

TIER 2 CURSOR SERIES

Industrial applications

C78

C78 ENT

C10

C10 ENT

C13

C13 ENT

CURSOR G-DRIVE

CURSOR 78 TE2

CURSOR 13 TE1

CURSOR 13 TE2

CURSOR 13 TE3

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.

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The logo for SATIZmsx INTERNATIONAL features the word "SATIZ" in a bold, black, sans-serif font, followed by "msx" in a smaller, red, lowercase sans-serif font. Below "msx" is the word "INTERNATIONAL" in a very small, black, uppercase sans-serif font. A red triangle points upwards from the top of the "I" in "INTERNATIONAL".

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CURSOR ENGINES

F2B Cursor engines

Part 1

F3A Cursor engines

Part 2

F3B Cursor engines

Part 3

Cursor Motors G-Drive application

Part 4

SPECIAL REMARKS

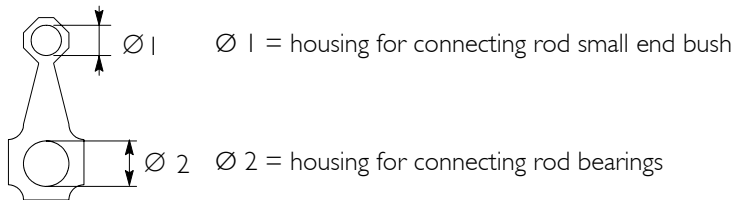
The subjects usually dealt with in each section are:

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



Tighten to torque

Tighten to torque + angular value

Graph and symbols

	Removal Disconnection		Intake
	Refitting Connection		Exhaust
	Removal Disassembly		Operation
	Fitting in place Assembly	ϱ	Compression ratio
	Tighten to torque		Tolerance Weight difference
	Tighten to torque + angle value		Rolling torque
	Press or caulk		Replacement Original spare parts
	Regulation Adjustment		Rotation
	Warning Note		Angle Angular value
	Visual inspection Fitting position check		Preload
	Measurement Value to find Check		Number of revolutions
	Equipment		Temperature
	Surface for machining Machine finish		Pressure
	Interference Strained assembly	$>$	Oversized Higher than.... Maximum, peak
	Thickness Clearance	$<$	Undersized Less than.... Minimum
	Lubrication Damp Grease		Selection Classes Oversizing
	Sealant Adhesive		Temperature < 0 °C Cold Winter
	Air bleeding		Temperature > 0 °C Hot Summer

Part I	
F2B CURSOR ENGINES	
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General specifications	I
Fuel	2
Industrial application	3
Overhaul and technical specifications	4
Tools	5
Safety prescriptions	Appendix

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.

UPDATING

Section	Description	Page	Date of revision

SECTION I

General specifications

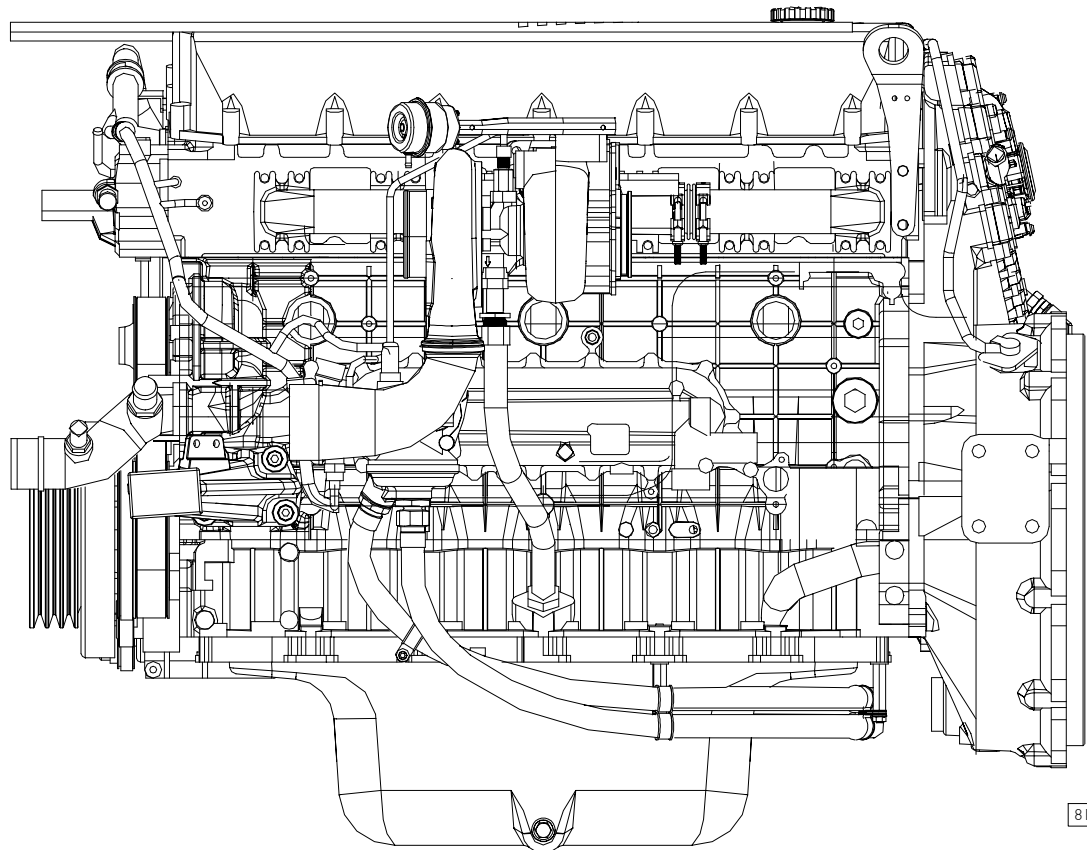
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VIEWS OF ENGINE (version F2BE0687A*B101)	9
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CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F2BE0684A*B001	-
F2BE0684A*B002	-
F2BE0687A*B101	C78 ENT

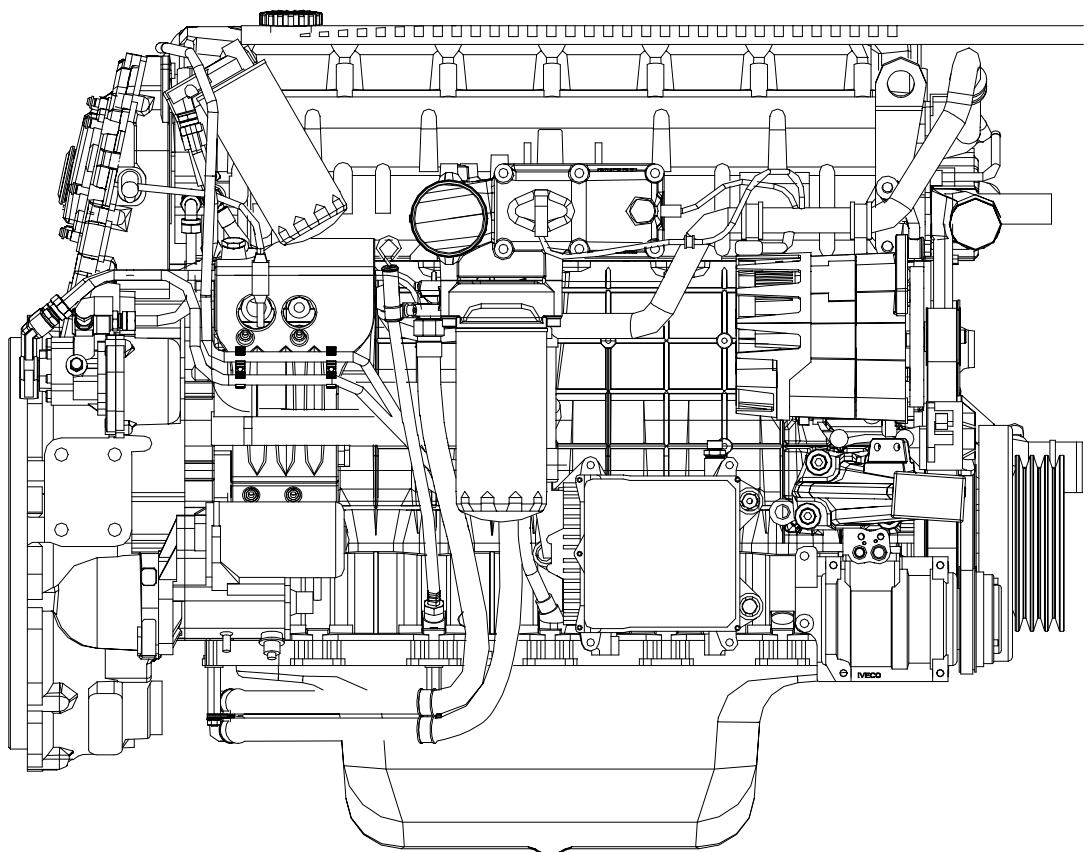
VIEWS OF ENGINE (version F2BE0684A*B001)

Figure 1



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LEFT-HAND SIDE VIEW

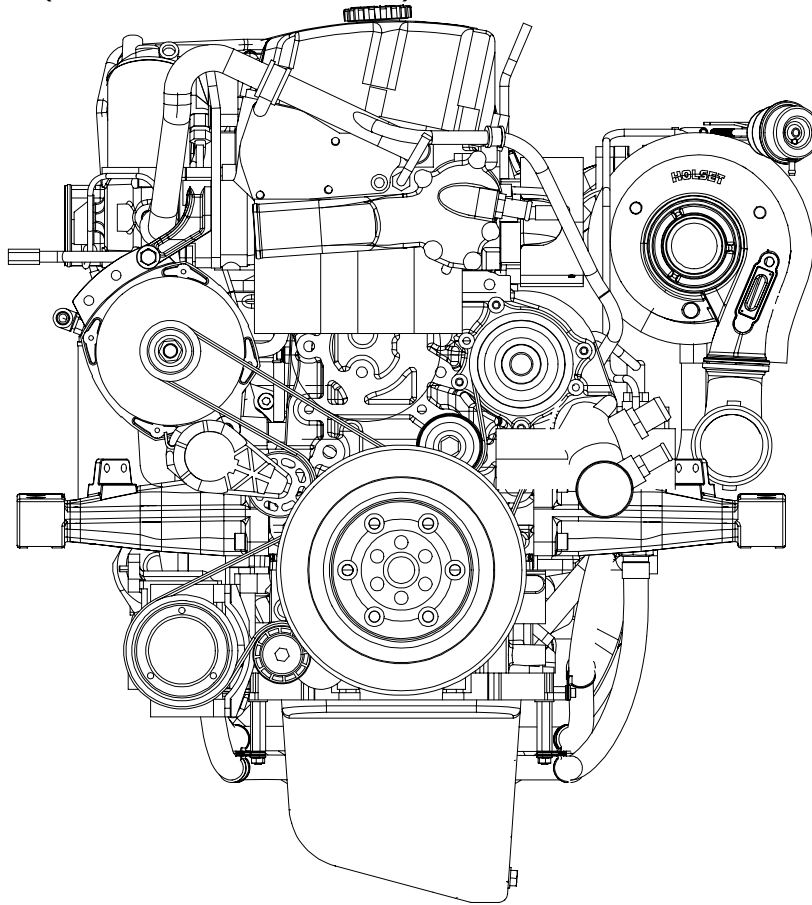


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RIGHT-HAND SIDE VIEW

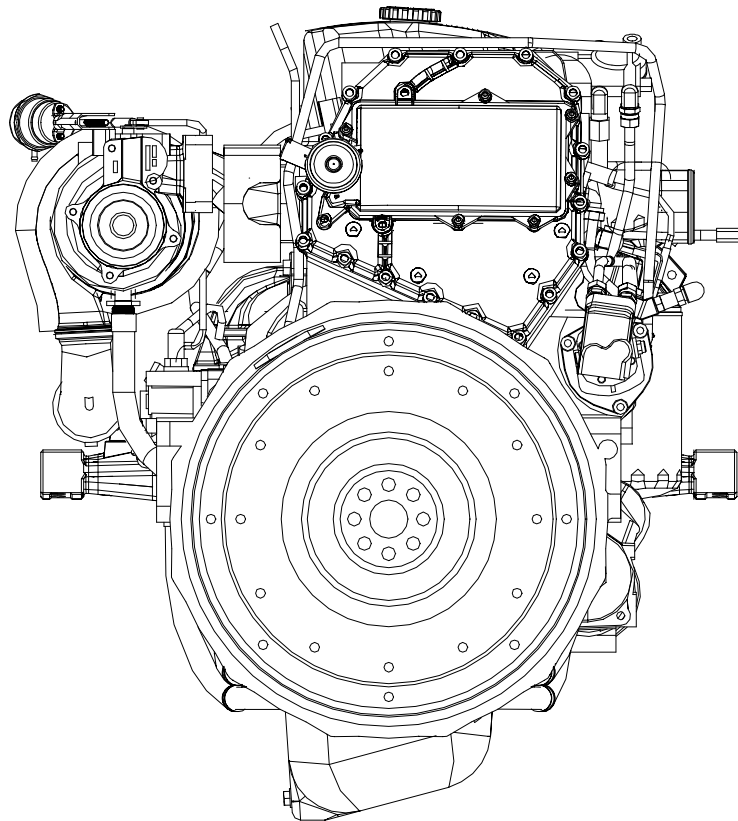
VIEWS OF ENGINE (version F2BE0684A*B001)

Figure 2



FRONT VIEW

81810

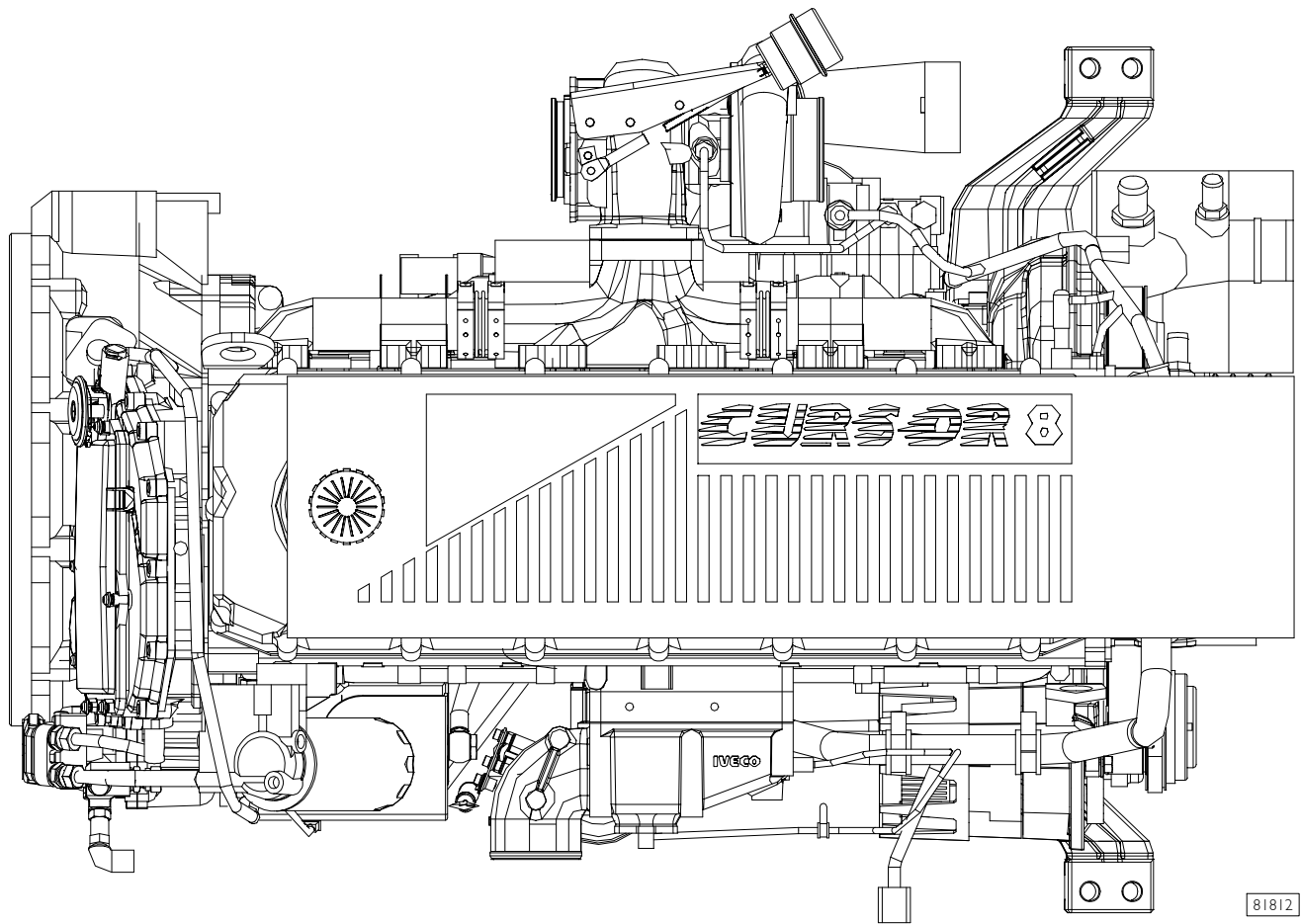


REAR VIEW

81811

VIEW OF ENGINE (version F2BE0684A*B001)

Figure 3

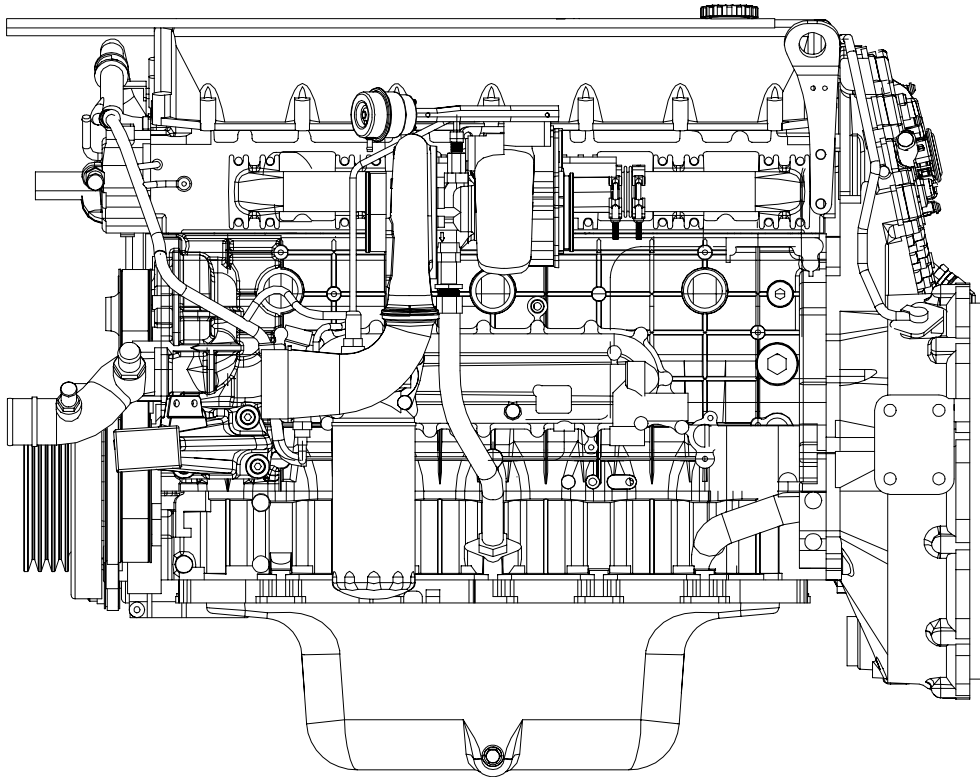


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TOP VIEW

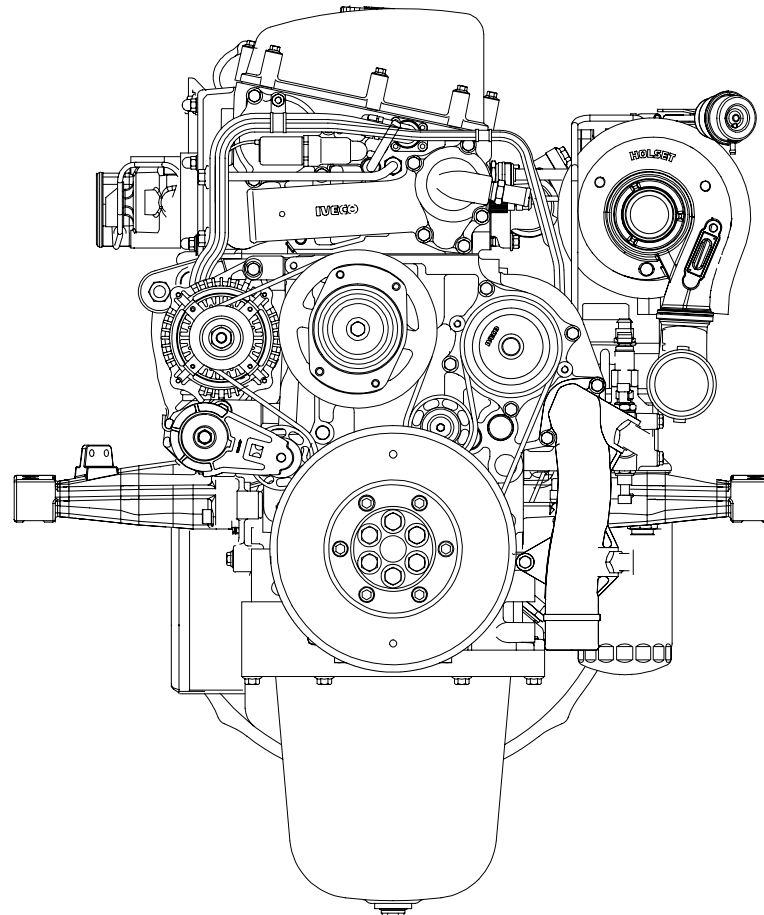
VIEW OF ENGINE (version F2BE0684A*B002)

Figure 4



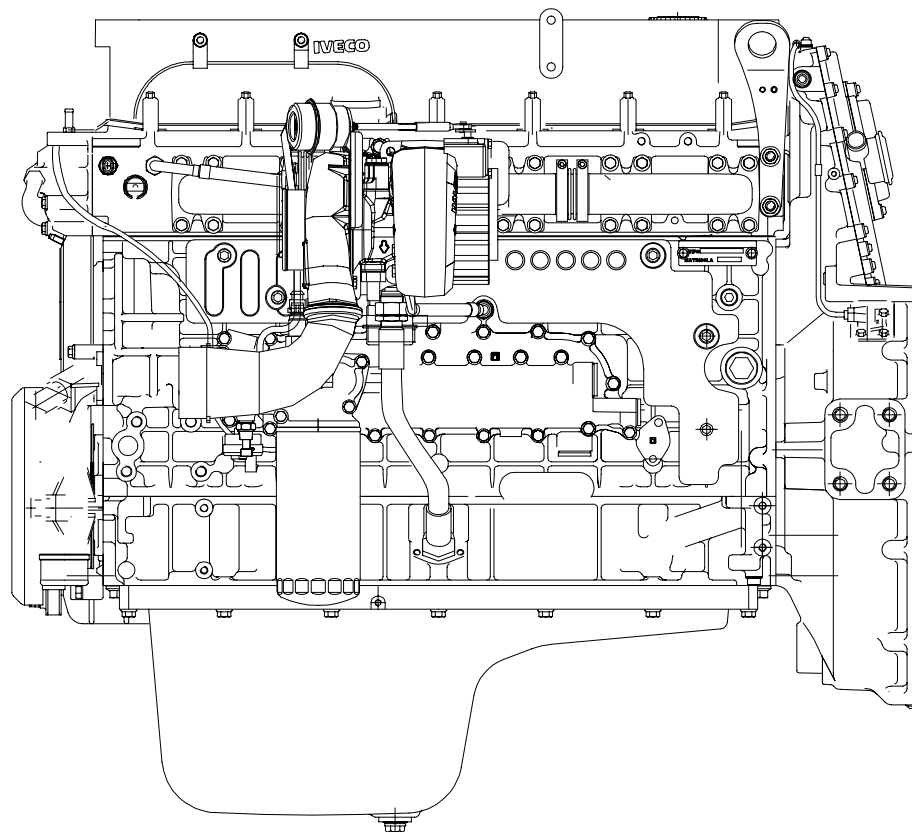
LEFT-HAND SIDE VIEW

81813

VIEWS OF ENGINE (version F2BE0687A*B101)**Figure 5**

FRONT VIEW

81814



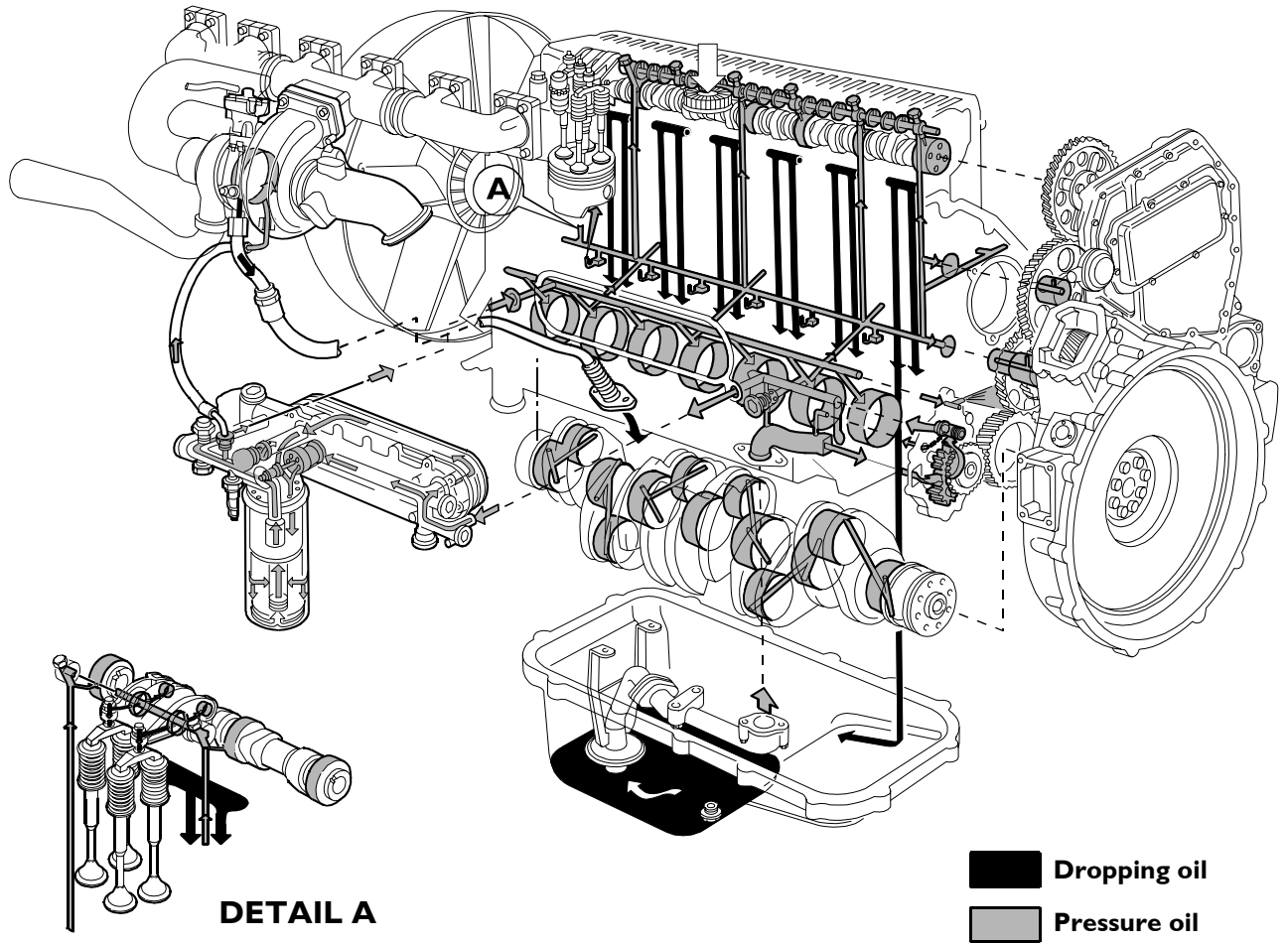
LEFT-HAND SIDE VIEW

81815

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 6

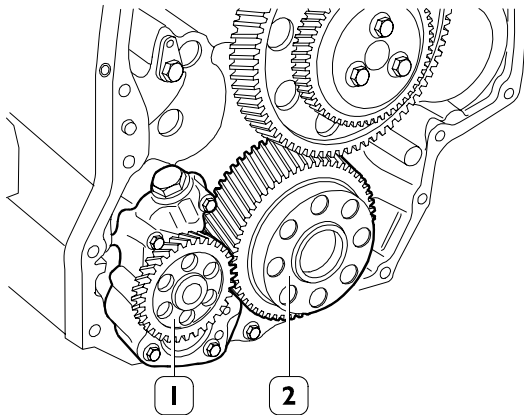


LUBRICATION CIRCUIT

99247

Oil pump

Figure 7



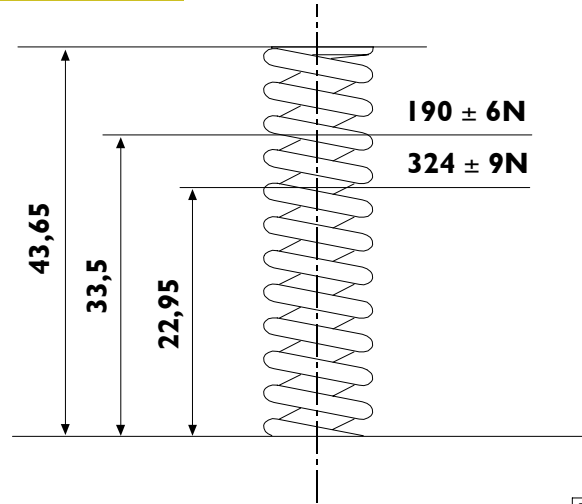
60560

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

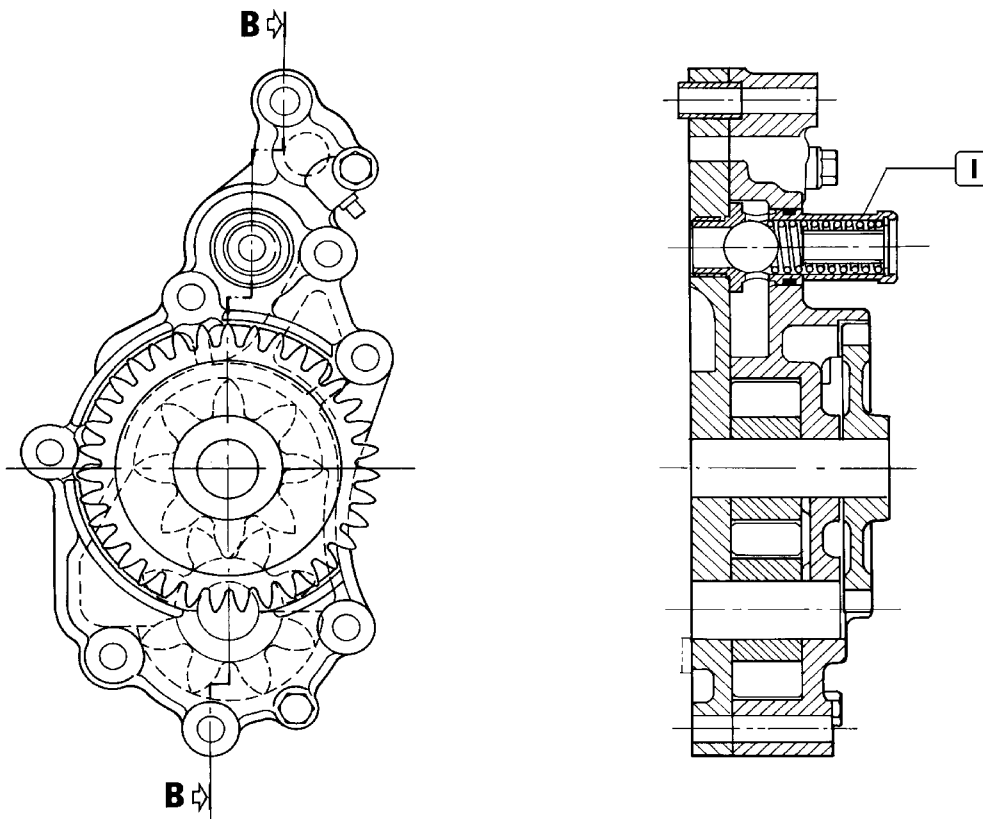
Figure 9



77820

MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

Figure 8



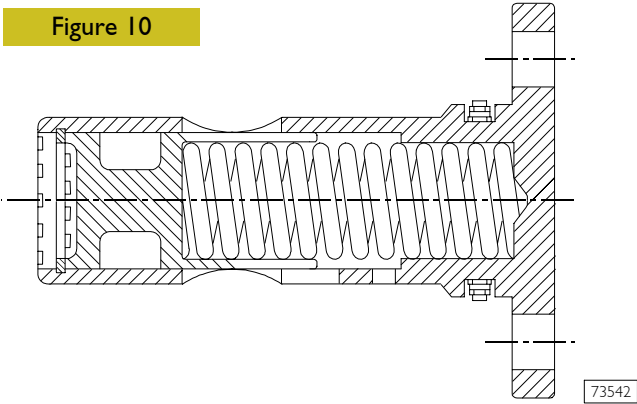
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OIL PUMP CROSS-SECTION

I. Overpressure valve – Start of opening pressure 10.1 ± 0.7 bars.

Oil pressure control valve (on the base unit)

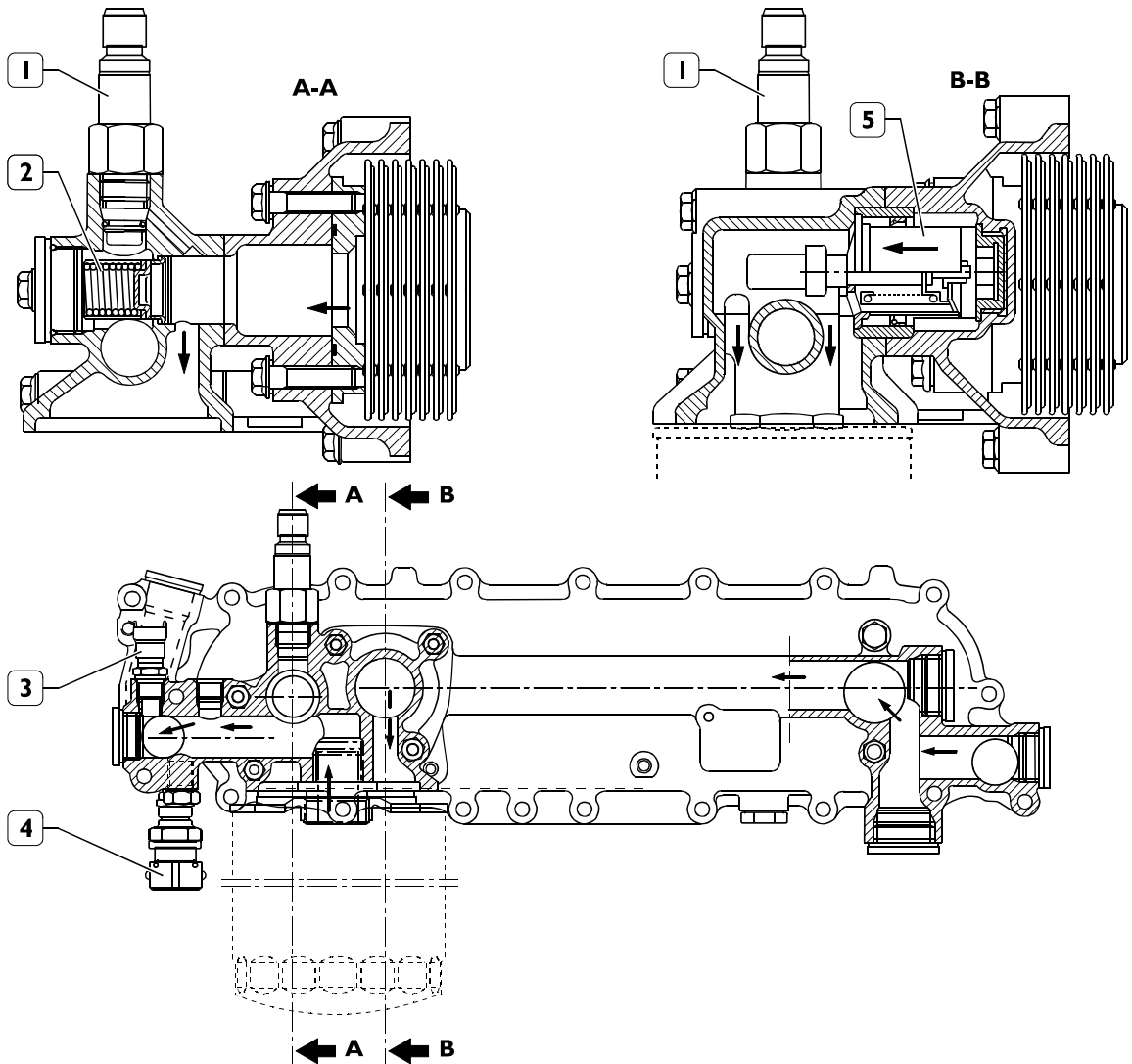
Figure 10



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

Filter support and heat exchanger

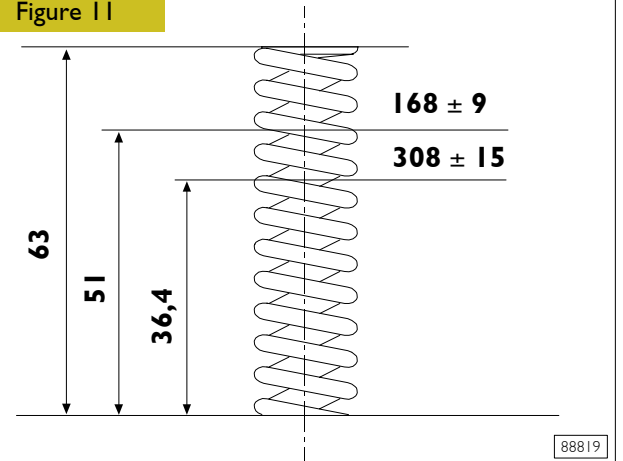
Figure 12



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

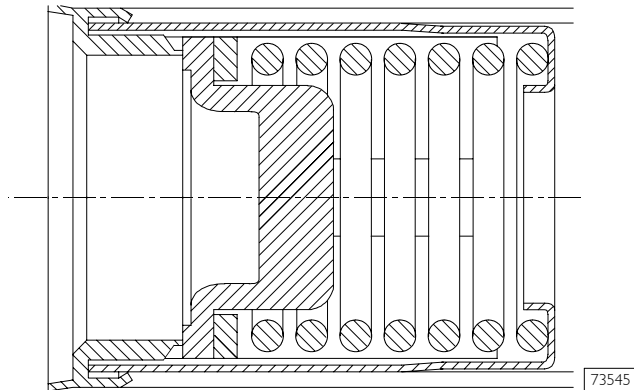
Figure 11



MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

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

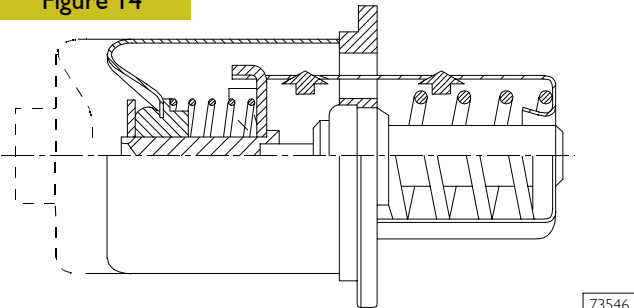
Figure 13



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

Thermostatic valve

Figure 14



Start of opening:

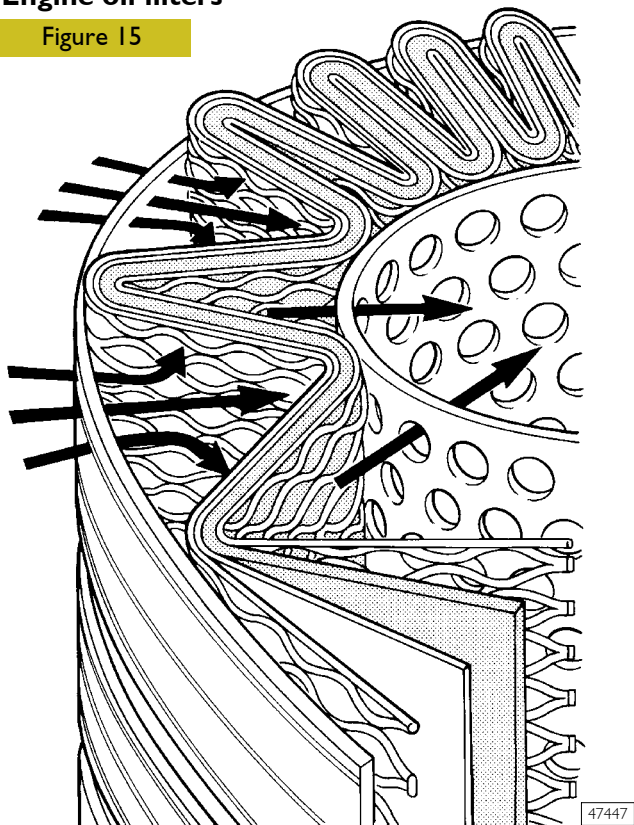
- travel 0.1 mm at a temperature of $82 \pm 2^\circ\text{C}$.

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 hold 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 $35 \pm 40 \text{ Nm}$.

COOLING

Description

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

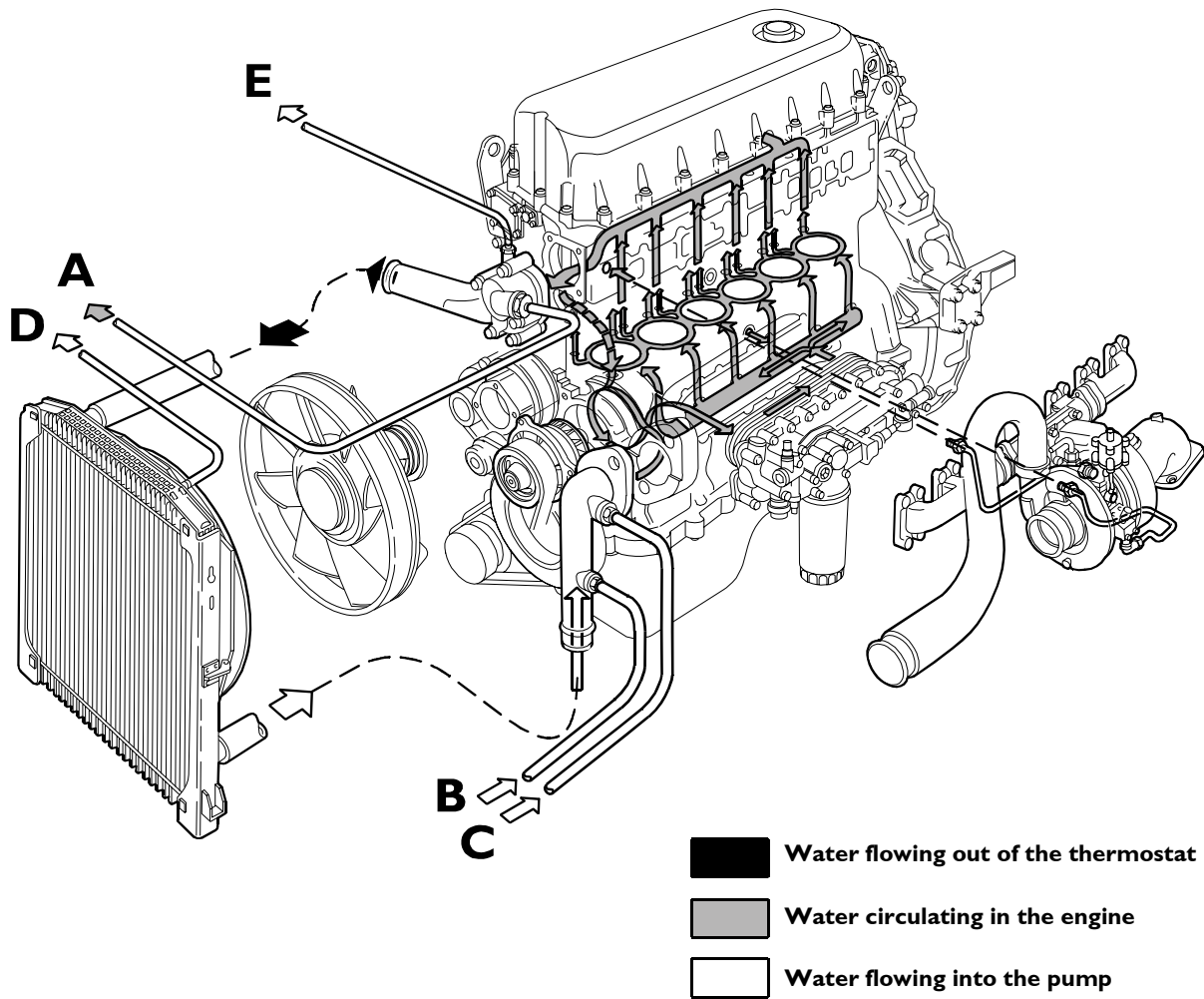
- expansion tank, not supplied (by IVECO);
- a heat exchanger to cool down lubrication oil;
- a water pump with centrifugal system incorporated in the cylinder block;
- fan, not supplied;
- a 2-way thermostat controlling the coolant circulation.

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 16

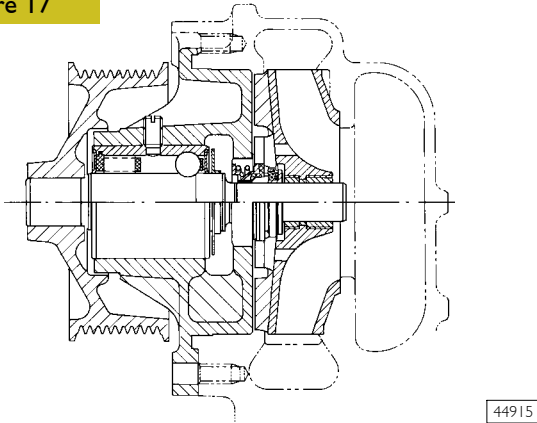


99248

- 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 17



WATER PUMP SECTION

44915

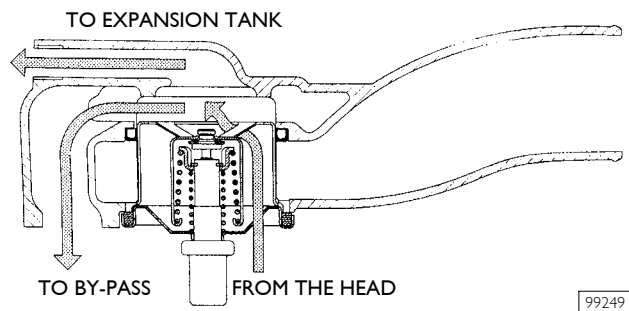
The water pump consists of: rotor, seal bearing and control pulley.

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

Thermostat

THERMOSTAT OPERATION VIEW

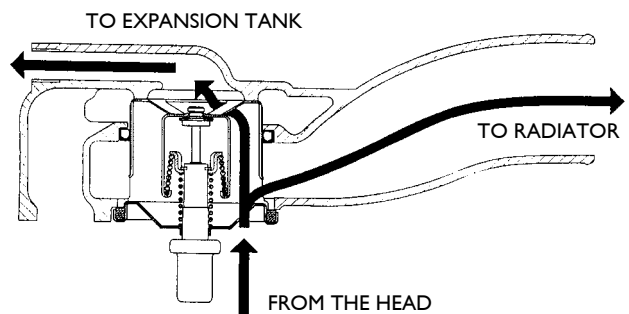
Figure 18



99249

Water circulating in the engine

Figure 19



99250

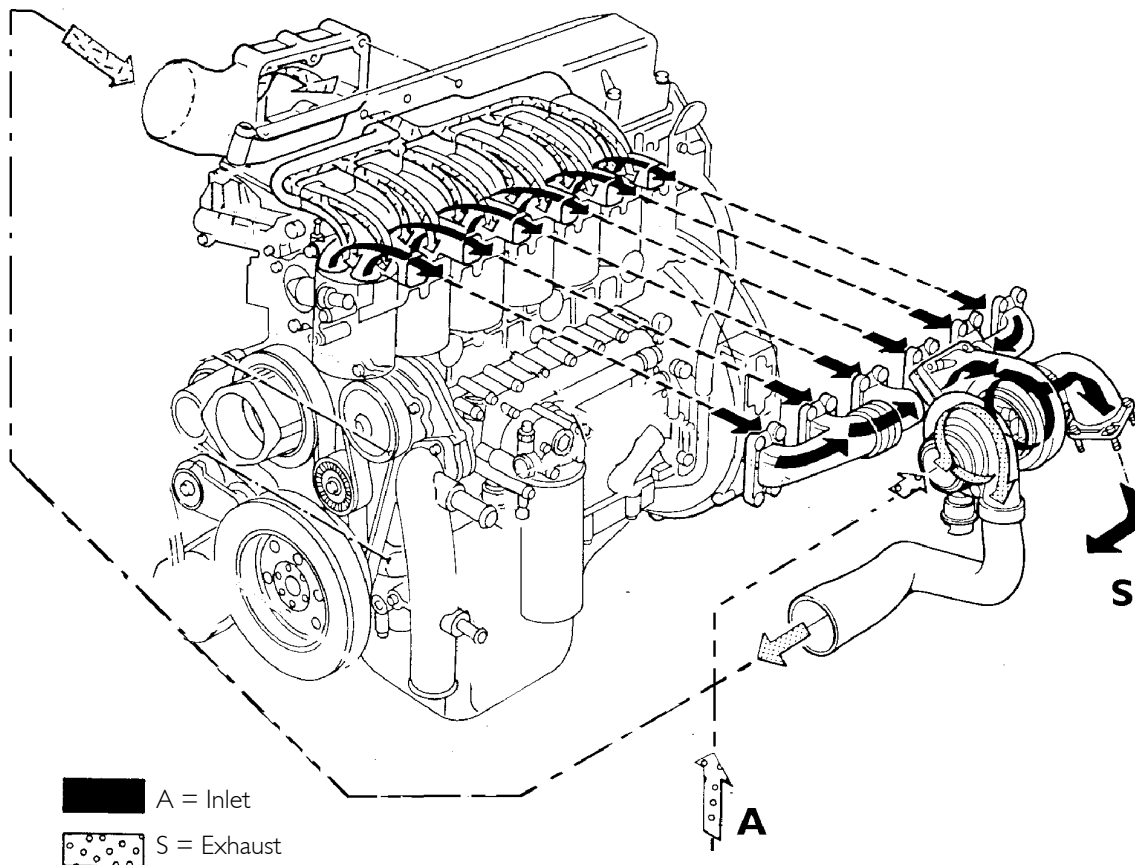
Water issuing from thermostat

TURBOCHARGING

The turbocharging system consists of:

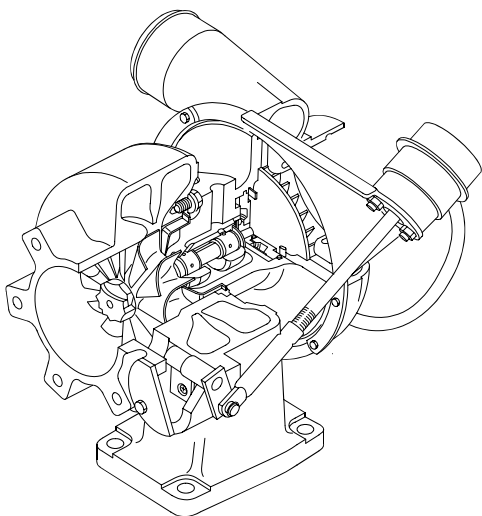
- air filter;
- Wastegate turbocharger.

Figure 20



99251

HOLSET HX 40W turbocompressor



71766

The turbocompressor is a turbocompressor with a return valve.

It is mainly composed by:

- a central unit where a shaft is positioned supported by bushings, a turbine rotor and a compressor rotor are mounted on each end;
- a turbine unit and a compressor unit mounted at the end of the central unit;
- return valve applied on the turbine unit. It divides burnt gases outlet, sending one part directly to the outlet tube when the boost of the compressor reaches the setting value.

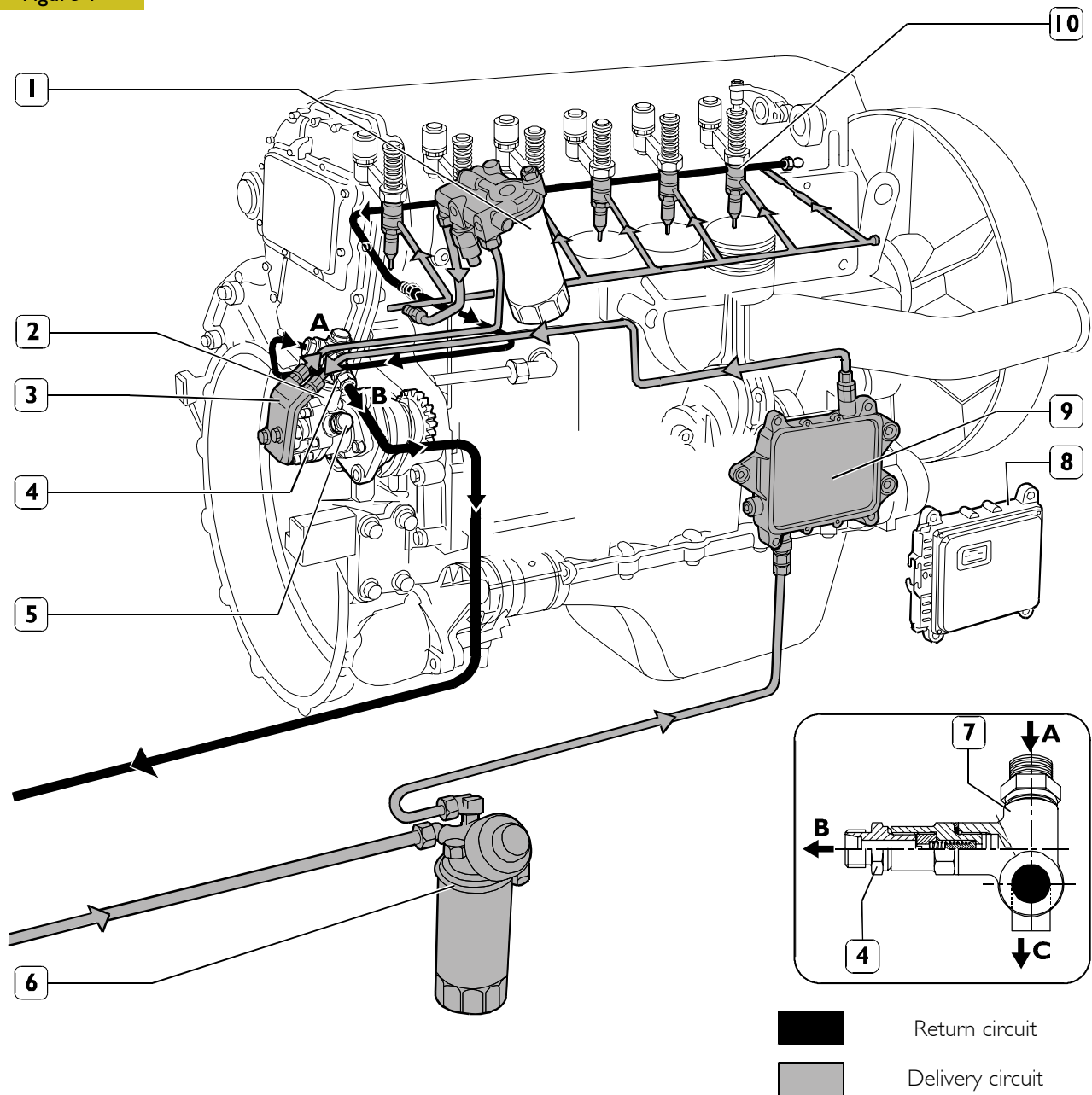
SECTION 2

Fuel

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FUEL SUPPLY DIAGRAM	4
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<input type="checkbox"/> Fuel pump	5
<input type="checkbox"/> Injector-pump	5
<input type="checkbox"/> Injector Phases	6

FUEL FEED

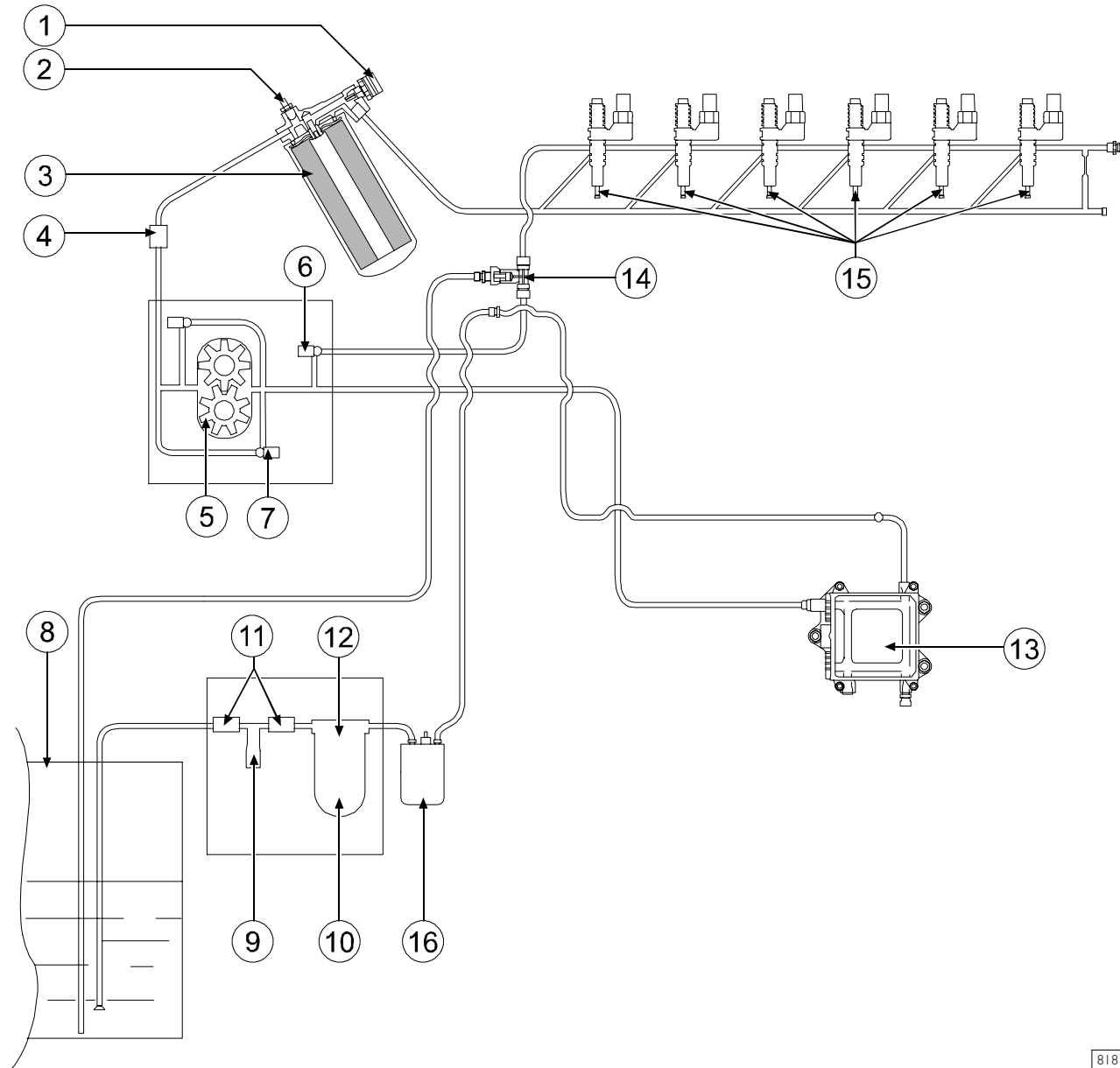
Fuel feed is obtained by means of a pump, fuel filter and pre-filter, 6 pump-injectors controlled by the camshaft by means of rockers and by the electronic control unit.

Figure 1**ENGINE FUEL SUPPLY DIAGRAM WITH FUEL PUMP ON THE TIMING SYSTEM CONTROL**

1. Fuel filter - 2. Valve for fuel recirculation from injectors integrated in the fuel pump (start opening 3,5 bar) - 3. Fuel pump - 4. Overpressure valve for fuel return to the tank (start opening 0,2 bar) - 5. Pressure control valve (start opening 5 bar) - 6. Prefilter with priming pump - 7. Connector - 8. Gearcase - 9. Heat exchanger - 10. Pump injectors.

A. Fuel arrival from injectors - B. Fuel return to the tank - C. Fuel inlet from injectors in the fuel filter

92828

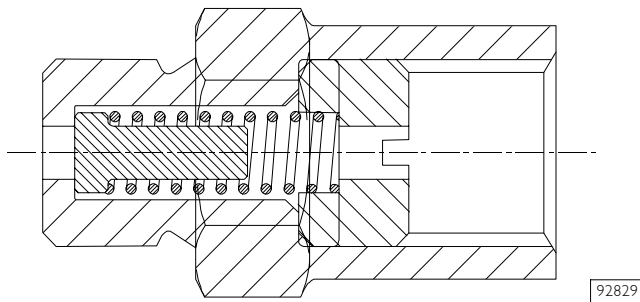
FUEL SUPPLY DIAGRAM**Figure 2**

81817

1. Temperature sensor - 2. Bleed valve - 3. Secondary fuel filter - 4. By-pass valve (0.3 ± 0.4 bar) - 5. Fuel supply pump - 6. Integrated valve (3.5 bar) - 7. Pressure relief valve (5 bar) - 8. Fuel tank - 9. Priming pump - 10. Primary fuel filter - 11. Check valve (opening 0.1 bar) - 12. Heater - 13. Electronic control unit - 14. Fuel return union with valve built in (0.2 bar) - 15. Pump-injectors - 16. Electric fuel pump.

Overpressure valve

Figure 3

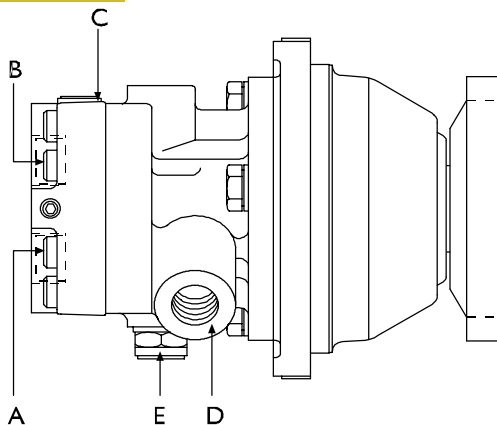


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An overpressure valve is a single-acting valve, calibrated to 0.2 ± 0.3 bar, placed on the piping that returns fuel to tank. The overpressure valve prevents fuel duct in cylinder head from emptying with engine stopped.

Fuel pump

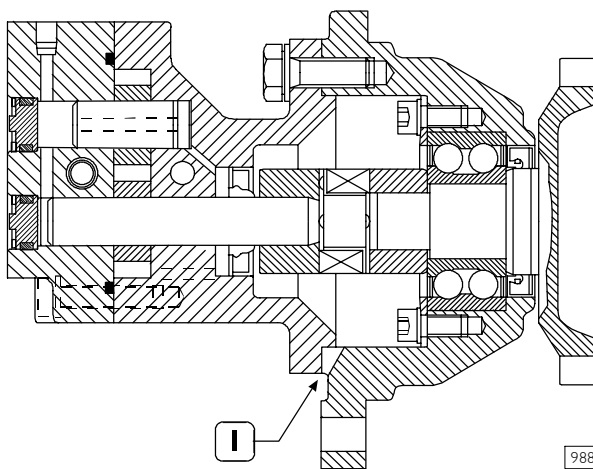
Figure 4



73547

Fuel pump mounted on timing system
 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



98870

CROSS-SECTION OF THE FUEL PUMP
 I. Oil and fuel leakage 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)	30	30	30	20
	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

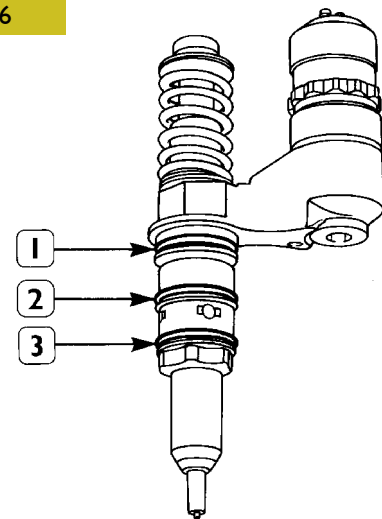
Valve calibration	5 ± 5.8
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Injectors return valve

Valve calibration	3.2 ± 3.8
-------------------	-----------

Injector-pump

Figure 6



44908

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.

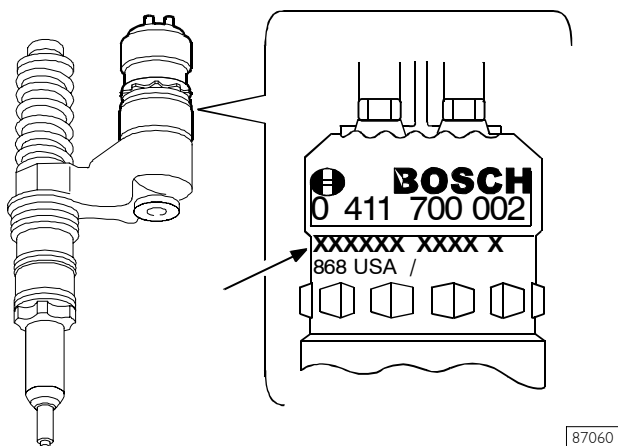
The amount of fuel injected depends on the length of time the slide valve is closed and therefore on the time for which the solenoid is energized.

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).

Figure 7



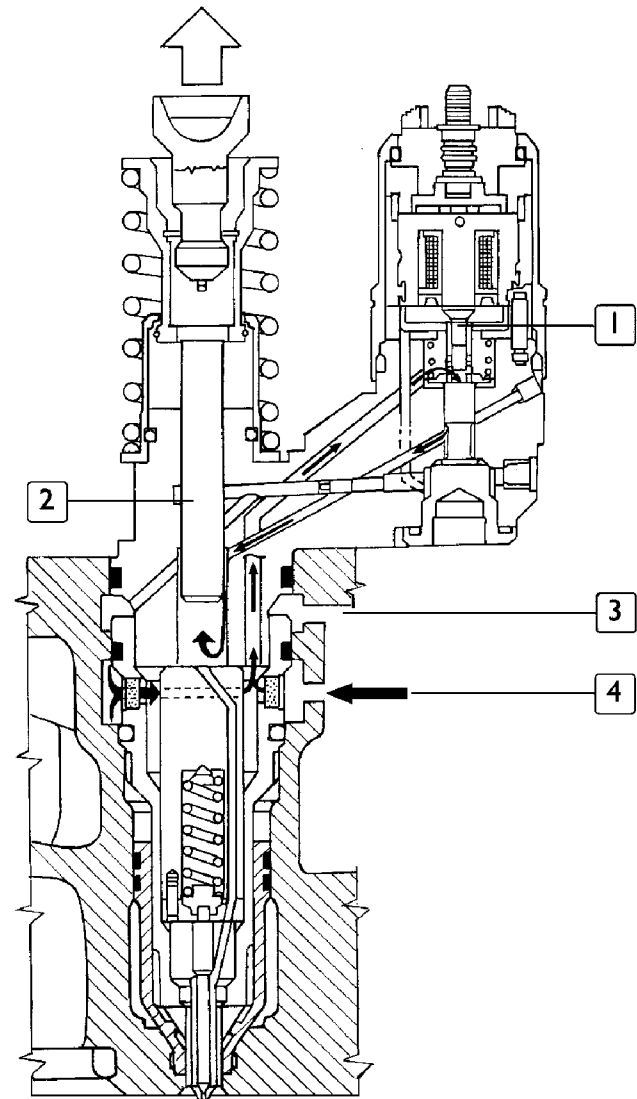
87060

For each replaced injector you shall connect with the diagnosis device and when it is required by the program you shall insert the printed code on the injector (→) to program the gearcase again.

NOTE When checking the clearance of the rocker arms, it is important to check the injector-pump pre-load.

Injector Phases

Figure 8



60669

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

Filling phase

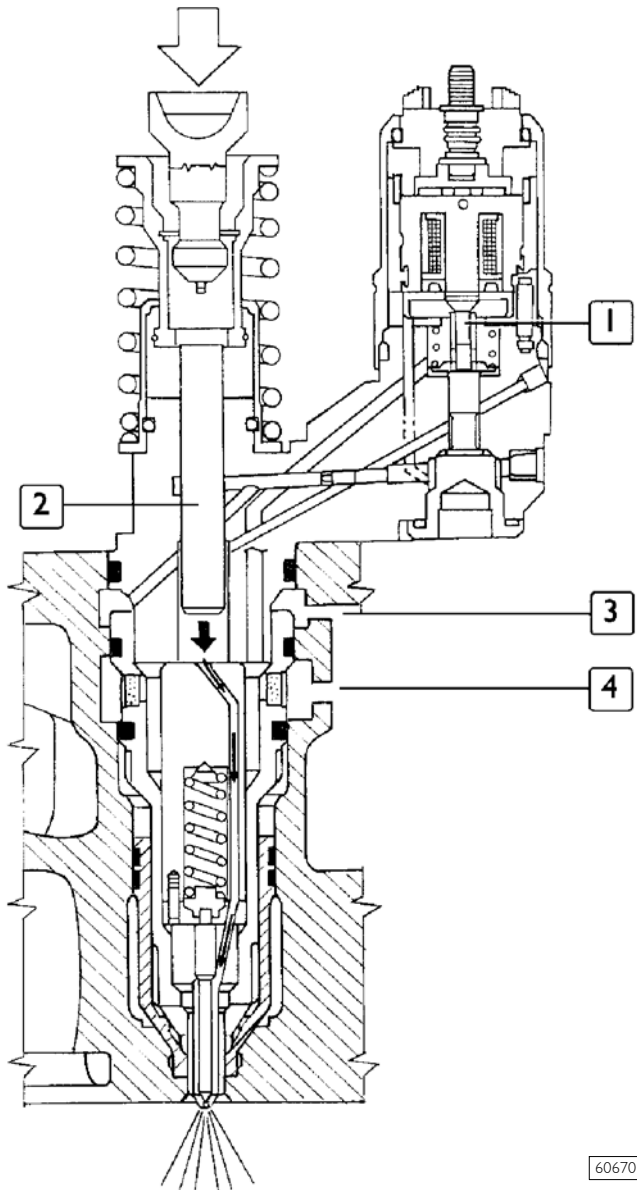
During the filling phase the pumping element (2) runs up to the top position.

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 9



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

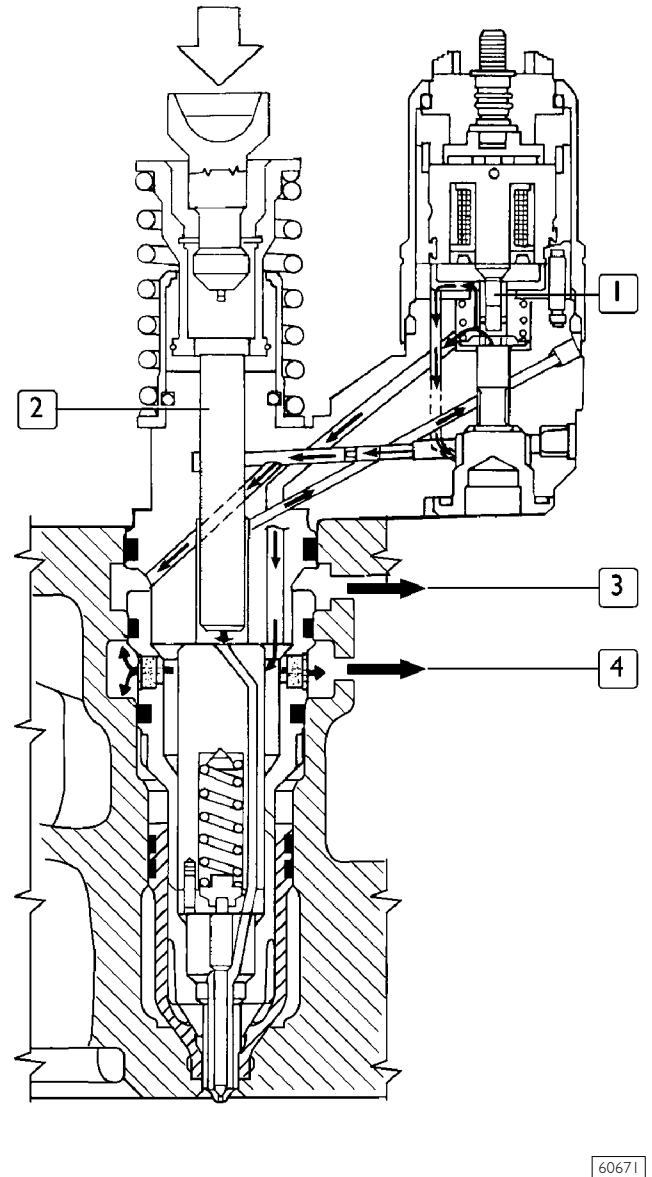
Injection phase

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 10



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.

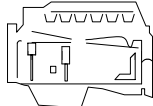



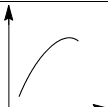



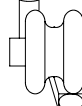

The time for which the solenoid valve stays energized, appropriately calculated by the electronic control unit, is the duration of injection (delivery) and it depends on the working conditions of the engine.

SECTION 3**Industrial application**

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CLEARANCE DATA

	Type	F2BE0684		F2B0687
		A*B001	A*B002	A*B101
	Compression ratio	16 ± 0.8	16 ± 0.8	16 ± 0.8
 	Max. output kW (HP) rpm	265 (360) 2100	265 (360) 2100	220 (300) 2200
 	Max. torque Nm (kgm) rpm	1420 (142) 1500	1420 (142) 1500	1250 (125) 1200
	Loadless engine idling rpm	1300	1300	900
	Loadless engine peak rpm	2110	2110	2430
	Bore x stroke Displacement	mm cm ³	115 x 125 7790	115 x 125 7790
	SUPERCHARGING Turbocharger type	Intercooler Direct injection HX40W		
	LUBRICATION Oil pressure (warm engine) - idling - peak rpm	bar bar	Forced by gear pump, relief valve single action oil filter 4 5	
	COOLING Water pump control Thermostat - start of opening °C		Liquid Through belt 85	

NOTE Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turns based on which the engine has been designed.

PART ONE - MECHANICAL COMPONENTS

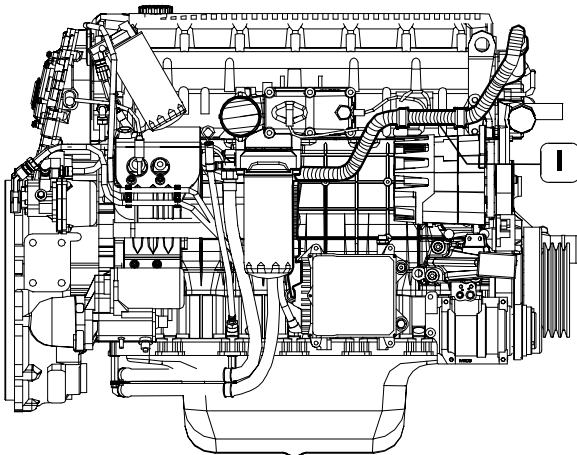
ENGINE ASSEMBLY DISASSEMBLY

NOTE Handle all parts extremely carefully. Never get your hands or fingers between pieces.
Wear the required safety clothing such as goggles, gloves and safety shoes.

Protect the electric parts before doing any washing with high-pressure jets.

The following descriptions and illustrations refer to the operations for stripping the engine.

Figure 1

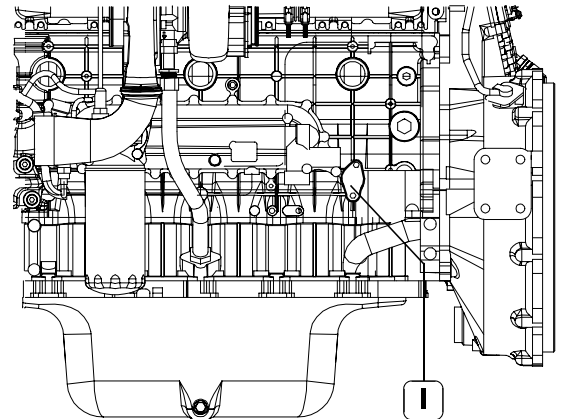


99252

Before securing the engine on the rotary stand, remove:

- the electric engine cable (1) by disconnecting it from the control unit and all the sensors/transmitters to which it is connected;
- the starting motor;
- air compressor (if available).

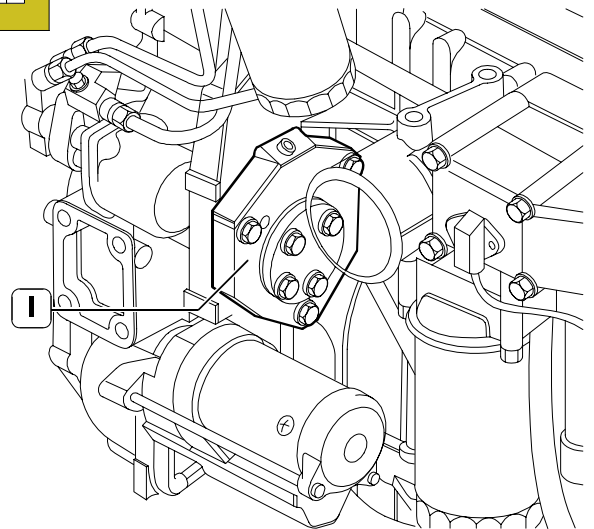
Figure 2



99253

- Remove the engine supports.
- Remove the oil pressure adjuster valve (1).

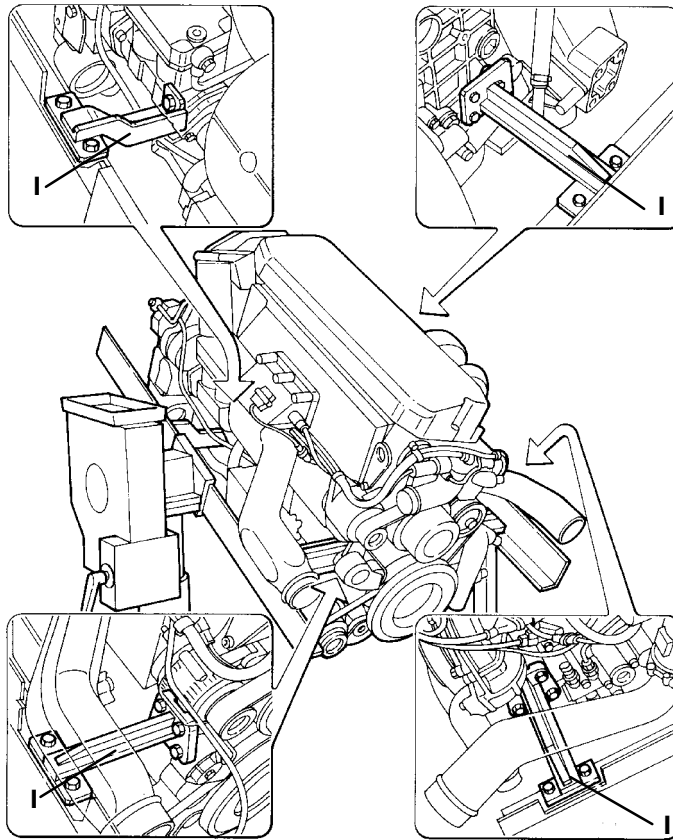
Figure 3



99254

- Remove the drive (1).

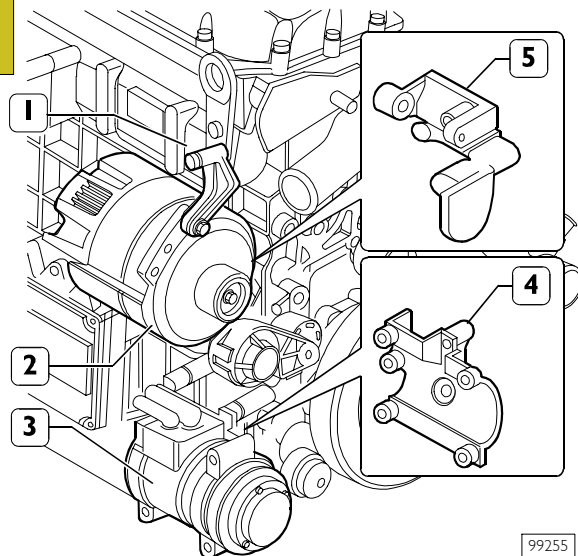
Figure 4



47601

- Secure the engine to the rotary stand by means of brackets 993601036 (1).
- Drain lubricating oil off the sump.

Figure 5

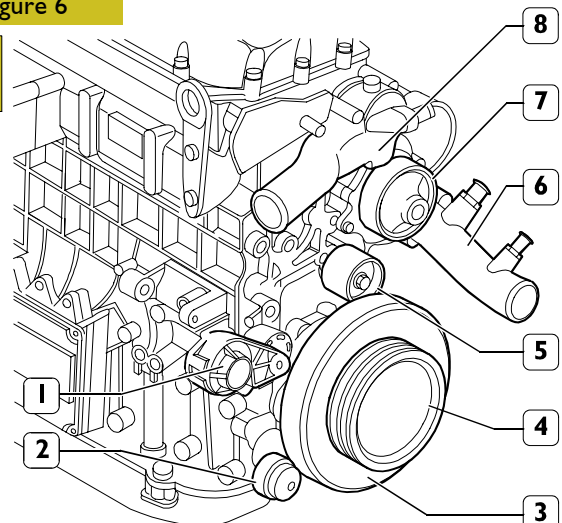


99255

Remove

- the compressor (3) for the air-conditioner and its support (4), except for engine F2BE0687A*B101;
- the alternator (2);
- the supports (1 and 5).

Figure 6

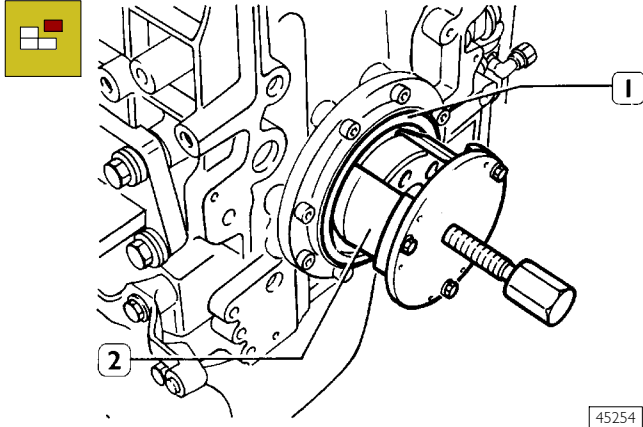


99256

Remove

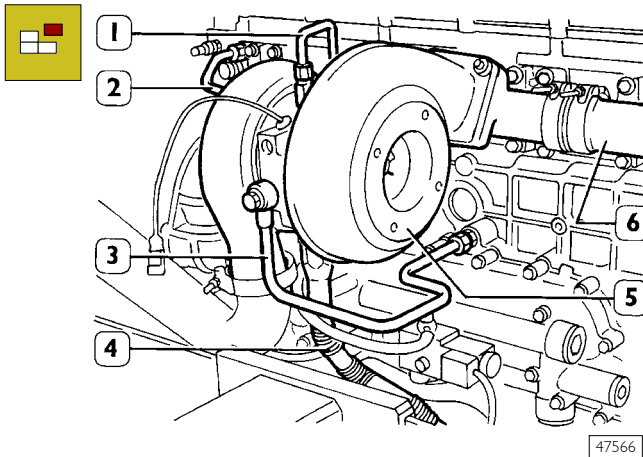
- thermostat assembly (8);
- pipes complete with coolant (6);
- the pulley (4);water pump (7);
- automatic tightener support (1);
- fixed tightener (5);
- damper flywheel (3) and pulley beneath;automatic tightener (2).

Figure 7



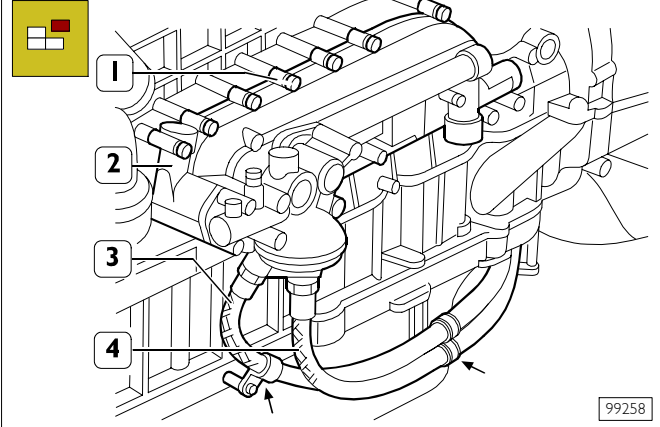
Install extractor 99340051 (2) and remove the seal gaskets (1). Unscrew the screws and remove the cover. Disconnect all electric connections and sensors.

Figure 8



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).

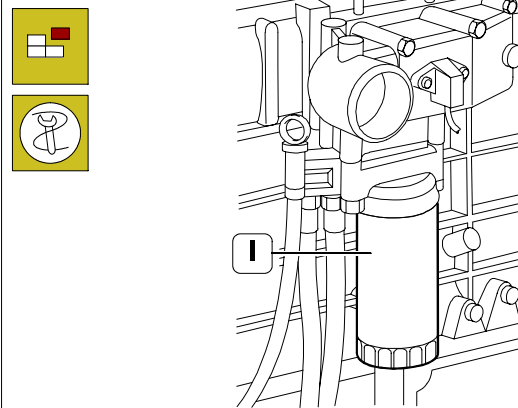
Figure 9



For versions with oil filter support secured to the inlet manifold.

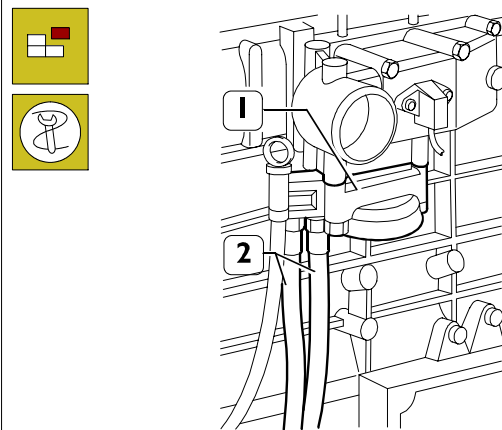
- disconnect the oil pipes (3) and (4) and disengage them from the clamps (←);
- take out the fixing screws (1) and remove the cooler (2).

Figure 10



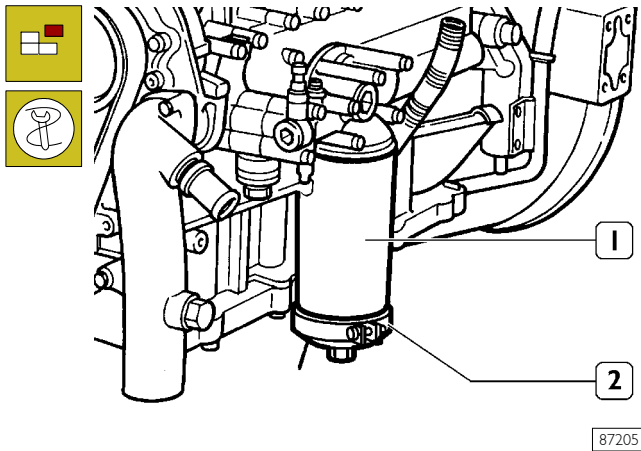
Using tool 99360314, unscrew the oil filter (1).

Figure 11



- Disconnect the pipes (2) from the support (1) disengaging them from the clamps and remove them.
- Take out the screws and remove the support (1).

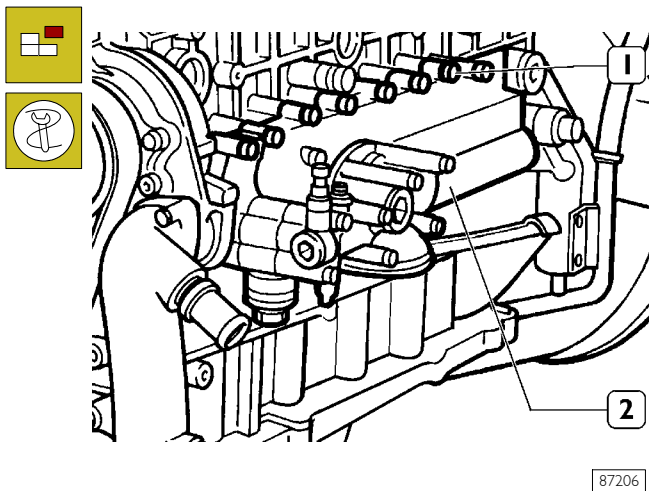
Figure 12



For versions with oil filter support positioned on the water/oil heat exchanger

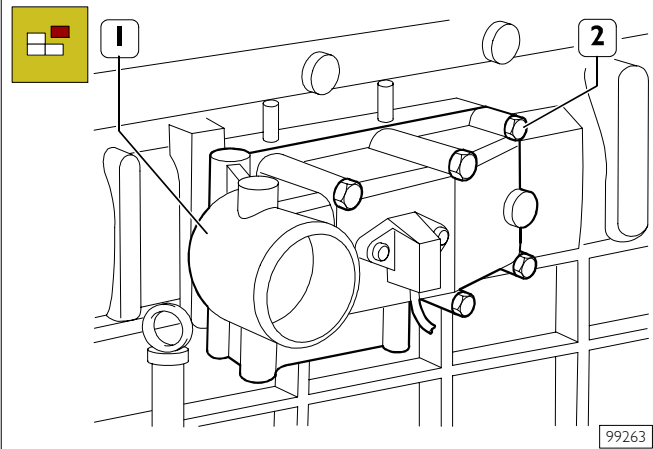
Unscrew the oil filter (1) by tool 99360314 (2).

Figure 13



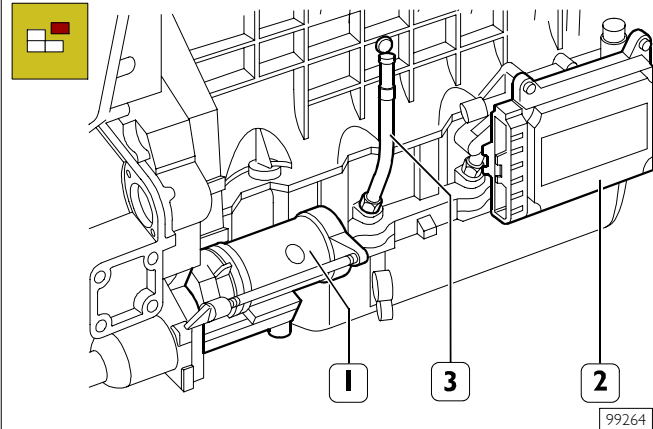
Unscrew the screws (1) and remove the entire heat exchanger (2).

Figure 14



- Take out the screws (2) and remove the intake manifold (1).

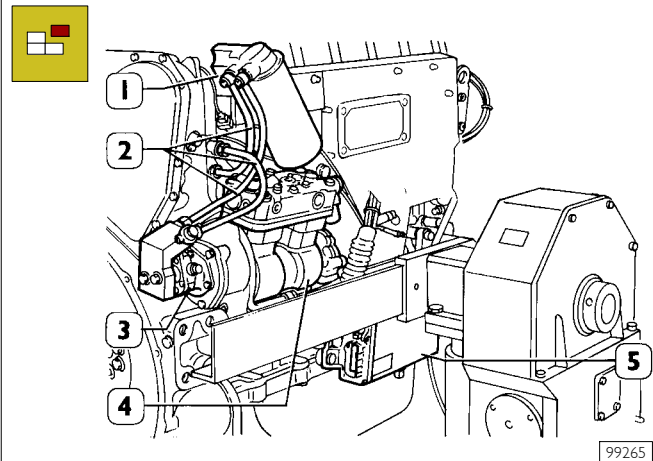
Figure 15



Remove

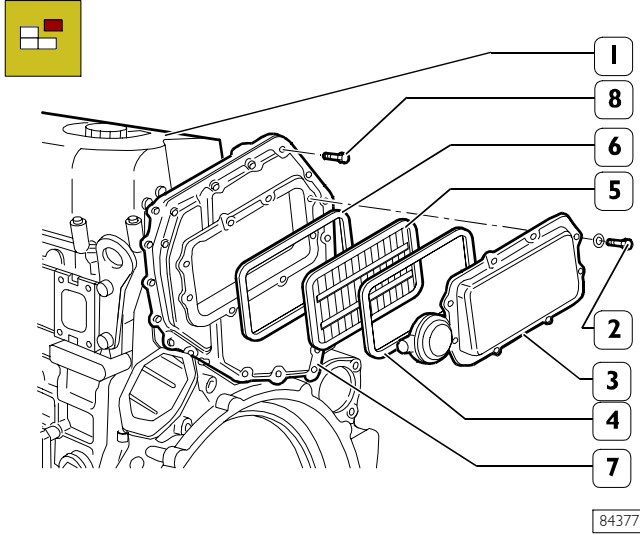
- the starter motor (1);
- the control unit (2) and its support;
- the oil dipstick (3) from the crankcase.

Figure 16



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

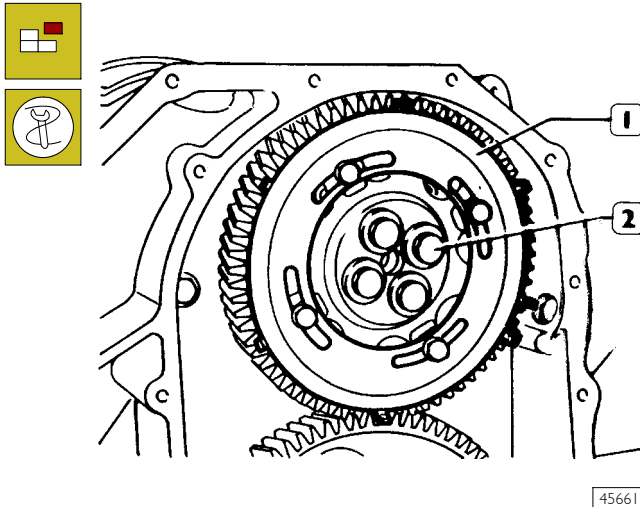
Figure 17



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).

84377

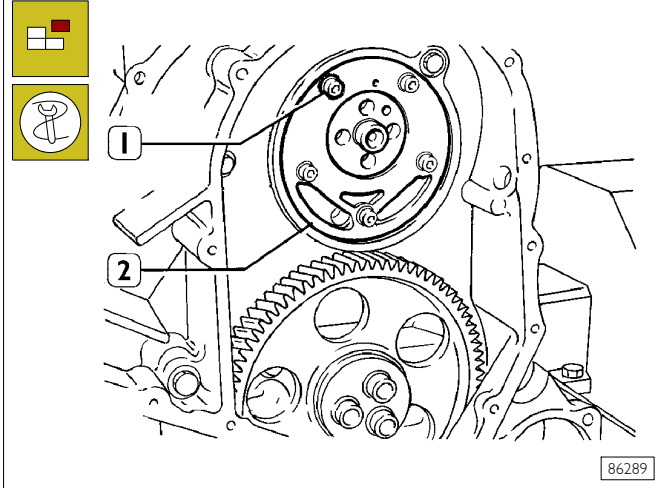
Figure 18



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

45661

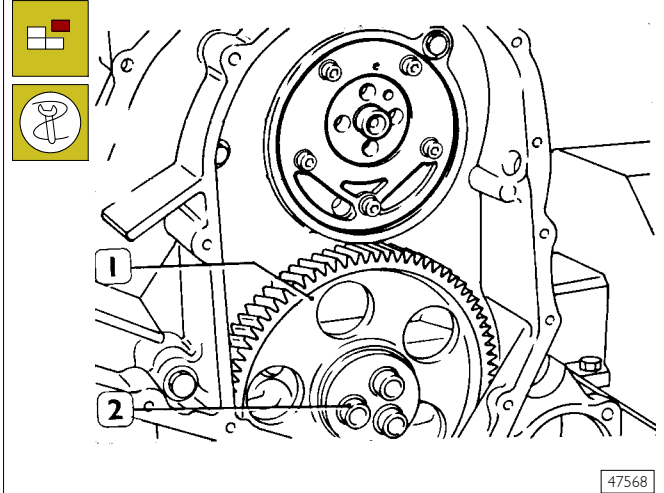
Figure 19



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

86289

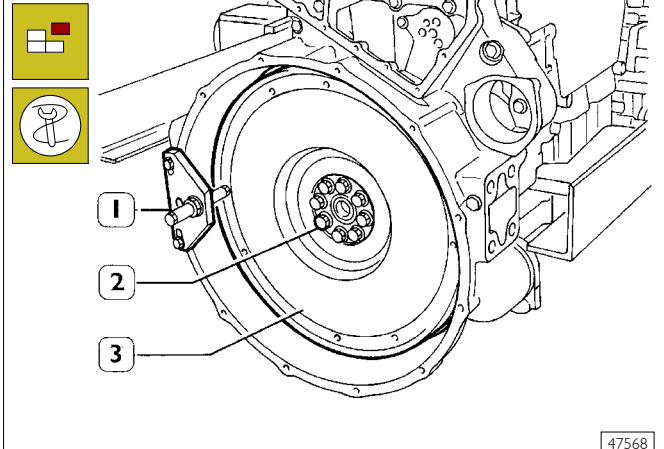
Figure 20



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

47568

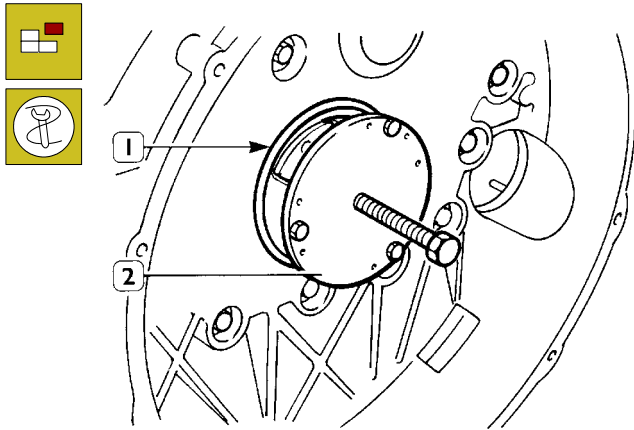
Figure 21



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

47568

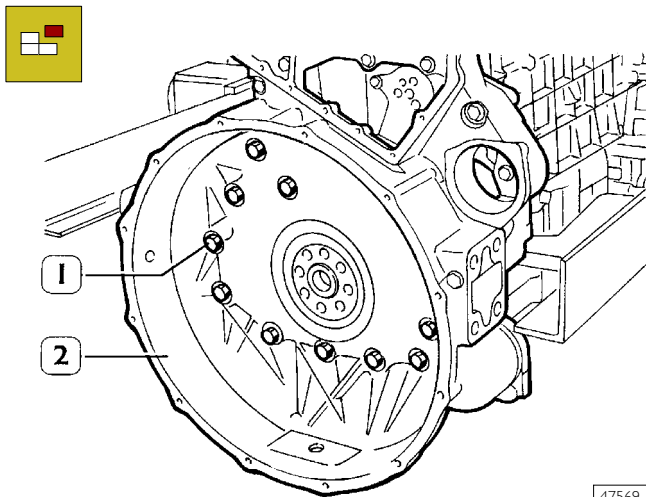
Figure 22



45257

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

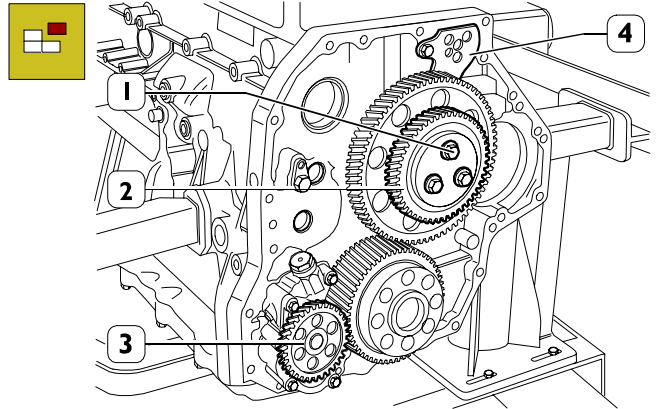
Figure 23



47569

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

Figure 24

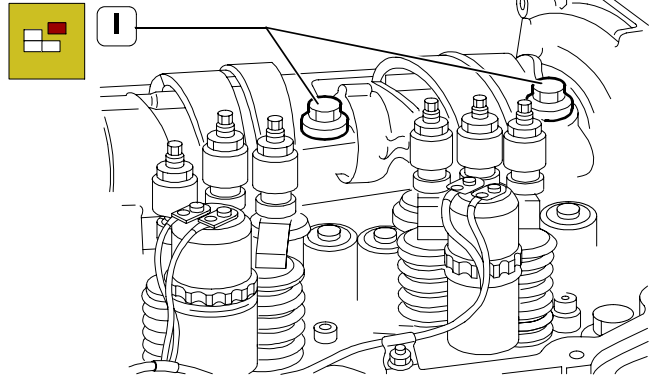


107965

In sequence, take out the:

- if the P.T.O. control gear (1) is present (if available);
- idle gear (2);
- link rod (4);
- oil pump (3);

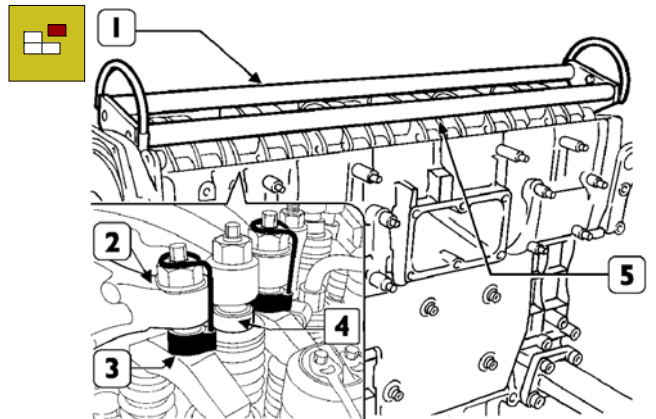
Figure 25



99261

- Untighten the fixing screws (1) of rocker arm shaft.

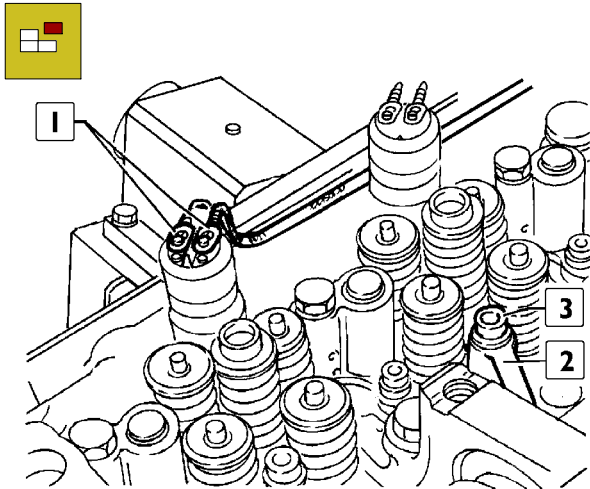
Figure 26



73533

- Using tool 99360144 (3), constrain the blocks (4) to the rockers (2).
- Apply tool 99360553 (1) to the rocker holder shaft (5) and remove the shaft (5) from the cylinder head.

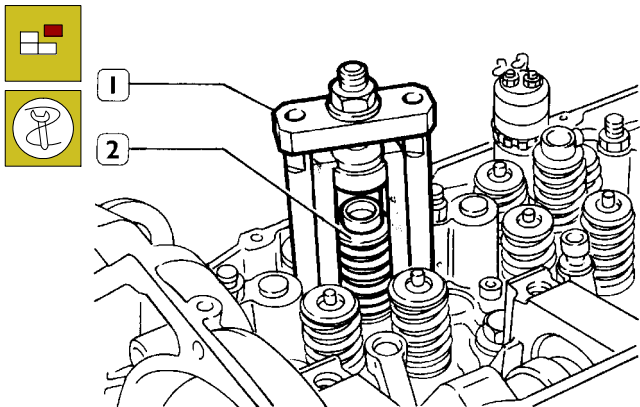
Figure 27



99266

- Untighten screws and remove electric connections (1) from solenoid valves;
- Untighten fixing screws (2) of injector brackets (3).

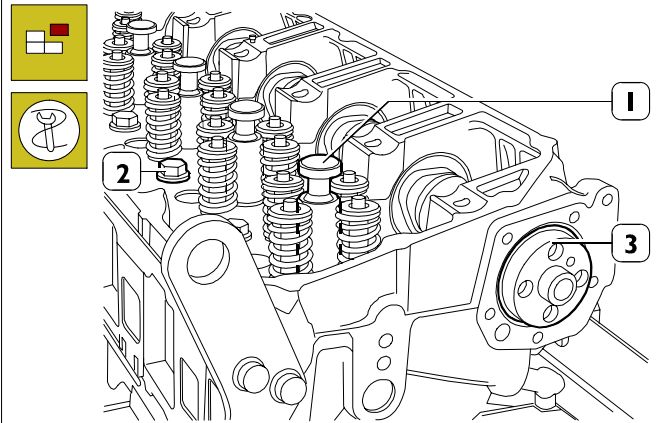
Figure 28



45263

- Remove injectors (2)
- If this operations is difficult, use extractor 99342148 (1).

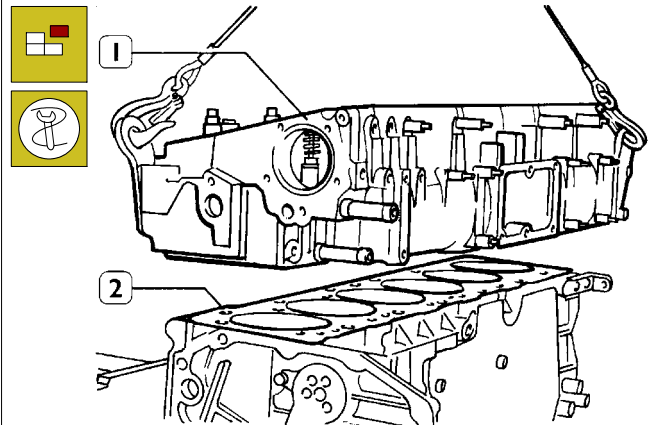
Figure 29



99267

- Fit the plugs 99360177 (1) in place of the injectors.
- Take out the camshaft (3).
- Take out the screws (2) fixing the cylinder head.

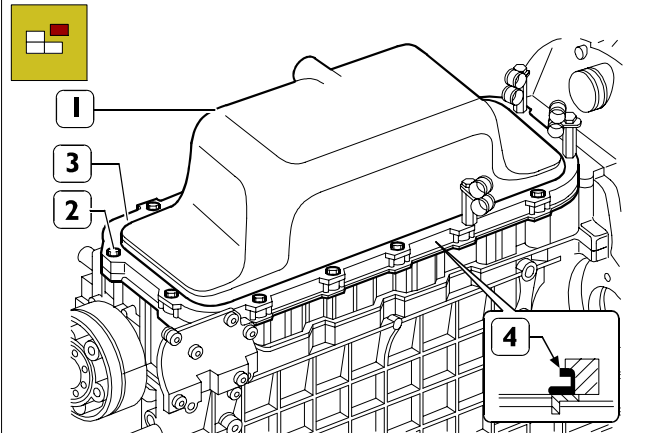
Figure 30



45266

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

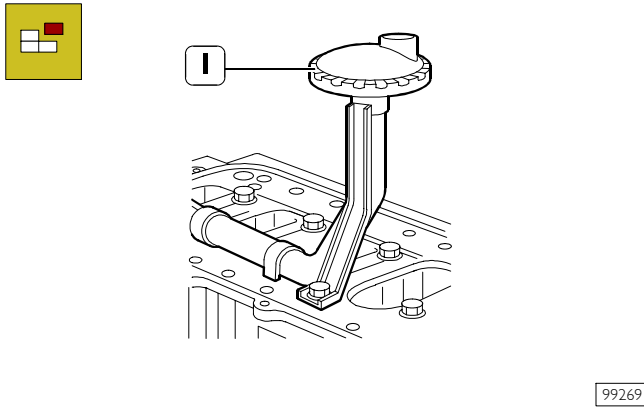
Figure 31



99268

- Untighten screws (2) and remove the engine oil sump (1) with spacer (3) and seal (4).

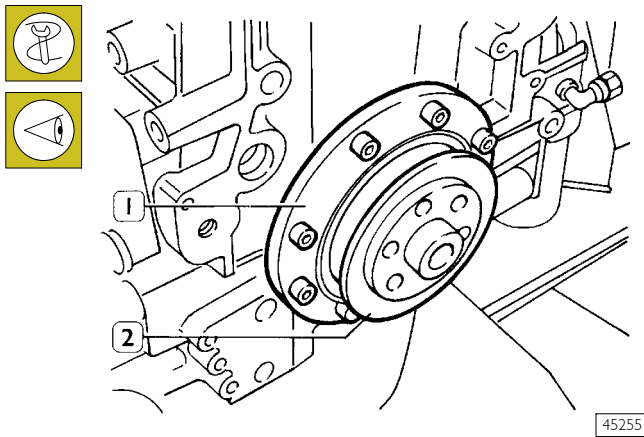
Figure 32



Undo the screws and remove the suction strainer (1).

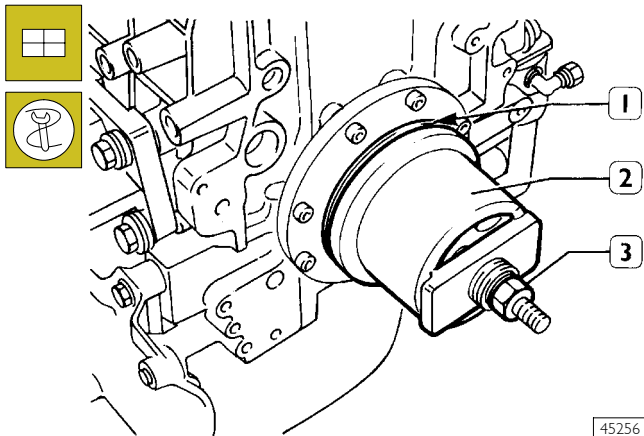
ASSEMBLING THE ENGINE ON THE BENCH

Figure 33



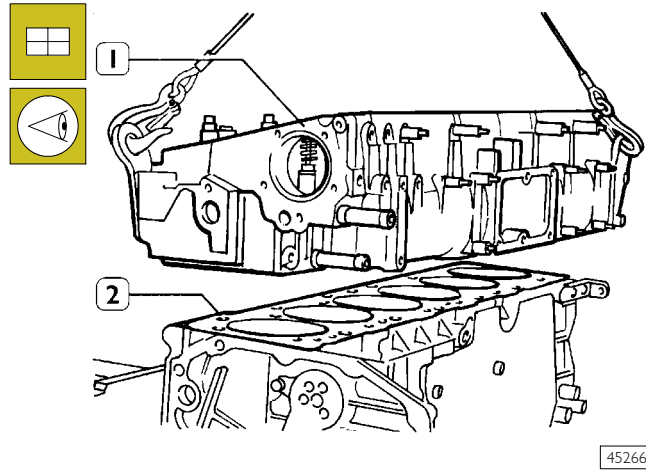
By means of centering ring 99396033 (2), check the exact cover position (1), otherwise act as necessary and tighten the screws.

Figure 34



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

Figure 35



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. 36, 37 and 38.

Figure 36

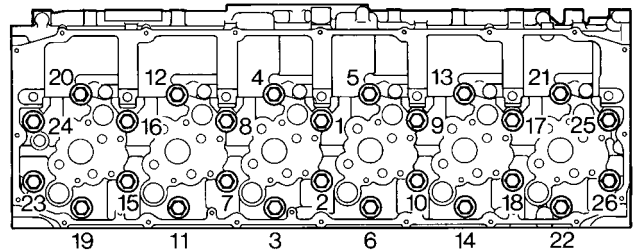
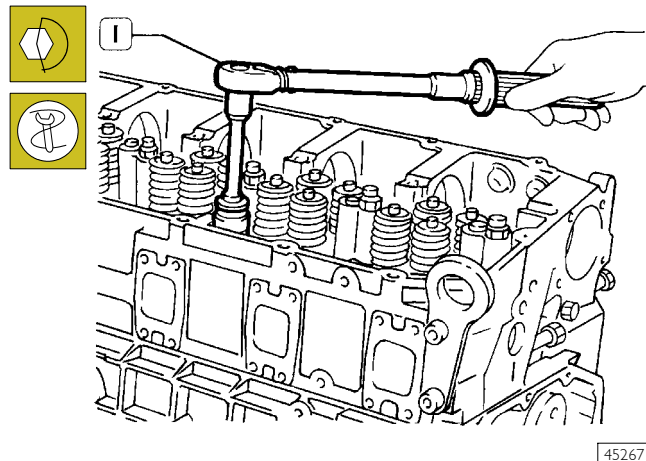


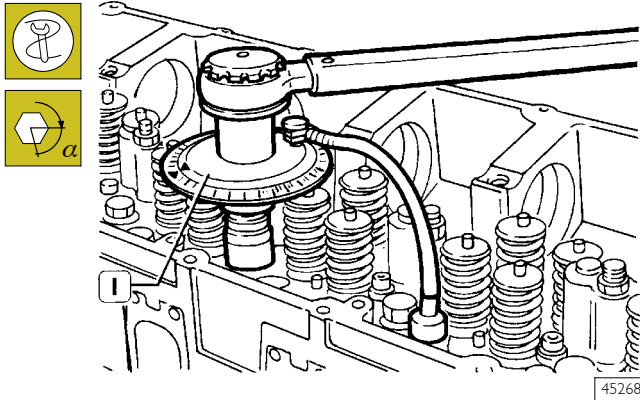
Diagram showing the cylinder head fixing screws tightening order

Figure 37



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

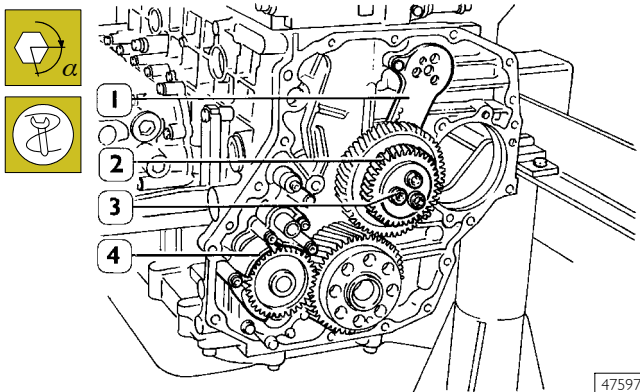
Figure 38



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

45268

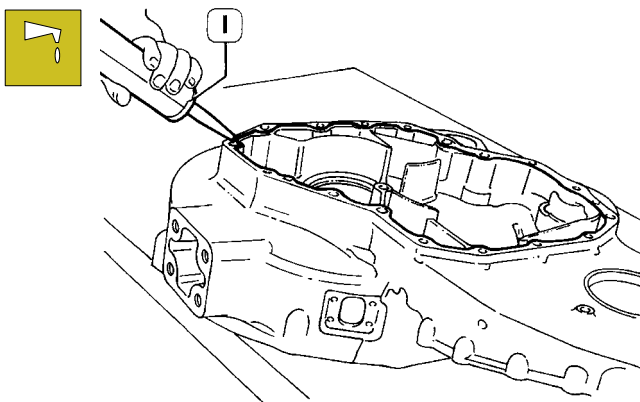
Figure 39



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°

47597

Figure 40



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

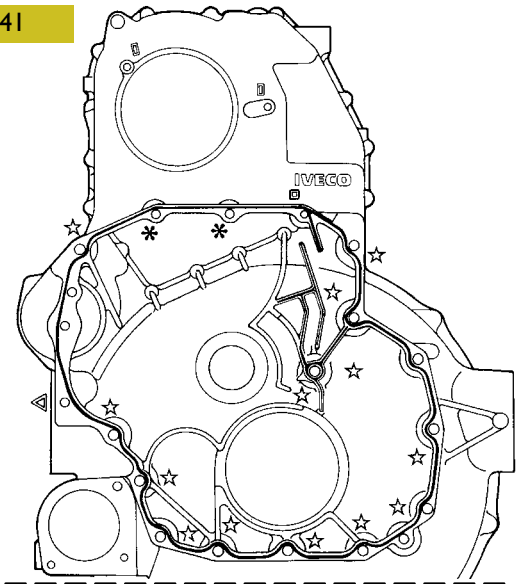
The sealer string (1) diameter is to be $1,5 \pm \begin{matrix} 0,5 \\ 0,2 \end{matrix}$

47592

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 41

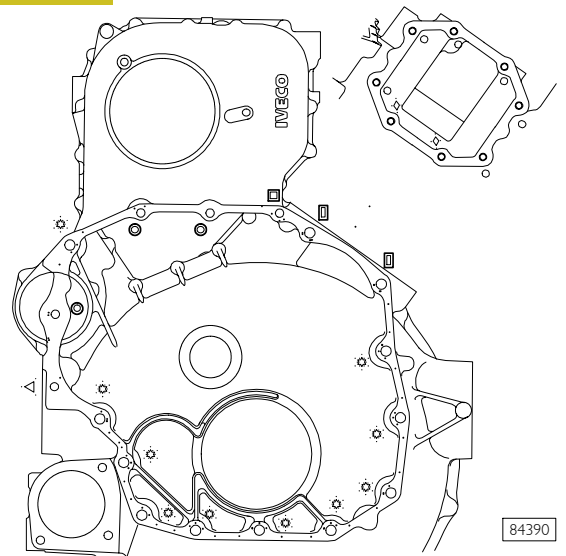


47598

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 42

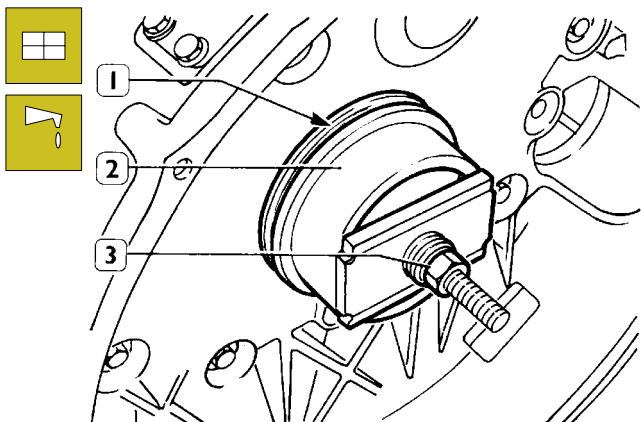


84390

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 43



45258

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

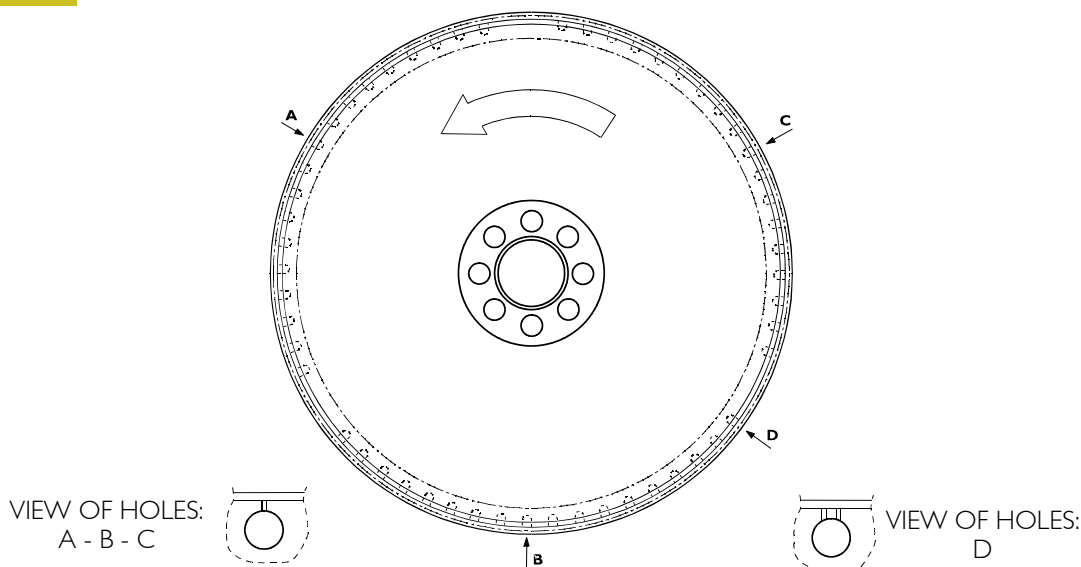
ENGINE FLYWHEEL

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.

Fitting engine flywheel

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

Figure 44

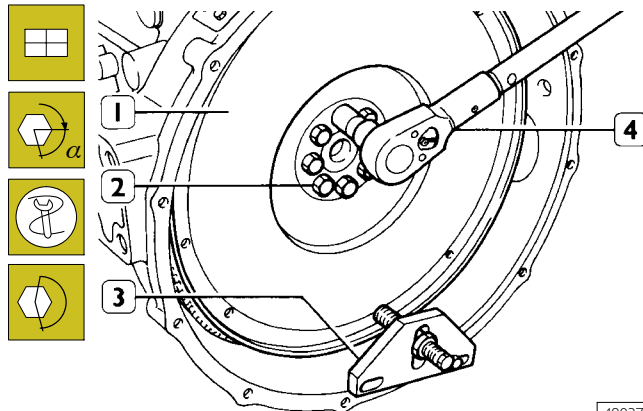


60668

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°.

Figure 45

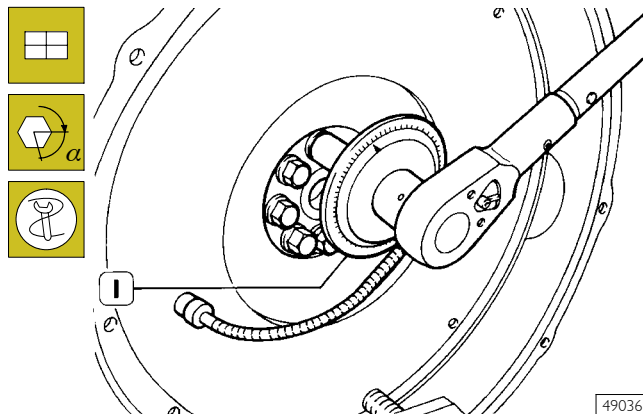


49037

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 9936035 I (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 46

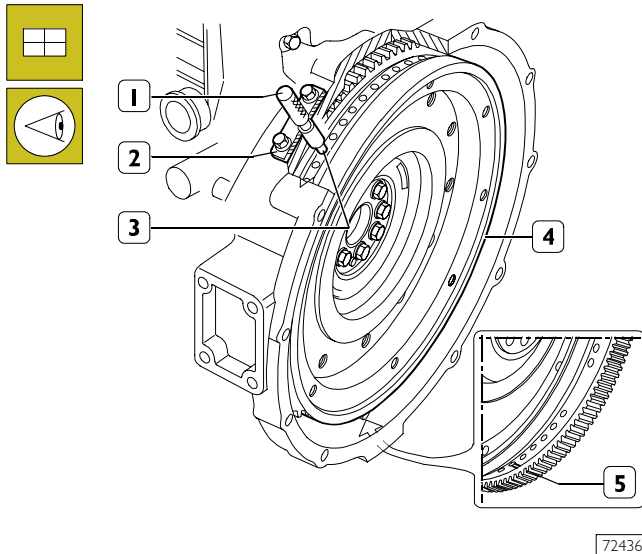


49036

Second phase: closing to angle of 60° with tool 993952 I 6 (1).

Fitting camshaft

Figure 47



72436

Position the crankshaft with the pistons 1 and 6 at the top dead centre (T.D.C.).

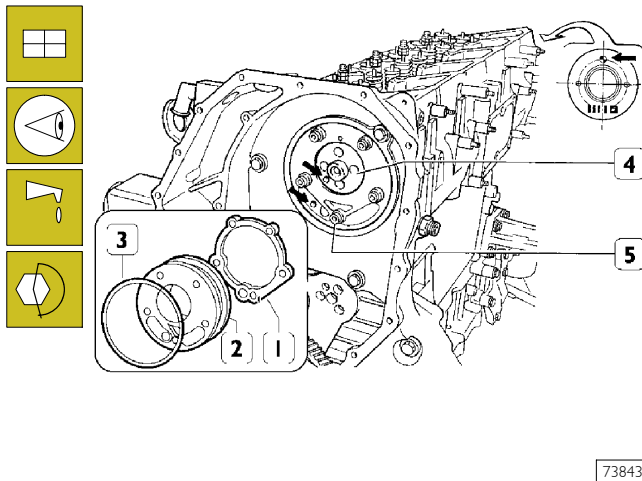
This situation occurs when:

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 48



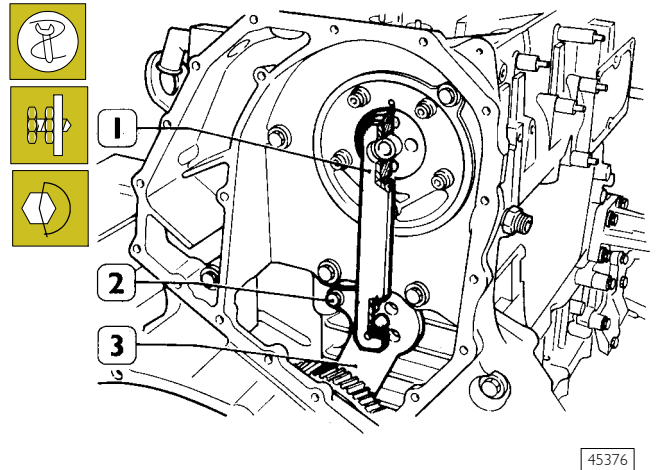
73843

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.

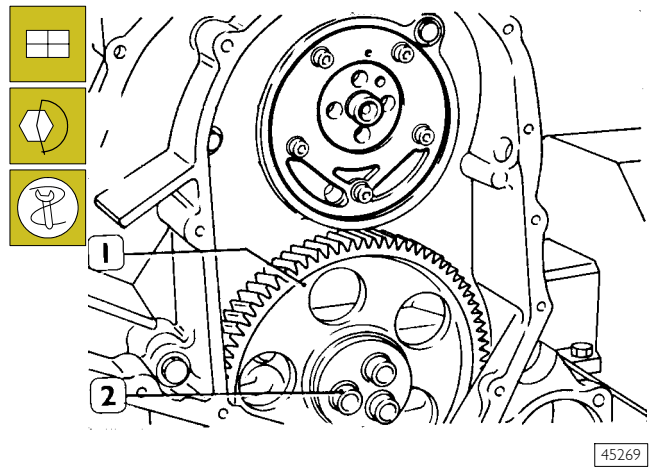
Figure 49



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 50

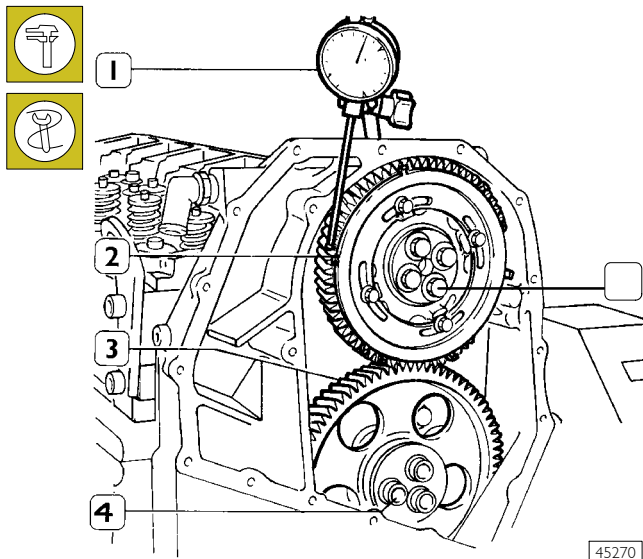


45269

- 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 58.010 ± 0.10 mm.

Figure 51



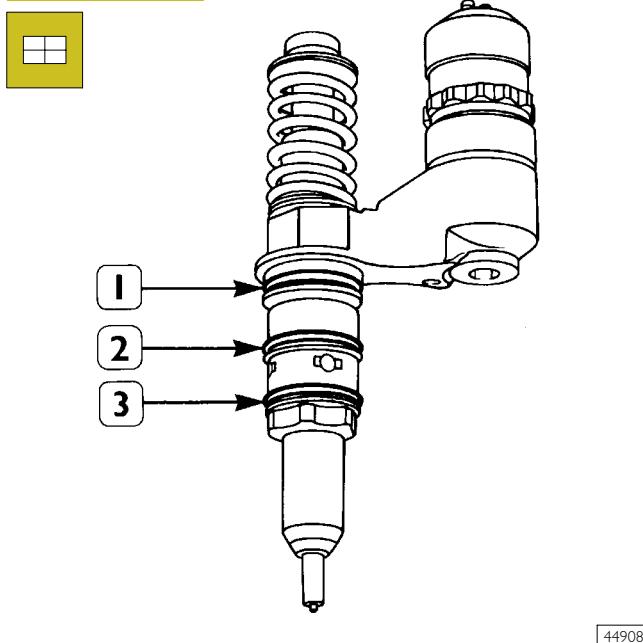
Position the gear (2) on the camshaft so that the 4 slots are centred with the holes for fixing the camshaft, without fully locking the screws (5).

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 49) fixing the link rod. Shift the link rod (3, Figure 49) to obtain the required clearance.
- Lock the screw (2, Figure 49) fixing the link rod and screws (4, Figure 49) fixing the idle gear to the required torque.

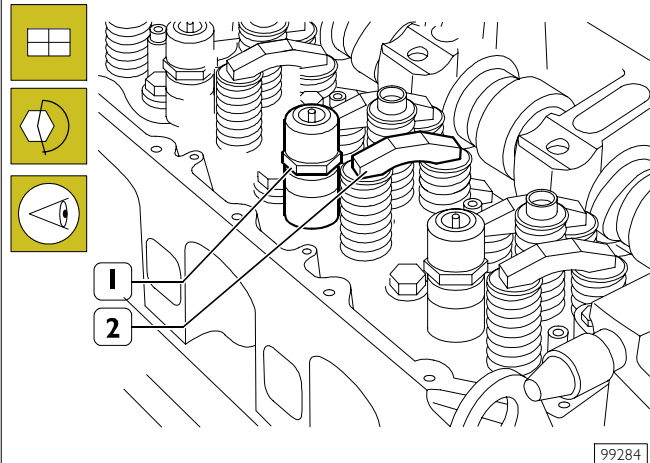
Fitting pump-injectors

Figure 52



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

Figure 53



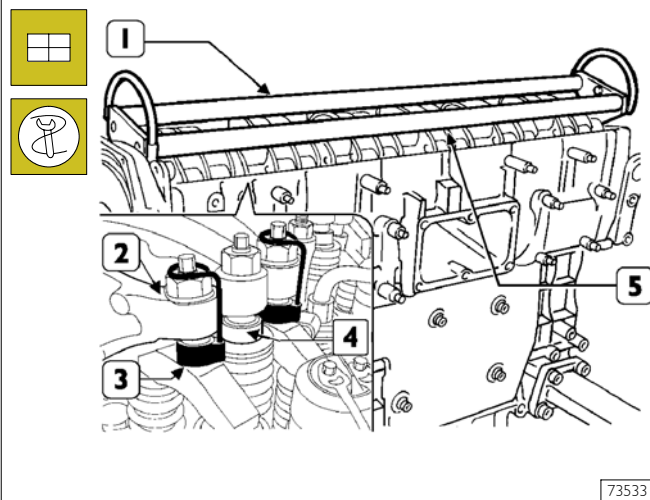
Mount:

- The injectors (1) and, using a torque wrench, lock the bracket fixing screws to a torque of 26 Nm.
- The crosspieces (2) on the valve stem, all with the largest hole on the same side.

Fitting rocker-arm shaft assembly

Figure 54

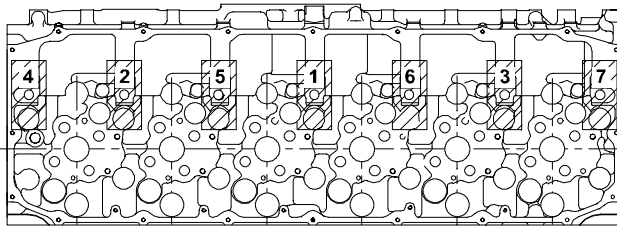
NOTE Before refitting the rocker-arm shaft assembly, make sure that all the adjustment screws have been fully unscrewed.



Using tool 99360144 (3), fasten the blocks (4) to the rocker arms (2).

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

Figure 55

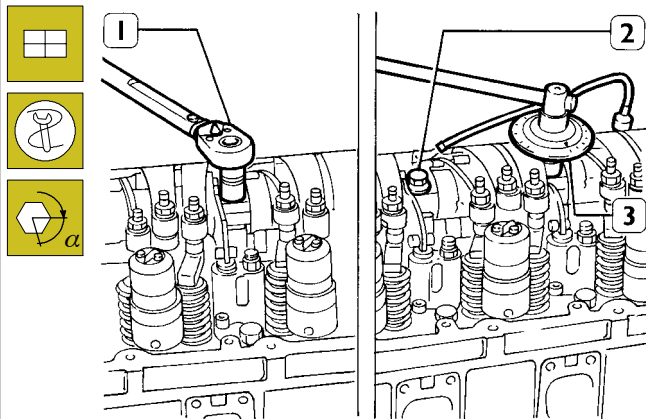


70567A

**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.

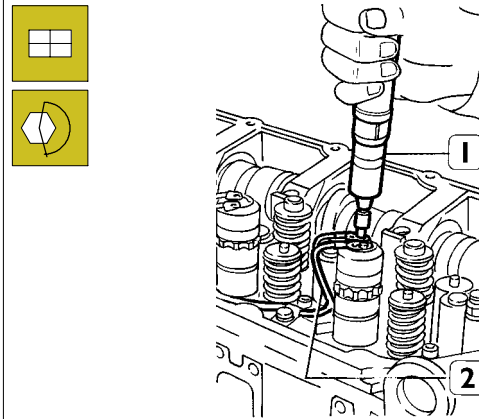
Figure 56



45261

- 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 57

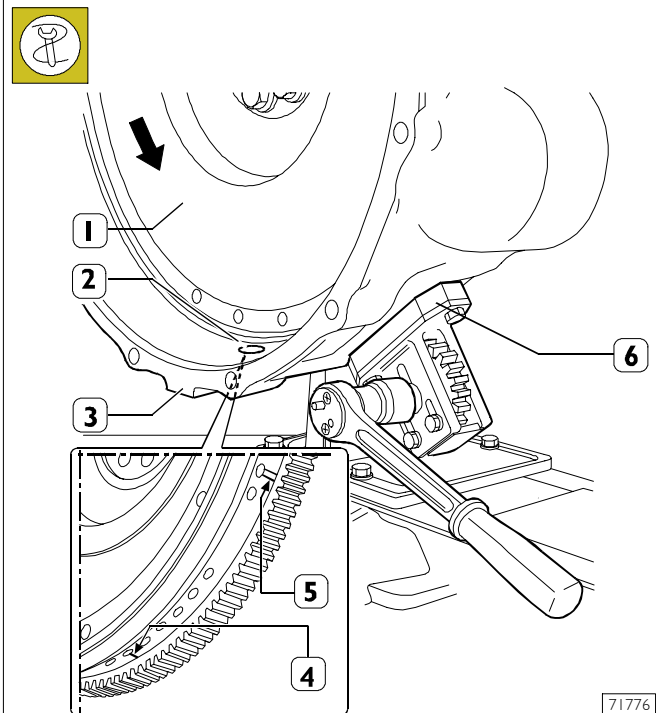


71777

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 58

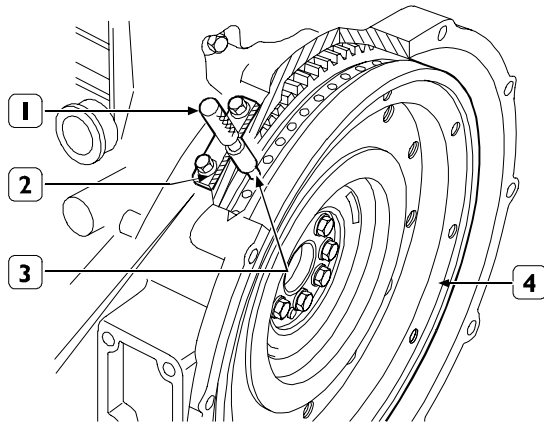


71776

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 59



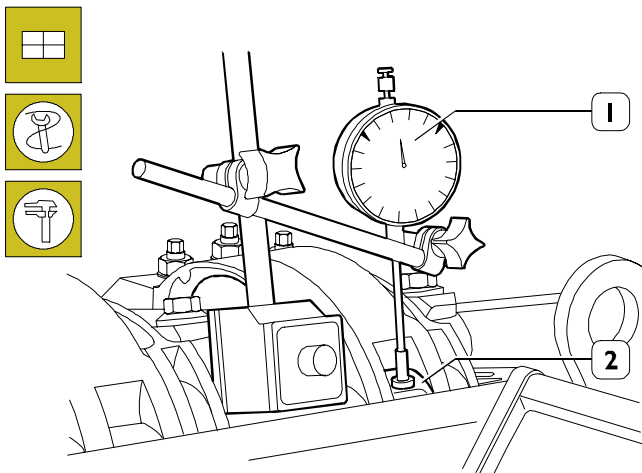
71774

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 60



106535

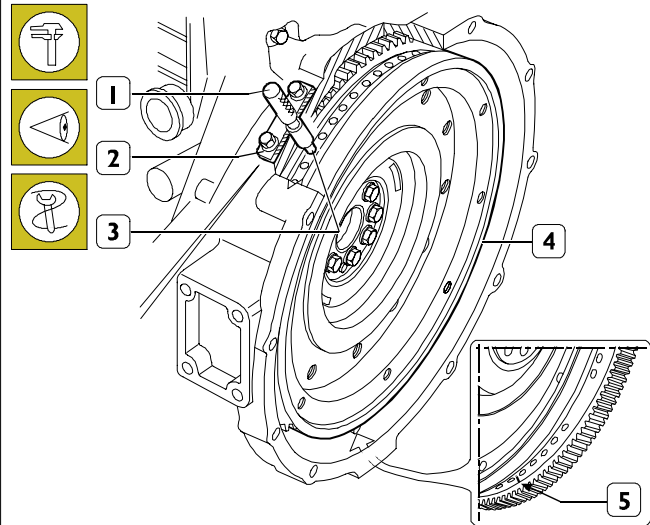
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

With tool 99360321 (6, NO TAG), 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 61

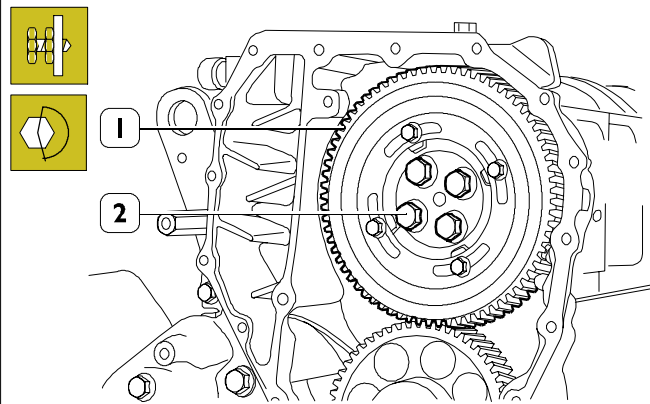


77259

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 62



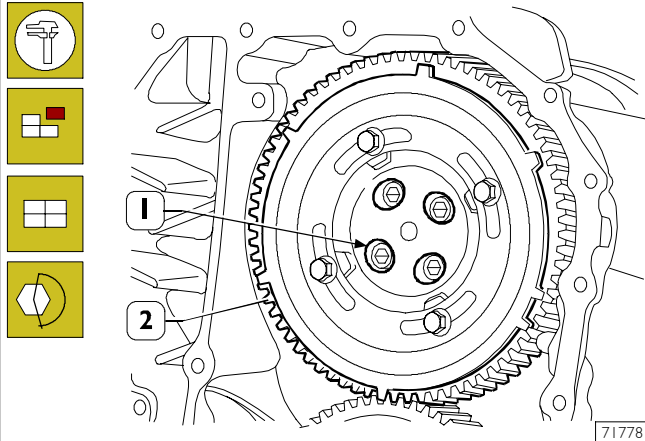
60575

If you do not obtain the conditions illustrated in Figure 61 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 63) on the gear (2, Figure 63);
- 2) turn the engine flywheel appropriately so as to bring about the conditions described in points 1 and 2 Figure 61, 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.

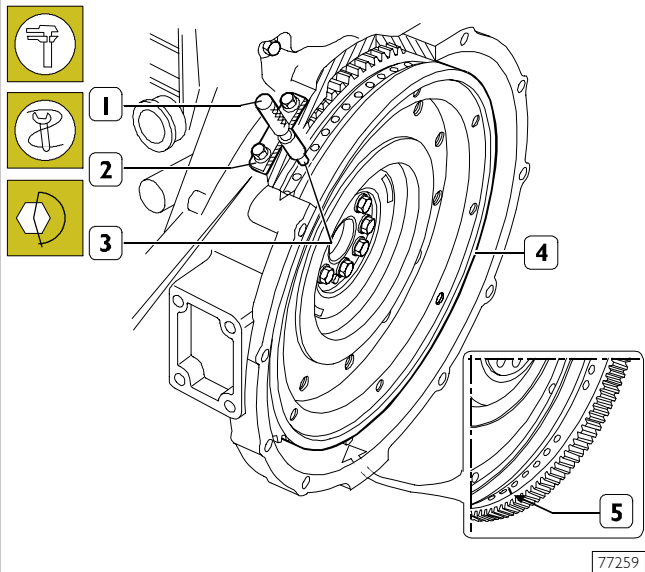
Figure 63



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 62) 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 62) and remove the gear (2) from the camshaft.

Figure 64



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).

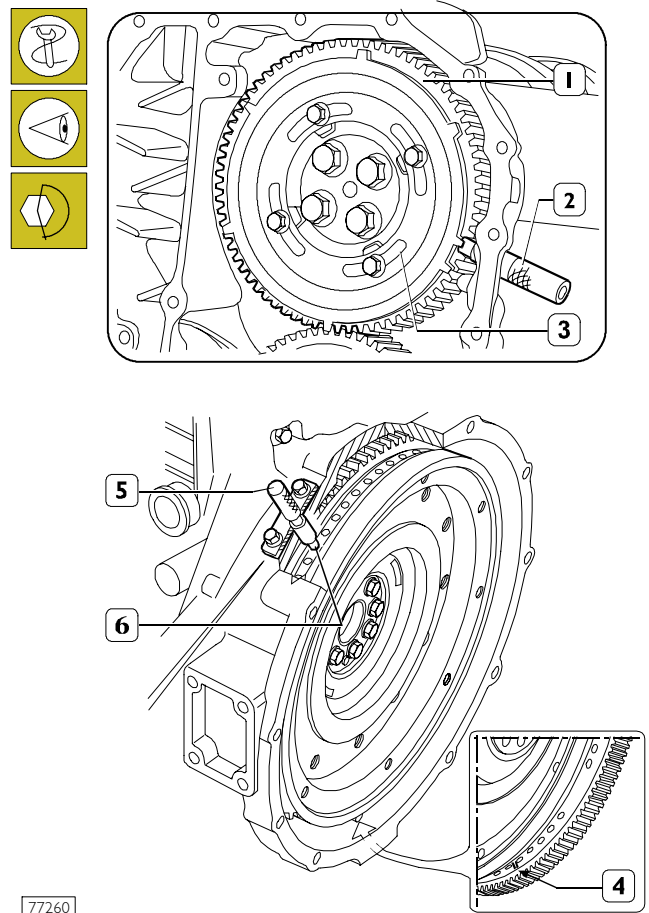
Mount the gear (2, Figure 63) with the 4 slots (1, Figure 63) centred with the fixing holes of the camshaft, locking the relevant screws to the required tightening torque.

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 61.

Phonic wheel timing

Figure 65



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.

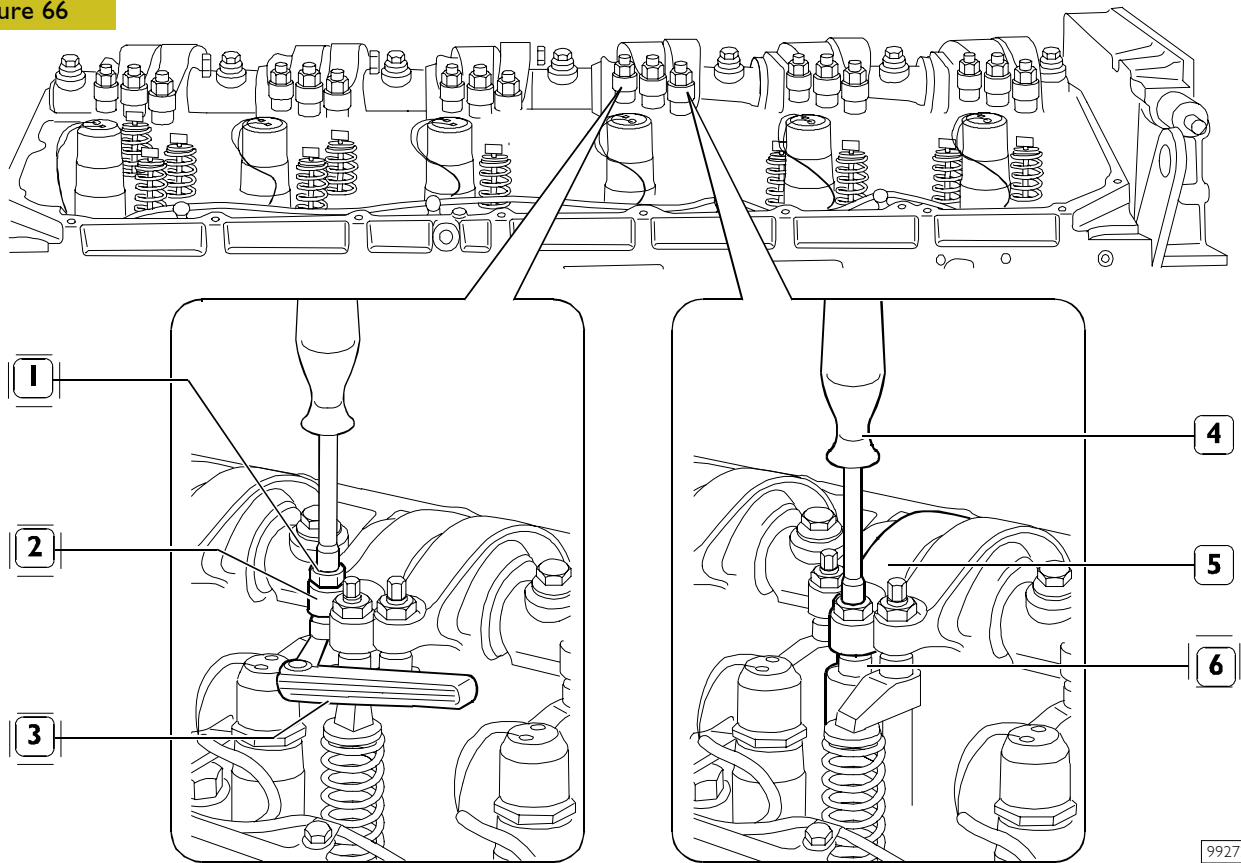
Again turn the flywheel in its normal direction of rotation until you see the hole marked with the double notch (4) through the inspection hole under the flywheel housing. Insert tool 99360612 (5) into the seat of the flywheel sensor (6).

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 66



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.

Adjustment of clearance between the rockers and rods controlling intake and exhaust valves:

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

Pre-loading of rockers controlling pump injectors:

- 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.

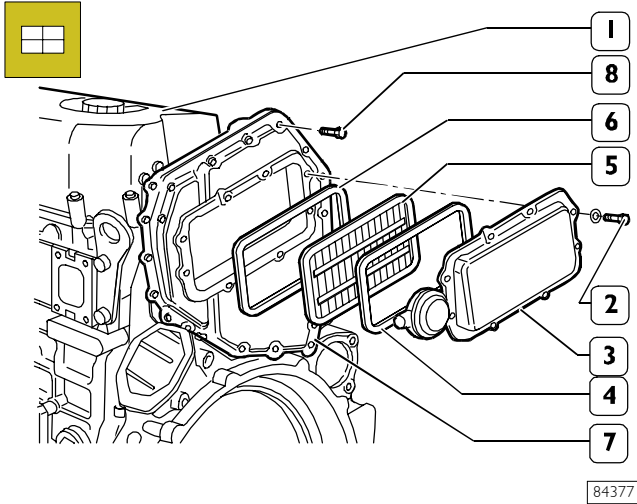
FIRING ORDER 1-4-2-6-3-5

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.

ENGINE COMPLETION

Figure 67



Fit the distribution cover (1).

NOTE The valve rocker arm cover fastening screws (1) shall be tightened according to the sequence shown in Figure 68.

Fit the blow-by case (7) and its gasket and then tighten the screws (8).
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).

NOTE Apply silicone LOCTITE 5970 IVECO n° 2992644 on the blow-by case (7) surface of engines fitted with P.T.O. according to the procedure described in the following figure.

Figure 68

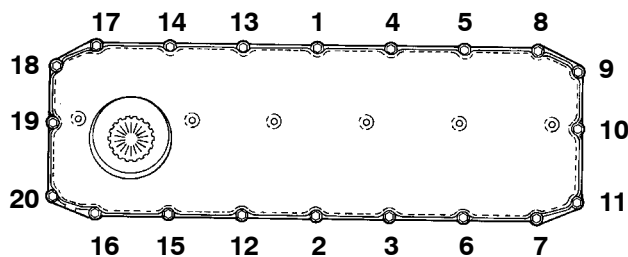
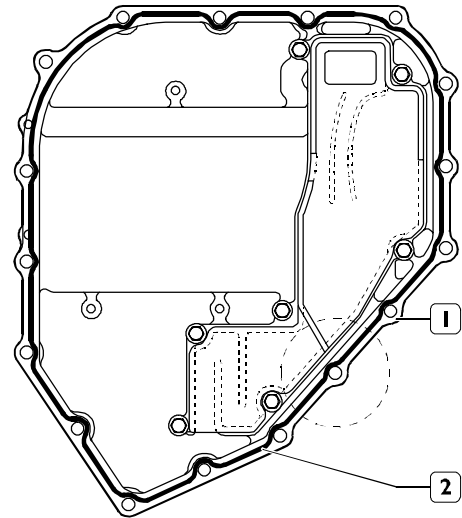


DIAGRAM OF ROCKER ARM CAP FIXING SCREWS TIGHTENING SEQUENCE

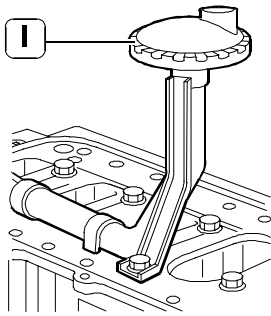
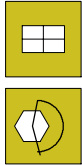
Figure 69



Apply silicone LOCTITE 5970 IVECO No. 2992644 on the blow-by case and form a string (2) of $\varnothing 1,5 \pm_{0,2}^{0,5}$ as shown in the figure.

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

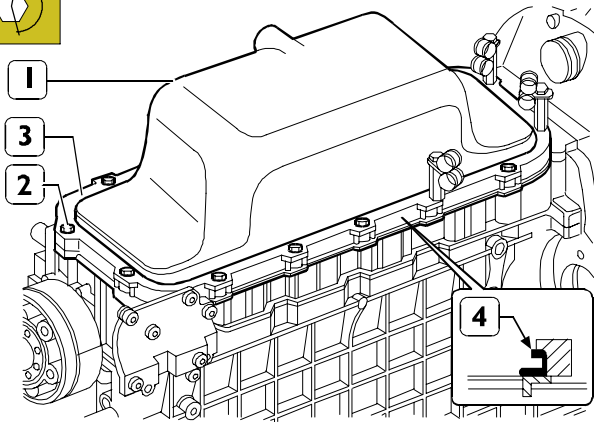
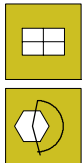
Figure 70



99269

Fit the suction strainer (1) and tighten the screws.

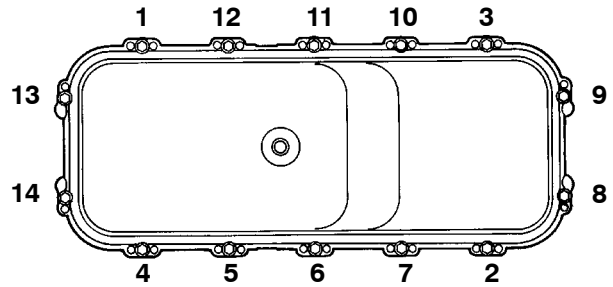
Figure 71



99268

Place gasket (4) on oil sump (1), position spacer (3) and fit the sump on the engine base by tightening screws (2) and complying with the tightening sequence shown in Figure 72.

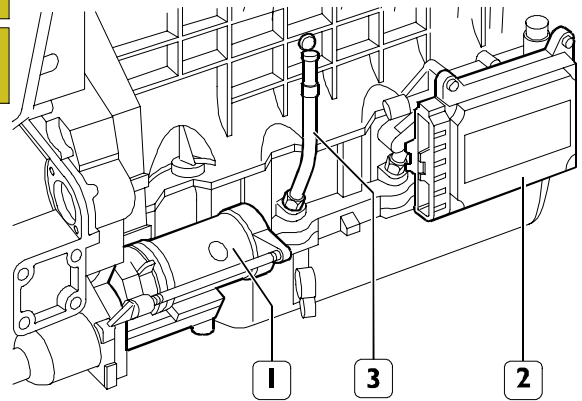
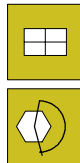
Figure 72



45362

DIAGRAM OF ENGINE OIL SUMP FIXING SCREWS TIGHTENING SEQUENCE

Figure 73



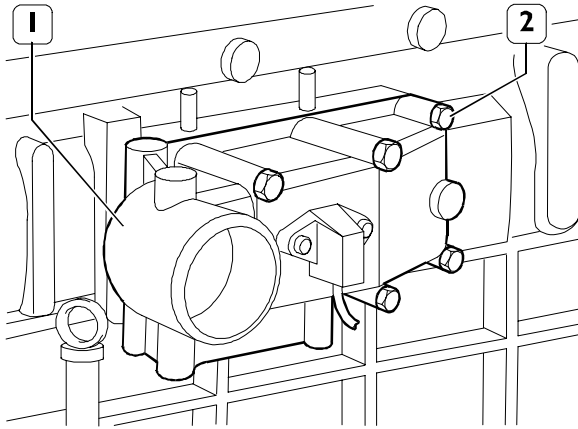
99264

Tightening the fixing screws, mount:

- the starter motor (1);
- the control unit (2) and its support;
- the oil dipstick (3) in the crankcase.

NOTE Check the state of the flexible elements of the control unit support and change them if they have deteriorated.

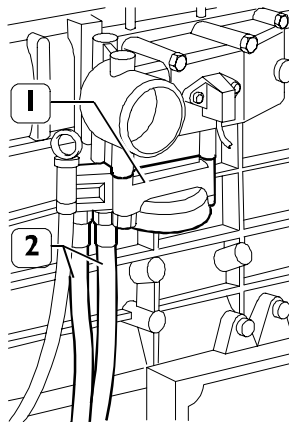
Figure 74



99263

Fit the intake manifolds (1) and tighten the fixing screws (2) to the prescribed torque.

Figure 75

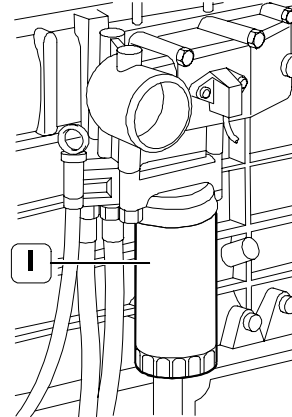


99260

For versions with oil filter support secured to the inlet manifold

Mount the support (1).
Connect the oil pipes (2) to the support (1) tightening the fittings to the prescribed torque.

Figure 76

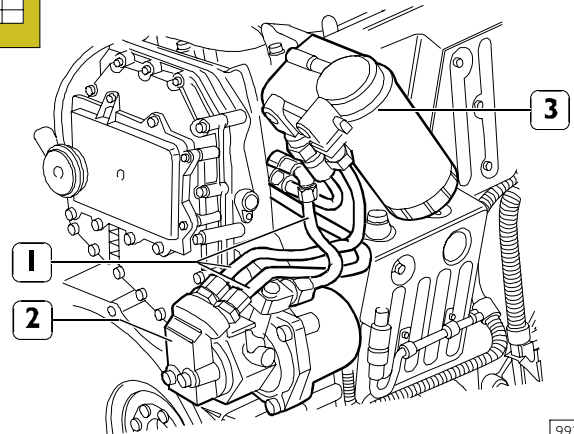


99259

Mount the oil filter (1) on the relevant support as follows:

- oil the seal;
- screw the filter fully down for the seal to make contact with the supporting base;
- tighten the filter to a torque of 35 ± 40 Nm.

Figure 77

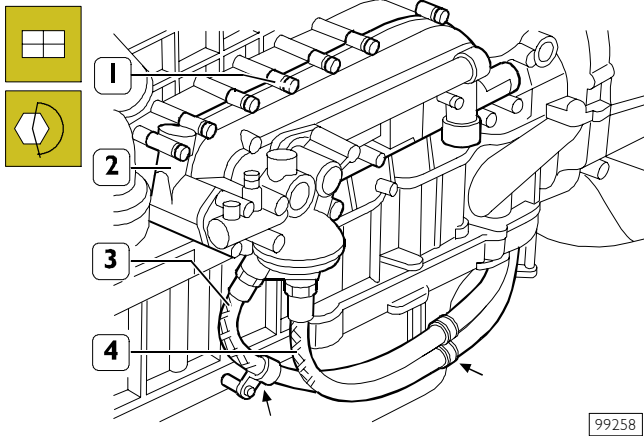


99273

Mount the following with the relevant seals and tightening the screws to the prescribed torque:

- the fuel pump (2);
- the support (3) comprehensive of fuel filter and pipes (1);
- connect the pipes (1) to the fuel pump (2).

Figure 78

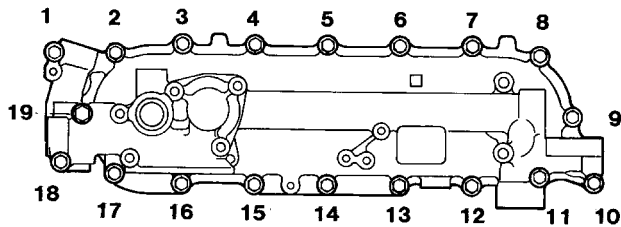


99258

Mount the cooler (2) with the relevant seal and tighten the fixing screws (←) (1).

Tighten the screws fixing the clamps retaining the pipes (3 and 4) to the spacer.

Figure 79

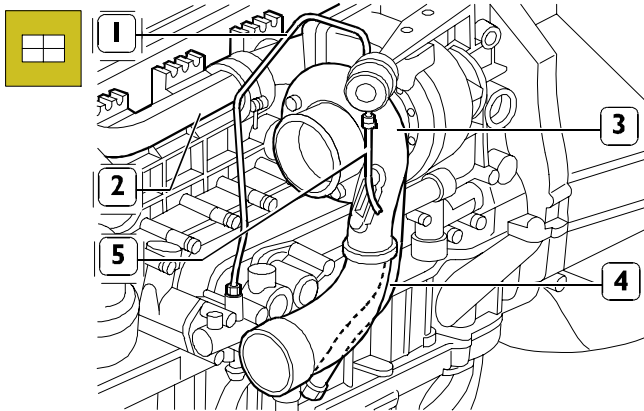


455361

DIAGRAM OF HEAT EXCHANGER FIXING SCREWS TIGHTENING SEQUENCE

In case of versions with oil filter positioned on the exchanger, the oil filter shall be fitted as described in Figure 76.

Figure 80

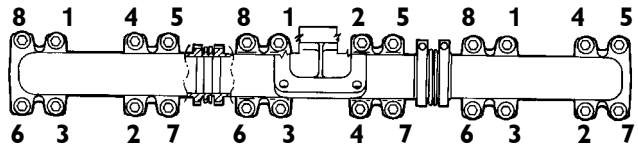


99274

Mount the following with new seals:

- exhaust manifold (2);
- turbocharger (3);
- oil pipe (1 and 4);
- pipe to the actuator (5).

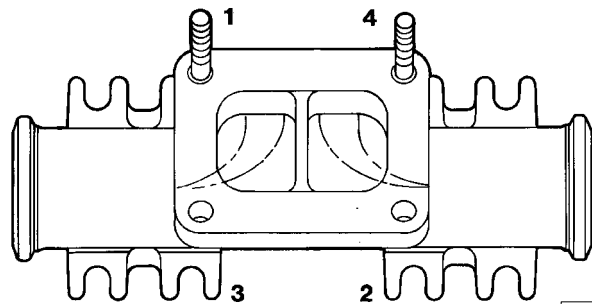
Figure 81



45359

DIAGRAM OF EXHAUST MANIFOLD FIXING SCREWS TIGHTENING SEQUENCE

Figure 82

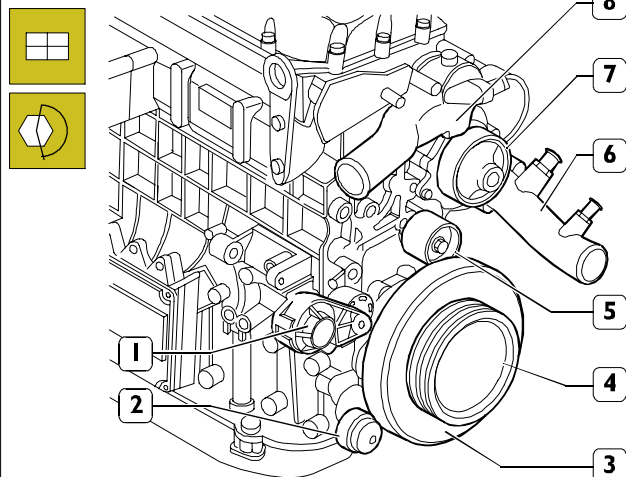


45360

DIAGRAM OF TURBOCHARGER FIXING SCREWS AND NUTS TIGHTENING SEQUENCE

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

Figure 83

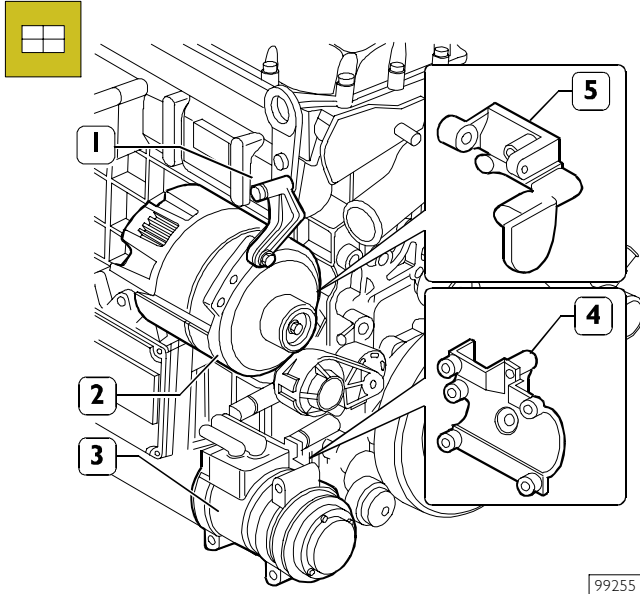


99256

Fit, together with the respective gaskets, then tighten the following parts:

- automatic tightener support (1);
- automatic tightener (2);
- damper flywheel (3) and pulley beneath;
- fixed tightener (5);
- water pump (7);
- pulley (4);
- pipe comprehensive of coolant (6);
- thermostat assembly (8).

Figure 84

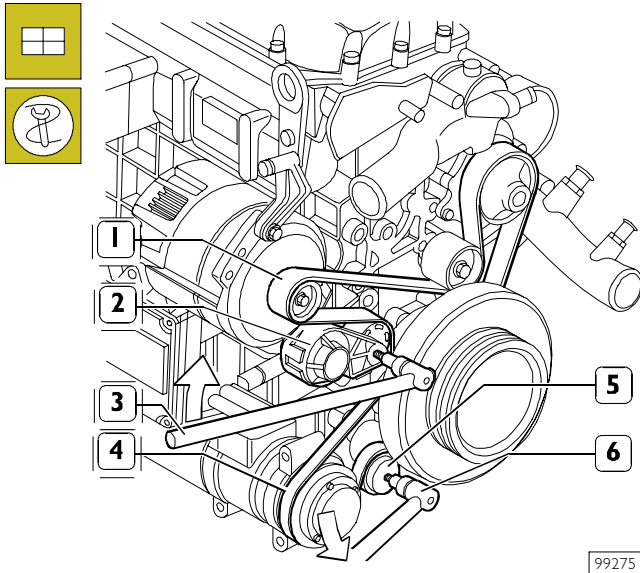


99255

Mount the following, tightening the screws to the prescribed torque:

- supports (1 and 5)
- alternator (2);
- support (4) and compressor (3) (not engine F2BE0687A*B101).

Figure 85



99275

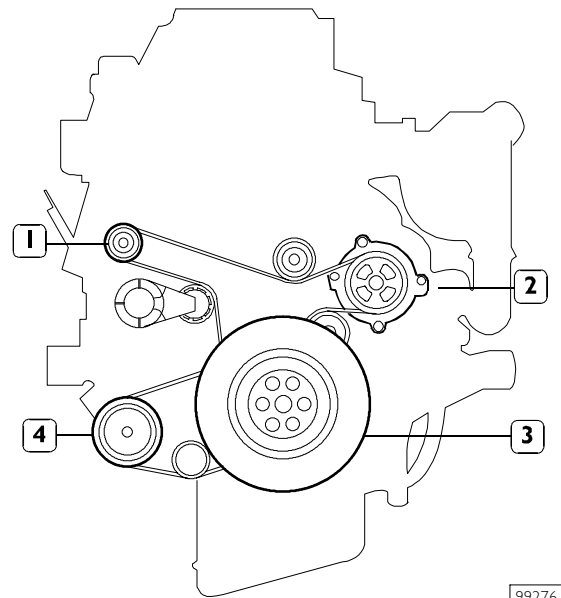
Using a suitable tool (6), work in the direction of the arrow on the tightener (5) and mount the belt (4).

Using a suitable tool (3), work in the direction of the arrow on the tightener (2) and mount the belt (1).

NOTE The tighteners are automatic, so there are no other adjustments after assembly.

DIAGRAM FOR FITTING BELT DRIVING FAN - WATER PUMP - ALTERNATOR

Figure 86

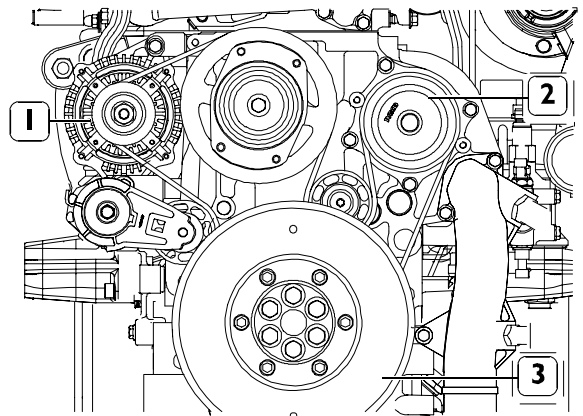


99276

ENGINES F2BE0684A*B001
F2BE0684A*B002

1. Alternator - 2. Water pump - 3. Crankshaft -
4. Compressor.

Figure 87

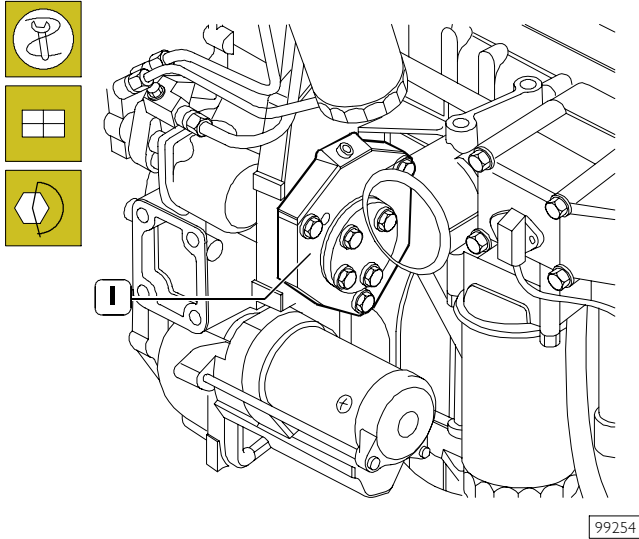


99277

ENGINE F2BE0687A*B101

1. Alternator - 2. Water pump - 3. Crankshaft.

Figure 88



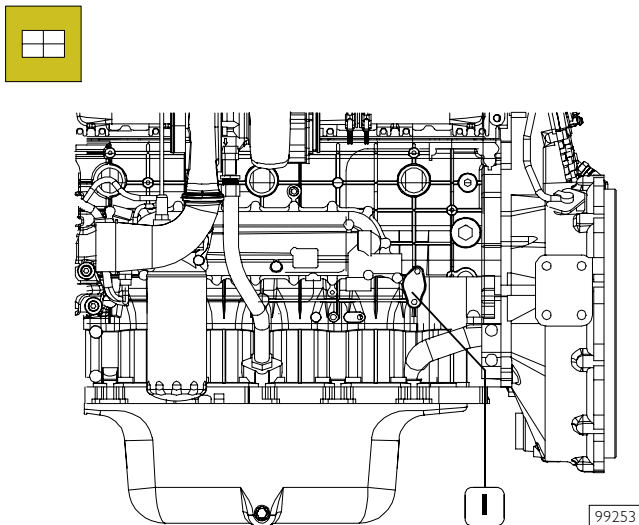
Fit the arm 99360585 onto the engine lifting hooks and hook the arm onto the hoist.

Take out the screws fixing the brackets 99361035 to the rotary stand. Lift the engine and remove the above-mentioned brackets from it.

Complete engine assembly with the following parts, tightening the fixing screws or nuts to the prescribed torque:

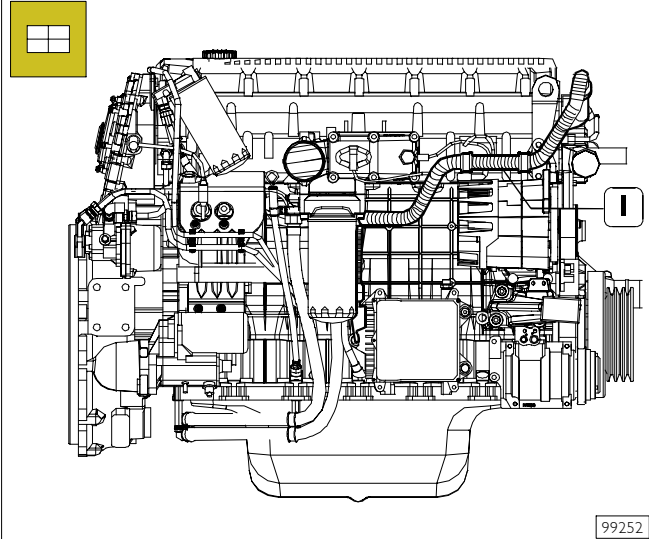
- mount the drive (I);
- mount the engine supports;

Figure 90



- mount the oil pressure adjuster valve (I).

Figure 89

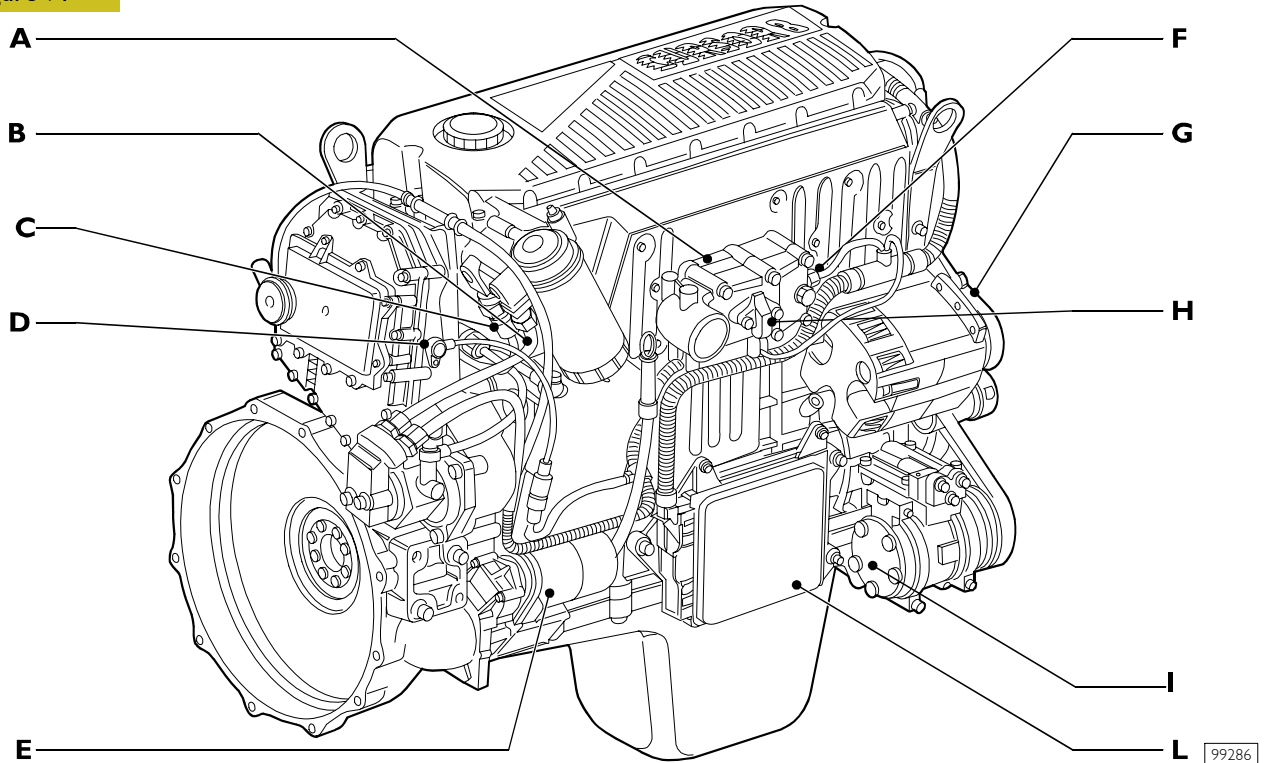


- Connect the engine electric cable to the sensors and control unit.
Refill the engine with lubricating oil of the prescribed grade and quantity.

