

Part 2

F3B CURSOR ENGINES

Section

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 F3B engine illustrating its features and working in general.

Section 2 describes the type of fuel feed.

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

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

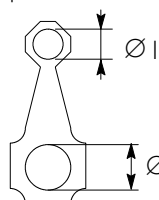
Sections 4 and 5 illustrate the overhaul operations of the engine overhaul on stand and the necessary equipment to execute such operations.

The appendix contains a list of the general safety regulations to be respected by all installation and maintenance engineers in order to prevent serious accidents taking place.

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



Ø 1 = housing for connecting rod small end bush

Ø 2 = housing for connecting rod bearings



Tighten to torque

Tighten to torque + angular value

SYMBOLS - ASSISTANCE OPERATIONS

	Removal Disconnection		Intake
	Refitting Connection		Exhaust
	Removal Disassembly		Operation
	Fitting in place Assembly		Compression ratio
	Tighten to torque		Tolerance Weight difference
	Tighten to torque + angle value		Rolling torque
	Press or caulk		Rotation
	Regulation Adjustment		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
	Replacement Original spare parts		

UPDATING

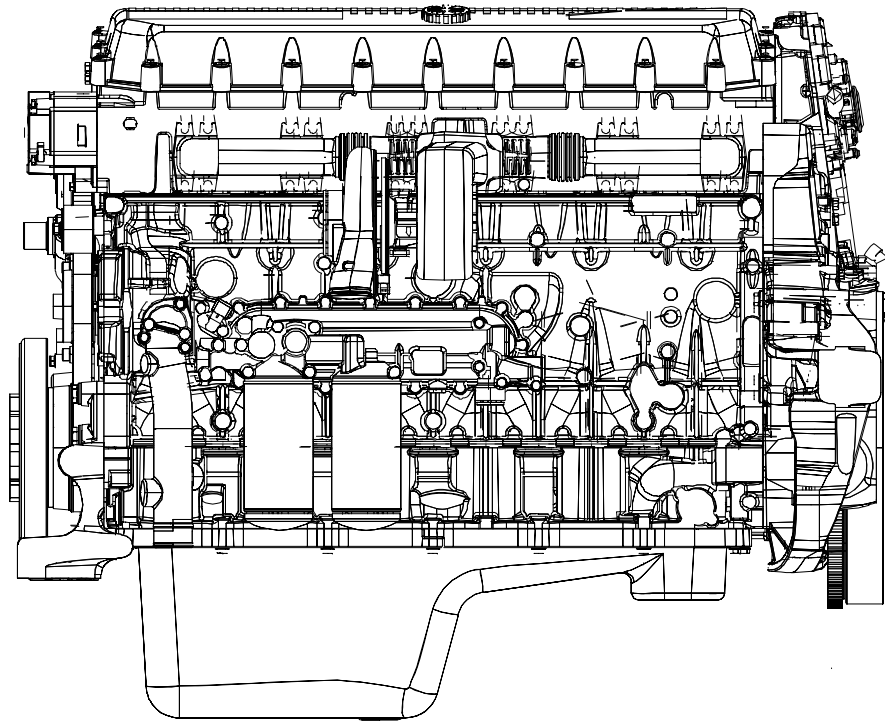
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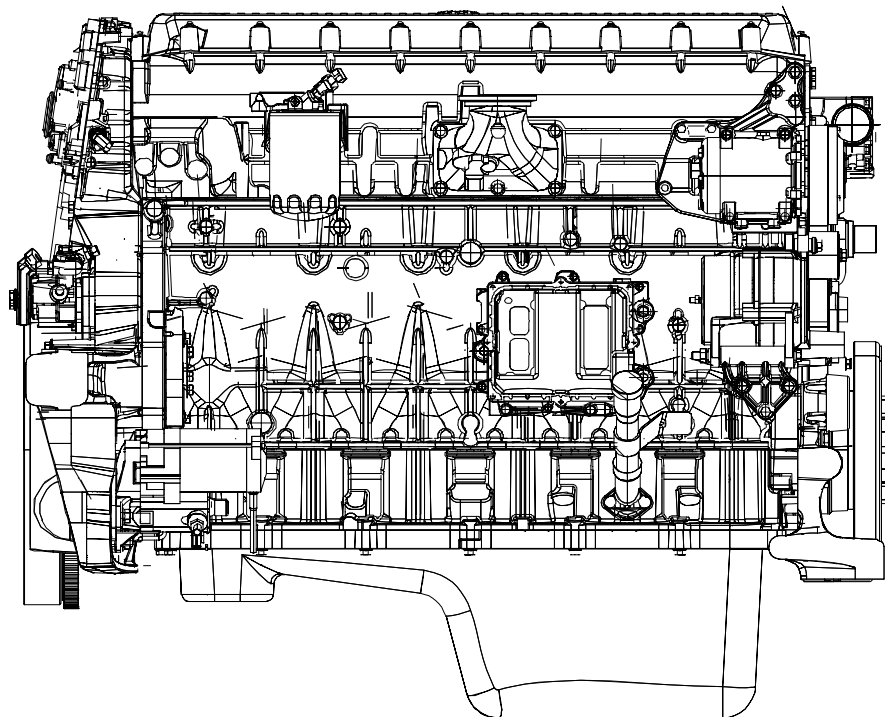
CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F3BE0684H*E90I F3BE0684G*E90I F3BE0684J*E902 F3BE9687A*E00I F3BE9687B*E00I F3BE9687C*E00I	C13 ENT X

VIEWS OF ENGINE (FOR TYPES: F3BE0684H*E90I - F3BE0684G*E90I)**Figure 1**

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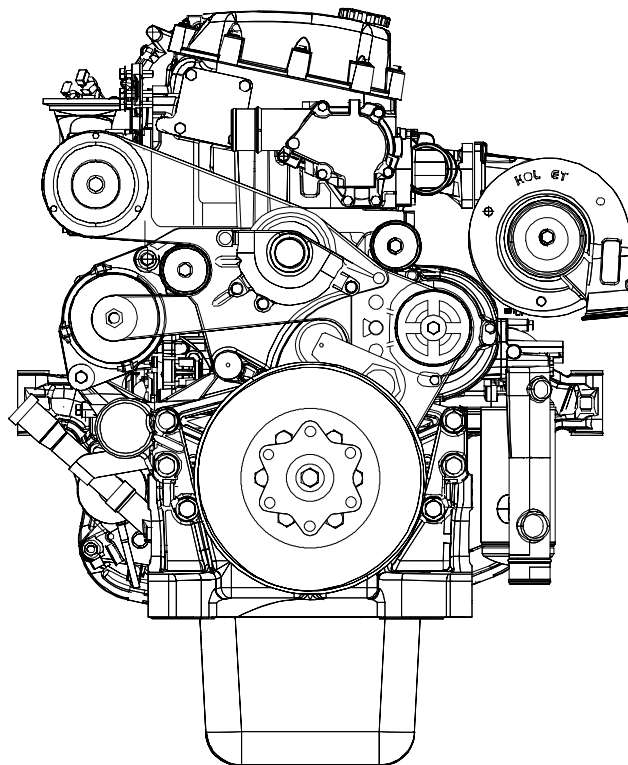
LEFT-HAND SIDE VIEW

Figure 2

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RIGHT-HAND SIDE VIEW

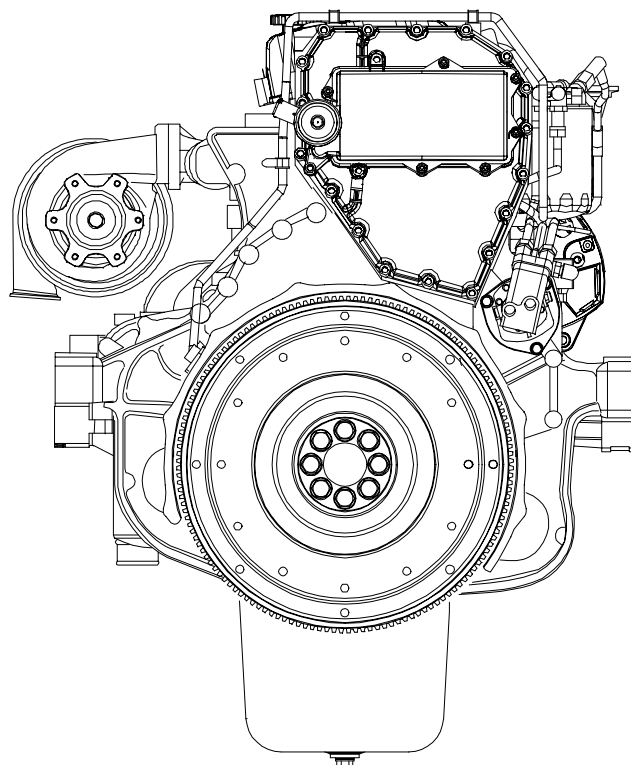
Figure 3



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FRONT VIEW

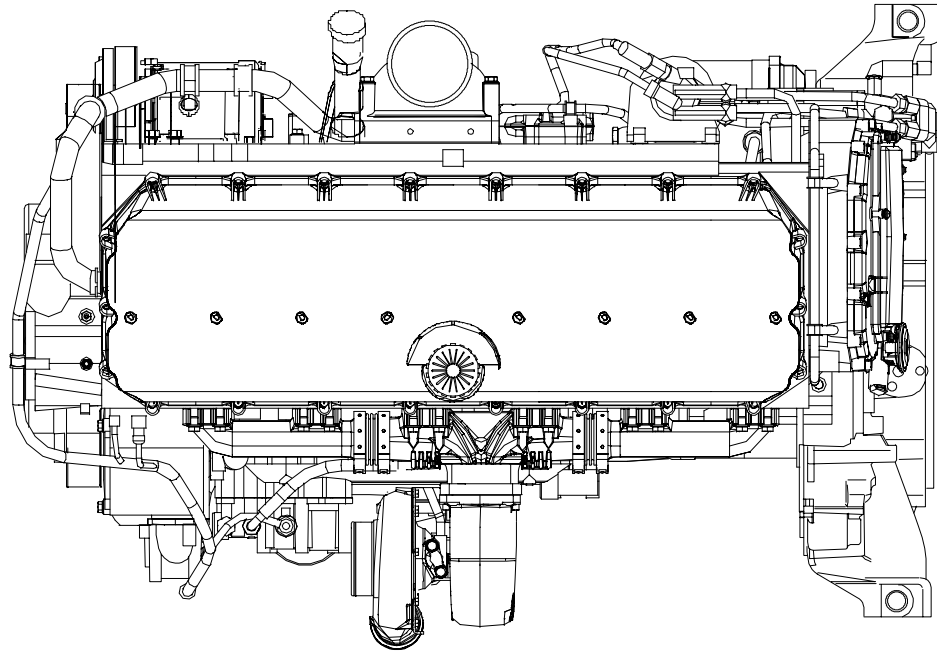
Figure 4



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REAR VIEW

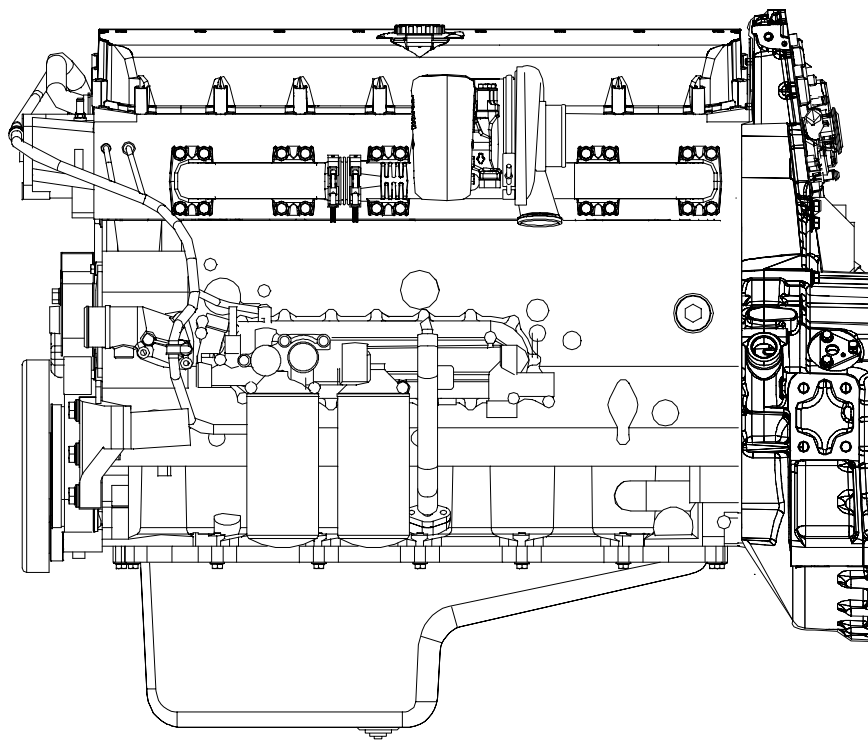
Figure 5



TOP VIEW

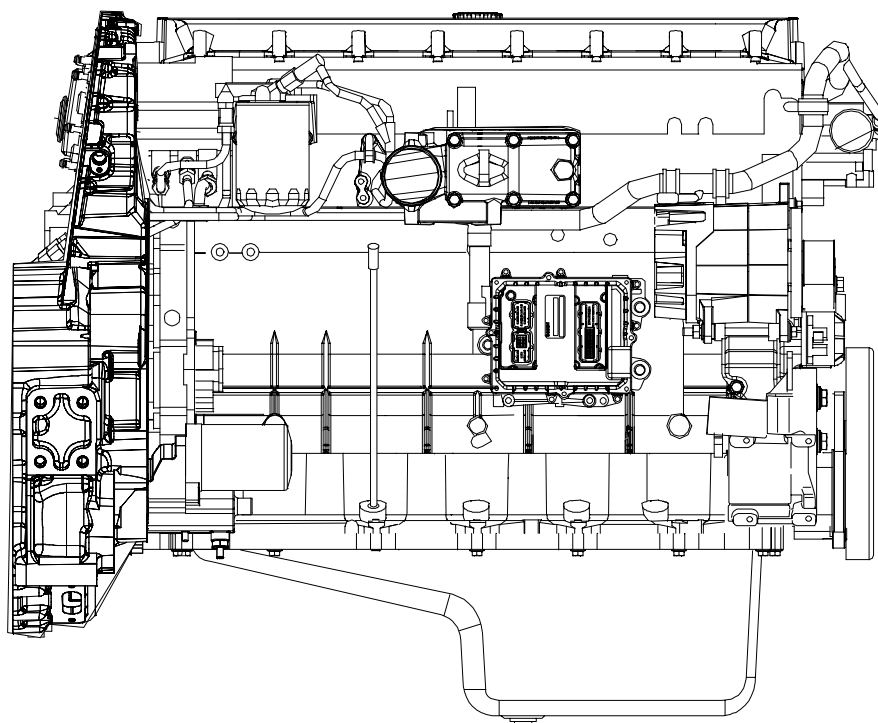
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VIEWS OF ENGINE (ONLY FOR TYPE F3BE0684)*E902)**Figure 6**

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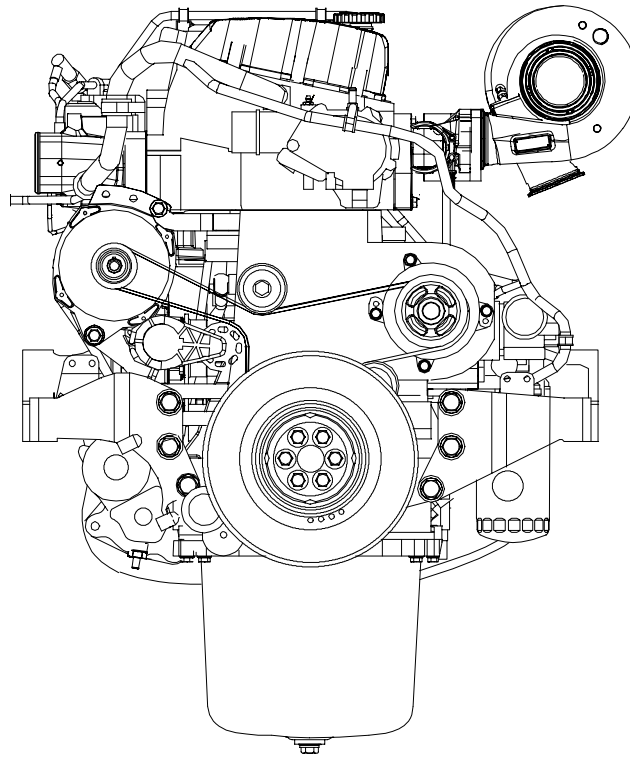
LEFT-HAND SIDE VIEW

Figure 7

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RIGHT-HAND SIDE VIEW

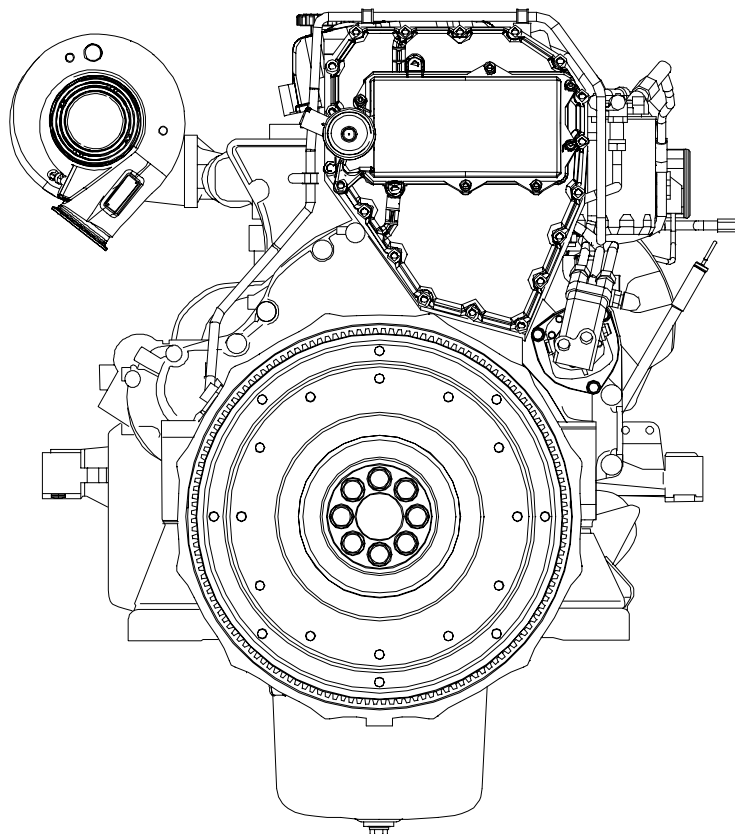
Figure 8



FRONT VIEW

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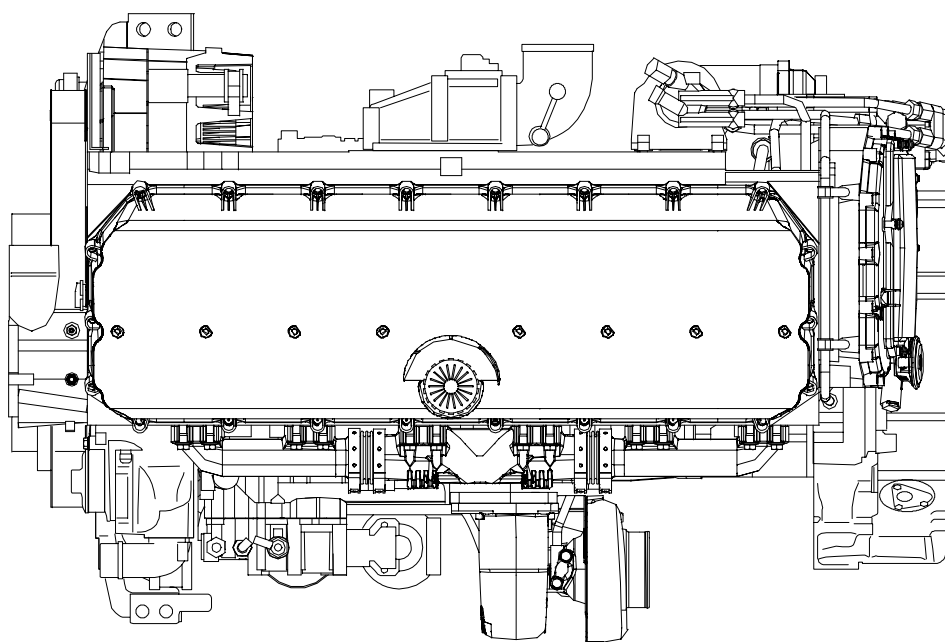
Figure 9



REAR VIEW

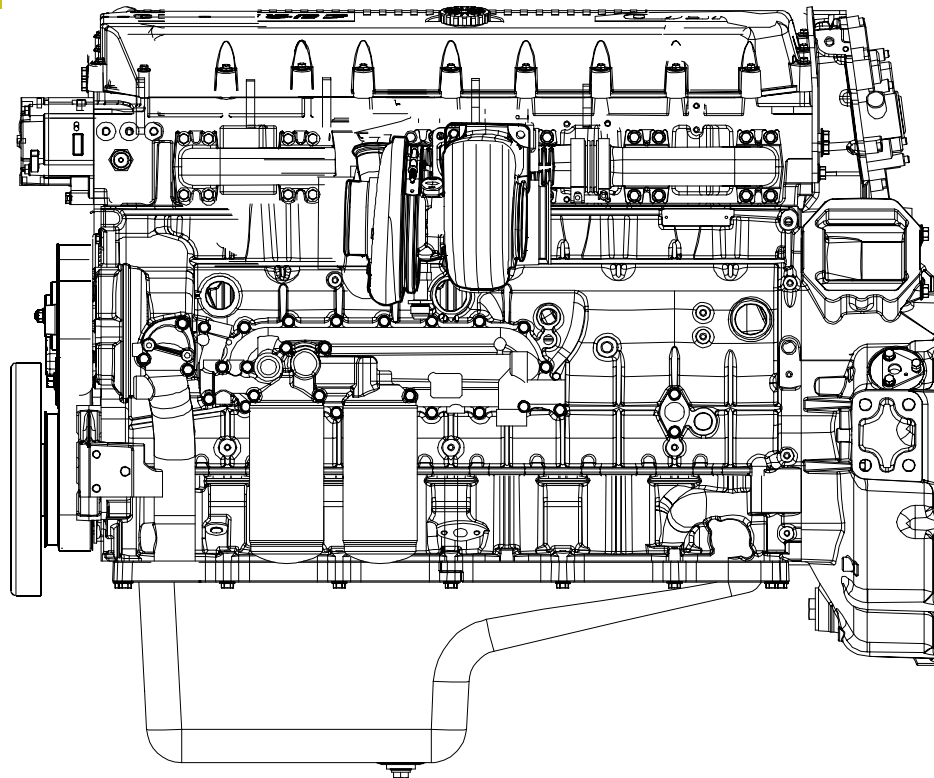
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Figure 10



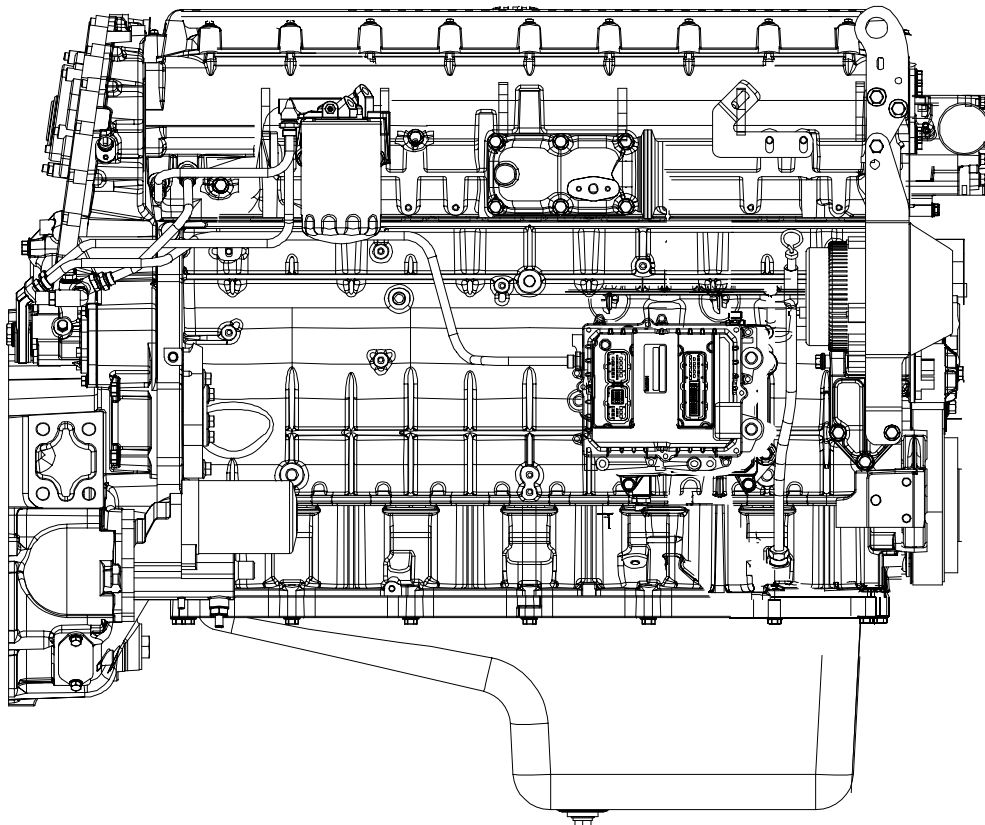
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TOP VIEW

VIEWS OF ENGINE (ONLY FOR TYPES: F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001)**Figure 11**

LEFT-HAND SIDE VIEW

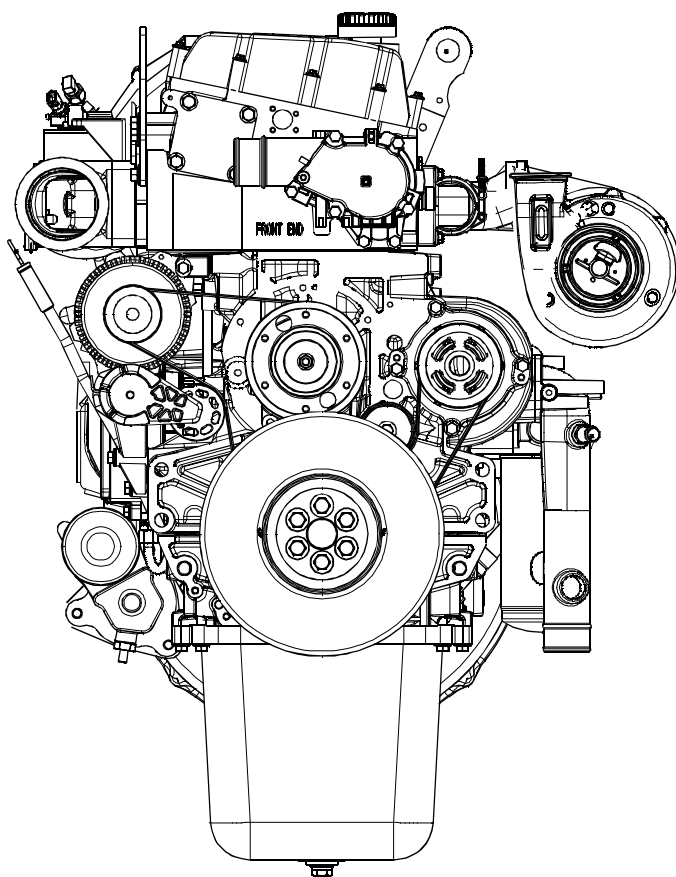
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Figure 12

RIGHT-HAND SIDE VIEW

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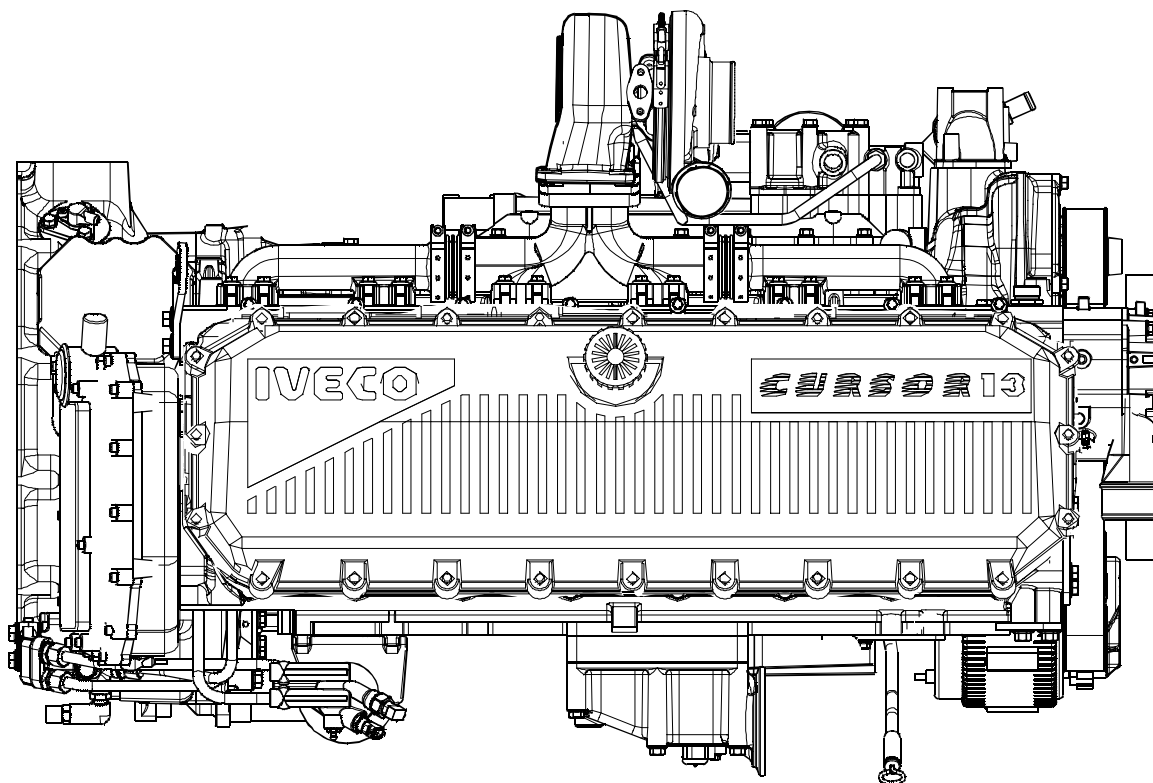
Figure 13



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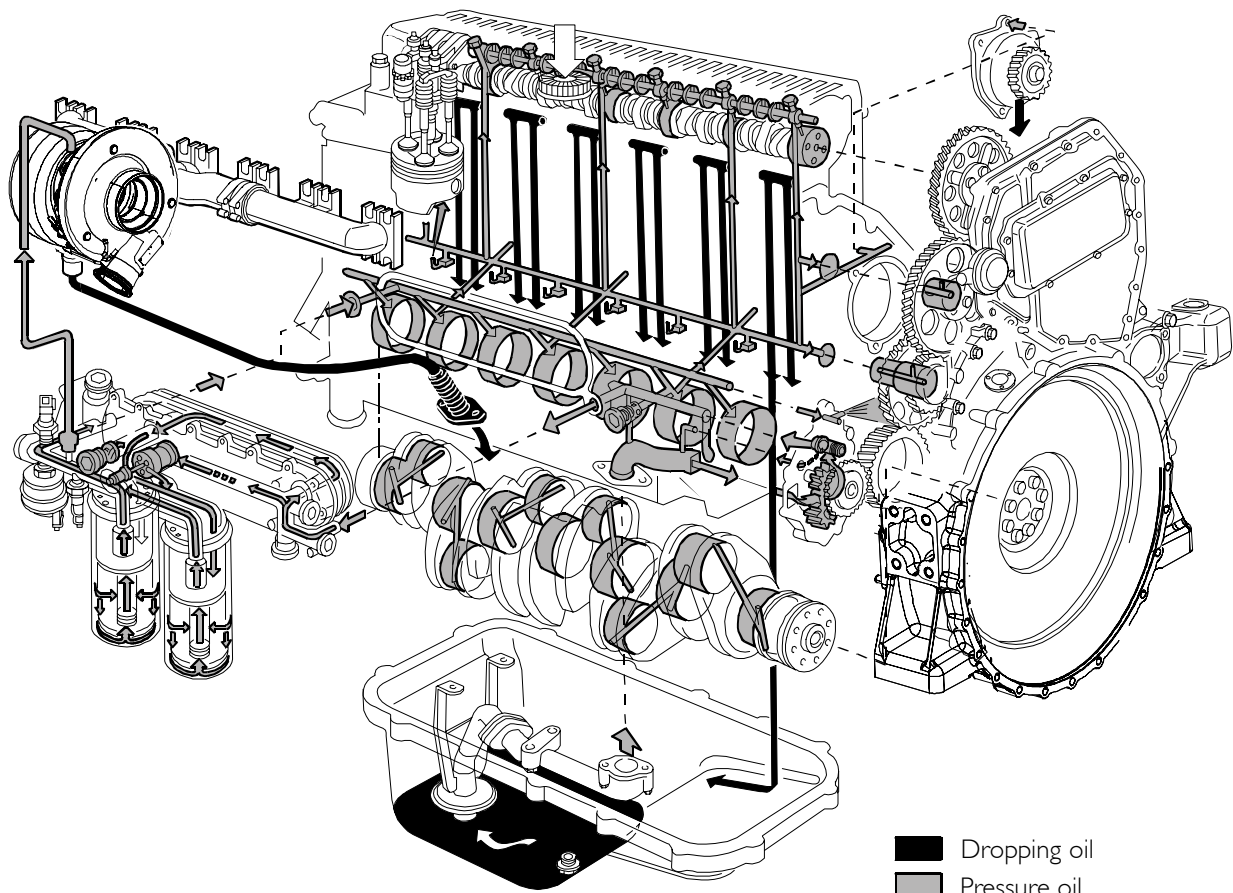
FRONT VIEW

Figure 14

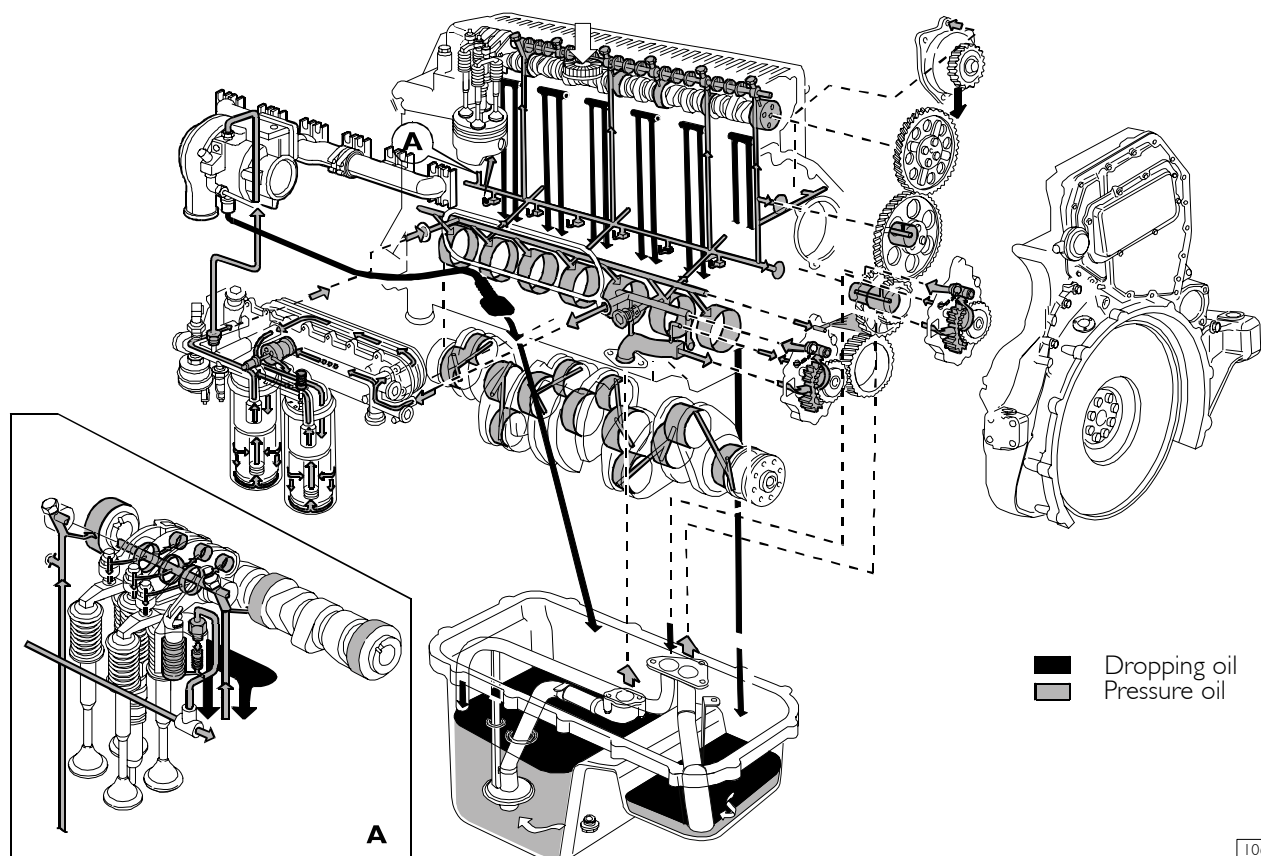


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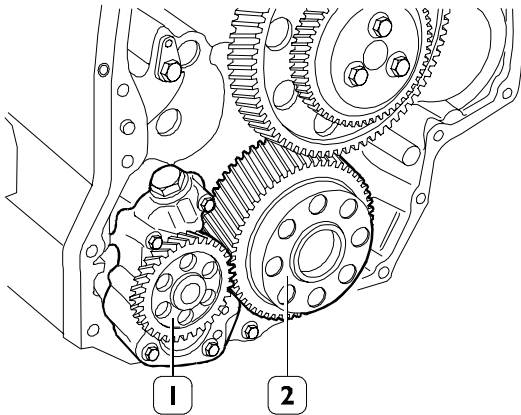
TOP VIEW

LUBRICATION DIAGRAM (ONLY FOR TYPES F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001)**Figure I5**

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For types: (F3BE0684G*E90I - F3BE0684H*E90I)**Figure I6**

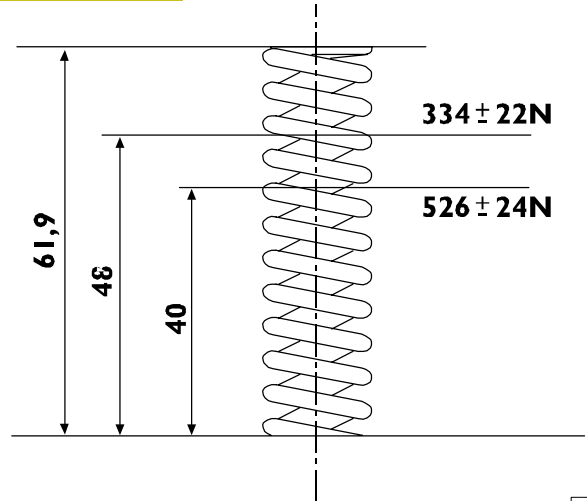
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Oil pump**Figure 17**

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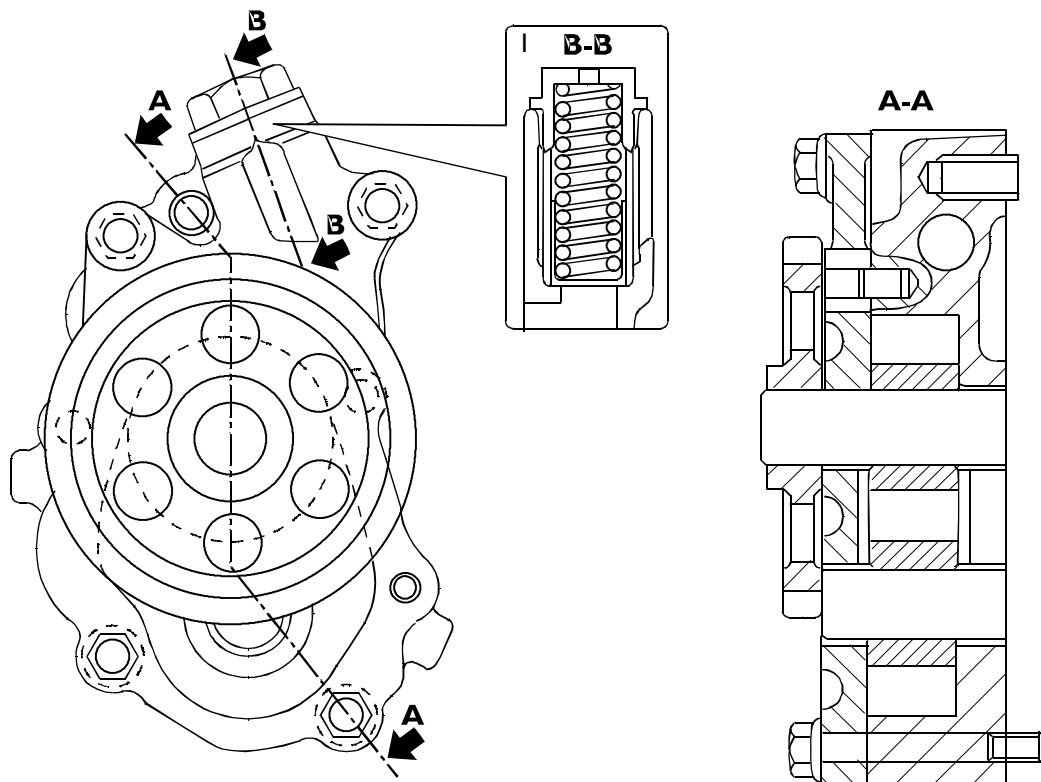
The oil pump (1) cannot be overhauled. On finding any damage, replace the oil pump assembly.

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

Overpressure valve**Figure 19**

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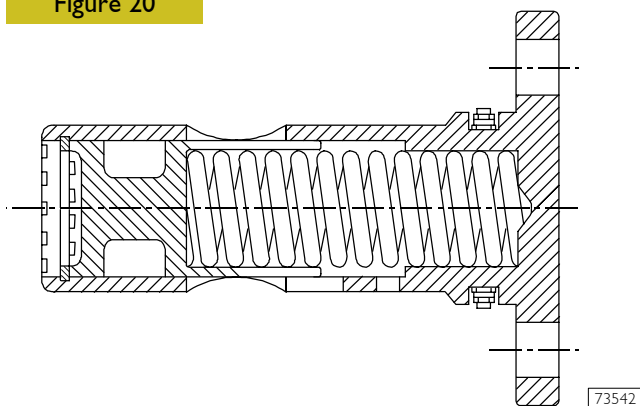
MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

Figure 18

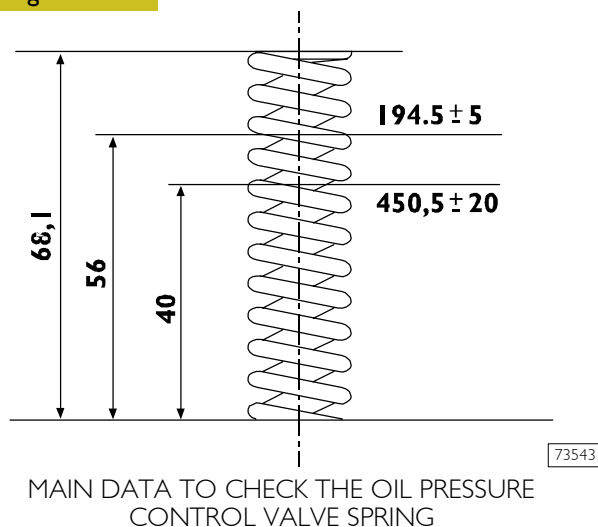
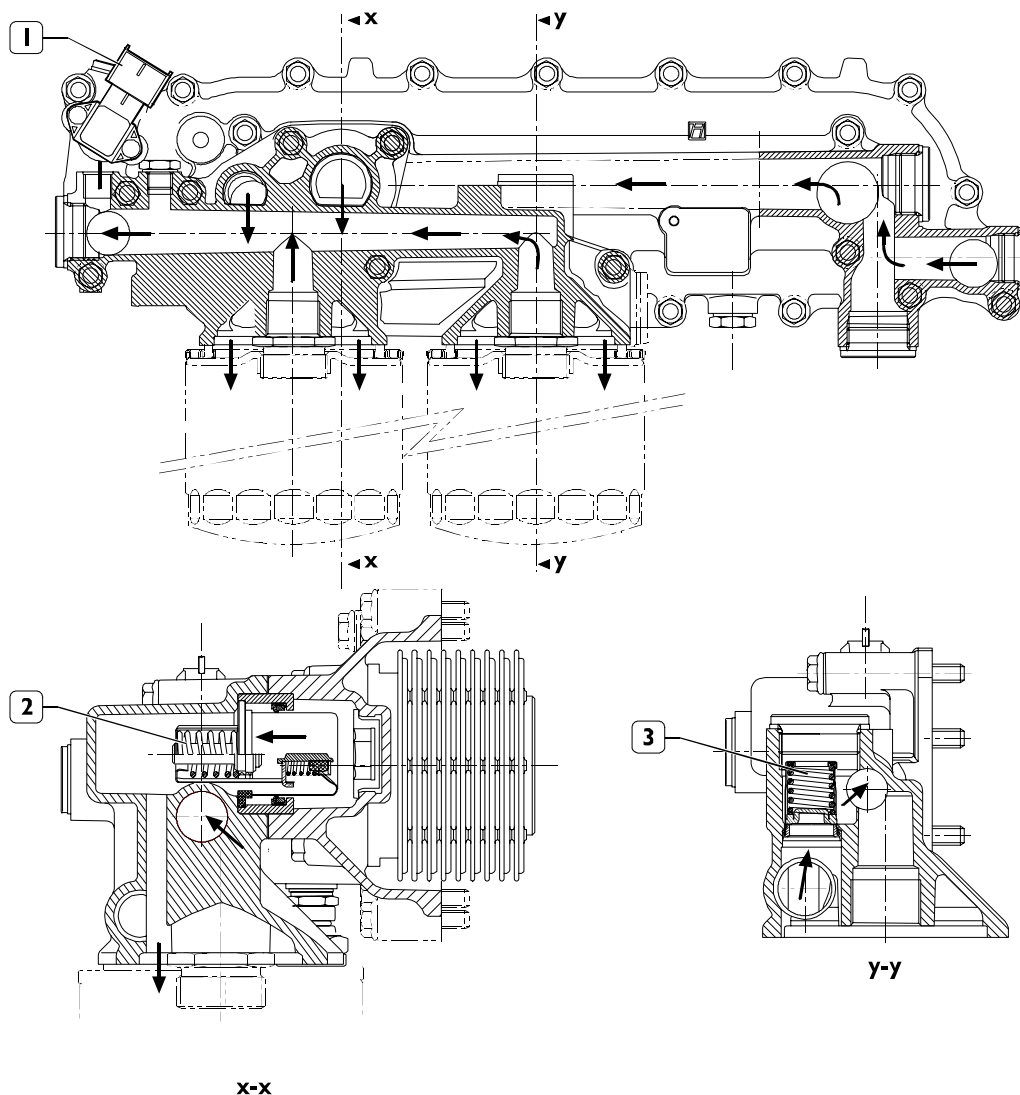
OIL PUMP CROSS-SECTION

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

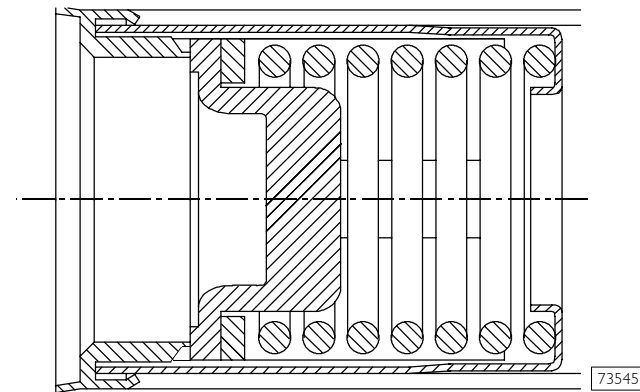
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Oil pressure control valve**Figure 20**

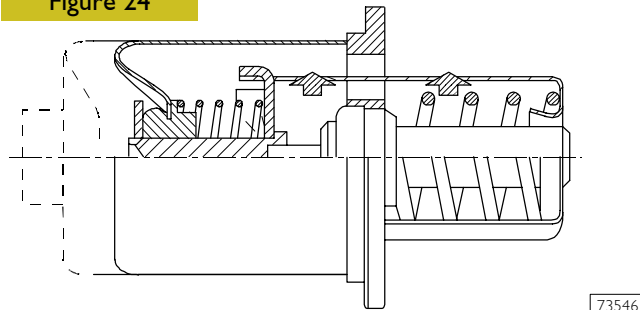
The oil pressure control valve is located on the left-hand side of the crankcase.
Start of opening pressure 5 bars.

Figure 21**Heat exchanger****Figure 22**

The heat exchanger is fitted with: 1. Oil pressure/temperature sensor - 2. By-pass valve - 3. Heat valve.

