CURSOR TIER 3 SERIES

Industrial application

C10

C10 ENT X

C13

C13 ENT X

CURSOR G-DRIVE

CURSOR 10 TE X
CURSOR 13 TE X

Technical and Repair manual

This publication provides unit and relevant component repair data, specifications, instructions and methodologies.

This publication has been drawn up for qualified and specialised personnel.

Before performing any operation check that the part relevant to the unit on which you must work is available along with all safety devices for accident-prevention, such as, goggles, helmet, gloves, shoes, etc. and hoisting and transporting equipment.

Operations are to be performed by following the indications included here, using the special equipment indicated and assuring proper repair, compliance with schedule and operator's safety requirements.

Each repair must aim to restore operating efficiency and safety in compliance with the FPT provisions.

FPT cannot be held liable for modifications, alterations or other interventions non authorised by FPT on the vehicle and if the unit is warranted the above mentioned interventions will cause its expiration.

FPT is not liable for repairing interventions.

FPT will provide further details required to carry out the interventions and all the instructions that are not included on this publication.

Data included in this publication may not be up-to-date therefore subject to Manufacturer's modifications that can be added at any time for technical or commercial purposes and also to meet new law regulations in other Countries.

If issues on this publication differ from what is actually noticed on the unit, please get in touch with the FPT network before starting any intervention".

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CURSOR ENGINES

PRELIMINARY REMARKS

Manuals for repairs are split into Parts and Sections, each one of which is marked by a numeral; the contents of these sections are indicated in the general table of contents.
The sections dealing with things mechanic introduce the specifications, tightening torque values, tool lists, assembly detaching/reattaching operations, bench overhauling operations, diagnosis procedures and maintenance schedules.
The sections (or parts) of the electric/electronic system include the descriptions of the electric network and the assembly's electronic systems, wiring diagrams, electric features of components, component coding and the diagnosis procedures for the control units peculiar to the electric system.
The manual uses proper symbols in its descriptions; the purpose of these symbols is to classify contained information. In particular, there have been defined a set of symbols to classify warnings and a set for assistance operations.

SYMBOLS - WARNINGS

Danger for persons
Missing or incomplete observance of these prescriptions can cause serious danger for persons' safety.

Danger of serious damage for the assembly
Failure to comply, both fully or in part, with such prescriptions will involve serious damage to the assembly and may sometimes cause the warranty to become null and void.

General danger
It includes the dangers of above described signals.

Environment protection
Moreover, it describes the correct actions to be taken to ensure that the assembly is used in such a way so as to protect the environment as much as possible.

NOTE It indicates an additional explanation for a piece of information.

GENERAL WARNINGS

Warnings shown cannot be representative of all danger situations possibly occurring. Therefore, it is suggested to contact immediate superiors where a danger situation occurs which is not described.

Use both specific and general-purpose toolings according to the prescriptions contained in respective use and maintenance handbooks. Check use state and suitability of tools not subjected to regular check.

The manual handling of loads must be assessed in advance because it also depends, besides weight, on its size and on the path.

Handling by mechanical means must be with hoisters proper as for weight as well as for shape and volume. Hoisters, ropes and hooks used must contain clear indications on maximum carrying capacity acceptable. The use of said means is compulsorily permitted to authorised personnel only. Stay duly clear of the load, and, anyhow, never under it.

In disassembling operations, always observe provided prescriptions; prevent mechanical parts being taken out from accidentally striking workshop personnel.

Workshop jobs performed in pairs must always be performed in maximum safety; avoid operations which could be dangerous for the co-operator because of lack of visibility or of his/her not correct position.

Keep personnel not authorised to operations clear of working area.

You shall get familiar with the operating and safety instructions for the assembly prior to operating on the latter. Strictly follow all the safety indications found on the assembly.

Do not leave the running assembly unattended when making repairs.

When carrying out work on the assembly lifted off the ground, verify that the assembly is firmly placed on its supporting stands, and that the manual/automatic safety devices have been actuated in the event that the assembly is to be lifted by means of a hoist.

When you have to operate on assemblies powered by natural gas, follow the instructions contained in the document, as well as all the specific safety standards provided for.

Only remove radiator cap when the engine is cold by cautiously unscrewing it in order to let system residual pressure out.

Inflammable fuel and all inflammable fluids and liquids must be handled with care, according to what contained on harmful materials 12-point cards. Refuelling must be performed outdoors with the engine off, avoiding lit cigarettes, free flames or sparks in order to prevent sudden fires/bursts. Adequately store inflammable, corrosive and polluting fluids and liquids according to what provided by regulations in force. Compulsorily avoid to use food containers to store harmful liquids. Avoid to drill or bore pressurised containers, and throw cloths impregnated with inflammable substances into suitable containers.

Worn out, damaged or consumable parts must be replaced by original spares.

During workshop activity, always keep the work place clean; timely clear or clean floors from accidental liquid or oil spots. Electric sockets and electric equipment necessary to perform repair interventions must meet safety rules.

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Put on, where required by the intervention, garments and protections provided in accident prevention rules; contact with moving parts can cause serious injuries. Use suitable, preferably tight-fitted garments, and avoid to use jewels, scarves, etc.

Do not leave the engine in motion at workshop locations not provided with a pipe to scavenge exhaust gas outside.

Avoid to breathe fumes coming from heating or from paint welding because they can cause damages to health; operate outdoors or in suitably ventilated areas. Put on proper inspirator if paint powder is present.

Avoid contact with hot water or steam coming from the engine, radiator and pipings because they could cause serious burns. Avoid direct contact with liquids and fluids present in vehicle systems; where an accidental contact has occurred, refer to 12-point cards for provisions to make.

Clean the assemblies and carefully verify that they are intact prior to overhauling. Tidy up detached or disassembled parts with their securing elements (screws, nuts, etc.) into special containers.

Check for the integrity of the parts which prevent screws from being unscrewed: broken washers, dowels, clips, etc. Self-locking nuts with an insert made of nylon must always be replaced.

Avoid contact of rubber parts with diesel oil, petrol or other not compatible substances.

Before washing under pressure mechanical parts, protect electric connectors, and central units, if present.

Tightening screws and nuts must always be according to prescriptions; FPT commercial and assistance network is available to give all clarifications necessary to perform repair interventions not provided in this document.

Before welding:

- ❑ Disconnect all electronic central units, take power cable off battery positive terminal (connect it to chassis bonding) and detach connectors.
- ❑ Remove paint by using proper solvents or paint removers and clean relevant surfices with soap and water.
- ❑ Await about 15 minutes before welding.
- ❑ Equip with suitable fire resistant protections to protect hoses or other components where fluids or other materials flow which may catch fire easily on welding.

Should the vehicle be subjected to temperatures exceeding 80°C (dryer ovens), disassemble drive electronic central units.

The disposal of all liquids and fluids must be performed with full observance of specific rules in force.

GENERAL WARNINGS ON THE ELECTRIC SYSTEM

If an intervention has to be made on the electric/electronic system, disconnect batteries from the system; in this case, always disconnect, as a first one, the chassis bonding cable from batteries negative terminal.

Before connecting the batteries to the system, make sure that the system is well isolated.

Disconnect the external recharging apparatus from the public utility network before taking apparatus pins off battery terminals.

Do not cause sparks to be generated in checking if the circuit is energised.

Do not use a test lamp in checking circuit continuity, but only use proper control apparatuses.

Make sure that the electronic devices wiring harnesses (length, lead type, location, strapping, connection to screening braiding, bonding, etc.) comply with system and are carefully recovered after repair or maintenance interventions.

Measurements in drive electronic central units, plugged connections and electric connections to components can only be made on proper testing lines with special plugs and plug bushes. Never use improper means like wires, screwdrivers, clips and the like in order to avoid the danger of causing a short circuit, as well as of damaging plugged connections, which would later cause contact problems.

To start up the engine, do not use fast chargers. Start up must only be performed with either separate batteries or special truck.

A wrong polarisation of supply voltage in drive electronic central units (for instance, a wrong polarisation of batteries) can cause them to be destroyed.

Disconnect the batteries from the system during their recharging with an external apparatus.

On connecting, only screw up connector (temperature sensors, pressure sensors etc.) nuts at prescribed tightening torque.

Before disconnecting the junction connector from an electronic central unit, isolate the system.

Do not directly supply electronic central units servo components at nominal vehicle voltage.

Cables must be arranged such as to result to be parallel to reference plane, i.e. as close as possible to chassis/body structure.

Once the intervention on the electric system has been completed, recover connectors and wiring harnesses according to original arrangement.

NOTE Connectors present must be seen from cable side. Connectors views contained in the manual are representative of cable side.

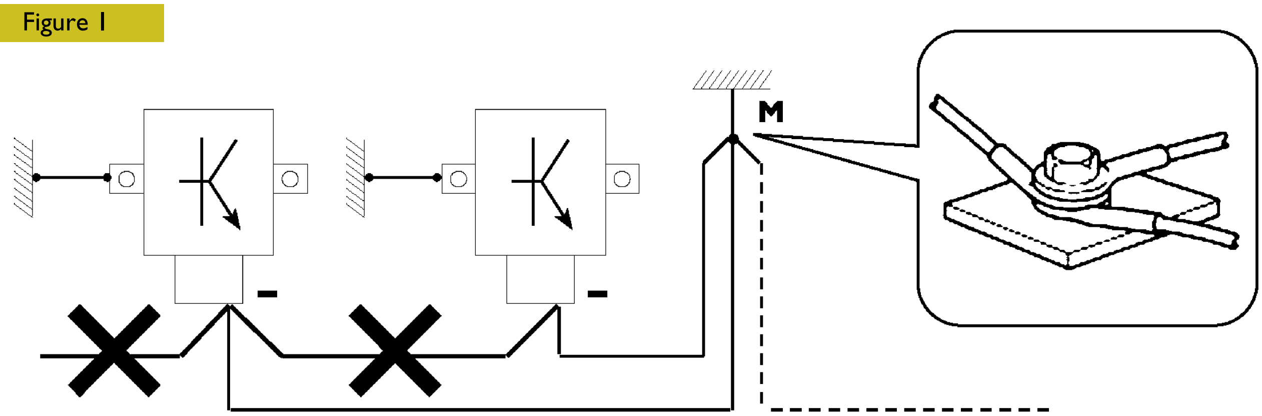
Bonding and screening

Negative leads connected to a system bonded point must be both as short and possible and "star"-connected to each other, trying then to have their centering tidily and properly made (Figure 1, re. M).

Further, following warnings are to be compulsorily observed for electronic components:

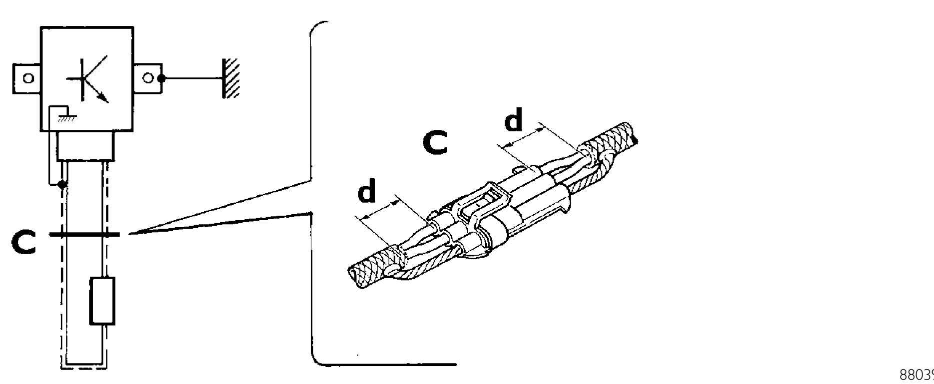
- Electronic central units must be connected to system bonding when they are provided with a metallic shell.
- Electronic central units negative cables must be connected both to a system bonding point such as the dashboard opening bonding (avoiding "serial" or "chain" connections), and to battery negative terminal.
- Analog bonding (sensors), although not connected to battery negative system/terminal bonding, must have optimal isolation. Consequently, particularly considered must be parasitic resistances in lugs: oxidising, clinching defects, etc.
- Screened circuits braiding must only electrically contact the end towards the central unit entered by the signal (Figure 2).
- If junction connectors are present, unscreened section **d**, near them, must be as short as possible (Figure 2).
- Cables must be arranged such as to result to be parallel to reference plane, i.e. as close as possible to chassis/body structure.

Figure 1



1. NEGATIVE CABLES "STAR" CONNECTION TO SYSTEM BONDING M

Figure 2



2. SCREENING THROUGH METALLIC BRAIDING OF A CABLE TO AN ELECTRONIC COMPONENT – **C.** CONNECTOR
d. DISTANCE → 0

OPTIONAL ELECTRICAL AND MECHANICAL PARTS INSTALLATIONS

Assemblies shall be modified and equipped with additions - and their accessories shall be fitted - in accordance with the assembling directives issued by FPT.
It is reminded that, especially about the electric system, several electric sockets are provided for as series (or optional) sockets in order to simplify and normalise the electrical intervention that is care of preparation personnel.

It is absolutely forbidden to make modifications or connections to electric central units wiring harnesses; in particular, the data interconnection line between central units (CAN line) is to be considered inviolable.

CONVERSIONS BETWEEN THE MAIN UNITS OF MEASUREMENT OF THE INTERNATIONAL SYSTEM AND MOST USED DERIVED QUANTITIES

Power

1 kW	=	1.36 metric HP
1 kW	=	1.34 HP
1 metric HP	=	0.736 kW
1 metric HP	=	0.986 HP
1 HP	=	0.746 kW
1 HP	=	1.014 metric HP

Torque

1 Nm	=	0.1019 kgm
1 kgm	=	9.81 Nm

Revolutions per time unit

1 rad/s	=	1 rpm x 0.1046
1 rpm	=	1 rad/s x 9.5602

Pressure

1 bar	=	1.02 kg/cm^2
1 kg/cm^2	=	0.981 bar
1 bar	=	10^5 Pa

Where accuracy is not particularly needed:

- Nm unit is for the sake of simplicity converted into kgm according to ratio 10:1

1 kgm = 10 Nm;

- bar unit is for the sake of simplicity converted into kg/cm^2 according to ratio 1:1

1 kg/cm^2 = 1 bar.

Temperature

0° C	=	32° F
1° C	=	(1 x 1.8 + 32) ° F

Part 1
CURSOR ENGINES F3A

PREFACE TO USER'S GUIDELINE MANUAL

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

Section 2 describes the type of fuel feed.

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

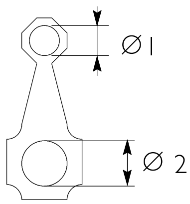
1. Mechanical part, related to the engine overhaul, limited to those components with different characteristics based on the relating specific duty.
2. Electrical part, concerning wiring harness, electrical and electronic equipment with different characteristics based on the relating specific duty.
3.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

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

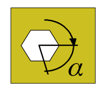
Diagrams and symbols have been widely used to give a clearer and more immediate illustration of the subject being dealt with, (see next page) instead of giving descriptions of some operations or procedures.

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

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

UPDATING

Section	Description	Page	Date of revision

SECTION 1

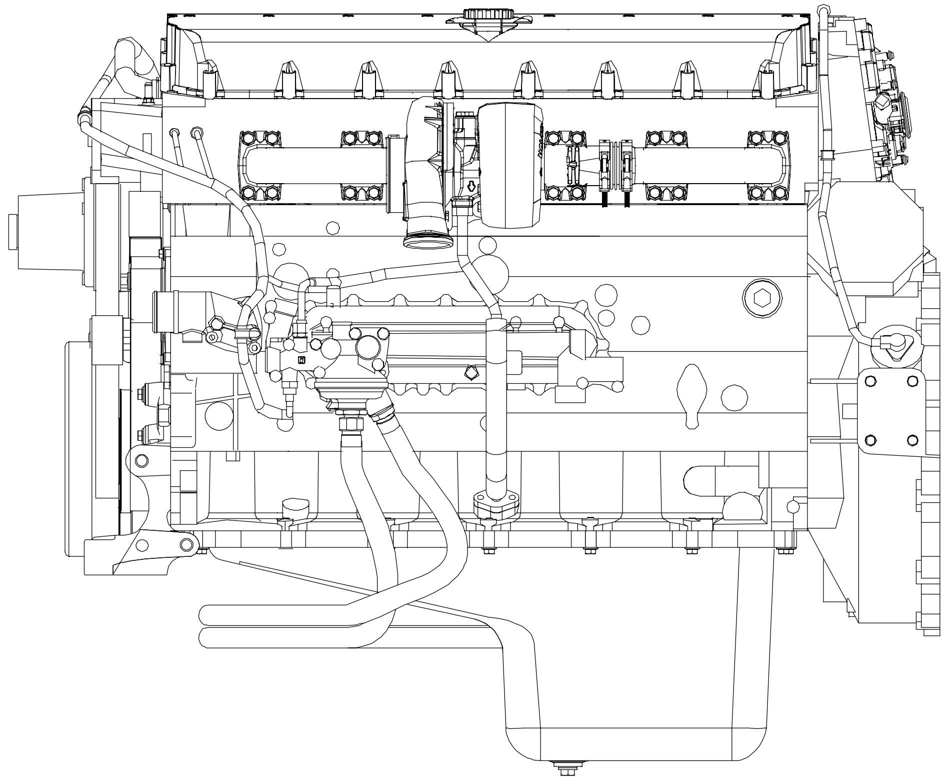
General Specifications

CORRESPONDENCE BETWEEN TECHNICAL AND COMMERCIAL CODES

Technical Code	Commerciale Code
F3AE0684P*E904	
F3AE0684P*E906	
F3AE0684L*E906	
F3AE0684P*E905	C10 ENT X
F3AE0684N*E907	
F3AE9687A*E001	
F3AE9687B*E001	
F3AE9687C*E001	

VIEWS OF THE ENGINE (ONLY FOR TYPE F3AE0684P*E904)

Figure 1



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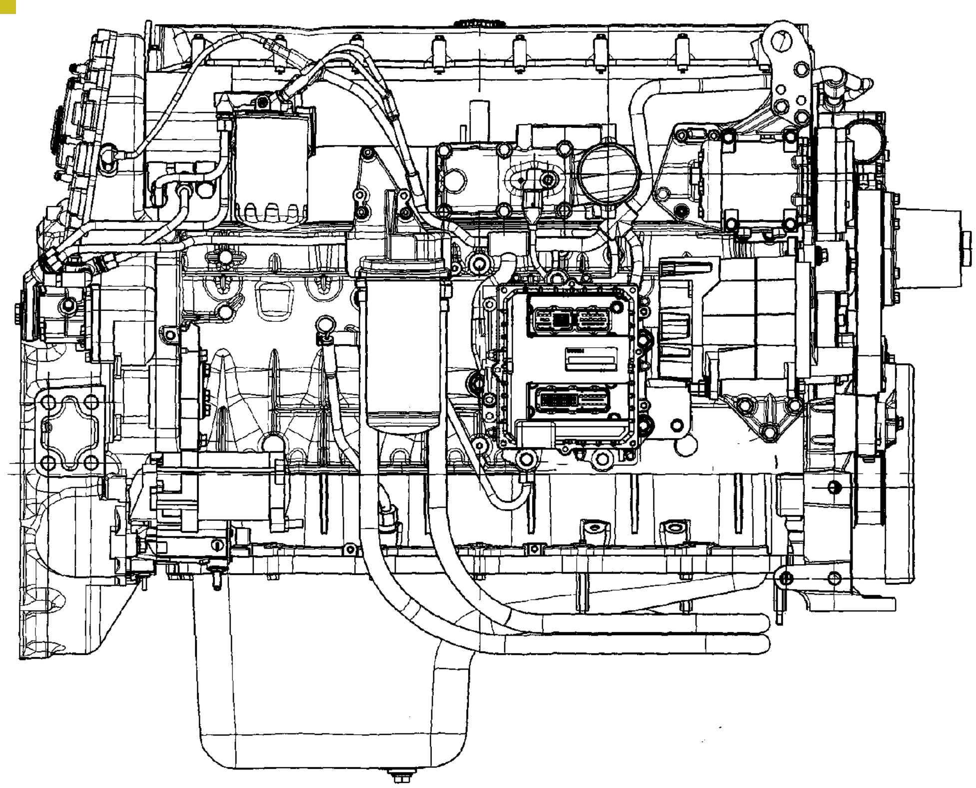
LEFT-HAND SIDE VIEW

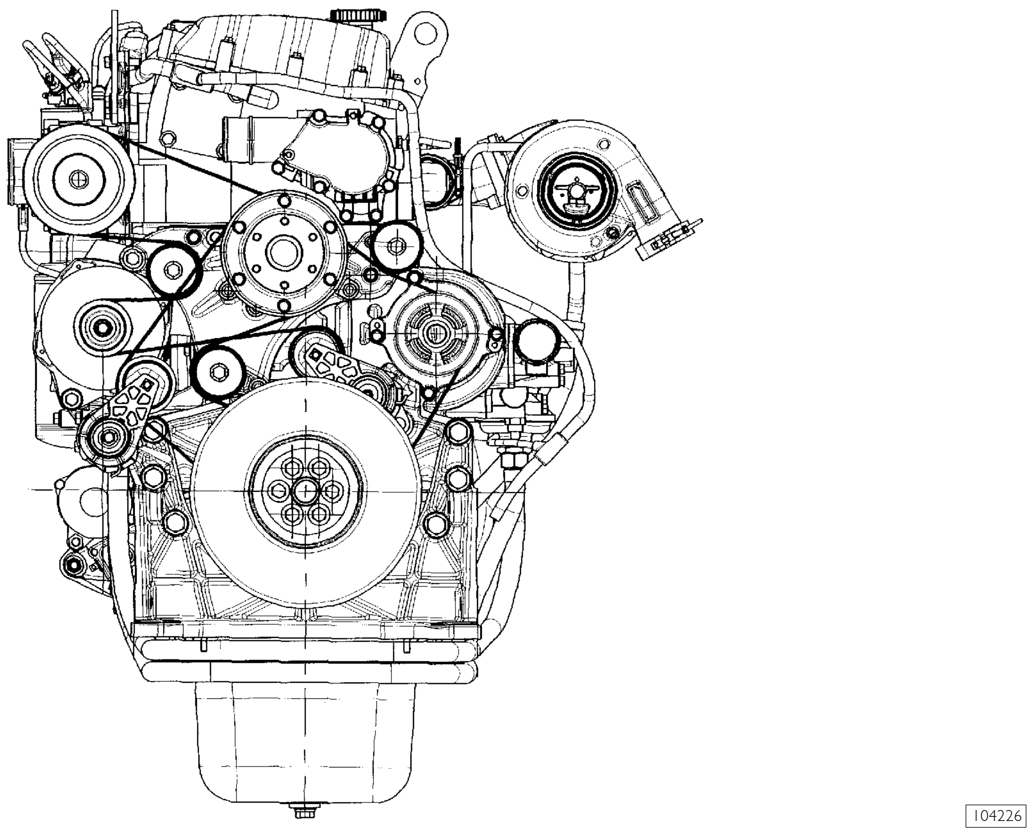
Figure 2



104225

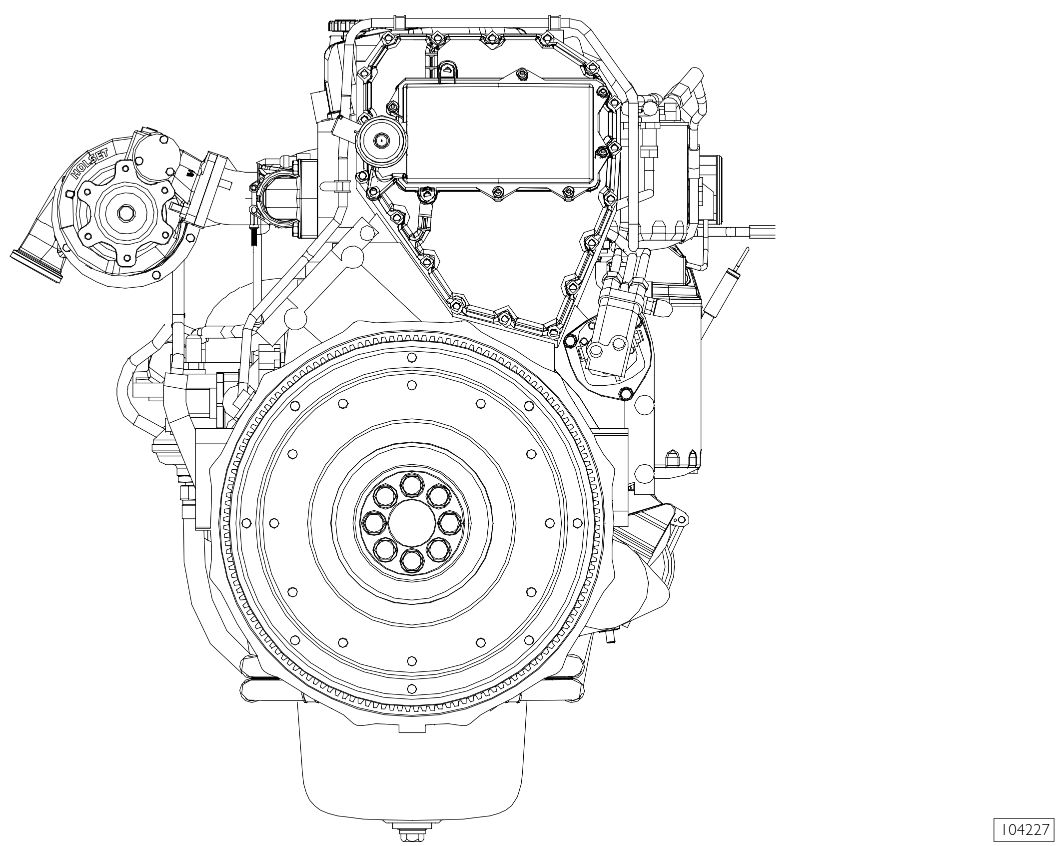
RIGHT-HAND SIDE VIEW

Figure 3



FRONT VIEW

Figure 4



REAR VIEW

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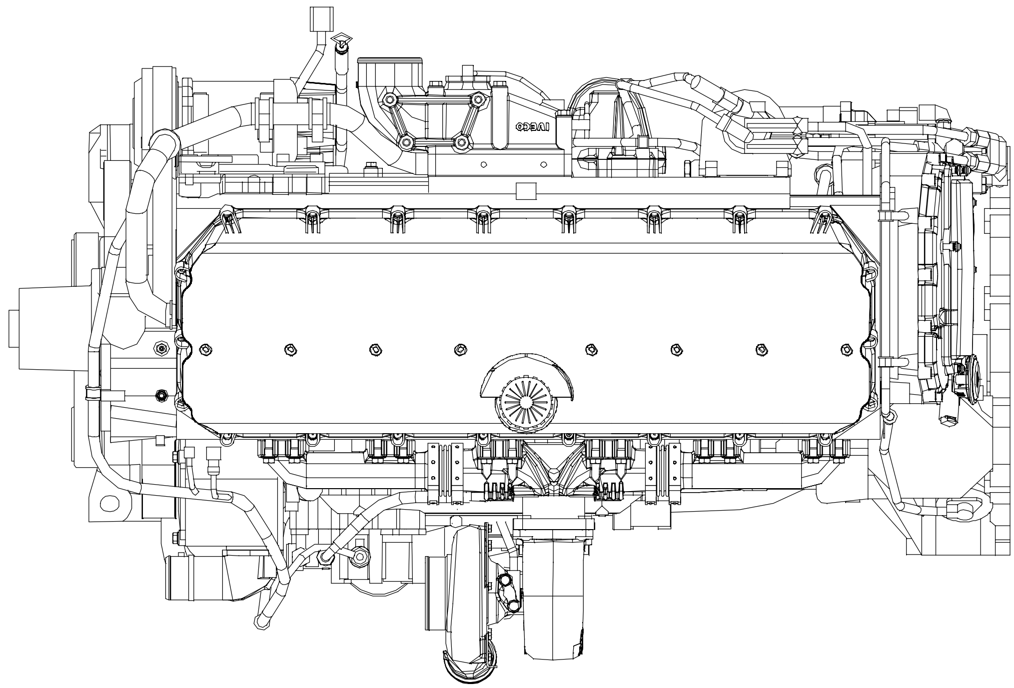
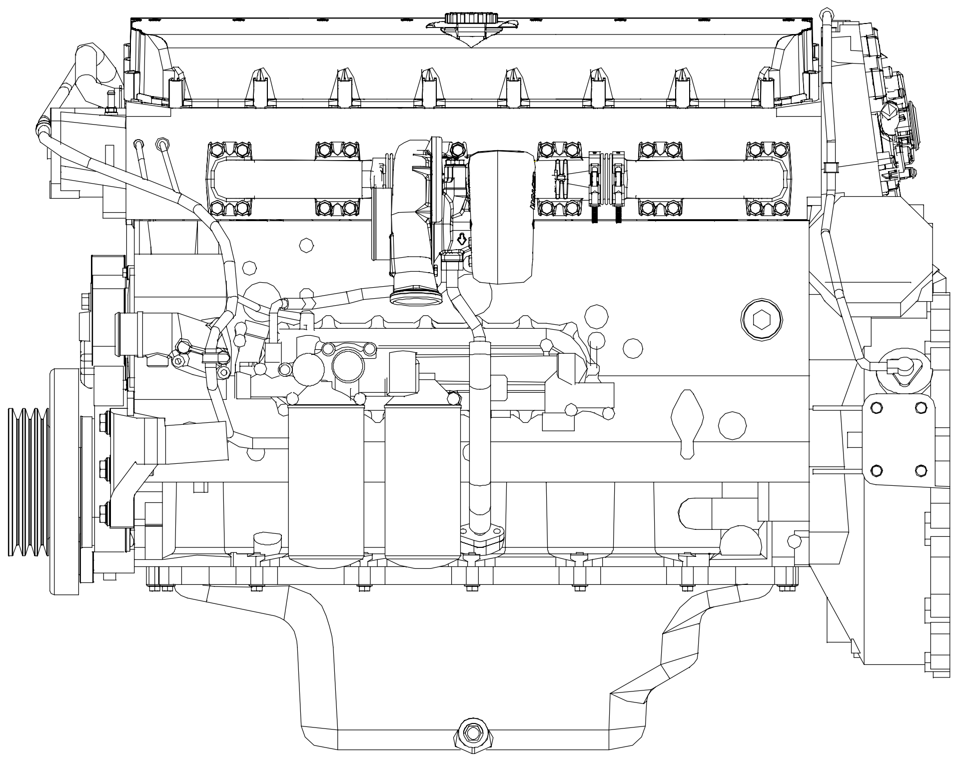
Figure 5


104228

TOP VIEW

VIEWS OF THE ENGINE (FOR TYPES: F3AE0684P*E906 - F3AE0684L*E906 - F3AE0684P*E905)