**PART TWO -
ELECTRICAL EQUIPMENT**

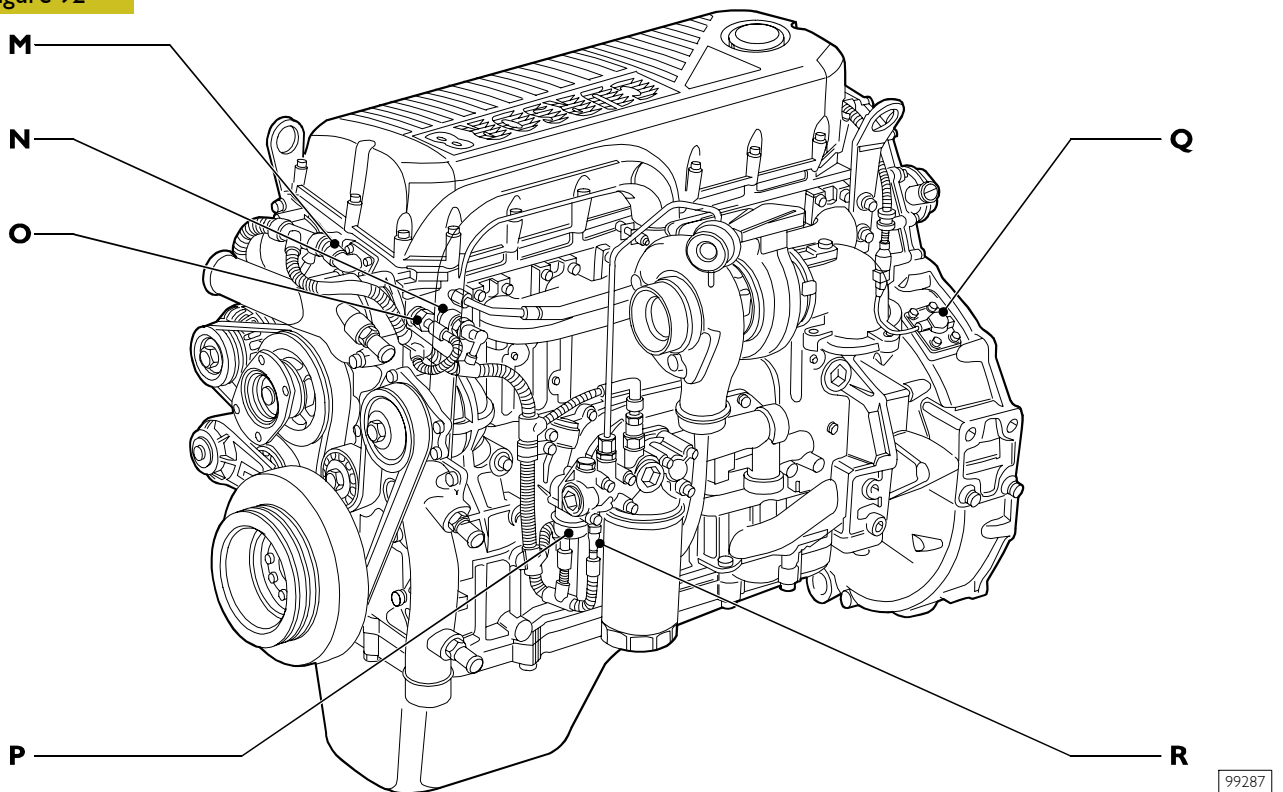
Components on the engine F2B

Figure 91



ENGINE RIGHT-HAND SIDE VIEW

Figure 92

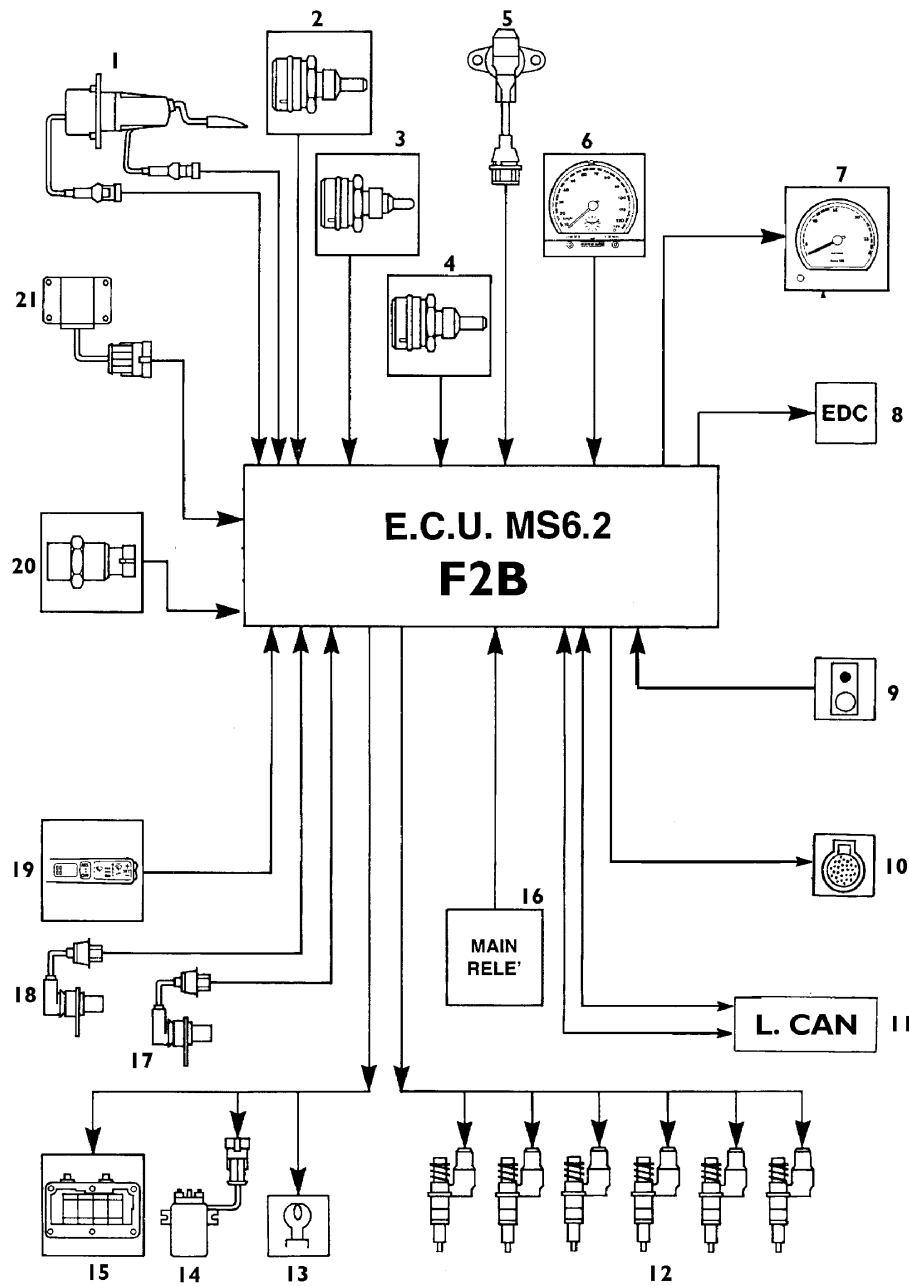


ENGINE LEFT-HAND SIDE VIEW

- 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 93



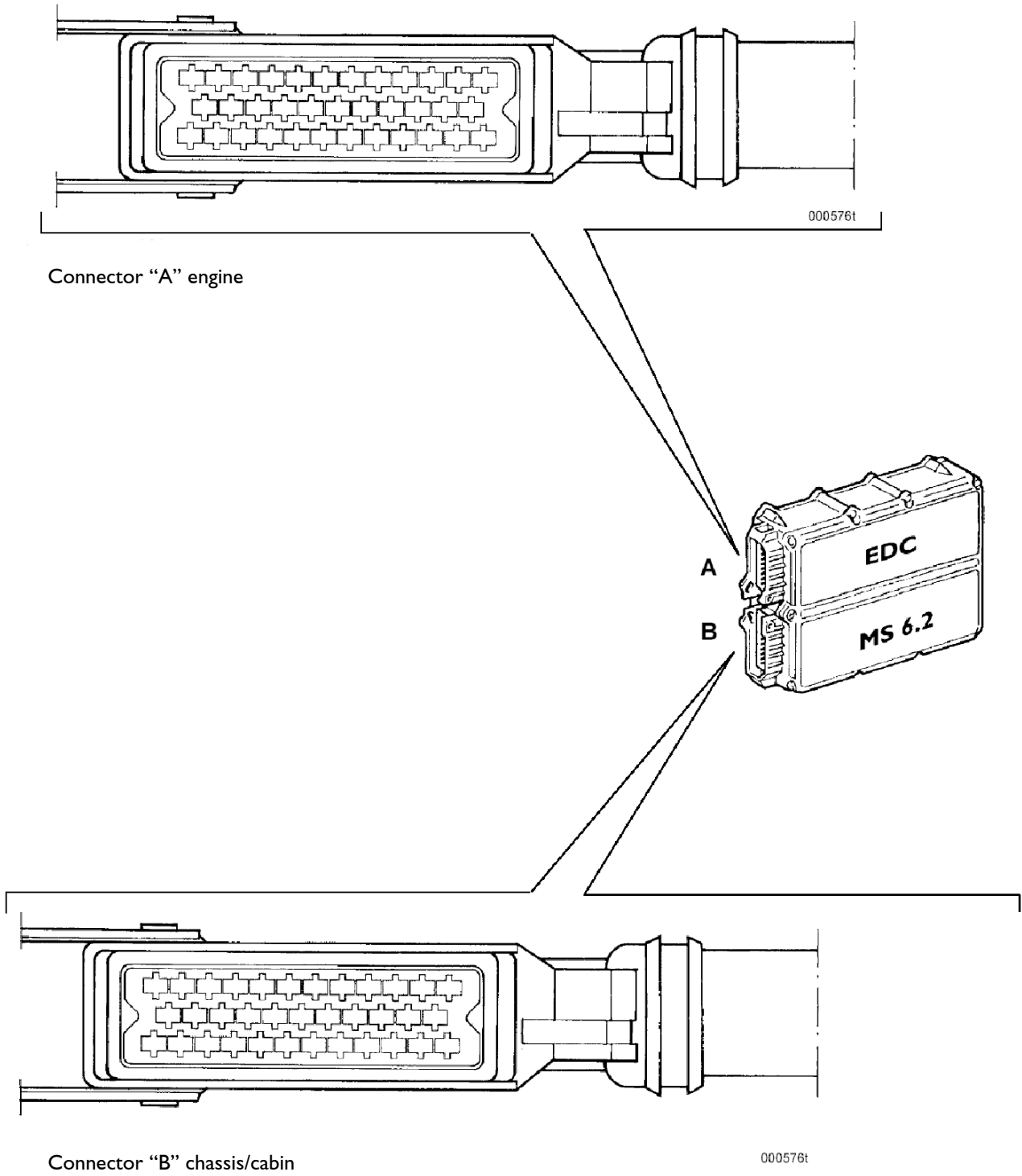
99288

KEYS

1. Accelerator pedal position sensor / switch accelerator depressed – 2. Engine coolant temperature sensor – 3. Oversupply air temperature sensor – 4. Fuel temperature sensor – 5. Oversupply air pressure sensor – 6. Input for electronic tachograph (if available) – 7. Output for electronic revs counter (if available) – 8. E.D.C. system failure warning light – 9. Blink-code button (if available) – 10. Diagnosis connector – 11. CAL L-H line – 12. Pump-injectors – 13. Warning light for pre/post-heating activated – 14. Remote control switch for pre/post-heating activation – 15. Pre/post-heating resistance – 16. Main remote control switch – 17. Flywheel sensor – 18. Distribution sensor – 19. Cruise Control buttons (if available) – 20. Clutch switch – 21. Primary / secondary brake switch.

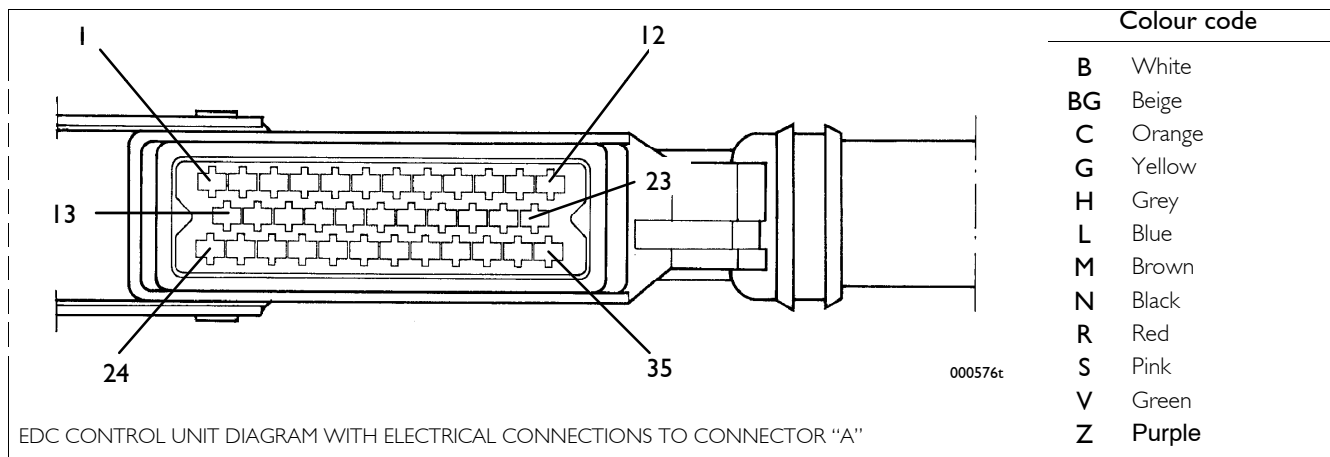
EDC MS 6.2 electronic control unit

Figure 94



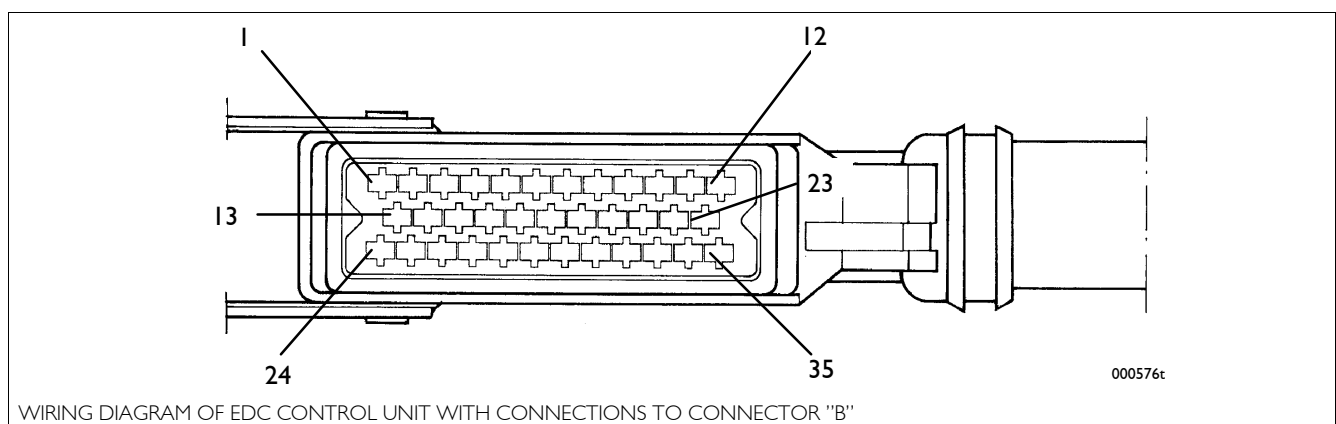
EDC control unit PIN-OUT**Connector "A" (Engine)**

Pin	Function
1 -	Engine rev sensor
2 -	Distribution rev sensor
3 -	---
4 -	Air temperature sensor mass
5 -	Engine coolant temperature sensor mass
6 -	Engine oil temperature and fuel temperature sensor ground
7 -	---
8 -	---
9 -	---
10 -	Engine oil temperature sensor signal
11 -	Fuel temperature sensor signal
12 -	Oversupply pressure sensor signal
13 -	Engine rev sensor
14 -	Distribution rev sensor
15 -	---
16 -	---
17 -	Boosting pressure sensor ground
18 -	---
19 -	---
20 -	---
21 -	Air temperature sensor signal
22 -	Engine coolant temperature sensor signal
23 -	Oversupply pressure sensor power supply
24 -	Injector power supply for cylinders 1 / 2 / 3
25 -	Injector power supply for cylinders 4 / 5 / 6
26 -	Cylinder 4 injector control
27 -	Cylinder 6 injector control
28 -	Cylinder 5 injector control
29 -	---
30 -	---
31 -	---
32 -	---
33 -	Cylinder 3 injector control
34 -	Cylinder 2 injector control
35 -	Cylinder 1 injector control

Figure 95

EDC control unit PIN-OUT**Connector "B" (Frame area)**

Pin	Functions
1 -	Negative direct from battery / blink button – code
2 -	Negative direct from battery / blink button – code
3 -	Positive from main remote switch
4 -	Positive from main remote switch
5 -	Signal for electronic rev. counter (if available)
6 -	Negative for EDC / blink button – code warning light (if available)
7 -	CAN line for Multiplex electric system architecture
8 -	---
9 -	Engine phase signal for diagnosis connector
10 -	Negative for pre-post heating remote switch engagement
11 -	CAN - L line for interconnection of the CAN line with control units (if any) available with the application
12 -	CAN - H line for interconnection of the CAN line with control units (if any) available with the application
13 -	K line for diagnosis connector
14 -	---
15 -	Key controlled supply positive
16 -	Accelerator pedal position sensor supply
17 -	Negative from idler switch
18 -	Negative for warning light pre – post heating
19 -	---
20 -	Positive from N.C. clutch switch (if available)
21 -	Function "RESUME" Cruise Control (if available)
22 -	Positive from speed reducer switch (if available)
23 -	Accelerator pedal position signal sensor
24 -	L line for diagnosis connector
25 -	Negative for accelerator pedal, multiple-state switch for torque reducer and negative for engine speed and vehicle speed sensors
26 -	Positive from primary N.C. brake switch
27 -	Negative for main remote switch
28 -	Signal from the multiple-state switch for the torque reducer (if available)
29 -	Vehicle speed (D3 tachograph) signal (if available)
30 -	PWM line
31 -	Positive from N.C. redundant brake switch
32 -	Function "SET -" Cruise Control (if available)
33 -	Function "OFF +" Cruise Control (if available)
34 -	Function "SET +" Cruise Control (if available)
35 -	Negative for accelerator pedal position sensor

Figure 96

PUMP INJECTOR

It consists mainly of:

- A) Solenoid valve
- B) Pumping element
- C) Nozzle

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

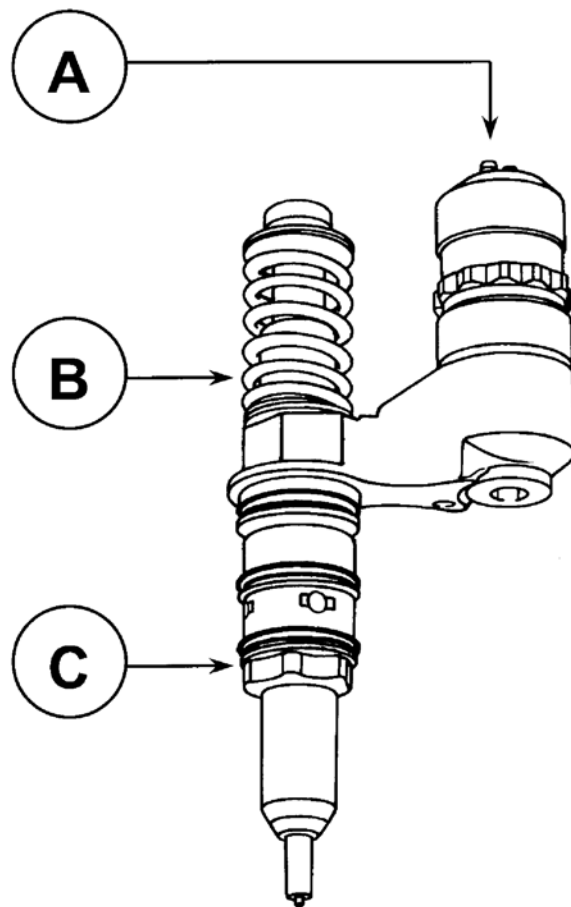
The pumping element, mechanically actuated at every rocker arm cycle, compresses the fuel container in the delivery chamber.

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 97



000578t

Engine coolant temperature sensor

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.

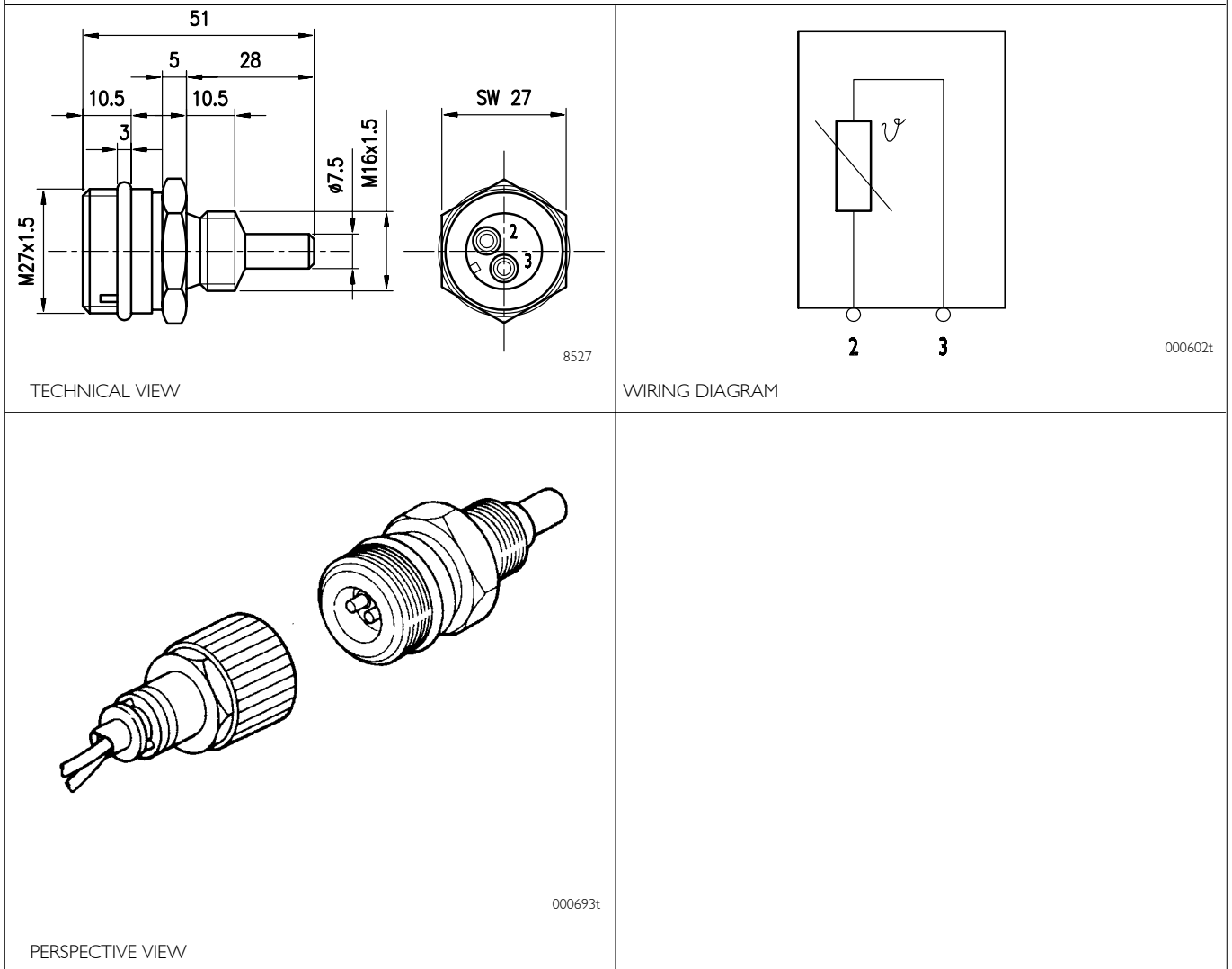
It is connected to electronic center pins A5/A22.

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 98



Connector	Function	Cable colour
2	To EDC center pin A 5	—
3	To EDC center pin A 22	—

Fuel temperature sensor

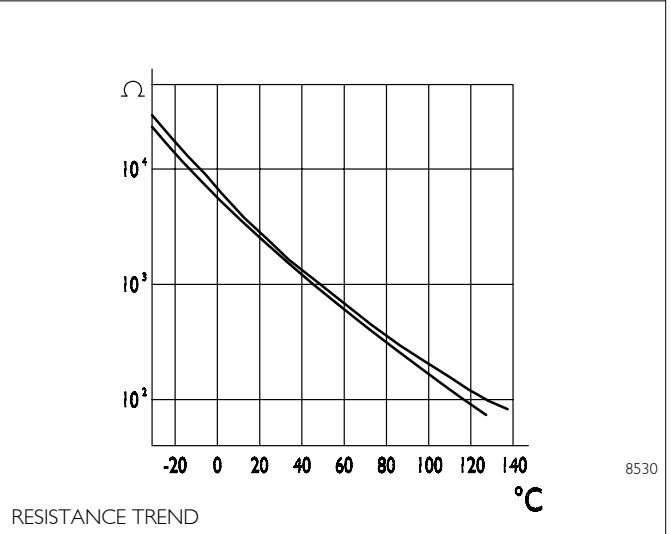
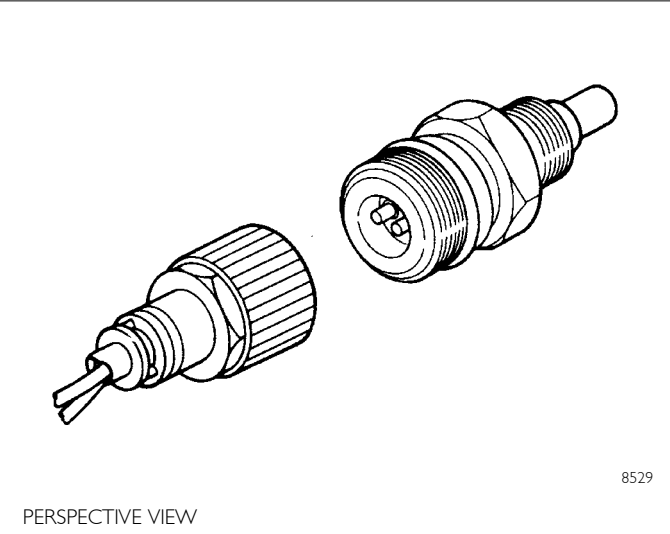
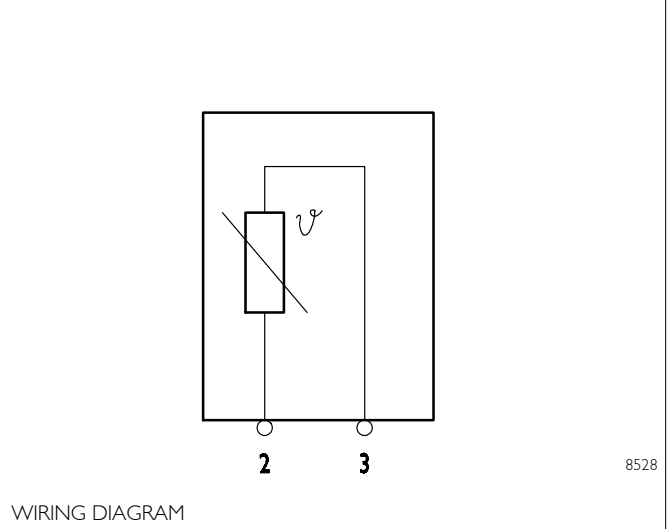
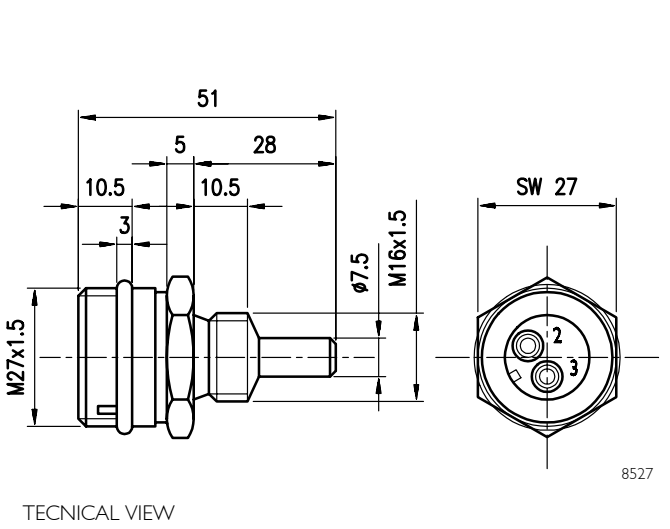
Specifications

Supplier

Max. tightening torque

BOSCH
35 Nm

Figure 99



Pin	Function	Cable colour
2	To pin 6 of EDC control unit	—
3	To pin 11 of EDC control unit	—

Pulse transmitter

Specifications

Supplier

Max. tightening torque

BOSCH
8 ± 2 Nm

Figure 100

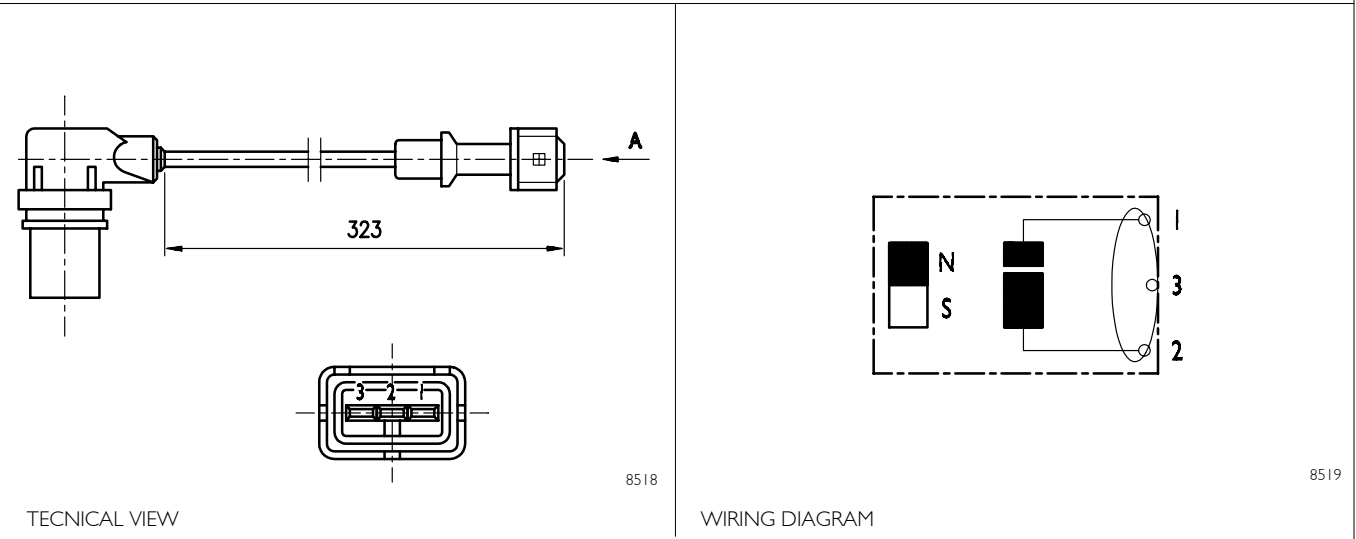
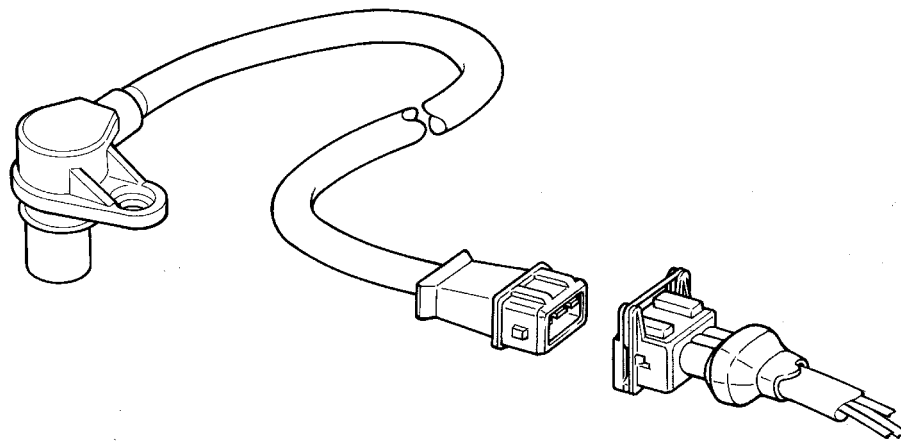


Figure 101



Pin	Function	Cable colour
1	To pin 1 of EDC control unit	—
2	To pin 13 of EDC control unit	—
3	Screens	—

Distribution pulse transmitter

Features

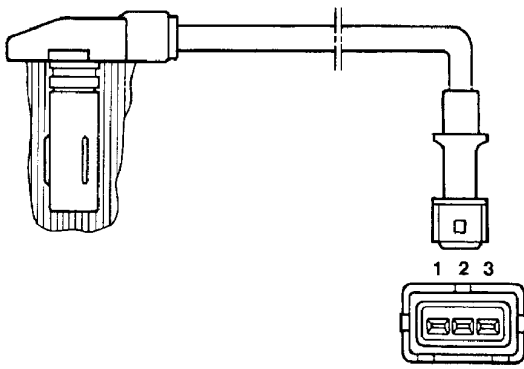
Vendor	BOSCH
Torque	8 ± 2 Nm
Resistance	880 ± 920 Ω

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.

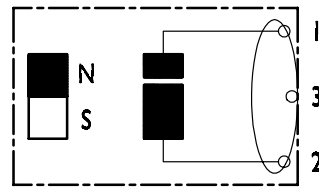
The electronic center uses the signal generated by this sensor as an injection step signal.

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

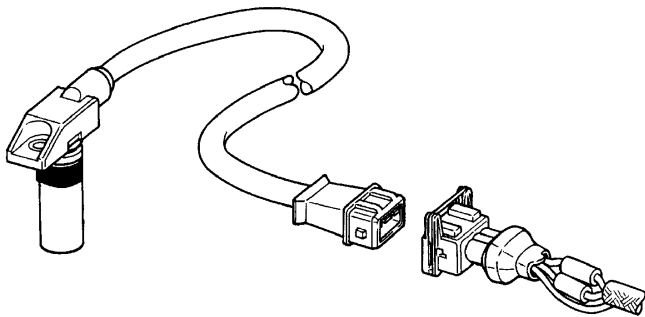
This sensor's air gap is NOT ADJUSTABLE.



TECHNICAL VIEW



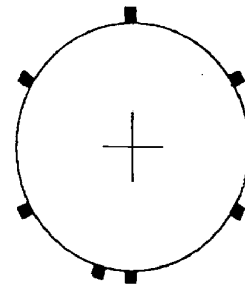
WIRING DIAGRAM



PERSPECTIVE VIEW

000606t

6 + 1



REFERENCE ON SOUND WHEEL

8520

Connector	Function	Cable colour
1	To EDC center pin A 2	—
2	To EDC center pin A 14	—
3	Shields	—

Boosting pressure transmitter

Specifications

Supplier

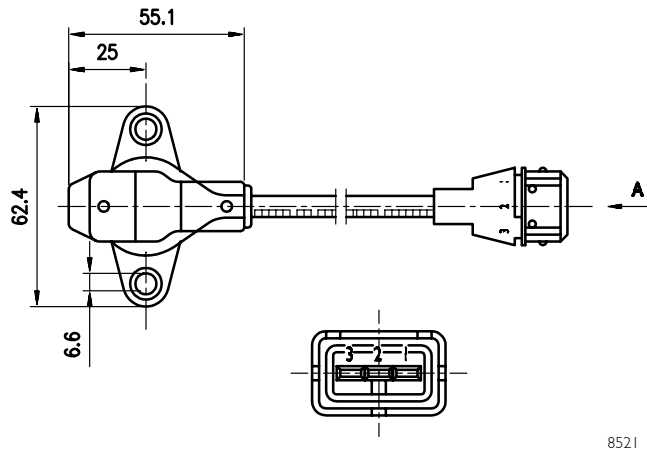
Code

Operating pressure field

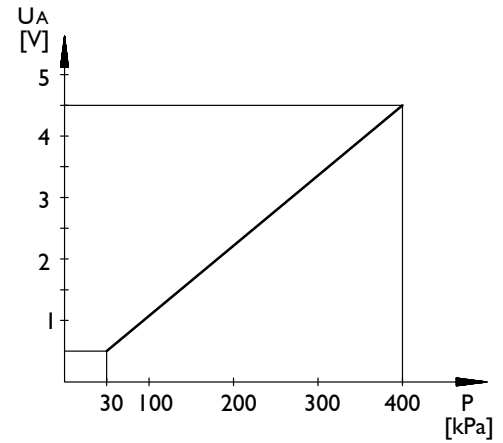
Max. tightening torque

BOSCH
B 281022 018
50 ÷ 400 kPa
10 Nm

Figure 102



8521

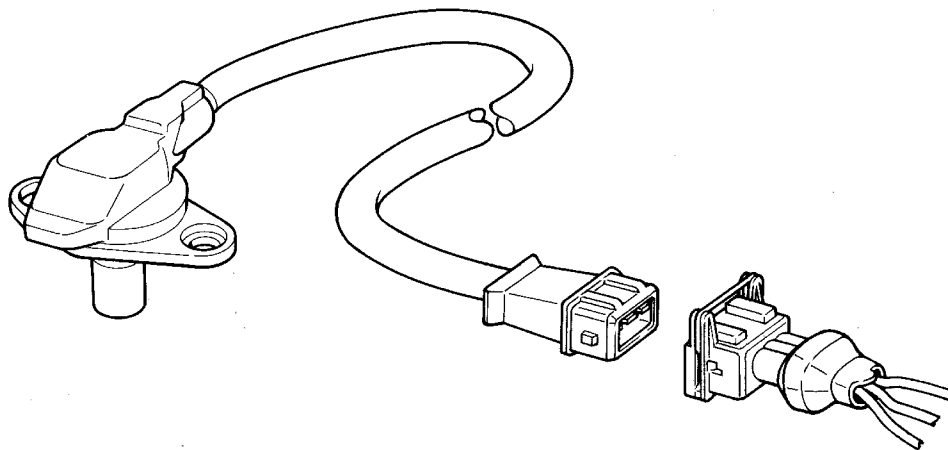


8522

TECNICAL VIEW

MAX ABSOLUTE PRESSURE SPECIFICATIONS 600 KPA

Figure 103



PERSPECTIVE VIEW

8523

Pin	Function	Cable colour
1	To pin 12 of EDC control unit	—
2	To pin 23 of EDC control unit	—
3	To pin 17 of EDC control unit	—

PRE/POST-HEATING RESISTANCE

The resistance is ~ 0,7 Ohm.

Such resistance is placed between the cylinder head and the suction manifold. It is used to heat up air during pre/post-heating operations.

When the ignition key is inserted, should any one of the temperature sensors – water, air, gas oil – detect a value below 10°C, the electronic control unit will activate pre/post-heating and turn on the relevant dashboard warning light for a variable time depending on the temperature.

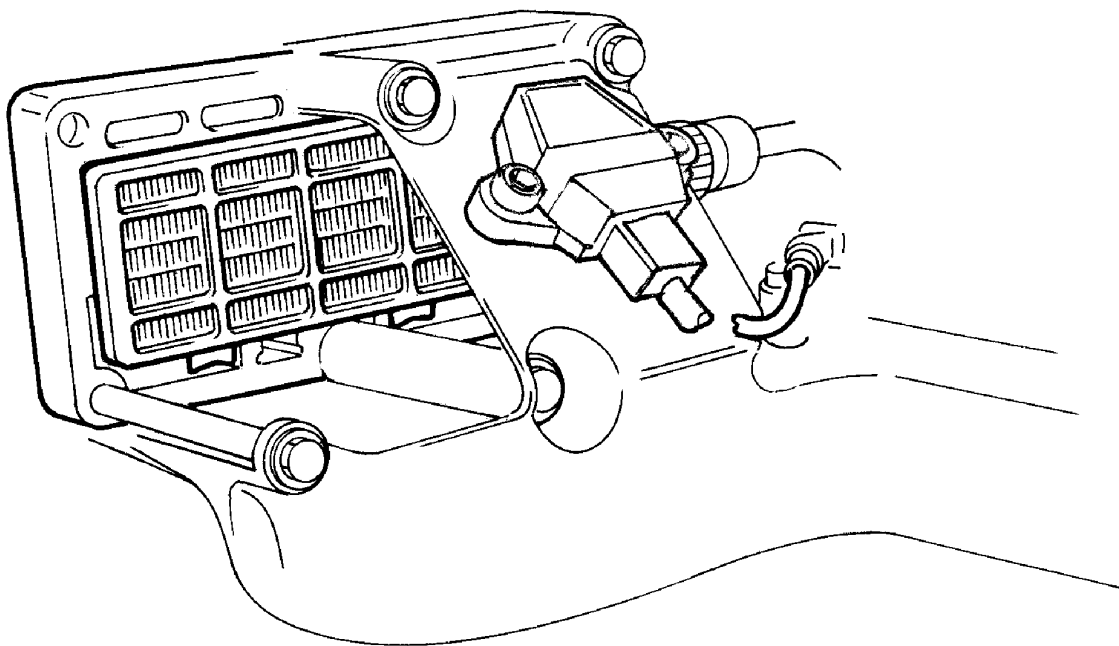
After that time, the warning light starts blinking thus informing the driver that the engine can be started.

When the engine is running the warning light goes off, while the resistance is being fed for a certain time as a result of post-heating.

If the engine is not started, with the warning light flashing, in 20 / 25 seconds, the operation is cancelled to prevent draining the battery.

On the contrary, if reference temperatures are over 10°C, when the ignition key is inserted the warning light comes on for about 2 seconds and carries out the test and then goes out to signal that the engine can be started.

Figure 105



001256t

EDC SYSTEM FUNCTIONS

The MS6.2 electronic center manages the following main functions:

Fuel injection
Accessory functions
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
- 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 still 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.

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.

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 inside 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.

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 issued by blinking of the failure led: the "blink-code" (whether programmed).

Please consider that the interpretation of the indications provided by the blink-code is not sufficient to guarantee the solution to the existing anomalies.

Using Iveco Motors 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 three different parts:

- Part 1: Blink Code, relating to the anomalies identified by the gearbox, mainly of electric and electrical nature;
- Part 2: Troubleshooting guide using PT-01 portable tester.
Tool identified as IVECO p/n 8093731.
- Part 3: Guideline for troubleshooting without blink code, divided per symptoms, describing all possible anomalies not detected by the electronic gearbox, often of mechanical and hydraulic nature.

NOTE Any kind of operation on the electronic center unit must be executed by qualified personnel, duly authorized by Iveco Motors.

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

PART I

EDC MS6.2 SW control unit Blink Table

Blink code	EDC warning lamp *	Fault
VEHICLE AREA		
1.1	GLOWING STEADILY	Vehicle speed signal (if available)
1.2	GLOWING STEADILY	Torque selector (if available)
1.3	OFF	Cruise Control (if available)
1.4	GLOWING STEADILY	Accelerator pedal
1.5	OFF	Clutch pressure switch (if available)
1.6	GLOWING STEADILY	Plausibility of brake pedal signal switches
1.7	OFF	Plausibility between accelerator / brake pedal
ENGINE AREA		
2.1	OFF	Water temperature sensor
2.2	OFF	Air temperature sensor
2.3	OFF	Fuel temperature sensor
2.4	GLOWING STEADILY	Supercharging pressure sensor
2.5	OFF	Ambient pressure sensor (inside control unit)
3.5	OFF	Battery voltage
INJECTORS		
5.1	GLOWING STEADILY	Fault on injector cylinder 1
5.2	GLOWING STEADILY	Fault on injector cylinder 4
5.3	GLOWING STEADILY	Fault on injector cylinder 2
5.4	GLOWING STEADILY	Fault on injector cylinder 6
5.5	GLOWING STEADILY	Fault on injector cylinder 3
5.6	GLOWING STEADILY	Fault on injector cylinder 5
ENGINE RPM SENSORS		
6.1	GLOWING STEADILY	Flywheel sensor
6.2	GLOWING STEADILY	Timing gear sensor
6.4	FLASHING	Engine over revving
INTERFACES WITH OTHER CONTROL UNITS		
7.2	OFF	CAN line
7.6	OFF	CAN line (ASR control) (if available)
7.7	OFF	CAN line (gearbox data control)
CONTROL UNIT		
9.1	FLASHING	Faulty control unit
9.2	GLOWING STEADILY	Incorrect data in EPROM
9.4	GLOWING STEADILY	Main relay
9.5	GLOWING STEADILY	Incorrect engine stopping procedure
9.6	GLOWING STEADILY	Incorrect data recording in control unit

- * Blink code warning lamp off = slight error
 Blink code warning lamp glowing steadily = significant error
 Blink code warning lamp flashing = serious error

PART 2

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
1.1	ON steady	Faulty vehicle speed sensor. The tachograph won't work. Odd behaviour of the tachograph pointer. (If available)	Vehicle speed no longer reduced: it can be exceeded in case of poor resistance to progressing. Serration with high speeds.	Flight recorder detects high time at low speed. Check cabling, connections and component.	Control unit replacement value: 5 km/h.
1.2	ON steady	Faulty multiple-state switch. (If available)		Check cabling, connections and component.	
1.3	OFF	Faulty Cruise Control switches. (If available)	The Cruise Control won't work.	Check cabling, connections and component.	Or non-plausible switch signals (switches pressed simultaneously).
1.4	ON steady	Accelerator pedal: faulty potentiometer or non-plausible signal. Odd reaction of engine when actuating the accelerator pedal.			Engine speed can be varied by means of the CC (Set + / Set -) switch. (If available)
1.5	OFF	Faulty clutch switch. CC won't work. (If available)	Serration when changing gear.	Check cabling, connections and component.	
1.6	ON steady	Brake switch plausibility. No reaction after actuating the CC/PTO switches. (If available)	The Cruise control / PTO won't work.	Check cabling, connections and component.	
1.7	OFF	Brake switch / accelerator pedal sensor plausibility.			No reaction from the system.

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
2.1	OFF	Faulty coolant temperature sensor. Excessive starting time in cold weather conditions.	Greater combustion noise due to high injection advance.	Pre-heating resistor active diagnosis. Parameter reading. Check cabling, connections and component.	No overheating protection, replacement value = 0°C.
2.2	OFF	Faulty boosting air temperature sensor.	If the sensor signals a temperature lower than the actual one, the error is not stored and the engine achieves better performance, yet with black smoke.	Parameter reading. Check cabling, connections and component.	Replacement value = 20°C.
2.3	OFF	Faulty fuel temperature sensor.		Parameter reading. Check cabling, connections and component.	No injection rate correction; yet, the driver is not aware of it. Replacement value = 30°C.
2.4	ON steady	Faulty boosting pressure sensor. Power reduction.	Significant black smoke in momentary conditions.	Parameter reading modus: if the replacement value is read when the engine is idling, the fault is confirmed.	Replacement value. Cursor 8 = 1,600 mbar, Cursor 10 = 2,800 mbar.
2.5	OFF	Faulty ambient pressure sensor.		Contact Help Desk for replacement (if any) of the control unit, owing to the sensor being integrated into the same.	EDC works with a replacement value of 28 V.
3.5	OFF	Too low battery voltage or voltage recognition fault.	Possible pre-heating and starting problems.	Battery test.	
5.x	ON steady	Problem with injection circuit on cylinder X. The engine speed is reduced, and the engine operated with 5 cylinders.	If the fault is intermittent, the engine sometimes works correctly; sometimes, it does not.	Engine test (if the fault is found). Check component, cabling and connections (head cable included).	

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
6.1	ON steady	Faulty flywheel sensor. Reduced engine speed and power.	Engine starting may take a longer time than usual.	Fault memory reading by means of the diagnosis instrument. Check cabling, connections and component.	
6.2	ON steady	Distributing shaft sensor. Reduced engine speed and power.	Engine starting may take a longer time than usual.	Fault memory reading by means of the diagnosis instrument. Check cabling, connections and component.	
(6.1 - 6.2)	ON steady	Distributing shaft phonic wheel has rotated, due to loosened screws. The engine won't start, or stops and cannot be started again.	Reduced power with engine started (after taking the measure recommended in the next column).	Disconnect the distributing shaft sensor connector. If the engine is started, even by taking a longer time than usual, the phonic wheel is out-of-phase.	
6.4	Blinking	The engine has reached (on pulling) the out-of-rev conditions for any reason whatsoever.		Fault memory reading. Flight recorder reading to get confirmation of the engine out-of-rev condition.	
(9.1)	Blinking	Faulty EDC control unit. The engine will stop or won't start.		Contact Help Desk for control unit replacement.	No diagnosis can be made. This error may even not be stored; this depends on the control unit conditions.
9.2	ON steady	Control unit fault (EEPROM memory). Reduced engine speed and power.	Faulty memory lost; only the diagnosis of existing faults can be made.	Contact Help Desk for replacement (if any) of the control unit.	
9.4	Blinking	Main relay faulty or locked in closed position. The EDC warning light remains ON when the key is turned to OFF; yet the engine will stop.	EDC power supply remains ON after the key has been turned to OFF; danger of battery run-down.	Check cabling, connections and component.	The fault will be stored only after the next time the engine is started.

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
9.5	ON steady	ECU power supply is cut out too often (5 times): faulty main relay or engine stop by means of battery disconnect switch. Reduced engine max. speed and power.		Check main relay, cabling and connections. Investigate whether the driver switches the engine off in other ways than by turning the key.	The problem will be solved by itself the next time the switch-off procedure and data storing are performed correctly.
9.6	ON steady	ECU stop test failure. Reduced engine speed and power.	This is a test procedure inherent to the control unit for power stage control. It might store other errors concerning the various power stages of actuators.	Contact Help Desk for replacement (if any) of the control unit.	

PART 3

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 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 PLANNING

Recovery

To ensure optimised working conditions, in the following pages we are providing instructions for the overhaul control interventions, checks and setting operations that must be performed on the engine at due planned dates.

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

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

Inspection and/or maintenance interventions

Intervention type	Frequency (hours)
Engine	
Engine visual inspection	Daily
Check presence of water in fuel prefilter	Daily
Engine oil change	-
Engine oil filter change	-
Fuel prefilter change (when it is required by the application)	-
Fuel filter change	-
Check Blow-by filter condition by clogging indicator	-
Check condition of water pump/alternator control belt	-
Check-up of EDC system by diagnostics tool	-
Check valve lash and adjust, if required	-
Dry air filter change and container cleaning	-

NOTE The maintenance operations are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Checks not included in maintenance planning-daily checks

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

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

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

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

MAINTENANCE PROCEDURES

Checks and controls

Engine oil level check.

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

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

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

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

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

To provide filling, operate through the upper top (1) or through the lateral top (2). During filling operation, the tops must be removed as well as the rod in order to make the oil flow easier".

Refill through upper tappet cover plug. During refill, remove dipstick for easier oil drain.



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



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

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

Check of fuel system

The check must be executed both when the engine disconnected and when it is running.

The check is made by observing the fuel pipes from the tank to the fuel pump and to the injectors.

Cooling system check

The check must be executed both when the engine disconnected and when it is running.

Check the pipes from the engine to the radiator and vice versa; note any seepage and the state of the pipes especially near the coupling clamps.

Verify that the radiator is clean, the correct working of the fan flywheels, the presence of any leakage from the connectors, from the manifold and from the radiating unit.



Due to the high temperatures achieved by the system, do not operate immediately after the engine's disconnection, but wait for the time deemed necessary for the cooling.

Protect the eyes and the skin from any eventual high pressure jet of cooling liquid.

The density of the cooling liquid must be checked any how every year before winter season and be replaced in any case every two year.

NOTE In case of new filling, proceed bleeding system, through the bleeds on the engine.

If bleeding of the system is not carried out, serious inconvenience might be caused to the engine due to the presence of air pockets in the engine's head.

Lubricating system check

The check must be executed both when the engine disconnected and when it is running.

Verify the presence of any oil leakage or blow-by from the head, from the engine pan or from the heat exchanger.



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

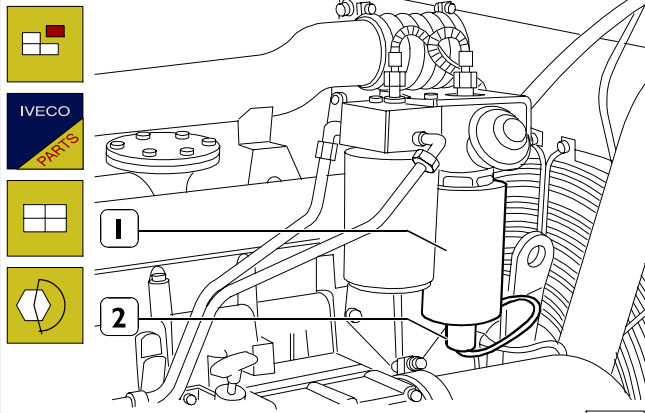


Adequately protect the skin and the eyes, operate in full compliance with safety regulations.

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

Replace fuel sedimentation tank prefilter (when it is required by the application)

Figure 106



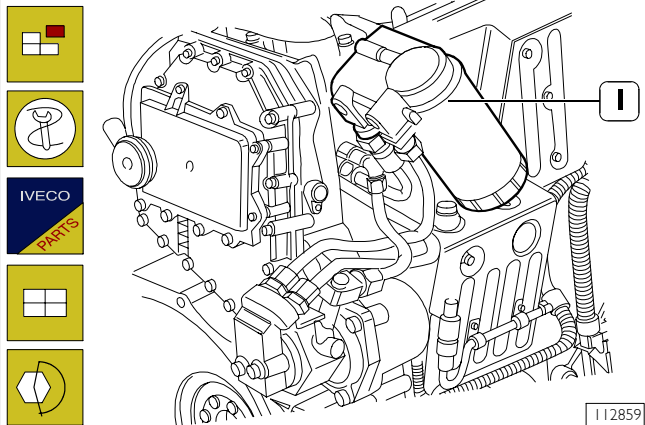
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Disconnect electric connector. Unlock prefilter (1) and change it. Before refitting a new cartridge, wet seal with fuel oil or engine oil. Lock cartridge by hand till in contact with support, then lock it by 3/4 of a rev. at predefined tightening torque.

NOTE At change, filter cartridge must not be prefilled to prevent circulating dirt that could damage injector/pump system components. Bleed air from fuel filter as described in previous pages.

Fuel filter change

Figure 107

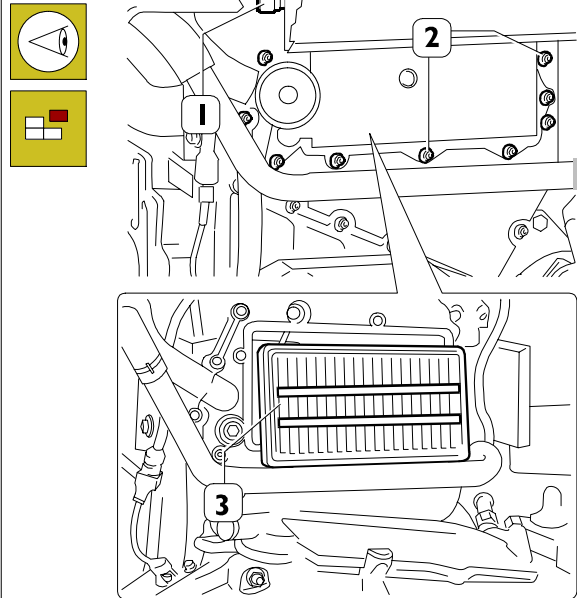


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Use tool 99360314 to remove fuel filter (1). Before fitting the new cartridge, wet seal with fuel oil or engine oil. Lock the new one by hand and carefully check that rubber seal and contact surface are clean and in perfect conditions. Lock cartridge by hand till contact with support and then lock it for 3/4 of a rev. at prescribed tightening torque. Bleed air from supply system as described in paragraph below:

Check Blow-by filter conditions by means of a clogging indicator

Figure 108

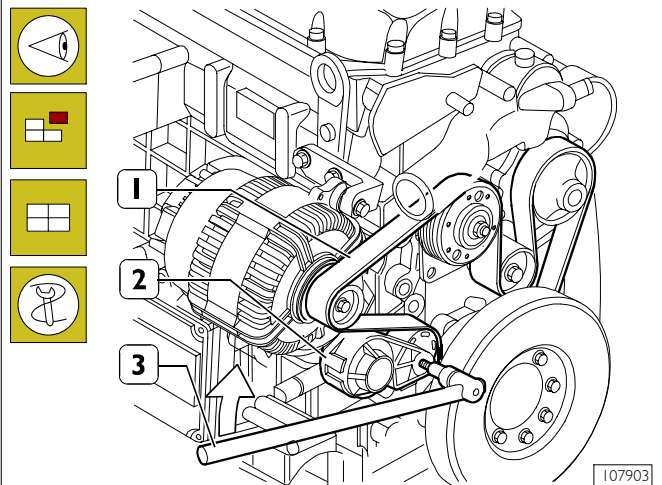


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- Check filter (3) conditions by means of a clogging indicator (1). In case the red area appears, change it.
- For screw (2) change, remove carter, pull out filter (3) and replace it with a new one. Filter has a one-way operation, therefore it must be installed with the two reinforcement bars visible, as shown in the picture.

Check of water pump/alternator control belt condition

Figure 109



107903

Visually check that belt (1) is not worn out or broken; change it as described below, if required.

Water pump/alternator control belt change

In order to remove and refit belt (1), operate using a specific tool (3) on belt tensioner (2) in direction shown by arrow.

NOTE Belt tensioner is automatic and requires no adjustment.

Check for any water in the fuel filter

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

Take prompt action on the filter to drain off the water in the fuel circuit.

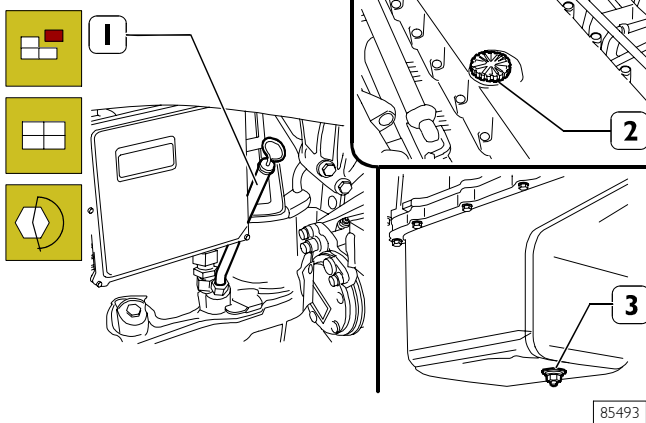
Fuel filter is equipped with pump screw-valve to drain the water eventually mixed with fuel.

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


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

Engine oil change

Figure 110



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


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

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

- Place a proper container for the oil collecting under the pan connected with the drain plug (3).
- Unscrew the plug (3) and then take out the control dipstick (1) and the inserting plug (2) to ease the downflow of the lubrication oil.

 The oil motor is very pollutant and harmful.

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

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

Dispose of the residual properly following the rules.

Lock plus (3) under oil sump at predefined tightening torque. Pour oil in prescribed quantity and quality in engine through filler (2) of tappet cover.

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

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

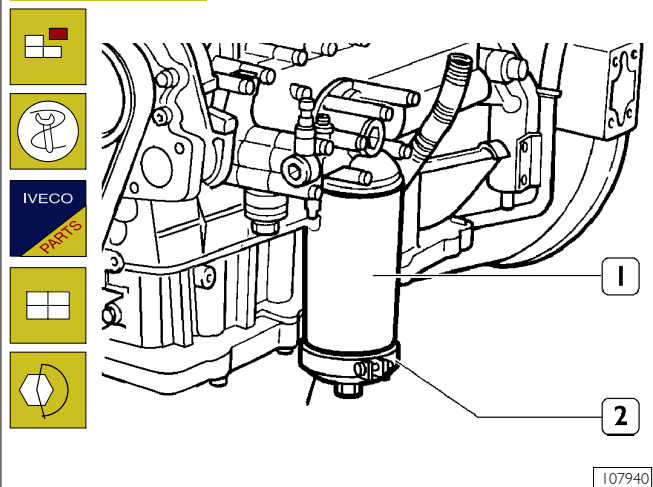
In case of topping up, don't mix oils having different features.

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

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


Engine oil filter change

Figure 111



Drain oil as described in "Engine oil change" chapter. Use tool 99360314 (2) to remove the oil filter (1).

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

 Place properly a container for the liquid.

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

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

NOTE Before refitting the new cartridge, wet seal using engine oil.

Lock oil filter (1) by hand till contact to support and then lock by $\frac{3}{4}$ of a rev. at prescribed tightening torque; pour oil in engine as described in "Engine oil change" chapter.

Valve lash check a adjustment

For correct operation, follow instructions contained in related chapter in section 3 – Industrial Applications.

Change dry air filter and clean its container

Refit container cover, remove cartridge from air filter.
Carefully clean container inside, insert new cartridge and refit cover.


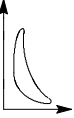
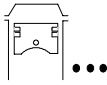
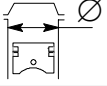
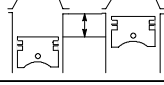
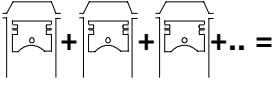
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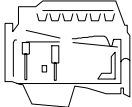
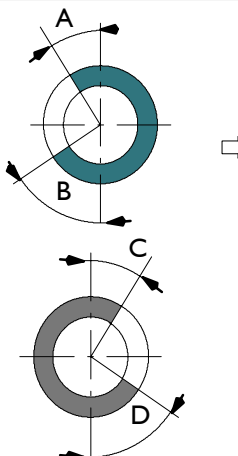
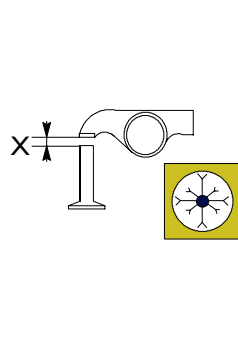
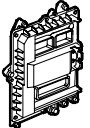
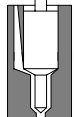
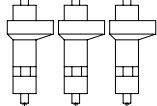
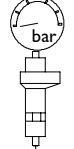
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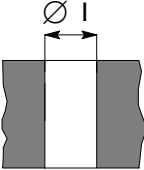
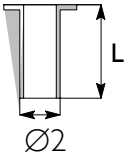


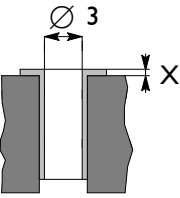
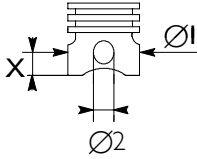
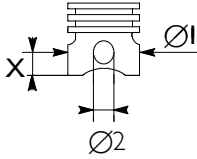


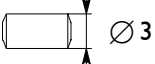
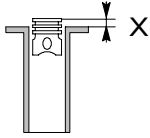
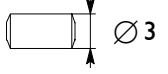

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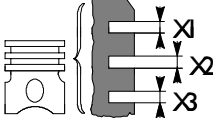
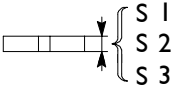


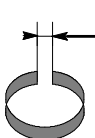
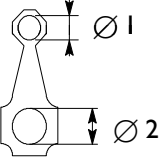
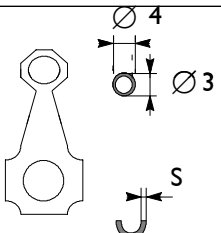



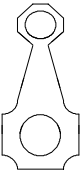
GENERAL CHARACTERISTICS

	Type	F2B	
	Cycle	Diesel 4 strokes	
	Feeding	Turbocharged	
	Injection	Direct	
	N. of cylinders	6 on-line	
	Diameter	mm	115
	Stroke	mm	125
	Total displacement	cm ³	7790

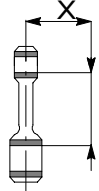
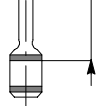
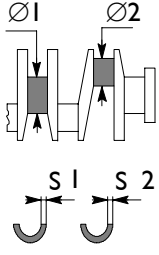
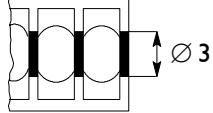


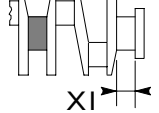
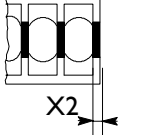
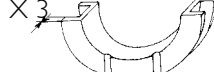

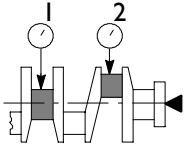
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	<p>VALVE TIMING</p> <p>opens before T.D.C. A</p> <p>closes after B.D.C. B</p> <p>opens before B.D.C. D</p> <p>closes after T.D.C. C</p>		<p>17°</p> <p>31°</p> <p>48°</p> <p>9°</p>
	<p>For timing check</p> <p>Running</p> <p>X</p> <p>X</p>	<p>{ mm</p> <p>{ mm</p> <p>{ mm</p> <p>{ mm</p>	<p>-</p> <p>-</p> <p>0.40 to 0.50</p> <p>0.40 to 0.50</p>
	<p>FEED</p> <p>Injection type: Bosch</p>	<p>Through fuel pump - filters</p> <p>With electronically regulated injectors PDE 30 pump injectors controlled by overhead camshaft MS6.2 ECU</p>	
	<p>Nozzle type</p>	<p>DLLA 143P894</p>	
	<p>Injection order</p>	<p>1 - 4 - 2 - 6 - 3 - 5</p>	
	<p>Injection pressure bar</p> <p>Injector calibration bar</p>	<p>1500</p> <p>-</p>	

ASSEMBLY CLEARANCE DATA

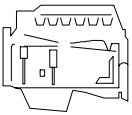
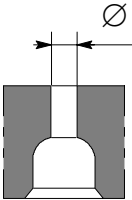
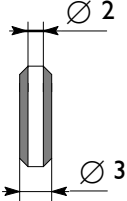




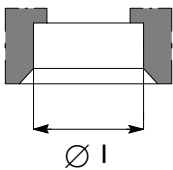
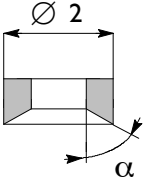
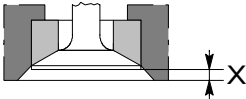

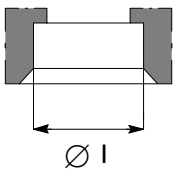


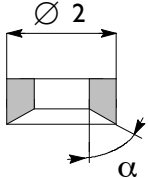


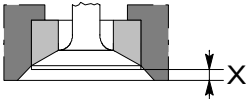





	Type	F2B
CYLINDER BLOCK AND CRANK MECHANISM COMPONENTS		mm
	Cylinder sleeve bore upper $\varnothing 1$ lower	130.200 to 130.225 128.510 to 128.535
	Cylinder liners: outer diameter: upper $\varnothing 2$ lower length L	130.161 to 130.186 128.475 to 128.500
	Cylinder sleeve - crankcase bore upper lower	0.014 to 0.064 0.010 to 0.060
		Outside diameter $\varnothing 2$
	Cylinder sleeve inside diameter $\varnothing 3$ A* inside diameter $\varnothing 3$ B* Protrusion X	115.000 to 115.012 115.010 to 115.022 0.035 to 0.065
* Available dia. class		
	Pistons: measuring dimension X outside diameter $\varnothing 1$ A• outside diameter $\varnothing 1$ B•• outside diameter $\varnothing 2$	18 114.888 to 114.900 114.898 to 114.910 46.010 to 46.018 114.898 to 114.910
<ul style="list-style-type: none"> • Class A pistons supplied as spares. •• Class B pistons are fitted in production only and are not supplied as spares. 		
	Piston - cylinder sleeve	0.100 to 0.124
		Piston diameter $\varnothing 1$
	Pistons protrusion X	-
	Gudgeon pin $\varnothing 3$	45.994 to 46.000
	Gudgeon pin - pin housing	0.010 to 0.024

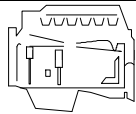
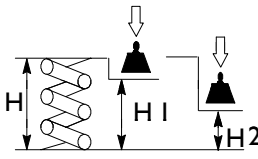
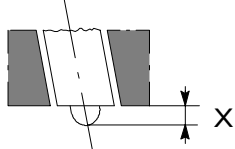
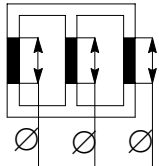
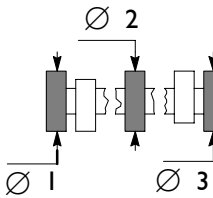
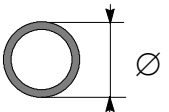
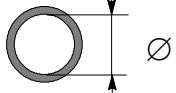


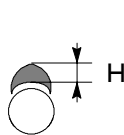
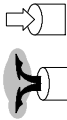
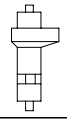
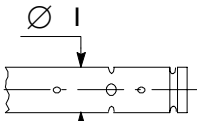
		F2B	
		mm	
	Type		
	Piston ring grooves	X1* X2 X3	2.71 to 2.74 2.55 to 2.57 4.02 to 4.04
		*measured on Ø of 112 mm	
	Piston rings: trapezoidal seal	S1*	2.575 to 2.595
	lune seal	S2	2.470 to 2.490
	milled scraper ring with slits and internal spring	S3	3.975 to 3.990
		*measured on Ø of 112 mm	
	Piston rings - grooves	1 2 3	0.115 to 0.165 0.060 to 0.100 0.030 to 0.065
	Piston rings		-
	Piston ring end gap in cylinder liners:	X1 X2 X3	0.35 to 0.50 0.70 to 0.95 0.30 to 0.60
	Small end bush housing	Ø1	49.975 to 50.000
	Big end bearing housing	Ø2	77.000 to 77.030
	Selection classes Ø2	1 2 3	77.000 to 77.010 77.010 to 77.020 77.020 to 77.030
	Small end bush diameter outside	Ø4	50.055 to 50.080
	inside	Ø3	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		g.
	Class	A	2865 to 2895
		B	2896 to 2925
		C	2926 to 2955

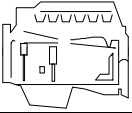
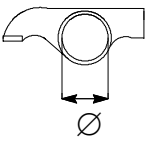

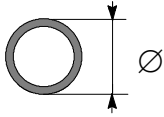
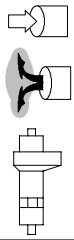
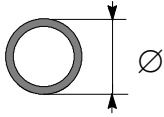


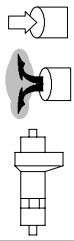
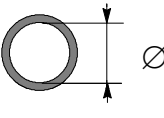
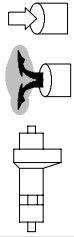
- Fitted in production only and not supplied as spares

		F2B	
		mm	
	Measuring dimension X	X	125
	Max. connecting rod axis misalignment tolerance	≡	0.08
	Main journals	∅1	82.910 to 82.940
	- nominal		82.910 to 82.919
	- class 1	1	82.920 to 82.929
	- class 2	2	82.930 to 82.940
	- class 3	3	
	Crankpins	∅2	72.915 to 72.945
	- nominal		72.915 to 72.924
	- class 1	1	72.925 to 72.934
	- class 2	2	72.935 to 72.945
	- class 3	3	
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	∅3	89.000 to 89.030
	- nominal		89.000 to 89.009
	- class 1	1	89.010 to 89.019
	- class 2	2	89.020 to 89.030
	Bearing shells - main journals ○		0.040 to 0.098 * - 0.040 to 0.0110 **
	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 40.04
	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 0.34
	Alignment	≡ 1 - 2	≤ 0.05
	Ovality	○ 1 - 2	_0.010
	Taper	∠ 1 - 2	0.010

● Fitted in production only and not supplied as spares
 ○ Spares provided: * = standard spares - 0.127; ** = 0.254 - 0.508

 Type	F2B	
CYLINDER HEADS - VALVE TRAIN		
mm		
 Valve guide housings in cylinder head	Ø 1	12.980 to 12.997
 Valve guide	Ø 2  Ø 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	>	-
 Valves:	 Ø 4 α  Ø 4 α	7.970 to 8.985 $60^{\circ} 30' \pm 7' 30''$ 7.970 to 8.985 $45^{\circ} + 15'$
 Valve stem and its guide		0.038 to 0.068
 Housing in head for valve seat	 Ø 1  Ø 1	41.985 to 42.020 40.985 to 41.020
 Outside diameter of valve seat; angle of valve seat in cylinder head:	 Ø 2 α  Ø 2 α	42.060 to 42.075 $60^{\circ} - 30'$ 41.060 to 41.075 $45^{\circ} - 30'$
 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	F2B
		mm
	Valve outside spring height: free height H under a load of: N 454 ± 22 H1 N 840 ± 42 H2	63.6 49.5 37.5
	Injector protrusion X	0.7
	Camshaft bush housing fitted in the cylinder head: I ⇒ 7 ∅	80.000 to 80.030
	Camshaft journal diameter: I ⇒ 7 ∅	75.924 to 75.940
	Camshaft bushing outer diameter: ∅	80.090 to 80.115
	Camshaft bushing inner diameter: ∅	75.990 to 76.045
	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
		8.82
	Rocker shaft ∅ I	37.984 to 38.000

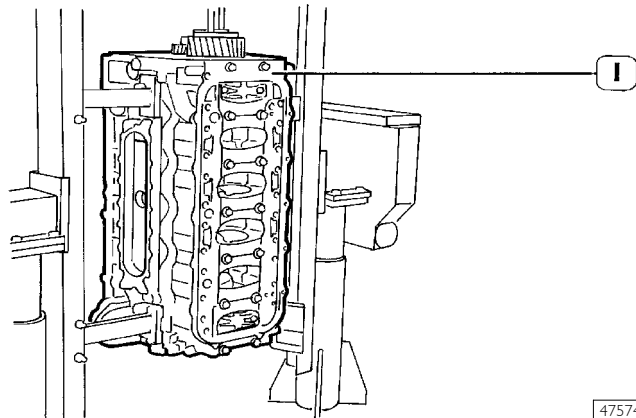
 Type	F2B mm
Bushing housing in rocker arms  	41.000 to 41.016 41.000 to 41.016 42.000 to 42.016
Bushing outer diameter for rocker arms:  	41.097 to 41.135 41.097 to 41.135 42.066 to 42.091
Bushing inner diameter for rocker arms:  	38.025 to 38.041 38.025 to 38.041 38.015 to 38.071
Between bushings and housings  	0.081 to 0.135 0.081 to 0.135 0.050 to 0.091
Between rocker arms and shaft  	0.025 to 0.057 0.225 to 0.057 0.015 to 0.087
TURBOCHARGER Type End float Radial play	HOLSET HX40W 0.025 to 0.127 0.254 to 0.356

ENGINE OVERHAUL ENGINE REMOVAL AT THE BENCH

The following instructions are prescribed on the understanding that the engine has previously been placed on the rotating bench and that removal of all specific components of the equipment have been already removed as well. (See Section 3 of the manual herein).

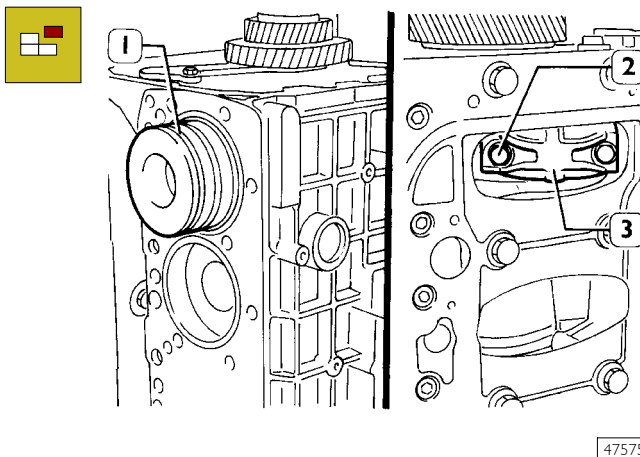
The section illustrates therefore all the most important engine overhaul procedures.

Figure 1



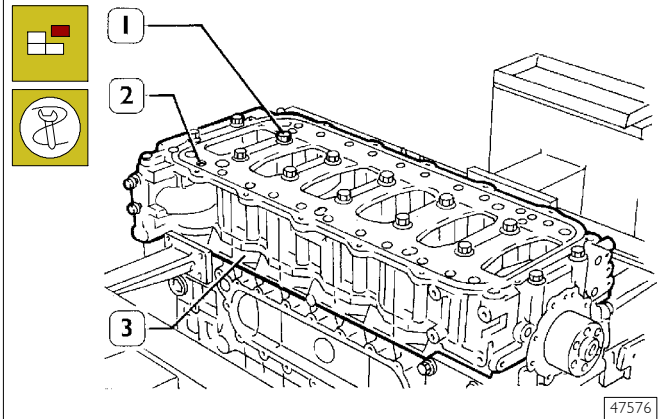
Rotate the block (1) to the vertical position.

Figure 2



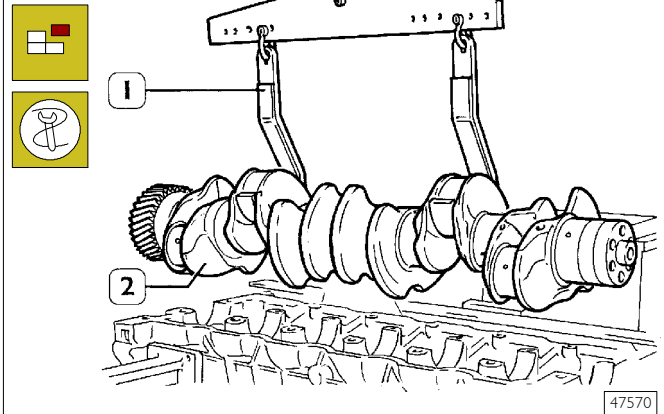
Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston assembly from the upper side. Repeat these operations for the other pistons.

Figure 3



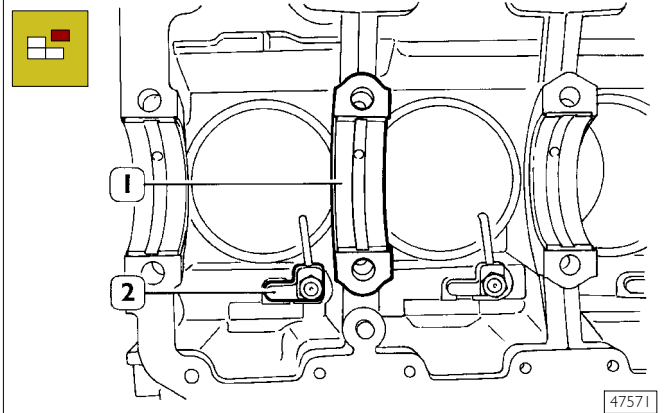
By means of proper and splined wrenches, untighten the screws (1) and (2) and remove the under-block (3).

Figure 4



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

Figure 5



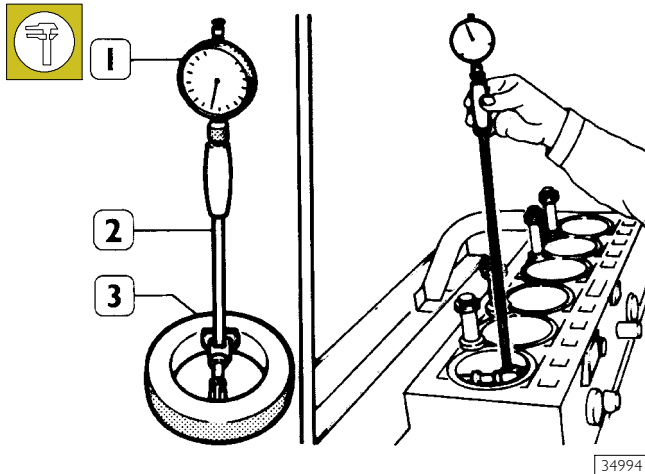
Remove the crankshaft half-bearings (1), untighten the screws and remove oil spray nozzles (2). Take down cylinder liners as specified in the relative paragraph on page 14.

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.

REPAIR OPERATIONS CYLINDER BLOCK

Checks and measurements

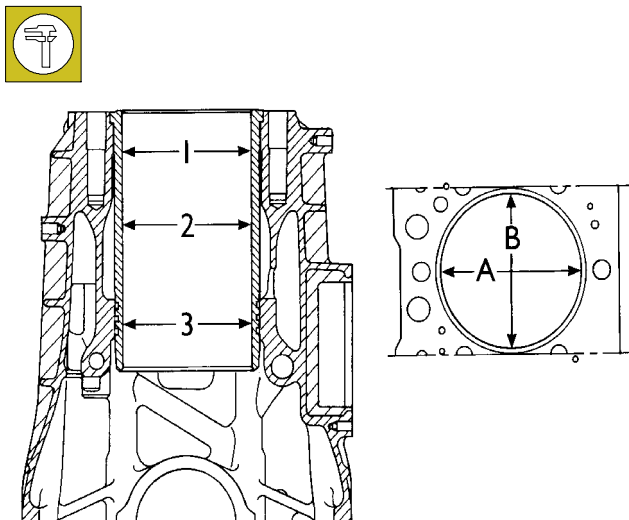
Figure 6 (Demonstration)



Internal diameter of the cylinder liners is checked for ovalization, taper and wear, using a bore dial (1) centesimal gauge 99395687 (2) previously reset to ring gauge (3), diameter 115 mm.

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

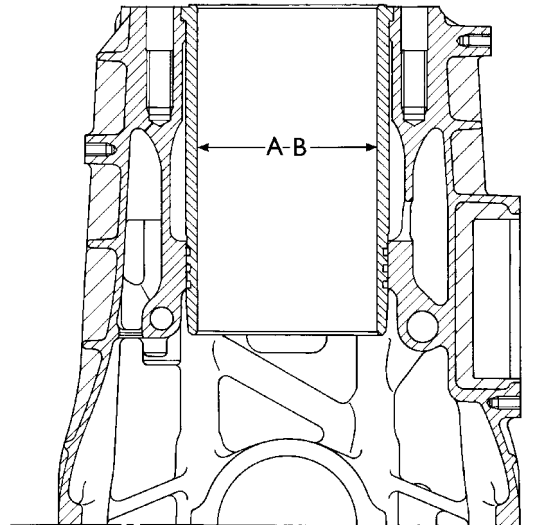
Figure 7



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

Carry out measurements on each cylinder liner at three different levels and on two (A-B) surfaces, to one another perpendicular, as shown in Figure 7.

Figure 8



- A = Selection class \varnothing 115 to 115.012 mm
B = Selection class \varnothing 115.010 to 115.022 mm

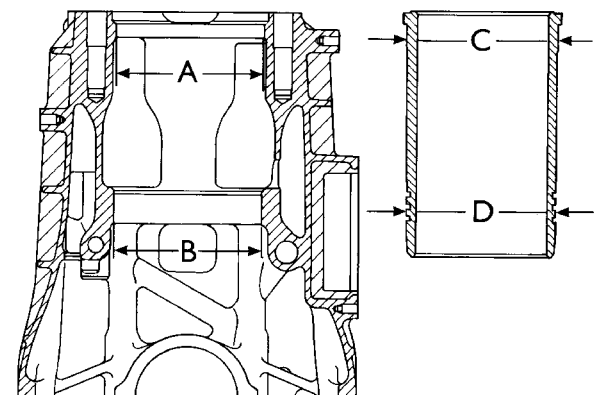
In case of maximum wear max 0.150 mm or maximum ovalization max 0.100 mm compared to the values indicated in the figure, the liners must be replaced as they cannot be ground, lapped or trued.

NOTE

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



Figure 9



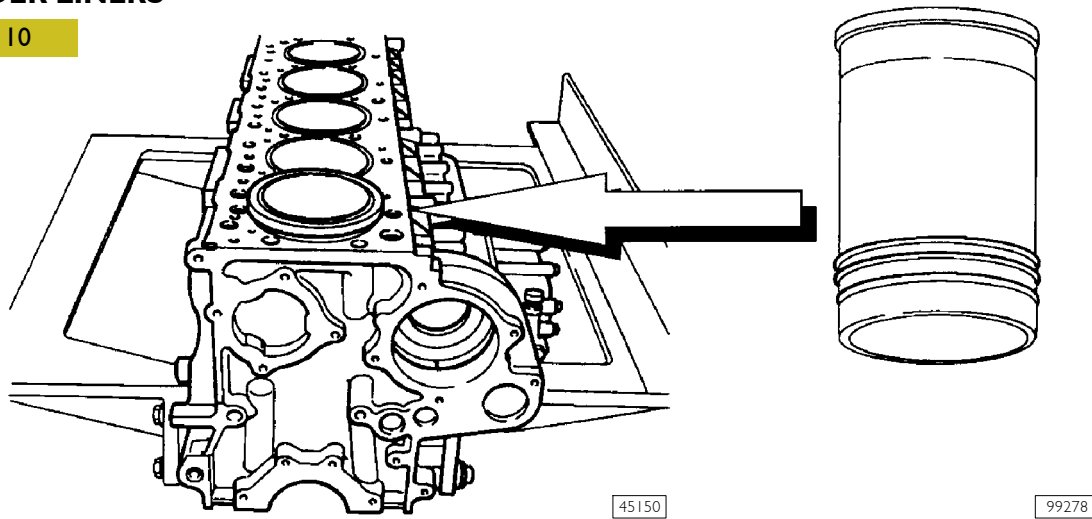
- A = \varnothing 130.200 to 130.225 mm
B = \varnothing 128.510 to 128.535 mm
C = \varnothing 130.161 to 130.186 mm
D = \varnothing 128.475 to 128.500 mm

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.

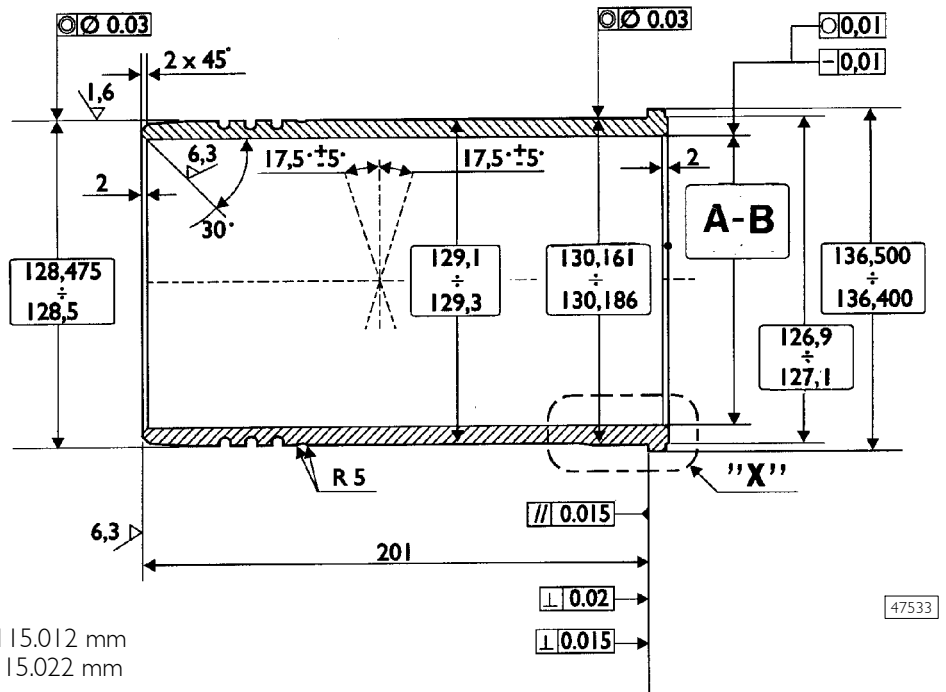
CYLINDER LINERS

Figure 10



BLOCK WITH CYLINDER LINERS

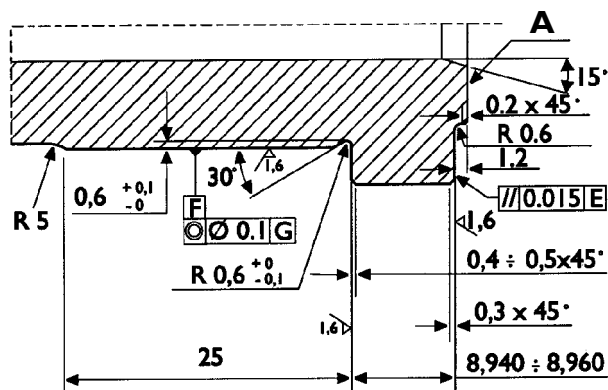
Figure 11



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

CYLINDER LINERS MAIN DATA

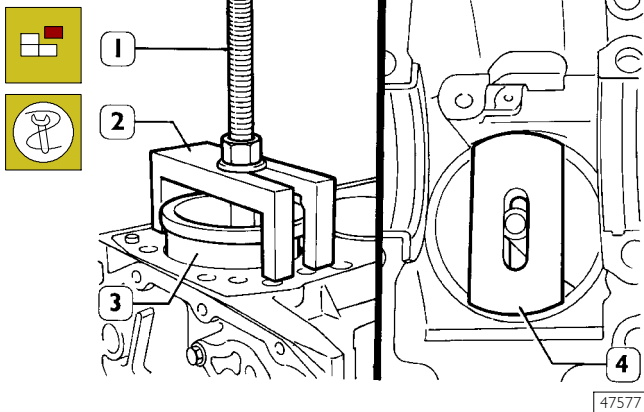
Figure 12



DETAIL "X"
"A" = Selection class marking area

Replacing cylinder liners Removal

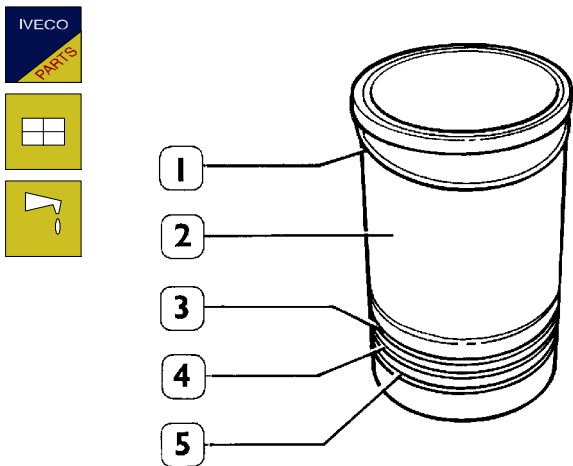
Figure 13



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 14

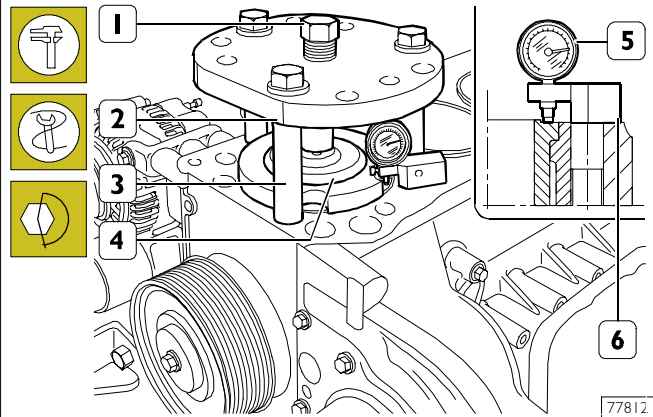


Always replace water sealing rings (3, 4 and 5). Install the adjustment ring (1) on the cylinder liner (2); lubricate lower part of liner and install it in the cylinder unit using the proper tool.

NOTE

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

Figure 15



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 16); otherwise replace the adjusting ring (1, Figure 14) fitted with spare parts having different thickness.

Figure 16

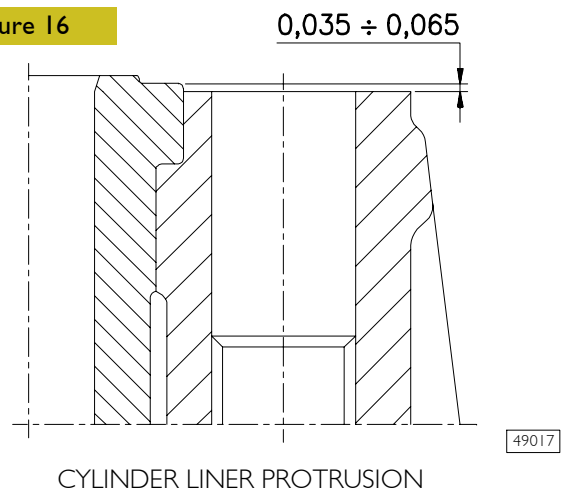
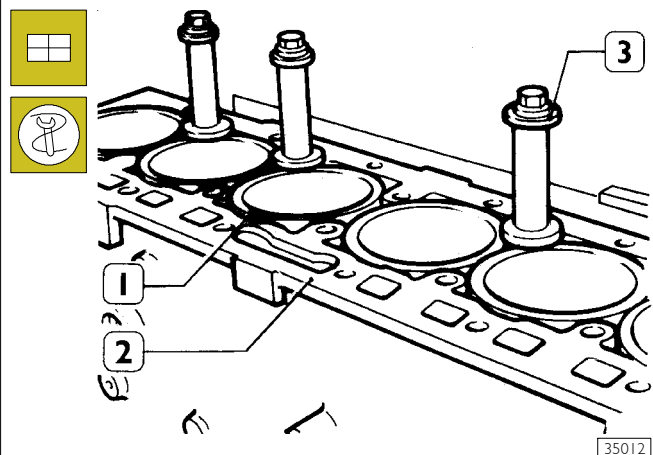


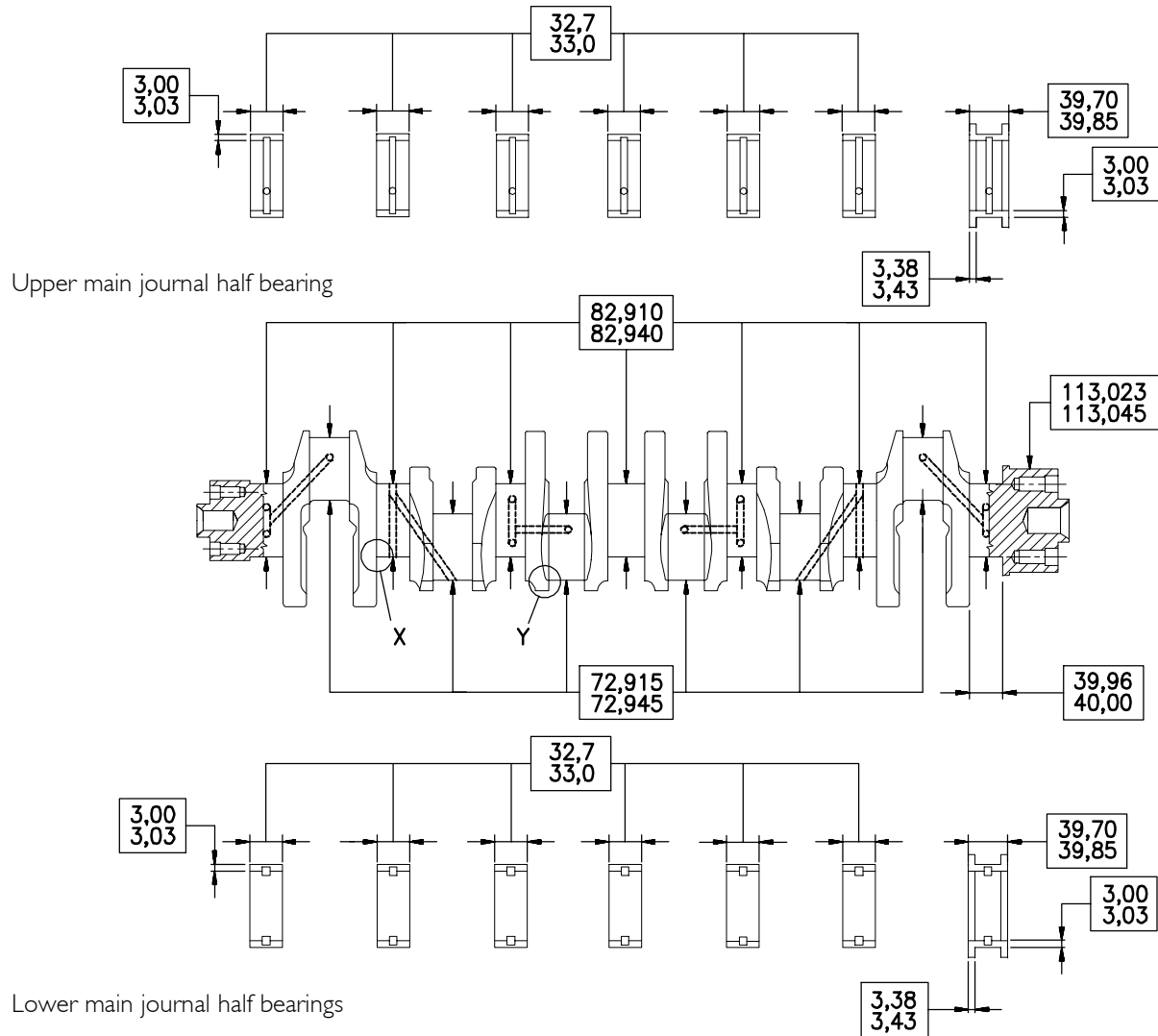
Figure 17 (Demonstration)



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

CRANKSHAFT

Figure 18

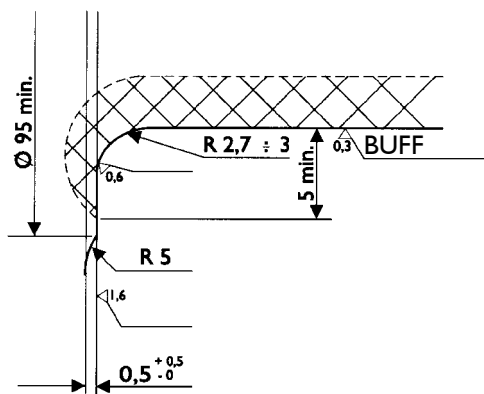


49018

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.

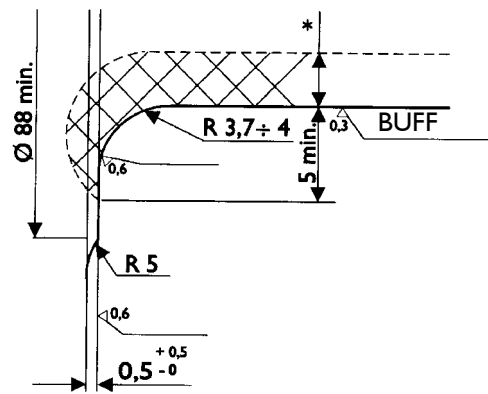
Figure 19



47537

X. Detail of main journals connections

Figure 20

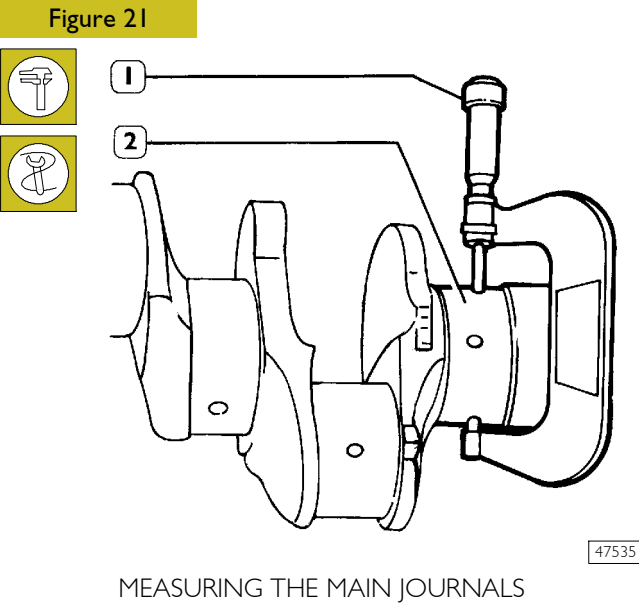


47538

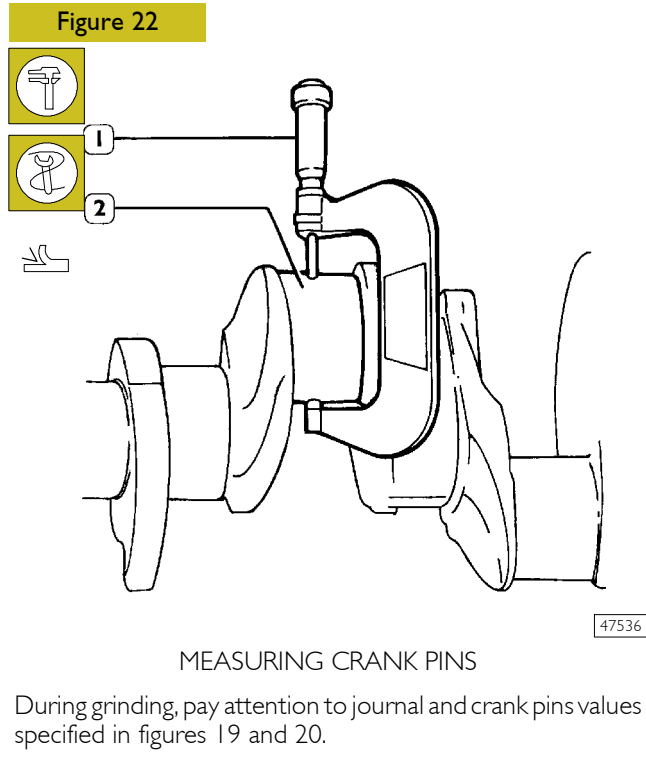
Y. Detail of crank pins connections

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.



NOTE It is advisable to enter the values found in a table (Figure 23).

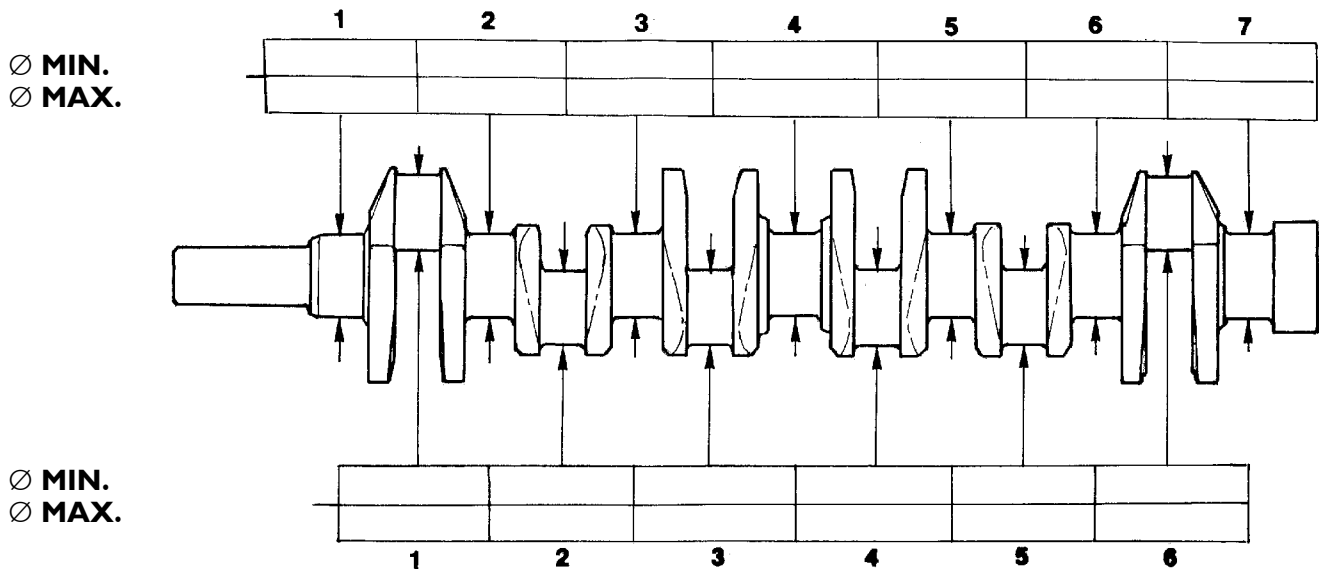


NOTE All journals and crank pins must also be ground to the same undersizing class, in order to avoid any alteration to shaft balance.

Figure 23

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:

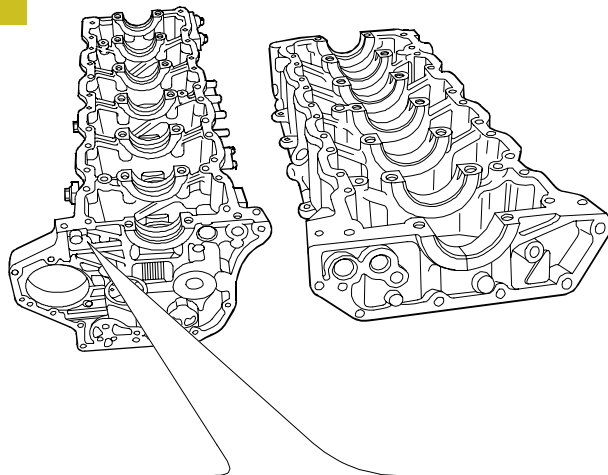
- Determine the class of diameter of the seat in the connecting rod.
- Determine the class of diameter of the crankpin.
- Select the class of the bearing shells to mount.

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

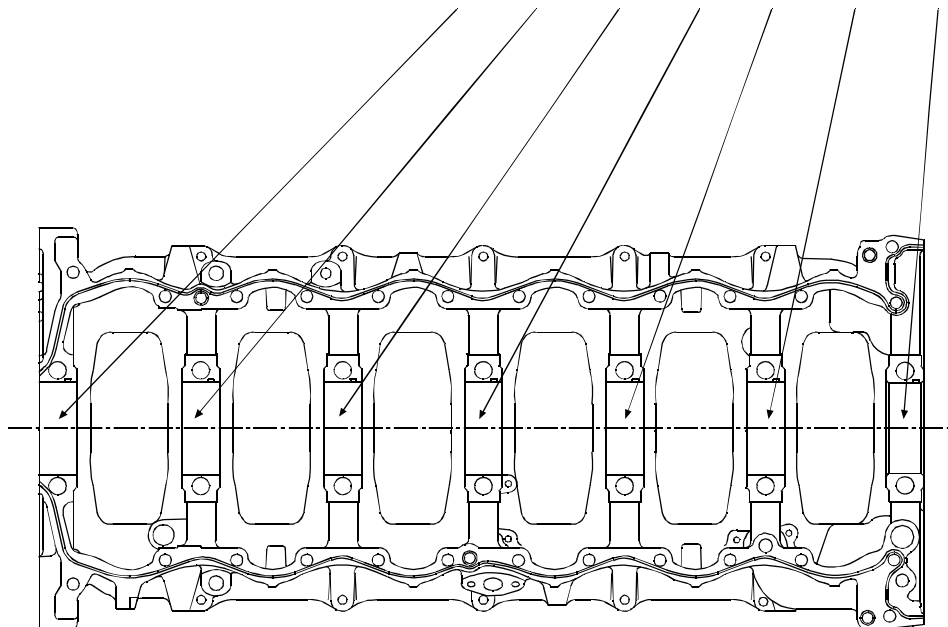
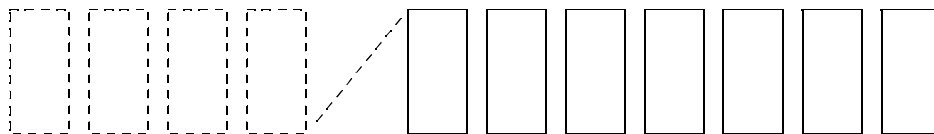
On the front of the crankcase, two sets of numbers are marked in the position shown (Figure 24 at top).

- 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 24 at bottom).
- Each of these digits may be **1**, **2** or **3**.

Figure 24



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.

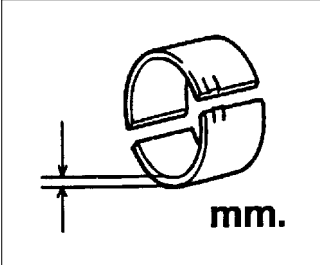
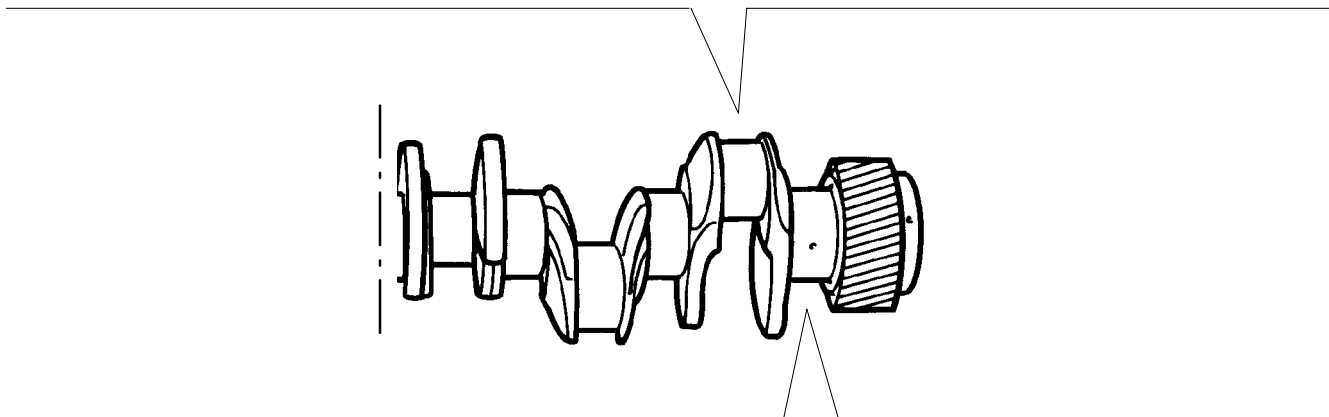
This operation makes it possible to identify the most suitable bearing shells for each of the journals (the bearing shells, if necessary, can have different classes from one journal to another).

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

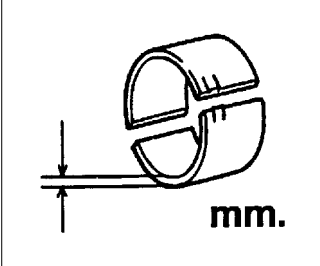
The following tables give the specifications of the main and big end bearing shells available as spares in the standard sizes (STD) and in the permissible oversizes (+0.127, +0.254, +0.508).

Figure 25

	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	3.254 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

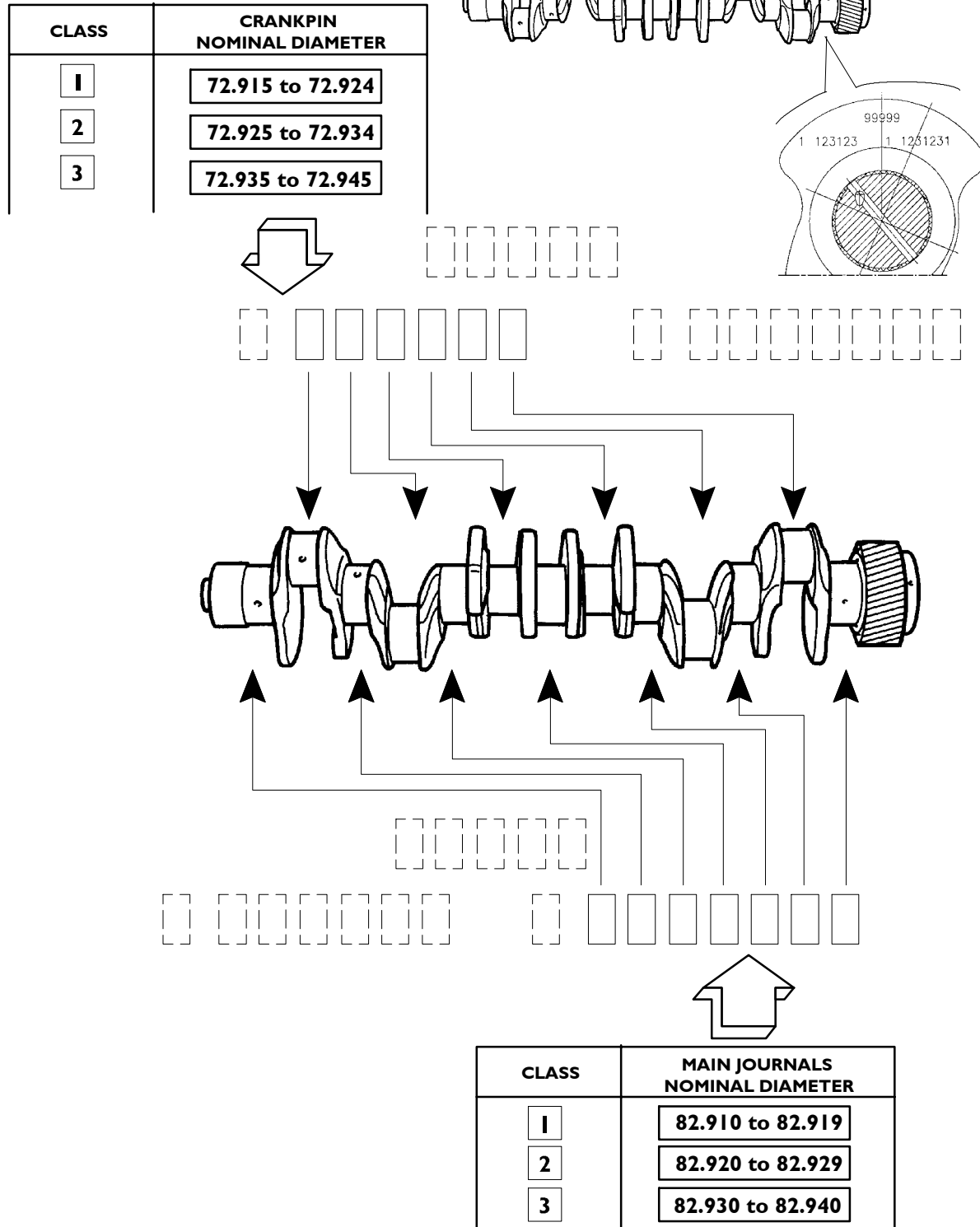
DEFINING THE CLASS OF DIAMETER OF THE MAIN JOURNALS AND CRANKPINS (Journals with nominal diameter)

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 26 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 26 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 26 at bottom).

Figure 26

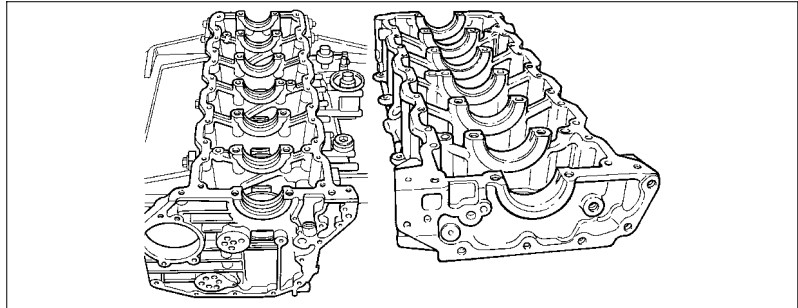


Selection of main half-bearings (nominal diameter pins)

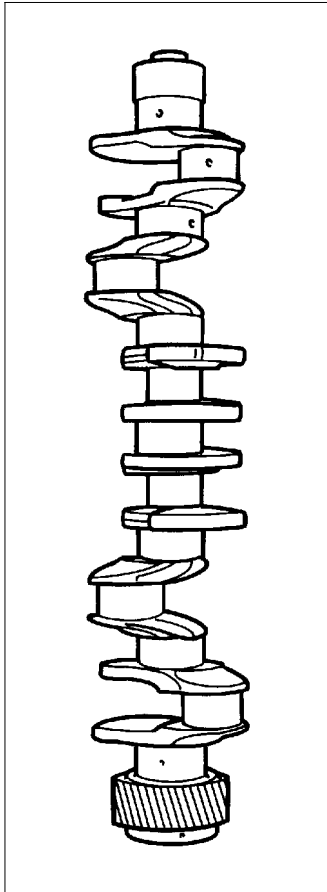
After detecting, for each journal, the necessary data on block and crankshaft, select the type of half-bearings to be used, in compliance with the following table:

Figure 27

STD.



1	2	3
----------	----------	----------



1	green	green	green
	green	green	green
2	red		green
	red		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.

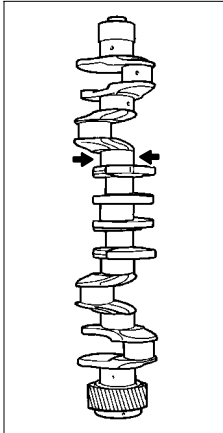
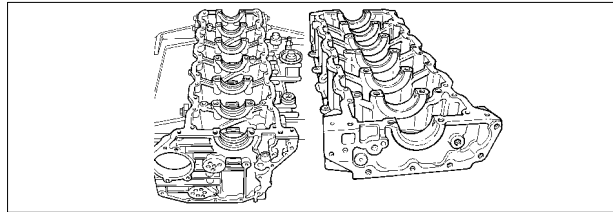
In this case, make sure that the new diameter of the journals is as specified on the table and install the only half-bearing type required for this undersizing.

Figure 28

red/black =
3.063 to 3.073 mm

green/black =
3.063 to 3.073 mm

-0.127



82.784
82.793

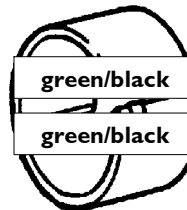
1
green/black
green/black

2
green/black
green/black

3
green/black
green/black

82.794
82.803

2
red/black
red/black



green/black
green/black

82.804
82.814

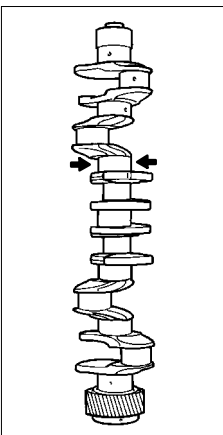
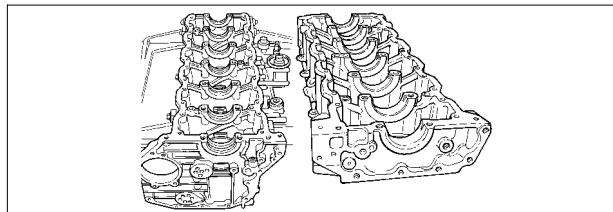
3
red/black
red/black

red/black
red/black

red/black
red/black

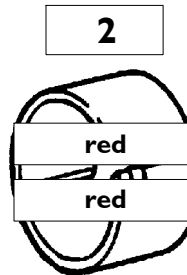
-0.254

red =
3.127 to 3.137 mm



82,666
82,686

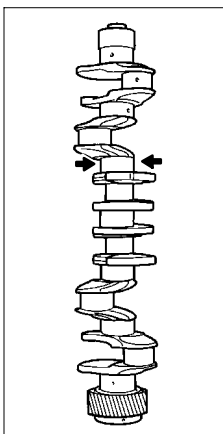
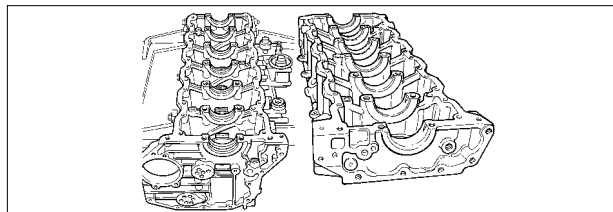
1
red
red



3
red
red

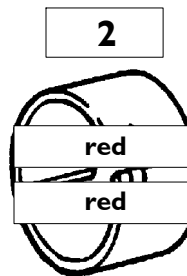
-0.508

red =
3.254 to 3.264 mm



82.412
82.432

1
red
red



3
red
red

SELECTING THE BIG END BEARING SHELLS (JOURNALS WITH NOMINAL DIAMETER)

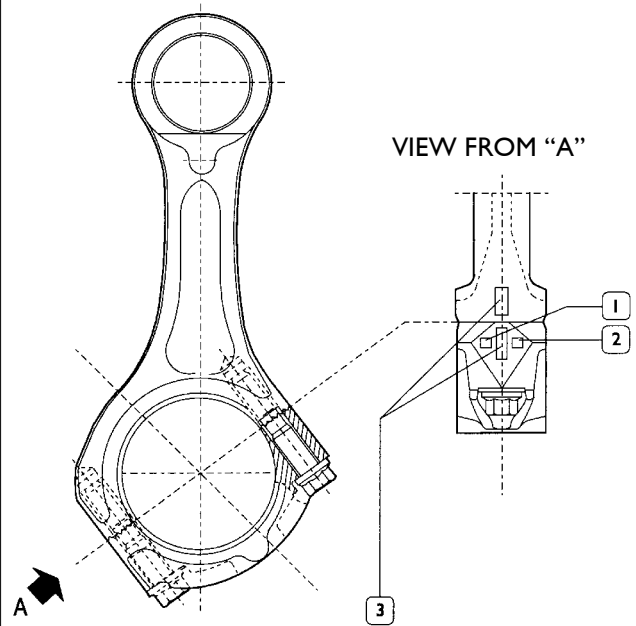
There are three markings on the body of the connecting rod in the position shown in the view from "A":

- 1 Letter indicating the class of weight:
 - A = 2865 to 2895 g.
 - B = 2896 to 2925 g.
 - C = 2926 to 2955 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 30).

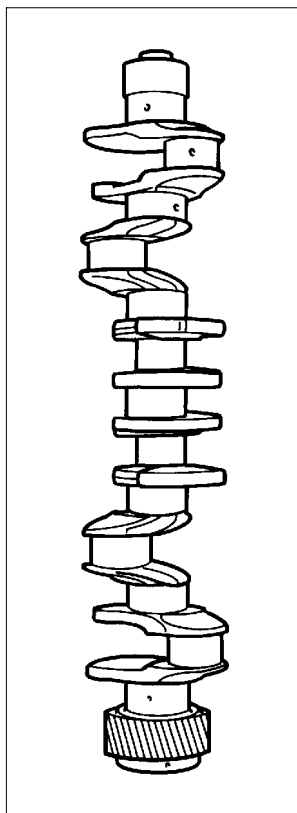
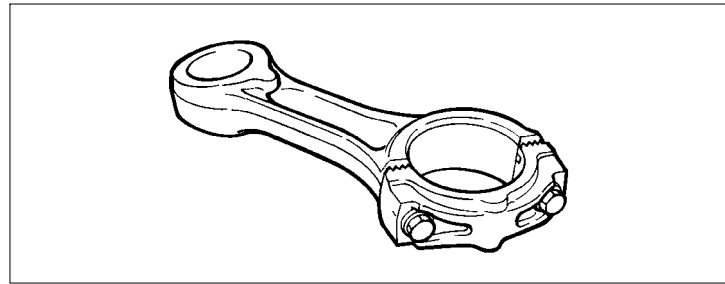
Figure 29



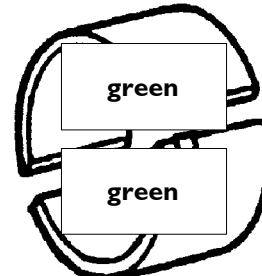
47557

Figure 30

STD.



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

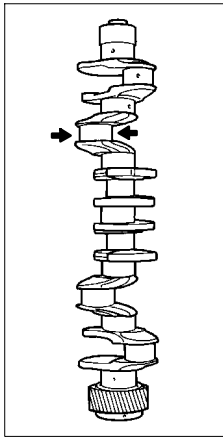
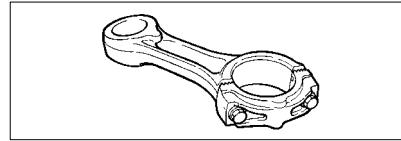
In this case, (for each undersizing) determine the tolerance field the new big end pins belong to, and install the half-bearings identified according to the relative table.

Figure 31

red/black =
2.074 to 2.083 mm

green/black =
2.063 to 2.073 mm

-0.127



72.789
72.798

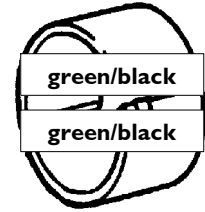
1
green/black
green/black

2
green/black
green/black

3
green/black
green/black

72.799
72.808

2
red/black
red/black



green/black
green/black

72.809
72.818

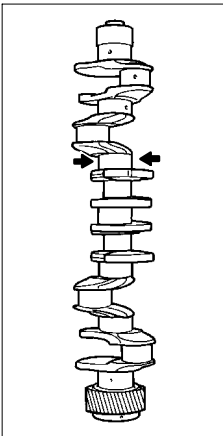
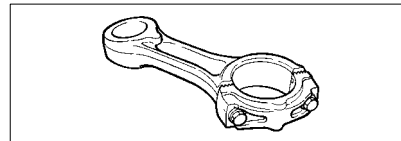
3
red/black
red/black

red/black
red/black

green/black
green/black

-0.254

red
2.127 to 2.137 mm
green =
2.138 to 2.147 mm



72.671
72.680

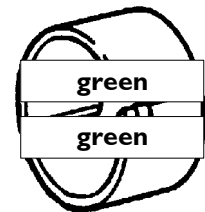
1
red
red

2
green
green

3
green
green

72.681
72.691

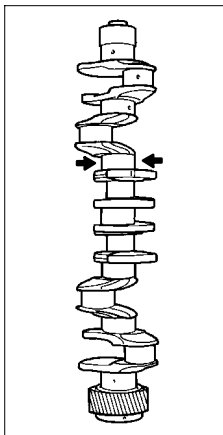
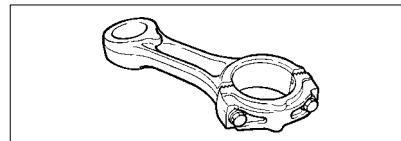
red
red



green
green

-0.508

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



72.417
72.426

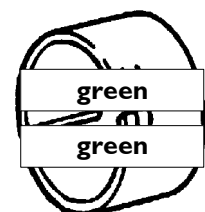
1
red
red

2
green
green

3
green
green

72.427
72.437

red
red

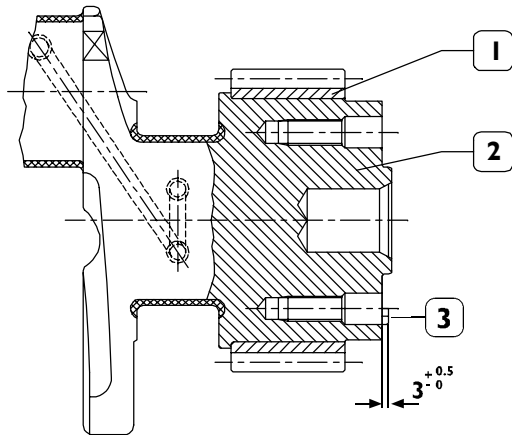


green
green

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 32



49020

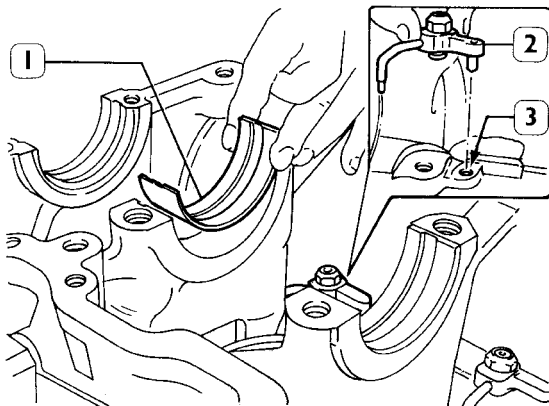
After fitting the gear (1) on the crankshaft (2), heat it for ~15 minutes in an oven at temperature not higher than 180°C.

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 33

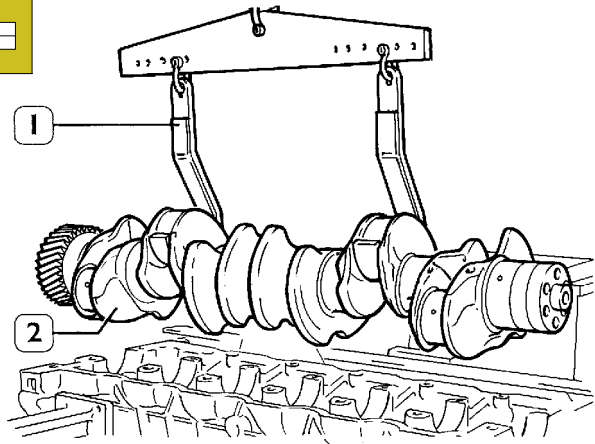


47579

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.

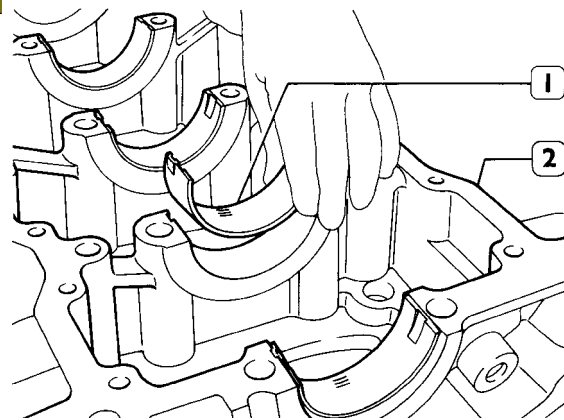
Figure 34



47578

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

Figure 35

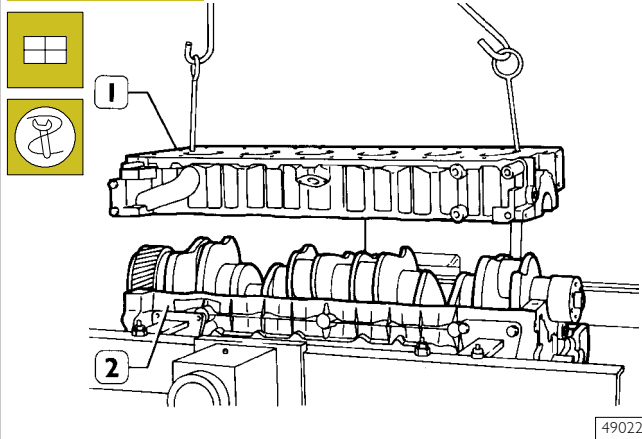


49021

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 36



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 38

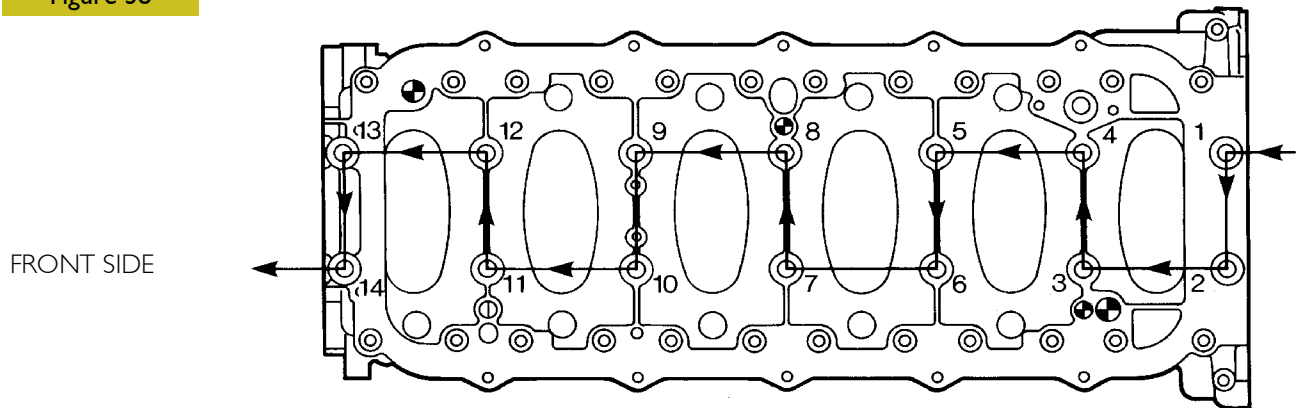
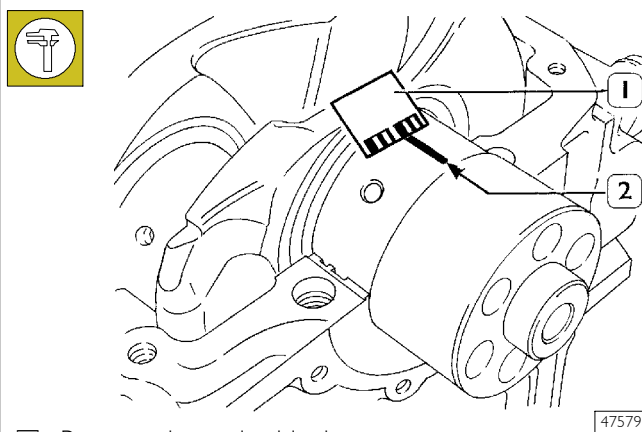


Diagram showing the tightening order of the screws fixing the lower under-block to the block

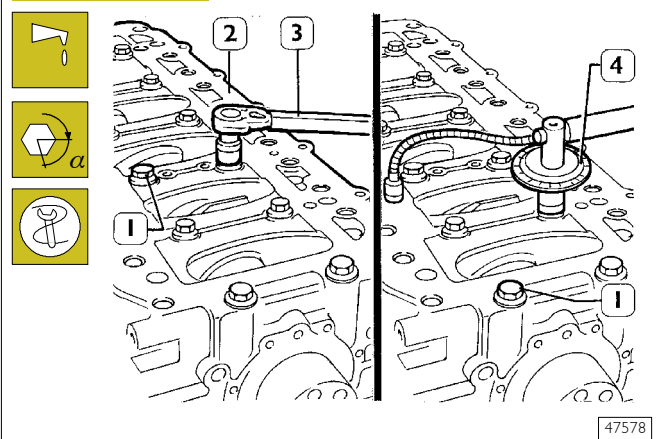
Figure 39



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.

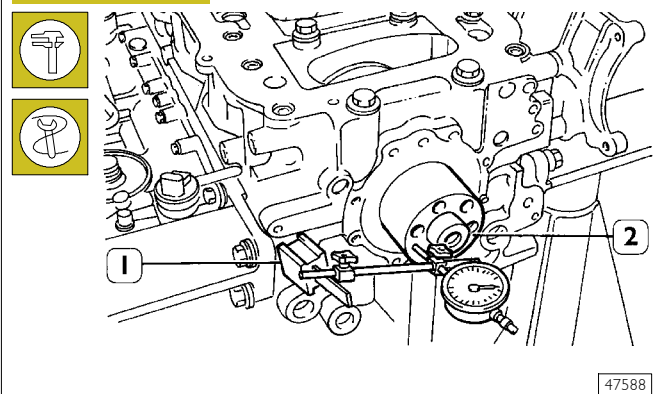
Figure 37



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

Checking crankshaft end float

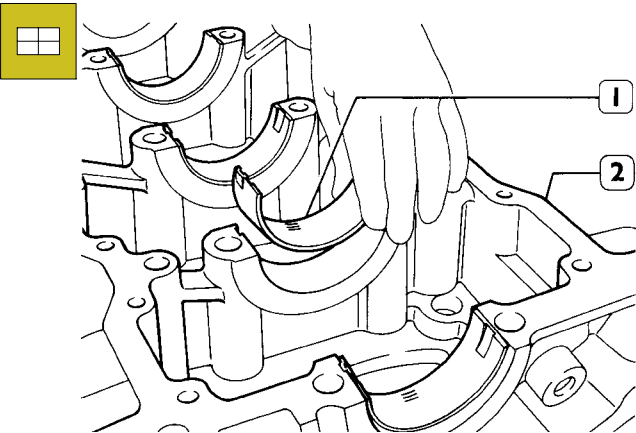
Figure 40



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.

ASSEMBLING THE ENGINE ON THE BENCH

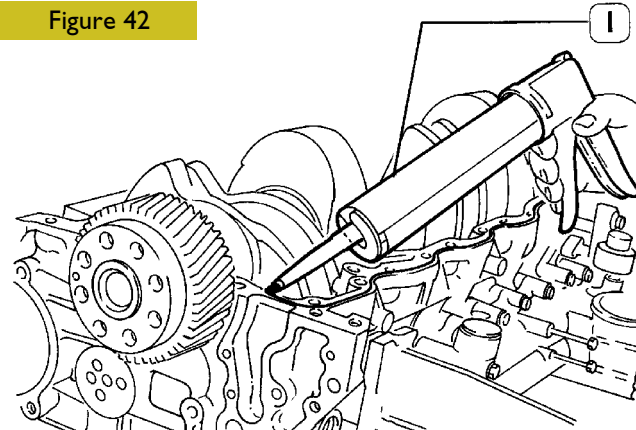
Figure 41



49021

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

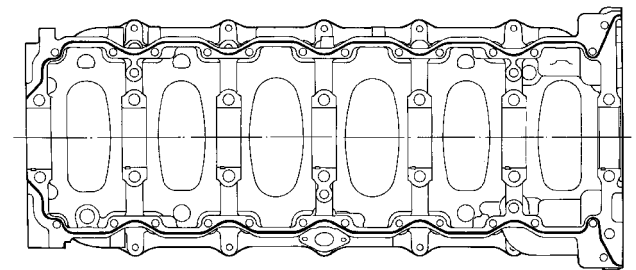
Figure 42



47595

By means of suitable equipment (1) apply silicone LOCTITE 5970 IVECO No. 2992644 to the block, as shown in the figure.

Figure 43

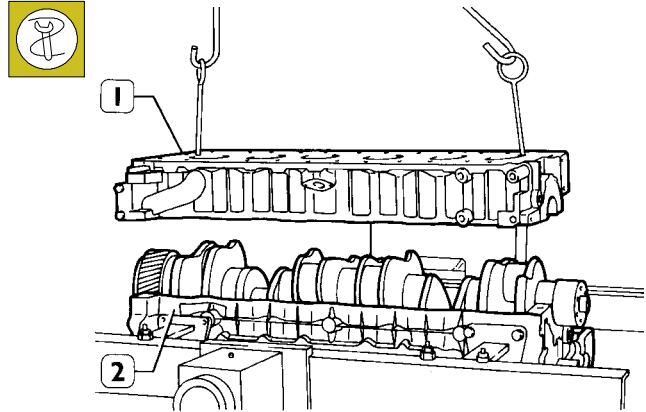


47596

Sealant application diagram

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

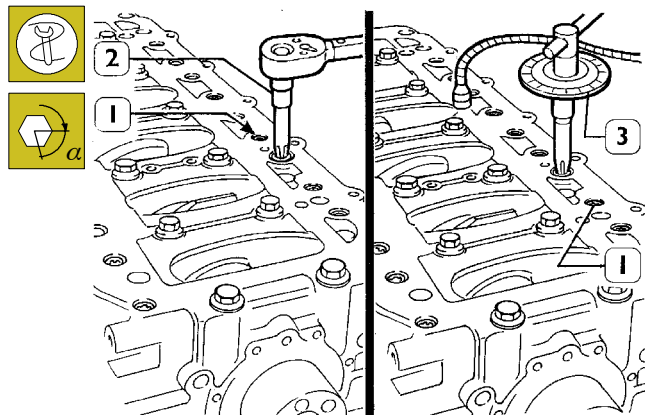
Figure 44



49022

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

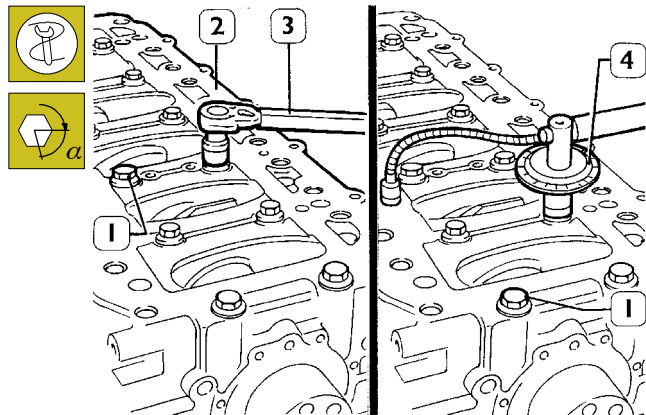
Figure 45



47581

Fit the sub-engine block and use a dynamometric wrench (2) to tighten the outer hexagonal-grooved screws (1) to 25 Nm according to the diagrams on the following page.

Figure 46



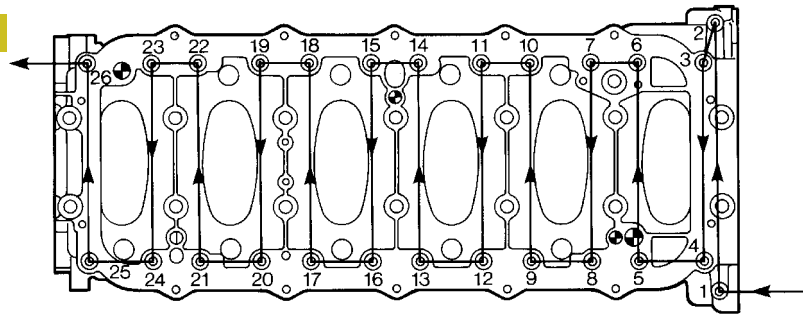
47579

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 45) with 90° angular closing, using tool 99395215 (3, Figure 45).

DIAGRAM SHOWING THE UNDERBLOCK FIXING SCREWS TIGHTENING ORDER

Figure 47

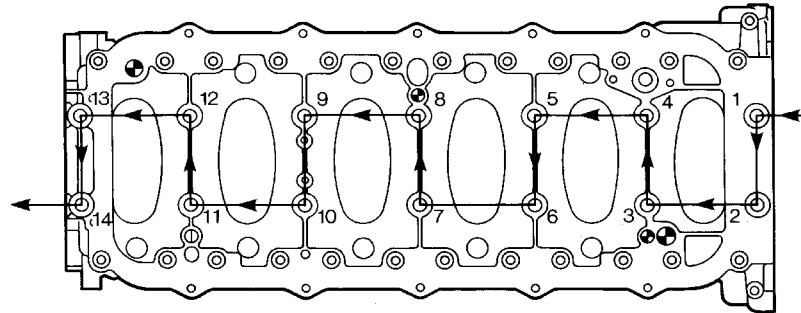
FRONT SIDE



First phase: outer screws preliminary tightening (25 Nm)

44897

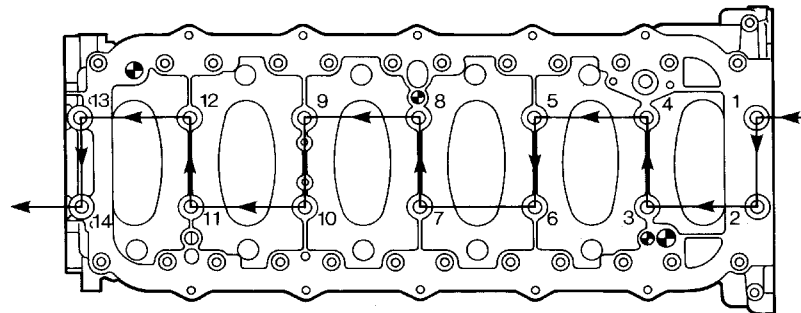
FRONT SIDE



Second phase: inner screws preliminary tightening (140 Nm)

44898

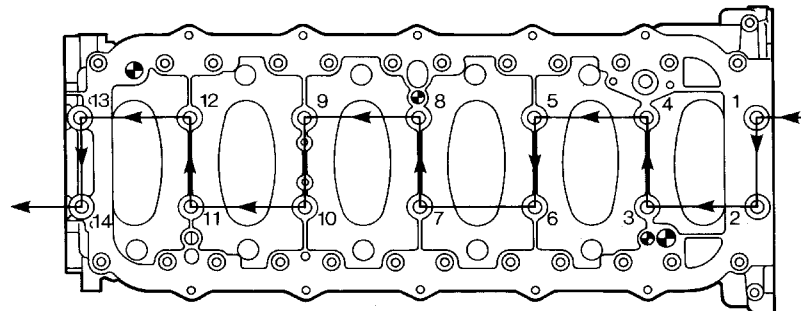
FRONT SIDE



Third phase: inner screws angle closing (60°)

44898

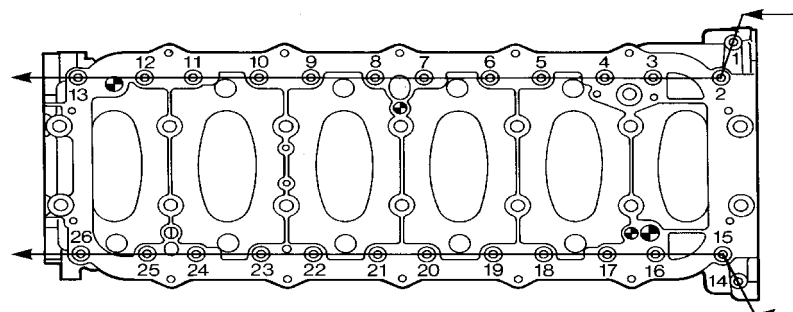
FRONT SIDE



Fourth phase: inner screws angle closing (60°)

44898

FRONT SIDE

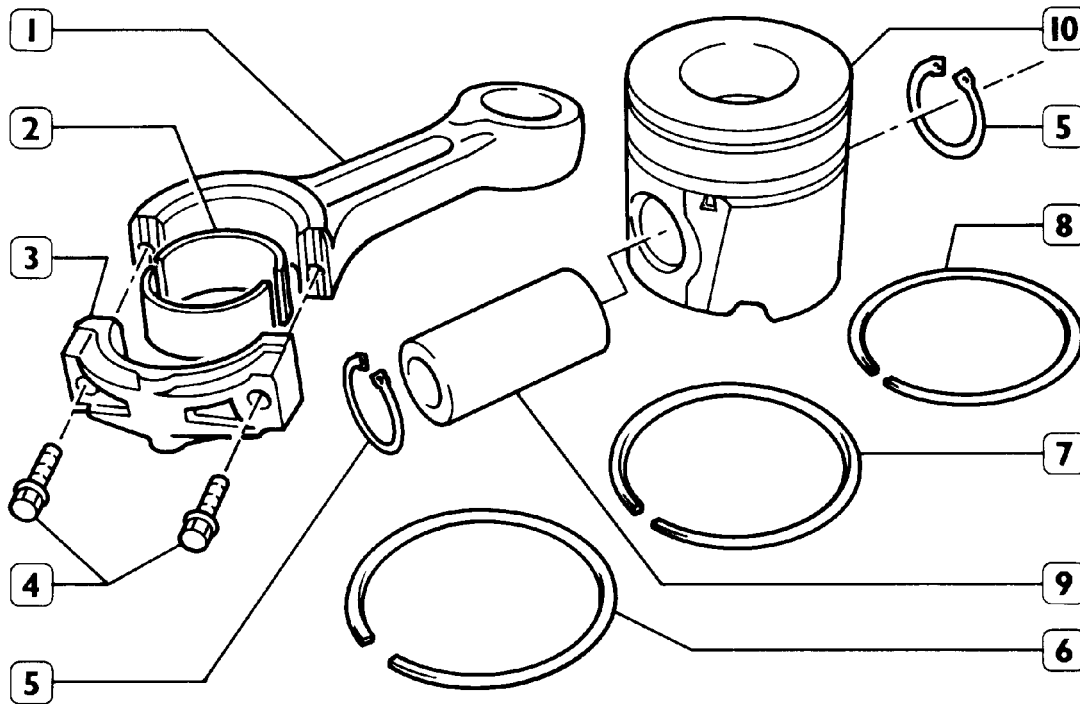


Fifth phase: outer screws angle closing (90°)

44899

PISTON-CONNECTING ROD ASSEMBLY

Figure 48



47580

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

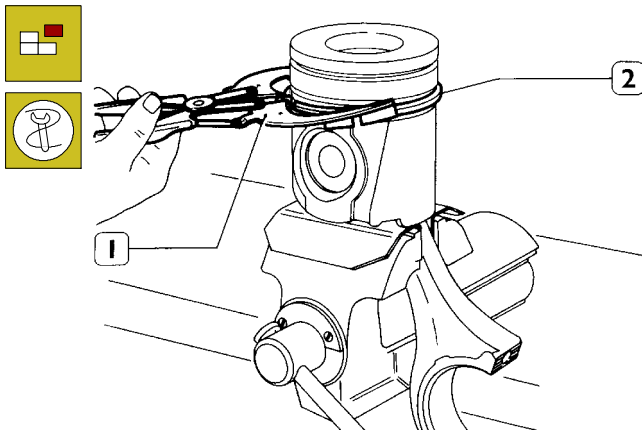
Make sure the piston does not show any trace of seizing, scoring, cracking; replace as necessary.

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.

Removal

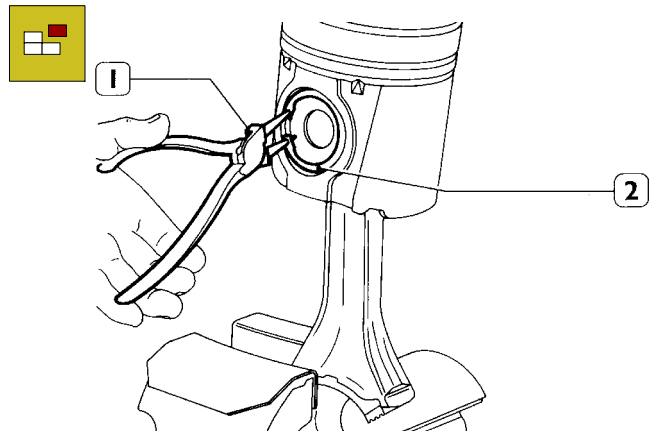
Figure 49



49023

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

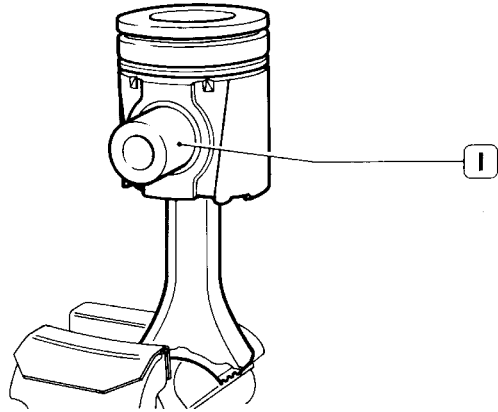
Figure 50



49024

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

Figure 51

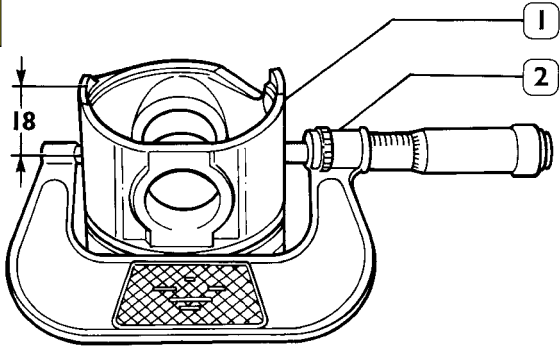


49025

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

Measuring the diameter of the pistons

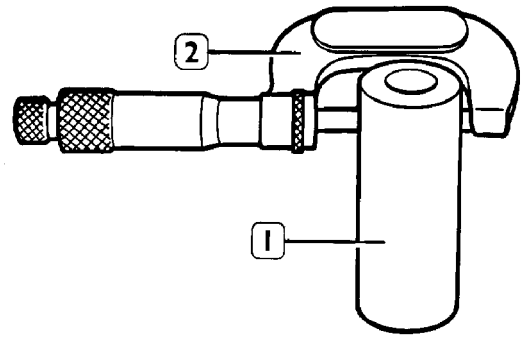
Figure 52



47584

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 53

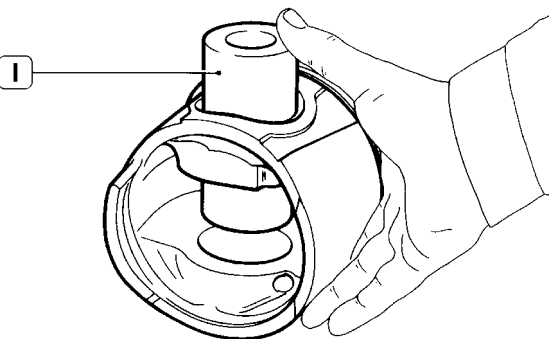


32618

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

Conditions for correct gudgeon pin-piston coupling

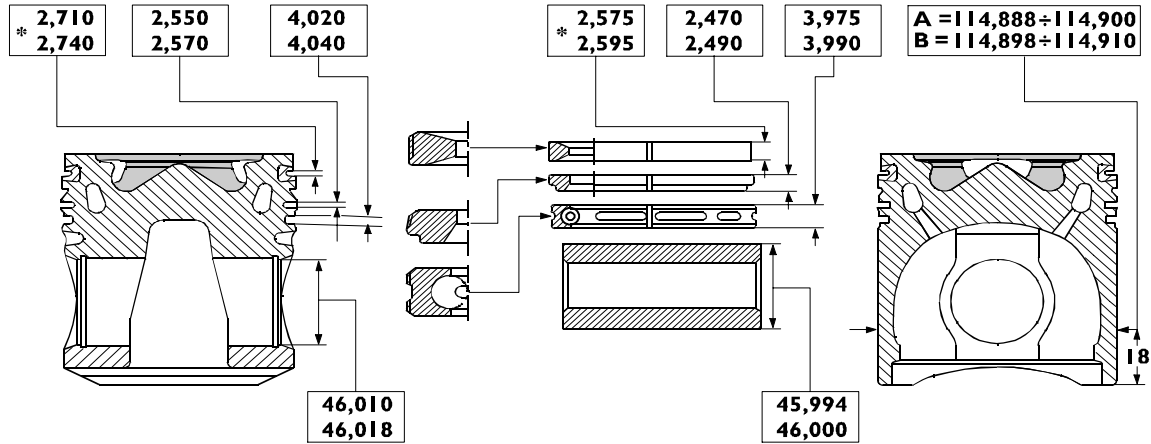
Figure 54



49026

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 55

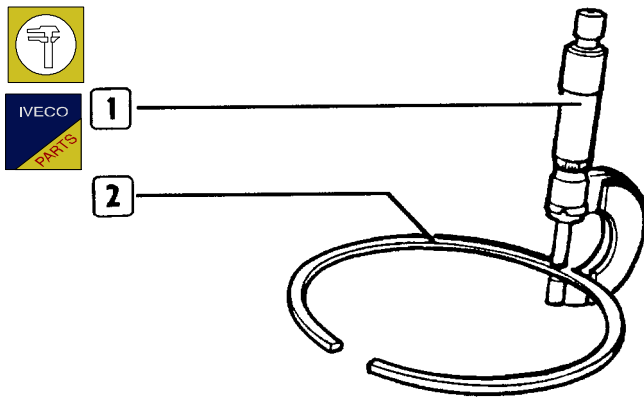


MAIN DATA ON PISTONS, AND PISTONS RINGS

* Values are determined on Ø of 112 mm.

Piston rings

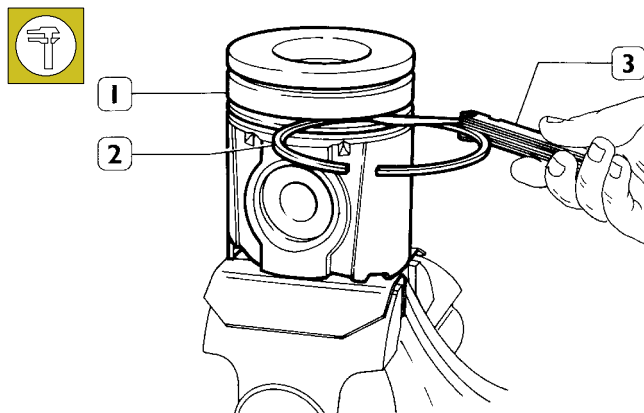
Figure 56



16552

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

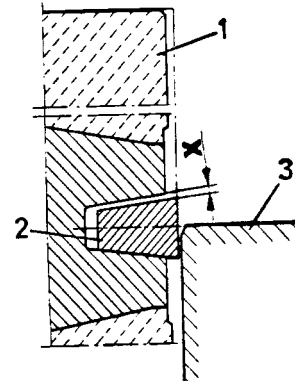
Figure 57



16552

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

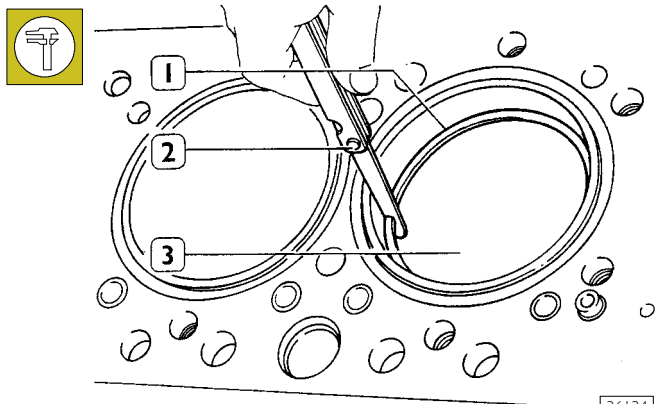
Figure 58



3513

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 59



36134

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

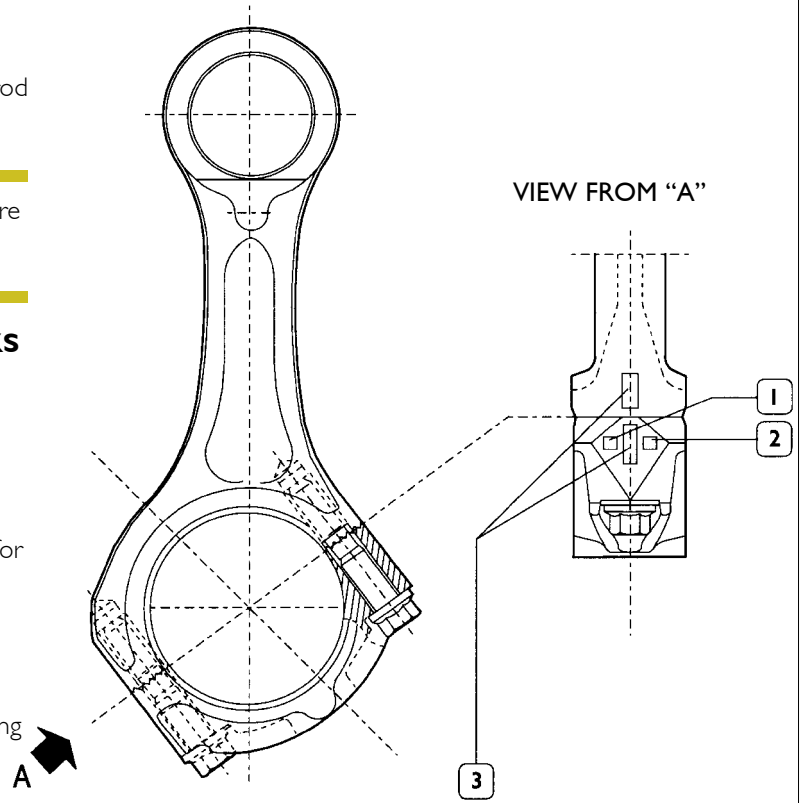
Figure 60

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.

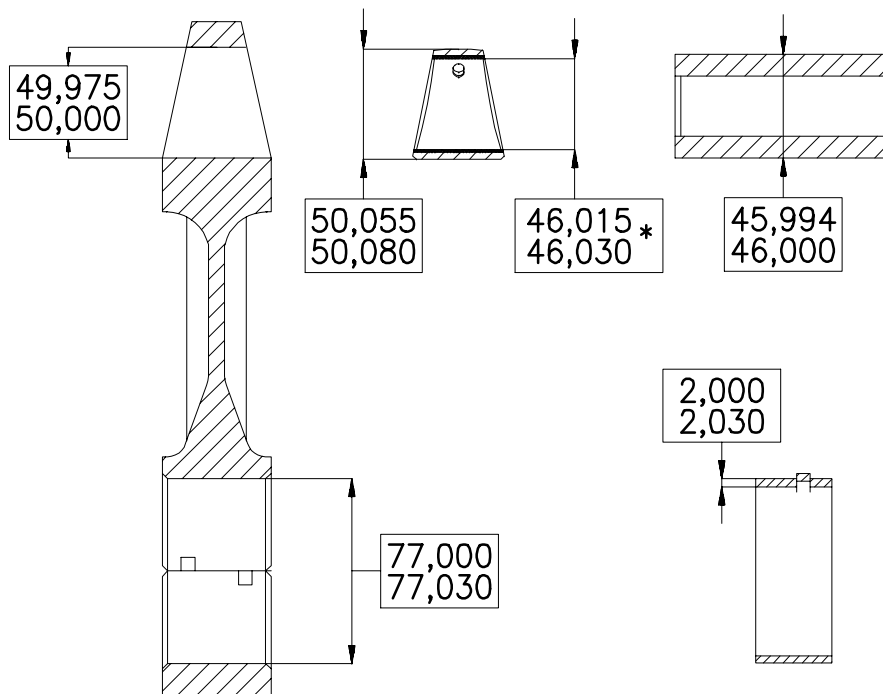
DIAGRAM CONNECTING ROD MARKS

- 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 61

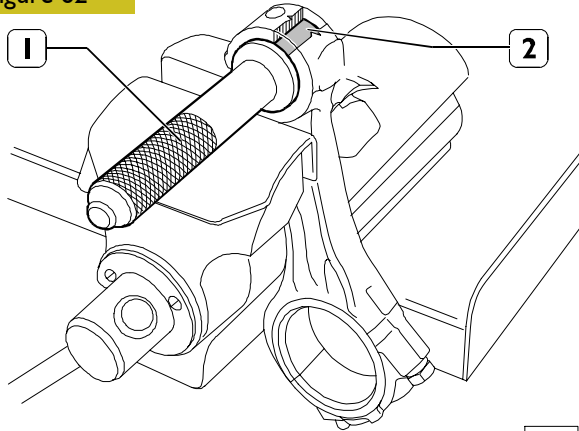


44927

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

Bushings

Figure 62

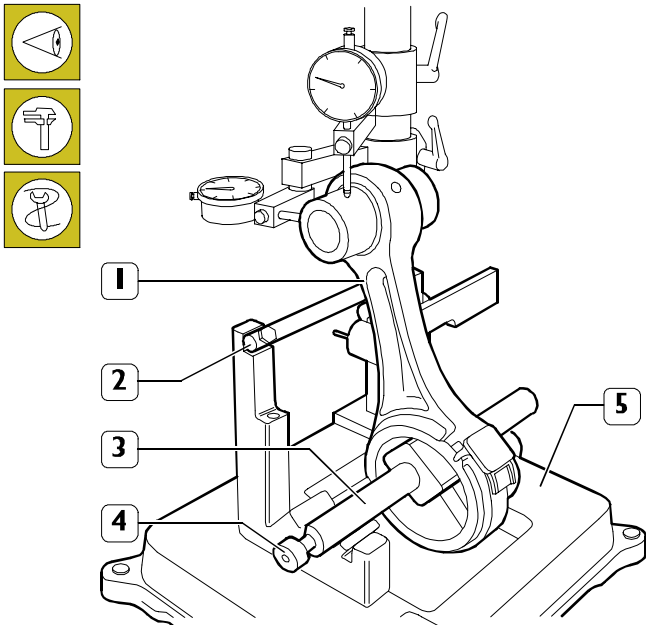


73535

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 46.015 – 46.030.

Checking connecting rods

Figure 63



61696

Checking axis alignment

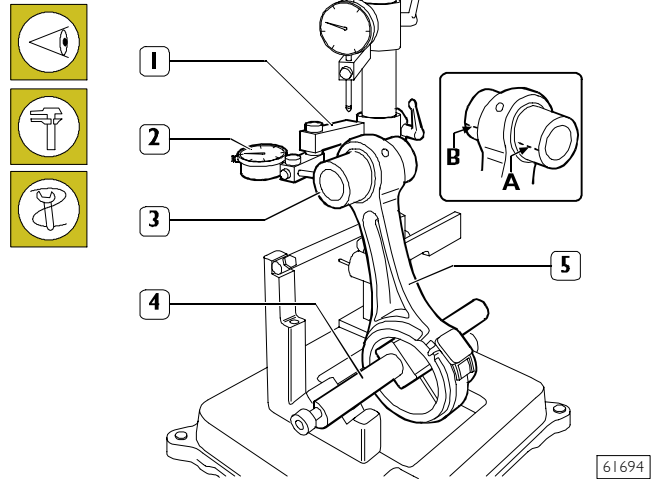
Check the alignment of the axes of the connecting rods (1) with device 99395363 (5), proceeding as follows:

Fit the connecting rod (1) on the spindle of the tool 99395363 (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 64



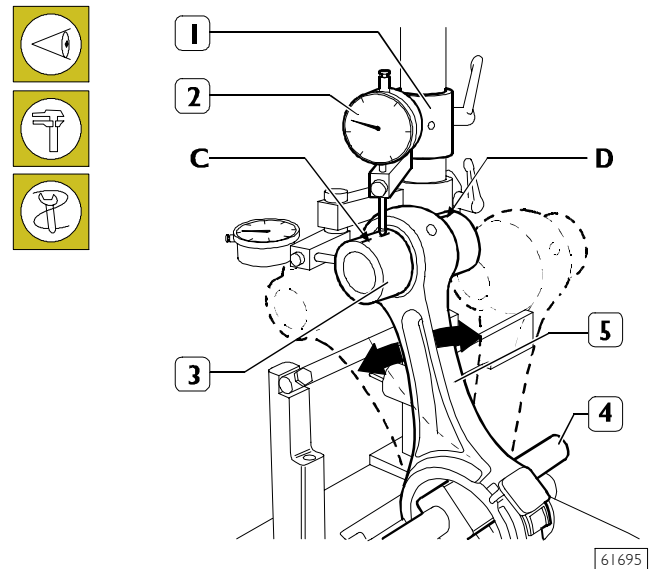
61694

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 65



61695

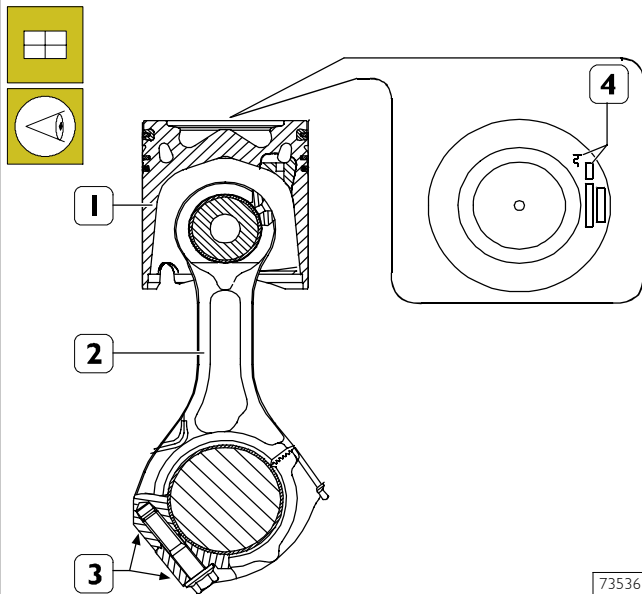
Check the bending of the connecting rod (5) by comparing two points C and D of the pin (3) on the vertical plane of the axis of the connecting rod.

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

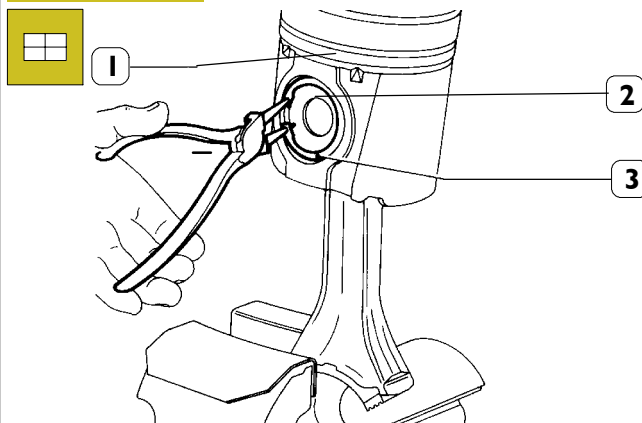
Figure 66



73536

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 67

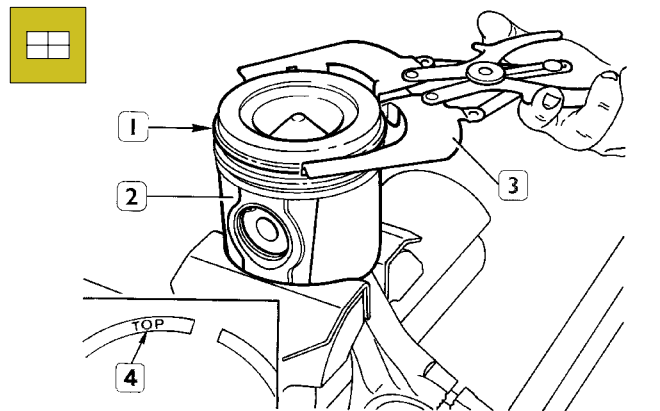


74052

Fit the pin (2) and fasten it on the piston (1) with the split rings (3).

Mounting the piston rings

Figure 68



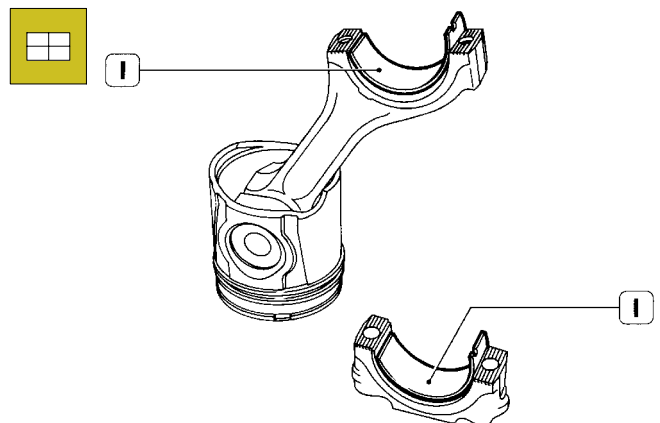
60614

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 69



49030

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.

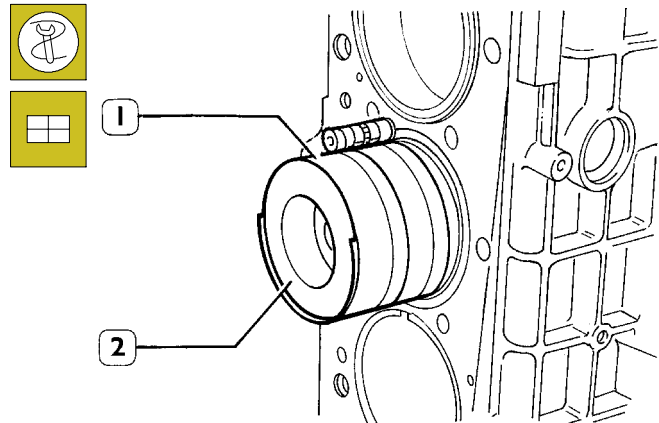
Fitting the connecting rod-piston assembly into the piston liners

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 71). Check the following:

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

Figure 71

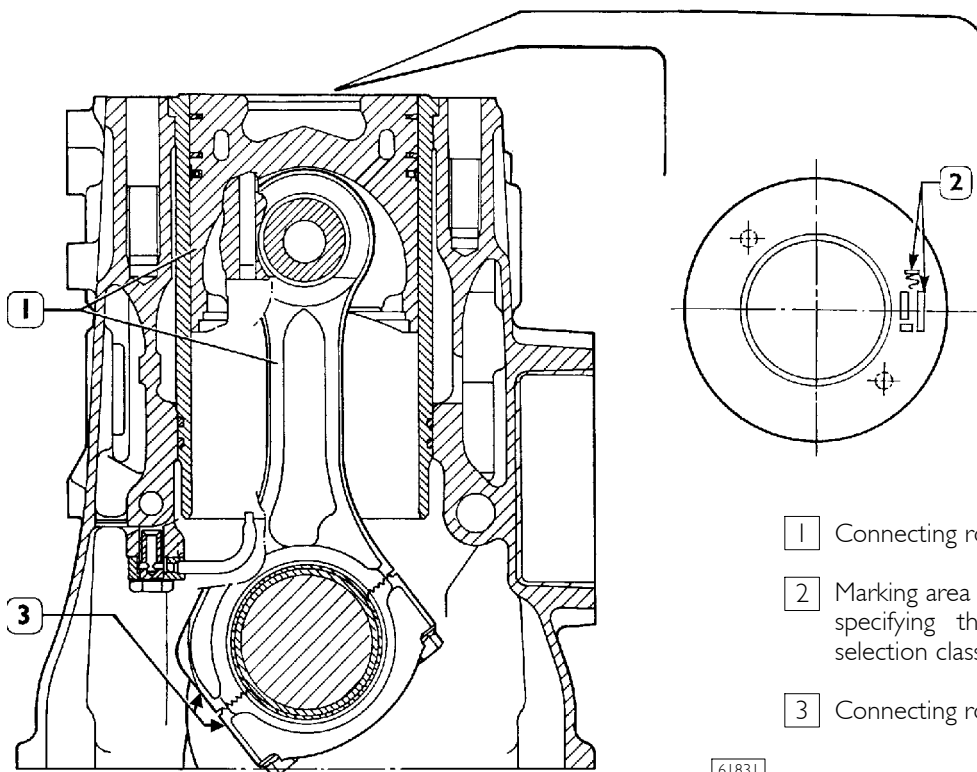


47593

Piston protrusion check

Once assembly is complete, check piston protrusion from cylinder barrels: it must be 0.32-0.99 mm.

Figure 70



- 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 61).