By-pass valve**Figure 23**

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

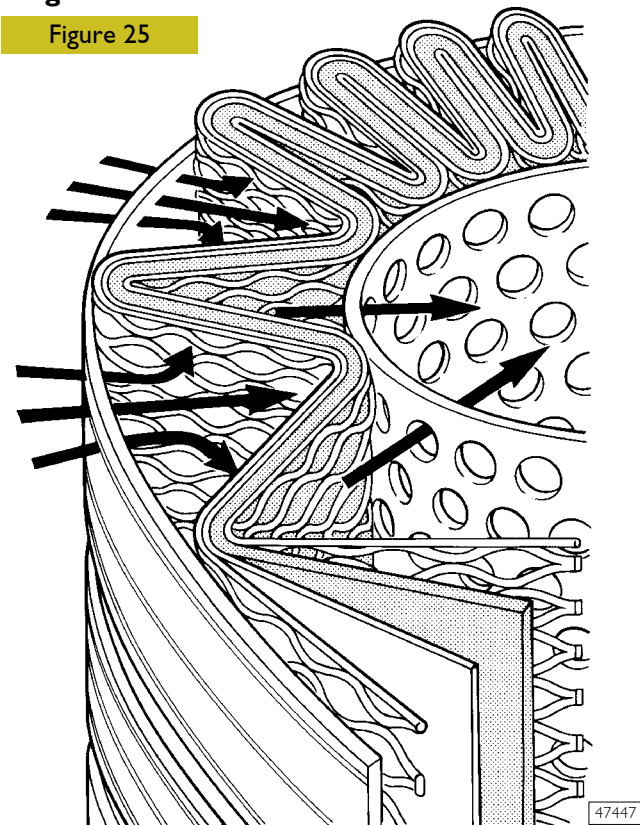
Thermostatic valve**Figure 24**

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 25**

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

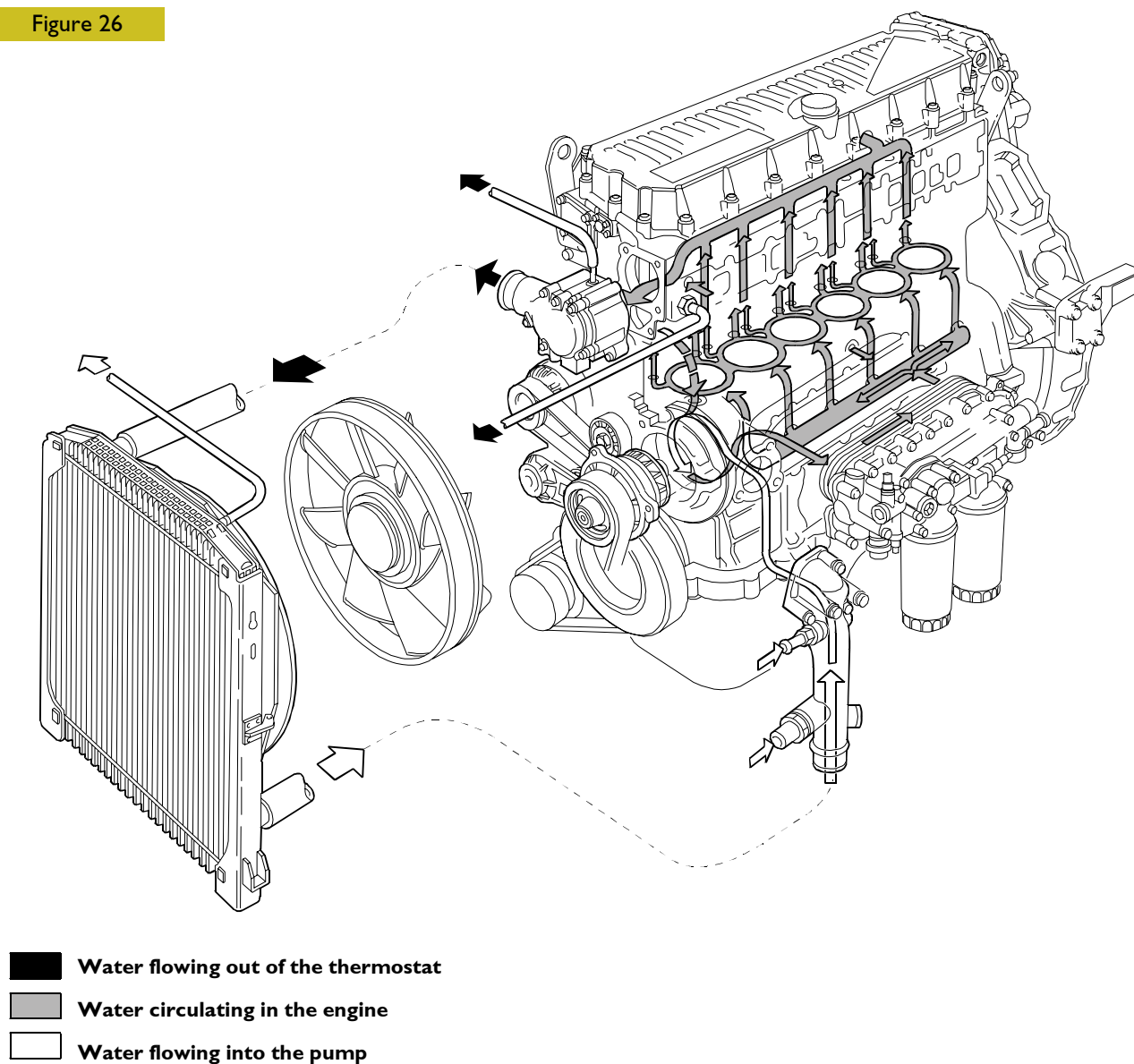
A mount for the filtering element and a strong nylon mesh make it even stronger, which is especially helpful during cold starts and long periods of use. The performance of the filter remains constant and reliable throughout its working life and from one element to another, irrespective of the changes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

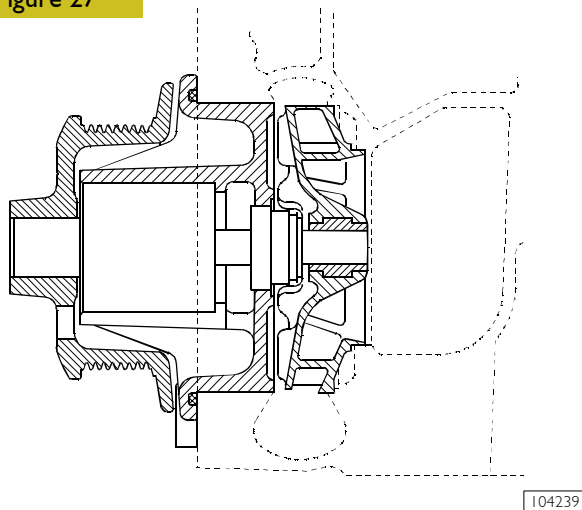
COOLING**Figure 26**

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ILLUSTRATIVE DIAGRAM

Water pump

Figure 27



CROSS-SECTION OF THE WATER PUMP

The water pump comprises: rotor, shaft with bearing, T-gasket and drive pulley.



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

Thermostat

View of thermostat operation

Figure 28

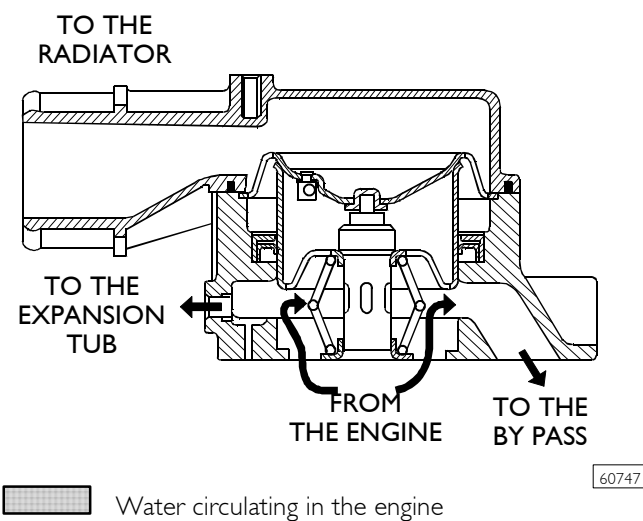
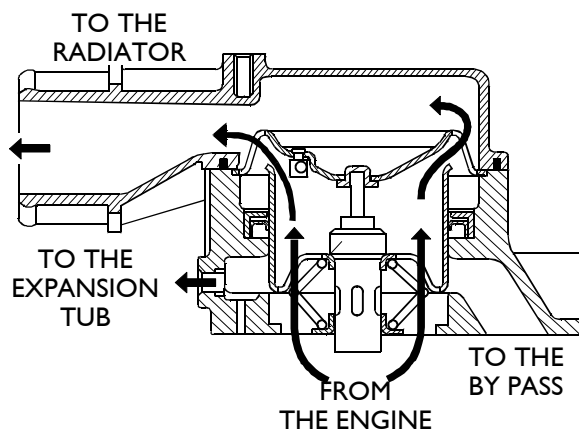


Figure 29



Water leaving the thermostat

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

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

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

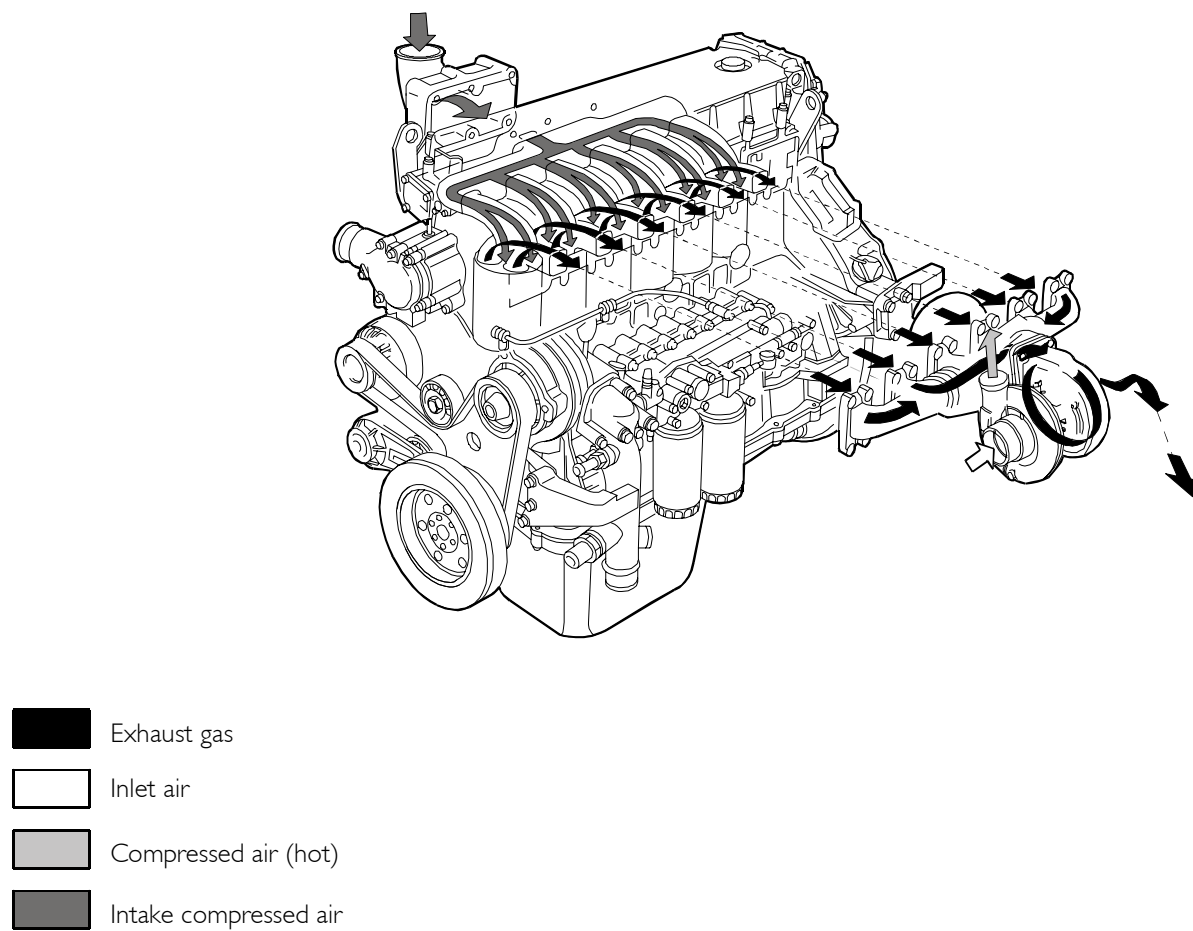
TURBOCHARGING

The turbocharging system consists of:

- ☐ air filter;
- ☐ turbocharger.

ILLUSTRATIVE DIAGRAM

Figure 30



TURBOCHARGER HX55

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EGR EXHAUST GAS RECIRCULATION SYSTEM (ONLY FOR F3BE0684J*E902)

The exhaust gases may be partially conveyed back into the cylinders to reduce the maximum combustion temperature responsible for producing nitrogen oxides (NO_x).

The exhaust gas recirculation (EGR) system, by reducing the combustion temperature, thus represents an effective NO_x emission controlling system.

INTERNAL EGR ACTING ON THE INTAKE VALVES

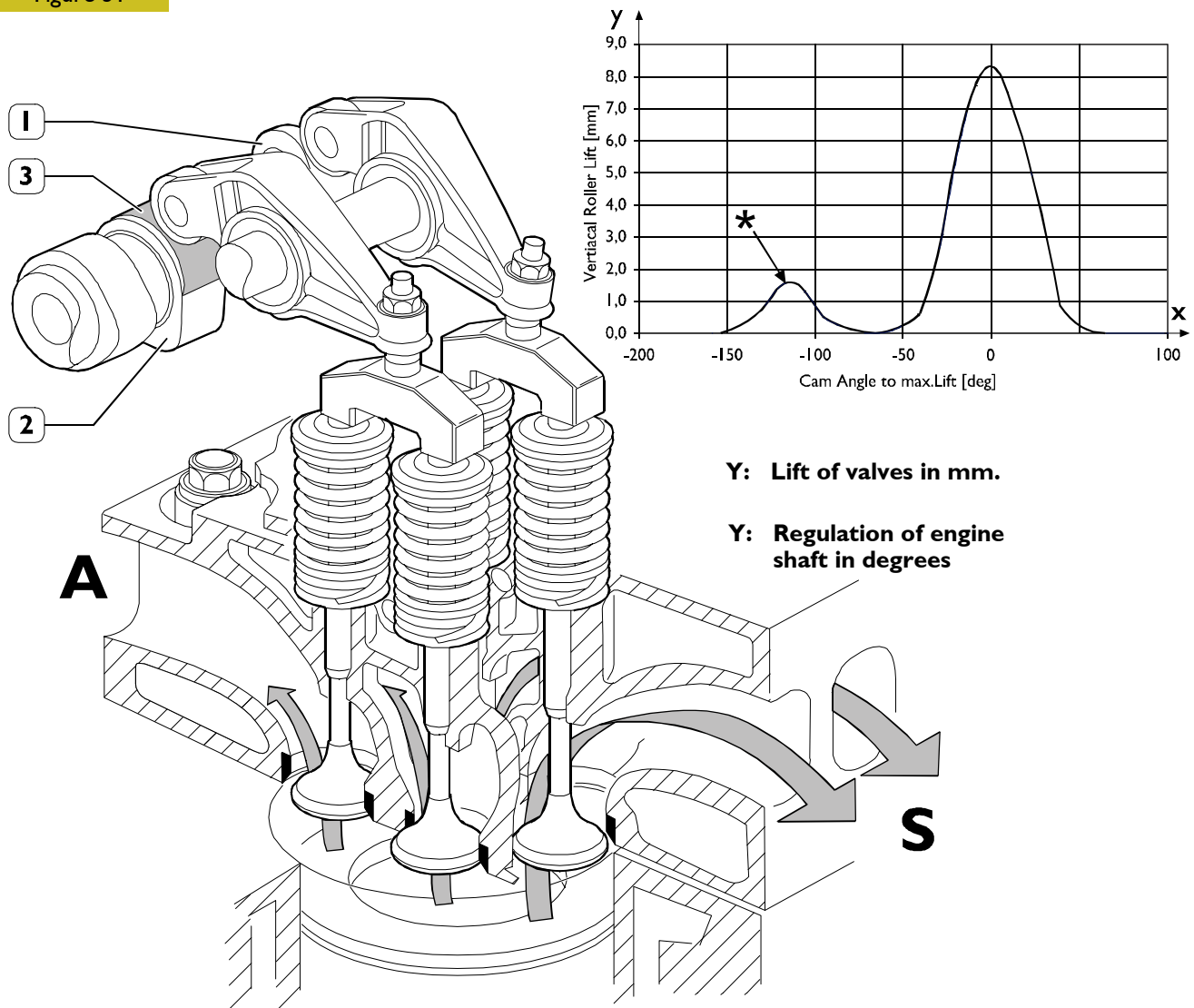
Through a modification to the design of the intake cams, the internal EGR system enables part of the exhaust gas to be conveyed back into the engine's cylinders.

This type of EGR, called internal EGR, has no electronically controlled elements, the system is always active.

Its configuration requires no additional elements such as control valves, pipes or heat exchangers, so the profile of the engine remains unchanged.

In addition to the main lobe, the intake cam presents an additional lobe (3) with respect to the configuration without EGR. During the exhaust stroke of the cylinder concerned, this lobe opens the intake valve slightly earlier (*). In this way, part of the exhaust gas is trapped in the intake pipe and then, during the intake stroke of the cylinder, is returned to the load of the cylinder for the power stroke.

Figure 31



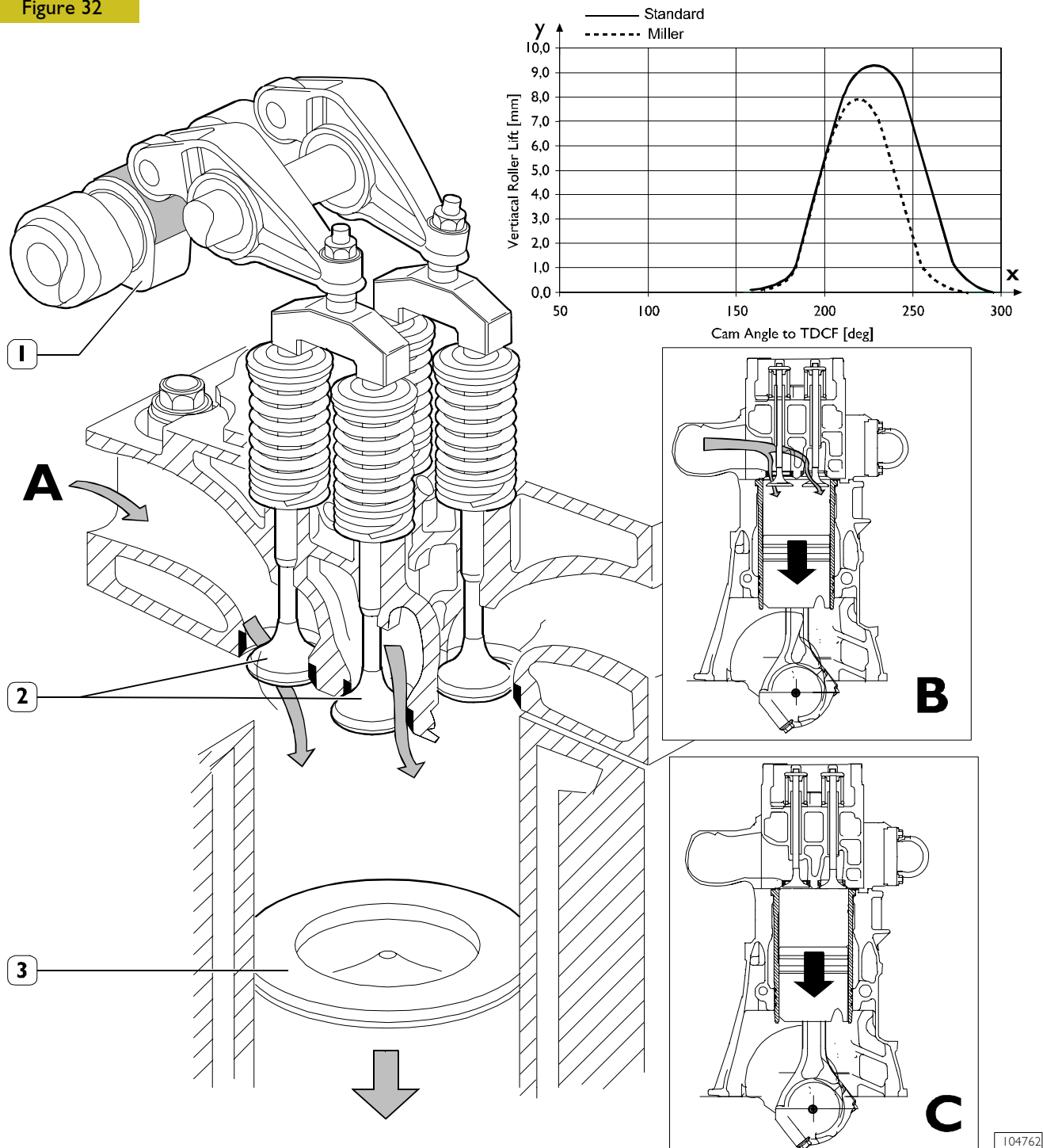
1. Exhaust cams - 2. Intake cams - 3. EGR lobe - S. Exhaust pipes - A. Intake pipes.

EARLY CLOSING SYSTEM FOR THE INTAKE VALVES ("MILLER" CYCLE) - (FOR TYPES F3BE0684H*E90I - F3BE9687A*E00I - F3BE9687B*E00I - F3BE9687C*E00I)

The "Miller" system is used to reduce the maximum combustion temperature in the cylinder, which is responsible for producing nitrogen oxides (NO_x).

The concentration of oxygen in the combustion chamber is reduced by closing the intake valves slightly before the end of the intake stroke of the cylinder, (see detail C).

Figure 32



1. Exhaust cams - 2. Intake cams - 3. EGR lobe - S. Exhaust pipes - A. Intake pipes.

B = End of standard intake stroke

C = End of intake stroke with "Miller" device

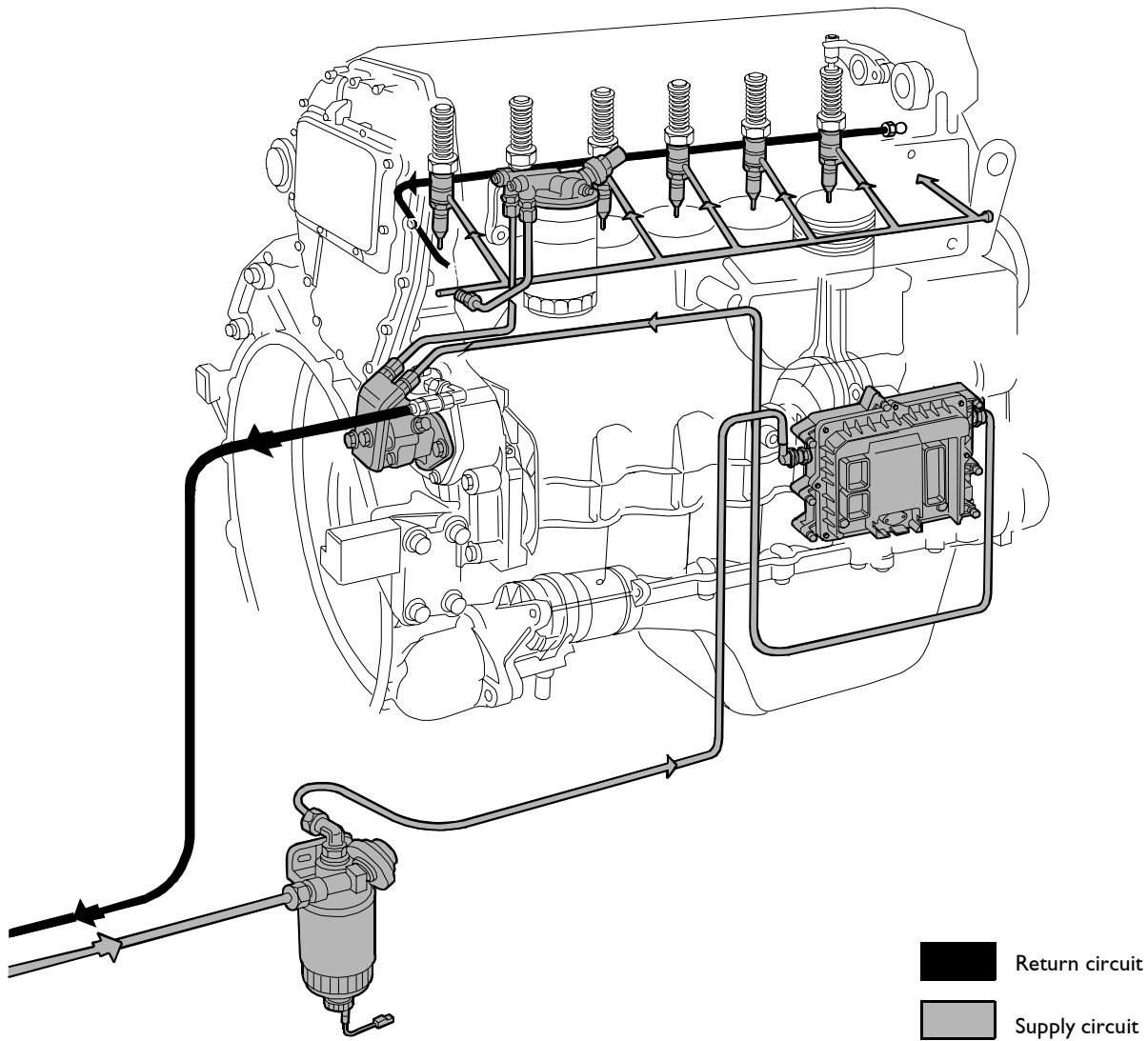
SECTION 2

Fuel

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☐ Fuel pump	5

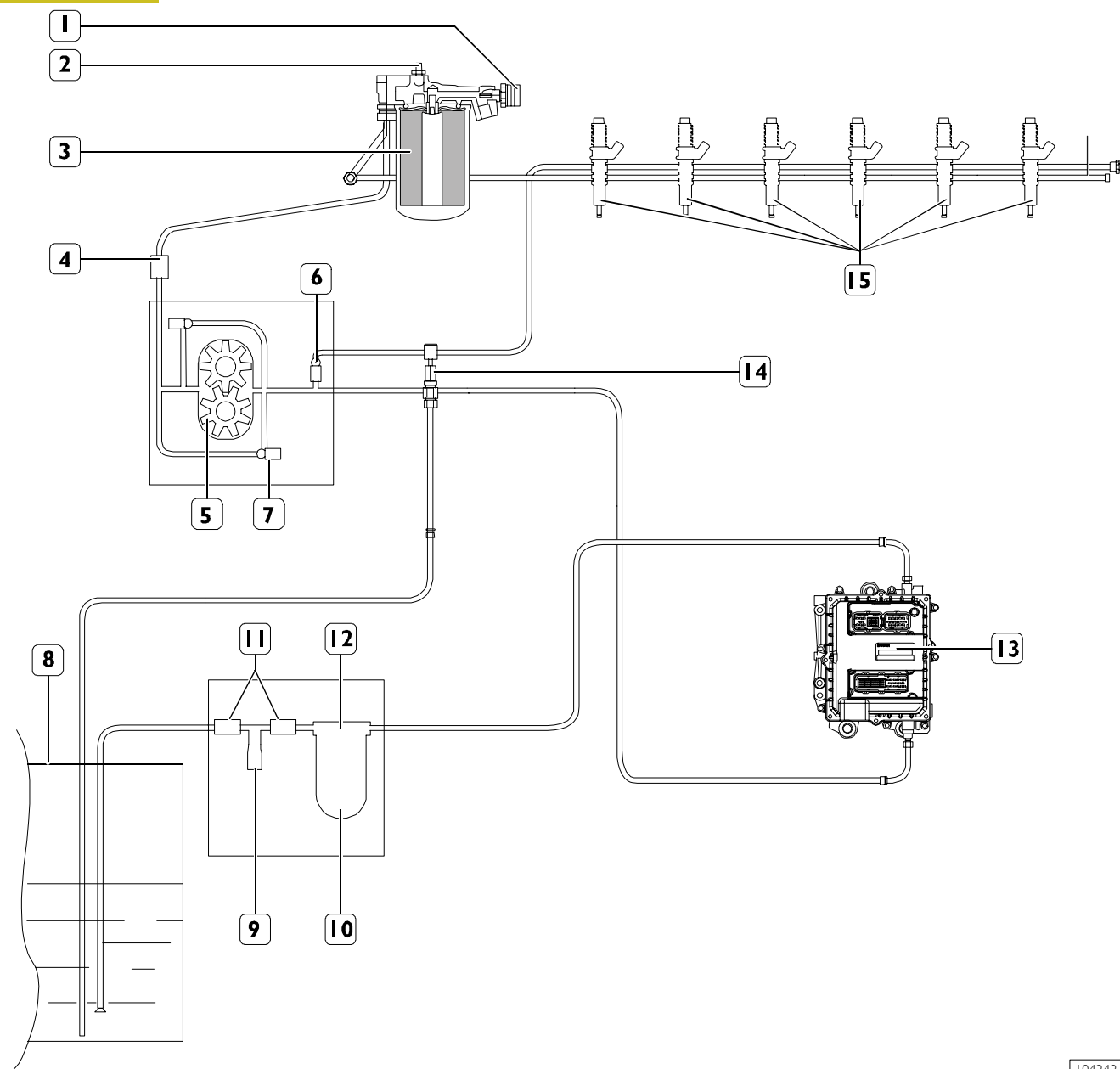
FEEDING

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 I

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1. Valve for return circuit, starts opening at 3.5 bars - 2. Valve for return circuit, starts opening at 0.2 bars.

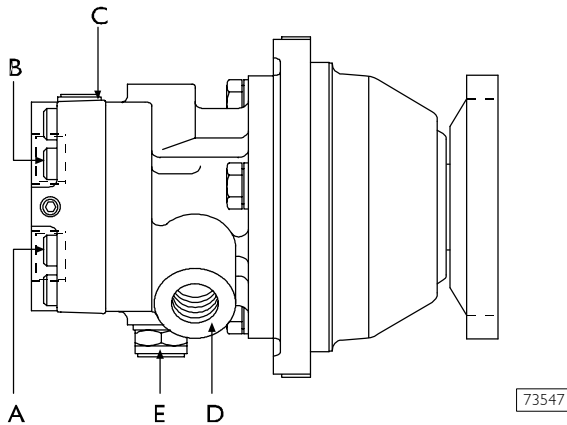
FUEL SUPPLY DIAGRAM**Figure 2**

104242

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.

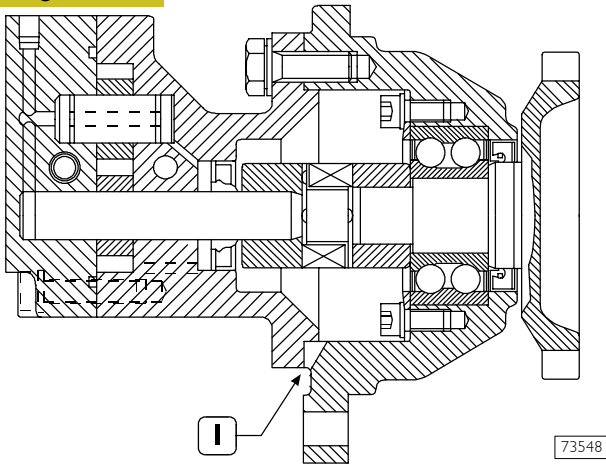
Fuel pump

Figure 3



- A. Fuel inlet – B. Fuel delivery – C. By-pass nut –
 D. Fuel return from the pump-injectors –
 E. Pressure relief valve – Opening pressure: 5 - 5.8 bars.

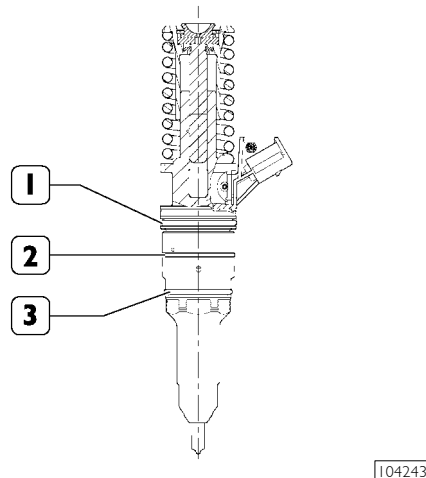
Figure 4



CROSS-SECTION OF THE FUEL PUMP
 I. Oil and fuel leakage indicator.

Injector-pump

Figure 5



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.

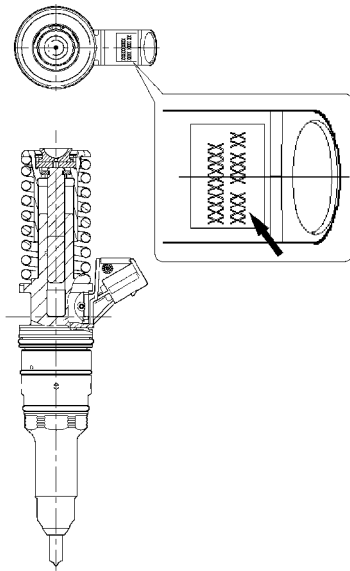
The amount of fuel injected depends on the length of time the slide valve is closed and therefore on the time for which the solenoid is energized.

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 6



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For each injector replaced, hook up to the diagnostic station and, when asked by the program, enter the code punched on the injector (→) to reprogram the control unit.

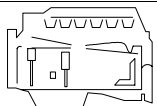
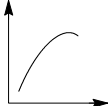
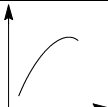
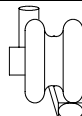
NOTE When checking the clearance of the rocker arms, it is important to check the injector-pump pre-load.

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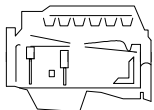
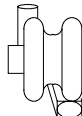
CLEARANCE DATA

	Type		F3BE0684H*E901	F3BE0684G*E901	F3BE0684J*E902
Q	Compression ratio		16.5 ± 0.8		
 	Max. output	kW (HP) rpm	324 (441) 2000	286 (389) 2000	343 (467) 2100
 	Max. torque	Nm (kgm) rpm	2164 (216) 1400	1914 (191) 1400	2144 (214) 1500
	Loadless engine idling	rpm	875	875	600
	Loadless engine peak	rpm	2350	2350	2110
	Bore x stroke	mm	135 x 150		
	Displacement	cm ³	12880		
	SUPERCHARGING		Intercooler Direct injection		
	Turbocharger type		HOLSET HX55		
 	LUBRICATION		Forced by gear pump, relief valve single action oil filter		
	Oil pressure (warm engine)				
	- idling	bar	-		
	- peak rpm	bar	-		
	COOLING		Liquid		
	Water pump control		Through belt		
	Thermostat				
	- start of opening	°C	-		

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

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

CLEARANCE DATA

		Type	F3BE9687			
			A*E00 I	B*E00 I	C*E00 I	
Q	Compression ratio		16.5 ± 0.8			
		Max. output	kW (HP) rpm	325 (442) 2100	350 (476) 2100	375 (510) 2100
		Max. torque	Nm (kgm) rpm	2140 (218) 1400	2140 (218) 1400	2140 (218) 1400
	Loadless engine idling		rpm	800	800	800
	Loadless engine peak		rpm	2300	2300	2300
Bore x stroke		mm	135 x 150			
Displacement		cm ³	12880			
	SUPERCHARGING		DIRECT INJECTION INTERCOOLER			
Turbocharger type			HOLSET HX 55			
	LUBRICATION		Forced by means of gear pump, pressure relief valve, oil filter			
Oil pressure (warm engine)						
- idling		bar	-			
- peak rpm		bar	-			
COOLING			Liquid			
Water pump control			By means of belt			
Thermostat						
- start of opening		°C	-			

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

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

**PART ONE -
MECHANICAL COMPONENTS**

ASSEMBLING AND DISASSEMBLING THE ENGINE



Handle all parts with great care. Never put your hands or fingers between one part and another. Wear suitable personal protective equipment such as a visor, gloves and safety shoes.

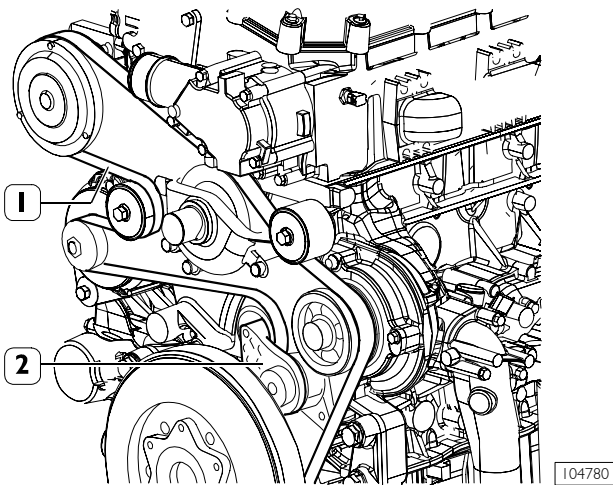
Cover all electrical components before washing with high-pressure water jets.

Before securing the engine to the rotary stand, remove:

- the electrical cable of the engine by unplugging it from the control unit and from all sensors/transmitters to which it is connected.

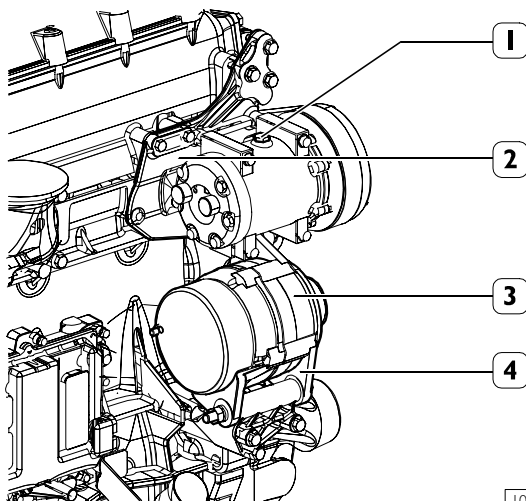
Only for the types: F3BE0684H*E90I and F3BE0684G*E90I

Figure 1



Using an appropriate tool, regulate the belt tightener (2) to release the pressure and remove the belt (1) for controlling various parts.

Figure 2

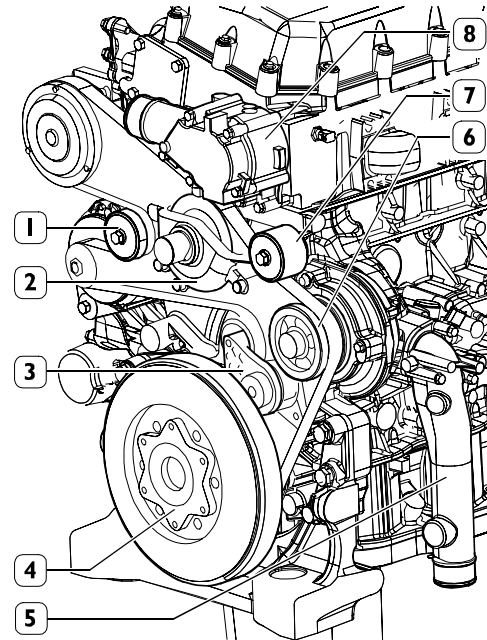


Loosen the locking screws and remove the compressor (1) complete with its support (2) from the engine.

Loosen the locking screws and remove the alternator (3).

Loosen the locking screws and remove the alternator support (4) from the engine.

Figure 3

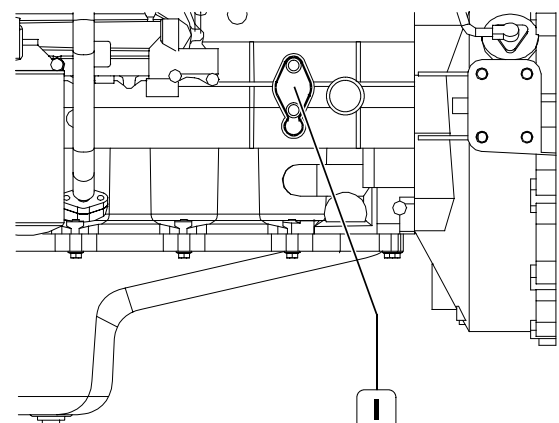


Remove:

- the fixed belt tightening roller (1);
- the support (2);
- the automatic belt tightener (3);
- the damping flywheel (4) and the pulley beneath it;
- all the coolant pipes (5);
- the water pump (6);
- the fixed belt tightening roller (7);
- the thermostat assembly (8).

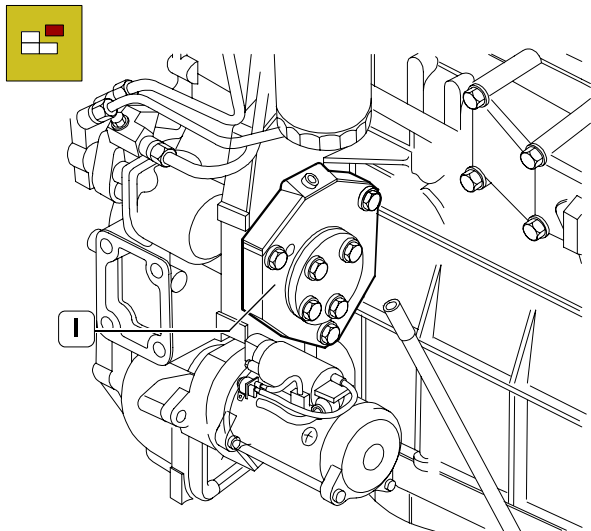
For all types

Figure 4



- Remove the oil pressure regulating valve (1).

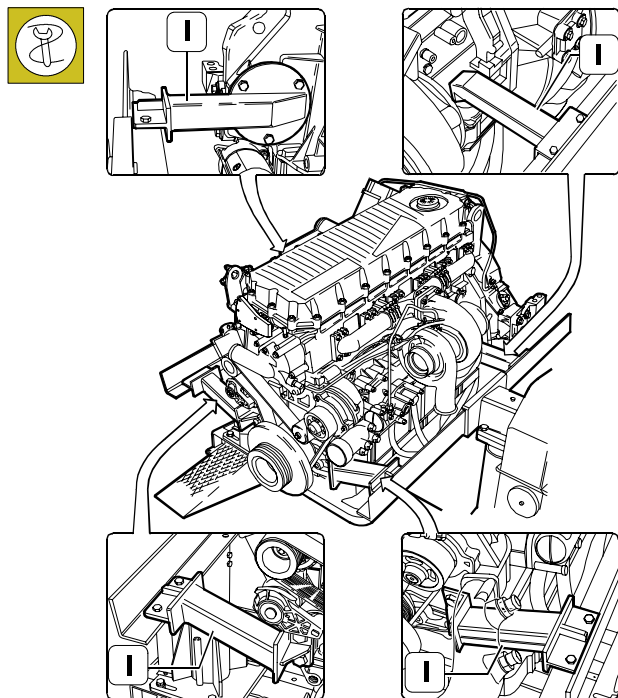
Figure 5



104247

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

Figure 6

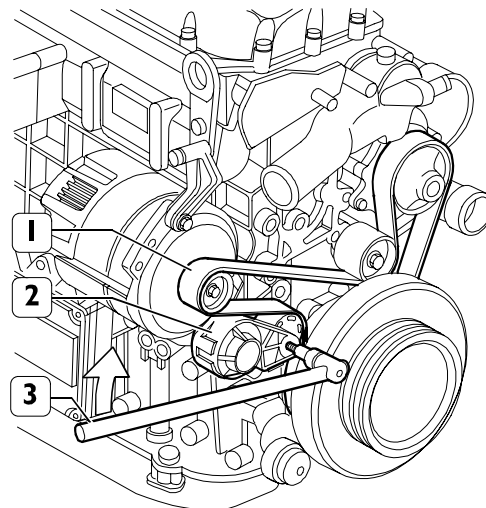


104248

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

Only for types: F3BE0684J*E902 - F3BE9687A*E001 -
F3BE9687B*E001 - F3BE9687C*E001

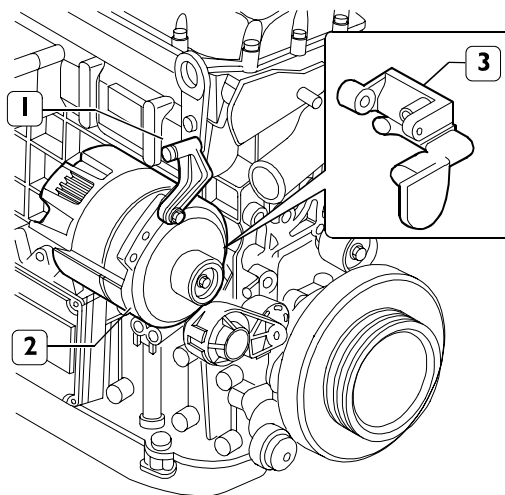
Figure 7



104249

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

Figure 8

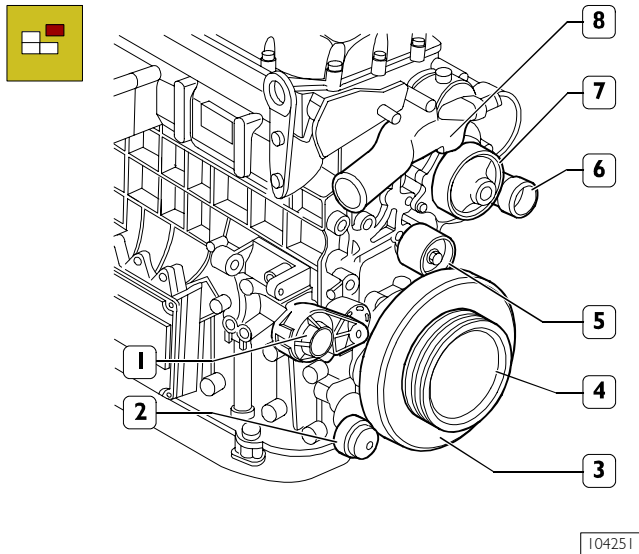


104249/A

Remove:

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

Figure 9

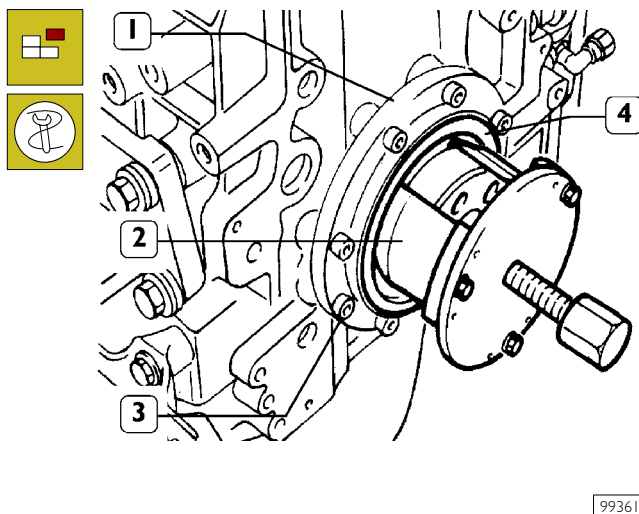


Remove:

- 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);

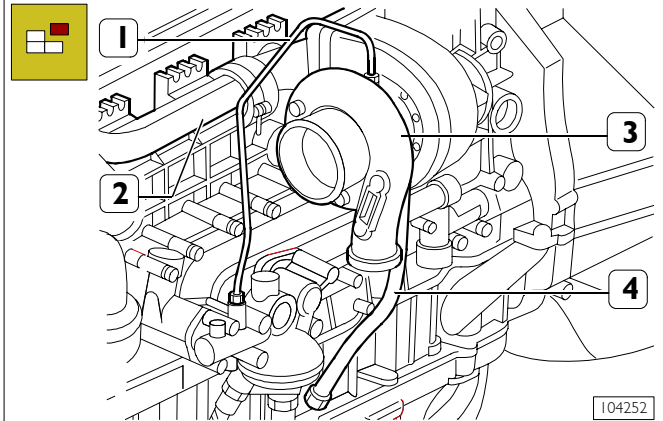
For all types except F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001

Figure 10



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.

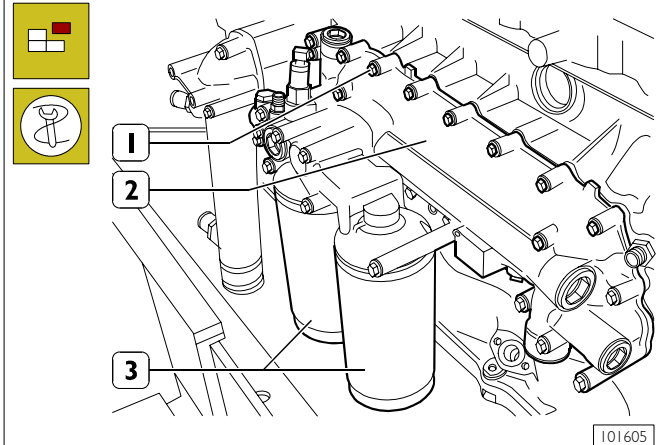
Figure 11



On the engine exhaust side, remove the following parts:

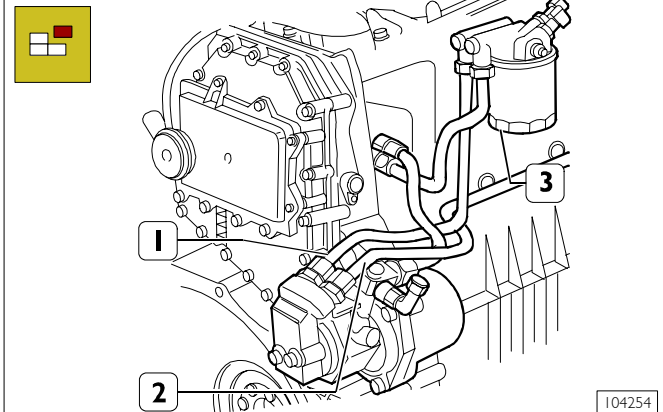
- oil delivery pipe (1);
- oil return pipe (4);
- turbocharger (3);
- exhaust manifold (2).

Figure 12



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

Figure 13

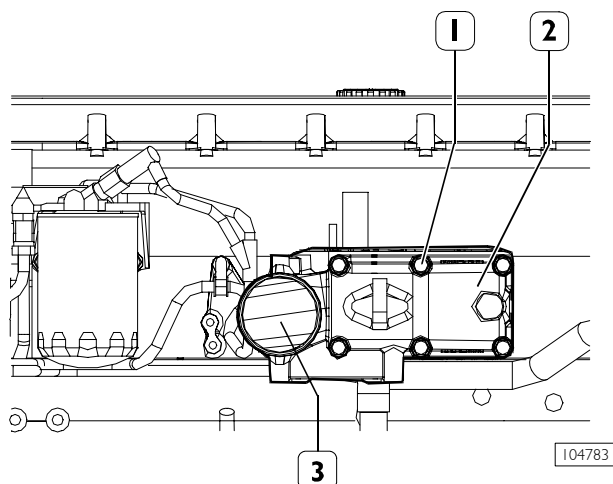


Disconnect the fuel pipes (1) from the fuel pump (2).

Remove:

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

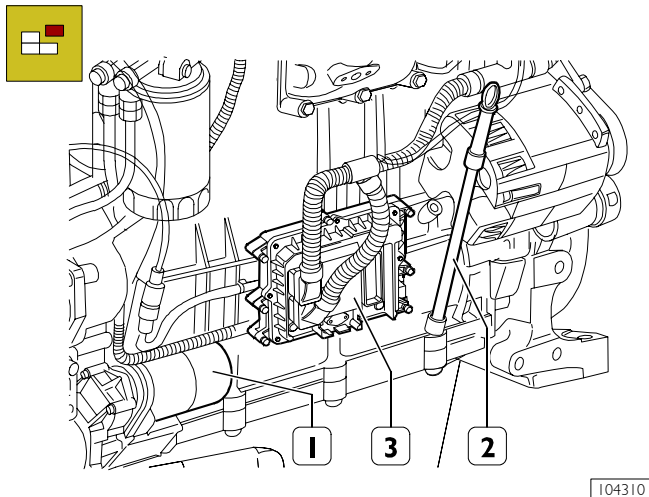
Figure 14



Loosen the screws (1) and remove the intake manifold (2) from the engine.

NOTE The air intake joint (3) may have different positions depending on the type of engine.

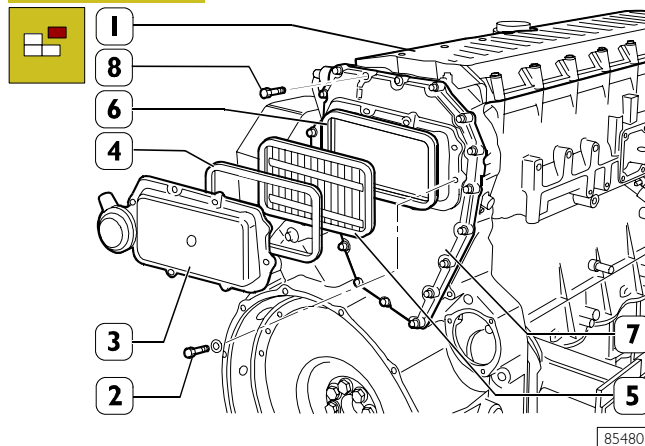
Figure 15



Remove:

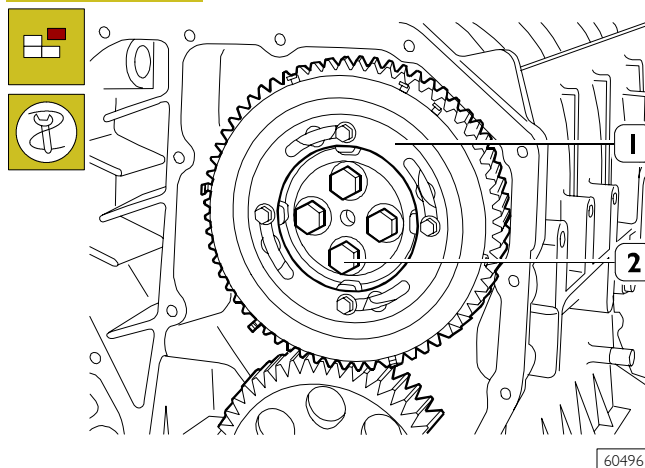
- the starter motor (1);
- the control unit (2) and its support;
- the oil dipstick (3) from the crankcase.

Figure 16



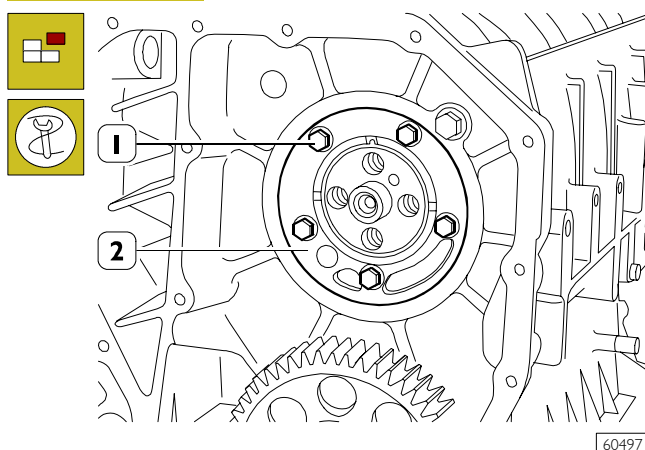
Remove the rocker arm cover (1), take off the screws (2) and remove: the cover (3), the filter (5) and the gaskets (4 and 6). Take off the screws (8) and remove the blow-by case (7).