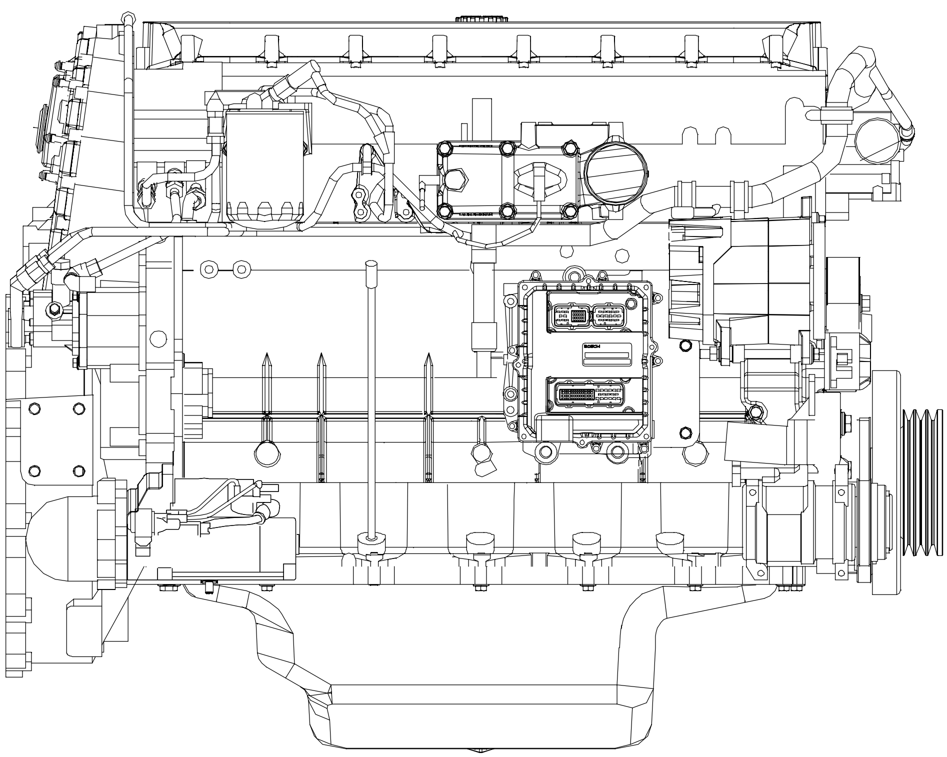
Figure 6



104229

LEFT-HAND SIDE VIEW

Figure 7



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RIGHT SIDE VIEW

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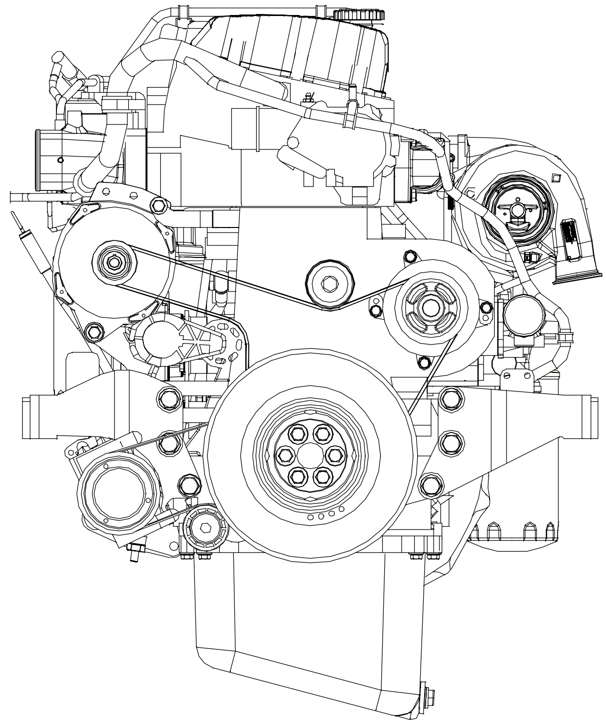
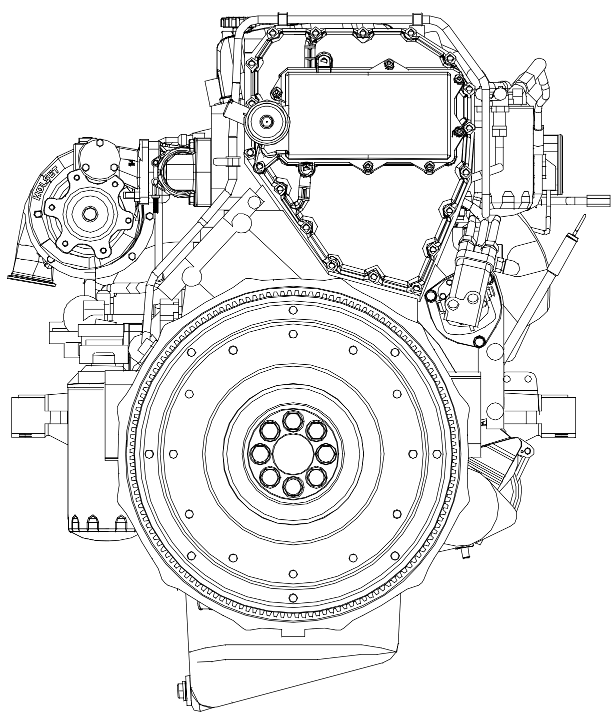
Figure 8


104231

FRONT SIDE VIEW

Figure 9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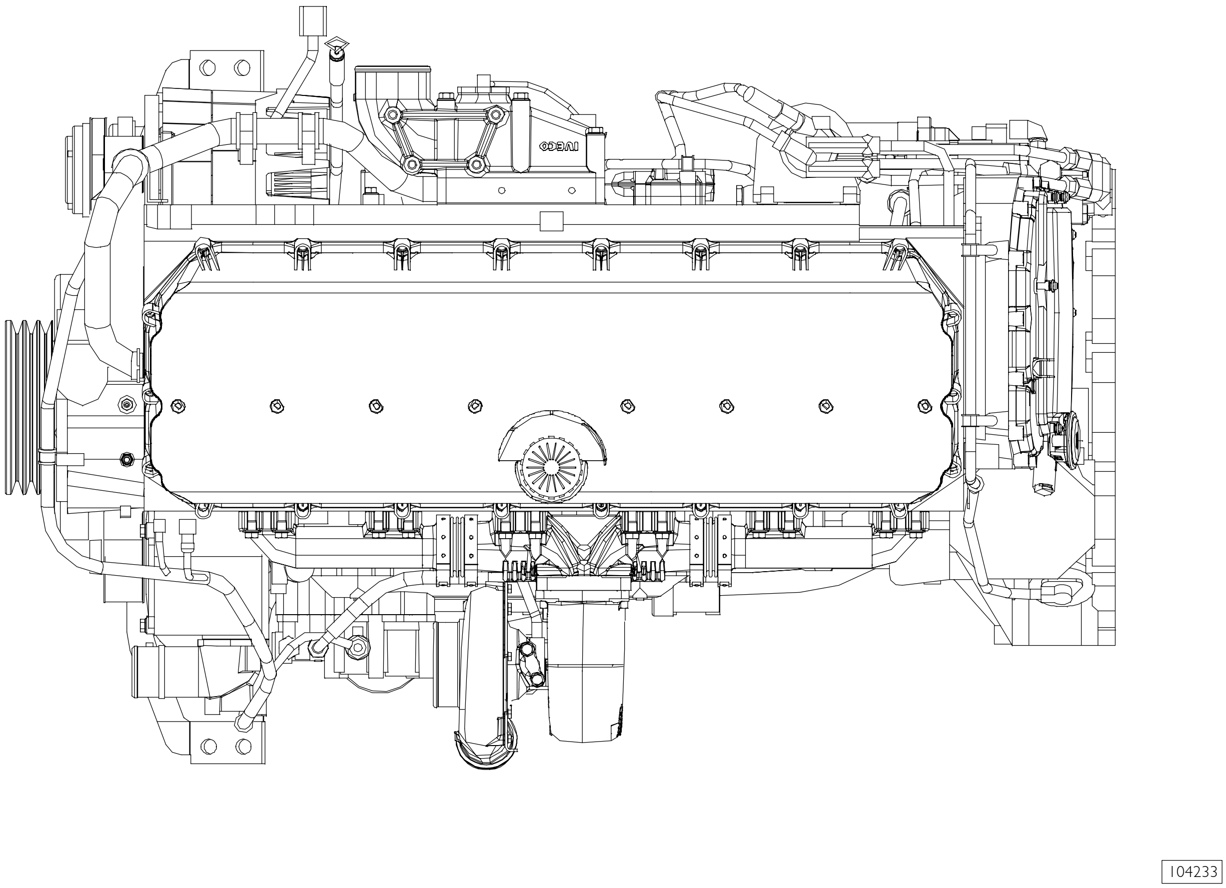
REAR SIDE VIEW

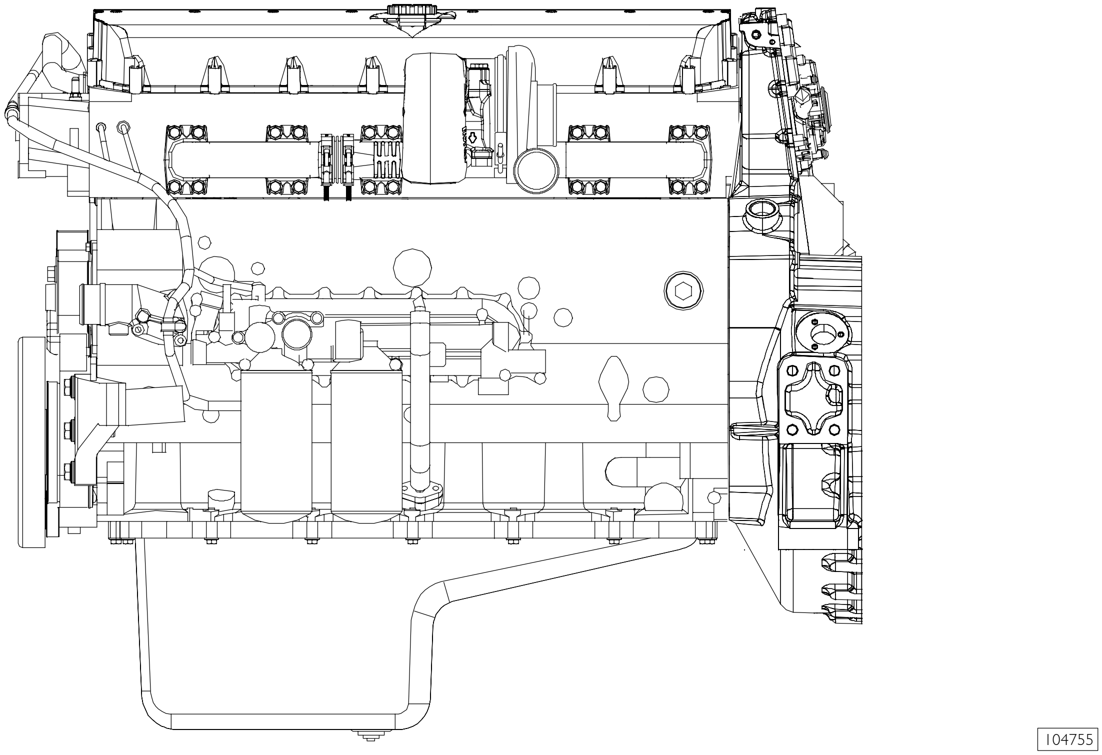
Figure 10



TOP SIDE VIEW

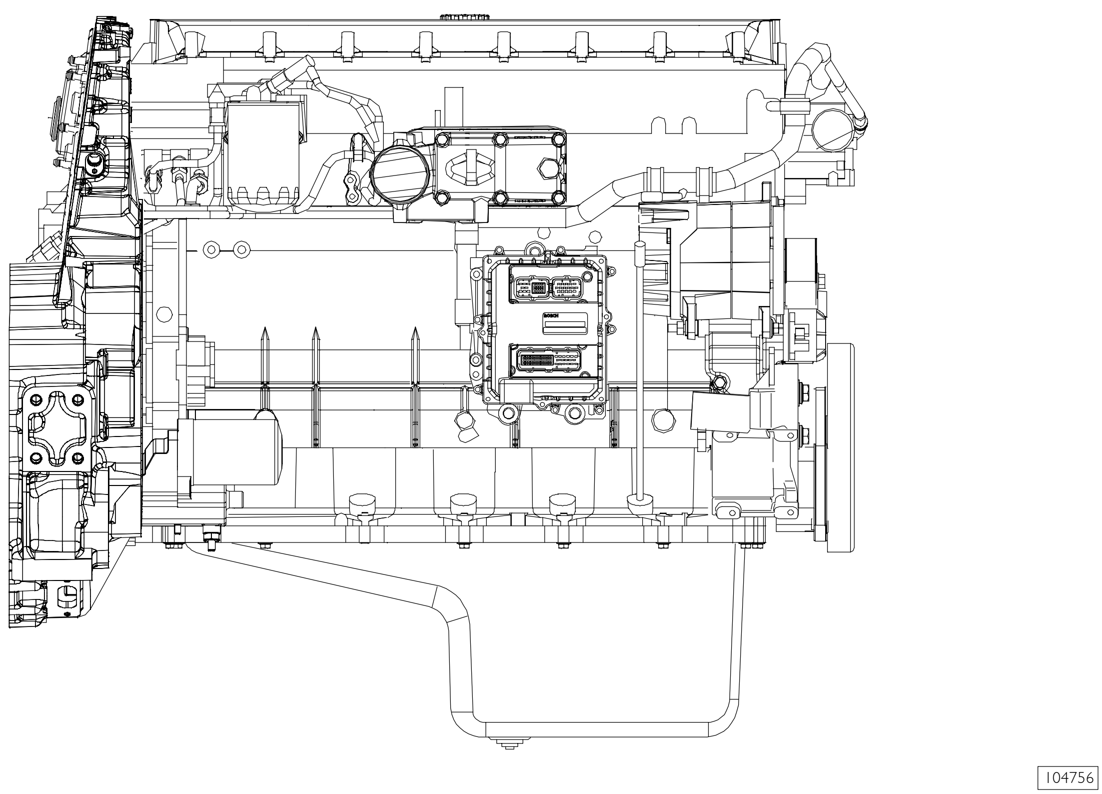
VIEWS OF THE ENGINE (ONLY FOR TYPE: F3AE0684N*E907)

Figure 11



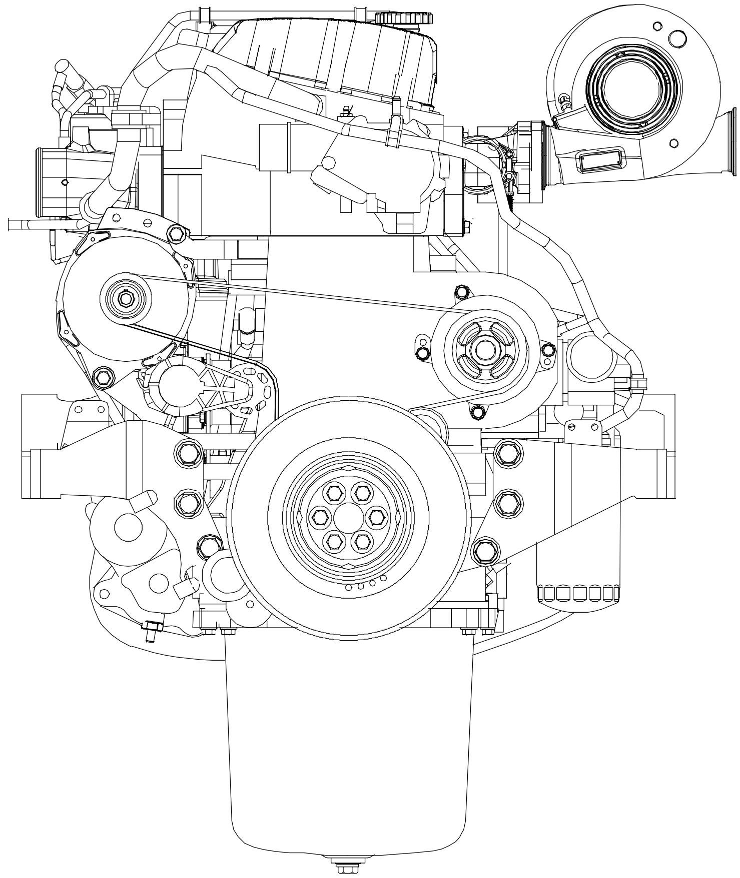
LEFT-HAND SIDE VIEW

Figure 12



RIGHT SIDE VIEW

Figure 13



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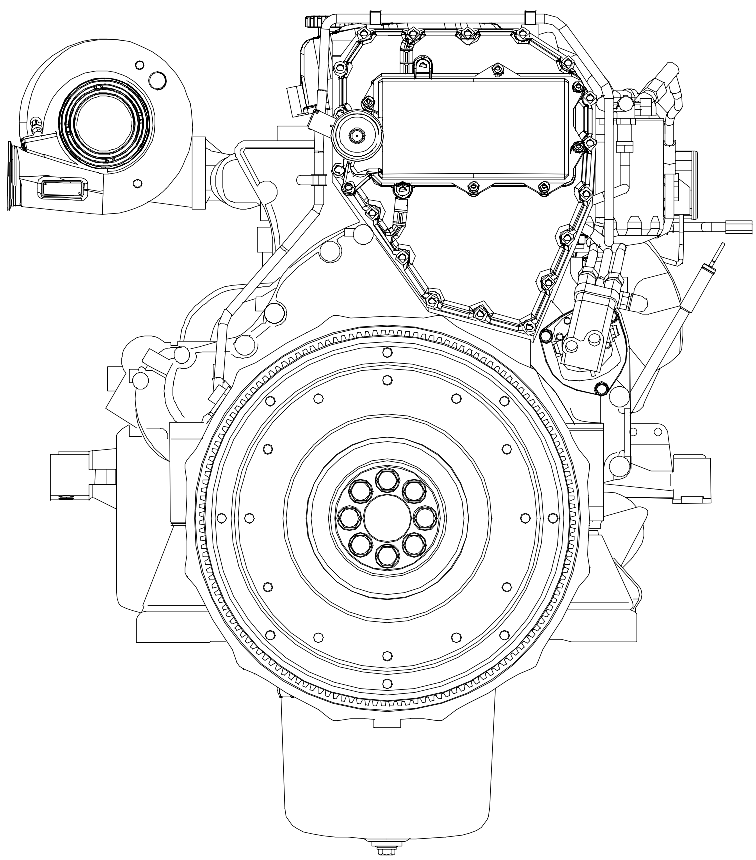
FRONT SIDE VIEW

Figure 14



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REAR SIDE VIEW

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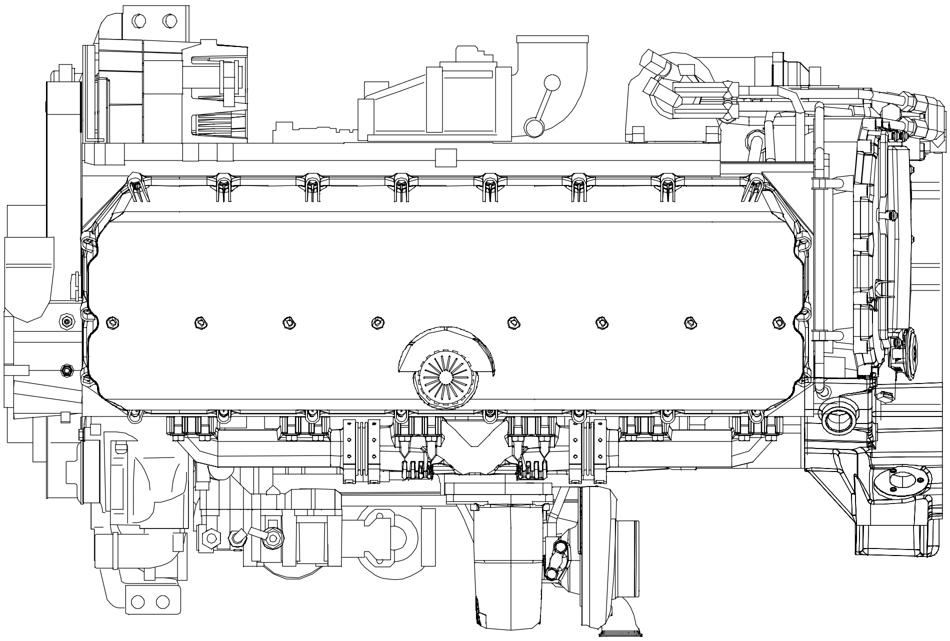
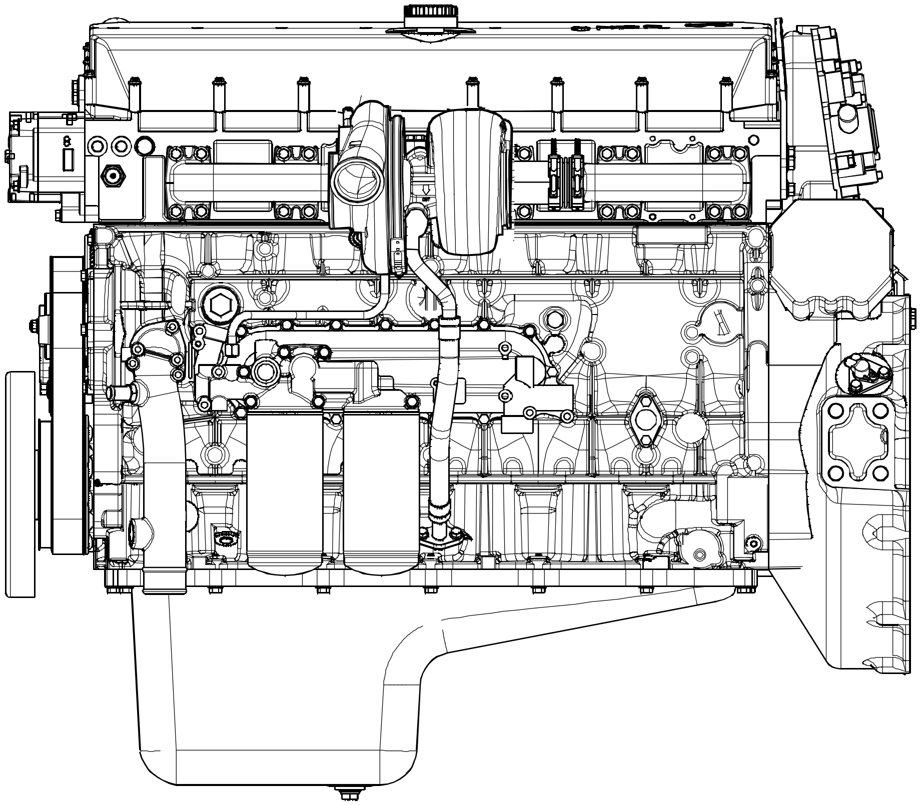
Figure 15



TOP SIDE VIEW

VIEWS OF THE ENGINE (FOR TYPES: F3AE9687A*E001 - F3AE9687B*E001 - F3AE9687C*E001)

Figure 16



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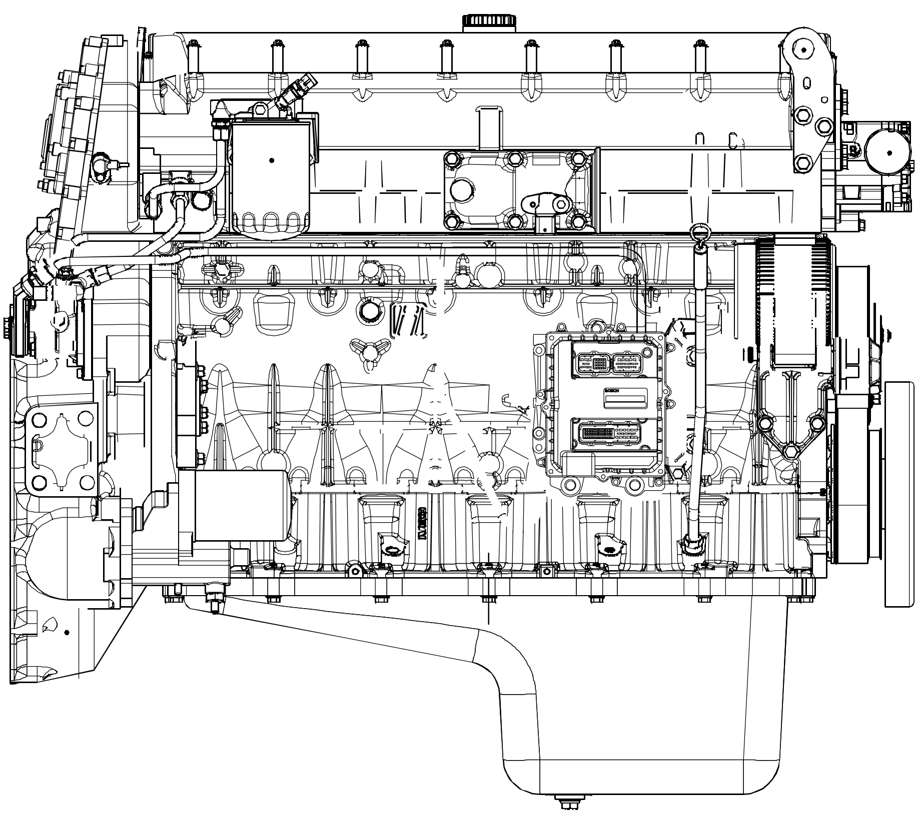
LEFT-HAND SIDE VIEW

Figure 17



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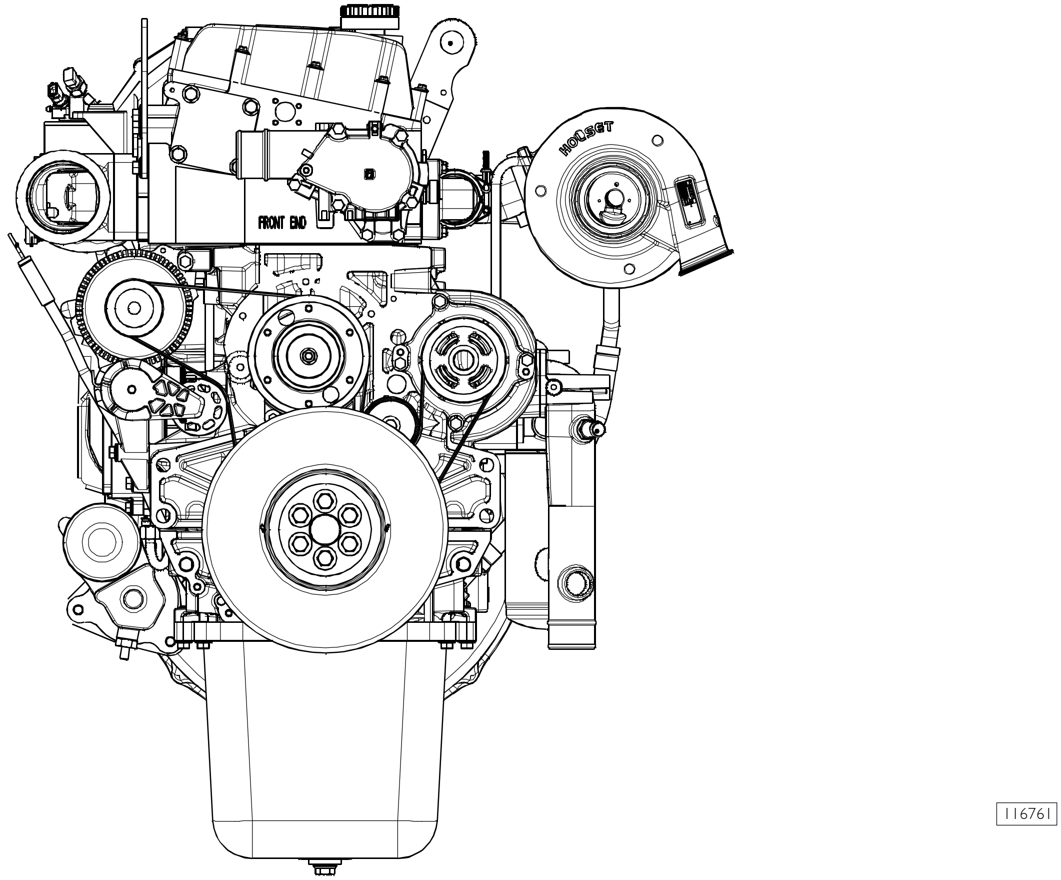
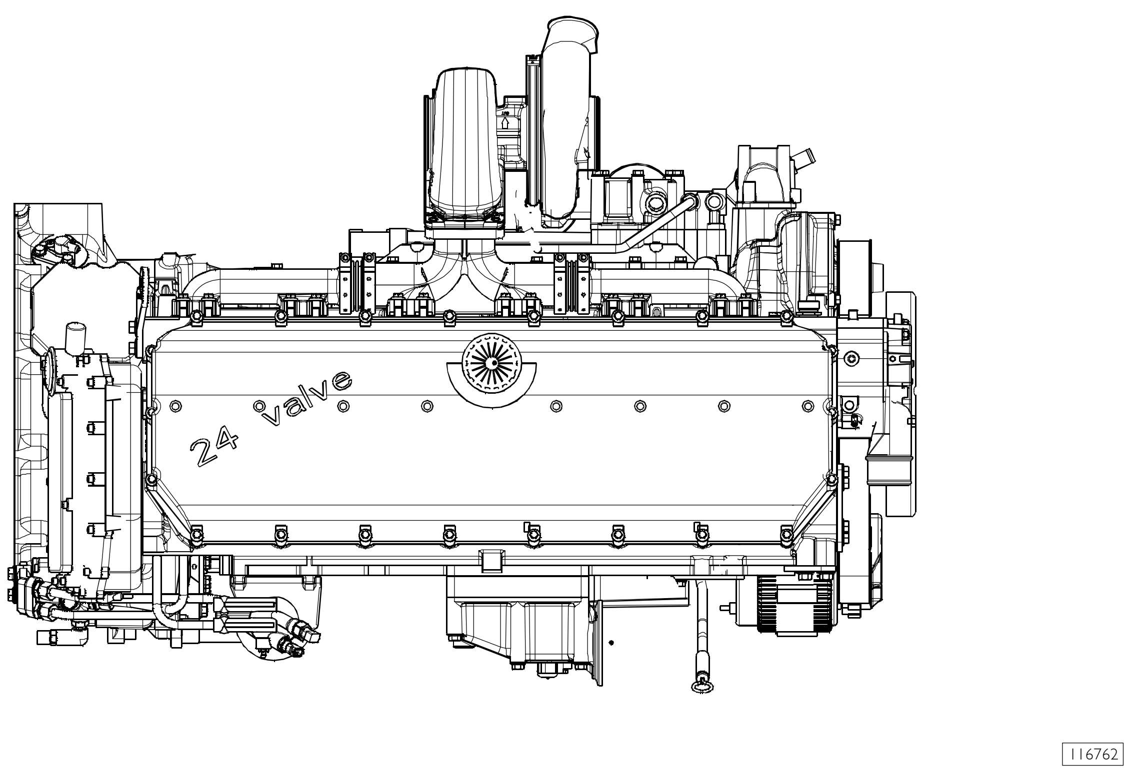
RIGHT SIDE VIEW

