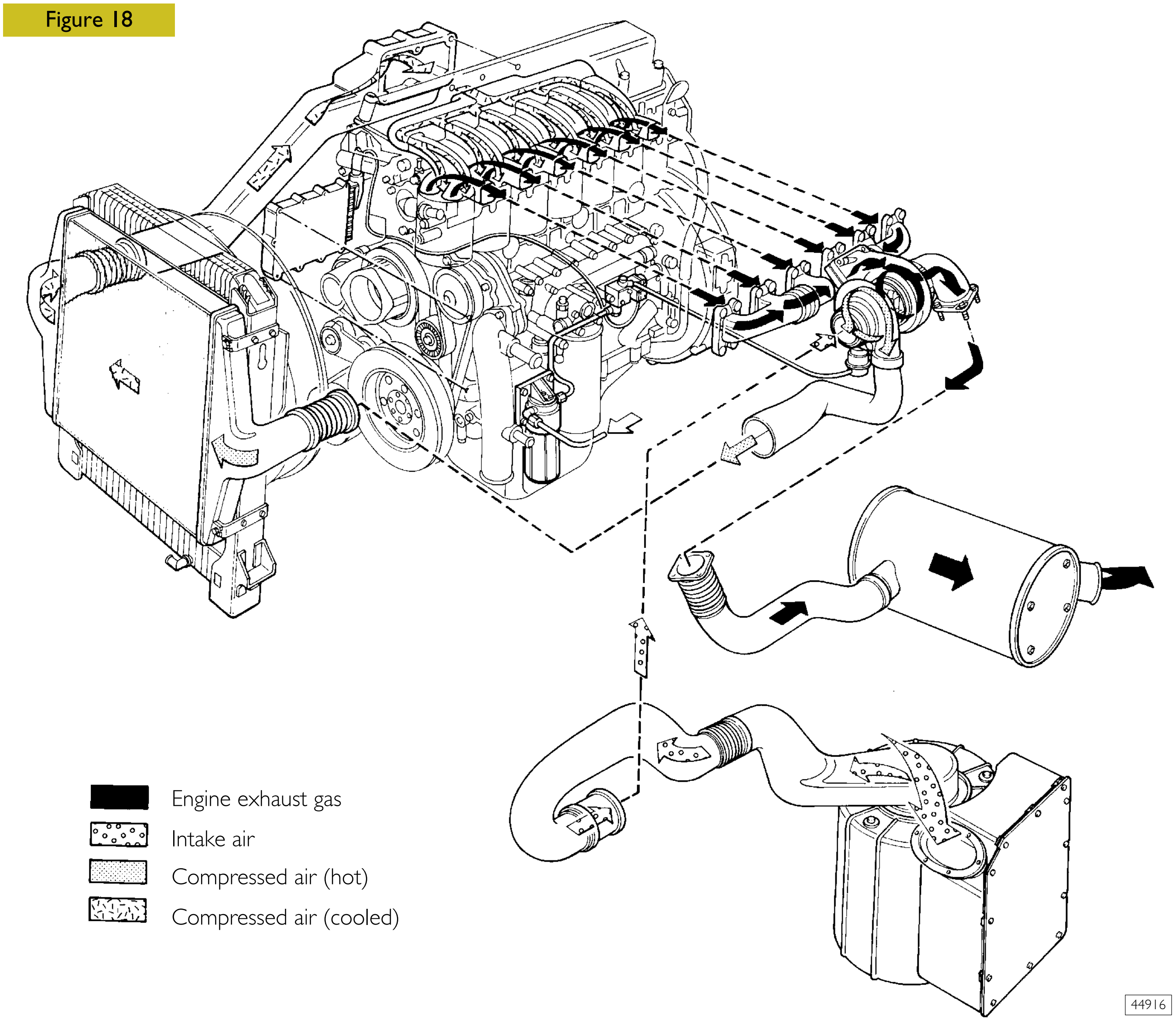


DIAGRAM OF SUPERCHARGING WITH THE VGT TURBOCHARGER

VGT TURBOCHARGER

Operating principle

The variable geometry turbocharger (VGT) consists of a centrifugal compressor and a turbine, equipped with a mobile device which adjusts the speed by changing the area of the passing section of exhaust gases to the turbine.

Thanks to this solution, gas velocity and turbine speed can be high even when the engine is idling.

If the gas is made to go through a narrow passage, in fact, it flows faster, so that the turbine rotates more quickly.

The movement of the device, choking the exhaust gas flowing section, is carried out by a mechanism, activated by a pneumatic actuator.

This actuator is directly controlled by the electronic control unit by a proportional solenoid valve.

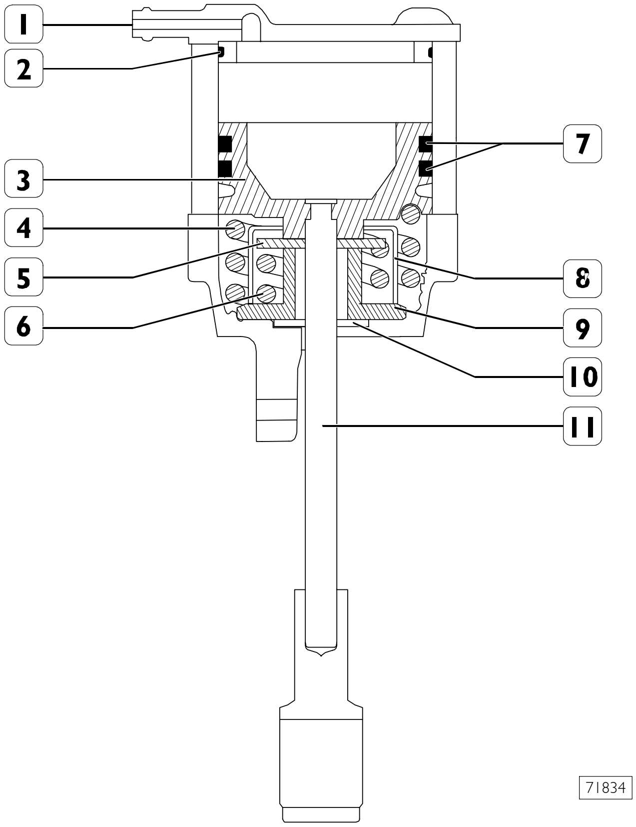
The device is in maximum closing condition at idle speed.

At high engine operating speed, the electronic control system is activated and increases the passing section, in order to allow the in-coming gases to flow without increasing their speed.

A toroidal chamber is obtained during the casting process in the central body for the passage of the coolant.

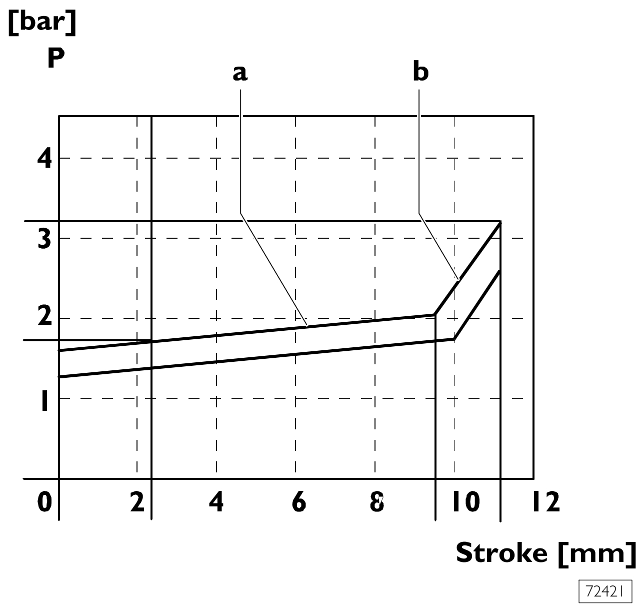
Actuator

Figure 19



1. Air inlet - 2. Gasket - 3. Piston - 4. External spring - 5. Internal spring control disc - 6. Internal spring - 7. O-ring - 8. Spring holder - 9. Limit stop - 10. Dust seal - 11. Control rod.

Figure 20



a Gradient characterized by the effect of the external spring (4, Figure 19).

b Gradient characterized by the effect of the external (4, Figure 19) and internal (6) springs.

Working principle (See Figure 19)

The actuator piston, connected to the drive rod, is controlled with the compressed air introduced through the air inlet (1) on the top of the actuator.

Modulating the air pressure varies the movement of the piston and turbine control rod. As the piston moves, it progressively compresses the external spring (4) until the base of the piston reaches the disc (5) controlling the internal spring (6).

On further increasing the pressure, the piston, via the disc (5), interferes with the bottom limit stop (10).

Using two springs makes it possible to vary the ratio between the piston stroke and the pressure. Approximately 85% of the stroke of the rod is opposed by the external spring and 15% by the internal one.

Solenoid valve for VGT control

This N.C. proportional solenoid valve is located on the left-hand side of the crankcase under the turbine.

The electronic control unit, via a PWM signal, controls the solenoid valve, governing the supply pressure of the turbine actuator, which, on changing its position, modifies the cross-section of the flow of exhaust gases onto the blades of the impeller and therefore its speed.

The resistance of the coil is approx. 20-30 Ohms.

DeNO$_x$ SYSTEM 2

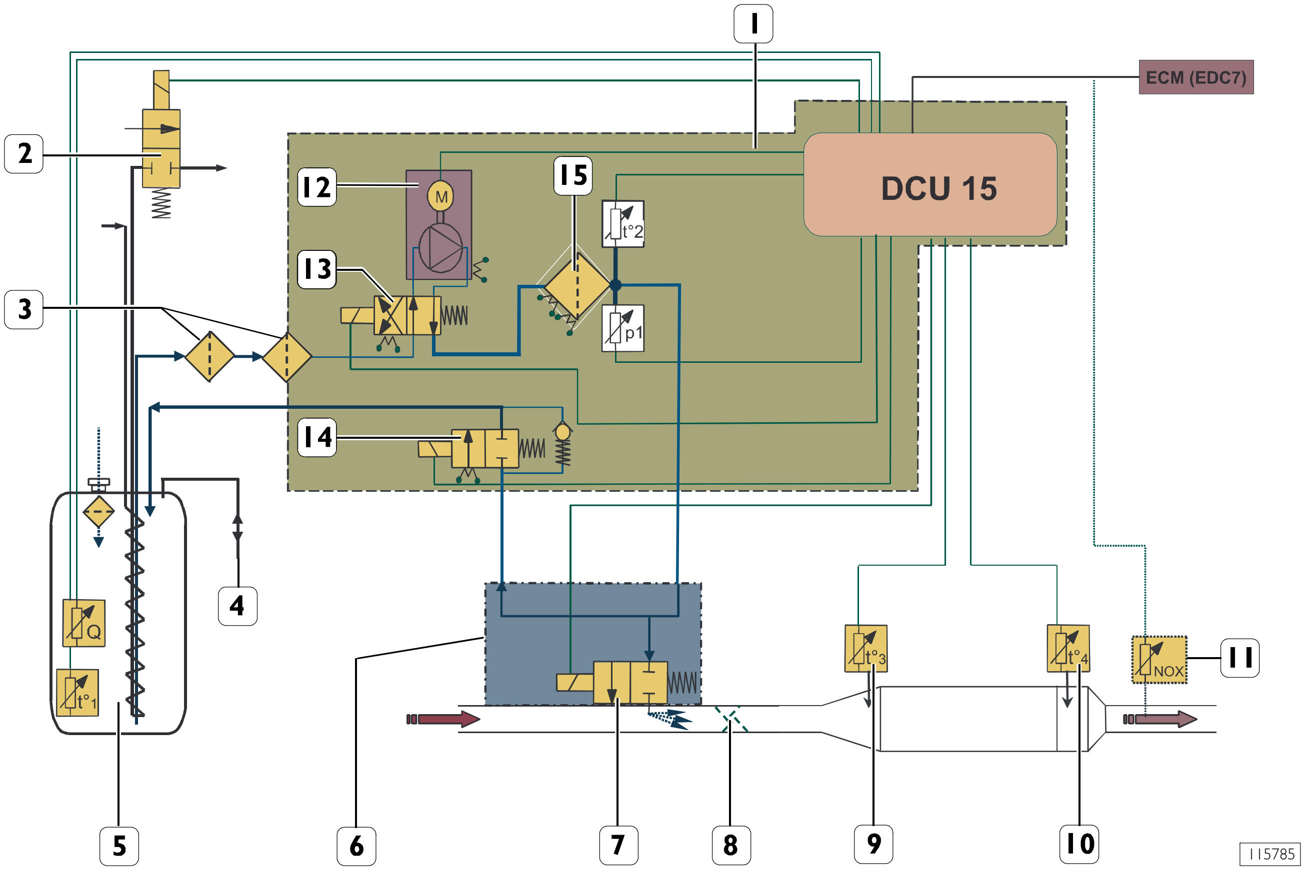
General remarks

In order to keep the exhaust emission values of nitric oxides (NO$_x$) within the limits prescribed by the Euro 4 standard, with low fuel consumption, a system for post-processing of the above substances found in exhaust gas has been fitted to the vehicles. This system essentially consists of an electronic-control oxidizing catalyst.

The system converts, through the SCR (Selective Catalytic Reduction) process, nitric oxides (NO$_x$) into inert compounds: free nitrogen (N_2) and water vapour (H_2O).

The SCR process is based on a series of chemical reactions, which leads, due to ammonia reacting with exhaust gas oxygen, to a reduction of nitric oxides (NO$_x$) found in exhaust gas.

Figure 21



SCR SYSTEM DIAGRAM

A. PUMP MODULE - B. MEASURING OUT MODULE

1. Supply module - 2. MV4 - 3. Pre-filters - 4. Tank vent - 5. AdBlue tank with gridle - 6. Dosing module - 7. MV2 - 8. Mixer - 9. - 10. Temperature sensors - 11. Nox sensor (*) - 12. Membrane pump - 13. MV1 - 14. MV3 - 15. Main filter.

* Future application

The system is essentially made up of:

- a tank (9) for reagent solution (water - urea: AdBlue), equipped with level gauge (8);
- an H2O diverter valve (1);
- pump module (10);
- a mixing and injection module (2);
- catalyst (4);
- two exhaust gas temperature sensors (5, 6) on catalyst output (4);
- a moisture detection sensor (7) fitted on the engine air intake pipe downstream from the air cleaner.

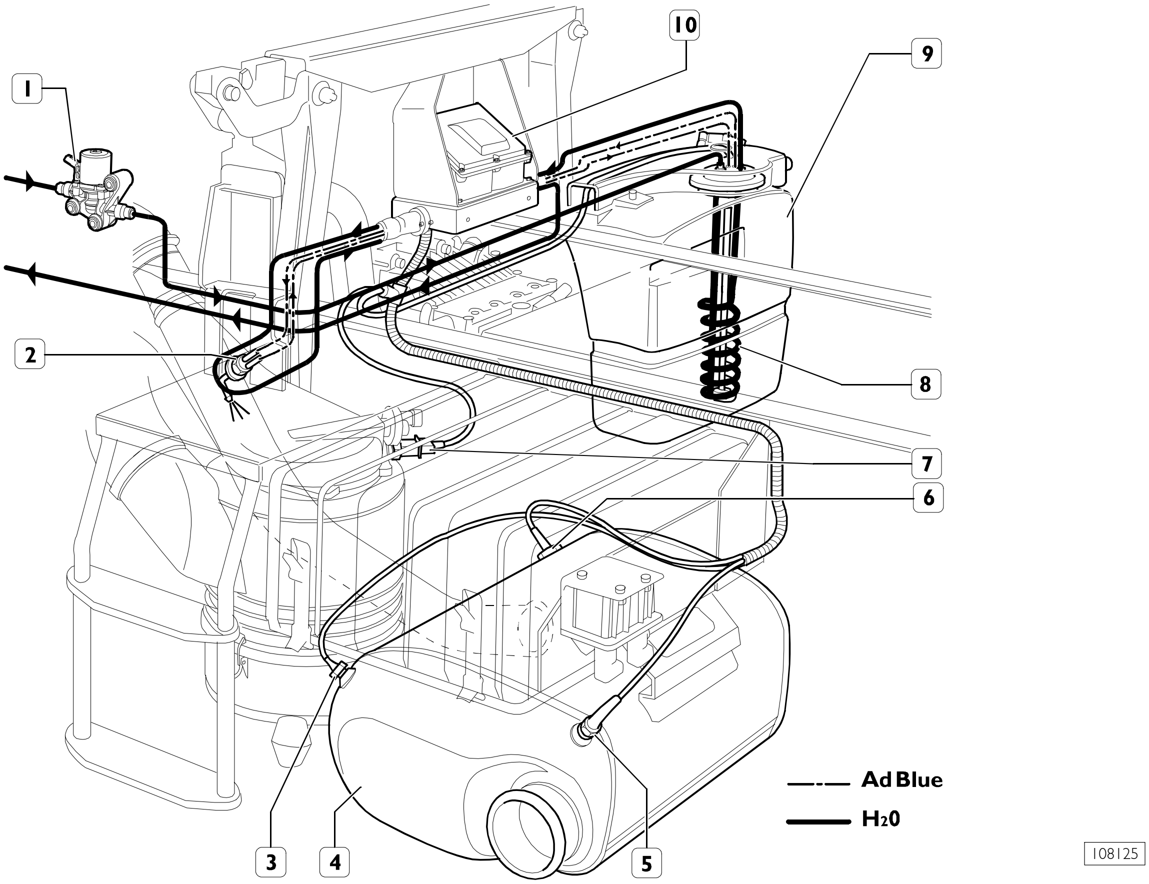
SCR system is electronically managed by DCU (Dosing Control Unit) incorporated into pump module (10); depending on engine rpm, supplied torque, exhaust gas temperature, quantity of nitrogen oxides and humidity of air sucked in, the control unit regulates the flow rate of AdBlue solution to be let into the system.

Pump module (10) takes reagent solution out of tank (9), then sends it under pressure into measuring out module (2); finally, the reagent solution is injected into the exhaust pipe upstream of catalyst (4).

Here, the first phase of the process is realized: the reagent solution will vaporize immediately, due to the exhaust gas temperature, and will be converted into ammonia ($2NH_3$) and carbon dioxide (CO_2), owing to hydrolysis. At the same time, vaporization of the solution will cause a decrease in the exhaust gas temperature: the latter will get near the optimum temperature required for the process.

Exhaust gas added with ammonia - and at the reaction temperature - will flow into catalyst where the second phase of the process will be realized: ammonia will, by reacting with the exhaust gas oxygen, convert into free nitrogen (N) and water vapour (H_2O).

Figure 22



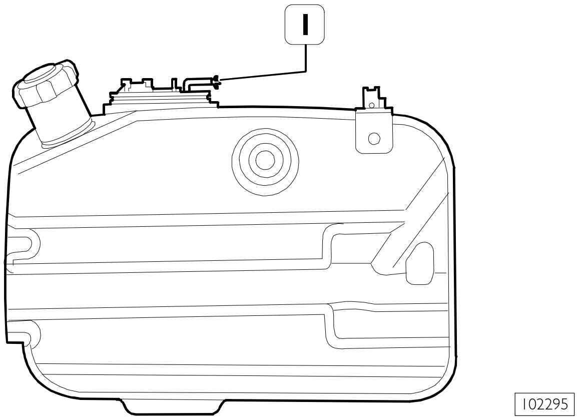
POSITION OF SCR SYSTEM COMPONENTS ON THE VEHICLE

1. H_2O valve - 2. Dosing module - 3. Nitric oxide detecting sensor (*) - 4. Catalyst - 5. Outlet temperature sensor - 6. Inflow exhaust gas temperature sensor - 7. Sucked air humidity and temperature sensor - 8. Level gauge - 9. Water-urea solution (AdBlue) tank - 10. Pump module.

* Future application

Tank

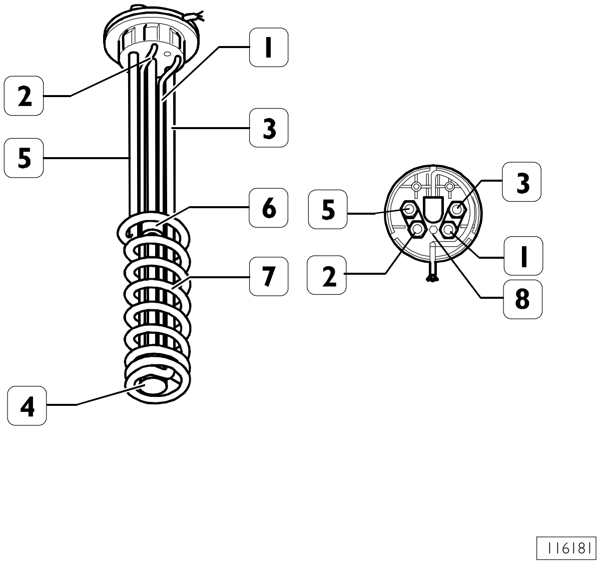
Figure 23



The tank equipped with level gauge control (1) contains the reducing substance required for the SCR process, which consists of a 35%-urea and water solution called AdBlue.

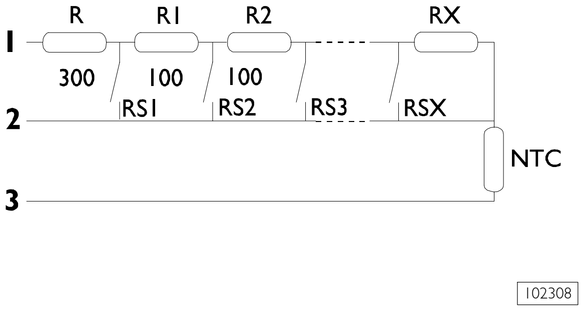
AdBlue fluid level gauge control

Figure 24



1. AdBlue fluid suction pipe - 2. AdBlue fluid return pipe - 3. Engine cooling hot fluid inlet pipe - 4. AdBlue (NTC) temperature sensor - 5. Engine cooling hot fluid outlet pipe - 6. Float - 7. AdBlue fluid heating coil - 8. AdBlue air vent.

Figure 25



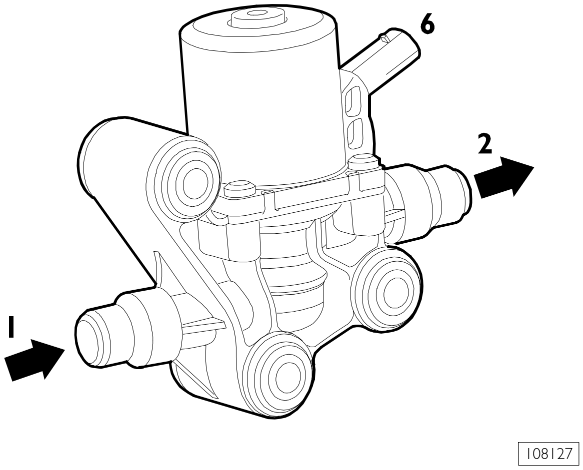
FUNCTIONAL WIRING DIAGRAM

The AdBlue fluid level gauge control consists of a device made up of a set of resistors, a float, a NTC temperature sensor, and a coil used to heat the fluid under low temperature conditions.

It informs the control unit of any current change due to the resistor determined by the float position with respect to the AdBlue fluid level.

By-pass valve

Figure 26



FUNCTIONAL WIRING DIAGRAM

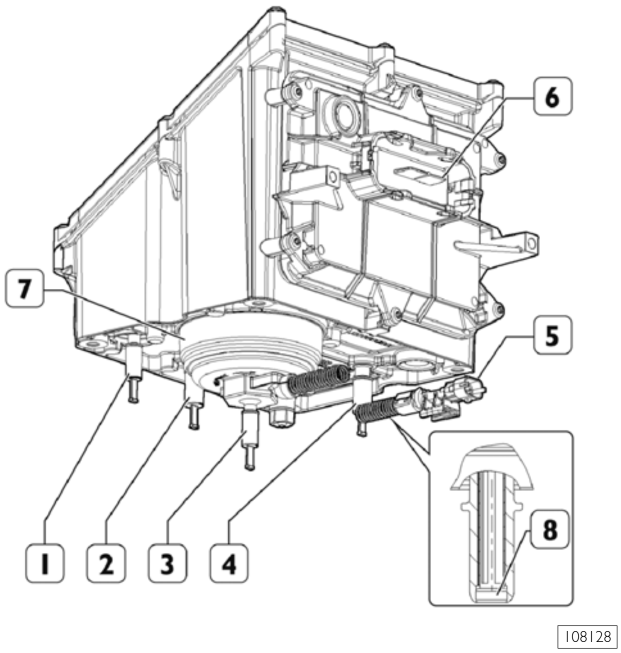
1. Coolant inlet - 2. Coolant outlet - 6. Electrical connection.

The valve, which is a Normally Closed type valve, allows AdBlue tank to be heated by engine coolant.

The NTC temperature sensor controls the by-pass valve which closes or opens (depending on temperature) the passage of the engine cooling hot fluid into the heating coil.

Pump module

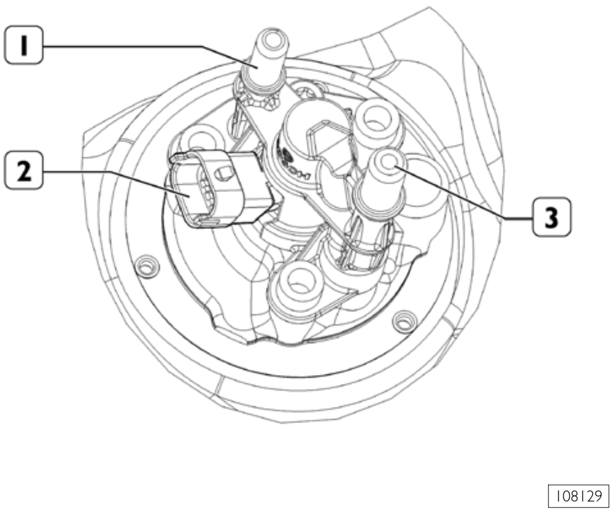
Figure 27



1. AdBlue return pipe to the tank - 2. AdBlue return pipe from dosing module - 3. AdBlue solution outlet - 4. AdBlue solution infeed - 5. Electrical connection - 6. DCU control unit connector - 7. Filter - 8. Prefilter.

Dosing module

Figure 28

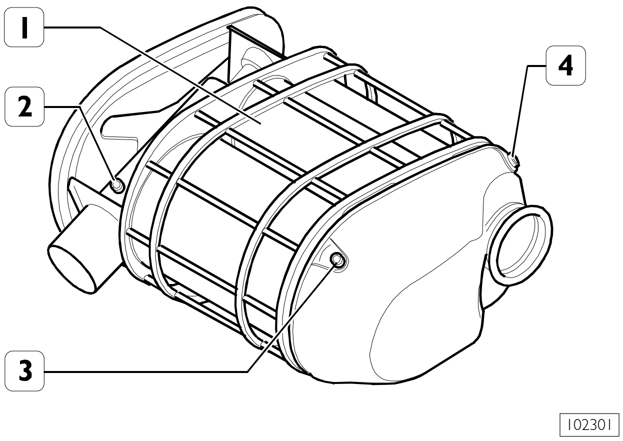


1. AdBlue infeed - 2. Electrical connection - 3. AdBlue outlet.

The function of this module is to dose the AdBlue solution to be conveyed to the injector.

Catalyst

Figure 29



Catalyst (1), equipped with sound-proofing material, replaces the exhaust silencer.

Inside the catalyst, the exhaust gas nitric oxides are, by reacting with ammonia, converted into free nitrogen and water vapour.

Temperature sensors (2 & 3) and nitric oxide detecting sensor (4) are fitted onto catalyst (1).

Exhaust gas temperature sensor

Figure 30

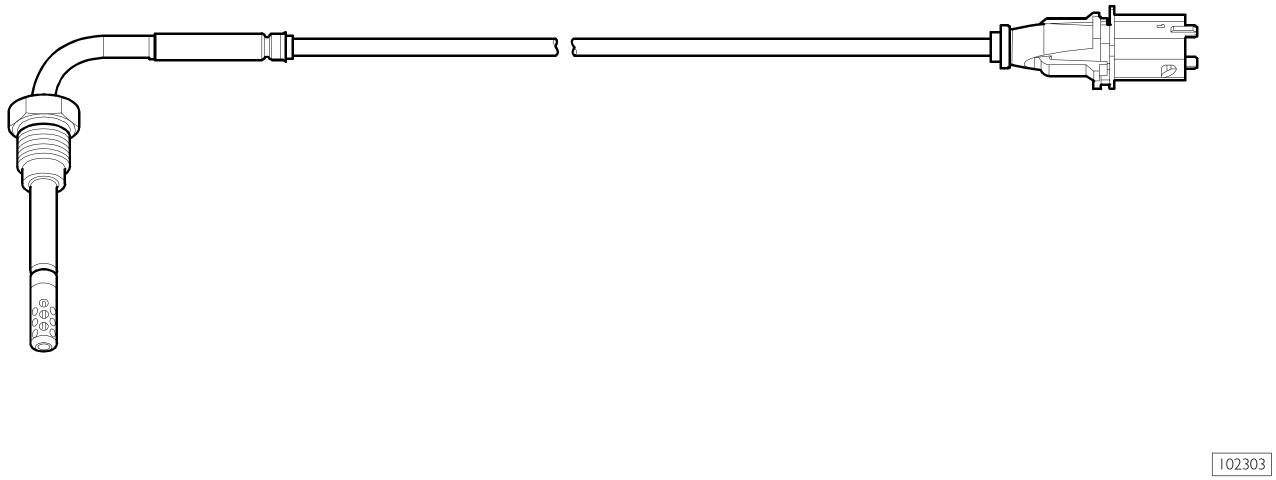
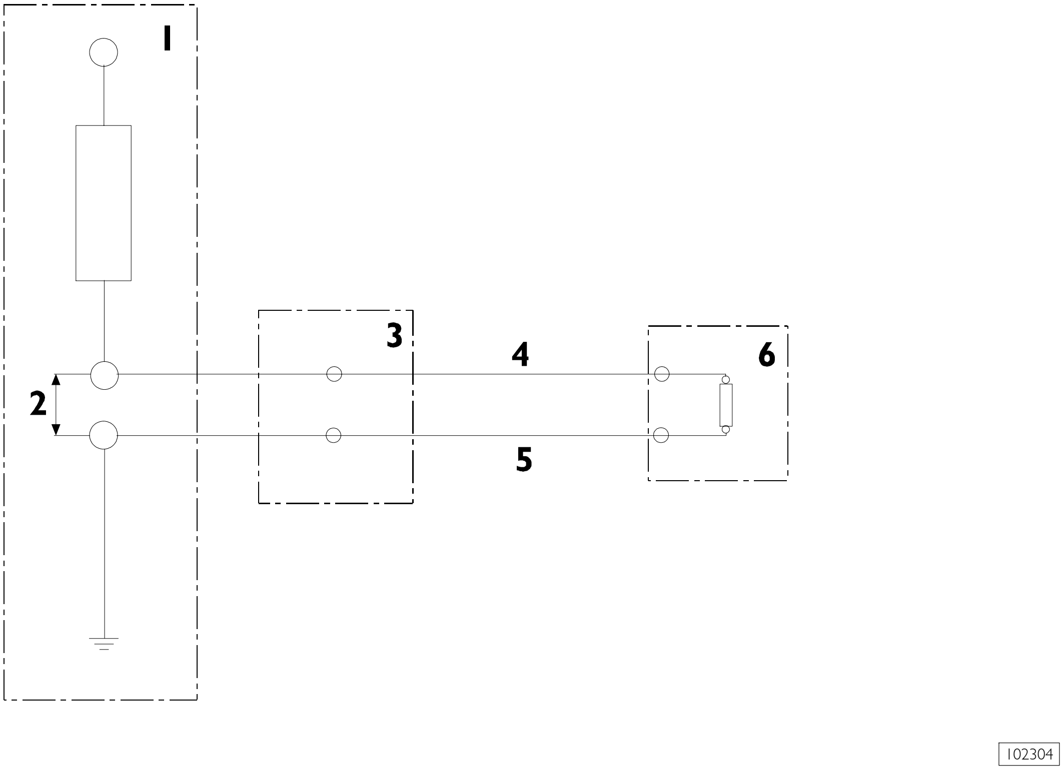


Figure 31



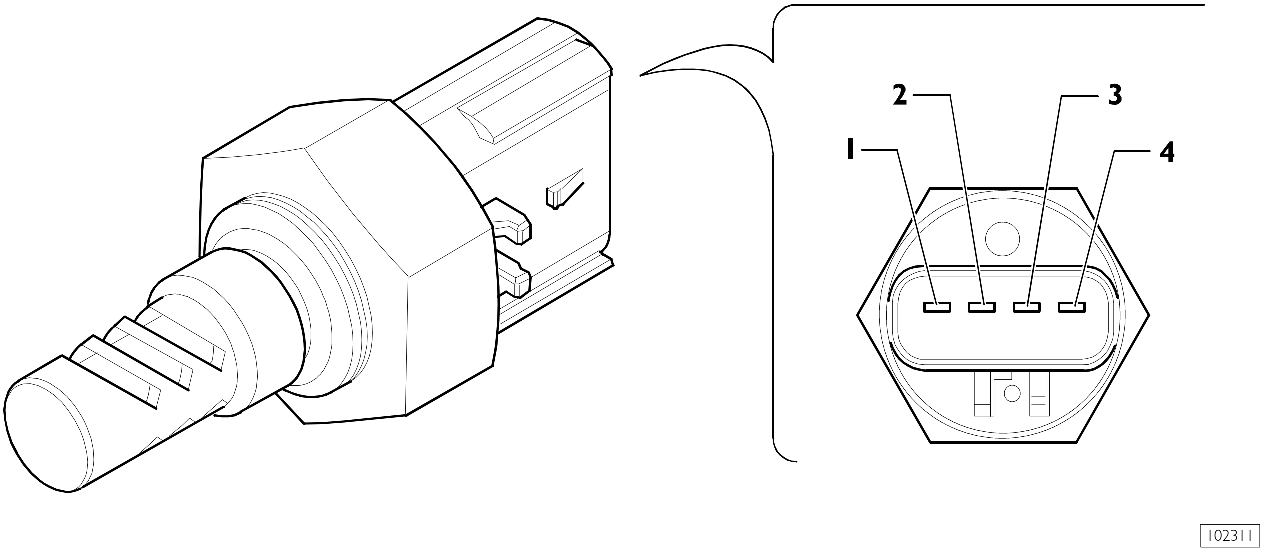
FUNCTIONAL WIRING DIAGRAM

1. Supply voltage - 2. Variable output voltage - 3. Connector - 4. Signal cable (grey) - 5. Earth cable (white) - 6. Sensor.

The function of this sensor is to send the control unit the catalyst inlet and outlet exhaust gas temperature values required to calculate the amount of urea to be injected into the system.

Humidity detecting sensor

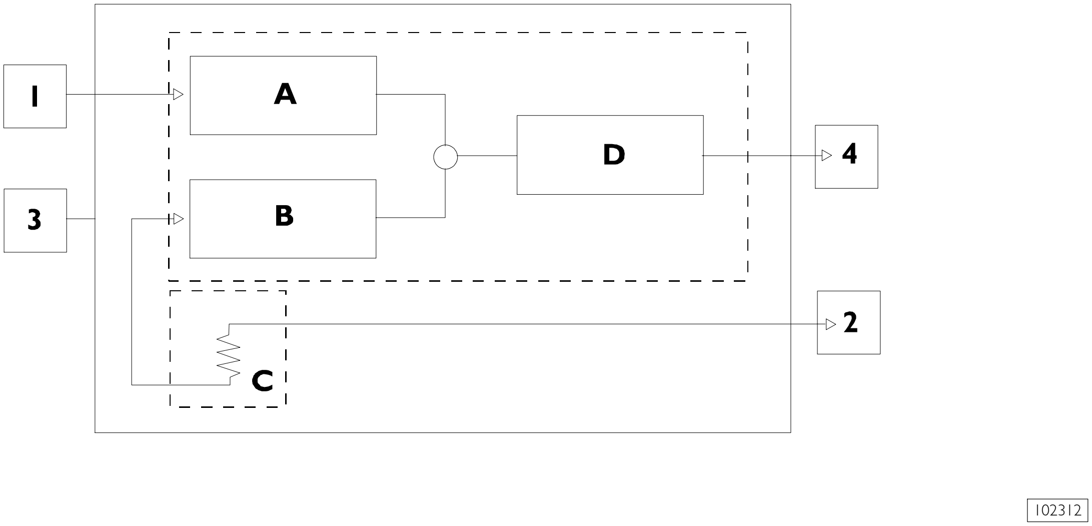
Figure 32



1. Temperature - 2. Earth - 3. Humidity percent value - 4. Power supply.

This sensor is located on the air filter output conveyor, and is used to inform the control unit of the amount (percentage) of humidity found in sucked air, to determine the calculation of nitric oxide emissions.

Figure 33



ELECTRIC BLOCK DIAGRAM

1. Earth - 2. Temperature - 3. Power supply unit - 4. Humidity percent value - A. Sample frequency generator - B. Reference oscillator - C. NTC temperature sensor - D. Amplifier lowpass filter

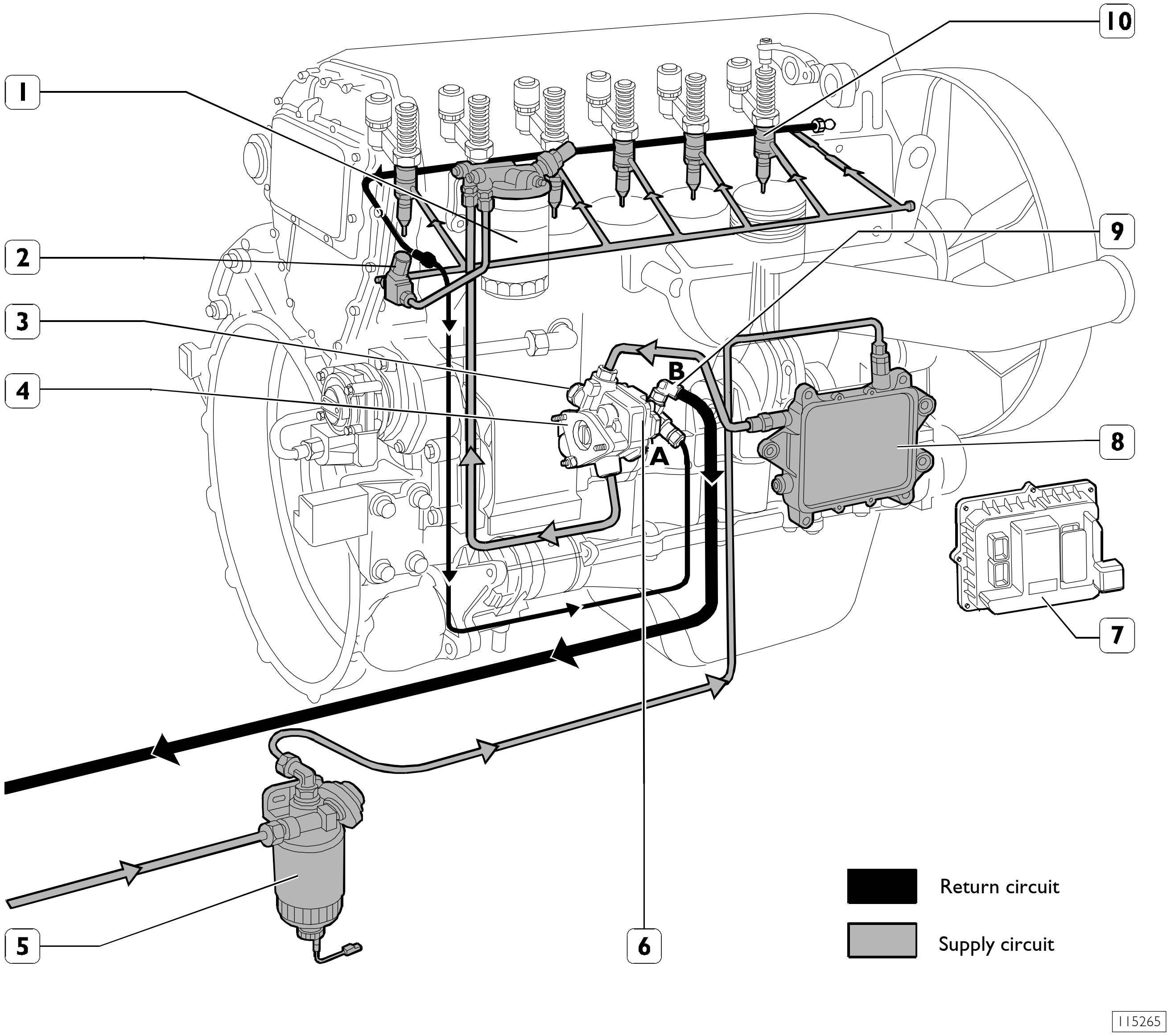
SECTION 2

Fuel

FUEL FEED

Fuel feed is obtained by means of a pump, fuel filter and pre-filter, 6 pump-injectors controlled by the camshaft by means of rockers and by the electronic control unit.

Figure 1

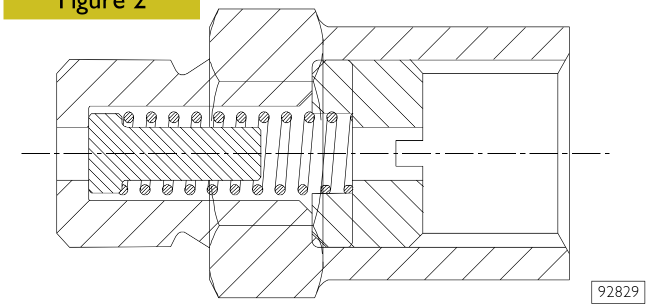


ENGINE FEED SCHEME
1. Fuel filter - 2. Pressure damping device - 3. Pressure control valve (start of opening at 5 bar) - 4. Feed pump - 5. Fuel pre-filter with priming pump - 6. Valve, to recirculate fuel from injectors, integrated in feed pump (start of opening at 3.5 bar) - 7. Central unit - 8. Heat exchanger - 9. Overpressure valve to return fuel to tank (start of opening at 0.2 bar) - 10. Pump injectors.

A. Fuel arriving at injectors - B. Fuel returning to tank

Overpressure valve

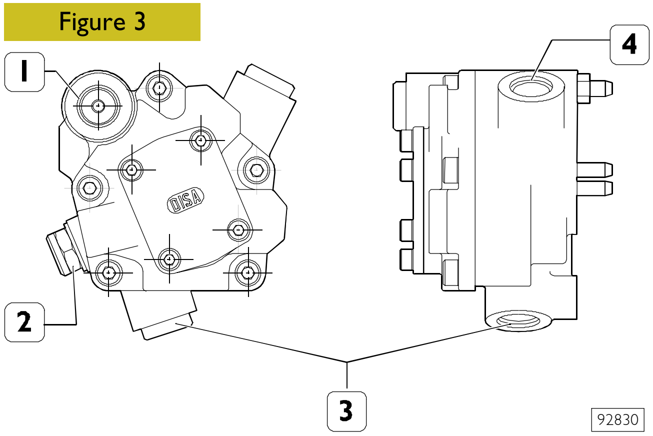
Figure 2



An overpressure valve is a single-acting valve, calibrated to 0.2 ÷ 0.3 bar, placed on the piping that returns fuel to tank. The overpressure valve prevents fuel duct in cylinder head from emptying with engine stopped.

Feed pump

Figure 3



Feed pump mounted laterally
1. Overpressure valve - 2. Delivering fuel to injectors - 3. Sucking in fuel - 4. Pressure control valve.

Pump performances

Pump rotation speed (rpm)		2600	600	170	100
Minimum flow rate (l/h)		310	45	12	
Test conditions	Negative pressure on aspiration (bar)	0.5	0.3	0.3	0.3
	Pressure on delivery (bar)	5	3	0,3	0.3
	Test liquid temperature (°C)	30	30	30	30
	Test liquid	ISO 4113			

Field of use

Pump rotation speed (rpm)	2600
Overrunning rotation speed (max 5 min) (rpm)	4100 max
Diesel oil temperature (°C)	-25/+80
Filtering rate on aspiration (micron)	30
Negative pressure on aspiration (bar)	0.5 max

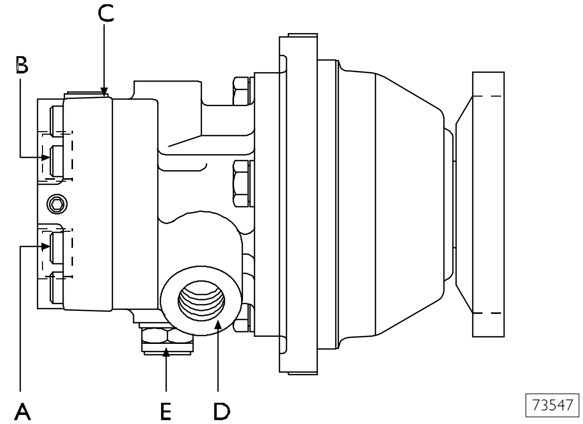
Pressure control valve

Valve calibration	5 ÷ 5.8

Injectors return valve

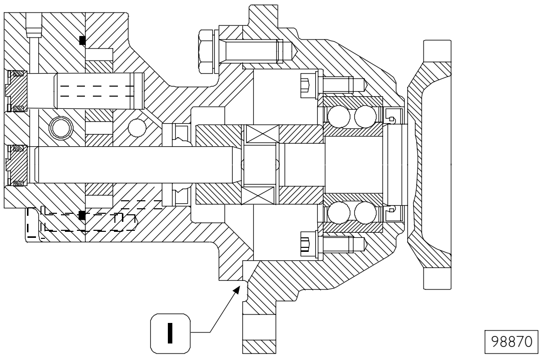
Valve calibration	3.4 ÷ 3.8

Figure 4



Feed pump mounted frontally
A. Fuel inlet – B. Fuel delivery – C. By-pass nut – D. Fuel return from the pump-injectors – E. Pressure relief valve – Opening pressure: 5-8 bars.

Figure 5



SECTION ON FEED PUMP
1. Oil and fuel leaks indicator

Pump performances

Pump rotation speed (rpm)		4100	900	250	140
Minimum flow rate (l/h)		310	45	12	6
Test conditions	Negative pressure on aspiration (bar)	0.5	0.3	0.3	0.3
	Pressure on delivery (bar)	5	3	0.3	0.3
	Test liquid temperature (°C)	50	50	50	20
	Test liquid	ISO 4113			

Field of use

Pump rotation speed (rpm)	4100
Overrunning rotation speed (max 5 min) (rpm)	5800 max
Diesel oil temperature (°C)	-25/+80
Filtering rate on aspiration (micron)	0.5 max
Negative pressure on aspiration (bar)	-25/+120

Pressure control valve

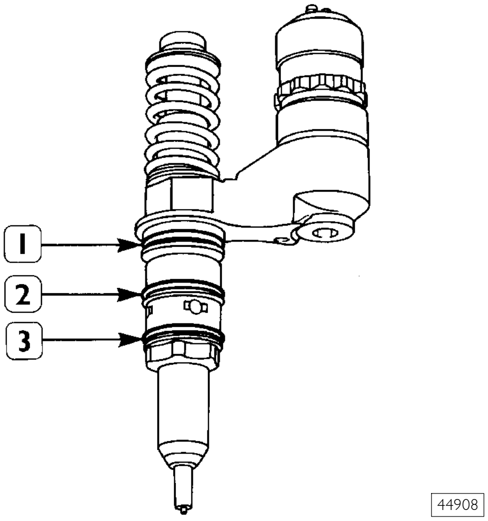
Valve calibration	5 ÷ 5.8

Injectors return valve

Valve calibration	3.4 ÷ 3.8

Injector-pump

Figure 6



1. Fuel/oil seal – 2. Fuel/diesel seal – 3. Fuel/exhaust gas seal.

The injector-pump is composed of: pumping element, nozzle, solenoid valve.

Pumping element

The pumping element is operated by a rocker arm governed directly by the cam of the camshaft.
The pumping element is able to ensure a high delivery pressure. The return stroke is made by means of a return spring.

Nozzle

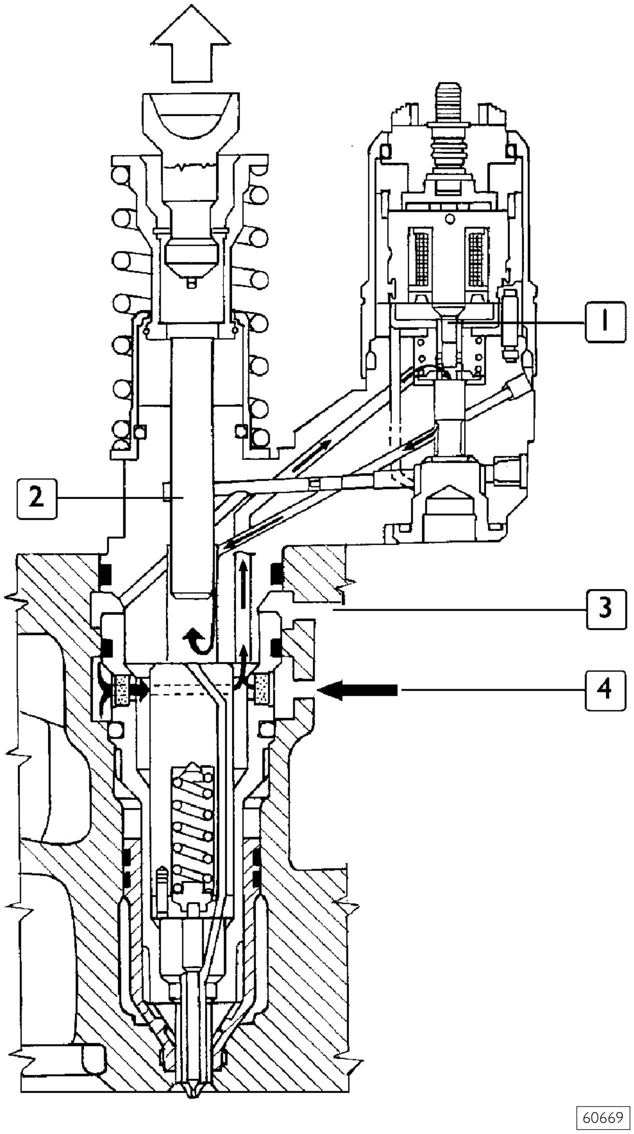
Garages are authorized to perform fault diagnosis solely on the entire injection system and may not work inside the injector-pump, which must only be replaced.
A specific fault-diagnosis program, included in the control unit, is able to check the operation of each injector (it deactivates one at a time and checks the delivery of the other five).
Fault diagnosis makes it possible to distinguish errors of an electrical origin from ones of a mechanical/hydraulic origin.
It indicates broken pump-injectors.
It is therefore necessary to interpret all the control unit error messages correctly.
Any defects in the injectors are to be resolved by replacing them.

Solenoid valve

The solenoid, which is energized at each active phase of the cycle, via a signal from the control unit, controls a slide valve that shuts off the pumping element delivery pipe.
When the solenoid is not energized, the valve is open, the fuel is pumped but it flows back into the return pipe with the normal transfer pressure of approximately 5 bars.
When the solenoid is energized, the valve shuts and the fuel, not being able to flow back into the return pipe, is pumped into the nozzle at high pressure, causing the needle to lift.
The amount of fuel injected depends on the length of time the slide valve is closed and therefore on the time for which the solenoid is energized.
The solenoid valve is joined to the injector body and cannot be removed.
On the top there are two screws securing the electrical wiring from the control unit.
To ensure signal transmission, tighten the screws with a torque wrench to a torque of 1.36 – 1.92 Nm (0.136 – 0.192 kgm).

Injector Phases

Figure 7

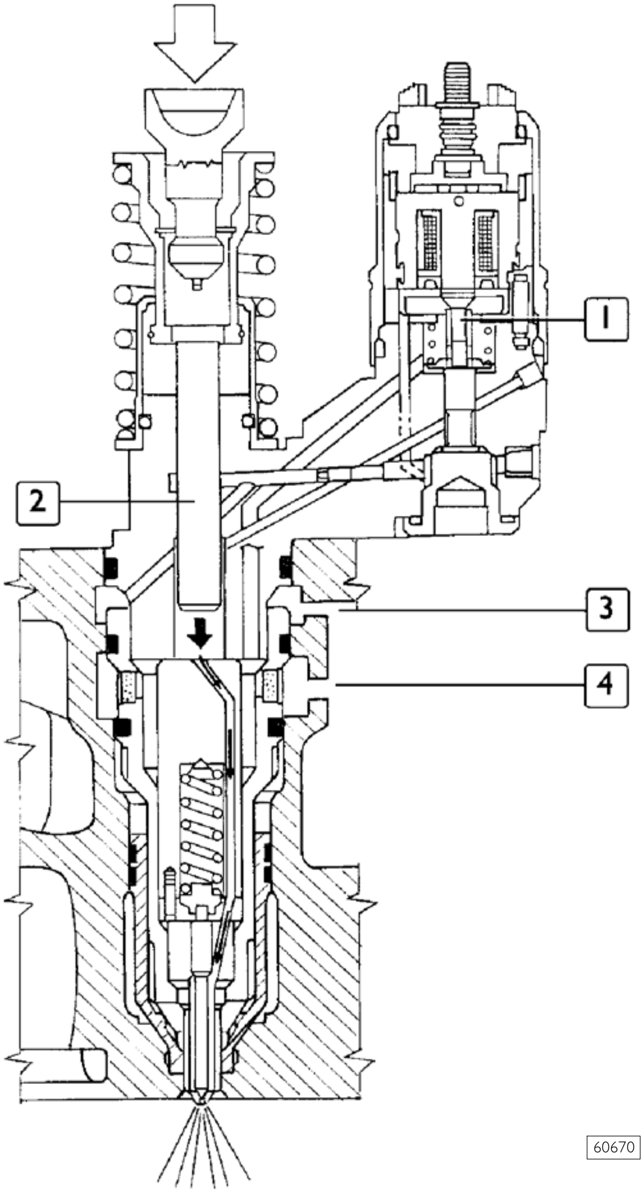


1. Fuel valve - 2. Pumping element - 3. Fuel outlet - 4. Filling and backflow passage.

Filling phase

During the filling phase the pumping element (2) runs up to the top position.
After passing the highest point of the cam, the rocker arm roller comes near the base ring of the cam.
The fuel valve (1) is open and fuel can flow into the injector via the bottom passage (4) of the cylinder head.
Filling continues until the pumping element reaches its top limit.

Figure 8



1. Fuel valve - 2. Pumping element - 3. Fuel outlet - 4. Filling and backflow passage.

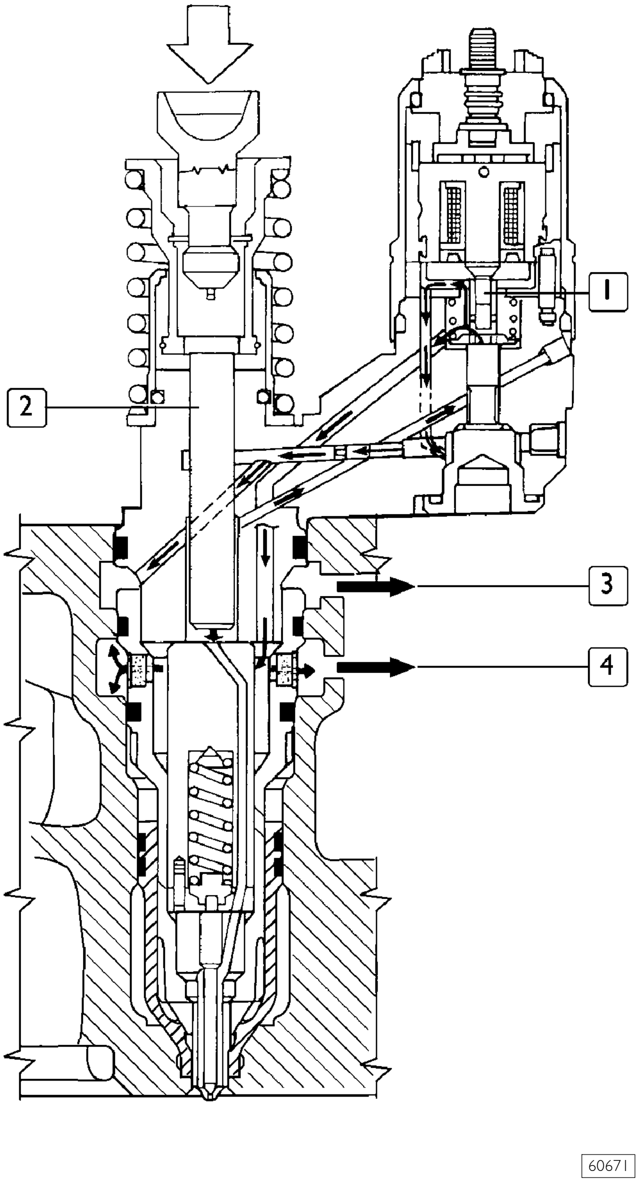
Injection phase

The injection phase begins when, at a certain point in the down phase of the pumping element, the solenoid valve gets energized and the fuel valve (1) shuts.

The moment delivery begins, appropriately calculated by the electronic control unit, depends on the working conditions of the engine.

The cam continues with the rocker arm to push the pumping element (2) and the injection phase continues as long as the fuel valve (1) stays shut.

Figure 9



1. Fuel valve - 2. Pumping element - 3. Fuel outlet - 4. Filling and backflow passage.

Pressure Reduction phase

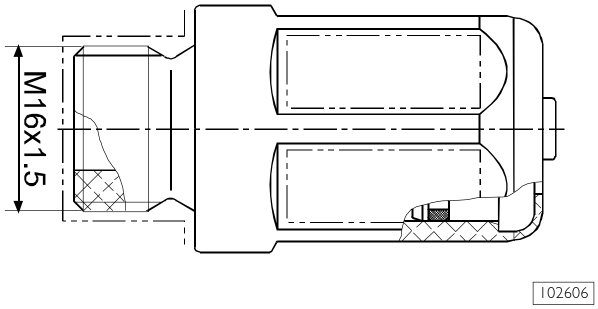
Injection ceases when the fuel valve (1) opens, at a certain point in the down stroke of the pumping element, after the solenoid valve gets de-energized.

The fuel flows back through the open valve (1), the injector holes and the passage (4) into the cylinder head.

The time for which the solenoid valve stays energized, appropriately calculated by the electronic control unit, is the duration of injection (delivery) and it depends on the working conditions of the engine.

Pressure damper

Figure 10



FUEL PRESSURE DAMPER

The fuel pressure damper on the delivery pipe between the fuel filter and the cylinder head has the function of damping the backflow pressure on the delivery due to the increase in injection pressure.

SECTION 3

Vehicle application

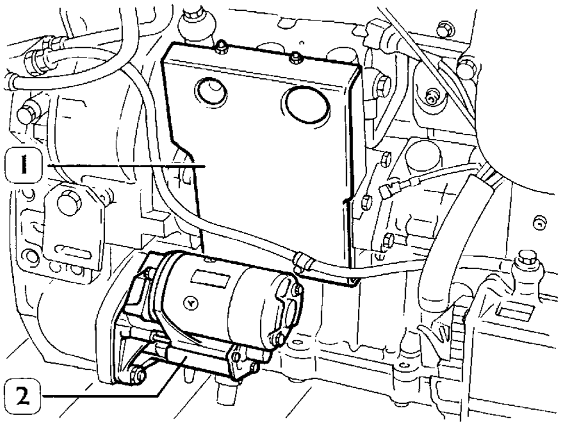
GENERAL FEATURES

	Type		F2BE3681C	F2BE3681B	F2BE3681A
ρ	Compression ratio		16 : 1		
	Max. output	kW (HP) rpm	230 (310) 2400	245 (330) 2400	265 (360) 2400
	Max. torque	Nm (kgm) rpm	1300 (132) 1200 ÷ 1675	1400 (143) 1080 ÷ 1655	1500 (153) 1200 ÷ 1685
	Loadless engine idling	rpm	600 ± 50		
	Loadless engine peak	rpm	2660 ± 50		
	Bore x stroke	mm	115 x 125		
	Displacement	cm^3	7790		
	SUPERCHARGING Turbocharger type		HOLSET with fixed geometry HX40	HOLSET with variable geometry HE 431 V	
	LUBRICATION		Forced by gear pump, relief valve single action oil filter		
	Oil pressure (warm engine) (100 °C ± 5 °C)				
	- idling	bar	1.5		
	- peak rpm	bar	5		
COOLING			By centrifugal pump, regulating thermostat, viscostatic fan, radiator and heat exchanger		
	Water pump control		By belt		
	Thermostat:		N. 1		
	starts to open:		~85 °C		
	fully open:		-		
	OIL FILLING Total capacity at 1st filling	liters kg	28 25.2		
	Capacity: - engine sump min level	liters kg	12.5 11.2		
	- engine sump max level	liters kg	23 21		
	- quantity in circulation that does not flow back to the engine sump	liters kg	5 4.5		
	- quantity contained in the cartridge filter (which has to be added to the cartridge filter refill)	liters kg	2.5 2.3		

PART ONE - MECHANICAL COMPONENTS

DISMANTLING THE ENGINE ON THE BENCH

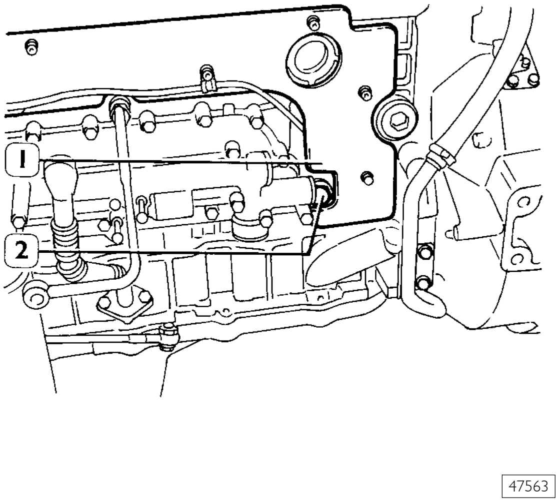
Figure 1



Before dismantling the engine on the rotary stand 99322230, remove the following components:

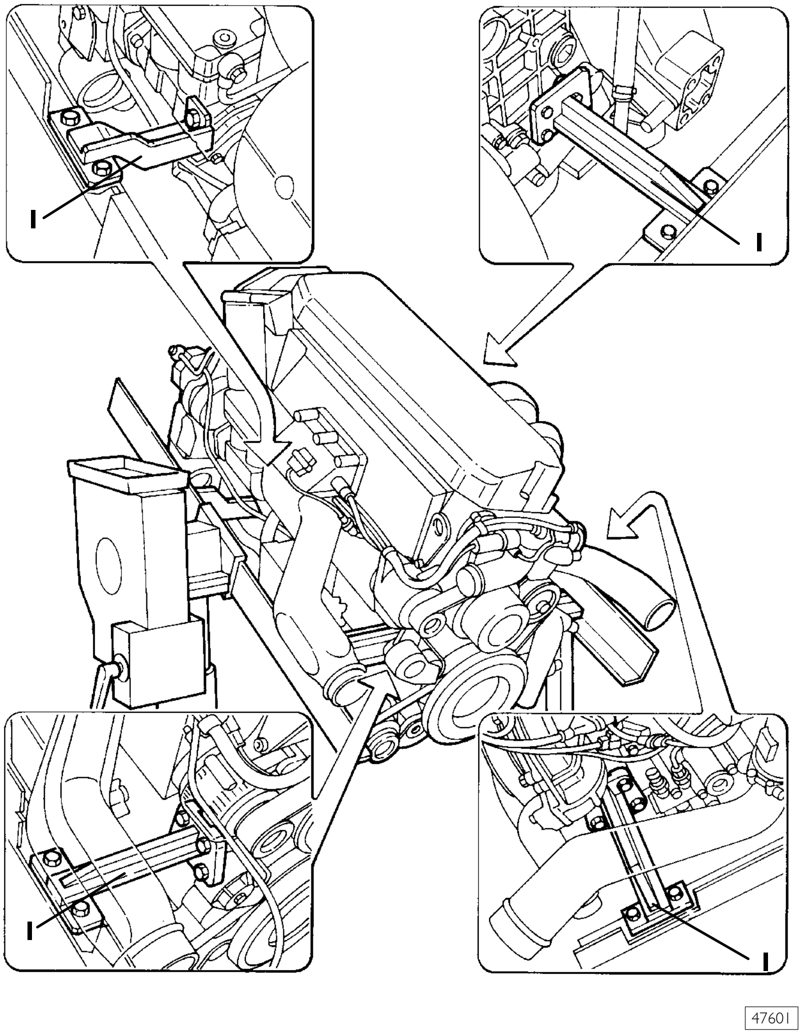
- starter (2)
- turbocharger soundproofing shield (1)

Figure 2



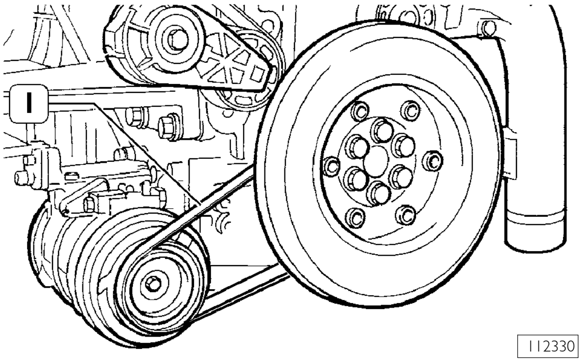
Remove the soundproofing shield (1) and plug (2).

Figure 3



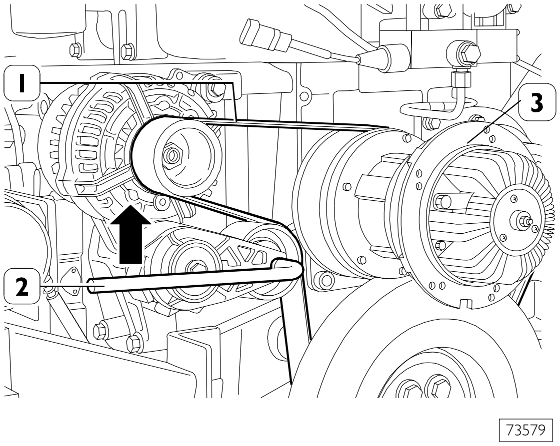
Fix the engine to the rotary stand 99322230, by means of brackets 99361035 (1), remove the fan.

Figure 4



Cut the belt (1) because it would not be re-used.

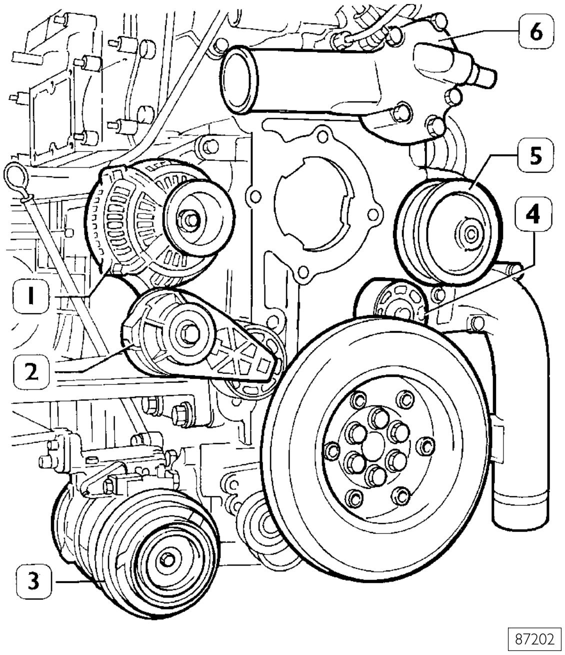
Figure 5



Using an appropriate tool (2), operate in the direction of the arrow, and remove the belt (1) driving the water pump, alternator and fan.

Take out the screws and remove the electromagnetic coupling (3).

Figure 6



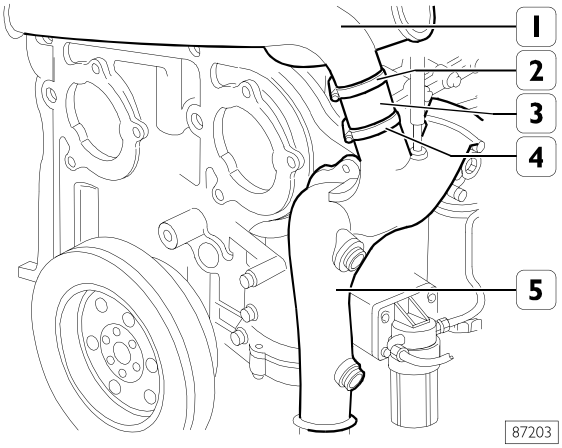
Remove the following components:

- alternator (1);
- belt tightener support (2);
- if present, air conditioner compressor (3);
- water pump (5) and pipe;
- fixed backstand (4).

Only models equipped without Intarder

- thermostat unit (6).

Figure 7

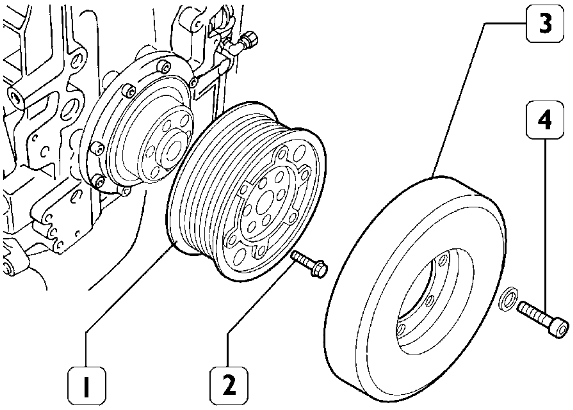


Only models equipped with Intarder

Loosen straps (2 and 4), then remove pipe (1) from the cylinder head and pipe (3).

Remove the fastening screws, then take off thermostat unit (5).

Figure 8



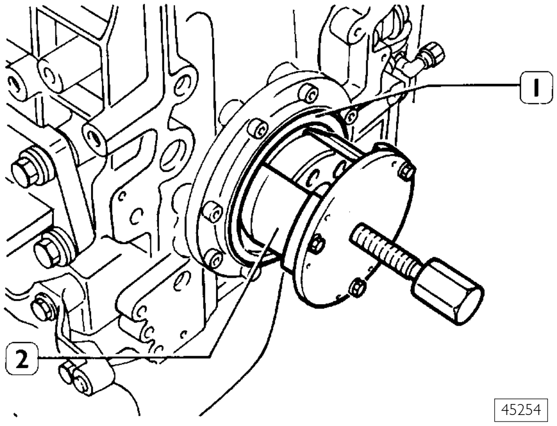
87204

Block the flywheel rotation with tool 99360351.

Remove screws (4), then disassemble damper flywheel (3).

Remove the screws (2) and the pulley (1).

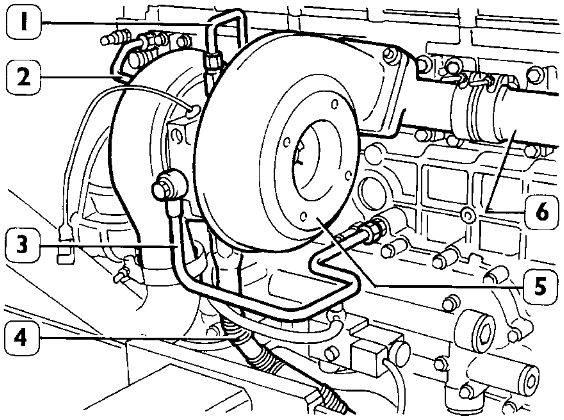
Figure 9



45254

Install extractor 99340051 (2) and remove the seal gaskets (1). Unscrew the screws and remove the cover.
Disconnect all electric connections and sensors.

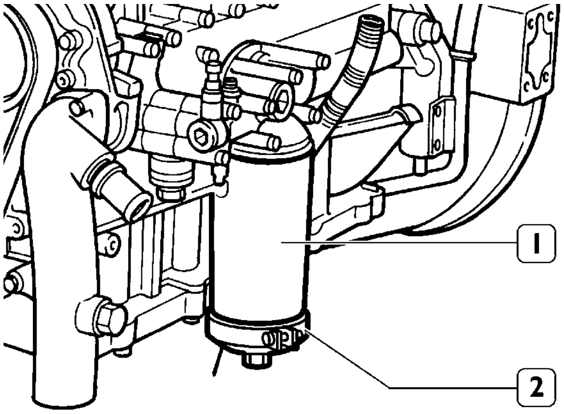
Figure 10



47566

Remove the following components: oil supply lines (1); water cooling supply lines (3); water discharge lines (2); oil return lines (4); turbocharger (5); exhaust manifold (6).

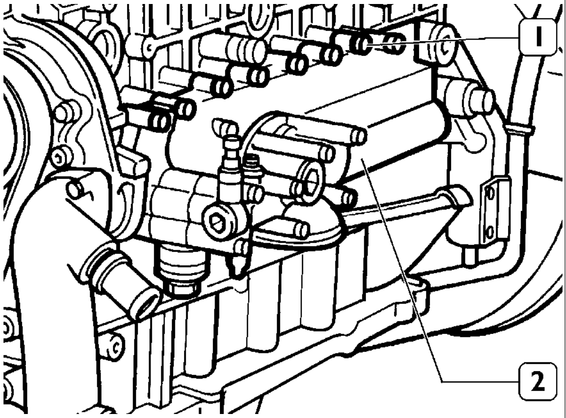
Figure 11



87205

Unscrew the oil filter (1) by tool 99360314 (2).

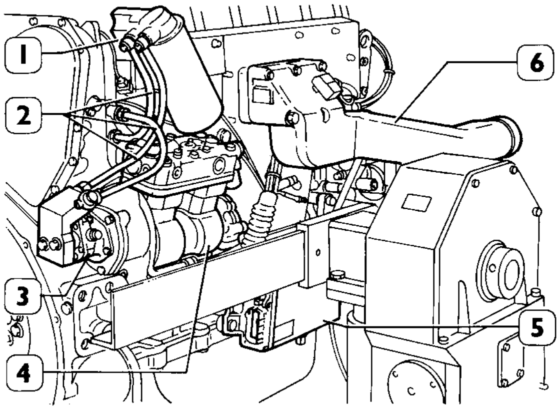
Figure 12



87206

Unscrew the screws (1) and remove the entire heat exchanger (2).

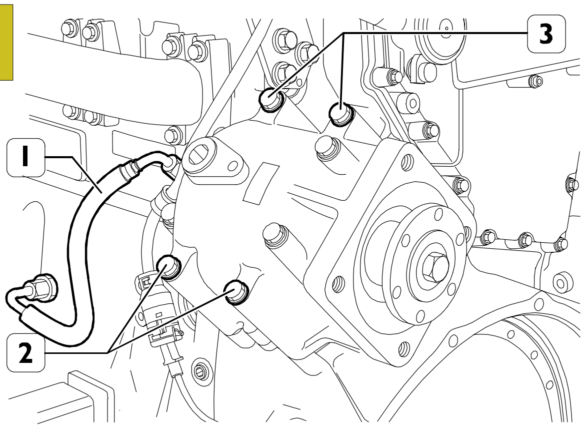
Figure 13



47587

Remove the following components: intake manifold (6); support for fuel filter (1); fuel lines (2); fuel pump (3);compressor (4); control unit (5).

Figure 14



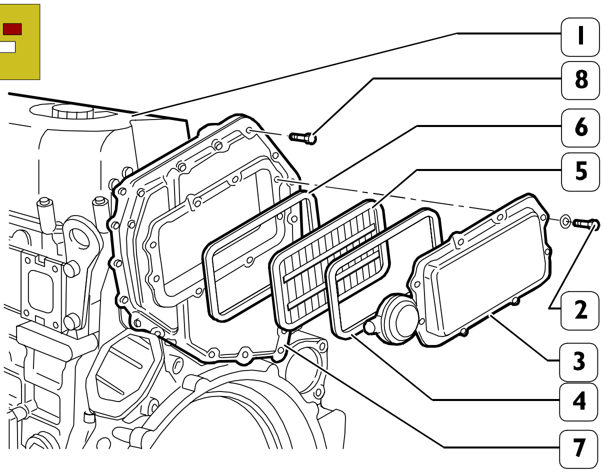
70708

To remove the P.T.O. (if applicable):

☐ Disconnect the oil pipe (1).

☐ Unscrew the 4 screws (2) and (3).

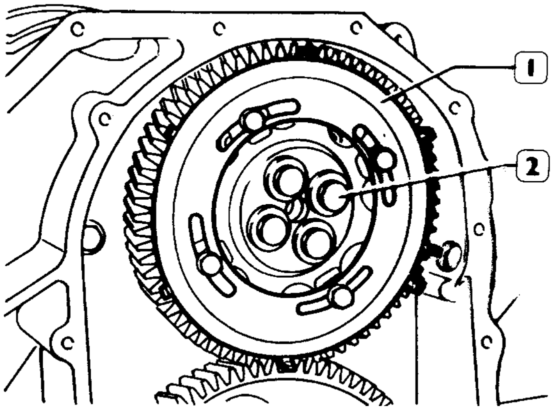
Figure 15



84377

Remove the rocker arm cover (1), take off the screws (2) and remove: the cover (3), the filter (5) and the gaskets (4 and 6). Take off the screws (8) and remove the blow-by case (7).

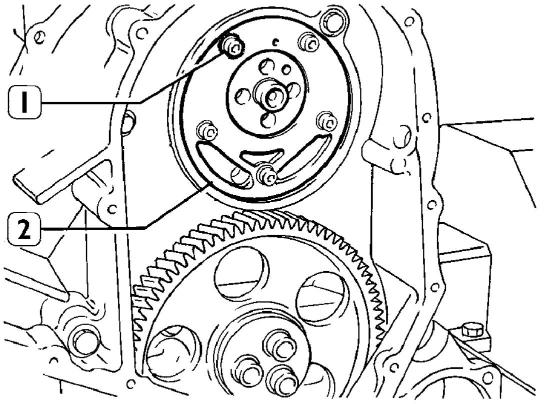
Figure 16



45661

Unscrew the screws (2), by using the proper wrench and remove the gear (1) with the phonic wheel.

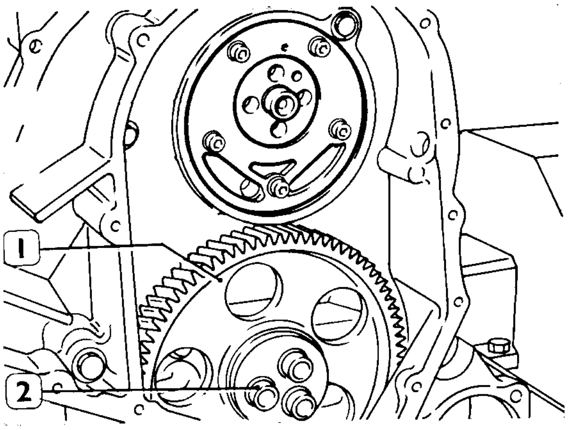
Figure 17



86289

Unscrew the screws (1); tighten a screw in a reaction hole and remove the shoulder plate (2), remove the sheet gasket.

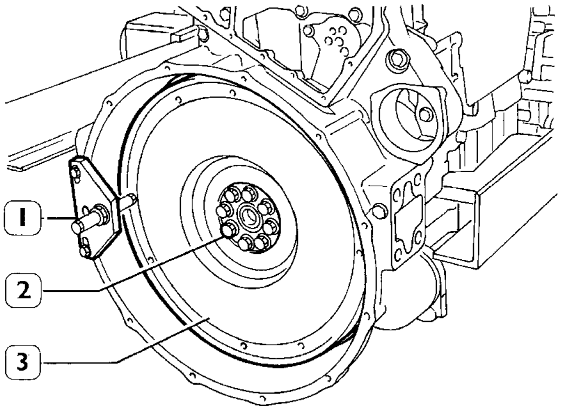
Figure 18



47568

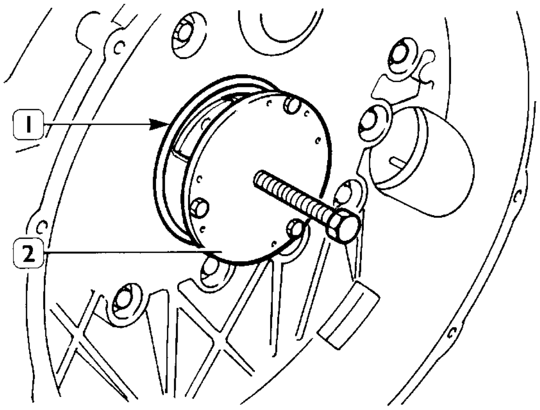
By means of a properly splined wrench, untighten screws (2) and remove the transmission gear (1)

Figure 19



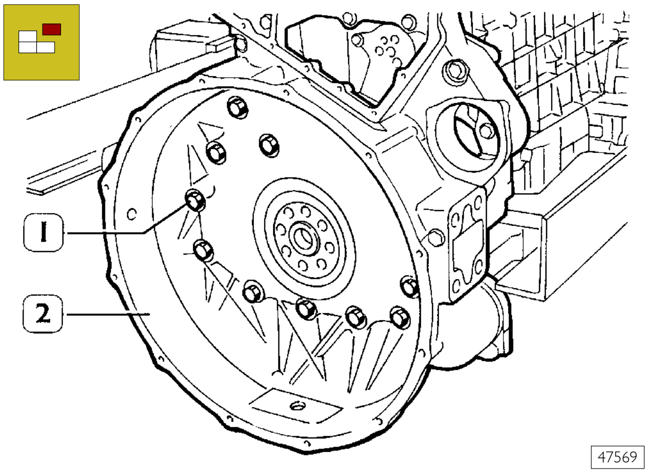
Stop the engine flywheel (3) rotation by means of tool 99360351 (1), untighten the fixing screws (2) and remove the engine flywheel.

Figure 20



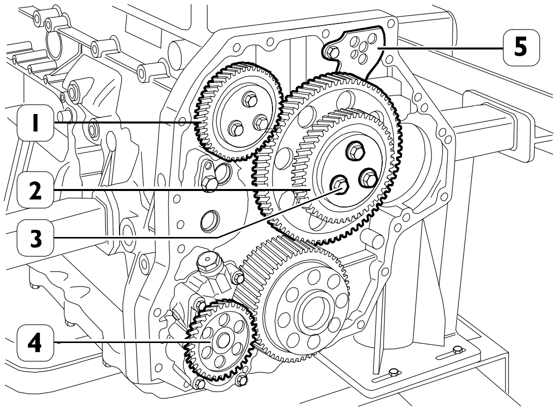
Apply extractor 99340052 (2) and pull out the seal gasket (1).

Figure 21



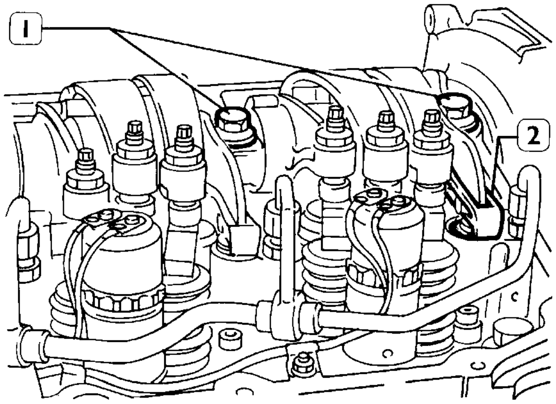
Untighten the screws (1) and take down the gear box (2).

Figure 22



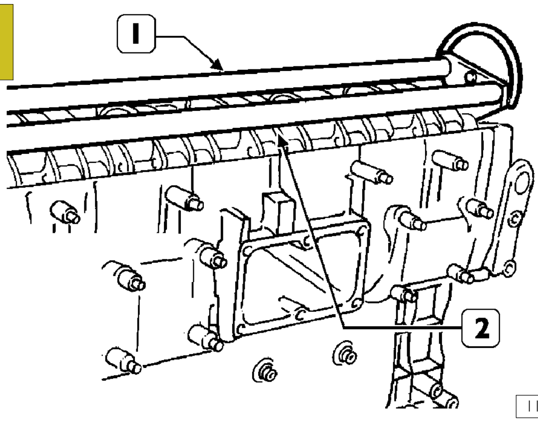
If present, dismount P.T.O. driving gear (1).
Remove screws (3) and dismount double gear (2).
Remove securing screw and dismount articulated rod (5).
Dismount oil pump (4).

Figure 23



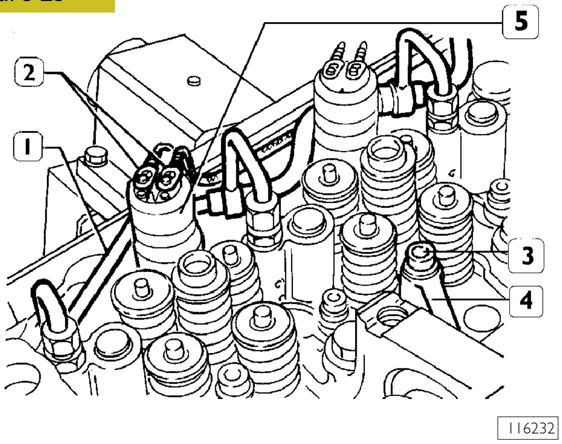
- ☐ Remove the check springs (2) of the exhaust brake lever;
- ☐ Untighten the fixing screws (1) of rocker arm shaft.

Figure 24



- ☐ Apply tool 99360558 (1) to the rocker holder shaft (2) and remove the shaft (2) from the cylinder head.

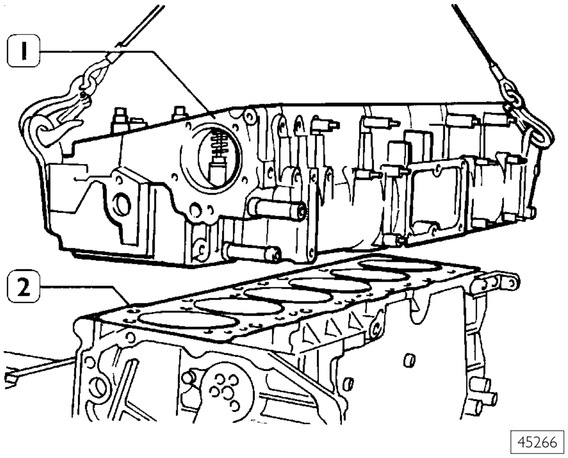
Figure 25



- ☐ Remove the piping (1) for exhaust brake pins;
- ☐ Untighten screws and remove electric connections (2) from solenoid valves;
- ☐ Untighten fixing screws (3) of injector brackets (4).
- ☐ Remove injectors (5).

Install plugs 99360177 instead of injectors.

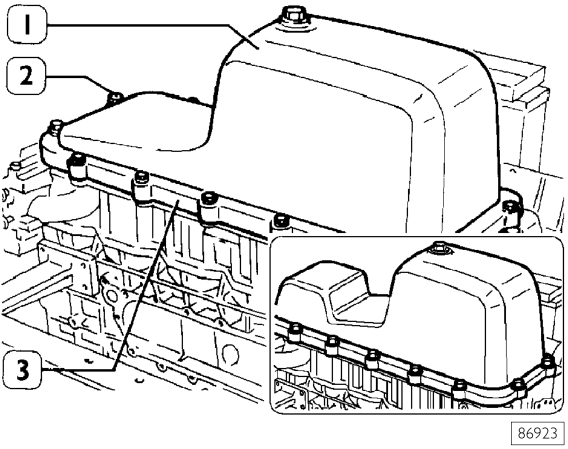
Figure 26



Remove the camshaft and the fixing screws on cylinder heads

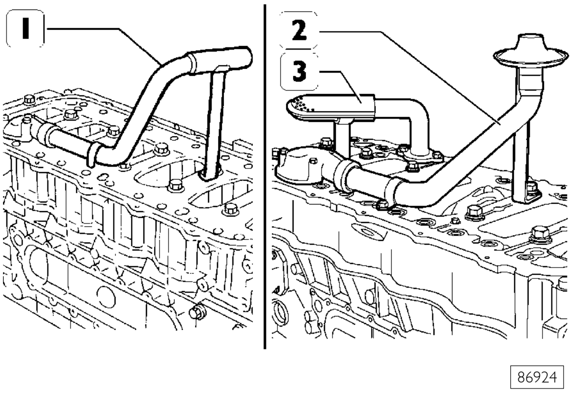
- ☐ By means of wire ropes, lift the cylinder head (1) and remove seals (2).

Figure 27



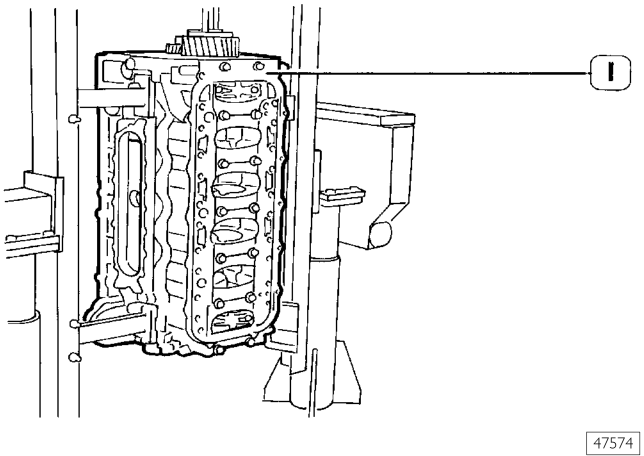
Untighten screws (2) and remove the engine oil sump (1) with spacer (3) and seal .
The box shows the oil sump mounted on the engines equipped with supplementary oil pump.

Figure 28



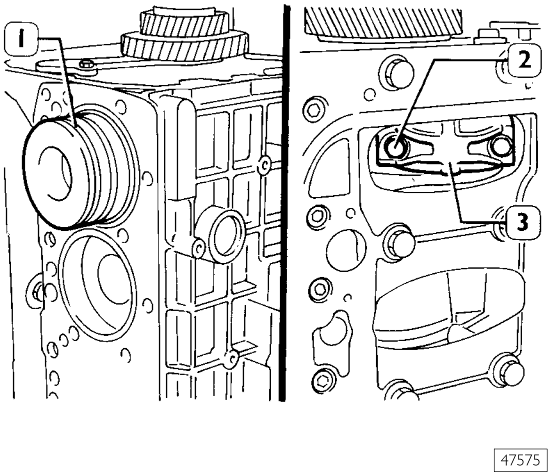
Remove the screws and the rose pipe (1).
For engines equipped with supplementary oil pump, remove the screws and take out strainers (2 and 3).

Figure 29



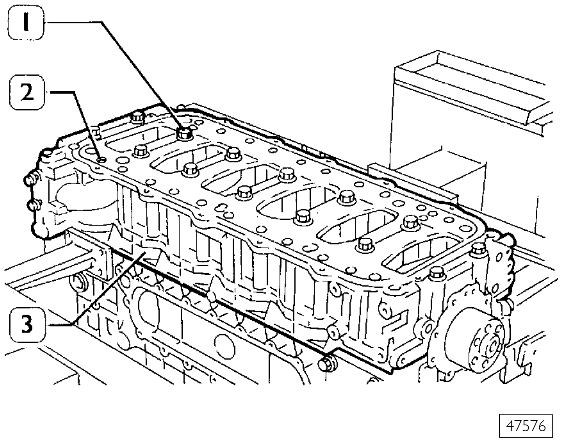
Rotate the block (1) to the vertical position.

Figure 30



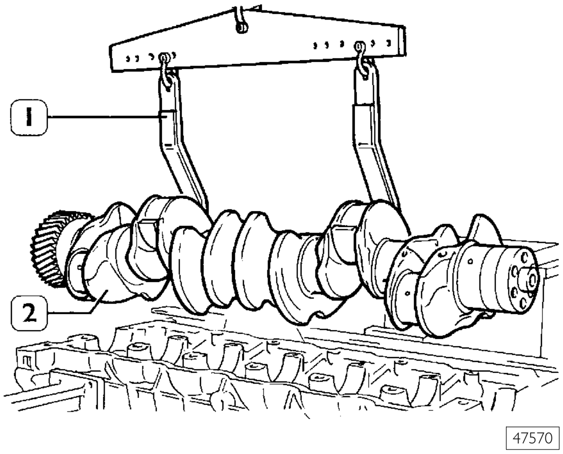
Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston assembly from the upper side. Repeat these operations for the other pistons.

Figure 31



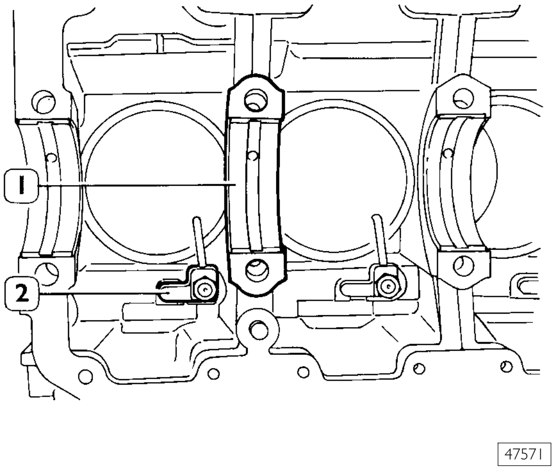
By means of proper and splined wrenches, untighten the screws (1) and (2) and remove the under-block (3).

Figure 32



Remove the crankshaft (2) with tool 99360500 (1).

Figure 33



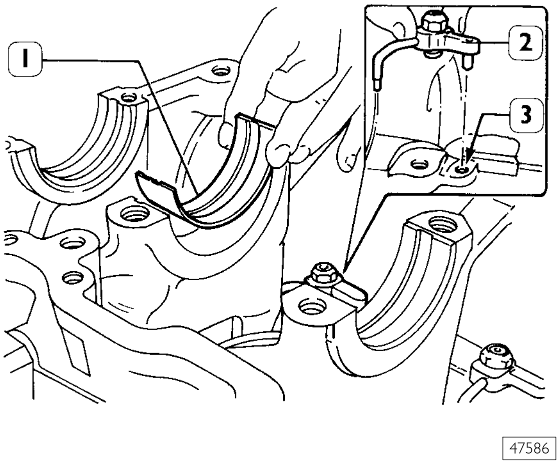
Remove the crankshaft half-bearings (1), untighten the screws and remove oil spray nozzles (2).
Take down cylinder liners as specified in the relative paragraph.

NOTE After disassembling the engine, thoroughly clean disassembled parts and check their integrity.
Instructions for main checks and measures are given in the following pages, in order to determine whether the parts can be re-used.

ASSEMBLING THE ENGINE ON THE BENCH

Fix the engine block to the stand 99322230 by means of brackets 99361035.
Mount cylinder liners (see Section 4).

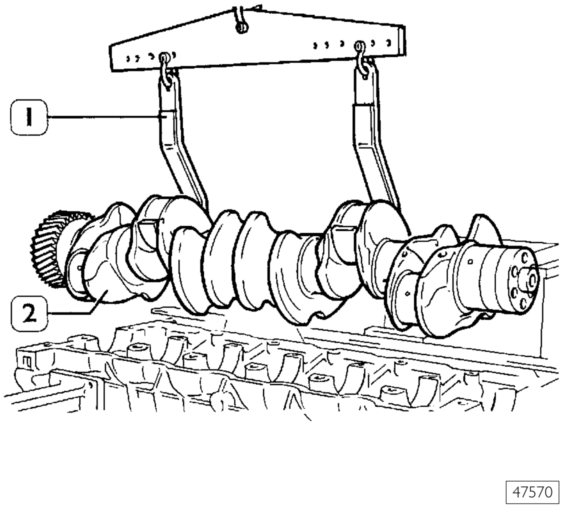
Figure 34



Fit the oil spray nozzles (2), so that the dowel coincides with the block hole (3).

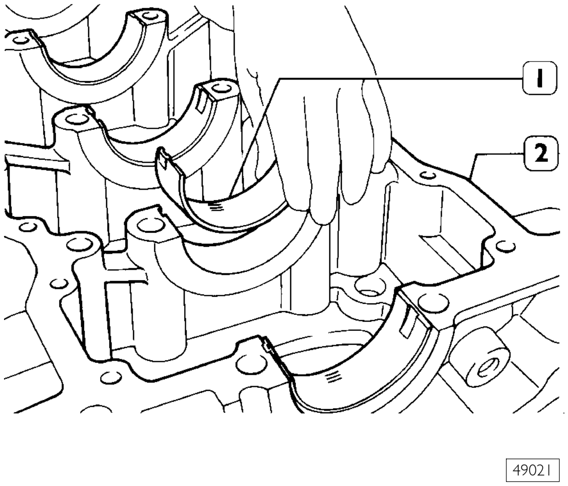
Place the half bearings (1) on the main bearings.

Figure 35



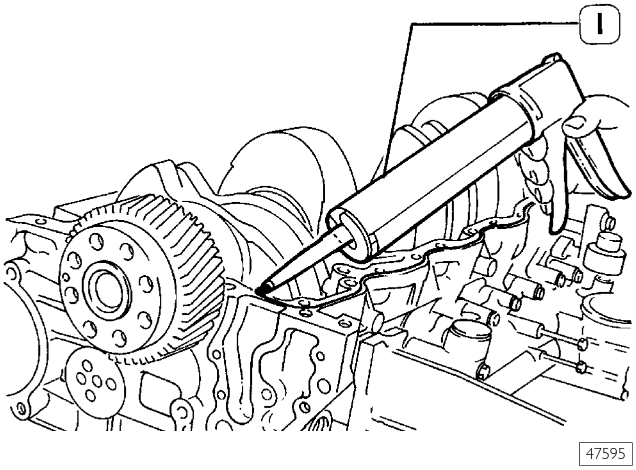
Lubricate the half bearings, then install the crankshaft (2) by means of hoist and hook 99360500 (1).

Figure 36



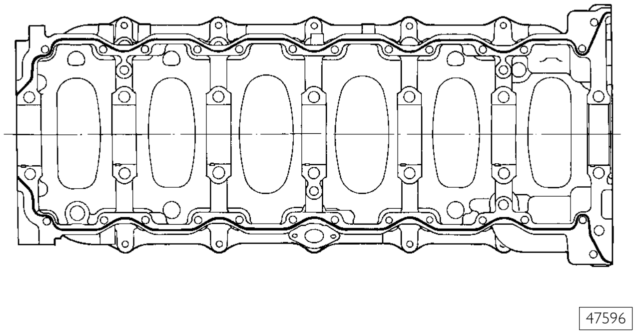
Place the half-bearings (1) on the main bearings in the underblock (2).

Figure 37



Use the suitable equipment (1) to apply silicone LOCTITE 5970 (IVECO No. 2995644) as shown in the following figure.

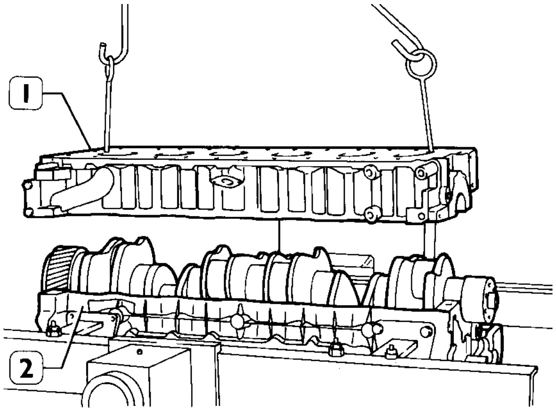
Figure 38



Sealant application diagram

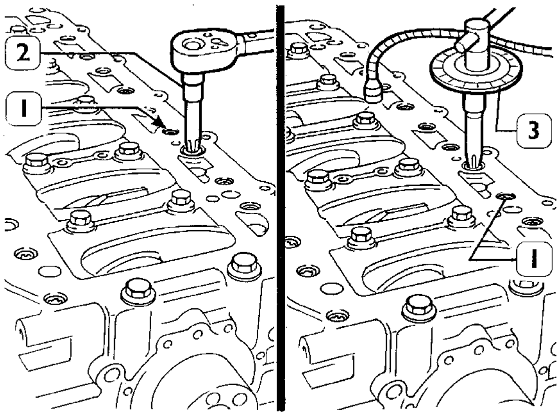
NOTE Fit the underblock within 10' of the application of the sealant.

Figure 39



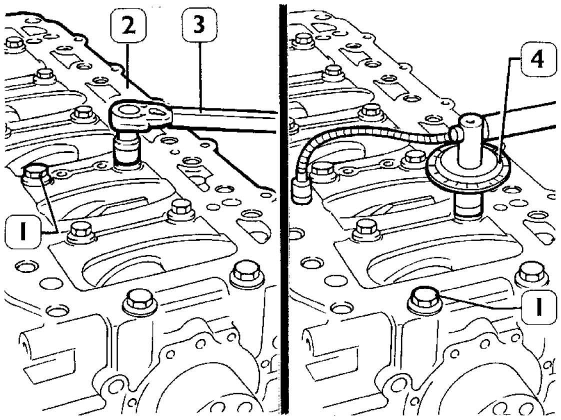
Fit the underblock by means of a suitable hoist and hooks (1).

Figure 40



Fit the engine block and use the dynamometric wrench (2) to lock the hexagonal threaded screws(1) to torque 25 Nm on the basis of the diagrams on the following page.

Figure 41

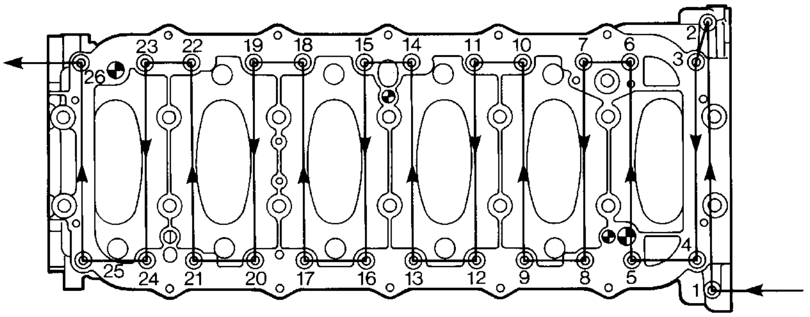


Close the inner screws (1) to 140 Nm torque by means of a dynamometric wrench (3), then with two further angular phases 60° + 60°, using tool 99395216 (4). Tighten again the outer screws (1, Figure 40) with 90° angular closing, using tool 99395215 (3, Figure 40).

Diagram showing the underblock fixing screws tightening order

Figure 42

FRONT SIDE

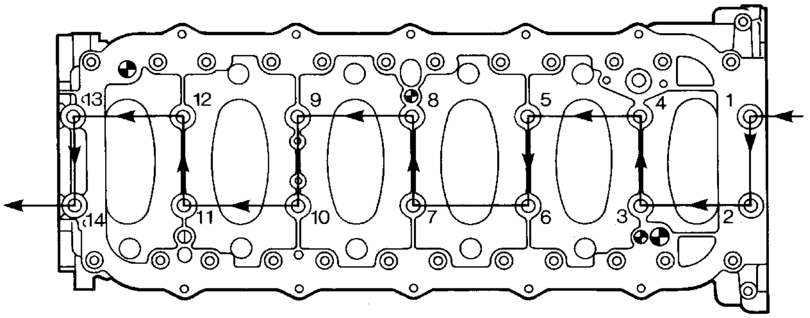


First phase: outer screws preliminary tightening

(25 Nm)

44897

FRONT SIDE

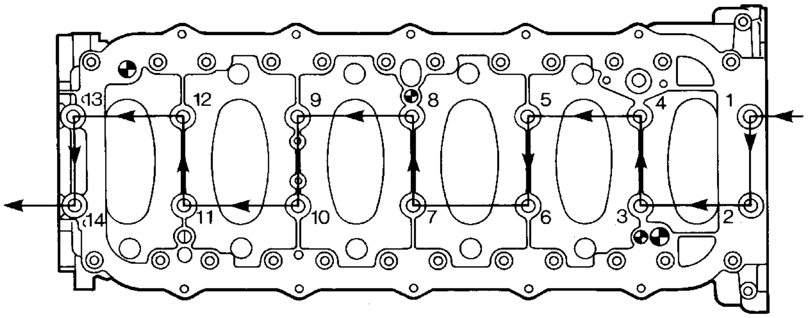


Second phase: inner screws preliminary tightening

(140 Nm)

44898

FRONT SIDE

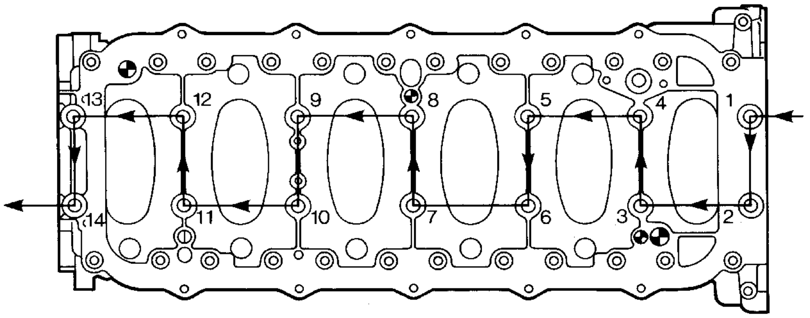


Third phase: inner screws angle closing

(60°)

44898

FRONT SIDE

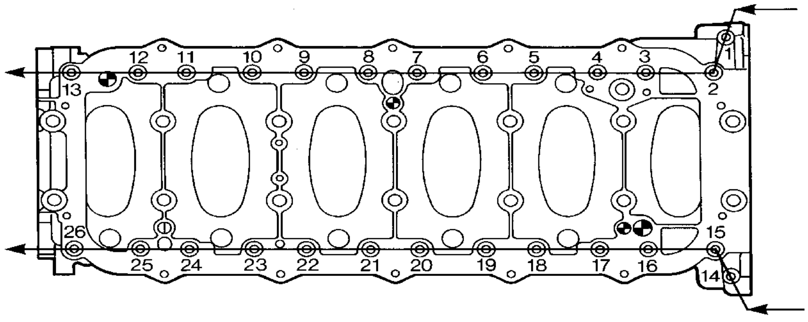


Fourth phase: inner screws angle closing

(60°)

44898

FRONT SIDE



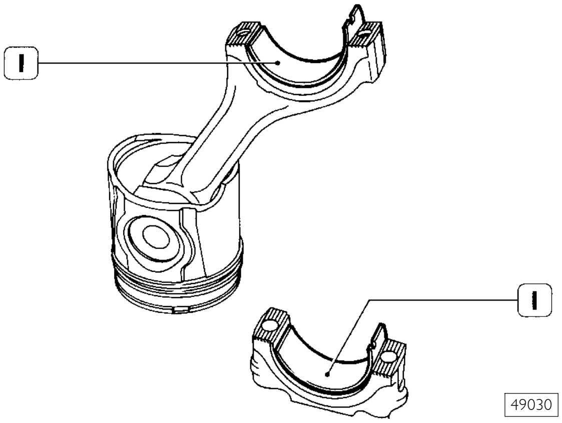
Fifth phase: outer screws angle closing

(90°)

44899

Fitting the connecting rod-piston assembly into the cylinder liners

Figure 43



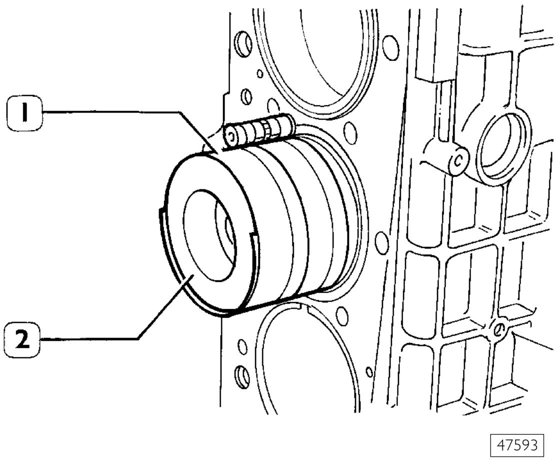
Rotate the cylinder assembly placing it vertically.

NOTE Not finding it necessary to replace the connecting rod bearings, you need to fit them back in exactly the same sequence and position as in removal.
If they are to be replaced, choose connecting rod bearings based on selection described in Section 4.

Lubricate the half-bearings (1) and fit them in the connecting rod and the cap.

NOTE Do not make any adjustment on the bearing shells.

Figure 45

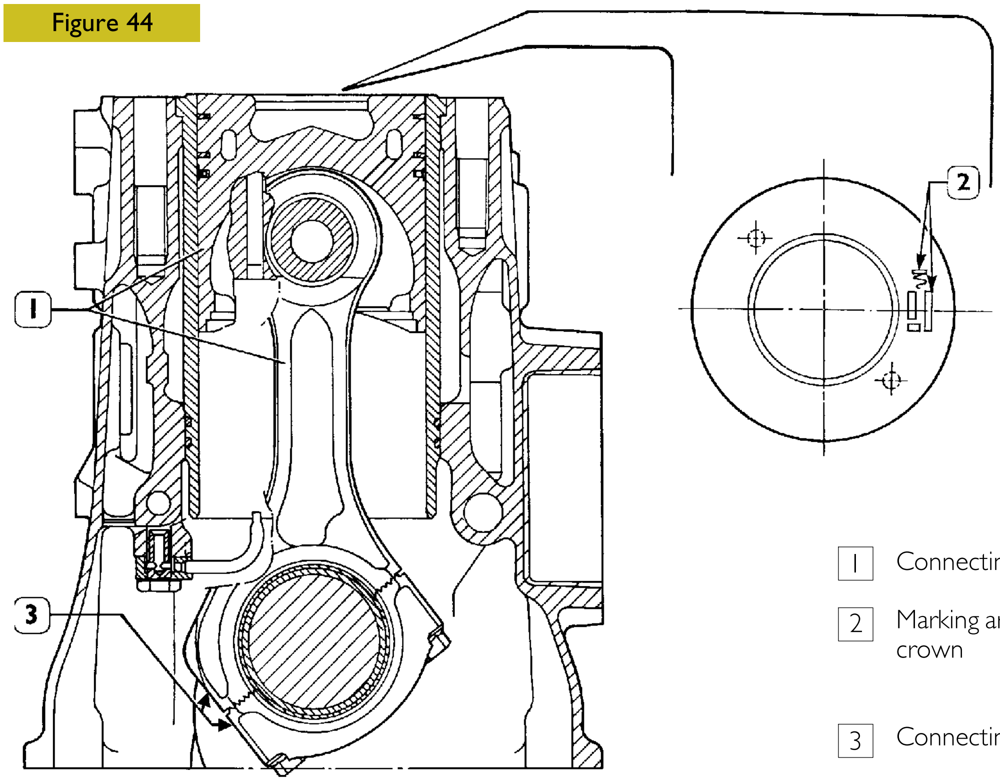


Fit the connecting rod-piston assemblies (2) into the piston liners, using the band 99360605 (1). Check the following:

- ☐ the openings of the split rings are offset by 120°;
- ☐ all pistons belong to the same class, A or B;
- ☐ ideogram (2, Figure 44), stamped on the piston crown, is placed toward the engine flywheel, or the cavity, on the piston skirt, corresponds to the position of the oil spray nozzles

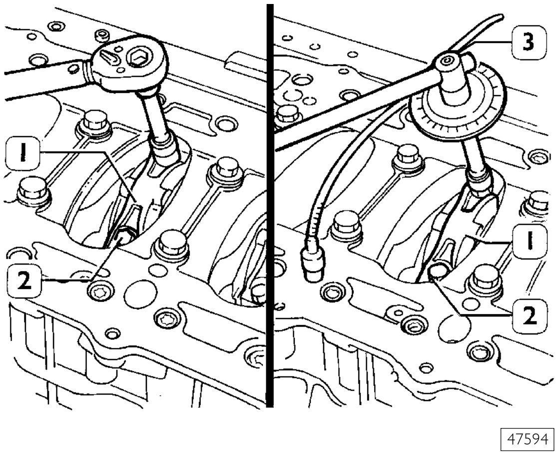
NOTE The pistons are supplied as spares in class A and can also be fitted in class B cylinder liners.

Figure 44



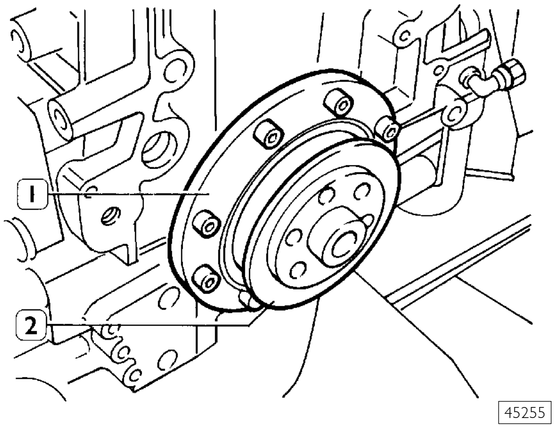
1	Connecting rod-piston assembly
2	Marking area of ideogram on the piston crown
3	Connecting rod marking area

Figure 46



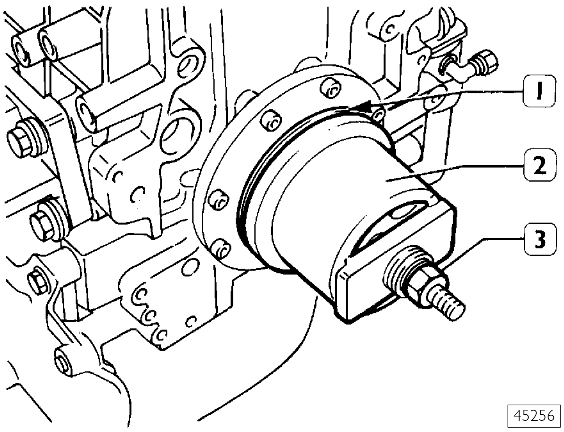
Connect the connecting rods to the relative journals, fit the connection rod caps (1) with half bearings; tighten the fixing screws (2) of the connecting rod caps to 50 Nm torque (5 kgm). Using tool 99395216 (3), further tighten screws with 40° angle.

Figure 47



By means of centering ring 99396033 (2), check the exact cover position (1), otherwise act as necessary and tighten the screws.

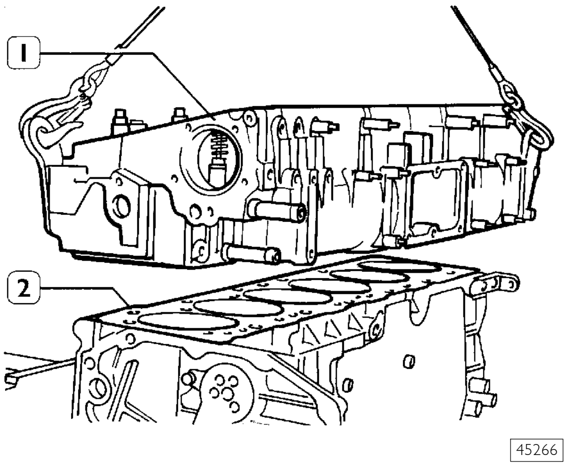
Figure 48



Fit the sealing gasket (1), install the fitting tool 99346245 (2) and drive the sealing gasket (1) by screwing nut (3).

Mounting cylinder head

Figure 49



Make sure that pistons 1-6 are exactly at the TDC Place the sealing gasket (2) on the block. Fit the cylinder head (1) and tighten screws as shown in figs. 50, 51 and 52.

Figure 50

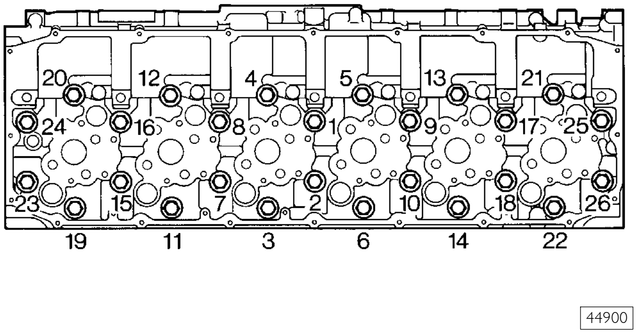
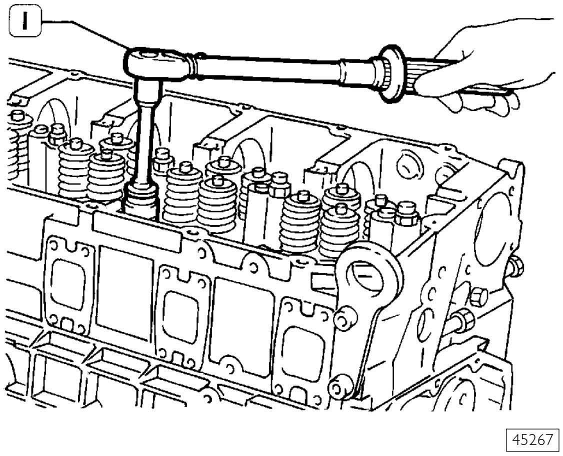


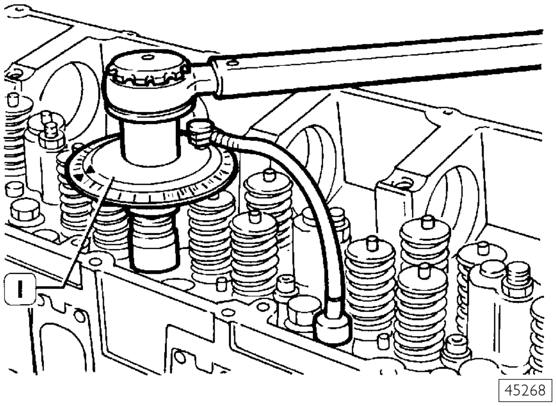
Diagram showing the cylinder head fixing screws tightening order.

Figure 51



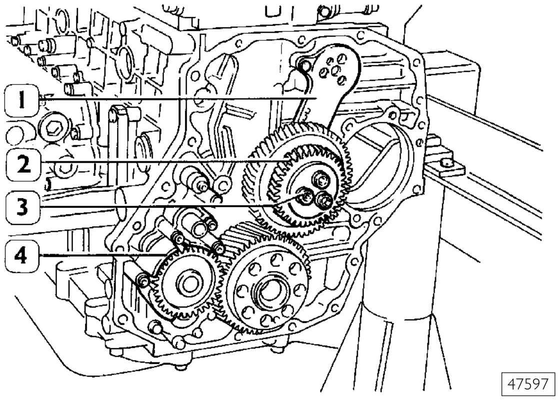
☐ Preliminary tightening by means of a dynamometric wrench (1):
1st phase: 50 Nm (5 kgm)
2nd phase: 100 Nm (10 kgm)

Figure 52



❑ Angle closing by means of tool 99395216 (1):
3rd phase: 90° angle
4th phase: 75° angle

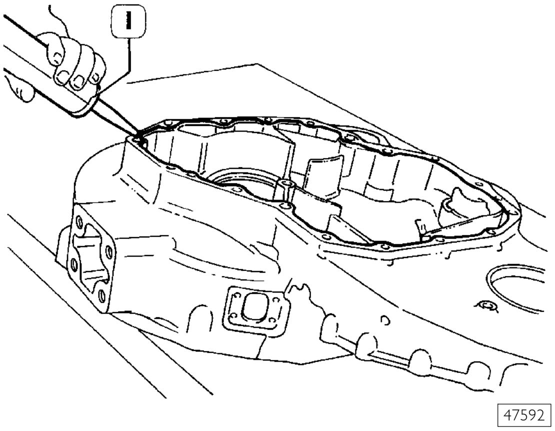
Figure 53



Fit the oil pump (4), intermediate gears (2) with rod (1) and tighten screws (3) in two phases:

preliminary tightening	30 Nm
angle closing	90°

Figure 54



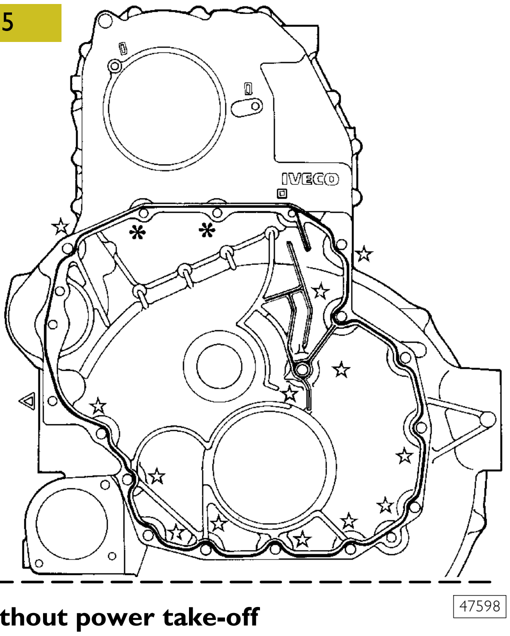
Apply sealant LOCTITE 5970 IVECO No. 2992644 to the gear box using the proper equipment (1).

The sealer string (1) diameter is to be $1,5 \pm^{0.5}_{0.2}$ mm.

NOTE Install the gear box within 10' of the application of the sealant.

Tighten the screws shown in the figure by means of a dynamometric wrench, in compliance with the following order and tightening torque:

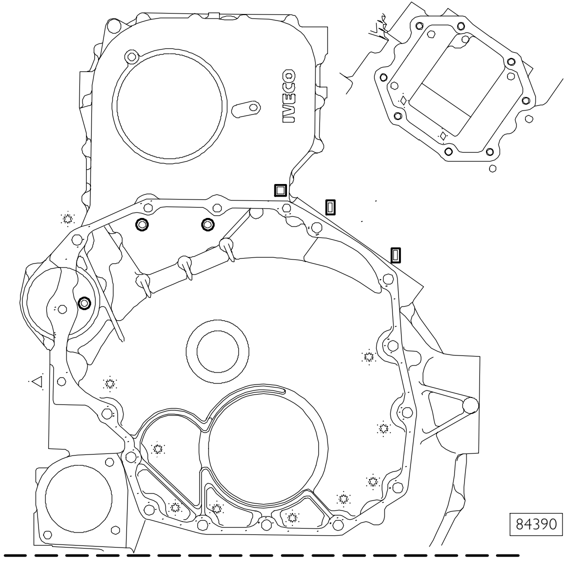
Figure 55



Engines without power take-off

☆	no. 13 screws M12 x 1.75 x 80 tightening torque 63 Nm
✳	no. 3 screws M10 x 1.5 x 35 tightening torque 42 Nm
□	no. 1 screw M10 x 1.5 x 100 tightening torque 42 Nm
△	no. 1 screw M10 x 1.5 x 180 tightening torque 42 Nm
▭	no. 2 screws M18 x 1.25 x 125 tightening torque 24 Nm

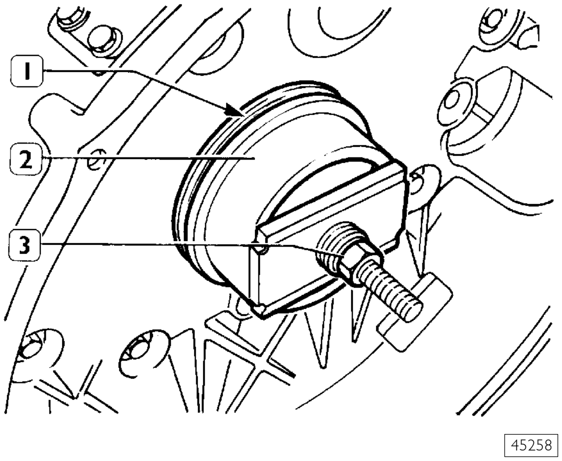
Figure 56



Engines with power take-off (if available)

☆	no. 10 screws M12 x 1.75 x 80 tightening torque 63 Nm
⊙	no. 3 screws M10 x 1.5 x 35 tightening torque 42 Nm
□	no. 1 screw M10 x 1.5 x 170 tightening torque 42 Nm
△	no. 1 screw M10 x 1.5 x 180 tightening torque 42 Nm
▭	no. 2 screws M12 x 1.75 x 125 tightening torque 63 Nm
○	no. 8 screw M10 x 1,5 x 120
◊	no. 2 screw M10 x 1,5 x 120 (apply to the thread LOCTITE 275)

Figure 57



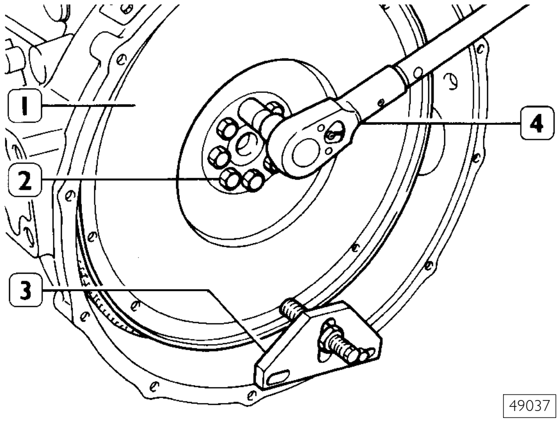
Fit the sealing gasket (1), install the fitting tool 99346246 (2) and drive the sealing gasket by screwing the nut (3).

Fitting engine flywheel

NOTE If the teeth of the ring gear mounted on the engine flywheel, for starting the engine, are very damaged, replace the ring gear. It must be fitted after heating the ring gear to a temperature of approx. 200°C.

NOTE The crankshaft has a locating peg that has to couple with the relevant seat on the engine flywheel.

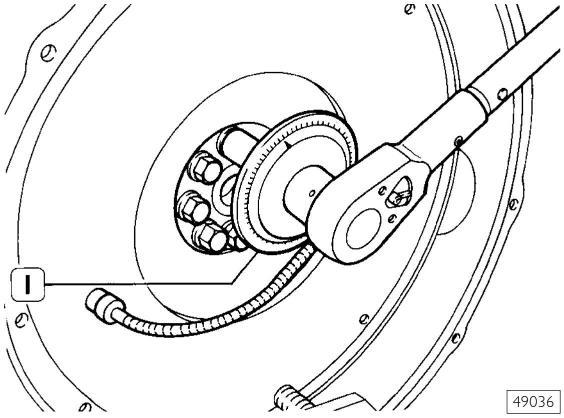
Figure 59



Position the flywheel (1) on the crankshaft, lubricate the thread of the screws (2) with engine oil and screw them down. Lock rotation with tool 99360351 (3). Lock the screws (2) in three phases.

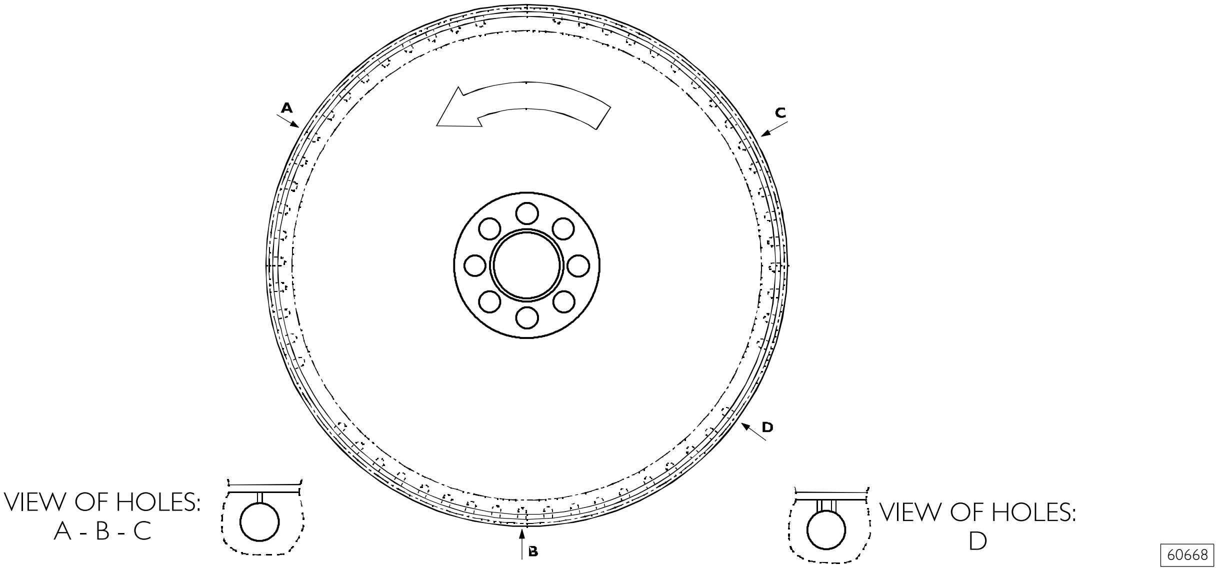
First phase: pre-tightening with torque wrench (4) to a torque of 100 Nm (10 kgm).

Figure 60



Second phase: closing to angle of 60° with tool 99395216 (1).

Figure 58

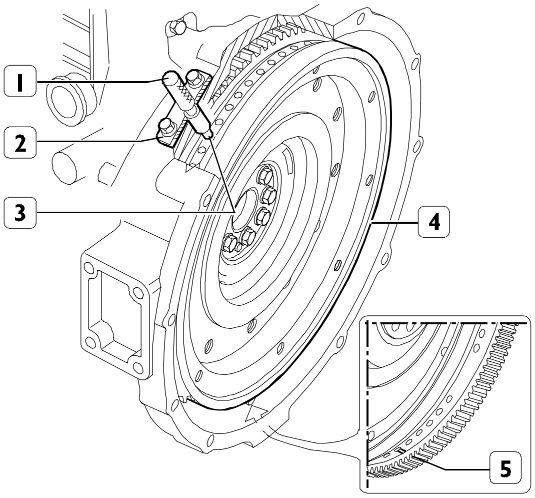


DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS

A. Hole on flywheel with one reference mark, corresponding to the TDC of pistons 3-4. - B. Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6. - C. Hole on flywheel with one reference mark, corresponding to the TDC of pistons 2-5. - D. Hole on flywheel with two reference marks, position corresponding to 54°.

Fitting camshaft

Figure 61



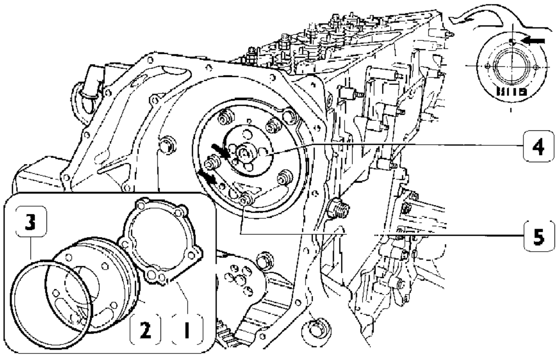
72436

Position the crankshaft with the pistons 1 and 6 at the top dead centre (T.D.C.).
This situation occurs when:

1. The hole with reference mark (5) of the engine flywheel (4) can be seen through the inspection window.
2. The tool 99360612 (1), through the seat (2) of the engine speed sensor, enters the hole (3) in the engine flywheel (4).

If this condition does not occur, turn the engine flywheel (4) appropriately.
Remove the tool 99360612 (1).

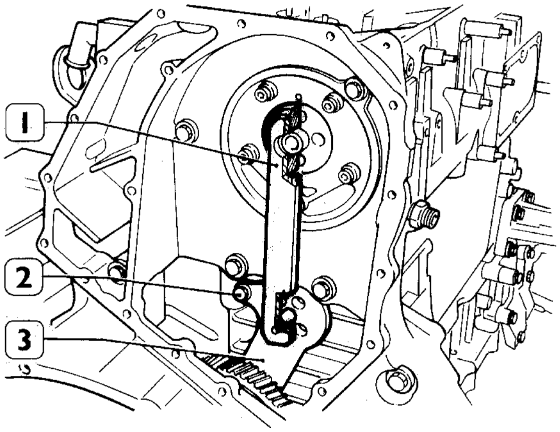
Figure 62



73843

Fit the camshaft (4), positioning it observing the reference marks (→) as shown in the figure.
Lubricate the seal (3) and fit it on the shoulder plate (2).
Mount the shoulder plate (2) with the sheet metal gasket (1) and tighten the screws (5) to the required torque.

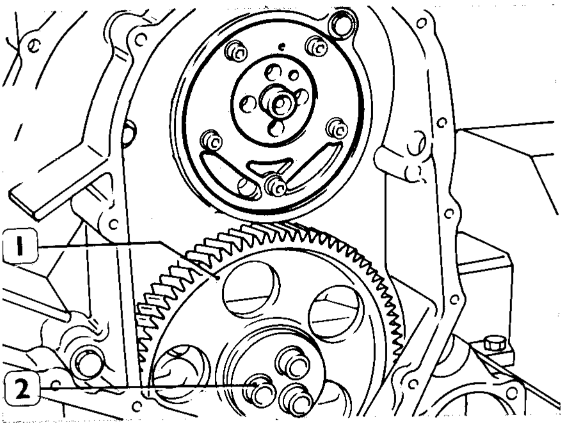
Figure 63



45376

☐ Apply gauge 99395215 (1), check and record the position of the rod (3) for the transmission gear, tighten the screw (2) to the prescribed torque.

Figure 64

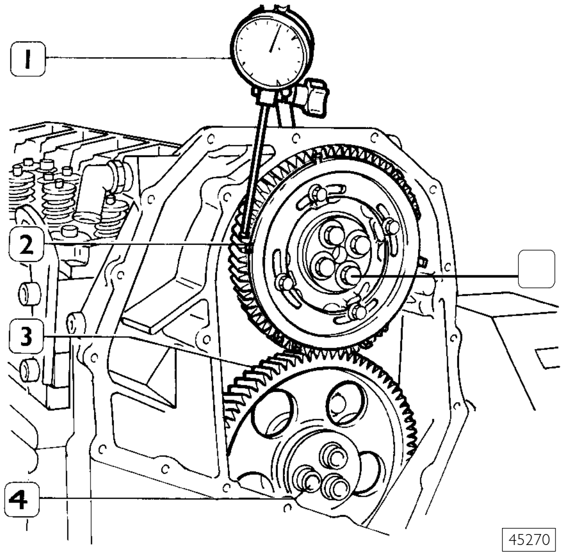


45269

☐ Remove the transmission gear (1) and tighten screws (2) by means of proper splined wrench, to the prescribed torque.

NOTE Replace the idle gear bushing (1) when wear is detected. After installing the bushing, adjust it to j 58.010 ± 0.10 mm.

Figure 65



Position the gear (2) on the camshaft so that the 4 slots are centred with the holes for fixing the camshaft, without fully locking the screws (5).
Using the dial gauge with a magnetic base (1), check that the clearance between the gears (2 and 3) is 0.073 – 0.195 mm; if this is not so, adjust the clearance as follows:

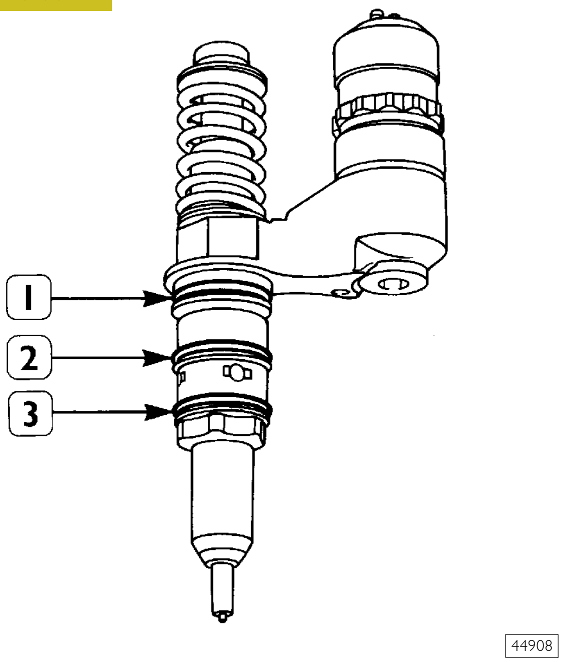
☐ Loosen the screws (4) fixing the idle gear (3).

☐ Loosen the screw (2, Figure 63) fixing the link rod. Shift the link rod (3, Figure 63) to obtain the required clearance.

☐ Lock the screw (2, Figure 63) fixing the link rod and screws (4, Figure 63) fixing the idle gear to the required torque.

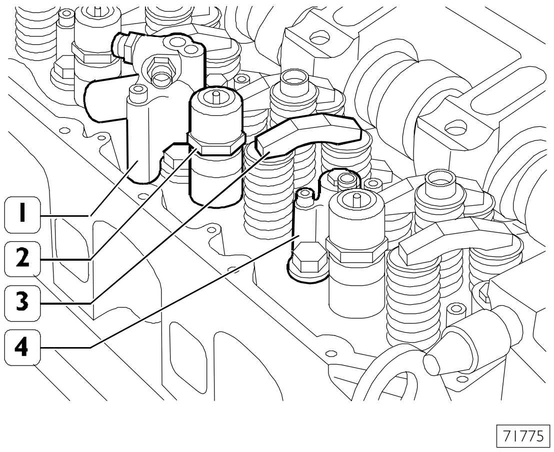
Fitting pump-injectors

Figure 66



Fit the seals (1) (2) (3) on the injectors.

Figure 67



Mount:

☐ The injectors (2) and, using a torque wrench, lock the bracket fixing screws to a torque of 36.5 Nm.

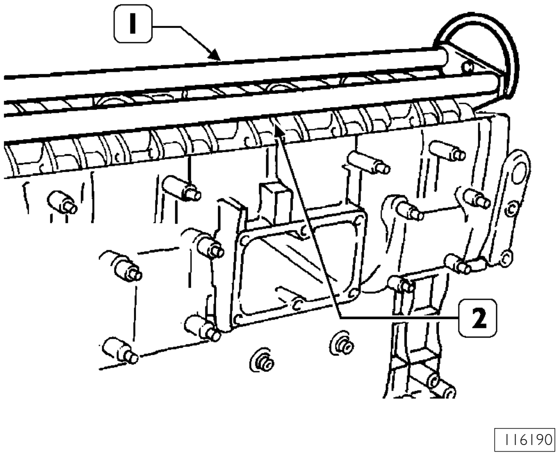
☐ The exhaust brake cylinders (1) and (4) and, using a torque wrench, fix them to a torque of 19 Nm.

☐ The crosspieces (3) on the valve stem, all with the largest hole on the same side.

Fitting rocker-arm shaft assembly

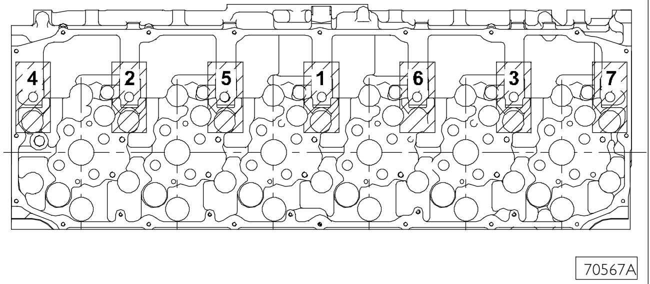
Figure 68

NOTE Before refitting the rocker-arm shaft assembly, make sure that all the adjustment screws have been fully unscrewed.



Apply the tool 99360553 (1) to the rocker arm shaft (5) and mount the shaft on the cylinder head.

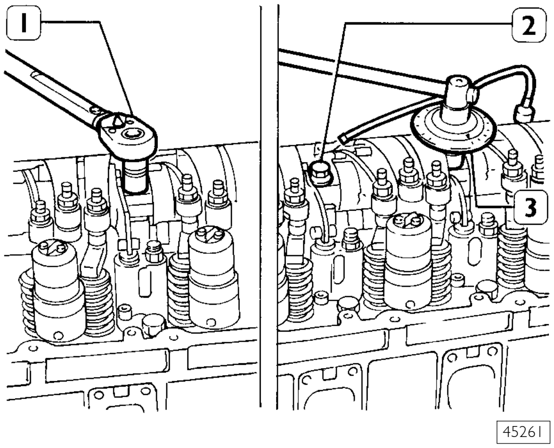
Figure 69



SCHEME OF SCREW TIGHTENING SEQUENCE SECURING ROCKER ARMS

Screw screws (1 - 2 - 3) until rocker arms are brought to contact relating seats on cylinder head, tighten the screws according to sequence indicated in figure operating in two steps as indicated in successive figure.

Figure 70

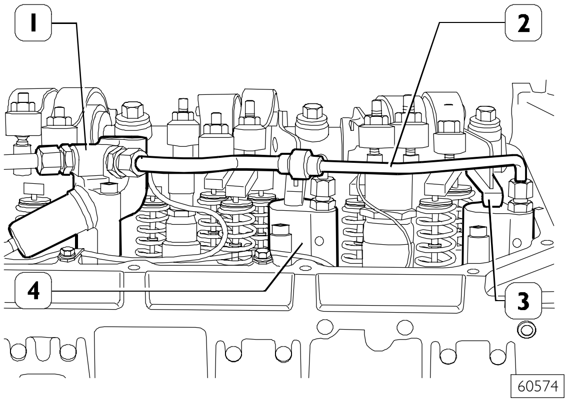


Lock the screws (2) fixing the rocker-arm shaft as follows:

☐ 1st phase: tightening to a torque of 40 Nm (10 kgm) with the torque wrench (1).

☐ 2nd phase: closing with an angle of 60° using the tool 99395216 (3).

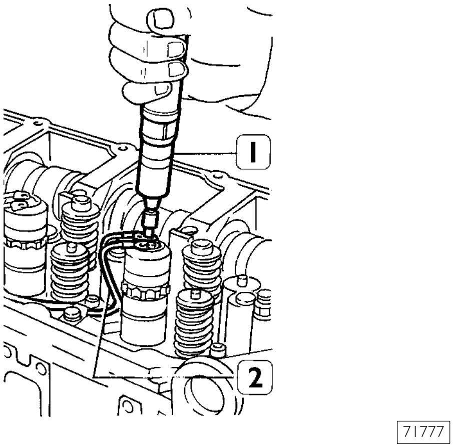
Figure 71



☐ Mount the engine brake lever retaining springs (3).

☐ Connect the pipe (2) to the engine brake cylinders (4) and to the cylinder with the engine brake solenoid valve (1).

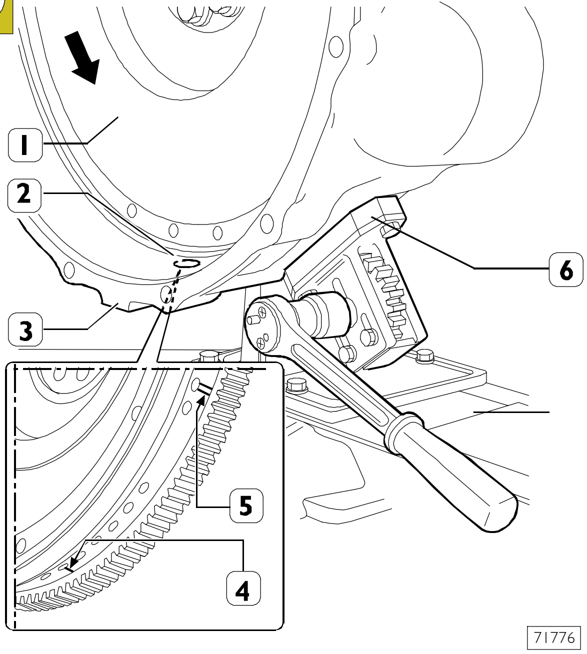
Figure 72



Mount the electric wiring (2), securing it on the electro-injectors with a torque screwdriver (1) to a torque of 1.36 - 1.92 Nm.

Camshaft timing

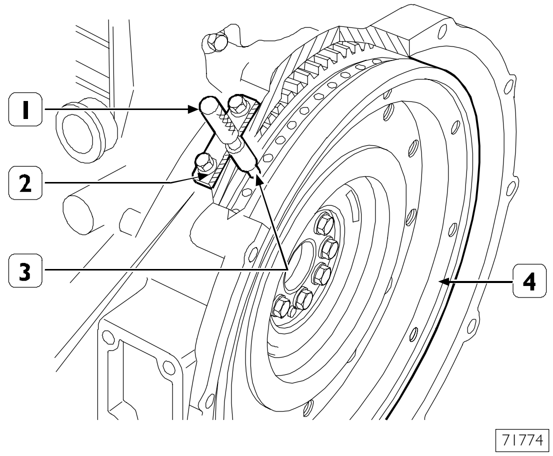
Figure 73



Apply the tool 99360321 (6) to the gearbox (3).

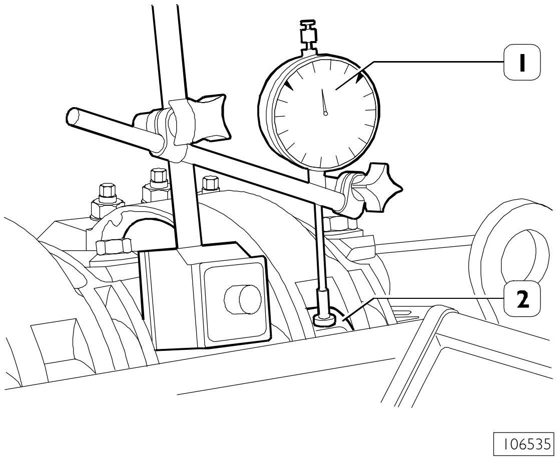
NOTE The arrow shows the direction of rotation of the engine when running.
Using the above-mentioned tool, turn the engine flywheel (1) in the direction of rotation of the engine so as to take the piston of cylinder no.1 to approximately the T.D.C. in the phase of combustion.
This condition occurs when the hole with one reference mark (4), after the hole with two reference marks (5) on the engine flywheel (1), can be seen through the inspection window (2).

Figure 74



The exact position of piston no.1 at the T.D.C. is obtained when in the above-described conditions the tool 99360612 (1) goes through the seat (2) of the engine speed sensor into the hole (3) in the engine flywheel (4).
If this is not the case, turn and adjust the engine flywheel (4) appropriately.
Remove the tool 99360612 (1).

Figure 75



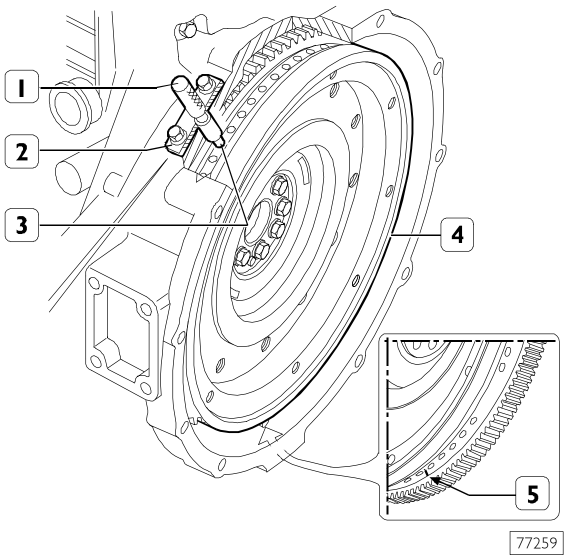
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

With tool 99360321 (6, Figure 73), turn the crankshaft clockwise until the pointer of the dial gauge reaches the minimum value beyond which it can no longer fall.

Reset the dial gauge.

Turn the engine flywheel anticlockwise until the dial gauge gives a reading for the lift of the cam of the camshaft of 4.90 ±0.05 mm.

Figure 76

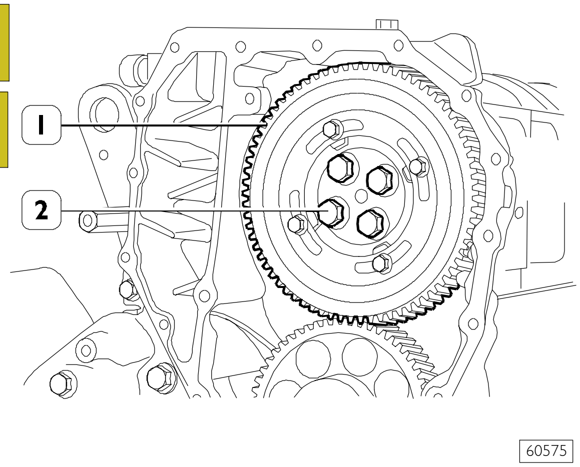


The camshaft is in step if at the cam lift values of 4.90 ±0.05 mm there are the following conditions:

1) the hole marked with a notch (5) can be seen through the inspection window;

2) the tool 99360612 (1) through the seat (2) of the engine speed sensor goes into the hole (3) in the engine flywheel (4).

Figure 77



If you do not obtain the conditions illustrated in Figure 76 and described in points 1 and 2, proceed as follows:

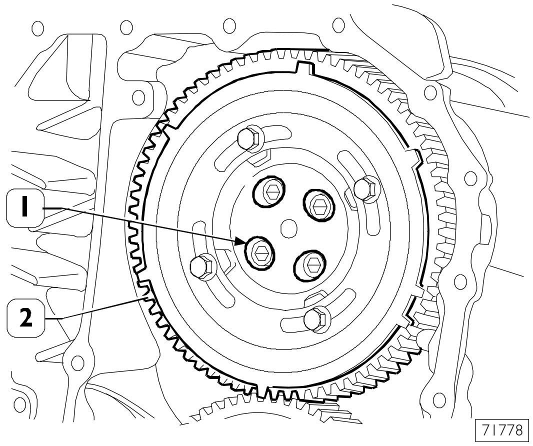
1) loosen the screws (2) securing the gear (1) to the camshaft and utilize the slots (1, Figure 78) on the gear (2, Figure 78);

2) turn the engine flywheel appropriately so as to bring about the conditions described in points 1 and 2 Figure 76, it being understood that the cam lift must not change at all;

3) lock the screws (2) and repeat the check as described above.

Tighten the screws (2) to the required torque.

Figure 78



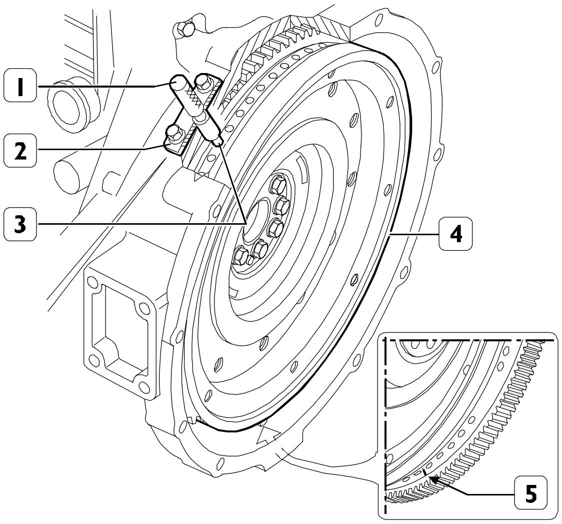
When the adjustment with the slots (1) is not enough to make up the phase difference and the camshaft turns because it becomes integral with the gear (2); as a result, the reference value of the cam lift varies, in this situation it is necessary to proceed as follows:

1) lock the screws (2, Figure 77) and turn the engine flywheel clockwise by approx. 1/2 turn;

2) turn the engine flywheel anticlockwise until the dial gauge gives a reading of the lift of the cam of the camshaft of 4.90 ±0.05 mm;

3) take out the screws (2, Figure 77) and remove the gear (2) from the camshaft.

Figure 79



Turn the flywheel (4) again to bring about the following conditions:

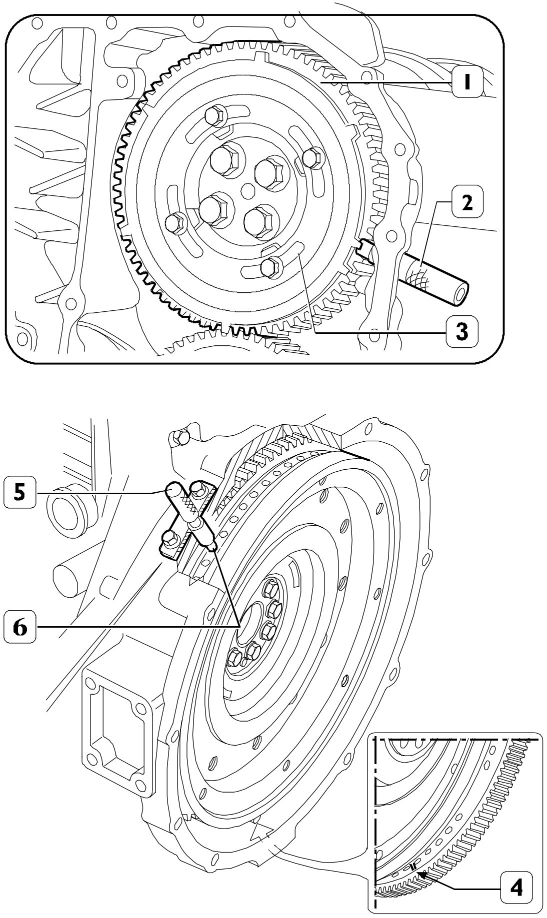
☐ a notch (5) can be seen through the inspection window;

☐ the tool 99360612 (1) inserted to the bottom of the seat of the engine speed sensor (2) and (3) on the flywheel (4).

Mount the gear (2, Figure 78) with the 4 slots (1, Figure 78) centred with the fixing holes of the camshaft, locking the relevant screws to the required tightening torque.
Check the timing of the shaft by first turning the flywheel clockwise to discharge the cylinder completely and then turn the flywheel anticlockwise until the dial gauge gives a reading of 4.90 ±0.05.
Check the timing conditions described in Figure 76.

Phonic wheel timing

Figure 80



Turn the crankshaft by taking the piston of cylinder no. 1 into the compression phase at T.D.C.; turn the flywheel in the opposite direction to the normal direction of rotation by approximately 1/4 of a turn.

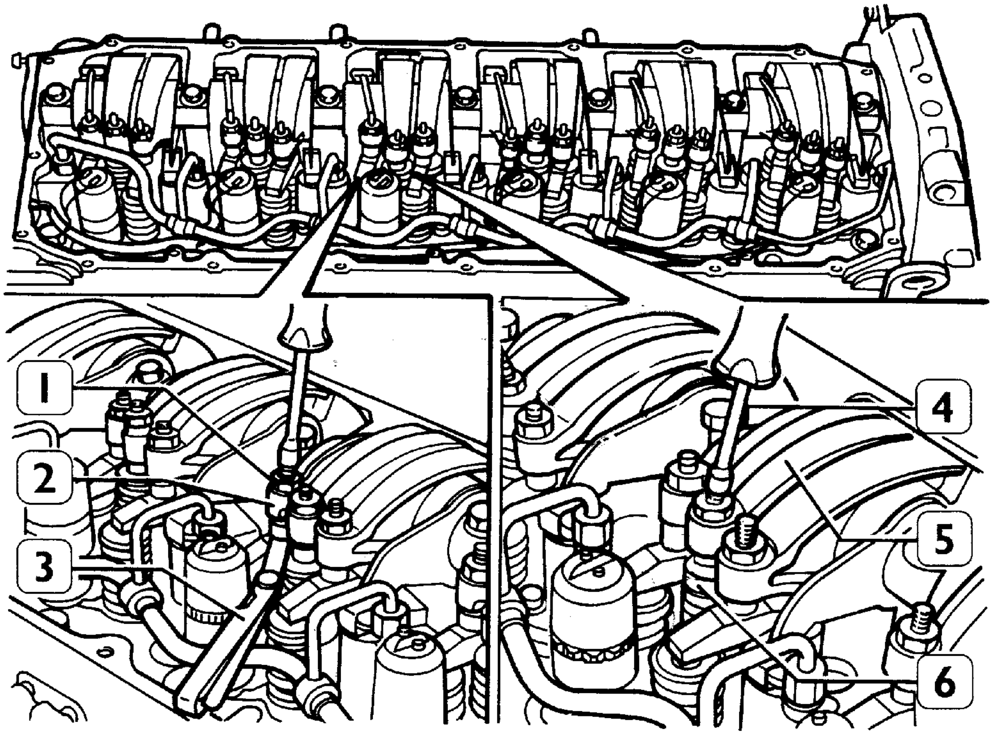
Again turn the flywheel in its normal direction of rotation until you see the hole marked with the double notch (4) through the inspection hole under the flywheel housing. Insert tool 99360612 (5) into the seat of the flywheel sensor (6).

Insert the tool 99360613 (2), via the seat of the phase sensor, onto the tooth obtained on the phonic wheel.

Should inserting the tool (2) prove difficult, loosen the screws (3) and adjust the phonic wheel (1) appropriately so that the tool (2) gets positioned on the tooth correctly. Go ahead and tighten the screws (3).

Intake and exhaust rocker play adjustment and pre-loading of rockers controlling pump injectors

Figure 81



ADJUSTMENT OF INTAKE, EXHAUST AND INJECTION ROCKERS

The adjustment of clearance between the rockers and rods controlling the intake and exhaust valves, as well as the adjustment of pre-loading of the rockers controlling pump injectors, must be carried out carefully.

Take the cylinder where clearance must be adjusted to the bursting phase; its valves are closed while balancing the symmetric cylinder valves.
Symmetric cylinders are 1-6, 2-5 and 3-4.

In order to properly operate, follow these instructions and data specified on the table.

<u>Adjustment of clearance between the rockers and rods controlling intake and exhaust valves:</u>

☐ use a polygonal wrench to slacken the locking nut (1) of the rocker arm adjusting screw (2).

☐ insert the thickness gauge blade (3);

☐ tighten or untighten the adjustment screw with the appropriate wrench;

☐ make sure that the gauge blade (3) can slide with a slight friction (for thickness values, refer to table "General features" in Section 4);

☐ lock the nut (1), by blocking the adjustment screw.

<u>Pre-loading of rockers controlling pump injectors:</u>

☐ using a polygonal wrench, loosen the nut locking the rocker adjustment screw (5) controlling the pump injector (6);

☐ using an appropriate wrench (4), loosen the adjustment screw until the pumping element is at the end-of-stroke;

☐ tighten the adjustment screw, with a dynamometric wrench, to 5 Nm tightening torque (0.5 kgm);

☐ untighten the adjustment screw by 1/2 to 3/4 rotation;

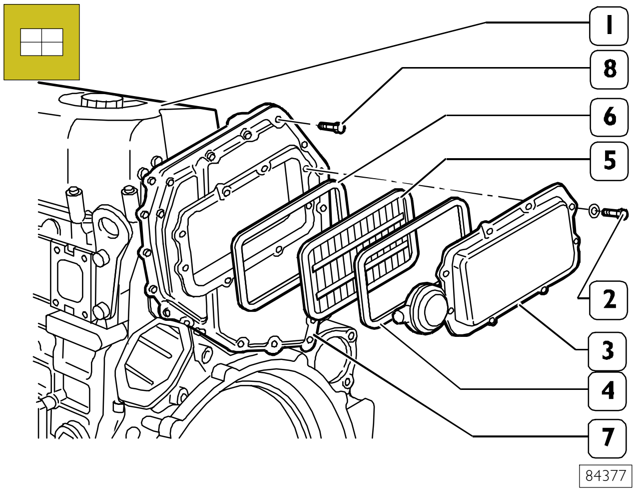
☐ tighten the locking nut.

FIRING ORDER <u>1-4-2-6-3-5</u>

Clockwise start-up and rotation	Adjusting cylinder valve no.	Adjusting clearance of cylinder valve no.	Adjusting pre-loading of cylinder injector no.
1 and 6 at TDC	6	1	5
120°	3	4	1
120°	5	2	4
120°	1	6	2
120°	4	3	6
120°	2	5	3

NOTE In order to properly carry out the above-mentioned adjustments, follow the sequence specified in the table, checking the exact position in each rotation phase by means of pin 99360612, to be inserted in the 11th hole in each of the three sectors with 18 holes each.

Figure 82



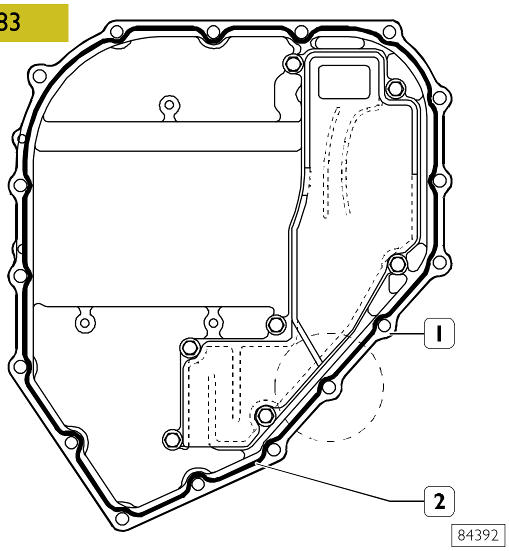
Fit the distribution cover (1).
Fit the blow-by case (7) and its gasket and then tighten the screws (8) to the prescribed torque.
Install the filter (5) and the gaskets (4 and 6).

NOTE The filter (5) operation is unidirectional, therefore it must be assembled with the two sight supports as illustrated in the figure.

Thoroughly clean cover (3) drain hole and suction ducts.
Fit the cover (3) and tighten the fastening screws (2) to the prescribed torque.

NOTE Apply silicone LOCTITE 5970 IVECO No. 29955644 on the blow-by case (7) surface of engines fitted with P.T.O. according to the procedure described in the following figure.

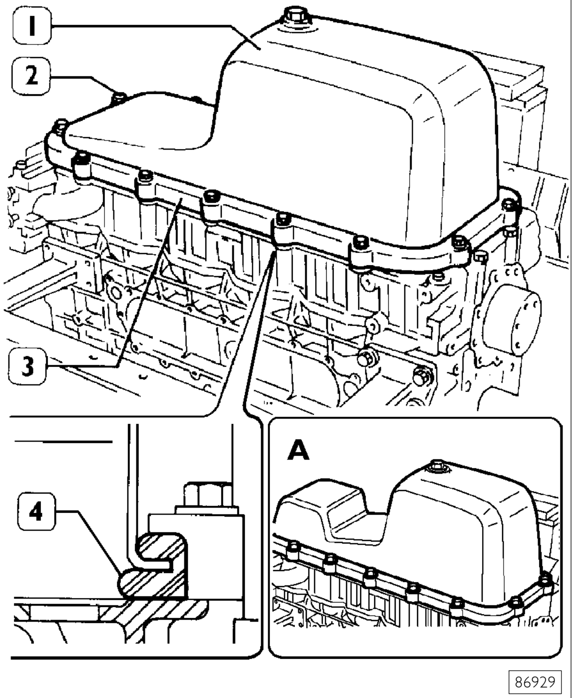
Figure 83



Apply silicone LOCTITE 5970 IVECO No. 2995644 on the blow-by case and form a string (2) of Ø $1.5 \pm {}^{0.5}_{0.2}$ as shown in the figure.

NOTE Fit the blow-by case (1) within 10' from sealer application.

Figure 84



Rotate the engine, then fit the oil suction strainer.
Place gasket (4) on oil sump (1), then position spacer (3) and fit the sump onto the engine base by tightening screws (2) to the specified torque.

ENGINE COMPLETION

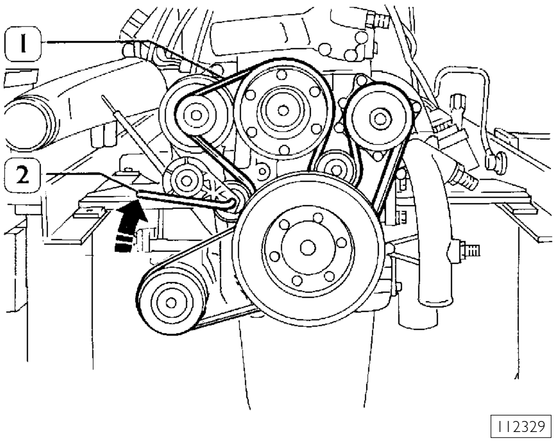
Make the engine complete by either fitting or disconnecting the items below:

- ☐ power take-off (P.T.O.), if any, and its respective pipes;
- ☐ air compressor complete with power steering pump;
- ☐ fuel pump;
- ☐ full fuel filter support and pipes;
- ☐ EDC control unit;
- ☐ intake manifold;
- ☐ preheating resistor;
- ☐ heat exchanger;
- ☐ oil filter (lubricate the gasket);
- ☐ exhaust manifold;
- ☐ turboblower and its respective water and oil pipes;
- ☐ damper flywheel and pulley;
- ☐ thermostat unit;
- ☐ belt stretcher, water pump and alternator;
- ☐ electromagnetic joint;
- ☐ drive belt;
- ☐ belt stretcher (if any), air-conditioner compressor;
- ☐ drive belt;
- ☐ oil level dipstick;
- ☐ electric connections and sensors.

NOTE The fittings of the cooling water and lubricating oil pipes of the turbocharger have to be tightened to a torque of:

- ☐ 35 ±5 Nm, water pipe fittings;
- ☐ 55 ±5 Nm, oil pipe female fitting;
- ☐ 20-25 Nm, oil pipe male fitting.

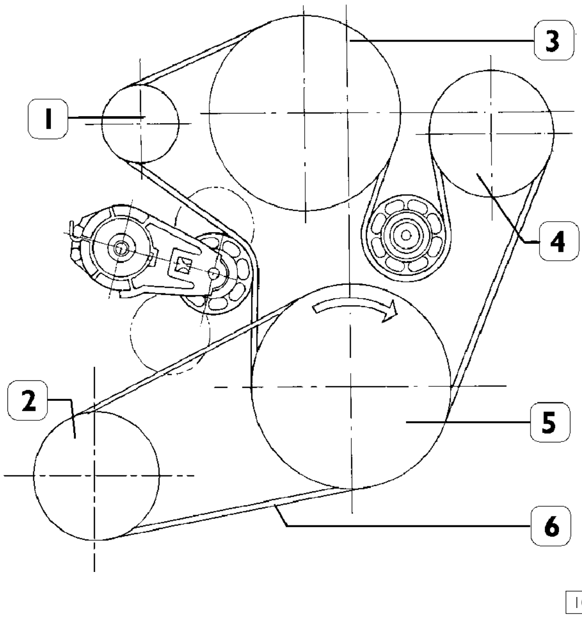
Figure 85



To fit the belt (1) use appropriate equipment (2) to adjust the belt tensioner in the direction indicated by the arrow.

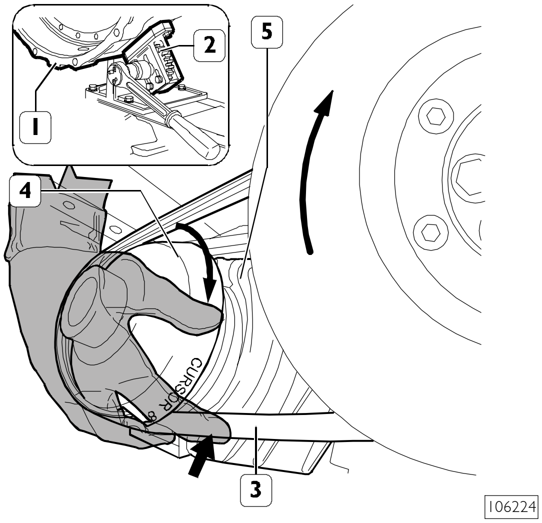
NOTE Automatic tensioners do not require further adjustments after the installation.

Figure 86



COMPRESSOR CONTROL BELT ASSEMBLY DIAGRAM
1. Alternator - 2. Air conditioner compressor - 3. Electromagnetic joint; - 4. Water pump - 5. Crankshaft - 6. Spring belt

Figure 87



NOTE To fit the elastic belt commanding the climate control compressor, you must use tool number 99360192 (4). Any other method might cause tension that would be harmful to the elastic belt itself.

Apply tool 99360321 (2) to gears box (1).
Mount spring belt (3) on driving shaft pulley, mount chock 99360192 (4) on compressor pulley (5) for climate control system. Position spring belt (3) in the opening of tool 99360192 marked with "cursor 8".
By tool 99360321, rotate driving shaft (6) according to the direction of the arrow (→) until spring belt (5) is correctly positioned on compressor pulley (3).

NOTE While operating, keep tool 99360192 (4) in contact to pulley (3) and at the same time guide spring belt (5) in order to prevent it from twisting.

NOTE Spring belt must be replaced by a new one after every dismounting operation.

☐ Refuel engine with provided oil quantity.
Dismount engine from rotary stand and take off brackets (99361036) securing the engine.

Mount:

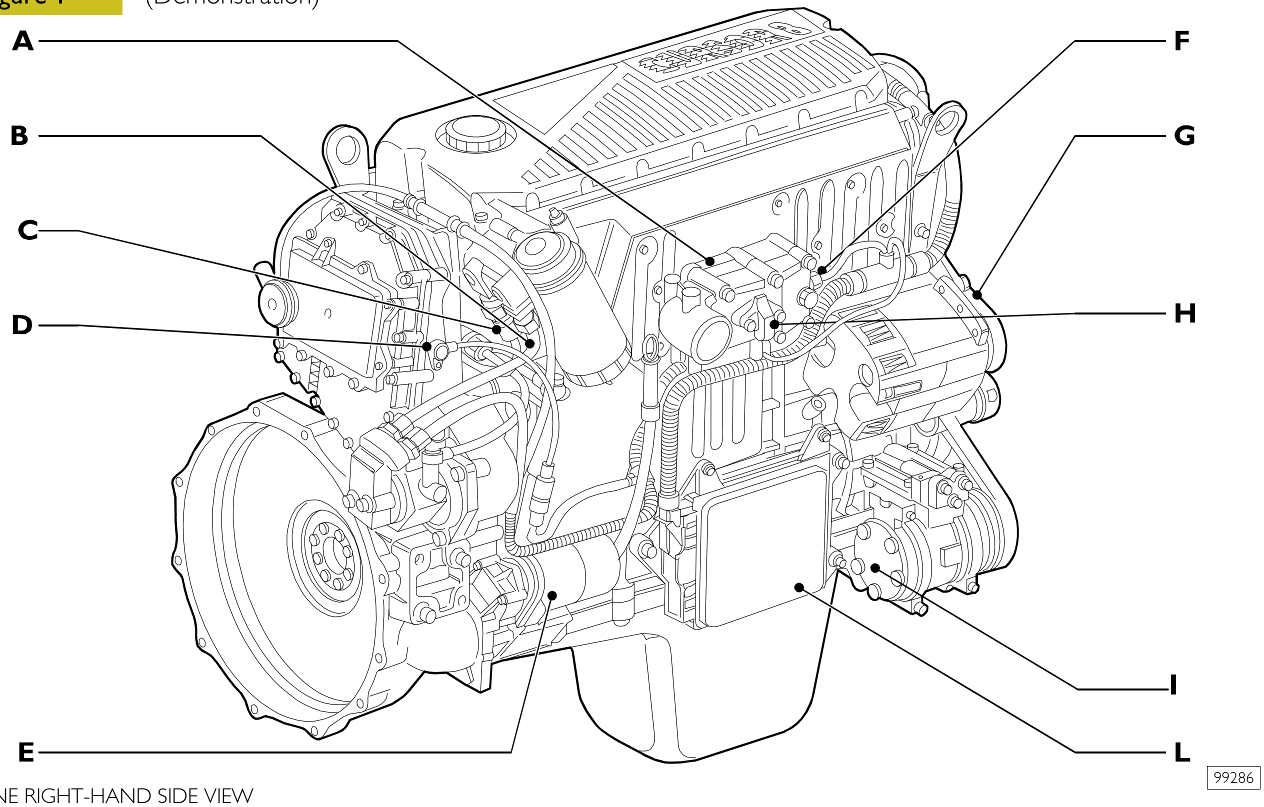
☐ sound deadening guard;
☐ pipes.

PART TWO -

ELECTRICAL EQUIPMENT

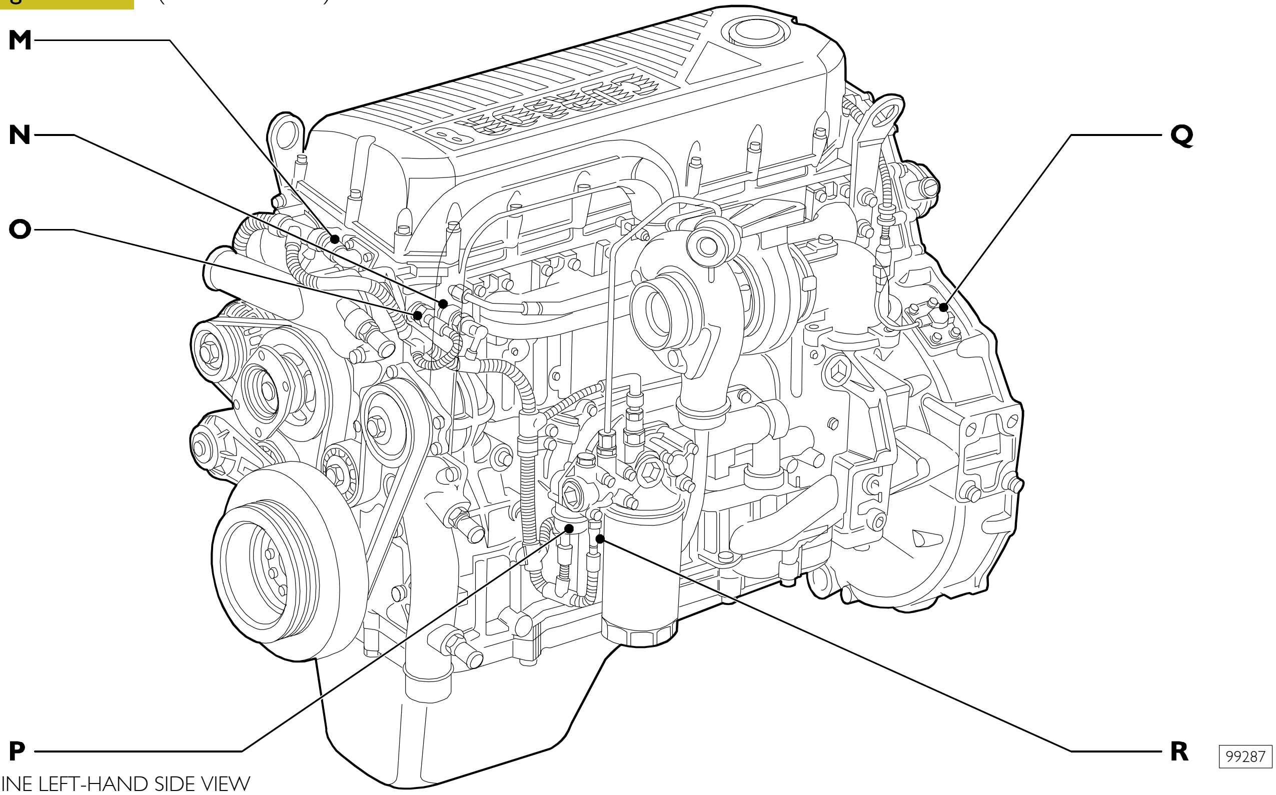
Components on the engine F2B

Figure 1 (Demonstration)



ENGINE RIGHT-HAND SIDE VIEW

Figure 2 (Demonstration)

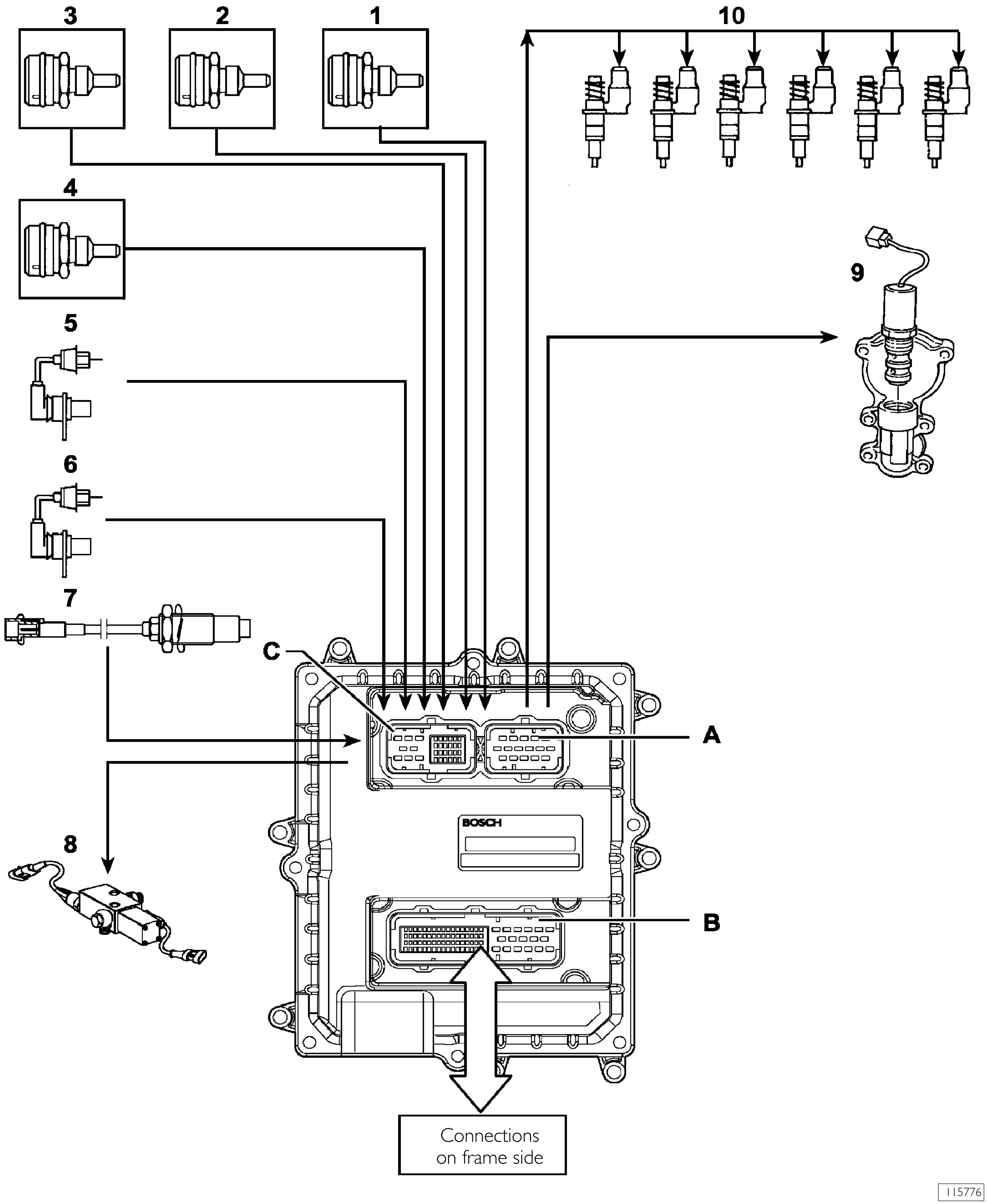


ENGINE LEFT-HAND SIDE VIEW

A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - F. Engine intake air temperature sensor - G. Alternator - H. Boosting pressure sensor - I. Conditioner compressor - L. EDC (MS6.2) control unit - M. Connector on engine head for connection with injector solenoid valves - N. Water temperature for EDC (MS6.2) - O. Water temperature sensor - P. Oil pressure transmitter - Q. Engine speed on flywheel sensor - R. Low oil pressure transmitter.

BLOCK DIAGRAM

Figure 3



KEYS

1. Solenoid valve for variable geometry control - 2. Engine oil pressure/temperature sensor - 3. Fuel temperature sensor - 4. Coolant temperature sensor - 5. Distribution sensor - 6. Flywheel sensor - 7. Turbine revs sensor - 8. Solenoid valve for VGT control - 9. Engine brake solenoid valve - 10. Pump injectors.

EDC SYSTEM FUNCTIONS

The EDC7 UC31 electronic center manages the following main functions:

Fuel injection
Accessory functions such as cruise control, speed limiter, PTO and the like
Self-diagnosis
Recovery

It also enables:

Interfacing with other electronic systems (if any) available on the vehicle
Diagnosis

Fuel dosing

Fuel dosing is calculated based on:
- accelerator pedal position
- engine rpm
- quantity of air admitted.

The result can be corrected based on:
- water temperature

or to prevent:
- noise
- fumes
- overloads
- overheating

Pressure can be adjusted in case of:
- engine brake actuation
- external device actuation (e.g. speed reducer, cruise control)
- serious defects involving load reduction or engine stop.

After determining the mass of air introduced by measuring its volume and temperature, the center calculates the corresponding mass of fuel to be injected into the cylinder involved, with account also taken of gas oil temperature.

Delivery correction based on water temperature

When cold, the engine encounters greater operating resistance, mechanical friction is high, oil is till very viscous and operating plays are not optimized yet.
Fuel injected also tends to condense on cold metal surfaces.
Fuel dosing with a cold engine is therefore greater than when hot.

Delivery correction to prevent noise, fumes or overloads

Behaviors that could lead to the defects under review are well known, so the designer has added specific instructions to the center to prevent them.

De-rating

In the event of engine overheating, decreasing delivery proportionally to the temperature reached by the coolant changes injection.

Turbine rpm regulation

Turbine speed is constantly regulated and rectified, if necessary, by operating on geometry variation.

Injection lead electronic control

Injection lead, or the start of fuel delivery expressed in degrees, can differ from one injection to the next, even from one cylinder to another and is calculated similarly to delivery according to engine load, namely, accelerator position, engine rpm and air admitted.
Lead is corrected as required:
- during acceleration
- according to water temperature

and to obtain:
- reduced emissions, noise abatement and no overload
- better vehicle acceleration

High injection lead is set at start, based on water temperature.
Delivery start feedback is given by injection electro valve impedance variation.

Engine start

Cylinder 1 step and recognition signal synchronization (flywheel and drive shaft sensors) takes place at first engine turns. Accelerator pedal signal is ignored at start. Star delivery is set exclusively based on water temperature, via a specific map. The center enables the accelerator pedal, when it detects flywheel acceleration and rpm such as to consider the engine as started and no longer drawn by the starter motor.

Cold start

Pre-post reheating is activated when even only one of the three water, air or gas oil temperature sensors records a temperature of below 10 °C. The pre-heat warning light goes on when the ignition key is inserted and stays on for a variable period of time according to temperature, while the intake duct input resistor heats the air, then starts blinking, at which point the engine can be started.
The warning light switches off with the engine revving, while the resistor continues being fed for a variable period of time to complete post-heating. The operation is cancelled to avoid uselessly discharging the batteries if the engine is not started within 20 ÷ 25 seconds with the warning light blinking. The pre-heat curve is also variable based on battery voltage.

Hot start

On inserting the ignition key the warning light goes on for some 2 seconds for a short test and then switches off when all reference temperatures are above 10 °C. The engine can be started at this point.

Run Up

When the ignition key is inserted, the center transfers data stored at previous engine stop to the main memory (Cf. After run), and diagnoses the system.

After Run

At each engine stop with the ignition key, the center still remains fed by the main relay for a few seconds, to enable the microprocessor to transfer some data from the main volatile memory to an non-volatile, cancelable and rewritable (Eeprom) memory to make tem available for the next start (Cf. Run Up).
These data essentially consists of:
- miscellaneous settings, such as engine idling and the like
- settings of some components
- breakdown memory

The process lasts for some seconds, typically from 2 to 7 according to the amount of data to be stored, after which the ECU sends a command to the main relay and makes it disconnect from the battery.

This procedure must never be interrupted, by cutting the engine off from the battery cutout or disconnecting the latter before 10 seconds at least after engine cutout.

In this case, system operation is guaranteed until the fifth improper engine cutout, after which an error is stored in the breakdown memory and the engine operates at lower performance at next start while the EDC warning light stays on.

Repeated procedure interruptions could in fact lead to center damage.

Cut-off

It refers to the supply cut-off function during deceleration.

Cylinder Balancing

Individual cylinder balancing contributes to increasing comfort and operability.
This function enables individual personalized fuel delivery control and delivery start for each cylinder, even differently between each cylinder, to compensate for injector hydraulic tolerances.
The flow (rating feature) differences between the various injectors cannot be evaluated directly by the control unit. This information is provided by the entry of the codes for every single injector, by means of the diagnosis instrument.

Synchronization search

The center can anyhow recognize the cylinder to inject fuel into even in the absence of a signal from the camshaft sensor.
If this occurs when the engine is already started, combustion sequence is already acquired, so the center continues with the sequence it is already synchronized on; if it occurs with the engine stopped, the center only actuates one electro valve. Injection occurs onside that cylinder within 2 shaft revs at the utmost so the center is only required to synchronize on the firing sequence and start the engine.

In order to reduce the number of connections, and of the cables connecting the injectors, and to consequently reduce the nose on transmitted signal, the central unit is directly mounted on the engine by a heat exchanger enabling its cooling, using spring blocks which reduce vibrations transmitted from engine.

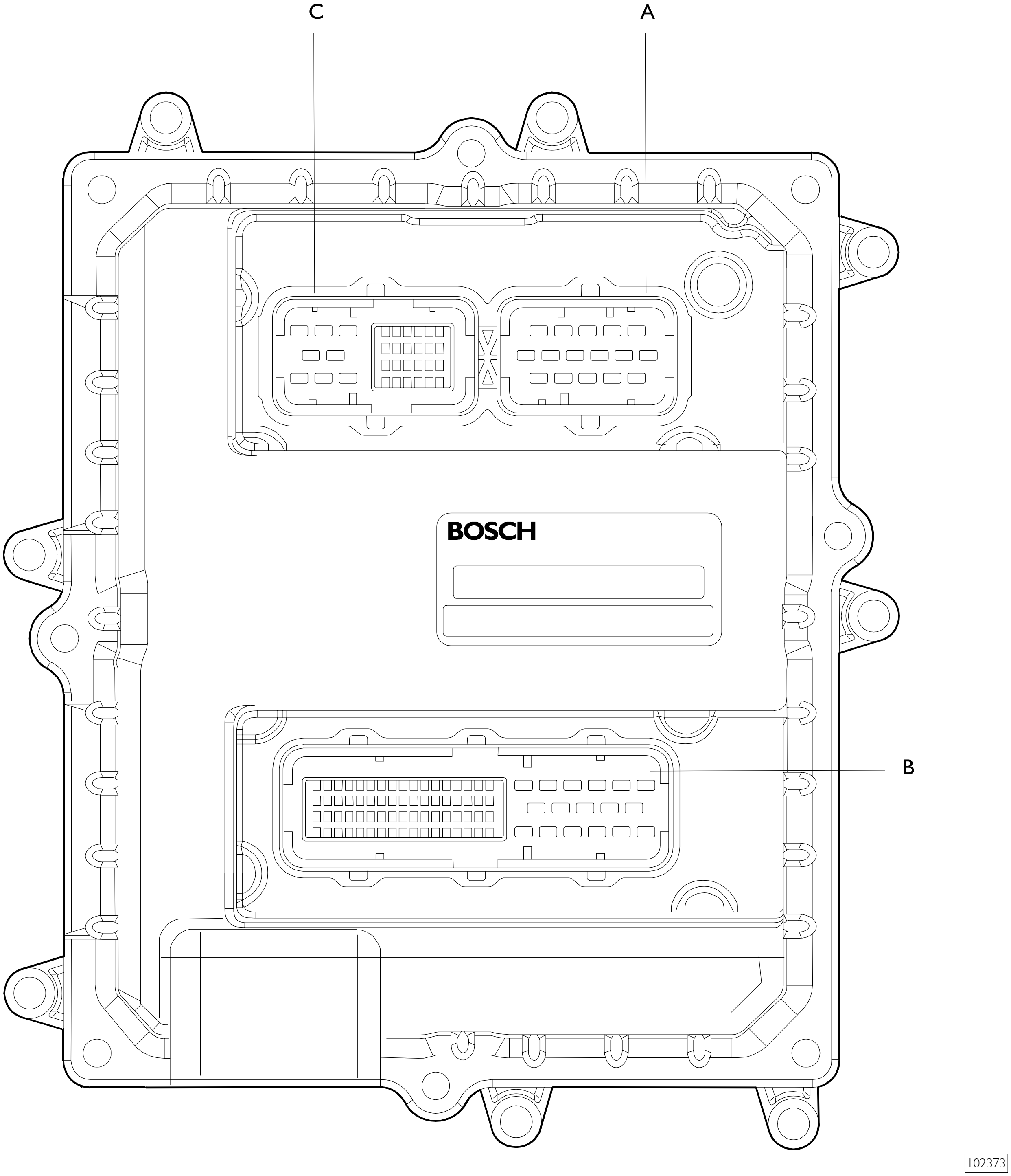
It is connected to vehicle wiring harness by two 35-pole connectors:
connector “A” for components present on the engine
connector “B” for components present on the cab

Internally, there is a pressure ambient sensor use to further improve injection system management.

The central unit is equipped with a much advanced self-diagnosis system and, depending on environmental conditions, is capable to identify and store any faults, even of intermittent type, occurred to the system during vehicle running, ensuring a more correct and reliable repair intervention.