Figure 17



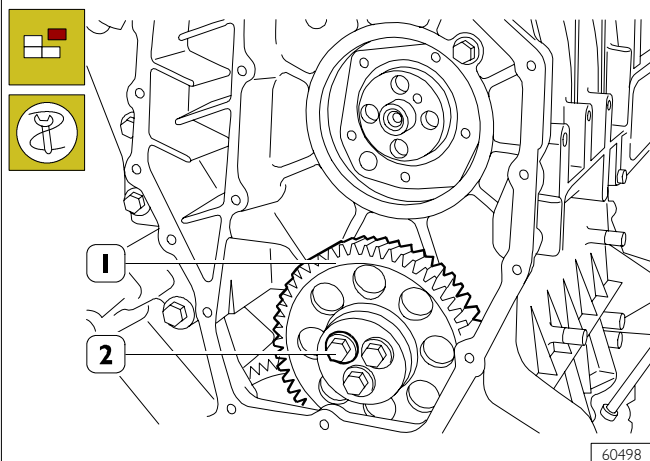
- Unscrew the screws (2) and remove the gear (1) fitted with phonic wheel.

Figure 18



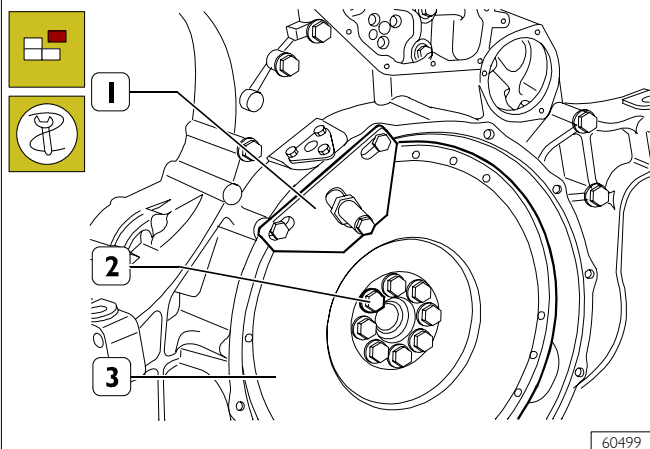
- Unscrew the screws (1); tighten one screw in a reaction hole and remove the shoulder plate (2), remove the sheet gasket.

Figure 19



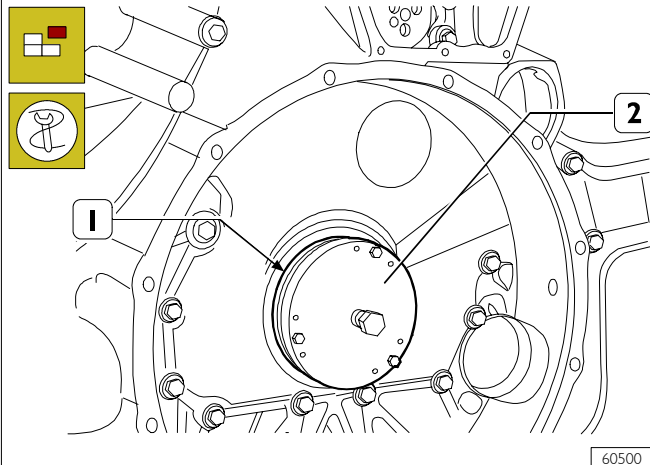
Unscrew the screws (2) and remove the transmission gear (1).

Figure 20



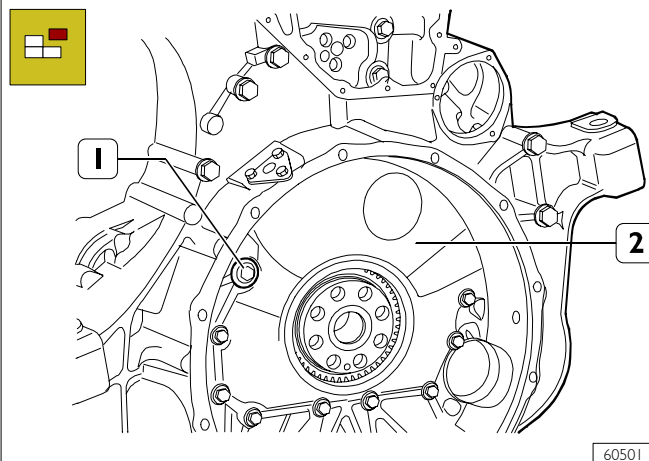
Stop the engine flywheel (3) rotation by means of tool 99360351 (1), unscrew the fixing screws (2) and remove the engine flywheel (3).

Figure 21



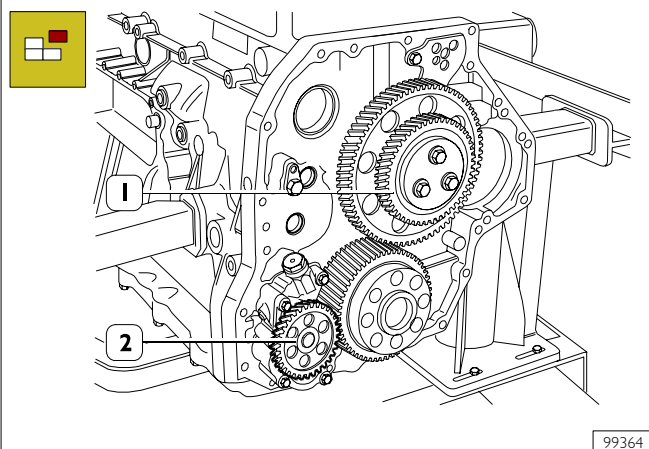
Apply the extractor 99340054 (2) and pull out the seal gasket (1).

Figure 22



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

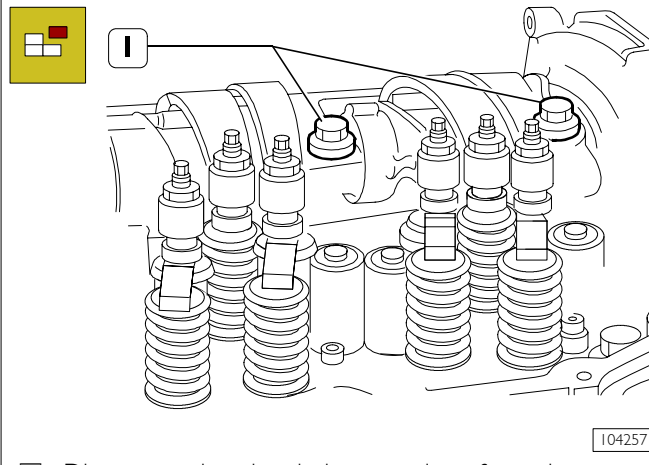
Figure 23



In sequence, take out the:

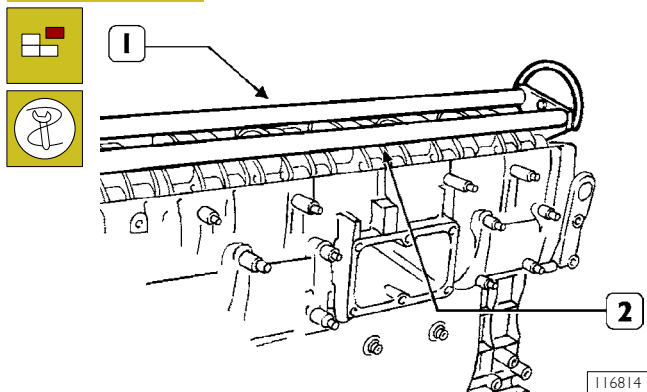
- ☐ idle gear (1);
- ☐ oil pump gear (2).

Figure 24



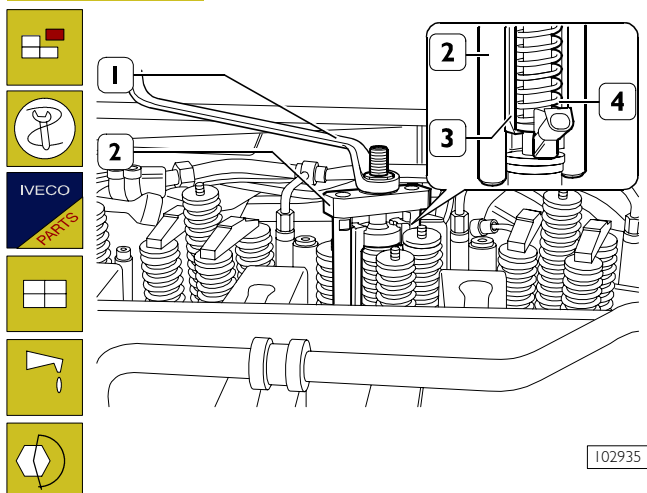
- ☐ Disconnect the electrical connections from the pump injectors.
- ☐ Unscrew the screws (1) fixing the rocker arm shaft.

Figure 25



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

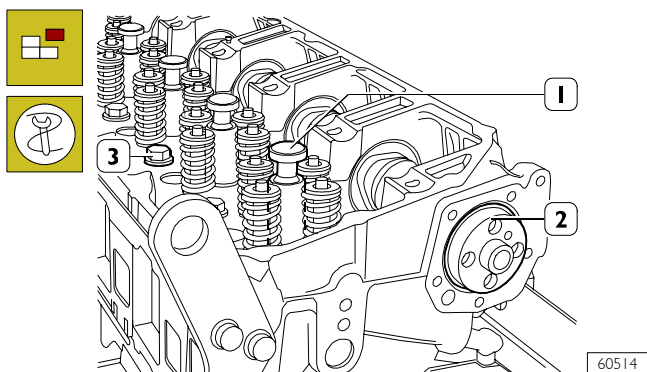
Figure 26



To extract the pump injector from the engine block, using the tool proceed as follows:

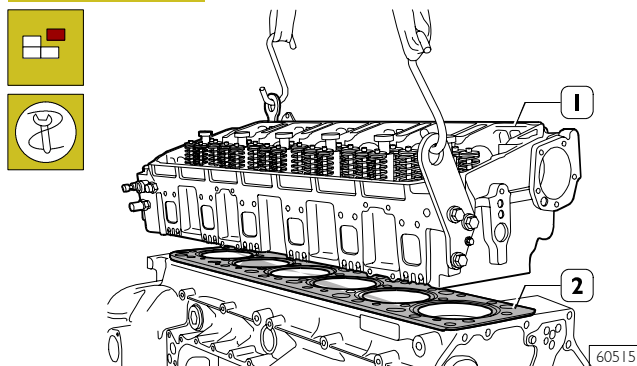
- ☐ Hook up the detail (3) of the tool illustrated in the figure to the injector pump (4);
- ☐ fit part (2) on part (3), resting the former on the cylinder head;
- ☐ tighten the nut (1) and extract the pump injector (4) from the engine block

Figure 27



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

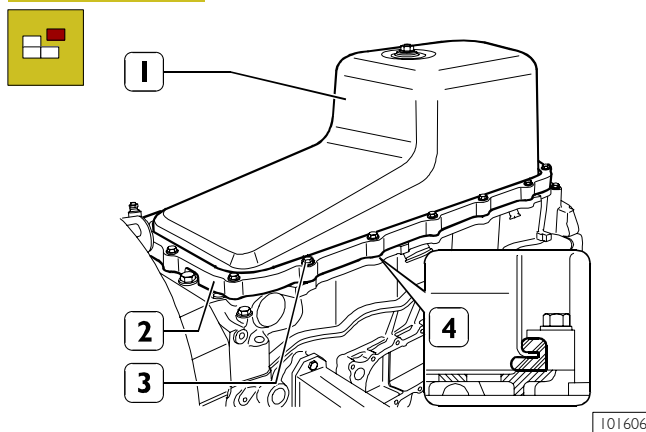
Figure 28



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

Only for types: F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001

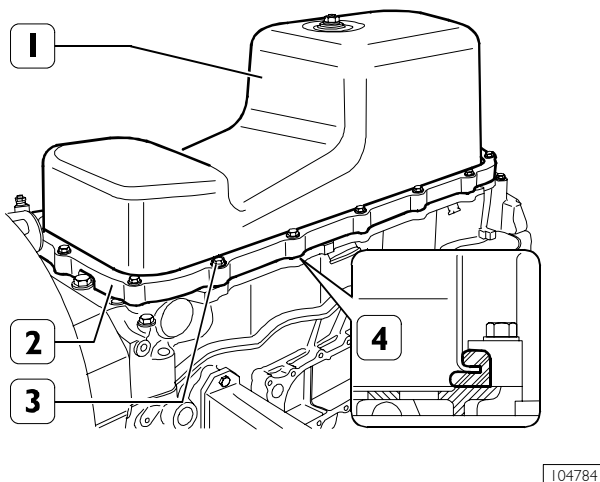
Figure 29



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

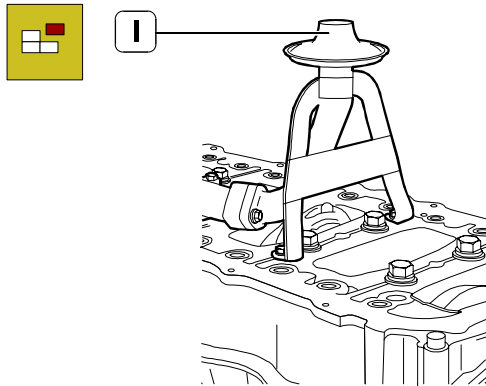
For all types except: F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001

Figure 30



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

Figure 31

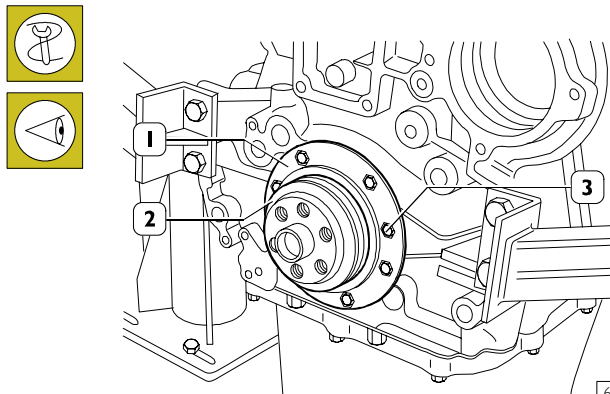


101607

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

ENGINE ASSEMBLY

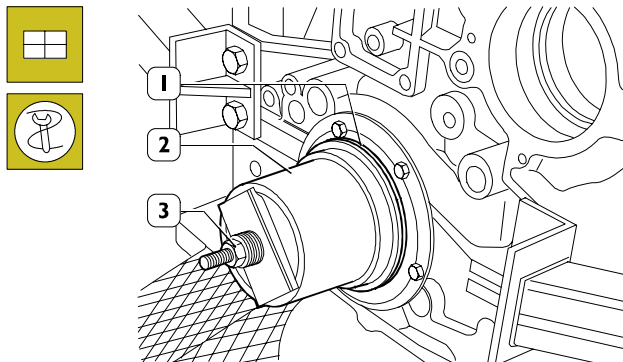
Figure 32



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).

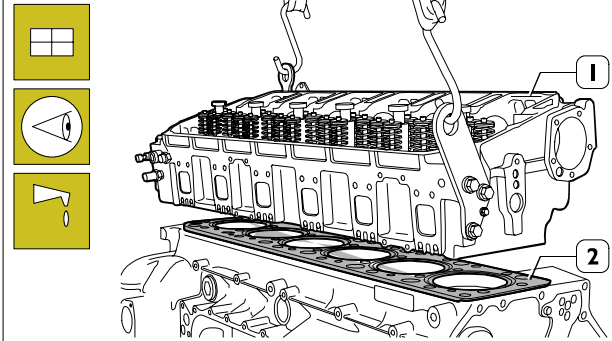
Figure 33



60564

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

Figure 34



60515

Check that the pistons 1-6 are exactly at the T.D.C.

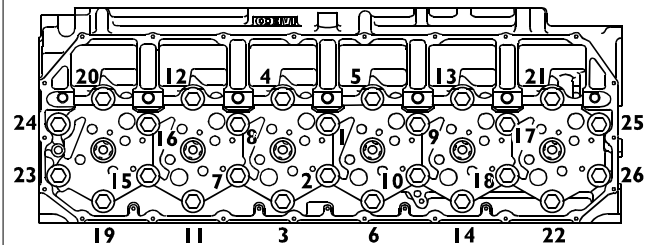
Put the gasket (2) on the crankcase.

Mount the cylinder head (1) and tighten the screws as shown in Figs. 34-35-36.

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

NOTE Use new screws every time the under block is re-assembled.

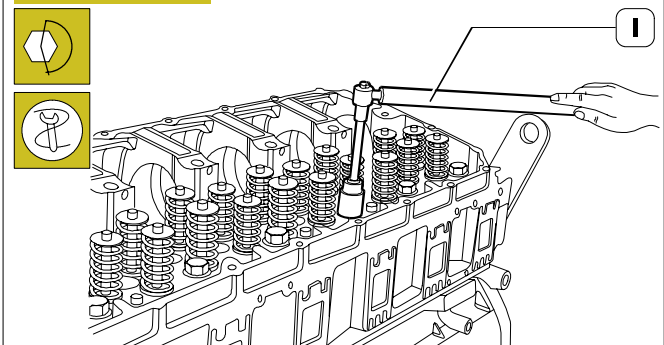
Figure 35



61270

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

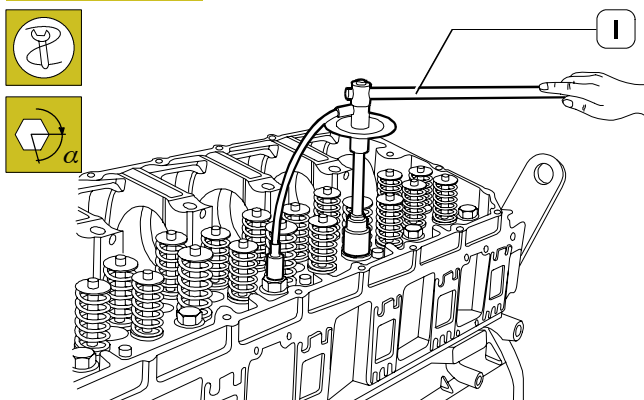
Figure 36



60565

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

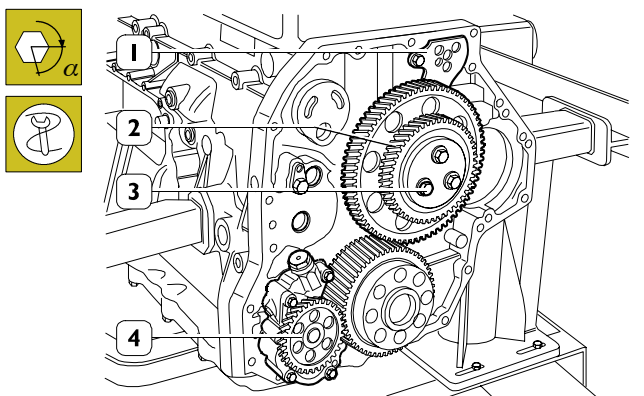
Figure 37



60566

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

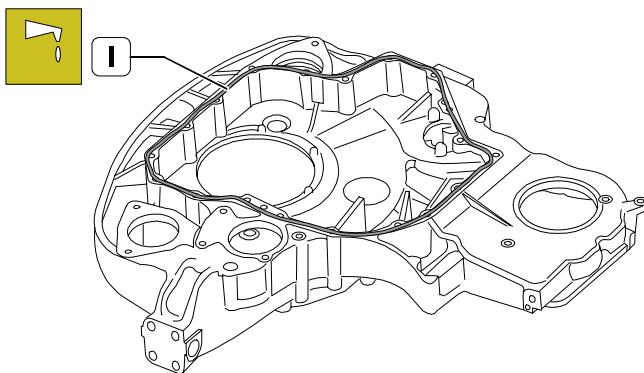
Figure 38



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 39

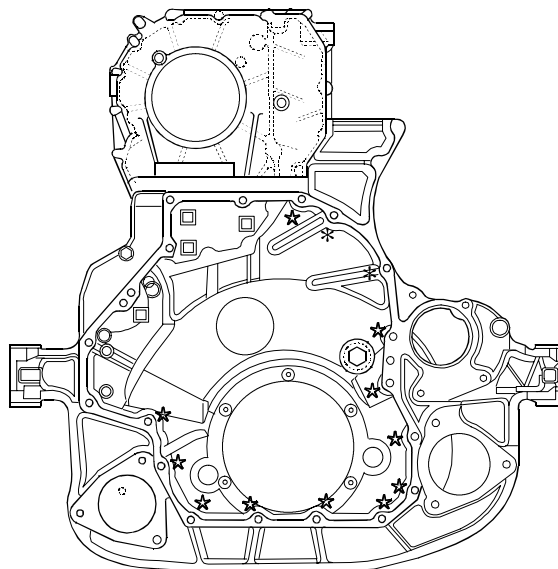


104311

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 $1,5 \pm \begin{smallmatrix} 0.5 \\ 0.2 \end{smallmatrix}$

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

Figure 40

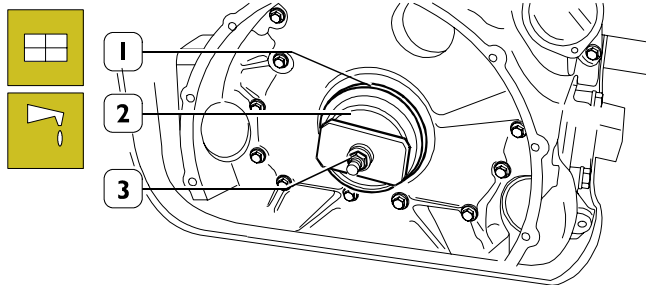


104281

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 41

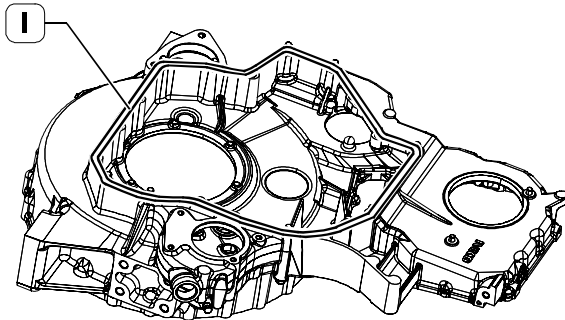


104282

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

Only for types: F3BE0684J*E902 - F3BE9687A*E001 -
F3BE9687B*E001 - F3BE9687C*E001

Figure 42



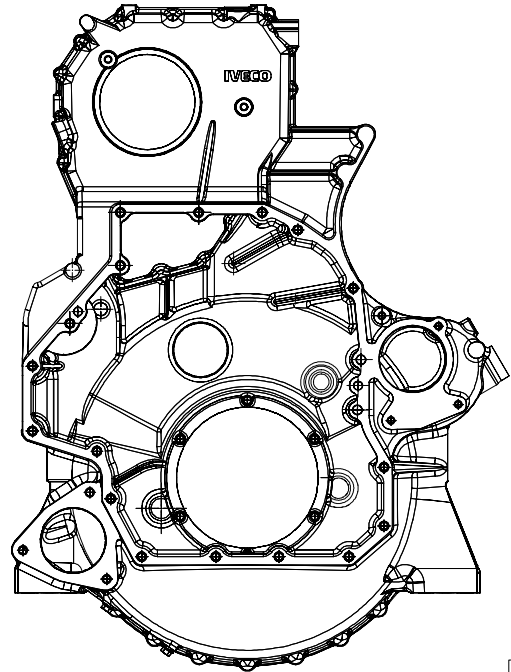
104785

Apply LOCTITE 5970 IVECO n° 2992644 silicone on the gear housing, using appropriate tools (I), as shown in the figure.

The sealer string (I) 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 43

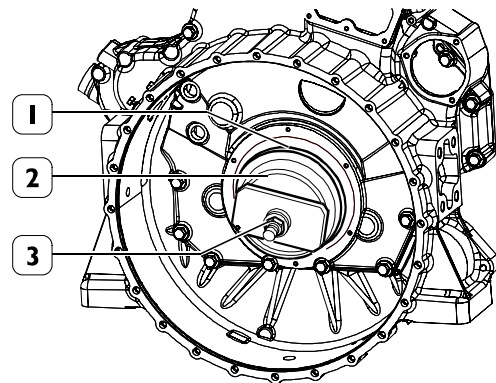


104786

Using a torque wrench, tighten the highlighted screws with the following sequence and tightening torques:

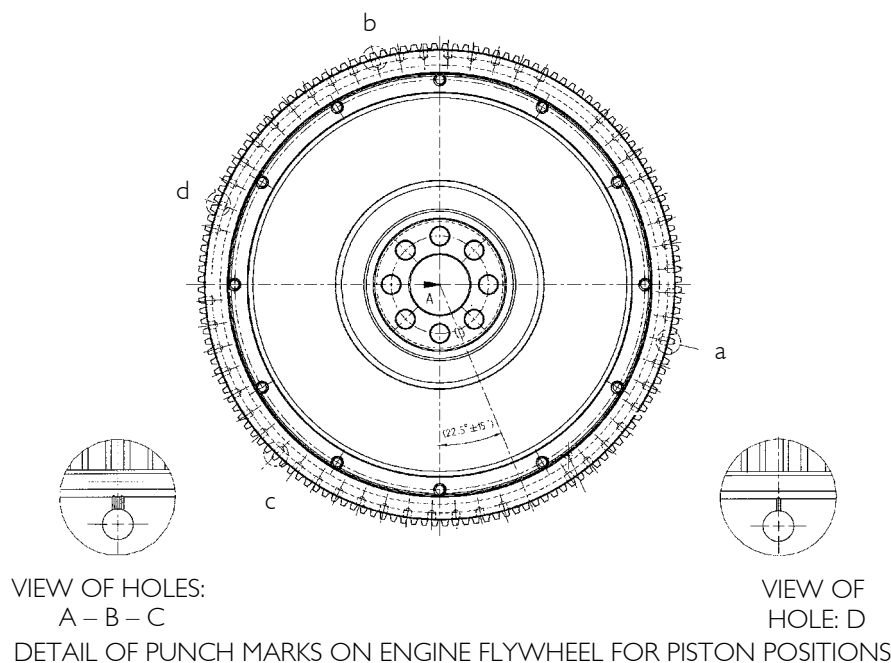
☆	10 screws M12 x 1.75 x 100	63 Nm
⊙	2 screws M12 x 1.75 x 70	63 Nm
□	4 screws M12 x 1.75 x 35	63 Nm
△	1 screw M12 x 1.75 x 120	63 Nm
✱	2 screws M12 x 1.75 x 193	63 Nm

Figure 44



104787

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 (For types: F3BE0684H*E90I - F3BE0684G*E90I)****Figure 45**

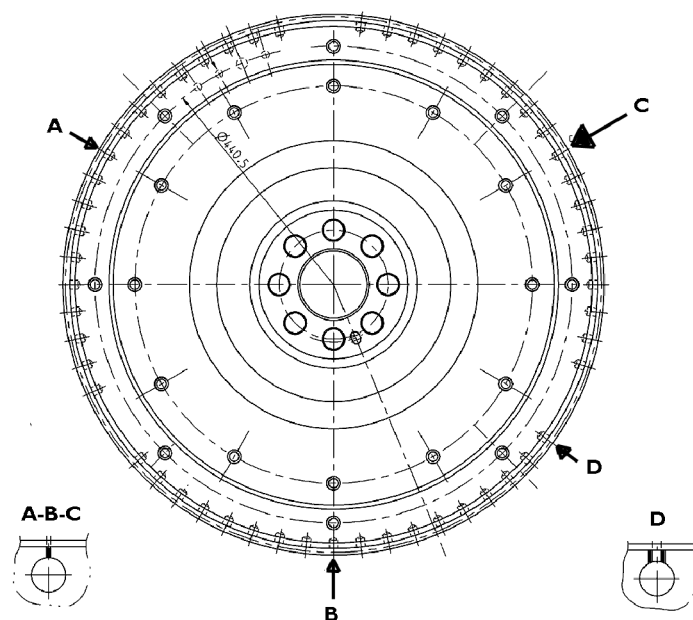
104283

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

C = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 2-5.

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

D = Hole on flywheel with two reference marks, position corresponding to 54°.

Fitting engine flywheel (For types: F3BE0684J*E902 - F3BE9687A*E00I - F3BE9687B*E00I - F3BE9687C*E00I)**Figure 46**

104788

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

C = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 2-5.

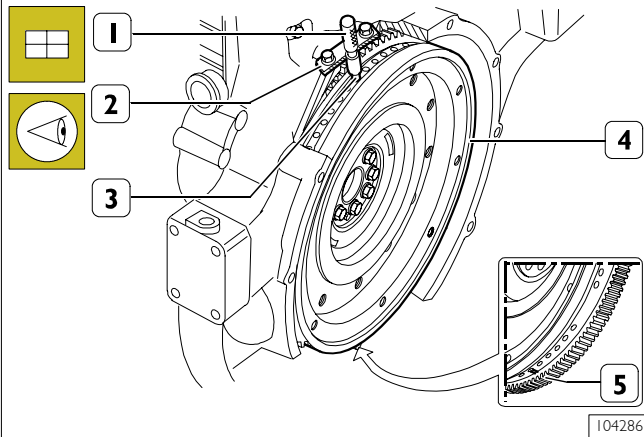
B = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6.

D = Hole on flywheel with two reference marks, position corresponding to 54°.

Fitting camshaft

For all types

Figure 47



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

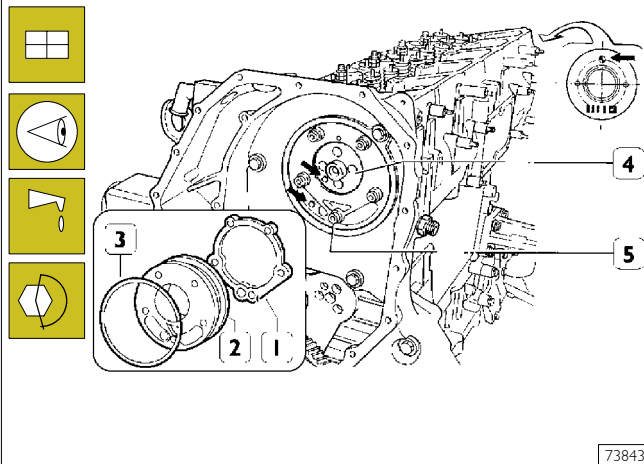
This situation occurs when:

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

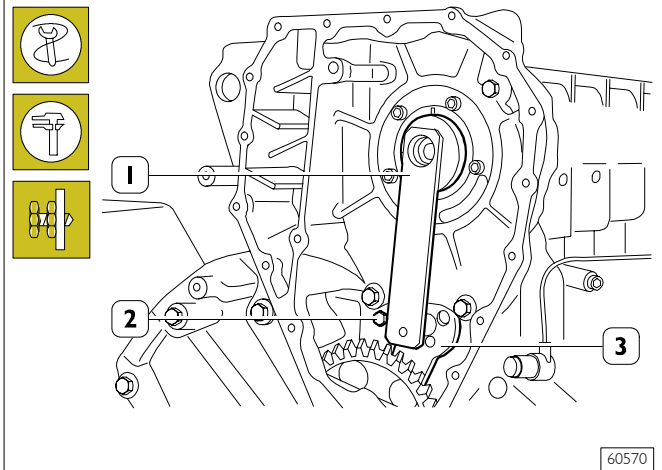


Fit the camshaft (4), positioning it observing the reference marks (→) as shown in the figure.

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

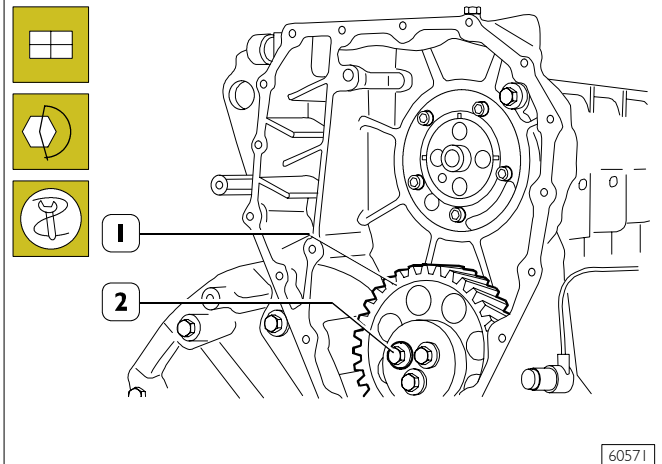
Mount the shoulder plate (2) with the sheet metal gasket (1) and tighten the screws (5) to the required torque.

Figure 49



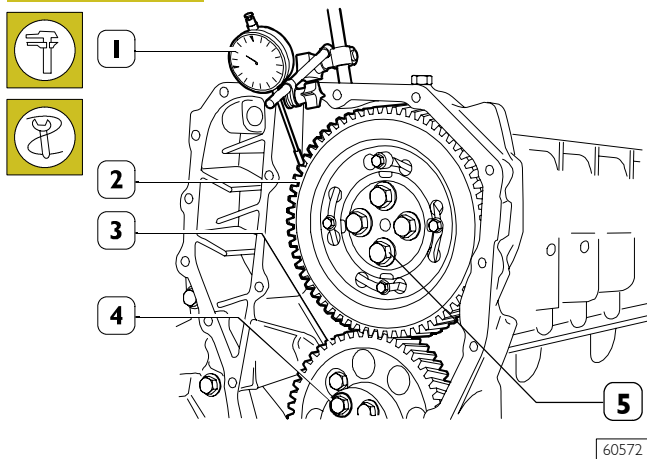
- ☐ Apply the gauge 99395219 (1). Check and adjust the position of the link rod (3) for the idle gear. Lock the screw (2) to the required torque.

Figure 50



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

Figure 51



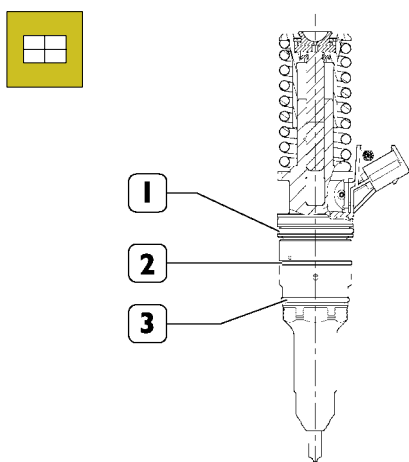
Position the gear (2) on the camshaft so that the 4 slots are centred with the holes for fixing the camshaft, without fully locking the screws (5).

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.

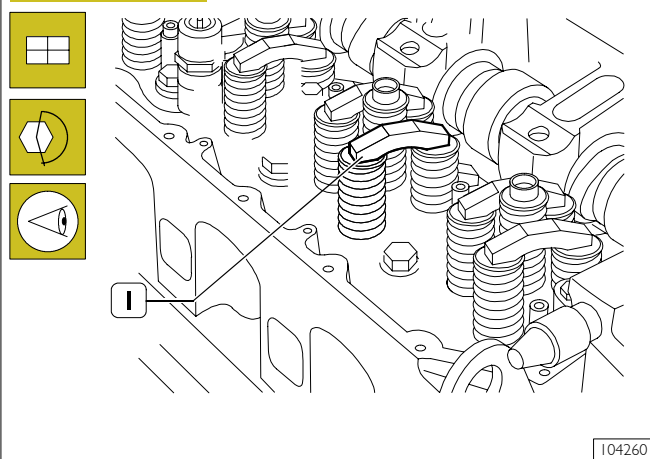
Fitting pump-injectors

Figure 52



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

Figure 53



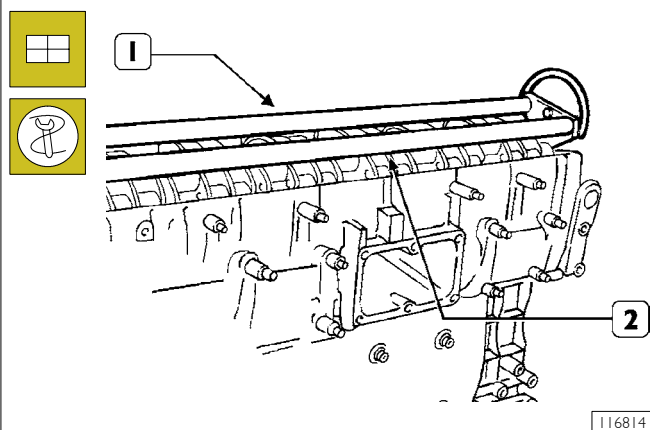
Mount:

- ☐ 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

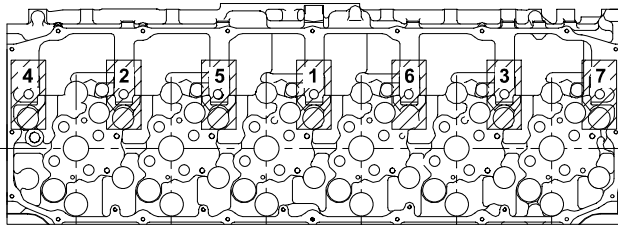
Figure 54

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



Apply the tool 99360553 (1) to the rocker arm shaft (2) and mount the shaft on the cylinder head.

Figure 55

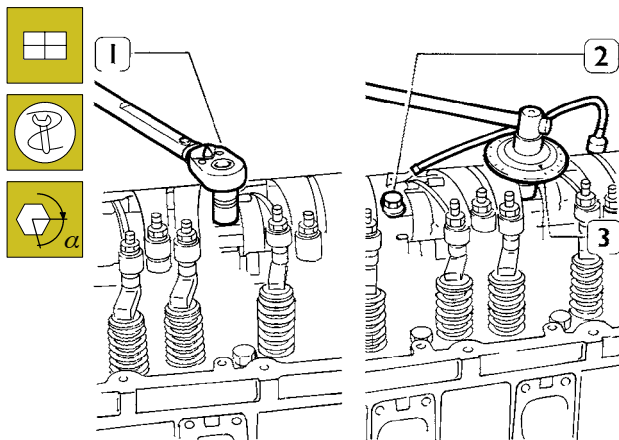


70567A

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



104261

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

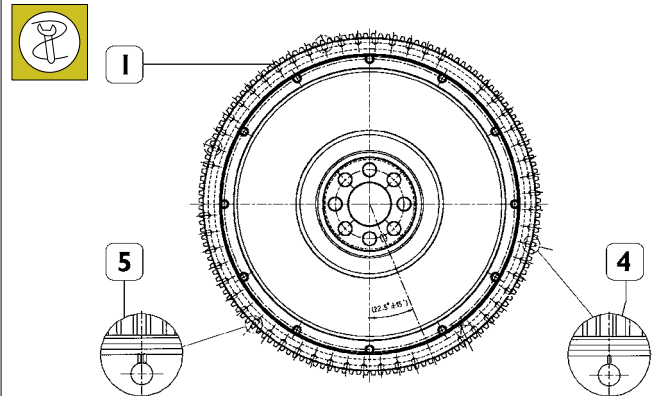
- ☐ 1st phase: tightening to a torque of 80 Nm (8 kgm) with the torque wrench (1);
- ☐ 2nd phase: closing with an angle of 60° using the tool 99395216 (3).

Mount the electric wiring on the electro-injectors.

Camshaft timing

(For types: F3BE0684N*E901 - F3BE0684G*E901)

Figure 57



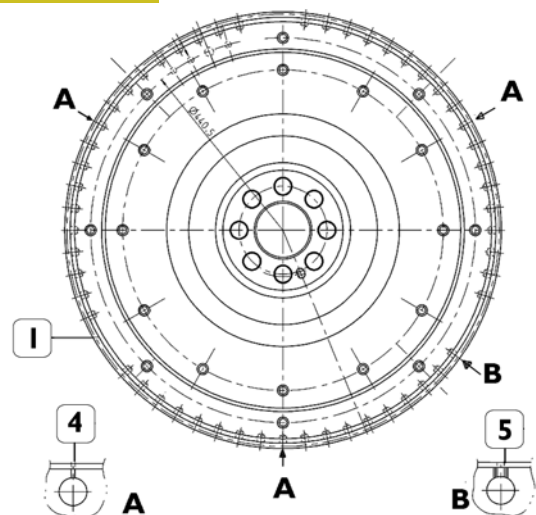
104316

Using the 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.

Camshaft timing

(For types: F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001)

Figure 58

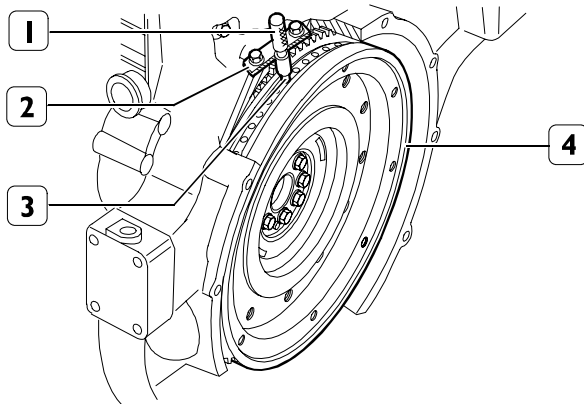


104789

Using the 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.

For all types

Figure 59



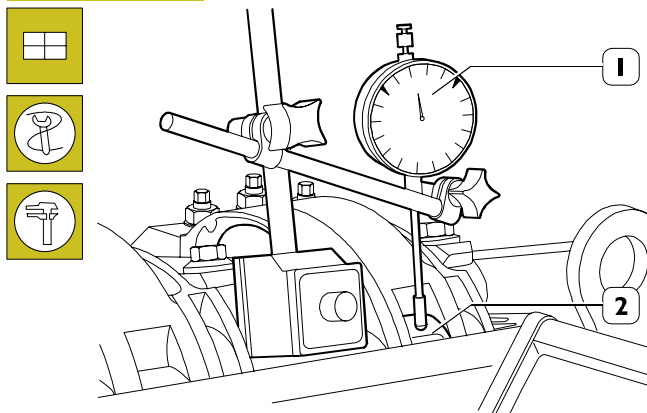
104288

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



60573

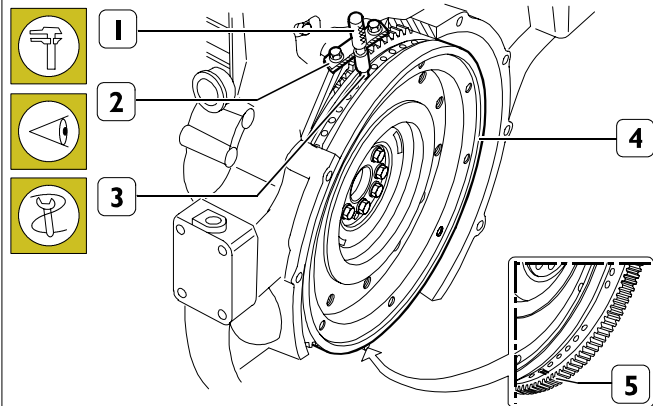
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

With tool 99360321 (7), turn the crankshaft clockwise until the pointer of the dial gauge reaches the minimum value beyond which it can no longer fall.

Reset the dial gauge.

Turn the engine flywheel anticlockwise until the dial gauge gives a reading for the lift of the cam of the camshaft of 5.45 ± 0.05 mm.

Figure 61

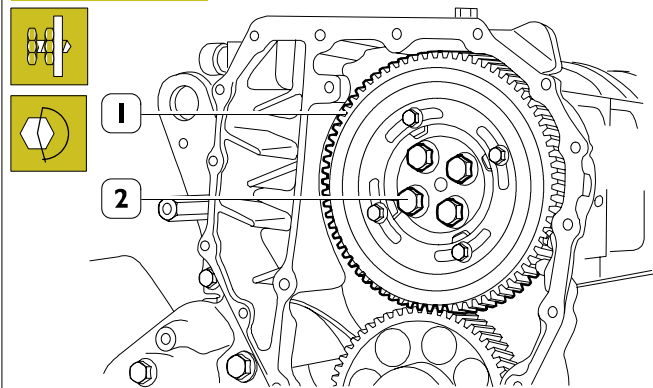


104286

The camshaft is in step if at the cam lift values of 5.45 ± 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



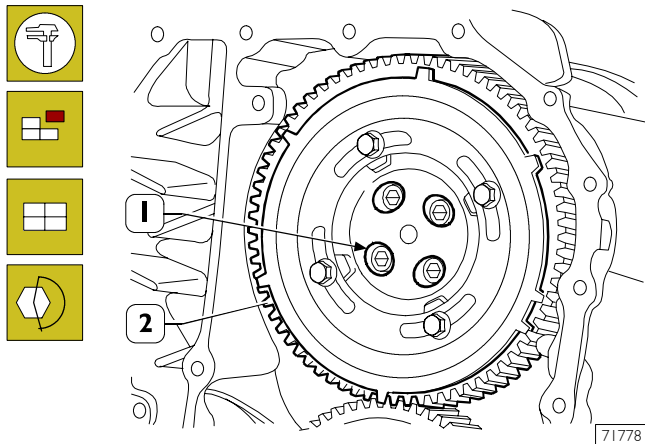
60575

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.

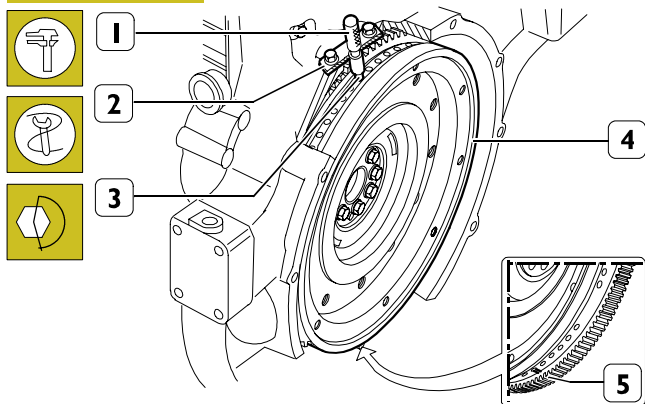
Figure 63



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 5.45 ± 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).

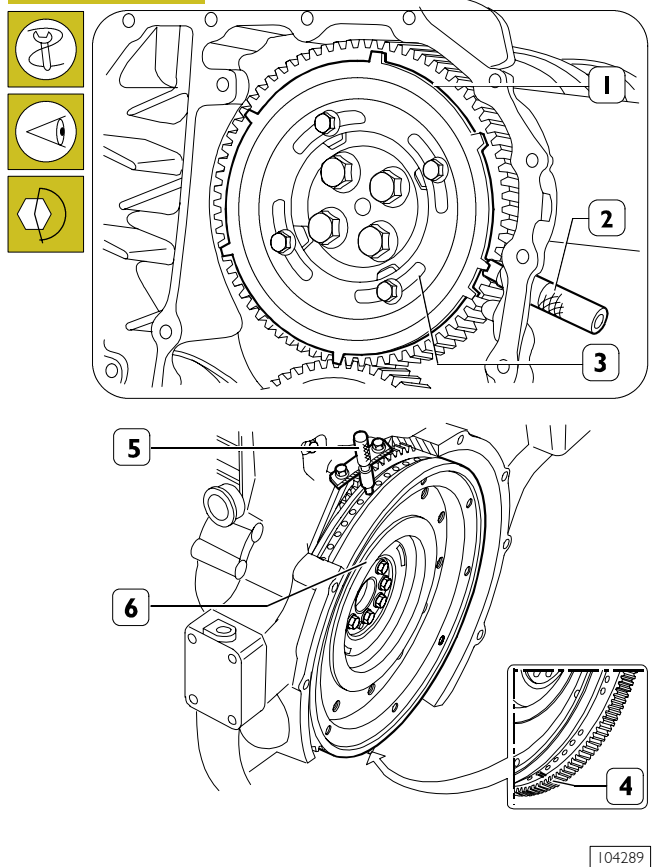
Mount the gear (2) Figure 63 with the 4 slots (1) centred with the fixing holes of the camshaft, locking the relevant screws to the required tightening torque.

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 5.45 ± 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.

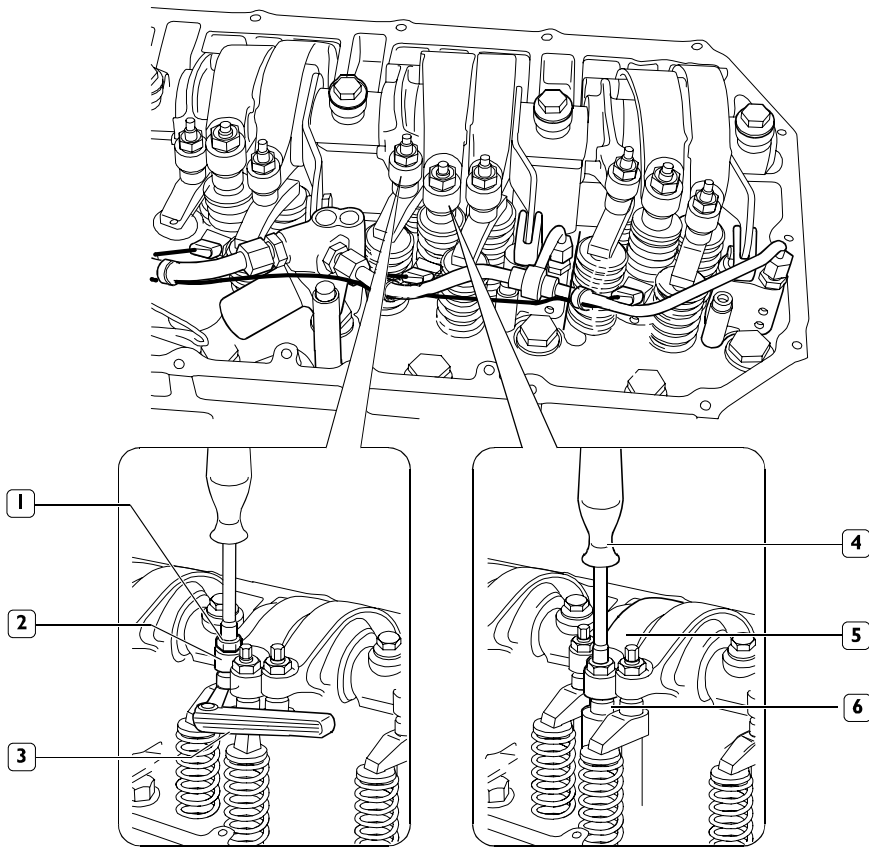
Again turn the flywheel in its normal direction of rotation until you see the hole marked with the double notch (4) through the inspection hole under the flywheel housing. Insert tool 99360612 (5) into the seat of the flywheel sensor (6).

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



116815

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.

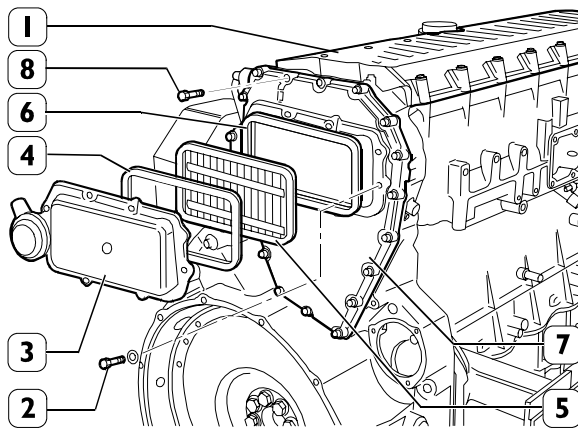
- ❑ Lock the adjusting screw to a torque of 5 Nm (0.5 kgm) by means of a torque wrench.
- ❑ Back off the adjusting screw 1/2 to 3/4 turn.
- ❑ Tighten the lock nut.

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 67



85480

Fit the distribution cover (1).

NOTE The rocker arm cover lock screws (1) must be tightened in the order indicated in NO TAG.

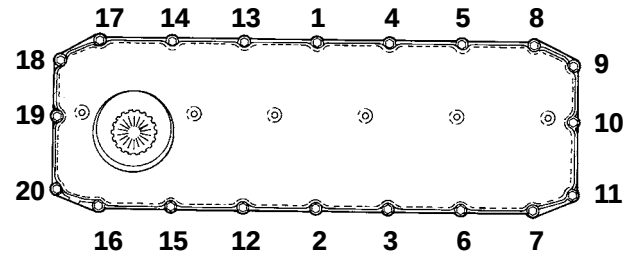
Fit the blow-by case (7) and its gasket and then tighten the screws (8) to the prescribed torque.
Install the filter (5) and the gaskets (4 and 6).

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.