Figure 18



FRONT SIDE VIEW

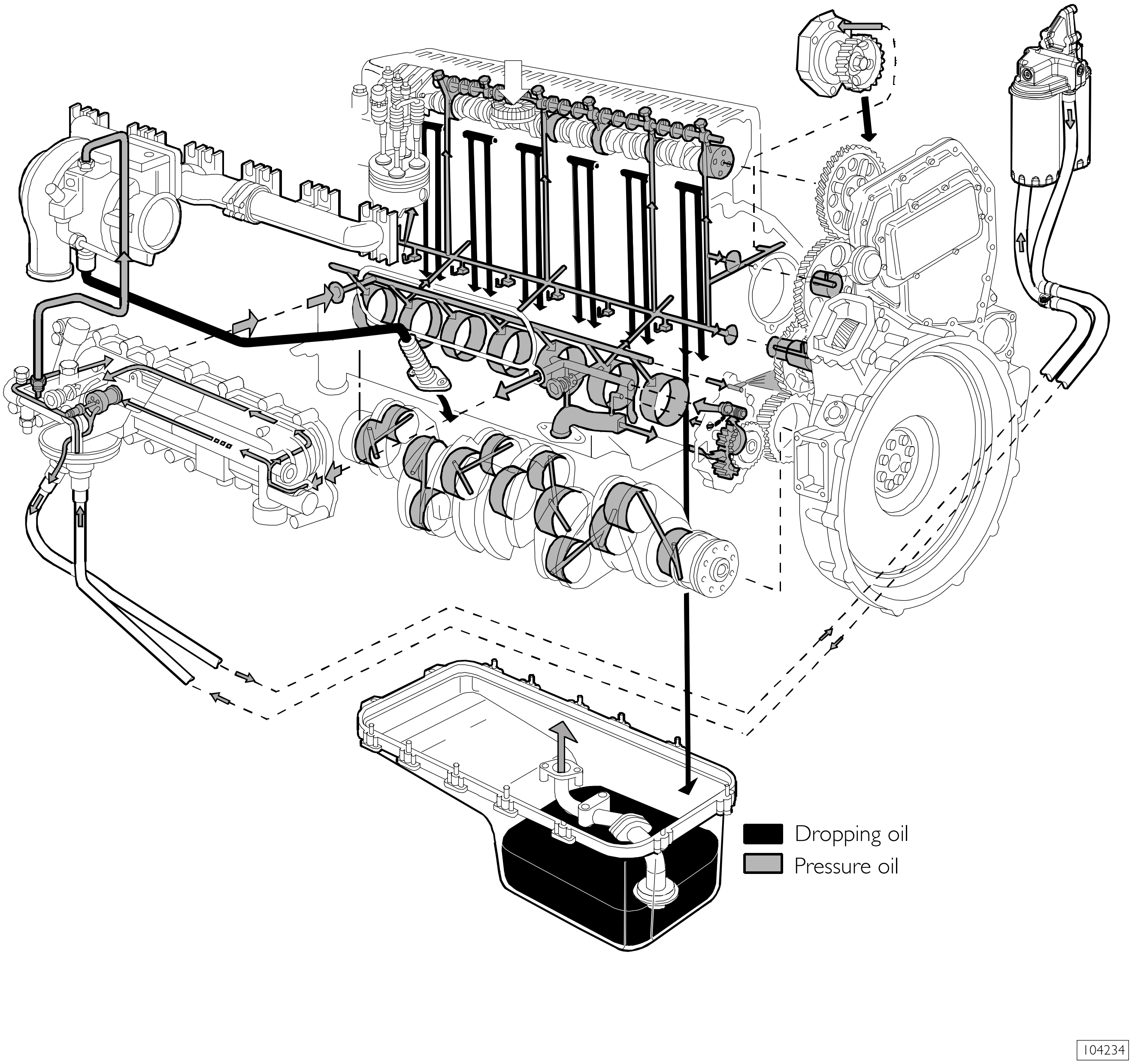
Figure 19



TOP SIDE VIEW

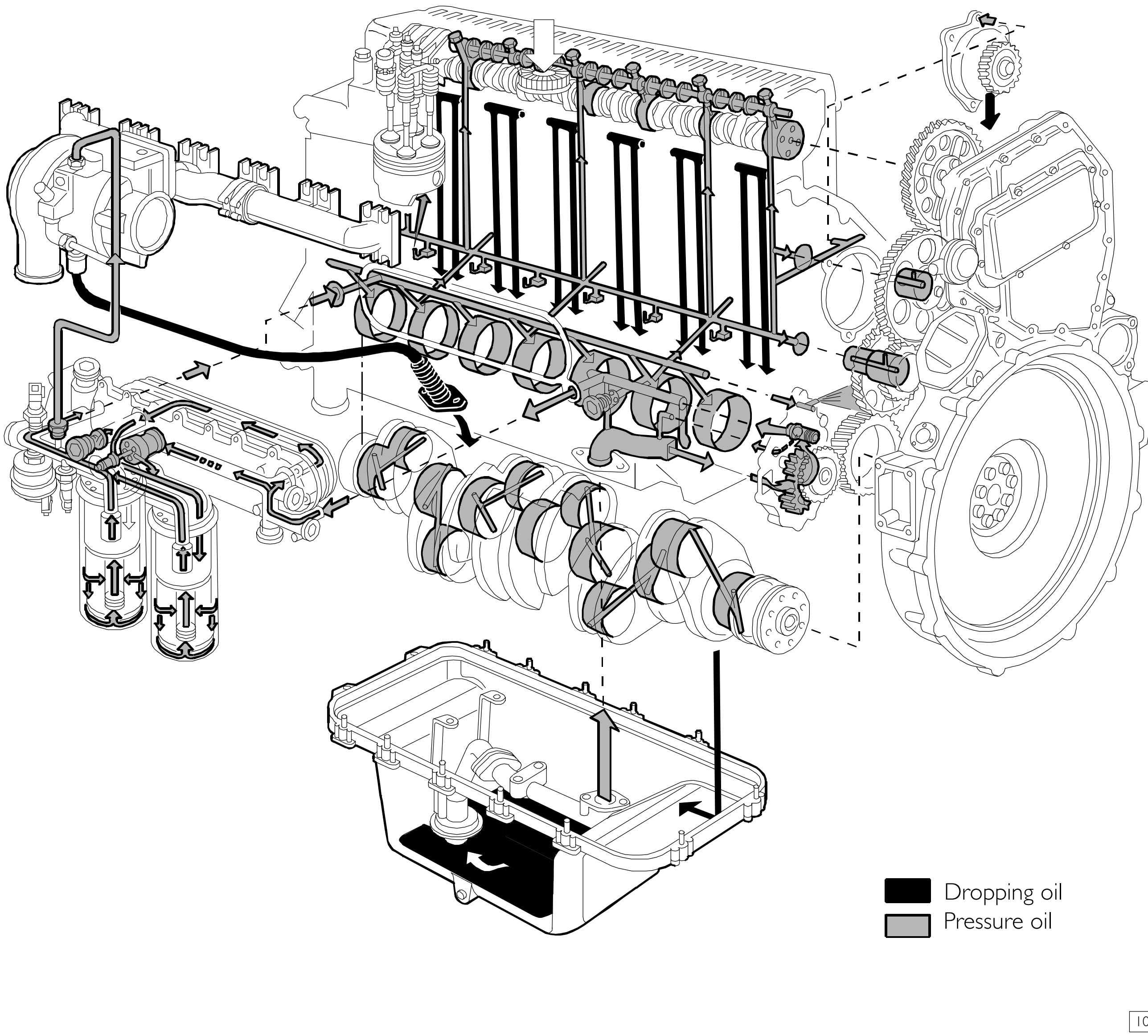
LUBRICATION DIAGRAM (ONLY FOR TYPE: F3AE0684P*E904)

Figure 20



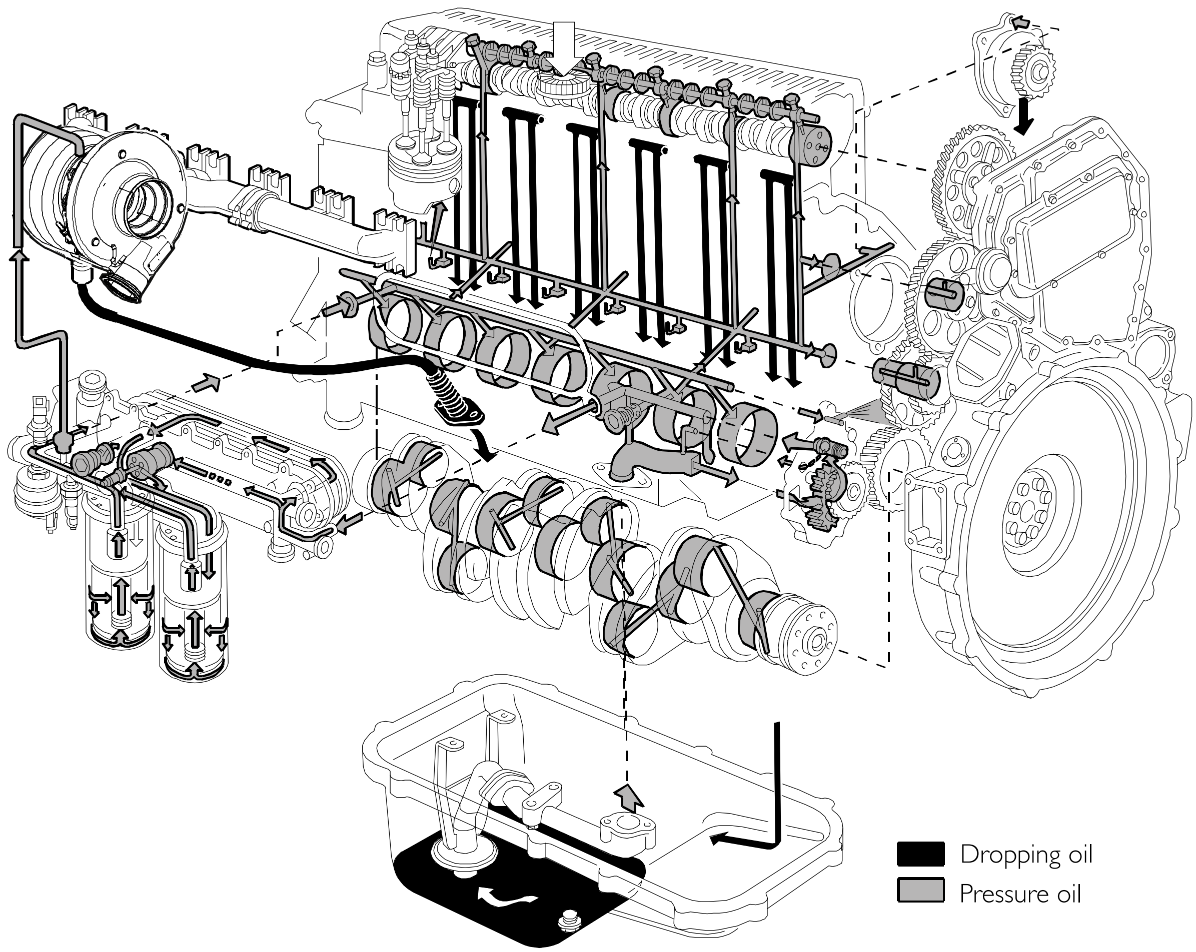
LUBRICATION DIAGRAM
(FOR TYPES: F3AE0684P*E906 - F3AE0684L*E906 - F3AE0684P*E905)

Figure 21



LUBRICATION DIAGRAM (ENGINES F3AE0684N*E907 - F3AE9687A*E001 - F3AE9687B*E001 - F3AE9687C*E001)

Figure 22



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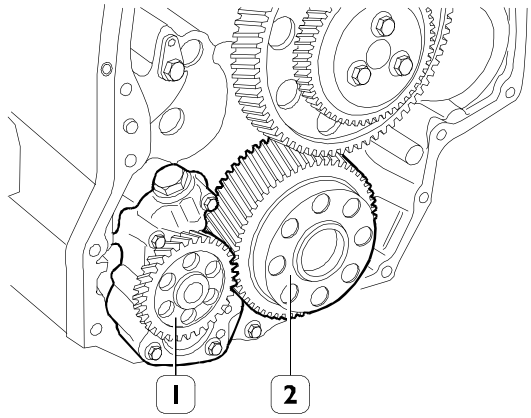
Oil pump

Figure 23

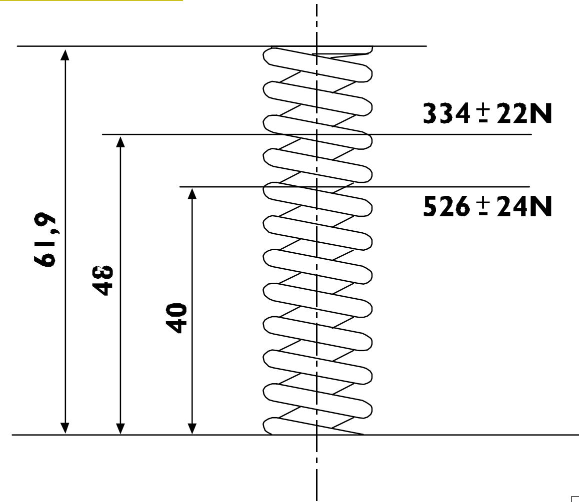


The oil pump (1) cannot be overhauled. On finding any damage, replace the oil pump assembly.

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

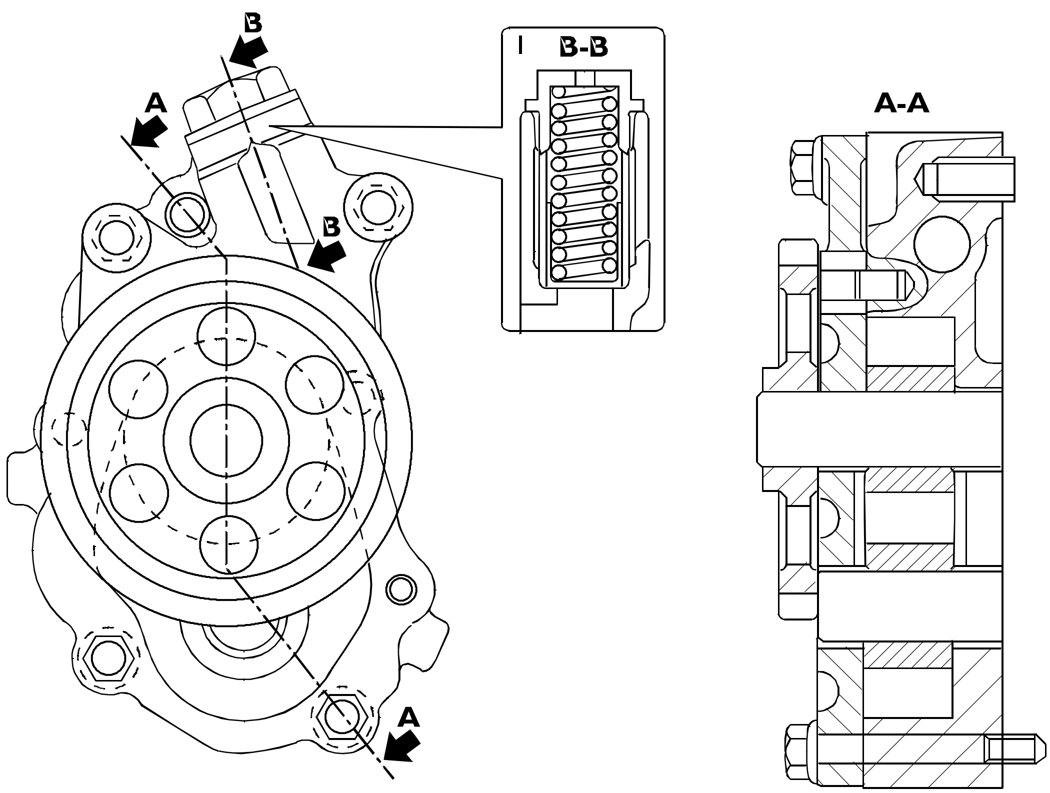
Overpressure valve

Figure 25



MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

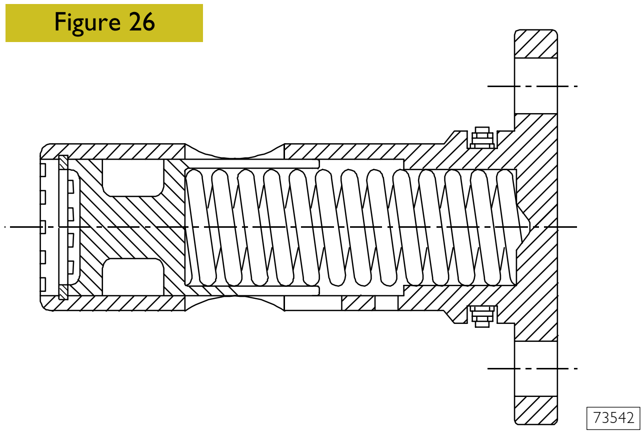
Figure 24



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

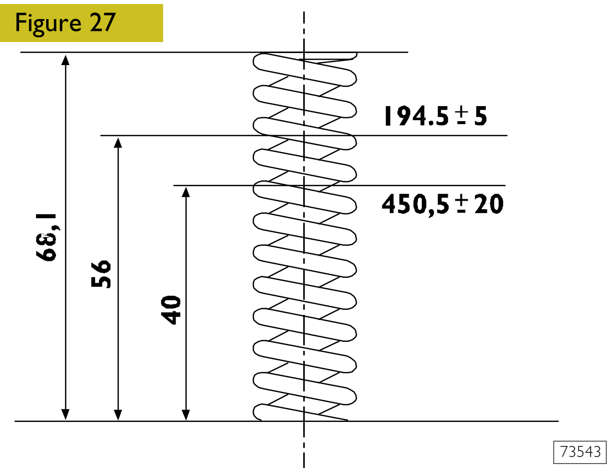
Oil pressure control valve

Figure 26



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

Figure 27

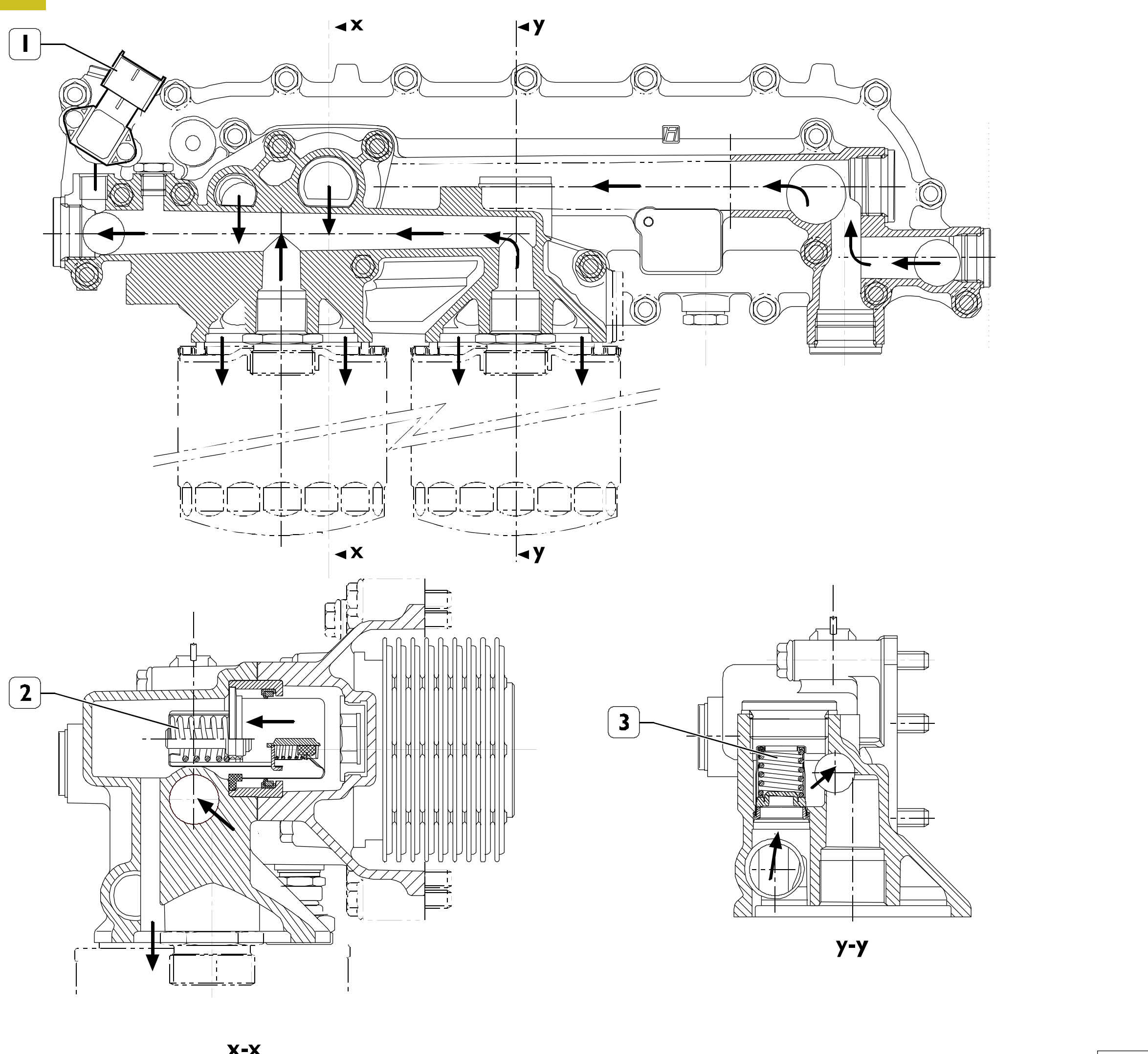


MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

Heat exchanger

(for type: F3AE0684P*E906 - F3AE0684L*E906 - F3AE0684P*E905 - F3AE0684N*E907 - F3AE9687A*E001 - F3AE9687B*E001 - F3AE9687C*E001)

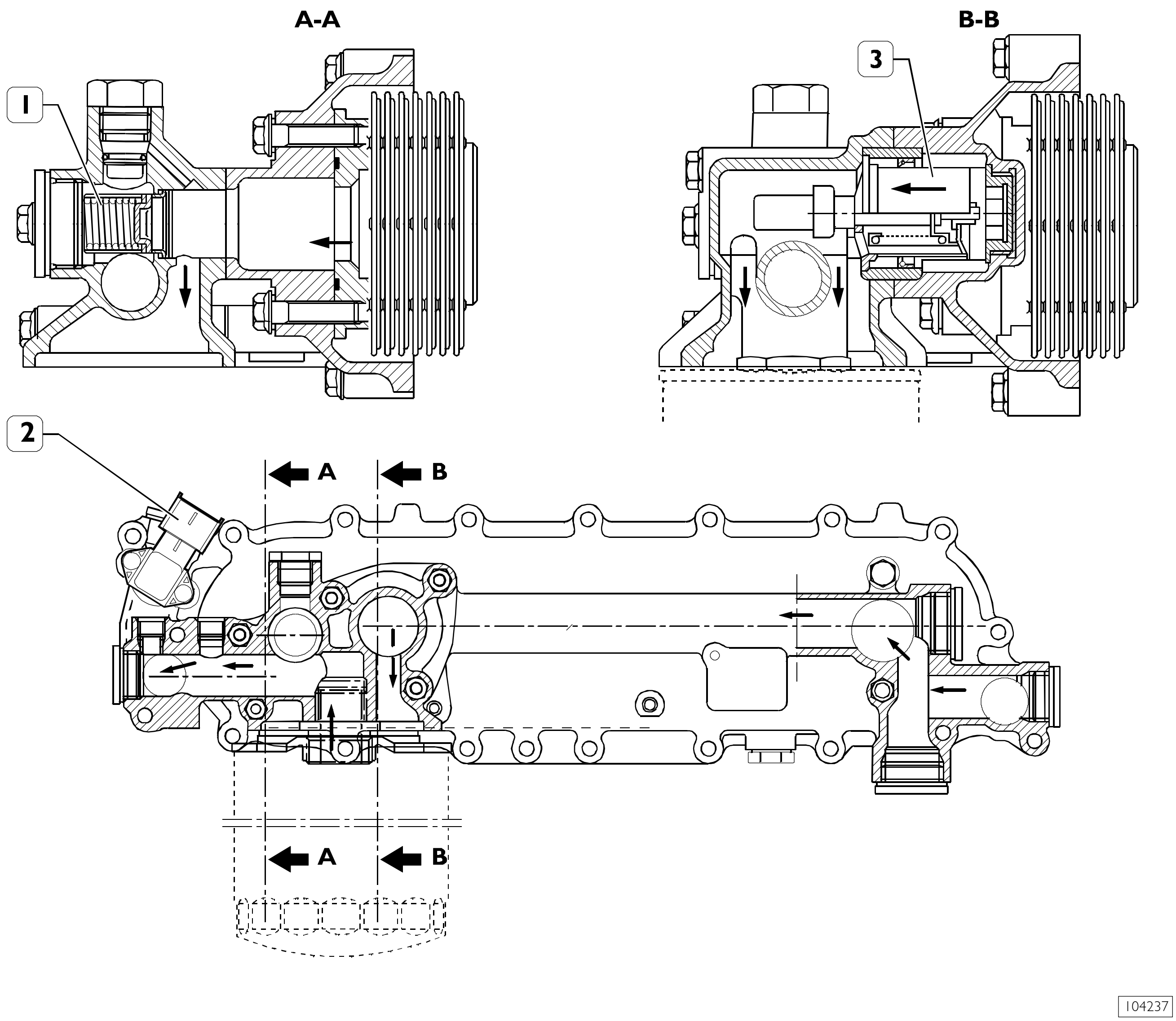
Figure 28



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

Heat exchanger (only for type: F3AE0684P*E904)

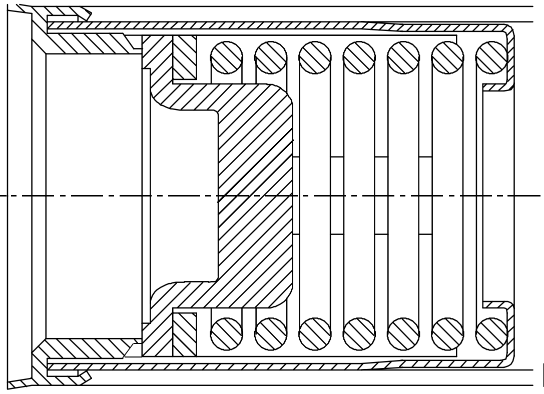
Figure 29



HEAT EXCHANGER
The following elements are fitted on the intercooler: 1. By-pass valve - 2. Oil pressure/temperature sensor - 3. Heat valve.

By-pass valve

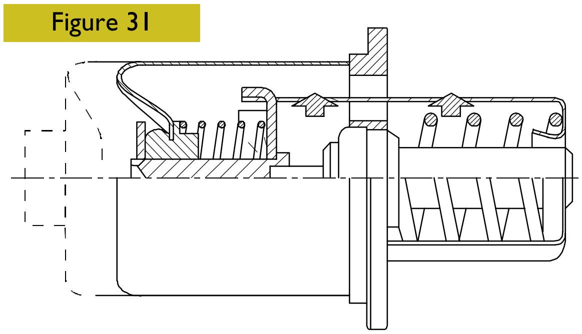
Figure 30



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

Thermostatic valve

Figure 31



Start of opening:

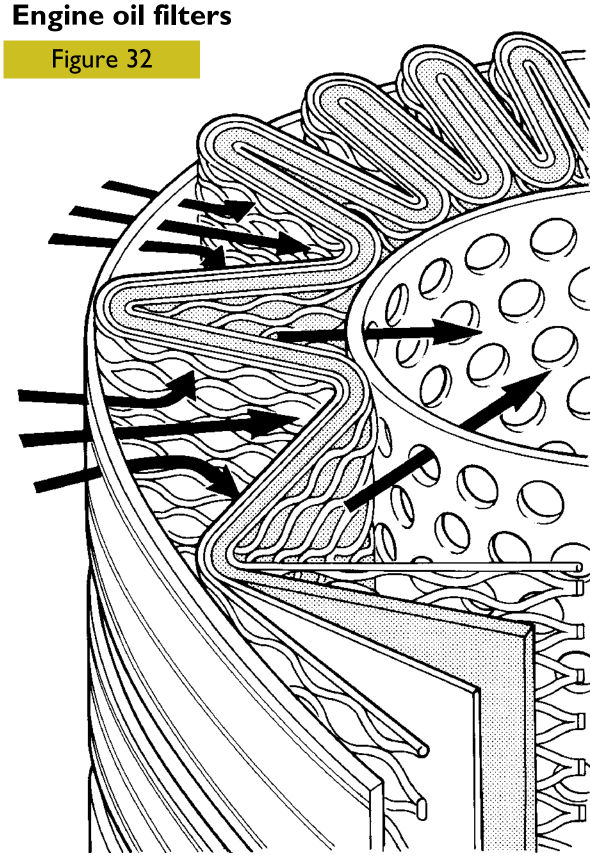
- travel 0.1 mm at a temperature of 82 ±2°C.

End of opening:

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

Engine oil filters

Figure 32



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

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

- reduce the wear of engine components over time;
- maintain the performance/specifications of the oil and thereby lengthen the time intervals between changes.

External spiral winding

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

Mount upstream

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

Filtering element

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

Mount downstream

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

Structural parts

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

When mounting the filters, keep to the following rules:

- Oil and fit new seals.
- Screw down the filters to bring the seals into contact with the supporting bases.
- Tighten the filter to a torque of 35-40 Nm.

COOLING

Description

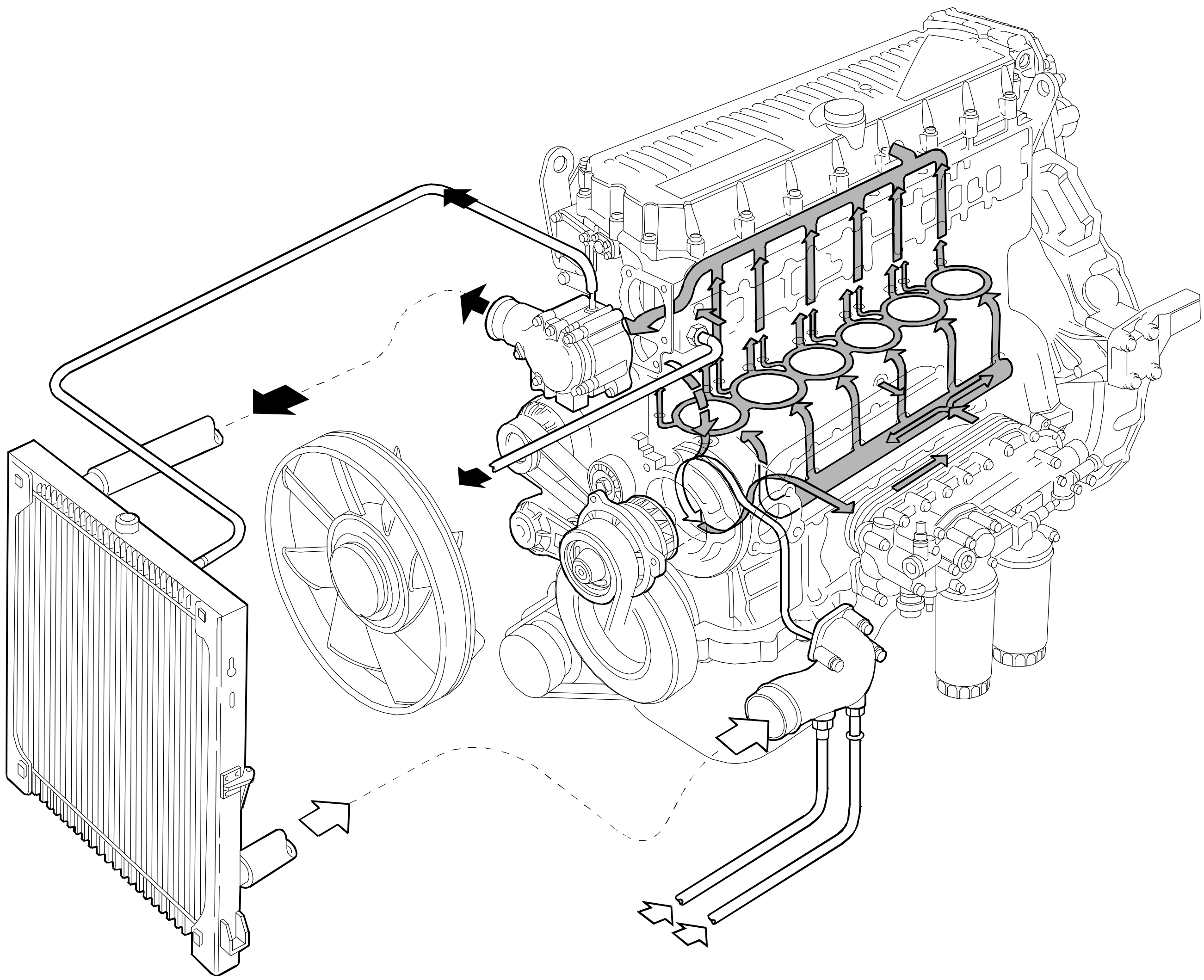
The engine cooling system is of the closed-circuit, forced circulation type.
It consists mainly of the following components:

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

Operation

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

Figure 33



Water flowing out of the thermostat

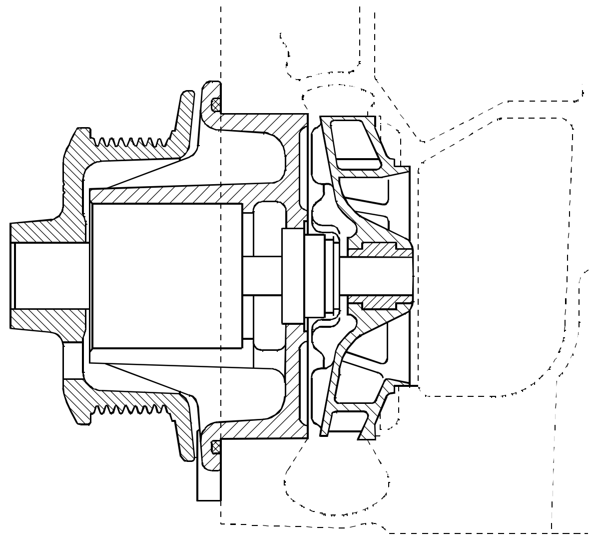
Water circulating in the engine

Water flowing into the pump

104238

Water pump

Figure 34



CROSS-SECTION OF THE WATER PUMP

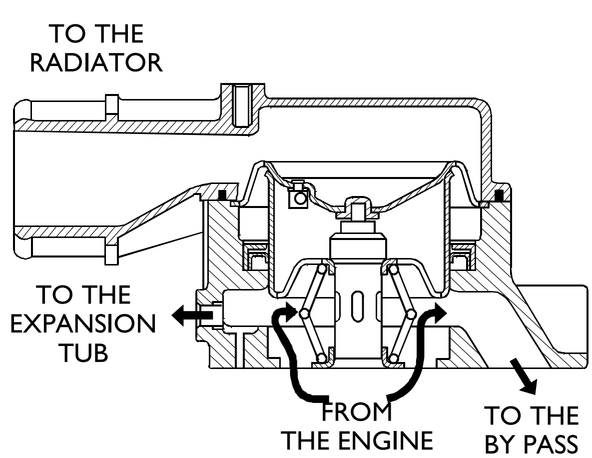
The water pump consists of: rotor, shaft with bearing, T-gasket and drive pulley with dust shield.