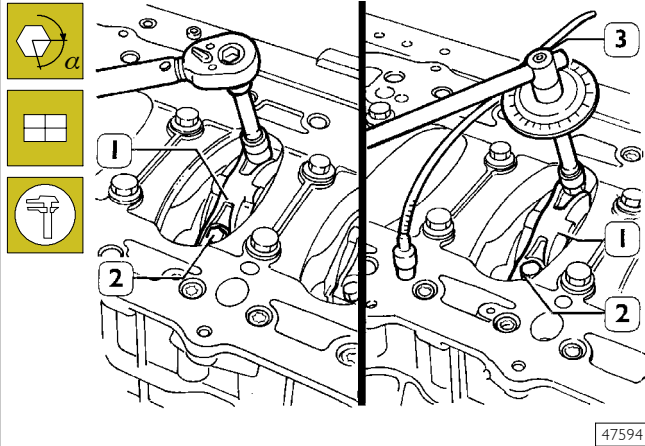
61831

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 72



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

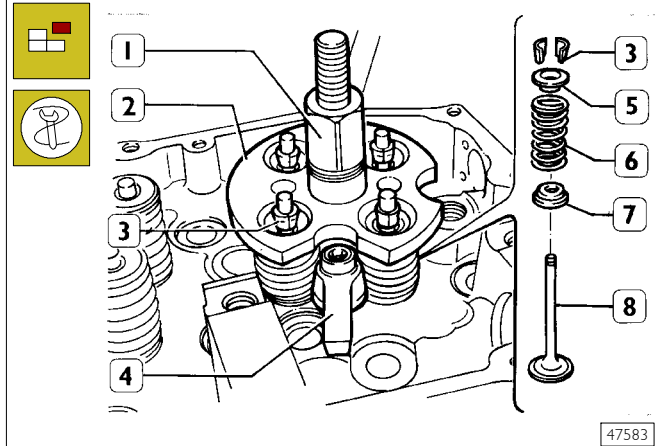
Before dismounting cylinder head, check cylinder head for hydraulic seal by proper tooling; in case of leaks not caused by cup plugs or threaded plugs, replace cylinder head.

NOTE In case of plugs dismounting/replacement, on mounting, apply sealant Loctite 243 IVECO nr. 2992693 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.

Figure 73

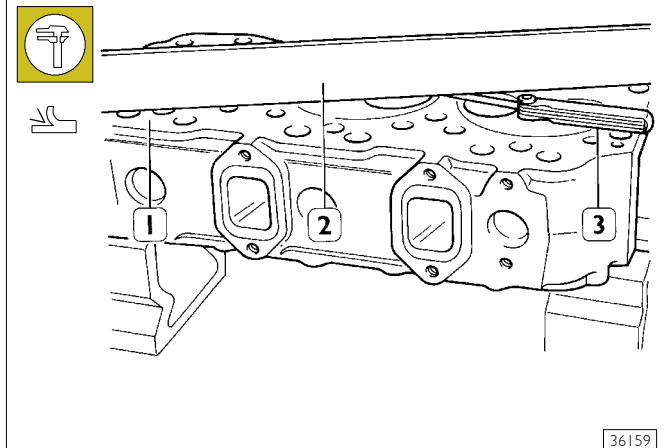


Install and fix tool 99360264 (2) with bracket (4); tighten by lever (1) until cotters are removed (3); remove the tool (2) and the upper plate (5), the spring (6) and the lower plate (7). Repeat the operation on all the valves. Turn the cylinder head upside down and remove the valves (8).

Checking the planarity of the head on the cylinder block

Figure 74

(Demonstration)



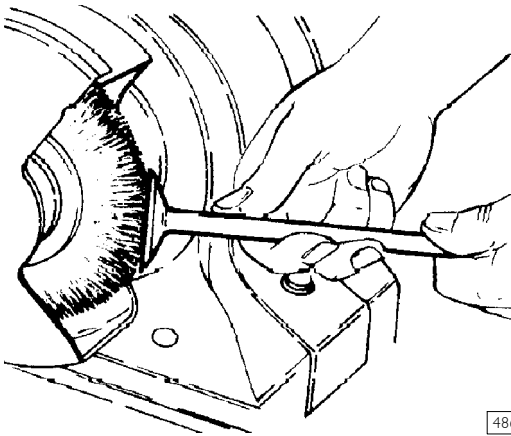
The planarity (1) is checked using a ruler (2) and a thickness gauge (3). If deformations exist, surface the head using proper surface grinder; the maximum amount of material to be removed is 0.2 mm.

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

VALVE

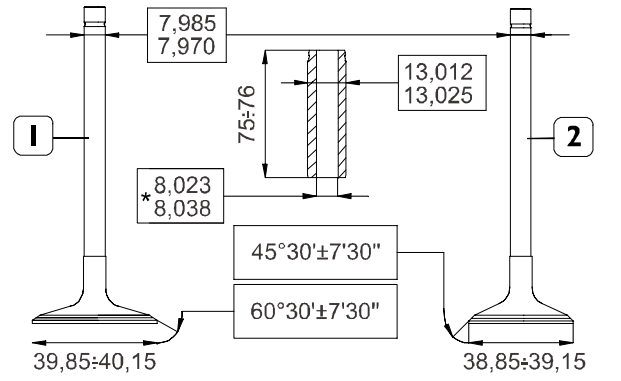
Removing deposits and checking the valves

Figure 75



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 75) and replace if necessary.

Figure 76



1) Inlet - 2) Exhaust 99280

MAIN DATA - VALVES AND VALVE GUIDES

* Values to be obtained after installing the valve guides

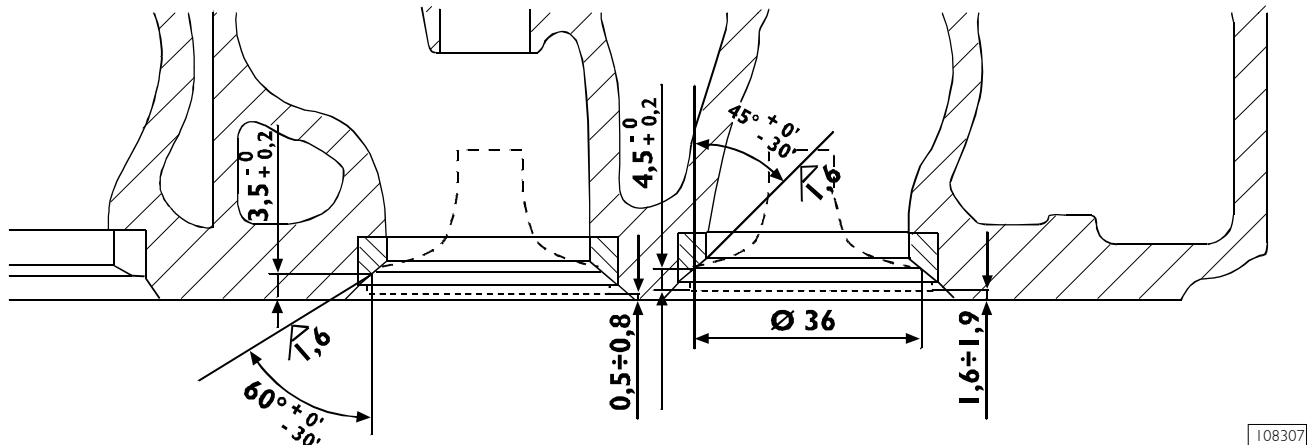
Check, by means of a micrometer, that valve stem diameters are as specified; if necessary, grind the valves seat with a grinder, removing the minimum quantity of material.

Valve seats

Regrinding – replacing valve seats

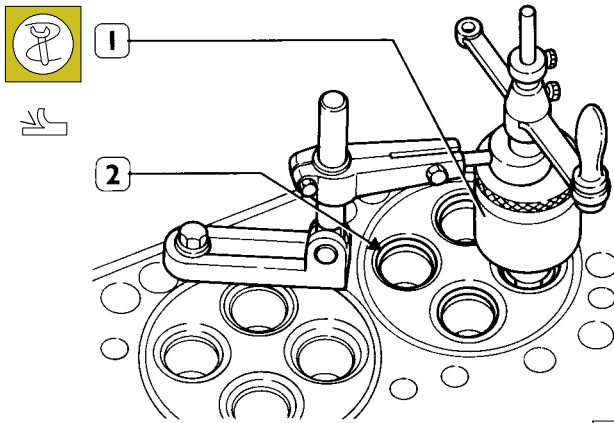
NOTE The valve seats are reground whenever the valves or valve guides are ground and replaced.

Figure 77



MAIN DATA OF VALVE SEATS
1. Intake valve seat – 2. Exhaust valve seat.

Figure 78



41032

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 78. 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 $80 \pm 100^\circ\text{C}$ 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 77.

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:

- -0.5 ± -0.8 mm (recessing) intake valves
- -1.6 ± -1.9 mm (recessing) exhaust valves.

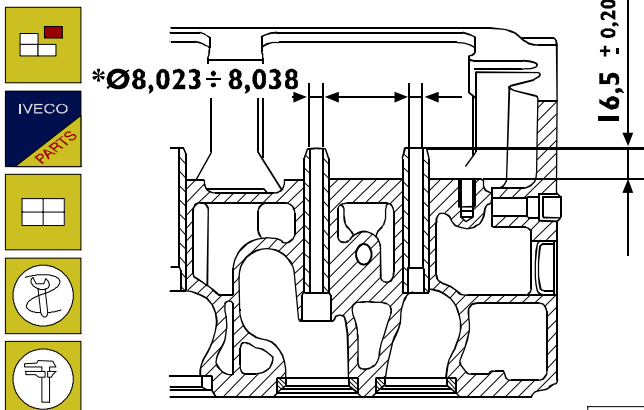
Checking clearance between valve-stem and associated valve guide

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 79



108308

The valve guides are removed with the drift 99360143. They are fitted with the drift 99360143 equipped with part 99360296.

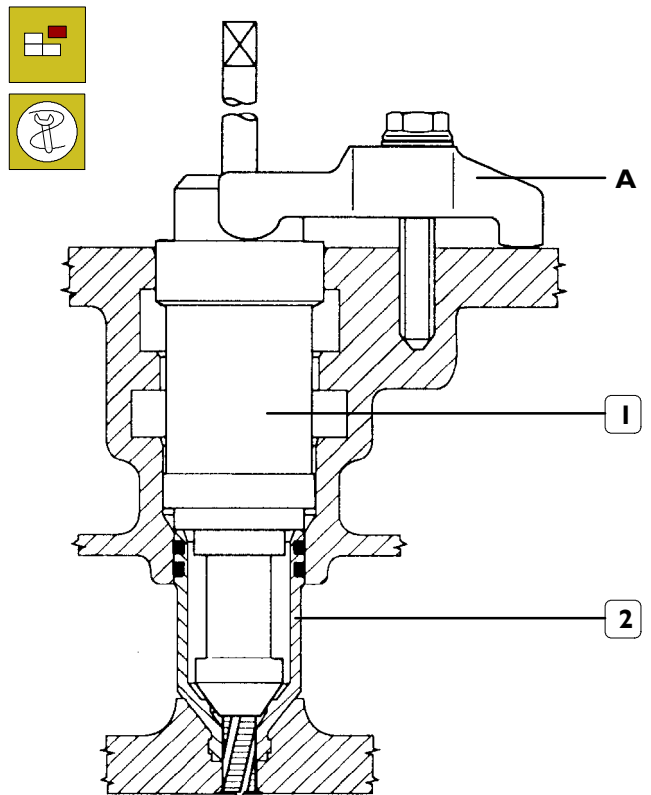
Part 99360296 determines the exact position of assembly of the valve guides in the cylinder head. If they are not available, you need to drive the valve guides into the cylinder head so they protrude by 16.3 ± 16.7 mm (Figure 79).

After driving in the valve guides, rebore their holes with the smoother 99390330.

REPLACING INJECTOR HOLDER CASES

Removal

Figure 80



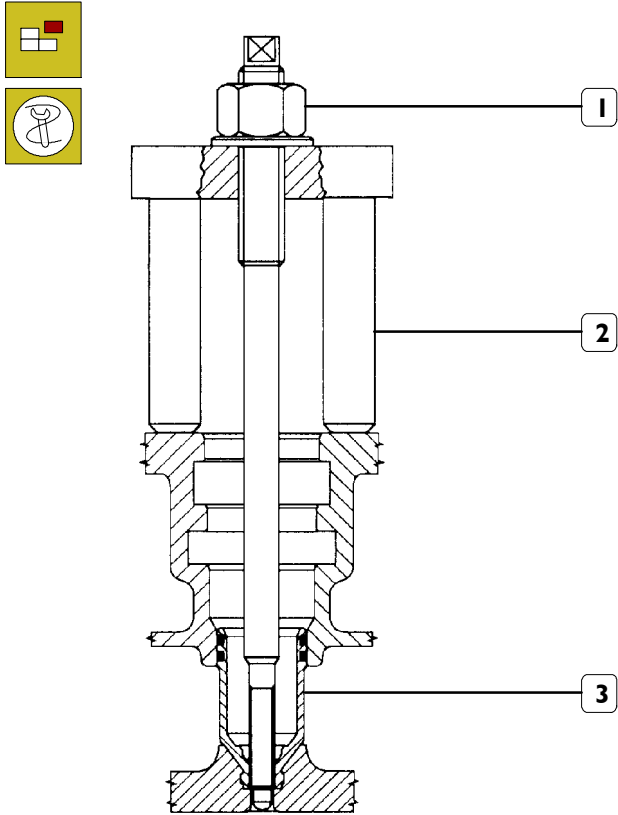
45634

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

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

Carry out operations described in figs. 80 - 83 - 84 - 85 by fixing tools to the cylinder head by means of bracket A.

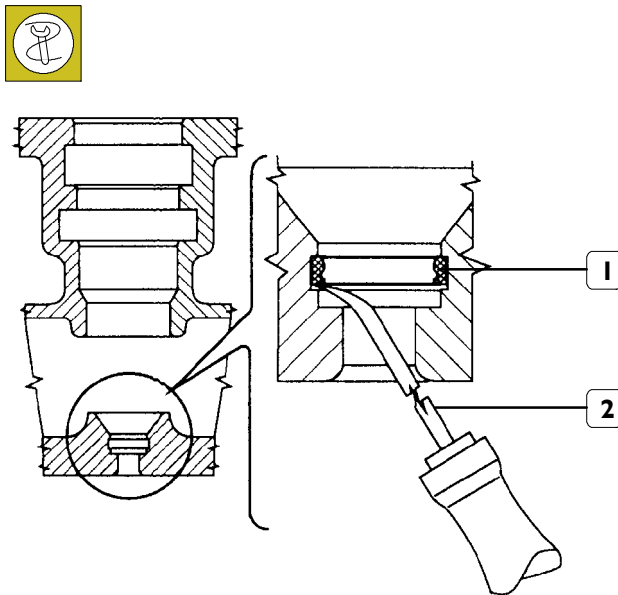
Figure 81



45631

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

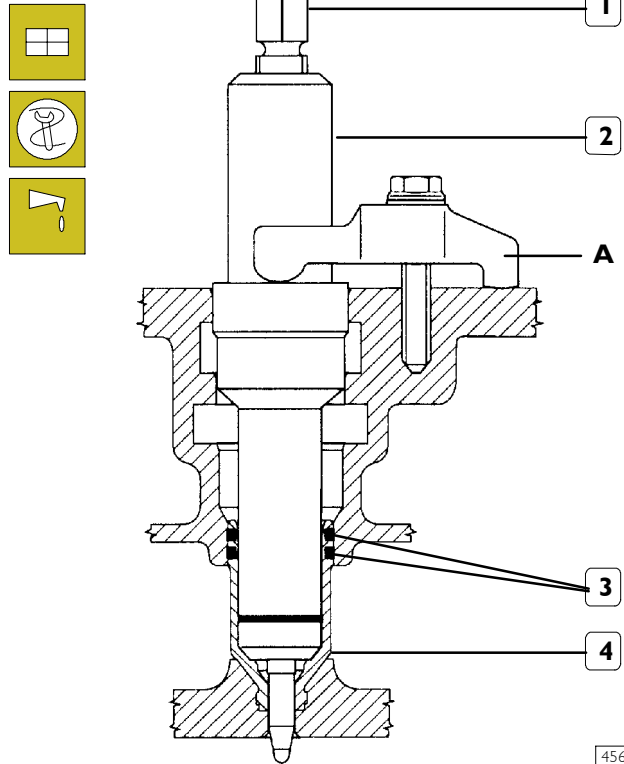
Figure 82



45633

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

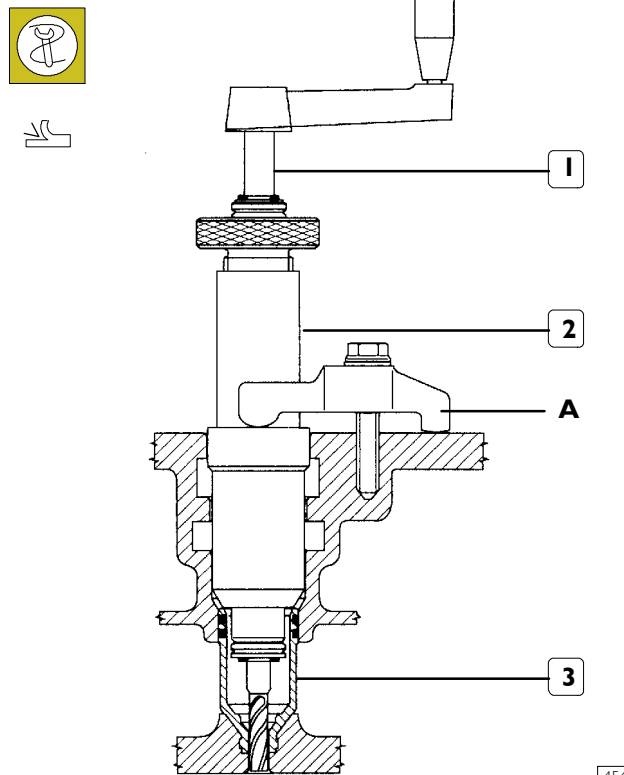
Figure 83



45635

- Lubricate sealing rings (3) and fit them to the case (4); fix tool 99365054 (2) to the cylinder head by means of bracket A, install the new case, tighten the screw (1), upsetting the case lower part.

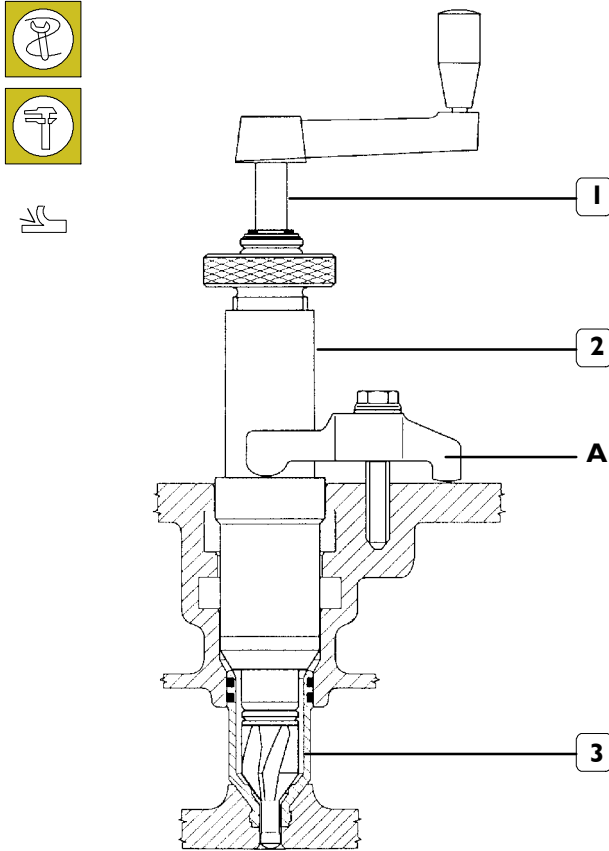
Figure 84



45632

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

Figure 85

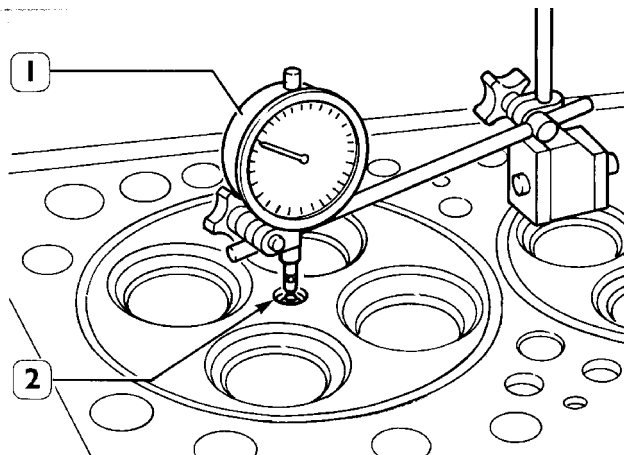


45636

- 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

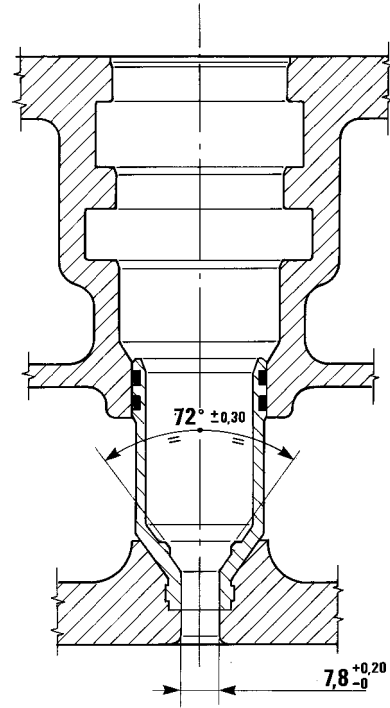
Figure 86



47585

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

Figure 87

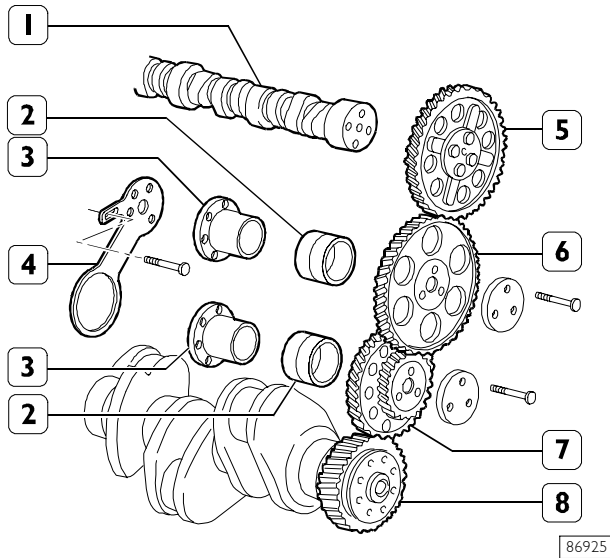


44909

INSTALLATION DIAGRAM FOR INJECTOR CASE

**TIMING GEAR
Camshaft drive**

Figure 88

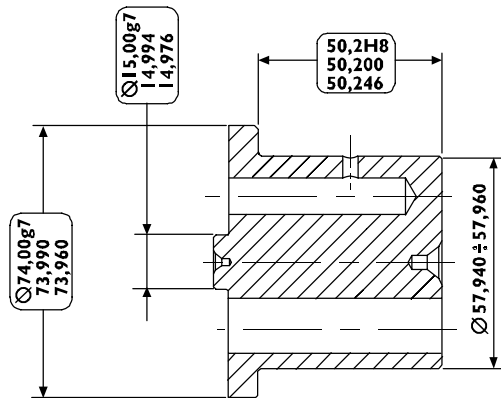


TIMING CONTROL COMPONENT PARTS

- 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

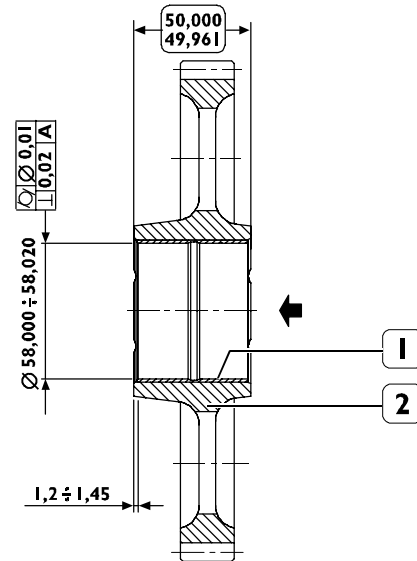
Figure 89



Rated assembling play between idler gear bushings and pins: $0.040 \div 0.080$ mm.

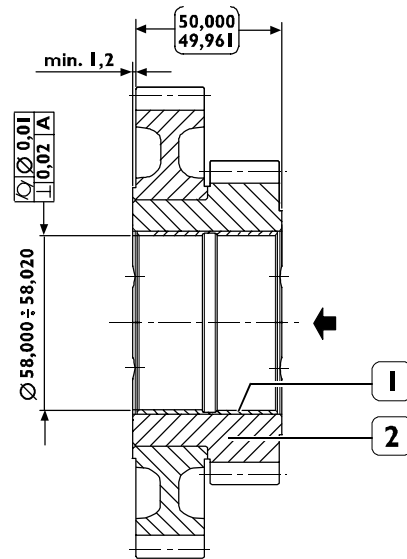
Idler gear

Figure 90



Twin idler gear

Figure 91



Replacing the bushings

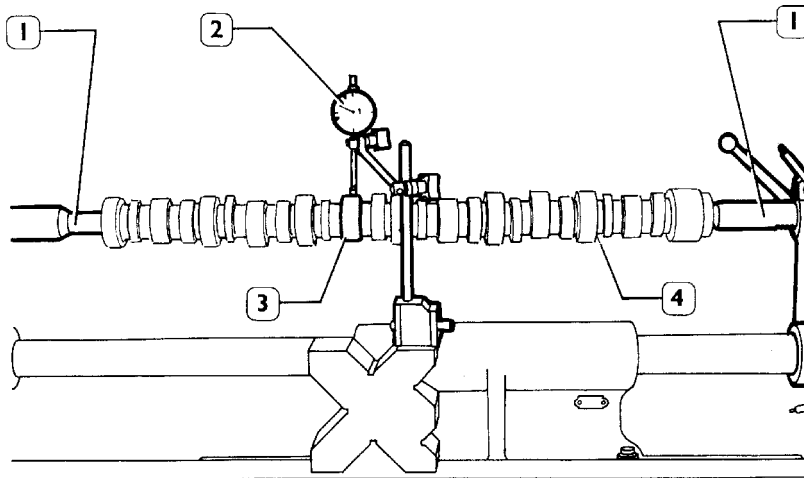
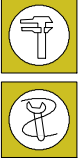
Bushings (1, Figures 89 - 90) can be replaced when they are worn. Put up the bushing, then grind it so as to bring it to a dimension of $\varnothing 58.010 \pm 0.10$ mm.

NOTE Bushings must be forced into gears (2, Figures 89 - 90) by following the direction of the arrow: they must be positioned at the level shown in the figures.

Camshaft

Checking cam lift and pin alignment

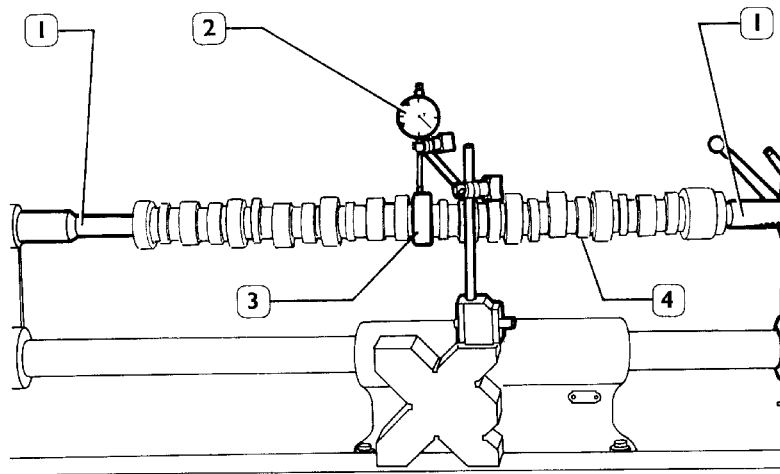
Figure 92



47506

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

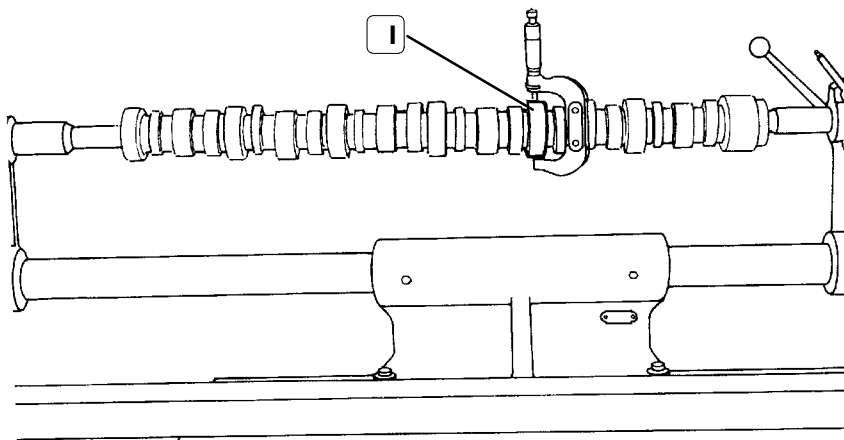
Figure 93



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 94

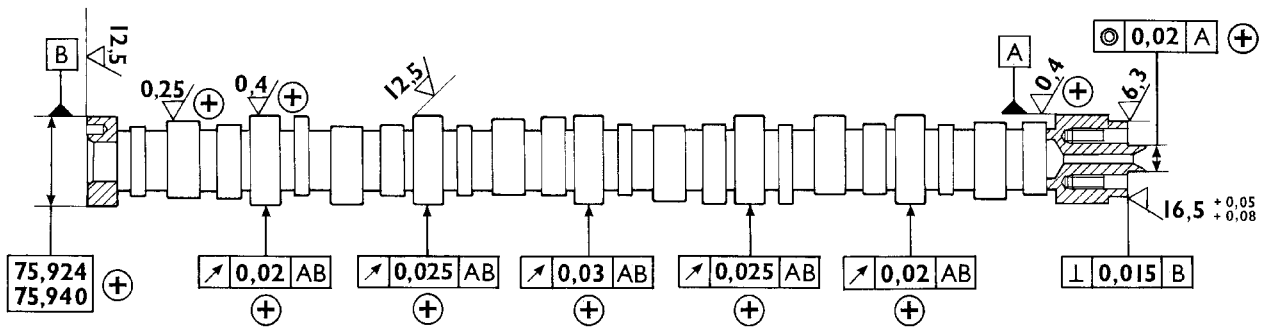


47505

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 95



47504

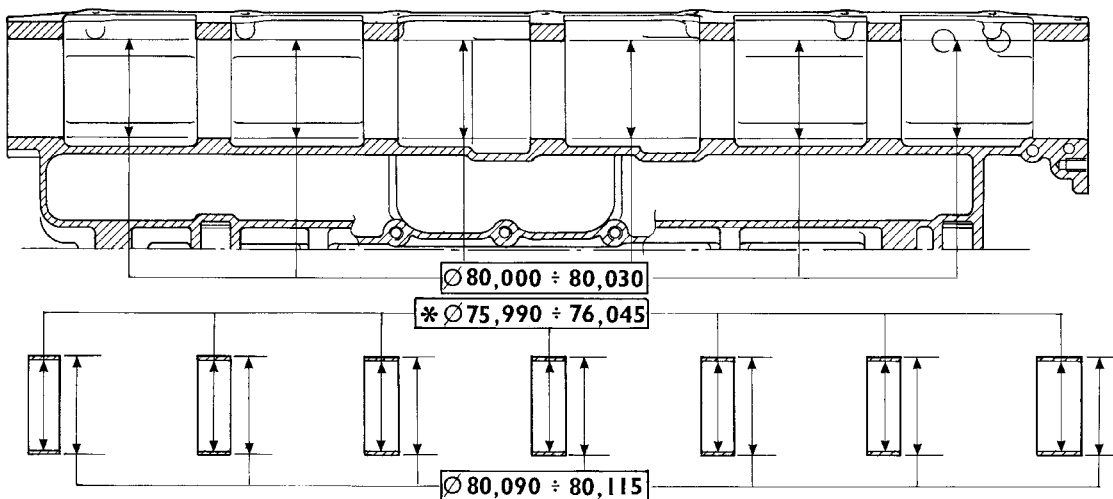
MAIN DATA - CAMSHAFT AND TOLERANCES

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 96



47508

MAIN DATA - CAMSHAFT BUSHES AND RELATIVE BLOCK SEATS

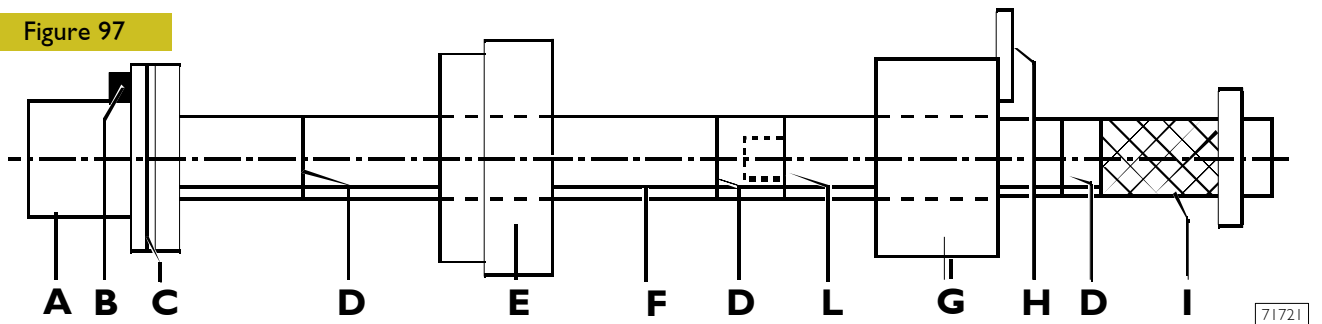
* Bush inner diameter after installation

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

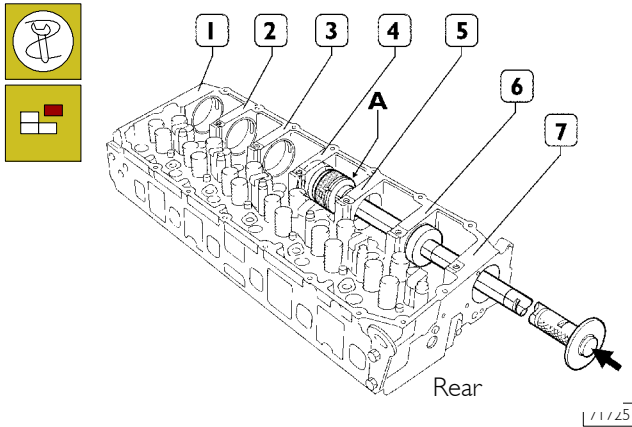
Figure 97



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.

Removal

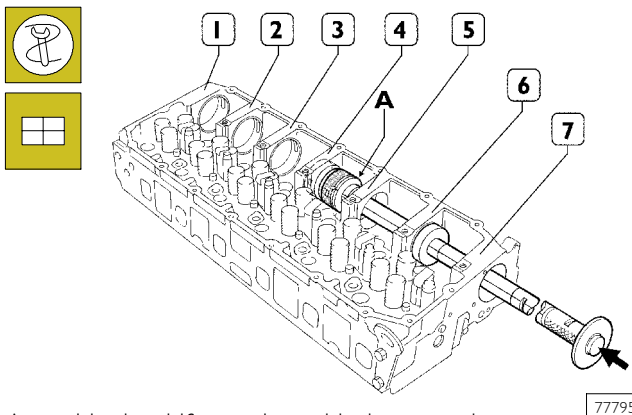
Figure 98



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

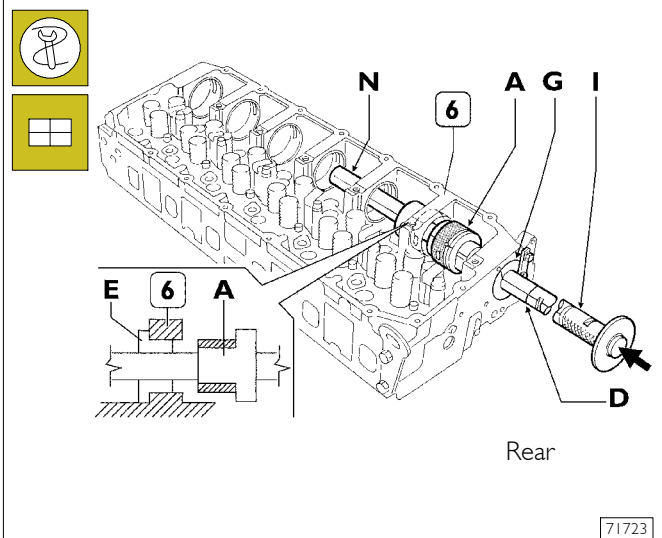
Figure 99



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 97) on the bushing.
- 2 Position the guide bushing (E) and secure the guide bushing (G) (Figure 97) 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).

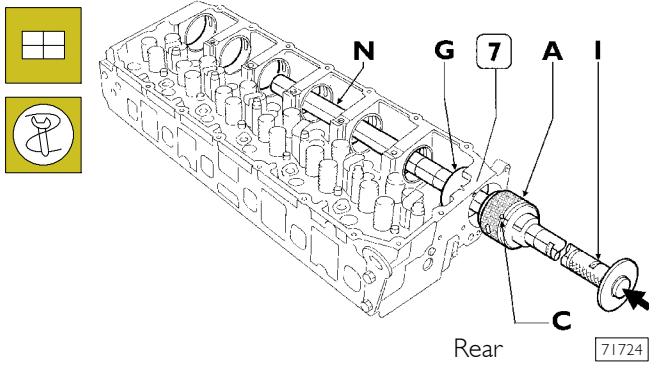
Figure 100



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 101

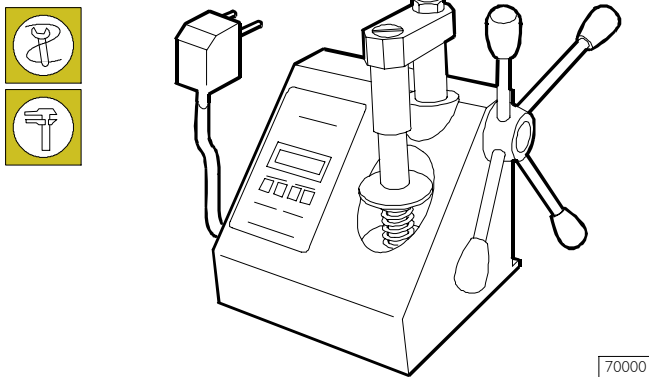


To insert bushing (7), proceed as follows:

- 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

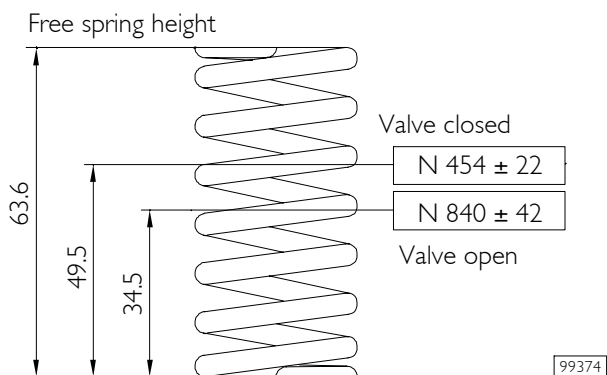
Figure 102



Before assembly, the flexibility of the valve springs has to be checked with the tool 99305047.

Compare the load and elastic deformation data with those of the new springs given in the following figure.

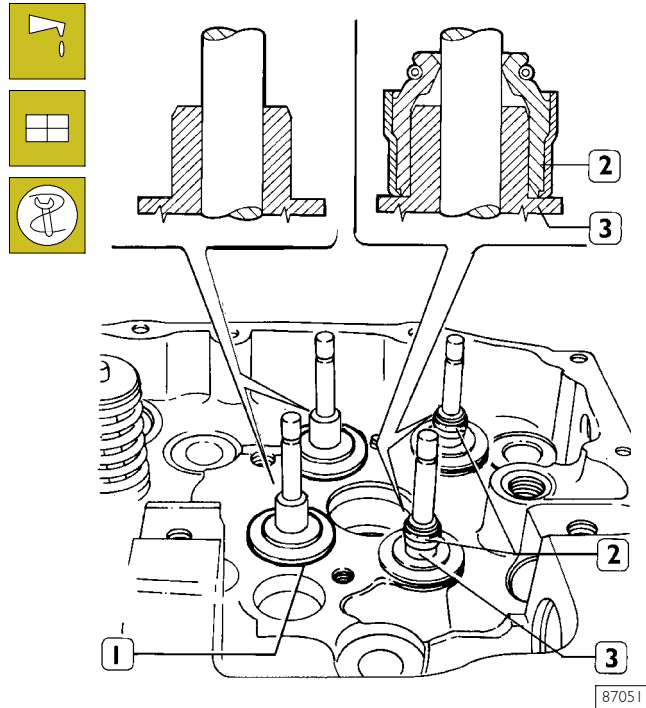
Figure 103



MAIN DATA TO CONTROL EXHAUST AND DISCHARGE VALVE SPRING

Fitting the valves and oil seal ring

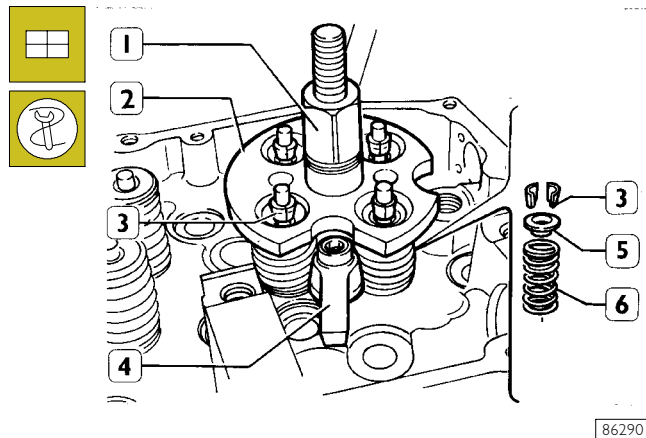
Figure 104



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 dismantling.

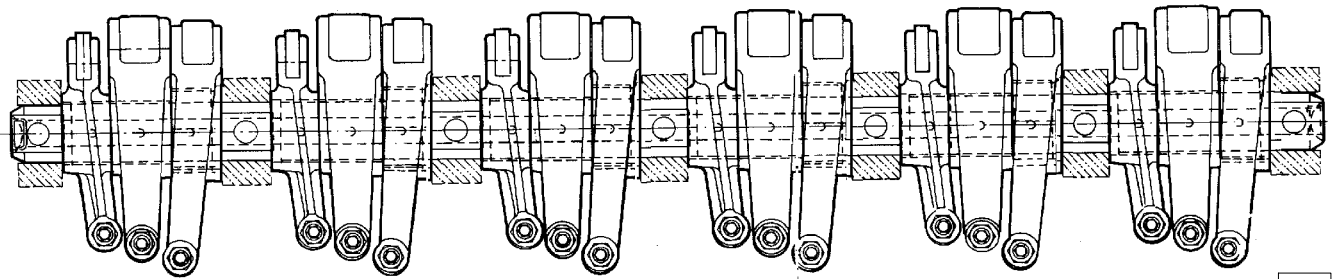
Figure 105



- 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 106



99281

The camshaft cams directly control rockers: 6 for injectors and 12 for valves.

Rockers slide directly on the cam profiles via rollers.

The other end acts on a bar directly supported by the two valves stems.

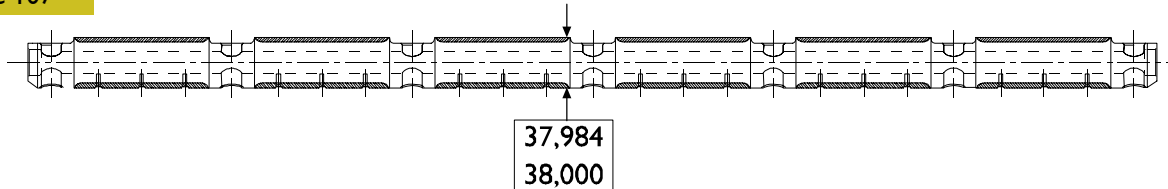
A pad is placed between the rocker adjusting screw and the bar.

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 107



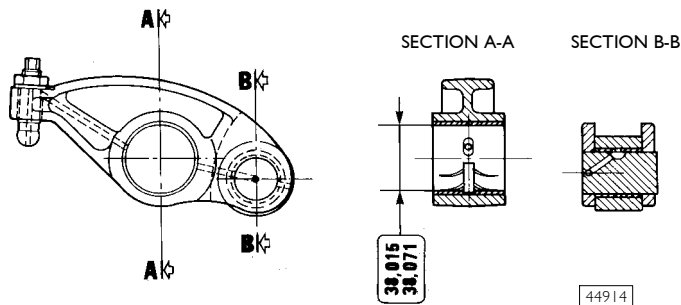
79171

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 108



44914

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

PUMP INJECTOR ROCKER

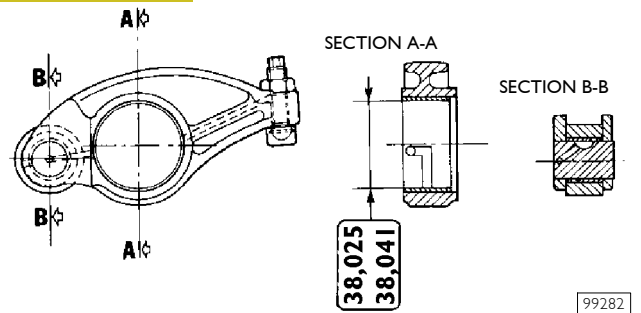
Figure 109



44912

EXHAUST VALVES ROCKER

Figure 110



99282

DISCHARGE VALVE ROCKER

TIGHTENING TORQUES

PART	TORQUE			
		Nm	kgm	
Under-basement fastening screws to cylinder block ◆				
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 ◆				
	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			41.5 ± 3.5	4.1 ± 0.3
Gearcase fastening screws to cylinder block				
			41.5 ± 3.5	4.1 ± 0.3
			63 ± 7	6.3 ± 0.7
			9 ± 3	1.9 ± 0.3
Cylinder head fastening screw: ◆				
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 ◆				
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 •				
	pre-tightening		40 ± 5	4 ± 0.5
	tightening		70 ± 5	70 ± 0.5
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°
Fixing screw for the phonic wheel fixed in the timing system gear			8.5 ± 1.5	0.8 ± 0.1
◆ 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
Idle gear pin fastening screws: ♦		
First stage	30	3
Second stage		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
Turbo-compressor fastening screws and nuts •		
pre-tightening	35 ± 5	3.5 ± 0.5
tightening	46 ± 2	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	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
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
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
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:		
M6x1	7 ± 1	0.7 ± 0.1
M8x1.25	14 ± 1	1.4 ± 0.1

SECTION 5

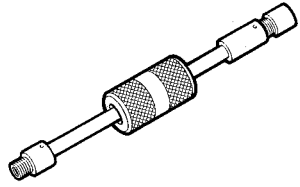
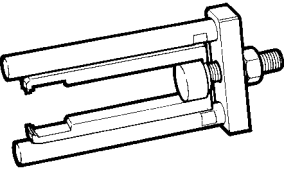
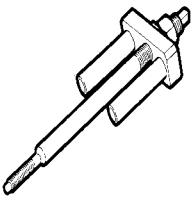
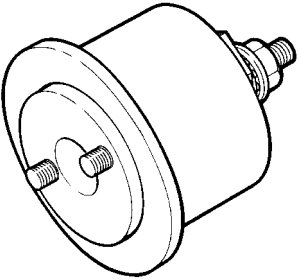
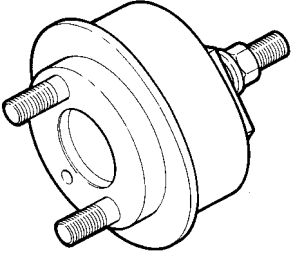
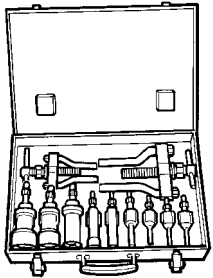
Tools

	Page
TOOLS	3

TOOLS

TOOL NO.	DESCRIPTION
8093731	Tester PT01
99305019	Full-optional tool-kit to rectify valve seat
99305047	Equipment for spring load check
99322230	Rotary telescopic stand
99340051	Extractor for crankshaft front gasket
99340052	Extractor for crankshaft rear gasket

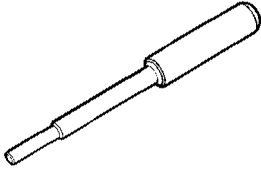
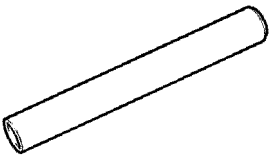
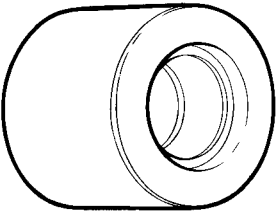
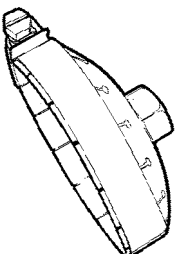
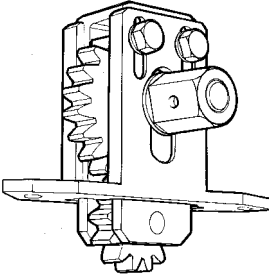
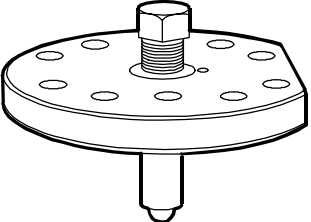
TOOLS

TOOL NO.	DESCRIPTION
99340205 	Percussion extractor
99342148 	Injector extractor
99342149 	Extractor for injector-holder
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

TOOLS

TOOL NO.	DESCRIPTION
99350072	Box wrench for transmission gear support fixing screws
99350074	Box wrench for block junction bolts to the underblock
99360144	Skid retaining tools (12+6) for rocker arm adjusting screws during rocker arm shaft removal/ refitting
99360177	Injector housing plug
99360184	Pincers for removing and refitting circlips and pistons (105-160 mm)
99360264	Tool to take down-fit engine valves

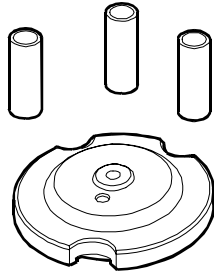
TOOLS

TOOL NO.		DESCRIPTION
99360288		Tool to remove valve guide
99360292		Tool to install gasket on valve guide
99360294		Tool to drive valve guide
99360314		Tool to remove cartridge filters
99360321		Tool to rotate engine flywheel
99360334		Tool for checking cylinder barrel projection.

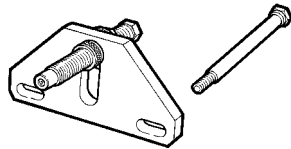
TOOLS

TOOL NO.

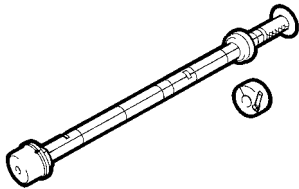
DESCRIPTION

99360335

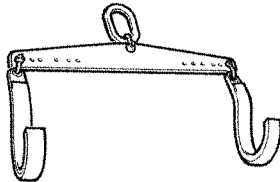
Cylinder barrel compression cap (to be used with 99360334)

99360351

Tool to stop engine flywheel

99360487

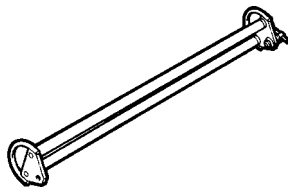
Tool to take down and fit back camshaft bushes

99360500

Tool to lift crankshaft

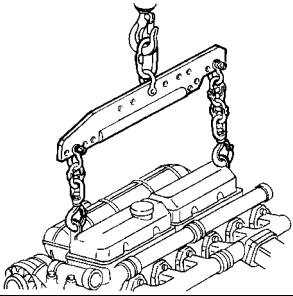
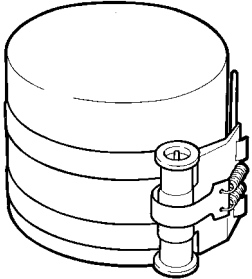
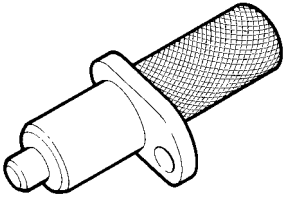
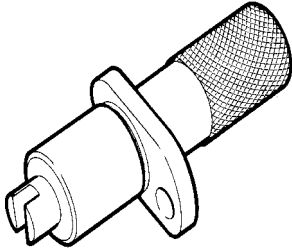
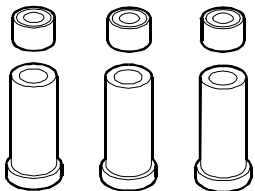
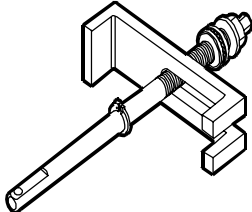
99360551

Bracket to take down and fit engine flywheel

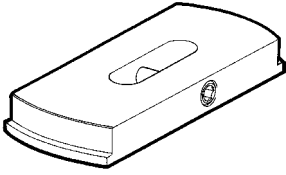
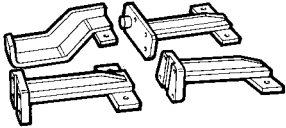
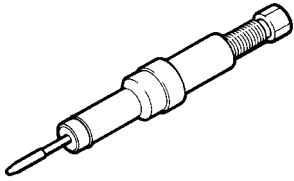
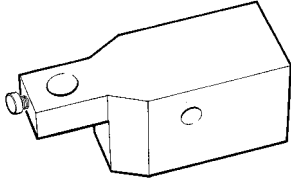
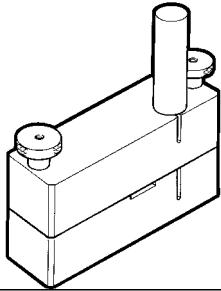
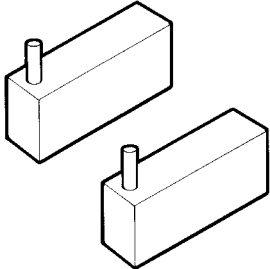
99360558

Tool to lift and transport rocker shaft

TOOLS

TOOL NO.	DESCRIPTION
99360585	 <p>Balance for lifting and handling engine</p>
99360605	 <p>Belt to insert piston in cylinder liner (60 - 125 mm)</p>
99360612	 <p>Engine flywheel timing pin</p>
99360613	 <p>Tool for timing of phonic wheel on timing gear</p>
99360703	 <p>Tool to stop cylinder liners</p>
99360706	 <p>Tool to extract cylinder liners</p>

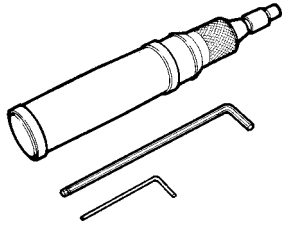
TOOLS

TOOL NO.	DESCRIPTION
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
99370415	 Tool to detect cylinder liner projections (use with 99395603)
99378100	 Tool for printing engine identification plates (to be used with special punches)
99378101 * 99378102 • 99378105 ■ 99378106 ▲	 Punches (A* - B• - E■ - F▲) for printing engine identification plates (to be used with 99378100)

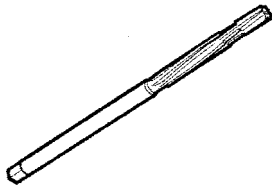
TOOLS

TOOL NO.

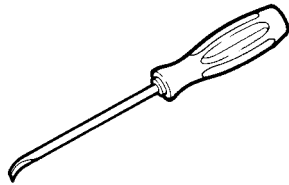
DESCRIPTION

99389834

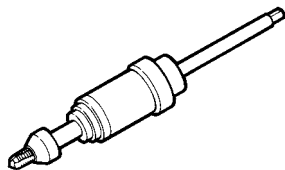
Dynamometric screwdriver to calibrate screws for injector solenoid valve

99390310

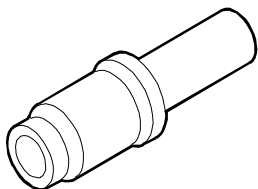
Valve guide sleeker

99390772

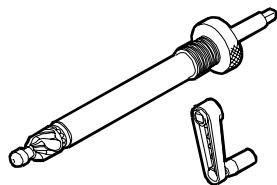
Tool to remove residues from injector holder

99390804

Tool to thread injector holders to be extracted

99394014

Guide bush (to be used with 99394041 or 99394043)

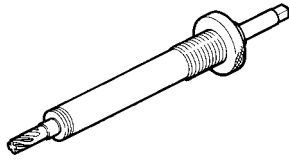
99394041

Cutter to rectify injector holder housing (to be used with 99394015)

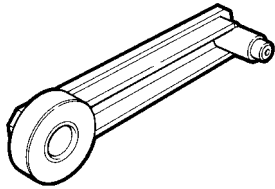
TOOLS

TOOL NO.

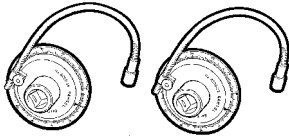
DESCRIPTION

99394043

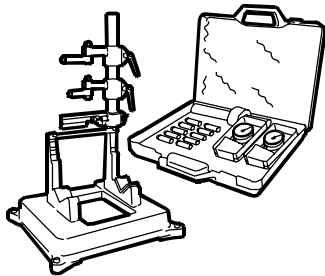
Reamer to rectify injector holder lower side (to be used with 99394015)

99395215

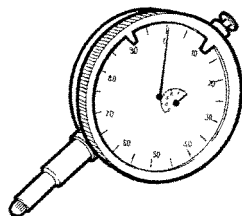
Gauge for centre distance check between camshaft and idle gear

99395216

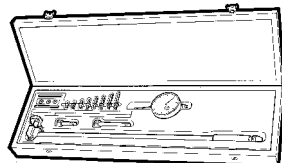
Measuring pair for angular tightening with 1/2" and 3/4" square couplings

99395363

Complete square to check connecting rod squaring

99395603

Dial gauge (0 - 5 mm)

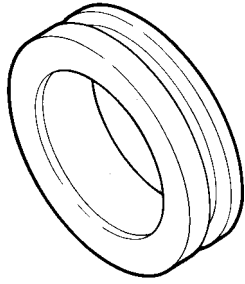
99395687

Reaming gauge (50-178 mm)

TOOLS

TOOL NO.

DESCRIPTION

99396033

Centering ring of crankshaft front cap

Appendix

	Page
SAFETY PRESCRIPTIONS	3

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 until 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 priority 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 ENGINES

Section

General specifications

1

Fuel

2

Industrial application

3

Overhaul and technical specifications

4

Tools

5

Safety prescriptions

Appendix

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.

UPDATING

Section	Description	Page	Date of revision

SECTION I

General specifications

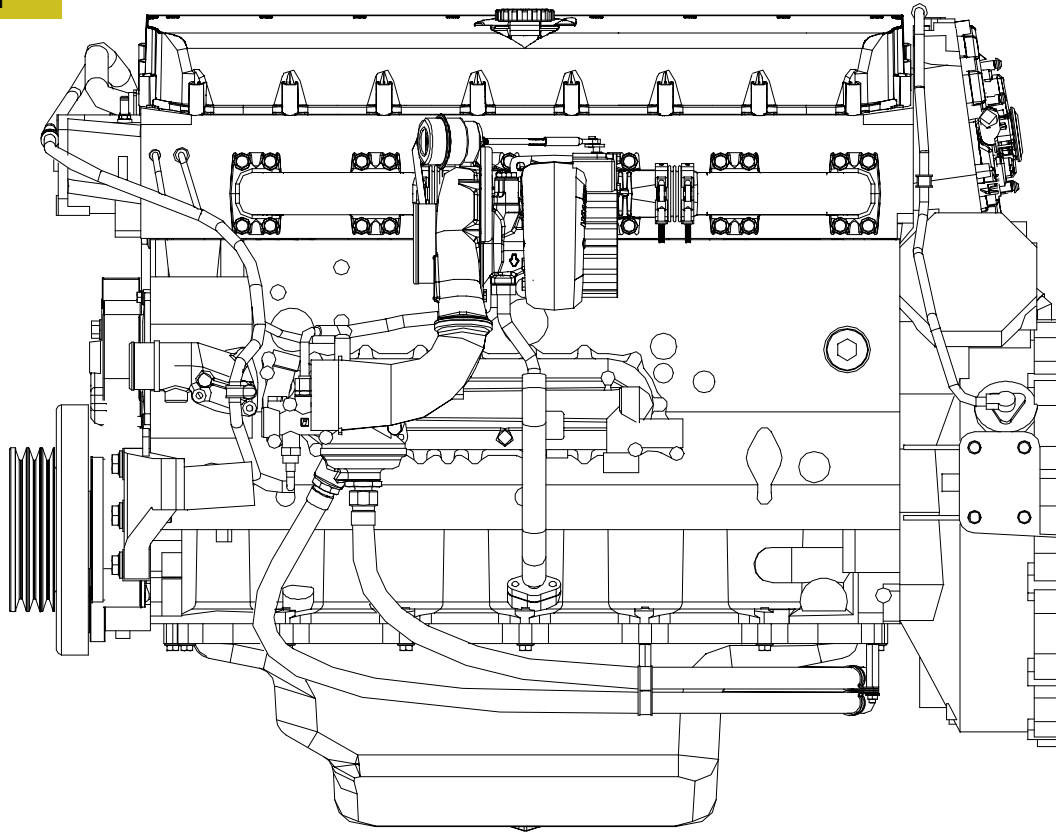
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VIEW OF ENGINE (TYPE F3AE0684D*B003 ONLY)	8
VIEW OF ENGINE (TYPE F3AE0684E*B002 ONLY)	9
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<input type="checkbox"/> Heat exchanger for engine versions with double filter	14
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CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F3AE0684D*B001	-
F3AE0684D*B003	-
F3AE0684E*B002	-
F3AE0684G*B003	-
F3AE0684J*B902	-
F3AE0687A*....	C10 ENT

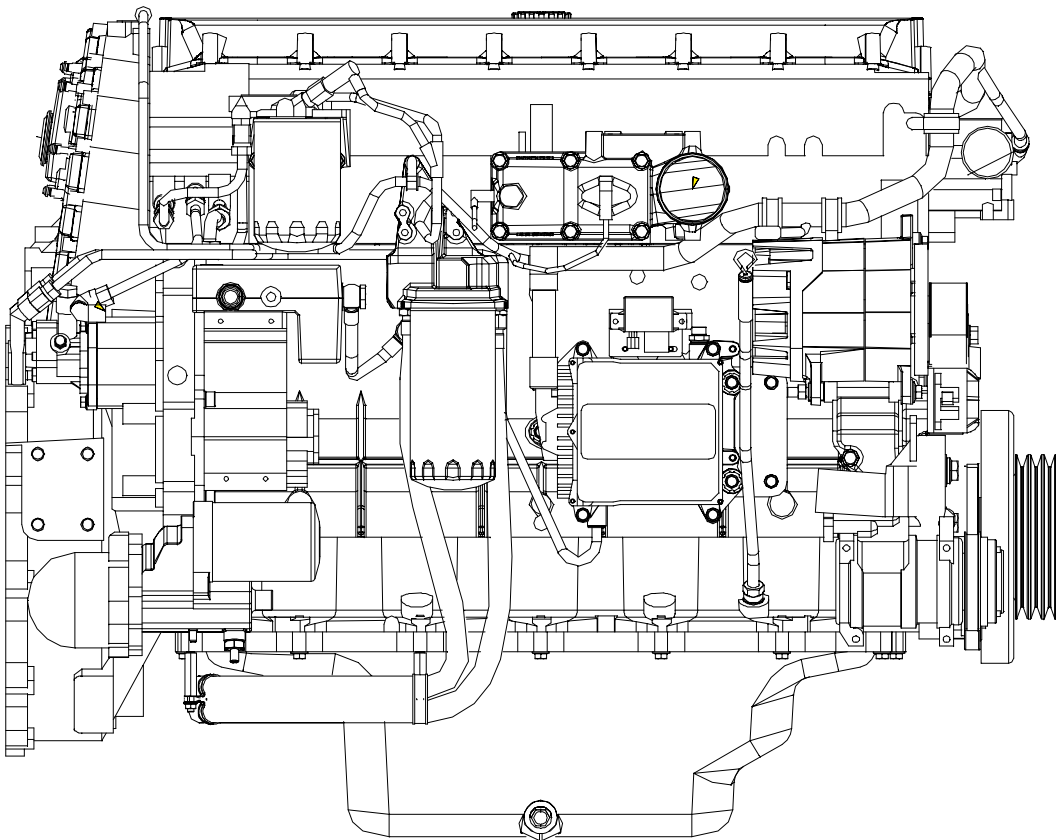
VIEWS OF ENGINE (F3AE0684D*B001 - F3AE0684G*B003)

Figure 1



LEFT-HAND SIDE VIEW

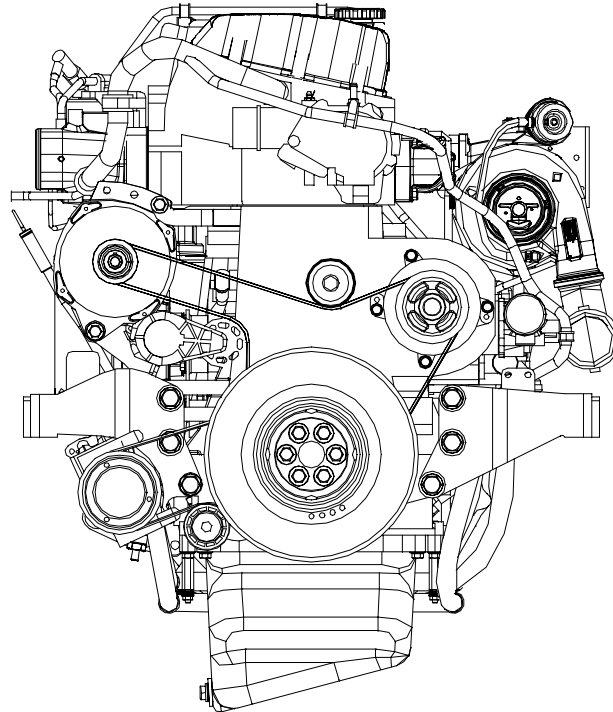
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RIGHT-HAND SIDE VIEW

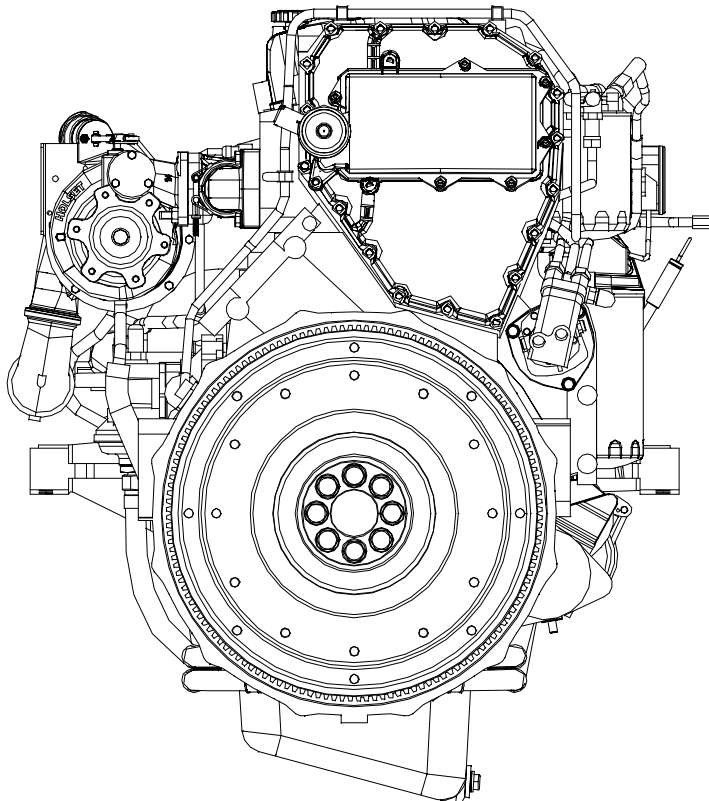
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Figure 2



81854

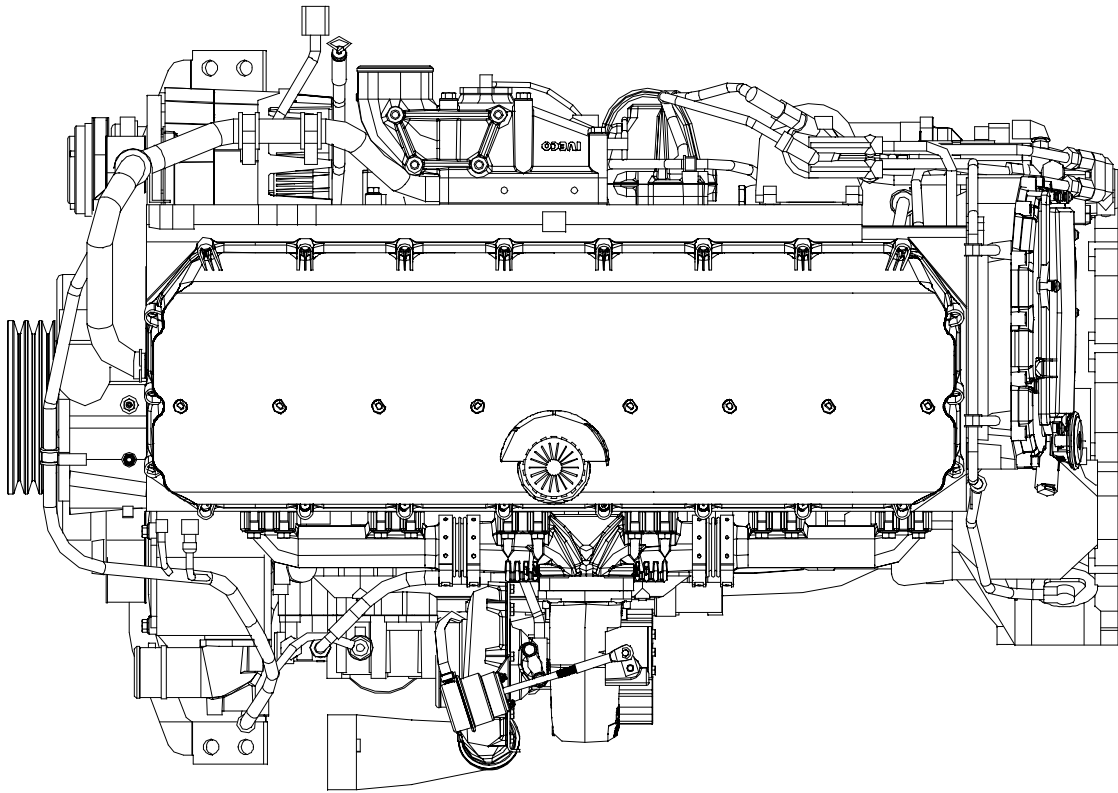
FRONT VIEW



81855

REAR VIEW

Figure 3

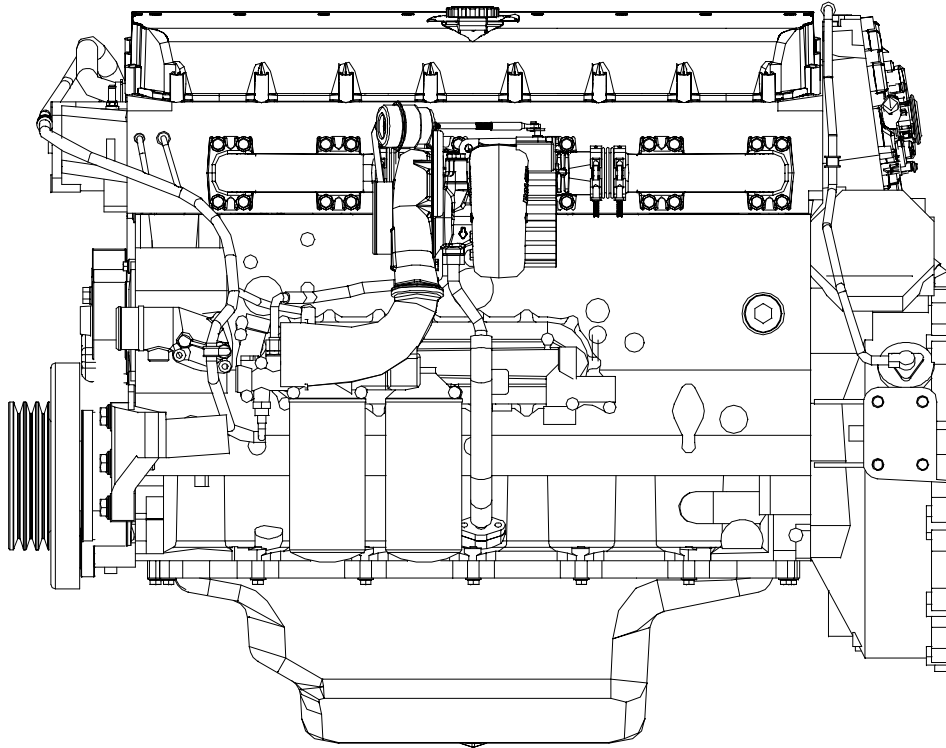


TOP VIEW

81856

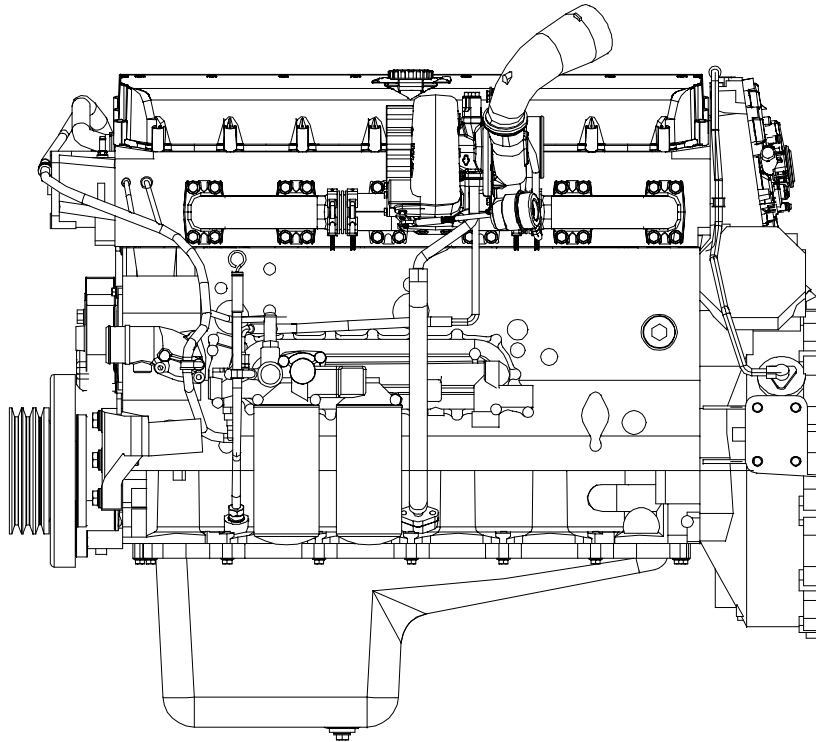
VIEW OF ENGINE (TYPE F3AE0684D*B003 ONLY)

Figure 4



81857

LEFT-HAND SIDE VIEW

VIEW OF ENGINE (TYPE F3AE0684E*B002 ONLY)**Figure 5**

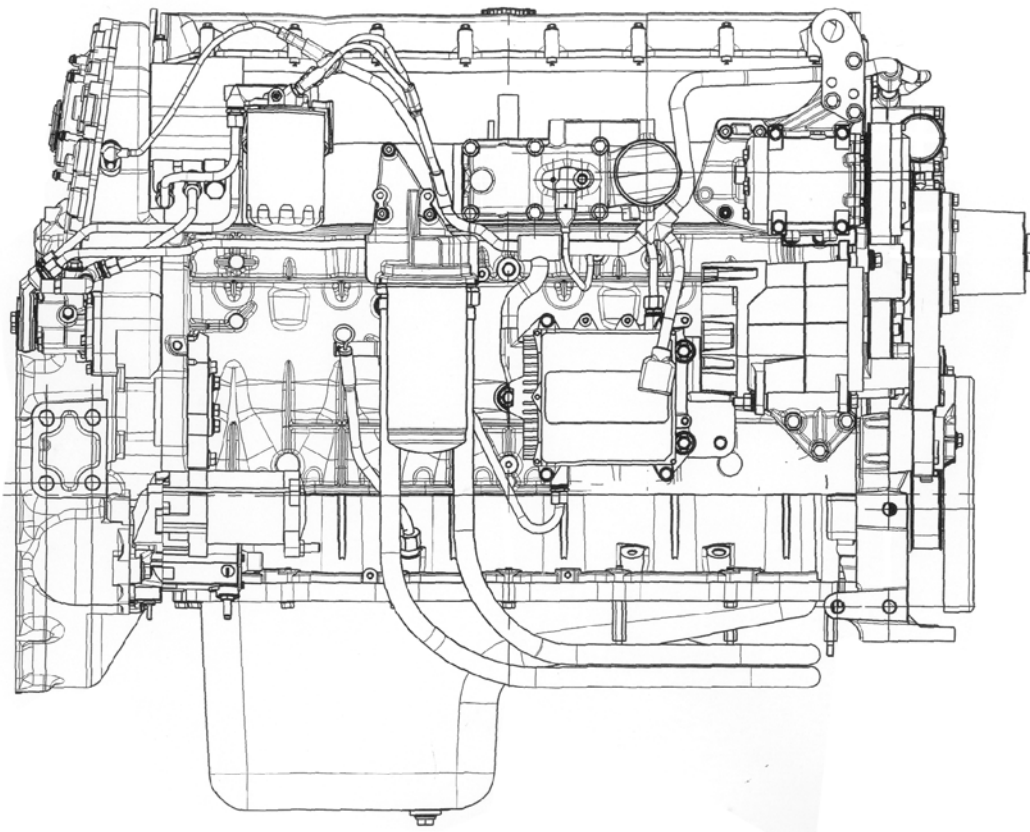
81858

LEFT-HAND SIDE VIEW

VIEWS OF ENGINE (TYPE F3AE0684J*B902 ONLY)

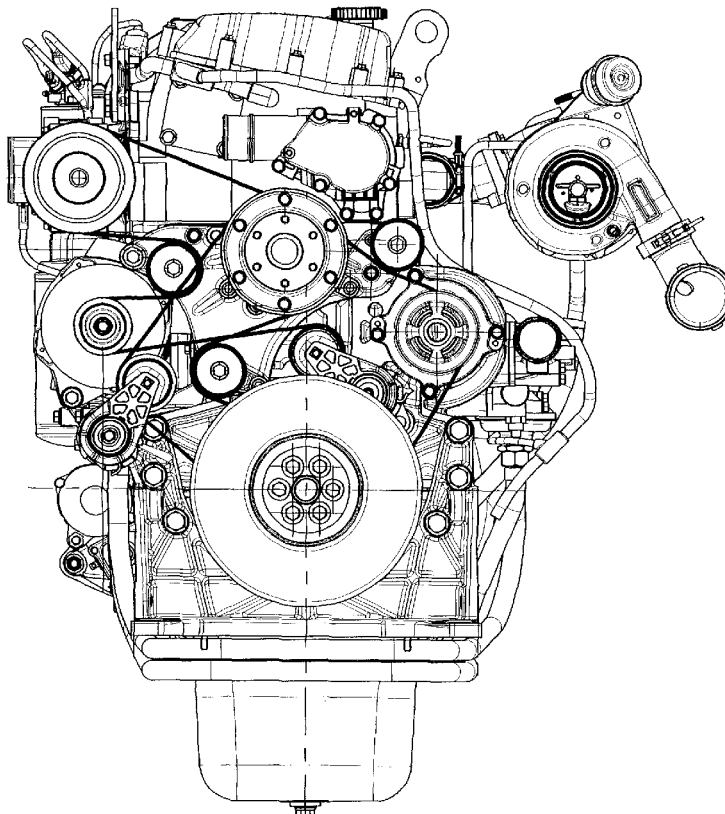
Figure 6

RIGHT-HAND SIDE VIEW



81859

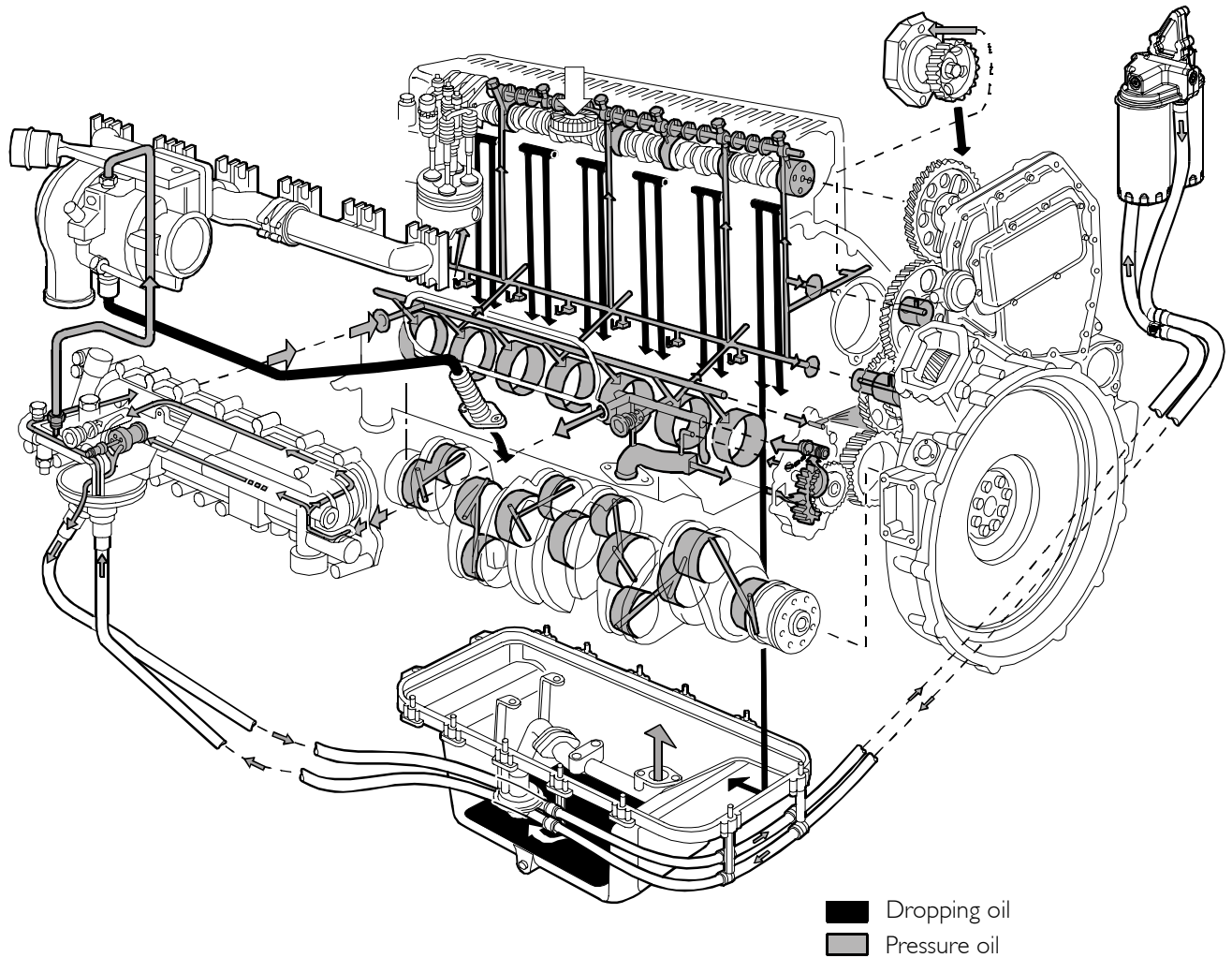
FRONT VIEW



81860

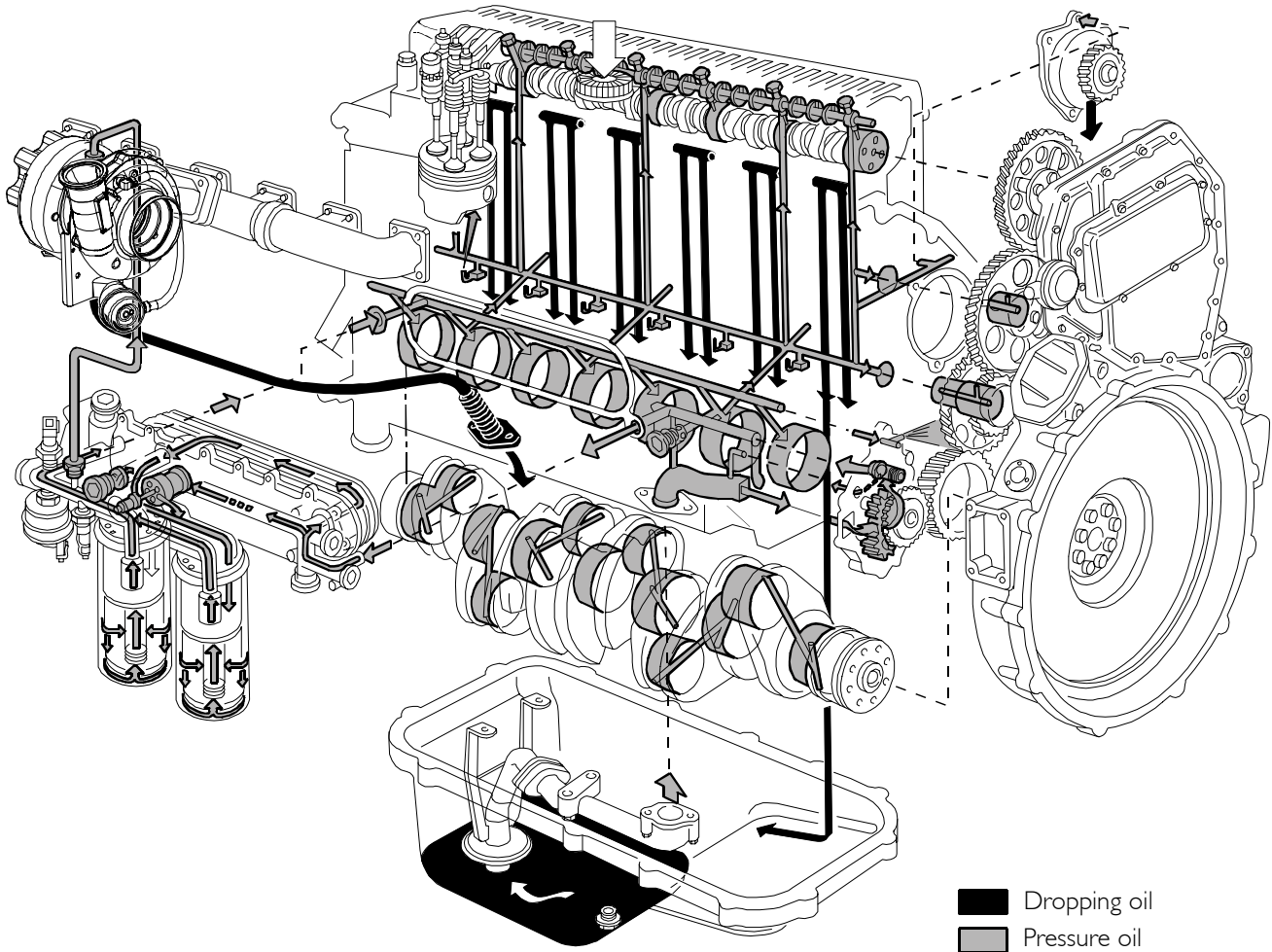
LUBRICATION DIAGRAM, FOR TYPES: F3AE0684D*B001 - F3AE0684G*B003

Figure 7



LUBRICATION DIAGRAM, FOR TYPE F3AE0684E*B002 ONLY

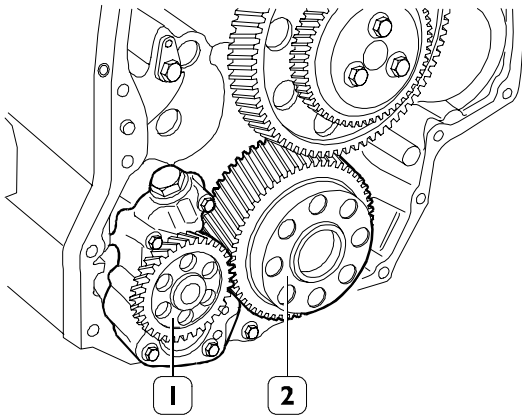
Figure 8



81862

Oil pump

Figure 9



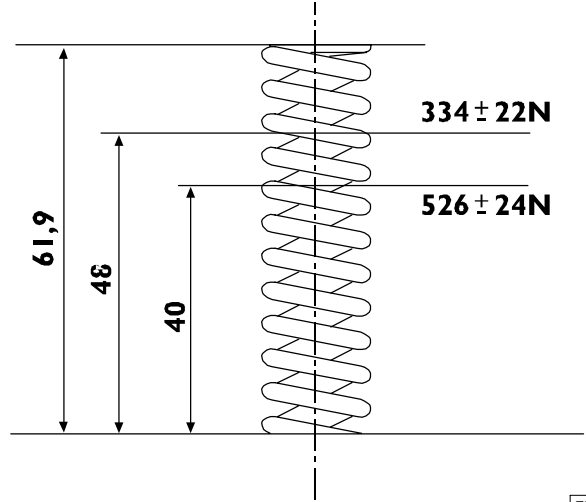
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The oil pump (1) cannot be overhauled. On finding any damage, replace the oil pump assembly.

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

Overpressure valve

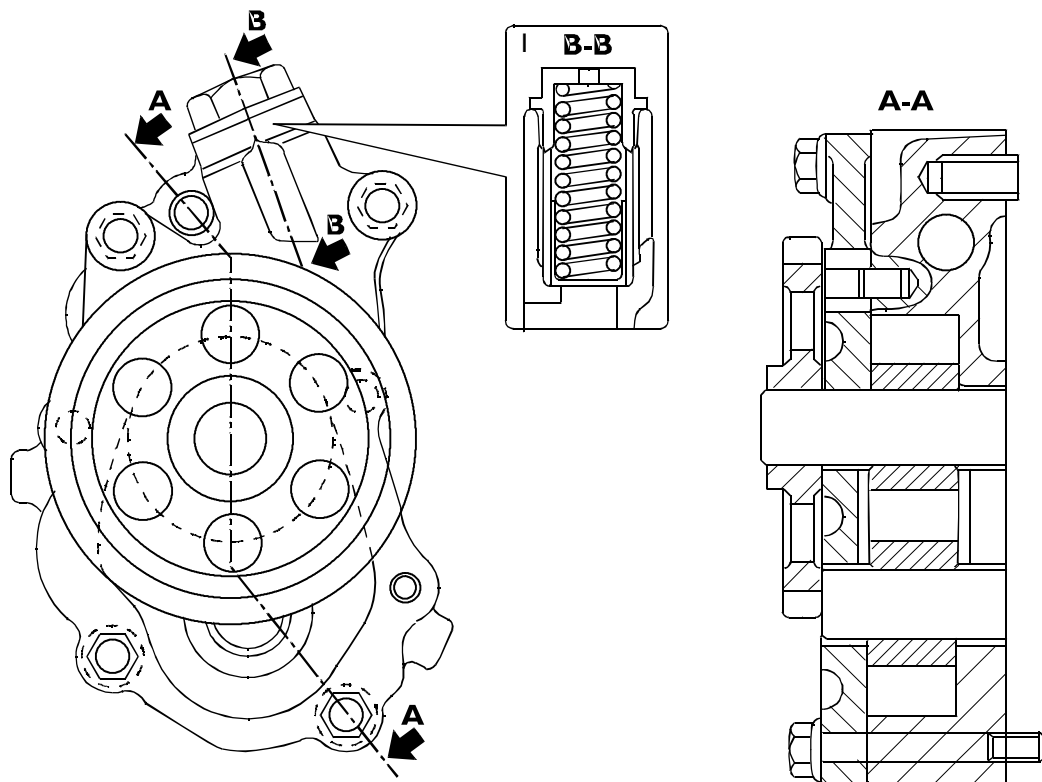
Figure 11



73540

MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

Figure 10



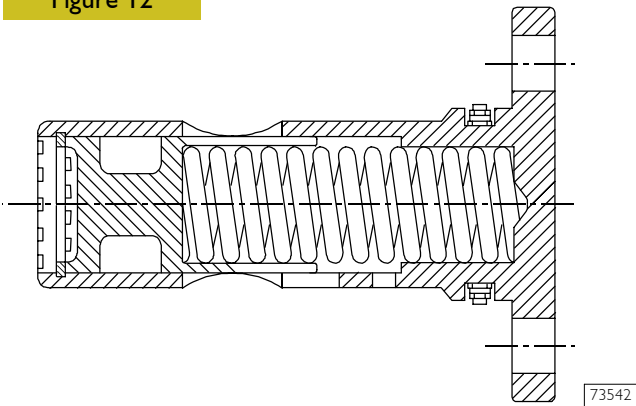
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OIL PUMP CROSS-SECTION

I. Overpressure valve – Start of opening pressure $10,1 \pm 0,7$ bars.

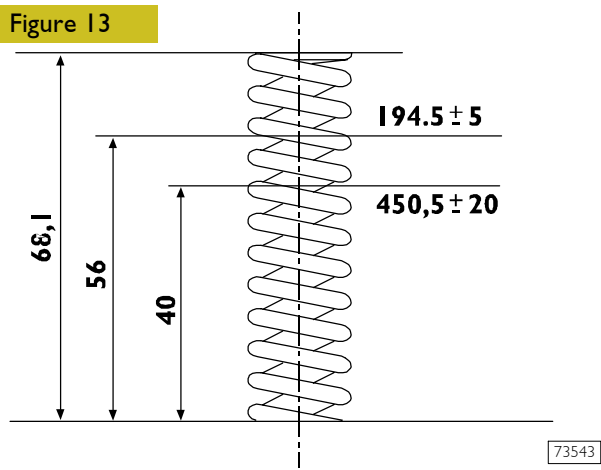
Oil pressure control valve

Figure 12



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

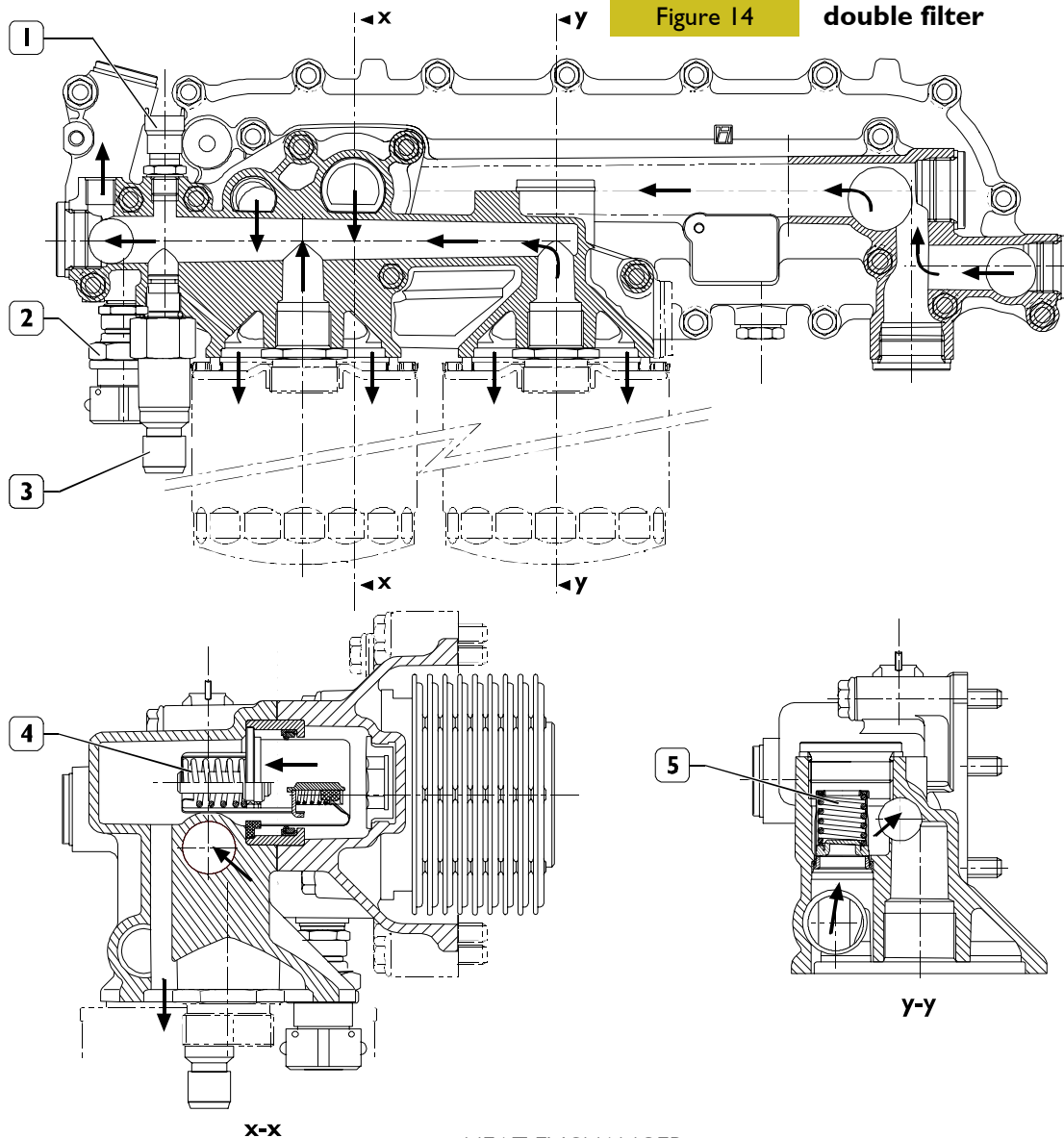
Figure 13



MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

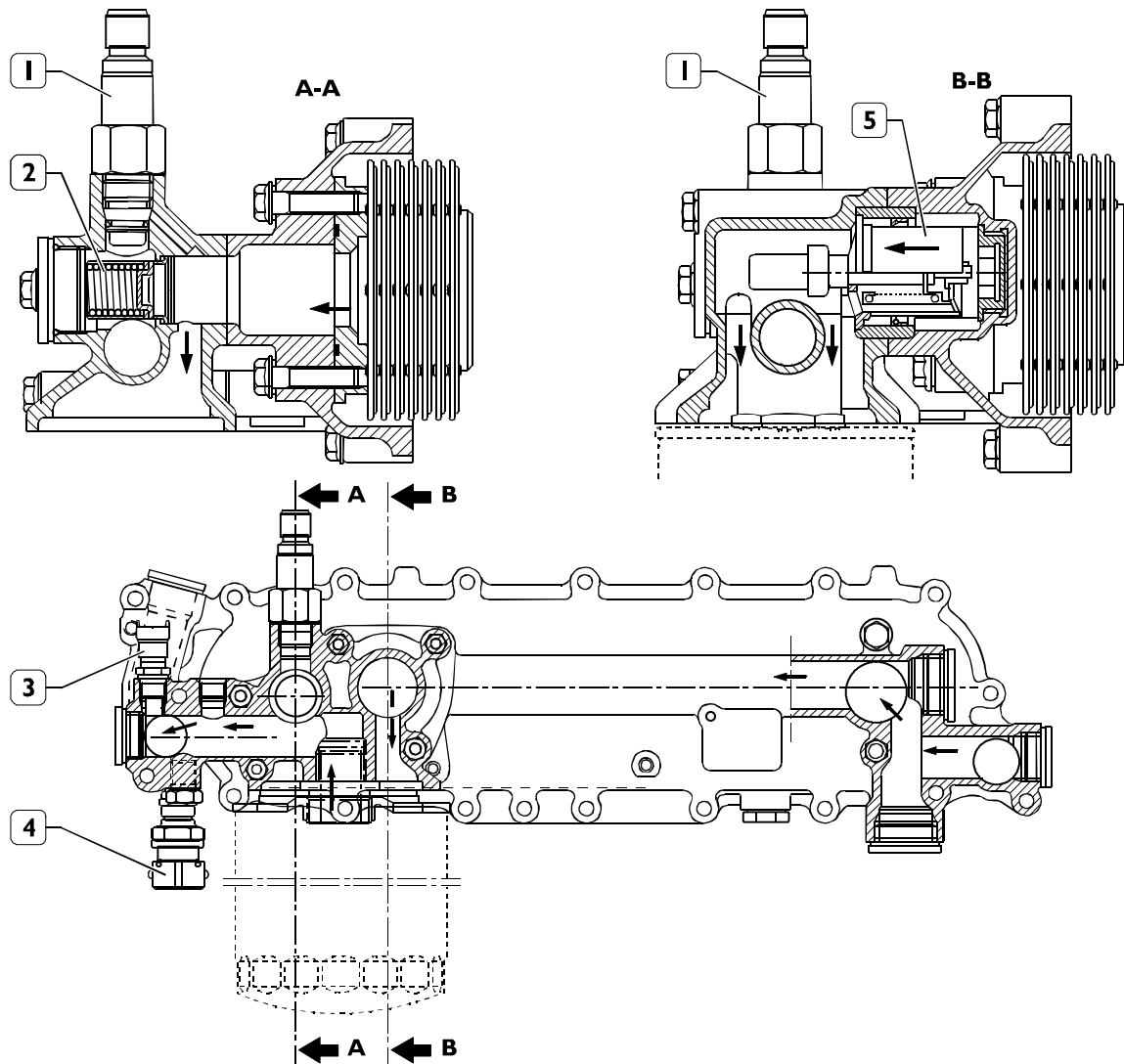
Heat exchanger for engine versions with double filter

Figure 14



HEAT EXCHANGER

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. Heat valve - 5. By-pass valve. Number of elements 9.

Heat exchanger for engine versions with single filter**Figure 15**

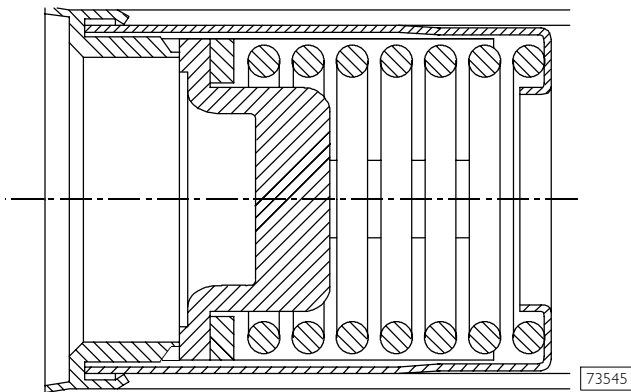
77818

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

Figure 16

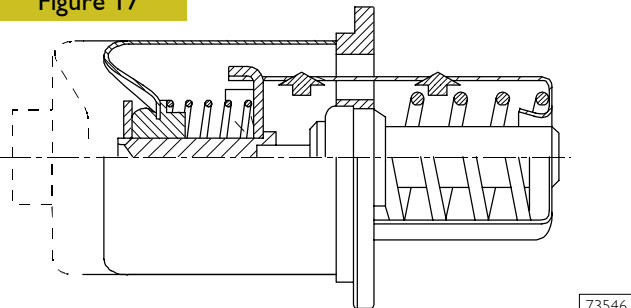


73545

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

Thermostatic valve

Figure 17



73546

Start of opening:

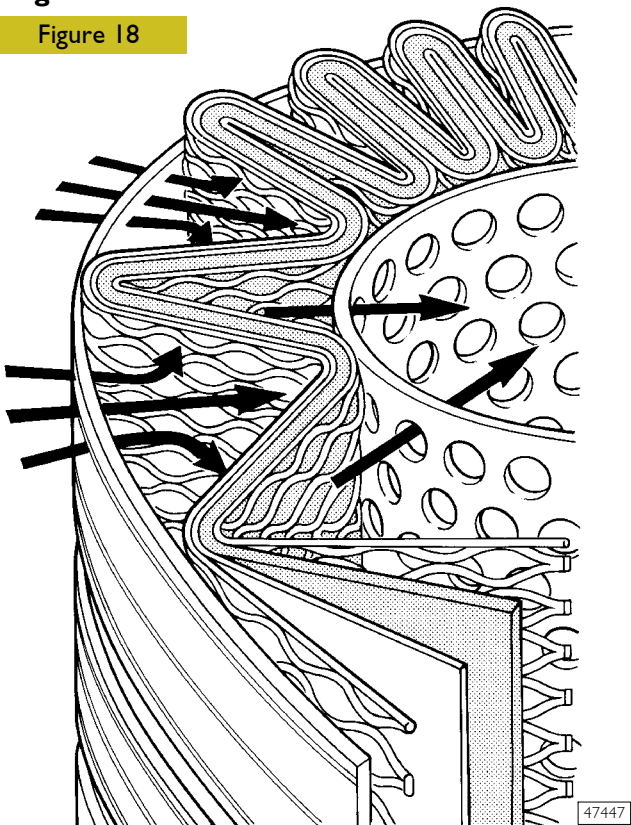
travel 0.1 mm at a temperature of $82 \pm 2^\circ\text{C}$.

End of opening:

travel 8 mm at a temperature of 97°C .

Engine oil filters

Figure 18



47447

This is a new generation of filters that permit much more thorough filtration as they are able to hold 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.

COOLING

Description

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

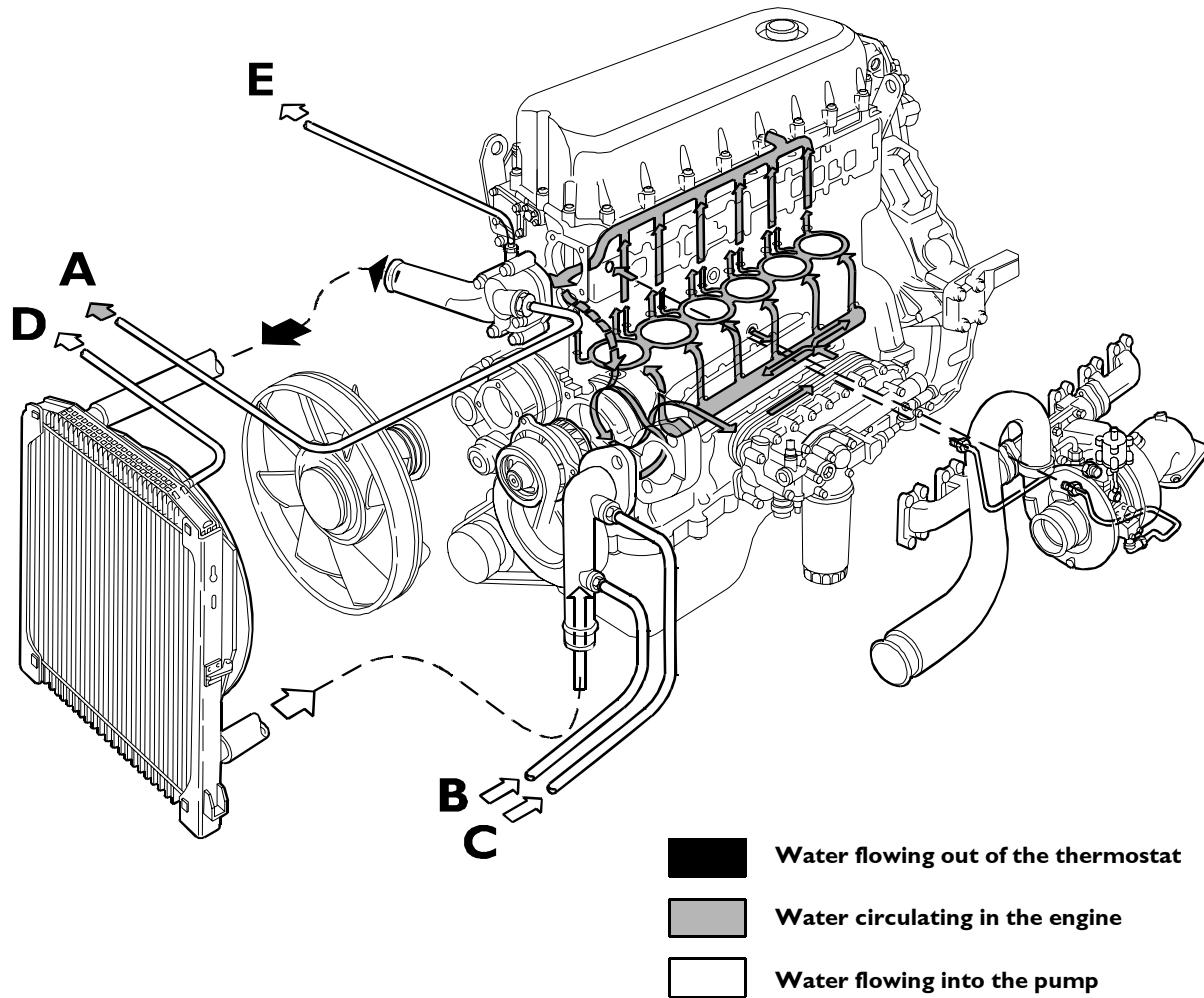
- expansion tank, not supplied (by IVECO);
- a heat exchanger to cool down lubrication oil;
- a water pump with centrifugal system incorporated in the cylinder block;
- fan, not supplied;
- a 2-way thermostat controlling the coolant circulation.

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 19

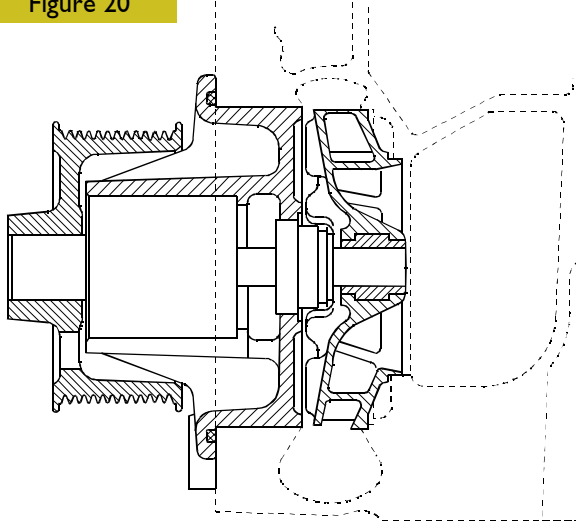


99248

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 20



60631

CROSS-SECTION OF THE WATER PUMP

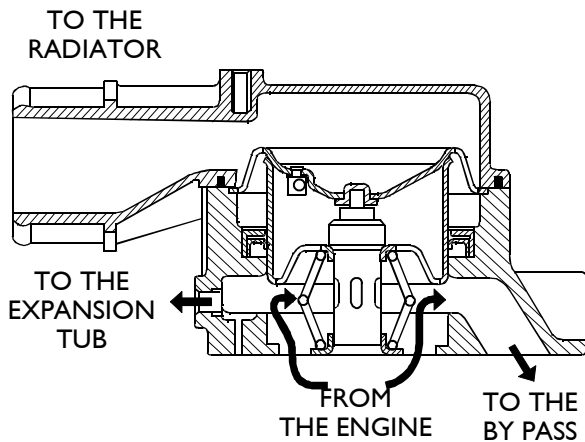
The water pump is composed of: impeller, bearing, seal and driving pulley.

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

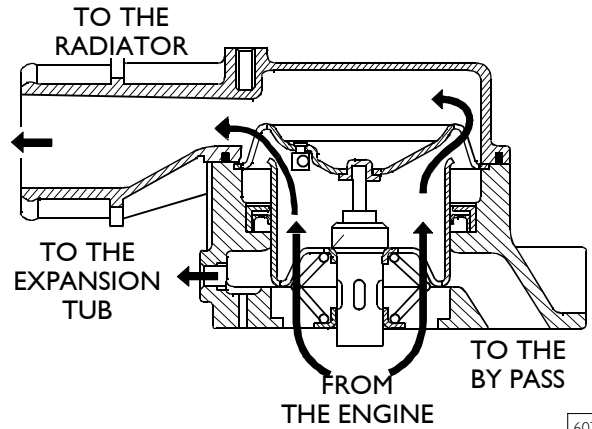
Figure 21



60747

Water circulating in the engine

Figure 22



60748

Water leaving the thermostat

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

Temperature of start of travel $84 \pm 2 \text{ }^\circ\text{C}$.

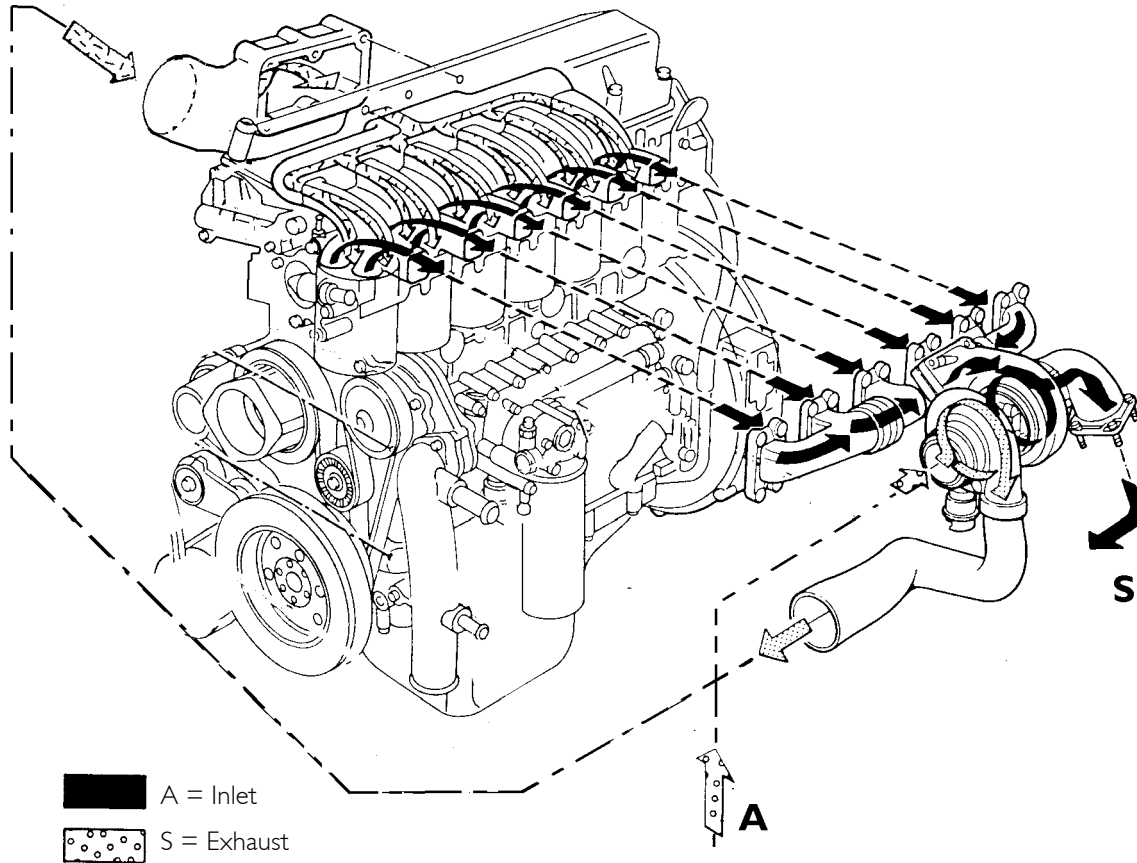
Minimum travel 15 mm at $94 \pm 2 \text{ }^\circ\text{C}$.

TURBOCHARGING

The turbocharging system consists of:

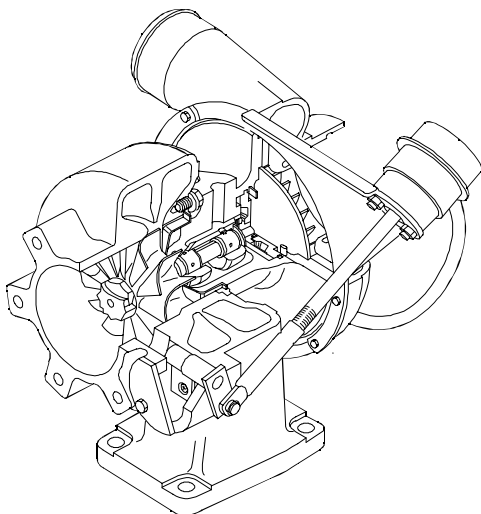
- air filter;
- Wastegate turbocharger.

Figure 23



99251

HOLSET HX 50W turbocompressor



71766

The turbocompressor is a turbocompressor with a return valve.

It is mainly composed by:

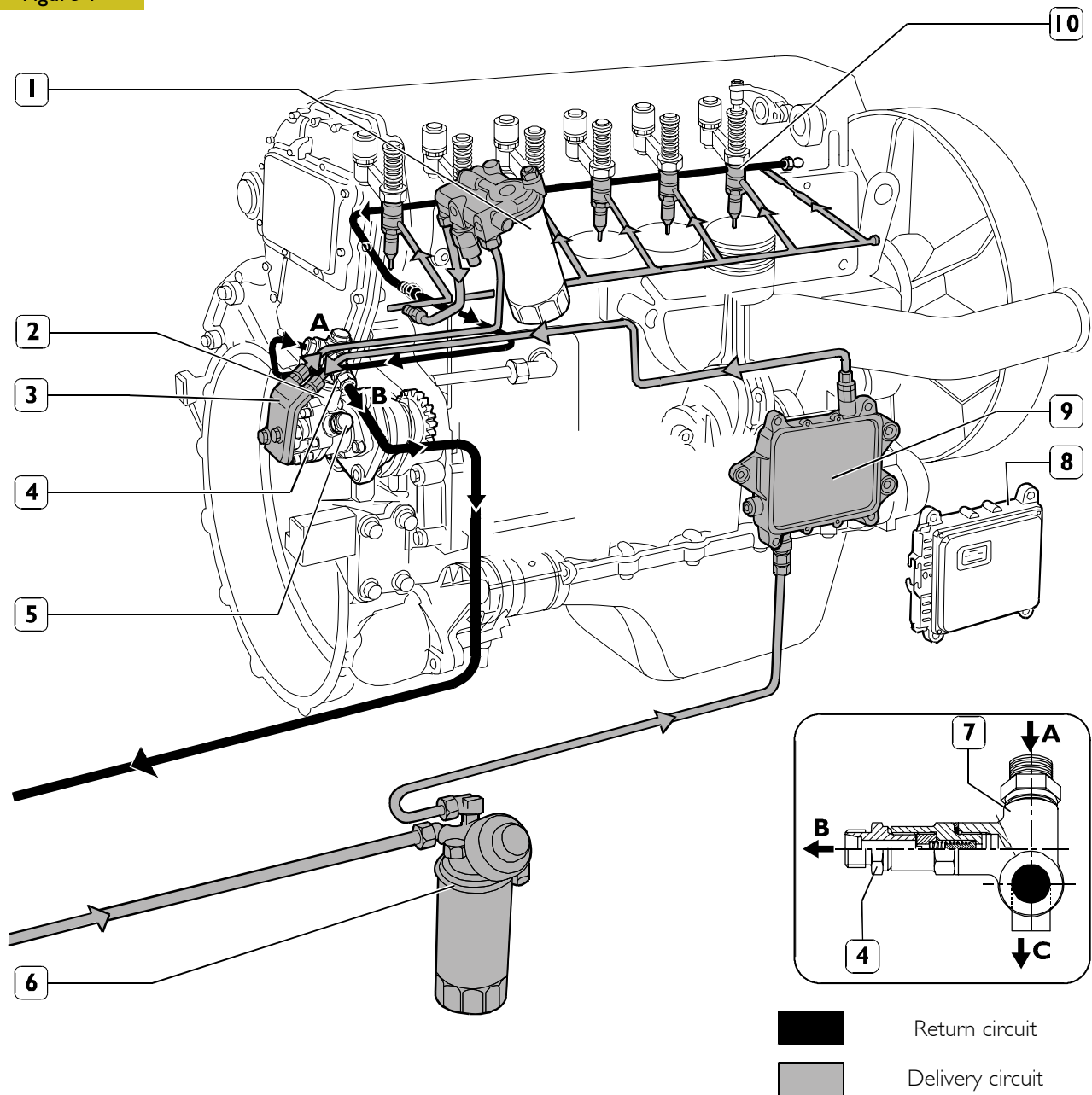
- a central unit where a shaft is positioned supported by bushings, a turbine rotor and a compressor rotor are mounted on each end;
- a turbine unit and a compressor unit mounted at the end of the central unit;
- return valve applied on the turbine unit. It divides burnt gases outlet, sending one part directly to the outlet tube when the boost of the compressor reaches the setting value.

SECTION 2**Fuel**

	Page
FUEL FEED	3
FUEL SUPPLY DIAGRAM (ALL TYPES)	4
<input type="checkbox"/> Overpressure valve	5
<input type="checkbox"/> Fuel pump	5
<input type="checkbox"/> Injector-pump	5
<input type="checkbox"/> Injector Phases	6

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.

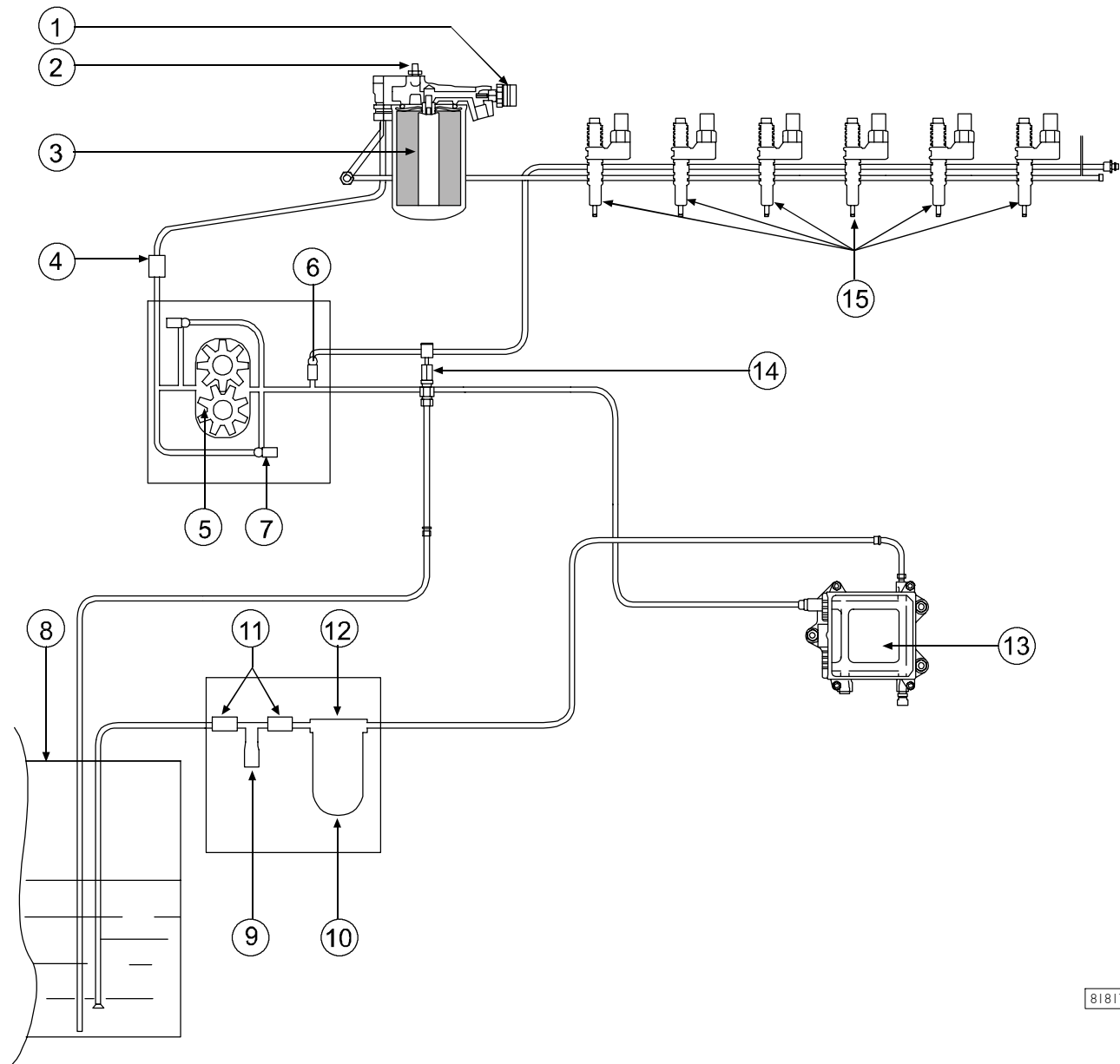
Figure 1

92828

ENGINE FUEL SUPPLY DIAGRAM WITH FUEL PUMP ON THE TIMING SYSTEM CONTROL

1. Fuel filter - 2. Valve for fuel recirculation from injectors integrated in the fuel pump (start opening 3,5 bar) - 3. Fuel pump - 4. Overpressure valve for fuel return to the tank (start opening 0,2 bar) - 5. Pressure control valve (start opening 5 bar) - 6. Prefilter with priming pump - 7. Connector - 8. Gearcase - 9. Heat exchanger - 10. Pump injectors.

A. Fuel arrival from injectors - B. Fuel return to the tank - C. Fuel inlet from injectors in the fuel filter

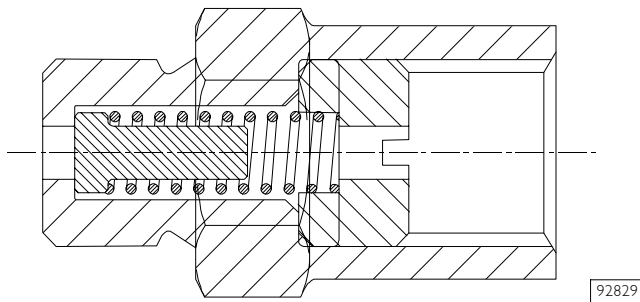
FUEL SUPPLY DIAGRAM (ALL TYPES)**Figure 2**

81817

1. Temperature sensor - 2. Bleed valve - 3. Secondary fuel filter - 4. By-pass valve (0.3 ± 0.4 bar) - 5. Fuel supply pump - 6. Integrated valve (3.5 bar) - 7. Pressure relief valve (5 bar) - 8. Fuel tank - 9. Priming pump - 10. Primary fuel filter - 11. Check valve (opening 0.1 bar) - 12. Heater - 13. Electronic control unit - 14. Fuel return union with valve built in (0.2 bar) - 15. Pump-injectors.

Overpressure valve

Figure 3

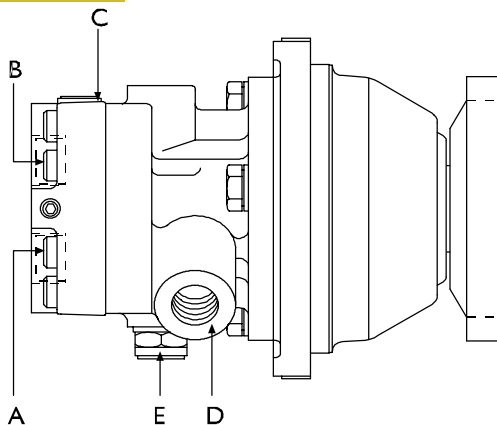


92829

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.

Fuel pump

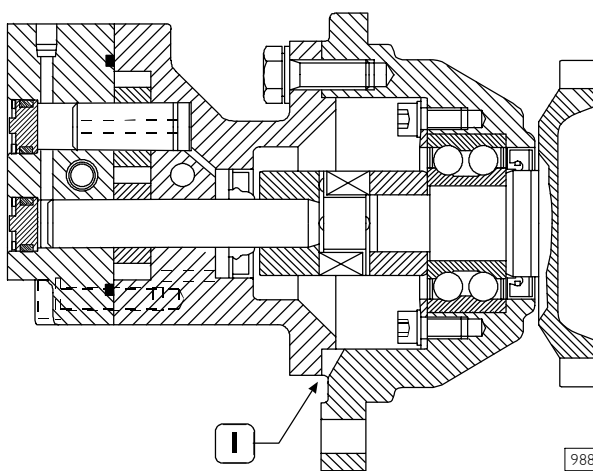
Figure 4



73547

Fuel pump mounted on timing system
 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



98870

CROSS-SECTION OF THE FUEL PUMP
 I. Oil and fuel leakage 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
	Pressure on delivery (bar)	5	3	0,3
	Test liquid temperature (°C)	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

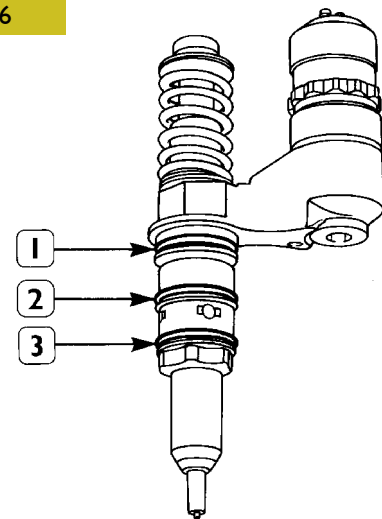
Valve calibration	5 ± 5.8
-------------------	---------

Injectors return valve

Valve calibration	3.2 ± 3.8
-------------------	-----------

Injector-pump

Figure 6



44908

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.

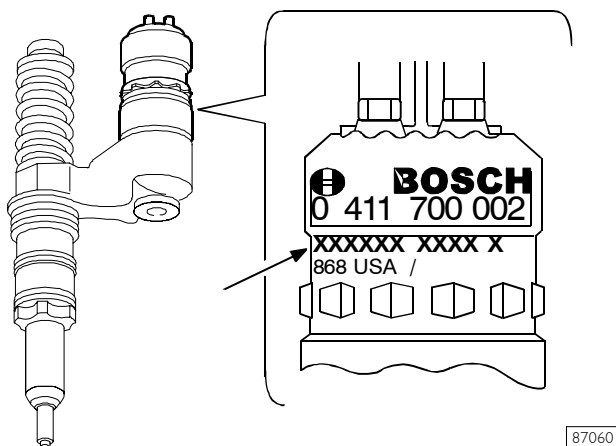
The amount of fuel injected depends on the length of time the slide valve is closed and therefore on the time for which the solenoid is energized.

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).

Figure 7

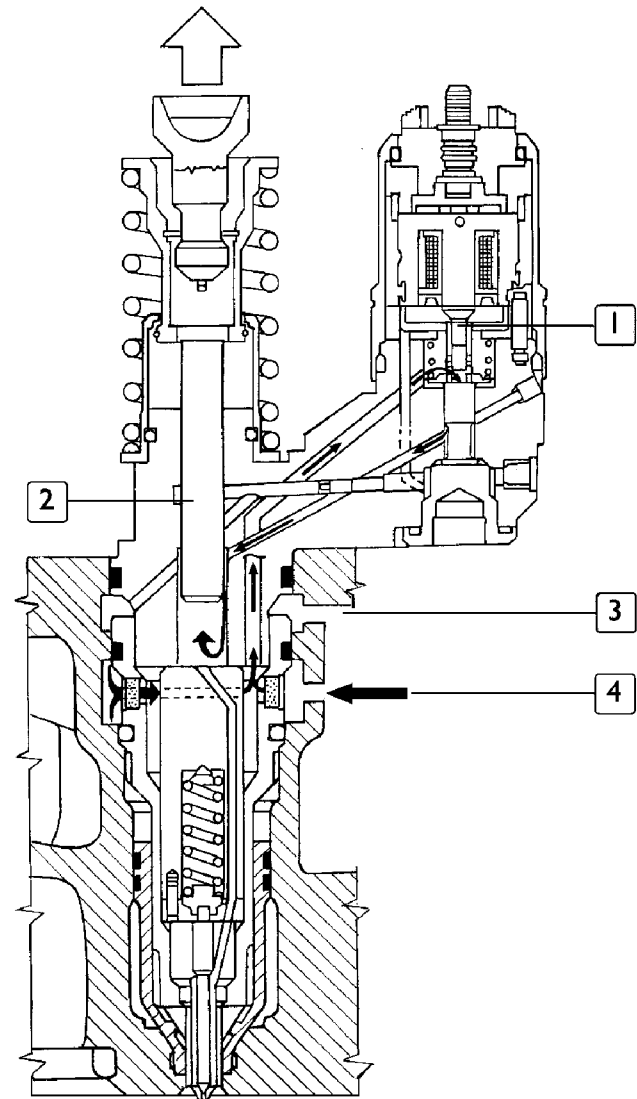


For each replaced injector you shall connect with the diagnosis device and when it is required by the program you shall insert the printed code on the injector (→) to program the gearcase again.

NOTE When checking the clearance of the rocker arms, it is important to check the injector-pump pre-load.

Injector Phases

Figure 8



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

Filling phase

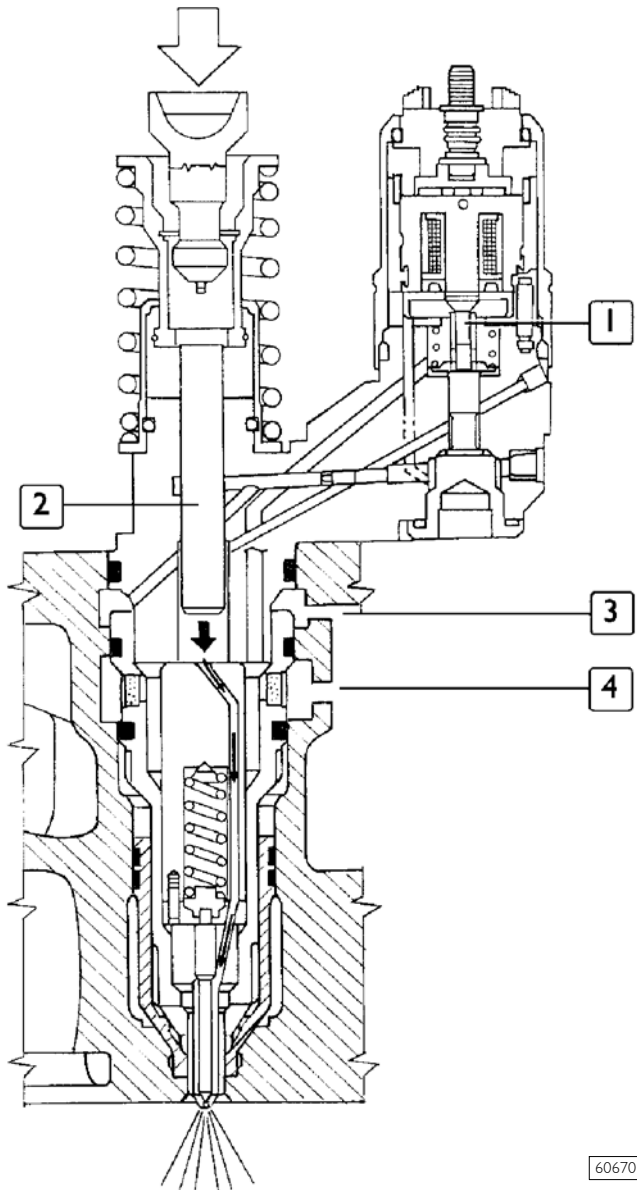
During the filling phase the pumping element (2) runs up to the top position.

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 9



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

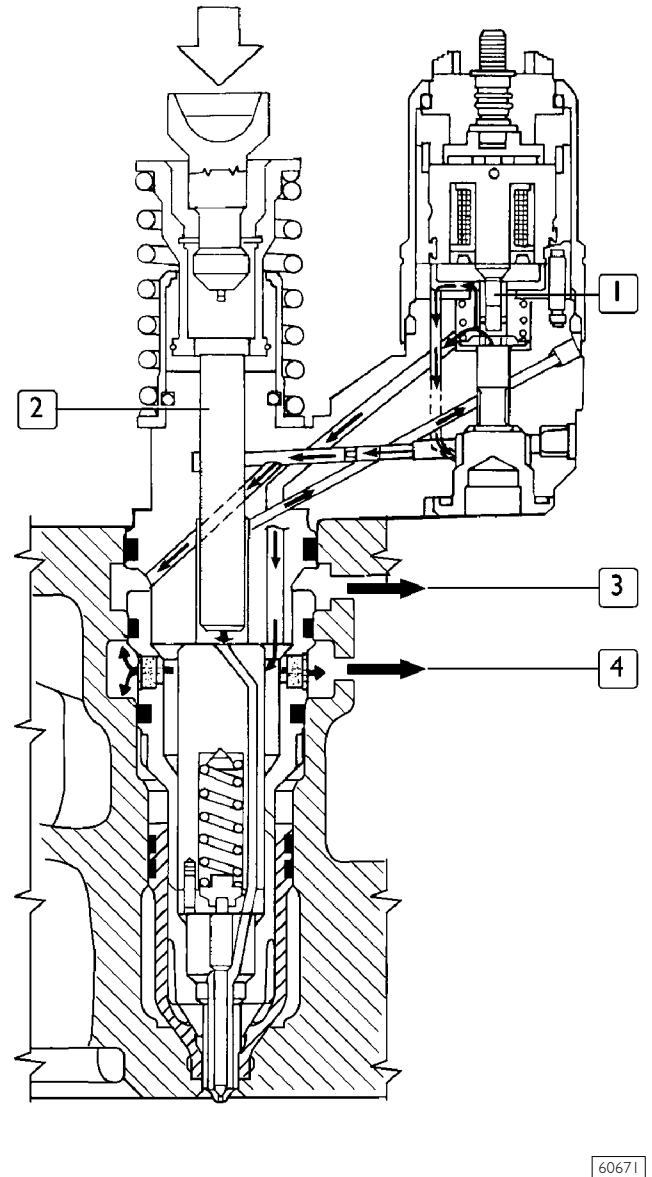
Injection phase

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 10



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.

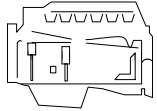

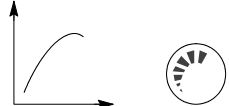
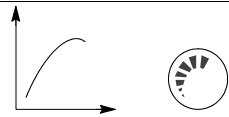


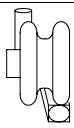

The time for which the solenoid valve stays energized, appropriately calculated by the electronic control unit, is the duration of injection (delivery) and it depends on the working conditions of the engine.

SECTION 3**Industrial application**

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<input type="checkbox"/> Fitting pump-injectors	18
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CLEARANCE DATA

	Type	F3AE0684					F3AE0687	
		D*B001	D*B003	E*B002	G*B003	J*B002	A*....	
	Compression ratio	17.5:1						
	Max. output	kW (HP) rpm	335 (455) 2100	335 (455) 2100	265/284 (360/386) 2100/1800	295 (401) 2100	335 (455) 2100	295 (400) 2100
	Max. torque	Nm (kgm) rpm	1900 (190) 1380	1900 (190) 1380	1656 (165) 1340	1719 (171) 1380	1900 (190) 1380	1719 (171) 1380
	Loadless engine idling	rpm	1300	1300	900	1300	1000	1300
	Loadless engine peak	rpm	2110	2110	2110	2110	2110	2110
	Bore x stroke Displacement	mm cm ³	125 x 140 10300					
	SUPERCHARGING Turbocharger type		Intercooler Direct injection HOLSET HX50W					
	LUBRICATION Oil pressure (warm engine) - idling - peak rpm	bar bar bar	Forced by gear pump, relief valve single action oil filter 4 5					
	COOLING Water pump control Thermostat - start of opening	°C	By centrifugal pump, regulating thermostat, heat exchanger, intercooler Through belt 80					

NOTE Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

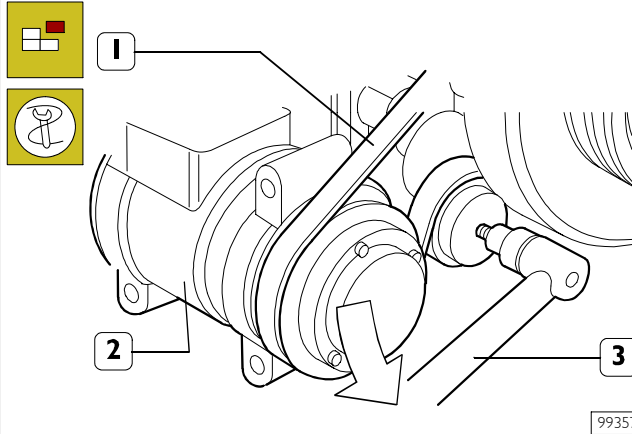
Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turns based on which the engine has been designed.

PART ONE - MECHANICAL COMPONENTS

ENGINE ASSEMBLY DISASSEMBLY

NOTE Handle all parts extremely carefully. Never get your hands or fingers between pieces. Wear the required safety clothing such as goggles, gloves and safety shoes.

Figure 1

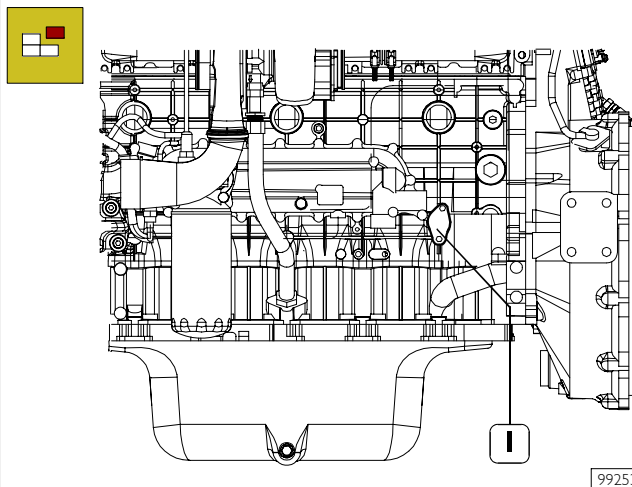


Protect the electric parts before doing any washing with high-pressure jets.

Before securing the engine on the rotary stand, remove:

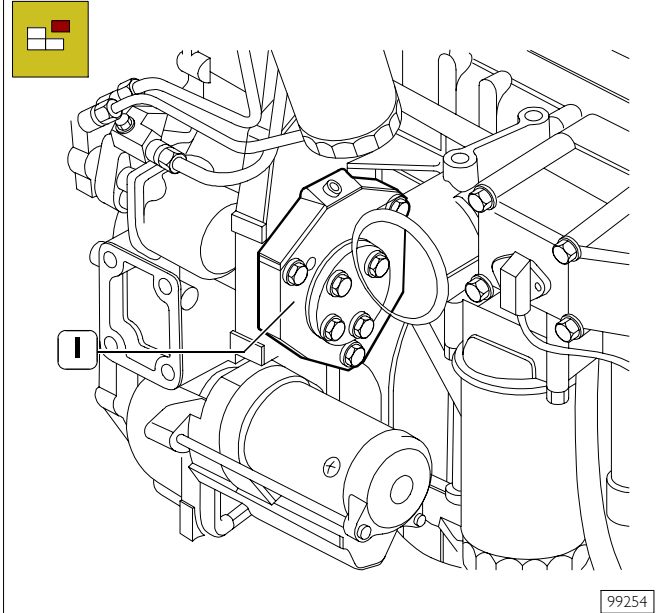
- the engine electric cable, disconnecting it from the control unit and from all the sensors/transmitters connected to it;
- using a suitable tool (3), work in the direction of the arrow on the tightener and remove the compressor drive belt (1);
- remove the compressor (2) together with the engine support.

Figure 2



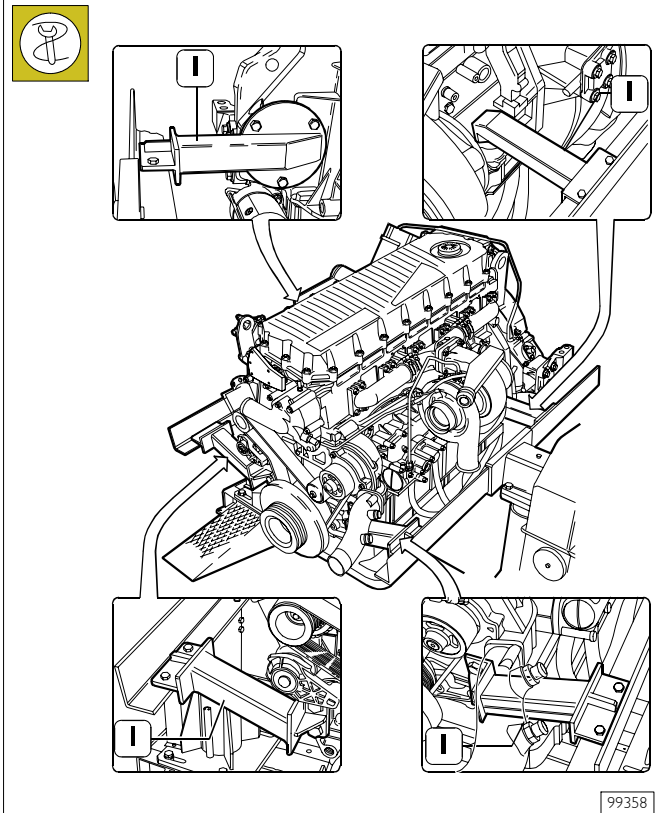
- Remove the oil pressure adjuster valve (1).

Figure 3



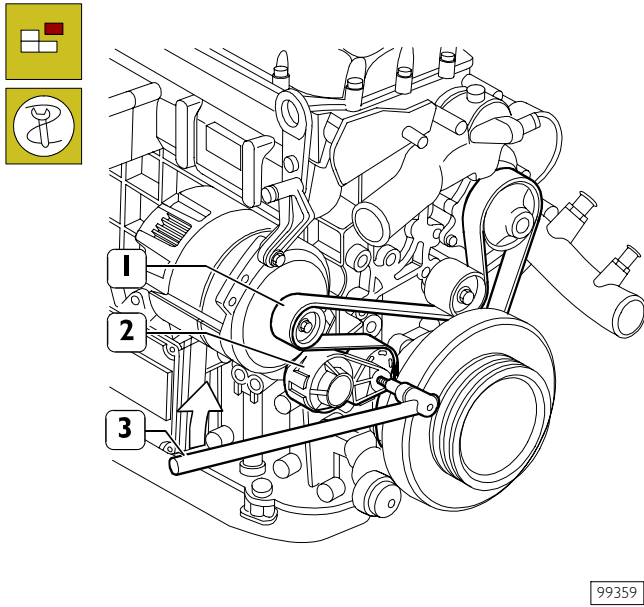
- Remove the engine supports;
- remove the drive (1).

Figure 4



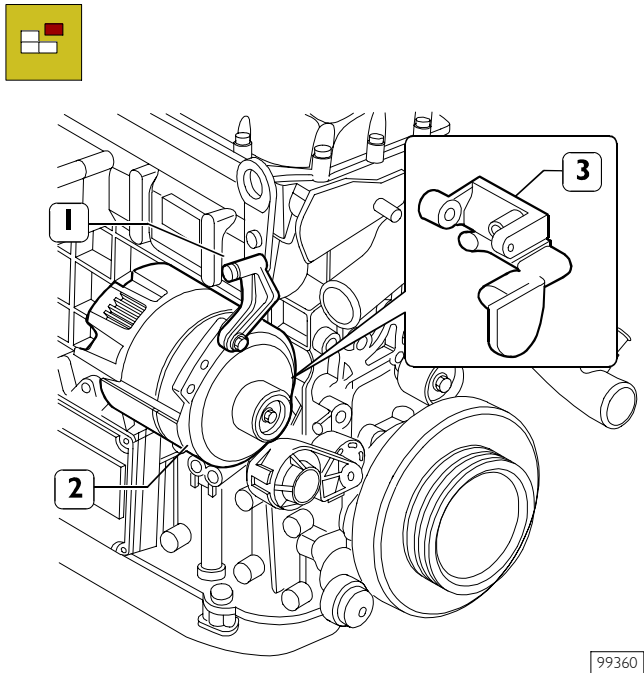
- Secure the engine to the rotary stand with the brackets 993601036.
- Drain the lubricating oil from the sump.

Figure 5



- Using a suitable tool (3), work in the direction of the arrow on the tightener (2) and remove the belt (1).

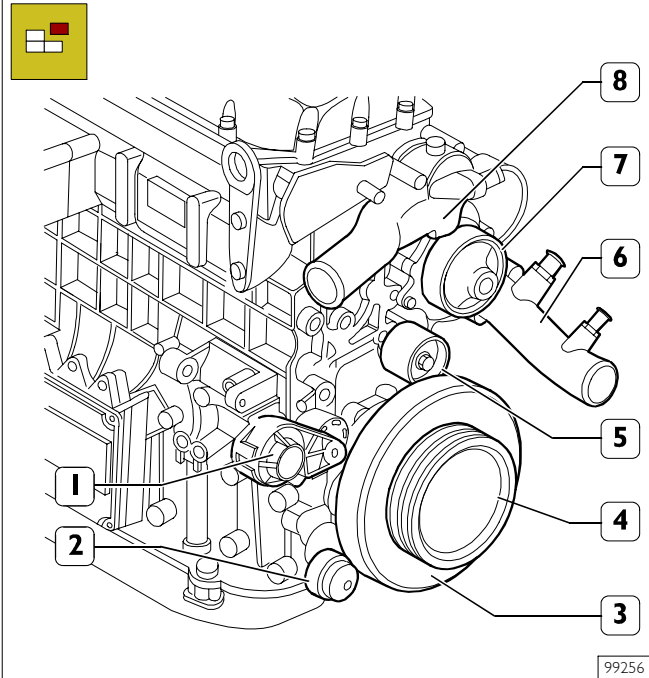
Figure 6



Remove:

- alternator (2).
- supports (1 and 3).

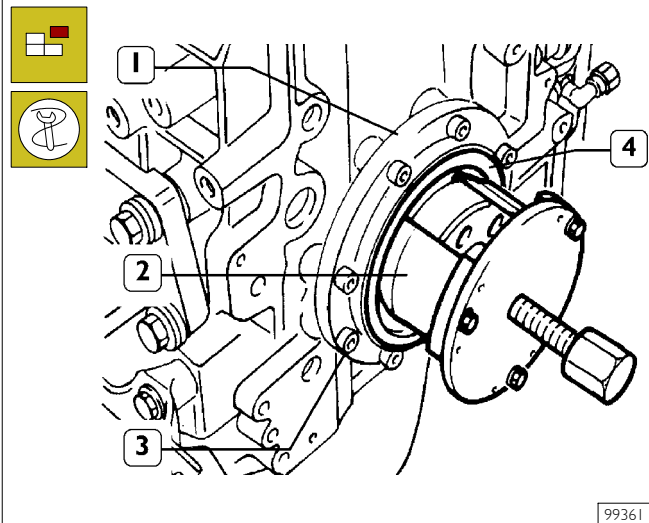
Figure 7



Remove:

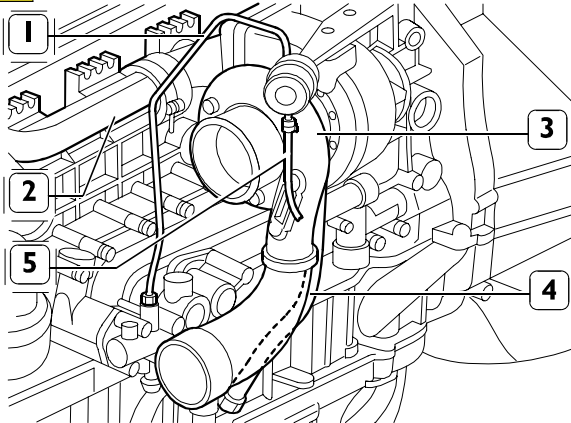
- thermostat assembly (8);
- pipes complete with coolant (6);
- pulley (4);
- water pump (7);
- automatic tightener support (1);
- fixed tightener (5);
- damper flywheel (3) and pulley beneath;
- automatic tightener (2);

Figure 8



with the extractor 99340053 (2) applied as shown in the figure, extract the seal (4). Undo the screws (3) and take off the cover (1). Disconnect all the electrical connections and sensors.

Figure 9

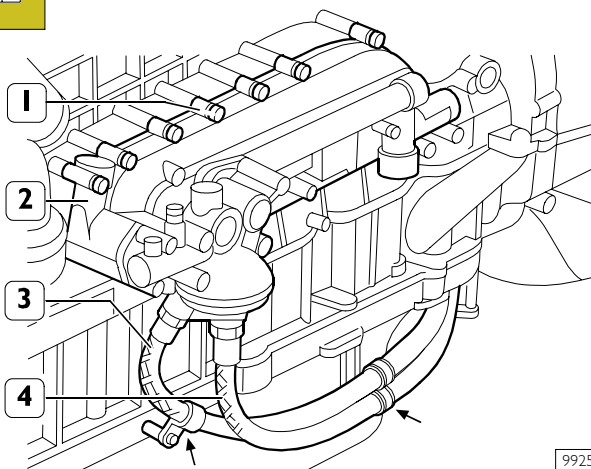


99274

On the engine exhaust side, remove the following parts:

- oil delivery pipe (1);
- actuator air pipe (5);
- oil return pipe (4);
- turbocharger (3);
- exhaust manifold (2).

Figure 10

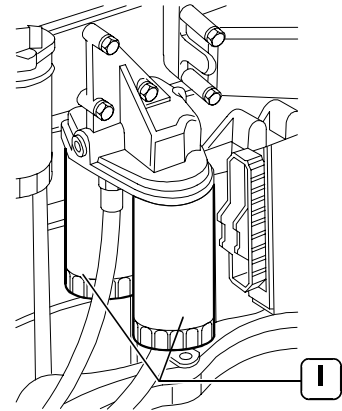


99258

For all types except F3AE0684D*B003 - F3AE0684E*B002

- disconnect the oil pipes (3) and (4) and disengage them from the clamps (←);
- take out the fixing screws (1) and remove the cooler (2);

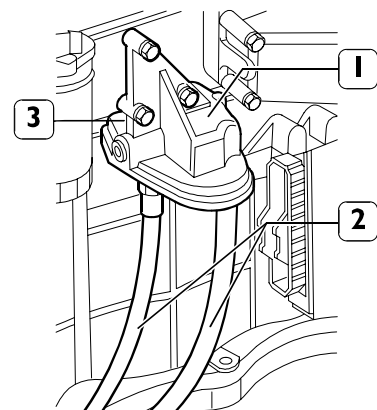
Figure 11



101960

- using tool 99360314 unscrew the oil filters (1).

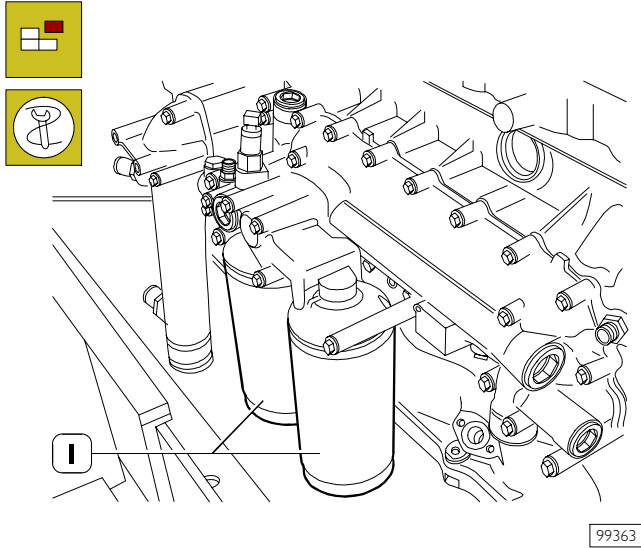
Figure 12



99362

- Disconnect the pipes (2) from the support (1) disengaging them from the clamps and remove them.
- Take out the screws (3) and remove the supports (1).

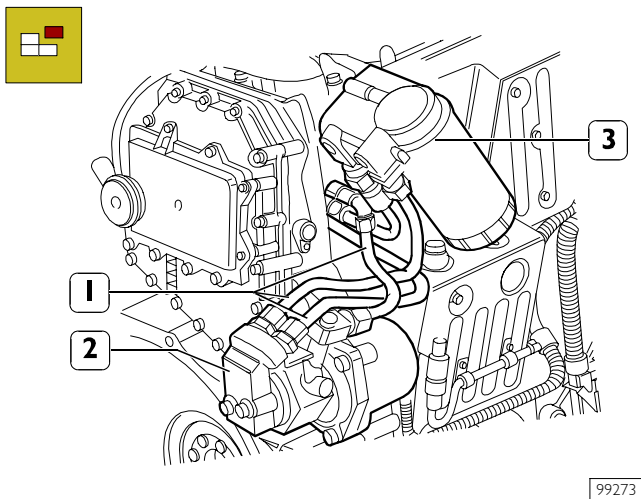
Figure 13



99363

For types F3AE0684D*B003 and F3AE0684E*B002 only, using tool 99360314 (2), unscrew the oil filters (1).

Figure 14



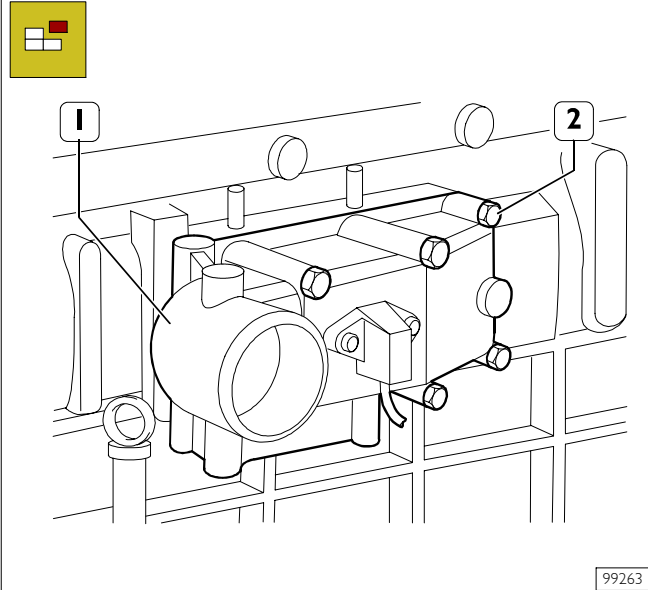
99273

Disconnect the fuel pipes (1) from the fuel pump (2).

Remove:

- the fuel pump (2);
- the fuel filter unit (3) and pipes (1).

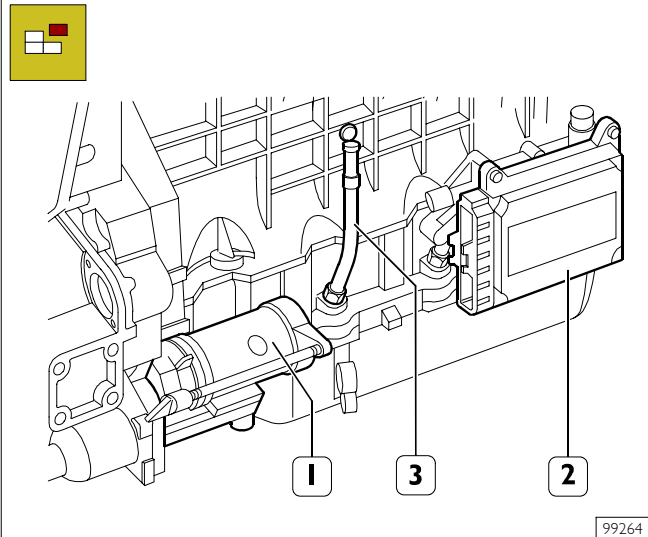
Figure 15



99263

Take out the screws (2) and remove the intake manifold (1).

Figure 16

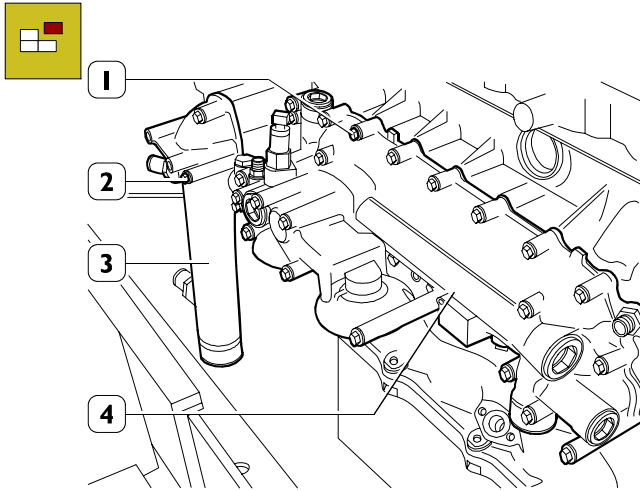


99264

Remove:

- the starter motor (1);
- the control unit (2) and its support;
- the oil dipstick (3) from the crankcase.

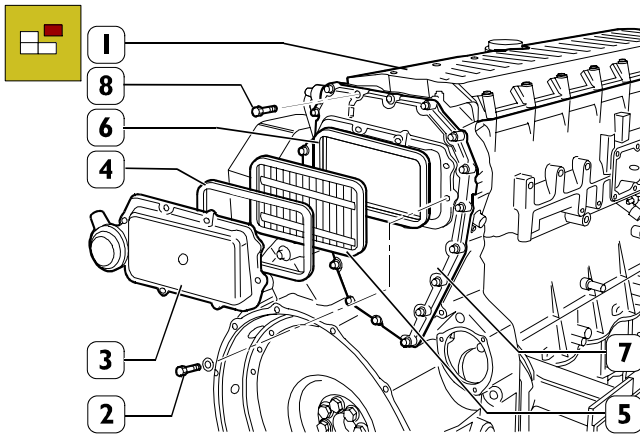
Figure 17



60493

- Unscrew the screws (1) and remove the heat exchanger (4);
- unscrew the screws (2) and remove the water line (3).

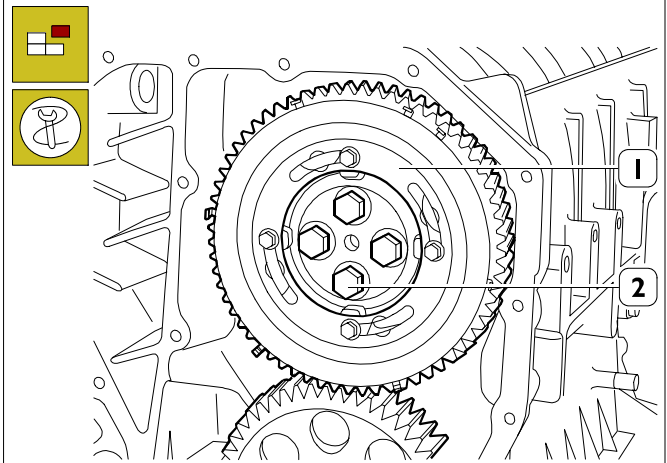
Figure 18



85480

- 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).

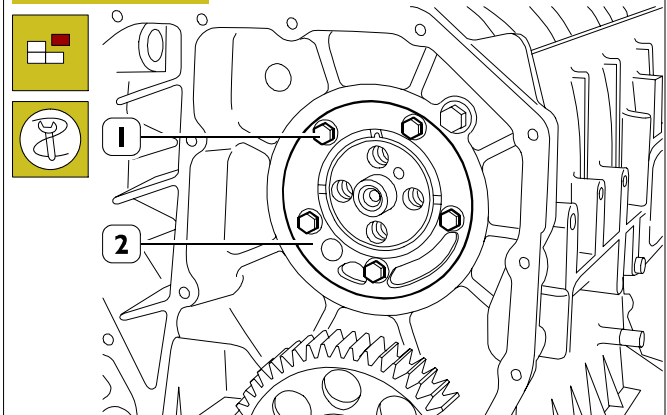
Figure 19



60496

- Unscrew the screws (2) and remove the gear (1) fitted with phonic wheel.

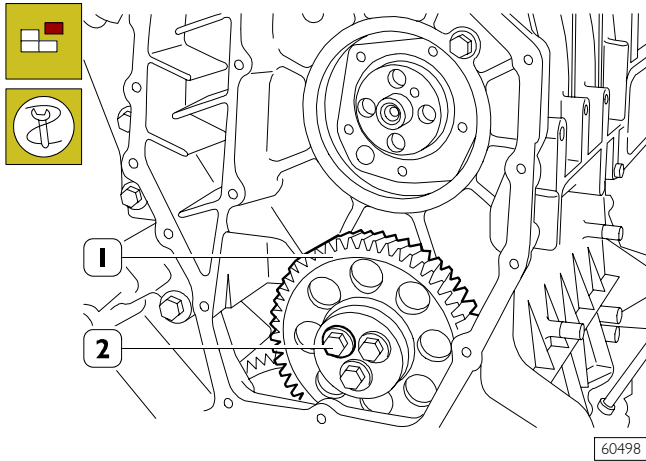
Figure 20



60497

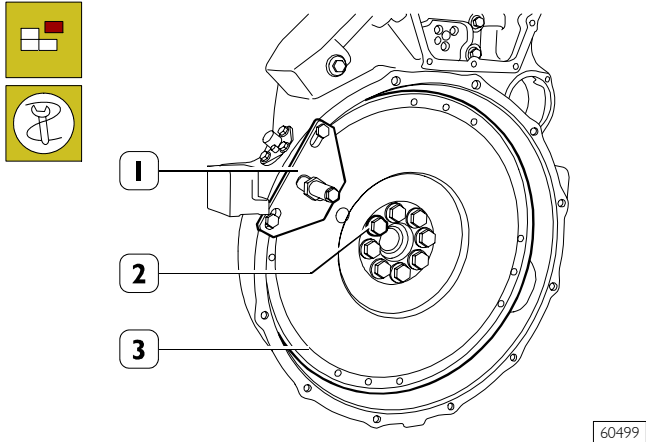
- Unscrew the screws (1); tighten one screw in a reaction hole and remove the shoulder plate (2), remove the sheet gasket.

Figure 21



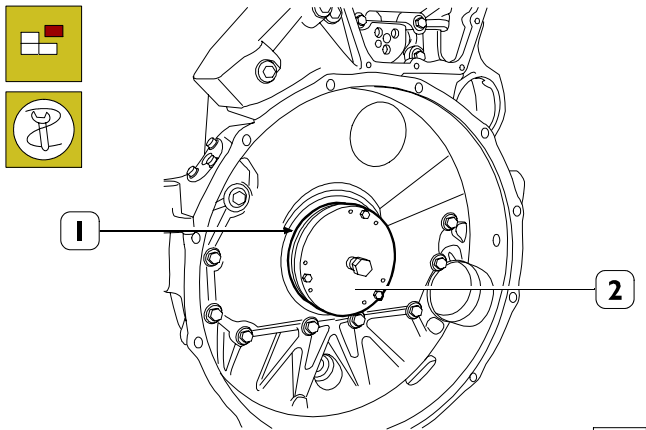
Unscrew the screws (2) and remove the transmission gear (1).

Figure 22



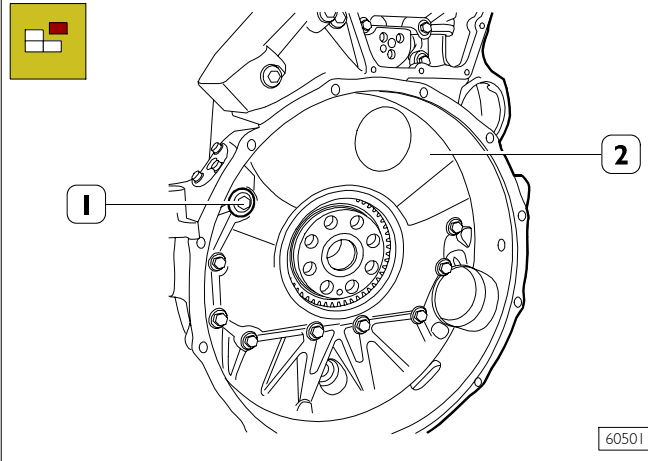
Stop the engine flywheel (3) rotation by means of tool 99360351 (1), unscrew the fixing screws (2) and remove the engine flywheel.

Figure 23



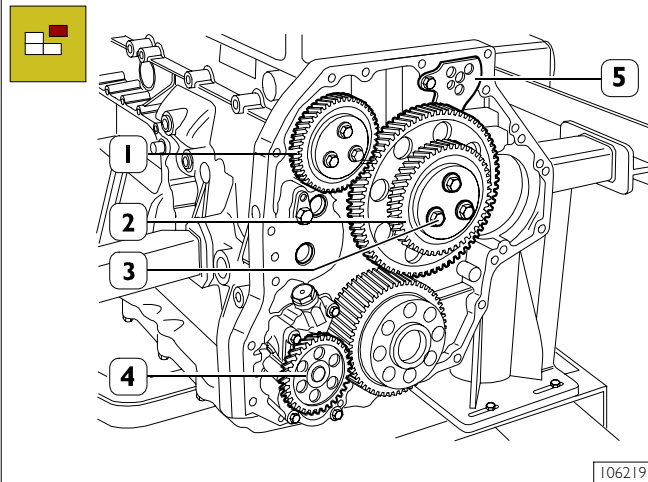
Apply the extractor 99340054 (2) and pull out the seal gasket (1).

Figure 24



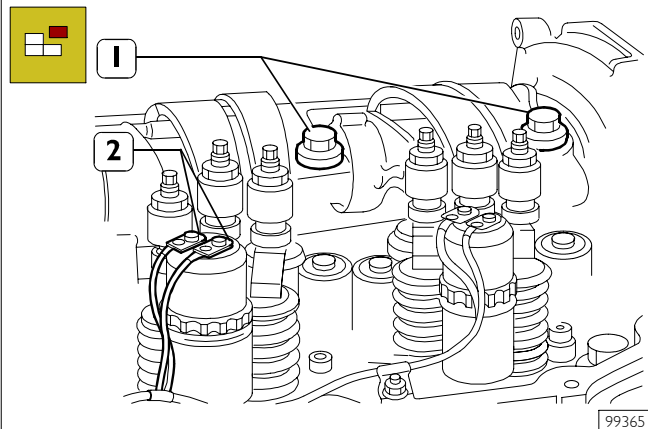
Unscrew the screws (1) and take down the gearbox (2).

Figure 25



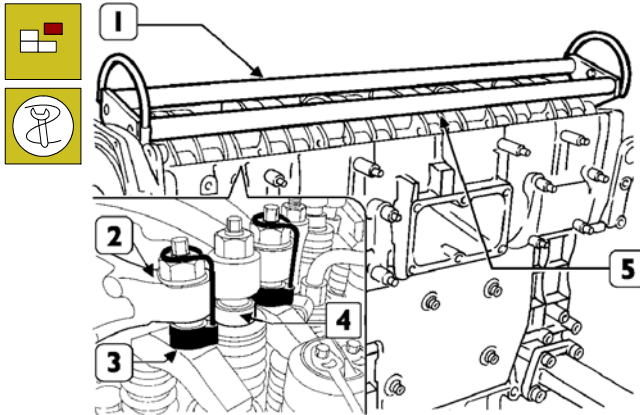
Remove screws (3) and dismount double gear (2). Remove securing screw and dismount articulated rod (5). Dismount oil pump (4).

Figure 26



- To release lever stop springs.
- Loosen the screws and remove electric connections (2) from the pump injector solenoid valves.
- Unscrew the screws (1) fixing the rocker arm shaft.

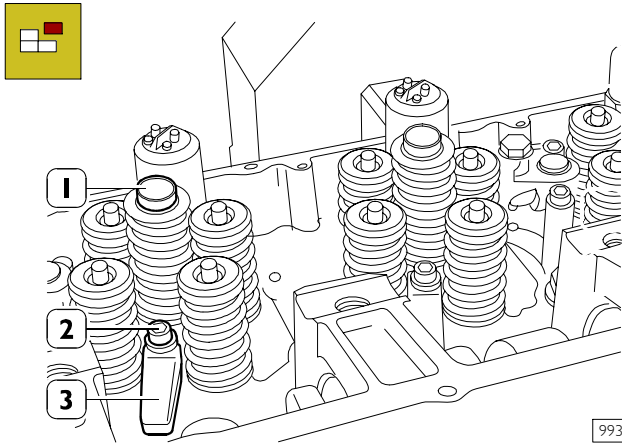
Figure 27



73533

Using tool 99360144 (3), constrain the blocks (4) to the rockers (2).
Apply tool 99360553 (1) to the rocker holder shaft (5) and remove the shaft (5) from the cylinder head.

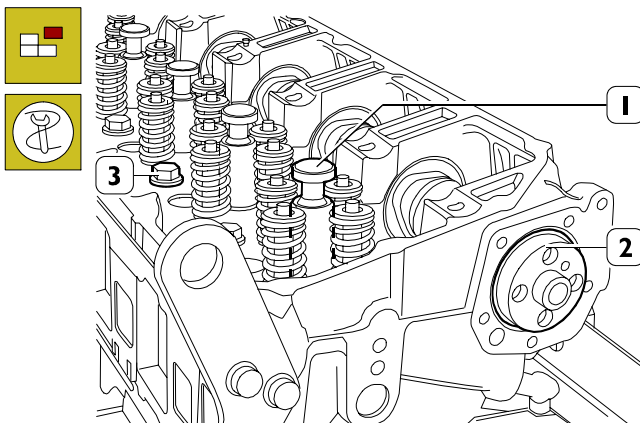
Figure 28



99366

□ Unscrew the screws (2) fixing the brackets (3) and remove the injectors (1).

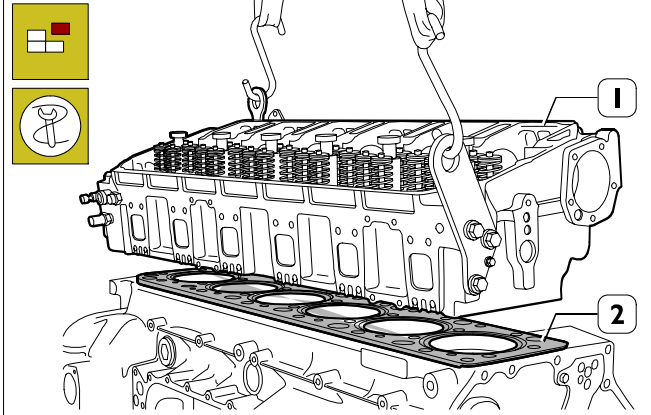
Figure 29



60514

□ Fit the plugs 99360180 (1) instead of injectors.
□ Remove the camshaft (2).
□ Unscrew the fixing screws on the cylinder head (3).

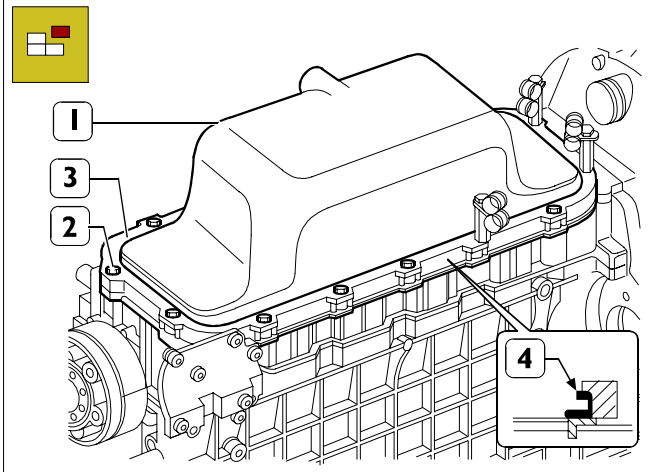
Figure 30



60515

□ By means of metal ropes, lift the cylinder head (1).
□ Remove the seal (2).