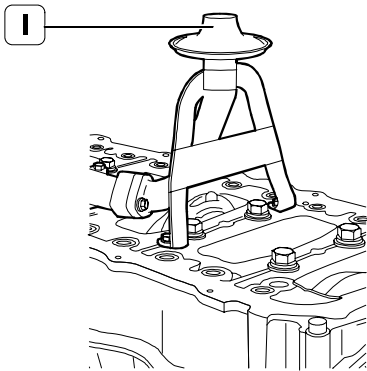
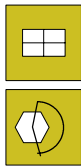
NOTE Apply silicone LOCTITE 5970 IVECO n° 2992644 on the blow-by case (7) surface of engines fitted with P.T.O. according to the procedure described in the following figure.

Figure 68



45363

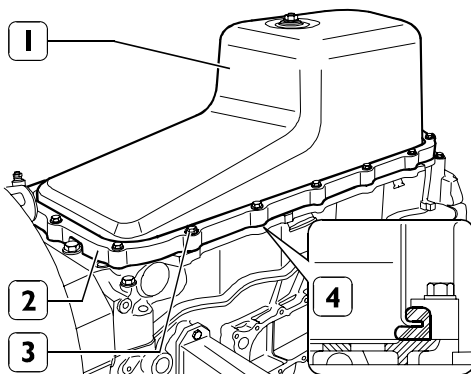
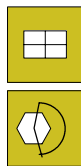
DIAGRAM OF ROCKER ARM CAP FIXING SCREWS
TIGHTENING SEQUENCE

ENGINE COMPLETION**Figure 69**

101607

Fit the strainer (1) and tighten the lock screw to the torque prescribed.

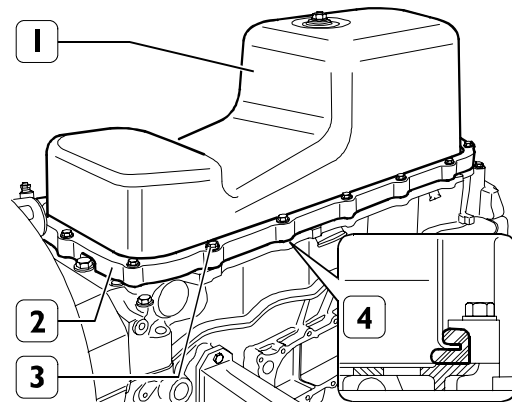
Only for types: F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001

Figure 70

101606

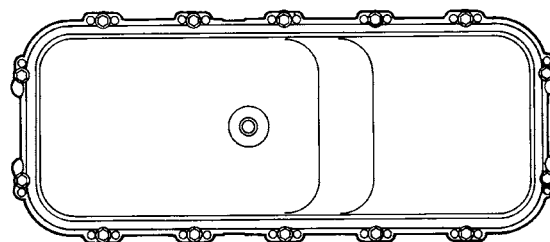
Loosen screws (3), then remove sump (1) complete with spacer (2) and seal gasket (4).

For all types except: F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001

Figure 71

104784

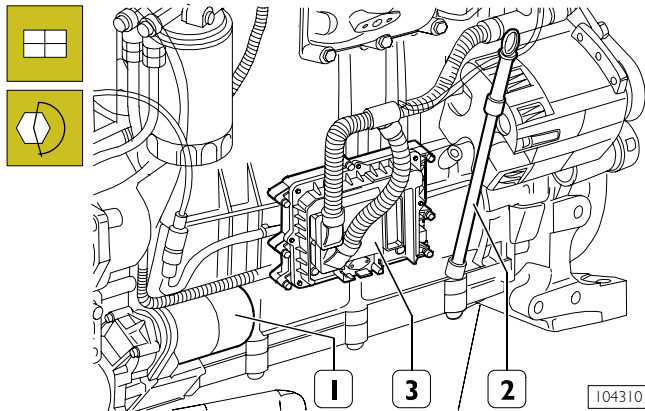
Place gasket (4) on oil sump (1), position spacer (2) and fit the sump onto the engine base by tightening screws (3) to the specified torque, by complying with the tightening sequence indicated in Figure 71.

Figure 72

45362

DIAGRAM OF ENGINE OIL SUMP FIXING SCREWS
TIGHTENING SEQUENCE

Figure 73

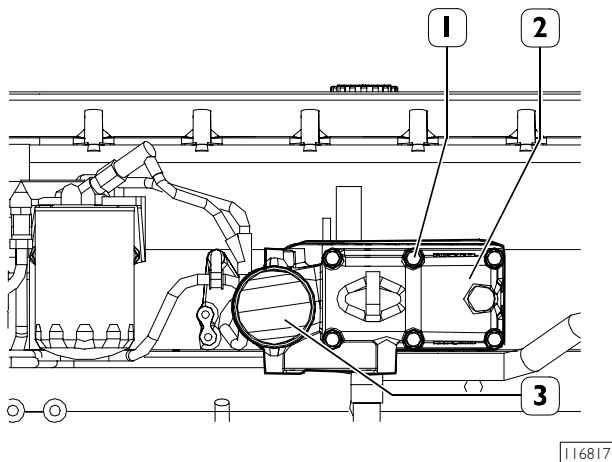


Tightening the fixing screws to the prescribed torque, mount:

- 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.

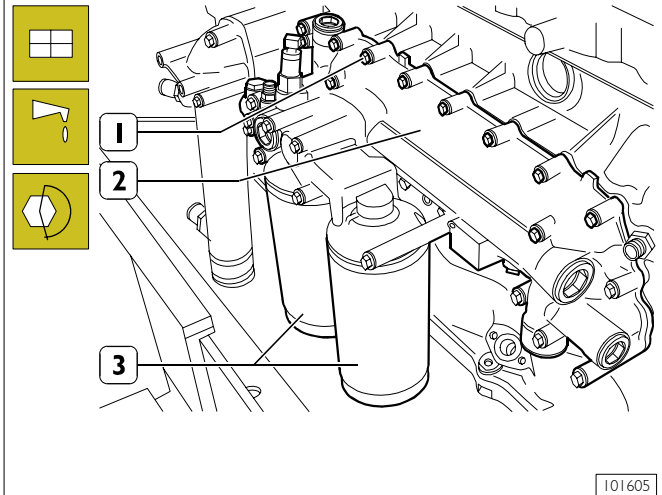
Figure 74



Assemble the intake manifold (1) and tighten the locking screws (2) to the specified torque.

NOTE The intake joint may have different positions depending on the type of engine.

Figure 75



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 75.

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 76

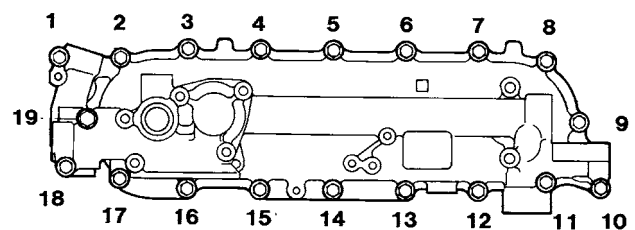
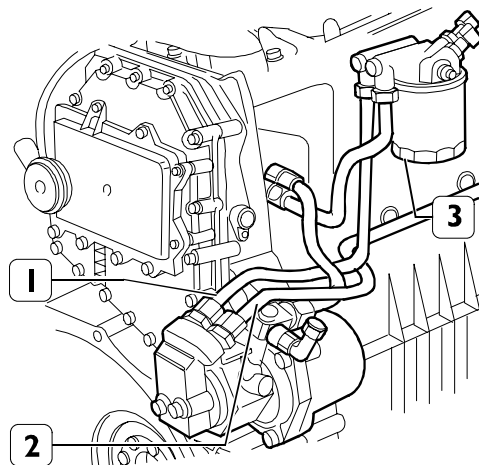


DIAGRAM OF HEAT EXCHANGER FIXING SCREWS
TIGHTENING SEQUENCE

Figure 77

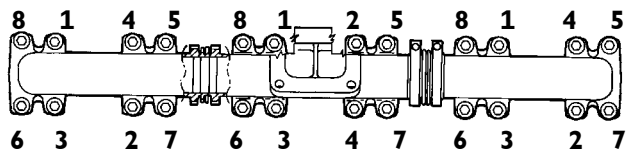


104254

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).

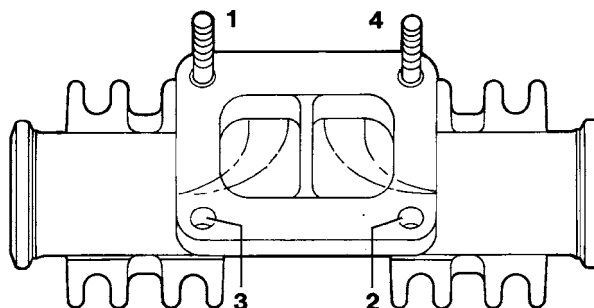
Figure 78



45359

DIAGRAM OF EXHAUST MANIFOLD FIXING SCREWS
TIGHTENING SEQUENCE

Figure 79

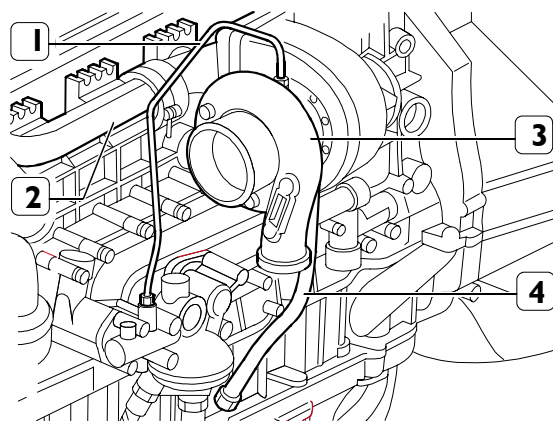


45360

DIAGRAM OF TURBOCHARGER FIXING SCREWS AND
NUTS TIGHTENING SEQUENCE

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

Figure 80



104252

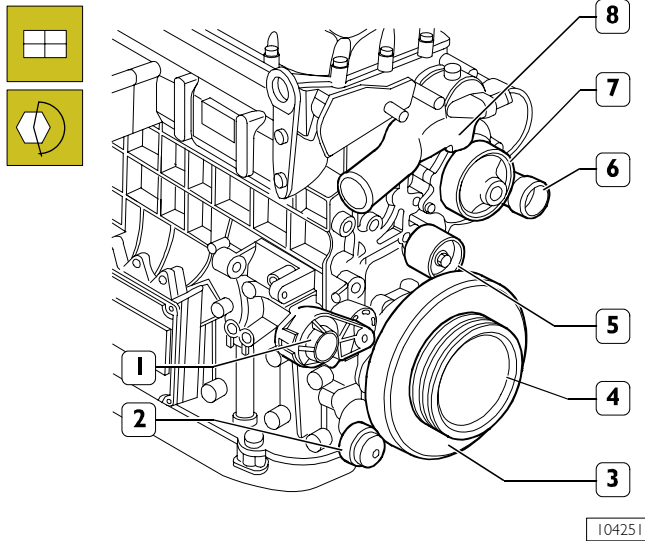
Mount the following with new seals:

- exhaust manifold (2);
- turbocharger (3);
- oil pipe (1 and 4);

NOTE The position of the turbine varies according to the equipment.

Only for type: F3BE0684J*E902

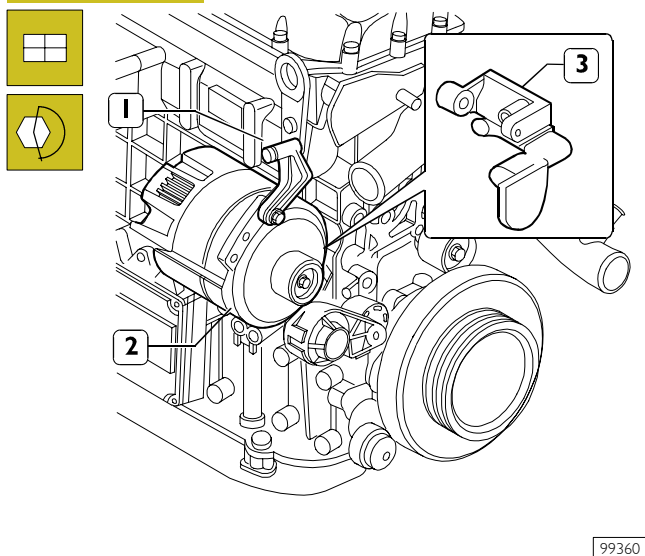
Figure 81



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).

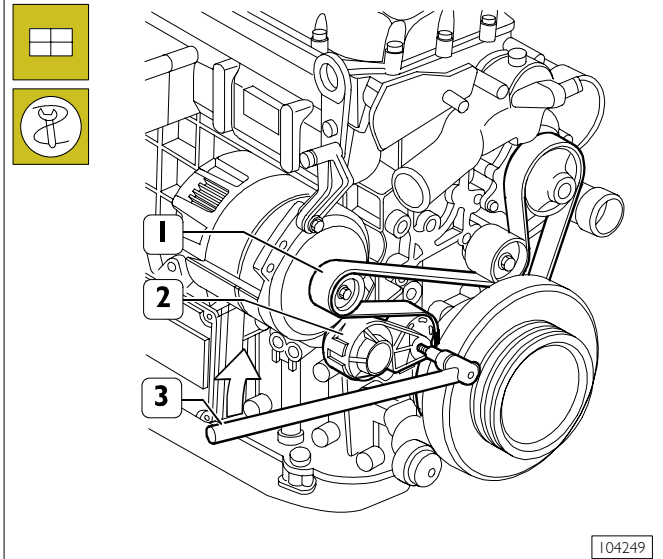
Figure 82



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

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

Figure 83



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 84

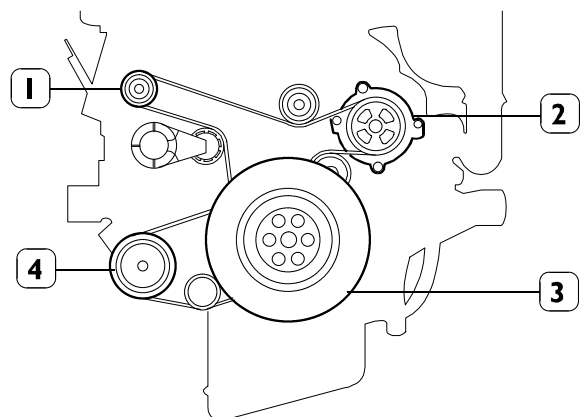
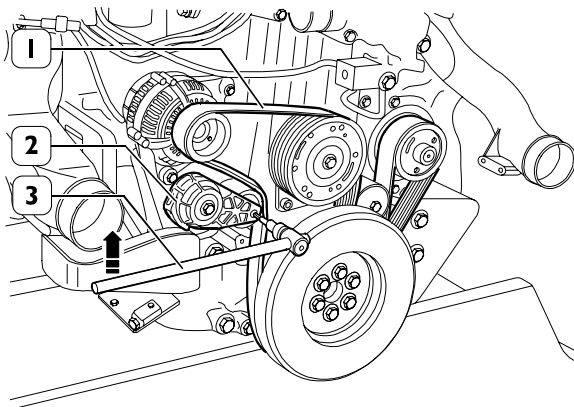


DIAGRAM FOR FITTING BELT DRIVING FAN - WATER PUMP - ALTERNATOR

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

Only for types: F3BE9687A*E001 - F3BE9687B*E001 - F3B9687C*E001

Figure 86

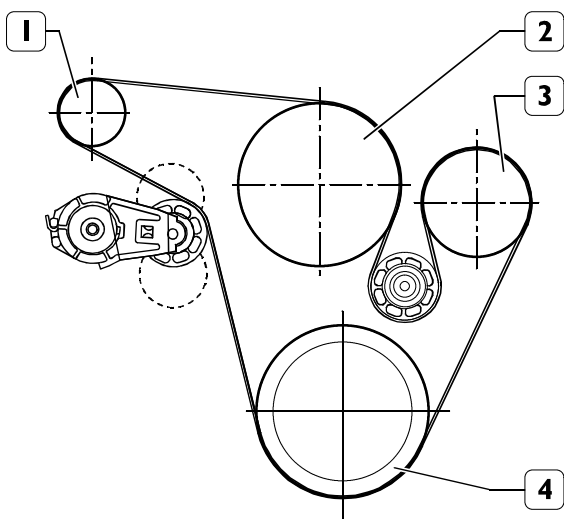


106223

□ driving belt.

To mount belt (1), belt tensioner (2) has to be operated by proper tooling (3) according to the direction indicated by the arrow in Figure.

Figure 85

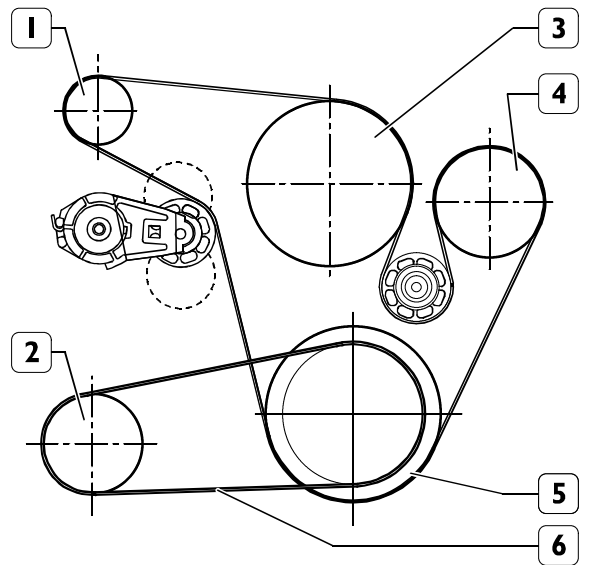


108844

ASSEMBLY DIAGRAM OF FAN – WATER PUMP – ALTERNATOR DRIVE BELT

1. Alternator – 2. Electromagnetic coupling –
3. Water pump – 4. Crankshaft

Figure 87



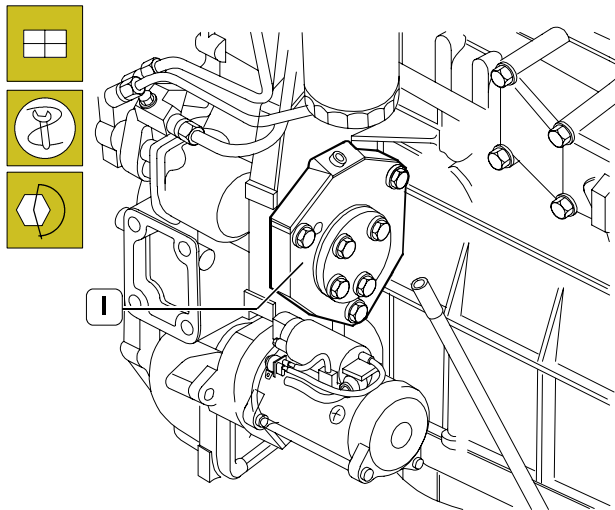
108845

COMPRESSOR CONTROL BELT
ASSEMBLY DIAGRAM

1. Alternator – 2. Climate control system compressor –
3. Electromagnetic coupling – 4. Water pump –
5. Crankshaft – 6. Spring belt.

For all types

Figure 88



104247

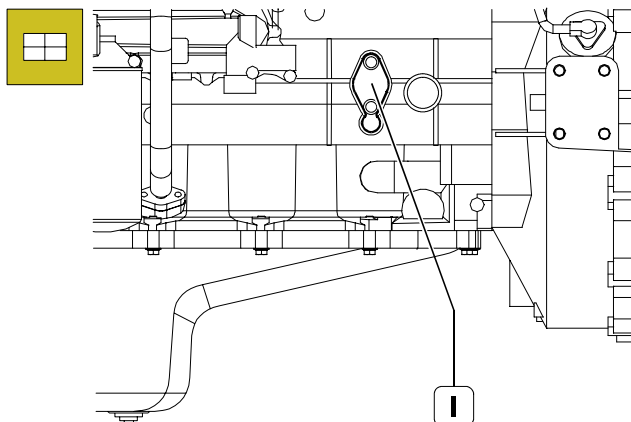
Fit the arm 99360585 onto the engine lifting hooks and hook the arm onto the hoist.

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 89

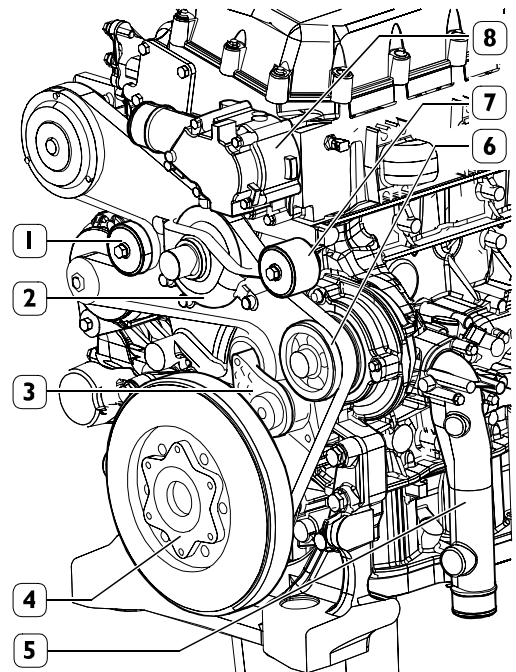


104246/A

- mount the oil pressure adjuster valve (1).

Only for types: F3BE0684H*E90I and F3BE0684G*E90I

Figure 90

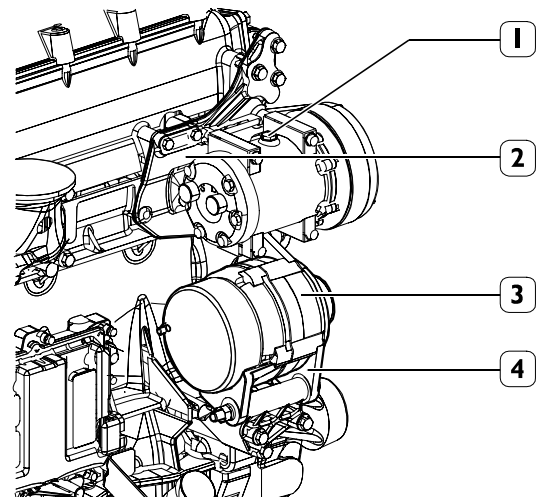


104782

Assemble the following components and tighten their fixtures to the specified torque:

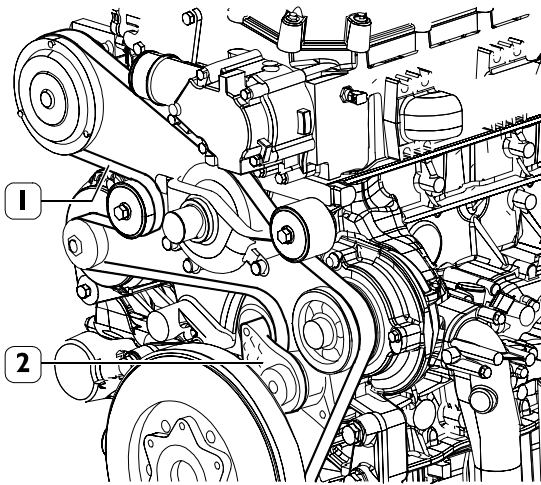
- the fixed belt tightening roller (1);
- the support (2);
- the automatic belt tightener (3);
- the damping flywheel (4) and the pulley beneath it;
- all the coolant pipes (5);
- the water pump (6);
- the fixed belt tightening roller (7);
- the thermostat assembly (8).

Figure 91



104781

Assemble the alternator support (3) on the engine and tighten the locking screws to the specified torque.
Assemble the alternator (4) and tighten the locking screws to the specified torque value.
Assemble the compressor (1) complete with its support (2) on the engine and tighten the locking screws to the specified torque.

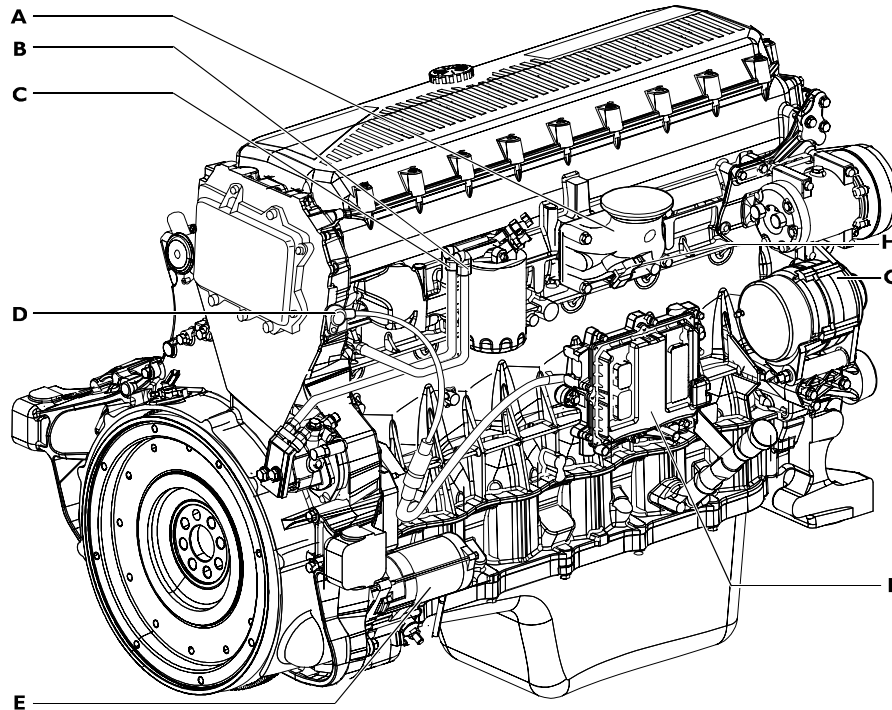
Figure 92

104780

Assemble the belt on the pulleys and tightening rollers, making sure that it is correctly inserted in its seats.

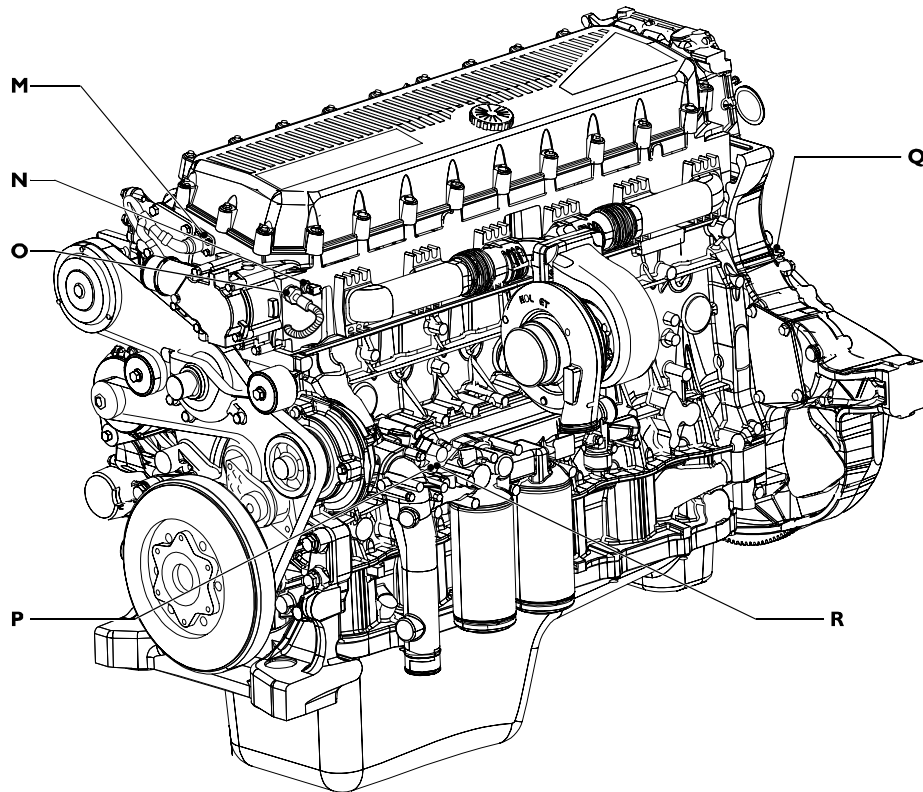
NOTE The belt tighteners are of the automatic type and so no further adjustment is required after assembly.

**PART TWO -
ELECTRICAL EQUIPMENT**

Components on the engine F3B (For types: F3BE0684H*E90I - F3BE0684G*E90I)**Figure 1**

ENGINE RIGHT-HAND SIDE VIEW

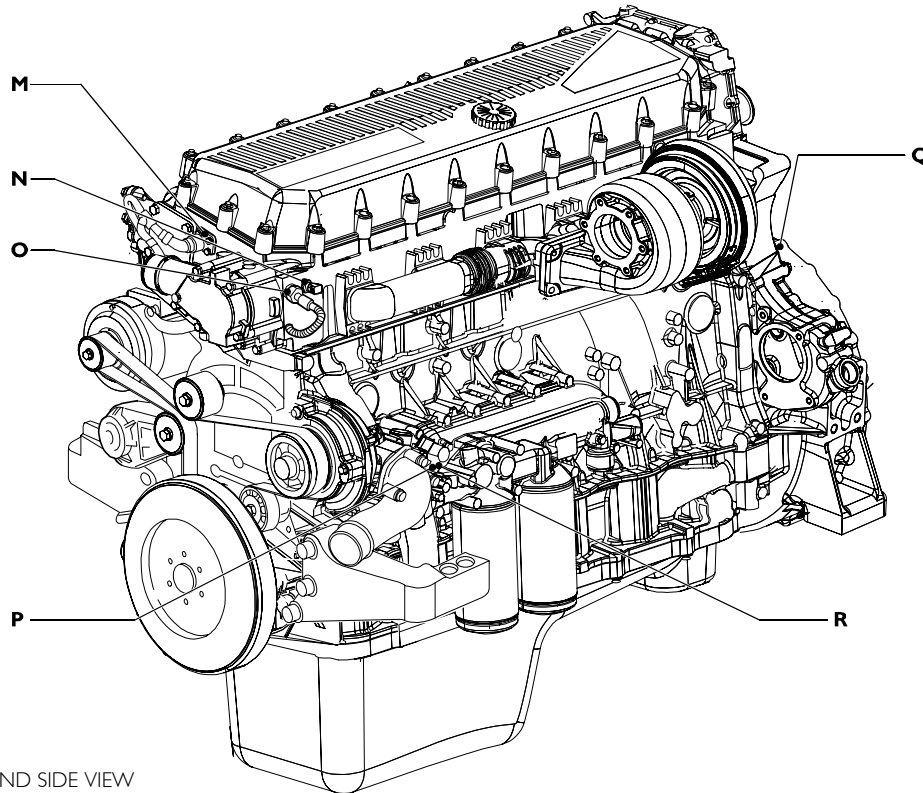
104790

Figure 2

ENGINE LEFT-HAND SIDE VIEW

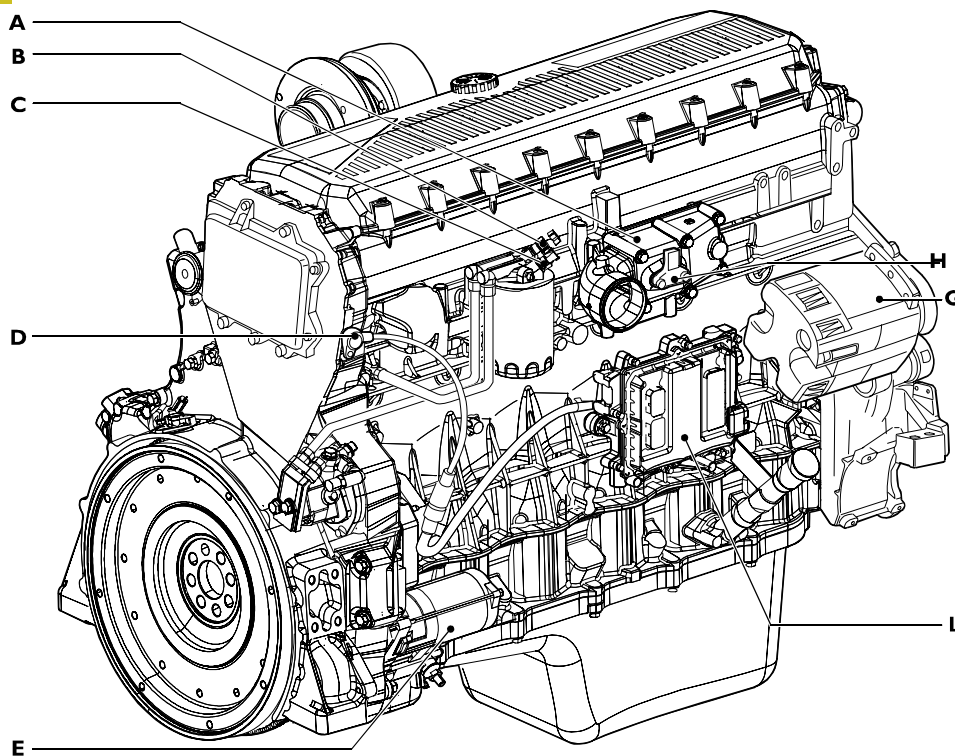
104791

- A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - G. Alternator - H. Temperature/air pressure sensor - I. Conditioner compressor - L. EDC 7 control unit - M. Connector on engine head for connection with injector solenoid valves - N. Water temperature for EDC 7 - O. Water temperature sensor - P. Oil pressure/temperature transmitter - Q. Engine speed on flywheel sensor - R. Low oil pressure transmitter.

Components on the engine F3B (Only for type: F3BE0684J*E902)**Figure 3**

ENGINE RIGHT-HAND SIDE VIEW

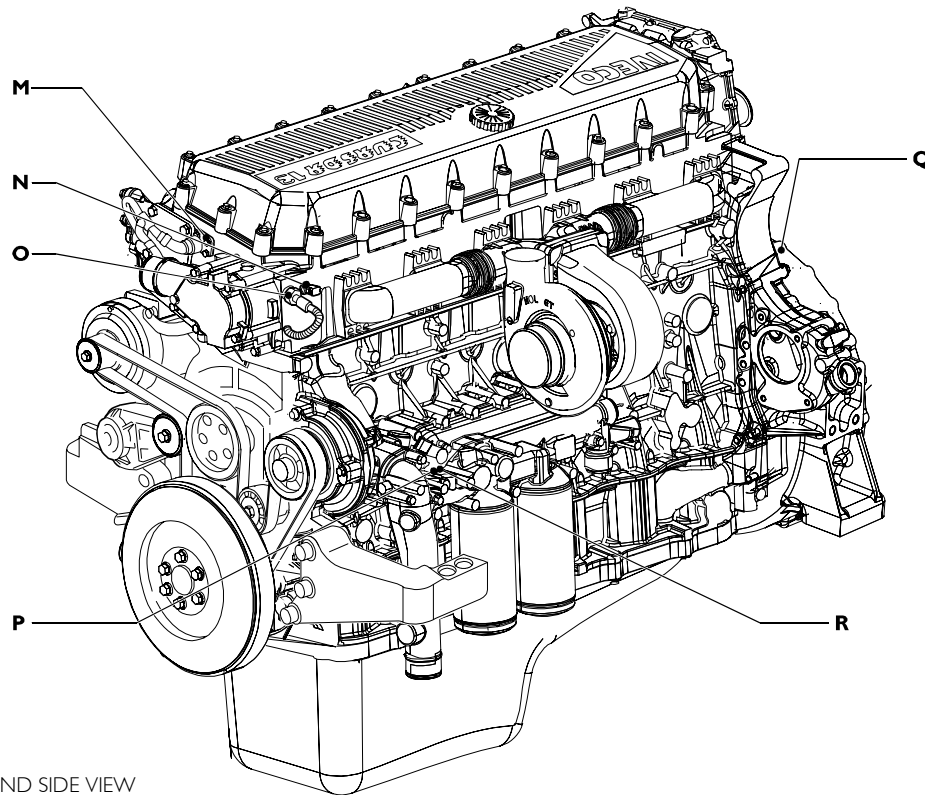
104792

Figure 4

ENGINE LEFT-HAND SIDE VIEW

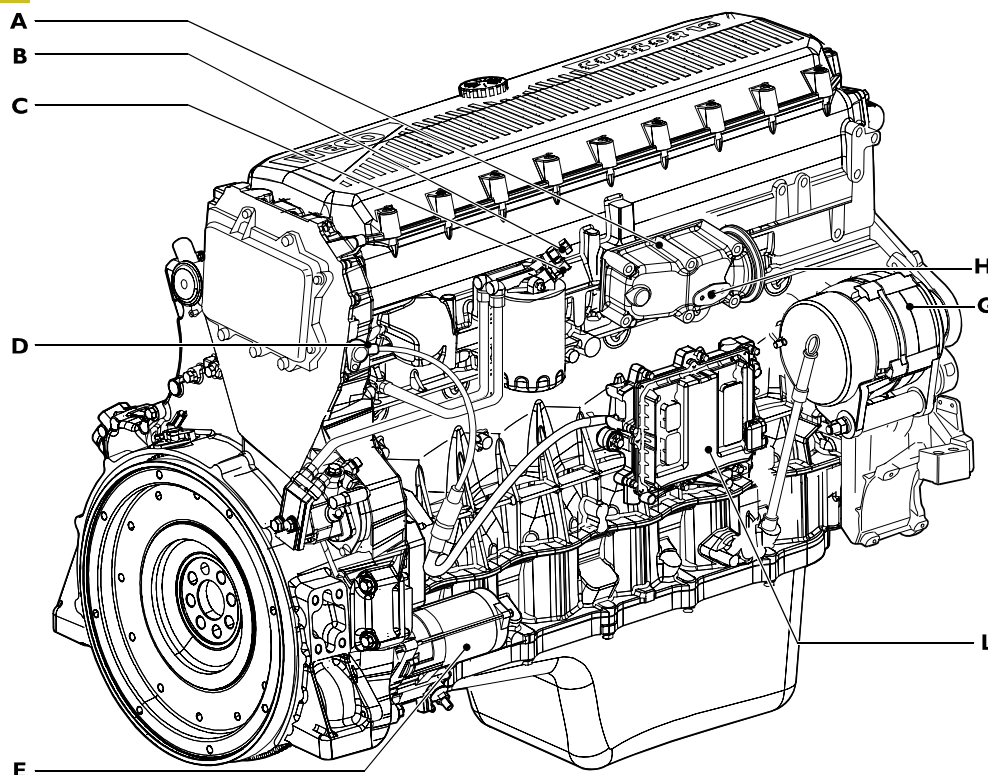
104793

- A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - G. Alternator - H. Temperature/air pressure sensor - I. Conditioner compressor - L. EDC 7 control unit - M. Connector on engine head for connection with injector solenoid valves - N. Water temperature for EDC 7 - O. Water temperature sensor - P. Oil pressure/temperature transmitter - Q. Engine speed on flywheel sensor - R. Low oil pressure transmitter.

Components on the engine F3B (F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001)**Figure 5**

ENGINE RIGHT-HAND SIDE VIEW

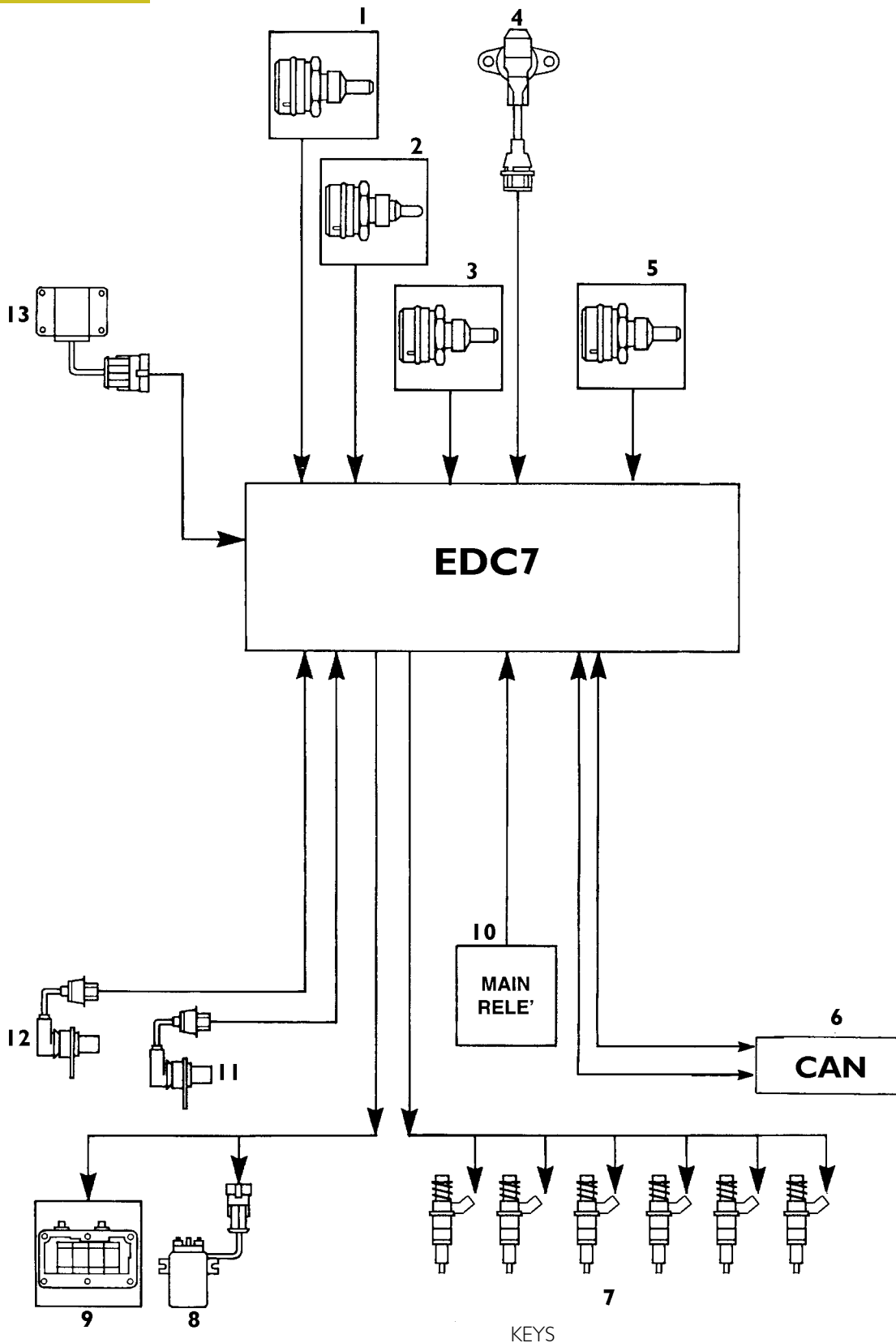
116818

Figure 6

ENGINE LEFT-HAND SIDE VIEW

116819

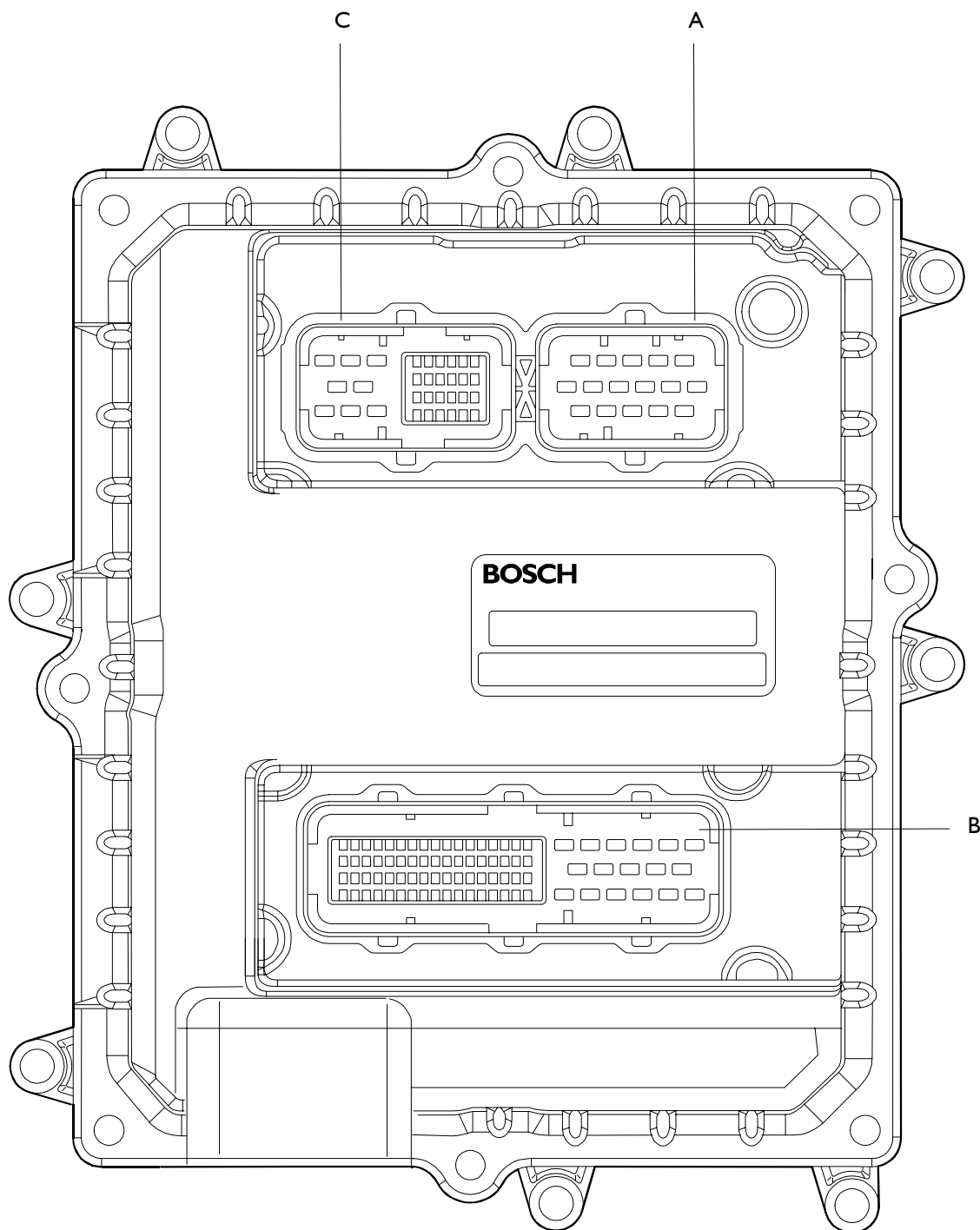
- A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - G. Alternator - H. Temperature/air pressure sensor - I. Conditioner compressor - L. EDC 7 control unit - M. Connector on engine head for connection with injector solenoid valves - N. Water temperature for EDC 7 - O. Water temperature sensor - P. Oil pressure/temperature transmitter - Q. Engine speed on flywheel sensor - R. Low oil pressure transmitter.

BLOCK DIAGRAM**Figure 7**

KEYS

116816

1. Engine coolant temperature sensor – 2. Oversupply air pressure temperature sensor – 3. Fuel temperature sensor – 4. Oversupply air pressure sensor – 5. Engine oil pressure and temperature sensor - 6. CAL L-H line – 7. Pump-injectors – 8. Remote control switch for pre/post-heating activation – 9. Pre/post-heating resistance – 10. Main remote control switch – 11. Flywheel sensor – 12. Distribution sensor – 13. Primary / secondary brake switch.

EDC 7 UC3I electronic control unit**Figure 8**

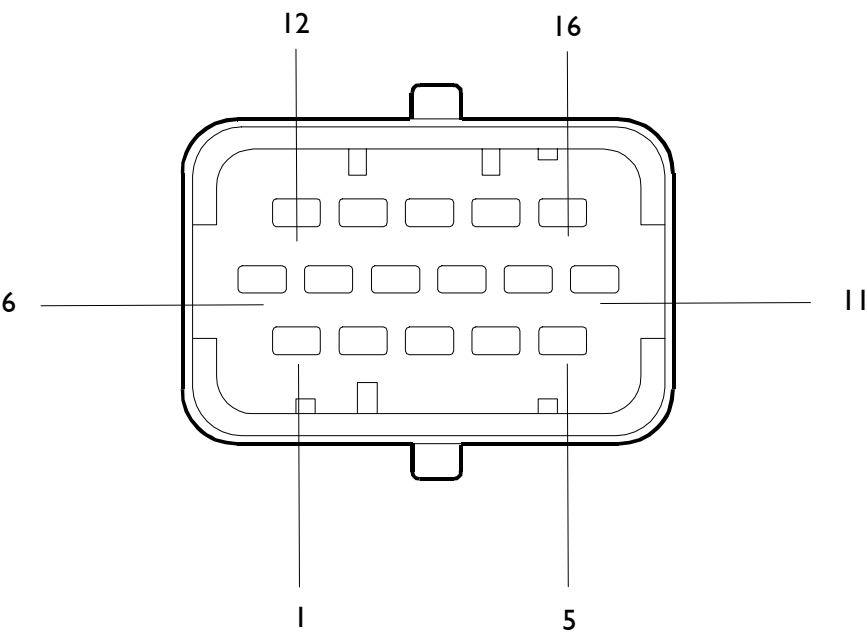
A. Electro-injector connector - B. Chassis connector - C. Sensor connector.