EDC 7 UC31 electronic control unit

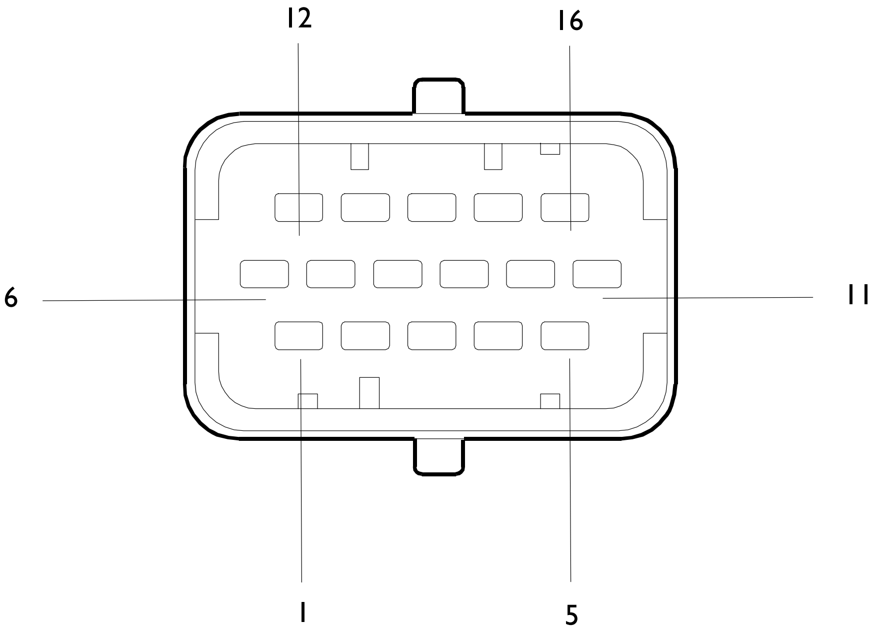
Figure 4



A. Injector connector - B. Chassis connector - C. Sensor connector.

Electric injector connector ”A”

Figure 5



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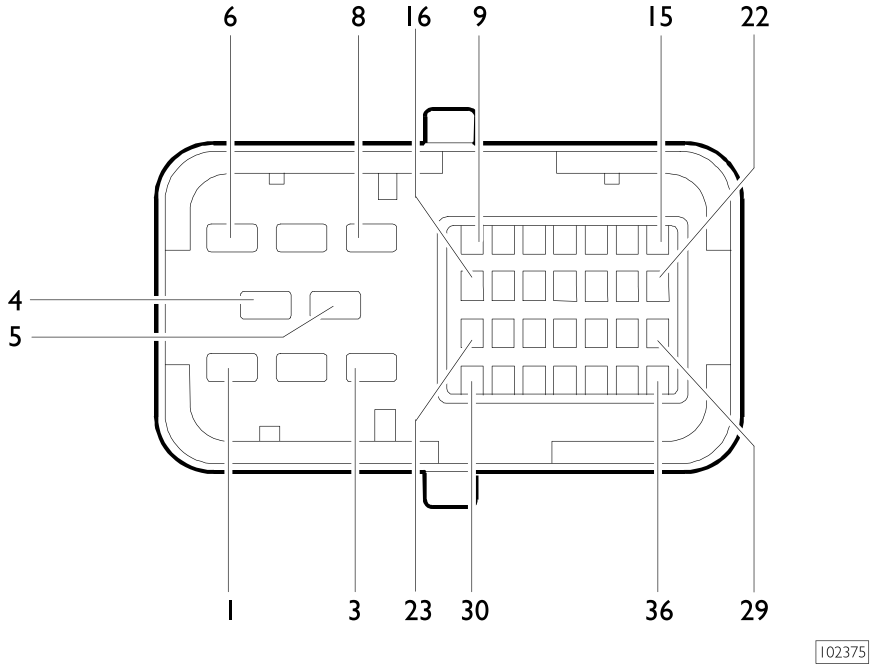
Colour legend

B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange
E	grey
K	pink

ECU Pin	Colour legend	Functio
1	B	Solenoid valve for electronic cylinder 5 injection
2	B	Solenoid valve for electronic cylinder 6 injection
3	B	Solenoid valve for electronic cylinder 4 injection
4	W	Solenoid valve for electronic cylinder 1 injection
5	G	Solenoid valve for electronic cylinder 3 injection
6	R	Solenoid valve for electronic cylinder 2 injection
7	O	Exhaust brake control solenoid valve
8	N	Exhaust brake control solenoid valve
9	-	Free
10	-	Free
11	Y	Solenoid valve for electronic cylinder 2 injection
12	R	Solenoid valve for electronic cylinder 3 injection
13	R	Solenoid valve for electronic cylinder 1 injection
14	U	Solenoid valve for electronic cylinder 4 injection
15	G	Solenoid valve for electronic cylinder 6 injection
16	P	Solenoid valve for electronic cylinder 5 injection

Sensor connector ”C”

Figure 6



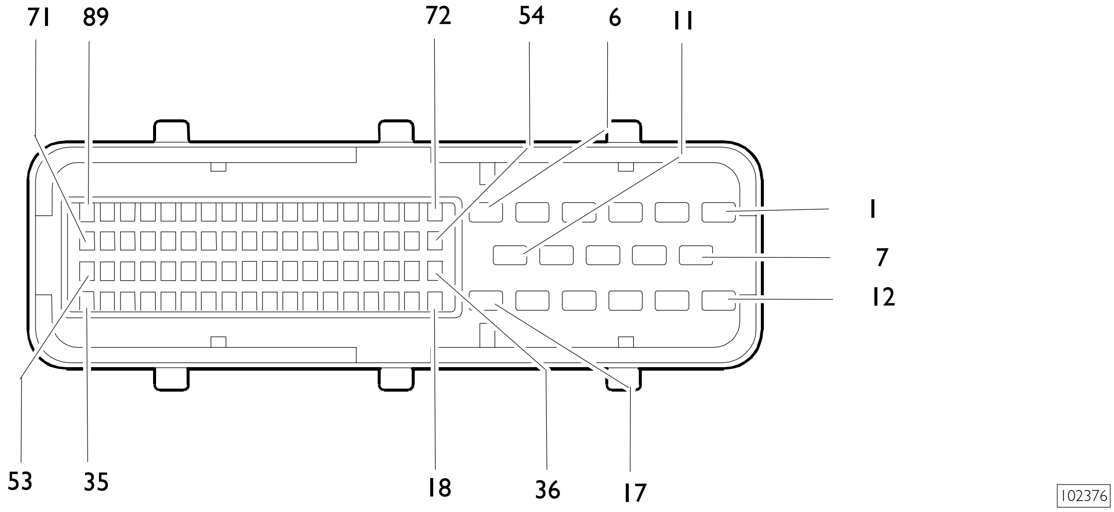
Colour legend

B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange
E	grey
K	pink

ECU Pin	Cable colour	Function
1	N	Solenoid valve for variable geometry turbine control
2	-	Free
3	B	Solenoid valve for variable geometry turbine control
4÷8	-	Free
9	W	Distribution sensor
10	R	Distribution sensor
11÷14	-	-
15	K	Coolant temperature sensor
16	-	Free
17	-	Fuel temperature sensor mass
18	O/B	Fuel temperature sensor
19	B	Flywheel sensor
20	N	Booster speed sensor
21÷22	-	Free
23	W	Flywheel sensor
24	N	Engine oil temperature/pressure sensor ground
25	W	Mass for air pressure / temperature sensor
26	Y	Coolant temperature sensor
27	O/B	Oil pressure signal from engine oil pressure / temperature sensor
28	U	Oil temperature signal from engine oil pressure / temperature sensor
29	-	Free
30	W	Booster speed sensor
31	-	Free
32	O	Engine oil temperature/pressure sensor power supply
33	R	Air temperature/pressure sensor power supply
34	G	Air pressure signal from the air temperature/ pressure sensor
35	W/R	Fuel temperature sensor
36	O	Air temperature signal from the air temperature / pressure sensor

Chassis connector ”B”

Figure 7



ECU pin	FUNCTION
1	Lambda sensor heater signal (*)
2	Positive voltage direct from battery
3	Positive voltage direct from battery
4	Lambda sensor heater supply (*)
5	Battery negative
6	Battery negative
7	Negative voltage for control relay of heater grid control 2 (*)
8	Positive voltage direct from battery
9	Positive voltage direct from battery
10	Battery negative voltage
11	Battery negative voltage
12	Signal from grid on heater 1 (*)
13	Positive voltage +15
14	Positive voltage for air conditioning compressor (*)
15	Signal from air conditioning compressor (*)
16	Negative voltage speed 1 fan
17	Starting relay negative voltage
18	Turbine sensor signal (*)
19	Turbine sensor earth (*)
20	Negative voltage intercooler by-pass valve (*)
21	Supply voltage for switches
22	To diagnostic warning light
23	Additional solenoid valve signal
24	Earth for particle filter temperature sensor (*)
25	Signal for particle filter temperature sensor (*)
26	Intake air humidity and temperature sensor signal
27	Intake air humidity and temperature sensor signal
28	Intake air humidity and temperature sensor earth
30	To diagnostic warning light
31	Cruise control positive signal (*)
32	Negative voltage from engine start switch from engine compartment
33	Tachometer output signal (*)
34	(Low) signal CAN 2 line interface input
35	(High) signal CAN 2 line interface

ECU pin	FUNCTION
36	Negative voltage for fuel filter heater switch (*)
37	Starting relay positive voltage
38	OBD lamp negative voltage (*)
39	Speed limiter lamp negative voltage (*)
40	Positive voltage +15 under lock
41	Positive voltage from main brake switch
42	Negative voltage from sensor detecting water in the pre-filter
43	Signal 1 from Lambda probe (*)
44	Signal 2 from Lambda probe (*)
45	Signal 3 from Lambda probe (*)
46	Cruise control positive signal (*)
47	Negative voltage from engine stop switch from engine compartment
48	Negative voltage from accelerator pedal idling switch
49	Positive voltage from brake switch (redundant signal)
50	Positive voltage +12
52	(Low) signal CAN 1 line interface input
53	(High) signal CAN 1 line interface
54	Negative voltage for fan second speed control switch (*)
55	Positive voltage for engine brake exhaust gas solenoid valve (*)
56	Negative voltage for pre-heating lamp (*)
57	Positive voltage speed 1 fan (*)
58	Earth for engine brake exhaust gas solenoid valve (*)
59	Earth for blow-by pressure difference sensor (*)
61	Positive voltage for blow-by pressure difference sensor (*)
62	Passive analogue signal from torque limiter multiple resistor (*)
63	Signal 4 from Lambda probe (*)
64	Cruise control positive signal (*)
65	Earth from multiple resistor torque limiter (*)
66	Positive voltage from clutch switch (torque converter) (*)
67	Earth for cooling fan speed sensor (*)
69	Signal from cooling fan speed sensor (*)
70	Vehicle speed sensor earth (*)
71	Vehicle speed sensor signal (*)
72	Synchronising bit on serial interface input signal
73	Local area network interconnection input signal
74	Cruise control positive signal (*)
75	Supply voltage for grid on heater 1 (*)
76	Earth for exhaust gas temperature sensor (*)
77	Supply voltage for accelerator potentiometer
78	Earth for accelerator potentiometer
79	Signal from accelerator potentiometer
80	Signal from exhaust gas temperature sensor (*)
81	Signal from particle trap differential pressure sensor (*)
82	Positive voltage from particle trap differential pressure sensor (*)
83	Earth from particle trap differential pressure sensor (*)
85	Negative voltage from diagnostic request switch
87	Crankshaft rotation output signal
88	Camshaft rotation output signal
89	ISO-K interface input signal

* If present

Pump injector (78247)

It consists mainly of:

A) Solenoid valve

B) Pumping element

C) Nozzle

These three parts **CANNOT be replaced individually and CANNOT be overhauled.**

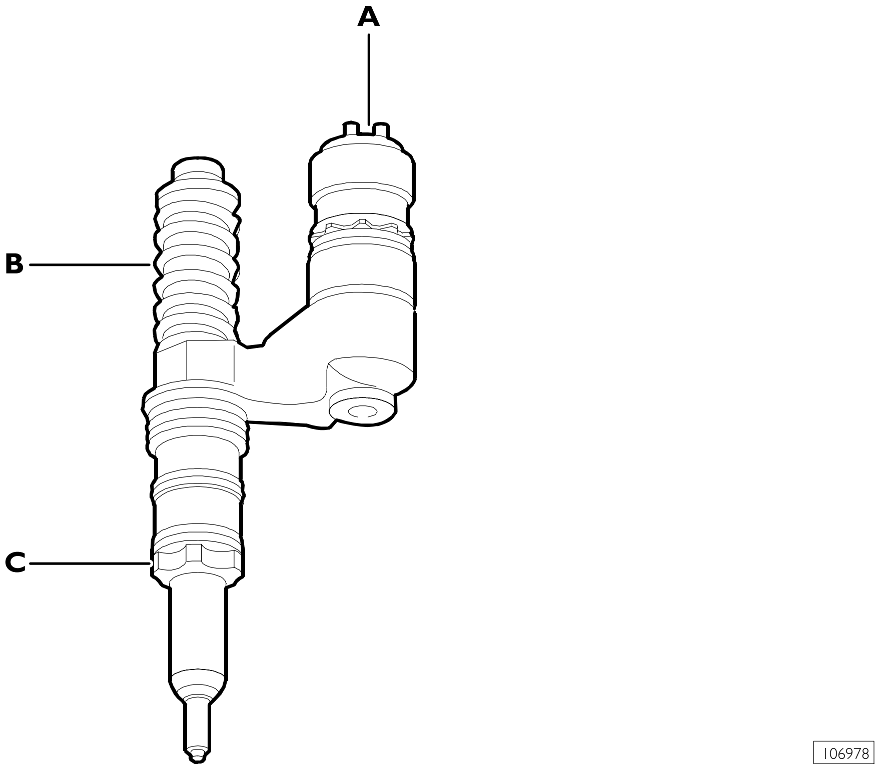
The pumping element, mechanically actuated at every rocker arm cycle, compresses the fuel container in the delivery chamber.

The nozzle, whose composition and operation are similar to those of traditional injectors, is opened by the fuel under pressure and sprays it into the combustion chamber.

A solenoid valve, directly controlled by the electronic control unit, determines delivery according to the control signal.

A casing houses the lower part of the pump injector in the cylinder head.

Figure 8



The electro valve is of the N.A. type.

Coil resistance is ~ 0.56 ÷ 0.57 Ohm.

Maximum operating voltage is ~ 12 ÷ 15 Amp.

Based on voltage absorbed by the electro valve, the electronic center can identify whether injection was correct or mechanical problems exist. It can also detect injector errors ONLY with the engine running or during starts.

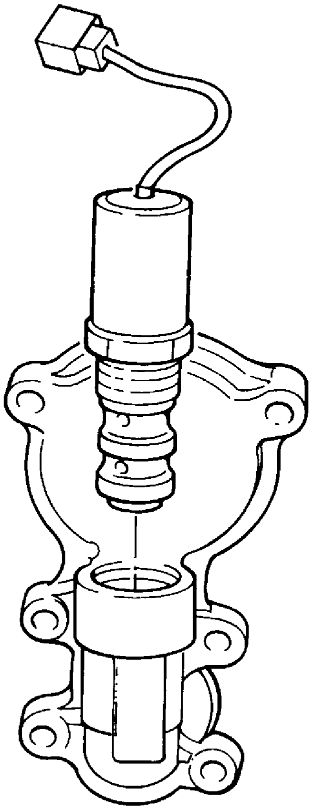
Injectors are individually connected to the center between pins:

A4 / A13 cylinder 1 injector
A11 / A6 cylinder 2 injector
A5 / A12 cylinder 3 injector
A3 / A14 cylinder 4 injector
A1 / A16 cylinder 5 injector
A2 / A15 cylinder 6 injector

Injectors are connected to the center with connector ST - E mounted on the engine front with a twisted cable, to avoid possible electromagnetic interference problems, so junctions or repairs on it must NOT be performed.

Exhaust brake solenoid valve (78050)

Figure 9

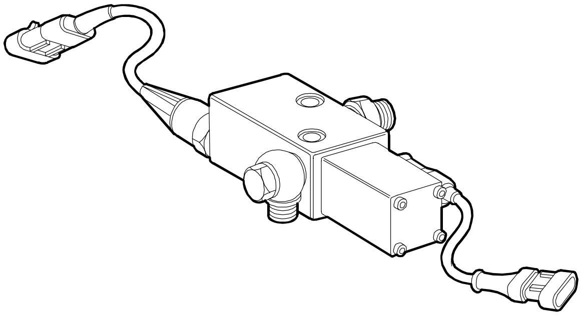


CURSOR 8

This on/off solenoid valve is NC type.
In Cursor 8 engines it is positioned in the front part of the engine on the head.
The electronic control unit pilots this solenoid valve and opens the way to engine oil so as to engage the hydraulic cylinders of the exhaust brake.
A warning light located on the dashboard is connected in parallel to this solenoid valve in order to inform the driver that it has tripped.
While feeding this solenoid valve, the control unit also activates the VGT.
The exhaust brake can be engaged only if the engine revolutions are > 1000 rpm.
This solenoid valve is connected to the EDC electronic control unit between pins A7 / A8.
The resistance of the coil is approx. 37 to 47 Ohm.

Solenoid valve for VGT control

Figure 10



This N.C. proportional solenoid valve is located on the left-hand side of the crankcase under the turbine.
The electronic control unit, via a PWM signal, controls the solenoid valve, governing the supply pressure of the turbine actuator, which, on changing its position, modifies the cross-section of the flow of exhaust gases onto the blades of the impeller and therefore its speed.
The resistance of the coil is approx. 20-30 Ohms.
The VGT electro valve is connected between electronic center pins C3/C1.

Distribution pulse transmitter (48042)

Features

Vendor	BOSCH
Torque	8 ± 2 Nm
Resistance	880 ÷ 920 Ω

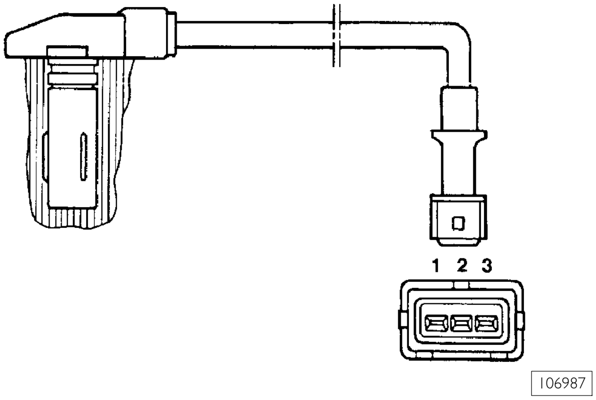
This induction type sensor located on the camshaft generates signals obtained from the magnetic flow lines that close through the 6 plus 1 phase teeth of a sound wheel mounted on the shaft.

The electronic center uses the signal generated by this sensor as an injection step signal.

Though electrically identical to (48035) engine rpm sensor mounted in the camshaft in is NOT interchangeable with it as it cable is shorter and it features a larger diameter.

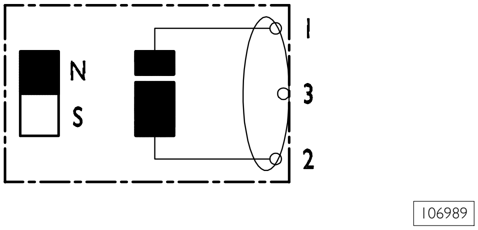
This sensor's air gap is NOT ADJUSTABLE.

Figure 11



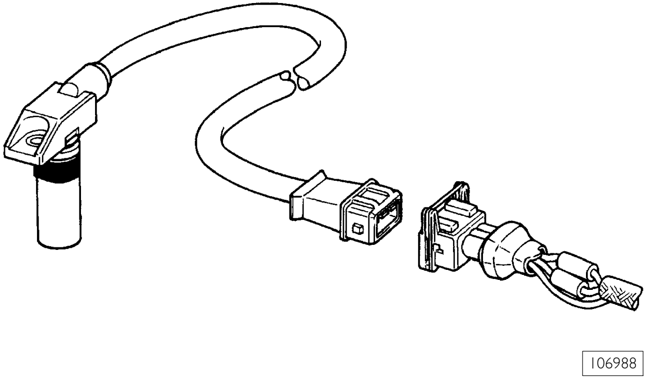
TECHNICAL VIEW

Figure 13



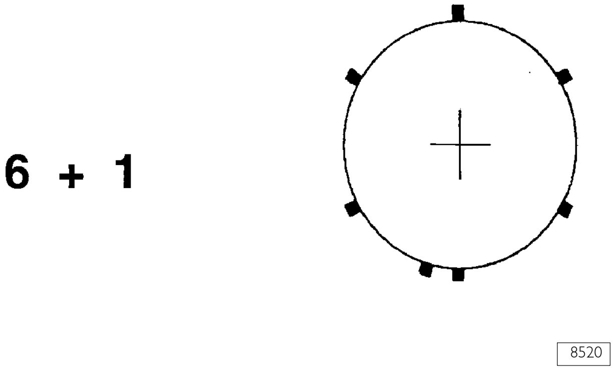
WIRING DIAGRAM

Figure 12



PERSPECTIVE VIEW

Figure 14



REFERENCE ON SOUND WHEEL

Connector	Function	Cable colour
1	To EDC center pin C 10	—
2	To EDC center pin C 9	—
3	Shields	—

Engine coolant temperature sensor (85153)

This N.T.C. type sensor located on the water outlet sump on the engine head left measures coolant temperature for the various operating logics with a hot or cold engine and identifies injection enrichment requirements for a cold engine or fuel reduction requirements for a hot engine.

The coolant temperature signal is used for display on the Cluster and to control the fan.

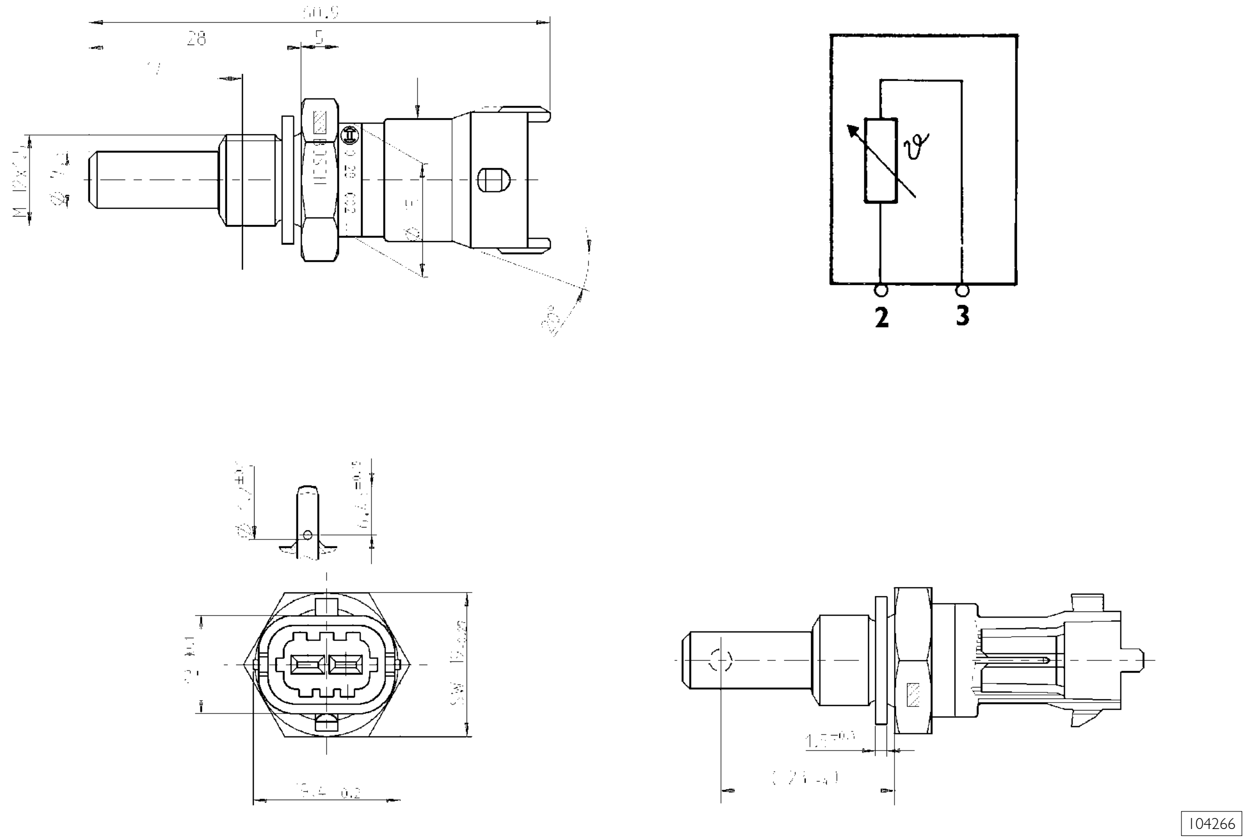
It is connected to electronic center pins C15/C26.

Sensor behavior as a function of temperature:

- 10 °C	8,10 ÷ 10,77 kOhm
+ 20 °C	2,28 ÷ 2,72 kOhm
+ 80 °C	0,29 ÷ 0,364 kOhm

At 60 to 90 °C, voltage at A5 and A22 ranges from 0.6 to 2.4V.

Figure 15



Connector	Function	Cable colour
2	To EDC center pin C 15	—
3	To EDC center pin C 26	—

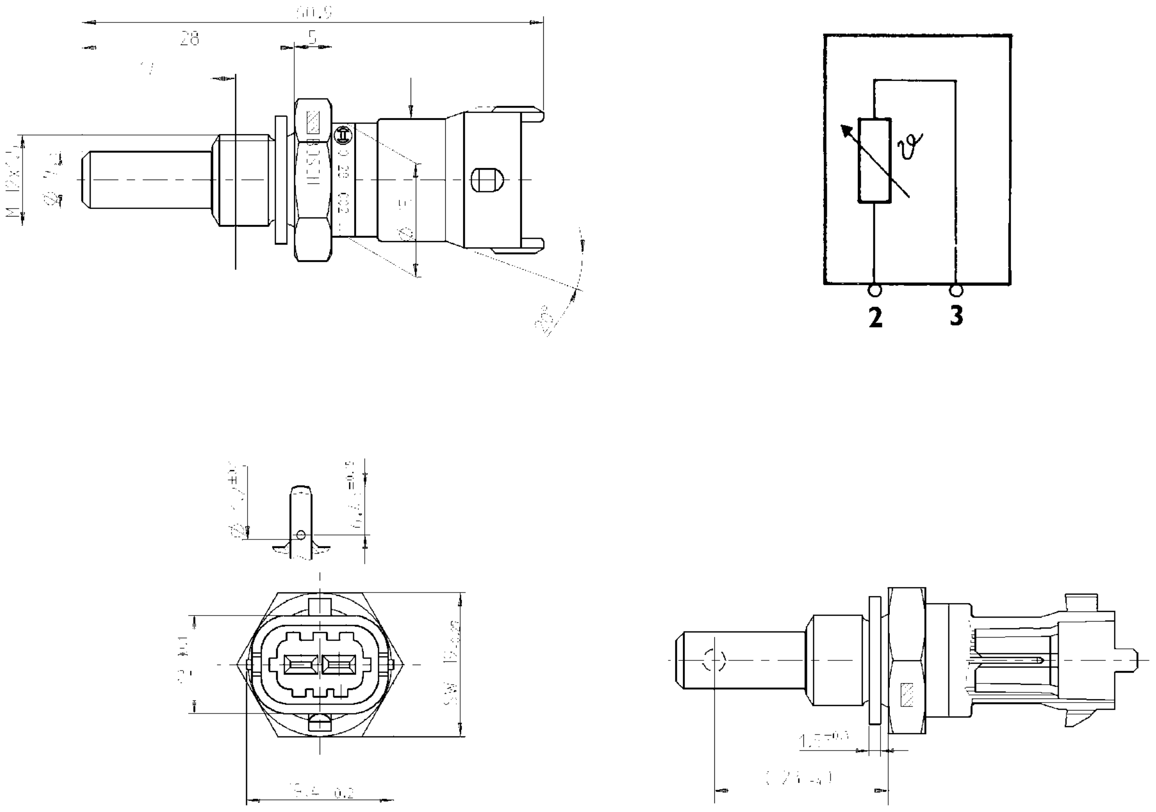
Fuel temperature sensor (47042)

Features

Vendor	BOSCH
Maximum torque	35 Nm

This N.T.C. type sensor located on the fuel filter on the engine left side detects fuel temperature and enables the electronic center to measure fuel density and volume for delivery correction.

Figure 16



104267

Connector	Function	Cable colour
2	To EDC center pin C 18	—
3	To EDC center pin C 35	—

Flywheel pulse transmitter (48035)

Features

Vendor	BOSCH
Torque	8 ± 2 Nm
Resistance	880 ÷ 920 Ω

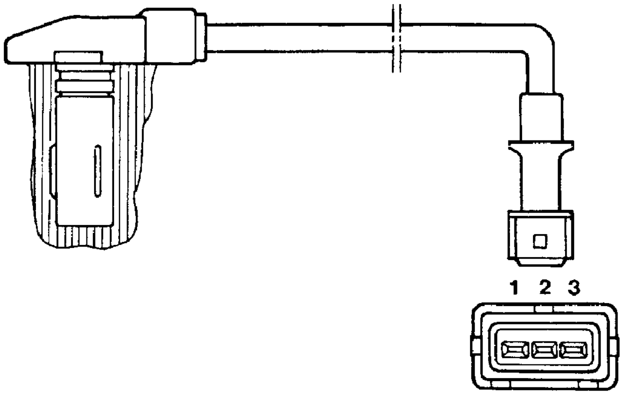
This induction type sensor located on the flywheel generates signals obtained from the magnetic flow lines that close through 54 holes in three series of 18 in the flywheel.

The electronic center uses this signal to detect the various engine ratings and pilot the electronic rev counter.

The rev counter does not operate in the absence of this signal.

This sensor's air gap is NOT ADJUSTABLE.

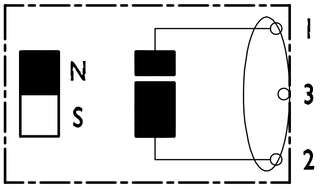
Figure 17



TECHNICAL VIEW

106984

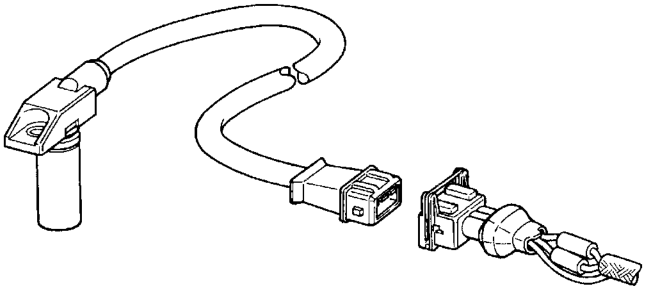
Figure 19



106986

WIRING DIAGRAM

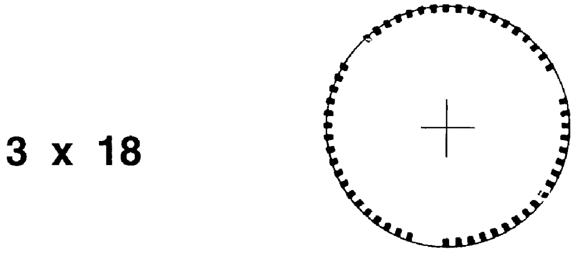
Figure 18



PERSPECTIVE VIEW

106985

Figure 20



8520

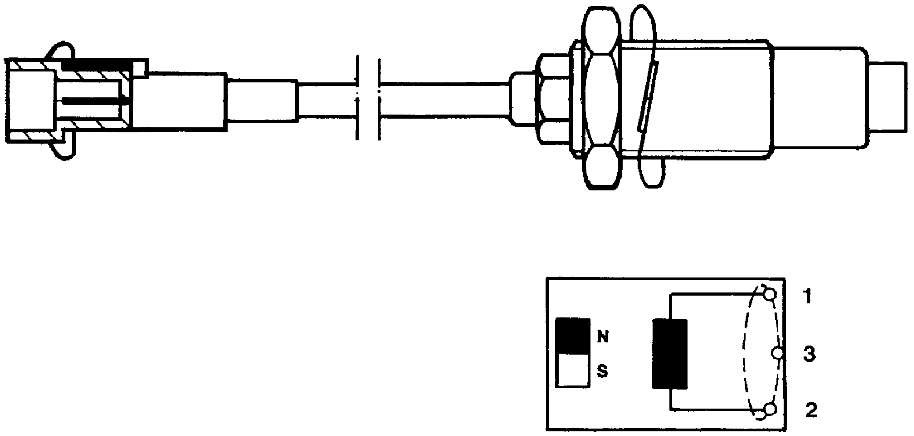
HOLES ON FLYWHEEL

Connector	Function	Cable colour
1	To EDC center pin C 23	—
2	To EDC center pin C 19	—
3	Shields	—

Turbine rpm sensor (48043)

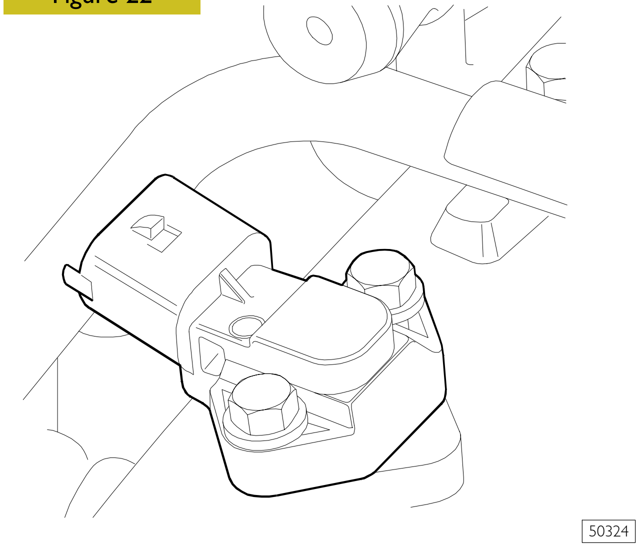
This is an inductive sensor positioned on the impeller shaft.
It generates signals obtained from the magnetic flow lines, which close through a notch obtained on the shaft itself.
The signal generated by this sensor is used by the electronic control unit to verify that the turbine revs number does not exceed the maximum value.
To control the revs number, the control unit acts on variable geometry.
If the revs number keeps on increasing until it reaches excessive r.p.m. values, the electronic control unit will detect an anomaly.
The gap of this sensor CANNOT BE ADJUSTED.
It is connected on electronic control unit pins C30 / C20.
The sensor resistance value is 400 Ohm.

Figure 21



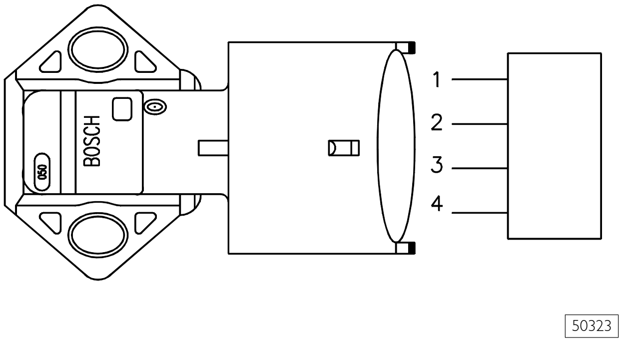
Wiring diagram

Figure 22



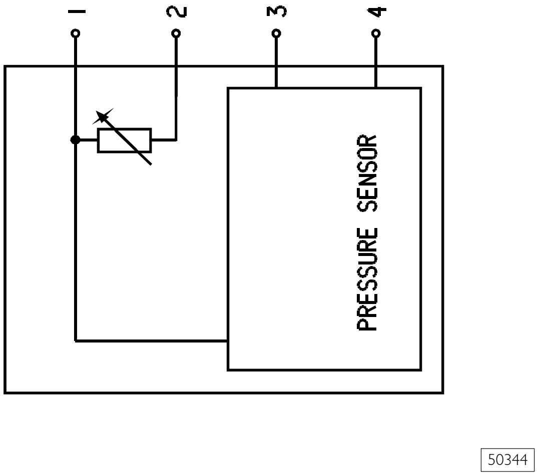
Sensor external view

Figure 23



Linking connector

Figure 24



Wiring diagram

Air pressure/temperature sensor (85156)

This component incorporates a temperature sensor and a pressure sensor.

Ilt replaces the temperature sensors (85155) and pressure sensors (85154) available in the preceding systems.

It is fitted onto the intake manifold and measures the maximum supplied air flow rate used to accurately calculate the amount of fuel to be injected at every cycle.

The sensor is powered with 5 V.

The output voltage is proportional to the pressure or temperature measured by the sensor.

Pin (EDC)	25/C - 33/C	Power supply
Pin (EDC)	36/C	Temperature
Pin (EDC)	34/C	Pressure

Oil temperature/pressure sensor (42030 / 47032)

This component is identical to the air pressure/temperature sensor and replaced single sensors 47032 / 42030.

It is fitted onto the engine oil filter, in a horizontal position.

It measures the engine oil temperature and pressure.

The measured signal is sent to the EDC control unit which controls, in turn, the indicator instrument on the dashboard (low pressure warning lights / gauge).

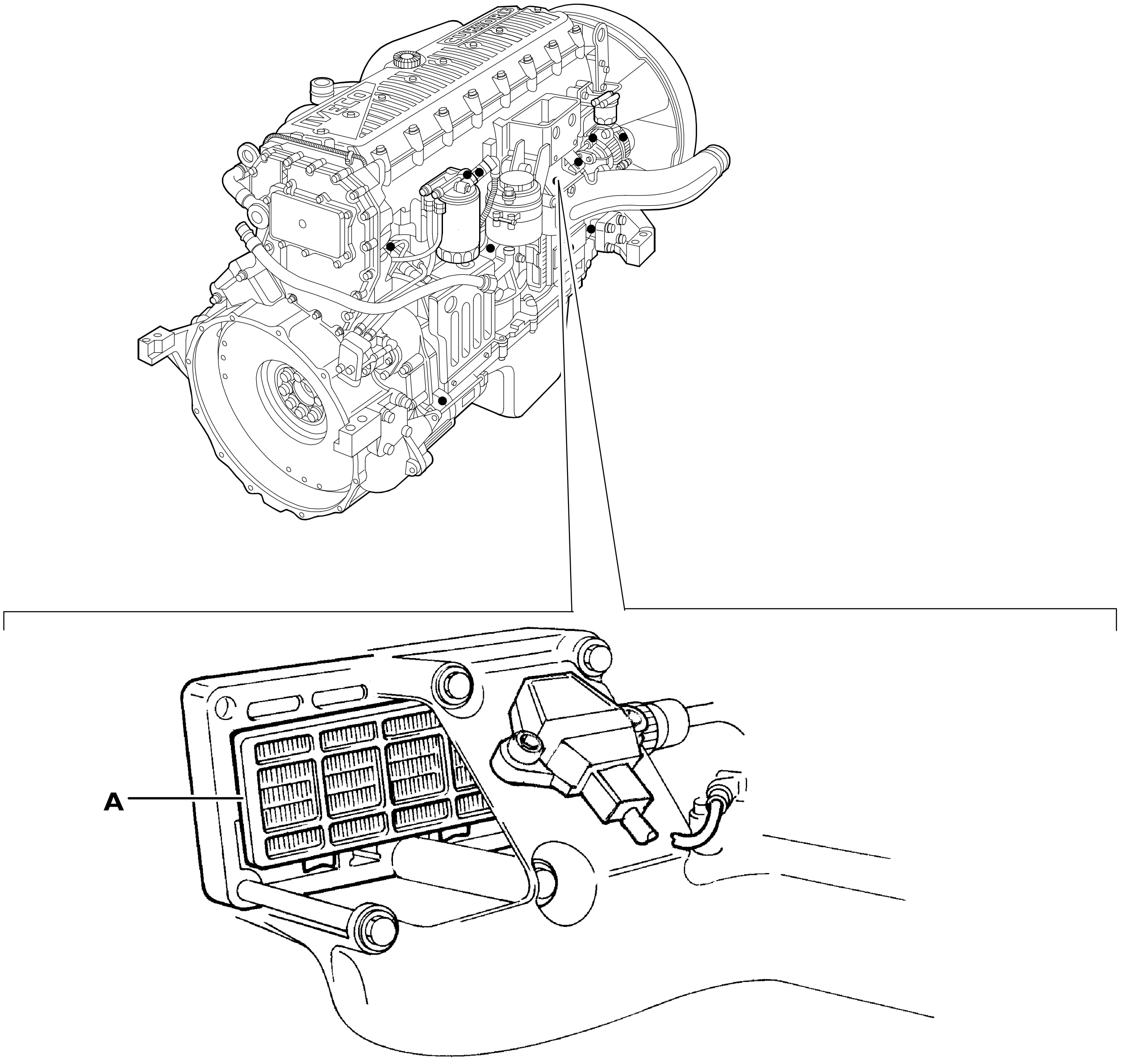
Pin (EDC)	24/C - 32/C	Power supply
Pin (EDC)	27/C	Temperature
Pin (EDC)	28/C	Pressure

The engine oil temperature is used only by the EDC control unit.

Ref.	Description	Control unit pin	
		Oil	Air
1	Ground	24C	25C
2	Temp. Sign.	27C	36C
3	+5	32C	33C
4	Press. Sign.	28C	34C

Pre-post reheat resistor (61121)

Figure 25



A. Pre/ort reheat resistor / 0.7 Ohm.

This resistor located between the cylinder head and the intake duct is used to heat air in pre/post reheat operations.

By inserting the key switch, when even only one of the water, air or gas oil temperature sensors record less than 10 °C, the electronic center activates pre/post reheating and switches on the warning light on the cab instrument panel for a variable period according to temperature, after which the light starts blinking to inform the operator that the engine can be started.

The warning light goes off after engine start but the resistor continues being supplied for a variable period of time to complete post reheating.

The operation is cancelled to prevent uselessly discharging the battery if the engine is not started within 20/25 seconds with the warning light blinking.

When reference temperature is above 10 °C, actuating the ignition key makes the warning light go on for some 2 seconds to complete the test and then turns it of to indicate the engine can be started.

PART THREE - TROUBLESHOOTING

PREFACE

A successful troubleshooting is carried out with the competence acquired by years of experience and attending training courses.

When the user complains for bad efficiency or working anomaly, his indications must be kept into proper consideration using them to acquire any useful information to focus the intervention.

After the detection of the existing anomaly, it is recommended to proceed with the operations of troubleshooting by decoding the auto-troubleshooting data provided by the EDC system electronic central unit.

The continuous efficiency tests of the components connected to, and the check of working conditions of the entire system carried out during working, can offer an important diagnosis indication, available through the decoding of the ''failure/anomaly'' codes.

It should be noted, that the interpretation of the indications given by the diagnostic device is not sufficient to guarantee that all failures are healed.

Using IVECO processing instruments, it is also possible to establish a bi-directional connection with the central unit, by which not only to decoding the failure codes but also input an enquiry relying on memory files, in order to achieve any further necessary information to identify the origin of the anomaly.

Every time there is a breakdown claim and this breakdown is actually detected, it is necessary to proceed inquiring the electronic unit in one of the ways indicated and then proceed with the diagnostic research making trials and tests in order to have a picture of the working conditions and identify the root causes of the anomaly.

In case the electronic device is not providing any indication, it will be necessary to proceed relying on the experience, adopting traditional diagnosis procedures.

In order to compensate the operators' lack of experience in this new system, we are hereby providing the USER's GUIDELINE FOR TROUBLESHOOTING in the following pages.

The GUIDELINE is composed of two different parts:

☐ Part 1: DTC codes and their indications are listed and interpreted; DTC codes can be viewed on the Iveco Motors diagnostic device;

☐ Part 2: guide to diagnostics, divided according to symptoms, including the description of possible failures not identified by the electronic control unit, often mechanical or hydraulic failures.

⚠ Any kind of operation on the electronic center unit must be executed by qualified personnel, duly authorized by IVECO.

Any unauthorized tamper will involve decay of after-sales service in warranty.

DTC error codes
with EDC7 UC31 central unit

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
113	ACCELERATOR PEDAL/BRAKE PEDAL SUSPECT	Vehicle acceleration very slow. Engine idle speed: 500 rpm.	Accelerator pedal and brake pressed simultaneously (for too long); Accelerator pedal blocked or faulty; Incorrect use of vehicle.	Check the accelerator pedal signal and pedal mechanical movement.				
116	CLUTCH SIGNAL SUSPECT	The parameter reading shows that the clutch is pressed.	Clutch switch faulty or wiring problems in pedal.	Check clutch pedal switch and wiring.				
117	BRAKE PEDAL SIGNAL ERROR	Slight power reduction.	Main and secondary brake switch not synchronised. One of the two brake pedal switches may be stuck.	Check the synchronisation of both switches (signal) and wiring.				
119	PLAUSIBILITY +15		Possible mechanical problem (in pawl) or electrical problem.	Check wiring.				
121	SPEED LIMITER W/LIGHT	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
122	WARNING LIGHT EOBD	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
123	EDC LAMP	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
124	COLD START LAMP	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
125	MAIN RELAY DEFECT	Possible problems during after-run.	Relay short circuit to battery positive or earth.	Check wiring between ECM and battery. Replace relay if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
126	BATTERY VOLTAGE	Possible problems during after-run.	Alternator or battery defective. Possible wiring problem.	Check wiring. Replace alternator regulator or battery. Replace the alternator if necessary.				
127	ENGINE BRAKE ELECTROVALVE	Engine brake not operational.	Relay or wiring short-circuited or interrupted.	Check wiring. Replace relay if necessary.				
128	MAIN RELAY - SHORT CIRCUIT TO BATTERY	Possible problems during after-run.	Relay short circuit to battery positive or earth. Relay may be faulty.	Check wiring between ECM and battery. Replace relay if necessary.				
129	AIR-CONDITIONER COMPRESSOR RELAY	Possible problems during after-run.	Relay short circuit to battery positive or earth. Relay may be faulty.	Check wiring between ECM and battery. Replace relay if necessary.				
12A	RELAIS FOR ENGINE BRAKE VALVE	Possible problems during after-run.	Relay short circuit to battery positive or earth. Relay may be faulty.	Check wiring between ECM and battery. Replace relay if necessary.				
12B	THERMOSTARTER RELAY 1 (HEATER)	Heater not working.	Relay or wiring short-circuited or interrupted.	Check wiring. Replace relay if necessary.				
12C	THERMOSTARTER RELAY 2	Heater not working.	Relay or wiring short-circuited or interrupted.	Check wiring. Replace relay if necessary.				
12E	MANAGEMENT SYSTEM PRE/POST-HEATING (ACTIVE)	Grid heater permanently operating.	Grid heater short circuited to earth.	Check wiring and component.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
131	COOLANT TEMPERATURE SENSOR	No reaction noticeable on behalf of the driver.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
132	COOLANT TEMPERATURE SENSOR (TEST)	Slight power reduction.	Operation in extreme environmental conditions or sensor inaccurate.	Ensure the engine is not working in extreme environmental conditions. Check the wiring and the sensor accuracy. Replace sensor if necessary.				
133	AIR TEMPERATURE SENSOR BOOST AIR	Slight power reduction.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
134	BOOST PRESSURE SENSOR	No reaction perceivable by the driver. Parameter recovery value: 2700 mbar.	Sensor short-circuited or difference between environmental pressure and turbo pressure implausible.	Check the wiring. Also check the environmental pressure sensor. Replace sensor if necessary.				
135	FUEL TEMPERATURE SENSOR	Slight power reduction.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
138	OIL PRESSURE SENSOR	No reaction perceivable by the driver. Parameter recovery value: 3000 mbar.	Sensor short-circuited or value implausible.	Check the wiring and oil level. Replace sensor if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
13A	OIL TEMPERATURE SENSOR	No reaction perceivable by the driver. Parameter recovery value: coolant temperature value (if intact) otherwise 120°C).	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
13C	ATMOSPHERIC TEMPERATURE SENSOR (HUMIDTIY?)	No reaction perceivable by the driver. Parameter recovery value: 40°C.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
141	CRANKSHAFT SPEED	No reaction noticeable on behalf of the driver.	Signal interrupted or wiring problem. Sensor installation may not be correct.	Check wiring and installation. Replace sensor if necessary.				
142	ENGINE WORKING ONLY WITH CAMSHAFT SENSOR	No reaction perceivable by the driver.	Signal interrupted or wiring problem. Sensor installation may not be correct.	Check wiring and installation. Replace sensor if necessary.				
143	CAMSHAFT SENSOR	No reaction perceivable by the driver.	Signal interrupted or wiring problem. Sensor installation may not be correct.	Check wiring and installation. Replace sensor if necessary.				
144	FAULT BETWEEN FLYWHEEL SENSOR AND CAMSHAFT	No reaction noticeable on behalf of the driver.	Signal interrupted or wiring problem. Flywheel and timing sensor installation may be incorrect.	Check wiring and installation of both sensors.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
145	FAN RELAY	No reaction perceivable by the driver. Fan off.	Short circuit or fan actuator faulty.	Check the wiring and the fan actuator. Replace the actuator if necessary.				
148	AIR-CONDITIONER COMPRESSOR RELAY	Air conditioner permanently off.	Wiring or relay short-circuited.	Check the wiring. Replace relay if necessary.				
149	PRE-HEATING RELAY FUEL FILTER	Filter heater not working.	Wiring or filter heater short-circuited.	Check the wiring. Replace the filter heater if necessary.				
151	INJECTOR CYLINDER 1	The engine runs on 5 cylinders.	Injector no.1 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
152	INJECTOR CYLINDER 2	The engine runs on 5 cylinders.	Injector no.2 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
153	INJECTOR CYLINDER 3	The engine runs on 5 cylinders.	Injector no.3 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
154	INJECTOR CYLINDER 4	The engine runs on 5 cylinders.	Injector no.4 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
155	INJECTOR CYLINDER 5	The engine runs on 5 cylinders.	Injector no.5 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
156	INJECTOR CYLINDER 6	The engine runs on 5 cylinders.	Injector no.6 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
161	INJECTOR CYLINDER 1 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
162	INJECTOR CYLINDER 2 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
163	INJECTOR CYLINDER 3 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
164	INJECTOR CYLINDER 4 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
165	INJECTOR CYLINDER 5 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
166	INJECTOR CYLINDER 6 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
167	INJECTOR CYLINDER 1 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
168	INJECTOR CYLINDER 2 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
169	INJECTOR CYLINDER 3 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16A	INJECTOR CYLINDER 4 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16B	INJECTOR CYLINDER 5 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16C	INJECTOR CYLINDER 6 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16D	COMPRESSION TEST IN PROGRESS		Compression Test in progress.	After carrying out the compression test, turn the key OFF (after-run).				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
16E	THE MINIMUM NUMBER OF INJECTIONS WAS NOT REACHED: STOP THE ENGINE	More than 2 injectors not operating.		See individual faults in injectors.				
171	BENCH 1 CC	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem. Injectors short-circuited.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
173	BENCH 2 CC	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem. Injectors short-circuited.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
17C	BENCH 1 INJECTORS CHECK (INTERNAL ECU)	One or more injectors (bank 1 or bank 2) may not be operating.	Fault in control unit.	Replace the engine control unit.				
189	EGR POWER ST. SHORT TO BATT.	No fault perceived by the driver. EGR not working.	Short circuit or EGR actuator faulty.	Check wiring. Replace the EGR actuator if necessary.				
191	TURBINE ACTUATOR CONTROL ELECTROVALVE	Poor performance.	VGT actuator or wiring defective.	Check VGT wiring and actuator.				
192	TURBINE ACTUATOR CONTROL ELECTROVALVE SHORT CIRCUIT TO POSITIVE	Poor performance.	VGT actuator or wiring defective.	Check VGT wiring and actuator.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
193	TURBINE WHEEL REVS SENSOR	Poor performance.	Air filter blocked or turbine rpm sensor signal implausible.	Check the air filter and check parameters linked with the turbine by performing a road test (parameter acquisition).				
198	FAULT ON AT LEAST TWO OF THE FOLLOWING SENSORS: TURBINE SPEED, BOOT PRESSURE AND EXHAUST GAS PRESSURE	Poor performance.	Sensor signal implausible. Sensor may be faulty.	Determine which turbine component caused the problem.				
199	TURBOCHARGER CONTROL BOOST PRESSURE FAILURE (PCR)	Poor performance.	Turbo sensor or actuator may be faulty. Air filter may be blocked.	Check turbine sensors and actuator (parameter acquisition). Check whether air filter is blocked.				
19A	TURBINE SPEED EXCEEDING EVERY PERMITTED RANGE	Poor performance.	Turbo sensor or actuator may be faulty. Air filter may be blocked.	Check turbine sensors and actuator (parameter acquisition). Check whether air filter is blocked.				
19B	TURBINE IN OVERSPEED (the fault is not displayed if it is caused by a low atmosperic pressure)	Poor performance.	Air filter blocked or turbine rpm sensor signal implausible.	Check the air filter and check parameters linked with the turbine by performing a road test (parameter acquisition).				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
19F	NOx SENSOR ERROR	No effect perceived by the driver.	Sensor signal implausible. Nox sensor may be faulty.	Check the Nox sensor.				
1A5	TIMEOUT OF CAN MESSAGE DM1DCU	No effect perceived by the driver.	Problems in the Denoxtronic (on the CAN line).	Check wiring. Check and correct any faults in the Denoxtronic control unit.				
1A6	TIMEOUT OF CAN MESSAGE SCR1	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check Denoxtronic control unit wiring and operation.				
1AE	HUMIDITY SENSOR	No effect perceived by the driver.	Sensor short-circuited or faulty.	Check wiring. Replace sensor if necessary.				
1AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
1B1	ERROR ON CAN CONTROLLER A	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check terminal resistances.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1B2	ERROR ON CAN CONTROLLER B	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check terminal resistances.				
1B3	ERROR ON CAN CONTROLLER C	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check terminal resistances.				
1B4	TIMEOUT CAN MESSAGE BC2EDC1	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check BC wiring and operation.				
1B5	TIMEOUT CAN MESSAGE VM2EDC	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check VCM wiring and operation.				
1B7	ERROR ON MESSAGES CAN IN TRANSMISSION	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check ECM wiring and operation.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1B9	ERROR ON THE EOBD LIGHT MANAGED BY THE CLUSTER)	No effect perceived by the driver.	MIL/Body Controller warning light defective.	Consult the Body Controller troubleshooting guide and check the CAN line.				
1BA	TIMEOUT CAN MESSAGE DASH DISPLAY	No effect perceived by the driver.	CAN messages from VCM inconsistent.	Consult the VCM troubleshooting guide and check the CAN line.				
1BC	TIMEOUT CAN MESSAGE AMBCOND	No effect perceived by the driver.	CAN messages from VCM inconsistent.	Consult the VCM troubleshooting guide and check the CAN line.				
1BD	TIMEOUT CAN MESSAGE CCVS	No effect perceived by the driver.	CAN messages from VCM or BC inconsistent.	Consult the VCM/BC troubleshooting guide and check the CAN line.				
1C2	ERROR MESSAGE CAN ETC1	No effect perceived by the driver.	CAN messages from ETC (gearbox) inconsistent.	Check the ETC connection with the CAN line.				
1C3	TIMEOUT IN RECEIVING TC01 CAN MESSAGE	No effect perceived by the driver.	CAN messages from TCO inconsistent.	Check the TCO connection with the CAN line.				
1C6	ERROR MESSAGE CAN TSC1-PE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
1C8	ERROR MESSAGE CAN TSC1-VE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
1D1	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Electrical interference or internal control unit problems.	If the error persists to replace ECU.				
1D2	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash. Possible internal fault.	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1D3	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash Possible internal fault	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				
1D4	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1D5	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1D6	ECU INTERNAL ERROR (TPU)	Control unit deactivation.	Electronic interference or control unit faulty.	If the error persists to replace ECU.				
1D8	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1E2	IMMOBILIZER	The engine fails to start.	Problem in CAN line or immobiliser control unit.	Check the Immobiliser control unit is correctly connected. Enter the Immobiliser PIN code during the emergency procedure.				
1E3	ERROR FOR ECU INTERNAL MONITORING	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1E4	ERROR FOR ECU INTERNAL MONITORING	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1E5	SENSORS POWER SUPPLY FAULT (12V)	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1E6	SENSOR POWER SUPPLY 1	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E7	SENSOR POWER SUPPLY 2	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E8	SENSOR POWER SUPPLY 3	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E9	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1EA	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1EB	ATMOSPHERIC PRESSURE SENSOR	No effect perceived by the driver. Environmental pressure recovery value: 700 mbar.	Fault in sensor inside control unit.	Change ECU.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1FA	TOO HIGH NUMBER OF REGENERATIONS DEMAND	No reaction perceivable by the driver. Too many filter regenerations carried out.	Particulate filter may be blocked.	Check filter.				
1FB	PERMANENT RIGENERATION ON TRAP PARTICLE	No reaction perceivable by the driver.	Catalytic converter not installed or damaged.	Check catalytic converter visually.				
1FC	FIRST SENSOR EXAUSTED GAS TEMPERATURE	No reaction perceivable by the driver.	Temperature sensors damaged or incorrectly fitted.	Check information and condition of sensors.				
21F	TOO HIGH EFFICIENCY OF CATALYST SYSTEM	No reaction noticeable on behalf of the driver.	Actuator coil faulty or not within specified tolerance limits.	Check actuator condition.				
225	INTERRUPTED AFTER-RUN	Slight power reduction.	The control unit is turned off by the general switch instead of by the key (k15). Possible problem in main relay or connections.	Check wiring and then replace the main relay.				
228	MAIN RELAY - SHORT CIRCUIT TO GROUND	Slight power reduction.	Short circuit in main relay or relay faulty.	Check wiring between battery and ECM and then replace the main relay.				
232	Coolant temperature sensor absolute test	Slight power reduction.	Extreme environmental conditions or sensor incorrectly adjusted.	Ensure the engine is working in non-critical conditions. Check the sensor connections and accuracy. Replace sensor if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
238	OIL LOW PRESSURE	Slight power reduction.	Sensor incorrectly adjusted or faults in lubrication system.	Check the sensor connections and accuracy. Check the lubrication system.				
23A	OIL TEMPERATURE ABOVE NORMAL	Slight power reduction.	Sensor incorrectly adjusted or faults in lubrication system.	Check the sensor connections and accuracy. Check the lubrication system.				
27C	BENCH 2 INJECTORS CHECK (INTERNAL ECU)	One or more injectors (bank 1 or bank 2) may not be operating.	Fault in control unit.	Replace the engine control unit.				
292	TURBINE ACTUATOR CONTROL ELECTROVALVE SHORT CIRCUIT TO GROUND	Poor performance.	VGT actuator or wiring defective.	Check VGT wiring and actuator.				
2A6	TIMEOUT OF CAN MESSAGE SCR2	No effect perceived by the driver.	Problem in the Denoxtronic (on the CAN line).	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide. Check wiring.				
2AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
2B4	TIMEOUT CAN MESSAGE BC2EDC2	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check BC wiring and operation.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
2C6	TIMEOUT OF CAN MESSAGE TSC1-PE PASSIVE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
2C8	ERROR MESSAGE CAN TSC1-VR	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
2C9	ERROR MESSAGE CAN TIMEDATE	No effect perceived by the driver.	CAN messages from TC (tachograph) inconsistent.	Check the tachograph connection with the CAN line.				
2D3	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash. Possible internal fault.	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				
2FF	ERROR CHECK OF CRITICAL TIME FOR OIL DILUTION	Slight power reduction.	Oil over-diluted.	Change the engine oil.				
392	TURBINE ACTUATOR CONTROL ELECTROVALVE	Poor performance.	Connection damaged. Battery voltage excessive (ECU overheating).	Check VGT connection and actuator.				
3AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
3C8	TIMEOUT OF CAN MESSAGE TSC1-VE PASSIVE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
3C9	ERROR MESSAGE CAN HRDV	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check BC wiring and operation.				
3D3	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash. Possible internal fault.	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				
3FA	REGENERATION DEMAND NUMBER 2	No effect perceived by the driver.	Too many regenerations carried out.	Check particulate filter and faults in sensors.				
4AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
4C8	TIMEOUT OF CAN MESSAGE TSC1-VR PASSIVE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
4FA	REGENERATION DEMAND NUMBER 3	No effect perceived by the driver.	Too many regenerations carried out.	Check particulate filter and faults in sensors.				
5AF	DM1DCU SPN5 message	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				

GUIDELINE FOR TROUBLESHOOTING

SIGNALLED ANOMALY	BLINK CODE	EDC WAR-NING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
The battery goes flat quickly.	-	-	Pre-heating resistor powered continuously.	Local overheating.		
The engine will stop or won't start.	-	-	Fuel pre-filter clogged.			
Difficult start when the engine is either hot or cold.	-	-	The 3.5 bar valve on fuel return is stuck open.			
Slight overheating.	-	-	Either 0.3 bar tank return valve or return piping clogged.			
After the new vehicle has been delivered, the engine will stop after a short operation time.The tank holds a lot of fuel; all the rest is O.K.	-	-	Reversed tank suction / return pipes.			The engine is fed by the return pipe, the suction of which in the tank is lower. When the pipe sucks no more, the engine will stop.
Reduced power / difficult engine maneuverability.	-	-	Injection system / the engine operates with one cylinder failing: - injector plunger seizure; - valve rocker arm seizure.	Overheating	Engine test: cylinder efficiency test. If the trouble is not related to electric components (Blink code 5.x), the rocker arm holder shaft needs be disassembled. Check the rocker arm roller and bushing as well as the respective cam.	
Fuel consumption increase.	-	-	Air filter clogging with no signal from the warning light on the instrument board.	Smoke.	Check the cabling, connections and component.	

SIGNALLED ANOMALY	BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
The engine does not reach the other speeds under load conditions.	-	-	The boosting pressure sensor provides too high values, which, in any case, fall within the range.	Smoke.		
The driver feels that the engine is not working correctly like it did before.	-	-	Impaired hydraulic performance of an injector.		Engine test: check-up	Replace the injector of the cylinder in which Modus detects lower performance levels (compared with the others) only after verifying that the control rocker arm adjustment is correct.
The driver feels that the engine is not working correctly like it did before.	-	-	Wrong adjustment of an injector control rocker arm.		Engine test: check up.	Perform correct adjustment, then repeat the engine test.
The engine operates with five cylinders; noise (knock).	-	-	Plunger seizure.	Possible overheating.	Engine test: cylinder efficiency.	Replace the injector of the cylinder in which the diagnosis instrument detects lower performance levels (compared with the others).
Replace the injector of the cylinder in which the diagnosis instrument detects lower performance levels (compared with the others).	-	-	Wrong adjustment of the injector control rocker arm (excessive travel) with impact on the plunger on the nozzle.	Possible mechanic damage to the areas surrounding the injector.	Engine test: cylinder efficiency.	Replace the injector of the cylinder in which the diagnosis instrument detects lower performance levels (compared with the others).
The engine will stop or won't start again.	-	-	Presence of air in the fuel supply circuit.	It might even not switch off; it might have operation oscillations, or start, yet with difficulty and after making many attempts.	Bleed air.	

PART FOUR - MAINTENANCE PLANNING

MAINTENANCE

Maintenance services scheme

Programmed maintenance is made up of ”Standard” services, plus a set of operations called ”Extra Plan” operations, as well as further operations called ”Temporal” operations.

Normally, no differentiated plans are prescribed in connection with vehicle use. Where a differentiation in terms of ”mission” exists, as many plants are forwarded as many are the ”missions”.

Using recommended lubricants systematically allows for long replacement intervals with relatively contained costs. To such purpose, see recommended lubricants summary card.

M = STANDARD SERVICE

”Standard” services are indicated by M = ”Maintenance”.
They must be performed at regular kilometre intervals that are normally multiple among one another.

EP = EXTRA PLAN OPERATIONS

Extra plan operations are indicated by EP = ”Extra Plan”.
They are services complementary to ”standard” services and are to be performed according to intervals which are not compatible with standard services.

T = TEMPORAL OPERATIONS

They are specific interventions that are exclusively connected to temporal intervals and are to be normally performed in particular season conditions. To minimise the number of stops for maintenance it is recommended to program extra plan stops based on average yearly run matching them as much as possible with predefined kilometre intervals.

To ensure optimum working conditions, the following pages give the checks, inspections and adjustments that need to be made on the various parts of the vehicle at the required times.

⚠ The kilometre frequency for engine lubrication is in relation to a percentage of sulphur in diesel of under 0.5%.

NOTE: If using diesel with a percentage of sulphur above 0.5%, the oil-change frequency has to be halved.

Use engine oil: ACEA E4 (URANIA FE 5W30)
ACEA E7 (URANIA LD7)

⚠

- ☐ If the vehicle is used very little or anyhow for less than 1000 hours/100,000 km a year, the engine oil and filter need to be replaced every 12 months.
- ☐ ACEA E4 lubricants classified as ACEA E6 cannot be used according to the change intervals established for class ACEA E4. They shall be changed according to the time intervals established for lubricants ACEA E2, i.e. every 400 hours/40,000 km.
- ☐ If class ACEA E7 engine oil is used, the engine oil and filters must be changed every 800 hours/80,000 km.
- ☐ If class ACEA E2 engine oil is used, the engine oil and filters must be changed every 400 hours/40,000 km.

MAINTENANCE INTERVALS

On road application

To schedule the work, keep to the following chart:

USAGE APPLICATIONS	OILS	SERVICES			EXTRA PLAN	PROGRAMMED OPERATIONS	
		M1	**M2**	**M3**	**EP3**	**T2**	**T5**
On road covering long distances. On road covering middle distances.	Engine (1) Urania FE5W30	Every 100,000 km or 2,000 hours	Every 150,000 km or 3,000 hours	Every 300,000 km or 6,000 hours	Every 240,000 km	Every year before the Winter	Every 2 years

(1) IVECO suggests the use of these lubricants to raise the vehicle "fuel economy". The new vehicle is already equipped by IVECO with these types of lubricants, suitable also for cold climates (minimum temperature down to -30°). The change intervals depend on the use of these oils.

Off road application (quarries-construction sites)

To schedule the work, keep to the following chart:

USAGE APPLICATIONS	OILS	SERVICES			PROGRAMMED OPERATIONS		
		M1	**M2**	**M3**	**T4**	**T6**	**T7**
Quarry and construction site vehicles: • concrete mixers • Tipper trucks Off road vehicles: • snowthrowers etc.	**Engine (1)** ACEA E4 Urania FE5W30	Every 1000 hours	Every 1500 hours	Every 3000 hours	Every year before winter	Every year	Every 2 years

(1) IVECO suggests the use of these lubricants to raise the vehicle "fuel economy". The new vehicle is already equipped by IVECO with these types of lubricants, suitable also for cold climates (minimum temperature down to -30°). The change intervals depend on the use of these oils.

Off road application (on road usage)

To schedule the work, keep to the following chart:

USAGE APPLICATIONS	OILS	SERVICES			PROGRAMMED OPERATIONS	
		M1	**M2**	**M3**	**T2**	**T5**
On road covering middle-long distances	**Engine (1)** Urania FE5W30	Every 1000 hours	Every 1500 hours	Every 3000 hours	Gearbox oil and Intarder filter	Every year before summer

(1) IVECO suggests the use of these lubricants to raise the vehicle "fuel economy". The new vehicle is already equipped by IVECO with these types of lubricants, suitable also for cold climates (minimum temperature down to -30°). The change intervals depend on the use of these oils.

CHECKS AND/OR MAINTENANCE WORK
On road application

Type of operation	M1 Every 100.000 km or 2000h	M2 Every 150.000 km or 3000h	M3 Every 300.000 km or 6000h
Engine			
Change engine oil	•		•
Change engine oil filters	•		•
Replacement of fuel filter cartridge	•		•
Replacing the Blow-by filter		•	•
Check control belt conditions	•		•
EDC system engine check-up through MODUS or IT2000 or E.A.SY.		•	•
Replacement of variable geometry turbocharger air filter		•	•
Check of clutch wear of fan electromagnetic joint	•		•
Replacement of fuel prefilter cartridge	•		•
Replacing the AdBlue system filter / pre-filter		•	•
Replace engine air filter (dry filter element) (1)		•	•
Test AdBlue system with E.A.S.Y, MODUS, IT 2000	•	•	•

(1) Early clogging of the air cleaner is generally due to environmental conditions. For this reason it needs to be replaced when signalled by the sensor irrespective of the guidelines that anyhow have to be observed if there are no specific instructions otherwise.

Off road application

Type of operation	M1 Every 100.000 km or 1000h	M2 Every 150.000 km or 1500h	M3 Every 300.000 km or 3000h
Engine			
Change engine oil	•		•
Change engine oil filter	•		•
Replacement of fuel filter cartridge	•		•
Check miscellaneous drive belts	•		•
Check-up of engine EDC system via MODUS, IT 2000 or E.A.SY.		•	•
Check valve clearance and adjust if necessary		•	•
Change variable geometry turbocharger valve air filter		•	•
Change engine auxiliary member drive belt **			•
Change air-conditioner compressor drive belt **			•
Checking fan electromagnetic joint clutch wear (if present)	•		•
Replacement of fuel prefilter cartridge	•		•
AdBlue system filter and pre-filter change		•	•
AdBlue system test with EASY, MODUS or IT2000	•	•	•
Replace engine air filter (dry filter element) (1)*		•	•
Replacing the Blow-by filter *		•	•

(1) Early clogging of the air cleaner is generally due to environmental conditions. For this reason it needs to be replaced when signalled by the sensor irrespective of the guidelines that anyhow have to be observed if there are no specific instructions otherwise.

* Only on road usage.

** Only quarry and construction site vehicles.

NON-PROGRAMMED/TIMED OPERATIONS
On road application

EP3 - Every 240,000 km

If possible, at the same time as a maintenance service.

Cheking and adjusting play in valves and iniectors
Replacing water pump belt and generator
Replacing air conditioner compressor control belt

T2 - Every year - Before the start of Winter

If possible, at the same time as a maintenance service.

Checking coolant density

T5 - Every two years

If possible, at the same time as a maintenance service.

Changing engine coolant

Off road application (quarries-construction sites)

T4 -Every year - Before the start of Winter

If possible, at the same time as a maintenance service.

Checking coolant density
Replacing additional heater fuel filter

T6 -Every year

If possible, at the same time as a maintenance service.

Replacing the cartridge and cleaning air filter container (5)
Replacing blow-by filter

T7 -Every 2 years

If possible, at the same time as a maintenance service.

Replacing engine coolant

(5) Early air filter clogging is generally caused by environmental conditions; for this reason, air filter must be replaced when relating warning from special sensor is issued independently of relevant prescription, which must be anyhow observed in lack of specific indications.

Off road application (on road usage)

T2 -Every year - Before the start of Winter

If possible, at the same time as a maintenance service.

Checking coolant density
Replacing additional heater fuel filter

T5 -Every 2 years

If possible, at the same time as a maintenance service.

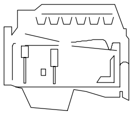
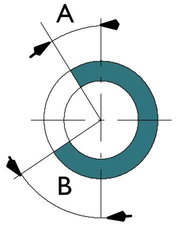
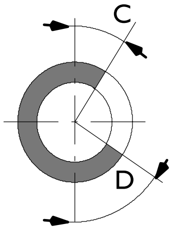
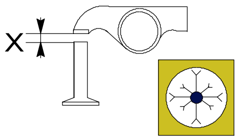
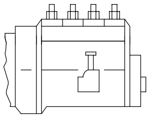
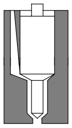
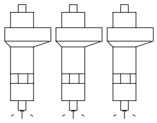
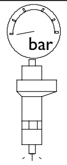
Replacing engine coolant

SECTION 4

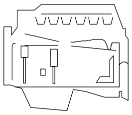
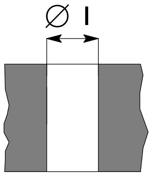
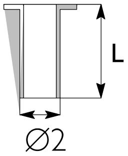
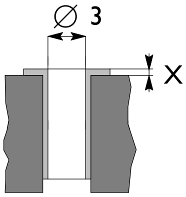
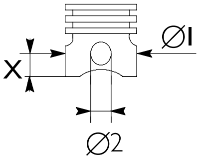
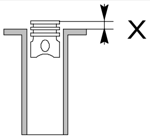
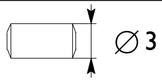
General overhaul

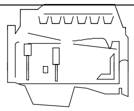
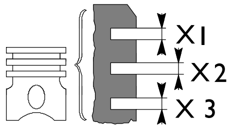
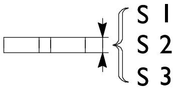
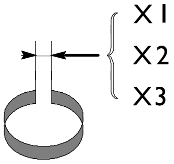
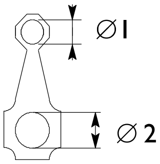
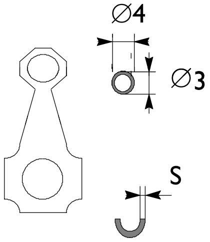
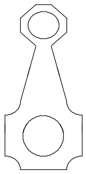
GENERAL CHARACTERISTICS

Type		**F2BE3681**
Cycle		Diesel 4 strokes
Feeding		Turbocharged with aftercooler
Injection		Direct
N. of cylinders		6 on-line
Diameter	mm	115
Stroke	mm	125
Total displacement	cm^3	7790

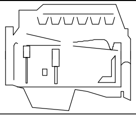
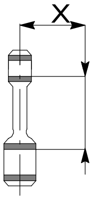
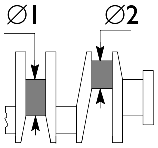
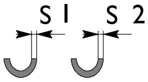
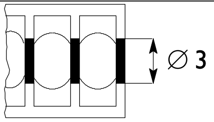
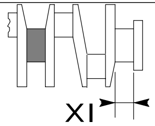
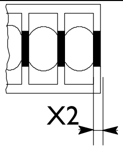
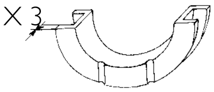
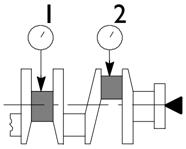
	Type		**F2BE3681**
	VALVE TIMING opens before T.D.C. closes after B.D.C.	 A B	 17° 31°
	opens before B.D.C. closes after T.D.C.	D C	48° 9°
	For timing check X	mm mm	– –
	Running X	mm mm	0.35 to 0.45 0.35 to 0.45
	FEED		Through fuel pump - Filters
	Injection type Bosch		With electronically regulated injectors UIN2 pump injectors controlled by overhead camshaft
	Nozzle type		-
	Injection order		1 - 4 - 2 - 6 - 3 - 5
	Injection pressure	bar	1600

ASSEMBLY CLEARANCE DATA

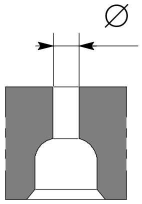
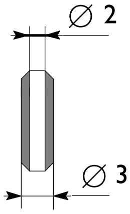
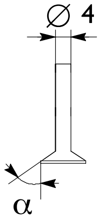
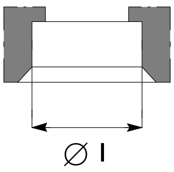
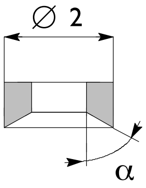
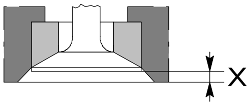
	Type	**F2BE3681**
CYLINDER BLOCK AND CRANK MECHANISM COMPONENTS		mm
	Cylinder sleeve bore upper Ø 1 lower	 130.200 to 130.225 128.510 to 128.535
	Cylinder liners: outer diameter: upper Ø 2 lower length L	 130.161 to 130.186 128.475 to 128.500 –
	Cylinder sleeve - crankcase bore upper lower	 0.014 to 0.064 0.010 to 0.060
>	Outside diameter Ø 2	
	Cylinder sleeve inside diameter Ø3 A* inside diameter Ø3 B* Protrusion X** * Available dia. class ** Under a load of 6000 kg	 115.000 to 115.012 115.010 to 115.022 0.035 to 0.065
	Pistons: measuring dimension X outside diameter Ø 1 A• outside diameter Ø 1 B•• outside diameter Ø 2 • Class A pistons supplied as spares. •• Class B pistons are fitted in production only and are not supplied as spares.	 18 114.871 to 114.883 114.881 to 114.893 46.010 to 46.018
	Piston - cylinder sleeve	0.117 to 0.141
<	Piston diameter Ø 1	–
	Pistons protrusion X	0.32 to 0.99
	Gudgeon pin Ø 3	45.994 to 46.000
	Gudgeon pin - pin housing	0.010 to 0.024

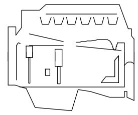
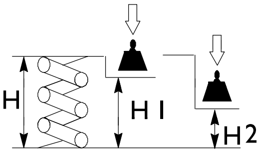
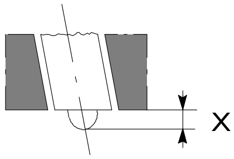
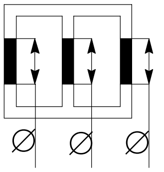
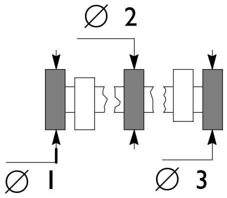
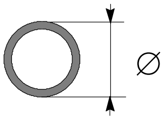
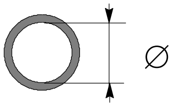
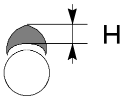
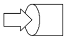
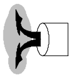
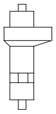
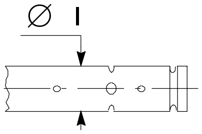
			F2BE3681	
			mm	
	Type		FEDERAL MOGUL ■	MAHLE PISTON ▲
 X1 X2 X 3	Piston ring grooves	X1*	1.583 (rated)	1.583 to 1.613
		X 2	1.554 to 1.574	1.550 to 1.570
		X3	4.02 to 4.04	
	*measured on Ø of 111 mm			
 S 1 S 2 S 3	Piston rings:			
	trapezoidal seal	S1●	1.429 to 2.463	
	lune seal	S2	1.47 to1.50	
	milled scraper ring with slits and internal spring	S3	3.970 to 3.990	
● Measured at 2 mm from the Ø outside				
	Piston rings - grooves	1	0.247 to 0.311	0.111 to 0.175
		2 ■	0.054 to 0.104	
		2 ▲	0.050 to 0.100	
		3	0.030 to 0.070	
	Piston rings		–	
 X1 X2 X3	Piston ring end gap in cylinder liners:			
		X1	0.30 to 0.40	
		X2	0.55 to 0.70	
		X3	0.35 to 0.65	
 Ø1 Ø 2	Small end bush housing	Ø 1	49.975 to 50.000	
	Big end bearing housing	Ø2	Rated value 77.000 to 77.030	
	Selection classes Ø	1	77.000 to 77.010	
		2	77.011 to 77.020	
		3	77.021 to 77.030	
 Ø4 Ø3 S	Small end bush diameter			
	outside	Ø4	50.055 to 50.080	
	inside	Ø 3	46.015 to 46.030	
	Big end bearing shell	S		
	Red		2.000 to 2.010	
	Green		2.011 to 2.020	
	Yellow		2.021 to 2.030	
	Small end bush - housing		0.055 to 0.105	
	Piston pin - bush		0.015 to 0.036	
	Big end bearing shells		0.127 - 0.254 - 0.508	
	Connecting rod weight			
	Class	A	g. 2865 to 2895	
		B	g. 28961 to 2925	
		C	g. 2926 to 2955	

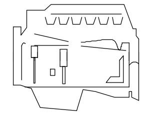
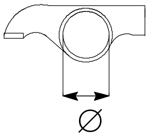
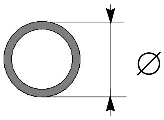
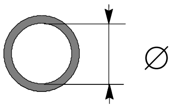
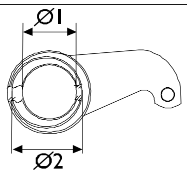
* Factory-assembled only, and not provided with a spare part.

	Type			F2BE3681
				mm
	Measuring dimension	X		125
	Max. connecting rod axis misalignment tolerance	—		0.08
	Main journals	Ø1	nominal value	82.910 to 82.940
	- class	1		82.910 to 82.919
	- class	2		82.920 to 82.929
	- class	3		82.930 to 82.940
	Crankpins	Ø2	nominal value	72.915 to 72.945
	- class	1		72.915 to 72.924
	- class	2		72.925 to 72.934
	- class	3		72.935 to 72.945
	Main bearing shells	S1		
	Red			3.000 to 3.010
	Green			3.011 to 3.020
	Yellow●			3.021 to 3.030
	Big end bearing shells	S2		
	Red			2.000 to 2.010
	Green			2.011 to 2.020
	Yellow●			2.021 to 2.030
	Main bearing housings	Ø3	nominal value	89,000 ÷ 89,030
	- class	1		89,000 ÷ 89,009
	- class	2		89,010 ÷ 89,019
	- class	3		89,020 ÷ 89,030
	Bearing shells - ◊ main journals			0.040 to 0.098 - 0.040 to 0.110 **
	Bearing shells - ◊ big ends			0.035 to 0.093 - 0.035 to 0.083 **
<	Main bearing shells			0.127 - 0.254 - 0.508
	Big end bearing shells			0.127 - 0.254 - 0.508
	Main journal, thrust bearing	X1		39.96 to 40.00
	Main bearing housing, thrust bearing	X2		32.94 to 32.99
	Thrust washer halves	X3		3.38 to 3.43
	Driving shaft shoulder			0.11 to 0.30
	Parallel	// 1 - 2		0.010
	Concentric	◎ 1 - 2		0.040

- ● Fitted in production only and not supplied as spares.
- ◊ Provided with spare: * = standard –0.127; ** = 0.254 – 0.508.

	Type		**F2BE3681**
CYLINDER HEADS - VALVE TRAIN			mm
	Valve guide housings in cylinder head	∅1	12.980 to 12.997
	Valve guide	∅ 2 ∅ 3	8.023 to 8.038 13.012 to 13.025
	Valve guides - housings in the cylinder heads		0.015 to 0.045
	Valve guide	>	0.2 - 0.4
	Valves:	∅ 4 α ∅ 4 α	7.970 to 7.985 60° 30′ ± 7′ 30″ 7.970 to 7.985 $45^{\circ}\,^{+15'}_{-0^{\circ}}$
	Valve stem and its guide		0.038 to 0.068
	Housing in head for valve seat	∅1 ∅1	41.985 to 42.020 40.985 to 41.020
	Outside diameter of valve seat; angle of valve seat in cylinder head:	∅ 2 α ∅ 2 α	42.060 to 42.075 60° - 30′ 41.060 to 41.075 45° - 30′
	Recessing of valve X		0.5 to 0.8 1.6 to 1.9
	Between valve seat and head		0.040 to 0.090

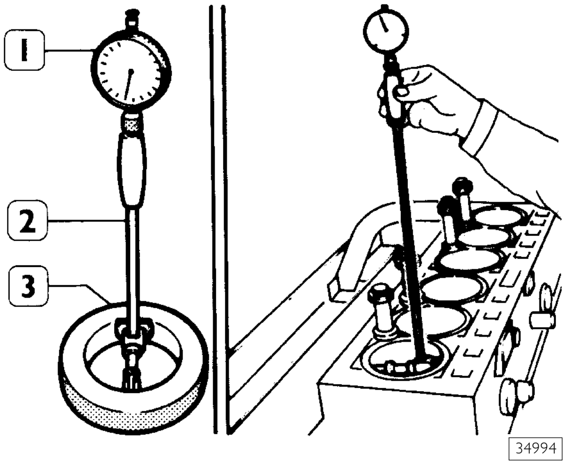
	Type	**F2BE3681** mm
	Valve outside spring height: free height H under a load of: 540 ± 27 N H1 966 ± 48N H2	 66 49.5 37.5
	Injector protrusion X	0.7
	Camshaft bush housing fitted in the cylinder head: 1 ⇒ 7 ∅	80.000 to 80.030
	Camshaft journal diameter: 1 ⇒ 7 ∅	75.924 to 75.940
	Camshaft bushing outer diameter: ∅	80.090 to 80.115
	Camshaft bushing ∅1⇒6 inner diameter: ∅7	75.990 to 76.045 76.008 to 76.063
	Bushings and housings in engine block	0.060 to 0.115
	Bushings and journals	0.050 to 0.121
	Cam lift:	
		8.07
		7.63
		8.828
	Rocker shaft ∅ 1	37.984 to 38.000

	Type	**F2BE3681**
		mm
	Bushing housing in rocker arms	41.000 to 41.016 53.000 to 53.019 42.000 to 42.016
	Bushing outer diameter for rocker arms:	41.097 to 41.135 53.105 to 53.156 42.066 to 42.091
	Bushing inner diameter for rocker arms:	38.025 to 38.041 50.025 to 50.041 38.015 to 38.071
	Between bushings and housings	0.081 to 0.135 0.086 to 0.156 0.050 to 0.091
	Between rocker arms and shaft	0.025 to 0.057 - 0.015 to 0.087
	Engine brake control lever Eccentric pin outer diameter Ø1 Rocker arms shaft seat Ø2	 49.984 ÷ 50.000 38.025 ÷ 38.041

	Type	F2BE3681C	F2BE3681B	F2BE3681A
		mm		
	Rocker arms and engine brake control lever pin	0.025 to 0.068		
	Rocker arm shaft and seat on engine brake control lever	0.025 to 0.057		
TURBOCHARGER				
Type		HOLSET with fixed geometry HX40	HOLSET with variable geometry HE 431 V	
End play		0.025 to 0.127	0.025 to 0.127	
Radial play		0.330 to 0.508	0.254 to 0.356	

REPAIR OPERATIONS
CYLINDER BLOCK
Checks and measurements

Figure 1 (Demonstration)

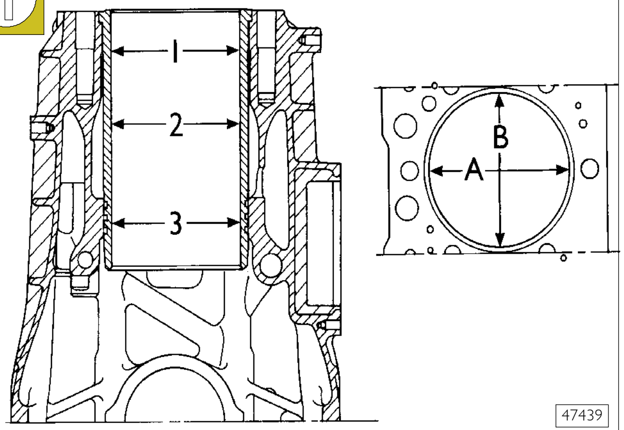


Once engine has been dismounted, accurately clean cylinders-base assembly. Accurately check for block not to show cracks. Check machining caps conditions. If taps are rusted, or on least doubt of their sealing capacity, replace them. On caps mounting, apply sealant Loctite 270 on to the caps.

Internal diameter of the cylinder liners is checked for ovalization, taper and wear, using a bore dial (1) centesimal gauge (2) previously reset to ring gauge (3), diameter 115 mm.

NOTE If a 115 ring gauge is not available use a micrometer caliper.

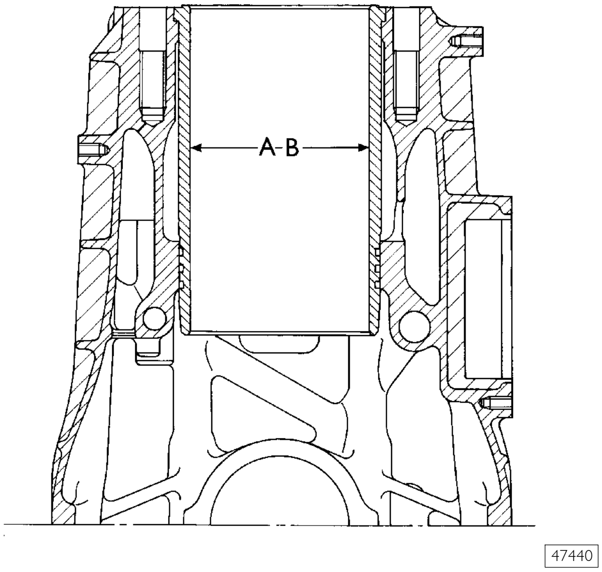
Figure 2



1 = 1st measuring
2 = 2nd measuring
3 = 3rd measuring

Carry out measurings on each cylinder liner at three different levels and on two (A-B) surfaces, to one another perpendicular, as shown in Figure 2.

Figure 3



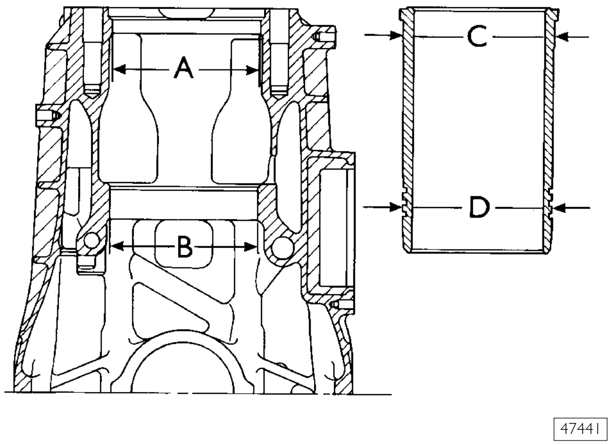
A = Selection class Ø 115 to 115.012 mm
B = Selection class Ø 115.010 to 115.022 mm

In case of maximum wear max 0.150 mm or maximum ovalization max 0.100 mm compared to the values indicated in the figure, the liners must be replaced as they cannot be ground, lapped or trued.

NOTE

Cylinder liners are equipped with spare parts with “A“ selection class.

Figure 4



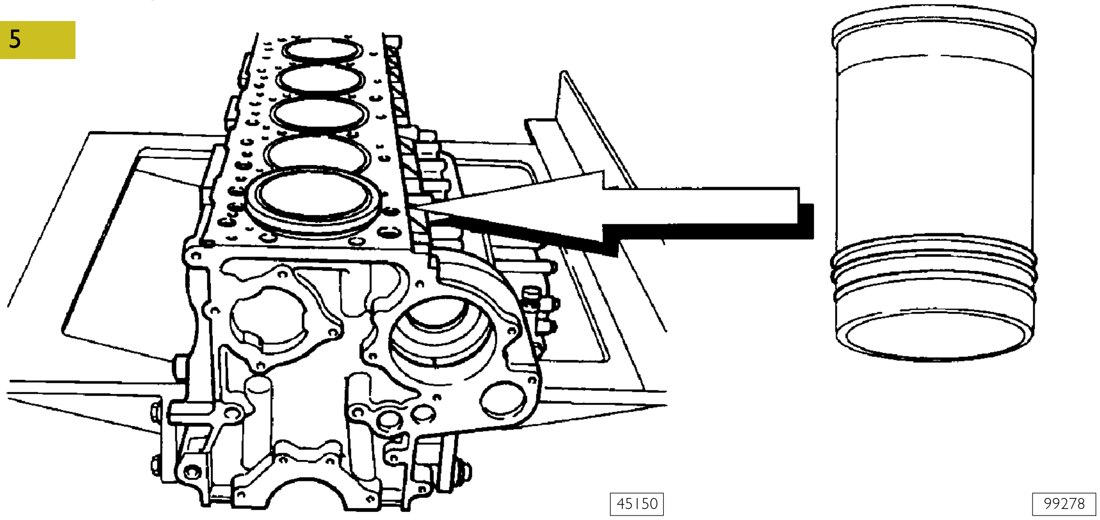
A = Ø 130.200 to 130.225 mm
B = Ø 128.510 to 128.535 mm
C = Ø 130.161 to 130.186
D = Ø 128.475 to 128.500 mm

The figure shows the outer diameters of the cylinder liners and the relative seat inner diameters.

The cylinder liners can be extracted and installed several times in different seats, if necessary.

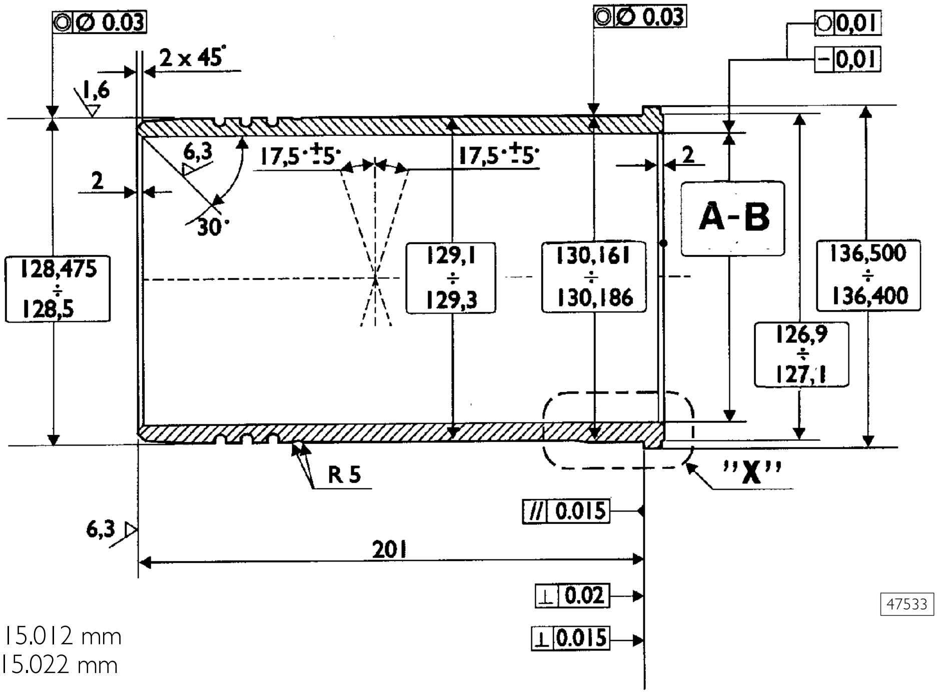
CYLINDER LINERS

Figure 5



BLOCK WITH CYLINDER LINERS

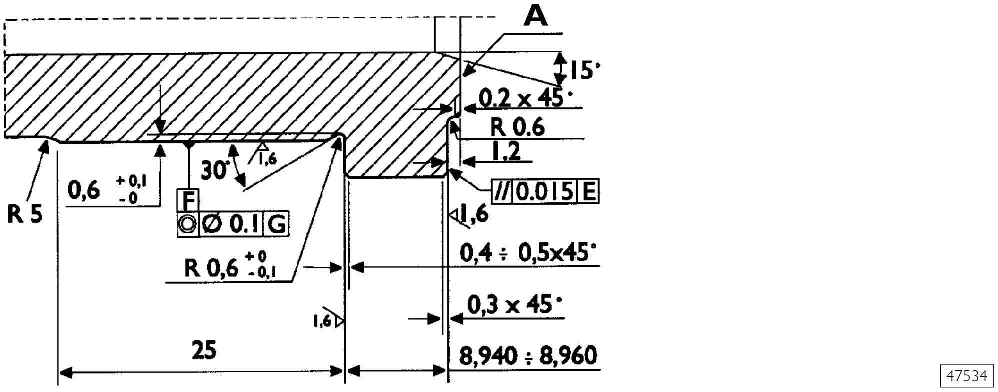
Figure 6



Selection class { A 115.000 to 115.012 mm
B 115.010 to 115.022 mm

CYLINDER LINERS MAIN DATA

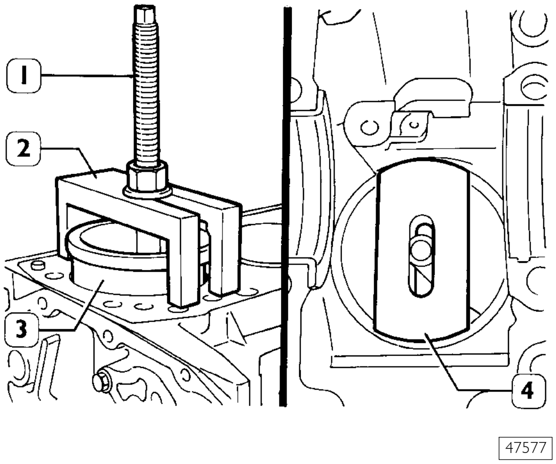
Figure 7



DETAIL “X”
“A“ = Selection class marking area

Removal of cylinder liners

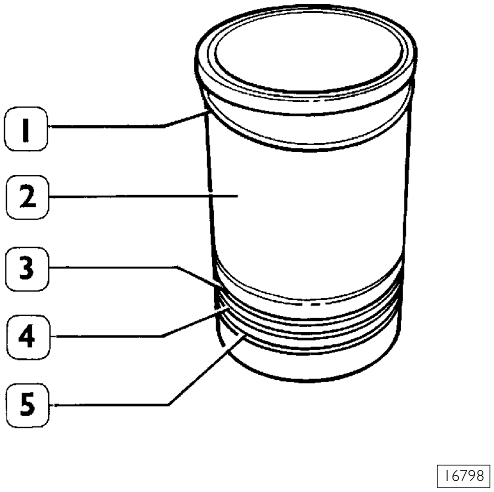
Figure 8



Place details 99360706 (1 and 2) and plate 99360724 (4) as shown in the figure, by making sure that the plate (4) is properly placed on the cylinder liners.
Tighten the screw nut (1) and remove the cylinder liner (3) from the block.

Fitting and checking protrusion

Figure 9

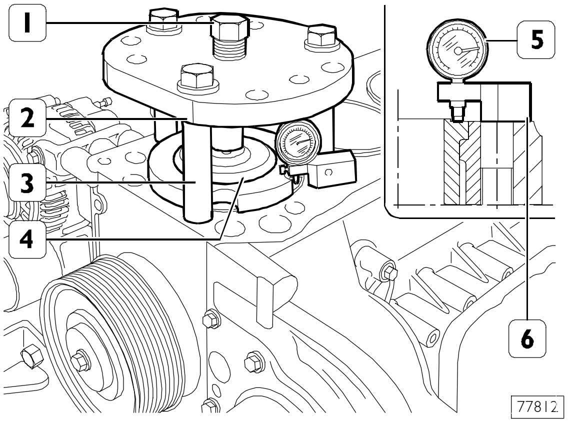


Always replace water sealing rings (3, 4 and 5).
Install the adjustment ring (1) on the cylinder liner (2); lubricate lower part of liner and install it in the cylinder unit using the proper tool.

NOTE

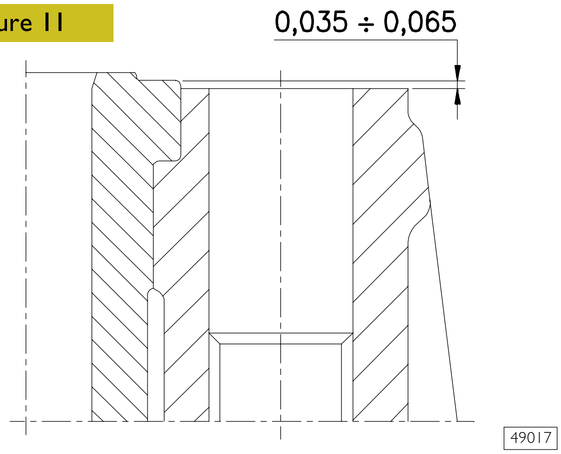
The adjustment ring (1) is supplied as spare parts in the following thicknesses: 0.08 mm - 0.10 mm - 0.12 mm.

Figure 10



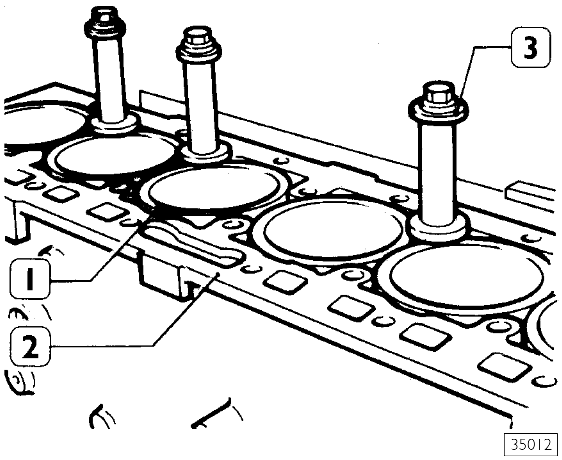
Check cylinder barrel protrusion with tool 99360334 (1-2-3-4) and tighten screw (1) to 170 Nm.
With dial gauge 99395603 (5) placed on base 99370415 (6).
Measure the cylinder barrel protrusion compared to the cylinder head supporting plane, it must be 0.035 to 0.065 mm (Figure 11); otherwise replace the adjusting ring (1, Figure 9) fitted with spare parts having different thickness.

Figure 11



CYLINDER LINER PROTRUSION

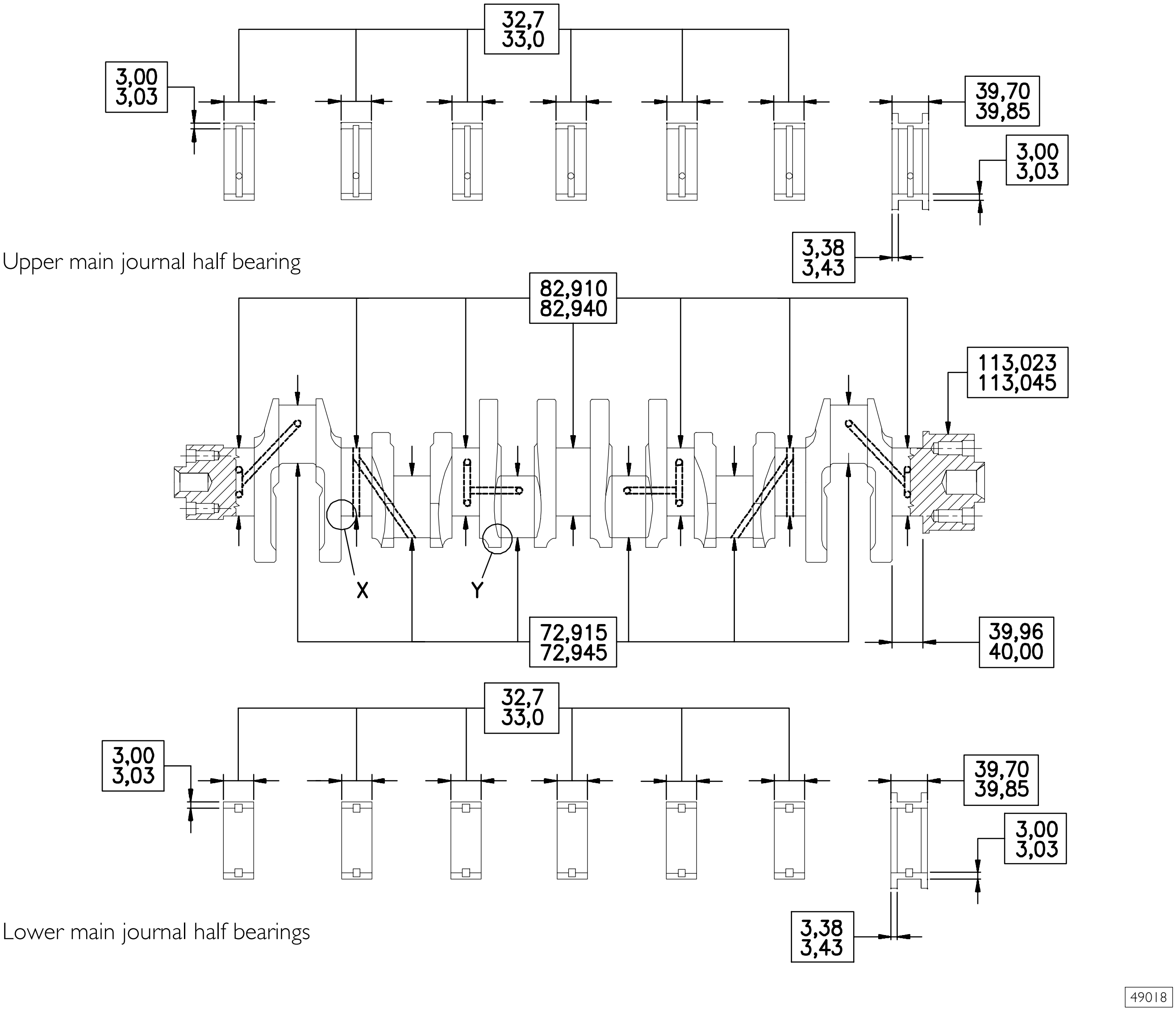
Figure 12 (Demonstration)



When the installation is completed, block the cylinder liners (1) to the block (2) with studs 99360703 (3).

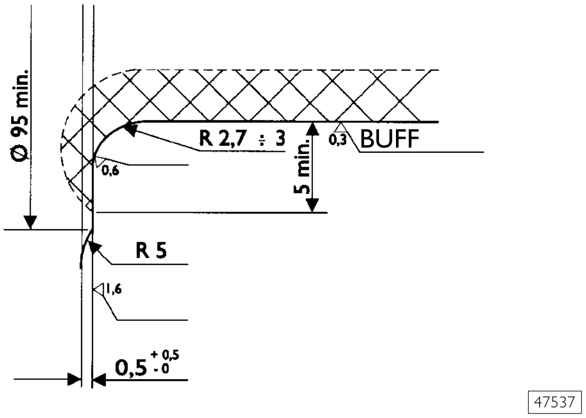
CRANKSHAFT

Figure 13



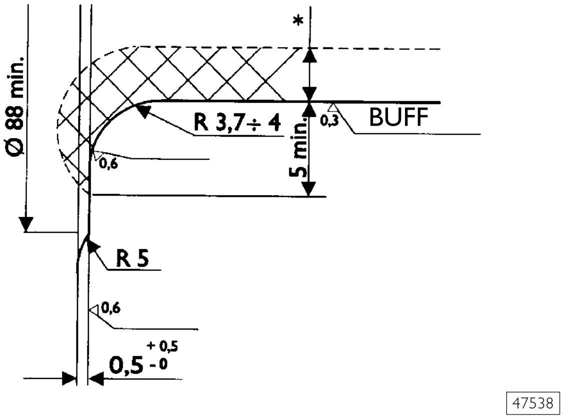
MAIN DATA FOR THE CRANK SHAFT PINS AND THE HALF BEARINGS
Check the condition of the journals and the big end pins; there must no be signs of scoring, ovalization or excessive wear.
The data given refer to the normal diameter of the pins.

Figure 14



X. Detail of main journals connections

Figure 15

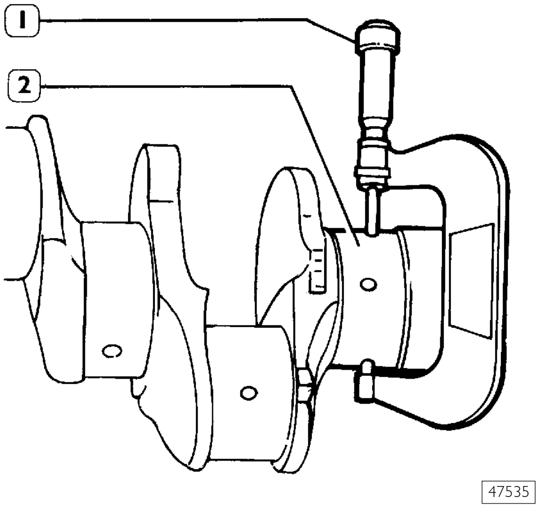


Y. Detail of crank pins connections

Measuring main journals and crank pins

Before grinding the crank pins using a micrometer (1), measure the main journals and the crank pins (2) and decide, on the basis of the undersizing of the bearings, the final diameter to which the pins are to be ground.

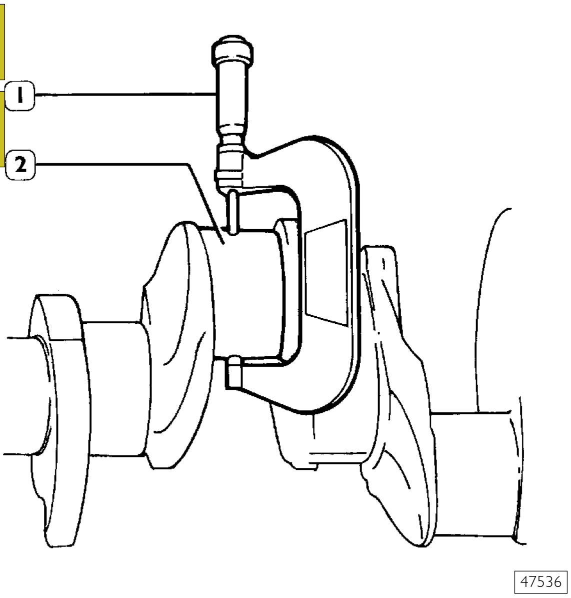
Figure 16



MEASURING THE MAIN JOURNALS

NOTE It is advisable to enter the values found in a table (Figure 18).

Figure 17



MEASURING CRANK PINS

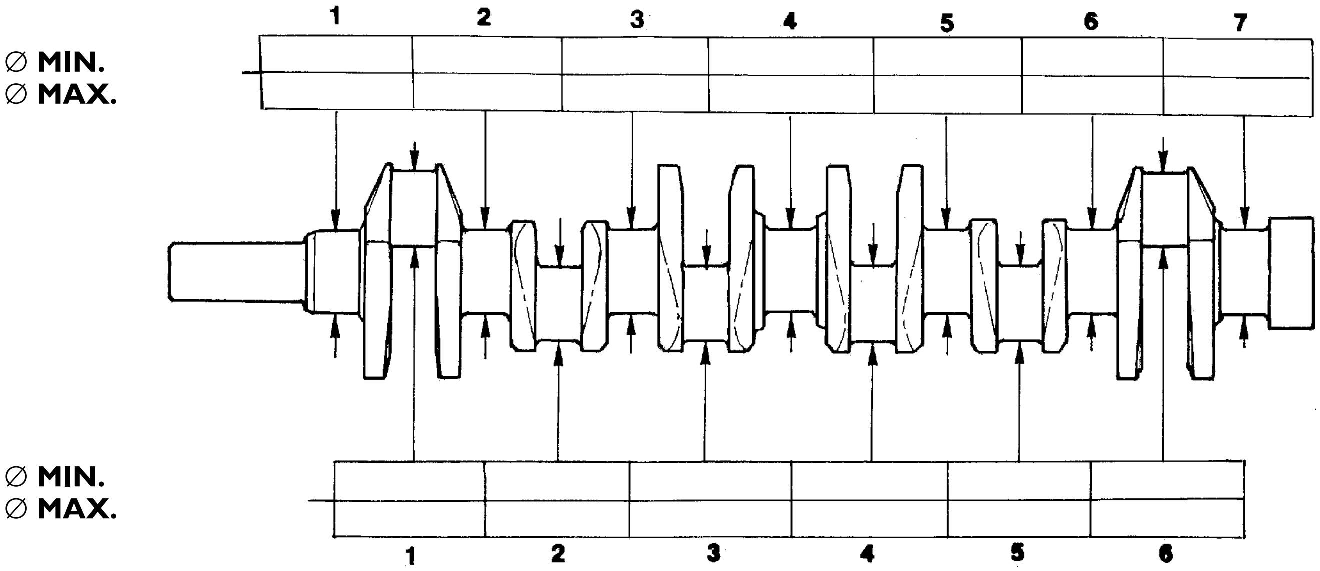
During grinding, pay attention to journal and crank pins values specified in figures 14 and 15.

NOTE All journals and crank pins must also be ground to the same undersizing class, in order to avoid any alteration to shaft balance.

Figure 18

Fill in this table with the measurements of the main journals and the crank pins.

MAIN JOURNALS



CRANK PINS

Preliminary measurement of main and big end bearing shell selection data

For each of the journals of the crankshaft, it is necessary to carry out the following operations:

MAIN JOURNALS:

- ☐ Determine the class of diameter of the seat in the crankcase.
- ☐ Determine the class of diameter of the main journal.
- ☐ Select the class of the bearing shells to mount.

CRANKPINS:

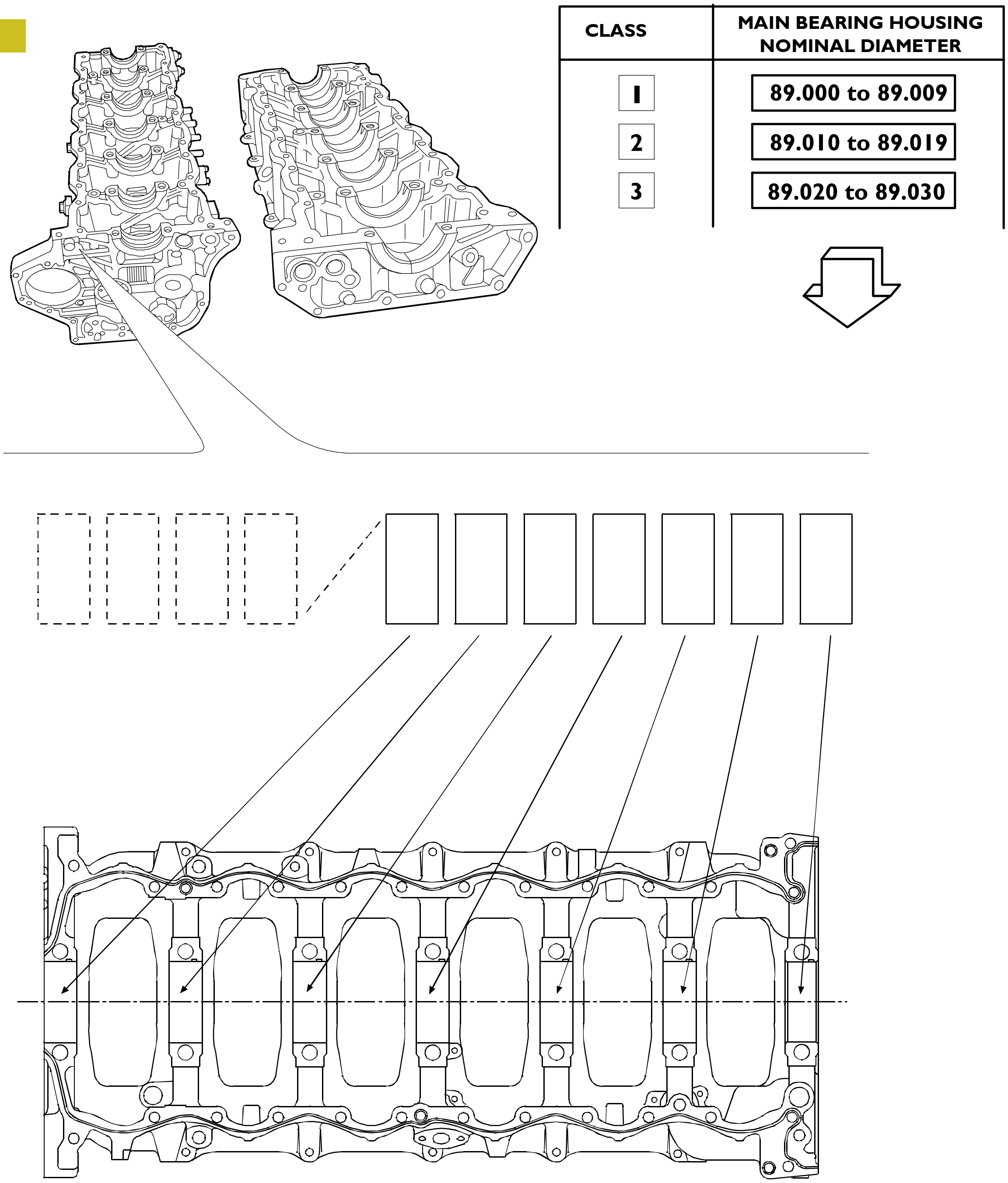
- ☐ Determine the class of diameter of the seat in the connecting rod.
- ☐ Determine the class of diameter of the crankpin.
- ☐ Select the class of the bearing shells to mount.

DEFINING THE CLASS OF DIAMETER OF THE SEATS FOR BEARING SHELLS ON THE CRANKCASE

On the front of the crankcase, two sets of numbers are marked in the position shown.

- ☐ The first set of digits (four) is the coupling number of the crankcase with its base.
- ☐ The following seven digits, taken singly, are the class of diameter of each of the seats referred to.
- ☐ Each of these digits may be **1**, **2** or **3**.

Figure 19



CLASS	MAIN BEARING HOUSING NOMINAL DIAMETER
1	89.000 to 89.009
2	89.010 to 89.019
3	89.020 to 89.030

Selecting the main and big end bearing shells

NOTE To obtain the required assembly clearances, the main and big end bearing shells need to be selected as described hereunder.

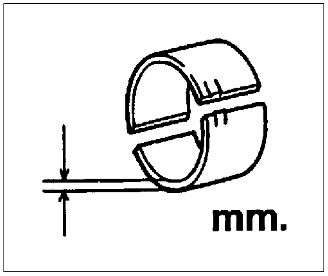
This operation makes it possible to identify the most suitable bearing shells for each of the journals (the bearing shells, if necessary, can have different classes from one journal to another).

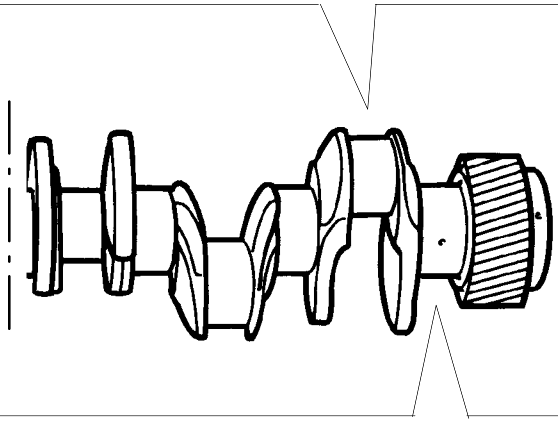
Depending on the thickness, the bearing shells are selected in classes of tolerance marked by a coloured sign (red-green – red/black – green/black).

The following tables give the specifications of the main and big end bearing shells available as spares in the standard sizes (STD) and in the permissible oversizes (+0.127, +0.254, +0.508).

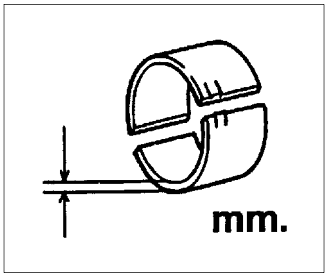
Figure 20

	STD	+0.127	+0.254	+0.508
red	2.000 to 2.010		2.127 to 2.137	2.254 to 2.264
red/black		2.063 to 2.073		
green	2.011 to 2.020		2.138 to 2.147	2.265 to 2.274
green/black		2.074 to 2.083		
yellow*	2.021 to 2.030			
yellow/black*		2.084 to 2.093		





	STD	+0.127	+0.254	+0.508
red	3.000 to 3.010		3.127 to 3.137	2.254 to 3.264
red/black		3.063 to 3.073		
green	3.011 to 3.020			
green/black		3.074 to 3.083		
yellow*	3.021 to 3.030			
yellow/black*		3.084 to 3.093		



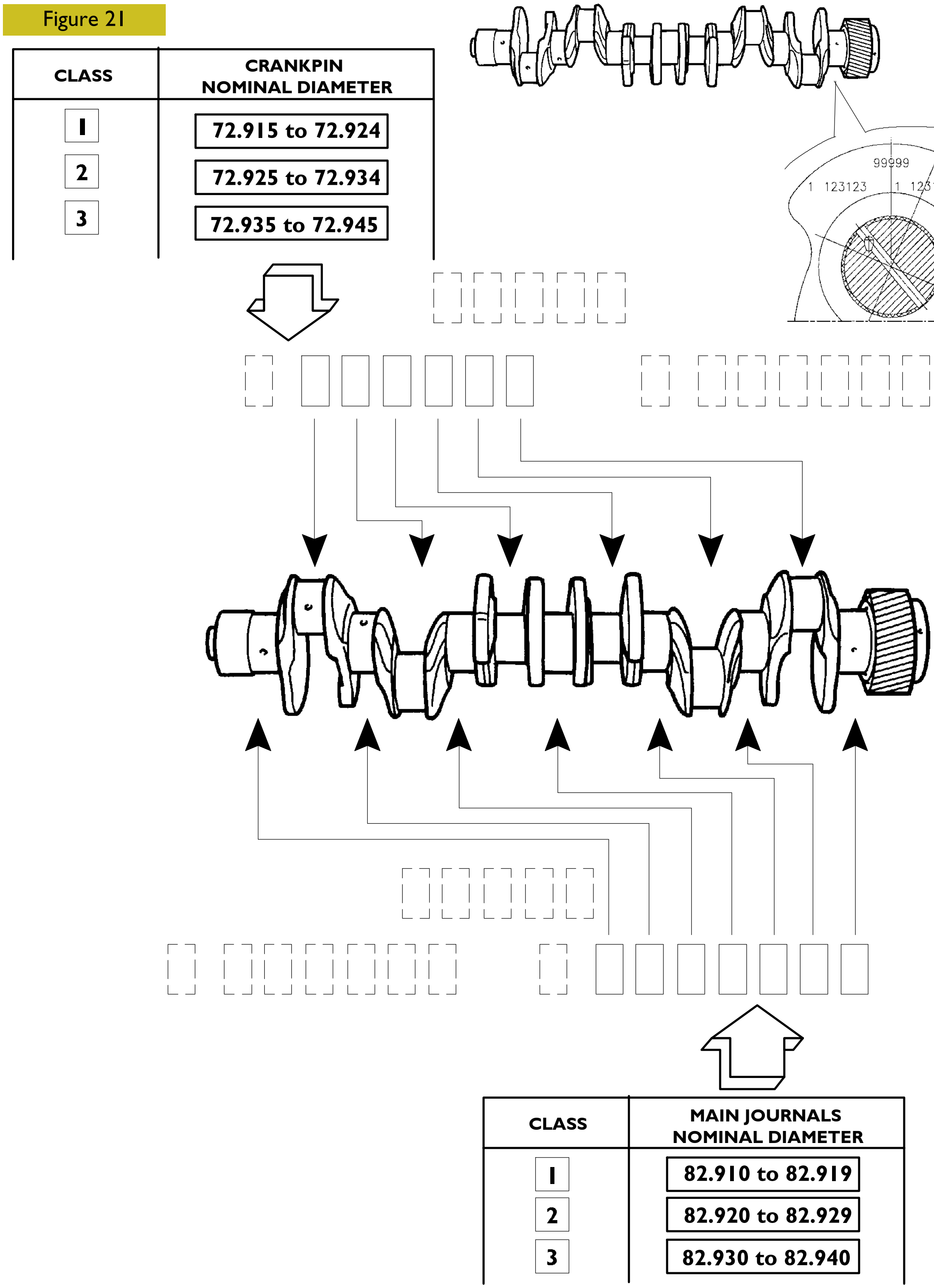
* Fitted in production only and not supplied as spares

Defining the class of diameter of the main journals and crankpins (Journals with nominal diameter)

Main journals and crankpins: determining the class of diameter of the journals.
Three sets of numbers are marked on the crankshaft in the position shown by the arrow (Figure 21 at top):

- ☐ The first number, of five digits, is the part number of the shaft.
- ☐ Under this number, on the left, a set of six digits refers to the crankpins and is preceded by a single digit showing the status of the journals (1 = STD, 2 = -0.127), the other six digits, taken singly, give the class of diameter of each of the crankpins they refer to (Figure 21 at top).
- ☐ The set of seven digits, on the right, refers to the main journals and is preceded by a single digit: the single digit shows the status of the journals (1 = STD, 2 = -0.127), the other seven digits, taken singly, give the class of diameter of each of the main journals they refer to (Figure 21 bottom).

Figure 21



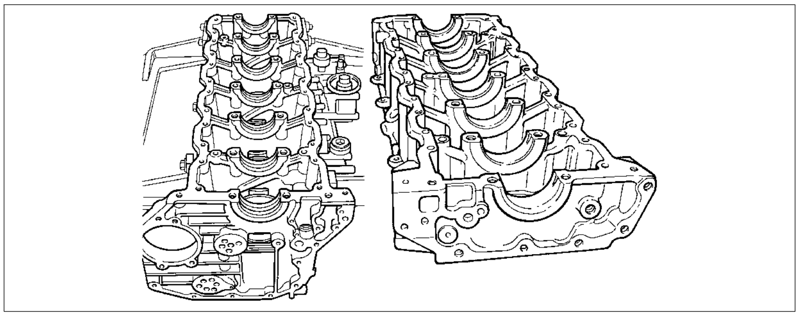
CLASS	CRANKPIN NOMINAL DIAMETER
1	72.915 to 72.924
2	72.925 to 72.934
3	72.935 to 72.945

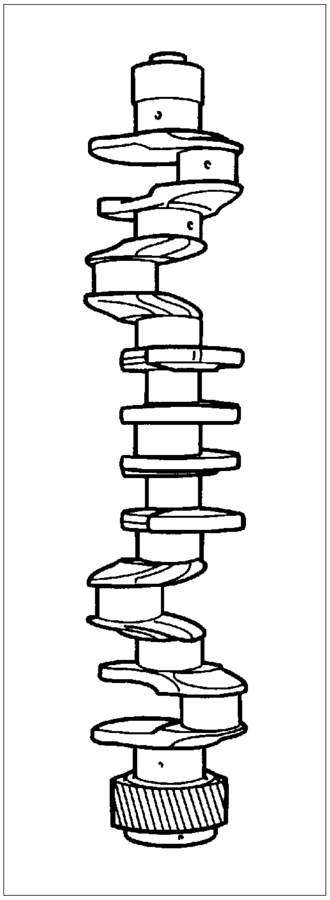
CLASS	MAIN JOURNALS NOMINAL DIAMETER
1	82.910 to 82.919
2	82.920 to 82.929
3	82.930 to 82.940

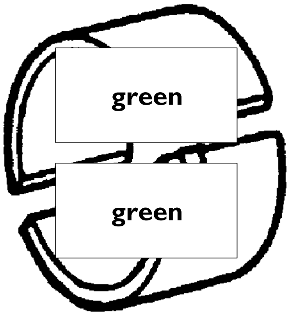
Selection of main half-bearings (nominal diameter pins)

After detecting, for each journal, the necessary data on block and crankshaft, select the type of half-bearings to be used, in compliance with the following table:

Figure 22







STD.	1	2	3
1	green green	green green	green green
2	red red	green green	green green
3	red red	red red	red red

Selection of main half-bearings (rectified pins)

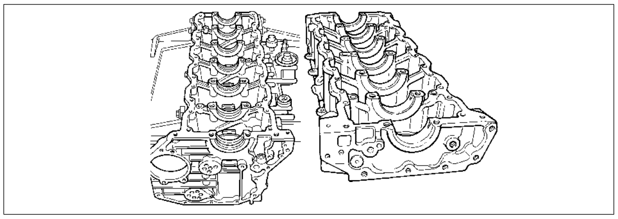
If the journals have been rectified, the procedure described cannot be applied.
In this case, make sure that the new diameter of the journals is as specified on the table and install the only half-bearing type required for this undersizing.

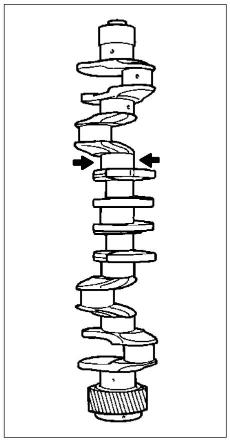
Figure 23

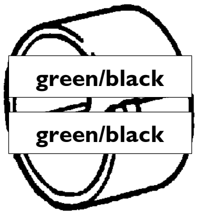
red/black = 3.063 to 3.073 mm

green/black = 3.063 to 3.073 mm

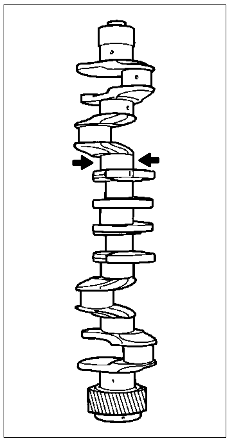
-0.127





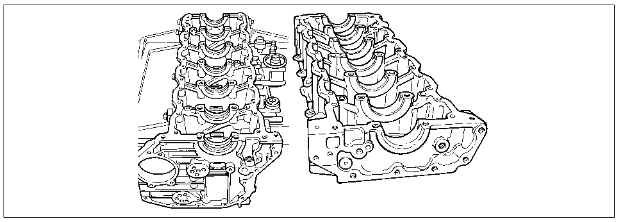


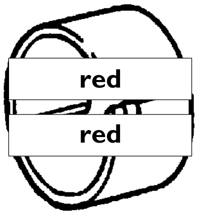
		1	2	3
82.784 82.793	1	green/black green/black	green/black green/black	green/black green/black
82.794 82.803	2	red/black red/black	green/black green/black	green/black green/black
82.804 82.814	3	red/black red/black	red/black red/black	red/black red/black



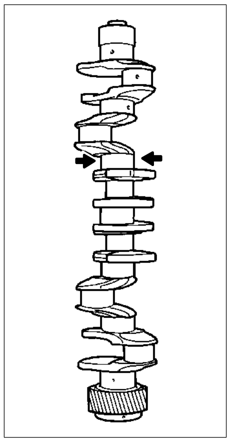
-0.254

red = 3.127 to 3.137 mm



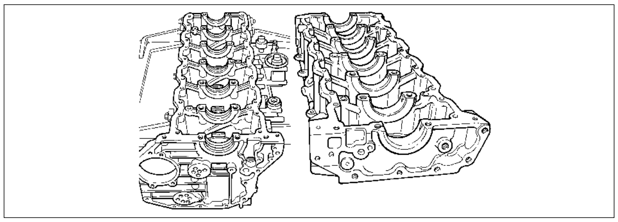


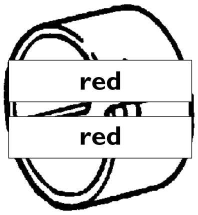
	1	2	3
82,666 82,686	red red	red red	red red



-0.508

red = 3.254 to 3.264 mm





	1	2	3
82.412 82.432	red red	red red	red red

Selecting the big end bearing shells (journals with nominal diameter)

There are three markings on the body of the connecting rod in the position shown in the view from "A":

1 Letter indicating the class of weight:

A = 2890 to 2920 g.
B = 2921 to 2950 g.
C = 2951 to 2980 g.

2 Number indicating the selection of the diameter of the big end bearing seat:

1 = 77.000 to 77.010 mm
2 = 77.011 to 77.020 mm
3 = 77.021 to 77.030 mm

3 Numbers identifying the cap-connecting rod coupling.

The number, indicating the class of diameter of the bearing shell seat may be **1**, **2** o **3**.

Determine the type of big end bearing to fit on each journal by following the indications in the table (Figure 25).

Figure 24

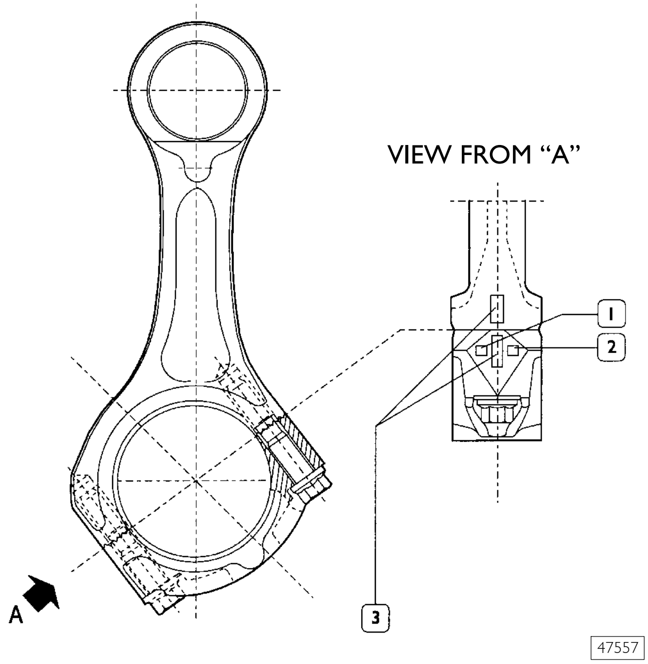
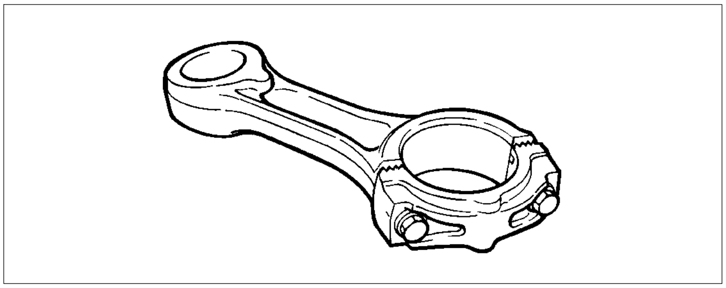
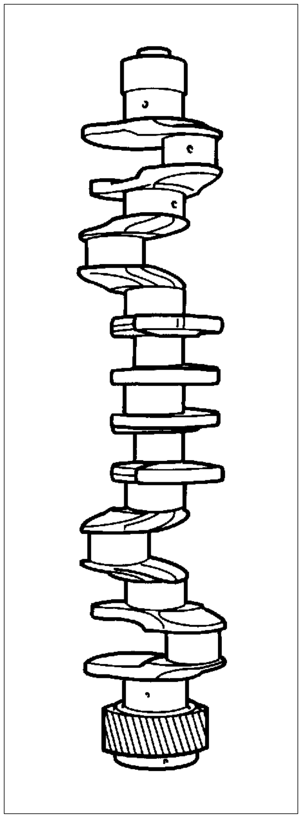


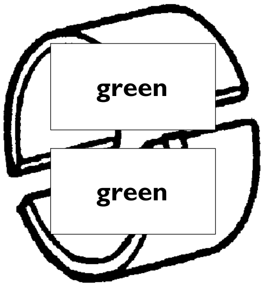
Figure 25

STD.





Class	1	2	3
1	green green	green green	green green
2	red red	green green	green green
3	red red	red red	red red



Selection of connecting rod half-bearings (rectified pins)

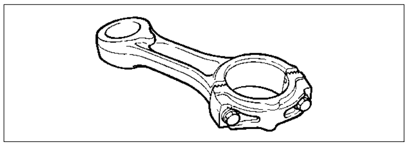
If pins have been rectified, the procedure described must be applied.
In this case, (for each undersizing) determine the tolerance field the new big end pins belong to, and install the half-bearings identified according to the relative table.

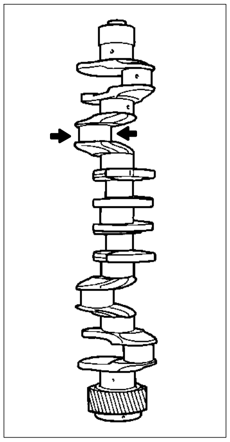
Figure 26

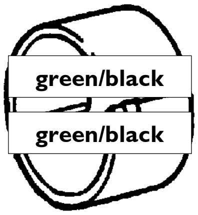
red/black =
2.074 to 2.083 mm

green/black =
2.063 to 2.073 mm

-0.127

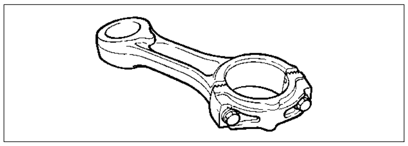




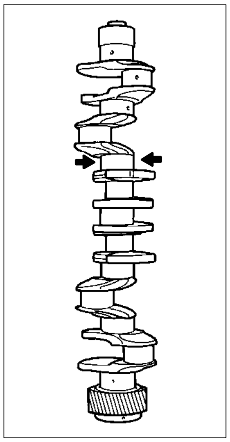


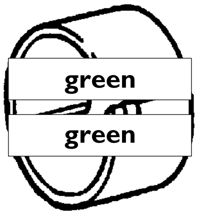
		1	2	3
72.789 72.798	1	green/black green/black	green/black green/black	green/black green/black
72.799 72.808	2	red/black red/black	green/black green/black	green/black green/black
72.809 72.818	3	red/black red/black	red/black red/black	green/black green/black

-0.254



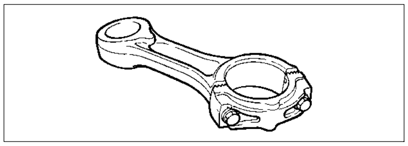
red
2.127 to 2.137 mm
green =
2.138 to 2.147 mm



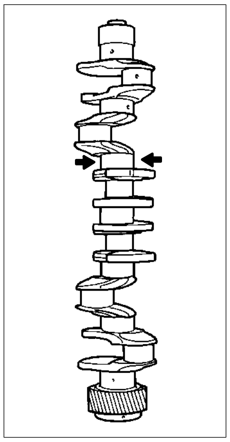


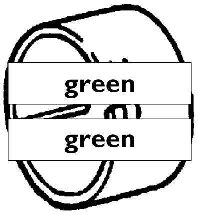
	1	2	3
72.671 72.680	red red	green green	green green
72.681 72.691	red red	red red	green green

-0.508



red =
2.254 to 2.264 mm
green =
2.265 to 2.274 mm



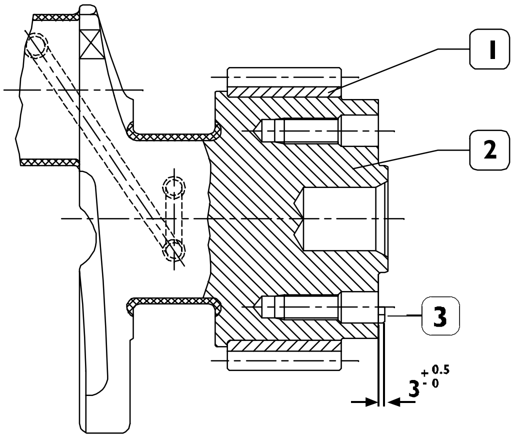


	1	2	3
72.417 72.426	red red	green green	green green
72.427 72.437	red red	red red	green green

Replacing the timing control gear and the oil pump

Check that the teeth of the gears are not damaged or worn, otherwise remove them using the appropriate extractor.

Figure 27

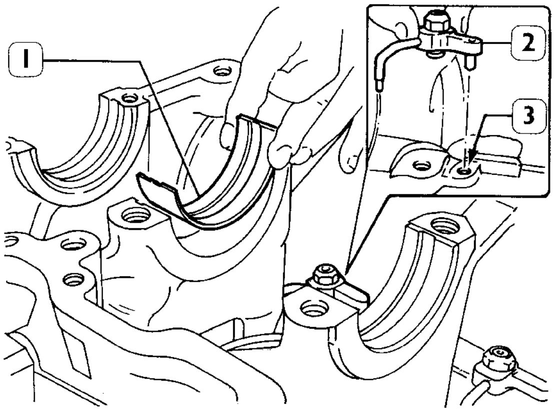


After fitting the gear (1) on the crankshaft (2), heat it for ~15 minutes in an oven at temperature not higher than 180°C.
Let them cool down after the installation.

If changing the pin (3), after fitting it on, check it protrudes from the crankshaft as shown in the figure.

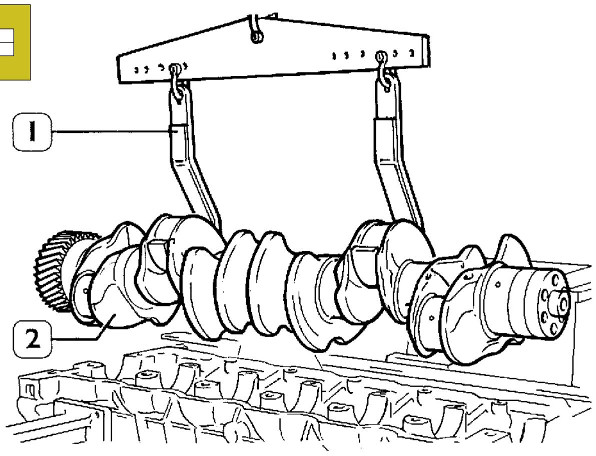
Checking main journal installation clearance

Figure 28



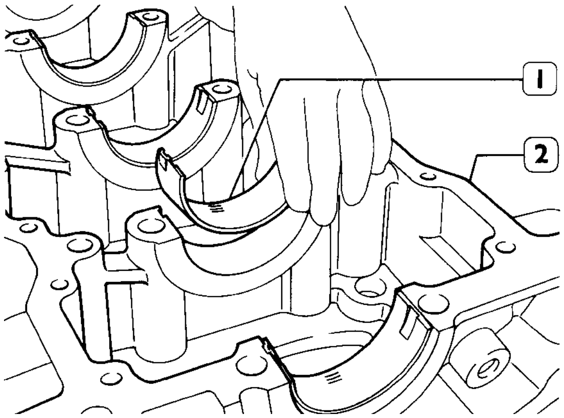
Install the oil spray nozzles (2) and have the dowel coincide with the block hole (3).
Install the half-bearings (1) on the main bearings.

Figure 29



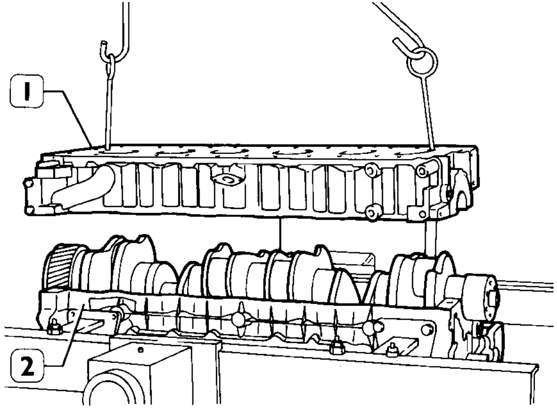
Using the hoist and hook 99360500 (1) mount the driving shaft (2).

Figure 30



Install the half-bearings (1) on the main bearings in the underblock (2).
Check the installation clearance between the main journals and the relative bearings as follows:

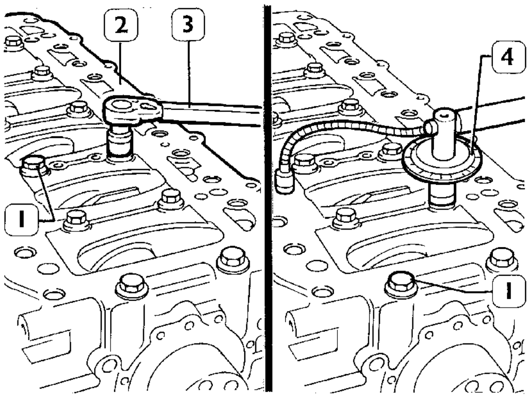
Figure 31



49022

Place a piece of calibrated wire on the journal of the crankshaft (2), parallel to the longitudinal axis; install the underblock (1), by hoist and appropriate hooks.

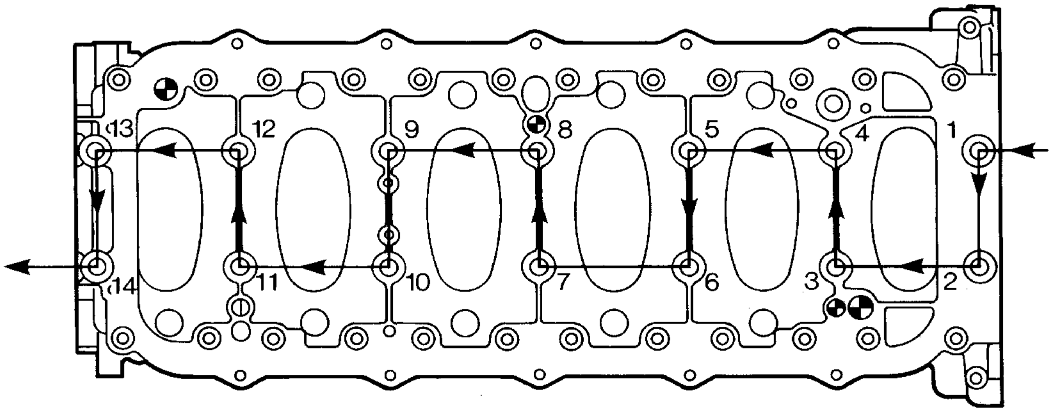
Figure 32



47578

☐ Lubricate inside screws (1) con UTDM oil, and tighten them by dynamometric wrench to 140 Nm torque, thus with 60° angle closing, by following the diagram below.

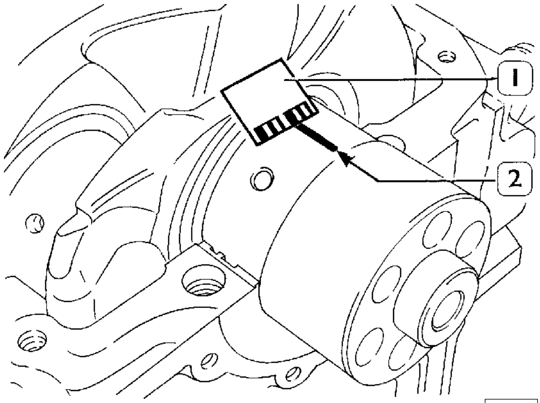
Figure 33



44898

Diagram showing the tightening order of the screws fixing the lower under-block to the block

Figure 34



47579

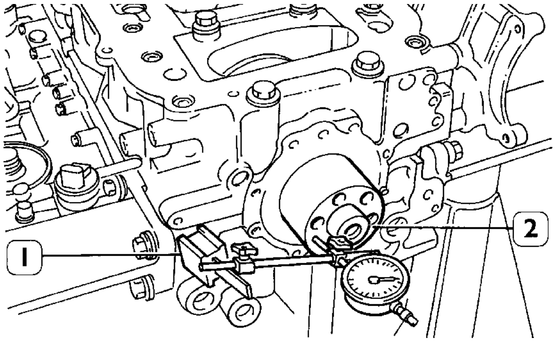
☐ Remove the under-block

The clearance between the main bearings and the journals is obtained by comparing the calibrated wire length (2) at the maximum deflection point, with the calibrated scale on the coating (1) containing the calibrated wire (1).

Numbers shown on the scale specify the clearance in coupling millimeters. If the clearance obtained is different from the clearance required, replace the half-bearings and repeat this check.

Checking crankshaft end float

Figure 35

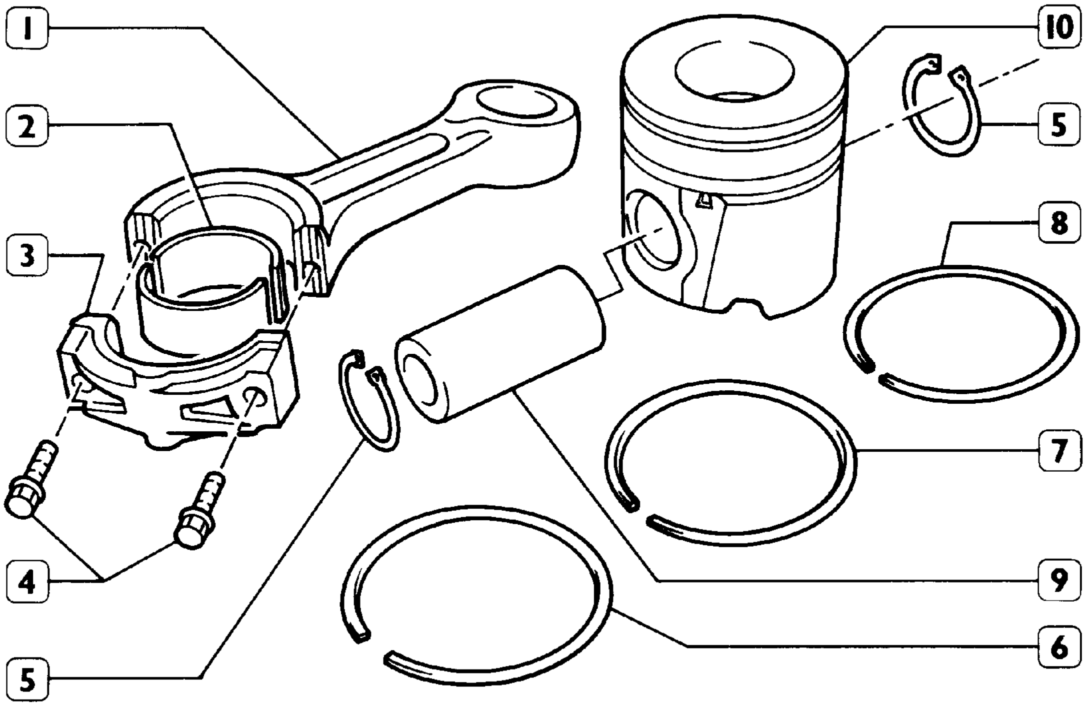


47588

End float is checked by placing a magnetic dial gauge (1) on the crankshaft (2), as shown in the figure. If the value obtained is higher than specified, replace the rear thrust half-bearings and repeat this check.

PISTON-CONNECTING ROD ASSEMBLY

Figure 36



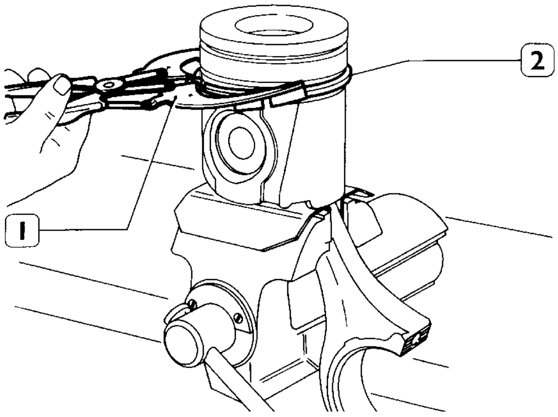
PISTON CONNECTING ROD ASSEMBLY

1. Connecting rod body - 2. Half bearings - 3. Connecting rod cap - 4. Cap fastening screws - 5. Split ring - 6. Scraper ring with spiral spring - 7. Bevel cut sealing ring - 8. Trapezoidal sealing ring - 9. Piston pin - 10. Piston

Make sure the piston does show any trace of seizing, scoring, cracking; replace as necessary.

Removal

Figure 37

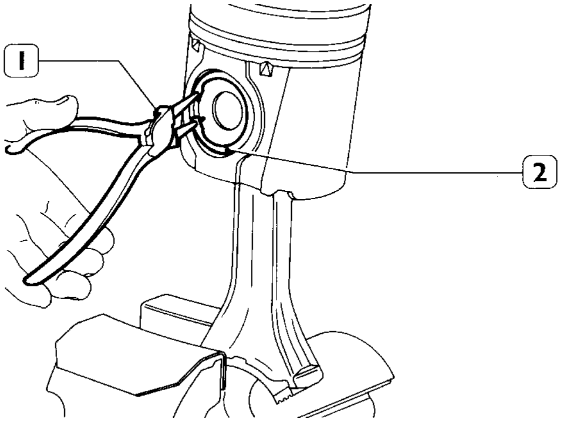


Removal of the piston split rings (2) using the pliers 99360184 (1).

Pistons are equipped with three elastic rings: a sealing ring, a trapezoidal ring and a scraper ring.

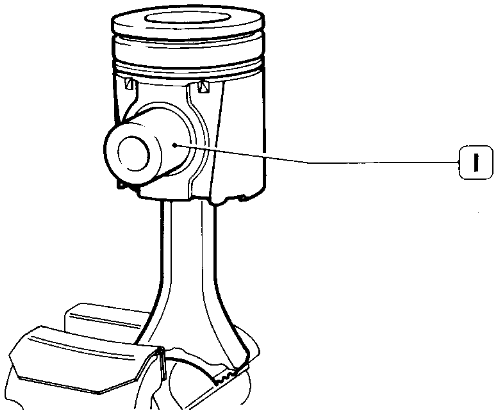
Pistons are grouped into classes A and B for diameter.

Figure 38



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

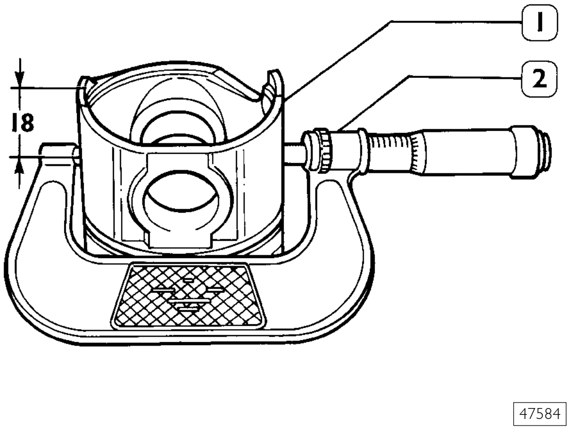
Figure 39



Remove the piston pin (1).
If removal is difficult use the appropriate beater.

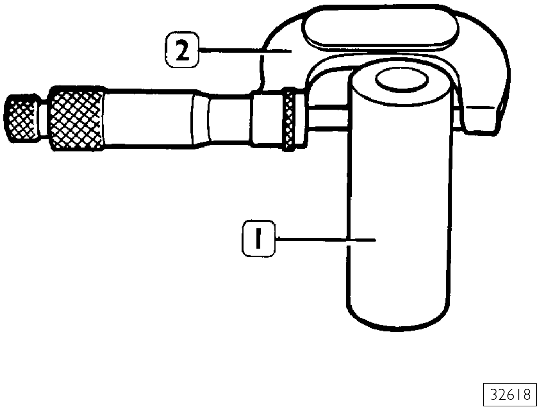
Measuring the diameter of the pistons

Figure 40



Using a micrometer (2), measure the diameter of the piston (1) to determine the assembly clearance; the diameter should be measured at the specified value.

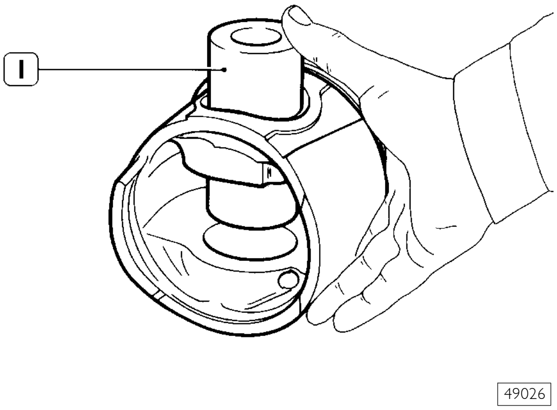
Figure 41



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

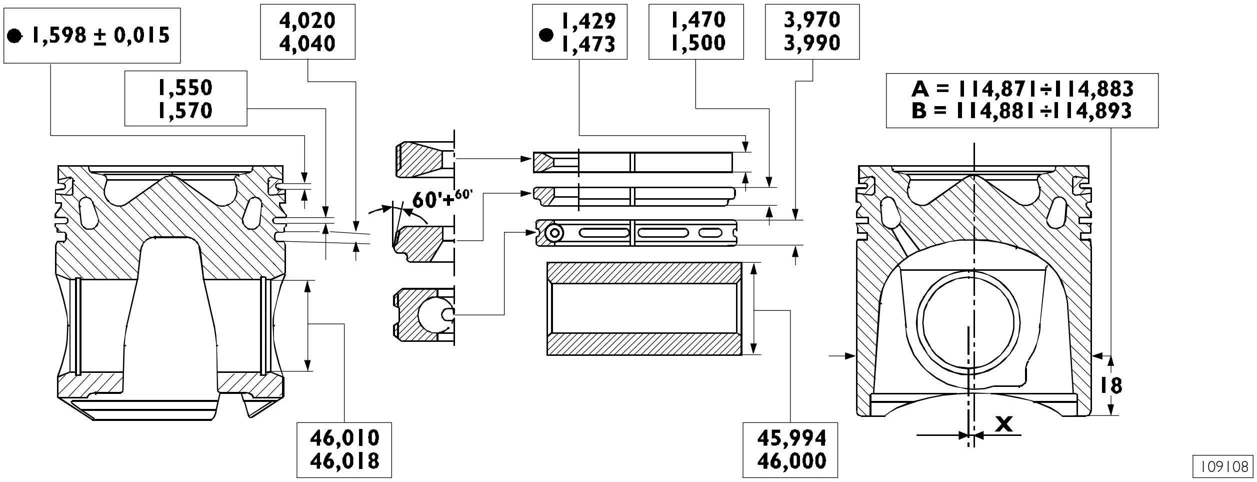
Conditions for correct gudgeon pin-piston coupling

Figure 42



Lubricate the pin (1) and the relevant housing on the piston hubs with engine oil; piston must be inserted with a slight finger pressure and it should not come out by gravity.

Figure 43

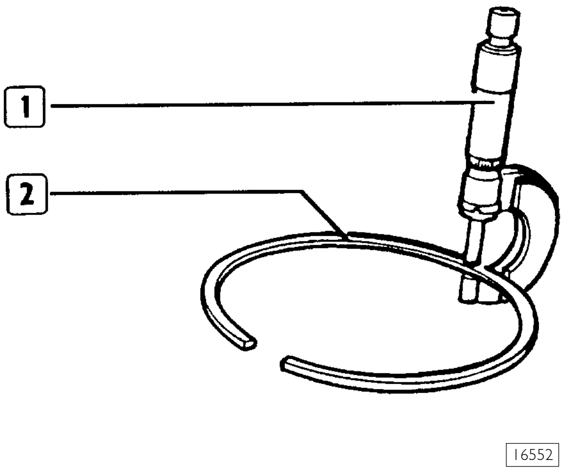


MAIN DATA ON PISTONS, AND PISTONS RINGS (MAHLE PISTON)

X = 0,6 ± 0,15
* Values are determined on ∅ of 111 mm.

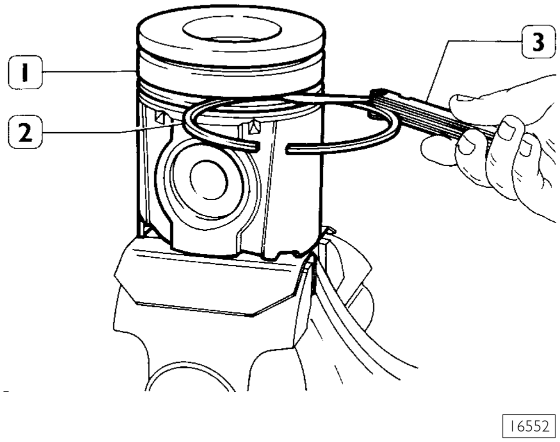
Piston rings

Figure 44



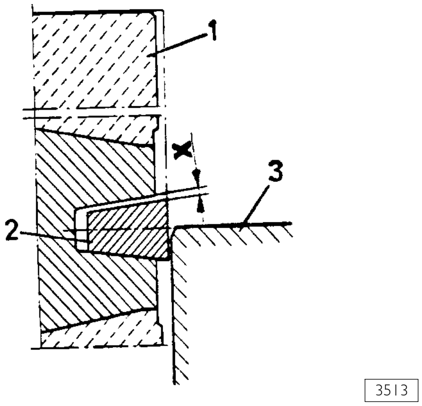
Check the thickness of the piston ring (2) using a micrometer (1).

Figure 45



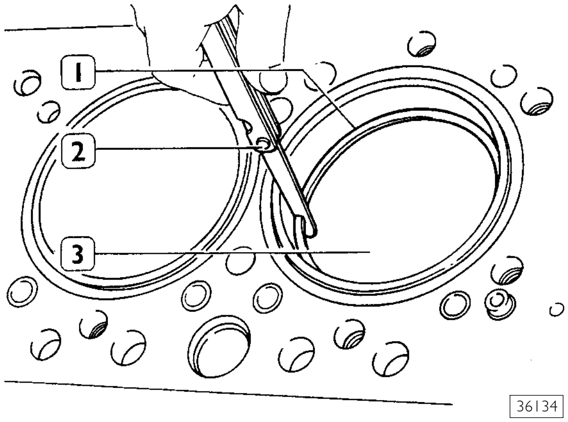
Check the clearance between the sealing rings (2) and the relative piston housings (1) using a thikness gauge (3).

Figure 46



The sealing ring (2) of the 1° cavity is trapezoidal. Clearance "X" between the sealing ring and its housing is measured by placing the piston (1) with its ring in the cylinder barrel (3), so that the sealing ring is half-projected out of the cylinder barrel.

Figure 47



Check the opening between the ends of the sealing rings (1), using a thickness gauge (2), entered in the cylinder barrel (3). If the distance between ends is lower or higher than the value required, replace split rings.

CONNECTING ROD

Figure 48

Data concerning the class section of connecting rod housing and weight are stamped on the big end.

When installing connecting rods, make sure they all belong to the same weight class.

DIAGRAM CONNECTING ROD MARKS

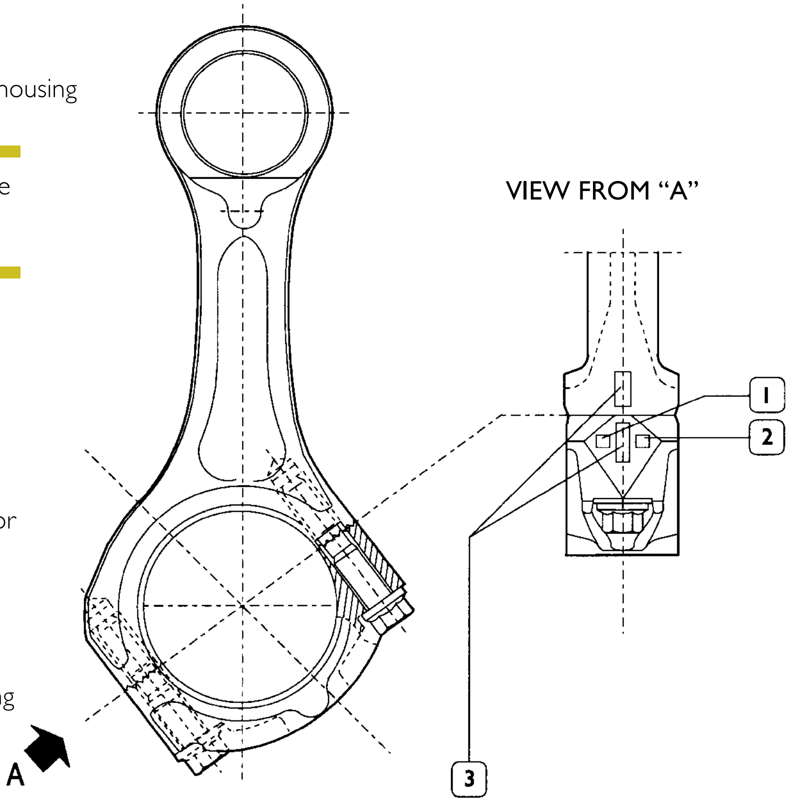
1 Letter indicating the weight class:

A = 2865 to 2895 g.
B = 2896 to 2925 g.
C = 2926 to 2955 g.

2 Number indicating the selection of diameter for the big end bearing housing:

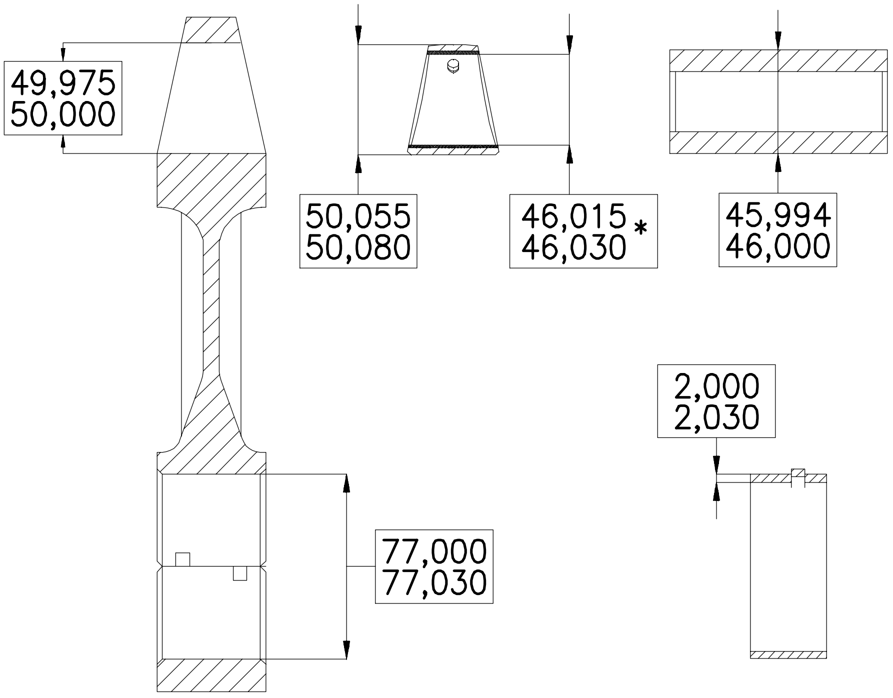
1 = 77.000 to 77.010 mm
2 = 77.011 to 77.020 mm
3 = 77.021 to 77.030 mm

3 Numbers identifying cap-connecting rod coupling



47557

Figure 49

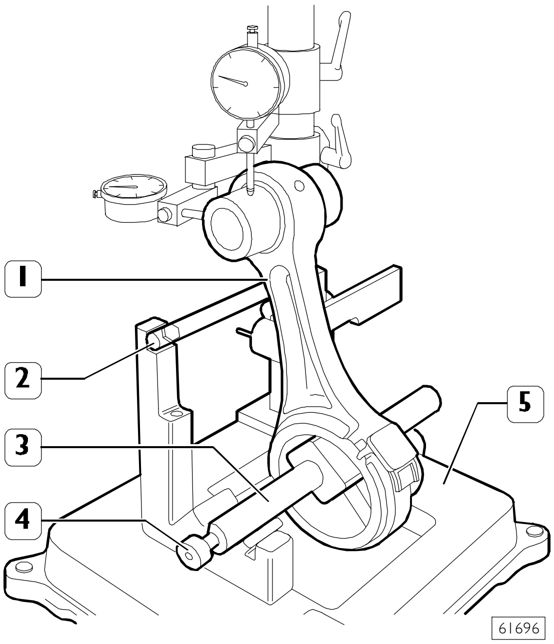


44927

MAIN DATA - BUSH, CONNECTING ROD, PIN AND HALF-BEARINGS
* Values to be obtained after installing the bush

Checking connecting rod alignment

Figure 50 (Demonstration)



Checking axis alignment

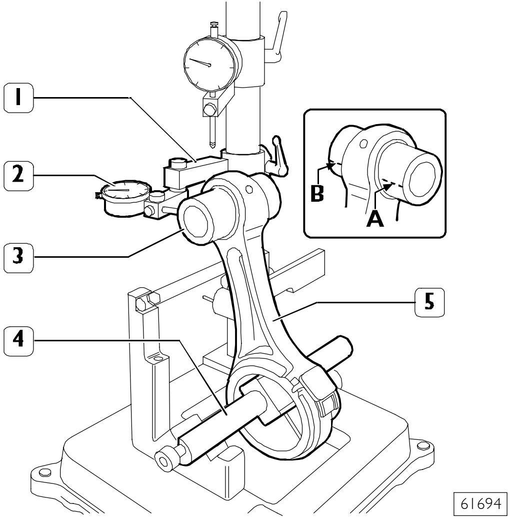
Check the toe-setting for the connecting rods (1) axles using the proper devices (5), according to this procedure:

☐ Fit the connecting rod (1) on the spindle of the tool (5) and lock it with the screw (4).

☐ Set the spindle (3) on the V-prisms, resting the connecting rod (1) on the stop bar (2).

Checking torsion

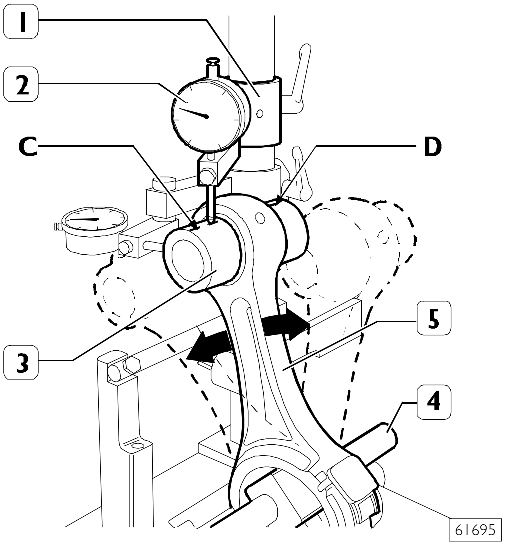
Figure 51 (Demonstration)



Check the torsion of the connecting rod (5) by comparing two points (**A** and **B**) of the pin (3) on the horizontal plane of the axis of the connecting rod.
Position the mount (1) of the dial gauge (2) so that this pre-loads by approx. 0.5 mm on the pin (3) at point **A** and zero the dial gauge (2). Shift the spindle (4) with the connecting rod (5) and compare any deviation on the opposite side **B** of the pin (3): the difference between **A** and **B** must be no greater than 0.08 mm.

Checking bending

Figure 52 (Demonstration)



Check the bending of the connecting rod (5) by comparing two points **C** and **D** of the pin (3) on the vertical plane of the axis of the connecting rod.
Position the vertical mount (1) of the dial gauge (2) so that this rests on the pin (3) at point **C**.
Swing the connecting rod backwards and forwards seeking the highest position of the pin and in this condition zero the dial gauge (2).
Shift the spindle (4) with the connecting rod (5) and repeat the check on the highest point on the opposite side **D** of the pin (3). The difference between point **C** and point **D** must be no greater than 0.08 mm.

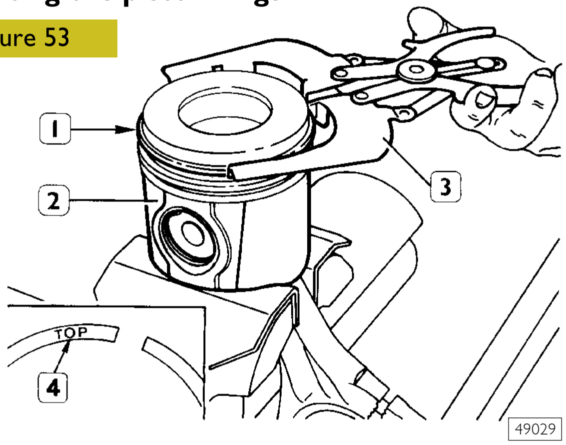
Mounting the connecting rod - piston assembly

Carry out the steps for removal described on pages 27 and 28 in reverse order.

The connecting rod screws can be reused as long as the diameter of the thread is not less than 13.4 mm.

Mounting the piston rings

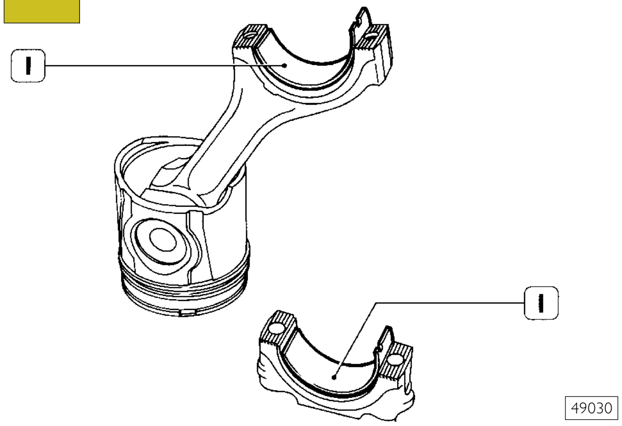
Figure 53



To fit the piston rings (1) on the piston (2) use the pliers 99360184 (3).
The rings need to be mounted with the word "TOP" (4) facing upwards. Direct the ring openings so they are staggered 120° apart.

Fitting the connecting rod-piston assembly into the piston liners

Figure 54



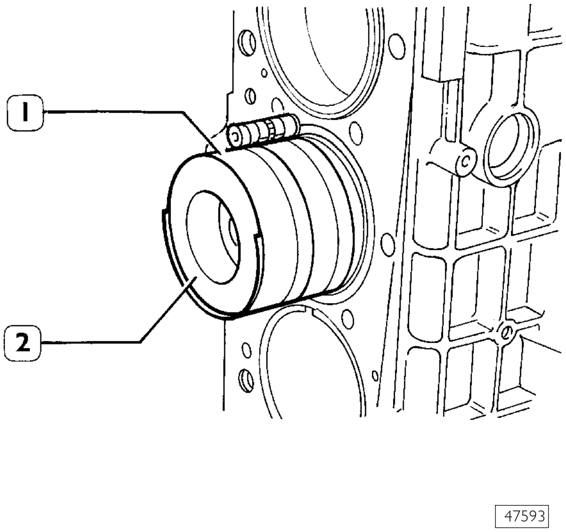
Fit the half-bearings (1), selected as described on pages 54 to 60, both on the connecting rod and on the stand.

NOTE As spares, class A pistons are provided and can be fitted also to cylinder barrels belonging to class B.

Fit the connecting rod-piston assemblies (1) into the piston liners (2) using band 99360605 (1, Figure 56). Check the following:

- ☐ the openings of the split rings are offset by 120°;

Figure 56

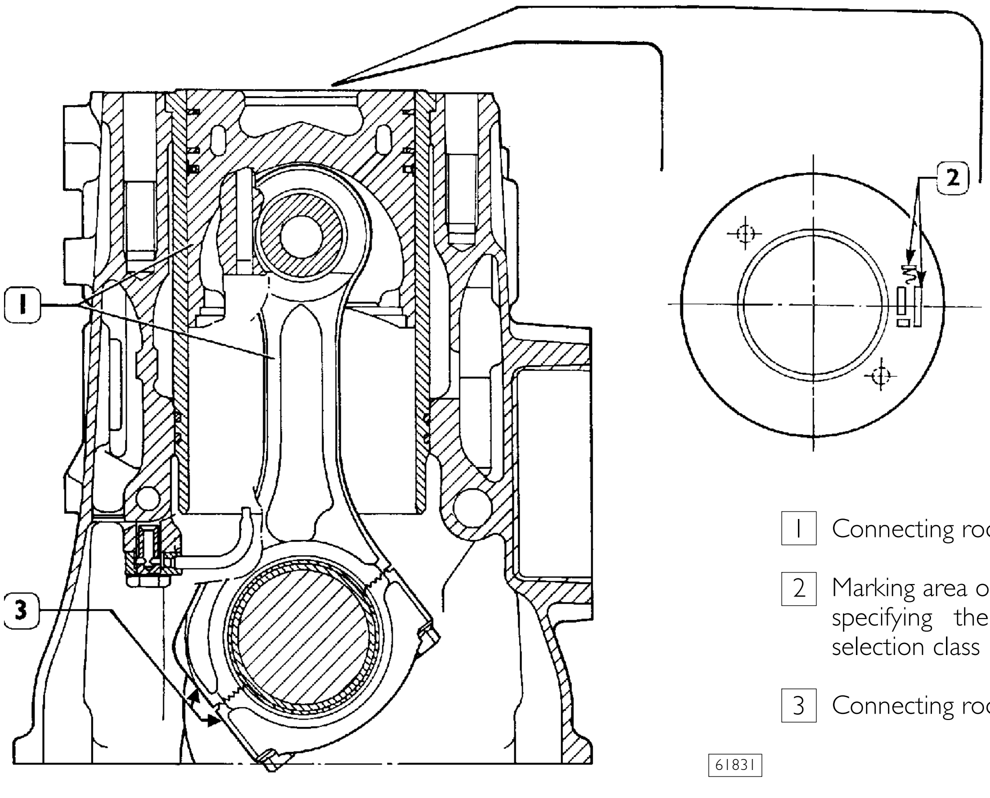


- ☐ all pistons belong to the same class, A or B;
- ☐ ideogram stamped on the piston crown is placed toward the engine flywheel, or the cavity, on the piston cover, corresponds to the position of the oil spray nozzles.

Piston protrusion check

Once assembly is complete, check piston protrusion from cylinder barrels: it must be 0.32-0.69 mm.

Figure 55



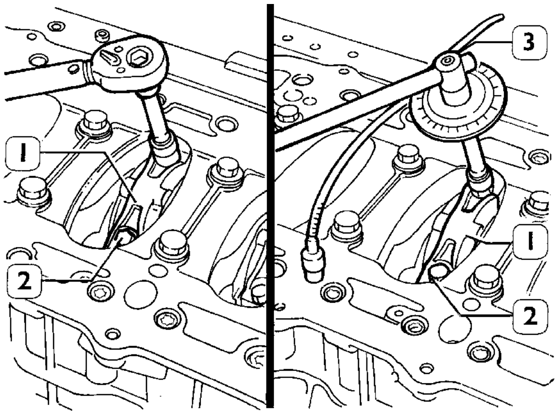
1	Connecting rod-piston assembly
2	Marking area on the piston crown of ideogram specifying the assembly position and the selection class
3	Connecting rod marking area (see Figure 48).

Checking assembly clearance of big end pins

To check the clearance proceed as follows:

Connect the connecting rods to the relative main journals, place a length of calibrated wire on the latter.

Figure 57



Install the connecting rod caps (1) with half-bearings; tighten the connecting rod cap fixing screws (2) to 50 Nm (5 kgm) torque. By tool 99395216 (3), tighten the screws further at 40° angle.

Remove the caps and check the clearance by comparing the width of the calibrated wire with the scale calibration on the envelope containing the wire.

CYLINDER HEAD

Before dismounting cylinder head, check cylinder head for hydraulic seal by proper tooling; in case of leaks not caused by cup plugs or threaded plugs, replace cylinder head.

When replacing, the cylinder head is supplied as a spare part with a threaded plug, which must be removed during assembly.

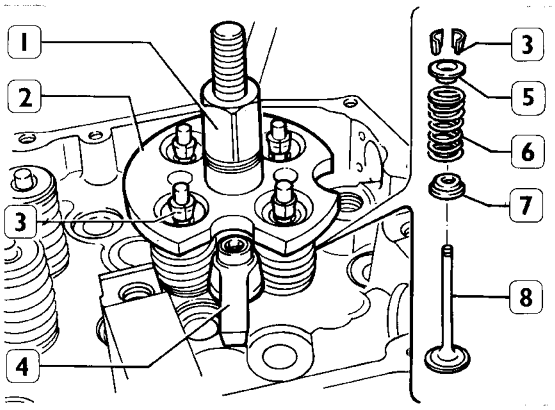
NOTE In case of plugs dismounting/replacement, on mounting, apply sealant Loctite 270 on plugs.

Dismounting the valves

NOTE Before dismounting cylinder head valves, number them in view of their remounting in the position observed on dismounting should they not have to be overhauled or replaced.

Intake valves are different form exhaust valves in that they have a notch placed at valve head centre.

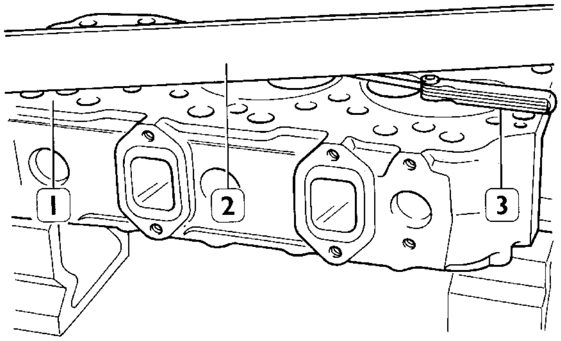
Figure 58



Install and fix tool 99360264 (2) with bracket (4); tighten by lever (1) until cotters are removed (3); remove the tool (2) and the upper plate (5), the spring (6) and the lower plate (7). Repeat the operation on all the valves. Turn the cylinder head upside down and remove the valves (8).

Checking the planarity of the head on the cylinder block

Figure 59 (Demonstration)



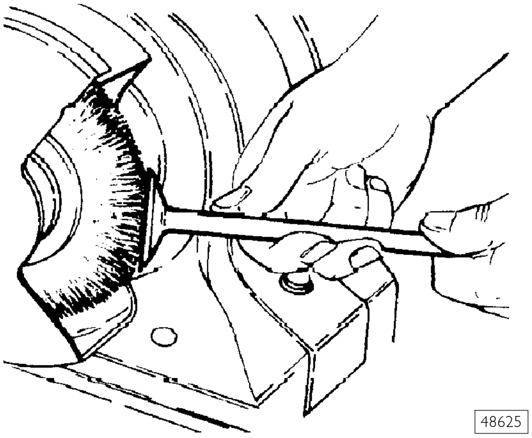
The planarity (1) is checked using a ruler (2) and a thikness gauge (3). If deformations exist, surface the head using proper surface grinder; the maximum amount of material to be removed is 0.2 mm.

NOTE After leveling, make sure that valve sinking and injector protrusion are as described in the relative paragraph.

VALVE

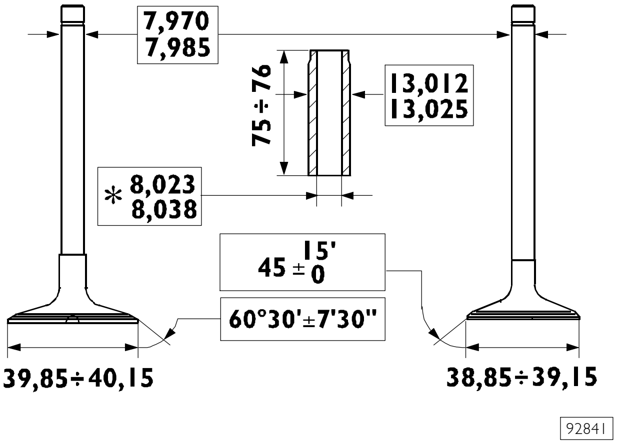
Removing deposits and checking the valves

Figure 60



Remove carbon deposits using the metal brush supplied. Check that the valves show no signs of seizure or cracking. Check the diameter of the valve stem using a micrometer (see Figure 61) and replace if necessary.

Figure 61



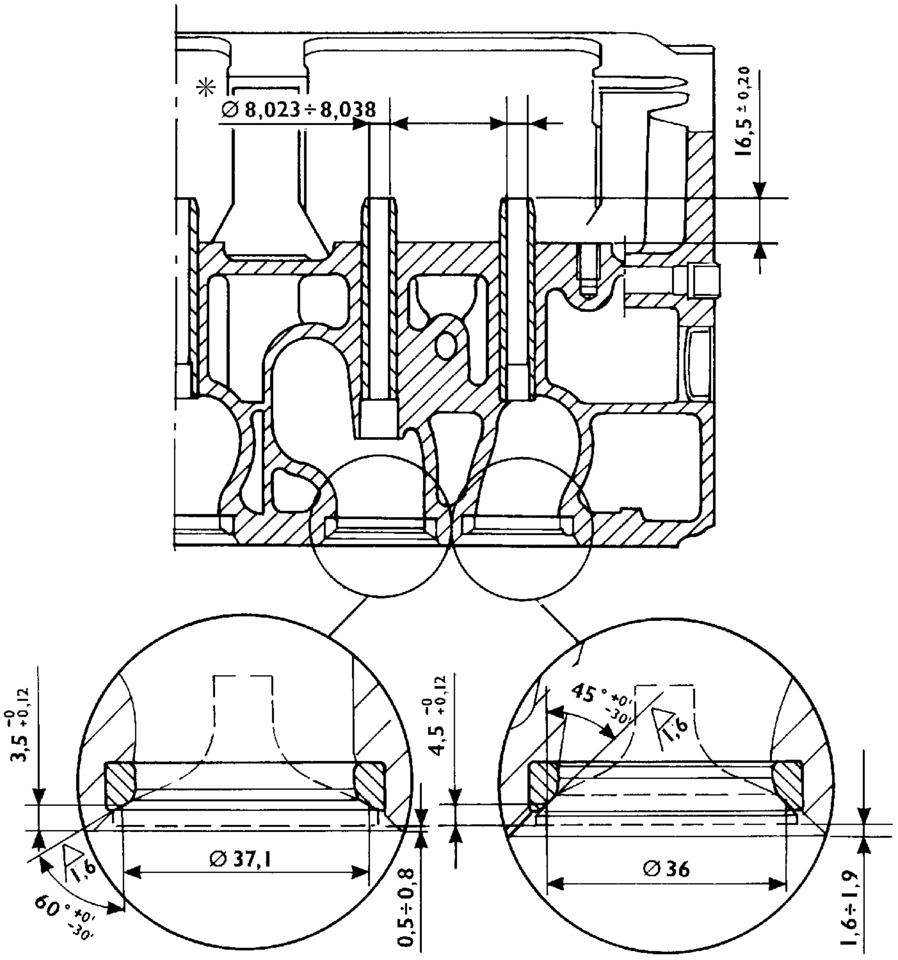
MAIN DATA - VALVES AND VALVE GUIDES

* Values to be obtained after installing the valve guides

Check, by means of a micrometer, that valve stem diameters are as specified; if necessary, grind the valves seat with a grinder, removing the minimum quantity of material.

VALVE GUIDES

Figure 62



INSTALLATION DIAGRAM FOR VALVE GUIDES AND VALVES

* Values to be obtained after installing the guide valves

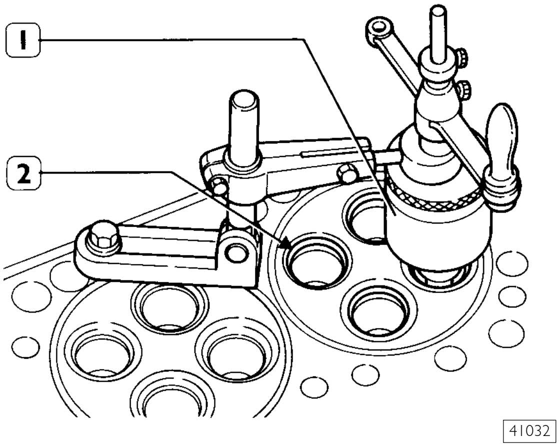
Replacing of valve guides

Remove valve guides by means of tool 99360288.
Install by means of tool 99360288 equipped with part 99360294, which determines the exact installation position of valve guides into the cylinder heads; if they are not available, install the valve guides in the cylinder head so that they project out by mm 16.3 to 16.7 (Figure 62).
After installing the valve guides, smooth their holes with sleeker 99390310.

Replacing - Reaming the valve seats

To replace the valve seats, remove them using the appropriate tool.

Figure 63



Ream the valve seats (2) on cylinder head using tool 99305019 (1).

NOTE Valve seats must be reamed whenever valves or valve guides are replaced or ground.

After reaming the valve seats, use tool 99370415, to make sure that the valve position, with respect to the cylinder head surface, is the following:

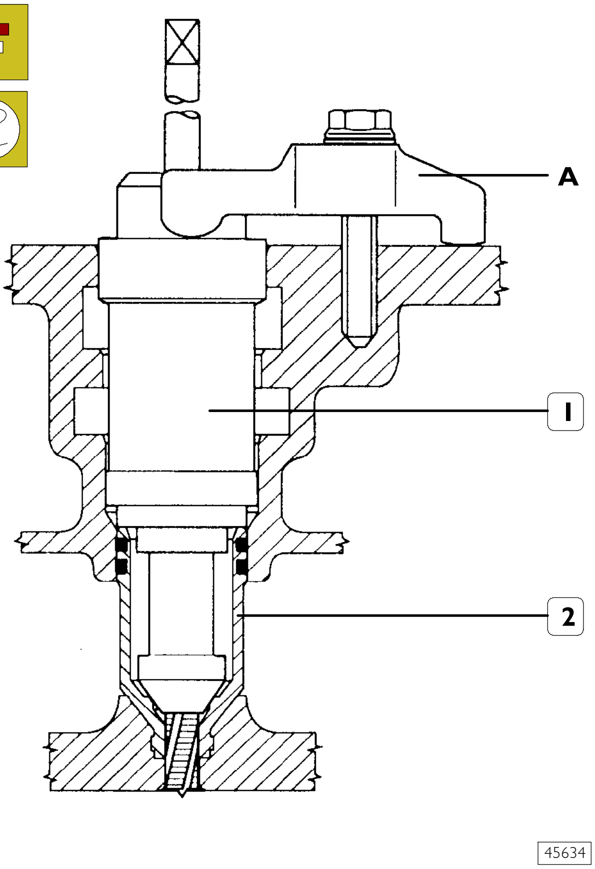
☐ -0.5 to -0.8 mm (recessing) of exhaust valves;

☐ -1.6 to -1.9 mm (recessing) of discharge valves.

REPLACING INJECTOR HOLDER CASES

Removal

Figure 64

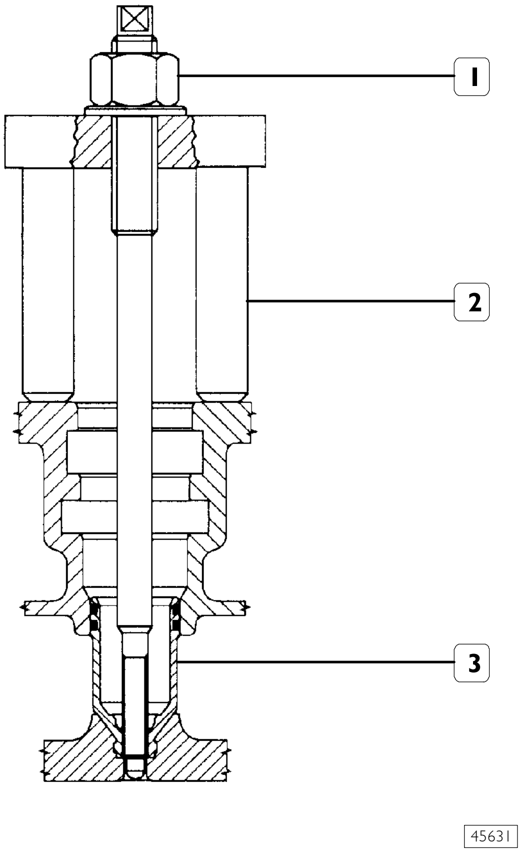


To replace the injector case (2), act as follows:

☐ thread the case (2) with tool 99390804 (1).

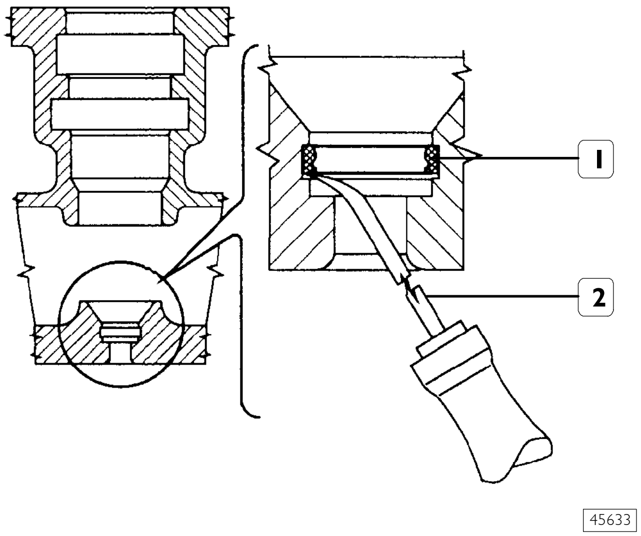
Carry out operations described in figs. 64 - 67 - 68 - 69 - 70 by fixing tools to the cylinder head by means of braket A.

Figure 65



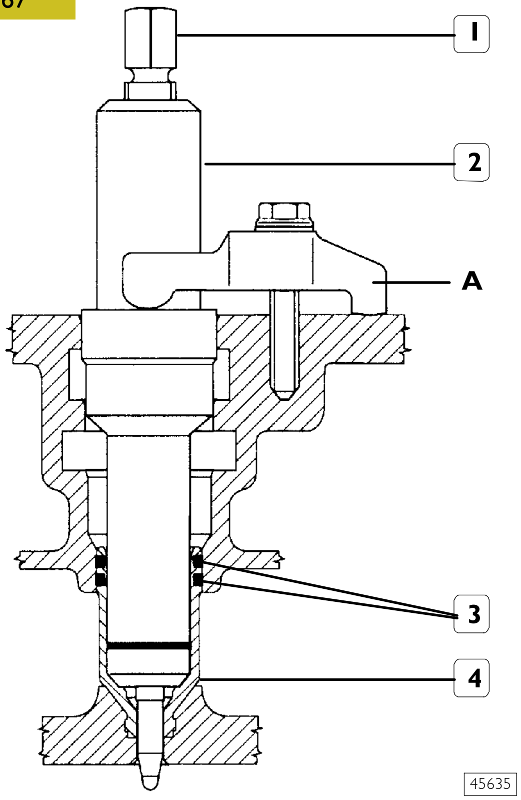
☐ Fasten extractor 99342149 (2) to case (3), by tightening the nut (1), and pull out the case from cylinder head.

Figure 66



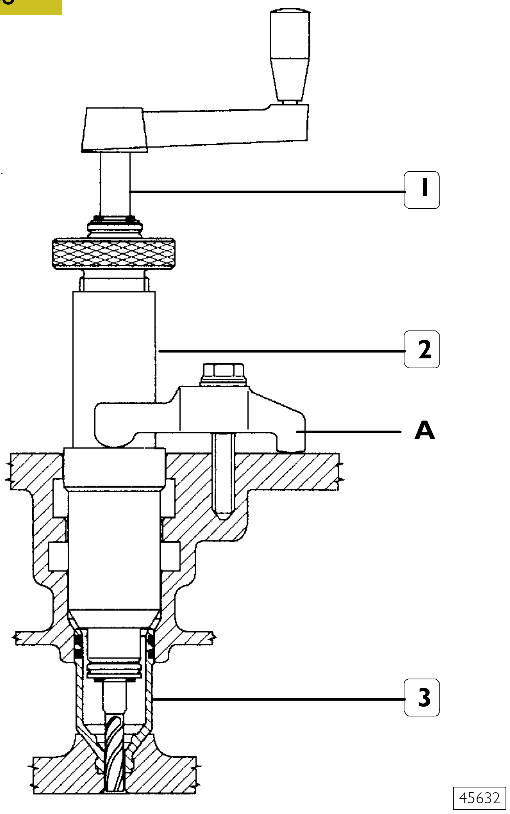
☐ Remove any residue (1), with tool 99390772 (2), from the cylinder head groove.

Figure 67



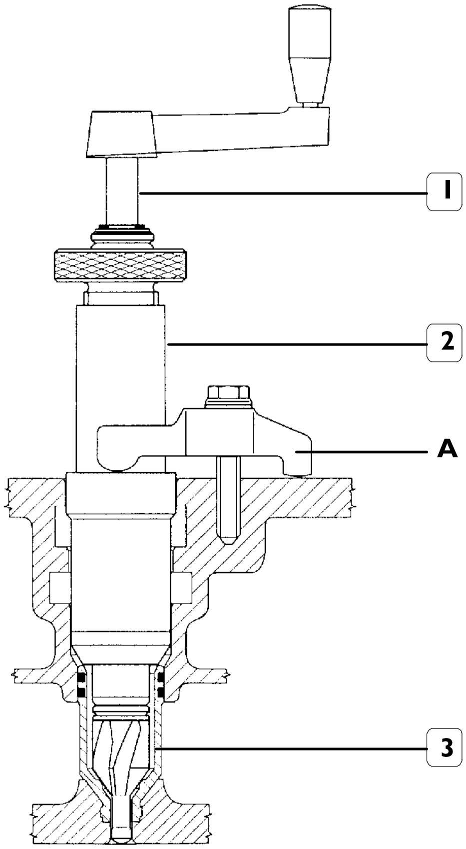
☐ Lubricate sealing rings (3) and fit them to the case (4); fix tool 99360554 (2) to the cylinder head by means of bracket **A**, install the new case, tighten the screw (1), upsetting the case lower part.

Figure 68



☐ Adjust the casing hole (3) with borer 99394043 (1) and guide bushing 99394014 (2).

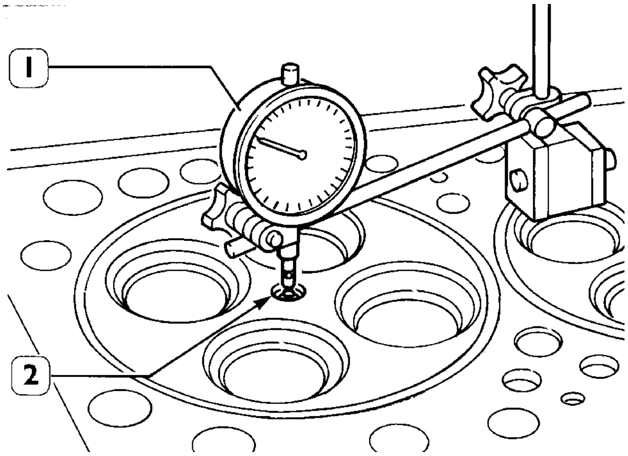
Figure 69



- Through miller 99394041 (1) and bushing 99394014 (2), ream the injector seat in the case (3), check the injector protrusion from the cylinder head plane which must be 0.7 mm.

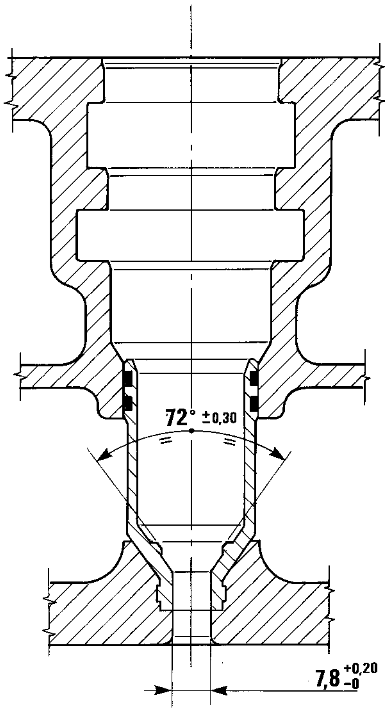
Checking protrusion of injectors

Figure 70



Using dial gauge (1), check the protrusion of the injector (2) which must be 0.7 mm.

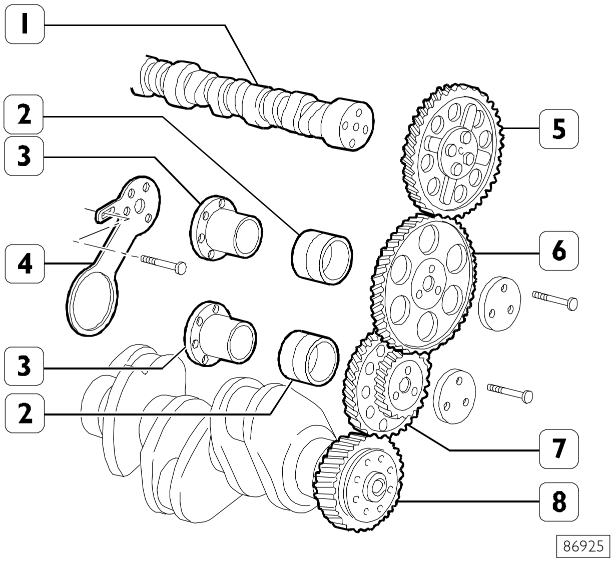
Figure 71



INSTALLATION DIAGRAM FOR INJECTOR CASE

TIMING GEAR
Camshaft drive

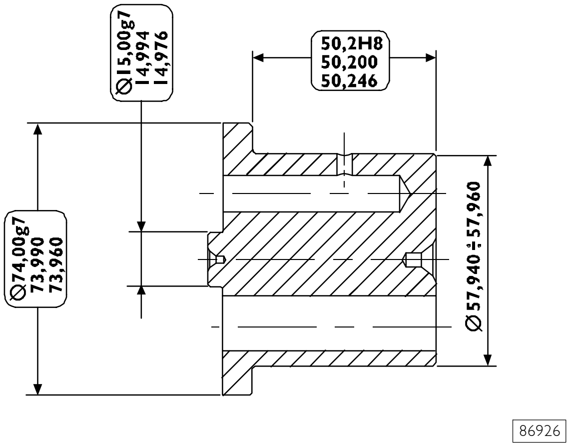
Figure 72



TIMING CONTROL COMPONENT PARTS
1. Camshaft - 2. Bushing - 3. Pin - 4. Articulated rod - 5. Camshaft control gear - 6. Idler gear - 7. Twin idler gear - 8. Drive shaft driving gear.

Intermediate gear pin

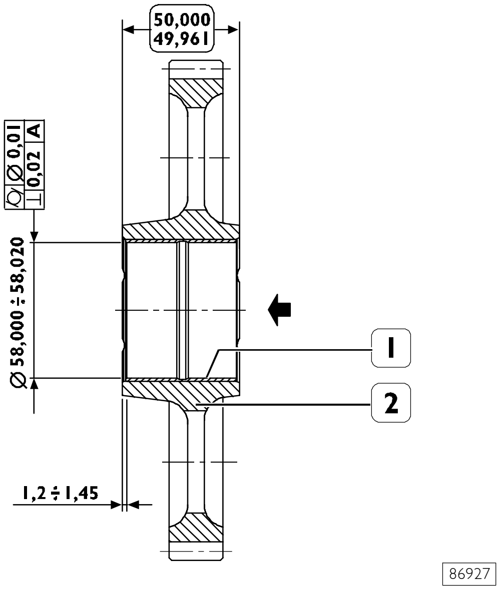
Figure 73



Rated assembling play between idler gear bushings and pins: 0.040 ÷ 0.080 mm.