Figure 31

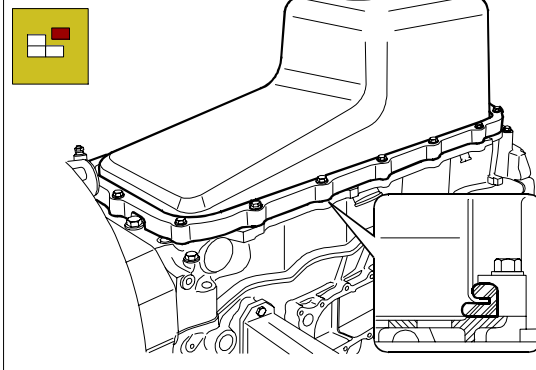


99268

Undo the screws (2) and remove the engine oil sump (1) together with the spacer (3) and the seal (4).

Valid for types: F3AE0684D*B001
F3AE0684G*B003
F3AE0684D*B003

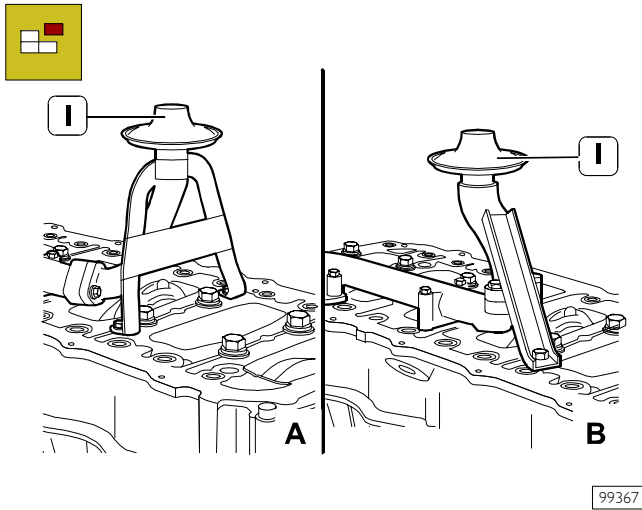
Figure 32



81871

Valid for F3AE0684E*B002 and F3AE0684J*B902 only.

Figure 33



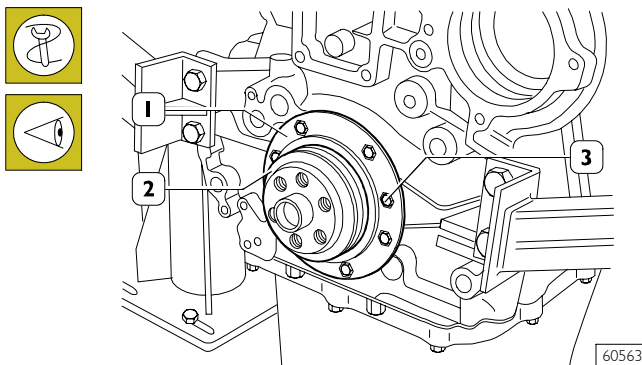
Undo the screws and remove the suction strainer (1).

A. for types: F3AE0684E*B002 - F3AE0684J*B902.

B. for types: F3AE0684D*B001 - F3AE0684G*B003
F3AE0684D*B003.

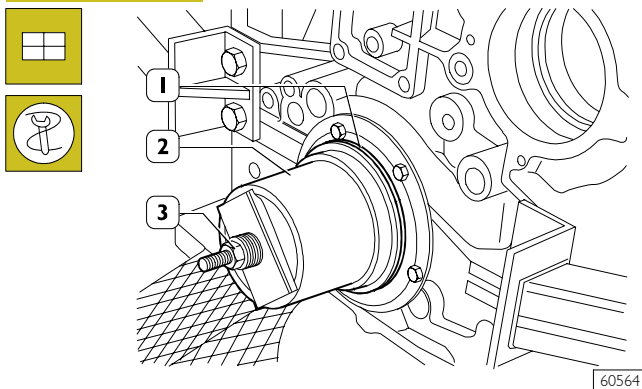
ENGINE ASSEMBLY

Figure 34



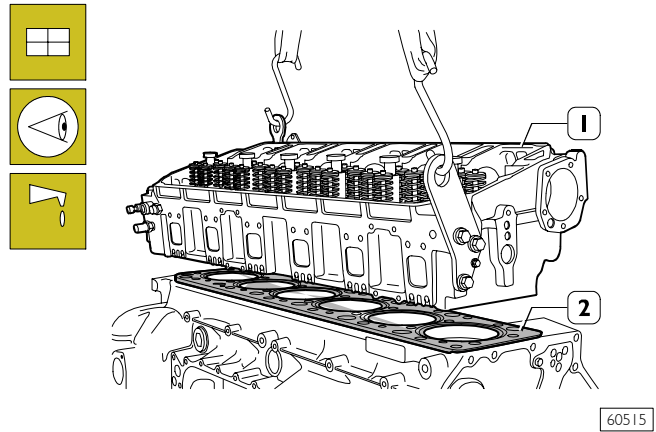
Using the centring ring 99396035 (2), check the exact position of the cover (1). If it is wrong, proceed accordingly and lock the screws (3).

Figure 35



Key on the gasket (1), mount the key 99346250 (2) and, screwing down the nut (3), drive in the gasket (1).

Figure 36



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. 38 - 39 - 40.

NOTE Lubricate the thread of the screws with engine oil before assembly.

Figure 37

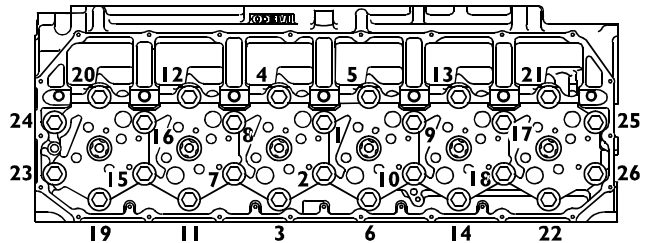
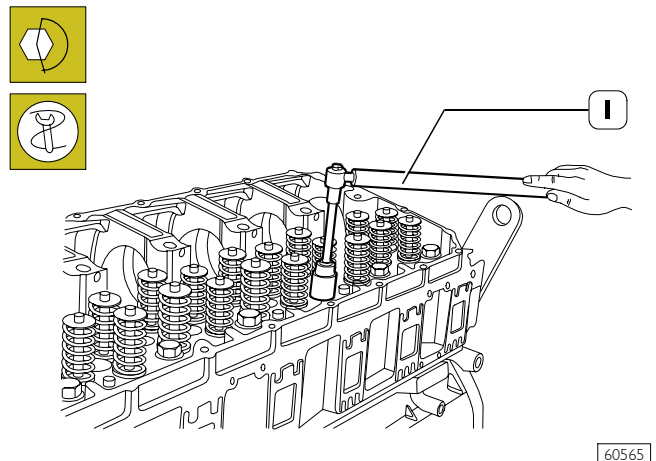


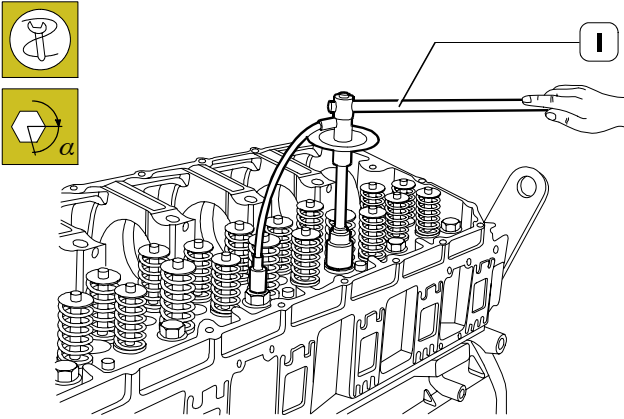
Diagram of the tightening sequence of the screws fixing the cylinder head.

Figure 38



□ Pre-tightening with the torque wrench (1):
1st phase: 60 Nm (6 kgm).
2nd phase: 120 Nm (12 kgm).

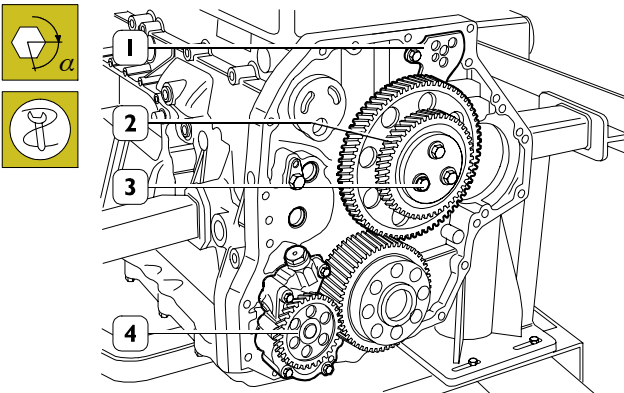
Figure 39



60566

- Closing to angle with tool 99395216 (1):
3rd phase: angle of 120°.
4th phase: angle of 60°.

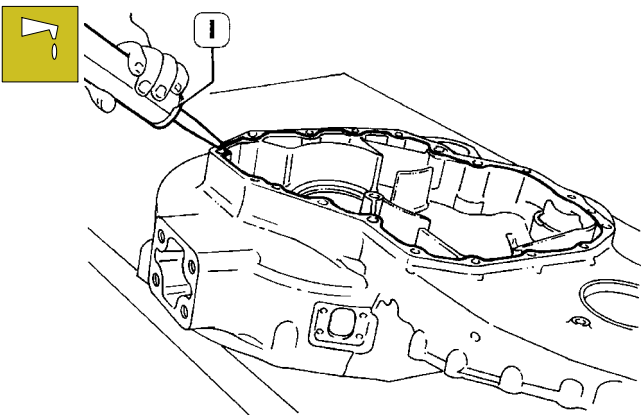
Figure 40



60567

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 41

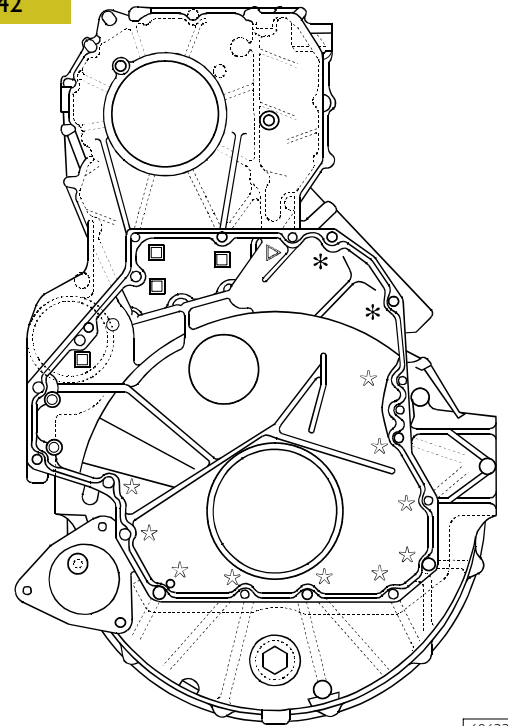


47592

Apply LOCTITE 5970 IVECO n° 2992644 silicone on the gear housing, using appropriate tools (1), as shown in the figure.
The sealer string (1) diameter is to be $1,5 \pm \begin{matrix} 0,5 \\ 0,2 \end{matrix}$

NOTE Mount the gear housing within 10 min. of applying the sealant.

Figure 42

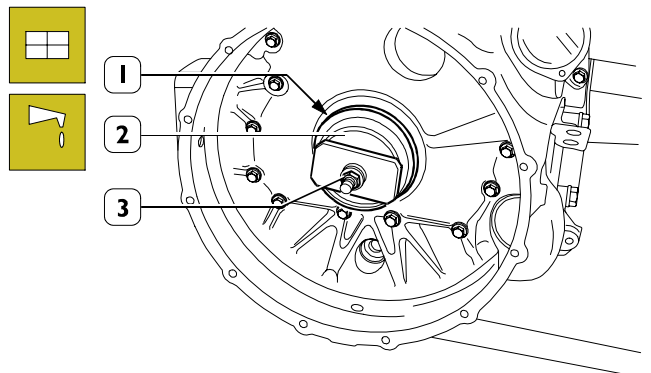


60633

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 43

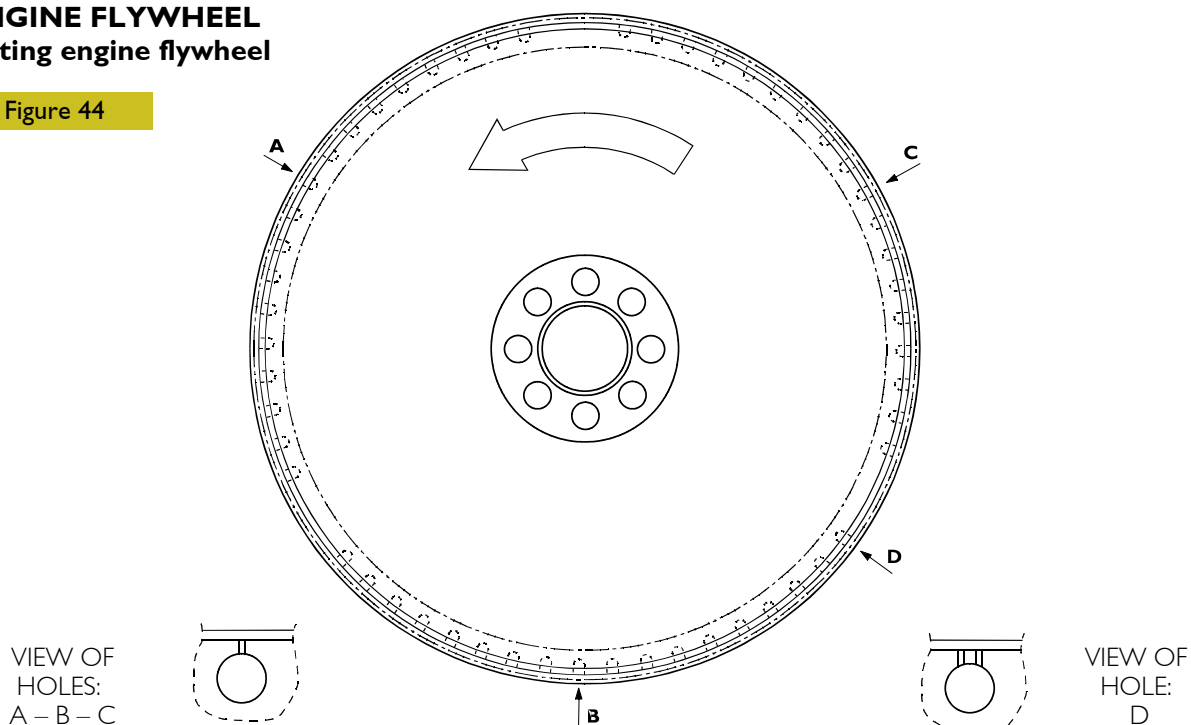


60568

Key on the gasket (1), mount the keying device 99346251 (2) and, screwing down the nut (3), drive in the gasket.

ENGINE FLYWHEEL Fitting engine flywheel

Figure 44



60668

DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS

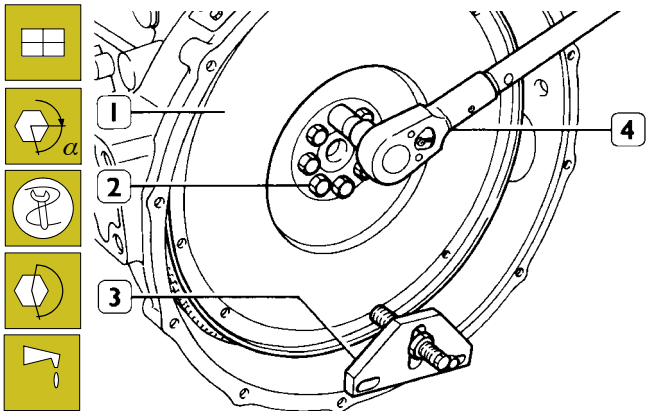
- A = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 3-4.
- B = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6.

- 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.

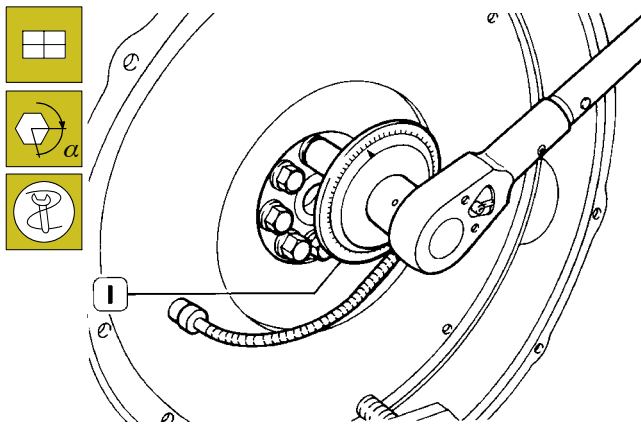
Position the flywheel (1) on the crankshaft, lubricate the thread of the screws (2) with engine oil and screw them down. Lock rotation with tool 99360351 (3). Lock the screws (2) in three phases.
First phase: pre-tightening with torque wrench (4) to a torque of 120 Nm (12 kgm).

Figure 45



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

Figure 46

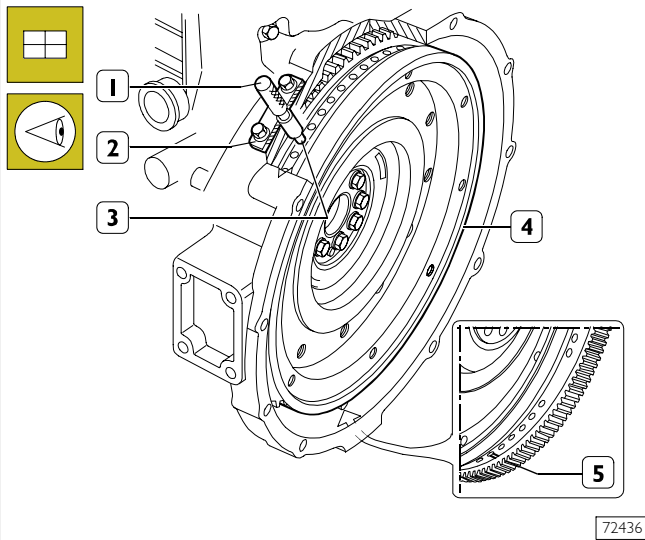


49036

Second and third phase: closing to angle of 60° + 30° with tool 99395216 (1).

Fitting camshaft

Figure 47



Position the crankshaft with the pistons 1 and 6 at the top dead centre (T.D.C.).

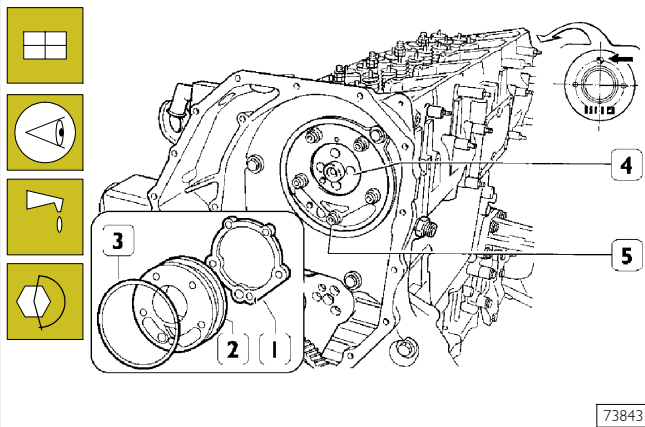
This situation occurs when:

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 48

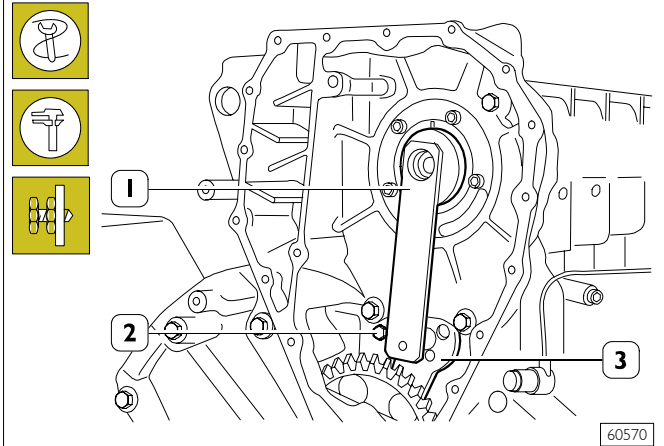


Fit the camshaft (4), positioning it observing the reference marks (→) as shown in the figure.

Lubricate the seal (3) and fit it on the shoulder plate (2).

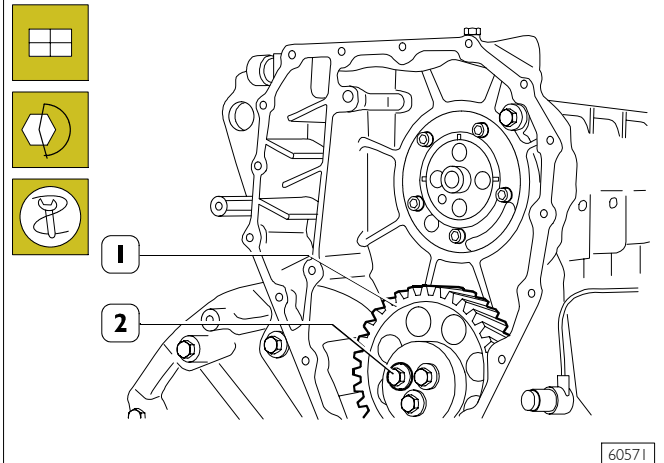
Mount the shoulder plate (2) with the sheet metal gasket (1) and tighten the screws (5) to the required torque.

Figure 49



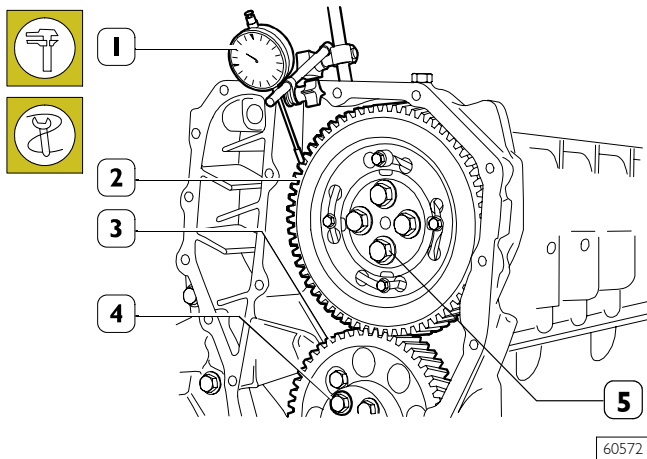
- Apply the gauge 99395219 (1). Check and adjust the position of the link rod (3) for the idle gear. Lock the screw (2) to the required torque.

Figure 50



- Fit the idle gear (1) back on and lock the screws (2) to the required torque.

Figure 51



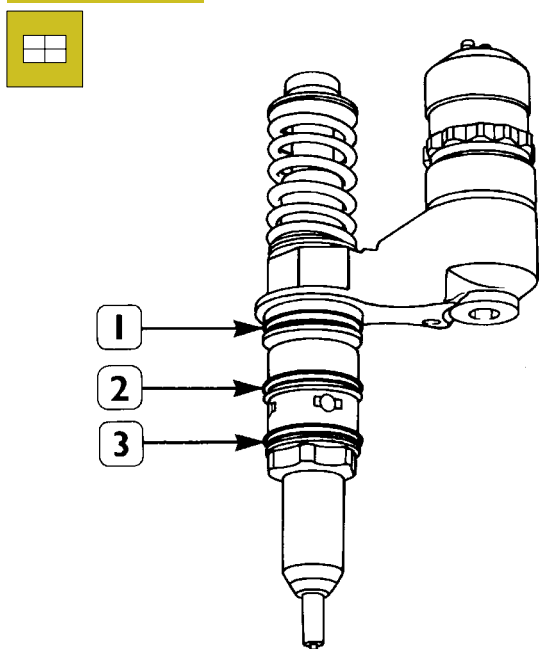
Position the gear (2) on the camshaft so that the 4 slots are centred with the holes for fixing the camshaft, without fully locking the screws (5).

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 49) fixing the link rod. Shift the link rod (3, Figure 49) to obtain the required clearance.
- Lock the screw (2, Figure 49) fixing the link rod and screws (4, Figure 51) fixing the idle gear to the required torque.

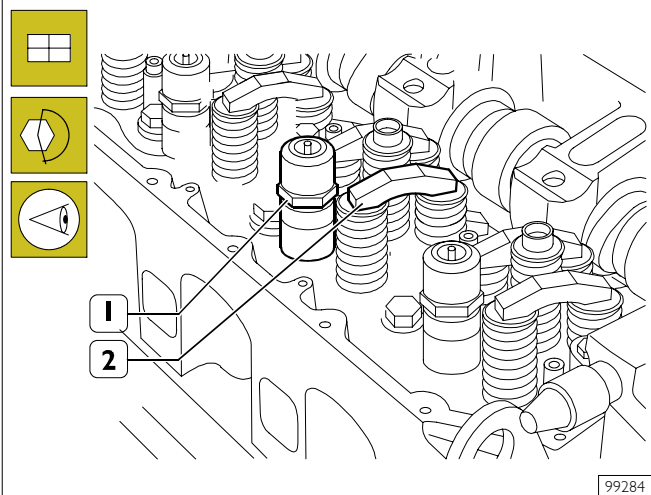
Fitting pump-injectors

Figure 52



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

Figure 53



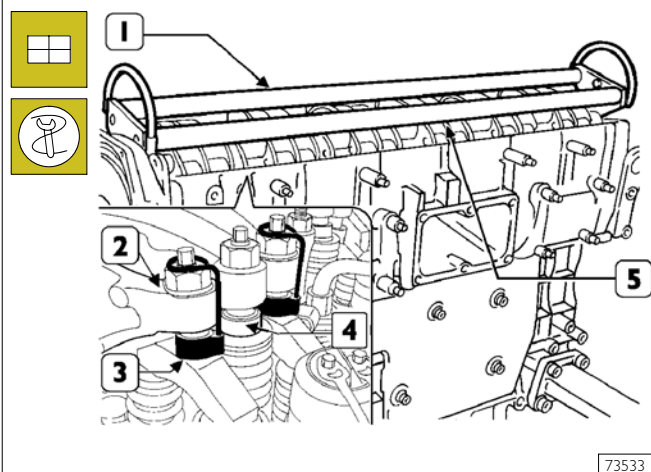
Mount:

- The injectors (1) and, using a torque wrench, lock the bracket fixing screws to a torque of 26 Nm.
- The crosspieces (2) on the valve stem, all with the largest hole on the same side.

Fitting rocker-arm shaft assembly

Figure 54

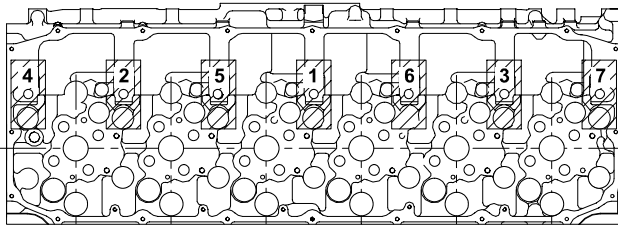
NOTE Before refitting the rocker-arm shaft assembly, make sure that all the adjustment screws have been fully unscrewed.



Using tool 99360144 (3), fasten the blocks (4) to the rocker arms (2).

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

Figure 55

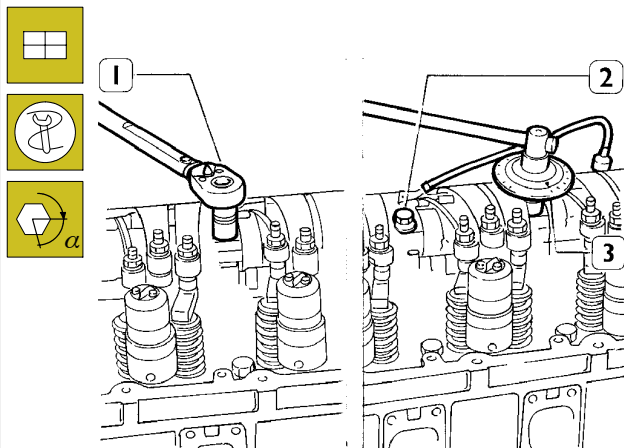


70567A

**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 56

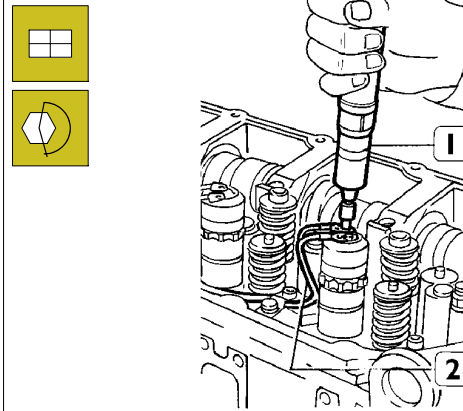


45261

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 57

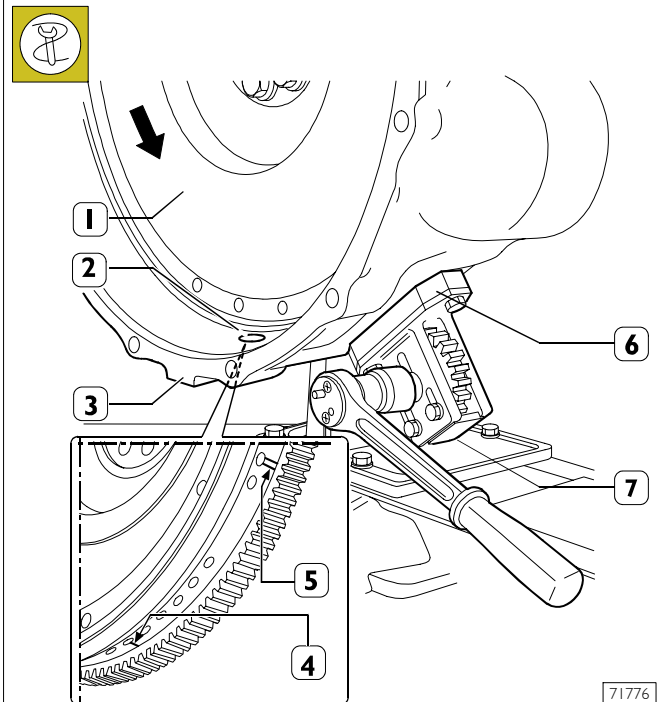


71777

To mount the lever stop spring.
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 58

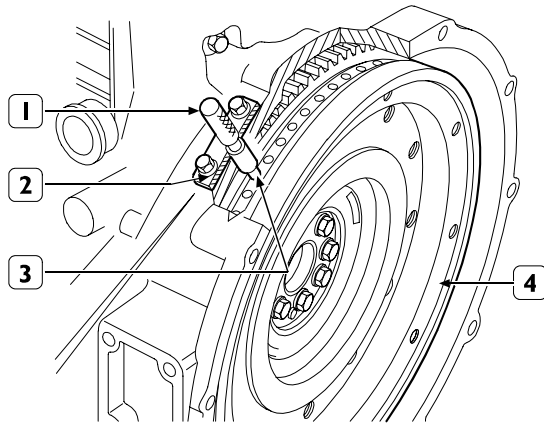


71776

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 59



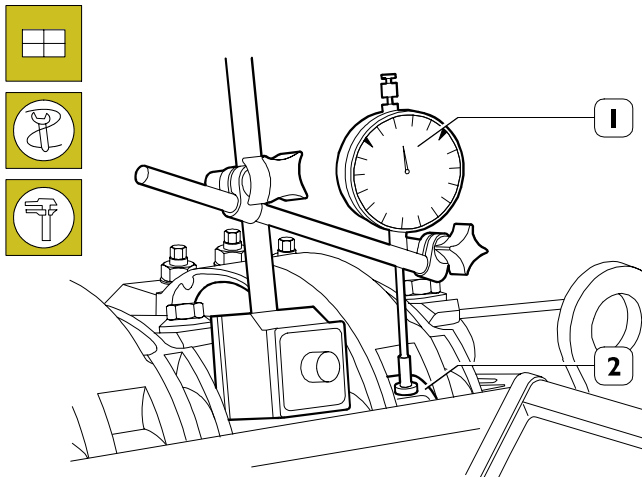
71774

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 60



106535

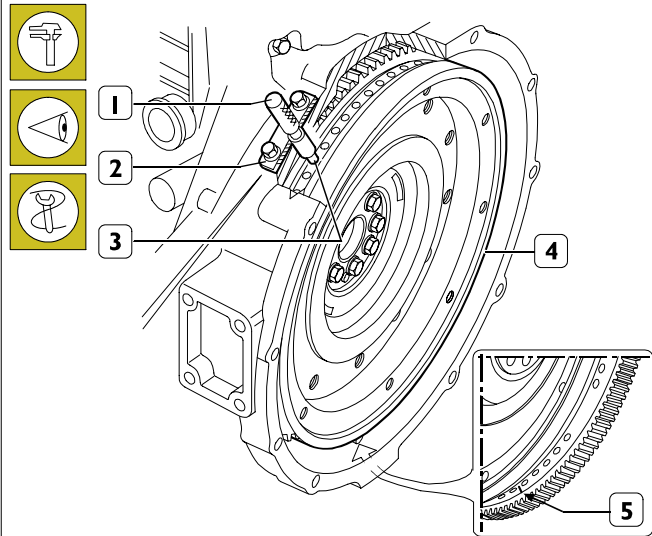
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

With tool 99360321 (7) Figure 57, 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 4.44 ± 0.05 mm.

Figure 61

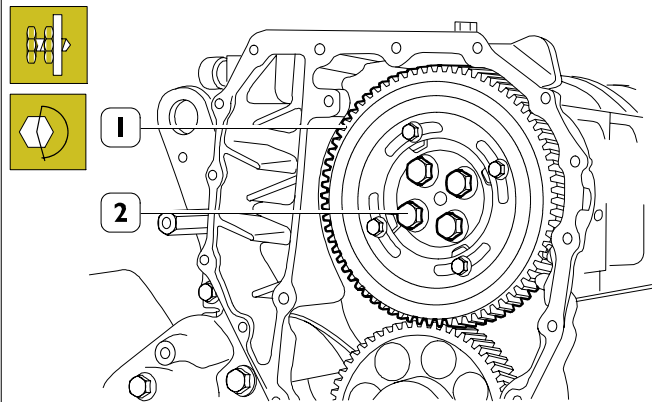


77259

The camshaft is in step if at the cam lift values of 4.44 ± 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 62



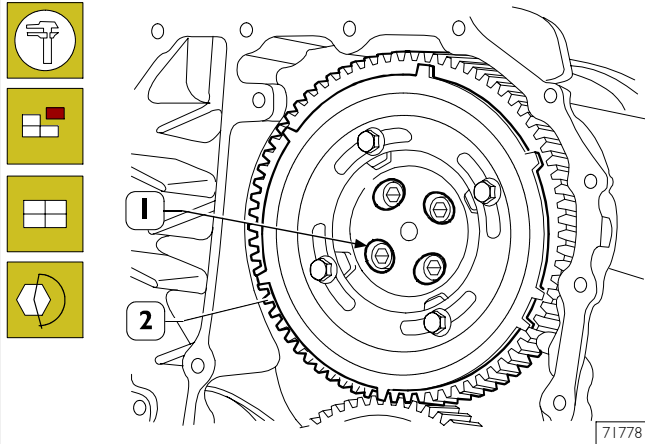
60575

If you do not obtain the conditions illustrated in Figure 61 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 63) on the gear (1);
- 2) turn the engine flywheel appropriately so as to bring about the conditions described in points 1 and 2 Figure 61, 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.

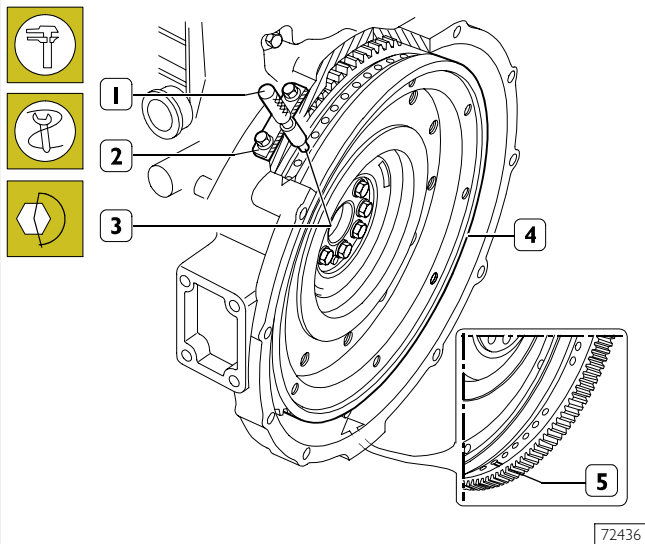
Figure 63



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 62) 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 4.44 ± 0.05 mm;
- 3) take out the screws (2, Figure 62) and remove the gear (1) from the camshaft.

Figure 64



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).

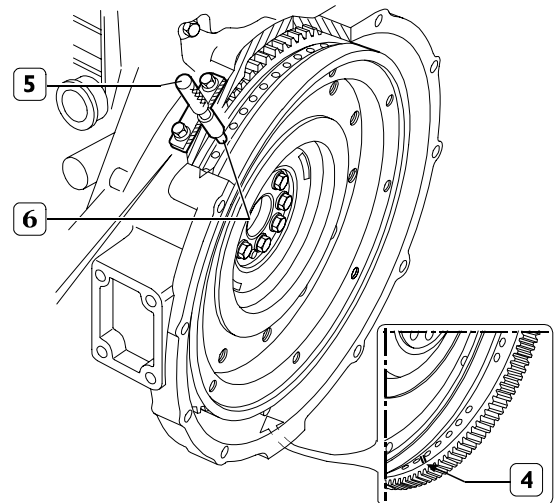
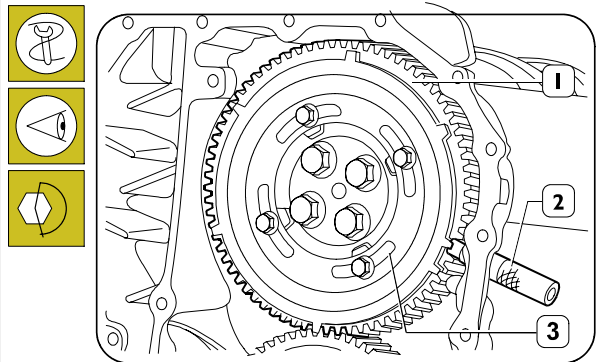
Mount the gear (2) Figure 63 with the 4 slots (1) centred with the fixing holes of the camshaft, locking the relevant screws to the required tightening torque.

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 4.44 ± 0.05 .

Check the timing conditions described in Figure 61.

Phonic wheel timing

Figure 65



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.

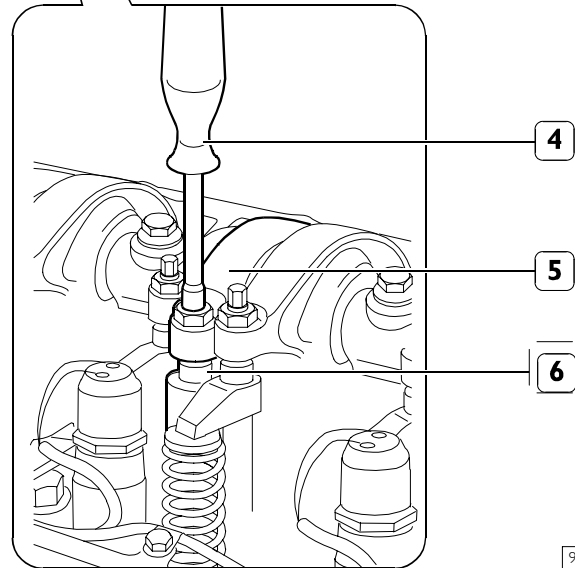
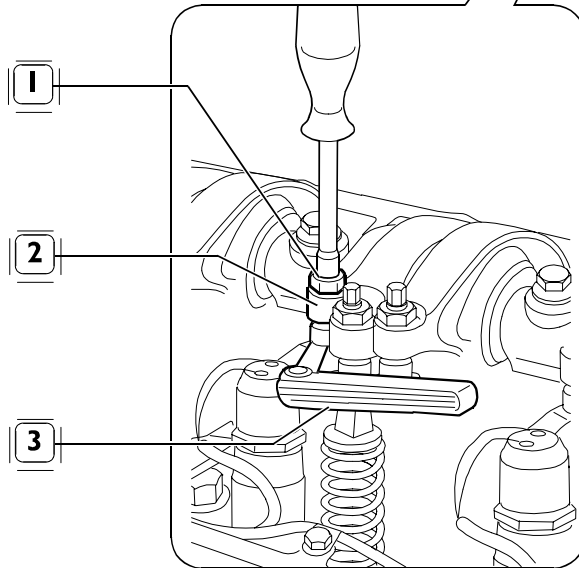
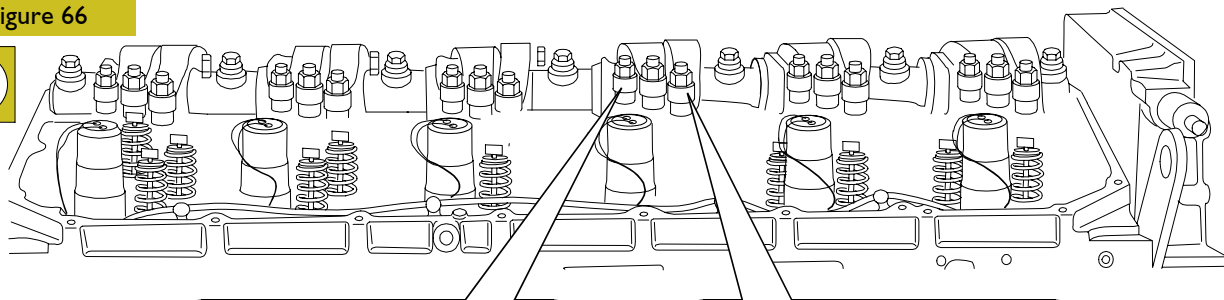
Again turn the flywheel in its normal direction of rotation until you see the hole marked with the double notch (4) through the inspection hole under the flywheel housing. Insert tool 99360612 (5) into the seat of the flywheel sensor (6).

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 66



99272

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.

Adjustment of clearance between the rockers and rods controlling intake and exhaust valves:

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

Pre-loading of rockers controlling pump injectors:

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

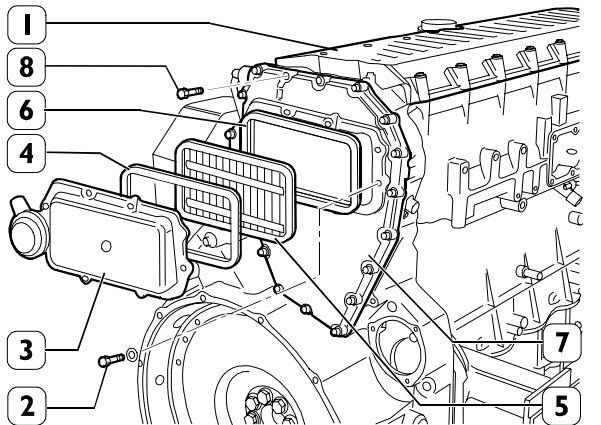
- using an appropriate wrench (4), loosen the adjustment screw until the pumping element is at the end-of-stroke;
- tighten the adjustment screw, with a dynamometric wrench, to 5 Nm tightening torque (0.5 kgm);
- untighten the adjustment screw by 1/2 to 3/4 rotation;
- tighten the locking nut.

FIRING ORDER 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 67



85480

Fit the distribution cover (1).

NOTE The valve rocker arm cover fastening screws (1) shall be tightened according to the sequence shown in Figure 68.

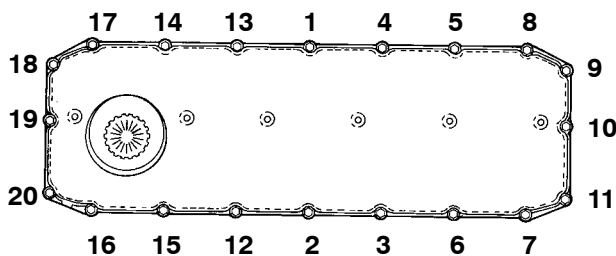
Fit the blow-by case (7) and its gasket and then tighten the screws (8) to the prescribed torque.
Install the filter (5) and the gaskets (4 and 6).

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 n° 2992644 on the blow-by case (7) surface of engines fitted with P.T.O. according to the procedure described in the following figure.

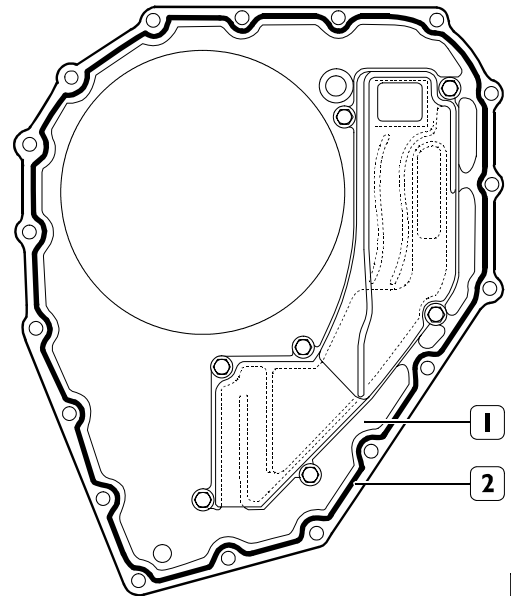
Figure 68



45363

DIAGRAM OF ROCKER ARM CAP FIXING SCREWS TIGHTENING SEQUENCE

Figure 69



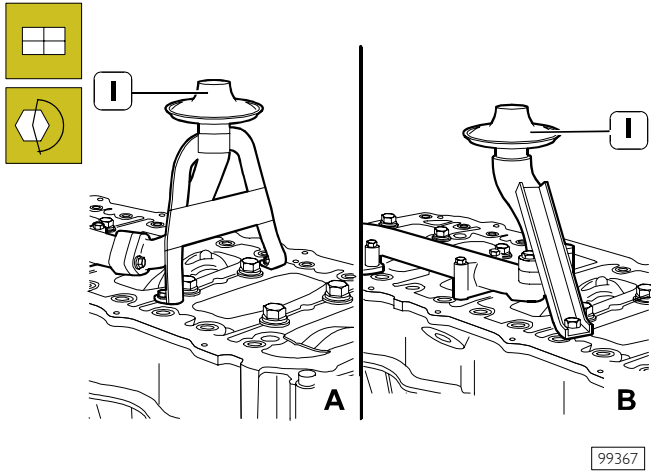
85481

Apply silicone LOCTITE 5970 IVECO No. 2992644 on the blow-by case and form a string (2) of $\varnothing 1,5 \pm_{0,2}^{0,5}$ as shown in the figure.

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

ENGINE COMPLETION

Figure 70

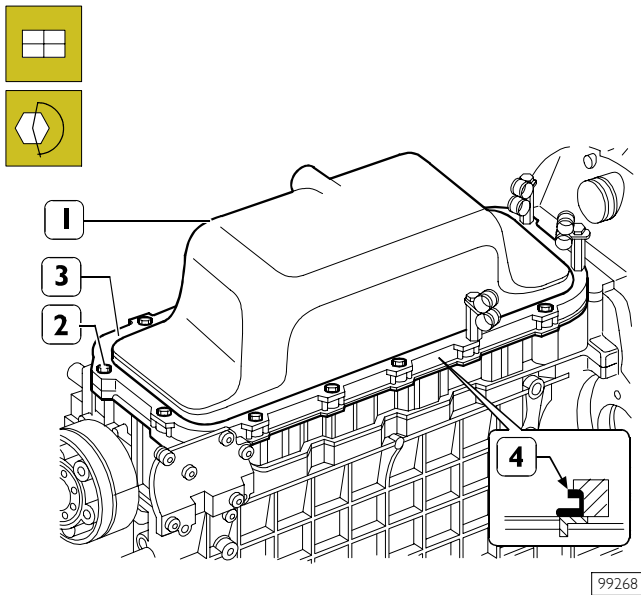


99367

Fit the suction strainer (1) and tighten the fixing screws to the prescribed torque.

- A.** for types: F3AE0684E*B002 - F3AE0684J*B902.
- B.** for types: F3AE0684D*B001 - F3AE0684G*B003
F3AE0684D*B003.

Figure 71

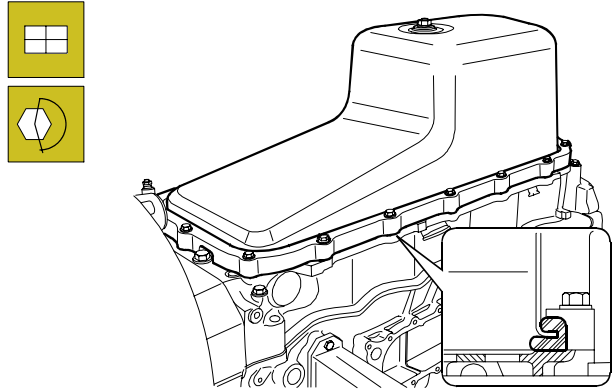


99268

Place gasket (4) on oil sump (1), position spacer (3) and fit the sump on the engine base by tightening screws (2) to the specified torque, by complying with the tightening sequence shown in Figure 73.

- For types: F3AE0684D*B001 - F3AE0684G*B003 -
F3AE0684D*B003.

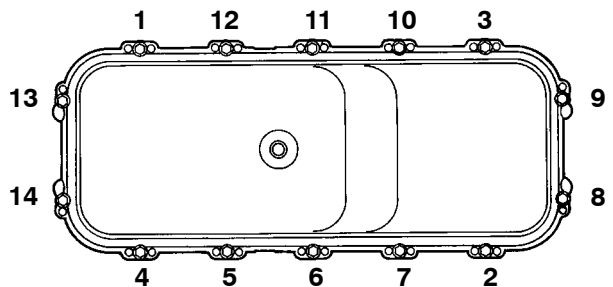
Figure 72



81871

For types: F3AE0684E*B002 - F3AE0684J*B902.

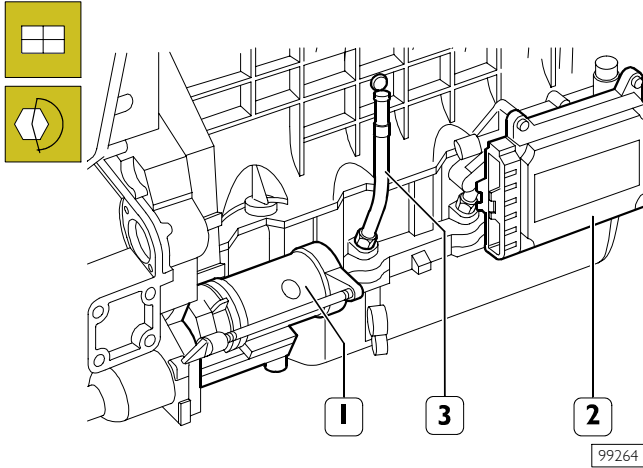
Figure 73



45362

DIAGRAM OF ENGINE OIL SUMP FIXING SCREWS TIGHTENING SEQUENCE

Figure 74

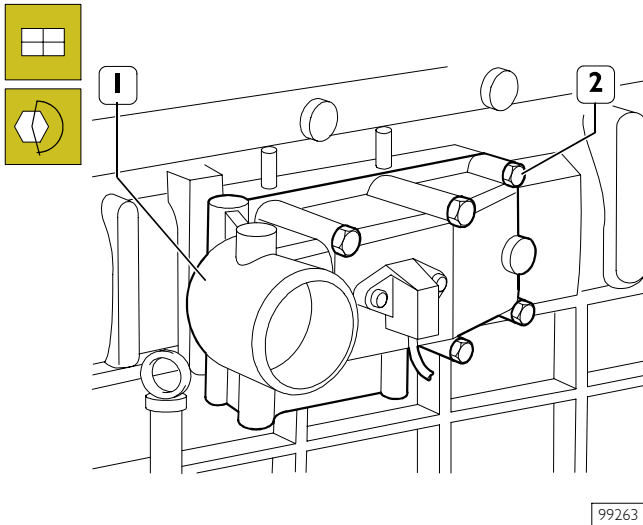


Tightening the fixing screws to the prescribed torque, mount:

- the starter motor (1);
- the control unit (2) and its support;
- the oil dipstick (3) in the crankcase.

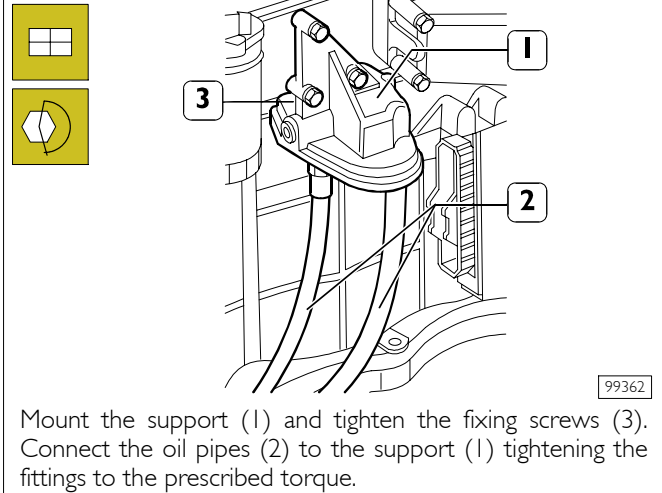
NOTE Check the state of the flexible elements of the control unit support and change them if they have deteriorated.

Figure 75



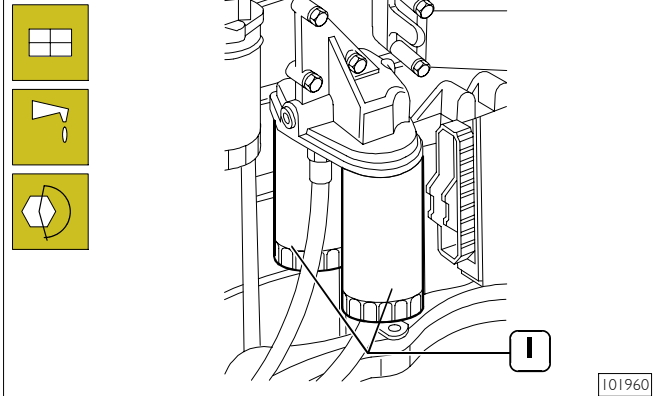
Fit the intake manifold (1) and tighten the fixing screws (2) to the prescribed torque.

Figure 76



Mount the support (1) and tighten the fixing screws (3). Connect the oil pipes (2) to the support (1) tightening the fittings to the prescribed torque.

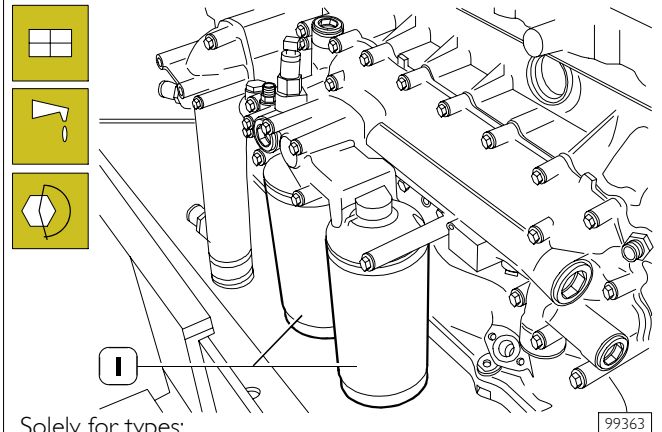
Figure 77



Fit the oil filters (1) on the relevant supports as follows:

- oil the seals;
- screw the filters down for the seals to make contact with the supporting bases;
- tighten the filters to a torque of 35 to 40 Nm.

Figure 78

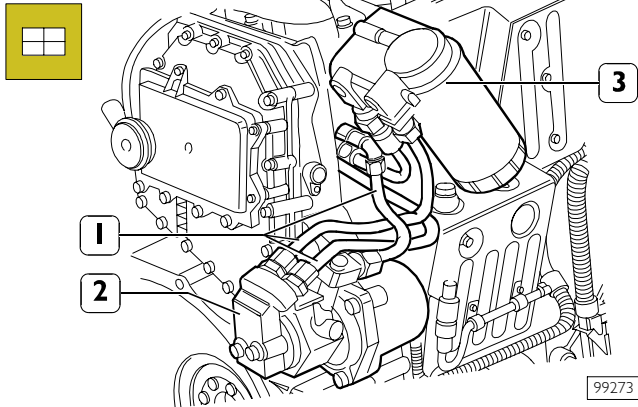


Solely for types:
F3AE0684D*B003 and F3AE0684E*B002

Mount the oil filters (1) on the support as follows:

- oil the seal;
- screw the filters down for the seals to make contact with the supporting bases;
- tighten the filters to a torque of 35 to 40 Nm.

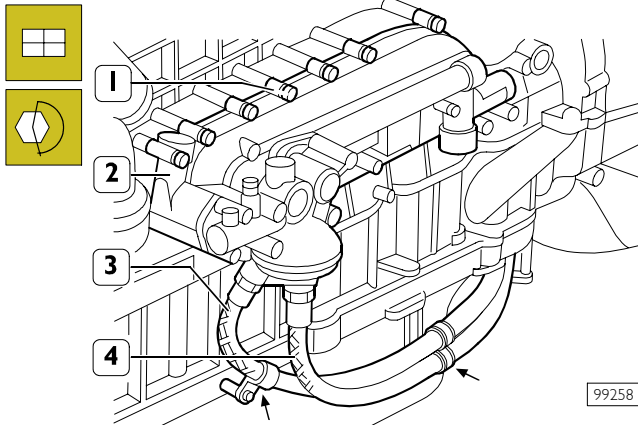
Figure 79



Fit, with the respective gaskets.

- the fuel pump (2);
- fuel filter unit (3) and pipes (1);
- connect the pipes (1) to the fuel pump (2).

Figure 80



For all types except:
F3AE0684D*B003 and F3AE0684E*B002

Mount the cooler (2) with the relevant seal and tighten the fixing screws (1) to the prescribed torque.

Tighten the screws (←) fixing the clamps retaining the pipes (3 and 4) to the spacer.

Figure 81

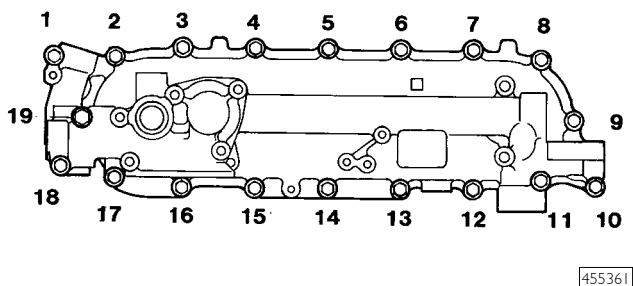
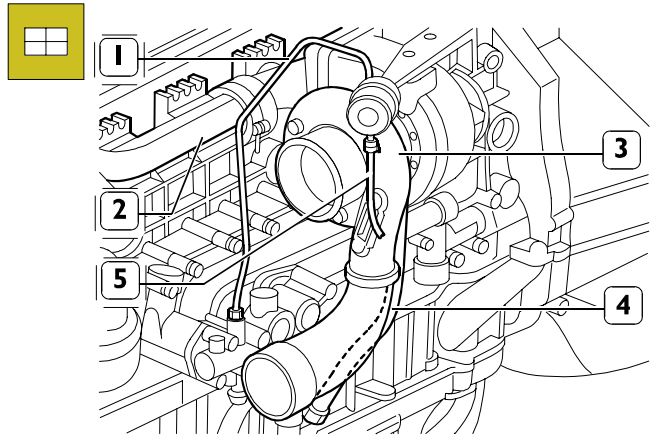


DIAGRAM OF HEAT EXCHANGER FIXING SCREWS TIGHTENING SEQUENCE

Figure 82



Mount the following with new seals:

- exhaust manifold (2);
- turbocharger (3);
- oil pipe (1 and 4);
- pipe to the actuator (5).

Figure 83

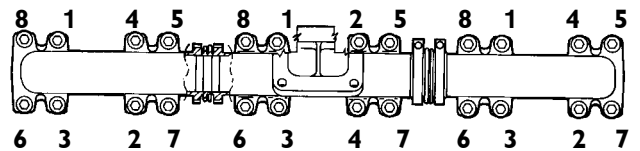


DIAGRAM OF EXHAUST MANIFOLD FIXING SCREWS TIGHTENING SEQUENCE

Figure 84

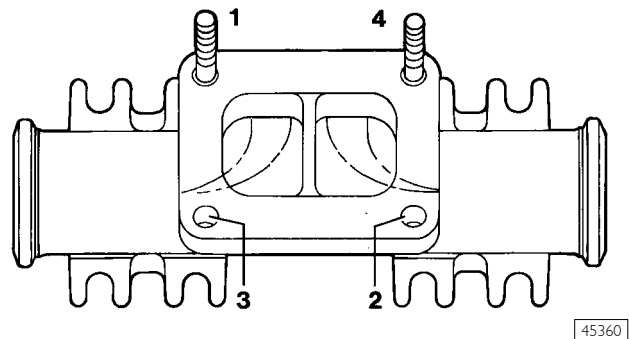
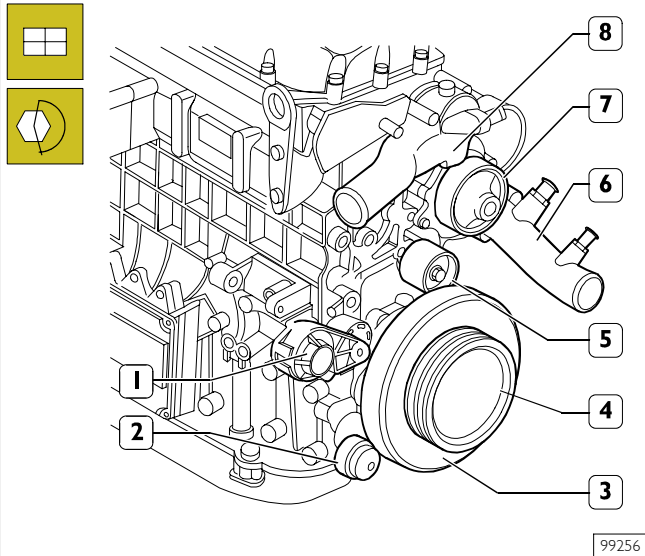


DIAGRAM OF TURBOCHARGER FIXING SCREWS AND NUTS TIGHTENING SEQUENCE

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

Figure 85

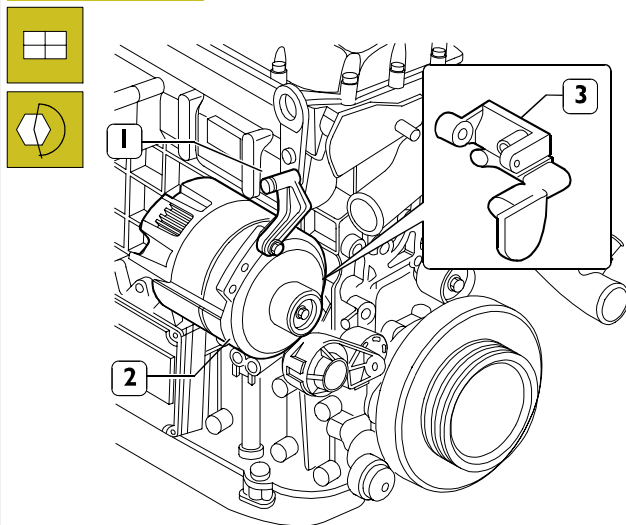


99256

Fit, with the following parts:

- automatic tightener support (1);
- automatic tightener (2);
- damper flywheel (3) and pulley beneath;
- fixed tightener (5);
- water pump (7);
- the pulley (4);
- pipe comprehensive of coolant (6);
- thermostat assembly (8).

Figure 86

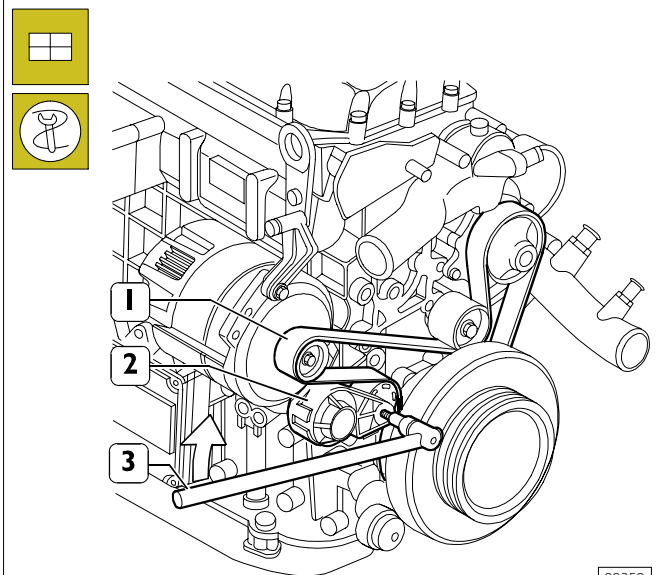


99360

Mount the following, tightening the screws to the prescribed torque:

- the supports (1 and 3);
- alternator (2).

Figure 87

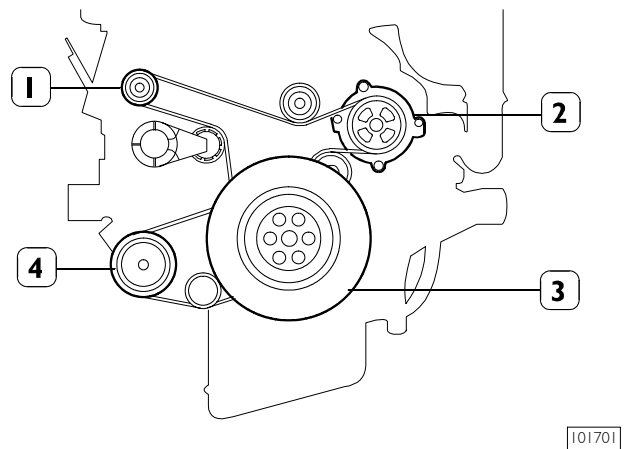


99359

Using a suitable tool (3), work in the direction of the arrow on the tightener (2) and mount the belt (1).

NOTE The tighteners are automatic, so there are no other adjustments after assembly.

Figure 88

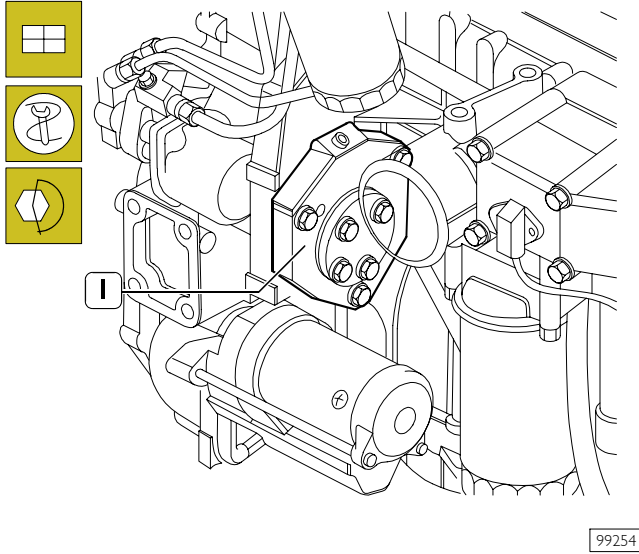


101701

DIAGRAM FOR FITTING BELT DRIVING FAN - WATER PUMP - ALTERNATOR

1. Alternator - 2. Water pump - 3. Crankshaft -
4. Compressor.

Figure 89



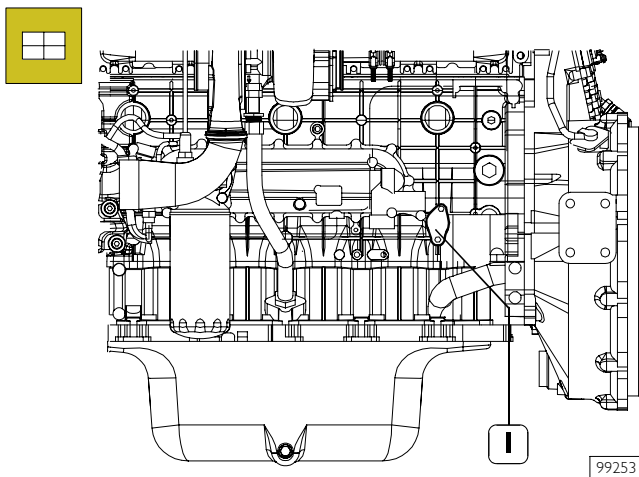
Fit the arm 99360585 onto the engine lifting hooks and hook the arm onto the hoist.

Take out the screws fixing the brackets 99361036 to the rotary stand. Lift the engine and remove the above-mentioned brackets from it.

Complete engine assembly with the following parts, tightening the fixing screws or nuts to the prescribed torque:

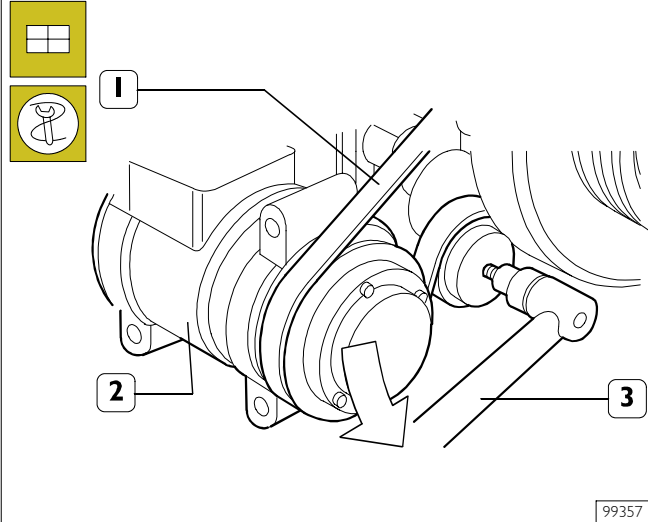
- mount the drive (1);
- mount the engine supports;

Figure 90



- mount the oil pressure adjuster valve (1).

Figure 91



Fit the engine support together with the air-conditioner compressor (2).

Using a suitable tool (3), work in the direction of the arrow and mount the belt (1).

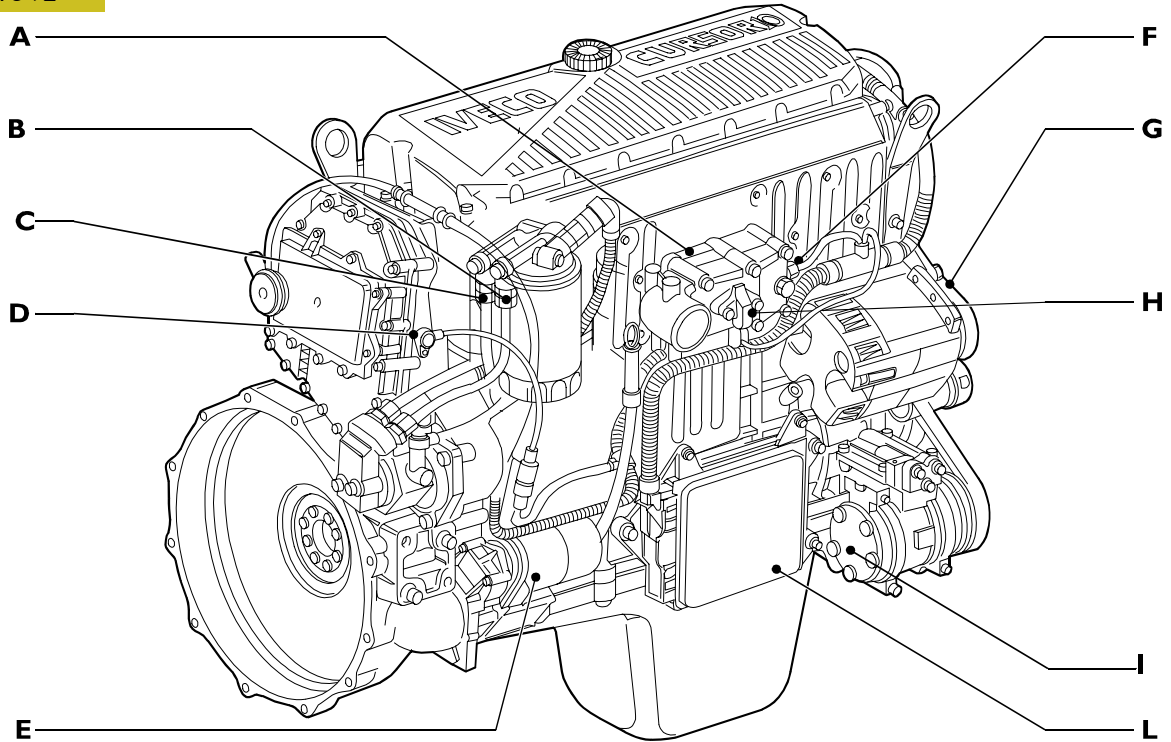
Connect the engine electric cable to the sensors and control unit.

Refill the engine with lubricating oil of the prescribed grade and quantity.

**PART TWO -
ELECTRICAL EQUIPMENT**

Components on the engine F3A

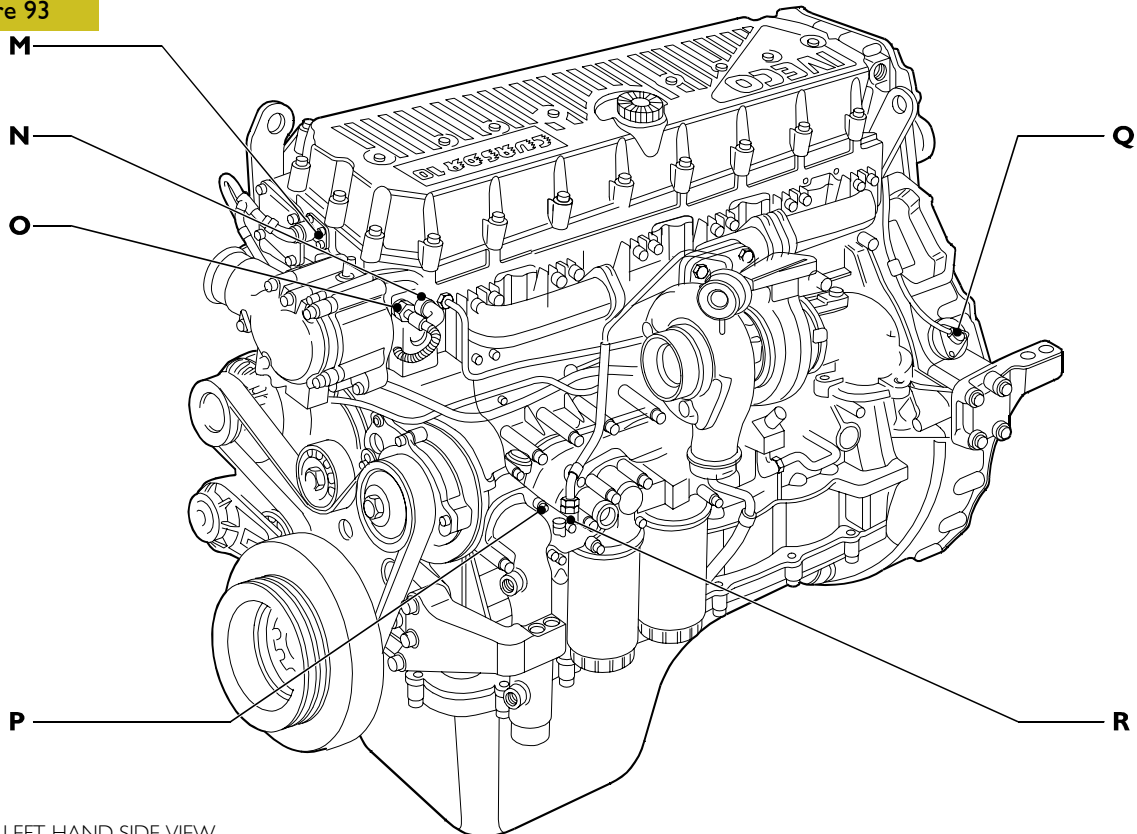
Figure 92



ENGINE RIGHT-HAND SIDE VIEW

99370

Figure 93



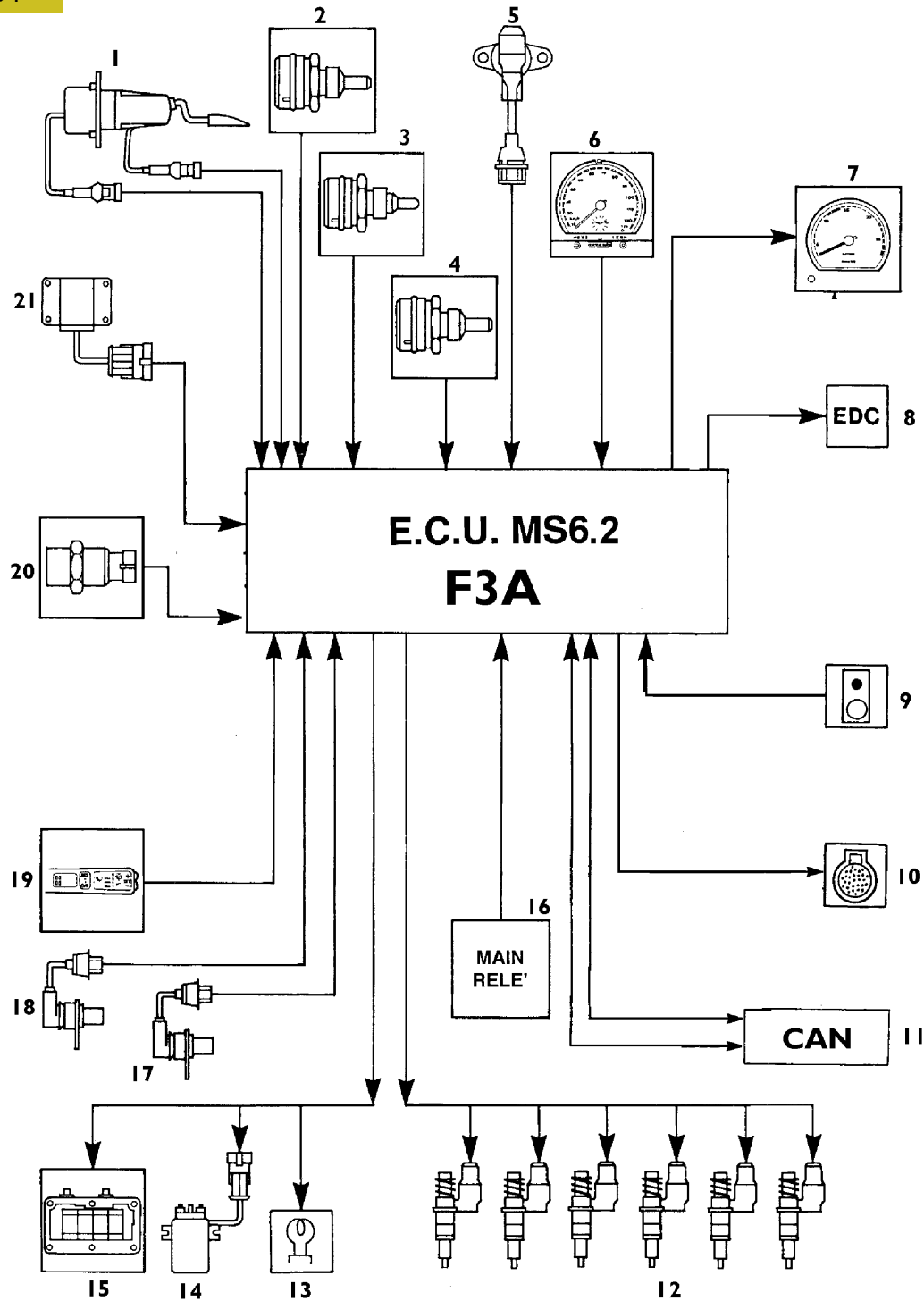
ENGINE LEFT-HAND SIDE VIEW

99371

- 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 94



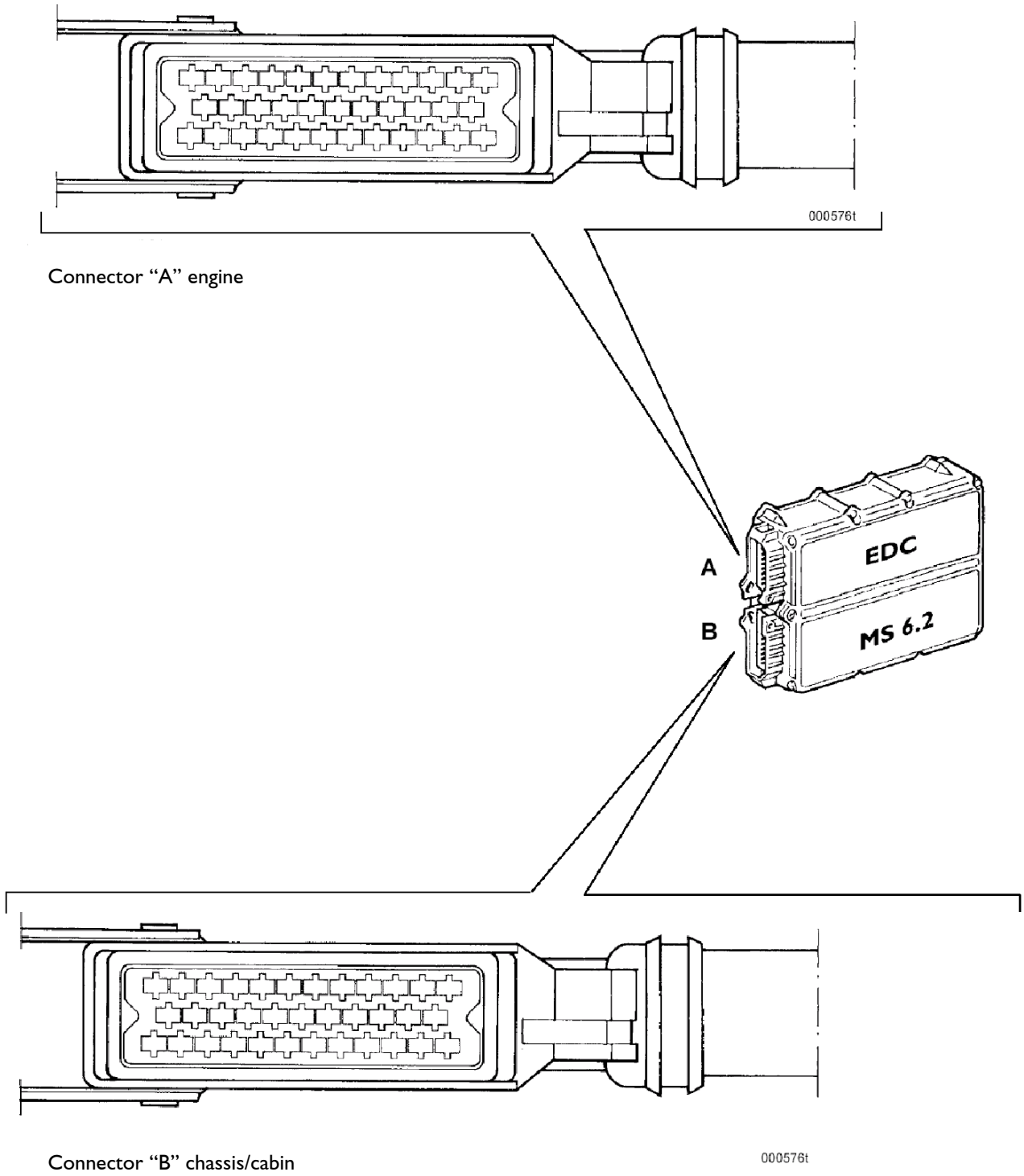
99372

KEYS

1. Accelerator pedal position sensor / switch accelerator depressed – 2. Engine coolant temperature sensor – 3. Oversupply air temperature sensor – 4. Fuel temperature sensor – 5. Oversupply air pressure sensor – 6. Input for electronic tachograph (if available) – 7. Output for electronic revs counter (if available) – 8. E.D.C. system failure warning light – 9. Blink-code button (if available) – 10. Diagnosis connector – 11. CAL L-H line – 12. Pump-injectors – 13. Warning light for pre/post-heating activated – 14. Remote control switch for pre/post-heating activation – 15. Pre/post-heating resistance – 16. Main remote control switch – 17. Flywheel sensor – 18. Distribution sensor – 19. Cruise Control buttons (if available) – 20. Clutch switch – 21. Primary / secondary brake switch.

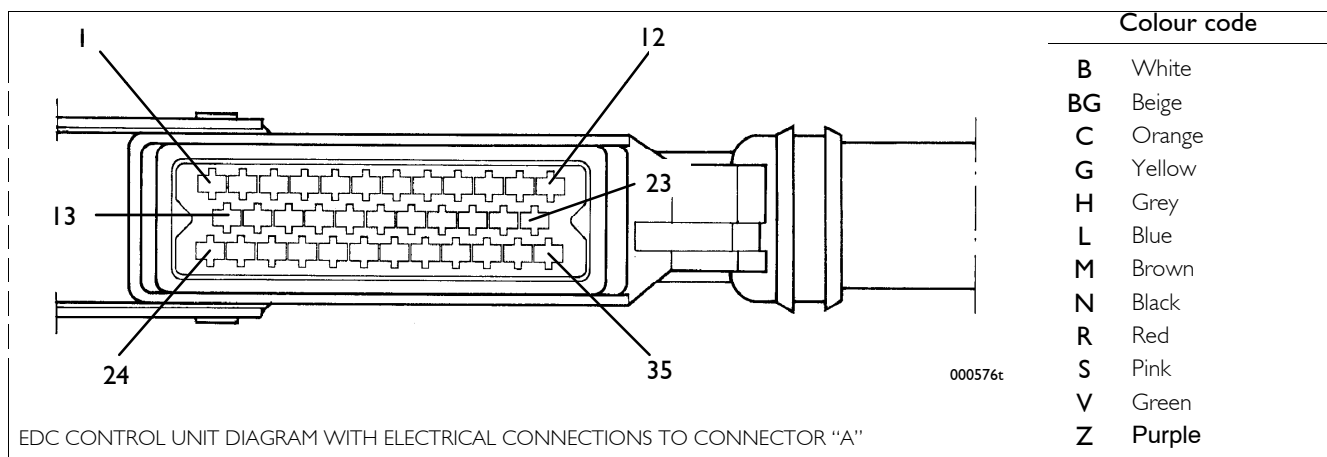
EDC MS 6.2 electronic control unit

Figure 95



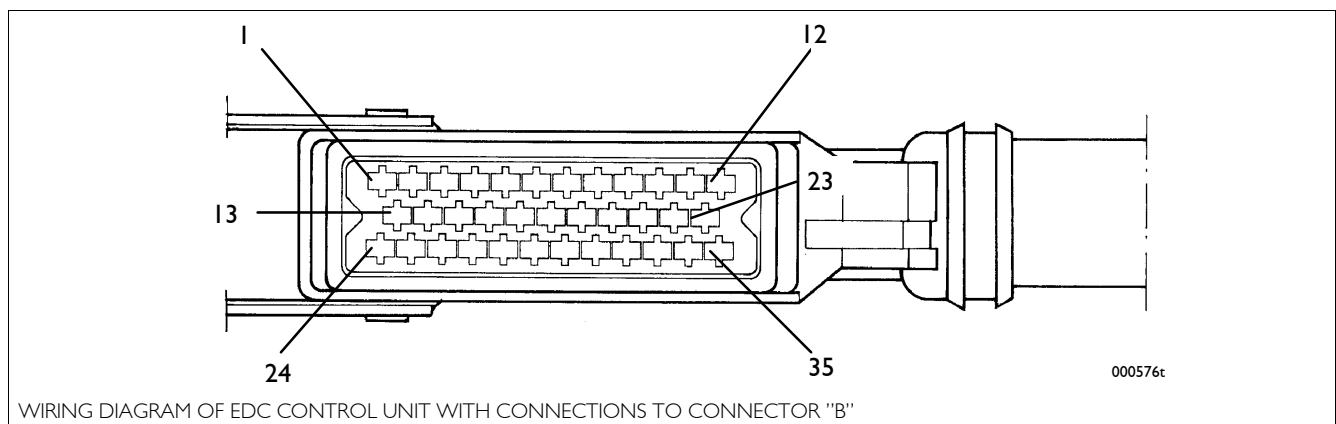
EDC control unit PIN-OUT**Connector "A" (Engine)**

Pin	Function
1 -	Engine rev sensor
2 -	Distribution rev sensor
3 -	---
4 -	Air temperature sensor mass
5 -	Engine coolant temperature sensor mass
6 -	Engine oil temperature and fuel temperature sensor ground
7 -	---
8 -	---
9 -	---
10 -	Engine oil temperature sensor signal
11 -	Fuel temperature sensor signal
12 -	Oversupply pressure sensor signal
13 -	Engine rev sensor
14 -	Distribution rev sensor
15 -	---
16 -	---
17 -	Boosting pressure sensor ground
18 -	---
19 -	---
20 -	---
21 -	Air temperature sensor signal
22 -	Engine coolant temperature sensor signal
23 -	Oversupply pressure sensor power supply
24 -	Injector power supply for cylinders 1 / 2 / 3
25 -	Injector power supply for cylinders 4 / 5 / 6
26 -	Cylinder 4 injector control
27 -	Cylinder 6 injector control
28 -	Cylinder 5 injector control
29 -	---
30 -	---
31 -	---
32 -	---
33 -	Cylinder 3 injector control
34 -	Cylinder 2 injector control
35 -	Cylinder 1 injector control

Figure 96

EDC control unit PIN-OUT**Connector "B" (Frame area)**

Pin	Functions
1 -	Negative direct from battery / blink button – code
2 -	Negative direct from battery / blink button – code
3 -	Positive from main remote switch
4 -	Positive from main remote switch
5 -	Signal for electronic rev. counter (if available)
6 -	Negative for EDC / blink button – code warning light (if available)
7 -	CAN line for Multiplex electric system architecture
8 -	---
9 -	Engine phase signal for diagnosis connector
10 -	Negative for pre-post heating remote switch engagement
11 -	CAN - L line for interconnection of the CAN line with control units (if any) available with the application
12 -	CAN - H line for interconnection of the CAN line with control units (if any) available with the application
13 -	K line for diagnosis connector
14 -	---
15 -	Key controlled supply positive
16 -	Accelerator pedal position sensor supply
17 -	Negative from idler switch
18 -	Negative for warning light pre – post heating
19 -	---
20 -	Positive from N.C. clutch switch (if available)
21 -	Function "RESUME" Cruise Control (if available)
22 -	Positive from speed reducer switch (if available)
23 -	Accelerator pedal position signal sensor
24 -	L line for diagnosis connector
25 -	Negative for accelerator pedal, multiple-state switch for torque reducer and negative for engine speed and vehicle speed sensors
26 -	Positive from primary N.C. brake switch
27 -	Negative for main remote switch
28 -	Signal from the multiple-state switch for the torque reducer (if available)
29 -	Vehicle speed (D3 tachograph) signal (if available)
30 -	PWM line
31 -	Positive from N.C. redundant brake switch
32 -	Function "SET –" Cruise Control (if available)
33 -	Function "OFF +" Cruise Control (if available)
34 -	Function "SET +" Cruise Control (if available)
35 -	Negative for accelerator pedal position sensor

Figure 97

PUMP INJECTOR

It consists mainly of:

- A) Solenoid valve
- B) Pumping element
- C) Nozzle

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

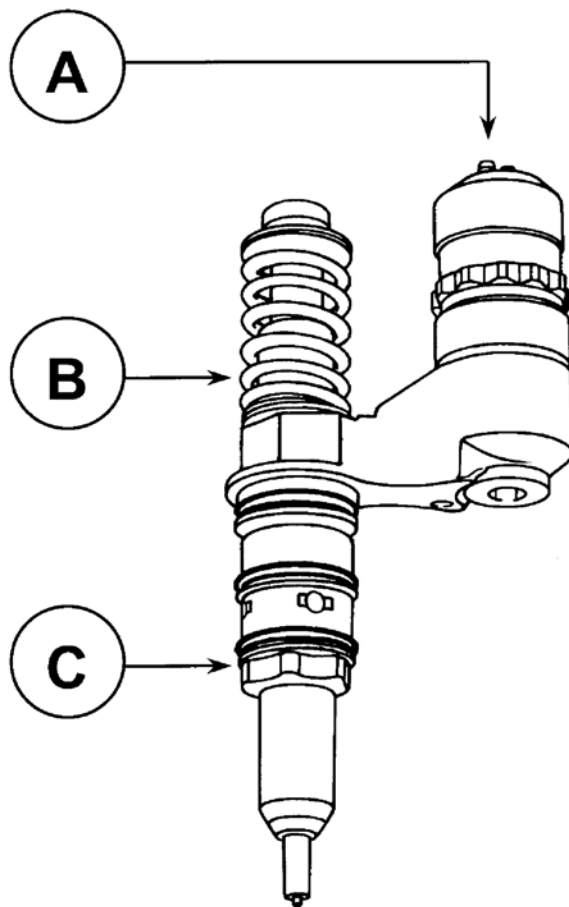
The pumping element, mechanically actuated at every rocker arm cycle, compresses the fuel container in the delivery chamber.

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 98



000578t

Engine coolant temperature sensor

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.

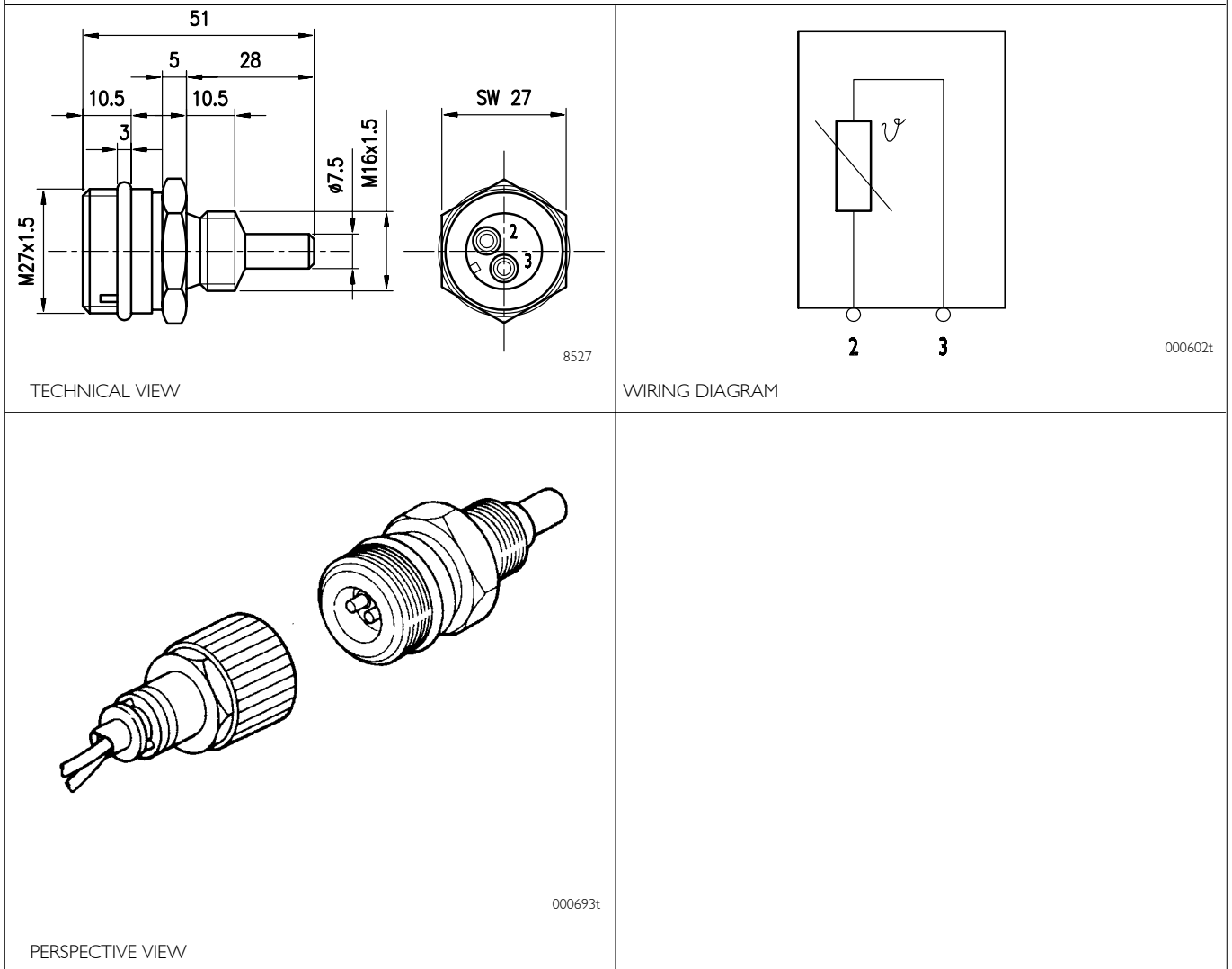
It is connected to electronic center pins A5/A22.

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 99



Connector	Function	Cable colour
2	To EDC center pin A 5	—
3	To EDC center pin A 22	—

Fuel temperature sensor

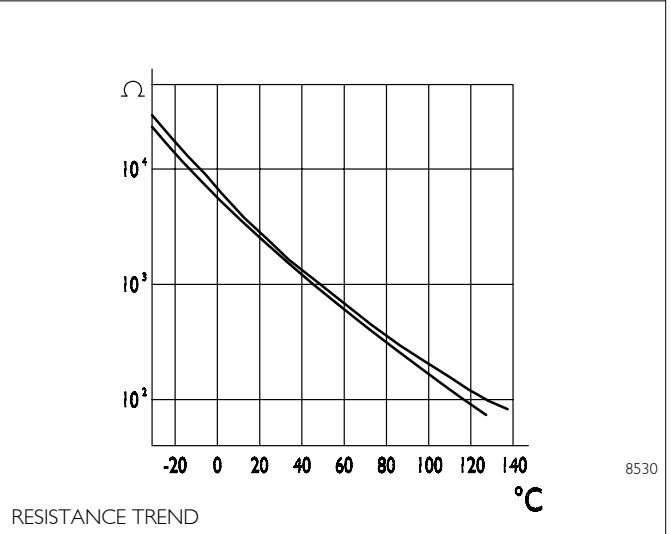
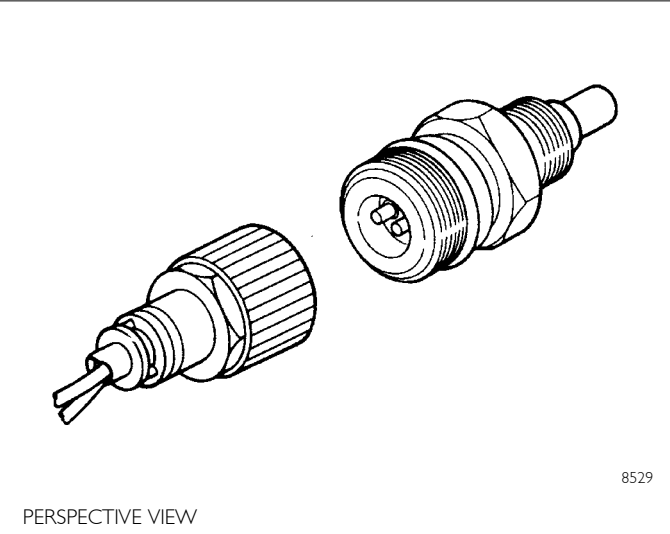
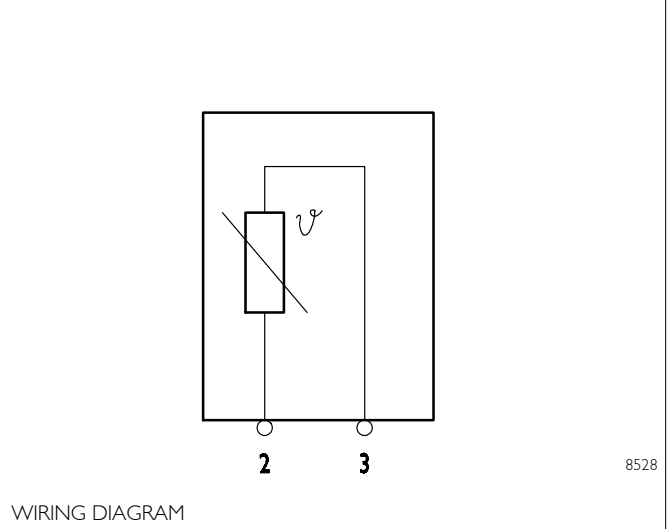
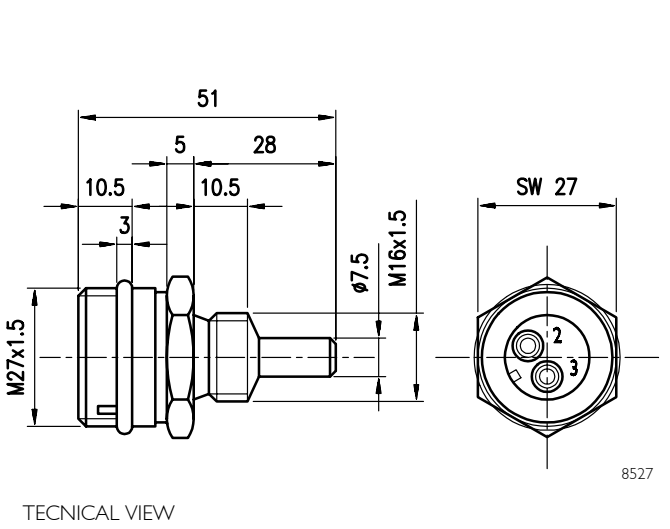
Specifications

Supplier

Max. tightening torque

BOSCH
35 Nm

Figure 100



Pin	Function	Cable colour
2	To pin 6 of EDC control unit	—
3	To pin 11 of EDC control unit	—

Flywheel pulse transmitter

Specifications

Supplier

Max. tightening torque

BOSCH
8 ± 2 Nm

Figure 101

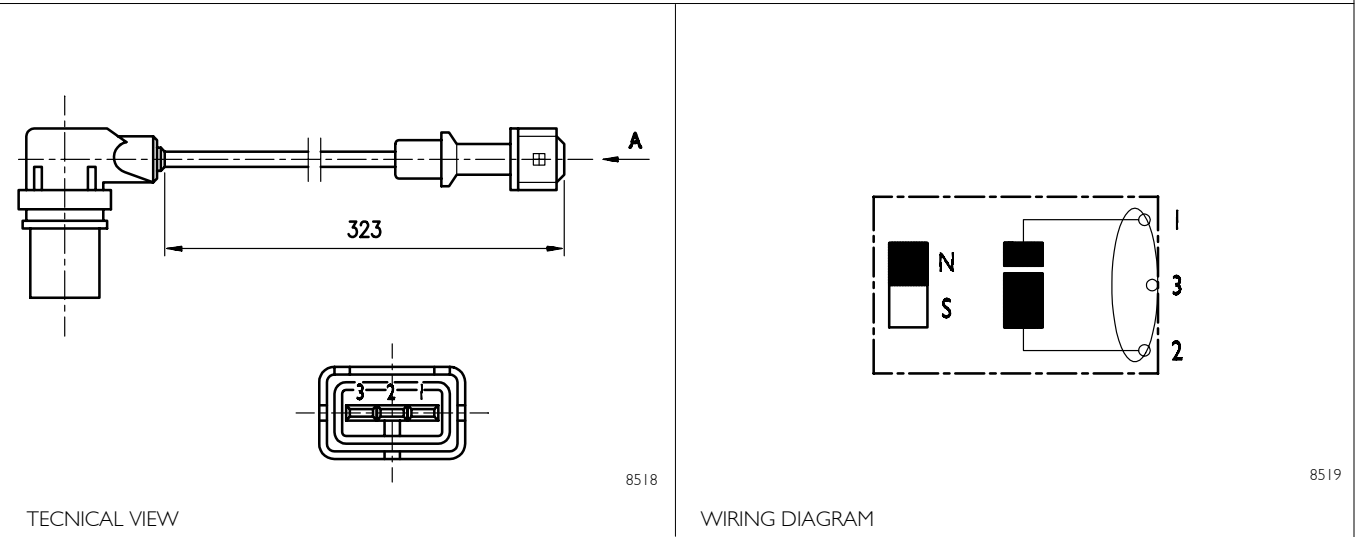
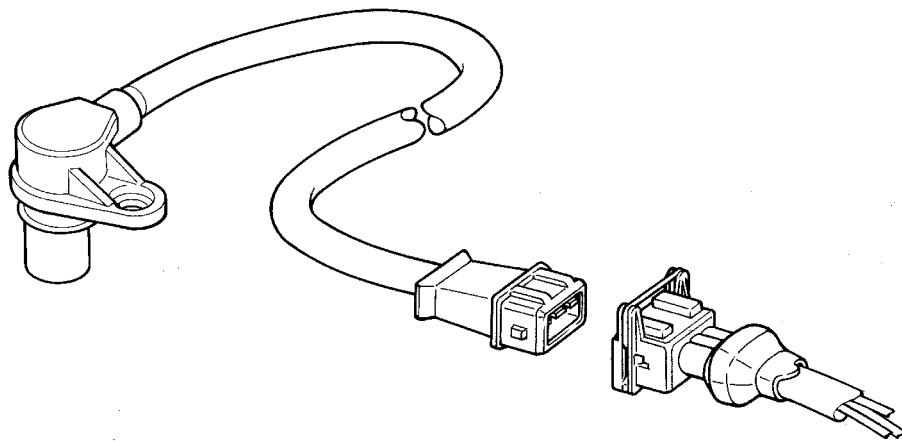


Figure 102



Pin	Function	Cable colour
1	To pin 1 of EDC control unit	—
2	To pin 13 of EDC control unit	—
3	Screens	—

Distribution pulse transmitter

Features

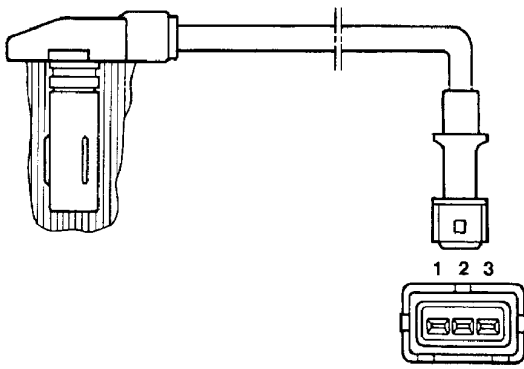
Vendor	BOSCH
Torque	8 ± 2 Nm
Resistance	880 ± 920 Ω

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 engine rpm sensor mounted in the camshaft in is NOT interchangeable with it as it cable is shorter and it features a larger diameter.

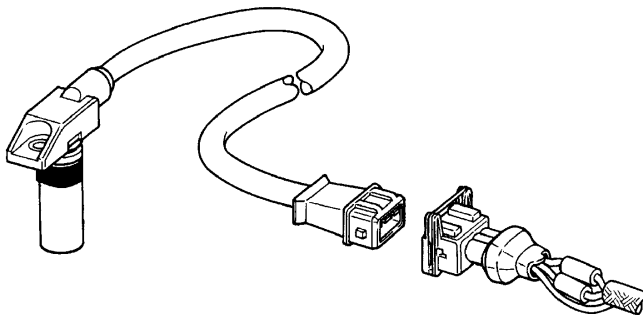
This sensor's air gap is NOT ADJUSTABLE.



TECHNICAL VIEW



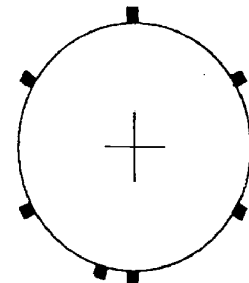
WIRING DIAGRAM



PERSPECTIVE VIEW

000606t

6 + 1



REFERENCE ON SOUND WHEEL

8520

Connector	Function	Cable colour
1	To EDC center pin A 2	—
2	To EDC center pin A 14	—
3	Shields	—

Boosting pressure transmitter

Specifications

Supplier

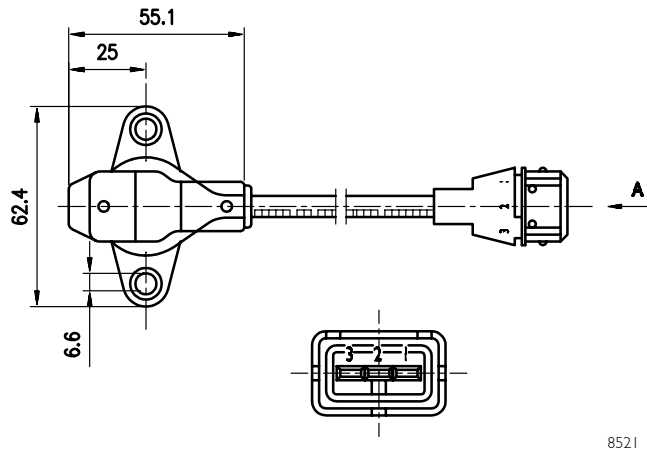
Code

Operating pressure field

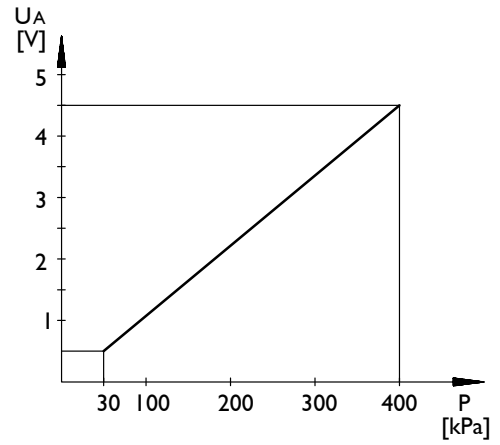
Max. tightening torque

BOSCH
 B 281022 018
 50 ÷ 400 kPa
 10 Nm

Figure 103



8521

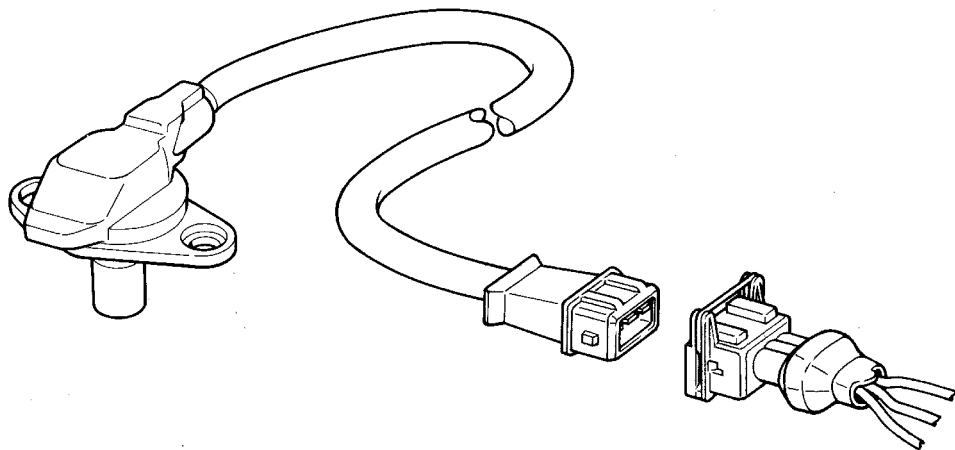


8522

TECNICAL VIEW

MAX ABSOLUTE PRESSURE SPECIFICATIONS 600 KPA

Figure 104



PERSPECTIVE VIEW

8523

Pin	Function	Cable colour
1	To pin 12 of EDC control unit	—
2	To pin 23 of EDC control unit	—
3	To pin 17 of EDC control unit	—

PRE/POST-HEATING RESISTANCE

The resistance is ~ 0,7 Ohm.

Such resistance is placed between the cylinder head and the suction manifold. It is used to heat up air during pre/post-heating operations.

When the ignition key is inserted, should any one of the temperature sensors – water, air, gas oil – detect a value below 10°C, the electronic control unit will activate pre/post-heating and turn on the relevant dashboard warning light for a variable time depending on the temperature.

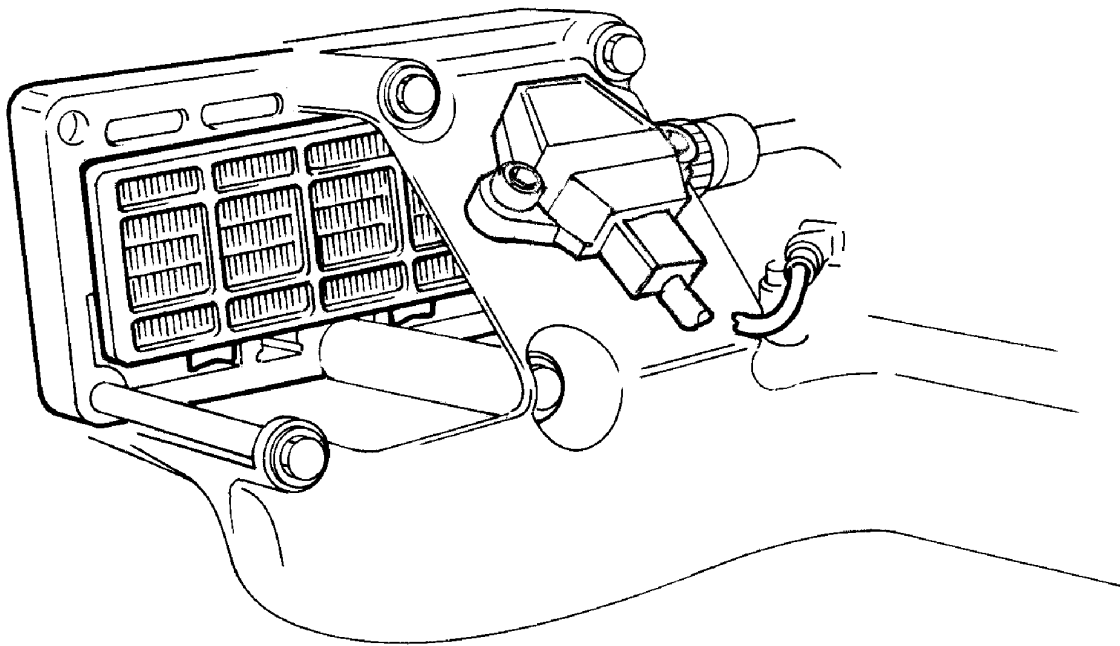
After that time, the warning light starts blinking thus informing the driver that the engine can be started.

When the engine is running the warning light goes off, while the resistance is being fed for a certain time as a result of post-heating.

If the engine is not started, with the warning light flashing, in 20 / 25 seconds, the operation is cancelled to prevent draining the battery.

On the contrary, if reference temperatures are over 10°C, when the ignition key is inserted the warning light comes on for about 2 seconds and carries out the test and then goes out to signal that the engine can be started.

Figure 106



001256t

EDC SYSTEM FUNCTIONS

The MS6.2 electronic center manages the following main functions:

Fuel injection
Accessory functions
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
- 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 still 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.

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.

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 inside 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.

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 issued by blinking of the failure led: the "blink-code" (whether programmed).

Please consider that the interpretation of the indications provided by the blink-code is not sufficient to guarantee the solution to the existing anomalies.

Using Iveco Motors 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 three different parts:

- Part 1: Blink Code, relating to the anomalies identified by the gearbox, mainly of electric and electrical nature;
- Part 2: Troubleshooting guide using PT-01 portable tester.
Tool identified as IVECO p/n 8093731.
- Part 3: Guideline for troubleshooting without blink code, divided per symptoms, describing all possible anomalies not detected by the electronic gearbox, often of mechanical and hydraulic nature.

NOTE Any kind of operation on the electronic center unit must be executed by qualified personnel, duly authorized by Iveco Motors.

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

PART I

EDC MS6.2 SW control unit Blink Table

Blink code	EDC warning lamp *	Fault
VEHICLE AREA		
1.1	GLOWING STEADILY	Vehicle speed signal (if available)
1.2	GLOWING STEADILY	Torque selector (if available)
1.3	OFF	Cruise Control (if available)
1.4	GLOWING STEADILY	Accelerator pedal
1.5	OFF	Clutch pressure switch
1.6	GLOWING STEADILY	Plausibility of brake pedal signal switches
1.7	OFF	Plausibility between accelerator / brake pedal
ENGINE AREA		
2.1	OFF	Water temperature sensor
2.2	OFF	Air temperature sensor
2.3	OFF	Fuel temperature sensor
2.4	GLOWING STEADILY	Supercharging pressure sensor
2.5	OFF	Ambient pressure sensor (inside control unit)
3.5	OFF	Battery voltage
INJECTORS		
5.1	GLOWING STEADILY	Fault on injector cylinder 1
5.2	GLOWING STEADILY	Fault on injector cylinder 4
5.3	GLOWING STEADILY	Fault on injector cylinder 2
5.4	GLOWING STEADILY	Fault on injector cylinder 6
5.5	GLOWING STEADILY	Fault on injector cylinder 3
5.6	GLOWING STEADILY	Fault on injector cylinder 5
ENGINE RPM SENSORS		
6.1	GLOWING STEADILY	Flywheel sensor
6.2	GLOWING STEADILY	Timing gear sensor
6.4	FLASHING	Engine over revving
INTERFACES WITH OTHER CONTROL UNITS		
7.2	OFF	CAN line
7.6	OFF	CAN line (ASR control)
7.7	OFF	CAN line (gearbox data control)
CONTROL UNIT		
9.1	FLASHING	Faulty control unit
9.2	GLOWING STEADILY	Incorrect data in EPROM
9.4	GLOWING STEADILY	Main relay
9.5	GLOWING STEADILY	Incorrect engine stopping procedure
9.6	GLOWING STEADILY	Incorrect data recording in control unit

- * Blink code warning lamp off = slight error
 Blink code warning lamp glowing steadily = significant error
 Blink code warning lamp flashing = serious error

PART 2

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
1.1	ON steady	Faulty vehicle speed sensor. The tachograph won't work. Odd behaviour of the tachograph pointer. (If available)	Vehicle speed no longer reduced: it can be exceeded in case of poor resistance to progressing. Serration with high speeds.	Flight recorder detects high time at low speed. Check cabling, connections and component.	Control unit replacement value: 5 km/h.
1.2	ON steady	Faulty multiple-state switch. (If available)		Check cabling, connections and component.	
1.3	OFF	Faulty Cruise Control switches. (If available)	The Cruise Control won't work.	Check cabling, connections and component.	Or non-plausible switch signals (switches pressed simultaneously).
1.4	ON steady	Accelerator pedal: faulty potentiometer or non-plausible signal. Odd reaction of engine when actuating the accelerator pedal.			Engine speed can be varied by means of the CC (Set + / Set -) switch. (If available)
1.5	OFF	Faulty clutch switch. CC won't work. (If available)	Serration when changing gear.	Check cabling, connections and component.	
1.6	ON steady	Brake switch plausibility. No reaction after actuating the CC/PTO switches. (If available)	The Cruise control / PTO won't work.	Check cabling, connections and component.	
1.7	OFF	Brake switch / accelerator pedal sensor plausibility.			No reaction from the system.

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
2.1	OFF	Faulty coolant temperature sensor. Excessive starting time in cold weather conditions.	Greater combustion noise due to high injection advance.	Pre-heating resistor active diagnosis. Parameter reading. Check cabling, connections and component.	No overheating protection, replacement value = 0°C.
2.2	OFF	Faulty boosting air temperature sensor.	If the sensor signals a temperature lower than the actual one, the error is not stored and the engine achieves better performance, yet with black smoke.	Parameter reading. Check cabling, connections and component.	Replacement value = 20°C.
2.3	OFF	Faulty fuel temperature sensor.		Parameter reading. Check cabling, connections and component.	No injection rate correction; yet, the driver is not aware of it. Replacement value = 30°C.
2.4	ON steady	Faulty boosting pressure sensor. Power reduction.	Significant black smoke in momentary conditions.	Parameter reading modus: if the replacement value is read when the engine is idling, the fault is confirmed.	Replacement value. Cursor 8 = 1,600 mbar, Cursor 10 = 2,800 mbar.
2.5	OFF	Faulty ambient pressure sensor.		Contact Help Desk for replacement (if any) of the control unit, owing to the sensor being integrated into the same.	EDC works with a replacement value of 28 V.
3.5	OFF	Too low battery voltage or voltage recognition fault.	Possible pre-heating and starting problems.	Battery test.	
5.x	ON steady	Problem with injection circuit on cylinder X. The engine speed is reduced, and the engine operated with 5 cylinders.	If the fault is intermittent, the engine sometimes works correctly; sometimes, it does not.	Engine test (if the fault is found). Check component, cabling and connections (head cable included).	

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
6.1	ON steady	Faulty flywheel sensor. Reduced engine speed and power.	Engine starting may take a longer time than usual.	Fault memory reading by means of the diagnosis instrument. Check cabling, connections and component.	
6.2	ON steady	Distributing shaft sensor. Reduced engine speed and power.	Engine starting may take a longer time than usual.	Fault memory reading by means of the diagnosis instrument. Check cabling, connections and component.	
(6.1 - 6.2)	ON steady	Distributing shaft phonic wheel has rotated, due to loosened screws. The engine won't start, or stops and cannot be started again.	Reduced power with engine started (after taking the measure recommended in the next column).	Disconnect the distributing shaft sensor connector. If the engine is started, even by taking a longer time than usual, the phonic wheel is out-of-phase.	
6.4	Blinking	The engine has reached (on pulling) the out-of-rev conditions for any reason whatsoever.		Fault memory reading. Flight recorder reading to get confirmation of the engine out-of-rev condition.	
(9.1)	Blinking	Faulty EDC control unit. The engine will stop or won't start.		Contact Help Desk for control unit replacement.	No diagnosis can be made. This error may even not be stored; this depends on the control unit conditions.
9.2	ON steady	Control unit fault (EEPROM memory). Reduced engine speed and power.	Faulty memory lost; only the diagnosis of existing faults can be made.	Contact Help Desk for replacement (if any) of the control unit.	
9.4	Blinking	Main relay faulty or locked in closed position. The EDC warning light remains ON when the key is turned to OFF; yet the engine will stop.	EDC power supply remains ON after the key has been turned to OFF; danger of battery run-down.	Check cabling, connections and component.	The fault will be stored only after the next time the engine is started.

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
9.5	ON steady	ECU power supply is cut out too often (5 times): faulty main relay or engine stop by means of battery disconnect switch. Reduced engine max. speed and power.		Check main relay, cabling and connections. Investigate whether the driver switches the engine off in other ways than by turning the key.	The problem will be solved by itself the next time the switch-off procedure and data storing are performed correctly.
9.6	ON steady	ECU stop test failure. Reduced engine speed and power.	This is a test procedure inherent to the control unit for power stage control. It might store other errors concerning the various power stages of actuators.	Contact Help Desk for replacement (if any) of the control unit.	

PART 3

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 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 PLANNING

Recovery

To ensure optimised working conditions, in the following pages we are providing instructions for the overhaul control interventions, checks and setting operations that must be performed on the engine at due planned dates.

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

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

Inspection and/or maintenance interventions

Intervention type	Frequency (hours)
Engine	
Engine visual inspection	Daily
Check presence of water in fuel prefilter	Daily
Engine oil change	-
Engine oil filter change	-
Fuel prefilter change (when it is required by the application)	-
Fuel filter change	-
Check Blow-by filter condition by clogging indicator	-
Check condition of water pump/alternator control belt	-
Check-up of EDC system by diagnostics tool	-
Check valve lash and adjust, if required	-
Dry air filter change and container cleaning	-

NOTE The maintenance operations are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Checks not included in maintenance planning-daily checks

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

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

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

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

MAINTENANCE PROCEDURES

Checks and controls

Engine oil level check.

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

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

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

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

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

To provide filling, operate through the upper top (1) or through the lateral top (2). During filling operation, the tops must be removed as well as the rod in order to make the oil flow easier".

Refill through upper tappet cover plug. During refill, remove dipstick for easier oil drain.



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



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

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

Check of fuel system

The check must be executed both when the engine disconnected and when it is running.

The check is made by observing the fuel pipes from the tank to the fuel pump and to the injectors.

Cooling system check

The check must be executed both when the engine disconnected and when it is running.

Check the pipes from the engine to the radiator and vice versa; note any seepage and the state of the pipes especially near the coupling clamps.

Verify that the radiator is clean, the correct working of the fan flywheels, the presence of any leakage from the connectors, from the manifold and from the radiating unit.



Due to the high temperatures achieved by the system, do not operate immediately after the engine's disconnection, but wait for the time deemed necessary for the cooling.

Protect the eyes and the skin from any eventual high pressure jet of cooling liquid.

The density of the cooling liquid must be checked any how every year before winter season and be replaced in any case every two year.

NOTE In case of new filling, proceed bleeding system, through the bleeds on the engine.

If bleeding of the system is not carried out, serious inconvenience might be caused to the engine due to the presence of air pockets in the engine's head.

Lubricating system check

The check must be executed both when the engine disconnected and when it is running.

Verify the presence of any oil leakage or blow-by from the head, from the engine pan or from the heat exchanger.



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

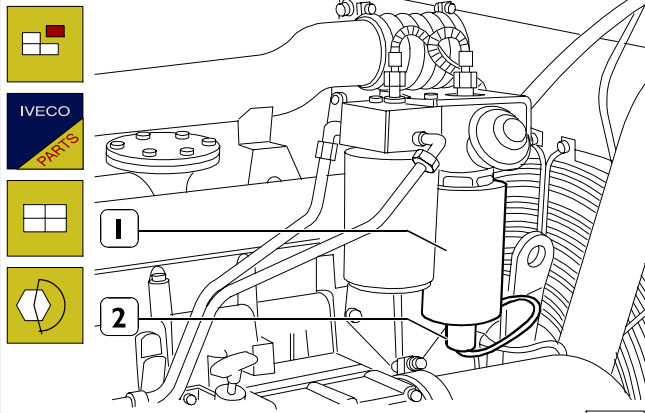


Adequately protect the skin and the eyes, operate in full compliance with safety regulations.

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

Replace fuel sedimentation tank prefilter (when it is required by the application)

Figure 107

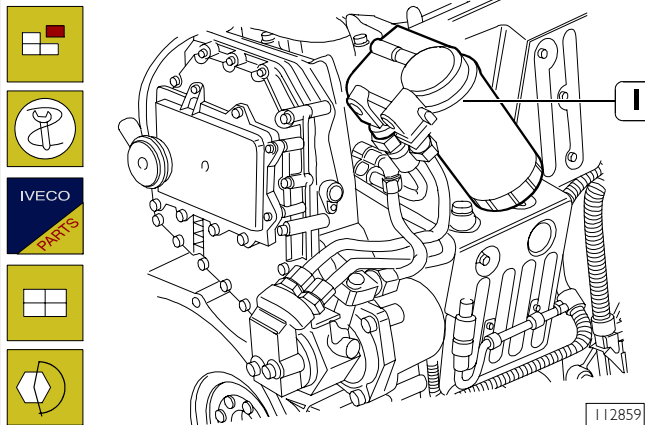


Disconnect electric connector. Unlock prefilter (1) and change it. Before refitting a new cartridge, wet seal with fuel oil or engine oil. Lock cartridge by hand till in contact with support, then lock it by 3/4 of a rev. at predefined tightening torque.

NOTE At change, filter cartridge must not be prefilled to prevent circulating dirt that could damage injector/pump system components. Bleed air from fuel filter as described in previous pages.

Fuel filter change

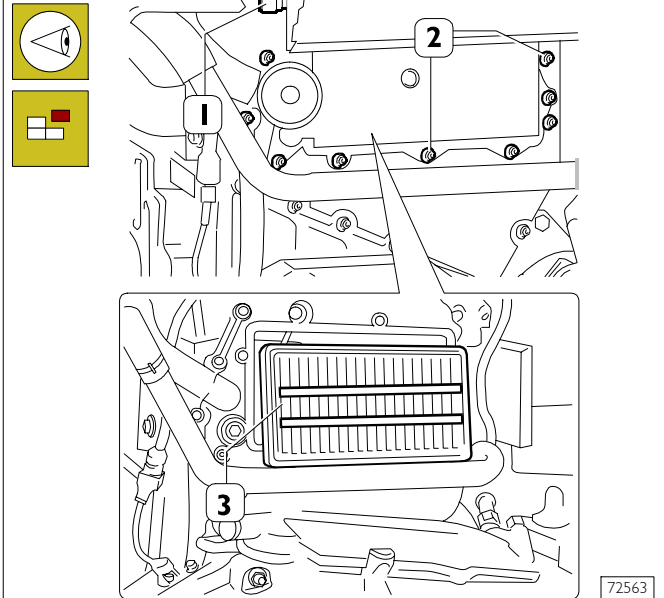
Figure 108



Use tool 99360314 to remove fuel filter (1). Before fitting the new cartridge, wet seal with fuel oil or engine oil. Lock the new one by hand and carefully check that rubber seal and contact surface are clean and in perfect conditions. Lock cartridge by hand till contact with support and then lock it for 3/4 of a rev. at prescribed tightening torque. Bleed air from supply system as described in paragraph below:

Check Blow-by filter conditions by means of a clogging indicator

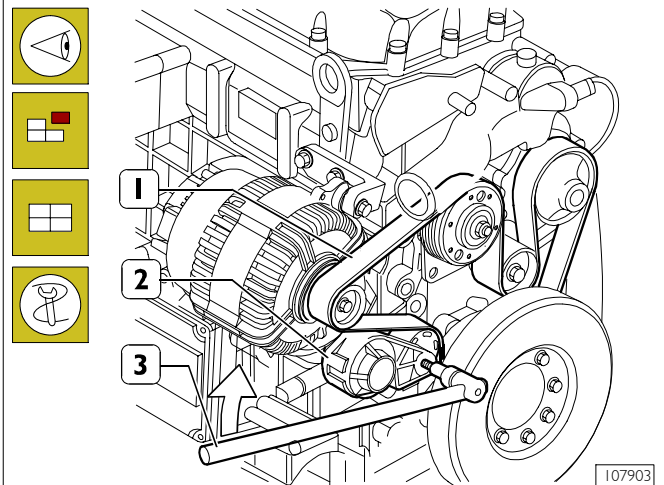
Figure 109



- Check filter (3) conditions by means of a clogging indicator (1). In case the red area appears, change it.
- For screw (2) change, remove carter, pull out filter (3) and replace it with a new one. Filter has a one-way operation, therefore it must be installed with the two reinforcement bars visible, as shown in the picture.

Check of water pump/alternator control belt condition

Figure 110



Visually check that belt (1) is not worn out or broken; change it as described below, if required.

Water pump/alternator control belt change

In order to remove and refit belt (1), operate using a specific tool (3) on belt tensioner (2) in direction shown by arrow.

NOTE Belt tensioner is automatic and requires no adjustment.

Check for any water in the fuel filter

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

Take prompt action on the filter to drain off the water in the fuel circuit.

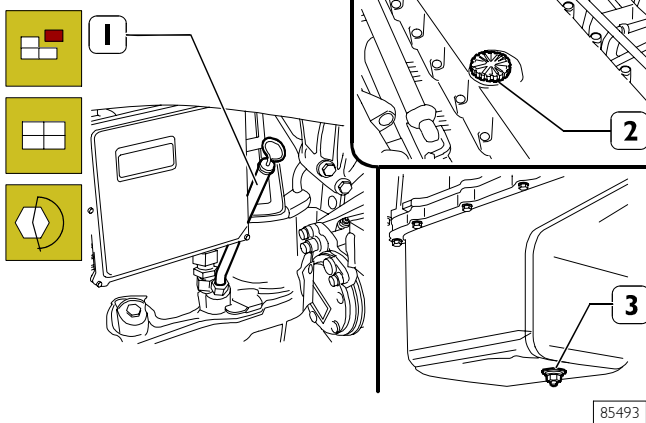
Fuel filter is equipped with pump screw-valve to drain the water eventually mixed with fuel.

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


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

Engine oil change

Figure I 11



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


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

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

- Place a proper container for the oil collecting under the pan connected with the drain plug (3).
- Unscrew the plug (3) and then take out the control dipstick (1) and the inserting plug (2) to ease the downflow of the lubrication oil.

 The oil motor is very pollutant and harmful.

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

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

Dispose of the residual properly following the rules.

Lock plus (3) under oil sump at predefined tightening torque. Pour oil in prescribed quantity and quality in engine through filler (2) of tappet cover.

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

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

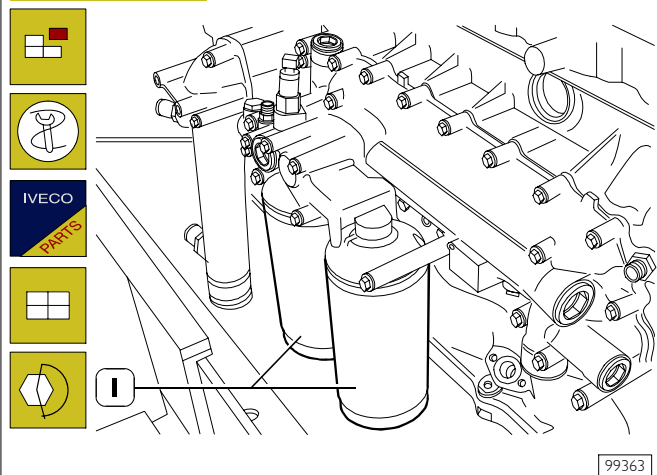
In case of topping up, don't mix oils having different features.

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

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


Engine oil filter change

Figure I 12



Drain oil as described in "Engine oil change" chapter. Use tool 99360314 (2) to remove the oil filters (1).

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

 Place properly a container for the liquid.

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

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

NOTE Before refitting the new cartridge, wet seal using engine oil.

Lock oil filter (1) by hand till contact to support and then lock by $\frac{3}{4}$ of a rev. at prescribed tightening torque; pour oil in engine as described in "Engine oil change" chapter.

Valve lash check a adjustment

For correct operation, follow instructions contained in related chapter in section 3 – Industrial Applications.

Change dry air filter and clean its container

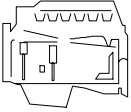

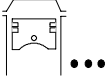

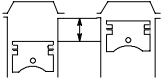
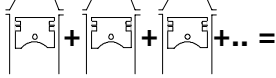
Refit container cover, remove cartridge from air filter.
Carefully clean container inside, insert new cartridge and refit cover.

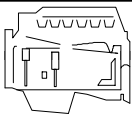
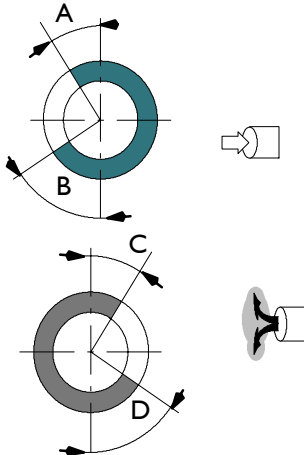
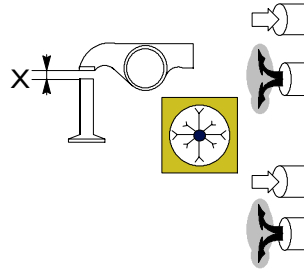
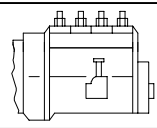
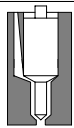
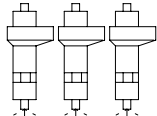
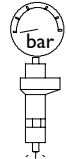
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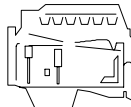
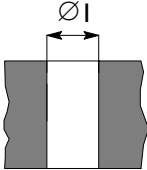
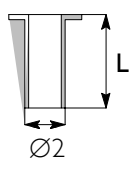


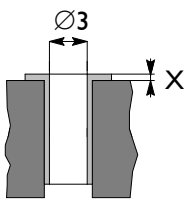
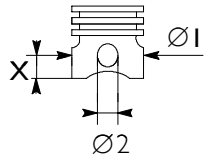
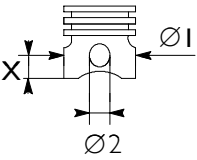


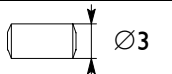
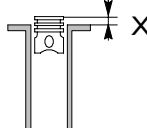
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GENERAL CHARACTERISTICS

	Type		F3A
	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

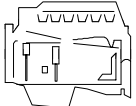
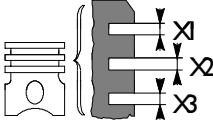
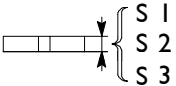


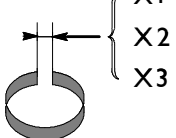
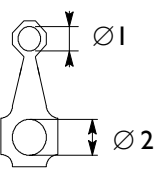
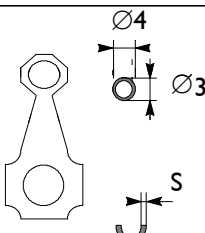




	Type	F3A	
		F3AE0684	F3AE0687
	<p>VALVE TIMING</p> <p>opens before T.D.C. A</p> <p>closes after B.D.C. B</p> <p>opens before B.D.C. D</p> <p>closes after T.D.C. C</p>	<p>16°</p> <p>32°</p> <p>51°</p> <p>11°</p>	<p>16°</p> <p>32°</p> <p>50°</p> <p>9°</p>
 <p>For timing check</p> <p>Running</p>	<p>X { mm</p> <p>X { mm</p> <p>X { mm</p> <p>X { mm</p>	<p>-</p> <p>-</p> <p>0.40 to 0.50</p> <p>0.40 to 0.50</p>	
	<p>FEED</p> <p>Injection type: Bosch</p>	<p>Through fuel pump - filters</p> <p>With electronically regulated injectors PDE 31 pump injectors controlled by overhead camshaft</p>	
	Nozzle type	-	
	Injection order	1 - 4 - 2 - 6 - 3 - 5	
	<p>Injection pressure bar</p> <p>Injector calibration bar</p>	<p>1500</p> <p>296 ± 6</p>	

ASSEMBLY CLEARANCE DATA

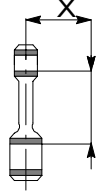
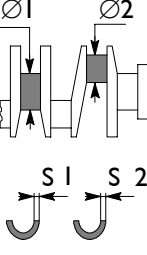
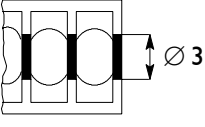


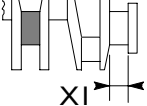
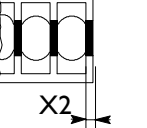
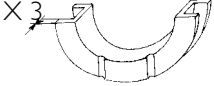

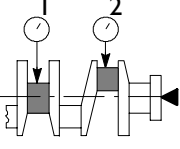
		Type	F3A								
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS			mm								
	Bores for cylinder liners:										
	<table border="0"> <tr> <td>Ø1</td> <td>upper</td> <td>142.000 to 142.025</td> </tr> <tr> <td>Ø1</td> <td>lower</td> <td>140.000 to 140.025</td> </tr> </table>	Ø1	upper	142.000 to 142.025	Ø1	lower	140.000 to 140.025				
Ø1	upper	142.000 to 142.025									
Ø1	lower	140.000 to 140.025									
	Cylinder liners:										
	external diameter:										
	<table border="0"> <tr> <td>Ø2</td> <td>upper</td> <td>141.961 to 141.986</td> </tr> <tr> <td>Ø2</td> <td>lower</td> <td>139.890 to 139.915</td> </tr> <tr> <td>length</td> <td>L</td> <td>-</td> </tr> </table>	Ø2	upper	141.961 to 141.986	Ø2	lower	139.890 to 139.915	length	L	-	
Ø2	upper	141.961 to 141.986									
Ø2	lower	139.890 to 139.915									
length	L	-									
	Cylinder liners - crankcase bores										
		upper lower	0.014 to 0.064 0.085 to 0.135								
	External diameter	Ø2	-								
	Cylinder sleeve										
	inside diameter	Ø3A*	125.000 to 125.013								
	inside diameter	Ø3B*	125.011 to 125.024								
	Protrusion	X	0.045 to 0.075								
* Selection class											
	Pistons:		NUERAL	MAHLE - MONDIAL							
	measuring dimension	X	18	18							
	external diameter	Ø1A●	124.884 to 124.896	124.881 to 124.893							
	external diameter	Ø1B●●	124.895 to 124.907	124.892 to 124.904							
	pin bore	Ø2	50.010 to 50.016	50.010 to 50.018							
	Piston - cylinder sleeve	A* B*	0.107 to 0.132 0.096 to 0.131								
* Selection class											
	Piston diameter	Ø1	-								
	Pistons protrusion	X	0.23 to 0.53								
	Gudgeon pin	Ø3	49.994 to 50.000								
	Gudgeon pin - pin housing		0.010 to 0.024	0.010 to 0.024							

● Class A pistons supplied as spares.

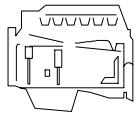
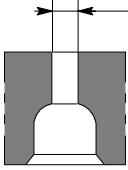
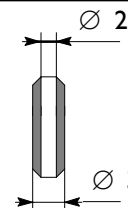



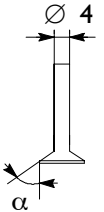
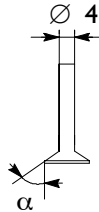

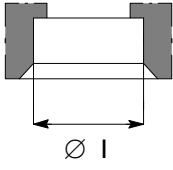

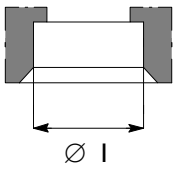

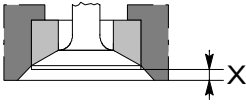
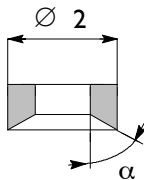


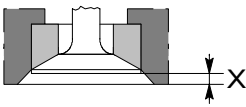





●● Class B pistons are fitted in production only and are not supplied as spares.

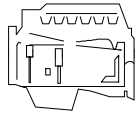
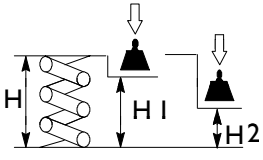
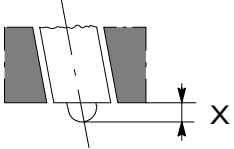
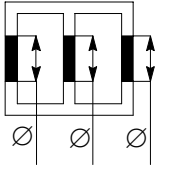
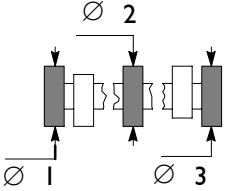
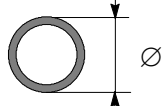
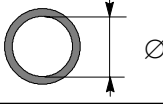


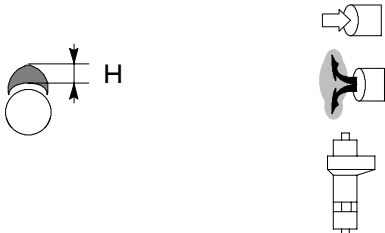
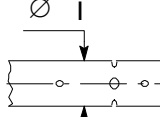

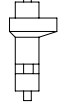
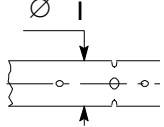
	Type	F3A	
		mm	
	Piston ring grooves * measured on \varnothing of 120 mm	X1* X2 X3	NUERAL *3.225 3.05 to 3.07 4.02 to 4.04 MAHLE - PISTON 2.955 to 2.985
	Piston rings: trapezoidal seal lune seal milled scraper ring with slits and internal spring * measured on \varnothing of 120 mm	S1* S2 S3	2.796 to 2.830 2.970 to 3.000 3.970 to 3.990
	Piston rings - grooves	1 2 3	0.3950 to 0.429 0.050 to 0.100 0.030 to 0.070
	Piston rings		-
	Piston ring end gap in cylinder liners	X1 X2 X3 X1 X2 X3	0.35 to 0.50 0.60 to 0.75 0.35 to 0.65
	Small end bush housing Big end bearing housing Selection classes	$\varnothing 1$ $\varnothing 2$ 1 2 3	54.000 to 54.030 87.000 to 87.030 87.000 to 87.010 87.011 to 87.020 87.021 to 87.030
	Small end bush diameter outside inside Big end bearing shell Red Green Yellow ●	$\varnothing 4$ $\varnothing 4$ $\varnothing 3$ S	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
	Big end bearing		0.127 - 0.254 - 0.508
	Connecting rod weight		g
	Class	A B C	4024 to 4054 4055 to 4085 4086 to 4116

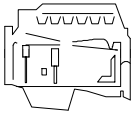
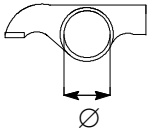


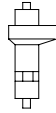
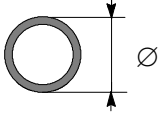


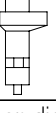
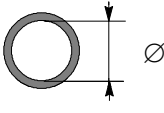


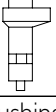



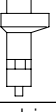



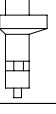
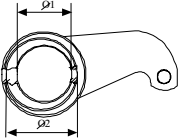
● Fitted in production only and not supplied as spares

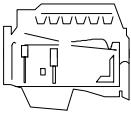


		F3A		
		mm		
	Measuring dimension X		125	
	Max. connecting rod axis misalignment tolerance =		0.08	
	Main journals	Ø1		
	- nominal		92.970 to 93.000	
	- class 1	1	92.970 to 92.979	
	- class 2	2	92.980 to 92.989	
	- class 3	3	92.990 to 93.000	
	Crankpins	Ø2		
	- nominal		82.970 to 83.000	
	- class 1	1	82.970 to 82.979	
	- class 2	2	82.980 to 82.989	
	- class 3	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	Ø3		
	- nominal		99.000 to 99.030	
	- class 1	1	99.000 to 99.009	
	- class 2	2	99.010 to 99.019	
- class 3	3	99.020 to 99.030		
	Bearing shells - main journals		0.050 to 0.090	
	Bearing shells - big ends		0.040 to 0.080	
	Main bearing shells		0.127 - 2.254 - 0.508	
	Big end bearing shells		0.127 - 2.254 - 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	
	Alignment	$\left. \begin{array}{l} = \\ \circ \\ \backslash \end{array} \right\} 1 - 2$	≤ 0.025	
	Ovalization		0.010	
	Taper		0.010	

* Fitted in production only and not supplied as spares

 Type	F3A	
CYLINDER HEAD - VALVE TRAIN		
mm		
 Valve guide housings in cylinder head	$\varnothing 1$	14.980 to 14.997
 Valve guide	 $\varnothing 2$ $\varnothing 3$	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:	 $\varnothing 4$ α  $\varnothing 4$ 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	 $\varnothing 1$  $\varnothing 1$	44.185 to 44.220 42.985 to 43.020
 Outside diameter of valve seat; angle of valve seat in cylinder head:	 $\varnothing 2$ α  $\varnothing 2$ α	44.260 to 44.275 60° - 30' 43.060 to 43.075 45° - 30'
 Recessing of valve	 \times  \times	0.65 to 0.95 1.8 to 2.1
 Between valve seat and head	 	0.040 to 0.090

 Type		F3A	
		mm	
 Valve spring height: free height H under a load of: N 500 ±25 H1 N 972 ±48 H2			
			76
			62
			48.8
 Injector protrusion X	X		0.14 to 1.4
 Camshaft bushing housing in the cylinder head: I ⇒ 7	∅		88.000 to 88.030
 Camshaft bearing journals: I ⇒ 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 9.45 11.21
 Rocker shaft	∅ I		41.984 to 42.000

 Type	F3A	
	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 0.025 to 0.057 0.015 to 0.087	
 Engine brake control lever Eccentric pin outer diameter $\varnothing 1$ Rocker arms shaft seat $\varnothing 2$	55.981 ÷ 56.000 42.025 ÷ 42.041	

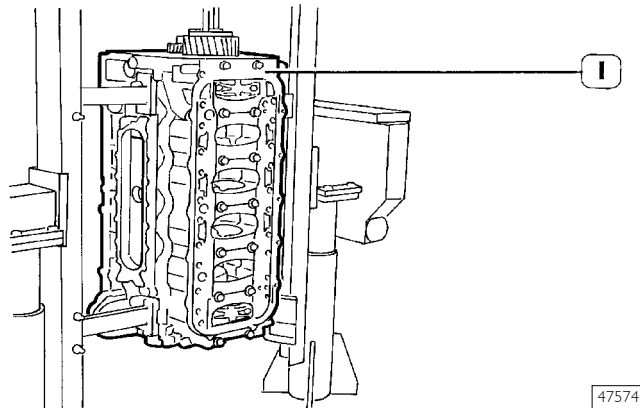
	Type	F3A
		mm
	Rocker arms and engine brake control lever pin	0.030 to 0.058
	Rocker arm shaft and seat on engine brake control lever	0.025 to 0.057
TURBOCHARGER		
Type		HOLSET HX 50W
End float		0.025 to 0.127
Radial play		0.381 to 0.610

ENGINE OVERHAUL ENGINE REMOVAL AT THE BENCH

The following instructions are prescribed on the understanding that the engine has previously been placed on the rotating bench and that removal of all specific components of the equipment have been already removed as well. (See Section 3 of the manual herein).

The section illustrates therefore all the most important engine overhaul procedures.

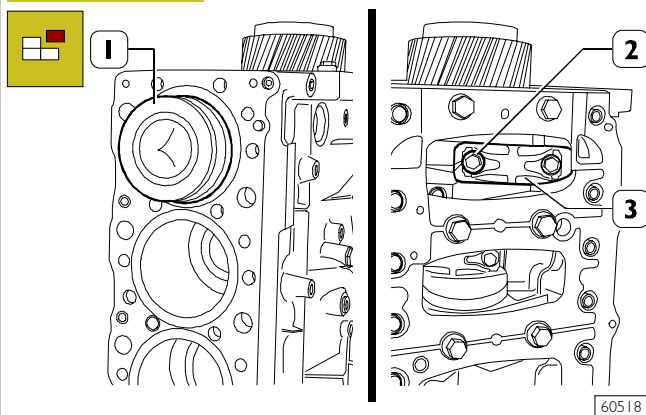
Figure 1



Rotate the block (1) to the vertical position.

47574

Figure 2

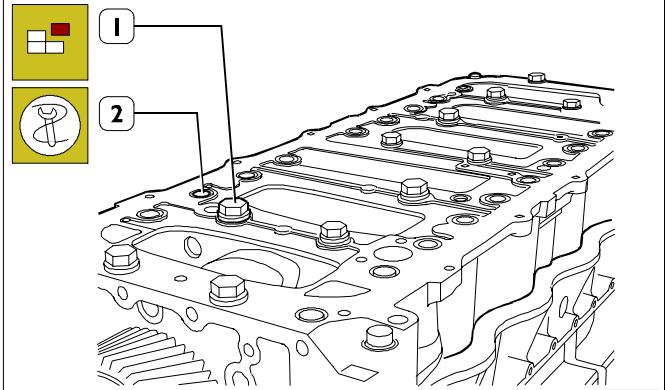


Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston (1) assembly from the upper side. Repeat these operations for the other pistons.

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.

60518

Figure 3

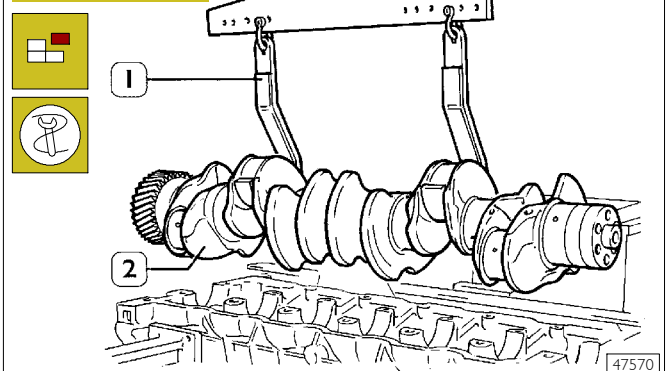


By means of proper and splined wrenches, untighten the screws (1) and (2) and remove the under-block.

60519

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.

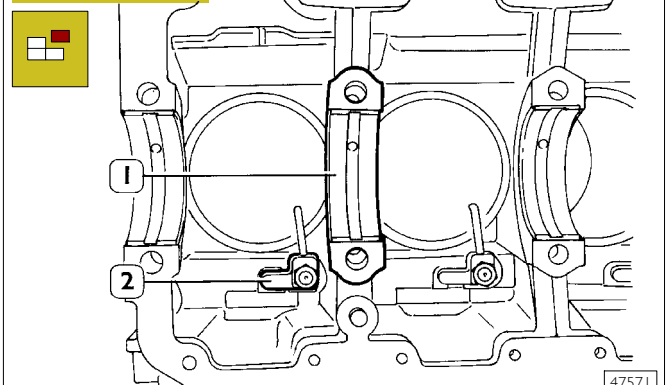
Figure 4



Using tool 99360500 (1), remove the crankshaft (2).

47570

Figure 5



Remove the main bearing shells (1), unscrew the screws and take out the oil nozzles (2). Remove the cylinder liners as described under the relevant subheading on page 16.

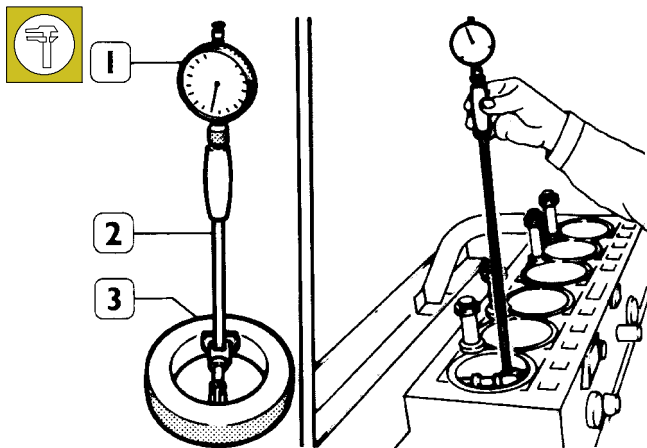
47571

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.

REPAIR OPERATIONS CYLINDER BLOCK

Checks and measurements

Figure 6 (Demonstration)

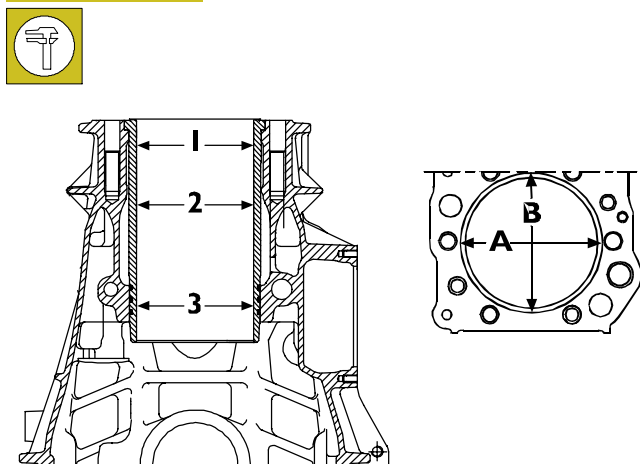


34994

Internal diameter of the cylinder liners is checked for ovalization, taper and wear, using a bore dial (1) centesimal gauge 99395687 (2) previously reset to ring gauge (3), diameter 125 mm.

NOTE If a 125 mm ring gauge is not available use a micrometer caliper.

Figure 7

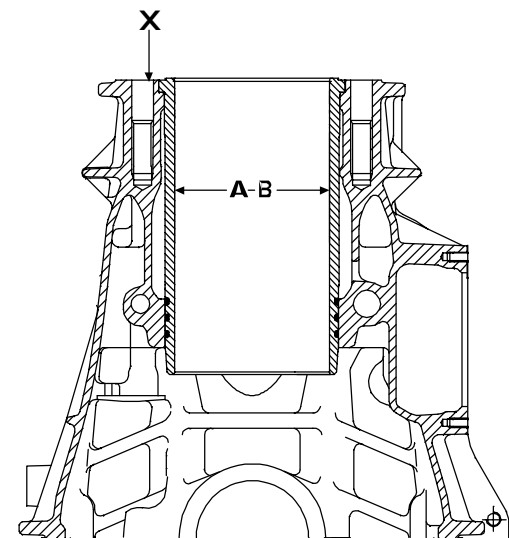


60596

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

Carry out measurements on each cylinder liner at three different levels and on two (A-B) surfaces, to one another perpendicular, as shown in Figure 7.

Figure 8



60595

- A = Selection class $\varnothing 125 - 125.013$ mm
- B = Selection class $\varnothing 125.011 - 125.024$ mm
- X = Selection class marking area

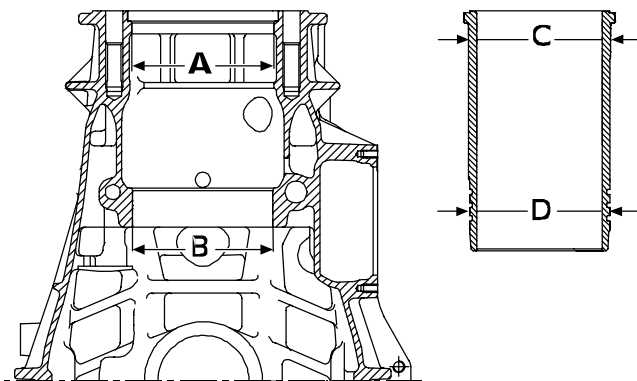
In case of maximum wear >0.150 mm or maximum ovalization >0.100 mm compared to the values indicated in the figure, the liners must be replaced as they cannot be ground, lapped or trued.

NOTE

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



Figure 9



60597

- A = $\varnothing 142.000$ to 142.025 mm
- B = $\varnothing 140.000$ to 140.025 mm
- C = $\varnothing 141.961$ to 141.986 mm
- D = $\varnothing 139.890$ to 139.915 mm

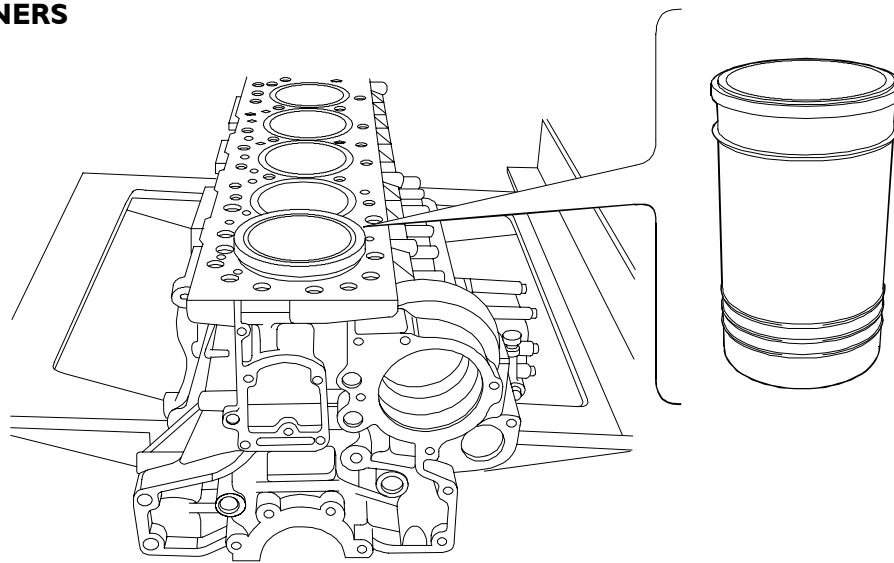
The figure shows the outer diameters of the cylinder liners and the relative seat inner diameters.

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

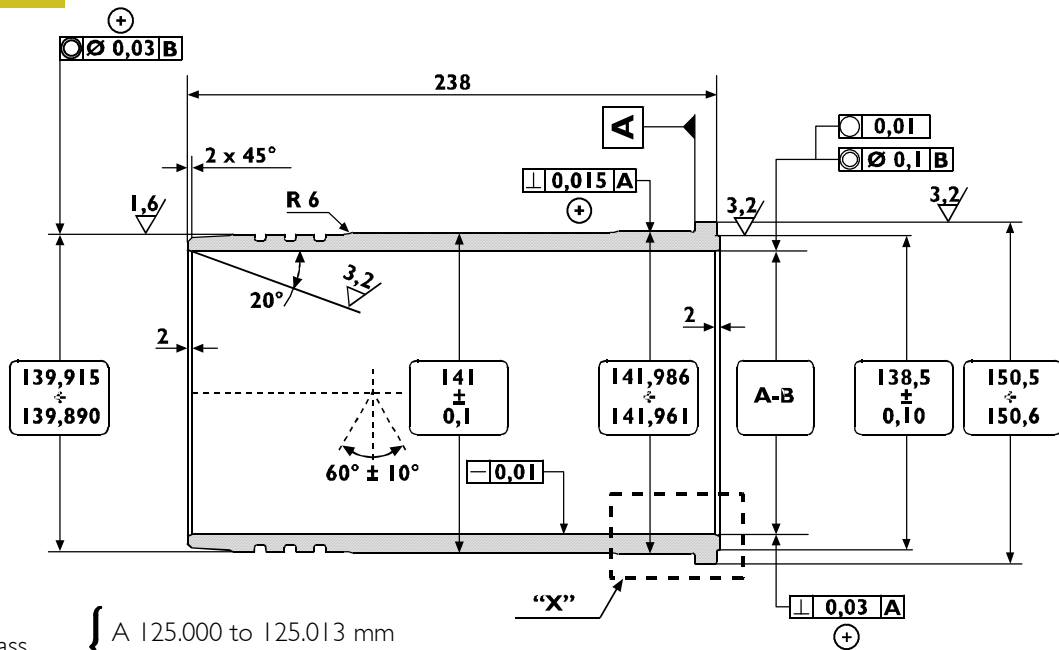
Figure 10



BLOCK WITH CYLINDER LINERS

60598

Figure 11

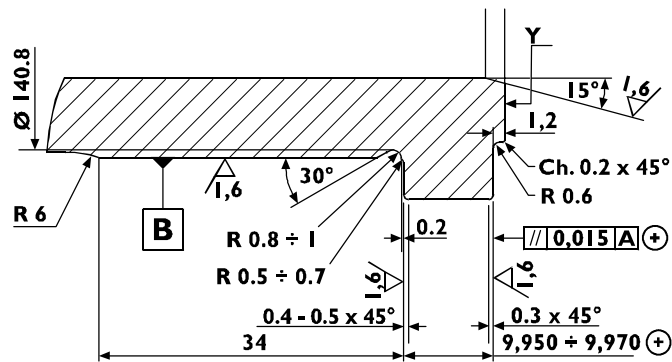


Selection class
 { A 125.000 to 125.013 mm
 B 125.011 to 125.024 mm

CYLINDER LINERS MAIN DATA

60600

Figure 12



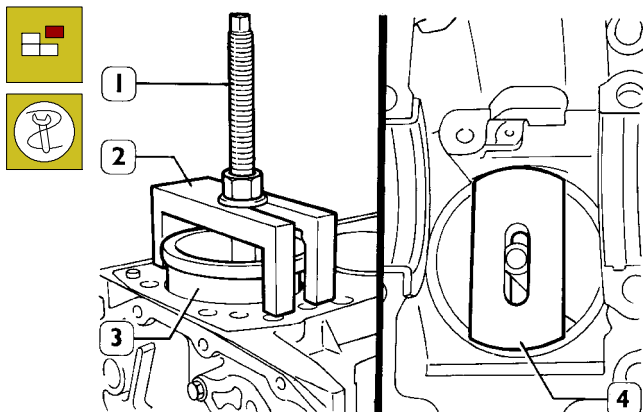
DETAIL "X"
 "Y" - Selection class marking area

60601

Replacing cylinder liners

Refitting

Figure 13



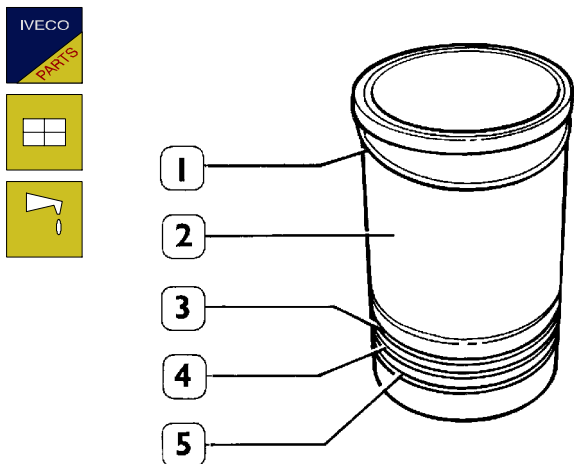
47577

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 14



16798

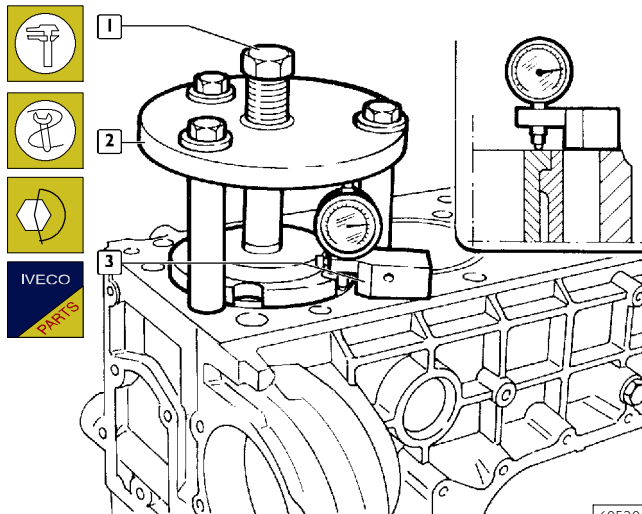
Always replace water sealing rings (3, 4 and 5). Install the adjustment ring (1) on the cylinder liner (2); lubricate lower part of liner and install it in the cylinder unit using the proper tool.

NOTE

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



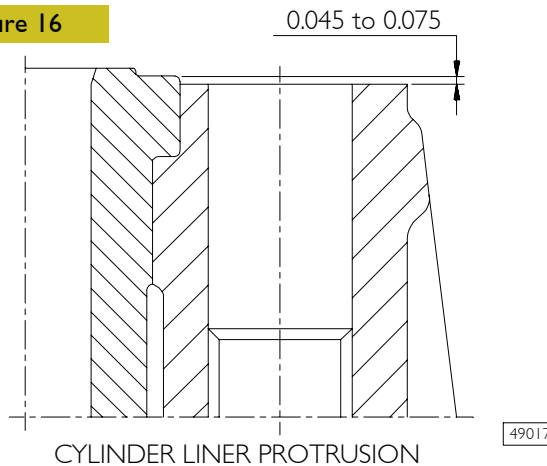
Figure 15



60520

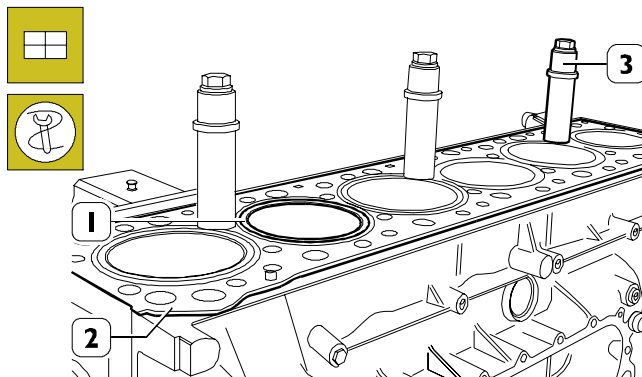
Check the protrusion of the cylinder liners, using tool 99360472 (2) and tightening screw (1) to 225 Nm torque. Using a dial gauge (3), measure the cylinder liner protrusion, from the cylinder head supporting surface, it must be 0.045 to 0.075 (Figure 16); otherwise, replace the adjustment ring (1, Figure 14) supplied as spare parts having different thicknesses.

Figure 16



49017

Figure 17

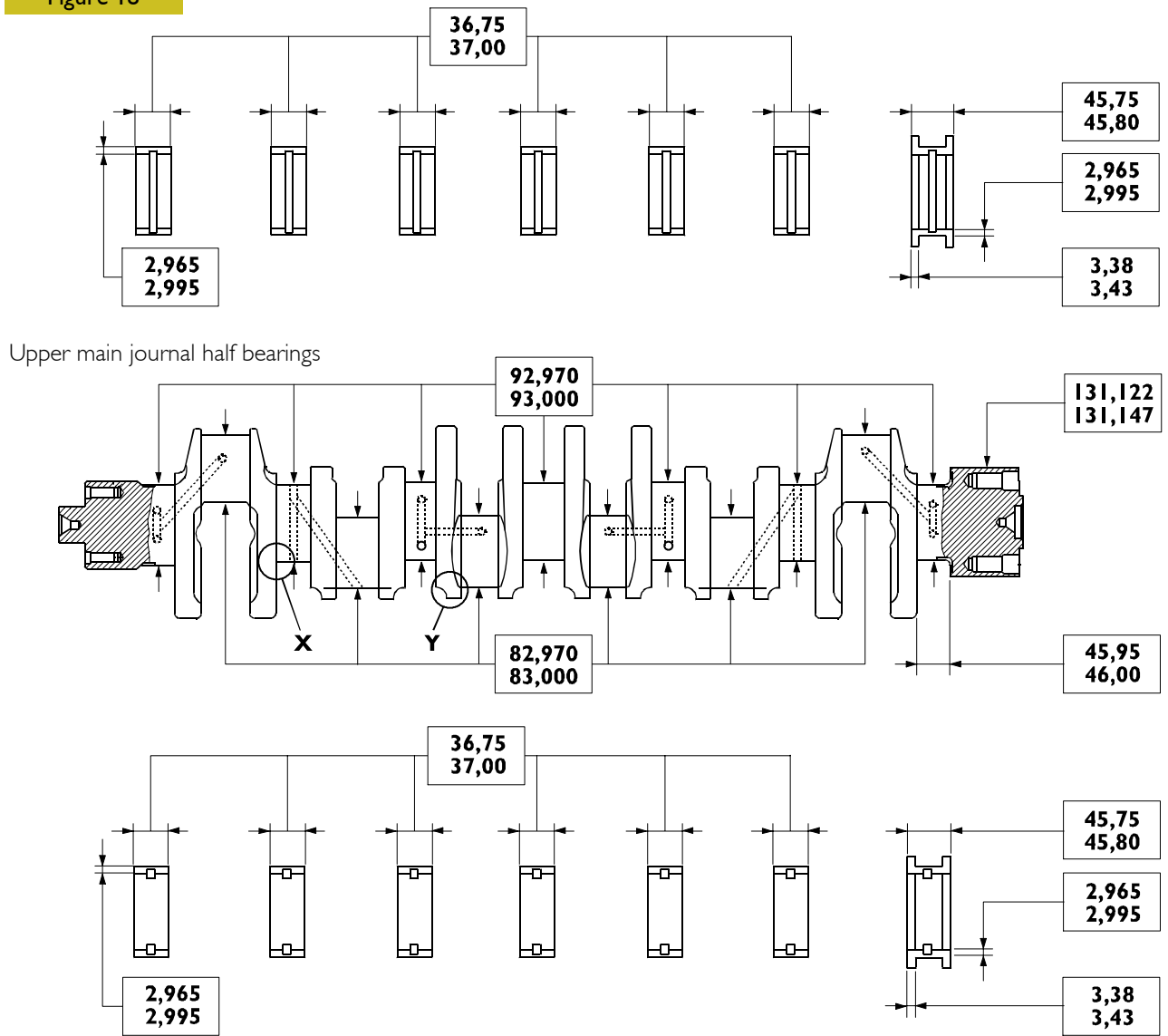


60521

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

CRANKSHAFT

Figure 18



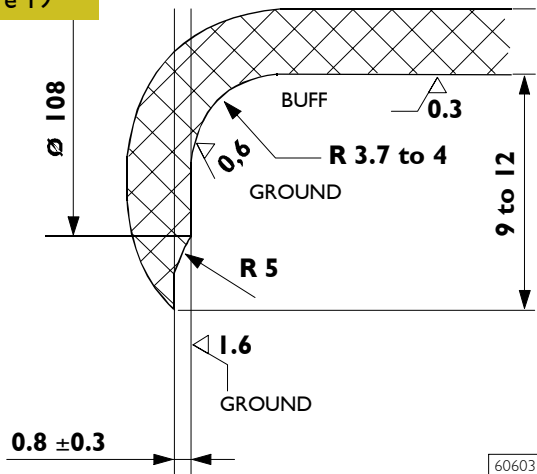
Upper main journal half bearings

Lower main journal half bearings

MAIN DATA FOR THE CRANK SHAFT PINS AND THE HALF BEARINGS

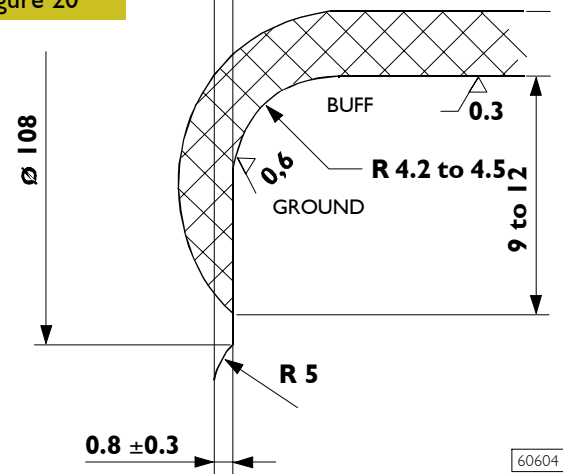
Check the condition of the journals and the big end pins; there must no be signs of scoring, ovalization or excessive wear. The data given refer to the normal diameter of the pins.

Figure 19



X. Detail of main journals connections

Figure 20

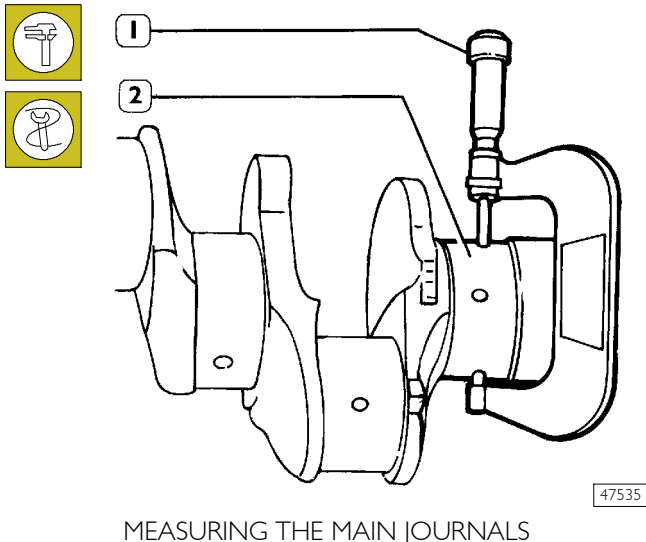


Y. Detail of crank pins connections

Measuring the main journals and crankpins

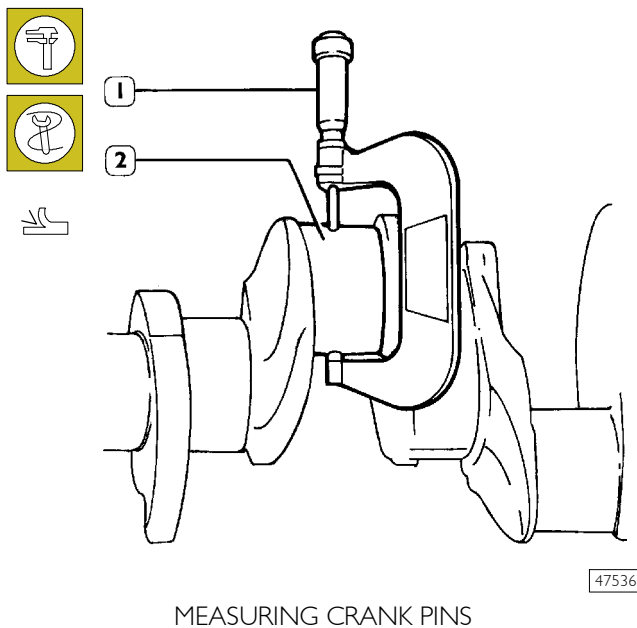
Before grinding the crank pins using a micrometer (1), measure the main journals and the crank pins (2) and decide, on the basis of the undersizing of the bearings, the final diameter to which the pins are to be ground. The undersize classes are 0.127 - 0.254 - 0.508 mm.