102373

EDC control unit PIN-OUT

Electric injector connector "A"

Figure 9



Colour legend

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

102374

ECU Pin	Colour legend	Function
1	Black	Solenoid valve for electronic cylinder 5 injection
2	Black	Solenoid valve for electronic cylinder 6 injection
3	Black	Solenoid valve for electronic cylinder 4 injection
4	White	Solenoid valve for electronic cylinder 1 injection
5	Green	Solenoid valve for electronic cylinder 3 injection
6	Red	Solenoid valve for electronic cylinder 2 injection
7	-	Free
8	-	Free
9	-	Free
10	-	Free
11	Yellow	Solenoid valve for electronic cylinder 2 injection
12	Red	Solenoid valve for electronic cylinder 3 injection
13	Red	Solenoid valve for electronic cylinder 1 injection
14	Bleu	Solenoid valve for electronic cylinder 4 injection
15	Green	Solenoid valve for electronic cylinder 6 injection
16	Purple	Solenoid valve for electronic cylinder 5 injection

cardiagn.com

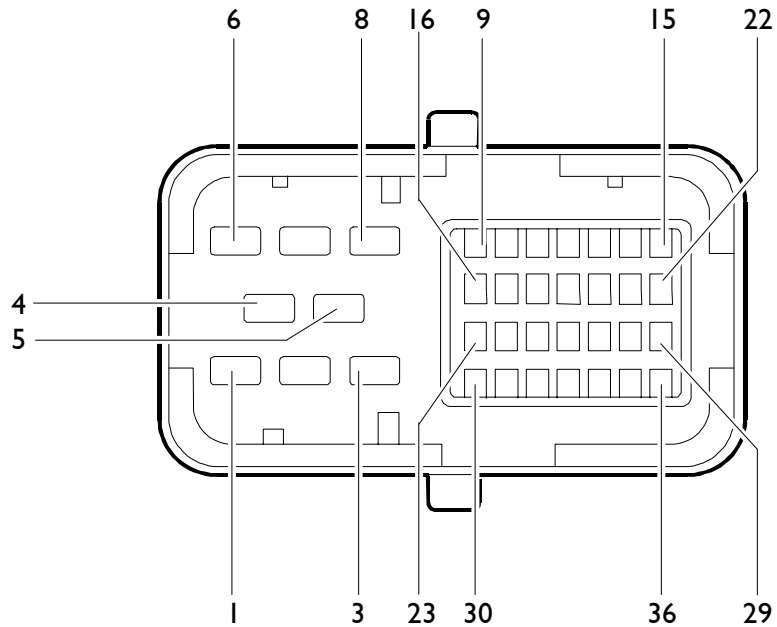
EDC control unit PIN-OUT

Sensor connector "C"

Figure 10

Colour legend

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



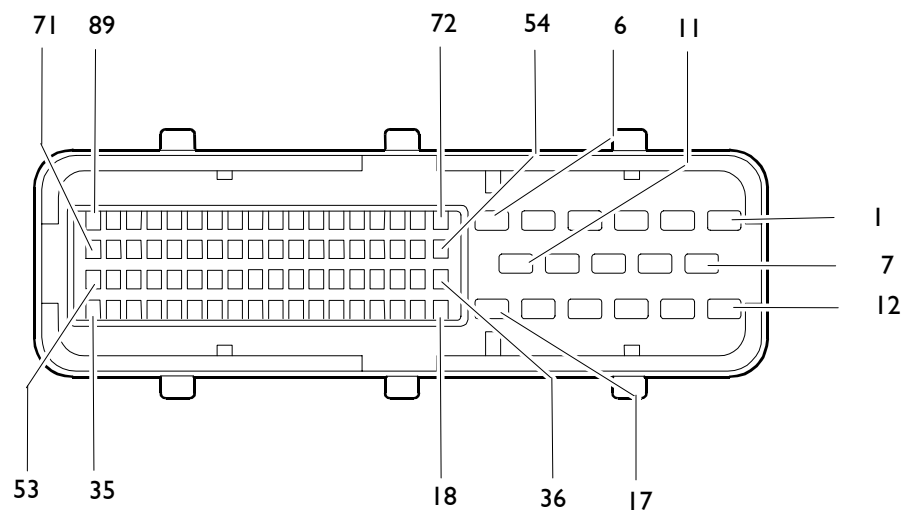
102375

ECU Pin	Cable colour	Function
1÷8	-	Free
9	W	Valve gear camshaft sensor
10	R	Valve gear camshaft sensor
11÷14	-	Free
15	K	Coolant temperature sensor
16÷17	-	Free
18	O/B	Fuel temperature sensor
19	B	Flywheel sensor
20÷22	-	Free
23	W	Flywheel sensor
24	N	Pressure sensor mass / Engine oil temperature
25	W	Air temperature/pressure sensor power supply
26	Y	Coolant temperature sensor
27	O/B	Oil temperature signal from the engine oil temperature/pressure sensor
28	U	Oil pressure signal from the engine oil temperature/pressure sensor
29÷31	-	Free
32	O	Engine oil temperature/pressure sensor power supply
33	R	Air temperature/pressure sensor power supply
34	G	Air pressure signal from the air temperature/ pressure sensor
35	W/R	Fuel temperature sensor
36	O	Air temperature signal from the air temperature / pressure sensor

EDC control unit PIN-OUT

Chassis connector "B"

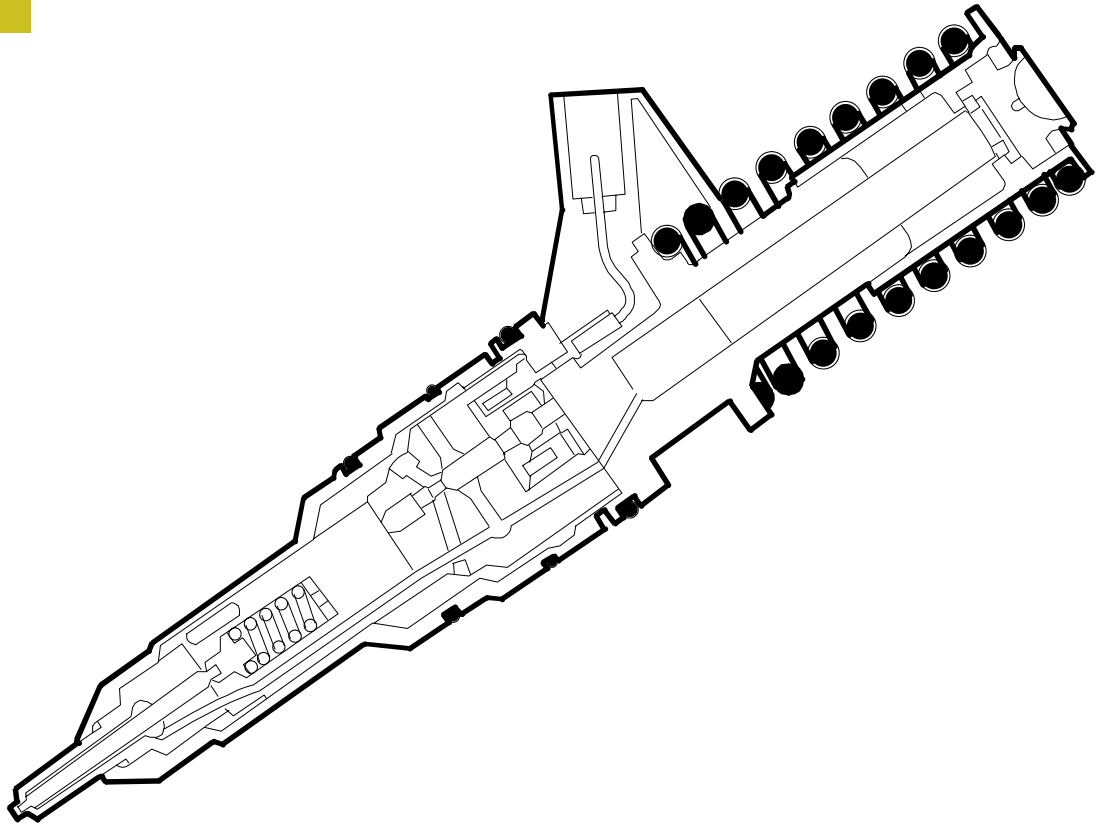
Figure 11



ECU Pin	Cable	Function
1	-	Free
2	7151	+30 positive
3	7153	+30 positive
4	-	Free
5	0151	Ground
6	0151	Ground
7	-	Free
8	7151	+30 positive
9	7151	+30 positive
10	0151	Ground
11	0151	Ground
12	0094	Preheating actuation enable relay ground
13÷25	-	Free
26	-	Free
27	-	Free
28	-	Free
29	5163	EDC system diagnosis inducing switch power supply (presetting)
30	-	Free
31	-	Free
32	-	Free
33	-	Free
34	Green	CAN - L line (ECB)
35	White	CAN - H line (ECB)
36÷39	-	-
40	-	+15 positive
41	-	Free
42	-	Signal for the sensor of water in the diesel
43÷55	-	Free
56	-	Free
57	-	Free
58÷67	-	Free
68	-	Free
69÷74	-	-
75	9164	Preheating actuation enable relay positive
76÷88	-	Free
89	2298	EDC control unit diagnosis K line

INJECTOR PUMP

Figure 12

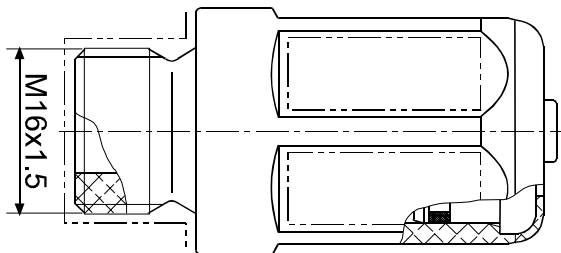


N3.I INJECTOR SECTION

102405

The new N 3.I pump injectors are capable, thanks to the higher injection pressure, of atomizing the fuel in the combustion chamber to a greater extent, thus improving combustion and therefore reducing the polluting exhaust emissions.

Figure 13



102606

FUEL PRESSURE DAMPER

The fuel pressure damper situated on the discharge line between the fuel filter and the cylinder head, has the function of buffering against the return pressure on the discharge line and on the filter due to the increase of the injection pressure.

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.

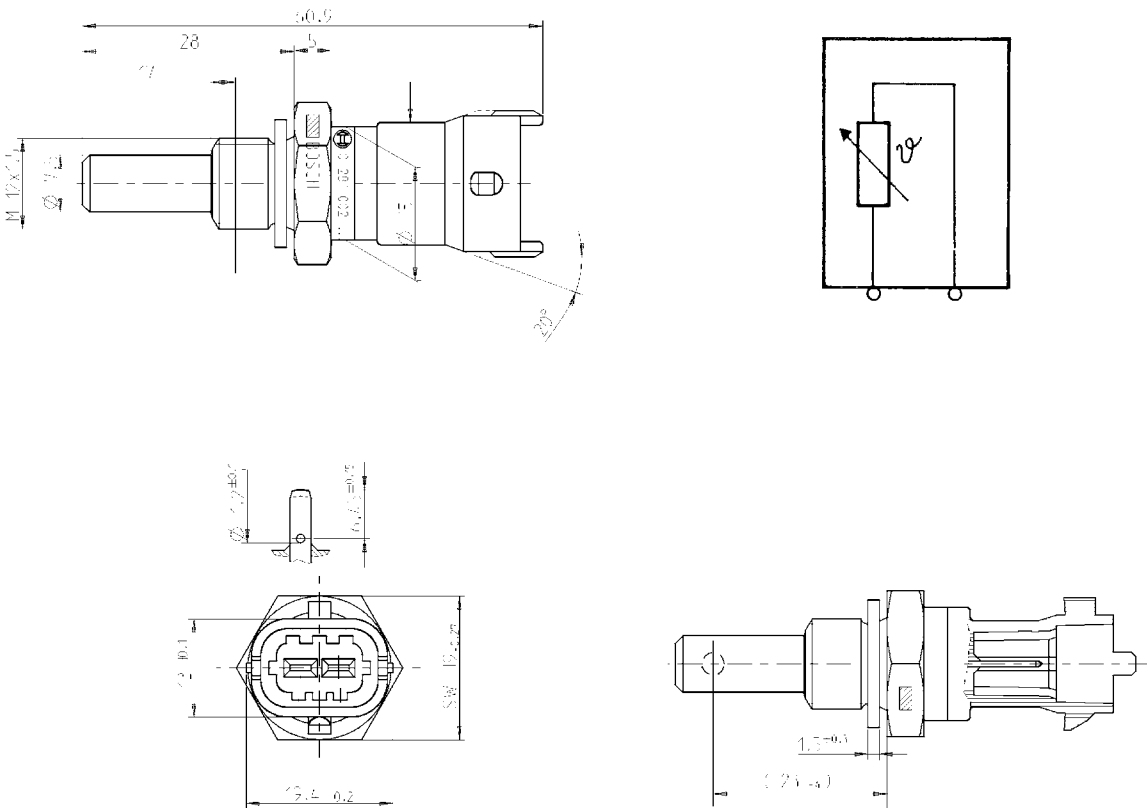
It is connected to electronic center pins 15/26.

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 14



Description	Cable colour
To EDC center pin 15 (Sensor connector "C")	K
To EDC center pin 26 (Sensor connector "C")	Y

Fuel temperature sensor

Specifications

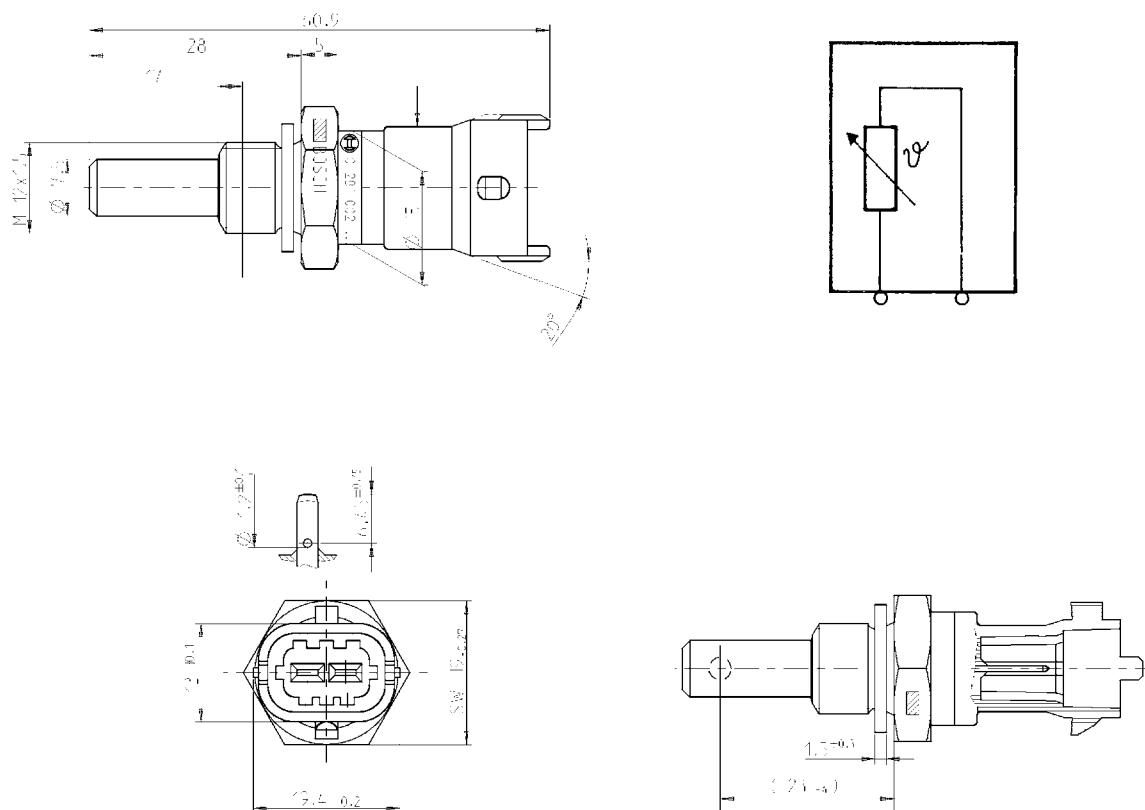
Supplier

Max. tightening torque

BOSCH

35 Nm

Figure 15



104267

Description	Cable colour
To pin 18 of EDC control unit (Sensor connector "C")	O/B
To pin 35 of EDC control unit (Sensor connector "C")	W/R

Flywheel pulse transmitter

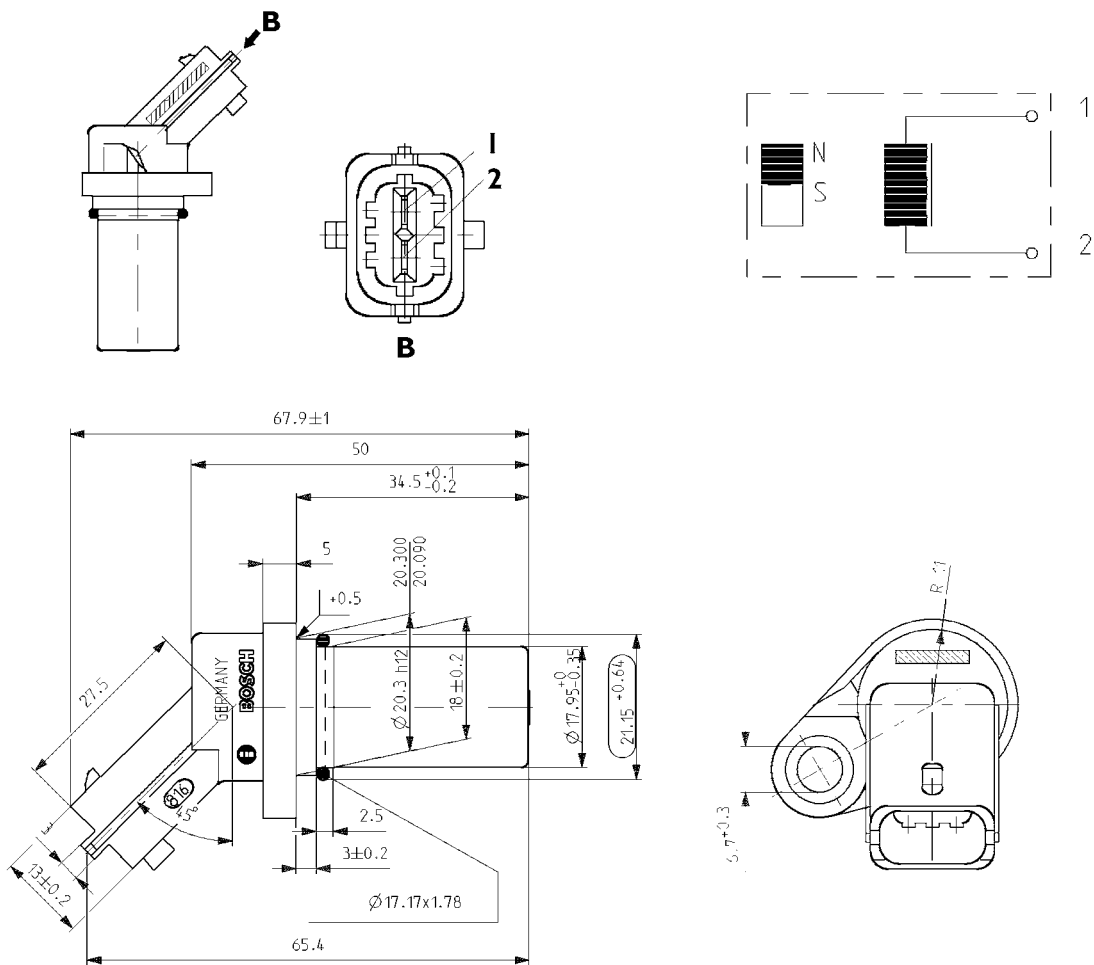
Specifications

Supplier

Max. tightening torque

BOSCH
8 ± 2 Nm

Figure I 6



104269

Description	Cable colour
To pin 19 of EDC control unit (Sensor connector "C")	B
To pin 23 of EDC control unit (Sensor connector "C")	W

Distribution pulse transmitter

Features

Vendor

BOSCH

Torque

$8 \pm 2 \text{ Nm}$

Resistance

$880 \div 920 \Omega$

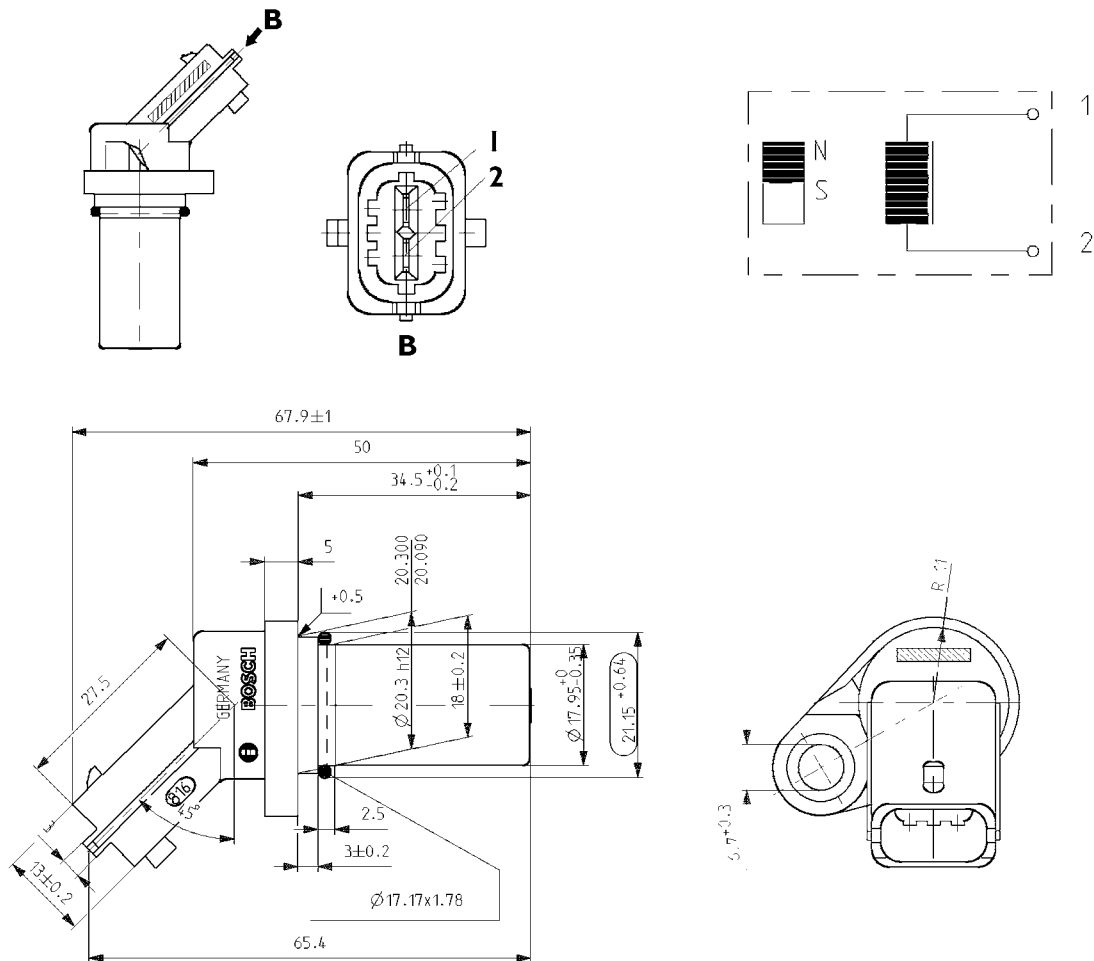
This induction type sensor located on the camshaft generates signals obtained from the magnetic flow lines that close through the 6 plus 1 phase teeth of a sound wheel mounted on the shaft.

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.

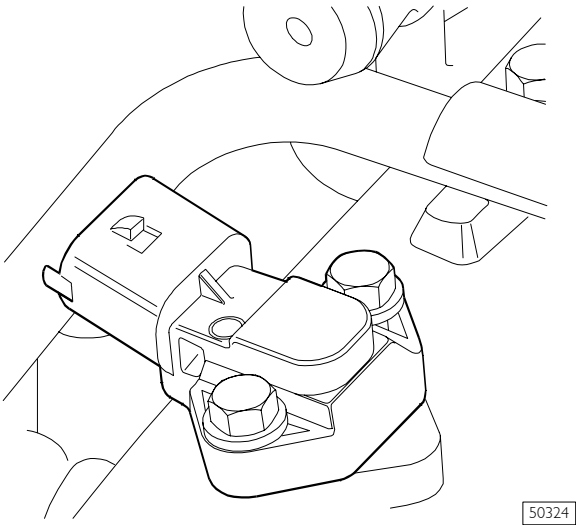
Figure 17



104269

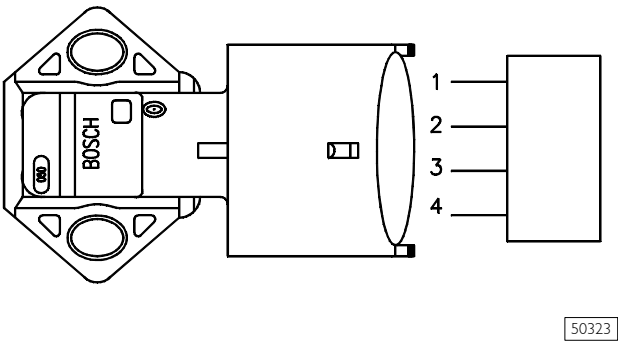
Description	Cable colour
To EDC center pin 9 (Sensor connector "C")	W
To EDC center pin 10 (Sensor connector "C")	R

Figure 18



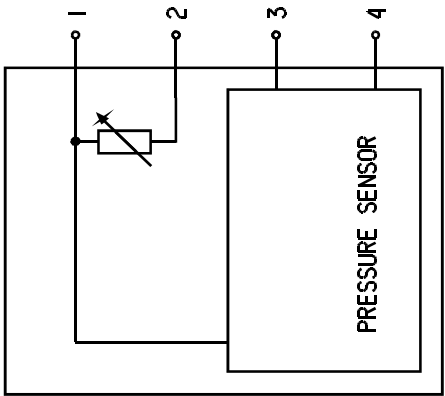
Sensor external view

Figure 19



Linking connector

Figure 20



Wiring diagram

Air pressure/temperature sensor (85156).

This component incorporates a temperature sensor and a pressure sensor.

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

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

The sensor is powered with 5 V.

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

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

Oil temperature/pressure sensor (42030 / 47032)

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

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

It measures the engine oil temperature and pressure.

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

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

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

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

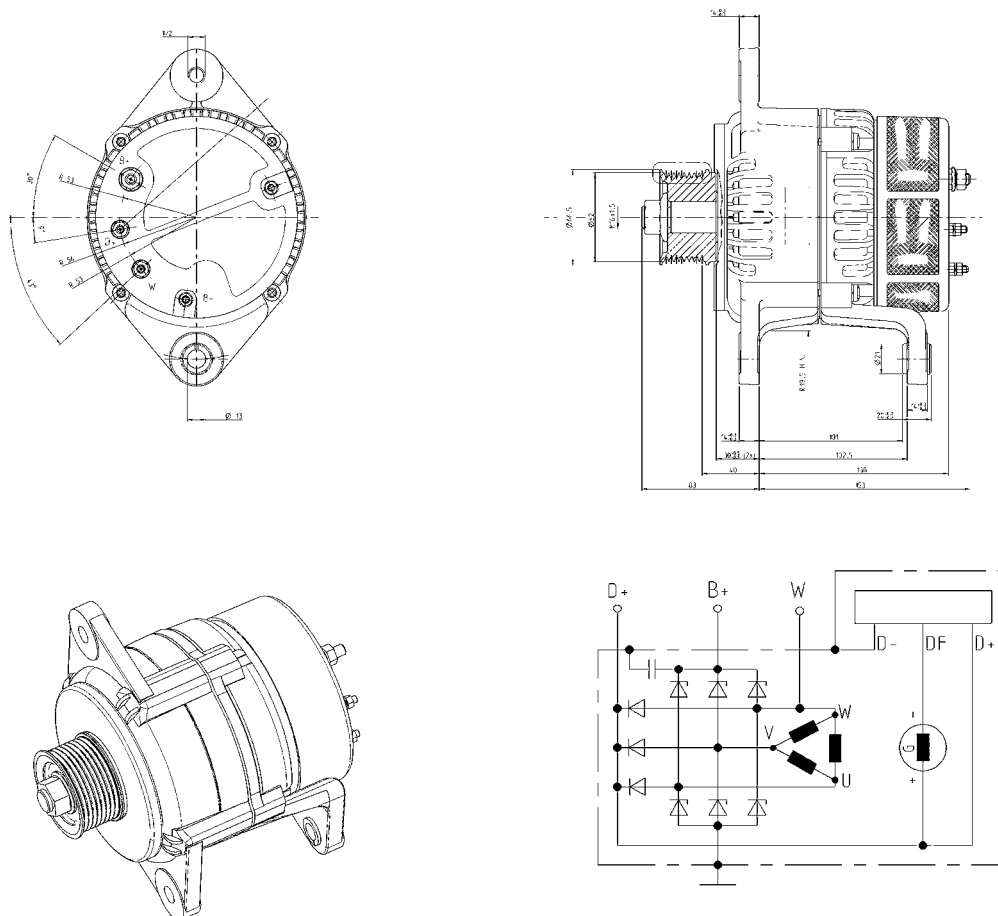
Alternator (For types: F3BE0684H*E90I - F3BE0684G*E90I)

Supplier

Technical features

ISKRA
14V - 175A

Figure 21



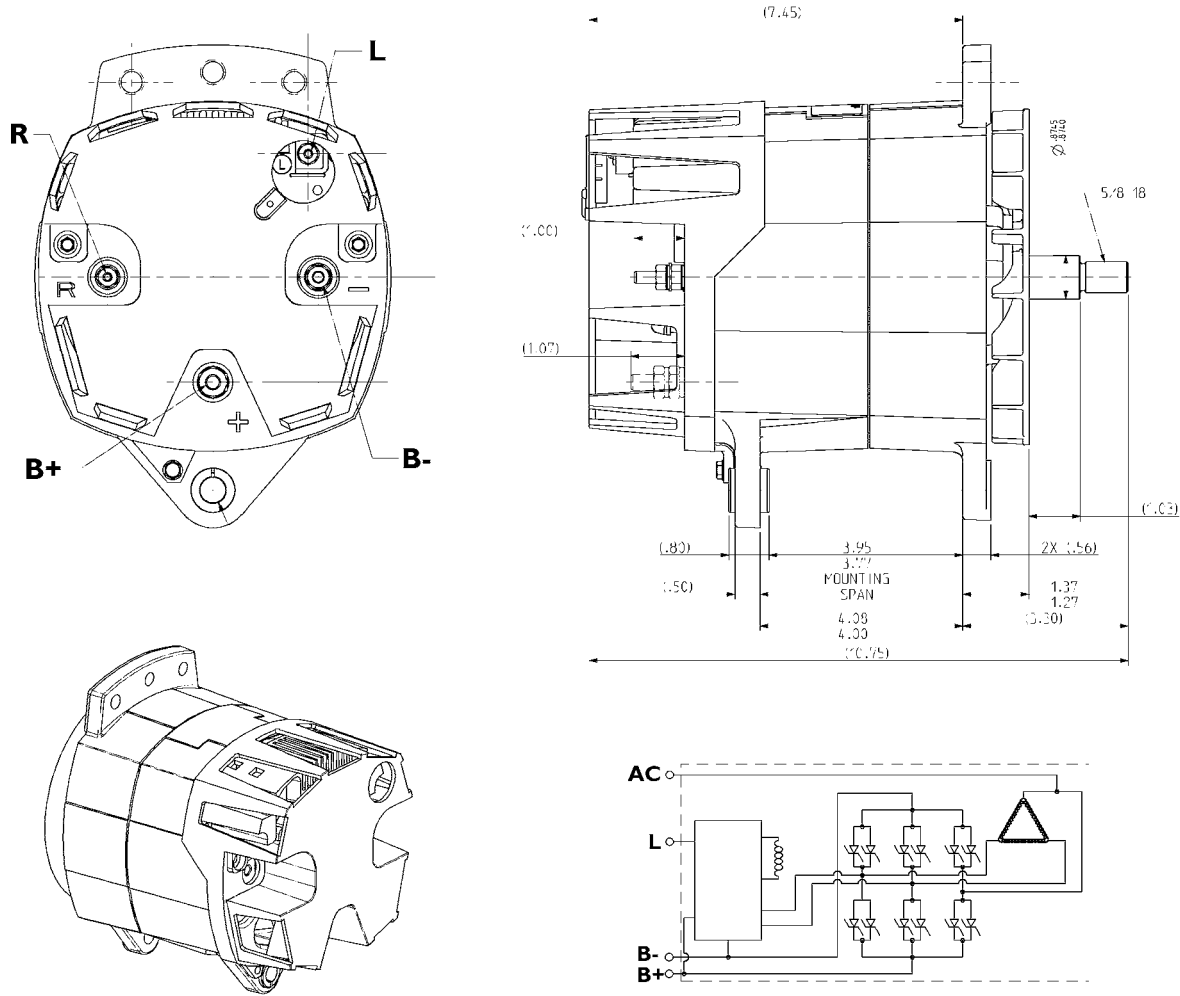
104313

Alternator (For type: F3BE0684J)*E902)

Supplier
Technical features

LEECE NEVILLE
12V - 185A

Figure 22



104314

Pin	Description
R	AC Connector
L	Driver warning light connector
B-	Negative
B+	Positive

Alternator (For types: F3BE9687A*E00I - F3BE9687B*E00I - F3BE9687C*E00I)

Supplier
Technical features

MITSUBISHI
24V - 90A

Figure 23

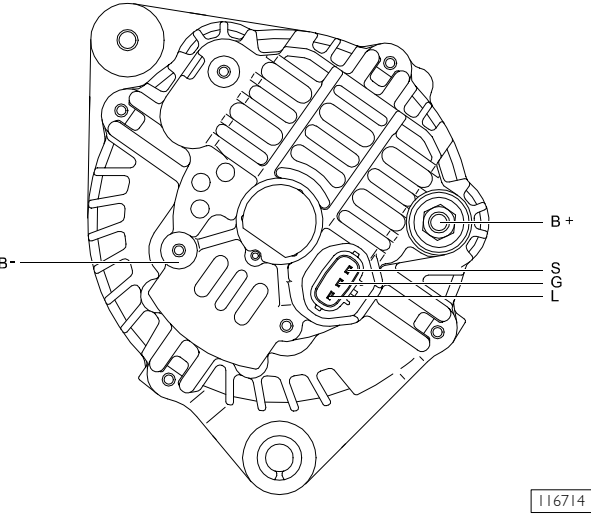


Figure 25

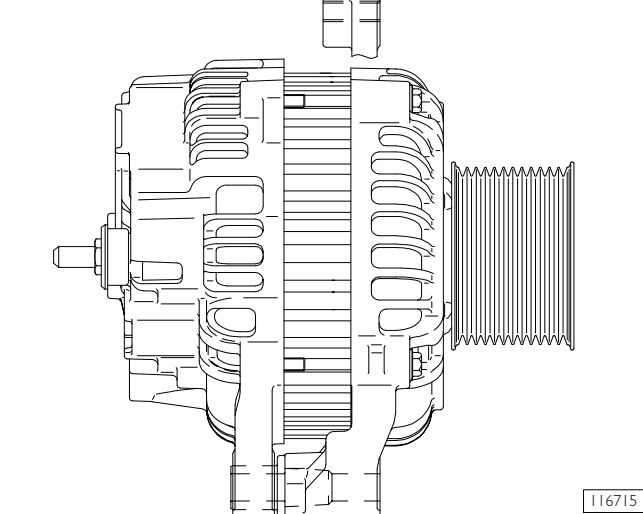


Figure 24

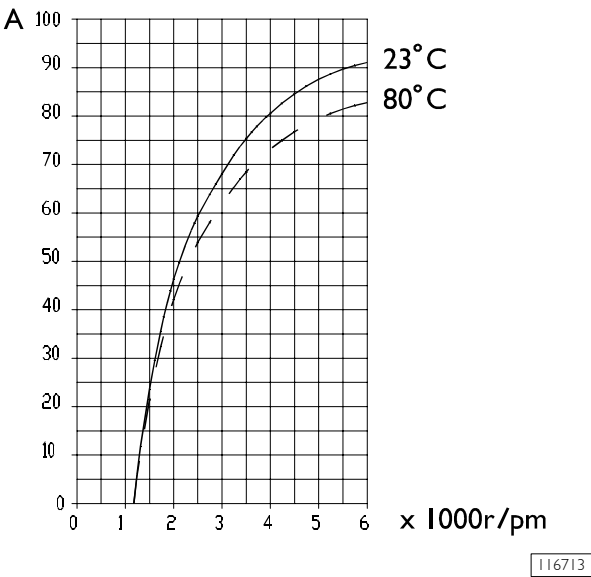
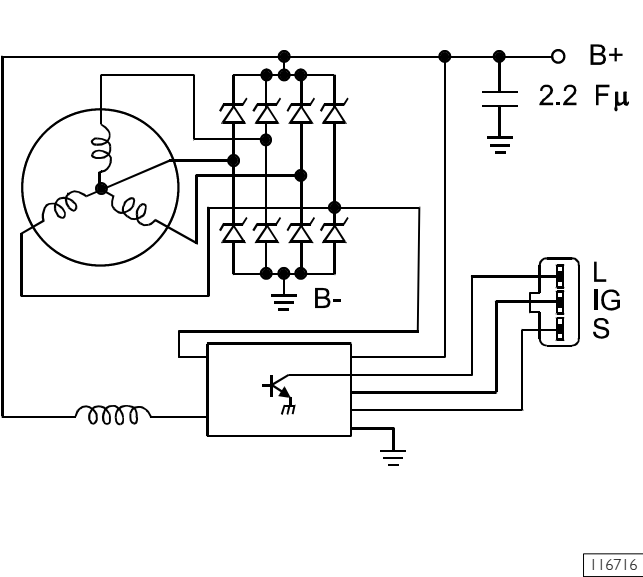


Figure 26



Pin	Description
S	+ 30
L	Battery recharge light
B-	Negative
B+	Positive
IG	+ 15

Starting motor

Specifications

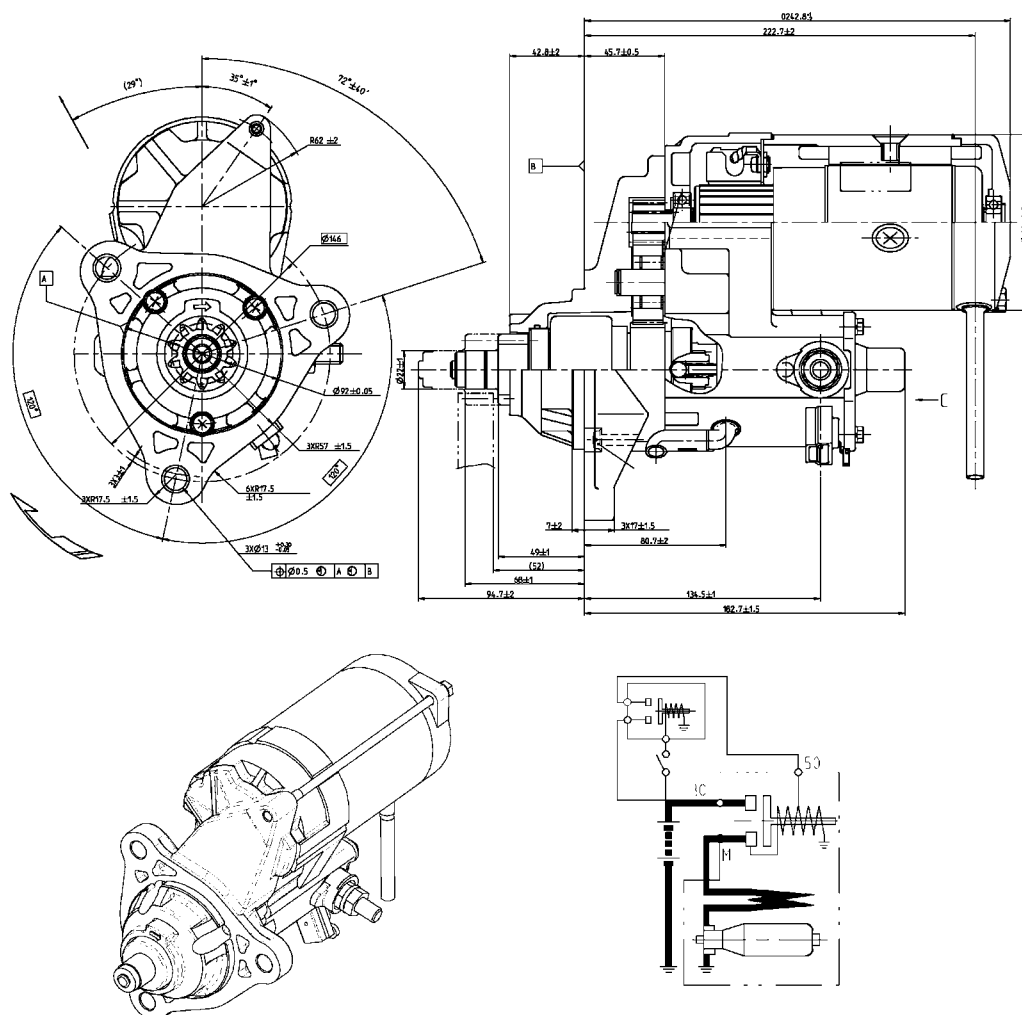
Supplier

Type

Electrical system

Nominal output

DENSO
2280007550
24 Volt
5.5 Kw

Figure 27

104315

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.

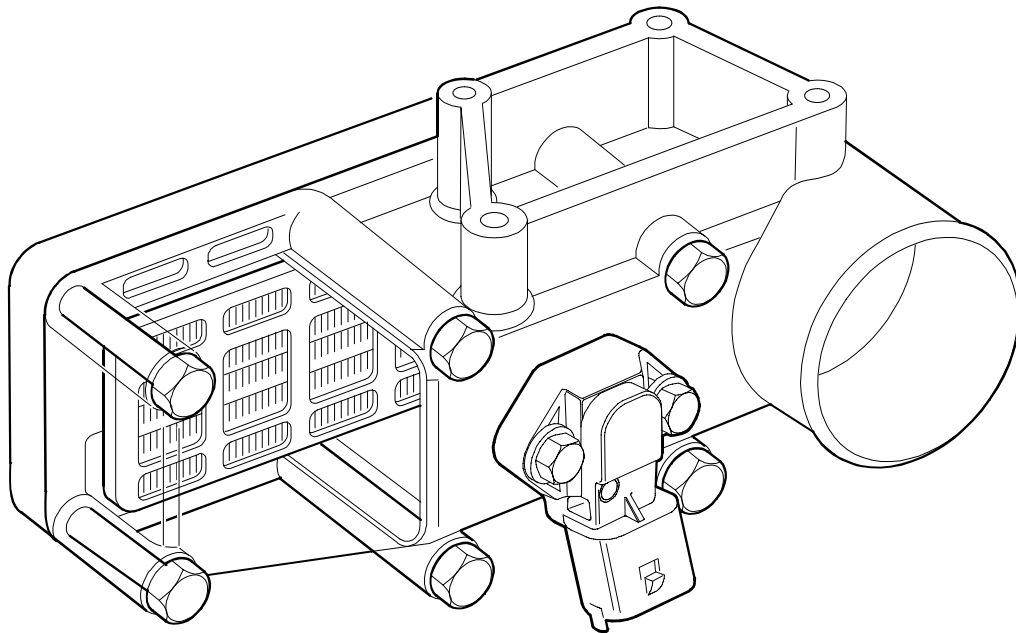
When the engine is running the warning light goes off, while the resistance is being fed for a certain time as a result of post-heating.

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.

NOTE The figure shows the intake manifold of the engine F3BE0684J*E902 but the theory of operation shown also applies to the other engines.

Figure 28



104270

EDC SYSTEM FUNCTIONS

The EDC 7 UC3 I electronic center manages the following main functions:

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

It also enables:

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

Fuel dosing

Fuel dosing is calculated based on:

- accelerator pedal position
- engine rpm
- quantity of air admitted.

The result can be corrected based on:

- water temperature

or to prevent:

- noise
- fumes
- overloads
- overheating

Pressure can be adjusted in case of:

- engine brake actuation
- external device actuation (e.g. speed reducer, cruise control)
- serious defects involving load reduction or engine stop.

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

Delivery correction based on water temperature

When cold, the engine encounters greater operating resistance, mechanical friction is high, oil is 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, namely, accelerator position, engine rpm and air admitted. Lead is corrected as required:

- during acceleration
- according to water temperature

and to obtain:

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

High injection lead is set at start, based on water temperature.

Delivery start feedback is given by injection electro valve impedance variation.

Engine start

Cylinder I 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

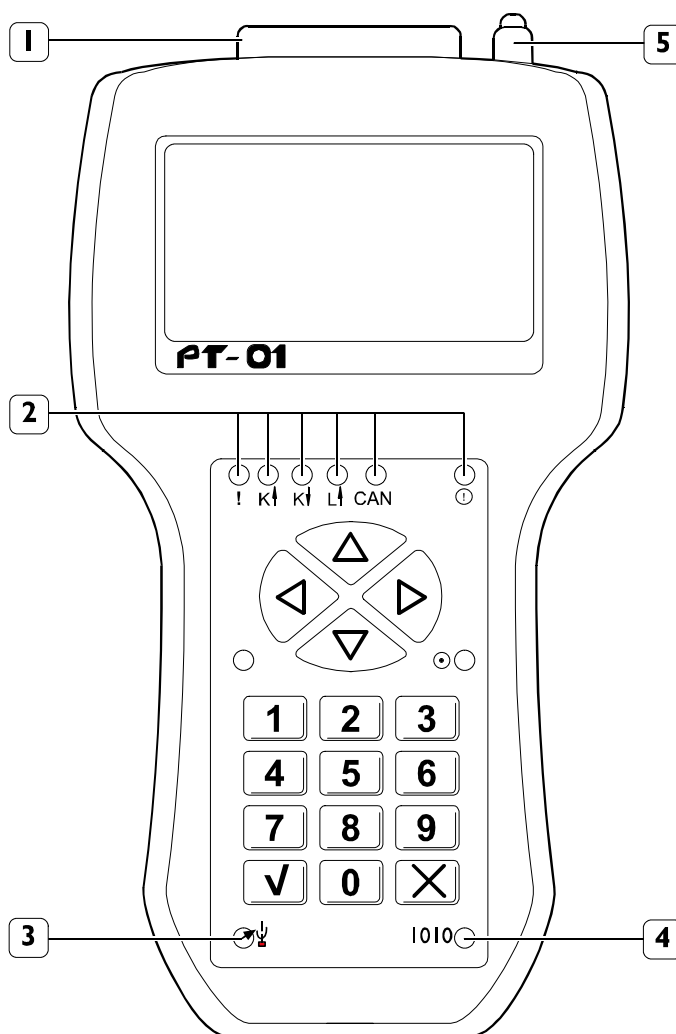
METHODS OF DIAGNOSIS

The available diagnosis systems are currently:

- ☐ BLINK CODE
- ☐ PT-01
- ☐ SYMPTOMS

PT-01

Figure 1



1. Connector with diagnosis outlet - 2. LED signalling communication between the instrument - control unit and correct power supply - 3. USB indicator light - 4. Serial port indicator light - 5. Power supply connector (power only to update SW with serial port).

117696

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.

PT-01 PORTABLE TESTER

Using PT-01 with portable tester it is possible to execute troubleshooting and test the EDC7 electronic module of NEF engines.

PT-01 has been designed and developed to ensure stoutness and practicality and is particularly suitable to be used in workshop and industrial environment.

The tool is connected to the engine gearbox by means of one only cable providing both tester feed and communication with the electronic module.

Main functions

NOTE Before connecting the tester to the electronic module, check the wording on the electronic module to select the correct software on the tool.

I	2	3	4	5	6	7	8	.	A	B	C
u	m	m	k	a	a	*	*	.	v	a	0

a	a	software 3.3_1
a	b	software 4.1_2

Easy access to different functions is available through the menu:

- ID. Reading of the electronic module;
- Reading of failure memory and relevant environment conditions;
- Failure memory clear;
- Reading of working parameters;
- Reading of status parameters;
- Active troubleshooting (switching on heat starter, fuel pump, EDC warning led and so on)

Test parameters

- Engine revolutions;
- Spark advance;
- Battery voltage;
- Accelerator foot pedal position;
- Over voltage pressure;
- Over voltage air temperature;
- Cooling liquid temperature;
- Fuel temperature;
- Oil temperature;
- Oil pressure;
- Fuel delivery;
- Fuel pressure;
- Rail pressure duty cycle electro-valve.

FAILURE CODES

DTC	Component failure
Vehicle 1 (Sensors/ Plausibility checks)	
I.1.9	PLAUSIBILITY +15
I.1.A	PLAUSIBILITY +50
Vehicle 2 (Warning signals / Relays / Actuators)	
I.2.5	MAIN RELAY
I.2.6	BATTERY VOLTAGE
I.2.8	MAIN RELAY - BATTERY SHORTED
I.2.9	AIR CONDITIONER COMPRESSOR RELAY
I.2.B	RELAY OF THERMOSTARTER 1 (HEATER)
I.2.E	PRE-POST HEATING CONTROL SYSTEM (ENABLED)
2.2.5	OVERRUN INTERRUPTED
2.2.8	MAIN RELAY - EARTH SHORT CIRCUIT
Engine 1 (Temperature and pressure sensors)	
I.3.1	COOLANT TEMPERATURE SENSOR
I.3.2	COOLANT TEMPERATURE SENSOR (TEST)
I.3.3	AIR TEMPERATURE SENSOR SUPERCHARGE
I.3.4	AIR PRESSURE SENSOR SUPERCHARGE
I.3.5	FUEL TEMPERATURE SENSOR
I.3.8	OIL PRESSURE SENSOR
I.3.A	OIL TEMPERATURE
2.3.2	ABSOLUTE TEST OF COOLANT TEMPERATURE SENSOR
2.3.8	LOW OIL PRESSURE
2.3.A	OIL TEMPERATURE TOO HIGH
Engine 2 (Speed sensors / actuators)	
I.4.1	ENGINE SHAFT REV SENSOR
I.4.2	ENGINE RUNNING ONLY WITH CAMSHAFT SENSOR
I.4.3	CAMSHAFT SENSOR
I.4.4	PLAUSIBILITY BETWEEN FLYWHEEL SENSOR AND CAMSHAFT
Damage information	
I.4.D	ENGINE OVERRUN
3.9.E	TURBO PROTECTION TORQUE LIMITATION
4.9.E	ENGINE PROTECTION TORQUE LIMITATION
6.9.E	TORQUE LIMITATION DUE TO LIMITED QUANTITY INJECTED
Fuel metering	
I.5.1	CYLINDER INJECTOR 1
I.5.2	CYLINDER INJECTOR 2
I.5.3	CYLINDER INJECTOR 3
I.5.4	CYLINDER INJECTOR 4
I.5.5	CYLINDER INJECTOR 5
I.5.6	CYLINDER INJECTOR 6

DTC	Component failure
Injectors 1	
I.6.1	CYLINDER INJECTOR 1 / SHORT CIRCUIT
I.6.2	CYLINDER INJECTOR 2 / SHORT CIRCUIT
I.6.3	CYLINDER INJECTOR 3 / SHORT CIRCUIT
I.6.4	CYLINDER INJECTOR 4 / SHORT CIRCUIT
I.6.5	CYLINDER INJECTOR 5 / SHORT CIRCUIT
I.6.6	CYLINDER INJECTOR 6 / SHORT CIRCUIT
I.6.7	CYLINDER INJECTOR 1 / OPEN CIRCUIT
I.6.8	CYLINDER INJECTOR 2 / OPEN CIRCUIT
I.6.9	CYLINDER INJECTOR 3 / OPEN CIRCUIT
I.6.A	CYLINDER INJECTOR 4 / OPEN CIRCUIT
I.6.B	CYLINDER INJECTOR 5 / OPEN CIRCUIT
I.6.C	CYLINDER INJECTOR 6 / OPEN CIRCUIT
I.6.E	THE LEAST NUMBER OF INJECTIONS HAS NOT BEEN REACHED : ENGINE SHUT DOWN
Injectors 2	
I.7.1	BENCH 1 CC
I.7.3	BENCH 2 CC
I.7.C	BENCH 1 INJECTOR CHECK (IN CONTROL UNIT)
I.7.F	INJECTED QUANTITY EVALUATION ERROR (NIMA PROGRAM)
2.7.C	BENCH 2 INJECTOR CHECK (IN CONTROL UNIT)
Supercharging system and turbine speed	
I.9.E	TORQUE RESTRICTION FOR SMOKE LIMITATION
Interfaces 1 (CAN-Bus)	
I.B.1	ERROR ON CAN CONTROLLER A
I.B.3	ERROR ON CAN CONTROLLER C
I.B.5	TIMEOUT CAN MESSAGE VM2EDC
2.B.4	TIMEOUT CAN MESSAGE BC2EDC2
Interface 2 (Can line timeout messages)	
I.C.6	MESSAGE CAN TSCI -PE ERROR
I.C.8	MESSAGE CAN TSCI -VE ERROR
2.C.6	MESSAGE CAN TSCI -VE ERROR
3.C.8	MESSAGE CAN TSCI -VE (passive) ERROR
ECU 1 (internal checks)	
I.D.1	CONTROL UNIT INTERNAL ERROR
I.D.2	CONTROL UNIT INTERNAL ERROR
I.D.3	CONTROL UNIT INTERNAL ERROR
I.D.4	CONTROL UNIT INTERNAL ERROR
I.D.5	CONTROL UNIT INTERNAL ERROR
I.D.6	CONTROL UNIT INTERNAL ERROR (TPU)
I.D.7	CONTROL UNIT INTERNAL ERROR (VARIANT AREA)
I.D.8	CONTROL UNIT INTERNAL ERROR
I.D.9	CONTROL UNIT INTERNAL ERROR
2.D.3	CONTROL UNIT INTERNAL ERROR
3.D.3	CONTROL UNIT INTERNAL ERROR

DTC	Component failure
ECU 2 (Supplier/ Immobilizer /Runaway speed / Sensor supply)	
I.E.3	CONTROL UNIT INTERNAL MONITORING ERROR
I.E.4	CONTROL UNIT INTERNAL MONITORING ERROR
I.E.5	ERRORE SENSOR SUPPLY (12V)
I.E.6	SENSOR SUPPLY 1
I.E.7	SENSOR SUPPLY 2
I.E.8	SENSOR SUPPLY 3
I.E.9	CONTROL UNIT INTERNAL ERROR
I.E.A	CONTROL UNIT INTERNAL ERROR
I.E.B	ATM. PRESSURE SENSOR

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.	