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

Thermostat

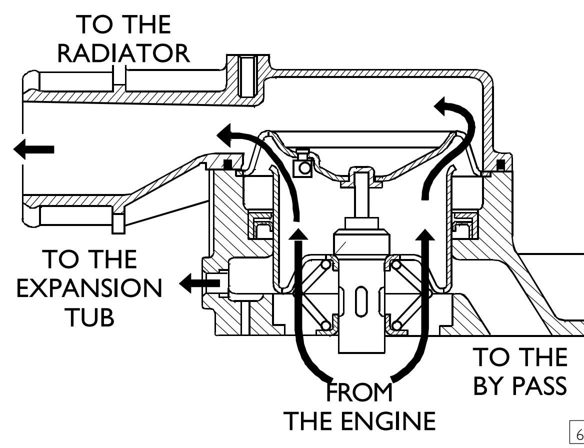
View of thermostat operation

Figure 35



Water circulating in the engine

Figure 36



Water leaving the thermostat

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

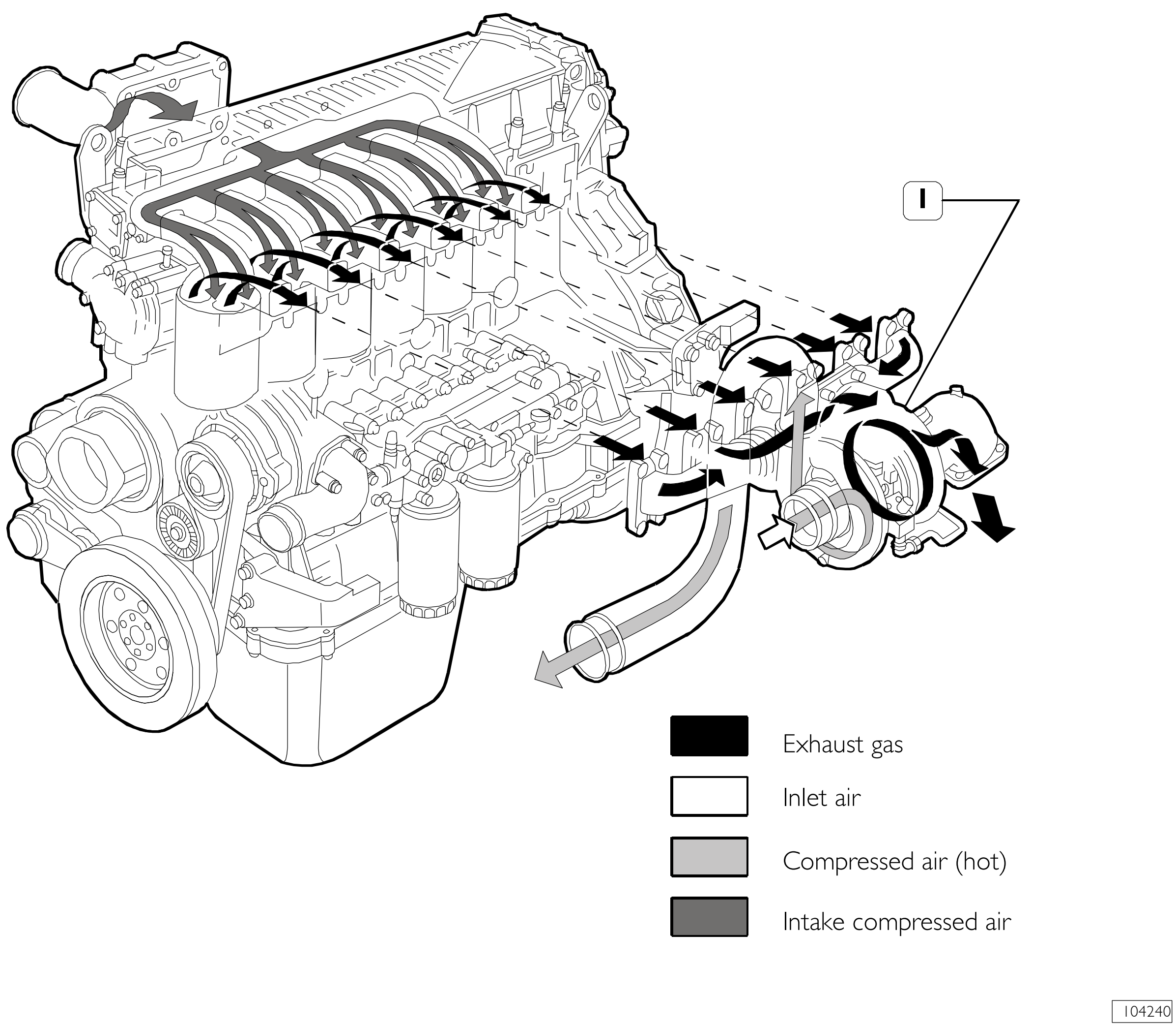
Temperature of start of travel 84°C ±2°C.
Minimum travel 15 mm at 94°C ±2°C.

TURBOCHARGING

The turbocharging system consists of:

- ❑ air filter;
- ❑ Wastegate turbocharger.

Figure 37



1. TURBOCHARGER HX55

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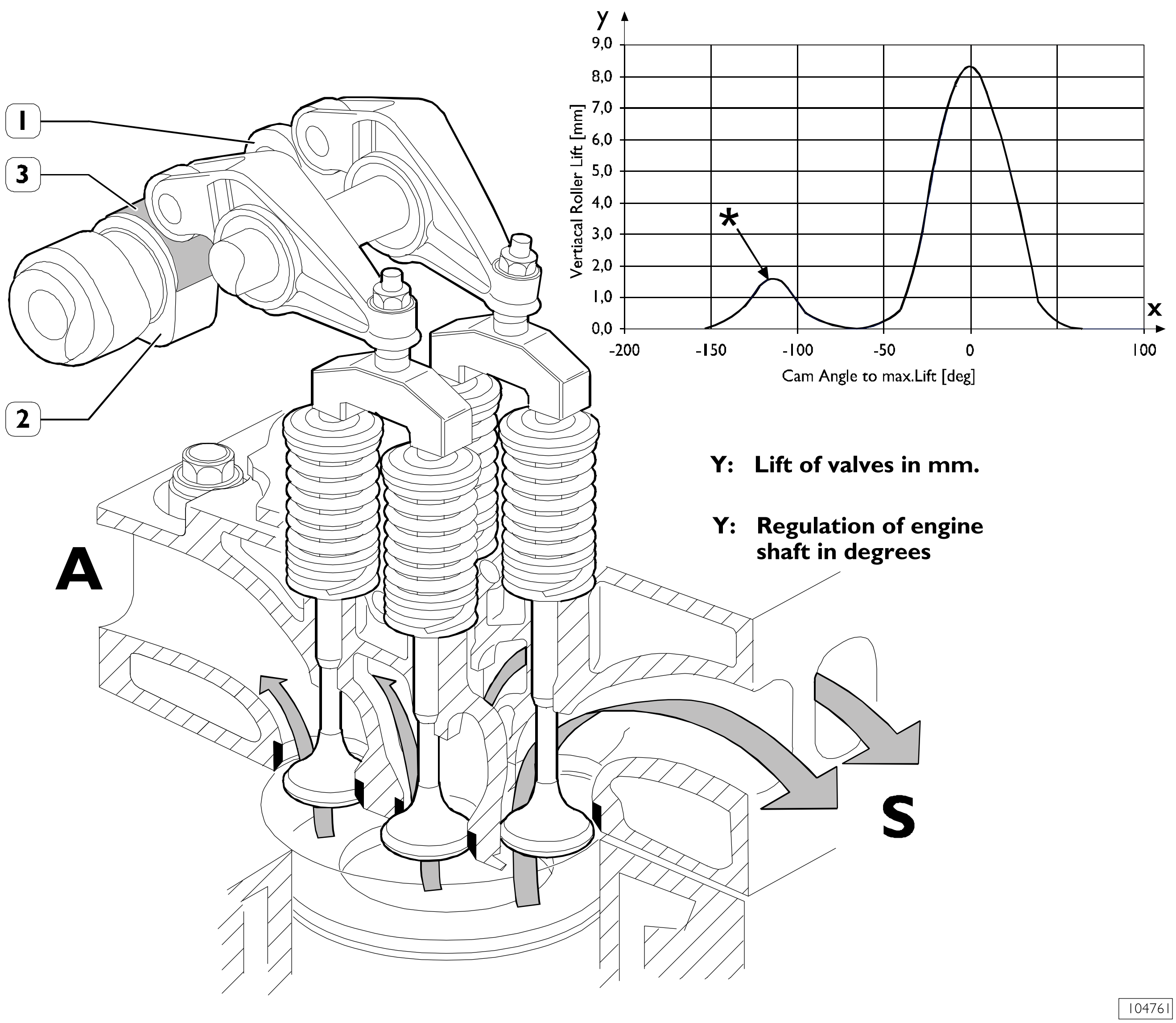
EGR EXHAUST GAS RECIRCULATION SYSTEM

The exhaust gases may be partially conveyed back into the cylinders to reduce the maximum combustion temperature responsible for producing nitrogen oxides (NOx).
The exhaust gas recirculation (EGR) system, by reducing the combustion temperature, thus represents an effective NOx 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 38



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

SECTION 2

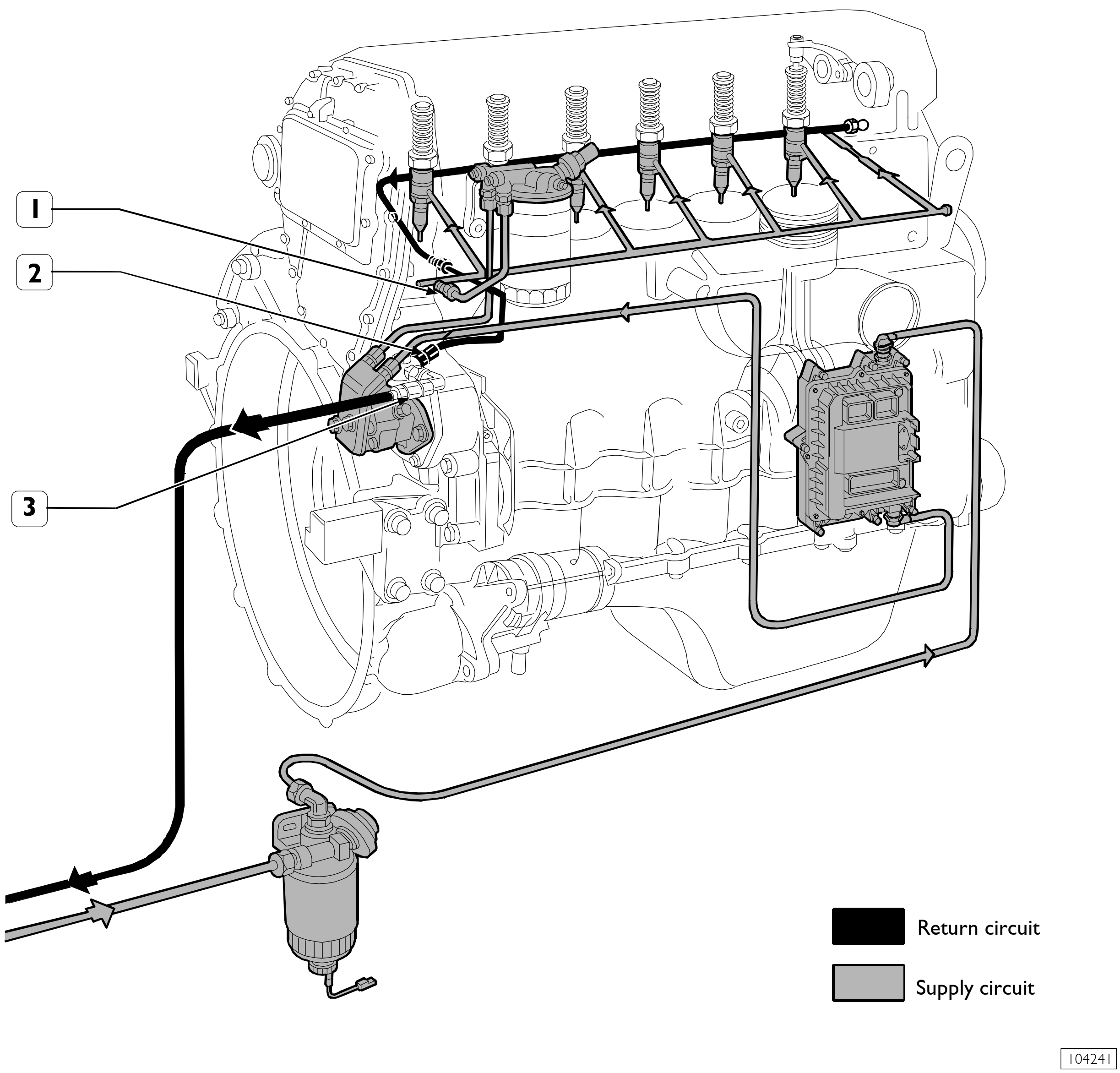
Fuel

Page

FEEDING

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

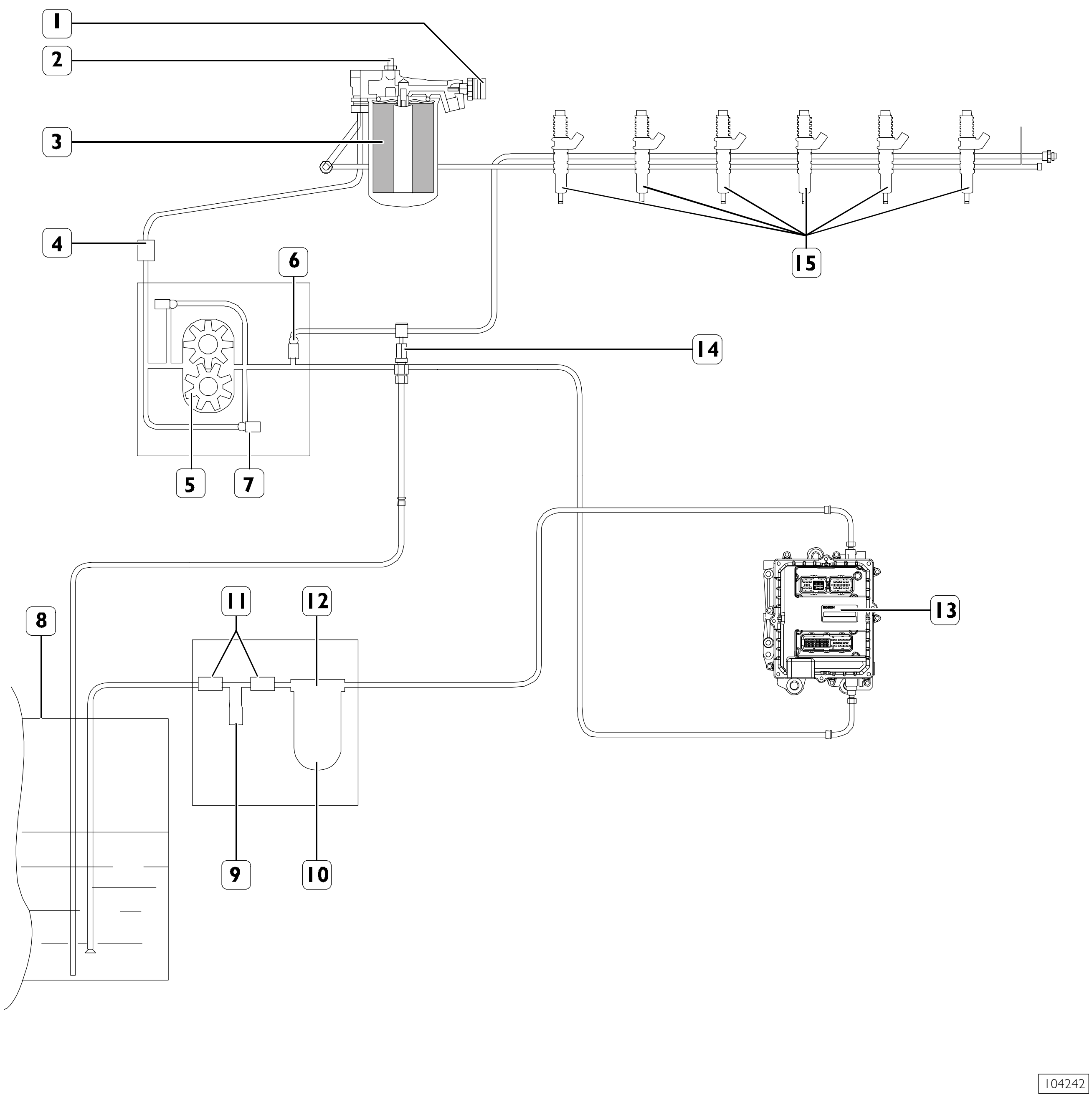
Figure 1



1. Fuel pressure damper - 2. Valve for return circuit, starts opening at 3.5 bars - 3. Valve for return circuit, starts opening at 0.2 bars.

FUEL SUPPLY DIAGRAM (ALL TYPES)

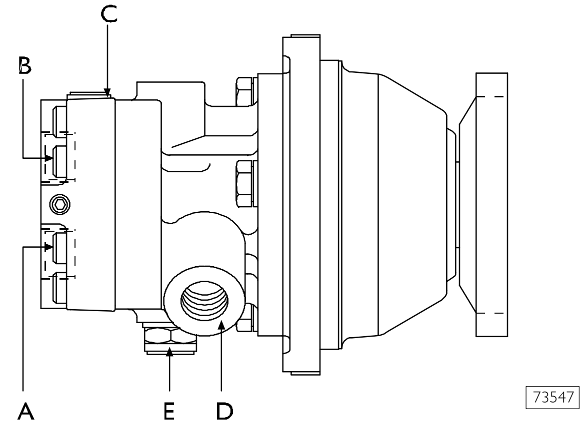
Figure 2



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.

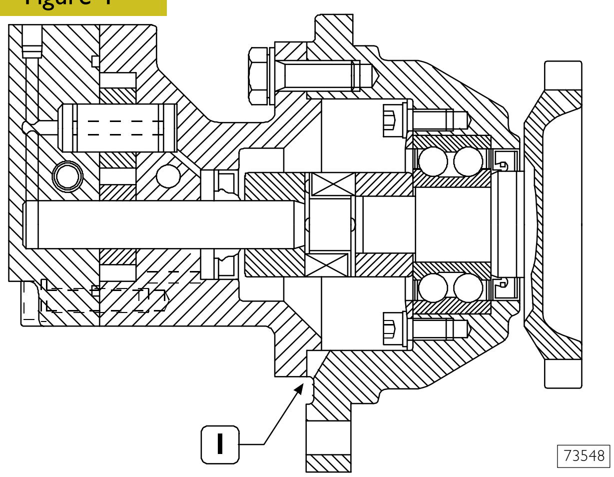
Fuel pump

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: 5-8 bars.

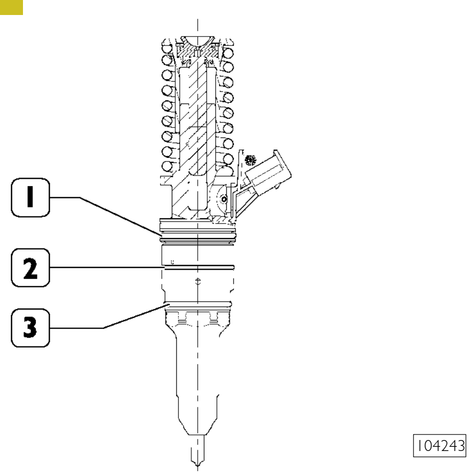
Figure 4



CROSS-SECTION OF THE FUEL PUMP
1. 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.

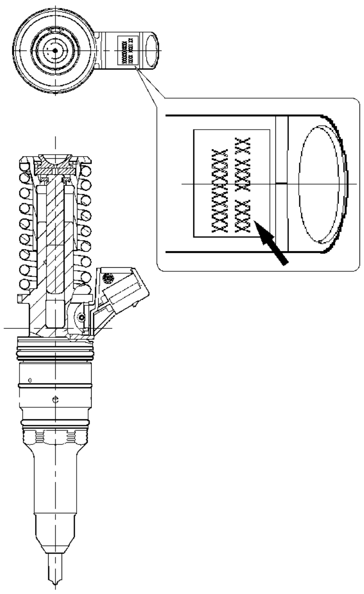
Nozzle

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



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.

SECTION 3
Industrial application

Page

CLEARANCE DATA

Type		F3AE0684				
		P*E904	P*E906	L*E906	P*E905	N*E907
ρ Compression ratio		16.5:1				
Max. output	kW (HP) rpm	317 (430) 2100	317 (430) 2100	335 (455) 2100	317 (430) 2100	291 (395) 2100
Max. torque	Nm (kgm) rpm	1900 (190) 1500	1900 (190) 1500	1900 (190) 1500	1900 (190) 1500	1820 (182) 1500
Loadless engine idling	rpm	1000	1000	1000	1000	600
Loadless engine peak	rpm	2110	2110	2110	2110	2110
Bore x stroke Displacement	mm cm^3	125 x 140 10300				
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		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.

CLEARANCE DATA

Type		F3AE9687		
		A*E001	B*E001	C*E001
ϱ Compression ratio		16.5:1		
Max. output	kW (HP) rpm	315 (428) 2100	290 (394) 2100	265 (360) 2100
Max. torque	Nm (kgm) rpm	1900 (190) 1500	1800 (180) 1500	1700 (170) 1500
Loadless engine idling	rpm	800	800	800
Loadless engine peak	rpm	2300	2300	2300
Bore x stroke Displacement	mm cm^3	125 x 140 10300		
SUPERCHARGING		DIRECT INJECTION INTERCOOLER		
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		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.

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PART ONE -

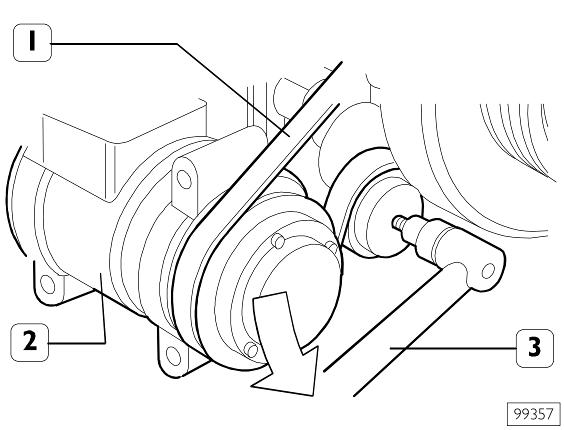
MECHANICAL COMPONENTS

ENGINE DISASSEMBLY ASSEMBLY

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

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

Figure 1



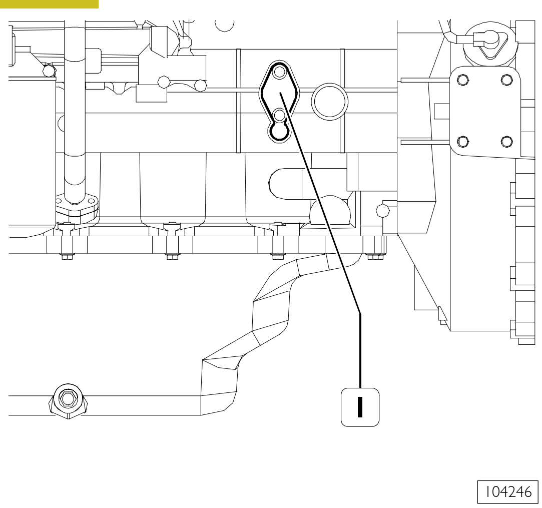
Before securing the engine on the rotary stand, remove:

- the engine electric cable, disconnecting it from the control unit and from all the sensors/transmitters connected to it;

For all types except F3AE0684P*E904 and F3AE0684N*E907.

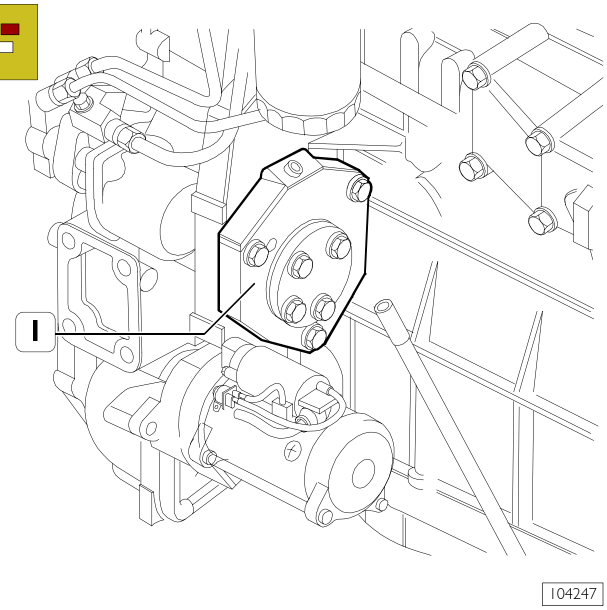
- using a suitable tool (3), work in the direction of the arrow on the tightener and remove the compressor drive belt (1);
- remove the compressor (2) together with the engine support.

Figure 2



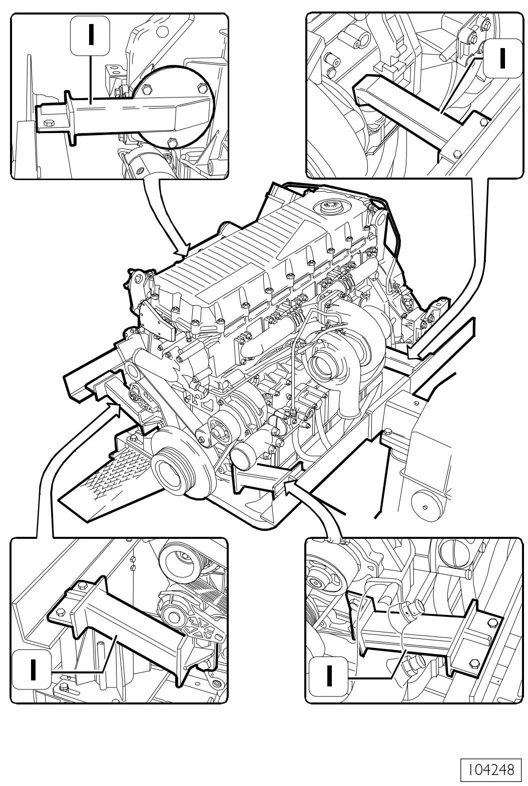
- Remove the oil pressure adjuster valve (1).

Figure 3



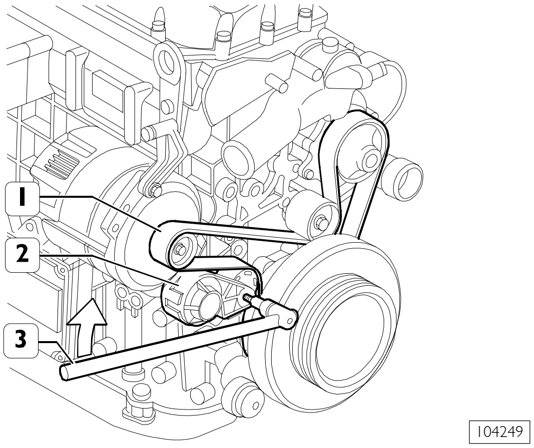
- Remove the engine supports;
- remove the drive (1).

Figure 4



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

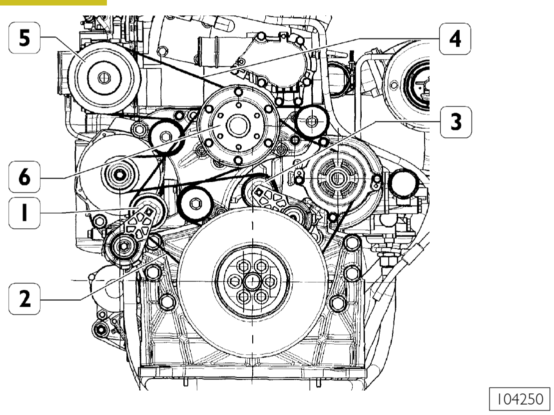
Figure 5



For all types excluding F3AE0684P*E904

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

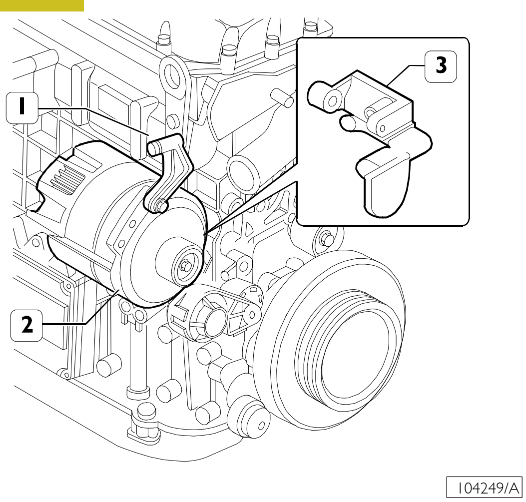
Figure 6



Only for type F3AE0684P*E904

- Using a suitable tool, operate on the belt take-up units (1) and (3) in order to remove the belts (2) and (4).
- Remove the compressor (5) and the fan hub (6) with related supports.