Figure 21



NOTE It is advisable to enter the values found in a table (Figure 22).

Figure 23



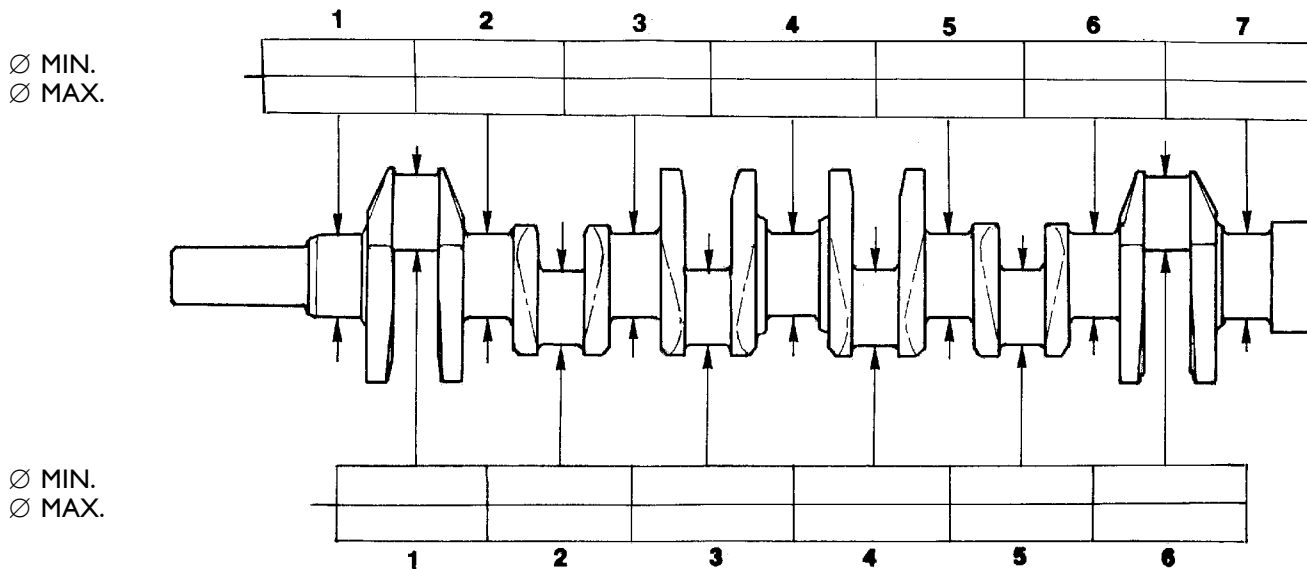
During grinding, pay attention to journal and crank pins values specified in Figure 19 and Figure 20.

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 22

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:

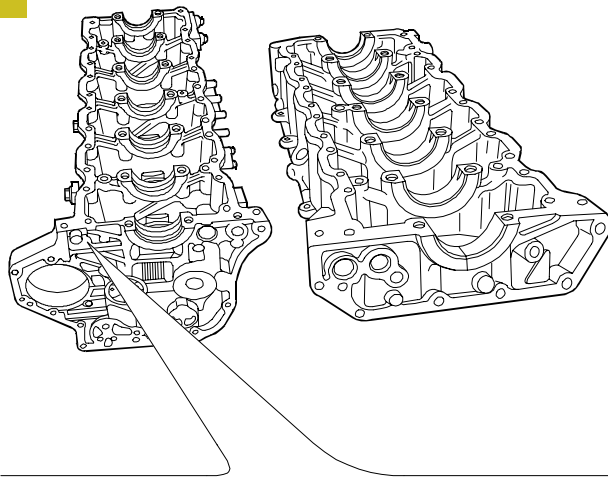
- Determine the class of diameter of the seat in the connecting rod.
- Determine the class of diameter of the crankpin.
- Select the class of the bearing shells to mount.

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

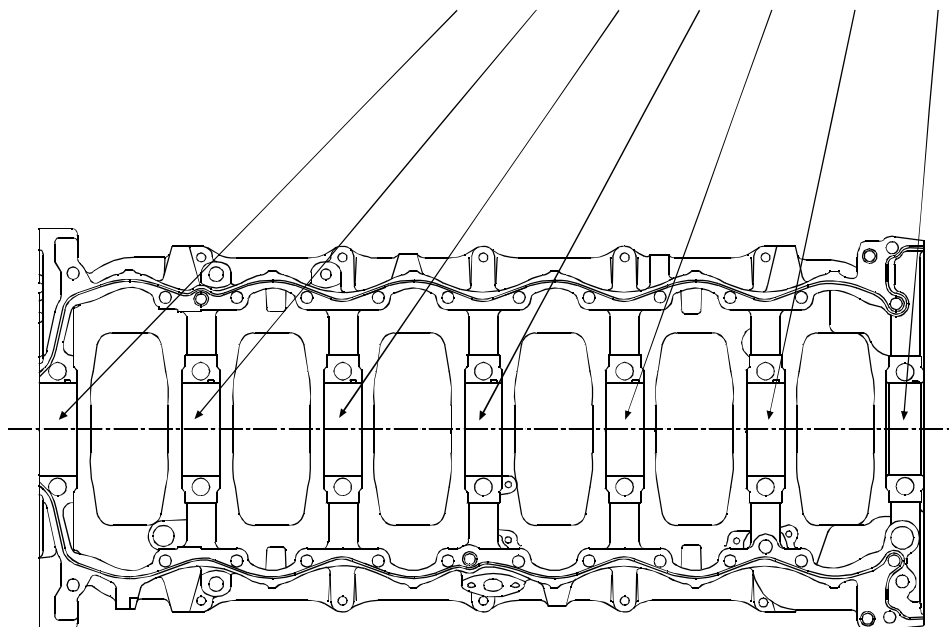
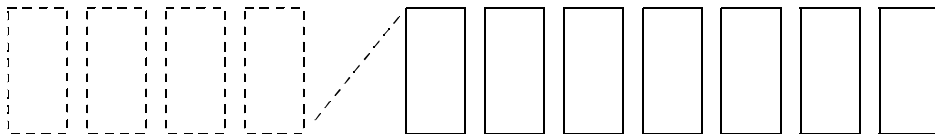
On the front of the crankcase, two sets of numbers are marked in the position shown (Figure 24 at top).

- 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 24 at bottom).
- Each of these digits may be **1, 2 or 3**.

Figure 24



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.

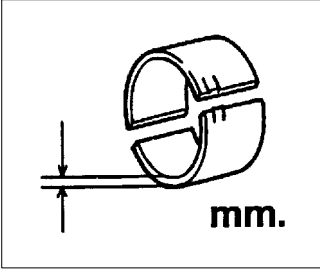
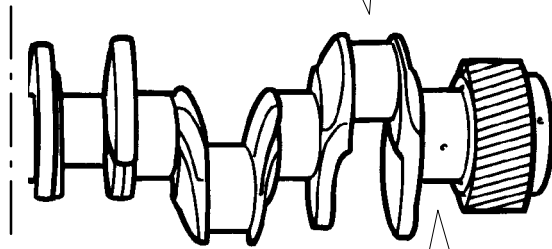
This operation makes it possible to identify the most suitable bearing shells for each of the journals (the bearing shells, if necessary, can have different classes from one journal to another).

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

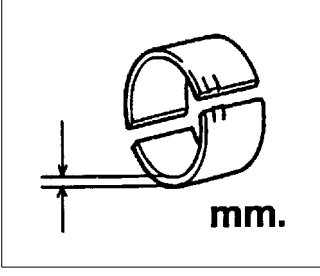
The following tables give the specifications of the main and big end bearing shells available as spares in the standard sizes (STD) and in the permissible oversizes (+0.127, +0.254, +0.508).

Figure 25

	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

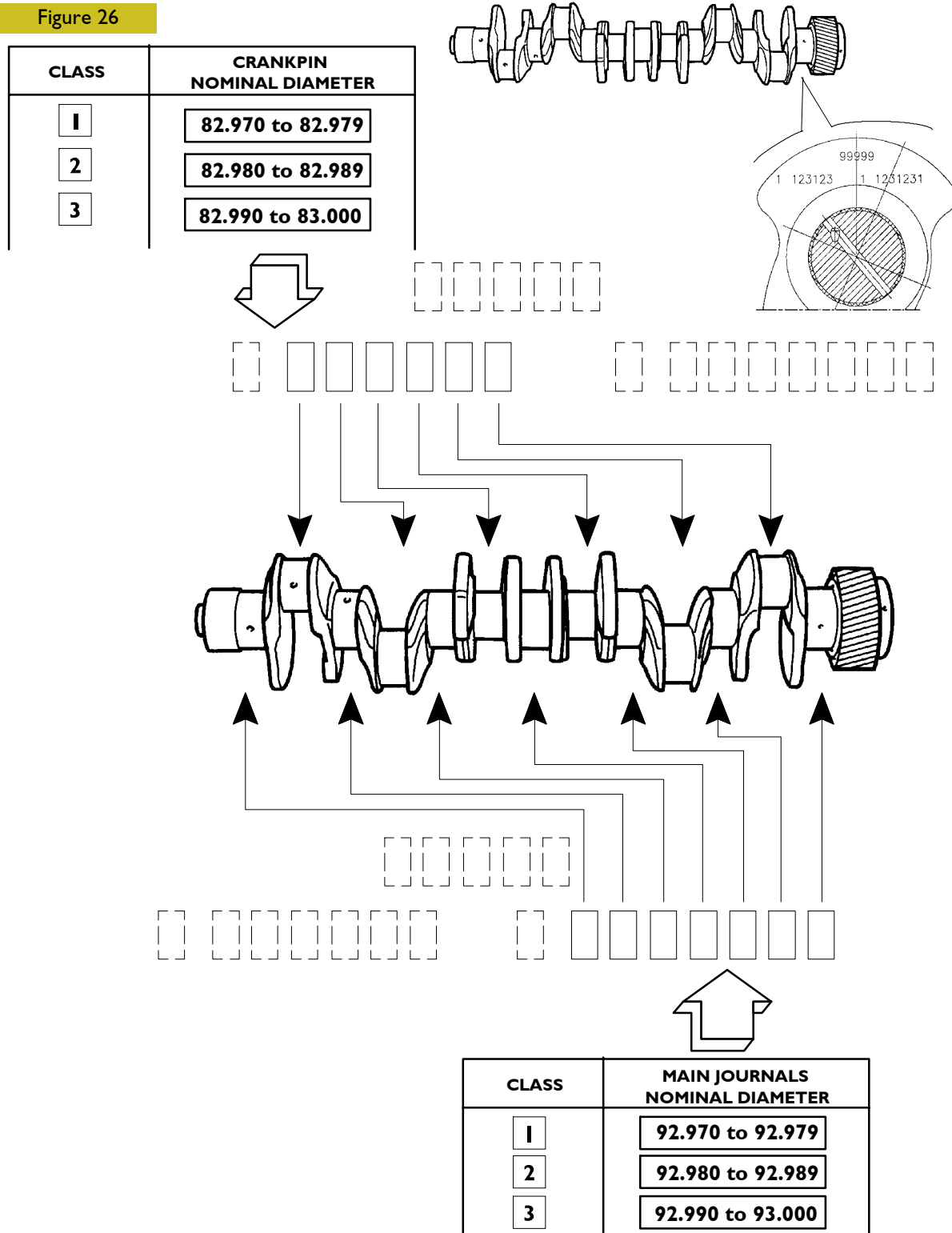
DEFINING THE CLASS OF DIAMETER OF THE MAIN JOURNALS AND CRANKPINS (Journals with nominal diameter)

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 26 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 26 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 26 at bottom).

Figure 26

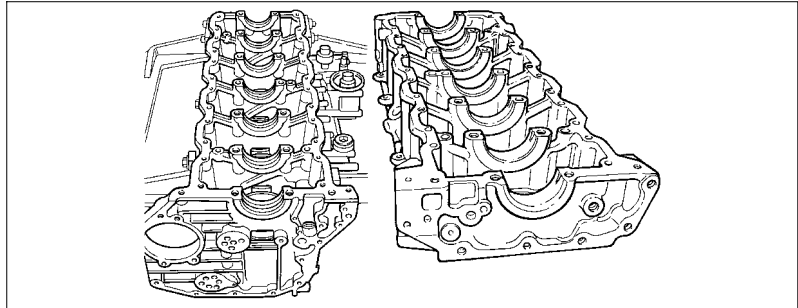


SELECTING THE MAIN BEARING SHELLS (Journals with nominal diameter)

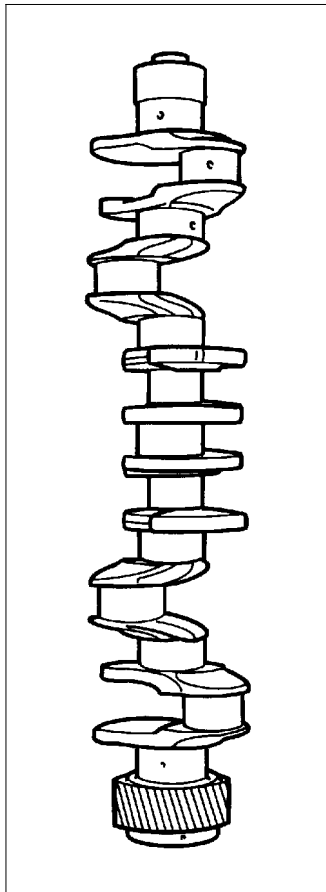
After reading off the data, for each of the main journals, on the crankcase and crankshaft, you choose the type of bearing shells to use according to the following table:

Figure 27

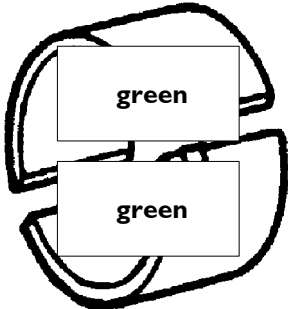
STD.



1	2	3
----------	----------	----------



1	green	green	green
	green	green	green
2	red	green	green
	red	green	green
3	red	red	green
	red	red	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 28

<p>red/black = 3.028 to 3.037 mm</p> <p>green/black = 3.038 to 3.047 mm</p>	<p>-0.127</p>													
	<p>99.843 99.852</p> <p>99.853 99.862</p> <p>99.863 99.873</p>	<table border="0"> <tr> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>green/black green/black</td> <td>green/black green/black</td> <td>green/black green/black</td> </tr> <tr> <td>red/black red/black</td> <td> green/black green/black</td> <td>green/black green/black</td> </tr> <tr> <td>red/black red/black</td> <td>red/black red/black</td> <td>green/black green/black</td> </tr> </table>	1	2	3	green/black green/black	green/black green/black	green/black green/black	red/black red/black	 green/black green/black	green/black green/black	red/black red/black	red/black red/black	green/black green/black
1	2	3												
green/black green/black	green/black green/black	green/black green/black												
red/black red/black	 green/black green/black	green/black green/black												
red/black red/black	red/black red/black	green/black green/black												
	<p>-0.254</p> <p>red = 3.092 to 3.102 mm</p>													
	<p>-0.508</p> <p>red = 3.219 to 3.229 mm</p>													
	<p>99.726 99.746</p> <p>93.468 93.508</p>	<table border="0"> <tr> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>red red</td> <td> red red</td> <td>red red</td> </tr> <tr> <td>red red</td> <td> red red</td> <td>red red</td> </tr> </table>	1	2	3	red red	 red red	red red	red red	 red red	red red			
1	2	3												
red red	 red red	red red												
red red	 red red	red red												

SELECTING THE BIG END BEARING SHELLS (JOURNALS WITH NOMINAL DIAMETER)

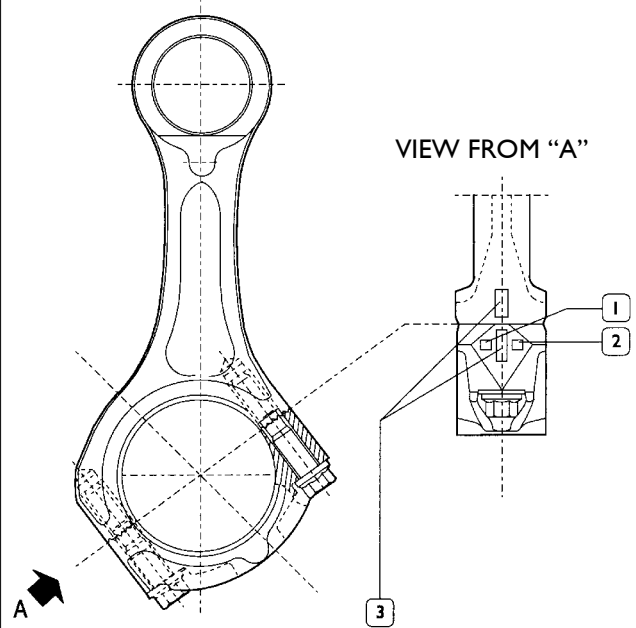
There are three markings on the body of the connecting rod in the position shown in the view from "A":

- 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 30).

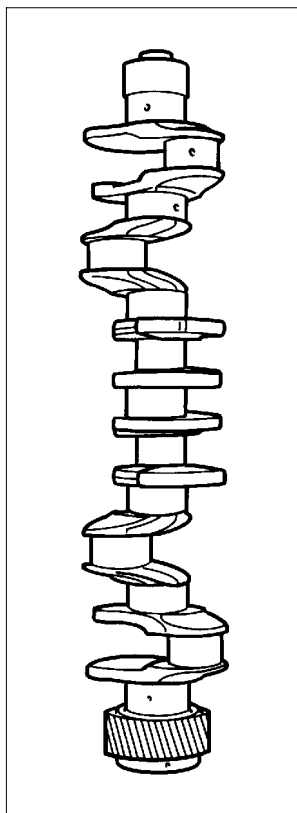
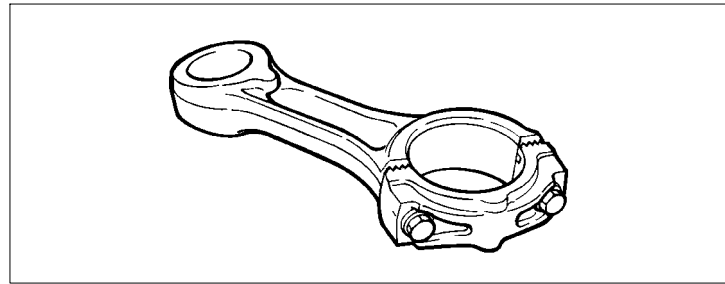
Figure 29



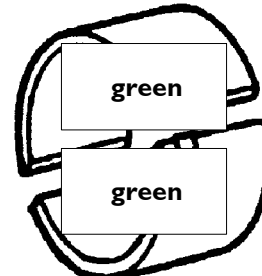
47557

Figure 30

STD.



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

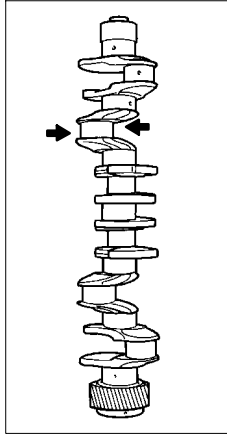
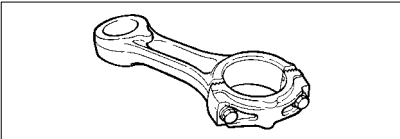
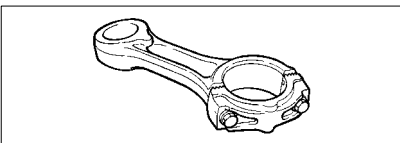
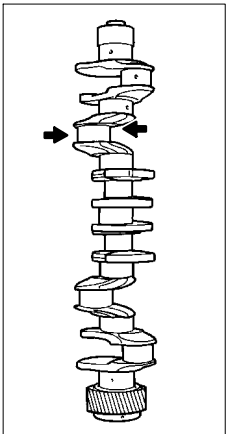
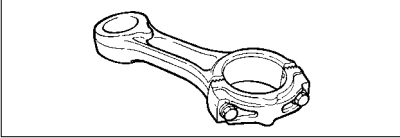

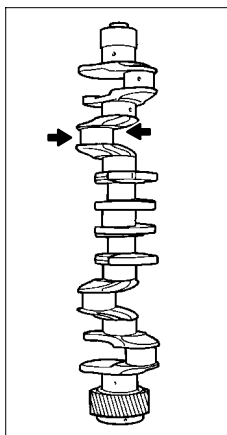
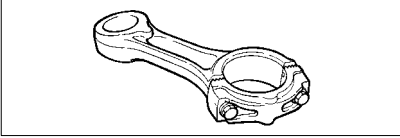



SELECTING BIG END BEARING SHELLS (GROUND JOURNALS)

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.

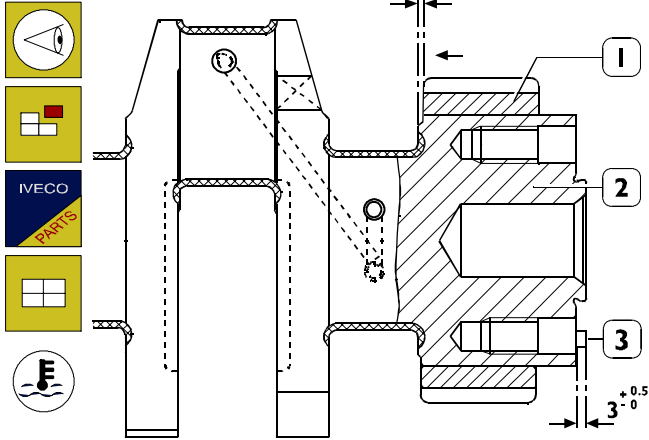
Figure 3I

	<p>red/black = 2.044 to 2.053 mm</p> <p>green/black = 2.033 to 2.043 mm</p>	<p>-0.127</p>		
	<p>82.843 82.852</p>	<p>1</p> <p>green/black green/black</p>	<p>2</p> <p>green/black green/black</p>	<p>3</p> <p>green/black green/black</p>
	<p>82.853 82.862</p>	<p>2</p> <p>green/black red/black</p>	 <p>green/black green/black</p>	<p>green/black green/black</p>
	<p>82.863 82.873</p>	<p>3</p> <p>red/black red/black</p>	<p>green/black red/black</p>	<p>green/black green/black</p>
	<p>red = 2.097 to 2.107 mm</p> <p>green = 2.108 to 2.117 mm</p>	<p>-0.254</p>		
	<p>82.726 82.735</p>	<p>1</p> <p>red red</p>	<p>2</p>  <p>green green</p>	<p>3</p> <p>green green</p>
	<p>82.736 82.746</p>	<p>red red</p>	<p>red red</p>	<p>green green</p>
	<p>red = 2.224 to 2.234 mm</p> <p>green = 2.235 to 2.244 mm</p>	<p>-0.508</p>		
	<p>82.472 82.481</p>	<p>1</p> <p>red red</p>	<p>2</p>  <p>green green</p>	<p>3</p> <p>green green</p>
	<p>82.482 82.492</p>	<p>red red</p>	<p>red red</p>	<p>green green</p>

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 32



73534

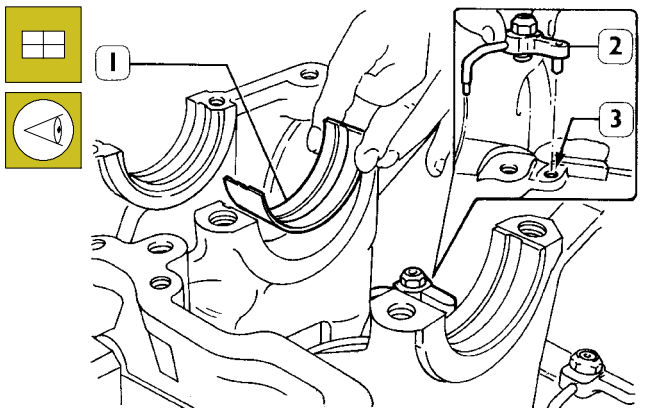
When fitting the gear (1) on the crankshaft (2), heat it for no longer than 2 hours in an oven at a temperature of 180°C. After heating the gear (1), fit it on the shaft by applying a load of 6000 N to it, positioning it at the distance shown in Figure 32.

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 33

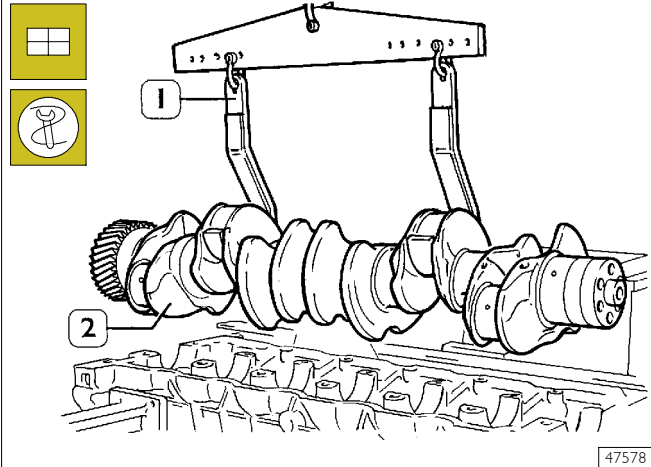


47579

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.

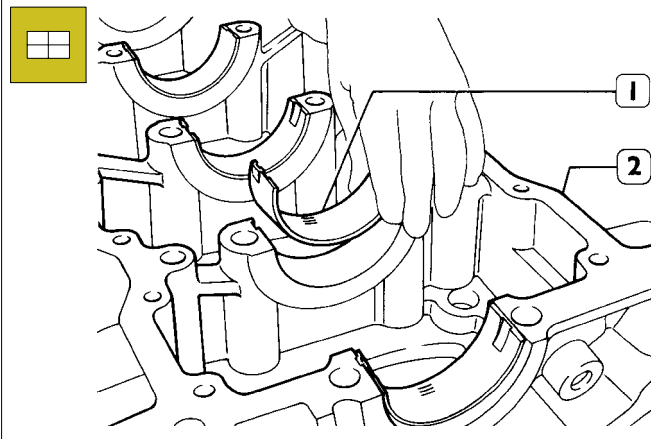
Figure 34



47578

Using the tackle and hook 99360500 (1), mount the crankshaft (2).

Figure 35

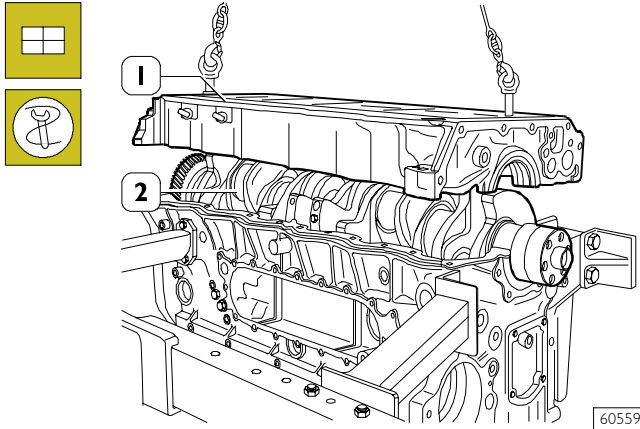


49021

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.

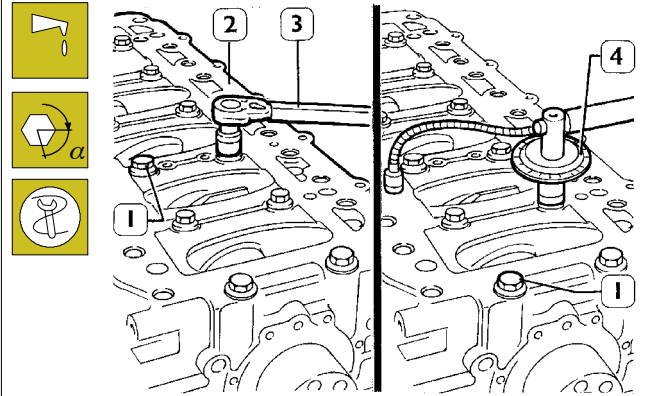
Figure 36



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).

60559

Figure 37



☐ 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 38.

47578

Figure 38

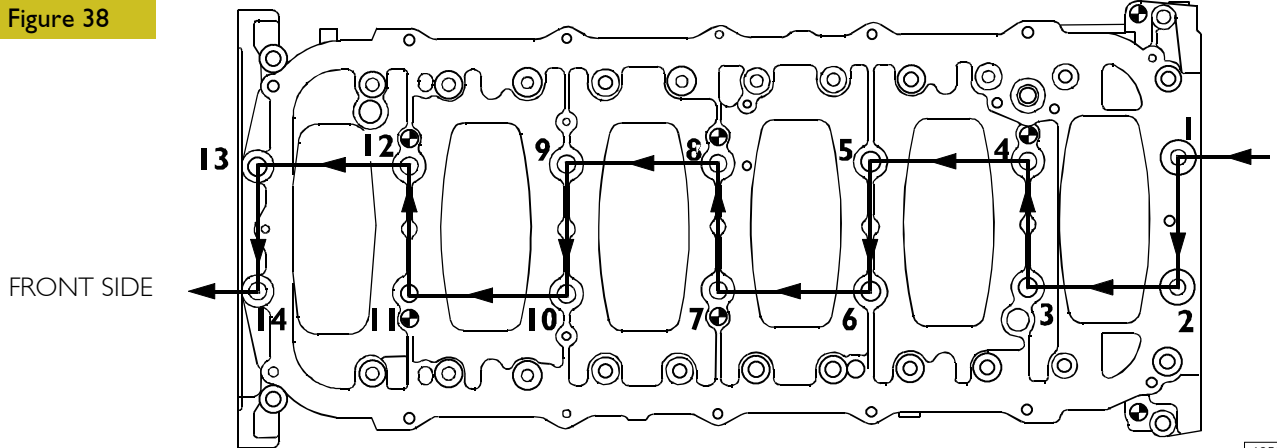
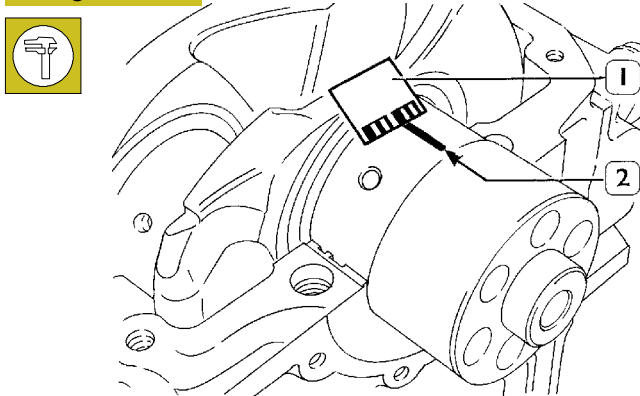


DIAGRAM OF SEQUENCE FOR TIGHTENING THE SCREWS FIXING THE BOTTOM CRANKCASE BASE TO THE CRANKCASE

60593

Figure 39



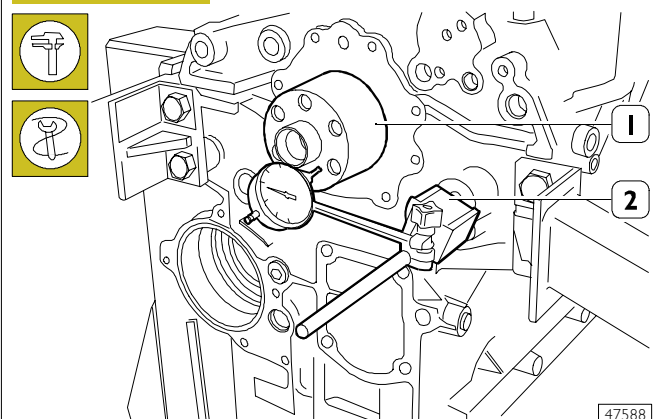
☐ Remove the crankcase base.

47579

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 40

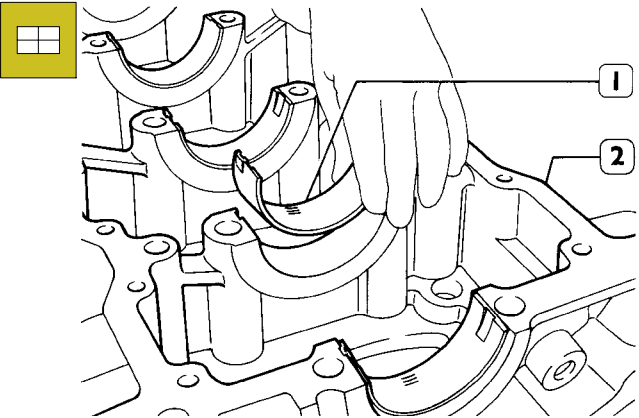


End float is checked by placing a magnetic dial gauge (2) on the crankshaft (1), as shown in the figure. If the value obtained is higher than specified, replace the rear thrust half-bearings and repeat this check.

47588

ASSEMBLING THE ENGINE ON THE BENCH

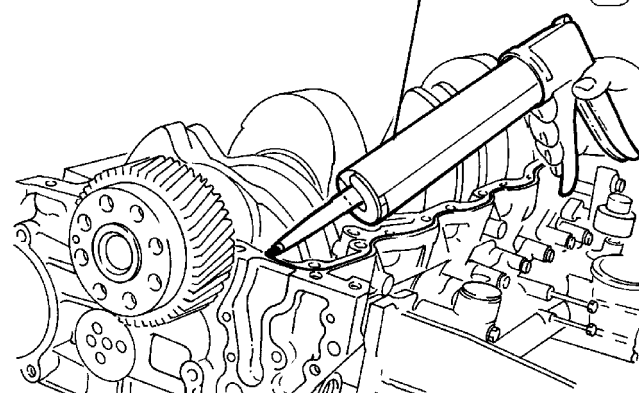
Figure 41



49021

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

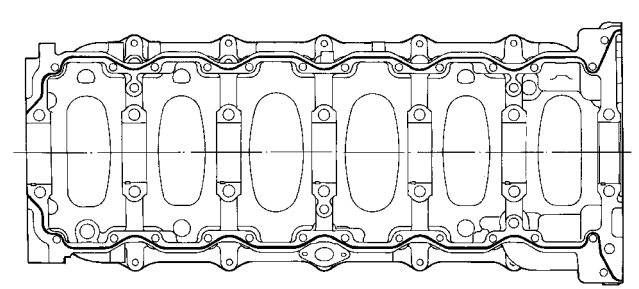
Figure 42



47595

By means of suitable equipment (1) apply silicone LOCTITE 5970 IVECO No. 2992644 to the block, as shown in the figure.

Figure 43

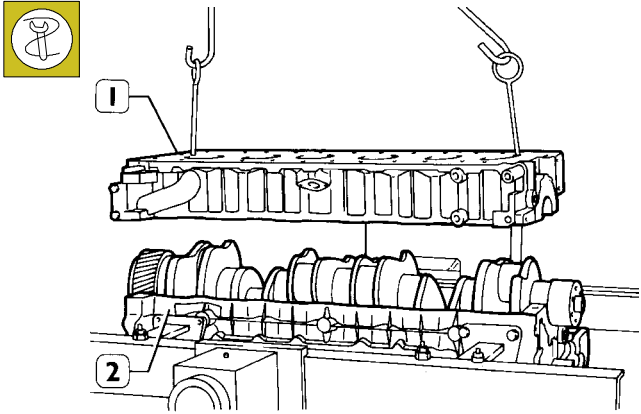


47596

Sealant application diagram

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

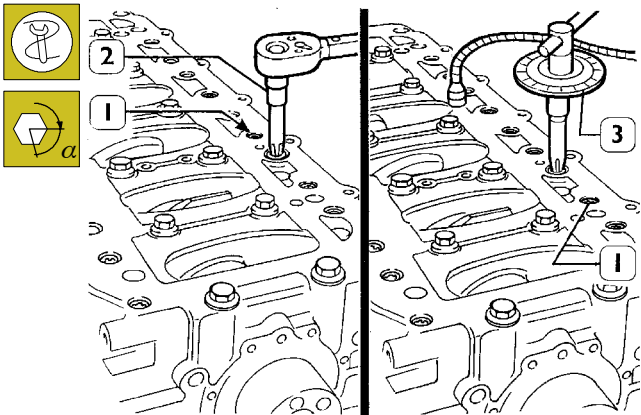
Figure 44



49022

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

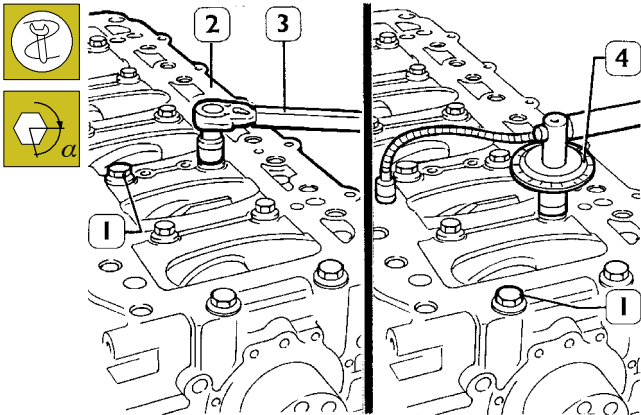
Figure 45



47581

Fit the sub-engine block and use a dynamometric wrench (2) to tighten the outer hexagonal-grooved screws (1) to 25 Nm according to the diagrams on the following page.

Figure 46



47579

Close the inner screws (1) to 140 Nm torque by means of a dynamometric wrench (3), then with two further angular phases $60^\circ + 60^\circ$, using tool 99395216 (4). Tighten again the outer screws (1, Figure 45) with 90° angular closing, using tool 99395215 (3, Figure 45).

Figure 47

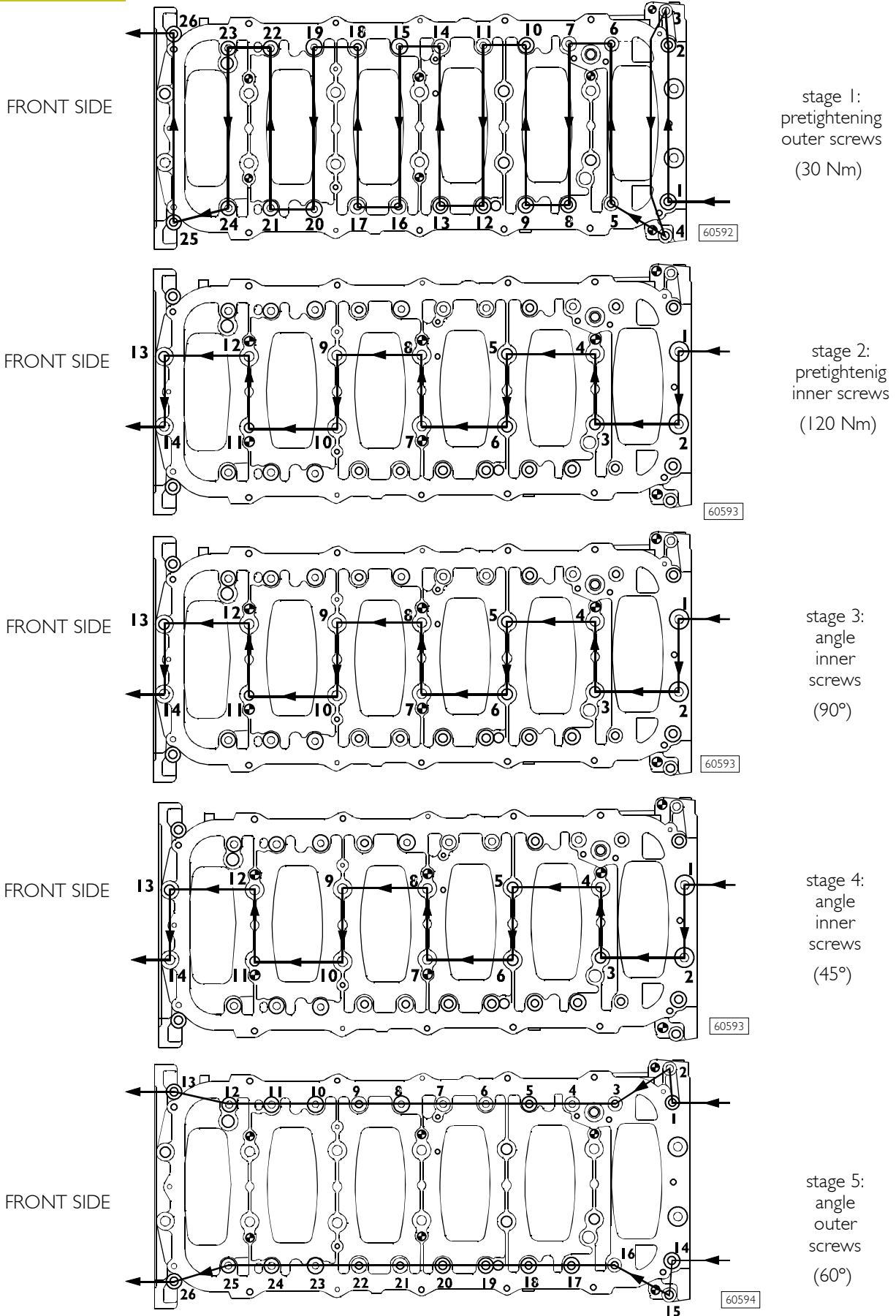
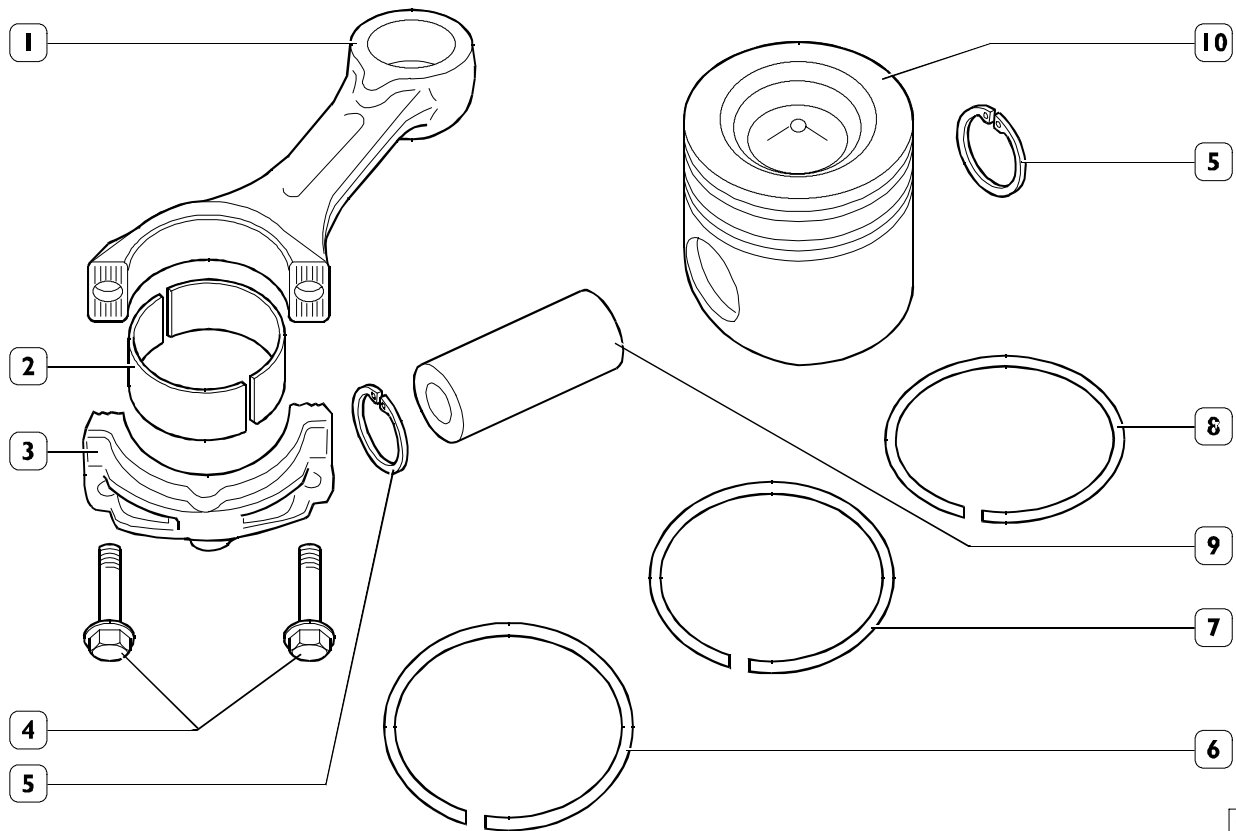


DIAGRAM OF TIGHTENING SEQUENCE OF CRANKCASE BASE FIXING SCREWS

Piston connecting rod assembly

Figure 48



60607

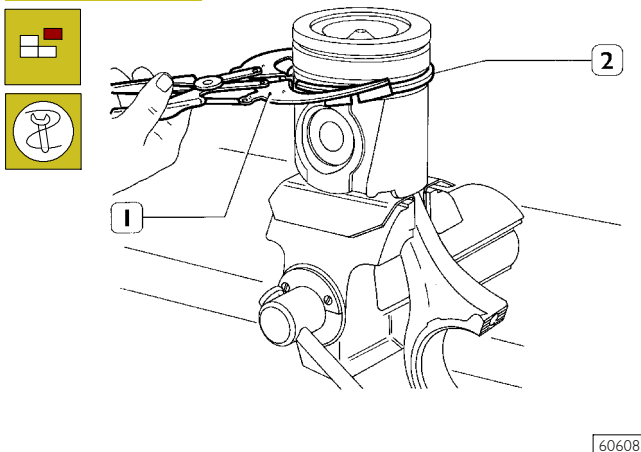
PISTON CONNECTING ROD ASSEMBLY

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 not show any trace of seizing, scoring, cracking; replace as necessary.

Removal

Figure 49



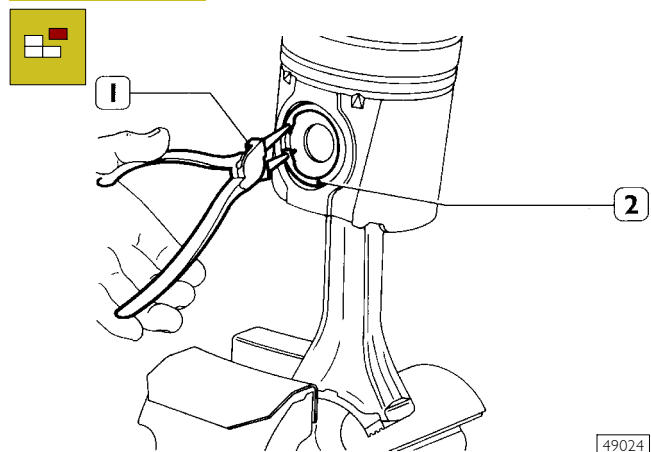
60608

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.

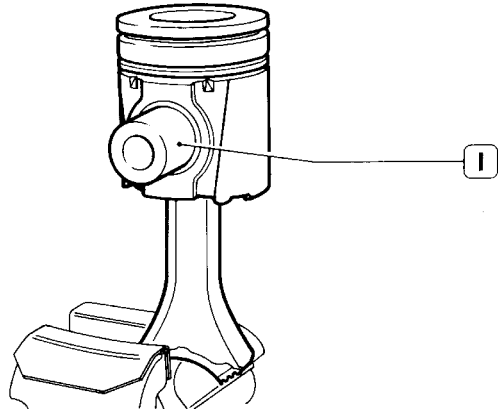
Figure 50



49024

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

Figure 51

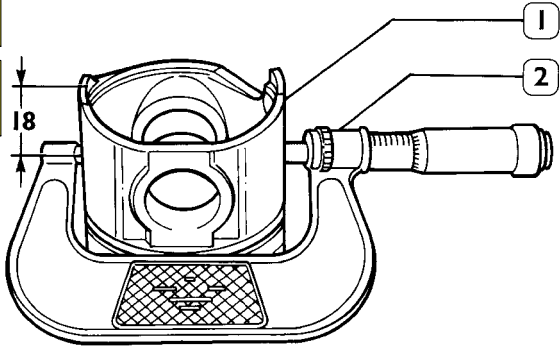


49025

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

Measuring the diameter of the pistons

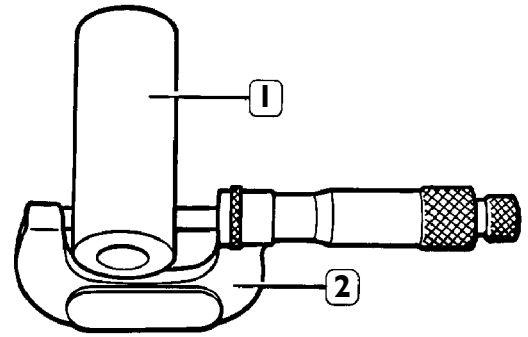
Figure 52



47584

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 53

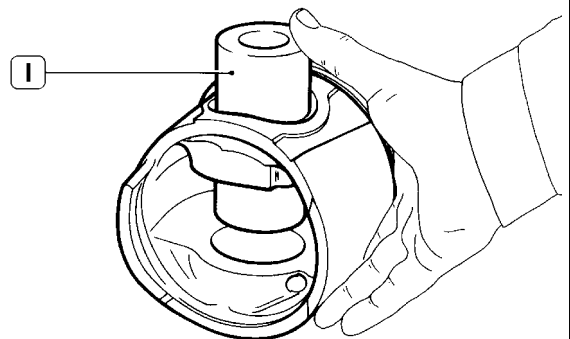


32618

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

Conditions for correct gudgeon pin-piston coupling

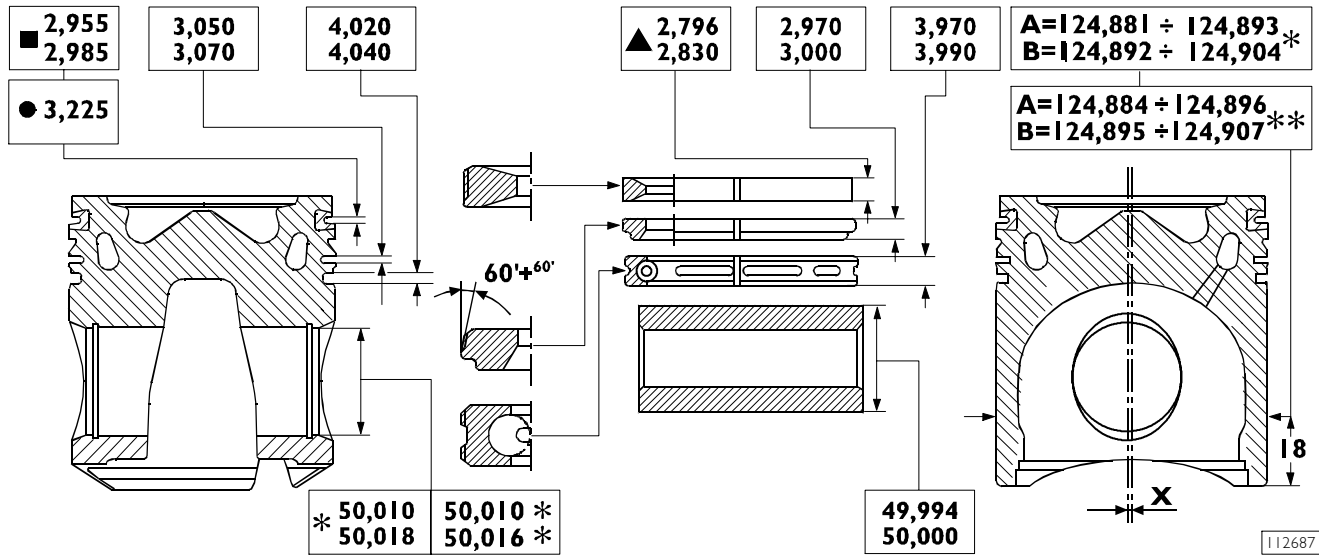
Figure 54



49026

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 55

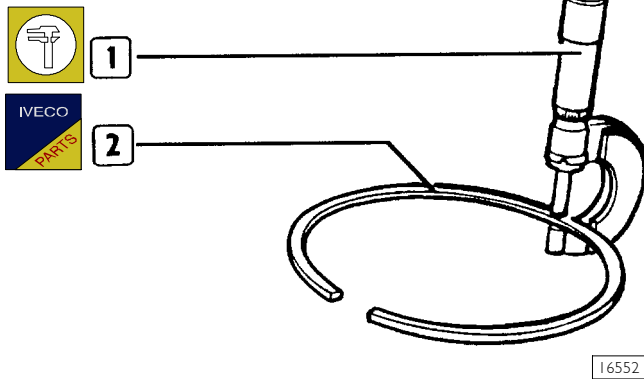


PISTON MAIN DATA, PISTON RINGS AND PIN

- * MAHLE PHISTON-piston: X = 0,8 ± 0,15
- ** NUERAL-piston: X = 0,7 ± 0,1
- The dimension is taken on Ø of 120 mm.
- The dimension is taken on Ø of 122 mm.
- ▲ The dimension is measured at 2,5 mm from outside Ø

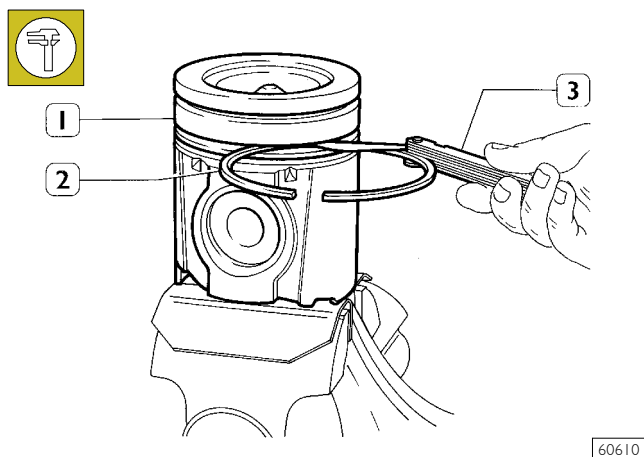
Piston rings

Figure 56



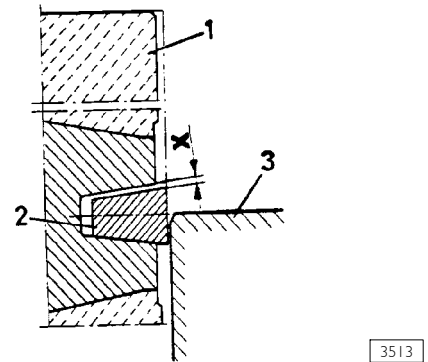
Check the thickness of the piston ring (2) using a micrometer (1).

Figure 57



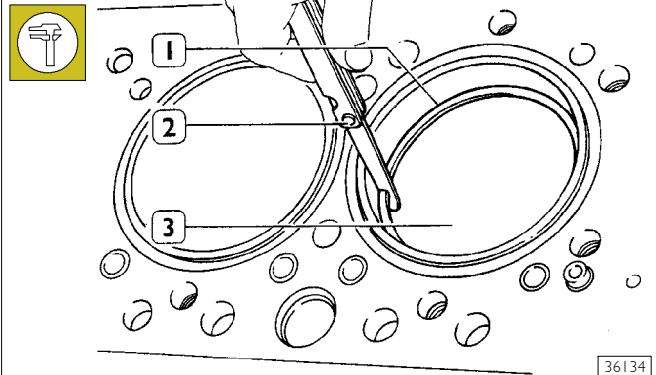
Check the clearance between the sealing rings (2) and the relative piston housings (1) using a thickness gauge (3).

Figure 58



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 59



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

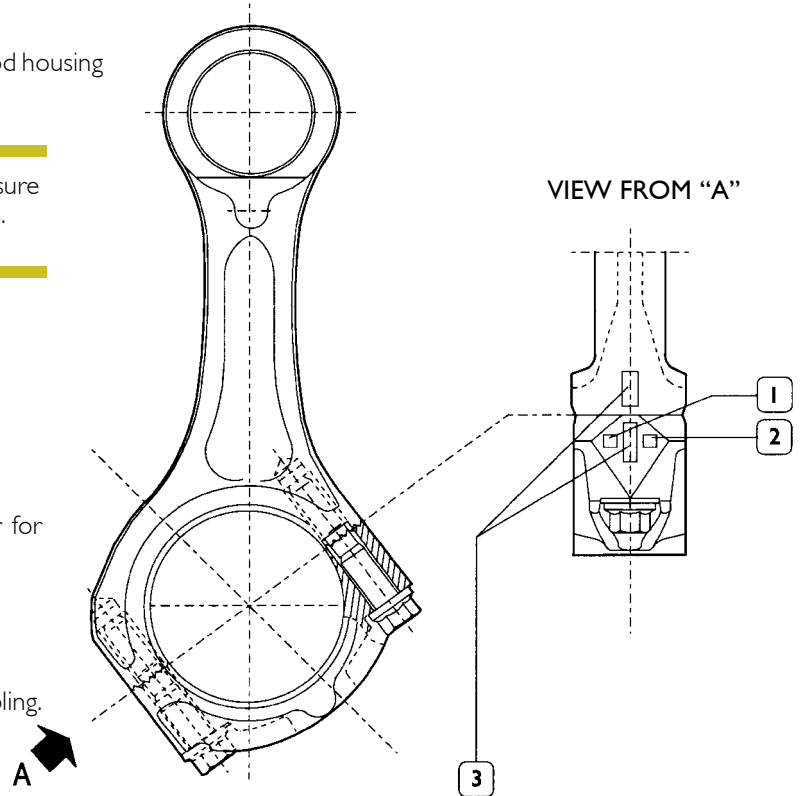
Figure 60

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.

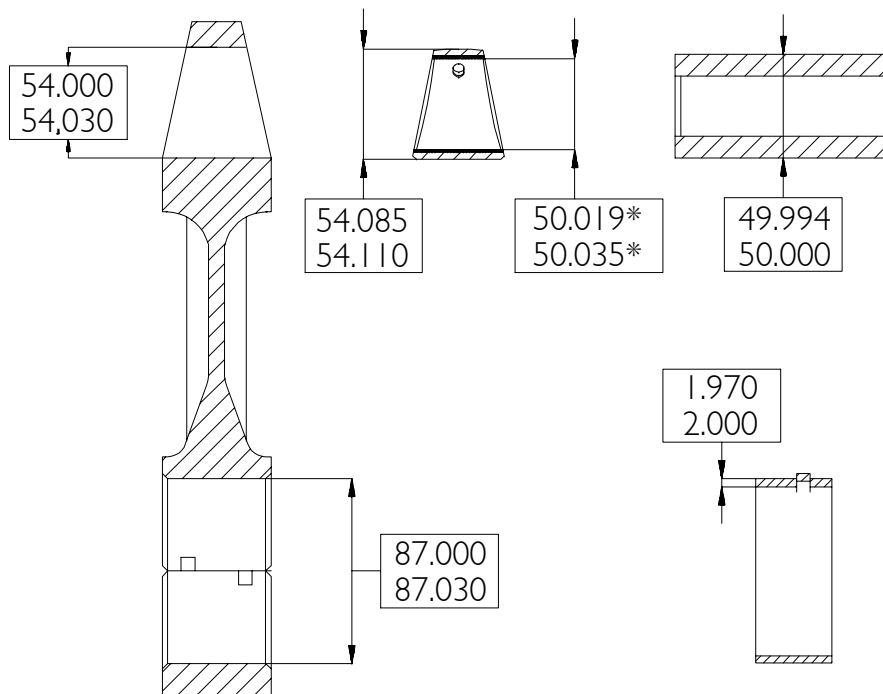
DIAGRAM OF THE CONNECTING ROD MARKS

- 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.



47557

Figure 61



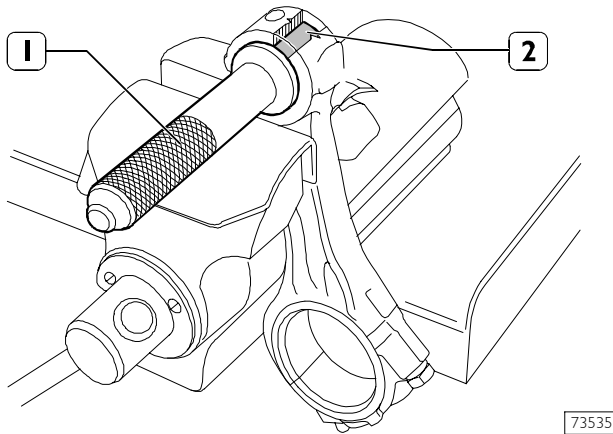
44927

MAIN DATA - BUSH, CONNECTING ROD, PIN AND HALF-BEARINGS

* Values to be obtained after installing the bush.

Bushings

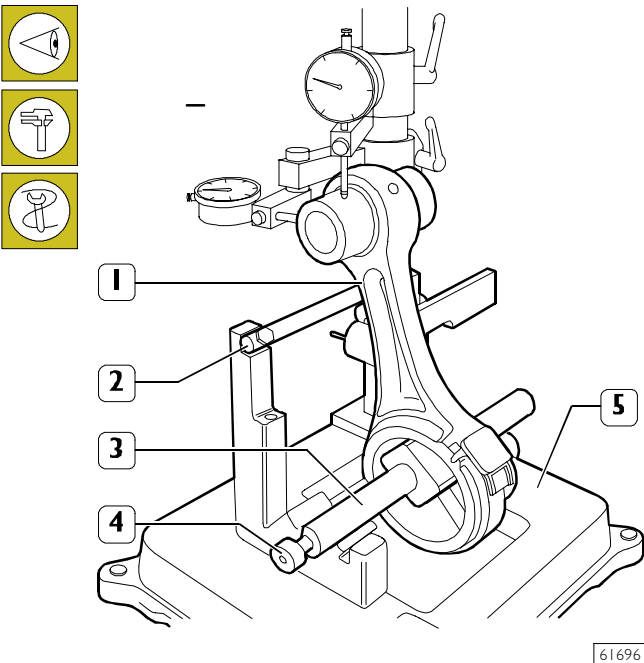
Figure 62



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

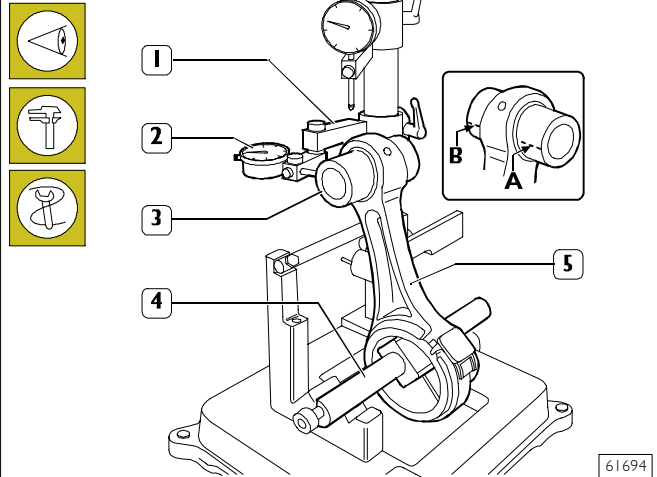
Figure 63



Checking axis alignment

Check the alignment of the axes of the connecting rods (1) with device 99395363 (5), proceeding as follows: Fit the connecting rod (1) on the spindle of the tool 99395363 (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).

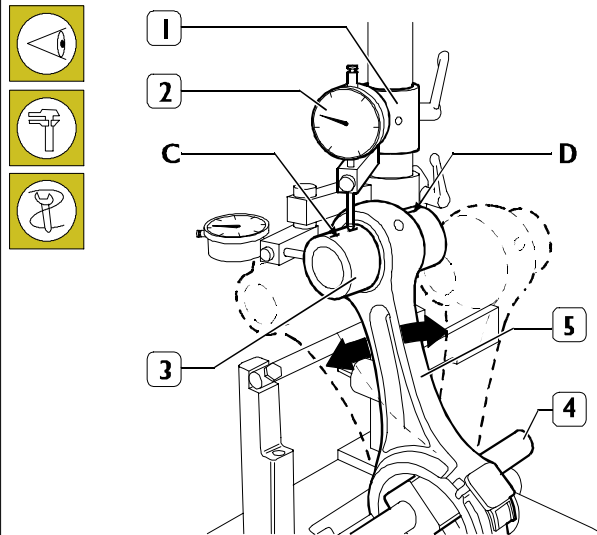
Figure 64



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

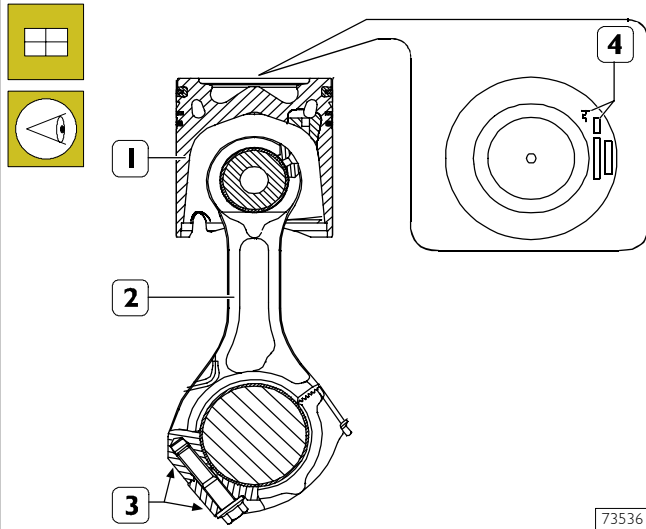
Figure 65



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

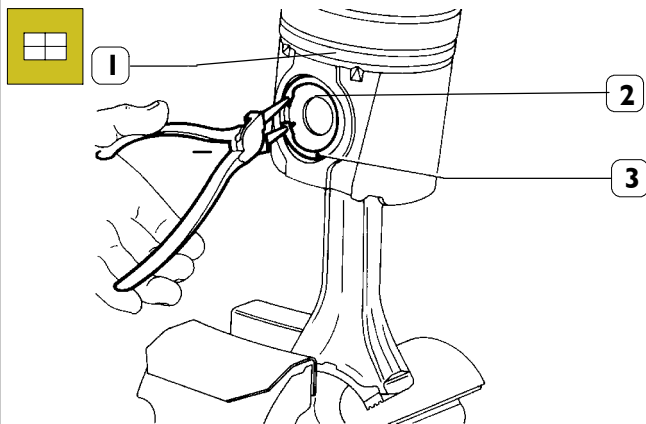
Figure 66



73536

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 67

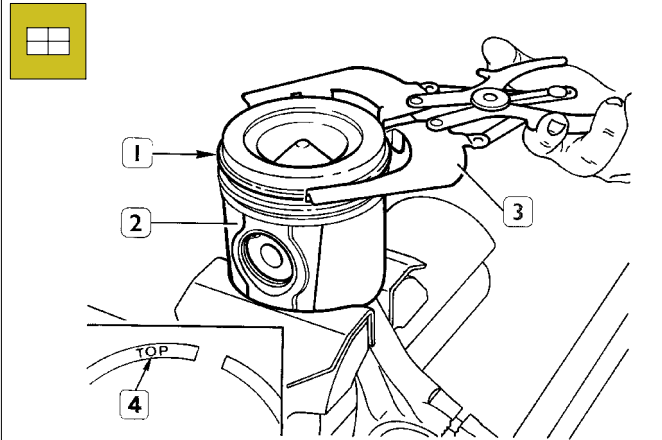


74052

Fit the pin (2) and fasten it on the piston (1) with the split rings (3).

Mounting the piston rings

Figure 68



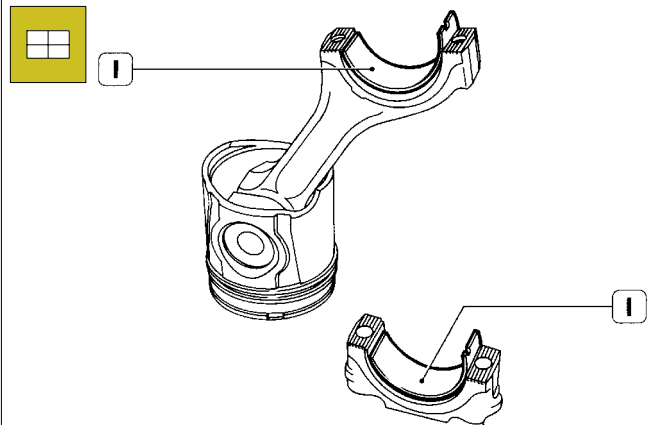
60614

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 69



49030

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.

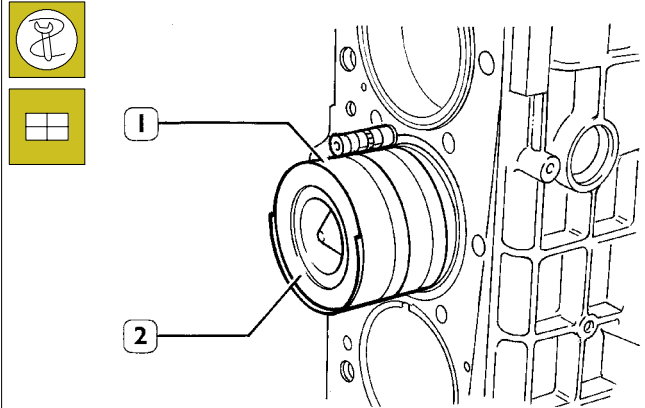
Fitting connecting rod - piston assemblies in the cylinder liners

With the aid of the clamp 99360605 (1, Figure 70), fit the connecting rod – piston assembly (2) in the cylinder liners, according to the diagram of Figure 71, 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 70

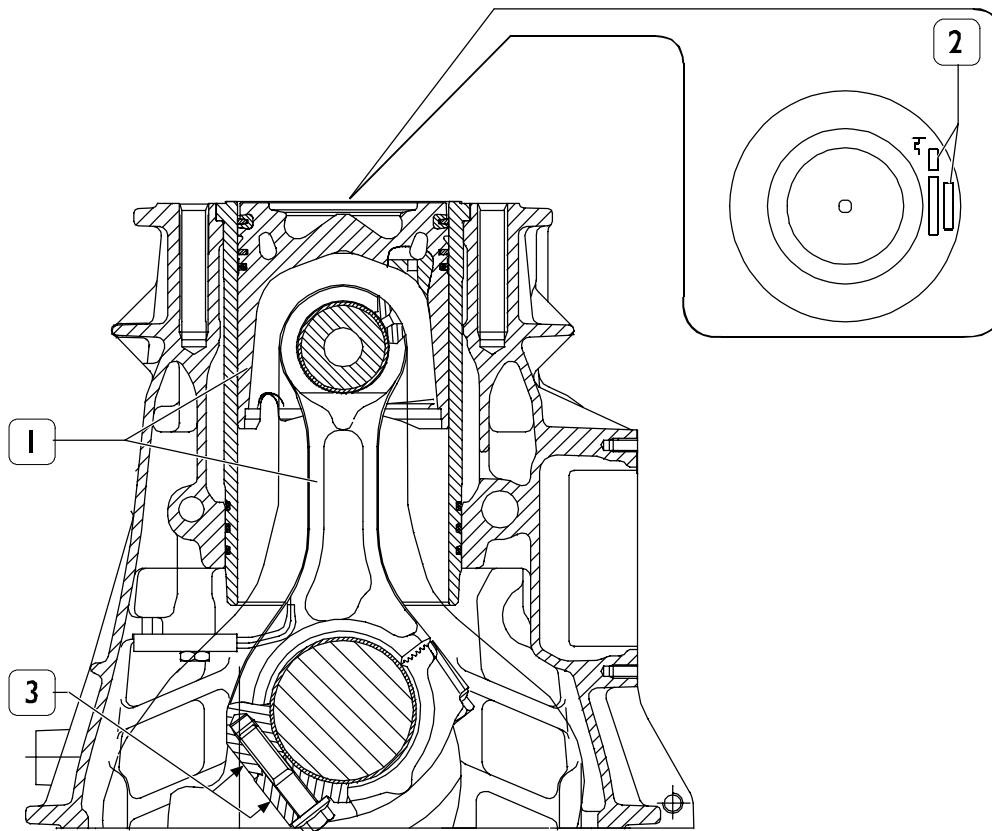


60616

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 71



60615

ASSEMBLY DIAGRAM OF CONNECTING ROD – PISTON ASSEMBLY IN CYLINDER LINER

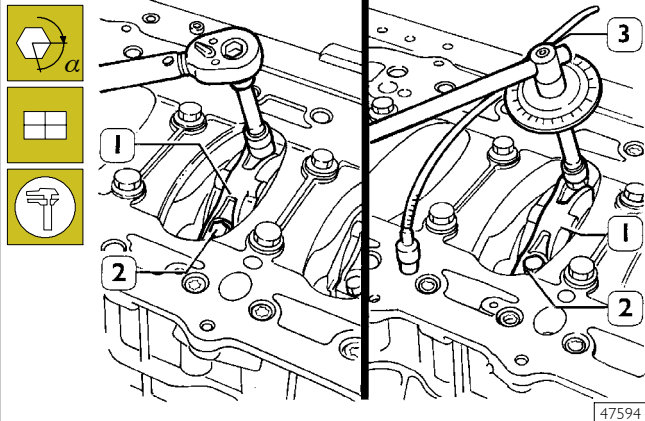
1. Connecting rod – piston assembly – 2. Area of punch marking on the top of the piston, symbol showing assembly position and selection class – 3. Connecting rod punch mark area.

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 72



Mount the connecting rod caps (1) together with the bearing shells. Tighten the screws (2) fixing the connecting rod caps to a torque of 50 Nm (5 kgm). Using tool 99395216 (3), further tighten the screws with an angle of 40°.

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.

CYLINDER HEAD

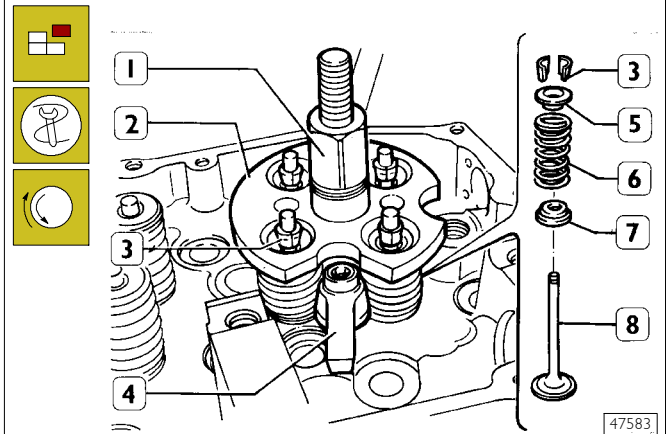
Before dismantling cylinder head, check cylinder head for hydraulic seal by proper tooling; in case of leaks not caused by cup plugs or threaded plugs, replace cylinder head.

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

Dismounting the valves

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

Figure 73



Mount and secure the tool 99360264 (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).

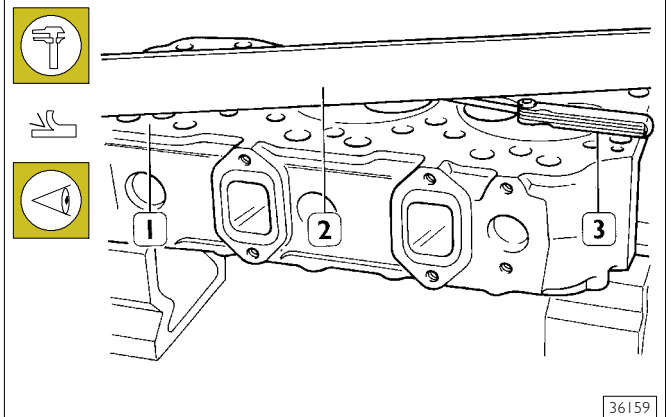
Repeat this process on all the valves.

Turn over the cylinder head and take out the valves (8).

Checking head bearing surface on cylinder block

Figure 74

(Demonstration)

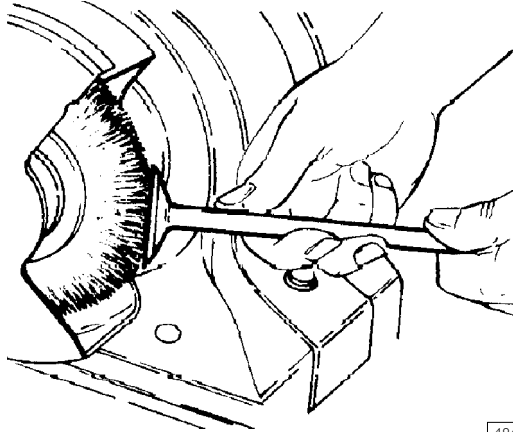


Check the supporting surface (1) of the head on the cylinder block with a rule (2) and a feeler gauge (3). If you find any deformation, level the head on a surface grinder; maximum amount of material that can be removed 0.2 mm.

NOTE After this process, you need to check the valve recessing and injector protrusion.

Valves Decarbonizing and checking valves

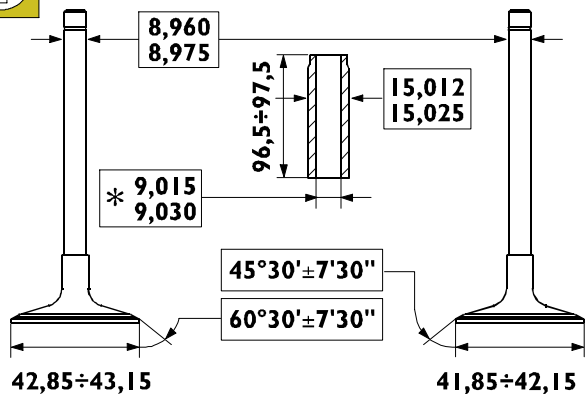
Figure 75



48625

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 76); replace the valves if it does not.

Figure 76



MAIN DATA OF VALVES AND VALVE GUIDES

* Measurement to be made after driving in the valve guides

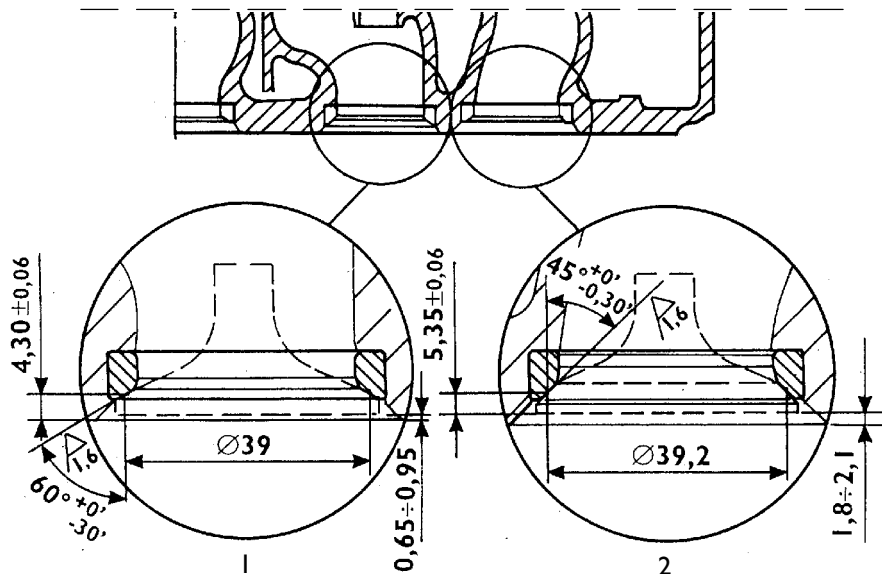
Check with a micrometer that the diameter of the valve stems is as indicated. If necessary, grind the valve seats with a grinding machine, removing as little material as possible.

Valve seats

Regrinding – replacing valve seats

NOTE The valve seats are reground whenever the valves or valve guides are ground and replaced.

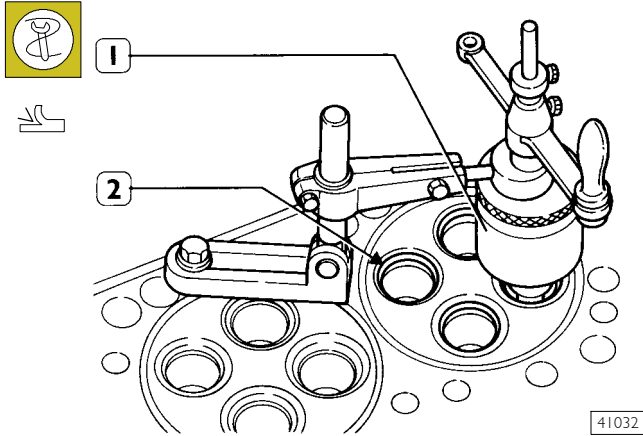
Figure 77



MAIN DATA OF VALVE SEATS
1. Intake valve seat – 2. Exhaust valve seat

73537

Figure 78



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 figures 78 and 79. 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 $80 \pm 100^\circ\text{C}$ 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 79.

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 ± -0.95 mm (recessing) intake valves
- -1.8 ± -2.1 mm (recessing) exhaust valves.

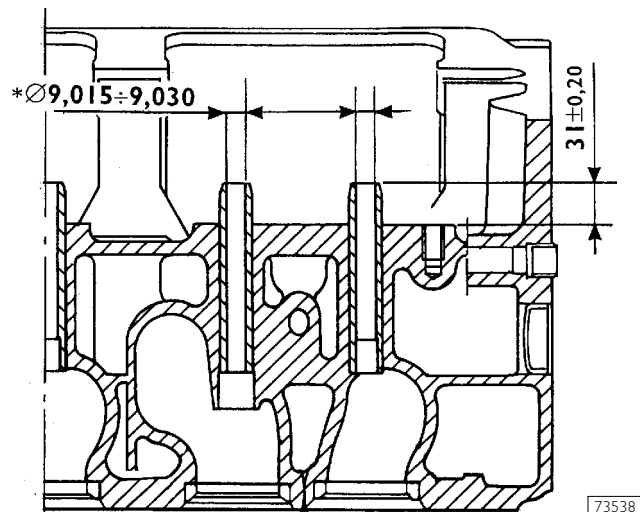
Checking clearance between valve-stem and associated valve guide

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 79

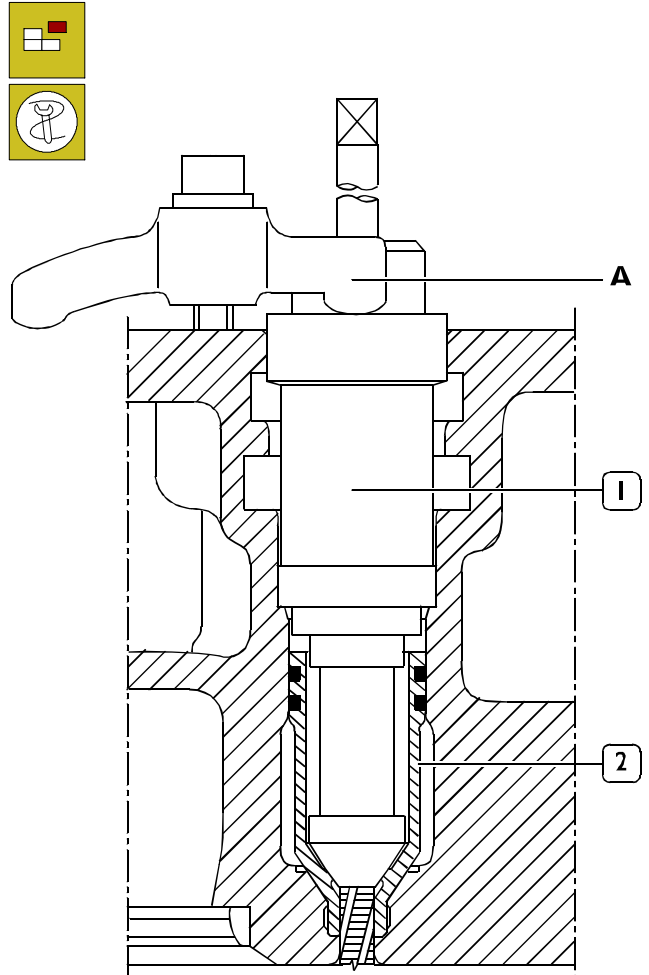


* Quote to obtain after valve guides driving.

Replacing injector cases

Removal

Figure 80

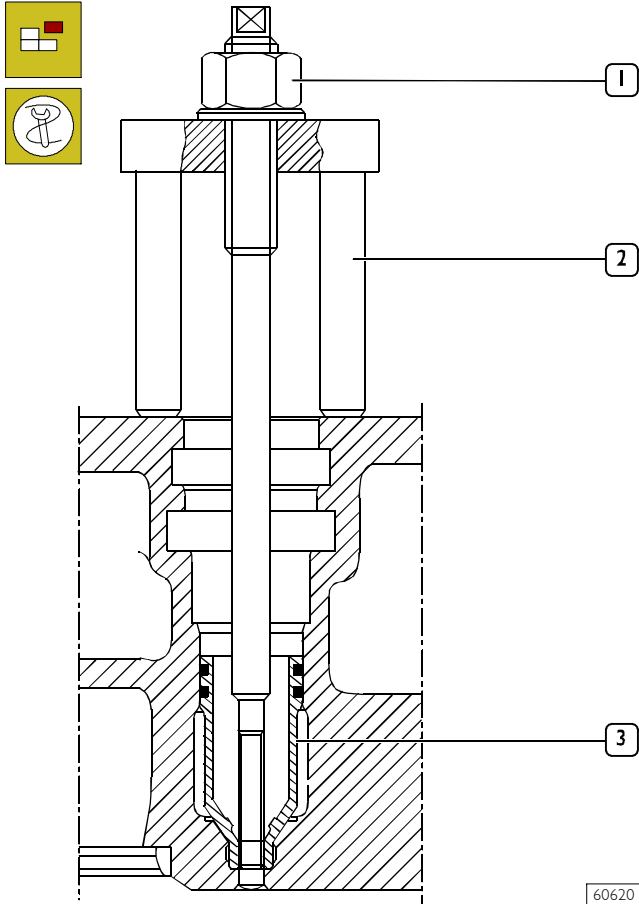


To replace the injector case (2), proceed as follows:

- Thread the case (2) with tool 99390804 (1).

The steps described in Figs. 74 - 76 - 77 - 78 need to be carried out by fixing the tools, with the bracket A, to the cylinder head.

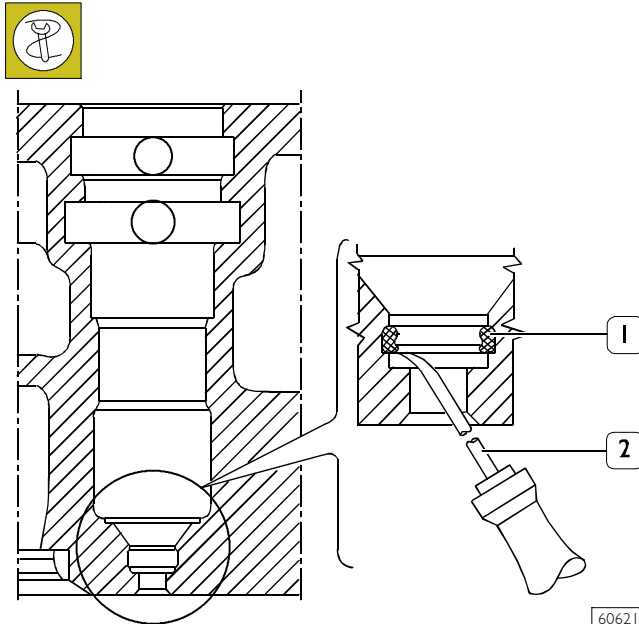
Figure 81



60620

- Screw the extractor 99342149 (2) into the case (3). Screw down the nut (1) and take the case out of the cylinder head.

Figure 82

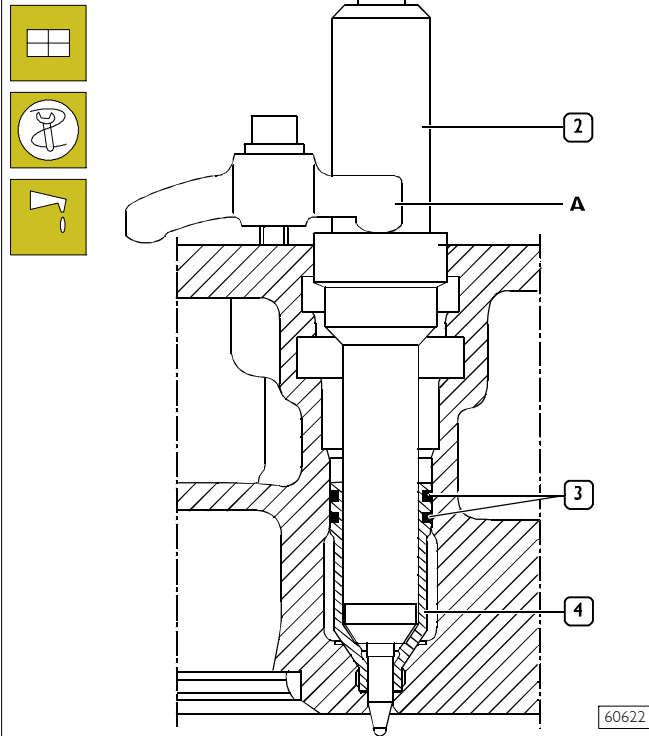


60621

- Using the tool 99390772 (2) remove any residues (1) left in the groove of the cylinder head.

Assembly

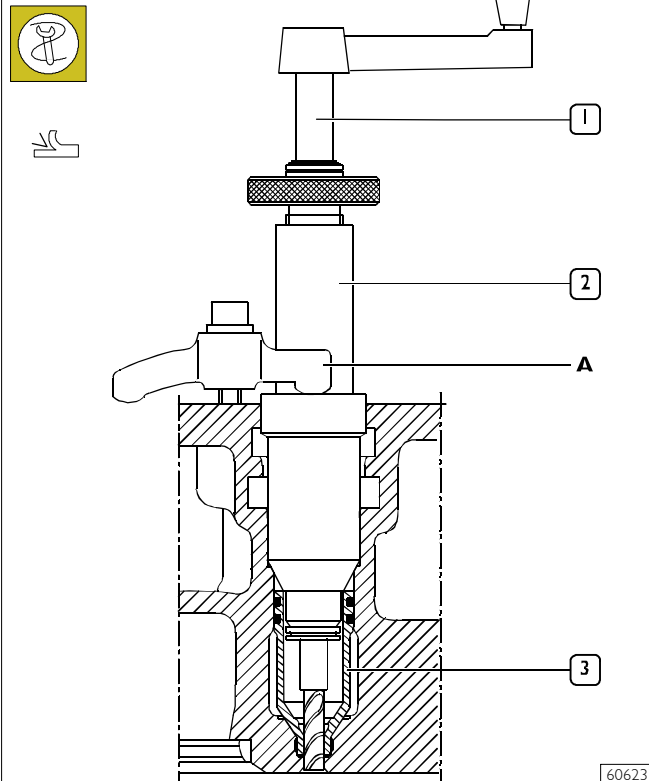
Figure 83



60622

- 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.

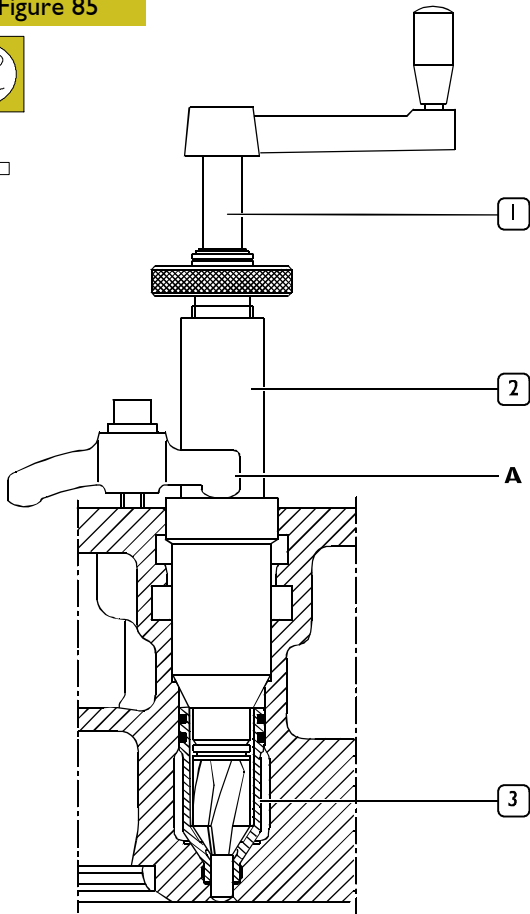
Figure 84



60623

- Using the reamer 99394041 (1-2), re-bore the hole in the case (3).

Figure 85

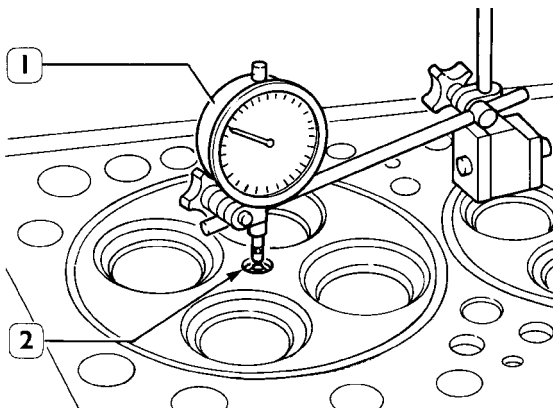


60624

- Using grinder 99394041 (1-2), ream the injector seat in the case (3), check the injector protrusion from the cylinder head plane which must be 1.14 to 1.4 mm.

Checking injector protrusion

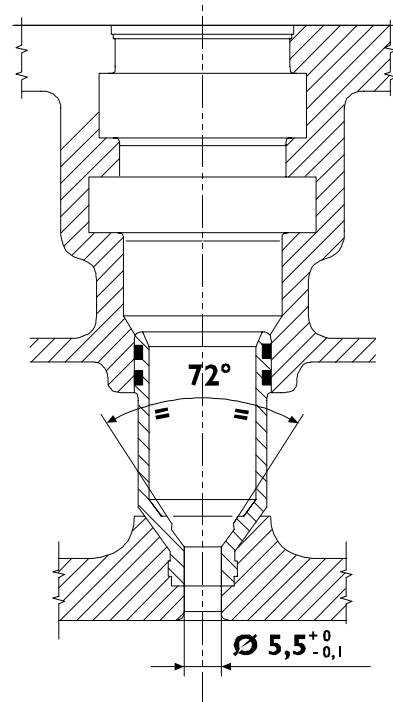
Figure 86



47585

- Check injector protrusion (2) with the dial gauge (1). The protrusion must be 1.14 to 1.4 mm.

Figure 87

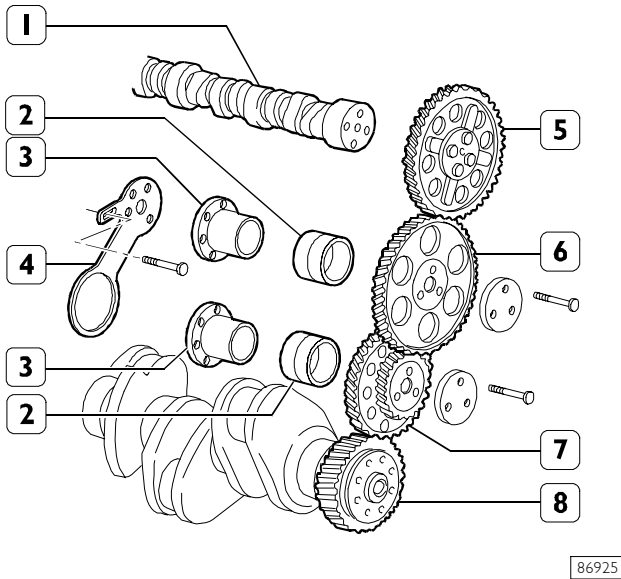


71720

INJECTOR CASE ASSEMBLY DIAGRAM

**TIMING GEAR
Camshaft drive**

Figure 88

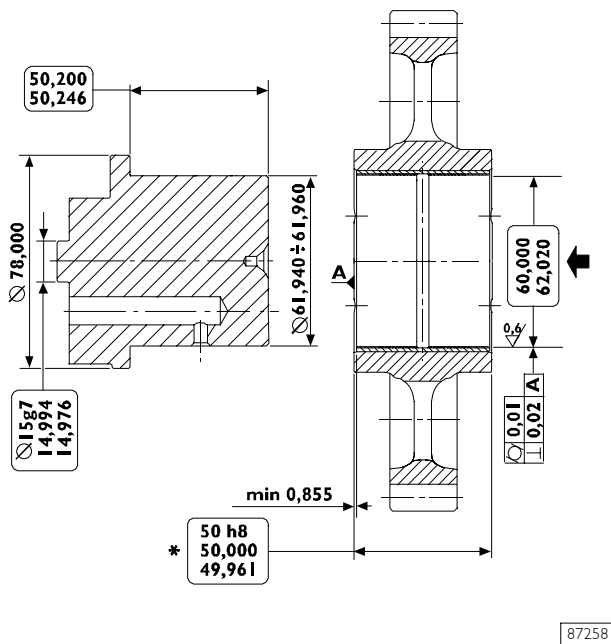


TIMING CONTROL COMPONENT PARTS

- 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.

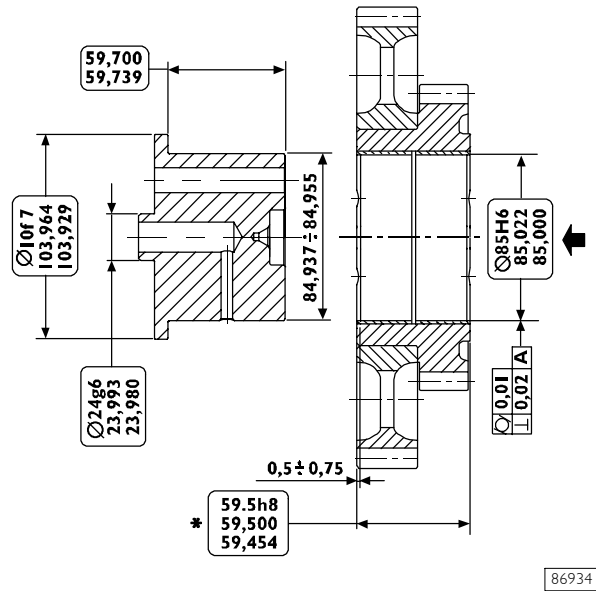
**Idler gear pin
Idler gear**

Figure 89



**Twin intermediate gear pin
Twin idler gear**

Figure 90



Replacing the bushings

Gear bushings shown on Figures 82 - 83 can be replaced when they are worn. Put up the bushing, then bore it to obtain the diameter shown on Figure 89 or Figure 90.

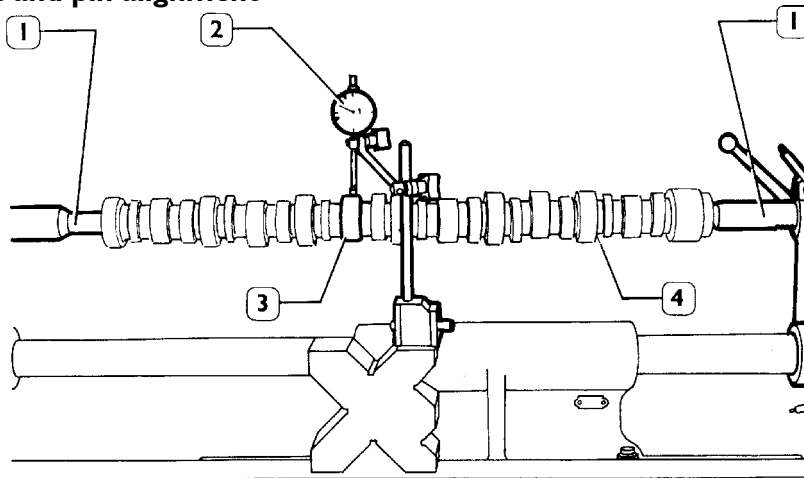
NOTE The bushing must be driven into the gear by following the direction of the arrow and setting the latter to the dimension shown on Figure 89 or Figure 90.

Rated assembling play between gear bushings and pins:
 Figure 89 – 0.040 ÷ 0.080 mm
 Figure 90 – 0.045 ÷ 0.085 mm.

Camshaft

Checking cam lift and pin alignment

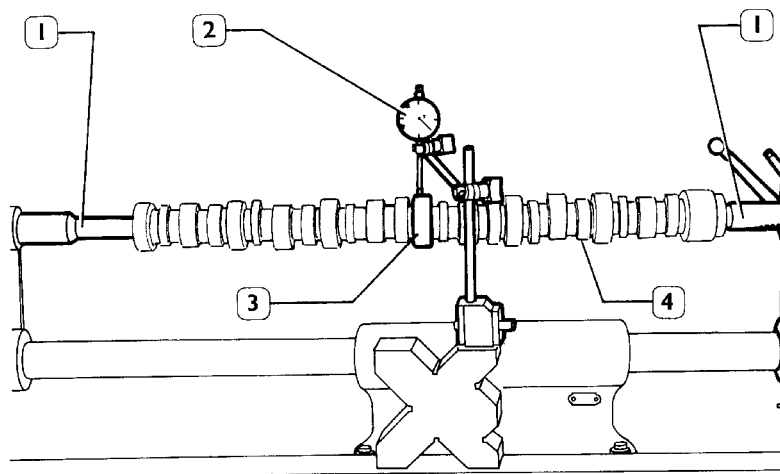
Figure 91



47506

Place the camshaft (4) on the tailstock (1) and check cam lift (3) using a centesimal gauge (2); values are shown in table on page 9.

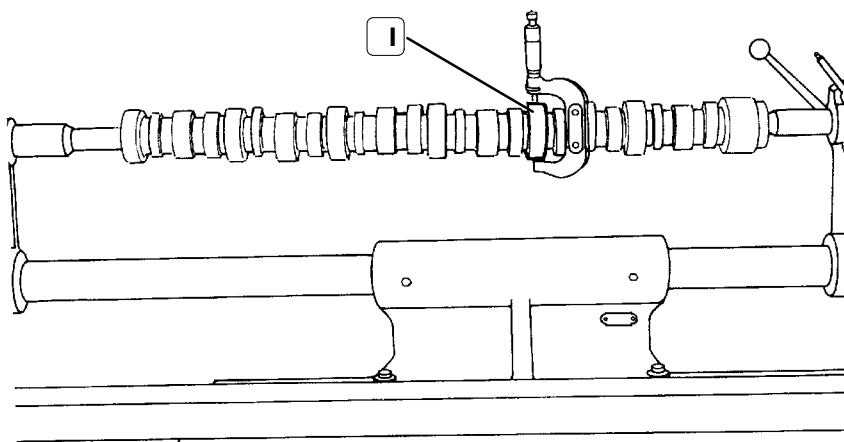
Figure 92



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 0.035 mm. If misalignment exceeds this value, replace the shaft.

Figure 93



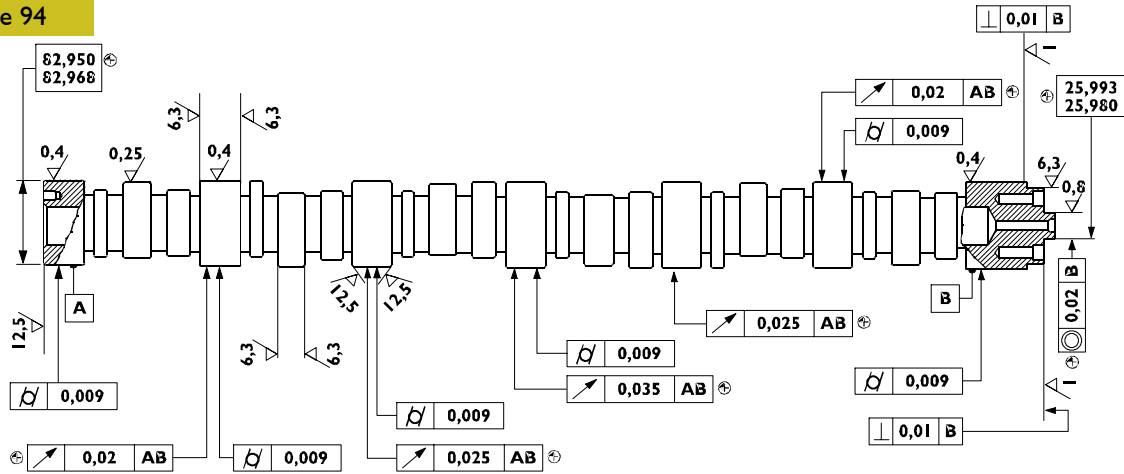
47505

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.

Camshaft

Figure 94



60626

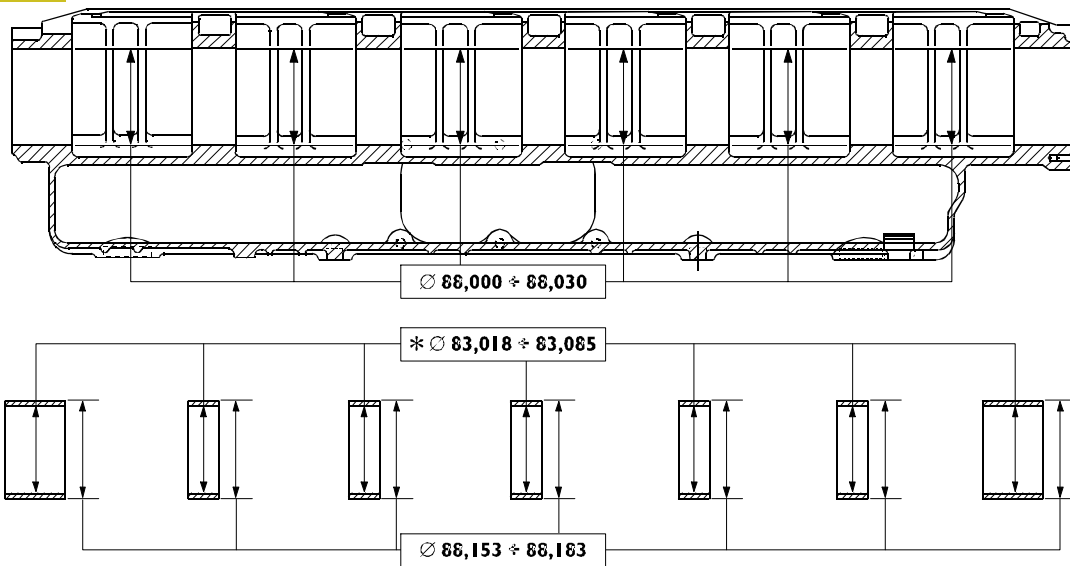
MAIN DATA - CAMSHAFT AND TOLERANCES

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 95



60627

MAIN DATA OF CAMSHAFT BUSHES AND RELEVANT HOUSINGS ON CYLINDER HEAD

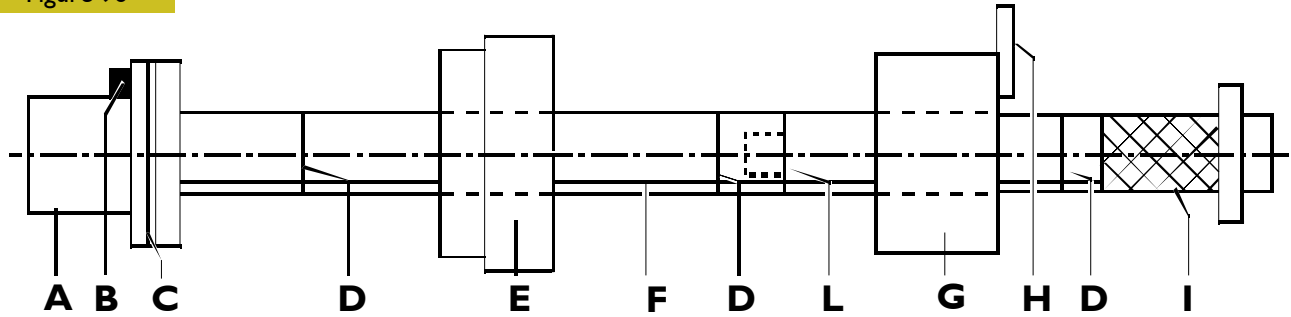
* Bush inner diameter after installation

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 96

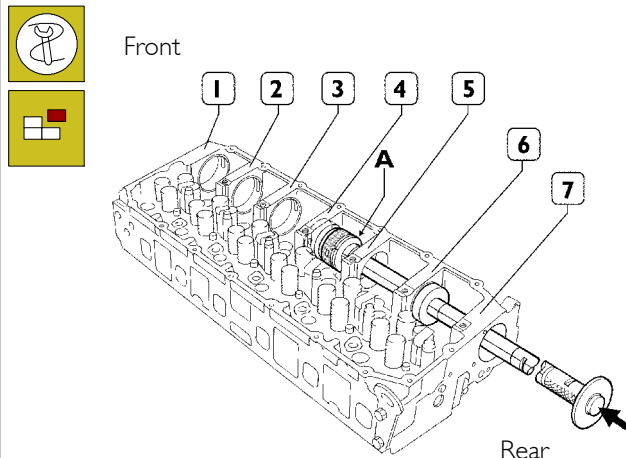


71721

- 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.

Removal

Figure 97

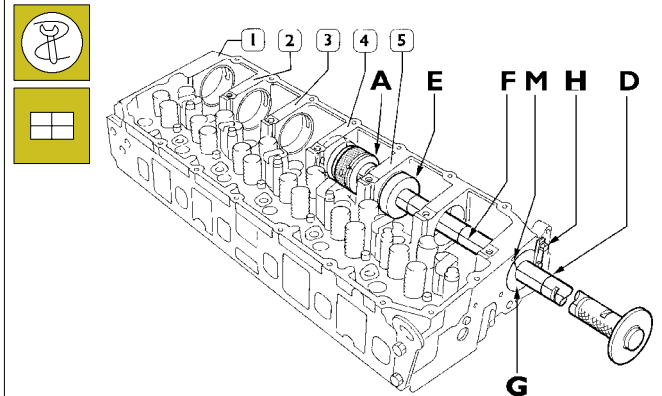


71725

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 98



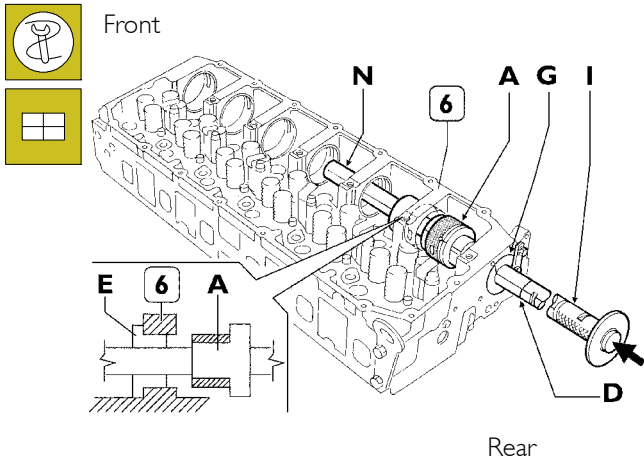
77795

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 96) on the bushing.
- 5 position the guide bushing (E) and secure the guide bushing (G) (Figure 96) 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 99

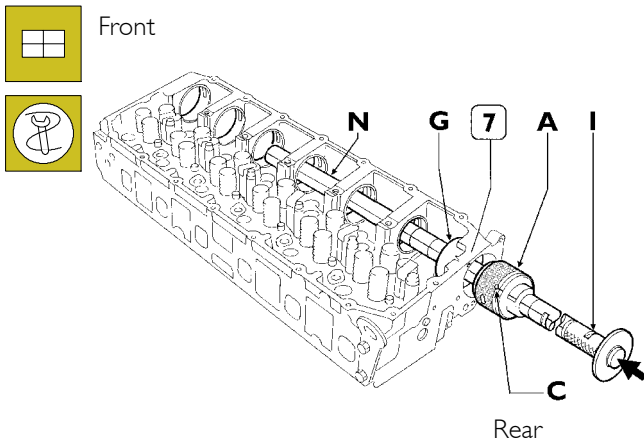


71723

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 100



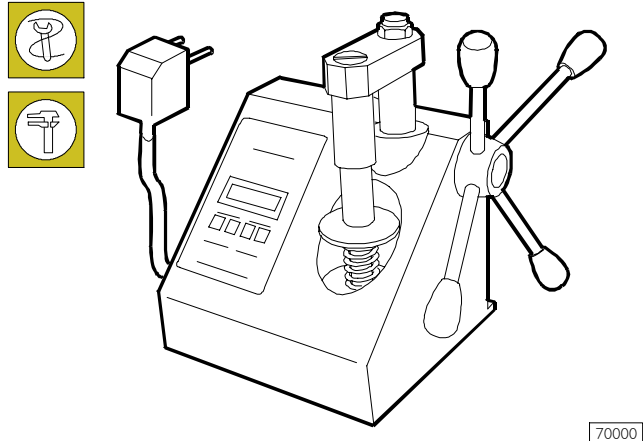
71724

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 101

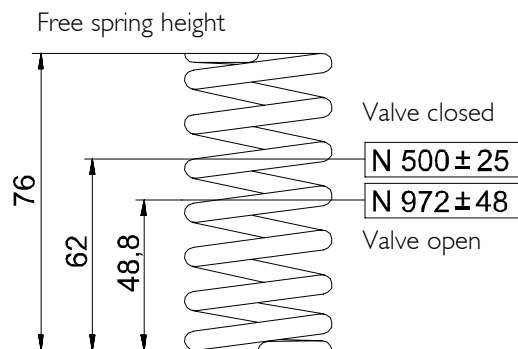


70000

Before assembly, the flexibility of the valve springs has to be checked with the tool 99305047.

Compare the load and elastic deformation data with those of the new springs given in the following figure.

Figure 102

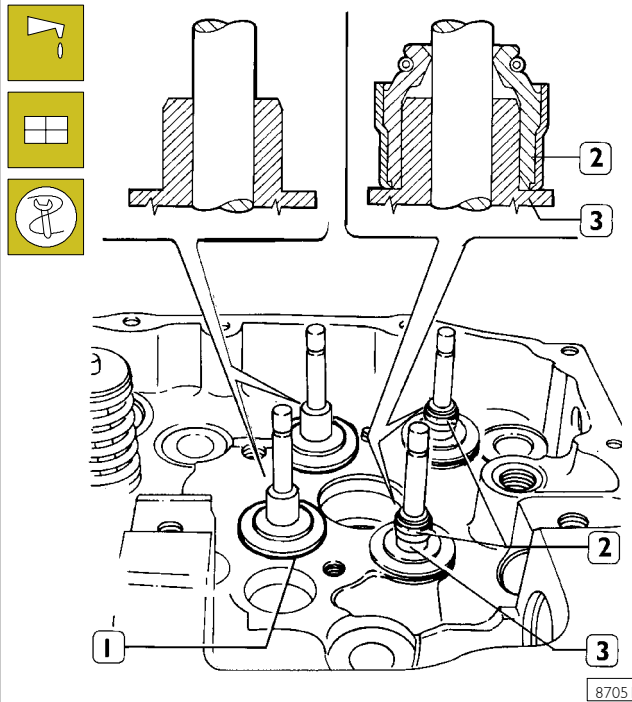


106222

MAIN DATA TO CHECK THE SPRING FOR INTAKE AND EXHAUST VALVES

Fitting valves and oil seal

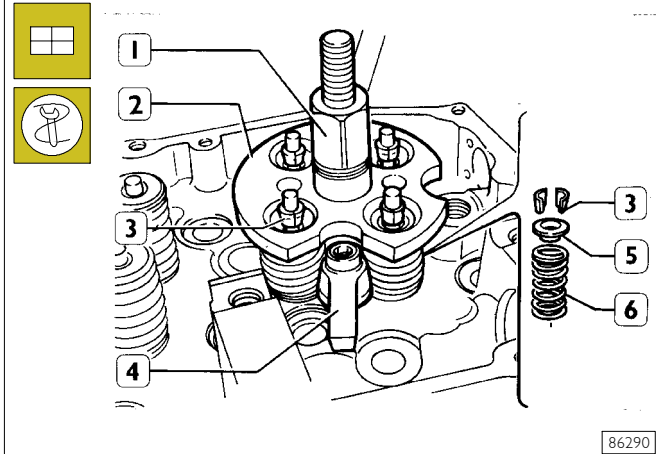
Figure 103



NOTE Should valves not have been overhauled or replaced, remount them according to numbering performed on dismantling.

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.

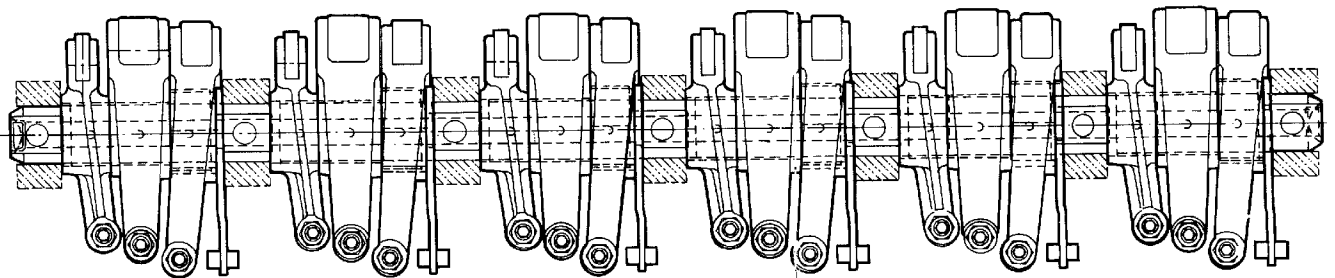
Figure 104



- 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 105



The cams of the camshaft control the rocker arms directly: 6 for the injectors and 12 for the valves.

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.

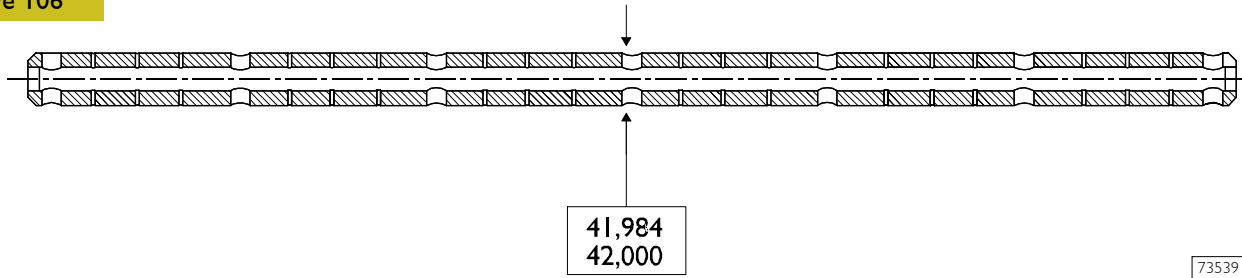
There is a pad between the rocker arm adjustment screw and the crosspiece.

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 106



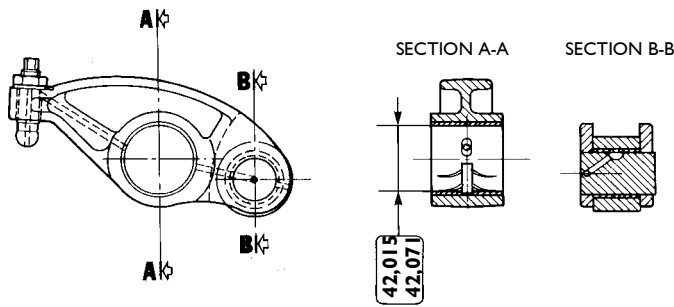
73539

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 107

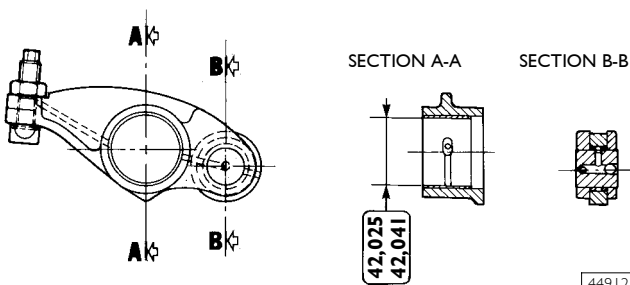


44914

Check the surfaces of the bushings, which must show no signs of scoring or excessive wear; if they do, replace the rocker arm assembly.

PUMP INJECTOR ROCKER ARMS

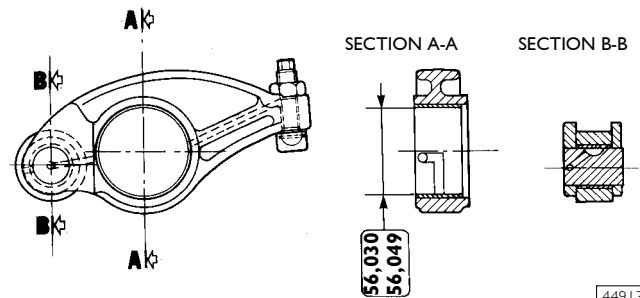
Figure 108



44912

INTAKE VALVE ROCKER ARMS

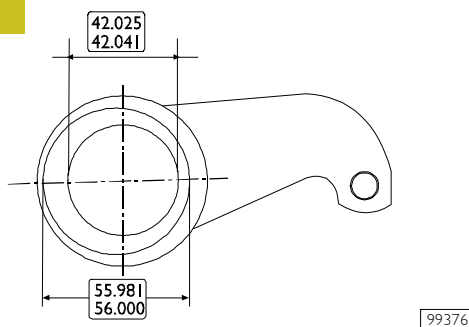
Figure 109



44913

EXHAUST VALVE ROCKER ARMS

Figure 110

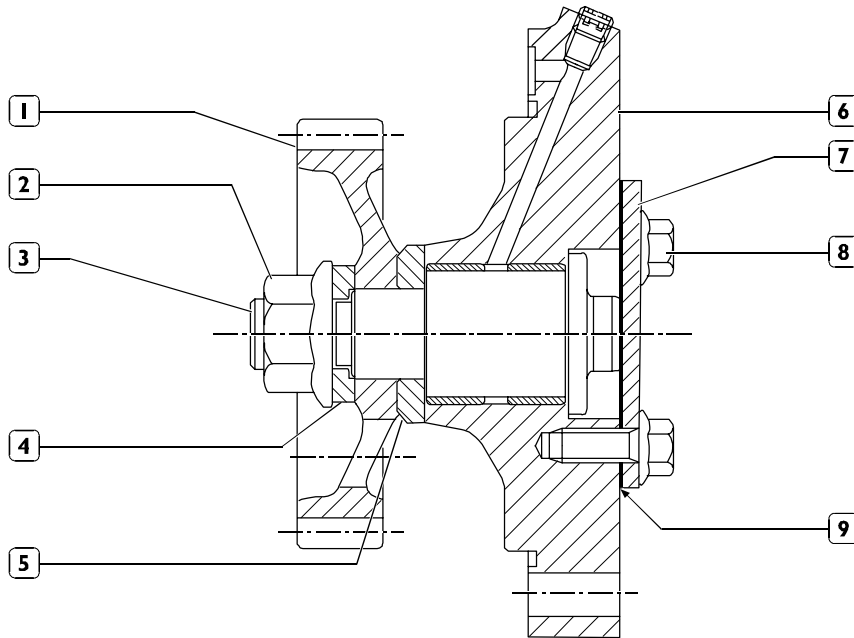


99376

EXHAUST VALVE ROCKER ARM HOLDER LEVER

REAR POWER TAKEOFF

Figure I11



107991

1. Gear - 2. Nut - 3. Shaft - 4. Washer - 5. Spacer - 6. Support - 7. Cover - 8. Screw - 9. Seal.



Removal

Remove retaining screws (8) and disconnect cover (7) with seal (9) from support (6).
 Lock shaft (3) rotation and remove nut (2) .
 Remove from shaft (3): washer (4), gear (1) and spacer (5).
 Remove shaft (3) from support (6).



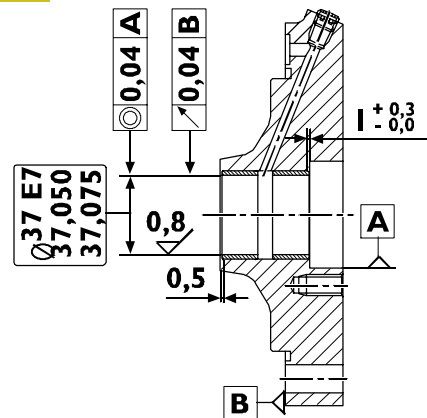
Refitting

For refitting, reverse operations described for removal according to instructions below:

- install a new seal (9);
- lubricate shaft shank (3) with engine oil;
- lock screws and nut at prescribed torque.



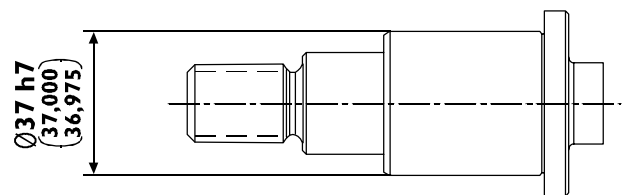
Figure I12



107992

Shaft

Figure I13



107993

Rated shaft/rear power takeoff supporting bushing backlash : 0,05 ± 0,10 mm.

TIGHTENING TORQUE

PART	TORQUE		
	Nm	kgm	
Capscrews, undercrankcase to crankcase ◆			
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 ◆			
	pretightening	11.5	1.15
	tightening	19	1.9
Spacer and oil sump capscrews ◆			
	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 ◆			
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 ◆			
		26	2.6
Capscrews, thrust plates to head ◆			
		19	1.9
Fixing screw M18x2 base engine mounting			
Stage 1:	pretightening	120	12
Stage 2:	angle		45°
Fixing screw M16x2 engine mounting to carter flywheel			
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 •			
	pretightening	32.5 ± 7.5	3.2 ± 0.7
	tightening	45 ± 5	4.5 ± 0.5
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	70	7
Second phase		50°
Screws fixing intermediate gear pins: ♦		
First phase	30	3
Second phase		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	8.5 ± 1.5	0.8 ± 0.1
Screws and nuts fixing turbocharger •		
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
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 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 ± 10
Screw fixing alternator bracket to crankcase	L = 35 mm	30 ± 3
	L = 60 mm	44 ± 4
	L = 30 mm	24.5 ± 2.5
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

- ◆ Before assembly, lubricate with engine oil
- Before assembly, lubricate with graphitized oil

SECTION 5

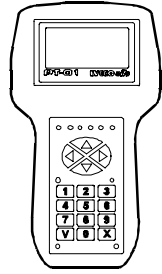
Tools

	Page
TOOLS	21

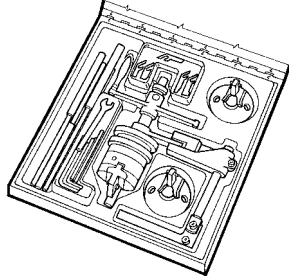
TOOLS

TOOL NO.

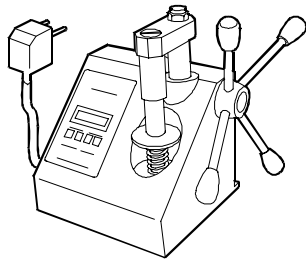
DESCRIPTION

8093731

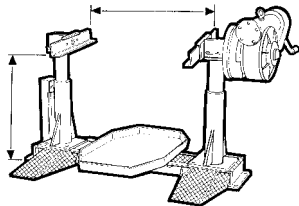
Tester PT01

99305019

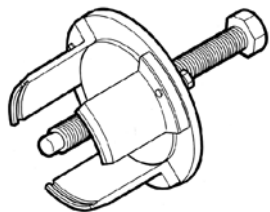
Full-optional tool-kit to rectify valve seat

99305047

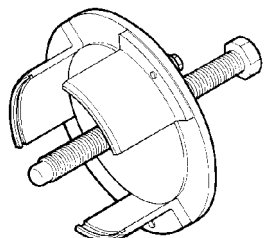
Spring load tester

99322230

Rotary telescopic stand (range 2000 daN, torque 375 daNm)

99340053

Extractor for crankshaft front gasket

99340054

Extractor for crankshaft rear gasket

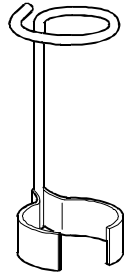
TOOLS

TOOL NO.	DESCRIPTION
99340205	Percussion extractor
99342149	Extractor for injector-holder
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

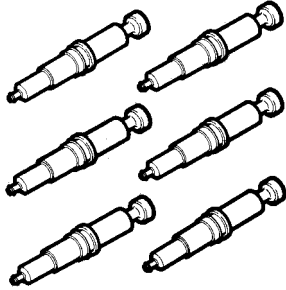
TOOLS

TOOL NO.

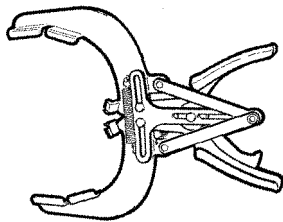
DESCRIPTION

99360144

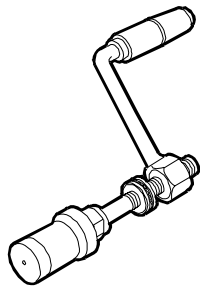
Tools (12 + 6) holding rocker adjustment screw blocks when removing/refitting the rocker shaft

99360180

Injector housing protecting plugs (6)

99360184

Pliers for assembling and disassembling piston split rings (105-106 mm)

99360261

Tool to take down-fit engine valves (to be used with special plates)

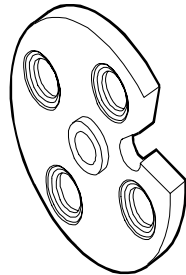
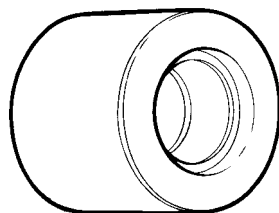
99360262

Plate for take down-fit engine valves (to be used with 99360261)

99360295

Tool to fit back valve guide (to be used with 99360481)

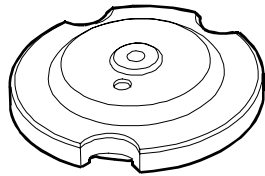
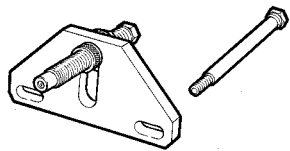
TOOLS

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)
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)

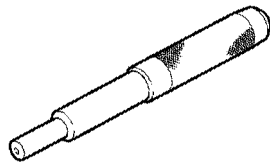
TOOLS

TOOL NO.

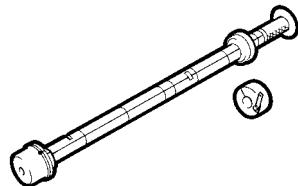
DESCRIPTION

99360337Cylinder liner compression plate
(to be used with 99360334-99360336)**99360351**

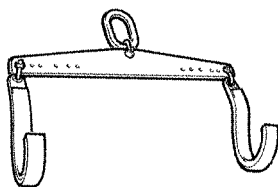
Tool to stop engine flywheel

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

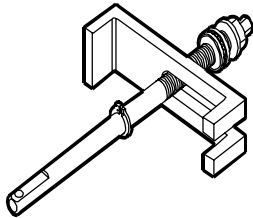
TOOLS

TOOL NO.	DESCRIPTION
99360553	Tool for assembling and installing rocker arm 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.
99360613	Tool for timing of phonic wheel on timing gear
99360703	Tool to stop cylinder liners

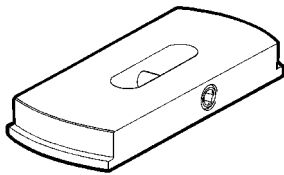
TOOLS

TOOL NO.

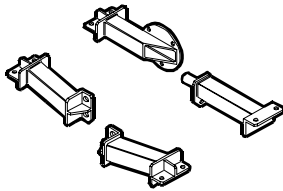
DESCRIPTION

99360706

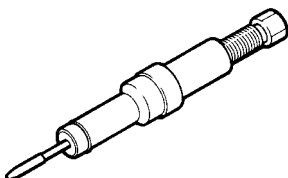
Tool to extract cylinder liners (to be used with specific rings)

99360726

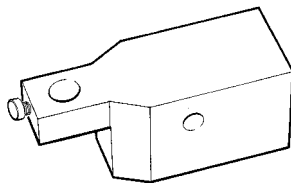
Ring (125 mm) (to be used with 99360706)

99361036

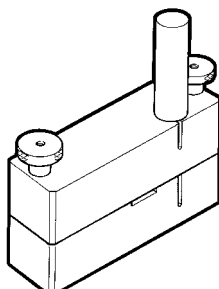
Brackets fixing the engine to rotary stand 99322230

99365056

Tool for injector holder heading

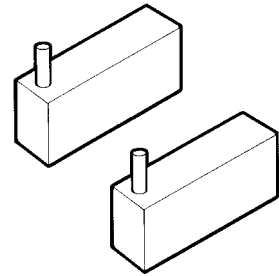
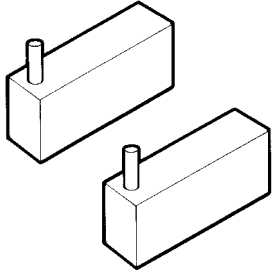
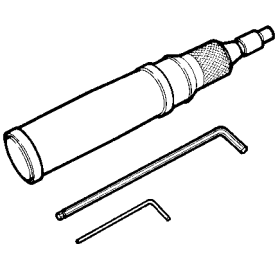
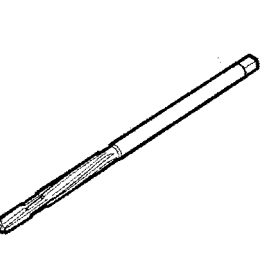
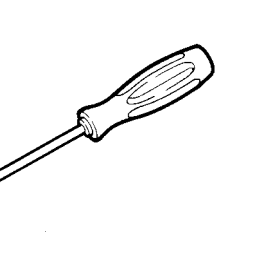
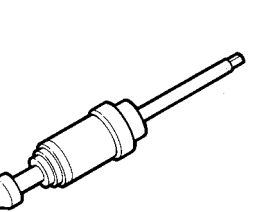
99370415

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)

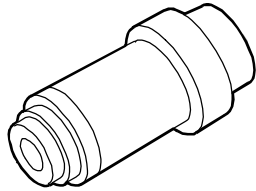
TOOLS**TOOL NO.****DESCRIPTION**

99378102		Punches (B) for printing engine identification plates (to be used with 99378100)
99378104		Punches (D) for printing engine identification plates (to be used with 99378100)
99389834		Torque screwdriver for calibrating the injector solenoid valve connector check nut
99390311		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)

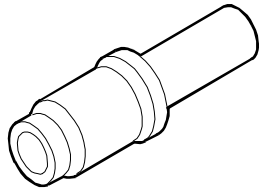
TOOLS

TOOL NO.

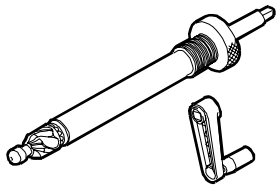
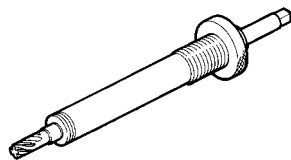
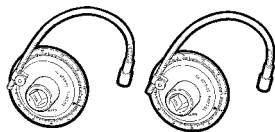
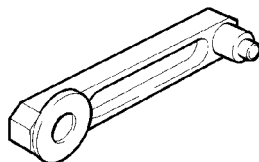
DESCRIPTION

99390805

Guide bush (to be used with 99390804)

99394015

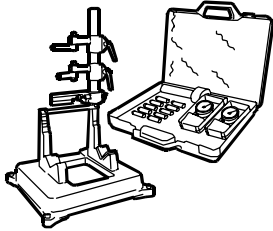
Guide bush (to be used with 99394041 or 99394043)

99394041Cutter 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

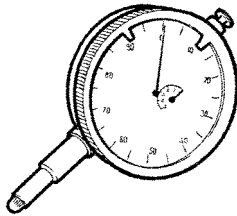
TOOLS

TOOL NO.

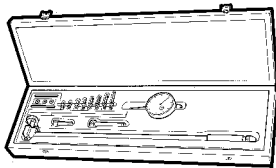
DESCRIPTION

99395363

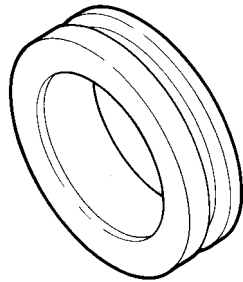
Complete square to check connecting rod squaring

99395603

Dial gauge (0 - 5 mm)

99395687

Reaming gauge (50 - 178 mm)

99396035

Centering ring of crankshaft front gasket cap

Appendix

	Page
SAFETY PRESCRIPTIONS	3

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 until 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 priority 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 3 F3B CURSOR ENGINES

Section

General specifications

1

Fuel

2

Industrial application

3

Overhaul and technical specifications

4

Tools

5

Safety prescriptions

Appendix

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.

UPDATING

Section	Description	Page	Date of revision

SECTION I

General specifications

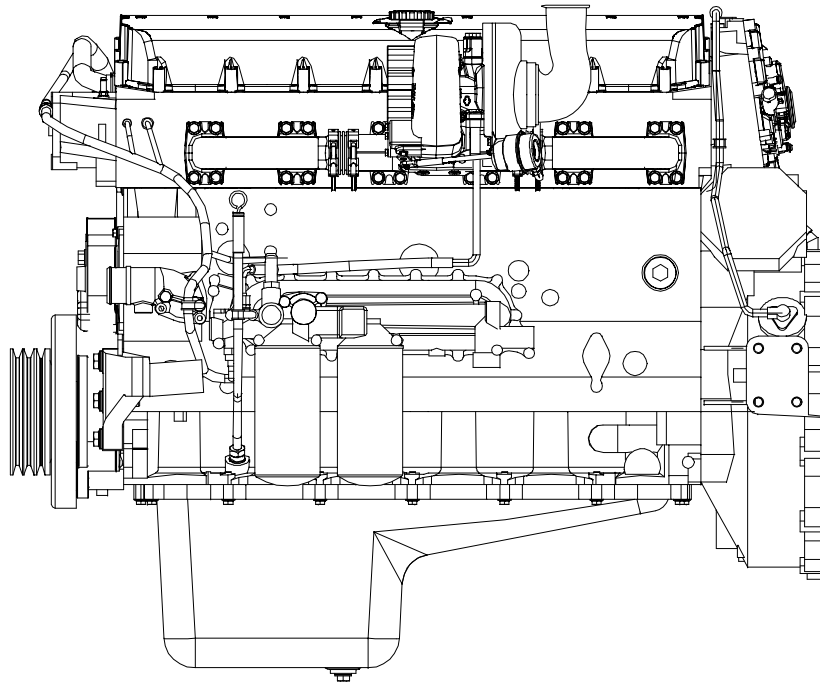
	Page
CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE	3
VIEWS OF ENGINE	5
LUBRICATION DIAGRAM	8
<input type="checkbox"/> Oil pump	9
<input type="checkbox"/> Overpressure valve	9
<input type="checkbox"/> Oil pressure control valve	10
<input type="checkbox"/> Heat exchanger	10
<input type="checkbox"/> By-pass valve	11
<input type="checkbox"/> Thermostatic valve	11
<input type="checkbox"/> Engine oil filters	11
<input type="checkbox"/> Water pump	13
<input type="checkbox"/> Thermostat	13
TURBOCHARGING	14
<input type="checkbox"/> HOLSET HX 60W turbocompressor	14

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F3BE0684A*B00I	-
F3BE0684E*B00I	-
F3BE0687A*....	CI3 ENT

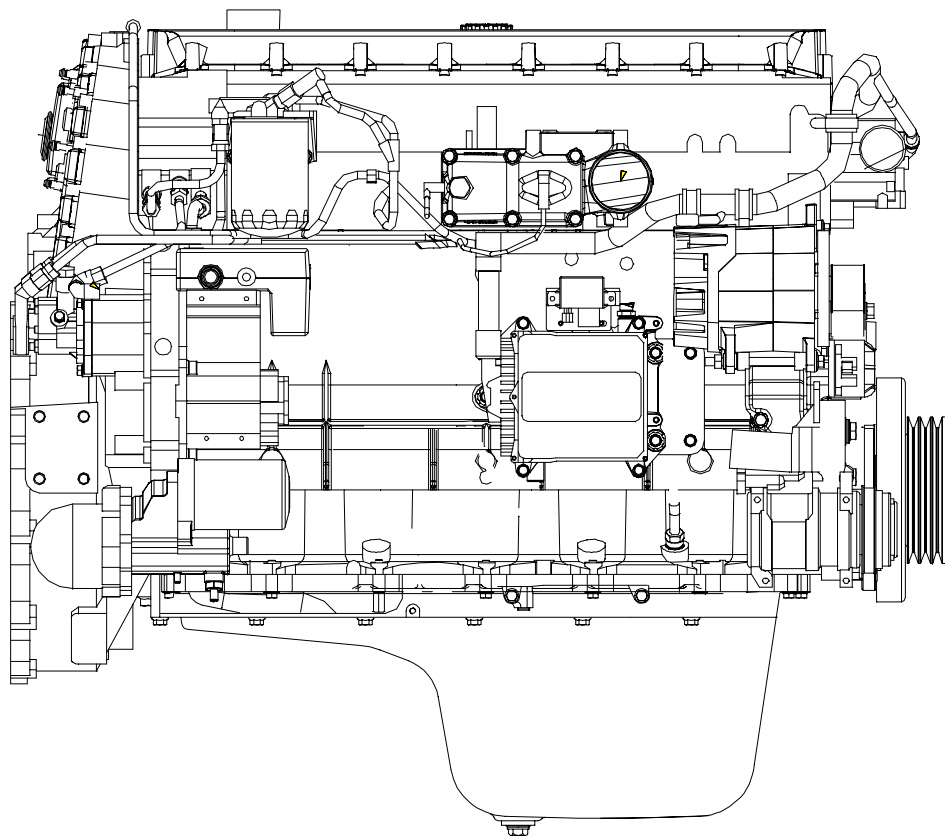
VIEWS OF ENGINE

Figure 1



LEFT-HAND SIDE VIEW

81875

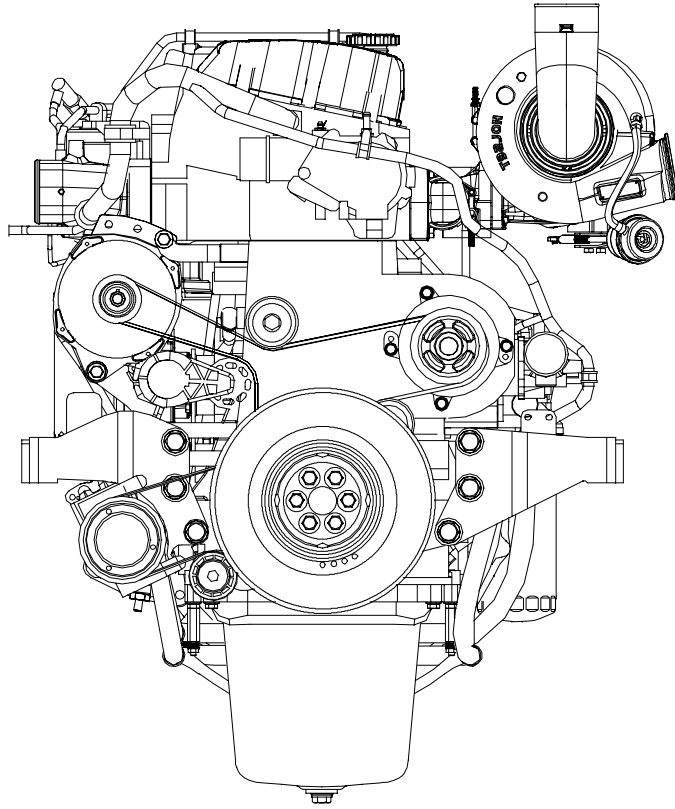


RIGHT-HAND SIDE VIEW

81876

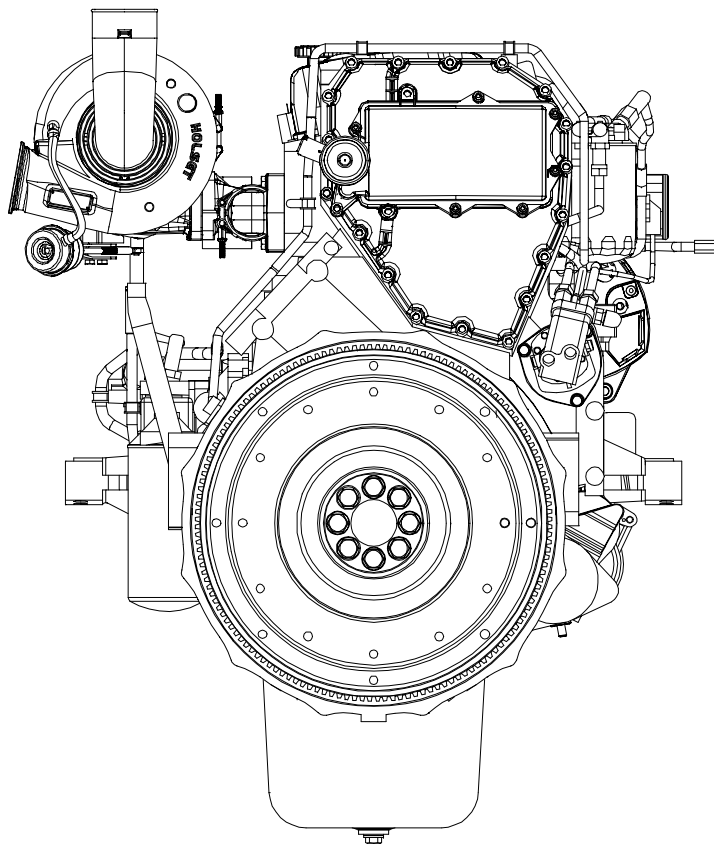
VIEWS OF ENGINE

Figure 2



81877

FRONT VIEW

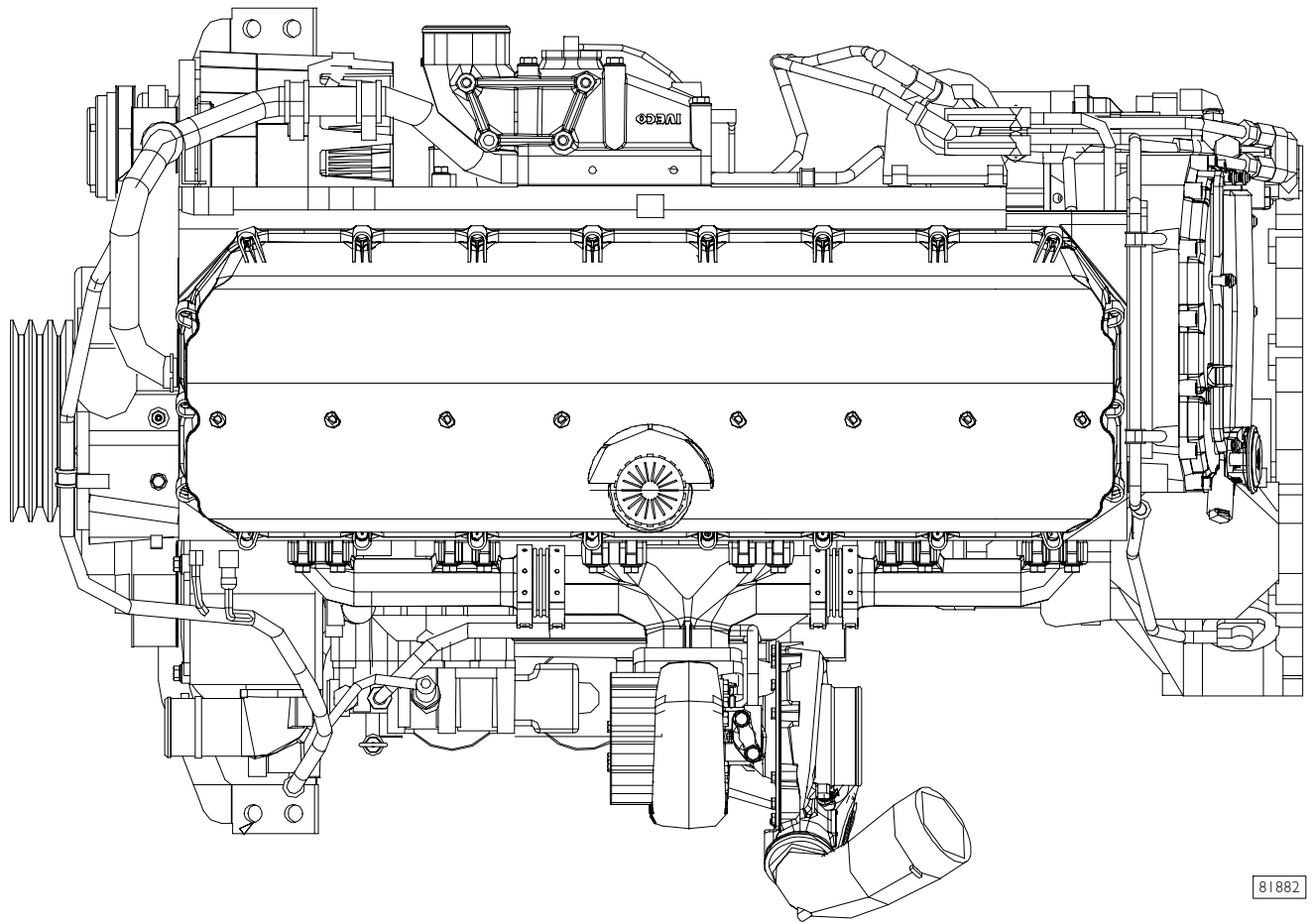


81878

REAR VIEW

VIEW OF ENGINE

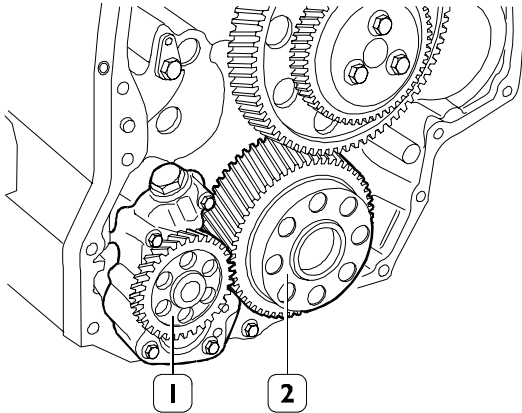
Figure 3



TOP VIEW

Oil pump

Figure 5



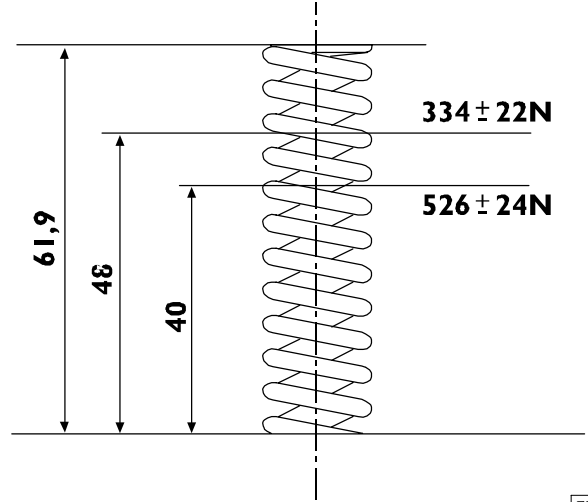
60560

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

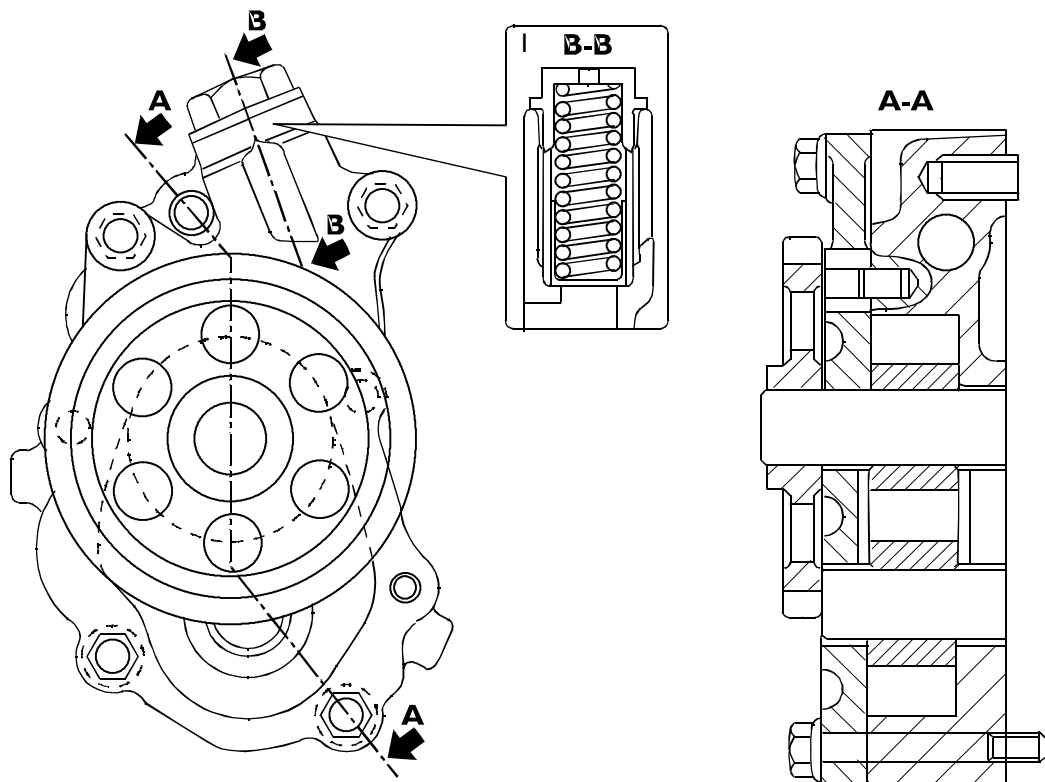
Figure 7



73540

MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

Figure 6



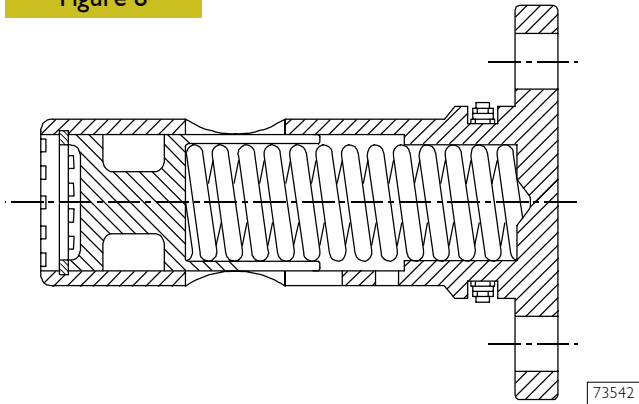
73541

OIL PUMP CROSS-SECTION

I. Overpressure valve – Start of opening pressure $10,1 \pm 0,7$ bars.

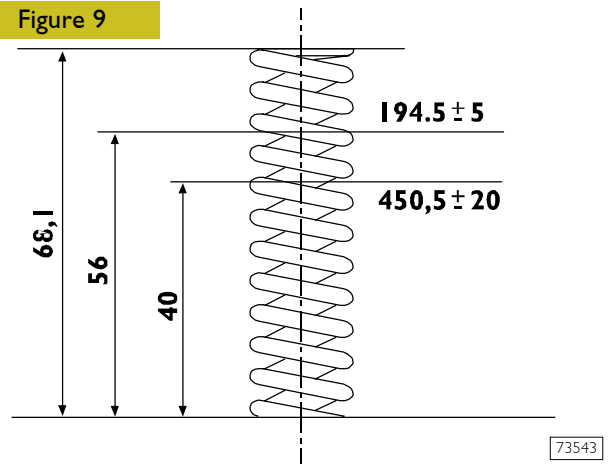
Oil pressure control valve

Figure 8



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

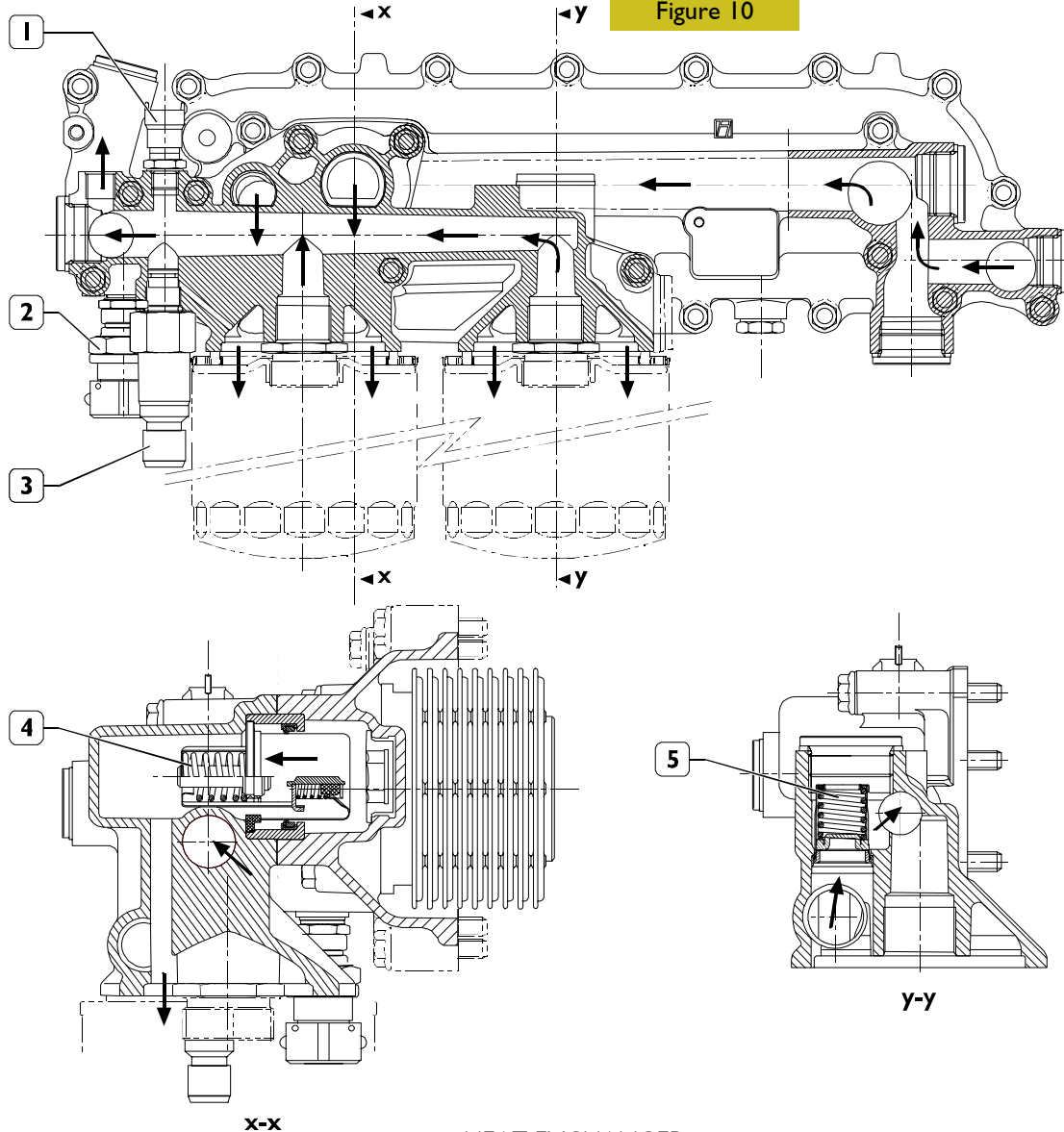
Figure 9



MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

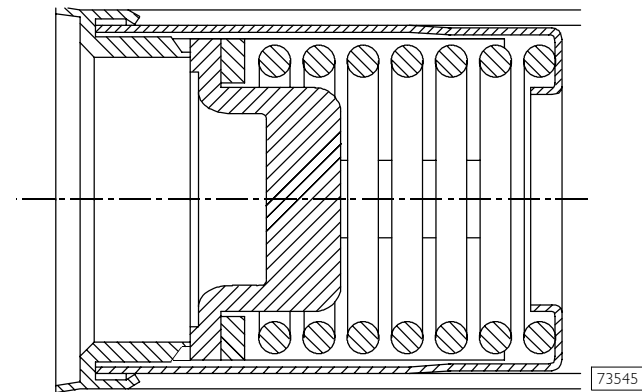
Heat exchanger

Figure 10

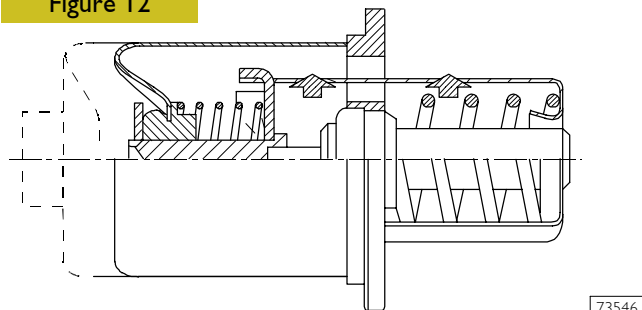


HEAT EXCHANGER

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. Heat valve - 5. By-pass valve. Number of elements 9.

By-pass valve**Figure 11**

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

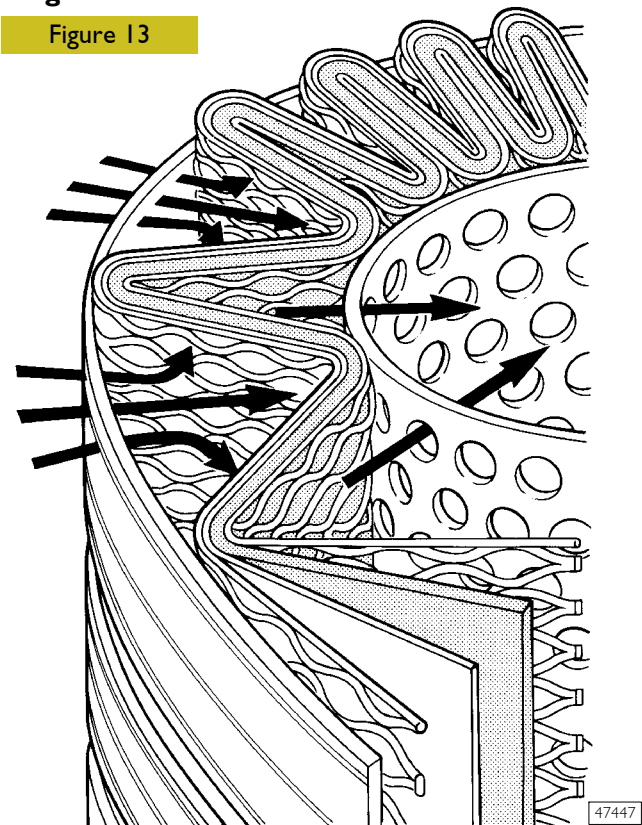
Thermostatic valve**Figure 12**

Start of opening:

travel 0.1 mm at a temperature of $82 \pm 2^\circ\text{C}$.

End of opening:

travel 8 mm at a temperature of 97°C .

Engine oil filters**Figure 13**

This is a new generation of filters that permit much more thorough filtration as they are able to hold 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.

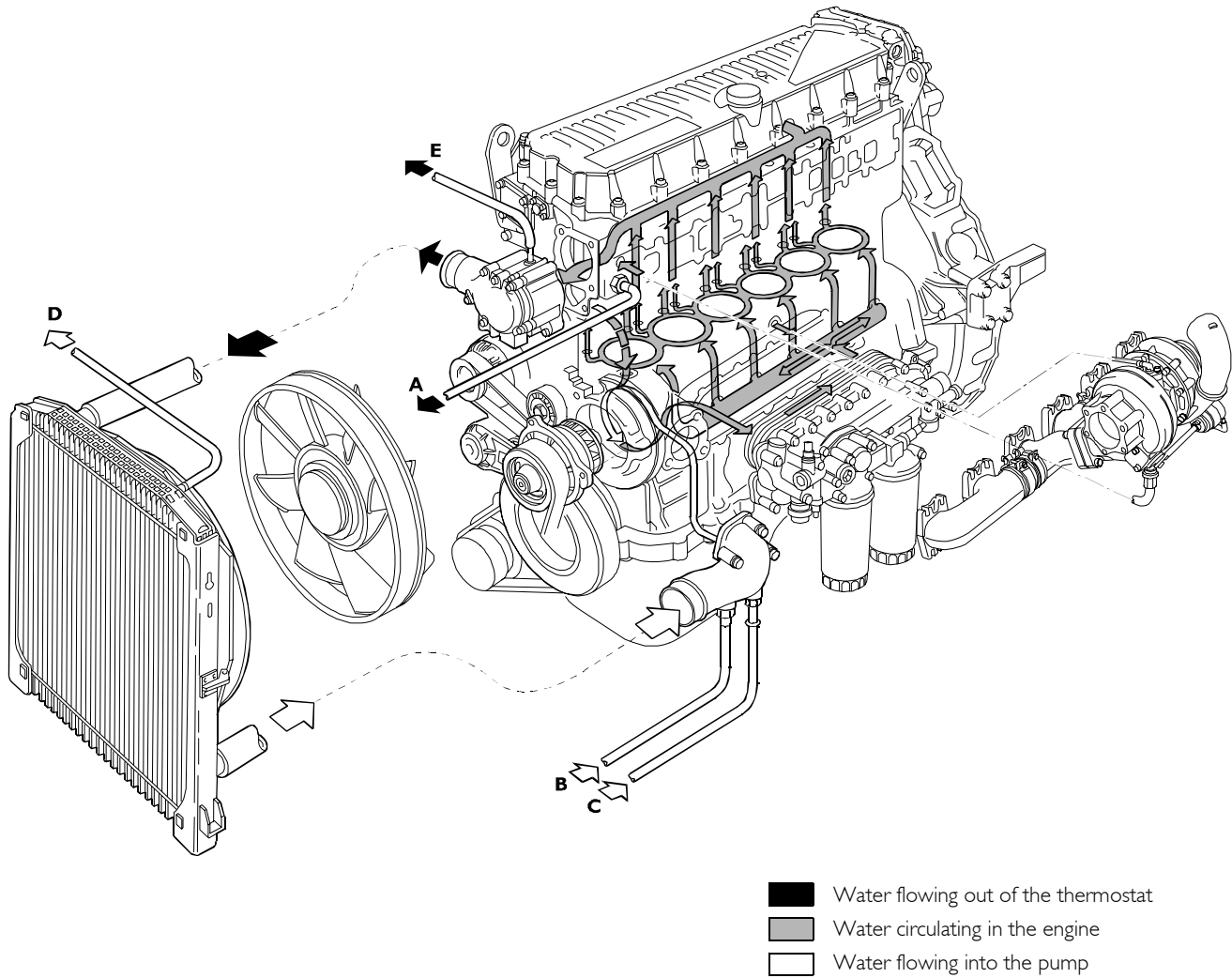
Structural parts

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.

Figure 14

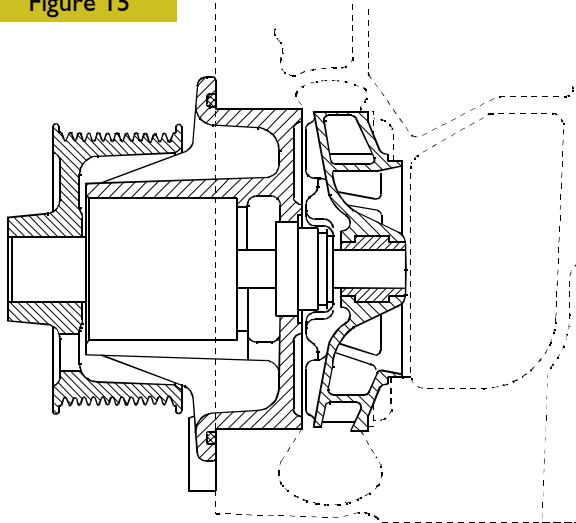


101603

- 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 15



60631

CROSS-SECTION OF THE WATER PUMP

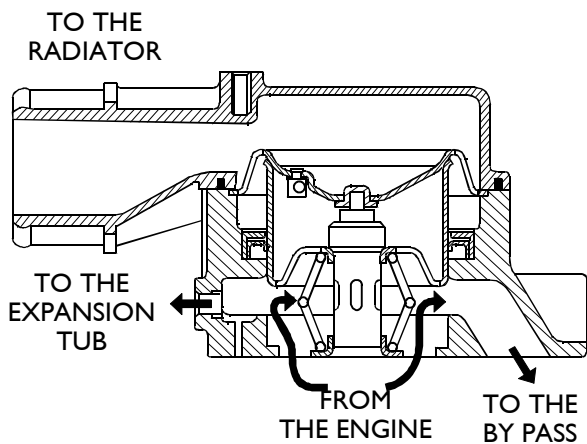
The water pump is composed of: impeller, bearing, seal and driving pulley.

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

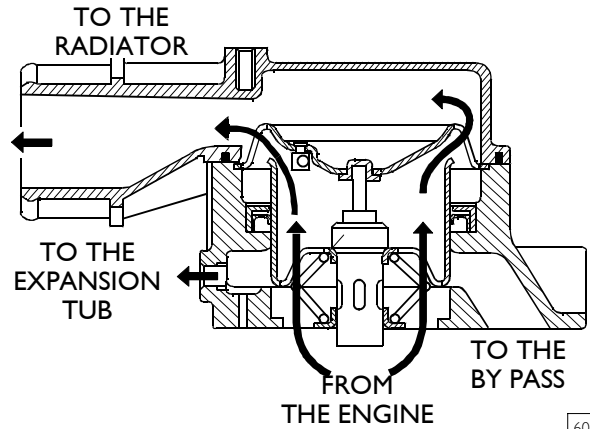
Figure 16



60747

Water circulating in the engine

Figure 17



60748

Water leaving the thermostat

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

Temperature of start of travel $84 \pm 2 \text{ }^\circ\text{C}$.

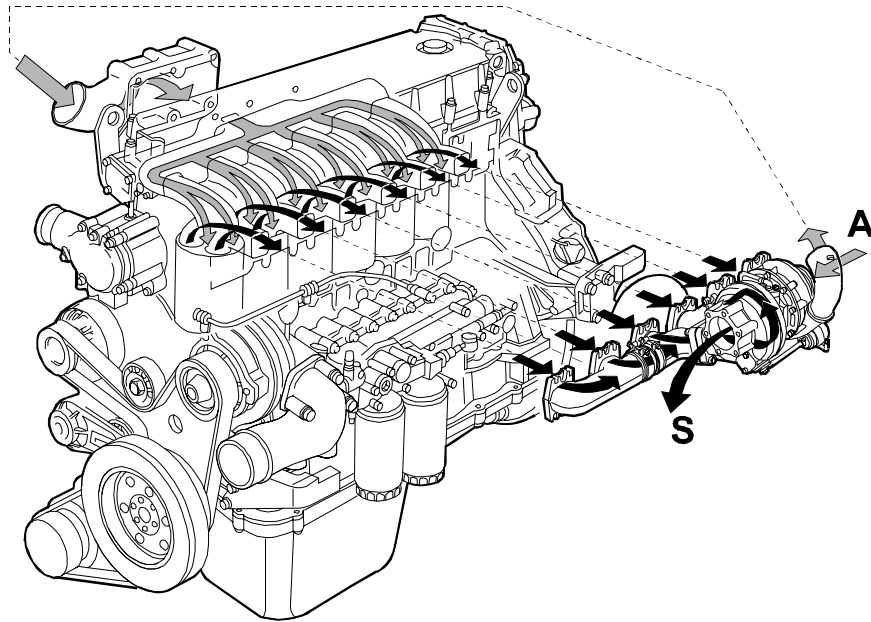
Minimum travel 15 mm at $94 \pm 2 \text{ }^\circ\text{C}$.

TURBOCHARGING

The turbocharging system consists of:

- air filter;
- Wastegate turbocharger.

Figure 18



 Engine exhaust gas

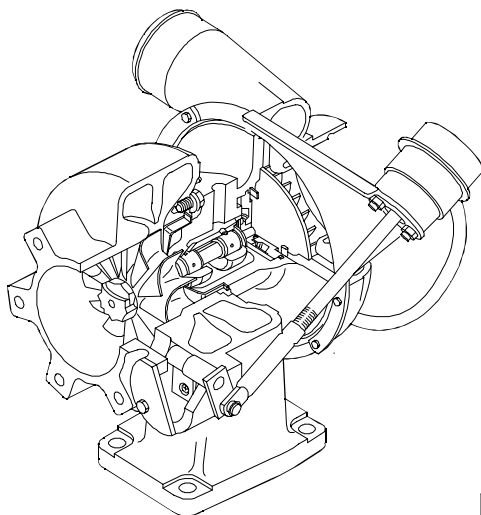
 Intake air

A A = Inlet

S S = Exhaust

101604

HOLSET HX 60W turbocompressor



71766

The turbocompressor is a turbocompressor with a return valve.