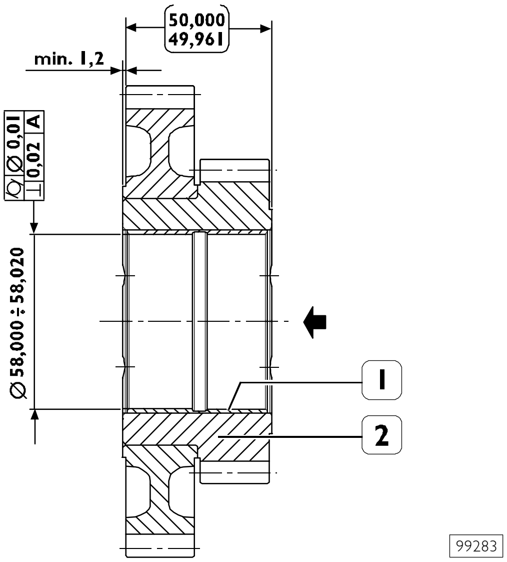
Idler gear

Figure 74



Twin idler gear

Figure 75



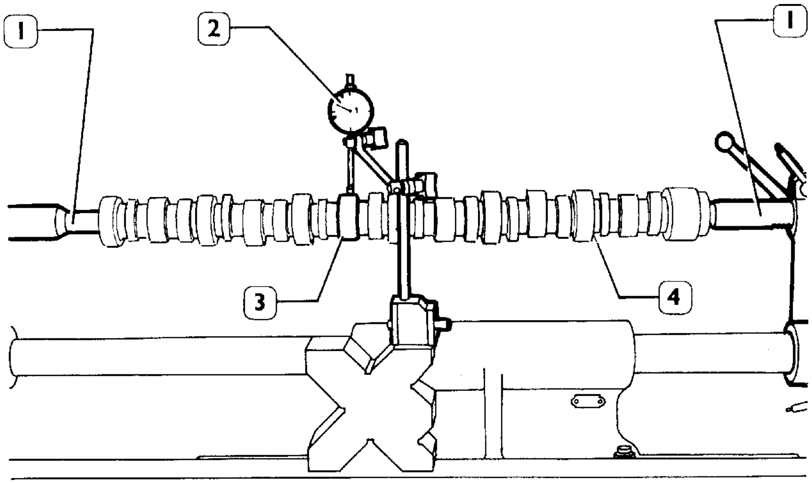
Replacing the bushings

Bushings (1, Figure 74 - 75) can be replaced when they are worn. Put up the bushing, then grind it so as to bring it to a dimension of Ø 58.010 ± 0.10 mm.

NOTE Bushings must be forced into gears (2, Figure 74 - 75) by following the direction of the arrow: they must be positioned at the level shown in the figures.

Check of cam lift and timing system shaft pins alignment

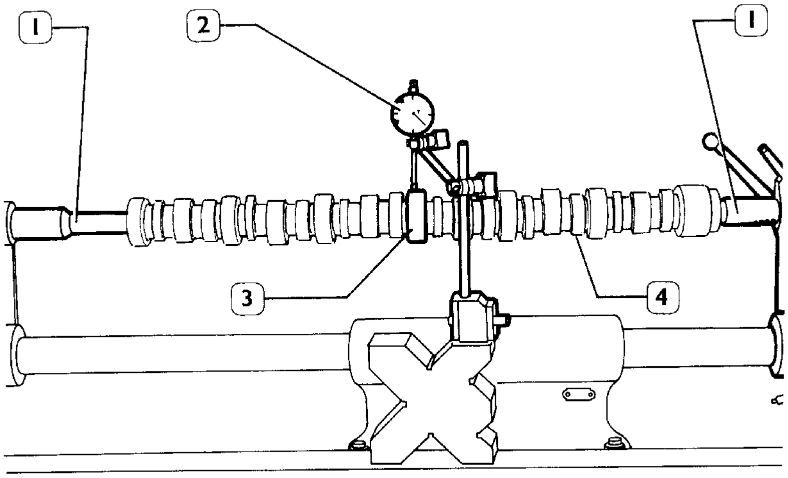
Figure 76



47506

Place the camshaft (4) on the tailstock (1) and check cam lift (3) using a centesimal gauge (2).

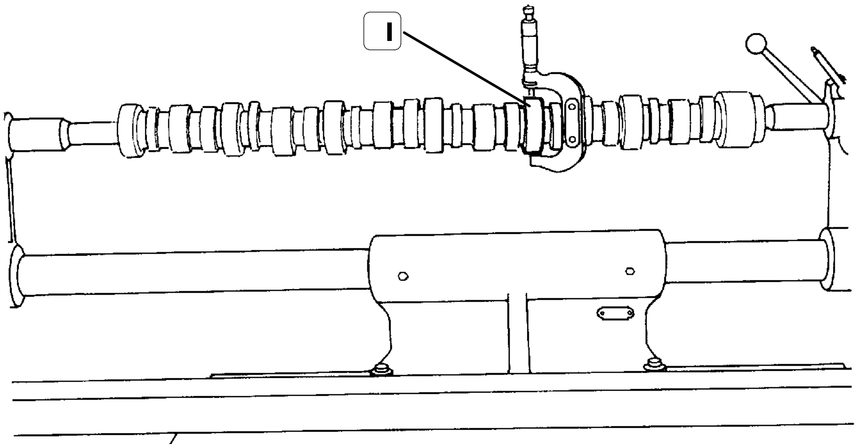
Figure 77



47507

When the camshaft (4) is on the tailstock (1), check alignment of supporting pin (3) using a centesimal gauge (2); it must not exceed 0.030 mm. If misalignment exceeds this value, replace the shaft.

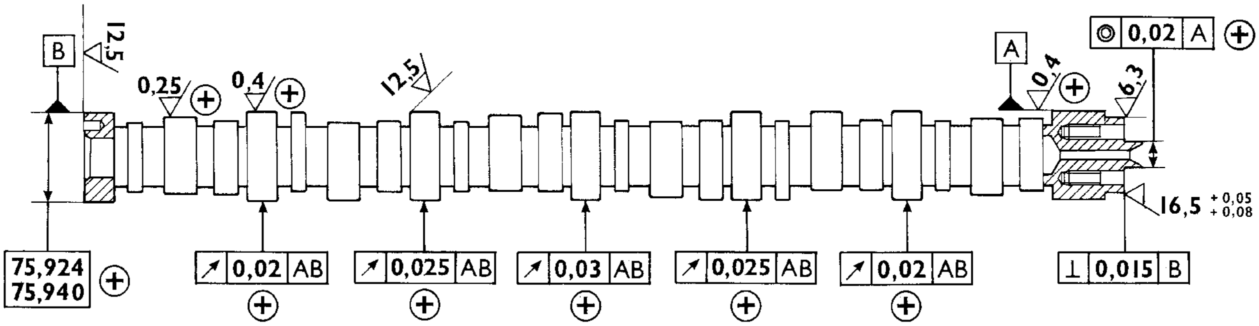
Figure 78



47505

In order to check installation clearance, measure bush inner diameter and camshaft pin (1) diameter; the real clearance is obtained by their difference.
If clearance exceeds 0.150 mm, replace bushes and, if necessary, the camshaft.

Figure 79



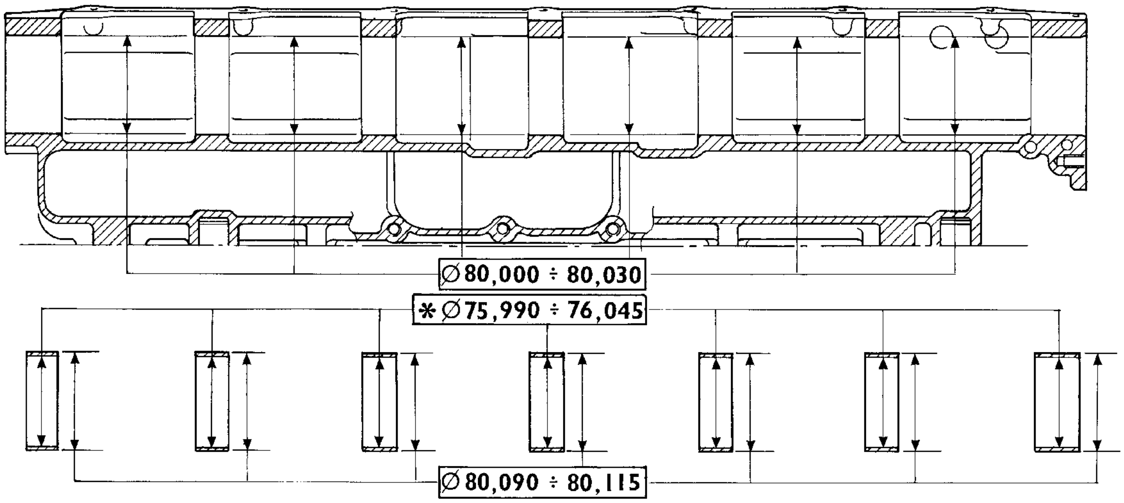
MAIN DATA - CAMSHAFT AND TOLERANCES

The surfaces of shaft supporting pin and cams must be extremely smooth; if you see any sign of seizing or scoring, replace the shaft and the relative bushes.

TOLERANCES	TOLERANCE CHARACTERISTIC	SYMBOL
ORIENTATION	Perpendicularity	⊥
POSITION	Concentricity or coaxial alignment	◎
OSCILLATION	Circular oscillation	↗
IMPORTANCE CLASS ASSIGNED TO PRODUCT CHARACTERISTICS		SYMBOL
CRITICAL		©
IMPORTANT		⊕
SECONDARY		⊖

Bushes

Figure 80



MAIN DATA - CAMSHAFT BUSHES AND RELATIVE BLOCK SEATS

* Bush inner diameter after installation

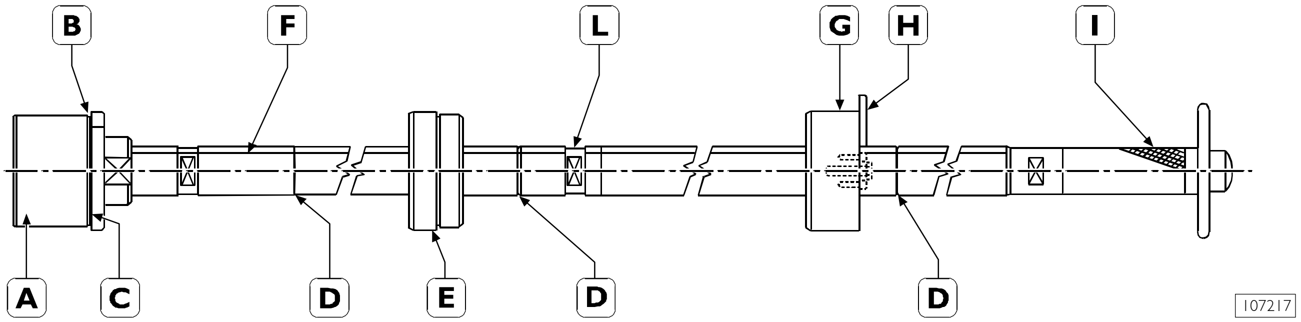
The bush surfaces must not show any sign of seizing or scoring; if they do replace them.

Measure the bush inner diameters with a baremeter and replace them, if the value measured exceeds the tolerance value.

To take down and fit back the bushes, use the proper tool 99360487.

Replacing camshaft bushes using beater 99360487

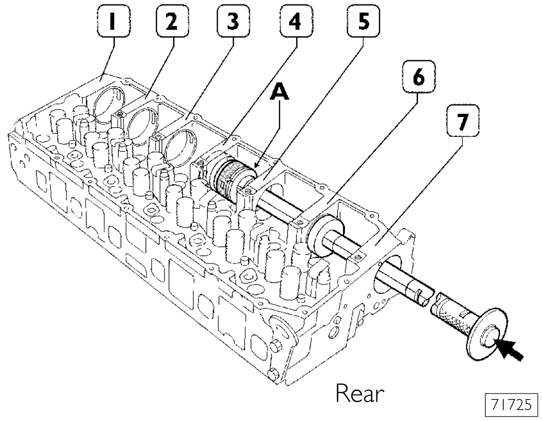
Figure 81



A. Drift with seat for bushings to insert/extract. - B. Grub screw for positioning bushings. - C. Reference mark to insert seventh bushing correctly. - D. Reference mark to insert bushings 1, 2, 3, 4, 5, 6 correctly (red marks). - E. Guide bushing. - F. Guide line. - G. Guide bushing to secure to the seventh bushing mount. - H. Plate fixing yellow bushing to cylinder head. - I. Grip. - L. Extension coupling.

Removing bushes

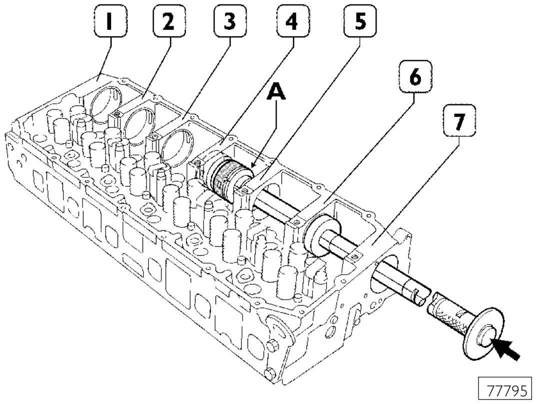
Figure 82



The sequence for removing the bushings is 7, 6, 5, 4, 3, 2, 1. The bushings are extracted from the front of the single seats. Removal does not require the drift extension for bushings 5, 6 and 7 and it is not necessary to use the guide bushing. For bushings 1, 2, 3 and 4 it is necessary to use the extension and the guide bushings.
Position the drift accurately during the phase of removal.

Assembling bushes

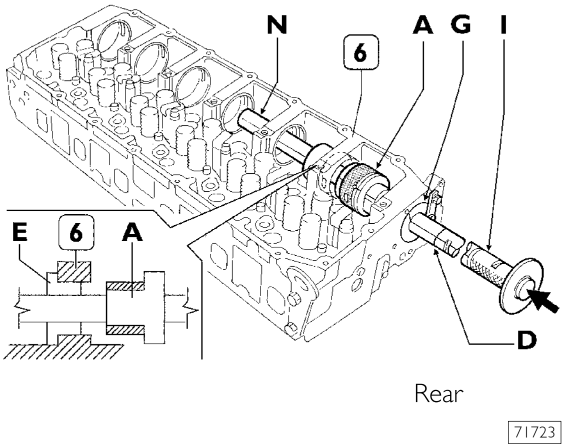
Figure 83



Assemble the drift together with the extension.
To insert bushings 1, 2, 3, 4 and 5, proceed as follows:

1. Position the bushing to insert on the drift (A) making the grub screw on it coincide with the seat (B) (Figure 81) on the bushing.
2. Position the guide bushing (E) and secure the guide bushing (G) (Figure 81) on the seat of the 7th bushing with the plate (H).
3. While driving in the bushing, make the reference mark (F) match the mark (M). In this way, when it is driven home, the lubrication hole on the bushing will coincide with the oil pipe in its seat.
   The bushing is driven home when the 1st red reference mark (D) is flush with the guide bushing (G).

Figure 84



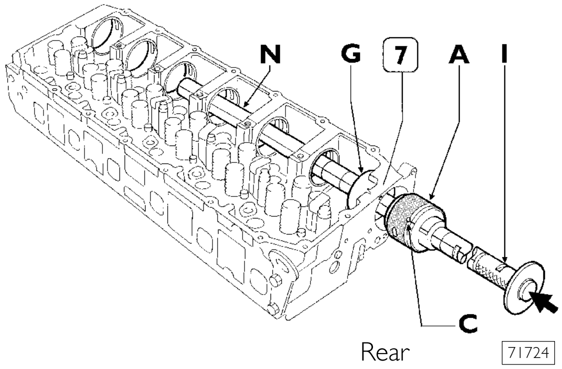
To insert the bushing (6), proceed as follows:

☐ Unscrew the grip (I) and the extension (N).

☐ Position the extension (N) and the guide bushing (E) as shown in the figure.

☐ Repeat steps 1, 2, 3.

Figure 85

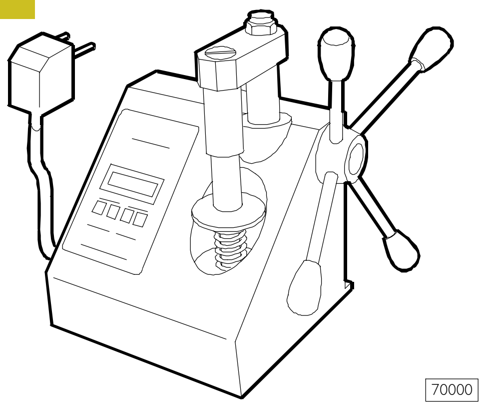


To insert bushing (7), proceed as follows:

- ☐ Unscrew the grip (I) and the extension (N).
- ☐ Refit the guide (G) from the inside as shown in the figure.
- ☐ Position the bushing on the drift (A) and bring it close up to the seat, making the bushing hole match the lubrication hole in the head. Drive it home.
  The 7th bushing is driven in when the reference mark (C) is flush with the bushing seat.

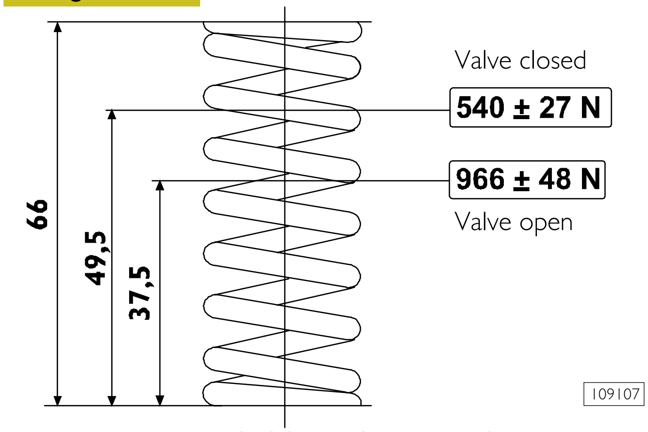
VALVE SPRINGS

Figure 86



Before assembly, the flexibility of the valve springs has to be checked.
Compare the load and elastic deformation data with those of the new springs given in the following figure.

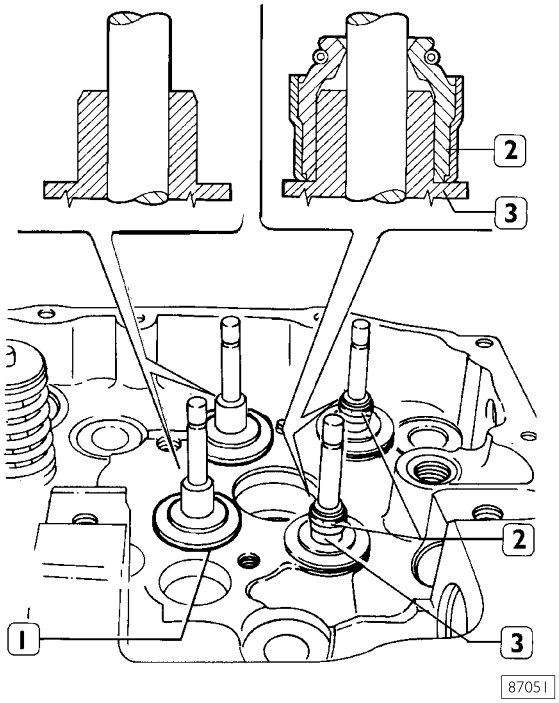
Figure 87



MAIN DATA TO CONTROL EXHAUST AND DISCHARGE VALVE SPRING

Fitting the valves and oil seal ring

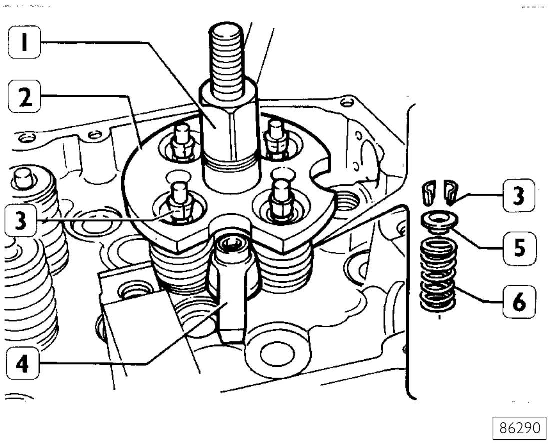
Figure 88



Lubricate the valve stem and insert the valves in the respective valve guides; fit the lower caps (1). Use tool 99360329 to fit the oil seal (2) on the valve guides (3) of the exhaust valves; then, to fit the valves, proceed as follows.

NOTE Where valves should not have been overhauled or replaced, remount them according to the numbering that was performed during mounting. Intake valves are distinguished from exhaust valves in that they have a recess located at the centre of valve mushroom.

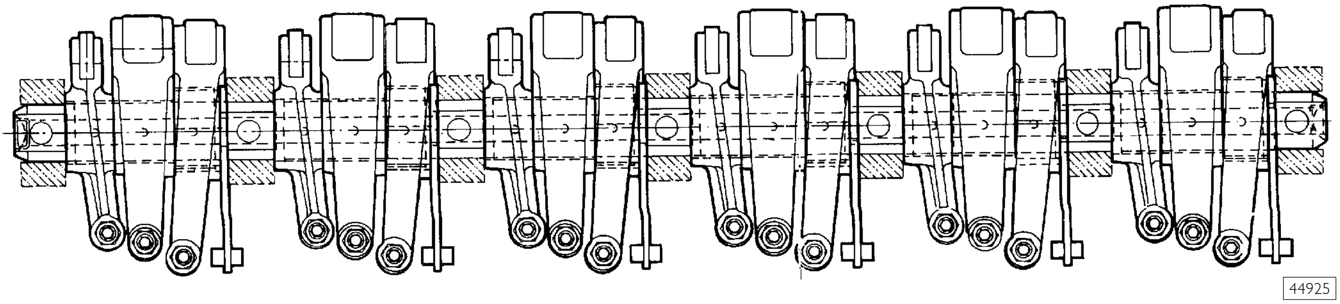
Figure 89



- ☐ fit springs (6) and the upper plate (5);
- ☐ apply tool 99360264 (2) and block it with bracket (4); tighten the lever (1) until cotters are installed (3), remove tool (2).

ROCKER SHAFT

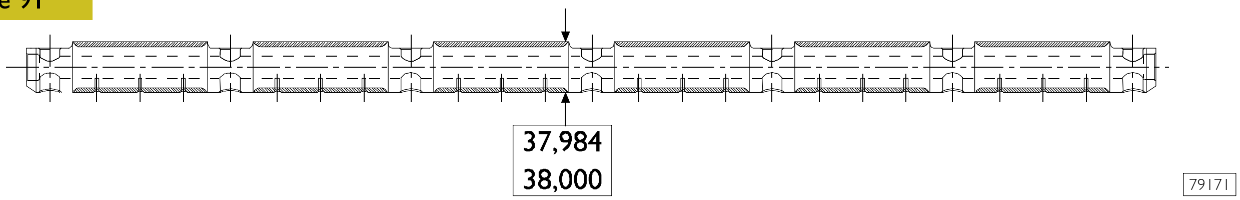
Figure 90



The camshaft cams directly control rockers: 6 for injectors and 12 for valves.
Injectors and intake valves control rocker arms are keyed on rocker arms shaft directly. Exhaust intake valves control rocker arms are keyed on rocker arms shaft putting in between the levers with engine brake control eccentric pin.
Rockers slide directly on the cam profiles via rollers. The other end acts on a bar directly supported by the two valves stems. A pad is placed between the rocker adjusting screw and the bar. Two lubrication holes are obtained inside the rockers. The rocker shaft practically covers the whole cylinder head; remove it to have access to all the underlying components.

Shaft

Figure 91

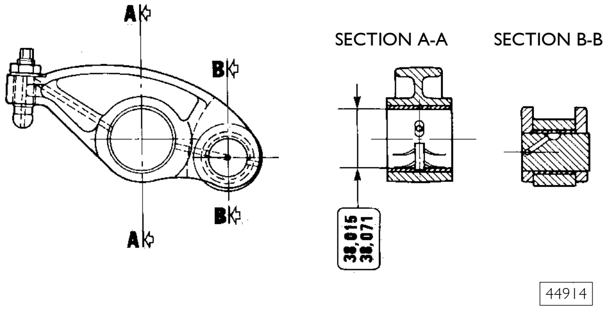


MAIN DATA OF THE ROCKER ARM SHAFT

Check that the surface of the shaft shows no scoring or signs of seizure; if it does, replace it.

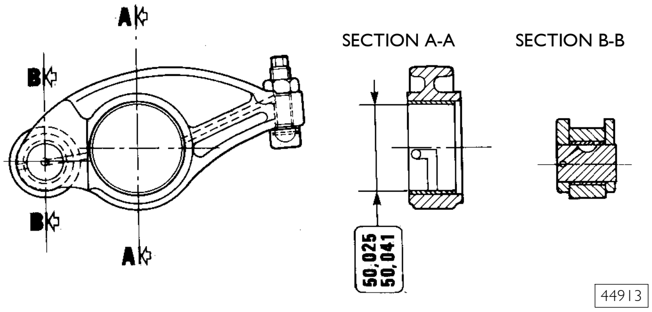
Rocker

Figure 92



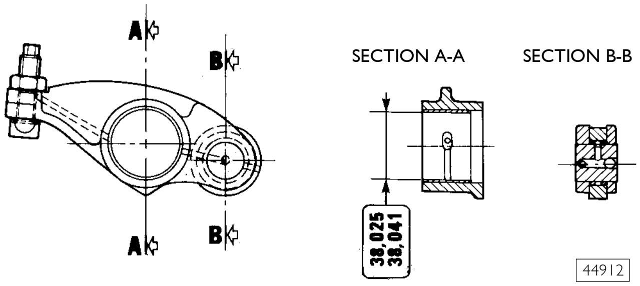
PUMP INJECTOR ROCKER

Figure 94



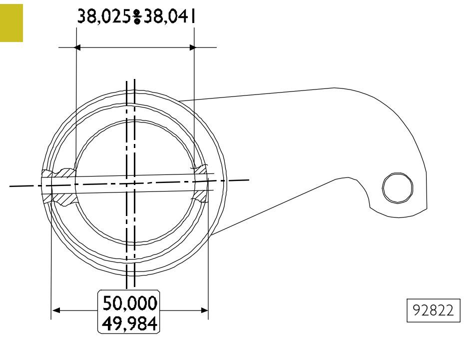
DISCHARGE VALVE ROCKER

Figure 93



EXHAUST VALVES ROCKER

Figure 95



LEVER WITH ENGINE BRAKE CONTROL ECCENTRIC PIN

The bush surfaces must not show any trace of scoring of excessive wear; otherwise, replace bushes or the whole rocker.

REPAIRING ACTIONS

NOTE If anomalous engine operation is found, which is due to the boosting system, it is advisable that you check the efficiency of seal gaskets and the fastening of connecting sleeves prior to carrying out the checks on the turboblower. Also check for obstructions in the sucking sleeves, air filter. If the turbocharger damage is due to a lack of lubrication, check that the oil circulation pipes are not damaged.
If so, change them or eliminate the cause.

After carrying out the above mentioned checks, check the turbocharger operation with an Engine Test by using IVECO diagnosis equipment (Modus - IT 2000 - E.A.SY.) according to the relevant procedure.

NOTE The test must be performed in following conditions:

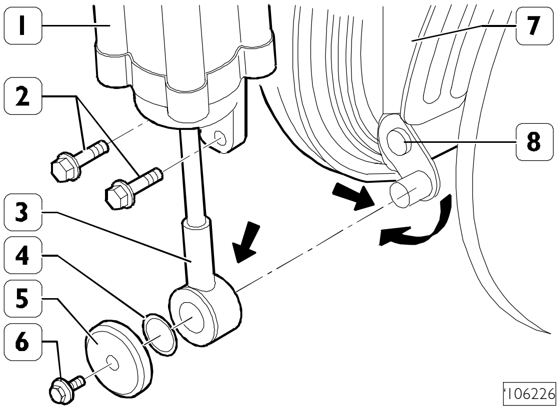
- engine coolant temperature >50 °C;
- battery up (voltage >22V) for compression test;
- efficient recharging system.

If values beyond tolerance are detected, check the efficiency of:

- shut-off valve;
- pressure sensor;
- engine cable pressure sensor connection (if oxidised, clean with a specific product);
- lack of electrical defects in solenoid valve VGT (continuity connection);
- actuator moved by active diagnosis as described in relating chapter, in case of locking, grease bushing with lubricant Kernite (for high temperatures); if the trouble persists, replace the actuator;
- sliding sleeve: it must slide freely when operated manually. If locked and if the bush check is not sufficient or effective, or no faults are detected in the other points, upon authorization of the "Help Desk" market operator, change the turbocharger according to the standard procedures.

Variable geometry movement control

Figure 96



Remove screws (2) and take actuator (1) off turbocompressor (7).
Remove screw (6), underlying disk (5), ring (4) and disconnect tie rod (3) of actuator (1) from the pin of variable geometry driving lever (8).
Accurately clean pin (→) of lever (8) and bushing (→) of tie rod (3) using a cloth made of non abrasive micro fibre.

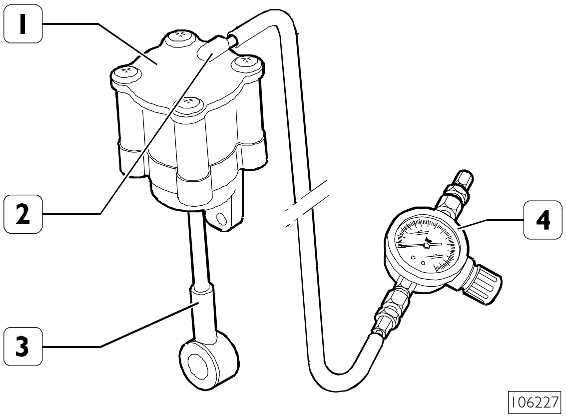
NOTE Do not use abrasive paper of any kind.

Visually check the conditions of bushing (→) of tie rod (3) and pin (→) of lever (8); where they are found to be worn out, replace actuator (1) or turbocompressor (7).

Check variable geometry inner driving mechanism movement by operating on lever (8); jamming must not occur; otherwise, clean turbine body, as described in relating chapter.

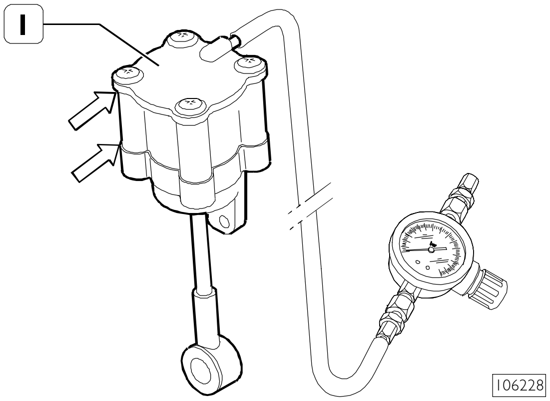
Checking the actuator

Figure 97



Check actuator efficiency (1) operating as follows.
Apply, to fitting (2) of actuator (1), compressed air feed piping provided with pressure regulator (4). By using the pressure regulator, introduce, into the actuator, compressed air slowly modulating it, from 0÷3.5 bar; tie rod (3) of actuator (1) must move without jamming; otherwise, replace actuator (1).

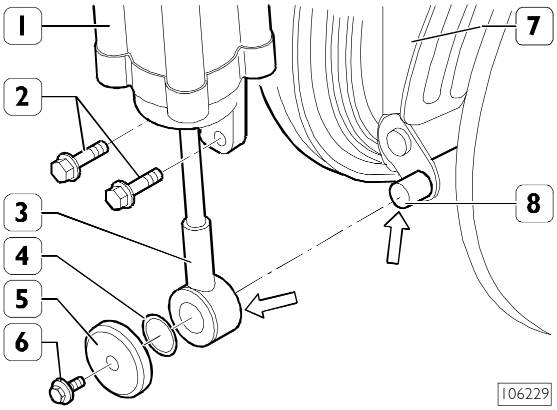
Figure 98



Check for any actuator leaks at indicated points (→) applying, on these points, a solution of suds.

When actuator (1) is fed with compressed air, no bubbles must be found at indicated points (→); otherwise, replace actuator (1).

Figure 99



Lubricate bushing (→) of tie rod (3) and pin (→) of lever (8) with lithium-based Castrol LM GREASE type and reconnect actuator (1) to turbocompressor (7) operating as follows.

Connect tie rod (3) to lever (8).

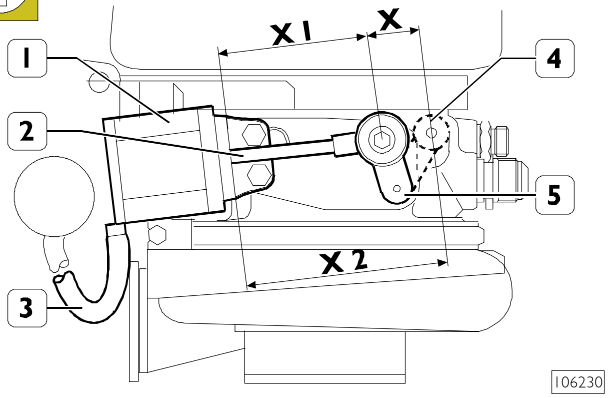
Mount new ring (4), mount disk (5) and screw up screw (6).

Screw up screws (2) securing actuator (1) to turbocompressor (7).

Tighten screws (2 and 6) at 25 Nm torque.

Checking actuator travel

Figure 100



Check travel X of tie rod (2) of actuator (1) operating as follows.

Measure distance X1 between actuator (1) and cross-axis of eyelet (4).

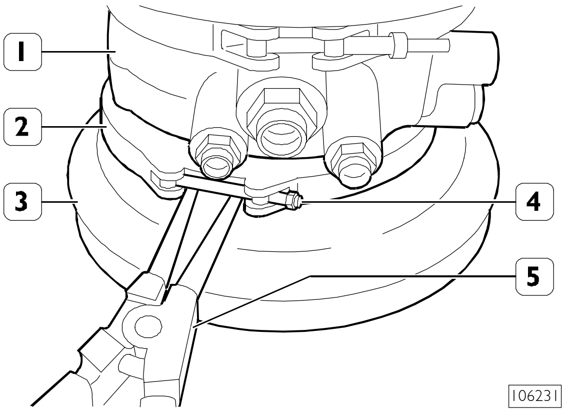
Apply, to fitting of actuator (1), piping (3) for compressed air feed provided with pressure regulator. By using the pressure regulator, introduce, into actuator (1) compressed air slowly modulating it, from 0÷3,5 bar, until lever (5) is taken to its end of travel.

Measure again the distance between actuator (1) and cross-axis of eyelet (4) dimension X2.

Travel X of tie rod (2) of actuator (1) is given by following subtraction X = X2-X1 and must result to be equal to 11.5±0.5 mm.

Cleaning turbine body

Figure 101



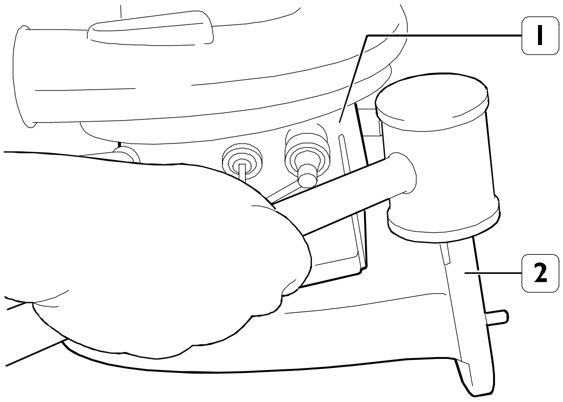
Mark mounting position of clamp (2) on central body (1).

On threading and nut (4), apply antioxidant spray lubricant and, operating on nut (4), loosen clamp (2).

Slightly rotate clamp (2) using pliers (5).

Mark mounting position of turbine body (3) on central body (1).

Figure 102

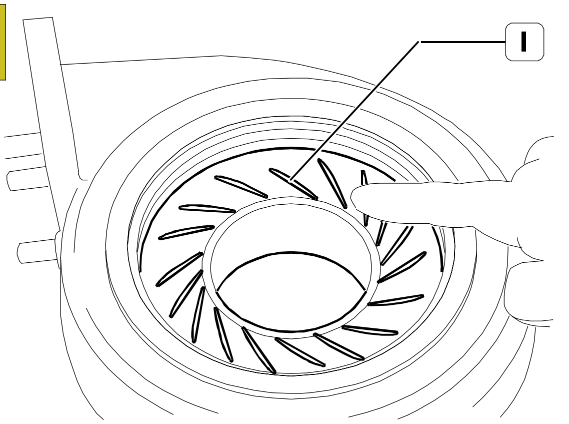


By a copper hammer, beat on two opposite points (~180°) on turbine body (2) to separate turbine body from central body (1).

NOTE In operation, take particular care to avoid damaging turbine rotor.

After dismounting turbine body, check variable geometry movement as described in relating chapter; where improvement in movement is not found with respect to previous check, replace turbocompressor.

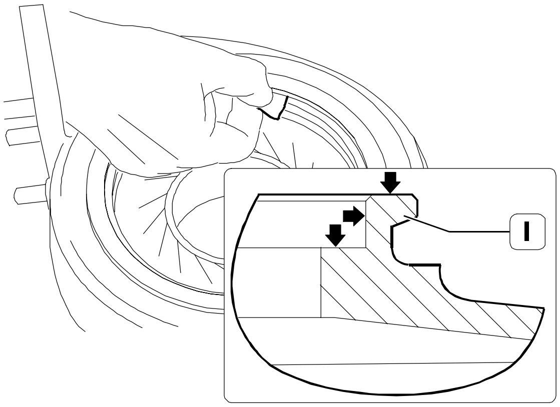
Figure 103



Accurately clean slot ring (1) and area around turbine body from carbonaceous deposits and check that the ring moves freely, otherwise, replace turbocompressor.

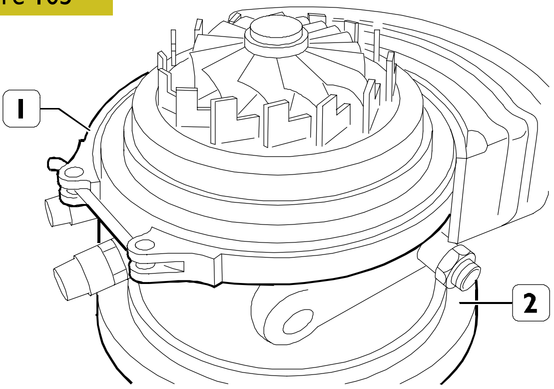
NOTE Any small cracks between slots and ring can be accepted, because they do not impair turbocompressor operation conditions.

Figure 104



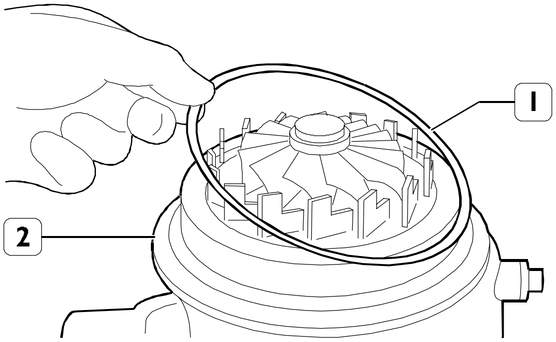
By suitable scraper and abrasive paper, accurately clean surfaces (→) of turbine body (1) from carbonaceous deposits, taking care to avoid damaging the surfaces.

Figure 105



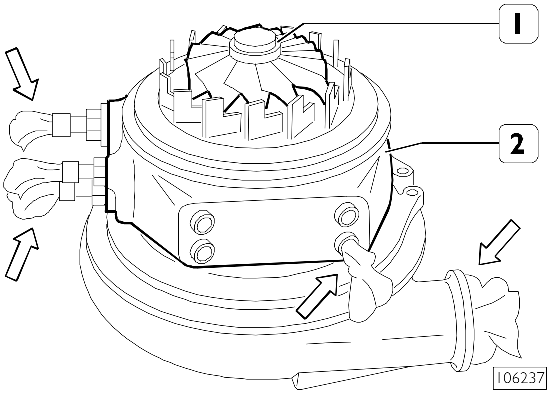
Dismount clamp (1) from central body (2) and check that the clamp does not result to be damaged; otherwise replace the clamp.

Figure 106



Dismount seal ring (1), external with respect to central body (2).
Accurately clean seal ring (1) and check that the ring does not result to be damaged; otherwise replace the ring.

Figure 107

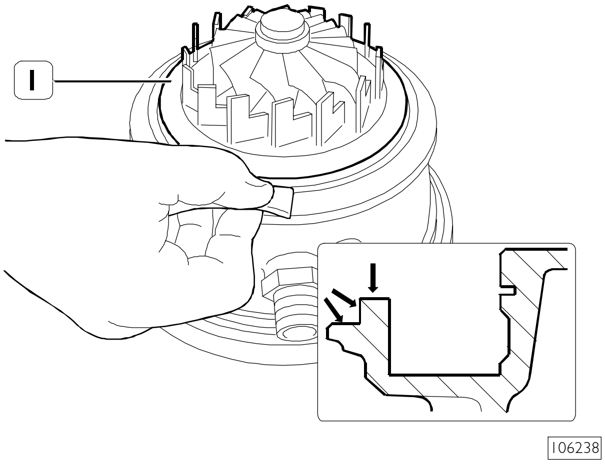


Check turbine rotor (1); there must not be found: carbonaceous deposits, deformation, cracks, blade scoring; also, turbine must turn freely.
By comparator, check clearance of turbine rotor stem (1); clearance must result to be:
- axial clearance: 0.025÷0.127 mm
- radial clearance: 0.254÷0.356 mm.

Where either clearance values over above ones or any one of above mentioned faults are found, replace turbocompressor.

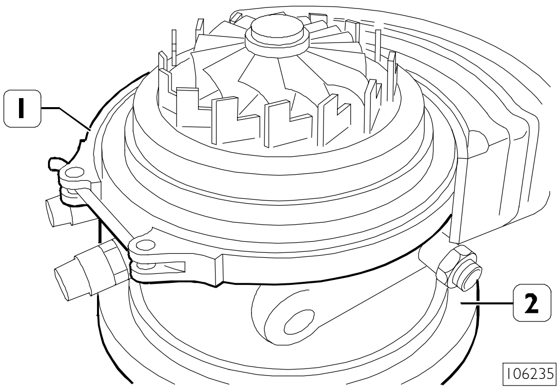
NOTE Before cleaning turbine side central body, properly protect oil, water and air inlets and outlets (→) in order to prevent dirt or foreign bodies from entering turbocompressor.

Figure 108



By suitable scraper and abrasive paper, accurately clean surfaces (→) of central body (1) from carbonaceous deposits, taking care to avoid damaging the surfaces and variable geometry ring.
Then, with compressed air, clean variable geometry surfaces and ring from removed residues.
Check again, as described in relating chapters:
- variable geometry movement;
- actuator;
- actuator travel.

Figure 109

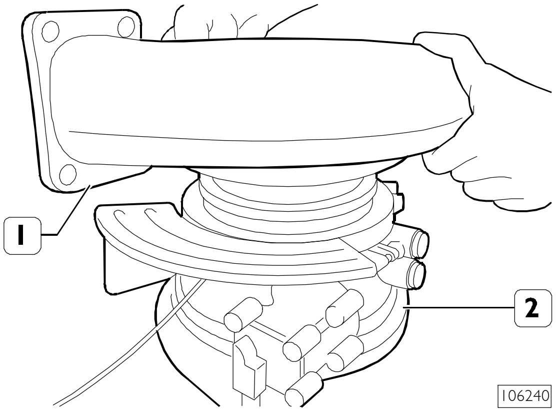


Position clamp (1) on central body (2)

NOTE Should clamp (1) be replaced with an integrated heat guard, a new actuator has to be mounted with an integrated heat guard at the place of existing one.

Position accurately cleaned seal ring on central body.
Apply a thin layer of antiscuff paste on cleaned matching surfaces: central body / turbine body.

Figure 110



Mount turbine body (1) on central body (2) taking care to avoid damaging turbine rotor and align turbine body variable geometry slot ring. Do not force mounting operation: in case of jamming, it might damage variable geometry with consequent regulation system faulty operation.
Once mounting has been completed, make sure that turbine body results to be matched correctly on central body.
Position turbine body on central body and clamp on central body in such a way that marks, made on dismounting, are matching.
Tighten nut clamping the clamp at 11.3 Nm torque.
Check again, as described in relating chapters:
- actuator;
- actuator travel.

TIGHTENING TORQUES

PART			TORQUE	
			Nm	kgm
Under-basement fastening screws to cylinder block (see Figure 111) ♦				
Outer screws	First stage : pre-tightening	M10x1.25	25	2.5
Inner screws	Second stage : pre-tightening	M16x2	140	14
Inner screws	Third stage : angle closing	M16x2	60°	
Inner screws	Fourth stage : angle closing	M16x2	60°	
Outer screws	Fifth stage : angle closing	M10x1,5	90°	
Pipe union for piston cooling nozzle		M12X1.5	35 ± 2	3.5 ± 0.2
Intercooler fastening screws to cylinder block ♦ (see Figure 116)				
pre-tightening			11.5 ± 3.5	1.15 ± 0.35
tightening			19 ± 3	1.9 ± 0.3
Plug			125 ± 15	12.5 ± 1.5
Spacer and oil sump fastening screws (see Figure 117)			41.5 ± 3.5	4.1 ± 0.3
Gearcase fastening screws to cylinder block		M10X1.25	41.5 ± 3.5	4.1 ± 0.3
		M12X1.75	63 ± 7	6.3 ± 0.7
		M8X1.25	23.5 ± 1.5	2.3 ± 0.1
Cylinder head fastening screw: (see Figure 112)				
First stage	pre-tightening		50	5
Second stage	pre-tightening		100	10
Third stage	angle closing		90°	
Fourth stage	angle closing		75°	
Rocker arm shaft fastening screw ♦ (see Figure 113)				
First stage	pre-tightening		40	4
Second stage	angle closing		60°	
Locknut for rocker arm adjusting screw ♦			39 ± 5	3.9 ± 5
Screws for injector fastening brackets ♦			36.5	3.65
Shoulder plate fastening screws to head ♦			20 ± 2	2 ± 0.2
Engine support bracket fastening screws to cylinder head			74 ± 8	7.4 ± 0.8
Gear fastening screws to camshaft: ♦				
First stage	pre-tightening		50	5
Second stage	angle closing		50°	
Phonic wheel fastening screws to distribution gear			8.5 ± 1.5	0.8 ± 0.1
Exhaust pipe fastening screws • (see Figure 114)				
pre-tightening			40 ± 5	4 ± 0.5
tightening			70 ± 5	7 ± 0.5
Engine brake actuator cylinder fastening screws			19 ± 3	1.9 ± 0.3
Connecting rod cap fastening screws: ♦				
First stage	pre-tightening		50	5
Second stage	angle closing		40°	
Engine flywheel fastening screws: ♦		M16x1.5x58		
First stage	pre-tightening		100	10
Second stage	angle closing		60°	
Engine flywheel fastening screws: ♦		M16x1.5x110		
First stage	pre-tightening		100	10
Second stage	angle closing		120°	
Flywheel pulley fastening screws to crankshaft : ♦				
First stage	pre-tightening		70	7
Second stage	angle closing		50°	

♦ Lubricate with oil MOLYKOTE before assembly

• Lubricate with graphitized oil before assembly

PART		TORQUE	
		Nm	kgm
Damper flywheel fastening screws: ♦		115 ± 15	11.5 ± 1.5
Idler gear pin fastening screws: ♦			
First stage	pre-tightening	30	3
Second stage	angle closing	90°	
Idle gear link rod fastening screw		24.5 ± 2.5	2.4 ± 0.2
Oil pump fastening screw		24.5 ± 2.5	2.4 ± 0.2
Oil pump suction rose fastening screw		24.5 ± 2.5	2.4 ± 0.2
Front cover fastening screw to cylinder block ♦		19 ± 3	1.9 ± 0.3
Control unit fastening screw to cylinder block ♦		19 ± 3	1.9 ± 0.3
Supply pump fastening screw to gearcase ♦		19 ± 3	1.9 ± 0.3
Fuel filter support fastening screw to cylinder head		24.5 ± 2.5	2.4 ± 0.2
M16x2 screw securing engine support to gears box ♦			
First stage	pre-tightening	100	10
Second stage	angle closing	60°	
Turbo-compressor fastening screws and nuts • (see Figure 115) pre-tightening tightening		 35 ± 5 46 ± 2	 3.5 ± 0.5 4.6 ± 0.2
Water pump fastening screw to cylinder block		24.5 ± 2.5	2.4 ± 0.2
Pulley fastening screw to hub		55 ± 5	5.5 ± 0.5
Rocker arm cover fastening screws (see Figure 118)		8.5 ± 1.5	0.8 ± 0.1
Thermostat box fastening screws to cylinder head		24.5 ± 2.5	2.4 ± 0.2
Automatic tightener fastening screws to cylinder block		45 ± 5	4.5 ± 0.5
Fixed tightener fastening screws to cylinder block		105 ± 5	10.5 ± 0.5
Fan support fastening screws to cylinder block		24.5 ± 2.5	2.4 ± 0.2
Starter fastening screws		44 ± 4	4 ± 0.4
Air heater on cylinder head		50 ± 5	5 ± 0.5
Air compressor fastening screw to cylinder head		74 ± 8	7.4 ± 0.8
Air compressor control gear fastening nut		170	17 ± 1
Hydraulic power steering pump gear fastening nut		46.5 ± 4.5	4.6 ± 0.4
Air conditioner compressor fastening screw to support		24.5 ± 2.5	2.4 ± 2.5
Air conditioner compressor support fastening screw to cylinder block		44 ± 4	4.4 ± 0.4
Alternator support fastening screw to cylinder block		44 ± 4	4.4 ± 0.4
Alternator bracket fastening screw to cylinder block		24.5 ± 2.5	2.4 ± 0.2
Water pipe unions		35	3.5
Water temperature sensor		32.5 ± 2.5	3.2 ± 0.2

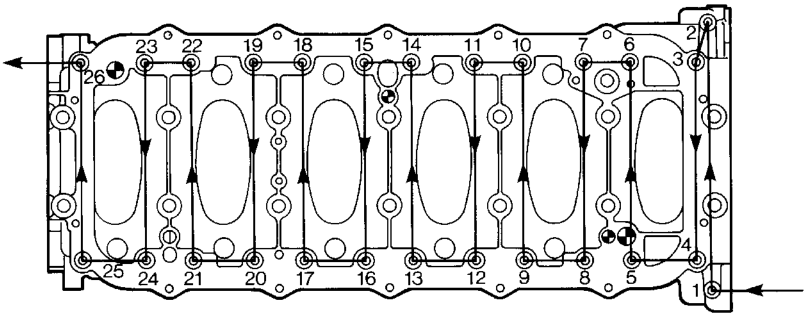
♦ Lubricate with oil MOLYKOTE before assembly
• Lubricate with graphitized oil before assembly

PART		TORQUE	
		Nm	kgm
Engine brake solenoid valve fastening screws		32.5 ± 2.5	3.2 ± 0.2
Flywheel rev sensor fastening screw		8 ± 4	0.8 ± 0.2
Camshaft rev sensor fastening screw		8 ± 2	0.8 ± 0.2
P.D.E solenoid connector fastening screw		1.62 ± 0.3	0.1 ± 0.3
Overboost pressure sensor fastening screw		8 ± 2	0.8 ± 0.2
Absolute pressure sensor fastening screw		22.5 ± 2.5	2.2 ± 0.2
P.W.M. control valve fastening screw/nut		8 ± 2	0.8 ± 0.2
Fuel/coolant temperature sensor		35	3.5
Coolant temperature indicator		23.5 ± 2.5	2.3 ± 0.2
Filter clogging sensor		10	1
Oil temperature switch		25 ± 1	2.5 ± 0.1
Oil pressure sensor		25 ± 1	2.5 ± 0.1
Oil clogging sensor		55 ± 5	5.5 ± 0.5
Electric wire fastening screw		8 ± 2	0.8 ± 0.2
Heater fastening screw:		12.5 ± 2.5	1.2 ± 0.2
M14X70/80 screw securing front and rear spring blocks to chassis		192.5 ± 19.5	19.2 ± 1.9
M16X130 screw securing front and rear spring blocks to engine		278 ± 28	27.8 ± 2.8
M18X62 flanged hex screw for front engine block:			
First stage	pre-tightening	120	12
Second stage	angle closing	45°	
M14X60 socket cheese-head screw for front engine block:			
First stage	pre-tightening	60	6
Second stage	angle closing	45°	
Flanged hex screw for rear engine block:			
First stage	pre-tightening	100	10
Second stage	angle closing	60°	

Underblock fixing screws tightening sequence

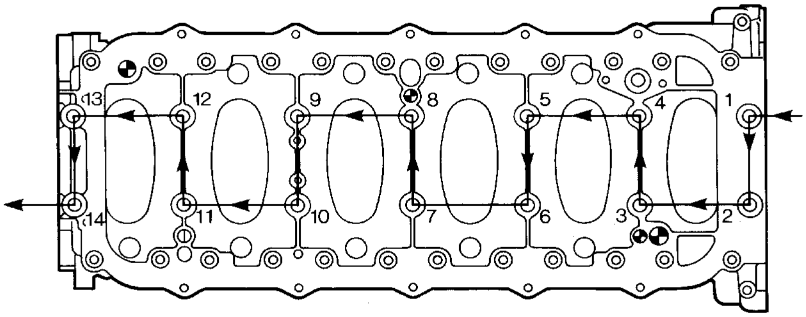
Figure 111

FRONT SIDE



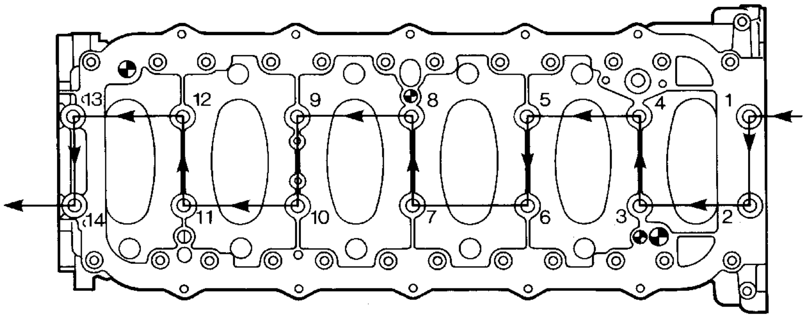
First phase:
preliminary tightening
of outer screws
(25 Nm)

FRONT SIDE



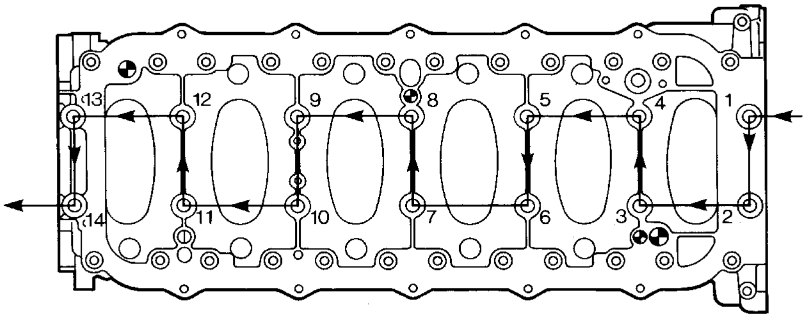
Second phase:
preliminary
tightening of
inner screws
(140 Nm)

FRONT SIDE



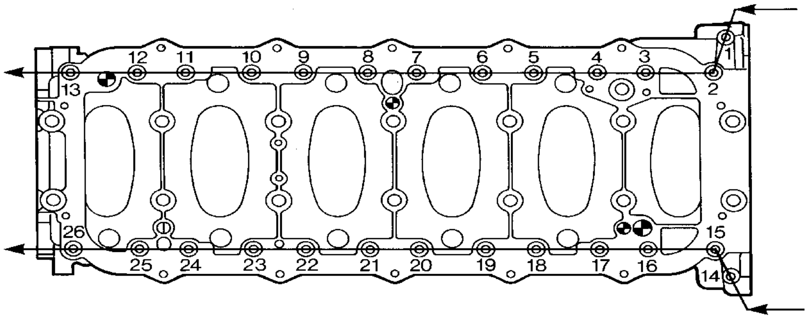
Third phase:
angle tightening
of inner screws
60°

FRONT SIDE



Front phase:
angle tightening
of inner screws
60°

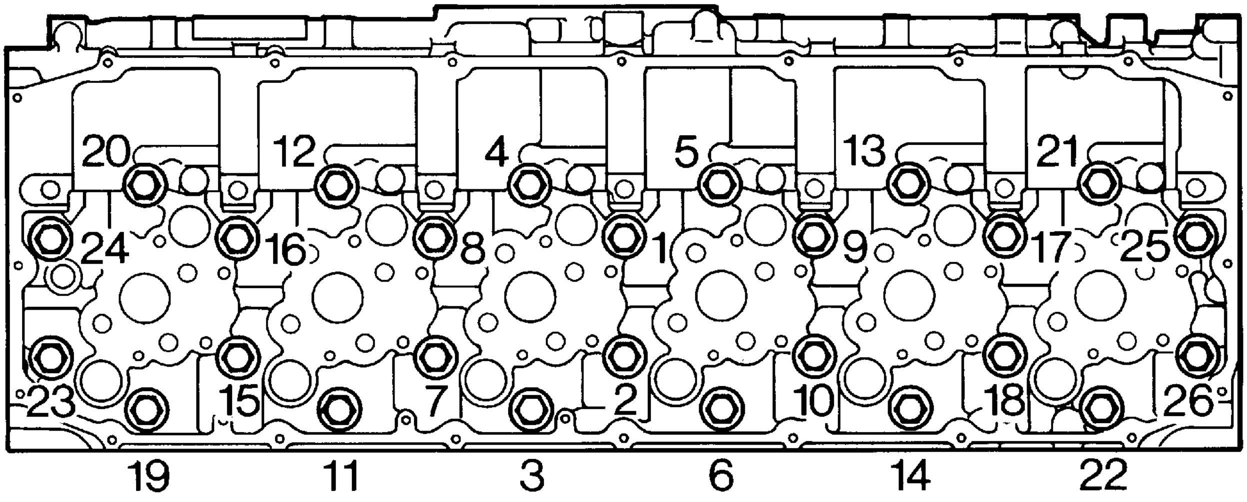
FRONT SIDE



Fifth phase: angle
tightening of
outer screws
90°

Diagram of cylinder head fixing screws tightening sequence

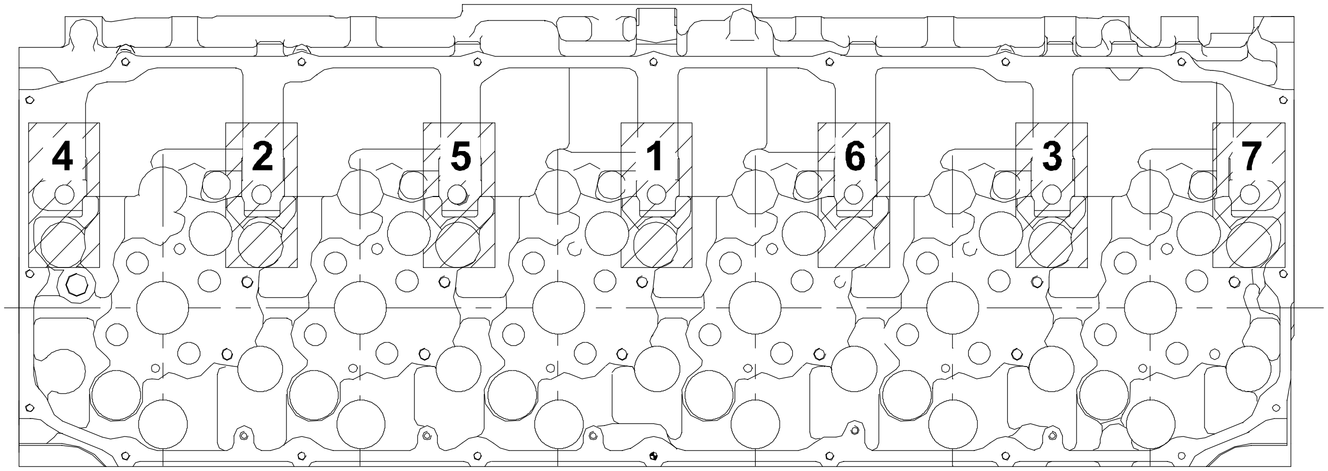
Figure 112



44900

Diagram of rocker shaft fixing screws tightening sequence

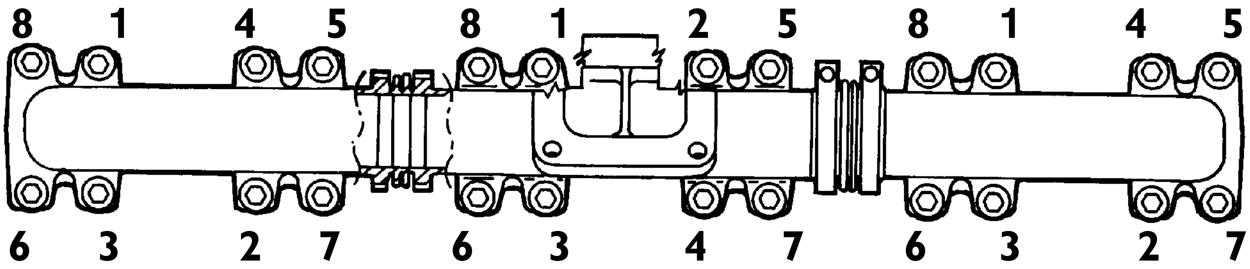
Figure 113



70567A

Diagram of exhaust manifold fixing screws tightening sequence

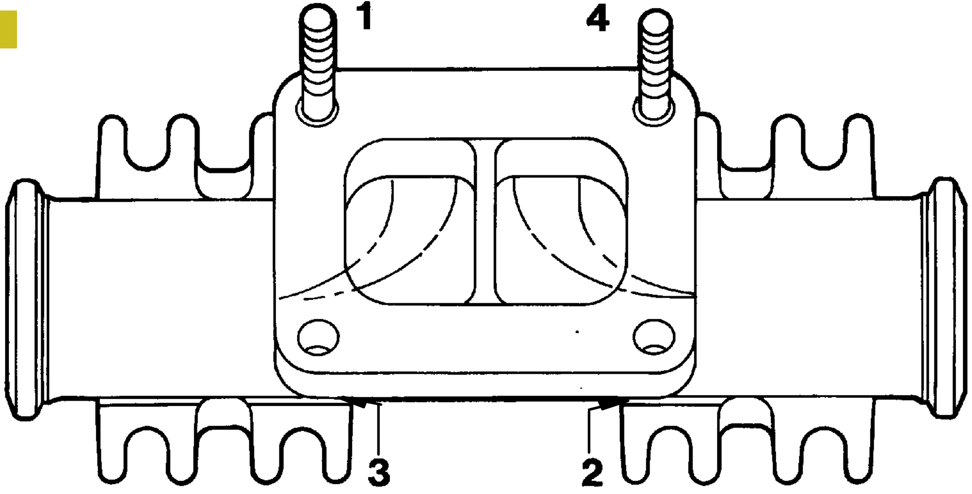
Figure 114



45359

Diagram of turbocharger fixing screws and nuts tightening sequence

Figure 115



SEQUENCE:	Preliminary tightening	4 - 3 - 1 - 2
	Tightening	1 - 4 - 2 - 3

Diagram of heat exchanger fixing screws tightening sequence

Figure 116

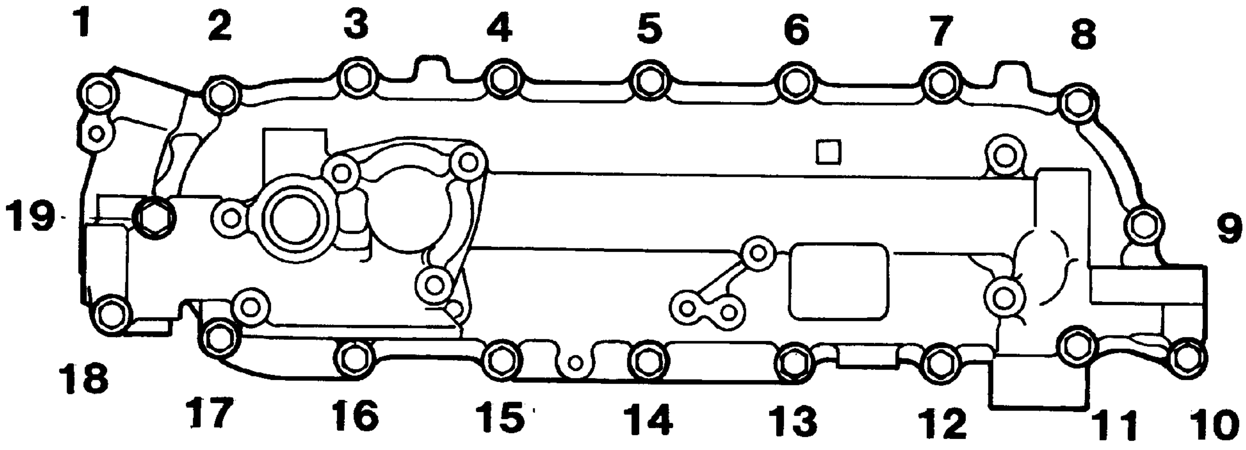


Diagram of engine oil sump fixing screws tightening sequence

Figure 117

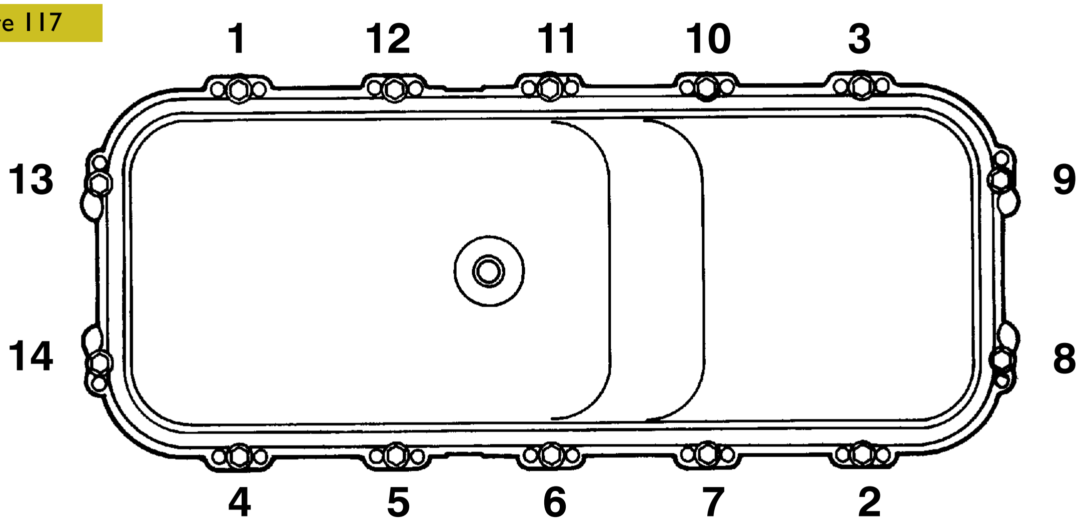
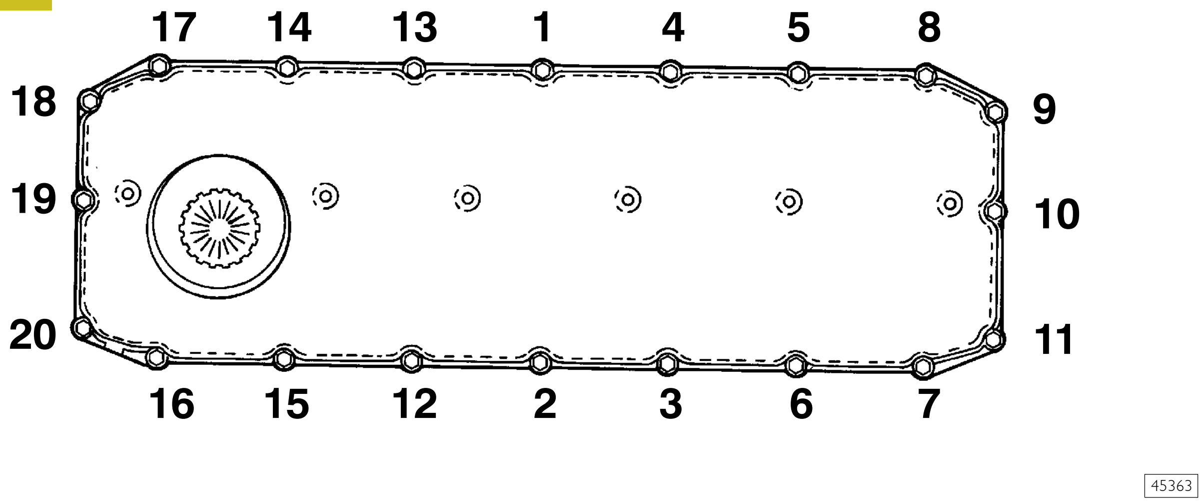


Diagram of rocker arm cap fixing screws tightening sequence

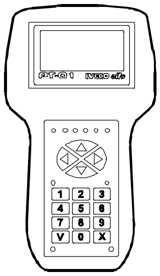
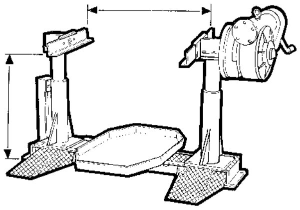
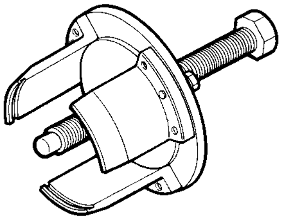
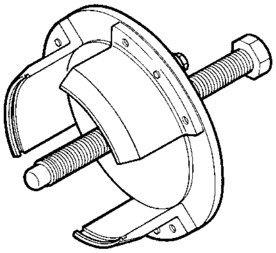
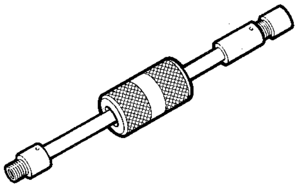
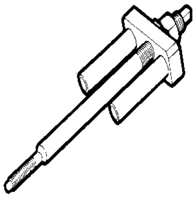
Figure 118



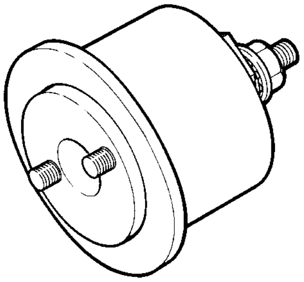
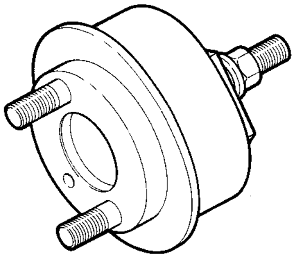
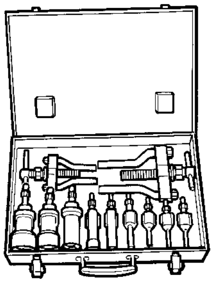
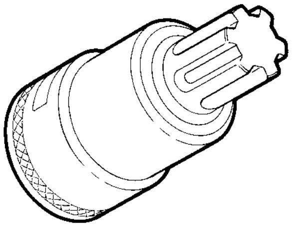
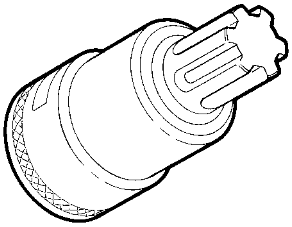
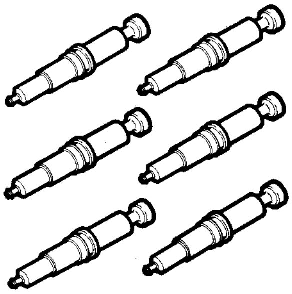
SECTION 5

Tools

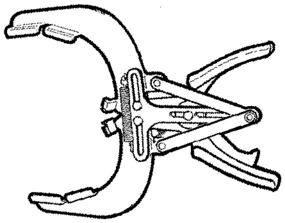
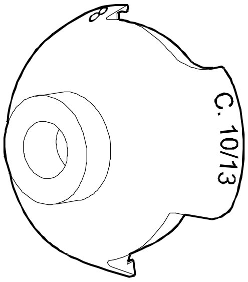
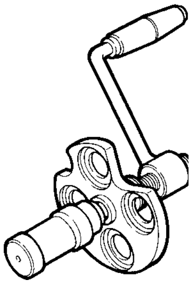
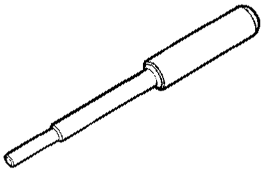
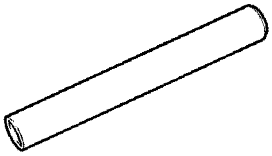
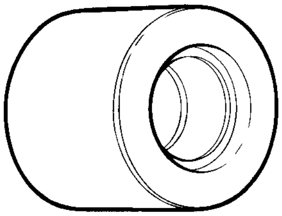
TOOLS

TOOL NO.		DESCRIPTION
8093731		Tester PT01
99322230		Rotary telescopic stand (range 2000 daN, torque 375 daNm)
99340051		Extractor for crankshaft front gasket
99340052		Extractor for crankshaft rear gasket
99340205		Percussion extractor
99342149		Extractor for injector-holder

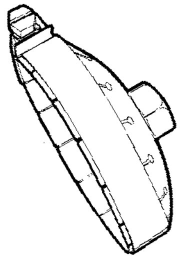
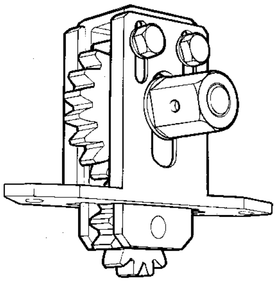
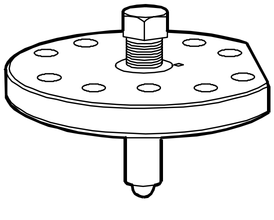
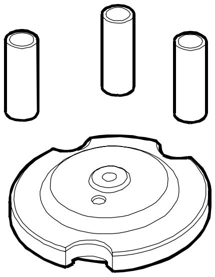
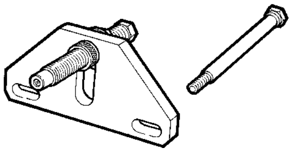
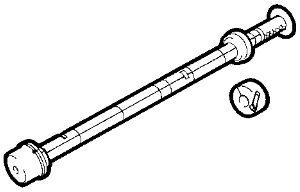
TOOLS

TOOL NO.		DESCRIPTION
99346245		Tool to install the crankshaft front gasket
99346246		Tool to install the crankshaft rear gasket
99348004		Universal extractor for 5 to 70 mm internal components
99350072		Box wrench for transmission gear support fixing screws
99350074		Box wrench for block junction bolts to the underblock
99360177		Injector housing protecting plugs (6)

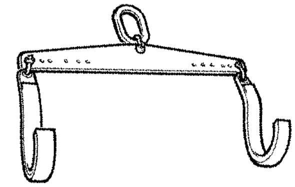
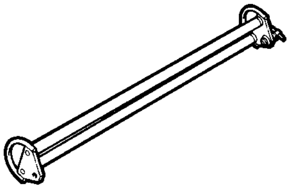
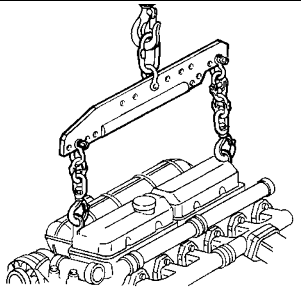
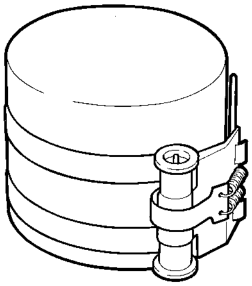
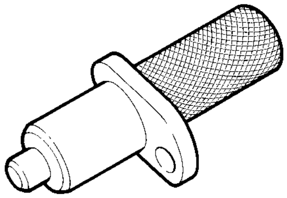
TOOLS

TOOL NO.		DESCRIPTION
99360184		Pincers for removing and refitting circlips and pistons (105-160 mm)
99360192		Guide for flexible belt
99360264		Tool to take down-fit engine valves
99360288		Tool to remove valve guide
99360292		Tool to install gasket on valve guide
99360294		Tool to drive valve guide (to be used with 99360288)

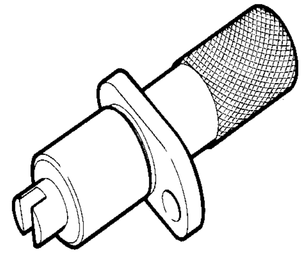
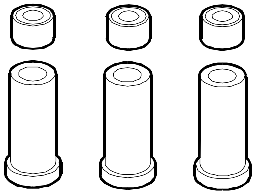
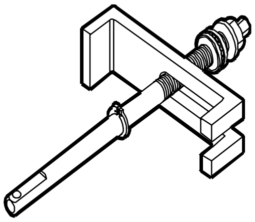
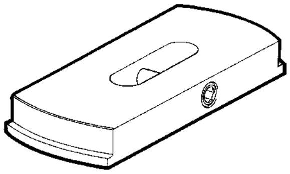
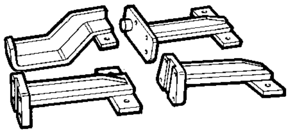
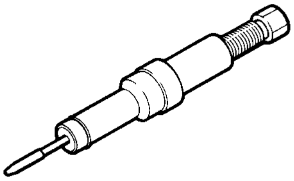
TOOLS

TOOL NO.		DESCRIPTION
99360314		Tool to remove oil filter (engine)
99360321		Tool to rotate engine flywheel
99360334		Compression tool for checking the protrusion of cylinder liners (to be used with 99370415-99395603 and special plates)
99360335		Cylinder barrel compression cap (to be used with 99360334)
99360351		Tool to stop engine flywheel
99360487		Tool to take down and fit back camshaft bushes

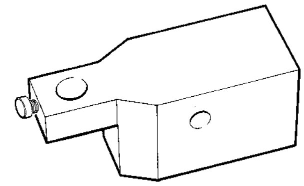
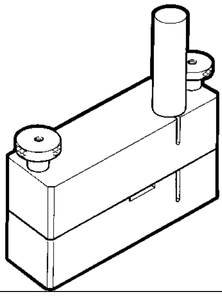
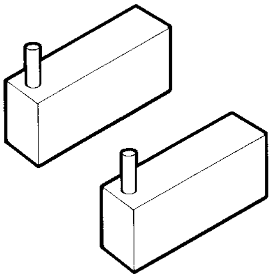
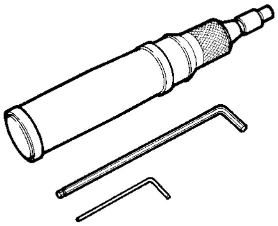
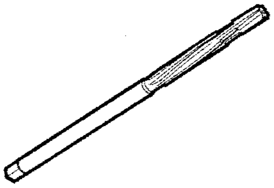
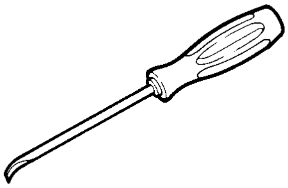
TOOLS

TOOL NO.		DESCRIPTION
99360500		Tool to lift crankshaft
99360551		Bracket to take down and fit engine flywheel
99360558		Tool to lift and transport rocker shaft
99360585		Swing hoist for engine disassembly assembly
99360605		Belt to insert piston in cylinder liner (60 - 125 mm)
99360612		Tool for positioning engine P.M.S.

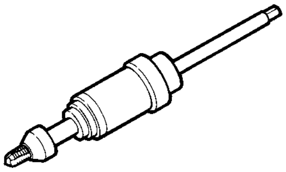
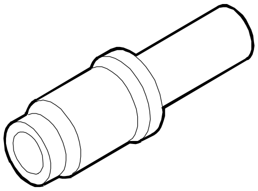
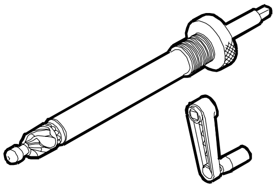
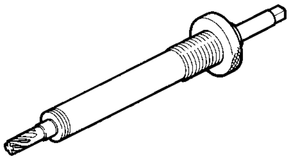
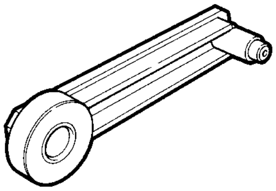
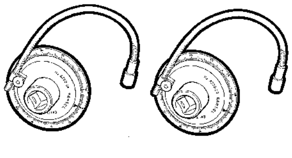
TOOLS

TOOL NO.		DESCRIPTION
99360613		Tool for timing of phonic wheel on timing gear
99360703		Tool to stop cylinder liners
99360706		Tool to extract cylinder liners (to be used with specific rings)
99360724		Tool to extract the cylinder liners (to be used with 99360723)
99361035		Brackets fixing the engine to rotary stand 99322230
99365054		Tool for injector holder heading

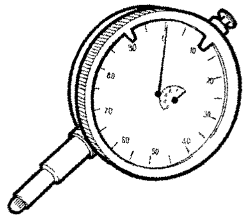
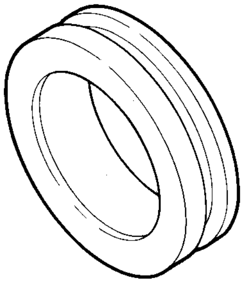
TOOLS

TOOL NO.		DESCRIPTION
99370415		Base supporting the dial gauge for checking cylinder liner protrusion (to be used with 99395603)
99378100		Tool for printing engine identification plates (to be used with special punches)
99378130		Punch kit to stamp engine identification data plates (compose of: 99378101(A) - 99378102(B) - 99378103(C) - 99378104(D) - 99378105(E) - 99378106(F) - 993378107(G) - 99378108(V))
99389834		Torque screwdriver (1-6 Nm) for calibrating the injector solenoid valve connector check nut
99390310		Valve guide sleeker
99390772		Tool to remove residues from injector holder

TOOLS

TOOL NO.		DESCRIPTION
99390804		Tool to thread injector holders to be extracted
99394014		Guide bush (to be used with 99394041 or 99394043)
99394041		Cutter to rectify injector holder housing (to be used with 99394014)
99394043		Reamer to rectify injector holder lower side (to be used with 99394014)
99395215		Gauge for centre distance check between camshaft and idle gear
99395216		Measuring pair for angular tightening with 1/2" and 3/4" square couplings

TOOLS

TOOL NO.		DESCRIPTION
99395603		Dial gauge (0 - 5 mm)
99396033		Centering ring of crankshaft front cap

Appendix

SAFETY PRESCRIPTIONS

Standard safety prescriptions

Particular attention shall be drawn on some precautions that must be followed absolutely in a standard working area and whose non fulfillment will make any other measure useless or not sufficient to ensure safety to the personnel in-charge of maintenance.

Be informed and inform personnel as well of the laws in force regulating safety, providing information documentation available for consultation.

☐ Keep working areas as clean as possible, ensuring adequate aeration.

☐ Ensure that working areas are provided with emergency boxes, that must be clearly visible and always provided with adequate sanitary equipment.

☐ Provide for adequate fire extinguishing means, properly indicated and always having free access. Their efficiency must be checked on regular basis and the personnel must be trained on intervention methods and priorities.

☐ Organize and displace specific exit points to evacuate the areas in case of emergency, providing for adequate indications of the emergency exit lines.

☐ Smoking in working areas subject to fire danger must be strictly prohibited.

☐ Provide Warnings throughout adequate boards signaling danger, prohibitions and indications to ensure easy comprehension of the instructions even in case of emergency.

Prevention of injury

☐ Do not wear unsuitable cloths for work, with fluttering ends, nor jewels such as rings and chains when working close to engines and equipment in motion.

☐ Wear safety gloves and goggles when performing the following operations:
- filling inhibitors or anti-frost
- lubrication oil topping or replacement
- utilization of compressed air or liquids under pressure (pressure allowed: ≤ 2 bar)

☐ Wear safety helmet when working close to hanging loads or equipment working at head height level.

☐ Always wear safety shoes when and cloths adhering to the body, better if provided with elastics at the ends.

☐ Use protection cream for hands.

☐ Change wet cloths as soon as possible

☐ In presence of current tension exceeding 48-60 V verify efficiency of earth and mass electrical connections. Ensure that hands and feet are dry and execute working operations utilizing isolating foot-boards. Do not carry out working operations if not trained for.

☐ Do not smoke nor light up flames close to batteries and to any fuel material.

☐ Put the dirty rags with oil, diesel fuel or solvents in anti-fire specially provided containers.

☐ Do not execute any intervention if not provided with necessary instructions.

☐ Do not use any tool or equipment for any different operation from the ones they've been designed and provided for: serious injury may occur.

☐ In case of test or calibration operations requiring engine running, ensure that the area is sufficiently aerated or utilize specific vacuum equipment to eliminate exhaust gas. Danger: poisoning and death.

During maintenance

☐ Never open filler cap of cooling circuit when the engine is hot. Operating pressure would provoke high temperature with serious danger and risk of burn. Wait unit the temperature decreases under 50ºC.

☐ Never top up an overheated engine with cooler and utilize only appropriate liquids.

☐ Always operate when the engine is turned off: whether particular circumstances require maintenance intervention on running engine, be aware of all risks involved with such operation.

☐ Be equipped with adequate and safe containers for drainage operation of engine liquids and exhaust oil.

☐ Keep the engine clean from oil tangles, diesel fuel and or chemical solvents.

☐ Use of solvents or detergents during maintenance may originate toxic vapors. Always keep working areas aerated. Whenever necessary wear safety mask.

☐ Do not leave rags impregnated with flammable substances close to the engine.

☐ Upon engine start after maintenance, undertake proper preventing actions to stop air suction in case of runaway speed rate.

☐ Do not utilize fast screw-tightening tools.

☐ Never disconnect batteries when the engine is running.

☐ Disconnect batteries before any intervention on the electrical system.

☐ Disconnect batteries from system aboard to load them with the battery loader.

☐ After every intervention, verify that battery clamp polarity is correct and that the clamps are tight and safe from accidental short circuit and oxidation.

☐ Do not disconnect and connect electrical connections in presence of electrical feed.

☐ Before proceeding with pipelines disassembly (pneumatic, hydraulic, fuel pipes) verify presence of liquid or air under pressure. Take all necessary precautions bleeding and draining residual pressure or closing dump valves. Always wear adequate safety mask or goggles. Non fulfillment of these prescriptions may cause serious injury and poisoning.

❑ Avoid incorrect tightening or out of couple. Danger: incorrect tightening may seriously damage engine's components, affecting engine's duration.

❑ Avoid priming from fuel tanks made out of copper alloys and/or with ducts not being provided with filters.

❑ Do not modify cable wires: their length shall not be changed.

❑ Do not connect any user to the engine electrical equipment unless specifically approved by Iveco.

❑ Do not modify fuel systems or hydraulic system unless Iveco specific approval has been released. Any unauthorized modification will compromise warranty assistance and furthermore may affect engine correct working and duration.

For engines equipped with electronic gearbox:

❑ Do not execute electric arc welding without having priory removed electronic gearbox.

❑ Remove electronic gearbox in case of any intervention requiring heating over 80°C temperature.

❑ Do not paint the components and the electronic connections.

❑ Do not vary or alter any data filed in the electronic gearbox driving the engine. Any manipulation or alteration of electronic components shall totally compromise engine assistance warranty and furthermore may affect engine correct working and duration.

Respect of the Environment

❑ Respect of the Environment shall be of primary importance: all necessary precautions to ensure personnel's safety and health shall be adopted.

❑ Be informed and inform the personnel as well of laws in force regulating use and exhaust of liquids and engine exhaust oil. Provide for adequate board indications and organize specific training courses to ensure that personnel is fully aware of such law prescriptions and of basic preventive safety measures.

❑ Collect exhaust oils in adequate specially provided containers with hermetic sealing ensuring that storage is made in specific, properly identified areas that shall be aerated, far from heat sources and not exposed to fire danger.

❑ Handle the batteries with care, storing them in aerated environment and within anti-acid containers. Warning: battery exhalation represent serious danger of intoxication and environment contamination.

Part 2
F3A CURSOR EURO 4 ENGINES

PREFACE TO USER'S GUIDELINE MANUAL

Section 1 describes the F3A engine illustrating its features and working in general.

Section 2 describes the type of fuel feed.

Section 3 relates to the specific duty and is divided in four separate parts:

1. Mechanical part, related to the engine overhaul, limited to those components with different characteristics based on the relating specific duty.
2. Electrical part, concerning wiring harness, electrical and electronic equipment with different characteristics based on the relating specific duty.
3. Maintenance planning and specific overhaul.
4. Troubleshooting part dedicated to the operators who, being entitled to provide technical assistance, shall have simple and direct instructions to identify the cause of the major inconveniences.

Sections 4 and 5 illustrate the overhaul operations of the engine overhaul on stand and the necessary equipment to execute such operations.
The appendix reports general safety prescriptions to be followed by all operators whether being in-charge of installation or maintenance, in order to avoid serious injury.

UPDATING

Section	Description	Page	Date of revision

SECTION 1

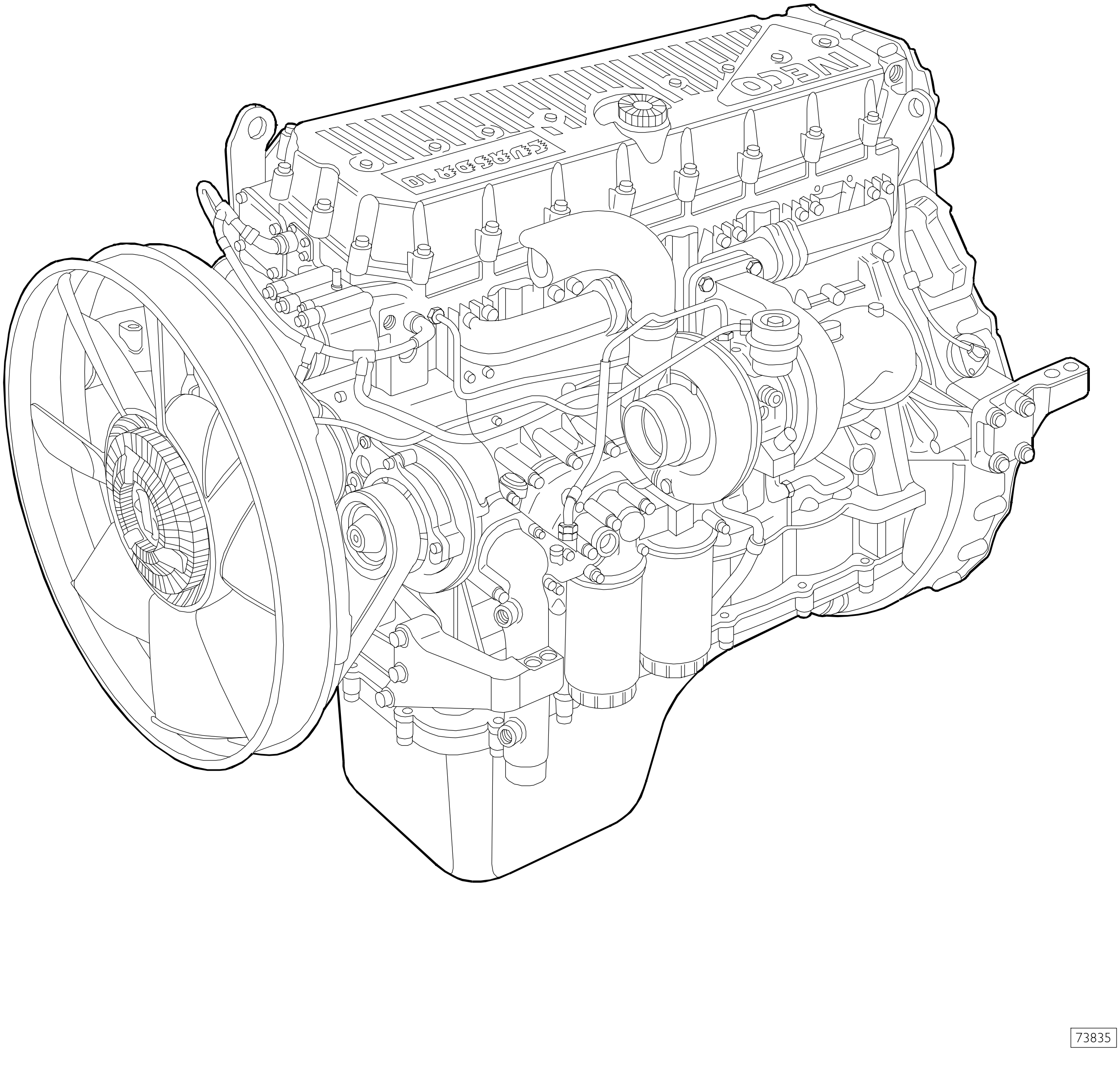
General specifications

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F3AE3681D	C10 ENT C
F3AE3681B	C10 ENT C
F3AE3681A	C10 ENT C

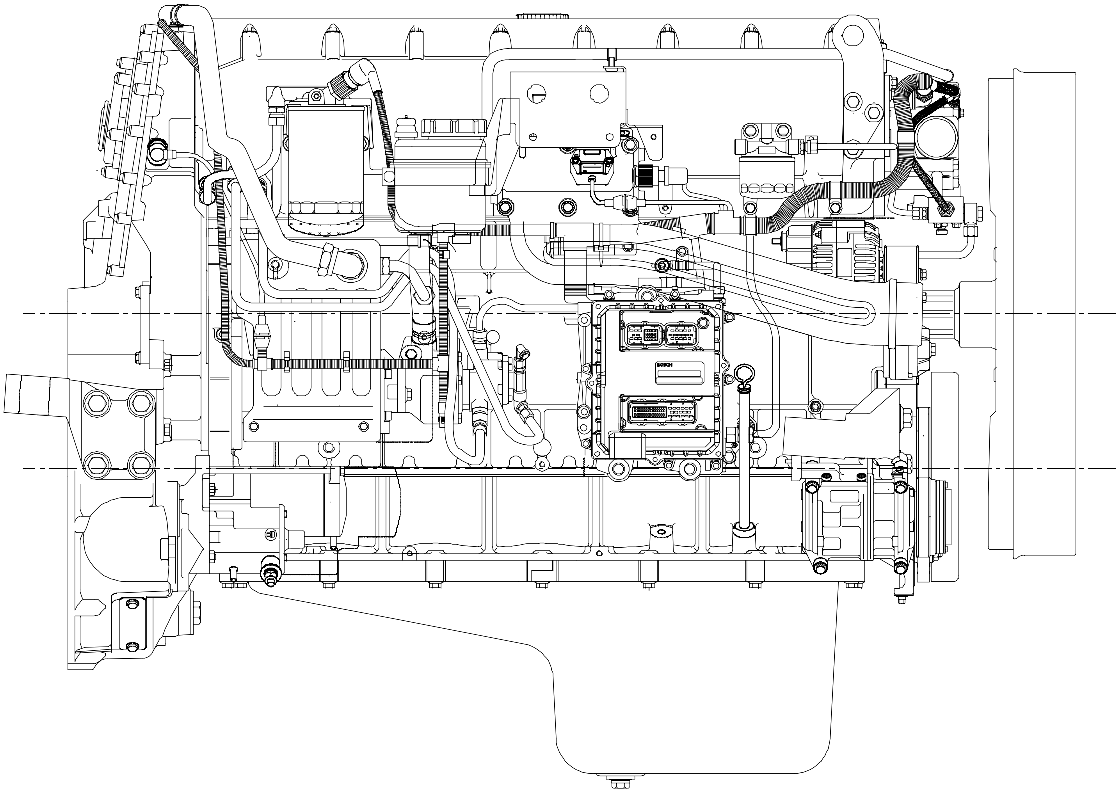
VIEWS OF THE ENGINE

Figure 1



F3A ENGINE

Figure 2



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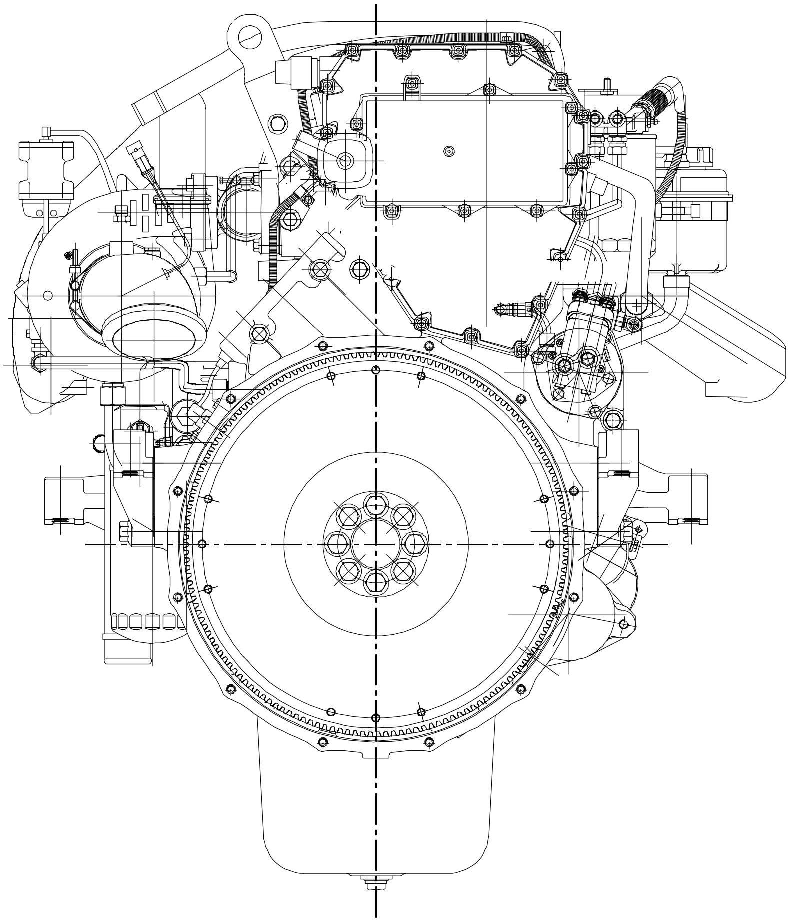
RIGHT-HAND SIDE VIEW OF THE ENGINE

Figure 3



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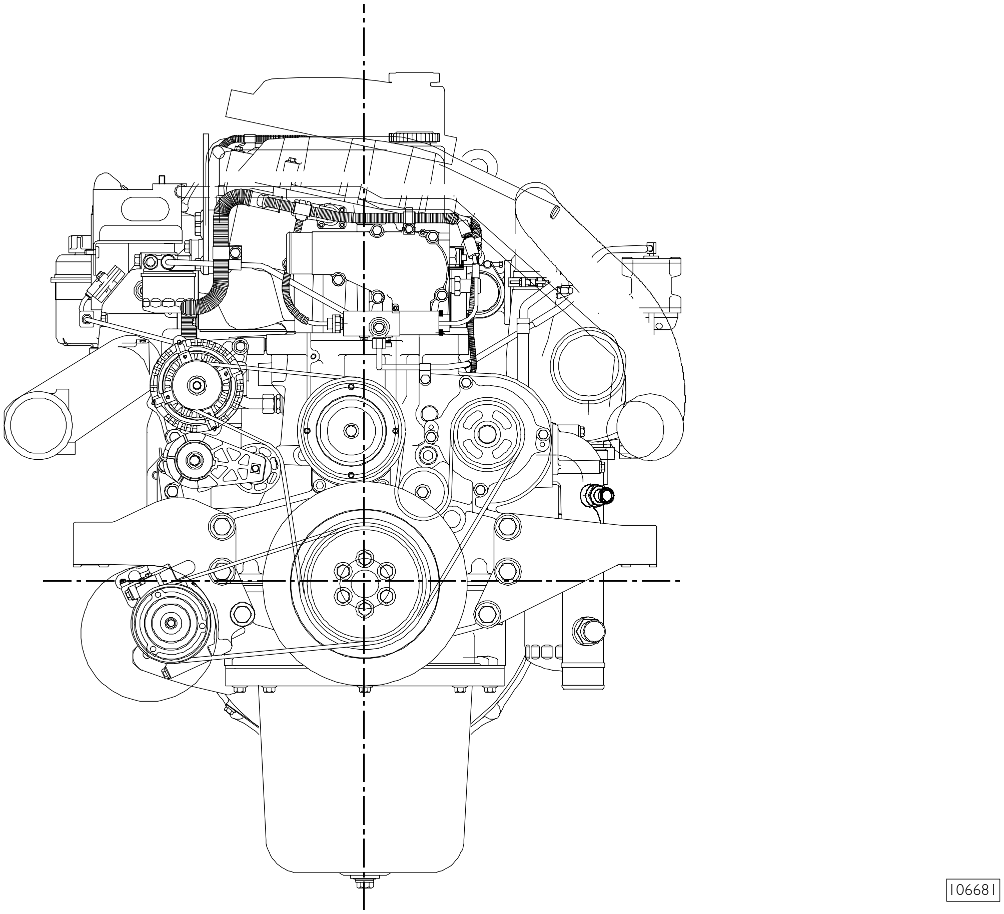
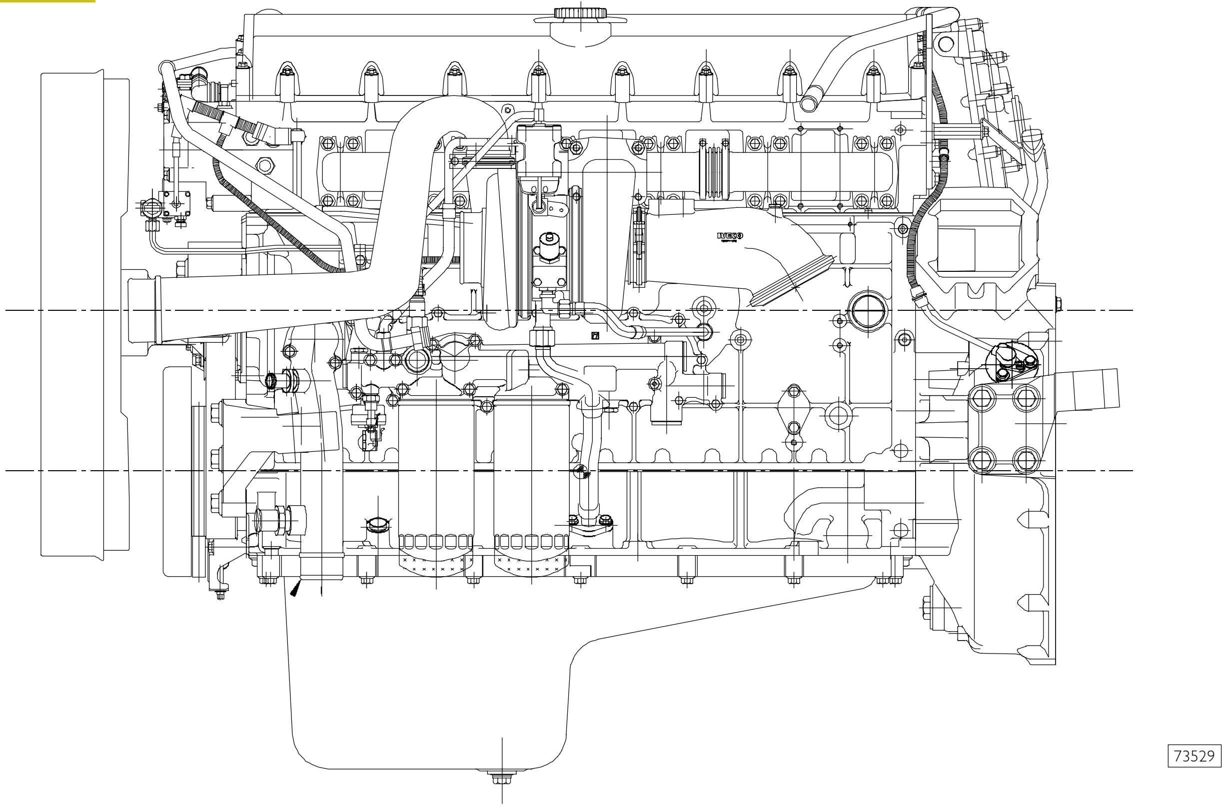
REAR VIEW OF THE ENGINE

Figure 4



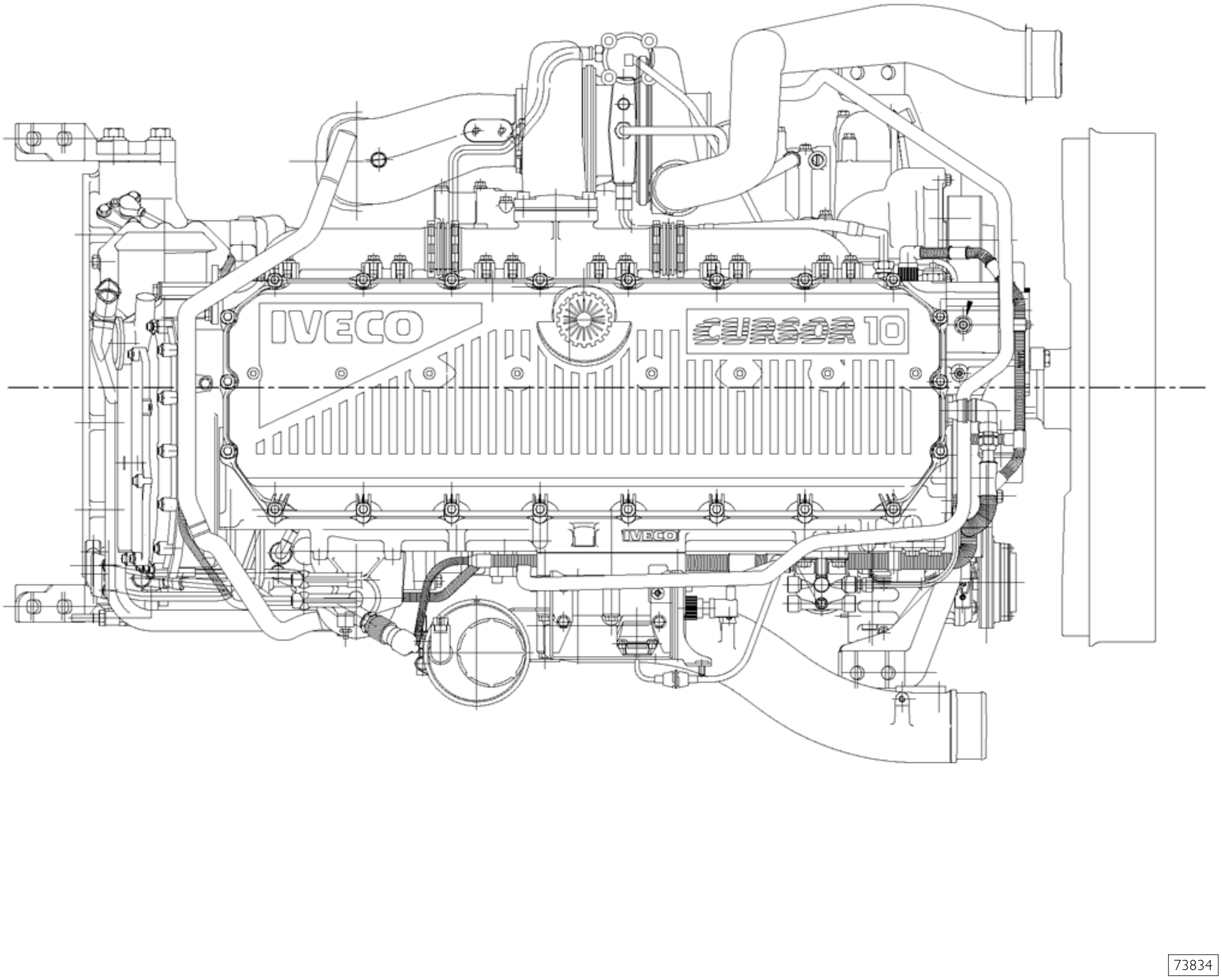
RIGHT-HAND SIDE VIEW OF THE ENGINE

Figure 5



LEFT-HAND SIDE VIEW OF THE ENGINE

Figure 6

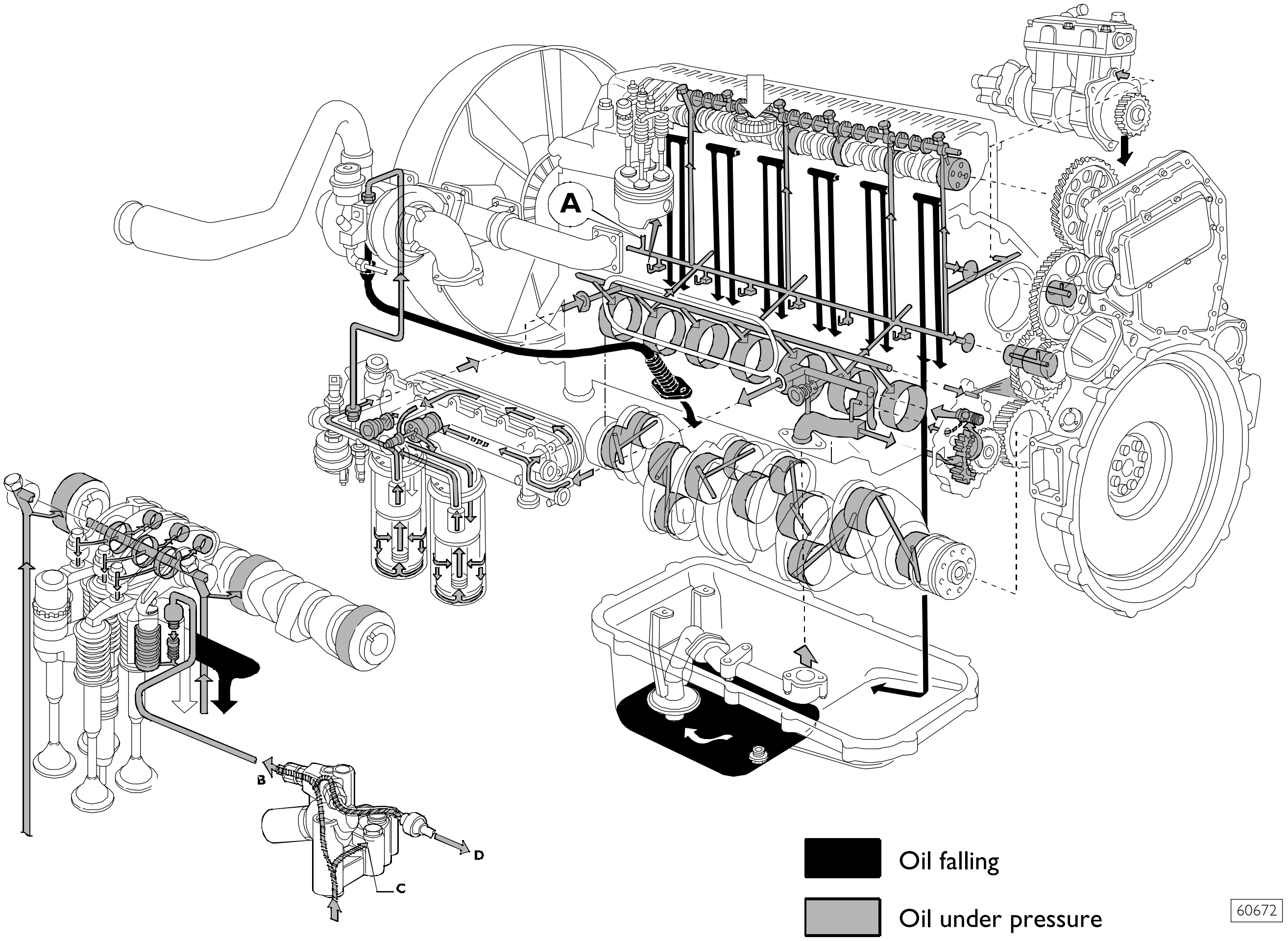


VIEW OF THE ENGINE FROM ABOVE

LUBRICATION

Engine lubrication is obtained with a gear pump driven by the crankshaft via gears.
A heat exchanger governs the temperature of the lubricating oil.
It houses two oil filters, indicator sensors and safety valves.

Figure 7

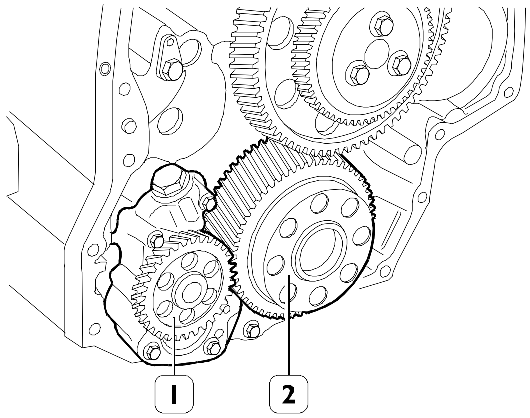


B - to cylinders 1 - 2 - 3
C - to cylinder 4
D - to cylinders 5 - 6

LUBRICATION CIRCUIT

Oil pump

Figure 8



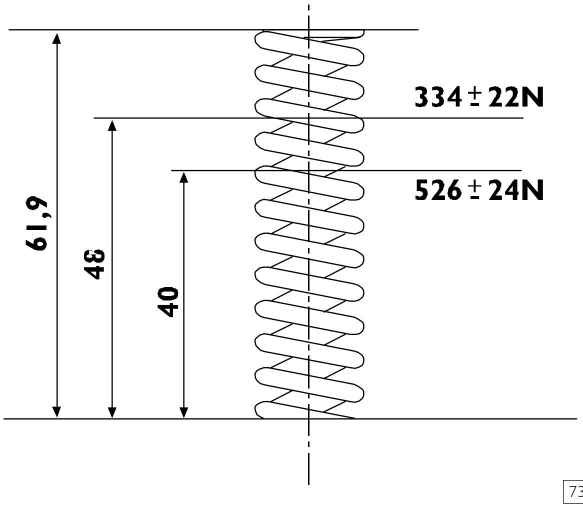
60560

The oil pump (1) cannot be overhauled. On finding any damage, replace the oil pump assembly.

See under the relevant heading for replacing the gear (2) of the crankshaft.

Overpressure valve

Figure 10



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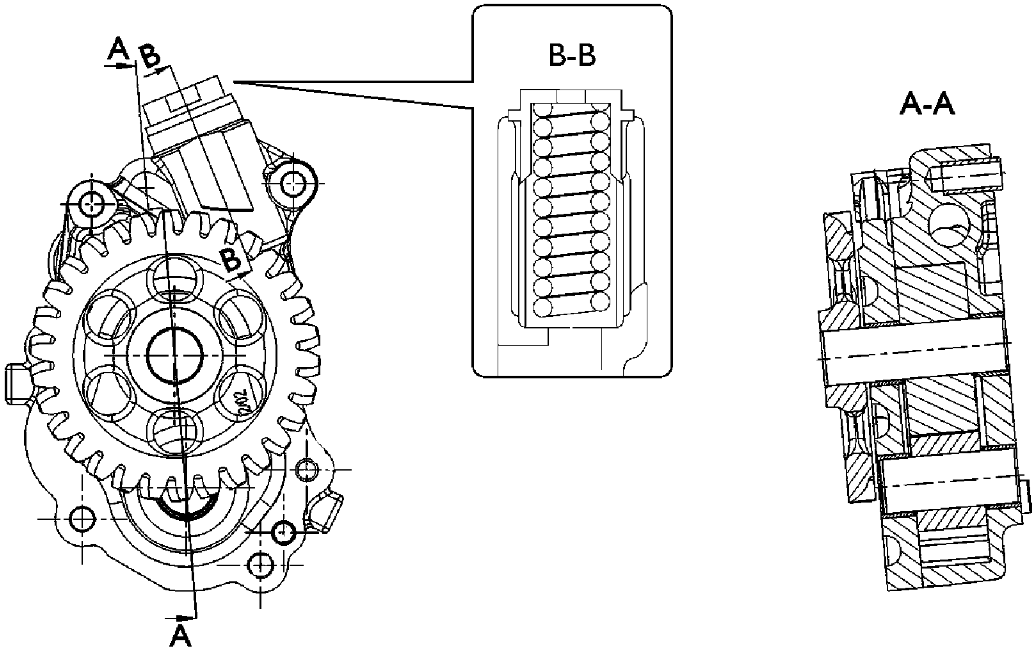
MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

Figure 9



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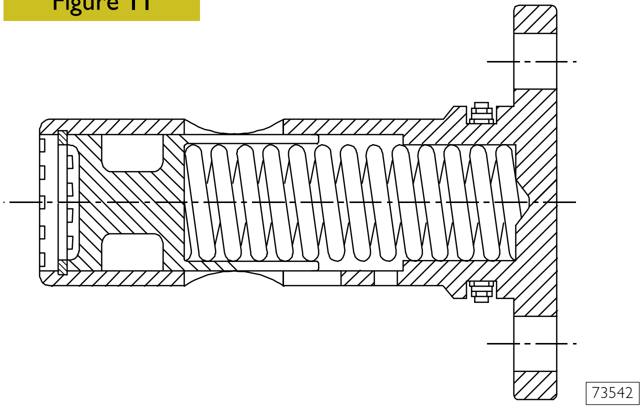
OIL PUMP CROSS-SECTION
Overpressure valve – Start of opening pressure 10 ± 1 bars

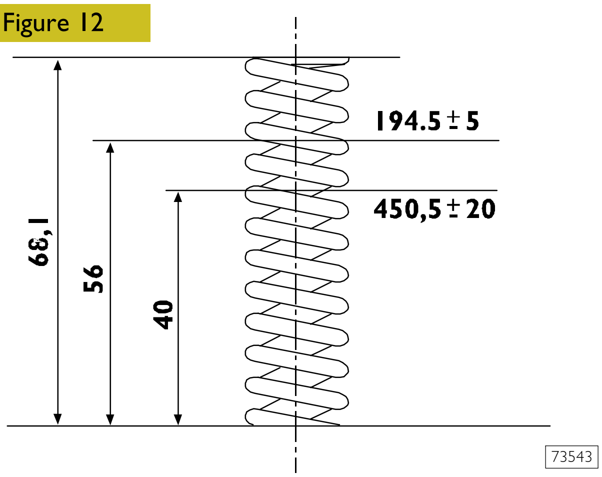
Oil pressure control valve

Figure 11



The oil pressure control valve is located on the left-hand side of the crankcase.
Start of opening pressure 5 bars.

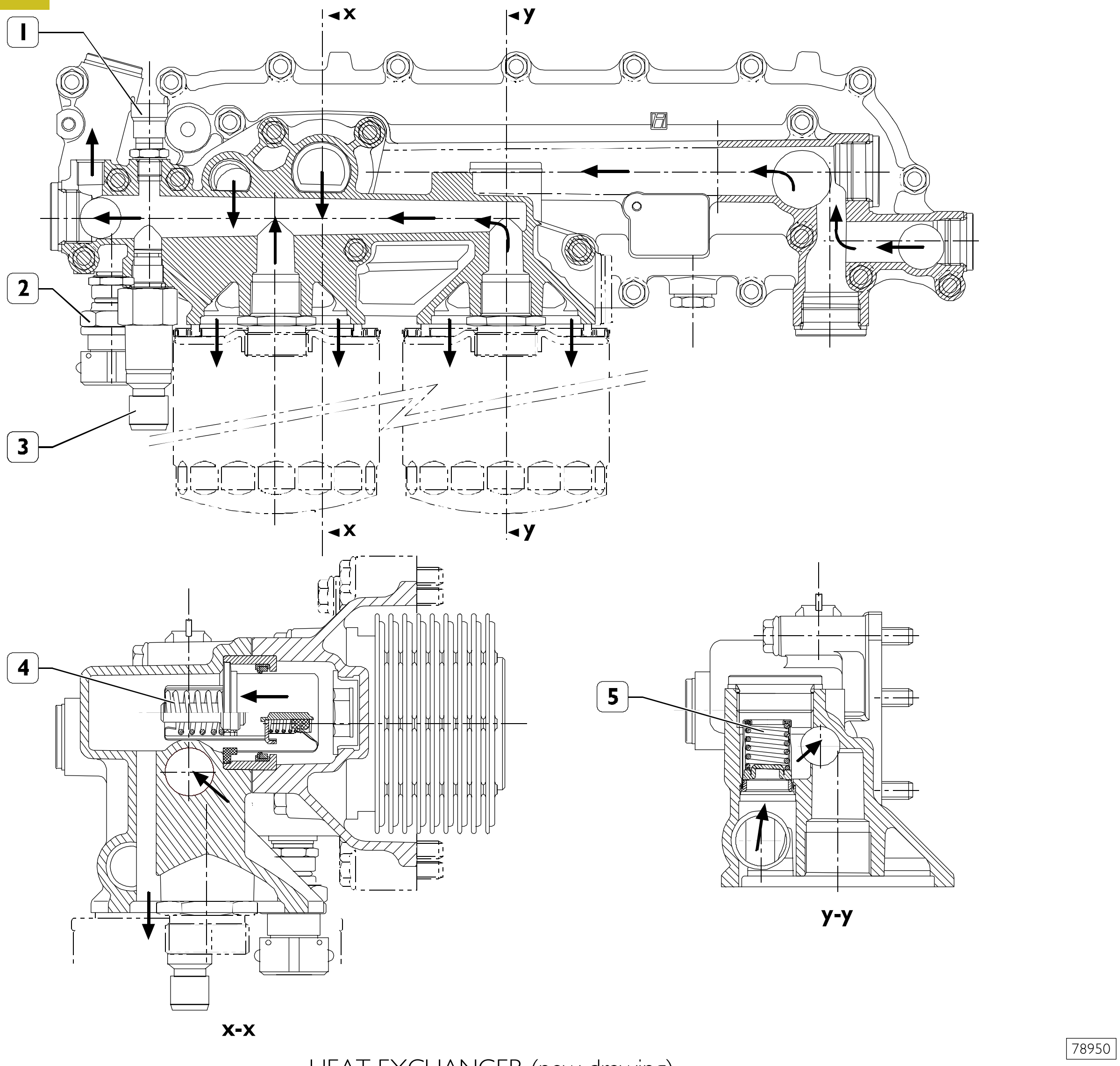
Figure 12



MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

Heat exchanger

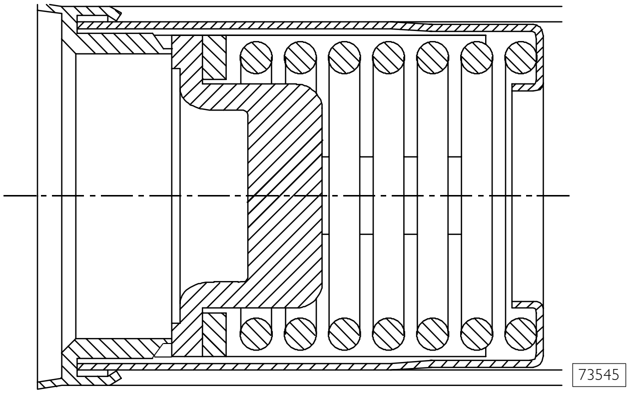
Figure 13



HEAT EXCHANGER (new drawing)
The heat exchanger is fitted with: 1. Oil temperature sensor - 2. Oil pressure sensor for pressure gauge - 3. Transmitter for low pressure warning lamp - 4. By-pass valve - 5. Heat valve. Number of elements 9

By-pass valve

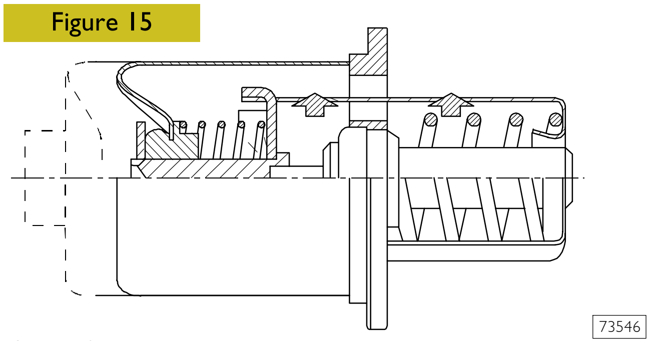
Figure 14



The valve quickly opens at a pressure of: 3 bars.

Thermostatic valve

Figure 15



Start of opening:

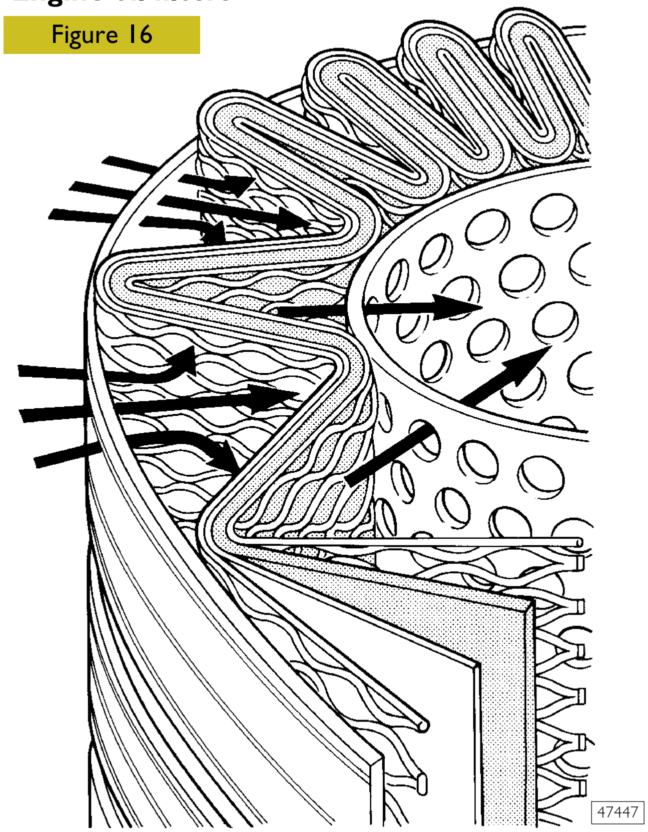
☐ travel 0.1 mm at a temperature of 82 ±2°C.

End of opening:

☐ travel 8 mm at a temperature of 97°C.

Engine oil filters

Figure 16



This is a new generation of filters that permit much more thorough filtration as they are able to holder back a greater amount of particles of smaller dimensions than those held back by conventional filters with a paper filtering element.

These high-filtration devices, to date used only in industrial processes, make it possible to:

☐ reduce the wear of engine components over time;

☐ maintain the performance/specifications of the oil and thereby lengthen the time intervals between changes.

External spiral winding

The filtering elements are closely wound by a spiral so that each fold is firmly anchored to the spiral with respect to the others. This produces a uniform use of the element even in the worst conditions such as cold starting with fluids with a high viscosity and peaks of flow. In addition, it ensures uniform distribution of the flow over the entire length of the filtering element, with consequent optimization of the loss of load and of its working life.

Mount upstream

To optimize flow distribution and the rigidity of the filtering element, this has an exclusive mount composed of a strong mesh made of nylon and an extremely strong synthetic material.

Filtering element

Composed of inert inorganic fibres bound with an exclusive resin to a structure with graded holes, the element is manufactured exclusively to precise procedures and strict quality control.

Mount downstream

A mount for the filtering element and a strong nylon mesh make it even stronger, which is especially helpful during cold starts and long periods of use. The performance of the filter remains constant and reliable throughout its working life and from one element to another, irrespective of the changes in working conditions.

Structural parts

The o-rings equipping the filtering element ensure a perfect seal between it and the container, eliminating by-pass risks and keeping filter performance constant. Strong corrosion-proof bottoms and a sturdy internal metal core complete the structure of the filtering element.

When mounting the filters, keep to the following rules:

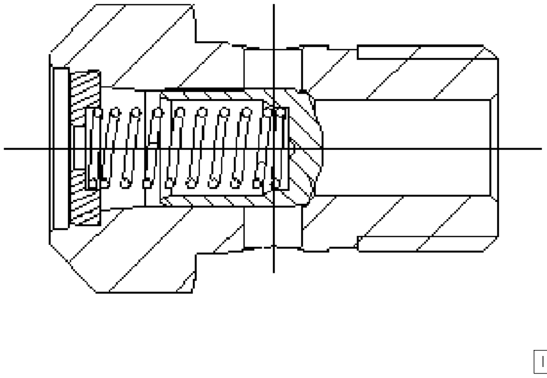
☐ Oil and fit new seals.

☐ Screw down the filters to bring the seals into contact with the supporting bases.

☐ Tighten the filter to a torque of 35-40 Nm.

Valve integrated in piston cooling nozzle

Figure 17



The valve allows oil to enter only above the threshold pressure of 1.7 ± 0.2 bar. This permits filling the circuit and therefore lubricating the most stressed parts even when working at lower pressures.

COOLING

Description

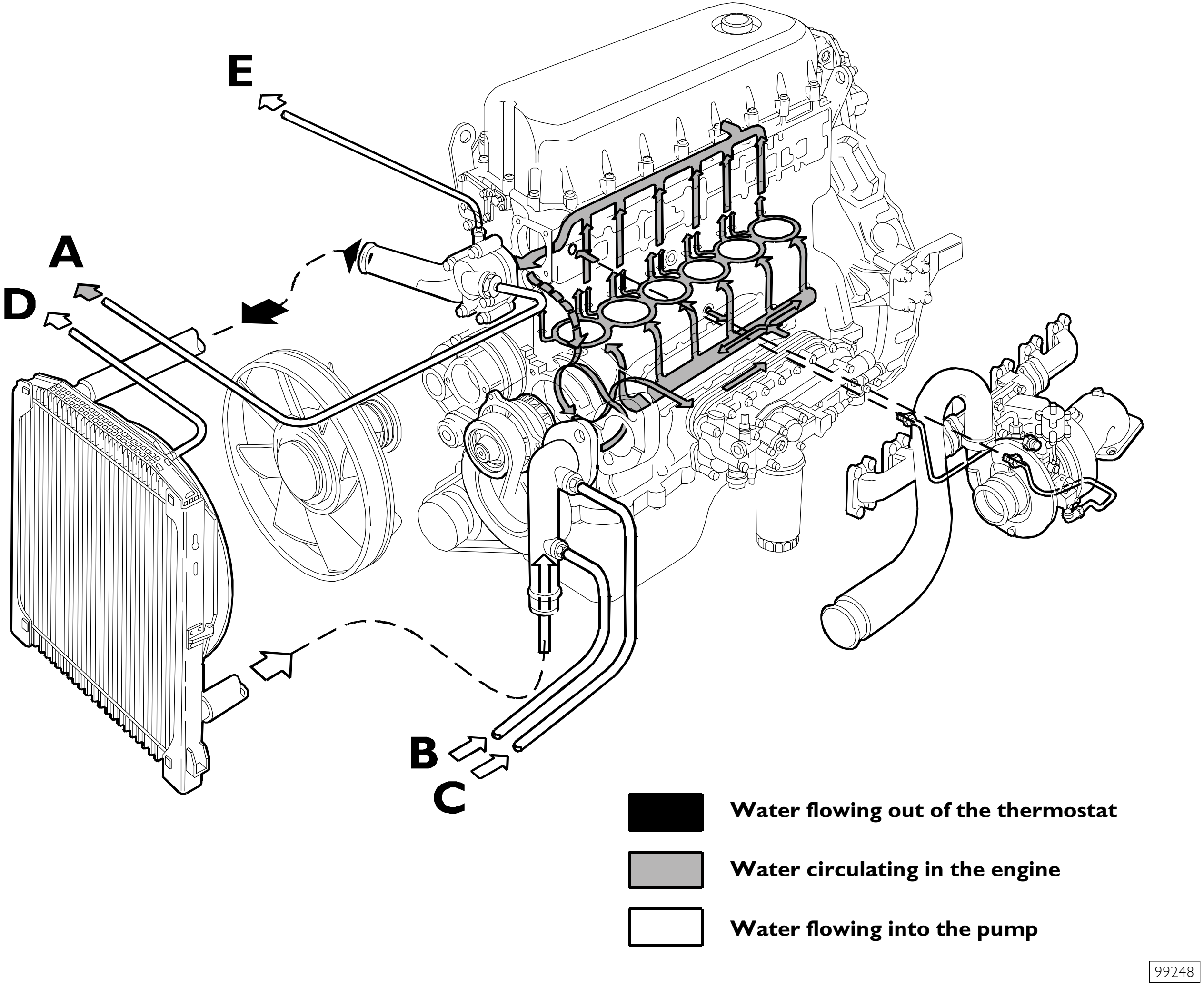
The engine cooling system is of the closed-circuit, forced circulation type.
It consists mainly of the following components:

- ☐ expansion tank, not supplied (by IVECO);
- ☐ a heat exchanger to cool down lubrication oil;
- ☐ a water pump with centrifugal system incorporated in the cylinder block;
- ☐ fan, not supplied;
- ☐ a 2-way thermostat controlling the coolant circulation.

Operation

The water pump is actuated by the crankshaft through a poli-V belt and sends coolant to the cylinder block, especially to the cylinder head (bigger quantity). When the coolant temperature reaches and overcomes the operating temperature, the thermostat is opened and from here the coolant flows into the radiator and is cooled down by the fan.
The pressure inside the system, due to temperature change, is adequately controlled through the expansion vessel.

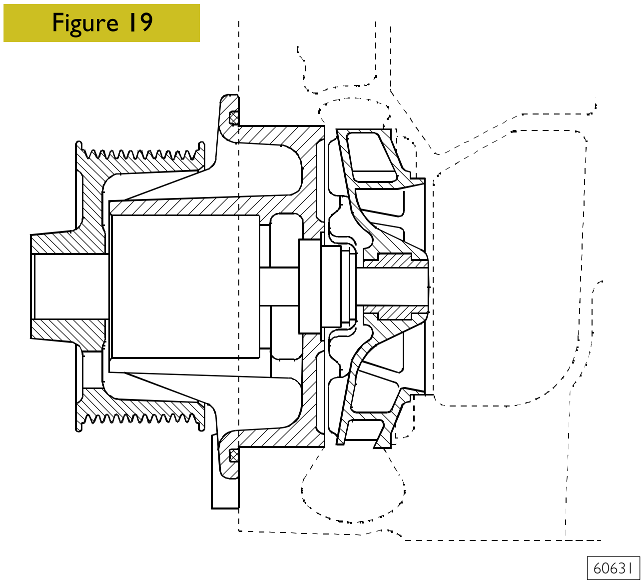
Figure 18 (Demonstration)



A/B	outlet/inlet for vehicle heater
C	inlet from the expansion vessel
D/E	outlet from the radiator and the thermostat body for expansion vessel inlet

Water pump

Figure 19



CROSS-SECTION OF THE WATER PUMP

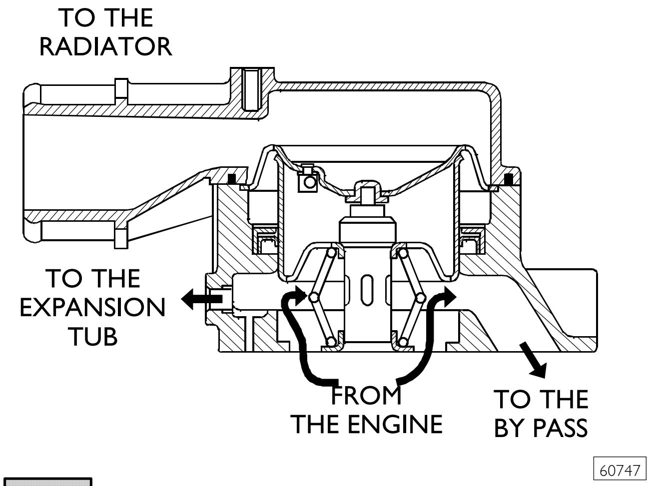
The water pump is composed of: impeller, bearing, seal and driving pulley.

NOTE Check that the pump body has no cracks or water leakage; if it does, replace the entire water pump.

Thermostat

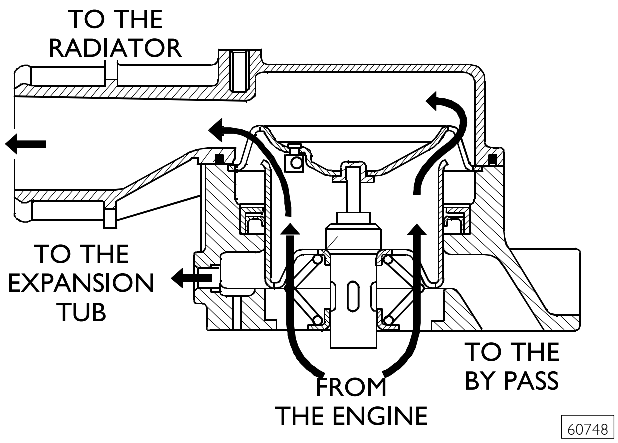
View of thermostat operation

Figure 20



░ Water circulating in the engine

Figure 21



■ Water leaving the thermostat

Check the thermostat works properly; replace it if in doubt.

Temperature of start of travel 84°C ±2°C.
Minimum travel 15 mm at 94°C ±2°C.

TURBOCHARGING

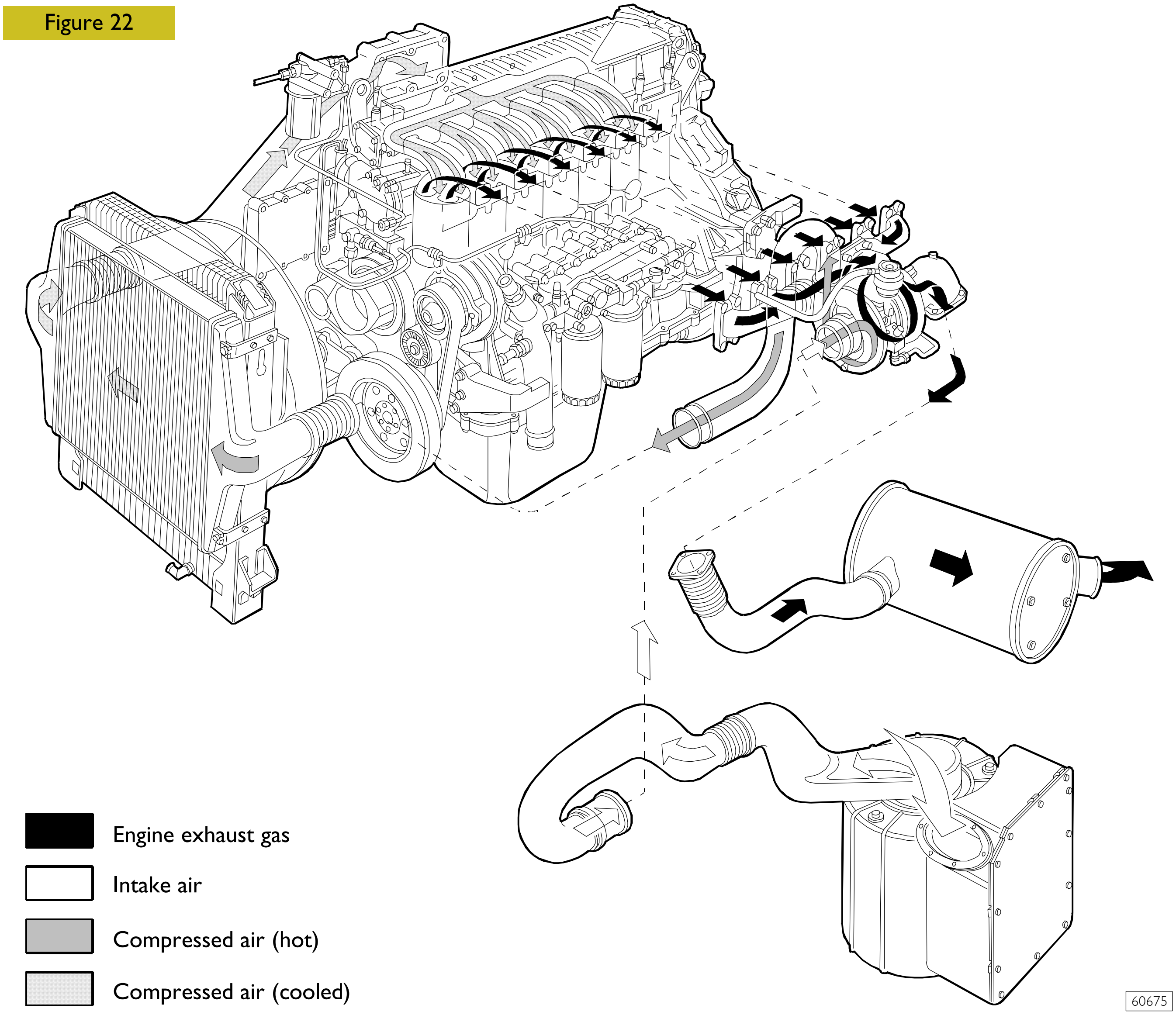
The turbocharging system consists of:

☐ air filter;

☐ variable geometry turbocharger;

☐ "intercooler" radiator.

Figure 22



■ Engine exhaust gas

□ Intake air

▩ Compressed air (hot)

░ Compressed air (cooled)

TURBOCHARGING DIAGRAM

Turbocharger HOLSET HE531V

Operating principle

The variable geometry turbocharger (VGT) consists of a centrifugal compressor and a turbine, equipped with a mobile device which adjusts the speed by changing the area of the passing section of exhaust gases to the turbine.

Thanks to this solution, gas velocity and turbine speed can be high even when the engine is idling.

If the gas is made to go through a narrow passage, in fact, it flows faster, so that the turbine rotates more quickly.

The movement of the device, choking the exhaust gas flowing section, is carried out by a mechanism, activated by a pneumatic actuator.

This actuator is directly controlled by the electronic control unit by a proportional solenoid valve.

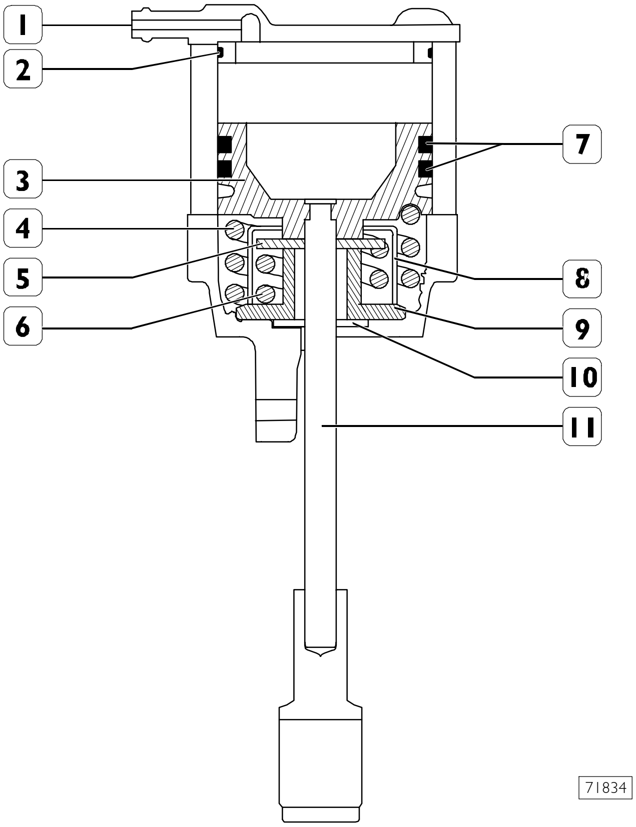
The device is in maximum closing condition at idle speed.

At high engine operating speed, the electronic control system is activated and increases the passing section, in order to allow the in-coming gases to flow without increasing their speed.

A toroidal chamber is obtained during the casting process in the central body for the passage of the coolant.

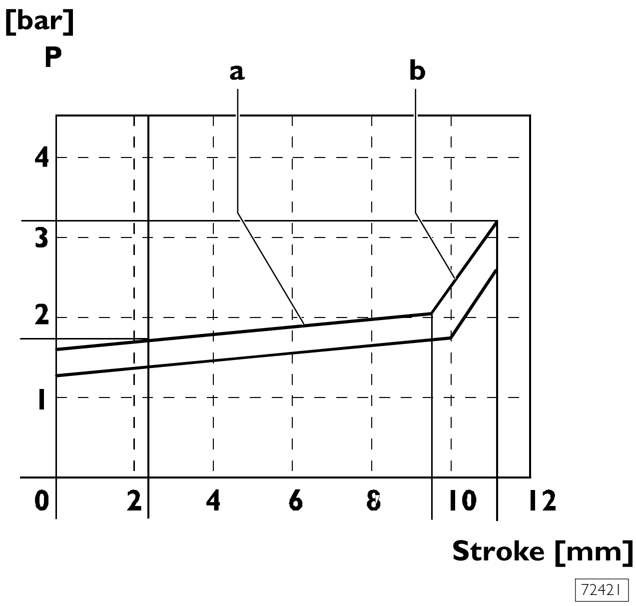
Actuator

Figure 23



1. Air inlet - 2. Gasket - 3. Piston - 4. External spring - 5. Internal spring control disc - 6. Internal spring - 7. O-ring - 8. Spring holder - 9. Limit stop - 10. Dust seal - 11. Control rod.

Figure 24



a Gradient characterized by the effect of the external spring (4, Figure 23).

b Gradient characterized by the effect of the external (4, Figure 23) and internal (6, Figure 23) springs.

Working principle (See Figure 23)

The actuator piston, connected to the drive rod, is controlled with the compressed air introduced through the air inlet (1) on the top of the actuator.

Modulating the air pressure varies the movement of the piston and turbine control rod. As the piston moves, it progressively compresses the external spring (4) until the base of the piston reaches the disc (5) controlling the internal spring (6).

On further increasing the pressure, the piston, via the disc (5), interferes with the bottom limit stop (10).

Using two springs makes it possible to vary the ratio between the piston stroke and the pressure. Approximately 85% of the stroke of the rod is opposed by the external spring and 15% by the internal one.

Solenoid valve for VGT control

This N.C. proportional solenoid valve is located on the left-hand side of the crankcase under the turbine.

The electronic control unit, via a PWM signal, controls the solenoid valve, governing the supply pressure of the turbine actuator, which, on changing its position, modifies the cross-section of the flow of exhaust gases onto the blades of the impeller and therefore its speed.

The resistance of the coil is approx. 20-30 Ohms.

DeNO$_x$ SYSTEM 2

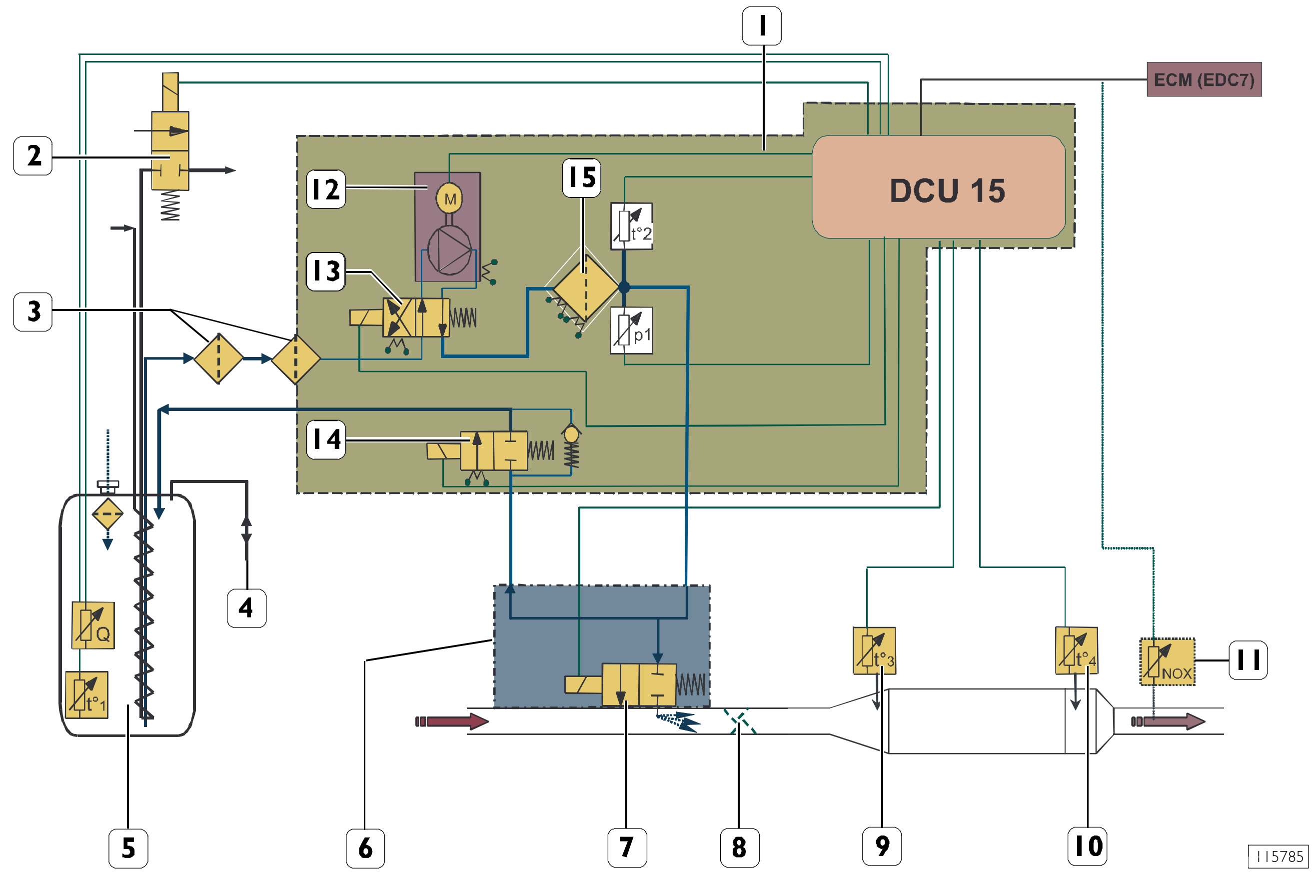
General remarks

In order to keep the exhaust emission values of nitric oxides (NO$_x$) within the limits prescribed by the Euro 4 standard, with low fuel consumption, a system for post-processing of the above substances found in exhaust gas has been fitted to the vehicles. This system essentially consists of an electronic-control oxidizing catalyst.

The system converts, through the SCR (Selective Catalytic Reduction) process, nitric oxides (NO$_x$) into inert compounds: free nitrogen (N_2) and water vapour (H_2O).

The SCR process is based on a series of chemical reactions, which leads, due to ammonia reacting with exhaust gas oxygen, to a reduction of nitric oxides (NO$_x$) found in exhaust gas.

Figure 25



SCR SYSTEM DIAGRAM

A. PUMP MODULE - B. MEASURING OUT MODULE

1. Supply module - 2. MV4 - 3. Pre-filters - 4. Tank vent - 5. AdBlue tank with gridle - 6. Dosing module - 7. MV2 - 8. Mixer - 9. - 10. Temperature sensors - 11. Nox sensor (*) - 12. Membrane pump - 13. MV1 - 14. MV3 - 15. Main filter.

* Future application

The system is essentially made up of:

- a tank (9) for reagent solution (water - urea: AdBlue), equipped with level gauge (8);
- an H2O diverter valve (1);
- pump module (10);
- a mixing and injection module (2);
- catalyst (4);
- two exhaust gas temperature sensors (5, 6) on catalyst output (4);
- a moisture detection sensor (7) fitted on the engine air intake pipe downstream from the air cleaner.

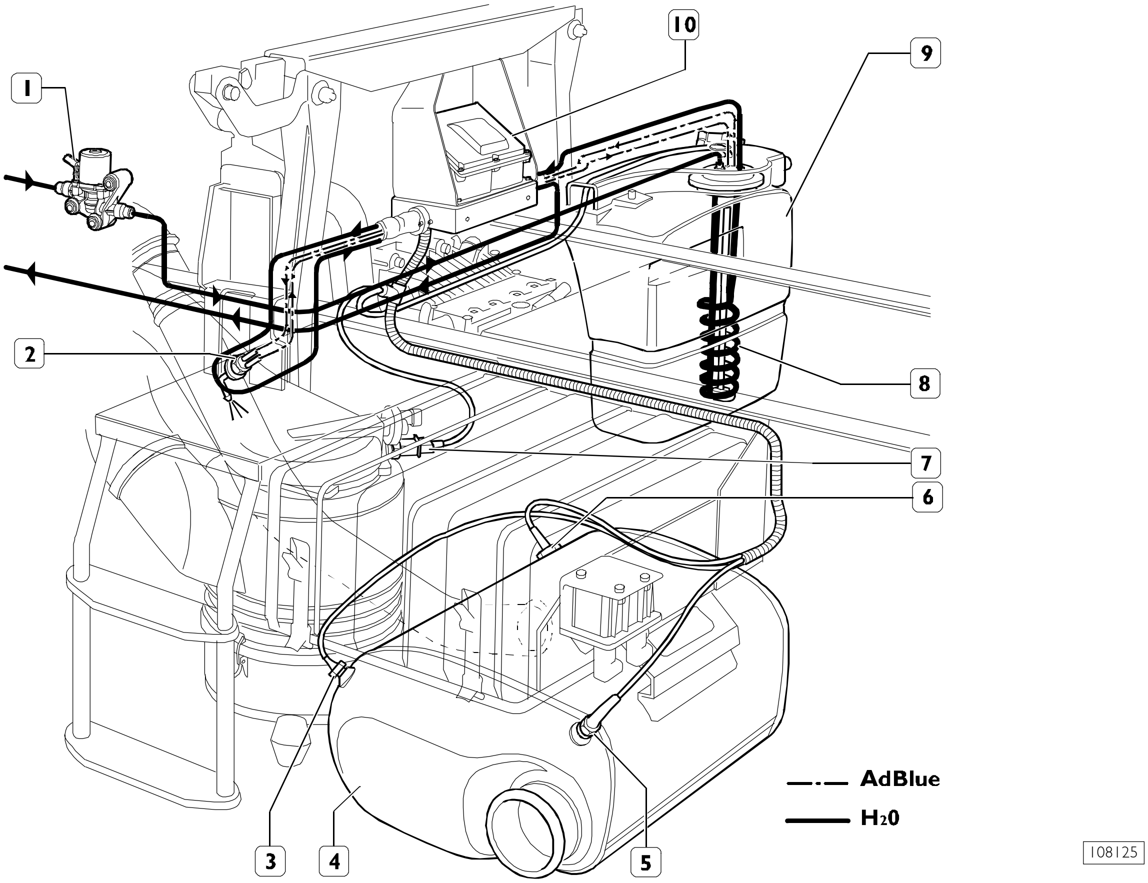
SCR system is electronically managed by DCU (Dosing Control Unit) incorporated into pump module (10); depending on engine rpm, supplied torque, exhaust gas temperature, quantity of nitrogen oxides and humidity of air sucked in, the control unit regulates the flow rate of AdBlue solution to be let into the system.

Pump module (10) takes reagent solution out of tank (9), then sends it under pressure into measuring out module (2); finally, the reagent solution is injected into the exhaust pipe upstream of catalyst (4).

Here, the first phase of the process is realized: the reagent solution will vaporize immediately, due to the exhaust gas temperature, and will be converted into ammonia ($2NH_3$) and carbon dioxide (CO_2), owing to hydrolysis. At the same time, vaporization of the solution will cause a decrease in the exhaust gas temperature: the latter will get near the optimum temperature required for the process.

Exhaust gas added with ammonia - and at the reaction temperature - will flow into catalyst where the second phase of the process will be realized: ammonia will, by reacting with the exhaust gas oxygen, convert into free nitrogen (N) and water vapour (H_2O).

Figure 26



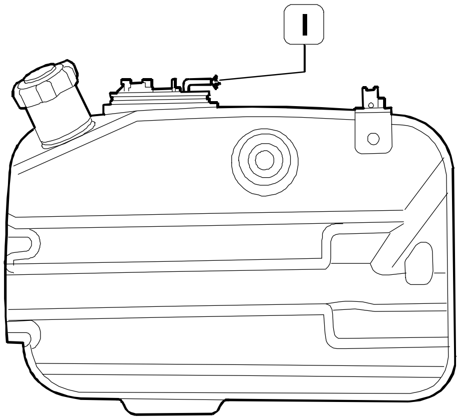
POSITION OF SCR SYSTEM COMPONENTS ON THE VEHICLE

1. H_2O valve - 2. By-pass valve - 3. Nitric oxide detecting sensor (*) - 4. Catalyst - 5. Outlet temperature sensor - 6. Inflow exhaust gas temperature sensor - 7. Sucked air humidity and temperature sensor - 8. Level gauge - 9. Water-urea solution (AdBlue) tank - 10. Pump module

* Future application

Tank

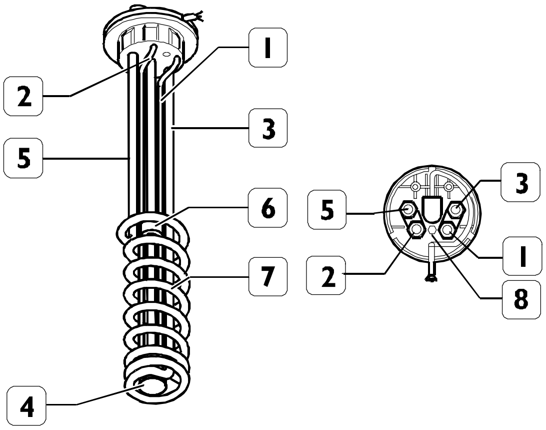
Figure 27



The tank equipped with level gauge control (1) contains the reducing substance required for the SCR process, which consists of a 35%-urea and water solution called AdBlue.

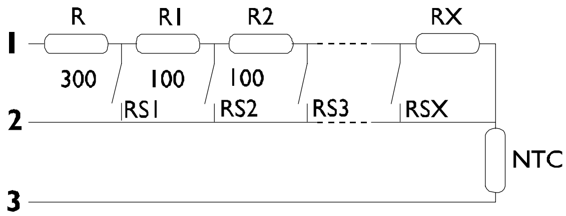
AdBlue fluid level gauge control

Figure 28



1. AdBlue fluid suction pipe - 2. AdBlue fluid return pipe - 3. Engine cooling hot fluid inlet pipe - 4. AdBlue (NTC) temperature sensor - 5. Engine cooling hot fluid outlet pipe - 6. Float - 7. AdBlue fluid heating coil - 8. AdBlue air vent.

Figure 29



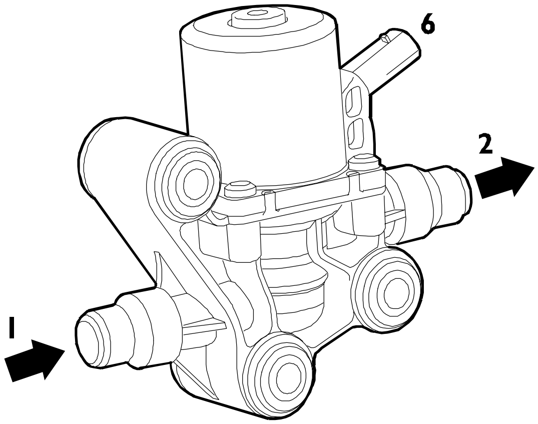
FUNCTIONAL WIRING DIAGRAM

The AdBlue fluid level gauge control consists of a device made up of a set of resistors, a float, a NTC temperature sensor, and a coil used to heat the fluid under low temperature conditions.

It informs the control unit of any current change due to the resistor determined by the float position with respect to the AdBlue fluid level.

By-pass valve

Figure 30



FUNCTIONAL WIRING DIAGRAM

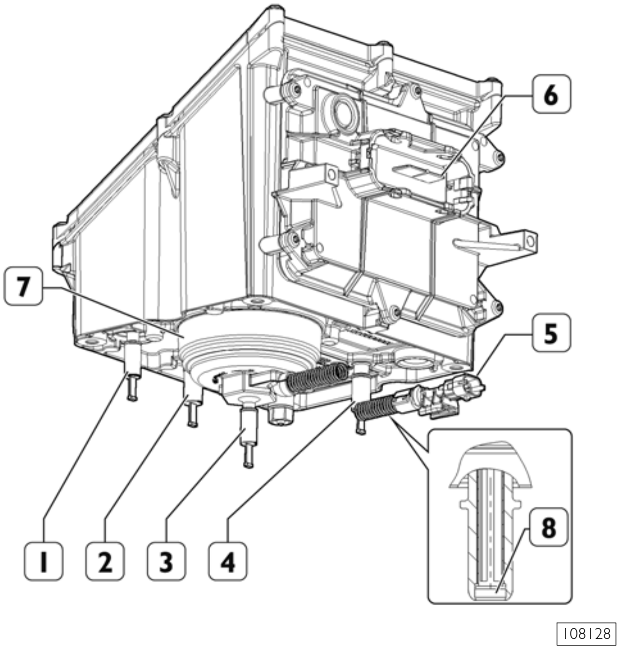
1. Coolant inlet - 2. Coolant outlet - 6. Electrical connection.

The valve, which is a Normally Closed type valve, allows AdBlue tank to be heated by engine coolant.

The NTC temperature sensor (Figure 29) controls the by-pass valve which closes or opens (depending on temperature) the passage of the engine cooling hot fluid into the heating coil.

Pump module

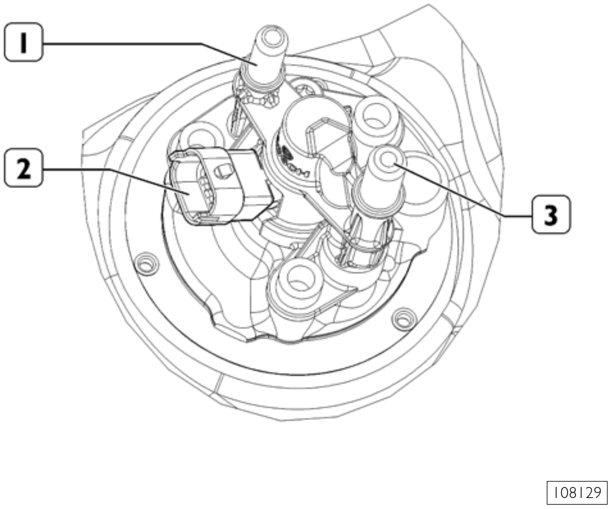
Figure 31



1. AdBlue return pipe to the tank - 2. AdBlue return pipe from dosing module - 3. AdBlue solution outlet - 4. AdBlue solution infeed - 5. Electrical connection - 6. DCU control unit connector - 7. Filter - 8. Prefilter.

Dosing module

Figure 32

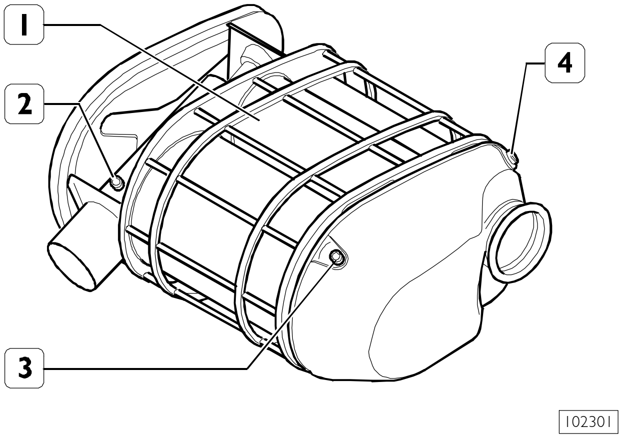


1. AdBlue infeed - 2. Electrical connection - 3. AdBlue outlet.

The function of this module is to dose the AdBlue solution to be conveyed to the injector.

Catalyst

Figure 33



Catalyst (1), equipped with sound-proofing material, replaces the exhaust silencer.

Inside the catalyst, the exhaust gas nitric oxides are, by reacting with ammonia, converted into free nitrogen and water vapour.

Temperature sensors (2 & 3) and nitric oxide detecting sensor (4) are fitted onto catalyst (1).

Exhaust gas temperature sensor

Figure 34

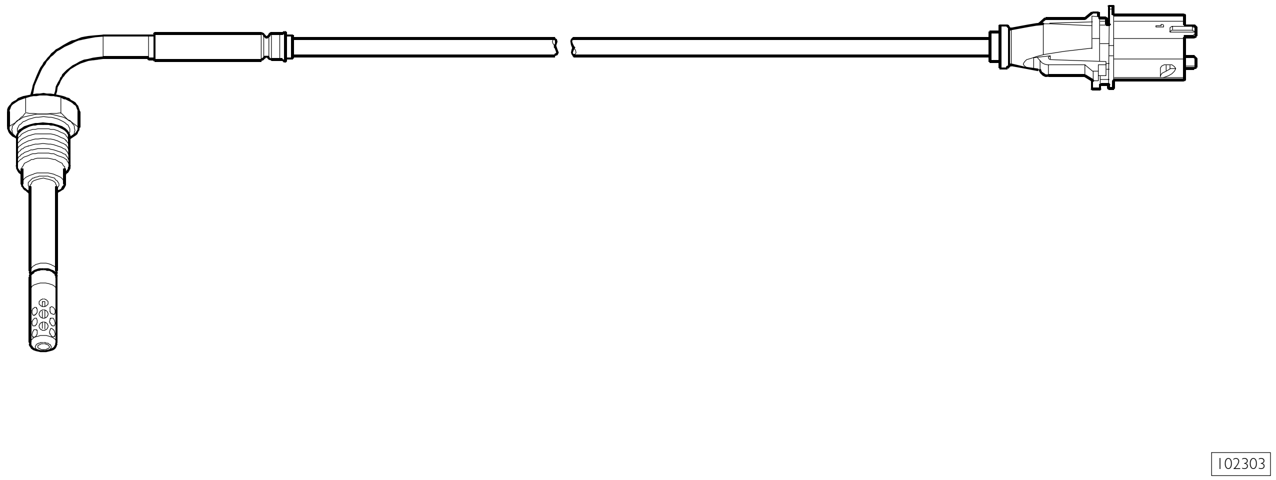
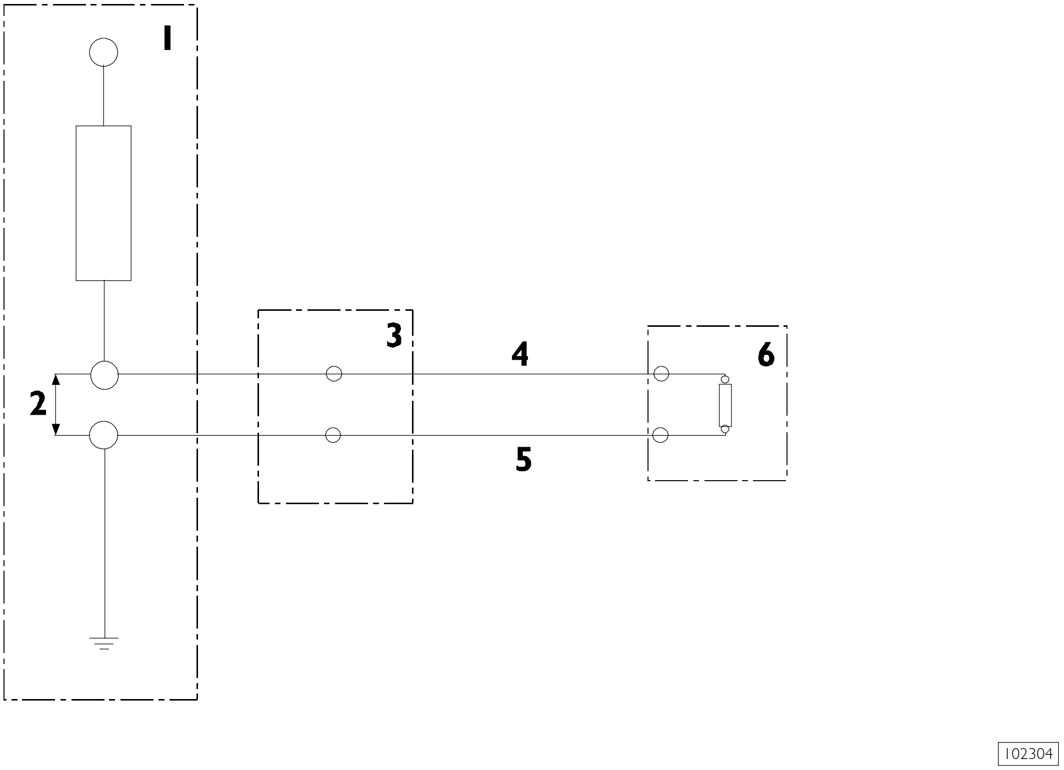


Figure 35



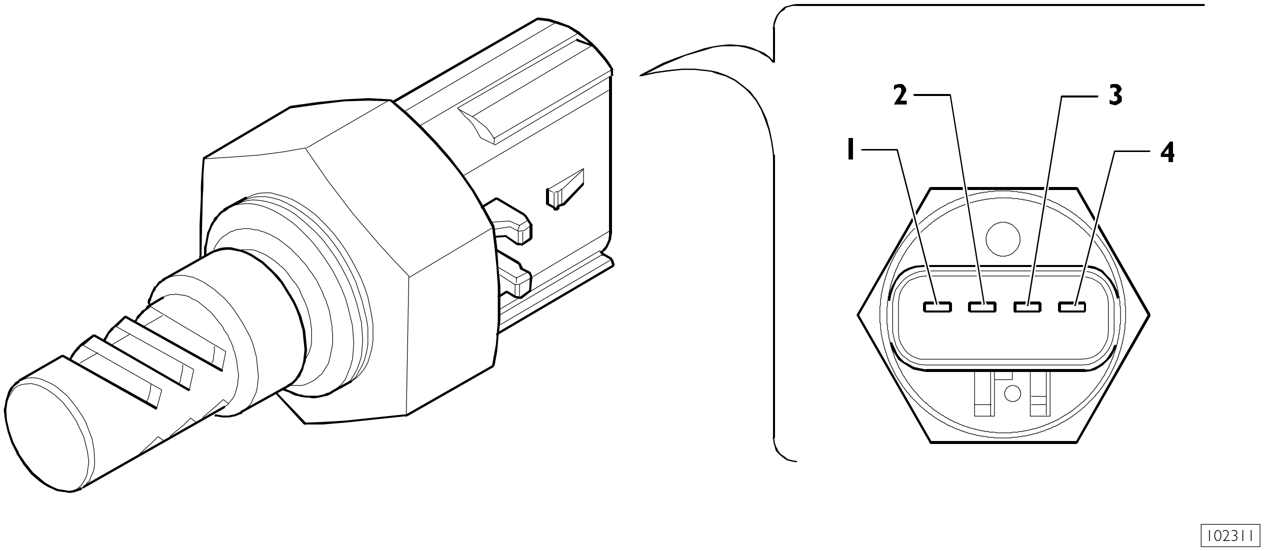
FUNCTIONAL WIRING DIAGRAM

1. Supply voltage - 2. Variable output voltage - 3. Connector - 4. Signal cable (grey) - 5. Earth cable (white) - 6. Sensor.

The function of this sensor is to send the control unit the catalyst inlet and outlet exhaust gas temperature values required to calculate the amount of urea to be injected into the system.

Humidity detecting sensor

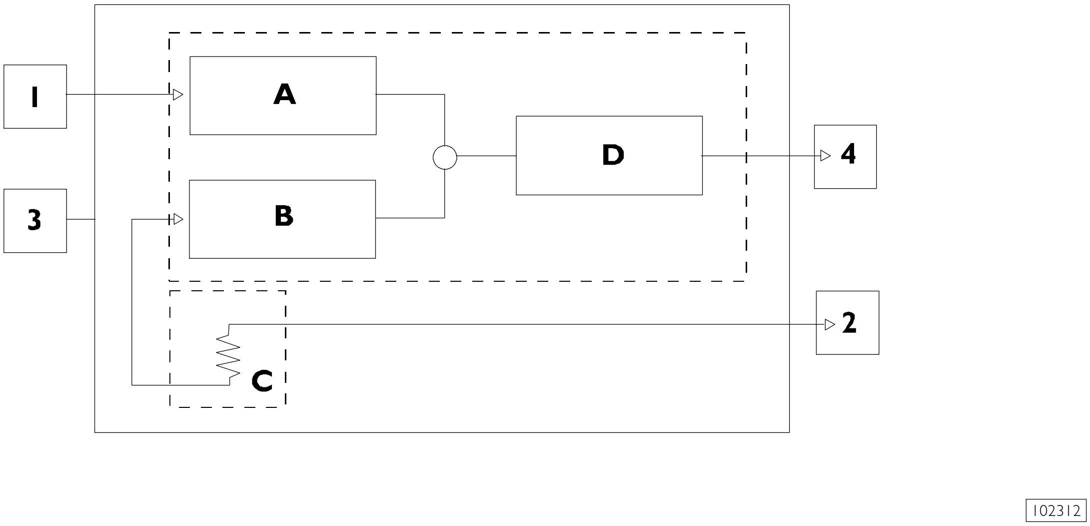
Figure 36



1. Temperature - 2. Earth - 3. Humidity percent value - 4. Power supply.

This sensor is located on the air filter output conveyor, and is used to inform the control unit of the amount (percentage) of humidity found in sucked air, to determine the calculation of nitric oxide emissions.

Figure 37



ELECTRIC BLOCK DIAGRAM

1. Earth - 2. Temperature - 3. Power supply unit - 4. Humidity percent value - A. Sample frequency generator - B. Reference oscillator - C. NTC temperature sensor - D. Amplifier lowpass filter.

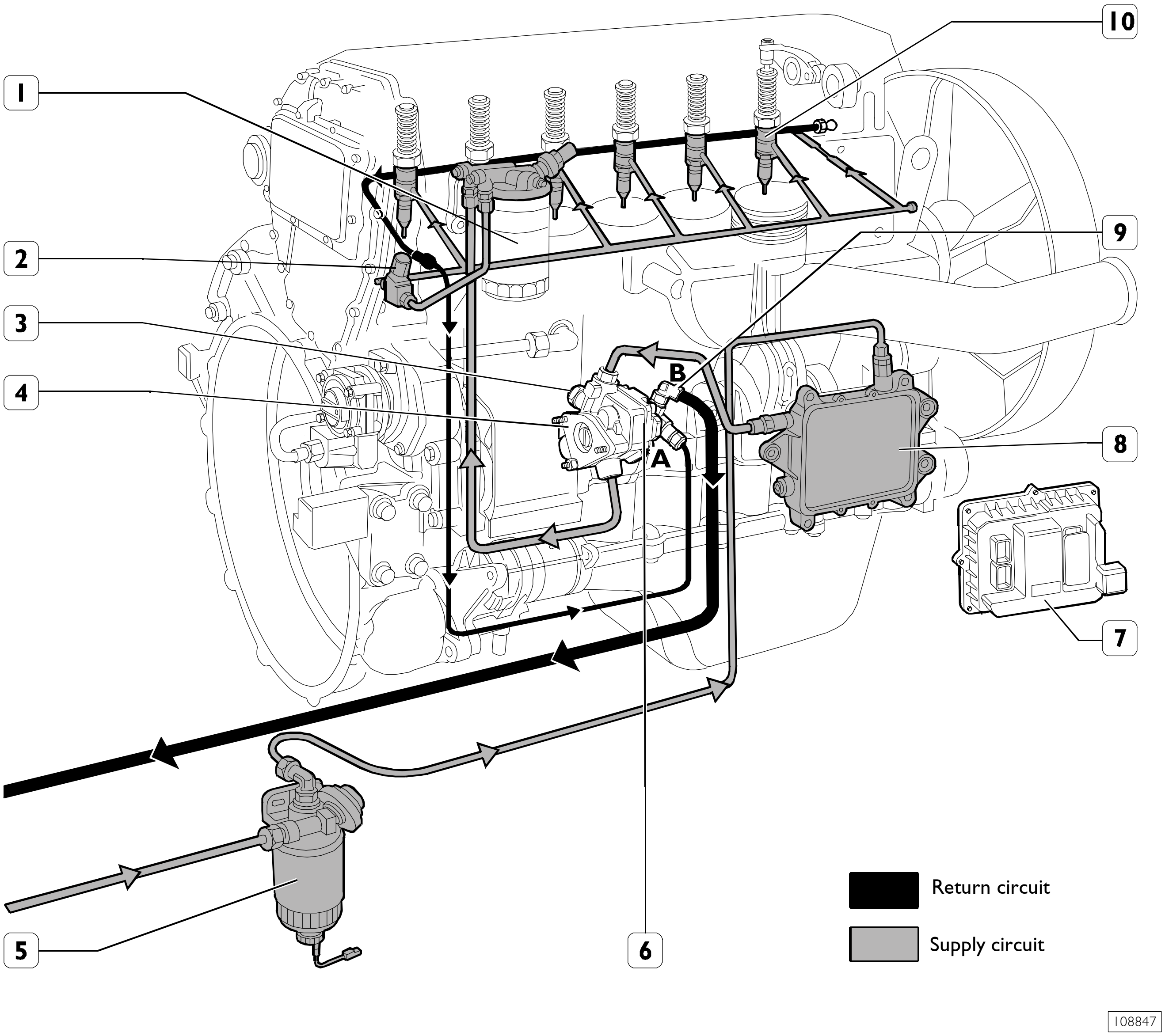
SECTION 2

Fuel

FEEDING

Fuel is supplied via a fuel pump, filter and pre-filter, 6 pump-injectors governed by the camshaft via rocker arms and by the electronic control unit.

Figure 1

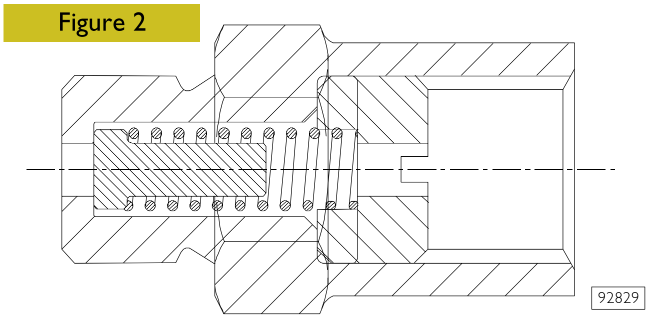


ENGINE FEED SCHEME
1. Fuel filter - 2. Pressure damping device - 3. Pressure control valve (start of opening at 5 bar) - 4. Feed pump - 5. Fuel pre-filter with priming pump - 6. Valve, to recirculate fuel from injectors, integrated in feed pump (start of opening at 3.5 bar) - 7. Central unit - 8. Heat exchanger - 9. Overpressure valve to return fuel to tank (start of opening at 0.2 bar) - 10. Pump injectors.

A. Fuel arriving at injectors - B. Fuel returning to tank

Overpressure valve

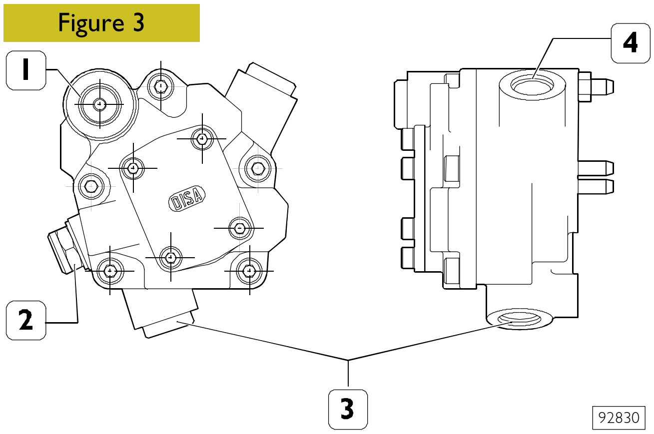
Figure 2



An overpressure valve is a single-acting valve, calibrated to 0.2 ÷ 0.3 bar, placed on the piping that returns fuel to tank. The overpressure valve prevents fuel duct in cylinder head from emptying with engine stopped.

Feed pump

Figure 3



Engine feed pump for vehicles 4x2 - 4x4 - 6x4
1. Overpressure valve - 2. Delivering fuel to injectors - 3. Sucking in fuel - 4. Pressure control valve.

Pump performances					
Pump rotation speed (rpm)		2600	600	170	100
Minimum flow rate (l/h)		310	45	12	
Test conditions	Negative pressure on aspiration (bar)	0.5	0.3	0.3	0.3
	Pressure on delivery (bar)	5	3	0,3	0.3
	Test liquid temperature (°C)	30	30	30	30
	Test liquid	ISO 4113			

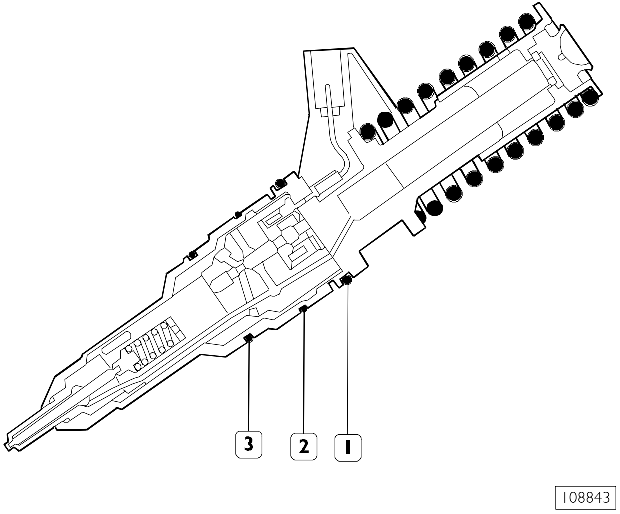
Field of use	
Pump rotation speed (rpm)	2600
Overrunning rotation speed (max 5 min) (rpm)	4100 max
Diesel oil temperature (°C)	-25/+80
Filtering rate on aspiration (micron)	30
Negative pressure on aspiration (bar)	0.5 max

Pressure control valve	
Valve calibration	5 ÷ 5.8

Injectors return valve	
Valve calibration	3.4 ÷ 3.8

Injector-pump

Figure 4



1. Fuel/oil seal – 2. Fuel/diesel seal – 3. Fuel/exhaust gas seal.

The injector-pump is composed of: pumping element, nozzle, solenoid valve.

Pumping element

The pumping element is operated by a rocker arm governed directly by the cam of the camshaft.

The pumping element is able to ensure a high delivery pressure. The return stroke is made by means of a return spring.

Nozzle

Garages are authorized to perform fault diagnosis solely on the entire injection system and may not work inside the injector-pump, which must only be replaced.

A specific fault-diagnosis program, included in the control unit, is able to check the operation of each injector (it deactivates one at a time and checks the delivery of the other five).

Fault diagnosis makes it possible to distinguish errors of an electrical origin from ones of a mechanical/hydraulic origin.

It indicates broken pump-injectors.

It is therefore necessary to interpret all the control unit error messages correctly.

Any defects in the injectors are to be resolved by replacing them.

Solenoid valve

The solenoid, which is energized at each active phase of the cycle, via a signal from the control unit, controls a slide valve that shuts off the pumping element delivery pipe.

When the solenoid is not energized, the valve is open, the fuel is pumped but it flows back into the return pipe with the normal transfer pressure of approximately 5 bars.

When the solenoid is energized, the valve shuts and the fuel, not being able to flow back into the return pipe, is pumped into the nozzle at high pressure, causing the needle to lift.

The amount of fuel injected depends on the length of time the slide valve is closed and therefore on the time for which the solenoid is energized.

The solenoid valve is joined to the injector body and cannot be removed.

On the top there are two screws securing the electrical wiring from the control unit.

To ensure signal transmission, tighten the screws with a torque wrench to a torque of 1.36 – 1.92 Nm (0.136 – 0.192 kgm).

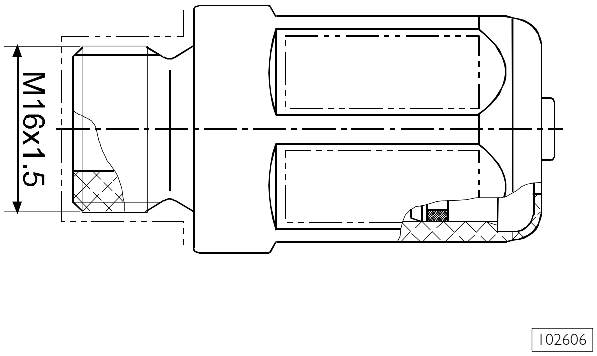
Replacing injectors-pump

Injectors have to be replaced with great care (for indications about deassembly/reassembly, refer to section 3).

NOTE If this job is done with the engine on the vehicle, before removing the injectors-pump drain off the fuel contained in the pipes in the cylinder head by unscrewing the delivery and return fittings on the cylinder head.

Pressure damper

Figure 5



FUEL PRESSURE DAMPER

The fuel pressure damper on the delivery pipe between the fuel filter and the cylinder head has the function of damping the backflow pressure on the delivery due to the increase in injection pressure.

SECTION 3

Vehicle application

GENERAL FEATURES

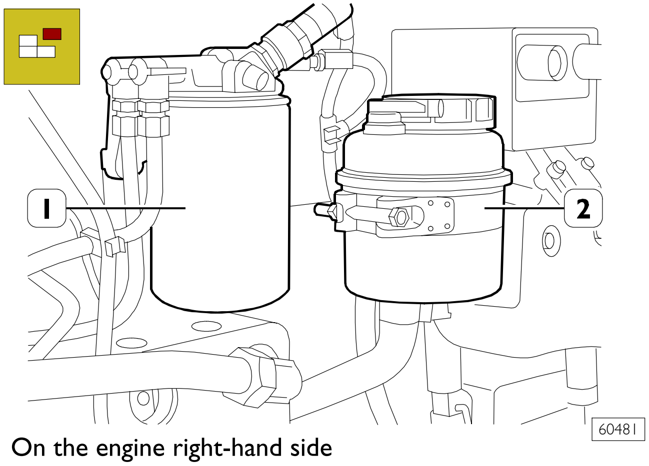
	Type		F3AE3681D	F3AE3681B	F3AE3681A
ϱ	Compression ratio		16.5 : 1		
	Max. output	kW (HP) rpm	310 (420) 2100	310 (420) 2100	332 (450) 2100
	Max. torque	Nm (kgm) rpm	1900 (194) 1050 ÷ 1550	1900 (194) 1200 ÷ 1550	2100 (214) 1050 ÷ 1550
	Loadless engine idling	rpm	550 ± 50		
	Loadless engine peak	rpm	2420 ± 50		
	Bore x stroke Displacement	mm cm^3	125x140 10300		
	SUPERCHARGING Turbocharger type		HOLSET HE531V with variable geometry		
bar	**LUBRICATION** Oil pressure (warm engine) (100 °C ± 5 °C) - idling - peak rpm	 bar bar	Forced by gear pump, relief valve single action oil filter 1.5 5		
	COOLING		By centrifugal pump, regulating thermostat, viscostatic fan, radiator and heat exchanger		
	Water pump control		By belt		
	Thermostat: starts to open: fully open:		N. 1 ~84 °C ± 2 °C 94 °C ± 2 °C		
Urania FE 5W30 **Urania LD 5** **Urania Turbo LD**	OIL FILLING Total capacity at 1st filling	liters kg	32 28.8		
	Capacity: - engine sump min level	liters kg	17 15.3		
	- engine sump max level	liters kg	25 22.5		
	- quantity in circulation that does not flow back to the engine sump	liters kg	7 6.3		
	- quantity contained in the cartridge filter (which has to be added to the cartridge filter refill)	liters kg	2.5 2.3		

PART ONE - MECHANICAL COMPONENTS

DISMANTLING THE ENGINE ON THE BENCH

Before fastening the engine on rotary stand 99322230, dismount or disconnect following parts:

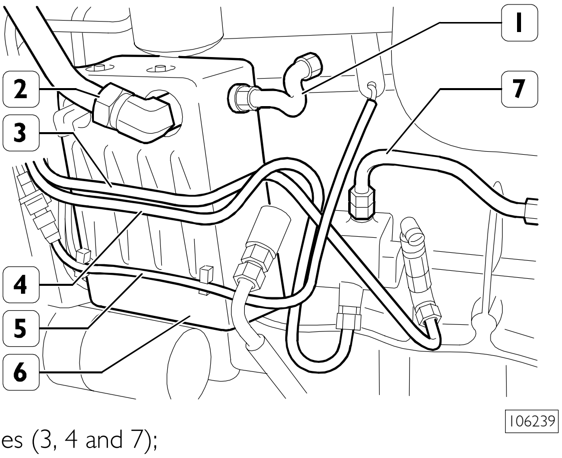
Figure 1



On the engine right-hand side

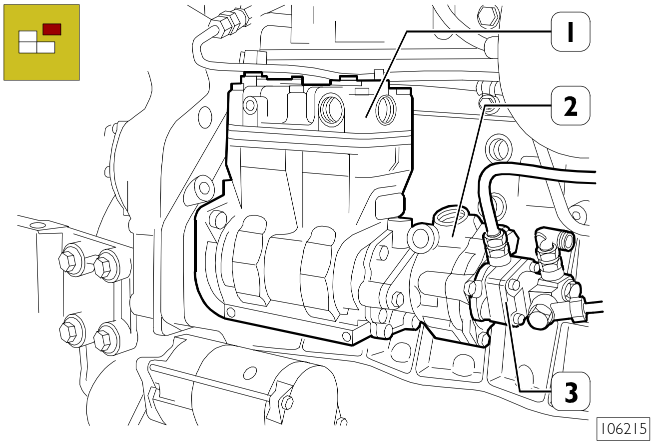
- diesel cartridge filter (1);
- power steering system tank (2);
- electric connections;

Figure 2



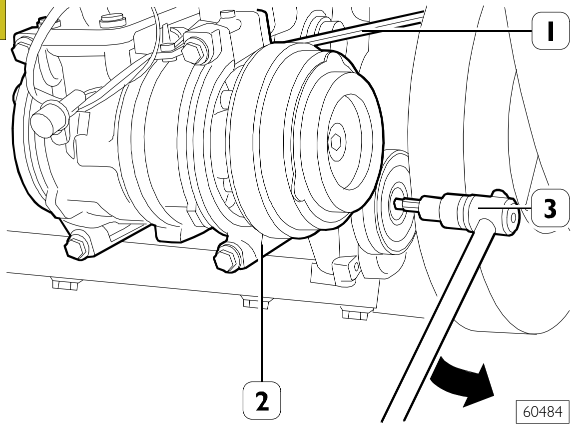
- pipes (3, 4 and 7);
- electrical cables (5);
- sound deadening guard (6);
- pipes (1 and 2).

Figure 3



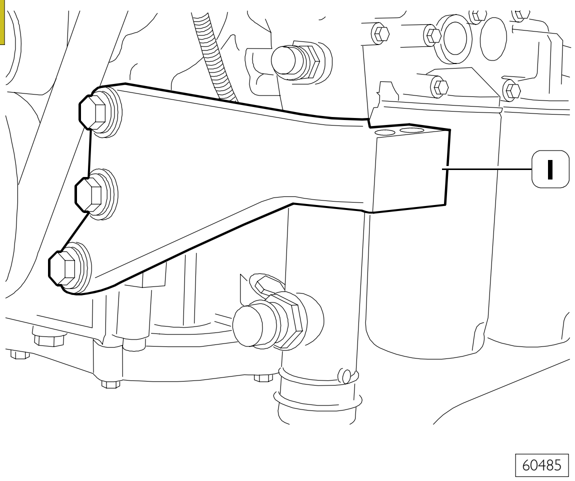
- compressor (1) complete with oversteering pump (2) and feed pump (3).

Figure 4



- remove the air conditioner control belt (1) using a fit tool (3) and acting in the direction shown by the arrow;
- disassemble the air conditioner (2) fitted with the engine support.

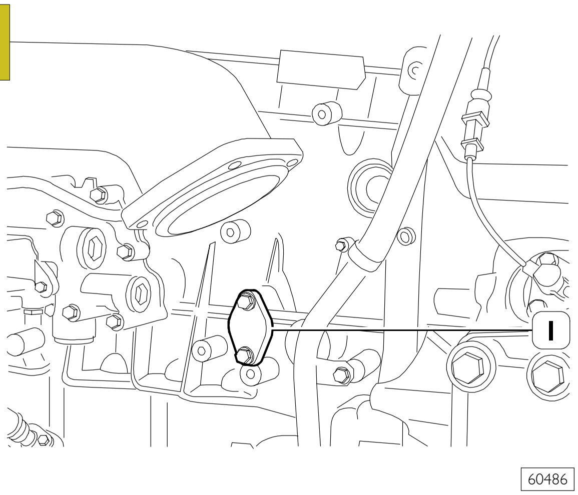
Figure 5



On the engine left-hand side

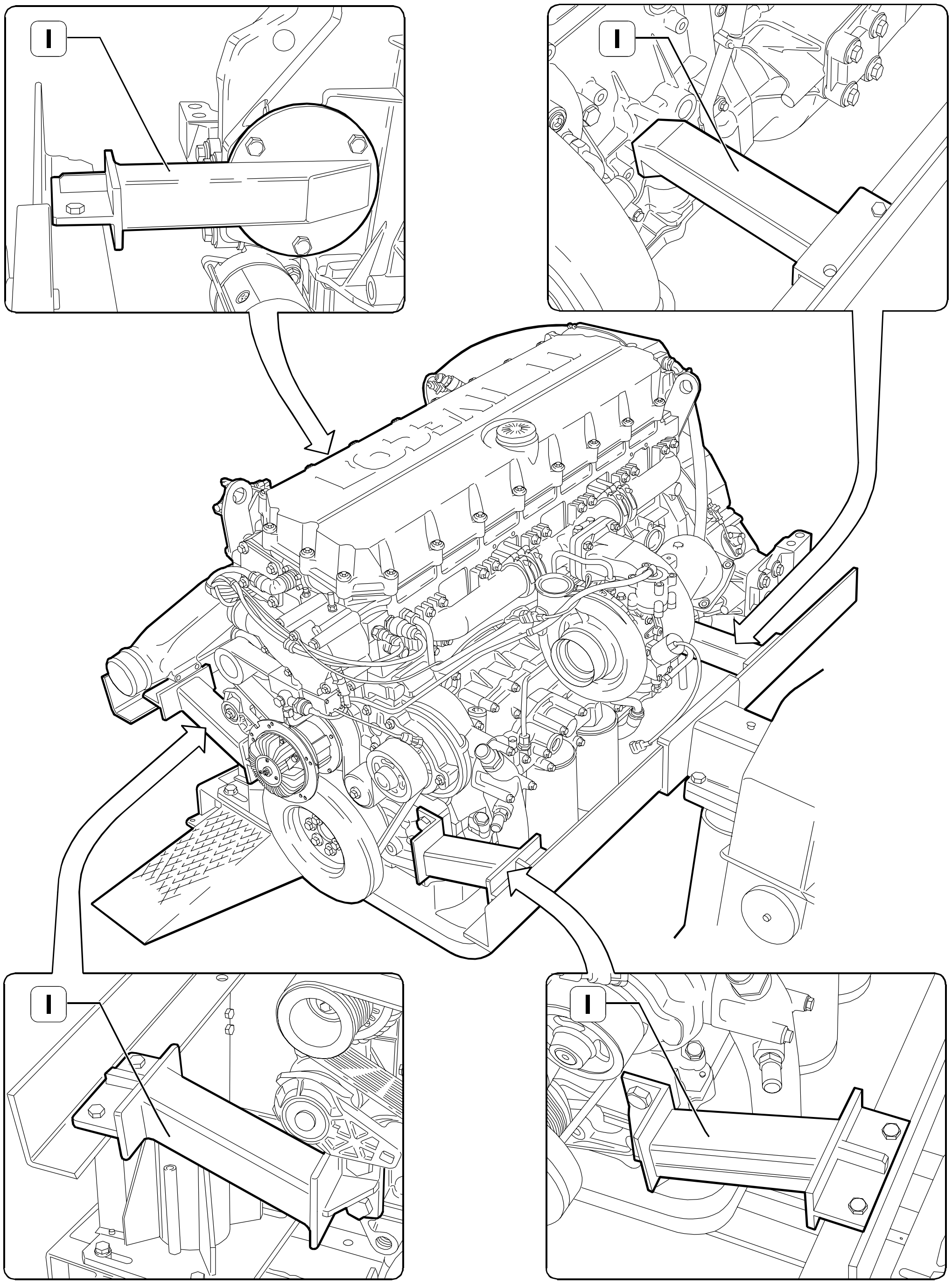
- engine support (1);

Figure 6



- oil pressure controlling valve (1).