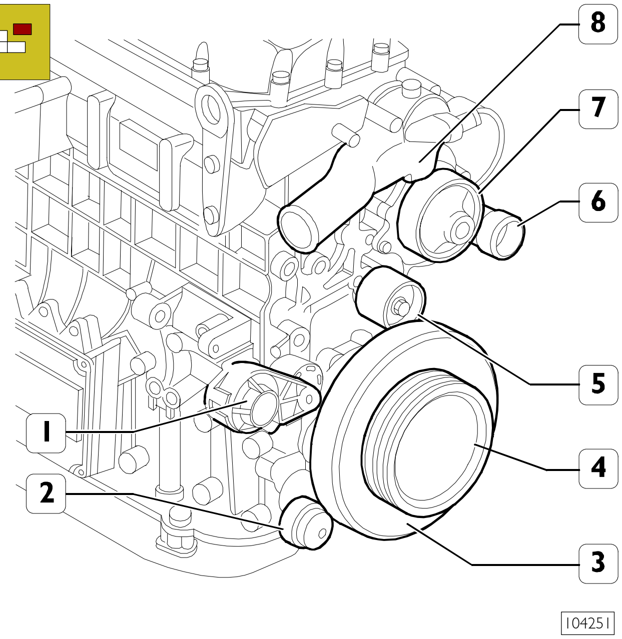
Figure 7



Remove:

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

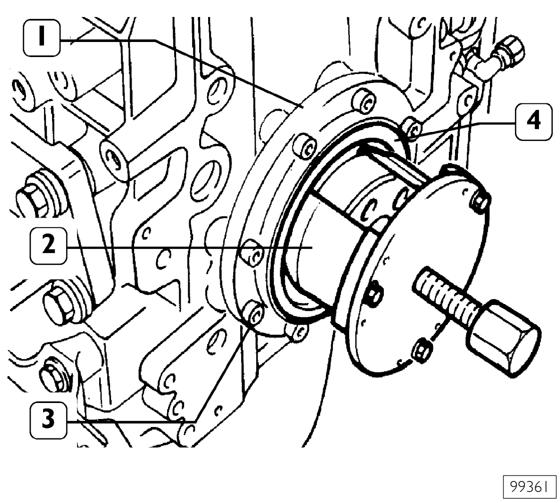
Figure 8



Remove:

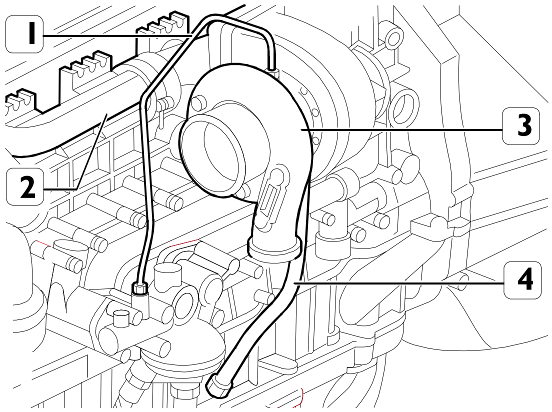
- thermostat assembly (8);
- pipes complete with coolant (6);
- pulley (4);
- water pump (7);
- automatic tightener support (1);
- fixed tightener (5);
- damper flywheel (3) and pulley beneath;
- automatic tightener (2);

Figure 9



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 10



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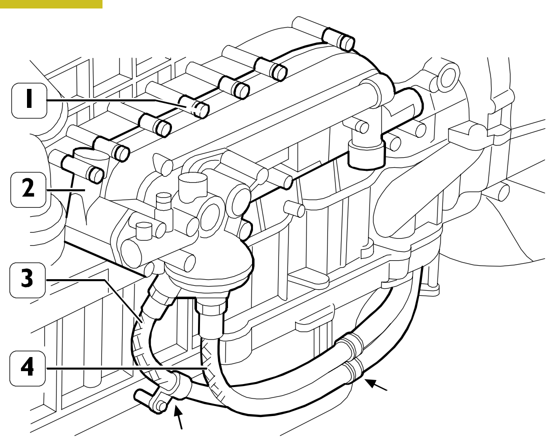
On the engine exhaust side, remove the following parts:

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

Figure 11

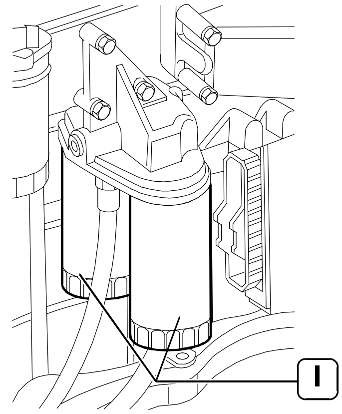


99258

Only for type F3AE0684P*E904

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

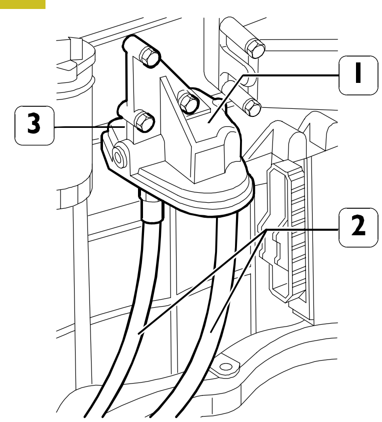
Figure 12



101960

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

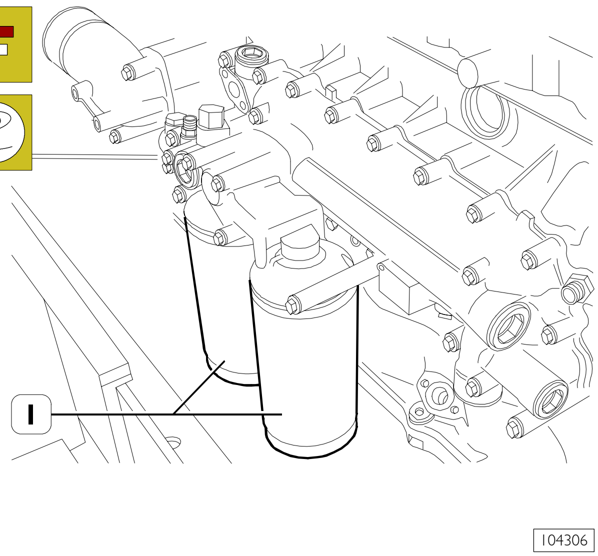
Figure 13



99362

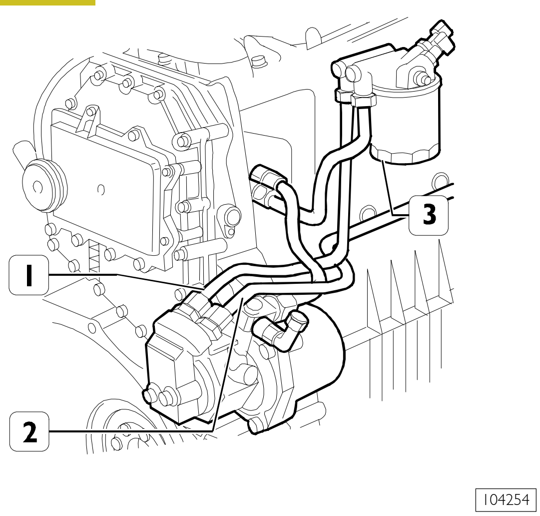
- Disconnect the pipes (2) from the support (1) disengaging them from the clamps and remove them.
- Take out the screws (3) and remove the supports (1).

Figure 14



For all types excluding F3AE0684P*E904 only, using tool 99360314 (2), unscrew the oil filters (1).

Figure 15

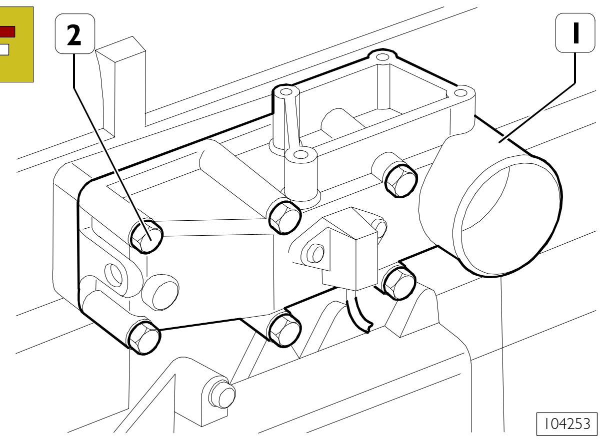


Disconnect the fuel pipes (1) from the fuel pump (2).

Remove:

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

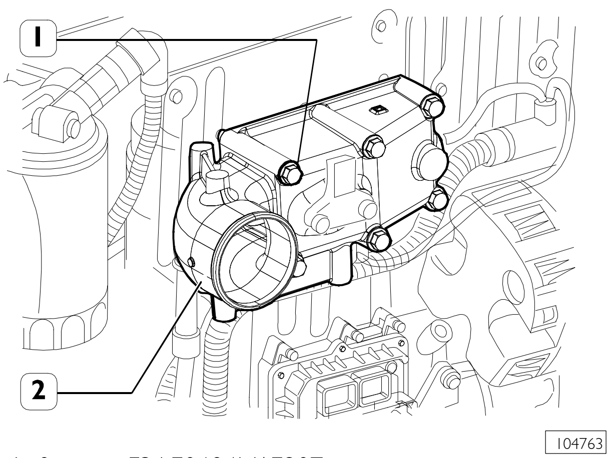
Figure 16



For all types except F3AE0684N*E907.

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

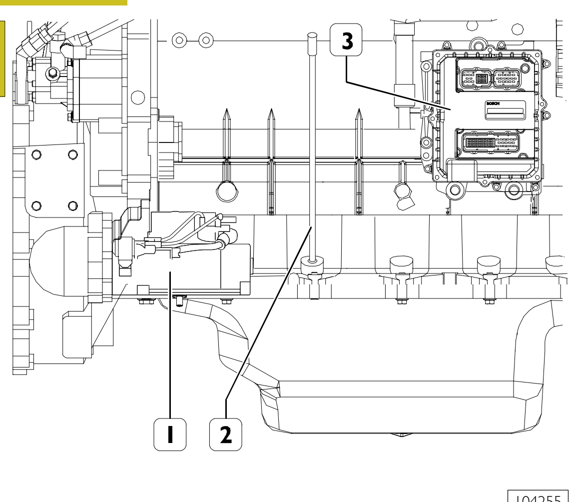
Figure 17



Only for type F3AE0684N*E907

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

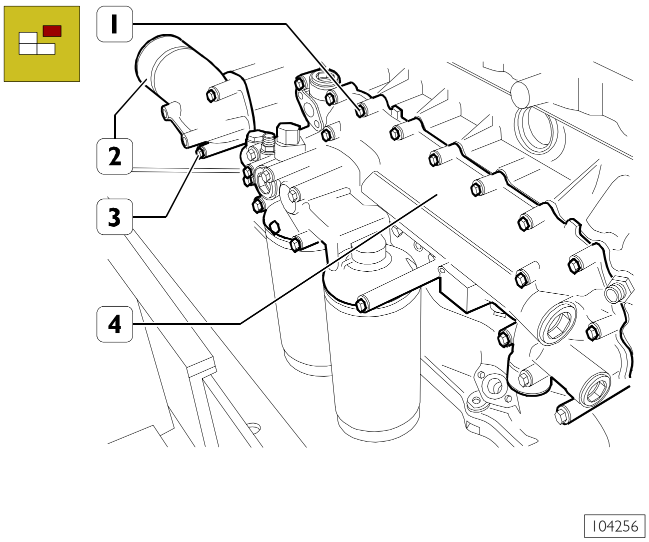
Figure 18



Remove:

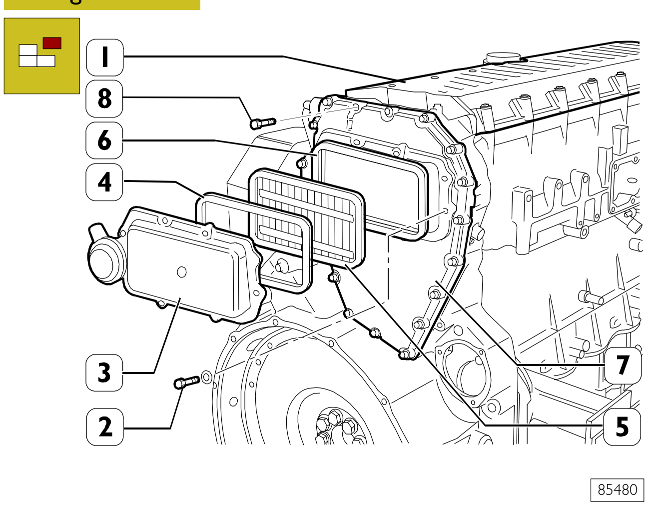
- the starter motor (1);
- the control unit (2) and its support;
- the oil dipstick (3) from the crankcase.

Figure 19



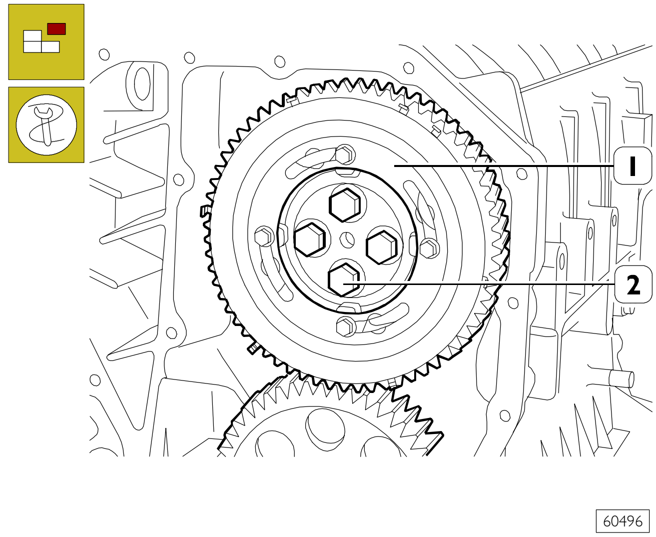
- Unscrew the screws (1) and remove the heat exchanger (4);
- unscrew the screws (2) and remove the water line (3).

Figure 20



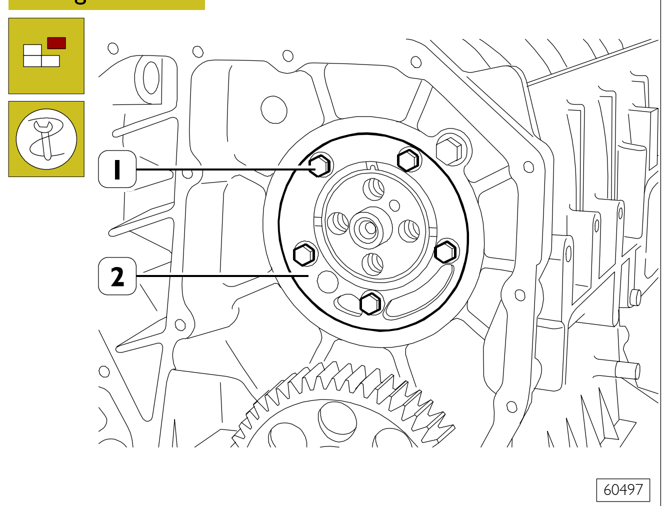
Remove the rocker arm cover (1), take off the screws (2) and remove: the cover (3), the filter (5) and the gaskets (4 and 6). Take off the screws (8) and remove the blow-by case (7).

Figure 21



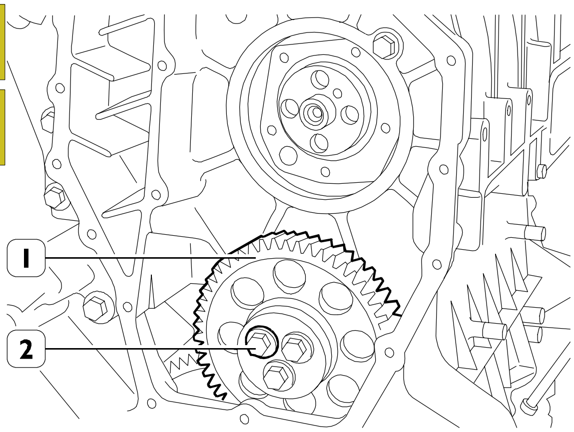
- Unscrew the screws (2) and remove the gear (1) fitted with phonic wheel.

Figure 22



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

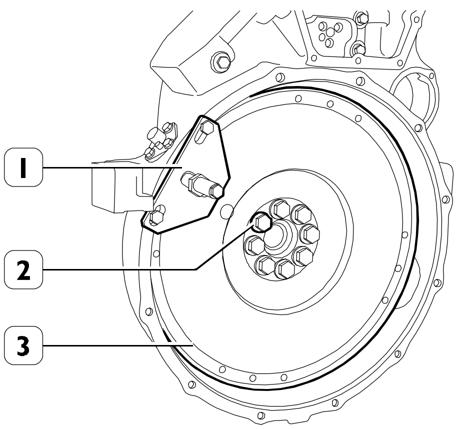
Figure 23



60498

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

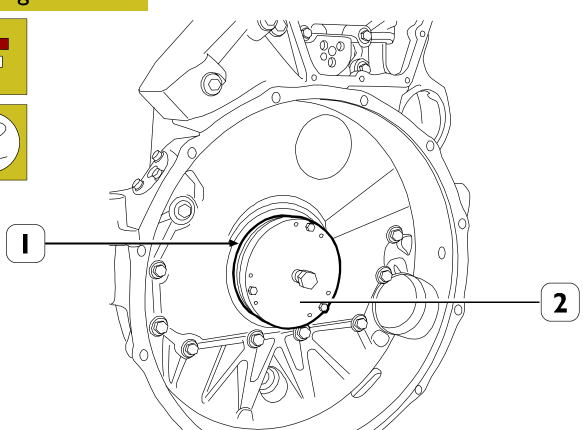
Figure 24



60499

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

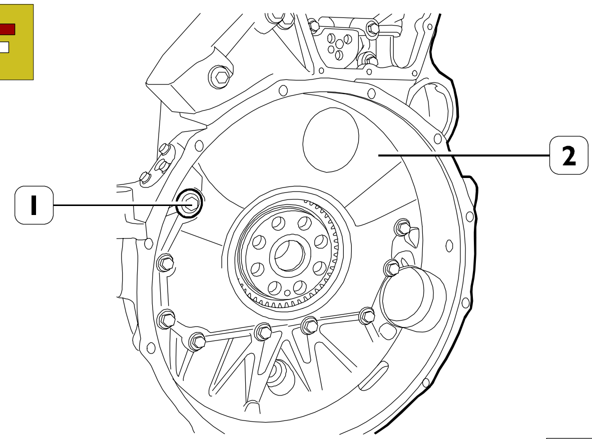
Figure 25



60500

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

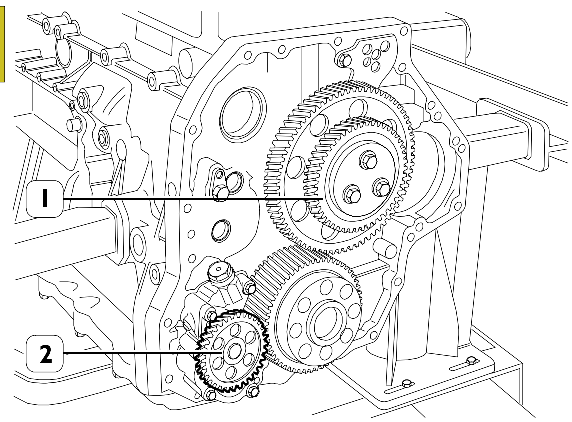
Figure 26



60501

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

Figure 27

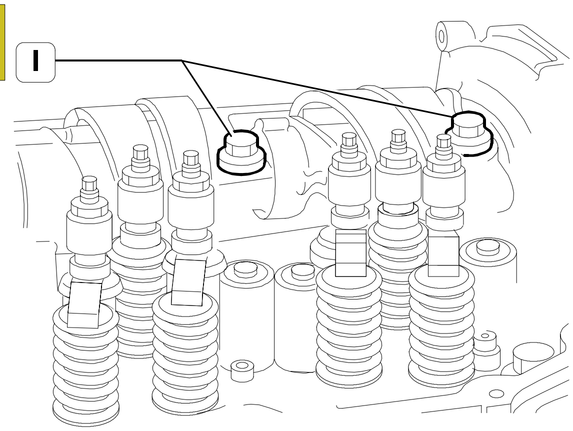


99364

In sequence, take out the:

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

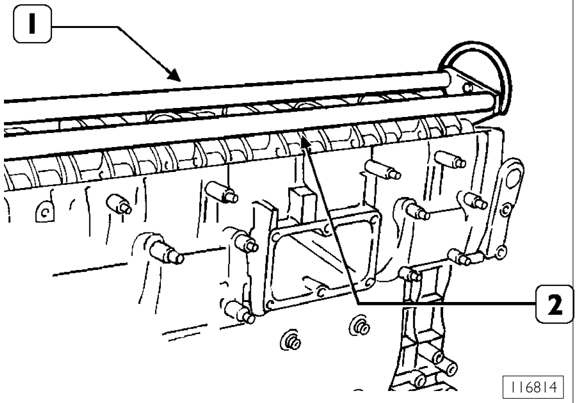
Figure 28



104257

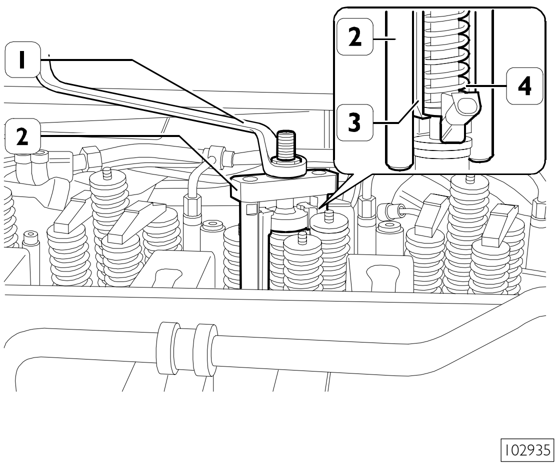
- ❑ Disconnect the electrical connections from the pump injectors from the pump injector solenoid valves.
- ❑ Unscrew the screws (1) fixing the rocker arm shaft.

Figure 29



Apply tool 99360553 (1) to the rocker holder shaft (2) and remove the shaft (2) from the cylinder head.

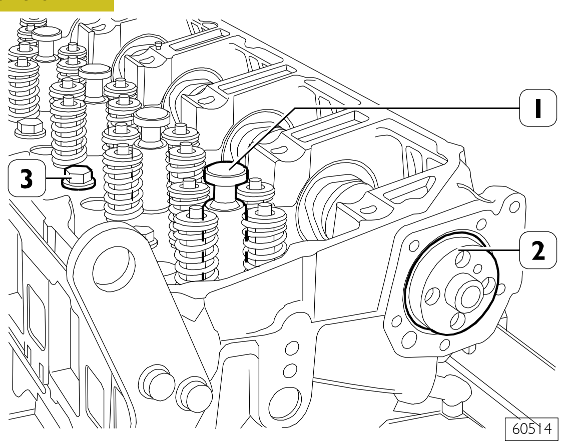
Figure 30



To extract pump injector from cylinder head, use the tool operating as follows:

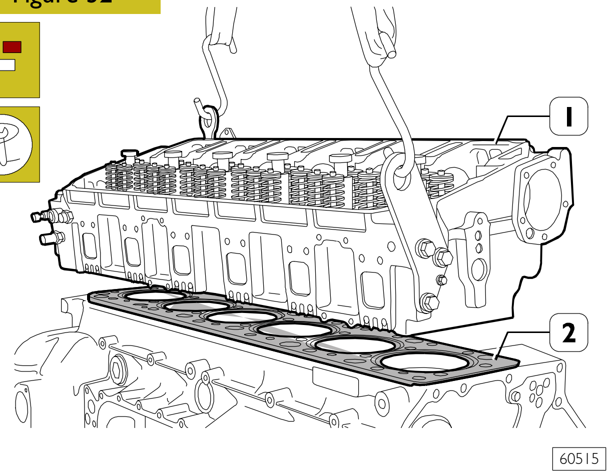
- ❑ hook tool 99342149 part (3) to pump injector (4);
- ❑ mount part (2) on part (3) resting part (2) on cylinder head;
- ❑ screw nut (1) and extract pump injector (4) from cylinder head.

Figure 31



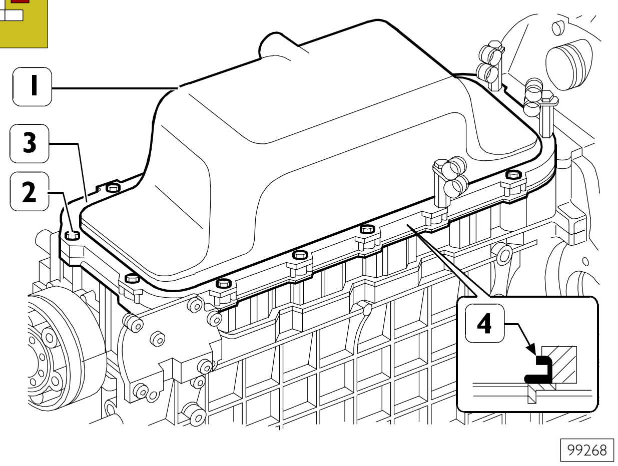
- ❑ Fit the plugs 99360180 (1) instead of injectors.
- ❑ Remove the camshaft (2).
- ❑ Unscrew the fixing screws on the cylinder head (3).

Figure 32



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

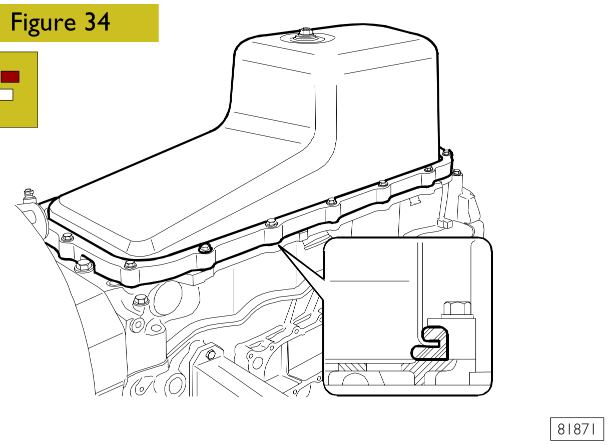
Figure 33



For all types except F3AE0684P*E904 and F3AE0684N*E907

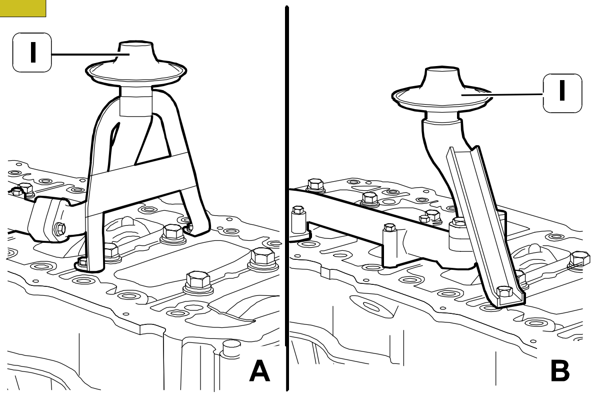
Undo the screws (2) and remove the engine oil sump (1) together with the spacer (3) and the seal (4).

Figure 34



Only valid for types F3AE0684P*E904 - F3AE0684N*E907 - F3AE9687A*E001 - F3AE9687B*E001 - F3AE9687C*E001.

Figure 35



99367

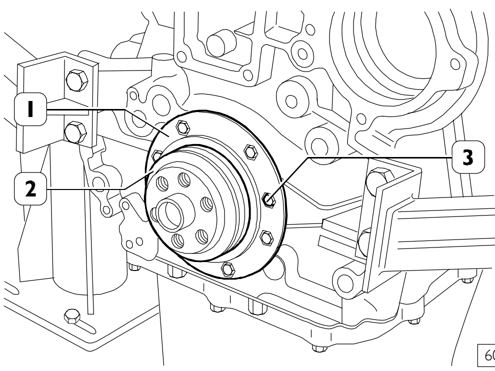
Undo the screws and remove the suction strainer (1).

A. F3AE0684P*E904 - F3AE0684N*E907 - F3AE9687A*E001 - F3AE9687B*E001 - F3AE9687C*E001

B. F3AE0684P*E906 - F3AE0684L*E906 F3AE0684P*E905 - F3AE0684N*E907.

ENGINE ASSEMBLY

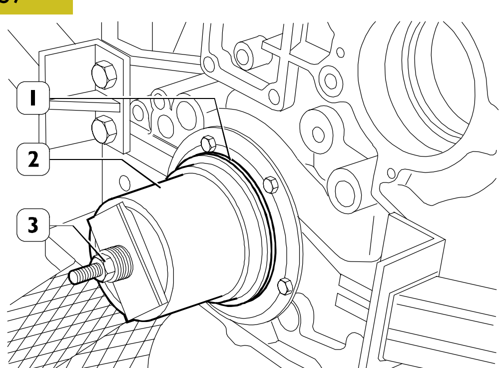
Figure 36



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).

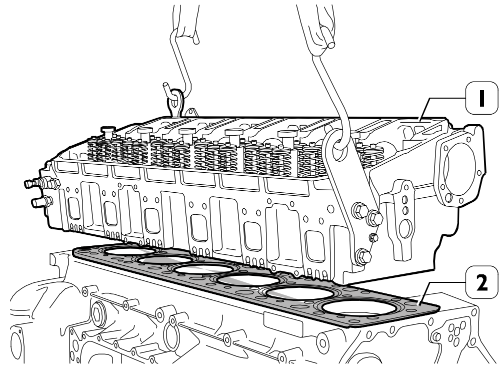
Figure 37



60564

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

Figure 38

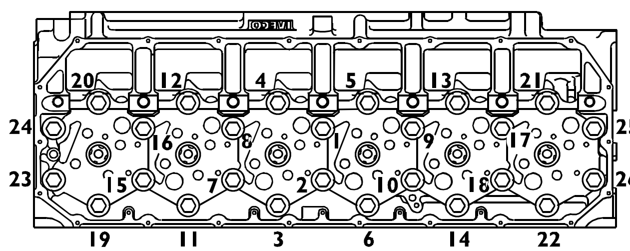


60515

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. 38 - 39 - 40.

NOTE Lubricate the thread of the screws with engine oil before assembly.
Use new screws every time for head assembly.