It is mainly composed by:

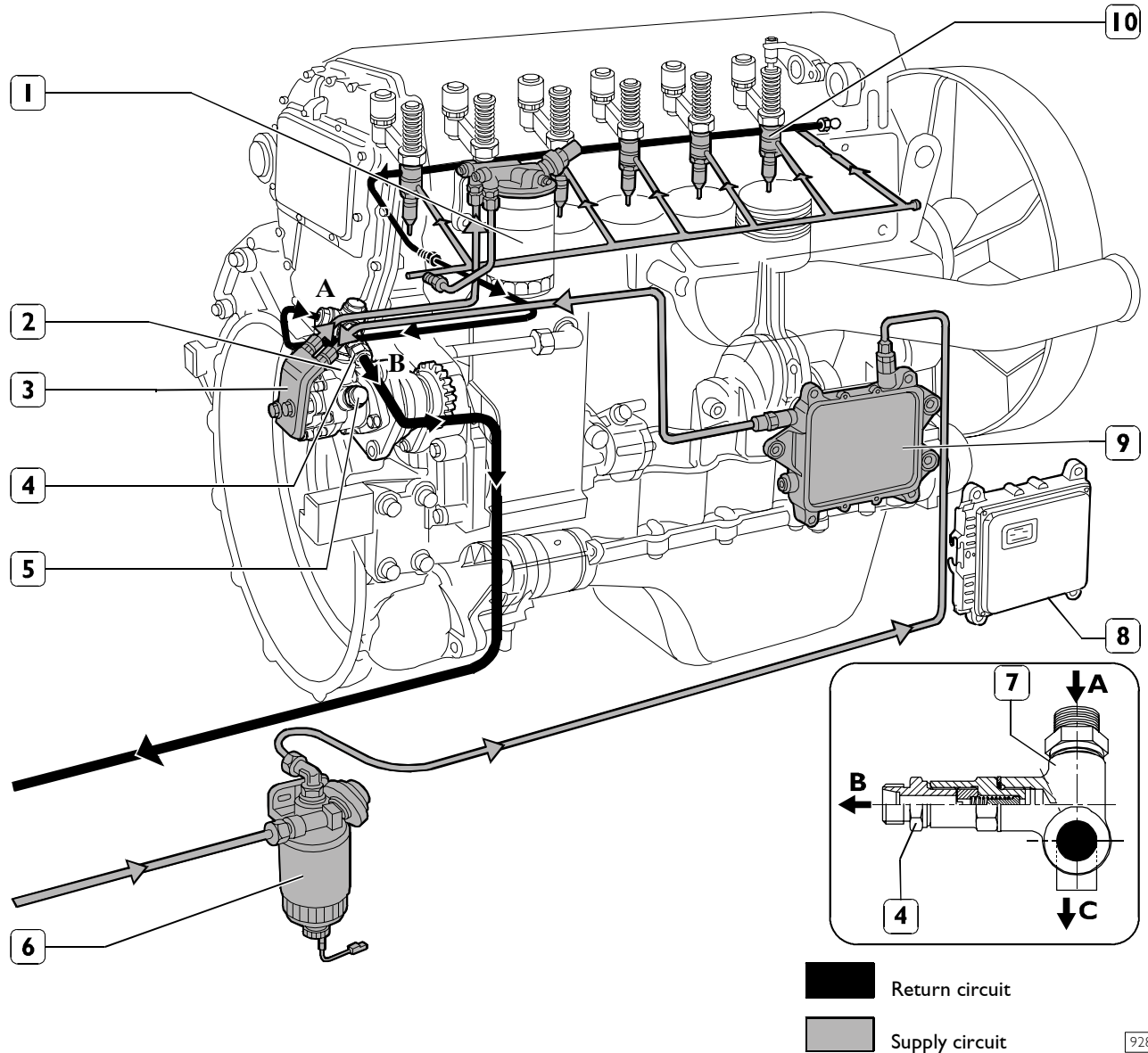
- a central unit where a shaft is positioned supported by bushings, a turbine rotor and a compressor rotor are mounted on each end;
- a turbine unit and a compressor unit mounted at the end of the central unit;
- return valve applied on the turbine unit. It divides burnt gases outlet, sending one part directly to the outlet tube when the boost of the compressor reaches the setting value.

SECTION 2**Fuel**

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FEEDING	3
FUEL SUPPLY DIAGRAM	4
<input type="checkbox"/> Overpressure valve	5
<input type="checkbox"/> Fuel pump	5
<input type="checkbox"/> Injector-pump	5
<input type="checkbox"/> Injector Phases	6

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

92847

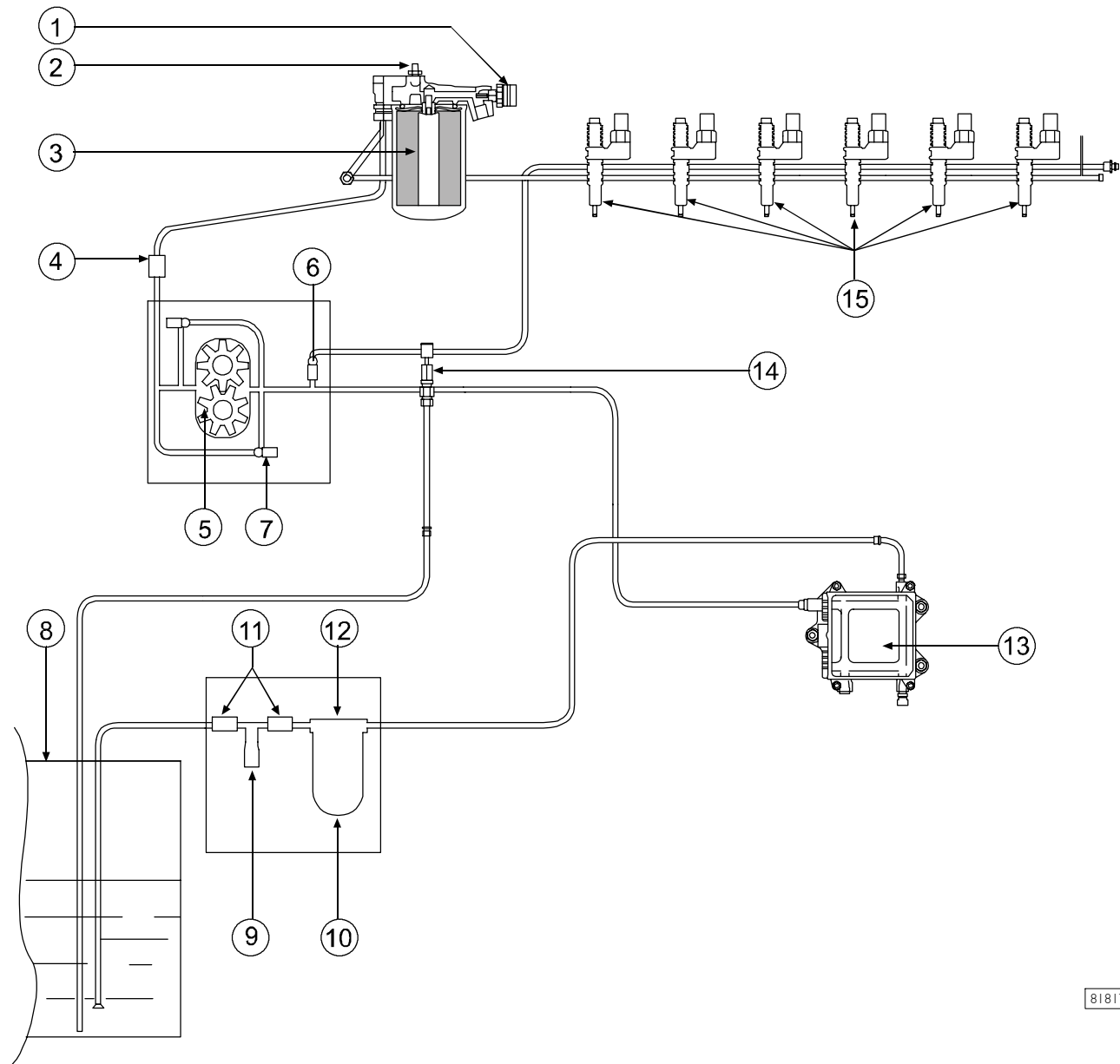
ENGINE FUEL SUPPLY

1. Fuel filter - 2. Valve for fuel recirculation from injectors integrated in the fuel pump (start opening 3,5 bar) - 3. Fuel pump - 4. Overpressure valve for fuel return to the tank (start opening 0,2 bar) - 5. Pressure control valve (start opening 5 bar) - 6. Prefilter with priming pump - 7. Connector - 8. Gearcase - 9. Heat exchanger - 10. Pump injectors.

A. Fuel arrival from injectors - B. Fuel return to the tank - C. Fuel inlet from injectors in the fuel filter

FUEL SUPPLY DIAGRAM

Figure 2

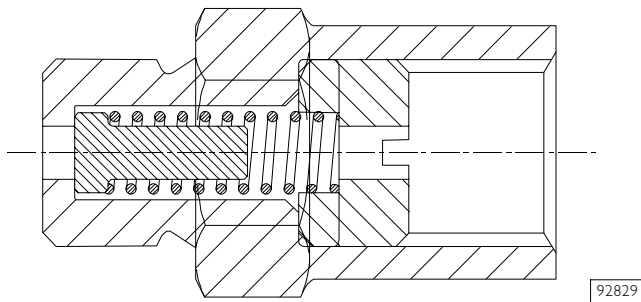


81817

1. Temperature sensor - 2. Bleed valve - 3. Secondary fuel filter - 4. By-pass valve (0.3 ÷ 0.4 bar) - 5. Fuel supply pump - 6. Integrated valve (3.5 bar) - 7. Pressure relief valve (5 bar) - 8. Fuel tank - 9. Priming pump - 10. Primary fuel filter - 11. Check valve (opening 0.1 bar) - 12. Heater - 13. Electronic control unit - 14. Fuel return union with valve built in (0.2 bar) - 15. Pump-injectors.

Overpressure valve

Figure 3

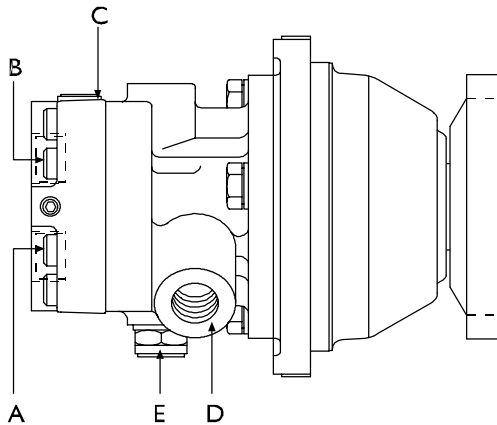


92829

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.

Fuel pump

Figure 4

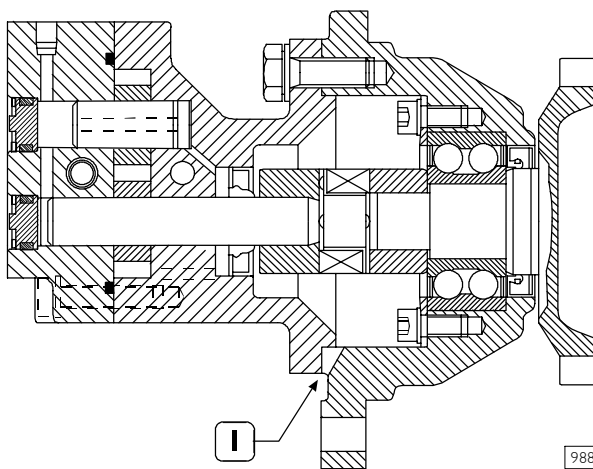


73547

Supply fuel filter for vehicles
8x8x4 - 8x8

- 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



98870

CROSS-SECTION OF THE FUEL PUMP
I. Oil and fuel leakage 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
	Pressure on delivery (bar)	5	3	0.3
	Test liquid temperature (°C)	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

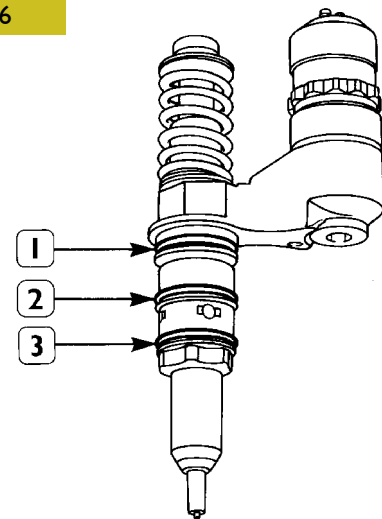
Valve calibration	5 ± 5.8
-------------------	---------

Injectors return valve

Valve calibration	3.2 ± 3.8
-------------------	-----------

Injector-pump

Figure 6



44908

- 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.

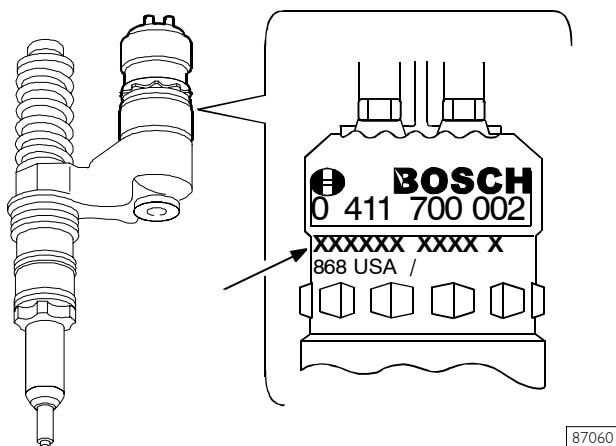
The amount of fuel injected depends on the length of time the slide valve is closed and therefore on the time for which the solenoid is energized.

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).

Figure 7

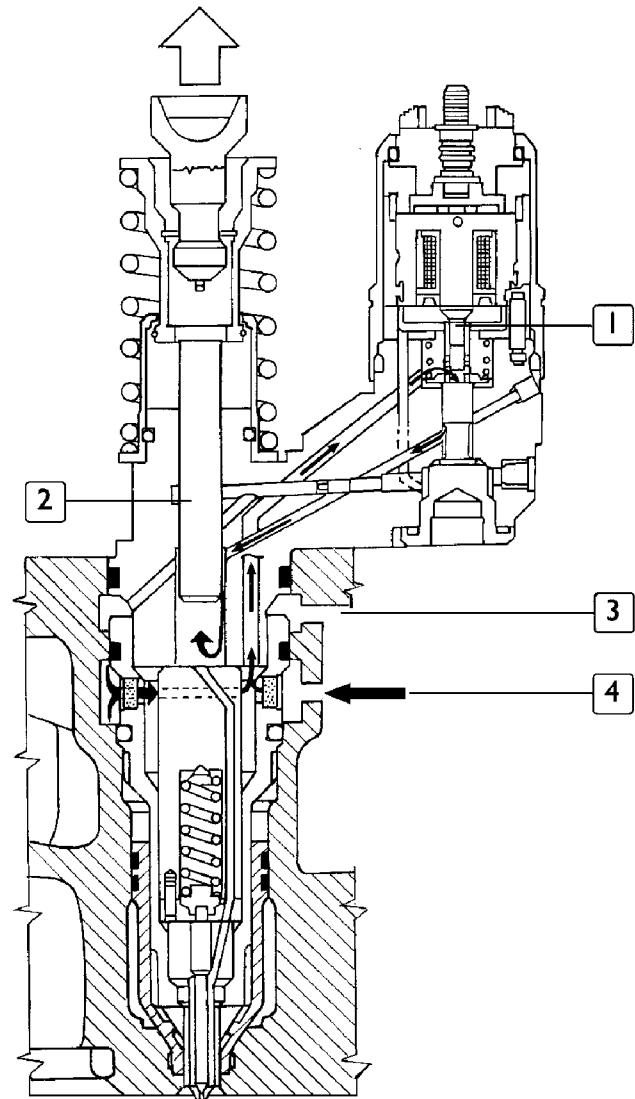


For each replaced injector you shall connect with the diagnosis device and when it is required by the program you shall insert the printed code on the injector (→) to program the gearcase again.

NOTE When checking the clearance of the rocker arms, it is important to check the injector-pump pre-load.

Injector Phases

Figure 8



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

Filling phase

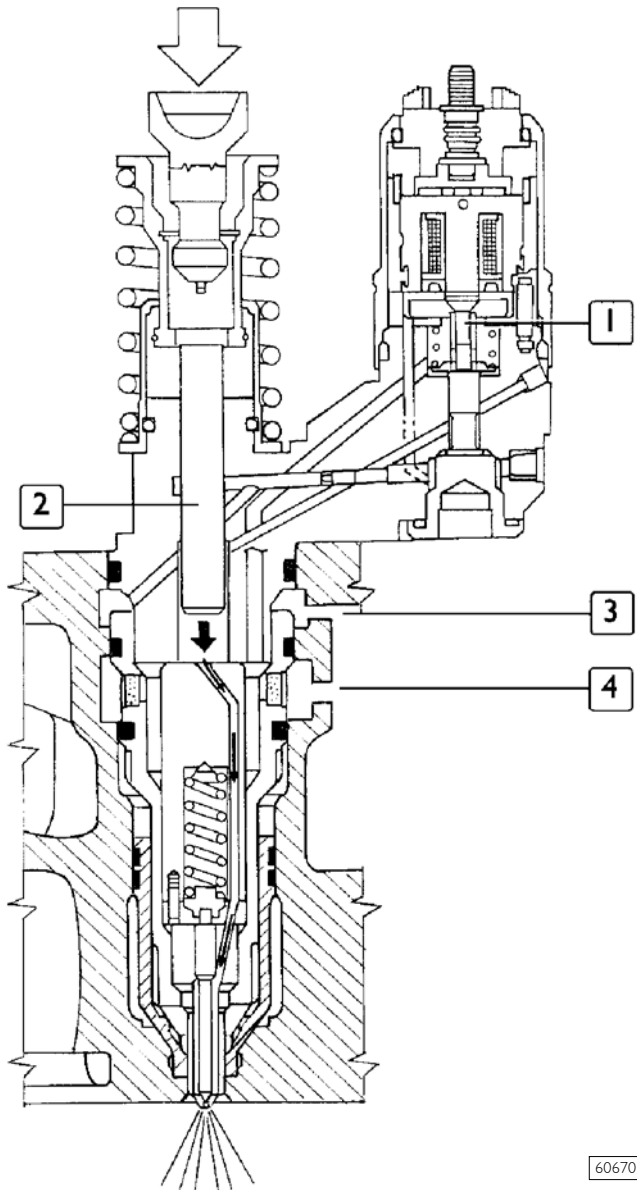
During the filling phase the pumping element (2) runs up to the top position.

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 9



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

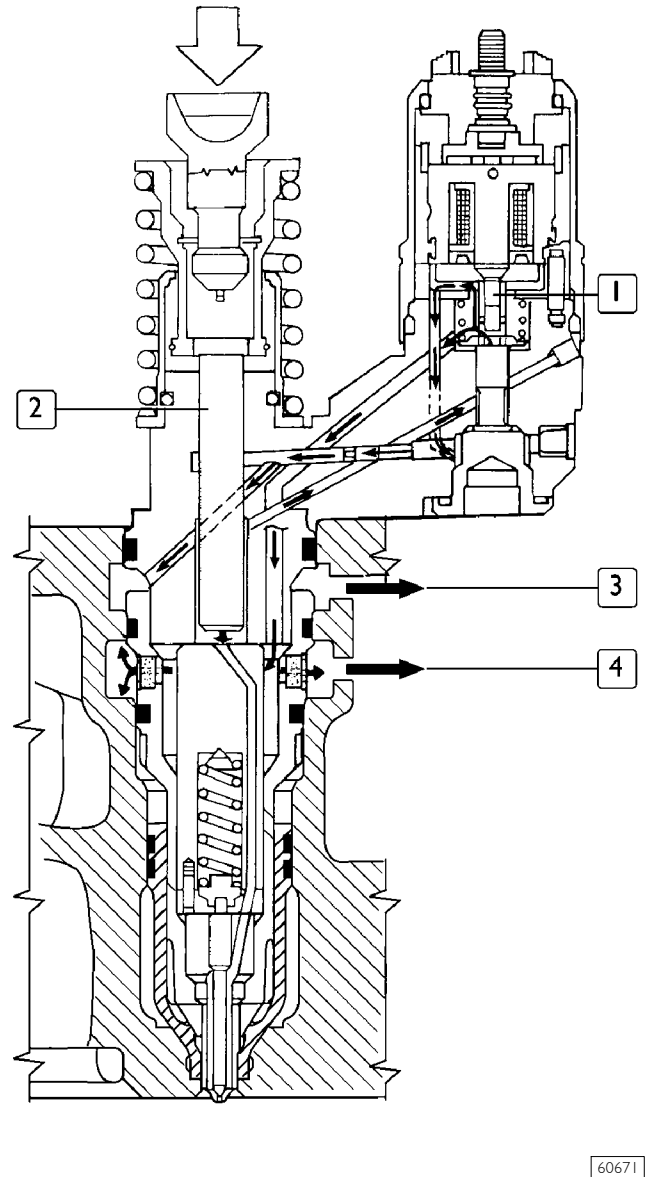
Injection phase

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 10



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.

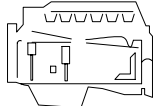

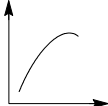

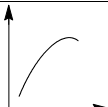



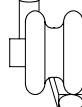

The time for which the solenoid valve stays energized, appropriately calculated by the electronic control unit, is the duration of injection (delivery) and it depends on the working conditions of the engine.

SECTION 3**Industrial application**

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CLEARANCE DATA

	Type		F3BE0684A*B00I	F3BE0684E*B00I	F3BE0687A*....
	Compression ratio		16.5 ± 0.8		
 	Max. output	kW (HP) rpm	315/338 (428/459) 2100 /1800	354/379 (481/515) 2100/1800	368 (500) 1900
 	Max. torque	Nm (kgm) rpm	1970 (197) 1340	2212 (221) 1340	2250 (225) 1200
	Loadless engine idling	rpm	900	900	-
	Loadless engine peak	rpm	2110	2110	-
	Bore x stroke Displacement	mm cm ³	135 x 150 12880		
	SUPERCHARGING Turbocharger type		Intercooler Direct injection HOLSET HX60W		
	LUBRICATION Oil pressure (warm engine) - idling - peak rpm	bar bar bar	Forced by gear pump, relief valve single action oil filter 4 5		
	COOLING Water pump control Thermostat - start of opening	°C	Liquid Through belt 80		

NOTE Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

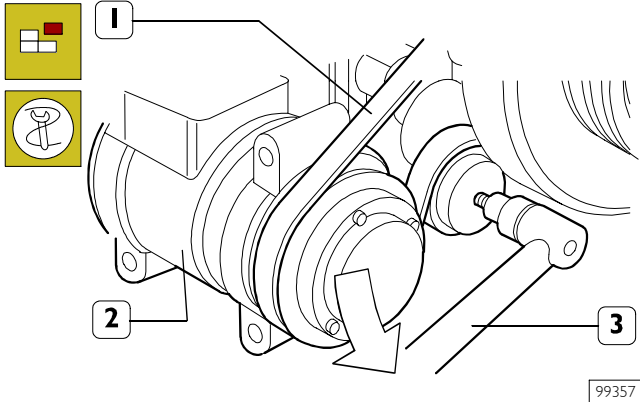
Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turns based on which the engine has been designed.

PART ONE - MECHANICAL COMPONENTS

ENGINE ASSEMBLY DISASSEMBLY

NOTE Handle all parts extremely carefully. Never get your hands or fingers between pieces. Wear the required safety clothing such as goggles, gloves and safety shoes.

Figure 1

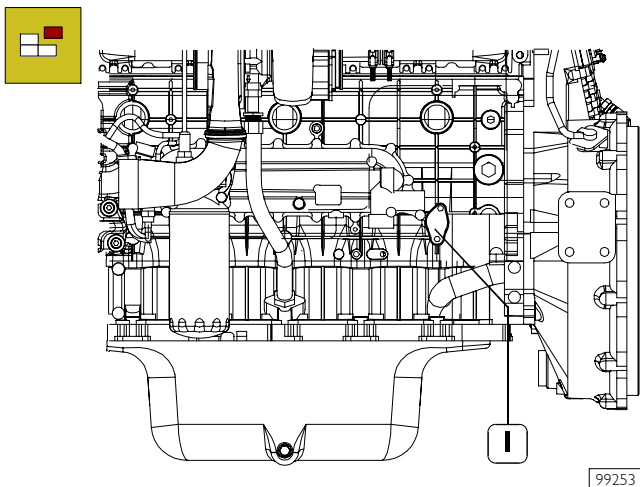


Protect the electric parts before doing any washing with high-pressure jets.

Before securing the engine on the rotary stand, remove:

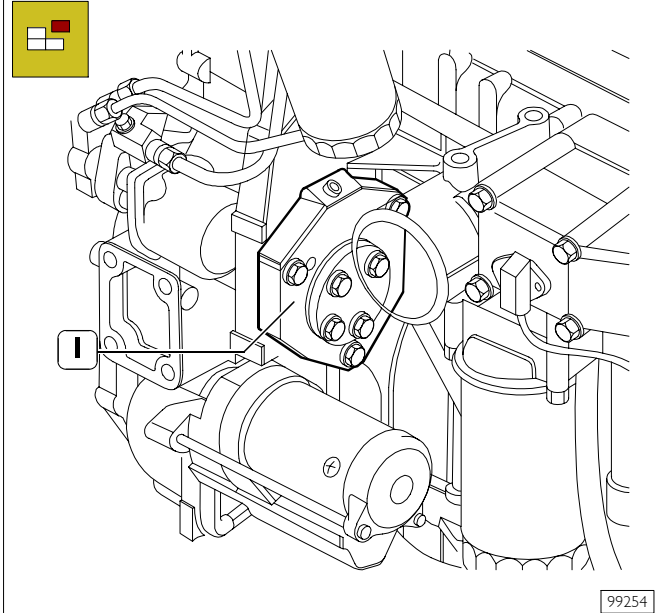
- the engine electric cable, disconnecting it from the control unit and from all the sensors/transmitters connected to it; if present:
- using a suitable tool (3), work in the direction of the arrow on the tightener and remove the compressor drive belt (1);
- remove the compressor (2) together with the engine support.

Figure 2



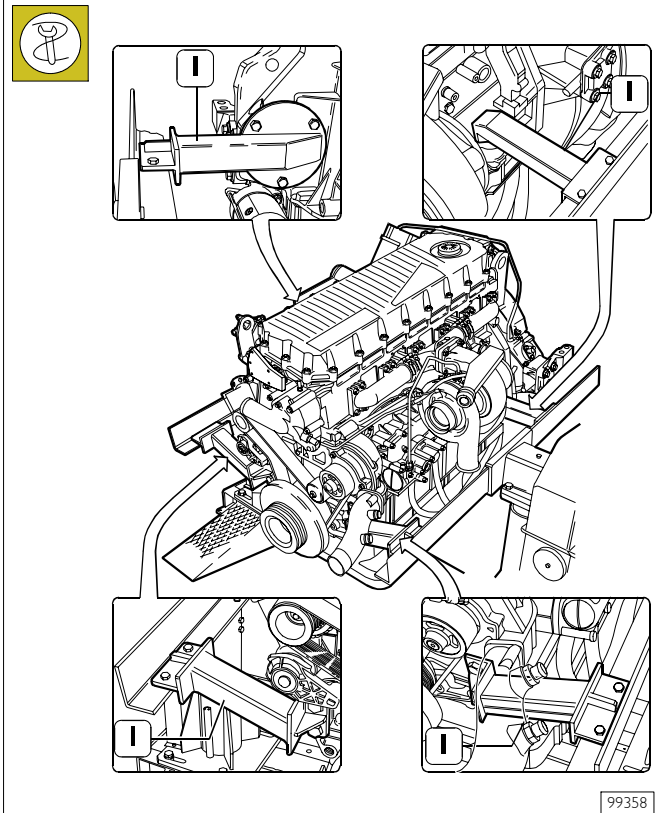
- Remove the oil pressure adjuster valve (1).

Figure 3



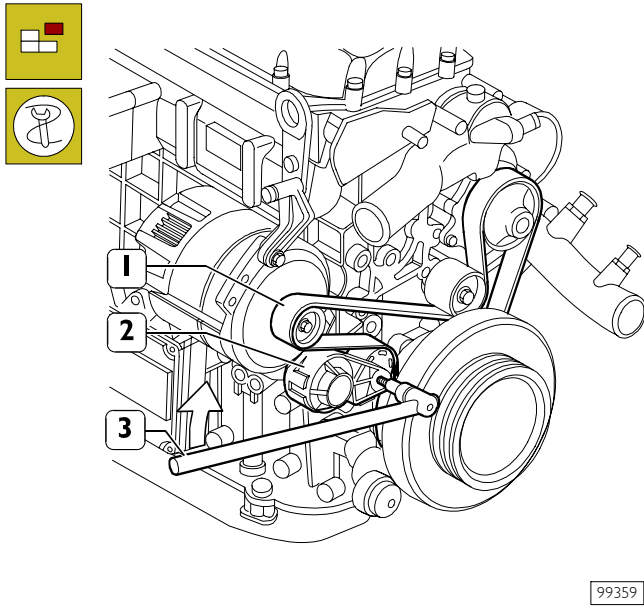
- Remove the engine supports;
- remove the drive (1).

Figure 4



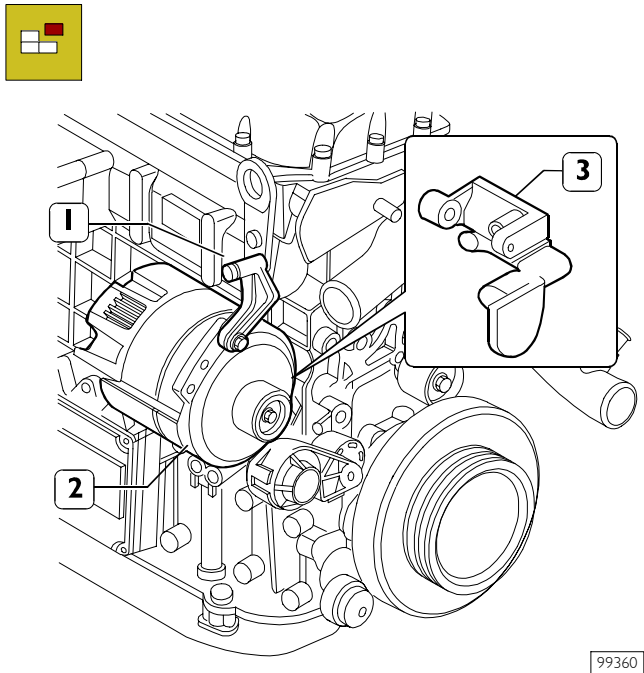
- Secure the engine to the rotary stand with the brackets 993601036 (1).
- Drain the lubricating oil from the sump.

Figure 5



- Using a suitable tool (3), work in the direction of the arrow on the tightener (2) and remove the belt (1).

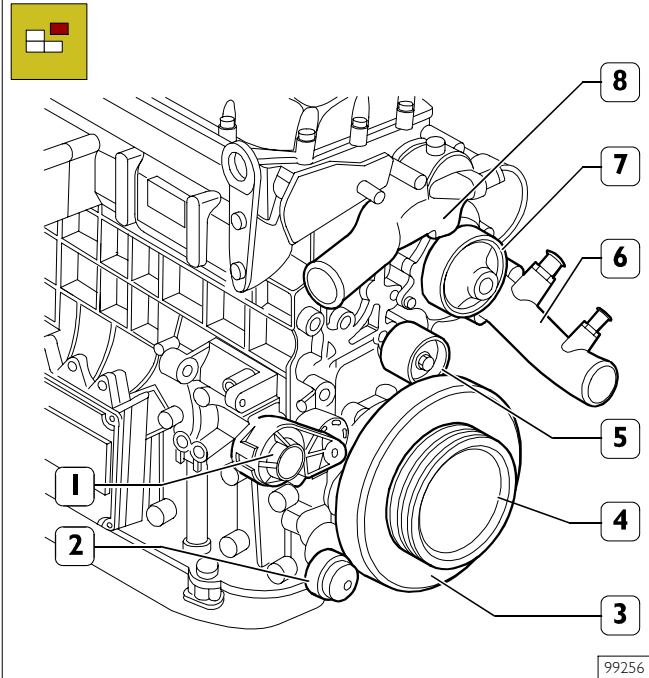
Figure 6



Remove:

- alternator (2).
- supports (1 and 3).

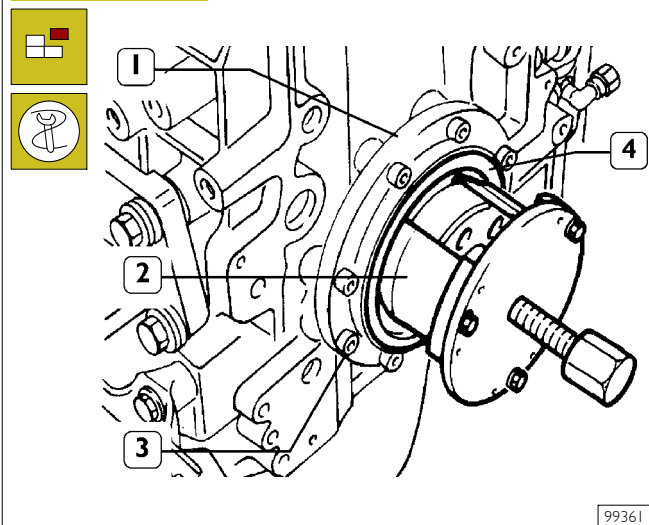
Figure 7



Remove:

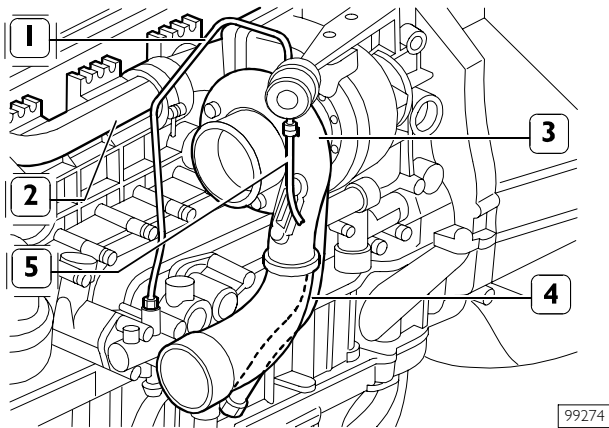
- thermostat assembly (8);
- pipes complete with coolant (6);
- pulley (4);
- water pump (7);
- automatic tightener support (1);
- fixed tightener (5);
- damper flywheel (3) and pulley beneath;
- automatic tightener (2);

Figure 8



With the extractor 99340053 (2) applied as shown in the figure, extract the seal (4). Undo the screws (3) and take off the cover (1). Disconnect all the electrical connections and sensors.

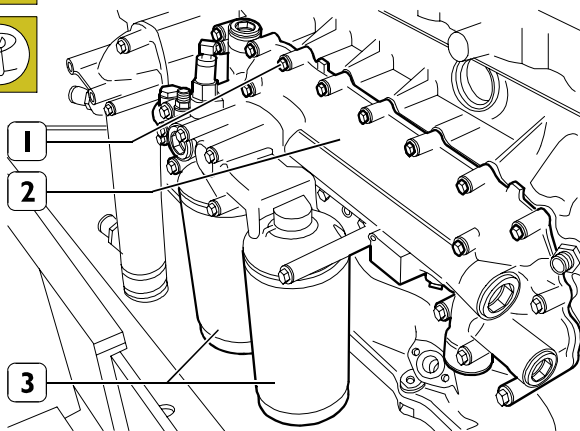
Figure 9



On the engine exhaust side, remove the following parts:

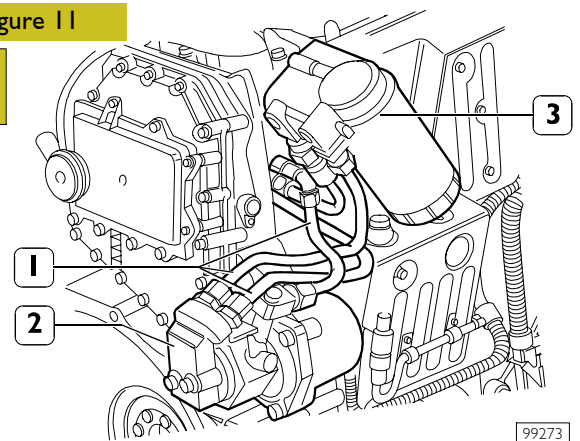
- oil delivery pipe (1);
- actuator air pipe (5);
- oil return pipe (4);
- turbocharger (3);
- exhaust manifold (2).

Figure 10



Using tool 99360314 unscrew the oil filters (3).
Remove fastening screws (1) and disassemble heat exchanger (2).

Figure 11

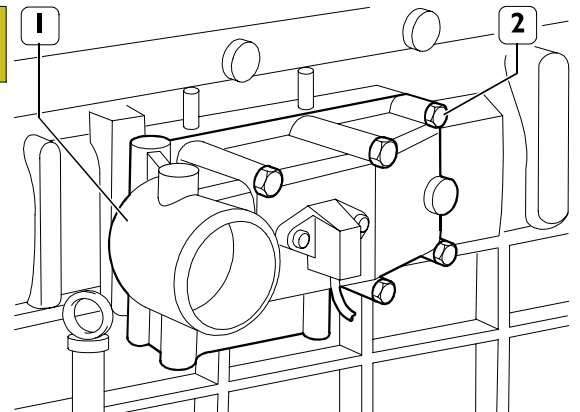


Disconnect the fuel pipes (1) from the fuel pump (2).

Remove:

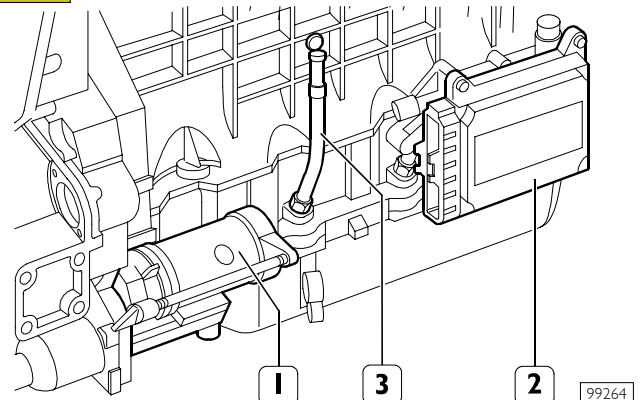
- the fuel pump (2);
- fuel filter (3) and fuel pipes (1).

Figure 12



Take out the screws (2) and remove the intake manifold (1).

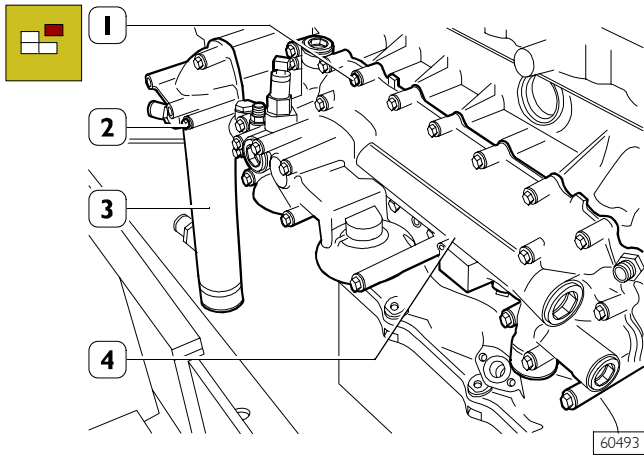
Figure 13



Remove:

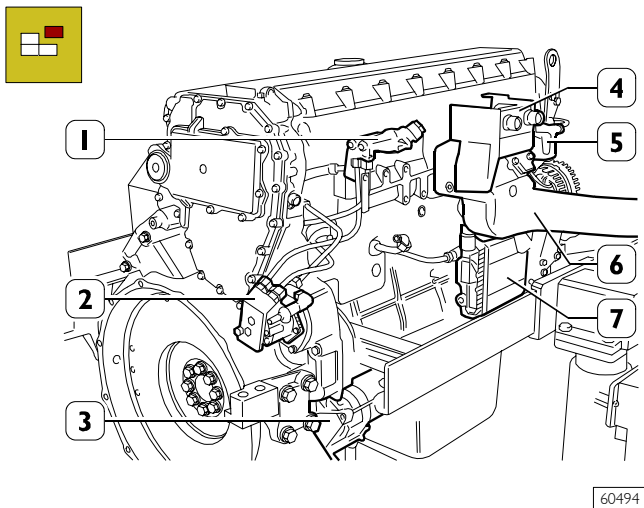
- the starter motor (1);
- the control unit (2) and its support;
- the oil dipstick (3) from the crankcase.

Figure 14



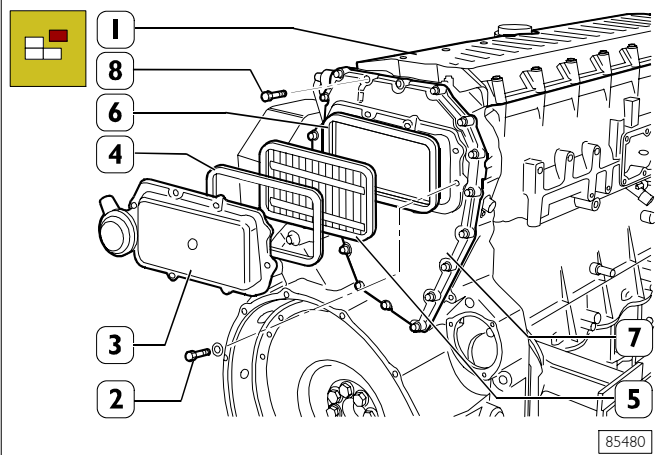
- Unscrew the screws (1) and remove the heat exchanger (4);
- unscrew the screws (2) and remove the water line (3).

Figure 15



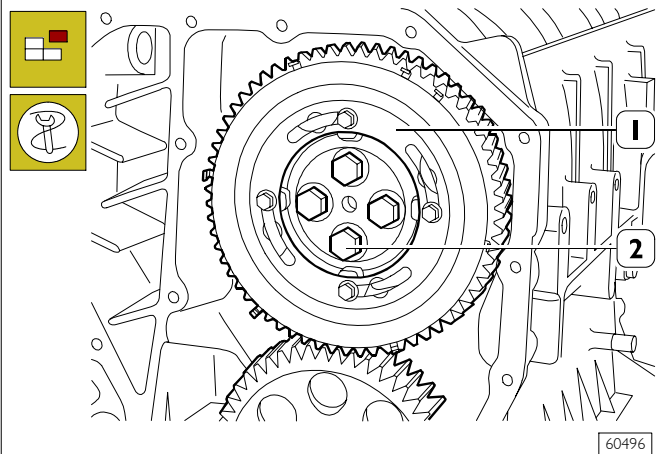
Disassemble the following parts: fuel filter support (1); fuel pump (2); engine start button support (4); PWV valve air filter (5); inlet manifold (6) complete with engine pre-heating resistor.

Figure 16



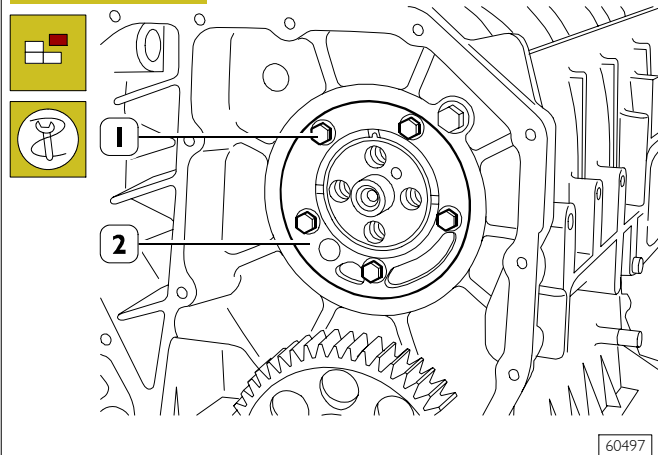
- Remove the rocker arm cover (1), take off the screws (2) and remove: the cover (3), the filter (5) and the gaskets (4 and 6).
- Take off the screws (8) and remove the blow-by case (7).

Figure 17



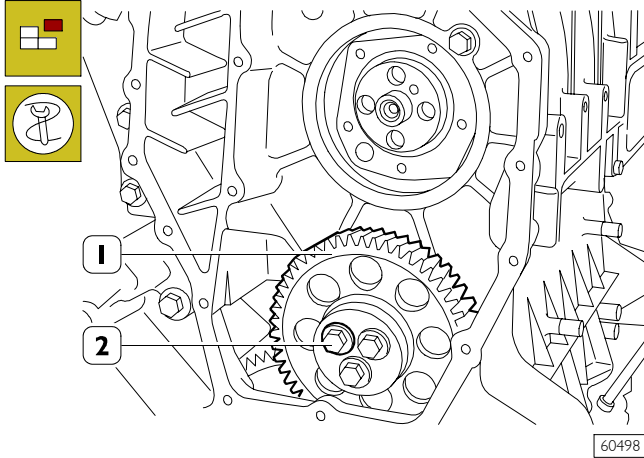
- Unscrew the screws (2) and remove the gear (1) fitted with phonic wheel.

Figure 18



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

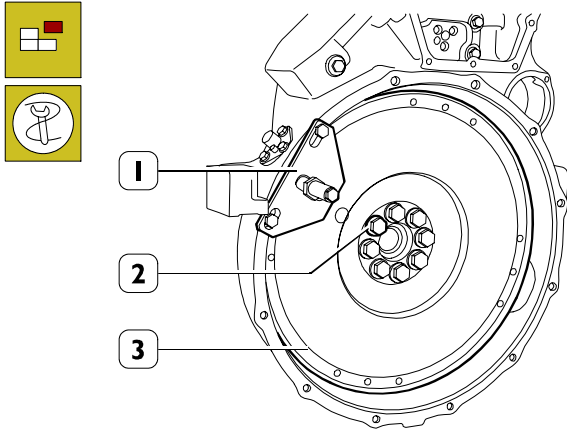
Figure 19



60498

Unscrew the screws (2) and remove the transmission gear (1).

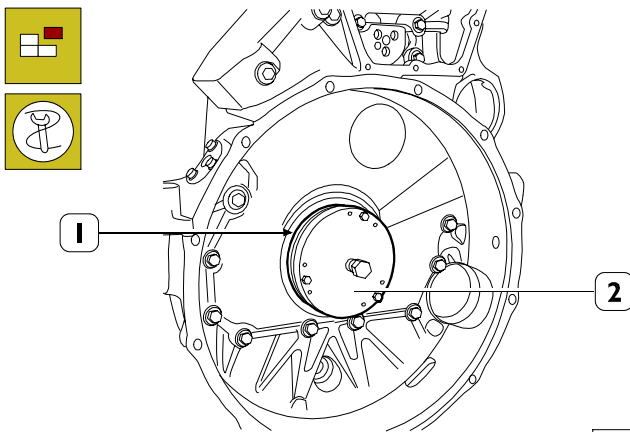
Figure 20



60499

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

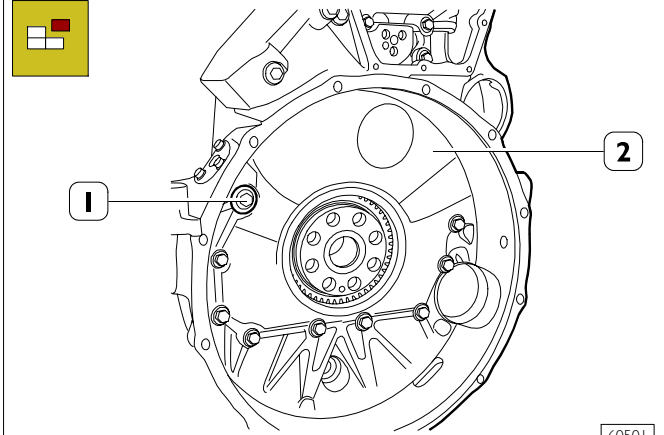
Figure 21



60500

Apply the extractor 99340054 (2) and pull out the seal gasket (1).

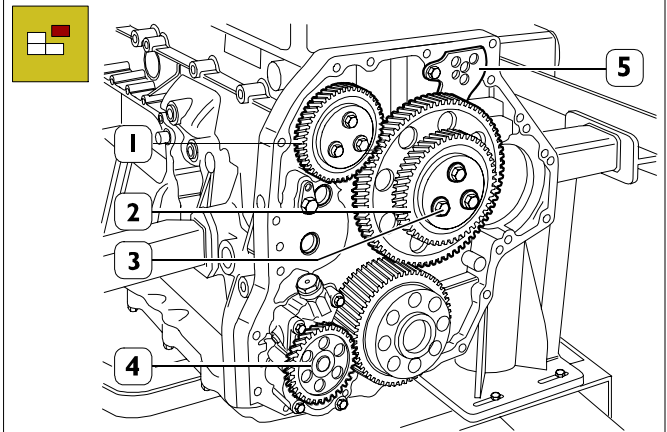
Figure 22



60501

Unscrew the screws (1) and take down the gearbox (2).

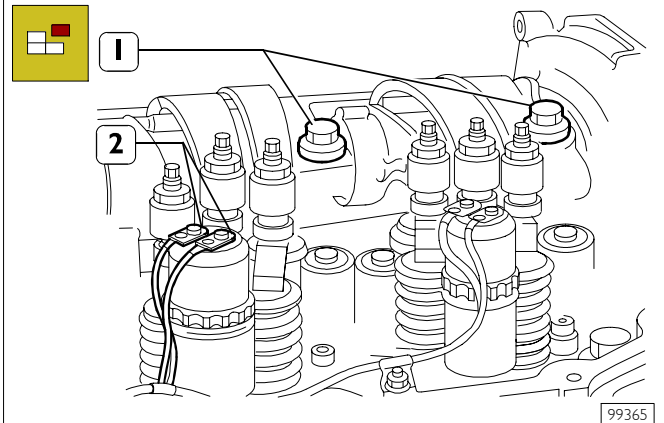
Figure 23



106219

Remove screws (3) and dismount double gear (2). Remove securing screw and dismount articulated rod (5). Dismount oil pump (4).

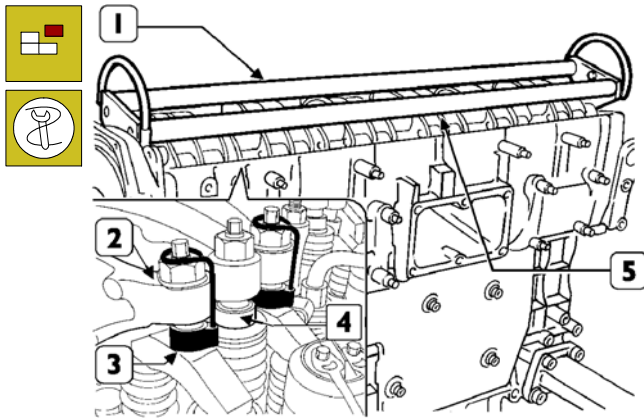
Figure 24



99365

- To release lever stop springs.
- Loosen the screws, then remove electric connections (1) from the pump injector solenoid valves.
- Unscrew the screws (2) fixing the rocker arm shaft.

Figure 25

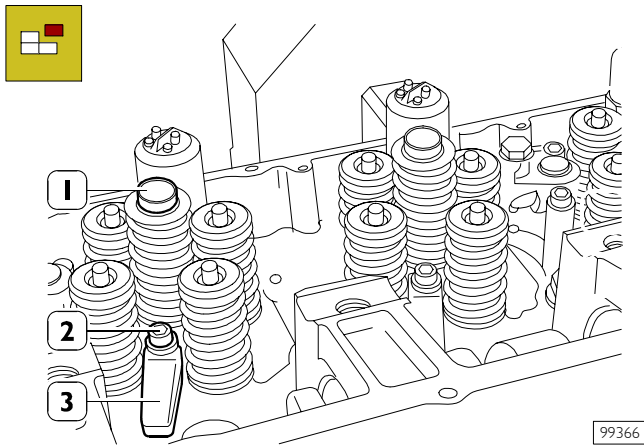


73533

Using tool 99360144 (3), constrain the blocks (4) to the rockers (2).

Apply tool 99360553 (1) to the rocker holder shaft (5) and remove the shaft (5) from the cylinder head.

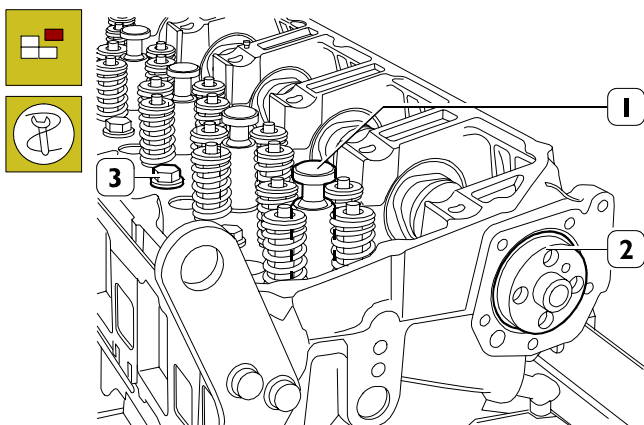
Figure 26



99366

Unscrew the screws (2) fixing the brackets (3) and remove the injectors (1).

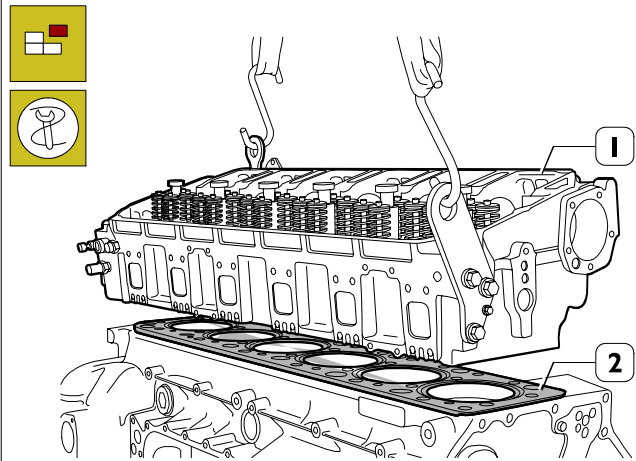
Figure 27



60514

- Fit the plugs 99360180 (1) instead of injectors.
- Remove the camshaft (2).
- Unscrew the fixing screws on the cylinder head (3).

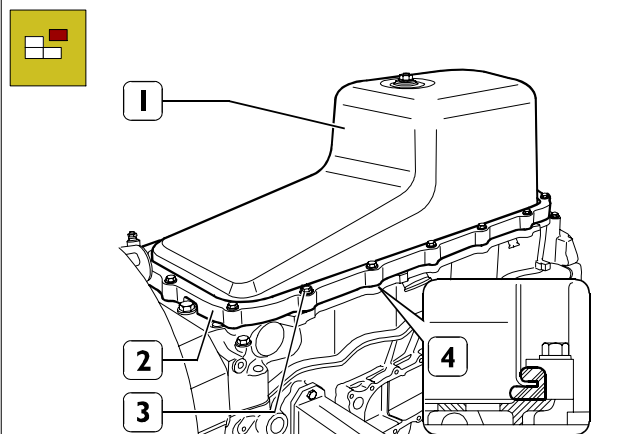
Figure 28



60515

- By means of metal ropes, lift the cylinder head (1).
- Remove the seal (2)

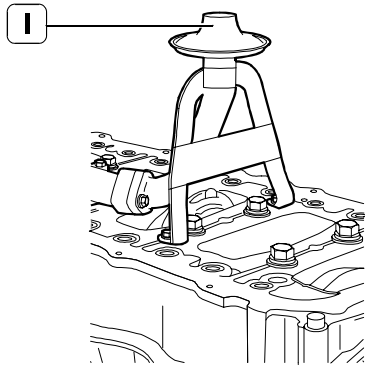
Figure 29



101606

Loosen screws (3), then remove sump (1) complete with spacer (2) and seal gasket (4).

Figure 30

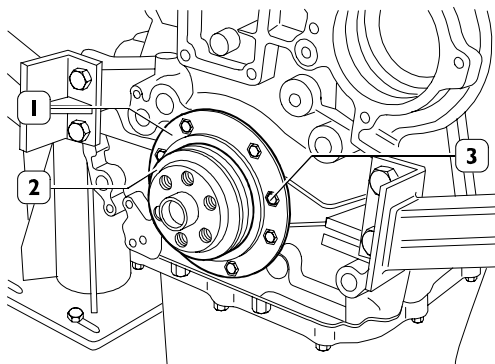


101607

Loosen the screws, then remove suction strainer (1).

ENGINE ASSEMBLY

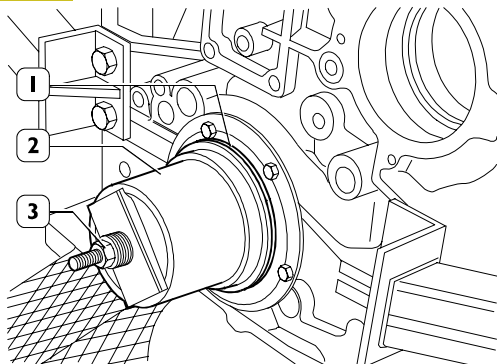
Figure 31



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).

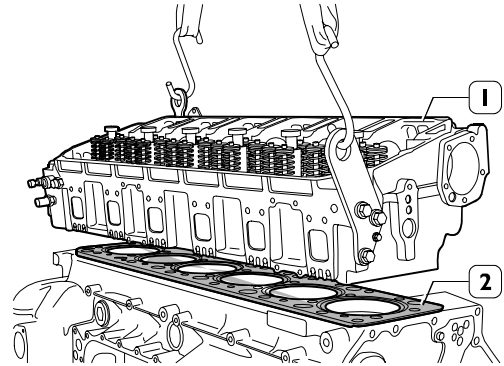
Figure 32



60564

Key on the gasket (1), mount the key 99346250 (2) and, screwing down the nut (3), drive in the gasket (1).

Figure 33

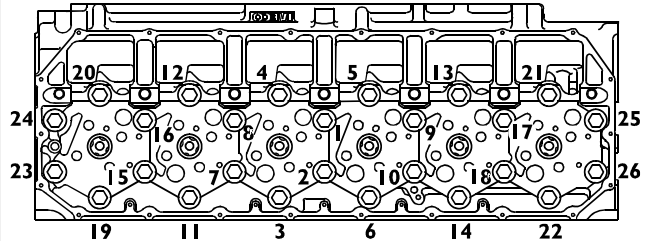


60515

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. 163 – 164 – 165.

NOTE Lubricate the thread of the screws with engine oil before assembly.

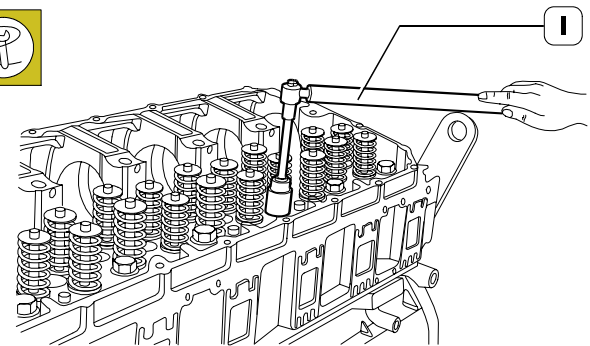
Figure 34



61270

Diagram of the tightening sequence of the screws fixing the cylinder head.

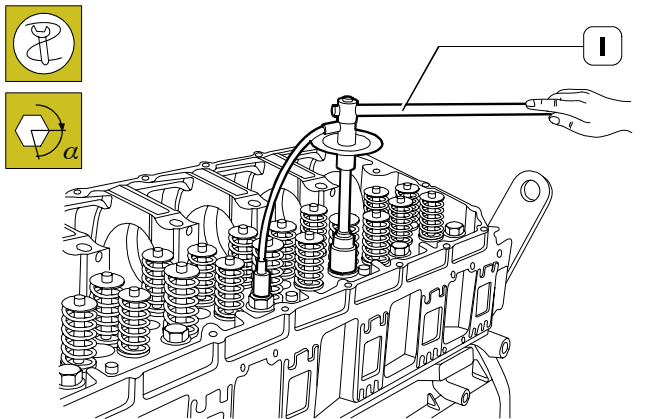
Figure 35



60565

Pre-tightening with the torque wrench (1):
 1st phase: 60 Nm (6 kgm).
 2nd phase: 120 Nm (12 kgm).

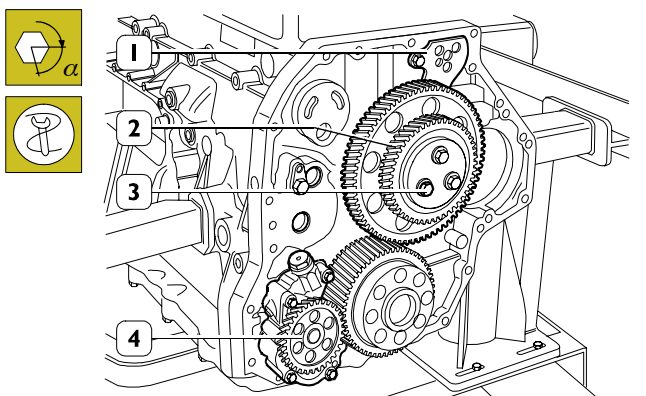
Figure 36



60566

□ Closing to angle with tool 99395216 (1):
 3rd phase: angle of 120°.
 4th phase: angle of 60°.

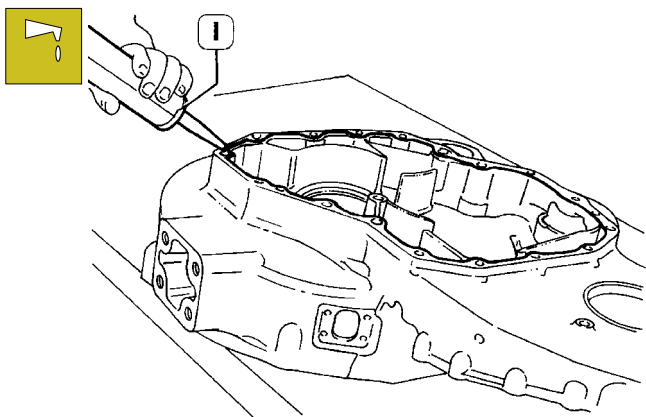
Figure 37



60567

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 38

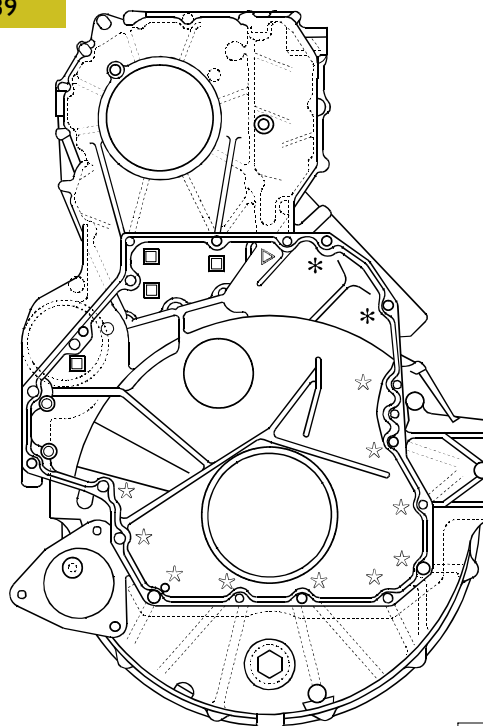


47592

Apply LOCTITE 5970 IVECO n° 2992644 silicone on the gear housing, using appropriate tools (1), as shown in the figure.
 The sealer string (1) diameter is to be $1,5 \pm \begin{matrix} 0.5 \\ 0.2 \end{matrix}$

NOTE Mount the gear housing within 10 min. of applying the sealant.

Figure 39

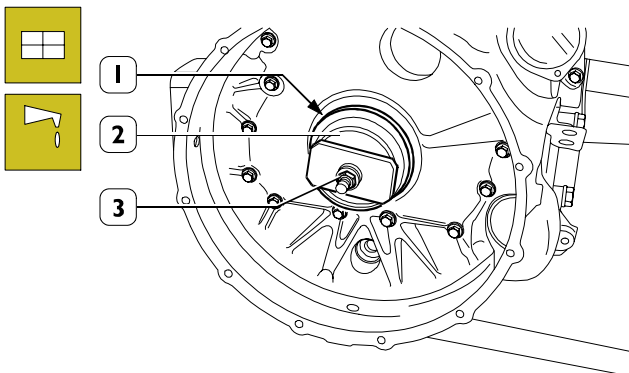


60633

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 40

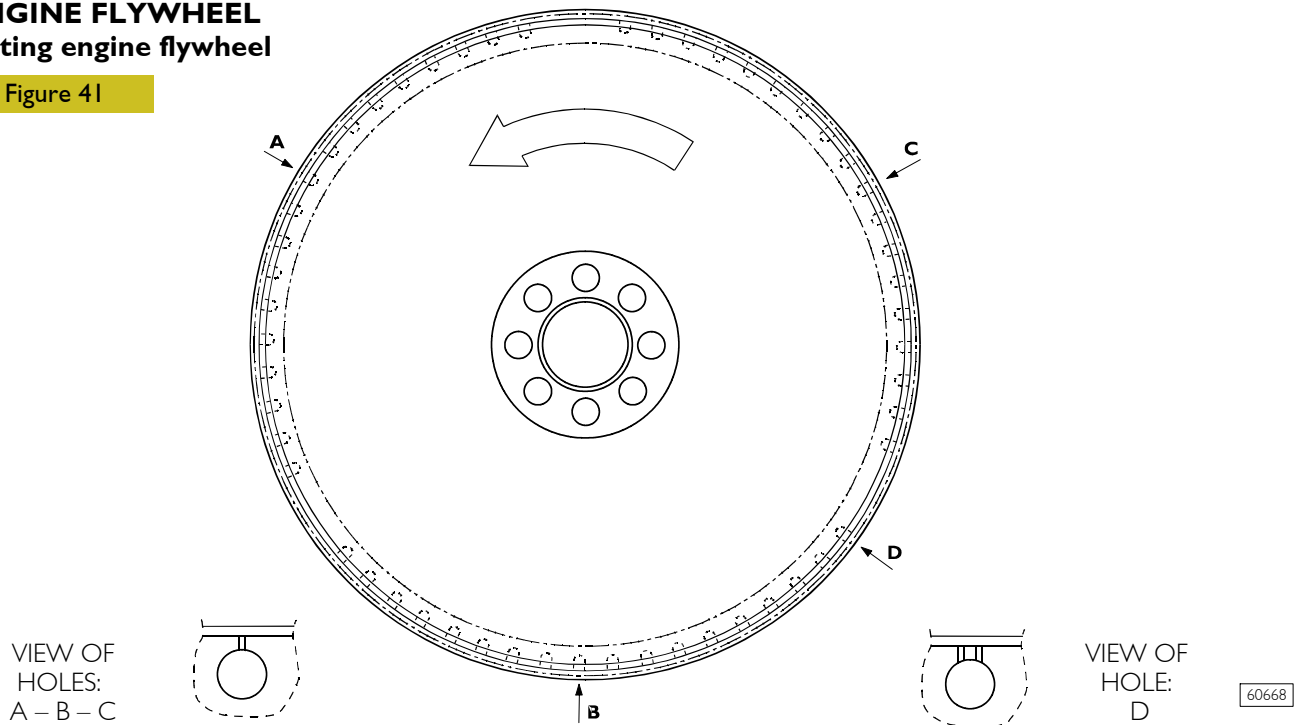


60568

Key on the gasket (1), mount the keying device 9934625 I (2) and, screwing down the nut (3), drive in the gasket.

ENGINE FLYWHEEL
Fitting engine flywheel

Figure 41



DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS

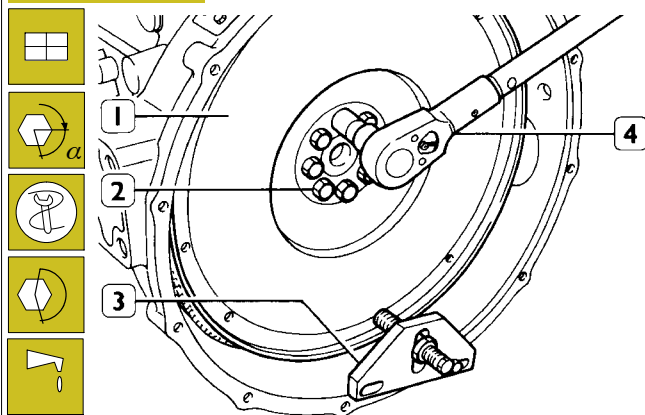
- A = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 3-4.
- B = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6.

- 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.

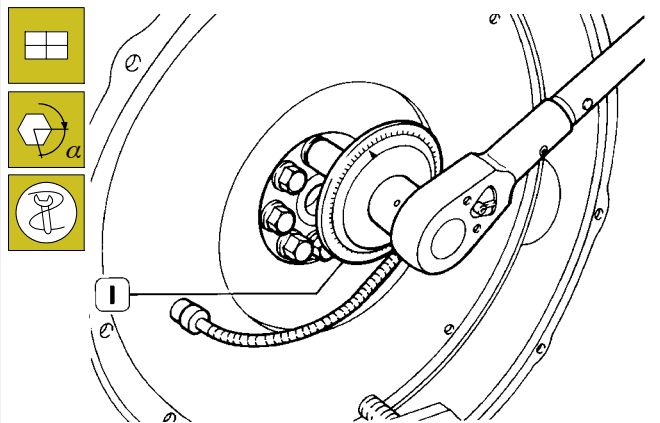
Position the flywheel (1) on the crankshaft, lubricate the thread of the screws (2) with engine oil and screw them down. Lock rotation with tool 99360351 (3). Lock the screws (2) in three phases.
 First phase: pre-tightening with torque wrench (4) to a torque of 120 Nm (12 kgm).

Figure 42



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

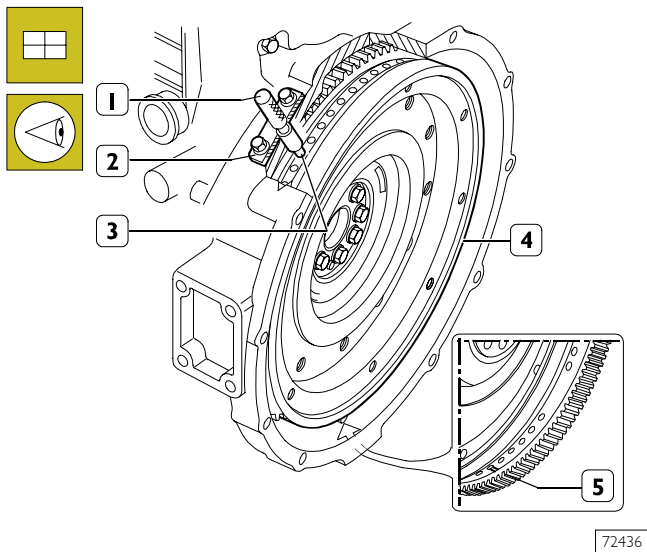
Figure 43



Second phase: 90° corner closing with tool 99395216 (1).

Fitting camshaft

Figure 44



Position the crankshaft with the pistons 1 and 6 at the top dead centre (T.D.C.).

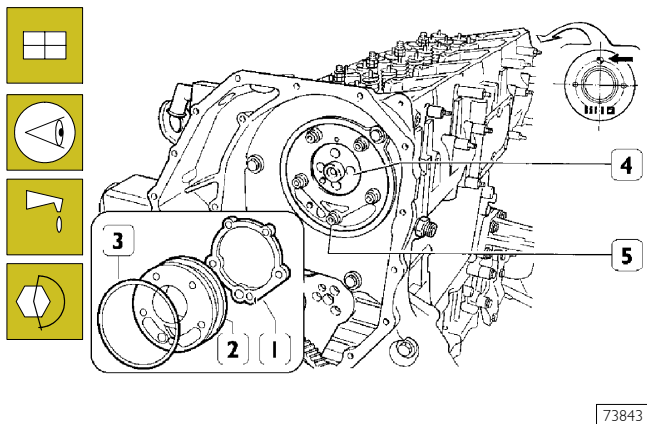
This situation occurs when:

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 45

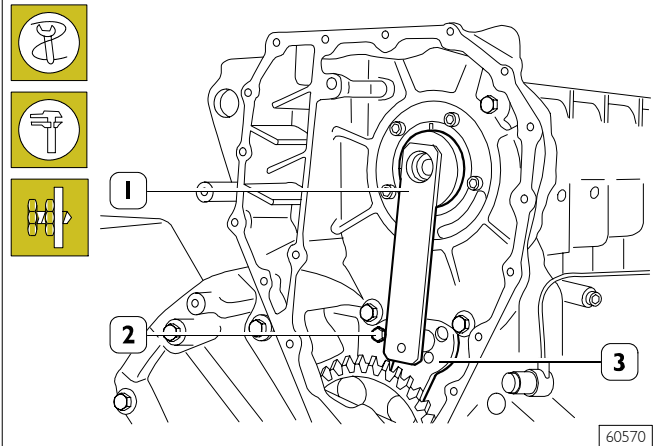


Fit the camshaft (4), positioning it observing the reference marks (→) as shown in the figure.

Lubricate the seal (3) and fit it on the shoulder plate (2).

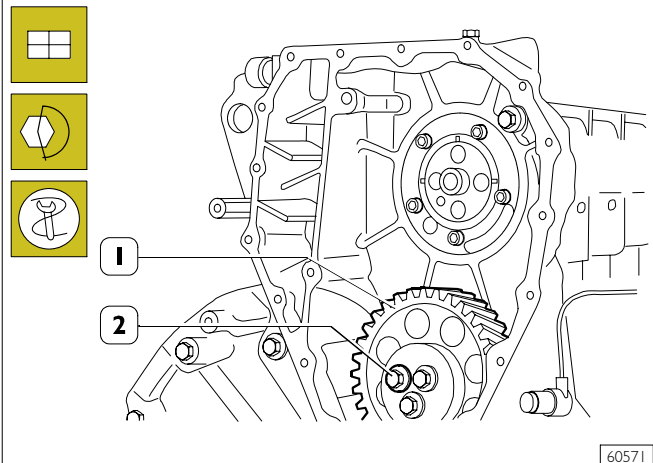
Mount the shoulder plate (2) with the sheet metal gasket (1) and tighten the screws (5) to the required torque.

Figure 46



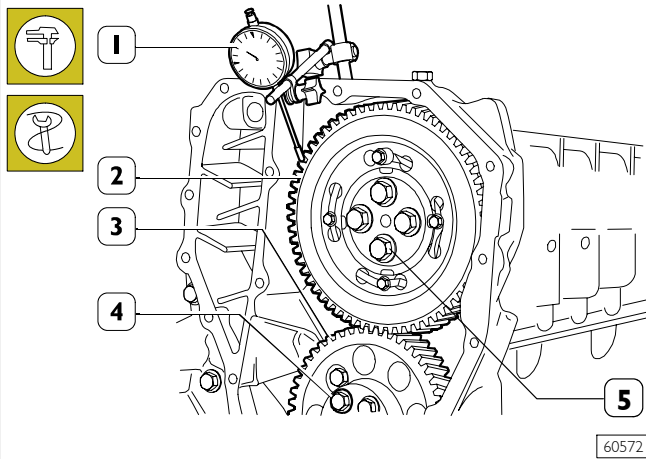
- Apply the gauge 99395219 (1). Check and adjust the position of the link rod (3) for the idle gear. Lock the screw (2) to the required torque.

Figure 47



- Fit the idle gear (1) back on and lock the screws (2) to the required torque.

Figure 48



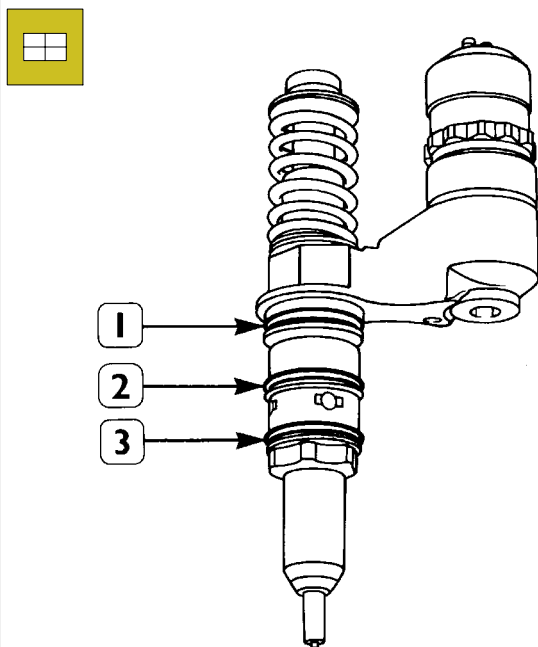
Position the gear (2) on the camshaft so that the 4 slots are centred with the holes for fixing the camshaft, without fully locking the screws (5).

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 46) fixing the link rod. Shift the link rod (3, Figure 46) to obtain the required clearance.
- Lock the screw (2, Figure 46) fixing the link rod and screws (4, Figure 48) fixing the idle gear to the required torque.

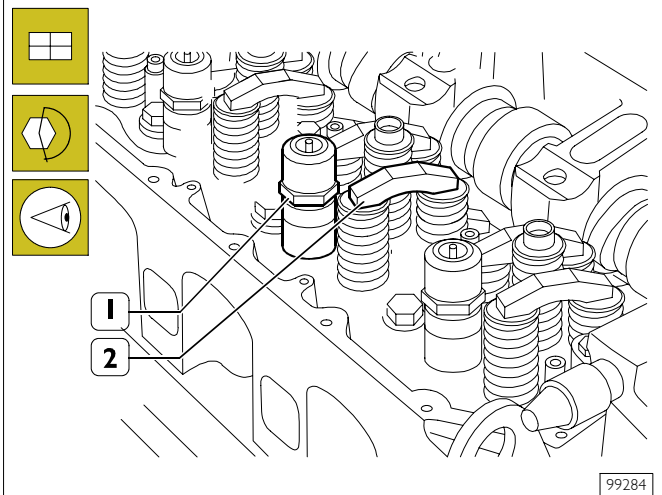
Fitting pump-injectors

Figure 49



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

Figure 50



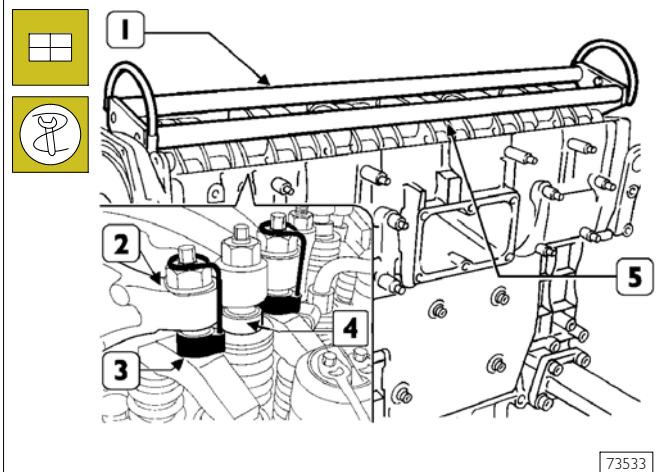
Mount:

- The injectors (1) and, using a torque wrench, lock the bracket fixing screws to a torque of 26 Nm.
- The crosspieces (2) on the valve stem, all with the largest hole on the same side.

Fitting rocker-arm shaft assembly

Figure 51

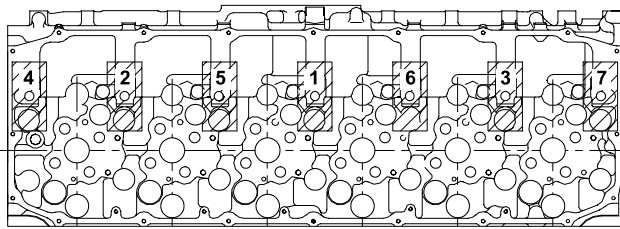
NOTE Before refitting the rocker-arm shaft assembly, make sure that all the adjustment screws have been fully unscrewed.



Using tool 99360144 (3), fasten the blocks (4) to the rocker arms (2).

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

Figure 52

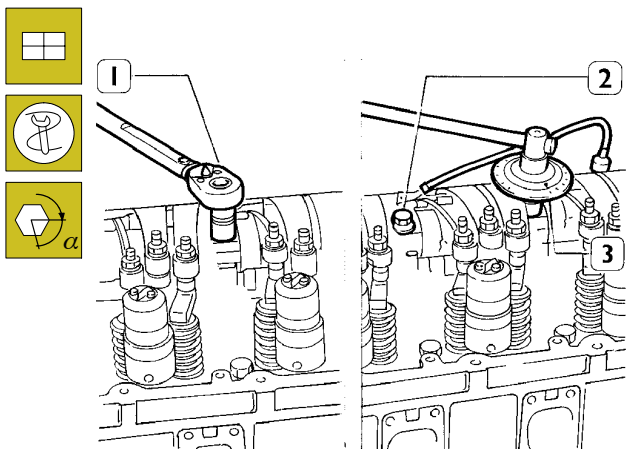


70567A

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 53

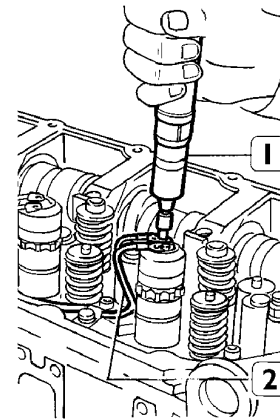


45261

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 54

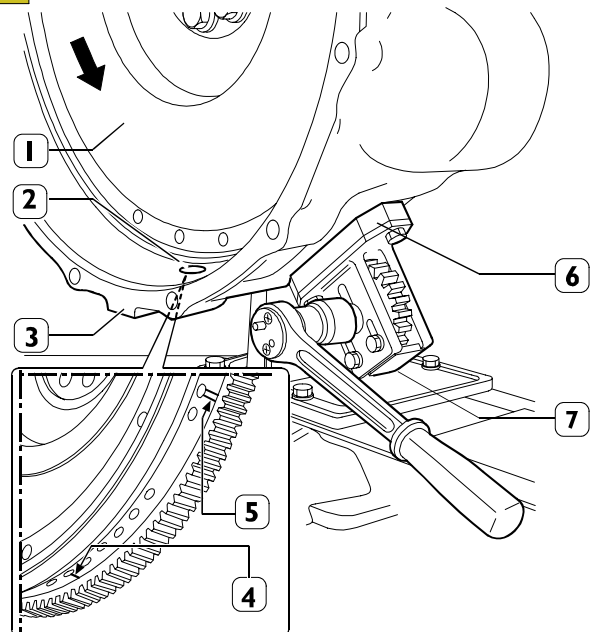


71777

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 55



71776

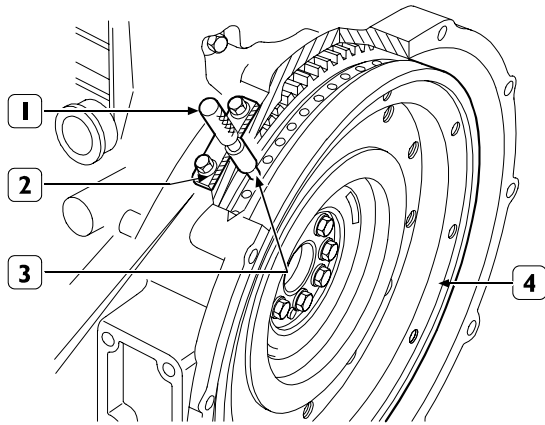
Apply the tool 99360321 (7) and the spacer 99360325 (6) to the gearbox (3).

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 56



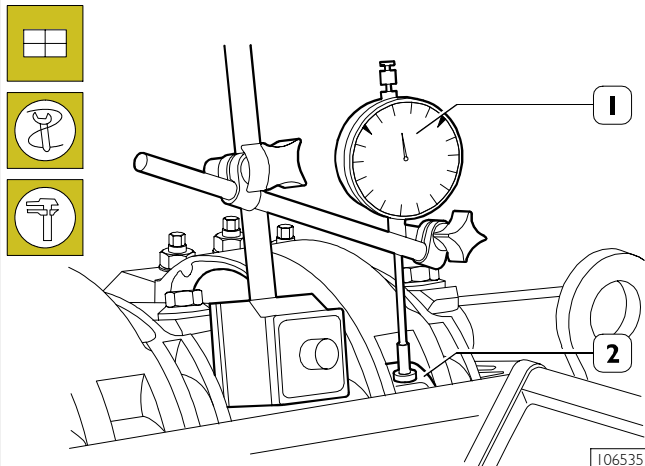
71774

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 57



106535

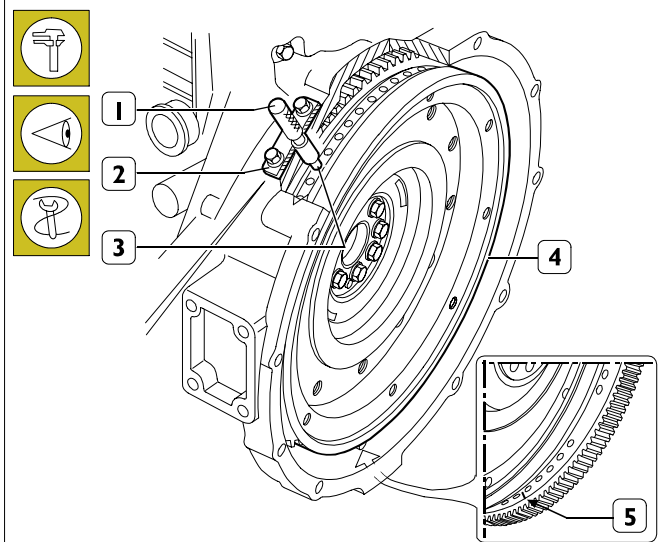
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

With tool 99360321 (7) Figure 54, 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 4.44 ± 0.05 mm.

Figure 58

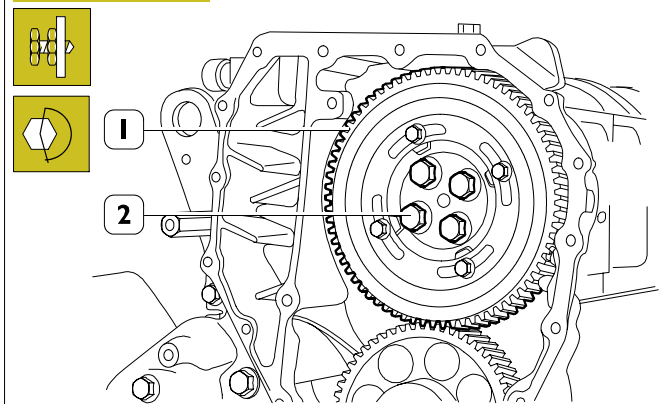


77259

The camshaft is in step if at the cam lift values of 4.44 ± 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 59



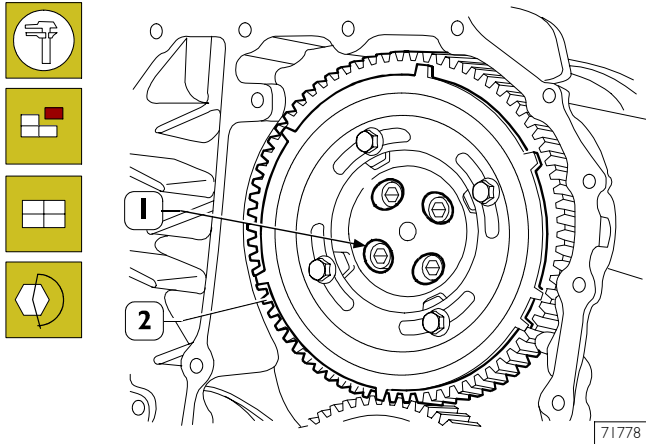
60575

If you do not obtain the conditions illustrated in Figure 58 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 60) on the gear (1);
- 2) turn the engine flywheel appropriately so as to bring about the conditions described in points 1 and 2 Figure 58, 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.

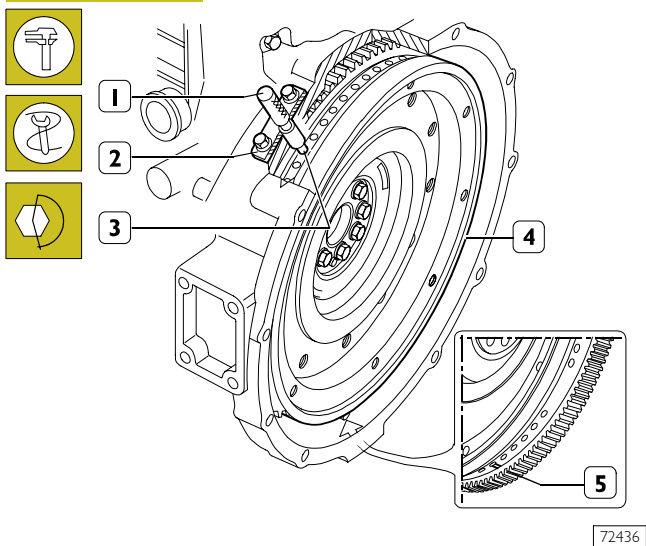
Figure 60



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 59) 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 4.44 ± 0.05 mm;
- 3) take out the screws (2, Figure 59) and remove the gear (1) from the camshaft.

Figure 61



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).

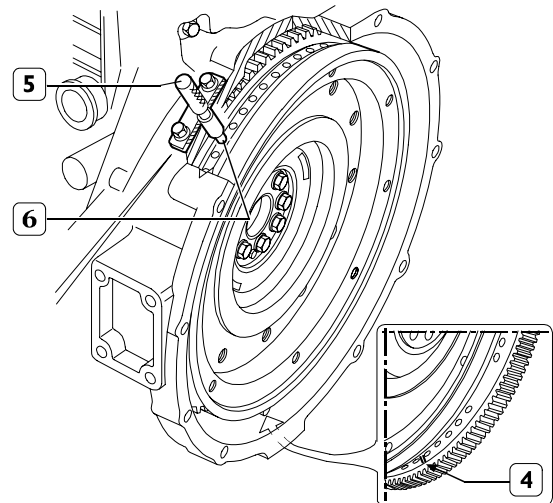
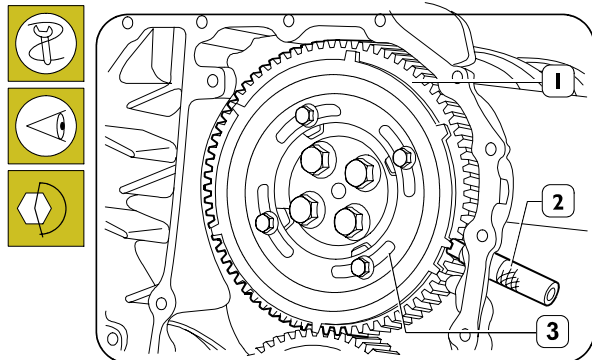
Mount the gear (2) Figure 60 with the 4 slots (1) centred with the fixing holes of the camshaft, locking the relevant screws to the required tightening torque.

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 4.44 ± 0.05 .

Check the timing conditions described in Figure 58.

Phonic wheel timing

Figure 62



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.

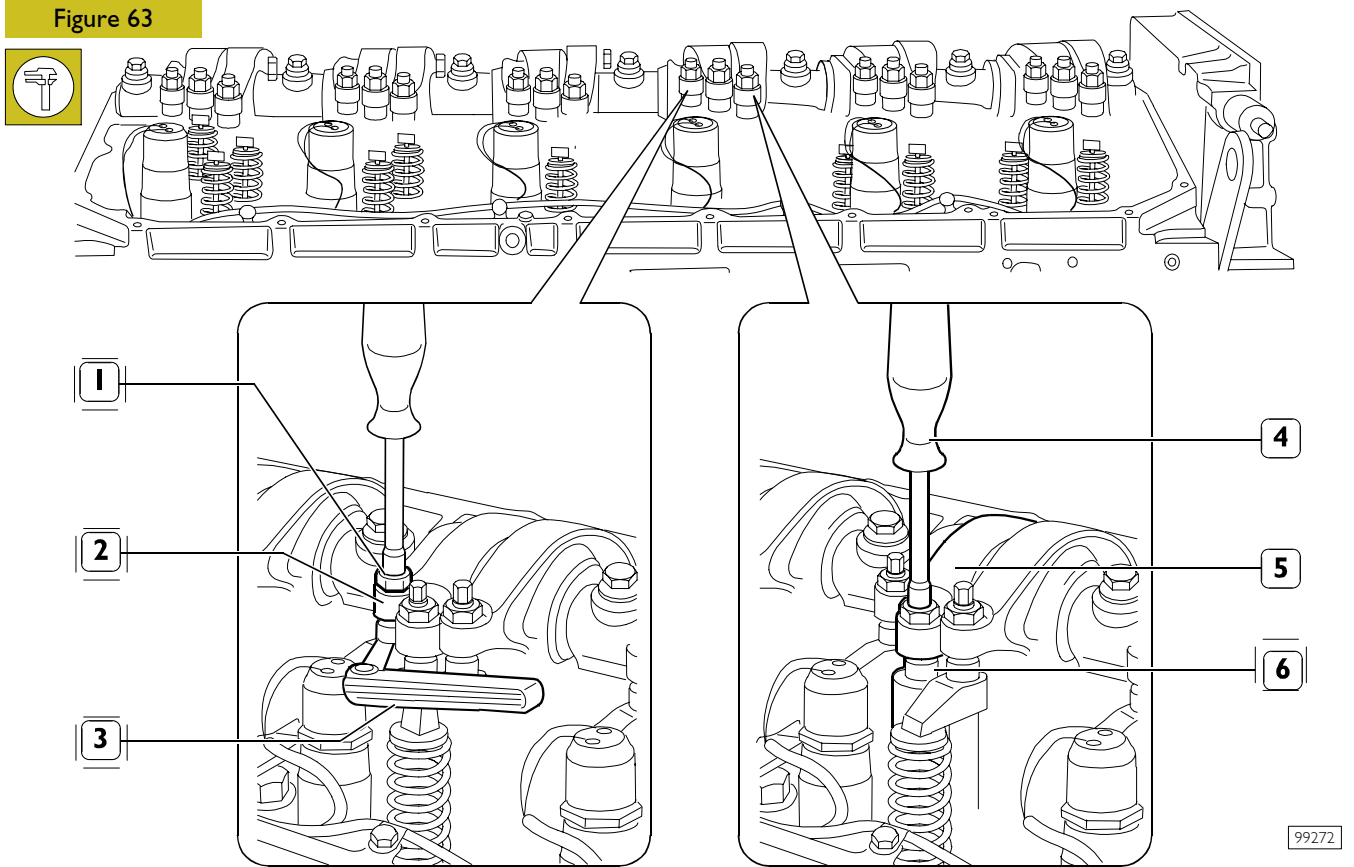
Again turn the flywheel in its normal direction of rotation until you see the hole marked with the double notch (4) through the inspection hole under the flywheel housing. Insert tool 99360612 (5) into the seat of the flywheel sensor (6).

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 63



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).
- Use a suitable wrench to screw the adjusting screw in or out as required.
- 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.

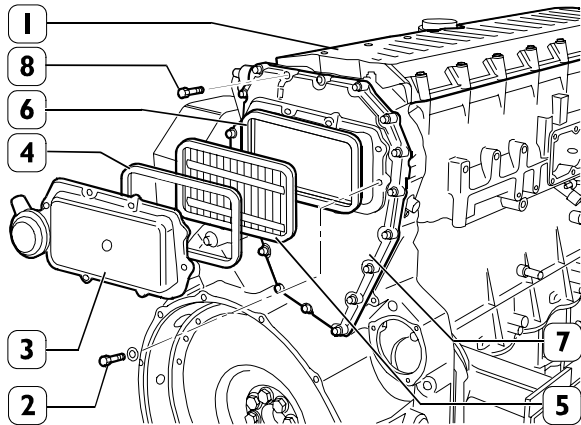
- Lock the adjusting screw to a torque of 5 Nm (0.5 kgm) by means of a torque wrench.
- Back off the adjusting screw 1/2 to 3/4 turn.
- Tighten the lock nut.

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 64



85480

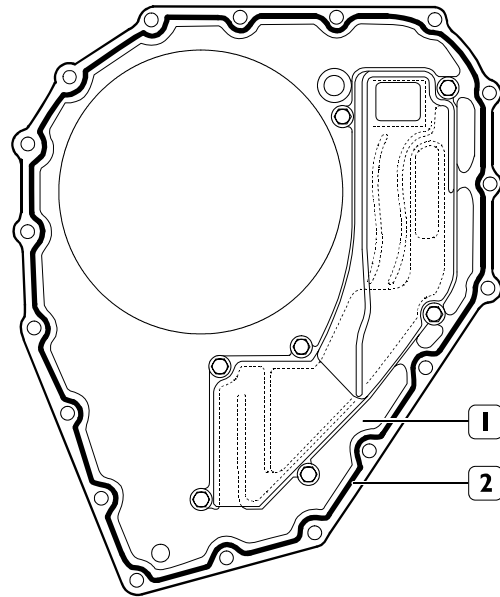
Fit the distribution cover (1).
Fit the blow-by case (7) and its gasket and then tighten the screws (8) to the prescribed torque.
Install the filter (5) and the gaskets (4 and 6).

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 n° 2992644 on the blow-by case (7) surface of engines fitted with P.T.O. according to the procedure described in the following figure.

Figure 65



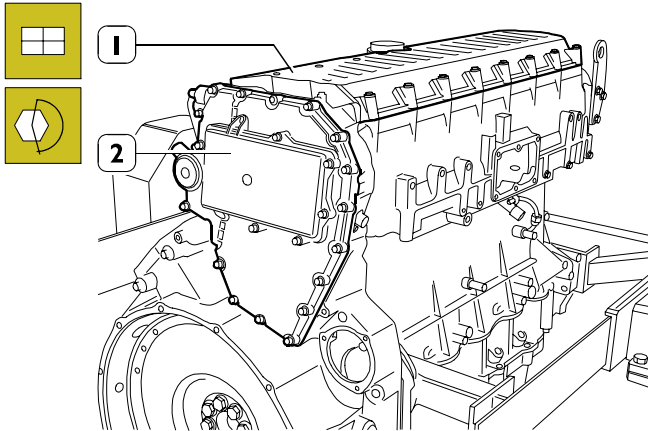
85481

Apply silicone LOCTITE 5970 IVECO No. 2992644 on the blow-by case and form a string (2) of $\varnothing 1,5 \pm_{0,2}^{0,5}$ as shown in the figure.

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

ENGINE COMPLETION

Figure 66

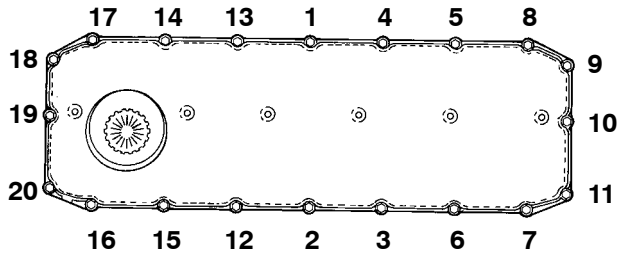


99368

Fit valve rocker arm cover (1) to the specified torque, by following the tightening sequence indicated in Figure 67.

Fit the suction strainer (1) and tighten the fixing screws to the prescribed torque.

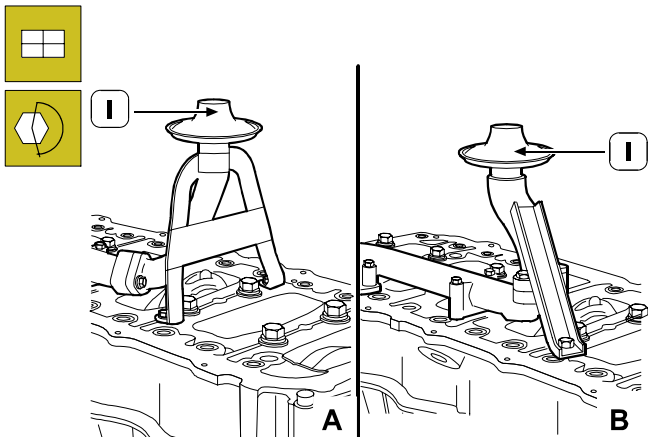
Figure 67



45363

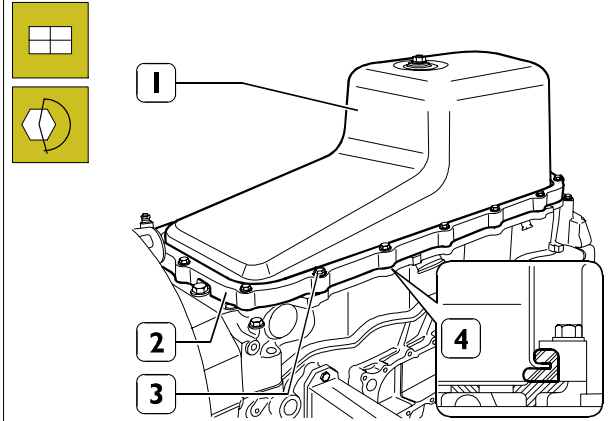
DIAGRAM OF ROCKER ARM CAP FIXING SCREWS TIGHTENING SEQUENCE

Figure 68



81872

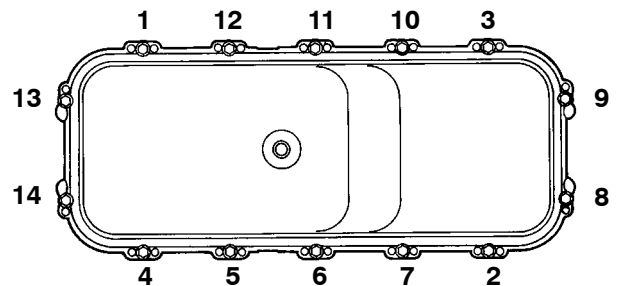
Figure 69



101606

Place gasket (4) on oil sump (1), position spacer (2) and fit the sump onto the engine base by tightening screws (3) to the specified torque, by complying with the tightening sequence indicated in Figure 70.

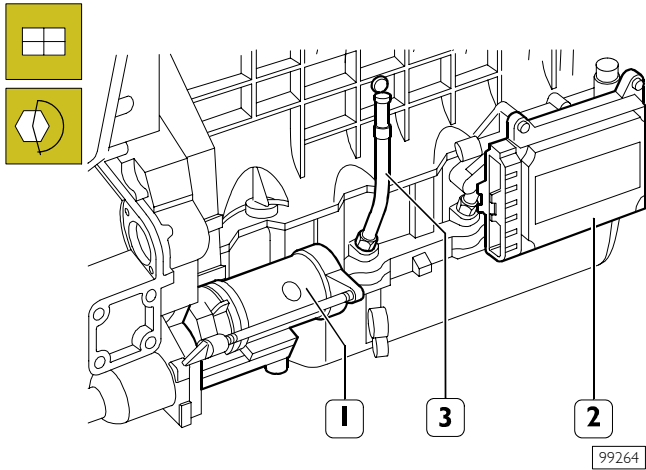
Figure 70



45362

DIAGRAM OF ENGINE OIL SUMP FIXING SCREWS TIGHTENING SEQUENCE

Figure 71

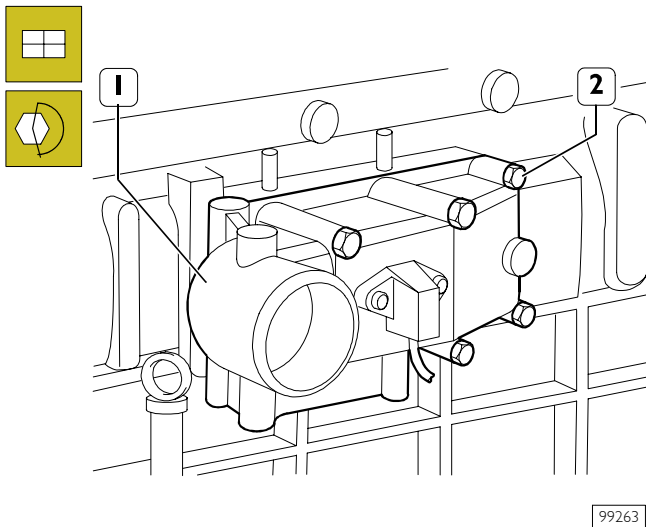


Tightening the fixing screws to the prescribed torque, mount:

- the starter motor (1);
- the control unit (2) and its support;
- the oil dipstick (3) in the crankcase.

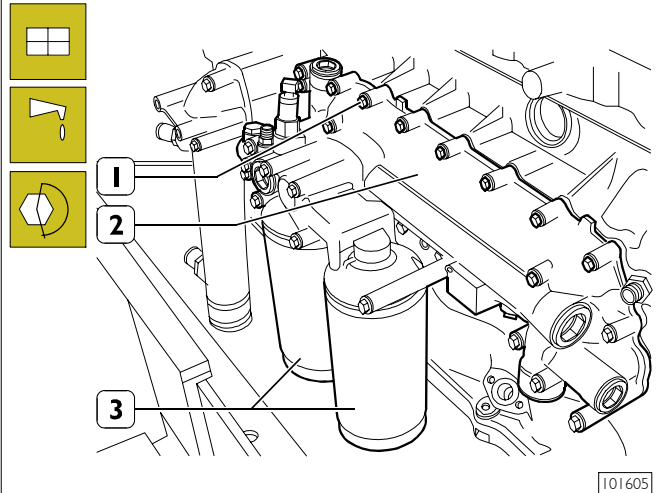
NOTE Check the state of the flexible elements of the control unit support and change them if they have deteriorated.

Figure 72



Fit the intake manifold (1) and tighten the fixing screws (2) to the prescribed torque.

Figure 73

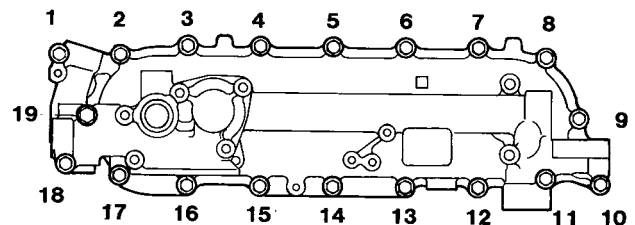


Fit heat exchanger (2) with its respective gasket, then tighten fastening screws (1) to the torque specified and according to the sequence indicated in Figure 74.

Fit the oil filters (1) on the relevant supports as follows:

- oil the seals;
- screw the filters down for the seals to make contact with the supporting bases;
- tighten the filters to a torque of 35 to 40 Nm.

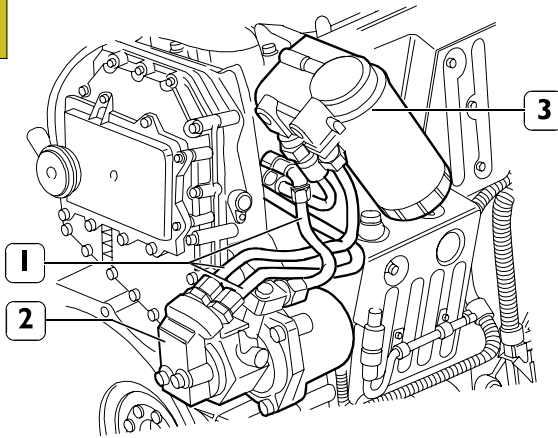
Figure 74



455361

DIAGRAM OF HEAT EXCHANGER FIXING SCREWS TIGHTENING SEQUENCE

Figure 75

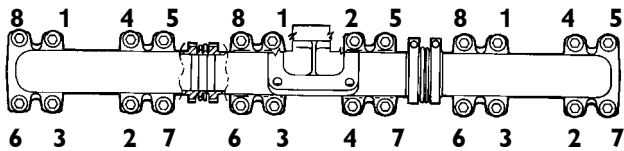


99273

Fit, with the respective gaskets.

- the fuel pump (2);
- fuel filter unit (3) with its respective pipes (1);
- connect the pipes (1) to the fuel pump (2).

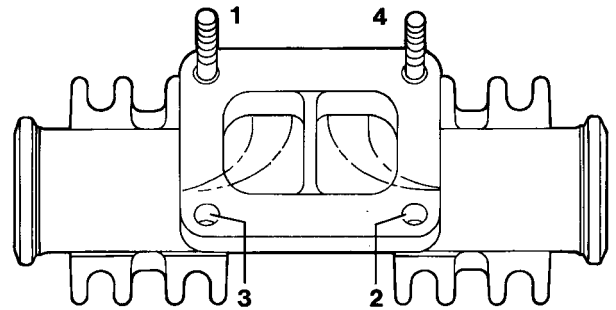
Figure 76



45359

DIAGRAM OF EXHAUST MANIFOLD FIXING SCREWS TIGHTENING SEQUENCE

Figure 77

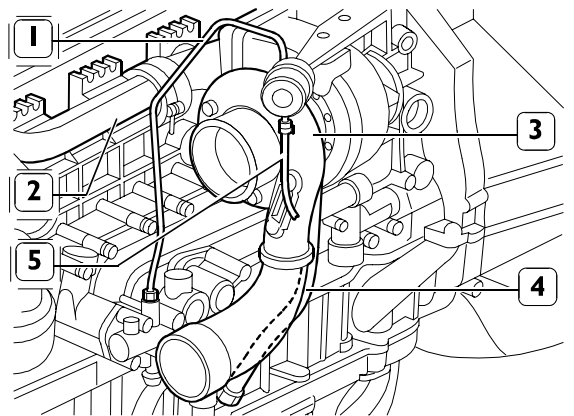


45360

DIAGRAM OF TURBOCHARGER FIXING SCREWS AND NUTS TIGHTENING SEQUENCE

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

Figure 78

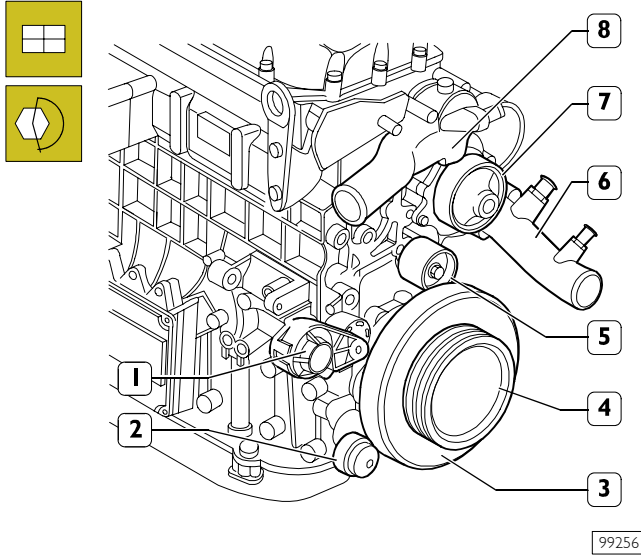


99274

Mount the following with new seals:

- exhaust manifold (2);
- turbocharger (3);
- oil pipe (1 and 4);
- pipe to the actuator (5).

Figure 79

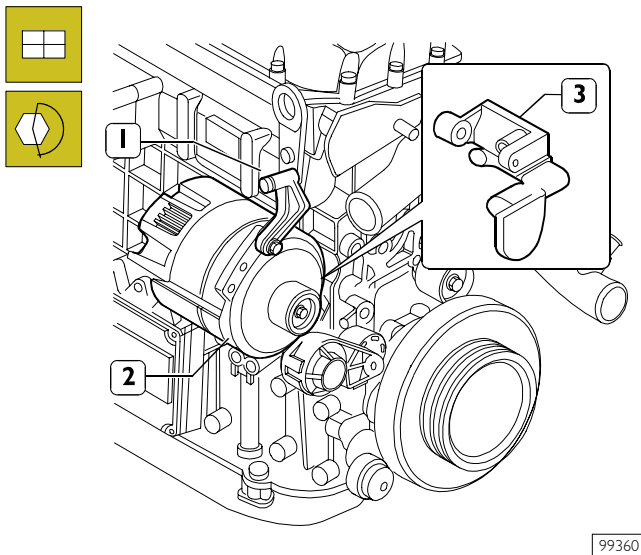


99256

Fit, with the following parts:

- automatic tightener support (1);
- automatic tightener (2);
- damper flywheel (3) and pulley beneath;
- fixed tightener (5);
- water pump (7);
- the pulley (4);
- pipe comprehensive of coolant (6);
- thermostat assembly (8).

Figure 80

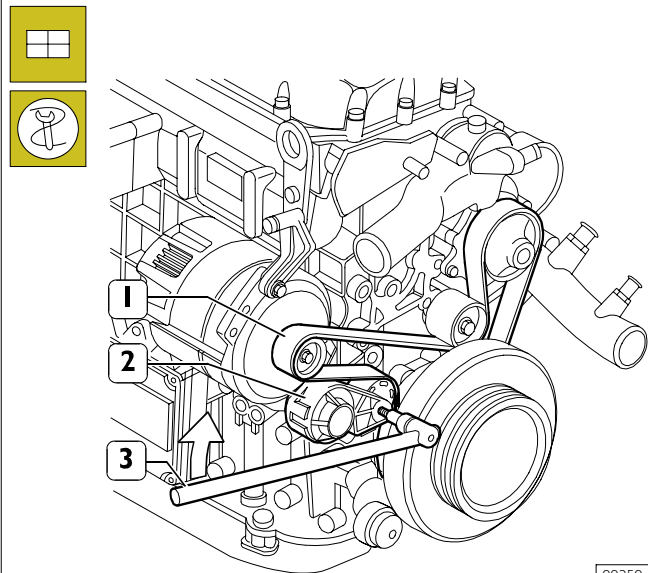


99360

Mount the following, tightening the screws to the prescribed torque:

- the supports (1 and 3);
- alternator (2).

Figure 81

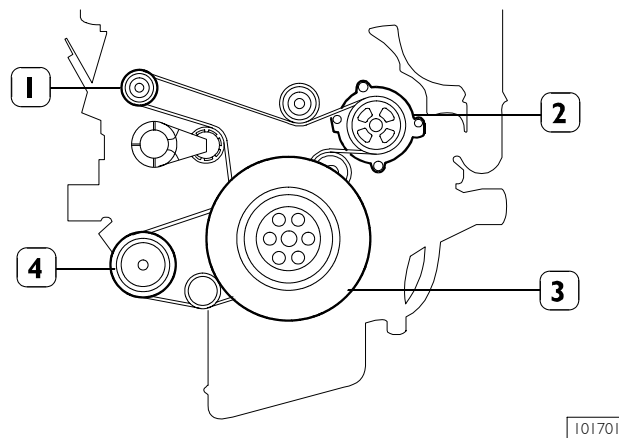


99359

Using a suitable tool (3), work in the direction of the arrow on the tightener (2) and mount the belt (1).

NOTE The tighteners are automatic, so there are no other adjustments after assembly.

Figure 82

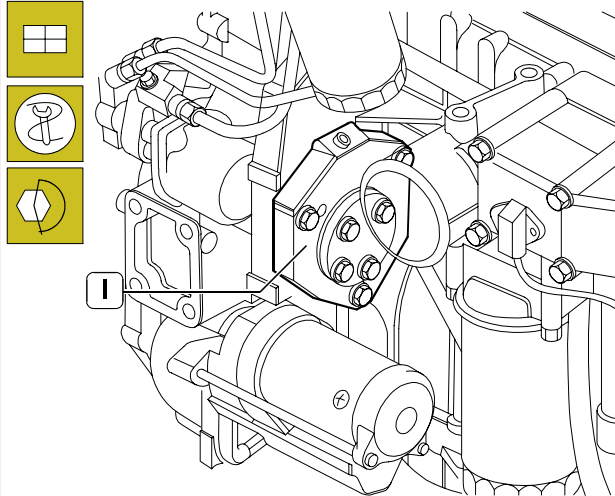


101701

DIAGRAM FOR FITTING BELT DRIVING FAN - WATER PUMP - ALTERNATOR

1. Alternator - 2. Water pump - 3. Crankshaft -
4. Compressor.

Figure 83



99254

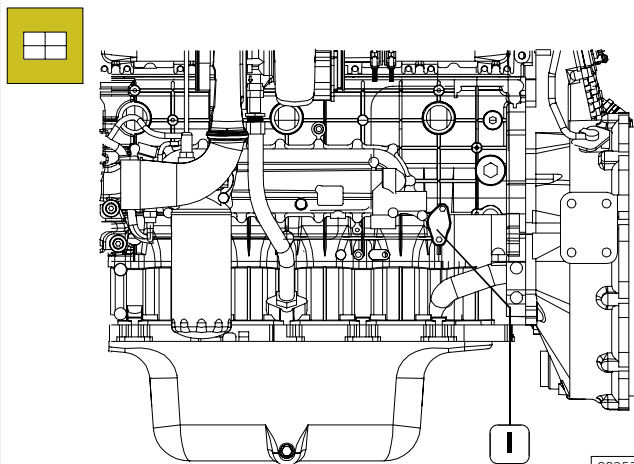
Fit the arm 99360585 onto the engine lifting hooks and hook the arm onto the hoist.

Take out the screws fixing the brackets 99361036 to the rotary stand. Lift the engine and remove the above-mentioned brackets from it.

Complete engine assembly with the following parts, tightening the fixing screws or nuts to the prescribed torque:

- mount the drive (1);
- mount the engine supports;

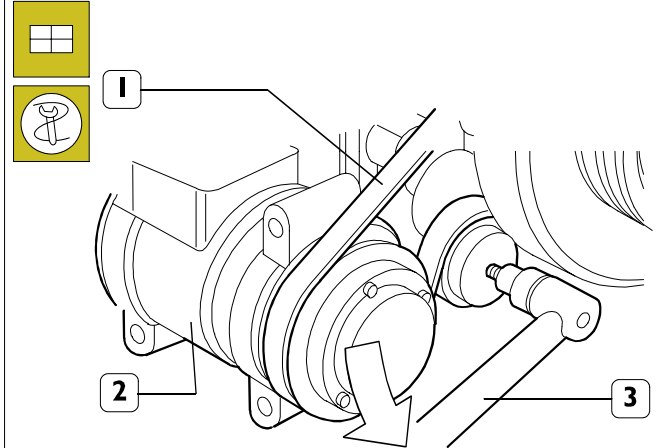
Figure 84



99253

- mount the oil pressure adjuster valve (1).

Figure 85



99357

Fit the engine support together with the air-conditioner compressor (2).

Using a suitable tool (3), work in the direction of the arrow and mount the belt (1).

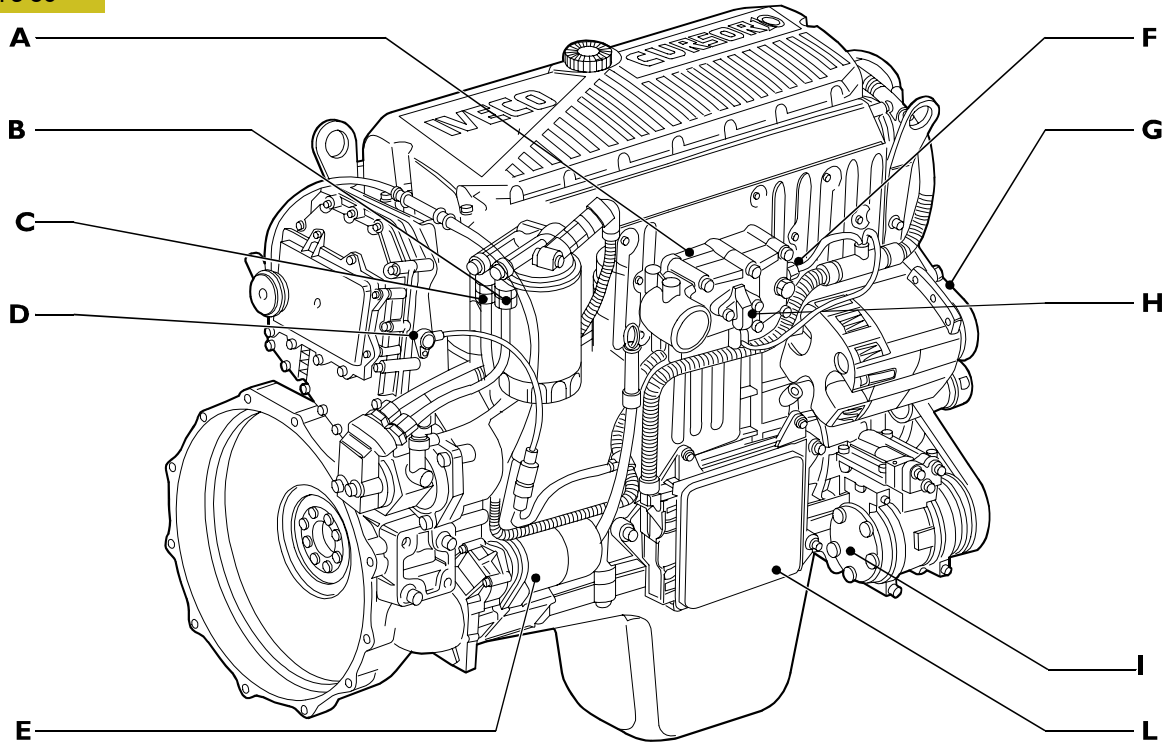
Connect the engine electric cable to the sensors and control unit.

Refill the engine with lubricating oil of the prescribed grade and quantity.

**PART TWO -
ELECTRICAL EQUIPMENT**

Components on the engine F3B

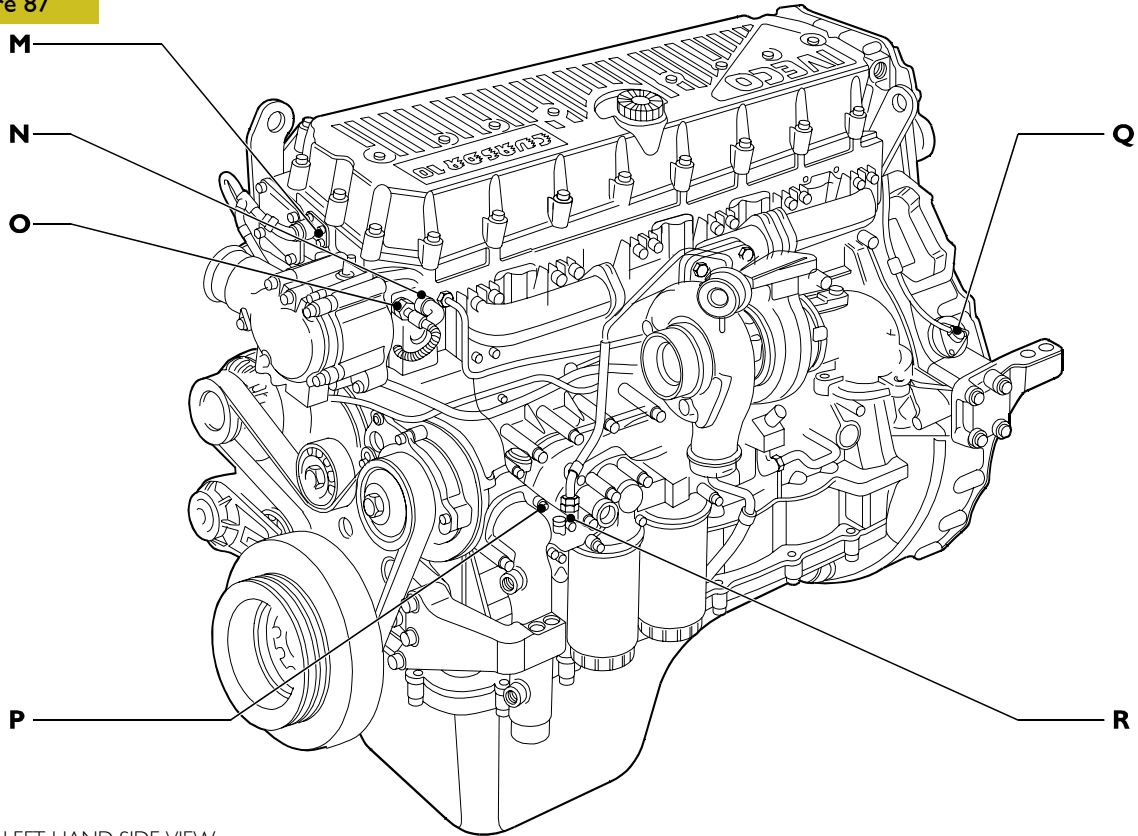
Figure 86



ENGINE RIGHT-HAND SIDE VIEW

99370

Figure 87



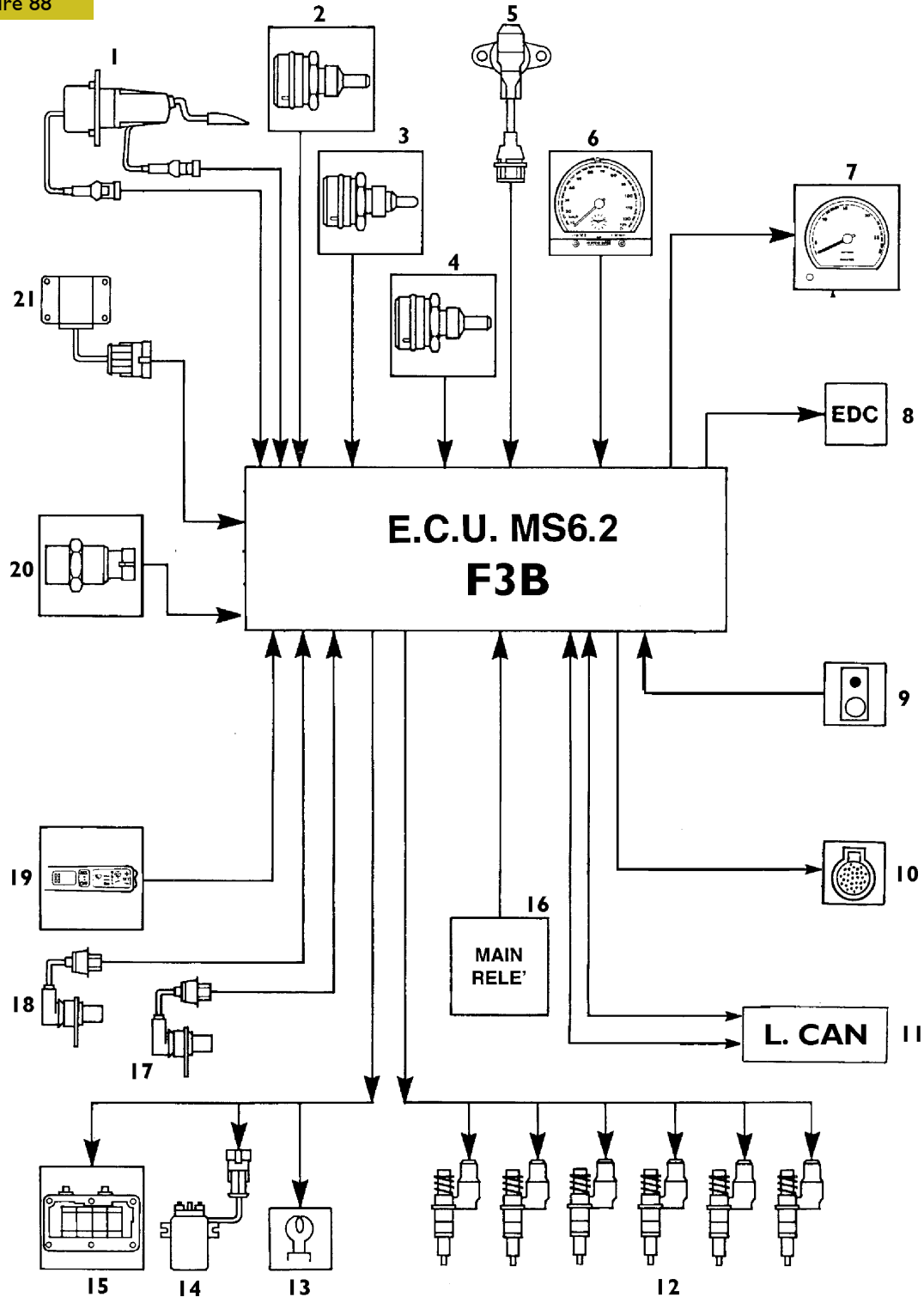
ENGINE LEFT-HAND SIDE VIEW

99371

- 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 88



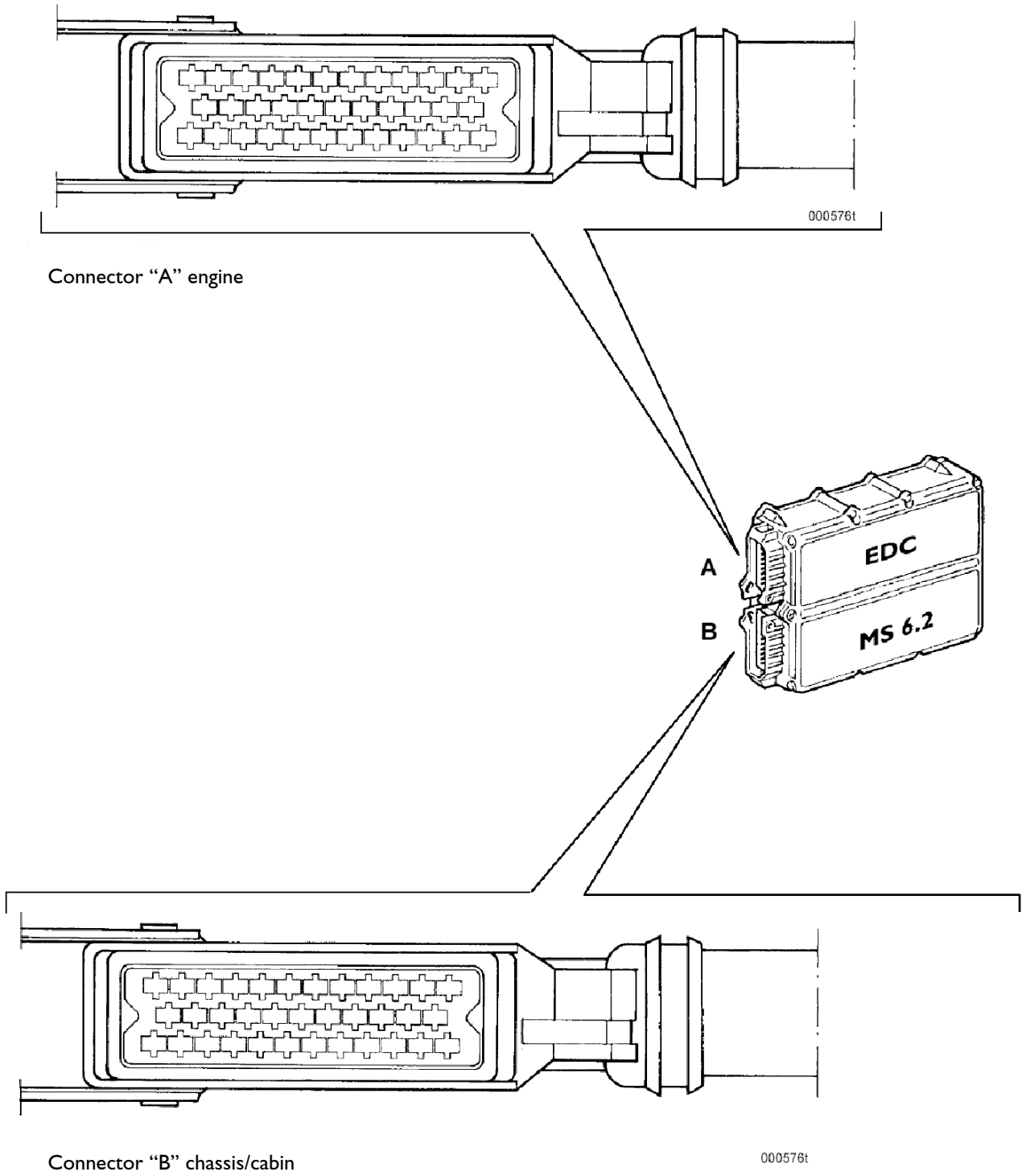
101609

KEYS

1. Accelerator pedal position sensor / switch accelerator depressed – 2. Engine coolant temperature sensor – 3. Oversupply air temperature sensor – 4. Fuel temperature sensor – 5. Oversupply air pressure sensor – 6. Input for electronic tachograph (if available) – 7. Output for electronic revs counter (if available) – 8. E.D.C. system failure warning light – 9. Blink-code button (if available) – 10. Diagnosis connector – 11. CAL L-H line – 12. Pump-injectors – 13. Warning light for pre/post-heating activated – 14. Remote control switch for pre/post-heating activation – 15. Pre/post-heating resistance – 16. Main remote control switch – 17. Flywheel sensor – 18. Distribution sensor – 19. Cruise Control buttons (if available) – 20. Clutch switch – 21. Primary / secondary brake switch.

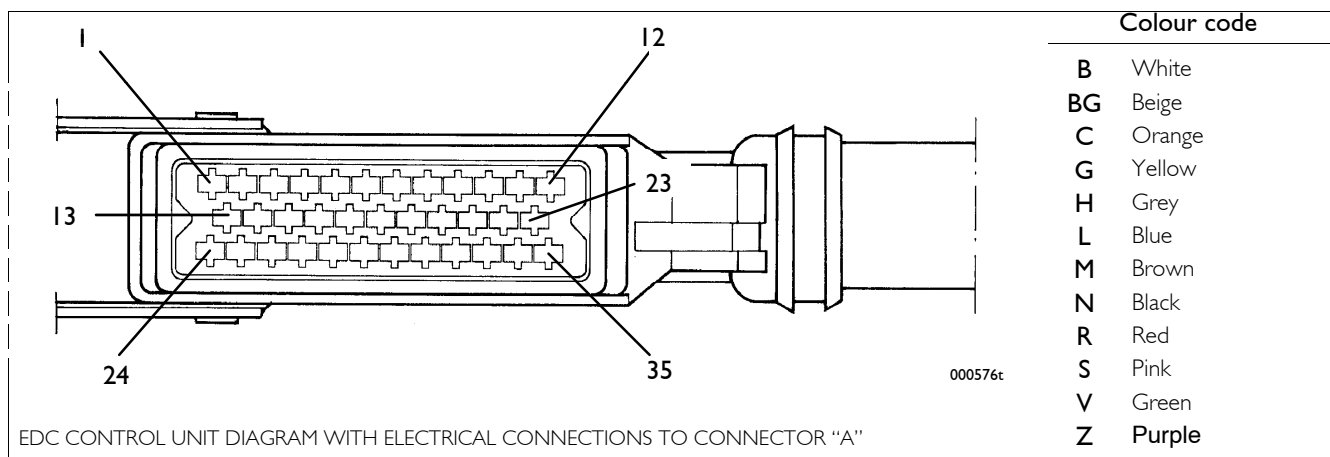
EDC MS 6.2 electronic control unit

Figure 89



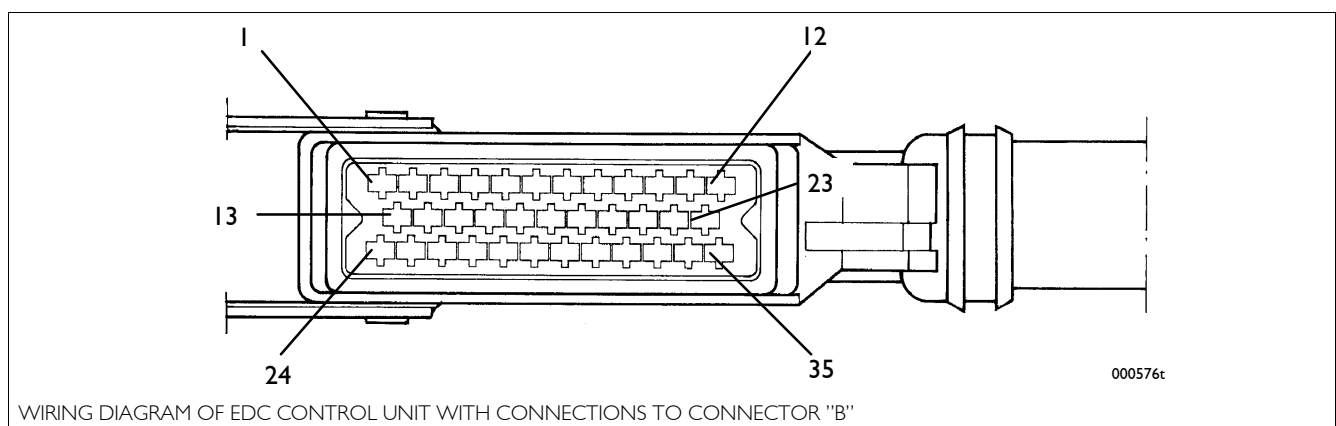
EDC control unit PIN-OUT**Connector "A" (Engine)**

Pin	Function
1 -	Engine rev sensor
2 -	Distribution rev sensor
3 -	---
4 -	Air temperature sensor mass
5 -	Engine coolant temperature sensor mass
6 -	Engine oil temperature and fuel temperature sensor ground
7 -	---
8 -	---
9 -	---
10 -	Engine oil temperature sensor signal
11 -	Fuel temperature sensor signal
12 -	Oversupply pressure sensor signal
13 -	Engine rev sensor
14 -	Distribution rev sensor
15 -	---
16 -	---
17 -	Boosting pressure sensor ground
18 -	---
19 -	---
20 -	---
21 -	Air temperature sensor signal
22 -	Engine coolant temperature sensor signal
23 -	Oversupply pressure sensor power supply
24 -	Injector power supply for cylinders 1 / 2 / 3
25 -	Injector power supply for cylinders 4 / 5 / 6
26 -	Cylinder 4 injector control
27 -	Cylinder 6 injector control
28 -	Cylinder 5 injector control
29 -	---
30 -	---
31 -	---
32 -	---
33 -	Cylinder 3 injector control
34 -	Cylinder 2 injector control
35 -	Cylinder 1 injector control

Figure 90

EDC control unit PIN-OUT**Connector "B" (Frame area)**

Pin	Functions
1 -	Negative direct from battery / blink button – code
2 -	Negative direct from battery / blink button – code
3 -	Positive from main remote switch
4 -	Positive from main remote switch
5 -	Signal for electronic rev. counter (if available)
6 -	Negative for EDC / blink button – code warning light (if available)
7 -	CAN line for Multiplex electric system architecture
8 -	---
9 -	Engine phase signal for diagnosis connector
10 -	Negative for pre-post heating remote switch engagement
11 -	CAN - L line for interconnection of the CAN line with control units (if any) available with the application
12 -	CAN - H line for interconnection of the CAN line with control units (if any) available with the application
13 -	K line for diagnosis connector
14 -	---
15 -	Key controlled supply positive
16 -	Accelerator pedal position sensor supply
17 -	Negative from idler switch
18 -	Negative for warning light pre – post heating
19 -	---
20 -	Positive from N.C. clutch switch (if available)
21 -	Function "RESUME" Cruise Control (if available)
22 -	Positive from speed reducer switch (if available)
23 -	Accelerator pedal position signal sensor
24 -	L line for diagnosis connector
25 -	Negative for accelerator pedal, multiple-state switch for torque reducer and negative for engine speed and vehicle speed sensors
26 -	Positive from primary N.C. brake switch
27 -	Negative for main remote switch
28 -	Signal from the multiple-state switch for the torque reducer (if available)
29 -	Vehicle speed (D3 tachograph) signal (if available)
30 -	PWM line
31 -	Positive from N.C. redundant brake switch
32 -	Function "SET –" Cruise Control (if available)
33 -	Function "OFF +" Cruise Control (if available)
34 -	Function "SET +" Cruise Control (if available)
35 -	Negative for accelerator pedal position sensor

Figure 91

PUMP INJECTOR

It consists mainly of:

- A) Solenoid valve
- B) Pumping element
- C) Nozzle

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

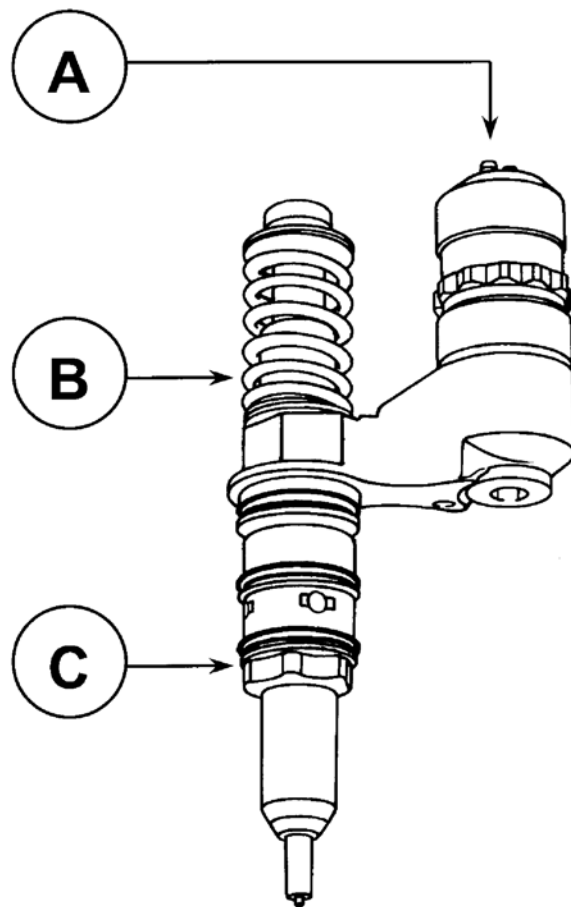
The pumping element, mechanically actuated at every rocker arm cycle, compresses the fuel container in the delivery chamber.

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 92



000578t

Pump-injector replacement



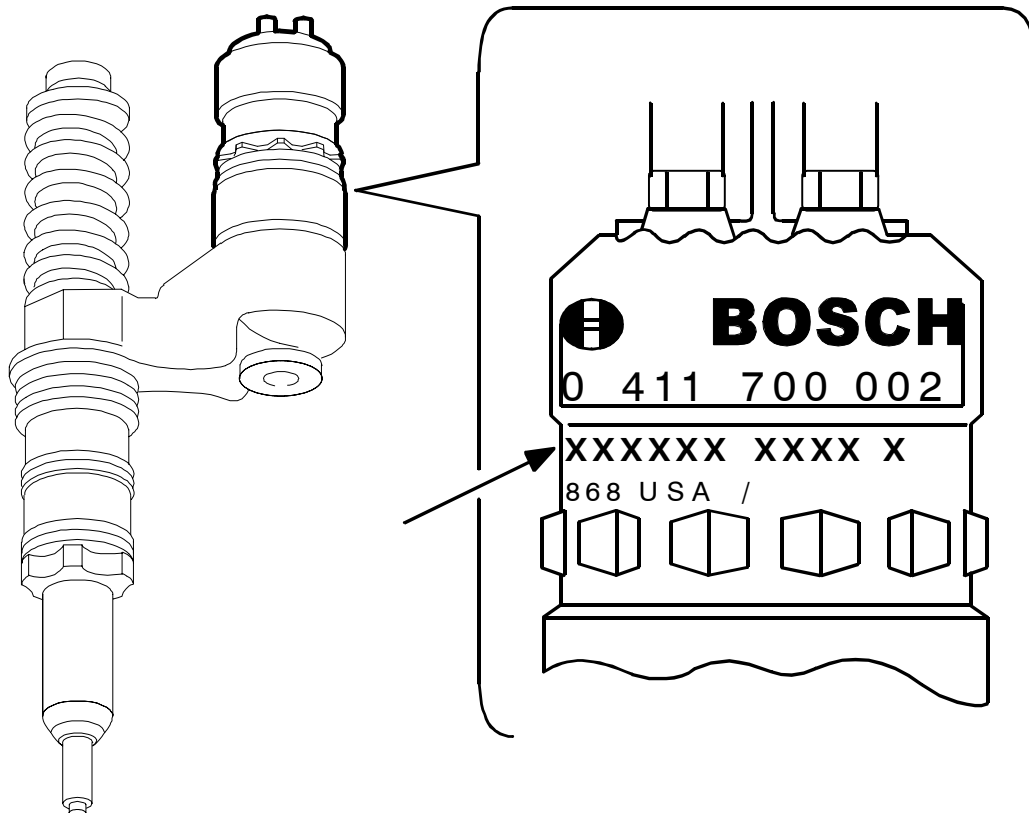
If the operation is carried out when the engine is on the vehicle, before removing the pump-injectors drain the fuel in the cylinder head pipes by releasing the delivery and return pipe unions on the cylinder head.

Connect to the diagnosis instrument for each replaced injector and, when required by the programme, enter the control unit re-programming code stamped on the injector.



In an emergency, when the Modus is not available, it is possible to replace 1 injector without the control unit recognition.

Figure 93



61487



When inspecting the rocker arm clearance, check also the pump-injector preload.

Engine coolant temperature sensor

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.

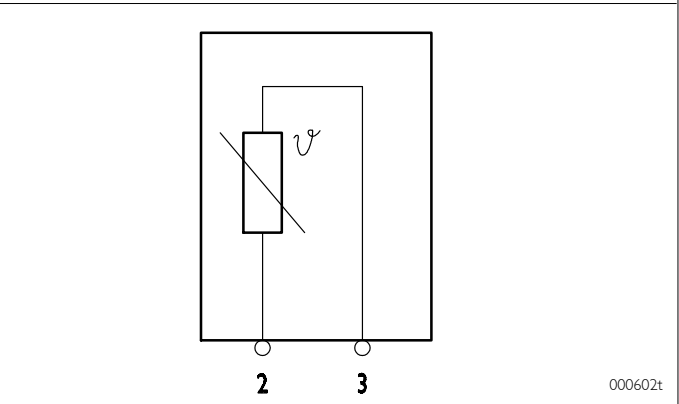
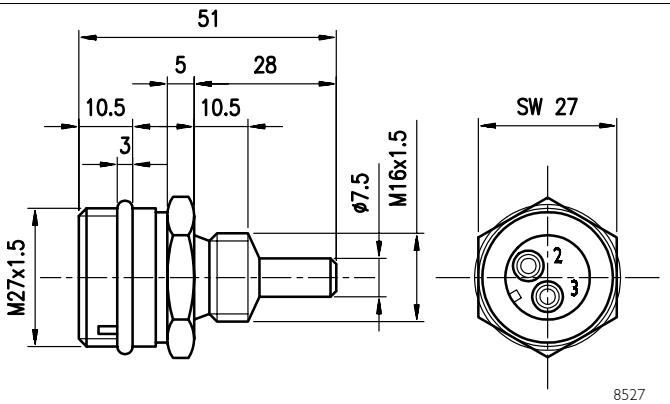
It is connected to electronic center pins A5/A22.

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

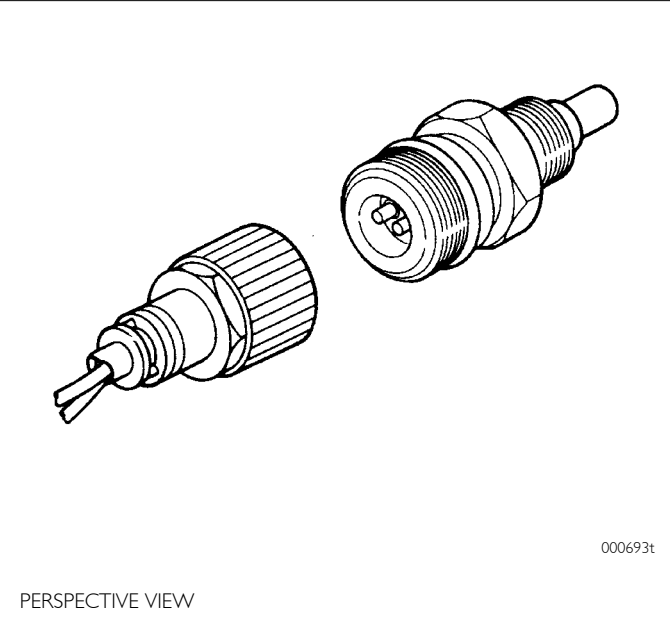
At 60 to 90 °C, voltage at A5 and A22 ranges from 0.6 to 2.4V.

Figure 94



TECHNICAL VIEW

WIRING DIAGRAM



PERSPECTIVE VIEW

Connector	Function	Cable colour
2	To EDC center pin A 5	—
3	To EDC center pin A 22	—

Fuel temperature sensor

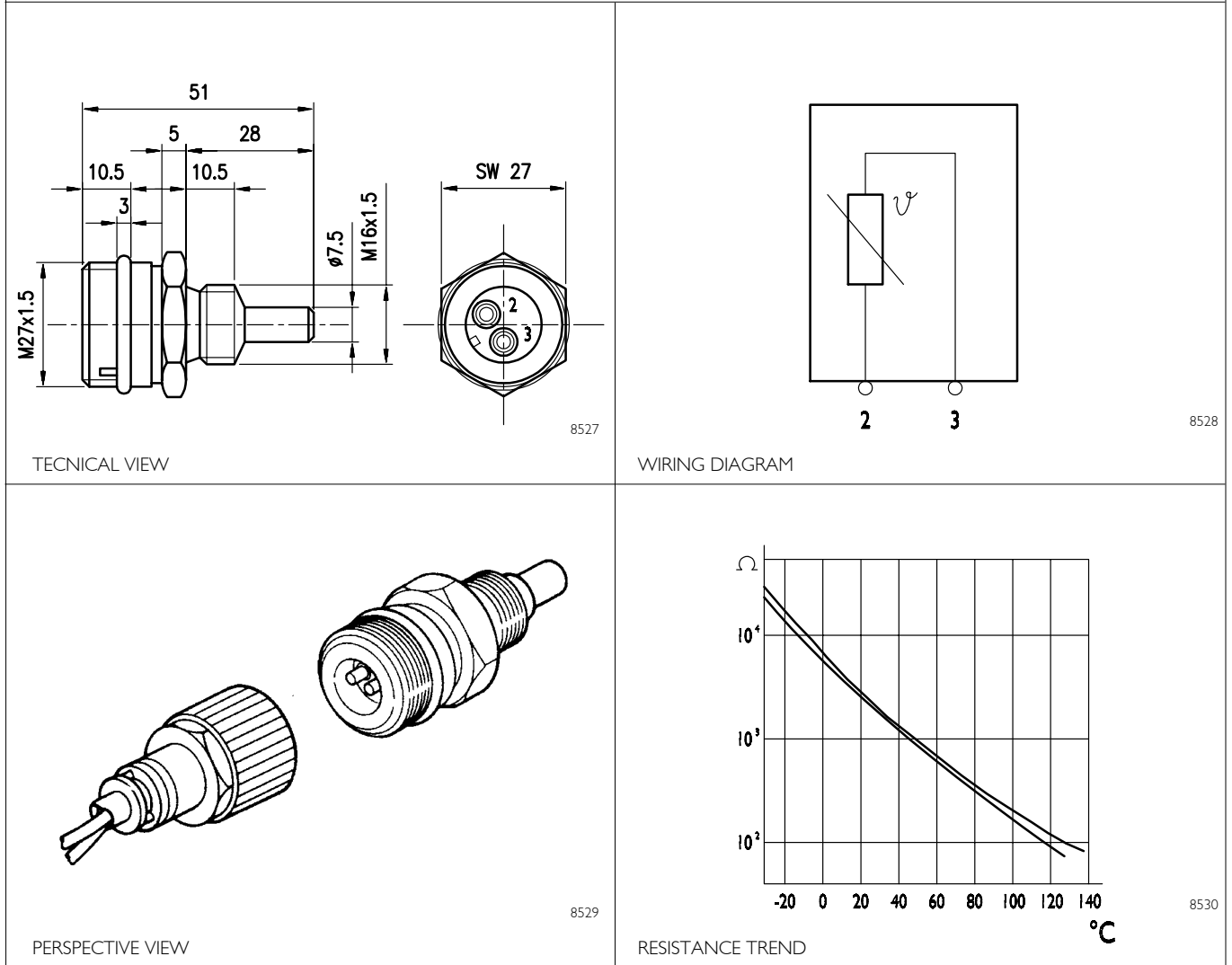
Specifications

Supplier

Max. tightening torque

BOSCH
35 Nm

Figure 95



Pin	Function	Cable colour
2	To pin 6 of EDC control unit	—
3	To pin 11 of EDC control unit	—

Flywheel pulse transmitter

Specifications

Supplier

BOSCH
8 ± 2 Nm

Max. tightening torque

Figure 96

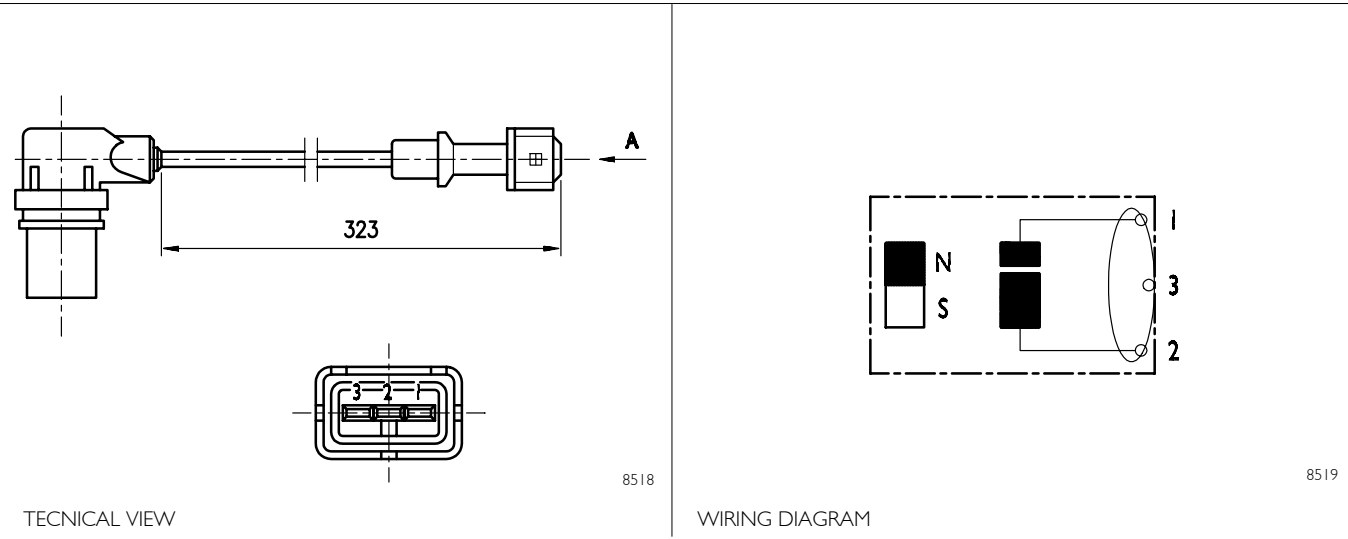
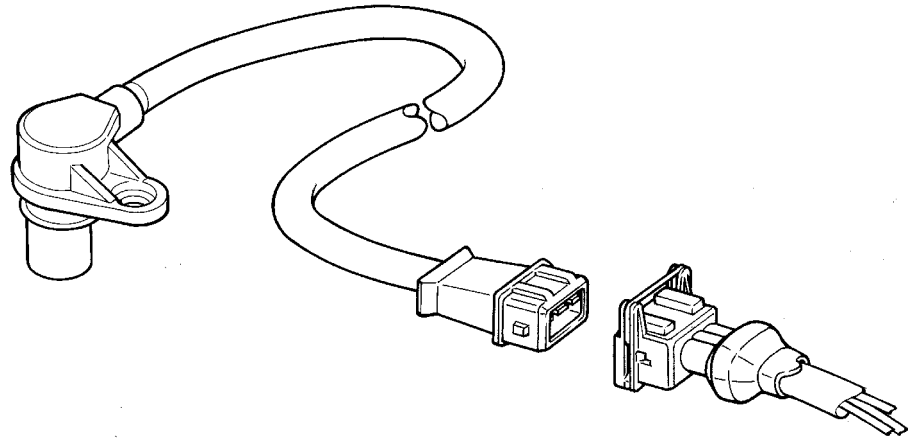


Figure 97



Pin	Function	Cable colour
1	To pin 1 of EDC control unit	—
2	To pin 13 of EDC control unit	—
3	Screens	—

Distribution pulse transmitter

Features

Vendor

BOSCH

Torque

8 ± 2 Nm

Resistance

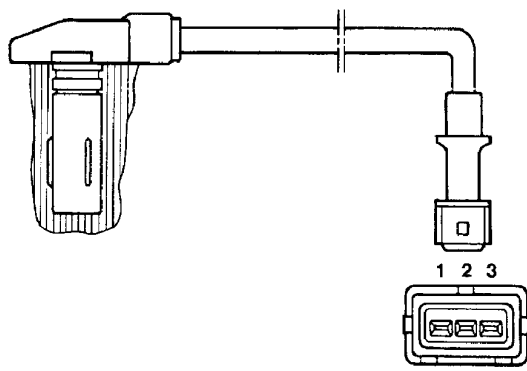
880 ± 920 Ω

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.

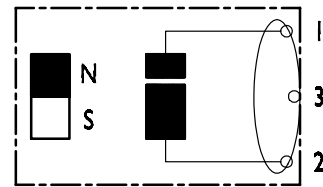
The electronic center uses the signal generated by this sensor as an injection step signal.

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

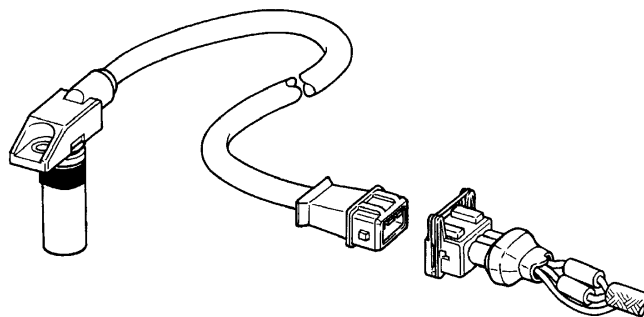
This sensor's air gap is NOT ADJUSTABLE.



TECHNICAL VIEW



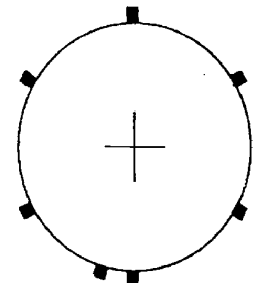
WIRING DIAGRAM



PERSPECTIVE VIEW

000606t

6 + 1



REFERENCE ON SOUND WHEEL

8520

Connector	Function	Cable colour
1	To EDC center pin A 2	—
2	To EDC center pin A 14	—
3	Shields	—

Boosting pressure transmitter

Specifications

Supplier

Code

Operating pressure field

Max. tightening torque

BOSCH
 B 281 022 018
 50 ÷ 400 kPa
 10 Nm

Figure 98

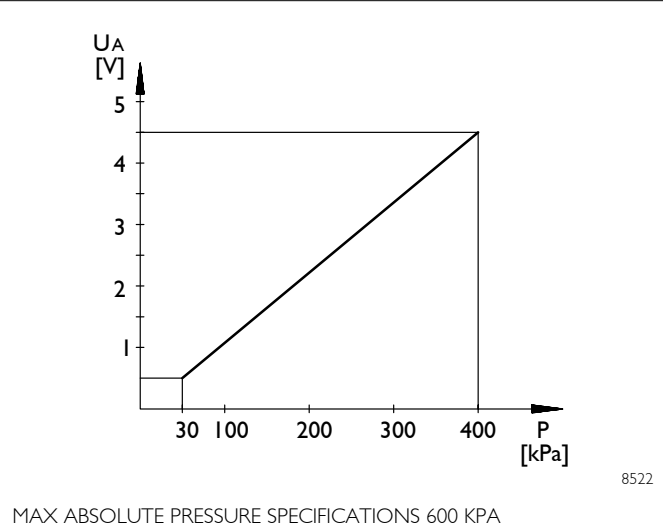
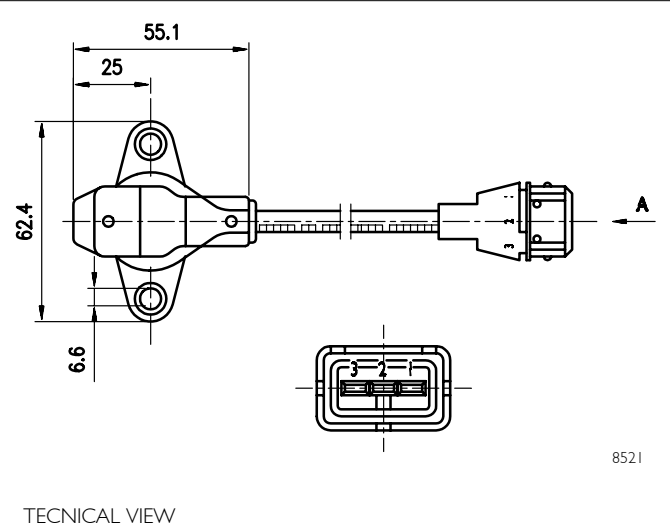
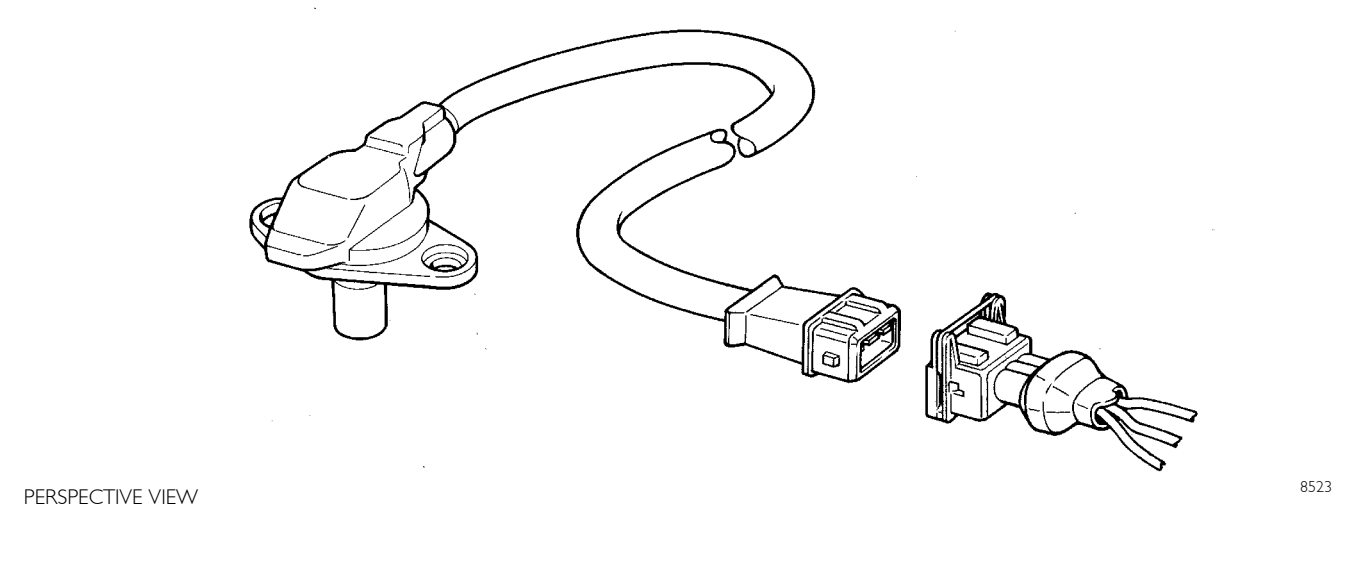


Figure 99



Pin	Function	Cable colour
1	To pin 12 of EDC control unit	—
2	To pin 23 of EDC control unit	—
3	To pin 17 of EDC control unit	—

Air temperature transmitter on manifold

Specifications

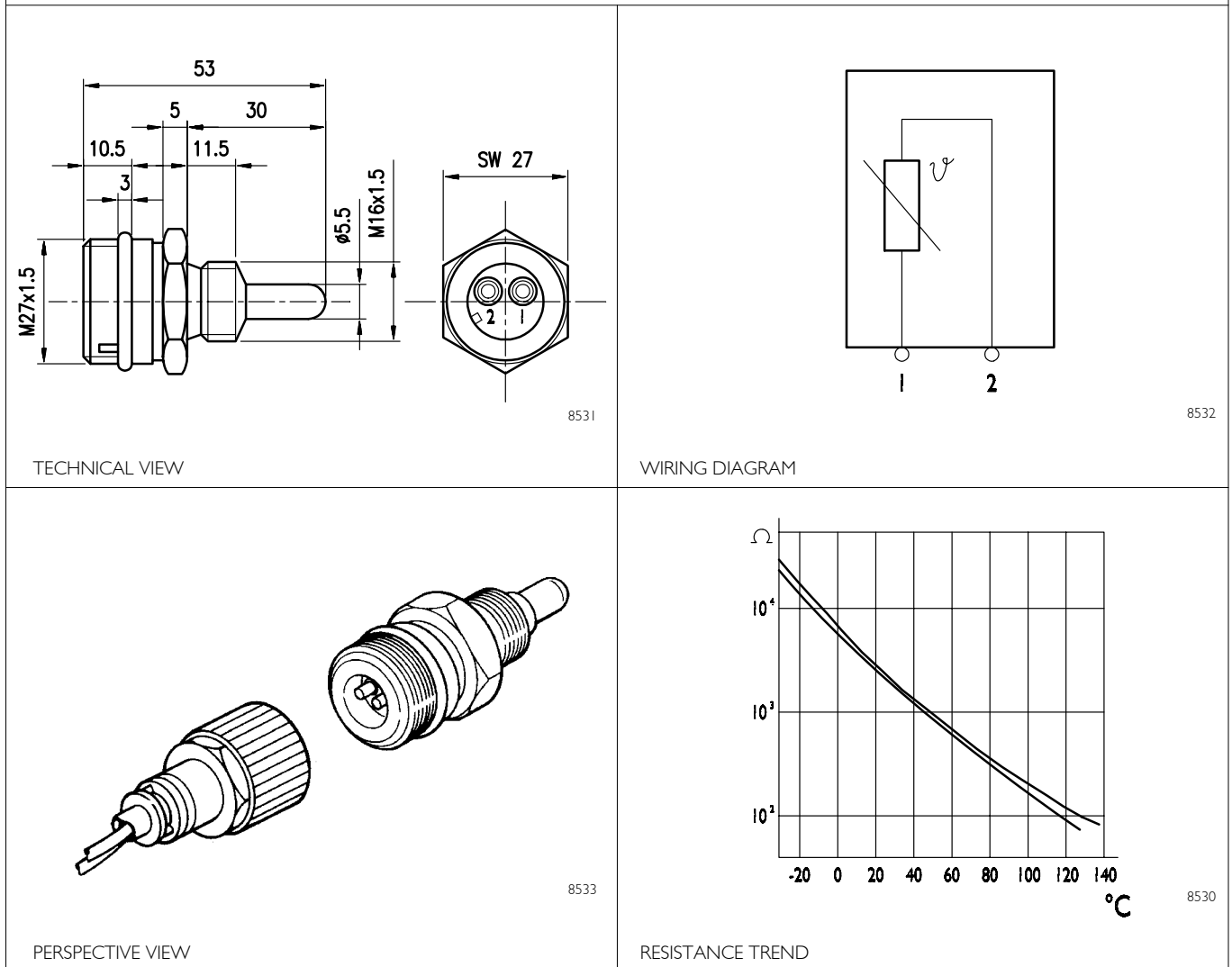
Supplier

Max. tightening torque

BOSCH
35 Nm

The device should be marked with the supplier's identification, catalogue number and date of manufacture.

Figure 100



Pin	Function	Cable colour
1	To pin 21 of EDC control unit	—
2	To pin 4 of EDC control unit	—

PRE/POST-HEATING RESISTANCE

The resistance is ~ 0,7 Ohm.

Such resistance is placed between the cylinder head and the suction manifold. It is used to heat up air during pre/post-heating operations.

When the ignition key is inserted, should any one of the temperature sensors – water, air, gas oil – detect a value below 10°C, the electronic control unit will activate pre/post-heating and turn on the relevant dashboard warning light for a variable time depending on the temperature.

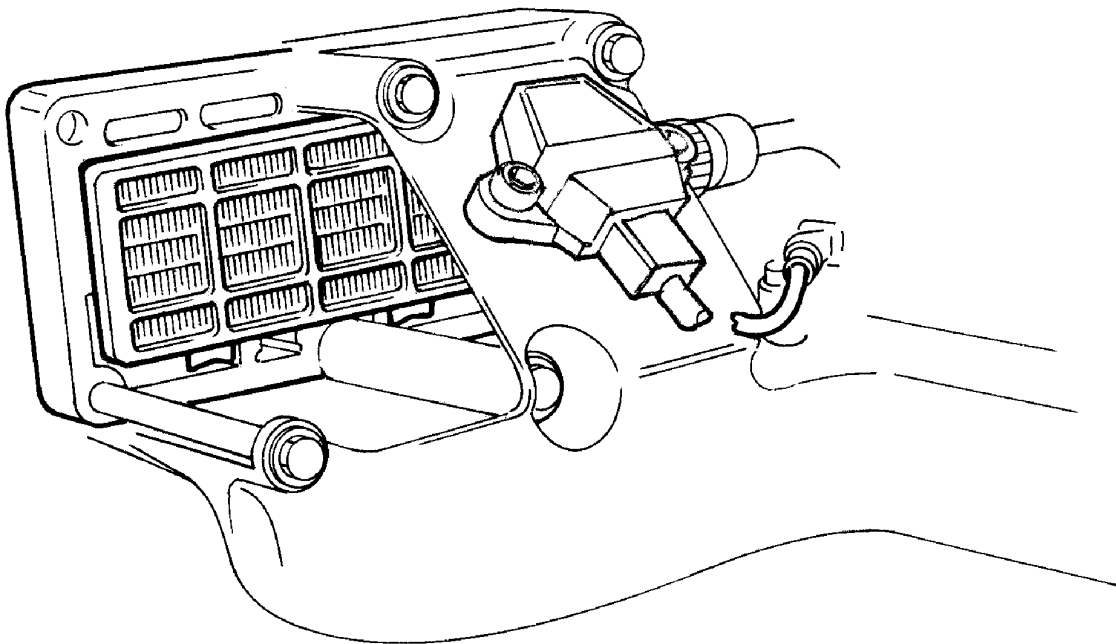
After that time, the warning light starts blinking thus informing the driver that the engine can be started.

When the engine is running the warning light goes off, while the resistance is being fed for a certain time as a result of post-heating.

If the engine is not started, with the warning light flashing, in 20 / 25 seconds, the operation is cancelled to prevent draining the battery.

On the contrary, if reference temperatures are over 10°C, when the ignition key is inserted the warning light comes on for about 2 seconds and carries out the test and then goes out to signal that the engine can be started.

Figure 101



001256t

EDC SYSTEM FUNCTIONS

The MS6.2 electronic center manages the following main functions:

Fuel injection
Accessory functions
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
- 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 still 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.

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.

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 a non-volatile, cancelable and rewritable (Eeprom) memory to make them 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 inside 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.

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 issued by blinking of the failure led: the "blink-code" (whether programmed).

Please consider that the interpretation of the indications provided by the blink-code is not sufficient to guarantee the solution to the existing anomalies.

Using Iveco Motors 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 three different parts:

- Part 1: Blink Code, relating to the anomalies identified by the gearbox, mainly of electric and electrical nature;
- Part 2: Troubleshooting guide using PT-01 portable tester.
Tool identified as IVECO p/n 8093731.
- Part 3: Guideline for troubleshooting without blink code, divided per symptoms, describing all possible anomalies not detected by the electronic gearbox, often of mechanical and hydraulic nature.

NOTE Any kind of operation on the electronic center unit must be executed by qualified personnel, duly authorized by Iveco Motors.

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

PART I

EDC MS6.2 SW control unit Blink Table

Blink code	EDC warning lamp *	Fault
VEHICLE AREA		
1.1	GLOWING STEADILY	Vehicle speed signal
1.2	GLOWING STEADILY	Torque selector (if available)
1.3	OFF	Cruise Control
1.4	GLOWING STEADILY	Accelerator pedal
1.5	OFF	Clutch pressure switch
1.6	GLOWING STEADILY	Plausibility of brake pedal signal switches
1.7	OFF	Plausibility between accelerator / brake pedal
ENGINE AREA		
2.1	OFF	Water temperature sensor
2.2	OFF	Air temperature sensor
2.3	OFF	Fuel temperature sensor
2.4	GLOWING STEADILY	Supercharging pressure sensor
2.5	OFF	Ambient pressure sensor (inside control unit)
3.5	OFF	Battery voltage
INJECTORS		
5.1	GLOWING STEADILY	Fault on injector cylinder 1
5.2	GLOWING STEADILY	Fault on injector cylinder 2
5.3	GLOWING STEADILY	Fault on injector cylinder 3
5.4	GLOWING STEADILY	Fault on injector cylinder 4
5.5	GLOWING STEADILY	Fault on injector cylinder 5
5.6	GLOWING STEADILY	Fault on injector cylinder 6
ENGINE RPM SENSORS		
6.1	GLOWING STEADILY	Flywheel sensor
6.2	GLOWING STEADILY	Timing gear sensor
6.4	FLASHING	Engine over revving
INTERFACES WITH OTHER CONTROL UNITS		
7.2	OFF	CAN line
7.6	OFF	CAN line (ASR control)
7.7	OFF	CAN line (gearbox data control)
CONTROL UNIT		
9.1	FLASHING	Faulty control unit
9.2	GLOWING STEADILY	Incorrect data in EPROM
9.4	GLOWING STEADILY	Main relay
9.5	GLOWING STEADILY	Incorrect engine stopping procedure
9.6	GLOWING STEADILY	Incorrect data recording in control unit

- * Blink code warning lamp off = slight error
 Blink code warning lamp glowing steadily = significant error
 Blink code warning lamp flashing = serious error

PART 2

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
1.1	ON steady	Faulty vehicle speed sensor. The tachograph won't work. Odd behaviour of the tachograph pointer. (If available)	Vehicle speed no longer reduced: it can be exceeded in case of poor resistance to progressing. Serration with high speeds.	Flight recorder detects high time at low speed. Check cabling, connections and component.	Control unit replacement value: 5 km/h.
1.2	ON steady	Faulty multiple-state switch. (If available)		Check cabling, connections and component.	
1.3	OFF	Faulty Cruise Control switches. (If available)	The Cruise Control won't work.	Check cabling, connections and component.	Or non-plausible switch signals (switches pressed simultaneously).
1.4	ON steady	Accelerator pedal: faulty potentiometer or non-plausible signal. Odd reaction of engine when actuating the accelerator pedal.			Engine speed can be varied by means of the CC (Set + / Set -) switch. (If available)
1.5	OFF	Faulty clutch switch. CC won't work. (If available)	Serration when changing gear.	Check cabling, connections and component.	
1.6	ON steady	Brake switch plausibility. No reaction after actuating the CC/PTO switches. (If available)	The Cruise control / PTO won't work.	Check cabling, connections and component.	
1.7	OFF	Brake switch / accelerator pedal sensor plausibility.			No reaction from the system.

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
2.1	OFF	Faulty coolant temperature sensor. Excessive starting time in cold weather conditions.	Greater combustion noise due to high injection advance.	Pre-heating resistor active diagnosis. Parameter reading. Check cabling, connections and component.	No overheating protection, replacement value = 0°C.
2.2	OFF	Faulty boosting air temperature sensor.	If the sensor signals a temperature lower than the actual one, the error is not stored and the engine achieves better performance, yet with black smoke.	Parameter reading. Check cabling, connections and component.	Replacement value = 20°C.
2.3	OFF	Faulty fuel temperature sensor.		Parameter reading. Check cabling, connections and component.	No injection rate correction; yet, the driver is not aware of it. Replacement value = 30°C.
2.4	ON steady	Faulty boosting pressure sensor. Power reduction.	Significant black smoke in momentary conditions.	Parameter reading modus: if the replacement value is read when the engine is idling, the fault is confirmed.	Replacement value. Cursor 8 = 1,600 mbar, Cursor 10 = 2,800 mbar.
2.5	OFF	Faulty ambient pressure sensor.		Contact Help Desk for replacement (if any) of the control unit, owing to the sensor being integrated into the same.	EDC works with a replacement value of 28 V.
3.5	OFF	Too low battery voltage or voltage recognition fault.	Possible pre-heating and starting problems.	Battery test.	
5.x	ON steady	Problem with injection circuit on cylinder X. The engine speed is reduced, and the engine operated with 5 cylinders.	If the fault is intermittent, the engine sometimes works correctly; sometimes, it does not.	Engine test (if the fault is found). Check component, cabling and connections (head cable included).	