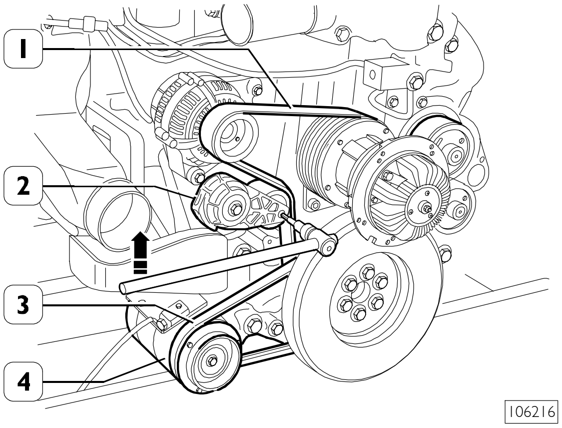
Figure 7



73582

Secure the engine to the rotary stand 99322030 with the brackets 99361036 (1).

Figure 8

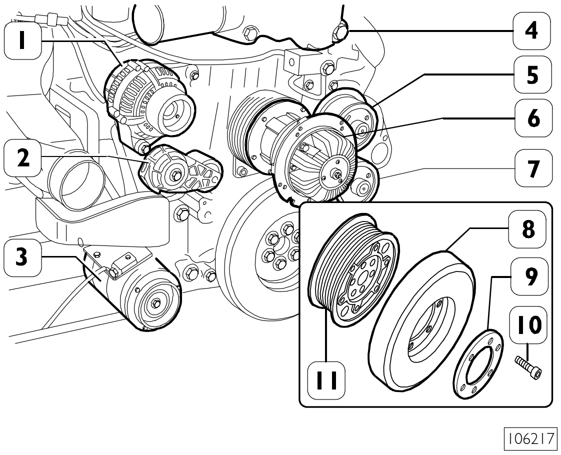


Use a suitable wrench to act on the belt-stretcher (2) roller fastening screw in the direction shown by the arrow, so as to loosen belt (1) tension, then take off the belt.

If present, dismount belt (3) driving compressor (4) for climate control system.

NOTE Belt (3) must be replaced by a new one after every dismounting operation.

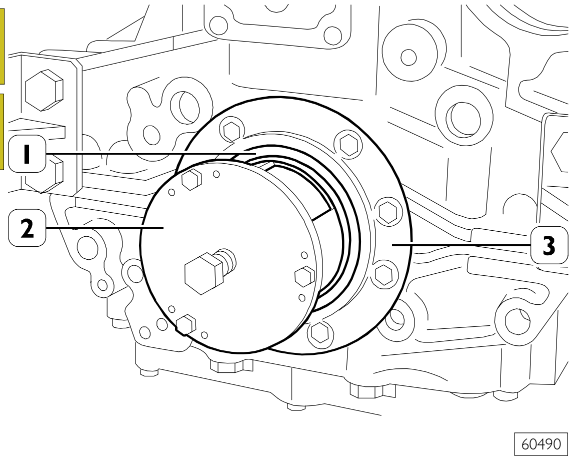
Figure 9



Remove the following components:
- thermostat unit (4) fitted with turbine actuator pressure sensor;
- alternator (1);
- electro-magnetic joint (6);
- water pump (5) and piping;
- automatic belt tightener support (2);
- fixed belt tightener (7);
- remove the screws (10), the spacer (9), the damper flywheel (8) and the pulley (11).
- disconnect all the electric connections and the sensors.

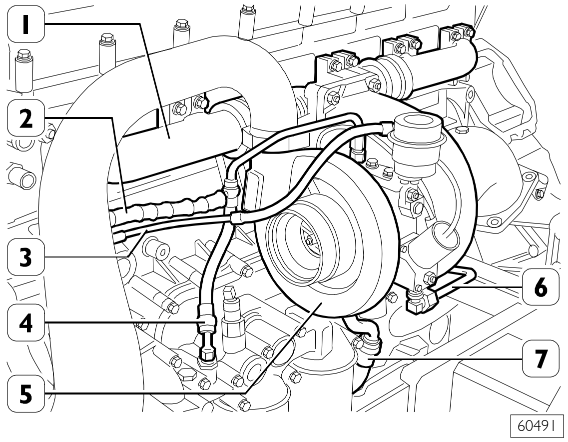
If present, remove:
- ☐ the climate control system compressor (3).

Figure 10



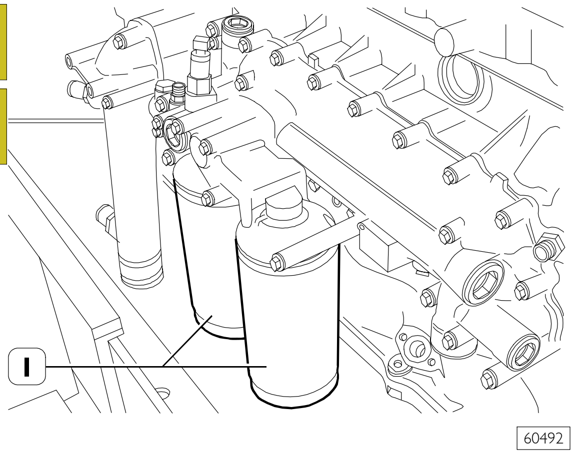
Fit the extractor 99340053 (2) and remove the engine crankshaft seal gasket (1), remove the cover (3).

Figure 11



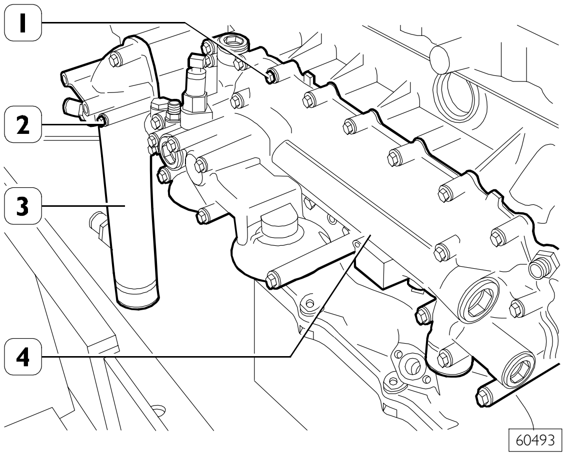
Remove the following components: water outlet line (2); oil delivery line (4); actuator air line (3); water delivery line (6); oil return line (7); turbocharger (5); exhaust manifold (1).

Figure 12



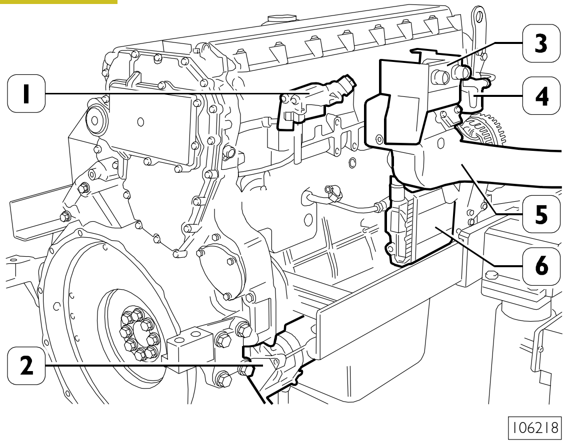
Unscrew the oil filters (1) using the tool 99360314.

Figure 13



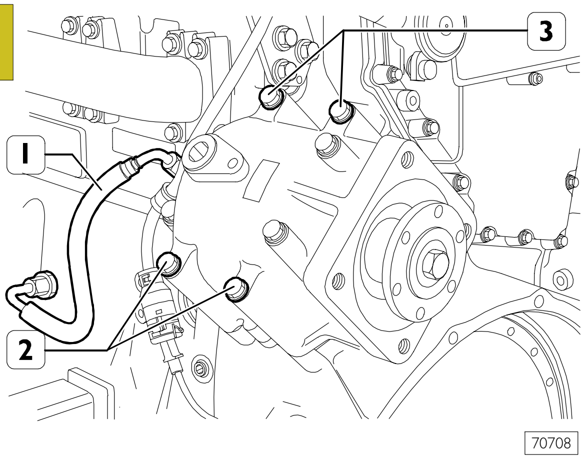
- Unscrew the screws (1) and remove the heat exchanger (4);
- unscrew the screws (2) and remove the water line (3).

Figure 14



Remove the following components: fuel filter support (1) and lines; starter (2); engine starting button support (3); PWM valve air filter (4); suction manifold (5) fitted with resistance for engine pre-heating; control unit (6).

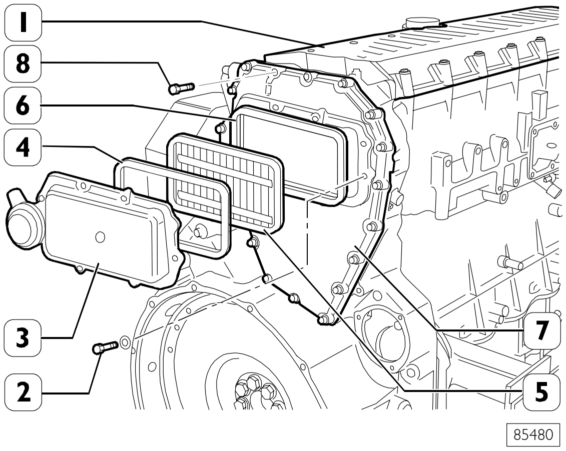
Figure 15



To remove the P.T.O. (if applicable):

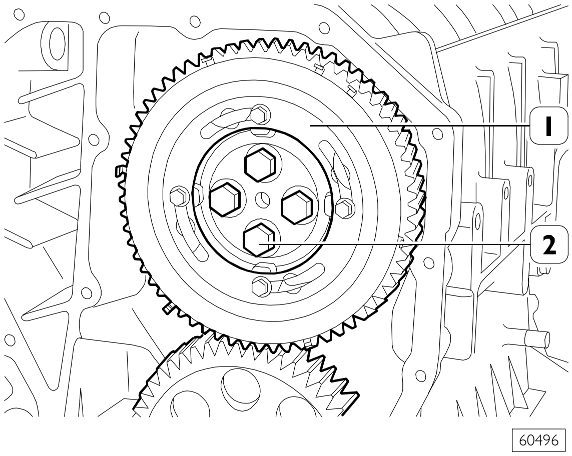
☐ Disconnect the oil pipe (1).
☐ Unscrew the 4 screws (2) and (3).

Figure 16



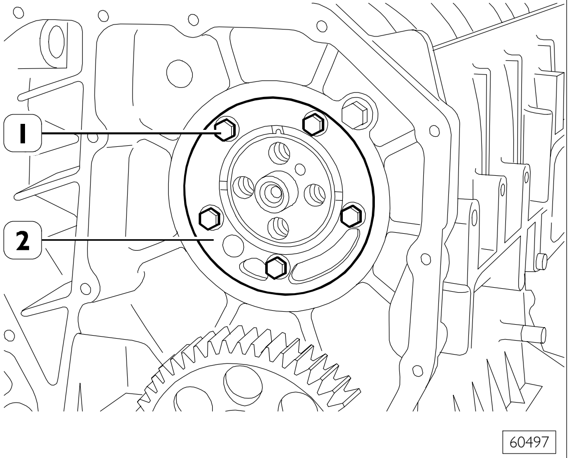
Remove the rocker arm cover (1), take off the screws (2) and remove: the cover (3), the filter (5) and the gaskets (4 and 6). Take off the screws (8) and remove the blow-by case (7).

Figure 17



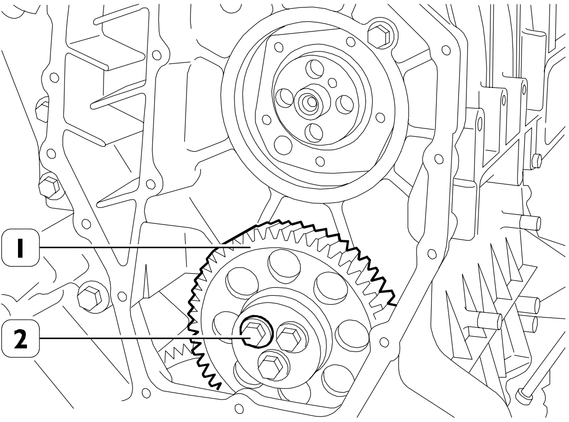
- Unscrew the screws (2) and remove the gear (1) fitted with phonic wheel.

Figure 18



- Unscrew the screws (1); tighten one screw in a reaction hole and remove the shoulder plate (2), remove the sheet gasket.

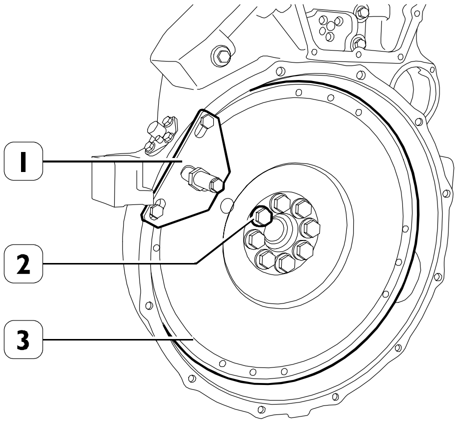
Figure 19



60498

Unscrew the screws (2) and remove the transmission gear (1).

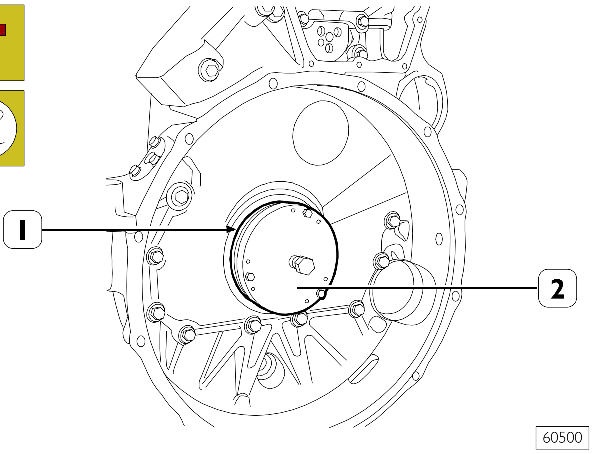
Figure 20



60499

Stop the engine flywheel (3) rotation by means of tool 99360351 (1), unscrew the fixing screws (2) and remove the engine flywheel.

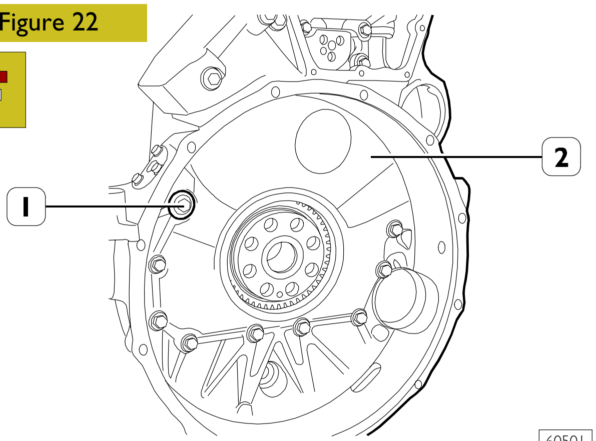
Figure 21



60500

Apply the extractor 99340054 (2) and pull out the seal gasket (1).

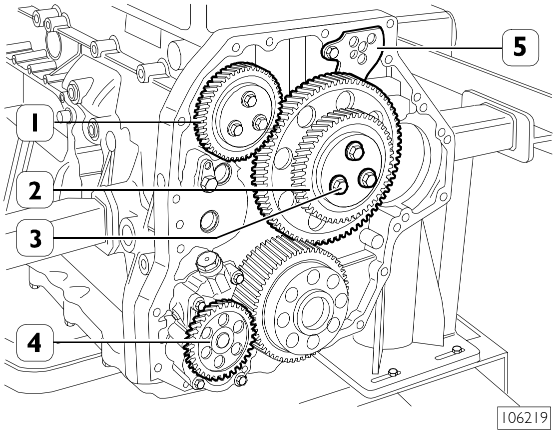
Figure 22



60501

Unscrew the screws (1) and take down the gearbox (2).

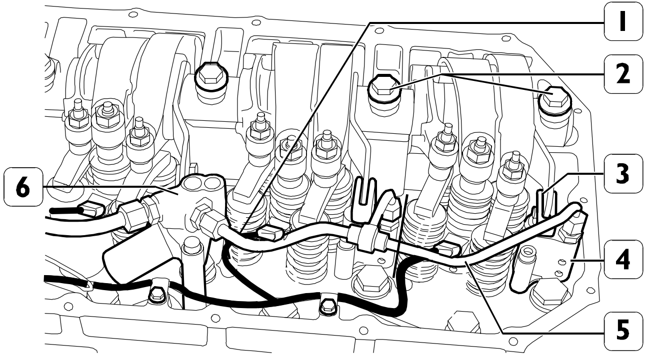
Figure 23



106219

If present, dismount P.T.O. driving gear (1).
Remove screws (3) and dismount double gear (2).
Remove securing screw and dismount articulated rod (5).
Dismount oil pump (4).

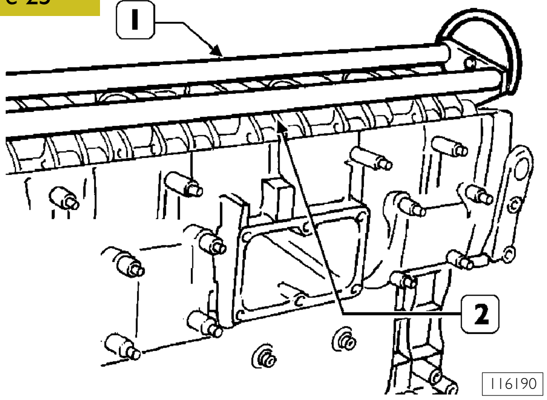
Figure 24



116721

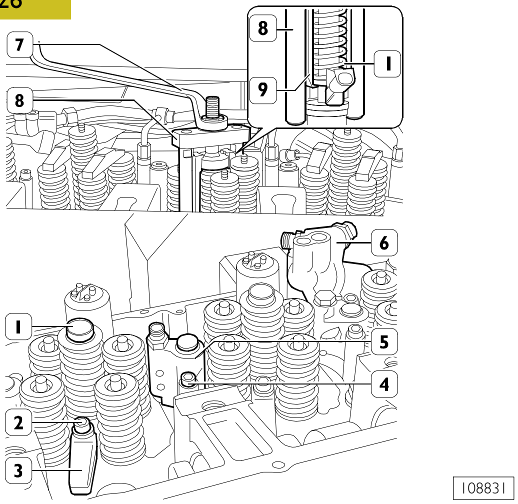
- ☐ Release the check springs (3) of the exhaust brake lever.
- ☐ Remove the electric connections (1).
- ☐ Remove exhaust brake pins (4) and slave cylinder (6) pipes (5).
- ☐ Unscrew the screws (2) fixing the rocker arm shaft.
- ☐ Remove the head injection wiring. The wiring has to be extracted from the front.

Figure 25



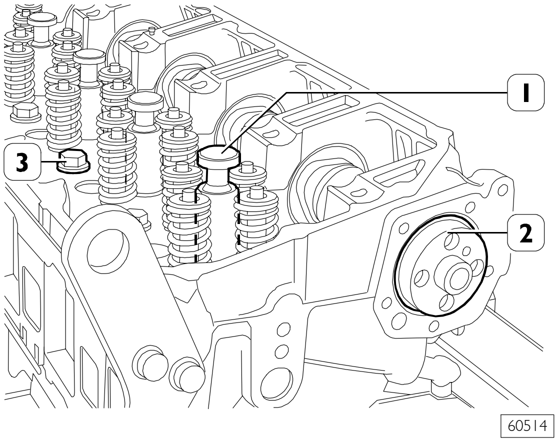
Apply tool 99360553 (1) to the rocker holder shaft (2) and remove the shaft (2) from the cylinder head.

Figure 26



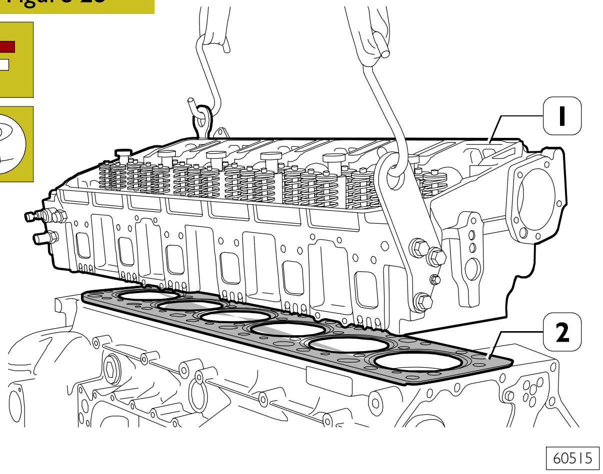
- ☐ Unscrew the screws (2) fixing the brackets (3);
- ☐ hook tool 99342155 part (9) to pump injector (1);
- ☐ mount part (8) on part (9) resting part on cylinder head;
- ☐ screw nut (7) and extract pump injector (1) from cylinder head.
- ☐ unscrew the screws (4) and remove the exhaust brake pins (5).
- ☐ unscrew the screws and remove the slave cylinder (6).

Figure 27



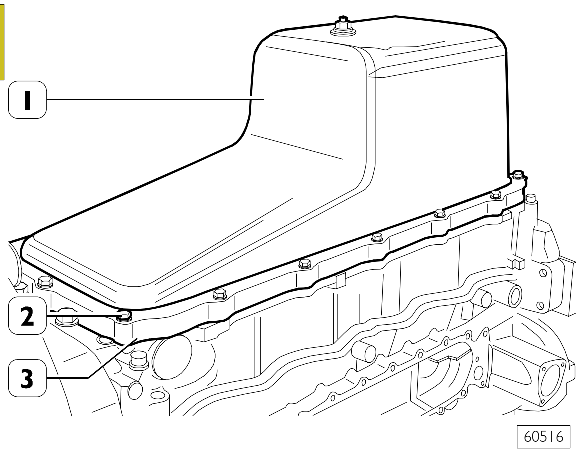
- ☐ Fit the plugs 99360180 (1) instead of injectors.
- ☐ Remove the camshaft (2).
- ☐ Unscrew the fixing screws on the cylinder head (3).

Figure 28



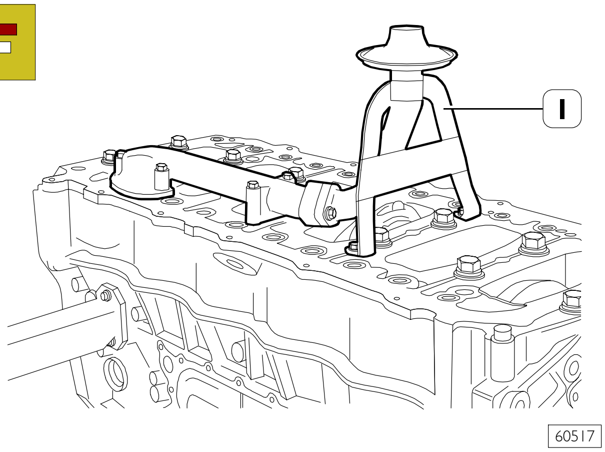
- ☐ By means of metal ropes, lift the cylinder head (1).
- ☐ Remove the seal (2)

Figure 29



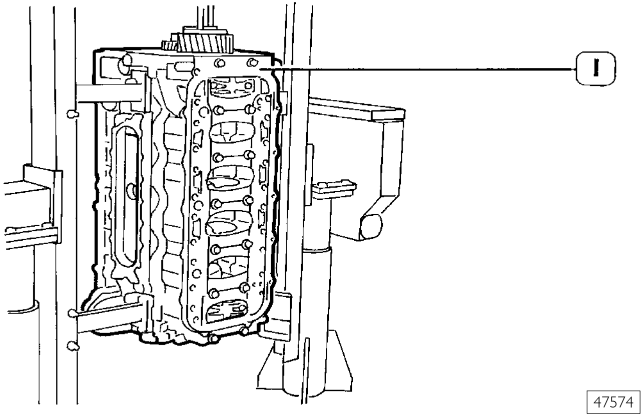
Unscrew the screws (2) and remove the engine oil sump (1) fitted with spacer (3) and seal.

Figure 30



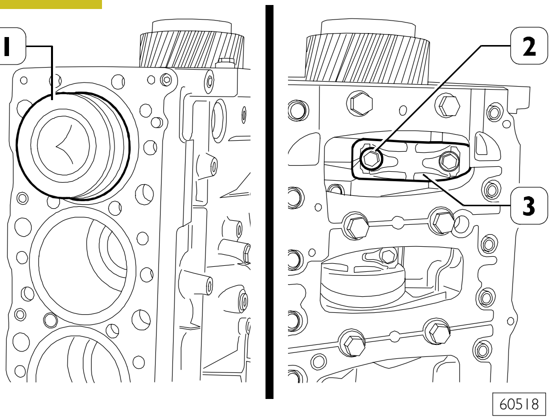
Unscrew the screws and remove suction rose (1).

Figure 31



Rotate the block (1) to the vertical position.

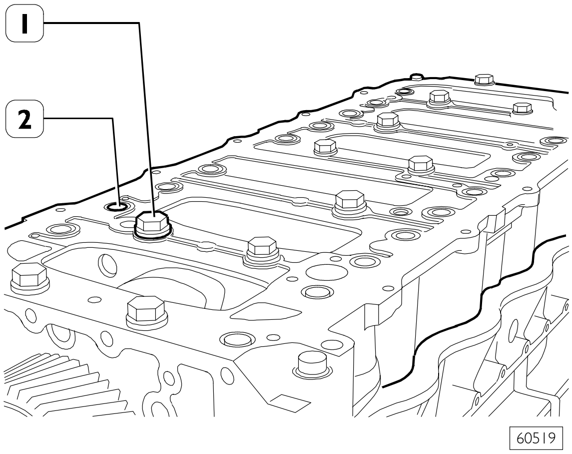
Figure 32



Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston (1) assembly from the upper side. Repeat these operations for the other pistons.

NOTE Keep the big end bearing shells in their respective housings and/or note down their assembly position since, if reusing them, they will need to be fitted in the position found upon removal.

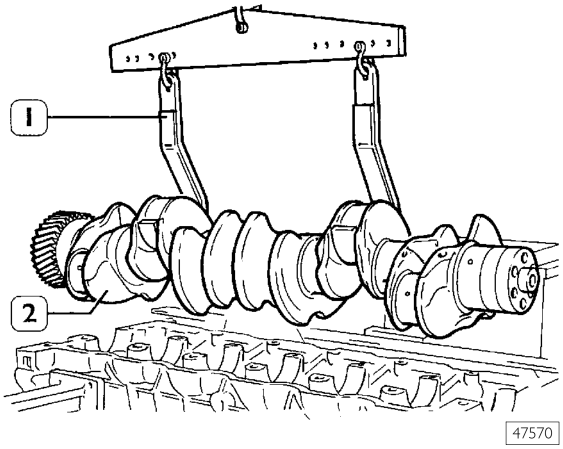
Figure 33



By means of proper and splined wrenches, untighten the screws (1) and (2) and remove the under-block.

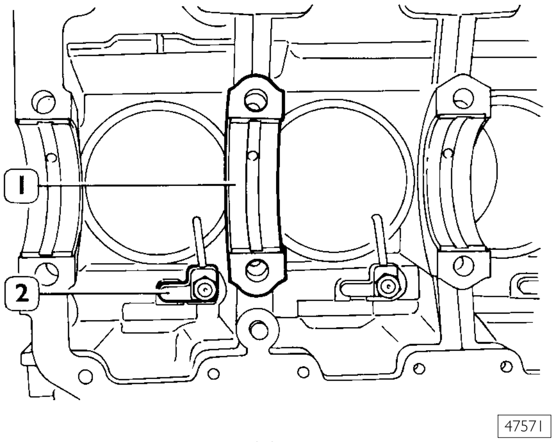
NOTE Note down the assembly position of the top and bottom main bearing shells since, if reusing them, they will need to be fitted in the position found upon removal.

Figure 34



Using tool 99360500 (1), remove the crankshaft (2).

Figure 35



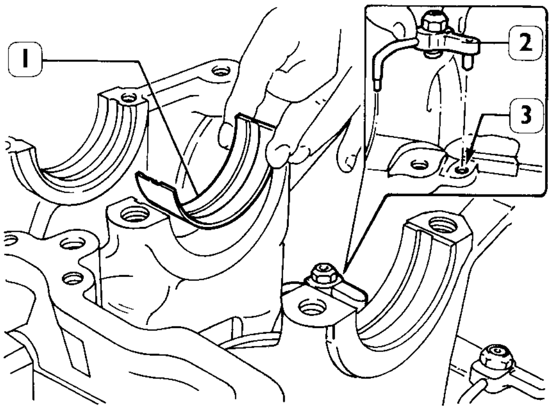
Remove the main bearing shells (1), unscrew the screws and take out the oil nozzles (2).
Remove the cylinder liners as described in section 4.

NOTE After disassembling the engine, thoroughly clean disassembled parts and check their integrity.
Instructions for main checks and measures are given in the following pages, in order to determine whether the parts can be re-used.

ENGINE ASSEMBLY ON BENCH

Fix the engine block to the stand 99361036 by means of brackets 99322230.
Install the cylinder liners as described in section 4.

Figure 36



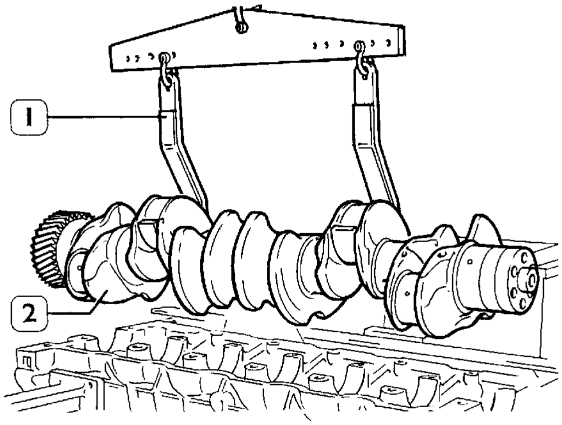
47586

Mount the oil nozzles (2), making the grub screw coincide with the hole (3) in the crankcase.

NOTE Not finding it necessary to replace the main bearings, you need to fit them back in exactly the same sequence and position as in removal. In case main bearings need replacing, choose them according to the selection described in chapter "Selecting the main and connecting-rod half bearings".

Arrange the bearing shells (1) on the main bearing housings.

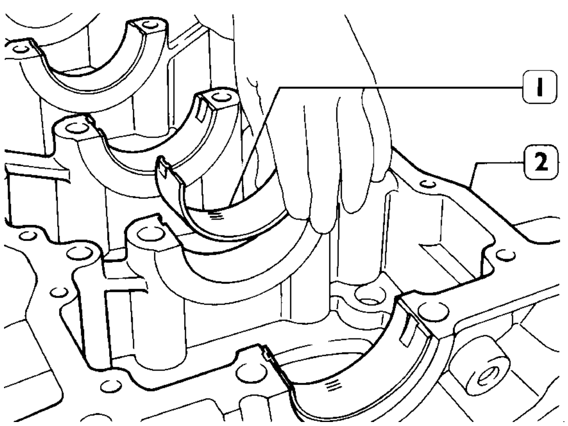
Figure 37



47570

Lubricate the half bearings, then install the crankshaft (2) by means of hoist and hook 99360500 (1).

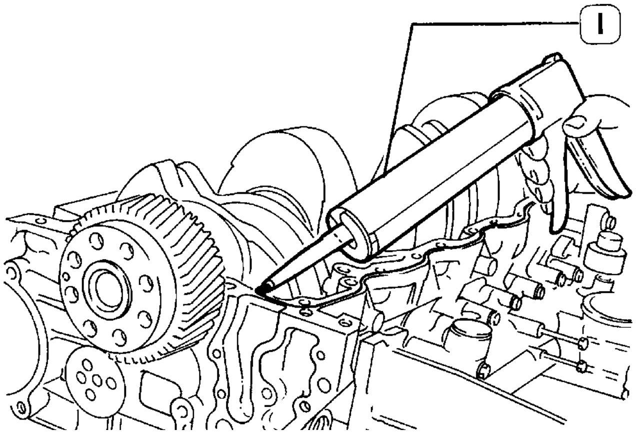
Figure 38



49021

Place the half-bearings (1) on the main bearings in the underblock (2).

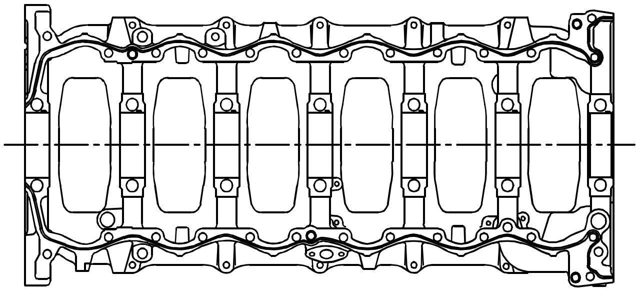
Figure 39



47595

Use a suitable tool (1) to apply LOCTITE 5970 IVECO No. 2992644, as shown on the next figure.

Figure 40

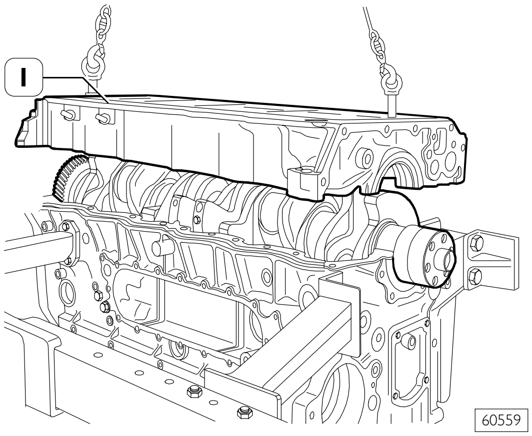


60632

Sealant application diagram.

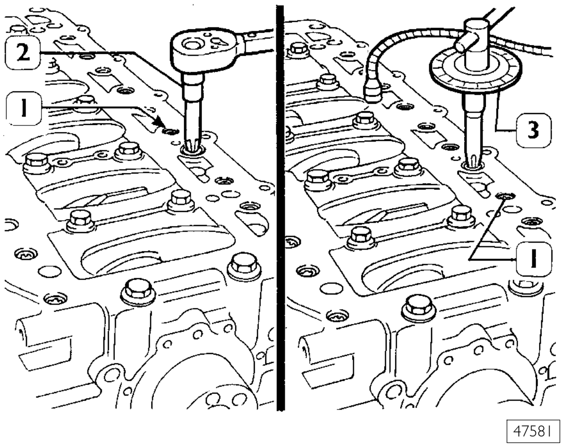
NOTE Fit the underblock within 10' of the application of the sealant.

Figure 41



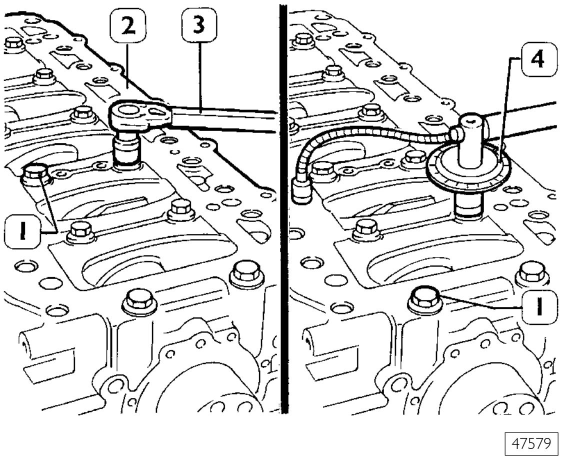
Mount the crankcase base (1) using appropriate tackle and hooks.

Figure 42



Mount the crankcase base and using a torque wrench (2), tighten the outside hex grooved screws (1) to a torque of 30 Nm following schemes contained in following page.

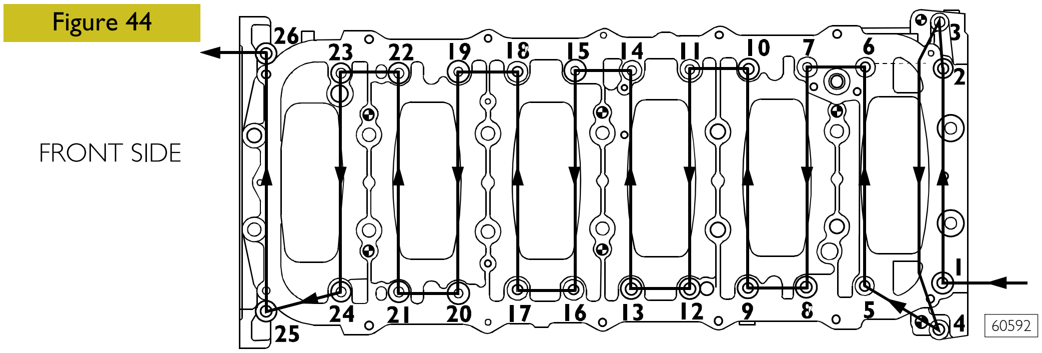
Figure 43



Using a torque wrench (3), tighten the inside screws (1) to a torque of 120 Nm. Then tighten them to an angle of 90° and 45° with tool 99395216 (4) with another two phases.
Regrind the outside screws (1, Figure 42) with closure to an angle of 60° using tool 99395216 (3, Figure 42).

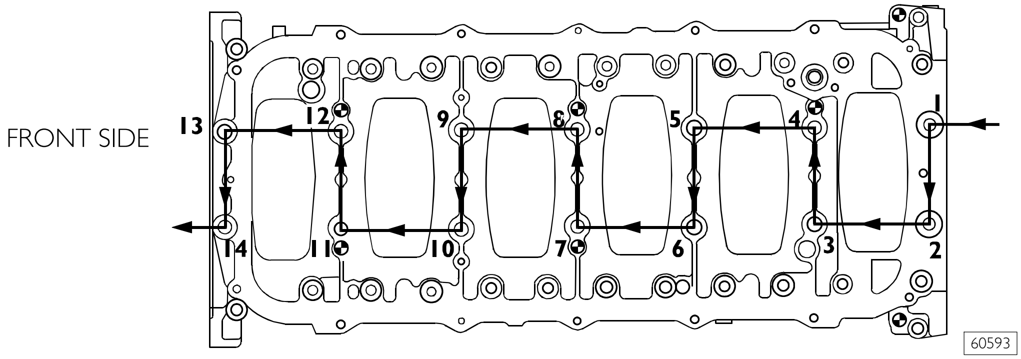
Diagram of tightening sequence of crankcase base fixing screws

Figure 44



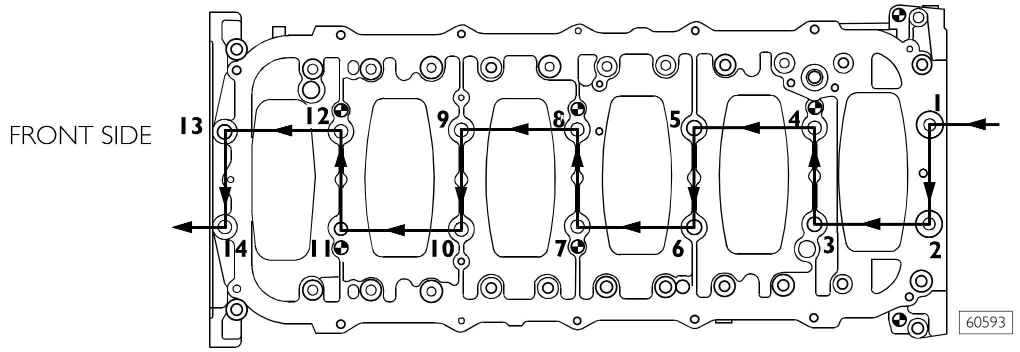
stage 1:
pretightening
outer screws

(30 Nm)



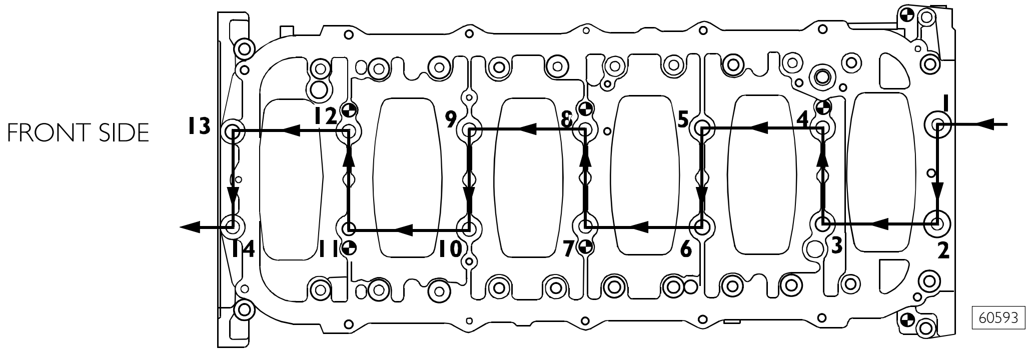
stage 2:
pretightenig
inner screws

(120 Nm)



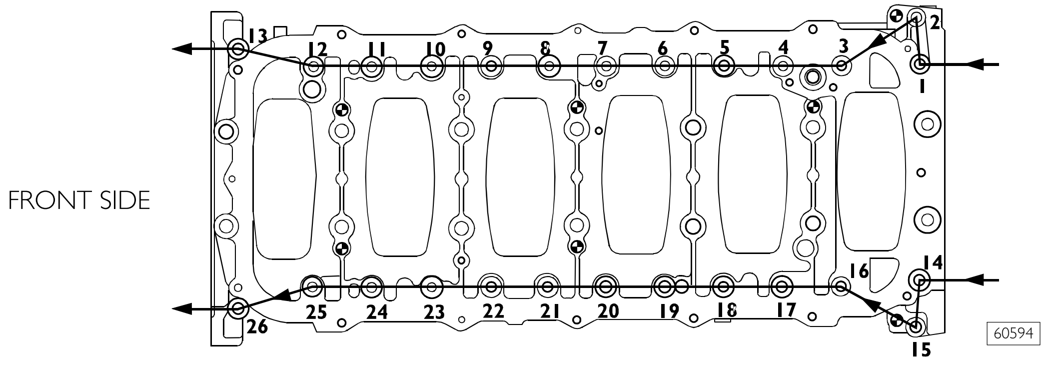
stage 3:
angle
inner
screws

(90°)



stage 4:
angle
inner
screws

(45°)



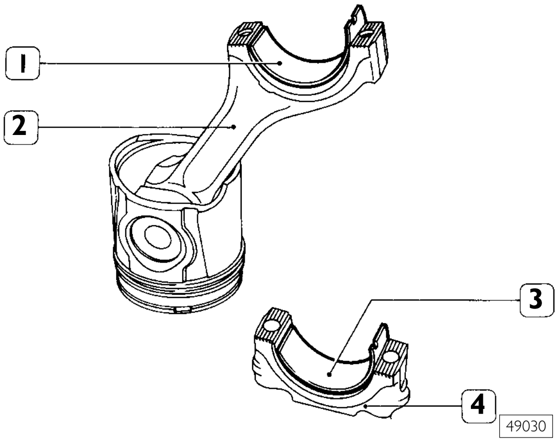
stage 5:
angle
outer
screws

(60°)

DIAGRAM OF TIGHTENING SEQUENCE OF CRANKCASE BASE FIXING SCREWS

Fitting connecting rod - piston assemblies in cylinder liners

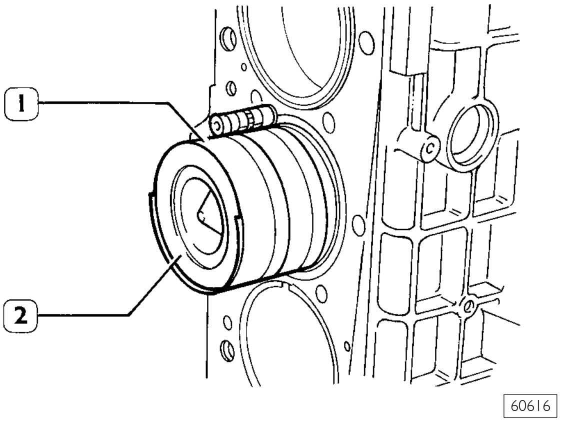
Figure 45



NOTE Not finding it necessary to replace the connecting rod bearings, you need to fit them back in exactly the same sequence and position as in removal.
If they are to be replaced, choose connecting rod bearings based on selection described in Section 4.
Lubricate the bearing shells (1 and 3) and fit them on the connecting rod (2) and on the cap (4).

NOTE Do not make any adjustment on the bearing shells.

Figure 47



Turn the cylinder block, setting it upright.

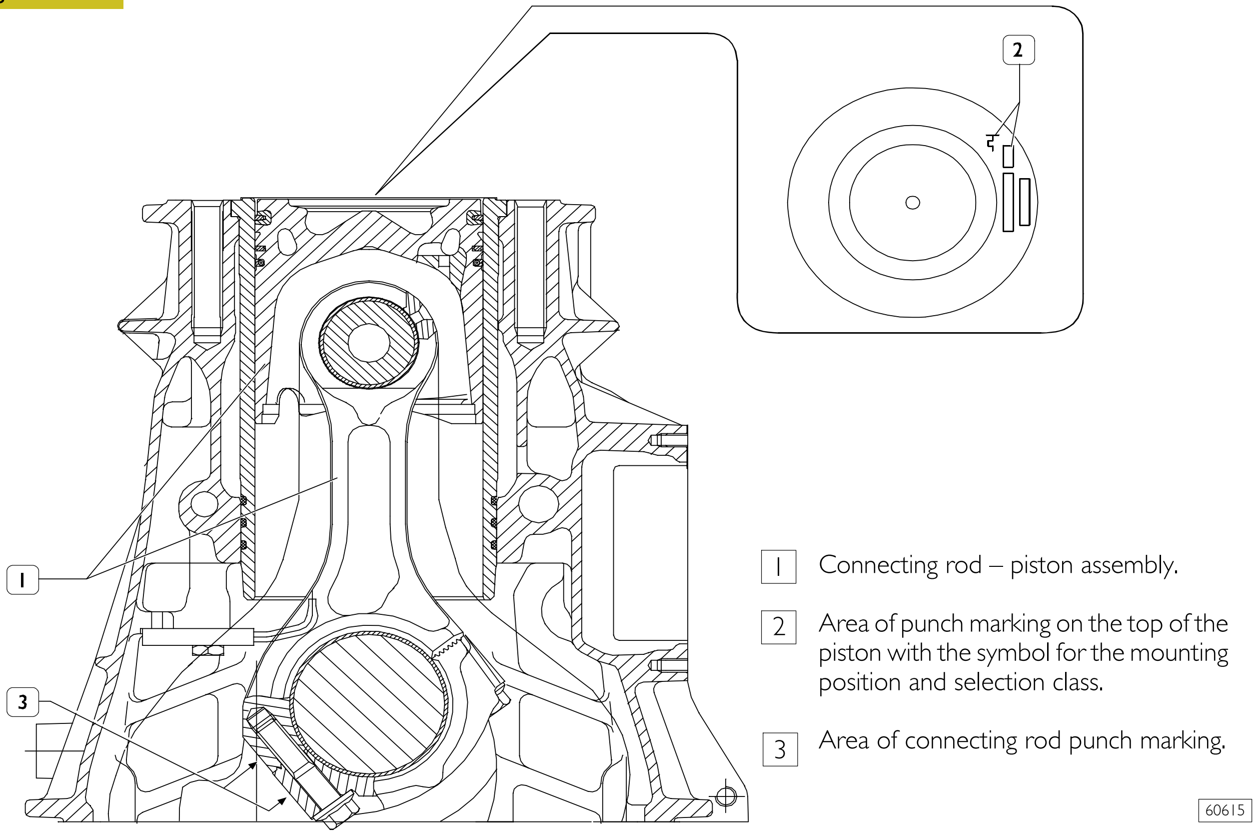
Lubricate the pistons, piston rings and inside the cylinder liners.

With the aid of the clamp 99360605 (1) mount the connecting rod – piston assemblies (2) in the cylinder liners according to Figure 46. Check that:

- ☐ The number of each connecting rod corresponds to the cap coupling number.
- ☐ The symbol (2, Figure 46) punched on the top of the pistons faces the engine flywheel or the recess in the piston skirt tallies with the position of the oil nozzles.

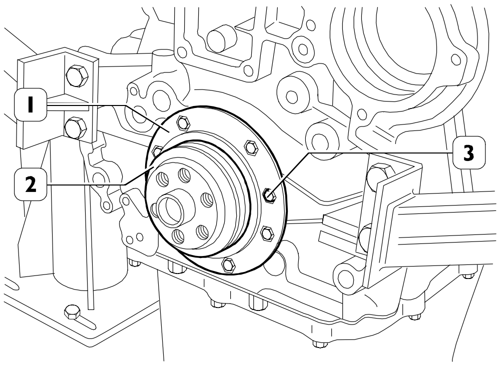
NOTE The pistons are supplied as spares in class A and can also be fitted in class B cylinder liners.

Figure 46



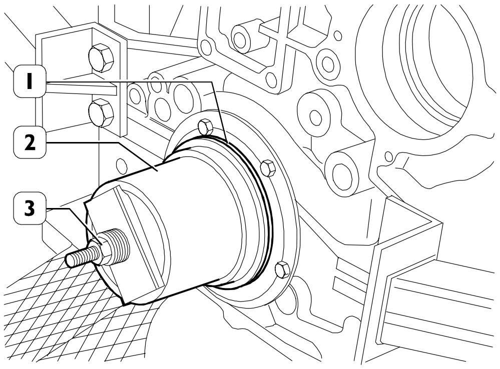
1	Connecting rod – piston assembly.
2	Area of punch marking on the top of the piston with the symbol for the mounting position and selection class.
3	Area of connecting rod punch marking.

Figure 48



Using the centring ring 99396035 (2), check the exact position of the cover (1). If it is wrong, proceed accordingly and lock the screws (3).

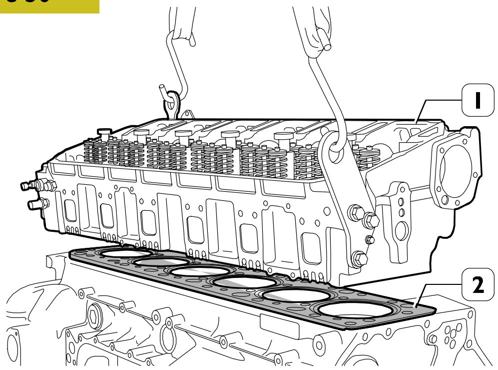
Figure 49



Key on the gasket (1), mount the key 99346250 (2) and, screwing down the nut (3), drive in the gasket (1).

Mounting cylinder head

Figure 50



Check that the pistons 1-6 are exactly at the T.D.C.
Put the gasket (2) on the crankcase.
Mount the cylinder head (1) and tighten the screws as shown in Figs. 51 - 52 - 53.

> ⚠ Lubricate the thread of the screws with engine oil before assembly.

Figure 51

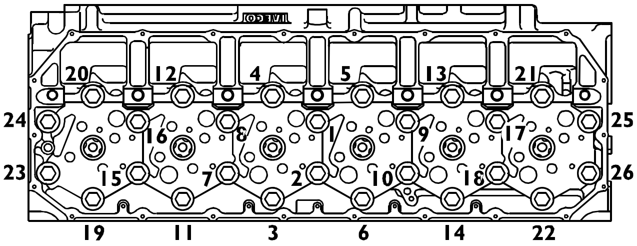
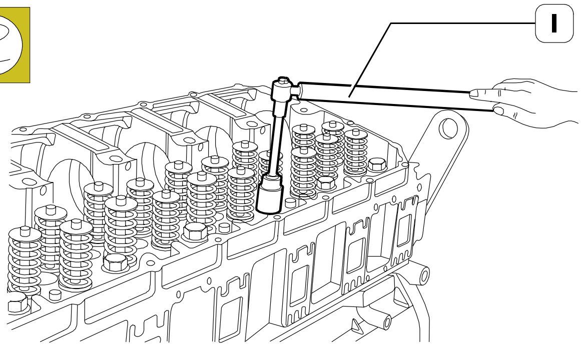


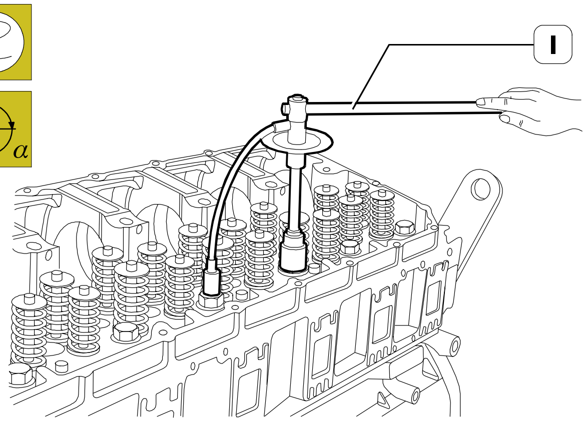
Diagram of the tightening sequence of the screws fixing the cylinder head.

Figure 52



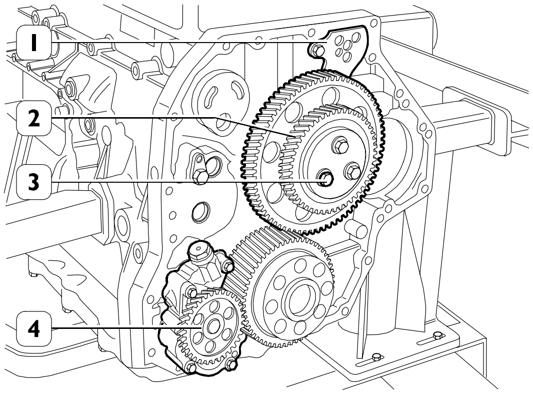
☐ Pre-tightening with the torque wrench (1):
1st phase: 60 Nm (6 kgm).
2nd phase: 120 Nm (12 kgm).

Figure 53



☐ Closing to angle with tool 99395216 (1):
3rd phase: angle of 120°.
4th phase: angle of 60°.

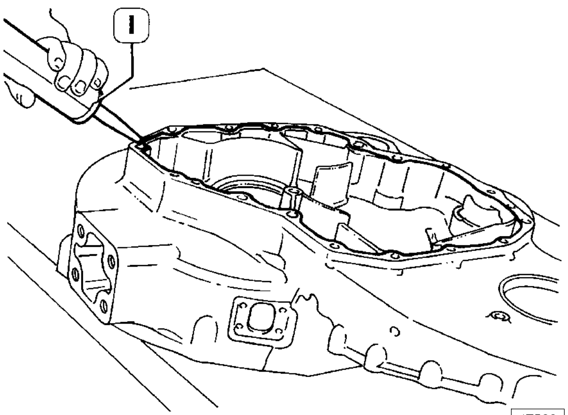
Figure 54



Mount the oil pump (4), the intermediate gears (2) together with the link rod (1) and lock the screws (3) in two phases:

pre-tightening 30 Nm.
closing to angle 90°.

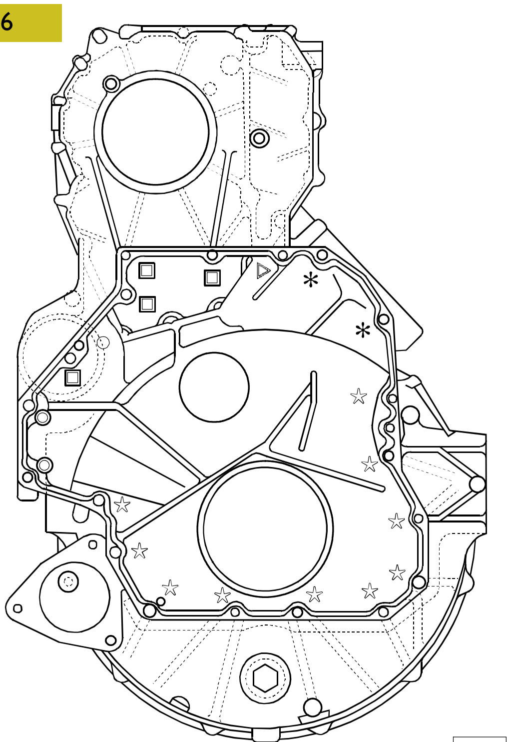
Figure 55



Apply LOCTITE 5970 IVECO No. 2995644 silicone on the gear housing, using appropriate tools (1), as shown in the figure.
The sealer string (1) diameter is to be $1,5 \pm^{0.5}_{0.2}$

NOTE Mount the gear housing within 10 min. of applying the sealant.

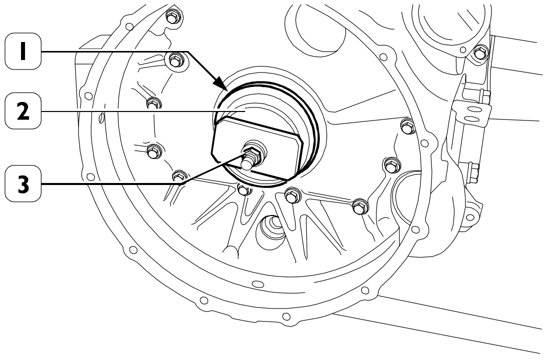
Figure 56



Using a torque wrench, tighten the highlighted screws with the following sequence and tightening torques:

☆	10 screws M12 x 1.75 x 100	63 Nm
◎	2 screws M12 x 1.75 x 70	63 Nm
◻	4 screws M12 x 1.75 x 35	63 Nm
△	1 screw M12 x 1.75 x 120	63 Nm
✳	2 screws M12 x 1.75 x 193	63 Nm

Figure 57

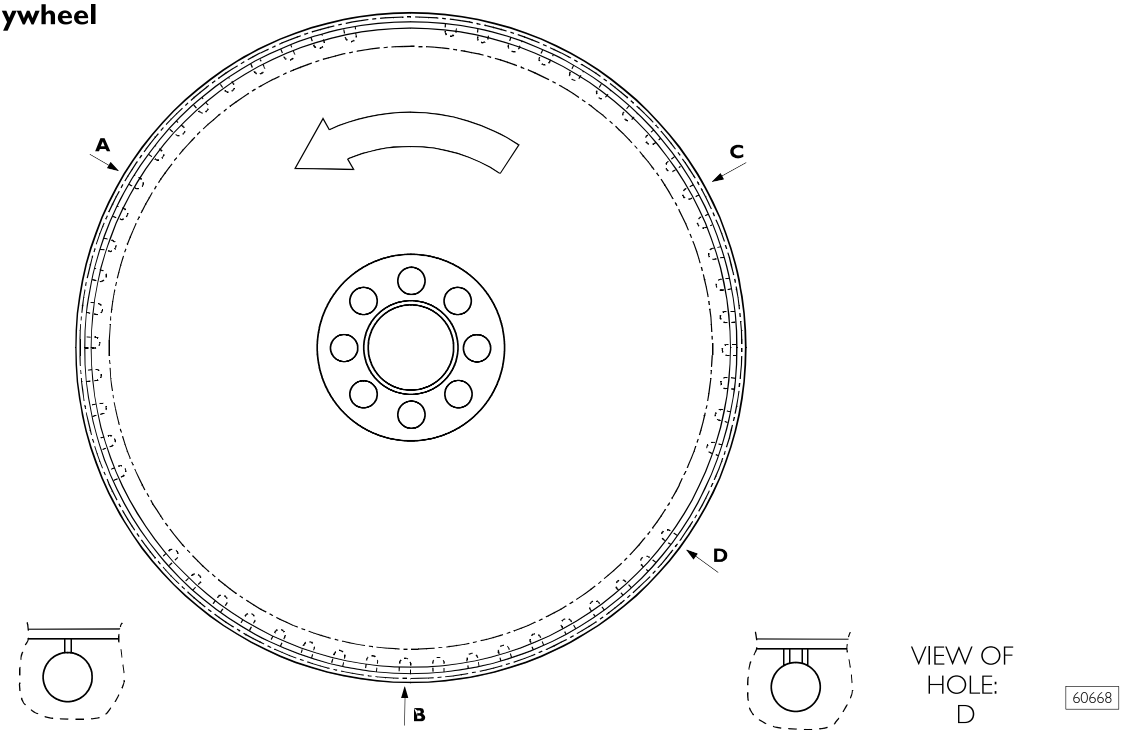


Lubricate driving shaft tang.

Key on the gasket (1), mount the keying device 99346251 (2) and, screwing down the nut (3), drive in the gasket.

Fitting engine flywheel

Figure 58



DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS

A = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 3-4.

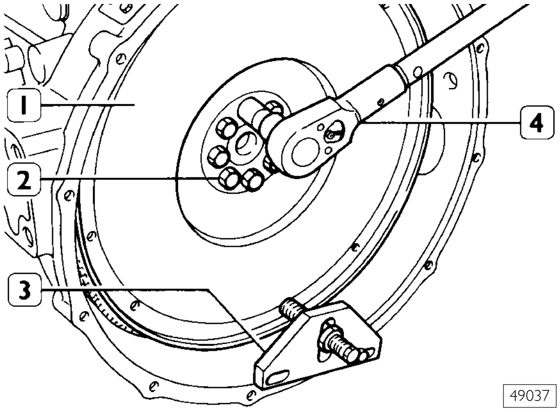
B = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6.

C = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 2-5.

D = Hole on flywheel with two reference marks, position corresponding to 54°.

NOTE If the teeth of the ring gear mounted on the engine flywheel, for starting the engine, are very damaged, replace the ring gear. It must be fitted after heating the ring gear to a temperature of approx. 200°C.

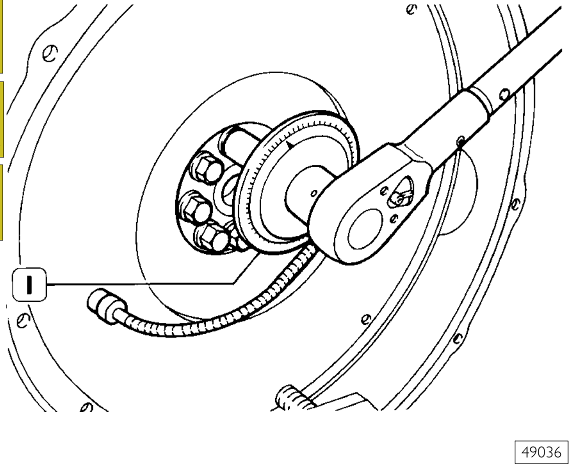
Figure 59



NOTE The crankshaft has a locating peg that has to couple with the relevant seat on the engine flywheel.

Position the flywheel (1) on the crankshaft, lubricate the thread of the screws (2) with engine oil and screw them down.
Lock rotation with tool 99360351 (3). Lock the screws (2) in two phases.
First phase: pre-tightening with torque wrench (4) to a torque of 120 Nm (12 kgm).

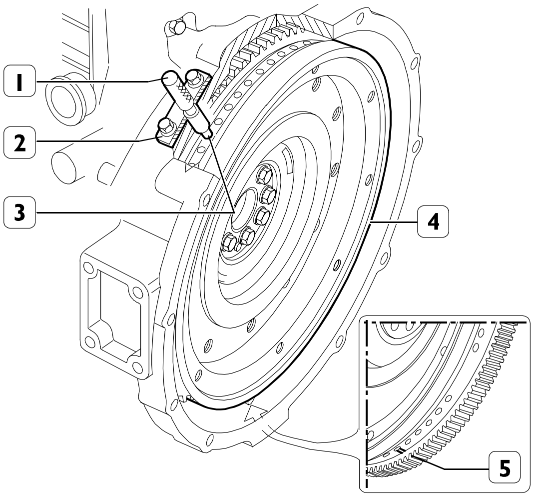
Figure 60



Second phase: closing to angle of 90° with tool 99395216 (1).

Fitting camshaft

Figure 61



Position the crankshaft with the pistons 1 and 6 at the top dead centre (T.D.C.).

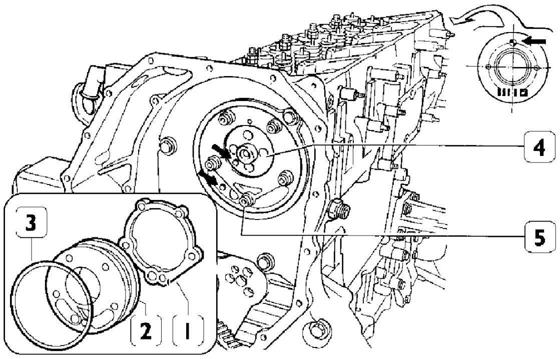
This situation occurs when:

1. The hole with reference mark (5) of the engine flywheel (4) can be seen through the inspection window.
2. The tool 99360612 (1), through the seat (2) of the engine speed sensor, enters the hole (3) in the engine flywheel (4).

If this condition does not occur, turn the engine flywheel (4) appropriately.

Remove the tool 99360612 (1).

Figure 62

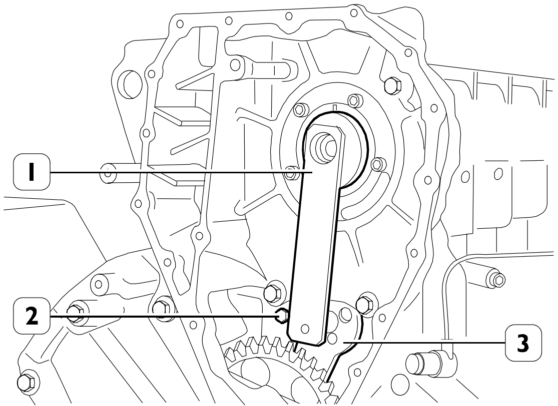


Fit the camshaft (4), positioning it observing the reference marks (→) as shown in the figure.

Lubricate the seal (3) and fit it on the shoulder plate (2).

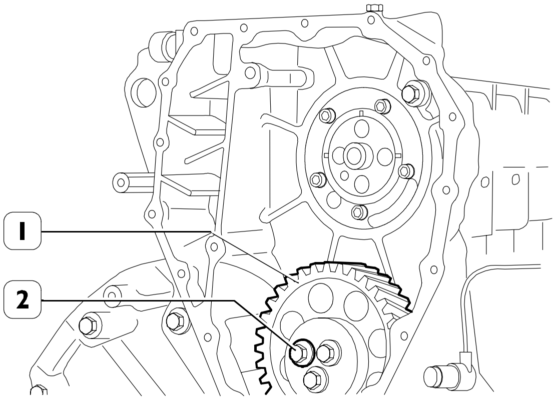
Mount the shoulder plate (2) with the sheet metal gasket (1) and tighten the screws (5) to the required torque.

Figure 63



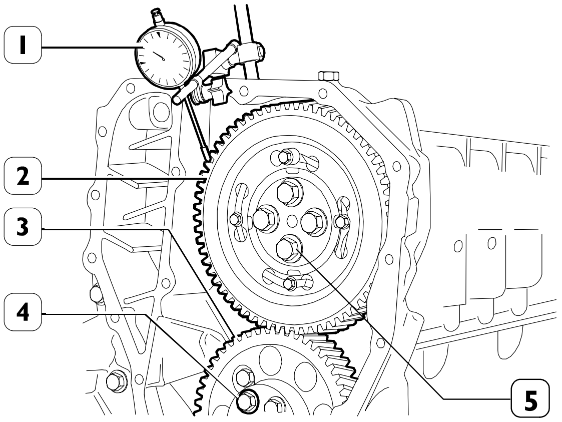
☐ Apply the gauge 99395218 (1). Check and adjust the position of the link rod (3) for the idle gear. Lock the screw (2) to the required torque.

Figure 64



☐ Fit the idle gear (1) back on and lock the screws (2) to the required torque.

Figure 65

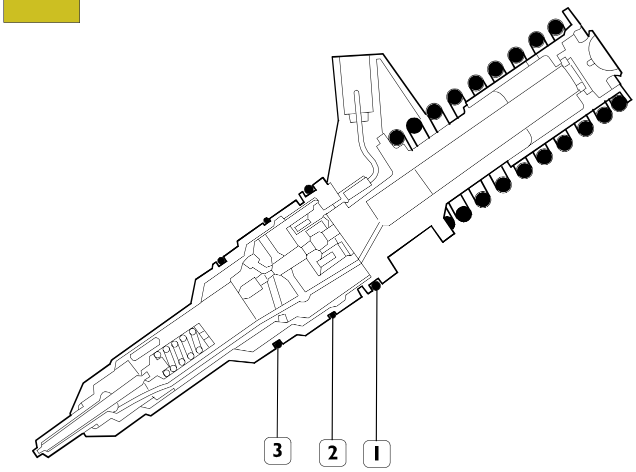


Position the gear (2) on the camshaft so that the 4 slots are centred with the holes for fixing the camshaft, without fully locking the screws (5).
Using the dial gauge with a magnetic base (1), check that the clearance between the gears (2 and 3) is 0.074 – 0.195 mm; if this is not so, adjust the clearance as follows:

- ☐ Loosen the screws (4) fixing the idle gear (3).
- ☐ Loosen the screw (2, Figure 63) fixing the link rod. Shift the link rod (3, Figure 63) to obtain the required clearance.
- ☐ Lock the screw (2, Figure 63) fixing the link rod and screws (4, Figure 65) fixing the idle gear to the required torque.

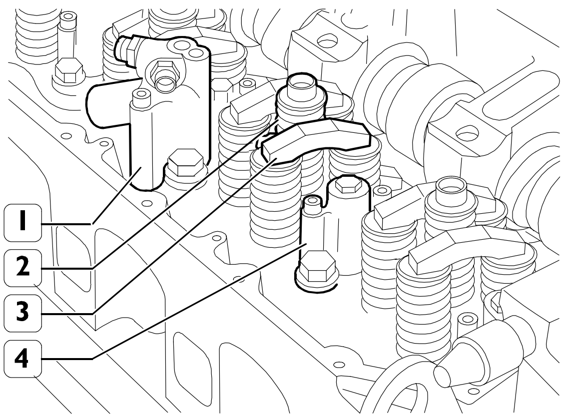
Fitting pump-injectors

Figure 66



Fit the seals (1) (2) (3) on the injectors.

Figure 67



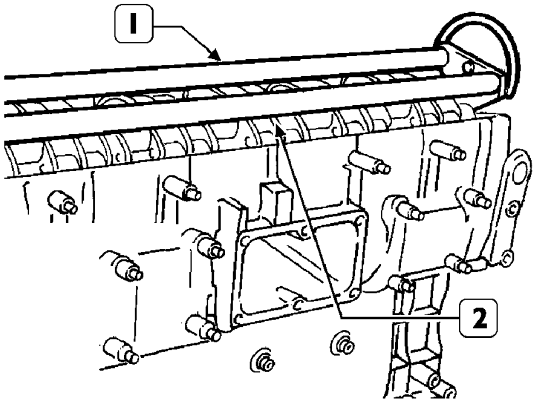
Mount:

- ☐ The injectors (2) and, using a torque wrench, lock the bracket fixing screws to a torque of 30 ÷ 35 Nm.
- ☐ The exhaust brake cylinders (1) and (4) and, using a torque wrench, fix them to a torque of 19 Nm.
- ☐ The crosspieces (3) on the valve stem, all with the largest hole on the same side.

Fitting rocker-arm shaft assembly

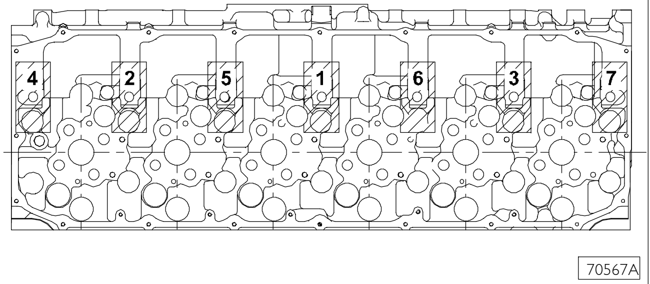
NOTE Before refitting the rocker-arm shaft assembly, make sure that all the adjustment screws have been fully unscrewed.

Figure 68



Apply the tool 99360553 (1) to the rocker arm shaft (2) and mount the shaft on the cylinder head.

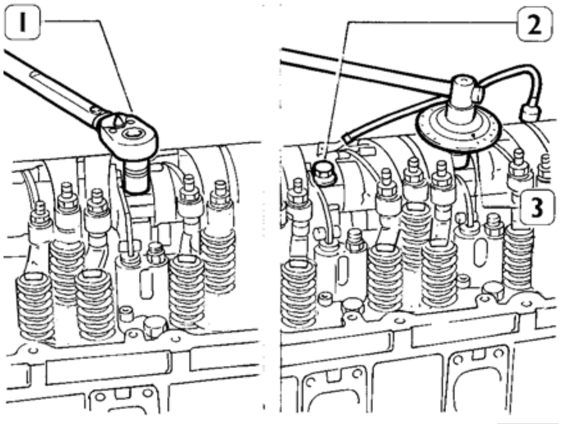
Figure 69



SCHEME OF SCREW TIGHTENING SEQUENCE SECURING ROCKER ARMS

Screw screws (1 - 2 - 3) until rocker arms are brought to contact relating seats on cylinder head, tighten the screws according to sequence indicated in figure operating in two steps as indicated in successive figure.

Figure 70

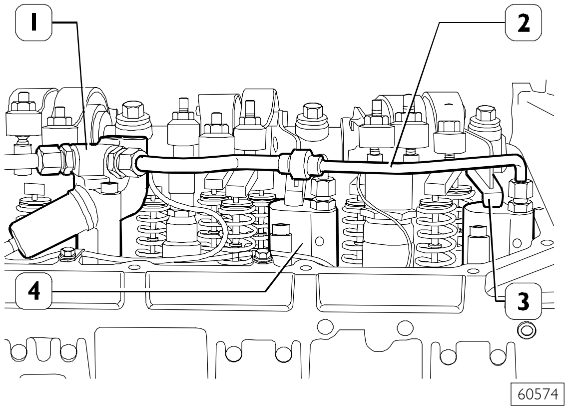


Lock the screws (2) fixing the rocker-arm shaft as follows:

☐ 1st phase: tightening to a torque of 80 Nm (8 kgm) with the torque wrench (1);

☐ 2nd phase: closing with an angle of 60° using the tool 99395216 (3).

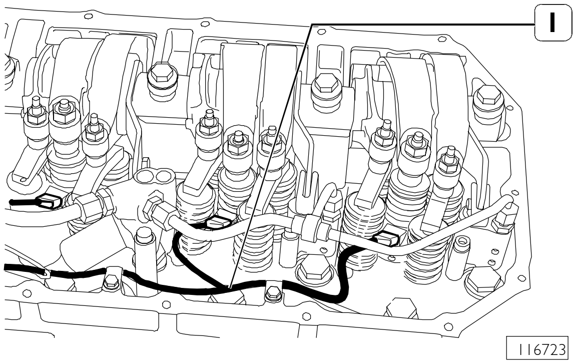
Figure 71



☐ Mount the engine brake lever retaining springs (3).

☐ Connect the pipe (2) to the engine brake cylinders (4) and to the cylinder with the engine brake solenoid valve (1).

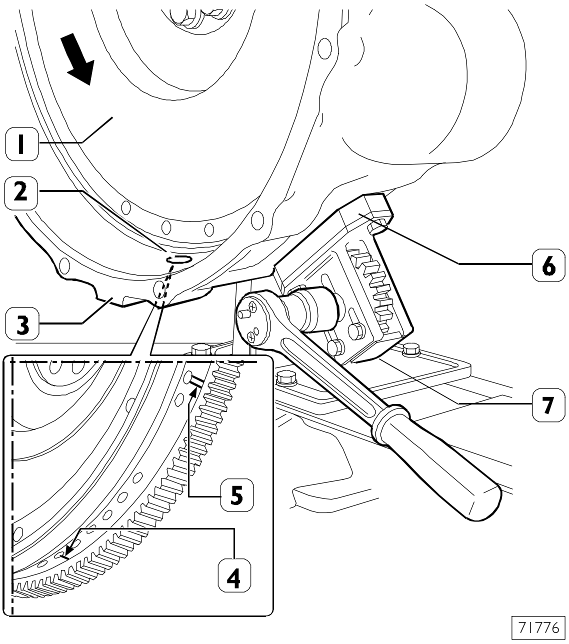
Figure 72



Mount the electric wiring (2), securing it on the electro-injectors with a torque screwdriver (1) to a torque of 1.36 - 1.92 Nm.

Camshaft timing

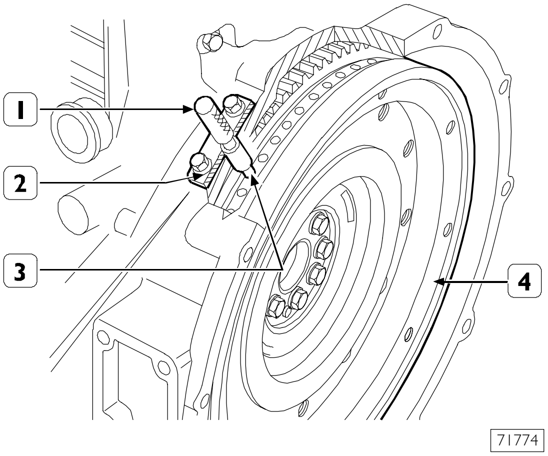
Figure 73



Apply the tool 99360321 (7) and the spacer 99360325 (6) to the gearbox (3).

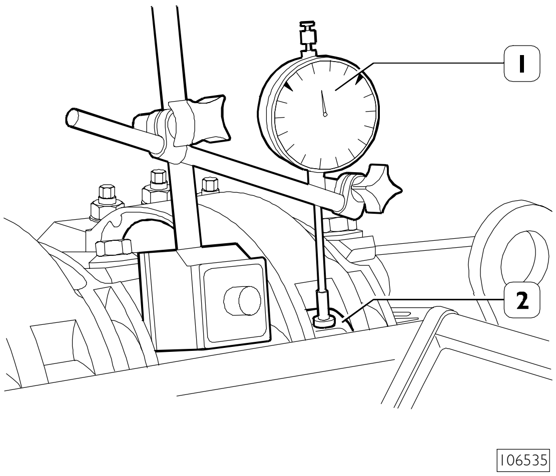
NOTE The arrow shows the direction of rotation of the engine when running.
Using the above-mentioned tool, turn the engine flywheel (1) in the direction of rotation of the engine so as to take the piston of cylinder no.1 to approximately the T.D.C. in the phase of combustion.
This condition occurs when the hole with one reference mark (4), after the hole with two reference marks (5) on the engine flywheel (1), can be seen through the inspection window (2).

Figure 74



The exact position of piston no.1 at the T.D.C. is obtained when in the above-described conditions the tool 99360612 (1) goes through the seat (2) of the engine speed sensor into the hole (3) in the engine flywheel (4).
If this is not the case, turn and adjust the engine flywheel (4) appropriately.
Remove the tool 99360612 (1).

Figure 75



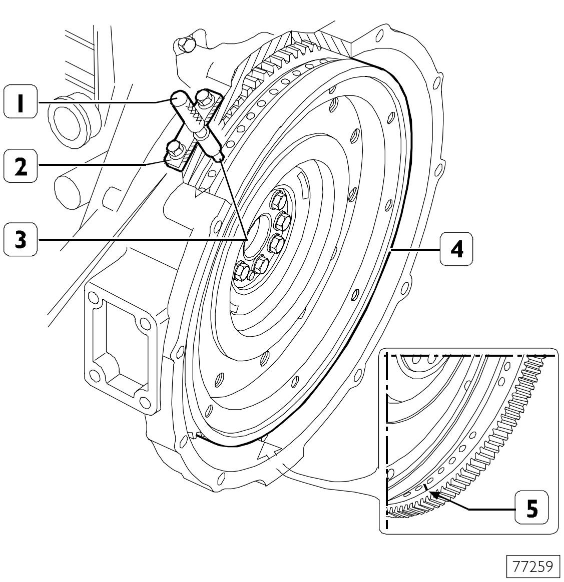
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

With tool 99360321 (7, Figure 73), turn the crankshaft clockwise until the pointer of the dial gauge reaches the minimum value beyond which it can no longer fall.

Reset the dial gauge.

Turn the engine flywheel anticlockwise until the dial gauge gives a reading for the lift of the cam of the camshaft of 5.30 ±0.05 mm.

Figure 76

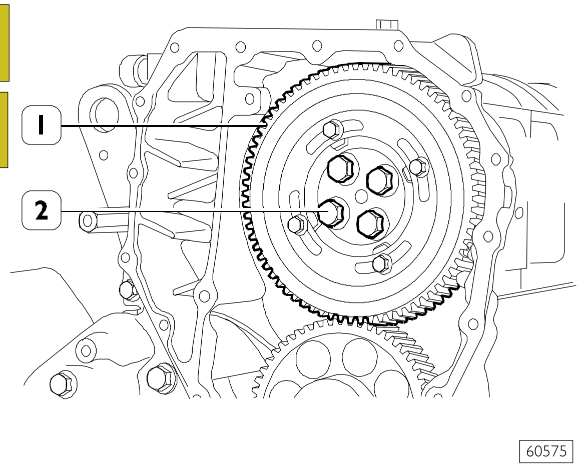


The camshaft is in step if at the cam lift values of 5.30 ±0.05 mm there are the following conditions:

1) the hole marked with a notch (5) can be seen through the inspection window;

2) the tool 99360612 (1) through the seat (2) of the engine speed sensor goes into the hole (3) in the engine flywheel (4).

Figure 77



If you do not obtain the conditions illustrated in Figure 76 and described in points 1 and 2, proceed as follows:

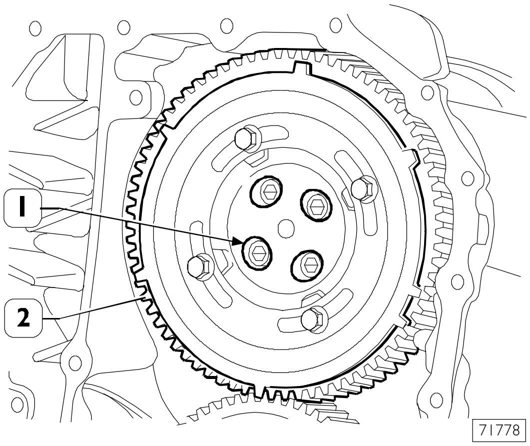
1) loosen the screws (2) securing the gear (1) to the camshaft and utilize the slots (see Figure 78) on the gear (1);

2) turn the engine flywheel appropriately so as to bring about the conditions described in points 1 and 2 Figure 76, it being understood that the cam lift must not change at all;

3) lock the screws (2) and repeat the check as described above.

Tighten the screws (2) to the required torque.

Figure 78



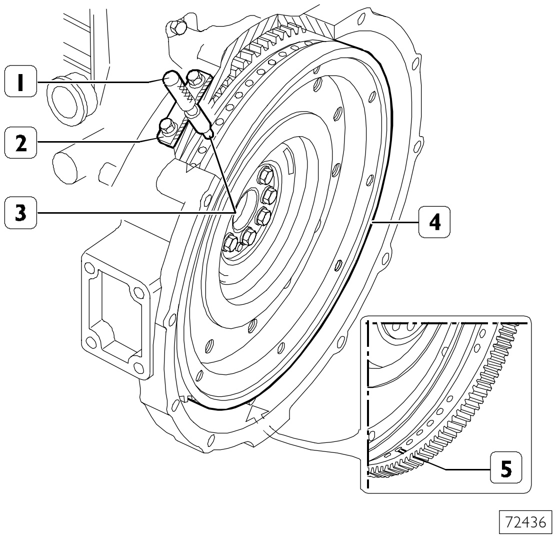
When the adjustment with the slots (1) is not enough to make up the phase difference and the camshaft turns because it becomes integral with the gear (2); as a result, the reference value of the cam lift varies, in this situation it is necessary to proceed as follows:

1) lock the screws (2, Figure 77) and turn the engine flywheel clockwise by approx. 1/2 turn;

2) turn the engine flywheel anticlockwise until the dial gauge gives a reading of the lift of the cam of the camshaft of 5.30 ±0.05 mm;

3) take out the screws (2, Figure 77) and remove the gear (1) from the camshaft.

Figure 79



Turn the flywheel (4) again to bring about the following conditions:

☐ a notch (5) can be seen through the inspection window;

☐ the tool 99360612 (1) inserted to the bottom of the seat of the engine speed sensor (2) and (3).

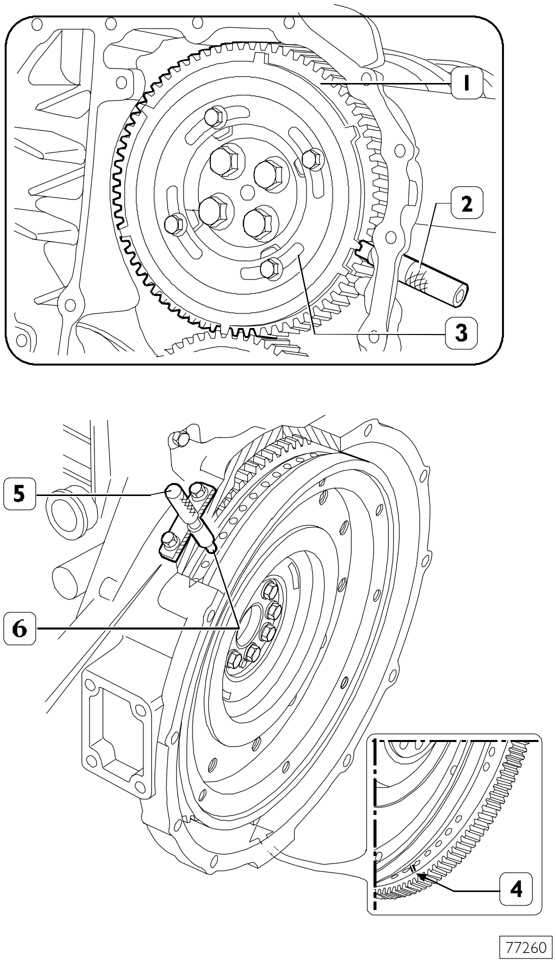
Mount the gear (2) Figure 78 with the 4 slots (1) centred with the fixing holes of the camshaft, locking the relevant screws to the required tightening torque.

Check the timing of the shaft by first turning the flywheel clockwise to discharge the cylinder completely and then turn the flywheel anticlockwise until the dial gauge gives a reading of 5.30 ±0,05.

Check the timing conditions described in Figure 76.

Phonic wheel timing

Figure 80



Turn the crankshaft by taking the piston of cylinder no. 1 into the compression phase at T.D.C.; turn the flywheel in the opposite direction to the normal direction of rotation by approximately 1/4 of a turn.

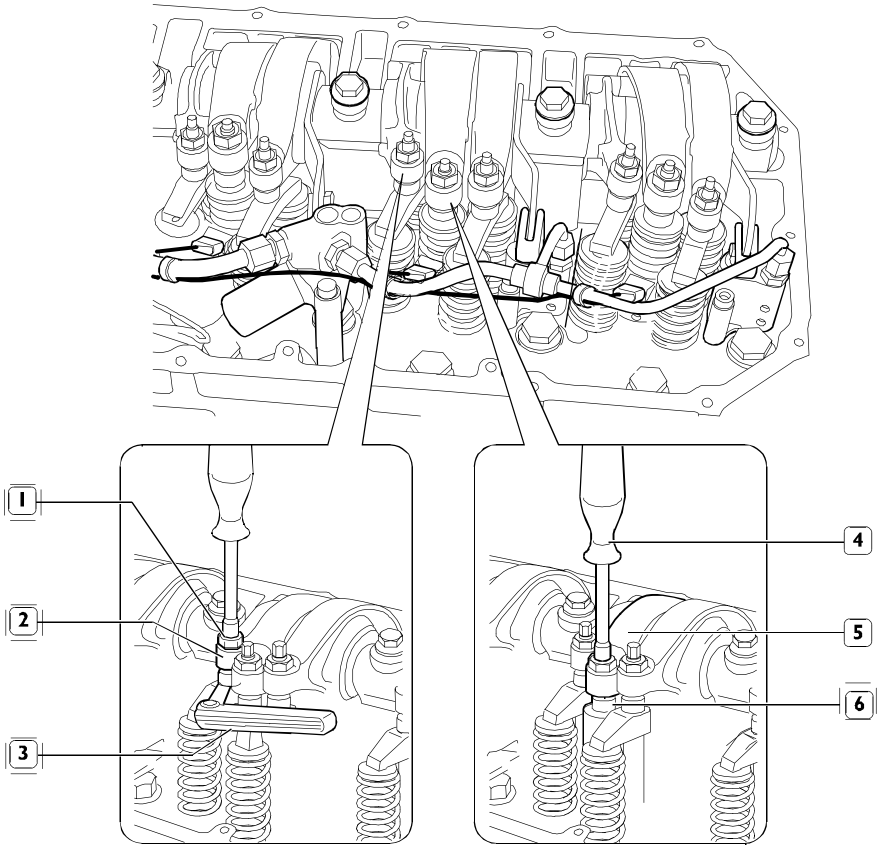
Again turn the flywheel in its normal direction of rotation until you see the hole marked with the double notch (4) through the inspection hole under the flywheel housing. Insert tool 99360612 (5) into the seat of the flywheel sensor (6).

Insert the tool 99360613 (2), via the seat of the phase sensor, onto the tooth obtained on the phonic wheel.

Should inserting the tool (2) prove difficult, loosen the screws (3) and adjust the phonic wheel (1) appropriately so that the tool (2) gets positioned on the tooth correctly. Go ahead and tighten the screws (3).

Intake and exhaust rocker play adjustment and pre-loading of rockers controlling pump injectors

Figure 81



ADJUSTMENT OF INTAKE, EXHAUST AND INJECTION ROCKERS

The adjustment of clearance between the rockers and rods controlling the intake and exhaust valves, as well as the adjustment of pre-loading of the rockers controlling pump injectors, must be carried out carefully.

Take the cylinder where clearance must be adjusted to the bursting phase; its valves are closed while balancing the symmetric cylinder valves.
Symmetric cylinders are 1-6, 2-5 and 3-4.

In order to properly operate, follow these instructions and data specified on the table.

<u>Adjustment of clearance between the rockers and rods controlling intake and exhaust valves:</u>

☐ use a box wrench to loosen rocker arm (2) adjusting screw fastening nut (1).

☐ insert the thickness gauge blade (3);

☐ tighten or untighten the adjustment screw with the appropriate wrench;

☐ make sure that the gauge blade (3) can slide with a slight friction;

☐ lock the nut (1), by blocking the adjustment screw.

<u>Pre-loading of rockers controlling pump injectors:</u>

☐ using a polygonal wrench, loosen the nut locking the rocker adjustment screw (5) controlling the pump injector (6);

☐ using an appropriate wrench (4), loosen the adjustment screw until the pumping element is at the end-of-stroke;

☐ tighten the adjustment screw, with a dynamometric wrench, to 5 Nm tightening torque (0.5 kgm);

☐ untighten the adjustment screw by 1/2 to 3/4 rotation;

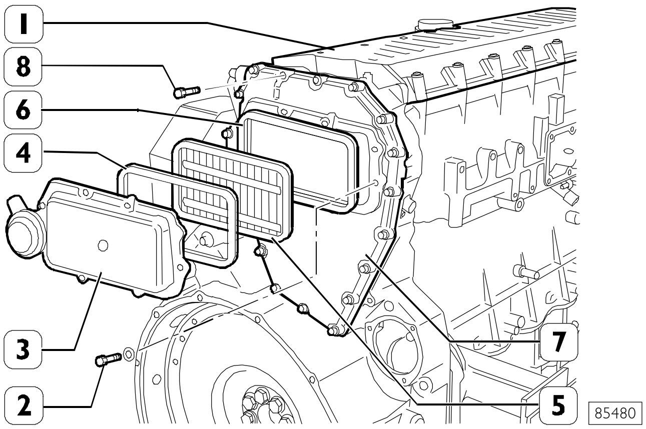
☐ tighten the locking nut.

FIRING ORDER <u>1-4-2-6-3-5</u>

Clockwise start-up and rotation	Adjusting cylinder valve no.	Adjusting clearance of cylinder valve no.	Adjusting pre-loading of cylinder injector no.
1 and 6 at TDC	6	1	5
120°	3	4	1
120°	5	2	4
120°	1	6	2
120°	4	3	6
120°	2	5	3

NOTE In order to properly carry out the above-mentioned adjustments, follow the sequence specified in the table, checking the exact position in each rotation phase by means of pin 99360612, to be inserted in the 11th hole in each of the three sectors with 18 holes each.

Figure 82



Fit the distribution cover (1).
Fit the blow-by case (7) and its gasket and then tighten the screws (8) to the prescribed torque.
Install the filter (5) and the gaskets (4 and 6).

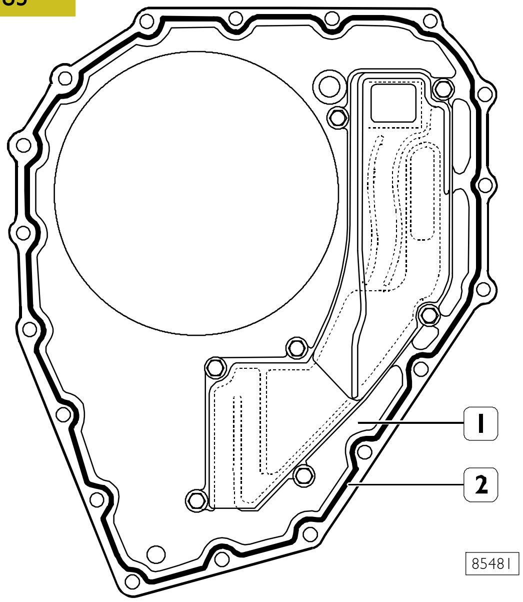
NOTE The filter (5) operation is unidirectional, therefore it must be assembled with the two sight supports as illustrated in the figure.

Accurately clean intake ducts and cover (3) drain hole.

Fit the cover (3) and tighten the fastening screws (2) to the prescribed torque.

NOTE Apply silicone LOCTITE 5970 IVECO No. 2995644 on the blow-by case (7) surface of engines fitted with P.T.O. according to the procedure described in the following figure.

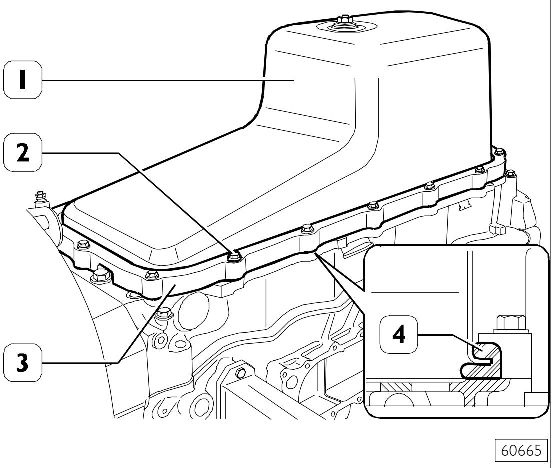
Figure 83



Apply silicone LOCTITE 5970 IVECO No. 2995644 on the blow-by case and form a string (2) of Ø 1,5 $\pm,^{0.5}_{0.2}$ as shown in the figure.

NOTE Fit the blow-by case (1) within 10' from sealer application.

Figure 84



Turn engine and mount oil rose pipe.
Arrange gasket (4) on oil sump (1), position spacer (3) and mount the sump on engine block screwing up screws (2) at prescribed torque:

Completing Engine Assembly

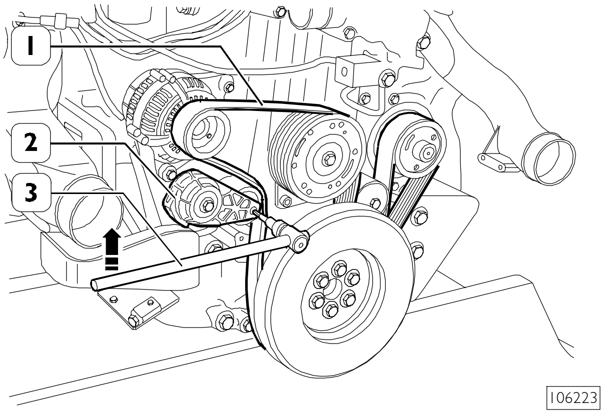
Complete the engine by fitting or hooking up the following parts:

- ☐ power take-off (P.T.O., if present) and relating pipes;
- ☐ fuel pump;
- ☐ support complete with fuel filter and pipes;
- ☐ EDC central unit;
- ☐ intake manifold;
- ☐ preheating resistance;
- ☐ heat exchanger;
- ☐ oil filters, lubricating the gasket;
- ☐ exhaust manifold;
- ☐ turbocompressor and relating water and oil pipes;
- ☐ pulley and damping flywheel;
- ☐ thermostat assembly;
- ☐ belt tensioner, water pump, alternator;
- ☐ electromagnetic joint;
- ☐ belt tensioner, if present, air-conditioner compressor;
- ☐ starter;
- ☐ oil level rod;
- ☐ electrical connections and sensors.

NOTE The fittings of the cooling water and lubricating oil pipes of the turbocharger have to be tightened to a torque of:

- ☐ 35 ±5 Nm, water pipe fittings;
- ☐ 55 ±5 Nm, oil pipe female fitting;
- ☐ 20-25 Nm, oil pipe male fitting.

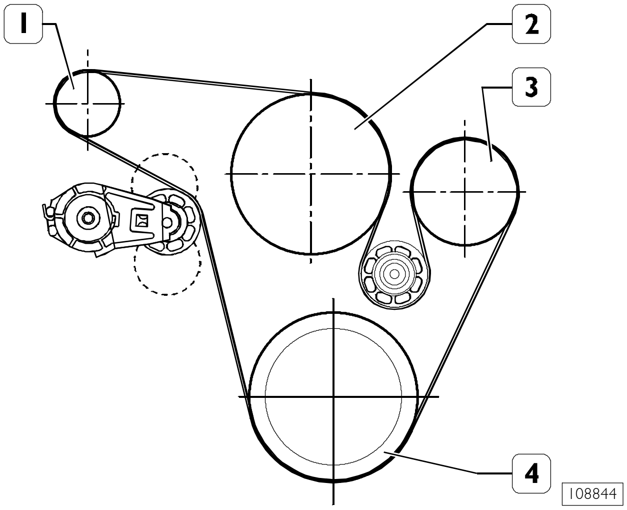
Figure 85



☐ driving belt.

To mount belt (1), belt tensioner (2) has to be operated by proper tooling (3) according to the direction indicated by the arrow in Figure.

Figure 86



ASSEMBLY DIAGRAM OF FAN – WATER PUMP – ALTERNATOR DRIVE BELT
1. Alternator – 2. Electromagnetic coupling – 3. Water pump – 4. Crankshaft.

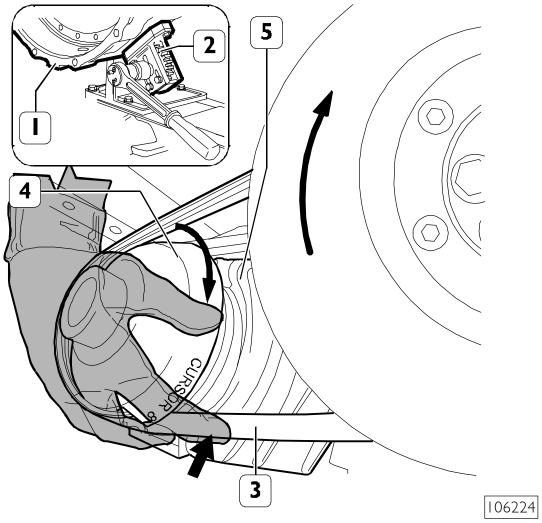
NOTE Belt tensioner is of automatic type; therefore, further adjusting is not provided after mounting.

☐ refuel engine with provided oil quantity;
☐ dismount engine from rotary stand and take off brackets (99361036) securing the engine.

Mount:

☐ oil pressure regulation valve;
☐ engine left support;
☐ air compressor complete with hydraulic guide pump;
☐ sound deadening guard;
☐ pipes.
☐ if present, climate control system compressor driving belt similarly to belt (1, Figure 85);

Figure 87



NOTE In the case of engines with climate control system compressor spring driving belt, for mounting the belt, tool 99360192 (4) must be used. Different methods may cause tensions impairing spring belt.

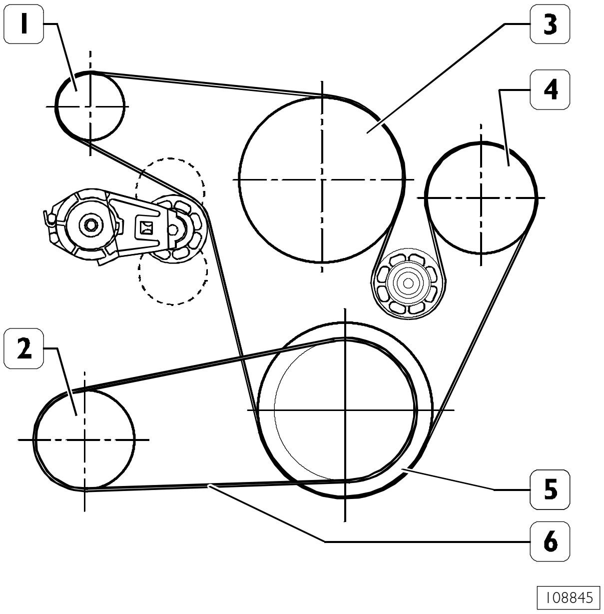
Apply tool 99360321 (2) provided with spacer 99360325 to gears box (1).
Mount spring belt (3) on driving shaft pulley, mount chock 99360192 (4) on compressor pulley (5) for climate control system. Position spring belt (3) in the opening of tool 99360192 marked with “cursor 10/13”.
By tool 99360321 (2), rotate driving shaft according to the direction of the arrow (→) until spring belt (3) is correctly positioned on compressor pulley (5).

NOTE While operating, keep tool 99360192 (4) in contact to pulley and at the same time guide spring belt (3) in order to prevent it from twisting.

NOTE Spring belt must be replaced by a new one after every dismounting operation.

NOTE Replacing spring belt with engine on the vehicle is from engine opening after tilting the cab.

Figure 88



COMPRESSOR CONTROL BELT
ASSEMBLY DIAGRAM
1. Crankshaft - 2. Air conditioner compressor

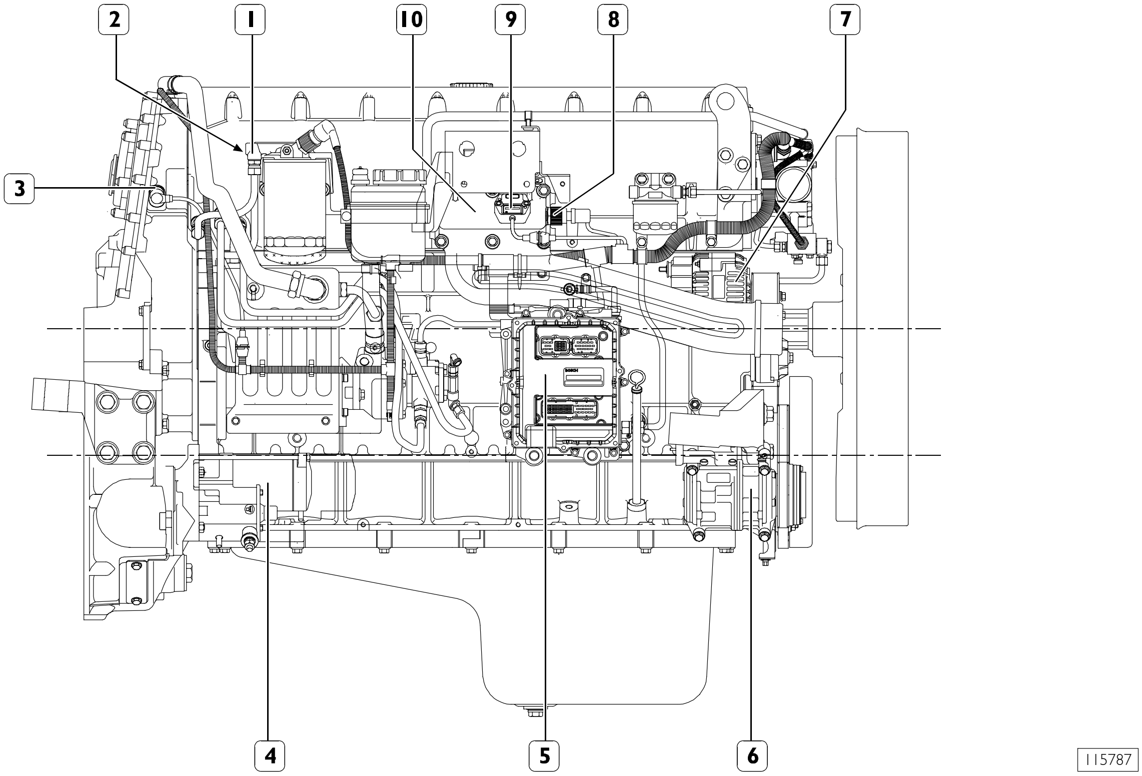
1. Alternator – 2. Climate control system compressor - 3. Electromagnetic coupling – 4. Water pump – 5. Crankshaft - 6. Spring belt.

PART TWO -

ELECTRICAL EQUIPMENT

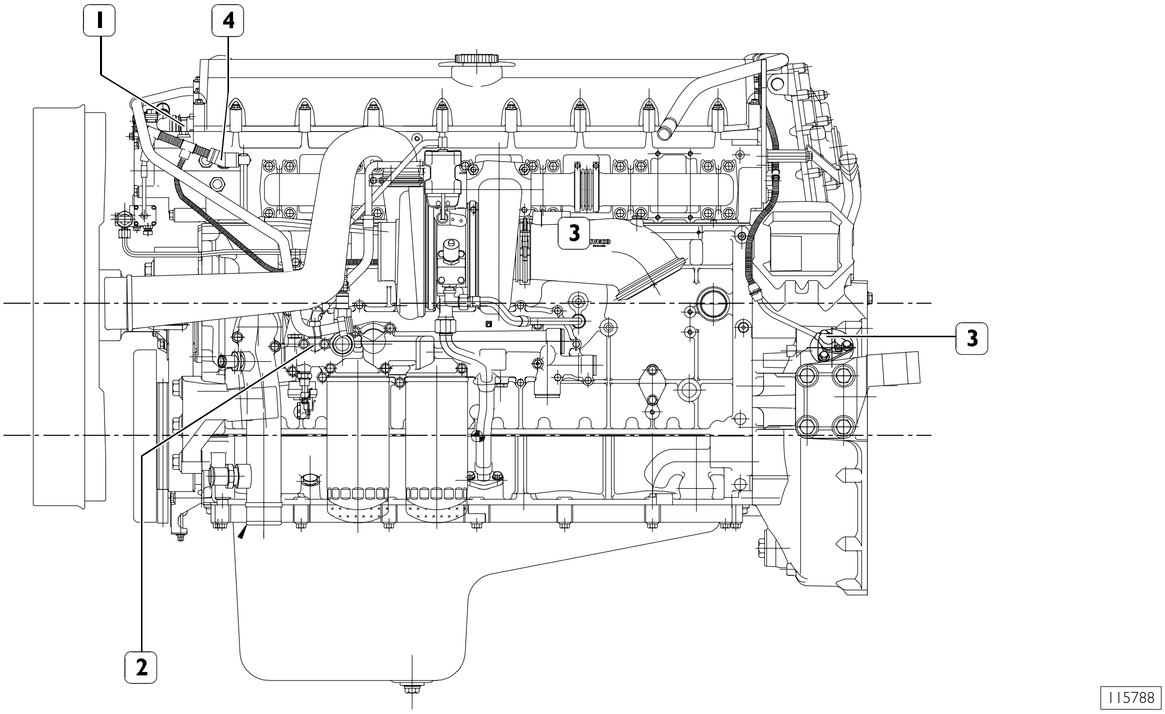
Components on the engine F3A

Figure 1 (Demonstration)



RIGHT SIDE VIEW OF ENGINE
1. Water detection sensor diesel fuel filter clogged - 2. Fuel temperature sensor - 3. Sensor for engine revs on distribution shaft - 4. Starter - 5. EDC7 UC31 Control Unit - 6. Air conditioner compressor - 7. Alternator - 8. Engine input air temperature sensor - 9. Boost pressure sensor - 10. Resistance for engine preheating.

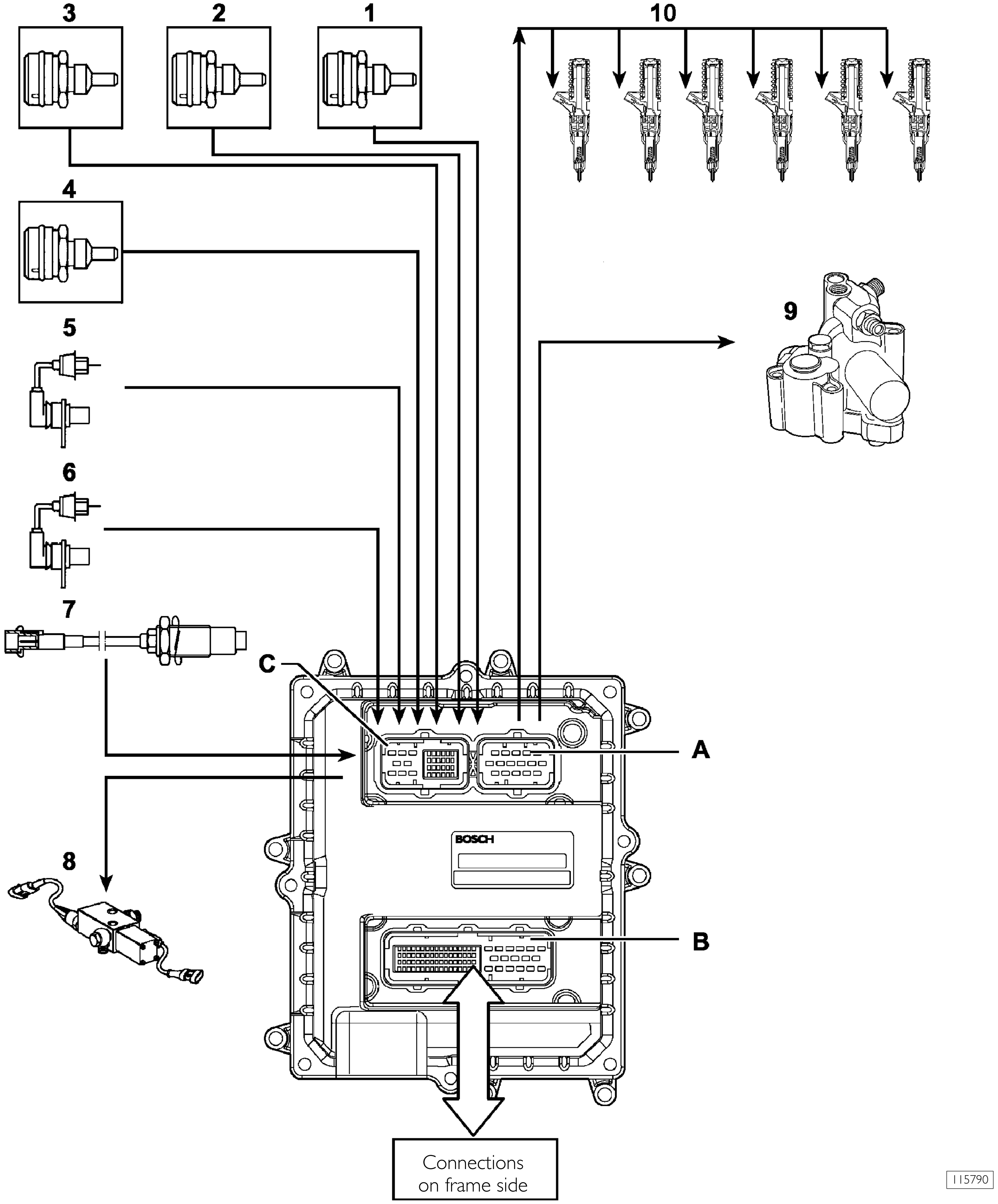
Figure 2 (Demonstration)



LEFT SIDE VIEW OF ENGINE
1. Connector on engine head for connection with injectors solenoid valve - 2. Engine oil temperature/pressure sensor - 3. Sensor for engine revs on flywheel - 4. Water temperature sensor.

BLOCK DIAGRAM

Figure 3



KEYS

1. Solenoid valve for variable geometry control - 2. Engine oil pressure/temperature sensor - 3. Fuel temperature sensor - 4. Coolant temperature sensor - 5. Distribution sensor - 6. Flywheel sensor - 7. Turbine revs sensor - 8. Solenoid valve for VGT control - 9. Engine brake solenoid valve - 10. Pump injectors.

EDC SYSTEM FUNCTIONS

The EDC7 UC31 electronic center manages the following main functions:

Fuel injection
Accessory functions such as cruise control, speed limiter, PTO and the like
Self-diagnosis
Recovery

It also enables:

Interfacing with other electronic systems (if any) available on the vehicle
Diagnosis

Fuel dosing

Fuel dosing is calculated based on:
- accelerator pedal position
- engine rpm
- quantity of air admitted.

The result can be corrected based on:
- water temperature

or to prevent:
- noise
- fumes
- overloads
- overheating

Pressure can be adjusted in case of:
- engine brake actuation
- external device actuation (e.g. speed reducer, cruise control)
- serious defects involving load reduction or engine stop.

After determining the mass of air introduced by measuring its volume and temperature, the center calculates the corresponding mass of fuel to be injected into the cylinder involved, with account also taken of gas oil temperature.

Delivery correction based on water temperature

When cold, the engine encounters greater operating resistance, mechanical friction is high, oil is till very viscous and operating plays are not optimized yet.
Fuel injected also tends to condense on cold metal surfaces.
Fuel dosing with a cold engine is therefore greater than when hot.

Delivery correction to prevent noise, fumes or overloads

Behaviors that could lead to the defects under review are well known, so the designer has added specific instructions to the center to prevent them.

De-rating

In the event of engine overheating, decreasing delivery proportionally to the temperature reached by the coolant changes injection.

Turbine rpm regulation

Turbine speed is constantly regulated and rectified, if necessary, by operating on geometry variation.

Injection lead electronic control

Injection lead, or the start of fuel delivery expressed in degrees, can differ from one injection to the next, even from one cylinder to another and is calculated similarly to delivery according to engine load, namely, accelerator position, engine rpm and air admitted.
Lead is corrected as required:

- during acceleration
- according to water temperature

and to obtain:

- reduced emissions, noise abatement and no overload
- better vehicle acceleration

High injection lead is set at start, based on water temperature.
Delivery start feedback is given by injection electro valve impedance variation.

Engine start

Cylinder 1 step and recognition signal synchronization (flywheel and drive shaft sensors) takes place at first engine turns. Accelerator pedal signal is ignored at start. Star delivery is set exclusively based on water temperature, via a specific map. The center enables the accelerator pedal, when it detects flywheel acceleration and rpm such as to consider the engine as started and no longer drawn by the starter motor.

Cold start

Pre-post reheating is activated when even only one of the three water, air or gas oil temperature sensors records a temperature of below 10 °C. The pre-heat warning light goes on when the ignition key is inserted and stays on for a variable period of time according to temperature, while the intake duct input resistor heats the air, then starts blinking, at which point the engine can be started.
The warning light switches off with the engine revving, while the resistor continues being fed for a variable period of time to complete post-heating. The operation is cancelled to avoid uselessly discharging the batteries if the engine is not started within 20 ÷ 25 seconds with the warning light blinking. The pre-heat curve is also variable based on battery voltage.

Hot start

On inserting the ignition key the warning light goes on for some 2 seconds for a short test and then switches off when all reference temperatures are above 10 °C. The engine can be started at this point.

Run Up

When the ignition key is inserted, the center transfers data stored at previous engine stop to the main memory (Cf. After run), and diagnoses the system.

After Run

At each engine stop with the ignition key, the center still remains fed by the main relay for a few seconds, to enable the microprocessor to transfer some data from the main volatile memory to an non-volatile, cancelable and rewritable (Eeprom) memory to make tem available for the next start (Cf. Run Up).
These data essentially consists of:

- miscellaneous settings, such as engine idling and the like
- settings of some components
- breakdown memory

The process lasts for some seconds, typically from 2 to 7 according to the amount of data to be stored, after which the ECU sends a command to the main relay and makes it disconnect from the battery.

This procedure must never be interrupted, by cutting the engine off from the battery cutout or disconnecting the latter before 10 seconds at least after engine cutout.

In this case, system operation is guaranteed until the fifth improper engine cutout, after which an error is stored in the breakdown memory and the engine operates at lower performance at next start while the EDC warning light stays on.

Repeated procedure interruptions could in fact lead to center damage.

Cut-off

It refers to the supply cut-off function during deceleration.

Cylinder Balancing

Individual cylinder balancing contributes to increasing comfort and operability.
This function enables individual personalized fuel delivery control and delivery start for each cylinder, even differently between each cylinder, to compensate for injector hydraulic tolerances.
The flow (rating feature) differences between the various injectors cannot be evaluated directly by the control unit. This information is provided by the entry of the codes for every single injector, by means of the diagnosis instrument.

Synchronization search

The center can anyhow recognize the cylinder to inject fuel into even in the absence of a signal from the camshaft sensor.
If this occurs when the engine is already started, combustion sequence is already acquired, so the center continues with the sequence it is already synchronized on; if it occurs with the engine stopped, the center only actuates one electro valve. Injection occurs onside that cylinder within 2 shaft revs at the utmost so the center is only required to synchronize on the firing sequence and start the engine.

In order to reduce the number of connections, and of the cables connecting the injectors, and to consequently reduce the nose on transmitted signal, the central unit is directly mounted on the engine by a heat exchanger enabling its cooling, using spring blocks which reduce vibrations transmitted from engine.

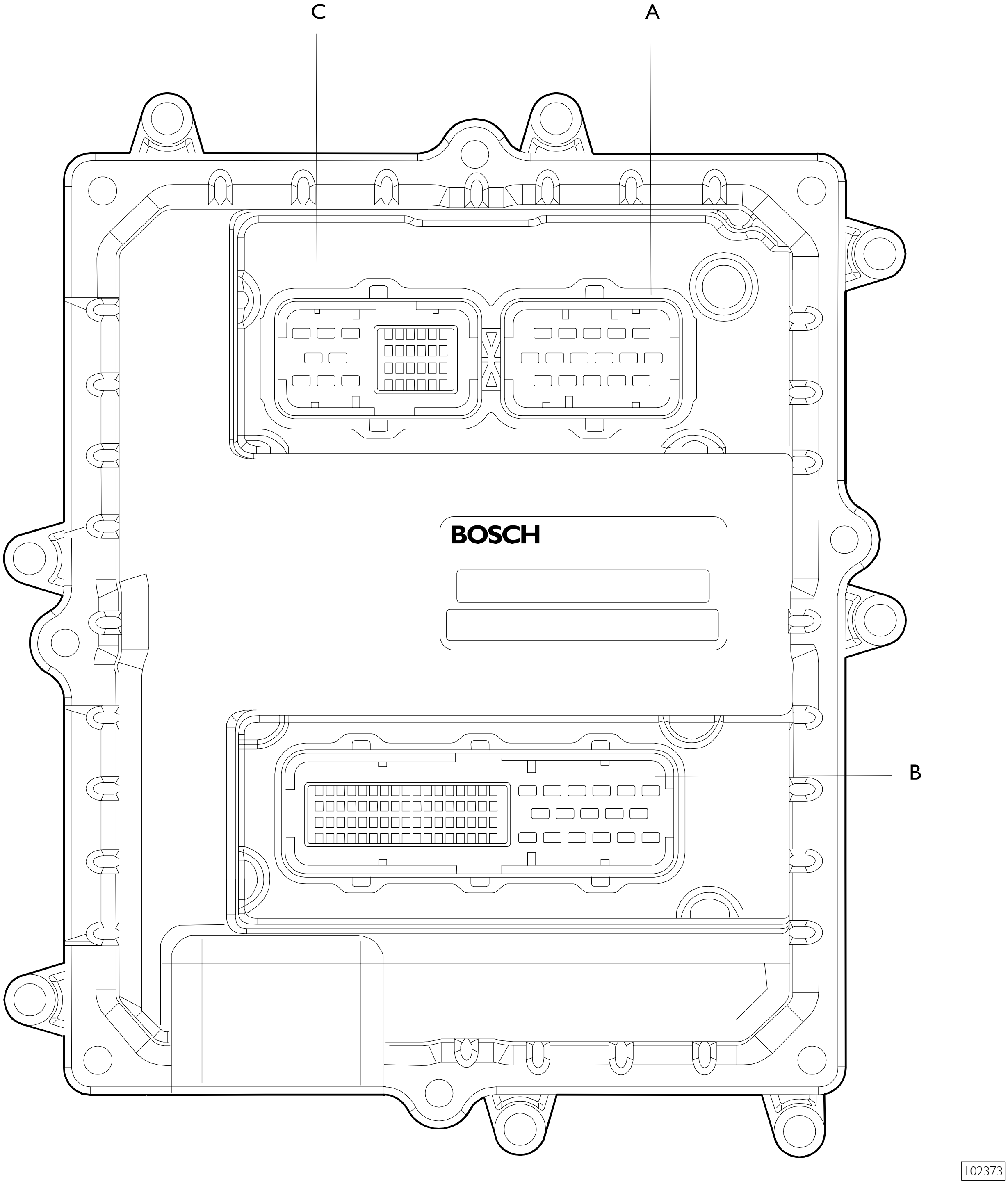
It is connected to vehicle wiring harness by two 35-pole connectors:
connector "A" for components present on the engine
connector "B" for components present on the cab

Internally, there is a pressure ambient sensor use to further improve injection system management.

The central unit is equipped with a much advanced self-diagnosis system and, depending on environmental conditions, is capable to identify and store any faults, even of intermittent type, occurred to the system during vehicle running, ensuring a more correct and reliable repair intervention.

EDC 7 UC31 electronic control unit

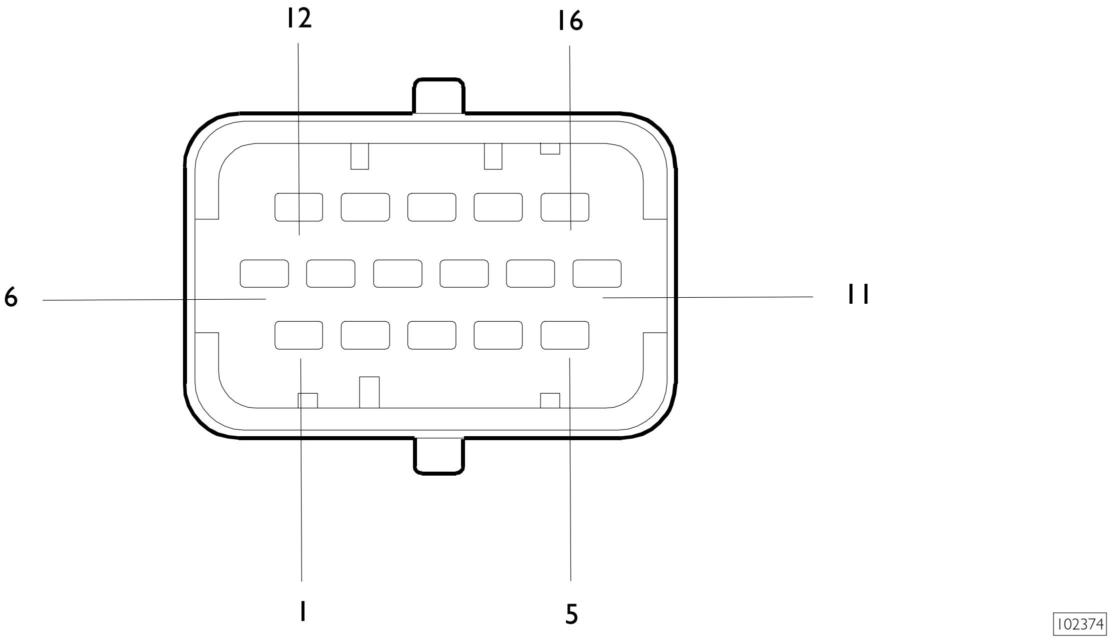
Figure 4



A. Injector connector - B. Chassis connector - C. Sensor connector.

Electric injector connector ”A”

Figure 5



Colour legend

B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange
E	grey
K	pink

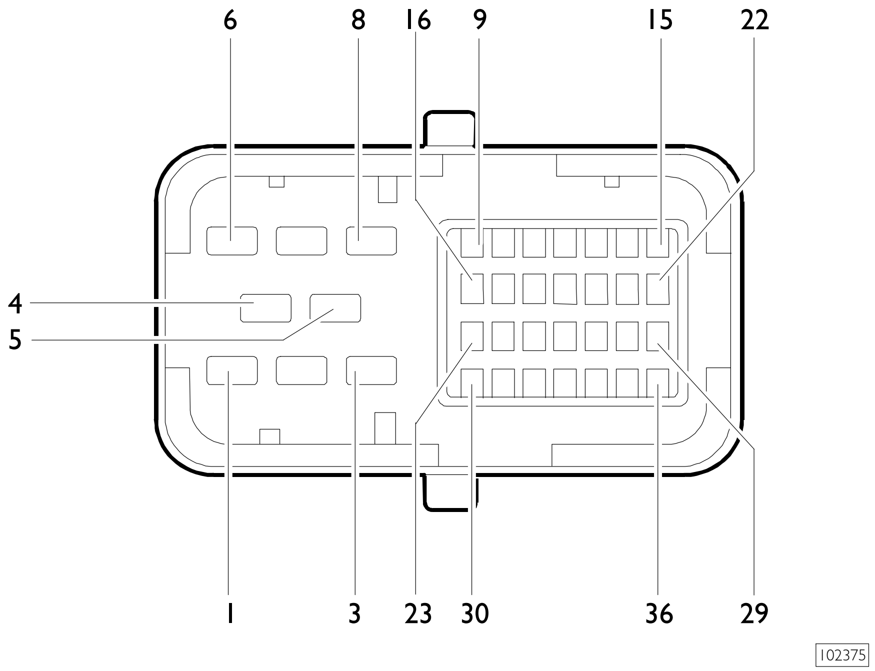
ECU Pin	Colour legend	Function
1	-	Free
2	-	Free
3	B	Solenoid valve for electronic cylinder (4-5-6) injection
4	-	Free
5	-	Free
6	W	Solenoid valve for electronic cylinder 2 injection
7	O	Exhaust brake control solenoid valve
8	N	Exhaust brake control solenoid valve
9	-	Free
10	-	Free
11	R	Solenoid valve for electronic cylinder (1-2-3) injection
12	G	Solenoid valve for electronic cylinder 3 injection
13	W	Solenoid valve for electronic cylinder 1 injection
14	U	Solenoid valve for electronic cylinder 4 injection
15	E	Solenoid valve for electronic cylinder 6 injection
16	P	Solenoid valve for electronic cylinder 5 injection

Sensor connector "C"

Figure 6

Colour legend

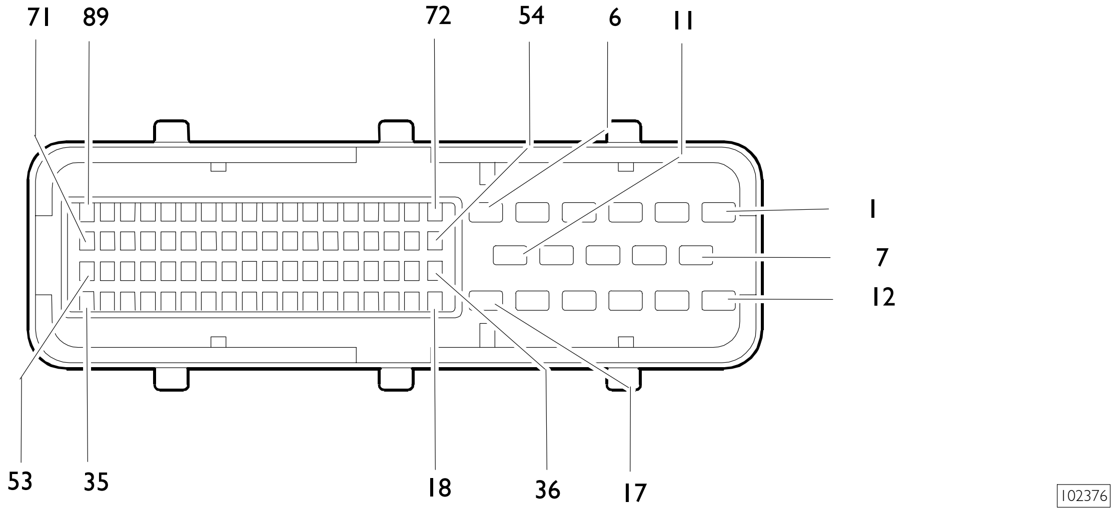
B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange
E	grey
K	pink



ECU Pin	Cable colour	Function
1	N	Solenoid valve for variable geometry turbine control
2	-	Free
3	B	Solenoid valve for variable geometry turbine control
4÷8	-	Free
9	W	Distribution sensor
10	R	Distribution sensor
11÷14	-	-
15	K	Coolant temperature sensor
16	-	Free
17	-	Fuel temperature sensor mass
18	O/B	Fuel temperature sensor
19	B	Flywheel sensor
20	N	Booster speed sensor
21÷22	-	Free
23	W	Flywheel sensor
24	N	Engine oil temperature/pressure sensor ground
25	W	Mass for air pressure / temperature sensor
26	Y	Coolant temperature sensor
27	O/B	Oil pressure signal from engine oil pressure / temperature sensor
28	U	Oil temperature signal from engine oil pressure / temperature sensor
29	-	Free
30	W	Booster speed sensor
31	-	Free
32	O	Engine oil temperature/pressure sensor power supply
33	R	Air temperature/pressure sensor power supply
34	G	Air pressure signal from the air temperature/ pressure sensor
35	W/R	Fuel temperature sensor
36	O	Air temperature signal from the air temperature / pressure sensor

Chassis connector ”B”

Figure 7



ECU pin	FUNCTION
1	Lambda sensor heater signal (*)
2	Positive voltage direct from battery
3	Positive voltage direct from battery
4	Lambda sensor heater supply (*)
5	Battery negative
6	Battery negative
7	Negative voltage for control relay of heater grid control 2 (*)
8	Positive voltage direct from battery
9	Positive voltage direct from battery
10	Battery negative voltage
11	Battery negative voltage
12	Signal from grid on heater 1 (*)
13	Positive voltage +15
14	Positive voltage for air conditioning compressor (*)
15	Signal from air conditioning compressor (*)
16	Negative voltage speed 1 fan
17	Starting relay negative voltage
18	Turbine sensor signal (*)
19	Turbine sensor earth (*)
20	Negative voltage intercooler by-pass valve (*)
21	Supply voltage for switches
22	To diagnostic warning light
23	Additional solenoid valve signal
24	Earth for particle filter temperature sensor (*)
25	Signal for particle filter temperature sensor (*)
26	Intake air humidity and temperature sensor signal
27	Intake air humidity and temperature sensor signal
28	Intake air humidity and temperature sensor earth
30	To diagnostic warning light
31	Cruise control positive signal (*)
32	Negative voltage from engine start switch from engine compartment
33	Tachometer output signal (*)
34	(Low) signal CAN 2 line interface input
35	(High) signal CAN 2 line interface

ECU pin	FUNCTION
36	Negative voltage for fuel filter heater switch (*)
37	Starting relay positive voltage
38	OBD lamp negative voltage (*)
39	Speed limiter lamp negative voltage (*)
40	Positive voltage +15 under lock
41	Positive voltage from main brake switch
42	Negative voltage from sensor detecting water in the pre-filter
43	Signal 1 from Lambda probe (*)
44	Signal 2 from Lambda probe (*)
45	Signal 3 from Lambda probe (*)
46	Cruise control positive signal (*)
47	Negative voltage from engine stop switch from engine compartment
48	Negative voltage from accelerator pedal idling switch
49	Positive voltage from brake switch (redundant signal)
50	Positive voltage +12
52	(Low) signal CAN 1 line interface input
53	(High) signal CAN 1 line interface
54	Negative voltage for fan second speed control switch (*)
55	Positive voltage for engine brake exhaust gas solenoid valve (*)
56	Negative voltage for pre-heating lamp (*)
57	Positive voltage speed 1 fan (*)
58	Earth for engine brake exhaust gas solenoid valve (*)
59	Earth for blow-by pressure difference sensor (*)
61	Positive voltage for blow-by pressure difference sensor (*)
62	Passive analogue signal from torque limiter multiple resistor (*)
63	Signal 4 from Lambda probe (*)
64	Cruise control positive signal (*)
65	Earth from multiple resistor torque limiter (*)
66	Positive voltage from clutch switch (torque converter) (*)
67	Earth for cooling fan speed sensor (*)
69	Signal from cooling fan speed sensor (*)
70	Vehicle speed sensor earth (*)
71	Vehicle speed sensor signal (*)
72	Synchronising bit on serial interface input signal
73	Local area network interconnection input signal
74	Cruise control positive signal (*)
75	Supply voltage for grid on heater 1 (*)
76	Earth for exhaust gas temperature sensor (*)
77	Supply voltage for accelerator potentiometer
78	Earth for accelerator potentiometer
79	Signal from accelerator potentiometer
80	Signal from exhaust gas temperature sensor (*)
81	Signal from particle trap differential pressure sensor (*)
82	Positive voltage from particle trap differential pressure sensor (*)
83	Earth from particle trap differential pressure sensor (*)
85	Negative voltage from diagnostic request switch
87	Crankshaft rotation output signal
88	Camshaft rotation output signal
89	ISO-K interface input signal

* If present

Pump injector (78247)

It consists mainly of:

A) Solenoid valve

B) Pumping element

C) Nozzle

These three parts **CANNOT be replaced individually and CANNOT be overhauled.**

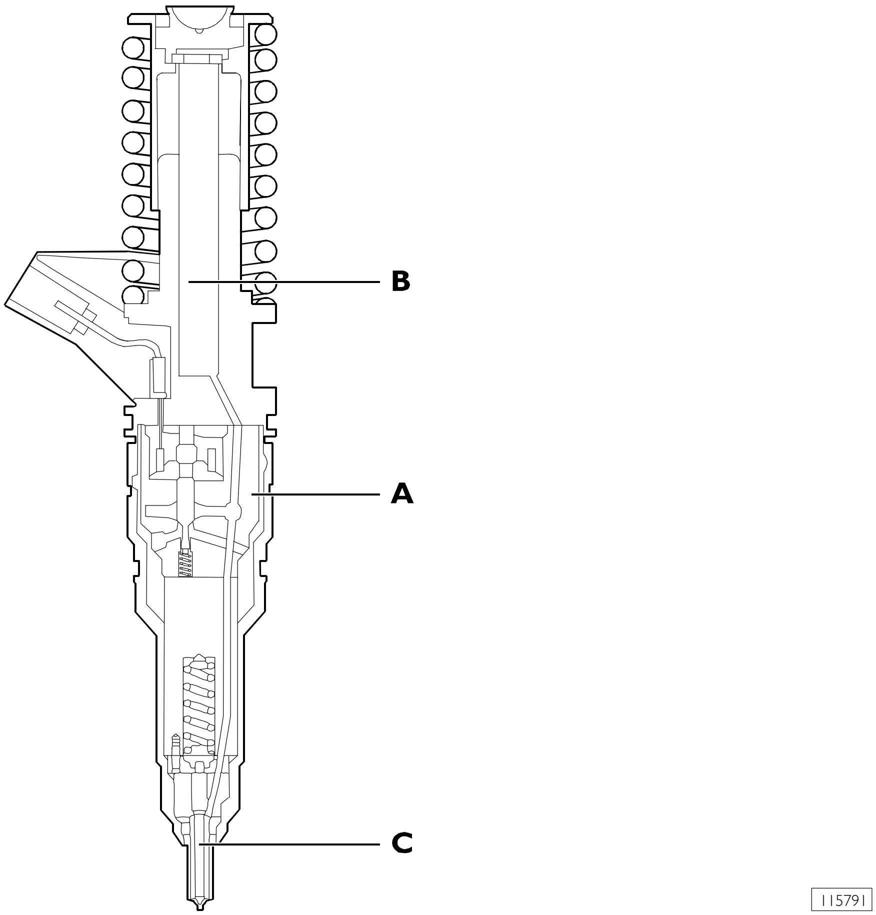
The pumping element, mechanically actuated at every rocker arm cycle, compresses the fuel container in the delivery chamber.

The nozzle, whose composition and operation are similar to those of traditional injectors, is opened by the fuel under pressure and sprays it into the combustion chamber.

A solenoid valve, directly controlled by the electronic control unit, determines delivery according to the control signal.

A casing houses the lower part of the pump injector in the cylinder head.

Figure 8



The electro valve is of the N.A. type.

Coil resistance is ~ 0.56 ÷ 0.57 Ohm.

Maximum operating voltage is ~ 12 ÷ 15 Amp.

Based on voltage absorbed by the electro valve, the electronic center can identify whether injection was correct or mechanical problems exist. It can also detect injector errors ONLY with the engine running or during starts.

They are connected to the electronic center with a positive common to groups of three injectors:

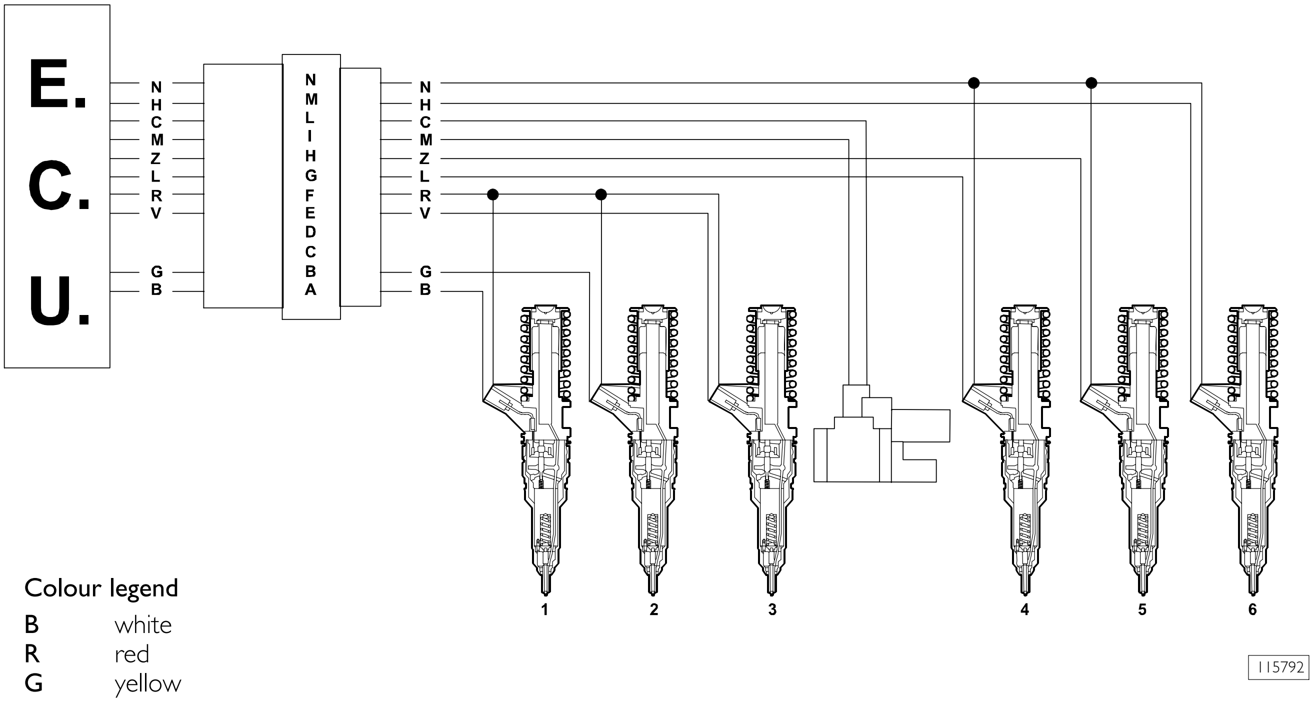
Cylinder 1 - 2 – 3 injector to pin A 11
Cylinder 4 - 5 - 6 injector to pin A 3.

Injectors are individually connected to the center between pins:

A11 / A13 cylinder 1 injector
A11 / A6 cylinder 2 injector
A11 / A12 cylinder 3 injector
A3 / A14 cylinder 4 injector
A3 / A16 cylinder 5 injector
A3 / A15 cylinder 6 injector

Injectors are connected to the center with connector ST - E mounted on the engine front with a twisted cable, to avoid possible electromagnetic interference problems, so junctions or repairs on it must NOT be performed.

Figure 9

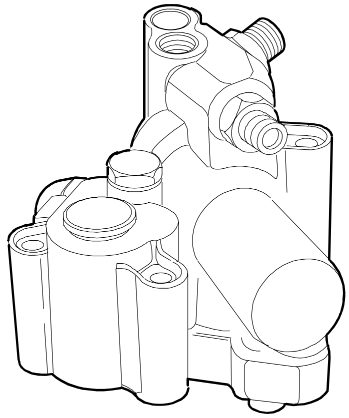


Colour legend

B	white
R	red
G	yellow
V	green
N	black
L	blue
Z	purple
H	grey
M	brown
C	orange

Exhaust brake solenoid valve (78050)

Figure 10

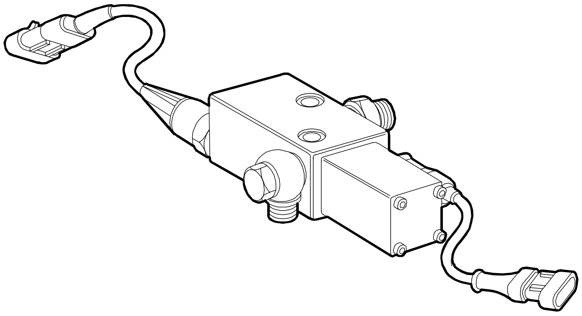


CURSOR 10

This on/off solenoid valve is NC type.
In Cursor 10 engines it is positioned under the tappets.
The electronic control unit pilots this solenoid valve and opens the way to engine oil so as to engage the hydraulic cylinders of the exhaust brake.
A warning light located on the dashboard is connected in parallel to this solenoid valve in order to inform the driver that it has tripped.
While feeding this solenoid valve, the control unit also activates the VGT.
The exhaust brake can be engaged only if the engine revolutions are > 1000 rpm.
This solenoid valve is connected to the EDC electronic control unit between pins A3 / A32.
The resistance of the coil is approx. 37 to 47 Ohm.

Solenoid valve for VGT control

Figure 11



This N.C. proportional solenoid valve is located on the left-hand side of the crankcase under the turbine.
The electronic control unit, via a PWM signal, controls the solenoid valve, governing the supply pressure of the turbine actuator, which, on changing its position, modifies the cross-section of the flow of exhaust gases onto the blades of the impeller and therefore its speed.
The VGT electro valve is connected between electronic center pins C1/C3.
The resistance of the coil is approx. 20-30 Ohms.

Distribution pulse transmitter (48042)

Features

Vendor	BOSCH
Torque	8 ± 2 Nm
Resistance	880 ÷ 920 Ω

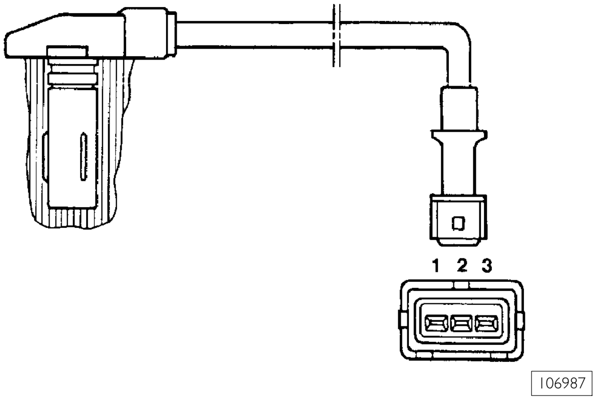
This induction type sensor located on the camshaft generates signals obtained from the magnetic flow lines that close through the 6 plus 1 phase teeth of a sound wheel mounted on the shaft.

The electronic center uses the signal generated by this sensor as an injection step signal.

Though electrically identical to (48035) engine rpm sensor mounted in the camshaft in is NOT interchangeable with it as it cable is shorter and it features a larger diameter.

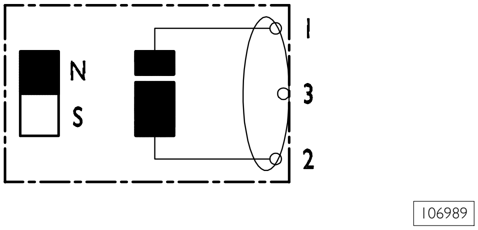
This sensor's air gap is NOT ADJUSTABLE.

Figure 12



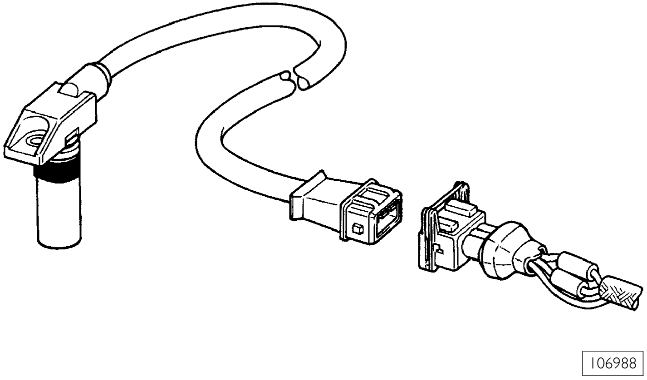
TECHNICAL VIEW

Figure 14



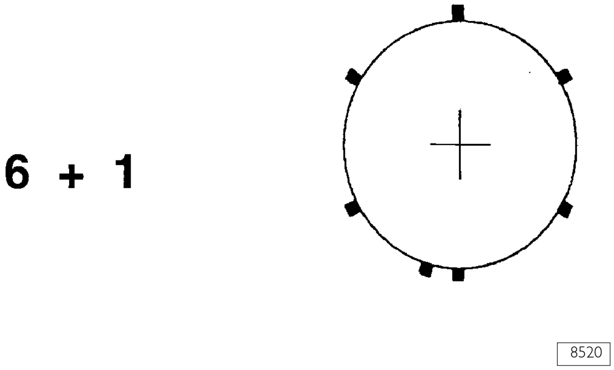
WIRING DIAGRAM

Figure 13



PERSPECTIVE VIEW

Figure 15



REFERENCE ON SOUND WHEEL

Connector	Function	Cable colour
1	To EDC center pin C 10	—
2	To EDC center pin C 9	—
3	Shields	—

Engine coolant temperature sensor (85153)

This N.T.C. type sensor located on the water outlet sump on the engine head left measures coolant temperature for the various operating logics with a hot or cold engine and identifies injection enrichment requirements for a cold engine or fuel reduction requirements for a hot engine.

The coolant temperature signal is used for display on the Cluster and to control the fan.

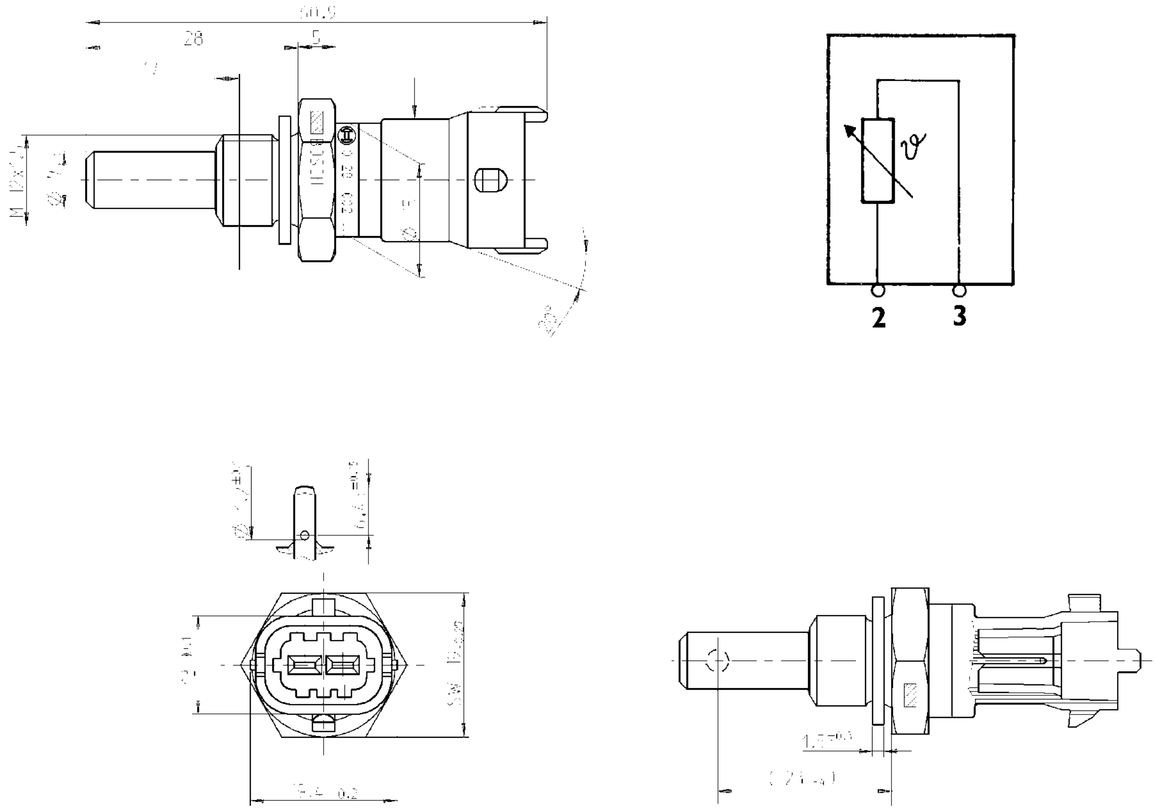
It is connected to electronic center pins C15/C26.

Sensor behavior as a function of temperature:

- 10 °C	8,10 ÷ 10,77 kOhm
+ 20 °C	2,28 ÷ 2,72 kOhm
+ 80 °C	0,29 ÷ 0,364 kOhm

At 60 to 90 °C, voltage at A5 and A22 ranges from 0.6 to 2.4V.

Figure 16



104266

Connector	Function	Cable colour
2	To EDC center pin C 15	—
3	To EDC center pin C 26	—

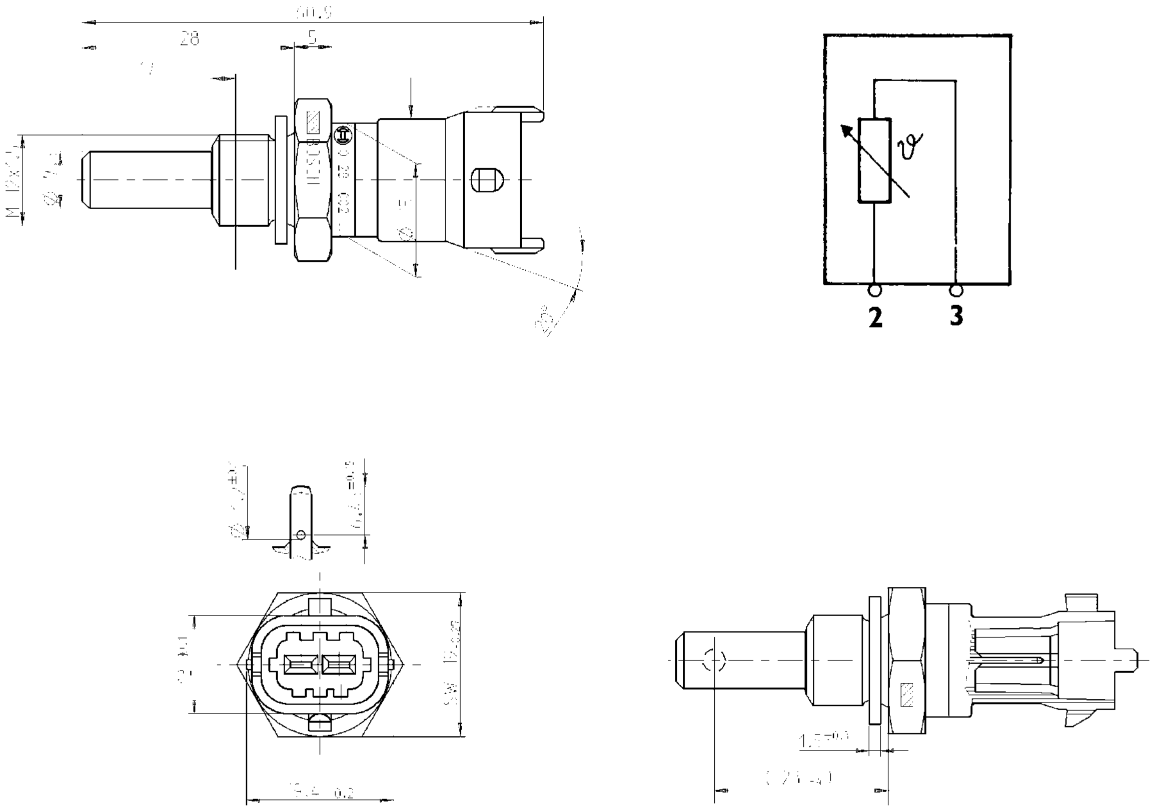
Fuel temperature sensor (47042)

Features

Vendor	BOSCH
Maximum torque	35 Nm

This N.T.C. type sensor located on the fuel filter on the engine left side detects fuel temperature and enables the electronic center to measure fuel density and volume for delivery correction.

Figure 17



104267

Connector	Function	Cable colour
2	To EDC center pin C 18	—
3	To EDC center pin C 35	—

Flywheel pulse transmitter (48035)

Features

Vendor	BOSCH
Torque	8 ± 2 Nm
Resistance	880 ÷ 920 Ω

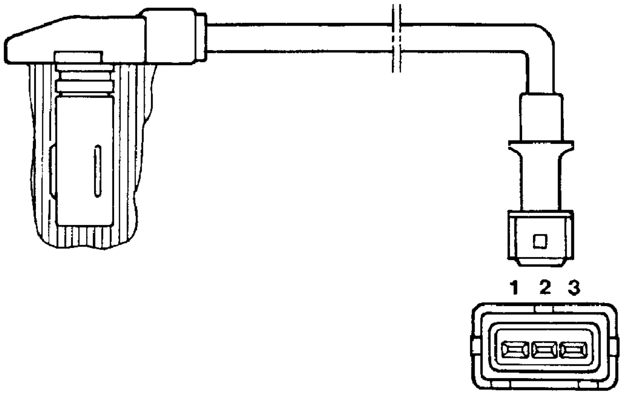
This induction type sensor located on the flywheel generates signals obtained from the magnetic flow lines that close through 54 holes in three series of 18 in the flywheel.

The electronic center uses this signal to detect the various engine ratings and pilot the electronic rev counter.

The rev counter does not operate in the absence of this signal.

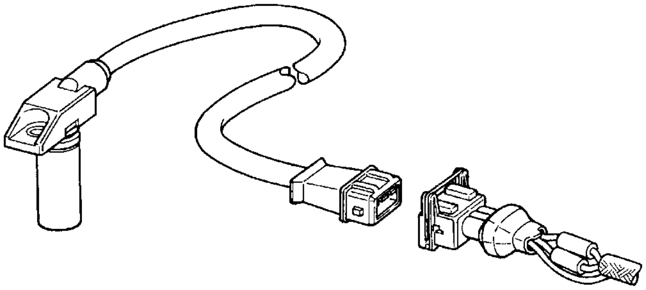
This sensor's air gap is NOT ADJUSTABLE.

Figure 18



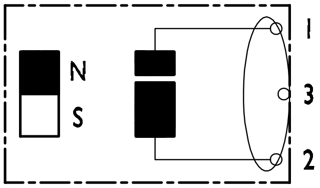
TECHNICAL VIEW

Figure 19



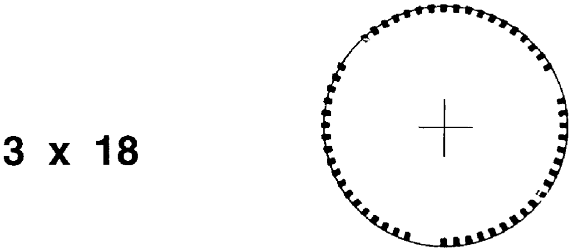
PERSPECTIVE VIEW

Figure 20



WIRING DIAGRAM

Figure 21



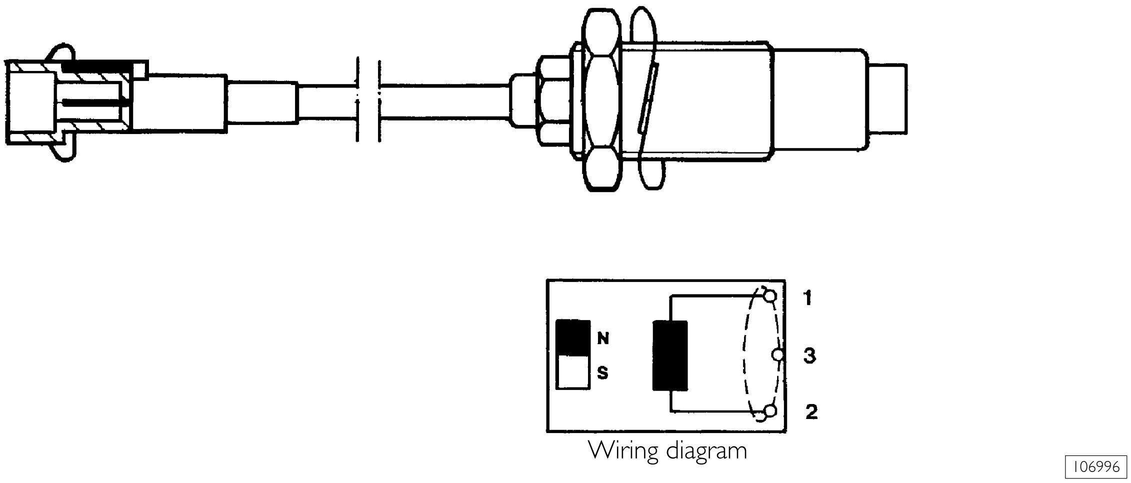
HOLES ON FLYWHEEL

Connector	Function	Cable colour
1	To EDC center pin C 23	—
2	To EDC center pin C 19	—
3	Shields	—

Turbine rpm sensor (48043)

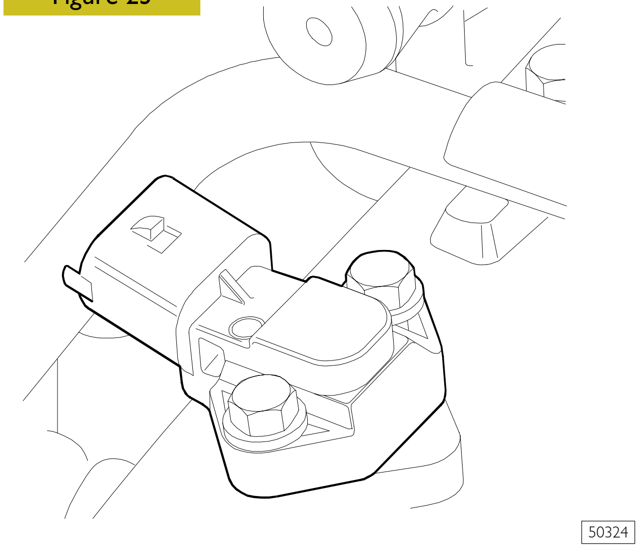
This is an inductive sensor positioned on the impeller shaft.
It generates signals obtained from the magnetic flow lines, which close through a notch obtained on the shaft itself.
The signal generated by this sensor is used by the electronic control unit to verify that the turbine revs number does not exceed the maximum value.
To control the revs number, the control unit acts on variable geometry.
If the revs number keeps on increasing until it reaches excessive r.p.m. values, the electronic control unit will detect an anomaly.
The gap of this sensor CANNOT BE ADJUSTED.
It is connected on electronic control unit pins C30 / C20.
The sensor resistance value is 400 Ohm.

Figure 22



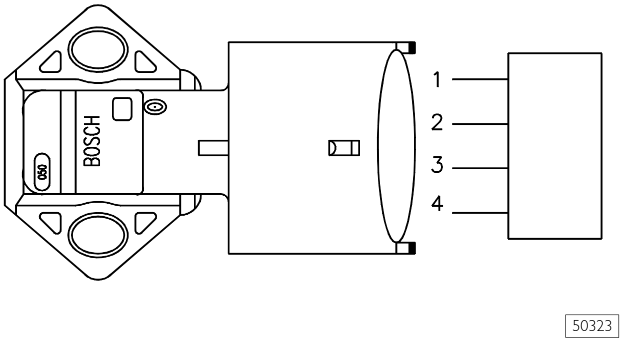
Wiring diagram

Figure 23



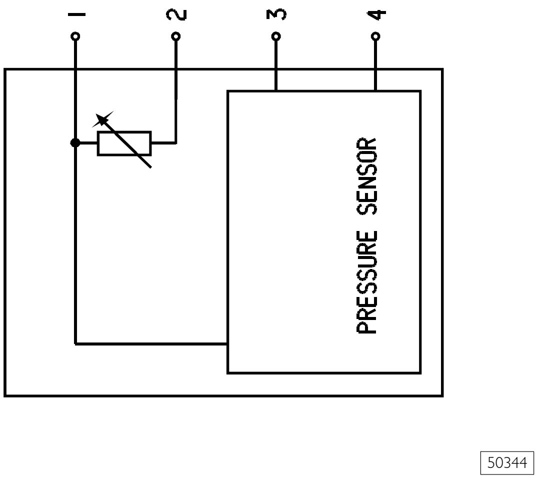
Sensor external view

Figure 24



Linking connector

Figure 25



Wiring diagram

Air pressure/temperature sensor (85156).

This component incorporates a temperature sensor and a pressure sensor.

Ilt replaces the temperature sensors (85155) and pressure sensors (85154) available in the preceding systems.

It is fitted onto the intake manifold and measures the maximum supplied air flow rate used to accurately calculate the amount of fuel to be injected at every cycle.

The sensor is powered with 5 V.

The output voltage is proportional to the pressure or temperature measured by the sensor.

Pin (EDC)	25/C - 33/C	Power supply
Pin (EDC)	36/C	Temperature
Pin (EDC)	34/C	Pressure

Oil temperature/pressure sensor (42030 / 47032)

This component is identical to the air pressure/temperature sensor and replaced single sensors 47032 / 42030.

It is fitted onto the engine oil filter, in a horizontal position.

It measures the engine oil temperature and pressure.

The measured signal is sent to the EDC control unit which controls, in turn, the indicator instrument on the dashboard (low pressure warning lights / gauge).

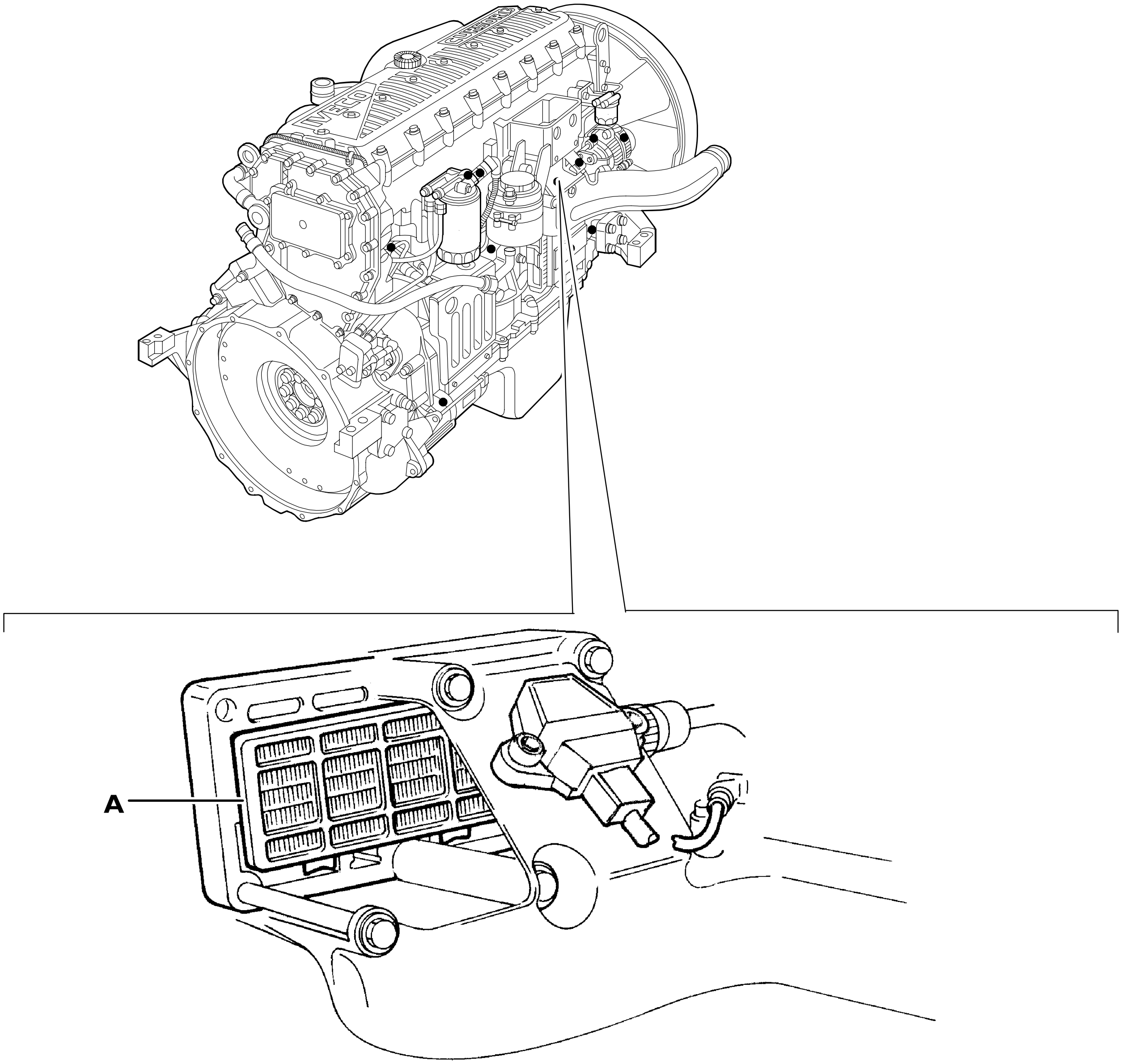
Pin (EDC)	24/C - 32/C	Power supply
Pin (EDC)	27/C	Temperature
Pin (EDC)	28/C	Pressure

The engine oil temperature is used only by the EDC control unit.

Ref.	Description	Control unit pin	
		Oil	Air
1	Ground	24C	25C
2	Temp. Sign.	27C	36C
3	+5	32C	33C
4	Press. Sign.	28C	34C

Pre-post reheat resistor (61121)

Figure 26



A. Pre/ort reheat resistor / 0.7 Ohm.

This resistor located between the cylinder head and the intake duct is used to heat air in pre/post reheat operations.

By inserting the key switch, when even only one of the water, air or gas oil temperature sensors record less than 10 °C, the electronic center activates pre/post reheating and switches on the warning light on the cab instrument panel for a variable period according to temperature, after which the light starts blinking to inform the operator that the engine can be started.

The warning light goes off after engine start but the resistor continues being supplied for a variable period of time to complete post reheating.

The operation is cancelled to prevent uselessly discharging the battery if the engine is not started within 20/25 seconds with the warning light blinking.

When reference temperature is above 10 °C, actuating the ignition key makes the warning light go on for some 2 seconds to complete the test and then turns it of to indicate the engine can be started.

PART THREE - TROUBLESHOOTING

PREFACE

A successful troubleshooting is carried out with the competence acquired by years of experience and attending training courses.

When the user complains for bad efficiency or working anomaly, his indications must be kept into proper consideration using them to acquire any useful information to focus the intervention.

After the detection of the existing anomaly, it is recommended to proceed with the operations of troubleshooting by decoding the auto-troubleshooting data provided by the EDC system electronic central unit.

The continuous efficiency tests of the components connected to, and the check of working conditions of the entire system carried out during working, can offer an important diagnosis indication, available through the decoding of the "failure/anomaly" codes.

It should be noted, that the interpretation of the indications given by the diagnostic device is not sufficient to guarantee that all failures are healed.

Using IVECO processing instruments, it is also possible to establish a bi-directional connection with the central unit, by which not only to decoding the failure codes but also input an enquiry relying on memory files, in order to achieve any further necessary information to identify the origin of the anomaly.

Every time there is a breakdown claim and this breakdown is actually detected, it is necessary to proceed inquiring the electronic unit in one of the ways indicated and then proceed with the diagnostic research making trials and tests in order to have a picture of the working conditions and identify the root causes of the anomaly.

In case the electronic device is not providing any indication, it will be necessary to proceed relying on the experience, adopting traditional diagnosis procedures.

In order to compensate the operators' lack of experience in this new system, we are hereby providing the USER's GUIDELINE FOR TROUBLESHOOTING in the following pages.

The GUIDELINE is composed of two different parts:

- ☐ Part 1: DTC codes and their indications are listed and interpreted; DTC codes can be viewed on the Iveco Motors diagnostic device;
- ☐ Part 2: guide to diagnostics, divided according to symptoms, including the description of possible failures not identified by the electronic control unit, often mechanical or hydraulic failures.

⚠ Any kind of operation on the electronic center unit must be executed by qualified personnel, duly authorized by IVECO.

Any unauthorized tamper will involve decay of after-sales service in warranty.

DTC error codes with EDC7 UC31 central unit

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
113	ACCELERATOR PEDAL/BRAKE PEDAL SUSPECT	Vehicle acceleration very slow. Engine idle speed: 500 rpm.	Accelerator pedal and brake pressed simultaneously (for too long); Accelerator pedal blocked or faulty; Incorrect use of vehicle.	Check the accelerator pedal signal and pedal mechanical movement.				
116	CLUTCH SIGNAL SUSPECT	The parameter reading shows that the clutch is pressed.	Clutch switch faulty or wiring problems in pedal.	Check clutch pedal switch and wiring.				
117	BRAKE PEDAL SIGNAL ERROR	Slight power reduction.	Main and secondary brake switch not synchronised. One of the two brake pedal switches may be stuck.	Check the synchronisation of both switches (signal) and wiring.				
119	PLAUSIBILITY +15		Possible mechanical problem (in pawl) or electrical problem.	Check wiring.				
121	SPEED LIMITER W/LIGHT	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
122	WARNING LIGHT EOBD	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
123	EDC LAMP	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
124	COLD START LAMP	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
125	MAIN RELAY DEFECT	Possible problems during after-run.	Relay short circuit to battery positive or earth.	Check wiring between ECM and battery. Replace relay if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
126	BATTERY VOLTAGE	Possible problems during after-run.	Alternator or battery defective. Possible wiring problem.	Check wiring. Replace alternator regulator or battery. Replace the alternator if necessary.				
127	ENGINE BRAKE ELECTROVALVE	Engine brake not operational.	Relay or wiring short-circuited or interrupted.	Check wiring. Replace relay if necessary.				
128	MAIN RELAY - SHORT CIRCUIT TO BATTERY	Possible problems during after-run.	Relay short circuit to battery positive or earth. Relay may be faulty.	Check wiring between ECM and battery. Replace relay if necessary.				
129	AIR-CONDITIONER COMPRESSOR RELAY	Possible problems during after-run.	Relay short circuit to battery positive or earth. Relay may be faulty.	Check wiring between ECM and battery. Replace relay if necessary.				
12A	RELAIS FOR ENGINE BRAKE VALVE	Possible problems during after-run.	Relay short circuit to battery positive or earth. Relay may be faulty.	Check wiring between ECM and battery. Replace relay if necessary.				
12B	THERMOSTARTER RELAY 1 (HEATER)	Heater not working.	Relay or wiring short-circuited or interrupted.	Check wiring. Replace relay if necessary.				
12C	THERMOSTARTER RELAY 2	Heater not working.	Relay or wiring short-circuited or interrupted.	Check wiring. Replace relay if necessary.				
12E	MANAGEMENT SYSTEM PRE/POST-HEATING (ACTIVE)	Grid heater permanently operating.	Grid heater short circuited to earth.	Check wiring and component.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
131	COOLANT TEMPERATURE SENSOR	No reaction noticeable on behalf of the driver.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
132	COOLANT TEMPERATURE SENSOR (TEST)	Slight power reduction.	Operation in extreme environmental conditions or sensor inaccurate.	Ensure the engine is not working in extreme environmental conditions. Check the wiring and the sensor accuracy. Replace sensor if necessary.				
133	AIR TEMPERATURE SENSOR BOOST AIR	Slight power reduction.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
134	BOOST PRESSURE SENSOR	No reaction perceivable by the driver. Parameter recovery value: 2700 mbar.	Sensor short-circuited or difference between environmental pressure and turbo pressure implausible.	Check the wiring. Also check the environmental pressure sensor. Replace sensor if necessary.				
135	FUEL TEMPERATURE SENSOR	Slight power reduction.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
138	OIL PRESSURE SENSOR	No reaction perceivable by the driver. Parameter recovery value: 3000 mbar.	Sensor short-circuited or value implausible.	Check the wiring and oil level. Replace sensor if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
13A	OIL TEMPERATURE SENSOR	No reaction perceivable by the driver. Parameter recovery value: coolant temperature value (if intact) otherwise 120°C).	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
13C	ATMOSPHERIC TEMPERATURE SENSOR (HUMIDTIY?)	No reaction perceivable by the driver. Parameter recovery value: 40°C.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
141	CRANKSHAFT SPEED	No reaction noticeable on behalf of the driver.	Signal interrupted or wiring problem. Sensor installation may not be correct.	Check wiring and installation. Replace sensor if necessary.				
142	ENGINE WORKING ONLY WITH CAMSHAFT SENSOR	No reaction perceivable by the driver.	Signal interrupted or wiring problem. Sensor installation may not be correct.	Check wiring and installation. Replace sensor if necessary.				
143	CAMSHAFT SENSOR	No reaction perceivable by the driver.	Signal interrupted or wiring problem. Sensor installation may not be correct.	Check wiring and installation. Replace sensor if necessary.				
144	FAULT BETWEEN FLYWHEEL SENSOR AND CAMSHAFT	No reaction noticeable on behalf of the driver.	Signal interrupted or wiring problem. Flywheel and timing sensor installation may be incorrect.	Check wiring and installation of both sensors.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
145	FAN RELAY	No reaction perceivable by the driver. Fan off.	Short circuit or fan actuator faulty.	Check the wiring and the fan actuator. Replace the actuator if necessary.				
148	AIR-CONDITIONER COMPRESSOR RELAY	Air conditioner permanently off.	Wiring or relay short-circuited.	Check the wiring. Replace relay if necessary.				
149	PRE-HEATING RELAY FUEL FILTER	Filter heater not working.	Wiring or filter heater short-circuited.	Check the wiring. Replace the filter heater if necessary.				
151	INJECTOR CYLINDER 1	The engine runs on 5 cylinders.	Injector no.1 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
152	INJECTOR CYLINDER 2	The engine runs on 5 cylinders.	Injector no.2 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
153	INJECTOR CYLINDER 3	The engine runs on 5 cylinders.	Injector no.3 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
154	INJECTOR CYLINDER 4	The engine runs on 5 cylinders.	Injector no.4 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
155	INJECTOR CYLINDER 5	The engine runs on 5 cylinders.	Injector no.5 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
156	INJECTOR CYLINDER 6	The engine runs on 5 cylinders.	Injector no.6 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
161	INJECTOR CYLINDER 1 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
162	INJECTOR CYLINDER 2 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
163	INJECTOR CYLINDER 3 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
164	INJECTOR CYLINDER 4 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
165	INJECTOR CYLINDER 5 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
166	INJECTOR CYLINDER 6 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
167	INJECTOR CYLINDER 1 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
168	INJECTOR CYLINDER 2 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
169	INJECTOR CYLINDER 3 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16A	INJECTOR CYLINDER 4 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16B	INJECTOR CYLINDER 5 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16C	INJECTOR CYLINDER 6 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16D	COMPRESSION TEST IN PROGRESS		Compression Test in progress.	After carrying out the compression test, turn the key OFF (after-run).				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
16E	THE MINIMUM NUMBER OF INJECTIONS WAS NOT REACHED: STOP THE ENGINE	More than 2 injectors not operating.		See individual faults in injectors.				
171	BENCH 1 CC	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem. Injectors short-circuited.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
173	BENCH 2 CC	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem. Injectors short-circuited.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
17C	BENCH 1 INJECTORS CHECK (INTERNAL ECU)	One or more injectors (bank 1 or bank 2) may not be operating.	Fault in control unit.	Replace the engine control unit.				
189	EGR POWER ST. SHORT TO BATT.	No fault perceived by the driver. EGR not working.	Short circuit or EGR actuator faulty.	Check wiring. Replace the EGR actuator if necessary.				
191	TURBINE ACTUATOR CONTROL ELECTROVALVE	Poor performance.	VGT actuator or wiring defective.	Check VGT wiring and actuator.				
192	TURBINE ACTUATOR CONTROL ELECTROVALVE SHORT CIRCUIT TO POSITIVE	Poor performance.	VGT actuator or wiring defective.	Check VGT wiring and actuator.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
193	TURBINE WHEEL REVS SENSOR	Poor performance.	Air filter blocked or turbine rpm sensor signal implausible.	Check the air filter and check parameters linked with the turbine by performing a road test (parameter acquisition).				
198	FAULT ON AT LEAST TWO OF THE FOLLOWING SENSORS: TURBINE SPEED, BOOT PRESSURE AND EXHAUST GAS PRESSURE	Poor performance.	Sensor signal implausible. Sensor may be faulty.	Determine which turbine component caused the problem.				
199	TURBOCHARGER CONTROL BOOST PRESSURE FAILURE (PCR)	Poor performance.	Turbo sensor or actuator may be faulty. Air filter may be blocked.	Check turbine sensors and actuator (parameter acquisition). Check whether air filter is blocked.				
19A	TURBINE SPEED EXCEEDING EVERY PERMITTED RANGE	Poor performance.	Turbo sensor or actuator may be faulty. Air filter may be blocked.	Check turbine sensors and actuator (parameter acquisition). Check whether air filter is blocked.				
19B	TURBINE IN OVERSPEED (the fault is not displayed if it is caused by a low atmosperic pressure)	Poor performance.	Air filter blocked or turbine rpm sensor signal implausible.	Check the air filter and check parameters linked with the turbine by performing a road test (parameter acquisition).				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
19F	NOx SENSOR ERROR	No effect perceived by the driver.	Sensor signal implausible. Nox sensor may be faulty.	Check the Nox sensor.				
1A5	TIMEOUT OF CAN MESSAGE DM1DCU	No effect perceived by the driver.	Problems in the Denoxtronic (on the CAN line).	Check wiring. Check and correct any faults in the Denoxtronic control unit.				
1A6	TIMEOUT OF CAN MESSAGE SCR1	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check Denoxtronic control unit wiring and operation.				
1AE	HUMIDITY SENSOR	No effect perceived by the driver.	Sensor short-circuited or faulty.	Check wiring. Replace sensor if necessary.				
1AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
1B1	ERROR ON CAN CONTROLLER A	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check terminal resistances.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1B2	ERROR ON CAN CONTROLLER B	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check terminal resistances.				
1B3	ERROR ON CAN CONTROLLER C	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check terminal resistances.				
1B4	TIMEOUT CAN MESSAGE BC2EDC1	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check BC wiring and operation.				
1B5	TIMEOUT CAN MESSAGE VM2EDC	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check VCM wiring and operation.				
1B7	ERROR ON MESSAGES CAN IN TRANSMISSION	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check ECM wiring and operation.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1B9	ERROR ON THE EOBD LIGHT MANAGED BY THE CLUSTER)	No effect perceived by the driver.	MIL/Body Controller warning light defective.	Consult the Body Controller troubleshooting guide and check the CAN line.				
1BA	TIMEOUT CAN MESSAGE DASH DISPLAY	No effect perceived by the driver.	CAN messages from VCM inconsistent.	Consult the VCM troubleshooting guide and check the CAN line.				
1BC	TIMEOUT CAN MESSAGE AMBCOND	No effect perceived by the driver.	CAN messages from VCM inconsistent.	Consult the VCM troubleshooting guide and check the CAN line.				
1BD	TIMEOUT CAN MESSAGE CCVS	No effect perceived by the driver.	CAN messages from VCM or BC inconsistent.	Consult the VCM/BC troubleshooting guide and check the CAN line.				
1C2	ERROR MESSAGE CAN ETC1	No effect perceived by the driver.	CAN messages from ETC (gearbox) inconsistent.	Check the ETC connection with the CAN line.				
1C3	TIMEOUT IN RECEIVING TC01 CAN MESSAGE	No effect perceived by the driver.	CAN messages from TCO inconsistent.	Check the TCO connection with the CAN line.				
1C6	ERROR MESSAGE CAN TSC1-PE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
1C8	ERROR MESSAGE CAN TSC1-VE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
1D1	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Electrical interference or internal control unit problems.	If the error persists to replace ECU.				
1D2	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash. Possible internal fault.	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1D3	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash Possible internal fault	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				
1D4	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1D5	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1D6	ECU INTERNAL ERROR (TPU)	Control unit deactivation.	Electronic interference or control unit faulty.	If the error persists to replace ECU.				
1D8	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1E2	IMMOBILIZER	The engine fails to start.	Problem in CAN line or immobiliser control unit.	Check the Immobiliser control unit is correctly connected. Enter the Immobiliser PIN code during the emergency procedure.				
1E3	ERROR FOR ECU INTERNAL MONITORING	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1E4	ERROR FOR ECU INTERNAL MONITORING	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1E5	SENSORS POWER SUPPLY FAULT (12V)	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1E6	SENSOR POWER SUPPLY 1	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E7	SENSOR POWER SUPPLY 2	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E8	SENSOR POWER SUPPLY 3	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E9	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1EA	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1EB	ATMOSPHERIC PRESSURE SENSOR	No effect perceived by the driver. Environmental pressure recovery value: 700 mbar.	Fault in sensor inside control unit.	Change ECU.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1FA	TOO HIGH NUMBER OF REGENERATIONS DEMAND	No reaction perceivable by the driver. Too many filter regenerations carried out.	Particulate filter may be blocked.	Check filter.				
1FB	PERMANENT RIGENERATION ON TRAP PARTICLE	No reaction perceivable by the driver.	Catalytic converter not installed or damaged.	Check catalytic converter visually.				
1FC	FIRST SENSOR EXAUSTED GAS TEMPERATURE	No reaction perceivable by the driver.	Temperature sensors damaged or incorrectly fitted.	Check information and condition of sensors.				
21F	TOO HIGH EFFICIENCY OF CATALYST SYSTEM	No reaction noticeable on behalf of the driver.	Actuator coil faulty or not within specified tolerance limits.	Check actuator condition.				
225	INTERRUPTED AFTER-RUN	Slight power reduction.	The control unit is turned off by the general switch instead of by the key (k15). Possible problem in main relay or connections.	Check wiring and then replace the main relay.				
228	MAIN RELAY - SHORT CIRCUIT TO GROUND	Slight power reduction.	Short circuit in main relay or relay faulty.	Check wiring between battery and ECM and then replace the main relay.				
232	Coolant temperature sensor absolute test	Slight power reduction.	Extreme environmental conditions or sensor incorrectly adjusted.	Ensure the engine is working in non-critical conditions. Check the sensor connections and accuracy. Replace sensor if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
238	OIL LOW PRESSURE	Slight power reduction.	Sensor incorrectly adjusted or faults in lubrication system.	Check the sensor connections and accuracy. Check the lubrication system.				
23A	OIL TEMPERATURE ABOVE NORMAL	Slight power reduction.	Sensor incorrectly adjusted or faults in lubrication system.	Check the sensor connections and accuracy. Check the lubrication system.				
27C	BENCH 2 INJECTORS CHECK (INTERNAL ECU)	One or more injectors (bank 1 or bank 2) may not be operating.	Fault in control unit.	Replace the engine control unit.				
292	TURBINE ACTUATOR CONTROL ELECTROVALVE SHORT CIRCUIT TO GROUND	Poor performance.	VGT actuator or wiring defective.	Check VGT wiring and actuator.				
2A6	TIMEOUT OF CAN MESSAGE SCR2	No effect perceived by the driver.	Problem in the Denoxtronic (on the CAN line).	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide. Check wiring.				
2AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
2B4	TIMEOUT CAN MESSAGE BC2EDC2	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check BC wiring and operation.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
2C6	TIMEOUT OF CAN MESSAGE TSC1-PE PASSIVE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
2C8	ERROR MESSAGE CAN TSC1-VR	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
2C9	ERROR MESSAGE CAN TIMEDATE	No effect perceived by the driver.	CAN messages from TC (tachograph) inconsistent.	Check the tachograph connection with the CAN line.				
2D3	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash. Possible internal fault.	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				
2FF	ERROR CHECK OF CRITICAL TIME FOR OIL DILUTION	Slight power reduction.	Oil over-diluted.	Change the engine oil.				
392	TURBINE ACTUATOR CONTROL ELECTROVALVE	Poor performance.	Connection damaged. Battery voltage excessive (ECU overheating).	Check VGT connection and actuator.				
3AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
3C8	TIMEOUT OF CAN MESSAGE TSC1-VE PASSIVE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
3C9	ERROR MESSAGE CAN HRDV	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check BC wiring and operation.				
3D3	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash. Possible internal fault.	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				
3FA	REGENERATION DEMAND NUMBER 2	No effect perceived by the driver.	Too many regenerations carried out.	Check particulate filter and faults in sensors.				
4AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
4C8	TIMEOUT OF CAN MESSAGE TSC1-VR PASSIVE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
4FA	REGENERATION DEMAND NUMBER 3	No effect perceived by the driver.	Too many regenerations carried out.	Check particulate filter and faults in sensors.				
5AF	DM1DCU SPN5 message	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				

GUIDELINE FOR TROUBLESHOOTING

SIGNALLED ANOMALY	BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
The battery goes flat quickly.	-	-	Pre-heating resistor powered continuously.	Local overheating.		
The engine will stop or won't start.	-	-	Fuel pre-filter clogged.			
Difficult start when the engine is either hot or cold.	-	-	The 3.5 bar valve on fuel return is stuck open.			
Slight overheating.	-	-	Either 0.3 bar tank return valve or return piping clogged.			
After the new vehicle has been delivered, the engine will stop after a short operation time.The tank holds a lot of fuel; all the rest is O.K.	-	-	Reversed tank suction / return pipes.			The engine is fed by the return pipe, the suction of which in the tank is lower. When the pipe sucks no more, the engine will stop.
Reduced power / difficult engine maneuverability.	-	-	Injection system / the engine operates with one cylinder failing: - injector plunger seizure; - valve rocker arm seizure.	Overheating	Engine test: cylinder efficiency test. If the trouble is not related to electric components (Blink code 5.x), the rocker arm holder shaft needs be disassembled. Check the rocker arm roller and bushing as well as the respective cam.	
Fuel consumption increase.	-	-	Air filter clogging with no signal from the warning light on the instrument board.	Smoke.	Check the cabling, connections and component.	

SIGNALLED ANOMALY	BLINK CODE	EDC WAR-NING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
The engine does not reach the other speeds under load conditions.	-	-	The boosting pressure sensor provides too high values, which, in any case, fall within the range.	Smoke.		
The driver feels that the engine is not working correctly like it did before.	-	-	Impaired hydraulic performance of an injector.		Engine test: check-up	Replace the injector of the cylinder in which Modus detects lower performance levels (compared with the others) only after verifying that the control rocker arm adjustment is correct.
The driver feels that the engine is not working correctly like it did before.	-	-	Wrong adjustment of an injector control rocker arm.		Engine test: check up.	Perform correct adjustment, then repeat the engine test.
The engine operates with five cylinders; noise (knock).	-	-	Plunger seizure.	Possible overheating.	Engine test: cylinder efficiency.	Replace the injector of the cylinder in which the diagnosis instrument detects lower performance levels (compared with the others).
Replace the injector of the cylinder in which the diagnosis instrument detects lower performance levels (compared with the others).	-	-	Wrong adjustment of the injector control rocker arm (excessive travel) with impact on the plunger on the nozzle.	Possible mechanic damage to the areas surrounding the injector.	Engine test: cylinder efficiency.	Replace the injector of the cylinder in which the diagnosis instrument detects lower performance levels (compared with the others).
The engine will stop or won't start again.	-	-	Presence of air in the fuel supply circuit.	It might even not switch off; it might have operation oscillations, or start, yet with difficulty and after making many attempts.	Bleed air.	

PART FOUR - MAINTENANCE PLANNING

MAINTENANCE

Maintenance services scheme

Out of plan operations are interventions complementary to standard services.
They are maintenance operations to be carried out at regular time or mileage intervals and concern optional components that are not present on all models.
Important! The correlation between kilometres and months only applies in cases where the distance travelled by the vehicle corresponds roughly to the specified average annual mileage. This is indicated only in order to suggest a hypothetical maintenance programme,. Note that the time intervals specified for Extra Plan operations are to be adhered to regardless of the actual mileage covered.

NOTE The kilometre frequency for engine lubrication is in relation to a percentage of sulphur in diesel of under 0.5%.
NOTE: If using diesel with a percentage of sulphur above 0.5%, the oil-change frequency has to be halved.

Use engine oil: **ACEA E4 (URANIA FE 5 W 30)**
ACEA E7 (URANIA LD7)

NOTE

☐ If class ACEA E7 (Urania LD7) engine oil is used, the engine oil and filters must be changed every 100,000 km.

☐ If class ACEA E2 (Urania Turbo) engine oil is used, the engine oil and filters must be changed every 50,000 km.

☐ In the case of very low annual mileage of less than 150,000 km/year, the engine oil and filters must be changed every 12 months.

☐ The ACEA E4 lubricants also classed as ACEA E6 must not be used with the change frequency contemplated for class ACEA E4. Their use must include changing the oil at the contemplated mileages for ACEA E2 lubricants and that is every 50,000 km.

Maintenance intervals

To schedule the work, keep to the following chart:

USAGE APPLICATIONS	**OILS**	**SERVICES**		**EXTRA PLAN**		**PROGRAMMED OPERATIONS**	
		M1	**M2**	**EP1**	**EP2**	**T2**	**T3**
On road	**Engine (1)** Urania FE5W30	Every 150,000 km	Every 300,000 km	Every 100,000 km	After the first 150,000 km and subsequently every 300,000 km	Every year	Every 2 years

(1) IVECO recommends using these oils to obtain benefits in terms of ''fuel economy''. IVECO already equips new vehicles with these types of lubricants, suited for cold climates too (minimum temperature down to -30°C). The lubricant change frequency is related to using these types of oil.

(2) In this case, IVECO already equips new vehicles with mineral base bridge oil.

CHECKS AND/OR MAINTENANCE WORK

Type of operation	M1	M2
	Every 150,000 km	Every 300,000 km
Engine		
Change engine oil	•	•
Change engine oil filters	•	•
Replacing the Blow-by filter	•	•
Check of clutch wear of fan electromagnetic joint	•	•
Check miscellaneous drive belts	•	
Check-up on engine EDC system with MODUS or IT2000	•	•
Change VGT variable geometry turbocharger valve air filter		•
Change miscellaneous drive belts		•
Replacing the Ad Blue filter / pre-filter	•	•
Replace engine air filter (dry filter element) (1)	•	•
Test Ad Blue system with E.A.S.Y, MODUS, IT 2000	•	•
Replacement of fuel prefilter cartridge	•	•

(1) Early clogging of the air cleaner is generally due to environmental conditions. For this reason it needs to be replaced when signalled by the sensor irrespective of the guidelines that anyhow have to be observed if there are no specific instructions otherwise.