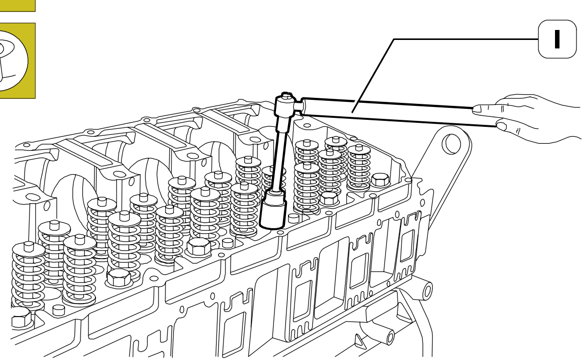
Figure 39



61270

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

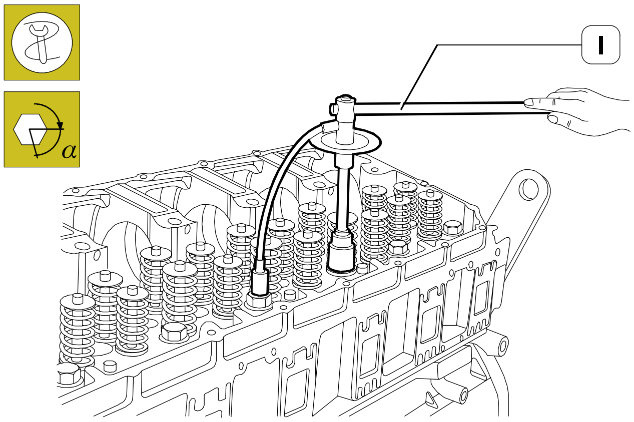
Figure 40



60565

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

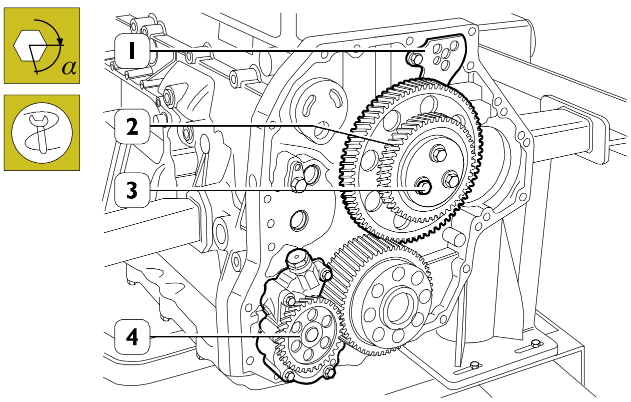
Figure 41



60566

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

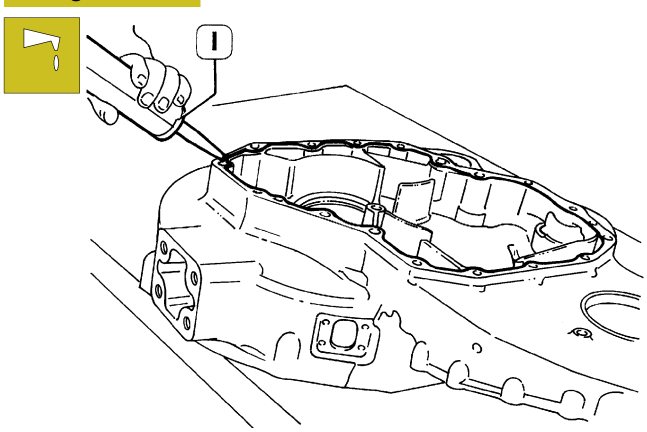
Figure 42



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 43

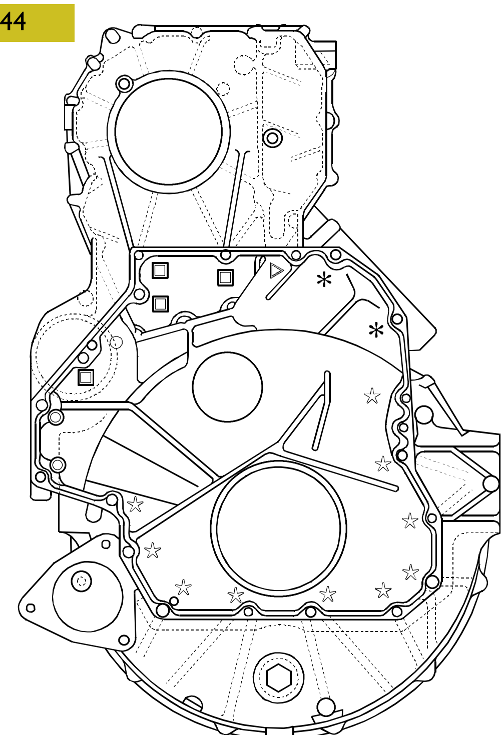


47592

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

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

Figure 44

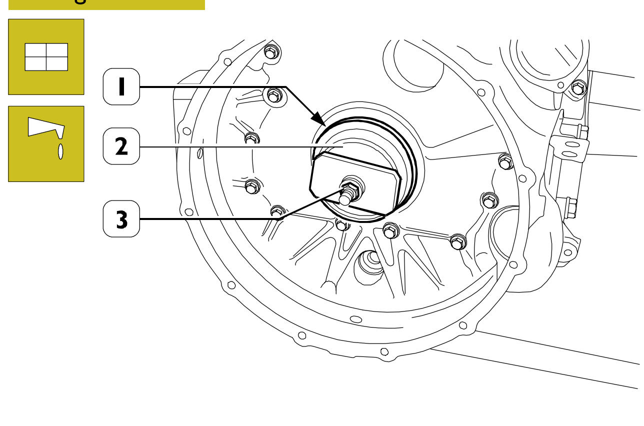


60633

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

✡	10 screws M12 x 1.75 x 100	63 Nm
◎	2 screws M12 x 1.75 x 70	63 Nm
□	4 screws M12 x 1.75 x 35	63 Nm
△	1 screw M12 x 1.75 x 120	63 Nm
✳	2 screws M12 x 1.75 x 193	63 Nm

Figure 45



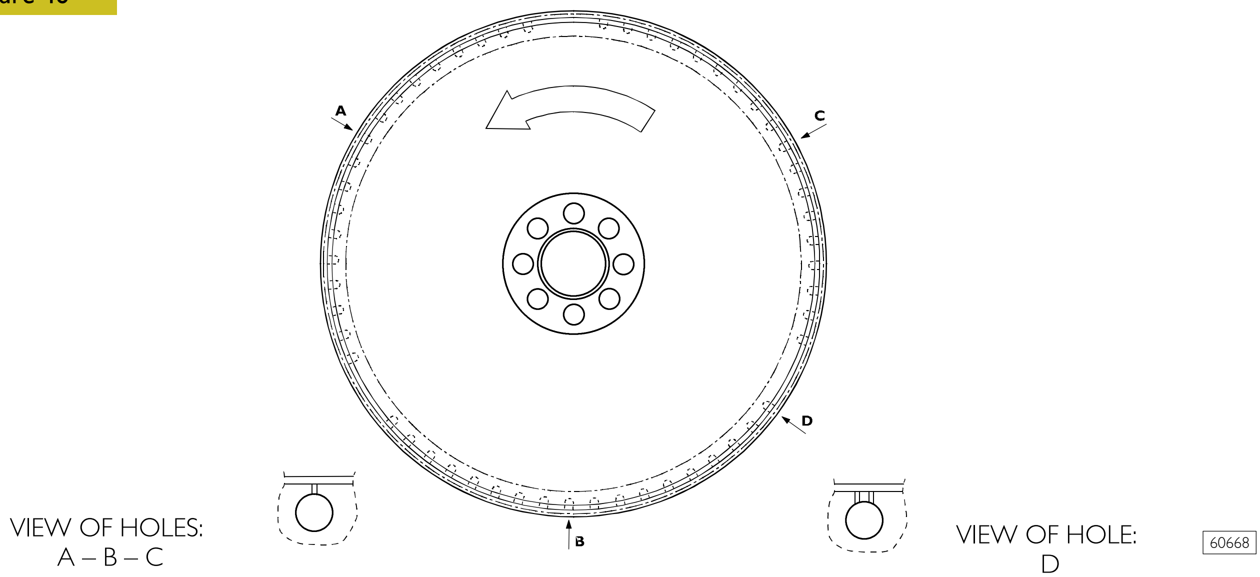
60568

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

ENGINE FLYWHEEL

Fitting engine flywheel (For types: F3AE0684P*E904 - F 3AE0684P*E906 - F 3AE0684L*E906)

Figure 46



DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS

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

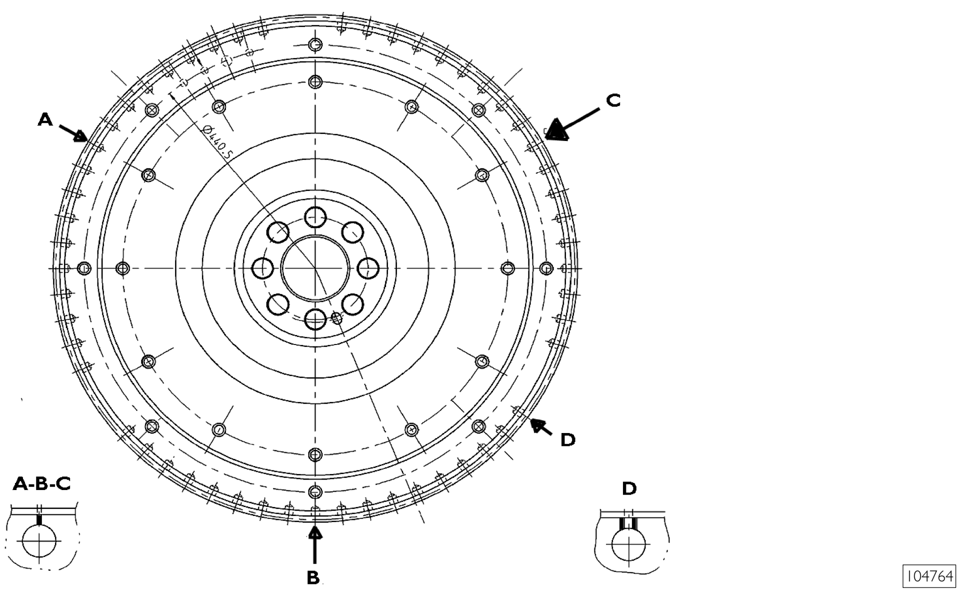
B = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6.

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

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

Fitting engines flywheel (Only for type: F3AE0684N*E907 - F3AE9687A*E001 - F3AE9687B*E001 - F3AE9687C*E001)

Figure 47



DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS

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

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

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

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

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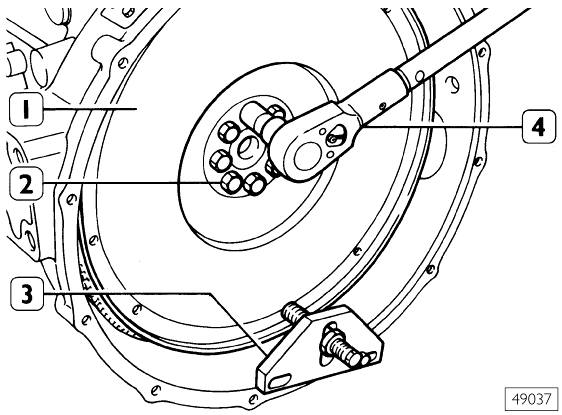
If the teeth of the ring gear mounted on the engine flywheel, for starting the engine, are very damaged, replace the ring gear. It must be fitted after heating the ring gear to a temperature of approx. 200°C.

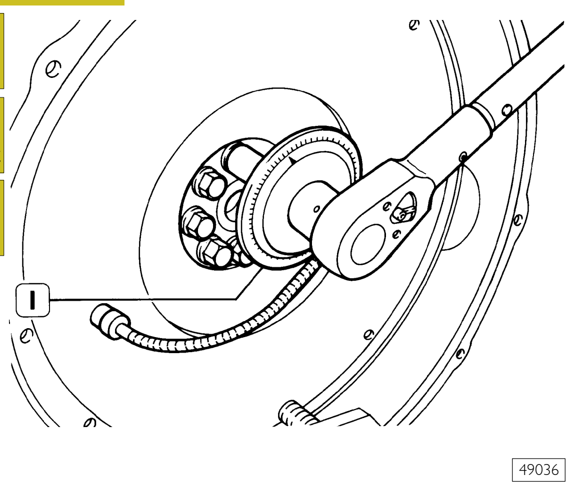
Figure 48



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

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

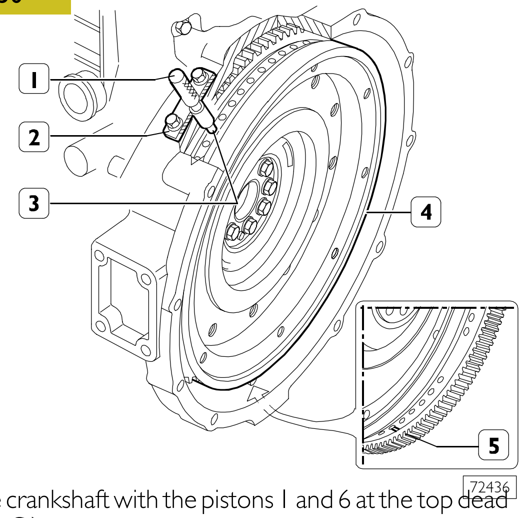
Figure 49



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

Fitting camshaft

Figure 50

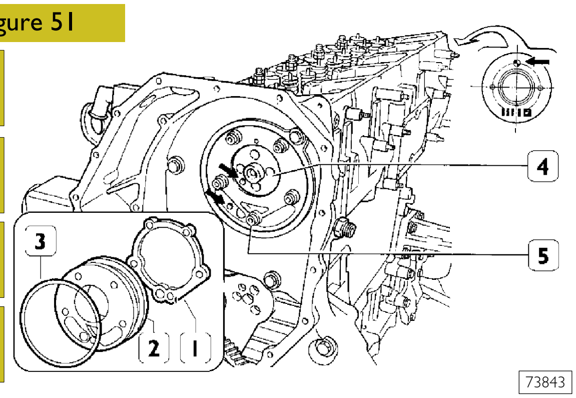


Position the crankshaft with the pistons 1 and 6 at the top dead centre (T.D.C.).
This situation occurs when:

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 51

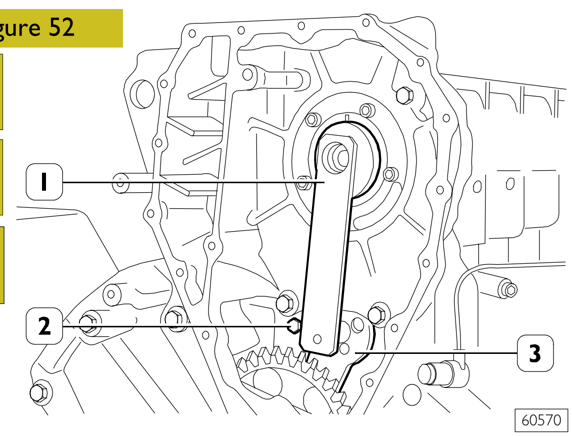


Fit the camshaft (4), positioning it observing the reference marks (→) as shown in the figure.

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

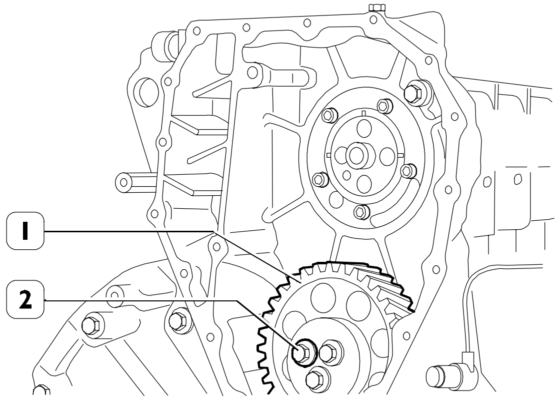
Mount the shoulder plate (2) with the sheet metal gasket (1) and tighten the screws (5) to the required torque.

Figure 52



- ❑ Apply the gauge 99395218 (1). Check and adjust the position of the link rod (3) for the idle gear. Lock the screw (2) to the required torque.

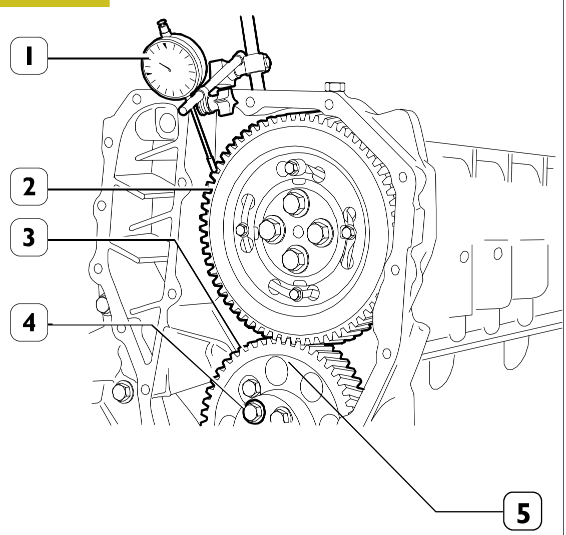
Figure 53



60571

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

Figure 54



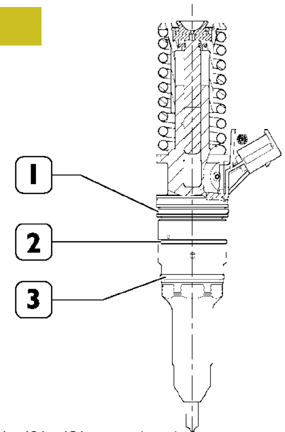
60572

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 52) fixing the link rod. Shift the link rod (3, Figure 52) to obtain the required clearance.
❑ Lock the screw (2, Figure 52) fixing the link rod and screws (2, Figure 53) fixing the idle gear to the required torque.

Fitting pump-injectors

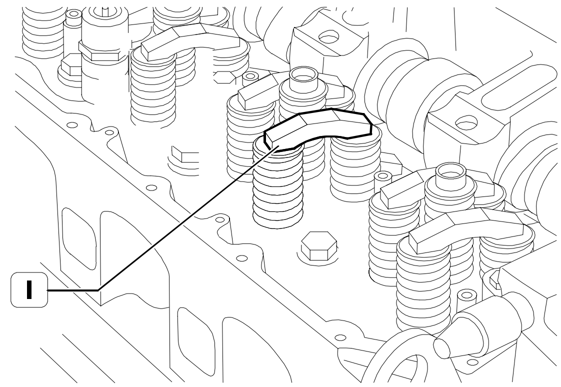
Figure 55



104243

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

Figure 56



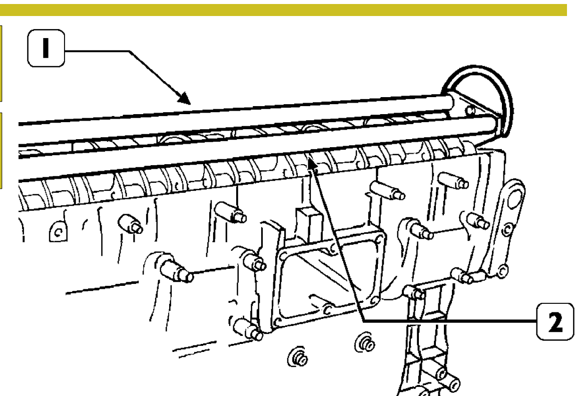
104260

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 57

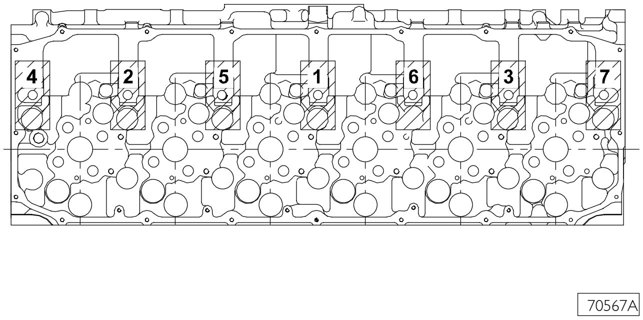
NOTE Before refitting the rocker-arm shaft assembly, make sure that all the adjustment screws have been fully unscrewed.



116814

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

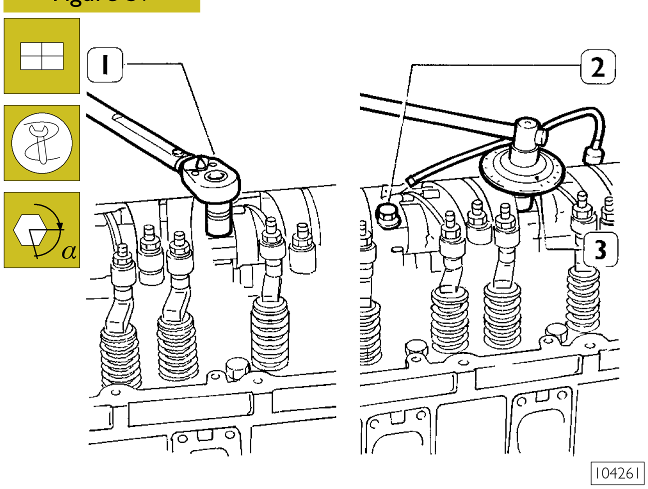
Figure 58



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 59



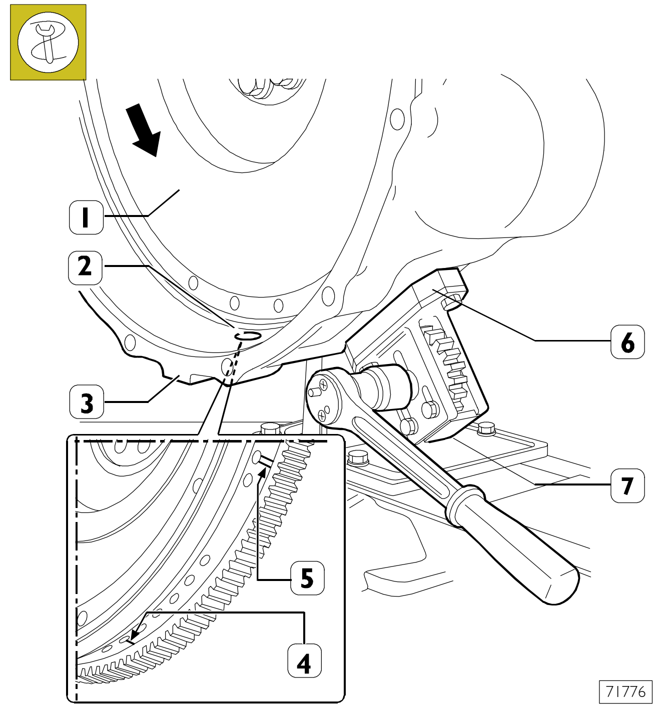
Lock the screws (2) fixing the rocker-arm shaft as follows:

- 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).

Fit and connect the wiring to the injectors.

Camshaft timing

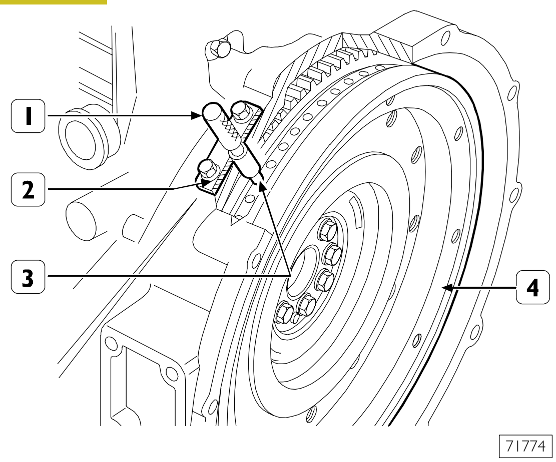
Figure 60



Apply the tool 99360321 (7) and the spacer 99360325 (6) to the gearbox (3).

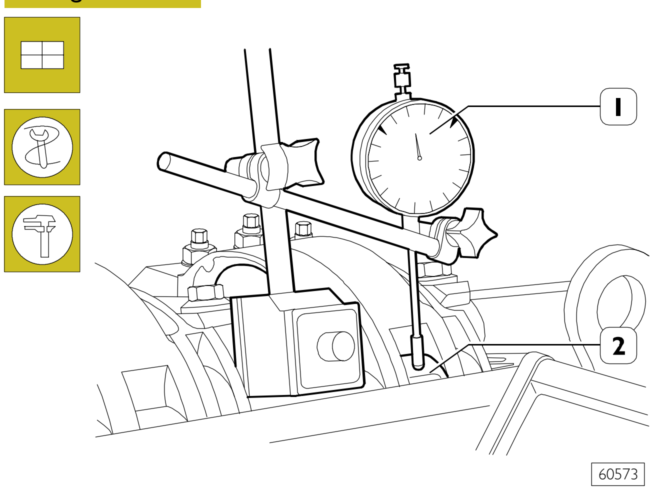
NOTE The arrow shows the direction of rotation of the engine when running.
Using the above-mentioned tool, turn the engine flywheel (1) in the direction of rotation of the engine so as to take the piston of cylinder no.1 to approximately the T.D.C. in the phase of combustion.
This condition occurs when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

Figure 61



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 62



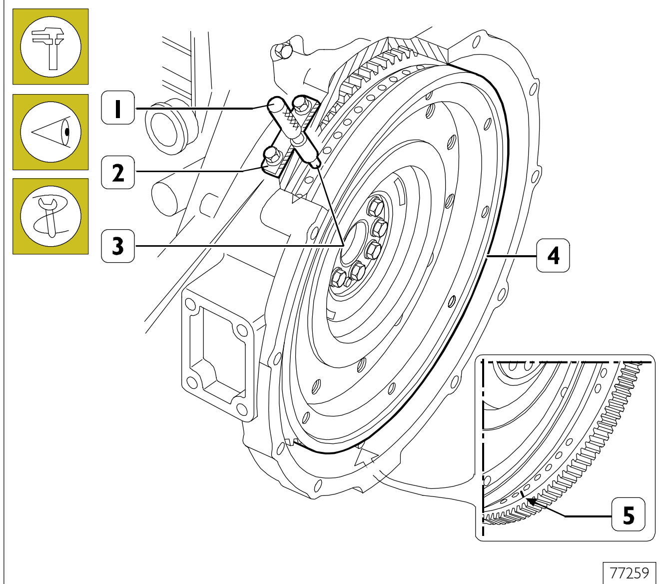
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

With tool 99360321 (7) Figure 60, turn the crankshaft clockwise until the pointer of the dial gauge reaches the minimum value beyond which it can no longer fall.

Reset the dial gauge.

Turn the engine flywheel anticlockwise until the dial gauge gives a reading for the lift of the cam of the camshaft of 4.44 ±0.05 mm.

Figure 63

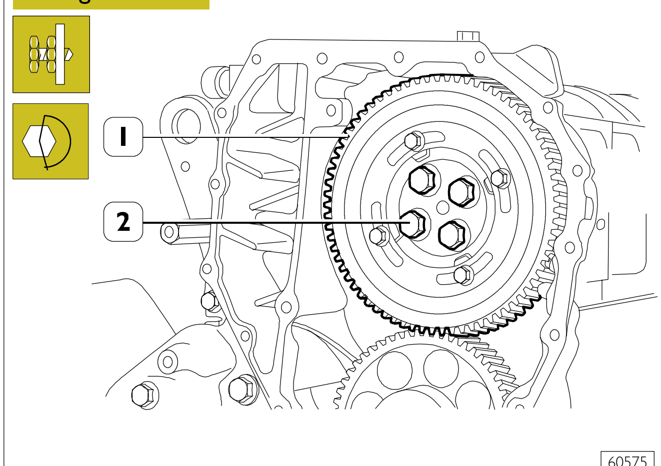


The camshaft is in step if at the cam lift values of 4.44 ±0.05 mm there are the following conditions:

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

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

Figure 64



If you do not obtain the conditions illustrated in Figure 63 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 65) on the gear (1);

2) turn the engine flywheel appropriately so as to bring about the conditions described in points 1 and 2 Figure 63, 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.

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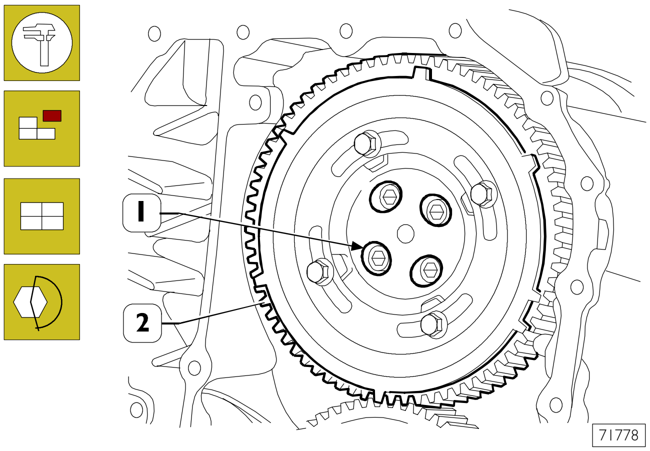
Figure 65



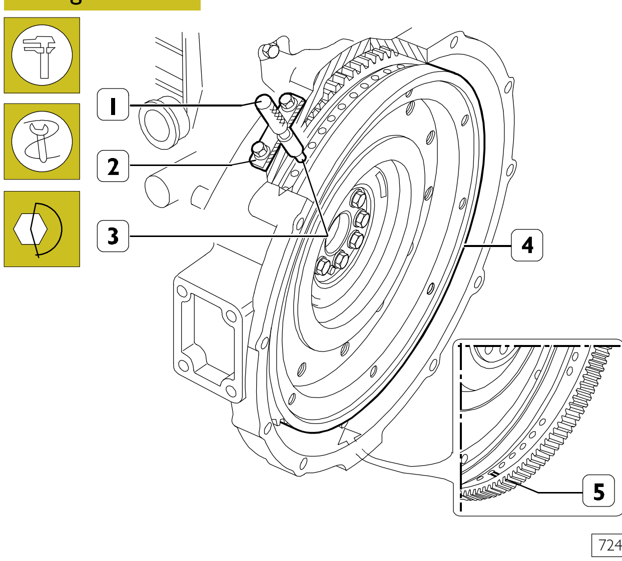
When the adjustment with the slots (1) is not enough to make up the phase difference and the camshaft turns because it becomes integral with the gear (2); as a result, the reference value of the cam lift varies, in this situation it is necessary to proceed as follows:

1) lock the screws (2, Figure 64) and turn the engine flywheel clockwise by approx. 1/2 turn;

2) turn the engine flywheel anticlockwise until the dial gauge gives a reading of the lift of the cam of the camshaft of 4.44 ±0.05 mm;

3) take out the screws (2, Figure 64) and remove the gear (1) from the camshaft.

Figure 66



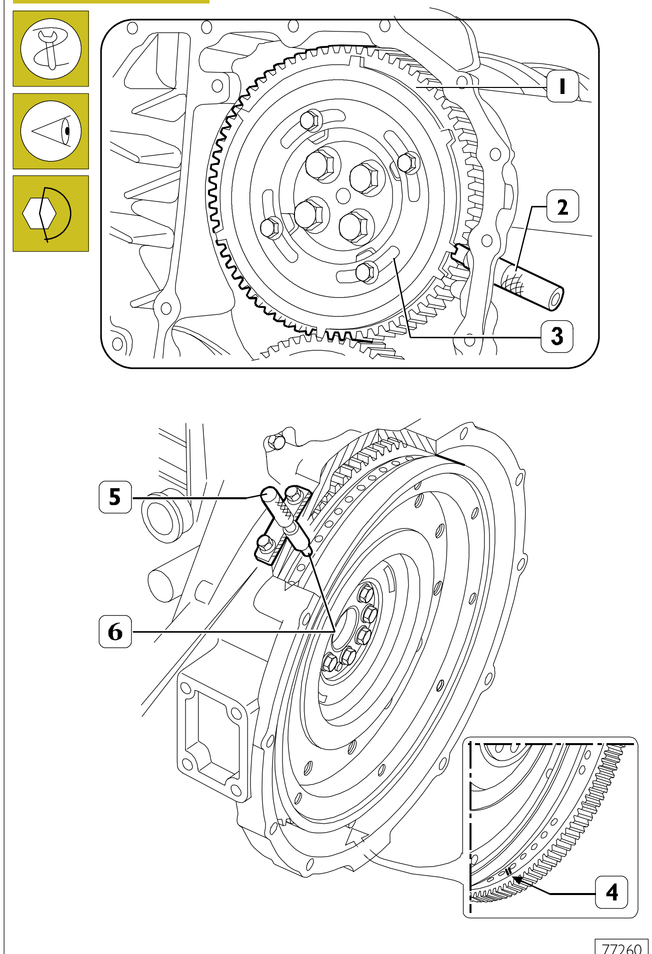
Turn the flywheel (4) again to bring about the following conditions:

- 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 65 with the 4 slots (1) centred with the fixing holes of the camshaft, locking the relevant screws to the required tightening torque.
Check the timing of the shaft by first turning the flywheel clockwise to discharge the cylinder completely and then turn the flywheel anticlockwise until the dial gauge gives a reading of 4.44 ±0.05.
Check the timing conditions described in Figure 63.

Phonic wheel timing

Figure 67



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.

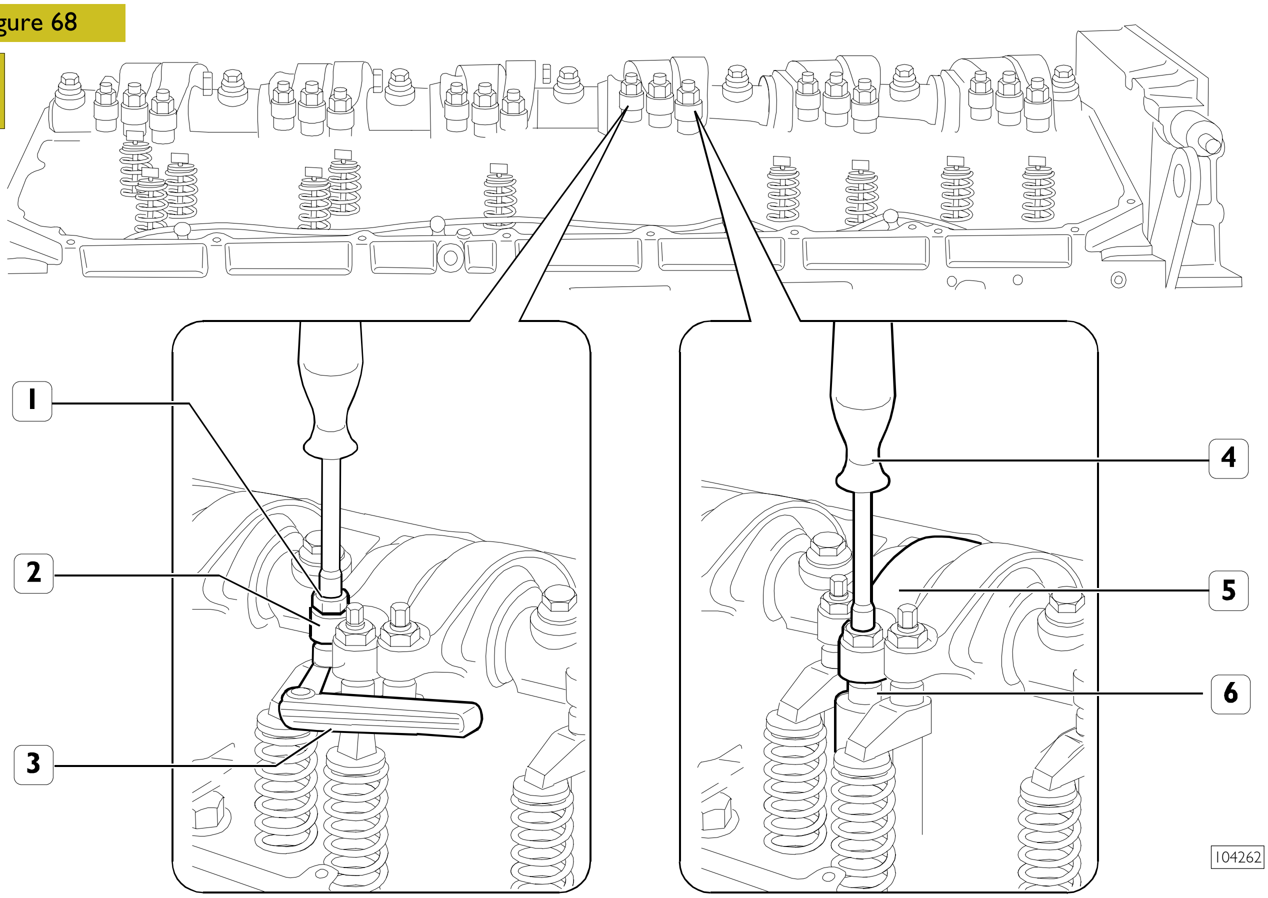
Again turn the flywheel in its normal direction of rotation until you see the hole marked with the double notch (4) through the inspection hole under the flywheel housing. Insert tool 99360612 (5) into the seat of the flywheel sensor (6).