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
6.1	ON steady	Faulty flywheel sensor. Reduced engine speed and power.	Engine starting may take a longer time than usual.	Fault memory reading by means of the diagnosis instrument. Check cabling, connections and component.	
6.2	ON steady	Distributing shaft sensor. Reduced engine speed and power.	Engine starting may take a longer time than usual.	Fault memory reading by means of the diagnosis instrument. Check cabling, connections and component.	
(6.1 - 6.2)	ON steady	Distributing shaft phonic wheel has rotated, due to loosened screws. The engine won't start, or stops and cannot be started again.	Reduced power with engine started (after taking the measure recommended in the next column).	Disconnect the distributing shaft sensor connector. If the engine is started, even by taking a longer time than usual, the phonic wheel is out-of-phase.	
6.4	Blinking	The engine has reached (on pulling) the out-of-rev conditions for any reason whatsoever.		Fault memory reading. Flight recorder reading to get confirmation of the engine out-of-rev condition.	
(9.1)	Blinking	Faulty EDC control unit. The engine will stop or won't start.		Contact Help Desk for control unit replacement.	No diagnosis can be made. This error may even not be stored; this depends on the control unit conditions.
9.2	ON steady	Control unit fault (EEPROM memory). Reduced engine speed and power.	Faulty memory lost; only the diagnosis of existing faults can be made.	Contact Help Desk for replacement (if any) of the control unit.	
9.4	Blinking	Main relay faulty or locked in closed position. The EDC warning light remains ON when the key is turned to OFF; yet the engine will stop.	EDC power supply remains ON after the key has been turned to OFF; danger of battery run-down.	Check cabling, connections and component.	The fault will be stored only after the next time the engine is started.

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
9.5	ON steady	ECU power supply is cut out too often (5 times): faulty main relay or engine stop by means of battery disconnect switch. Reduced engine max. speed and power.		Check main relay, cabling and connections. Investigate whether the driver switches the engine off in other ways than by turning the key.	The problem will be solved by itself the next time the switch-off procedure and data storing are performed correctly.
9.6	ON steady	ECU stop test failure. Reduced engine speed and power.	This is a test procedure inherent to the control unit for power stage control. It might store other errors concerning the various power stages of actuators.	Contact Help Desk for replacement (if any) of the control unit.	

PART 3

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 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 PLANNING

Recovery

To ensure optimised working conditions, in the following pages we are providing instructions for the overhaul control interventions, checks and setting operations that must be performed on the engine at due planned dates.

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

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

Inspection and/or maintenance interventions

Intervention type	Frequency (hours)
Engine	
Engine visual inspection	Daily
Check presence of water in fuel prefilter	Daily
Engine oil change	-
Engine oil filter change	-
Fuel prefilter change (when it is required by the application)	-
Fuel filter change	-
Check Blow-by filter condition by clogging indicator	-
Check condition of water pump/alternator control belt	-
Check-up of EDC system by diagnostics tool	-
Check valve lash and adjust, if required	-
Dry air filter change and container cleaning	-

NOTE The maintenance operations are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Checks not included in maintenance planning-daily checks

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

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

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

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

MAINTENANCE PROCEDURES

Checks and controls

Engine oil level check.

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

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

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

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

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

To provide filling, operate through the upper top (1) or through the lateral top (2). During filling operation, the tops must be removed as well as the rod in order to make the oil flow easier".

Refill through upper tappet cover plug. During refill, remove dipstick for easier oil drain.



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



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

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

Check of fuel system

The check must be executed both when the engine disconnected and when it is running.

The check is made by observing the fuel pipes from the tank to the fuel pump and to the injectors.

Cooling system check

The check must be executed both when the engine disconnected and when it is running.

Check the pipes from the engine to the radiator and vice versa; note any seepage and the state of the pipes especially near the coupling clamps.

Verify that the radiator is clean, the correct working of the fan flywheels, the presence of any leakage from the connectors, from the manifold and from the radiating unit.



Due to the high temperatures achieved by the system, do not operate immediately after the engine's disconnection, but wait for the time deemed necessary for the cooling.

Protect the eyes and the skin from any eventual high pressure jet of cooling liquid.

The density of the cooling liquid must be checked any how every year before winter season and be replaced in any case every two year.

NOTE In case of new filling, proceed bleeding system, through the bleeds on the engine.

If bleeding of the system is not carried out, serious inconvenience might be caused to the engine due to the presence of air pockets in the engine's head.

Lubricating system check

The check must be executed both when the engine disconnected and when it is running.

Verify the presence of any oil leakage or blow-by from the head, from the engine pan or from the heat exchanger.



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

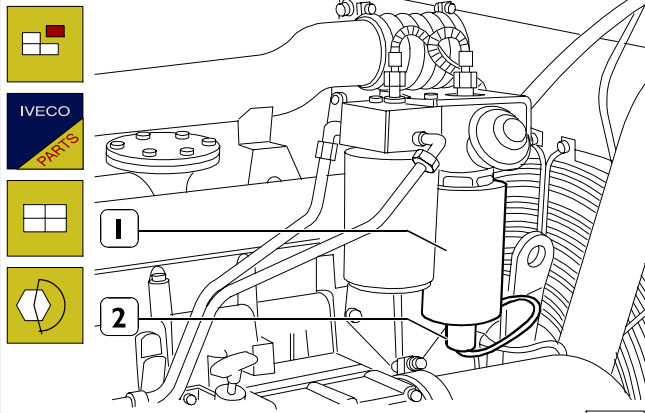


Adequately protect the skin and the eyes, operate in full compliance with safety regulations.

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

Replace fuel sedimentation tank prefilter (when it is required by the application)

Figure 102



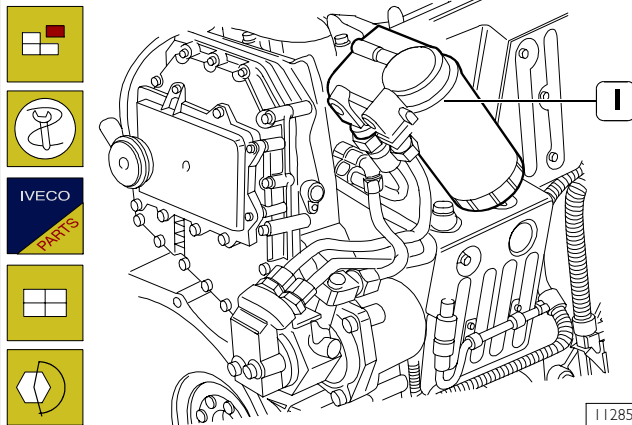
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Disconnect electric connector. Unlock prefilter (1) and change it. Before refitting a new cartridge, wet seal with fuel oil or engine oil. Lock cartridge by hand till in contact with support, then lock it by 3/4 of a rev. at predefined tightening torque.

NOTE At change, filter cartridge must not be prefilled to prevent circulating dirt that could damage injector/pump system components. Bleed air from fuel filter as described in previous pages.

Fuel filter change

Figure 103

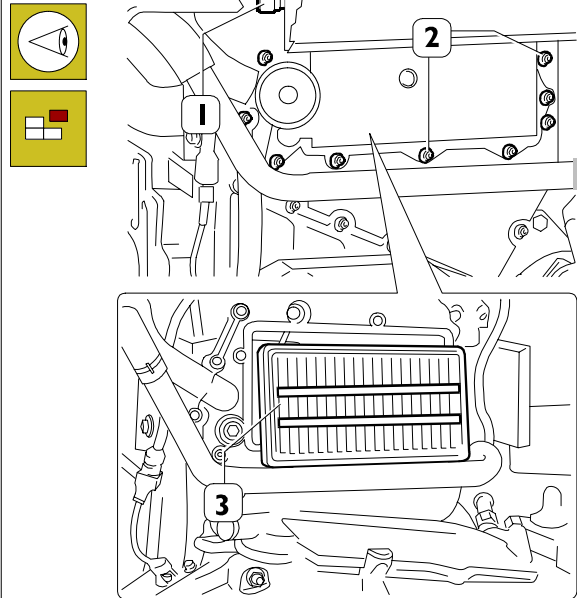


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Use tool 99360314 to remove fuel filter (1). Before fitting the new cartridge, wet seal with fuel oil or engine oil. Lock the new one by hand and carefully check that rubber seal and contact surface are clean and in perfect conditions. Lock cartridge by hand till contact with support and then lock it for 3/4 of a rev. at prescribed tightening torque. Bleed air from supply system as described in paragraph below:

Check Blow-by filter conditions by means of a clogging indicator

Figure 104

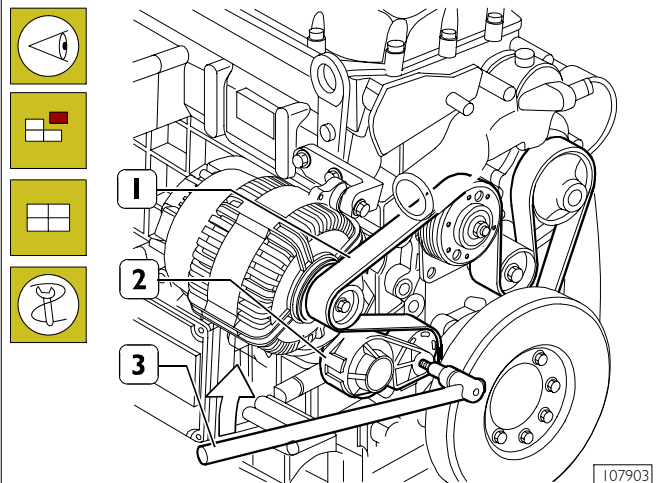


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- Check filter (3) conditions by means of a clogging indicator (1). In case the red area appears, change it.
- For screw (2) change, remove carter, pull out filter (3) and replace it with a new one. Filter has a one-way operation, therefore it must be installed with the two reinforcement bars visible, as shown in the picture.

Check of water pump/alternator control belt condition

Figure 105



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Visually check that belt (1) is not worn out or broken; change it as described below, if required.

Water pump/alternator control belt change

In order to remove and refit belt (1), operate using a specific tool (3) on belt tensioner (2) in direction shown by arrow.

NOTE Belt tensioner is automatic and requires no adjustment.

Check for any water in the fuel filter

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

Take prompt action on the filter to drain off the water in the fuel circuit.

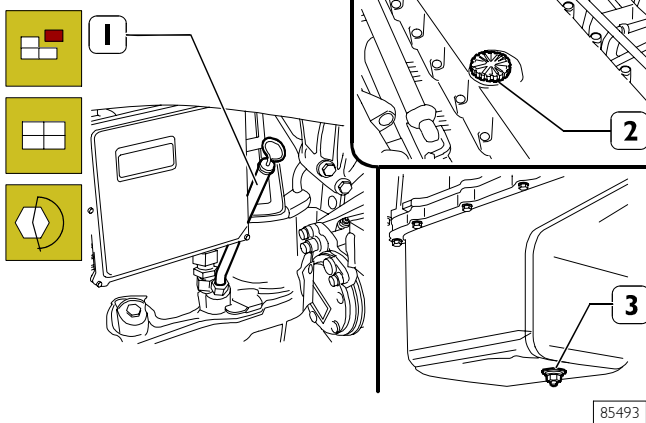
Fuel filter is equipped with pump screw-valve to drain the water eventually mixed with fuel.

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


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

Engine oil change

Figure I06



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


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

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

- Place a proper container for the oil collecting under the pan connected with the drain plug (3).
- Unscrew the plug (3) and then take out the control dipstick (1) and the inserting plug (2) to ease the downflow of the lubrication oil.

 The oil motor is very pollutant and harmful.

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

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

Dispose of the residual properly following the rules.

Lock plus (3) under oil sump at predefined tightening torque. Pour oil in prescribed quantity and quality in engine through filler (2) of tappet cover.

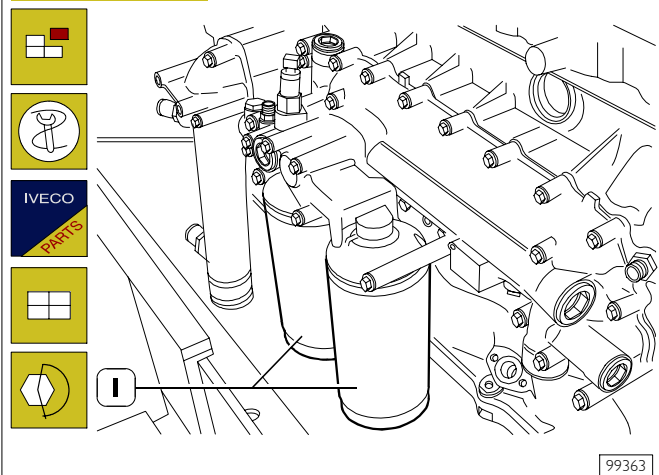
- After the complete drainage, screw the plug and carry out the clean oil filling.

NOTE Use only the recommended oil or oil having the requested features for the correct motor functioning. In case of topping up, don't mix oils having different features. If you don't comply with these rules, the service warranty is no more valid.

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


Engine oil filter change

Figure I07



Drain oil as described in "Engine oil change" chapter. Use tool 99360314 (2) to remove the oil filters (1).

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

 Place properly a container for the liquid.

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

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

NOTE Before refitting the new cartridge, wet seal using engine oil.

Lock oil filter (1) by hand till contact to support and then lock by $\frac{3}{4}$ of a rev. at prescribed tightening torque; pour oil in engine as described in "Engine oil change" chapter.

Valve lash check a adjustment

For correct operation, follow instructions contained in related chapter in section 3 – Industrial Applications.

Change dry air filter and clean its container

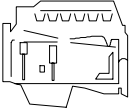

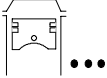

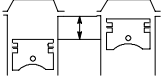
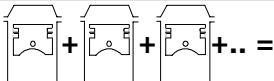
Refit container cover, remove cartridge from air filter.
Carefully clean container inside, insert new cartridge and refit cover.

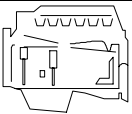
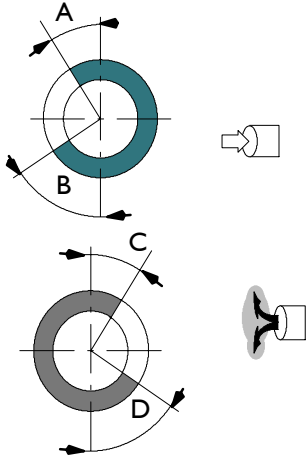
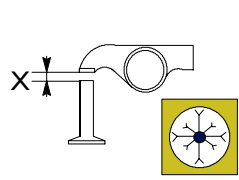
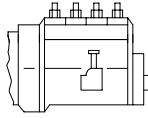
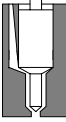
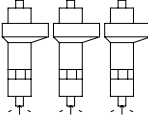
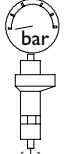
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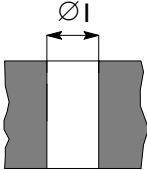
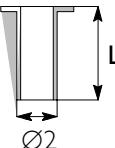



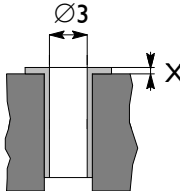
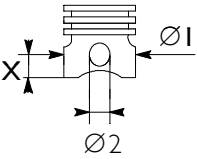



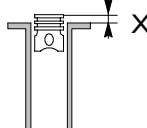
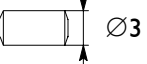

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GENERAL CHARACTERISTICS

	Type		F3B
	Cycle		4-stroke Diesel engine
	Fuel feed		Turbocharged
	Injection		Direct
	No. of cylinders		6 in line
	Bore	mm	135
	Stroke	mm	150
	Total displacement	cm ³	12880

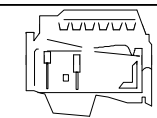
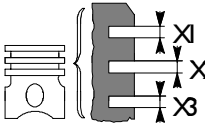
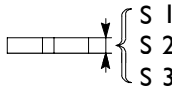


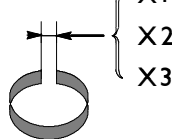
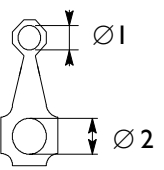
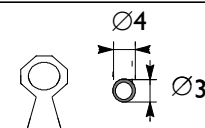
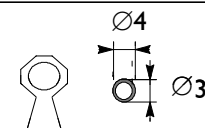




	Type	F3B
	<p>VALVE TIMING</p> <p>opens before T.D.C. A</p> <p>closes after B.D.C. B</p> <p>opens before B.D.C. D</p> <p>closes after T.D.C. C</p>	<p>19°</p> <p>36°</p> <p>50°</p> <p>9°</p>
	<p>For timing check</p> <p>Running</p> <p>X { mm</p> <p>X { mm</p> <p>X { mm</p> <p>X { mm</p>	<p>-</p> <p>-</p> <p>0.35 to 0.45</p> <p>0.45 to 0.55</p>
	<p>FEED</p> <p>Injection type: Bosch</p>	<p>Through fuel pump - filters</p> <p>With electronically regulated injectors PDE 31 pump injectors controlled by overhead camshaft</p>
	<p>Nozzle type</p>	<p>-</p>
	<p>Injection order</p>	<p>1 - 4 - 2 - 6 - 3 - 5</p>
	<p>Injection pressure bar</p> <p>Injector calibration bar</p>	<p>1500</p> <p>290 ± 12</p>


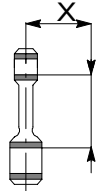
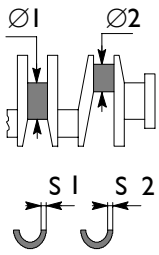
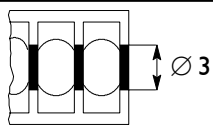
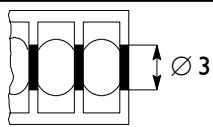


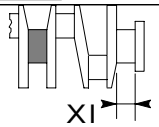
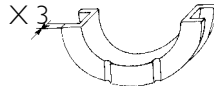
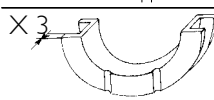
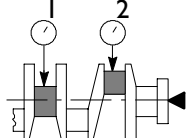
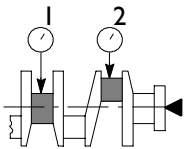
ASSEMBLY CLEARANCE DATA

	Type	F3B	
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS		mm	
	Bores for cylinder liners: $\varnothing 1$	upper lower	153.500 to 153.525 152.000 to 152.025
	Cylinder liners: external diameter: $\varnothing 2$ length L	upper lower L	153.461 to 153.486 151.890 to 151.915 -
	Cylinder liners - crankcase bores	upper lower	0.014 to 0.039 0.085 to 0.135
	 External diameter	$\varnothing 2$	-
	Cylinder sleeve inside diameter $\varnothing 3A^*$ inside diameter $\varnothing 3B^*$ Protrusion X		135.000 to 135.013 135.011 to 135.024 0.045 to 0.075
* Selection class * Under a load of 800 N			
	Pistons: measuring dimension external diameter $\varnothing 1A^*$ external diameter $\varnothing 1B^*$ pin bore $\varnothing 2$	X $\varnothing 1A^*$ $\varnothing 1B^*$ $\varnothing 2$	FEDERAL MOGUL 20 134.884 to 134.996 134.895 to 134.907 54.010 to 54.018 MAHLE MONDIAL 20 134.881 to 134.893 134.892 to 134.894
	Piston - cylinder sleeve	A* B*	0.104 to 0.129 0.104 to 0.129 0.107 to 0.132 0.107 to 0.132
* Selection class			
	 Piston diameter	$\varnothing 1$	-
	Pistons protrusion	X	0.12 to 0.42
	Gudgeon pin	$\varnothing 3$	53.994 to 54.000
	Gudgeon pin - pin housing		0.010 to 0.024

● Class A pistons supplied as spares.

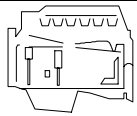
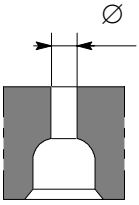
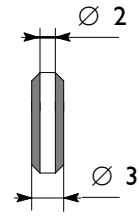



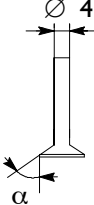
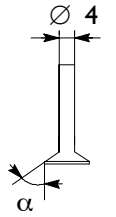


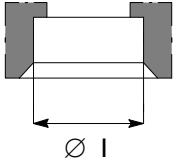
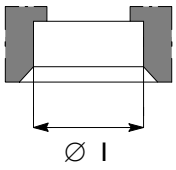

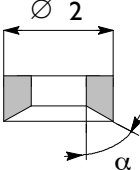
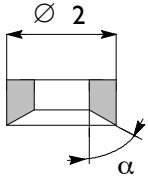

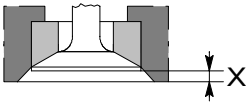
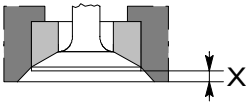




●● Class B pistons are fitted in production only and are not supplied as spares.

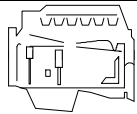
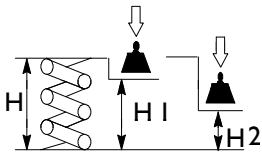
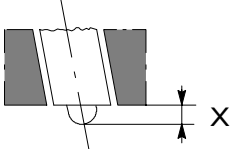
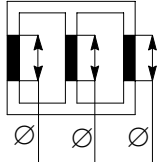
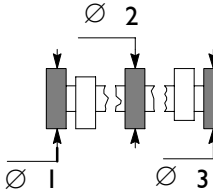
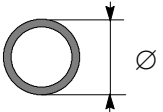
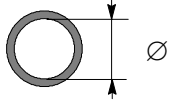


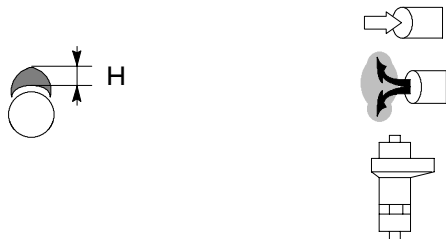
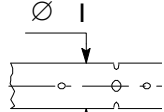
		F3B	
		mm	
	Type		
	Piston ring grooves	X1* X2 X3	FEDERAL MOGUL 3.433 3.060 to 3.080 5.020 to 5.040
			MAHLE MONDIAL 3.445 to 3.475 3.050 to 3.070 5.020 to 5.040
	* measured on \varnothing of 130 mm		
	Piston rings: trapezoidal seal lune seal milled scraper ring with slits and internal spring	S1* S2 S3	3.296 to 3.364 2.970 to 2.990 4.970 to 4.990
	* measured on \varnothing of 130 mm		
	Piston rings - grooves	1 2 3	0.069 to 0.137 0.070 to 0.110 0.030 to 0.070
	Piston rings		-
	Piston ring end gap in cylinder liners	X1 X2 X3	0.40 to 0.55 0.65 to 0.80 0.40 to 0.75
	Small end bush housing nominal Big end bearing housing nominal	$\varnothing 1$ $\varnothing 2$	59.000 to 59.030 94.000 to 94.030
	- Class	1	94.000 to 94.010
	- Class	2	94.011 to 94.020
	- Class	3	94.021 to 94.030
	Small end bush diameter outside inside	$\varnothing 4$ $\varnothing 3$	59.085 to 59.110 54.019 to 54.035
	Big end bearing shell	S	
	Red		1.965 to 1.975
	Green		1.976 to 1.985
	Yellow		1.986 to 1.995
	Small end bush - housing		0.055 to 0.110
	Piston pin - bush		0.019 to 0.041
	Big end bearing		0.127 - 0.254 - 0.508
	Connecting rod weight		g
	Class	A B C	4741 to 4780 4781 to 4820 4821 to 4860

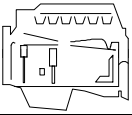
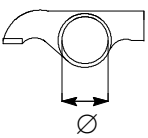


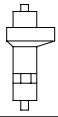
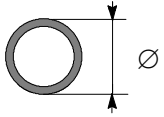



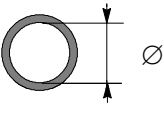











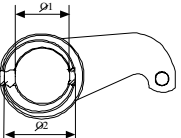
		Type		F3B	
				mm	
	Measuring dimension	X		125	
	Max. connecting rod axis misalignment tolerance		==	0.08	
	Main journals	Ø1		99.970 to 100.000	
	- rated value				
	- class	1		99.970 to 99.979	
	- class	2		99.980 to 99.989	
	- class	3		99.990 to 100.000	
	Crankpins	Ø2		89.970 to 90.000	
	- rated value				
	- class	1		89.970 to 89.979	
	- class	2		89.980 to 89.989	
	- class	3		89.990 to 90.000	
Main bearing shells	S1	Red		3.110 to 3.120	
		Green		3.121 to 3.130	
Big end bearing shells	S2	Red		1.965 to 1.975	
		Green		1.976 to 1.985	
		Yellow*		1.986 to 1.995	
	Main bearing housings	Ø3		106.300 to 106.330	
	- rated value				
	- class	1		106.300 to 106.309	
	- class	2		106.310 to 106.319	
	- class	3		106.320 to 106.330	
	Bearing shells - main journals ○			0.060 to 0.108 *	- 0.061 to 0.119 ** - 0.060 to 0.130 ***
	Bearing shells - big ends ○			0.050 to 0.108 *	- 0.051 to 0.109 ** - 0.050 to 0.098 ***
	Main bearing shells			0.127 - 2.254 - 0.508	
	Big end bearing shells			0.127 - 2.254 - 0.508	
	Main journal, thrust bearing	X1		47.95 to 48.00	
	Main bearing housing, thrust bearing	X2		40.94 to 40.99	
	Thrust washer halves	X3		3.38 to 3.43	
	Crankshaft end float			0.10 to 0.30	
	Alignment		1 - 2	≤ 0.025	
	Ovalization		1 - 2	0.010	
	Taper		1 - 2	0.010	

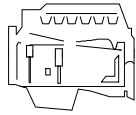




* Fitted in production only and not supplied as spares

○ Spares provided: : * = standard spares - 0.127; ** = 0.254 - 0.508

 Type	F3B	
CYLINDER HEAD - VALVE TRAIN		
mm		
 Valve guide housings in cylinder head	Ø1	15.980 to 15.997
 Valve guide	 Ø2 Ø3	10.015 to 10.030 16.012 to 16.025
 Valve guides - housings in the cylinder heads		0.015 to 0.045
 Valve guide		-
 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 its guide		0.040 to 0.070
 Valve seat in head	 Ø1  Ø1	49.185 to 49.220 46.985 to 47.020
 Outside diameter of valve seat; angle of valve seat in cylinder head:	 Ø2 α  Ø2 α	49.260 to 49.275 60° - 30' 47.060 to 47.075 45° - 30'
 Recessing of valve	 X  X	0.45 to 0.75 1.65 to 1.95
 Between valve seat and head	 	0.040 to 0.090

 Type	F3B	
	mm	
 <p>Valve spring height:</p> <p>free height H</p> <p>under a load of:</p> <p>575 ± 28 N H1</p> <p>1095 ± 54 N H2</p>		73.40 59 45
 <p>Injector protrusion X</p>	X	0.53 to 1.34
 <p>Camshaft bushing housing in the cylinder head: 1 ⇒ 7</p>	Ø	88.000 to 88.030
 <p>Camshaft bearing journals: 1 ⇒ 7</p>	Ø	82.950 to 82.968
 <p>Outer diameter of camshaft bushings: Ø</p>	Ø	88.153 to 88.183
 <p>Inner diameter of camshaft bushings: Ø</p>	Ø	83.018 to 83.085
 <p>Bushings and housings in the cylinder head</p>		0.123 to 0.183
 <p>Bushings and bearing journals</p>		0.050 to 0.135
 <p>Cam lift: H</p>		9.231 9.5607 11.216
 <p>Rocker shaft Ø1</p>	Ø1	41.984 to 42.000

 Type	F3B	
	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 0.025 to 0.057 0.015 to 0.087	
 Engine brake control lever Eccentric pin outer diameter $\varnothing 1$ Rocker arms shaft seat $\varnothing 2$	55.981 ÷ 56.000 42.025 ÷ 42.041	

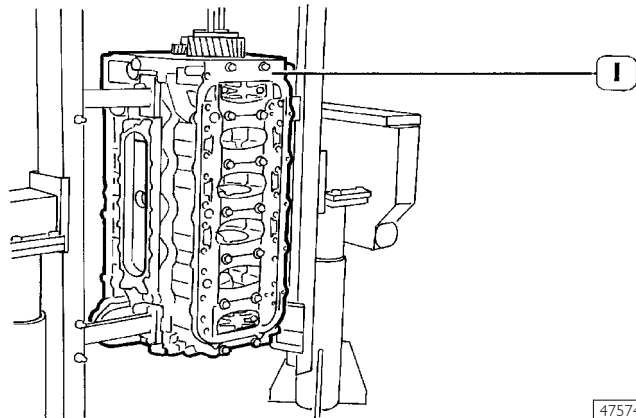
 Type	F3B mm
 Rocker arms and engine brake control lever pin 	0.025 to 0.057
 Rocker arm shaft and seat on engine brake control lever 	0.025 to 0.057
TURBOCHARGER Type End float Radial play	HOLSET HX 60W 0.025 to 0.127 0.406 to 0.584

ENGINE OVERHAUL ENGINE REMOVAL AT THE BENCH

The following instructions are prescribed on the understanding that the engine has previously been placed on the rotating bench and that removal of all specific components of the equipment have been already removed as well. (See Section 3 of the manual herein).

The section illustrates therefore all the most important engine overhaul procedures.

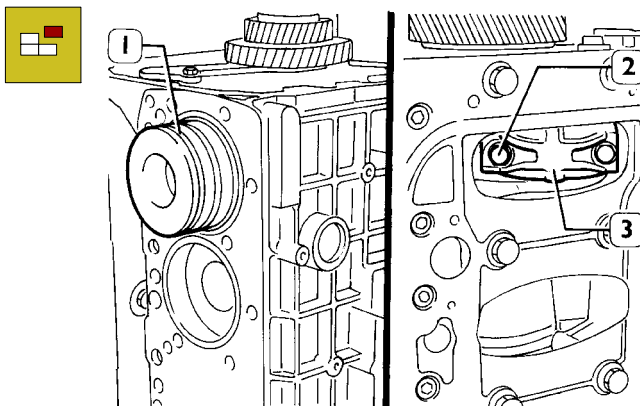
Figure 1



47574

Rotate the block (1) to the vertical position.

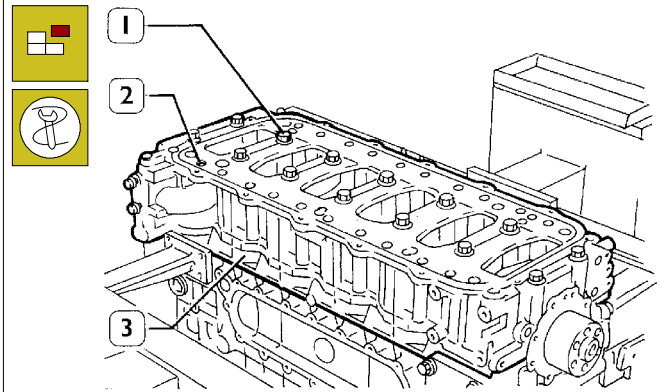
Figure 2



47575

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.

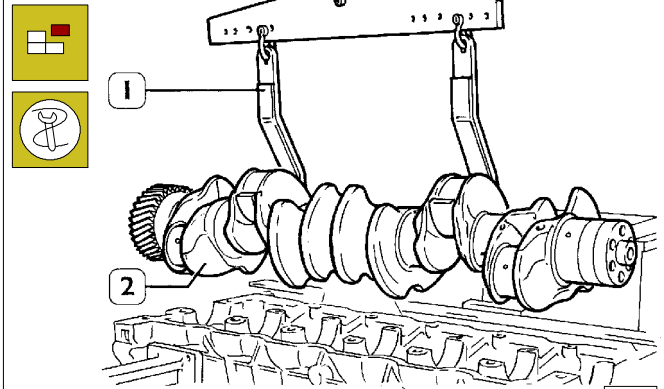
Figure 3



47576

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

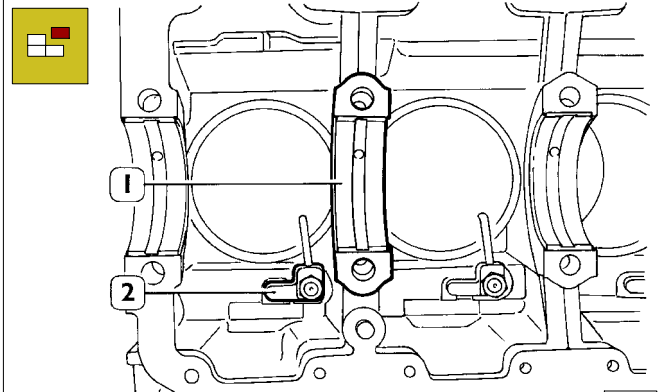
Figure 4



47570

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

Figure 5



47571

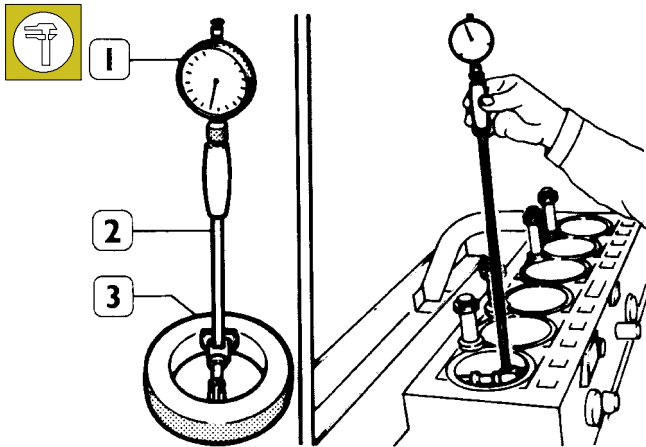
Remove the crankshaft half-bearings (1), untighten the screws and remove oil spray nozzles (2). Take down cylinder liners as specified in the relative paragraph on page 16.

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.

REPAIR OPERATIONS CYLINDER BLOCK

Checks and measurements

Figure 6 (Demonstration)

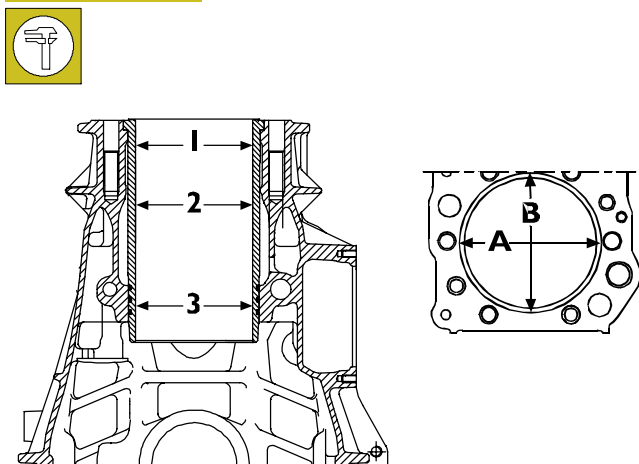


34994

Internal diameter of the cylinder liners is checked for ovalization, taper and wear, using a bore dial (1) centesimal gauge 99395687 (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 7

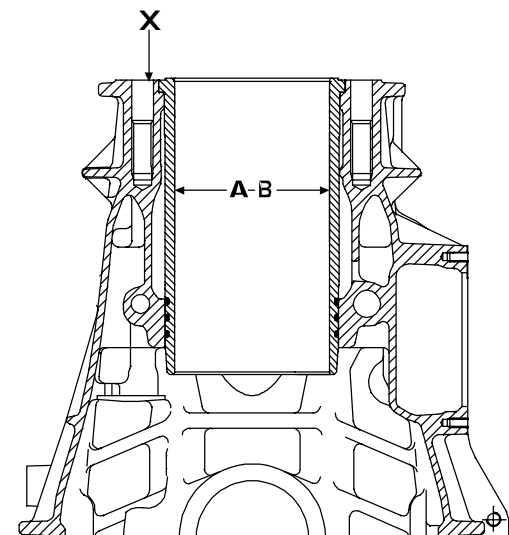


60596

- 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 7.

Figure 8



60595

- A = Selection class \varnothing 135.000 to 135.013 mm
- B = Selection class \varnothing 135.011 to 135.024 mm
- X = Selection class marking area

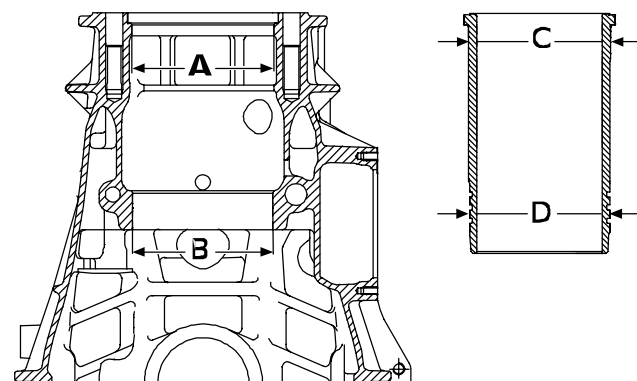
On finding maximum wear greater than 0.150 mm or maximum ovalization of 0.100 mm compared to the values shown in the figure, you need to replace the cylinder liner as no grinding, facing or reconditioning is permitted.

NOTE

The cylinder liners are supplied as spare parts with selection class "A".



Figure 9



60597

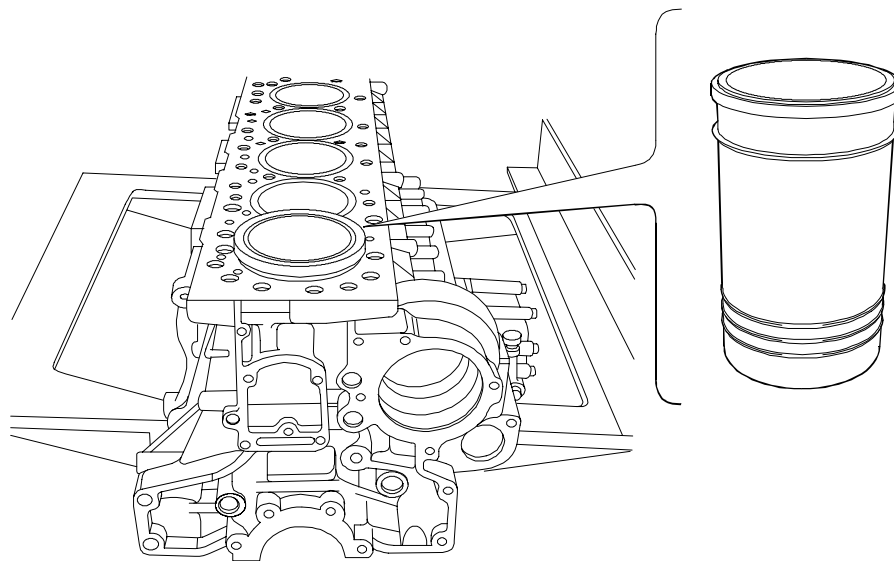
- A = \varnothing 153.500 to 153.525 mm
- B = \varnothing 152.000 to 152.025 mm
- C = \varnothing 153.461 to 153.486 mm
- D = \varnothing 151.890 to 151.915 mm

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

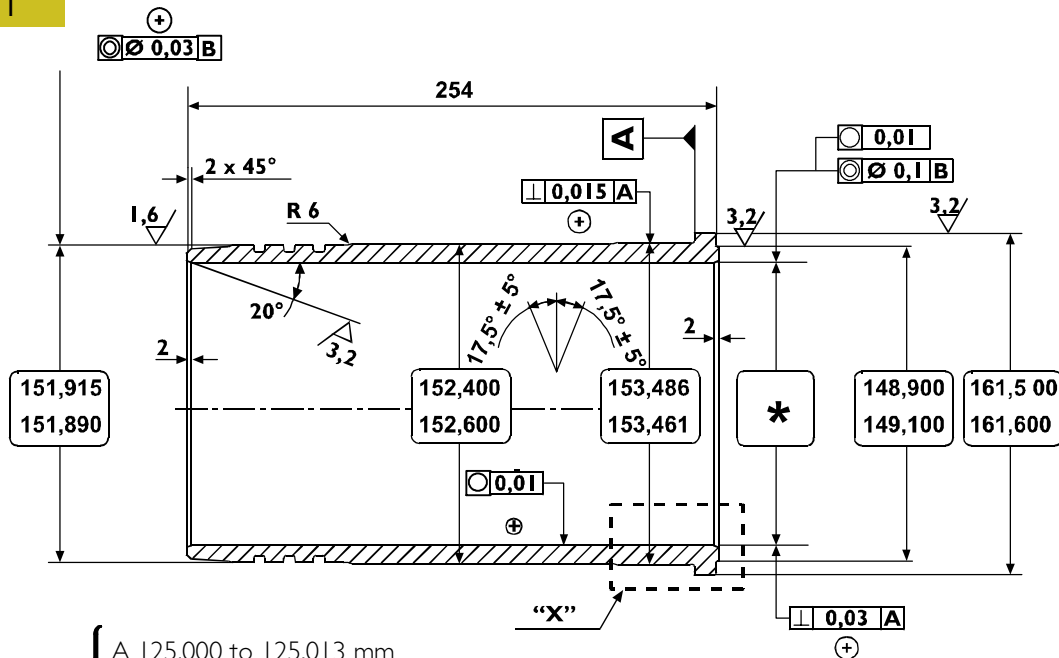
Figure 10



CRANKCASE ASSEMBLY WITH CYLINDER LINERS

60598

Figure 11

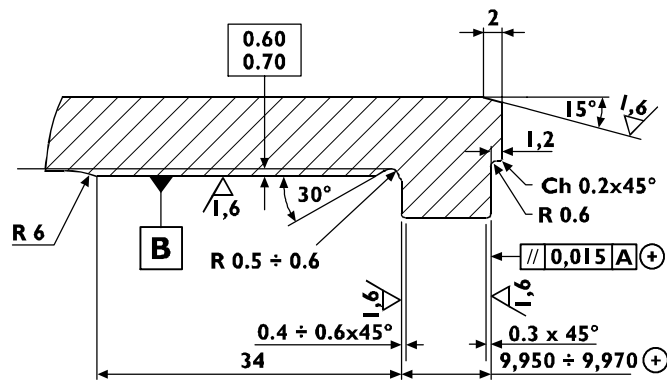


Selection class
 { A 125.000 to 125.013 mm
 B 125.011 to 125.024 mm

MAIN CYLINDER LINER DATA

101503

Figure 12



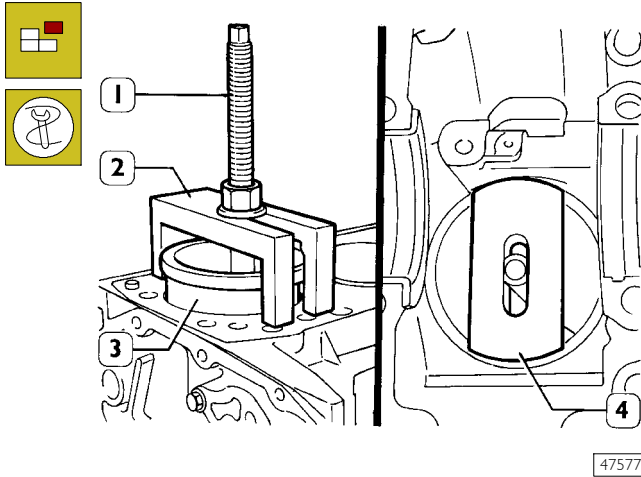
DETAIL "X"

"Y" - Selection class marking area

101502

Replacing cylinder liners Removal

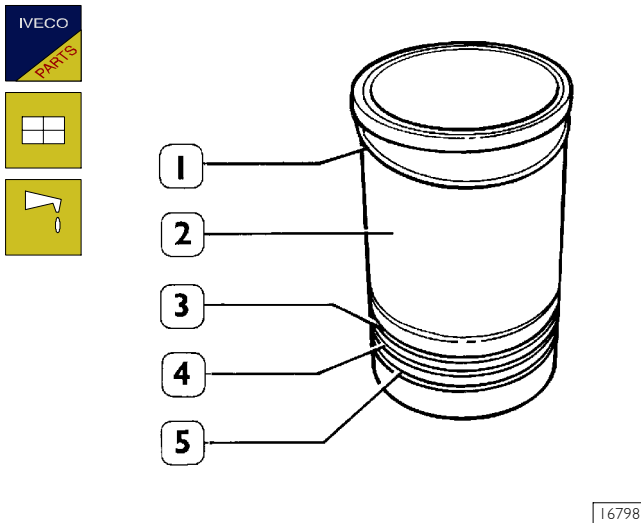
Figure 13



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 14



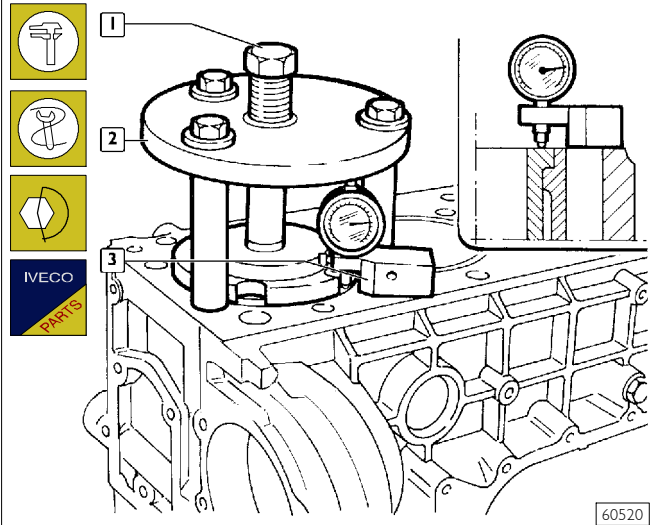
Always replace the water seals (3, 4 and 5).
Fit the adjustment ring (1) on the cylinder liner (2). Lubricate the bottom of it and mount it in the cylinder assembly using the appropriate tool.

NOTE

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 15



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 16); if this is not so, replace the adjustment ring (1) (Figure 14), supplied as a spare part with several thicknesses.

Figure 16

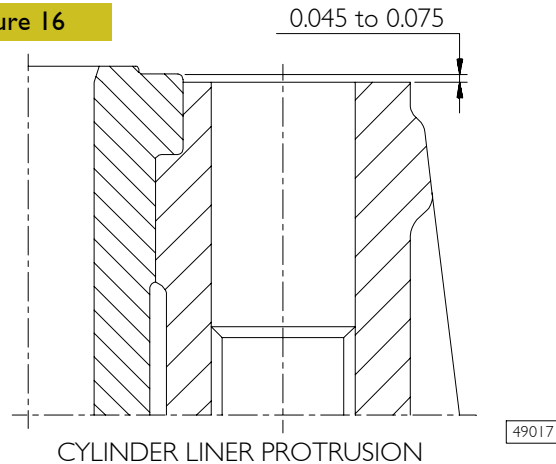
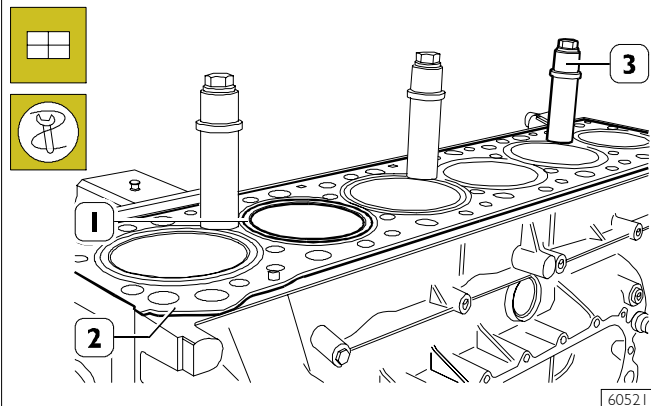


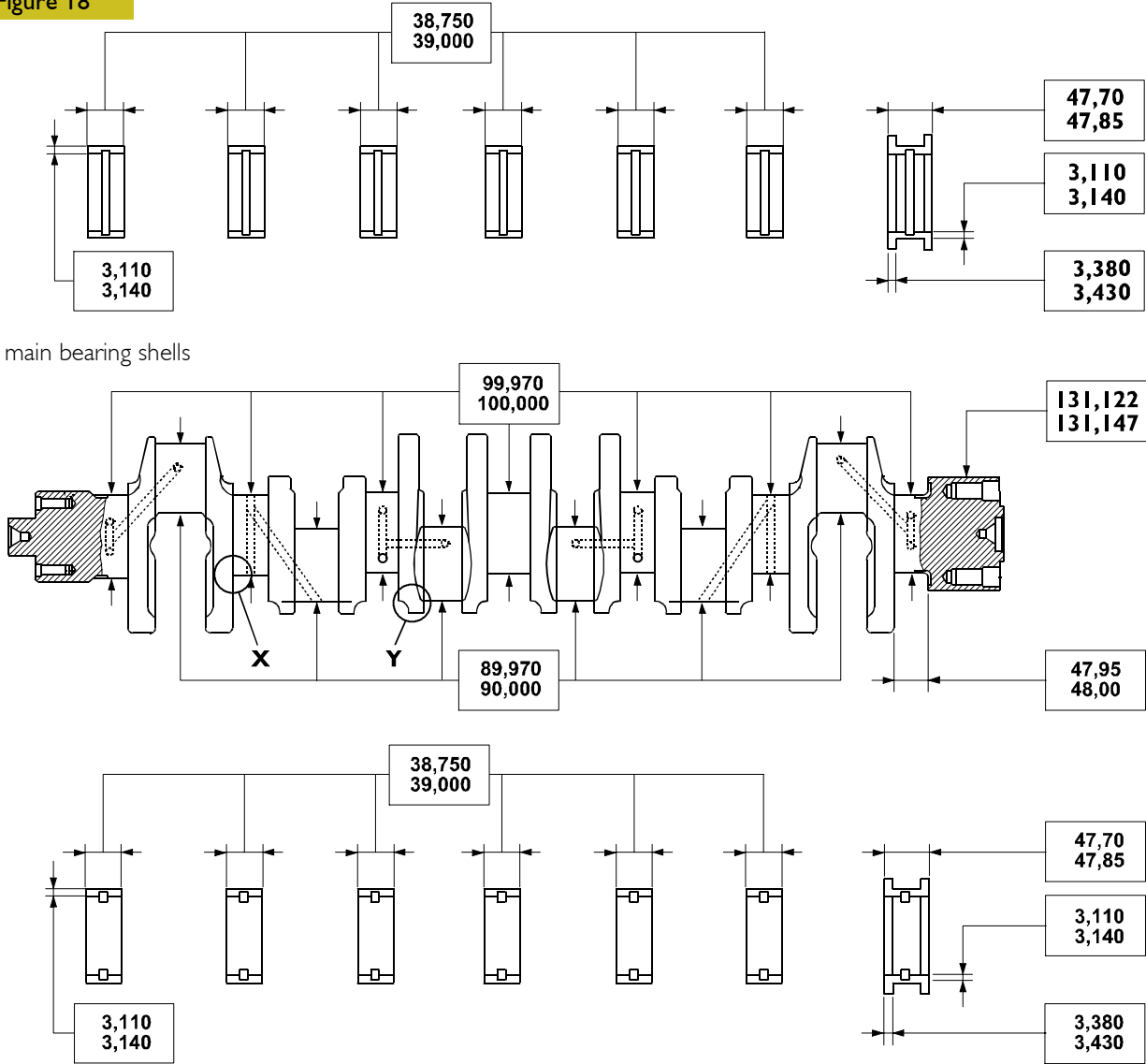
Figure 17



On completing assembly, lock the cylinder liners (1) to the crankcase (2) with the pins 99360703 (3).

Crankshaft

Figure 18



Top main bearing shells

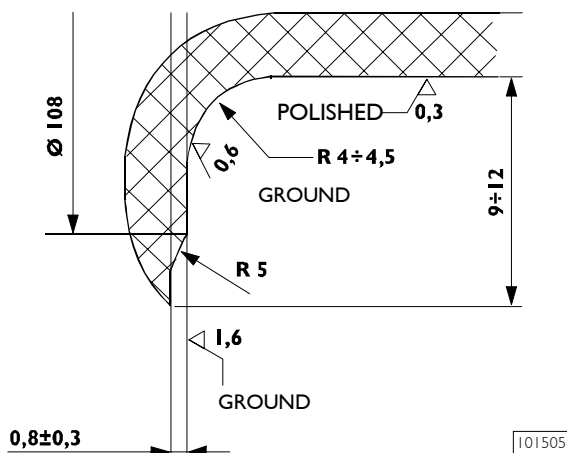
Bottom main bearing shells

101504

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.

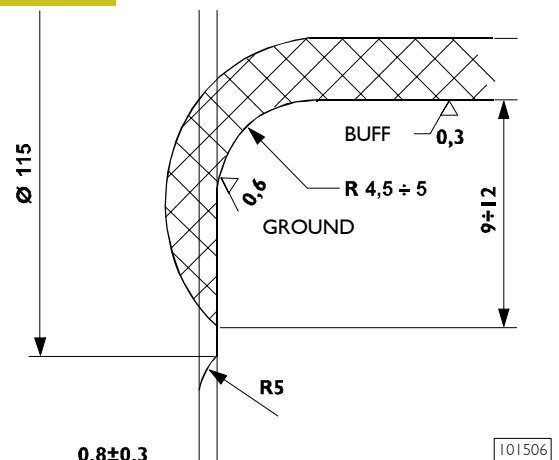
Figure 19



101505

X. Detail of the main journal unions

Figure 20



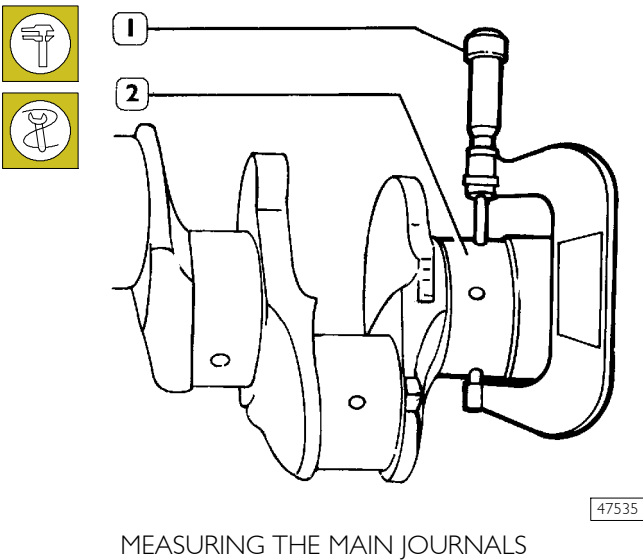
101506

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.

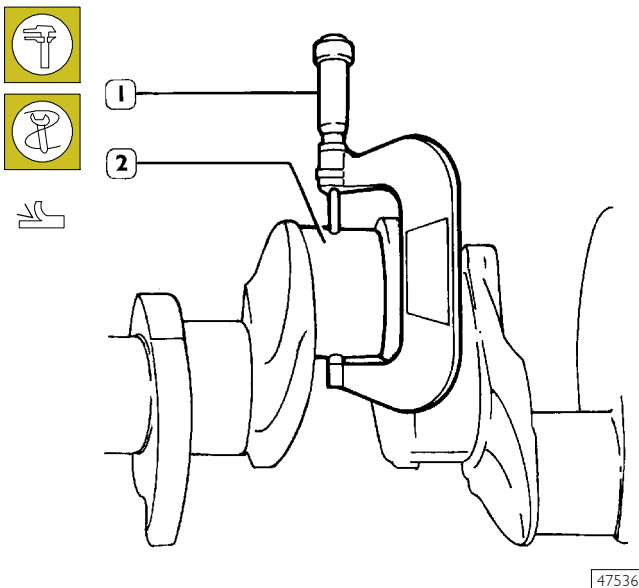
Figure 21



MEASURING THE MAIN JOURNALS

NOTE It is advisable to note the measurements in a table (Figure 22).

Figure 22



MEASURING CRANKPINS

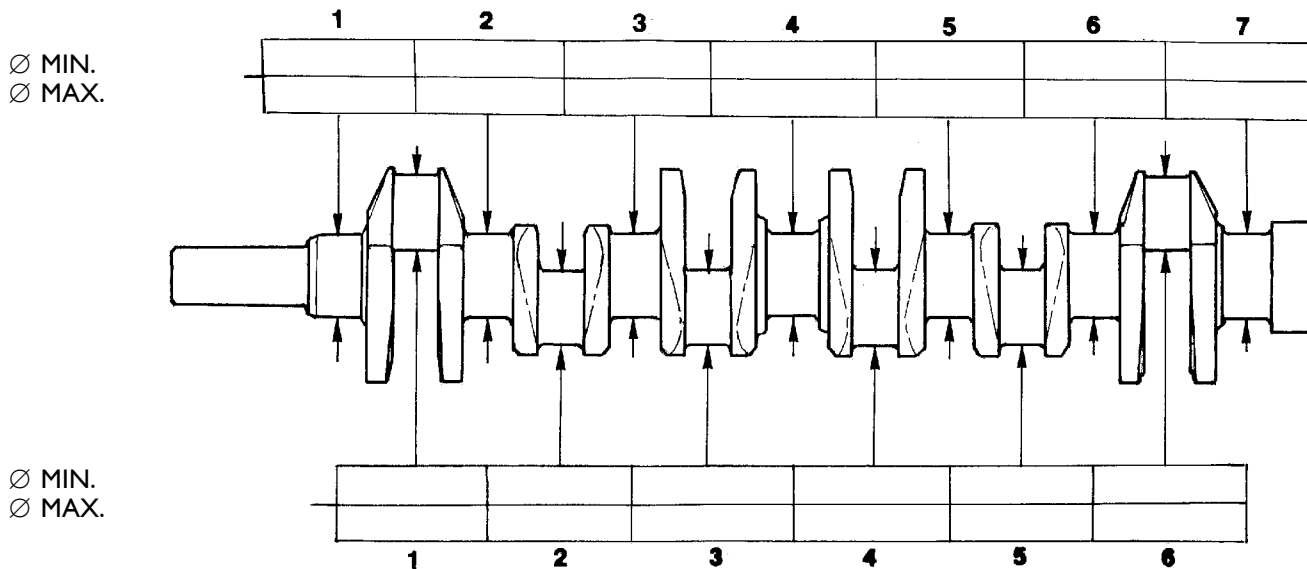
When grinding, pay the utmost attention to the values of the unions of the main journals and of the crankpins given in Figure 19 and Figure 20.

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 23

Table for noting down the measurements of the main journals and crankpins of the crankshaft.

MAIN JOURNALS



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:

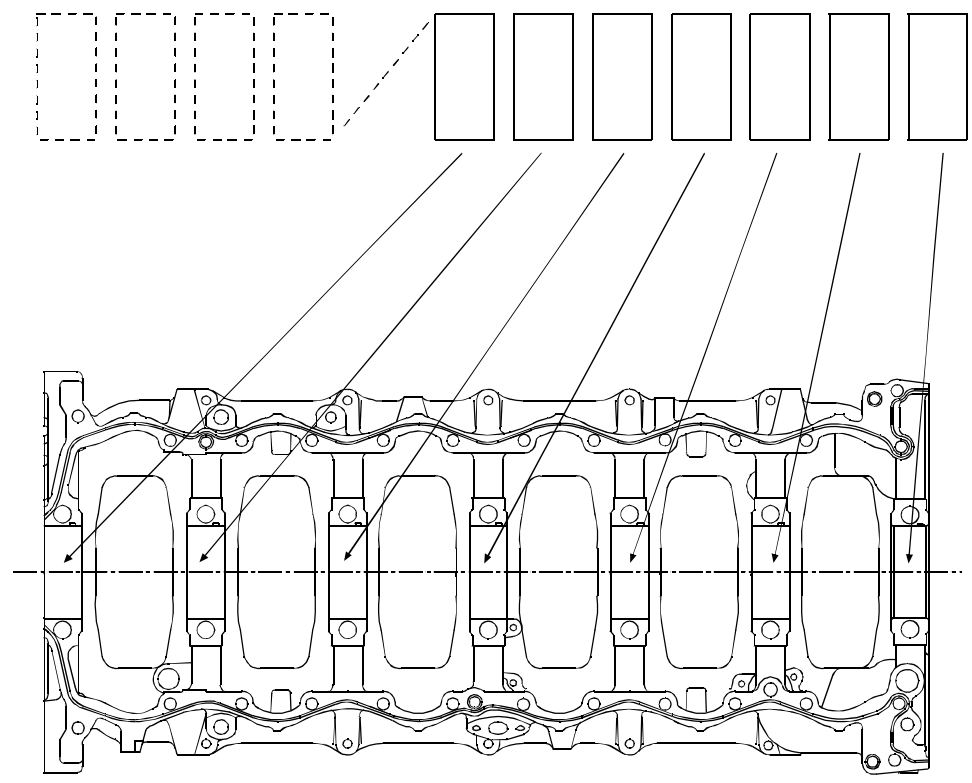
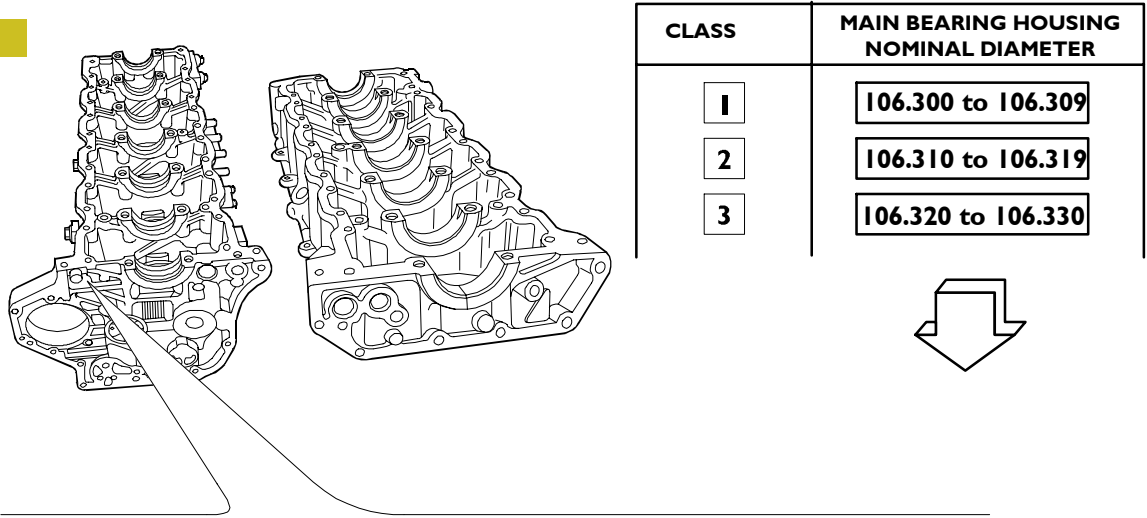
- Determine the class of diameter of the seat in the connecting rod.
- Determine the class of diameter of the crankpin.
- Select the class of the bearing shells to mount.

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 24 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 24 at bottom).
- Each of these digits may be **1**, **2** or **3**.

Figure 24



Selecting the main bearing and big end bearing shells

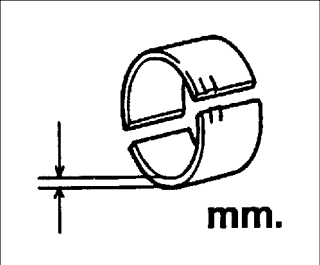
NOTE To obtain the required assembly clearances, the main bearing and big end bearing shells have to be selected as described hereunder.

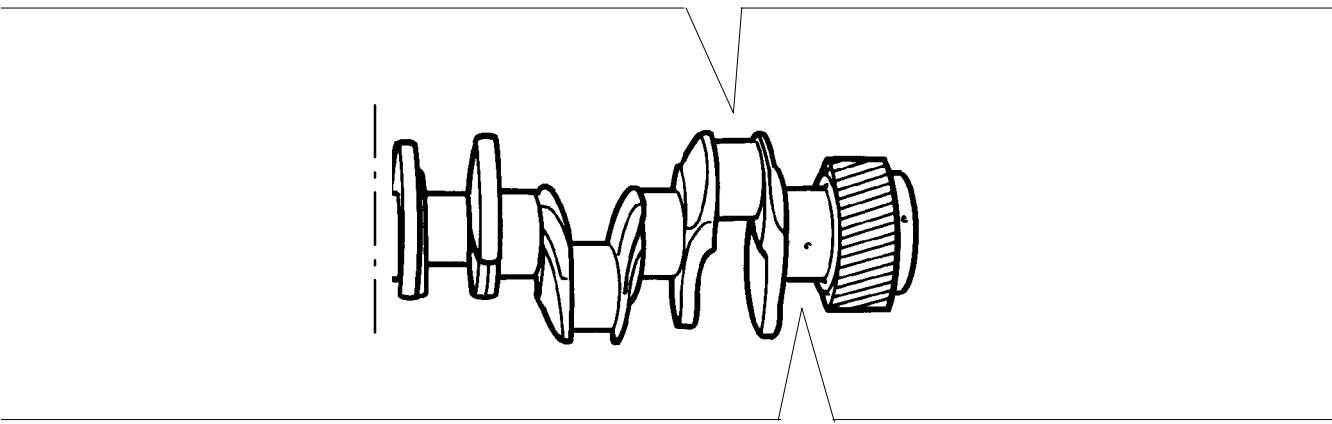
This operation makes it possible to identify the most suited bearing shells for each of the journals of the shaft (the bearing shells may even have different classes for different pins).

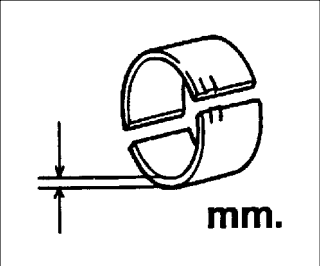
Depending on the thickness, the bearing shells are selected in classes of tolerance marked by a colour (red-green - red/black - green/black).

Figure 25 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 25

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		

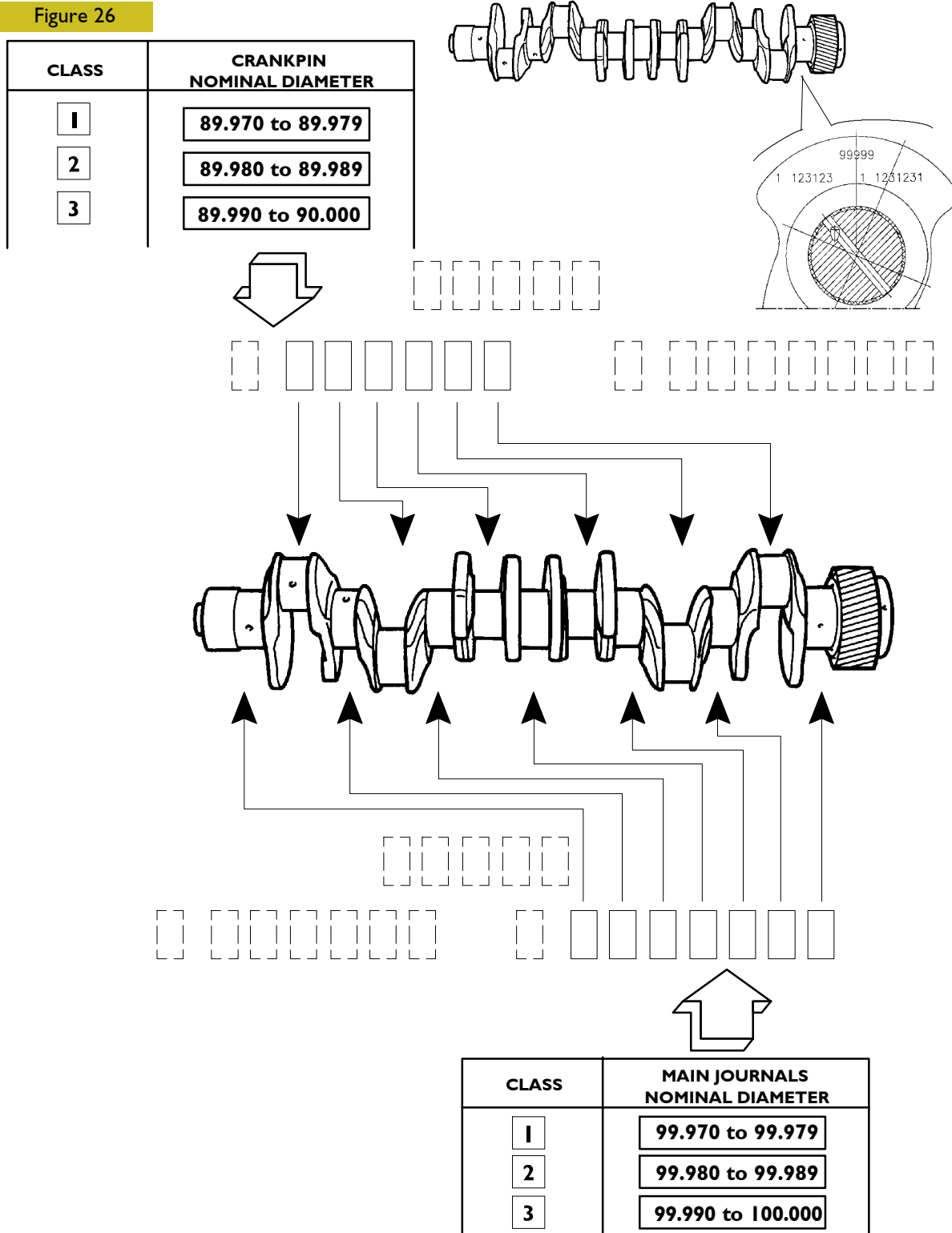
DEFINING THE CLASS OF DIAMETER OF THE MAIN JOURNALS AND CRANKPINS (Journals with nominal diameter)

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 26 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 26 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 26 at bottom).

Figure 26

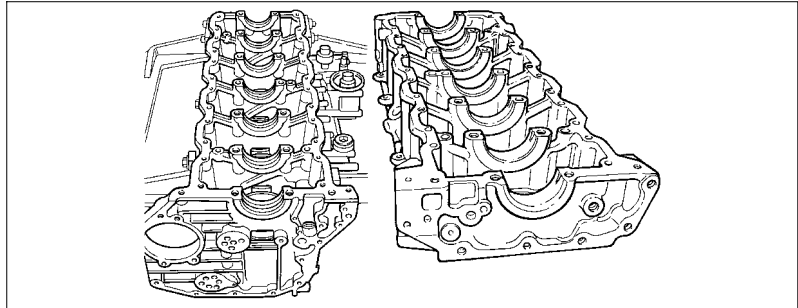


Selecting the main bearing shells (Journals with nominal diameter)

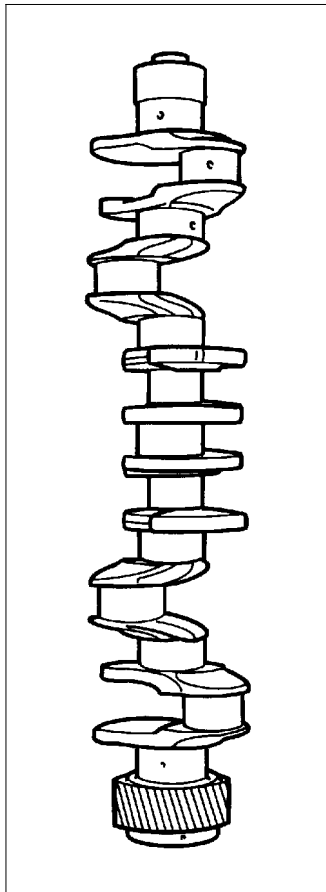
After reading off the data, for each of the main journals, on the crankcase and crankshaft, you choose the type of bearing shells to use according to the following table:

Figure 27

STD.



1	2	3
----------	----------	----------



1	green	green	green
	green	green	green
2	red		green
	red		green
3	red	red	green
	red	red	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 28

<p>red/black = 3.173 to 3.183 mm</p> <p>green/black = 3.184 to 3.193 mm</p>	<p>-0.127</p>													
	<p>99.843 99.852</p> <p>99.853 99.862</p> <p>99.863 99.873</p>	<table border="0"> <tr> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>green/black green/black</td> <td>green/black green/black</td> <td>green/black green/black</td> </tr> <tr> <td>red/black red/black</td> <td></td> <td>green/black green/black</td> </tr> <tr> <td>red/black red/black</td> <td>red/black red/black</td> <td>green/black green/black</td> </tr> </table>	1	2	3	green/black green/black	green/black green/black	green/black green/black	red/black red/black		green/black green/black	red/black red/black	red/black red/black	green/black green/black
1	2	3												
green/black green/black	green/black green/black	green/black green/black												
red/black red/black		green/black green/black												
red/black red/black	red/black red/black	green/black green/black												
	<p>-0.254</p> <p>red = 3.237 to 3.247 mm</p>													
	<p>-0.508</p> <p>red = 3.364 to 3.374 mm</p>													
	<p>99.726 99.746</p>	<table border="0"> <tr> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>red red</td> <td></td> <td>red red</td> </tr> <tr> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>red red</td> <td></td> <td>red red</td> </tr> </table>	1	2	3	red red		red red	1	2	3	red red		red red
1	2	3												
red red		red red												
1	2	3												
red red		red red												

SELECTING THE BIG END BEARING SHELLS (JOURNALS WITH NOMINAL DIAMETER)

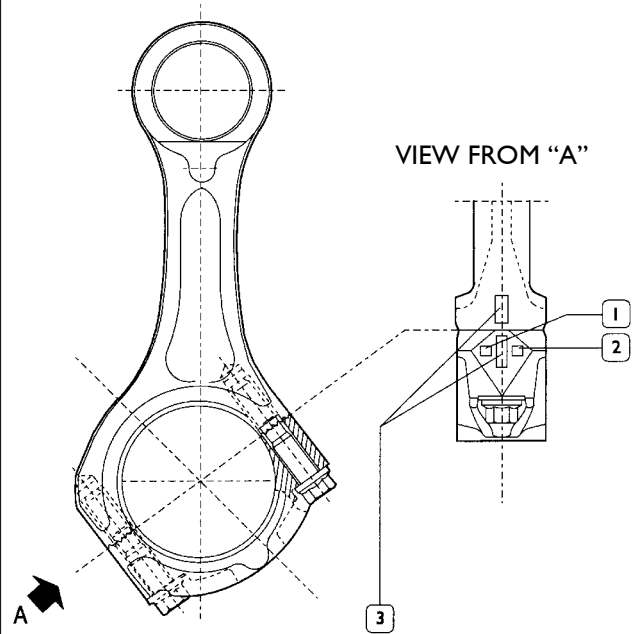
There are three markings on the body of the connecting rod in the position indicated as "A":

- 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** or **3**.

Determine the type of big end bearing to fit on each journal by following the indications in the table (Figure 30).

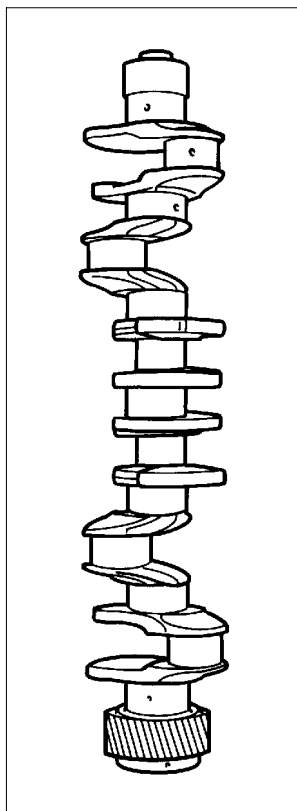
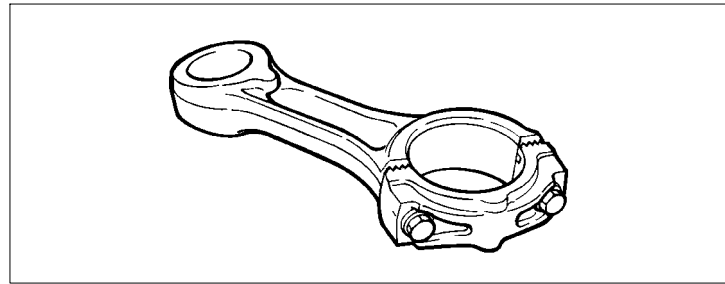
Figure 29



47557

Figure 30

STD.



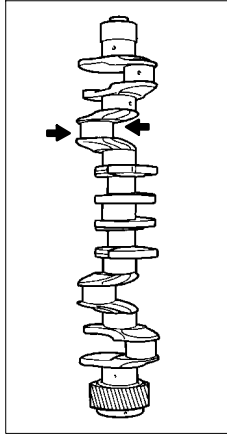
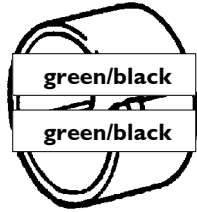
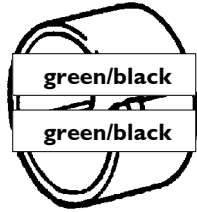
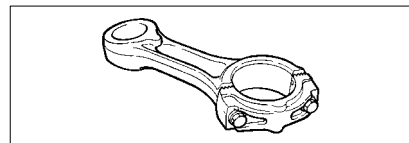
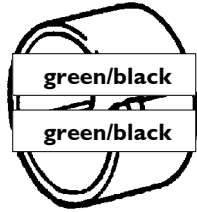
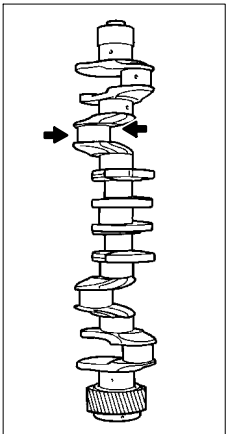
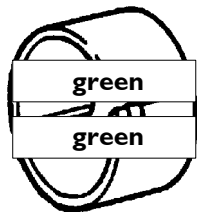
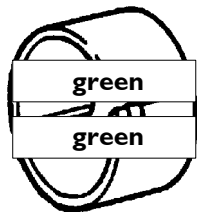
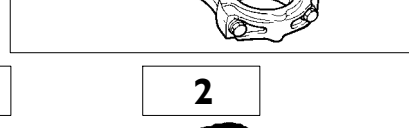
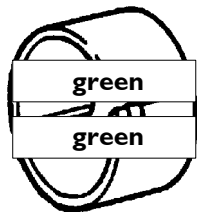
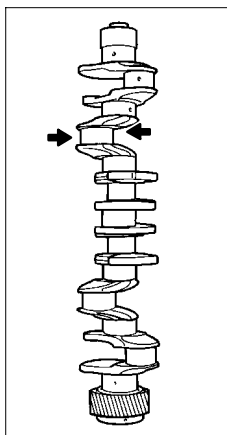
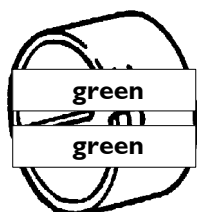
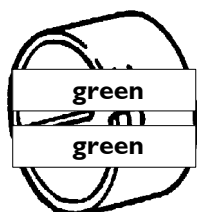
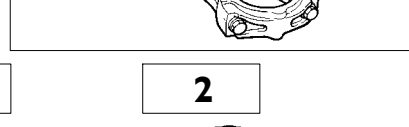
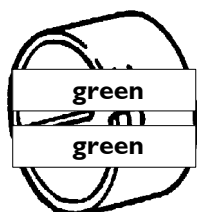
CLASS	1	2	3
1	green	green	green
	green	green	green
2	red	green	green
	red	green	green
3	red	red	green
	red	red	green

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.

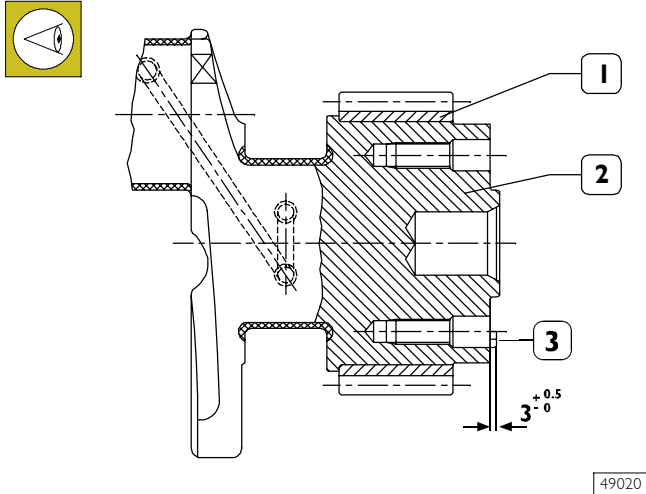
Figure 31

<p>red/black = 2.028 to 2.038 mm</p> <p>green/black = 2.039 to 2.048 mm</p> 	<p style="font-size: 2em; text-align: center;">-0.127</p> <table border="0"> <tr> <td style="text-align: center;">89.843</td> <td style="text-align: center;">1</td> <td style="text-align: center;">green/black</td> <td style="text-align: center;">2</td> <td style="text-align: center;">green/black</td> <td style="text-align: center;">3</td> <td style="text-align: center;">green/black</td> </tr> <tr> <td style="text-align: center;">89.852</td> <td style="text-align: center;">1</td> <td style="text-align: center;">green/black</td> <td style="text-align: center;">2</td> <td style="text-align: center;">green/black</td> <td style="text-align: center;">3</td> <td style="text-align: center;">green/black</td> </tr> <tr> <td style="text-align: center;">89.853</td> <td style="text-align: center;">2</td> <td style="text-align: center;">red/black</td> <td colspan="2" style="text-align: center;"></td> <td style="text-align: center;">3</td> <td style="text-align: center;">green/black</td> </tr> <tr> <td style="text-align: center;">89.862</td> <td style="text-align: center;">2</td> <td style="text-align: center;">red/black</td> <td style="text-align: center;">3</td> <td style="text-align: center;">red/black</td> <td style="text-align: center;">3</td> <td style="text-align: center;">green/black</td> </tr> <tr> <td style="text-align: center;">89.863</td> <td style="text-align: center;">3</td> <td style="text-align: center;">red/black</td> <td style="text-align: center;">3</td> <td style="text-align: center;">red/black</td> <td style="text-align: center;">3</td> <td style="text-align: center;">green/black</td> </tr> <tr> <td style="text-align: center;">89.873</td> <td style="text-align: center;">3</td> <td style="text-align: center;">red/black</td> <td style="text-align: center;">3</td> <td style="text-align: center;">red/black</td> <td style="text-align: center;">3</td> <td style="text-align: center;">green/black</td> </tr> </table>	89.843	1	green/black	2	green/black	3	green/black	89.852	1	green/black	2	green/black	3	green/black	89.853	2	red/black			3	green/black	89.862	2	red/black	3	red/black	3	green/black	89.863	3	red/black	3	red/black	3	green/black	89.873	3	red/black	3	red/black	3	green/black	
89.843	1	green/black	2	green/black	3	green/black																																						
89.852	1	green/black	2	green/black	3	green/black																																						
89.853	2	red/black			3	green/black																																						
89.862	2	red/black	3	red/black	3	green/black																																						
89.863	3	red/black	3	red/black	3	green/black																																						
89.873	3	red/black	3	red/black	3	green/black																																						
	<p style="font-size: 2em; text-align: center;">-0.254</p> <p>red = 2.092 to 2.102 mm</p> <p>green = 2.103 to 2.112 mm</p> <table border="0"> <tr> <td style="text-align: center;">89.726</td> <td style="text-align: center;">1</td> <td style="text-align: center;">red</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">89.735</td> <td style="text-align: center;">1</td> <td style="text-align: center;">red</td> <td colspan="2" style="text-align: center;"></td> </tr> <tr> <td style="text-align: center;">89.736</td> <td style="text-align: center;">1</td> <td style="text-align: center;">red</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">89.746</td> <td style="text-align: center;">1</td> <td style="text-align: center;">red</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> </tr> </table>	89.726	1	red	2	3	89.735	1	red			89.736	1	red	2	3	89.746	1	red	2	3																							
89.726	1	red	2	3																																								
89.735	1	red																																										
89.736	1	red	2	3																																								
89.746	1	red	2	3																																								
	<p style="font-size: 2em; text-align: center;">-0.508</p> <p>red = 2.219 to 2.229 mm</p> <p>green = 2.230 to 2.239 mm</p> <table border="0"> <tr> <td style="text-align: center;">89.472</td> <td style="text-align: center;">1</td> <td style="text-align: center;">red</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">89.481</td> <td style="text-align: center;">1</td> <td style="text-align: center;">red</td> <td colspan="2" style="text-align: center;"></td> </tr> <tr> <td style="text-align: center;">89.482</td> <td style="text-align: center;">1</td> <td style="text-align: center;">red</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">89.492</td> <td style="text-align: center;">1</td> <td style="text-align: center;">red</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> </tr> </table>	89.472	1	red	2	3	89.481	1	red			89.482	1	red	2	3	89.492	1	red	2	3																							
89.472	1	red	2	3																																								
89.481	1	red																																										
89.482	1	red	2	3																																								
89.492	1	red	2	3																																								

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 32



49020

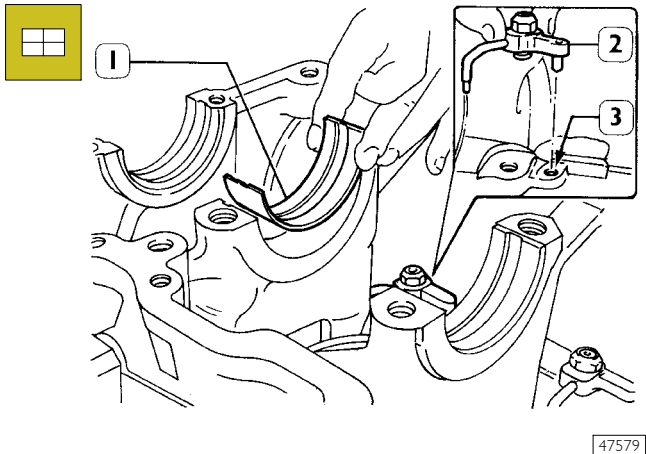
When fitting gear (1) onto drive shaft (2), the gear must be heated for 2 hours max. in a furnace, at a temperature not higher than 180 °C.

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 33

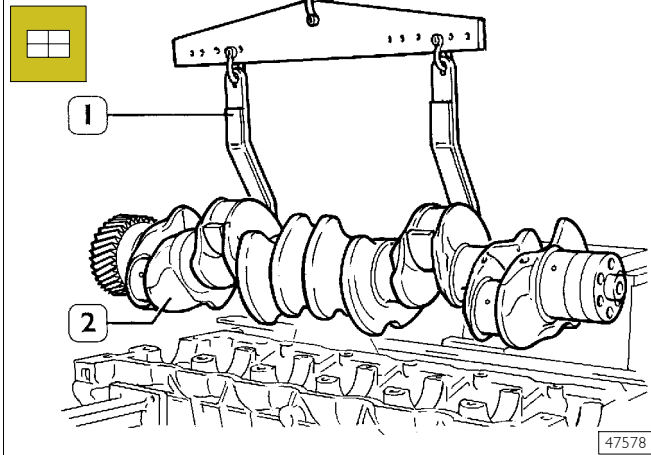


47579

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.

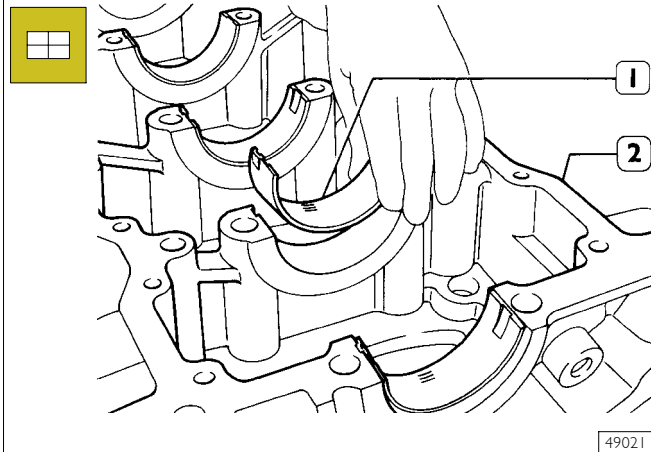
Figure 34



47578

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

Figure 35

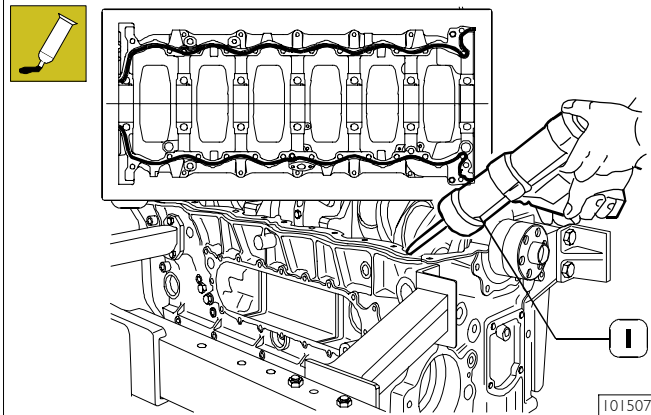


49021

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 36



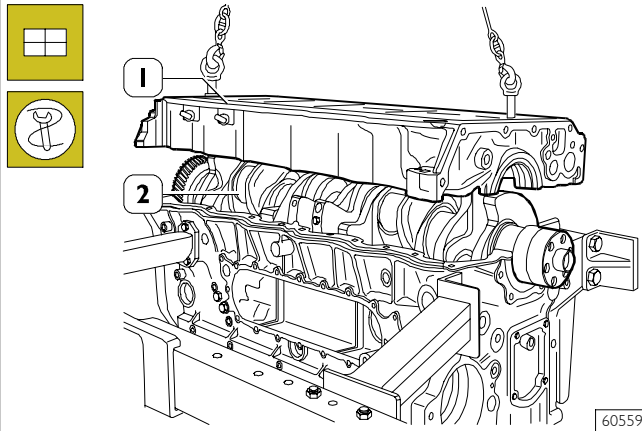
101507

By means of suitable equipment (1) apply silicone LOCTITE 5970 to the block, as shown in the figure.

Frame shows the application scheme for the LOCTITE 5970 sealant.

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

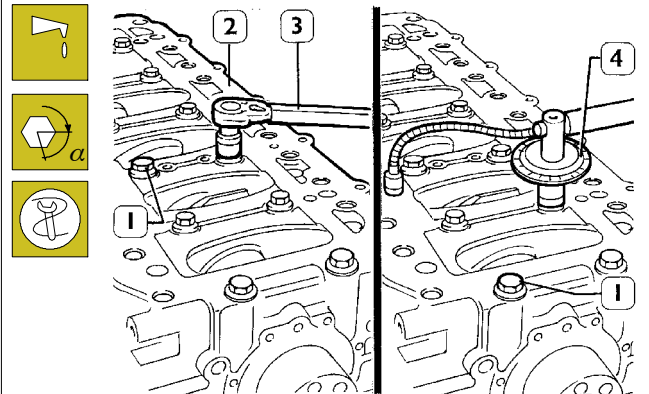
Figure 37



60559

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).

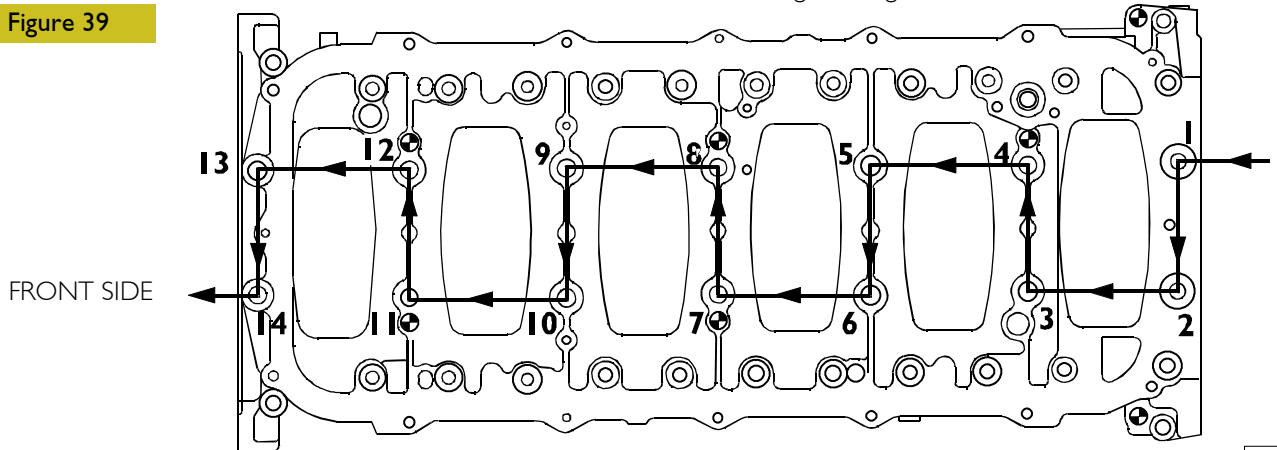
Figure 38



47578

☐ 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.

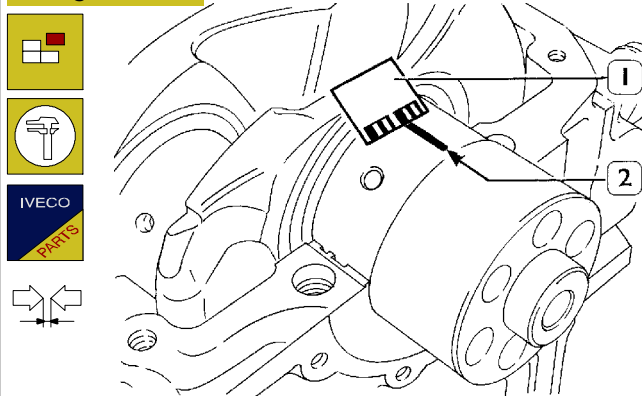
Figure 39



60593

DIAGRAM OF SEQUENCE FOR TIGHTENING THE SCREWS FIXING THE BOTTOM CRANKCASE BASE TO THE CRANKCASE

Figure 40



47579

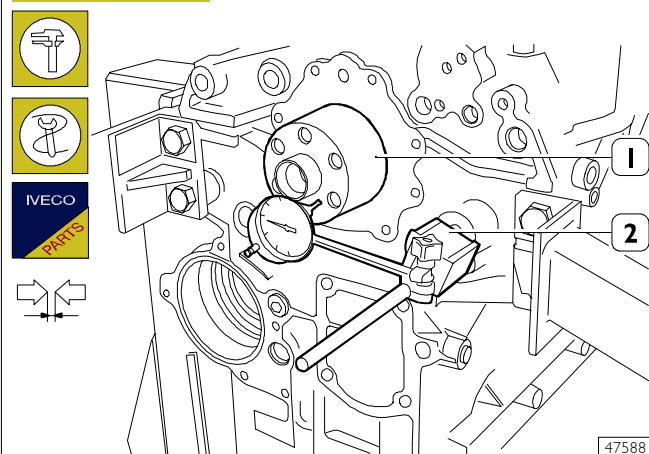
☐ Remove the crankcase base.

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 41

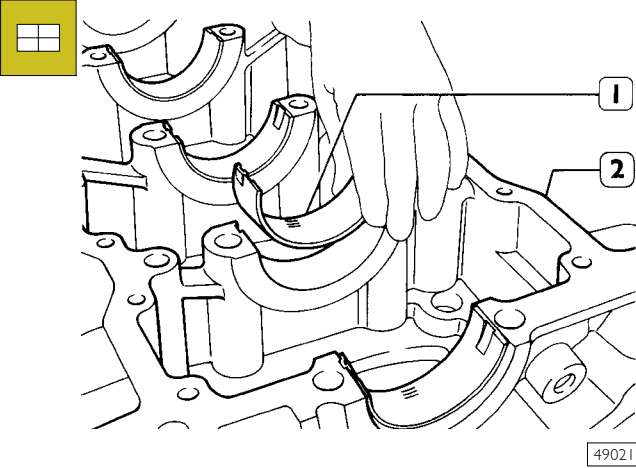


47588

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.

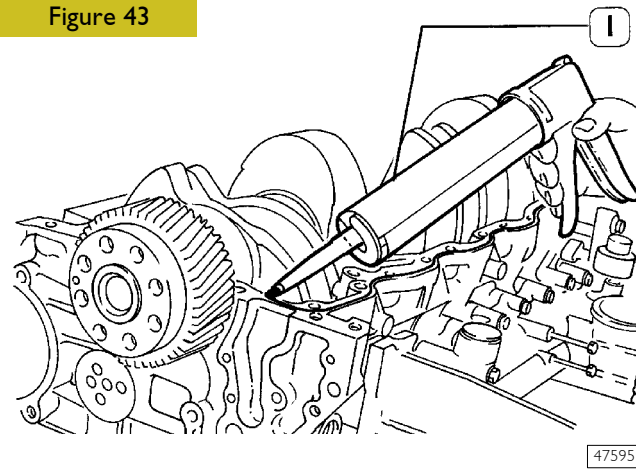
ASSEMBLING THE ENGINE ON THE BENCH

Figure 42



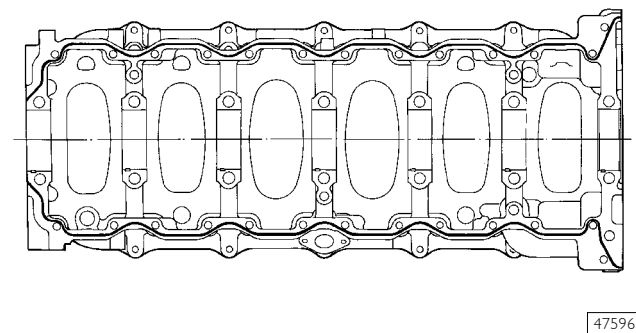
Place the half-bearings (1) on the main bearings in the underblock (2).

Figure 43



By means of suitable equipment (1) apply silicone LOCTITE 5970 IVECO No. 2992644 to the block, as shown in the figure.

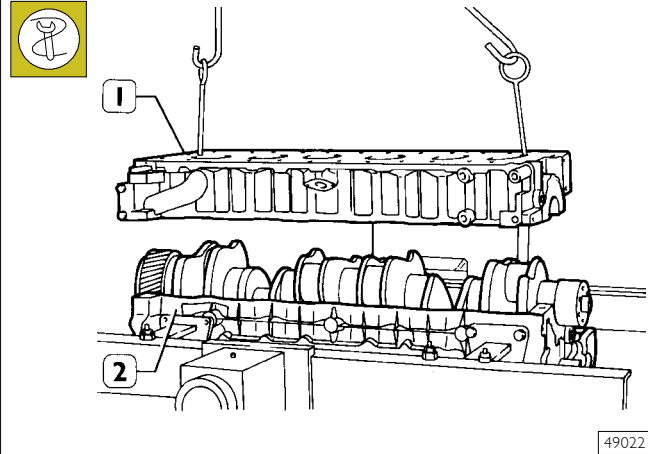
Figure 44



Sealant application diagram

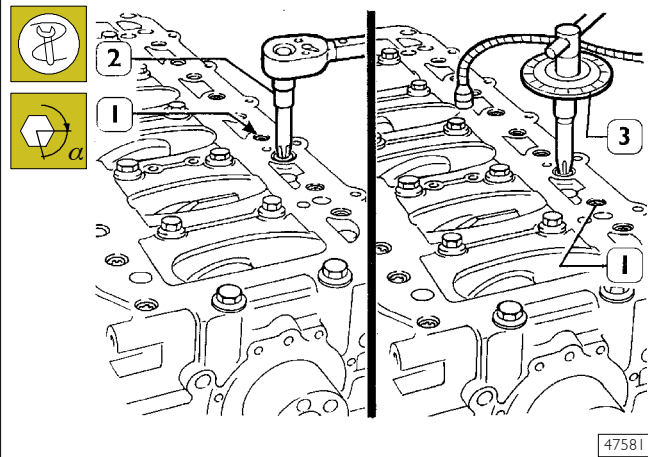
NOTE Fit the underblock within 10' of the application of the sealant.

Figure 45



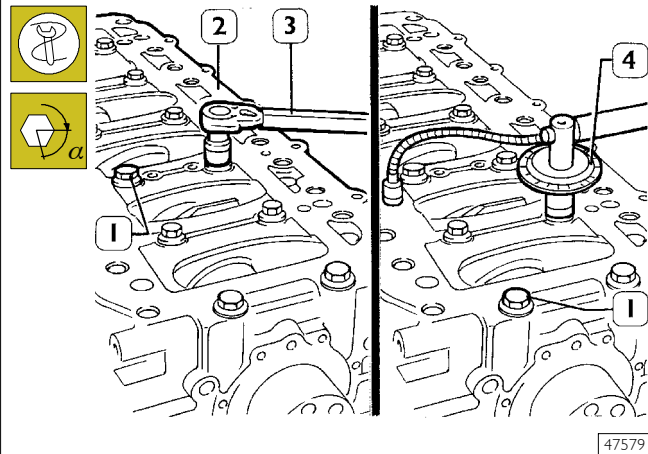
Fit the underblock by means of a suitable hoist and hooks (1).

Figure 46



Fit the sub-engine block and use a dynamometric wrench (2) to tighten the outer hexagonal-grooved screws (1) to 30 Nm according to the diagrams on the following page.

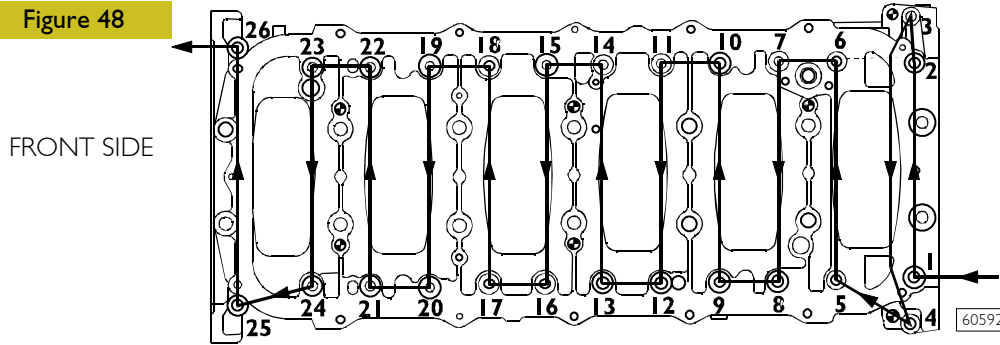
Figure 47



Close the inner screws (1) to 120 Nm torque by means of a dynamometric wrench (3), then with two further angular phases $60^\circ + 55^\circ$, using tool 99395216 (4). Tighten again the outer screws (1, Figure 46) with 60° angular closing, using tool 99395216 (3, Figure 46).

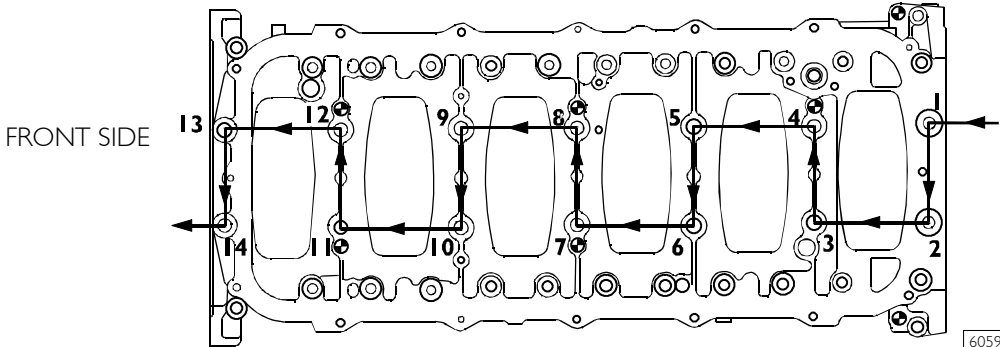
DIAGRAM SHOWING THE UNDERBLOCK FIXING SCREWS TIGHTENING ORDER

Figure 48



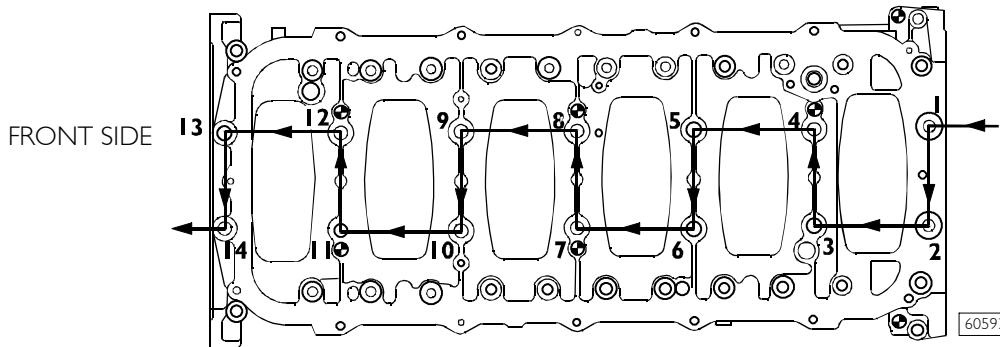
FRONT SIDE

stage 1:
pretightening
outer screws
(30 Nm)



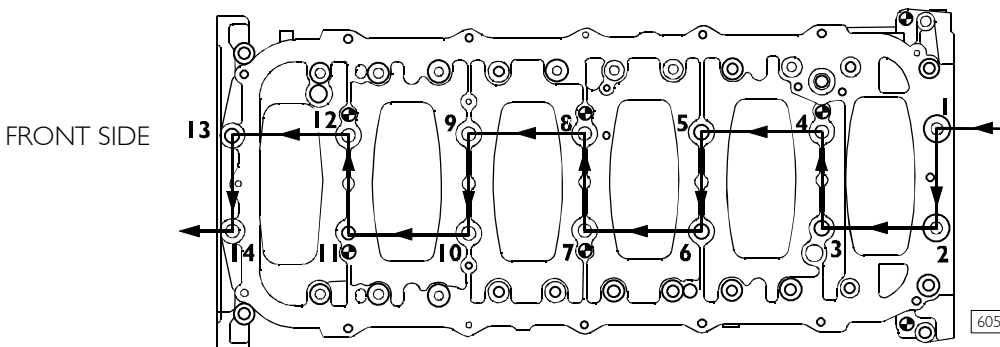
FRONT SIDE

stage 2:
pretightening
inner screws
(120 Nm)



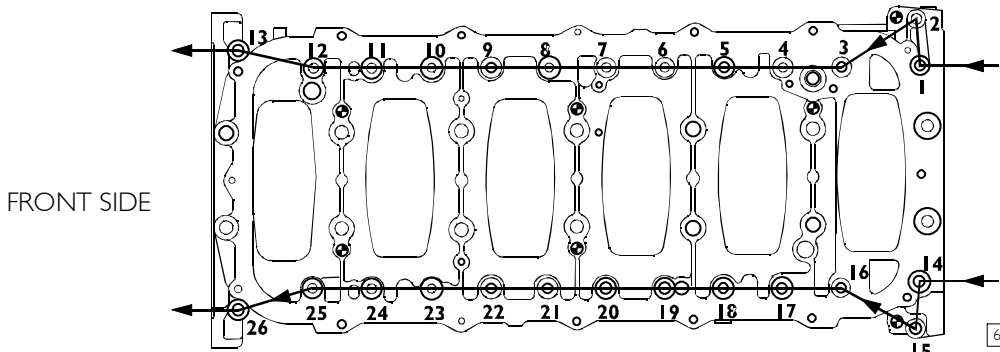
FRONT SIDE

stage 3:
angle
inner
screws
(60°)



FRONT SIDE

stage 4:
angle
inner
screws
(55°)

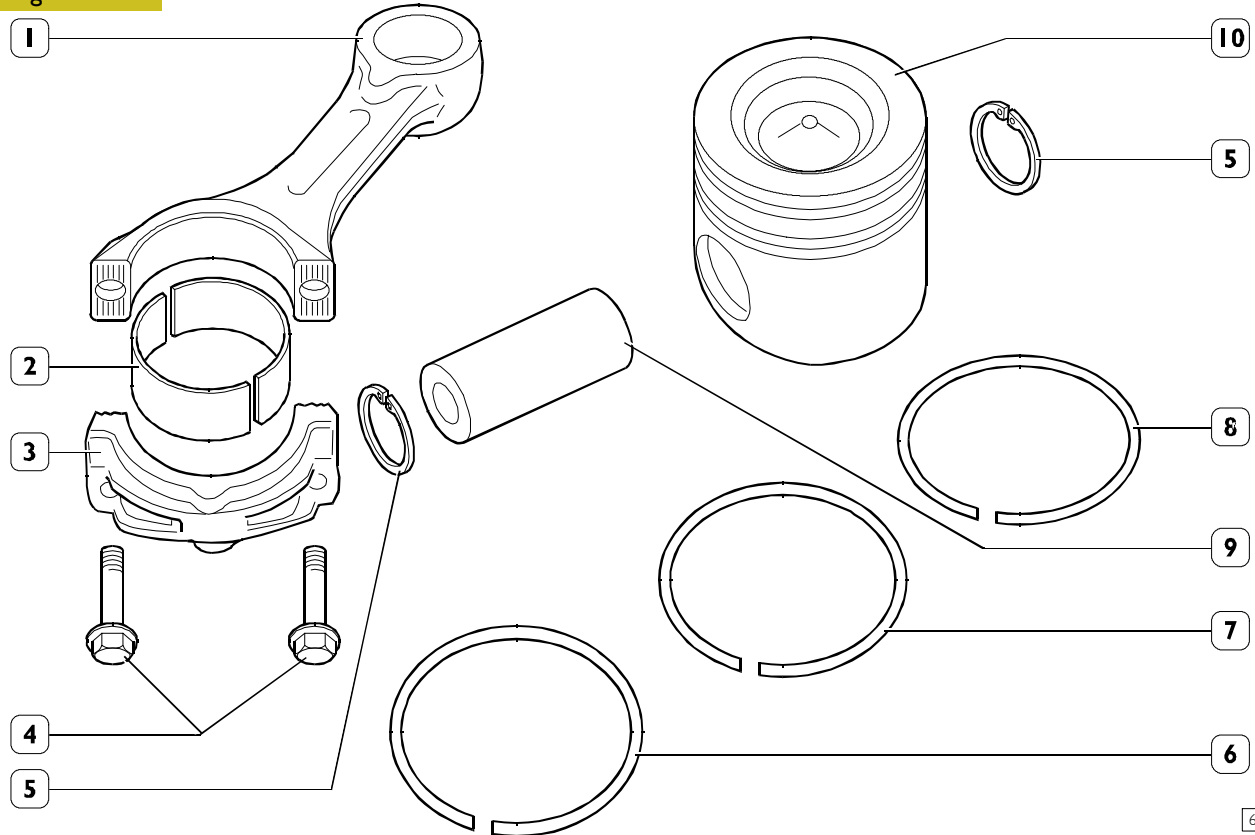


FRONT SIDE

stage 5:
angle
outer
screws
(60°)

PISTON CONNECTING ROD ASSEMBLY

Figure 49



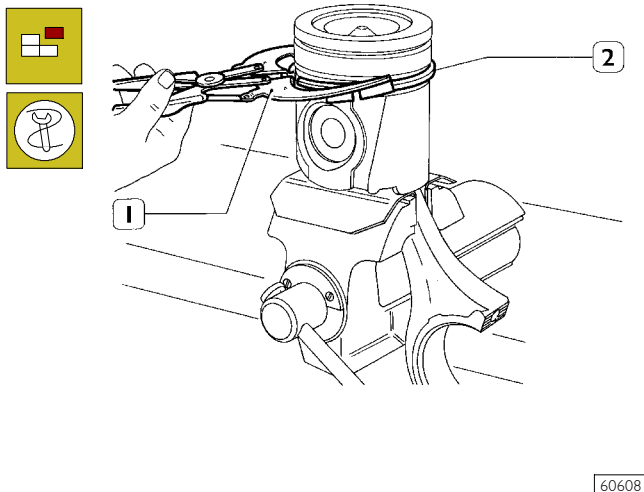
PISTON CONNECTING ROD ASSEMBLY

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 not show any trace of seizing, scoring, cracking; replace as necessary.

Removal

Figure 50

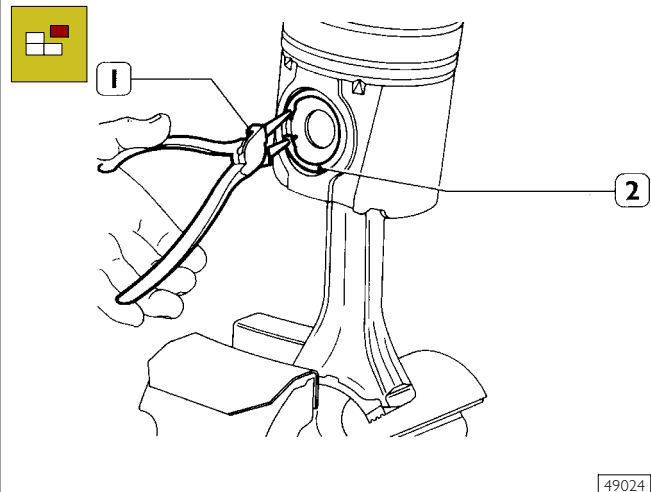


Removal of the piston split rings (2) using the pliers 99360184 (1).

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

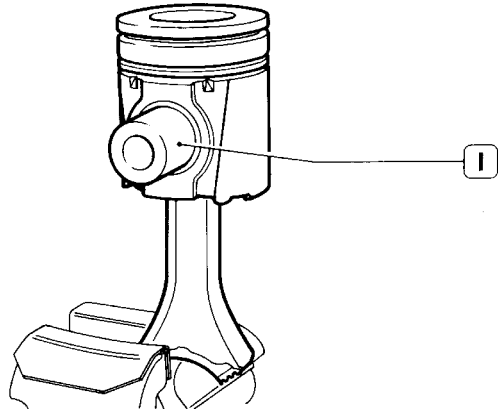
Pistons are grouped into classes A and B for diameter.

Figure 51



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

Figure 52

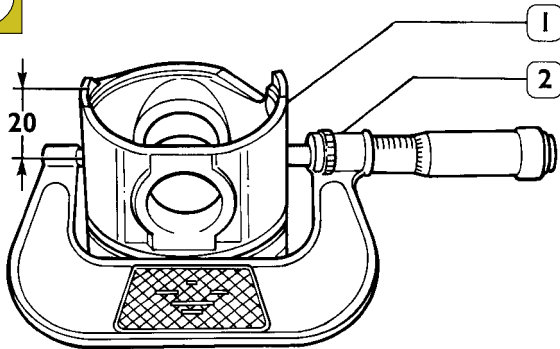


49025

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

Measuring the diameter of the pistons

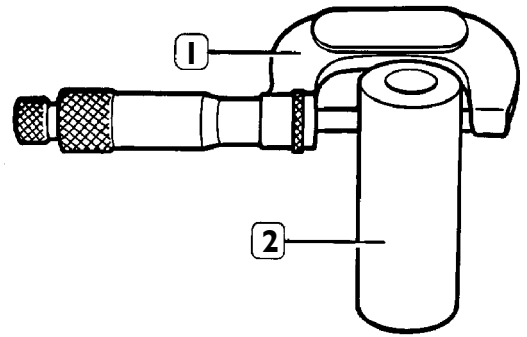
Figure 53



71714

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 54

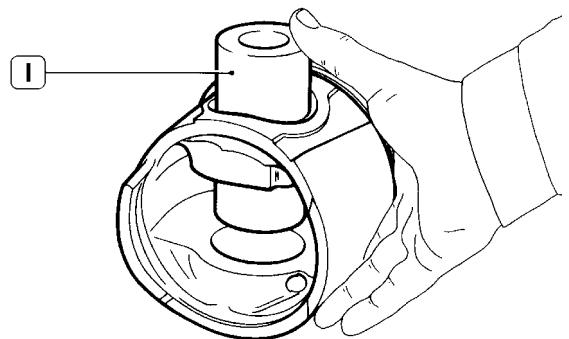


32618

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

Conditions for correct gudgeon pin-piston coupling

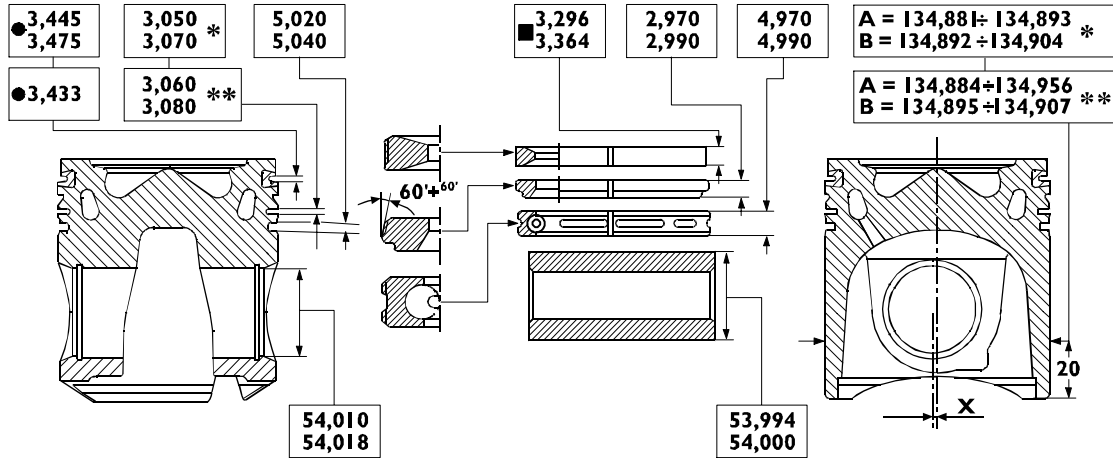
Figure 55



49026

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 56



106242

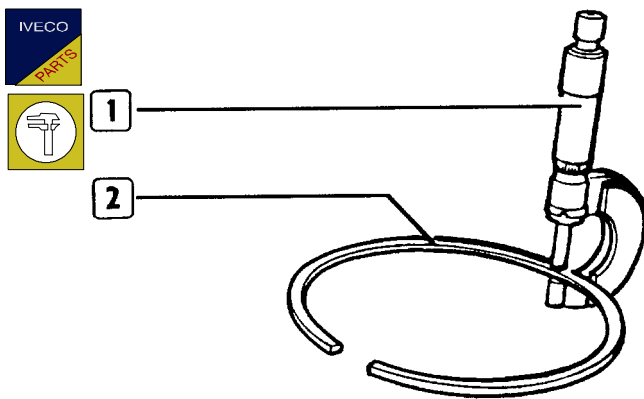
MAIN DATA OF THE PISTON, PISTON RINGS AND PIN

* MAHLE MONDIAL piston - ** FEDERAL MOGUL piston

● Dimension detected on 130 mm Ø. - ■ measured at 2.5 mm from outer Ø - X = 0,8±0,1

Piston rings

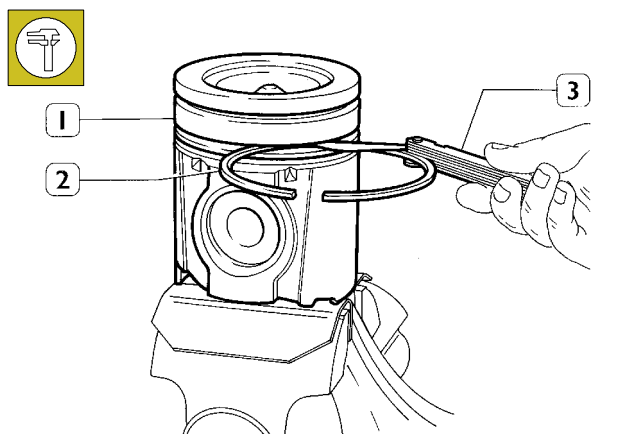
Figure 57



16552

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

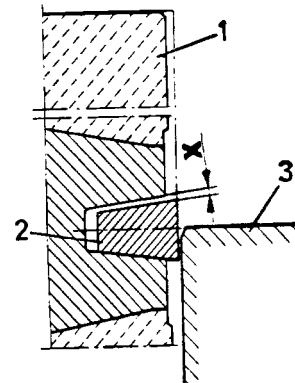
Figure 58



60610

Check the clearance between the seals (2) and their seats on the piston (1) with a feeler gauge (3).

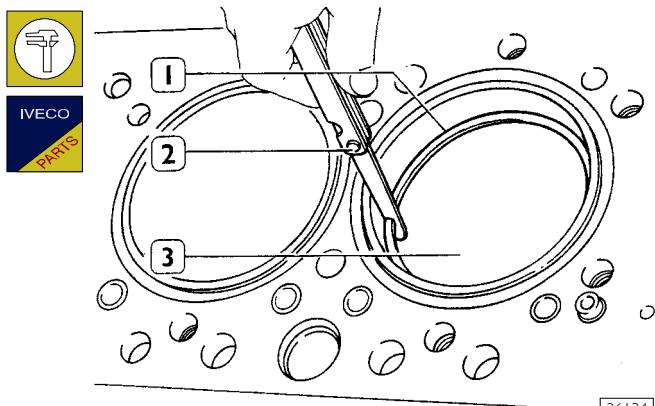
Figure 59



3513

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 60



36134

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

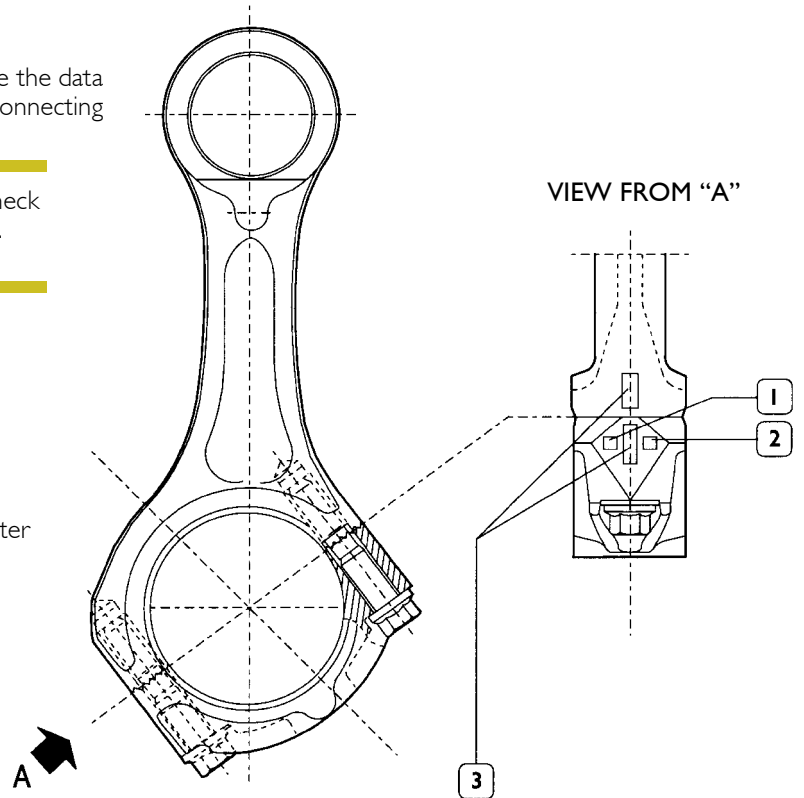
Figure 61

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.

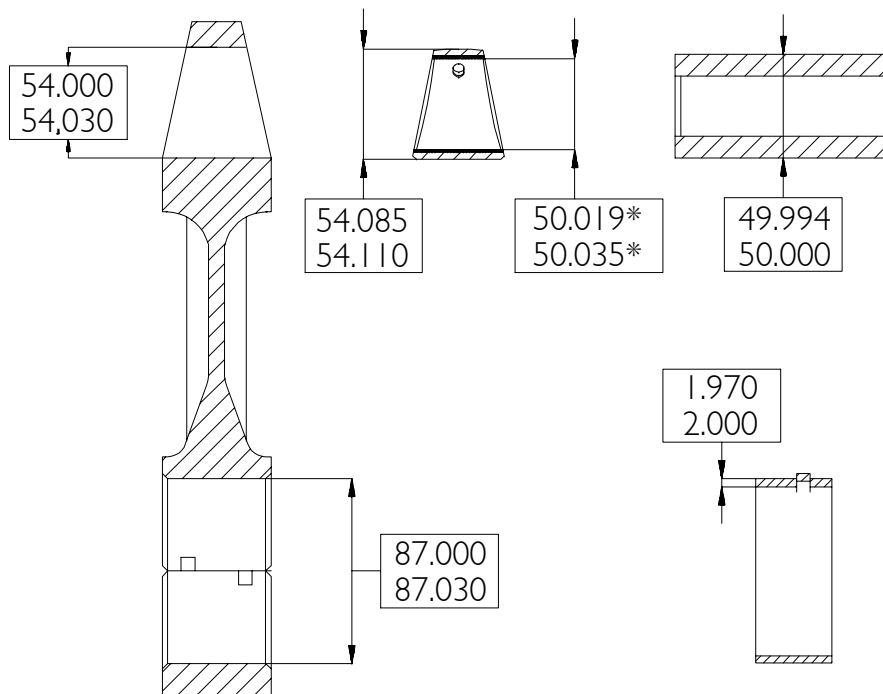
Connecting rod punch markings

- 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 62



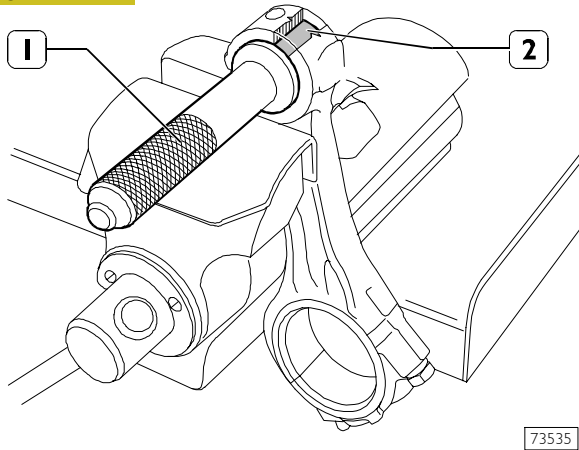
71716

MAIN DATA OF THE BUSHING, CONNECTING ROD, PIN AND BEARING SHELLS

* Measurement to be made after driving in the bushing.

Bushings

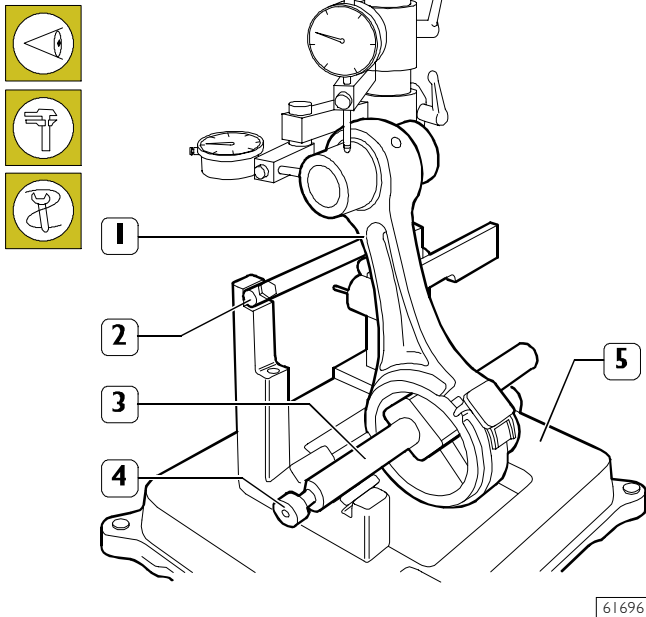
Figure 63



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 64



Checking axis alignment

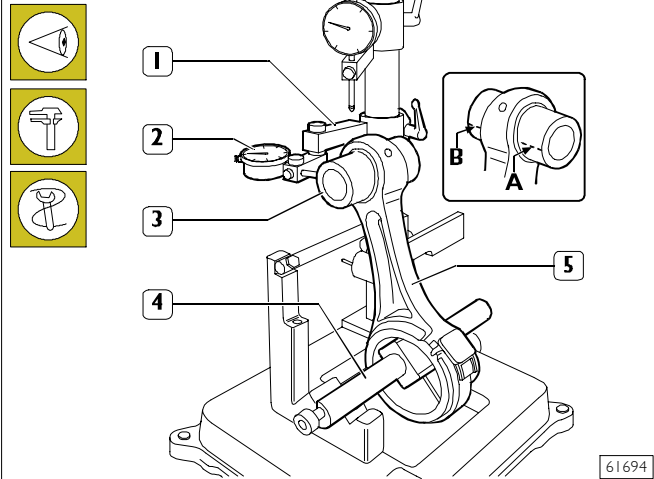
Check the alignment of the axes of the connecting rods (1) with device 99395363 (5), proceeding as follows:

Fit the connecting rod (1) on the spindle of the tool 99395363 (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 65

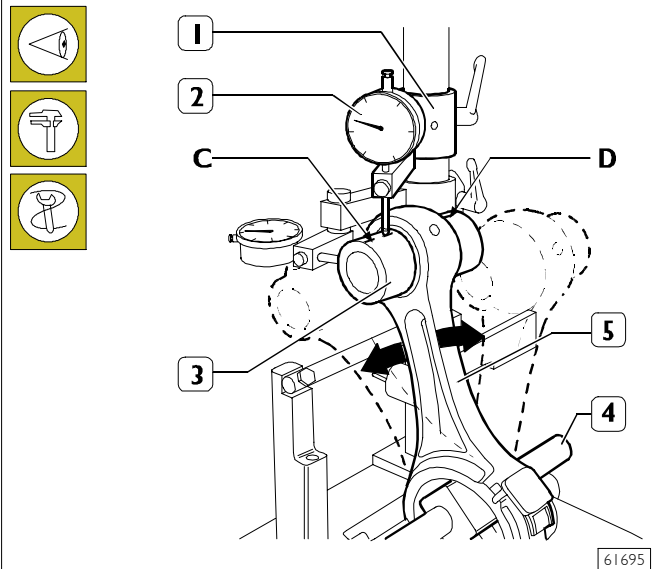


Check the torsion of the connecting rod (5) by comparing two points (A and B) of the pin (3) on the horizontal plane of the axis of the connecting rod.

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 66



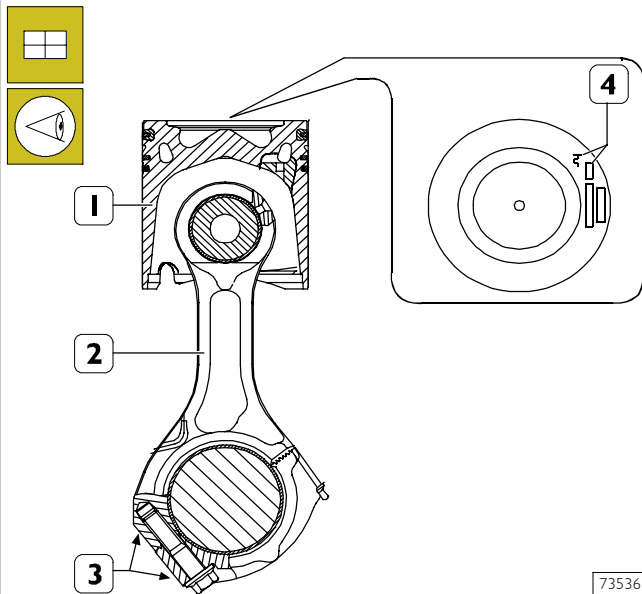
Check the bending of the connecting rod (5) by comparing two points C and D of the pin (3) on the vertical plane of the axis of the connecting rod.

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

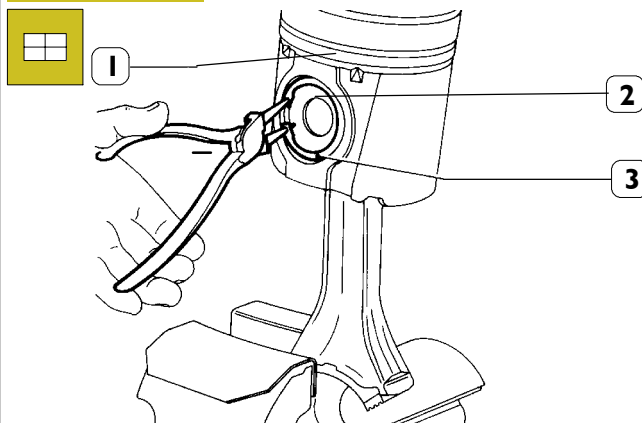
Figure 67



73536

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 68

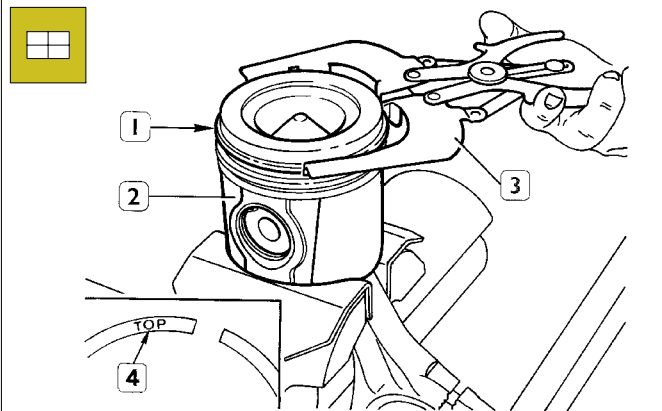


74052

Fit the pin (2) and fasten it on the piston (1) with the split rings (3).

Mounting the piston rings

Figure 69



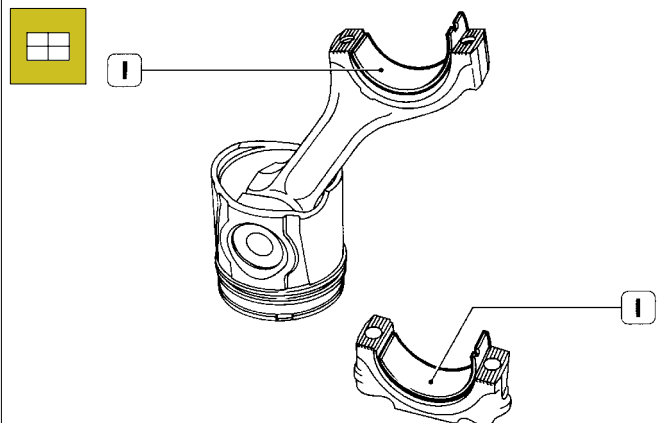
60614

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 70



49030

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.

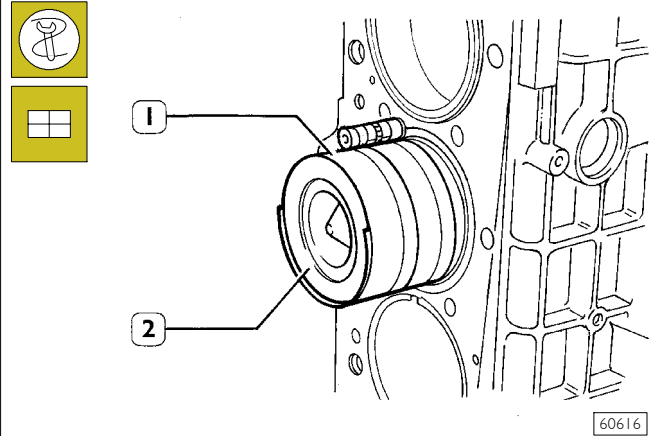
Fitting connecting rod - piston assemblies in the cylinder liners

With the aid of the clamp 99360605 (1, Figure 71), fit the connecting rod – piston assembly (2) in the cylinder liners, according to the diagram of Figure 72, 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.

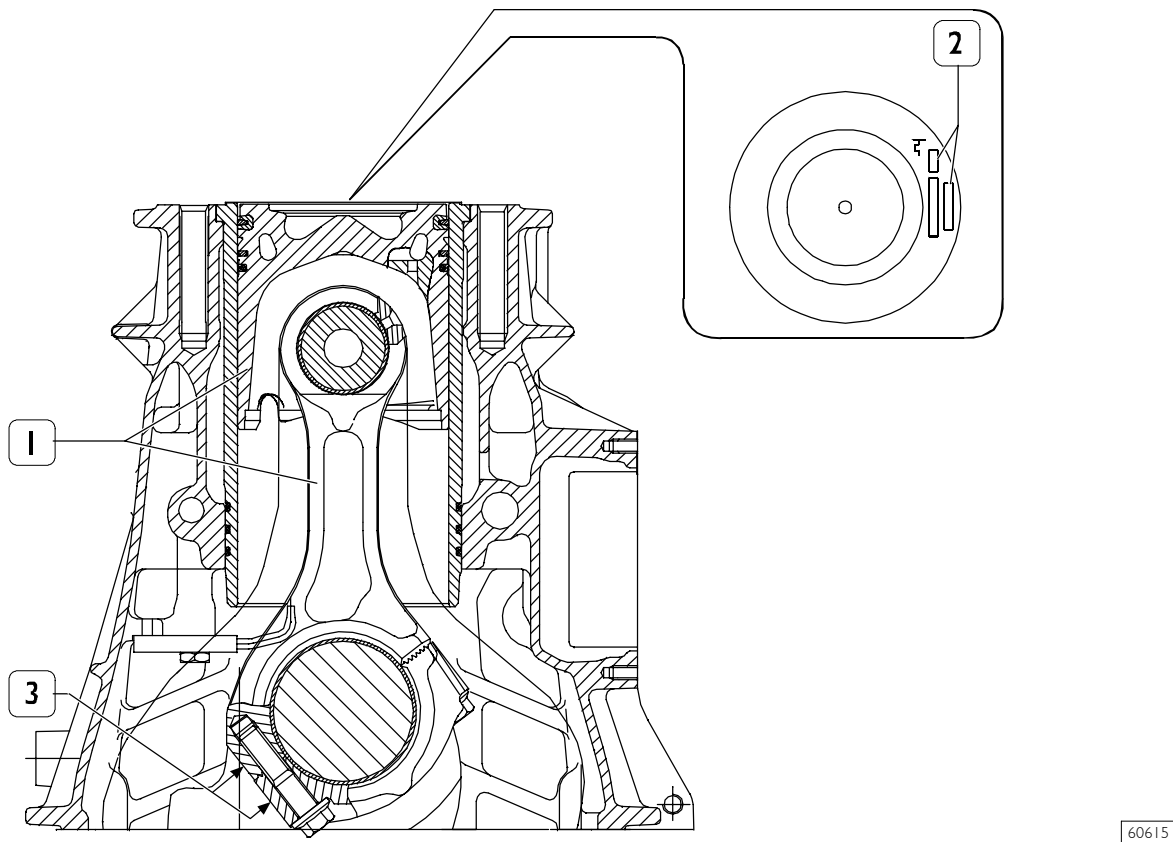
Figure 71



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 72



ASSEMBLY DIAGRAM OF CONNECTING ROD – PISTON ASSEMBLY IN CYLINDER LINER

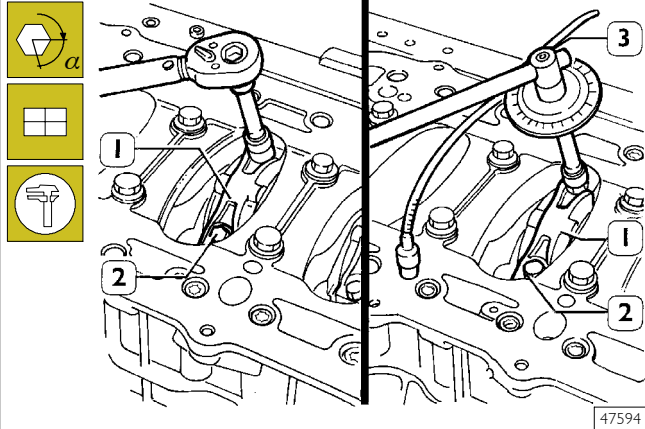
1. Connecting rod – piston assembly – 2. Area of punch marking on the top of the piston, symbol showing assembly position and selection class – 3. Connecting rod punch mark area

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 73



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

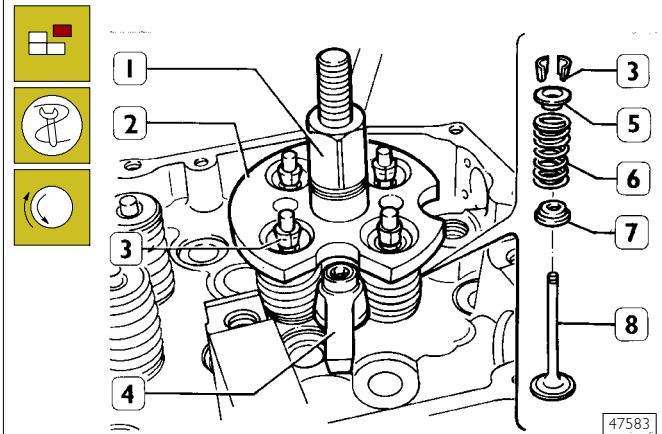
Before dismantling cylinder head, check cylinder head for hydraulic seal by proper tooling; in case of leaks not caused by cup plugs or threaded plugs, replace cylinder head.

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

Dismounting the valves

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

Figure 74



Mount and secure the tool 99360263 (2) with the bracket (4). Screw down with the device 99360261 (1) to be able to remove the cotter (3). Take out the tool (2) and extract the top plate (5), spring (6) and bottom plate (7).

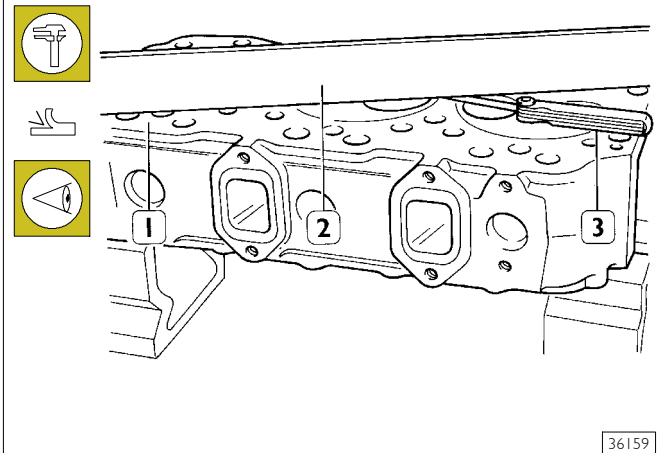
Repeat this process on all the valves.

Turn over the cylinder head and take out the valves (8).

Checking head bearing surface on cylinder block

Figure 75

(Demonstration)



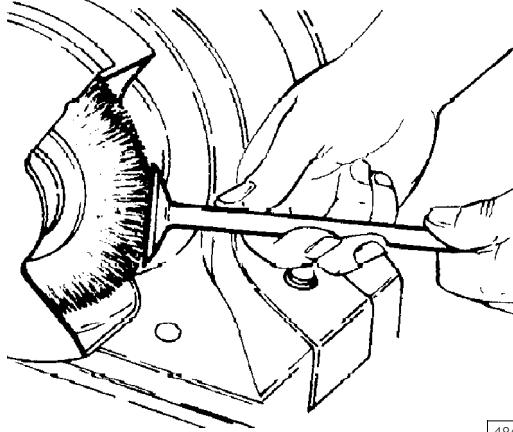
Check the supporting surface (1) of the head on the cylinder block with a rule (2) and a feeler gauge (3). If you find any deformation, level the head on a surface grinder; maximum amount of material that can be removed 0.2 mm.

NOTE After this process, you need to check the valve recessing and injector protrusion.

Valves

Decarbonizing and checking valves

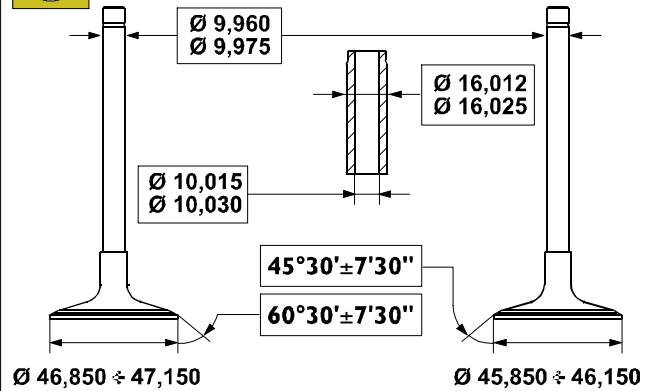
Figure 76



48625

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 77); replace the valves if it does not.

Figure 77



71718

MAIN DATA OF VALVES AND VALVE GUIDES

* Measurement to be made after driving in the valve guides

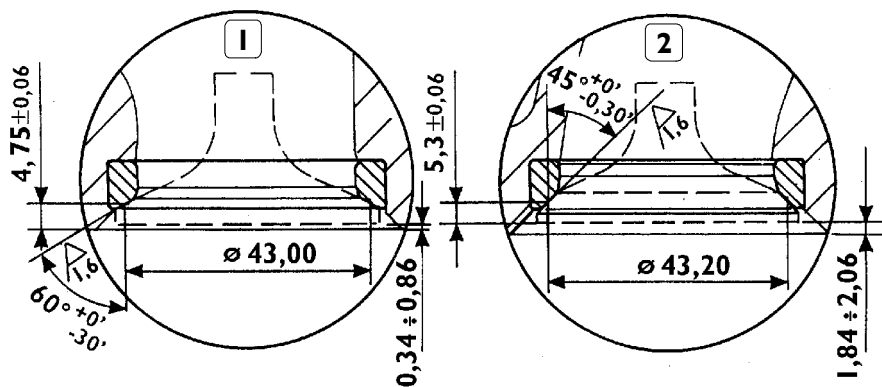
Check with a micrometer that the diameter of the valve stems is as indicated. If necessary, grind the valve seats with a grinding machine, removing as little material as possible.

Valve seats

Regrinding – replacing valve seats

NOTE The valve seats are reground whenever the valves or valve guides are ground and replaced.

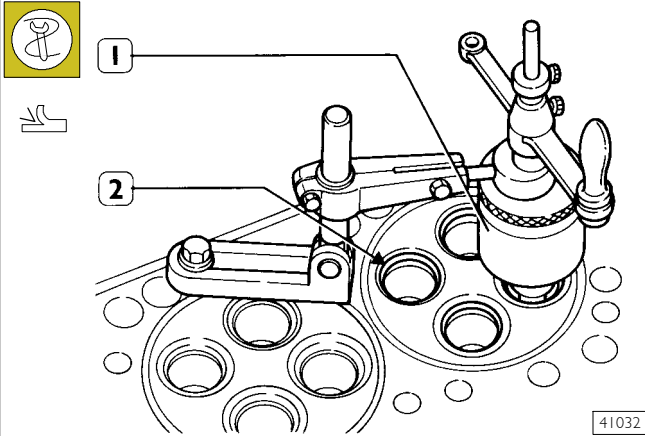
Figure 78



73555

MAIN DATA OF VALVE SEATS
 1. Intake valve seat – 2. Exhaust valve seat

Figure 79



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 78. 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 $80 \pm 100^{\circ}\text{C}$ 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 78.

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.

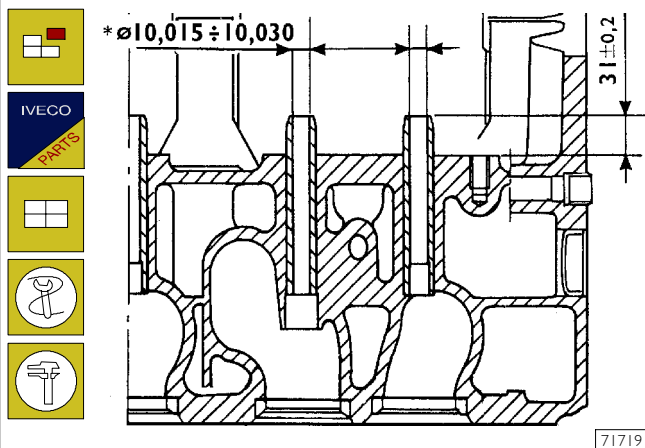
Checking clearance between valve-stem and associated valve guide

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 80



The valve guides are removed with the drift 99360143. They are fitted with the drift 99360143 equipped with part 99360296.

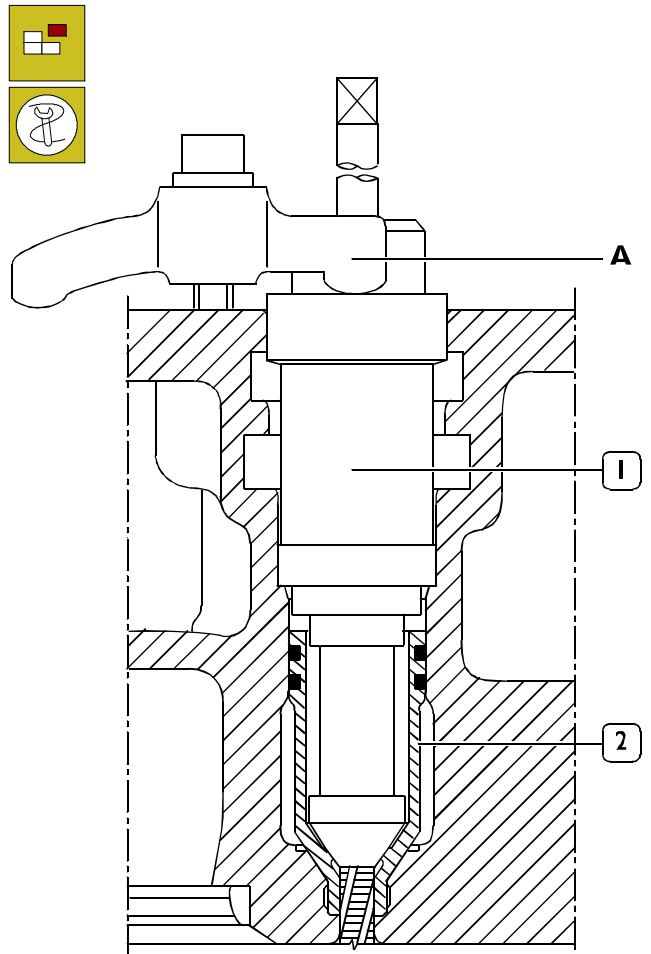
Part 99360296 determines the exact position of assembly of the valve guides in the cylinder head. If they are not available, you need to drive the valve guides into the cylinder head so they protrude by 30.8 ± 31.2 mm.

After driving in the valve guides, rebore their holes with the smoother 99390330.

Replacing injector cases

Removal

Figure 81

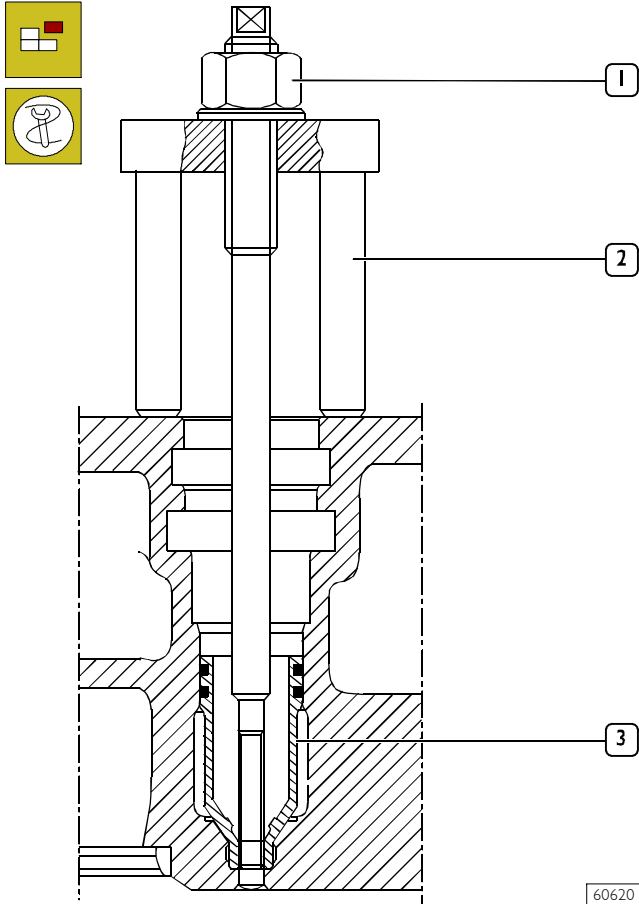


To replace the injector case (2), proceed as follows:

- Thread the case (2) with tool 99390804 (1).

The steps described in Figs. 81 - 84 - 85 - 86 need to be carried out by fixing the tools, with the bracket A, to the cylinder head.

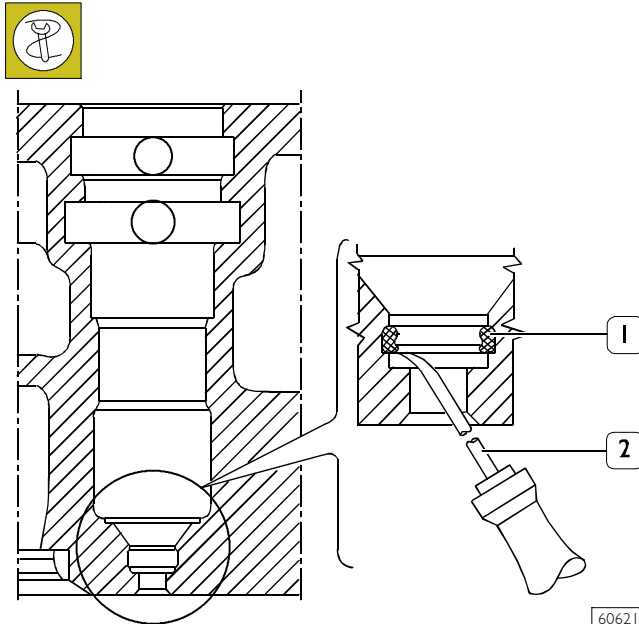
Figure 82



60620

- Screw the extractor 99342149 (2) into the case (3). Screw down the nut (1) and take the case out of the cylinder head.

Figure 83

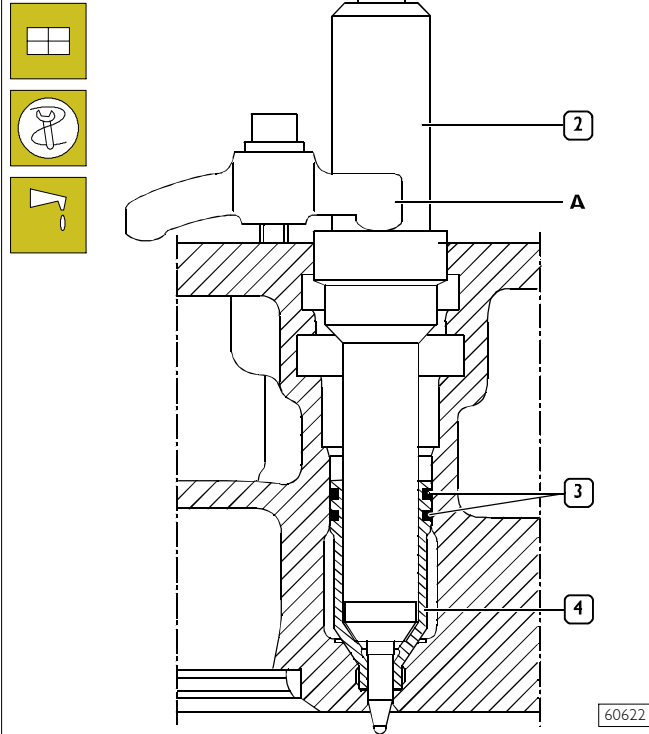


60621

- Using the tool 99390772 (2) remove any residues (1) left in the groove of the cylinder head.

Assembly

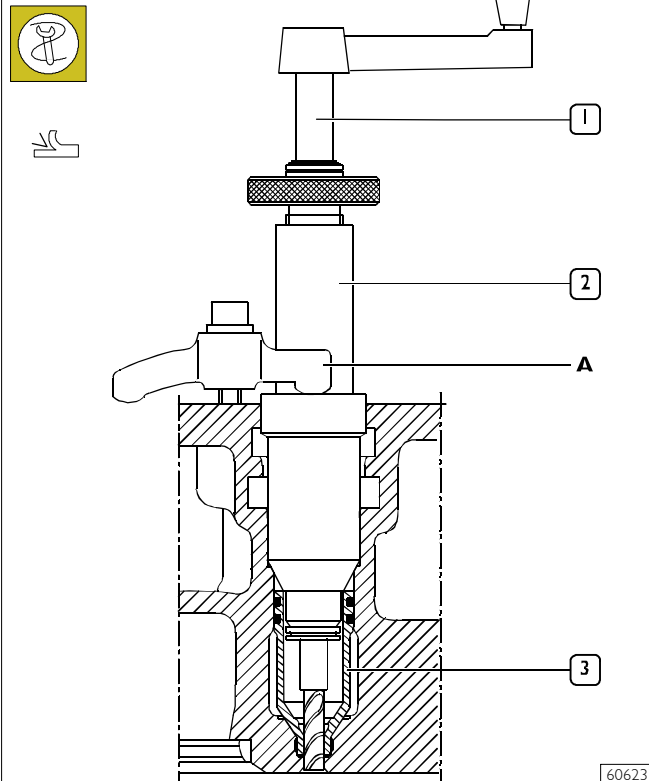
Figure 84



60622

- 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.

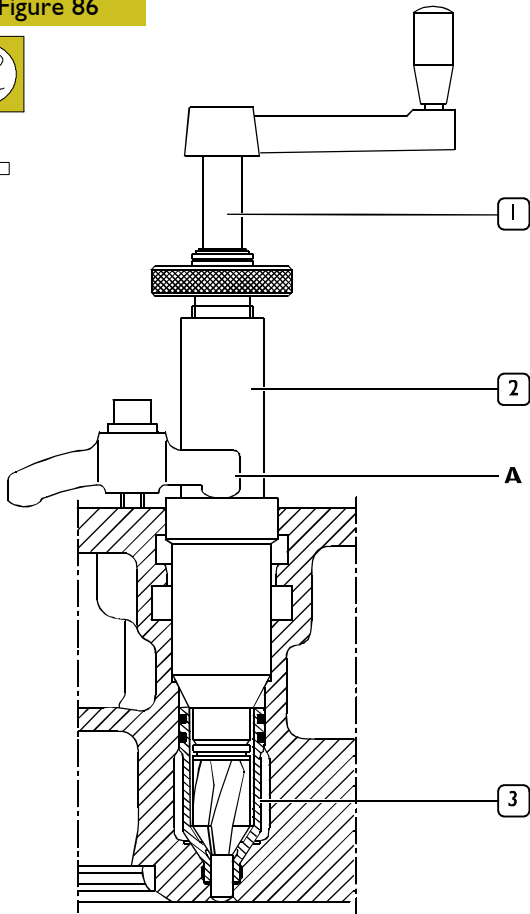
Figure 85



60623

- Using the reamer 99394041 (1-2), re-bore the hole in the case (3).

Figure 86

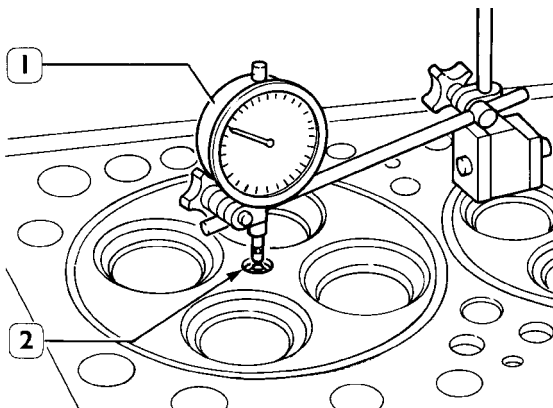


60624

- Using the milling cutter 99394043 (1-2), regrind the injector seat in the case (3).

Checking injector protrusion

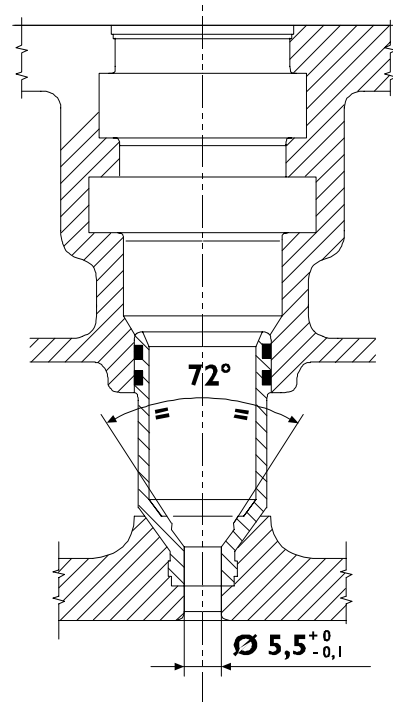
Figure 87



47585

- Check injector protrusion (2) with the dial gauge (1). The protrusion must be 0.52 - 1.34 mm.

Figure 88



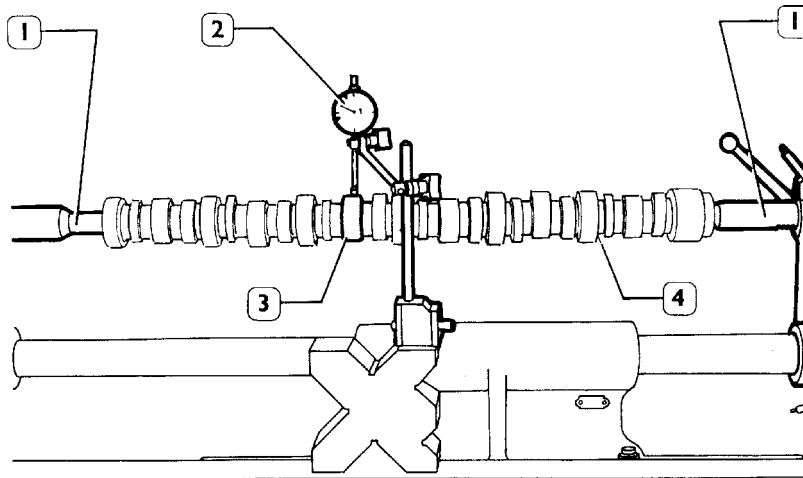
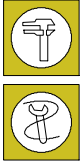
71720

INJECTOR CASE ASSEMBLY DIAGRAM

Camshaft

Checking cam lift and pin alignment

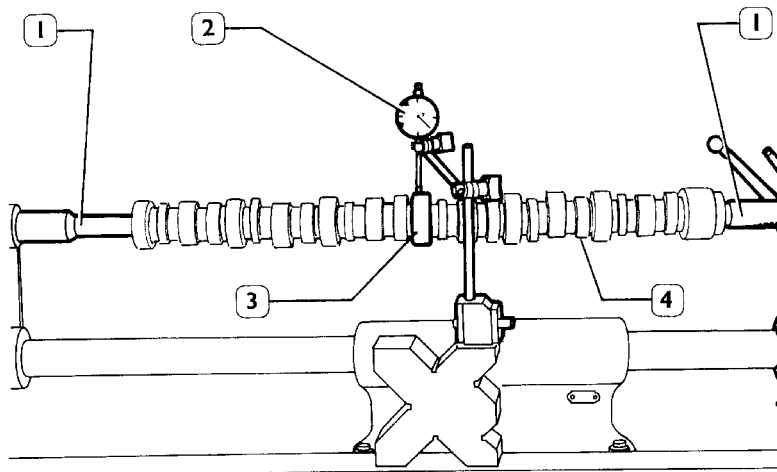
Figure 89



47506

Place the camshaft (4) on the tailstock (1) and check cam lift (3) using a centesimal gauge (2); values are shown in table on page 9.

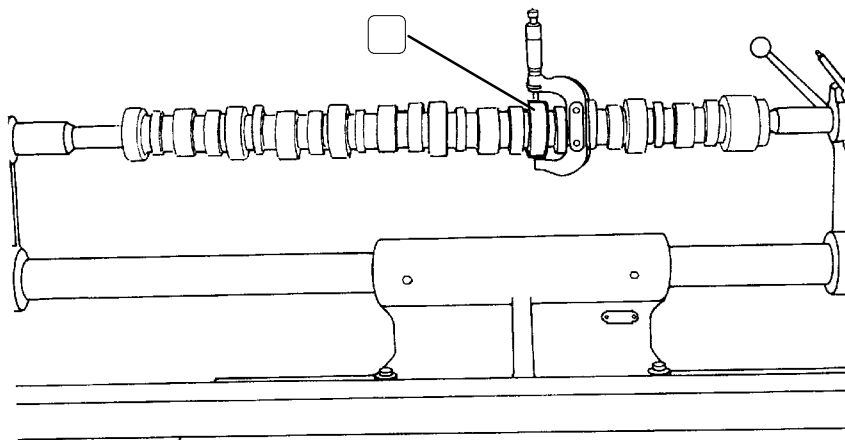
Figure 90



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 91

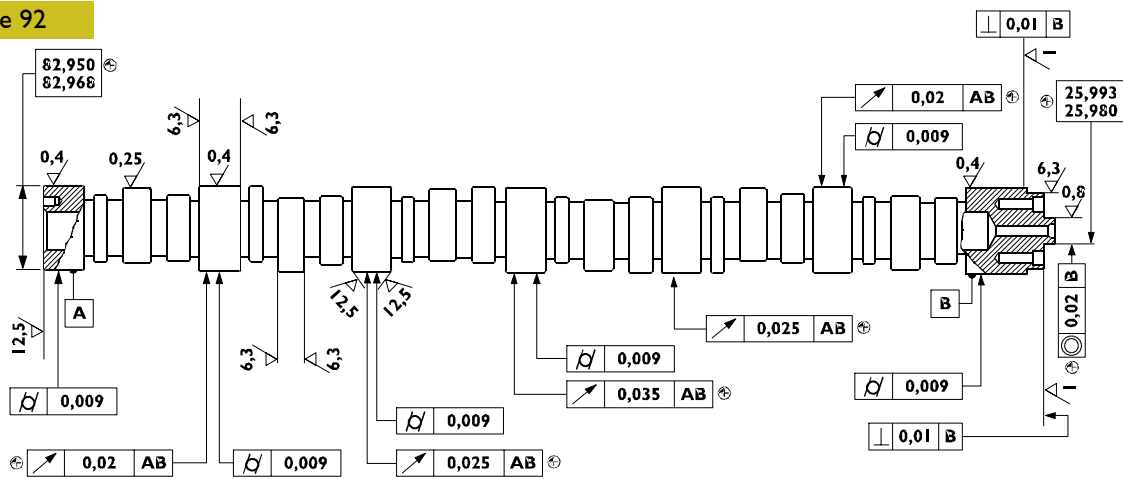


47505

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 0.135 mm, replace bushes and, if necessary, the camshaft.

Figure 92



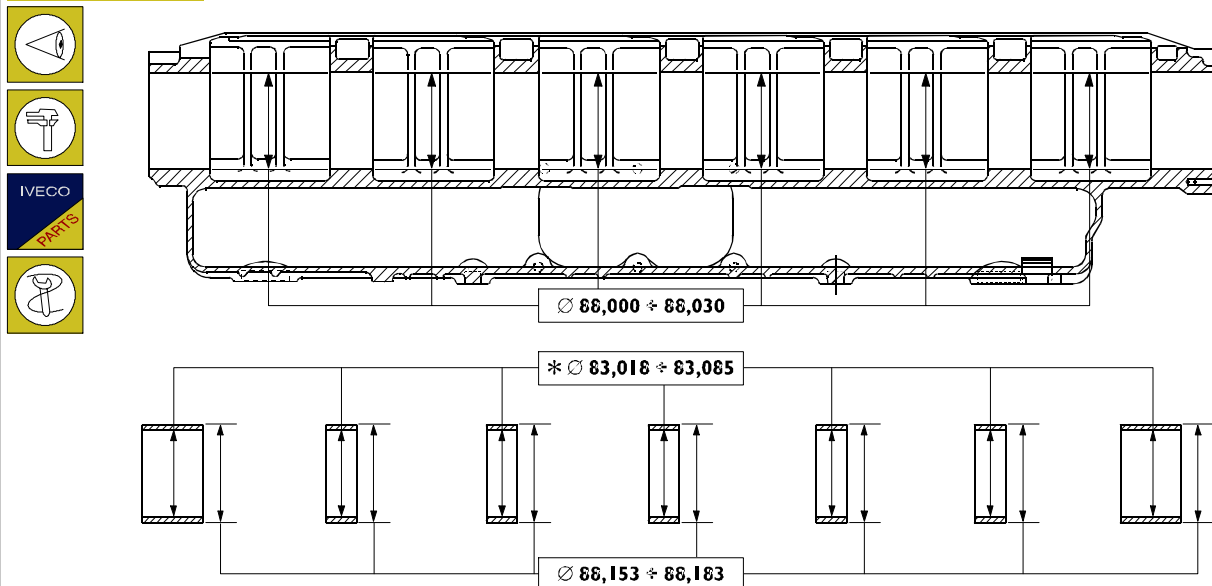
MAIN DATA OF THE CAMSHAFT AND TOLERANCES

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
CRITICAL		⊙
IMPORTANT		⊕
SECONDARY		⊖

Bushings

Figure 93



MAIN DATA OF THE BUSHINGS FOR THE CAMSHAFT AND SEATS ON THE CYLINDER HEAD

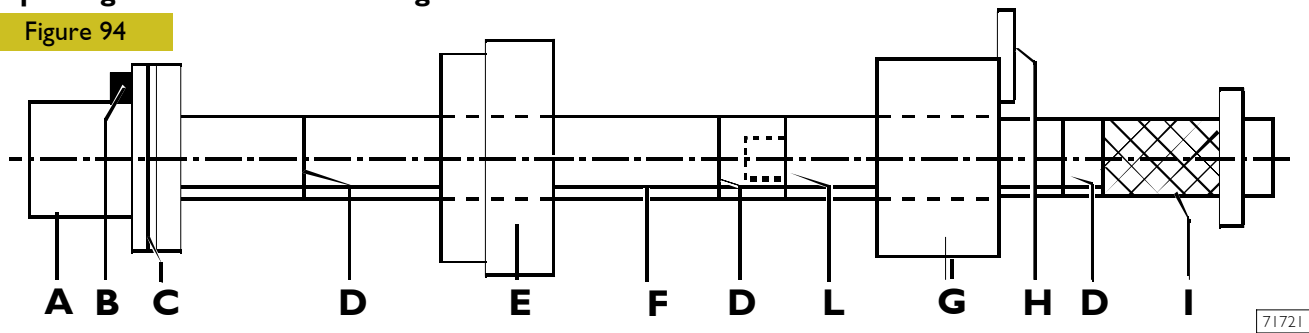
* Bushing inside diameter after driving in

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 bushes using beater 99360499

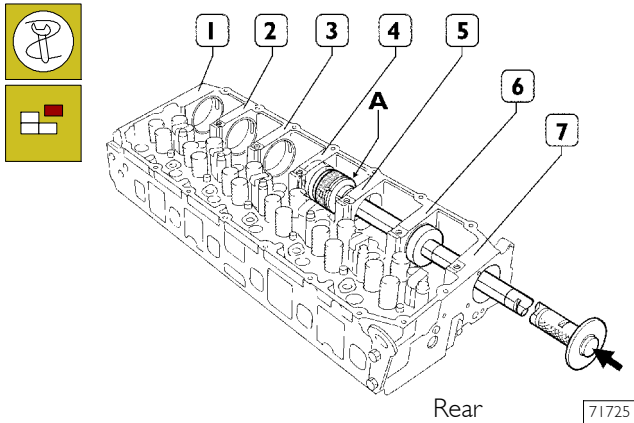
Figure 94



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.

Removal

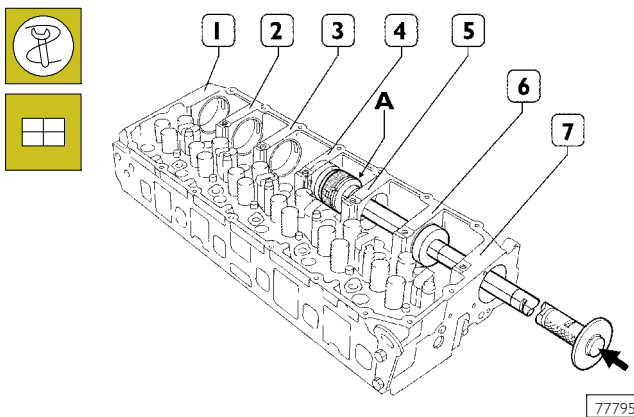
Figure 95



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

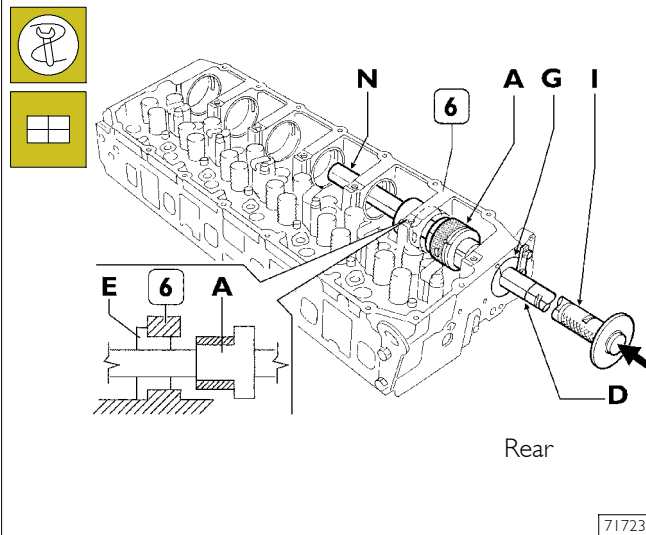
Figure 96



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 94) on the bushing.
- 2 Position the guide bushing (E) and secure the guide bushing (G) (Figure 94) 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).

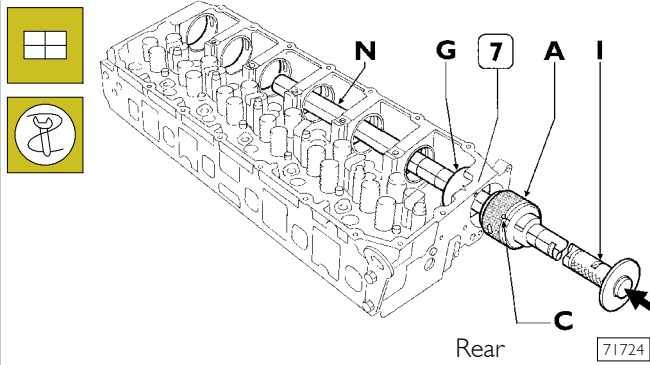
Figure 97



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 98

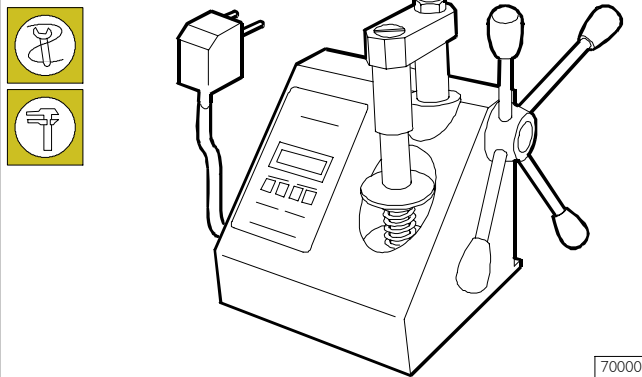


To insert bushing (7), proceed as follows:

- 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.