NON-PROGRAMMED/TIMED OPERATIONS

EP1 - Every 100.000 Km

if possible, at the same time as a maintenance service

Change fuel filter

EP2 - In the initial period at 150,000 km and then every 300,000 km

if possible, at the same time as a maintenance service

Check and adjust valve clearance and injectors

T2 - Every year – Before winter

if possible, at the same time as a maintenance service

Check coolant density

T3 - Every two years

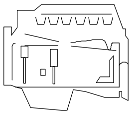
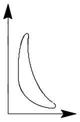
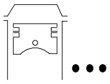
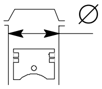
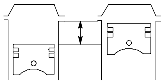
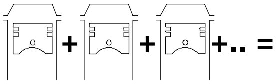
if possible, at the same time as a maintenance service

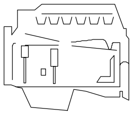
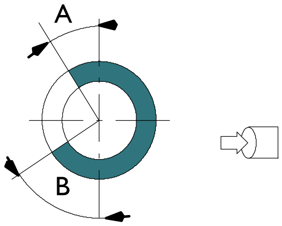
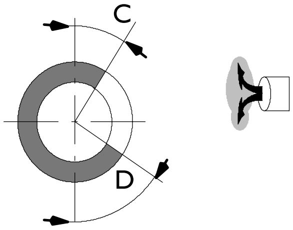
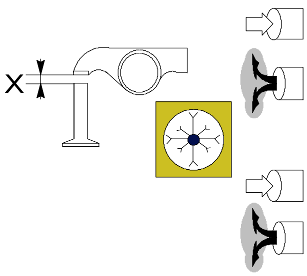
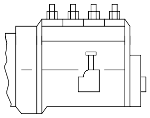
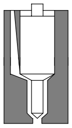
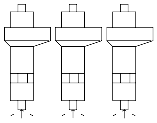
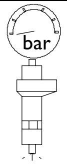
Change engine coolant

SECTION 4

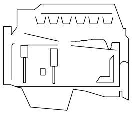
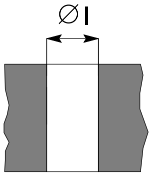
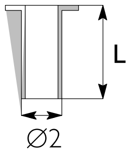
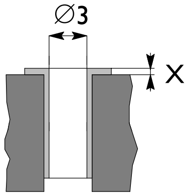
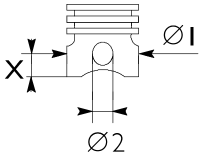
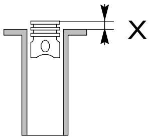
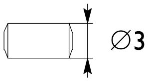
General overhaul

GENERAL CHARACTERISTICS

	Type		**F3AE3681**
	Cycle		4-stroke Diesel engine
	Fuel feed		Turbocharged
	Injection		Direct
	No. of cylinders		6 in line
	Bore	mm	125
	Stroke	mm	140
	Total displacement	cm^3	10300
ϱ	Compression ratio		16.5 : 1

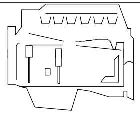
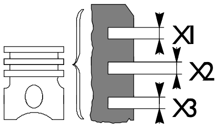
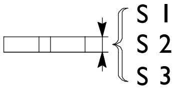
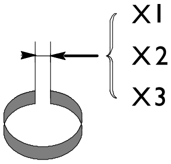
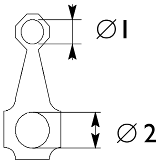
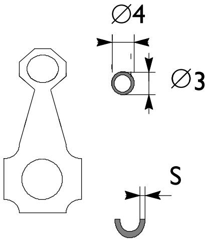
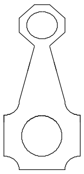
	Type		**F3AE3681**
	VALVE TIMING opens before T.D.C. closes after B.D.C.	 A B	 16° 32°
	opens before B.D.C. closes after T.D.C.	D C	50° 9°
	For timing check X	mm mm	- -
	Running X	mm mm	0.35 to 0.45 0.45 to 0.55
	FEED		Through fuel pump - filters
	Injection type: Bosch		With electronically regulated injectors UIN 3.1 pump injectors controlled by overhead camshaft
	Nozzle type		–
	Injection order		1 - 4 - 2 - 6 - 3 - 5
	Injection pressure	bar	2000

ASSEMBLY CLEARANCE DATA

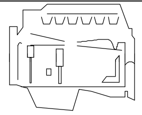
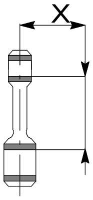
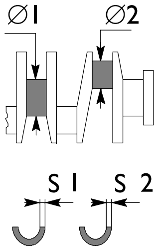
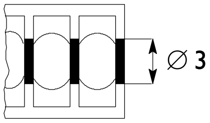
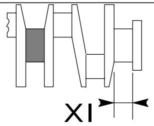
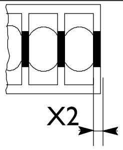
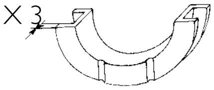
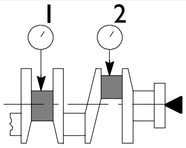
	Type	**F3AE3681**
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS		mm
	Bores for cylinder liners:	
	Ø1 upper	142.000 to 142.025
	lower	140.000 to 140.025
	Cylinder liners: external diameter:	
	Ø2 upper	141.961 to 141.986
	lower	139.890 to 139.915
	length L	-
	Cylinder liners - crankcase bores	
	upper	0.014 to 0.064
	lower	0.085 to 0.135
IVECO PARTS >	External diameter Ø2	-
	Cylinder sleeve	
	inside diameter Ø3A*	125.000 to 125.013
	inside diameter Ø3B*	125.011 to 125.024
* Selection class	Protrusion X	0.045 to 0.075
	Pistons:	
	measuring dimension X	18
	external diameter Ø1A●	124.861 to 124.873
	external diameter Ø1B●●	124.872 to 124.884
	pin bore Ø2	50.030 to 50.038
	Piston - cylinder sleeve	
	A*	-
* Selection class	B*	-
IVECO PARTS <	Piston diameter Ø1	-
	Pistons protrusion X	0.23 to 0.53
	Gudgeon pin Ø3	49.994 to 50.000
	Gudgeon pin - pin housing	0.030 to 0.044

● Class A pistons supplied as spares.

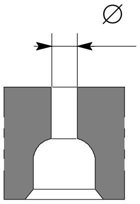
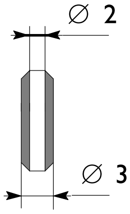
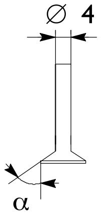
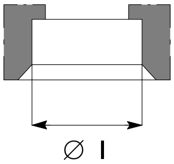
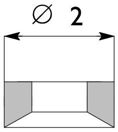
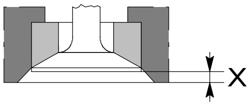
●● Class B pistons are fitted in production only and are not supplied as spares.

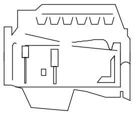
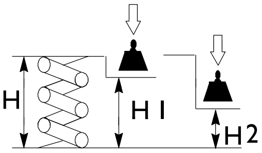
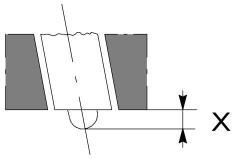
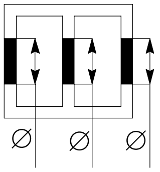
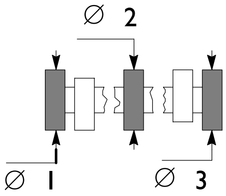
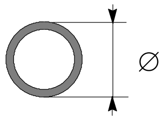
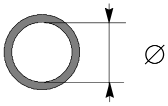
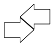
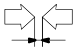
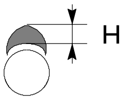
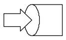
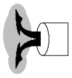
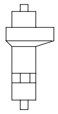
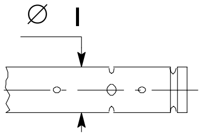
	Type	F3AE3681 mm
	Piston ring grooves X1 X2 X3 * measured on Ø of 120 mm	2.098 to 2.128 * 1.550 to 1.570 4.020 to 4.040
	Piston rings: - trapezoidal seal S1* - lune seal S2 - milled scraper ring with slits and internal spring S3 * measured at 2 mm from outer Ø	1.929 to 1.973 1.470 to 1.500 3.970 to 3.990
	Piston rings - grooves 1 2 3	0.125 to 0.199 0.050 to 0.100 0.030 to 0.070
IVECO PARTS	Piston rings	-
	Piston ring end gap in cylinder liners X1 X2 X3	0.35 to 0.45 0.60 to 0.75 0.35 to 0.65
	Small end bush housing Ø1 Big end bearing housing Ø2 - Class 1 - Class 2 - Class 3	54.000 to 54.030 87.000 to 87.010 87.011 to 87.020 87.021 to 87.030
	Small end bush diameter outside Ø4 inside Ø3 Big end bearing shell S Red Green Yellow ●	54.085 to 54.110 50.019 to 50.035 1.970 to 1.980 1.981 to 1.990 1.991 to 2.000
	Small end bush - housing	0.055 to 0.110
	Piston pin - bush	0.019 to 0.041
IVECO PARTS	Big end bearing	0.127 - 0.254 - 0.508
	Connecting rod weight Class A Class B Class C	g. 4024 to 4054 g. 4055 to 4054 g. 4105 to 4135

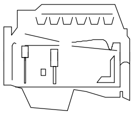
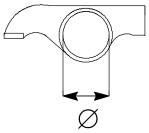
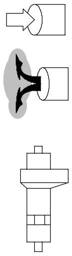
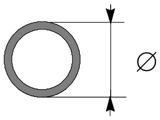
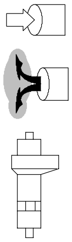
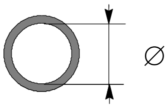
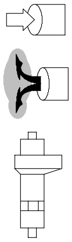
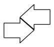
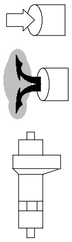
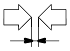
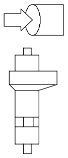
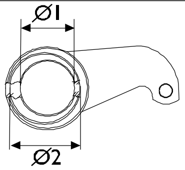
● Fitted in production only and not supplied as spares

	Type		F3AE3681
			mm
	Measuring dimension	X	125
	Max. connecting rod axis misalignment tolerance	=	0.08
	Main journals	∅1	
	- nominal		92.970 to 93.000
	- class	1	92.970 to 92.979
	- class	2	92.980 to 92.989
	- class	3	92.990 to 93.000
	Crankpins	∅2	
	- nominal		82.970 to 83.000
	- class	1	82.970 to 82.979
	- class	2	82.980 to 82.989
	- class	3	82.990 to 83.000
	Main bearing shells	S1	
	Red		2.965 to 2.974
	Green		2.975 to 2.984
	Yellow*		2.985 to 2.995
	Big end bearing shells	S2	
	Red		1.970 to 1.980
	Green		1.981 to 1.990
	Yellow*		1.991 to 2.000
	Main bearing housings	∅3	
	- nominal		99.000 to 99.030
	- class	1	99.000 to 99.009
	- class	2	99.010 to 99.019
	- class	3	99.020 to 99.030
	Bearing shells - main journals		0.050 to 0.090
	Bearing shells - big ends		0.040 to 0.080
IVECO PARTS	Main bearing shells	<	0.127 - 0.254 - 0.508
	Big end bearing shells		0.127 - 0.254 - 0.508
	Main journal, thrust bearing	X1	45.95 to 46.00
	Main bearing housing, thrust bearing	X2	38.94 to 38.99
	Thrust washer halves	X3	3.38 to 3.43
	Crankshaft end float		0.10 to 0.30
	Parallelism	// 1 - 2	0.025
	Concentricity	◎ 1 - 2	0.040

* Fitted in production only and not supplied as spares.

	Type	F3AE3681
CYLINDER HEAD - VALVE TRAIN		mm
	Valve guide housings in cylinder head Ø1	14.980 to 14.997
	Valve guide Ø2 Ø3	9.015 to 9.030 15.012 to 15.025
	Valve guides - housings in the cylinder heads	0.015 to 0.045
	Valve guide	0.2 - 0.4
	Valves: Ø4 α Ø4 α	 8.960 to 8.975 60° 30′ ± 7′ 30″ 8.960 to 8.975 45° 30′ ± 7′ 30″
	Valve stem and its guide	0.040 to 0.070
	Valve seat in head Ø1 Ø1	 44.185 to 44.220 42.985 to 43.020
	Outside diameter of valve seat; angle of valve seat in cylinder head: Ø2 Ø2	 44.260 to 44.275 43.060 to 43.075
	Valve guide	0.2
	Recessing of valve X X	0.65 to 0.95 1.8 to 2.1
	Between valve seat and head	0.040 to 0.090

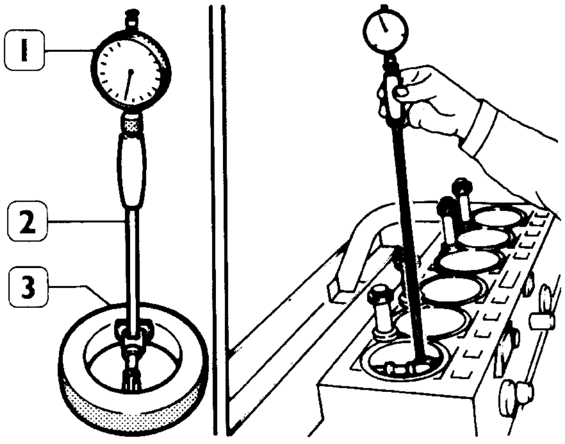
	Type	**F3AE3681** mm
	Valve spring height: free height H under a load of: 660 ± 33 N H1 1140 ± 57 N H2	 80 62 48.8
	Injector protrusion X	0.32 to 1.14
	Camshaft bushing housing in the cylinder head: 1 ⇒ 7 ∅	88.000 to 88.030
	Camshaft bearing journals: 1 ⇒ 7 ∅	82.950 to 82.968
	Outer diameter of camshaft bushings: ∅	88.153 to 88.183
	Inner diameter of camshaft bushings: ∅	83.018 to 83.085
	Bushings and housings in the cylinder head	0.123 to 0.183
	Bushings and bearing journals	0.050 to 0.135
	Cam lift:	
		9.30
		9.458
		13.376
	Rocker shaft ∅1	41.984 to 42.000

	Type	F3AE3681 mm
	Bushing housing in rocker arms 	45.000 to 45.016 59.000 to 59.019 46.000 to 46.016
	Bushing outer diameter for rocker arms 	45.090 to 45.130 59.100 to 59.140 46.066 to 46.091
	Bushing inner diameter for rocker arms 	42.025 to 42.041 56.030 to 56.049 42.015 to 42.071
	Between bushings and housings 	0.074 to 0.130 0.081 to 0.140 0.050 to 0.091
	Between bushings of rocker arms and shaft 	0.025 to 0.057 0.015 to 0.087
	Engine brake control lever Eccentric pin outer diameter Ø1 Rocker arms shaft seat Ø2	 55.981 to 56.000 42.025 to 42.041

Type	**F3AE3681**
	mm
Rocker arms and engine brake control lever pin	0.030 to 0.068
Rocker arm shaft and seat on engine brake control lever	0.025 to 0.057
TURBOCHARGER **Type**	HOLSET HE 531 V with variable geometry
End play	0.025 to 0.127
Radial play	0.381 to 0.533

REPAIR OPERATIONS
CYLINDER BLOCK
Checks and measurements

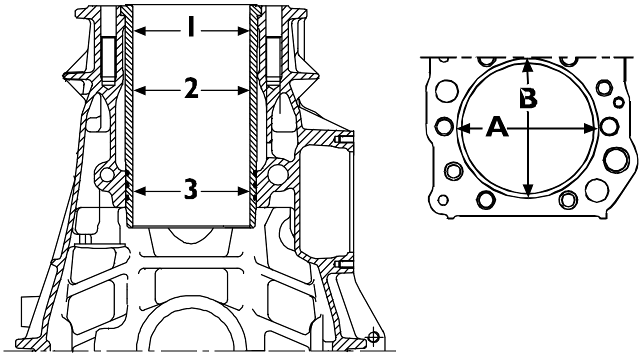
Figure 1 (Demonstration)



Internal diameter of the cylinder liners is checked for ovalization, taper and wear, using a bore dial (1) centesimal gauge (2) previously reset to ring gauge (3), diameter 135 mm.

NOTE If a 135 mm ring gauge is not available use a micrometer caliper.

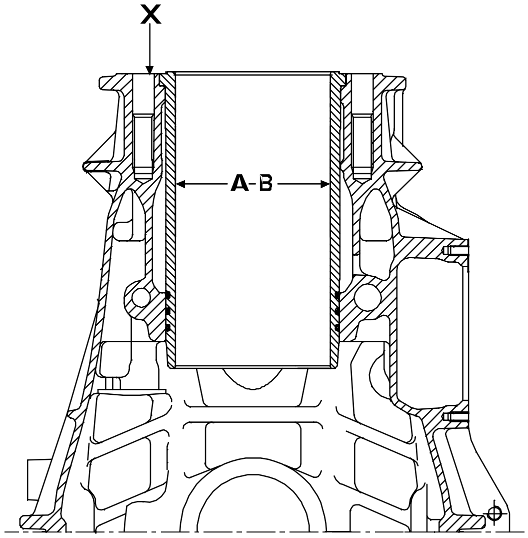
Figure 2



1 = 1st measuring
2 = 2nd measuring
3 = 3rd measuring

Carry out measurings on each cylinder liner at three different levels and on two (A-B) surfaces, to one another perpendicular, as shown in Figure 2.

Figure 3



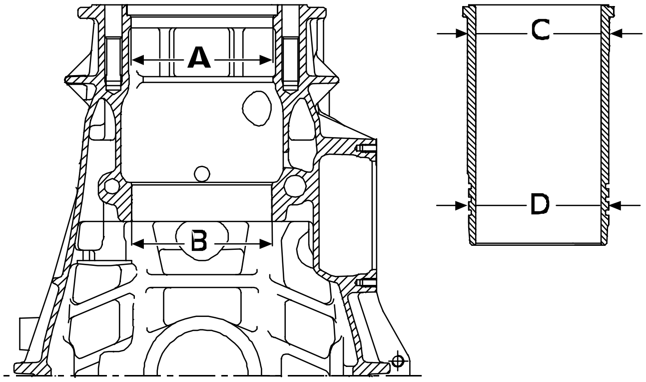
A = Selection class Ø 125 – 125.013 mm
B = Selection class Ø 125.011 – 125.024 mm
X = Selection class marking area

In case of maximum wear >0.150 mm or maximum ovalization >0.100 mm compared to the values indicated in the figure, the liners must be replaced as they cannot be ground, lapped or trued.

NOTE

Cylinder liners are equipped with spare parts with “A“ selection class.

Figure 4



A = Ø 142.000 to 142.025 mm
B = Ø 140.000 to 140.025 mm
C = Ø 141.961 to 141.986 mm
D = Ø 139.890 to 139.915 mm

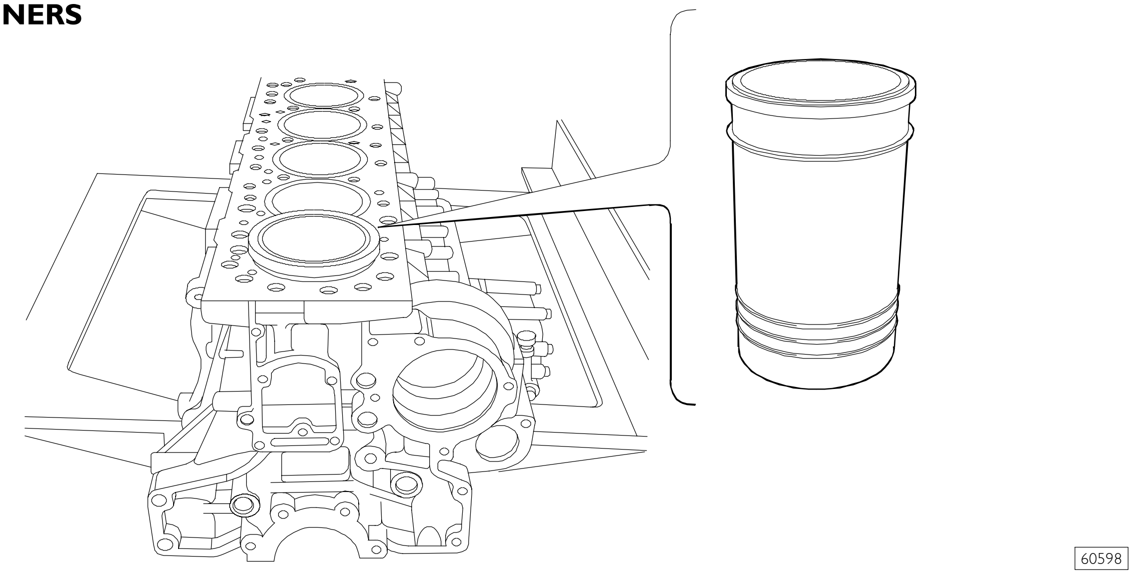
The figure shows the outer diameters of the cylinder liners and the relative seat inner diameters.

The cylinder liners can be extracted and installed several times in different seats, if necessary.

Check the state of the cylinder assembly machining plugs: if they are rusty or there is any doubt at all about their seal, change them.

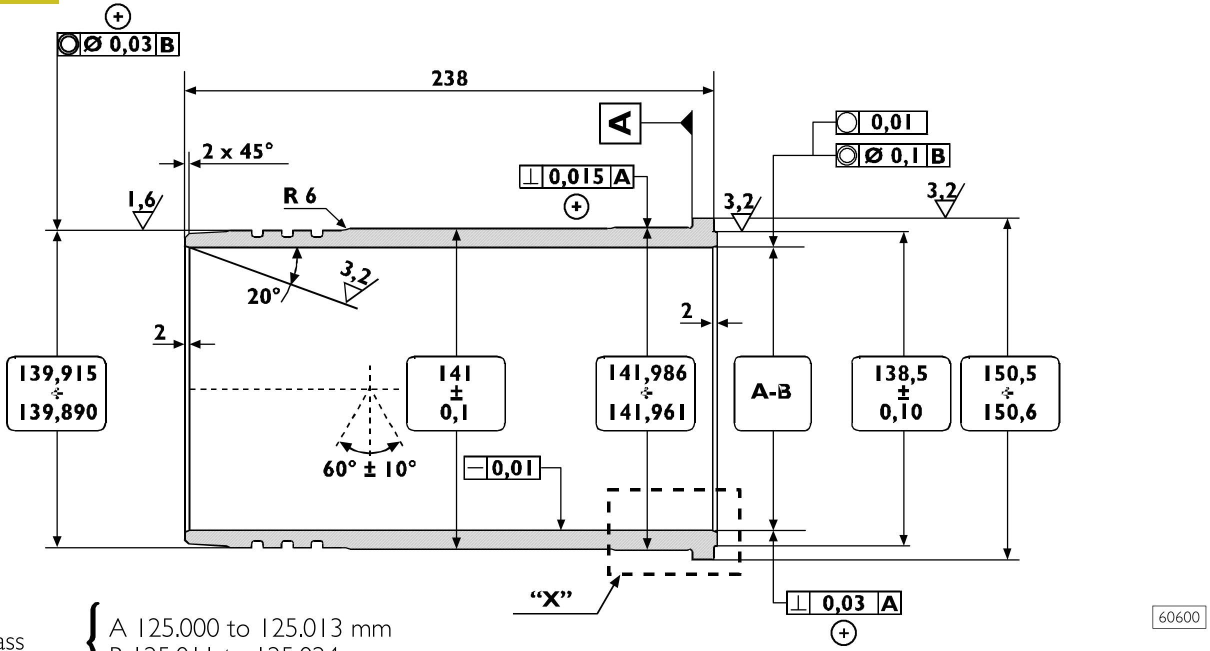
CYLINDER LINERS

Figure 5



BLOCK WITH CYLINDER LINERS

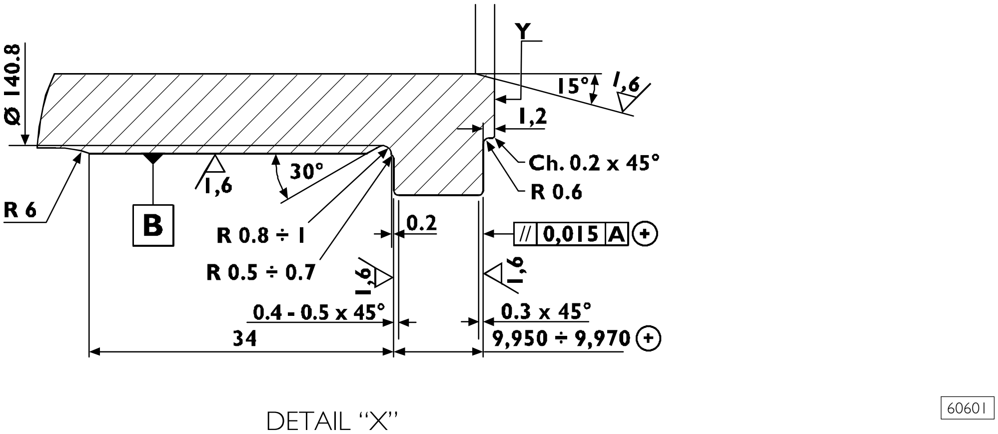
Figure 6



Selection class { A 125.000 to 125.013 mm
B 125.011 to 125.024 mm

CYLINDER LINERS MAIN DATA

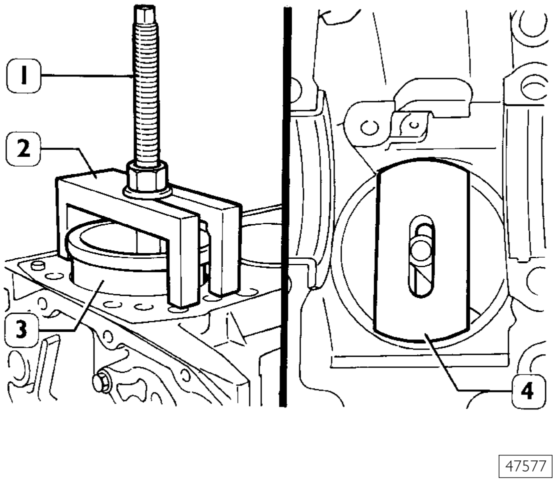
Figure 7



DETAIL "X"
"Y" - Selection class marking area

Removing cylinder liners

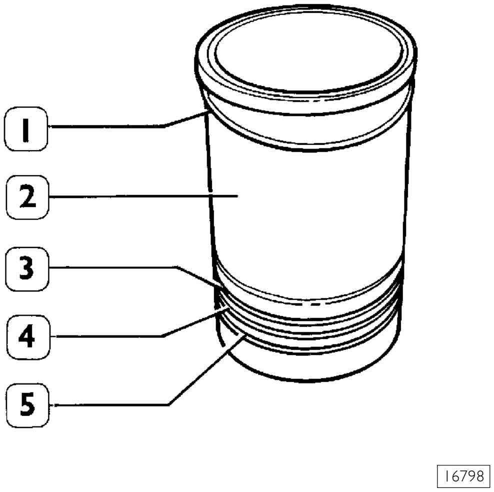
Figure 8



Place details 99360706 (2) and plate 99360726 (4) as shown in the figure, by making sure that the plate (4) is properly placed on the cylinder liners.
Tighten the screw nut (1) and remove the cylinder liner (3) from the block.

Fitting and checking protrusion

Figure 9

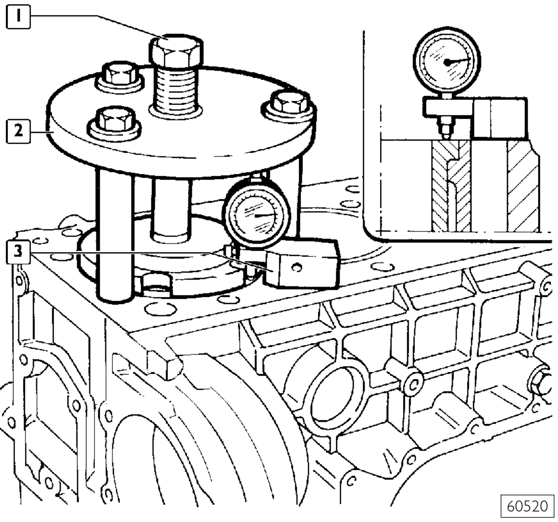


Always replace water sealing rings (3, 4 and 5).
Install the adjustment ring (1) on the cylinder liner (2); lubricate lower part of liner and install it in the cylinder unit using the proper tool.

NOTE

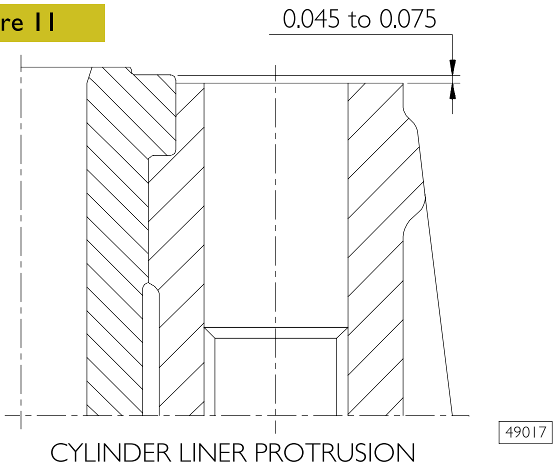
The adjustment ring (1) is supplied as spare parts in the following thicknesses: 0.08 mm - 0.10 mm - 0.12 mm.

Figure 10 (Demonstration)



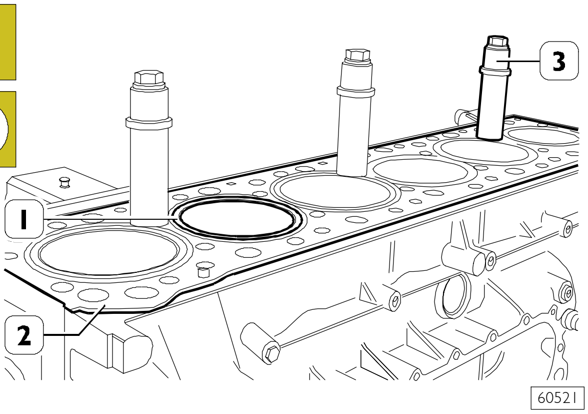
Check the protrusion of the cylinder liners, using tool 99360334 (2) and tightening screw (1) to 225 Nm torque.
Using a dial gauge (3), measure the cylinder liner protrusion, from the cylinder head supporting surface, it must be 0.045 to 0.075 (Figure 11); otherwise, replace the adjustment ring (1, Figure 9) supplied as spare parts having different thicknesses.

Figure 11



CYLINDER LINER PROTRUSION

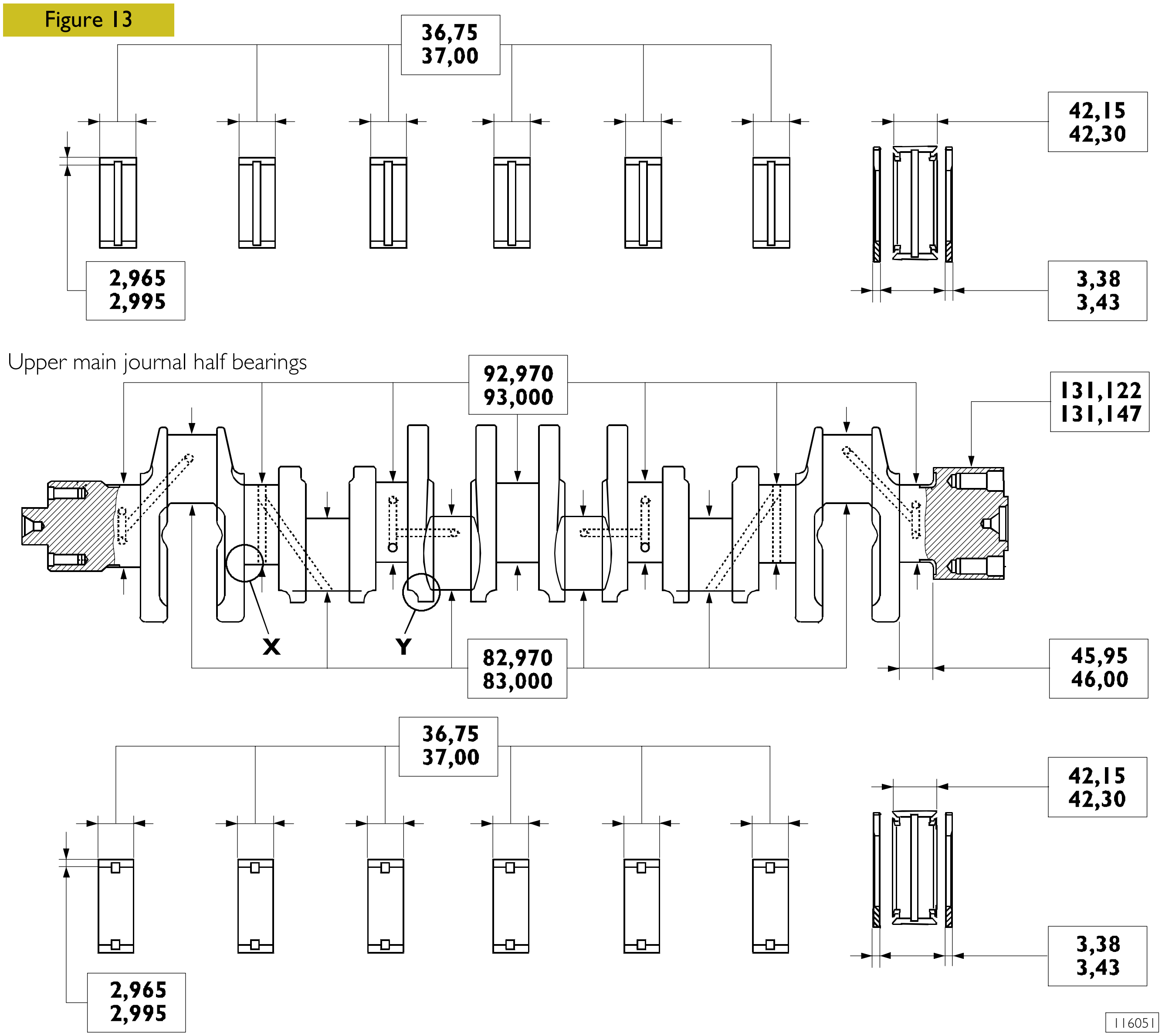
Figure 12 (Demonstration)



When the installation is completed, block the cylinder liners (1) to the block (2) with studs 99360703 (3).

CRANKSHAFT

Figure 13

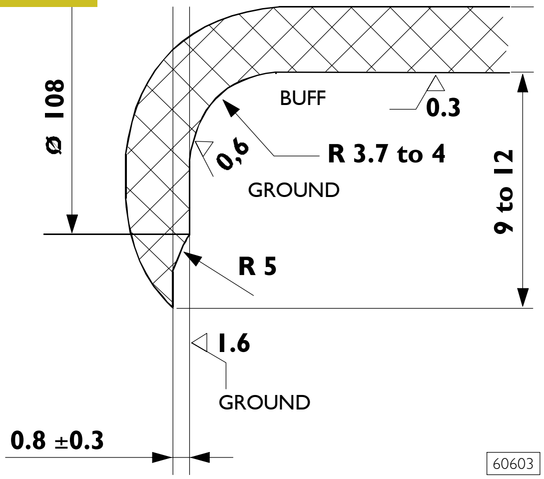


Lower main journal half bearings

MAIN DATA FOR THE CRANK SHAFT PINS AND THE HALF BEARINGS

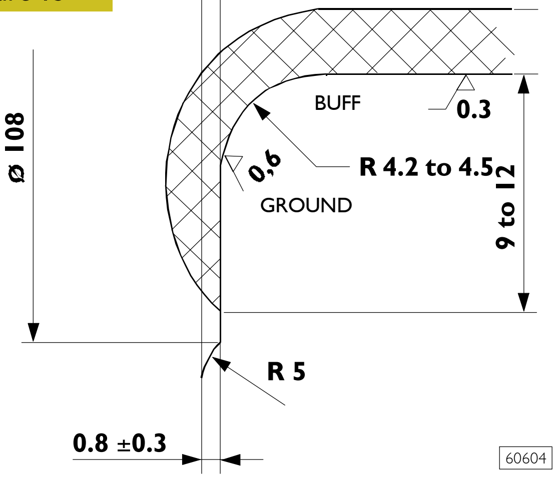
Check the condition of the journals and the big end pins; there must no be signs of scoring, ovalization or excessive wear. The data given refer to the normal diameter of the pins.

Figure 14



X. Detail of main journals connections

Figure 15

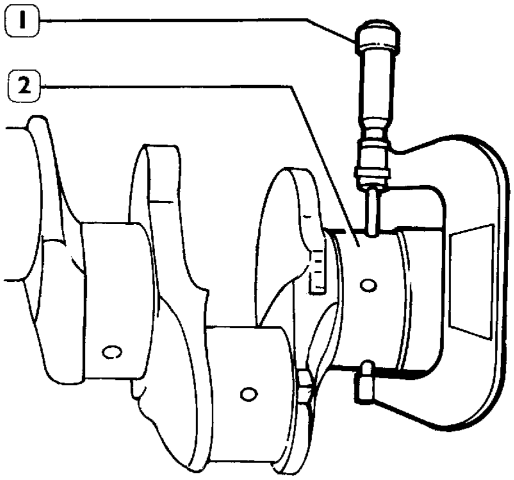


Y. Detail of crank pins connections

Measuring the main journals and crankpins

Before grinding the crank pins using a micrometer (1), measure the main journals and the crank pins (2) and decide, on the basis of the undersizing of the bearings, the final diameter to which the pins are to be ground.
The undersize classes are 0.127 - 0.254 - 0.508 mm.

Figure 16

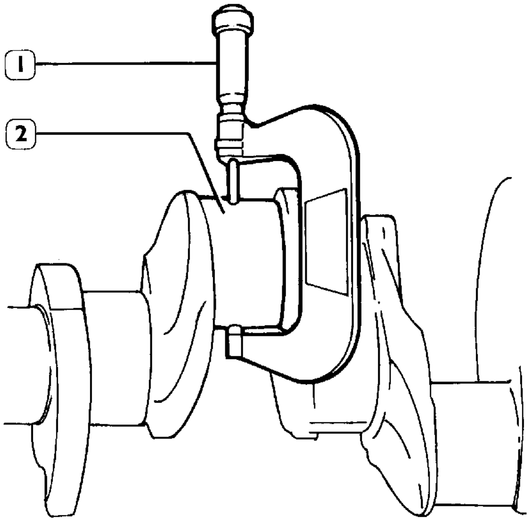


47535

MEASURING THE MAIN JOURNALS

NOTE It is advisable to enter the values found in a table (Figure 18).

Figure 17



47536

MEASURING CRANK PINS

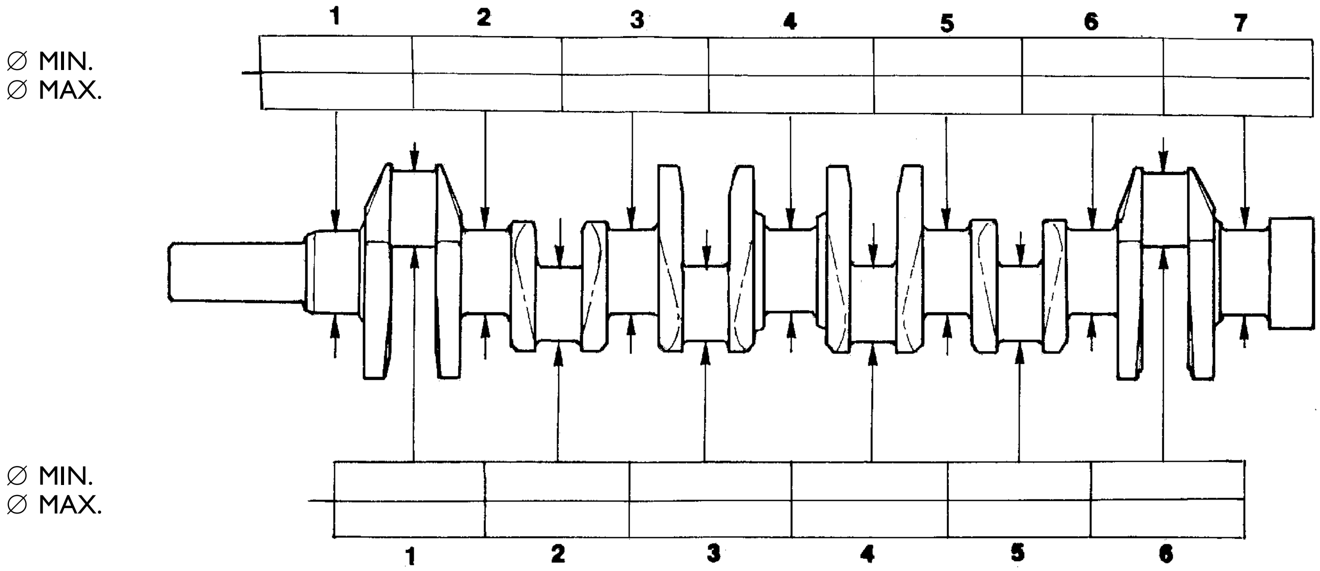
During grinding, pay attention to journal and crank pins values specified in Figure 14 and Figure 15.

NOTE All journals and crank pins must also be ground to the same undersizing class, in order to avoid any alteration to shaft balance.

Figure 18

Fill in this table with the measurements of the main journals and the crank pins.

MAIN JOURNALS



CRANK PINS

36061

Preliminary measurement of main and big end bearing shell selection data

For each of the journals of the crankshaft, it is necessary to carry out the following operations:

MAIN JOURNALS:

- Determine the class of diameter of the seat in the crankcase.
- Determine the class of diameter of the main journal.
- Select the class of the bearing shells to mount.

CRANKPINS:

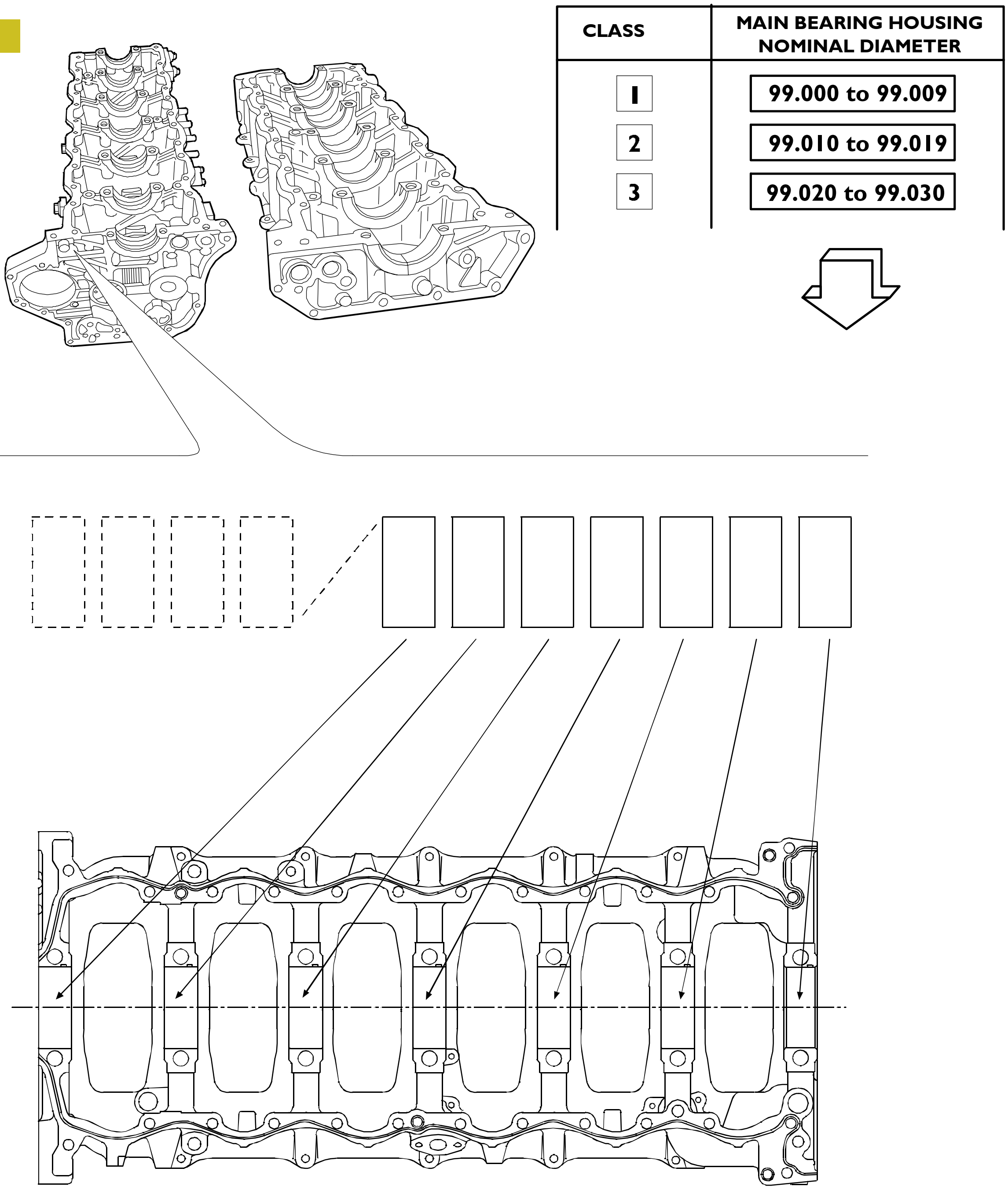
- Determine the class of diameter of the seat in the connecting rod.
- Determine the class of diameter of the crankpin.
- Select the class of the bearing shells to mount.

DEFINING THE CLASS OF DIAMETER OF THE SEATS FOR BEARING SHELLS ON THE CRANKCASE

On the front of the crankcase, two sets of numbers are marked in the position shown.

- The first set of digits (four) is the coupling number of the crankcase with its base.
- The following seven digits, taken singly, are the class of diameter of each of the seats referred to.
- Each of these digits may be **1**, **2** or **3**.

Figure 19



CLASS	MAIN BEARING HOUSING NOMINAL DIAMETER
1	99.000 to 99.009
2	99.010 to 99.019
3	99.020 to 99.030

Selecting the main and big end bearing shells

NOTE To obtain the required assembly clearances, the main and big end bearing shells need to be selected as described hereunder.

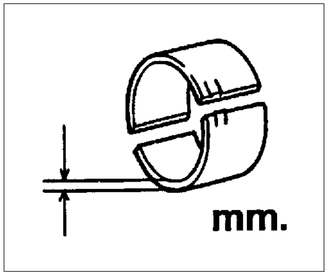
This operation makes it possible to identify the most suitable bearing shells for each of the journals (the bearing shells, if necessary, can have different classes from one journal to another).

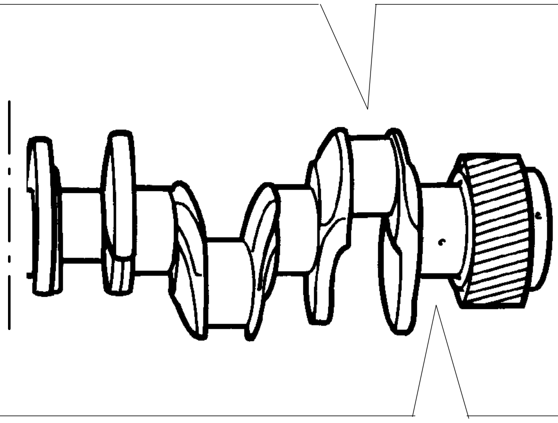
Depending on the thickness, the bearing shells are selected in classes of tolerance marked by a coloured sign (red-green – red/black – green/black).

The following tables give the specifications of the main and big end bearing shells available as spares in the standard sizes (STD) and in the permissible oversizes (+0.127, +0.254, +0.508).

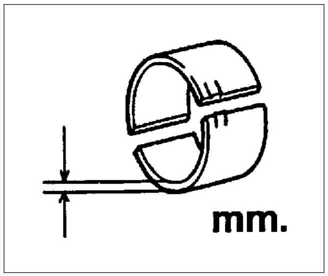
Figure 20

	STD	+0.127	+0.254	+0.508
red	1.970 to 1.980		2.097 to 2.107	2.224 to 2.234
red/black		2.033 to 2.043		
green	1.981 to 1.990		2.108 to 2.117	2.235 to 2.244
green/black		2.044 to 2.053		
yellow*	1.991 to 2.000			
yellow/black*		2.054 to 2.063		





	STD	+0.127	+0.254	+0.508
red	2.965 to 2.974		2.097 to 2.107	2.224 to 2.234
red/black		3.028 to 3.037		
green	2.975 to 2.984		2.108 to 2.117	2.235 to 2.244
green/black		3.038 to 3.047		
yellow*	2.985 to 2.995			
yellow/black*		3.048 to 3.058		



* Fitted in production only and not supplied as spares

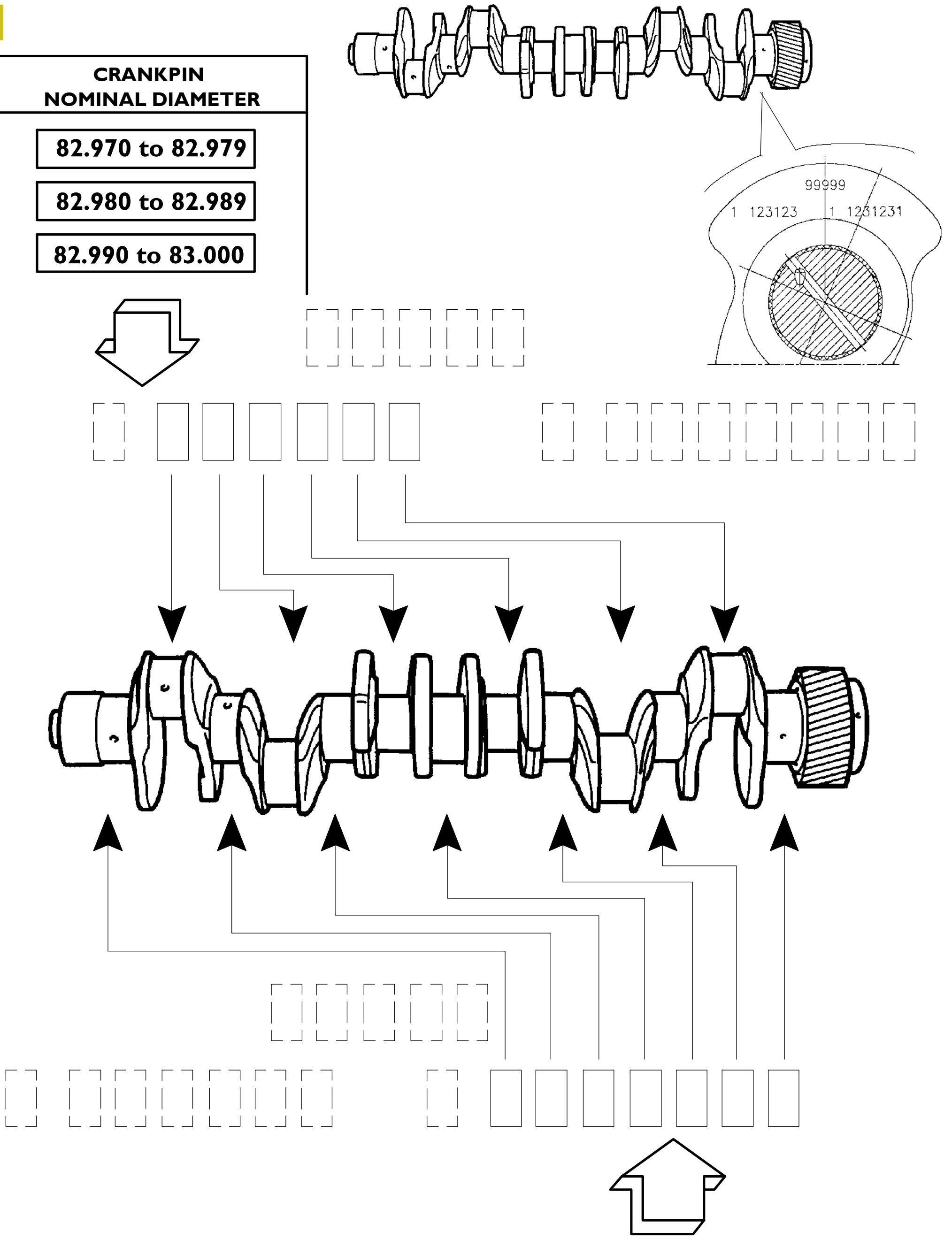
Defining the class of diameter of the main journals and crankpins (Journals with nominal diameter)

Main journals and crankpins: determining the class of diameter of the journals.
Three sets of numbers are marked on the crankshaft in the position shown by the arrow (Figure 21 at top):

- ☐ The first number, of five digits, is the part number of the shaft.
- ☐ Under this number, on the left, a set of six digits refers to the crankpins and is preceded by a single digit showing the status of the journals (1 = STD, 2 = -0.127), the other six digits, taken singly, give the class of diameter of each of the crankpins they refer to (Figure 21 at top).
- ☐ The set of seven digits, on the right, refers to the main journals and is preceded by a single digit: the single digit shows the status of the journals (1 = STD, 2 = -0.127), the other seven digits, taken singly, give the class of diameter of each of the main journals they refer to (Figure 21 bottom).

Figure 21

CLASS	CRANKPIN NOMINAL DIAMETER
1	82.970 to 82.979
2	82.980 to 82.989
3	82.990 to 83.000

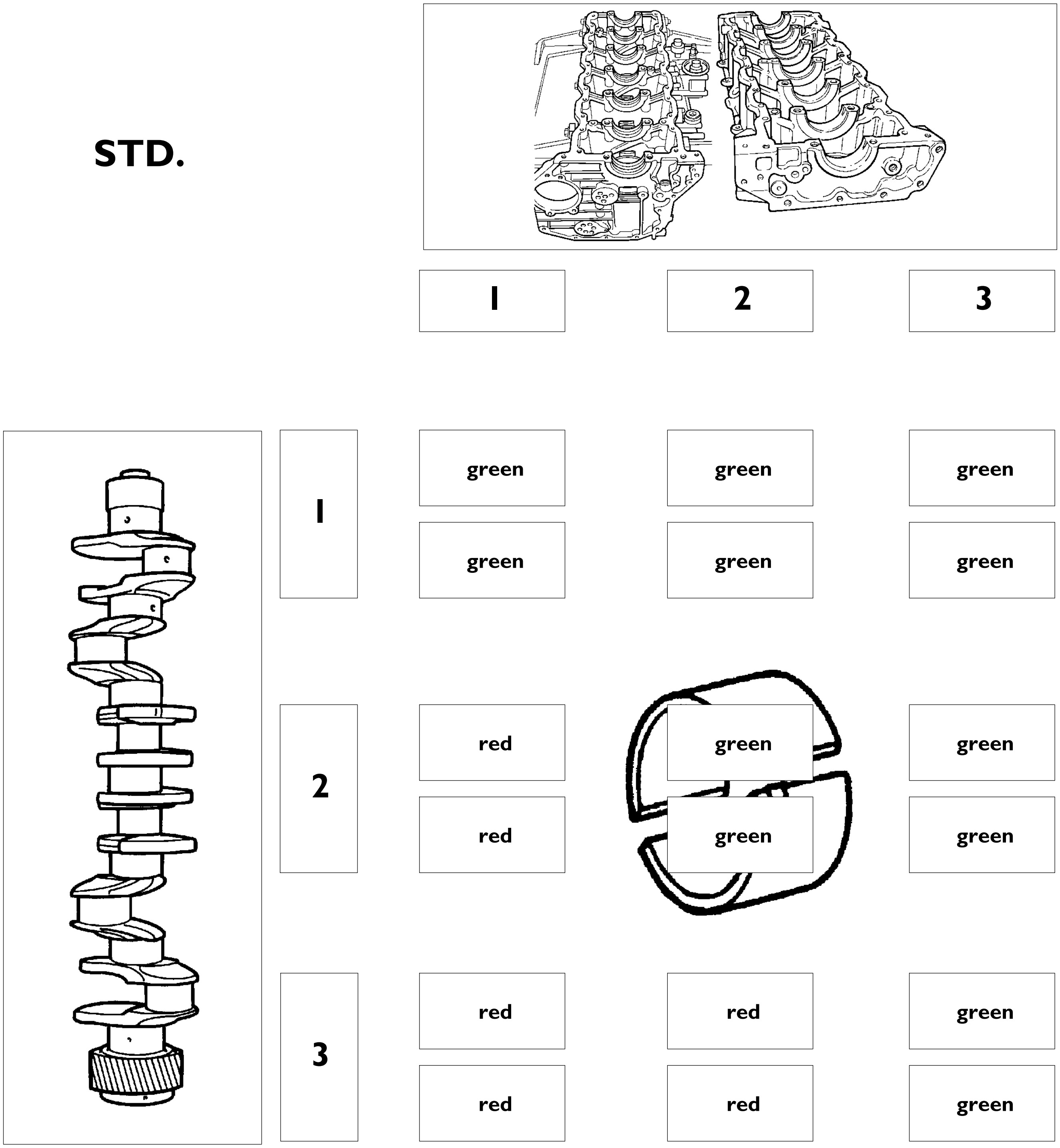


CLASS	MAIN JOURNALS NOMINAL DIAMETER
1	92.970 to 92.979
2	92.980 to 92.989
3	92.990 to 93.000

Selecting the main bearing shells (Journals with nominal diameter)

After reading off the data, for each of the main journals, on the crankcase and crankshaft, you choose the type of bearing shells to use according to the following table:

Figure 22

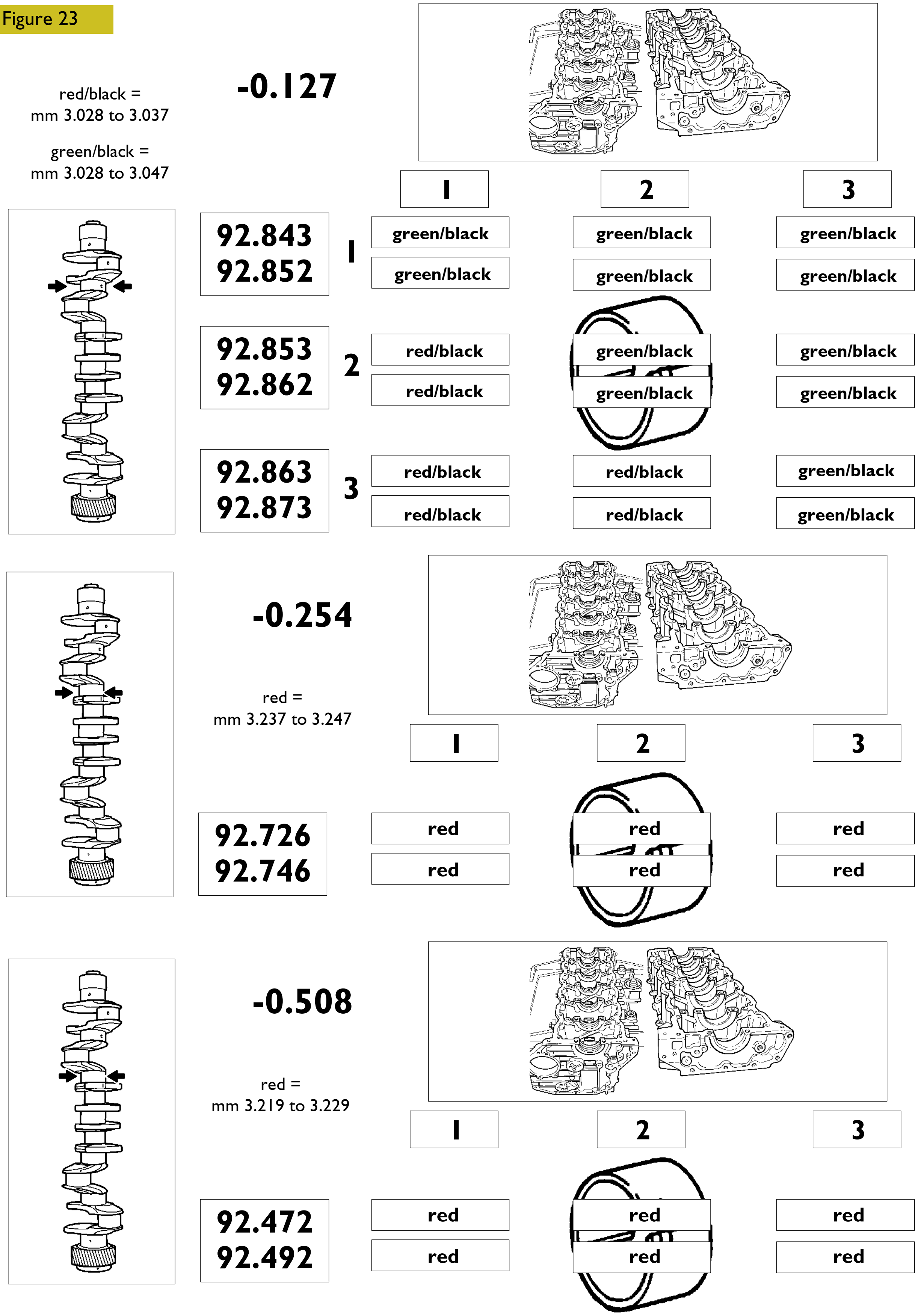


STD.	1	2	3
1	green green	green green	green green
2	red red	green green	green green
3	red red	red red	green green

Selecting the main bearing shells (ground journals)

If the journals have been ground, the procedure described so far cannot be applied.
In this case, it is necessary to check that the new diameter of the journals is as shown in the table and to mount the only type of bearing shell envisaged for the relevant undersizing.

Figure 23



-0.127

red/black = mm 3.028 to 3.037

green/black = mm 3.028 to 3.047

		1	2	3
92.843 92.852	1	green/black green/black	green/black green/black	green/black green/black
92.853 92.862	2	red/black red/black	green/black green/black	green/black green/black
92.863 92.873	3	red/black red/black	red/black red/black	green/black green/black

-0.254

red = mm 3.237 to 3.247

	1	2	3
92.726 92.746	red red	red red	red red

-0.508

red = mm 3.219 to 3.229

	1	2	3
92.472 92.492	red red	red red	red red

SELECTING THE BIG END BEARING SHELLS (JOURNALS WITH NOMINAL DIAMETER)

There are three markings on the body of the connecting rod in the position shown in the view from "A":

1. Letter indicating the class of weight:

   A = 4024 to 4054 g.
   B = 4055 to 4085 g.
   C = 4086 to 4116 g.

2. Number indicating the selection of the diameter of the big end bearing seat:

   1 = 87.000 to 87.010 mm
   2 = 87.011 to 87.020 mm
   3 = 87.021 to 87.030 mm

3. Numbers identifying the cap-connecting rod coupling.

The number, indicating the class of diameter of the bearing shell seat may be **1**, **2** o **3**.

Determine the type of big end bearing to fit on each journal by following the indications in the table (Figure 24).

Figure 25

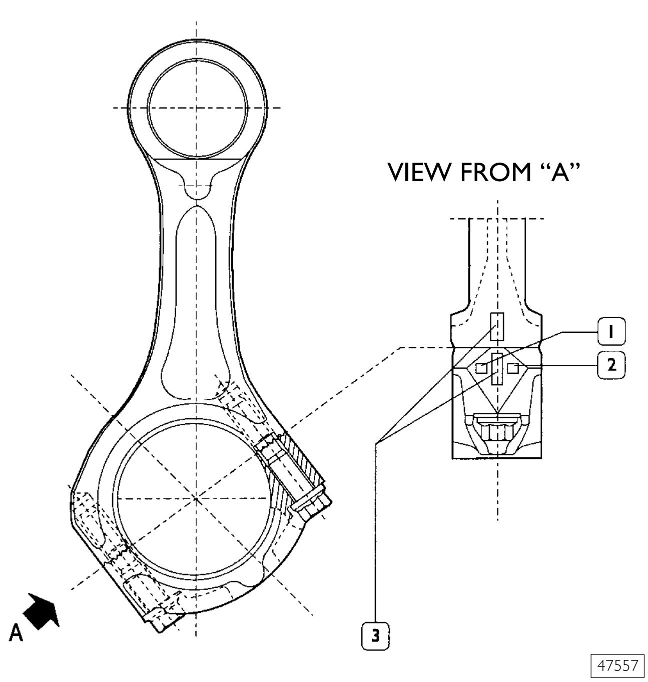
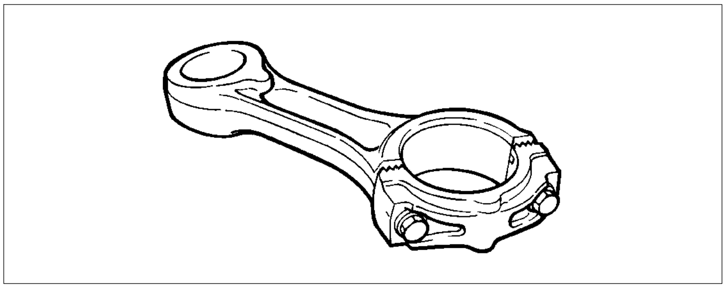
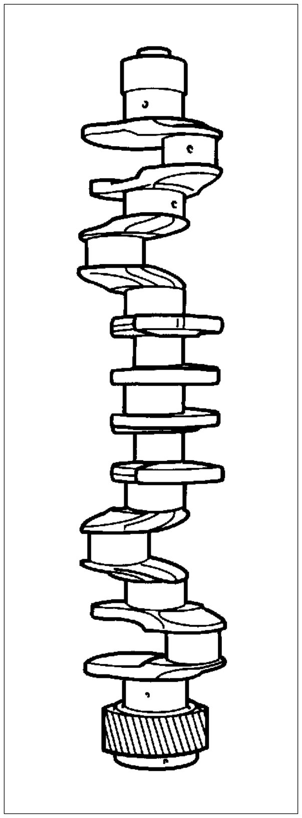
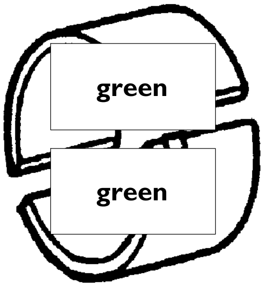


Figure 24

STD.







Class	1	2	3
1	green green	green green	green green
2	red red	green green	green green
3	red red	red red	green green

SELECTING BIG END BEARING SHELLS (GROUND JOURNALS)

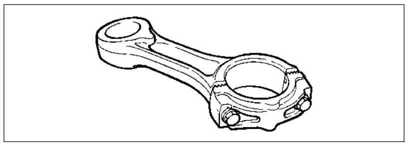
If the journals have been ground, the procedure described so far cannot be applied.
In this case, it is necessary to check (for each of the undersizings) which field of tolerance includes the new diameter of the crankpins and to mount the bearing shells identified with the relevant table.

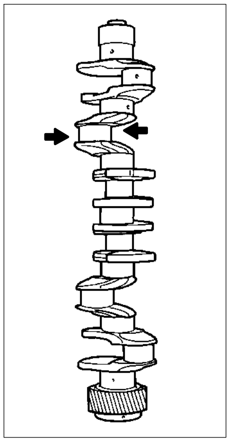
Figure 26

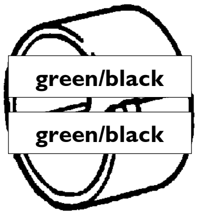
red/black =
mm 2.033 to 2.043

green/black =
mm 2.044 to 2.053

-0.127

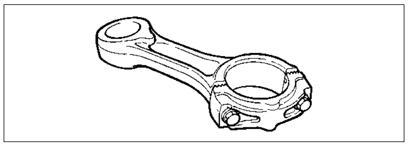




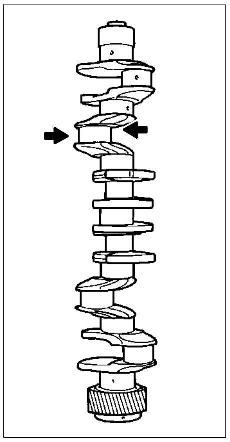


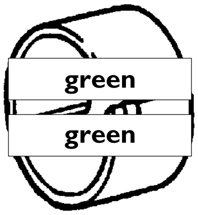
		1	2	3
82.843 82.852	1	green/black green/black	green/black green/black	green/black green/black
82.853 82.862	2	red/black red/black	green/black green/black	green/black green/black
82.863 82.873	3	red/black red/black	red/black red/black	green/black green/black

-0.254



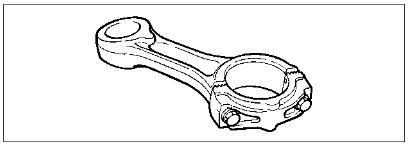
red =
mm 2.097 to 2.107
green =
mm 2.108 to 2.117



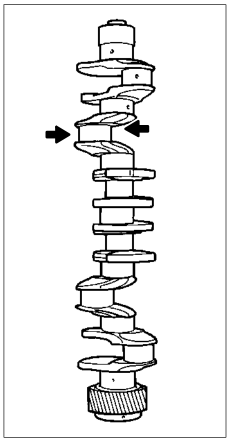


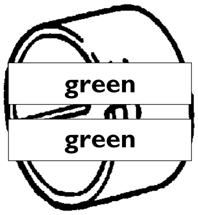
	1	2	3
82.726 82.735	red red	green green	green green
82.736 82.746	red red	red red	green green

-0.508



red =
mm 2.224 to 2.234
green =
mm 2.235 to 2.244



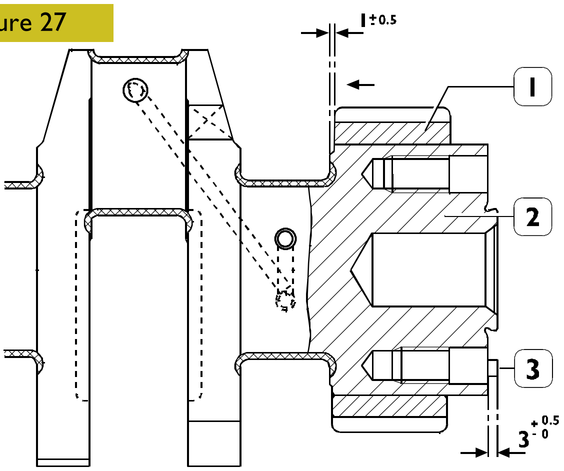


	1	2	3
82.472 82.481	red red	green green	green green
82.482 82.492	red red	red red	green green

Replacing the timing gear and oil pump

Check that the toothing of the gear is neither damaged nor worn; if it is, take it out with an appropriate extractor and replace it.

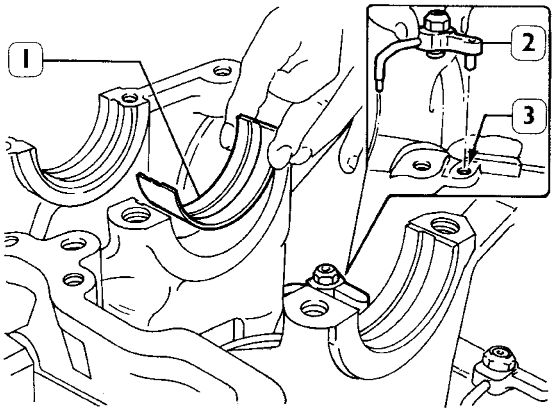
Figure 27



When fitting the gear (1) on the crankshaft (2), heat it for no longer than 2 hours in an oven at a temperature of 180°C.
After heating the gear (1), fit it on the shaft by applying a load of 6000 N to it, positioning it at the distance shown in Figure 27.
After cooling, the gear must have no axial movement under a load of 29100 N.
If changing the pin (3), after fitting it on, check it protrudes from the crankshaft as shown in the figure.

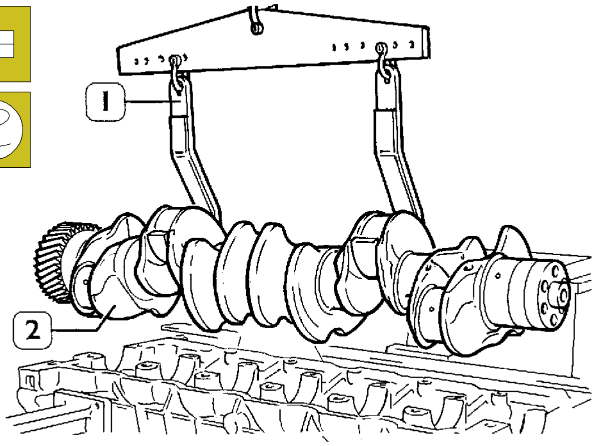
Checking main journal assembly clearance

Figure 28



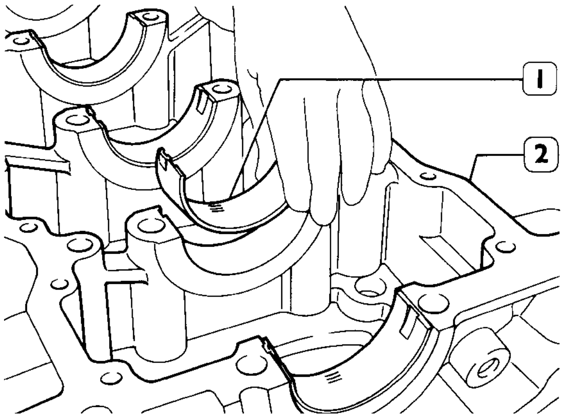
Mount the oil nozzles (2), making the grub screw match the hole (3) on the crankcase.
Arrange the bearing shells (1) on the main bearing housings.

Figure 29



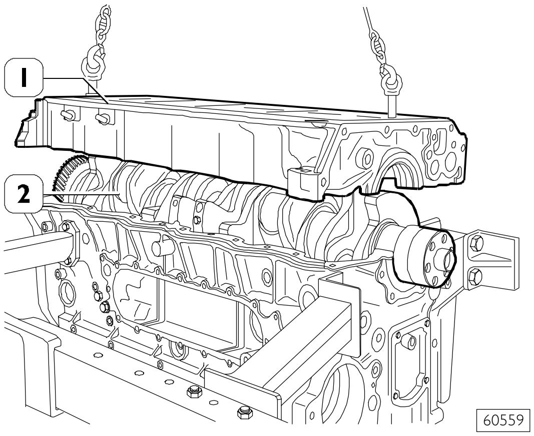
Using the tackle and hook 99360500 (1), mount the crankshaft (2).

Figure 30



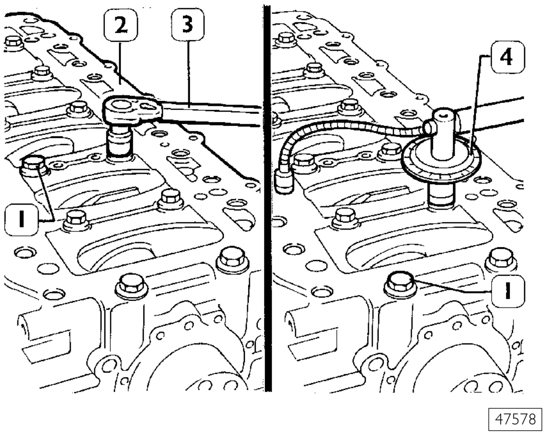
Arrange the bearing shells (1) on the main bearing housings in the crankcase base (2).
Check the assembly clearance between the main journals of the crankshaft and their bearings, proceeding as illustrated on the following pages.

Figure 31



Set two journals of the crankshaft (2) parallel to the longitudinal axis, a section of calibrated wire. Using appropriate hooks and tackle, mount the crankcase base (1).

Figure 32



☐ Lubricate the internal screws (1) with UTDM oil and tighten them with a torque wrench (3) to a torque of 120 Nm, using tool 99395216 (4), to an angle of 90°, following the diagram of Figure 33.

Figure 33

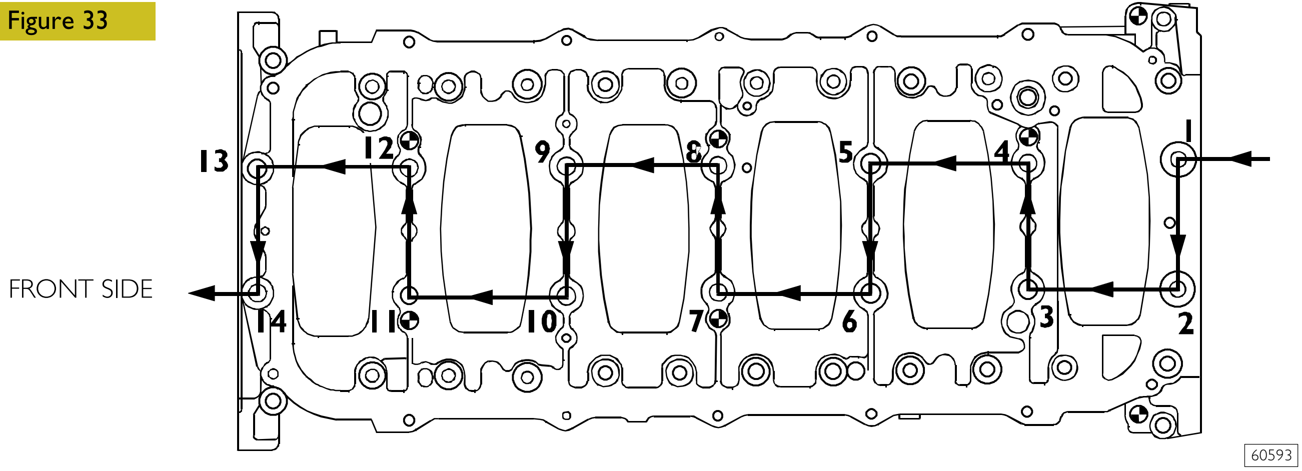
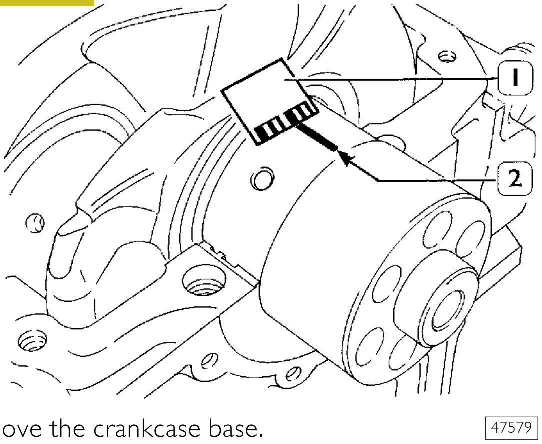


DIAGRAM OF SEQUENCE FOR TIGHTENING THE SCREWS FIXING THE BOTTOM CRANKCASE BASE TO THE CRANKCASE

Figure 34



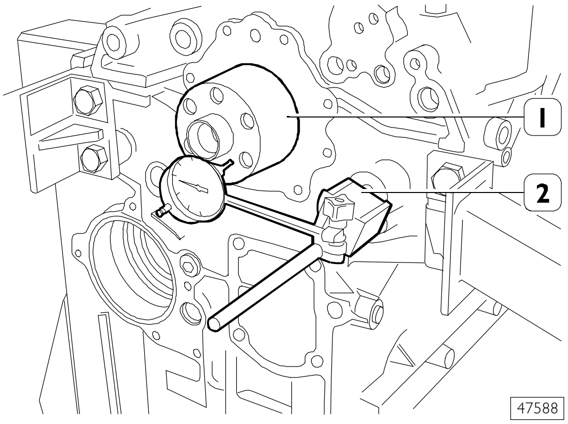
☐ Remove the crankcase base.

The clearance between the main bearings and their journals is measured by comparing the width taken on by the calibrated wire (2) at the point of greatest crushing with the graduated scale on the case (1) containing the calibrated wire.

The numbers on the scale give the clearance of the coupling in millimetres. If you find the clearance is not as required, replace the bearing shells and repeat the check.

Checking crankshaft end float

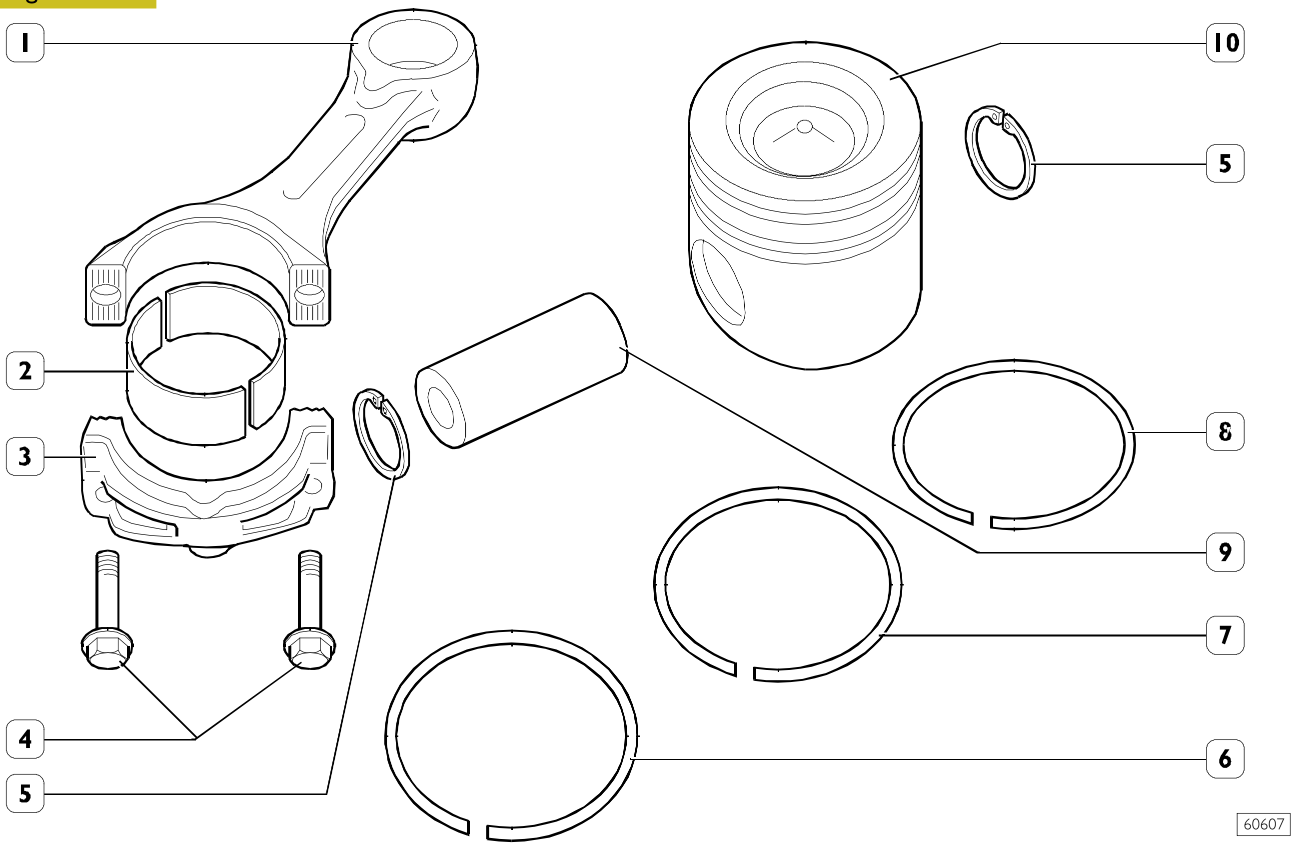
Figure 35



End float is checked by placing a magnetic dial gauge (2) on the crankshaft (1), as shown in the figure. If the value obtained is higher than specified, replace the rear thrust half-bearings and repeat this check.

PISTON CONNECTING ROD ASSEMBLY

Figure 36



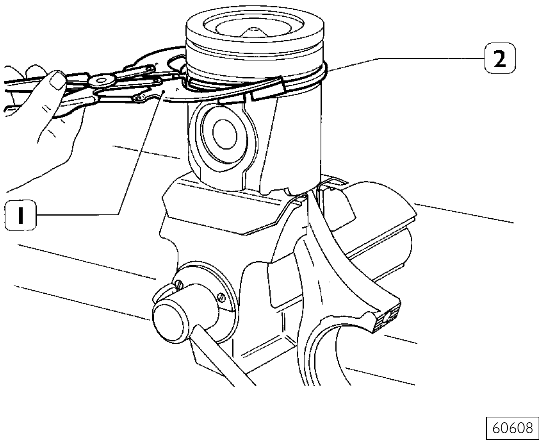
PISTON CONNECTING ROD ASSEMBLY

1. Connecting rod body - 2. Half bearings - 3. Connecting rod cap - 4. Cap fastening screws - 5. Split ring - 6. Scraper ring with spiral spring - 7. Bevel cut sealing ring - 8. Trapezoidal sealing ring - 9. Piston pin - 10. Piston.

Make sure the piston does show any trace of seizing, scoring, cracking; replace as necessary.

Removal

Figure 37

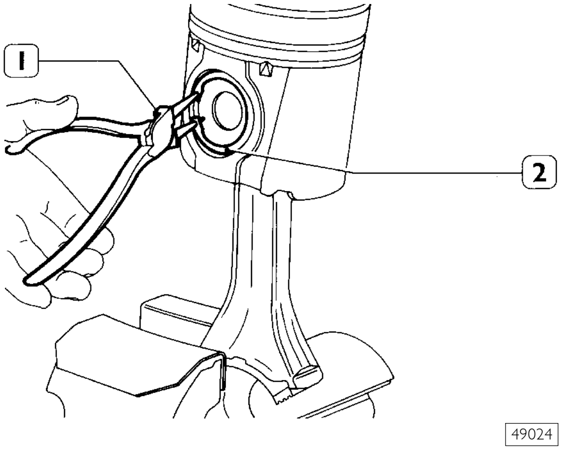


Removal of the piston split rings (2) using the pliers 99360184 (1).

Pistons are equipped with three elastic rings: a sealing ring, a trapezoidal ring and a scraper ring.

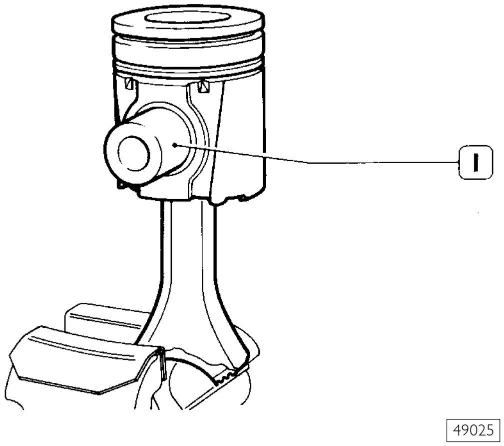
Pistons are grouped into classes A and B for diameter.

Figure 38



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

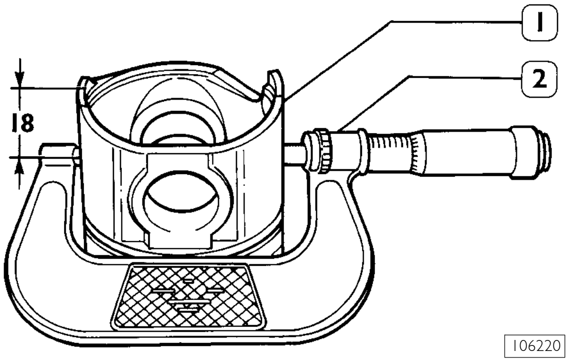
Figure 39



Remove the piston pin (1).
If removal is difficult use the appropriate beater.

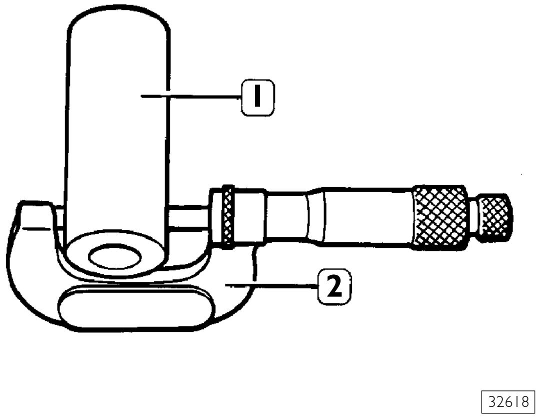
Measuring the diameter of the pistons

Figure 40



Using a micrometer (2), measure the diameter of the piston (1) to determine the assembly clearance; the diameter has to be measured at the value X shown:

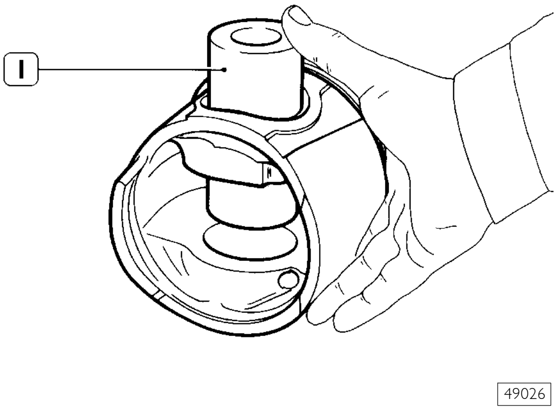
Figure 41



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

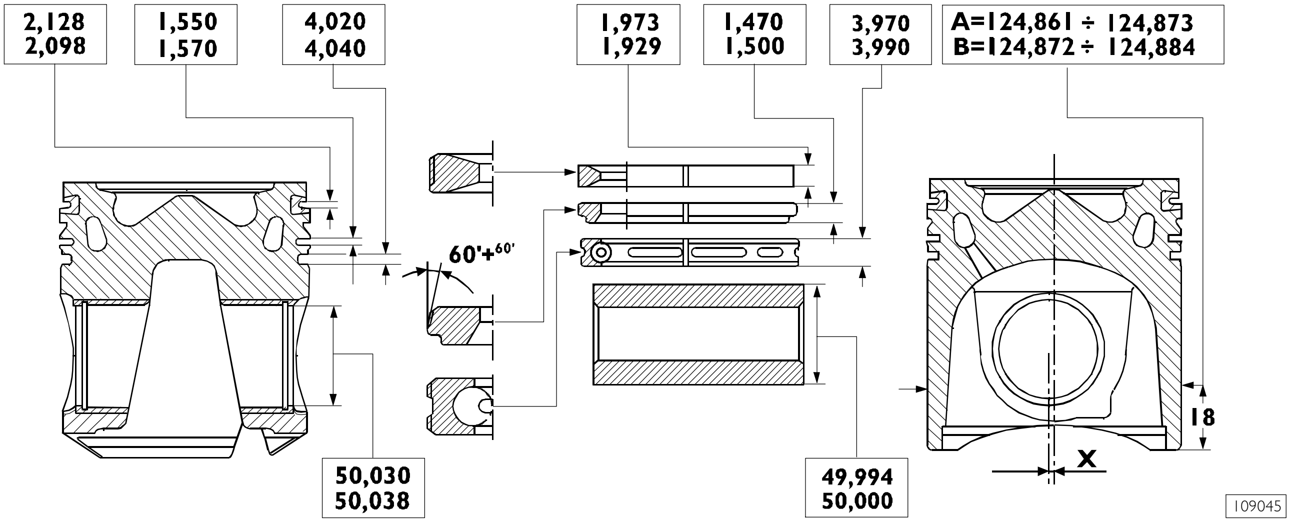
Conditions for correct gudgeon pin-piston coupling

Figure 42



Lubricate the pin (1) and the relevant housing on the piston hubs with engine oil; piston must be inserted with a slight finger pressure and it should not come out by gravity.

Figure 43

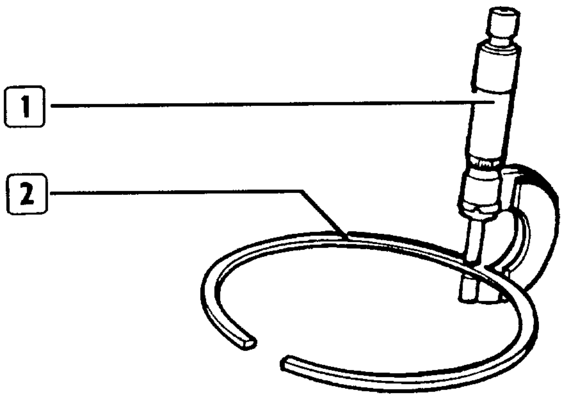


MAIN DATA OF THE PISTON, PISTON RINGS AND PIN

X = 0,8 ± 0,15

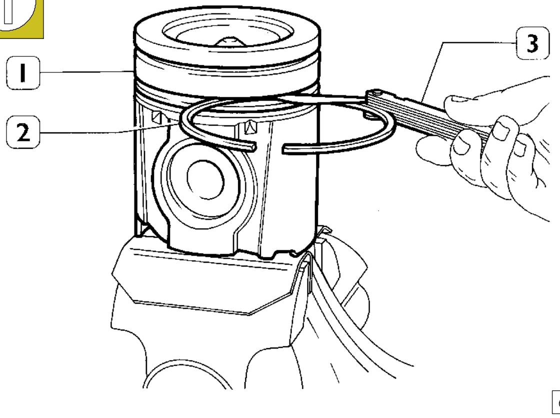
Piston rings

Figure 44



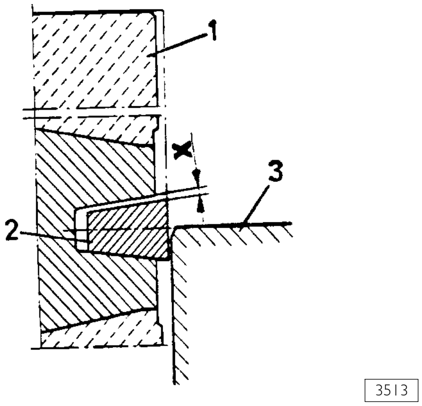
Check the thickness of the piston ring (2) using a micrometer (1).

Figure 45



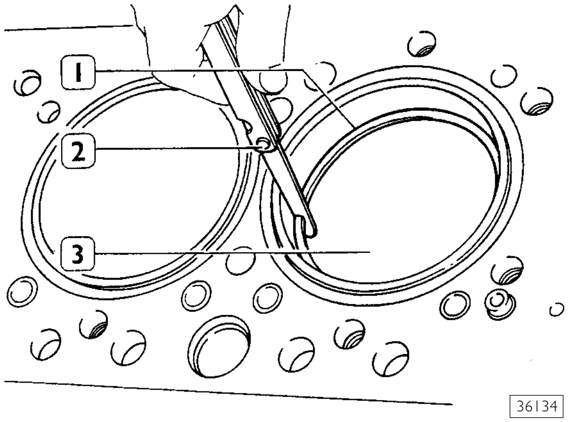
Check the clearance between the sealing rings (2) and the relative piston housings (1) using a thikness gauge (3).

Figure 46



The sealing ring (2) of the 1st cavity is trapezoidal. Clearance "X" between the sealing ring and its housing is measured by placing the piston (1) with its ring in the cylinder barrel (3), so that the sealing ring is half-projected out of the cylinder barrel.

Figure 47



Check the opening between the ends of the sealing rings (1), using a thickness gauge (2), entered in the cylinder barrel (3). If the distance between ends is lower or higher than the value required, replace split rings.

CONNECTING RODS

Figure 48

Data concerning the class section of connecting rod housing and weight are stamped on the big end.

NOTE When installing connecting rods, make sure they all belong to the same weight class.

DIAGRAM OF THE CONNECTING ROD MARKS

1 Letter indicating the weight class:

A = 4024 to 4054 g.
B = 4055 to 4085 g.
C = 4086 to 4116 g.

2 Number indicating the selection of diameter for the big end bearing housing:

1 = 87.000 to 87.010 mm
2 = 87.011 to 87.020 mm
3 = 87.021 to 87.030 mm

3 Numbers identifying cap-connecting rod coupling.

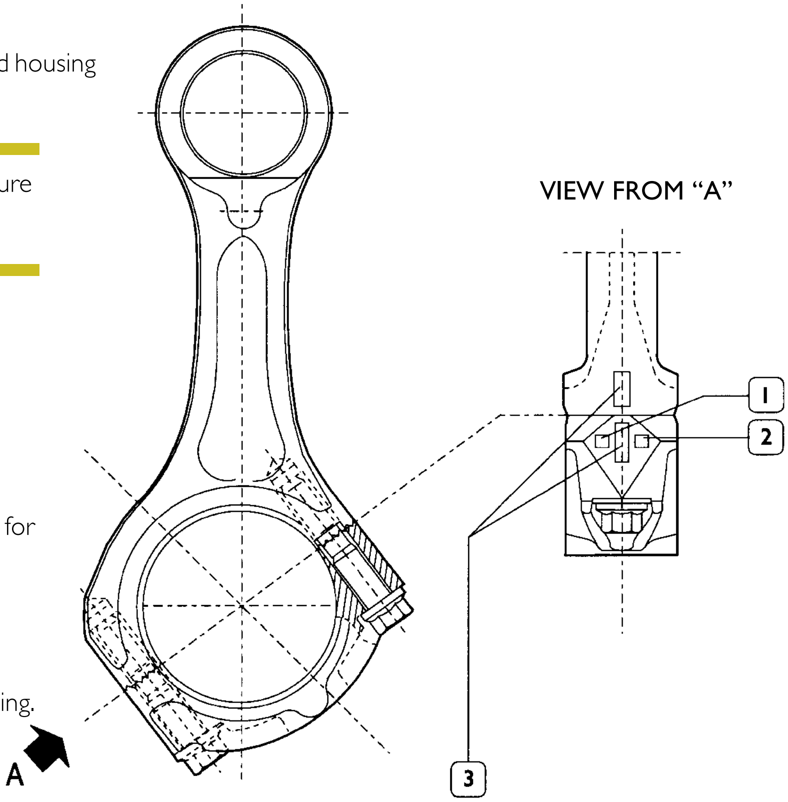


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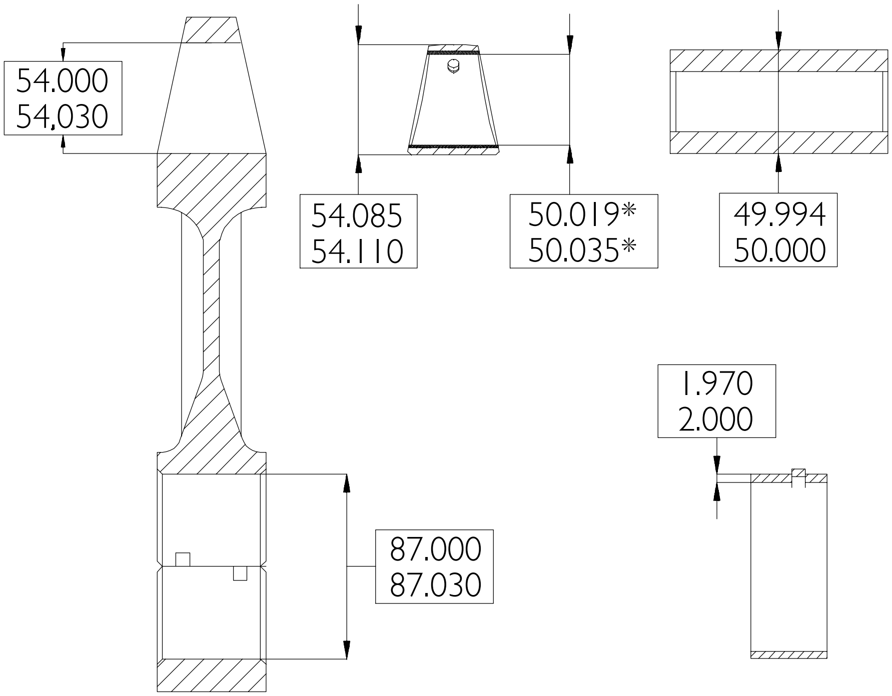
Figure 49



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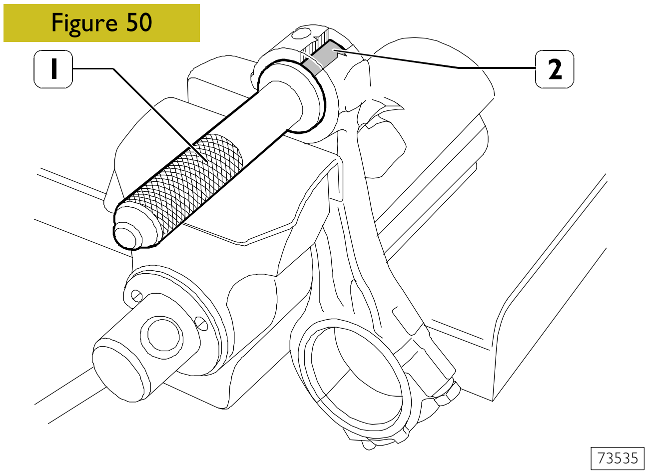
MAIN DATA - BUSH, CONNECTING ROD, PIN AND HALF-BEARINGS

* Values to be obtained after installing the bush.

Bushings

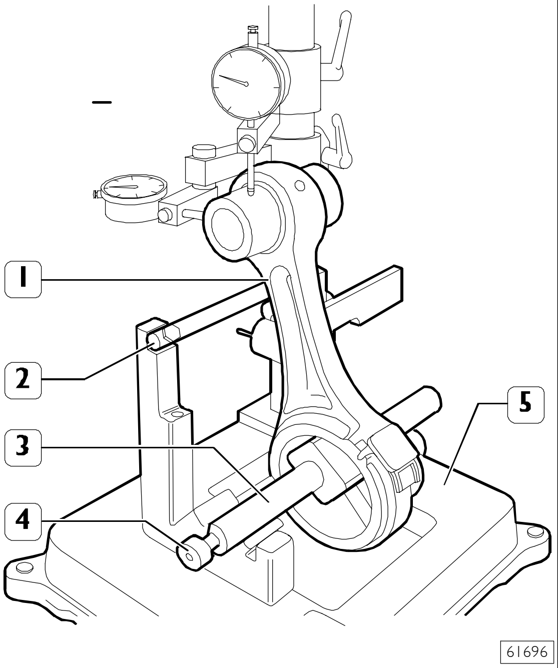
Figure 50



Check the bushing in the small end has not come loose and shows no sign of scoring or seizure; replace it if it does. The bushing (2) is removed and fitted with a suitable drift (1). When driving it in, make absolutely sure that the holes for the oil to pass through in the bushing and small end coincide. Using a boring machine, rebore the bushing so as to obtain a diameter of 50.019 – 50.035.

Checking connecting rods

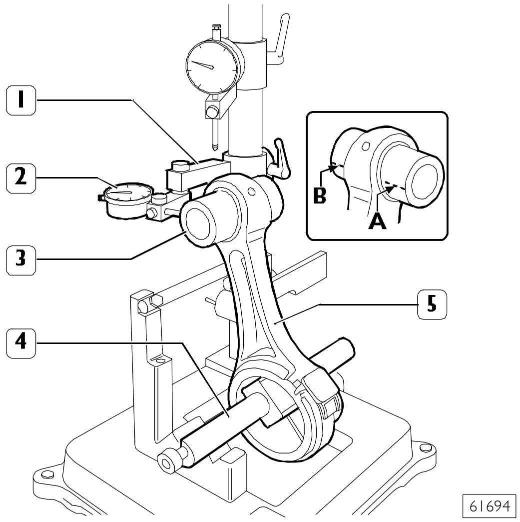
Figure 51 (Demonstration)



Checking axis alignment

Check the toe-setting for the connecting rods (1) axles using the proper devices (5), according to this procedure:
Fit the connecting rod (1) on the spindle of the tool (5) and lock it with the screw (4).
Set the spindle (3) on the V-prisms, resting the connecting rod (1) on the stop bar (2).

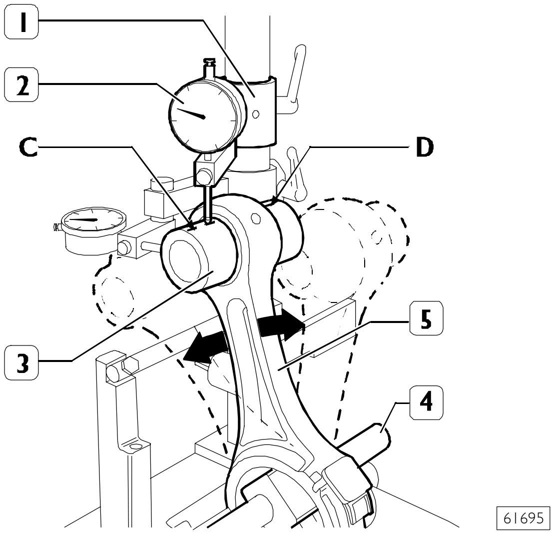
Figure 52 (Demonstration)



Check the torsion of the connecting rod (5) by comparing two points (**A** and **B**) of the pin (3) on the horizontal plane of the axis of the connecting rod.
Position the mount (1) of the dial gauge (2) so that this pre-loads by approx. 0.5 mm on the pin (3) at point **A** and zero the dial gauge (2). Shift the spindle (4) with the connecting rod (5) and compare any deviation on the opposite side **B** of the pin (3): the difference between **A** and **B** must be no greater than 0.08 mm.

Checking bending

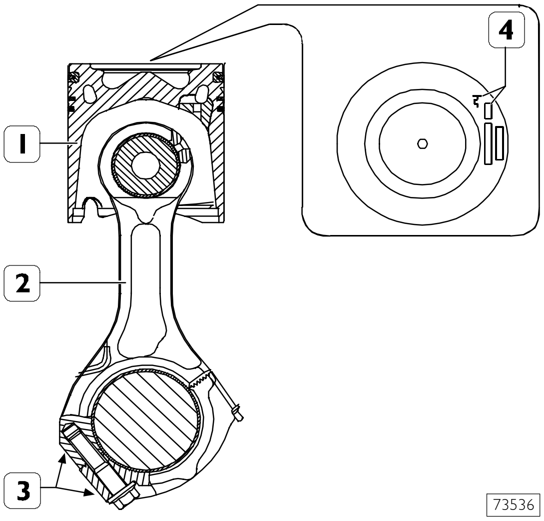
Figure 53 (Demonstration)



Check the bending of the connecting rod (5) by comparing two points **C** and **D** of the pin (3) on the vertical plane of the axis of the connecting rod.
Position the vertical mount (1) of the dial gauge (2) so that this rests on the pin (3) at point **C**.
Swing the connecting rod backwards and forwards seeking the highest position of the pin and in this condition zero the dial gauge (2).
Shift the spindle (4) with the connecting rod (5) and repeat the check on the highest point on the opposite side **D** of the pin (3). The difference between point **C** and point **D** must be no greater than 0.08 mm.

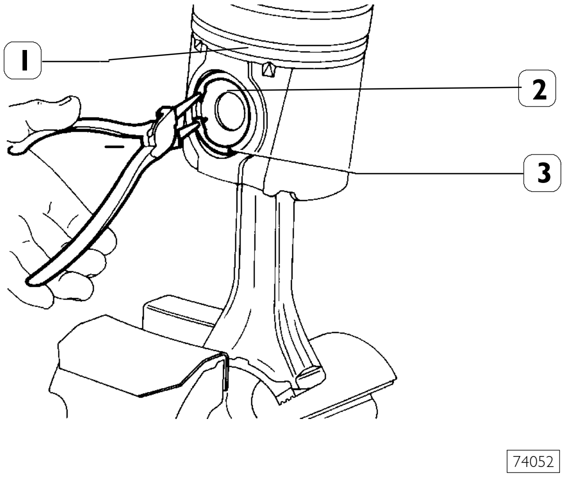
Mounting the connecting rod – piston assembly

Figure 54



The piston (1) has to be fitted on the connecting rod (2) so that the graphic symbol (4), showing the assembly position in the cylinder liner, and the punch marks (3) on the connecting rod are observed as shown in the figure.

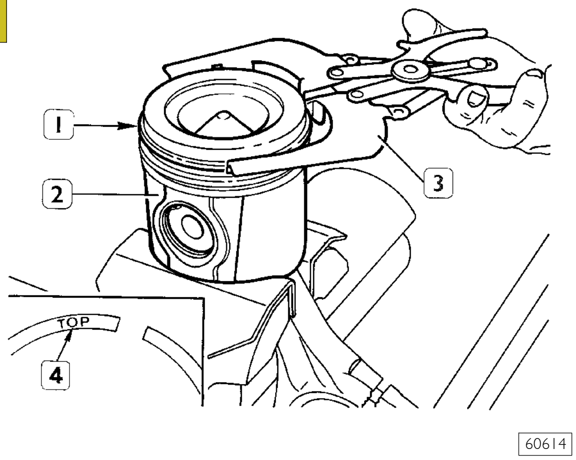
Figure 55



Fit the pin (2) and fasten it on the piston (1) with the split rings (3).

Mounting the piston rings

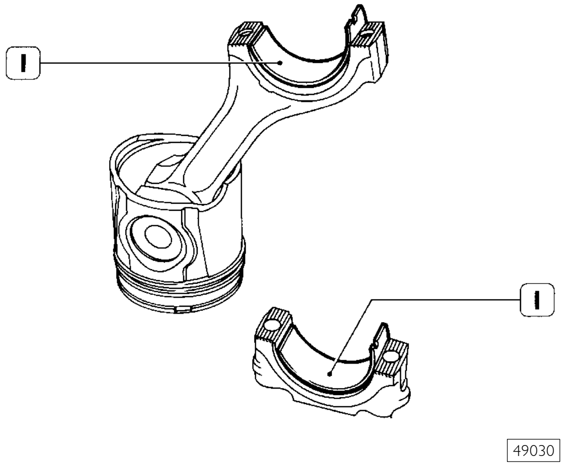
Figure 56



To fit the piston rings (1) on the piston (2) use the pliers 99360184 (3).
The rings need to be mounted with the word "TOP" (4) facing upwards. Direct the ring openings so they are staggered 120° apart.

Fitting the big end bearing shells

Figure 57



Fit the bearing shells (1), selected as described under the heading "Selecting the main and big end bearing shells", on both the connecting rod and the cap.

If reusing bearing shells that have been removed, fit them back into their respective seats in the positions marked during removal.

Fitting connecting rod - piston assemblies in the cylinder liners

With the aid of the clamp 99360605 (1, Figure 58), fit the connecting rod – piston assembly (2) in the cylinder liners, according to the diagram of Figure 59, checking that:

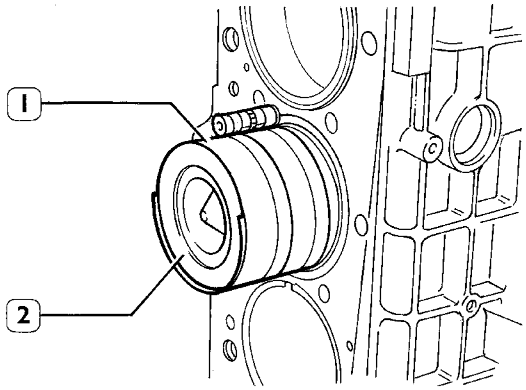
☐ The openings of the piston rings are staggered 120° apart.

☐ The pistons are all of the same class, A or B.

☐ The symbol punched on the top of the pistons faces the engine flywheel, or the recess in the skirt of the pistons tallies with the oil nozzles.

NOTE The pistons are supplied as spares in class A and can be fitted in class B cylinder liners.

Figure 58

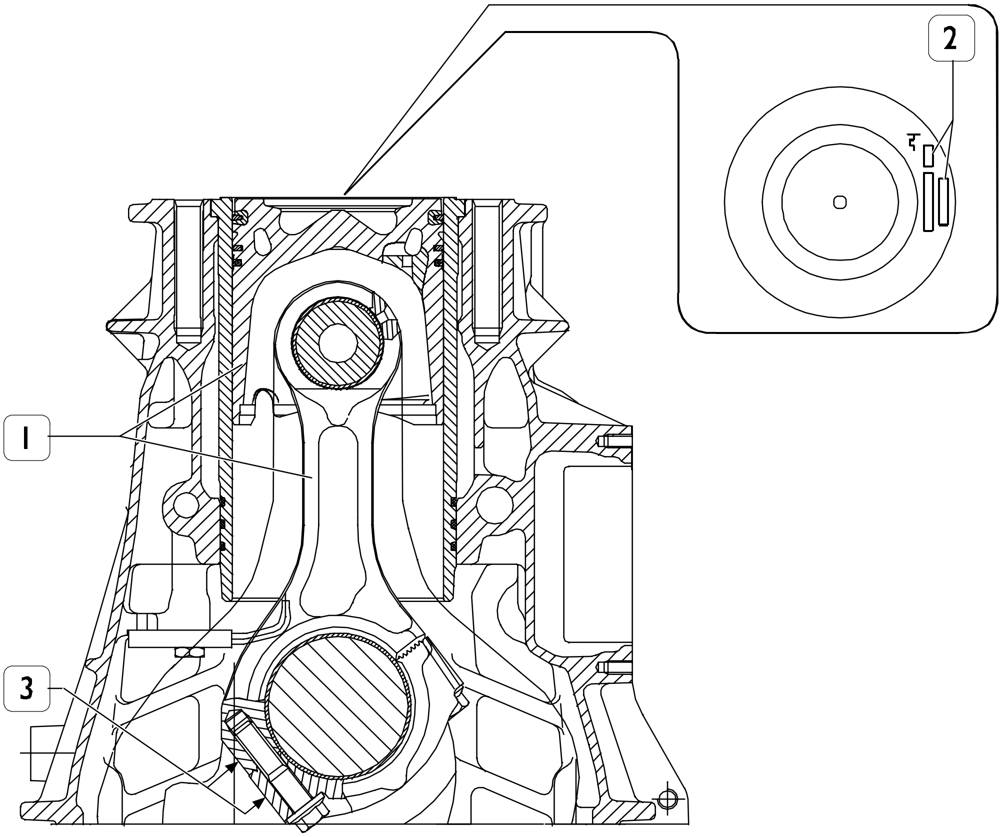


60616

Checking piston protrusion

On completing assembly, check the protrusion of the pistons from the cylinder liners; it must be 0.23 – 0.53 mm.

Figure 59



60615

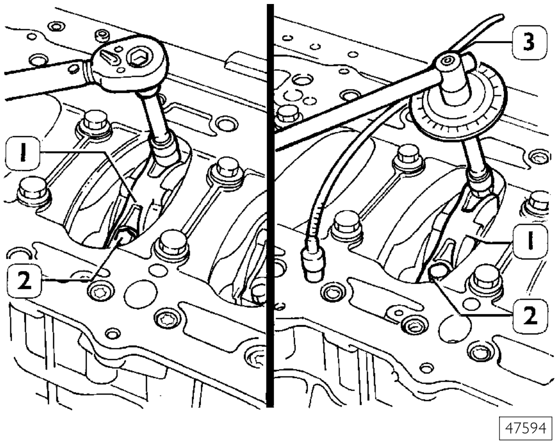
ASSEMBLY DIAGRAM OF CONNECTING ROD – PISTON ASSEMBLY IN CYLINDER LINER

1. Connecting rod – piston assembly – 2. Area of punch marking on the top of the piston, symbol showing assembly position and selection class – 3. Connecting rod punch mark area.

Checking crankpin assembly clearance

To measure the clearance, carry out the following operations.
Connect the connecting rods to the relevant journals of the crankshaft, placing a length of calibrated wire on the journals.

Figure 60



Mount the connecting rod caps (1) together with the bearing shells. Tighten the screws (2) fixing the connecting rod caps to a torque of 60 Nm (6 kgm). Using tool 99395216 (3), further tighten the screws with an angle of 60°.

NOTE The thread of the screws (2), before assembly, has to be lubricated with engine oil.

Remove the caps and determine the clearance by comparing the width of the calibrated wire with the graduated scale on the case containing the calibrated wire.
Upon final assembly: check the diameter of the thread of the screws (2), it must be no less than 13.4 mm; if it is, change the screw. Lubricate the crankpins and connecting rod bearings. Tighten the screws (2) as described above.

CYLINDER HEAD

Before dismounting cylinder head, check cylinder head for hydraulic seal by proper tooling; in case of leaks not caused by cup plugs or threaded plugs, replace cylinder head.

NOTE When replacing, the cylinder head is supplied as a spare part with a threaded plug, which must be removed during assembly.

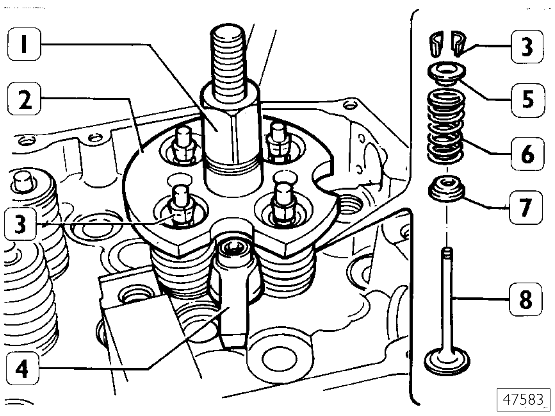
NOTE In case of plugs dismounting/replacement, on mounting, apply sealant Loctite 270 on plugs.

Disassembly the valves

NOTE Before dismounting cylinder head valves, number them in view of their remounting in the position observed on dismounting should they not have to be overhauled or replaced.

Intake valves are different form exhaust valves in that they have a notch placed at valve head centre.

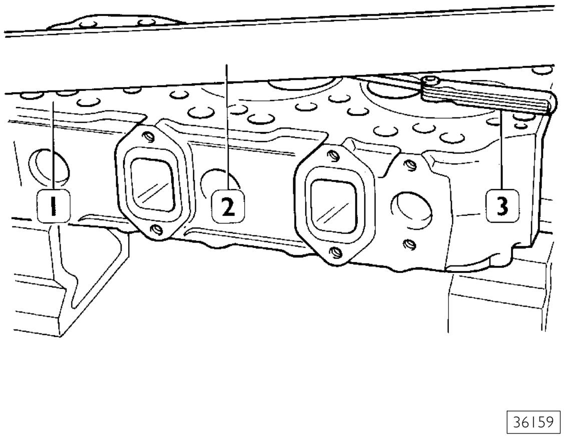
Figure 61



Mount and secure the tool 99360262 (2) with the bracket (4). Screw down with the device 99360261 (1) to be able to remove the cotters (3). Take out the tool (2) and extract the top plate (5), spring (6) and bottom plate (7).
Repeat this process on all the valves.
Turn over the cylinder head and take out the valves (8).

Checking head bearing surface on cylinder block

Figure 62 (Demonstration)



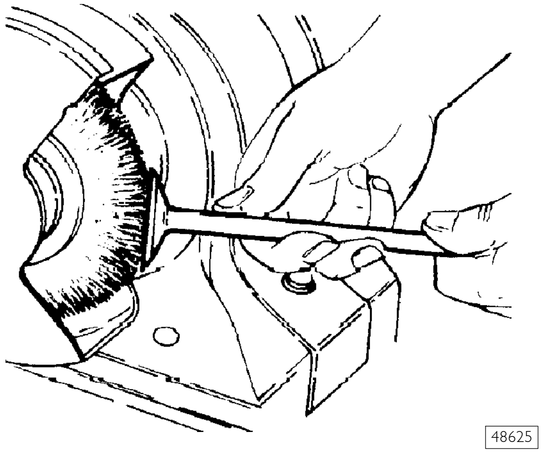
Check the supporting surface (1) of the head on the cylinder block with a rule (2) and a feeler gauge (3). If you find any deformation, level the head on a surface grinder; maximum amount of material that can be removed 0.2 mm.

NOTE After this process, you need to check the valve recessing and injector protrusion.

Valves

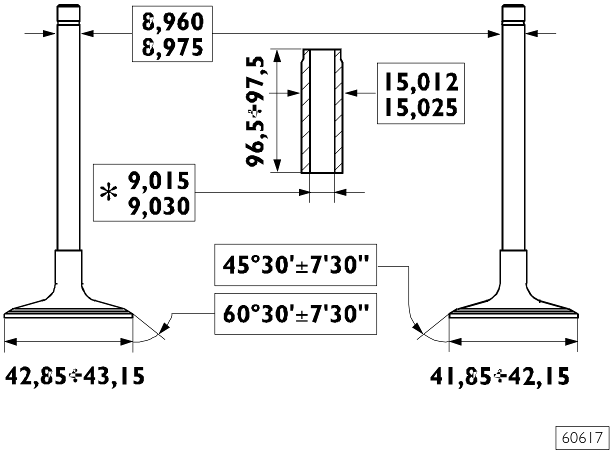
Removing deposits and checking the valves

Figure 63



Remove carbon deposits using the metal brush supplied. Check that the valves show no signs of seizure or cracking. Check the diameter of the valve stem using a micrometer (see Figure 64) and replace if necessary.

Figure 64



MAIN DATA OF VALVES AND VALVE GUIDES

* Measurement to be made after driving in the valve guides

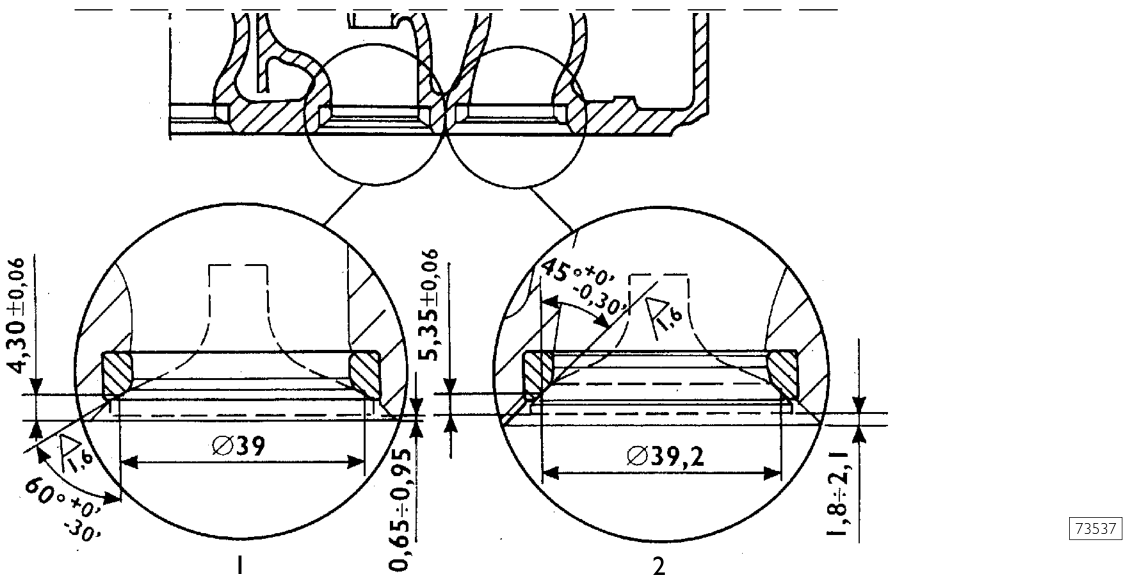
Check with a micrometer that the diameter of the valve stems is as indicated. If necessary, grind the valve seats with a grinding machine, removing as little material as possible.

Valve seats

Regrinding – replacing valve seats

NOTE The valve seats are reground whenever the valves or valve guides are ground and replaced.

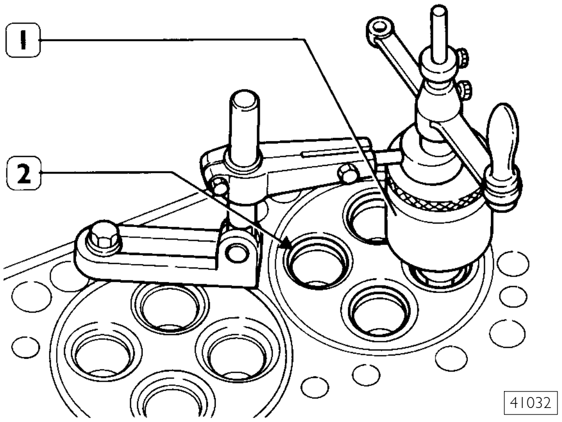
Figure 65



MAIN DATA OF VALVE SEATS

1. Intake valve seat – 2. Exhaust valve seat

Figure 66 (Demonstration)



Check the valve seats (2). If you find any slight scoring or burns, regrind them with tool 99305019 (1) according to the angles shown in Figure 64 and Figure 65. If it is necessary to replace them, using the same tool and taking care not to affect the cylinder head, remove as much material as possible from the valve seats so that, with a punch, it is possible to extract them from the cylinder head.

Heat the cylinder head to 80 – 100°C and, using a drift, fit in the new valve seats (2), chilled beforehand in liquid nitrogen. Using tool 99305019 (1), regrind the valve seats according to the angles shown in Figure 65.

After regrinding the valve seats, using tool 99370415 and dial gauge 99395603, check that the position of the valves in relation to the plane of the cylinder head is:

- -0.65 to -0.95 mm (recessing) intake valves;
- -1.8 to -2.1 mm (recessing) exhaust valves.

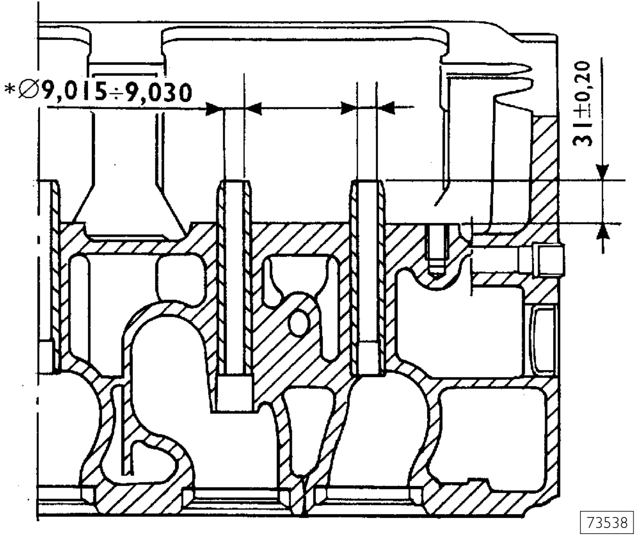
Checking clearance between valve-stem and associated valve guide

Using a dial gauge with a magnetic base, check the clearance between the valve stem and the associated guide. If the clearance is too great, change the valve and, if necessary, the valve guide.

Valve guides

Replacing valve guides

Figure 67



* Measurement to be made after driving in the valve guides

The valve guides are removed with the drift 99360481.

They are fitted with the drift 99360481 equipped with part 99360295.

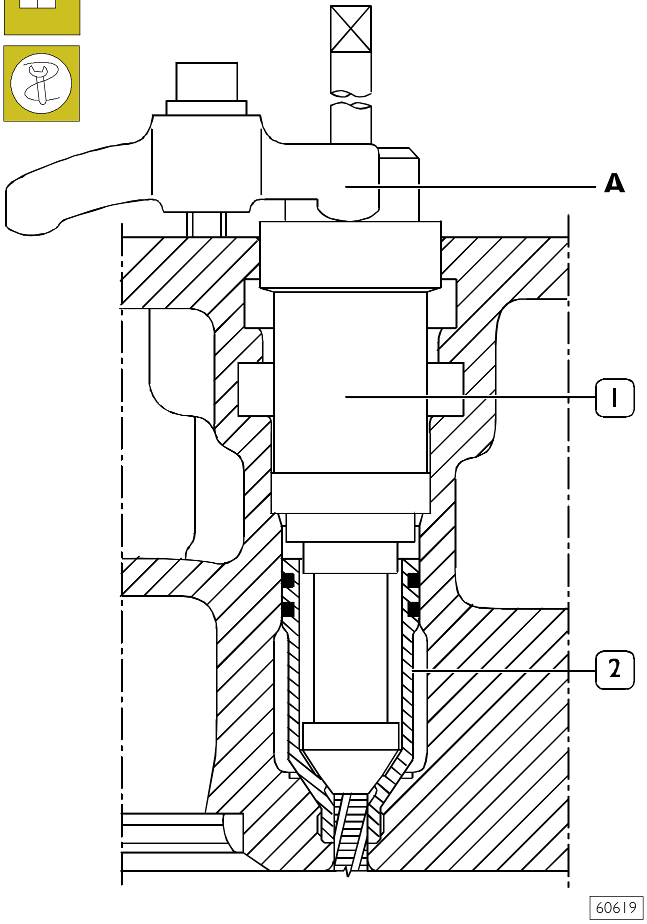
Part 99360295 determines the exact position of assembly of the valve guides in the cylinder head. If they are not available, you need to drive the valve guides into the cylinder head so they protrude by 30.8-31.2 mm.

After driving in the valve guides, rebore their holes with the smoother 99390311.

Replacing injector cases

Removal

Figure 68

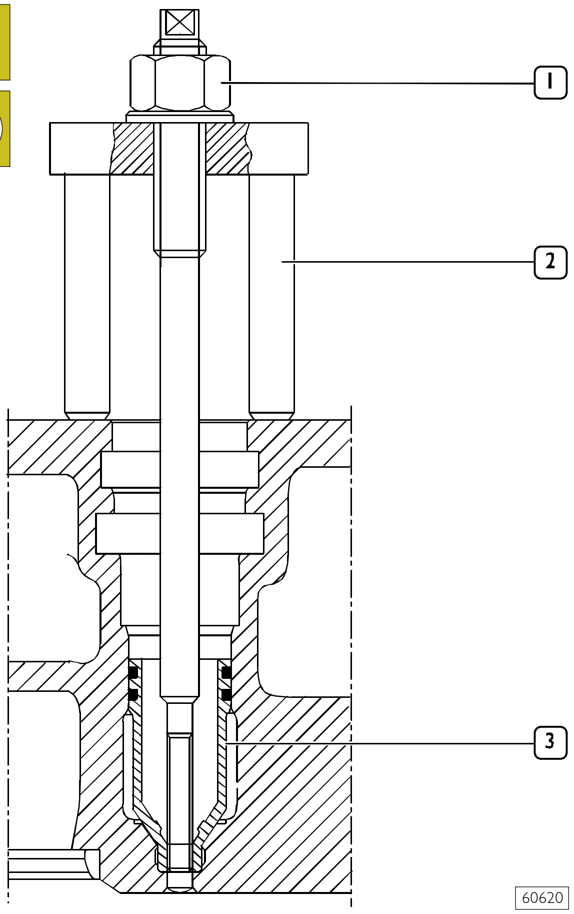


To replace the injector case (2), proceed as follows:

☐ Thread the case (2) with tool 99390804 (1).

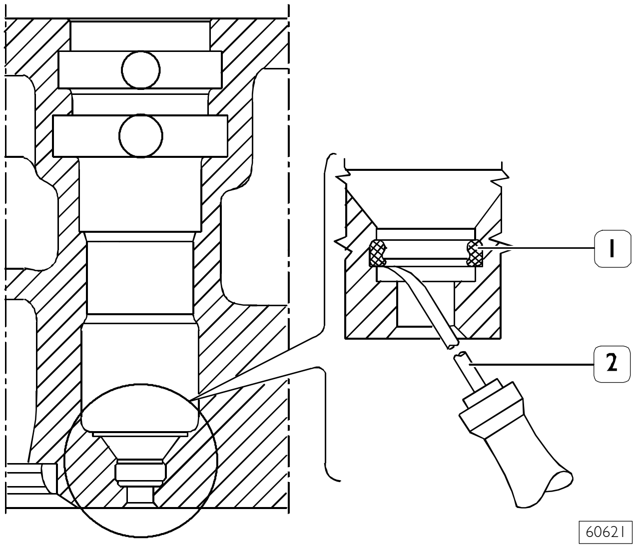
The steps described in Figs. 68 – 71 – 72 – 73 need to be carried out by fixing the tools, with the bracket A, to the cylinder head.

Figure 69



☐ Screw the extractor 99342149 (2) into the case (3). Screw down the nut (1) and take the case out of the cylinder head.

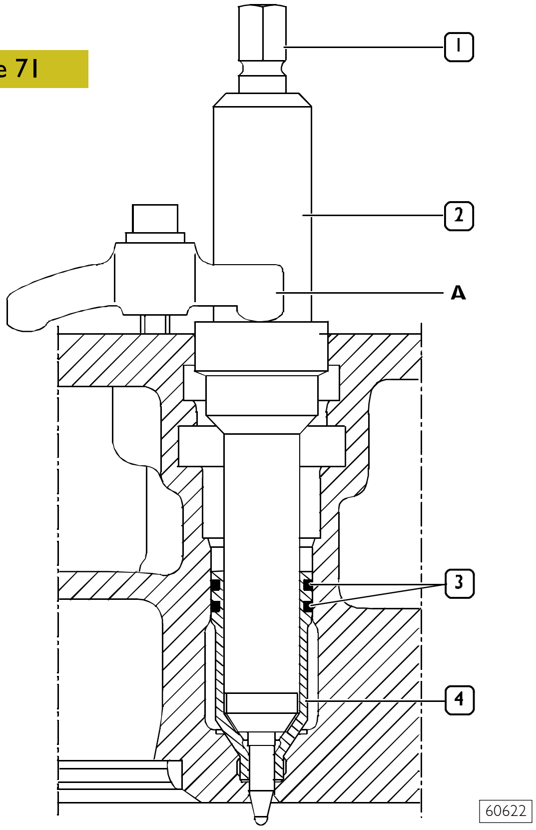
Figure 70



☐ Using the tool 99390772 (2) remove any residues (1) left in the groove of the cylinder head.

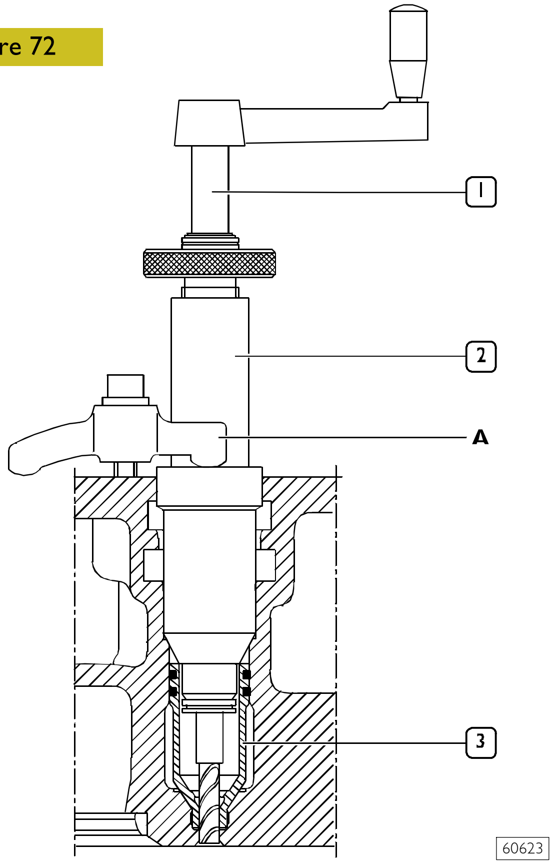
Assembly

Figure 71



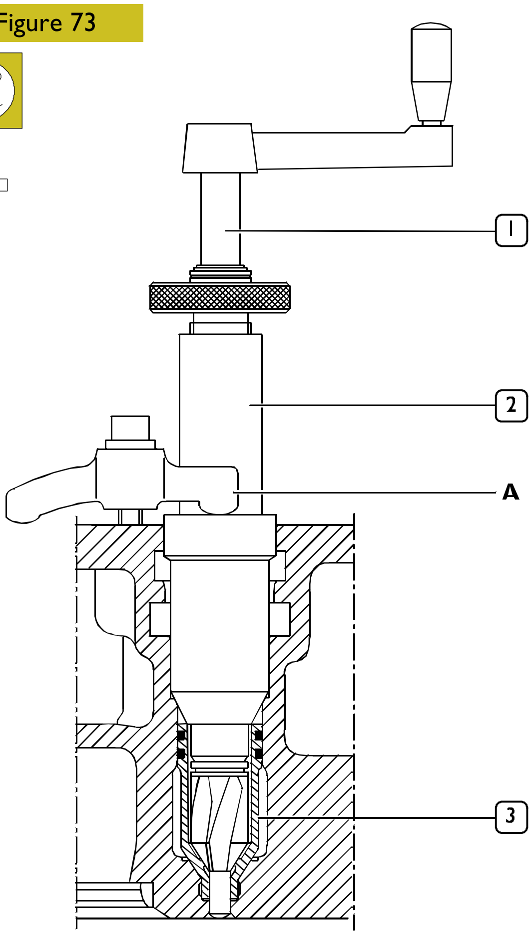
☐ Lubricate the seals (3) and fit them on the case (4). Using tool 99365056 (2) secured to the cylinder head with bracket **A**, drive in the new case, screwing down the screw (1) upsetting the bottom portion of the case.

Figure 72



☐ Using the reamer 99394041 (1-2), rebore the hole in the case (3).

Figure 73



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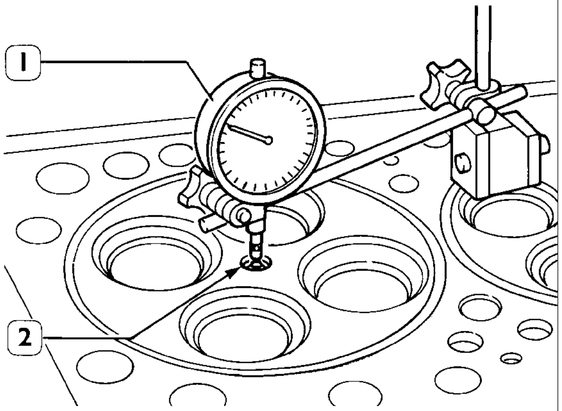
☐ Using grinder 99394041 (1-2), ream the injector seat in the case (3).

Checking injector protrusion

Figure 74



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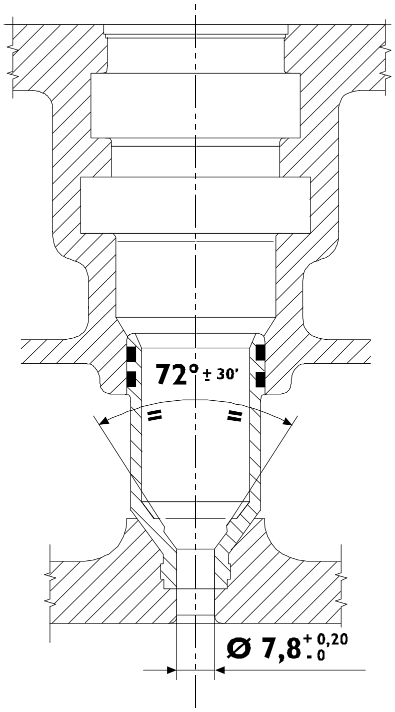
Check injector protrusion (2) with the dial gauge (1). The protrusion must be 1.32 to 1.14 mm.

Figure 75



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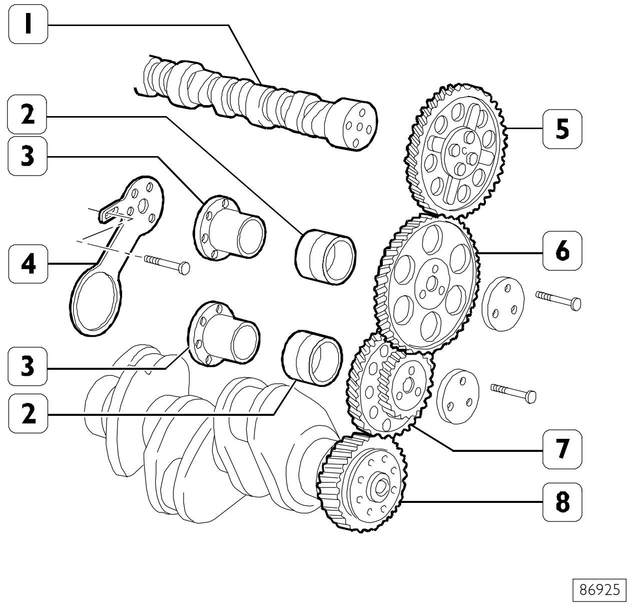
INJECTOR CASE ASSEMBLY DIAGRAM

TIMING GEAR

Camshaft drive

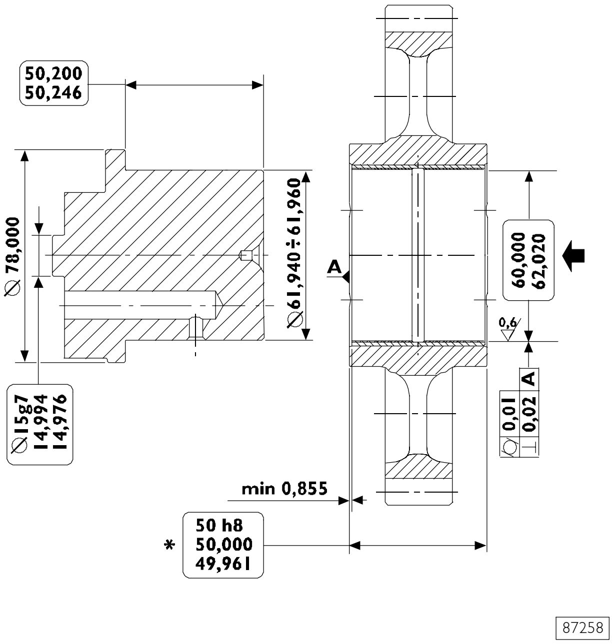
Figure 76



TIMING CONTROL COMPONENT PARTS
1. Camshaft - 2. Bushing - 3. Pin - 4. Articulated rod - 5. Camshaft control gear - 6. Idler gear - 7. Twin idler gear - 8. Drive shaft driving gear.

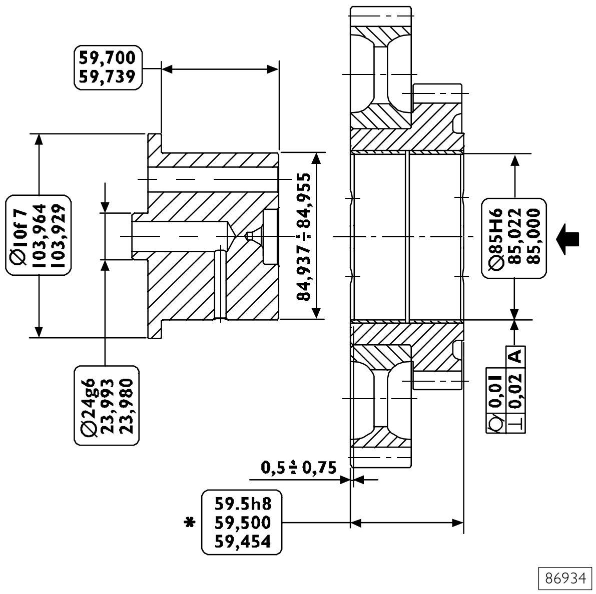
Idler gear and pin

Figure 77



Twin intermediate gear and pin

Figure 78



Replacing the bushings

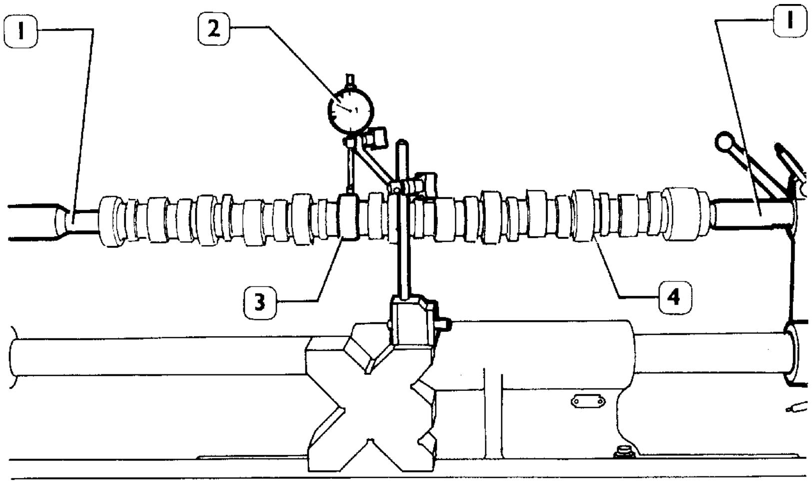
Gear bushings shown on Figures 77 and 78 can be replaced when they are worn. Put up the bushing, then bore it to obtain the diameter shown on Figure 77 or Figure 78.

NOTE The bushing must be driven into the gear by following the direction of the arrow and setting the latter to the dimension shown on Figure 77 or Figure 78.

Rated assembling play between gear bushings and pins:
Figure 77 – 0.040 ÷ 0.080 mm
Figure 78 – 0.045 ÷ 0.085 mm.

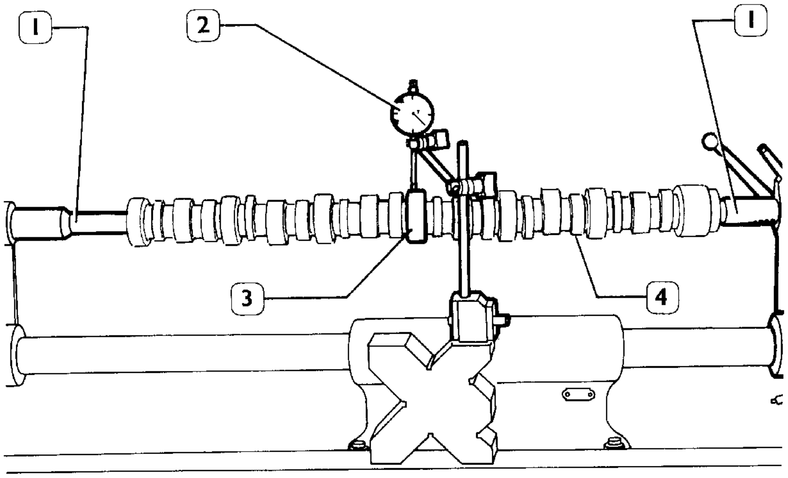
Check of cam lift and timing system shaft pins alignment

Figure 79



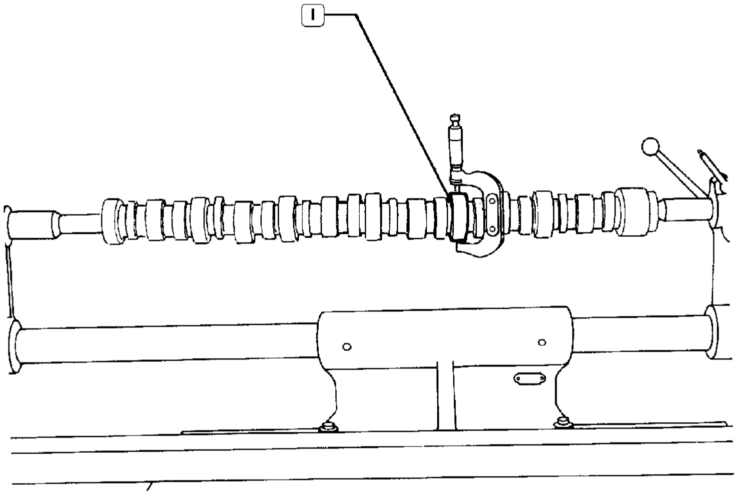
Place the camshaft (4) on the tailstock (1) and check cam lift (3) using a centesimal gauge (2).

Figure 80



When the camshaft (4) is on the tailstock (1), check alignment of supporting pin (3) using a centesimal gauge (2); it must not exceed 0.035 mm. If misalignment exceeds this value, replace the shaft.

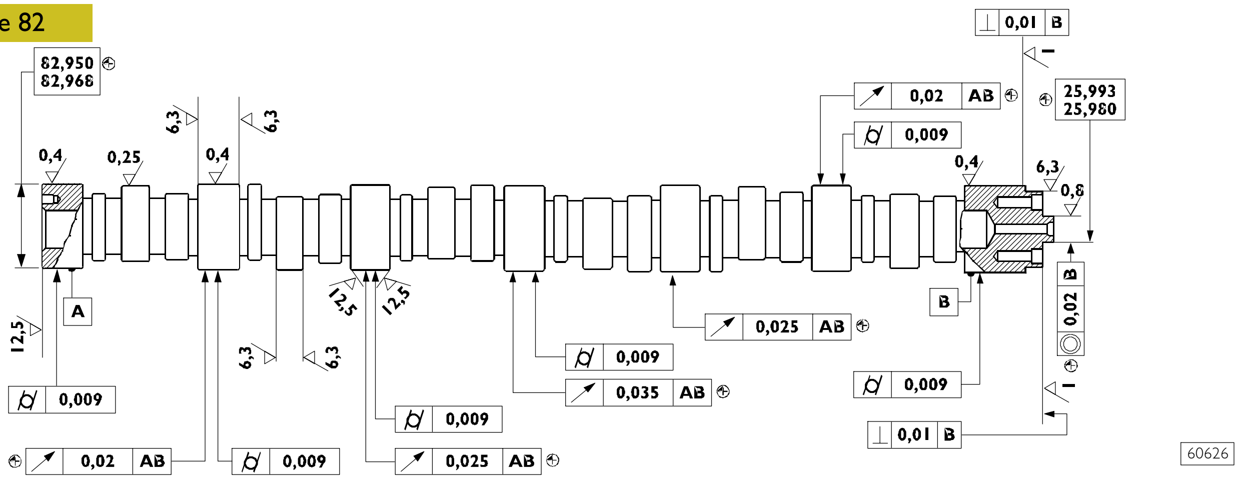
Figure 81



In order to check installation clearance, measure bush inner diameter and camshaft pin (1) diameter; the real clearance is obtained by their difference.
If clearance exceeds 0.150 mm, replace bushes and, if necessary, the camshaft.

Camshaft

Figure 82

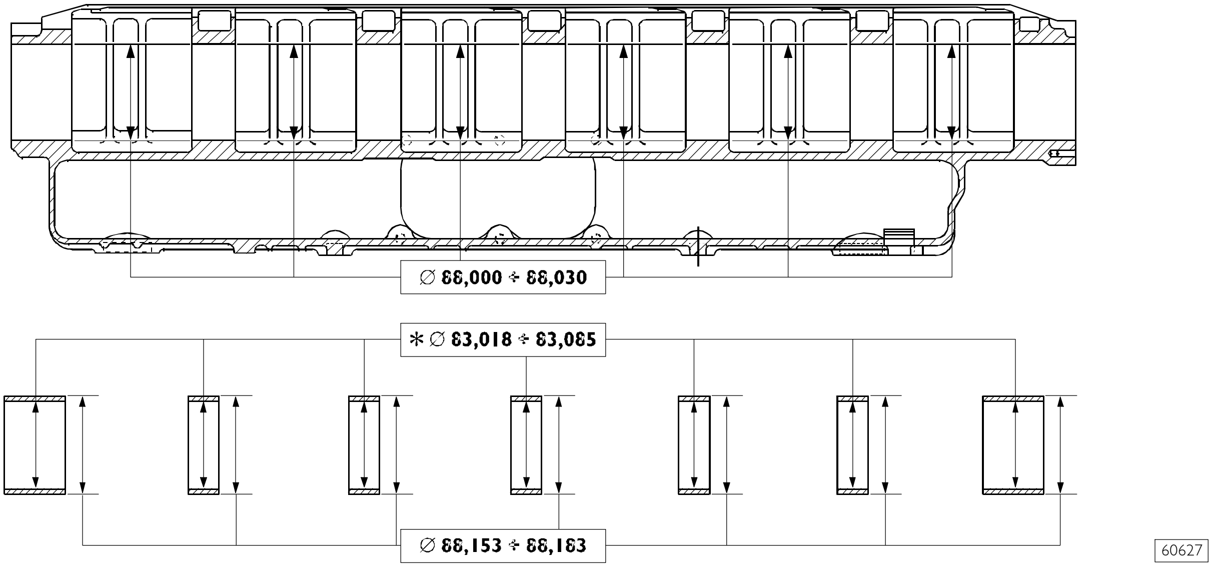


MAIN DATA - CAMSHAFT AND TOLERANCES
The surfaces of shaft supporting pin and cams must be extremely smooth; if you see any sign of seizing or scoring, replace the shaft and the relative bushes.

TOLERANCES	TOLERANCE CHARACTERISTIC	SYMBOL
ORIENTATION	Perpendicularity	⊥
POSITION	Concentricity or coaxial alignment	◎
OSCILLATION	Circular oscillation	↗
IMPORTANCE CLASS ASSIGNED TO PRODUCT CHARACTERISTICS		SYMBOL
CRITICAL		©
IMPORTANT		⊕
SECONDARY		⊖

Bushings

Figure 83



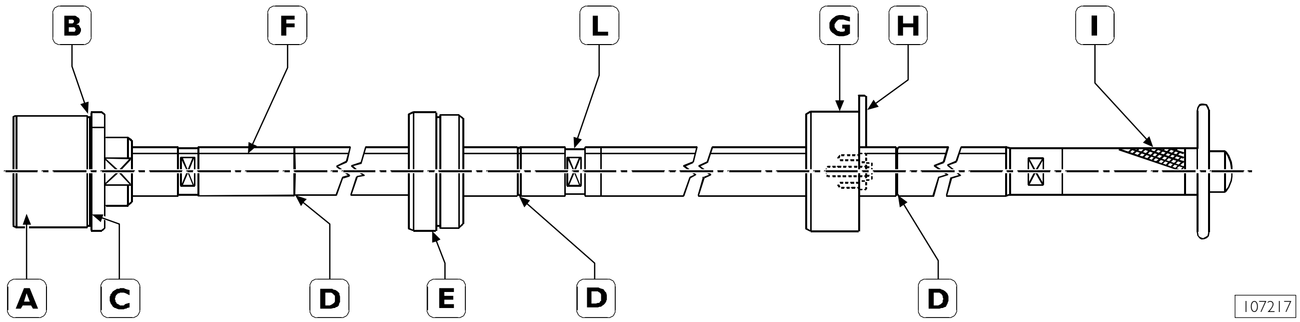
MAIN DATA OF CAMSHAFT BUSHES AND RELEVANT HOUSINGS ON CYLINDER HEAD
∗ Bush inner diameter after installation

The bush surfaces must not show any sign of seizing or scoring; if they do replace them.

Measure the bush inner diameters with a baremeter and replace them, if the value measured exceeds the tolerance value.
To take down and fit back the bushes, use the proper tool 99360499.

Replacing camshaft bushings with drift 99360499

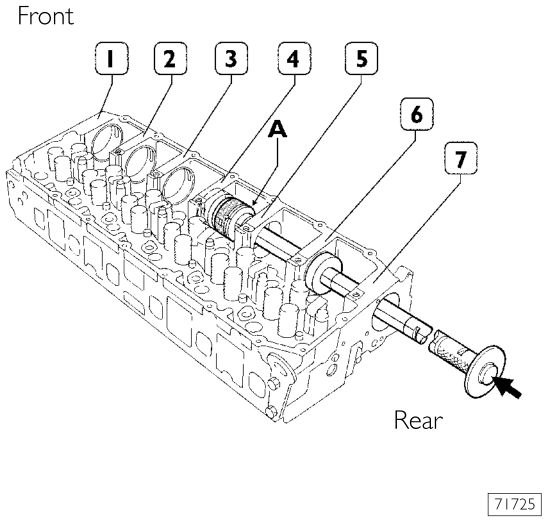
Figure 84



A = Drift with seat for bushings to insert/extract.
B = Grub screw for positioning bushings.
C = Reference mark to insert seventh bushing correctly.
D = Reference mark to insert bushings 1, 2, 3, 4, 5, 6 correctly (red marks).
E = Guide bushing.
F = Guide line.
G = Guide bushing to secure to the seventh bushing mount.
H = Plate fixing bushing G to cylinder head.
I = Grip.
L = Extension coupling.

Dismounting the bushings

Figure 85

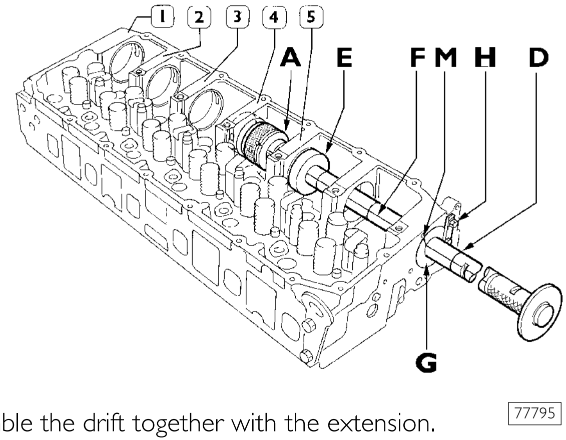


The sequence for removing the bushings is 7, 6, 5, 4, 3, 2, 1. The bushings are extracted from the front of the single seats. Removal does not require the drift extension for bushings 5, 6 and 7 and it is not necessary to use the guide bushing. For bushings 1, 2, 3 and 4 it is necessary to use the extension and the guide bushings.

Position the drift accurately during the phase of removal.

Mounting the bushings

Figure 86



Assemble the drift together with the extension.

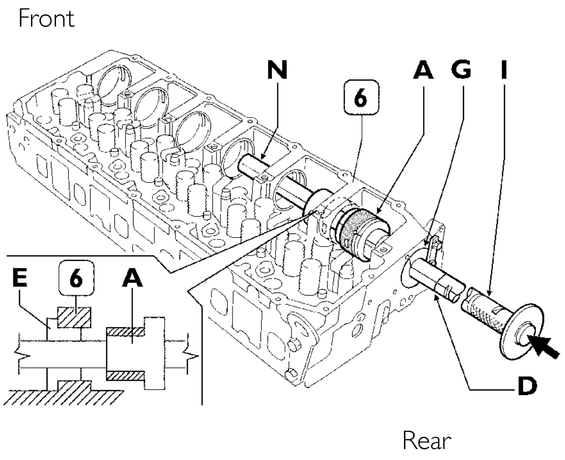
To insert bushings 1, 2, 3, 4 and 5, proceed as follows:

4 position the bushing to insert on the drift (A) making the grub screw on it coincide with the seat (B) (Figure 84) on the bushing.

5 position the guide bushing (E) and secure the guide bushing (G) (Figure 84) on the seat of the 7th bushing with the plate (H).

6 while driving in the bushing, make the reference mark (F) match the mark (M). In this way, when it is driven home, the lubrication hole on the bushing will coincide with the oil pipe in its seat.
The bushing is driven home when the 1st red reference mark (D) is flush with the guide bushing (G).

Figure 87

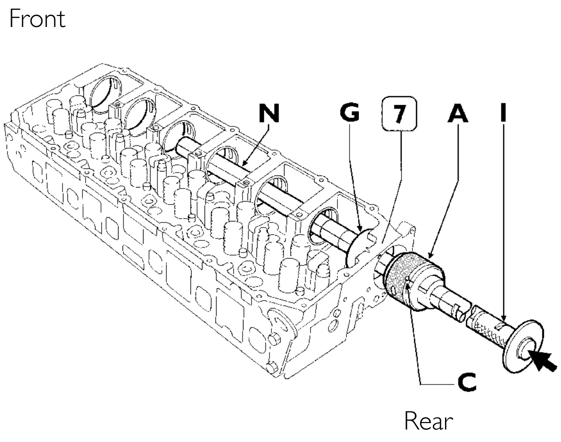


71723

To insert the bushing (6), proceed as follows:

- ☐ Unscrew the grip (I) and the extension (N).
- ☐ Position the extension (N) and the guide bushing (E) as shown in the figure.
- ☐ Repeat steps 1, 2, 3.

Figure 88



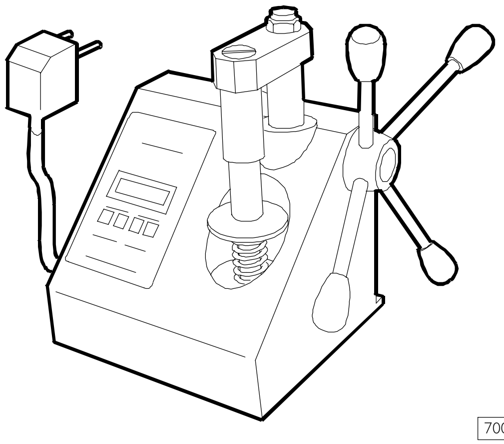
71724

To insert bushing (7), proceed as follows:

- ☐ Unscrew the grip (I) and the extension (N).
- ☐ Refit the guide (G) from the inside as shown in the figure.
- ☐ Position the bushing on the drift (A) and bring it close up to the seat, making the bushing hole match the lubrication hole in the head. Drive it home.
  The 7th bushing is driven in when the reference mark (C) is flush with the bushing seat.

Valve springs

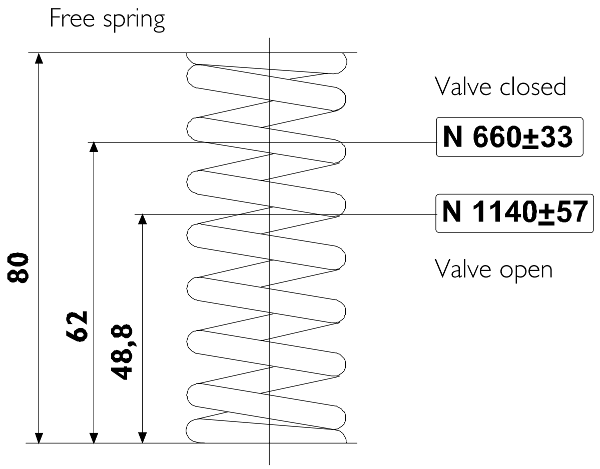
Figure 89



70000

Before assembly, the flexibility of the valve springs has to be checked.
Compare the load and elastic deformation data with those of the new springs given in the following figure.

Figure 90



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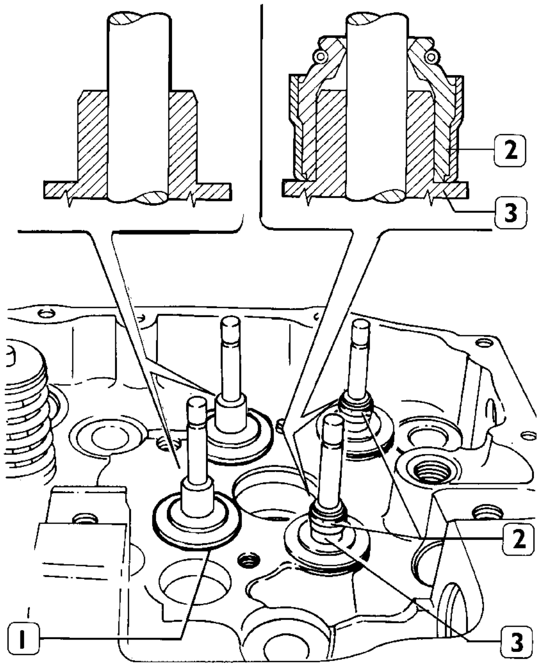
MAIN DATA TO CHECK THE SPRING
FOR INTAKE AND EXHAUST VALVES

Fitting valves and oil seal

Figure 91



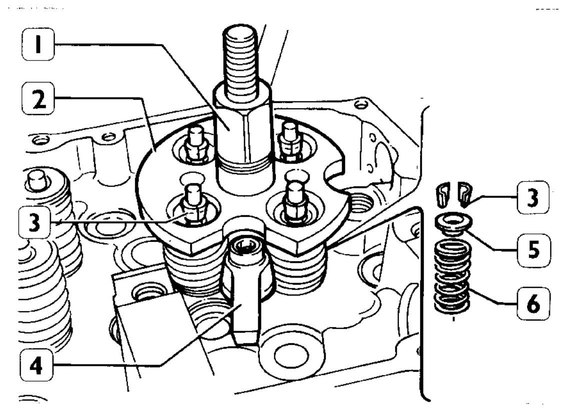
87051

Lubricate the valve stem and insert the valves in the respective valve guides; fit the lower caps (1). Use tool 99360328 to fit the oil seal (2) on the valve guides (3) of the exhaust valves; then, to fit the valves, proceed as follows.

NOTE Should valves not have been overhauled or replaced, remount them according to numbering performed on dismounting.

Intake valves are different form exhaust valves in that they have a notch placed at valve head centre.

Figure 92



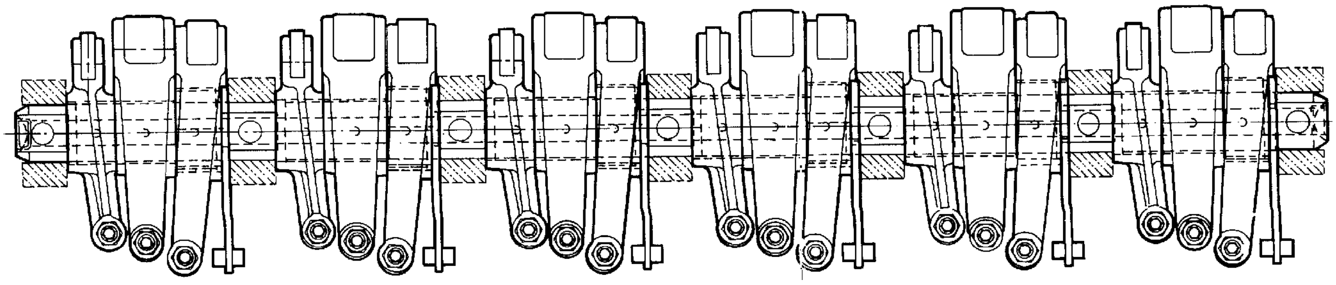
86290

☐ Mount the springs (6) and the top plate (5).

☐ Fit the tool 99360262 (2) and secure it with the bracket (4). Screw down the lever (1) to be able to fit on the cotters (3). Take off the tool (2).

ROCKER SHAFT

Figure 93



44925

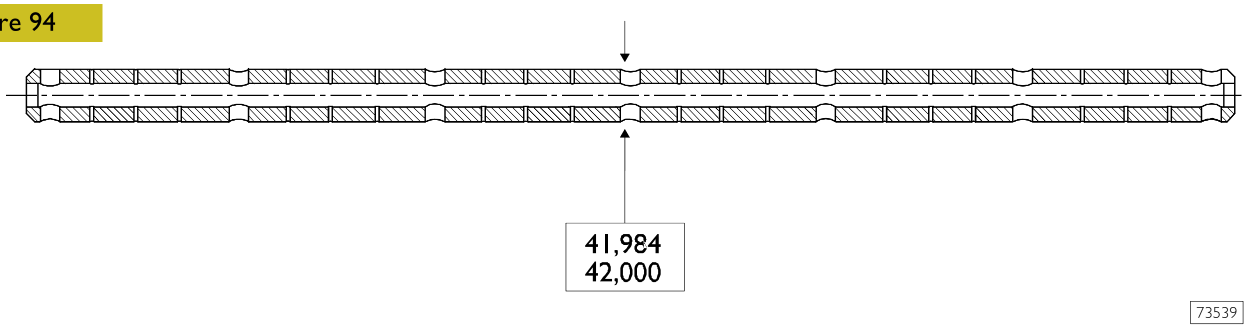
The cams of the camshaft control the rocker arms directly: 6 for the injectors and 12 for the valves.

Injectors and intake valves control rocker arms are keyed on rocker arms shaft directly. Exhaust intake valves control rocker arms are keyed on rocker arms shaft putting in between the levers with engine brake control eccentric pin.

The rocker arms run directly on the profiles of the cams by means of rollers.
The other end acts on a crosspiece that rests on the stem of the two valves.
There is a pad between the rocker arm adjustment screw and the crosspiece.
There are two lubrication ducts inside the rocker arms.
The length of the rocker arm shaft is basically the same as that of the cylinder head. It has to be detached to be able to reach all the parts beneath.

Shaft

Figure 94

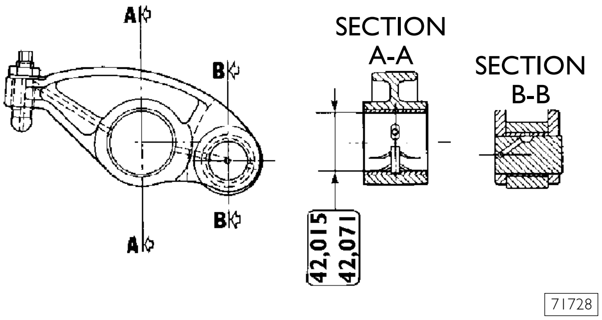


MAIN DATA OF THE ROCKER ARM SHAFT

Check that the surface of the shaft shows no scoring or signs of seizure; if it does, replace it.

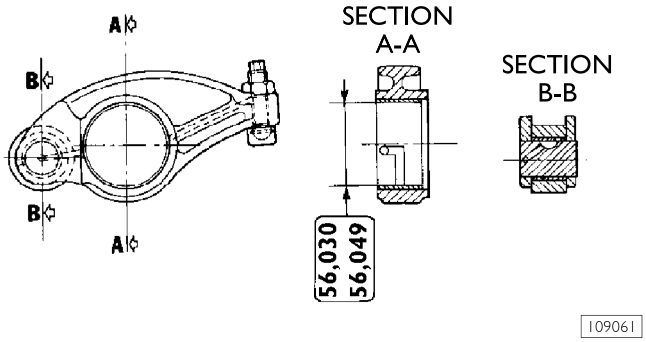
Rocker arms

Figure 95



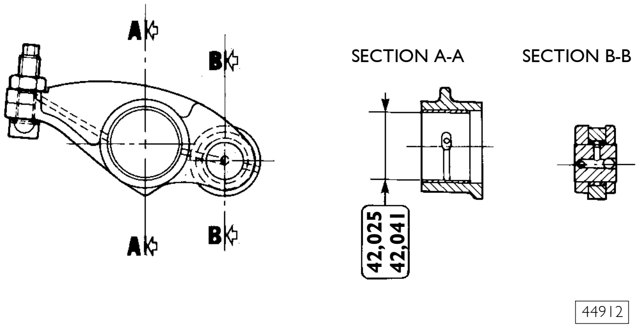
PUMP INJECTOR ROCKER ARMS

Figure 97



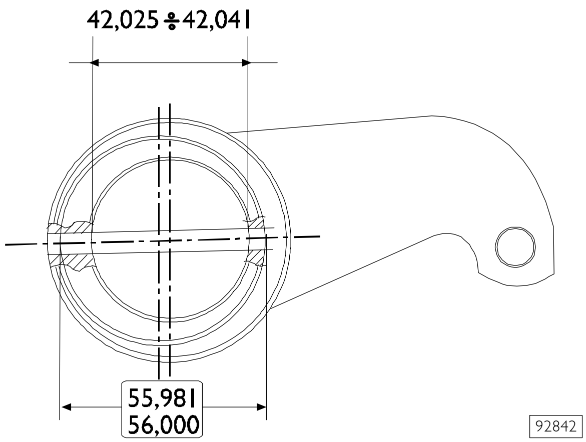
EXHAUST VALVE ROCKER ARMS

Figure 96



INTAKE VALVE ROCKER ARMS

Figure 98



LEVER WITH ENGINE BRAKE CONTROL ECCENTRIC PIN

Check the surfaces of the bushings, which must show no signs of scoring or excessive wear; if they do, replace the rocker arm assembly.

REPAIR

NOTE If anomalous engine operation is found, which is due to the boosting system, it is advisable that you check the efficiency of seal gaskets and the fastening of connecting sleeves prior to carrying out the checks on the turboblower. Also check for obstructions in the sucking sleeves, air filter. If the turbocharger damage is due to a lack of lubrication, check that the oil circulation pipes are not damaged.
If so, change them or eliminate the cause.

After carrying out the above mentioned checks, check the turbocharger operation with an Engine Test by using IVECO diagnosis equipment (Modus - IT 2000 - E.A.SY.) according to the relevant procedure.

NOTE The test must be performed in following conditions:

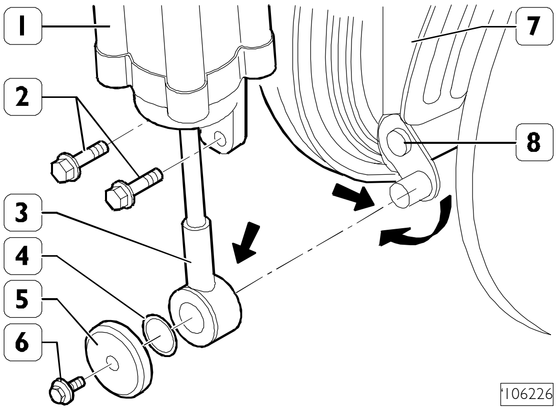
- engine coolant temperature >50 °C;
- battery up (voltage >22V) for compression test;
- efficient recharging system.

If values beyond tolerance are detected, check the efficiency of:

- shut-off valve;
- pressure sensor;
- engine cable pressure sensor connection (if oxidised, clean with a specific product);
- lack of electrical defects in solenoid valve VGT (continuity connection);
- actuator moved by active diagnosis as described in relating chapter, in case of locking, grease bushing with lubricant Kernite (for high temperatures); if the trouble persists, replace the actuator;
- sliding sleeve: it must slide freely when operated manually. If locked and if the bush check is not sufficient or effective, or no faults are detected in the other points, upon authorization of the "Help Desk" market operator, change the turbocharger according to the standard procedures.

Variable geometry movement control

Figure 99



Remove screws (2) and take actuator (1) off turbocompressor (7).
Remove screw (6), underlying disk (5), ring (4) and disconnect tie rod (3) of actuator (1) from the pin of variable geometry driving lever (8).
Accurately clean pin (→) of lever (8) and bushing (→) of tie rod (3) using a cloth made of non abrasive micro fibre.

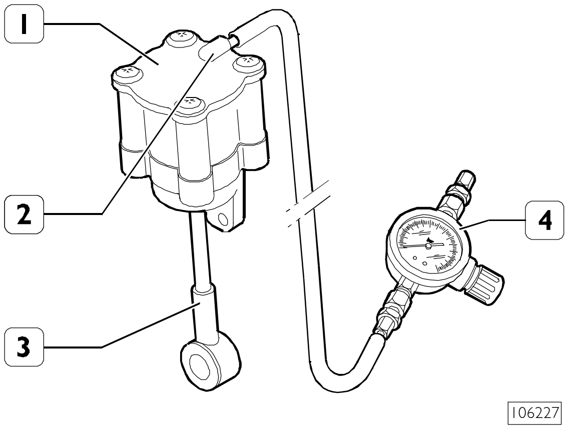
NOTE Do not use abrasive paper of any kind.

Visually check the conditions of bushing (→) of tie rod (3) and pin (→) of lever (8); where they are found to be worn out, replace actuator (1) or turbocompressor (7).

Check variable geometry inner driving mechanism movement by operating on lever (8); jamming must not occur; otherwise, clean turbine body, as described in relating chapter.

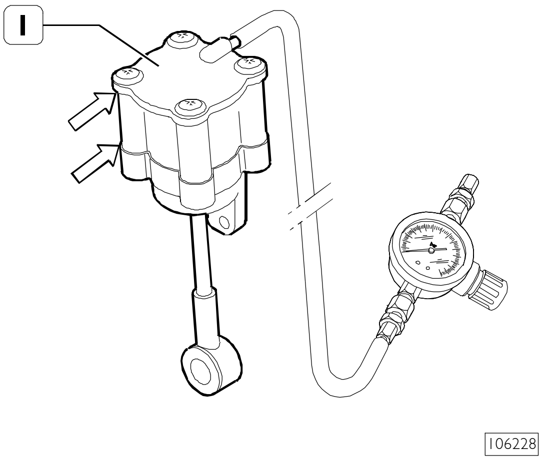
Checking the actuator

Figure 100



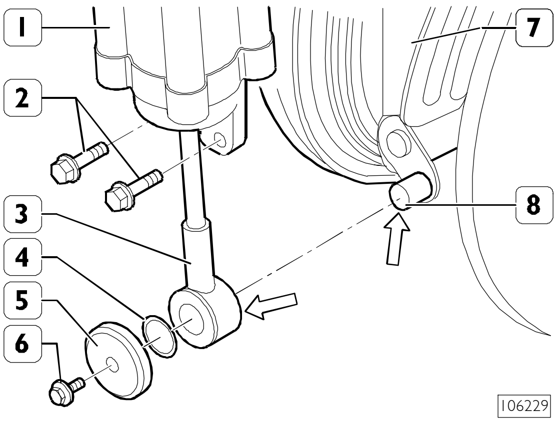
Check actuator efficiency (1) operating as follows.
Apply, to fitting (2) of actuator (1), compressed air feed piping provided with pressure regulator (4). By using the pressure regulator, introduce, into the actuator, compressed air slowly modulating it, from 0÷3.5 bar; tie rod (3) of actuator (1) must move without jamming; otherwise, replace actuator (1).

Figure 101



Check for any actuator leaks at indicated points (→) applying, on these points, a solution of suds.
When actuator (1) is fed with compressed air, no bubbles must be found at indicated points (→); otherwise, replace actuator (1).

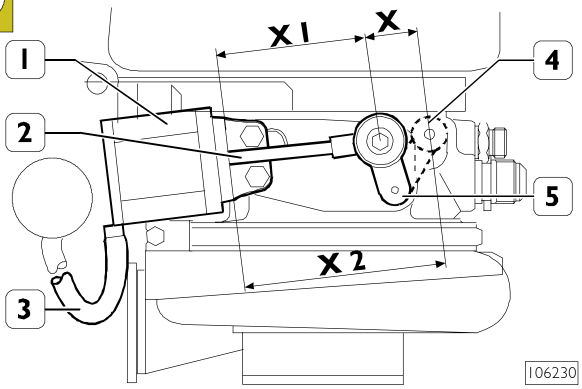
Figure 102



Lubricate bushing (→) of tie rod (3) and pin (→) of lever (8) with lithium-based Castrol LM GREASE type and reconnect actuator (1) to turbocompressor (7) operating as follows.
Connect tie rod (3) to lever (8).
Mount new ring (4), mount disk (5) and screw up screw (6).
Screw up screws (2) securing actuator (1) to turbocompressor (7).
Tighten screws (2 and 6) at 25 Nm torque.

Checking actuator travel

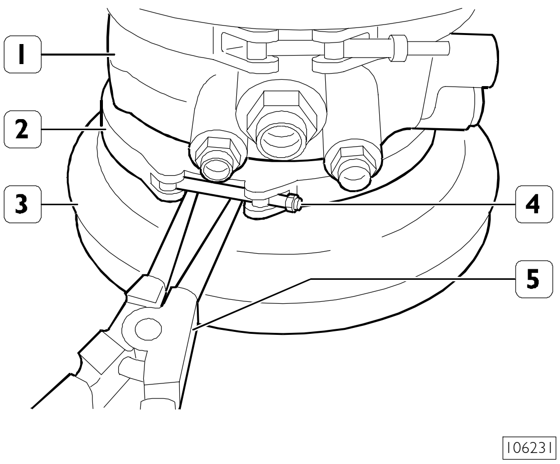
Figure 103



Check travel X of tie rod (2) of actuator (1) operating as follows.
Measure distance X1 between actuator (1) and cross-axis of eyelet (4).
Apply, to fitting of actuator (1), piping (3) for compressed air feed provided with pressure regulator. By using the pressure regulator, introduce, into actuator (1) compressed air slowly modulating it, from 0÷3,5 bar, until lever (5) is taken to its end of travel.
Measure again the distance between actuator (1) and cross-axis of eyelet (4) dimension X2.
Travel X of tie rod (2) of actuator (1) is given by following subtraction X = X2-X1 and must result to be equal to 11.5±0.5 mm.

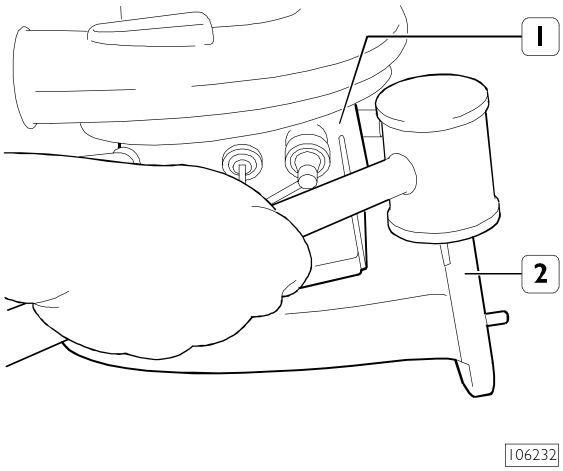
Cleaning turbine body

Figure 104



Mark mounting position of clamp (2) on central body (1).
On threading and nut (4), apply antioxidant spray lubricant and, operating on nut (4), loosen clamp (2).
Slightly rotate clamp (2) using pliers (5).
Mark mounting position of turbine body (3) on central body (1).

Figure 105

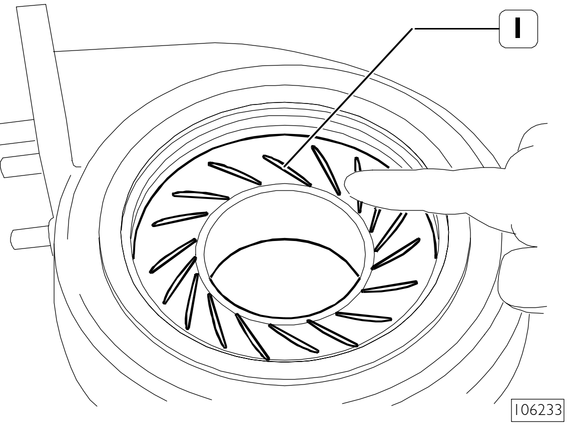


By a copper hammer, beat on two opposite points (~180°) on turbine body (2) to separate turbine body from central body (1).

NOTE In operation, take particular care to avoid damaging turbine rotor.

After dismounting turbine body, check variable geometry movement as described in relating chapter; where improvement in movement is not found with respect to previous check, replace turbocompressor.

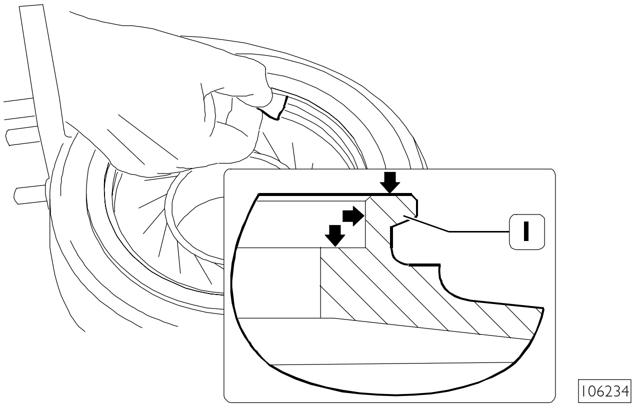
Figure 106



Accurately clean slot ring (1) and area around turbine body from carbonaceous deposits and check that the ring moves freely, otherwise, replace turbocompressor.

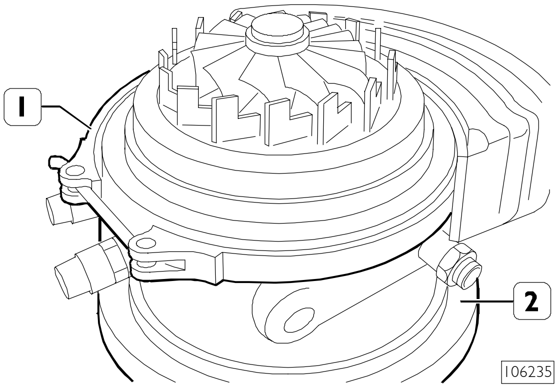
NOTE Any small cracks between slots and ring can be accepted, because they do not impair turbocompressor operation conditions.

Figure 107



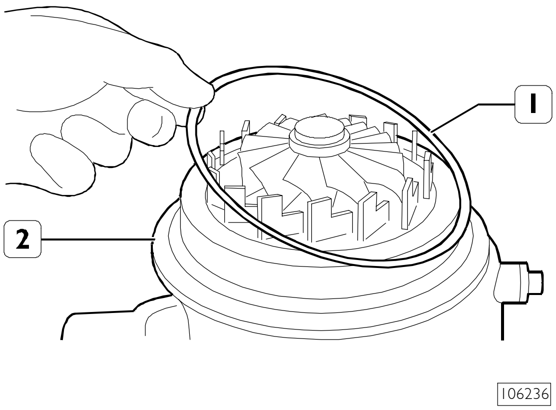
By suitable scraper and abrasive paper, accurately clean surfaces (→) of turbine body (1) from carbonaceous deposits, taking care to avoid damaging the surfaces.

Figure 108



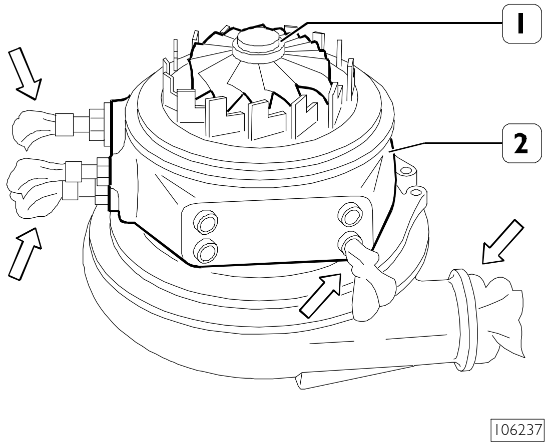
Dismount clamp (1) from central body (2) and check that the clamp does not result to be damaged; otherwise replace the clamp.

Figure 109



Dismount seal ring (1), external with respect to central body (2).
Accurately clean seal ring (1) and check that the ring does not result to be damaged; otherwise replace the ring.

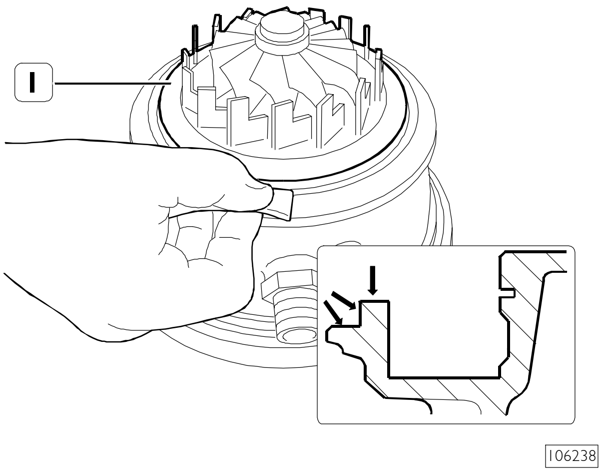
Figure 110



Check turbine rotor (1); there must not be found: carbonaceous deposits, deformation, cracks, blade scoring; also, turbine must turn freely.
By comparator, check clearance of turbine rotor stem (1); clearance must result to be:
- axial clearance: 0.025÷0.127 mm
- radial clearance: 0.381÷0.533 mm.
Where either clearance values over above ones or any one of above mentioned faults are found, replace turbocompressor.

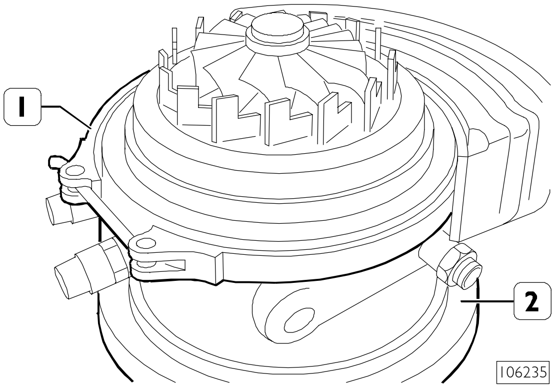
NOTE Before cleaning turbine side central body, properly protect oil, water and air inlets and outlets (→) in order to prevent dirt or foreign bodies from entering turbocompressor.

Figure 111



By suitable scraper and abrasive paper, accurately clean surfaces (→) of central body (1) from carbonaceous deposits, taking care to avoid damaging the surfaces and variable geometry ring.
Then, with compressed air, clean variable geometry surfaces and ring from removed residues.
Check again, as described in relating chapters:
- variable geometry movement;
- actuator;
- actuator travel.

Figure 112

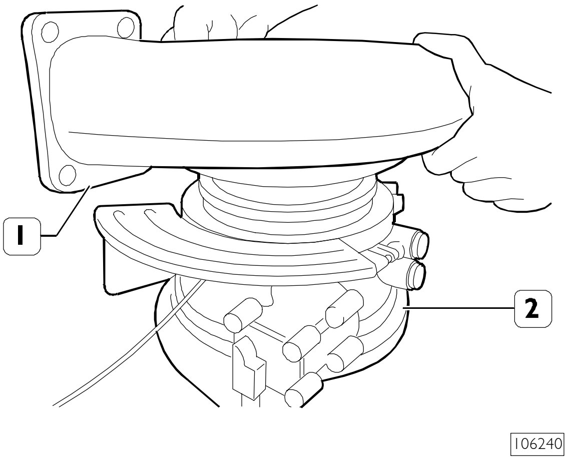


Position clamp (1) on central body (2)

NOTE Should clamp (1) be replaced with an integrated heat guard, a new actuator has to be mounted with an integrated heat guard at the place of existing one.

Position accurately cleaned seal ring on central body.
Apply a thin layer of antiscuff paste on cleaned matching surfaces: central body / turbine body.

Figure 113



Mount turbine body (1) on central body (2) taking care to avoid damaging turbine rotor and align turbine body variable geometry slot ring. Do not force mounting operation: in case of jamming, it might damage variable geometry with consequent regulation system faulty operation.

Once mounting has been completed, make sure that turbine body results to be matched correctly on central body.

Position turbine body on central body and clamp on central body in such a way that marks, made on dismounting, are matching.

Tighten nut clamping the clamp at 11.3 Nm torque.

Check again, as described in relating chapters:

- actuator;
- actuator travel.