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 68



ADJUSTMENT OF INTAKE, EXHAUST AND INJECTION ROCKERS

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

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

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

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

- ❑ use a polygonal wrench to slacken the locking nut (1) of the rocker arm adjusting screw (2).
- ❑ insert the thickness gauge blade (3);
- ❑ tighten or untighten the adjustment screw with the appropriate wrench;
- ❑ make sure that the gauge blade (3) can slide with a slight friction;
- ❑ lock the nut (1), by blocking the adjustment screw.

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

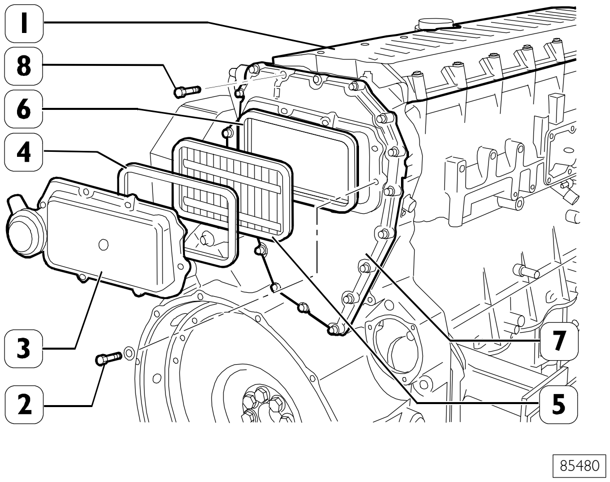
- ❑ using a polygonal wrench, loosen the nut locking the rocker adjustment screw (5) controlling the pump injector (6);
- ❑ using an appropriate wrench (4), loosen the adjustment screw until the pumping element is at the end-of-stroke;
- ❑ tighten the adjustment screw, with a dynamometric wrench, to 5 Nm tightening torque (0.5 kgm);
- ❑ untighten the adjustment screw by 1/2 to 3/4 rotation;
- ❑ tighten the locking nut.

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

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

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

Figure 69



Fit the distribution cover (1).

NOTE The valve rocker arm cover fastening screws (1) shall be tightened according to the sequence shown in Figure 70.

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 70

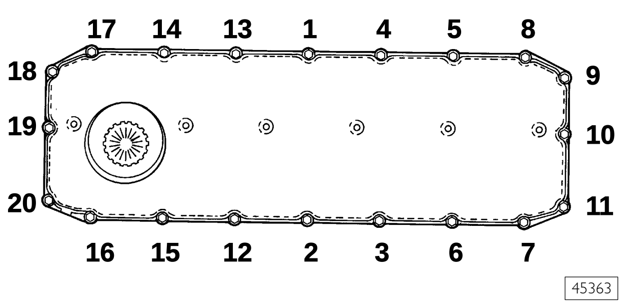
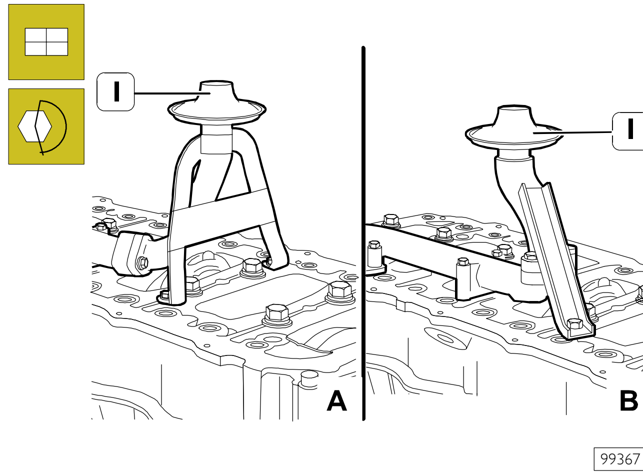


DIAGRAM OF ROCKER ARM CAP FIXING SCREWS TIGHTENING SEQUENCE

ENGINE COMPLETION

Figure 71

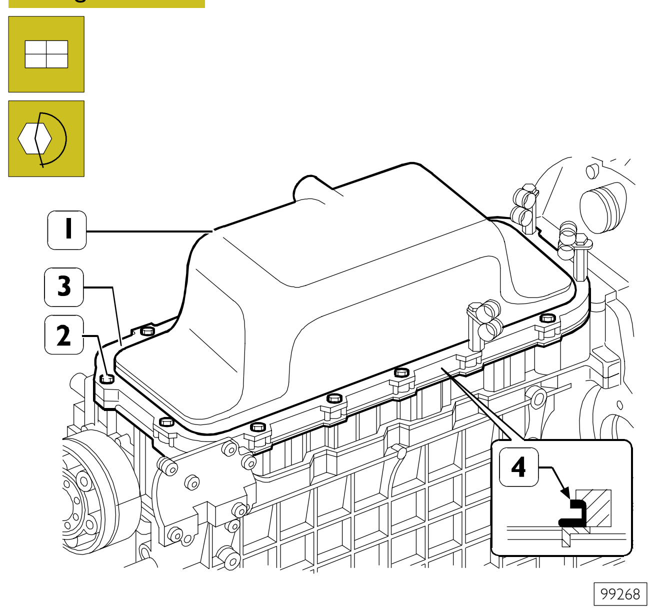


Fit the suction strainer (1) and tighten the fixing screws to the prescribed torque.

A. F3AE0684P*E904 - F3AE0684N*E907 - F3AE9687A*E001 - F3AE9687B*E001 - F3AE9687C*E001

B. F3AE0684P*E906 - F3AE0684L*E906 F3AE0684P*E905.

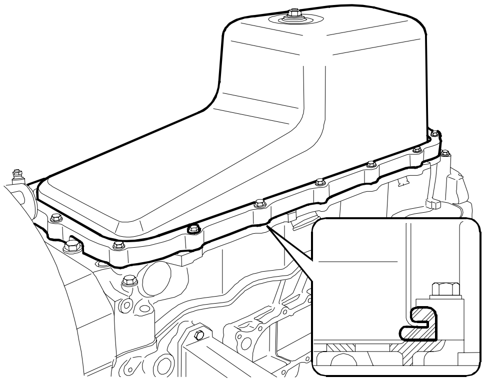
Figure 72



For all types except F3AE0684P*E904 and F3AE0684N*E907

Place gasket (4) on oil sump (1), position spacer (3) and fit the sump on the engine base by tightening screws (2) to the specified torque, by complying with the tightening sequence shown in Figure 74.

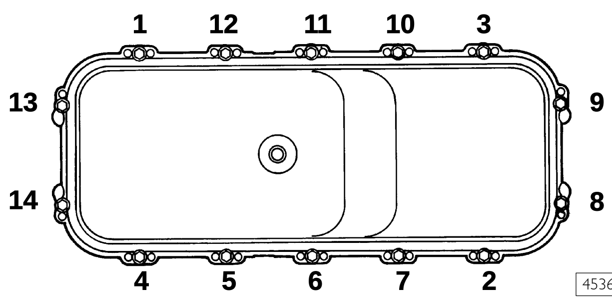
Figure 73



81871

Only for types F3AE0684P*E904 and F3AE0684N*E907 - F3AE9687A*E001 - F3AE9687B*E001 - F3AE9687C*E001

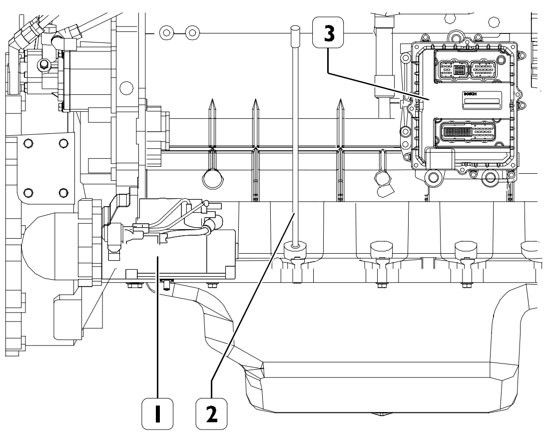
Figure 74



45362

DIAGRAM OF ENGINE OIL SUMP FIXING SCREWS TIGHTENING SEQUENCE

Figure 75



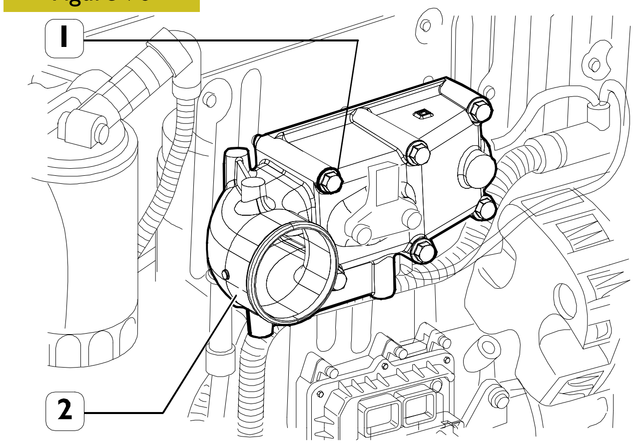
104255

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.

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

Figure 76

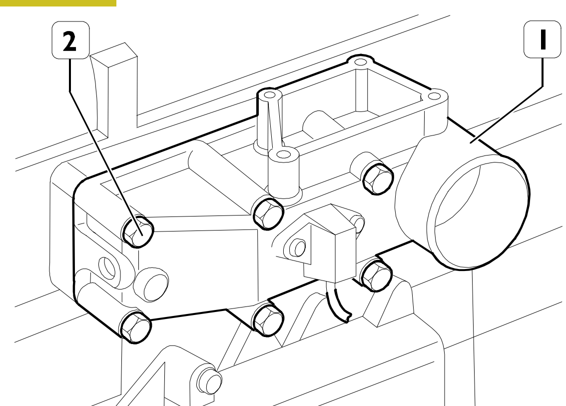


104763

Only for type F3AE0684N*E907 - F3AE9687A*E001 - F3AE9687B*E001 - F3AE9687C*E001

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

Figure 77



104253

For all types except.

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

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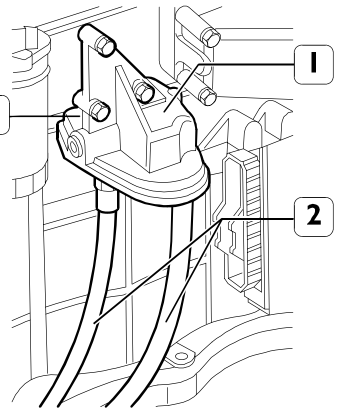
Figure 78

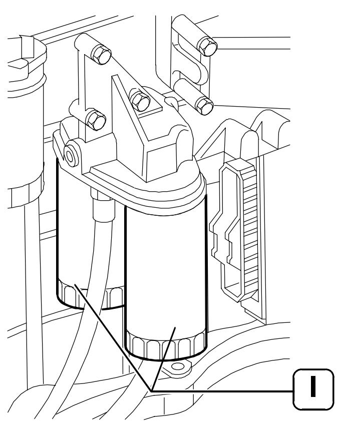


99362

Only for type F3AE0684P*E904

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

Figure 79

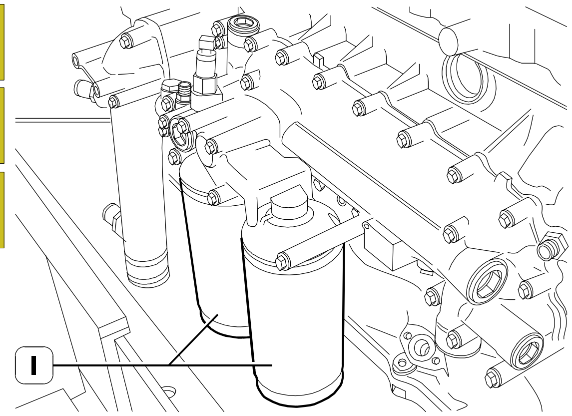


101960

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 80



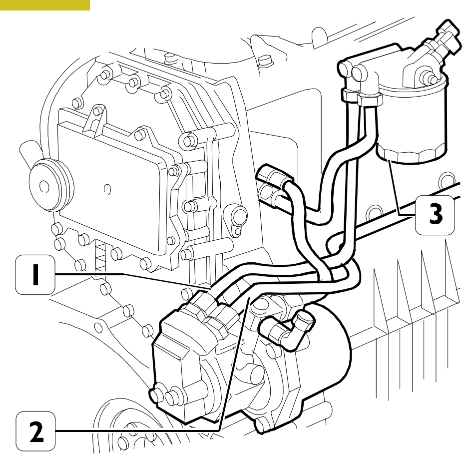
99363

For all types excluding F3AE0684P*E904

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

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

Figure 81

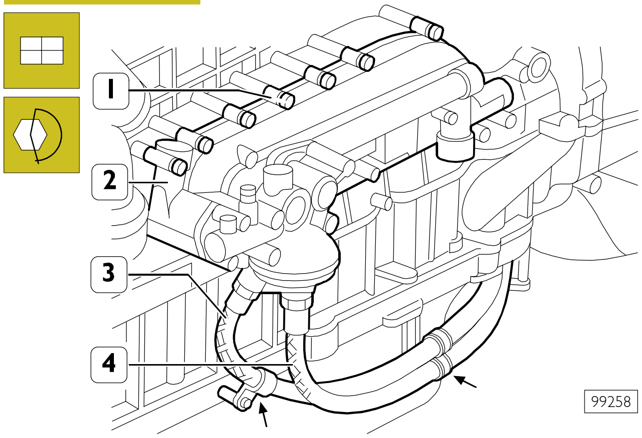


104254

Fit, with the respective gaskets.

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

Figure 82



Only for type F3AE0684P*E904

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

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

Figure 83

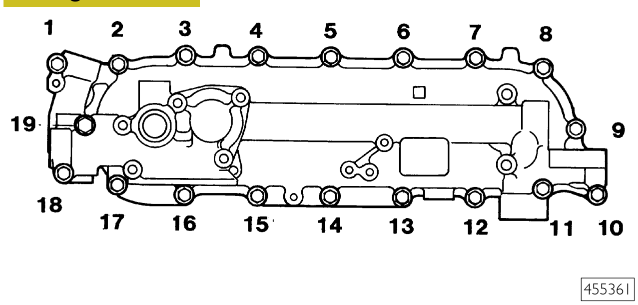
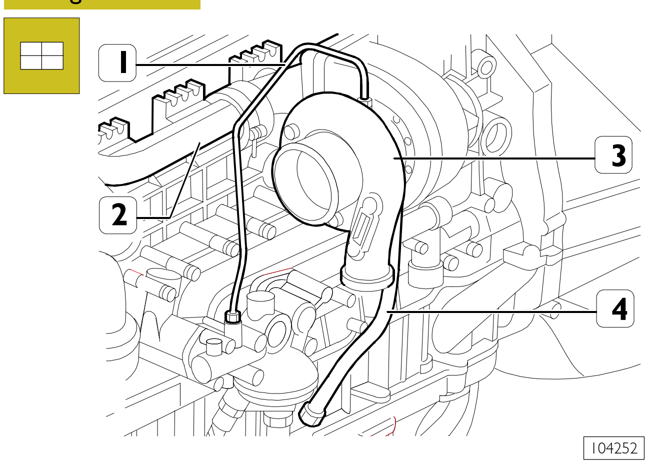


DIAGRAM OF HEAT EXCHANGER FIXING SCREWS TIGHTENING SEQUENCE

Figure 84



Mount the following with new seals:

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

Figure 85

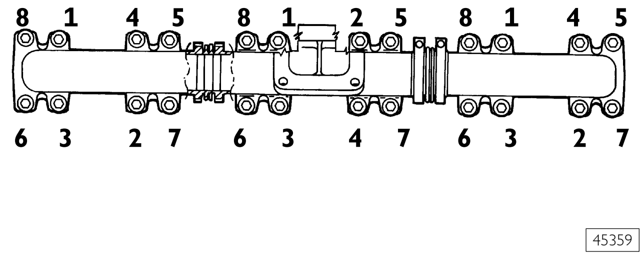


DIAGRAM OF EXHAUST MANIFOLD FIXING SCREWS TIGHTENING SEQUENCE

Figure 86

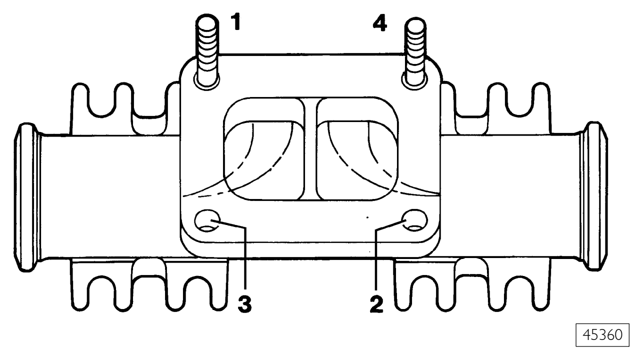


DIAGRAM OF TURBOCHARGER FIXING SCREWS AND NUTS TIGHTENING SEQUENCE

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

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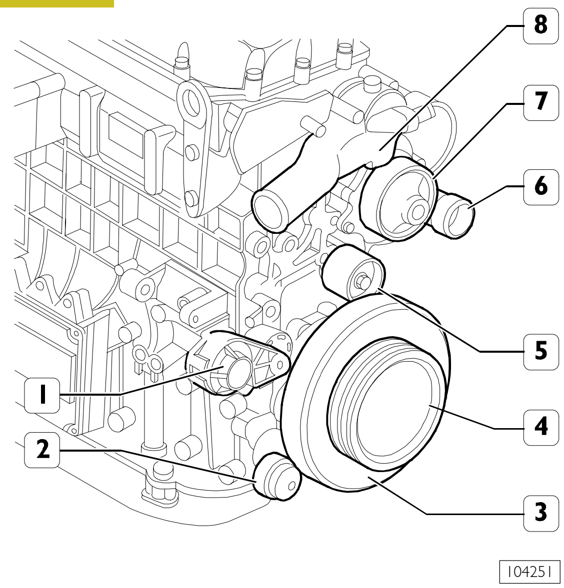
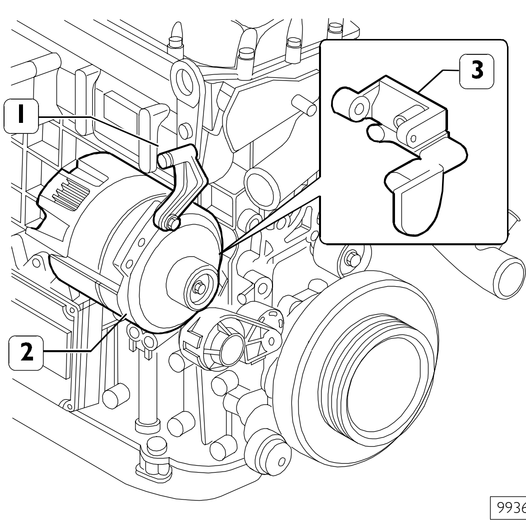
Figure 87



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).

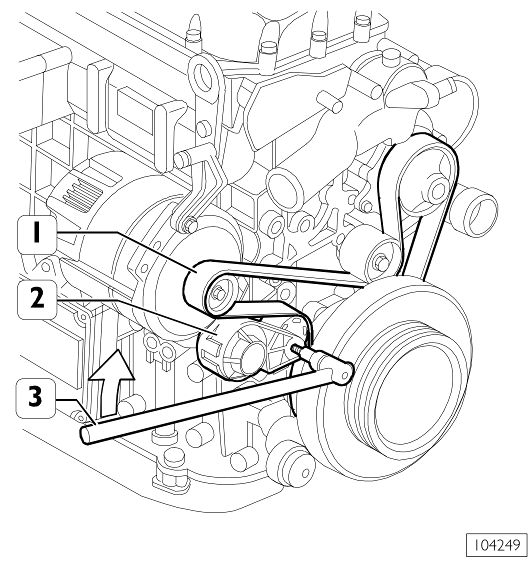
Figure 88



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

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

Figure 89



For all types excluding F3AE0684P*E904

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

NOTE The take-up units are of the automatic type; therefore no further adjustments are required after assembly.

Figure 90

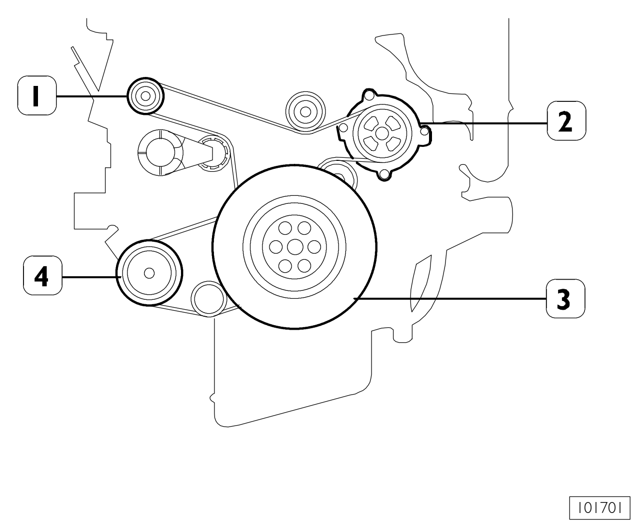
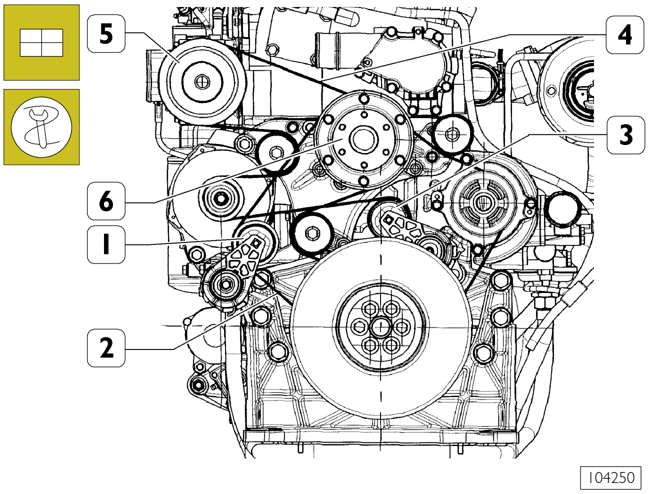


DIAGRAM FOR FITTING BELT DRIVING FAN - WATER PUMP - ALTERNATOR

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

Figure 91

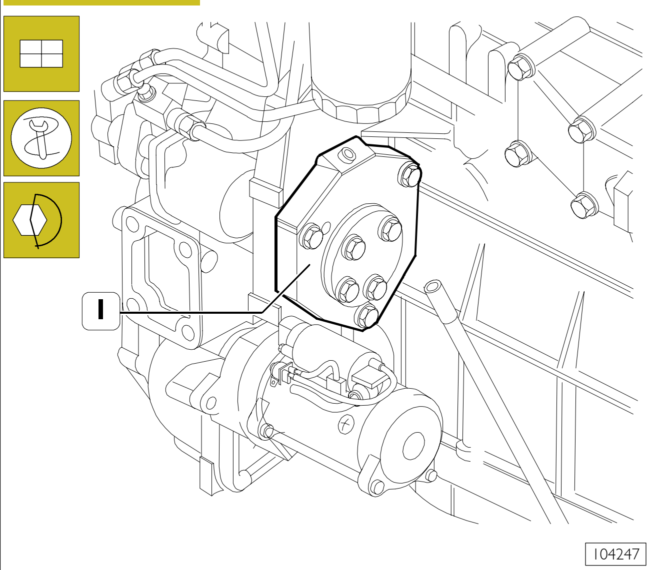


Only for type F3AE0684P*E904

Fit the fan hub (6) and the compressor (5) with related supports.
Using a suitable tool, operate on the belt take-up units (1) and (3) and fit the belts (2) and (4).

NOTE The take-up units are of the automatic type; therefore no further adjustments are required after assembly.

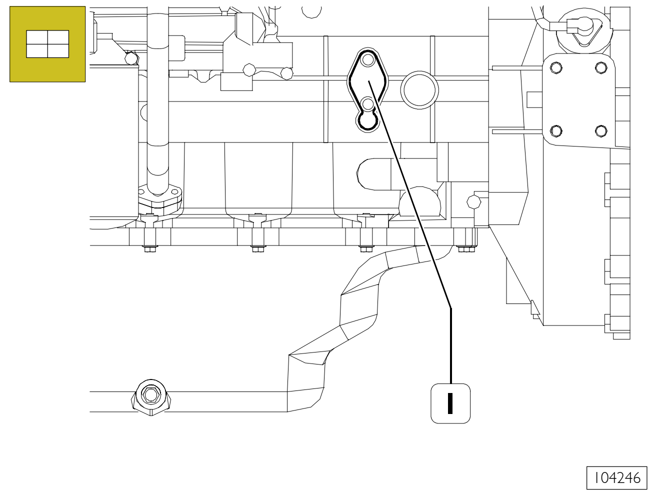
Figure 92



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:

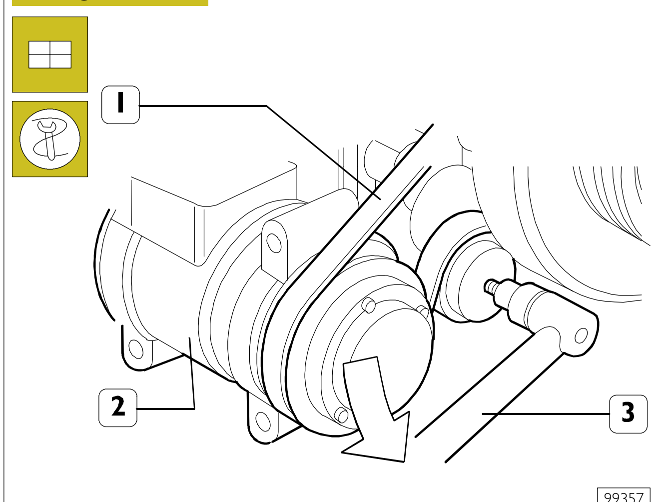
- mount the drive (1);
- mount the engine supports;

Figure 93



- mount the oil pressure adjuster valve (1).

Figure 94



For all types except F3AE0684P*E904 and F3AE0684N*E907

Fit the engine support together with the air-conditioner compressor (2).
Using a suitable tool (3), work in the direction of the arrow and mount the belt (1).