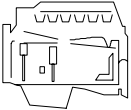
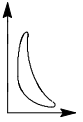
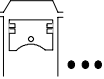
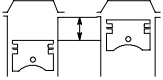
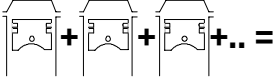
SECTION 4**Overhaul and technical specifications**

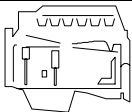
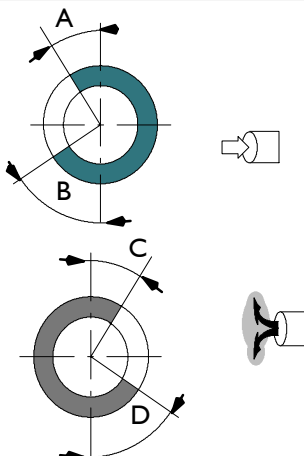
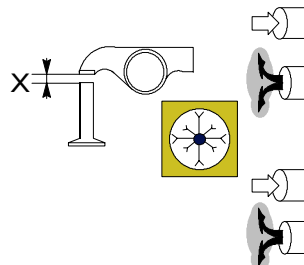
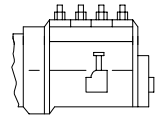
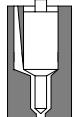
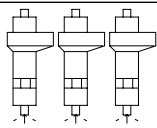
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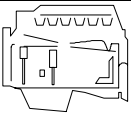
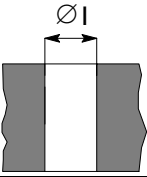
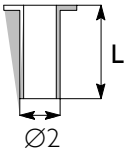
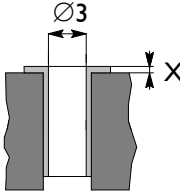
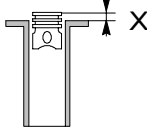
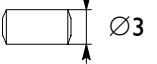
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GENERAL CHARACTERISTICS

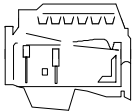
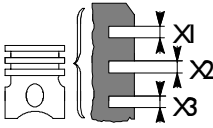
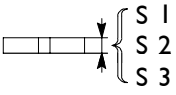
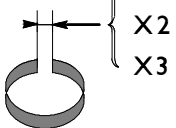
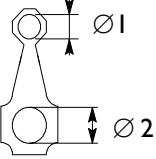
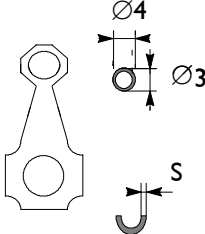
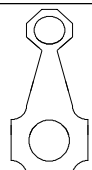
	Type		F3B
	Cycle		4-stroke Diesel engine
	Fuel feed		Turbocharged
	Injection		Direct
	No. of cylinders		6 in line
	Bore	mm	135
	Stroke	mm	150
	Total displacement	cm ³	12880

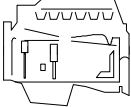
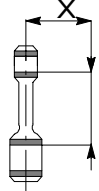
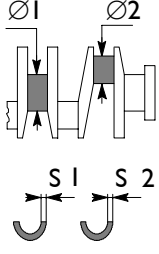
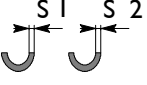
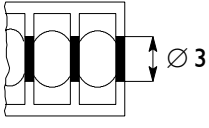
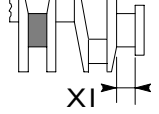
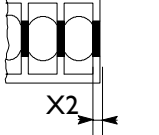
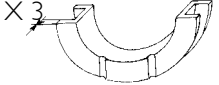
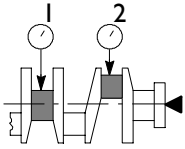
	Type	F3B	
	VALVE TIMING opens before T.D.C. A closes after B.D.C. B opens before B.D.C. D closes after T.D.C. C		17° 30° 50° 9°
	For timing check Running X { mm mm X { mm mm		- - 0.35 to 0.45 0.45 to 0.55
	FEED	Through fuel pump - filters	
	Injection type: Bosch	With electronically regulated injectors UIN3 pump injectors controlled by overhead camshaft	
	Nozzle type	-	
	Injection order	1 - 4 - 2 - 6 - 3 - 5	
	Injection pressure	bar	2000
	Injector calibration	bar	296 ± 6

ASSEMBLY CLEARANCE DATA

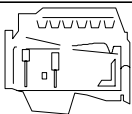
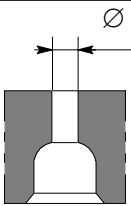
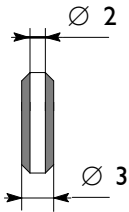
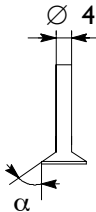
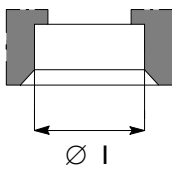
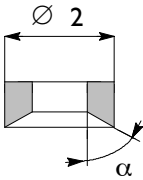
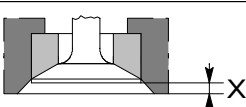
	Type	F3B
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS		mm
	Bores for cylinder liners: upper lower	153.500 to 153.525 152.000 to 152.025
	Cylinder liners: external diameter: length	153.461 to 153.486 151.890 to 151.915 -
	Cylinder liners - crankcase bores upper lower	0.014 to 0.039 0.085 to 0.135
	External diameter	-
	Cylinder sleeve inside diameter inside diameter Protrusion	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	18 134.861 to 134.873 134.872 to 134.884 54.010 to 54.018
	Piston - cylinder sleeve A* B*	0.127 to 0.151 0.127 to 0.151
	Piston diameter	-
	Pistons protrusion	0.12 to 0.42
	Gudgeon pin	53.994 to 54.000
	Gudgeon pin - pin housing	0.010 to 0.024

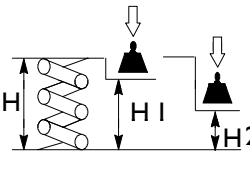
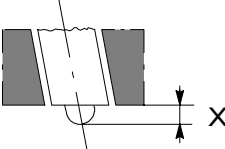
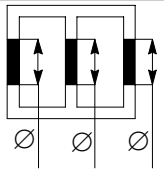
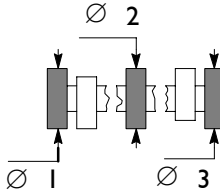
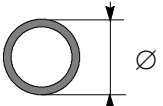
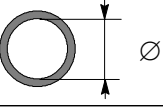
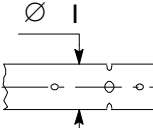
- Class A pistons supplied as spares.
- Class B pistons are fitted in production only and are not supplied as spares.

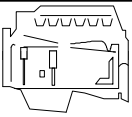
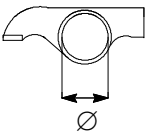
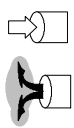
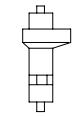
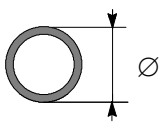
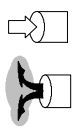
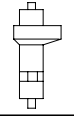
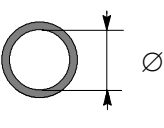
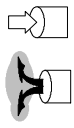
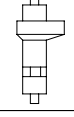
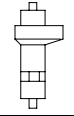
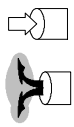
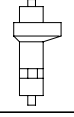
	Type	F3B	
		mm	
	Piston ring grooves	X1	3.100 to 3.120
		X2	1.550 to 1.570
		X3	5.020 to 5.040
	Piston rings: trapezoidal seal	S1*	3.000
	lune seal	S2	1.470 to 1.500
	milled scraper ring with slits and internal spring	S3	4.970 to 4.990
	* measured on Ø of 130 mm		
	Piston rings - grooves	1	0.100 to 0.120
		2	0.050 to 0.100
		3	0.030 to 0.070
	 Piston rings	-	
	Piston ring end gap in cylinder liners	X1	0.40 to 0.50
		X2	0.65 to 0.80
		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	94.000 to 94.010
	- Class		94.011 to 94.020
	- Class		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	
	Class	A	4756 to 4795
		B	4796 to 4835
		C	4836 to 4875

	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
	Yellow*		3.131 to 3.140
	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 0.100
	Bearing shells - big ends		0.050 to 0.090
	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		≤ 0.025
	Ovalization		0.010
	Taper		0.010
		I - 2	

* Fitted in production only and not supplied as spares

		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		 	0.54 to 0.85 1.75 to 2.05
		Between valve seat and head		 	0.040 to 0.090

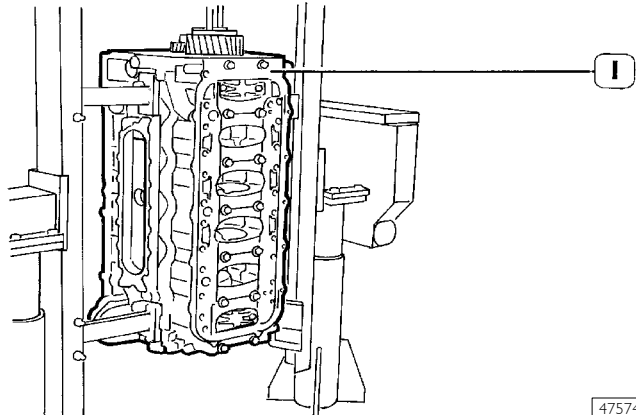
 Type	F3B	
	mm	
 Valve spring height: free height H under a load of: 575 ± 28 N H1 1095 ± 54 N H2		73.40 59 45
 Injector protrusion X	×	0.53 to 1.34
 Camshaft bushing housing in the cylinder head: $l \Rightarrow 7$	Ø	88.000 to 88.030
 Camshaft bearing journals: $l \Rightarrow 7$	Ø	82.950 to 82.968
 Outer diameter of camshaft bushings: Ø	Ø	88.153 to 88.183
 Inner diameter of camshaft bushings: Ø	Ø	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 9.30 11.216
 Rocker shaft	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	
TURBOCHARGER Type End float Radial play	HOLSET HX55 - -	

ENGINE OVERHAUL ENGINE REMOVAL AT THE BENCH

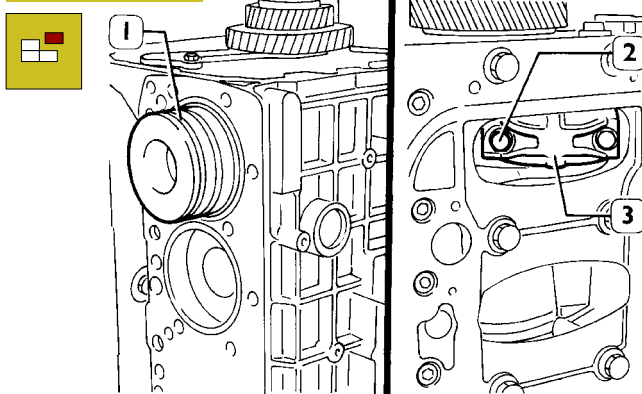
The following instructions are prescribed on the understanding that the engine has previously been placed on the rotating bench and that removal of all specific components of the equipment have been already removed as well. (See Section 3 of the manual herein). The section illustrates therefore all the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

Figure 1



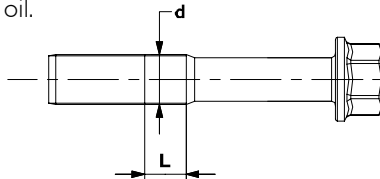
Rotate the block (1) to the vertical position.

Figure 2



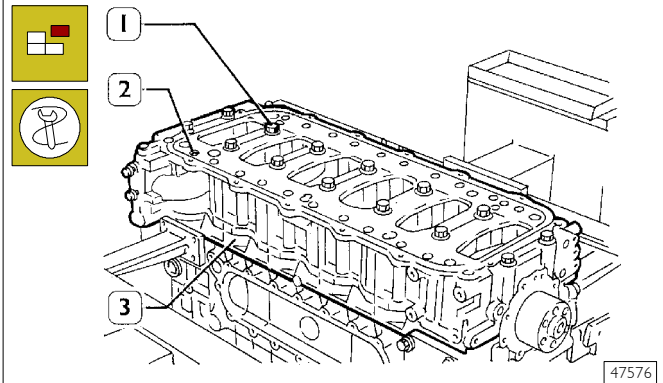
Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston assembly from the upper side. Repeat these operations for the other pistons.

NOTE The screws of the connecting rod wires must be used again up to when the diameter of the threading (d) measured in zone (L) is not less than 13.4 mm. Otherwise replace the screw. Before assembly lubricated screw threading with engine oil.



NOTE Keep the big end bearing shells in their respective housings and/or note down their assembly position since, if reusing them, they will need to be fitted in the position found upon removal.

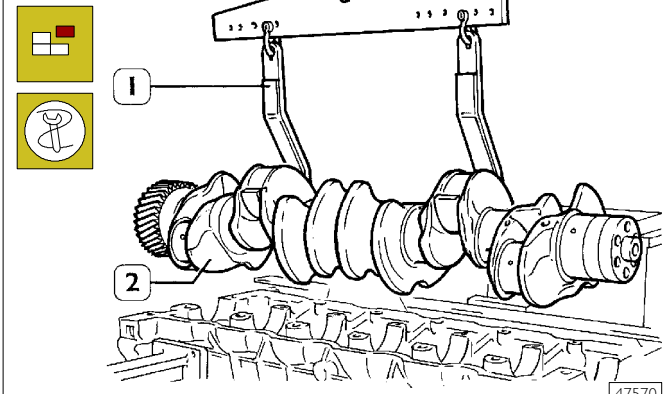
Figure 3



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

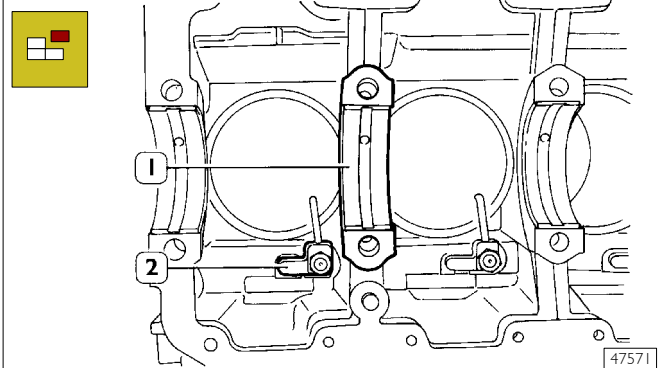
NOTE Note down the assembly position of the top and bottom main bearing shells since, if reusing them, they will need to be fitted in the position found upon removal.

Figure 4



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

Figure 5



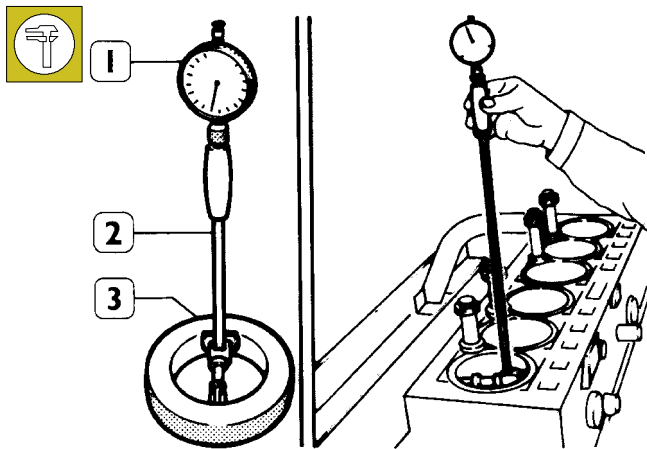
Remove the crankshaft half-bearings (1), untighten the screws and remove oil spray nozzles (2). Take down cylinder liners as specified in the relative paragraph on page 14.

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)

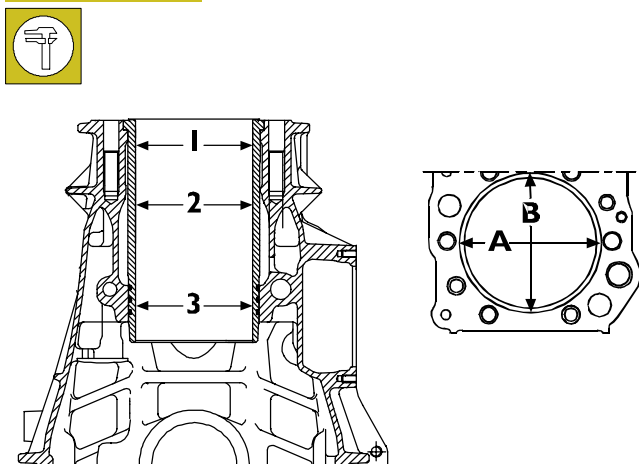


34994

Internal diameter of the cylinder liners is checked for ovalization, taper and wear, using a bore dial (1) centesimal gauge (2) previously reset to ring gauge (3), diameter 135 mm.

NOTE If a 135 mm ring gauge is not available use a micrometer caliper.

Figure 7

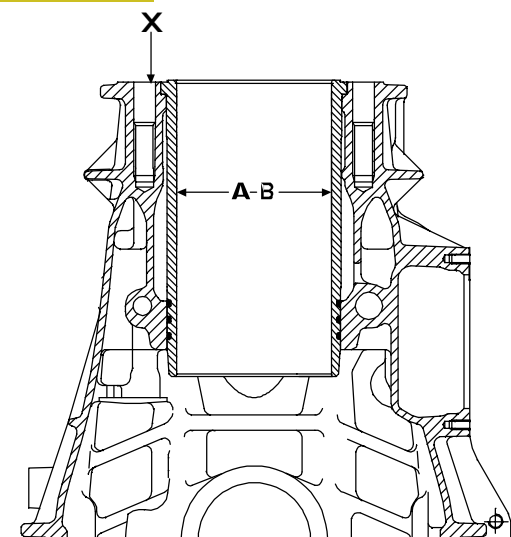


60596

- 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 135.012 mm
- B = Selection class $\varnothing$ 135.011 to 135.023 mm
- X = Selection class marking area

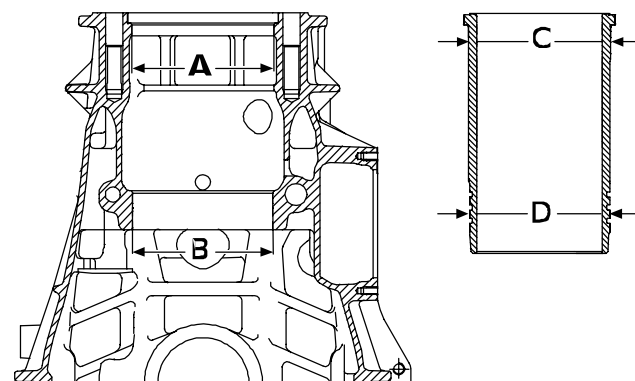
On finding maximum wear greater than 0.150 mm or maximum ovalization of 0.100 mm compared to the values shown in the figure, you need to replace the cylinder liner as no grinding, facing or reconditioning is permitted.

NOTE



The cylinder liners are supplied as spare parts with selection class "A".

Figure 9



60597

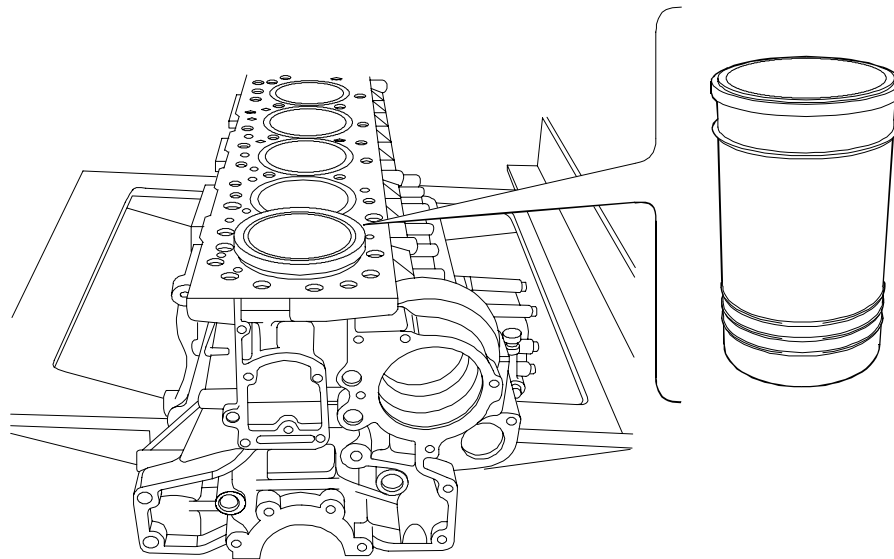
- A = $\varnothing$ 153.500 to 153.525 mm
- B = $\varnothing$ 152.000 to 152.025 mm
- C = $\varnothing$ 153.461 to 153.486 mm
- D = $\varnothing$ 151.890 to 151.915 mm

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

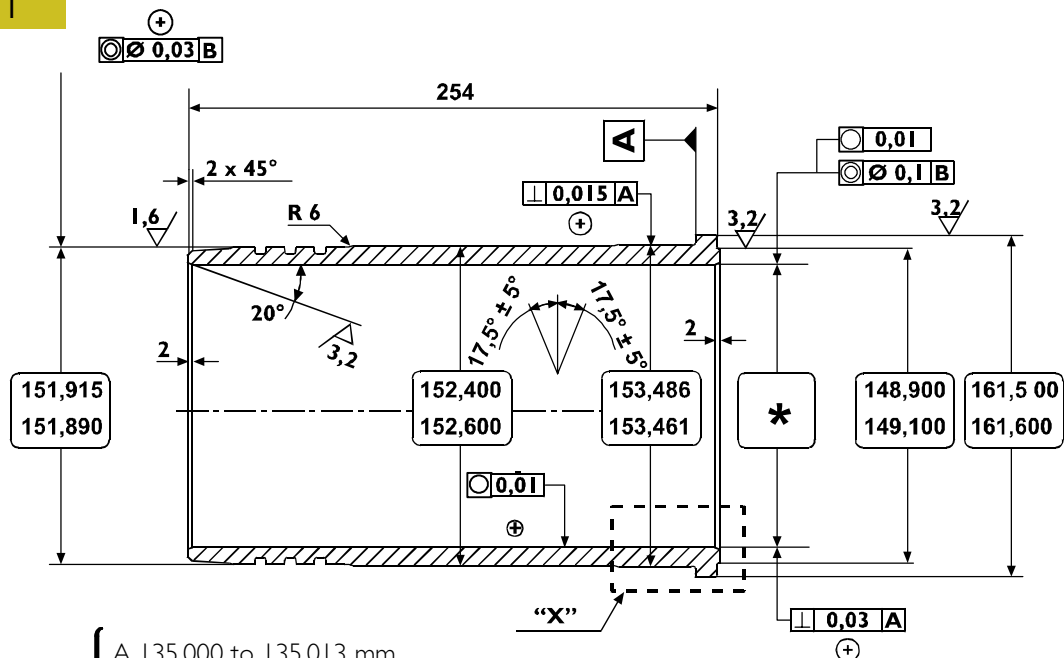
Figure 10



CRANKCASE ASSEMBLY WITH CYLINDER LINERS

60598

Figure 11

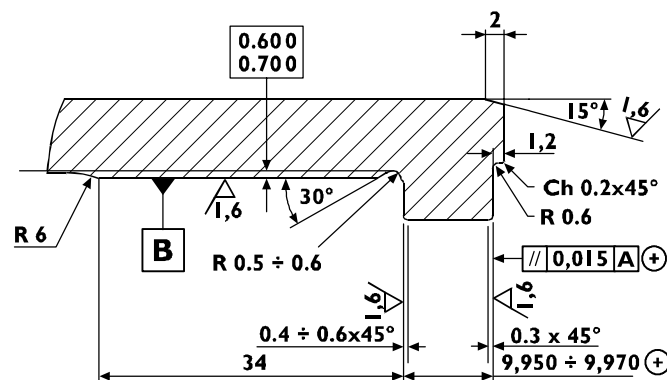


Selection class $\left\{ \begin{array}{l} \text{A } 135.000 \text{ to } 135.013 \text{ mm} \\ \text{B } 135.011 \text{ to } 135.024 \text{ mm} \end{array} \right.$

MAIN CYLINDER LINER DATA

101503

Figure 12



DETAIL "X"

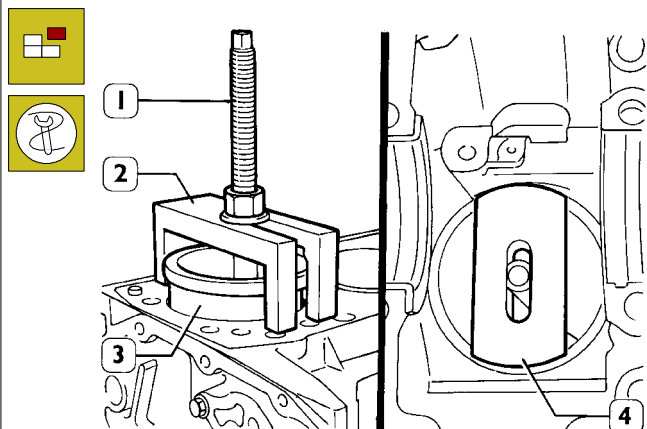
"Y" - Selection class marking area

101502

Replacing cylinder liners

Removal

Figure 13



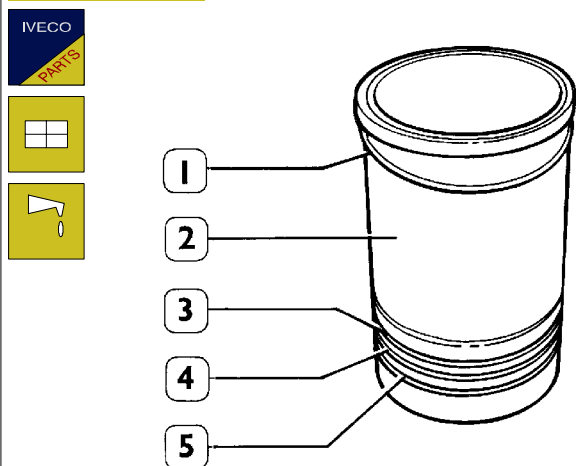
47577

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



16798

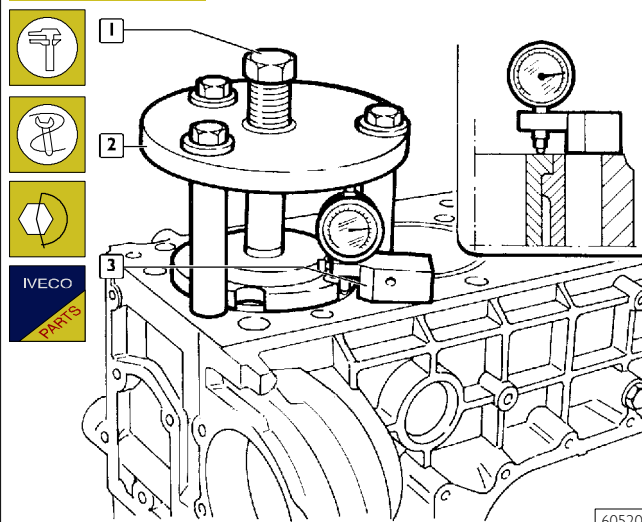
Always replace the water seals (3, 4 and 5).

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

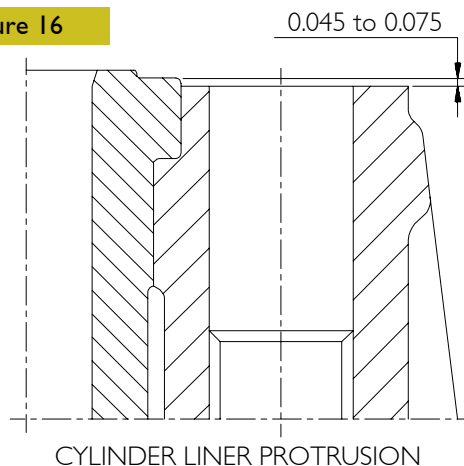


60520

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.

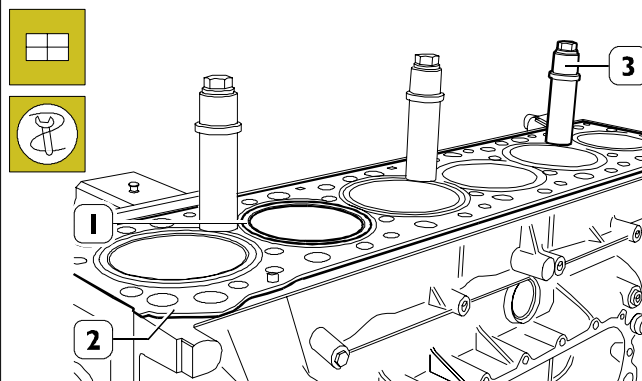
Figure 16



49017

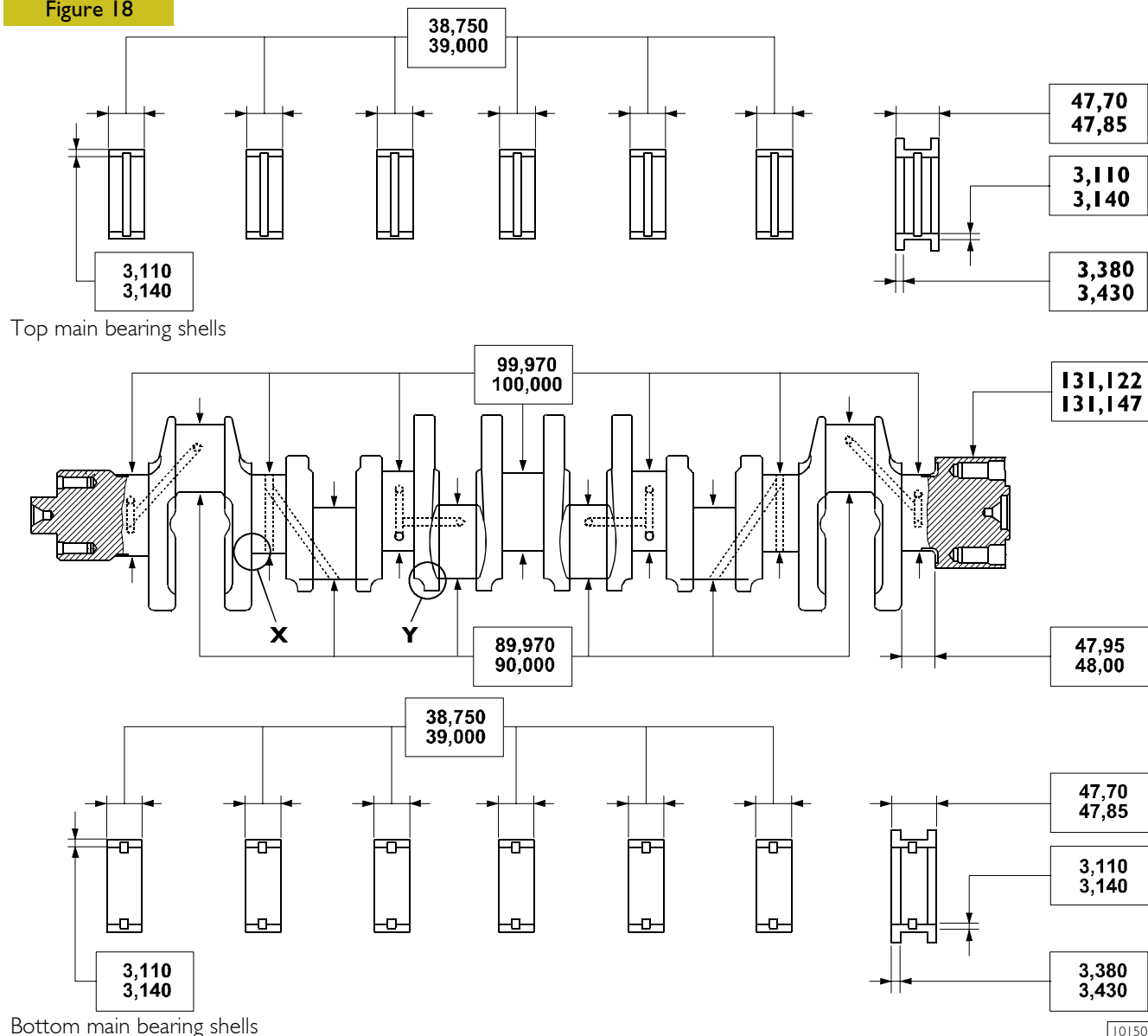
CYLINDER LINER PROTRUSION

Figure 17

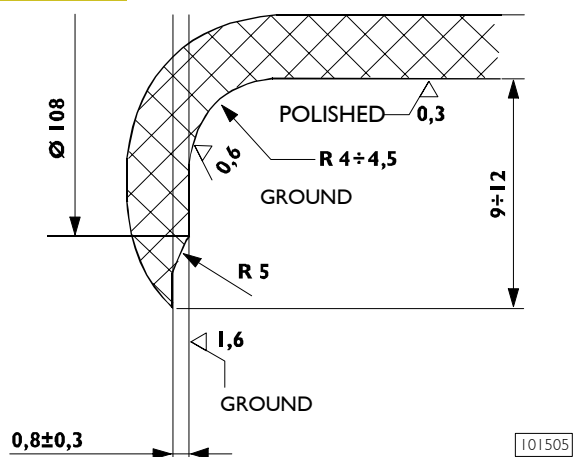
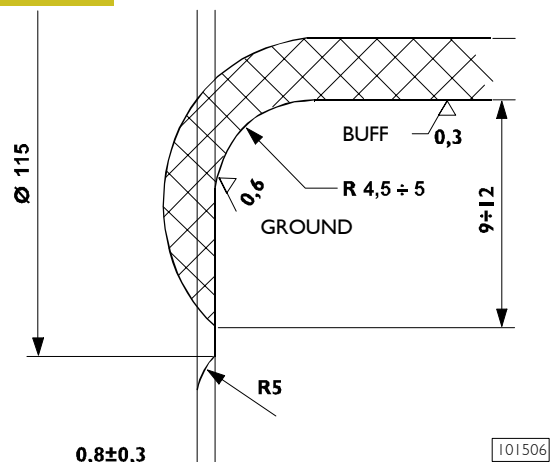


60521

On completing assembly, lock the cylinder liners (1) to the crankcase (2) with the pins 99360703 (3).

Crankshaft**Figure 18****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**X. Detail of the main journal unions****Figure 20****Y. Detail of the crankpin unions**

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.

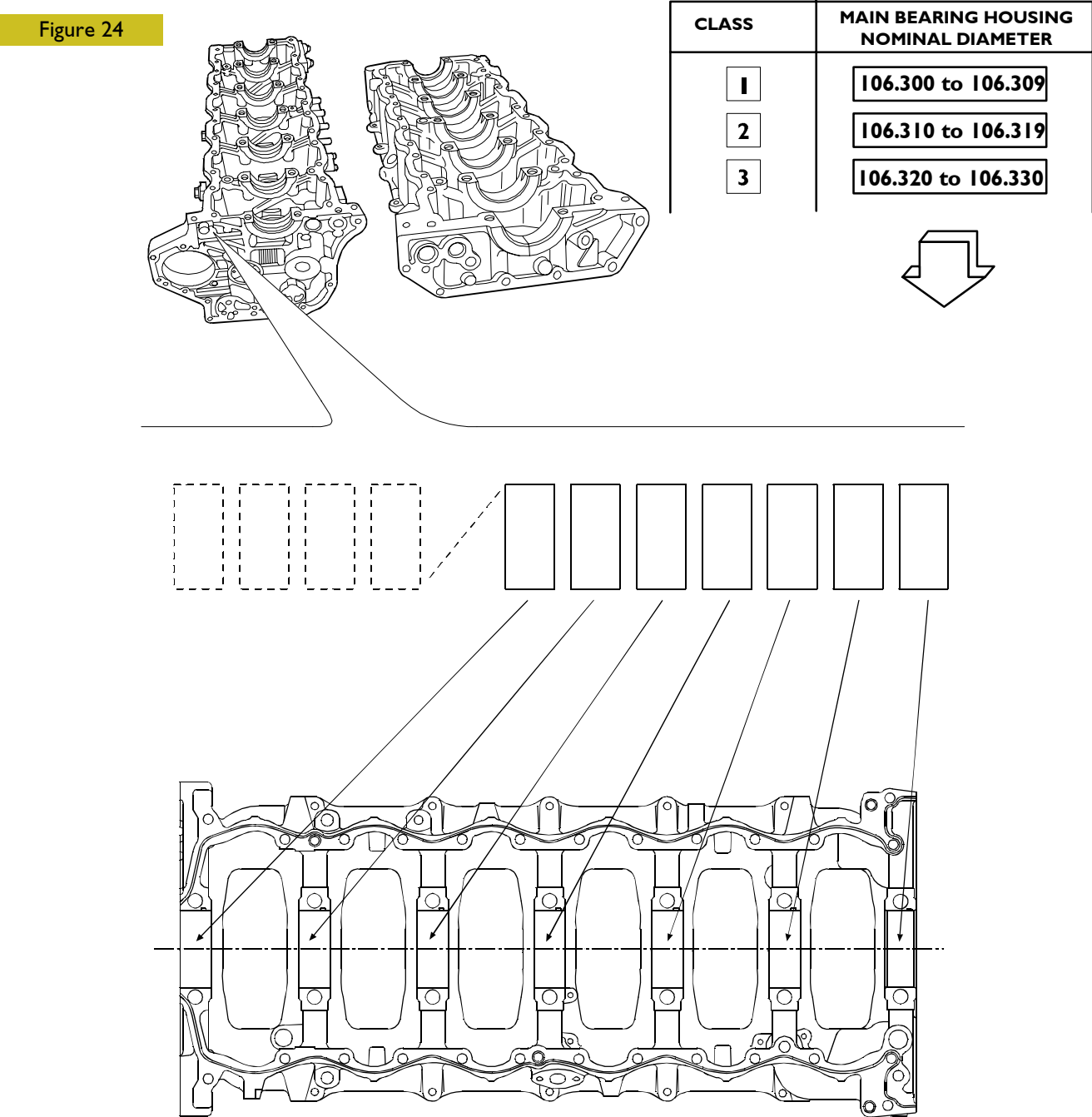
CRANKPINS:

- ☐ 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**.



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.

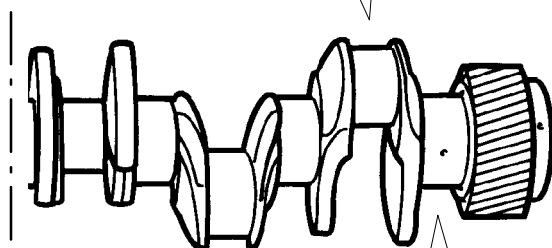
This operation makes it possible to identify the most suited bearing shells for each of the journals of the shaft (the bearing shells may even have different classes for different pins).

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		

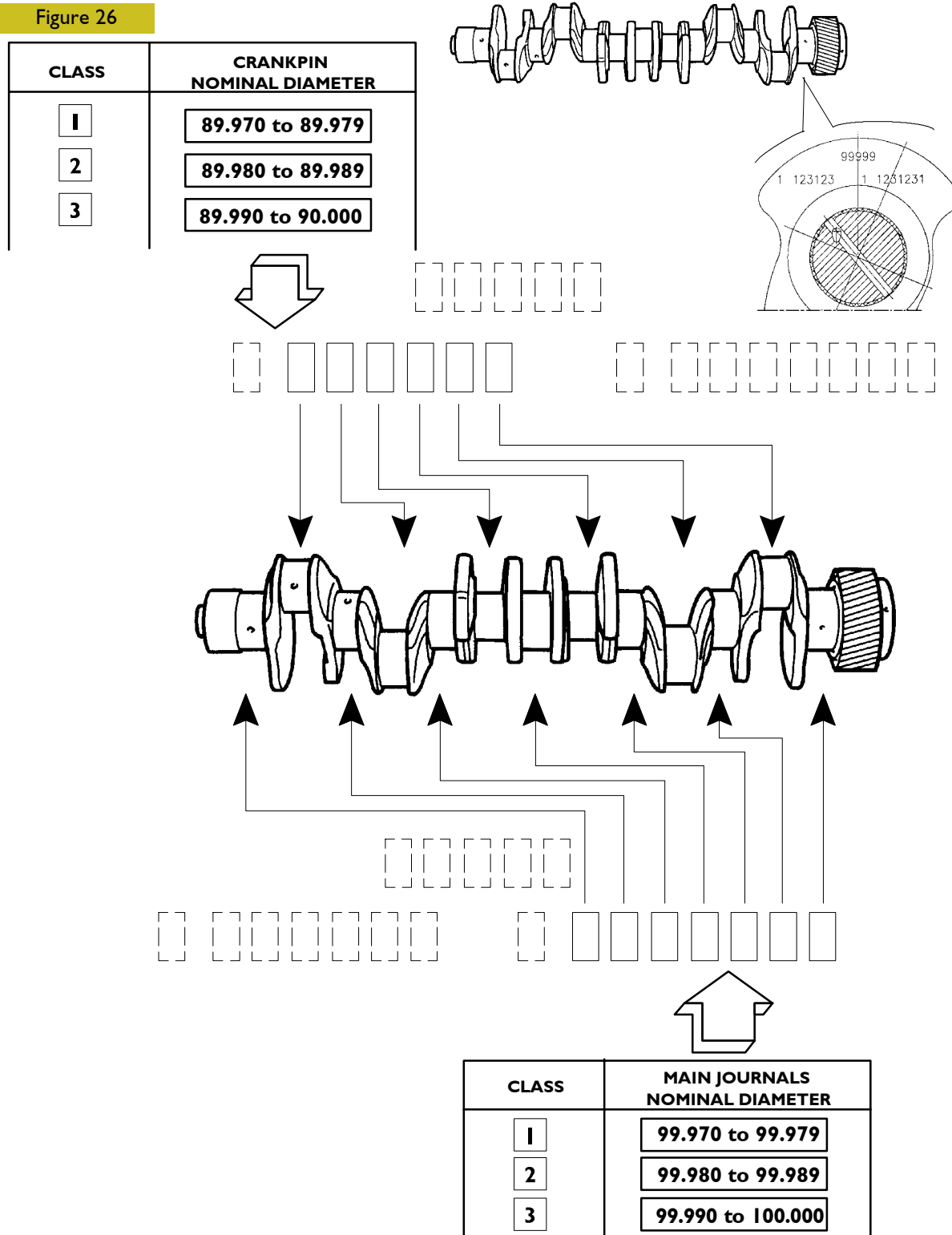
DEFINING THE CLASS OF DIAMETER OF THE MAIN JOURNALS AND CRANKPINS (Journals with nominal diameter)

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

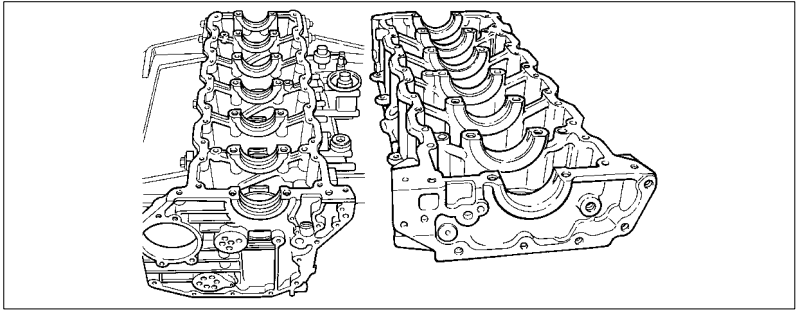


Selecting the main bearing shells (Journals with nominal diameter)

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

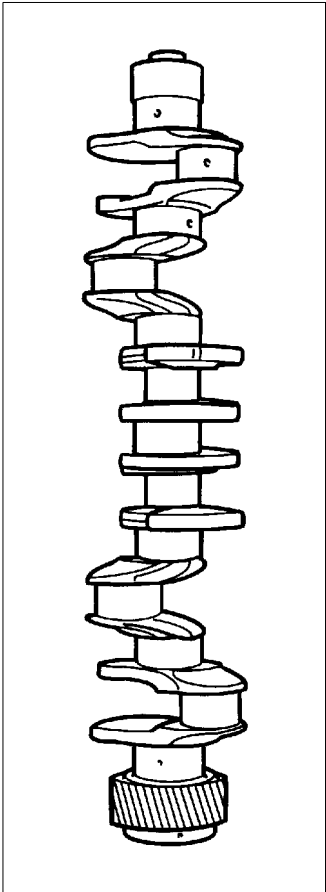
STD.

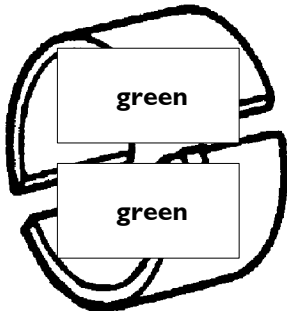


1

2

3



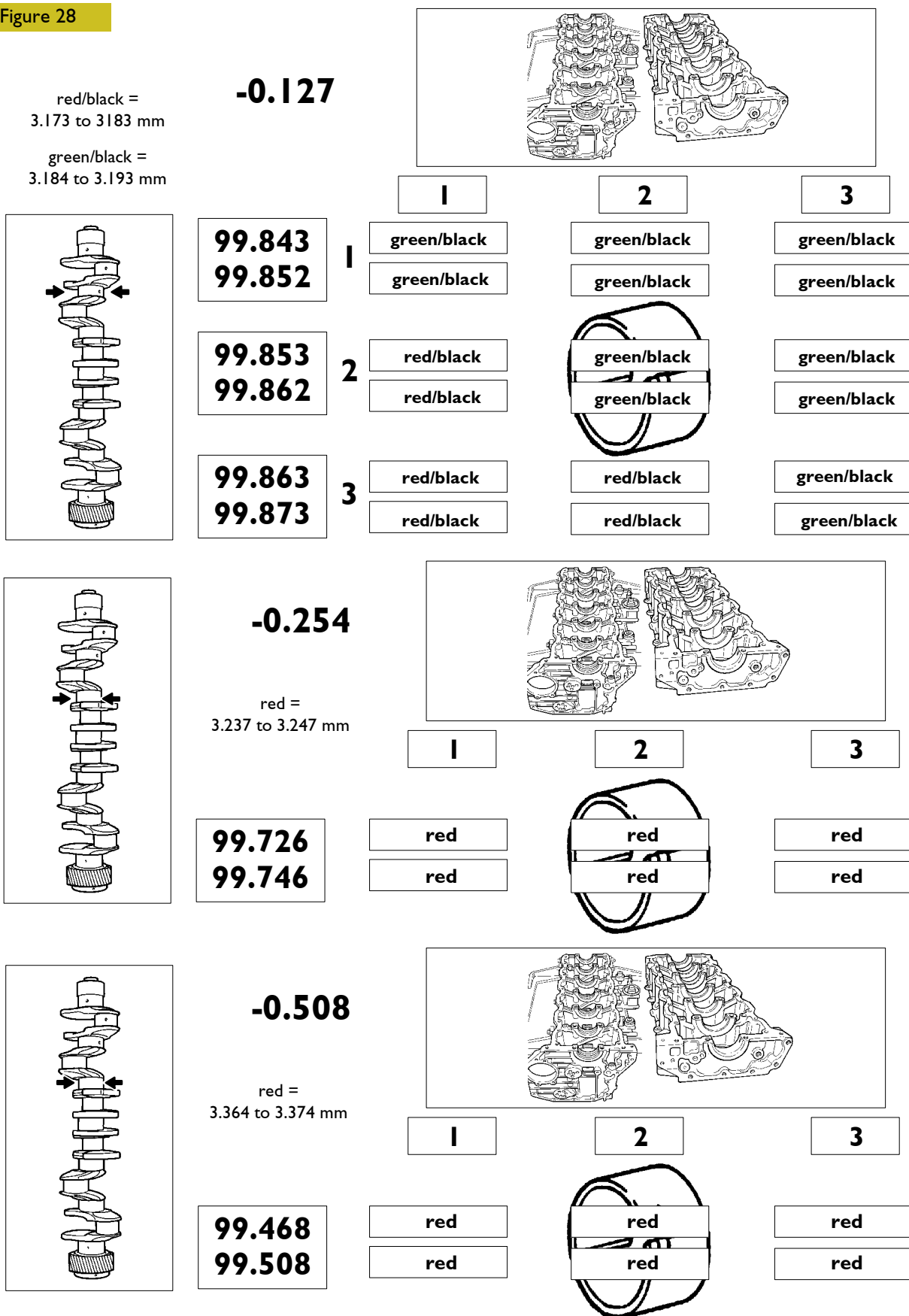
1	green	green	green
	green	green	green
2	red		green
	red	green	green
3	red	red	green
	red	red	green

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



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 = 4756 to 4795 g.
B = 4796 to 4835 g.
C = 4830 to 4875 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

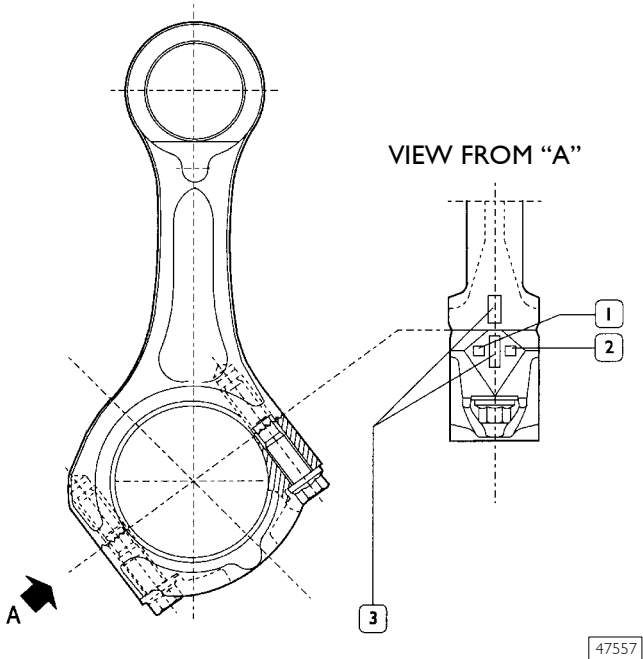
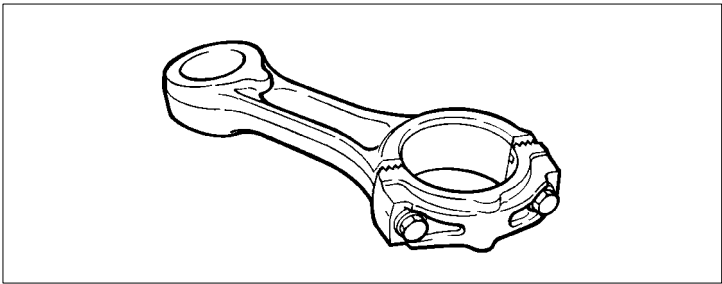


Figure 30

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 3I

Figure 31

red/black =
2.028 to 2.038 mm

green/black =
2.039 to 2.048 mm

-0.127

1

green/black

green/black

2

green/black

green/black

3

green/black

green/black

89.843
89.852

1

89.853
89.862

2

red/black

red/black

green/black

green/black

green/black

green/black

89.863
89.873

3

red/black

red/black

red/black

red/black

green/black

green/black

-0.254

red =
2.092 to 2.102 mm
green =
2.103 to 2.112 mm

1

red

red

2

green

green

3

green

green

89.726
89.735

89.736
89.746

red

red

red

red

green

green

-0.508

red =
2.219 to 2.229 mm
green =
2.230 to 2.239 mm

1

red

red

2

green

green

3

green

green

89.472
89.481

89.482
89.492

red

red

red

red

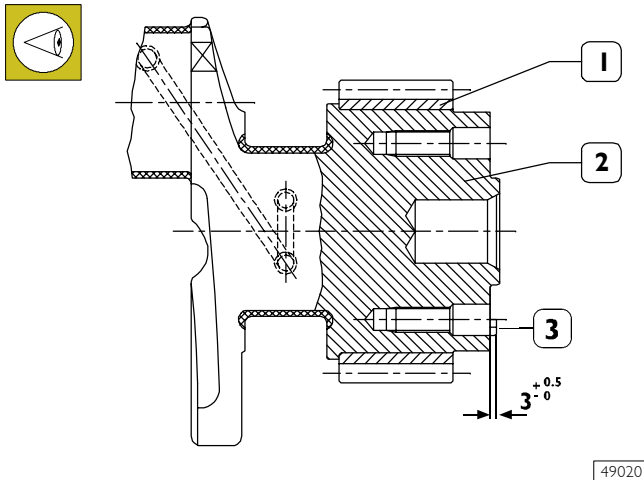
green

green

Replacing the timing gear and oil pump

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

Figure 32



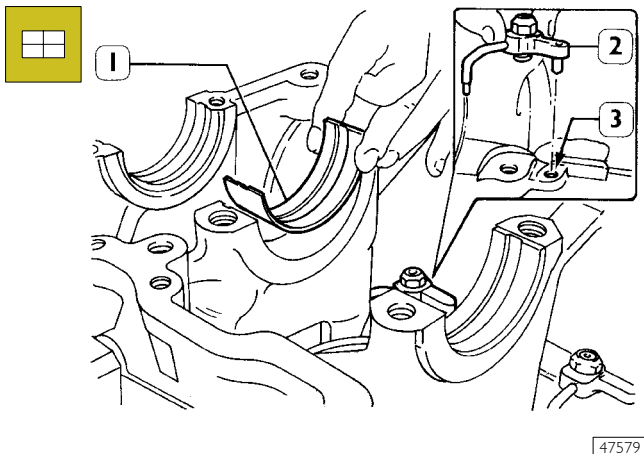
When fitting gear (1) onto drive shaft (2), the gear must be heated for 2 hours max. in a furnace, at a temperature not higher than 180°C.