TIGHTENING TORQUES

PART		TORQUE	
		Nm	kgm
Capscrews, undercrankcase to crankcase (see Figure 114) ♦			
M12x1.75 outer screws	Stage 1: pretightening	30	3
M 17x2 inner screws	Stage 2: pretightening	120	12
Inner screws	Stage 3: angle	90°	
Inner screws	Stage 4: angle	45°	
Outer screws	Stage 5: angle	60°	
Piston cooling nozzle union ♦		35 ± 2	3.5 ± 2
Capscrews, heat exchanger to crankcase ♦ (see Figure 118)			
pretightening		11.5	1.15
tightening		19	1.9
Spacer and oil sump capscrews ♦ (see Figure 119)			
pretightening		38	3.8
tightening		45	4.5
M 12x1.75 screws, gear case to crankcase ♦		63 ± 2	6.3 ± 0.7
Cylinder head capscrews (see Figure 115) ♦			
Stage 1:	pretightening	60	6
Stage 2	pretightening	120	12
Stage 3:	angle	120°	
Stage 4:	angle	60°	
Air compressor capscrews		100	10
Rocker shaft capscrew ♦			
Stage 1:	pretightening	80	8
Stage 2:	angle	60°	
Locknut, rocker adjusting screw ♦		39 ± 5	3.9 ± 0.5
Capscrews, injector securing brackets ♦		32.5 ± 2.5	3.25 ± 0.25
Capscrews, thrust plates to head ♦		19	1.9
Screw fastening the engine supporting bracket to the cylinder head			
Stage 1:	pretightening	120	12
Stage 2:	angle	45°	
Screw fastening the engine supporting bracket to the flywheel case			
Stage 1:	pretightening	100	10
Stage 2:	angle	60°	
Camshaft gear capscrews ♦			
Stage 1:	pretightening	60	6
Stage 2:	angle	60°	
Screw fixing phonic wheel to timing system gear ♦		8.5 ± 1.5	0.8 ± 0.1
Exhaust manifold capscrews • (see Figure 116)			
pretightening		40 ± 5	4 ± 0.5
tightening		70 ± 5	7 ± 0.5
Capscrews, exhaust brake actuator cylinder ♦		19	1.9
Capscrews, connecting rod caps ♦			
Stage 1:	pretightening	60	6
Stage 2:	angle	60°	
Engine flywheel capscrews ♦			
Stage 1:	pretightening	120	12
Stage 2:	angle	90°	

♦ Before assembly, lubricate with engine oil
● Before assembly, lubricate with graphitized oil

PART		TORQUE	
		Nm	kgm
Screws fixing damper flywheel: ♦			
First phase	pre-tightening	70	7
Second phase	closing to angle	50°	
Screws fixing intermediate gear pins: ♦			
First phase	pre-tightening	30	3
Second phase	closing to angle	90°	
Screw fixing connecting rod for idle gear		25 ± 2.5	2.5 ± 0.2
Screws fixing oil pump		25 ± 2.5	2.5 ± 0.2
Screw fixing suction strainer and oil pump pipe to crankcase		25 ± 2.5	2.5 ± 0.2
Screws fixing crankshaft gasket cover		25 ± 2.5	2.5 ± 0.2
Screws fixing fuel pump/filter		37 ± 3	3.7 ± 0.3
Screw fixing control unit mount to crankcase		19 ± 3	1.9 ± 0.3
Screw fixing fuel pump to flywheel cover box		19 ± 3	1.9 ± 0.3
Screw fixing thermostat box to cylinder head		22 ± 2	2.2 ± 0.2
Screw fixing rocker cover (see Figure 120)		8.5 ± 1.5	0.8 ± 0.1
Screws and nuts fixing turbocharger • (see Figure 117)			
pre-tightening		33.5 ± 7.5	3.3 ± 0.7
tightening		46 ± 2	4.6 ± 0.2
Screws fixing water pump to crankcase		25 ± 2.5	2.5 ± 0.2
Screws fixing spacer/pulley to fan		30 ± 3	3 ± 0.3
Screw fixing automatic tensioner to crankcase		50 ± 5	5 ± 0.5
Screw fixing fixed tensioner to crankcase		105 ± 5	10.5 ± 0.5
Screws fixing fan mount to crankcase		100 ± 5	10 ± 0.5
Screws fixing starter motor		74 ± 8	7.4 ± 0.8
Screws fixing air heater to cylinder head		37 ± 3	3.7 ± 0.3
Screw fixing air compressor		74 ± 8	7.4 ± 0.8
Nut fixing gear driving air compressor		170 ± 10	17 ± 1
Screw fixing automatic tensioner for belt driving air-conditioning compressor to crankcase		26 ± 2	2.6 ± 0.2
Screw fixing alternator bracket to crankcase	L = 35 mm	30 ± 3	3 ± 0.3
	L = 60 mm	44 ± 4	4.4 ± 0.4
	L = 30 mm	24.5 ± 2.5	2.4 ± 0.2
Screws fixing hydraulic power steering pump		46.5 ± 4.5	4.65 ± 0.45
Screws fixing air-conditioner compressor to mount		24.5 ± 2.5	2.5 ± 0.25
Screws fixing guard		24.5 ± 25	2.5 ± 0.25
Filter clogging sensor fastening		55 ± 5	5.5 ± 0.5

♦ Before assembly, lubricate with engine oil

• Before assembly, lubricate with graphitized oil

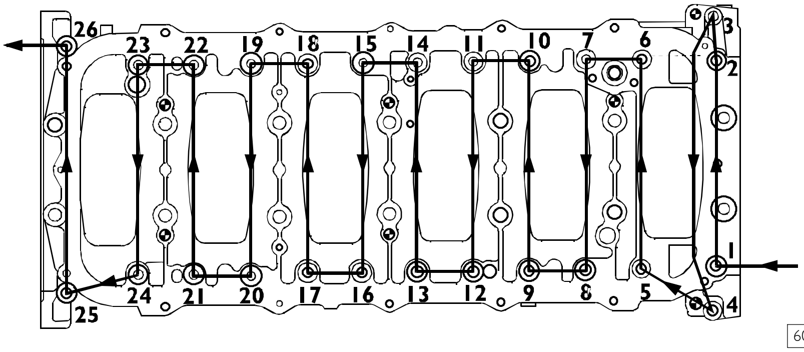
PART	TORQUE	
	Nm	kgm
Pressure transmitter fastener	8 ± 2	0.8 ± 0.2
Water/fuel temperature sensor fastener	32.5 ± 2.5	3.2 ± 0.2
Thermometric switch/transmitter fastener	23 ± 2.5	2.5 ± 0.2
Air temperature transmitter fastener	32.5 ± 2.5	3.2 ± 0.2
Pulse transmitter fastener	8 ± 2	0.8 ± 0.2
Injector-pump connections fastener	1.36 ± 1.92	0.13 ± 0.19
Screw fixing electric cables	8 ± 2	0.8 ± 0.2
Screw fixing electric cables	8 ± 2	0.8 ± 0.2
Exhaust brake solenoid valve fastener	32	3.2
PWM solenoid valve fastener	9 ± 1	0.9 ± 0.1
M14x70/80 screw securing front and rear elastic blocks to chassis	192.5 ± 19.5	19.2 ± 1.9
M16x130 screw securing front and rear elastic blocks to engine	278 ± 28	27.8 ± 2.8
M18x62 flanged HEX screw for front engine block		
Pre-tightening 1st step	120	12
Angle closing 2nd step	45°	
M14x60 socket cheese-head TC screw for front engine block		
Pre-tightening 1st step	60	6
Angle closing 2nd step	45°	
Flanged HEX screw for rear engine block		
Pre-tightening 1st step	100	10
Angle closing 2nd step	60°	

◆ Before assembly, lubricate with engine oil
● Before assembly, lubricate with graphitized oil

Diagrams of tightening sequence for screws fixing crankcase base

Figure 114

FRONT SIDE

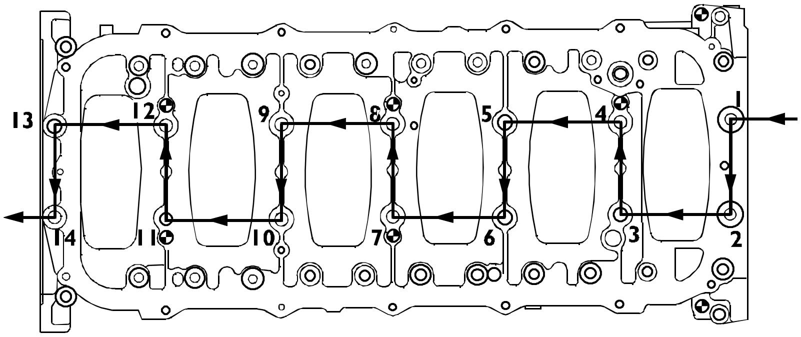


60592

stage 1:
pretightening,
outer screws

(30 Nm)

FRONT SIDE

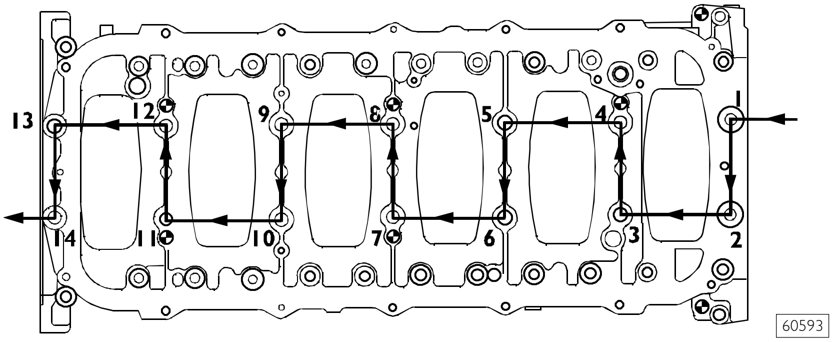


60593

stage 2:
pretightenig, inner
screws

(120 Nm)

FRONT SIDE

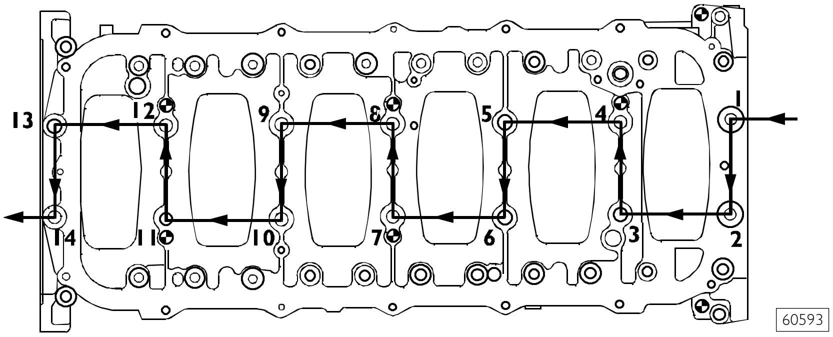


60593

stage 3:
angle, inner
screws

90°

FRONT SIDE

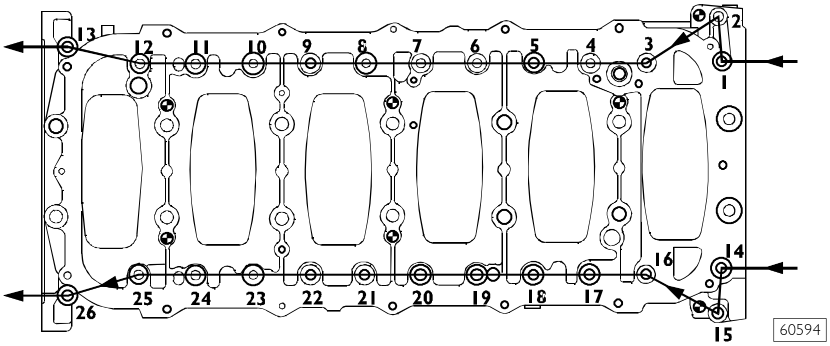


60593

stage 4:
angle, inner
screws

45°

FRONT SIDE



60594

60°

stage 5:
angle, outer
screws

Diagram of cylinder head fixing screws tightening sequence

Figure 115

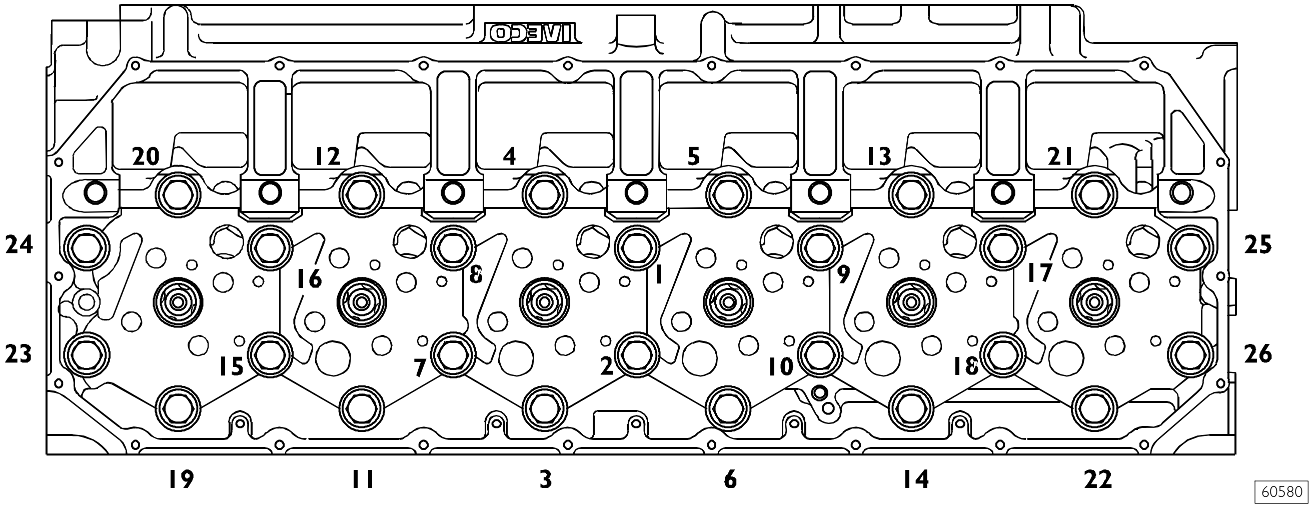


Diagram of exhaust manifold fixing screws tightening sequence

Figure 116

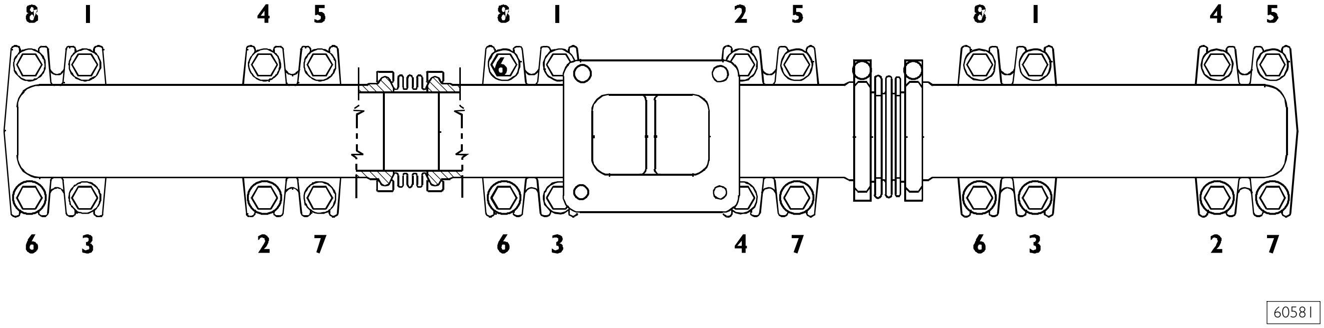
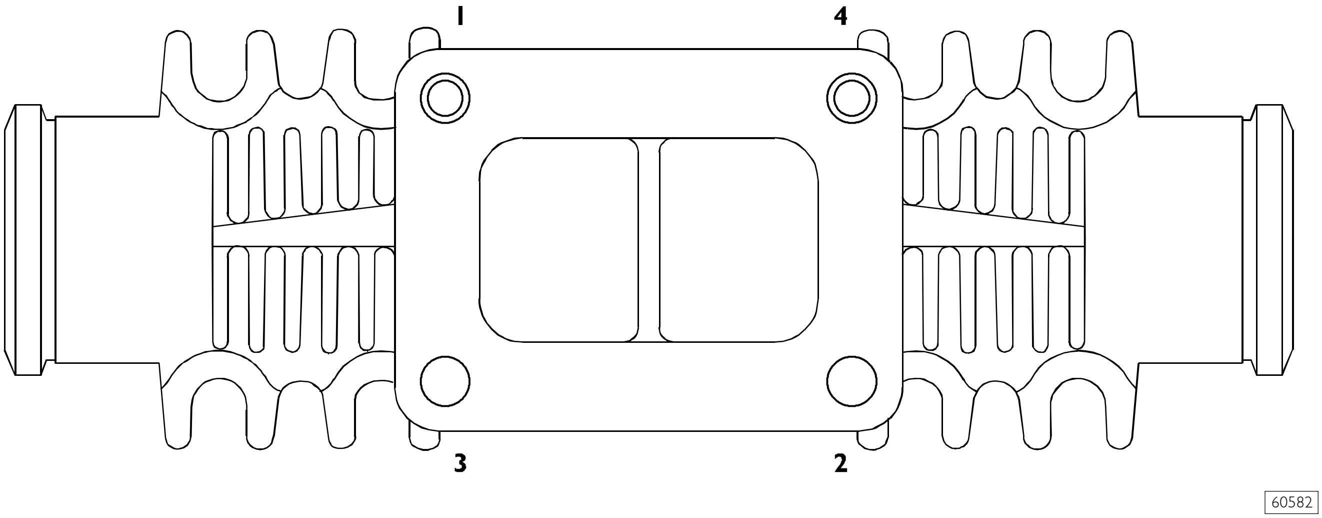


Diagram of turbocharger fixing screws and nuts tightening sequence

Figure 117



SEQUENCE:	Pretightening	4 - 3 - 1 - 2
	Tightening	1 - 4 - 2 - 3

Diagram of tightening sequence for heat exchanger screws

Figure 118

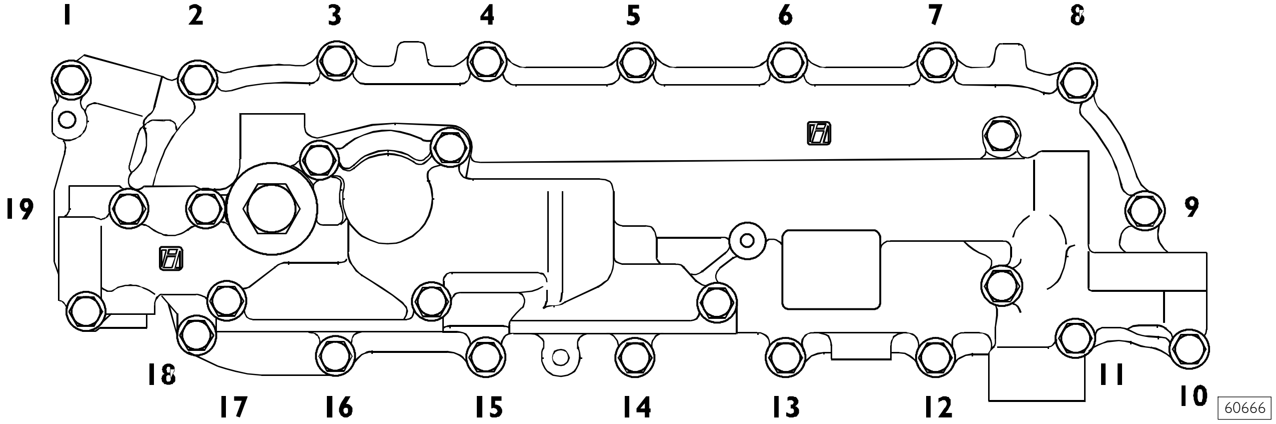
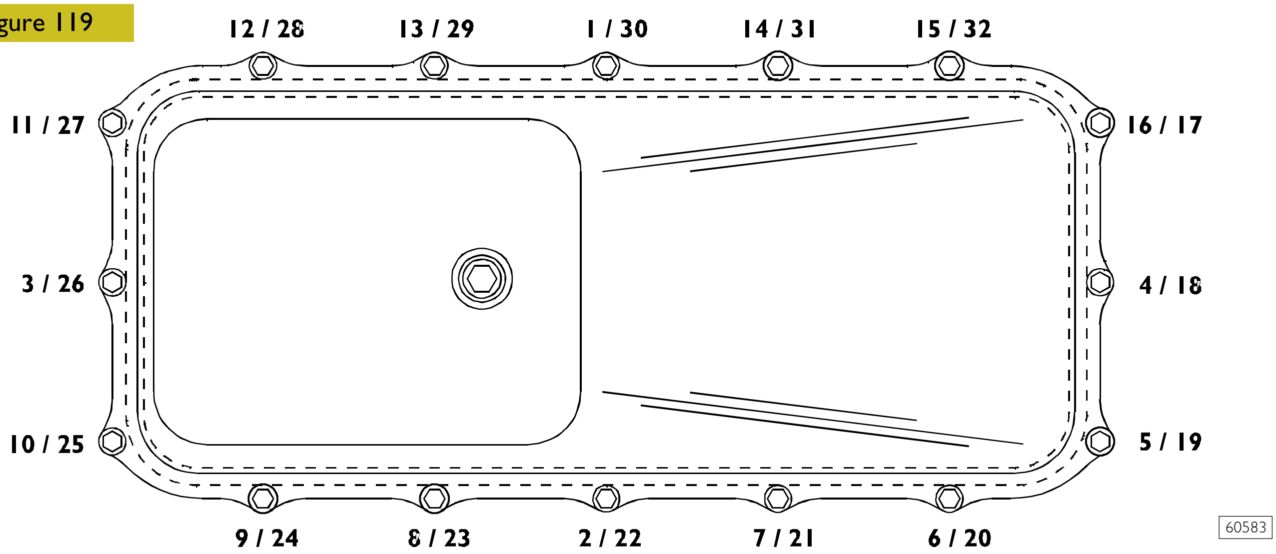


Diagram of tightening sequence for engine oil sump screws

Figure 119

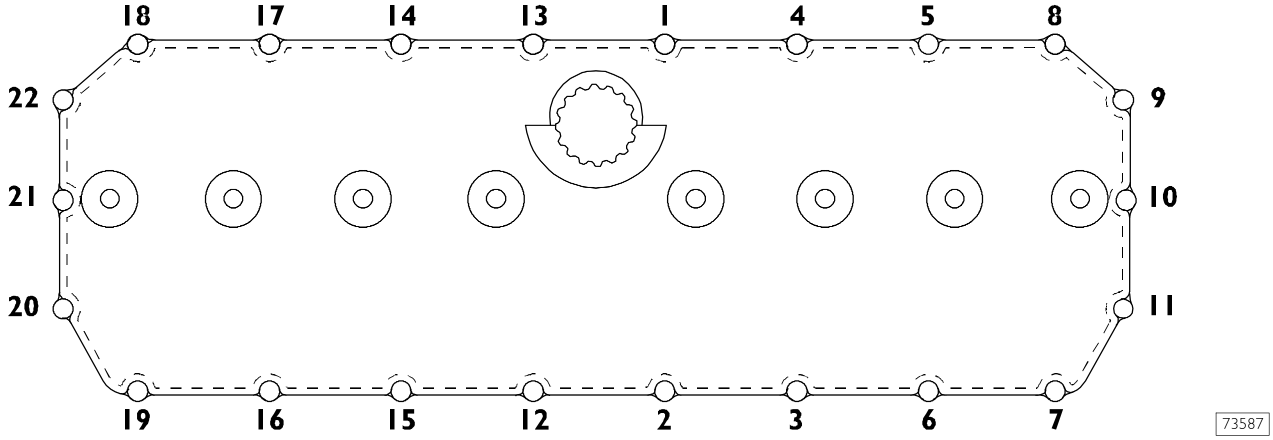


NOTE Stage 1 from 1 to 16.

Stage 2 from 17 to 32

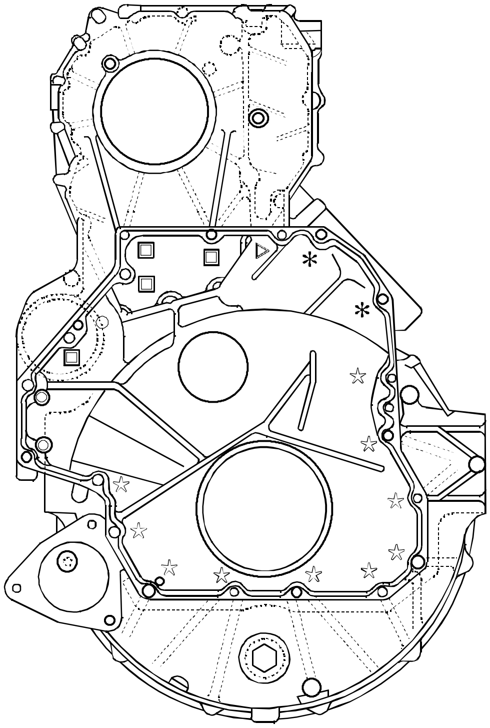
Diagram of tightening sequence for screws fixing rocker cover

Figure 120



F3A ENGINE

Figure 121

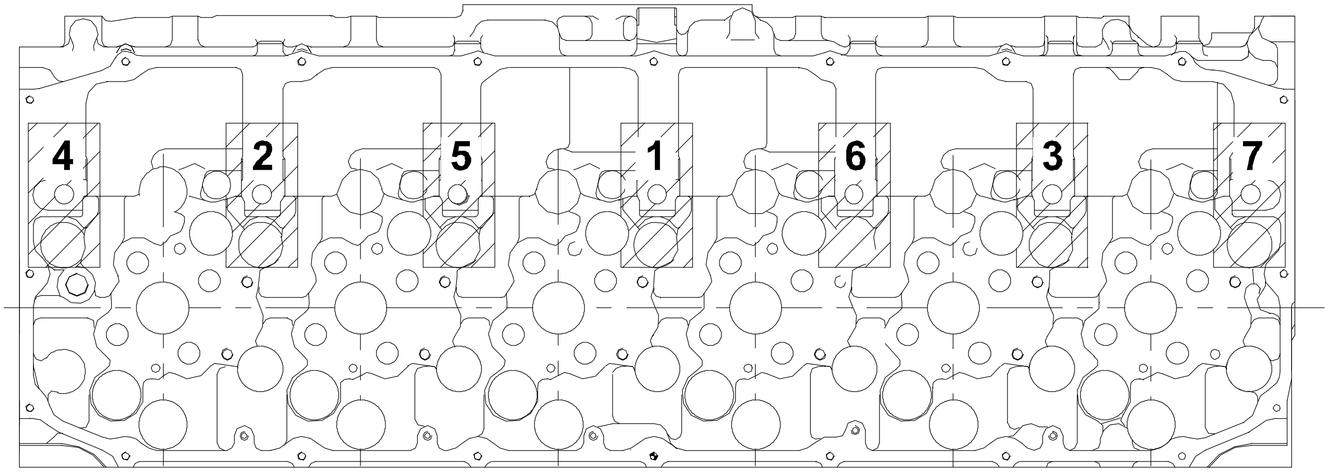


Using a torque wrench, tighten the highlighted screws with the following sequence and tightening torques:

✡	10 screws M12 x 1.75 x 100	63 Nm
◎	2 screws M12 x 1.75 x 70	63 Nm
☐	4 screws M12 x 1.75 x 35	63 Nm
△	1 screw M12 x 1.75 x 120	63 Nm
✱	2 screws M12 x 1.75 x 193	63 Nm

Diagram of cylinder head fixing screws tightening sequence

Figure 122



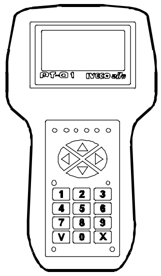
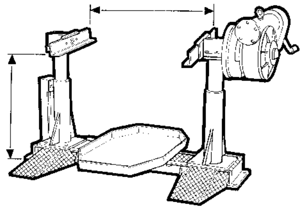
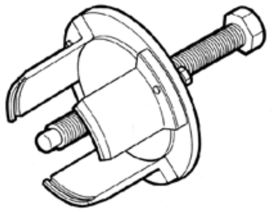
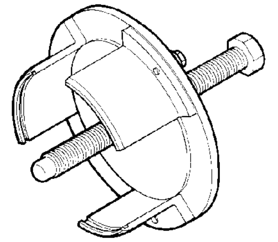
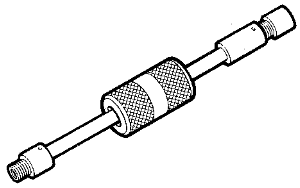
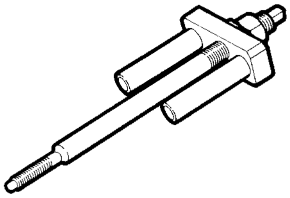
1st step	80 Nm
2nd step	closing to angle 60°

SECTION 5

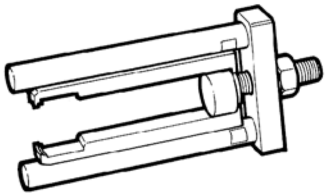
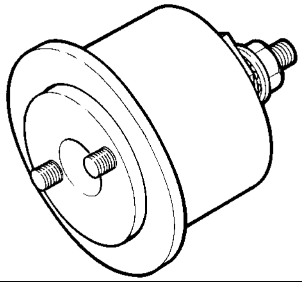
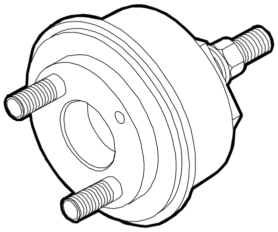
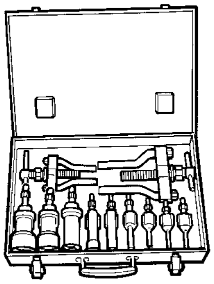
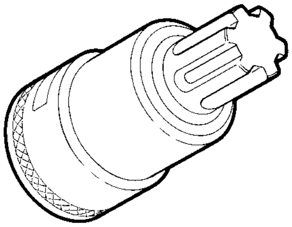
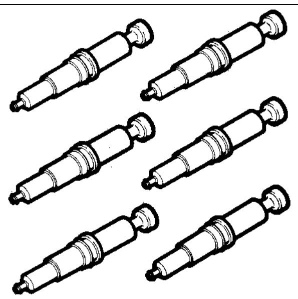
Tools

Page

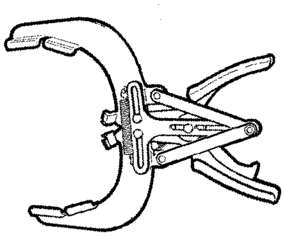
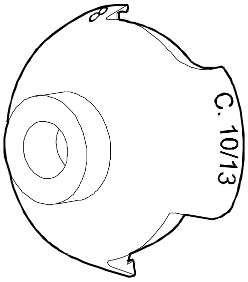
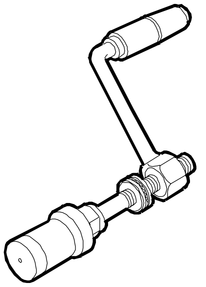
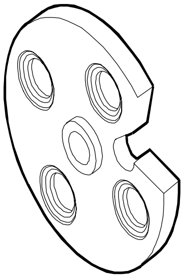
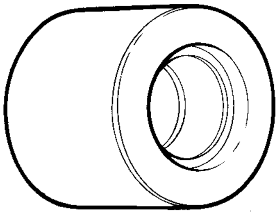
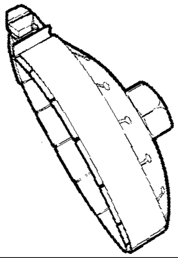
TOOLS

TOOL NO.		DESCRIPTION
8093731		Tester PT01
99322230		Rotary telescopic stand (range 2000 daN, torque 375 daNm)
99340053		Extractor for crankshaft front gasket
99340054		Extractor for crankshaft rear gasket
99340205		Percussion extractor
99342149		Extractor for injector-holder

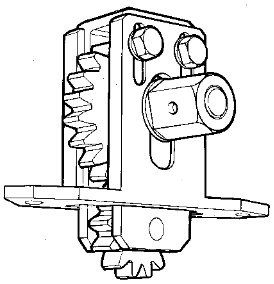
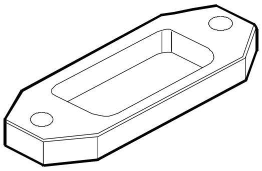
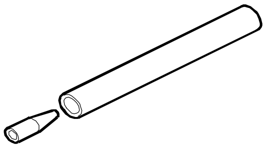
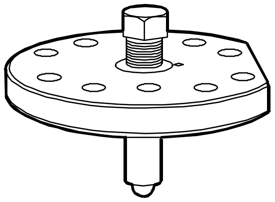
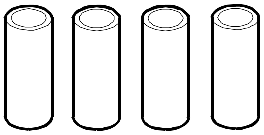
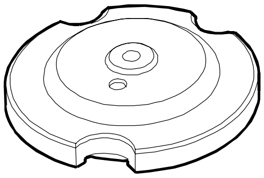
TOOLS

TOOL NO.		DESCRIPTION
99342155		Tool to extract injectors
99346250		Tool to install the crankshaft front gasket
99346251		Tool to install the crankshaft rear gasket
99348004		Universal extractor for 5 to 70 mm internal components
99350072		Box wrench for block junction bolts to the underblock
99360180		Injector housing protecting plugs (6)

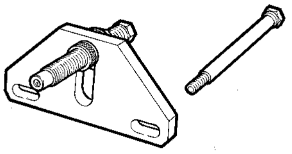
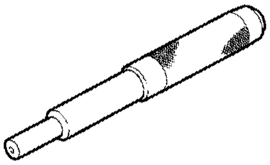
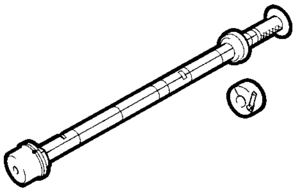
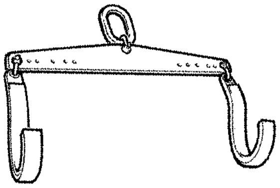
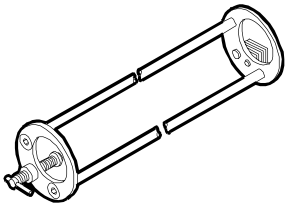
TOOLS

TOOL NO.		DESCRIPTION
99360184		Pliers for assembling and disassembling piston split rings (105-160 mm)
99360192		Guide for flexible belt
99360261		Tool to take down-fit engine valves (to be used with special plates)
99360262		Plate for take down-fit engine valves (to be used with 99360261)
99360295		Tool to fit back valve guide (to be used with 99360481)
99360314		Tool to remove oil filter (engine)

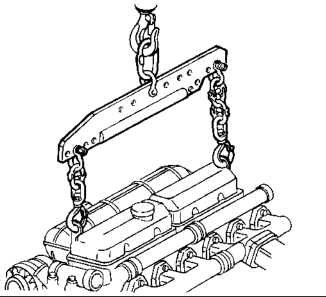
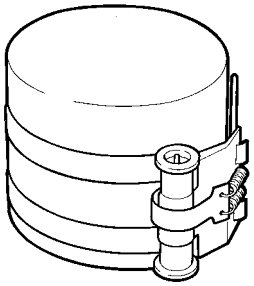
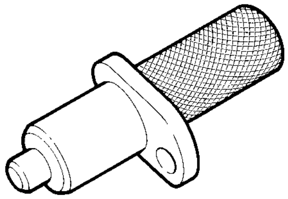
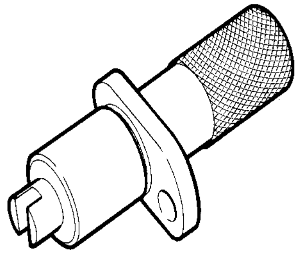
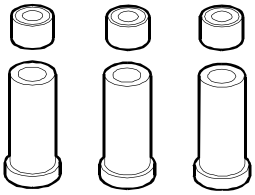
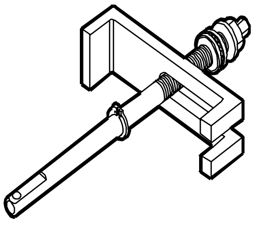
TOOLS

TOOL NO.		DESCRIPTION
99360321		Tool to rotate engine flywheel (to be used with 99360325)
99360325		Spacer (to be used with 99360321)
99360328		Tool to install gasket on valve guide
99360334		Compression tool for checking the protrusion of cylinder liners (to be used with 99370415-99395603 and special plates)
99360336		Spacer (to be used with 99360334)
99360337		Cylinder liner compression plate (to be used with 99360334-99360336)

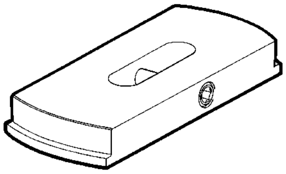
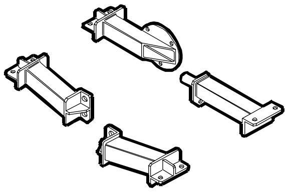
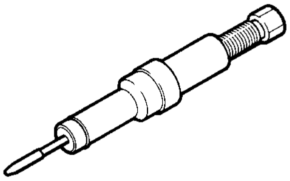
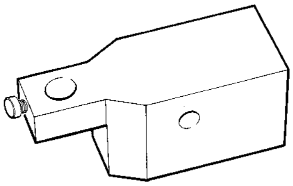
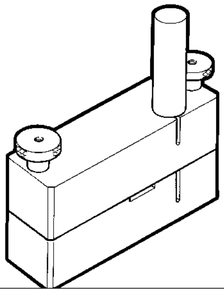
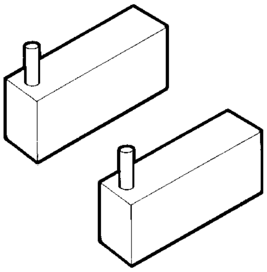
TOOLS

TOOL NO.		DESCRIPTION
99360351		Tool to stop engine flywheel
99360481		Tool to remove valve guide
99360499		Tool to take down and fit back camshaft bushes
99360500		Tool to lift crankshaft
99360551		Bracket to take down and fit engine flywheel
99360553		Tool for assembling and installing rocker arm shaft

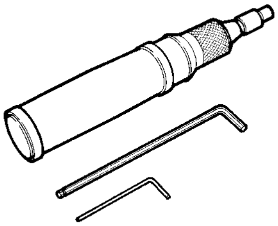
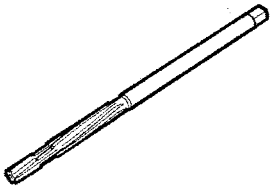
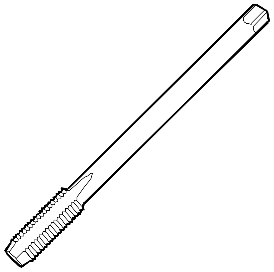
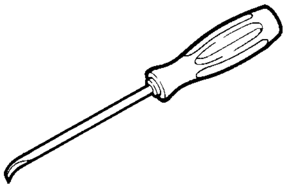
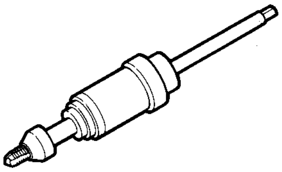
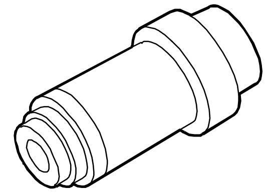
TOOLS

TOOL NO.		DESCRIPTION
99360585		Swing hoist for engine disassembly assembly
99360605		Belt to insert piston in cylinder liner (60 - 125 mm)
99360612		Tool for positioning engine P.M.S.
99360613		Tool for timing of phonic wheel on timing gear
99360703		Tool to stop cylinder liners
99360706		Tool to extract cylinder liners (to be used with specific rings)

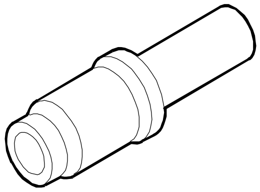
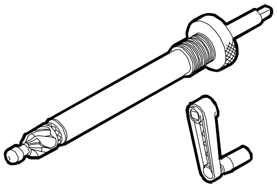
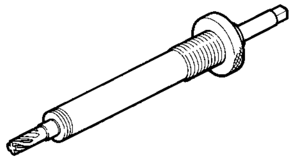
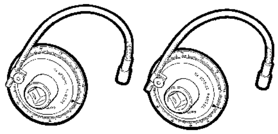
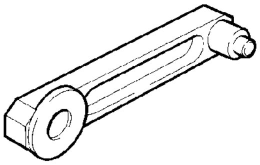
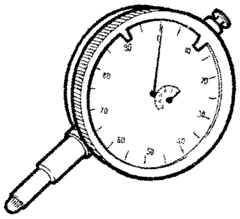
TOOLS

TOOL NO.		DESCRIPTION
99360726		Ring (125 mm) (to be used with 99360706)
99361036		Brackets fixing the engine to rotary stand 99322230
99365056		Tool for injector holder heading
99370415		Base supporting the dial gauge for checking cylinder liner protrusion (to be used with 99395603)
99378100		Tool for printing engine identification plates (to be used with special punches)
99378130		Punch kit to stamp engine identification data plates (compose of: 99378101(A) - 99378102(B) - 99378103(C) - 99378104(D) - 99378105(E) - 99378106(F) - 993378107(G) - 99378108(V))

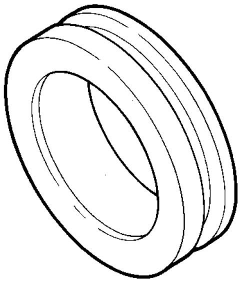
TOOLS

TOOL NO.		DESCRIPTION
99389834		Torque screwdriver (1-6 Nm) for calibrating the injector solenoid valve connector check nut
99390311		Valve guide sleeker
99390426		Tap (M17x2) for rectifying the threaded holes of the jointing screws cylinder head/block and block/under block
99390772		Tool for removing injector holding case deposits
99390804		Tool for threading injector holding cases to be extracted (to be used with 99390805)
99390805		Guide bush (to be used with 99390804)

TOOLS

TOOL NO.		DESCRIPTION
99394015		Guide bush (to be used with 99394041 or 99394043)
99394041		Cutter to rectify injector holder housing (to be used with 99394015)
99394043		Reamer to rectify injector holder lower side (to be used with 99394015)
99395216		Measuring pair for angular tightening with 1/2" and 3/4" square couplings
99395218		Gauge for defining the distance between the centres of camshaft and transmission gear
99395603		Dial gauge (0 - 5 mm)

TOOLS

TOOL NO.		DESCRIPTION
99396035		Centering ring of crankshaft front gasket cap

Appendix

SAFETY PRESCRIPTIONS

Standard safety prescriptions

Particular attention shall be drawn on some precautions that must be followed absolutely in a standard working area and whose non fulfillment will make any other measure useless or not sufficient to ensure safety to the personnel in-charge of maintenance.

Be informed and inform personnel as well of the laws in force regulating safety, providing information documentation available for consultation.

- ☐ Keep working areas as clean as possible, ensuring adequate aeration.
- ☐ Ensure that working areas are provided with emergency boxes, that must be clearly visible and always provided with adequate sanitary equipment.
- ☐ Provide for adequate fire extinguishing means, properly indicated and always having free access. Their efficiency must be checked on regular basis and the personnel must be trained on intervention methods and priorities.
- ☐ Organize and displace specific exit points to evacuate the areas in case of emergency, providing for adequate indications of the emergency exit lines.
- ☐ Smoking in working areas subject to fire danger must be strictly prohibited.
- ☐ Provide Warnings throughout adequate boards signaling danger, prohibitions and indications to ensure easy comprehension of the instructions even in case of emergency.

Prevention of injury

- ☐ Do not wear unsuitable cloths for work, with fluttering ends, nor jewels such as rings and chains when working close to engines and equipment in motion.
- ☐ Wear safety gloves and goggles when performing the following operations:
  - filling inhibitors or anti-frost
  - lubrication oil topping or replacement
  - utilization of compressed air or liquids under pressure (pressure allowed: ≤ 2 bar)
- ☐ Wear safety helmet when working close to hanging loads or equipment working at head height level.
- ☐ Always wear safety shoes when and cloths adhering to the body, better if provided with elastics at the ends.
- ☐ Use protection cream for hands.
- ☐ Change wet cloths as soon as possible
- ☐ In presence of current tension exceeding 48-60 V verify efficiency of earth and mass electrical connections. Ensure that hands and feet are dry and execute working operations utilizing isolating foot-boards. Do not carry out working operations if not trained for.
- ☐ Do not smoke nor light up flames close to batteries and to any fuel material.
- ☐ Put the dirty rags with oil, diesel fuel or solvents in anti-fire specially provided containers.
- ☐ Do not execute any intervention if not provided with necessary instructions.
- ☐ Do not use any tool or equipment for any different operation from the ones they've been designed and provided for: serious injury may occur.
- ☐ In case of test or calibration operations requiring engine running, ensure that the area is sufficiently aerated or utilize specific vacuum equipment to eliminate exhaust gas. Danger: poisoning and death.

During maintenance

- ☐ Never open filler cap of cooling circuit when the engine is hot. Operating pressure would provoke high temperature with serious danger and risk of burn. Wait unit the temperature decreases under 50°C.
- ☐ Never top up an overheated engine with cooler and utilize only appropriate liquids.
- ☐ Always operate when the engine is turned off: whether particular circumstances require maintenance intervention on running engine, be aware of all risks involved with such operation.
- ☐ Be equipped with adequate and safe containers for drainage operation of engine liquids and exhaust oil.
- ☐ Keep the engine clean from oil tangles, diesel fuel and or chemical solvents.
- ☐ Use of solvents or detergents during maintenance may originate toxic vapors. Always keep working areas aerated. Whenever necessary wear safety mask.
- ☐ Do not leave rags impregnated with flammable substances close to the engine.
- ☐ Upon engine start after maintenance, undertake proper preventing actions to stop air suction in case of runaway speed rate.
- ☐ Do not utilize fast screw-tightening tools.
- ☐ Never disconnect batteries when the engine is running.
- ☐ Disconnect batteries before any intervention on the electrical system.
- ☐ Disconnect batteries from system aboard to load them with the battery loader.
- ☐ After every intervention, verify that battery clamp polarity is correct and that the clamps are tight and safe from accidental short circuit and oxidation.
- ☐ Do not disconnect and connect electrical connections in presence of electrical feed.
- ☐ Before proceeding with pipelines disassembly (pneumatic, hydraulic, fuel pipes) verify presence of liquid or air under pressure. Take all necessary precautions bleeding and draining residual pressure or closing dump valves. Always wear adequate safety mask or goggles. Non fulfillment of these prescriptions may cause serious injury and poisoning.

☐ Avoid incorrect tightening or out of couple. Danger: incorrect tightening may seriously damage engine's components, affecting engine's duration.

☐ Avoid priming from fuel tanks made out of copper alloys and/or with ducts not being provided with filters.

☐ Do not modify cable wires: their length shall not be changed.

☐ Do not connect any user to the engine electrical equipment unless specifically approved by Iveco.

☐ Do not modify fuel systems or hydraulic system unless Iveco specific approval has been released. Any unauthorized modification will compromise warranty assistance and furthermore may affect engine correct working and duration.

For engines equipped with electronic gearbox:

☐ Do not execute electric arc welding without having priory removed electronic gearbox.

☐ Remove electronic gearbox in case of any intervention requiring heating over 80ºC temperature.

☐ Do not paint the components and the electronic connections.

☐ Do not vary or alter any data filed in the electronic gearbox driving the engine. Any manipulation or alteration of electronic components shall totally compromise engine assistance warranty and furthermore may affect engine correct working and duration.

Respect of the Environment

☐ Respect of the Environment shall be of primary importance: all necessary precautions to ensure personnel's safety and health shall be adopted.

☐ Be informed and inform the personnel as well of laws in force regulating use and exhaust of liquids and engine exhaust oil. Provide for adequate board indications and organize specific training courses to ensure that personnel is fully aware of such law prescriptions and of basic preventive safety measures.

☐ Collect exhaust oils in adequate specially provided containers with hermetic sealing ensuring that storage is made in specific, properly identified areas that shall be aerated, far from heat sources and not exposed to fire danger.

☐ Handle the batteries with care, storing them in aerated environment and within anti-acid containers. Warning: battery exhalation represent serious danger of intoxication and environment contamination.

Part 3
F3B CURSOR EURO 4 ENGINES

PREFACE TO USER'S GUIDELINE MANUAL

Section 1 describes the F3B engine illustrating its features and working in general.

Section 2 describes the type of fuel feed.

Section 3 relates to the specific duty and is divided in four separate parts:

1. Mechanical part, related to the engine overhaul, limited to those components with different characteristics based on the relating specific duty.
2. Electrical part, concerning wiring harness, electrical and electronic equipment with different characteristics based on the relating specific duty.
3. Maintenance planning and specific overhaul.
4. Troubleshooting part dedicated to the operators who, being entitled to provide technical assistance, shall have simple and direct instructions to identify the cause of the major inconveniences.

Sections 4 and 5 illustrate the overhaul operations of the engine overhaul on stand and the necessary equipment to execute such operations.
The appendix reports general safety prescriptions to be followed by all operators whether being in-charge of installation or maintenance, in order to avoid serious injury.

UPDATING

Section	Description	Page	Date of revision

SECTION 1

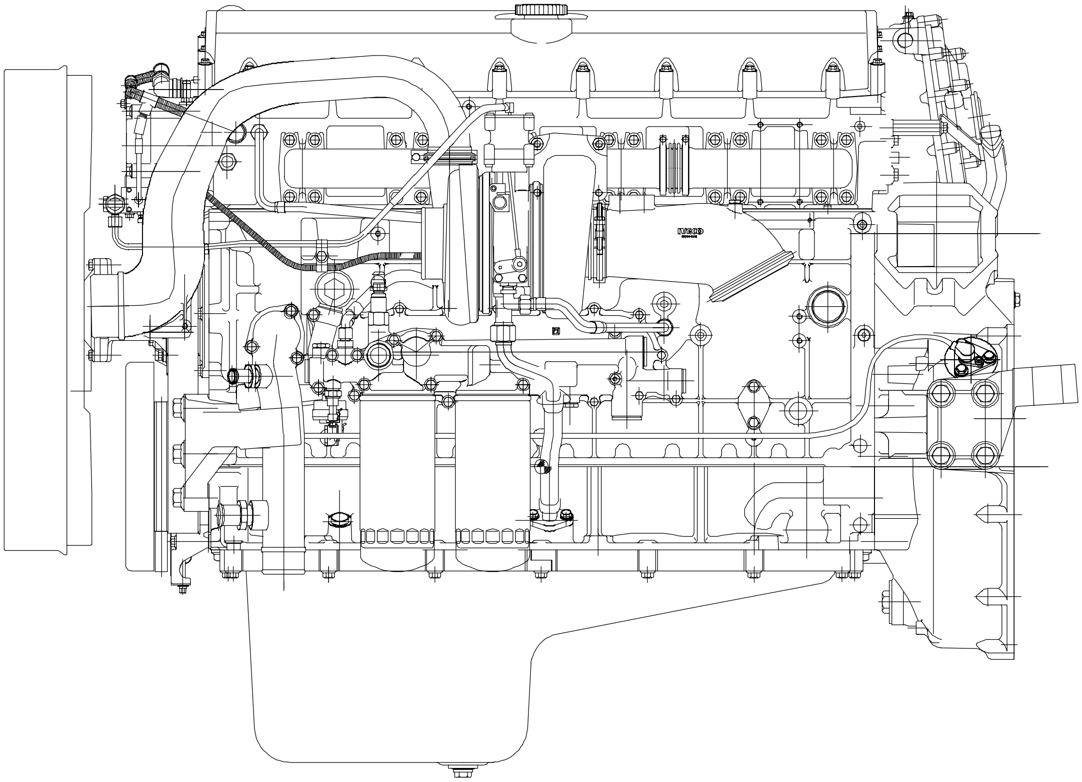
General specifications

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F3BE3681B	C13 ENT C
F3BE3681A	C13 ENT C
F3BE3681D	C13 ENT C
F3BE3681C	C13 ENT C

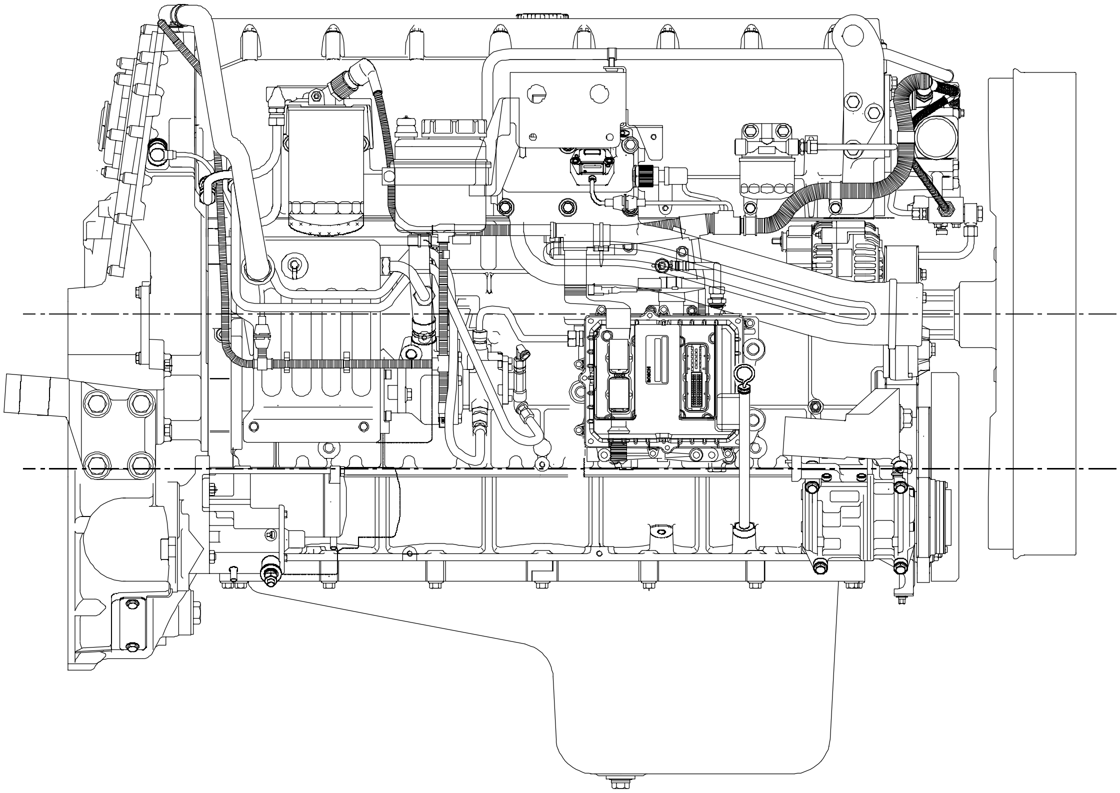
VIEWS OF ENGINE

Figure 1



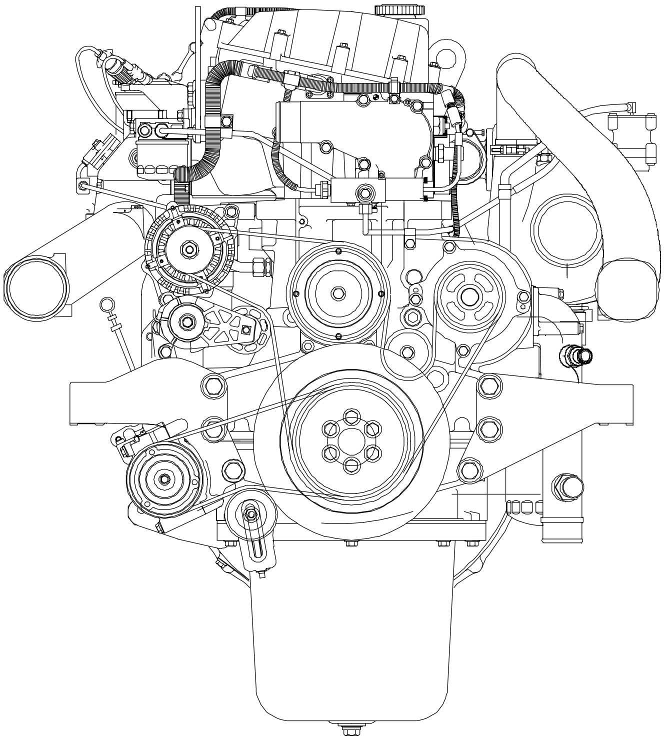
LEFT-HAND SIDE VIEW

Figure 2



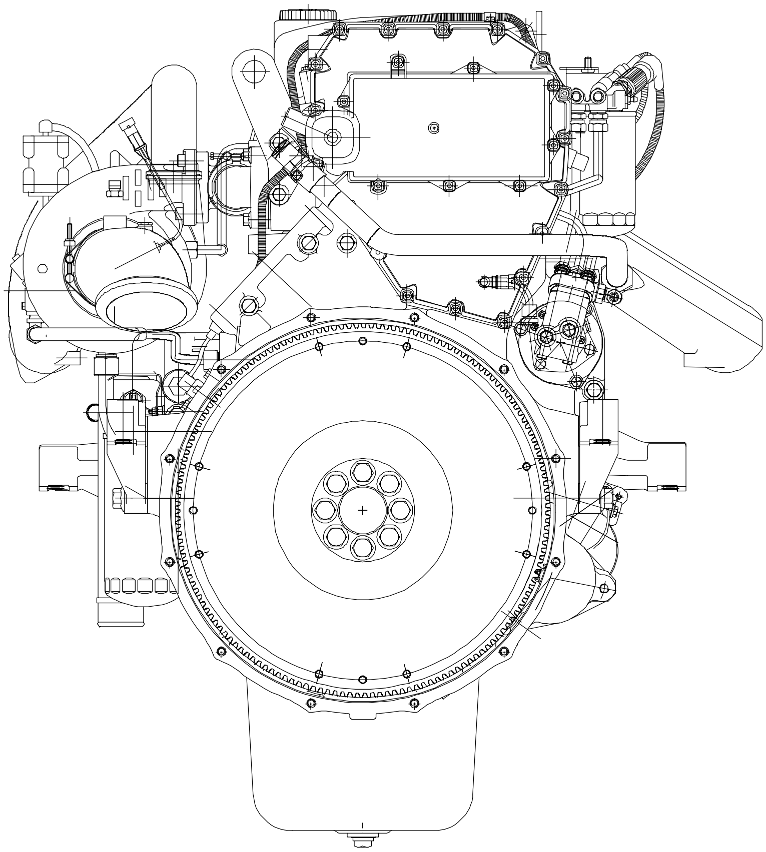
RIGHT-HAND SIDE VIEW

Figure 3



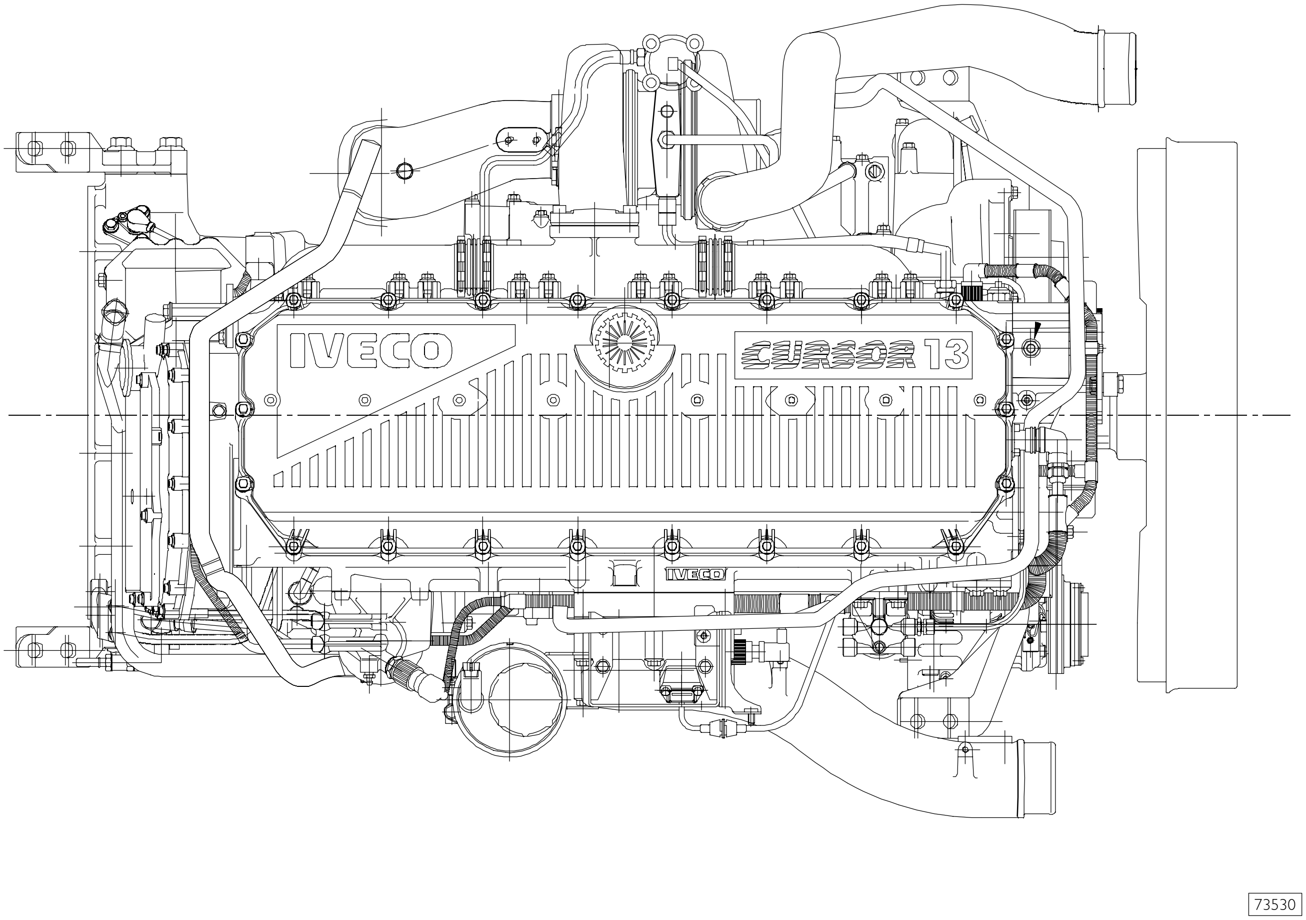
FRONT VIEW

Figure 4



REAR VIEW

Figure 5



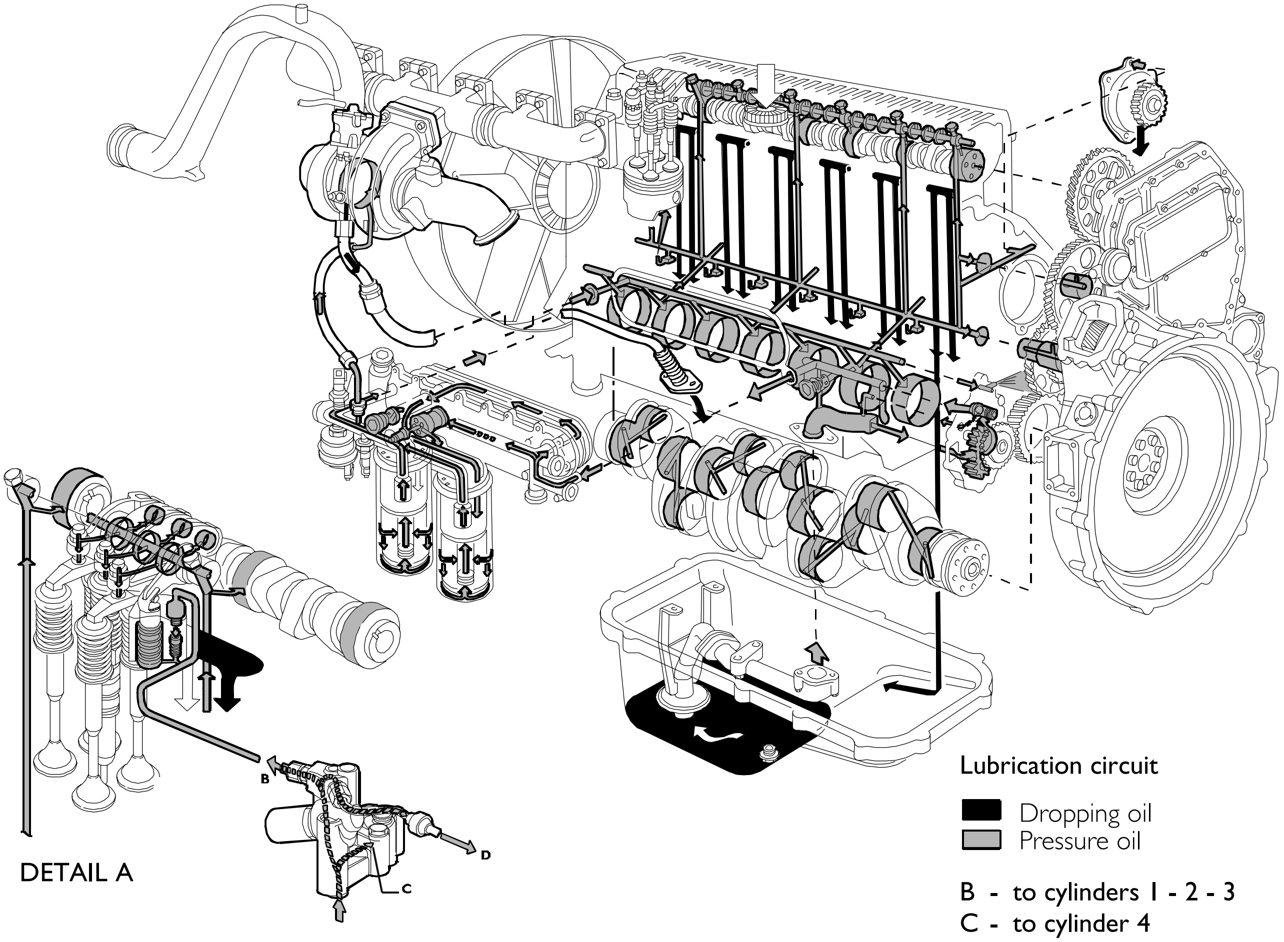
TOP VIEW

LUBRICATION

Engine lubrication is obtained with a gear pump driven by the crankshaft via gears.

A heat exchanger governs the temperature of the lubricating oil. It houses two oil filters, indicator sensors and safety valves.

Figure 6



Exhaust brake solenoid valve with piston driving the exhaust brake of the 4th cylinder.

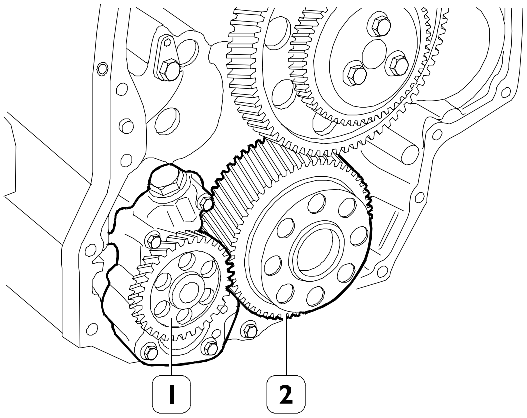
Lubrication circuit

■ Dropping oil
▨ Pressure oil

B - to cylinders 1 - 2 - 3
C - to cylinder 4
D - to cylinders 5 - 6

Oil pump

Figure 7



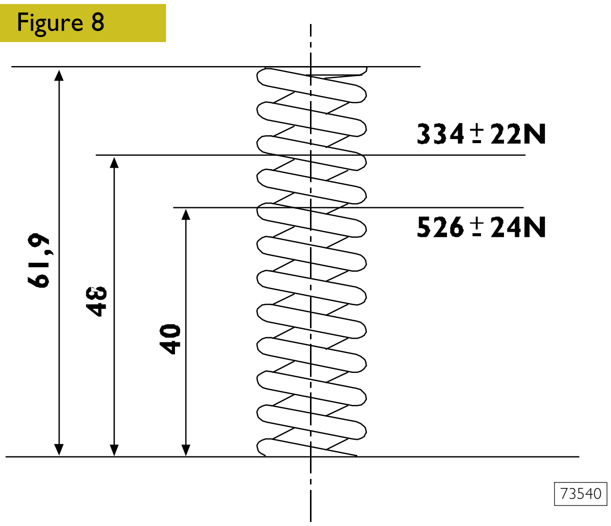
60560

The oil pump (1) cannot be overhauled. On finding any damage, replace the oil pump assembly.

See under the relevant heading for replacing the gear (2) of the crankshaft.

Overpressure valve

Figure 8



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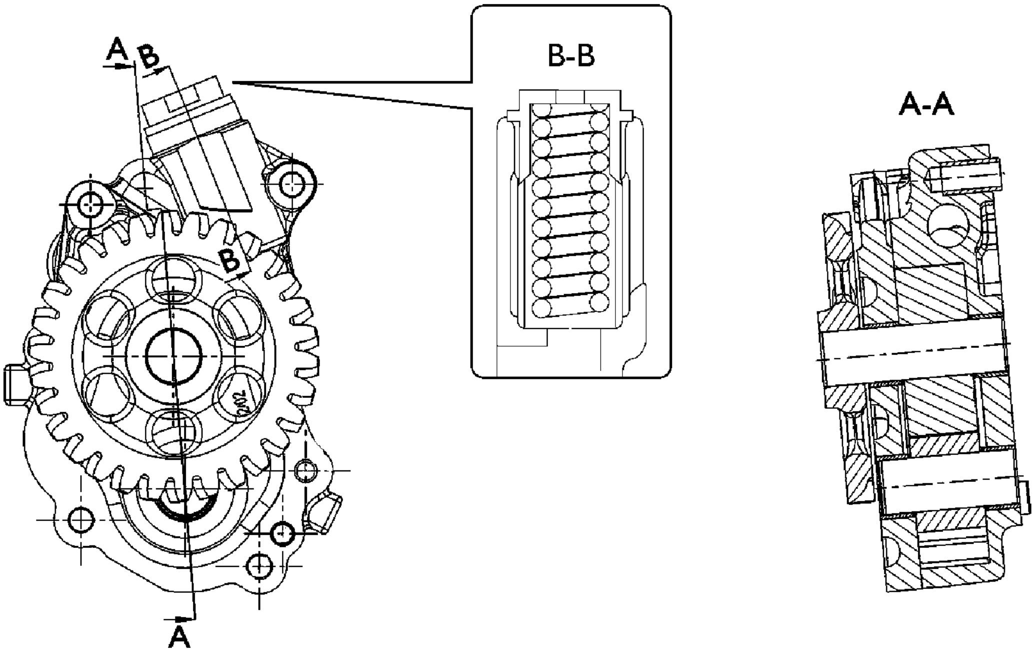
MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

Figure 9

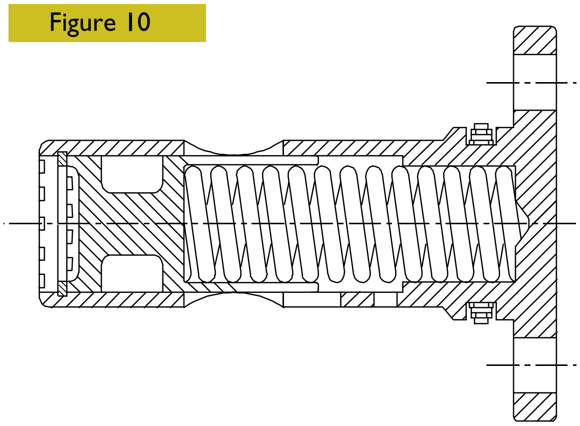


108846

OIL PUMP CROSS-SECTION
Overpressure valve – Start of opening pressure 10 ± 1 bars.

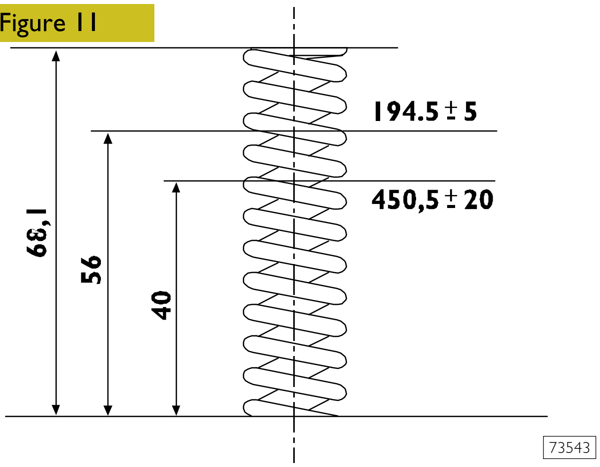
Oil pressure control valve

Figure 10



The oil pressure control valve is located on the left-hand side of the crankcase.
Start of opening pressure 5 bars.

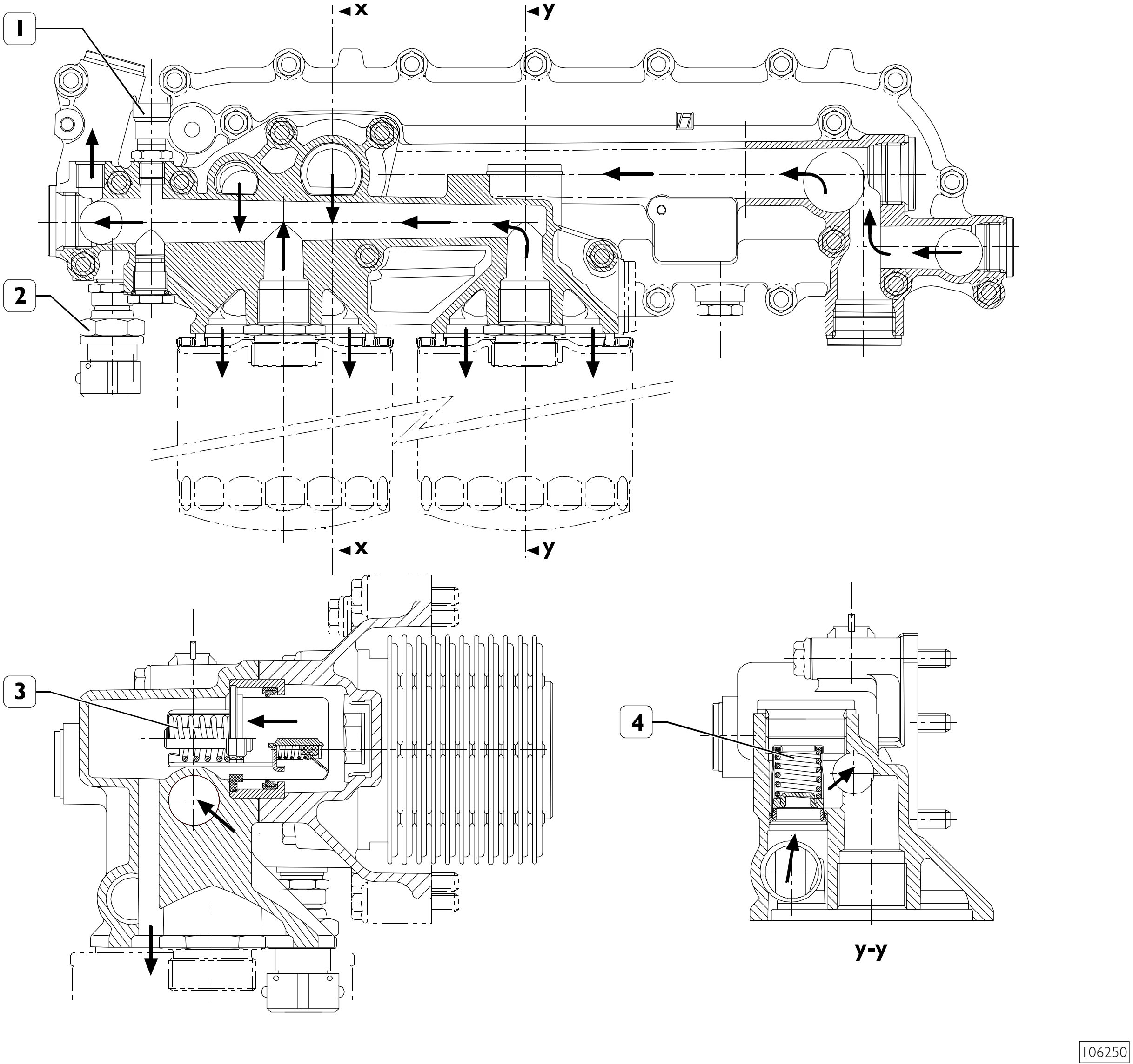
Figure 11



MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

Heat exchanger

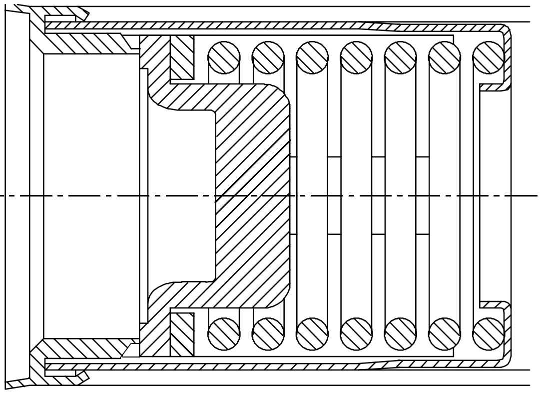
Figure 12



HEAT EXCHANGER
The heat exchanger is fitted with: 1. Oil temperature transmitter – 2. Oil pressure transmitter – 3. Filter bypass valve – 4. Thermostat
Number of heat exchanger elements: 11.

By-pass valve

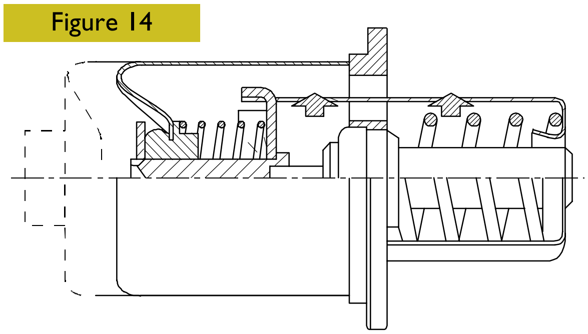
Figure 13



The valve quickly opens at a pressure of: 3 bars.

Thermostatic valve

Figure 14



Start of opening:

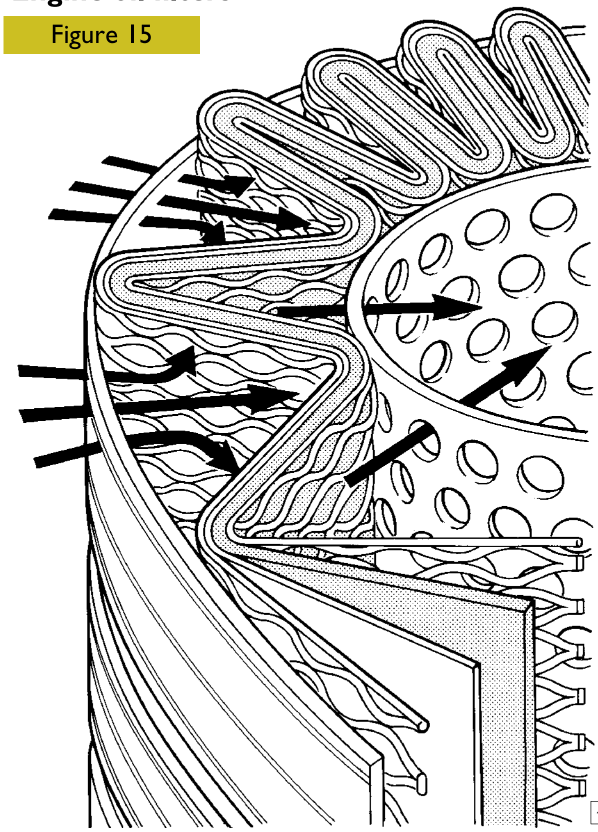
- travel 0.1 mm at a temperature of 82 ±2°C.

End of opening:

- travel 8 mm at a temperature of 97°C.

Engine oil filters

Figure 15



This is a new generation of filters that permit much more thorough filtration as they are able to holder back a greater amount of particles of smaller dimensions than those held back by conventional filters with a paper filtering element.

These high-filtration devices, to date used only in industrial processes, make it possible to:

- reduce the wear of engine components over time;
- maintain the performance/specifications of the oil and thereby lengthen the time intervals between changes.

External spiral winding

The filtering elements are closely wound by a spiral so that each fold is firmly anchored to the spiral with respect to the others. This produces a uniform use of the element even in the worst conditions such as cold starting with fluids with a high viscosity and peaks of flow. In addition, it ensures uniform distribution of the flow over the entire length of the filtering element, with consequent optimization of the loss of load and of its working life.

Mount upstream

To optimize flow distribution and the rigidity of the filtering element, this has an exclusive mount composed of a strong mesh made of nylon and an extremely strong synthetic material.

Filtering element

Composed of inert inorganic fibres bound with an exclusive resin to a structure with graded holes, the element is manufactured exclusively to precise procedures and strict quality control.

Mount downstream

A mount for the filtering element and a strong nylon mesh make it even stronger, which is especially helpful during cold starts and long periods of use. The performance of the filter remains constant and reliable throughout its working life and from one element to another, irrespective of the changes in working conditions.

Structural parts

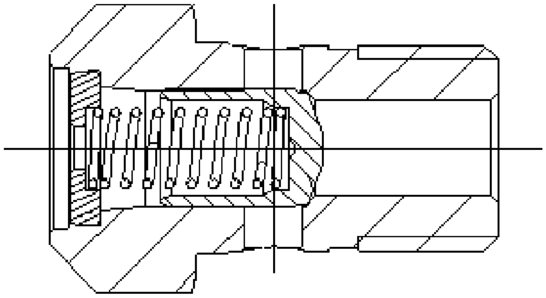
The o-rings equipping the filtering element ensure a perfect seal between it and the container, eliminating by-pass risks and keeping filter performance constant. Strong corrosion-proof bottoms and a sturdy internal metal core complete the structure of the filtering element.

When mounting the filters, keep to the following rules:

- Oil and fit new seals.
- Screw down the filters to bring the seals into contact with the supporting bases.
- Tighten the filter to a torque of 35-40 Nm.

Valve integrated in piston cooling nozzle

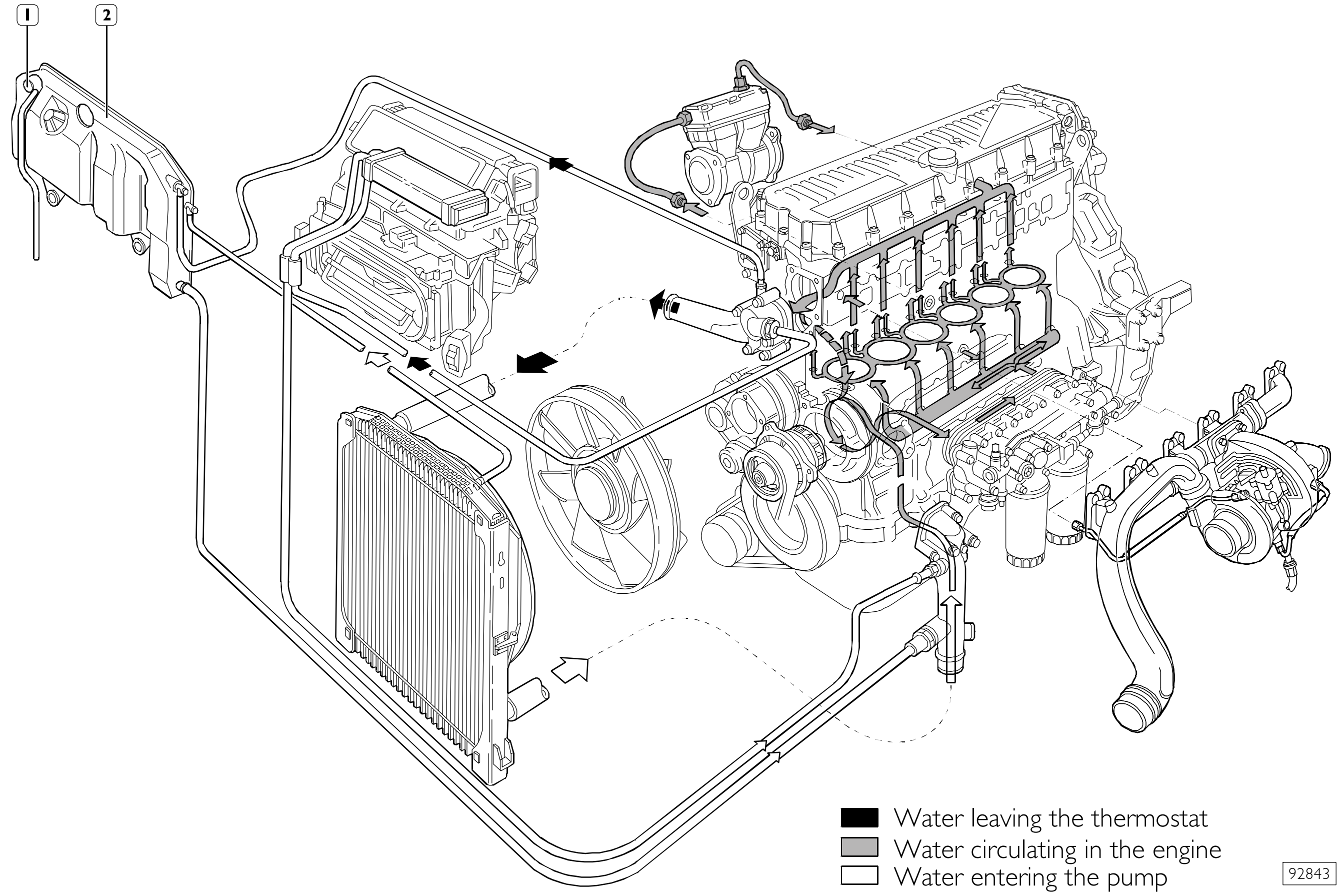
Figure 16



The valve allows oil to enter only above the threshold pressure of 1.7 ± 0.2 bar. This permits filling the circuit and therefore lubricating the most stressed parts even when working at lower pressures.

COOLING

Figure 17



COOLING CIRCUIT VERSION WITHOUT INTARDER

Description

The engine cooling system works with forced circulation inside closed circuit and can be connected to an additional heater (if any) and to the intarder intercooler.
It consists mainly of the following components:

- an expansion reservoir whose plug (1) incorporates two valves – discharge and charge – controlling the system pressure;
- a coolant level sensor;
- an engine cooling unit to dissipate the heat taken by the coolant from the engine through the intercooler;
- a heat exchanger to cool down lubrication oil;
- a water pump with centrifugal system incorporated in the cylinder block;
- an electric fan;
- a 3-way thermostat controlling the coolant circulation.

Operation

The water pump is actuated by the crankshaft through a poli-V belt and sends coolant to the cylinder block, especially to the cylinder head (bigger quantity). When the coolant temperature reaches and overcomes the operating temperature, the thermostat is opened and from here the coolant flows into the radiator and is cooled down by the fan.
The pressure inside the system depending on the temperature variation is controlled by the discharge and charge valves incorporated in the expansion reservoir filling plug (1).
The discharge valve has a double function:

- keep the system under light pressure in order to raise the coolant boiling point;
- discharge the pressure surplus in the atmosphere as a result of the coolant high temperature.

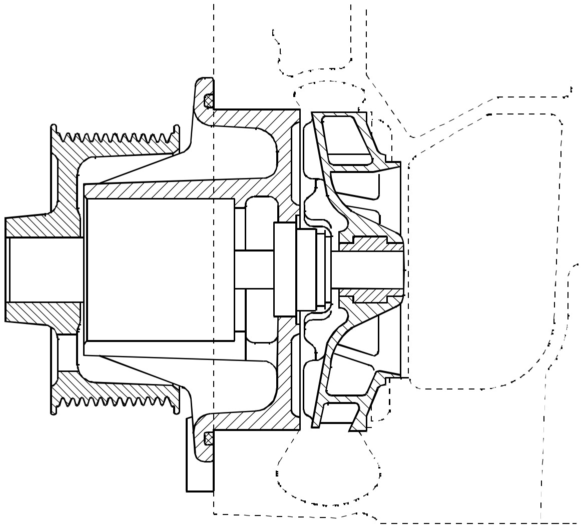
The charge valve makes it possible to transfer the coolant from the expansion reservoir to the radiator when a depression is generated inside the system as a result of the coolant volume reduction depending on the fall in the coolant temperature.
Discharge valve opening:

- 1st breather $0.9^{+0.2}_{-0.1}$ bar
- 2nd breather $1.2^{+0.2}_{-0.1}$ bar

Charge valve opening $-0.03^{+0}_{-0.02}$ bar

Water pump

Figure 18



CROSS-SECTION OF THE WATER PUMP

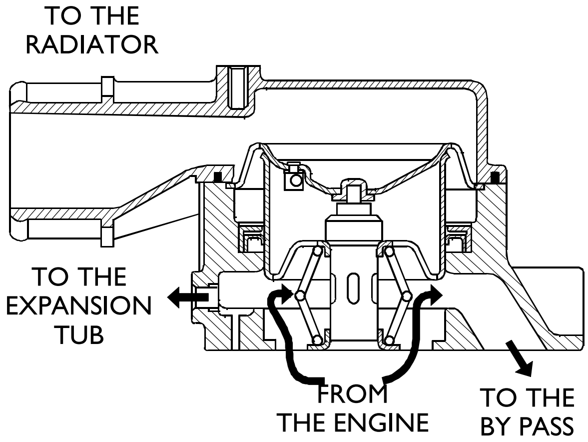
The water pump is composed of: impeller, bearing, seal and driving pulley.

⚠ Check that the pump body has no cracks or water leakage; if it does, replace the entire water pump.

Thermostat

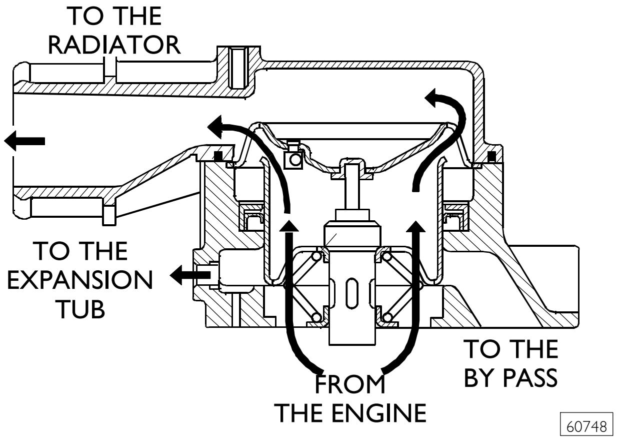
View of thermostat operation

Figure 19



▭ Water circulating in the engine

Figure 20



■ Water leaving the thermostat

Check the thermostat works properly; replace it if in doubt.

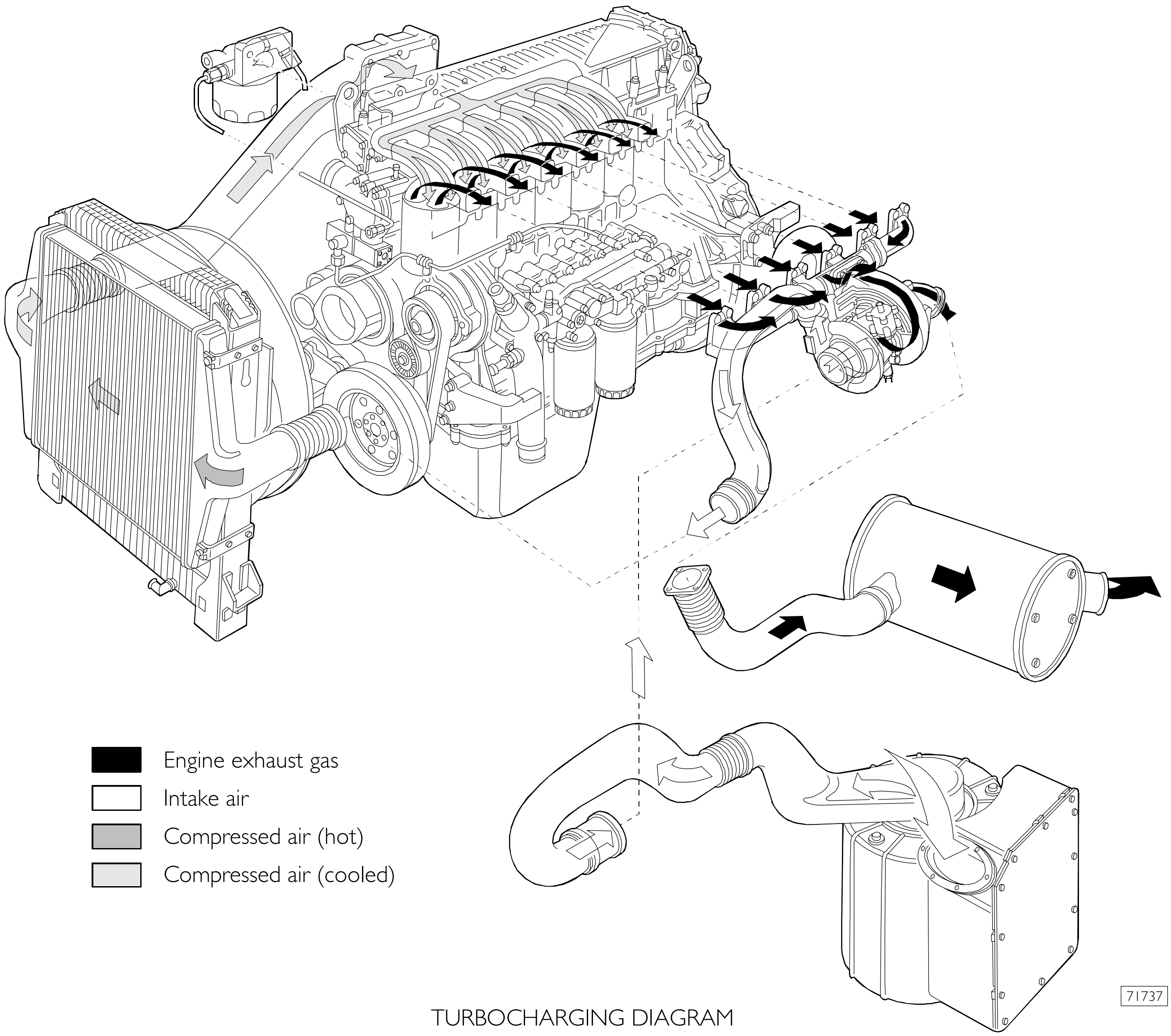
Temperature of start of travel 84°C ±2°C.
Minimum travel 15 mm at 94°C ±2°C.

TURBOCHARGING

The turbocharging system is composed of:

- ☐ an air filter;
- ☐ a variable geometry turbocharger;
- ☐ an "intercooler" radiator.

Figure 21



TURBOCHARGING DIAGRAM

Turbocharger HOLSET HE 551 V

Working principle

The variable geometry turbocharger (VGT) is composed of a centrifugal compressor and a turbine equipped with a mobile device that, by changing the area of cross-section of the passage of the exhaust gases going to the turbine, governs the speed.

Thanks to this solution, it is possible to keep the speed of the gases and turbine high even when the engine is running at low speed.

By making the gases pass through small cross-sections, they flow faster, so that the turbine turns faster as well.

The movement of the device changing the cross-section of the flow of exhaust gases is accomplished with a mechanism operated by a pneumatic actuator.

This actuator is controlled directly by the electronic control unit via a proportional solenoid valve.

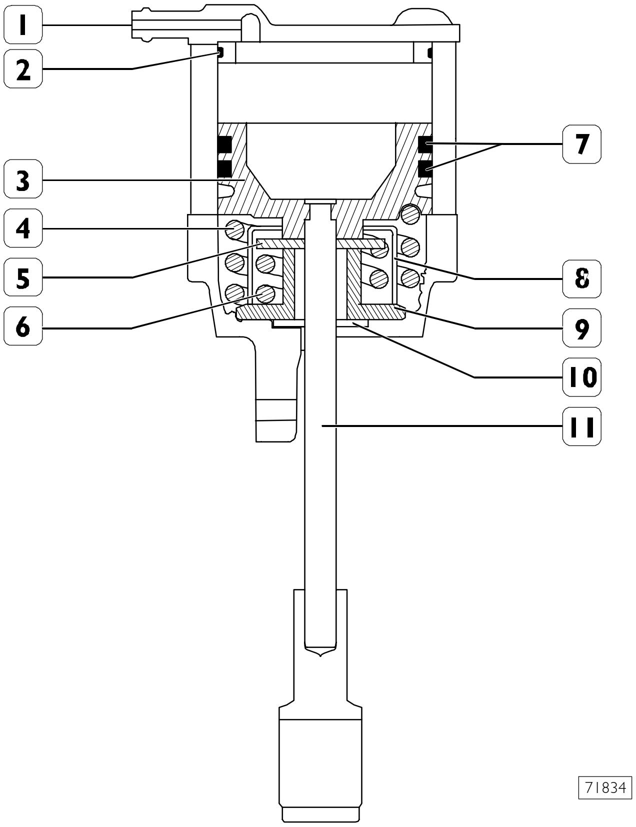
This device is most closed at low speed.

At high engine speeds, the electronic control system increases the cross-section of the passage to permit the incoming gases to flow without increasing their speed too much.

Cast in the central body there is a toroidal chamber for the coolant to pass through.

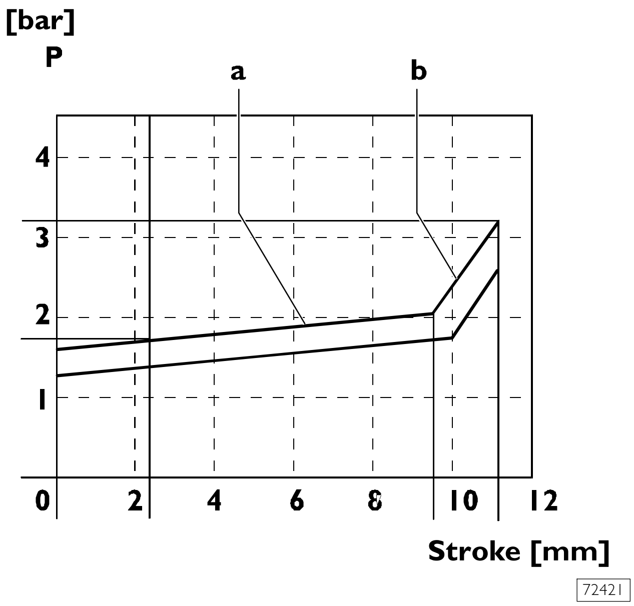
Actuator

Figure 22



1. Air inlet - 2. Gasket - 3. Piston - 4. External spring - 5. Internal spring control disc - 6. Internal spring - 7. O-ring - 8. Spring holder - 9. Limit stop - 10. Dust seal - 11. Control rod

Figure 23



a Gradient characterized by the effect of the external spring (4, Figure 22).

b Gradient characterized by the effect of the external (4, Figure 22) and internal (6, Figure 22) springs.

Working principle (See Figure 22)

The actuator piston, connected to the drive rod, is controlled with the compressed air introduced through the air inlet (1) on the top of the actuator.

Modulating the air pressure varies the movement of the piston and turbine control rod. As the piston moves, it progressively compresses the external spring (4) until the base of the piston reaches the disc (5) controlling the internal spring (6).

On further increasing the pressure, the piston, via the disc (5), interferes with the bottom limit stop (10).

Using two springs makes it possible to vary the ratio between the piston stroke and the pressure. Approximately 85% of the stroke of the rod is opposed by the external spring and 15% by the internal one.

Solenoid valve for VGT control

This N.C. proportional solenoid valve is located on the left-hand side of the crankcase under the turbine.

The electronic control unit, via a PWM signal, controls the solenoid valve, governing the supply pressure of the turbine actuator, which, on changing its position, modifies the cross-section of the flow of exhaust gases onto the blades of the impeller and therefore its speed.

The resistance of the coil is approx. 20-30 Ohms.

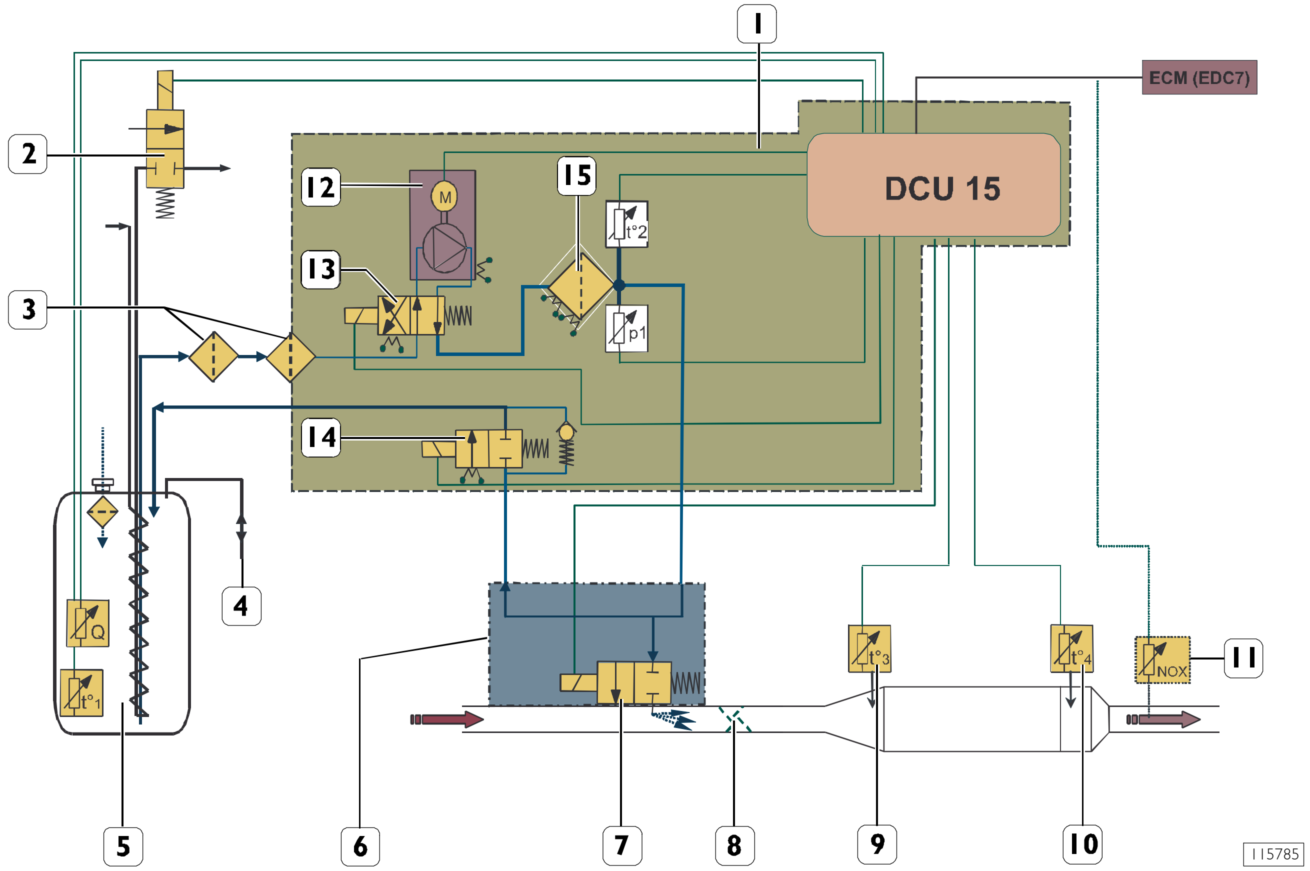
DeNO$_x$ SYSTEM 2
General remarks

In order to keep the exhaust emission values of nitric oxides (NO$_x$) within the limits prescribed by the Euro 4 standard, with low fuel consumption, a system for post-processing of the above substances found in exhaust gas has been fitted to the vehicles. This system essentially consists of an electronic-control oxidizing catalyst.

The system converts, through the SCR (Selective Catalytic Reduction) process, nitric oxides (NO$_x$) into inert compounds: free nitrogen (N_2) and water vapour (H_2O).

The SCR process is based on a series of chemical reactions, which leads, due to ammonia reacting with exhaust gas oxygen, to a reduction of nitric oxides (NO$_x$) found in exhaust gas.

Figure 24



SCR SYSTEM DIAGRAM

A. PUMP MODULE - B. MEASURING OUT MODULE

1. Supply module - 2. MV4 - 3. Pre-filters - 4. Tank vent - 5. AdBlue tank with gridle - 6. Dosing module - 7. MV2 - 8. Mixer - 9. - 10. Temperature sensors - 11. Nox sensor (*) - 12. Membrane pump - 13. MV1 - 14. MV3 - 15. Main filter.

* Future application

The system is essentially made up of:

- a tank (9) for reagent solution (water - urea: AdBlue), equipped with level gauge (8);
- an H2O diverter valve (1);
- pump module (10);
- a mixing and injection module (2);
- catalyst (4);
- two exhaust gas temperature sensors (5, 6) on catalyst output (4);
- a moisture detection sensor (7) fitted on the engine air intake pipe downstream from the air cleaner.

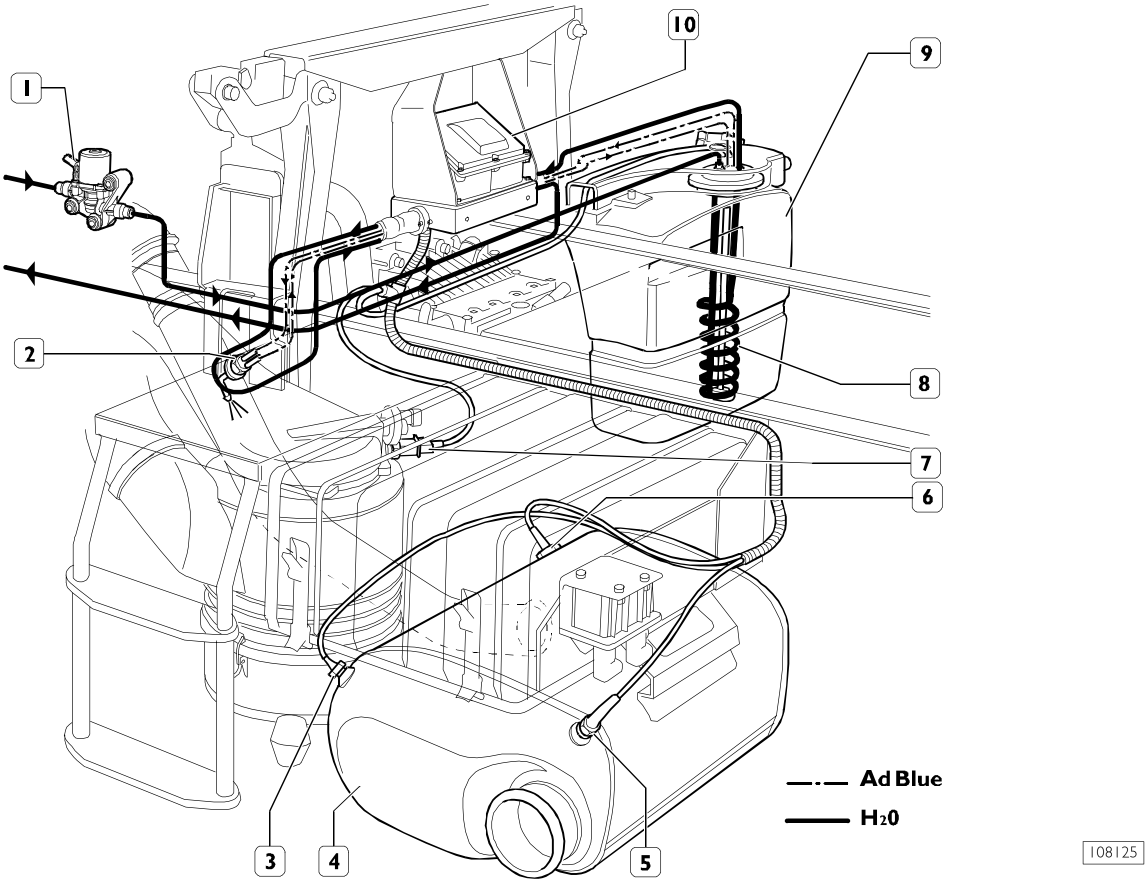
SCR system is electronically managed by DCU (Dosing Control Unit) incorporated into pump module (10); depending on engine rpm, supplied torque, exhaust gas temperature, quantity of nitrogen oxides and humidity of air sucked in, the control unit regulates the flow rate of AdBlue solution to be let into the system.

Pump module (10) takes reagent solution out of tank (9), then sends it under pressure into measuring out module (2); finally, the reagent solution is injected into the exhaust pipe upstream of catalyst (4).

Here, the first phase of the process is realized: the reagent solution will vaporize immediately, due to the exhaust gas temperature, and will be converted into ammonia ($2NH_3$) and carbon dioxide (CO_2), owing to hydrolysis. At the same time, vaporization of the solution will cause a decrease in the exhaust gas temperature: the latter will get near the optimum temperature required for the process.

Exhaust gas added with ammonia - and at the reaction temperature - will flow into catalyst where the second phase of the process will be realized: ammonia will, by reacting with the exhaust gas oxygen, convert into free nitrogen (N) and water vapour (H_2O).

Figure 25



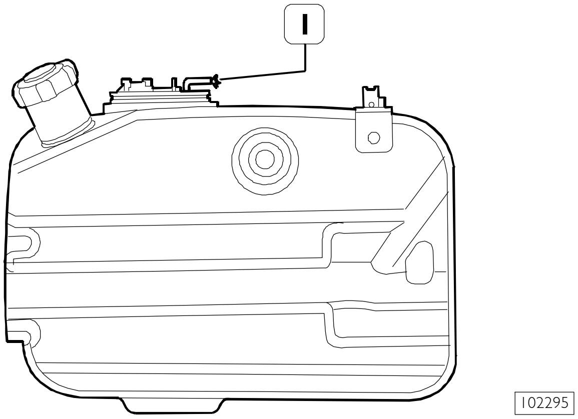
POSITION OF SCR SYSTEM COMPONENTS ON THE VEHICLE

1. H_2O valve - 2. By-pass valve - 3. Nitric oxide detecting sensor (*) - 4. Catalyst - 5. Outlet temperature sensor - 6. Inflow exhaust gas temperature sensor - 7. Sucked air humidity and temperature sensor - 8. Level gauge - 9. Water-urea solution (AdBlue) tank - 10. Pump module.

* Future application

Tank

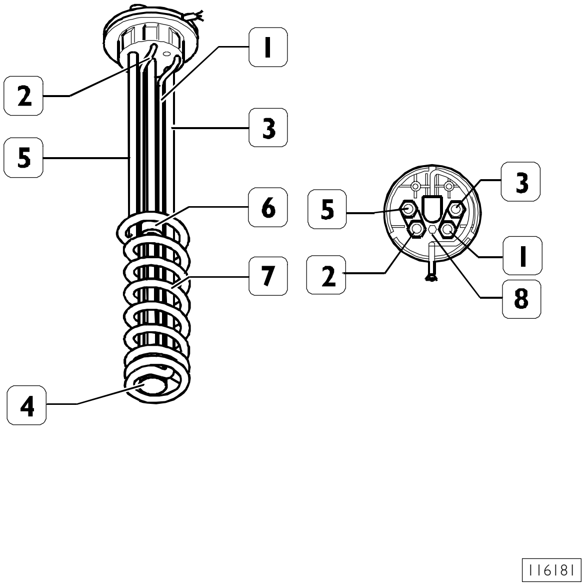
Figure 26



The tank equipped with level gauge control (1) contains the reducing substance required for the SCR process, which consists of a 35%-urea and water solution called AdBlue.

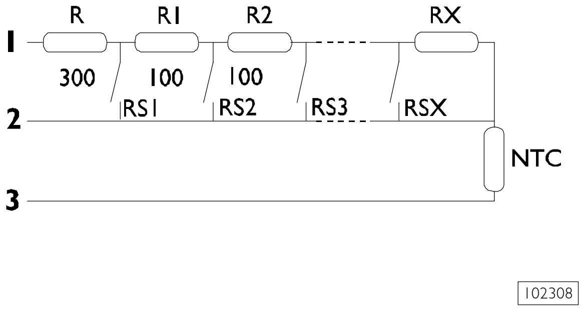
AdBlue fluid level gauge control

Figure 27



1. AdBlue fluid suction pipe - 2. AdBlue fluid return pipe - 3. Engine cooling hot fluid inlet pipe - 4. AdBlue (NTC) temperature sensor - 5. Engine cooling hot fluid outlet pipe - 6. Float - 7. AdBlue fluid heating coil - 8. AdBlue air vent.

Figure 28



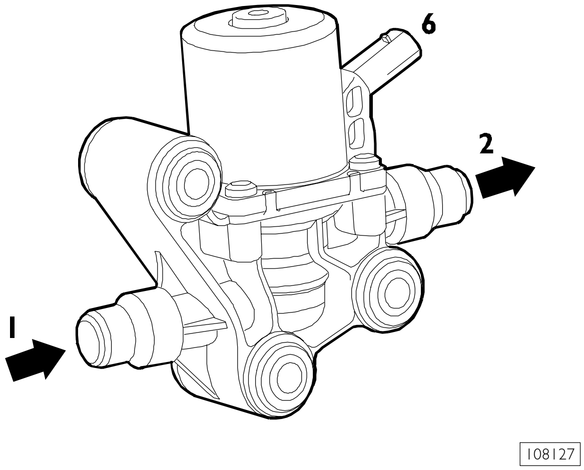
FUNCTIONAL WIRING DIAGRAM

The AdBlue fluid level gauge control consists of a device made up of a set of resistors, a float, a NTC temperature sensor, and a coil used to heat the fluid under low temperature conditions.

It informs the control unit of any current change due to the resistor determined by the float position with respect to the AdBlue fluid level.

By-pass valve

Figure 29



FUNCTIONAL WIRING DIAGRAM

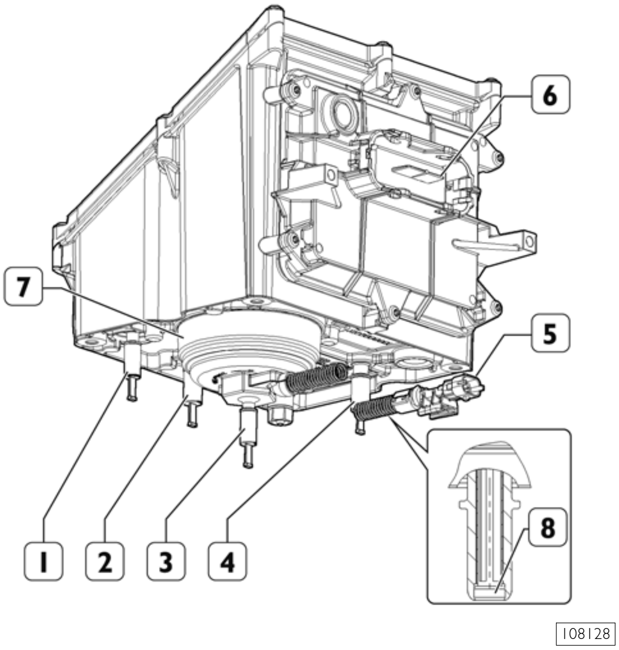
1. Coolant inlet - 2. Coolant outlet - 6. Electrical connection.

The valve, which is a Normally Closed type valve, allows AdBlue tank to be heated by engine coolant.

The NTC temperature sensor controls the by-pass valve which closes or opens (depending on temperature) the passage of the engine cooling hot fluid into the heating coil.

Pump module

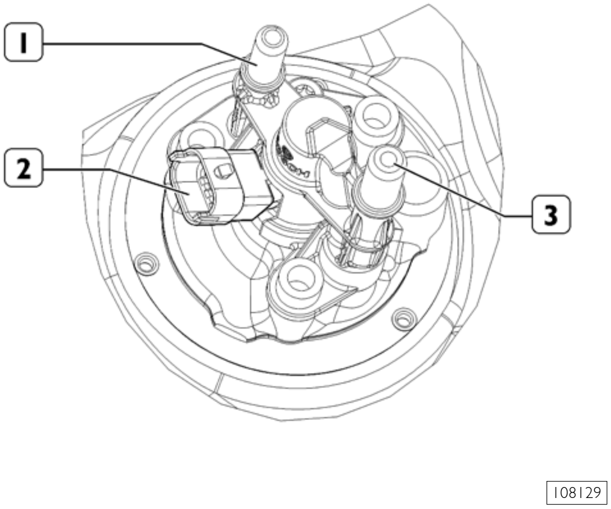
Figure 30



1. AdBlue return pipe to the tank - 2. AdBlue return pipe from dosing module - 3. AdBlue solution outlet - 4. AdBlue solution infeed - 5. Electrical connection - 6. DCU control unit connector - 7. Filter - 8. Prefilter.

Dosing module

Figure 31

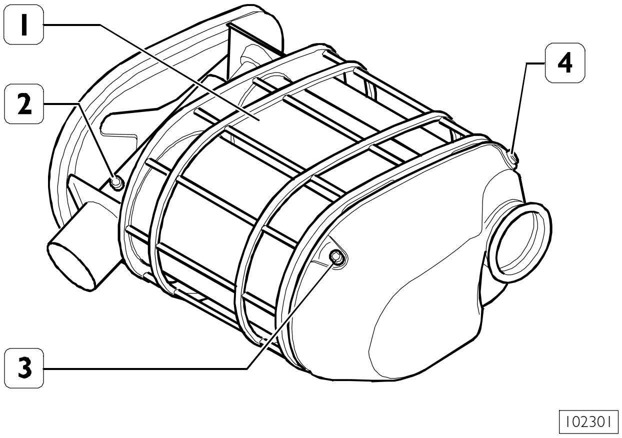


1. AdBlue infeed - 2. Electrical connection - 3. AdBlue outlet.

The function of this module is to dose the AdBlue solution to be conveyed to the injector.

Catalyst

Figure 32



Catalyst (1), equipped with sound-proofing material, replaces the exhaust silencer.

Inside the catalyst, the exhaust gas nitric oxides are, by reacting with ammonia, converted into free nitrogen and water vapour.

Temperature sensors (2 & 3) and nitric oxide detecting sensor (4) are fitted onto catalyst (1).

Exhaust gas temperature sensor

Figure 33

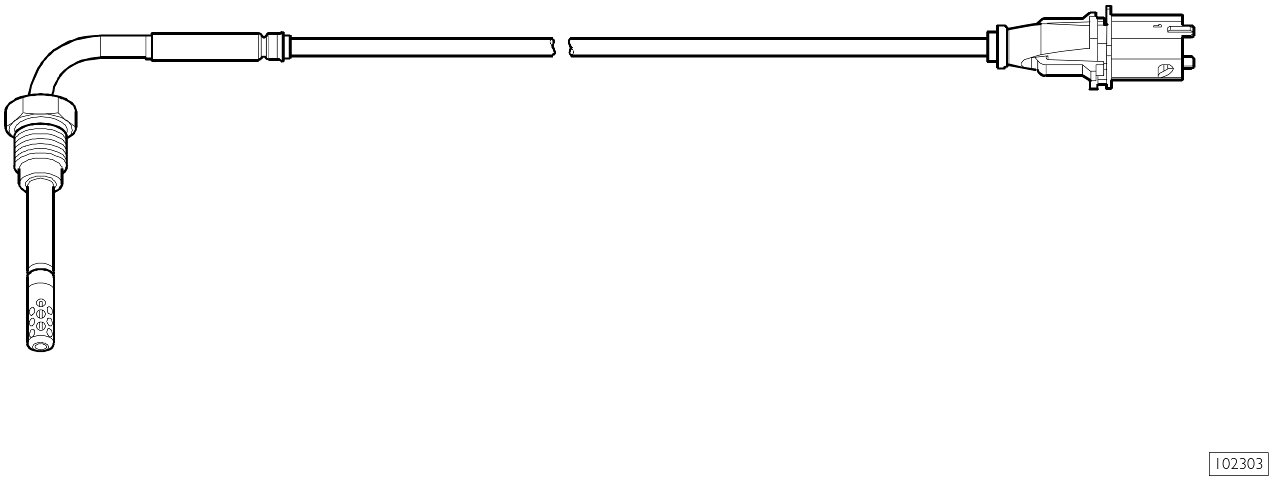
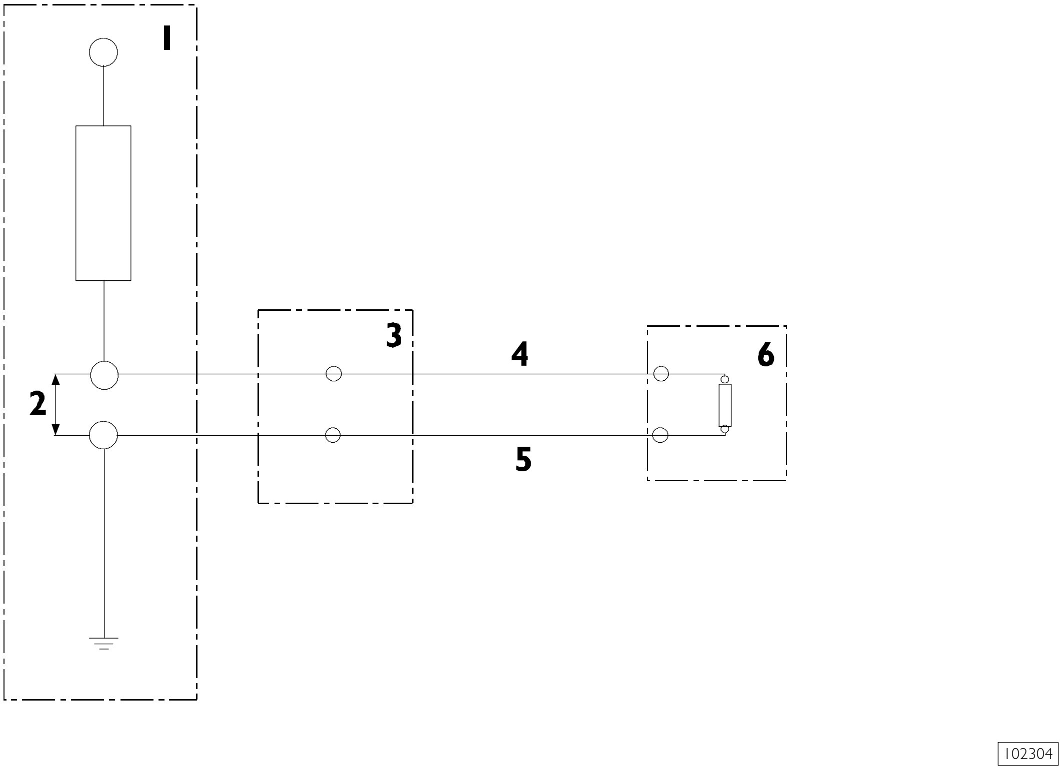


Figure 34



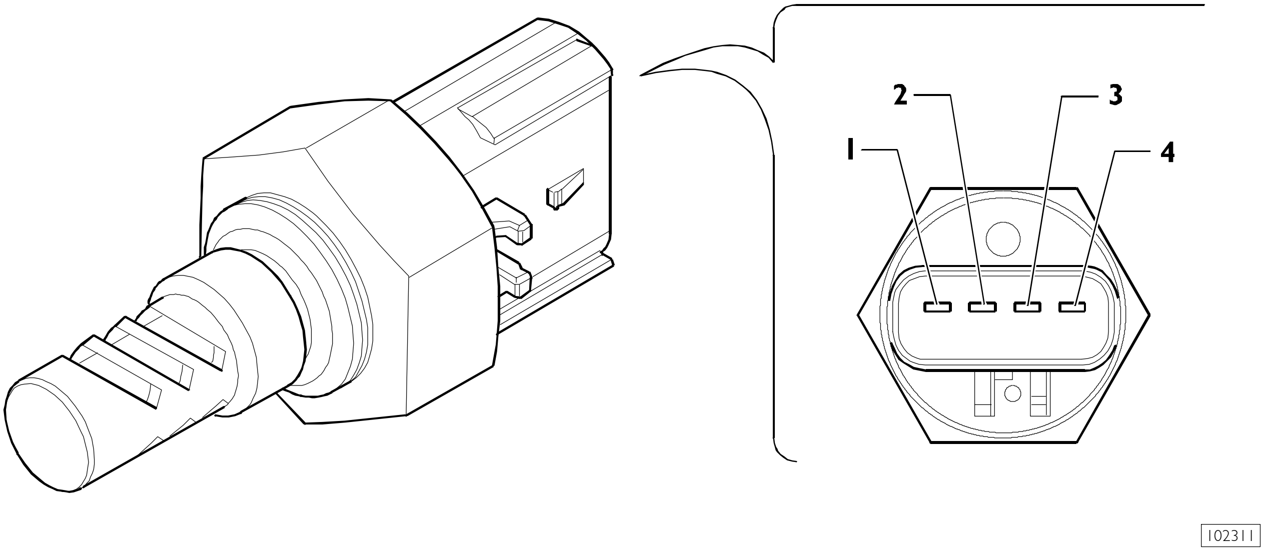
FUNCTIONAL WIRING DIAGRAM

1. Supply voltage - 2. Variable output voltage - 3. Connector - 4. Signal cable (grey) - 5. Earth cable (white) - 6. Sensor.

The function of this sensor is to send the control unit the catalyst inlet and outlet exhaust gas temperature values required to calculate the amount of urea to be injected into the system.

Humidity detecting sensor

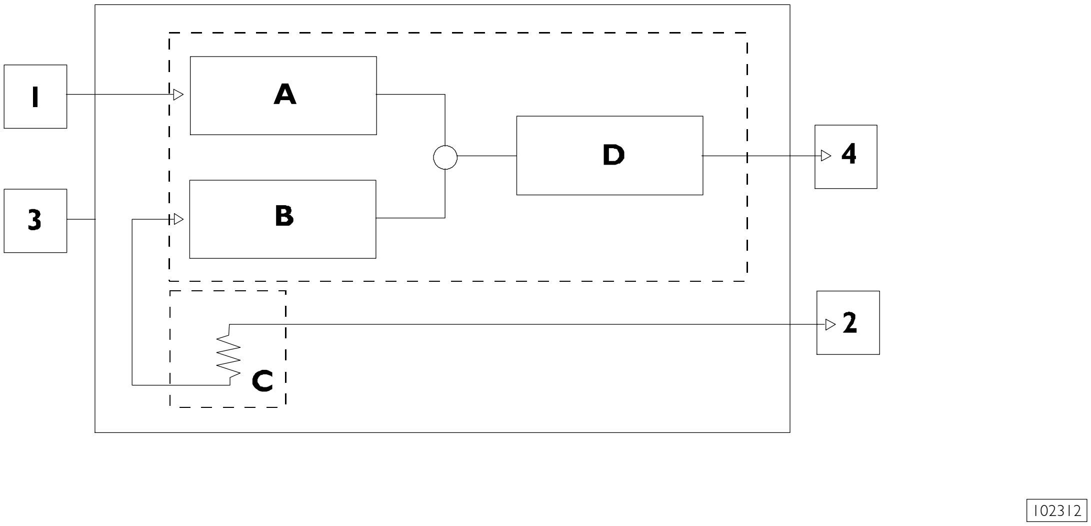
Figure 35



1. Temperature - 2. Earth - 3. Humidity percent value - 4. Power supply.

This sensor is located on the air filter output conveyor, and is used to inform the control unit of the amount (percentage) of humidity found in sucked air, to determine the calculation of nitric oxide emissions.

Figure 36



ELECTRIC BLOCK DIAGRAM

1. Earth - 2. Temperature - 3. Power supply unit - 4. Humidity percent value - A. Sample frequency generator - B. Reference oscillator - C. NTC temperature sensor - D. Amplifier lowpass filter.

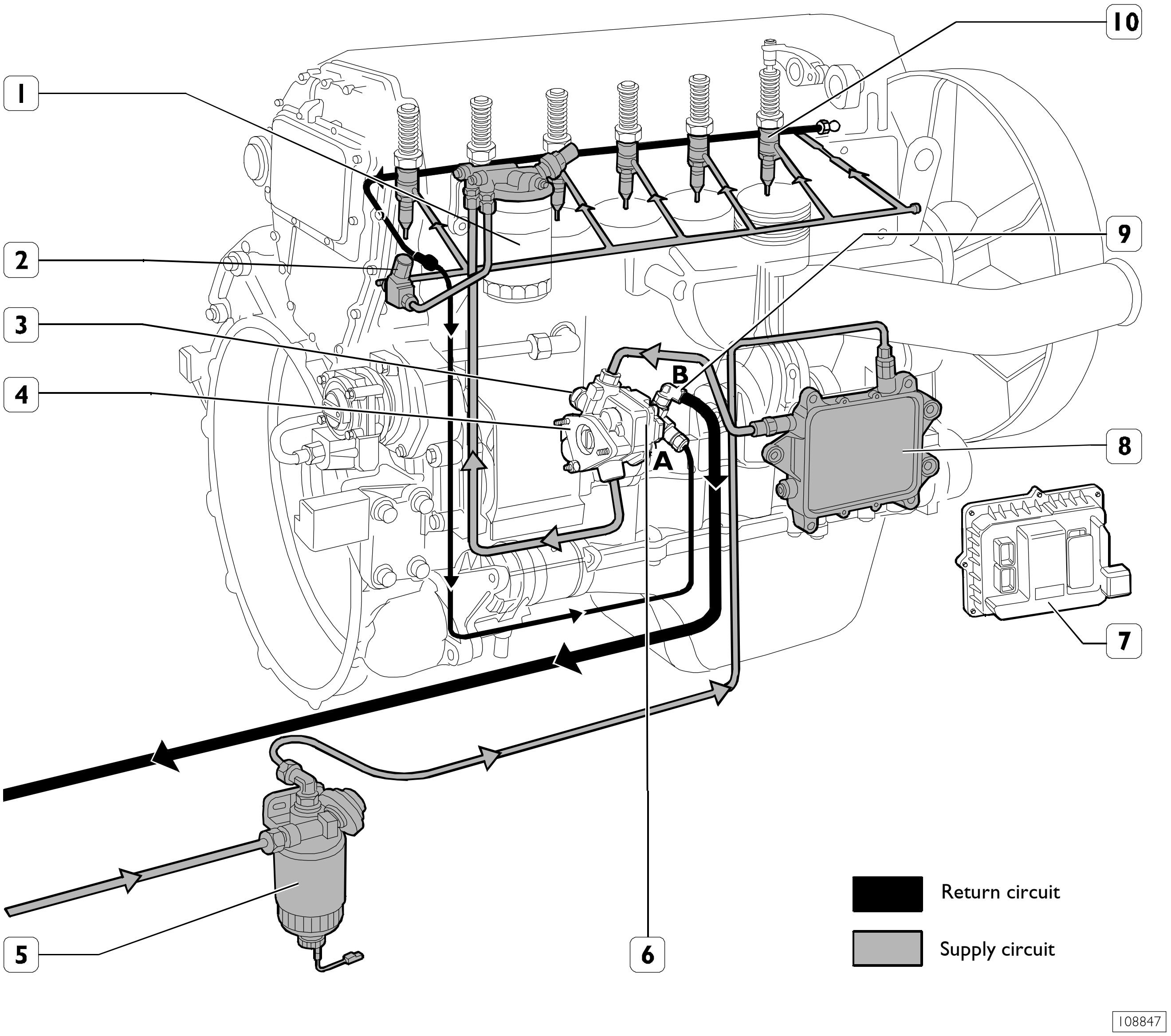
SECTION 2

Fuel

FEEDING

Fuel is supplied via a fuel pump, filter and pre-filter, 6 pump-injectors governed by the camshaft via rocker arms and by the electronic control unit.

Figure 37

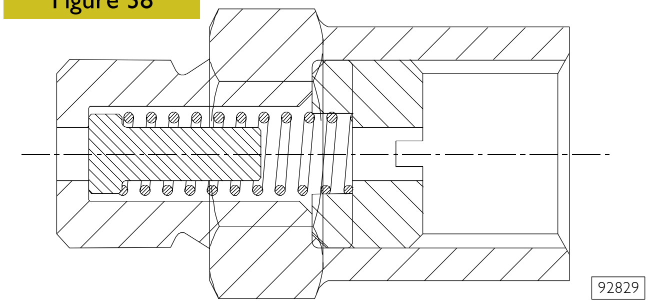


ENGINE FEED SCHEME
1. Fuel filter - 2. Pressure damping device - 3. Pressure control valve (start of opening at 5 bar) - 4. Feed pump - 5. Fuel pre-filter with priming pump - 6. Valve, to recirculate fuel from injectors, integrated in feed pump (start of opening at 3.5 bar) - 7. Central unit - 8. Heat exchanger - 9. Overpressure valve to return fuel to tank (start of opening at 0.2 bar) - 10. Pump injectors.

A. Fuel arriving at injectors - B. Fuel returning to tank

Overpressure valve

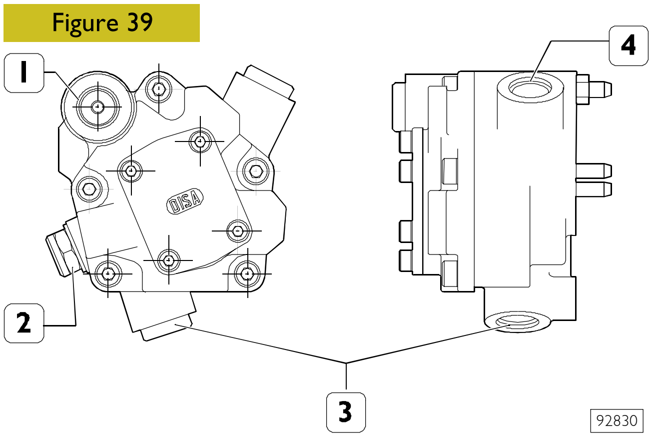
Figure 38



An overpressure valve is a single-acting valve, calibrated to 0.2 ÷ 0.3 bar, placed on the piping that returns fuel to tank. The overpressure valve prevents fuel duct in cylinder head from emptying with engine stopped.

Feed pump

Figure 39



Engine feed pump for vehicles 4x2 - 4x4 - 6x4
1. Overpressure valve - 2. Delivering fuel to injectors - 3. Sucking in fuel - 4. Pressure control valve

Pump performances					
Pump rotation speed (rpm)		2600	600	170	100
Minimum flow rate (l/h)		310	45	12	
Test conditions	Negative pressure on aspiration (bar)	0.5	0.3	0.3	0.3
	Pressure on delivery (bar)	5	3	0,3	0.3
	Test liquid temperature (°C)	30	30	30	30
	Test liquid	ISO 4113			

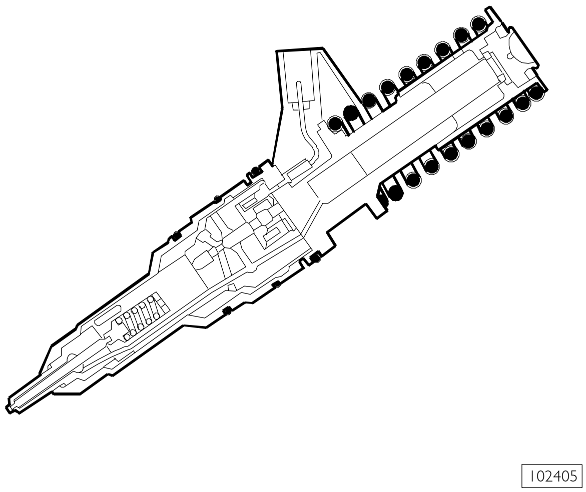
Field of use	
Pump rotation speed (rpm)	2600
Overrunning rotation speed (max 5 min) (rpm)	4100 max
Diesel oil temperature (°C)	-25/+80
Filtering rate on aspiration (micron)	30
Negative pressure on aspiration (bar)	0.5 max

Pressure control valve	
Valve calibration	5 ÷ 5.8

Injectors return valve	
Valve calibration	3.4 ÷ 3.8

Injector-pump

Figure 40

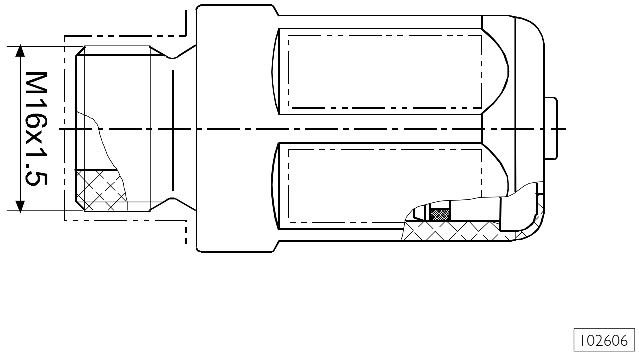


INJECTOR SECTION

The new pump injectors are capable, thanks to the higher injection pressure, of atomizing the fuel in the combustion chamber to a greater extent, thus improving combustion and therefore reducing the polluting exhaust emissions.

Pressure damper

Figure 41



FUEL PRESSURE DAMPER

The function of the fuel pressure damper located on the delivery pipe between the fuel filter and the cylinder head is to attenuate the supply return back pressure due to the increase of the injection pressure.

SECTION 3

Vehicle application

CLEARANCE DATA

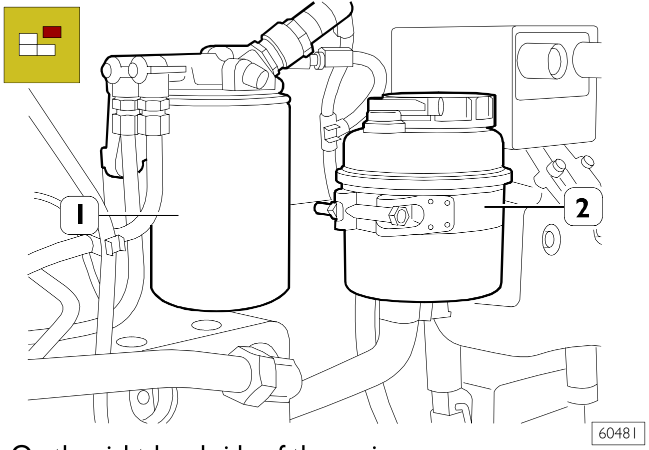
	Type		F3BE3681			
			D	C	B	A
ϱ	Compression ratio		16.5 : 1			
	Max. output	kW (HP) rpm	302 (410) 1900	332 (450) 1900	368 (500) 1900	412 (560) 1900
	Max. torque	Nm (kgm) rpm	1900 (194) 1000 ÷ 1515	2200 (224) 1000 ÷ 1435	2300 (234) 1000 ÷ 1525	2500 (255) 1000 ÷ 1575
	Loadless engine idling	rpm	550 ± 50			
	Loadless engine peak	rpm	2320 ± 50			
	Bore x stroke Displacement	mm cm^3	135 x 150 12880			
	SUPERCHARGING Turbocharger type		HOLSET with fixed geometry HX50W	With aftercooler HOLSET HE551V with variable geometry		
	LUBRICATION		Forced by gear pump, relief valve single action oil filter			
	Oil pressure (warm engine) (100 °C ± 5 °C) - idling - peak rpm	 bar bar	 1.5 5			
COOLING			By centrifugal pump, regulating thermostat, viscostatic fan, radiator and heat exchanger			
	Water pump control		By belt			
	Thermostat: starts to open: fully open:		N. 1 84 ± 2 °C 94 ± 2 °C			
Urania FE 5W30 **Urania LD 5** **Urania Turbo LD**	OIL FILLING Total capacity at 1st filling	liters kg	35 31.5			
	Capacity: - engine sump min level	liters kg	20 18			
	- engine sump max level	liters kg	28 25.2			
	- quantity in circulation that does not flow back to the engine sump	liters kg	7 6.3			
	- quantity contained in the cartridge filter (which has to be added to the cartridge filter refill)	liters kg	3 2.7			

PART ONE - MECHANICAL COMPONENTS

DISASSEMBLY THE ENGINE ON THE BENCH

Before fastening the engine on rotary stand 99322230, dismount or disconnect following parts:

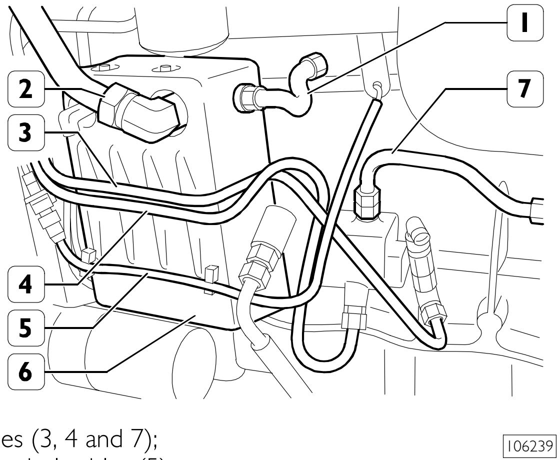
Figure 1



On the right-hand side of the engine

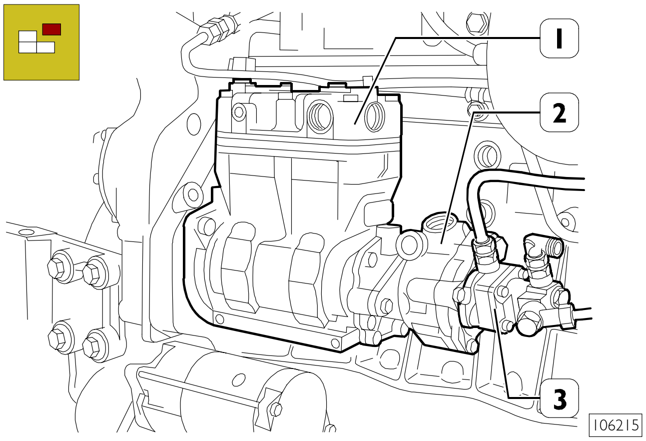
☐ the fuel cartridge filter (1).
☐ the hydraulic power steering tank (2).
☐ the electrical connections.

Figure 2



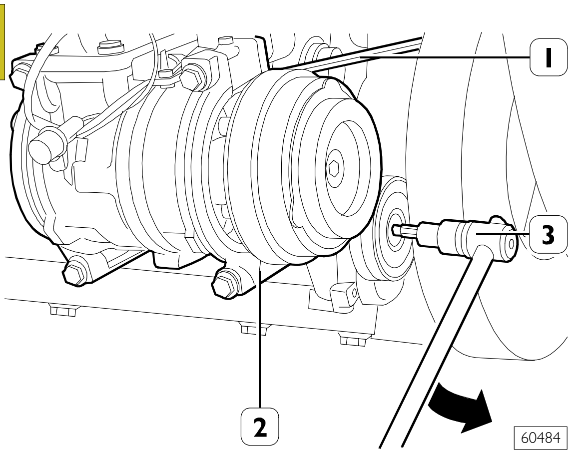
☐ pipes (3, 4 and 7);
☐ electrical cables (5);
☐ sound deadening guard (6);
☐ pipes (1 and 2).

Figure 3



☐ compressor (1) complete with oversteering pump (2) and feed pump (3).

Figure 4

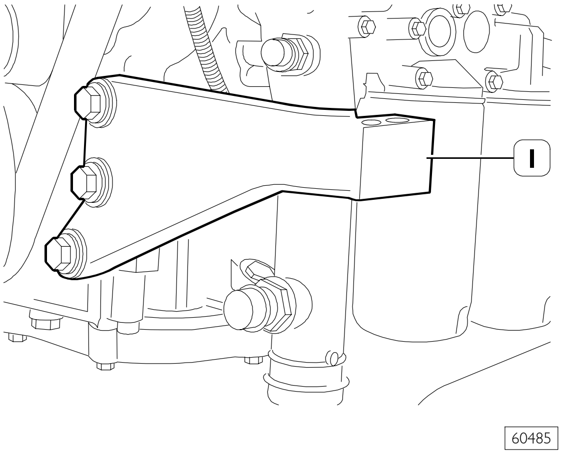


☐ Using the right tool (3), turn it in the direction shown by the arrow and remove the air-conditioner drive belt (1).

☐ Remove the air-conditioner (2) together with the engine mounting.

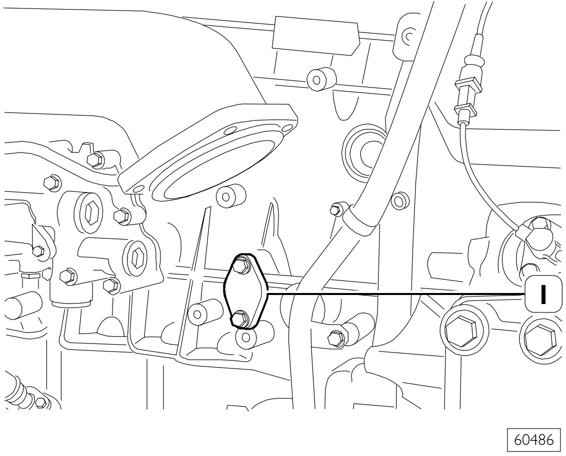
On the left-hand side of the engine

Figure 5



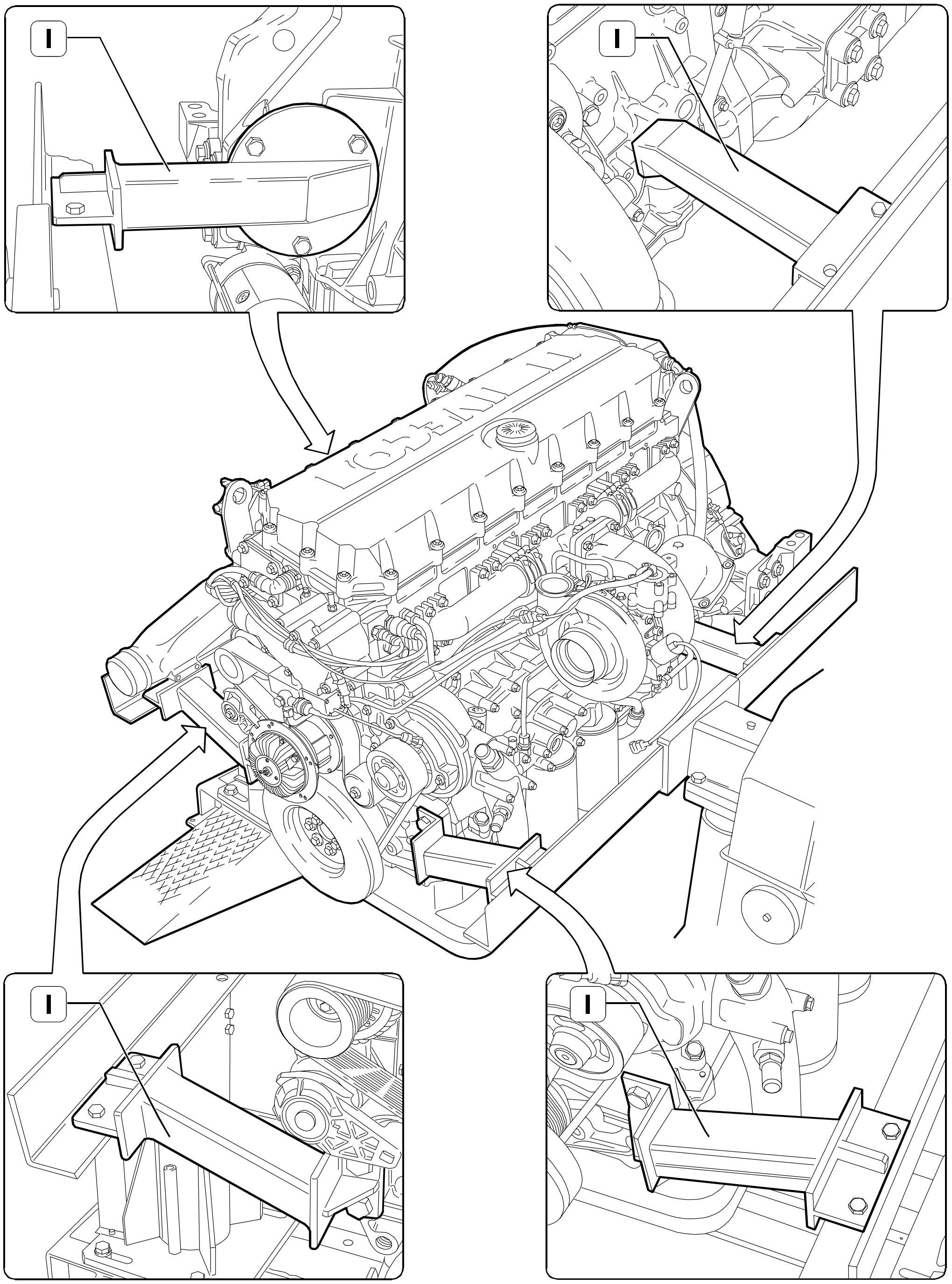
☐ the engine mounting (1).

Figure 6



☐ the oil pressure adjustment valve (1).

Figure 7 (Demonstration)



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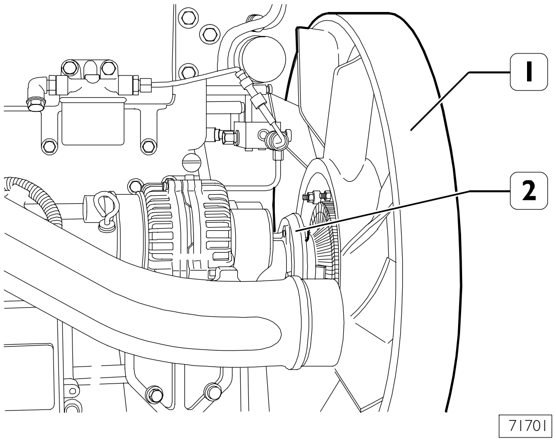
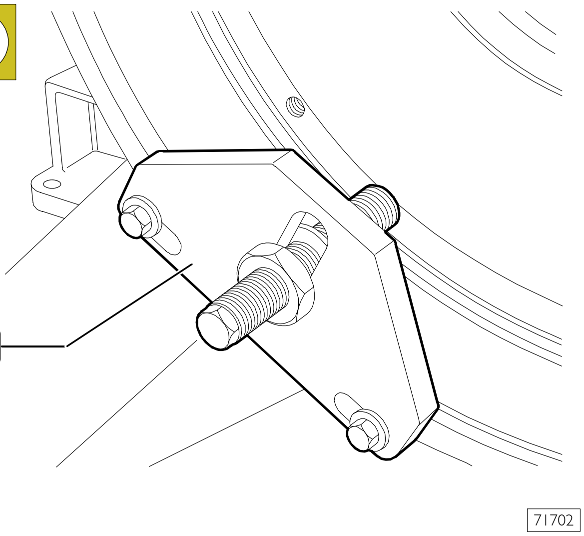
Secure the engine to the rotary stand 99322030 with the brackets 99361036 (1).
Remove the electric wiring by disconnecting it from the sensors and the electric actuators.

Figure 8



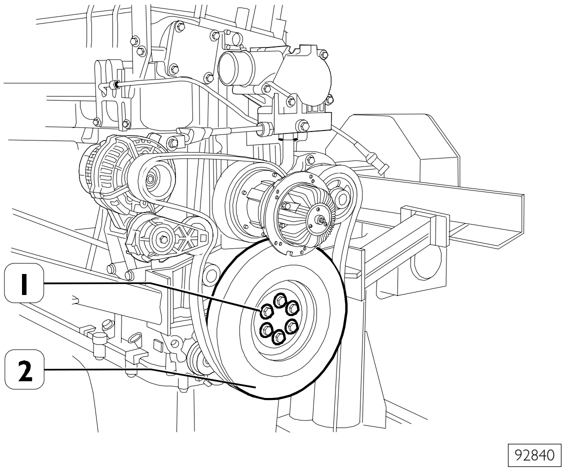
If present, dismount fan (1) from electromagnetic joint (2).

Figure 9



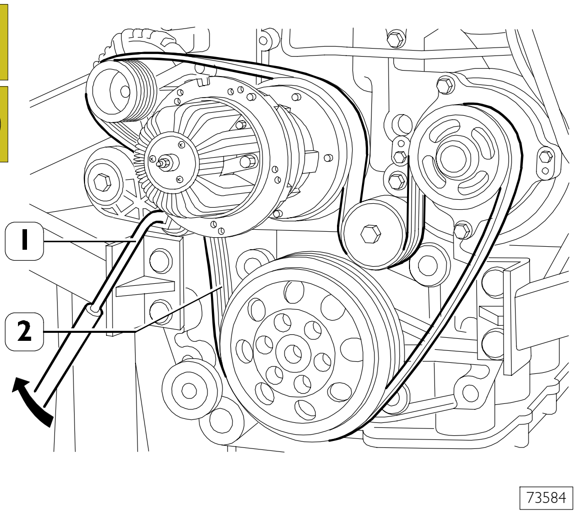
Use tool (1) 99360351 to lock the engine flywheel.

Figure 10



Operate the 6 Allen screws to remove the damper flywheel (1).

Figure 11

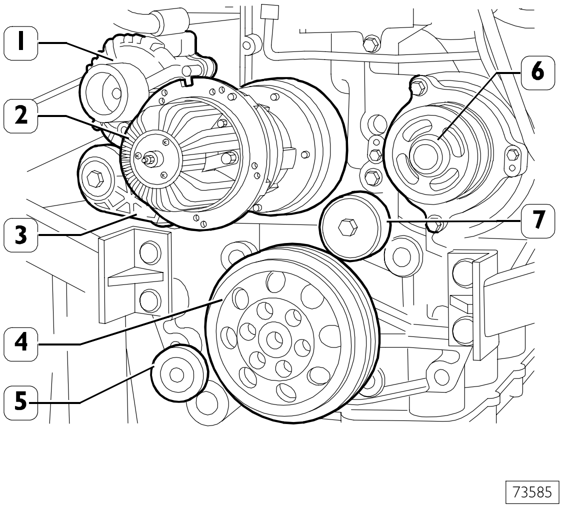


Using an appropriate tool (1), turn it in the direction shown by the arrow and remove the auxiliary member drive belt (2).

If present, dismount compressor for climate control system and relating driving spring belt.

NOTE Spring belt must be replaced by a new one after every dismounting operation.

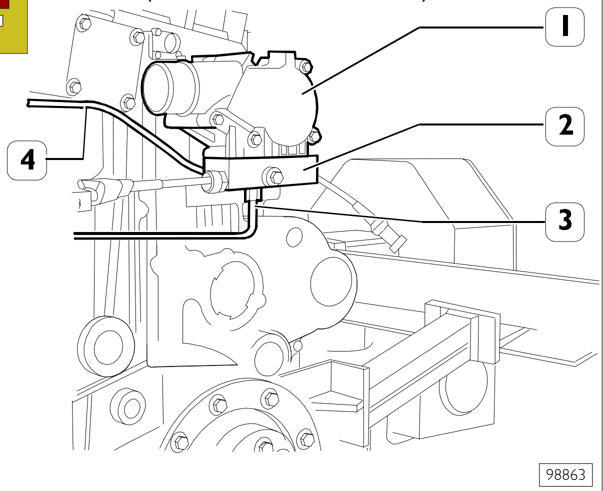
Figure 12



Remove the alternator (1), electric fan coupling (2), automatic tensioners (3 and 5), pulley (4), water pump (6) and pulley (7).

Figure 13

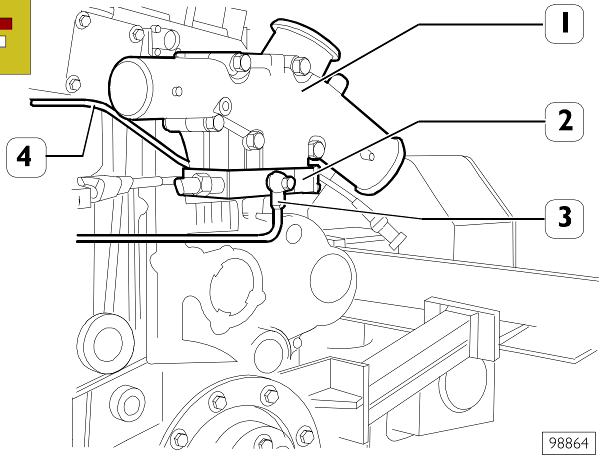
(Version without Intarder)



Disconnect the pipes (3 and 4) from the V.G.T control solenoid valves.
Remove the thermostat assembly (1) together with the V.G.T. control solenoid valve (2).

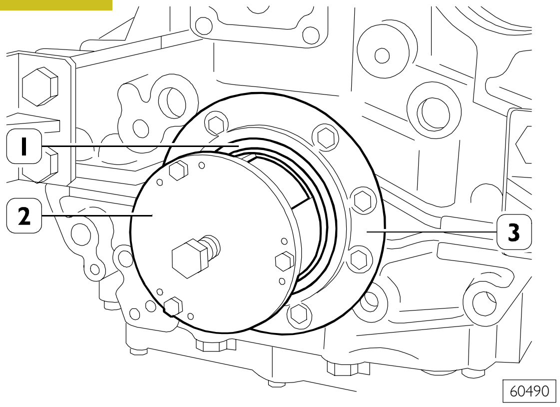
Figure 14

(Version with Intarder)



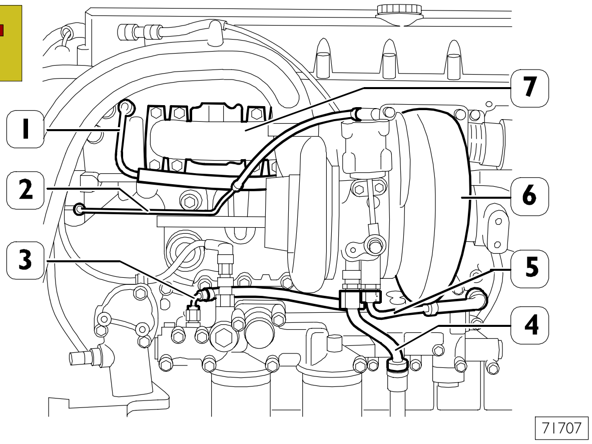
Disconnect the pipes (3 and 6) from the V.G.T control solenoid valves. Remove the water inlet/outlet pipe assembly (1) together with the V.G.T. control solenoid valve (2).

Figure 15



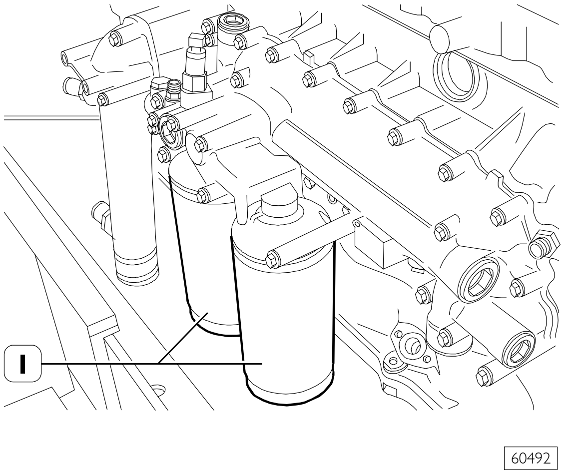
Apply extractor 99340053 (2) and take out the crankshaft seal (1); now remove the flange (3).

Figure 16



Remove the following components: water delivery pipe (5); water outlet pipe (1); actuator control air pipe (2); oil delivery pipes (3); oil return pipes (4); turbo-compressor unit (6); exhaust manifold (7).

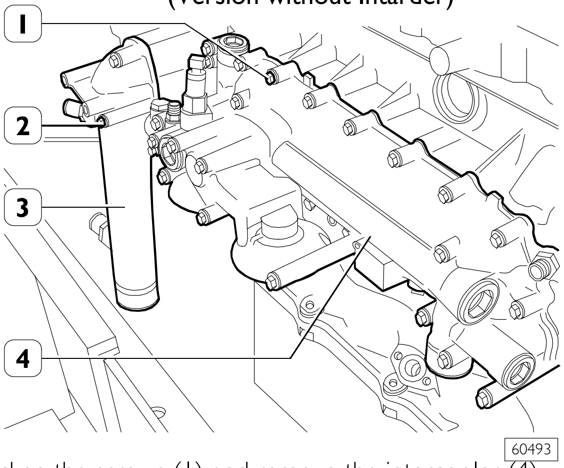
Figure 17



Use tool 99360314 to slacken the oil filters (1).

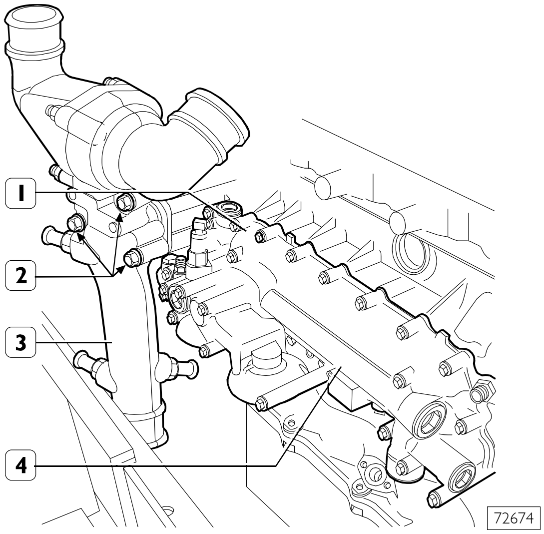
Figure 18

(Version without Intarder)



- ☐ Slacken the screws (1) and remove the intercooler (4);
- ☐ Slacken the screws (2) and remove the water pipe (3).

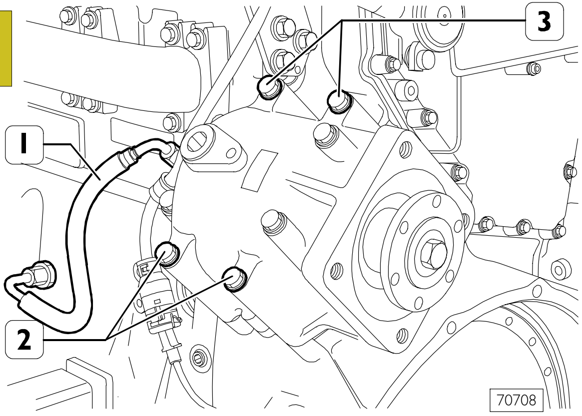
Figure 19 (Version with Intarder)



☐ Slacken the screws (1) and remove the intercooler (4);

☐ slacken the screws (2) and remove the thermostat (3).

Figure 20

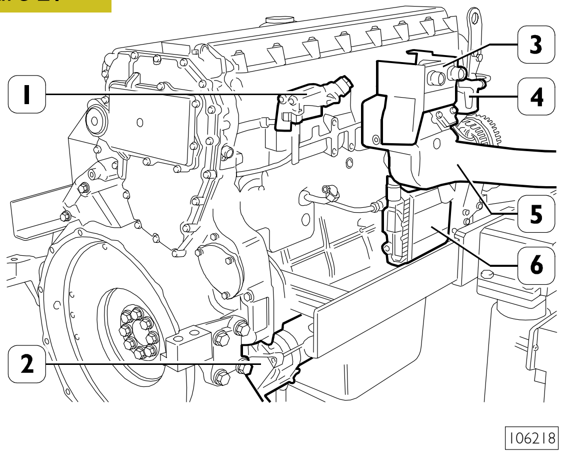


The remove the P.T.O. (if fitted):

☐ disconnect the oil pipe (1);

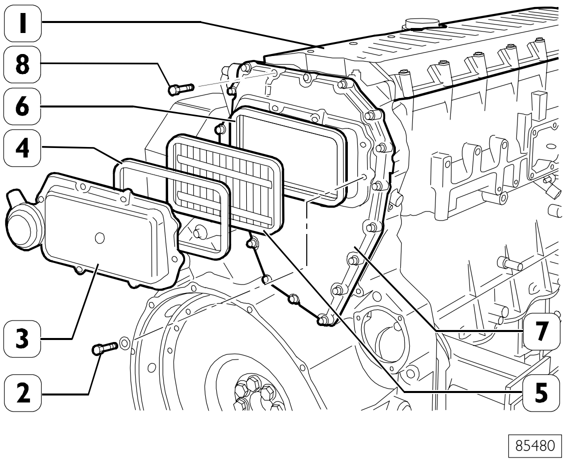
☐ slacken the 4 screws (2) and (3).

Figure 21



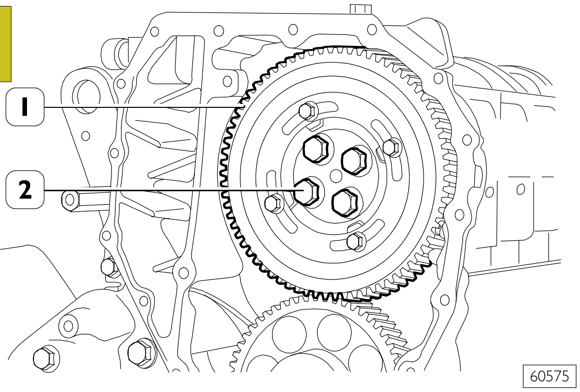
Dismount following parts: fuel filter support (1); relating pipes; starter (2); support for engine startup pushbuttons (3); air filter for PWM valve (4); intake manifold (5) complete with resistance for engine preheating; engine central unit (6);

Figure 22



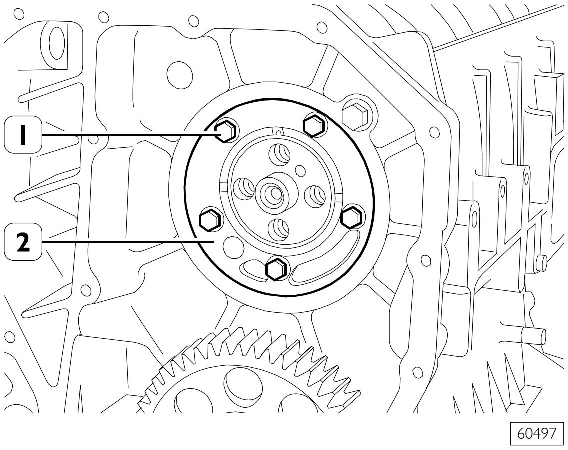
Remove the rocker arm cover (1), take off the screws (2) and extract the cover (3), the filter (5) and the gaskets (4 and 6). Remove the screws (8) and the blow-by case (7).

Figure 23



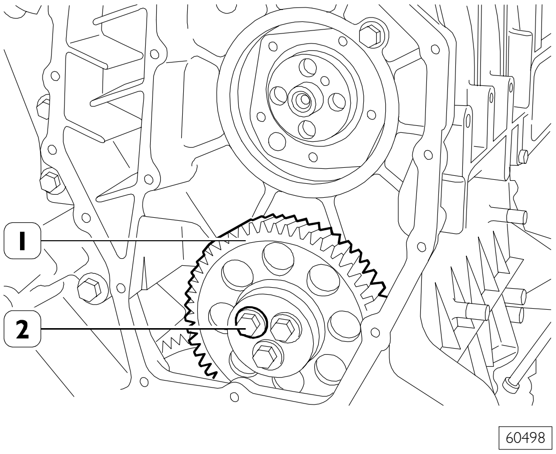
☐ Slacken the screws (2) and remove the gear (1) together with the phonic wheel.

Figure 24



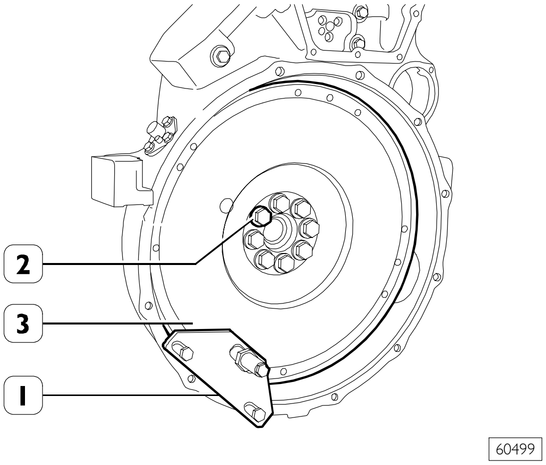
☐ Slacken the screws (1); drive one of them in a torque hole in order to remove the shoulder plate (2) and extract the metal sheet gasket.

Figure 25



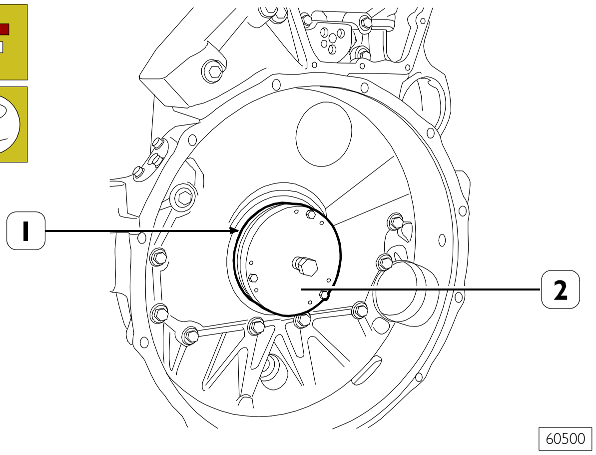
Unscrew the screws (2) and remove the idle gear (1).

Figure 26



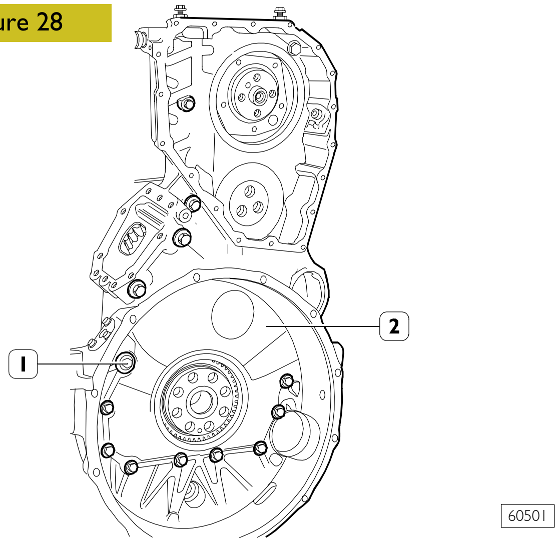
With the engine flywheel locking tool 99360351 (1) fitted, unscrew the fixing screws (2). Take off the tool (1) and extract the flywheel (3).

Figure 27



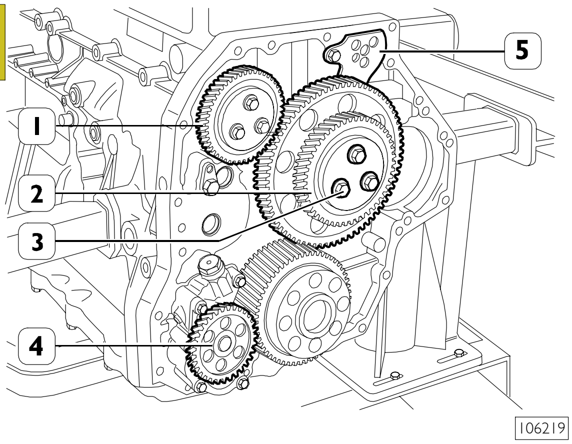
Fit on the extractor 99340054 (2) and extract the gasket (1).

Figure 28



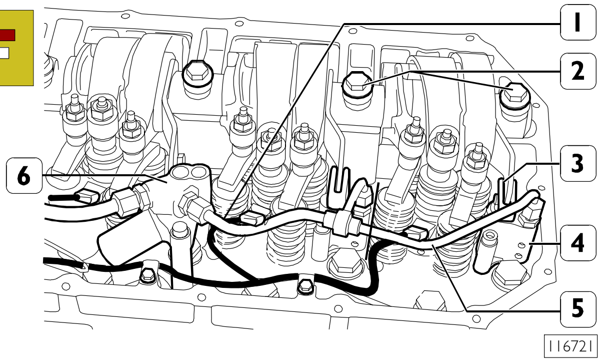
Unscrew the screws (1) and remove the gearbox (2).

Figure 29



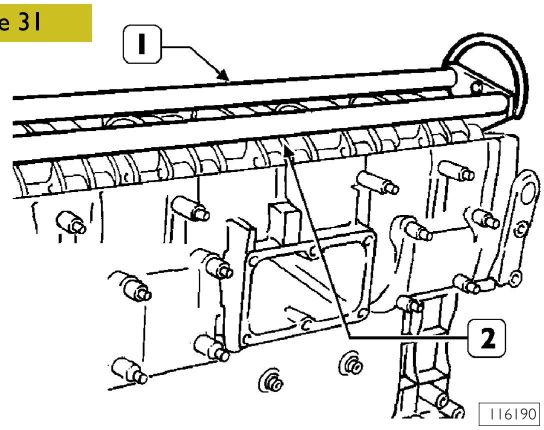
If present, dismount P.T.O. driving gear (1).
Remove screws (3) and dismount double gear (2).
Remove securing screw and dismount articulated rod (5).
Dismount oil pump (5).

Figure 30



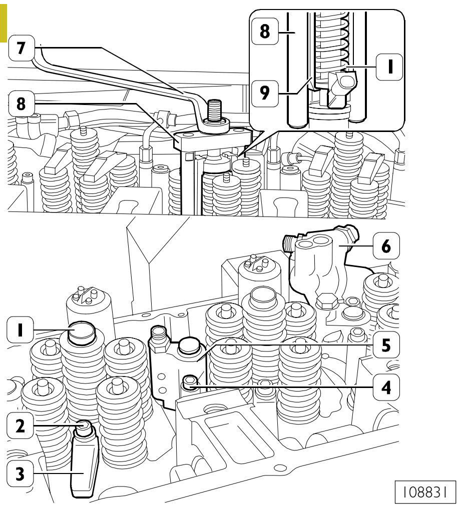
- ☐ Release the check springs (3) of the exhaust brake lever.
- ☐ Remove the electric connections (1).
- ☐ Remove exhaust brake pins (4) and slave cylinder (6) pipes (5).
- ☐ Unscrew the screws (2) fixing the rocker arm shaft.
- ☐ Remove the head injection wiring. The wiring has to be extracted from the front.

Figure 31



Apply tool 99360553 (1) to the rocker holder shaft (2) and remove the shaft (2) from the cylinder head.

Figure 32



☐ Unscrew the screws (2) fixing the brackets (3);

☐ hook tool 99342155 part (9) to pump injector (1);

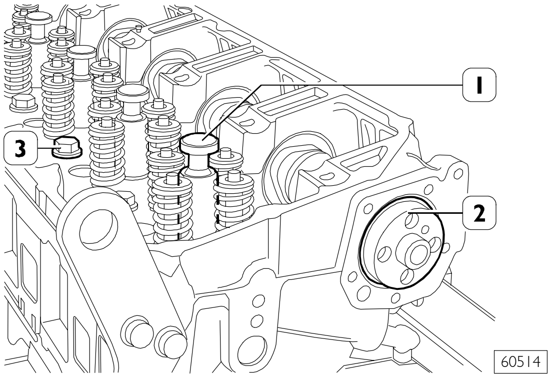
☐ mount part (8) on part (9) resting part on cylinder head;

☐ screw nut (7) and extract pump injector (1) from cylinder head.

☐ unscrew the screws (4) and remove the exhaust brake pins (5).

☐ unscrew the screws and remove the slave cylinder (6).

Figure 33

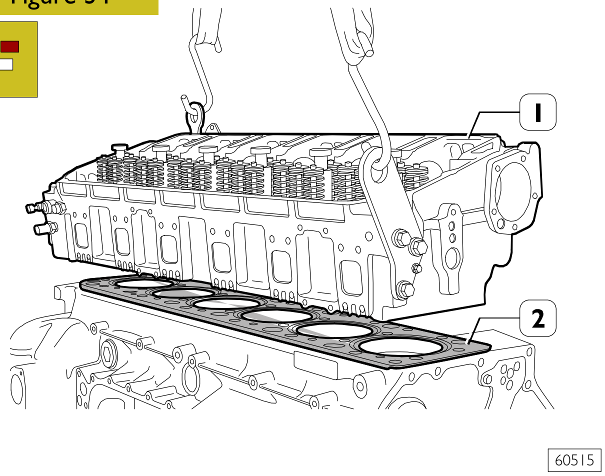


☐ Insert the plugs 99360180 (1) in place of the injectors.

☐ Extract the camshaft (2).

☐ Unscrew the screws fixing the cylinder head (3).

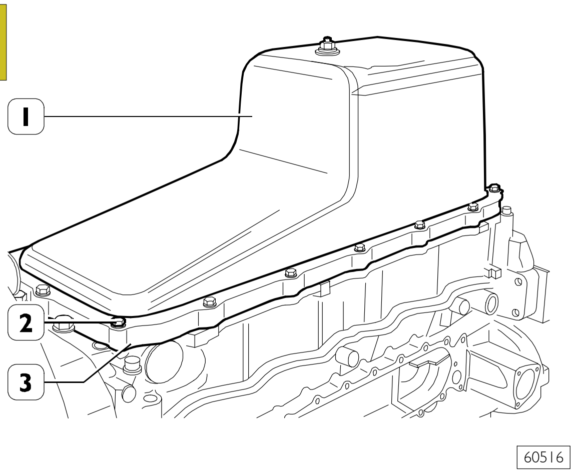
Figure 34



☐ Using metal ropes, lift the cylinder head (1).

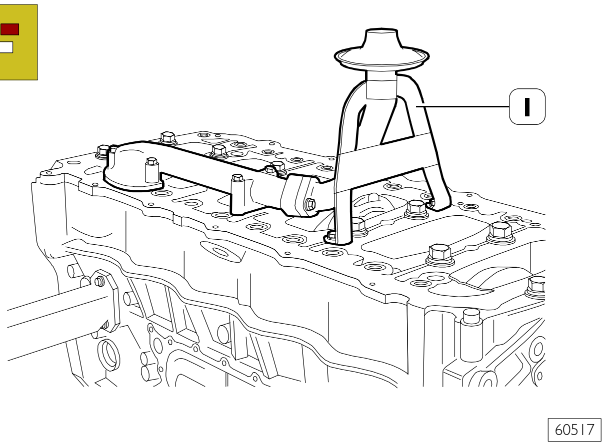
☐ Take off the gasket (2).

Figure 35



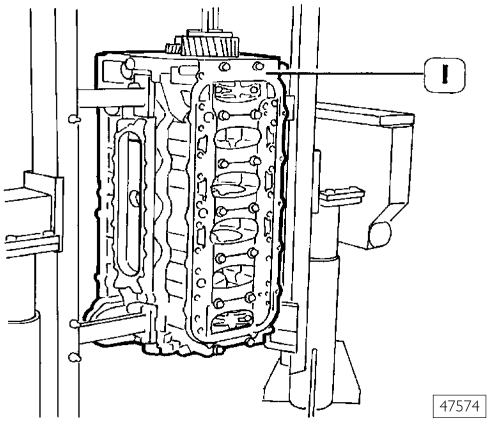
Unscrew the screws (2) and take out the engine oil sump (1) together with the spacer (3) and gasket.

Figure 36



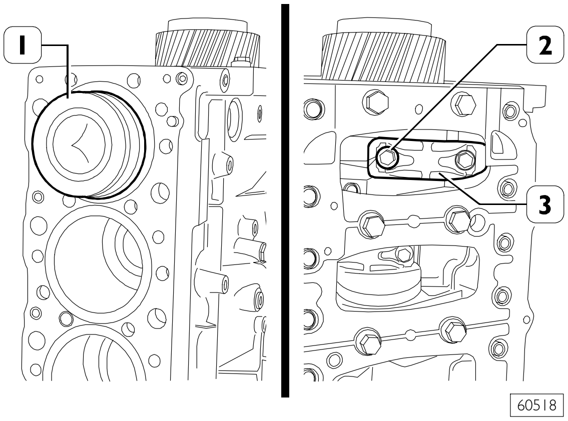
Unscrew the screws and take out the suction strainer (1).

Figure 37



Turn the crankcase (1) upright.

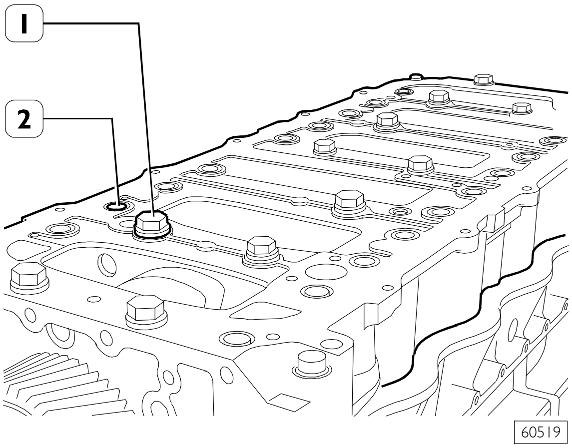
Figure 38



Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston (1) assembly from the upper side. Repeat these operations for the other pistons.

NOTE Keep the big end bearing shells in their respective housings and/or note down their assembly position since, if reusing them, they will need to be fitted in the position found upon removal.

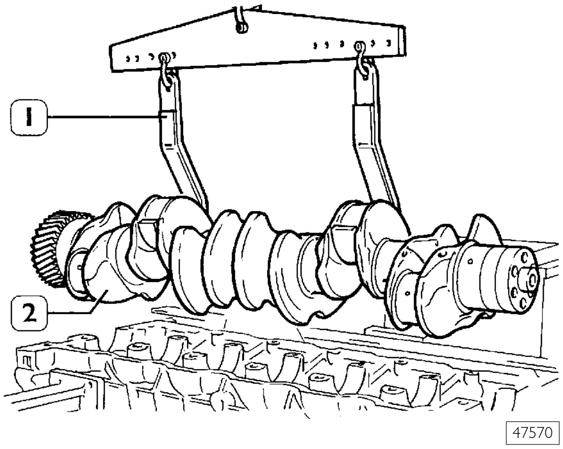
Figure 39



Using an appropriate wrench and the hex wrench unscrew the screws (1) and (2) and take off the crankcase base.

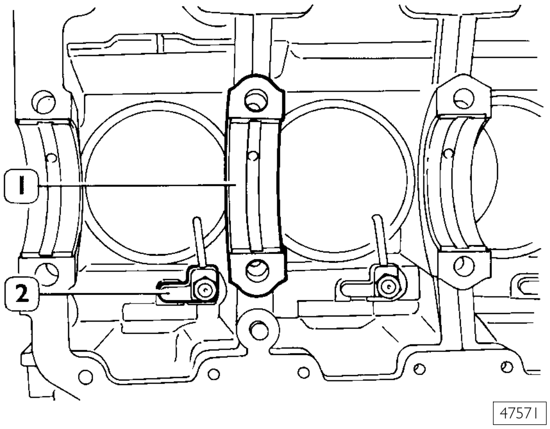
NOTE Note down the assembly position of the top and bottom main bearing shells since, if reusing them, they will need to be fitted in the position found upon removal.

Figure 40



Using tool 99360500 (1), remove the crankshaft (2).

Figure 41



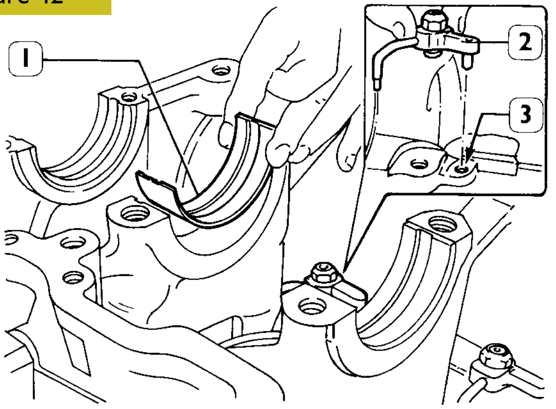
Extract the main bearing shells (1), unscrew the screws and take out the oil nozzles (2).
Dismount cylinder liners as described in Section 4.

NOTE After removing the engine, you need to clean the removed parts thoroughly and check their integrity. The following pages give the instructions for making the checks and the main measurements to make to determine whether the parts can be reused.

ASSEMBLING THE ENGINE ON THE BENCH

Using the brackets 99361036, secure the crankcase to the stand 99322230.
Mount cylinder liners as described in Section 4.

Figure 42



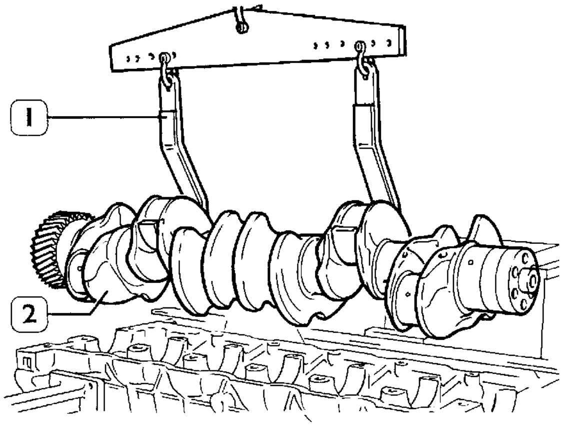
47586

Mount the oil nozzles (2), making the grub screw coincide with the hole (3) in the crankcase.

Arrange the bearing shells (1) on the main bearing housings.

NOTE Not finding it necessary to replace the main bearings, you need to fit them back in exactly the same sequence and position as in removal.
If to be changed, choose the main bearings according to the procedure in chapter "Selection of main bearings and connecting rod bearings".

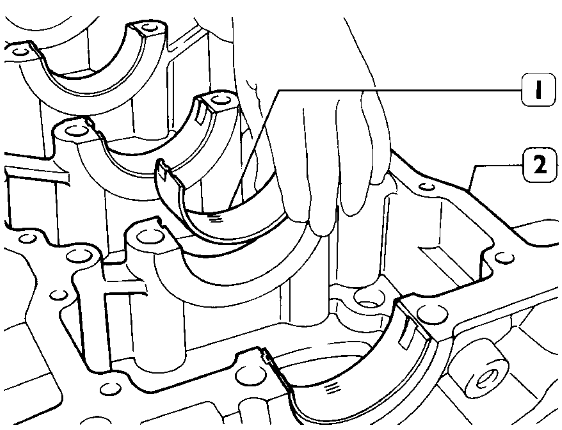
Figure 43



47570

Lubricate the bearing shells then mount the crankshaft (2) using the tackle and hook 99360500 (1).

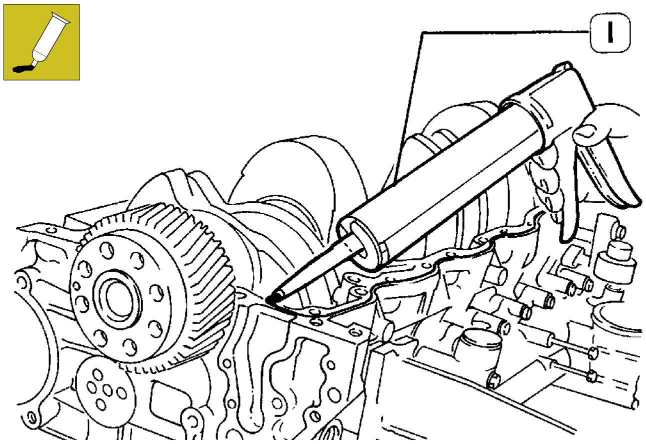
Figure 44



49021

Arrange the bearing shells (1) on the main bearing housings in the crankcase base (2).

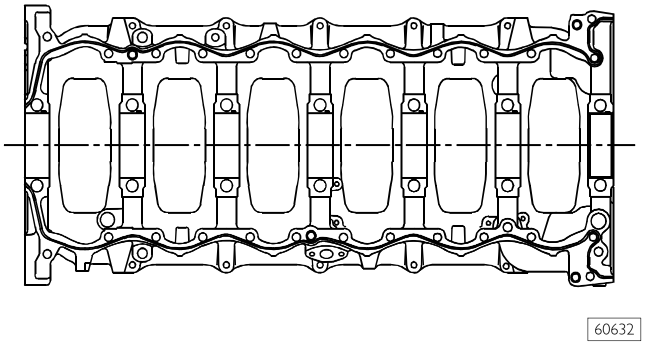
Figure 45



47595

Apply LOCTITE 5970 (IVECO No. 2995644) silicone on the crankcase using the appropriate tools (1) as shown in Figure 46.

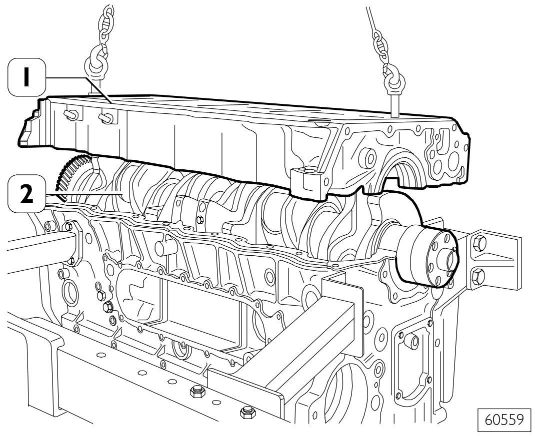
Figure 46



Sealant application diagram.

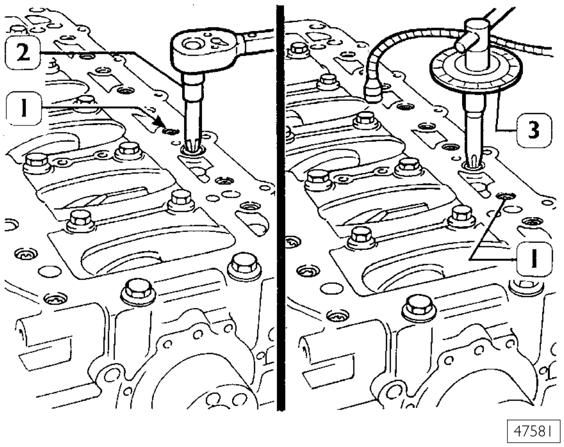
NOTE Mount the crankcase base within 10 min. of applying the sealant.

Figure 47



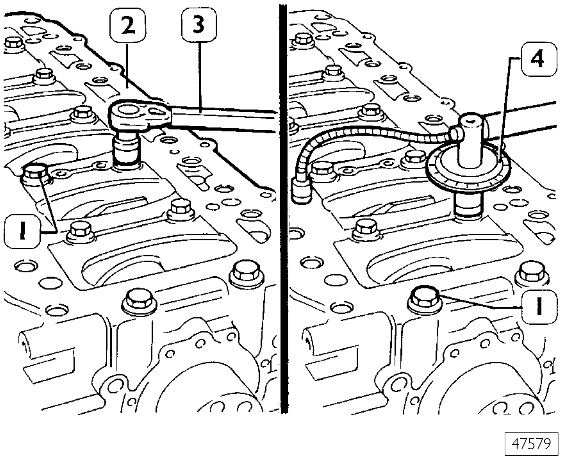
Mount the crankcase base (1) using appropriate tackle and hooks.

Figure 48



Using a torque wrench (2), tighten the outside hex grooved screws (1) to a torque of 30 Nm, following the diagrams given on the following page.

Figure 49

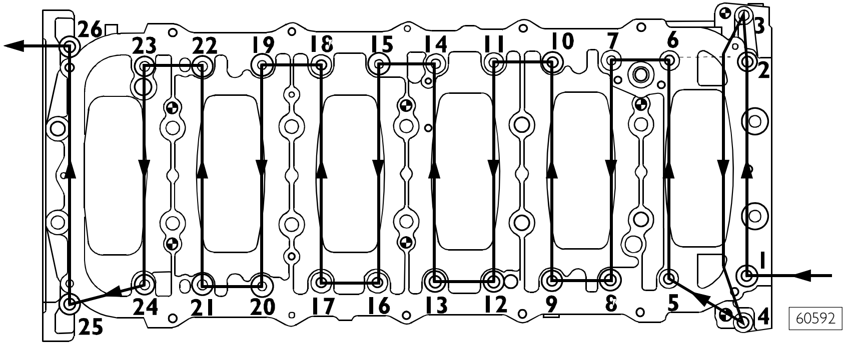


Using a torque wrench (3), tighten the inside screws (1) to a torque of 120 Nm. Then tighten them to an angle of 60° and 55° with tool 99395216 (4) with another two phases. Regrind the outside screws (1, Figure 48) with closure to an angle of 60° using tool 99395216 (4).

Diagram of tightening sequence of crankcase base fixing screws

Figure 50

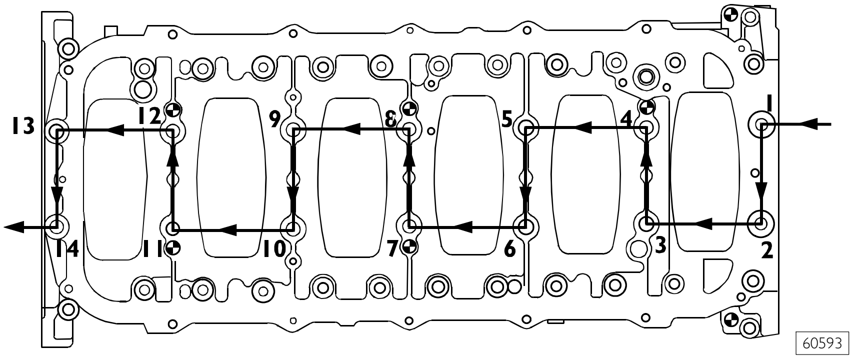
FRONT SIDE



First phase:
pre-tightening
outside screws

30 Nm

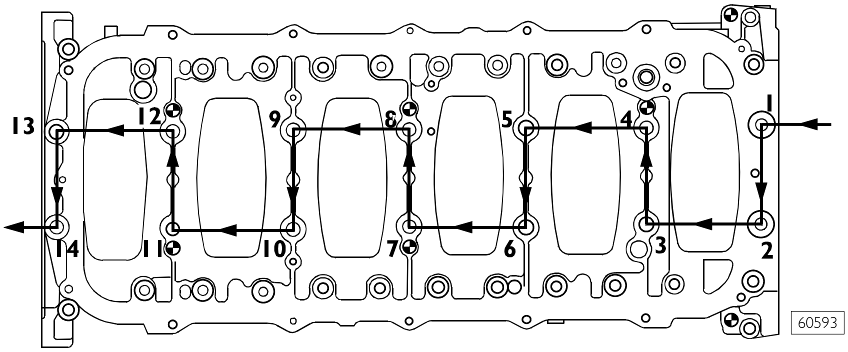
FRONT SIDE



Second phase:
pre-tightening
inside screws

120 Nm

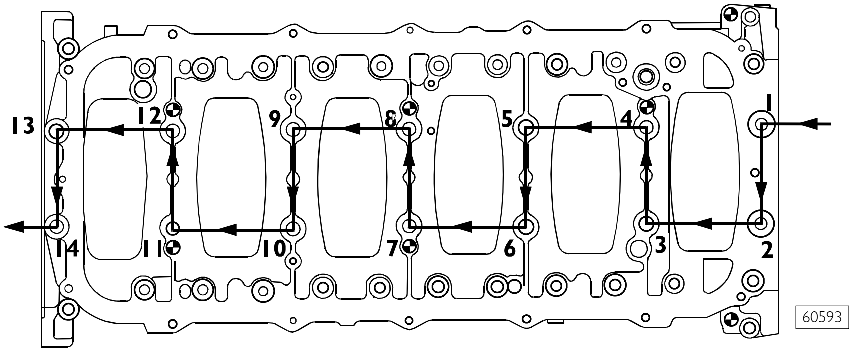
FRONT SIDE



Third phase:
closing inside
screws to angle

60°

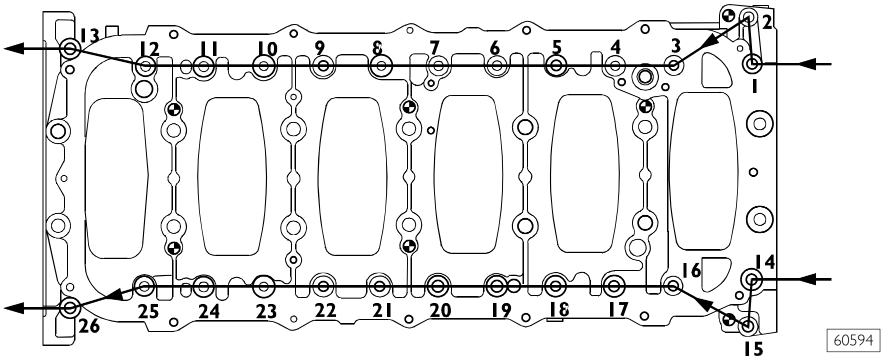
FRONT SIDE



Fourth phase:
closing inside
ìscrews to angle

55°

FRONT SIDE

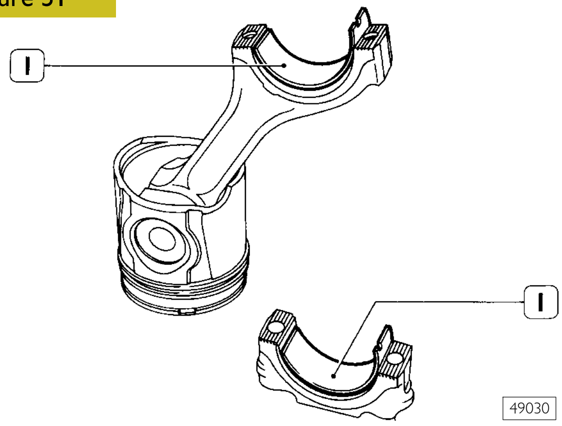


Fifth phase:
closing outside
screws to angle

60°

Fitting connecting rod - piston assemblies in cylinder liners

Figure 51

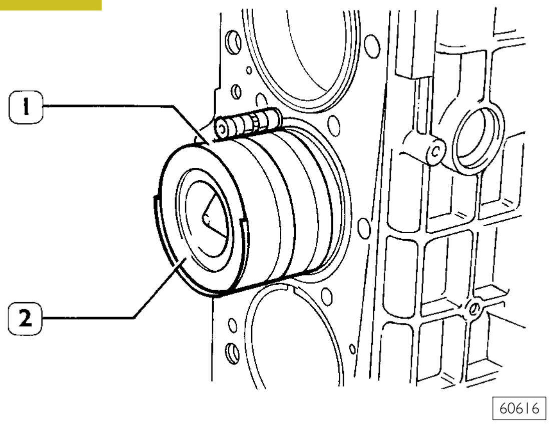


NOTE Not finding it necessary to replace the connecting rod bearings, you need to fit them back in exactly the same sequence and position as in removal.
If to be changed, choose the main bearings according to the procedure in chapter "Selection of main bearings and connecting rod bearings".

Lubricate the bearing shells (1 and 3) and fit them on the connecting rod (2) and on the cap (4).

NOTE Do not make any adjustment on the bearing shells.