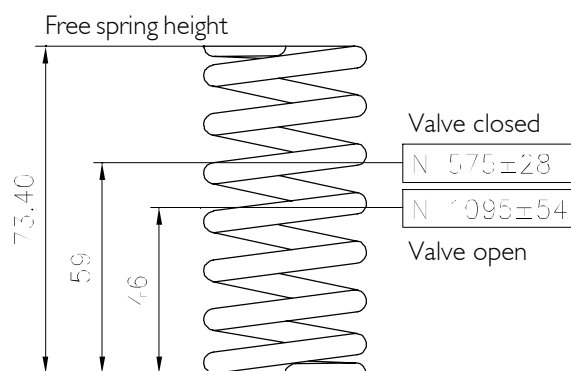
VALVE SPRINGS

Figure 99



Before assembly, the flexibility of the valve springs has to be checked with the tool 99305047. Compare the load and elastic deformation data with those of the new springs given in the following figure.

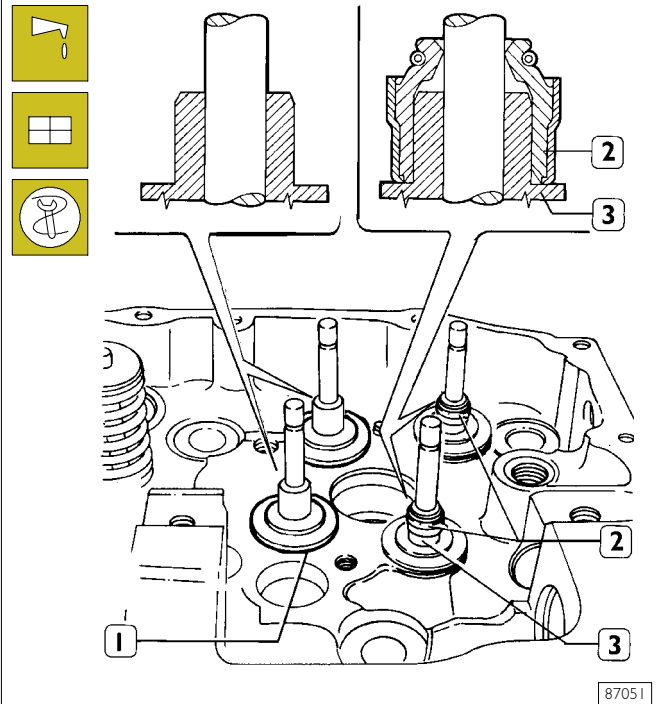
Figure 100



MAIN DATA TO CONTROL EXHAUST AND DISCHARGE VALVE SPRING

Fitting the valves and oil seal ring

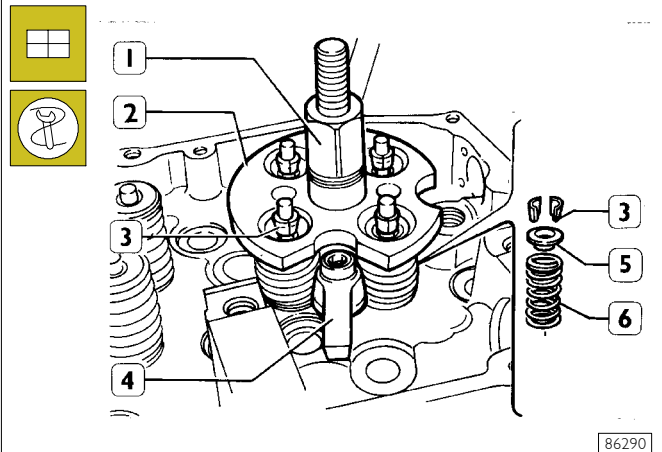
Figure 101



NOTE Should valves not have been overhauled or replaced, remount them according to numbering performed on dismantling.

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.

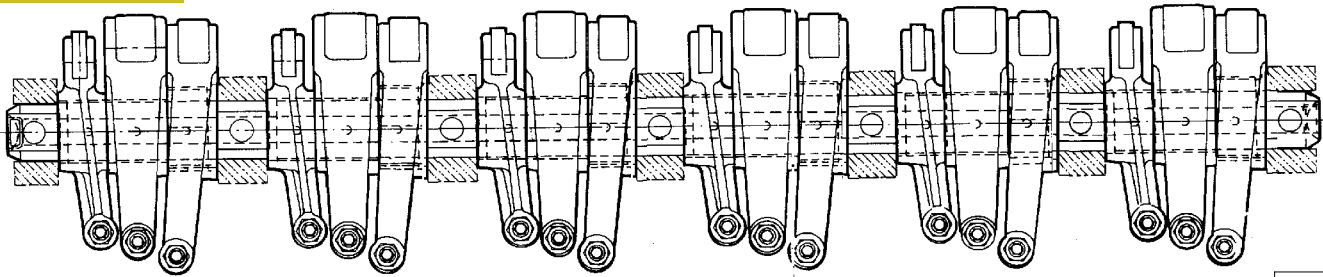
Figure 102



- fit springs (6) and the upper plate (5);
- apply tool 99360263 (2) and block it with bracket (4); tighten the lever (1) until cotters are installed (3), remove tool (2).

ROCKER SHAFT

Figure 103



99281

The camshaft cams directly control rockers: 6 for injectors and 12 for valves.

Rockers slide directly on the cam profiles via rollers.

The other end acts on a bar directly supported by the two valves stems.

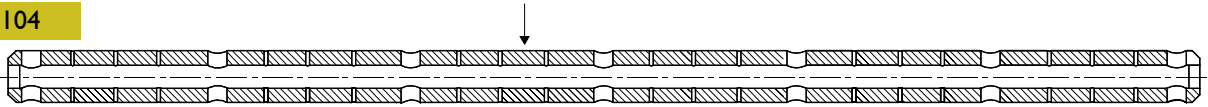
A pad is placed between the rocker adjusting screw and the bar.

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 104



41,984
42,000

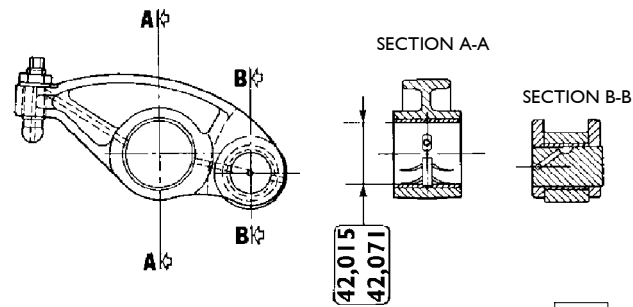
73557

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

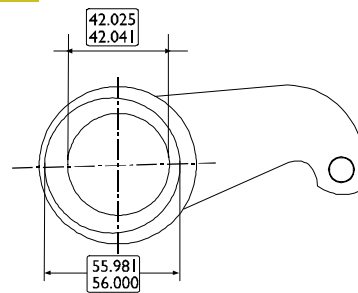
Figure 105



PUMP INJECTOR ROCKER

71728

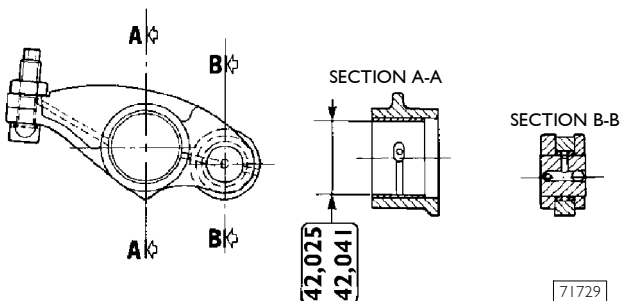
Figure 107



99376

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

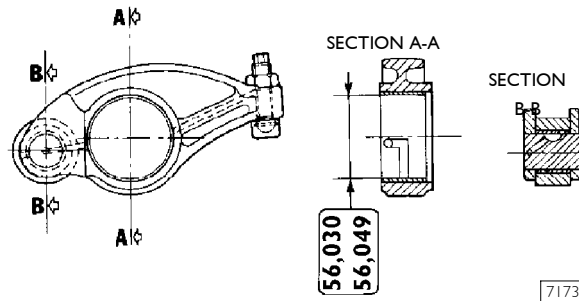
Figure 106



EXHAUST VALVES ROCKER

71729

Figure 108

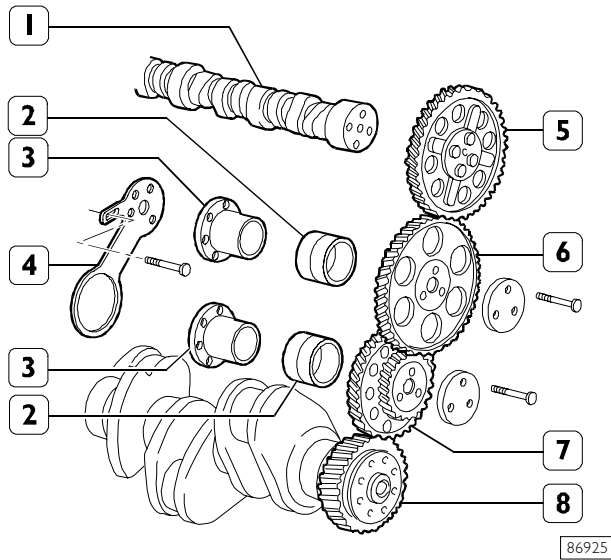


DISCHARGE VALVE ROCKER

71730

**TIMING GEAR
Camshaft drive**

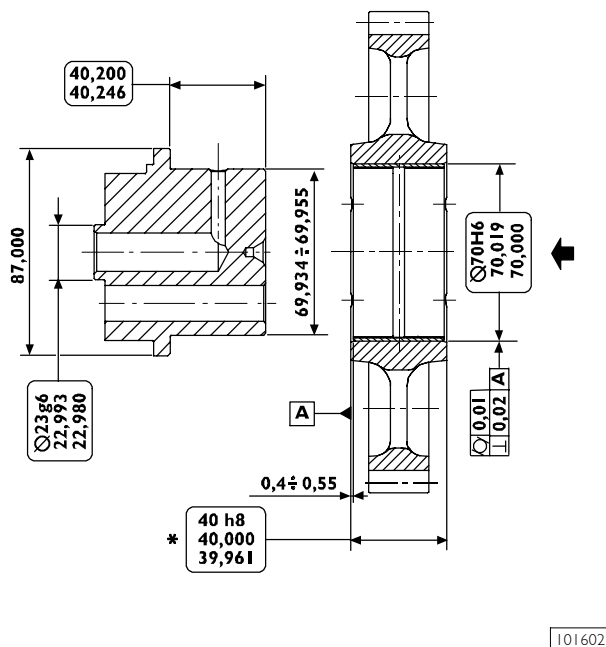
Figure 109



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**

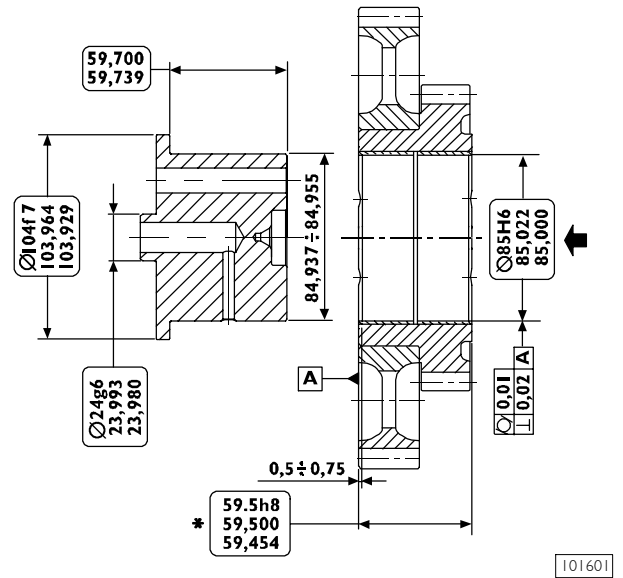
Figure 110



* This measurement is obtained after assembling.

**Twin intermediate gear pin
Twin idler gear**

Figure 111



* This measurement is obtained after assembling.

Replacing the bushings

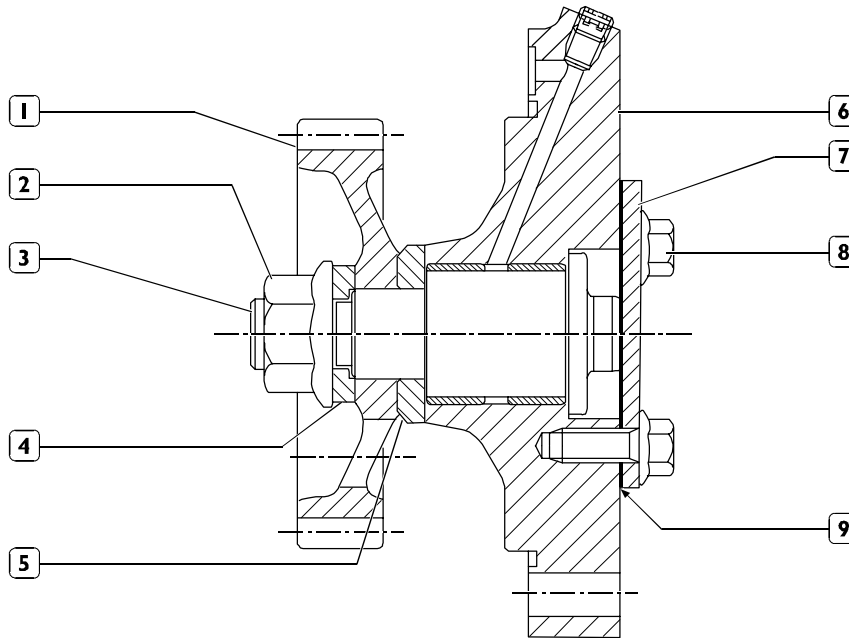
Bushings (2) can be replaced when they are worn. Put up the bushing, then bore it to obtain the diameter shown on Figure 110 or Figure 111.

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 110 or Figure 111.

Rated assembling play between gear bushings and pins:
 Figure 110 – 0.045 ÷ 0.075 mm
 Figure 111 – 0.045 ÷ 0.085 mm.

REAR POWER TAKEOFF

Figure I12



107991

1. Gear - 2. Nut - 3. Shaft - 4. Washer - 5. Spacer - 6. Support - 7. Cover - 8. Screw - 9. Seal.



Removal

Remove retaining screws (8) and disconnect cover (7) with seal (9) from support (6).
 Lock shaft (3) rotation and remove nut (2).
 Remove from shaft (3): washer (4), gear (1) and spacer (5).
 Remove shaft (3) from support (6).



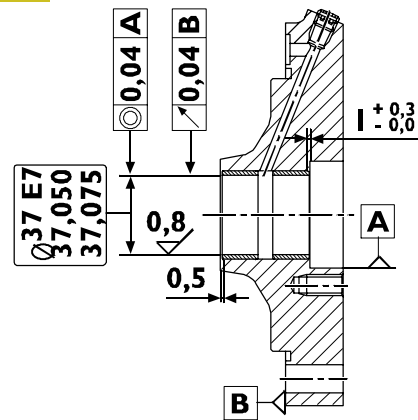
Refitting

For refitting, reverse operations described for removal according to instructions below:

- install a new seal (9);
- lubricate shaft shank (3) with engine oil;
- lock screws and nut at prescribed torque.



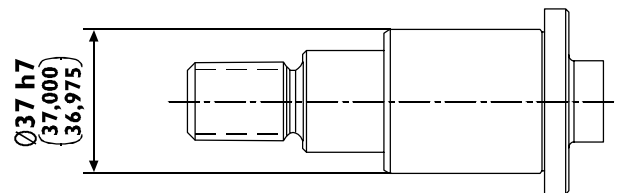
Figure I13



107992

Shaft

Figure I14



107993

Rated shaft/rear power takeoff supporting bushing backlash : 0,05 ± 0,10 mm.

TIGHTENING TORQUE

PART	TORQUE	
	Nm	kgm
Capscrews, undercrankcase to crankcase ♦		
M12x1.75 outer screws	Stage 1: pretightening	30 (3)
M 17x2 inner screws	Stage 2: pretightening	120 (12)
Inner screws	Stage 3: angle	60°
Inner screws	Stage 4: angle	55°
Outer screws	Stage 5: angle	60°
Piston cooling nozzle union ♦		
		35 ± 2 (3.5 ± 0.2)
Capscrews, heat exchanger to crankcase ♦		
pretightening		11.5 ± 3.5 (1.15 ± 0.35)
tightening		19 ± 3 (1.9 ± 0.3)
Piston cooling nozzle union ♦		
		24,5 ± 2,5 (2.4 ± 0.25)
Spacer and oil sump capscrews ♦		
pretightening		38 (3.8)
tightening		45 (4.5)
M 12x1.75 screws, gear case to crankcase ♦		
		63 ± 7 (6.3 ± 0.7)
M 12x1.75 screws, gear case to crankcase ♦		
		24 ± 2,5 (2.4 ± 0.25)
Cylinder head capscrews ♦		
Stage 1:	pretightening	60 (6)
Stage 2	pretightening	120 (12)
Stage 3:	angle	90°
Stage 4:	angle	65°
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 ♦		
		26 (2.6)
Capscrews, injector securing brackets ♦		
		8,5 ± 1,5 (0.8 ± 0.15)
Capscrews, thrust plates to head ♦		
		19 ± 3 (1.9 ± 0.3)
Screw fastening the engine supporting bracket to the cylinder head		
Stage 1:	pretightening	120 (12)
Stage 2:	angle	45°

- ♦ Before assembly, lubricate with UTDM oil
- Before assembly, lubricate with graphitized oil

PART	TORQUE	
	Nm	kgm
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	(0.85 ± 0.15)
Exhaust manifold capscrews •		
pretightening	40 ± 5	(4 ± 0.5)
tightening	70 ± 5	(7 ± 0.5)
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°
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	24.5 ± 2.5	(2.45 ± 0.25)
Screws fixing oil pump	24.5 ± 2.5	(2.45 ± 0.25)
Screws fixing crankshaft gasket cover	24.5 ± 2.5	(2.45 ± 0.25)
Screws fixing fuel pump/filter	19	(1.9)
Screw fixing control unit mount to crankcase	19 ± 3	(1.9 ± 0.3)
Screws and nuts fixing turbocharger •		
pre-tightening	35	(3.5)
tightening	46	(4.6)
Screws fixing water pump to crankcase	22 ± 2	(2.2 ± 0.2)
Screws fixing water pump to crankcase	25	(2.5)
Screw fixing automatic tensioner to crankcase	26 ± 3	(2.6 ± 0.3)
Screw fixing fixed tensioner to crankcase	50 ± 5	(5 ± 0.5)
Screws fixing fan mount to crankcase	105 ± 5	(10.5 ± 0.5)
Screws fixing starter motor	74 ± 4	(7.4 ± 0.4)
Screws fixing air heater to cylinder head	30 ± 3	(3 ± 0.3)

- ♦ Before assembly, lubricate with UTDM oil
- Before assembly, lubricate with graphitized oil

PART			TORQUE	
			Nm	kgm
Screw fixing alternator	M 10x1,5	l = 35 mm	30 ± 3	(3 ± 0.3)
	M 10x1,5	l = 60 mm	44 ± 4	(4.4 ± 0.4)
Screws fixing air-conditioner compressor to mount			24.5 ± 2.5	(2.5 ± 0.25)
Screws fixing guard			24.5 ± 2.5	(2.5 ± 0.25)
Filter clogging sensor fastening			55 ± 5	(5.5 ± 0.5)
Water/fuel temperature sensor fastener			35	(3.5)
Thermometric switch/transmitter fastener			25	(2.5)
Air temperature transmitter fastener			35	(3.5)
Pulse transmitter fastener			8 ± 2	(0.8 ± 0.2)
Injector-pump connections fastener			1.36 ± 1.92	(0.13 ± 0.19)

- ◆ Before assembly, lubricate with UTDM oil
- Before assembly, lubricate with graphitized oil

SECTION 5

Tools

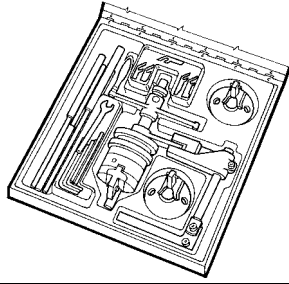
Page

TOOLS	3
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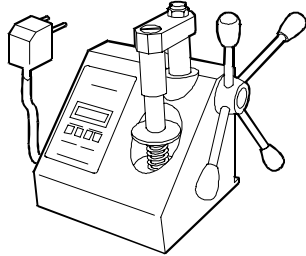
TOOLS

TOOL NO.

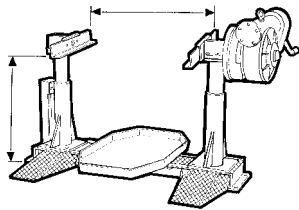
DESCRIPTION

99305019

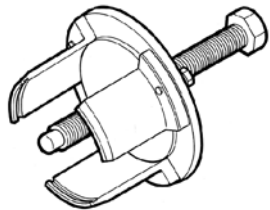
Full-optional tool-kit to rectify valve seat

99305047

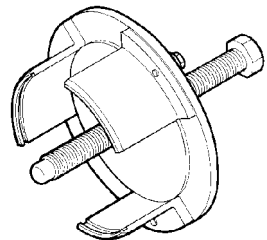
Spring load tester

99322230

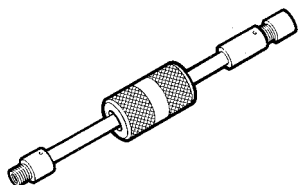
Rotary telescopic stand (range 2000 daN, torque 375 daNm)

99340053

Extractor for crankshaft front gasket

99340054

Extractor for crankshaft rear gasket

99340205

Percussion extractor

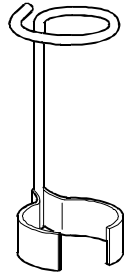
TOOLS

TOOL NO.	DESCRIPTION
99342149	Extractor for injector-holder
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	Box wrench for block junction bolts to the underblock

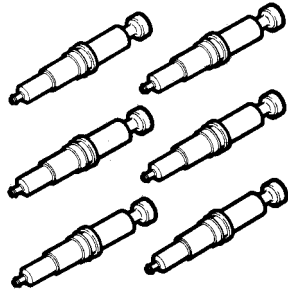
TOOLS

TOOL NO.

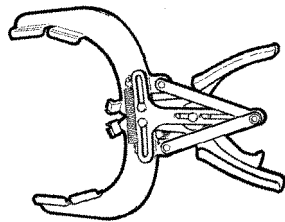
DESCRIPTION

99360144

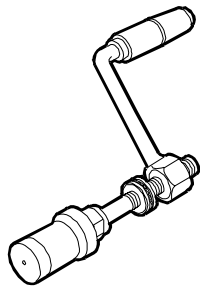
Tools (12 + 6) holding rocker adjustment screw blocks when removing/refitting the rocker shaft

99360180

Injector housing protecting plugs (6)

99360184

Pliers for assembling and disassembling piston split rings (105-106 mm)

99360261

Tool to take down-fit engine valves (to be used with special plates)

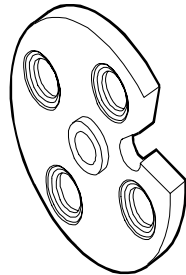
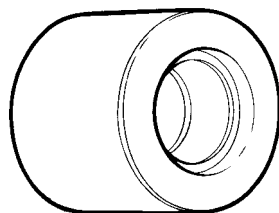
99360262

Plate for take down-fit engine valves (to be used with 99360261)

99360296

Tool to fit back valve guide (to be used with 99360481)

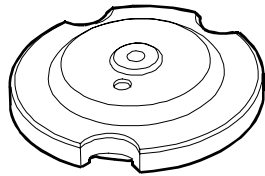
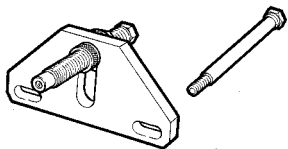
TOOLS

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)

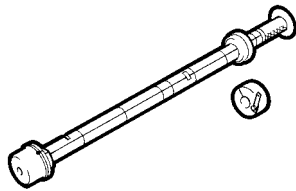
TOOLS

TOOL NO.

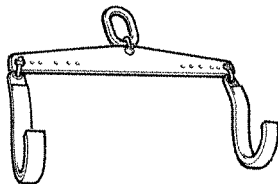
DESCRIPTION

99360337Cylinder liner compression plate
(to be used with 99360334-99360336)**99360351**

Tool to stop engine flywheel

99360499

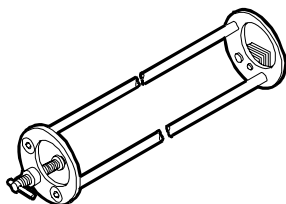
Tool to take down and fit back camshaft bushes

99360500

Tool to lift crankshaft

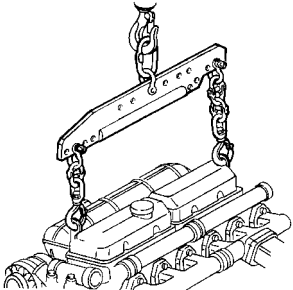
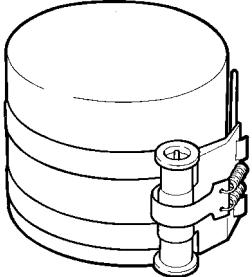
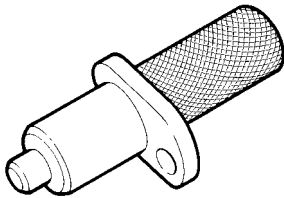
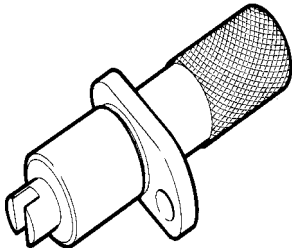
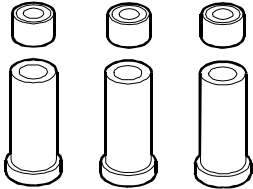
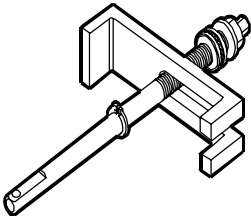
99360551

Bracket to take down and fit engine flywheel

99360553

Tool for assembling and installing rocker arm shaft

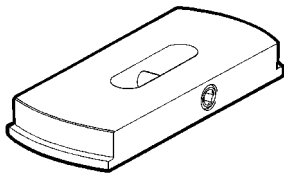
TOOLS

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)

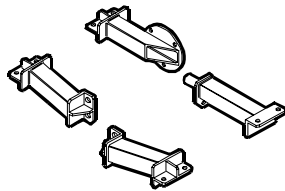
TOOLS

TOOL NO.

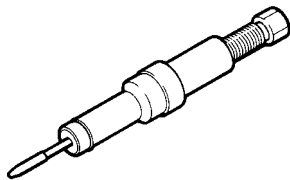
DESCRIPTION

99360726

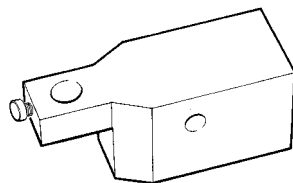
Ring (125 mm) (to be used with 99360706)

99361036

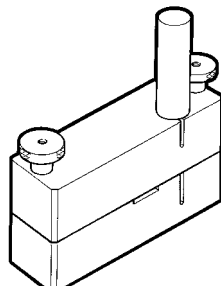
Brackets fixing the engine to rotary stand 99322230

99365056

Tool for injector holder heading

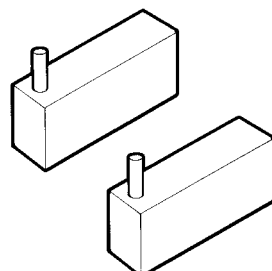
99370415

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)

99378101*
99378103•
99378105■

Punches (**B**) for printing engine identification plates (to be used with 99378100)

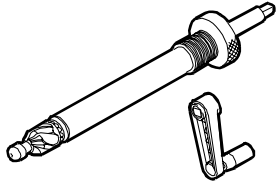
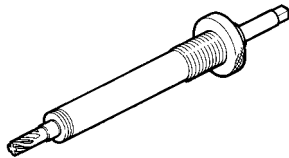
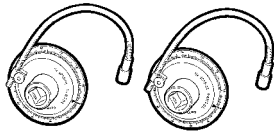
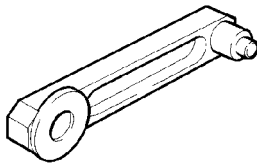
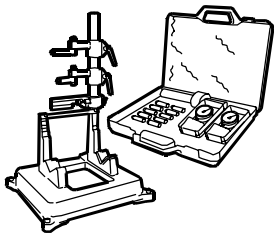
TOOLS

TOOL NO.	DESCRIPTION
99389834	Torque screwdriver for calibrating the injector solenoid valve connector check nut
99390311	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)

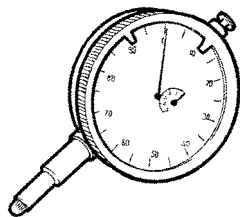
TOOLS

TOOL NO.

DESCRIPTION

99394041Cutter 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**99395363**

Complete square to check connecting rod squaring

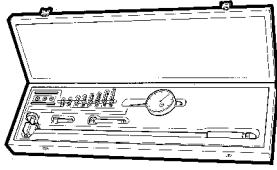
99395603

Dial gauge (0 - 5 mm)

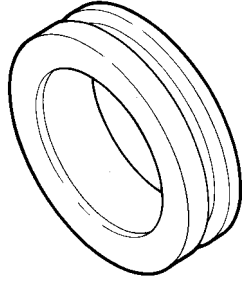
TOOLS

TOOL NO.

DESCRIPTION

99395687

Reaming gauge (50 - 178 mm)

99396035

Centering ring of crankshaft front gasket cap

Appendix

	Page
SAFETY PRESCRIPTIONS	3

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 until 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 priority 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 4
G-DRIVE CURSOR ENGINES

Section

General specifications

1

G-Drive Application

2**PREFACE TO USER'S GUIDELINE MANUAL**

Section 1 describes engines F2B and F3B in their characteristics and general operation.

Section 2 is specific of use.

NOTE Part no. 4 is characterized by describing a particular industrial/agricultural application: G-Drive motors.

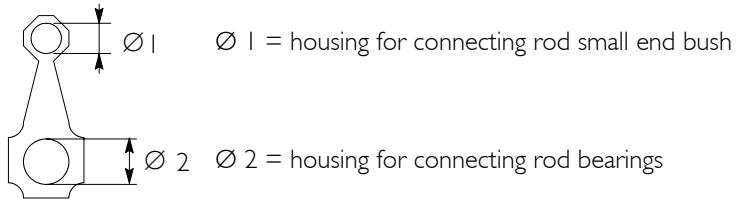
These engines are marketed as an assembly that is also equipped with the air/coolant and possibly air/air (intercooler) cooling device.

The description of this application gives the differences with the industrial application (given in the preceding Parts) and reference must be made to it for all repair and maintenance work.

SPECIAL REMARKS

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



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



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



Replacement
Original spare parts



Intake



Exhaust



Operation



Compression ratio



Tolerance
Weight difference



Rolling torque



Rotation



Angle
Angular value



Preload



Number of revolutions



Temperature



Pressure



Oversized
Higher than....
Maximum, peak



Undersized
Less than....
Minimum



Selection
Classes
Oversizing



Temperature < 0 °C
Cold
Winter



Temperature > 0 °C
Hot
Summer

UPDATING

Section	Description	Page	Date of revision

SECTION I

General specifications

	Page
CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE	3
VIEWS OF F2B ENGINE	5
VIEWS OF F3B ENGINE	8
LUBRICATION	11
COOLING	13
<input type="checkbox"/> Description	13
<input type="checkbox"/> Operation	13
FUEL FEED	15
<input type="checkbox"/> F2B engine fuel supply pump	17
<input type="checkbox"/> Heated sedimentation tank prefilter	17
TURBOCHARGING	18
<input type="checkbox"/> HX 40W turbocompressor	18
<input type="checkbox"/> HX 60W turbocompressor	19

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

F2B engine

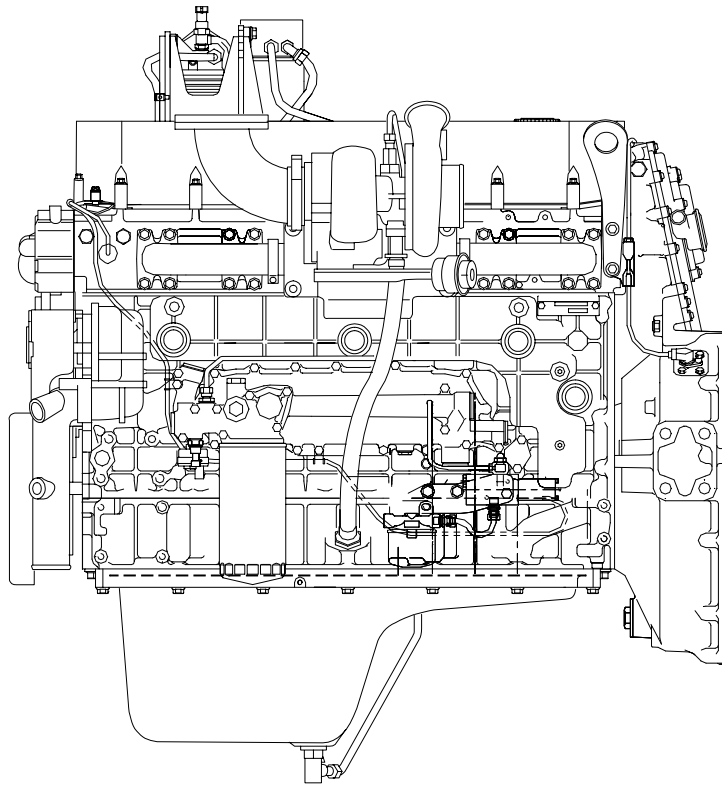
Technical Code	Commercial Code
F2BE0685A*B30I	CURSOR 78 TE2

F3B engine

Technical Code	Commercial Code
F3BE0685C*B00I	CURSOR 13 TE1
F3BE0685B*B00I	CURSOR 13 TE2
F3BE0685A*B00I	CURSOR 13 TE3

VIEWS OF F2B ENGINE**Figure 1**

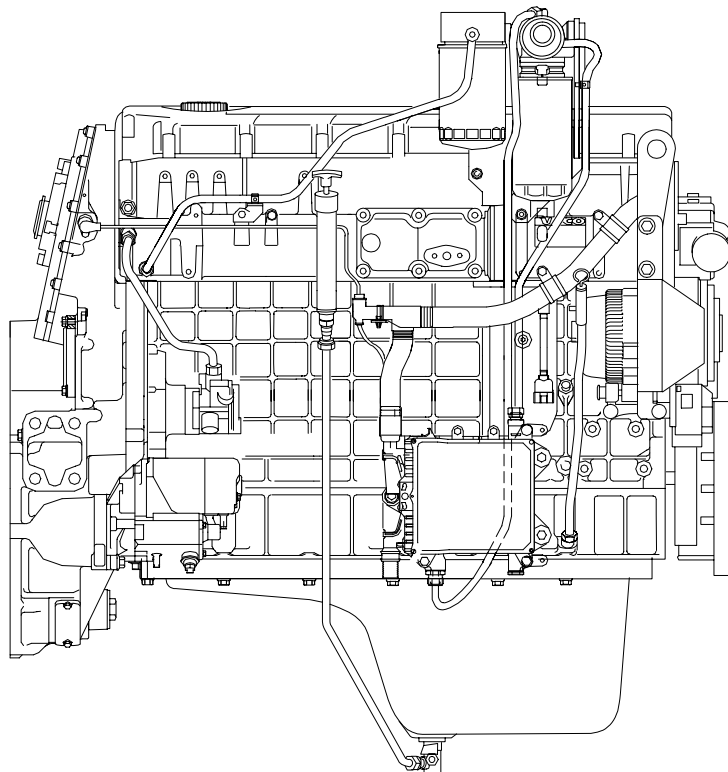
LEFT-HAND SIDE VIEW



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Figure 2

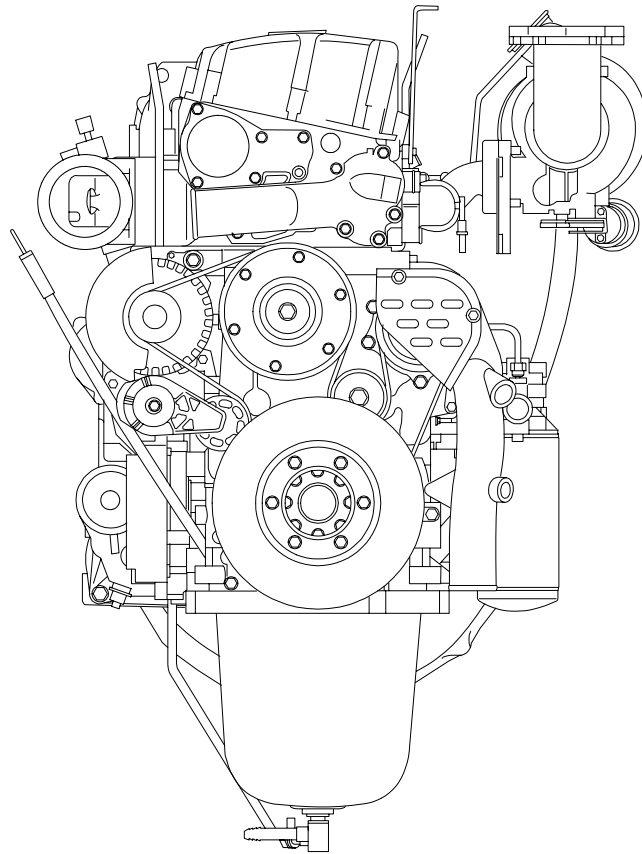
RIGHT-HAND SIDE VIEW



107876

Figure 3

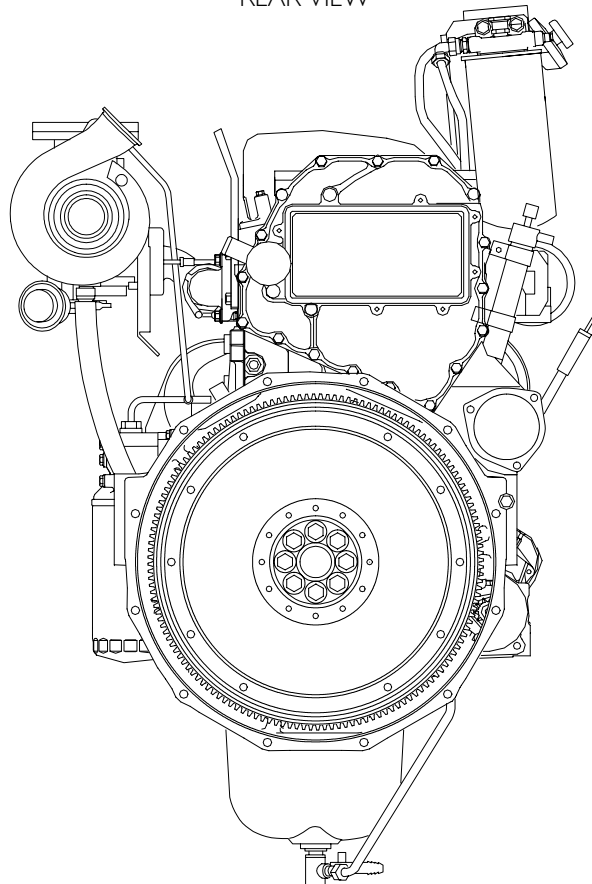
FRONT VIEW



107877

Figure 4

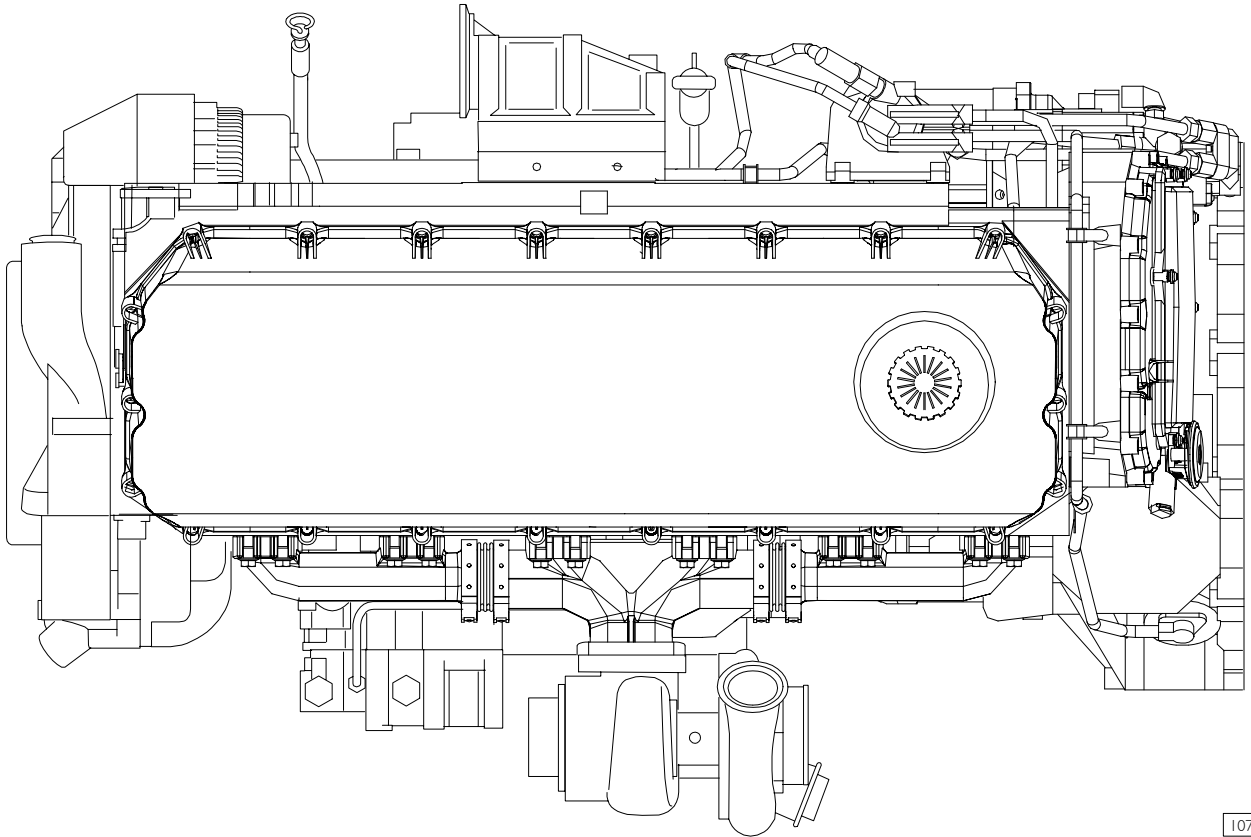
REAR VIEW



107878

Figure 5

TOP VIEW

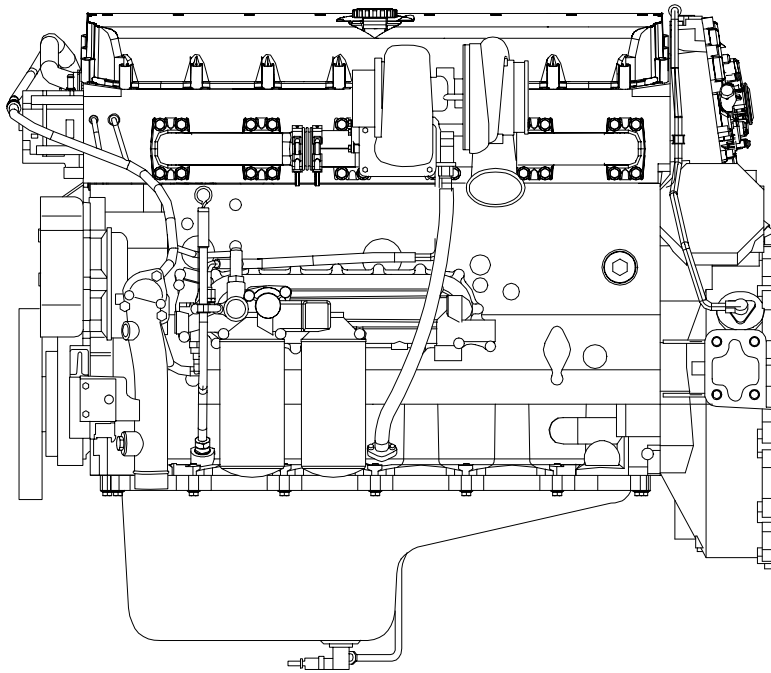


107879

VIEWS OF F3B ENGINE

Figure 6

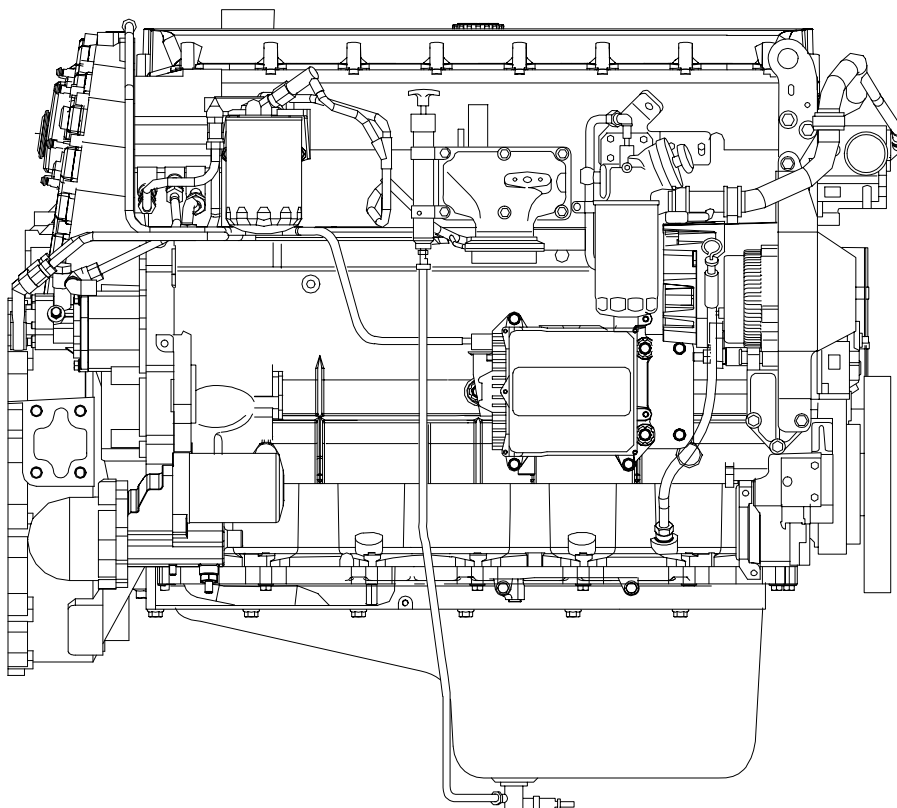
LEFT-HAND SIDE VIEW



107891

Figure 7

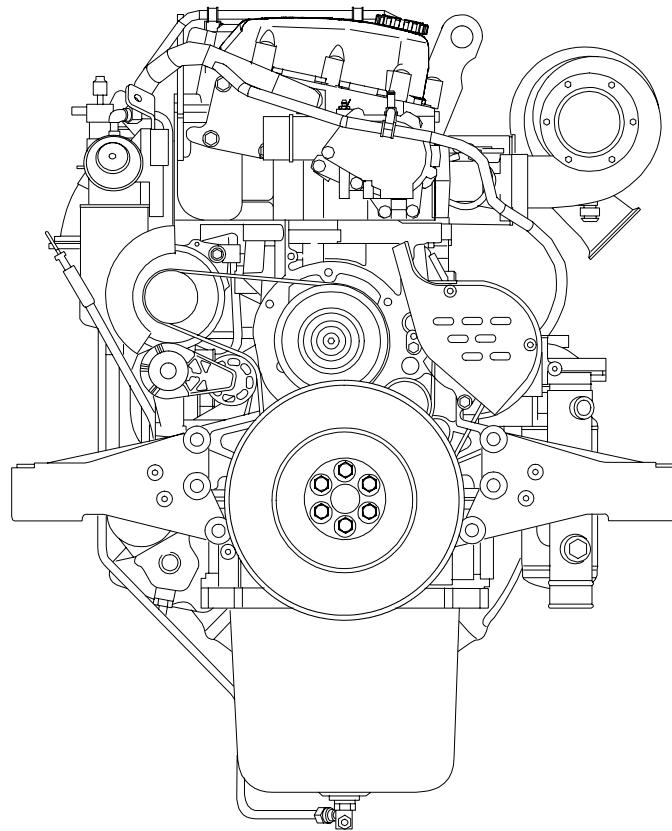
RIGHT-HAND SIDE VIEW



107892

Figure 8

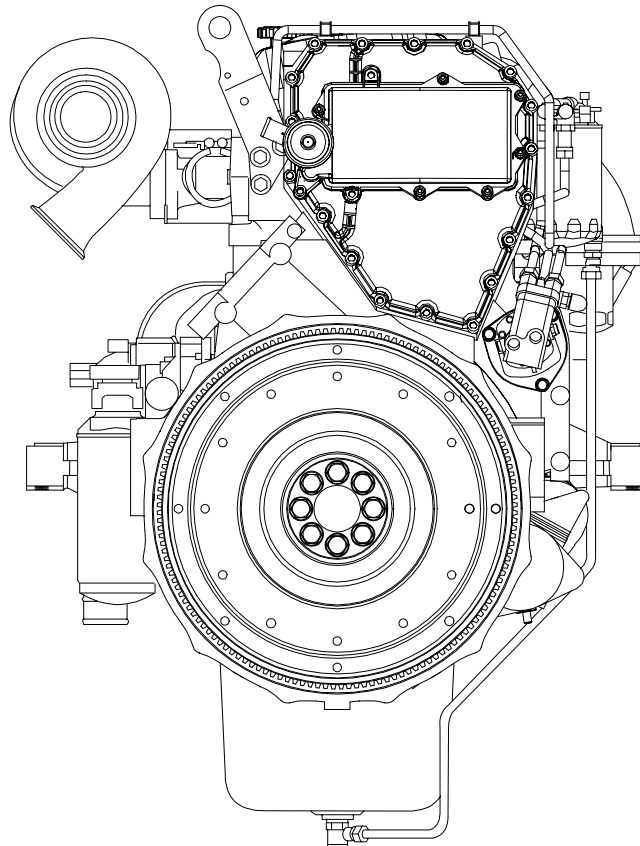
FRONT VIEW



107893

Figure 9

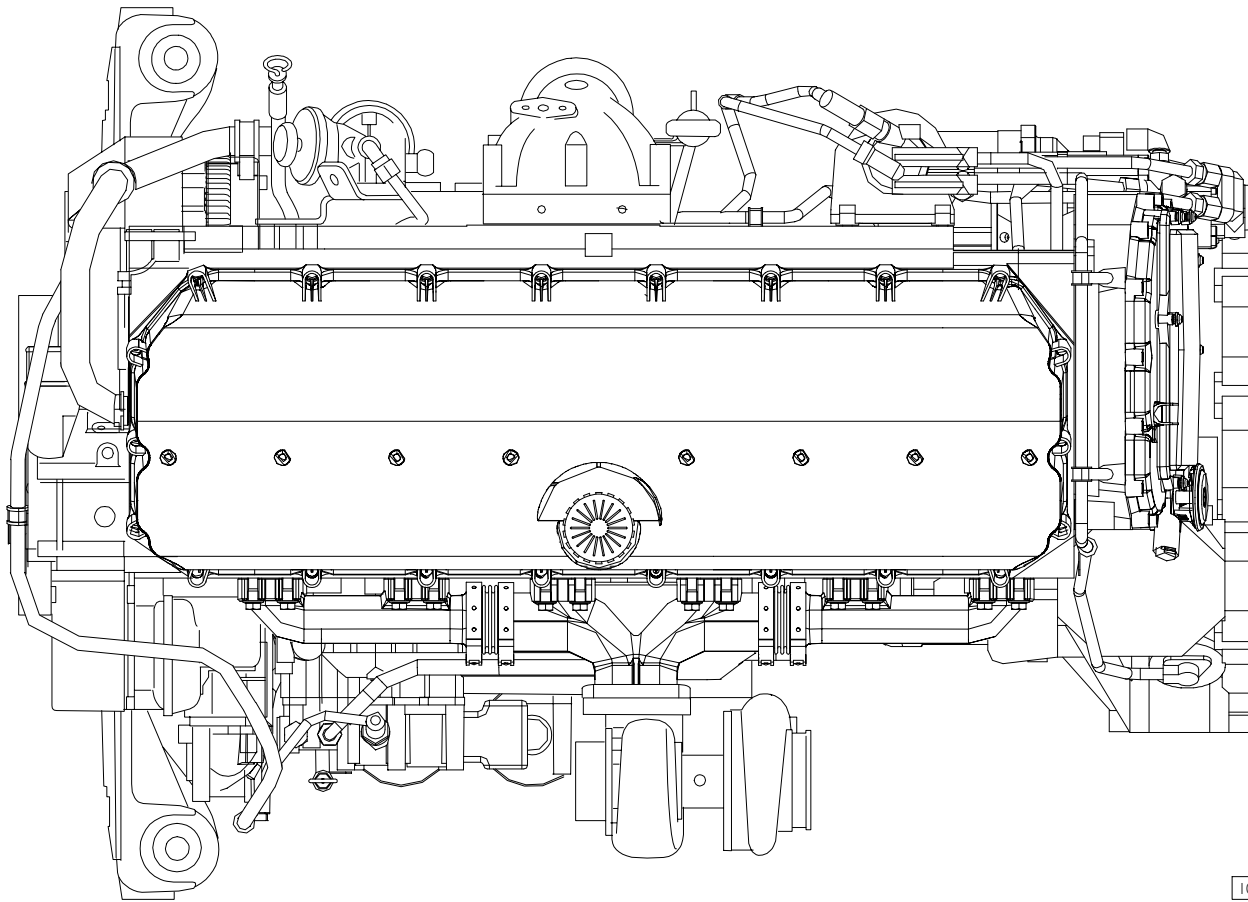
REAR VIEW



107894

Figure 10

TOP VIEW

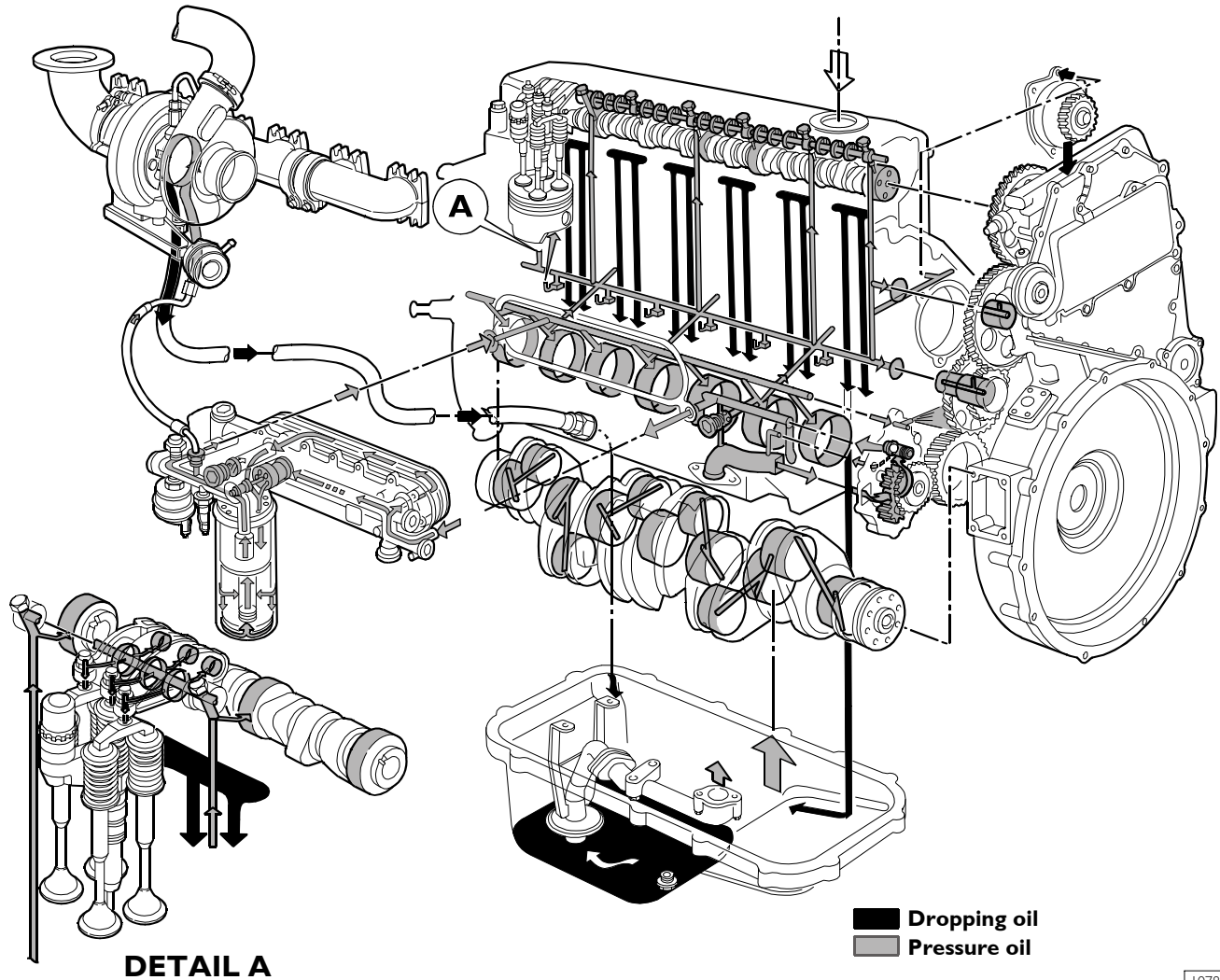


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LUBRICATION

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.

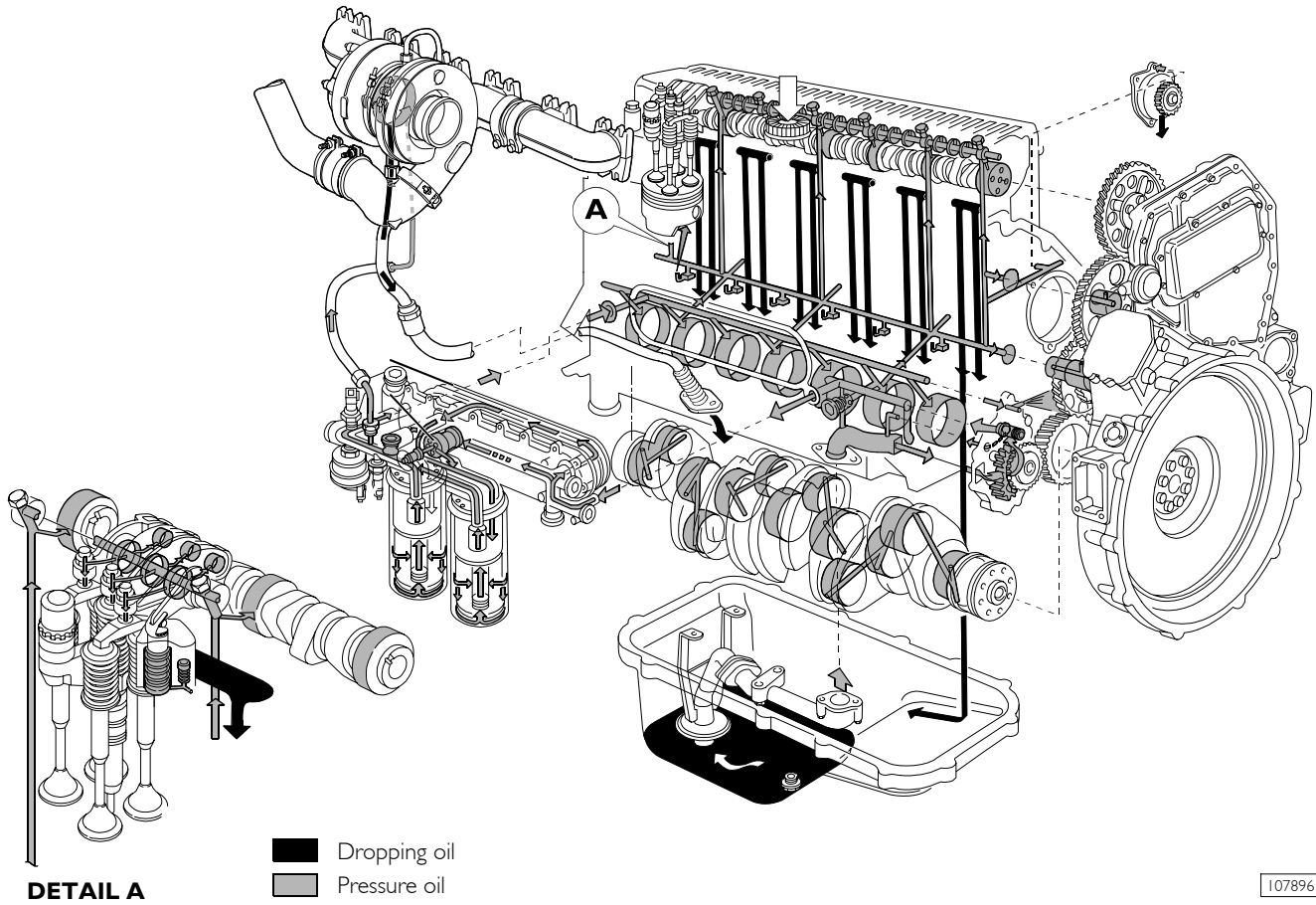
Figure 11



107880

ENGINE F2B LUBRICATION DIAGRAM

Figure 12



ENGINE F3B LUBRICATION DIAGRAM

COOLING

Description

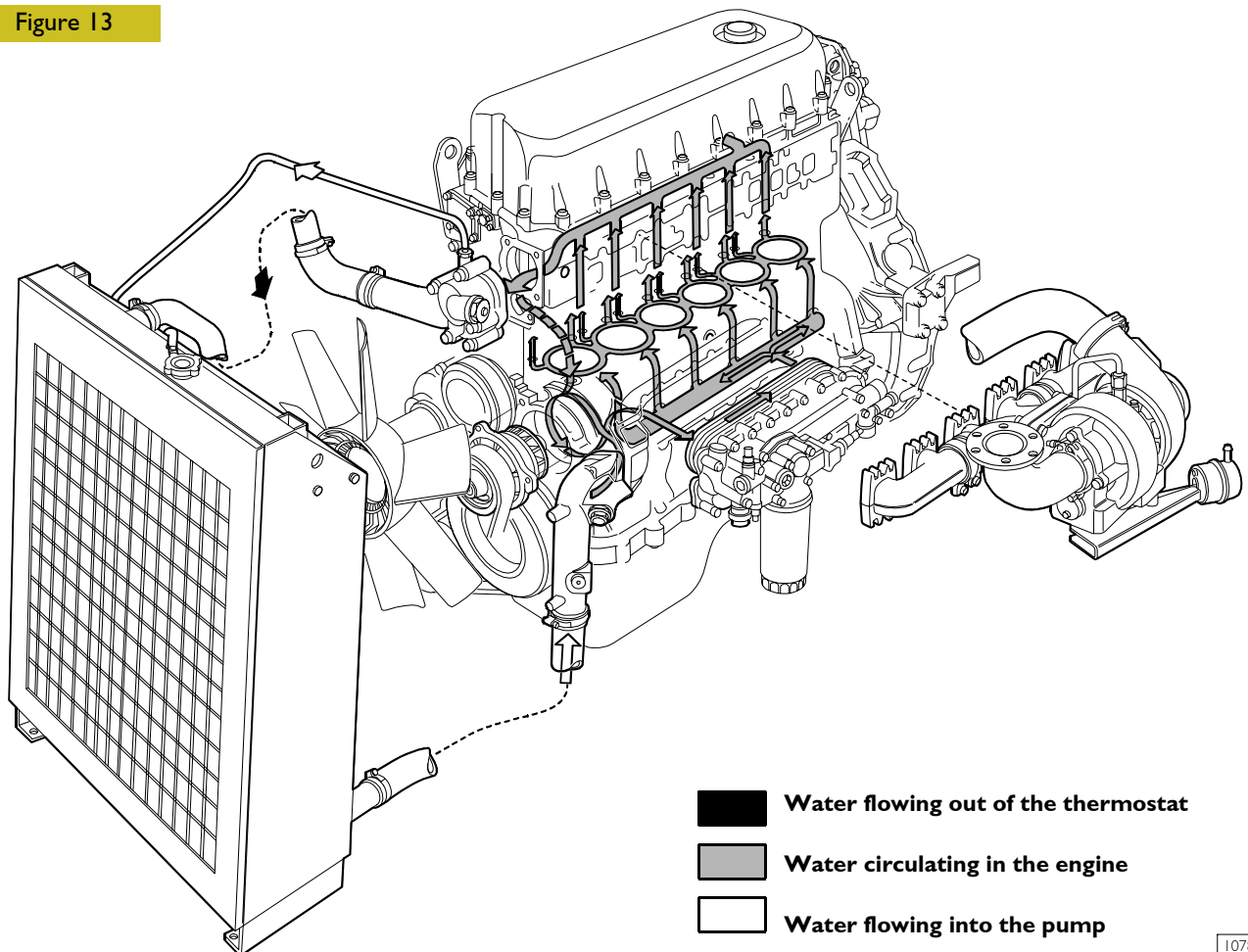
The engine cooling system is of the closed-circuit, forced circulation type. It consists mainly of the following components:

- expansion tank,
- a heat exchanger to cool down lubrication oil;
- a water pump with centrifugal system incorporated in the cylinder block;
- fan;
- a 2-way thermostat controlling the coolant circulation.

Operation

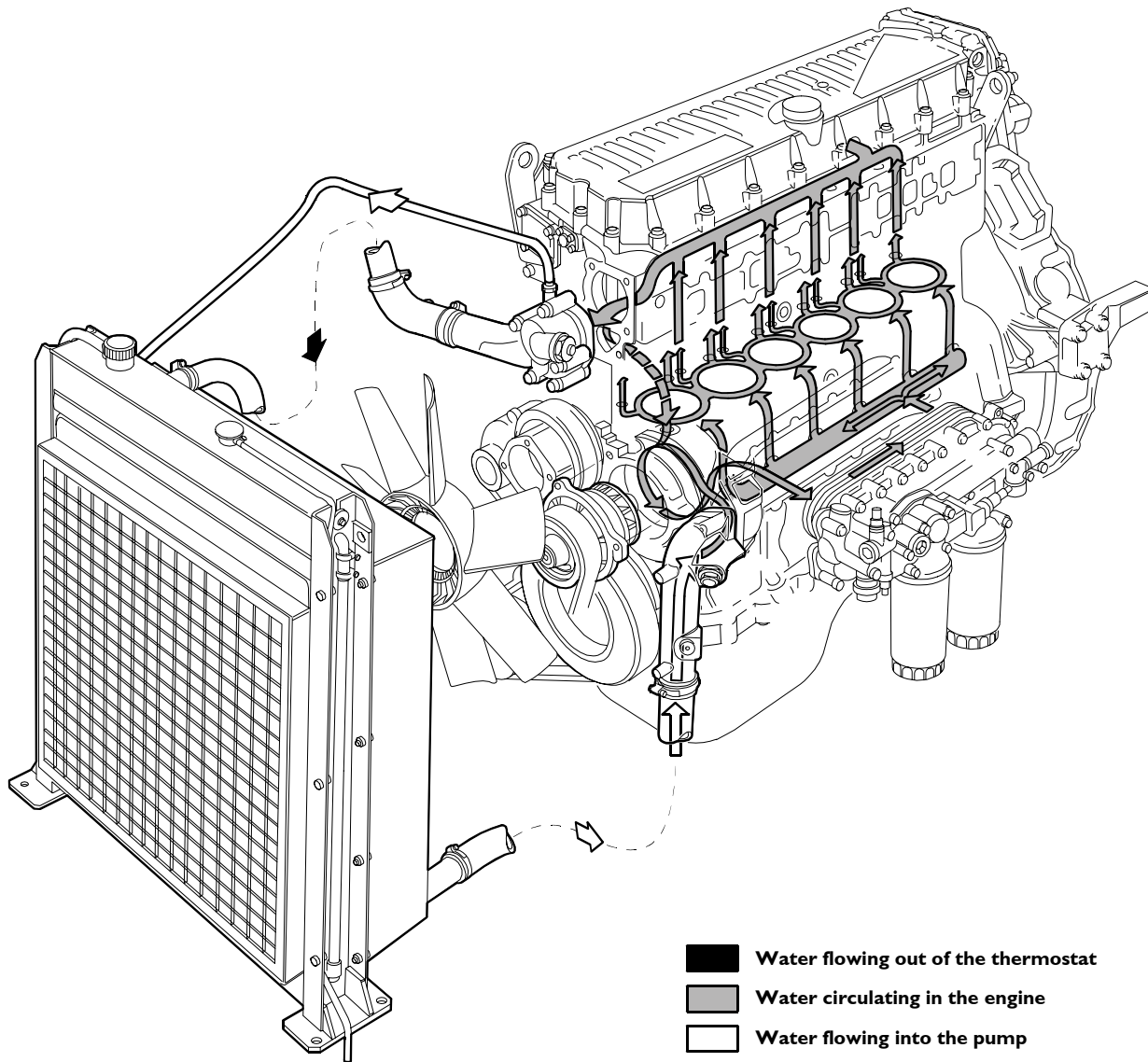
The water pump is actuated by the crankshaft through a poli-V belt and sends coolant to the cylinder block, especially to the cylinder head (bigger quantity). When the coolant temperature reaches and overcomes the operating temperature, the thermostat is opened and from here the coolant flows into the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

Figure 13



F2B ENGINE COOLING SYSTEM DIAGRAM

Figure 14

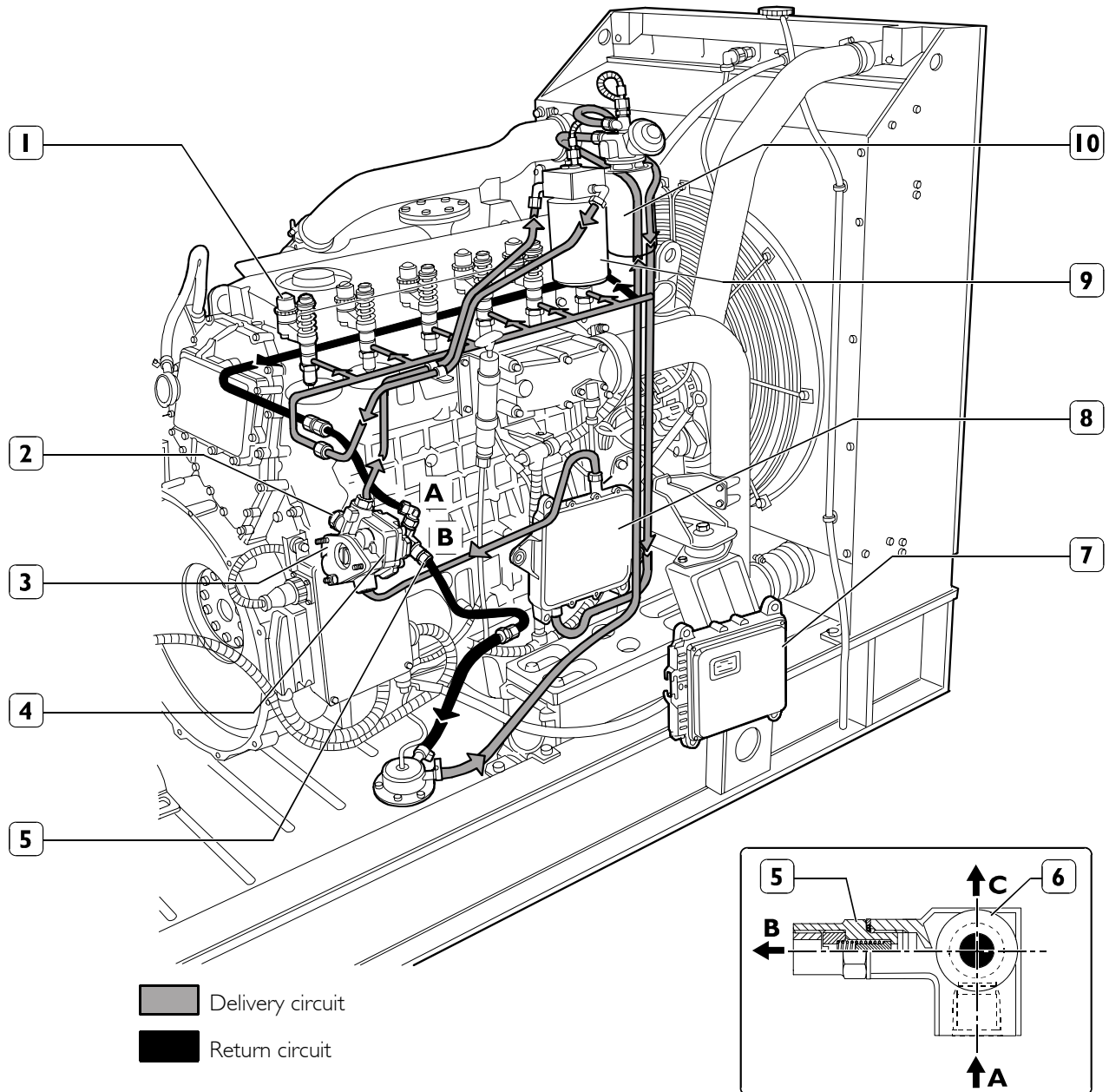


F3B ENGINE COOLING SYSTEM DIAGRAM

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 15



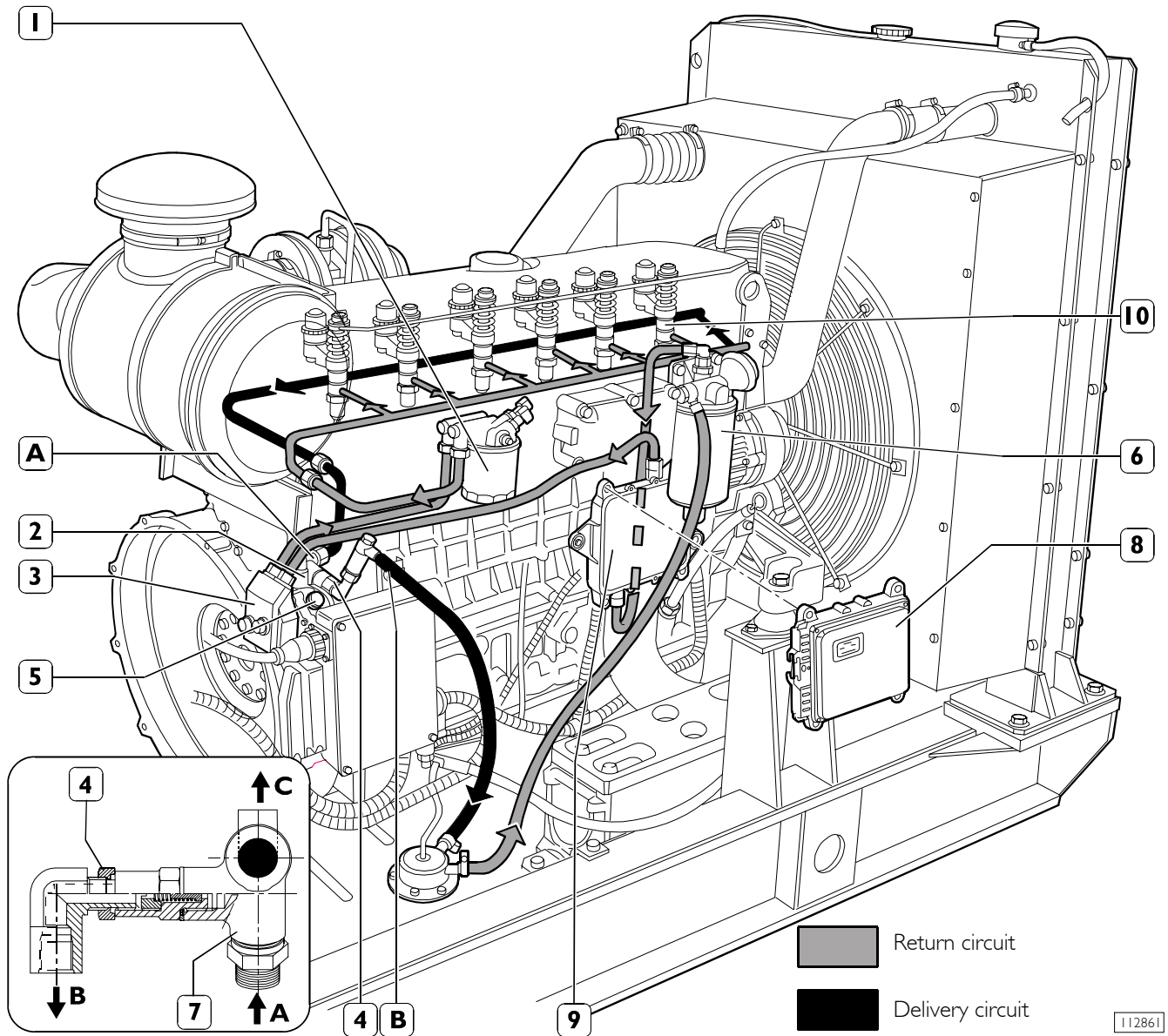
112860

F2B ENGINE FEED SCHEME

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

A. Fuel arriving at injectors - B. Fuel returning to tank - C. Fuel entering from injectors into feed pump

Figure 16



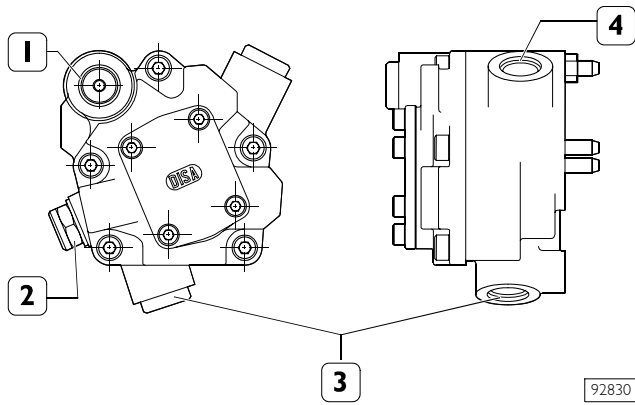
F3B ENGINE FEED SCHEME

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

A. Fuel arriving at injectors - B. Fuel returning to tank - C. Fuel entering from injectors into feed pump

F2B engine fuel supply pump

Figure 17



Engine feed pump
 1. Overpressure valve - 2. Pressure control valve -
 3. Sucking in fuel - 4. Delivering fuel to injectors.

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			

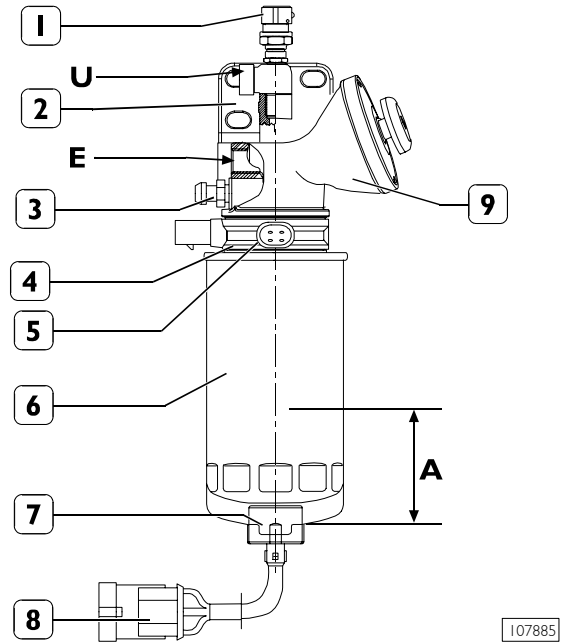
Field of use	
Pump rotation speed (rpm)	2600
Overrunning rotation speed (max 5 min) (rpm)	4100 max -25/+80
Diesel oil temperature (°C)	
Filtering rate on aspiration (micron)	30 0.5 max

Pressure control valve	
Valve calibration	5 ± 5.8

Injectors return valve	
Valve calibration	3.2 ± 3.8

Heated sedimentation tank prefilter

Figure 18



1. Thermostat - 2. Support - 3. Air bleed screw -
 4. Heater - 5. Heater connector - 6. Water separation
 cartridge - 7. Water present indication sensor -
 8. Connector - 9. Priming pump -
 A. Water accumulation capacity- E. Fuel entry -
 U. Fuel exit .

Characteristics

Water accumulation capacity ~ 270 ml
 Thermostat:
 - opening temperature +5 ± 3 °C
 - closing temperature -3 ± 3 °C

Tightening torque

Bleed screw locking (3) 7 ± 1 Nm
 Cartridge locking (6) 18 ± 2 Nm
 Locking water present indicator sensor 0.8 ± 0.1 Nm

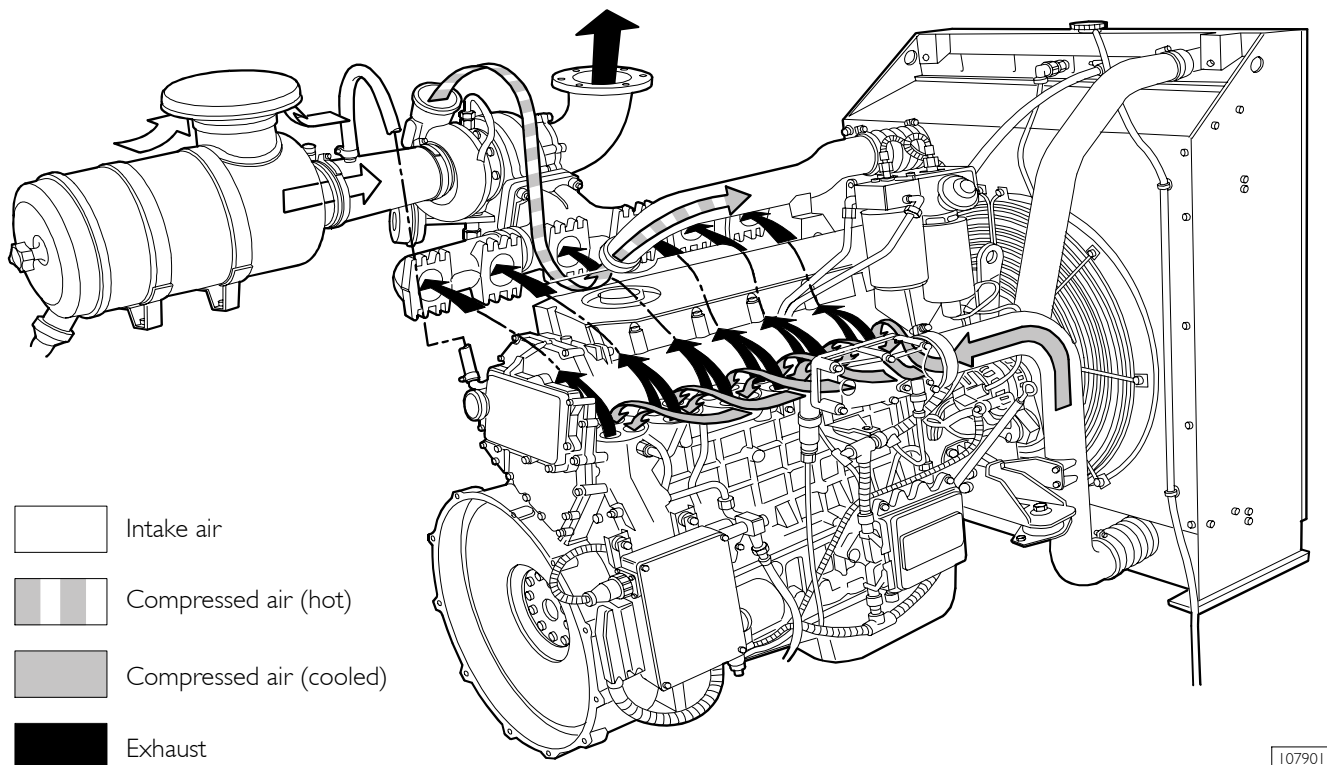
TURBOCHARGING

The turbocharging system consists of:

- air filter;
- Wastegate turbocharger.

F2B engine

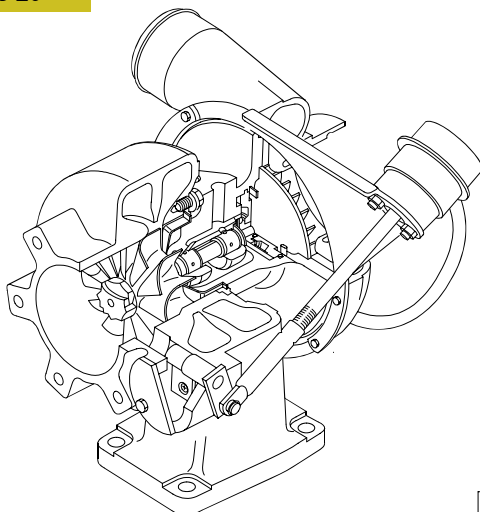
Figure 19



F2B ENGINE SUPERCHARGING SYSTEM DIAGRAM

HX 40W turbocompressor

Figure 20



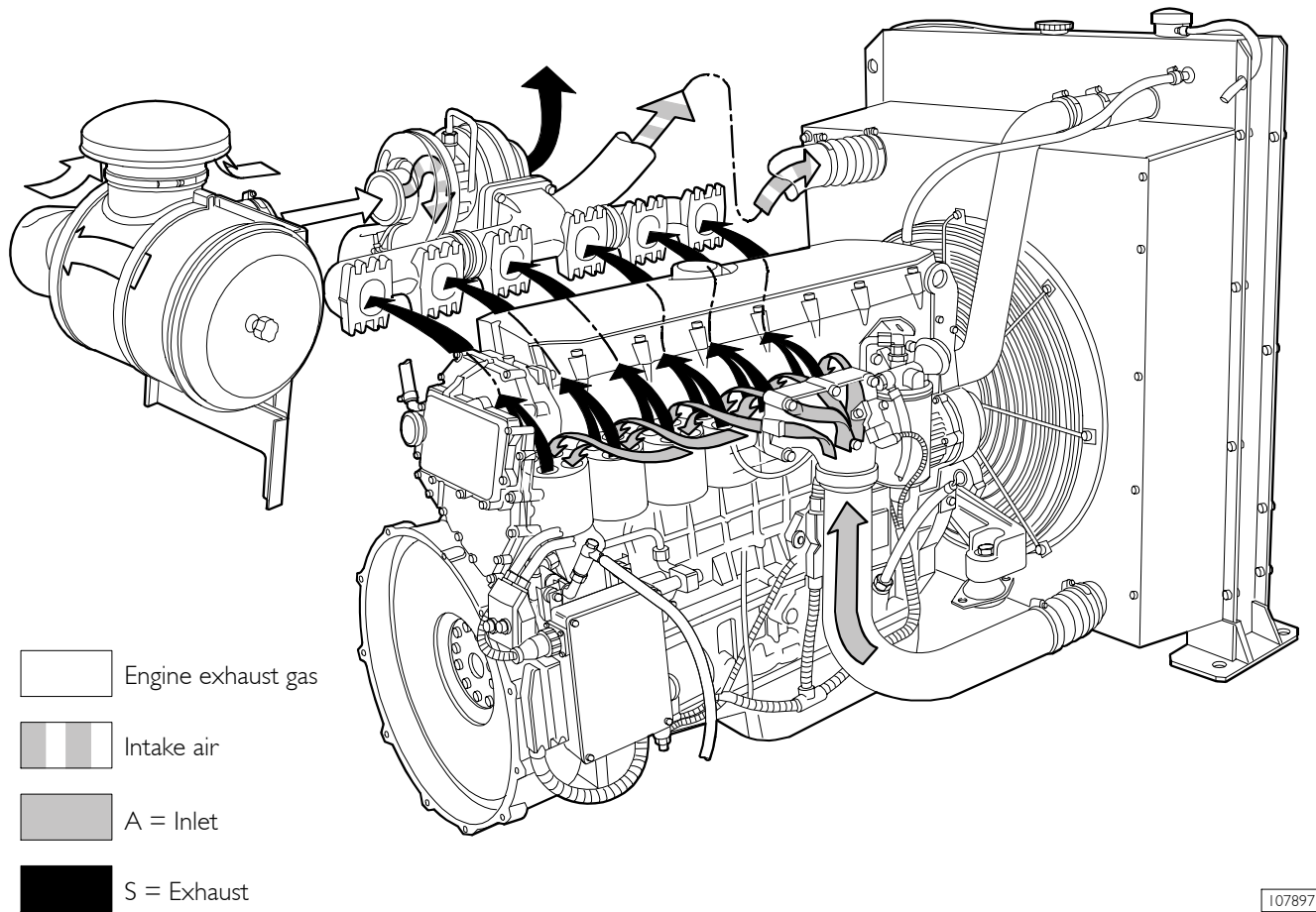
The turbocompressor is a turbocompressor with a return valve.

It is mainly composed by:

- a central unit where a shaft is positioned supported by bushings, a turbine rotor and a compressor rotor are mounted on each end;
- a turbine unit and a compressor unit mounted at the end of the central unit;
- return valve applied on the turbine unit. It divides burnt gases outlet, sending one part directly to the outlet tube when the boost of the compressor reaches the setting value.

F3B engine

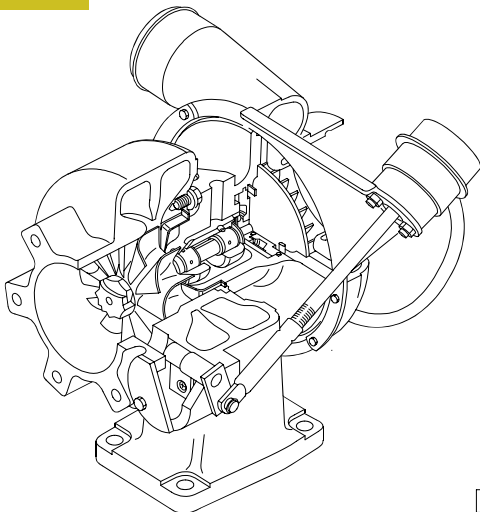
Figure 21



F3B ENGINE SUPERCHARGING SYSTEM DIAGRAM

HX 60W turbocompressor

Figure 22



The turbocompressor is a turbocompressor with a return valve.

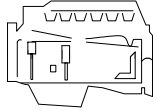

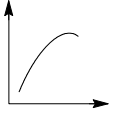
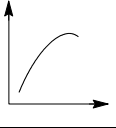
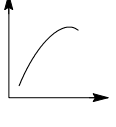
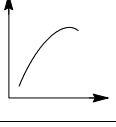
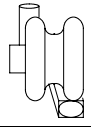

It is mainly composed by:

- a central unit where a shaft is positioned supported by bushings, a turbine rotor and a compressor rotor are mounted on each end;
- a turbine unit and a compressor unit mounted at the end of the central unit;
- return valve applied on the turbine unit. It divides burnt gases outlet, sending one part directly to the outlet tube when the boost of the compressor reaches the setting value.

SECTION 2**G-Drive application**

	Page
F2B ENGINE CLEARANCE DATA	3
F3B ENGINE CLEARANCE DATA	4
F2B GENERAL CHARACTERISTICS	5
F2B ASSEMBLY CLEARANCE DATA	7
F3B GENERAL CHARACTERISTICS	13
F3B ASSEMBLY CLEARANCE DATA	15
ENGINE CONNECTION AND DISCONNECTION FROM THE RADIATOR	22
<input type="checkbox"/> Removal	22
<input type="checkbox"/> Refitting	22
ENGINE ASSEMBLY/DISASSEMBLY	23
<input type="checkbox"/> F2B engine disassembly	23
<input type="checkbox"/> F2B engine assembly	26
<input type="checkbox"/> F3B engine disassembly	26
<input type="checkbox"/> F3B engine assembly	29
PISTONS	29
MAINTENANCE PLANNING	31
<input type="checkbox"/> Recovery	33
<input type="checkbox"/> Inspection and/or maintenance interventions ..	33
<input type="checkbox"/> Checks not included in maintenance planning-daily checks	34
MAINTENANCE PROCEDURES	34
<input type="checkbox"/> Checks and controls	34

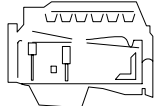

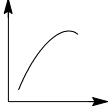

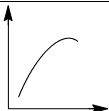

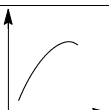

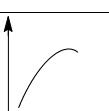

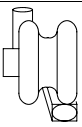

F2B ENGINE CLEARANCE DATA

	Type	F2BE0685	
		A*B30I	
	Compression ratio	16 ± 0.8	
	Europe market Max. output	kW (HP) rpm	234.8 (319.2) 1500/50 Hz
	Max. torque	Nm (kgm) rpm	1494.5 (152.28) 1500
	USA market Max. output	kW (HP) rpm	257.3 (249.9) 1800/60 Hz
	Max. torque	Nm (kgm) rpm	1365.2 (139.1) 1500
	Bore x stroke Displacement	mm cm ³	115 x 125 7790
	SUPERCHARGING Turbocharger type	HX40W	
	LUBRICATION Oil pressure (warm engine)	Forced by gear pump, relief valve single action oil filter	
	- idling - peak rpm	bar bar	4 5

NOTE Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turns based on which the engine has been designed.

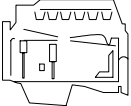
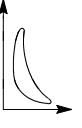
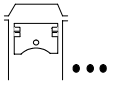
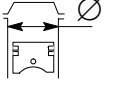
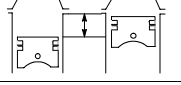
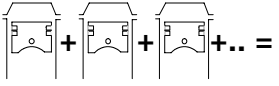
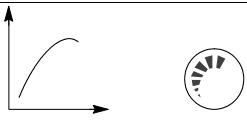
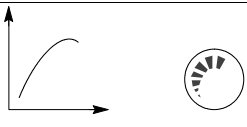
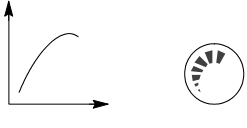
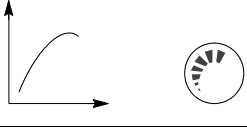
F3B ENGINE CLEARANCE DATA

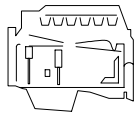
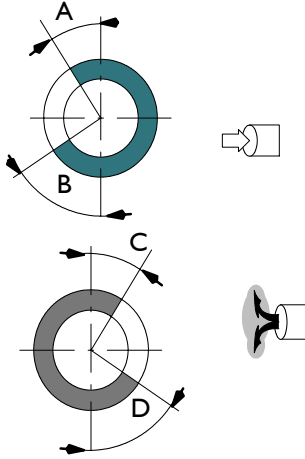
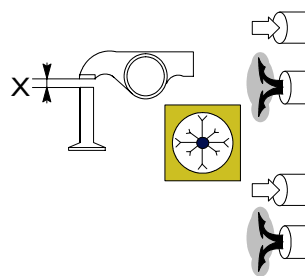
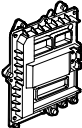
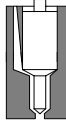
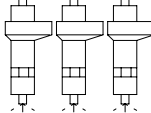
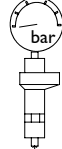
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 	Europe market Max. output	kW (HP) rpm	295 (420) 1500/50Hz	345 (469) 1500/50Hz
 	Max. torque	Nm (kgm) rpm	1879 (1914) 1500	2198 (223.9) 1500
 	USA market Max. output	kW (HP) rpm	- - -	420 (571.2) 1800/60Hz
 	Max. torque	Nm (kgm) rpm	- 1500	- 1500
	Bore x stroke Displacement	mm cm ³	135 x 150 12880	
	SUPERCHARGING Turbocharger type		Direct injection HOLSET HX60W	
	LUBRICATION Oil pressure (warm engine) - idling - peak rpm	bar bar	Forced by gear pump, relief valve single action oil filter 4 5	
	COOLING Water pump control Thermostat - start of opening	°C	Liquid Through belt 80	

NOTE Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.


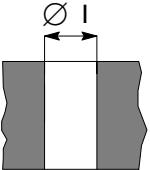
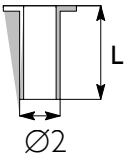


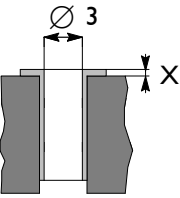
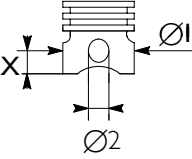


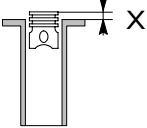
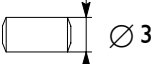

Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turns based on which the engine has been designed.

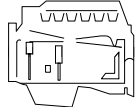
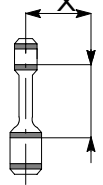
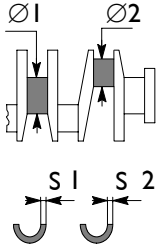
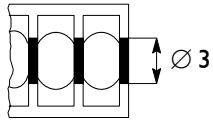


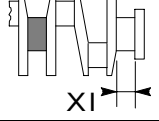
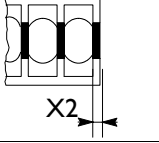
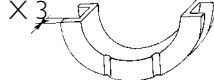

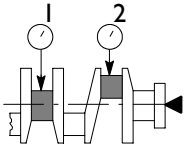
F2B GENERAL CHARACTERISTICS

	Type	F2B	
	Cycle	Diesel 4 strokes	
	Feeding	Turbocharged	
	Injection	Direct	
	N. of cylinders	6 on-line	
	Diameter	mm	115
	Stroke	mm	125
	Total displacement	cm ³	7790
	Europe market Max. output	kW (HP) rpm	234.8 (319.2) 1500/50 Hz
	Max. torque	Nm (kgm) rpm	1494.5 (152.28) 1500
	USA market Max. output	kW (HP) rpm	257.3 (249.9) 1800/60 Hz
	Max. torque	Nm (kgm) rpm	1365.2 (139.1) 1500


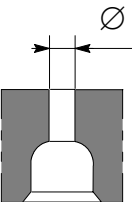
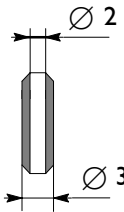



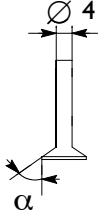



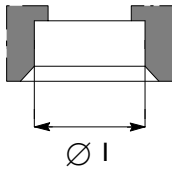


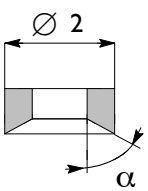


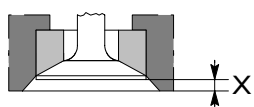





	Type	F2B	
	<p>VALVE TIMING</p> <p>opens before T.D.C. A</p> <p>closes after B.D.C. B</p> <p>opens before B.D.C. D</p> <p>closes after T.D.C. C</p>	17°	31°
 <p>For timing check</p> <p>Running</p>	<p>X { mm</p> <p>X { mm</p> <p>X { mm</p> <p>X { mm</p>	-	-
	<p>FEED</p> <p>Injection type: Bosch</p>	<p>Through fuel pump - filters</p> <p>With electronically regulated injectors PDE 30 pump injectors controlled by overhead camshaft MS6.2 ECU</p>	
	Nozzle type	DLLA 143P894	
	Injection order	1 - 4 - 2 - 6 - 3 - 5	
	<p>Injection pressure bar</p> <p>Injector calibration bar</p>	1500	-

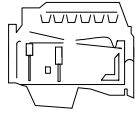
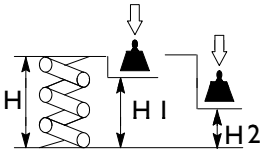
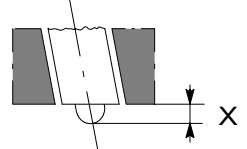
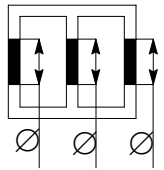
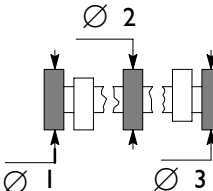
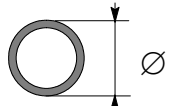
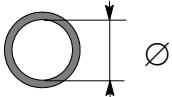


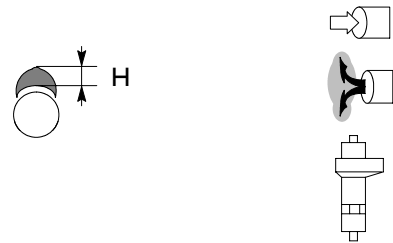
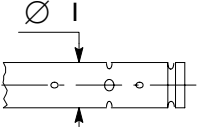
F2B ASSEMBLY CLEARANCE DATA

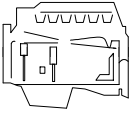
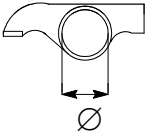
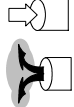
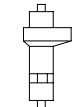
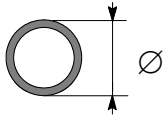
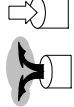
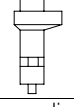
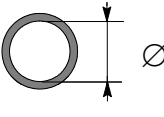
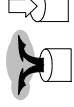
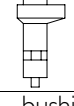

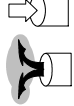
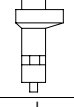

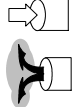
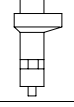
	Type	F2B
CYLINDER BLOCK AND CRANK MECHANISM COMPONENTS		mm
	Cylinder sleeve bore upper $\varnothing 1$ lower	130.200 to 130.225 128.510 to 128.535
	Cylinder liners: outer diameter: upper $\varnothing 2$ lower length L	130.161 to 130.186 128.475 to 128.500
	Cylinder sleeve - crankcase bore upper lower	0.014 to 0.064 0.010 to 0.060
	Outside diameter $\varnothing 2$	
	Cylinder sleeve inside diameter $\varnothing 3$ A* inside diameter $\varnothing 3$ B* Protrusion X	115.000 to 115.012 115.010 to 115.022 0.035 to 0.065
* Available dia. class		
	Pistons: measuring dimension X outside diameter $\varnothing 1$ A• outside diameter $\varnothing 1$ B•• outside diameter $\varnothing 2$	18 114.888 to 114.900 114.898 to 114.910 46.010 to 46.016
<ul style="list-style-type: none"> • Class A pistons supplied as spares. •• Class B pistons are fitted in production only and are not supplied as spares. 		
	Piston - cylinder sleeve	0.100 to 0.124
	Piston diameter $\varnothing 1$	-
	Pistons protrusion X	-
	Gudgeon pin $\varnothing 3$	45.994 to 46.000
	Gudgeon pin - pin housing	0.010 to 0.022

 Type		F2B		
		mm		
	Measuring dimension X	X	125	
	Max. connecting rod axis misalignment tolerance	≡	0.08	
	Main journals	∅1	82.910 to 82.940	
	- nominal		82.910 to 82.940	
	- class 1	1	82.910 to 82.919	
	- class 2	2	82.920 to 82.929	
	- class 3	3	82.930 to 82.940	
	Crankpins	∅2	72.915 to 72.945	
	- nominal		72.915 to 72.945	
	- class 1	1	72.915 to 72.924	
	- class 2	2	72.925 to 72.934	
	- class 3	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	∅3	89.000 to 89.030	
	- nominal		89.000 to 89.030	
	- class 1	1	89.000 to 89.009	
	- class 2	2	89.010 to 89.019	
- class 3	3	89.020 to 89.030		
	Bearing shells - main journals		0.040 to 0.098 * - 0.040 to 0.0110 **	
	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 40.04	
	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 0.34	
	Alignment	≡ 1 - 2	≤ 0.05	
	Ovality	○ 1 - 2	_0.010	
	Taper	∠ 1 - 2	0.010	

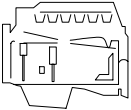

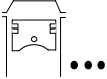

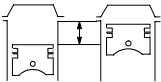
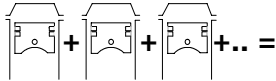

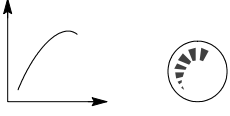
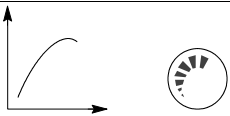
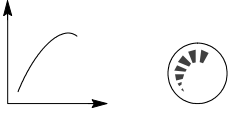
● Fitted in production only and not supplied as spares
 ○ Spares provided: : * = standard spares - 0.127; ** = 0.254 - 0.508

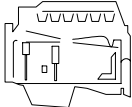
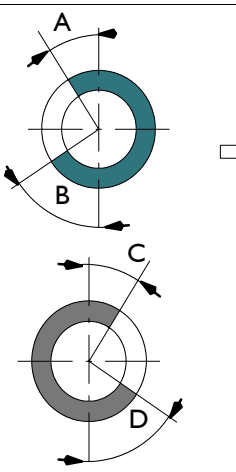
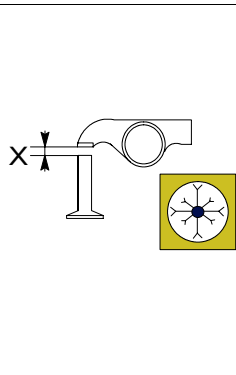
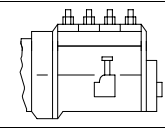
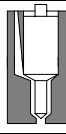
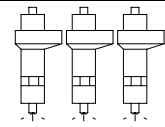
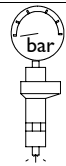
 Type	F2B	
CYLINDER HEADS - VALVE TRAIN		
mm		
 Valve guide housings in cylinder head	Ø 1	12.980 to 12.997
 Valve guide	 Ø 2 Ø 3	8.023 to 8.038 13.012 to 13.025
 Valve guides - housings in the cylinder heads		0.015 to 0.045
 Valve guide		0.2 to 0.4
 Valves:	 Ø 4 α  Ø 4 α	7.970 to 7.985 60° 30' ± 7' 30" 7.970 to 7.985 45° + 15'
 Valve stem and its guide		0.038 to 0.068
 Housing in head for valve seat	 Ø 1  Ø 1	41.985 to 42.020 40.985 to 41.020
 Outside diameter of valve seat; angle of valve seat in cylinder head:	 Ø 2 α  Ø 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	F2B
		mm
	Valve outside spring height: free height H under a load of: N 454 ± 22 H1 N 840 ± 42 H2	63.6 49.5 37.5
	Injector protrusion X	0.7
	Camshaft bush housing fitted in the cylinder head: I ⇒ 7 Ø	80.000 to 80.030
	Camshaft journal diameter: I ⇒ 7 Ø	75.924 to 75.940
	Camshaft bushing outer diameter: Ø	80.090 to 80.115
	Camshaft bushing inner diameter: Ø 6 Ø 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 I ⇒ 6 7	0.050 to 0.121 0.068 to 0.139
	Cam lift:	8.07 7.33 8.820
	Rocker shaft Ø 1	37.984 to 38.000

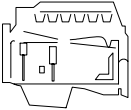
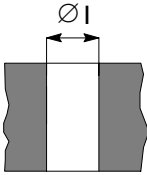
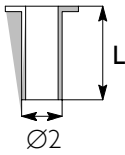



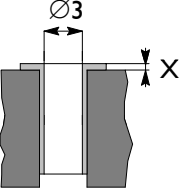
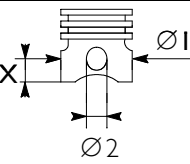



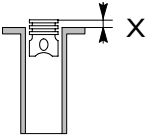
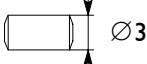

 Type	F2B mm
Bushing housing in rocker arms   	41.000 to 41.016 41.000 to 41.016 42.000 to 42.016
Bushing outer diameter for rocker arms:   	41.097 to 41.135 41.097 to 41.135 42.066 to 42.091
Bushing inner diameter for rocker arms:   	38.025 to 38.041 38.025 to 38.041 38.015 to 38.071
Between bushings and housings   	0.081 to 0.135 0.081 to 0.135 0.050 to 0.091
Between rocker arms and shaft   	0.025 to 0.057 0.225 to 0.057 0.015 to 0.087
TURBOCHARGER Type End float Radial play Wastegate opening stroke at 1.8 ± 0.01 bar pressure: - control - adjustment	HOLSET HX40W 0.025 to 0.127 0.254 to 0.356 0.33 to 1.27 0.5 to 1.04

F3B GENERAL CHARACTERISTICS

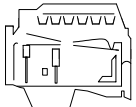
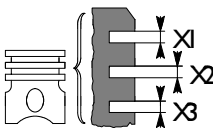
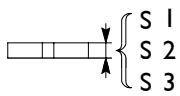



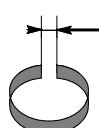
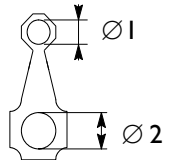
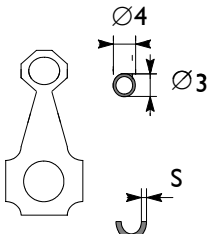




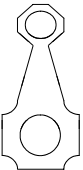
	Type		F3BE0685C	F3BE0685B	F3BE0685A
	Cycle		4-stroke Diesel engine		
	Fuel feed		Turbocharged		
	Injection		Direct		
	No. of cylinders		6 in line		
	Bore	mm	135		
	Stroke	mm	150		
	Total displacement	cm ³	12880		
	Compression ratio		16.5 ± 0.8		
	Europe market				
	Max. output	kW (HP) rpm	295 (420) 1500/50Hz	345 (469) 1500/50Hz	400 (544) 1500/50Hz
	Max. torque		Nm (kgm) rpm	1879 (191.4) 1500	2548 (259.6) 1500
	USA market				
	Max. output	kW (HP) rpm	- - -	- - -	420 (571.2) 1800/60Hz
	Max. torque		Nm (kgm) rpm	- - -	- - -

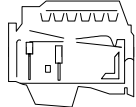
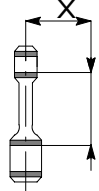
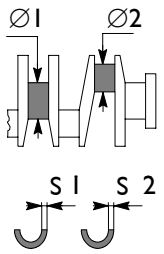
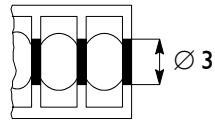


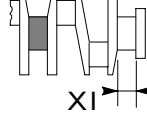
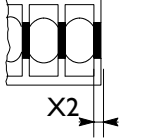
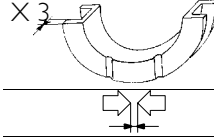

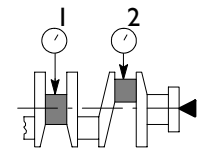
	<p>Type</p>	<p>F3B</p>
	<p>VALVE TIMING</p> <p>opens before T.D.C. A</p> <p>closes after B.D.C. B</p> <p>opens before B.D.C. D</p> <p>closes after T.D.C. C</p>	<p>19°</p> <p>36°</p> <p>50°</p> <p>9°</p>
	<p>For timing check</p> <p>Running</p> <p>X { mm</p> <p>X { mm</p>	<p>-</p> <p>-</p> <p>0.35 to 0.45</p> <p>0.45 to 0.55</p>
	<p>FEED</p> <p>Injection type: Bosch</p>	<p>Through fuel pump - filters</p> <p>With electronically regulated injectors PDE 3 l pump injectors controlled by overhead camshaft</p>
	<p>Nozzle type</p>	<p>-</p>
	<p>Injection order</p>	<p>1 - 4 - 2 - 6 - 3 - 5</p>
	<p>Injection pressure bar</p> <p>Injector calibration bar</p>	<p>1500</p> <p>290 ± 12</p>

F3B ASSEMBLY CLEARANCE DATA

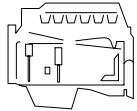
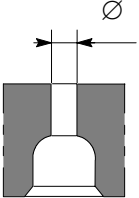
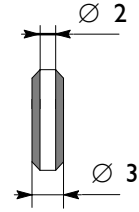




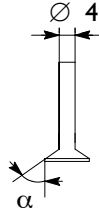



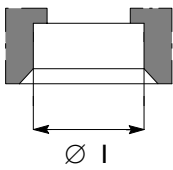


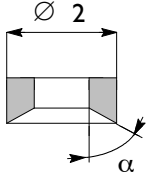


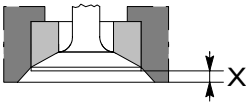





	Type	F3B	
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS			mm
	Bores for cylinder liners: upper lower	$\varnothing 1$	153.500 to 153.525 152.000 to 152.025
	Cylinder liners: external diameter: length	$\varnothing 2$ L	upper lower L 153.461 to 153.486 151.890 to 151.915 -
	Cylinder liners - crankcase bores	upper lower	0.014 to 0.039 0.085 to 0.135
	 External diameter	$\varnothing 2$	-
	Cylinder sleeve inside diameter inside diameter Protrusion	$\varnothing 3$ $\varnothing 3A^*$ $\varnothing 3B^*$ X	135.000 to 135.013 135.011 to 135.024 0.045 to 0.075
* Selection class * Under a load of 800 N			
	Pistons: measuring dimension external diameter external diameter pin bore	X $\varnothing 1A^*$ $\varnothing 1B^*$ $\varnothing 2$	FEDERAL MOGUL 20 134.884 to 134.996 134.895 to 134.907 54.010 to 54.018 MAHLE MONDIAL 20 134.881 to 134.893 134.892 to 134.904
	Piston - cylinder sleeve	A* B*	0.107 to 0.132 0.096 to 0.132
* Selection class			
	 Piston diameter	$\varnothing 1$	-
	Pistons protrusion	X	0.12 to 0.42
	Gudgeon pin	$\varnothing 3$	53.994 to 54.000
	Gudgeon pin - pin housing		0.010 to 0.024


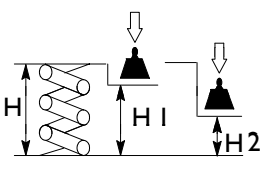
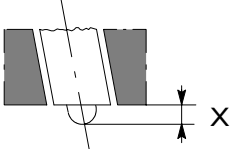
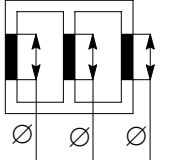
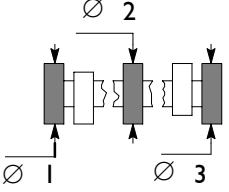
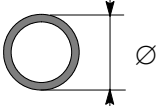
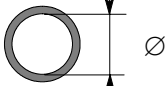


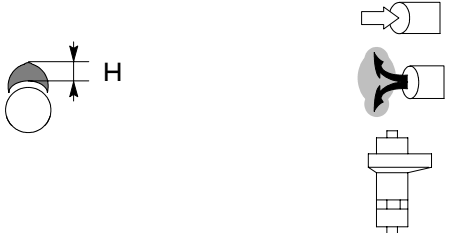
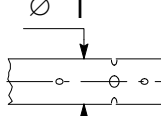
- Class A pistons supplied as spares.
- Class B pistons are fitted in production only and are not supplied as spares.

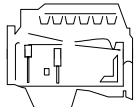
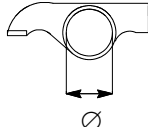


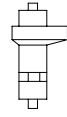
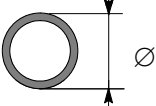


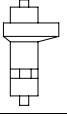
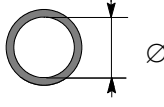


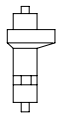



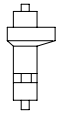



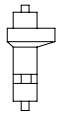
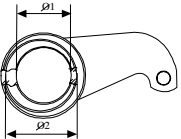
		Type		F3B	
				mm	
	Piston ring grooves	X1*		FEDERAL MOGUL 3.433	MAHLE MONDIAL 3.445 to 3.475
		X2		3.060 to 3.080	3.050 to 3.070
		X3		5.020 to 5.040	5.020 to 5.040
* measured on Ø of 130 mm					
	Piston rings: trapezoidal seal	S1*		3.296 to 2.364	
	lune seal	S2		2.970 to 2.990	
	milled scraper ring with slits and internal spring	S3		4.970 to 4.990	
	* measured on Ø of 130 mm				
	Piston rings - grooves	1		0.069 to 0.137	0.081 to 0.179
		2		0.070 to 0.110	0.060 to 0.100
		3		0.030 to 0.070	0.030 to 0.070
		Piston rings		-	
	Piston ring end gap in cylinder liners	X1		0.40 to 0.55	
		X2	X1	0.65 to 0.80	
		X3	X3	0.40 to 0.75	
	Small end bush housing nominal	Ø1		59.000 to 59.030	
	Big end bearing housing nominal	Ø2		94.000 to 94.030	
	- Class	{ 1 2 3	1	94.000 to 94.010	
	- Class		2	94.011 to 94.020	
- Class	3		94.021 to 94.030		
	Small end bush diameter outside	Ø4		59.085 to 59.110	
	inside	Ø3		54.019 to 54.035	
	Big end bearing shell	S			
	Red			1.965 to 1.975	
	Green			1.976 to 1.985	
Yellow			1.986 to 1.995		
	Small end bush - housing			0.055 to 0.110	
	Piston pin - bush			0.019 to 0.041	
		Big end bearing		0.127 - 0.254 - 0.508	
	Connecting rod weight			g.	
		Ag		4741 to 4780	
	Class	Bg		4781 to 4820	
		Cg		4821 to 4860	

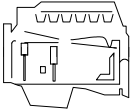


 Type		F3B	
		mm	
 Measuring dimension X	X	125	
	Max. connecting rod axis misalignment tolerance =	0.08	
 Main journals - rated value - class - class - class Crankpins - rated value - class - class - class Main bearing shells Red Green Yellow* Big end bearing shells Red Green Yellow*	∅1	99.970 to 100.000	
	1	99.970 to 99.979	
	2	99.980 to 99.989	
	3	99.990 to 100.000	
	∅2	89.970 to 90.000	
	1	89.970 to 89.979	
	2	89.980 to 89.989	
	3	89.990 to 90.000	
	S1	3.110 to 3.120	
	S2	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 - rated value - class - class - class	∅3	106.300 to 106.330	
	1	106.300 to 106.309	
	2	106.310 to 106.319	
	3	106.320 to 106.330	
 Bearing shells - main journals ○ Bearing shells - big ends ○		0.060 ÷ 0.108 * - 0.061 ÷ 0.119 ** - 0.060 ÷ 0.130 ***	
		0.050 ÷ 0.108 * - 0.051 ÷ 0.109 ** - 0.050 ÷ 0.098 ***	
 Main bearing shells Big end bearing shells		0.127 - 2.254 - 0.508	
		0.127 - 2.254 - 0.508	
 Main journal, thrust bearing X1	X1	47.95 to 48.00	
 Main bearing housing, thrust bearing X2	X2	40.94 to 40.99	
 Thrust washer halves X3	X3	3.38 to 3.43	
 Crankshaft end float		0.10 to 0.30	
 Alignment Ovalization Taper	} = } ○ } /	1 - 2	≤ 0.025
		1 - 2	0.010
		1 - 2	0.010

* Fitted in production only and not supplied as spares
 ○ Spares provided: : * = standard spares - 0.127; ** = 0.254 - 0.508

 Type	F3B	
CYLINDER HEAD - VALVE TRAIN	mm	
 Valve guide housings in cylinder head	Ø1	15.980 to 15.997
 Valve guide	 Ø2 Ø3	10.015 to 10.030 16.012 to 16.025
 Valve guides - housings in the cylinder heads	0.015 to 0.045	
  > Valve guide	0.2 - 0.4	
 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 its guide	0.040 to 0.070	
 Valve seat in head	 Ø1  Ø1	49.185 to 49.220 46.985 to 47.020
 Outside diameter of valve seat; angle of valve seat in cylinder head:	 Ø2 α  Ø2 α	49.260 to 49.275 60° - 30' 47.060 to 47.075 45° - 30'
 Recessing of valve	X X  	0.45 to 0.75 1.65 to 1.95
 Between valve seat and head	 	0.040 to 0.090

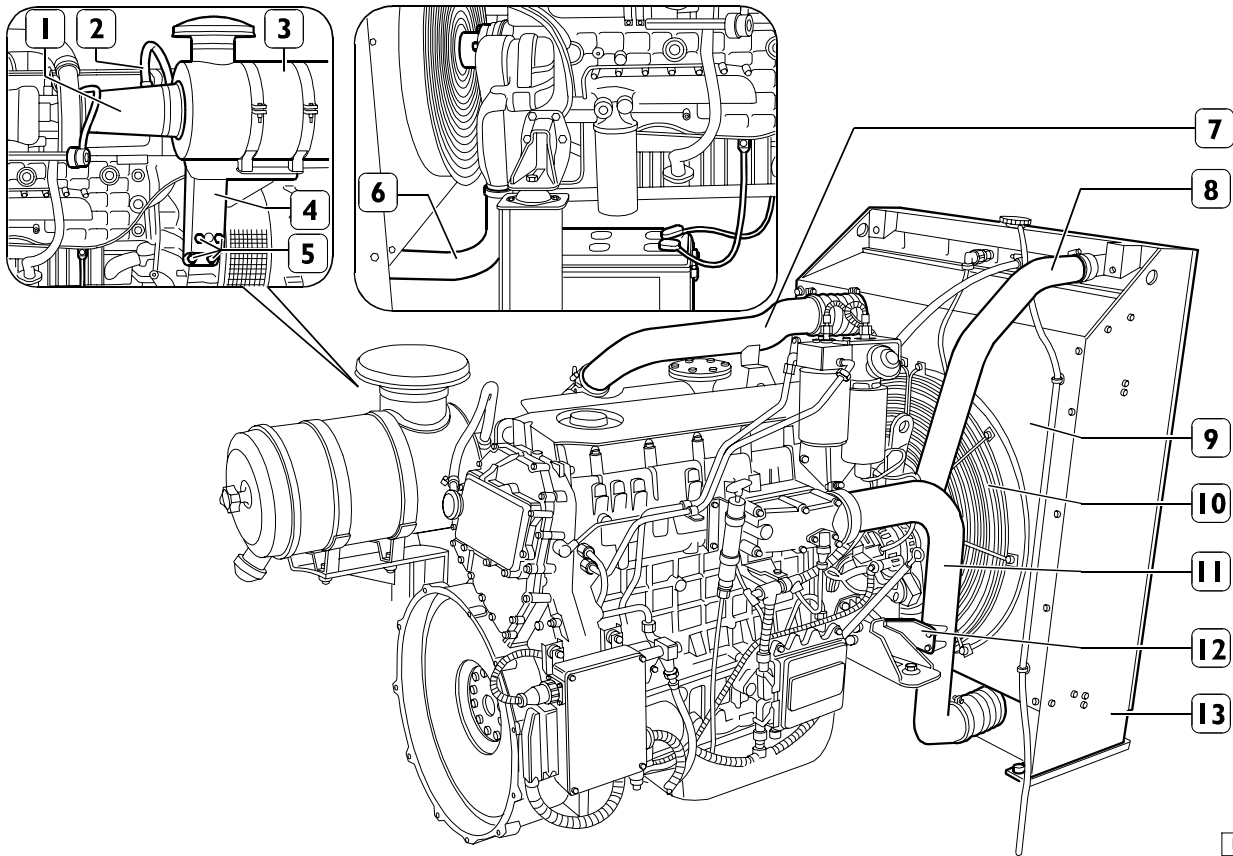
 Type	F3B mm
 <p>Valve spring height:</p> <p>free height H</p> <p>under a load of:</p> <p>575 ± 28 N H1</p> <p>1095 ± 54 N H2</p>	73.40 59 45
 <p>Injector protrusion X</p>	0.53 to 1.34
 <p>Camshaft bushing housing in the cylinder head: I ⇒ 7</p>	Ø 88.000 to 88.030
 <p>Camshaft bearing journals: I ⇒ 7</p> <p>Ø 1, Ø 2, Ø 3</p>	Ø 82.950 to 82.968
 <p>Outer diameter of camshaft bushings: Ø</p>	Ø 88.153 to 88.183
 <p>Inner diameter of camshaft bushings: Ø</p>	Ø 83.018 to 83.085
 <p>Bushings and housings in the cylinder head</p>	0.123 to 0.183
 <p>Bushings and bearing journals</p>	0.050 to 0.135
 <p>Cam lift: H</p>	9.560 9.231 11.216
 <p>Rocker shaft Ø1</p>	Ø1 41.984 to 42.000

	Type	F3B
		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 0.025 to 0.057 0.015 to 0.087
	Engine brake control lever Eccentric pin outer diameter $\varnothing 1$ Rocker arms shaft seat $\varnothing 2$	55.981 to 56.000 42.025 to 42.041

	Type	F3B
		mm
	Rocker arms and engine brake control lever pin	0.030 to 0.058
	Rocker arm shaft and seat on engine brake control lever	0.025 to 0.057
TURBOCHARGER Type 380 CV Engine		HOLSET HX 60
End play		0.025 ÷ 0.127
Radial play		0.406 ÷ 0.580

ENGINE CONNECTION AND DISCONNECTION FROM THE RADIATOR

Figure 1



112827

NOTE Here are described the F2B engines control and/or maintenance operations which are similar to the operations for F3B engines. For this reason they are valid for F3B engines as well.

**Removal**

To prearrange a suited container near the sleeve (6) to recover the cooling liquid. Disconnect and remove the sleeve (6) and (8) by means of suited hose clamps.
 To disconnect and to remove pipes (7) and (11) from engine and radiator by means of the suited collars hanger. (12).
 To remove the protection grids (10) and the ventilator guard (9) by means of clamps.
 To block the radiator unit (13) and to release it from the mounting by means of the clamps operating by both sides.
 Detach the air filter (3) from the engine complete with support (4) by means of clamps (5) after disconnecting the oil vapour pipes (2) and the sleeve (1) from the turbocompressor.
 To remove the engine fixing screws from the mounting and to disconnect the engine.

**Refitting**

For the connection operation repeat the described operations for the disconnection on the contrary and apply the following instructions:

- to control the engine elastic supports and to replace them in case of deterioration ;
- to control that the exhaust pipes are not deteriorated or are going to deteriorate; in this case you shall replace them;
- to clamp the screws and/or nuts to the described couple;
- to fill the cooling system with cooling liquid;
- to carry out bleeding operation from the fuel supply system as described in the suited paragraph.
- to control engine oil level;
- to carry out the tests and controls as described in the suited chapter.



ENGINE ASSEMBLY/DISASSEMBLY

F2B engine disassembly

NOTE Handle all parts extremely carefully. Never get your hands or fingers between pieces.
Wear the required safety clothing such as goggles, gloves and safety shoes.

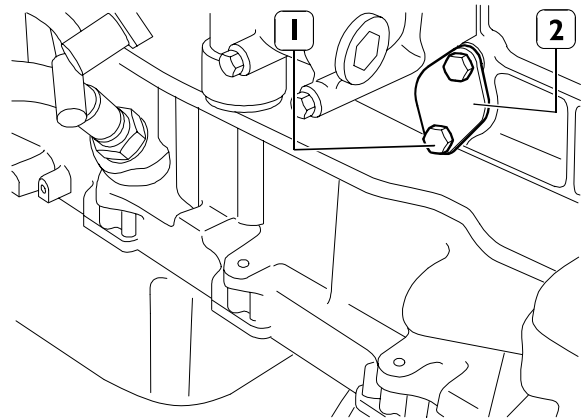
Protect the electric parts before doing any washing with high-pressure jets.

Here are described and illustrated the engine disassembly operation which are different from the operations for the industrial or agricultural applications engines.

Before securing the engine on the rotary stand, remove:

- the electric engine cable (1) by disconnecting it from the control unit and all the sensors/transmitters to which it is connected;
- the starting motor;
- air compressor (if available).

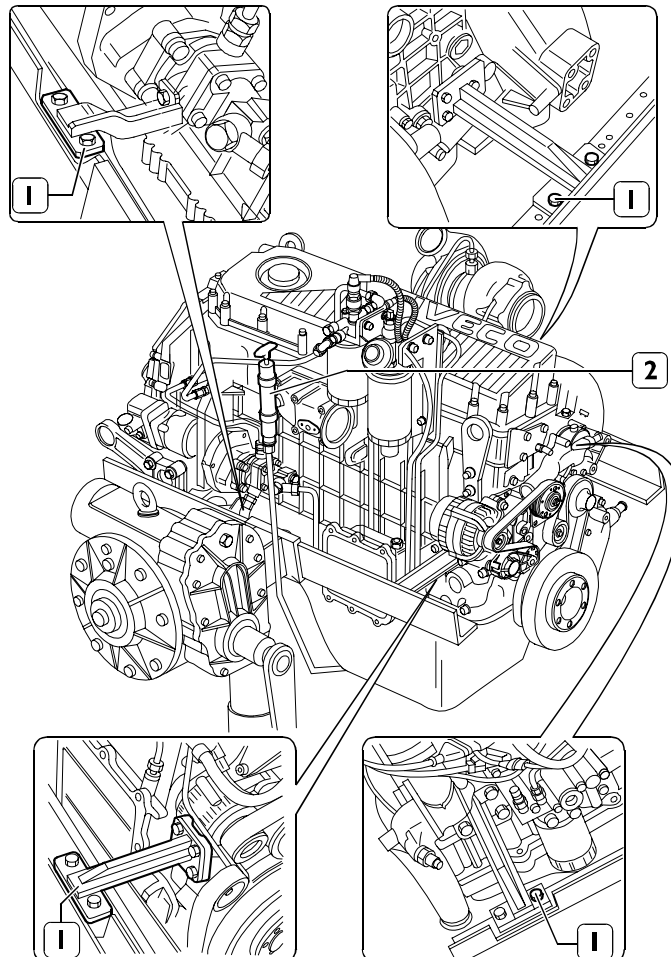
Figure 2



107887

- Remove the engine supports.
- Remove screws (1) and remove oil pressure adjustment valve (2).

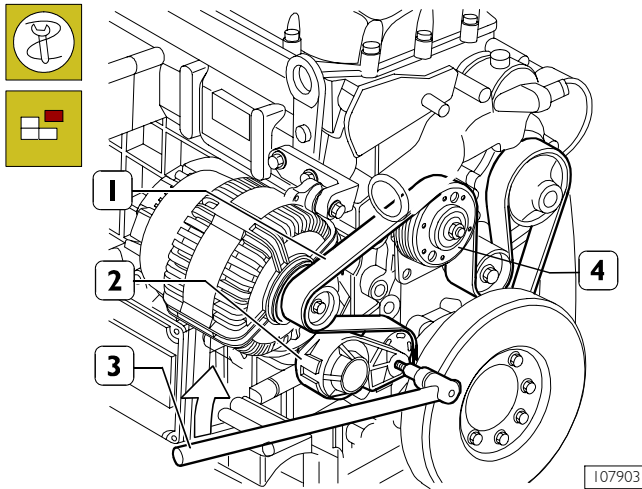
Figure 3



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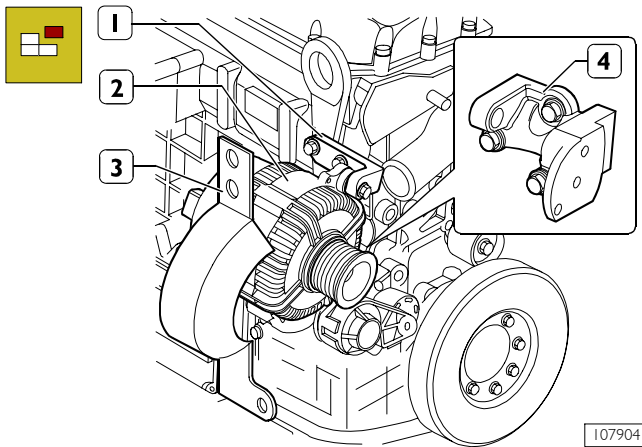
Fix the engine to the rotary stand 99322230, by means of brackets 99361035 (1).
Disconnect line to manual pump (2) from oil sump and drain engine oil.

Figure 4



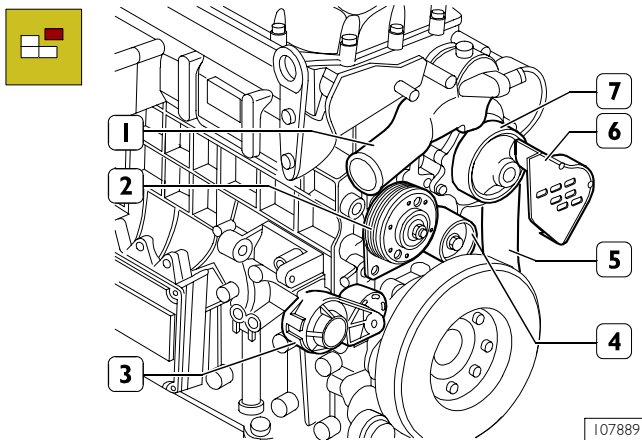
Use specific tool (3) to operate on belt tensioner (2) in direction of arrow, remove water pump alternator and ventilator control belt (1). Remove screws and disconnect electromagnetic ventilator coupling (4).

Figure 5



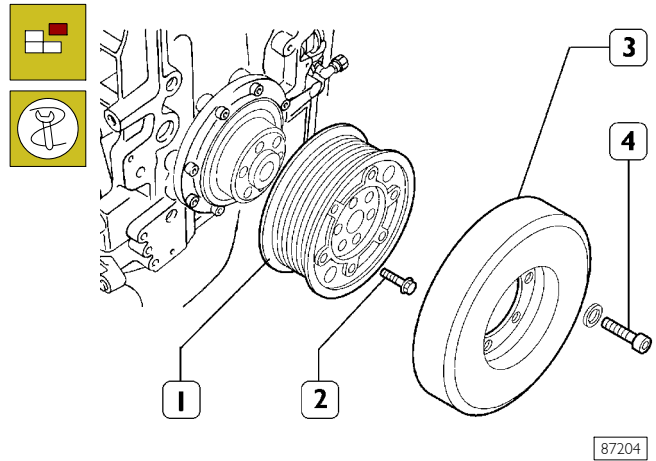
Remove guard (3). Remove retaining screws and remove alternator (2) from bracket (1) and from support (4), then remove the latter from block.

Figure 6



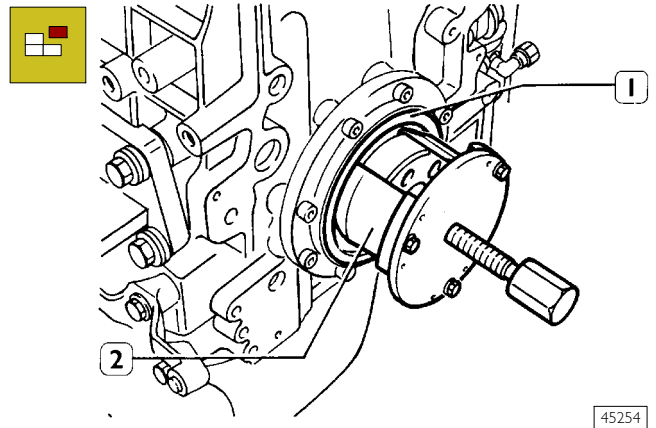
Remove thermostat (1), ventilator support (2), automatic belt tensioner (3), fixed belt tensioner (4), pipeline (5), guard (6), water pump (7).

Figure 7



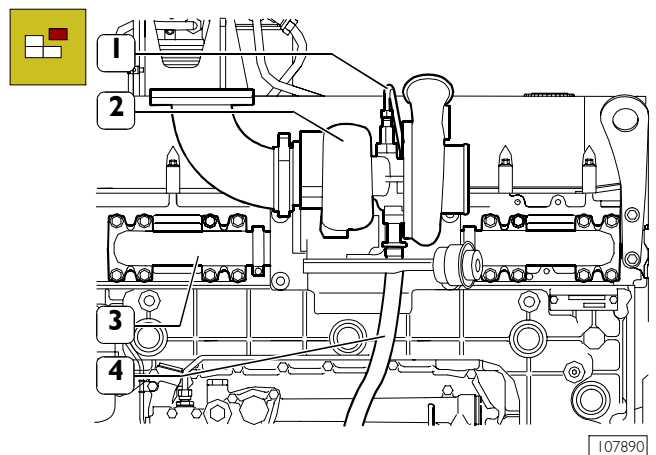
Block the flywheel rotation with tool 99360351. Remove screws (4), then disassemble damper flywheel (3). Remove the screws (2) and the pulley (1).

Figure 8



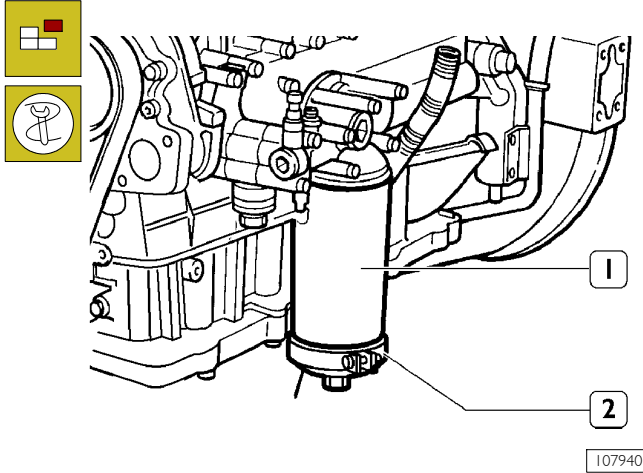
Install extractor 99340051 (2) and remove the seal gaskets (1). Unscrew the screws and remove the cover. Disconnect all electric connections and sensors.

Figure 9



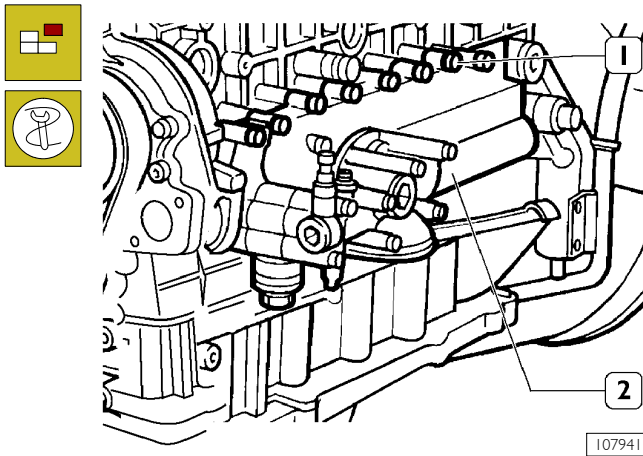
Disconnect oil pipes (1 and 4) of turbo compressor (2). Disconnect turbo compressor (2) from exhaust manifold (3).

Figure 10



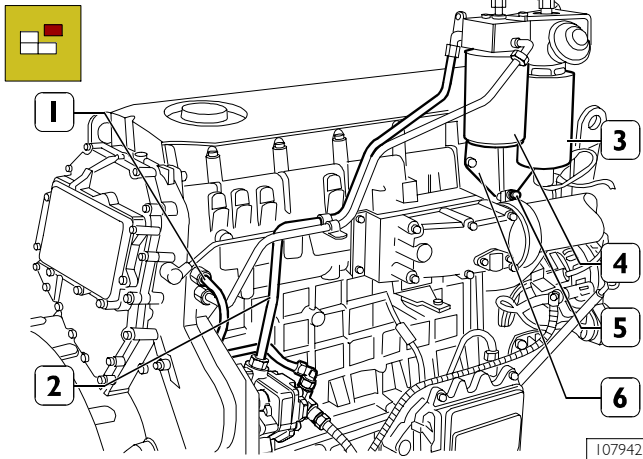
Unscrew the oil filter (1) by tool 99360314 (2).

Figure 11



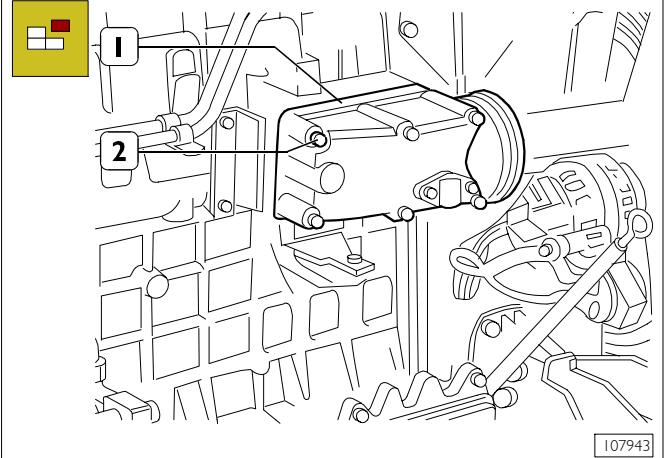
Unscrew the screws (1) and remove the entire heat exchanger (2).

Figure 12



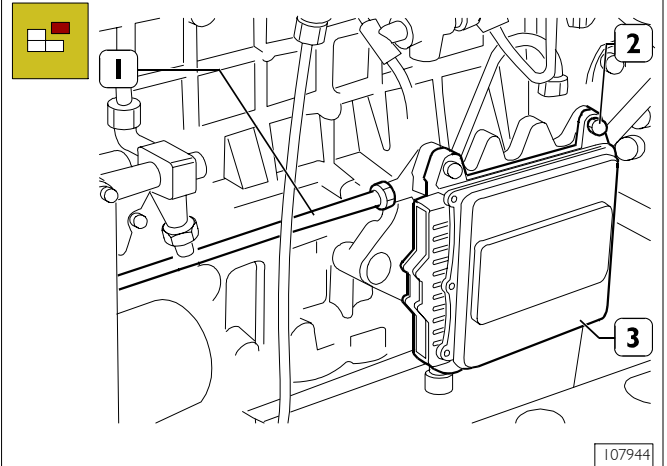
Disconnect fuel lines (1) from cylinder head; (2) and supply pump.
Remove screws (5) and support (6) complete with fuel filter (3) and sedimentation filter (4).

Figure 13



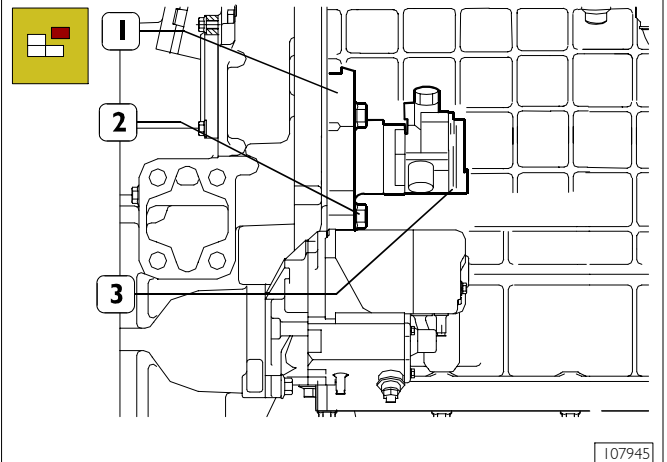
Take out the screws (2) and remove the intake manifold (1).

Figure 14



Disconnect fuel line (1) from central unit (3).
Remove screws (2) and disconnect central unit (3).

Figure 15



Remove screws (2) and disconnect power takeoff (1) complete with supply pump (3).
To go on with the engine disassembly as described for the industrial/agricultural applications engines.

F2B engine assembly

To assembly again the engine inverting the described operations for the disassembly.

F3B engine disassembly

NOTE Handle all parts extremely carefully. Never get your hands or fingers between pieces.
Wear the required safety clothing such as goggles, gloves and safety shoes.

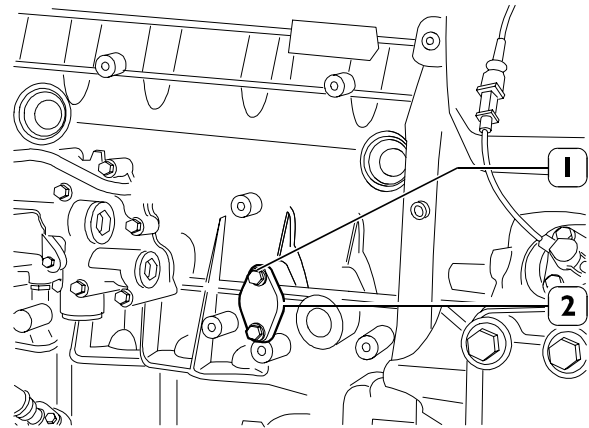
Protect the electric parts before doing any washing with high-pressure jets.

Here are described and illustrated the engine disassembly operations which are different from the operations for the industrial application engines.

Before securing the engine on the rotary stand, remove:

- the electric engine cable (1) by disconnecting it from the control unit and all the sensors/transmitters to which it is connected.
- Remove the engine supports.

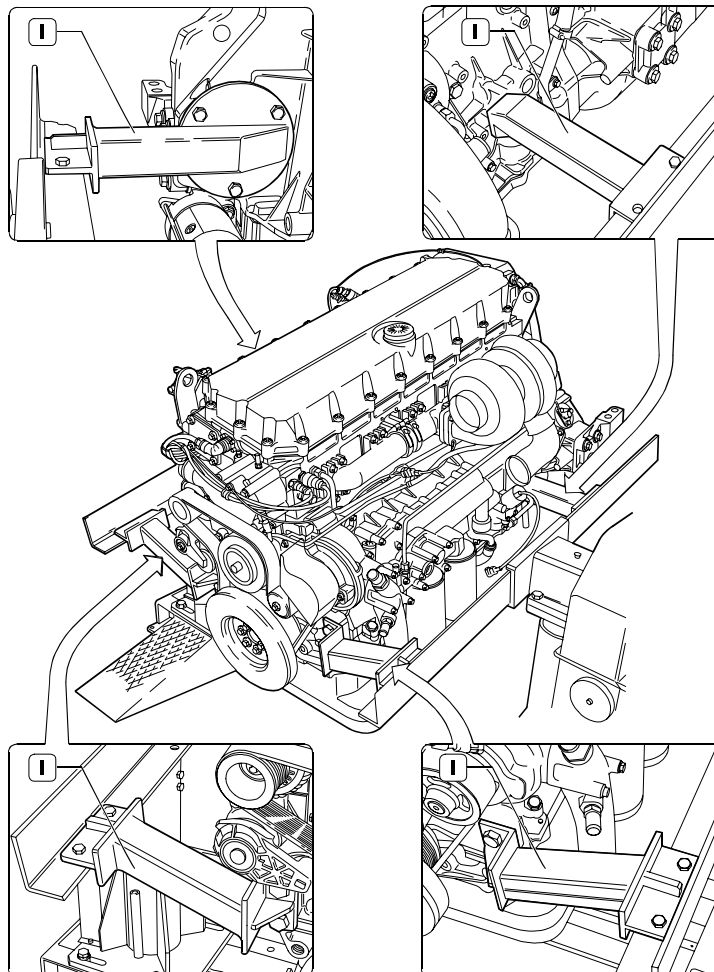
Figure 16



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Remove screws (1) and remove oil pressure adjustment valve (2).

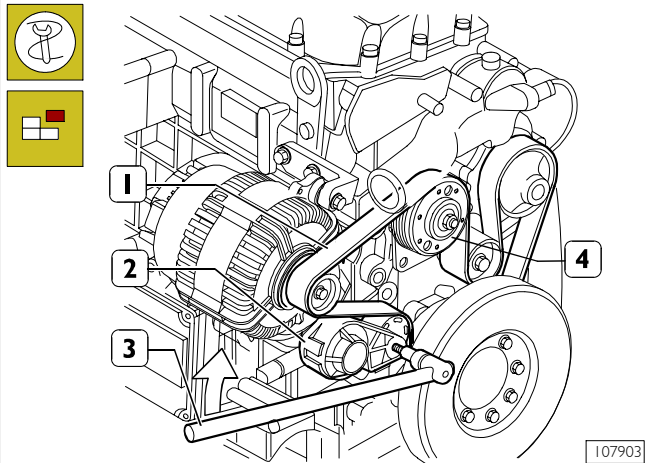
Figure 17



107971

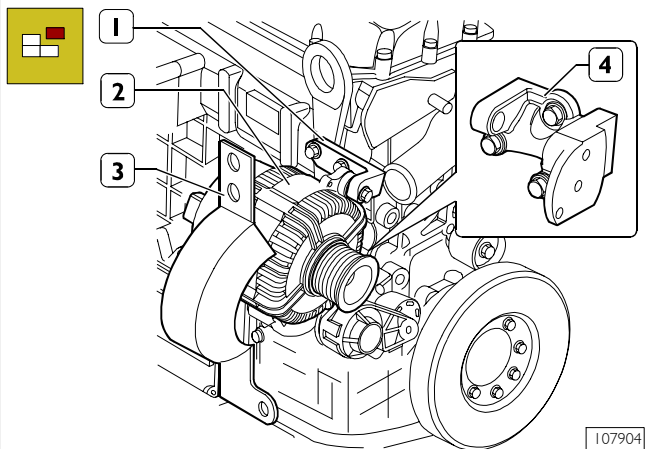
Secure the engine to the rotary stand with the brackets 99361036 (1).
To release the lubrication oil from the pan.

Figure 18



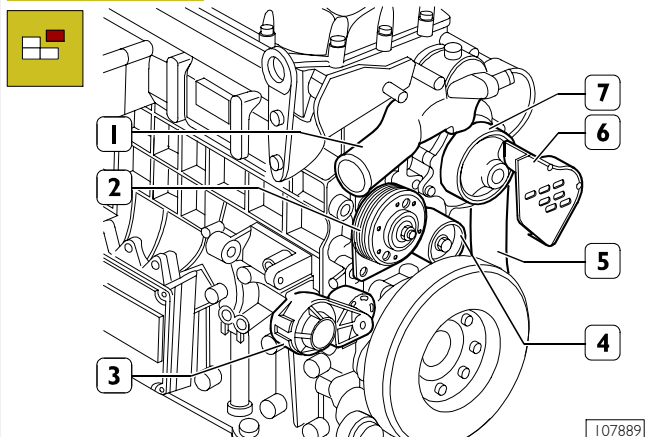
Use specific tool (3) to operate on belt tensioner (2) in direction of arrow, remove water pump alternator and ventilator control belt (1). Remove screws and disconnect electromagnetic ventilator coupling (4).

Figure 19



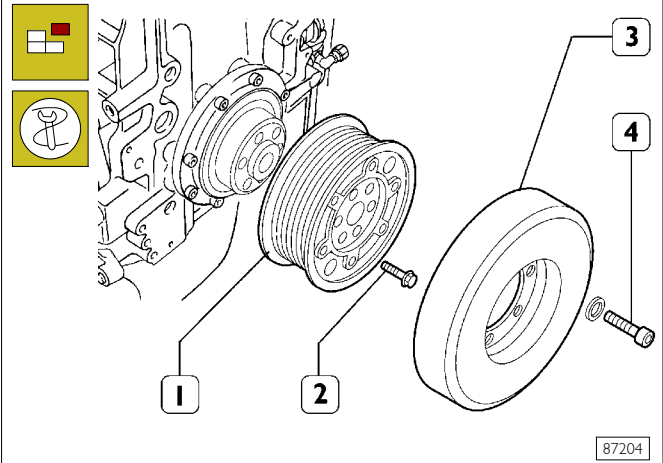
Remove guard (3).
Remove retaining screws and remove alternator (2) from bracket (1) and from support (4), then remove the latter from block.

Figure 20



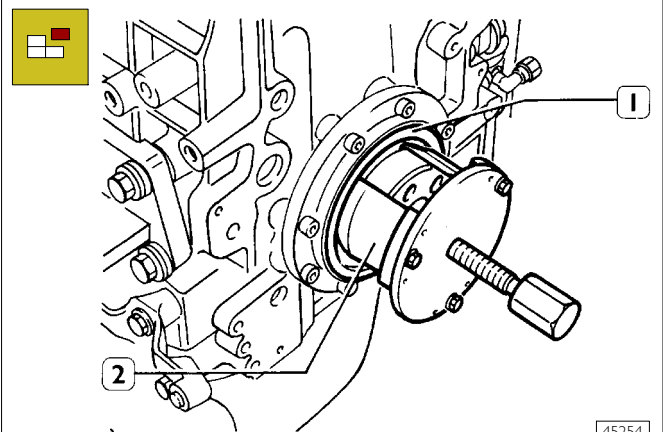
Remove thermostat (1), ventilator support (2), automatic belt tensioner (3), fixed belt tensioner (4), pipeline (5), guard (6), water pump (7).

Figure 21



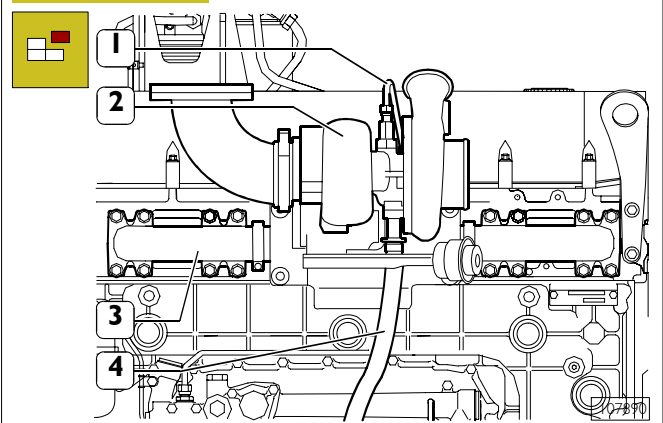
Block the flywheel rotation with tool 99360351.
Remove screws (4), then disassemble damper flywheel (3).
Remove the screws (2) and the pulley (1).

Figure 22



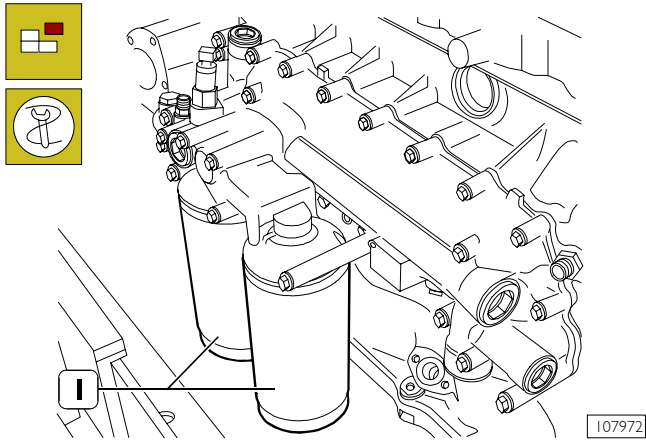
Install extractor 99340051 (2) and remove the seal gaskets (1). Unscrew the screws and remove the cover.
Disconnect all electric connections and sensors.

Figure 23



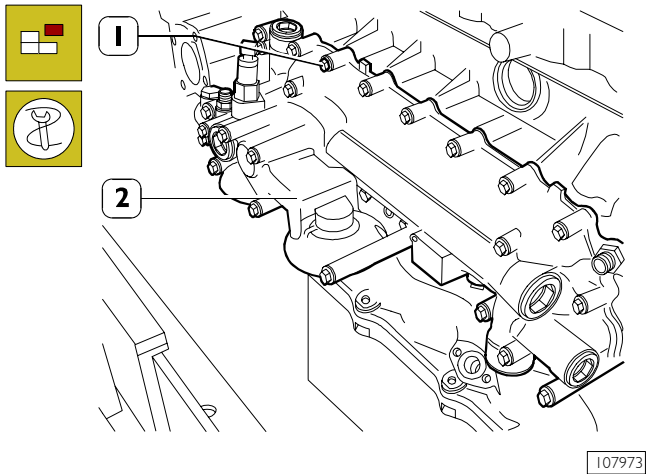
Disconnect oil pipes (1 and 4) of turbo compressor (2).
Disconnect turbo compressor (2) from exhaust manifold (3).

Figure 24



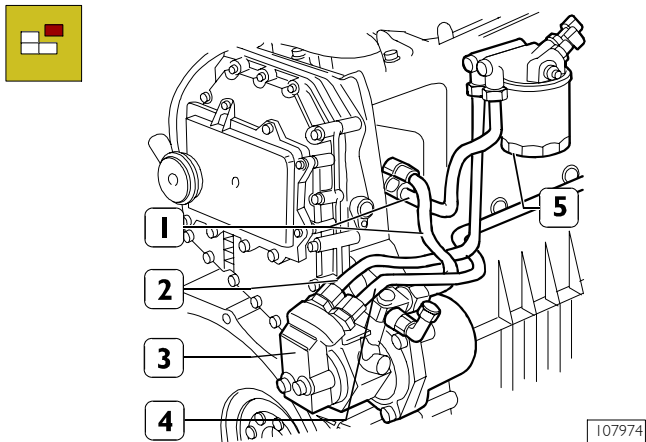
Unscrew the oil filter (1) by tool 99360314.

Figure 25



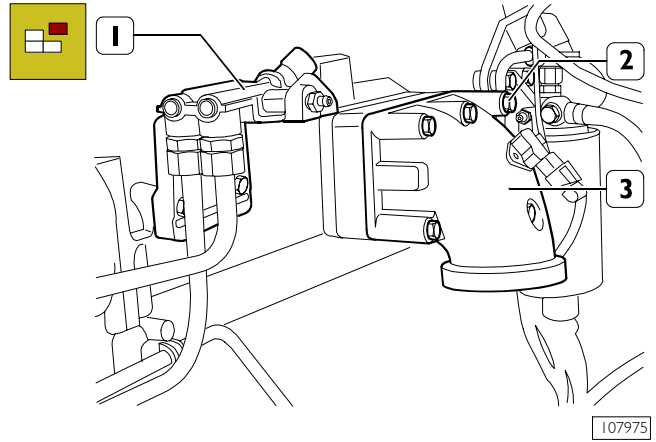
Unscrew the screws (1) and remove the heat exchanger (2).

Figure 26



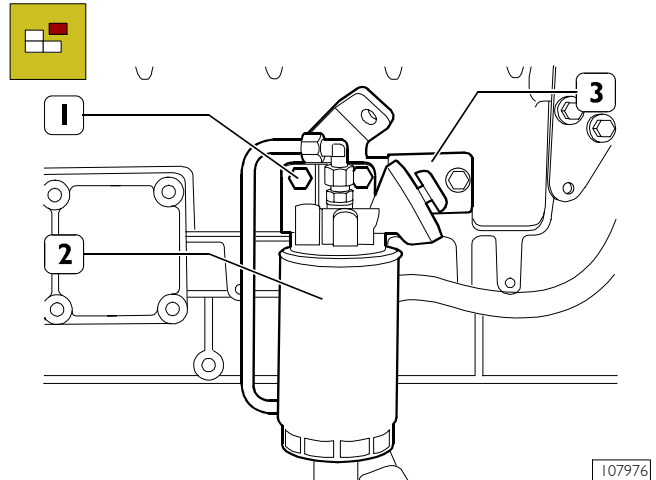
Disconnect the fuel pipes (1 and 4) from the fuel pump (2). Remove supply pump (3) and fuel filter (5).

Figure 27



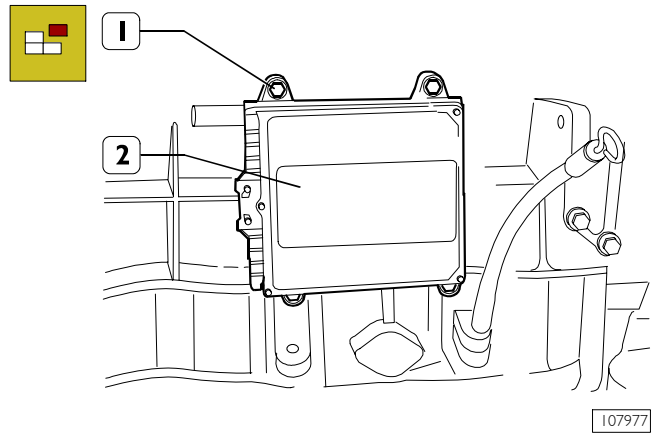
Remove retaining screws and support (1) of fuel filter. Remove screws (2) and remove intake manifold (3).

Figure 28



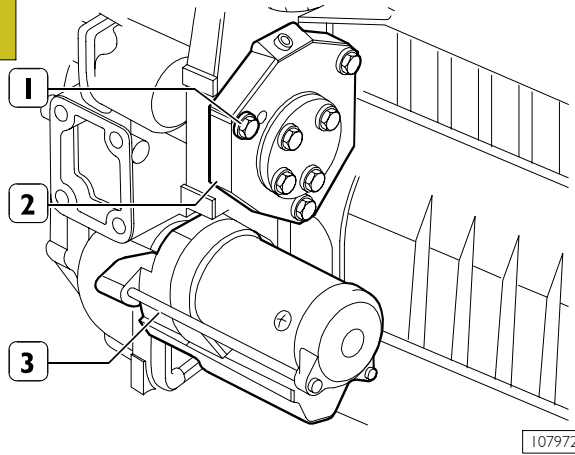
Remove screws (1) and bracket (3) supporting sedimentation tank prefilter (2).

Figure 29



Remove screws (1) and disconnect ECU (2).

Figure 30



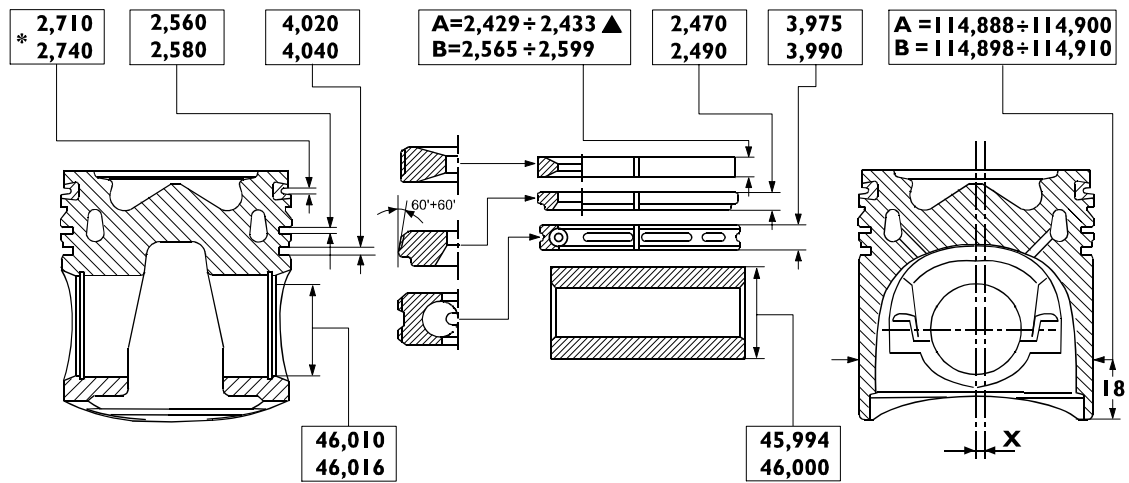
Remove screws (1) and remove power takeoff (2).
Remove screws and remove starter motor (3).

F3B engine assembly

To assembly again the engine inverting the described operations for the disassembly.

PISTONS

Figure 31



MAIN DATA ON PISTONS, PISTONS RINGS AND PIN

* Dimension detected on 112 mm Ø. - ▲ measured from outer Ø at : **A** (AEGOETZE) = 2 mm - **B** (DANA) = 1.5 mm
: X = 0.7 ± 0.1

MAINTENANCE PLANNING

MAINTENANCE PLANNING

Recovery

To ensure optimised working conditions, in the following pages we are providing instructions for the overhaul control interventions, checks and setting operations that must be performed on the engine at due planned dates.

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

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

NOTE Here are described the F2B engines control and/or maintenance operations which are similar to the operations for F3B engines. For this reason they are valid for F3B engines as well.

Inspection and/or maintenance interventions

Intervention type	Frequency (hours)
Engine	
Engine visual inspection	Daily
Check presence of water in fuel prefilter	Daily
Engine oil change	-
Engine oil filter change	-
Fuel prefilter change	-
Fuel filter change	-
Check Blow-by filter condition by clogging indicator	-
Check condition of water pump/alternator control belt	-
Check-up of EDC system by diagnostics tool	-
Check valve lash and adjust, if required	-
Dry air filter change and container cleaning	-

NOTE The maintenance operations are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Checks not included in maintenance planning-daily checks

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

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

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

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

MAINTENANCE PROCEDURES

Checks and controls

Engine oil level check.

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

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

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

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

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

To provide filling, operate through the upper top (1) or through the lateral top (2). During filling operation, the tops must be removed as well as the rod in order to make the oil flow easier".

Refill through upper tappet cover plug. During refill, remove dipstick for easier oil drain.



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



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

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

Check of fuel system

The check must be executed both when the engine disconnected and when it is running.

The check is made by observing the fuel pipes from the tank to the fuel pump and to the injectors.

Cooling system check

The check must be executed both when the engine disconnected and when it is running.

Check the pipes from the engine to the radiator and vice versa; note any seepage and the state of the pipes especially near the coupling clamps.

Verify that the radiator is clean, the correct working of the fan flywheels, the presence of any leakage from the connectors, from the manifold and from the radiating unit.



Due to the high temperatures achieved by the system, do not operate immediately after the engine's disconnection, but wait for the time deemed necessary for the cooling.

Protect the eyes and the skin from any eventual high pressure jet of cooling liquid.

The density of the cooling liquid must be checked any how every year before winter season and be replaced in any case every two year.

NOTE In case of new filling, proceed bleeding system, through the bleeds on the engine.

If bleeding of the system is not carried out, serious inconvenience might be caused to the engine due to the presence of air pockets in the engine's head.

Lubricating system check

The check must be executed both when the engine disconnected and when it is running.

Verify the presence of any oil leakage or blow-by from the head, from the engine pan or from the heat exchanger.



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

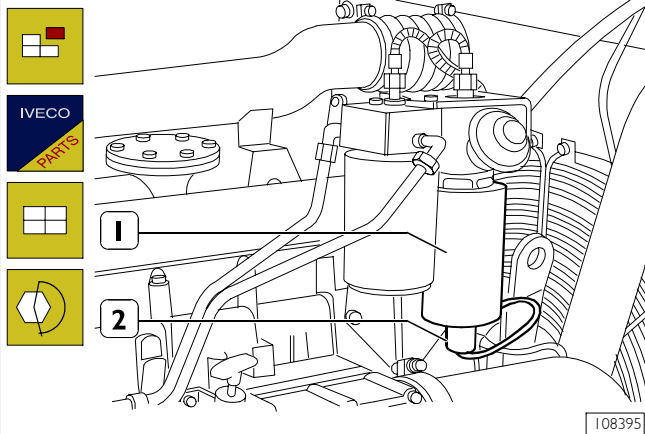


Adequately protect the skin and the eyes, operate in full compliance with safety regulations.

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

Replace fuel sedimentation tank prefilter

Figure 32

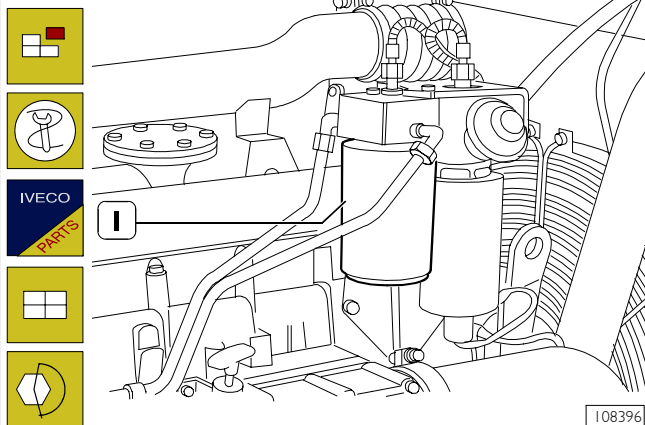


Disconnect electric connector. Unlock prefilter (1) and change it. Before refitting a new cartridge, wet seal with fuel oil or engine oil. Lock cartridge by hand till in contact with support, then lock it by $\frac{3}{4}$ of a rev. at predefined tightening torque.

NOTE At change, filter cartridge must not be prefiltered to prevent circulating dirt that could damage injector/pump system components. Bleed air from fuel filter as described in previous pages.

Fuel filter change

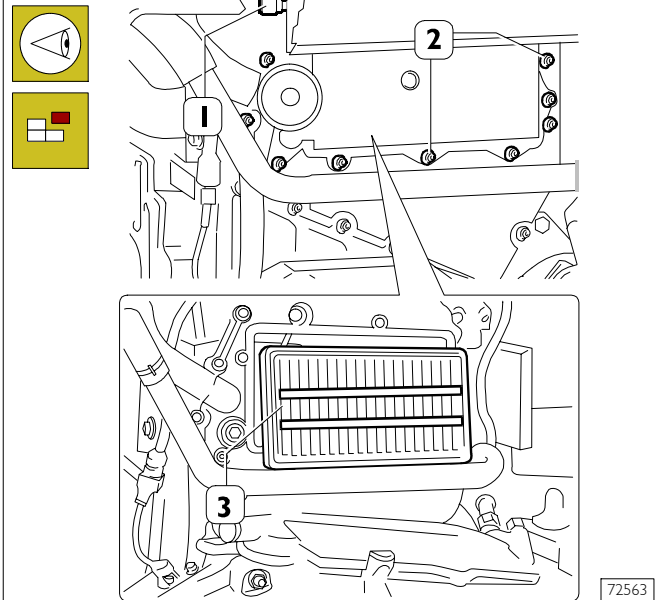
Figure 33



Use tool 99360314 to remove fuel filter (1). Before fitting the new cartridge, wet seal with fuel oil or engine oil. Lock the new one by hand and carefully check that rubber seal and contact surface are clean and in perfect conditions. Lock cartridge by hand till contact with support and then lock it for $\frac{3}{4}$ of a rev. at prescribed tightening torque. Bleed air from supply system as described in paragraph below:

Check Blow-by filter conditions by means of a clogging indicator

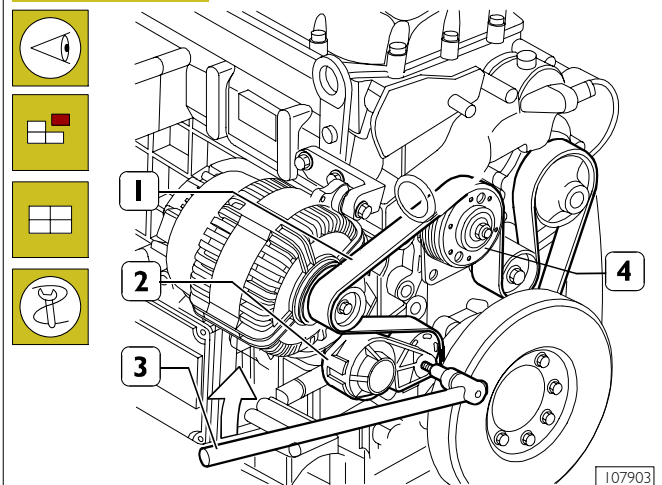
Figure 34



- Check filter (3) conditions by means of a clogging indicator (1). In case the red area appears, change it.
- For screw (2) change, remove carter, pull out filter (3) and replace it with a new one. Filter has a one-way operation, therefore it must be installed with the two reinforcement bars visible, as shown in the picture.

Check of water pump/alternator control belt condition

Figure 35



Visually check that belt (1) is not worn out or broken; change it as described below, if required.

Water pump/alternator control belt change

In order to remove and refit belt (1), operate using a specific tool (3) on belt tensioner (2) in direction shown by arrow.

NOTE Belt tensioner is automatic and requires no adjustment.

Check for any water in the fuel filter

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

Take prompt action on the filter to drain off the water in the fuel circuit.

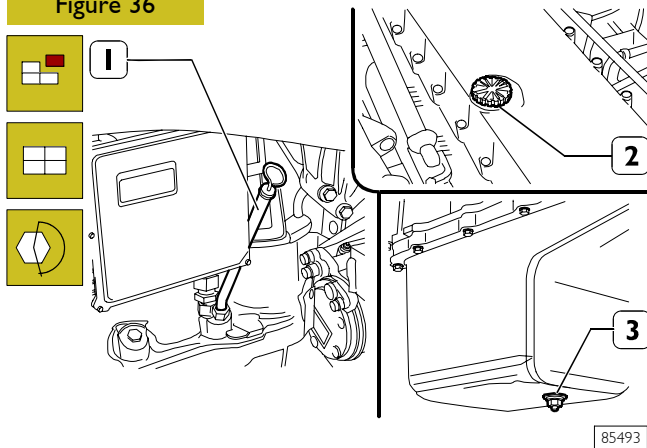
Fuel filter is equipped with pump screw-valve to drain the water eventually mixed with fuel.

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


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

Engine oil change


Figure 36




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

 Warning: We recommend to wear proper protections because of high motor service temperature. The motor oil reaches very high temperature: you must always wear protection gloves.

- Place a proper container for the oil collecting under the pan connected with the drain plug (3).
- Unscrew the plug (3) and then take out the control dipstick (1) and the inserting plug (2) to ease the downflow of the lubrication oil.

 The oil motor is very pollutant and harmful. In case of contact with the skin, wash with much water and detergent.

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

Dispose of the residual properly following the rules.

Lock plus (3) under oil sump at predefined tightening torque. Pour oil in prescribed quantity and quality in engine through filler (2) of tappet cover.

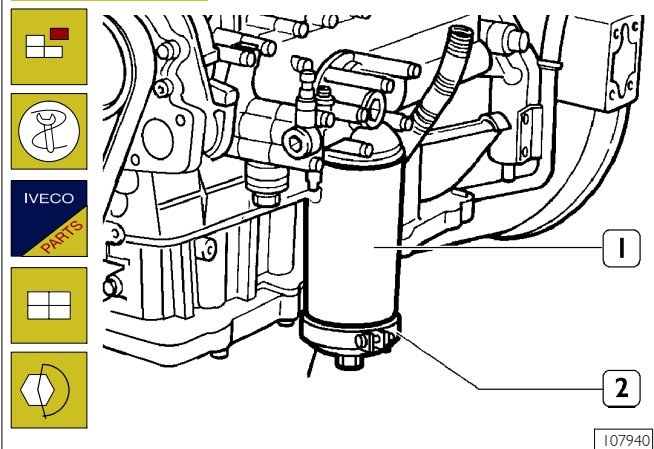
- After the complete drainage, screw the plug and carry out the clean oil filling.

NOTE Use only the recommended oil or oil having the requested features for the correct motor functioning. In case of topping up, don't mix oils having different features. If you don't comply with these rules, the service warranty is no more valid.

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


Engine oil filter change

Figure 37



Drain oil as described in "Engine oil change" chapter. By means of 99360314 tool (2) to disassemble oil filter (1) or filters for F3B engine .

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

 Place properly a container for the liquid. Warning: avoid the contact of skin with the motor oil: in case of contact wash the skin with running water.

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

NOTE Before refitting the new cartridge, wet seal using engine oil.

Lock oil filter (1) by hand till contact to support and then lock by $\frac{3}{4}$ of a rev. at prescribed tightening torque; pour oil in engine as described in "Engine oil change" chapter.

Valve lash check a adjustment

For correct operation, follow instructions contained in related chapter in section 3 – Industrial Application.

Change dry air filter and clean its container

Refit container cover, remove cartridge from air filter.
Carefully clean container inside, insert new cartridge and refit cover.