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

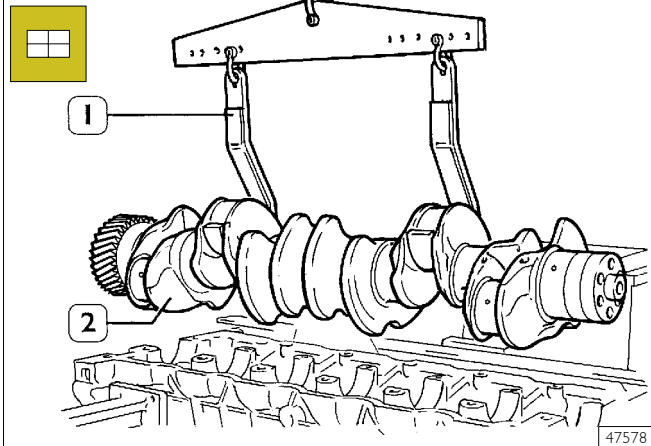
Figure 33



Install the oil spray nozzles (2) and have the dowel coincide with the block hole (3).

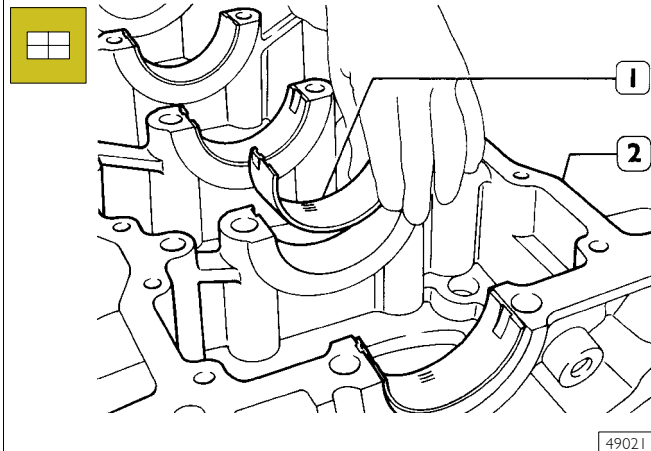
Install the half-bearings (1) on the main bearings.

Figure 34



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

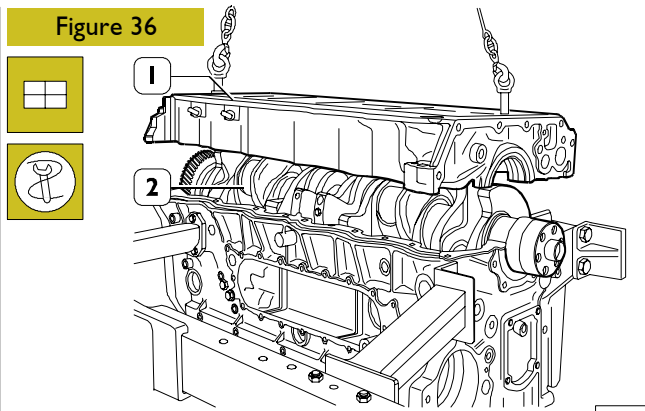
Figure 35



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:

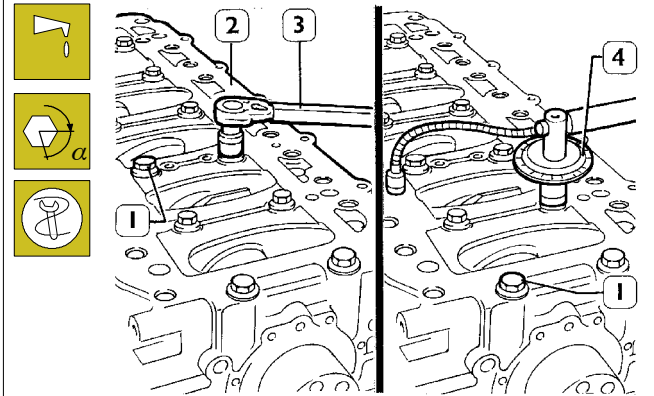
Figure 36



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).

NOTE To check bench pin assembly clearance use the screws removed during under block disassembly seeing to replace them with new ones for definitive assembly.

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 60°, following the diagram below.

Figure 38

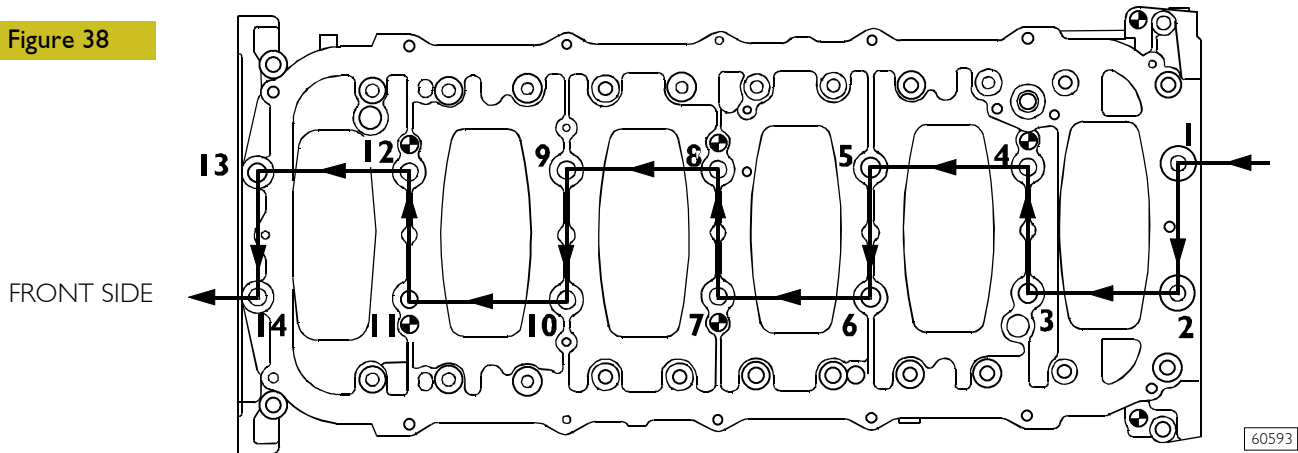
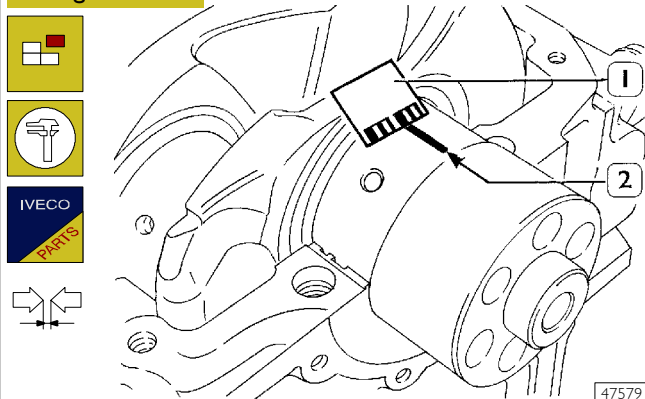


DIAGRAM OF SEQUENCE FOR TIGHTENING THE SCREWS FIXING THE BOTTOM CRANKCASE BASE TO THE CRANKCASE

Figure 39



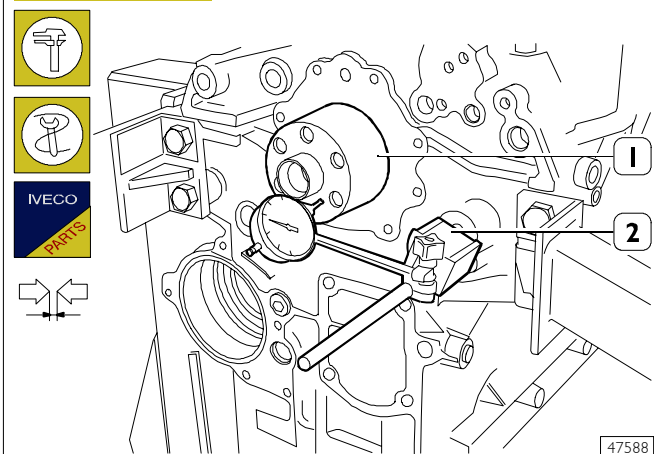
□ Remove the crankcase base.

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

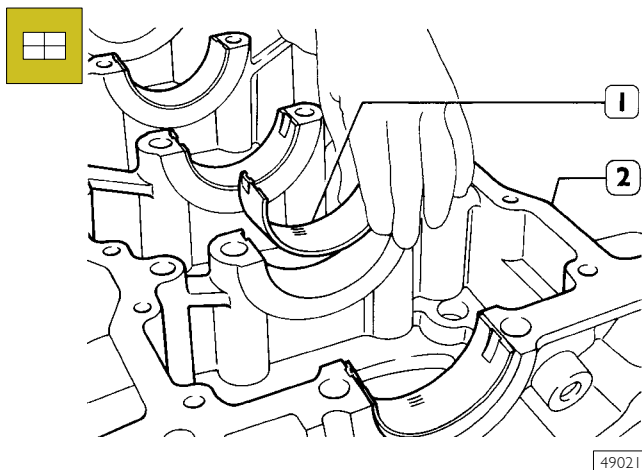
Figure 40



The end float is checked by setting a dial gauge (1) 99395603 with a magnetic base (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.

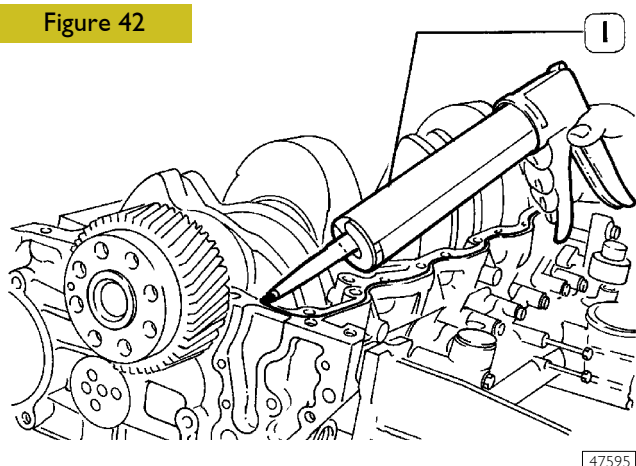
ASSEMBLING THE ENGINE ON THE BENCH

Figure 41



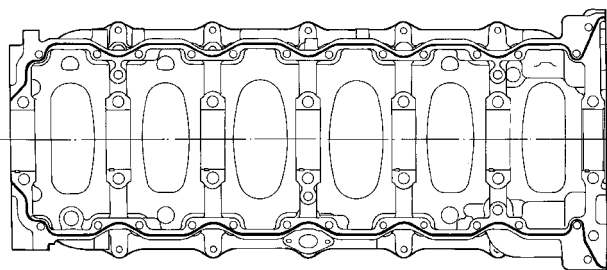
Place the half-bearings (1) on the main bearings in the underblock (2).

Figure 42



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

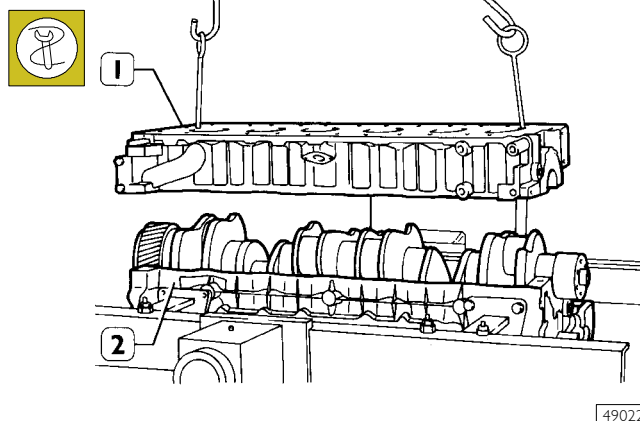
Figure 43



Sealant application diagram

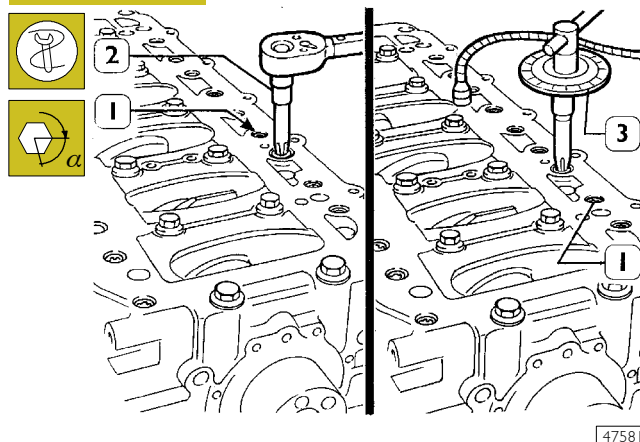
NOTE Fit the underblock within 10' of the application of the sealant.

Figure 44



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

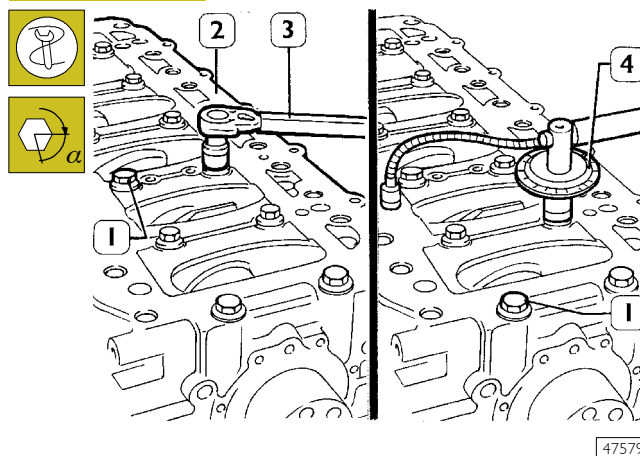
Figure 45



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.

NOTE Use new screws every time the under block is re-assembled.

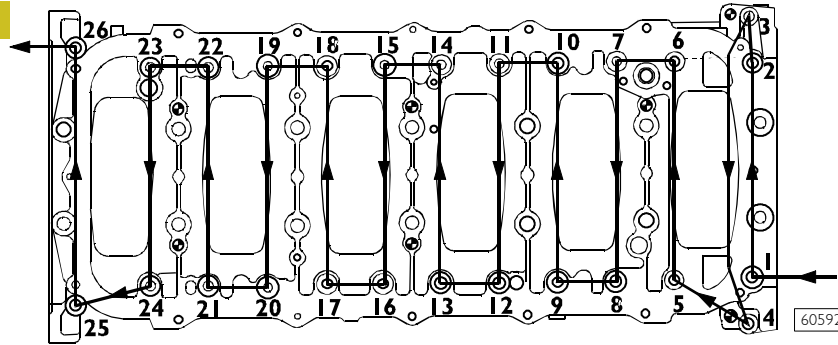
Figure 46



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 45) with 60° angular closing, using tool 99395216 (3, Figure 45).

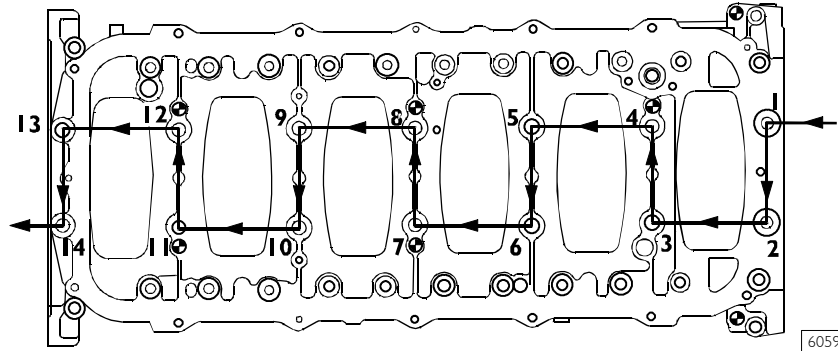
DIAGRAM SHOWING THE UNDERBLOCK FIXING SCREWS TIGHTENING ORDER**Figure 47**

FRONT SIDE



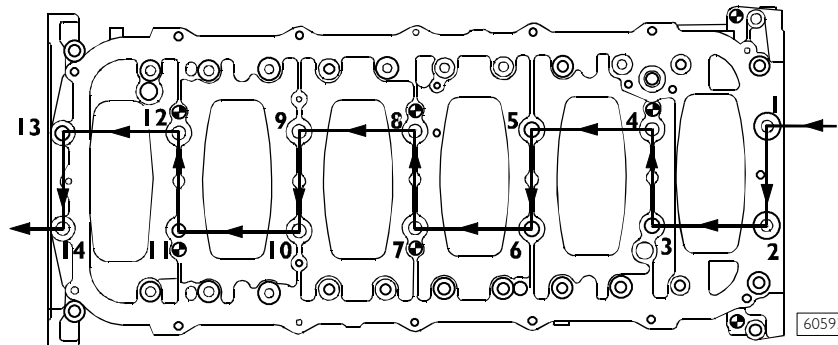
stage 1:
pretightening
outer screws
(30 Nm)

FRONT SIDE



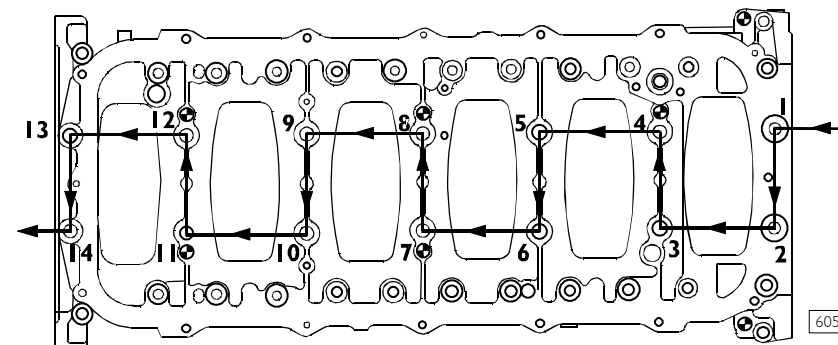
stage 2:
pretightening
inner screws
(120 Nm)

FRONT SIDE



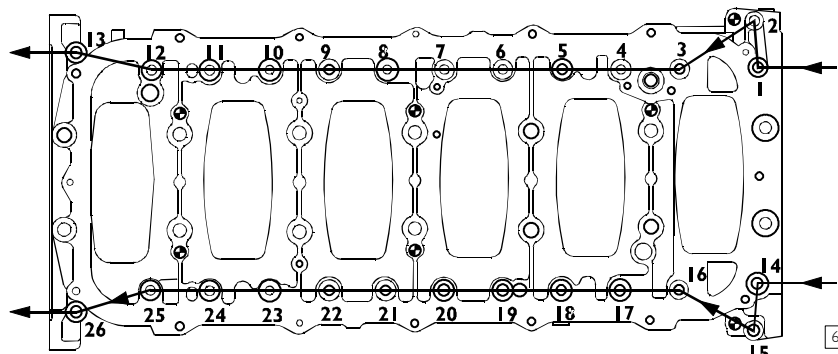
stage 3:
angle
inner
screws
(60°)

FRONT SIDE

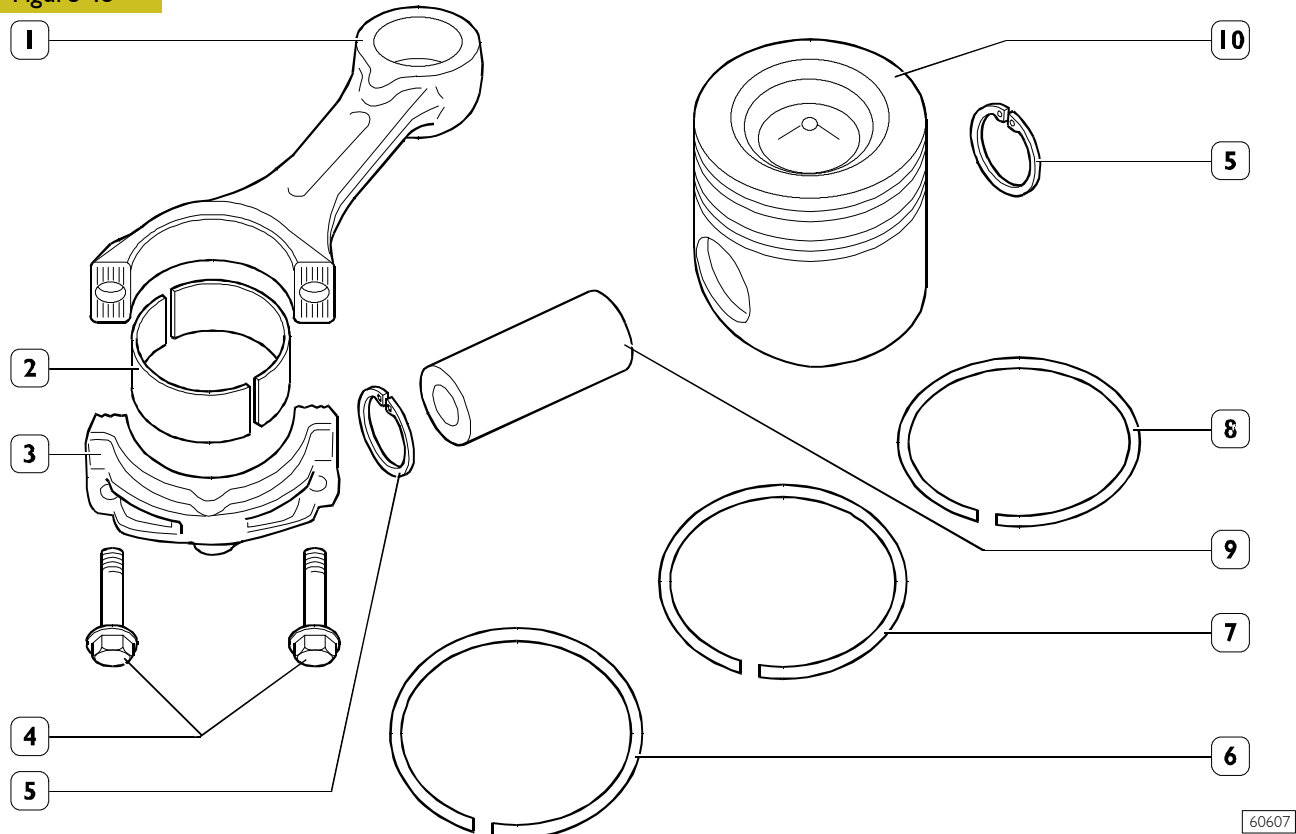


stage 4:
angle
inner
screws
(55°)

FRONT SIDE



stage 5:
angle
outer
screws
(60°)

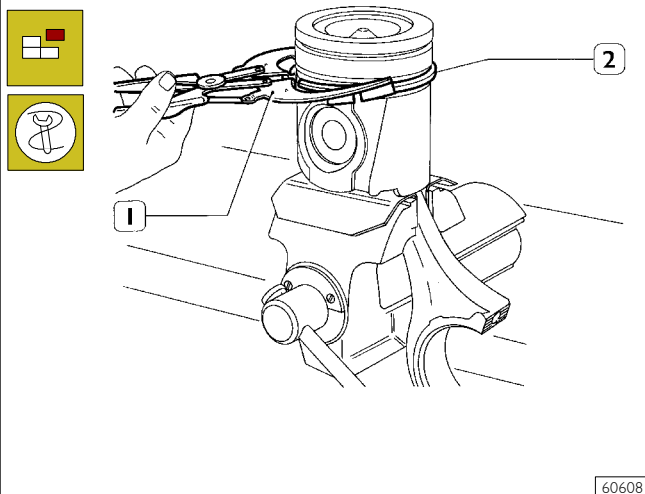
PISTON CONNECTING ROD ASSEMBLY**Figure 48****PISTON CONNECTING ROD ASSEMBLY**

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.

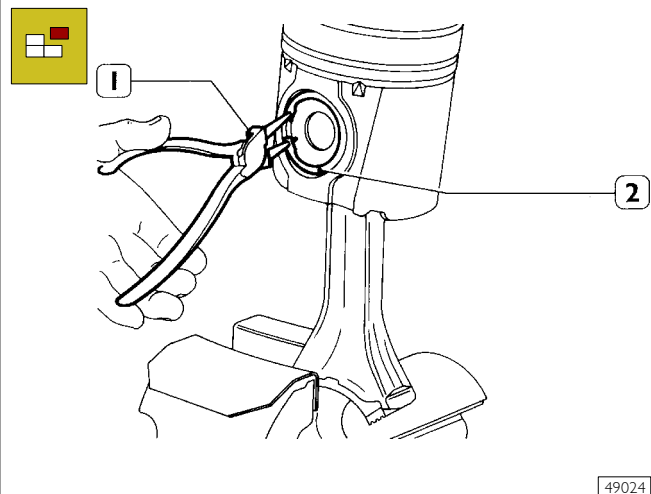
Make sure the piston does not show any trace of seizing, scoring, cracking; replace as necessary.

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.

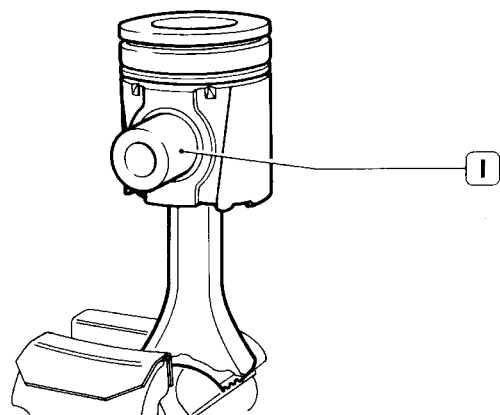
Removal**Figure 49**

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

Figure 50

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

Figure 51

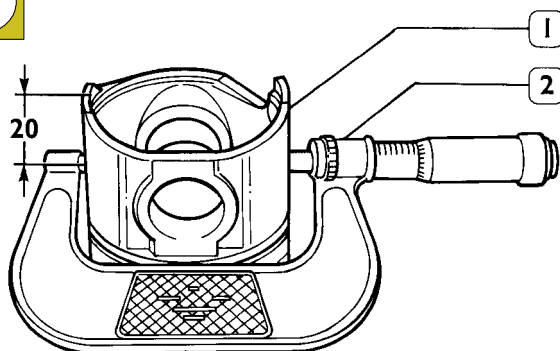


49025

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

Measuring the diameter of the pistons

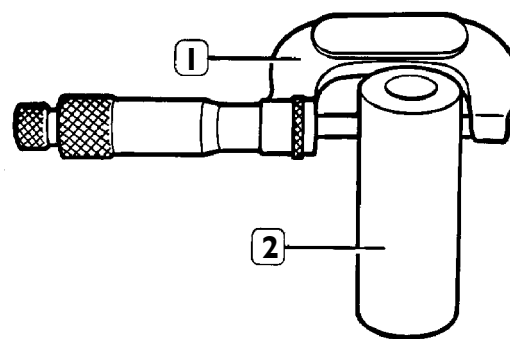
Figure 52



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 53

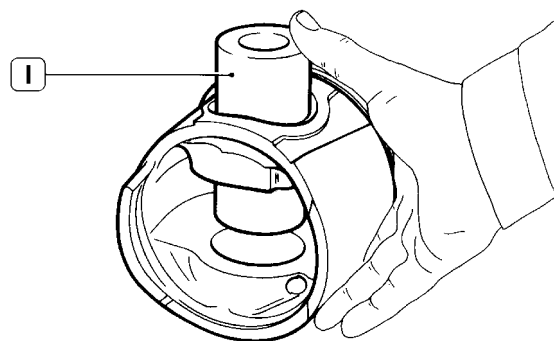


32618

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

Conditions for correct gudgeon pin-piston coupling

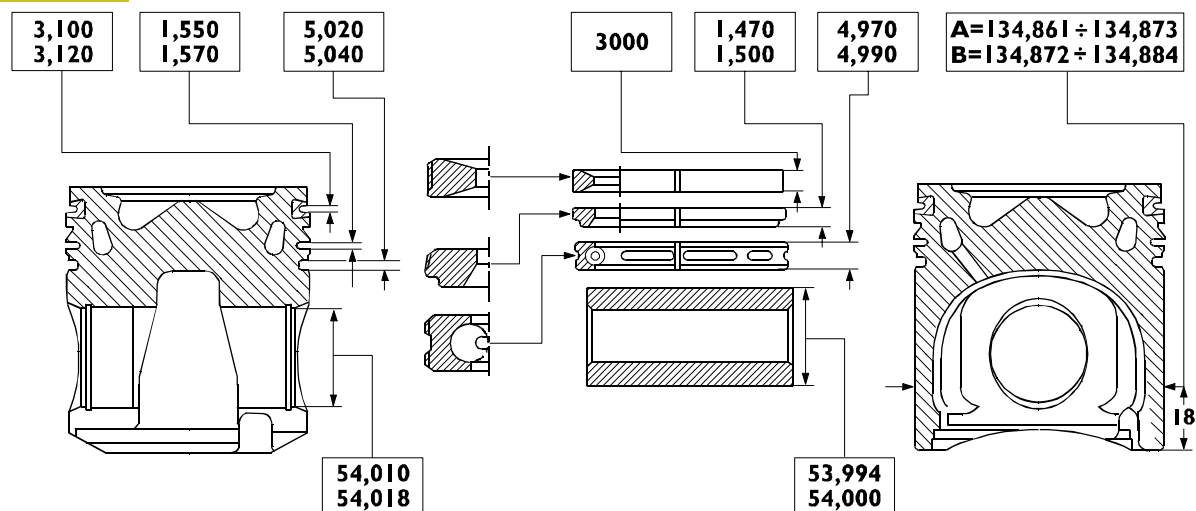
Figure 54



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

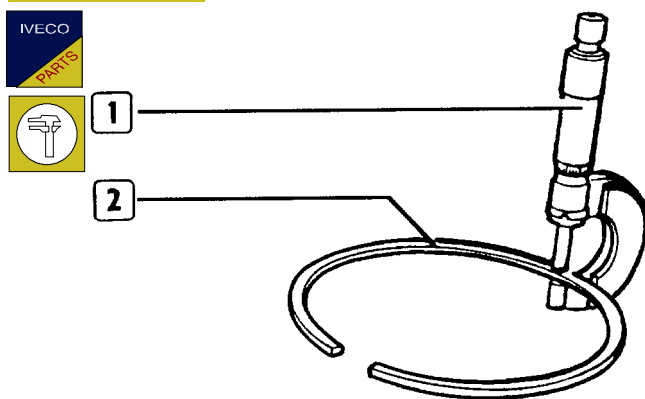


104292

MAIN DATA OF THE PISTON, PISTON RINGS AND PIN

Piston rings

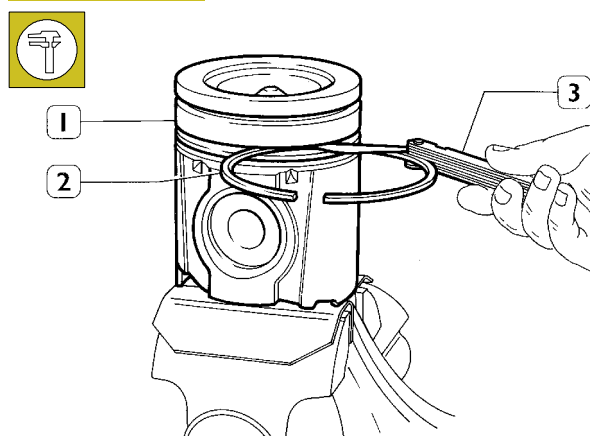
Figure 56



16552

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

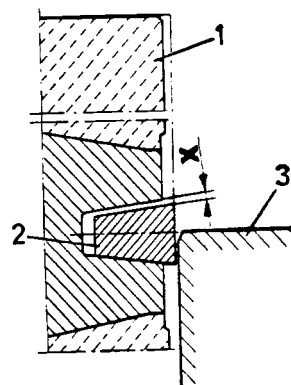
Figure 57



60610

Check the clearance between the seals (2) and their seats on the piston (1) with a feeler gauge (3).

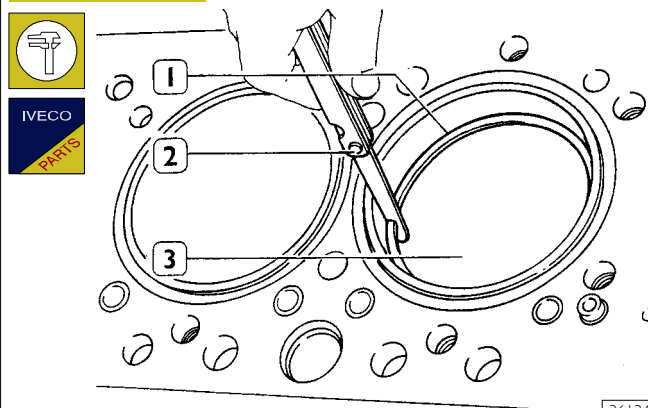
Figure 58



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 59



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

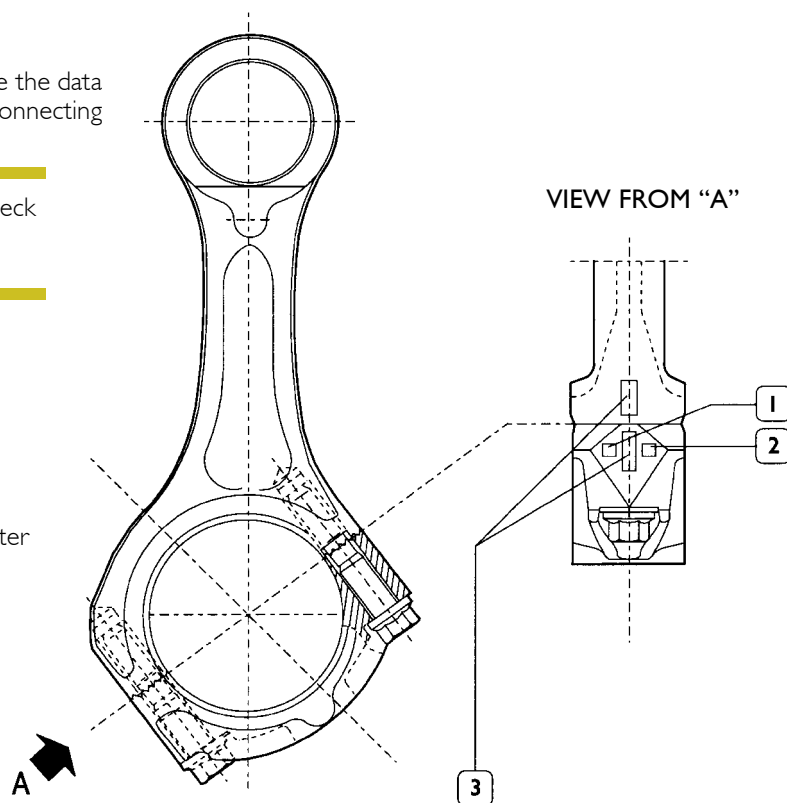
Figure 60

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.

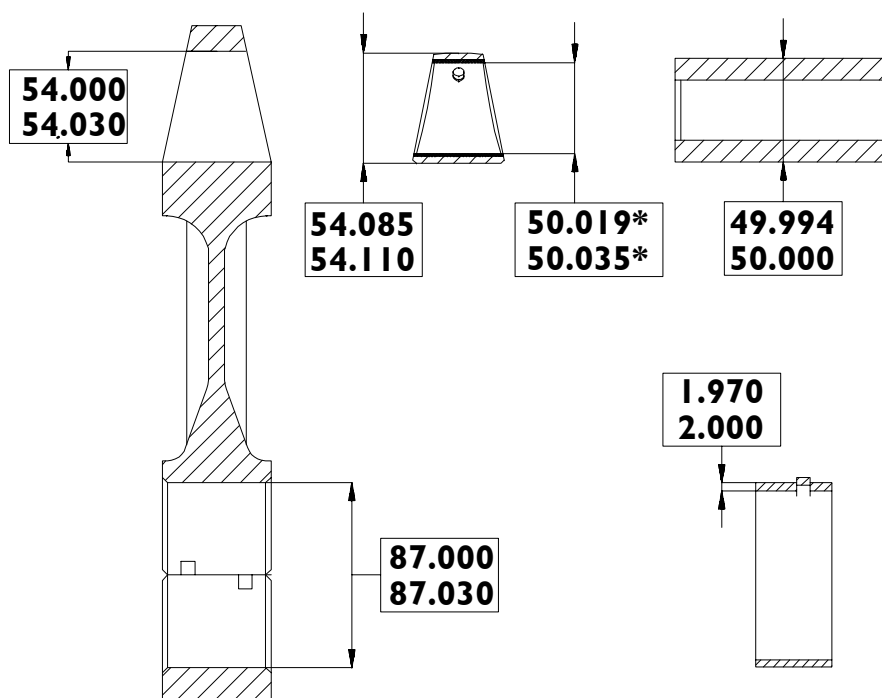
Connecting rod punch markings

- 1 Letter indicating the class of weight:
 - A = 4661 to 4694 g.
 - B = 4695 to 4728 g.
 - C = 4729 to 4762 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

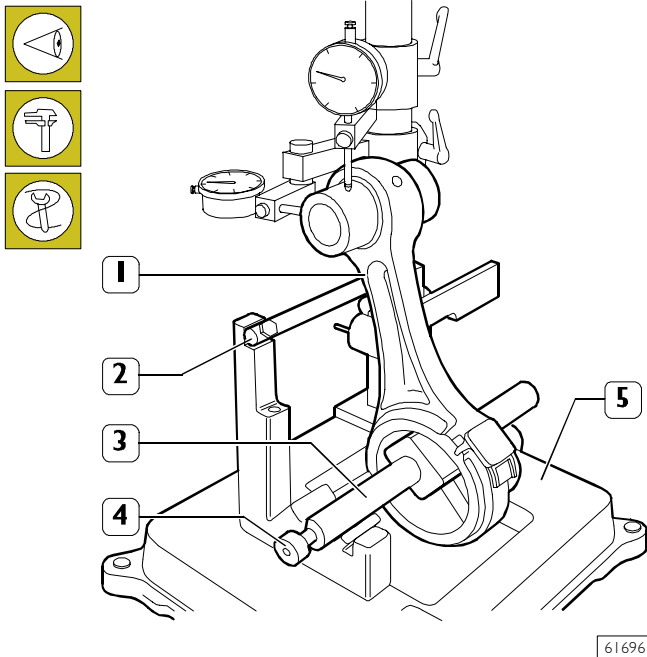
Figure 61



71716

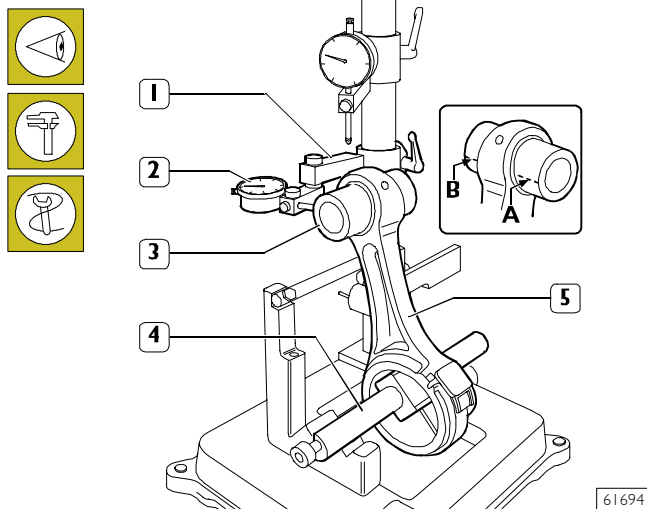
MAIN DATA OF THE BUSHING, CONNECTING ROD, PIN AND BEARING SHELLS

* Measurement to be made after driving in the bushing.

Checking connecting rod alignment**Figure 62****(Demonstration)****Checking axis alignment**

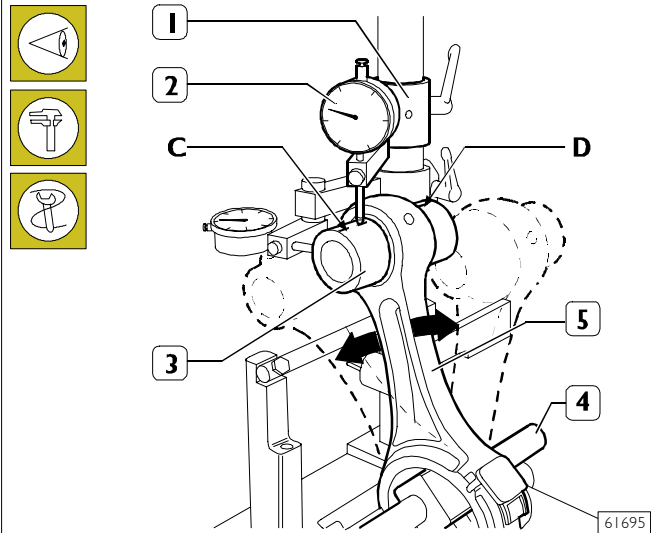
Check the parallelism of the rod axes (1) by using a suitable device (5) and operating as follows:

- ☐ Fit the connecting rod (1) on the spindle of the tool (5) and lock it with the screw (4).
- ☐ Set the spindle (3) on the V-prisms, resting the connecting rod (1) on the stop bar (2).

Checking torsion**Figure 63****(Demonstration)**

Check the torsion of the connecting rod (5) by comparing two points (A and B) of the pin (3) on the horizontal plane of the axis of the connecting rod.

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

Checking bending**Figure 64****(Demonstration)**

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

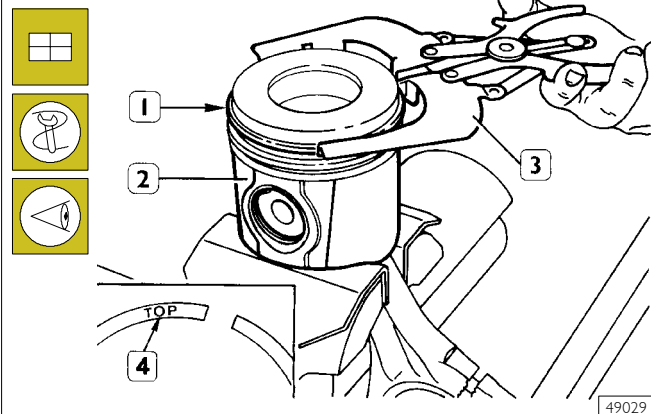
Position the vertical mount (1) of the dial gauge (2) so that this rests on the pin (3) at point C. Swing the connecting rod backwards and forwards seeking the highest position of the pin and in this condition zero the dial gauge (2).

Shift the spindle (4) with the connecting rod (5) and repeat the check on the highest point on the opposite side D of the pin (3). The difference between point C and point D must be no greater than 0.08 mm.

Mounting the connecting rod - piston assembly

Carry out the steps for removal described on pages 28 and 29 in reverse order.

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

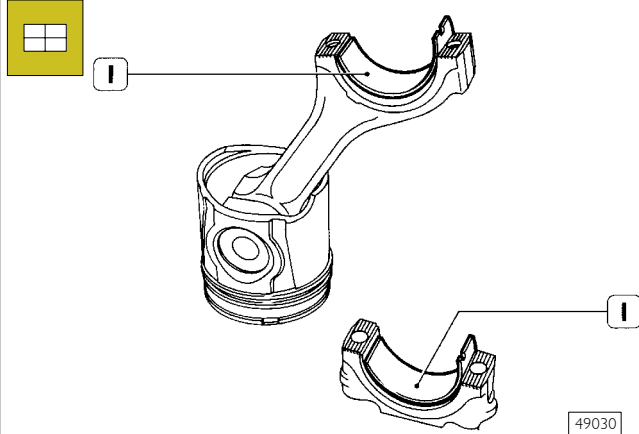
Mounting the piston rings**Figure 65**

To fit the piston rings (1) on the piston (2) use the pliers 99360184 (3).

The rings need to be mounted with the word "TOP" (4) facing upwards. Direct the ring openings so they are staggered 120° apart.

Fitting the connecting rod-piston assembly into the piston liners

Figure 66



Fit the half-bearings (1), selected as described on pages 22 to 23, both on the connecting rod and on the stand.

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

Fit the connecting rod-piston assemblies (1) into the piston liners (2) using band 99360605 (1, Figure 68). Check the following:

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

Figure 67

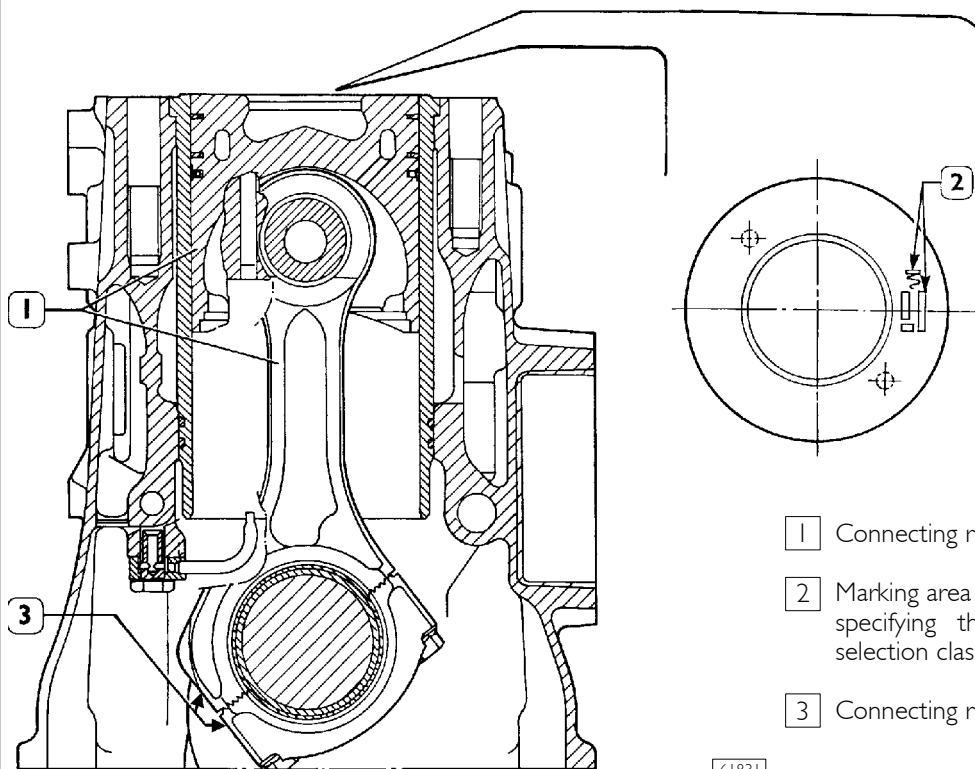
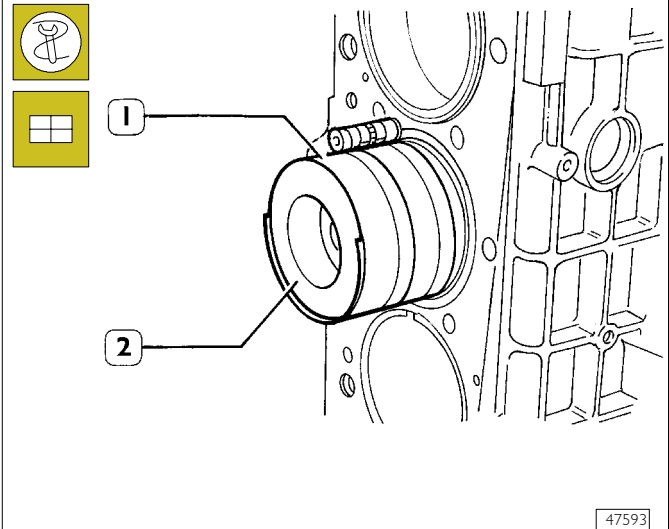


Figure 68



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

Piston protrusion check

Once assembly is complete, check piston protrusion from cylinder barrels: it must be 0.12-0.42 mm.

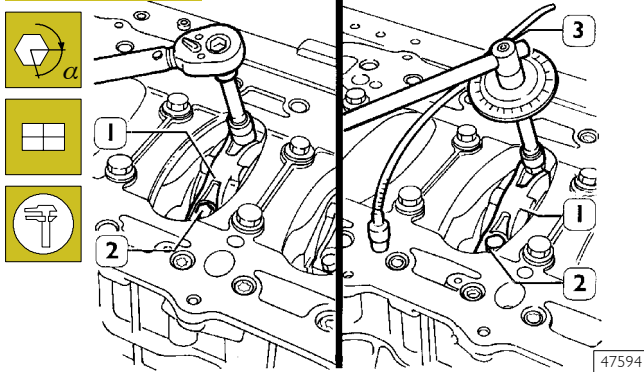
- ☐ 1 Connecting rod-piston assembly
- ☐ 2 Marking area on the piston crown of ideogram specifying the assembly position and the selection class
- ☐ 3 Connecting rod marking area (see Figure 60).

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



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 Screw threading (2) must be lubricated with engine oil before assembly.

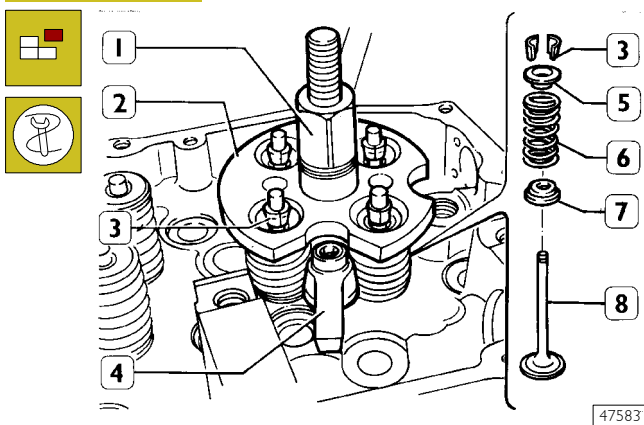
Remove the caps and determine the clearance by comparing the width of the calibrated wire with the graduated scale on the case containing the calibrated wire.
Definitive assembly: check the diameter of screw threading (2) it must not be less than 13.4mm along the entire length, otherwise the screw is to be replaced; lubricate the pins and bearings of the connecting rod; tighten the screws (2) as described above.

CYLINDER HEAD

Before taking down the cylinder head, check the seal using the appropriate tool; in case of leakage replace the cylinder head.

Valve removal

Figure 69

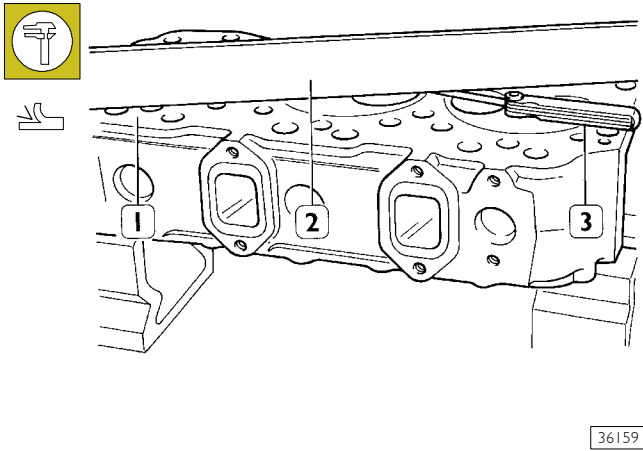


Install and fix tool 99360263 (2) with bracket (4); tighten by lever (1) until cotters are removed (3); remove the tool (2) and the upper plate (5), the spring (6) and the lower plate (7). Repeat the operation on all the valves.
Turn the cylinder head upside down and remove the valves (8).

Checking the planarity of the head on the cylinder block

Figure 70

(Demonstration)

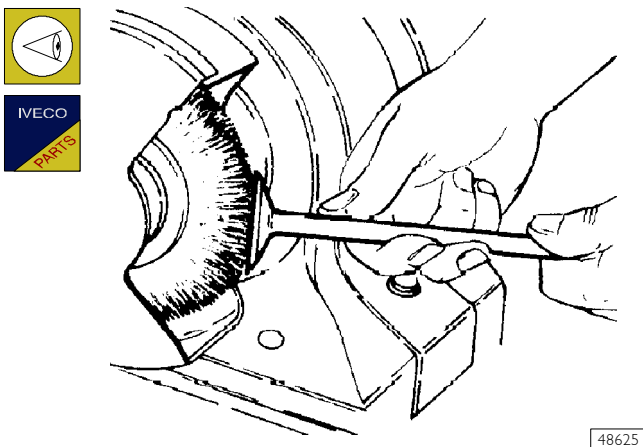


The planarity (1) is checked using a ruler (2) and a thickness gauge (3). If deformations exist, surface the head using proper surface grinder; the maximum amount of material to be removed is 0.2 mm.