Figure 53

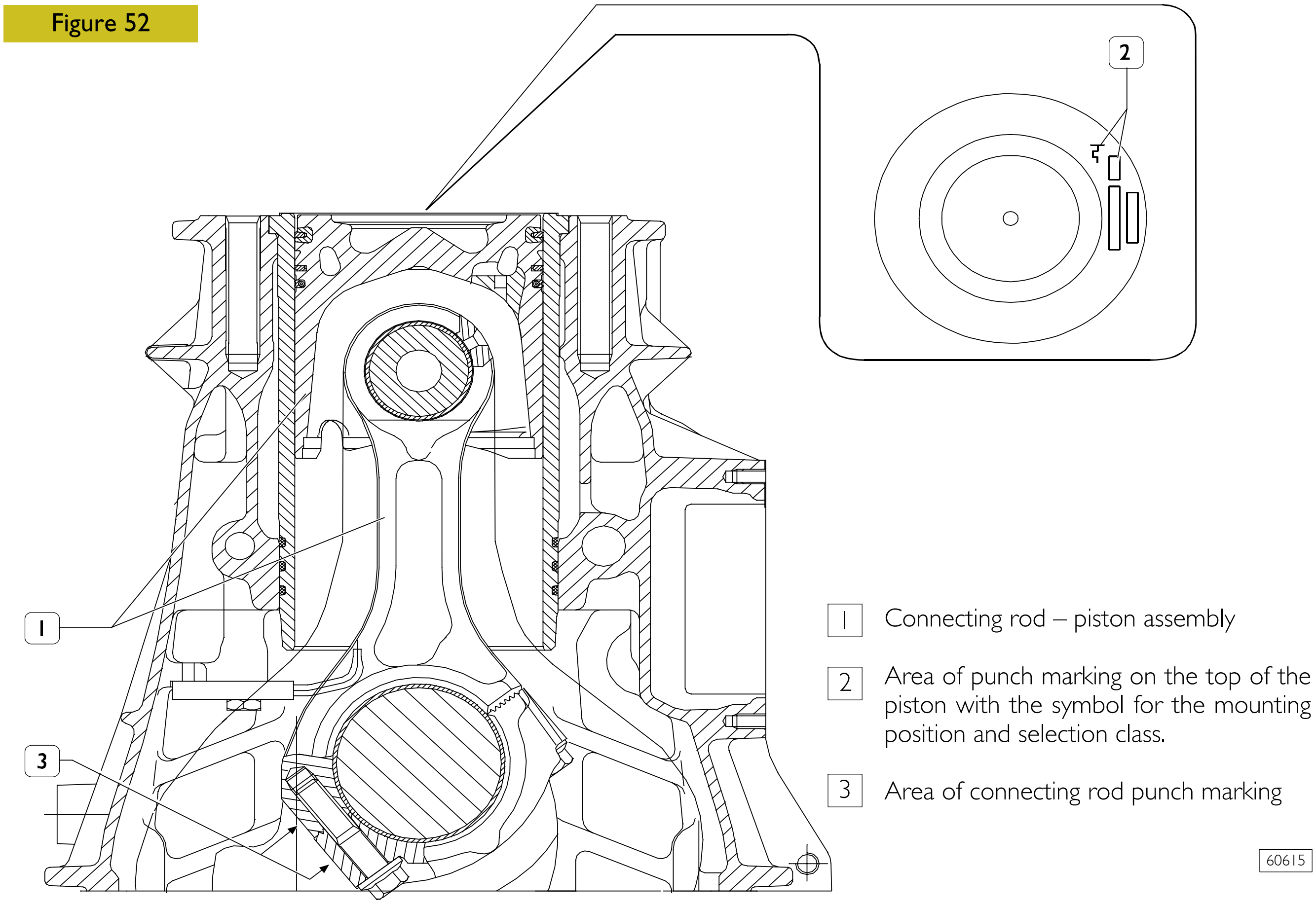


Turn the cylinder block, setting it upright.
Lubricate the pistons, piston rings and inside the cylinder liners.
With the aid of the clamp 99360605 (1) mount the connecting rod – piston assemblies (2) in the cylinder liners according to Figure 52. Check that:

- ☐ The number of each connecting rod corresponds to the cap coupling number.
- ☐ The symbol (2, Figure 52) punched on the top of the pistons faces the engine flywheel or the recess in the piston skirt tallies with the position of the oil nozzles.

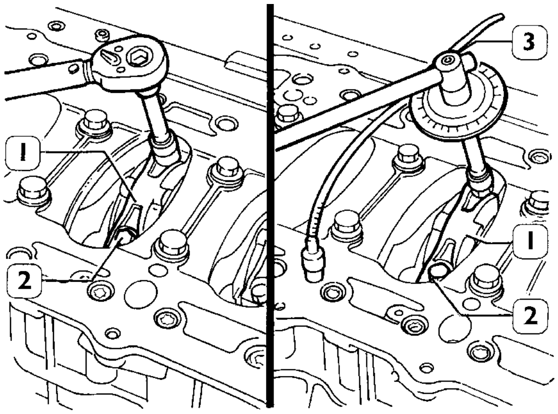
NOTE The pistons are supplied as spares in class A and can also be fitted in class B cylinder liners.

Figure 52



1	Connecting rod – piston assembly
2	Area of punch marking on the top of the piston with the symbol for the mounting position and selection class.
3	Area of connecting rod punch marking

Figure 54

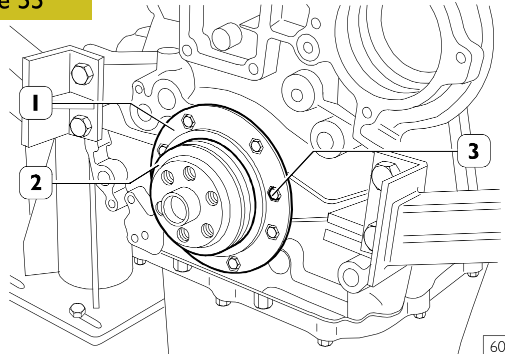


47594

NOTE Before reusing the screws (2), measure the diameter of the thread; it must be no less than 13.4 mm; if it is, change the screw.
Lubricate the thread of the screws with engine oil before assembly.

Connect the connecting rods to the relevant pins of the crankshaft, mount the connecting rod caps (1) together with the bearing shells. Tighten the screws (2) fixing the connecting rod caps to a torque of 60 Nm (6 kgm). Using tool 99395216 (3), tighten the screws further with an angle of 60°.

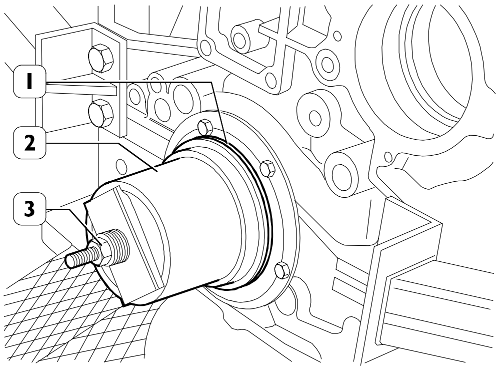
Figure 55



60563

Using the centring ring 99396035 (2), check the exact position of the cover (1). If it is wrong, proceed accordingly and lock the screws (3).

Figure 56

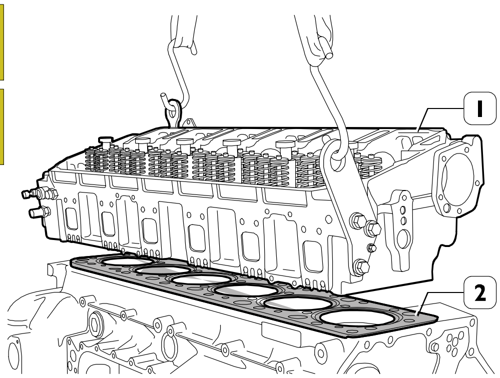


60564

Key on the gasket (1), mount the key 99346250 (2) and, screwing down the nut (3), drive in the gasket (1).

Mounting cylinder head

Figure 57

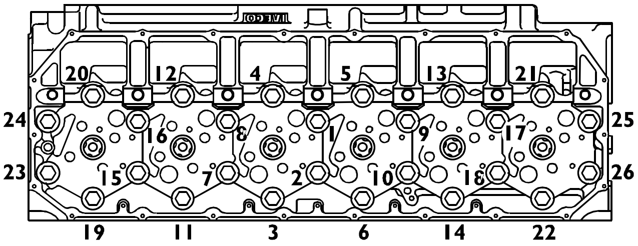


60515

Check that the pistons 1-6 are exactly at the T.D.C.
Put the gasket (2) on the crankcase.
Mount the cylinder head (1) and tighten the screws as shown in Figs. 58, 59 and 60.

NOTE Lubricate the thread of the screws with engine oil before assembly.

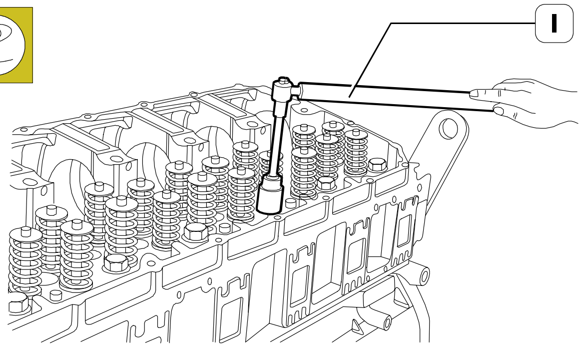
Figure 58



61270

Diagram of the tightening sequence of the screws fixing the cylinder head.

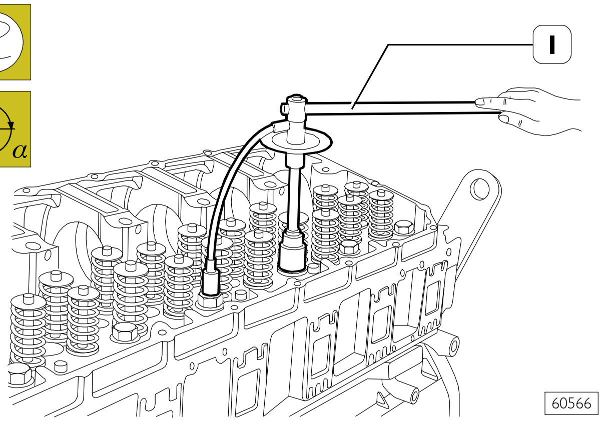
Figure 59



60565

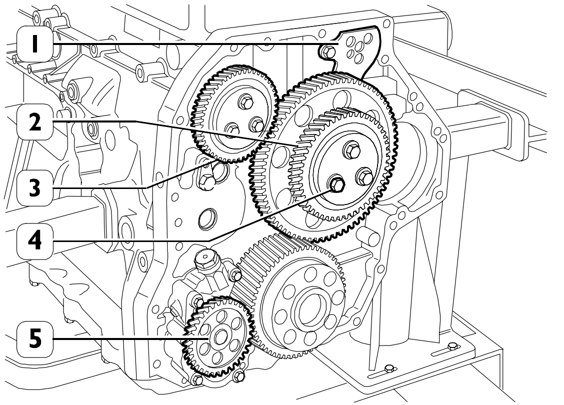
☐ Pre-tightening with the torque wrench (1):
1st phase: 60 Nm (6 kgm).
2nd phase: 120 Nm (12 kgm).

Figure 60



☐ Closing to angle with tool 99395216 (1):
3rd phase: angle of 90°
4th phase: angle of 65°.

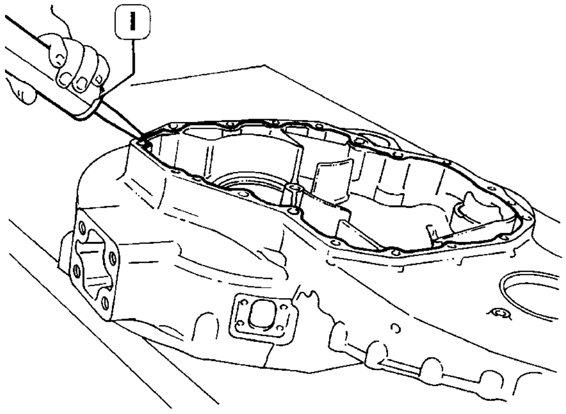
Figure 61



Mount the oil pump (5), the middle gears (2) together with the link rod (1) and the PTO driving gear (3).
Tighten the screws (4) to the required torque.

Fitting flywheel box

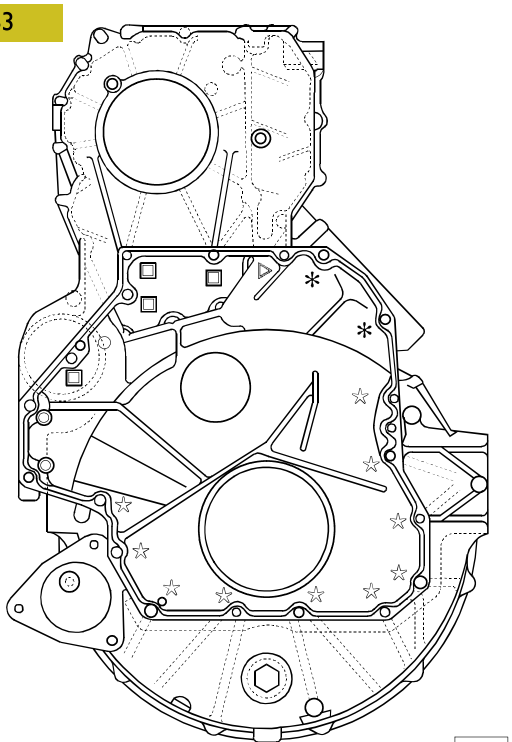
Figure 62



Apply LOCTITE 5970 IVECO No. 2995644 silicone on the gearbox using appropriate tools (1) as shown in the figure.

NOTE Mount the gearbox within 10 min. of applying the sealant.

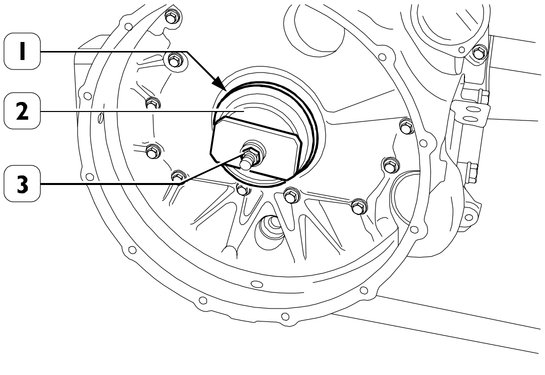
Figure 63



Using a torque wrench, tighten the highlighted screws with the following sequence and torque:

✡	10 screws M12 × 1.75 × 100	56 to 70 Nm
◎	2 screws M12 × 1.75 × 70	56 to 70 Nm
☐	4 screws M12 × 1.75 × 35	56 to 70 Nm
△	1 screw M12 × 1.75 × 120	56 to 70 Nm
✻	2 screws M12 × 1.75 × 193	56 to 70 Nm

Figure 64

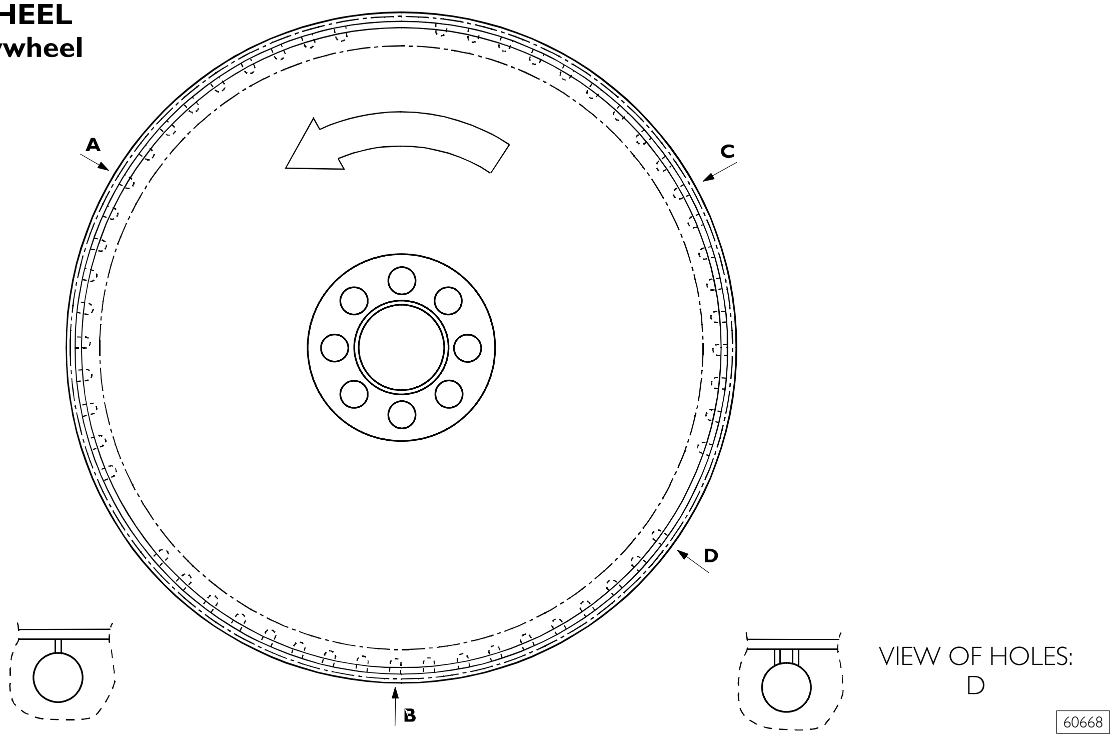


Key on the gasket (1), fit the key 99346251 (2) and, screwing down the nut (3), drive in the gasket.

ENGINE FLYWHEEL

Fitting engine flywheel

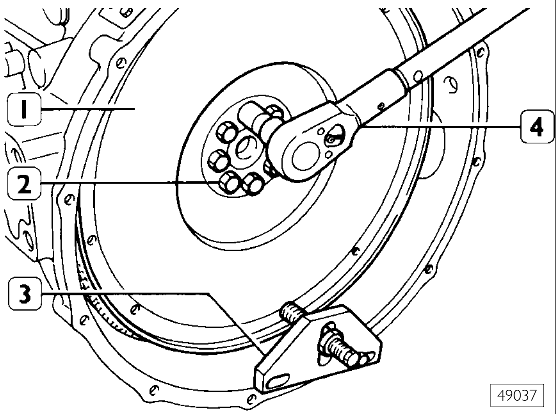
Figure 65



DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS
A. Hole on flywheel with one reference mark, corresponding to the TDC of pistons 3-4. - B. Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6. - C. Hole on flywheel with one reference mark, corresponding to the TDC of pistons 2-5. - D. Hole on flywheel with two reference marks, position corresponding to 54°.

NOTE If the teeth of the ring gear mounted on the engine flywheel, for starting the engine, are very damaged, replace the ring gear. It must be fitted after heating the ring gear to a temperature of approx. 200°C.

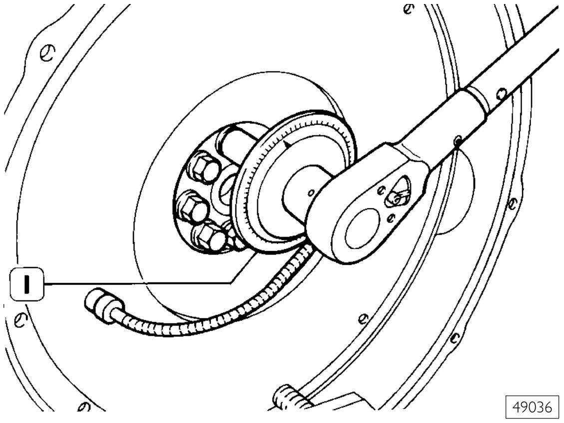
Figure 66



NOTE The crankshaft has a locating peg that has to couple with the relevant seat on the engine flywheel.

Position the flywheel (1) on the crankshaft, lubricate the thread of the screws (2) with engine oil and screw them down. Lock rotation with tool 99360351 (3). Lock the screws (2) in three phases.
First phase: pre-tightening with torque wrench (4) to a torque of 120 Nm (12 kgm).

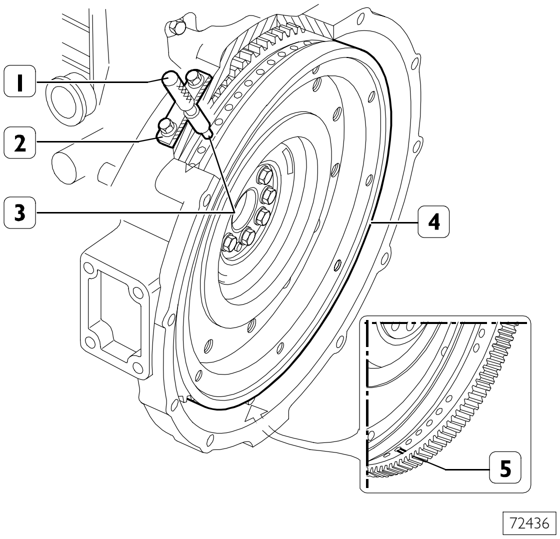
Figure 67



Second phase: closing to angle of 90° with tool 99395216 (1).

Fitting camshaft

Figure 68



Position the crankshaft with the pistons 1 and 6 at the top dead centre (T.D.C.).

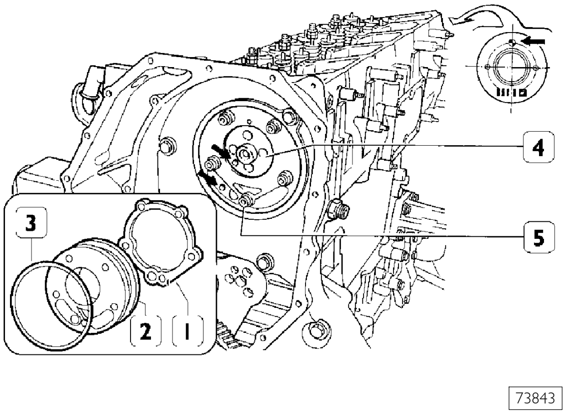
This situation occurs when:

1. The hole with reference mark (5) of the engine flywheel (4) can be seen through the inspection window.
2. The tool 99360612 (1), through the seat (2) of the engine speed sensor, enters the hole (3) in the engine flywheel (4).

If this condition does not occur, turn the engine flywheel (4) appropriately.

Remove the tool 99360612 (1).

Figure 69

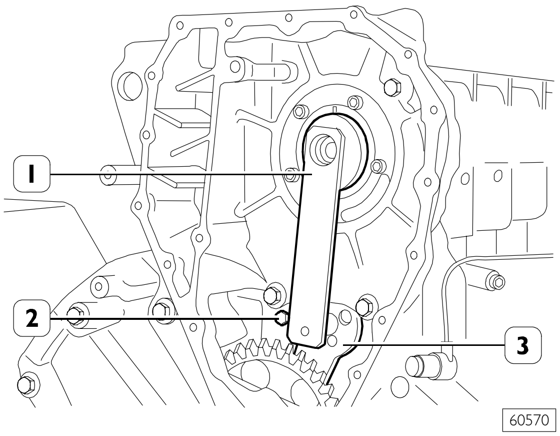


Fit the camshaft (4), positioning it observing the reference marks (→) as shown in the figure.

Lubricate the seal (3) and fit it on the shoulder plate (2).

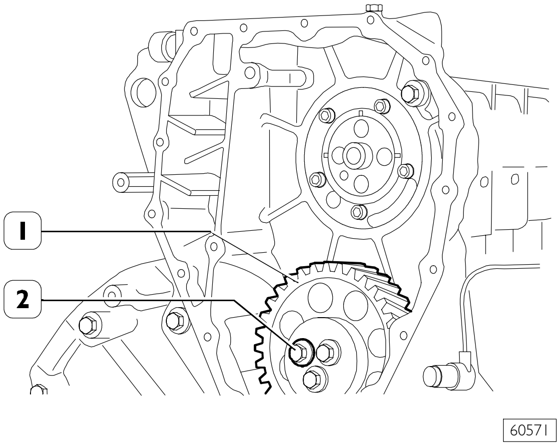
Mount the shoulder plate (2) with the sheet metal gasket (1) and tighten the screws (5) to the required torque.

Figure 70



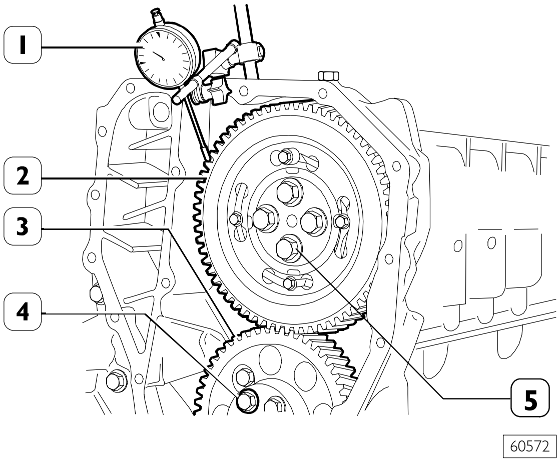
☐ Apply the gauge 99395219 (1). Check and adjust the position of the link rod (3) for the idle gear. Lock the screw (2) to the required torque.

Figure 71



☐ Fit the idle gear (1) back on and lock the screws (2) to the required torque.

Figure 72



Position the gear (2) on the camshaft so that the 4 slots are centred with the holes for fixing the camshaft, without fully locking the screws (5).
Using the dial gauge with a magnetic base (1), check that the clearance between the gears (2 and 3) is 0.074 – 0.195 mm; if this is not so, adjust the clearance as follows:

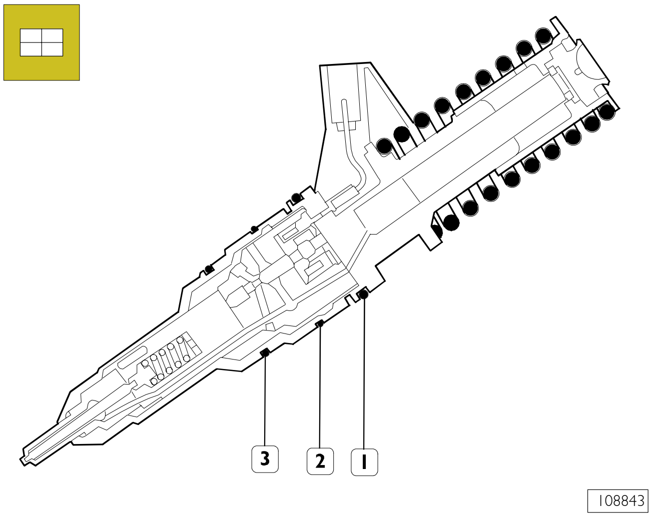
❑ Loosen the screws (4) fixing the idle gear (3).

❑ Loosen the screw (2, Figure 70) fixing the link rod. Shift the link rod (3, Figure 70) to obtain the required clearance.

❑ Lock the screw (2, Figure 70) fixing the link rod and screws (4, Figure 72) fixing the idle gear to the required torque.

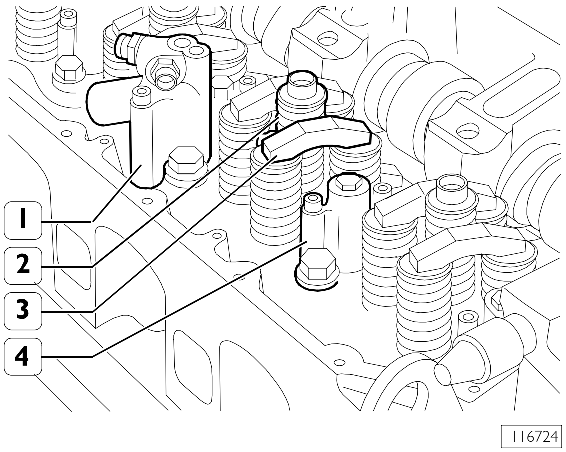
Fitting pump-injectors

Figure 73



Fit the seals (1) (2) (3) on the injectors.

Figure 74



Mount:

❑ The injectors (2) and, using a torque wrench, lock the bracket fixing screws to a torque of 30 ÷ 35 Nm.

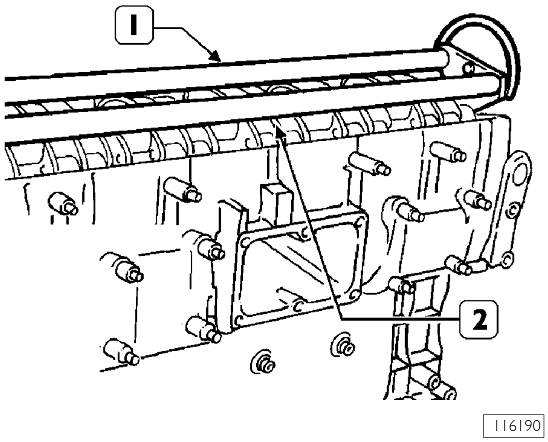
❑ The exhaust brake cylinders (1) and (4) and, using a torque wrench, fix them to a torque of 19 Nm.

❑ The crosspieces (3) on the valve stem, all with the largest hole on the same side.

Fitting rocker-arm shaft assembly

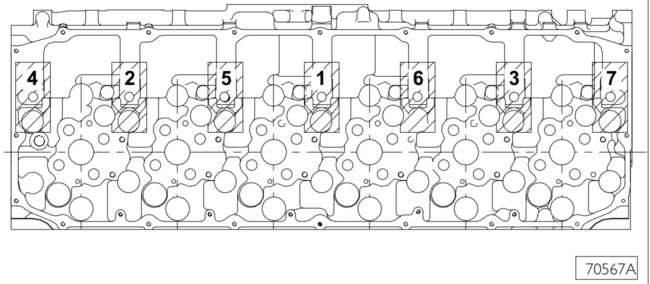
NOTE Before refitting the rocker-arm shaft assembly, make sure that all the adjustment screws have been fully unscrewed.

Figure 75



Apply the tool 99360553 (1) to the rocker arm shaft (2) and mount the shaft on the cylinder head.

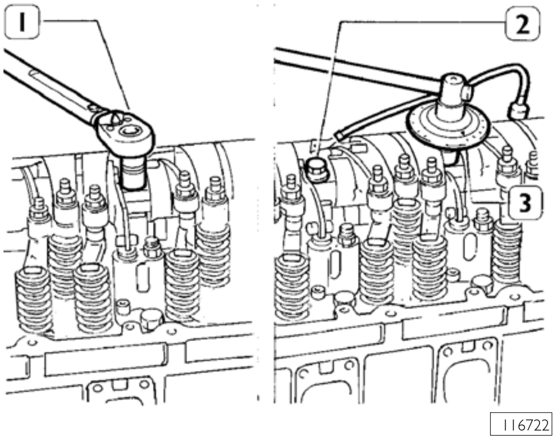
Figure 76



SCHEME OF SCREW TIGHTENING SEQUENCE SECURING ROCKER ARMS

Screw screws (1 - 2 - 3) until rocker arms are brought to contact relating seats on cylinder head, tighten the screws according to sequence indicated in figure operating in two steps as indicated in successive figure.

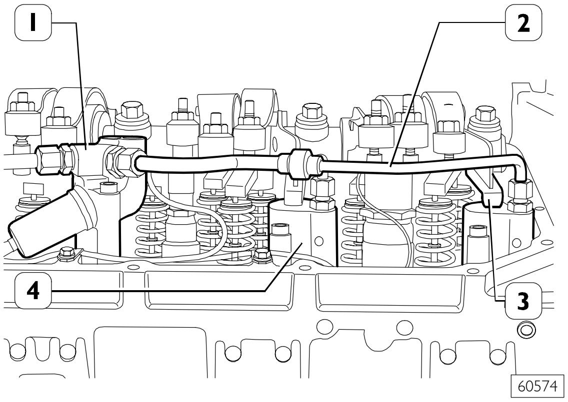
Figure 77



Lock the screws (2) fixing the rocker-arm shaft as follows:

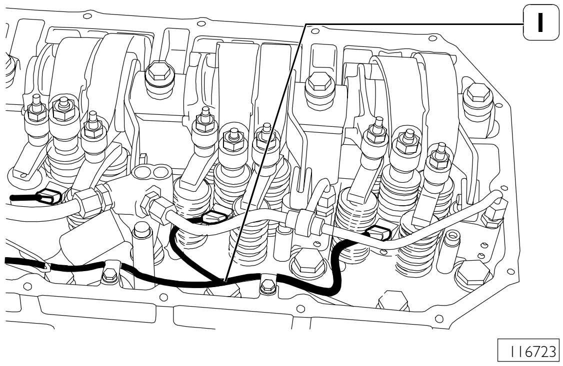
- 1st phase: tightening to a torque of 80 Nm (8 kgm) with the torque wrench (1).
- 2nd phase: closing with an angle of 60° using the tool 99395216 (3).

Figure 78



- Mount the engine brake lever retaining springs (3).
- Connect the pipe (2) to the engine brake cylinders (4) and to the cylinder with the engine brake solenoid valve (1).

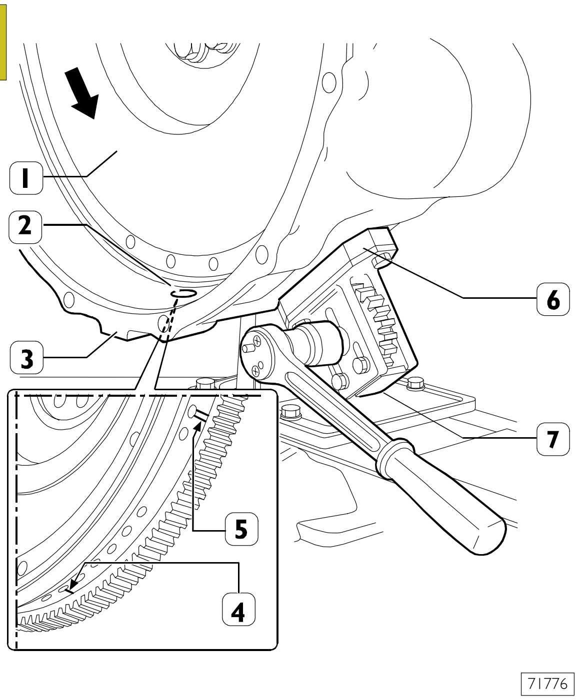
Figure 79



Mount the electric wiring (1).

Camshaft timing

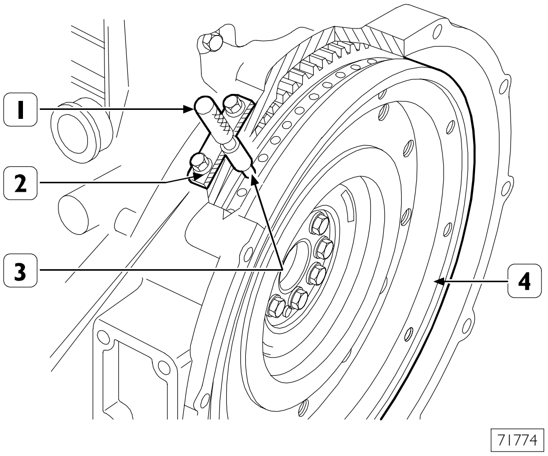
Figure 80



Apply tool 99360321 (7) and spacer (6) to gears box (3).

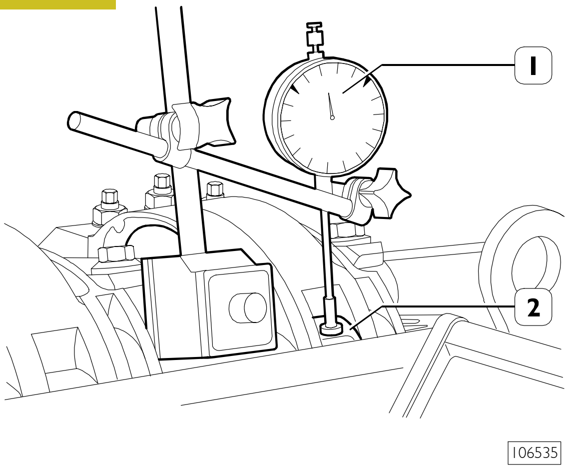
NOTE The arrow shows the direction of rotation of the engine when running.
Using the above-mentioned tool, turn the engine flywheel (1) in the direction of rotation of the engine so as to take the piston of cylinder no.1 to approximately the T.D.C. in the phase of combustion.
This condition occurs when the hole with one reference mark (4), after the hole with two reference marks (5) on the engine flywheel (1), can be seen through the inspection window (2).

Figure 81



The exact position of piston no.1 at the T.D.C. is obtained when in the above-described conditions the tool 99360612 (1) goes through the seat (2) of the engine speed sensor into the hole (3) in the engine flywheel (4).
If this is not the case, turn and adjust the engine flywheel (4) appropriately.
Remove the tool 99360612 (1).

Figure 82



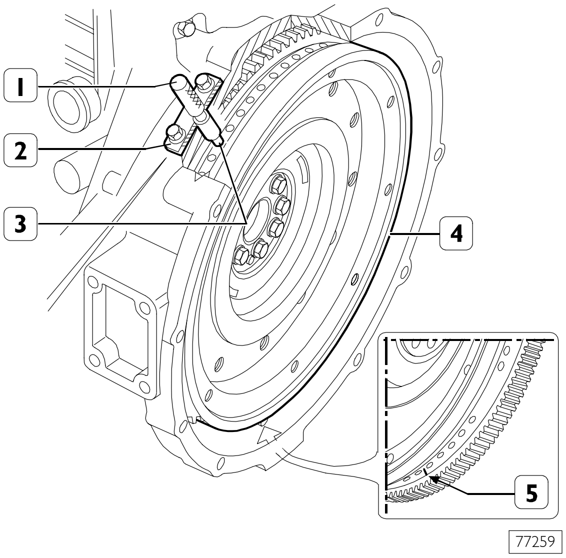
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

With tool 99360321 (7, Figure 80), turn the crankshaft clockwise until the pointer of the dial gauge reaches the minimum value beyond which it can no longer fall.

Reset the dial gauge.

Turn the engine flywheel anticlockwise until the dial gauge gives a reading for the lift of the cam of the camshaft of 5.33±0.05 mm.

Figure 83

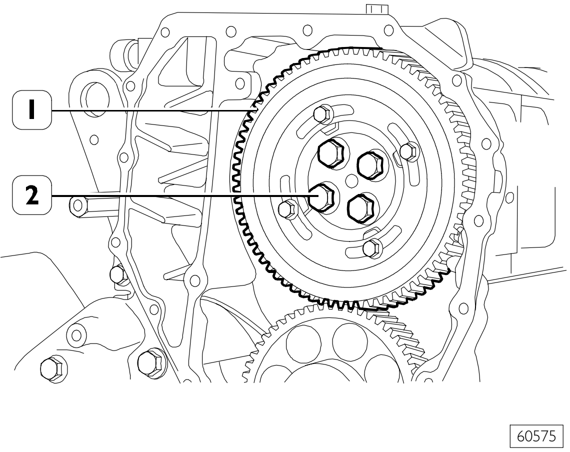


The camshaft is in step if at the cam lift values of 5.33±0.05 mm there are the following conditions:

1) a notch (5) can be seen through the inspection window;

2) the tool 99360612 (1) through the seat (2) of the engine speed sensor goes into the hole (3) in the engine flywheel (4).

Figure 84



If you do not obtain the conditions illustrated in Figure 83 and described in points 1 and 2, proceed as follows:

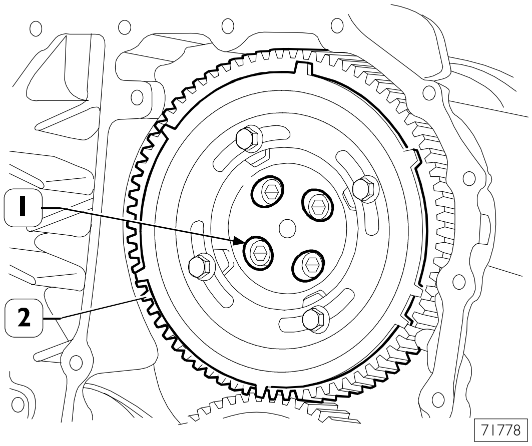
1) loosen the screws (2) securing the gear (1) to the camshaft and utilize the slots on the gear (1, Figure 85);

2) turn the engine flywheel appropriately so as to bring about the conditions described in points 1 and 2 Figure 83, it being understood that the cam lift must not change at all;

3) lock the screws (2) and repeat the check as described above;

4) tighten the screws (2) to the required torque.

Figure 85



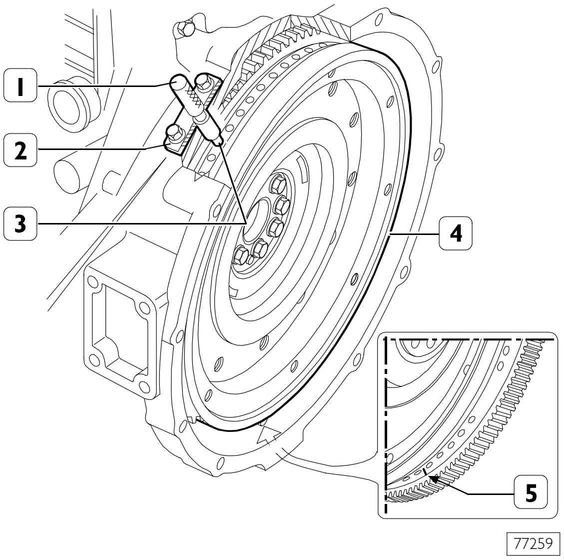
When the adjustment with the slots (1) is not enough to make up the phase difference and the camshaft turns because it becomes integral with the gear (2); as a result, the reference value of the cam lift varies, in this situation it is necessary to proceed as follows:

1) lock the screws (2, Figure 84) and turn the engine flywheel clockwise by approx. 1/2 turn;

2) turn the engine flywheel anticlockwise until the dial gauge gives a reading of the lift of the cam of the camshaft of 5.33 ±0.05 mm;

3) take out the screws (2, Figure 84) and remove the gear (2) from the camshaft.

Figure 86



Turn the flywheel (4) again to bring about the following conditions:

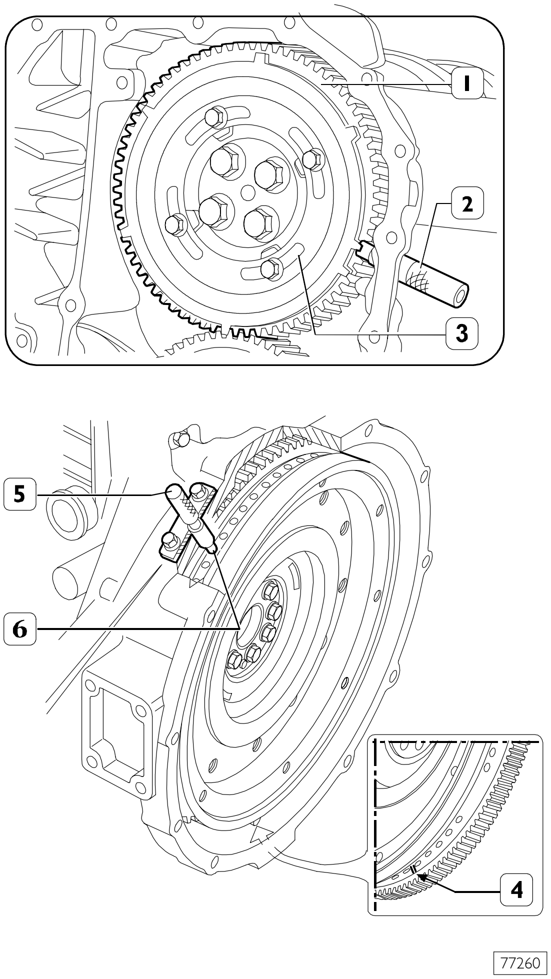
☐ a notch (5) can be seen through the inspection window;

☐ the tool 99360612 (1) inserted in the hole (3) in the engine flywheel (4) through the seat (2) of the engine speed sensor.

Mount the gear (2, Figure 85) with the 4 slots (1, Figure 85) centred with the fixing holes of the camshaft, locking the relevant screws to the required tightening torque.
Check the timing of the shaft by first turning the flywheel clockwise to discharge the cam completely and then turn the flywheel anticlockwise until the dial gauge gives a reading of 5.33 ±0.05 mm.
Check the timing conditions described in Figure 83.

Phonic wheel timing

Figure 87



Turn the crankshaft by taking the piston of cylinder no. 1 into the compression phase at T.D.C.; turn the flywheel in the opposite direction to the normal direction of rotation by approximately 1/4 of a turn.

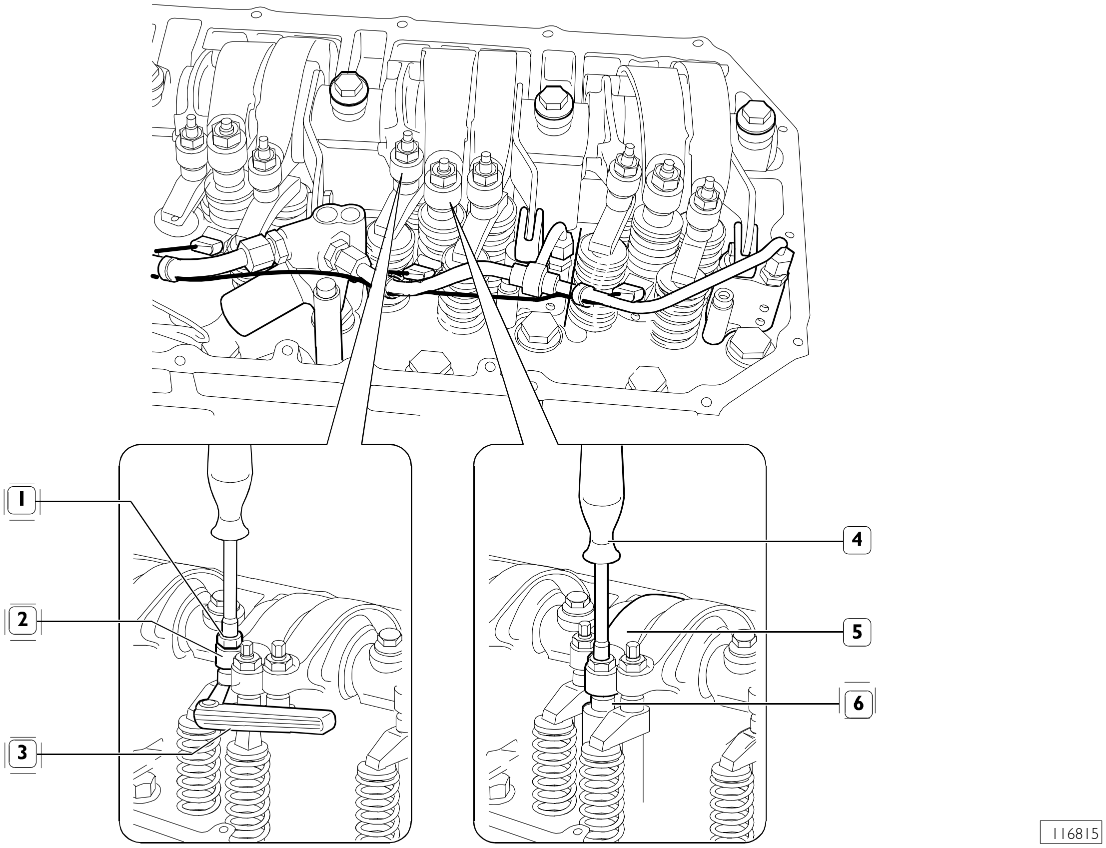
Again turn the flywheel in its normal direction of rotation until you see the hole marked with the double notch (4) through the inspection hole under the flywheel housing. Insert tool 99360612 (5) into the seat of the flywheel sensor (6).

Insert the tool 99360613 (2), via the seat of the phase sensor, onto the tooth obtained on the phonic wheel.

Should inserting the tool (2) prove difficult, loosen the screws (3) and adjust the phonic wheel (1) appropriately so that the tool (2) gets positioned on the tooth correctly. Go ahead and tighten the screws (3).

Intake and exhaust rocker play adjustment and pre-loading of rockers controlling pump injectors

Figure 88



ADJUSTING INTAKE/EXHAUST ROCKERS AND INJECTION

Adjustment of clearances between rockers and valve studs and preloading of pump injector rockers should be carried out with extreme care.
Bring the cylinder under examination to the firing stage, the valves of this cylinder remain closed while the valves of the other cylinder in the pair can be adjusted.
The cylinder pairs are 1-6,2-5,3-4.
Strictly adhere to directions and data given on the table below.

Adjusting clearances between rockers and intake/exhaust/valve studs:

- ☐ Use a box wrench to loosen the adjusting screw locking nut (1).
- ☐ Insert the feeler gauge blade (3).
- ☐ By using proper wrench, screw or unscrew rocker arm adjusting screw (2);
- ☐ Ensure the feeler gauge blade (3) can slide between the parts concerned with a slight friction.
- ☐ Hold the screw still while tightening the nut (1).

Setting pump-injector rocker preloading:

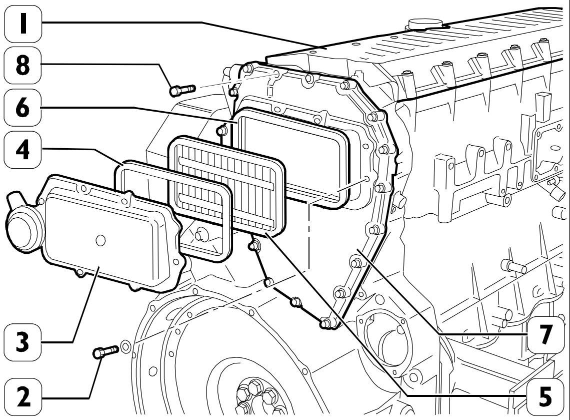
- ☐ Use a box wrench to loosen the nut fastening the adjusting screw for rocker arm (5) controlling pump-injector (6).
- ☐ With a suitable wrench (4) tighten the adjusting screw until the pumping element reaches its-end-of-stroke point.
- ☐ Lock the adjusting screw to a torque of 5 Nm (0.5 kgm) by means of a torque wrench.
- ☐ Back off the adjusting screw 1/2 to 3/4 turn.
- ☐ Tighten the lock nut.

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

Clockwise start-up and rotation	Adjusting cylinder valve no.	Adjusting clearance of cylinder valve no.	Adjusting pre-loading of cylinder injector no.
1 and 6 at TDC	6	1	5
120°	3	4	1
120°	5	2	4
120°	1	6	2
120°	4	3	6
120°	2	5	3

NOTE In order to properly carry out the above-mentioned adjustments, follow the sequence specified in the table, checking the exact position in each rotation phase by means of pin 99360612, to be inserted in the 11th hole in each of the three sectors with 18 holes each.

Figure 89



85480

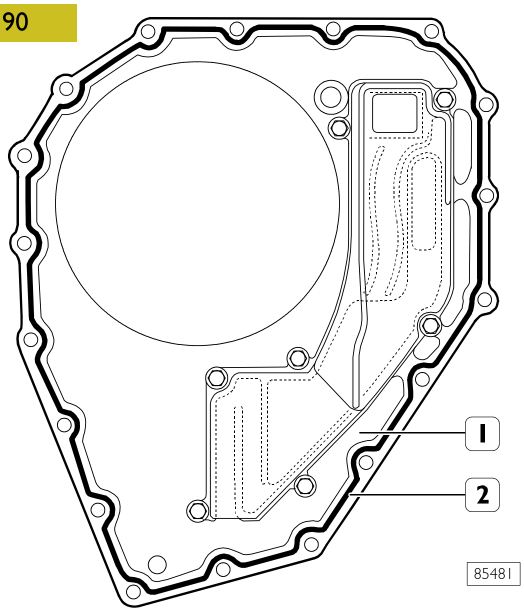
Fit the distribution cover (1).
Fit the blow-by case (7) and its gasket and then tighten the screws (8) to the prescribed torque.
Install the filter (5) and the gaskets (4 and 6).

NOTE The filter (5) operation is unidirectional, therefore it must be assembled with the two sight supports as illustrated in the figure.

Fit the cover (3) and tighten the fastening screws (2) to the prescribed torque.

NOTE Apply silicone LOCTITE 5970 (IVECO No. 2995644) on the blow-by case (7) surface of engines fitted with P.T.O. according to the procedure described in the following figure.

Figure 90

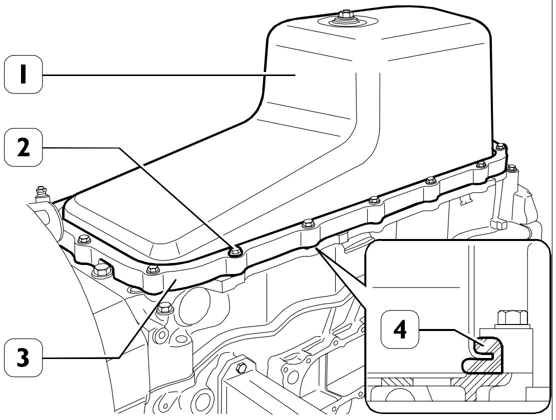


85481

Apply silicone LOCTITE 5970 (IVECO No. 2995644) on the blow-by case and form a string (2) of Ø 1,5 ±, $^{0.5}_{0.2}$ as shown in the figure.

NOTE Fit the blow-by case (1) within 10' from sealer application.

Figure 91



60665

Turn engine and mount oil rose pipe.
Arrange gasket (4) on oil sump (1), position spacer (3) and mount the sump on engine block screwing up screws (2) at prescribed torque:

Completing Engine Assembly

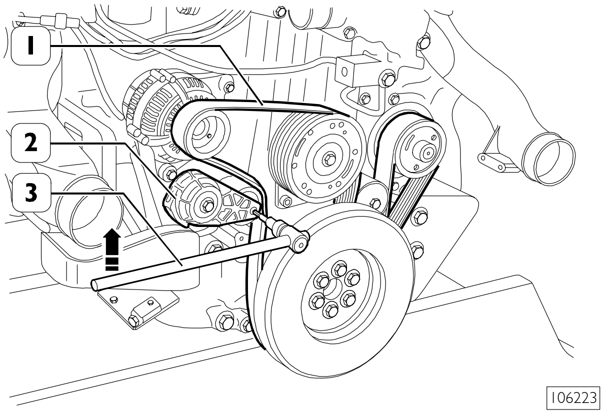
Complete the engine by fitting or hooking up the following parts:

☐ power take-off (P.T.O., if present) and relating pipes;
☐ fuel pump;
☐ support complete with fuel filter and pipes;
☐ EDC central unit;
☐ intake manifold;
☐ preheating resistance;
☐ heat exchanger;
☐ oil filters, lubricating the gasket;
☐ exhaust manifold;
☐ turbocompressor and relating water and oil pipes;
☐ pulley and damping flywheel;
☐ thermostat assembly;
☐ belt tensioner, water pump, alternator;
☐ electromagnetic joint;
☐ belt tensioner, if present, air-conditioner compressor;
☐ starter;
☐ oil level rod;
☐ electrical connections and sensors.

NOTE The fittings of the cooling water and lubricating oil pipes of the turbocharger have to be tightened to a torque of:

☐ 35 ±5 Nm, water pipe fittings;
☐ 55 ±5 Nm, oil pipe female fitting;
☐ 20-25 Nm, oil pipe male fitting.

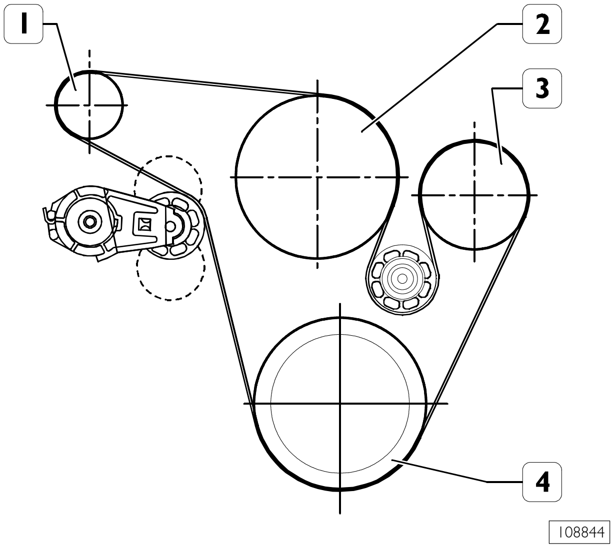
Figure 92



☐ driving belt.

To mount belt (1), belt tensioner (2) has to be operated by proper tooling (3) according to the direction indicated by the arrow in Figure.

Figure 93



ASSEMBLY DIAGRAM OF FAN – WATER PUMP – ALTERNATOR DRIVE BELT

1. Alternator – 2. Electromagnetic coupling – 3. Water pump – 4. Crankshaft

NOTE Belt tensioner is of automatic type; therefore, further adjusting is not provided after mounting.

☐ refuel engine with provided oil quantity;

☐ dismount engine from rotary stand and take off brackets (99361036) securing the engine.

Mount:

☐ oil pressure regulation valve;

☐ engine left support;

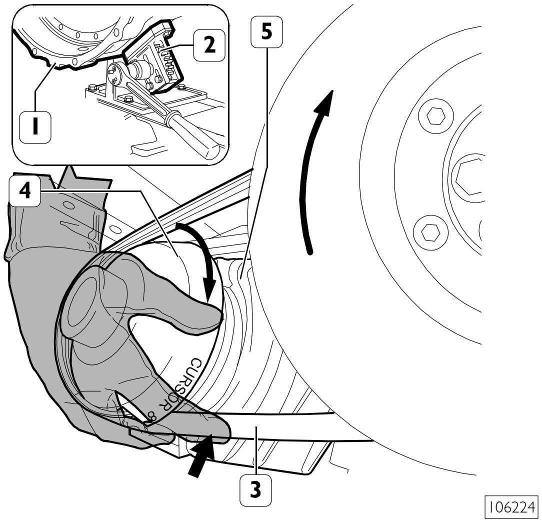
☐ air compressor complete with hydraulic guide pump;

☐ sound deadening guard;

☐ pipes.

☐ if present, climate control system compressor driving belt similarly to belt (1, Figure 92);

Figure 94



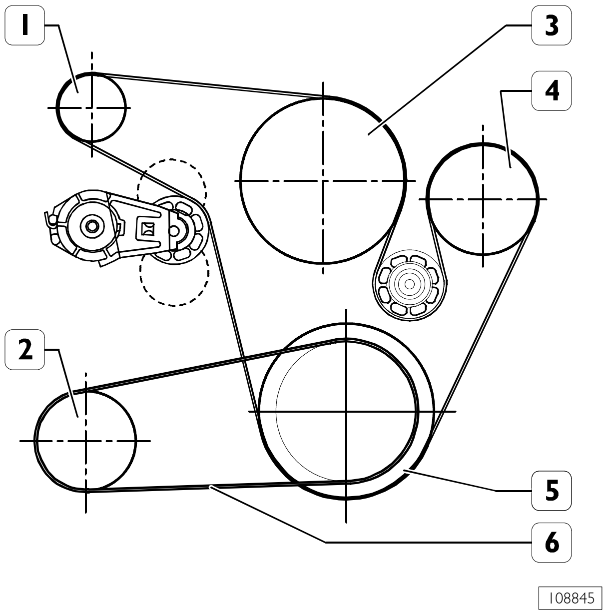
NOTE In the case of engines with climate control system compressor spring driving belt, for mounting the belt, tool 99360192 (4) must be used. Different methods may cause tensions impairing spring belt.

Apply tool 99360321 (2) provided with spacer 99360325 to gears box (1).
Mount spring belt (3) on driving shaft pulley, mount chock 99360192 (4) on compressor pulley (5) for climate control system. Position spring belt (3) in the opening of tool 99360192 marked with "cursor 10/13".
By tool 99360321 (2), rotate driving shaft according to the direction of the arrow (→) until spring belt (3) is correctly positioned on compressor pulley (5).

NOTE While operating, keep tool 99360192 (4) in contact to pulley and at the same time guide spring belt (3) in order to prevent it from twisting.

NOTE Spring belt must be replaced by a new one after every dismounting operation.

Figure 95

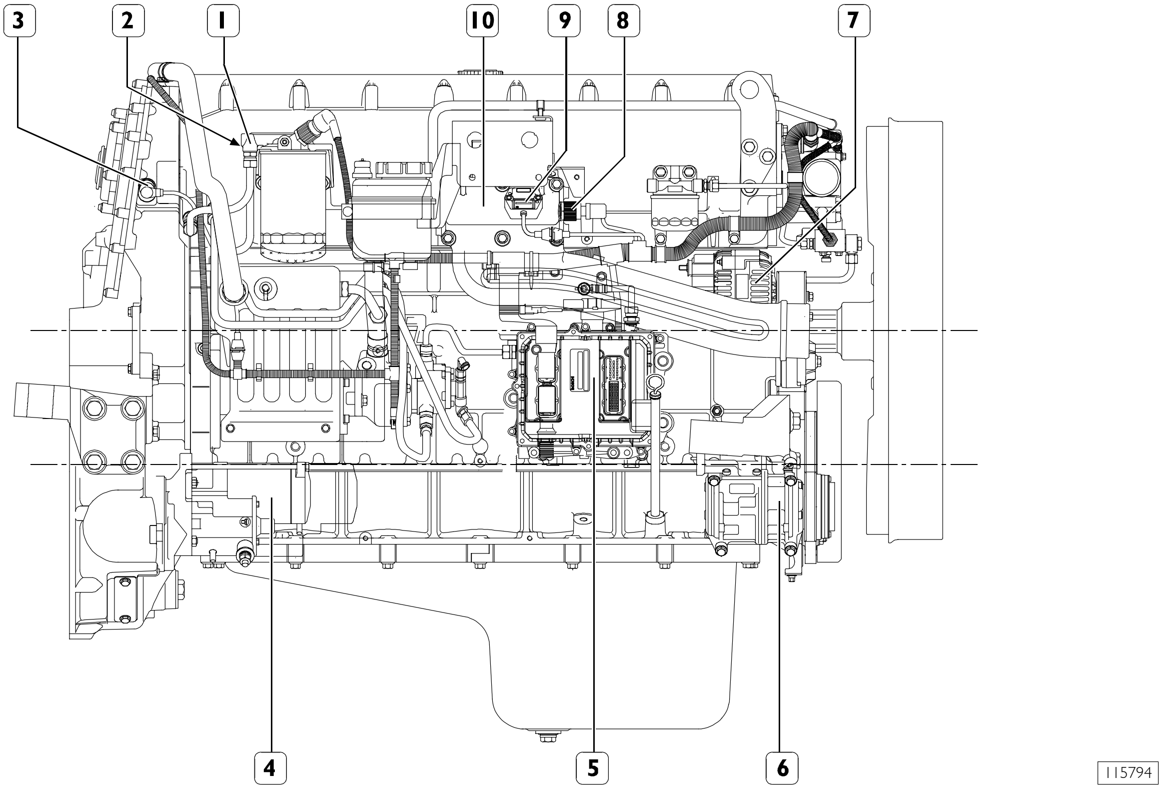


COMPRESSOR CONTROL BELT
ASSEMBLY DIAGRAM
1. Alternator – 2. Climate control system compressor – 3. Electromagnetic coupling – 4. Water pump – 5. Crankshaft – 6. Spring belt.

PART TWO -
ELECTRICAL EQUIPMENT

Components on the engine F3B

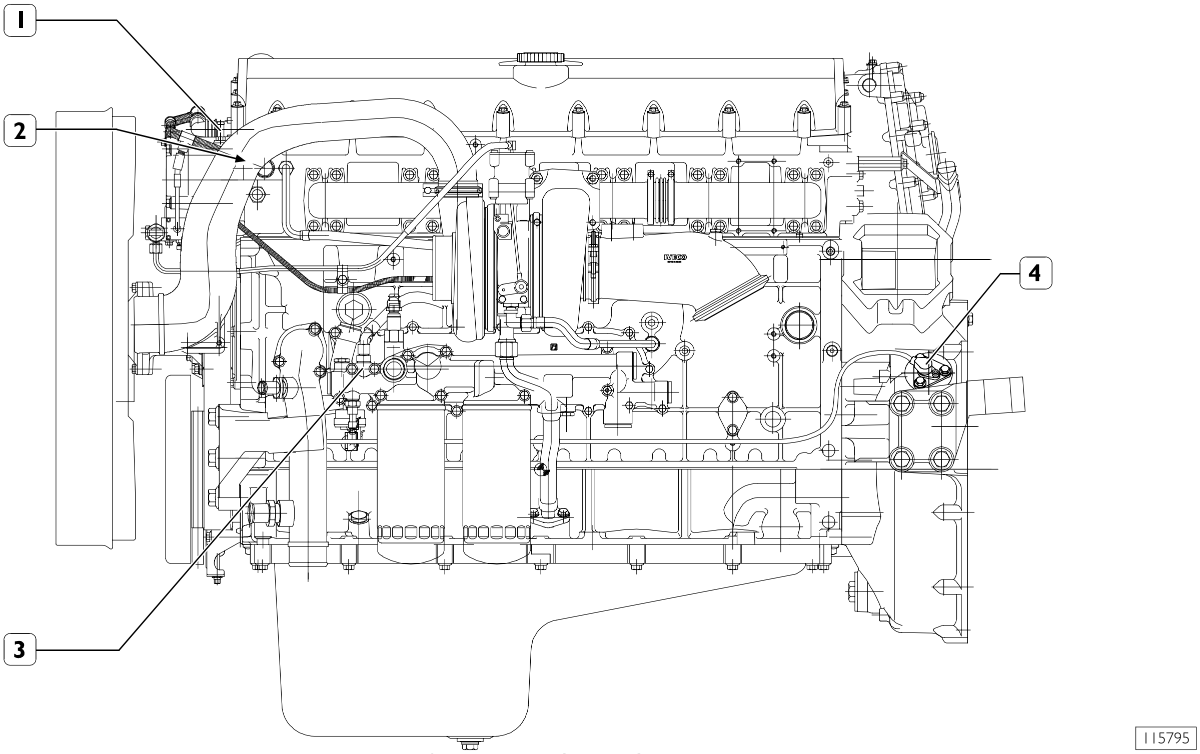
Figure 1 (Demonstration)



RIGHT SIDE VIEW OF ENGINE

1. Water detection sensor diesel fuel filter clogged - 2. Fuel temperature sensor - 3. Sensor for engine revs on distribution shaft - 4. Starter - 5. EDC7 UC31 Control Unit - 6. Air conditioner compressor - 7. Alternator - 8. Engine input air temperature sensor - 9. Boost pressure sensor - 10. Resistance for engine preheating.

Figure 2 (Demonstration)

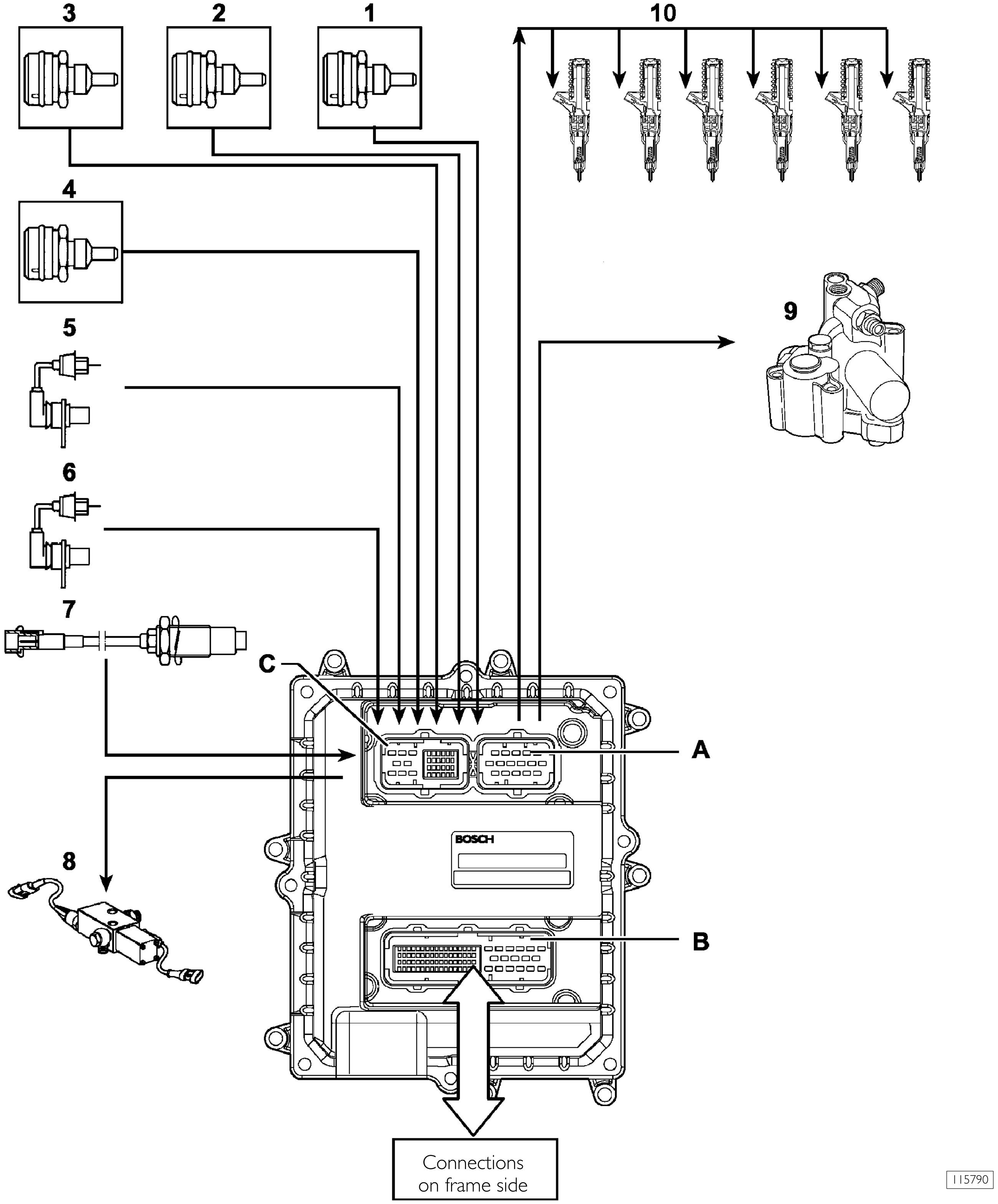


LEFT SIDE VIEW OF ENGINE

1. Connector on engine head for connection with injectors solenoid valve - 2. Water temperature sensor - 3. Engine oil temperature/pressure sensor - 4. Sensor for engine revs on flywheel.

BLOCK DIAGRAM

Figure 3



KEYS
1. Solenoid valve for variable geometry control - 2. Engine oil pressure/temperature sensor - 3. Fuel temperature sensor - 4. Coolant temperature sensor - 5. Distribution sensor - 6. Flywheel sensor - 7. Turbine revs sensor - 8. Solenoid valve for VGT control - 9. Engine brake solenoid valve - 10. Pump injectors.

EDC SYSTEM FUNCTIONS

The EDC7 UC31 electronic center manages the following main functions:

Fuel injection
Accessory functions such as cruise control, speed limiter, PTO and the like
Self-diagnosis
Recovery

It also enables:

Interfacing with other electronic systems (if any) available on the vehicle
Diagnosis

Fuel dosing

Fuel dosing is calculated based on:
- accelerator pedal position
- engine rpm
- quantity of air admitted.

The result can be corrected based on:
- water temperature

or to prevent:
- noise
- fumes
- overloads
- overheating

Pressure can be adjusted in case of:
- engine brake actuation
- external device actuation (e.g. speed reducer, cruise control)
- serious defects involving load reduction or engine stop.

After determining the mass of air introduced by measuring its volume and temperature, the center calculates the corresponding mass of fuel to be injected into the cylinder involved, with account also taken of gas oil temperature.

Delivery correction based on water temperature

When cold, the engine encounters greater operating resistance, mechanical friction is high, oil is till very viscous and operating plays are not optimized yet.
Fuel injected also tends to condense on cold metal surfaces.
Fuel dosing with a cold engine is therefore greater than when hot.

Delivery correction to prevent noise, fumes or overloads

Behaviors that could lead to the defects under review are well known, so the designer has added specific instructions to the center to prevent them.

De-rating

In the event of engine overheating, decreasing delivery proportionally to the temperature reached by the coolant changes injection.

Turbine rpm regulation

Turbine speed is constantly regulated and rectified, if necessary, by operating on geometry variation.

Injection lead electronic control

Injection lead, or the start of fuel delivery expressed in degrees, can differ from one injection to the next, even from one cylinder to another and is calculated similarly to delivery according to engine load, namely, accelerator position, engine rpm and air admitted.
Lead is corrected as required:

- during acceleration
- according to water temperature

and to obtain:

- reduced emissions, noise abatement and no overload
- better vehicle acceleration

High injection lead is set at start, based on water temperature.
Delivery start feedback is given by injection electro valve impedance variation.

Engine start

Cylinder 1 step and recognition signal synchronization (flywheel and drive shaft sensors) takes place at first engine turns. Accelerator pedal signal is ignored at start. Star delivery is set exclusively based on water temperature, via a specific map. The center enables the accelerator pedal, when it detects flywheel acceleration and rpm such as to consider the engine as started and no longer drawn by the starter motor.

Cold start

Pre-post reheating is activated when even only one of the three water, air or gas oil temperature sensors records a temperature of below 10 °C. The pre-heat warning light goes on when the ignition key is inserted and stays on for a variable period of time according to temperature, while the intake duct input resistor heats the air, then starts blinking, at which point the engine can be started.
The warning light switches off with the engine revving, while the resistor continues being fed for a variable period of time to complete post-heating. The operation is cancelled to avoid uselessly discharging the batteries if the engine is not started within 20 ÷ 25 seconds with the warning light blinking. The pre-heat curve is also variable based on battery voltage.

Hot start

On inserting the ignition key the warning light goes on for some 2 seconds for a short test and then switches off when all reference temperatures are above 10 °C. The engine can be started at this point.

Run Up

When the ignition key is inserted, the center transfers data stored at previous engine stop to the main memory (Cf. After run), and diagnoses the system.

After Run

At each engine stop with the ignition key, the center still remains fed by the main relay for a few seconds, to enable the microprocessor to transfer some data from the main volatile memory to an non-volatile, cancelable and rewritable (Eeprom) memory to make tem available for the next start (Cf. Run Up).
These data essentially consists of:

- miscellaneous settings, such as engine idling and the like
- settings of some components
- breakdown memory

The process lasts for some seconds, typically from 2 to 7 according to the amount of data to be stored, after which the ECU sends a command to the main relay and makes it disconnect from the battery.

This procedure must never be interrupted, by cutting the engine off from the battery cutout or disconnecting the latter before 10 seconds at least after engine cutout.

In this case, system operation is guaranteed until the fifth improper engine cutout, after which an error is stored in the breakdown memory and the engine operates at lower performance at next start while the EDC warning light stays on.

Repeated procedure interruptions could in fact lead to center damage.

Cut-off

It refers to the supply cut-off function during deceleration.

Cylinder Balancing

Individual cylinder balancing contributes to increasing comfort and operability.
This function enables individual personalized fuel delivery control and delivery start for each cylinder, even differently between each cylinder, to compensate for injector hydraulic tolerances.
The flow (rating feature) differences between the various injectors cannot be evaluated directly by the control unit. This information is provided by the entry of the codes for every single injector, by means of the diagnosis instrument.

Synchronization search

The center can anyhow recognize the cylinder to inject fuel into even in the absence of a signal from the camshaft sensor.
If this occurs when the engine is already started, combustion sequence is already acquired, so the center continues with the sequence it is already synchronized on; if it occurs with the engine stopped, the center only actuates one electro valve. Injection occurs onside that cylinder within 2 shaft revs at the utmost so the center is only required to synchronize on the firing sequence and start the engine.

In order to reduce the number of connections, and of the cables connecting the injectors, and to consequently reduce the nose on transmitted signal, the central unit is directly mounted on the engine by a heat exchanger enabling its cooling, using spring blocks which reduce vibrations transmitted from engine.

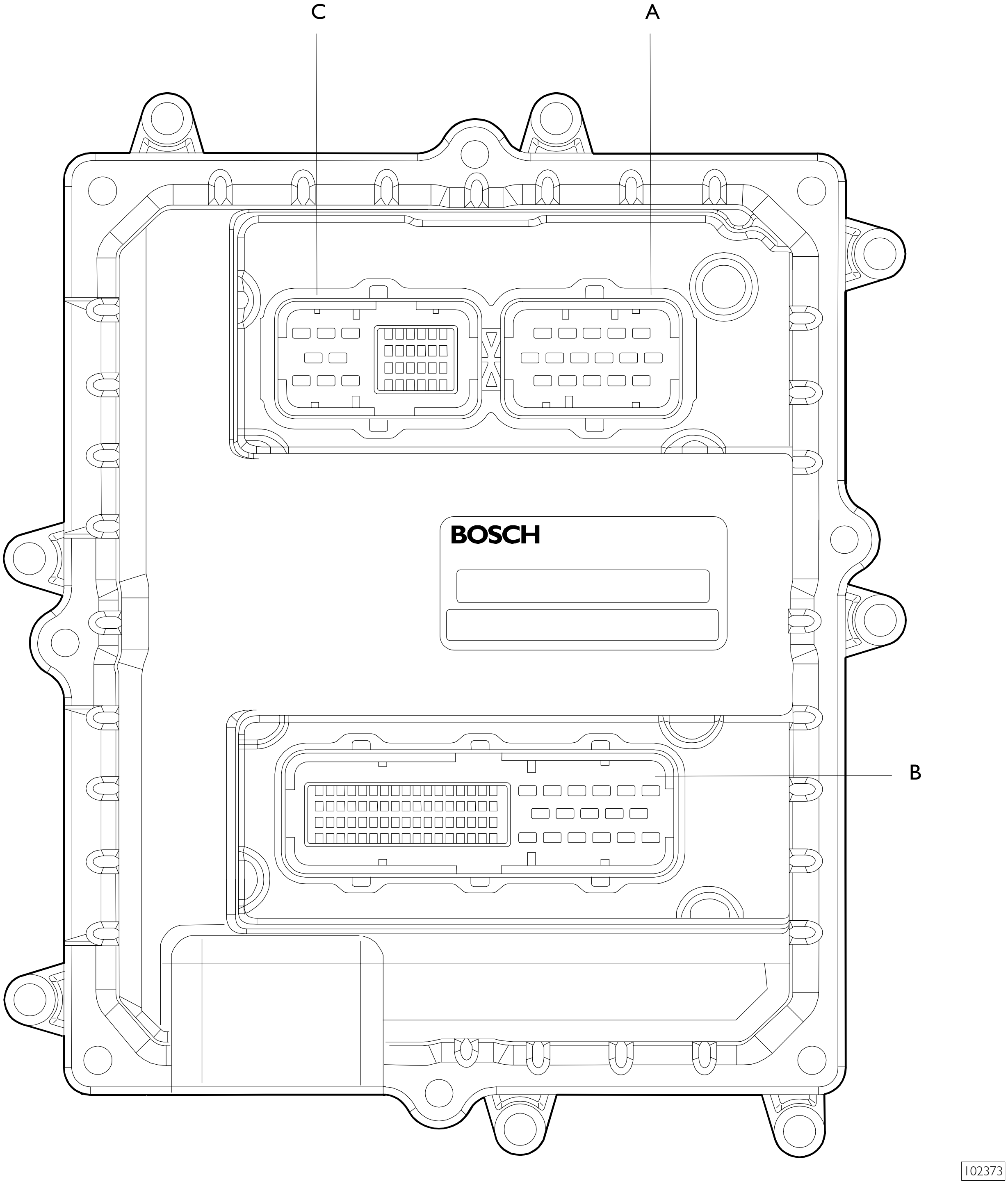
It is connected to vehicle wiring harness by two 35-pole connectors:
connector "A" for components present on the engine
connector "B" for components present on the cab

Internally, there is a pressure ambient sensor use to further improve injection system management.

The central unit is equipped with a much advanced self-diagnosis system and, depending on environmental conditions, is capable to identify and store any faults, even of intermittent type, occurred to the system during vehicle running, ensuring a more correct and reliable repair intervention.

EDC 7 UC31 electronic control unit

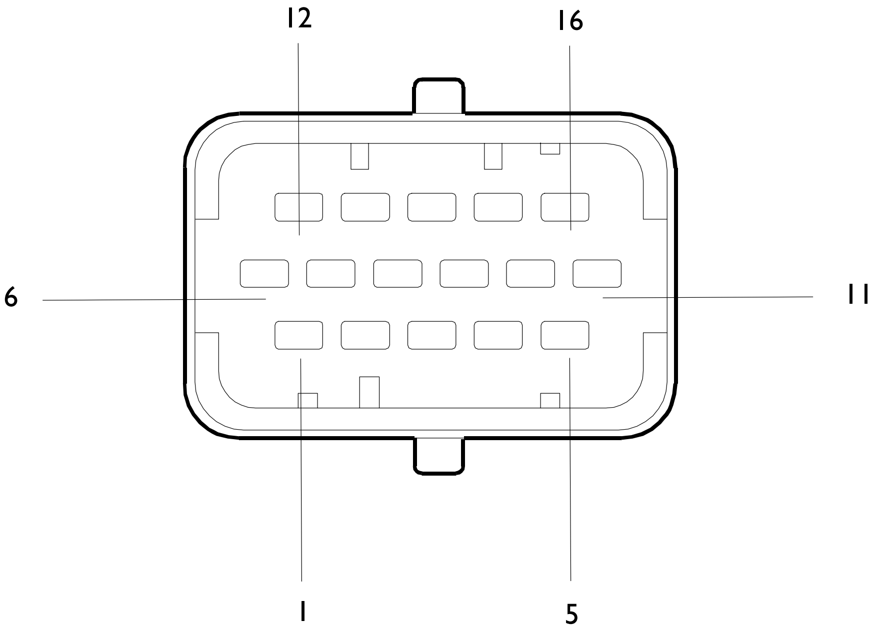
Figure 4



A. Injector connector - B. Chassis connector - C. Sensor connector.

Electric injector connector ”A”

Figure 5



102374

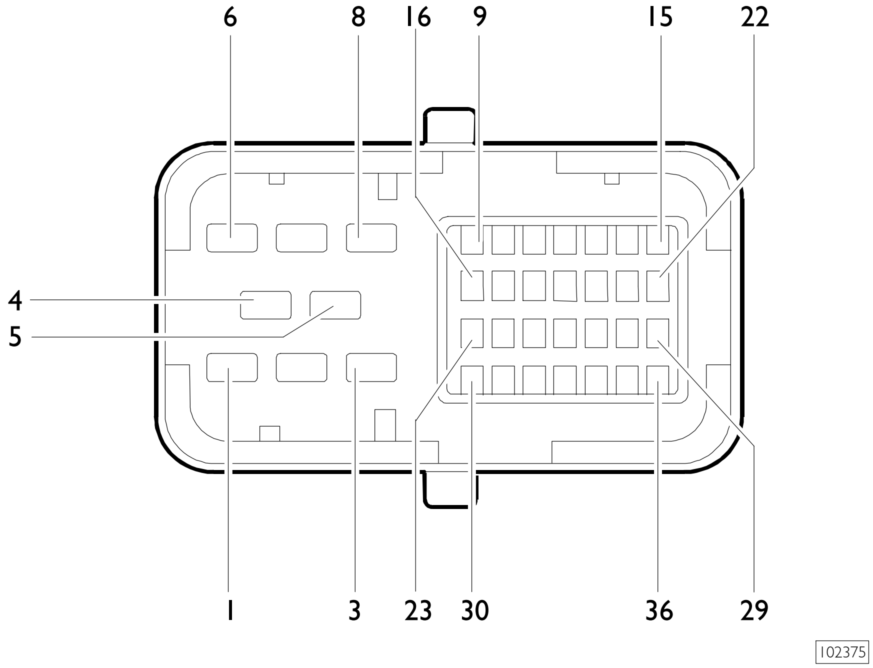
Colour legend

B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange
E	grey
K	pink

ECU Pin	Colour legend	Function
1	-	Free
2	-	Free
3	B	Solenoid valve for electronic cylinder (4-5-6) injection
4	-	Free
5	-	Free
6	W	Solenoid valve for electronic cylinder 2 injection
7	O	Exhaust brake control solenoid valve
8	N	Exhaust brake control solenoid valve
9	-	Free
10	-	Free
11	R	Solenoid valve for electronic cylinder (1-2-3) injection
12	G	Solenoid valve for electronic cylinder 3 injection
13	W	Solenoid valve for electronic cylinder 1 injection
14	U	Solenoid valve for electronic cylinder 4 injection
15	E	Solenoid valve for electronic cylinder 6 injection
16	P	Solenoid valve for electronic cylinder 5 injection

Sensor connector "C"

Figure 6



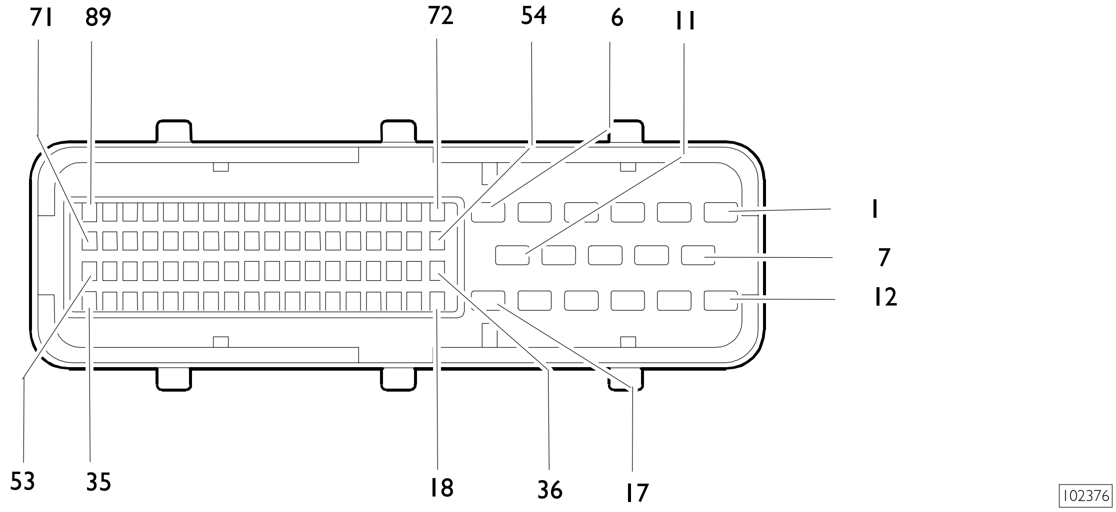
Colour legend

B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange
E	grey
K	pink

ECU Pin	Cable colour	Function
1	N	Solenoid valve for variable geometry turbine control
2	-	Free
3	B	Solenoid valve for variable geometry turbine control
4÷8	-	Free
9	W	Distribution sensor
10	R	Distribution sensor
11÷14	-	-
15	K	Coolant temperature sensor
16	-	Free
17	-	Fuel temperature sensor mass
18	O/B	Fuel temperature sensor
19	B	Flywheel sensor
20	N	Booster speed sensor
21÷22	-	Free
23	W	Flywheel sensor
24	N	Engine oil temperature/pressure sensor ground
25	W	Mass for air pressure / temperature sensor
26	Y	Coolant temperature sensor
27	O/B	Oil pressure signal from engine oil pressure / temperature sensor
28	U	Oil temperature signal from engine oil pressure / temperature sensor
29	-	Free
30	W	Booster speed sensor
31	-	Free
32	O	Engine oil temperature/pressure sensor power supply
33	R	Air temperature/pressure sensor power supply
34	G	Air pressure signal from the air temperature/ pressure sensor
35	W/R	Fuel temperature sensor
36	O	Air temperature signal from the air temperature / pressure sensor

Chassis connector ”B”

Figure 7



ECU pin	FUNCTION
1	Lambda sensor heater signal (*)
2	Positive voltage direct from battery
3	Positive voltage direct from battery
4	Lambda sensor heater supply (*)
5	Battery negative
6	Battery negative
7	Negative voltage for control relay of heater grid control 2 (*)
8	Positive voltage direct from battery
9	Positive voltage direct from battery
10	Battery negative voltage
11	Battery negative voltage
12	Signal from grid on heater 1 (*)
13	Positive voltage +15
14	Positive voltage for air conditioning compressor (*)
15	Signal from air conditioning compressor (*)
16	Negative voltage speed 1 fan
17	Starting relay negative voltage
18	Turbine sensor signal (*)
19	Turbine sensor earth (*)
20	Negative voltage intercooler by-pass valve (*)
21	Supply voltage for switches
22	To diagnostic warning light
23	Additional solenoid valve signal
24	Earth for particle filter temperature sensor (*)
25	Signal for particle filter temperature sensor (*)
26	Intake air humidity and temperature sensor signal
27	Intake air humidity and temperature sensor signal
28	Intake air humidity and temperature sensor earth
30	To diagnostic warning light
31	Cruise control positive signal (*)
32	Negative voltage from engine start switch from engine compartment
33	Tachometer output signal (*)
34	(Low) signal CAN 2 line interface input
35	(High) signal CAN 2 line interface

ECU pin	FUNCTION
36	Negative voltage for fuel filter heater switch (*)
37	Starting relay positive voltage
38	OBD lamp negative voltage (*)
39	Speed limiter lamp negative voltage (*)
40	Positive voltage +15 under lock
41	Positive voltage from main brake switch
42	Negative voltage from sensor detecting water in the pre-filter
43	Signal 1 from Lambda probe (*)
44	Signal 2 from Lambda probe (*)
45	Signal 3 from Lambda probe (*)
46	Cruise control positive signal (*)
47	Negative voltage from engine stop switch from engine compartment
48	Negative voltage from accelerator pedal idling switch
49	Positive voltage from brake switch (redundant signal)
50	Positive voltage +12
52	(Low) signal CAN 1 line interface input
53	(High) signal CAN 1 line interface
54	Negative voltage for fan second speed control switch (*)
55	Positive voltage for engine brake exhaust gas solenoid valve (*)
56	Negative voltage for pre-heating lamp (*)
57	Positive voltage speed 1 fan (*)
58	Earth for engine brake exhaust gas solenoid valve (*)
59	Earth for blow-by pressure difference sensor (*)
61	Positive voltage for blow-by pressure difference sensor (*)
62	Passive analogue signal from torque limiter multiple resistor (*)
63	Signal 4 from Lambda probe (*)
64	Cruise control positive signal (*)
65	Earth from multiple resistor torque limiter (*)
66	Positive voltage from clutch switch (torque converter) (*)
67	Earth for cooling fan speed sensor (*)
69	Signal from cooling fan speed sensor (*)
70	Vehicle speed sensor earth (*)
71	Vehicle speed sensor signal (*)
72	Synchronising bit on serial interface input signal
73	Local area network interconnection input signal
74	Cruise control positive signal (*)
75	Supply voltage for grid on heater 1 (*)
76	Earth for exhaust gas temperature sensor (*)
77	Supply voltage for accelerator potentiometer
78	Earth for accelerator potentiometer
79	Signal from accelerator potentiometer
80	Signal from exhaust gas temperature sensor (*)
81	Signal from particle trap differential pressure sensor (*)
82	Positive voltage from particle trap differential pressure sensor (*)
83	Earth from particle trap differential pressure sensor (*)
85	Negative voltage from diagnostic request switch
87	Crankshaft rotation output signal
88	Camshaft rotation output signal
89	ISO-K interface input signal

* If present

Pump injector (78247)

It consists mainly of:

A) Solenoid valve

B) Pumping element

C) Nozzle

These three parts **CANNOT be replaced individually and CANNOT be overhauled.**

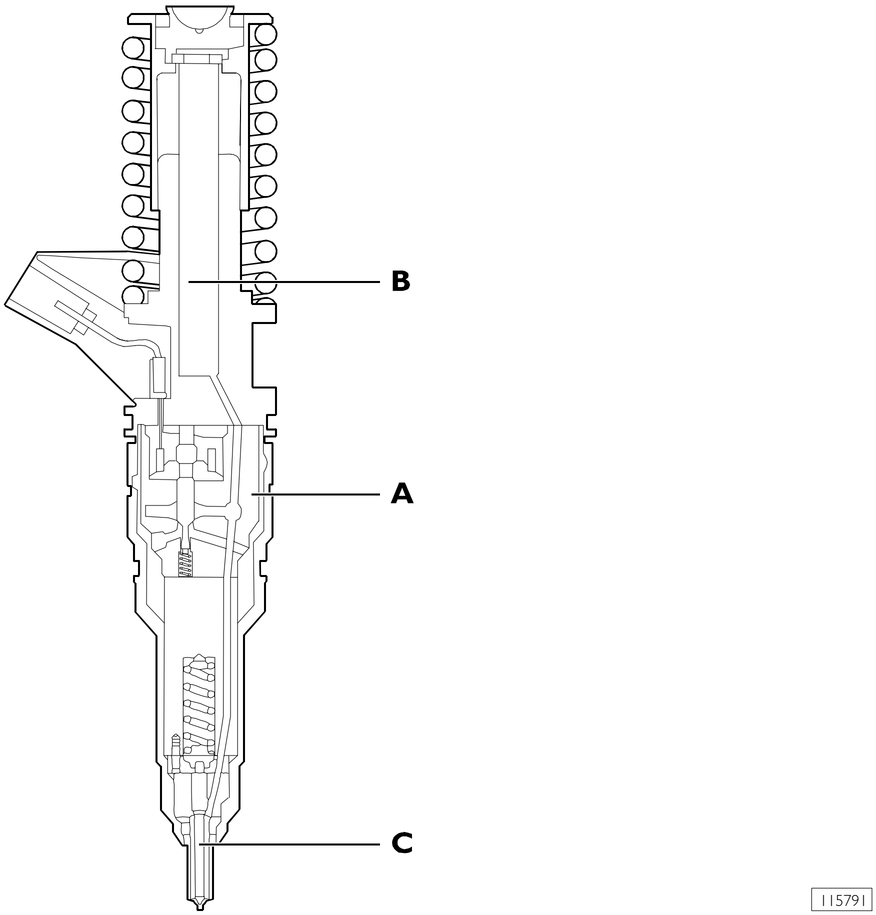
The pumping element, mechanically actuated at every rocker arm cycle, compresses the fuel container in the delivery chamber.

The nozzle, whose composition and operation are similar to those of traditional injectors, is opened by the fuel under pressure and sprays it into the combustion chamber.

A solenoid valve, directly controlled by the electronic control unit, determines delivery according to the control signal.

A casing houses the lower part of the pump injector in the cylinder head.

Figure 8



The electro valve is of the N.A. type.

Coil resistance is ~ 0.56 ÷ 0.57 Ohm.

Maximum operating voltage is ~ 12 ÷ 15 Amp.

Based on voltage absorbed by the electro valve, the electronic center can identify whether injection was correct or mechanical problems exist. It can also detect injector errors ONLY with the engine running or during starts.

They are connected to the electronic center with a positive common to groups of three injectors:

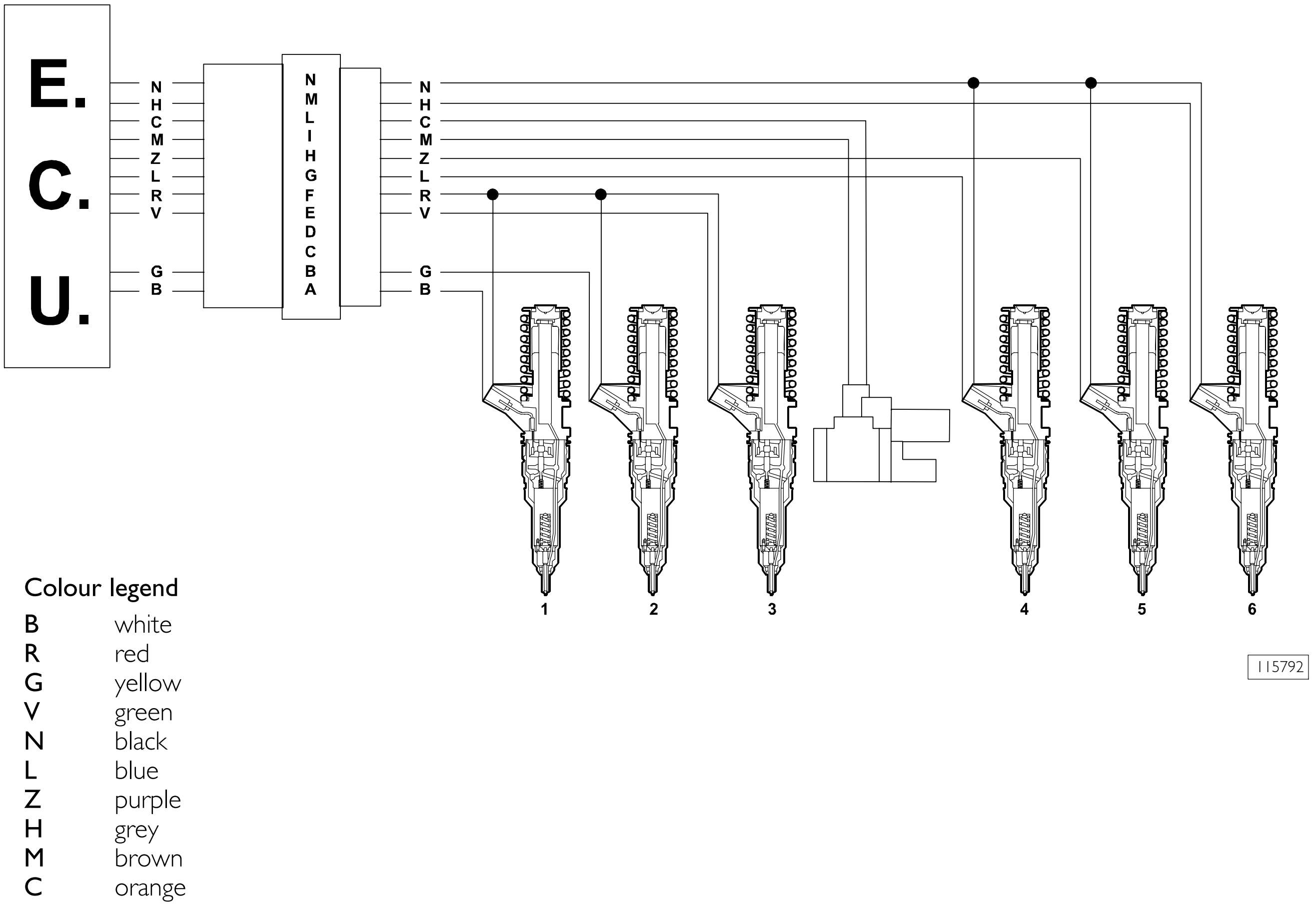
Cylinder 1 - 2 – 3 injector to pin A 11
Cylinder 4 - 5 - 6 injector to pin A 3.

Injectors are individually connected to the center between pins:

A11 / A13 cylinder 1 injector
A11 / A6 cylinder 2 injector
A11 / A12 cylinder 3 injector
A3 / A14 cylinder 4 injector
A3 / A16 cylinder 5 injector
A3 / A15 cylinder 6 injector

Injectors are connected to the center with connector ST - E mounted on the engine front with a twisted cable, to avoid possible electromagnetic interference problems, so junctions or repairs on it must NOT be performed.

Figure 9

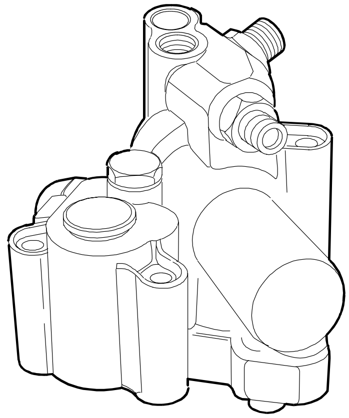


Colour legend

B	white
R	red
G	yellow
V	green
N	black
L	blue
Z	purple
H	grey
M	brown
C	orange

Exhaust brake solenoid valve (78050)

Figure 10

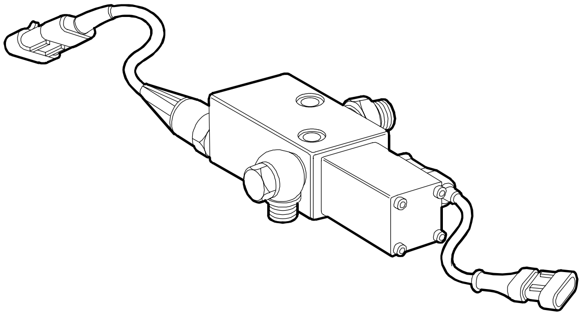


CURSOR 13

This on/off solenoid valve is NC type.
In Cursor 10 engines it is positioned under the tappets.
The electronic control unit pilots this solenoid valve and opens the way to engine oil so as to engage the hydraulic cylinders of the exhaust brake.
A warning light located on the dashboard is connected in parallel to this solenoid valve in order to inform the driver that it has tripped.
While feeding this solenoid valve, the control unit also activates the VGT.
The exhaust brake can be engaged only if the engine revolutions are > 1000 rpm.
This solenoid valve is connected to the EDC electronic control unit between pins A3 / A32.
The resistance of the coil is approx. 37 to 47 Ohm.

Solenoid valve for VGT control

Figure 11



This N.C. proportional solenoid valve is located on the left-hand side of the crankcase under the turbine.
The electronic control unit, via a PWM signal, controls the solenoid valve, governing the supply pressure of the turbine actuator, which, on changing its position, modifies the cross-section of the flow of exhaust gases onto the blades of the impeller and therefore its speed.
The VGT electro valve is connected between electronic center pins C1/C3.
The resistance of the coil is approx. 20-30 Ohms.

Distribution pulse transmitter (48042)

Features

Vendor	BOSCH
Torque	8 ± 2 Nm
Resistance	880 ÷ 920 Ω

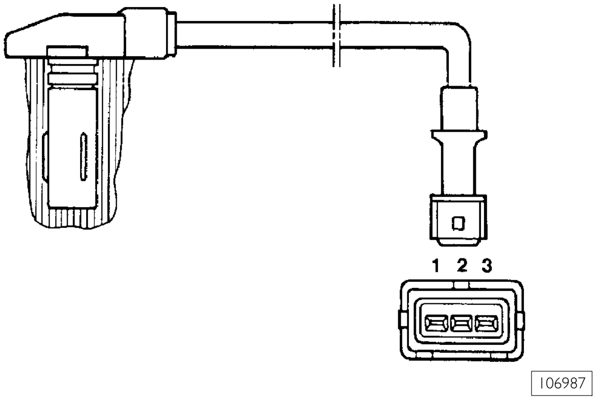
This induction type sensor located on the camshaft generates signals obtained from the magnetic flow lines that close through the 6 plus 1 phase teeth of a sound wheel mounted on the shaft.

The electronic center uses the signal generated by this sensor as an injection step signal.

Though electrically identical to (48035) engine rpm sensor mounted in the camshaft in is NOT interchangeable with it as it cable is shorter and it features a larger diameter.

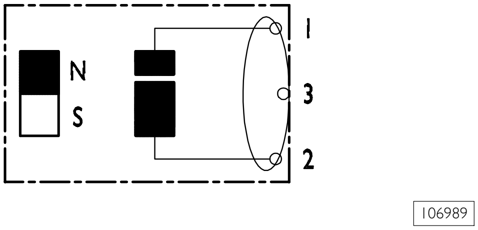
This sensor's air gap is NOT ADJUSTABLE.

Figure 12



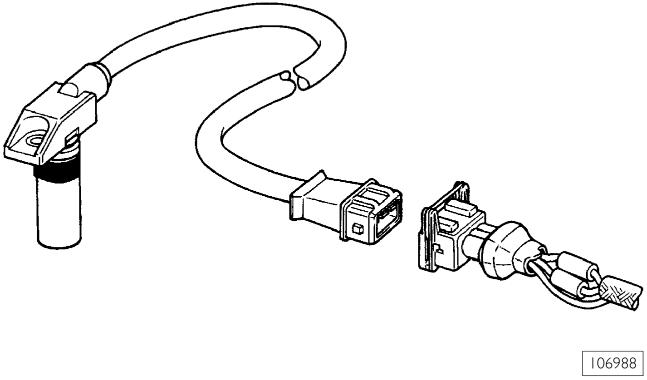
TECHNICAL VIEW

Figure 14



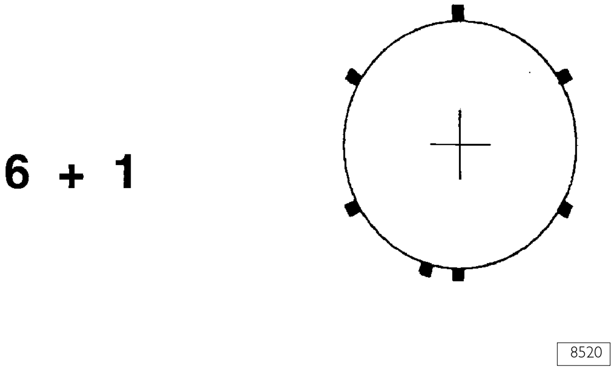
WIRING DIAGRAM

Figure 13



PERSPECTIVE VIEW

Figure 15



REFERENCE ON SOUND WHEEL

Connector	Function	Cable colour
1	To EDC center pin C 10	—
2	To EDC center pin C 9	—
3	Shields	—

Engine coolant temperature sensor (85153)

This N.T.C. type sensor located on the water outlet sump on the engine head left measures coolant temperature for the various operating logics with a hot or cold engine and identifies injection enrichment requirements for a cold engine or fuel reduction requirements for a hot engine.

The coolant temperature signal is used for display on the Cluster and to control the fan.

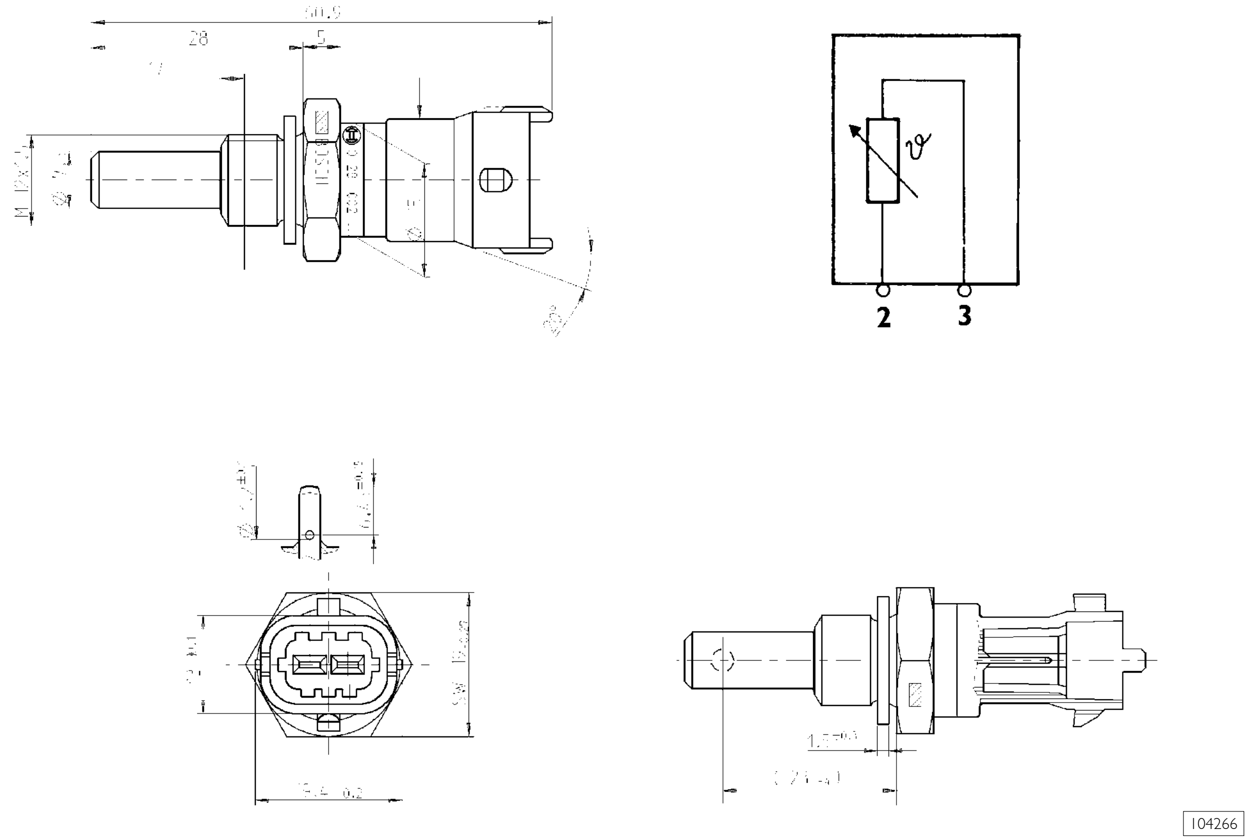
It is connected to electronic center pins C15/C26.

Sensor behavior as a function of temperature:

- 10 °C	8,10 ÷ 10,77 kOhm
+ 20 °C	2,28 ÷ 2,72 kOhm
+ 80 °C	0,29 ÷ 0,364 kOhm

At 60 to 90 °C, voltage at A5 and A22 ranges from 0.6 to 2.4V.

Figure 16



Connector	Function	Cable colour
2	To EDC center pin C 15	—
3	To EDC center pin C 26	—

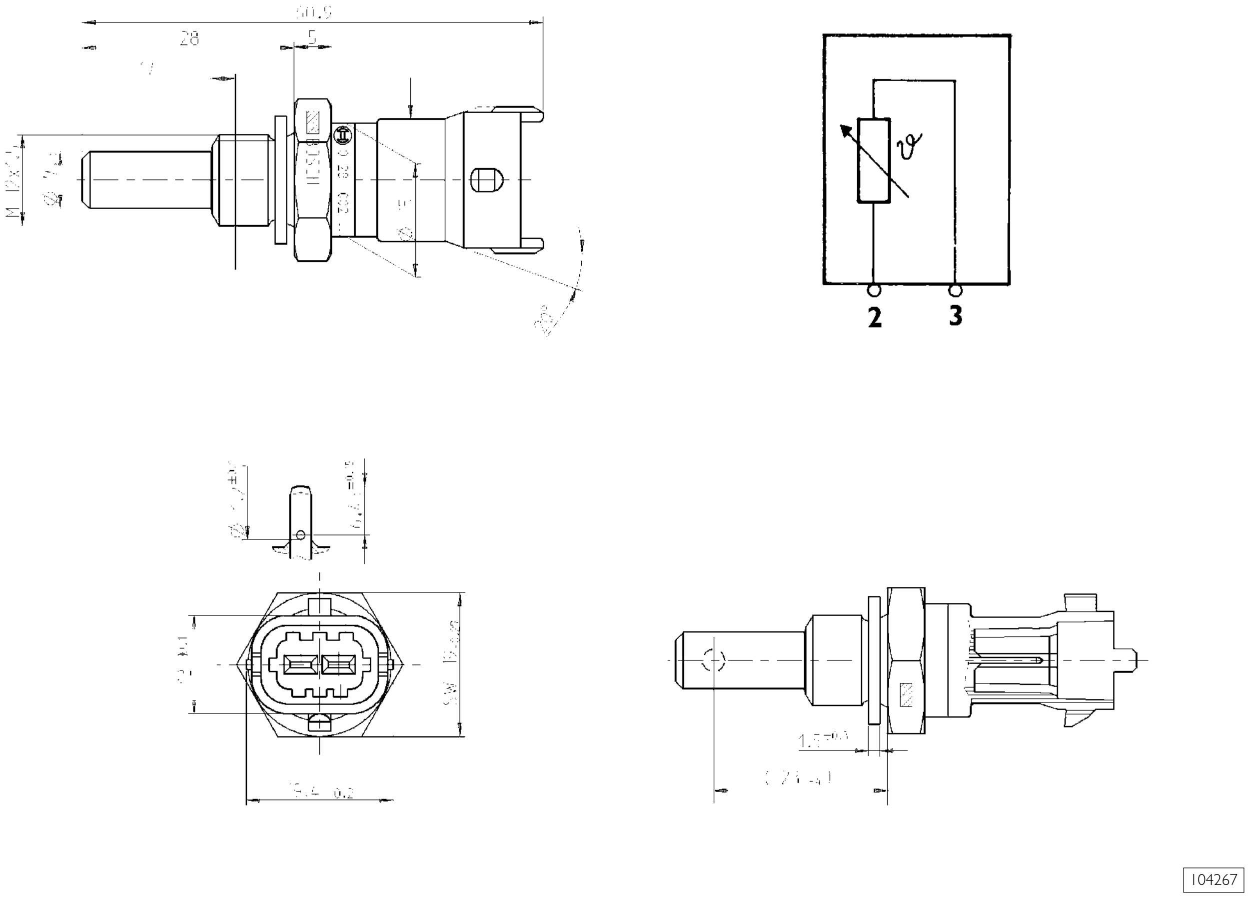
Fuel temperature sensor (47042)

Features

Vendor	BOSCH
Maximum torque	35 Nm

This N.T.C. type sensor located on the fuel filter on the engine left side detects fuel temperature and enables the electronic center to measure fuel density and volume for delivery correction.

Figure 17



Connector	Function	Cable colour
2	To EDC center pin C 18	—
3	To EDC center pin C 35	—

Flywheel pulse transmitter (48035)

Features

Vendor	BOSCH
Torque	8 ± 2 Nm
Resistance	880 ÷ 920 Ω

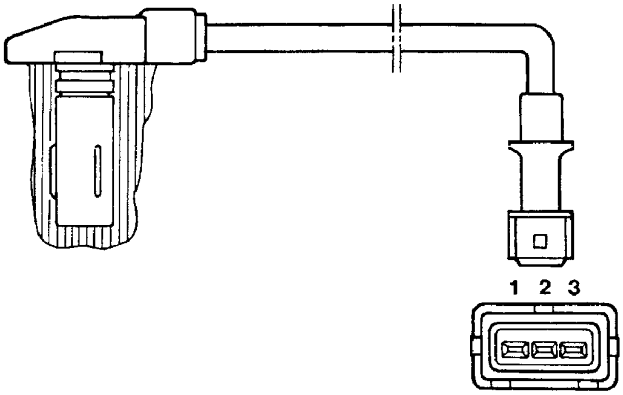
This induction type sensor located on the flywheel generates signals obtained from the magnetic flow lines that close through 54 holes in three series of 18 in the flywheel.

The electronic center uses this signal to detect the various engine ratings and pilot the electronic rev counter.

The rev counter does not operate in the absence of this signal.

This sensor's air gap is NOT ADJUSTABLE.

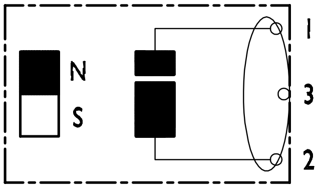
Figure 18



TECHNICAL VIEW

106984

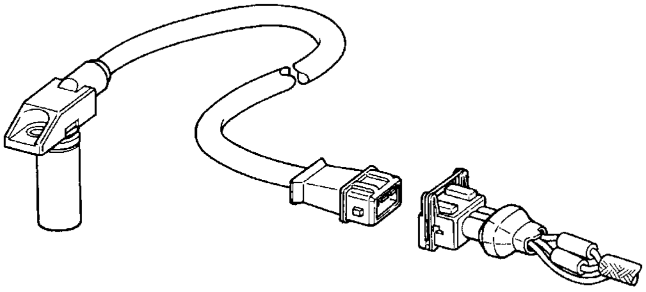
Figure 20



WIRING DIAGRAM

106986

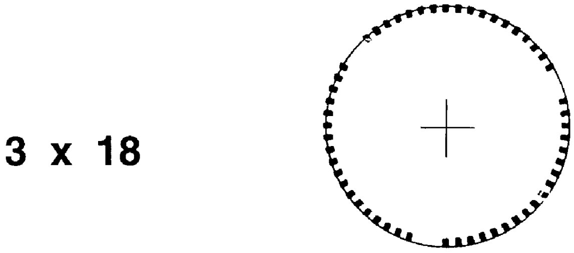
Figure 19



PERSPECTIVE VIEW

106985

Figure 21



8520

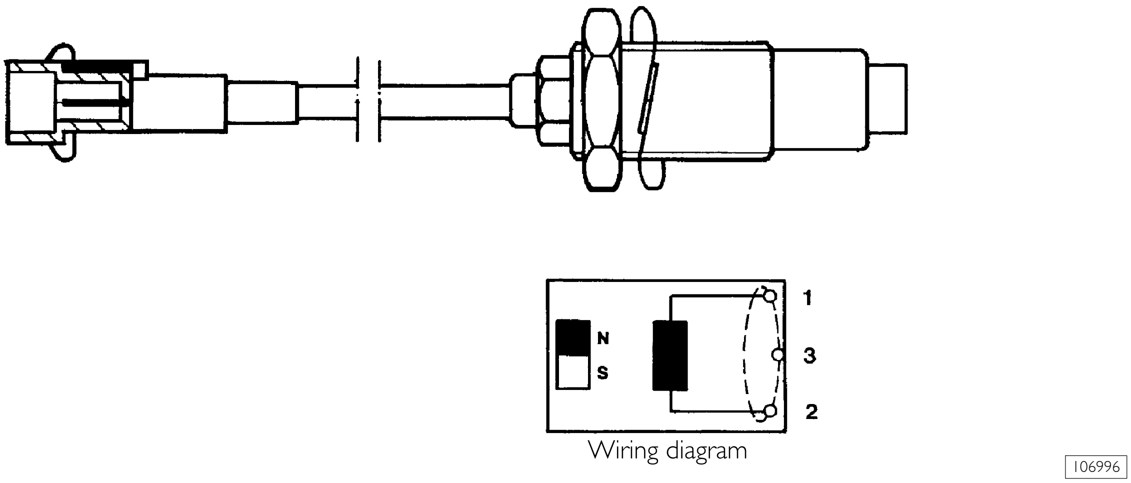
HOLES ON FLYWHEEL

Connector	Function	Cable colour
1	To EDC center pin C 23	—
2	To EDC center pin C 19	—
3	Shields	—

Turbine rpm sensor (48043)

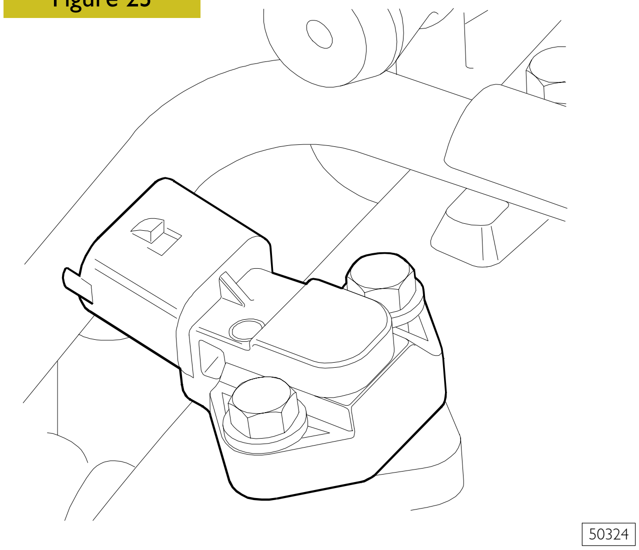
This is an inductive sensor positioned on the impeller shaft.
It generates signals obtained from the magnetic flow lines, which close through a notch obtained on the shaft itself.
The signal generated by this sensor is used by the electronic control unit to verify that the turbine revs number does not exceed the maximum value.
To control the revs number, the control unit acts on variable geometry.
If the revs number keeps on increasing until it reaches excessive r.p.m. values, the electronic control unit will detect an anomaly.
The gap of this sensor CANNOT BE ADJUSTED.
It is connected on electronic control unit pins C30 / C20.
The sensor resistance value is 400 Ohm.

Figure 22



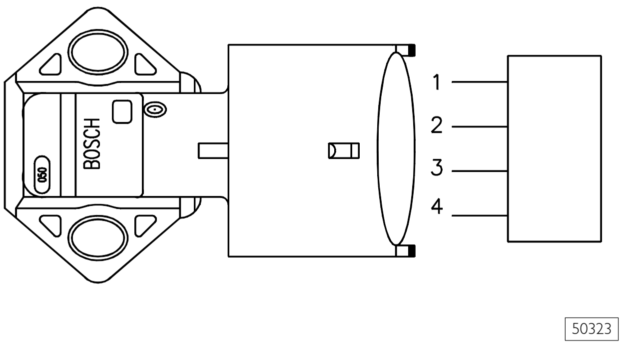
Wiring diagram

Figure 23



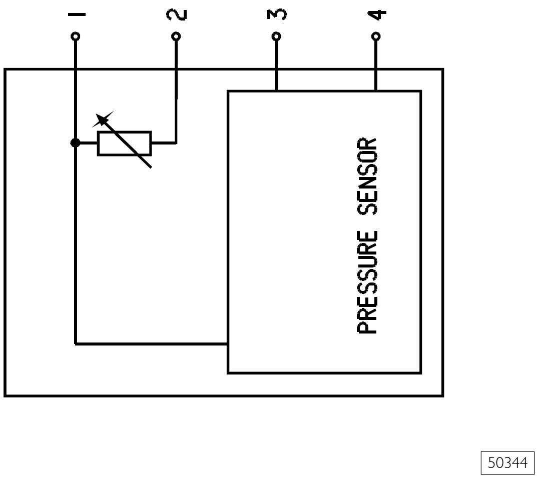
Sensor external view

Figure 24



Linking connector

Figure 25



Wiring diagram

Air pressure/temperature sensor (85156).

This component incorporates a temperature sensor and a pressure sensor.

Ilt replaces the temperature sensors (85155) and pressure sensors (85154) available in the preceding systems.

It is fitted onto the intake manifold and measures the maximum supplied air flow rate used to accurately calculate the amount of fuel to be injected at every cycle.

The sensor is powered with 5 V.

The output voltage is proportional to the pressure or temperature measured by the sensor.

Pin (EDC)	25/C - 33/C	Power supply
Pin (EDC)	36/C	Temperature
Pin (EDC)	34/C	Pressure

Oil temperature/pressure sensor (42030 / 47032)

This component is identical to the air pressure/temperature sensor and replaced single sensors 47032 / 42030.

It is fitted onto the engine oil filter, in a horizontal position.

It measures the engine oil temperature and pressure.

The measured signal is sent to the EDC control unit which controls, in turn, the indicator instrument on the dashboard (low pressure warning lights / gauge).

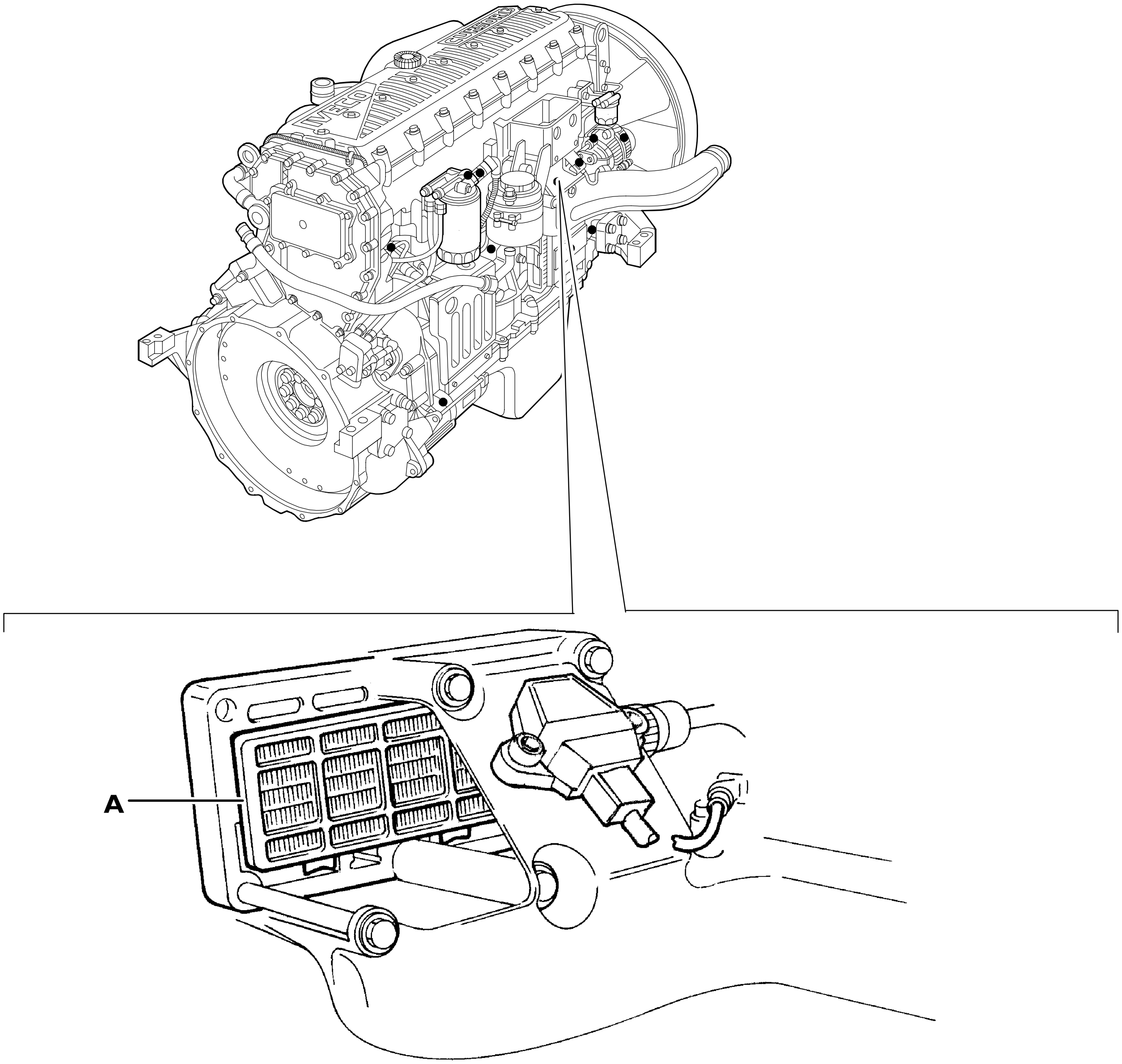
Pin (EDC)	24/C - 32/C	Power supply
Pin (EDC)	27/C	Temperature
Pin (EDC)	28/C	Pressure

The engine oil temperature is used only by the EDC control unit.

Ref.	Description	Control unit pin	
		Oil	Air
1	Ground	24C	25C
2	Temp. Sign.	27C	36C
3	+5	32C	33C
4	Press. Sign.	28C	34C

Pre-post reheat resistor (61121)

Figure 26



A. Pre/ort reheat resistor / 0.7 Ohm.

This resistor located between the cylinder head and the intake duct is used to heat air in pre/post reheat operations.

By inserting the key switch, when even only one of the water, air or gas oil temperature sensors record less than 10 °C, the electronic center activates pre/post reheating and switches on the warning light on the cab instrument panel for a variable period according to temperature, after which the light starts blinking to inform the operator that the engine can be started.

The warning light goes off after engine start but the resistor continues being supplied for a variable period of time to complete post reheating.

The operation is cancelled to prevent uselessly discharging the battery if the engine is not started within 20/25 seconds with the warning light blinking.

When reference temperature is above 10 °C, actuating the ignition key makes the warning light go on for some 2 seconds to complete the test and then turns it of to indicate the engine can be started.

PART THREE - TROUBLESHOOTING

PREFACE

A successful troubleshooting is carried out with the competence acquired by years of experience and attending training courses.

When the user complains for bad efficiency or working anomaly, his indications must be kept into proper consideration using them to acquire any useful information to focus the intervention.

After the detection of the existing anomaly, it is recommended to proceed with the operations of troubleshooting by decoding the auto-troubleshooting data provided by the EDC system electronic central unit.

The continuous efficiency tests of the components connected to, and the check of working conditions of the entire system carried out during working, can offer an important diagnosis indication, available through the decoding of the "failure/anomaly" codes.

It should be noted, that the interpretation of the indications given by the diagnostic device is not sufficient to guarantee that all failures are healed.

Using IVECO processing instruments, it is also possible to establish a bi-directional connection with the central unit, by which not only to decoding the failure codes but also input an enquiry relying on memory files, in order to achieve any further necessary information to identify the origin of the anomaly.

Every time there is a breakdown claim and this breakdown is actually detected, it is necessary to proceed inquiring the electronic unit in one of the ways indicated and then proceed with the diagnostic research making trials and tests in order to have a picture of the working conditions and identify the root causes of the anomaly.

In case the electronic device is not providing any indication, it will be necessary to proceed relying on the experience, adopting traditional diagnosis procedures.

In order to compensate the operators' lack of experience in this new system, we are hereby providing the USER's GUIDELINE FOR TROUBLESHOOTING in the following pages.

The GUIDELINE is composed of two different parts:

- ☐ Part 1: DTC codes and their indications are listed and interpreted; DTC codes can be viewed on the Iveco Motors diagnostic device;
- ☐ Part 2: guide to diagnostics, divided according to symptoms, including the description of possible failures not identified by the electronic control unit, often mechanical or hydraulic failures.

⚠ Any kind of operation on the electronic center unit must be executed by qualified personnel, duly authorized by IVECO.

Any unauthorized tamper will involve decay of after-sales service in warranty.

DTC error codes
with EDC7 UC31 central unit

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
113	ACCELERATOR PEDAL/BRAKE PEDAL SUSPECT	Vehicle acceleration very slow. Engine idle speed: 500 rpm.	Accelerator pedal and brake pressed simultaneously (for too long); Accelerator pedal blocked or faulty; Incorrect use of vehicle.	Check the accelerator pedal signal and pedal mechanical movement.				
116	CLUTCH SIGNAL SUSPECT	The parameter reading shows that the clutch is pressed.	Clutch switch faulty or wiring problems in pedal.	Check clutch pedal switch and wiring.				
117	BRAKE PEDAL SIGNAL ERROR	Slight power reduction.	Main and secondary brake switch not synchronised. One of the two brake pedal switches may be stuck.	Check the synchronisation of both switches (signal) and wiring.				
119	PLAUSIBILITY +15		Possible mechanical problem (in pawl) or electrical problem.	Check wiring.				
121	SPEED LIMITER W/LIGHT	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
122	WARNING LIGHT EOBD	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
123	EDC LAMP	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
124	COLD START LAMP	Warning light permanently off.	Short circuit or defective wiring.	Check wiring.				
125	MAIN RELAY DEFECT	Possible problems during after-run.	Relay short circuit to battery positive or earth.	Check wiring between ECM and battery. Replace relay if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
126	BATTERY VOLTAGE	Possible problems during after-run.	Alternator or battery defective. Possible wiring problem.	Check wiring. Replace alternator regulator or battery. Replace the alternator if necessary.				
127	ENGINE BRAKE ELECTROVALVE	Engine brake not operational.	Relay or wiring short-circuited or interrupted.	Check wiring. Replace relay if necessary.				
128	MAIN RELAY - SHORT CIRCUIT TO BATTERY	Possible problems during after-run.	Relay short circuit to battery positive or earth. Relay may be faulty.	Check wiring between ECM and battery. Replace relay if necessary.				
129	AIR-CONDITIONER COMPRESSOR RELAY	Possible problems during after-run.	Relay short circuit to battery positive or earth. Relay may be faulty.	Check wiring between ECM and battery. Replace relay if necessary.				
12A	RELAIS FOR ENGINE BRAKE VALVE	Possible problems during after-run.	Relay short circuit to battery positive or earth. Relay may be faulty.	Check wiring between ECM and battery. Replace relay if necessary.				
12B	THERMOSTARTER RELAY I (HEATER)	Heater not working.	Relay or wiring short-circuited or interrupted.	Check wiring. Replace relay if necessary.				
12C	THERMOSTARTER RELAY 2	Heater not working.	Relay or wiring short-circuited or interrupted.	Check wiring. Replace relay if necessary.				
12E	MANAGEMENT SYSTEM PRE/POST-HEATING (ACTIVE)	Grid heater permanently operating.	Grid heater short circuited to earth.	Check wiring and component.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
131	COOLANT TEMPERATURE SENSOR	No reaction noticeable on behalf of the driver.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
132	COOLANT TEMPERATURE SENSOR (TEST)	Slight power reduction.	Operation in extreme environmental conditions or sensor inaccurate.	Ensure the engine is not working in extreme environmental conditions. Check the wiring and the sensor accuracy. Replace sensor if necessary.				
133	AIR TEMPERATURE SENSOR BOOST AIR	Slight power reduction.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
134	BOOST PRESSURE SENSOR	No reaction perceivable by the driver. Parameter recovery value: 2700 mbar.	Sensor short-circuited or difference between environmental pressure and turbo pressure implausible.	Check the wiring. Also check the environmental pressure sensor. Replace sensor if necessary.				
135	FUEL TEMPERATURE SENSOR	Slight power reduction.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
138	OIL PRESSURE SENSOR	No reaction perceivable by the driver. Parameter recovery value: 3000 mbar.	Sensor short-circuited or value implausible.	Check the wiring and oil level. Replace sensor if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
13A	OIL TEMPERATURE SENSOR	No reaction perceivable by the driver. Parameter recovery value: coolant temperature value (if intact) otherwise 120°C).	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
13C	ATMOSPHERIC TEMPERATURE SENSOR (HUMIDTIY?)	No reaction perceivable by the driver. Parameter recovery value: 40°C.	Sensor short-circuited or value implausible.	Check the wiring. Replace sensor if necessary.				
141	CRANKSHAFT SPEED	No reaction noticeable on behalf of the driver.	Signal interrupted or wiring problem. Sensor installation may not be correct.	Check wiring and installation. Replace sensor if necessary.				
142	ENGINE WORKING ONLY WITH CAMSHAFT SENSOR	No reaction perceivable by the driver.	Signal interrupted or wiring problem. Sensor installation may not be correct.	Check wiring and installation. Replace sensor if necessary.				
143	CAMSHAFT SENSOR	No reaction perceivable by the driver.	Signal interrupted or wiring problem. Sensor installation may not be correct.	Check wiring and installation. Replace sensor if necessary.				
144	FAULT BETWEEN FLYWHEEL SENSOR AND CAMSHAFT	No reaction noticeable on behalf of the driver.	Signal interrupted or wiring problem. Flywheel and timing sensor installation may be incorrect.	Check wiring and installation of both sensors.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
145	FAN RELAY	No reaction perceivable by the driver. Fan off.	Short circuit or fan actuator faulty.	Check the wiring and the fan actuator. Replace the actuator if necessary.				
148	AIR-CONDITIONER COMPRESSOR RELAY	Air conditioner permanently off.	Wiring or relay short-circuited.	Check the wiring. Replace relay if necessary.				
149	PRE-HEATING RELAY FUEL FILTER	Filter heater not working.	Wiring or filter heater short-circuited.	Check the wiring. Replace the filter heater if necessary.				
151	INJECTOR CYLINDER 1	The engine runs on 5 cylinders.	Injector no.1 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
152	INJECTOR CYLINDER 2	The engine runs on 5 cylinders.	Injector no.2 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
153	INJECTOR CYLINDER 3	The engine runs on 5 cylinders.	Injector no.3 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
154	INJECTOR CYLINDER 4	The engine runs on 5 cylinders.	Injector no.4 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
155	INJECTOR CYLINDER 5	The engine runs on 5 cylinders.	Injector no.5 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
156	INJECTOR CYLINDER 6	The engine runs on 5 cylinders.	Injector no.6 electric trouble.	Check correct tightness to torque of the connectors on the solenoid valve of the injector (1.36 - 1.92 Nm). Check the integrity of the injector coil and replace the injector if defective. If the coil is integral, check the wiring between the solenoid valve and EDC connector.				
161	INJECTOR CYLINDER 1 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
162	INJECTOR CYLINDER 2 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
163	INJECTOR CYLINDER 3 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
164	INJECTOR CYLINDER 4 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
165	INJECTOR CYLINDER 5 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
166	INJECTOR CYLINDER 6 / SHORT CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible short circuit in connections. Possible problem in injector coil. Possible problem in control unit.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
167	INJECTOR CYLINDER 1 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
168	INJECTOR CYLINDER 2 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
169	INJECTOR CYLINDER 3 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16A	INJECTOR CYLINDER 4 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16B	INJECTOR CYLINDER 5 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16C	INJECTOR CYLINDER 6 / OPEN CIRCUIT	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem (or disconnected internally). Possible problem in control unit (condenser).	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
16D	COMPRESSION TEST IN PROGRESS		Compression Test in progress.	After carrying out the compression test, turn the key OFF (after-run).				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
16E	THE MINIMUM NUMBER OF INJECTIONS WAS NOT REACHED: STOP THE ENGINE	More than 2 injectors not operating.		See individual faults in injectors.				
171	BENCH 1 CC	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem. Injectors short-circuited.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
173	BENCH 2 CC	One or more injectors (bank 1 or bank 2) not operating.	Possible injector connection problem. Injectors short-circuited.	Check wiring. Possible internal problem also in ECM. Replace the injector if necessary.				
17C	BENCH 1 INJECTORS CHECK (INTERNAL ECU)	One or more injectors (bank 1 or bank 2) may not be operating.	Fault in control unit.	Replace the engine control unit.				
189	EGR POWER ST. SHORT TO BATT.	No fault perceived by the driver. EGR not working.	Short circuit or EGR actuator faulty.	Check wiring. Replace the EGR actuator if necessary.				
191	TURBINE ACTUATOR CONTROL ELECTROVALVE	Poor performance.	VGT actuator or wiring defective.	Check VGT wiring and actuator.				
192	TURBINE ACTUATOR CONTROL ELECTROVALVE SHORT CIRCUIT TO POSITIVE	Poor performance.	VGT actuator or wiring defective.	Check VGT wiring and actuator.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
193	TURBINE WHEEL REVS SENSOR	Poor performance.	Air filter blocked or turbine rpm sensor signal implausible.	Check the air filter and check parameters linked with the turbine by performing a road test (parameter acquisition).				
198	FAULT ON AT LEAST TWO OF THE FOLLOWING SENSORS: TURBINE SPEED, BOOT PRESSURE AND EXHAUST GAS PRESSURE	Poor performance.	Sensor signal implausible. Sensor may be faulty.	Determine which turbine component caused the problem.				
199	TURBOCHARGER CONTROL BOOST PRESSURE FAILURE (PCR)	Poor performance.	Turbo sensor or actuator may be faulty. Air filter may be blocked.	Check turbine sensors and actuator (parameter acquisition). Check whether air filter is blocked.				
19A	TURBINE SPEED EXCEEDING EVERY PERMITTED RANGE	Poor performance.	Turbo sensor or actuator may be faulty. Air filter may be blocked.	Check turbine sensors and actuator (parameter acquisition). Check whether air filter is blocked.				
19B	TURBINE IN OVERSPEED (the fault is not displayed if it is caused by a low atmosperic pressure)	Poor performance.	Air filter blocked or turbine rpm sensor signal implausible.	Check the air filter and check parameters linked with the turbine by performing a road test (parameter acquisition).				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
19F	NOx SENSOR ERROR	No effect perceived by the driver.	Sensor signal implausible. Nox sensor may be faulty.	Check the Nox sensor.				
1A5	TIMEOUT OF CAN MESSAGE DM1DCU	No effect perceived by the driver.	Problems in the Denoxtronic (on the CAN line).	Check wiring. Check and correct any faults in the Denoxtronic control unit.				
1A6	TIMEOUT OF CAN MESSAGE SCR1	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check Denoxtronic control unit wiring and operation.				
1AE	HUMIDITY SENSOR	No effect perceived by the driver.	Sensor short-circuited or faulty.	Check wiring. Replace sensor if necessary.				
1AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
1B1	ERROR ON CAN CONTROLLER A	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check terminal resistances.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1B2	ERROR ON CAN CONTROLLER B	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check terminal resistances.				
1B3	ERROR ON CAN CONTROLLER C	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check terminal resistances.				
1B4	TIMEOUT CAN MESSAGE BC2EDC1	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check BC wiring and operation.				
1B5	TIMEOUT CAN MESSAGE VM2EDC	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check VCM wiring and operation.				
1B7	ERROR ON MESSAGES CAN IN TRANSMISSION	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check ECM wiring and operation.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1B9	ERROR ON THE EOBD LIGHT MANAGED BY THE CLUSTER)	No effect perceived by the driver.	MIL/Body Controller warning light defective.	Consult the Body Controller troubleshooting guide and check the CAN line.				
1BA	TIMEOUT CAN MESSAGE DASH DISPLAY	No effect perceived by the driver.	CAN messages from VCM inconsistent.	Consult the VCM troubleshooting guide and check the CAN line.				
1BC	TIMEOUT CAN MESSAGE AMBCOND	No effect perceived by the driver.	CAN messages from VCM inconsistent.	Consult the VCM troubleshooting guide and check the CAN line.				
1BD	TIMEOUT CAN MESSAGE CCVS	No effect perceived by the driver.	CAN messages from VCM or BC inconsistent.	Consult the VCM/BC troubleshooting guide and check the CAN line.				
1C2	ERROR MESSAGE CAN ETC1	No effect perceived by the driver.	CAN messages from ETC (gearbox) inconsistent.	Check the ETC connection with the CAN line.				
1C3	TIMEOUT IN RECEIVING TC01 CAN MESSAGE	No effect perceived by the driver.	CAN messages from TCO inconsistent.	Check the TCO connection with the CAN line.				
1C6	ERROR MESSAGE CAN TSC1-PE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
1C8	ERROR MESSAGE CAN TSC1-VE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
1D1	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Electrical interference or internal control unit problems.	If the error persists to replace ECU.				
1D2	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash. Possible internal fault.	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1D3	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash Possible internal fault	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				
1D4	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1D5	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1D6	ECU INTERNAL ERROR (TPU)	Control unit deactivation.	Electronic interference or control unit faulty.	If the error persists to replace ECU.				
1D8	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1E2	IMMOBILIZER	The engine fails to start.	Problem in CAN line or immobiliser control unit.	Check the Immobiliser control unit is correctly connected. Enter the Immobiliser PIN code during the emergency procedure.				
1E3	ERROR FOR ECU INTERNAL MONITORING	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1E4	ERROR FOR ECU INTERNAL MONITORING	No effect perceived by the driver.	Ecu internal failure.	If the error persists to replace ECU.				
1E5	SENSORS POWER SUPPLY FAULT (12V)	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1E6	SENSOR POWER SUPPLY 1	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E7	SENSOR POWER SUPPLY 2	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E8	SENSOR POWER SUPPLY 3	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E9	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1EA	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1EB	ATMOSPHERIC PRESSURE SENSOR	No effect perceived by the driver. Environmental pressure recovery value: 700 mbar.	Fault in sensor inside control unit.	Change ECU.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1FA	TOO HIGH NUMBER OF REGENERATIONS DEMAND	No reaction perceivable by the driver. Too many filter regenerations carried out.	Particulate filter may be blocked.	Check filter.				
1FB	PERMANENT RIGENERATION ON TRAP PARTICLE	No reaction perceivable by the driver.	Catalytic converter not installed or damaged.	Check catalytic converter visually.				
1FC	FIRST SENSOR EXAUSTED GAS TEMPERATURE	No reaction perceivable by the driver.	Temperature sensors damaged or incorrectly fitted.	Check information and condition of sensors.				
21F	TOO HIGH EFFICIENCY OF CATALYST SYSTEM	No reaction noticeable on behalf of the driver.	Actuator coil faulty or not within specified tolerance limits.	Check actuator condition.				
225	INTERRUPTED AFTER-RUN	Slight power reduction.	The control unit is turned off by the general switch instead of by the key (k15). Possible problem in main relay or connections.	Check wiring and then replace the main relay.				
228	MAIN RELAY - SHORT CIRCUIT TO GROUND	Slight power reduction.	Short circuit in main relay or relay faulty.	Check wiring between battery and ECM and then replace the main relay.				
232	Coolant temperature sensor absolute test	Slight power reduction.	Extreme environmental conditions or sensor incorrectly adjusted.	Ensure the engine is working in non-critical conditions. Check the sensor connections and accuracy. Replace sensor if necessary.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
238	OIL LOW PRESSURE	Slight power reduction.	Sensor incorrectly adjusted or faults in lubrication system.	Check the sensor connections and accuracy. Check the lubrication system.				
23A	OIL TEMPERATURE ABOVE NORMAL	Slight power reduction.	Sensor incorrectly adjusted or faults in lubrication system.	Check the sensor connections and accuracy. Check the lubrication system.				
27C	BENCH 2 INJECTORS CHECK (INTERNAL ECU)	One or more injectors (bank 1 or bank 2) may not be operating.	Fault in control unit.	Replace the engine control unit.				
292	TURBINE ACTUATOR CONTROL ELECTROVALVE SHORT CIRCUIT TO GROUND	Poor performance.	VGT actuator or wiring defective.	Check VGT wiring and actuator.				
2A6	TIMEOUT OF CAN MESSAGE SCR2	No effect perceived by the driver.	Problem in the Denoxtronic (on the CAN line).	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide. Check wiring.				
2AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
2B4	TIMEOUT CAN MESSAGE BC2EDC2	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check BC wiring and operation.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
2C6	TIMEOUT OF CAN MESSAGE TSC1-PE PASSIVE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
2C8	ERROR MESSAGE CAN TSC1-VR	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
2C9	ERROR MESSAGE CAN TIMEDATE	No effect perceived by the driver.	CAN messages from TC (tachograph) inconsistent.	Check the tachograph connection with the CAN line.				
2D3	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash. Possible internal fault.	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				
2FF	ERROR CHECK OF CRITICAL TIME FOR OIL DILUTION	Slight power reduction.	Oil over-diluted.	Change the engine oil.				
392	TURBINE ACTUATOR CONTROL ELECTROVALVE	Poor performance.	Connection damaged. Battery voltage excessive (ECU overheating).	Check VGT connection and actuator.				
3AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
3C8	TIMEOUT OF CAN MESSAGE TSC1-VE PASSIVE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
3C9	ERROR MESSAGE CAN HRDV	No effect perceived by the driver.	CAN configuration incorrect. CAN connections defective. Terminal resistance not suitable.	Check CAN line wiring. Check BC wiring and operation.				
3D3	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Poor control unit programming/flash. Possible internal fault.	Reprogram the central unit. If the error is repeated, replace the central unit, if needed.				
3FA	REGENERATION DEMAND NUMBER 2	No effect perceived by the driver.	Too many regenerations carried out.	Check particulate filter and faults in sensors.				
4AF	SERIOUS EOBD FAULT FROM DENOXTRONIC (EOBD FLASHING LIGHT)	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				
4C8	TIMEOUT OF CAN MESSAGE TSC1-VR PASSIVE	No effect perceived by the driver.	CAN messages from TCU (Transmission Control Unit) inconsistent.	Check the TCU connection with the CAN line.				
4FA	REGENERATION DEMAND NUMBER 3	No effect perceived by the driver.	Too many regenerations carried out.	Check particulate filter and faults in sensors.				
5AF	DM1DCU SPN5 message	No effect perceived by the driver.	Problems in AdBlue dosing system.	Check the faults in the Denoxtronic and consult the control unit troubleshooting guide.				

GUIDELINE FOR TROUBLESHOOTING

SIGNALLED ANOMALY	BLINK CODE	EDC WAR-NING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
The battery goes flat quickly.	-	-	Pre-heating resistor powered continuously.	Local overheating.		
The engine will stop or won't start.	-	-	Fuel pre-filter clogged.			
Difficult start when the engine is either hot or cold.	-	-	The 3.5 bar valve on fuel return is stuck open.			
Slight overheating.	-	-	Either 0.3 bar tank return valve or return piping clogged.			
After the new vehicle has been delivered, the engine will stop after a short operation time.The tank holds a lot of fuel; all the rest is O.K.	-	-	Reversed tank suction / return pipes.			The engine is fed by the return pipe, the suction of which in the tank is lower. When the pipe sucks no more, the engine will stop.
Reduced power / difficult engine maneuverability.	-	-	Injection system / the engine operates with one cylinder failing: - injector plunger seizure; - valve rocker arm seizure.	Overheating	Engine test: cylinder efficiency test. If the trouble is not related to electric components (Blink code 5.x), the rocker arm holder shaft needs be disassembled. Check the rocker arm roller and bushing as well as the respective cam.	
Fuel consumption increase.	-	-	Air filter clogging with no signal from the warning light on the instrument board.	Smoke.	Check the cabling, connections and component.	

SIGNALLED ANOMALY	BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
The engine does not reach the other speeds under load conditions.	-	-	The boosting pressure sensor provides too high values, which, in any case, fall within the range.	Smoke.		
The driver feels that the engine is not working correctly like it did before.	-	-	Impaired hydraulic performance of an injector.		Engine test: check-up	Replace the injector of the cylinder in which Modus detects lower performance levels (compared with the others) only after verifying that the control rocker arm adjustment is correct.
The driver feels that the engine is not working correctly like it did before.	-	-	Wrong adjustment of an injector control rocker arm.		Engine test: check up.	Perform correct adjustment, then repeat the engine test.
The engine operates with five cylinders; noise (knock).	-	-	Plunger seizure.	Possible overheating.	Engine test: cylinder efficiency.	Replace the injector of the cylinder in which the diagnosis instrument detects lower performance levels (compared with the others).
Replace the injector of the cylinder in which the diagnosis instrument detects lower performance levels (compared with the others).	-	-	Wrong adjustment of the injector control rocker arm (excessive travel) with impact on the plunger on the nozzle.	Possible mechanic damage to the areas surrounding the injector.	Engine test: cylinder efficiency.	Replace the injector of the cylinder in which the diagnosis instrument detects lower performance levels (compared with the others).
The engine will stop or won't start again.	-	-	Presence of air in the fuel supply circuit.	It might even not switch off; it might have operation oscillations, or start, yet with difficulty and after making many attempts.	Bleed air.	

PART FOUR - MAINTENANCE PLANNING

MAINTENANCE

Maintenance services scheme

Programmed maintenance is made up of ”Standard” services, plus a set of operations called ”Extra Plan” operations, as well as further operations called ”Temporal” operations.

Normally, no differentiated plans are prescribed in connection with vehicle use. Where a differentiation in terms of ”mission” exists, as many plants are forwarded as many are the ”missions”.

Using recommended lubricants systematically allows for long replacement intervals with relatively contained costs. To such purpose, see recommended lubricants summary card.

M = STANDARD SERVICE

”Standard” services are indicated by M = ”Maintenance”.
They must be performed at regular kilometre intervals that are normally multiple among one another.

EP = EXTRA PLAN OPERATIONS

Extra plan operations are indicated by EP = ”Extra Plan”.
They are services complementary to ”standard” services and are to be performed according to intervals which are not compatible with standard services.

T = TEMPORAL OPERATIONS

They are specific interventions that are exclusively connected to temporal intervals and are to be normally performed in particular season conditions. To minimise the number of stops for maintenance it is recommended to program extra plan stops based on average yearly run matching them as much as possible with predefined kilometre intervals.

To ensure optimum working conditions, the following pages give the checks, inspections and adjustments that need to be made on the various parts of the vehicle at the required times.

The kilometre frequency for engine lubrication is in relation to a percentage of sulphur in diesel of under 0.5%.

NOTE: If using diesel with a percentage of sulphur above 0.5%, the oil-change frequency has to be halved.

Use engine oil: ACEA E4 (URANIA FE 5W30)
ACEA E7 (URANIA LD7)

- If the vehicle is used very little or anyhow for less than 1000 hours/100,000 km a year, the engine oil and filter need to be replaced every 12 months.
- ACEA E4 lubricants classified as ACEA E6 cannot be used according to the change intervals established for class ACEA E4. They shall be changed according to the time intervals established for lubricants ACEA E2, i.e. every 400 hours/40,000 km.
- If class ACEA E7 engine oil is used, the engine oil and filters must be changed every 800 hours/80,000 km.
- If class ACEA E2 engine oil is used, the engine oil and filters must be changed every 400 hours/40,000 km.

MAINTENANCE INTERVALS

On road application

To schedule the work, keep to the following chart:

USAGE APPLICATIONS	OILS	SERVICES		EXTRA PLAN		PROGRAMMED OPERATIONS	
		M1	**M2**	**EP1**	**EP2**	**T2**	**T3**
On road	Engine (1) Urania FE5W30	Every 150,000 km	Every 300,000 km	Every 100,000 km	After the first 150,000 km and subsequently every 300,000 km	Every year	Every 2 years

(1) IVECO suggests the use of these lubricants to raise the vehicle "fuel economy". The new vehicle is already equipped by IVECO with these types of lubricants, suitable also for cold climates (minimum temperature down to -30°). The change intervals depend on the use of these oils.

Off road application (quarries-construction sites)

To schedule the work, keep to the following chart:

USAGE APPLICATIONS	OILS	SERVICES			PROGRAMMED OPERATIONS		
Quarry and construction site vehicles: • concrete mixers • Tipper trucks Off road vehicles: • snowthrowers etc.	**Engine (1)** ACEA E4 Urania FE5W30	**M1**	**M2**	**M3**	**T4**	**T6**	**T7**
		Every 1000 hours	Every 1500 hours	Every 3000 hours	Every year before winter	Every year	Every 2 years

(1) IVECO suggests the use of these lubricants to raise the vehicle "fuel economy". The new vehicle is already equipped by IVECO with these types of lubricants, suitable also for cold climates (minimum temperature down to -30°). The change intervals depend on the use of these oils.

Off road application (on road usage)

To schedule the work, keep to the following chart:

USAGE APPLICATIONS	OILS	SERVICES			PROGRAMMED OPERATIONS	
		M1	**M2**	**M3**	**T2**	**T5**
On road covering middle-long distances	**Engine (1)** Urania FE5W30	Every 1000 hours	Every 1500 hours	Every 3000 hours	Gearbox oil and Intarder filter	Every year before summer

(1) IVECO suggests the use of these lubricants to raise the vehicle "fuel economy". The new vehicle is already equipped by IVECO with these types of lubricants, suitable also for cold climates (minimum temperature down to -30°). The change intervals depend on the use of these oils.

CHECKS AND/OR MAINTENANCE WORK

On road application

Type of operation	M1 Every 150.000 km	M2 Every 300.000 km
Engine		
Change engine oil	•	•
Change engine oil filters	•	•
Replacing the Blow-by filter	•	•
Check control belt conditions	•	
Change miscellaneous drive belts		•
EDC system engine check-up through MODUS or IT2000 or E.A.SY.	•	•
Replacement of variable geometry turbocharger air filter		•
Check of clutch wear of fan electromagnetic joint	•	•
Replacement of fuel prefilter cartridge	•	•
Replacing the AdBlue system filter / pre-filter	•	•
Replace engine air filter (dry filter element) (1)	•	•
Test AdBlue system with E.A.S.Y, MODUS, IT 2000	•	•

(1) Early clogging of the air cleaner is generally due to environmental conditions. For this reason it needs to be replaced when signalled by the sensor irrespective of the guidelines that anyhow have to be observed if there are no specific instructions otherwise.

Off road application

Type of operation	M1 Every 100.000 km or 1000h	M2 Every 150.000 km or 1500h	M3 Every 300.000 km or 3000h
Engine			
Change engine oil	•		•
Change engine oil filter	•		•
Replacement of fuel filter cartridge	•		•
Check miscellaneous drive belts	•		•
Check-up of engine EDC system via MODUS, IT 2000 or E.A.SY.		•	•
Check valve clearance and adjust if necessary		•	•
Change variable geometry turbocharger valve air filter		•	•
Change engine auxiliary member drive belt **			•
Change air-conditioner compressor drive belt **			•
Checking fan electromagnetic joint clutch wear (if present)	•		•
Replacement of fuel prefilter cartridge	•		•
AdBlue system filter and pre-filter change		•	•
AdBlue system test with EASY, MODUS or IT2000	•	•	•
Replace engine air filter (dry filter element) (1)*		•	•
Replacing the Blow-by filter *		•	•

(1) Early clogging of the air cleaner is generally due to environmental conditions. For this reason it needs to be replaced when signalled by the sensor irrespective of the guidelines that anyhow have to be observed if there are no specific instructions otherwise.

* Only on road usage.

** Only quarry and construction site vehicles.

NON-PROGRAMMED/TIMED OPERATIONS

On road application

EP1 - Every 100,000 km

If possible, at the same time as a maintenance service.

Cheking and adjusting play in valves and iniectors

EP2 - In the initial period at 150,000 km and then every 300,000 km

If possible, at the same time as a maintenance service.

Replacing water pump belt and generator

T2 - Every year - Before the start of Winter

If possible, at the same time as a maintenance service.

Checking coolant density

T3 - Every two years

If possible, at the same time as a maintenance service.

Changing engine coolant

Off road application (quarries-construction sites)

T4 -Every year - Before the start of Winter

If possible, at the same time as a maintenance service.

Checking coolant density
Replacing additional heater fuel filter

T6 -Every year

If possible, at the same time as a maintenance service.

Replacing the cartridge and cleaning air filter container (5)
Replacing blow-by filter

T7 -Every 2 years

If possible, at the same time as a maintenance service.

Replacing engine coolant

(5) Early air filter clogging is generally caused by environmental conditions; for this reason, air filter must be replaced when relating warning from special sensor is issued independently of relevant prescription, which must be anyhow observed in lack of specific indications.

Off road application (on road usage)

T2 -Every year - Before the start of Winter

If possible, at the same time as a maintenance service.

Checking coolant density
Replacing additional heater fuel filter

T5 -Every 2 years

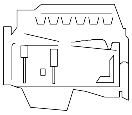
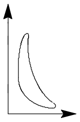
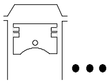
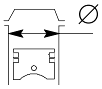
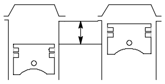
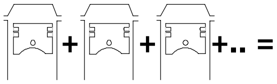
If possible, at the same time as a maintenance service.

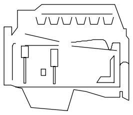
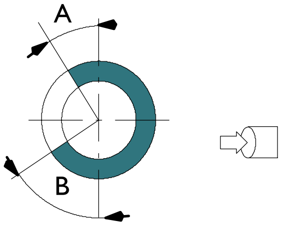
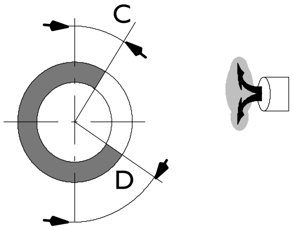
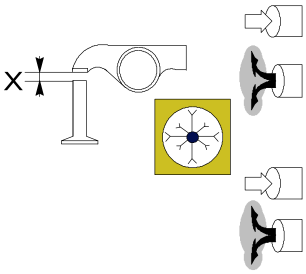
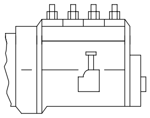
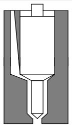
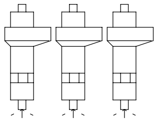
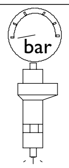
Replacing engine coolant

SECTION 4

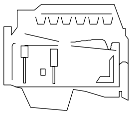
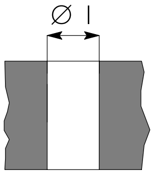
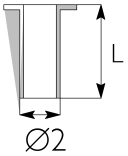
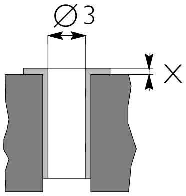
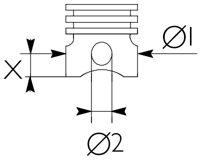
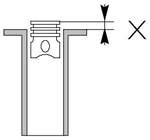
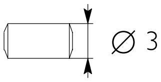
General overhaul

GENERAL CHARACTERISTICS

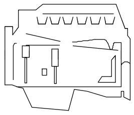
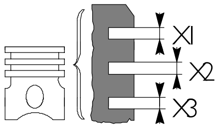
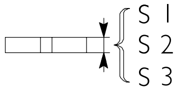
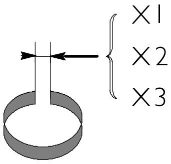
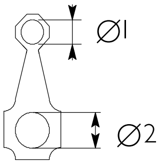
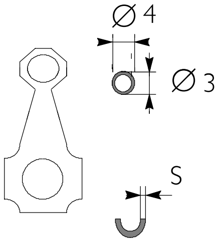
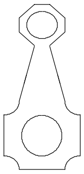
	Type		**F3BE3681**
	Cycle		4-stroke Diesel engine
	Fuel feed		Overfed with aftercooler
	Injection		Direct
	No. of cylinders		6 in line
	Bore	mm	135
	Stroke	mm	150
	Total displacement	cm^3	12880

	Type		**F3BE3681**
	VALVE TIMING		
	opens before T.D.C.	A	19°
	closes after B.D.C.	B	36°
	opens before B.D.C.	D	50°
	closes after T.D.C.	C	9°
	For timing check		
	X	mm	-
		mm	-
	Running		
	X	mm	0.35 to 0.45
		mm	0.45 to 0.55
	FEED		Through fuel pump - filters
	Injection type: Bosch		With electronically regulated injectors UIN 3.1 pump injectors controlled by overhead camshaft
	Nozzle type		–
	Injection order		1 - 4 - 2 - 6 - 3 - 5
	Injection pressure	bar	2000

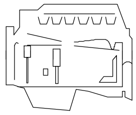
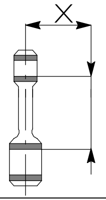
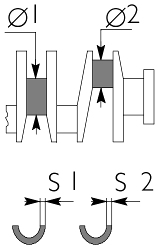
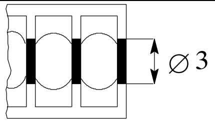
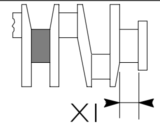
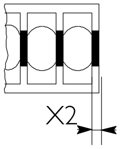
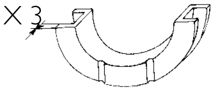
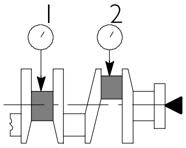
ASSEMBLY DATA - CLEARANCE

	Type		**F3BE3681**
CYLINDER ASSEMBLY AND CRANK MEMBERS			mm
 Ø 1	Cylinder liner seats Ø 1	top	153.500 to 153.525
		bottom	152.000 to 152.025
 L Ø2	Cylinder liners: outside diameter: Ø 2	top	153.461 to 153.486
		bottom	151.890 to 151.915
	length	L	–
	Cylinder liners - crankcase seats	top	0.014 to 0.039
		bottom	0.085 to 0.135
IVECO PARTS >	Outside diameter	Ø2	–
 Ø 3 X	Cylinder liners: inside diameter	Ø3A*	135.000 to 135.013
	inside diameter	Ø3B*	135.011 to 135.024
* Selection class ** Under a load of 8000 kg	protrusion	X**	0.045 to 0.075
 ØI X Ø2	Pistons:		FEDERAL MOGUL
	measurement	X	18
	outside diameter	Ø1A●	134.861 to 134.873
	outside diameter	Ø1B●●	134.872 to 134.884
	seat for pin	Ø2	54.010 to 54.018
	Piston - cylinder liners	A*	0.127 to 0.152
* Selection class		B*	0.127 to 0.152
IVECO PARTS <	Piston diameter	Ø1	–
 X	Piston protrusion	X	0.12 to 0.42
 Ø 3	Piston gudgeon pin	Ø3	53.994 to 54.000
	Piston gudgeon pin - pin seat		0.010 to 0.024

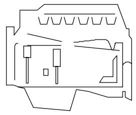
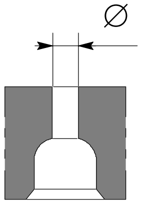
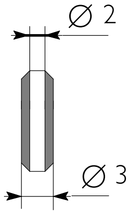
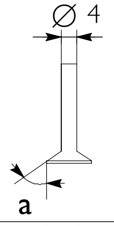
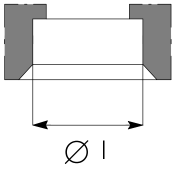
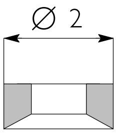
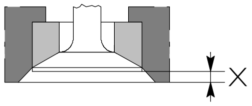
● Class A pistons supplied as spares.
●● Class B pistons are fitted in production only and are not supplied as spares.

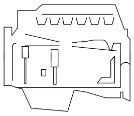
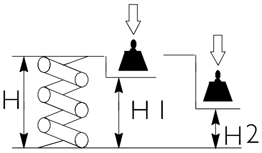
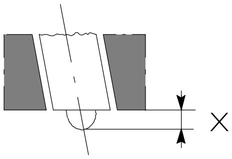
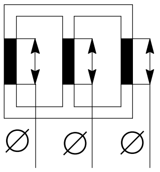
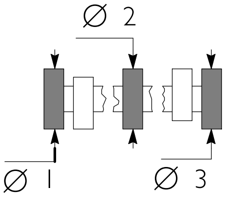
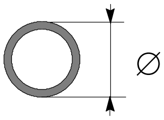
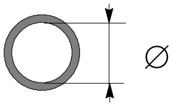
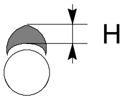
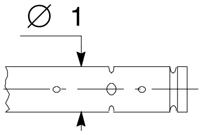
	Type	**F3BE3681** mm
	Piston ring slots X1* X2 X3 * measured on Ø of 130 mm	FEDERAL MOGUL 2.427 1.550 to 1.570 5.020 to 5.040
	Piston rings: - sealing trapezoidal S1* - sealing bevelled S2 - milled scraper ring with slots and internal spring S3 * measured at 2.5 mm from outer Ø	2.296 to 2.340 1.470 to 1.500 4.970 to 4.990
	Piston rings - slots 1 2 3	0.087 to 0.131 0.050 to 0.100 0.030 to 0.070
	Piston rings	–
	Piston ring end opening in cylinder liner X1 X2 X3	0.40 to 0.50 0.65 to 0.80 0.40 to 0.75
	Small end bushing seat Ø1 Connecting rod bearing seat Ø2 Selection class Ø2 1 2 3	59.000 to 59.030 94.000 to 94.010 94.011 to 94.020 94.021 to 94.030
	Small end bushing diameter outside Ø4 inside Ø3 Big end bearing shells S Red Green Yellow*	59.085 to 59.110 54.019 to 54.035 1.965 to 1.975 1.976 to 1.985 1.986 to 1.995
	Small end pushing - seat	0.055 to 0.110
	Piston gudgeon pin - bushing	0.019 to 0.041
	Big end bearing shells	-
	Weight of connecting rod Classes A B C	4741 to 4780 g. 4781 to 4820 g. 4821 to 4860 g.

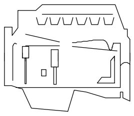
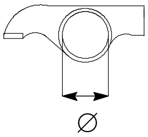
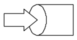
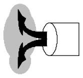
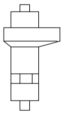
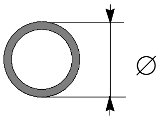
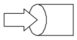
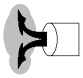
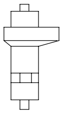
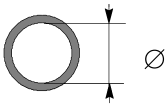
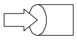
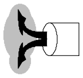
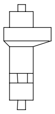
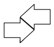
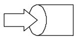
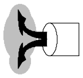
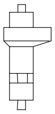
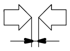
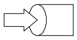
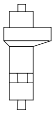
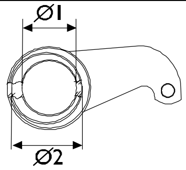
* Only mounted on production and not provided with spare.

	Type	F3BE3681
		mm
	Measurement X Maximum error on alignment of connecting rod axe //	125 0.08
	Main journals Ø1 - nominal - class 1 - class 2 - class 3 Crankpins Ø2 - nominal - class 1 - class 2 - class 3 Main bearing shells S1 Red Green Yellow* Big end bearing shells S2 Red Green Yellow*	 99.970 to 100.000 99.970 to 99.979 99.980 to 99.989 99.990 to 100.000 89.970 to 90.000 89.970 to 89.979 89.980 to 89.989 89.990 to 90.000 3.110 to 3.120 3.121 to 3.130 3.131 to 3.140 1.965 to 1.975 1.976 to 1.985 1.986 to 1.995
	Main bearing housings Ø3	106.300 to 106.330
	Bearing shells - main journals ○	0,060 to 0,108 * - 0,061 to 0,119 ** - 0,060 to 0,130 ***
	Bearing shells - crankpins ○	0,050 to 0,108 * - 0,051 to 0,109 ** - 0,050 to 0,098 ***
	Main bearing shells Big end bearing shells	0.127 - 0.254 - 0.508 0.127 - 0.254 - 0.508
	Main journal for shoulder X1	47.95 to 48.00
	Main bearing housing for shoulder X2	40.94 to 40.99
	Half thrust washers X3	3.38 to 3.43
	Crankshaft shoulder	0.10 to 0.30
	Alignment // 1 - 2 Roundness ◎ 1 - 2	0.025 0.040

* Fitted in production only and not supplied as spares.
○ Supplied as spares: * standard; ** = 0.127; *** = 0.254 - 0.508.

	Type		**F3BE3681**	
CYLINDER HEAD - TIMING SYSTEM			mm	
	Guide valve seats on cylinder head	Ø1	15.980 to 15.997	
	Valve guides	Ø2 Ø3	10.015 to 10.030 16.012 to 16.025	
	Valve guides and seats on head		0.015 to 0.045	
IVECO PARTS	Valve guides		–	
	Valves:	Ø4 α Ø4 α	9.960 to 9.975 60° 30′ ± 7′ 30″ 9.960 to 9.975 45° 30′ ± 7′ 30″	
	Valve stem and relevant guide		0.040 to 0.070	
	Seat on head for valve seat:	Ø1 Ø1	49.185 to 49.220 46.985 to 47.020	
 * provided with spare	Outside diameter of valve seats on cylinder head:	Ø2 Ø2	49.260 to 49.275 47.060 to 47.075	49.460 to 49.475* 47.260 to 47.275*
IVECO PARTS	Valve seats		0,2	
	Recessing	X X	0.45 to 0.75 1.65 to 1.95	

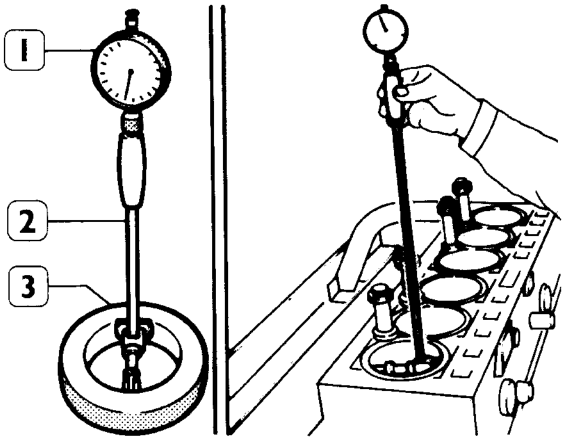
	Type	F3BE3681
		mm
	Between valve seat and head	0.040 to 0.090
	Valve spring height: free spring H under a load of: 775 ± 39 N H1 1366 ± 68 N H2	 76 59 46
	Injector protrusion X	0.52 to 1.34
	Seats for camshaft bushings in cylinder head: 1 ⇒ 7 Ø	88.000 to 88.030
	Camshaft supporting pins: 1 ⇒ 7 Ø	82.950 to 82.968
	Outside diameter of bushings for camshaft: Ø	88.153 to 88.183
	Bushing inside diameter: Ø	83.018 to 83.085
	Bushings and seats in cylinder head	0.123 to 0.183
	Bushings and supporting pins	0.050 to 0.135
	Useful cam height	9.231 9.5607 13.376
	Rocker arm shaft Ø1	41.984 to 42.000

	Type	F3BE3681 mm
	Seats for bushings in rocker arms:	
		45.000 to 45.016
		59.000 to 59.019
		46.000 to 46.016
	Outside diameter of bushings for rocker arms:	
		45.090 to 45.130
		59.100 to 59.140
		46.066 to 46.091
	Inside diameter of bushings for rocker arms:	
		42.025 to 42.041
		56.030 to 56.049
		42.015 to 42.071
	Bushings and seats:	
		0.074 to 0.130
		0.081 to 0.140
		0.050 to 0.091
	Rocker arm bushings and shaft:	
		0.025 to 0.057
		0.015 to 0.087
	Engine brake control lever	
	Eccentric pin outer diameter Ø1	55.981 to 56.000
	Rocker arms shaft seat Ø2	42.025 to 42.041

	Type	F3BE3681	
		mm	
	Rocker arms and engine brake control lever pin	0.030 to 0.068	
	Rocker arm shaft and seat on engine brake control lever	0.025 to 0.057	
TURBOCHARGER			
Type		Holset with fixed geometry HX 50	Holset with variable geometry HE 551V
End play		0.025 ÷ 0.127	0.051 ÷ 0.152
Radial movement		0.381 ÷ 0.610	0.381 ÷ 0.533

REPAIRS
CYLINDER BLOCK
Checks and measurements

Figure 1 (Demonstration)

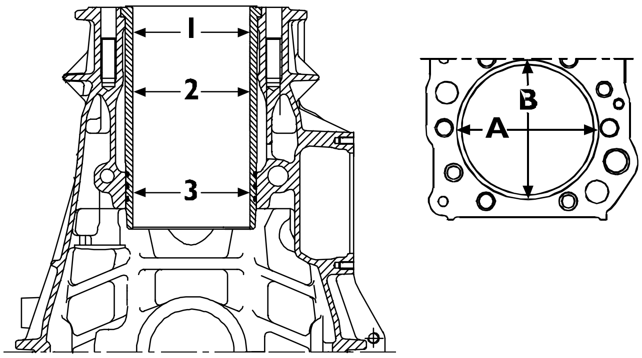


34994

The inside diameter of the cylinder liners is checked to ascertain the extent of ovalization, taper and wear using the gauge (2) fitted with the dial gauge (1), zeroed beforehand on the ring gauge (3) of diameter 135 mm.

NOTE If you do not have a ring gauge of diameter 135 mm, use a micrometer for this purpose.

Figure 2

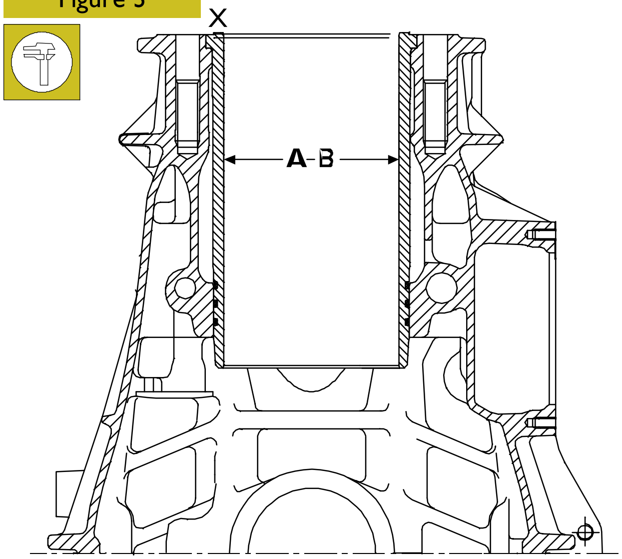


60596

1 = 1st measurement
2 = 2nd measurement
3 = 3rd measurement

The measurements have to be made on each single cylinder liner at three different heights and on two levels (A-B) at right angles to each other as shown in figure.

Figure 3



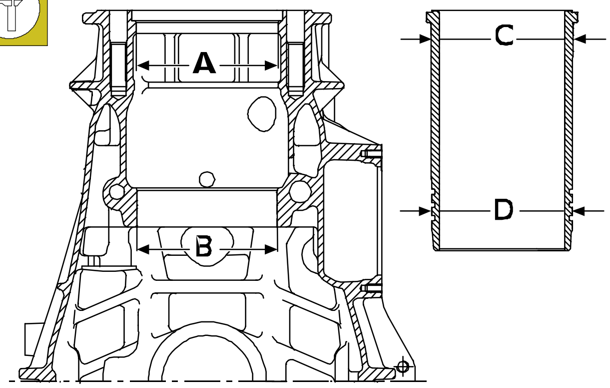
60595

A = Selection class ∅ 135.000 to 135.013 mm
B = Selection class ∅ 135.011 to 135.024 mm
X = Selection class marking area

On finding maximum wear greater than 0.150 mm or maximum ovalization of 0.100 mm compared to the values shown in the figure, you need to replace the cylinder liner as no grinding, facing or reconditioning is permitted.

NOTE The cylinder liners are supplied as spare parts with selection class "A".

Figure 4



60597

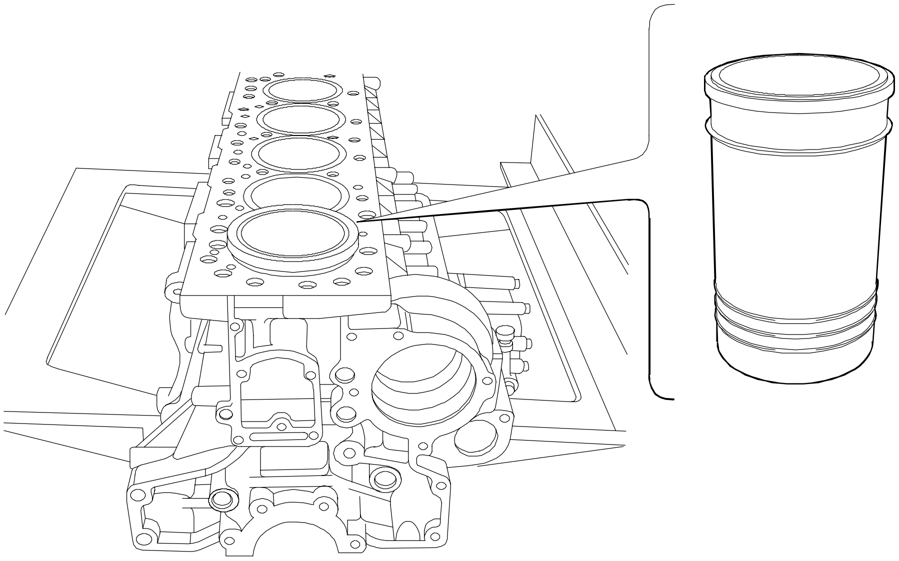
A = ∅ 153.500 to 153.525 mm
B = ∅ 152.000 to 152.025 mm
C = ∅ 153.461 to 153.486 mm
D = ∅ 151.890 to 151.915 mm

The diagram shown in the figure gives the outside diameter of the cylinder liner and inside diameter of its seat.

The cylinder liners can, if necessary, be extracted and fitted several times in different seats.

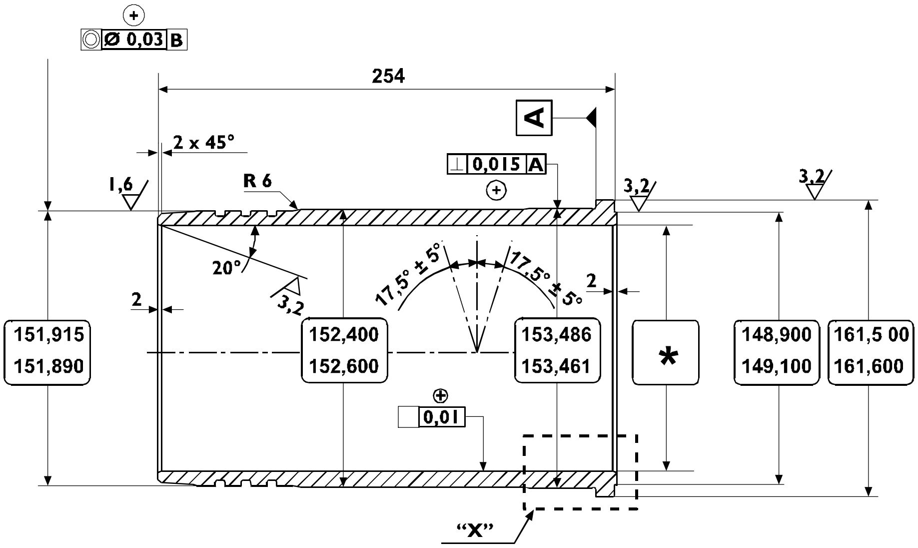
Cylinder liners

Figure 5



CRANKCASE ASSEMBLY WITH CYLINDER LINERS

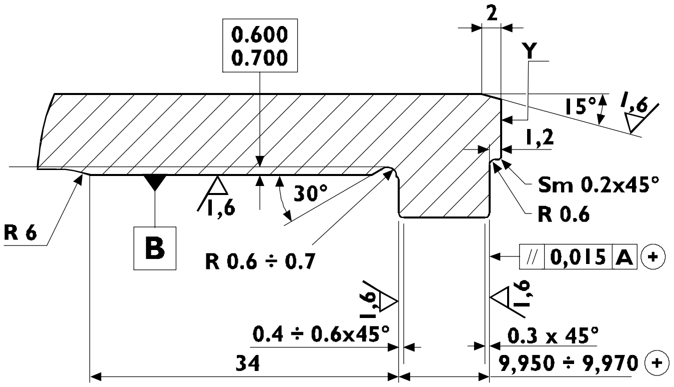
Figure 6



* Selection class
A mm 135.000 to 135.013
B mm 135.011 to 135.024

MAIN CYLINDER LINER DATA

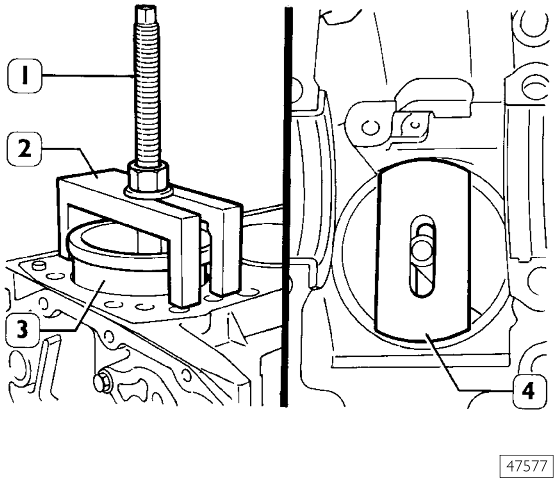
Figure 7



DETAIL "X"
"Y" - Selection class marking area

Removing cylinder liners

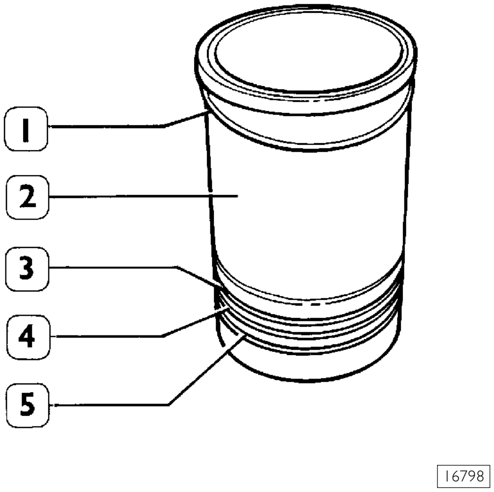
Figure 8



Position the parts 99360706 (2) and the plate 99360728 (4) as shown in the figure, checking that the plate (4) rests on the cylinder liner correctly.
Screw down the nut of screw (1) and extract the cylinder liner (3) from the crankcase.

Assembly and checking protrusion

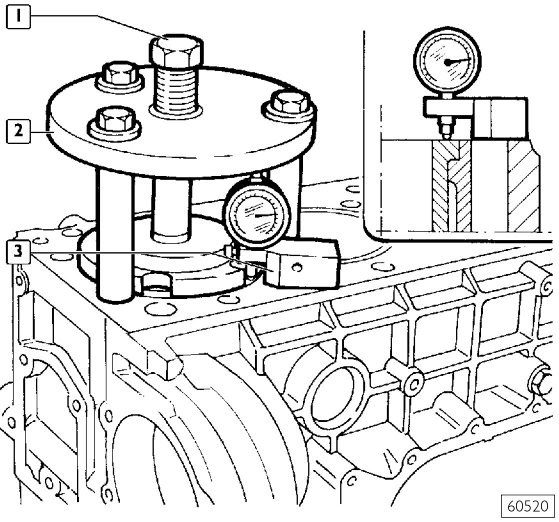
Figure 9



Always replace the water seals (3, 4 and 5).
Fit the adjustment ring (1) on the cylinder liner (2). Lubricate the bottom of it and mount it in the cylinder assembly using the appropriate tool.

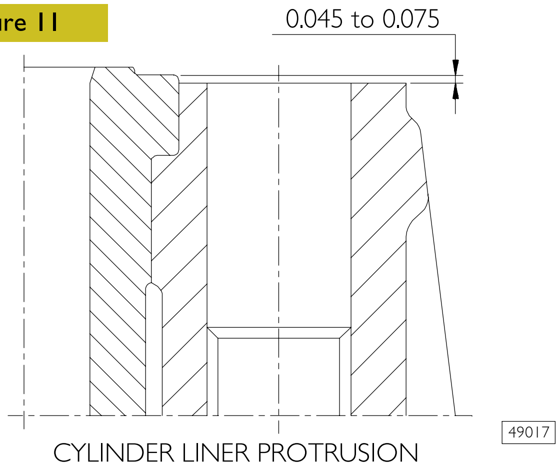
The adjustment ring (1) is supplied as a spare part with the following thicknesses: 0.08 mm - 0.10 mm - 0.12 mm - 0.14 mm.

Figure 10 (Demonstration)



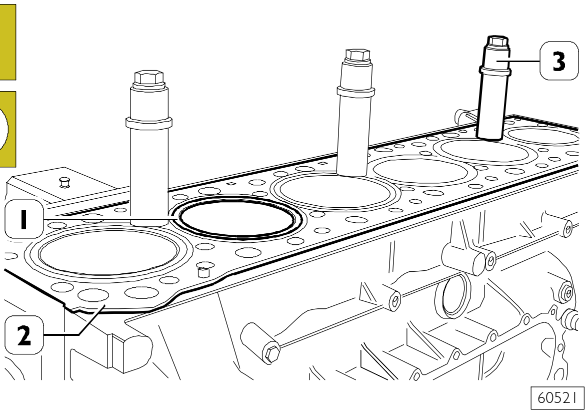
Check the protrusion of the cylinder liners with tool 99360334 (2) and tightening the screw (1) to a torque of 225 Nm.
Using the dial gauge 99395603 supplied as standard with the dial gauge base 99370415 (3), check that the protrusion of the cylinder liner over the supporting face of the cylinder head is 0.045 - 0.075 mm (Figure 11); if this is not so, replace the adjustment ring (1) (Figure 9), supplied as a spare part with several thicknesses.

Figure 11



CYLINDER LINER PROTRUSION

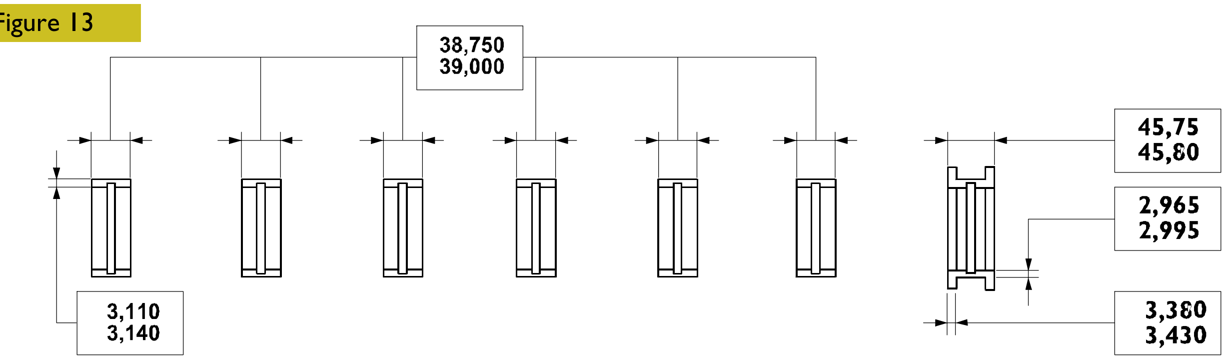
Figure 12



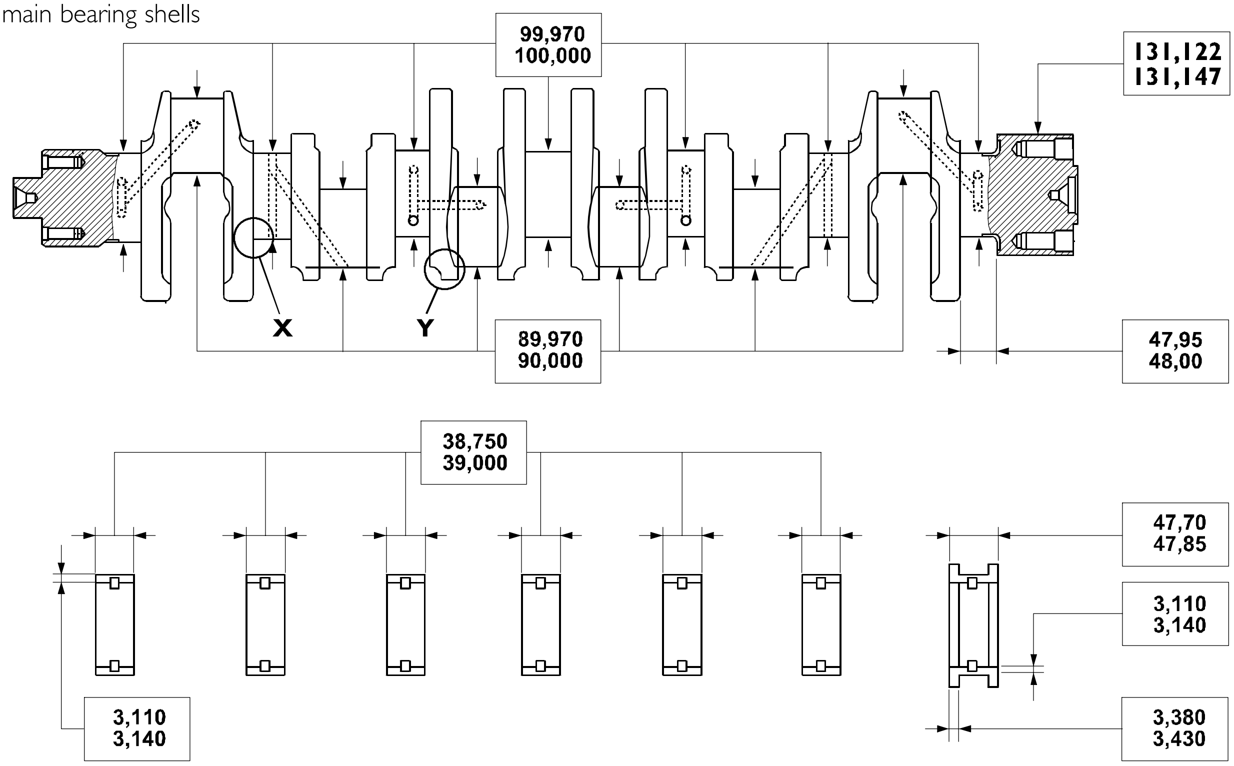
On completing assembly, lock the cylinder liners (1) to the crankcase (2) with the pins 99360703 (3).

Crankshaft

Figure 13



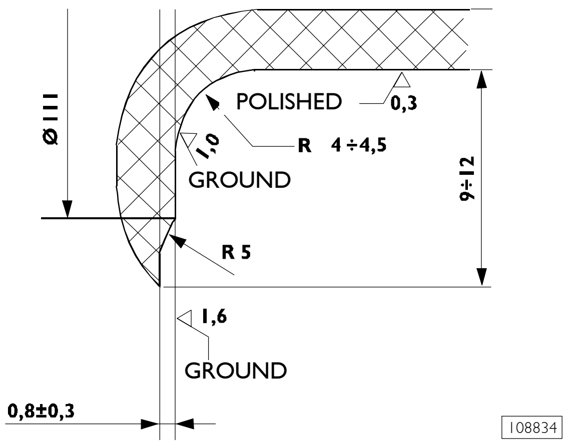
Top main bearing shells



Bottom main bearing shells

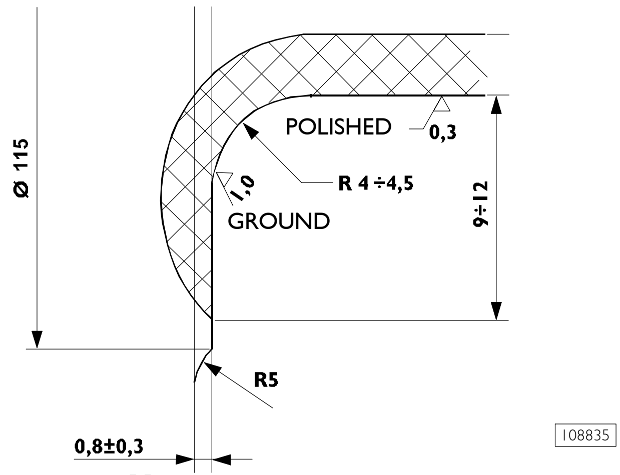
MAIN DATA OF CRANKSHAFT AND MAIN BEARING SHELLS
Check the state of the main journals and crankpins of the crankshaft. They must not be scored or be too ovalized or worn.
The data given refer to the normal diameter of the journals.

Figure 14



X. Detail of the main journal unions

Figure 15

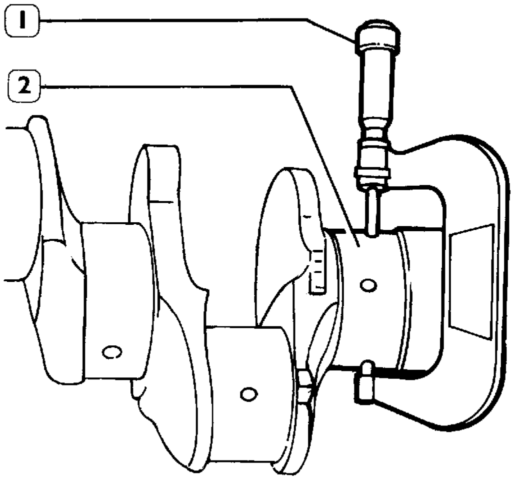


Y. Detail of the crankpin unions

Measuring the main journals and crankpins

Before grinding the journals, use a micrometric gauge (1) to measure the journals of the shaft (2) and establish, on the basis of the undersizing of the spare bearing shells, to what diameter it is necessary to reduce the journals.

Figure 16

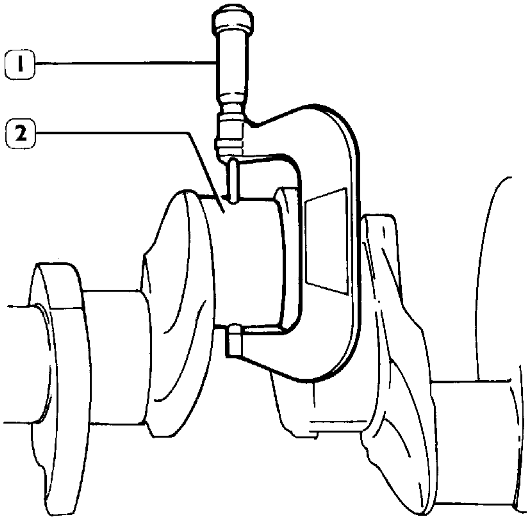


47535

MEASURING THE MAIN JOURNALS

NOTE It is advisable to note the measurements in a table (Figure 17).

Figure 18



47536

MEASURING CRANKPINS

When grinding, pay the utmost attention to the values of the unions of the main journals and of the crankpins given in Figure 14 and Figure 15.

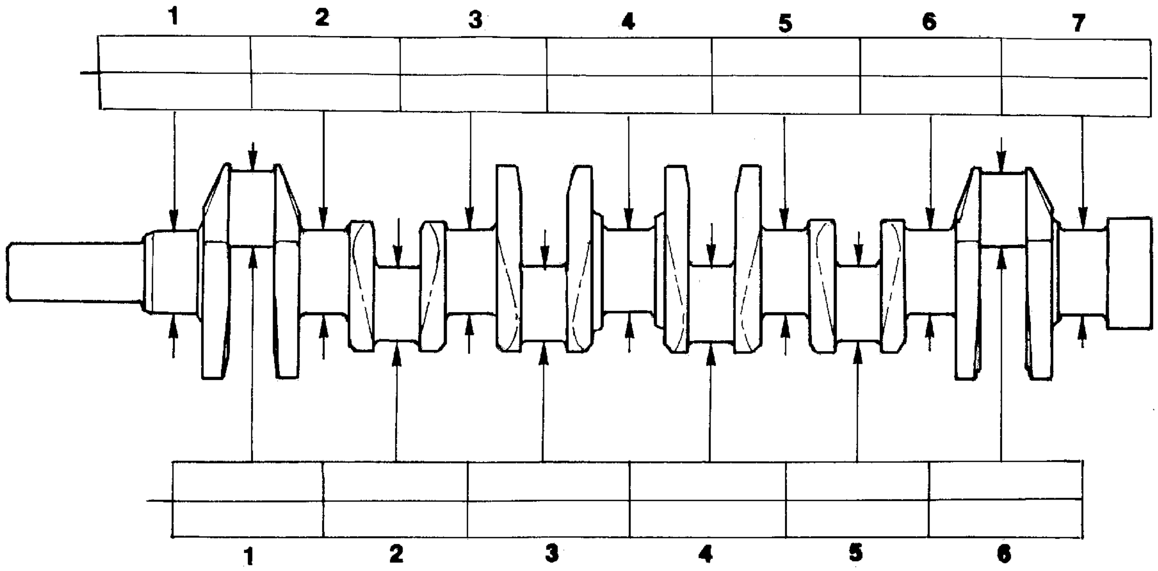
NOTE All the main journals and crankpins should always be ground to the same undersizing class so as not to alter the balance of the shaft.