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

Removing deposits and checking the valves

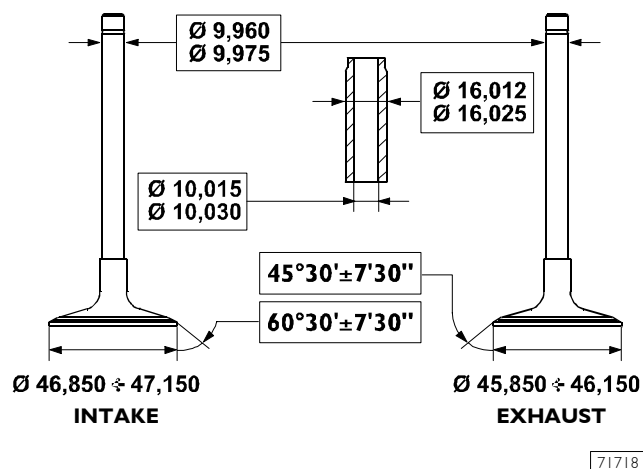
Figure 71



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 73) and replace if necessary.

Valves

Figure 73

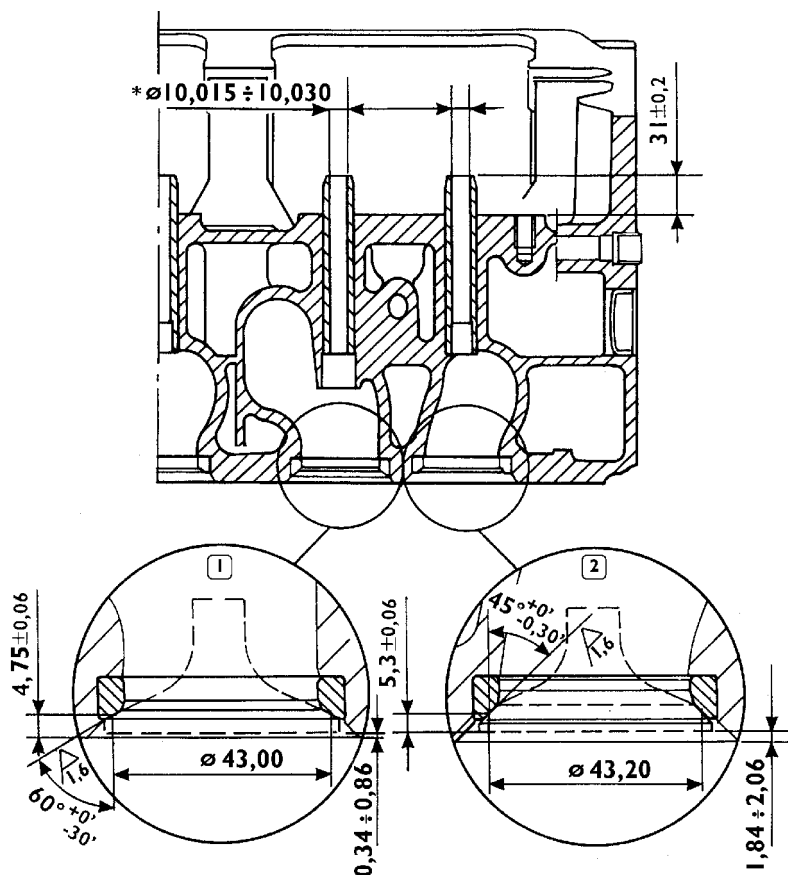


MAIN DATA - VALVES AND VALVE GUIDES

* Values to be obtained after installing the valve guides

Valve guides

Figure 74



INSTALLATION DIAGRAM FOR VALVE GUIDES AND VALVES

* Values to be obtained after installing the guide valves

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.

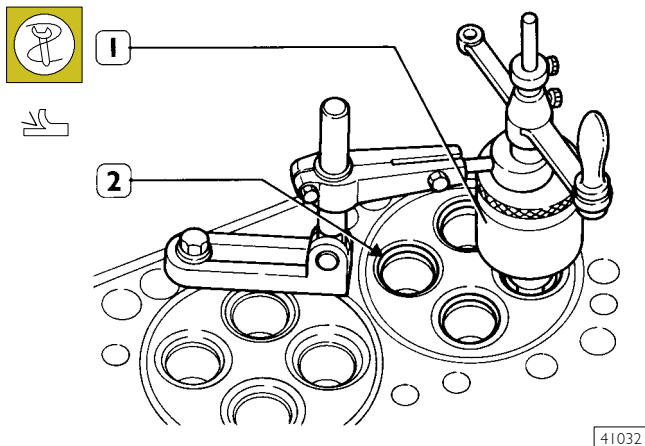
Replacing of valve guides

Remove valve guides by means of tool 99360143. Install by means of tool 99360143 equipped with part 99360296, which determines the exact installation position of valve guides into the cylinder heads; if they are not available, install the valve guides in the cylinder head so that they project out by mm 30.8 to 31.2 (Figure 74). After installing the valve guides, smooth their holes with sleeker 99390330.

Replacing - Reaming the valve seats

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

Figure 75



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

Check the valve seats (2). Should slight scratches or burns be found, go over them with a suitable tool (1) according to the inclination values shown in Figure 73. If it is necessary to replace them, using the same tool and taking care not to affect the cylinder head, remove as much material as possible from the valve seats so that, with a punch, it is possible to extract them from the cylinder head.

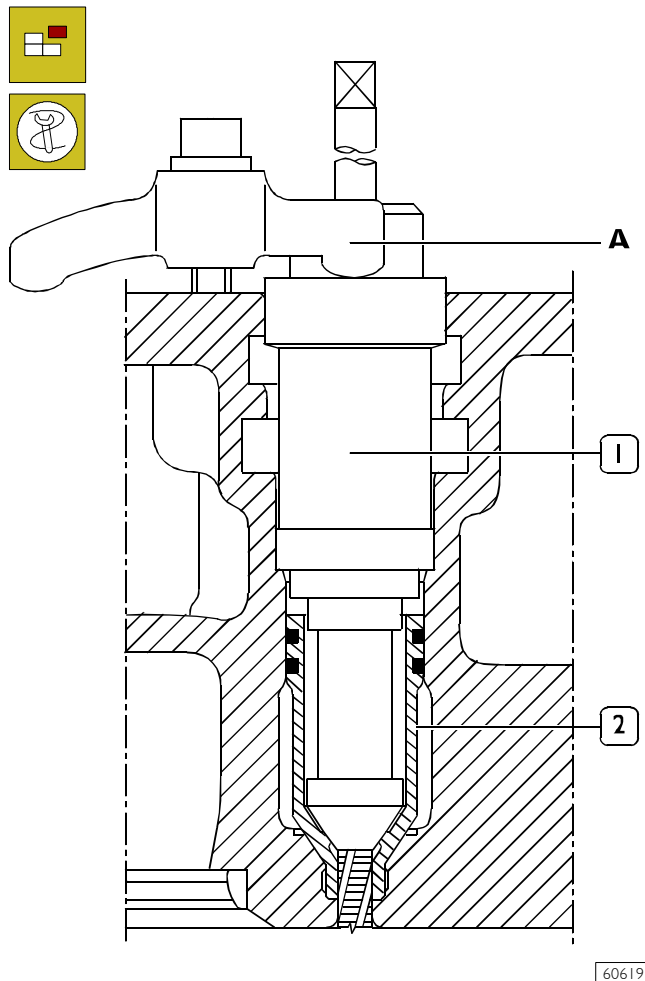
Heat the cylinder head to 80 – 100°C and, using a drift, fit in the new valve seats (2), chilled beforehand in liquid nitrogen. Using tool (1), regrind the valve seats according to the angles shown in Figure 74.

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 - -2.105 mm (recessing) exhaust valves.

Replacing injector cases Removal

Figure 76

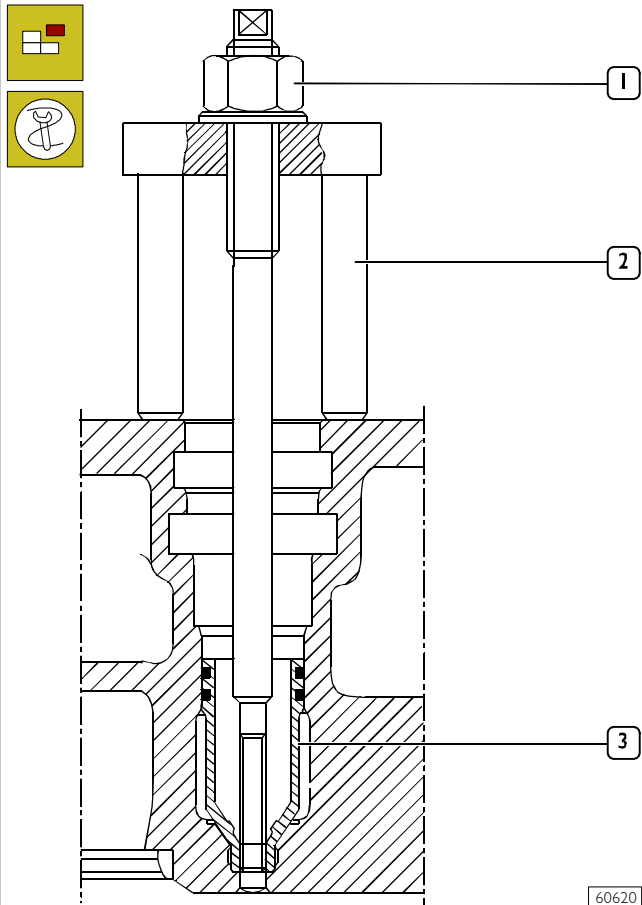


To replace the injector case (2), act as follows:

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

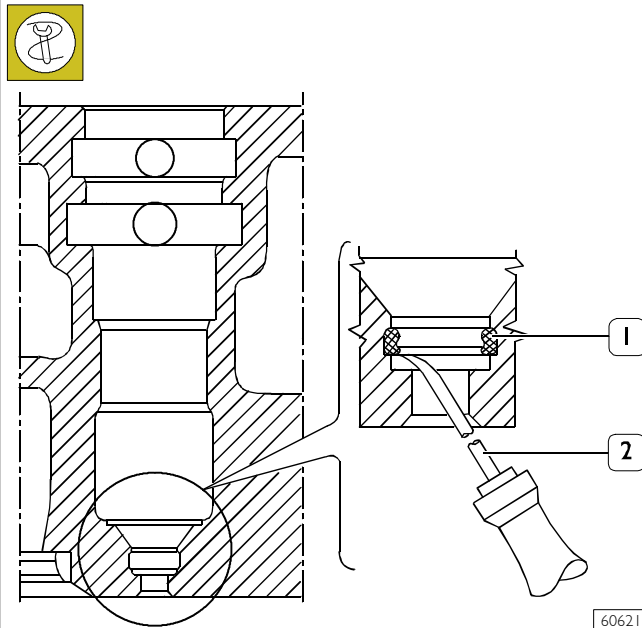
Carry out operations described in figs. 77 - 80 - 81 - 82 by fixing tools to the cylinder head by means of bracket A.

Figure 77



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

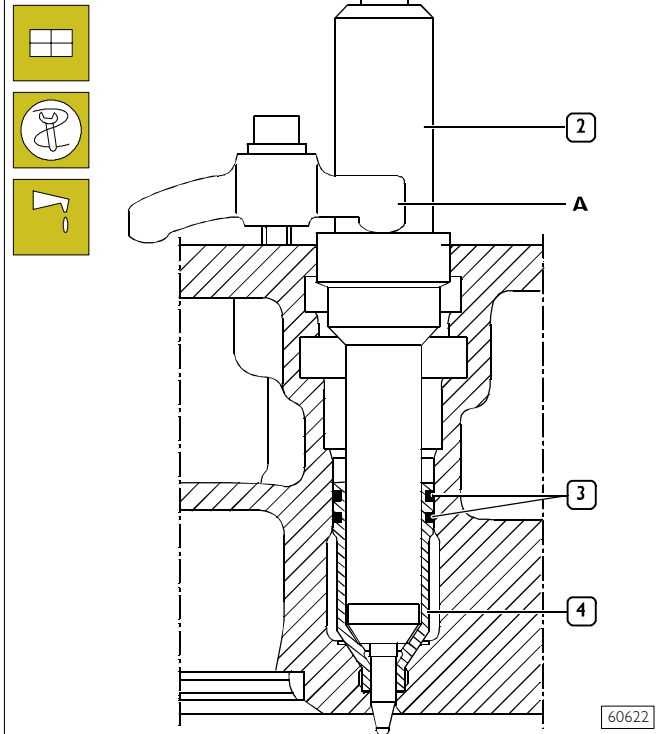
Figure 78



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

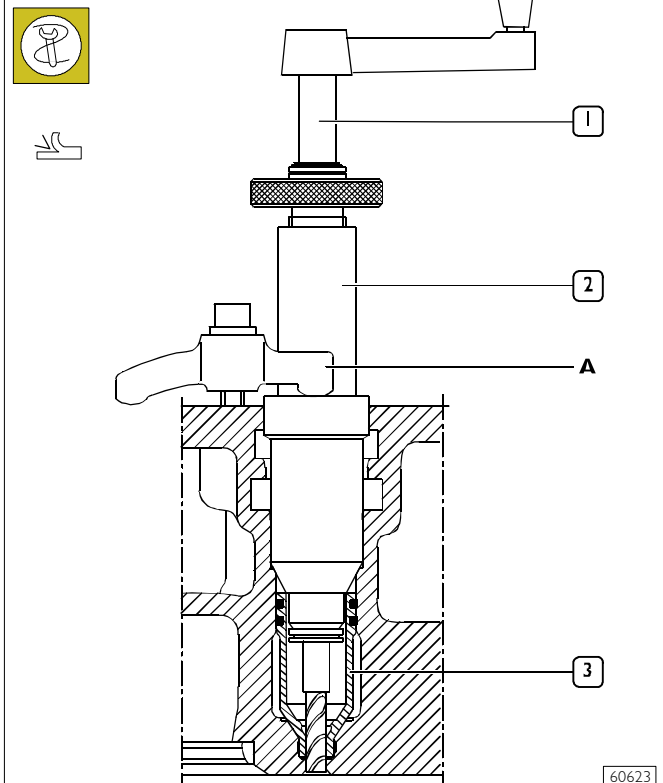
Assembly

Figure 79



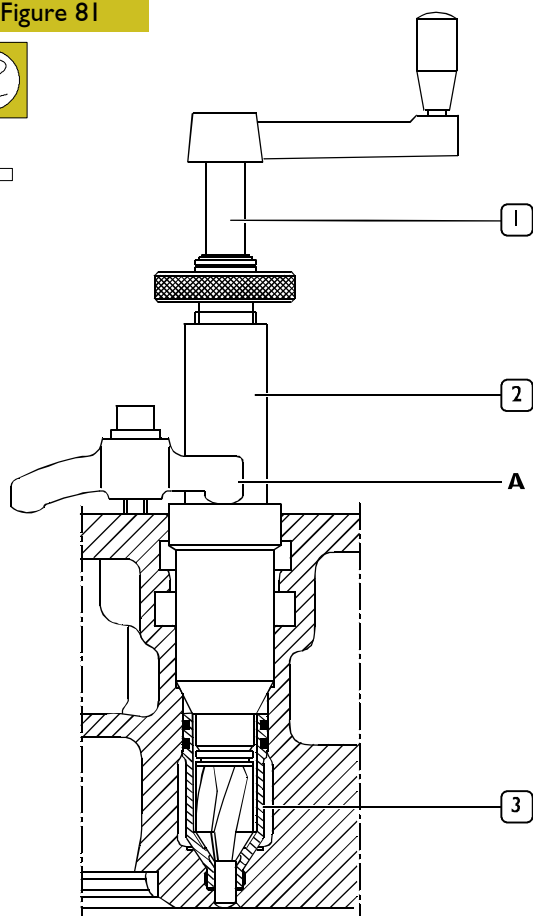
- Lubricate the seals (3) and fit them on the case (4). Using tool 99365056 (2) secured to the cylinder head with bracket A, drive in the new case, screwing down the screw (1) upsetting the bottom portion of the case.

Figure 80



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

Figure 81

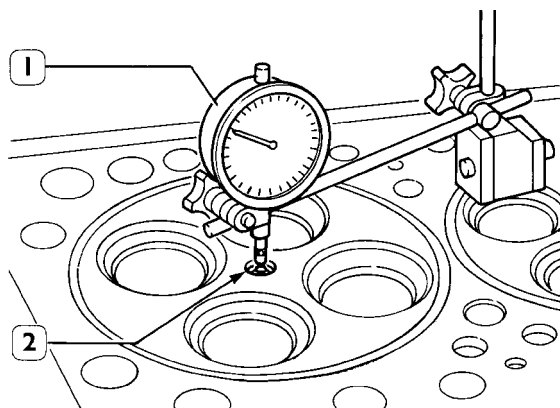


60624

- ❑ Using the milling cutter 99394043 (1-2), regrind the injector seat in the case (3).

Checking injector protrusion

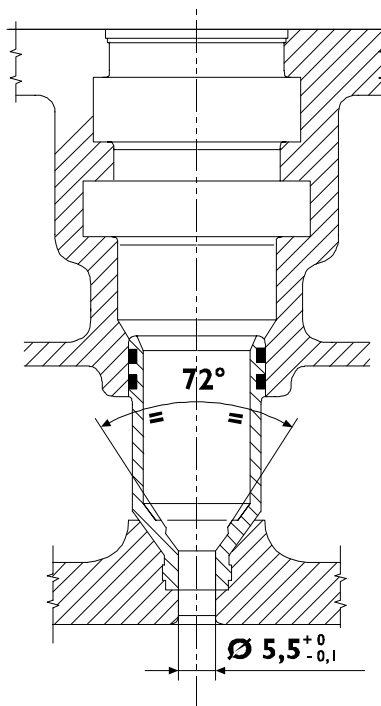
Figure 82



47585

Check injector protrusion (2) with the dial gauge (1).
The protrusion must be 0.52 - 1.34 mm.

Figure 83



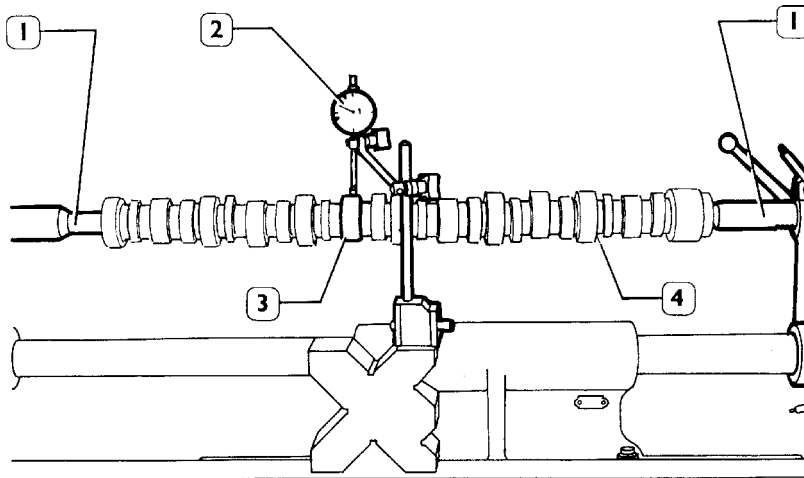
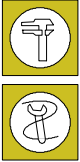
71720

INJECTOR CASE ASSEMBLY DIAGRAM

Camshaft

Checking cam lift and pin alignment

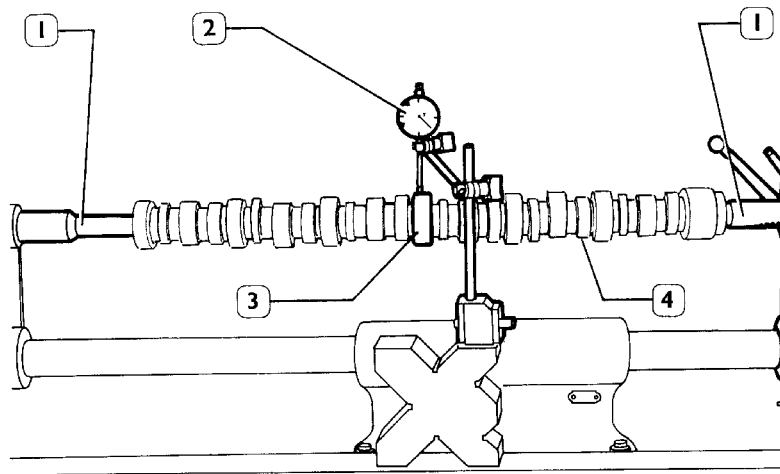
Figure 84



47506

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

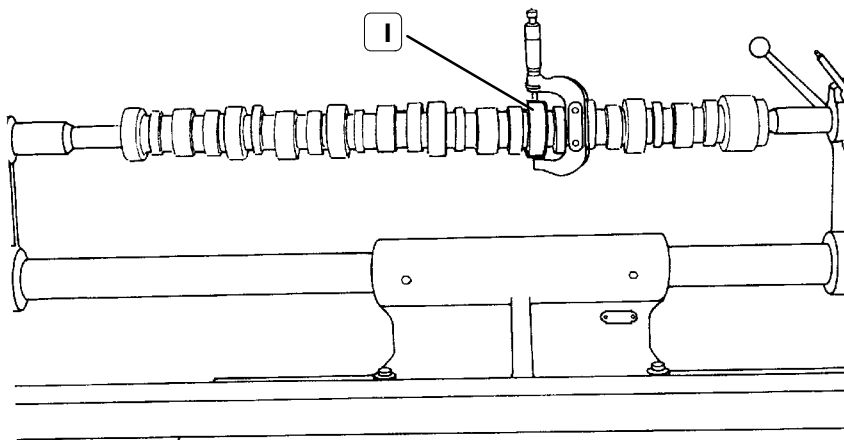
Figure 85



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 86



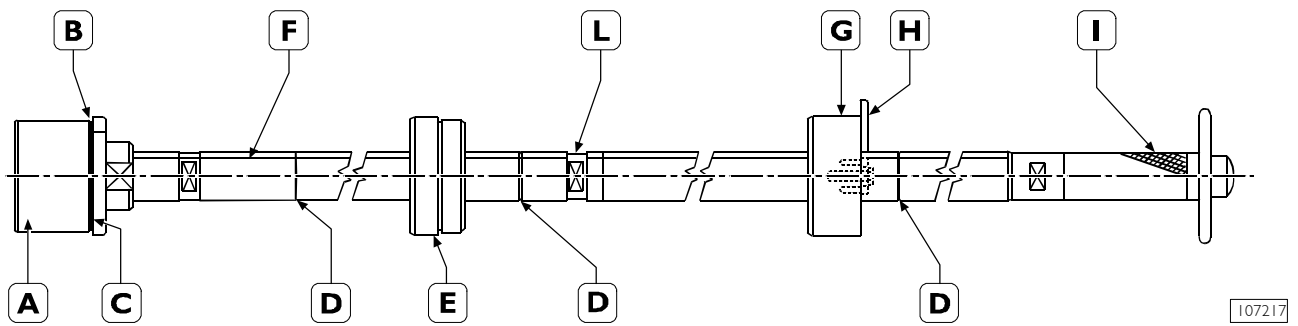
47505

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.

Replacing camshaft bushes using beater 99360499

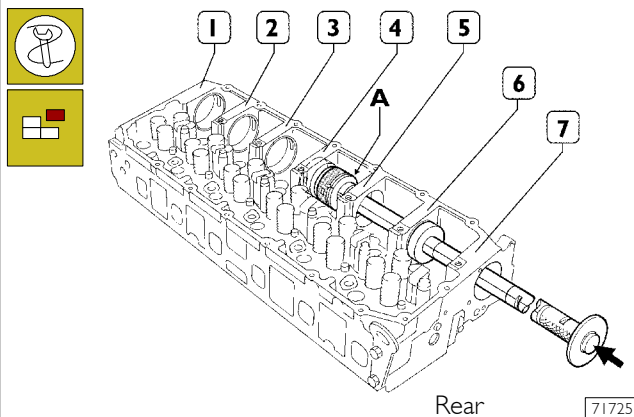
Figure 89



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

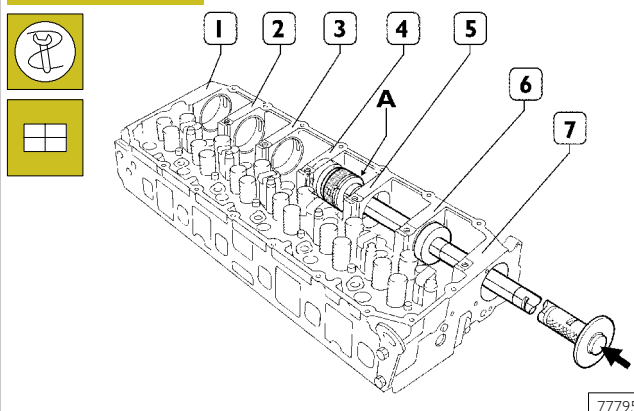
Figure 90



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

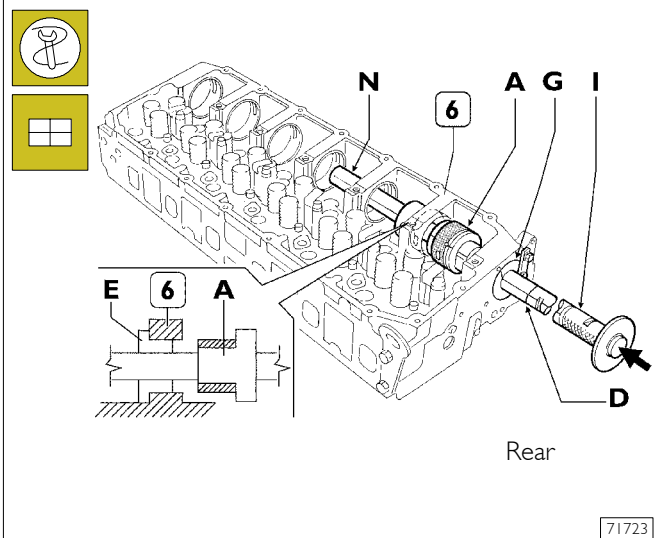
Figure 91



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 89) on the bushing.
- 2 Position the guide bushing (E) and secure the guide bushing (G) (Figure 89) 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).

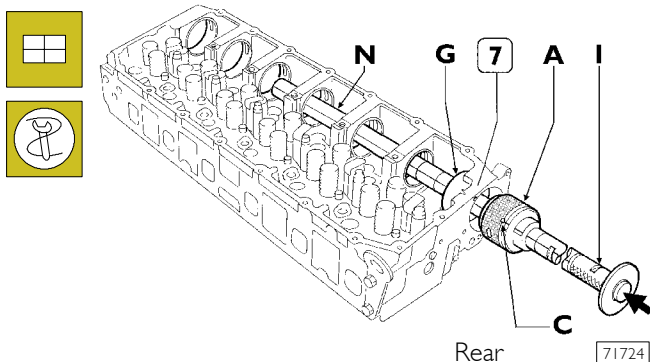
Figure 92



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 93

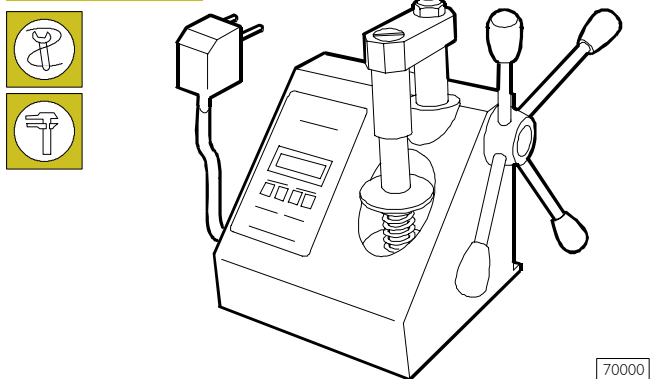


To insert bushing (7), proceed as follows:

- ☐ 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

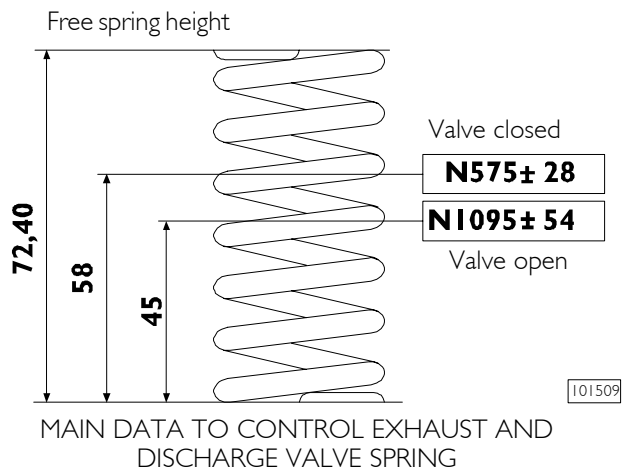
Figure 94



Before assembly, the flexibility of the valve springs must be checked.

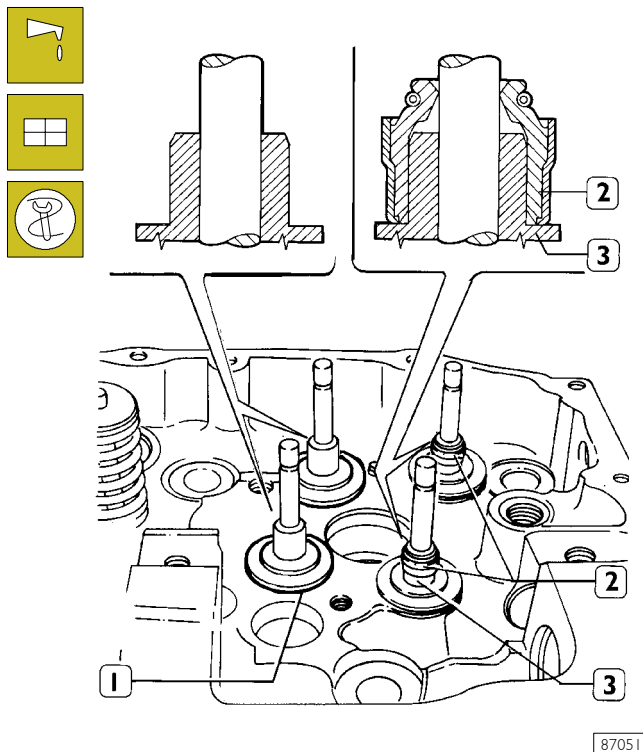
Compare the load and elastic deformation data with those of the new springs given in the following figure.

Figure 95



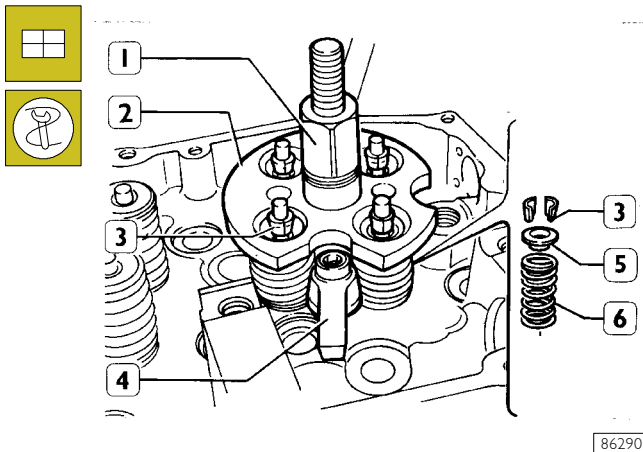
Fitting the valves and oil seal ring

Figure 96



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.

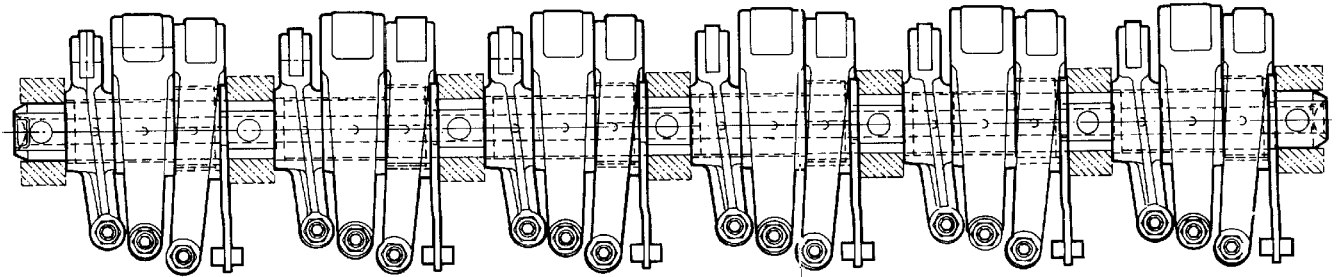
Figure 97



- ☐ fit springs (6) and the upper plate (5);
- ☐ apply tool 99360263 (2) and block it with bracket (4); tighten the lever (1) until cottons are installed (3), remove tool (2).

ROCKER SHAFT

Figure 98



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.

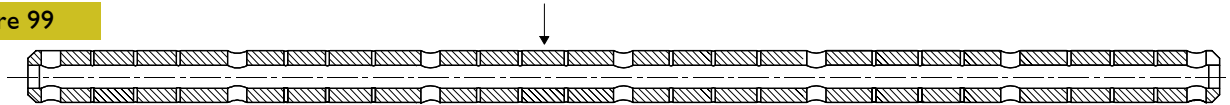
A pad is placed between the rocker adjusting screw and the bar.

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 99



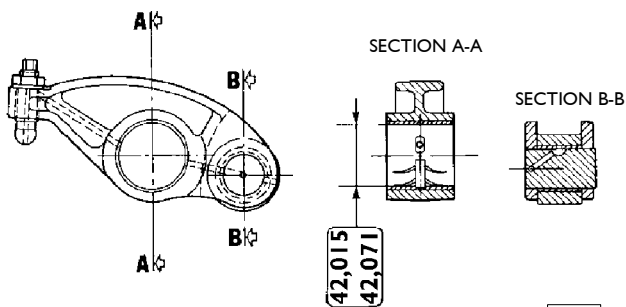
41,984
42,000

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.

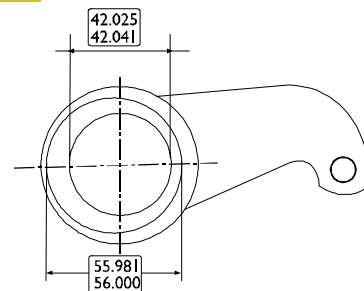
Rocker

Figure 100



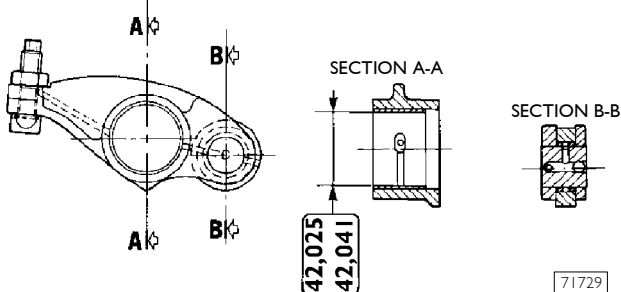
PUMP INJECTOR ROCKER

Figure 102



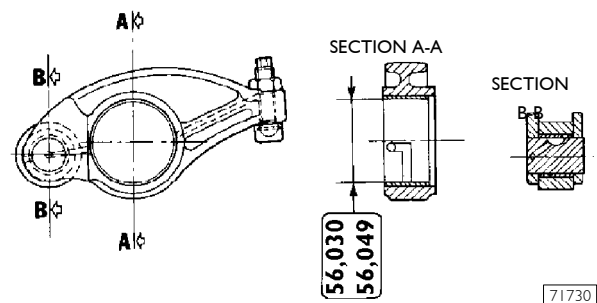
The bush surfaces must not show any trace of scoring or excessive wear; otherwise, replace bushes or the whole rocker.

Figure 101



EXHAUST VALVES ROCKER

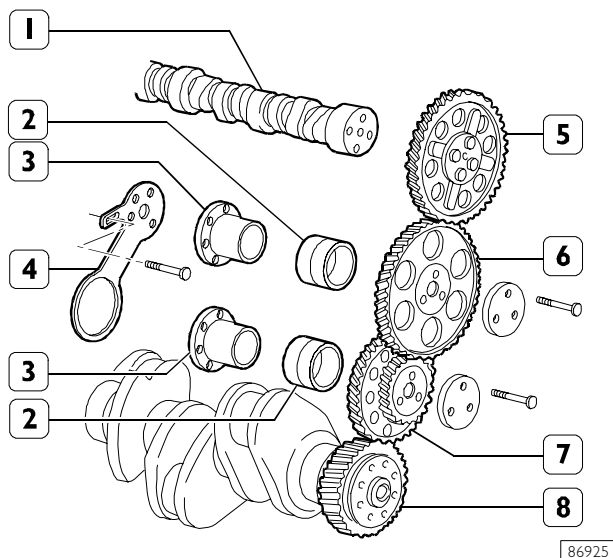
Figure 103



DISCHARGE VALVE ROCKER

TIMING GEAR Camshaft drive

Figure 104

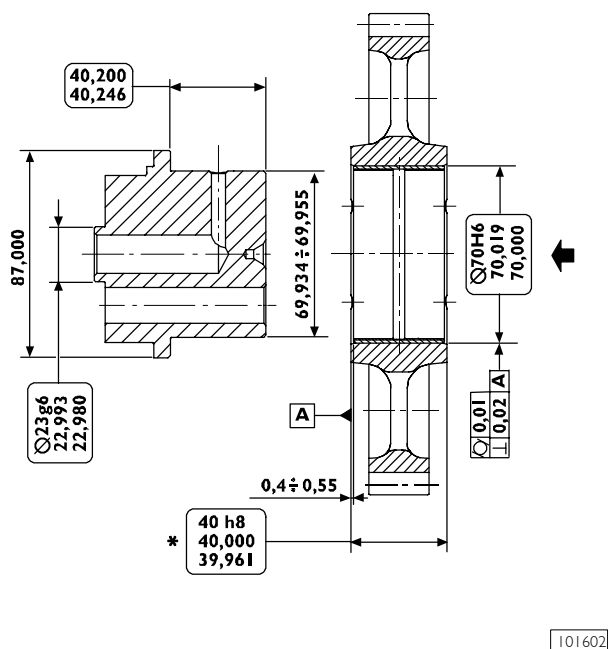


TIMING CONTROL COMPONENT PARTS

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

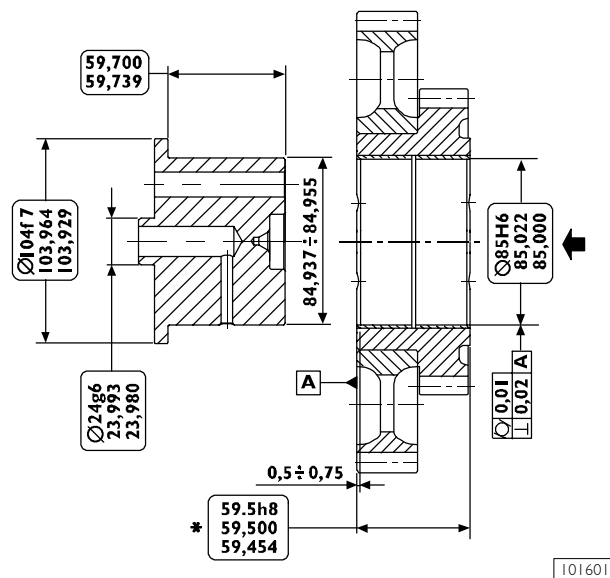
Figure 105



* This measurement is obtained after assembling.

Twin intermediate gear pin Twin idler gear

Figure 106



* 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 105 or Figure 106.

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 105 or Figure 106.

Rated assembling play between gear bushings and pins:
Figure 105 – 0.045 ± 0.075 mm
Figure 106 – 0.045 ± 0.085 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 ± 5	(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	100	(10)
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 M 10x1,5 l = 60 mm	30 ± 3	(3 ± 0.3)
	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)

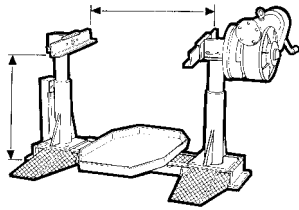
- ◆ Before assembly, lubricate with UTDM oil
- Before assembly, lubricate with graphitized oil

SECTION 5

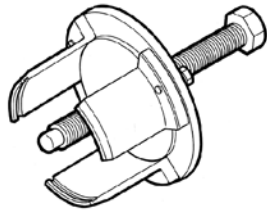
Tools

Page

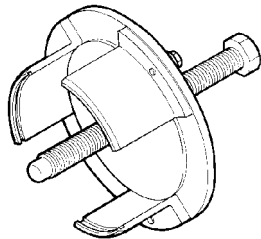
TOOLS	3
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TOOLS**TOOL NO.****DESCRIPTION****99322230**

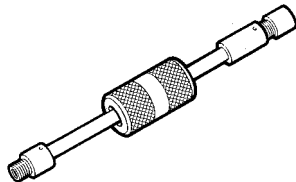
Rotary telescopic stand (range 2000 daN, torque 375 daNm)

99340053

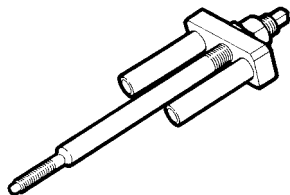
Extractor for crankshaft front gasket

99340054

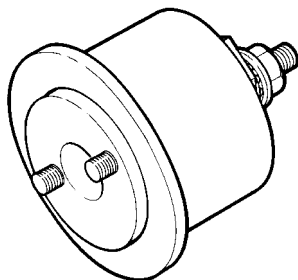
Extractor for crankshaft rear gasket

99340205

Percussion extractor

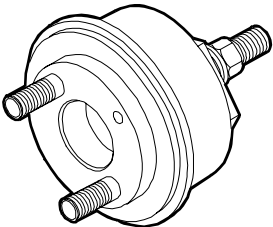
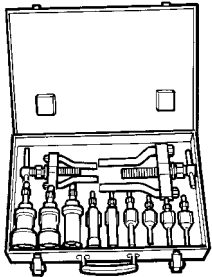
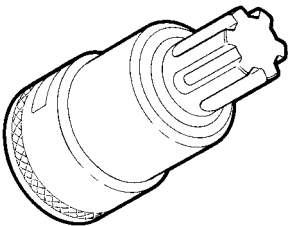
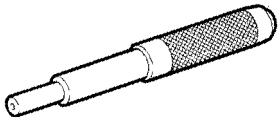
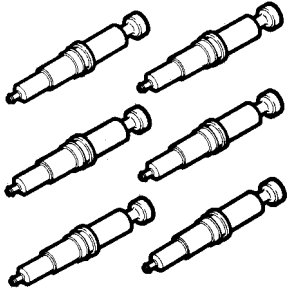
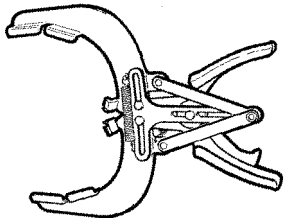
99342149

Extractor for injector-holder

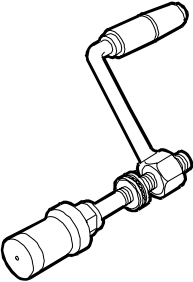
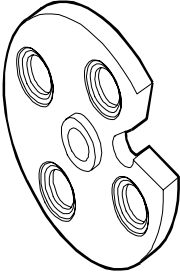
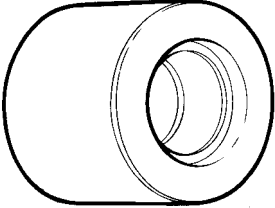
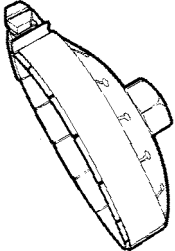
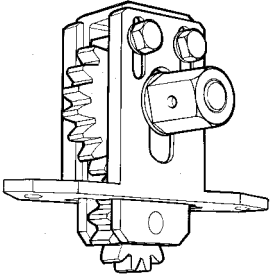
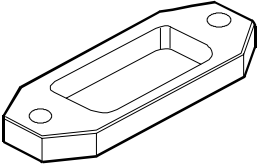
99346250

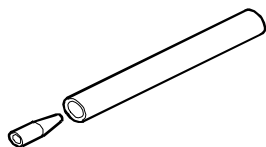
Tool to install the crankshaft front gasket

TOOLS

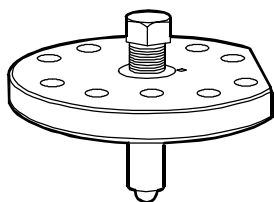
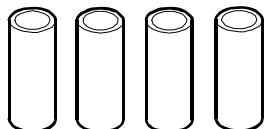
TOOL NO.	DESCRIPTION	
99346251		Tool to install the crankshaft rear gasket
99348004		Universal extractor for 5 to 70 mm internal components
99350072		Box wrench for block junction bolts to the underblock
99360143		Box wrench for block junction bolts to the underblock
99360180		Injector housing protecting plugs (6)
99360184		Pliers for assembling and disassembling piston split rings (105-106 mm)

TOOLS

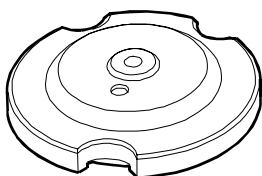
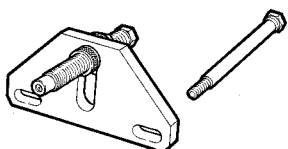
TOOL NO.	DESCRIPTION	
99360261		Tool to take down-fit engine valves (to be used with special plates)
99360263		Plate for take down-fit engine valves (to be used with 99360261)
99360296		Tool to fit back valve guide (to be used with 99360481)
99360314		Tool to remove oil filter (engine)
99360321		Tool to rotate engine flywheel (to be used with 99360325)
99360325		Spacer (to be used with 99360321)

TOOLS**TOOL NO.****DESCRIPTION****99360329**

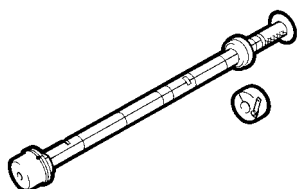
Tool to install gasket on valve guide

99360334Compression tool for checking the protrusion of cylinder liners
(to be used with 99370415-99395603 and special plates)**99360336**

Spacer (to be used with 99360334)

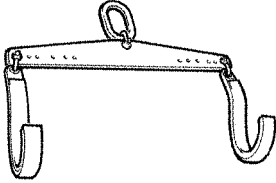
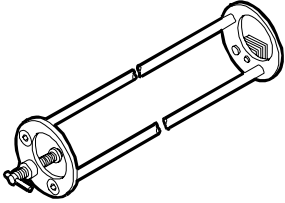
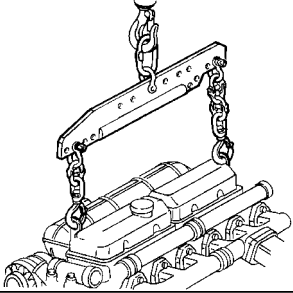
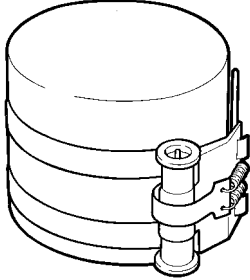
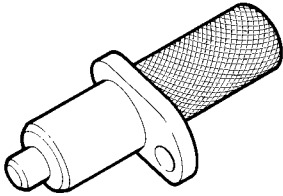
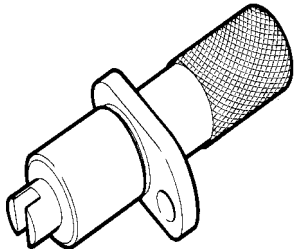
99360338Cylinder liner compression plate
(to be used with 99360334-99360336)**99360351**

Tool to stop engine flywheel

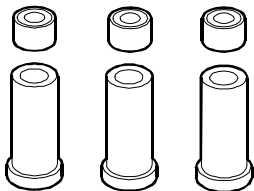
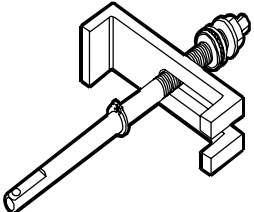
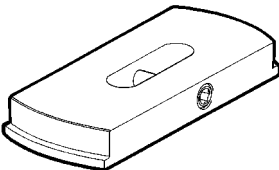
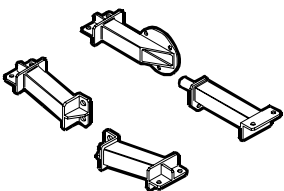
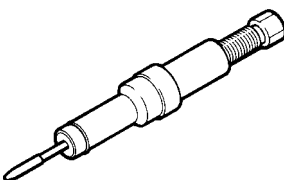
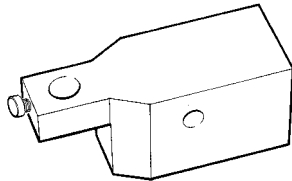
99360499

Tool to take down and fit back camshaft bushes

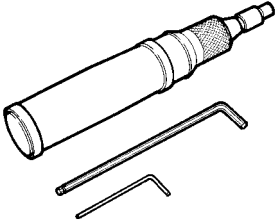
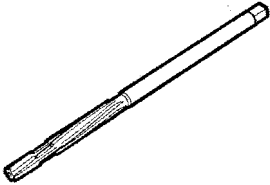
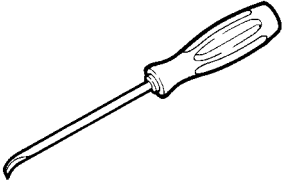
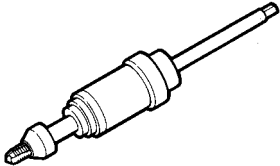
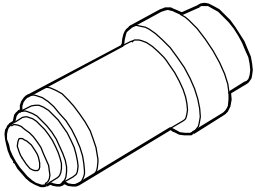
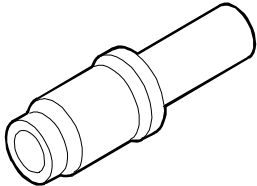
TOOLS

TOOL NO.	DESCRIPTION	
99360500		Tool to lift crankshaft
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

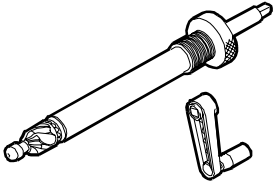
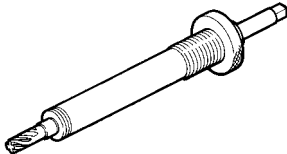
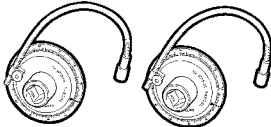
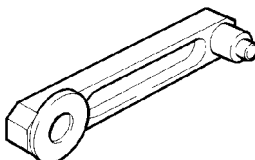
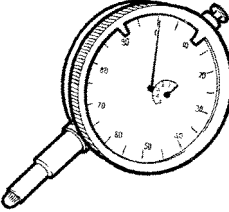
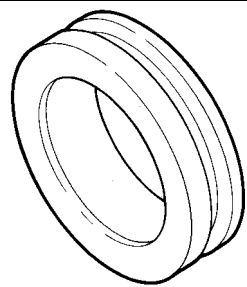
TOOLS

TOOL NO.	DESCRIPTION
99360703 	Tool to stop cylinder liners
99360706 	Tool to extract cylinder liners (to be used with specific rings)
99360728 	Ring (135 mm) (to be used with 99360706)
99361036 	Brackets fixing the engine to rotary stand 99322230
99365056 	Tool for injector holder heading
99370415 	Base supporting the dial gauge for checking cylinder liner protrusion (to be used with 99395603)

TOOLS

TOOL NO.		DESCRIPTION
99389834		Torque screwdriver (1-6 Nm) for calibrating the injector solenoid valve connector check nut
99390330		Valve guide sleeker
99390772		Tool for removing injector holding case deposits
99390804		Tool for threading injector holding cases to be extracted (to be used with 99390805)
99390805		Guide bush (to be used with 99390804)
99394015		Guide bush (to be used with 99394041 or 99394043)

TOOLS

TOOL NO.	DESCRIPTION	
99394041		Cutter to rectify injector holder housing (to be used with 99394015)
99394043		Reamer to rectify injector holder lower side (to be used with 99394015)
99395216		Measuring pair for angular tightening with 1/2" and 3/4" square couplings
99395219		Gauge for defining the distance between the centres of camshaft and transmission gear
99395603		Dial gauge (0 - 5 mm)
99396035		Centering ring of crankshaft front gasket cap

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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 FPT.
- ☐ Do not modify fuel systems or hydraulic system unless FPT 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.