Figure 17

Table for noting down the measurements of the main journals and crankpins of the crankshaft.

MAIN JOURNALS

∅ MIN.
∅ MAX.



∅ MIN.
∅ MAX.

CRANKPINS

36061

Preliminary measurement of main and big end bearing shell selection data

For each of the journals of the crankshaft, it is necessary to carry out the following operations:

MAIN JOURNALS:

- ☐ Determine the class of diameter of the seat in the crankcase.
- ☐ Determine the class of diameter of the main journal.
- ☐ Select the class of the bearing shells to mount.

CRANKPINS:

- ☐ Determine the class of diameter of the seat in the connecting rod.
- ☐ Determine the class of diameter of the crankpin.
- ☐ Select the class of the bearing shells to mount.

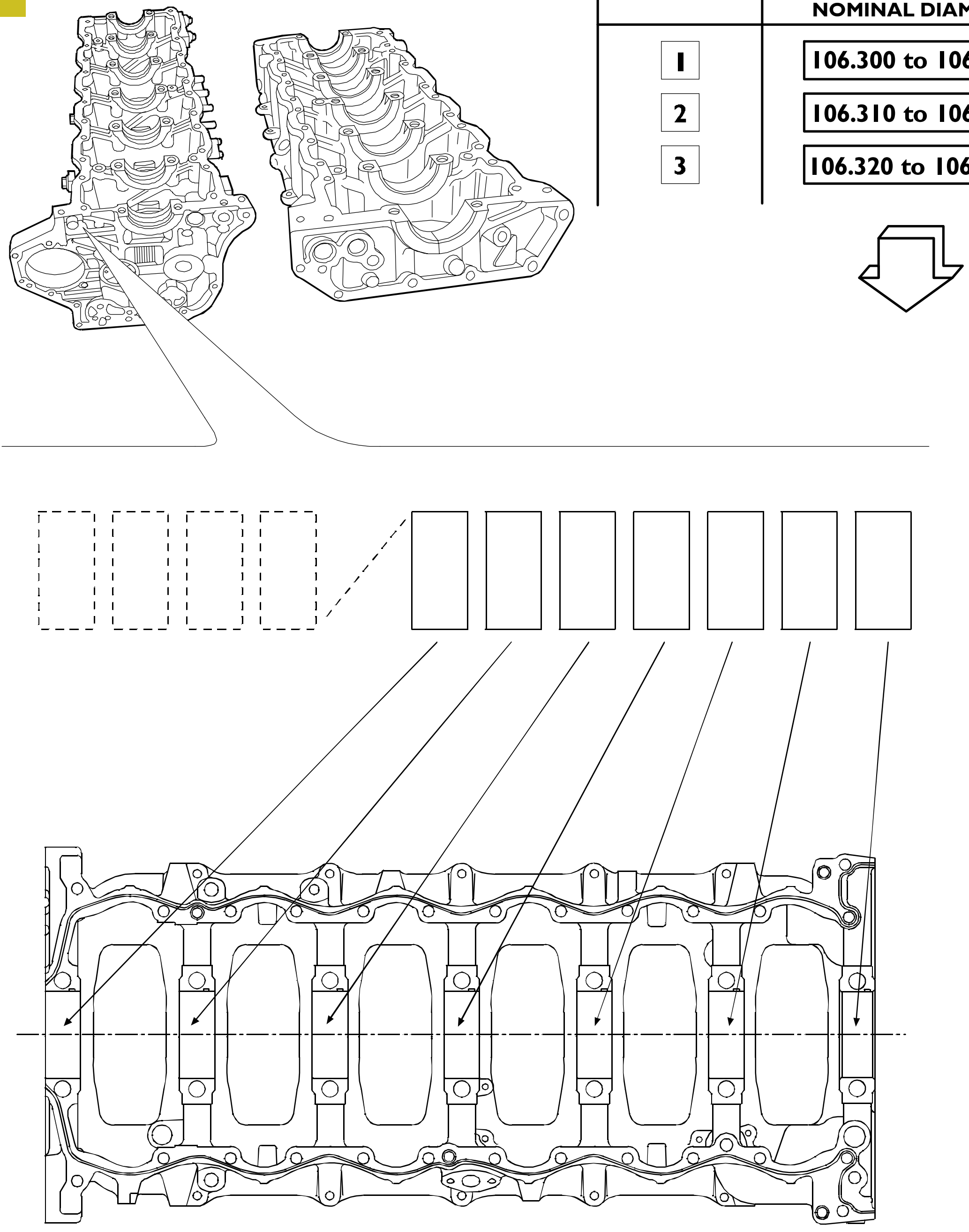
DEFINING THE CLASS OF DIAMETER OF THE SEATS FOR BEARING SHELLS ON THE CRANKCASE

On the front of the crankcase, two sets of numbers are marked in the position shown (Figure 19 at top).

- ☐ The first set of digits (four) is the coupling number of the crankcase with its base.
- ☐ The following seven digits, taken singly, are the class of diameter of each of the seats referred to (Figure 19 at bottom).
- ☐ Each of these digits may be **1**, **2** or **3**.

Figure 19

CLASS	MAIN BEARING HOUSING NOMINAL DIAMETER
1	106.300 to 106.309
2	106.310 to 106.319
3	106.320 to 106.330



Selecting the main bearing and big end bearing shells

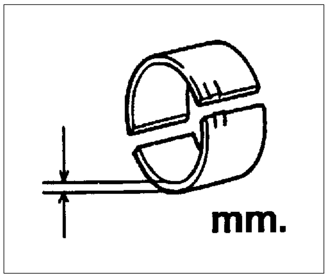
NOTE To obtain the required assembly clearances, the main bearing and big end bearing shells have to be selected as described hereunder.

This operation makes it possible to identify the most suited bearing shells for each of the journals of the shaft (the bearing shells may even have different classes for different pins).

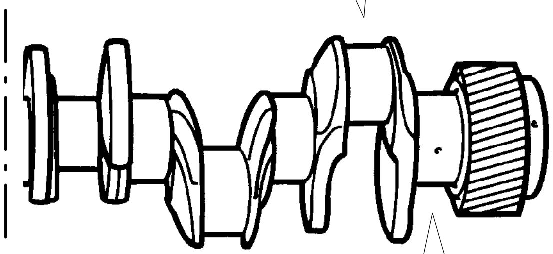
Depending on the thickness, the bearing shells are selected in classes of tolerance marked by a colour (red-green - red/black - green/black).

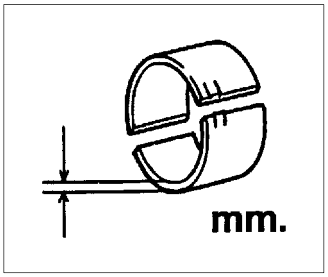
Figure 20 gives the specifications of the main bearing and big end bearing shells available as spare parts in the standard sizes (STD) and in the permissible oversizes (+0.127, +0.254, +0.508).

Figure 20



Big end bearing shells	STD	+0.127	+0.254	+0.508
red	1.965 to 1.975		2.092 to 2.102	2.219 to 2.229
red/black		2.028 to 2.038		
green	1.976 to 1.985		2.103 to 2.112	2.230 to 2.239
green/black		2.039 to 2.048		





Main bearing shells	STD	+0.127	+0.254	+0.508
red	3.110 to 3.120		3.237 to 3.247	3.364 to 3.374
red/black		3.173 to 3.183		
green	3.121 to 3.130			
green/black		3.184 to 3.193		

Defining the class of diameter of the main journals and crankpins (Journals with nominal diameter)

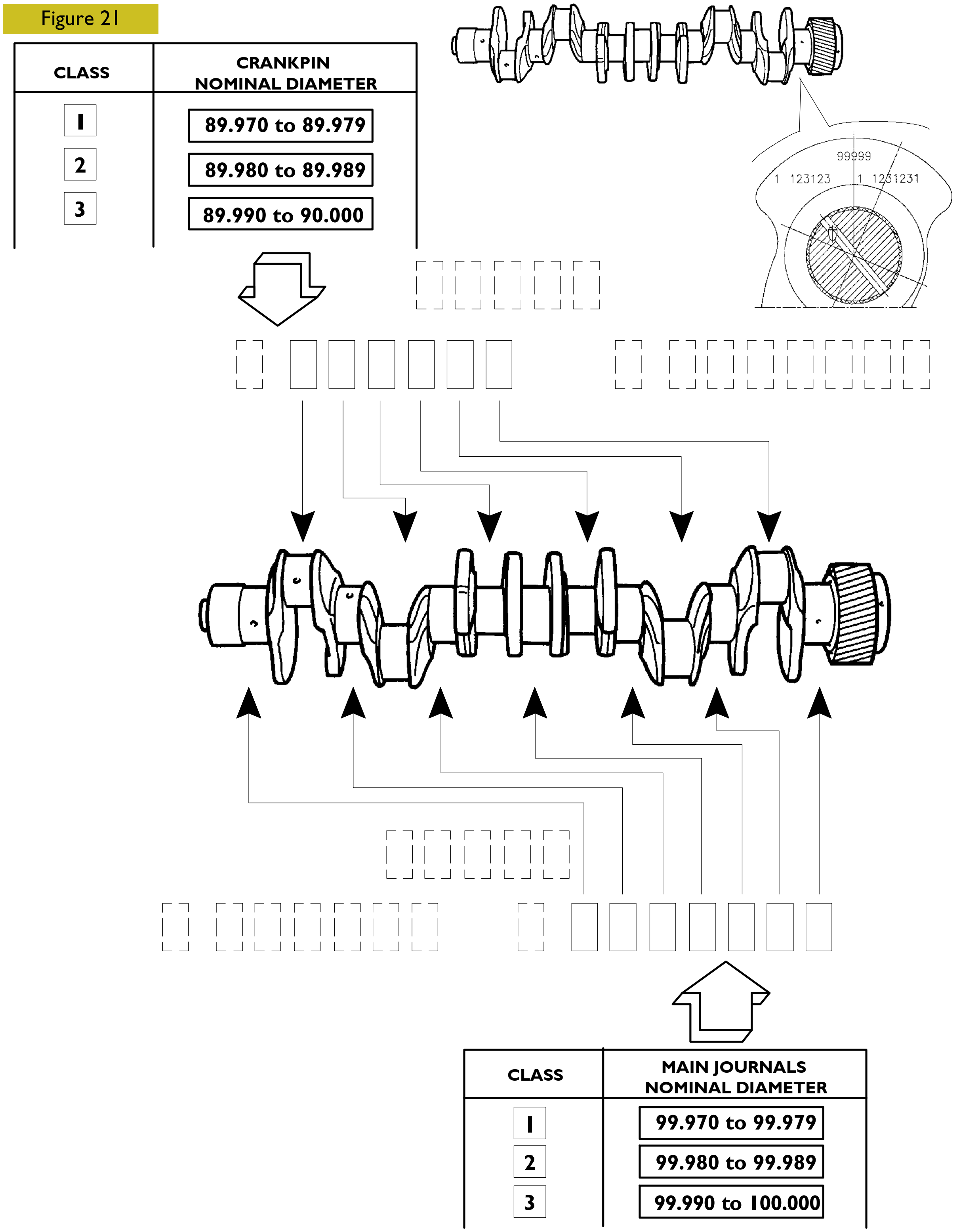
Main journals and crankpins: determining the class of diameter of the journals.
Three sets of numbers are marked on the crankshaft in the position shown by the arrow (Figure 21 at top):

☐ The first number, of five digits, is the part number of the shaft.

☐ Under this number, on the left, a set of six digits refers to the crankpins and is preceded by a single digit showing the status of the journals (1 = STD, 2 = -0.127), the other six digits, taken singly, give the class of diameter of each of the crankpins they refer to (Figure 21 at top).

☐ The set of seven digits, on the right, refers to the main journals and is preceded by a single digit: the single digit shows the status of the journals (1 = STD, 2 = -0.127), the other seven digits, taken singly, give the class of diameter of each of the main journals they refer to (Figure 21 at bottom).

Figure 21



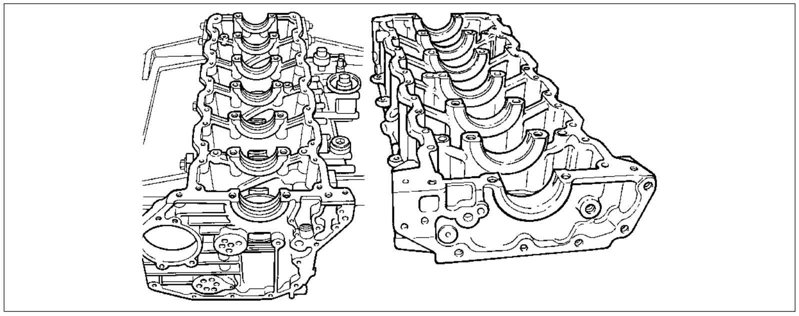
CLASS	CRANKPIN NOMINAL DIAMETER
1	89.970 to 89.979
2	89.980 to 89.989
3	89.990 to 90.000

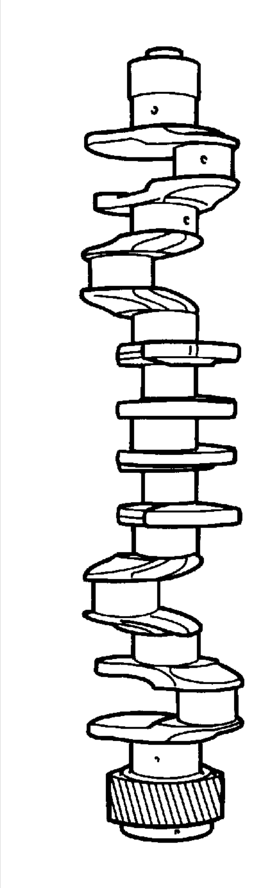
CLASS	MAIN JOURNALS NOMINAL DIAMETER
1	99.970 to 99.979
2	99.980 to 99.989
3	99.990 to 100.000

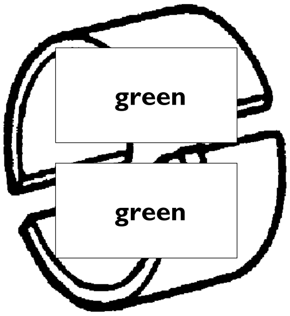
Selecting the main bearing shells (Journals with nominal diameter)

After reading off the data, for each of the main journals, on the crankcase and crankshaft, you choose the type of bearing shells to use according to the following table:

Figure 22





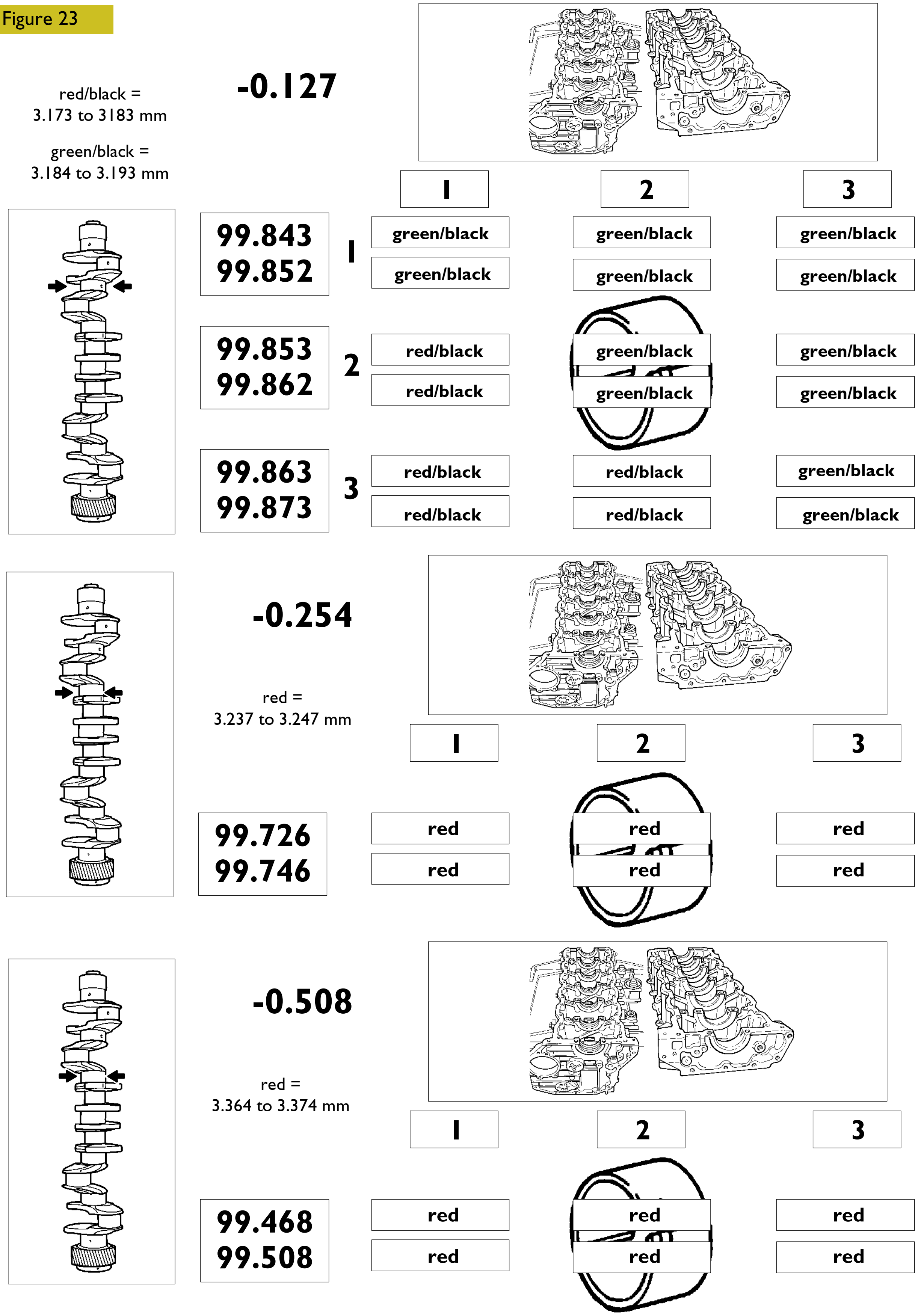


STD.	1	2	3
1	green green	green green	green green
2	red red	green green	green green
3	red red	red red	green green

Selecting the main bearing shells (ground journals)

If the journals have been ground, the procedure described so far cannot be applied.
In this case, it is necessary to check that the new diameter of the journals is shown in the table and to mount the only type of bearing shell envisaged for the relevant undersizing.

Figure 23



red/black =
3.173 to 3183 mm

green/black =
3.184 to 3.193 mm

-0.127

		1	2	3
99.843 99.852	1	green/black green/black	green/black green/black	green/black green/black
99.853 99.862	2	red/black red/black	green/black green/black	green/black green/black
99.863 99.873	3	red/black red/black	red/black red/black	green/black green/black

-0.254

red =
3.237 to 3.247 mm

	1	2	3
99.726 99.746	red red	red red	red red

-0.508

red =
3.364 to 3.374 mm

	1	2	3
99.468 99.508	red red	red red	red red

Selecting the big end bearing shells (journals with nominal diameter)

There are three markings on the body of the connecting rod in the position indicated as "A":

1 Letter indicating the class of weight:

A = 4741 to 4780 g.
B = 4781 to 4820 g.
C = 4821 to 4860 g.

2 Number indicating the selection of the diameter of the big end bearing seat:

1 = 94.000 to 94.010 mm
2 = 94.011 to 94.020 mm
3 = 94.021 to 94.030 mm

3 Numbers identifying the cap-connecting rod coupling.

The number, indicating the class of diameter of the bearing shell seat may be **1**, **2** o **3**.

Determine the type of big end bearing to fit on each journal by following the indications in the table (Figure 25).

Figure 24

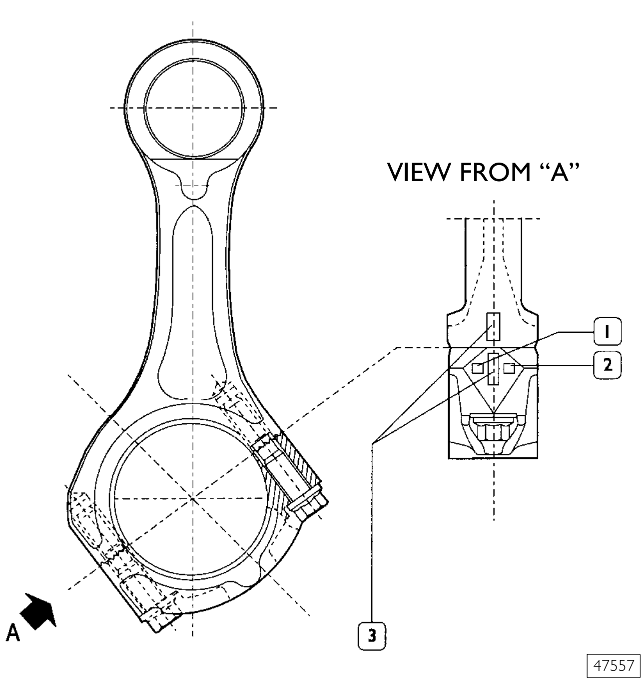
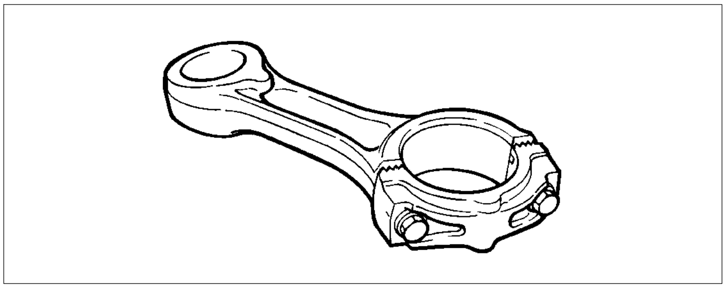
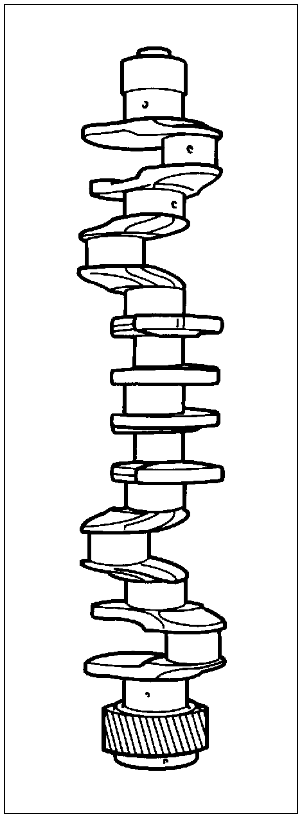


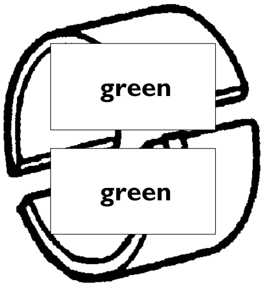
Figure 25

STD.





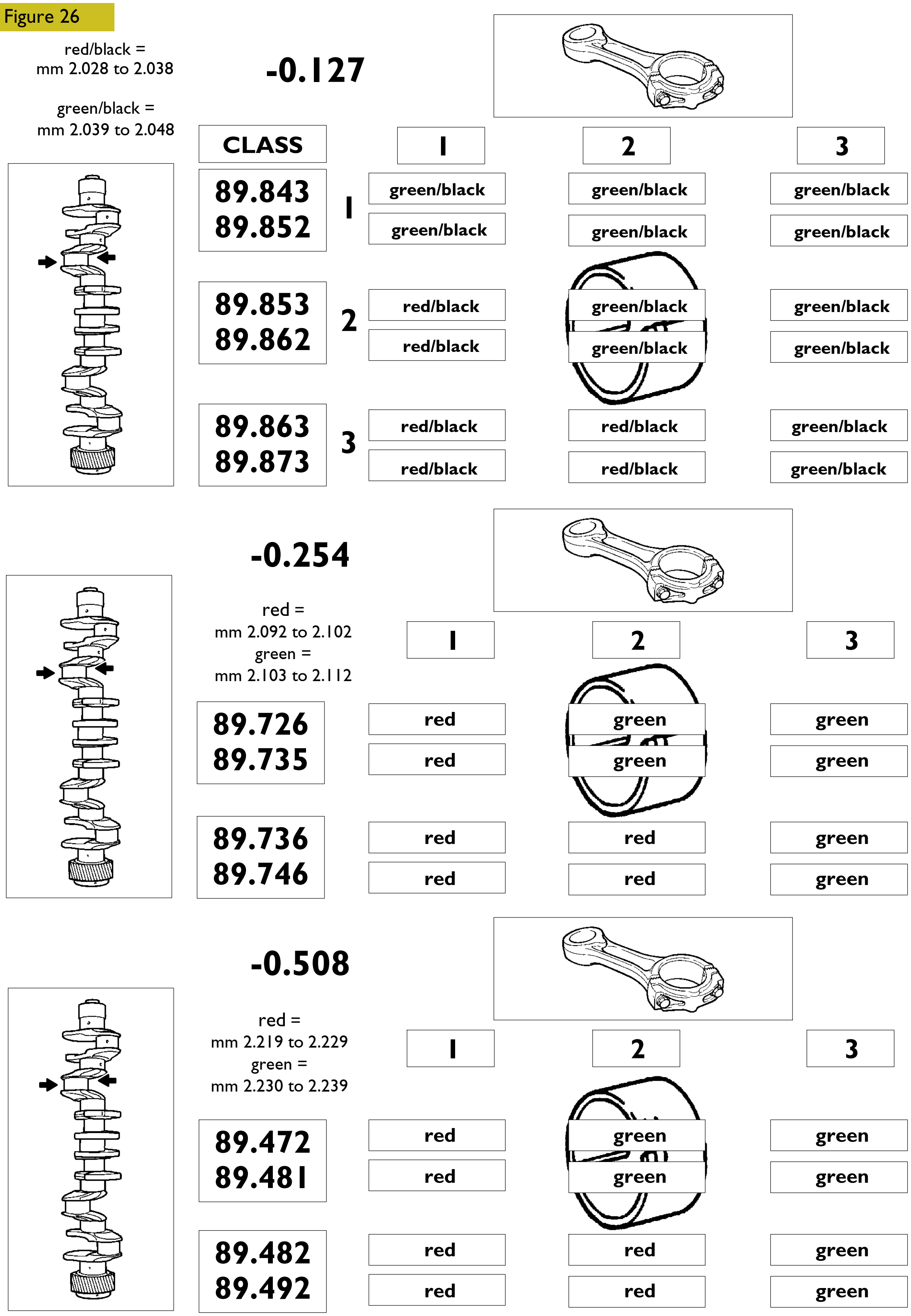
CLASS	1	2	3
1	green green	green green	green green
2	red red	green green	green green
3	red red	red red	green green



SELECTING BIG END BEARING SHELLS (GROUND JOURNALS)

If the journals have been ground, the procedure described so far cannot be applied.
In this case, it is necessary to check (for each of the undersizings) which field of tolerance includes the new diameter of the crankpins and to mount the bearing shells identified with the relevant table.

Figure 26



-0.127

red/black = mm 2.028 to 2.038

green/black = mm 2.039 to 2.048

CLASS		1	2	3
89.843 89.852	1	green/black green/black	green/black green/black	green/black green/black
89.853 89.862	2	red/black red/black	green/black green/black	green/black green/black
89.863 89.873	3	red/black red/black	red/black red/black	green/black green/black

-0.254

red = mm 2.092 to 2.102
green = mm 2.103 to 2.112

	1	2	3
89.726 89.735	red red	green green	green green
89.736 89.746	red red	red red	green green

-0.508

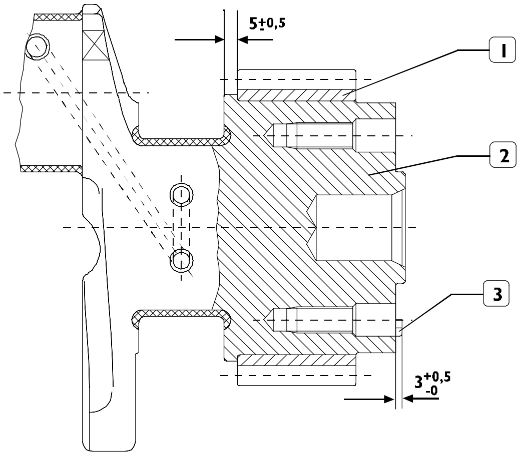
red = mm 2.219 to 2.229
green = mm 2.230 to 2.239

	1	2	3
89.472 89.481	red red	green green	green green
89.482 89.492	red red	red red	green green

Replacing the timing gear and oil pump

Check that the toothing of the gear is neither damaged nor worn; if it is, take it out with an appropriate extractor and replace it.

Figure 27



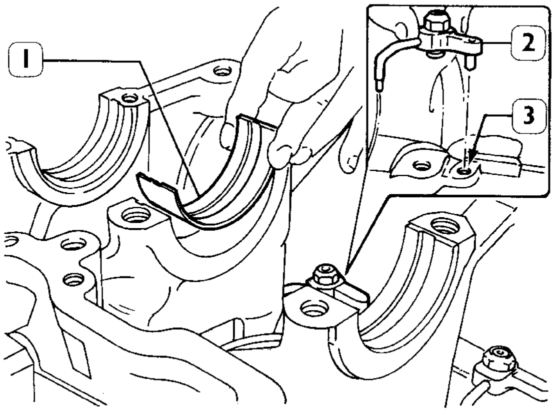
108836

When fitting the gear (1) on the crankshaft (2), heat it for no longer than 2 hours in an oven at a temperature of 180°C. After driving it in, leave it to cool.

If changing the pin (3), after fitting it on, check it protrudes from the crankshaft as shown in the figure.

Checking main journal assembly clearance

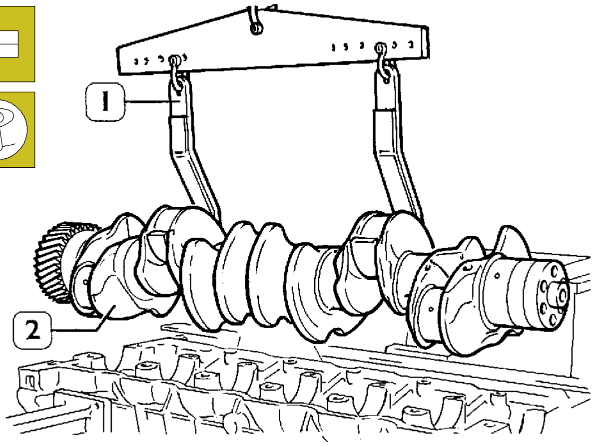
Figure 28



47579

Mount the oil nozzles (2), making the grub screw match the hole (3) on the crankcase.
Arrange the bearing shells (1) on the main bearing housings.

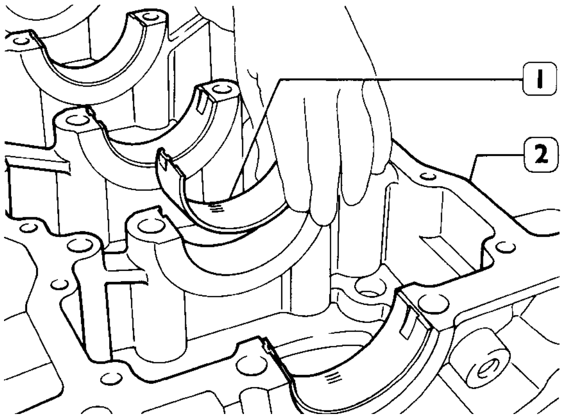
Figure 29



47578

Using the tackle and hook 99360500 (1), mount the crankshaft (2).

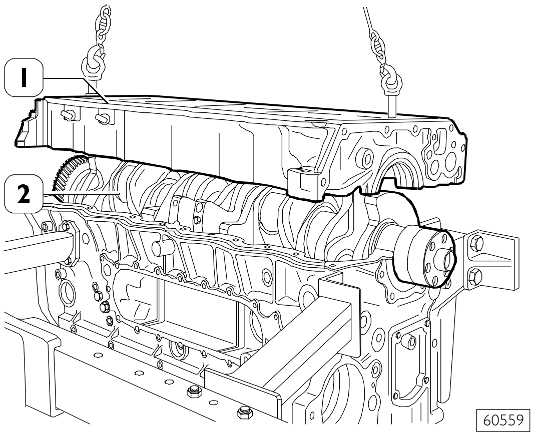
Figure 30



49021

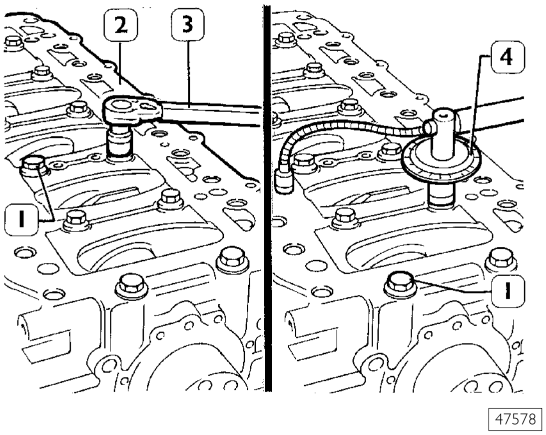
Arrange the bearing shells (1) on the main bearing housings in the crankcase base (2).
Check the assembly clearance between the main journals of the crankshaft and their bearings, proceeding as illustrated on the following pages.

Figure 31



Set two journals of the crankshaft (2) parallel to the longitudinal axis, a section of calibrated wire. Using appropriate hooks and tackle, mount the crankcase base (1).

Figure 32



☐ Lubricate the internal screws (1) with UTDM oil and tighten them with a torque wrench (3) to a torque of 120 Nm, using tool 99395216 (4), to an angle of 60°, following the diagram below.

Figure 33

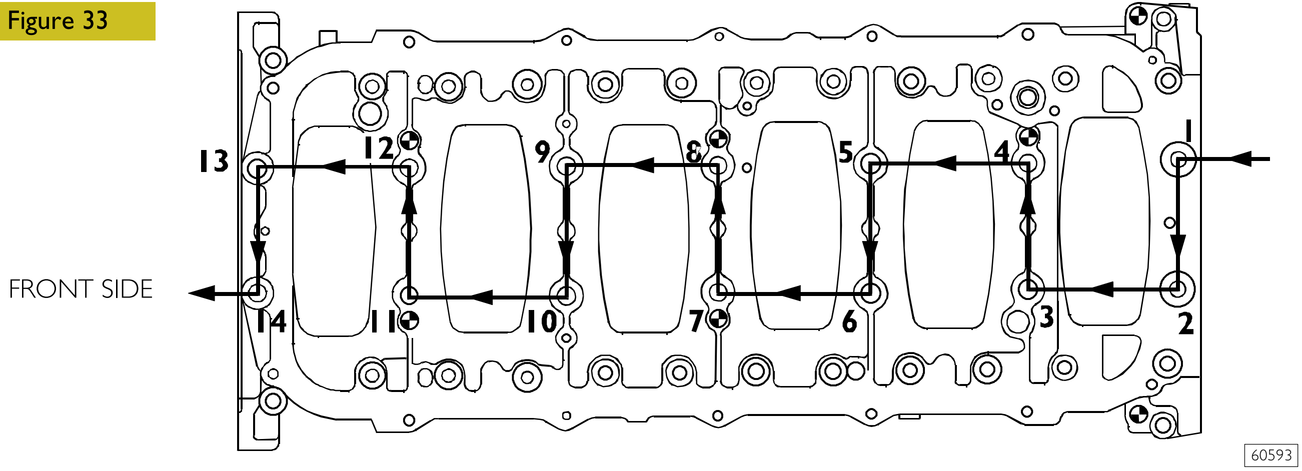
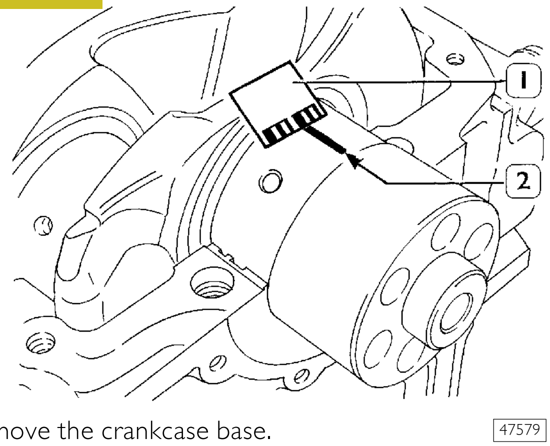


DIAGRAM OF SEQUENCE FOR TIGHTENING THE SCREWS FIXING THE BOTTOM CRANKCASE BASE TO THE CRANKCASE

Figure 34



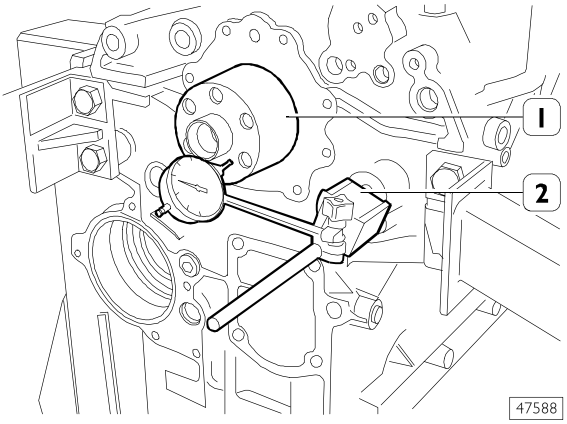
☐ Remove the crankcase base.

The clearance between the main bearings and their journals is measured by comparing the width taken on by the calibrated wire (2) at the point of greatest crushing with the graduated scale on the case (1) containing the calibrated wire.

The numbers on the scale give the clearance of the coupling in millimetres. If you find the clearance is not as required, replace the bearing shells and repeat the check.

Checking crankshaft end float

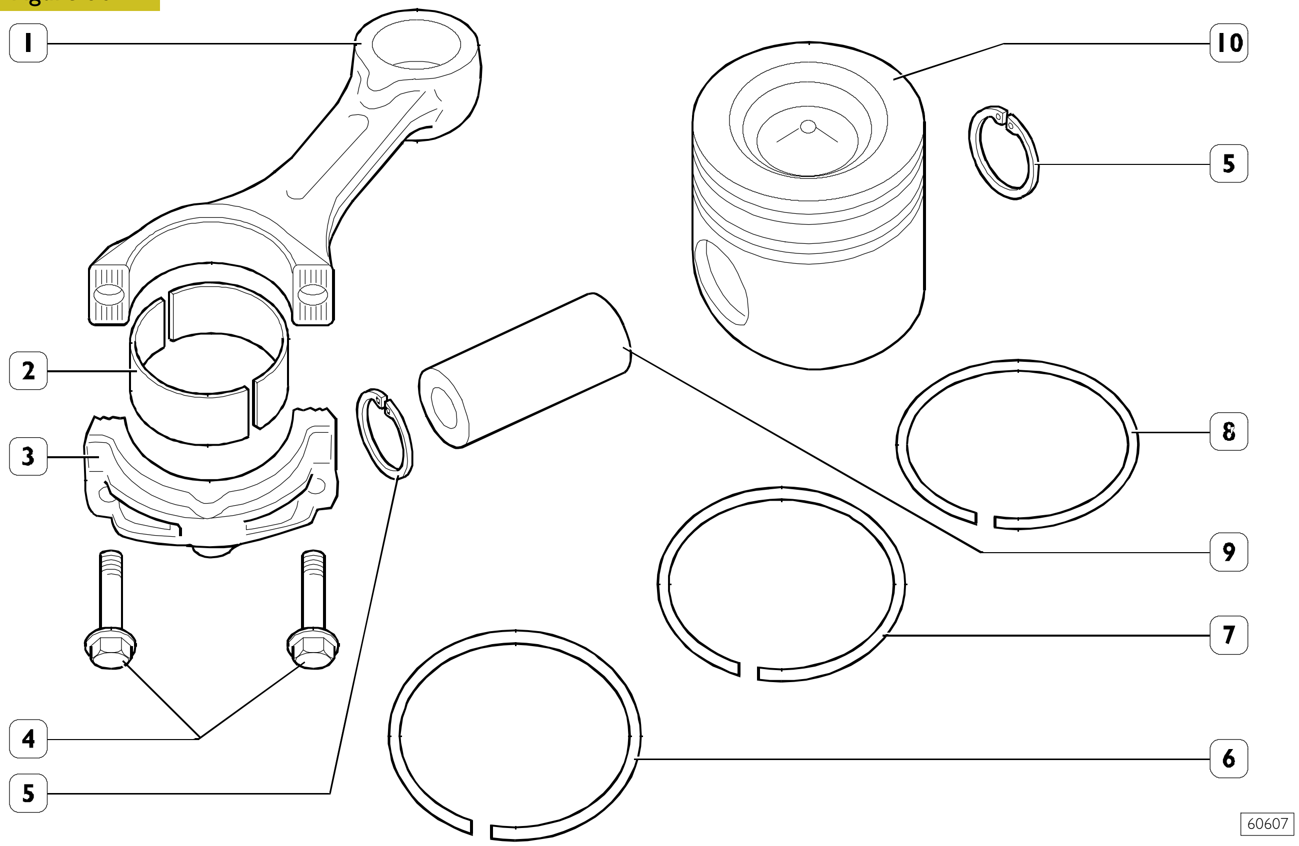
Figure 35



The end float is checked by setting a dial gauge (1) 99395603 with a magnetic base on the crankshaft (2) as shown in the figure. If you find the clearance to be greater than as required, replace the rear main bearing shells carrying the thrust bearings and repeat the clearance check.

PISTON CONNECTING ROD ASSEMBLY

Figure 36



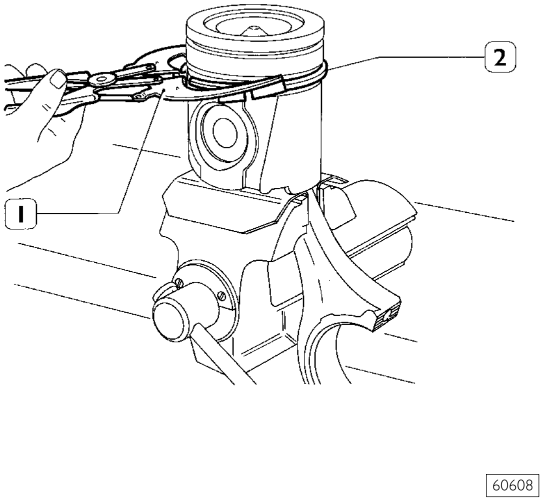
PISTON CONNECTING ROD ASSEMBLY

1. Connecting rod body - 2. Half bearings - 3. Connecting rod cap - 4. Cap fastening screws - 5. Split ring - 6. Scraper ring with spiral spring - 7. Bevel cut sealing ring - 8. Trapezoidal sealing ring - 9. Piston pin - 10. Piston.

Make sure the piston does show any trace of seizing, scoring, cracking; replace as necessary.

Removal

Figure 37

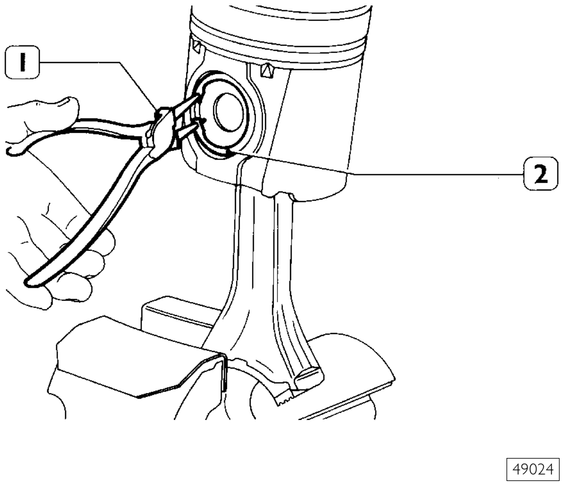


Removal of the piston split rings (2) using the pliers 99360184 (1).

Pistons are equipped with three elastic rings: a sealing ring, a trapezoidal ring and a scraper ring.

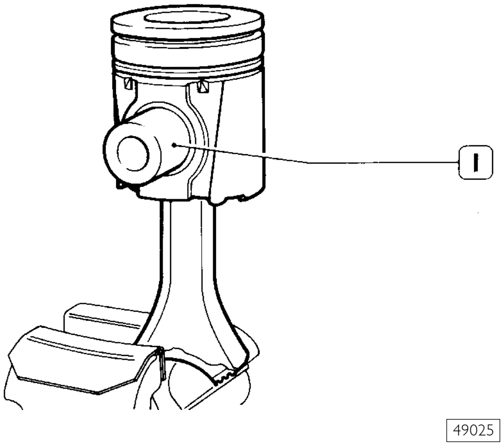
Pistons are grouped into classes A and B for diameter.

Figure 38



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

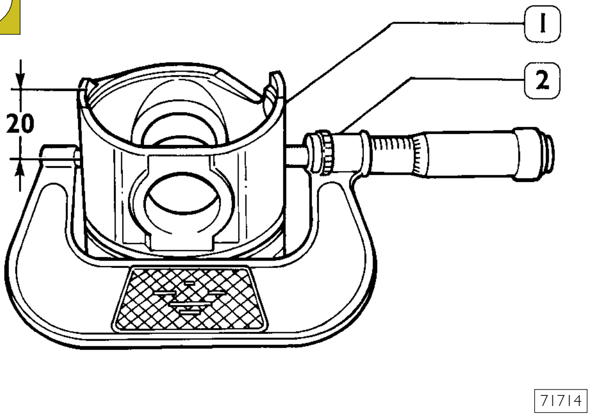
Figure 39



Remove the piston pin (1).
If removal is difficult use the appropriate beater.

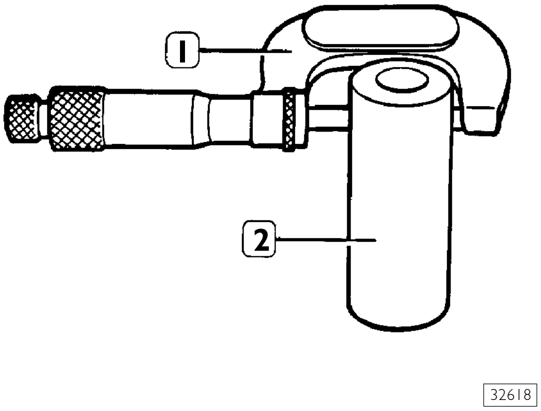
Measuring the diameter of the pistons

Figure 40



Using a micrometer (2), measure the diameter of the piston (1) to determine the assembly clearance; the diameter has to be measured at the value X shown:

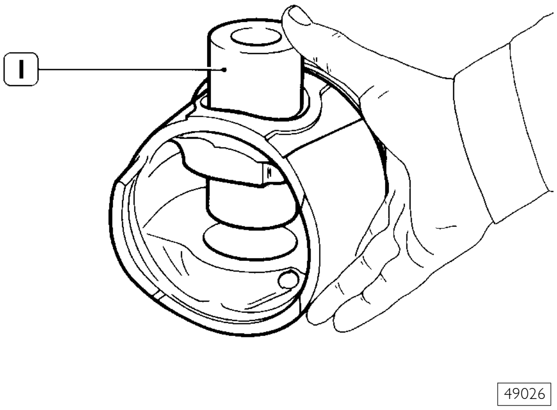
Figure 41



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

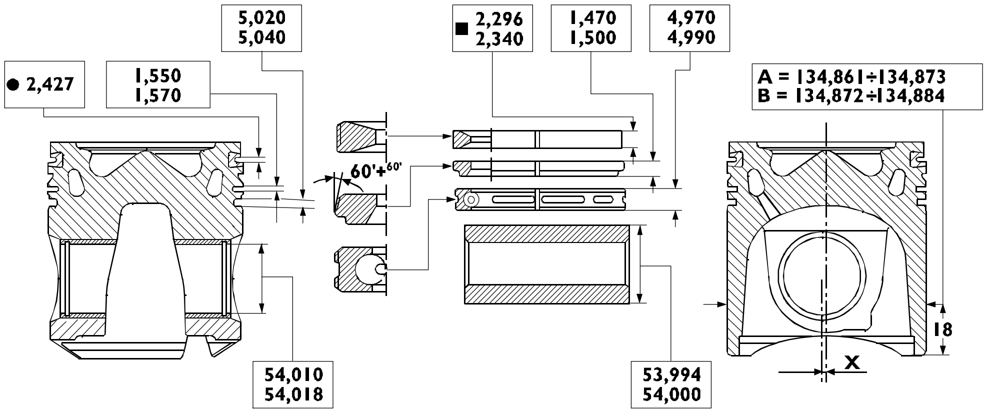
Conditions for correct gudgeon pin-piston coupling

Figure 42



Lubricate the pin (1) and the relevant housing on the piston hubs with engine oil; piston must be inserted with a slight finger pressure and it should not come out by gravity.

Figure 43

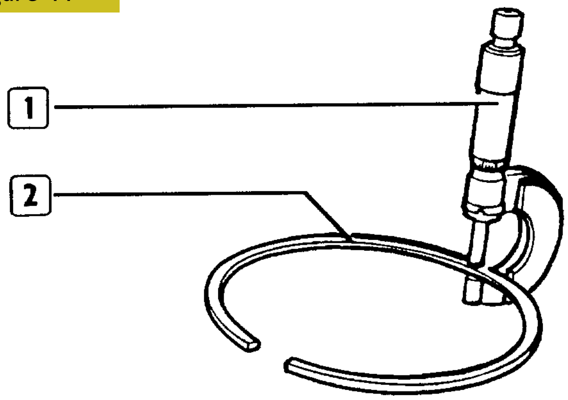


MAIN DATA OF THE PISTON, PISTON RINGS AND PIN

● Dimension detected on 130 mm ∅. - ■ measured at 2.5 mm from outer ∅ - X = 0,8±0,1

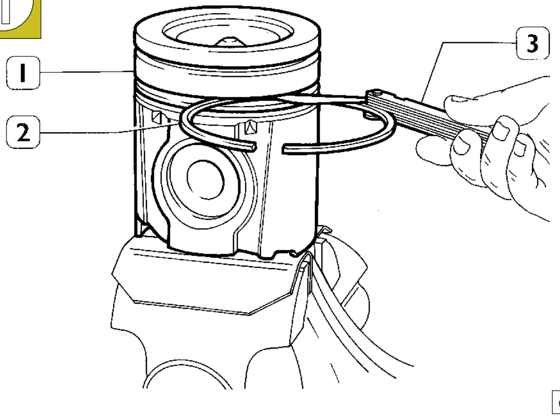
Piston rings

Figure 44



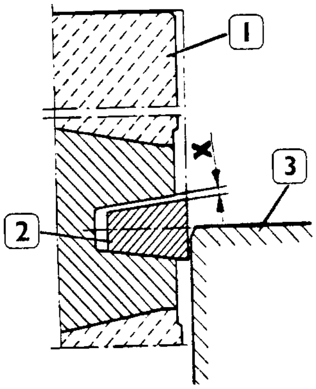
Check the thickness of the piston ring (2) with a micrometer (1).

Figure 45



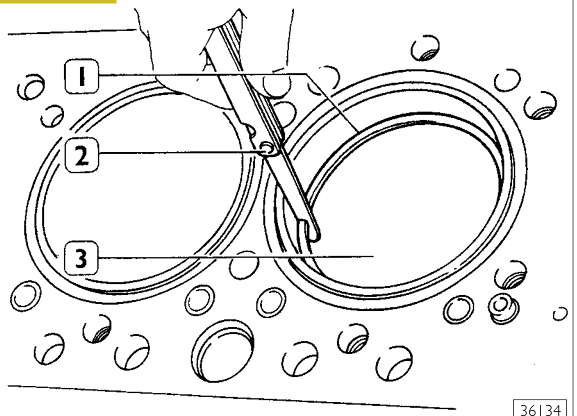
Check the clearance between the seals (2) and their seats on the piston (1) with a feeler gauge (3).

Figure 46



The seal (2) of the 1st slot has a V shape. The clearance "X" between the seal and its seat is measured by setting the piston (1) with the ring in the cylinder liner (3) so that the seal comes half out of the cylinder liner.

Figure 47



Using a feeler gauge (2), check the opening between the ends of the seals (1) inserted in the cylinder liner (3).

If you find the distance between the ends is less than or greater than as required, replace the piston rings.

Connecting rod

Figure 48

Punched on the big end of the connecting rod are the data relating to the section in classes relating to the connecting rod seats and the weights.

NOTE On assembling the connecting rods, check they are all of the same class of weight.

Connecting rod punch markings

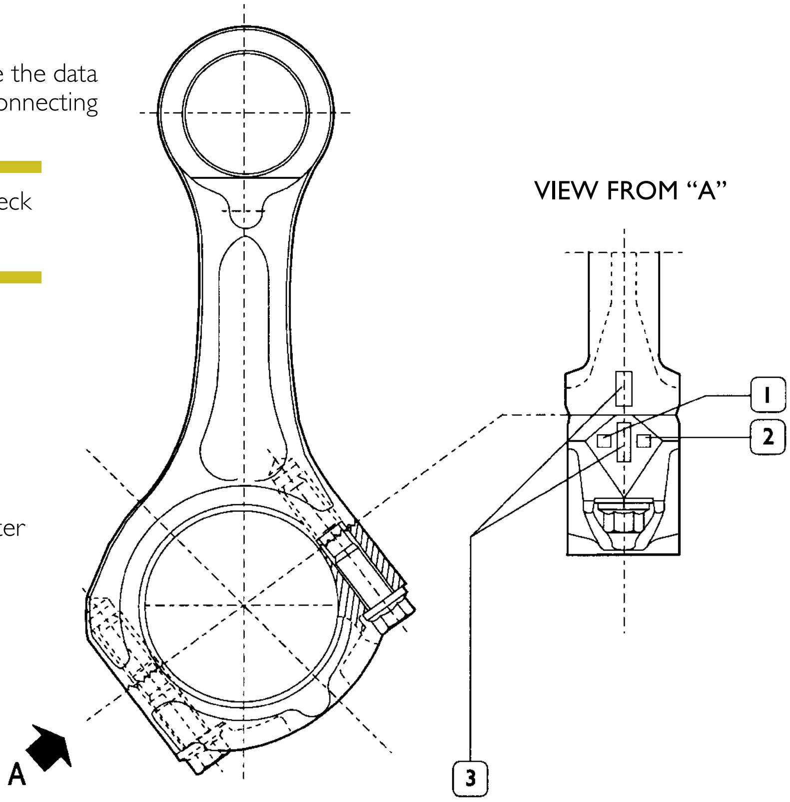
1 Letter indicating the class of weight:

A = 4741 to 4780 g.
B = 4781 to 4820 g.
C = 4821 to 4860 g.

2 Number indicating the selection of the diameter of the big end bearing seat:

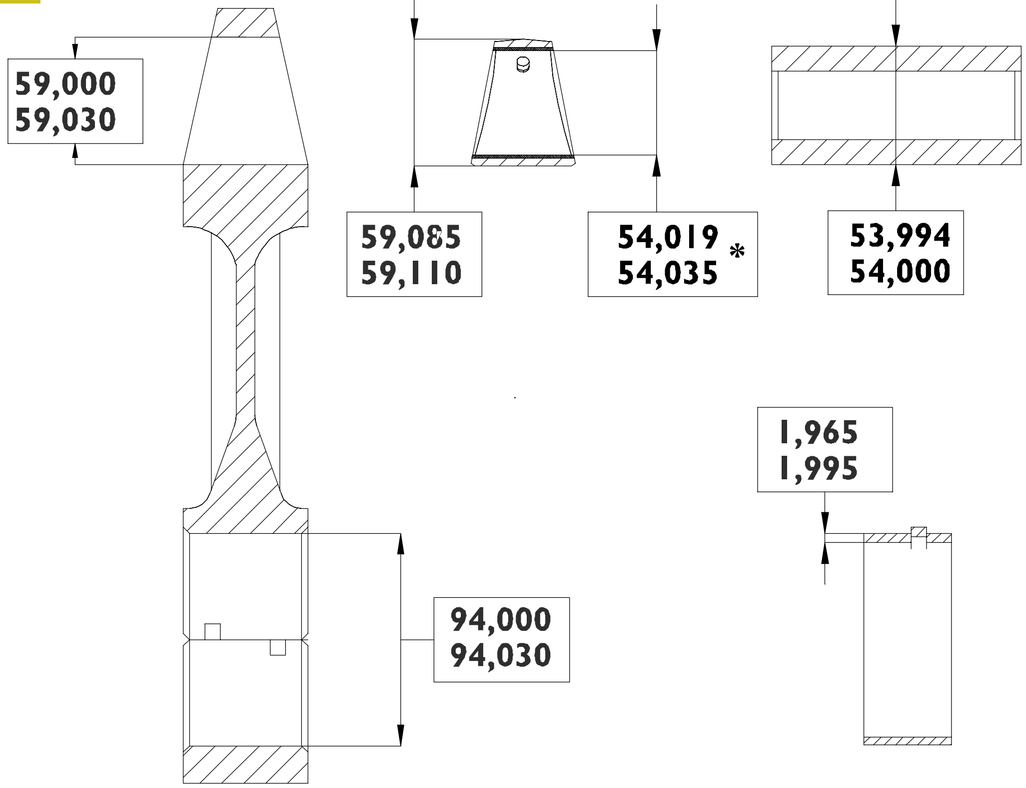
1 = 94.000 to 94.010 mm
2 = 94.011 to 94.020 mm
3 = 94.021 to 94.030 mm

3 Number indicating the selection of diameter for the big end bearing housing:



47957

Figure 49



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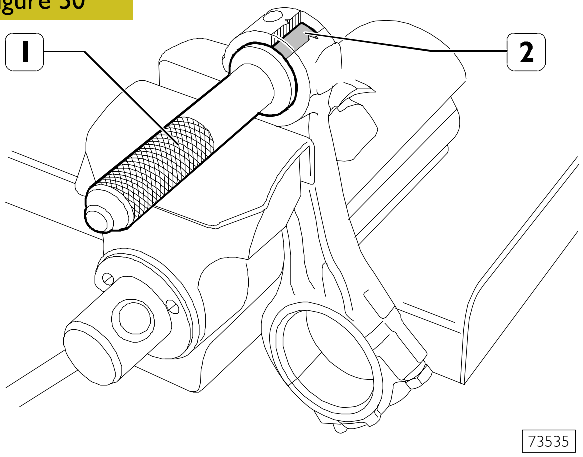
MAIN DATA OF THE BUSHING, CONNECTING ROD, PIN AND BEARING SHELLS

* Measurement to be made after driving in the bushing.

Connecting rods bushings

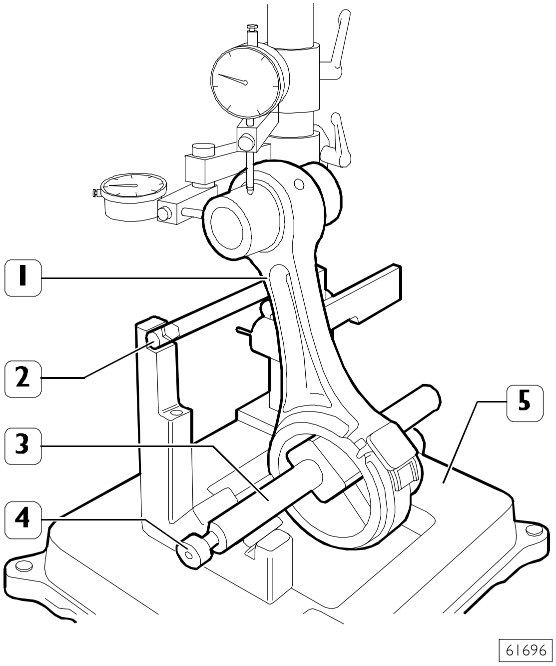
Figure 50



Check the bushing in the small end has not come loose and shows no sign of scoring or seizure; replace it if it does.
The bushing (2) is removed and fitted with a suitable drift (1).
When driving it in, make absolutely sure that the holes for the oil to pass through in the bushing and small end coincide.
Using a boring machine, rebore the bushing so as to obtain a diameter of 54.019 – 54.035.

Checking connecting rods

Figure 51 (Demonstration)



Checking axis alignment

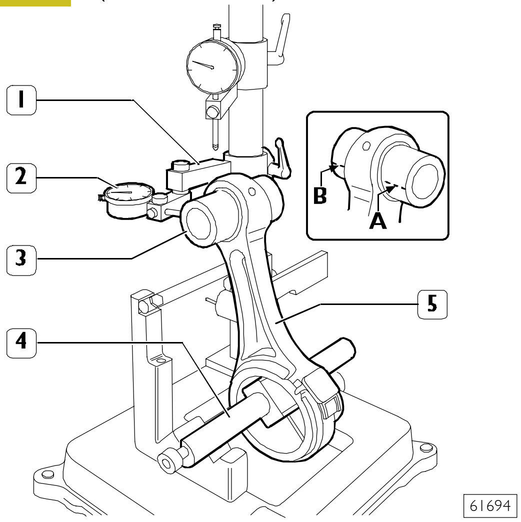
Check the toe-setting for the connecting rods (1) axles using the proper devices (5), according to this procedure:

Fit the connecting rod (1) on the spindle of the tool (5) and lock it with the screw (4).

Set the spindle (3) on the V-prisms, resting the connecting rod (1) on the stop bar (2).

Checking torsion

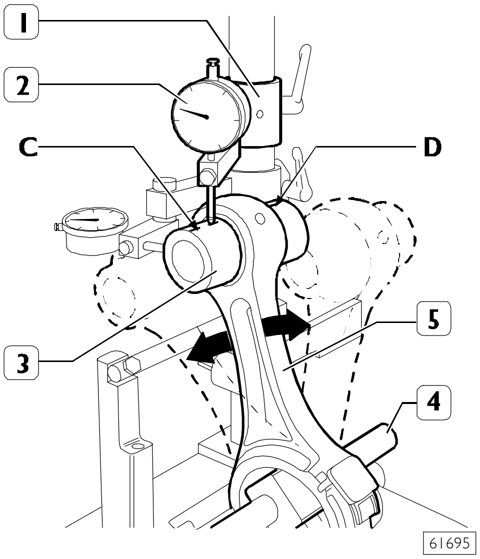
Figure 52 (Demonstration)



Check the torsion of the connecting rod (5) by comparing two points (**A** and **B**) of the pin (3) on the horizontal plane of the axis of the connecting rod.
Position the mount (1) of the dial gauge (2) so that this pre-loads by approx. 0.5 mm on the pin (3) at point **A** and zero the dial gauge (2). Shift the spindle (4) with the connecting rod (5) and compare any deviation on the opposite side **B** of the pin (3): the difference between **A** and **B** must be no greater than 0.08 mm.

Checking bending

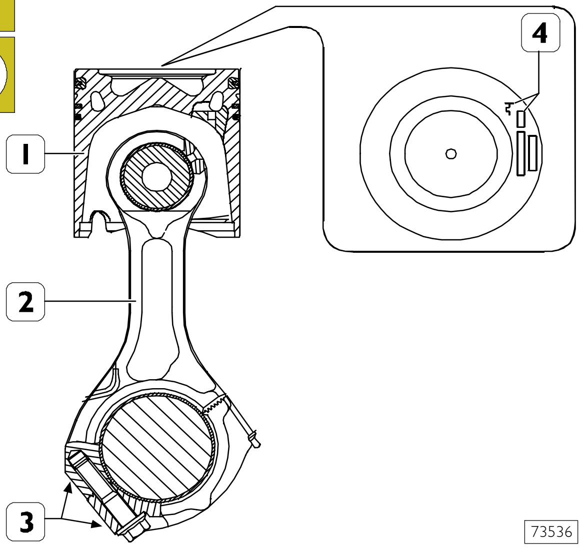
Figure 53 (Demonstration)



Check the bending of the connecting rod (5) by comparing two points **C** and **D** of the pin (3) on the vertical plane of the axis of the connecting rod.
Position the vertical mount (1) of the dial gauge (2) so that this rests on the pin (3) at point **C**.
Swing the connecting rod backwards and forwards seeking the highest position of the pin and in this condition zero the dial gauge (2). Shift the spindle (4) with the connecting rod (5) and repeat the check on the highest point on the opposite side **D** of the pin (3). The difference between point **C** and point **D** must be no greater than 0.08 mm.

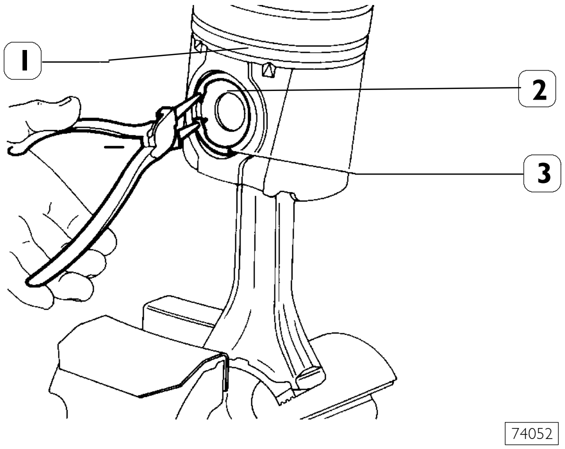
Mounting the connecting rod – piston assembly

Figure 54



The piston (1) has to be fitted on the connecting rod (2) so that the graphic symbol (4), showing the assembly position in the cylinder liner, and the punch marks (3) on the connecting rod are observed as shown in the figure.

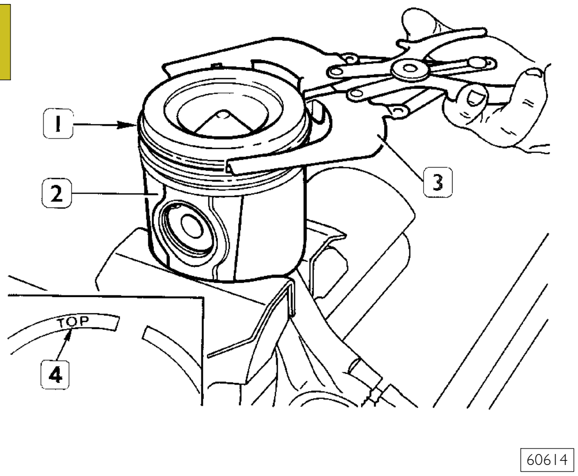
Figure 55



Fit the pin (2) and fasten it on the piston (1) with the split rings (3).

Mounting the piston rings

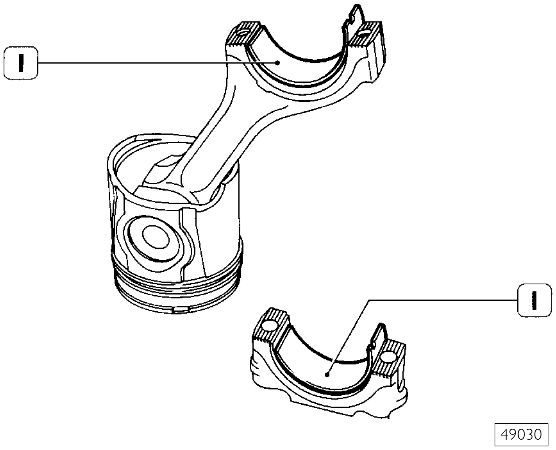
Figure 56



To fit the piston rings (1) on the piston (2) use the pliers 99360184 (3).
The rings need to be mounted with the word "TOP" (4) facing upwards. Direct the ring openings so they are staggered 120° apart.

Fitting the big end bearing shells

Figure 57



Fit the bearing shells (1), selected as described under the heading "Selecting the main and big end bearing shells", on both the connecting rod and the cap.
If reusing bearing shells that have been removed, fit them back into their respective seats in the positions marked during removal.

Fitting connecting rod - piston assemblies in the cylinder liners

With the aid of the clamp 99360605 (1, Figure 58), fit the connecting rod – piston assembly (2) in the cylinder liners, according to the diagram of Figure 59, checking that:

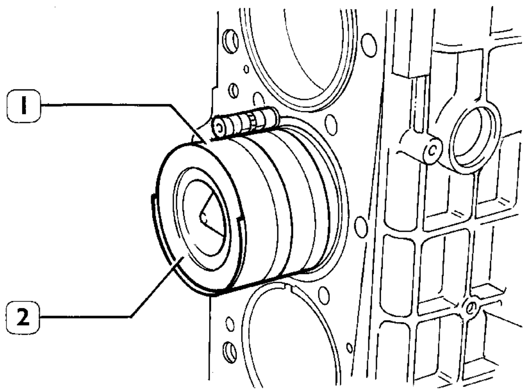
☐ The openings of the piston rings are staggered 120° apart.

☐ The pistons are all of the same class, A or B.

☐ The symbol punched on the top of the pistons faces the engine flywheel, or the recess in the skirt of the pistons tallies with the oil nozzles.

NOTE The pistons are supplied as spares in class A and can be fitted in class B cylinder liners.

Figure 58



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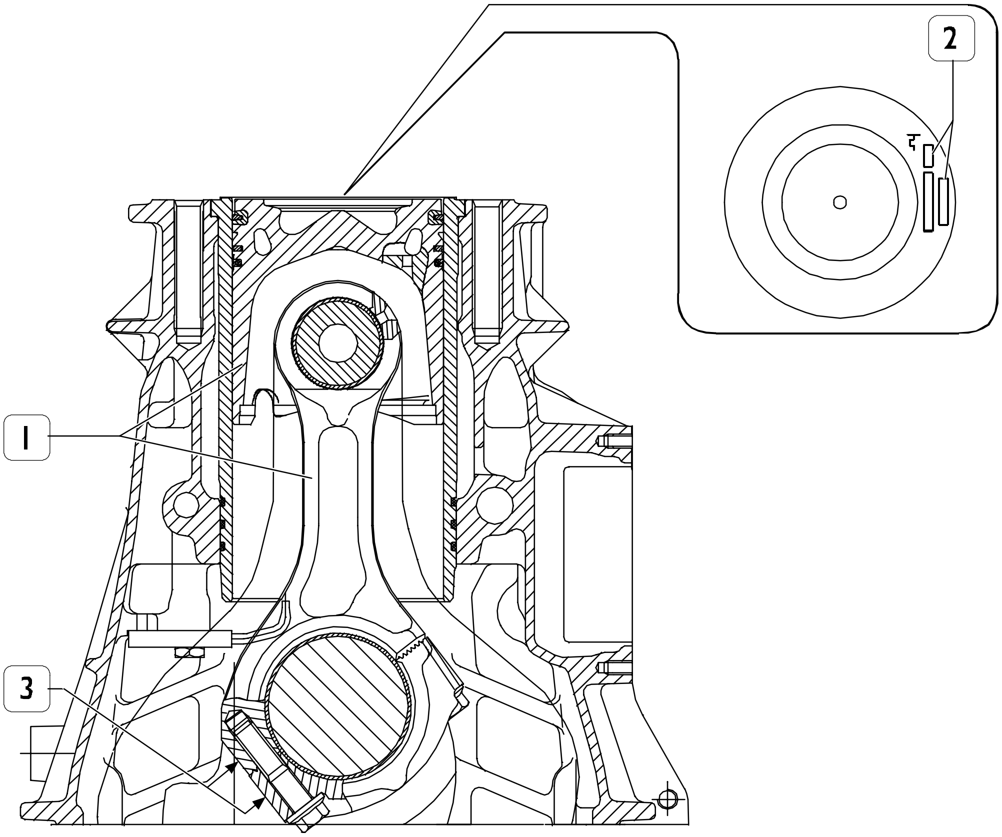
Checking piston protrusion

On completing assembly, check the protrusion of the pistons from the cylinder liners; it must be 0.12 – 0.42 mm.

Figure 59



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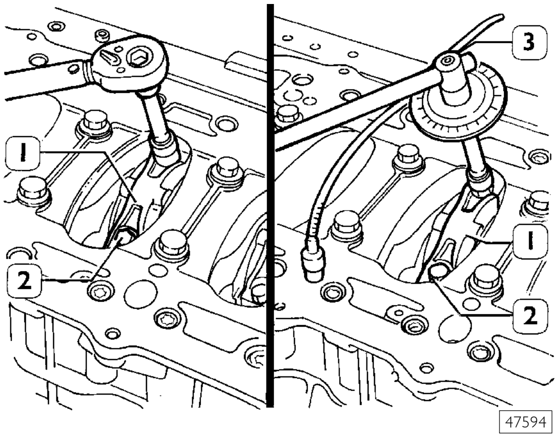
ASSEMBLY DIAGRAM OF CONNECTING ROD – PISTON ASSEMBLY IN CYLINDER LINER
1. Connecting rod – piston assembly – 2. Area of punch marking on the top of the piston, symbol showing assembly position and selection class – 3. Connecting rod punch mark area

Checking crankpin assembly clearance

To measure the clearance, carry out the following operations.
Connect the connecting rods to the relevant journals of the crankshaft, placing a length of calibrated wire on the journals.

Figure 60



Mount the connecting rod caps (1) together with the bearing shells. Tighten the screws (2) fixing the connecting rod caps to a torque of 60 Nm (6 kgm). Using tool 99395216 (3), further tighten the screws with an angle of 60°.

NOTE The thread of the screws (2), before assembly, has to be lubricated with engine oil.

Remove the caps and determine the clearance by comparing the width of the calibrated wire with the graduated scale on the case containing the calibrated wire.
Upon final assembly: check the diameter of the thread of the screws (2), it must be no less than 13.4 mm; if it is, change the screw. Lubricate the crankpins and connecting rod bearings. Tighten the screws (2) as described above.

CYLINDER HEAD

Before dismounting cylinder head, check cylinder head for hydraulic seal by proper tooling; in case of leaks not caused by cup plugs or threaded plugs, replace cylinder head.

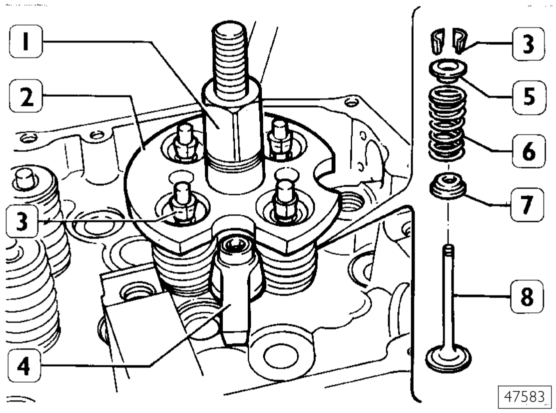
NOTE In case of plugs dismounting/replacement, on mounting, apply sealant Loctite 270 on plugs.

Dismounting the valves

NOTE Before dismounting cylinder head valves, number them in view of their remounting in the position observed on dismounting should they not have to be overhauled or replaced.

Intake valves are different form exhaust valves in that they have a notch placed at valve head centre.

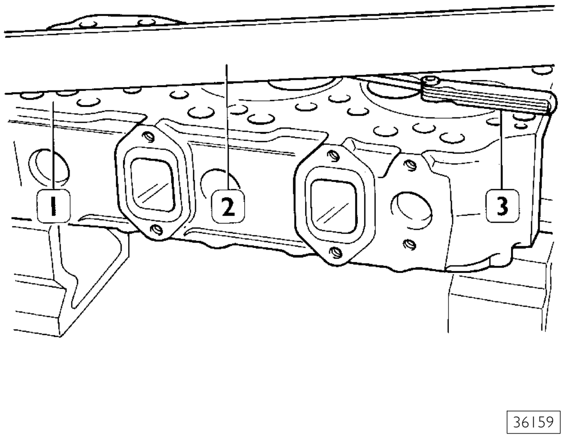
Figure 61



Mount and secure the tool 99360263 (2) with the bracket (4). Screw down with the device 99360261 (1) to be able to remove the cotters (3). Take out the tool (2) and extract the top plate (5), spring (6) and bottom plate (7).
Repeat this process on all the valves.
Turn over the cylinder head and take out the valves (8).

Checking head bearing surface on cylinder block

Figure 62 (Demonstration)



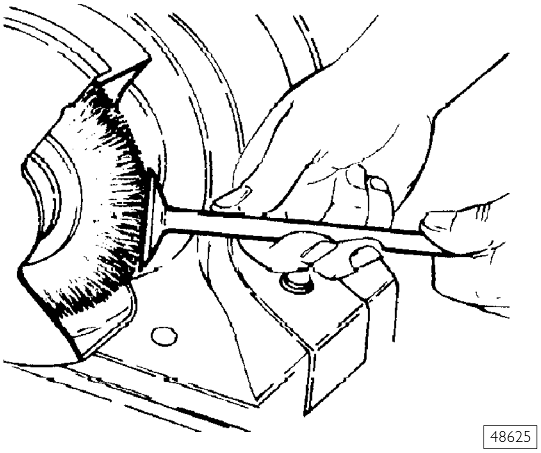
Check the supporting surface (1) of the head on the cylinder block with a rule (2) and a feeler gauge (3). If you find any deformation, level the head on a surface grinder; maximum amount of material that can be removed 0.2 mm.

NOTE After this process, you need to check the valve recessing and injector protrusion.

Valves

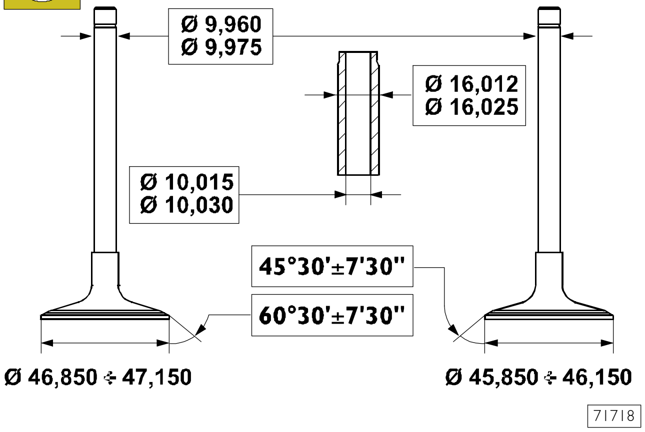
Decarbonizing and checking valves

Figure 63



Remove the carbon deposits on the valves with a wire brush. Check that the valves show no signs of seizure or cracking and check with a micrometer that the valve stem diameter comes within the required values (see Figure 64); replace the valves if it does not.

Figure 64



MAIN DATA OF VALVES AND VALVE GUIDES

* Measurement to be made after driving in the valve guides

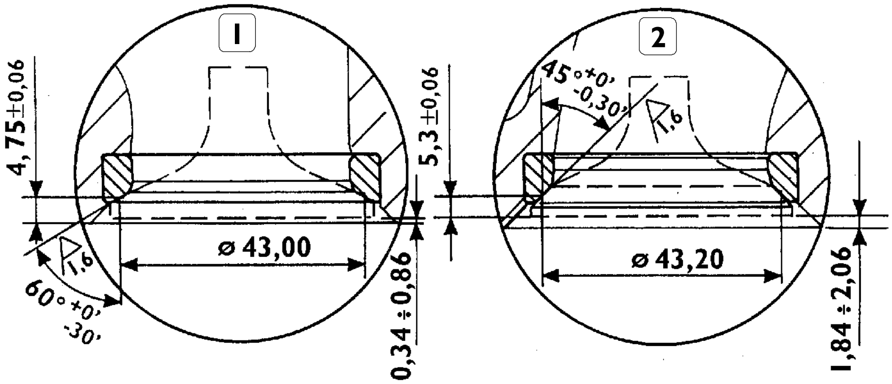
Check with a micrometer that the diameter of the valve stems is as indicated. If necessary, grind the valve seats with a grinding machine, removing as little material as possible.

Valve seats

Regrinding – replacing valve seats

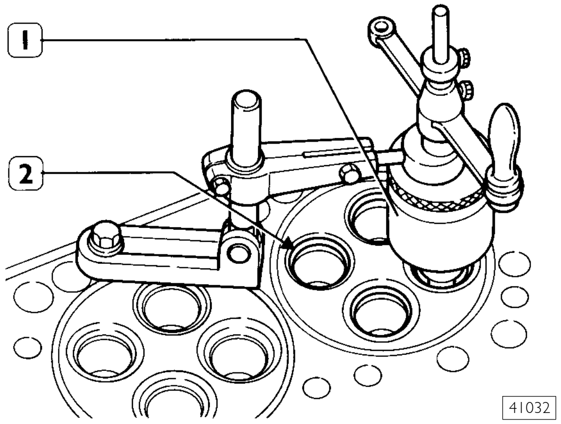
NOTE The valve seats are reground whenever the valves or valve guides are ground and replaced.

Figure 65



MAIN DATA OF VALVE SEATS
1. Intake valve seat – 2. Exhaust valve seat

Figure 66



Check the valve seats (2). If you find any slight scoring or burns, regrind them with tool 99305019 (1) according to the angles shown in Figure 65. If it is necessary to replace them, using the same tool and taking care not to affect the cylinder head, remove as much material as possible from the valve seats so that, with a punch, it is possible to extract them from the cylinder head.

Heat the cylinder head to 80 ÷ 100°C and, using a drift, fit in the new valve seats (2), chilled beforehand in liquid nitrogen. Using tool 99305019 (1), regrind the valve seats according to the angles shown in Figure 65.

After regrinding the valve seats, using tool 99370415 and dial gauge 99395603, check that the position of the valves in relation to the plane of the cylinder head is:

☐ -0.45 ÷ -0.75 mm (recessing) intake valves

☐ -1.65 ÷ -1.95 mm (recessing) exhaust valves.

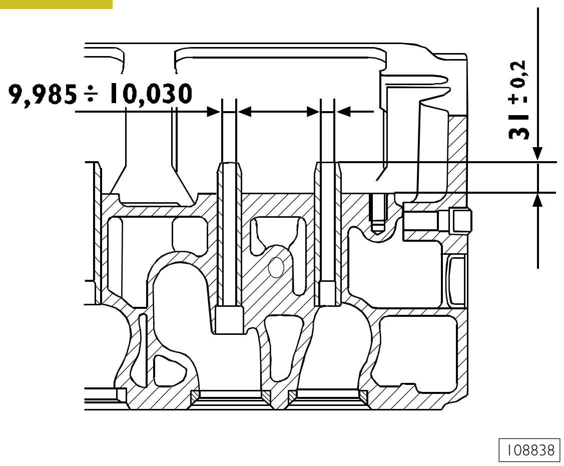
Checking clearance between valve-stem and associated valve guide

Using a dial gauge with a magnetic base, check the clearance between the valve stem and the associated guide. If the clearance is too great, change the valve and, if necessary, the valve guide.

Valve guides

Replacing valve guides

Figure 67



The valve guides are removed with the drift 99360143. They are fitted with the drift 99360143 equipped with part 99360296.

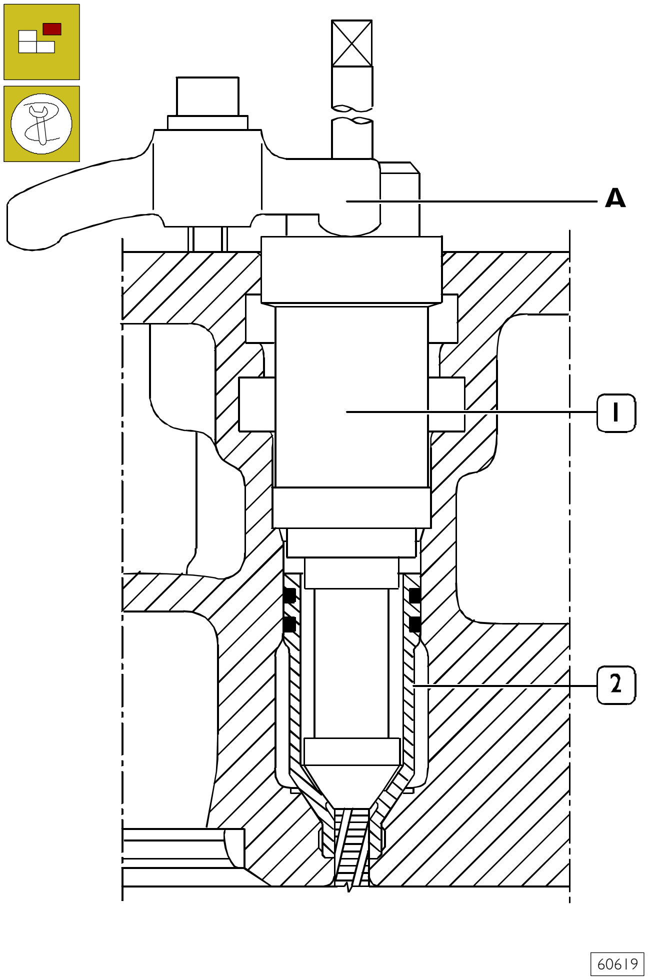
Part 99360296 determines the exact position of assembly of the valve guides in the cylinder head. If they are not available, you need to drive the valve guides into the cylinder head so they protrude by 30.8÷31.2 mm.

After driving in the valve guides, rebore their holes with the smoother 99390330.

Replacing injector cases

Removal

Figure 68

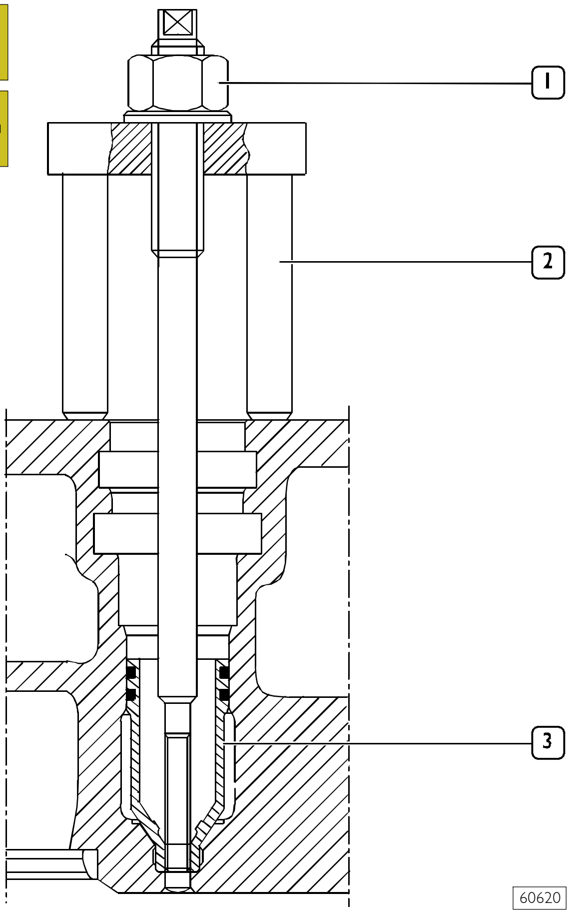


To replace the injector case (2), proceed as follows:

☐ Thread the case (2) with tool 99390804 (1).

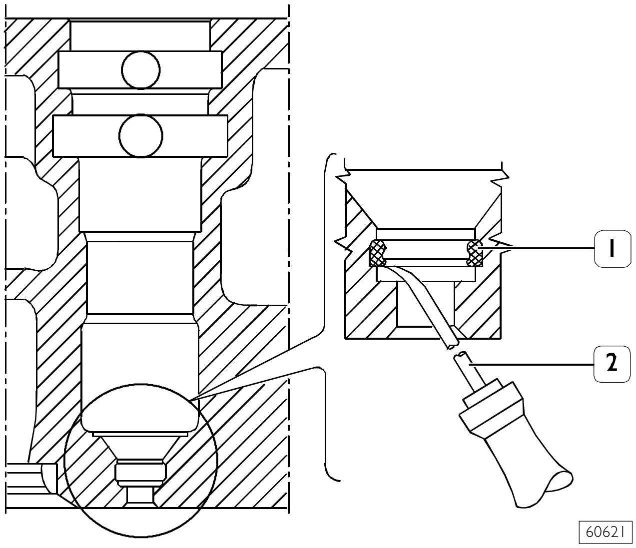
The steps described in Figs. 68 - 71 - 72 - 73 need to be carried out by fixing the tools, with the bracket A, to the cylinder head.

Figure 69



❑ Screw the extractor 99342149 (2) into the case (3). Screw down the nut (1) and take the case out of the cylinder head.

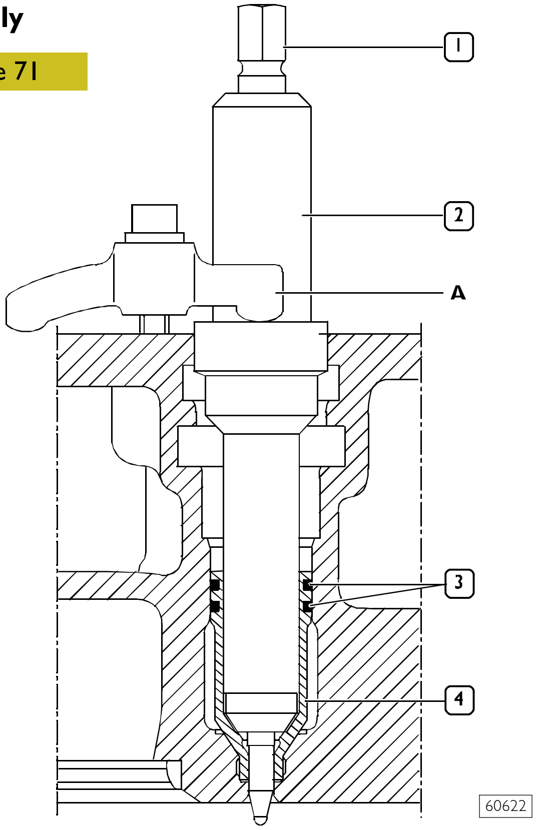
Figure 70



❑ Using the tool 99390772 (2) remove any residues (1) left in the groove of the cylinder head.

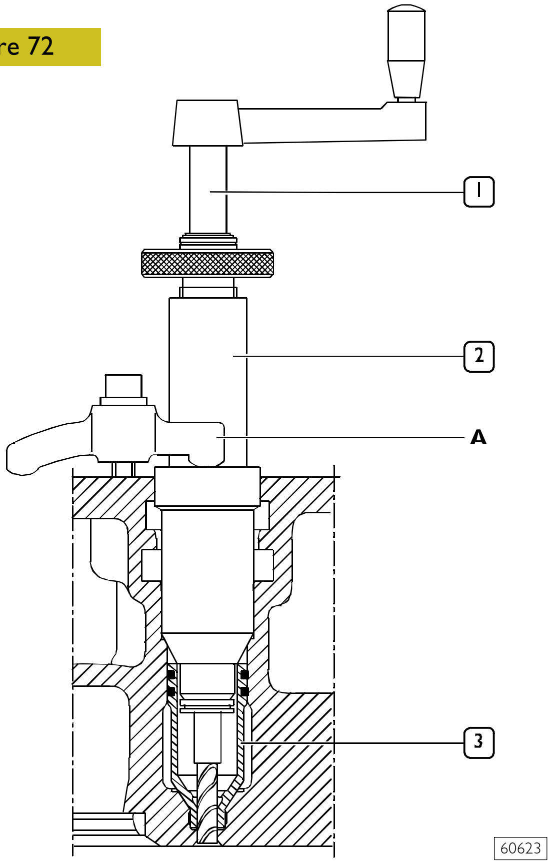
Assembly

Figure 71



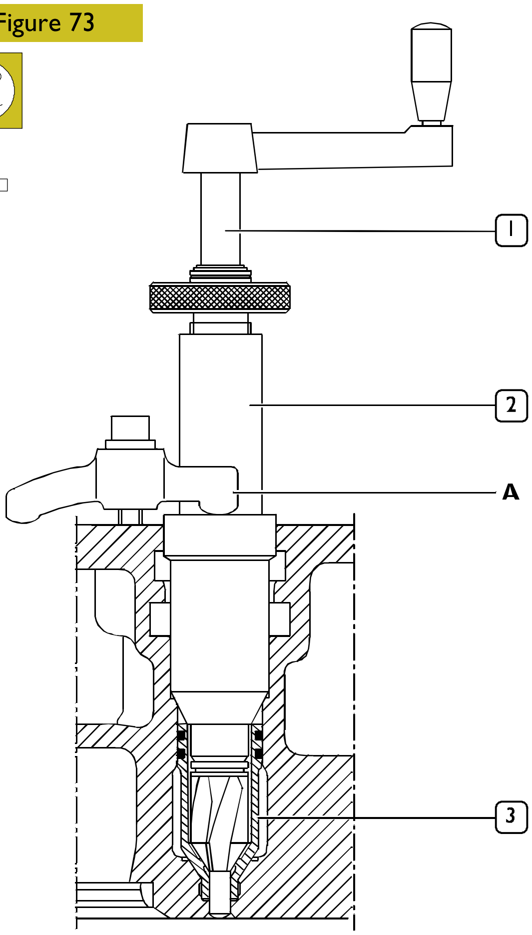
❑ Lubricate the seals (3) and fit them on the case (4). Using tool 99365056 (2) secured to the cylinder head with bracket **A**, drive in the new case, screwing down the screw (1) upsetting the bottom portion of the case.

Figure 72



❑ Using the reamer 99394041 (1-2), rebore the hole in the case (3).

Figure 73

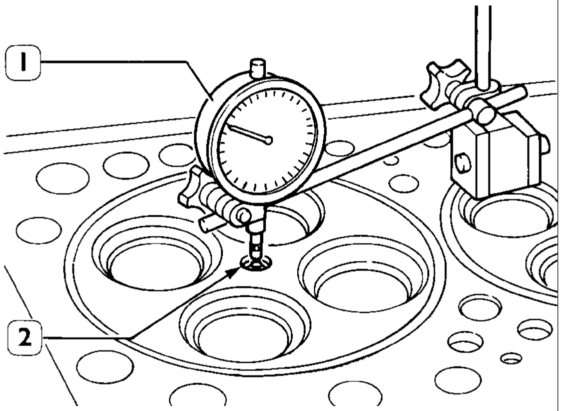


60624

☐ Using the milling cutter 99394043 (1-2), regrind the injector seat in the case (3).

Checking injector protrusion

Figure 74



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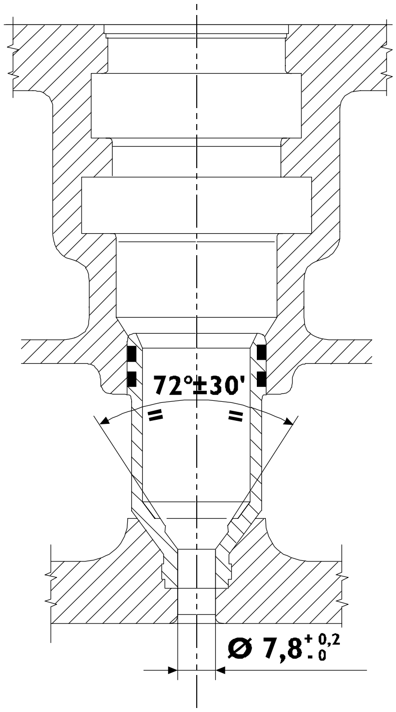
Check injector protrusion (2) with the dial gauge (1).
The protrusion must be 0.52 - 1.34 mm.

Figure 75



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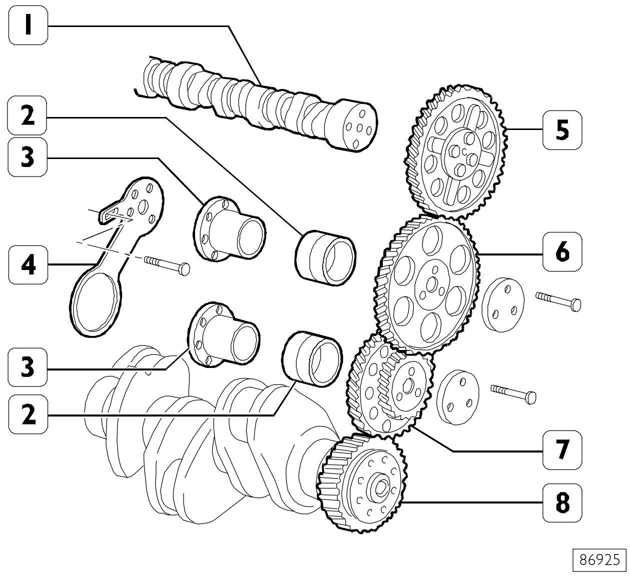
INJECTOR CASE ASSEMBLY DIAGRAM

TIMING GEAR

Camshaft drive

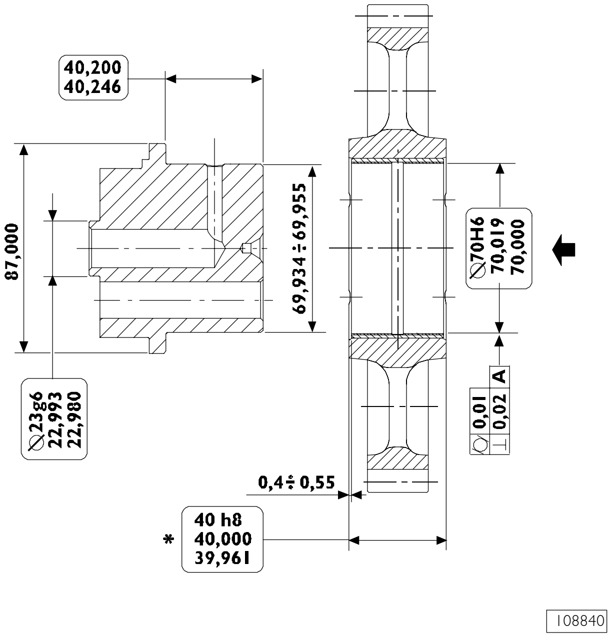
Figure 76



TIMING CONTROL COMPONENT PARTS
1. Camshaft - 2. Bushing - 3. Pin - 4. Articulated rod - 5. Camshaft control gear - 6. Idler gear - 7. Twin idler gear - 8. Drive shaft driving gear.

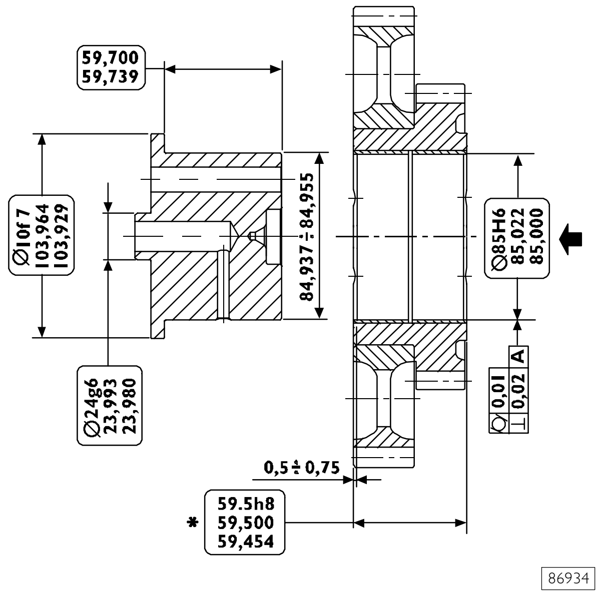
Idler gear pin
Idler gear

Figure 77



Twin intermediate gear pin
Twin idler gear

Figure 78



Replacing the bushings

Bushings (2, Figure 77, and 2, Figure 78 can be replaced when they are worn. Put up the bushing, then bore it to obtain the diameter shown on Figure 77 or .Figure 78

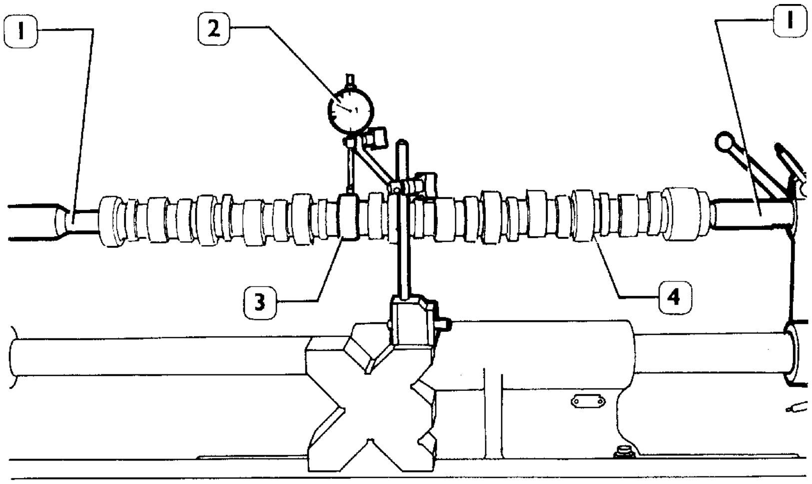
NOTE The bushing must be driven into the gear by following the direction of the arrow and setting the latter to the dimension shown on Figure 77 or .Figure 78

Rated assembling play between gear bushings and pins:
Figure 77 – 0.045 ÷ 0.085 mm
Figure 78 – 0.045 ÷ 0.085 mm.

Timing system

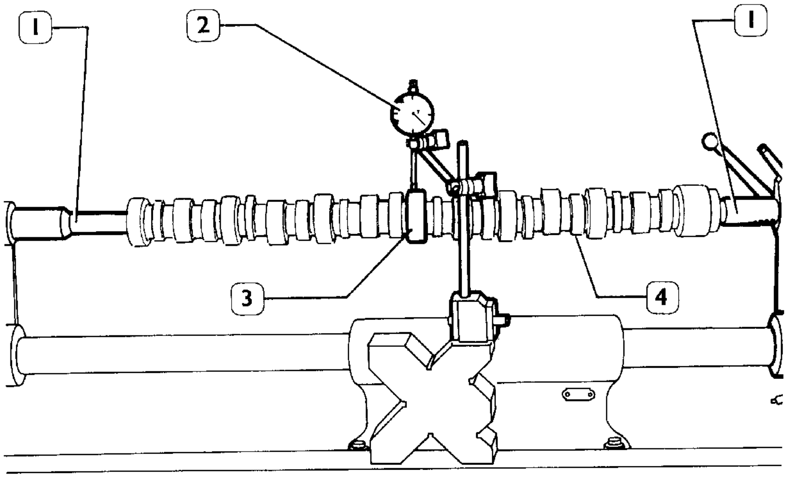
Checking cam lift and pin alignment

Figure 79



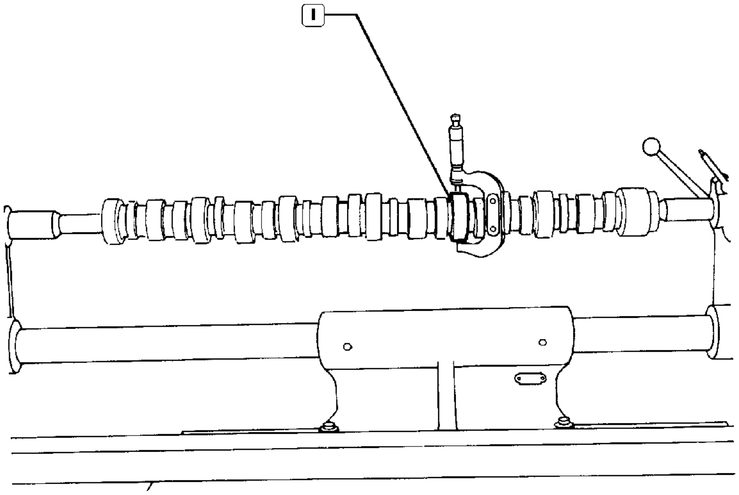
Set the camshaft (4) on the tailstocks (1) and check the lift of the cams (3) with the dial gauge (2).

Figure 80



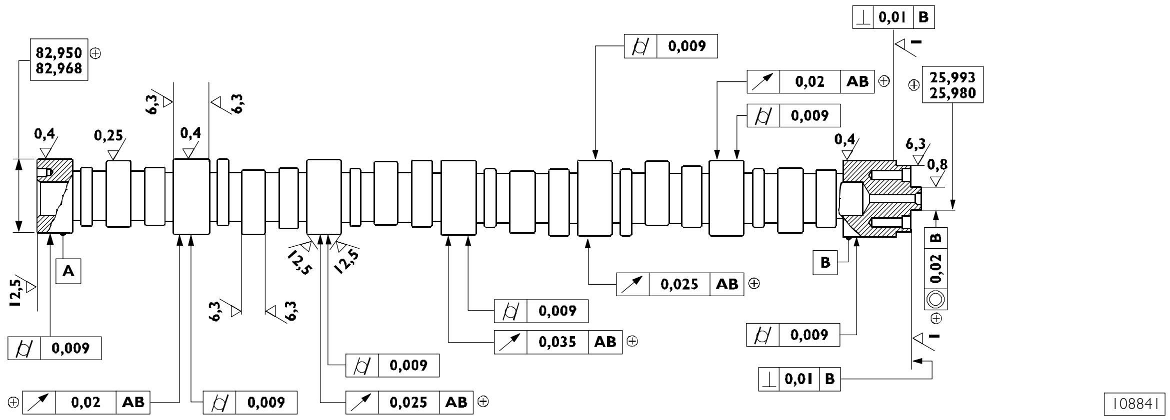
Still with the camshaft (4) set on the tailstocks (1), check the alignment of the supporting pins (3) with the dial gauge (2); it must be no greater than 0.030 mm. If you find a greater misalignment, replace the shaft.

Figure 81



To check the assembly clearance, measure the inside diameter of the bushings and the diameter of the pins (1) of the camshaft: the difference will give the actual clearance.
If you find any clearances over 0.135 mm, replace the bushings and, if necessary, the camshaft as well.

Figure 82

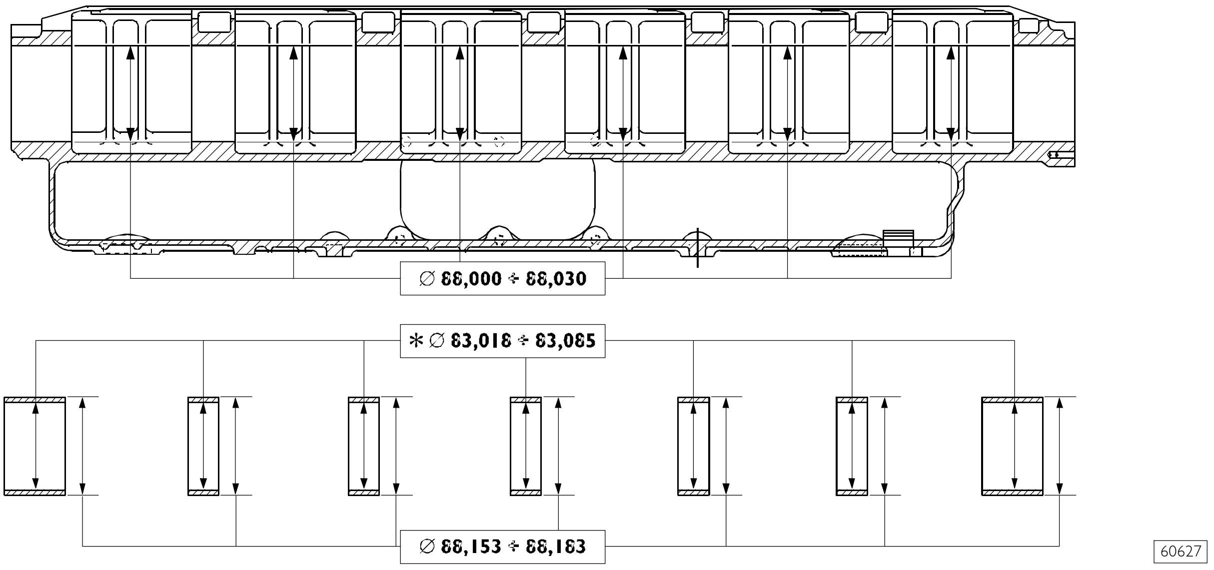


MAIN DATA OF THE CAMSHAFT AND TOLERANCES
The surfaces of the supporting pins of the shaft and those of the cams need to be extra smooth.
Whereas, if they show any signs of seizing or scoring, you should replace the shaft and the relevant bushings.

TOLERANCES	FEATURE SUBJECT OF TOLERANCE	SYMBOL
DIRECTION	Perpendicularity	⊥
POSITION	Concentricity or coaxiality	◎
SWING	Circular oscillation	↗
CLASS OF IMPORTANT ASCRIBED TO PRODUCT CHARACTERISTICS		SYMBOL
CRUCIAL		©
IMPORTANT		⊕
SECONDARY		⊖

Bushings

Figure 83



MAIN DATA OF THE BUSHINGS FOR THE CAMSHAFT AND SEATS ON THE CYLINDER HEAD
∗ Bushing inside diameter after driving in

The surface of the bushings must show no sign of seizing or scoring; replace them if they do.

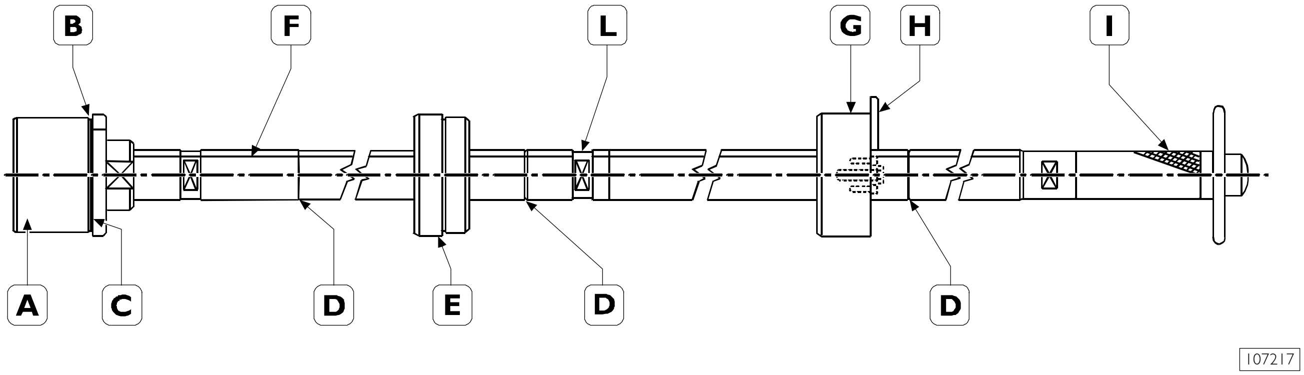
Measure the inside diameter of the bushings with a bore gauge.

If you find a higher value than the tolerance, replace them.

To remove and fit the bushings, use the appropriate drift 99360499.

Replacing camshaft bushings with drift 99360499
Drift

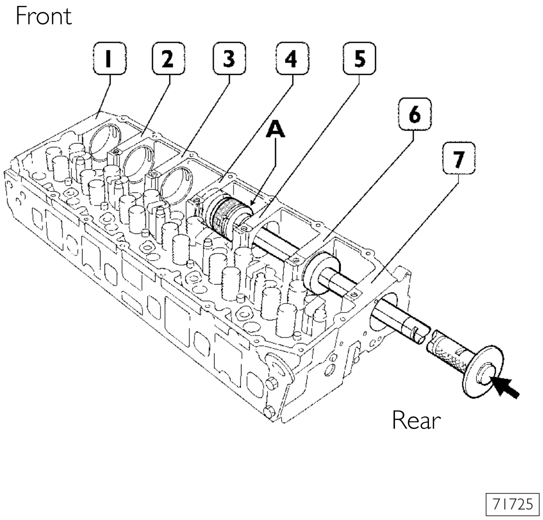
Figure 84



A = Drift with seat for bushings to insert/extract.
B = Grub screw for positioning bushings.
C = Reference mark to insert seventh bushing correctly.
D = Reference mark to insert bushings 1, 2, 3, 4, 5, 6 correctly (yellow marks).
E = Guide bushing.
F = Guide line.
G = Guide bushing to secure to the seventh bushing mount.
H = Plate fixing bushing G to cylinder head.
I = Grip.
L = Extension coupling.

Removal

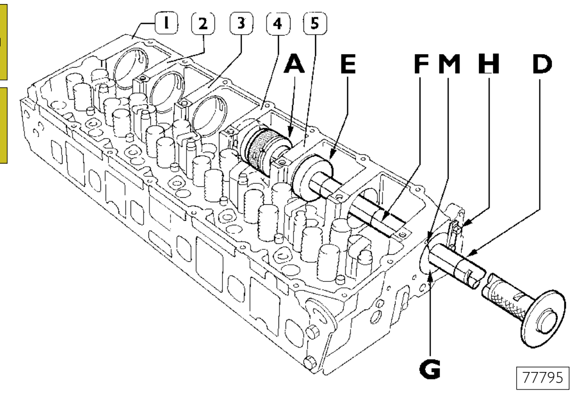
Figure 85



The sequence for removing the bushings is 7, 6, 5, 4, 3, 2, 1. The bushings are extracted from the front of the single seats. Removal does not require the drift extension for bushings 5, 6 and 7 and it is not necessary to use the guide bushing. For bushings 1, 2, 3 and 4 it is necessary to use the extension and the guide bushings.
Position the drift accurately during the phase of removal.

Assembly

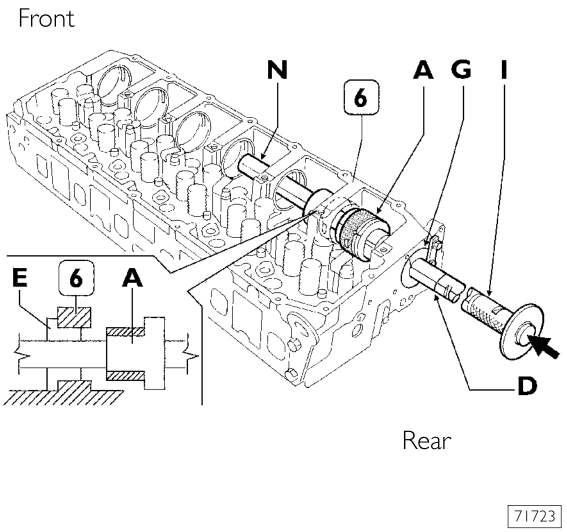
Figure 86



Assemble the drift together with the extension.
To insert bushings 1, 2, 3, 4 and 5, proceed as follows:

1. position the bushing to insert on the drift (A) making the grub screw on it coincide with the seat (B) (Figure 84) on the bushing;
2. position the guide bushing (E) and secure the guide bushing (G) (Figure 84) on the seat of the 7th bushing with the plate (H);
3. while driving in the bushing, make the reference mark (F) match the mark (M). In this way, when it is driven home, the lubrication hole on the bushing will coincide with the oil pipe in its seat.
   The bushing is driven home when the 1st yellow reference mark (D) is flush with the guide bushing (G).

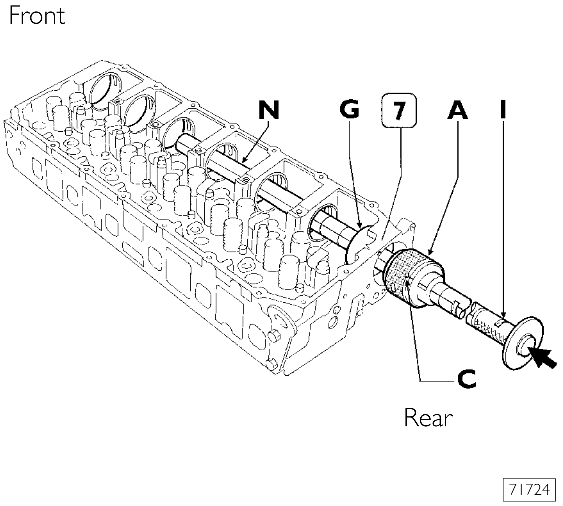
Figure 87



To insert the bushing (6), proceed as follows:

- ☐ Unscrew the grip (I) and the extension (N).
- ☐ Position the extension (N) and the guide bushing E as shown in the figure.
- ☐ Repeat steps 1, 2, 3.

Figure 88

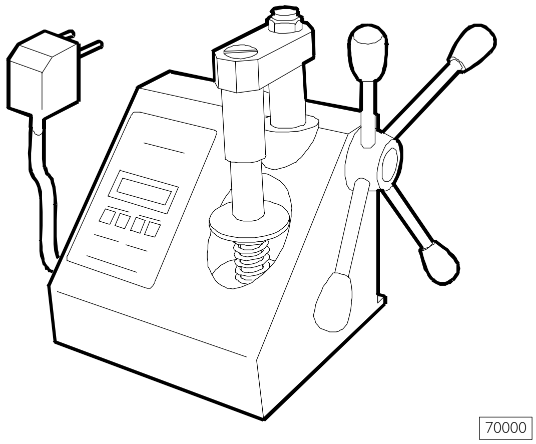


To insert bushing (7), proceed as follows:

- ☐ Unscrew the grip (I) and the extension (N).
- ☐ Refit the guide (G) from the inside as shown in the figure.
- ☐ Position the bushing on the drift (A) and bring it close up to the seat, making the bushing hole match the lubrication hole in the head. Drive it home.
  The 7th bushing is driven in when the reference mark (C) is flush with the bushing seat.

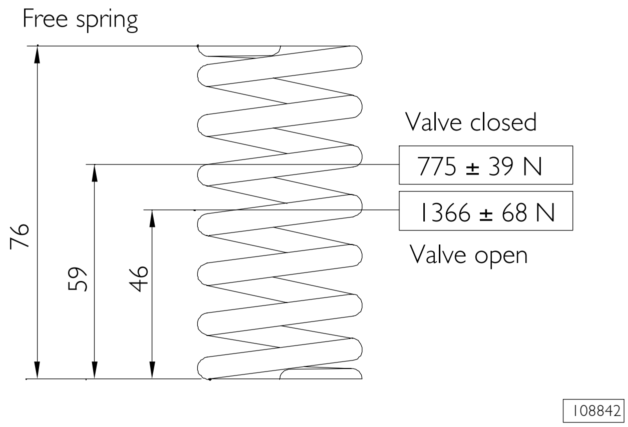
Valve springs

Figure 89



Before assembly, the flexibility of the valve springs has to be checked.
Compare the load and elastic deformation data with those of the new springs given in the following figure.

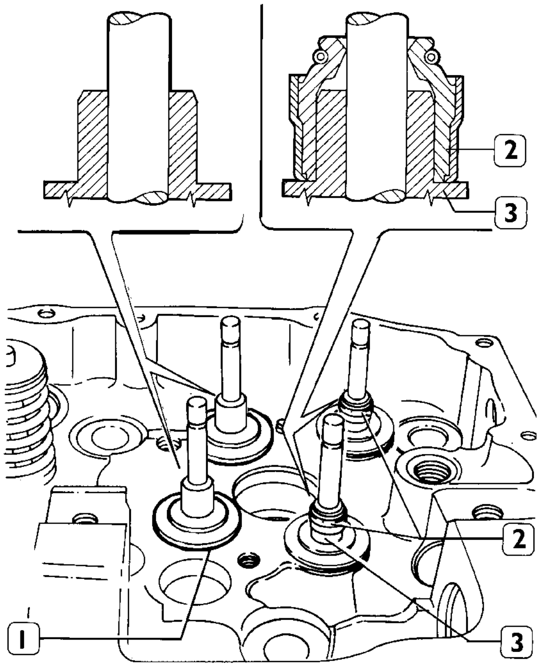
Figure 90



MAIN DATA TO CHECK THE SPRING FOR INTAKE AND EXHAUST VALVES

Fitting valves and oil seal

Figure 91

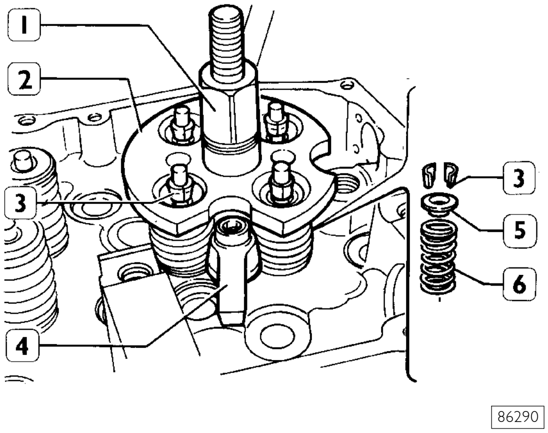


Lubricate the valve stem and insert the valves in the respective valve guides; fit the lower caps (1). Use tool 99360329 to fit the oil seal (2) on the valve guides (3) of the exhaust valves; then, to fit the valves, proceed as follows.

NOTE Should valves not have been overhauled or replaced, remount them according to numbering performed on dismounting.

Intake valves are different form exhaust valves in that they have a notch placed at valve head centre.

Figure 92

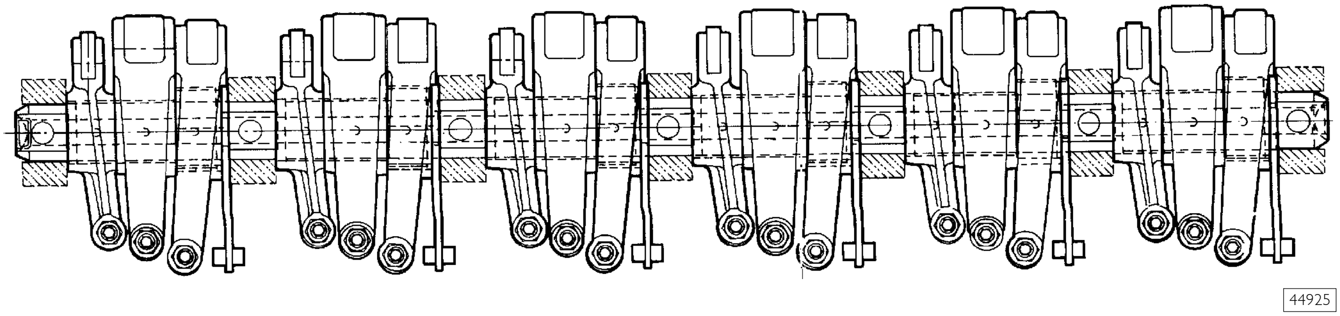


☐ Mount the springs (6) and the top plate (5).

☐ Fit the tool 99360263 (2) and secure it with the bracket (4). Screw down the lever (1) to be able to fit on the cotters (3). Take off the tool (2).

ROCKER SHAFT

Figure 93



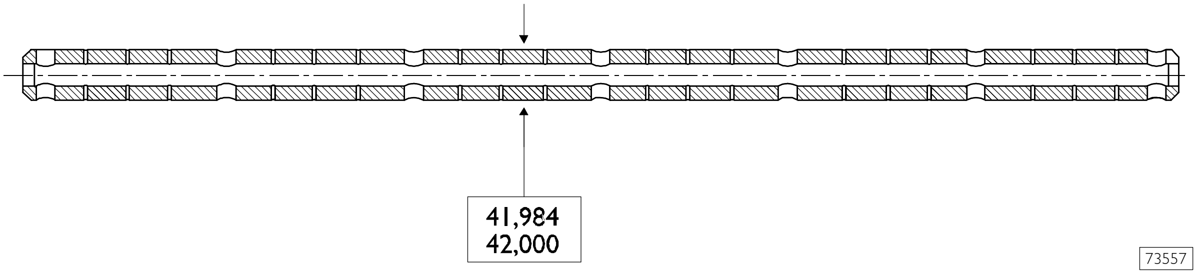
The cams of the camshaft control the rocker arms directly: 6 for the injectors and 12 for the valves.

Injectors and intake valves control rocker arms are keyed on rocker arms shaft directly. Exhaust intake valves control rocker arms are keyed on rocker arms shaft putting in between the levers with engine brake control eccentric pin.

The rocker arms run directly on the profiles of the cams by means of rollers.
The other end acts on a crosspiece that rests on the stem of the two valves.
There is a pad between the rocker arm adjustment screw and the crosspiece.
There are two lubrication ducts inside the rocker arms.
The length of the rocker arm shaft is basically the same as that of the cylinder head. It has to be detached to be able to reach all the parts beneath.

Shaft

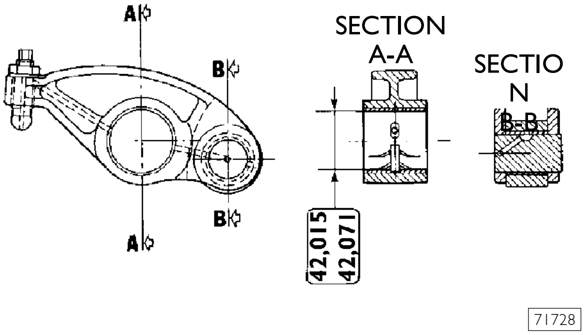
Figure 94



MAIN DATA OF THE ROCKER ARM SHAFT
Check that the surface of the shaft shows no scoring or signs of seizure; if it does, replace it.

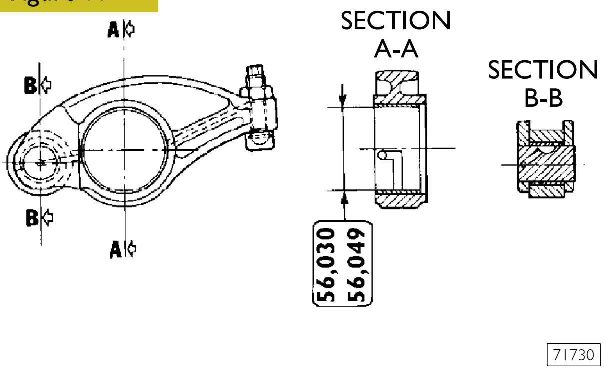
Rocker arms

Figure 95



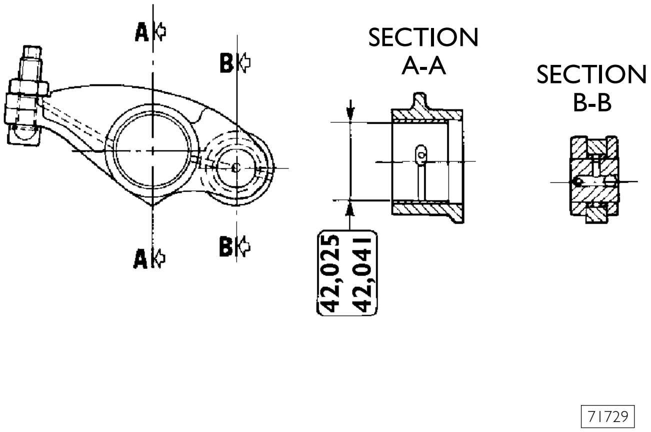
PUMP INJECTOR ROCKER ARMS

Figure 97



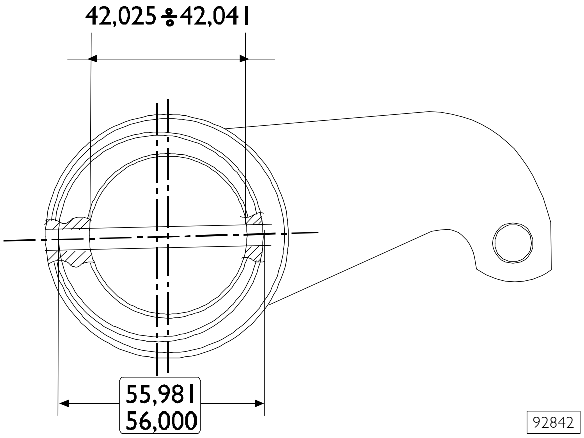
EXHAUST VALVE ROCKER ARMS

Figure 96



INTAKE VALVE ROCKER ARMS

Figure 98



LEVER WITH ENGINE BRAKE CONTROL ECCENTRIC PIN

Check the surfaces of the bushings, which must show no signs of scoring or excessive wear; if they do, replace the rocker arm assembly.

REPAIR

NOTE If anomalous engine operation is found, which is due to the boosting system, it is advisable that you check the efficiency of seal gaskets and the fastening of connecting sleeves prior to carrying out the checks on the turboblower. Also check for obstructions in the sucking sleeves, air filter. If the turbocharger damage is due to a lack of lubrication, check that the oil circulation pipes are not damaged. If so, change them or eliminate the cause.

After carrying out the above mentioned checks, check the turbocharger operation with an Engine Test by using IVECO diagnosis equipment (Modus - IT 2000 - E.A.SY.) according to the relevant procedure.

NOTE The test must be performed in following conditions:

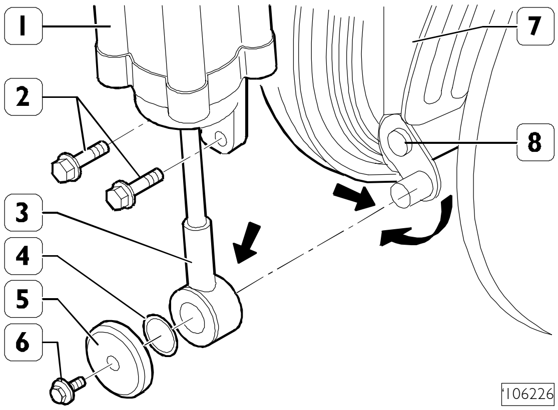
- engine coolant temperature >50 °C;
- battery up (voltage >22V) for compression test;
- efficient recharging system.

If values beyond tolerance are detected, check the efficiency of:

- shut-off valve;
- pressure sensor;
- engine cable pressure sensor connection (if oxidised, clean with a specific product);
- lack of electrical defects in solenoid valve VGT (continuity connection);
- actuator moved by active diagnosis as described in relating chapter, in case of locking, grease bushing with lubricant Kernite (for high temperatures); if the trouble persists, replace the actuator;
- sliding sleeve: it must slide freely when operated manually. If locked and if the bush check is not sufficient or effective, or no faults are detected in the other points, upon authorization of the "Help Desk" market operator, change the turbocharger according to the standard procedures.

Variable geometry movement control

Figure 99



Remove screws (2) and take actuator (1) off turbocompressor (7).
Remove screw (6), underlying disk (5), ring (4) and disconnect tie rod (3) of actuator (1) from the pin of variable geometry driving lever (8).
Accurately clean pin (→) of lever (8) and bushing (→) of tie rod (3) using a cloth made of non abrasive micro fibre.

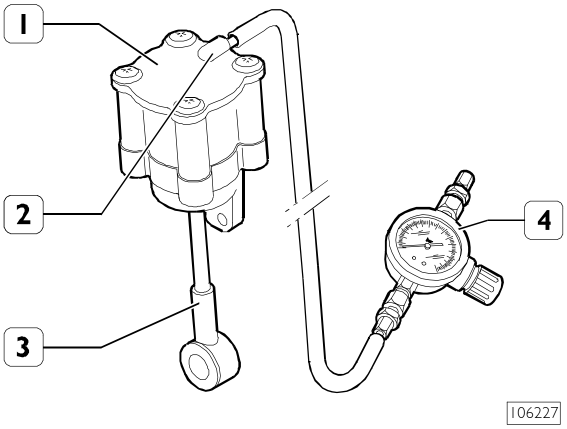
NOTE Do not use abrasive paper of any kind.

Visually check the conditions of bushing (→) of tie rod (3) and pin (→) of lever (8); where they are found to be worn out, replace actuator (1) or turbocompressor (7).

Check variable geometry inner driving mechanism movement by operating on lever (8); jamming must not occur; otherwise, clean turbine body, as described in relating chapter.

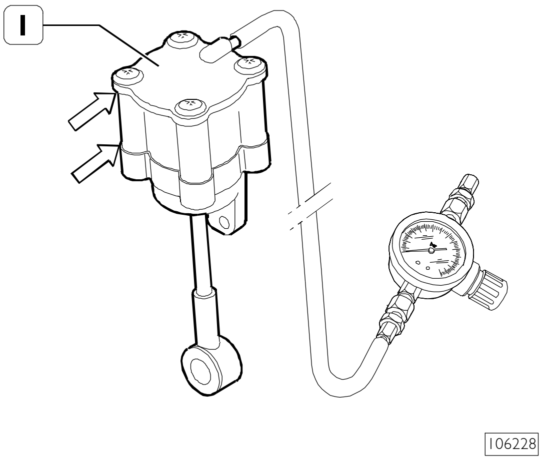
Checking the actuator

Figure 100



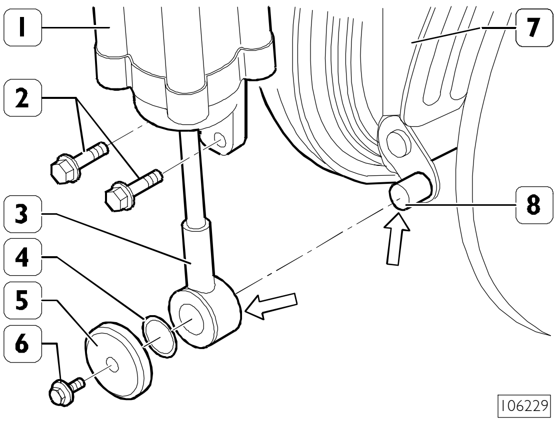
Check actuator efficiency (1) operating as follows.
Apply, to fitting (2) of actuator (1), compressed air feed piping provided with pressure regulator (4). By using the pressure regulator, introduce, into the actuator, compressed air slowly modulating it, from 0÷3.5 bar; tie rod (3) of actuator (1) must move without jamming; otherwise, replace actuator (1).

Figure 101



Check for any actuator leaks at indicated points (→) applying, on these points, a solution of suds.
When actuator (1) is fed with compressed air, no bubbles must be found at indicated points (→); otherwise, replace actuator (1).

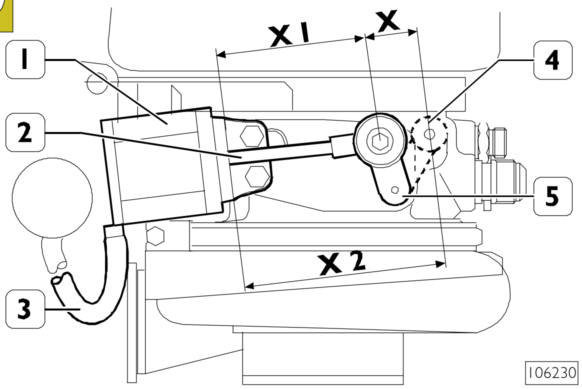
Figure 102



Lubricate bushing (→) of tie rod (3) and pin (→) of lever (8) with lithium-based Castrol LM GREASE type and reconnect actuator (1) to turbocompressor (7) operating as follows.
Connect tie rod (3) to lever (8).
Mount new ring (4), mount disk (5) and screw up screw (6).
Screw up screws (2) securing actuator (1) to turbocompressor (7).
Tighten screws (2 and 6) at 25 Nm torque.

Checking actuator travel

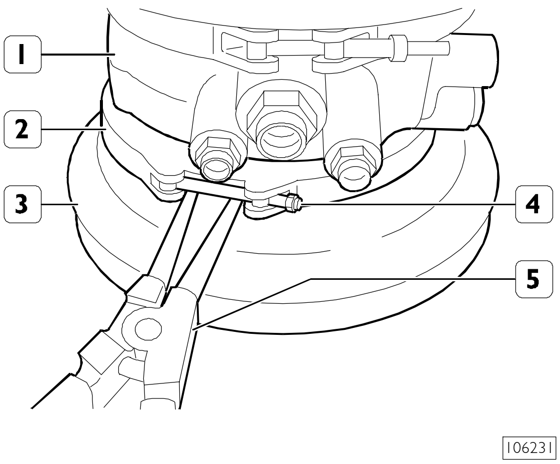
Figure 103



Check travel X of tie rod (2) of actuator (1) operating as follows.
Measure distance X1 between actuator (1) and cross-axis of eyelet (4).
Apply, to fitting of actuator (1), piping (3) for compressed air feed provided with pressure regulator. By using the pressure regulator, introduce, into actuator (1) compressed air slowly modulating it, from 0÷3,5 bar, until lever (5) is taken to its end of travel.
Measure again the distance between actuator (1) and cross-axis of eyelet (4) dimension X2.
Travel X of tie rod (2) of actuator (1) is given by following subtraction X = X2-X1 and must result to be equal to 11.5±0.5 mm.

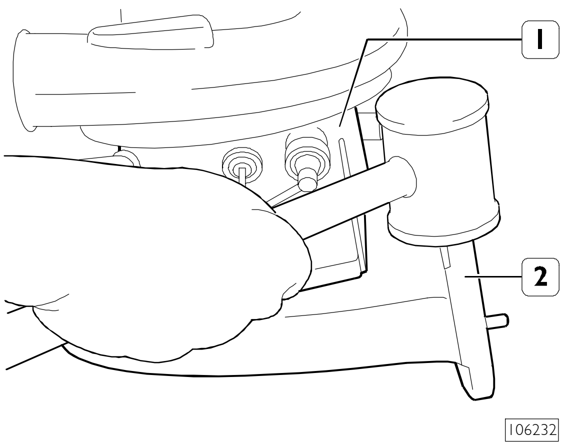
Cleaning turbine body

Figure 104



Mark mounting position of clamp (2) on central body (1).
On threading and nut (4), apply antioxidant spray lubricant and, operating on nut (4), loosen clamp (2).
Slightly rotate clamp (2) using pliers (5).
Mark mounting position of turbine body (3) on central body (1).

Figure 105

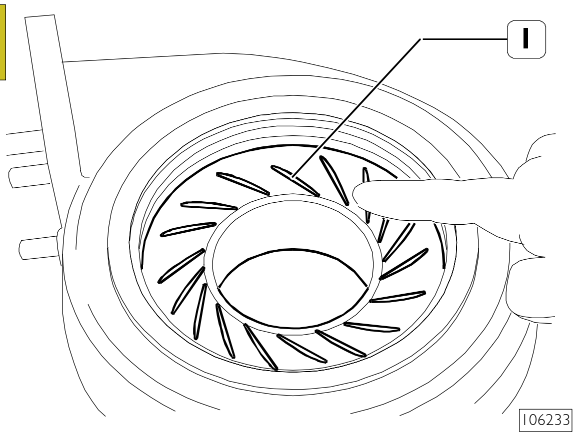


By a copper hammer, beat on two opposite points (~180°) on turbine body (2) to separate turbine body from central body (1).

NOTE In operation, take particular care to avoid damaging turbine rotor.

After dismounting turbine body, check variable geometry movement as described in relating chapter; where improvement in movement is not found with respect to previous check, replace turbocompressor.

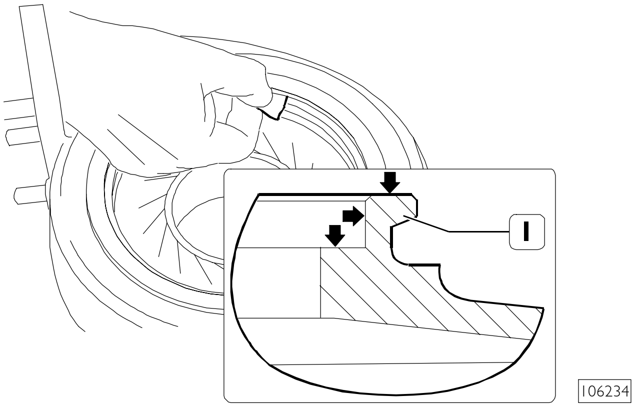
Figure 106



Accurately clean slot ring (1) and area around turbine body from carbonaceous deposits and check that the ring moves freely, otherwise, replace turbocompressor.

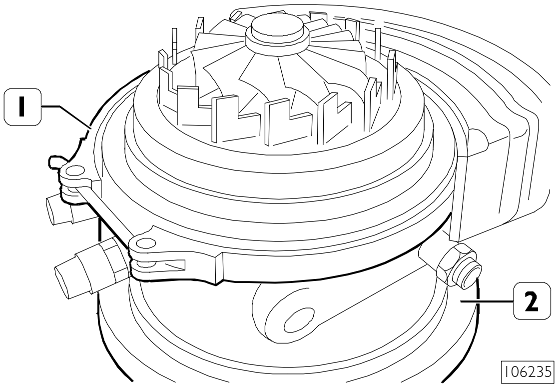
NOTE Any small cracks between slots and ring can be accepted, because they do not impair turbocompressor operation conditions.

Figure 107



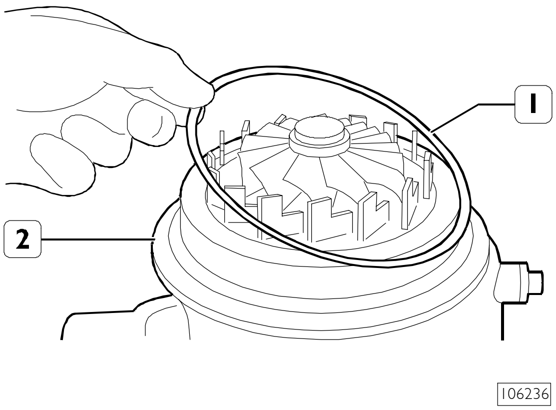
By suitable scraper and abrasive paper, accurately clean surfaces (→) of turbine body (1) from carbonaceous deposits, taking care to avoid damaging the surfaces.

Figure 108



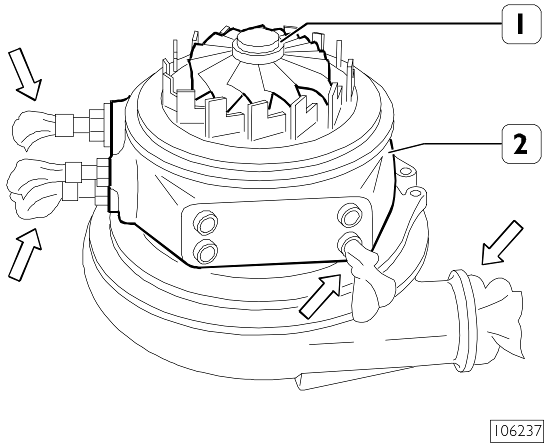
Dismount clamp (1) from central body (2) and check that the clamp does not result to be damaged; otherwise replace the clamp.

Figure 109



Dismount seal ring (1), external with respect to central body (2).
Accurately clean seal ring (1) and check that the ring does not result to be damaged; otherwise replace the ring.

Figure 110



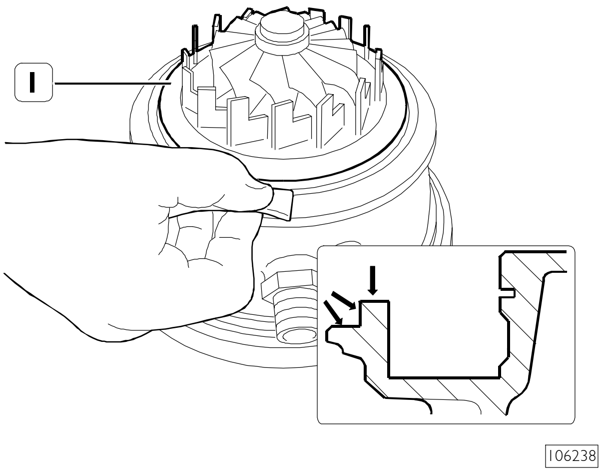
Check turbine rotor (1); there must not be found: carbonaceous deposits, deformation, cracks, blade scoring; also, turbine must turn freely.
By comparator, check clearance of turbine rotor stem (1); clearance must result to be:
Holset with fixed geometry:
- axial clearance: 0.025÷0.127 mm
- radial clearance: 0.381÷0.610 mm.

Holset with variable geometry:
- axial clearance: 0.051÷0.152 mm
- radial clearance: 0.381÷0.533 mm.

Where either clearance values over above ones or any one of above mentioned faults are found, replace turbocompressor.

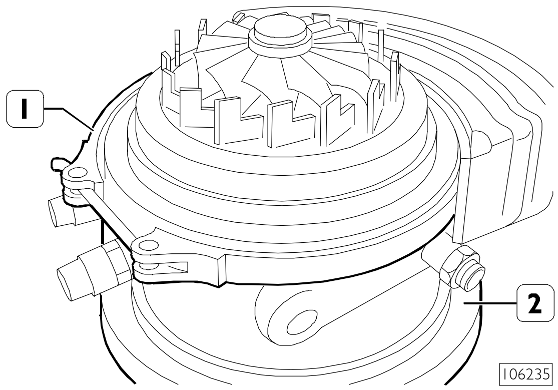
NOTE Before cleaning turbine side central body, properly protect oil, water and air inlets and outlets (→) in order to prevent dirt or foreign bodies from entering turbocompressor.

Figure 111



By suitable scraper and abrasive paper, accurately clean surfaces (→) of central body (1) from carbonaceous deposits, taking care to avoid damaging the surfaces and variable geometry ring.
Then, with compressed air, clean variable geometry surfaces and ring from removed residues.
Check again, as described in relating chapters:
- variable geometry movement;
- actuator;
- actuator travel.

Figure 112

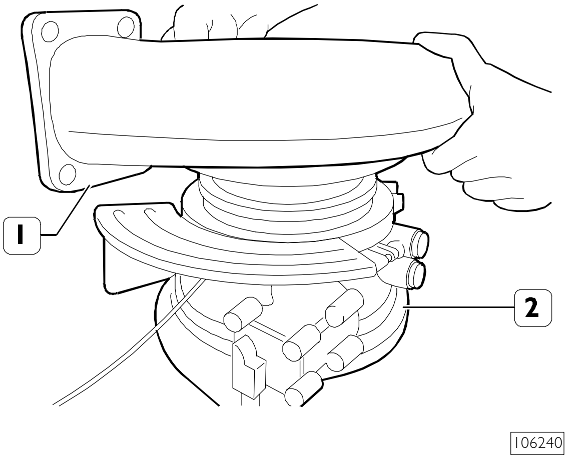


Position clamp (1) on central body (2)

NOTE Should clamp (1) be replaced with an integrated heat guard, a new actuator has to be mounted with an integrated heat guard at the place of existing one.

Position accurately cleaned seal ring on central body.
Apply a thin layer of antiscuff paste on cleaned matching surfaces: central body / turbine body.

Figure 113



Mount turbine body (1) on central body (2) taking care to avoid damaging turbine rotor and align turbine body variable geometry slot ring. Do not force mounting operation: in case of jamming, it might damage variable geometry with consequent regulation system faulty operation.

Once mounting has been completed, make sure that turbine body results to be matched correctly on central body.

Position turbine body on central body and clamp on central body in such a way that marks, made on dismounting, are matching.

Tighten nut clamping the clamp at 11.3 Nm torque.

Check again, as described in relating chapters:

- actuator;
- actuator travel.

TIGHTENING TORQUE

PART		TORQUE	
		Nm	kgm
Screws fixing crankcase base to crankcase (see Figure 114) ♦			
Outside screws M12x1.75	First phase: pre-tightening	30	(3)
Inside screws M18x2	Second phase: pre-tightening	120	(12)
Inside screws	Third phase: closing to angle	60°	
Inside screws	Fourth phase: closing to angle	55°	
Outside screws	Fifth phase: closing to angle	60°	
Piston cooling nozzle union ♦		35 ±2	(3,5 ±0,2)
Screws fixing heat exchanger to crankcase ♦ (see Figure 118)			
pre-tightening		11.5 ±3.5	(1.15 ±0.35)
tightening		19 ±3	(1.9 ±0.3)
Screws fixing suction strainer to crankcase base ♦		24.5 ±2.5	(2.4 ±0.25)
Screws fixing oil sump spacer ♦ (see Figure 119)			
pre-tightening		38	(3.8)
tightening		45	(4.5)
Screws fixing gearbox to crankcase M12x1.75 ♦ (see Figure 121)		63 ±7	(6.3 ±0.7)
Screws fixing control unit to crankcase base ♦		24 ±2.5	(2.4 ±0.25)
Screws fixing cylinder head (see Figure 115) ♦			
First phase	pre-tightening	60	(6)
Second phase	pre-tightening	120	(12)
Third phase	closing to angle	90°	
Fourth phase	closing to angle	-	
Fifth phase	closing to angle	65°	
Screws fixing rocker arm shaft ♦			
First phase	pre-tightening	80	(8)
Second phase	closing to angle	60°	
Lock nut for rocker arm adjustment screw ♦		39 ±5	(3.9 ±0.5)
Screws for injector brackets ♦		32.5 ± 2.5	3.25 ± 0.25
Screws fixing plastic cover		8.5 ±1.5	(0.85 ±0.15)
Screws fixing shoulder plate to head ♦		19 ±3	(1.9 ±0.3)
Screws fixing engine mount bracket to cylinder head			
First phase	pre-tightening	120	(12)
Second phase	closing to angle	45°	

♦ Before assembly, lubricate with UTDM oil

• Before assembly, lubricate with graphitized oil

PART			TORQUE	
			Nm	kgm
Screws fixing engine mount bracket to flywheel casing				
	First phase	pre-tightening	100	(10)
	Second phase	closing to angle	60°	
Screws fixing camshaft gear ♦				
	First phase	pre-tighteningirst	60	(6)
	Second phase	closing to angle	60°	
Screws fixing phonic wheel on camshaft gear			8.5 ±1.5	(0.85 ±0.15)
Screws fixing exhaust manifold • (see Figure 116)				
		pre-tightening	40±5	(4±0.5)
		tightening	70±5	(3.2)
Screws fixing engine brake actuator cylinder			19	(1.9)
Screws fixing connecting rod cap ♦				
	First phase	pre-tightening	60	(6)
	Second phase	closing to angle	60°	
Screws fixing engine flywheel ♦				
	First phase	pre-tightening	120	(12)
	Second phase	closing to angle	90°	
Screws fixing damper flywheel ♦				
	First phase	pre-tightening	70	(7)
	Second phase	closing to angle	50°	
Screws fixing middle gear pins ♦				
	First phase	pre-tightening	30	(3)
	Second phase	closing to angle	90°	
Screws fixing idle gear adjustment connecting rod:			24.5 ±2.5	(2.45 ±0.25)
Screws fixing oil pump			24.5 ±2.5	(2.45 ±0.25)
Screws fixing crankshaft gasket front cover			24.5 ±2.5	(2.45 ±0.25)
Screws fixing fuel pump / filter mount			19	(1.9)
Screw fixing control unit mount			19 ±3	(1.9 ±0.3)
Screws and nuts fixing turbocharger • (see Figure 117)				
		pre-tightening	35	(3.5)
		tightening	46	(4.6)
Screw fixing thermostat assembly			22 ± 2	(2.2 ±0.2)
Screws fixing water pump			24.5 ± 2.5	(2.45 ± 0.25)
Screws fixing fan hub to spacer			30	(3)
Screw fixing fan spacer to pulley			30	(3)
Screws fixing fan mount to crankcase			100	(10)
Screw securing steady tensioner			10.5 ± 5	(10 ±0.5)
Screw securing automatic belt tensioner			50 ±5	(5 ±0.5)
Screws fixing fixed pulley for auxiliary member drive belt to crankcase			105 ±5	(10.5 ±0.5)
Screws fixing starter motor			74 ±4	(7.4 ±0.4)
Screws fixing air heater			50 ±5	(5 ±0.5)
Screws fixing air compressor			74 ±4	(7.4 ±0.4)

♦ Before assembly, lubricate with UTDM oil

• Before assembly, lubricate with graphitized oil

PART	TORQUE	
	Nm	kgm
Nut fixing air compressor gear	170 ±10	(17 ±1)
Screws fixing alternator: M 10x1,5 l = 35 mm	44 ±4	(4.4 ±0.4)
M 10x1,5 l = 60 mm	44 ±4	(4.4 ±0.4)
Screws fixing hydraulic power steering pump	46.5 ±4.5	(4.65 ±0.45)
Screws fixing air-conditioner compressor to the mount	24.5 ±2.5	(2.5 ±0.25)
Screws fixing guard	24.5 ±2.5	(2.5 ±0.25)
Filter clogging sensor fixing	55 ±5	(5.5 ±0.5)
Water / fuel temperature sensor fixing	35	(3.5)
Transmitter / thermometric switch fixing	25	(2.5)
Air temperature transmitter fixing	35	(3.5)
Pulse transmitter fixing	8 ±2	(0.8 ±0.2)
Fixing connections to injector	1.36 ±1.92	(0.13 ±0.19)
Fixing engine brake solenoid valve	32	(3.2)
M14X70/80 screw securing front and rear spring blocks to chassis	192.5 ± 19.5	19.2 ± 1.9
M16X130 screw securing front and rear spring blocks to engine	278 ± 28	27.8 ± 2.8
M18X62 flanged hex screw for front engine block:		
First stage pre-tightening	120	12
Second stage angle closing	45°	
M14X60 socket cheese-head screw for front engine block:		
First stage pre-tightening	60	6
Second stage angle closing	45°	
Flanged hex screw for rear engine block:		
First stage pre-tightening	100	10
Second stage angle closing	60°	

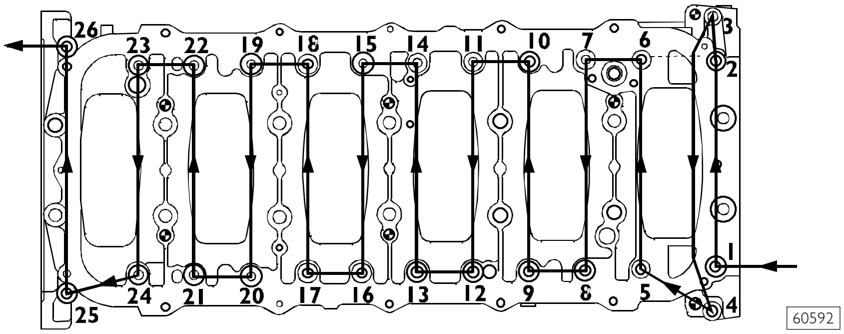
◆ Before assembly, lubricate with UTDM oil

- Before assembly, lubricate with graphitized oil

Diagram of tightening sequence of crankcase base fixing screws

Figure 114

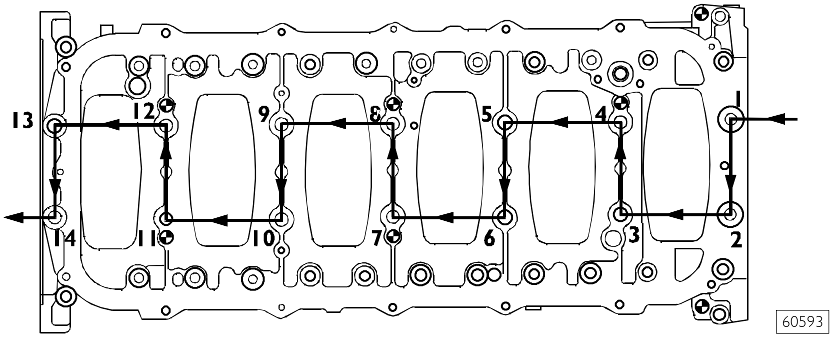
FRONT SIDE



First phase:
pre-tightening
outside screws

30 Nm

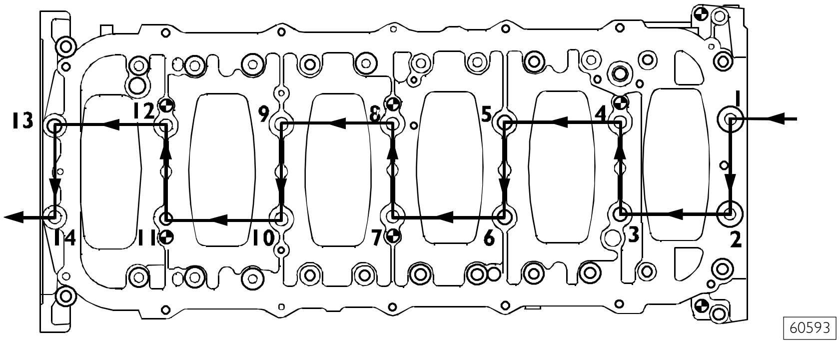
FRONT SIDE



Second phase:
pre-tightening
inside screws

120 Nm

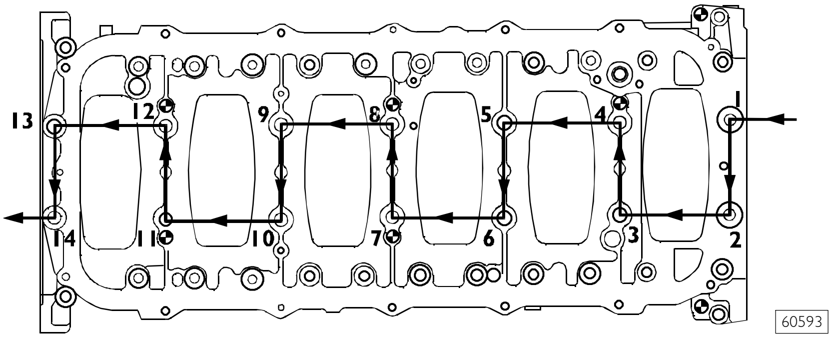
FRONT SIDE



Third phase:
closing inside
screws to angle

60°

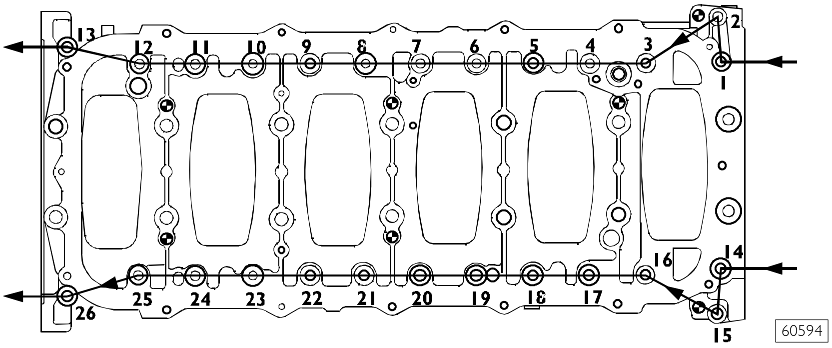
FRONT SIDE



Fourth phase:
closing inside
screws to angle

55°

FRONT SIDE

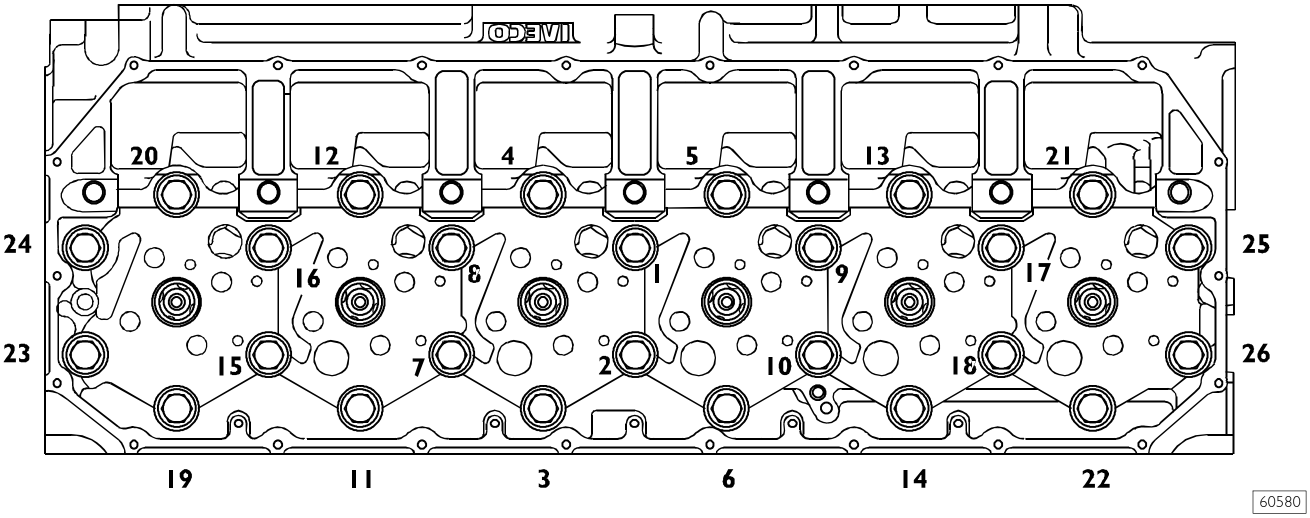


Fifth phase:
closing outside
screws to angle

60°

Diagram of tightening sequence of exhaust manifold fixing screws

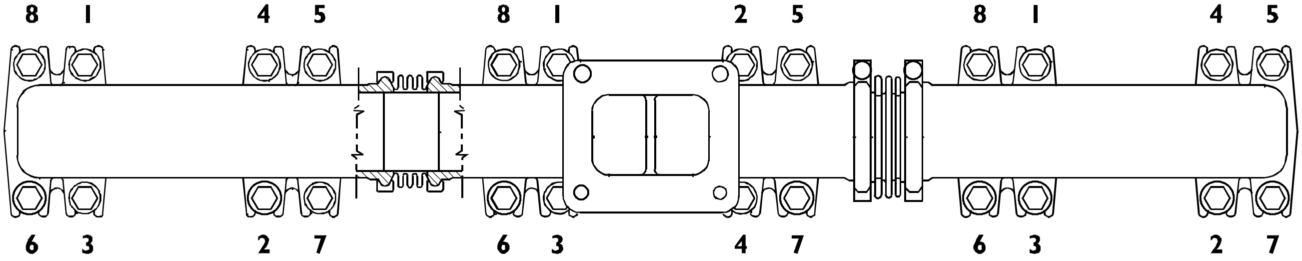
Figure 115



60580

Diagram of tightening sequence of exhaust manifold fixing screws

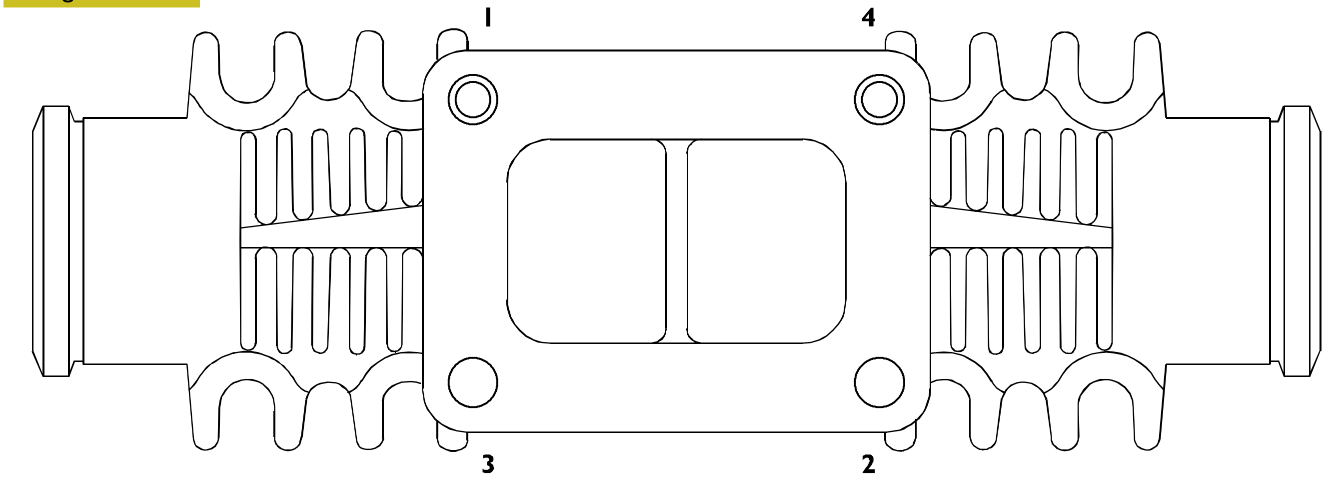
Figure 116



60581

Diagram of tightening sequence of screws and nuts fixing turbocharger on exhaust manifold

Figure 117



60582

Figure 118

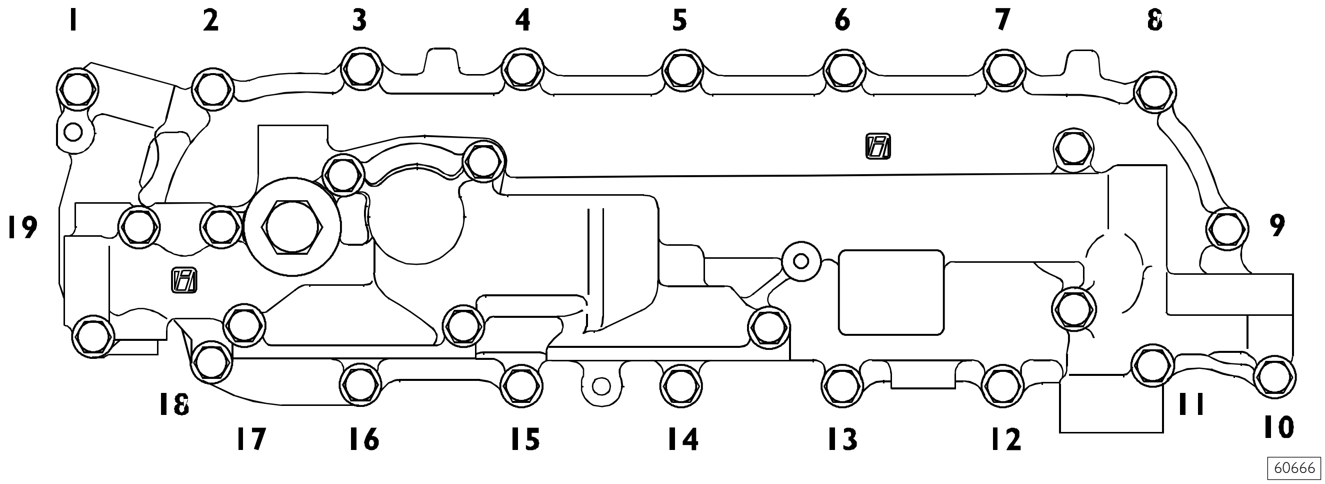


DIAGRAM OF TIGHTENING SEQUENCE OF HEAT EXCHANGER FIXING SCREWS

Figure 119

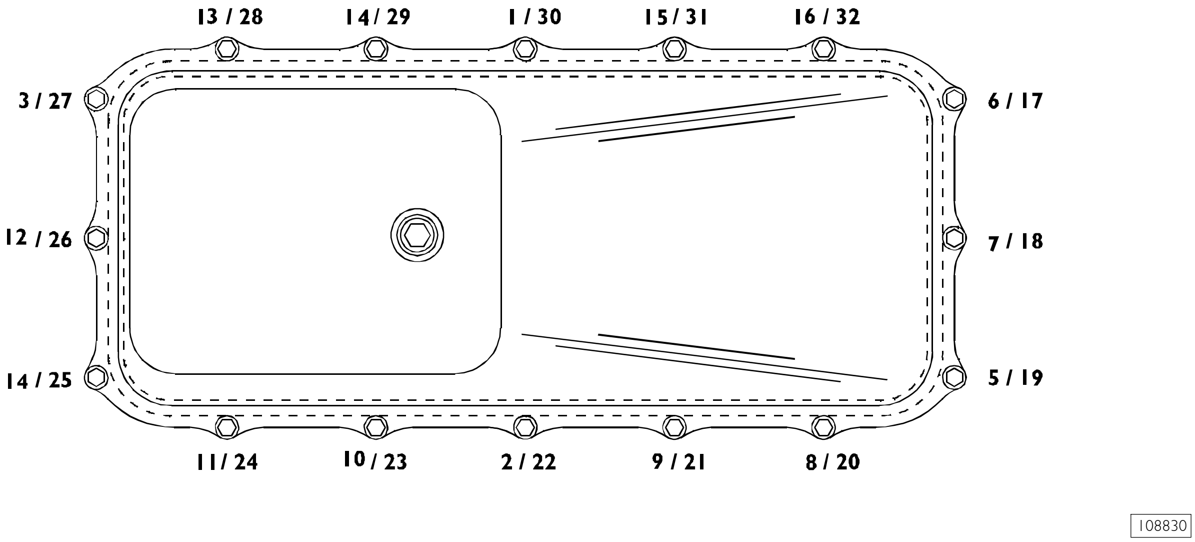


DIAGRAM OF TIGHTENING SEQUENCE OF ENGINE OIL SUMP FIXING SCREWS

Figure 120

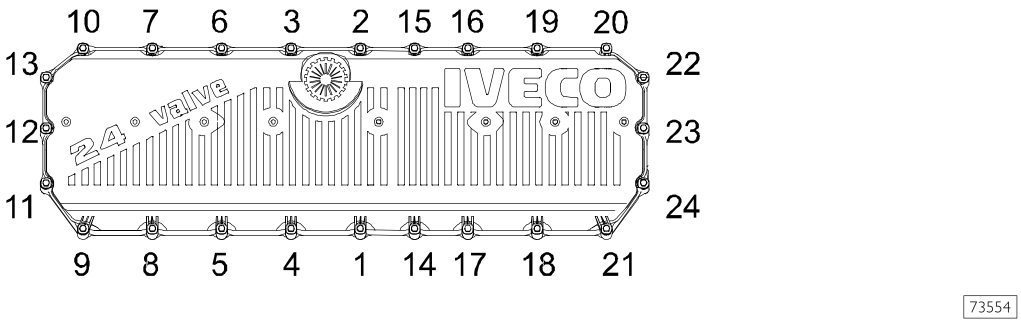


DIAGRAM OF TIGHTENING SEQUENCE FOR SCREWS FIXING ROCKER COVER

Figure 121

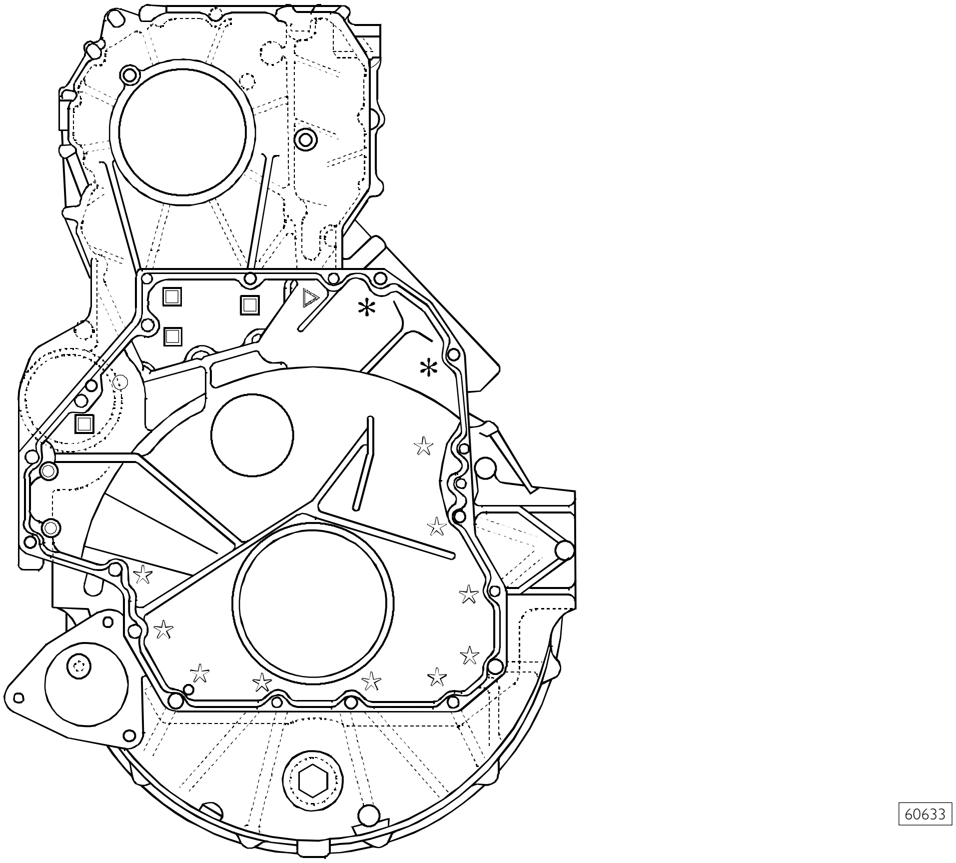


DIAGRAM OF TIGHTENING SEQUENCE OF SCREWS FIXING GEARBOX TO CRANKCASE

Tightening sequence

✡ 10 screws M12 x 1.75 x 100

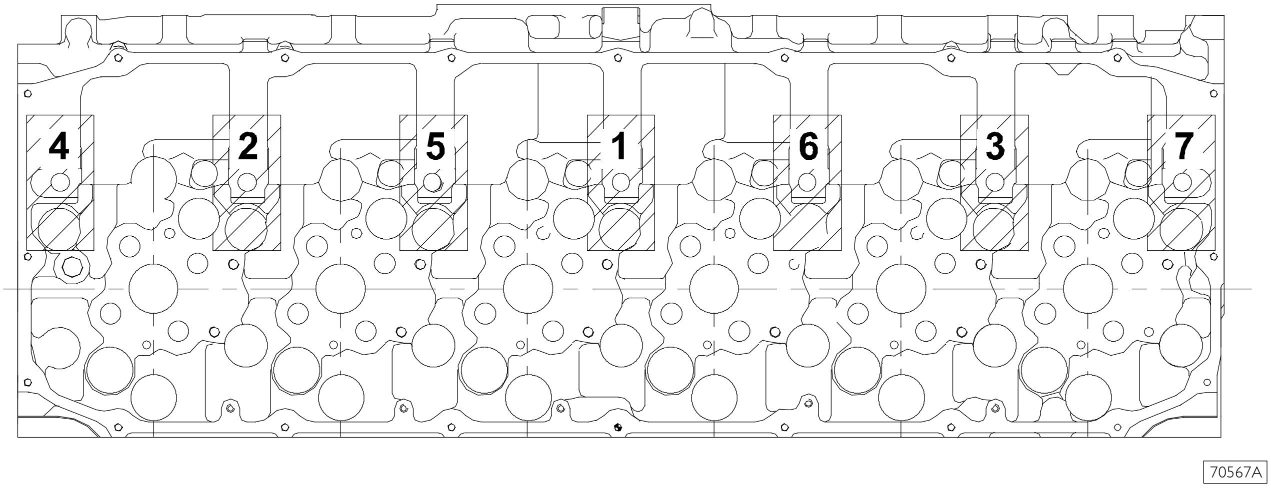
◎ 2 screws M12 x 1.75 x 70

▢ 4 screws M12 x 1.75 x 35

△ 1 screw M12 x 1.75 x 120

✳ 2 screws M12 x 1.75 x 193

Figure 122

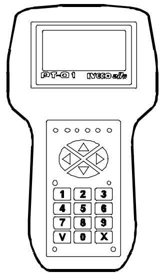
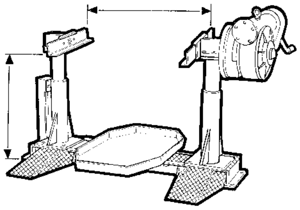
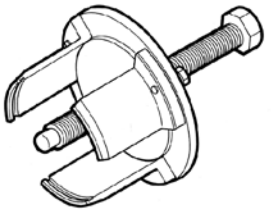
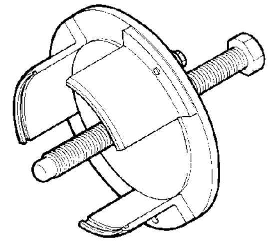
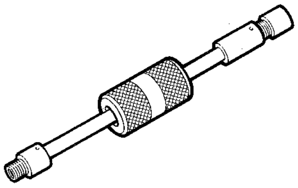
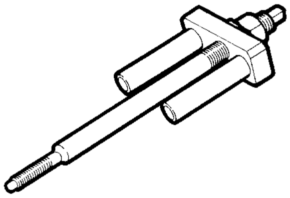


SCHEME OF THE TIGHTENING ORDER OF ROCKER ARMS SHAFTS FASTENING SCREWS

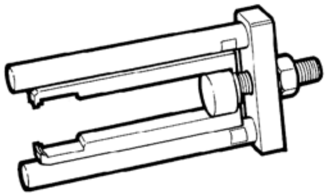
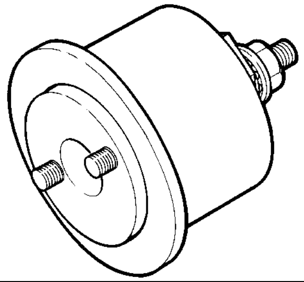
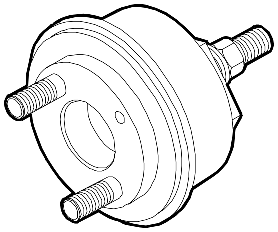
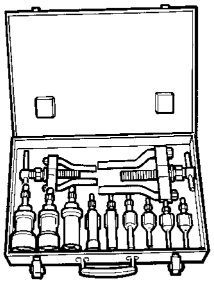
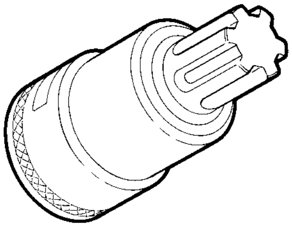
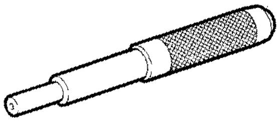
SECTION 5

Tools

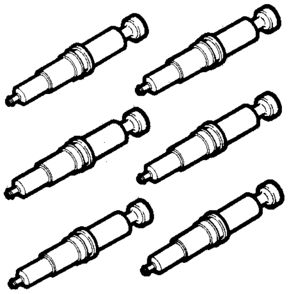
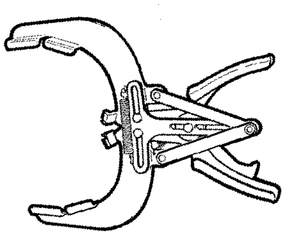
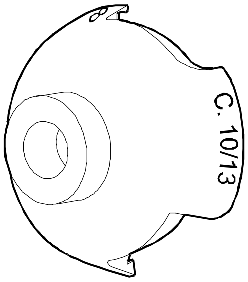
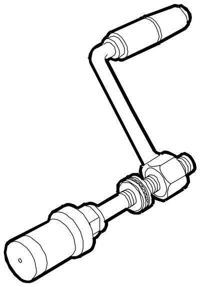
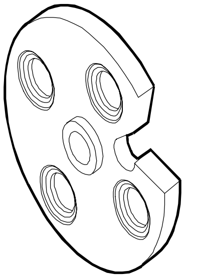
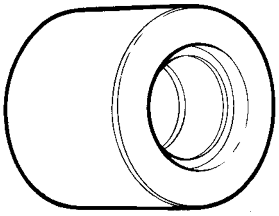
TOOLS

TOOL NO.		DESCRIPTION
8093731		Tester PT01
99322230		Rotary telescopic stand (range 2000 daN, torque 375 daNm)
99340053		Extractor for crankshaft front gasket
99340054		Extractor for crankshaft rear gasket
99340205		Percussion extractor
99342149		Extractor for injector-holder

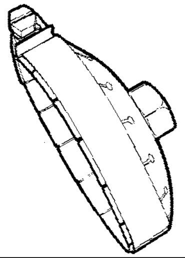
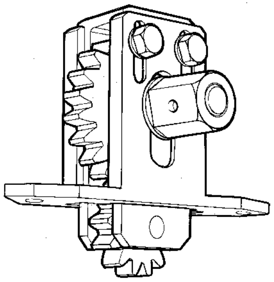
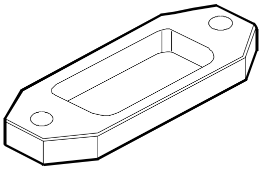
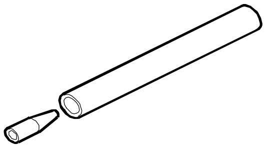
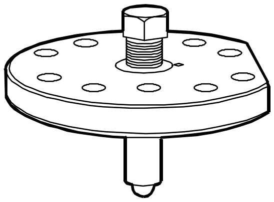
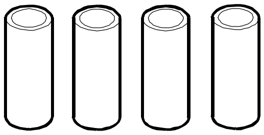
TOOLS

TOOL NO.		DESCRIPTION
99342155		Tool to extract injectors
99346250		Tool to install the crankshaft front gasket
99346251		Tool to install the crankshaft rear gasket
99348004		Universal extractor for 5 to 70 mm internal components
99350072		Box wrench for block junction bolts to the underblock
99360143		Easy puller for valve guide deassembly

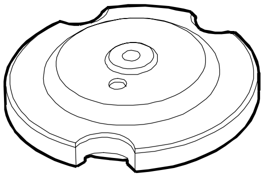
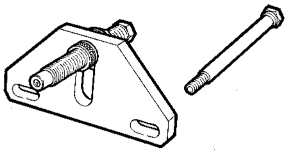
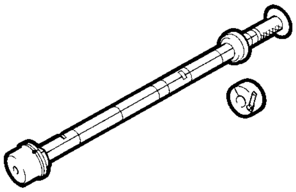
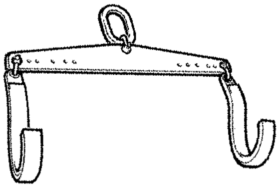
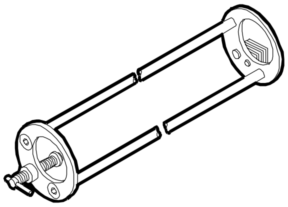
TOOLS

TOOL NO.		DESCRIPTION
99360180		Injector housing protecting plugs (6)
99360184		Pliers for assembling and disassembling piston split rings (105-106 mm)
99360192		Guide for flexible belt
99360261		Tool to take down-fit engine valves (to be used with special plates)
99360263		Plate for take down-fit engine valves (to be used with 99360261)
99360296		Tool to fit back valve guide (to be used with 99360143)

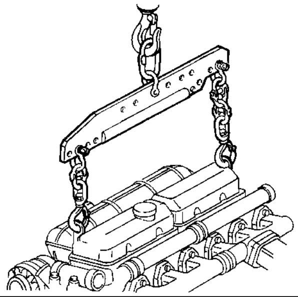
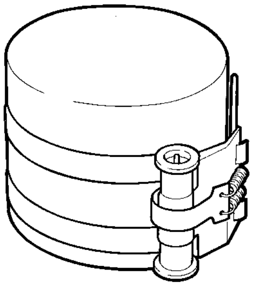
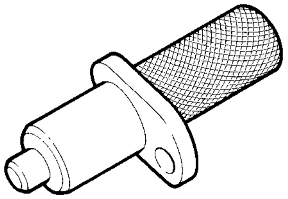
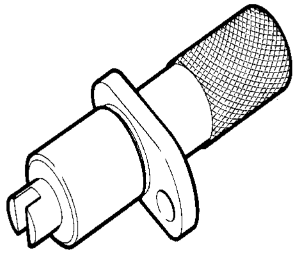
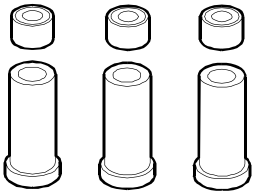
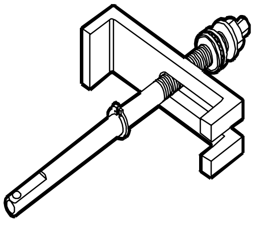
TOOLS

TOOL NO.		DESCRIPTION
99360314		Tool to remove oil filter (engine)
99360321		Tool to rotate engine flywheel (to be used with 99360325)
99360325		Spacer (to be used with 99360321)
99360329		Tool to install gasket on valve guide
99360334		Compression tool for checking the protrusion of cylinder liners (to be used with 99370415-99395603 and special plates)
99360336		Spacer (to be used with 99360334)

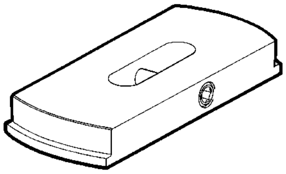
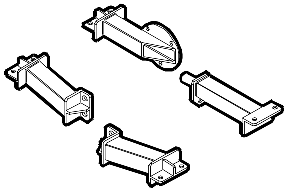
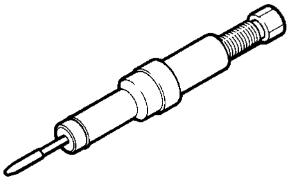
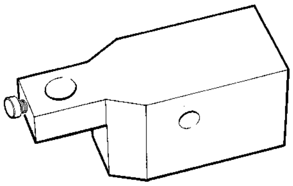
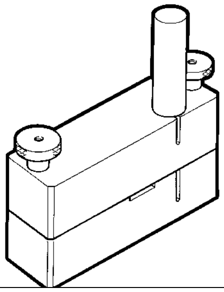
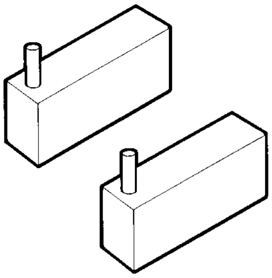
TOOLS

TOOL NO.		DESCRIPTION
99360338		Cylinder liner compression plate (to be used with 99360334-99360336)
99360351		Tool to stop engine flywheel
99360499		Tool to take down and fit back camshaft bushes
99360500		Tool to lift crankshaft
99360551		Bracket to take down and fit engine flywheel
99360553		Tool for assembling and installing rocker arm shaft

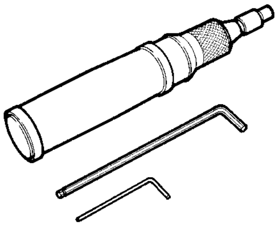
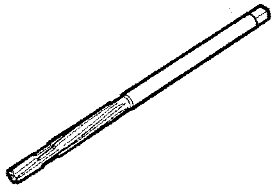
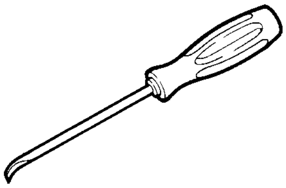
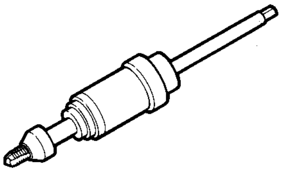
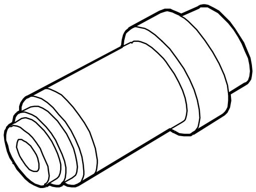
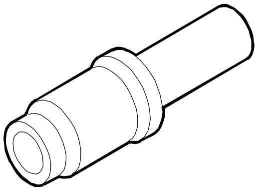
TOOLS

TOOL NO.		DESCRIPTION
99360585		Swing hoist for engine disassembly assembly
99360605		Belt to insert piston in cylinder liner (60 - 125 mm)
99360612		Tool for positioning engine P.M.S.
99360613		Tool for timing of phonic wheel on timing gear
99360703		Tool to stop cylinder liners
99360706		Tool to extract cylinder liners (to be used with specific rings)

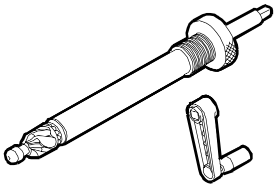
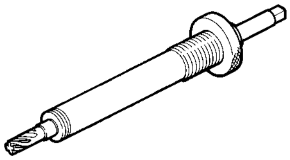
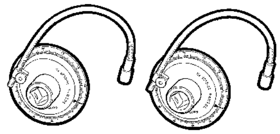
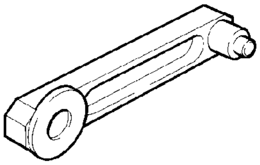
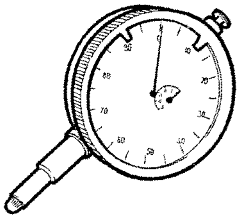
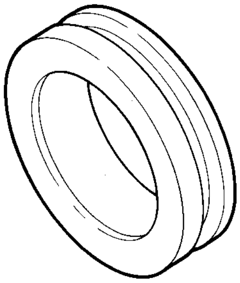
TOOLS

TOOL NO.		DESCRIPTION
99360728		Ring (135 mm) (to be used with 99360706)
99361036		Brackets fixing the engine to rotary stand 99322230
99365056		Tool for injector holder heading
99370415		Base supporting the dial gauge for checking cylinder liner protrusion (to be used with 99395603)
99378100		Tool for printing engine identification plates (to be used with special punches)
99378130		Punch kit to stamp engine identification data plates (compose of: 99378101(A) - 99378102(B) - 99378103(C) - 99378104(D) - 99378105(E) - 99378106(F) - 993378107(G) - 99378108(V))

TOOLS

TOOL NO.		DESCRIPTION
99389834		Torque screwdriver (1-6 Nm) for calibrating the injector solenoid valve connector check nut
99390330		Valve guide sleeker
99390772		Tool for removing injector holding case deposits
99390804		Tool for threading injector holding cases to be extracted (to be used with 99390805)
99390805		Guide bush (to be used with 99390804)
99394015		Guide bush (to be used with 99394041 or 99394043)

TOOLS

TOOL NO.		DESCRIPTION
99394041		Cutter to rectify injector holder housing (to be used with 99394015)
99394043		Reamer to rectify injector holder lower side (to be used with 99394015)
99395216		Measuring pair for angular tightening with 1/2" and 3/4" square couplings
99395219		Gauge for defining the distance between the centres of camshaft and transmission gear
99395603		Dial gauge (0 - 5 mm)
99396035		Centering ring of crankshaft front gasket cap

Appendix

SAFETY PRESCRIPTIONS

Standard safety prescriptions

Particular attention shall be drawn on some precautions that must be followed absolutely in a standard working area and whose non fulfillment will make any other measure useless or not sufficient to ensure safety to the personnel in-charge of maintenance.

Be informed and inform personnel as well of the laws in force regulating safety, providing information documentation available for consultation.

- ☐ Keep working areas as clean as possible, ensuring adequate aeration.
- ☐ Ensure that working areas are provided with emergency boxes, that must be clearly visible and always provided with adequate sanitary equipment.
- ☐ Provide for adequate fire extinguishing means, properly indicated and always having free access. Their efficiency must be checked on regular basis and the personnel must be trained on intervention methods and priorities.
- ☐ Organize and displace specific exit points to evacuate the areas in case of emergency, providing for adequate indications of the emergency exit lines.
- ☐ Smoking in working areas subject to fire danger must be strictly prohibited.
- ☐ Provide Warnings throughout adequate boards signaling danger, prohibitions and indications to ensure easy comprehension of the instructions even in case of emergency.

Prevention of injury

- ☐ Do not wear unsuitable cloths for work, with fluttering ends, nor jewels such as rings and chains when working close to engines and equipment in motion.
- ☐ Wear safety gloves and goggles when performing the following operations:
  - filling inhibitors or anti-frost
  - lubrication oil topping or replacement
  - utilization of compressed air or liquids under pressure (pressure allowed: ≤ 2 bar)
- ☐ Wear safety helmet when working close to hanging loads or equipment working at head height level.
- ☐ Always wear safety shoes when and cloths adhering to the body, better if provided with elastics at the ends.
- ☐ Use protection cream for hands.
- ☐ Change wet cloths as soon as possible
- ☐ In presence of current tension exceeding 48-60 V verify efficiency of earth and mass electrical connections. Ensure that hands and feet are dry and execute working operations utilizing isolating foot-boards. Do not carry out working operations if not trained for.
- ☐ Do not smoke nor light up flames close to batteries and to any fuel material.
- ☐ Put the dirty rags with oil, diesel fuel or solvents in anti-fire specially provided containers.
- ☐ Do not execute any intervention if not provided with necessary instructions.
- ☐ Do not use any tool or equipment for any different operation from the ones they've been designed and provided for: serious injury may occur.
- ☐ In case of test or calibration operations requiring engine running, ensure that the area is sufficiently aerated or utilize specific vacuum equipment to eliminate exhaust gas. Danger: poisoning and death.

During maintenance

- ☐ Never open filler cap of cooling circuit when the engine is hot. Operating pressure would provoke high temperature with serious danger and risk of burn. Wait unit the temperature decreases under 50°C.
- ☐ Never top up an overheated engine with cooler and utilize only appropriate liquids.
- ☐ Always operate when the engine is turned off: whether particular circumstances require maintenance intervention on running engine, be aware of all risks involved with such operation.
- ☐ Be equipped with adequate and safe containers for drainage operation of engine liquids and exhaust oil.
- ☐ Keep the engine clean from oil tangles, diesel fuel and or chemical solvents.
- ☐ Use of solvents or detergents during maintenance may originate toxic vapors. Always keep working areas aerated. Whenever necessary wear safety mask.
- ☐ Do not leave rags impregnated with flammable substances close to the engine.
- ☐ Upon engine start after maintenance, undertake proper preventing actions to stop air suction in case of runaway speed rate.
- ☐ Do not utilize fast screw-tightening tools.
- ☐ Never disconnect batteries when the engine is running.
- ☐ Disconnect batteries before any intervention on the electrical system.
- ☐ Disconnect batteries from system aboard to load them with the battery loader.
- ☐ After every intervention, verify that battery clamp polarity is correct and that the clamps are tight and safe from accidental short circuit and oxidation.
- ☐ Do not disconnect and connect electrical connections in presence of electrical feed.
- ☐ Before proceeding with pipelines disassembly (pneumatic, hydraulic, fuel pipes) verify presence of liquid or air under pressure. Take all necessary precautions bleeding and draining residual pressure or closing dump valves. Always wear adequate safety mask or goggles. Non fulfillment of these prescriptions may cause serious injury and poisoning.

☐ Avoid incorrect tightening or out of couple. Danger: incorrect tightening may seriously damage engine's components, affecting engine's duration.

☐ Avoid priming from fuel tanks made out of copper alloys and/or with ducts not being provided with filters.

☐ Do not modify cable wires: their length shall not be changed.

☐ Do not connect any user to the engine electrical equipment unless specifically approved by Iveco.

☐ Do not modify fuel systems or hydraulic system unless Iveco specific approval has been released. Any unauthorized modification will compromise warranty assistance and furthermore may affect engine correct working and duration.

For engines equipped with electronic gearbox:

☐ Do not execute electric arc welding without having priory removed electronic gearbox.

☐ Remove electronic gearbox in case of any intervention requiring heating over 80°C temperature.

☐ Do not paint the components and the electronic connections.

☐ Do not vary or alter any data filed in the electronic gearbox driving the engine. Any manipulation or alteration of electronic components shall totally compromise engine assistance warranty and furthermore may affect engine correct working and duration.

Respect of the Environment

☐ Respect of the Environment shall be of primary importance: all necessary precautions to ensure personnel's safety and health shall be adopted.

☐ Be informed and inform the personnel as well of laws in force regulating use and exhaust of liquids and engine exhaust oil. Provide for adequate board indications and organize specific training courses to ensure that personnel is fully aware of such law prescriptions and of basic preventive safety measures.

☐ Collect exhaust oils in adequate specially provided containers with hermetic sealing ensuring that storage is made in specific, properly identified areas that shall be aerated, far from heat sources and not exposed to fire danger.

☐ Handle the batteries with care, storing them in aerated environment and within anti-acid containers. Warning: battery exhalation represent serious danger of intoxication and environment contamination.