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

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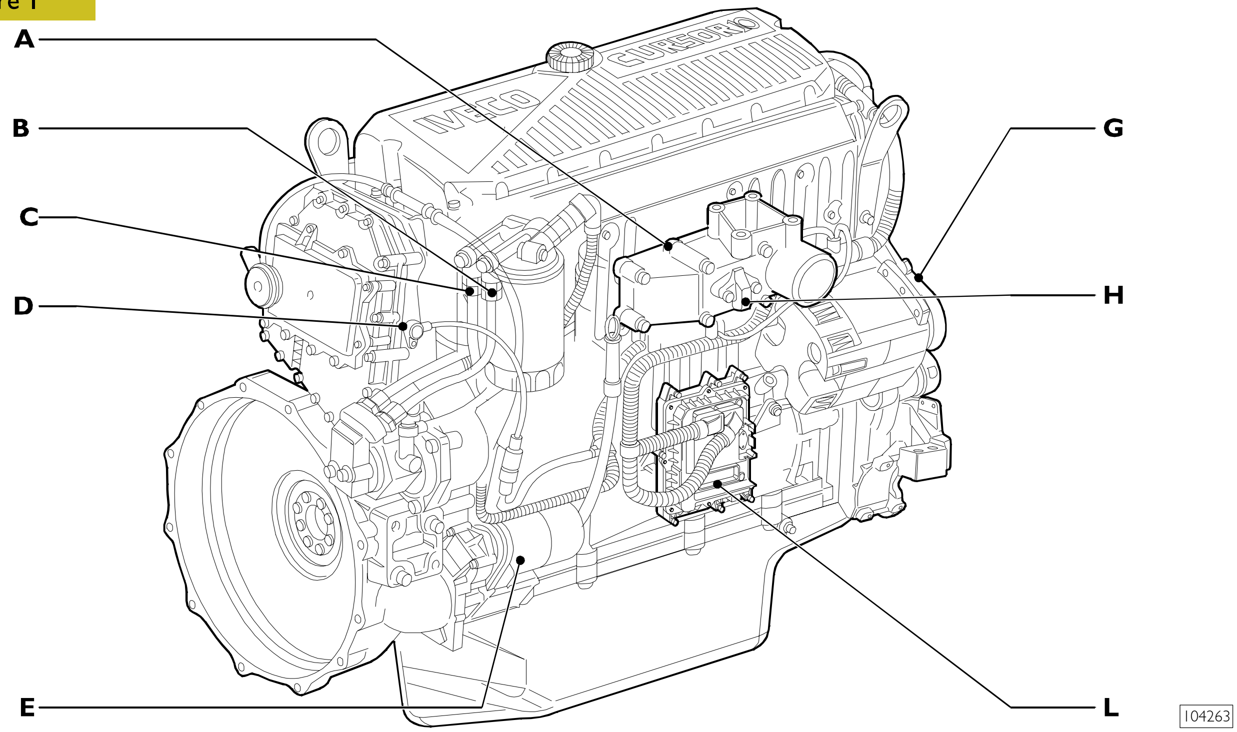
PART TWO -

ELECTRICAL EQUIPMENT

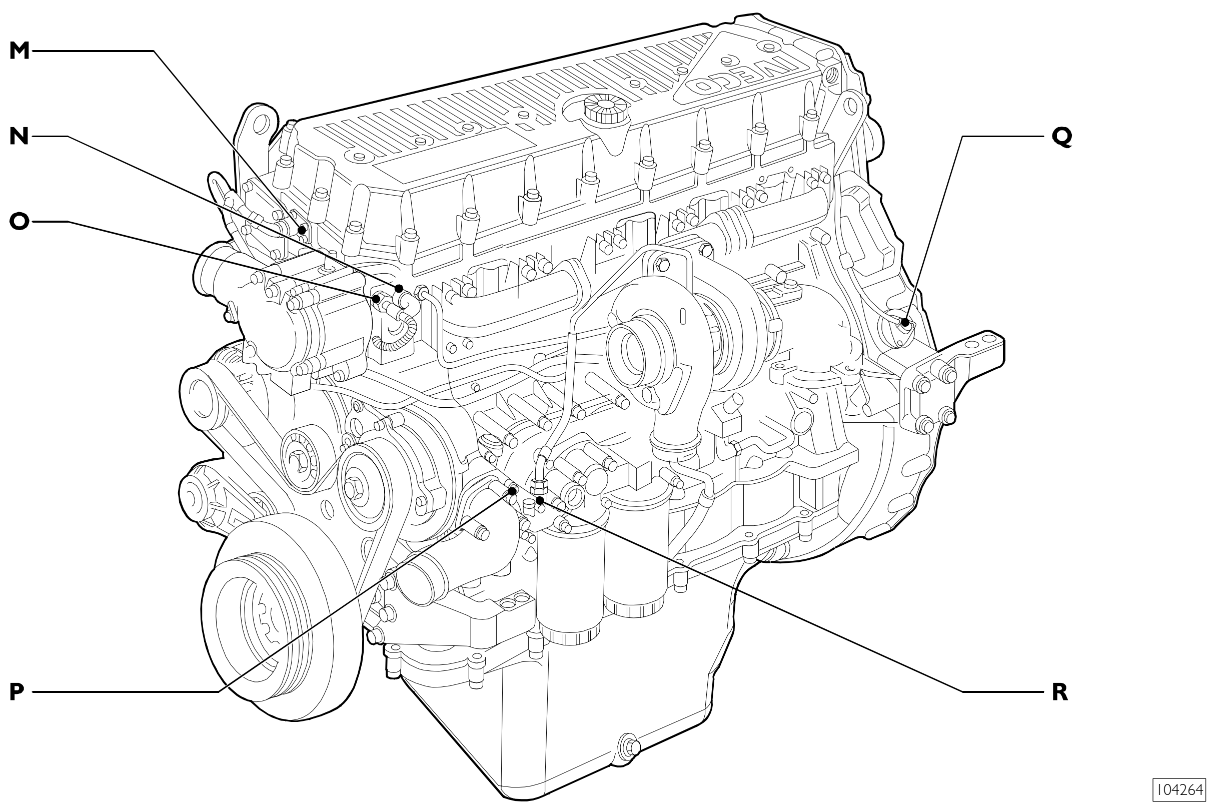
Components on the engine F3A (For all types except F3AE0684P*E904)

Figure 1



ENGINE RIGHT-HAND SIDE VIEW

Figure 2

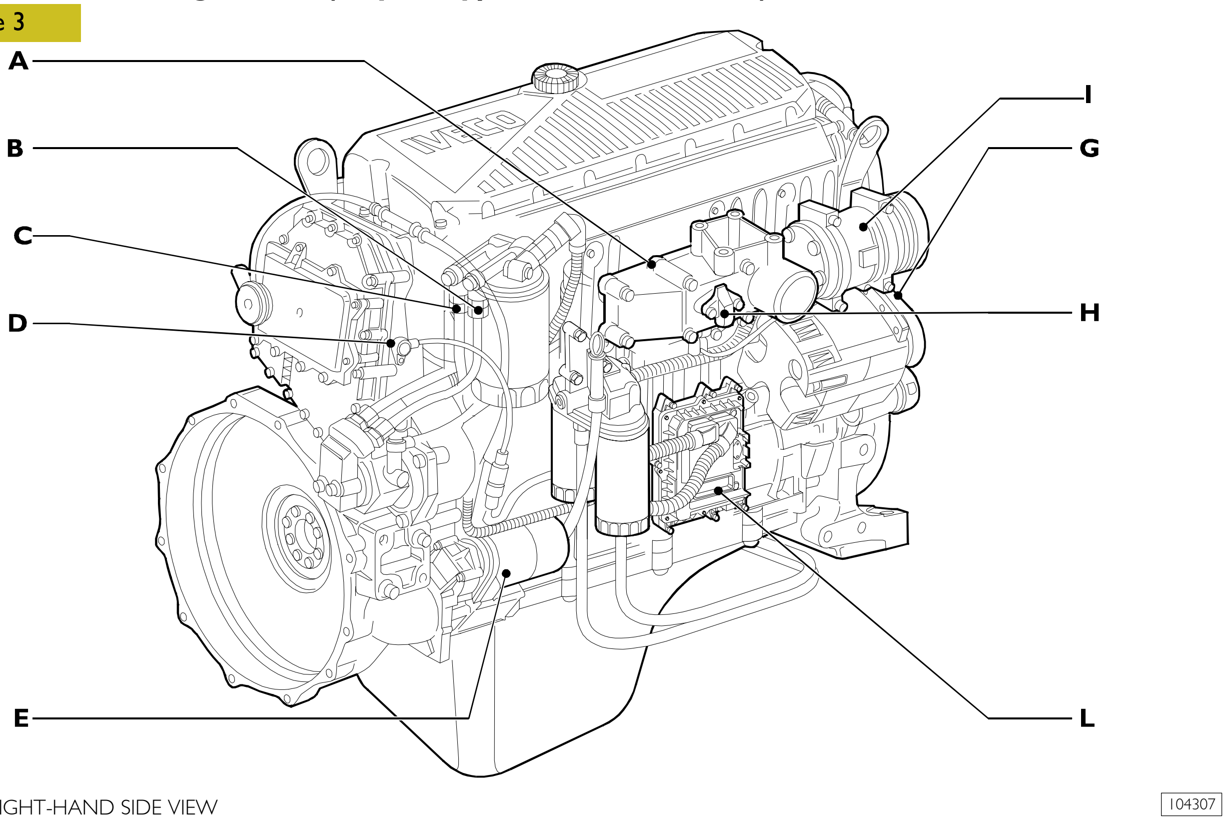


ENGINE LEFT-HAND SIDE VIEW

A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - G. Alternator - H. Air temperature/pressure sensor - I. Conditioner compressor - L. EDC 7 control unit - M. Connector on engine block for connection with electro-injectors - 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.

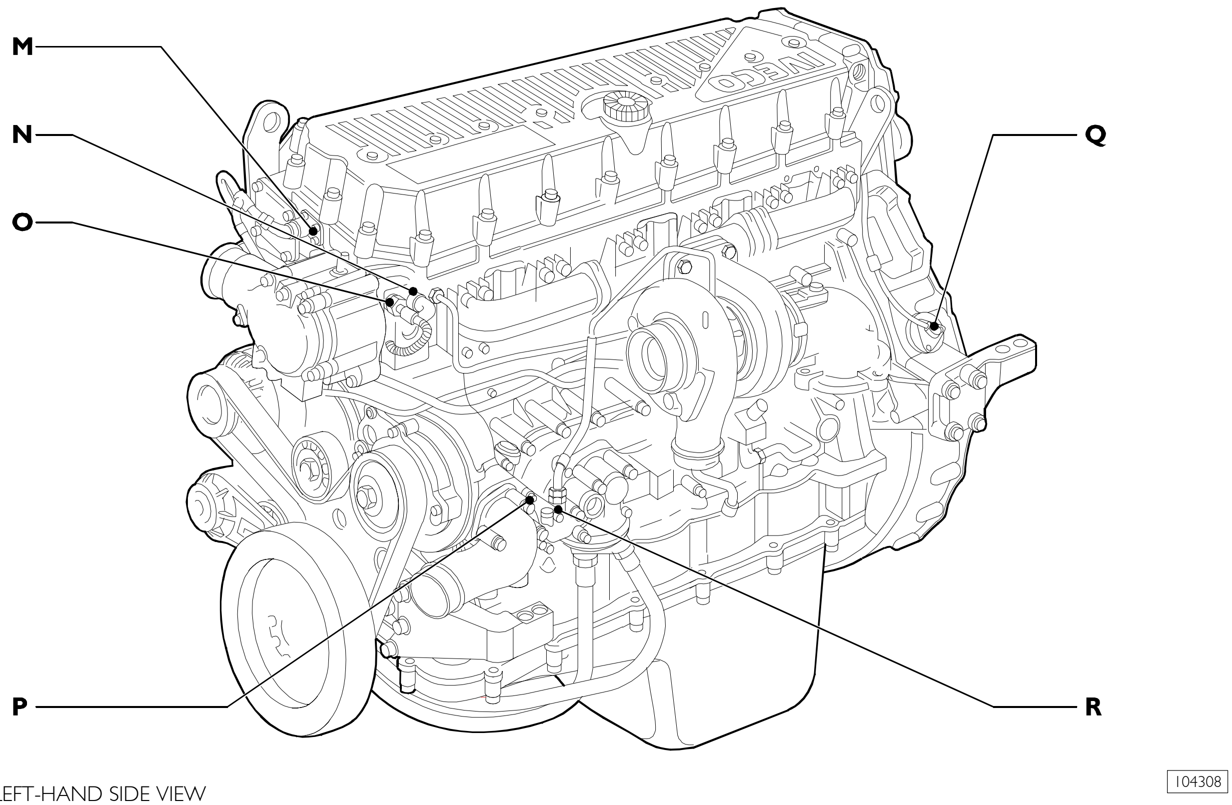
Components on the engine F3A (only for type F3AE0684P*E904)

Figure 3



ENGINE RIGHT-HAND SIDE VIEW

Figure 4



ENGINE LEFT-HAND SIDE VIEW

A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - G. Alternator - H. Air temperature/pressure sensor - I. Conditioner compressor - L. EDC 7 control unit - M. Connector on engine block for connection with electro-injectors - 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.

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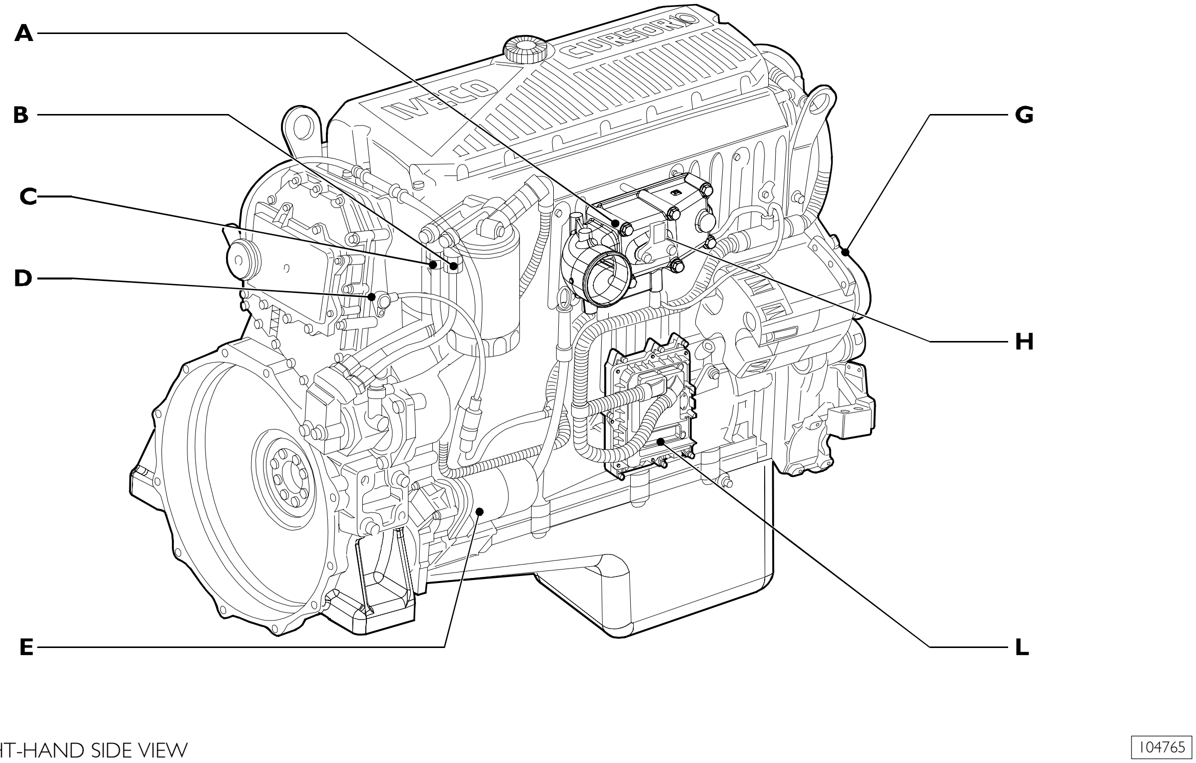
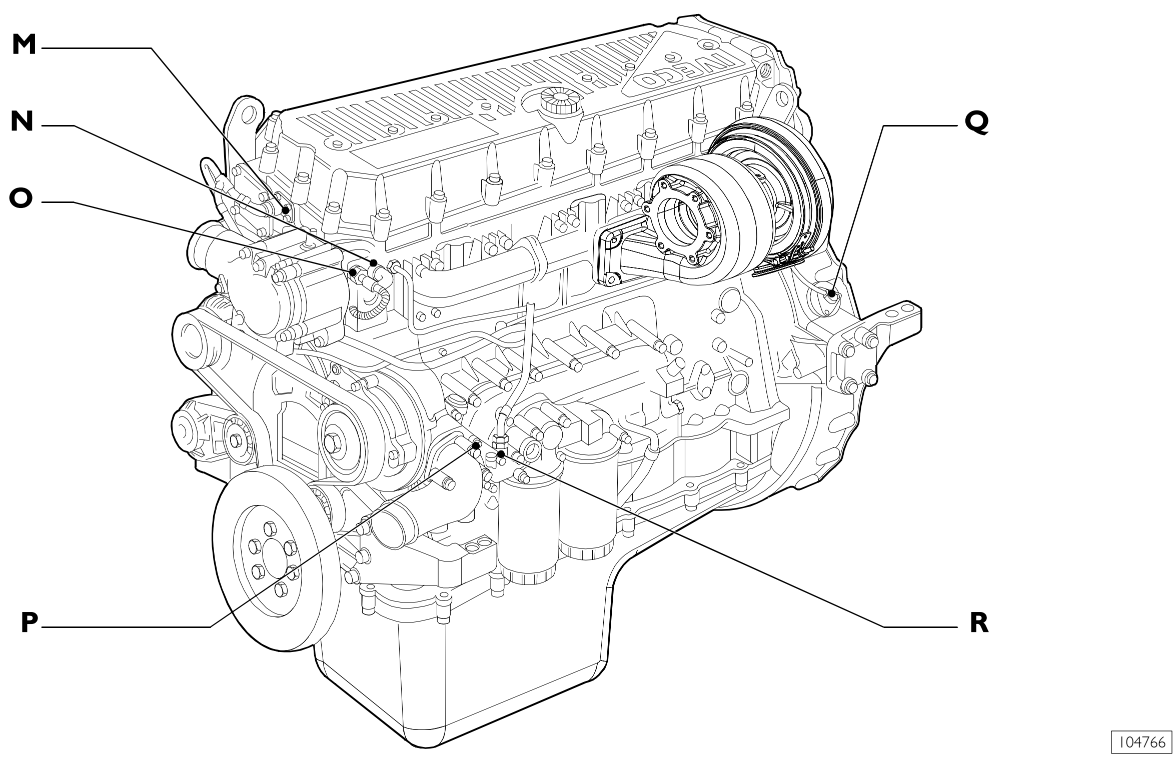
Components on the engine F3A (only for type F3AE0684N*E907)

Figure 5



ENGINE RIGHT-HAND SIDE VIEW

Figure 6

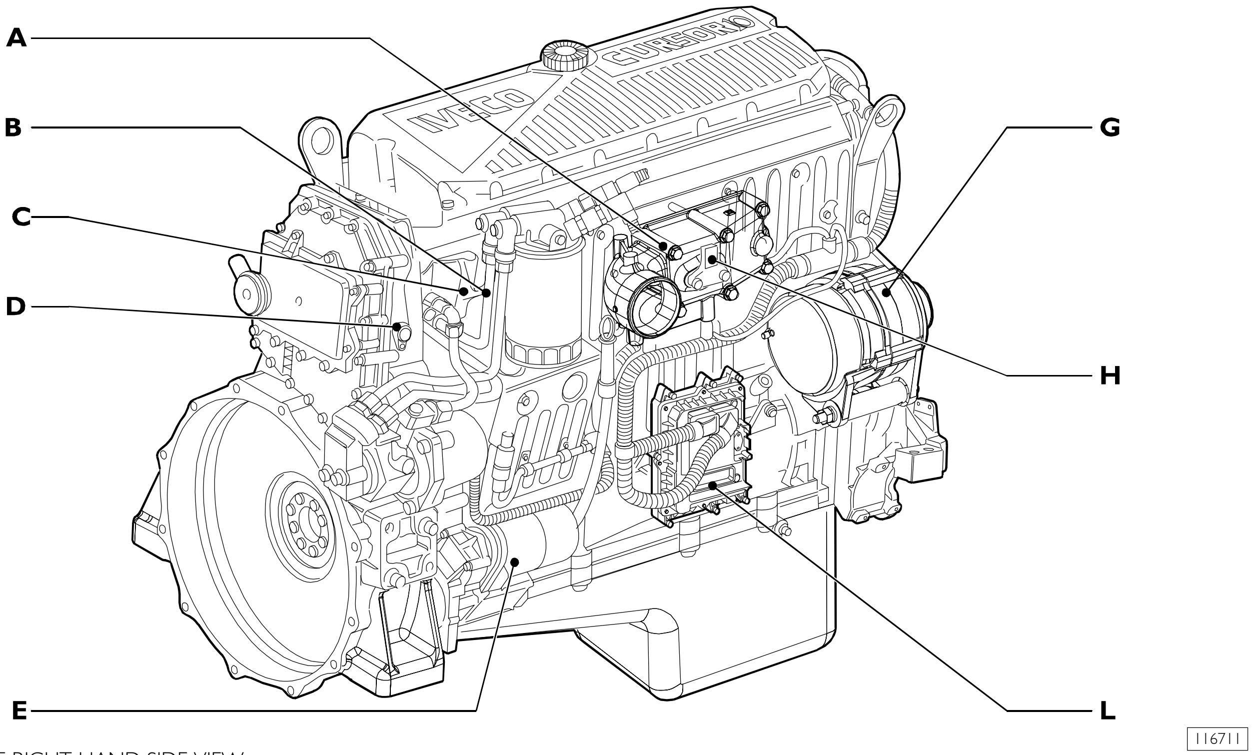


ENGINE LEFT-HAND SIDE VIEW

A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - G. Alternator - H. Air temperature/pressure sensor - I. Conditioner compressor - L. EDC 7 control unit - M. Connector on engine block for connection with electro-injectors - 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.

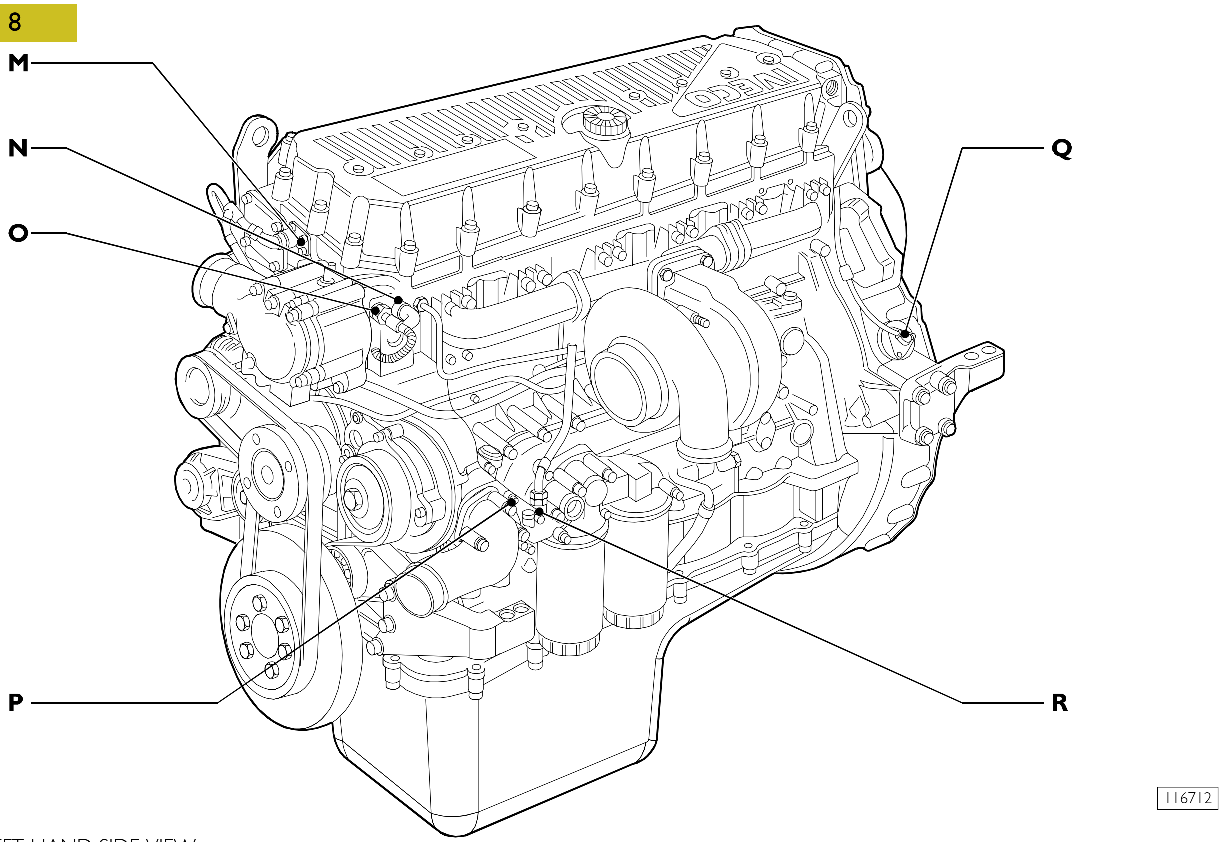
Components on the engine F3A (only for type F3AE9687A*E001)

Figure 7



ENGINE RIGHT-HAND SIDE VIEW

Figure 8



ENGINE LEFT-HAND SIDE VIEW

A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - G. Alternator - H. Air temperature/pressure sensor - I. Conditioner compressor - L. EDC 7 control unit - M. Connector on engine block for connection with electro-injectors - 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.

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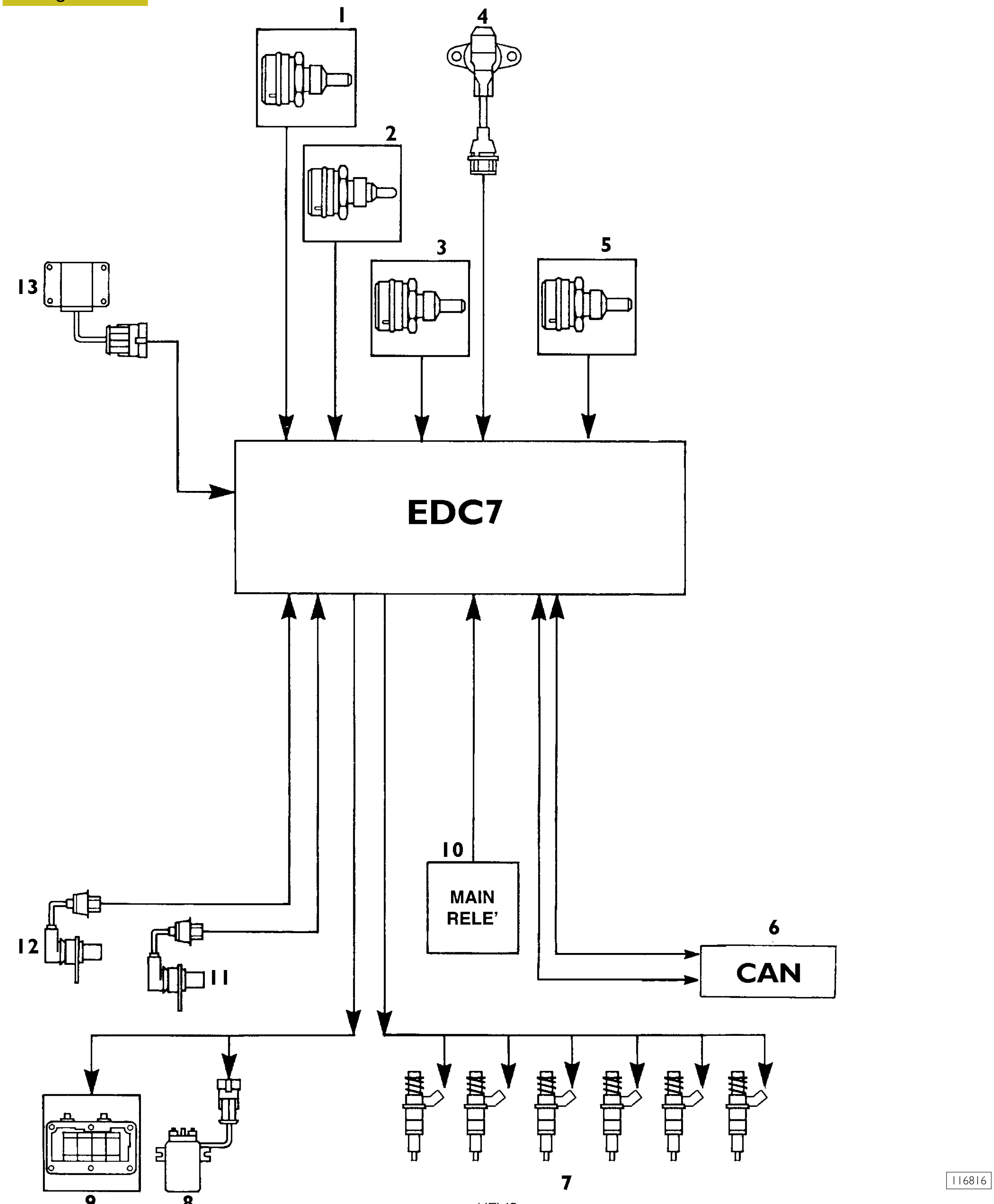
BLOCK DIAGRAM

Figure 9

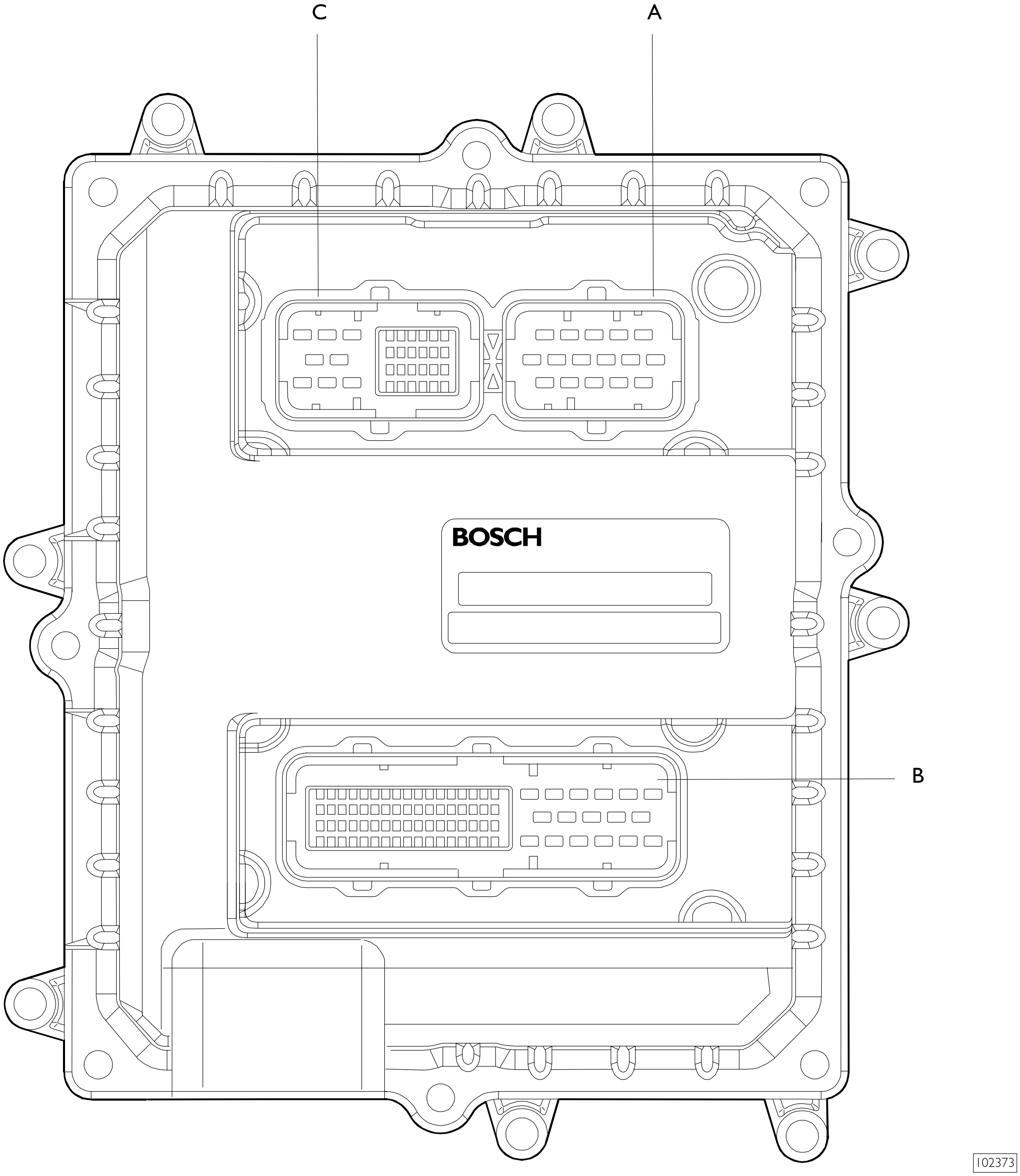


KEYS

1. Engine coolant temperature sensor - 2. Boost air pressure temperature sensor - 3. Fuel temperature sensor - 4. Boost air pressure sensor - 5. Engine oil temperature and pressure sensor - 6. CAN H/L line - 7. Injectors - pump - 8. Pre-heating and heating contactor - 9. Oil electric heater - 10. Main remote-control switch - 11. Flywheel sensor - 12. Distribution sensor - 13. Primary/secondary brake switch.

EDC 7 UC31 electronic control unit

Figure 10

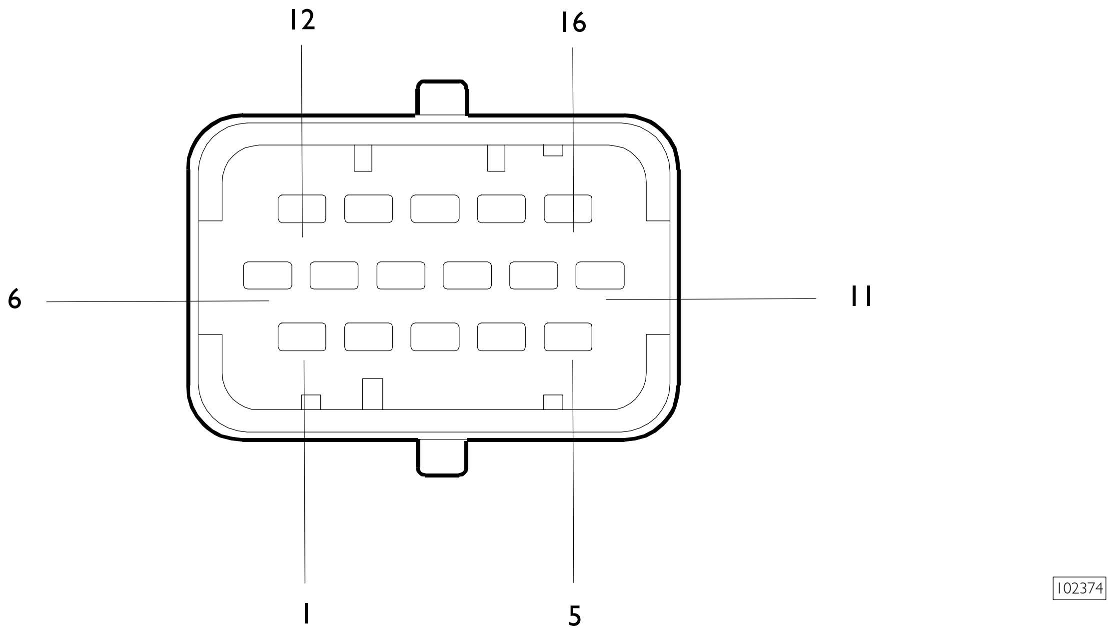


A. Electro-injector connector - B. Chassis connector - C. Sensor connector

EDC control unit PIN-OUT

Electric injector connector ”A”

Figure 11



Colour legend

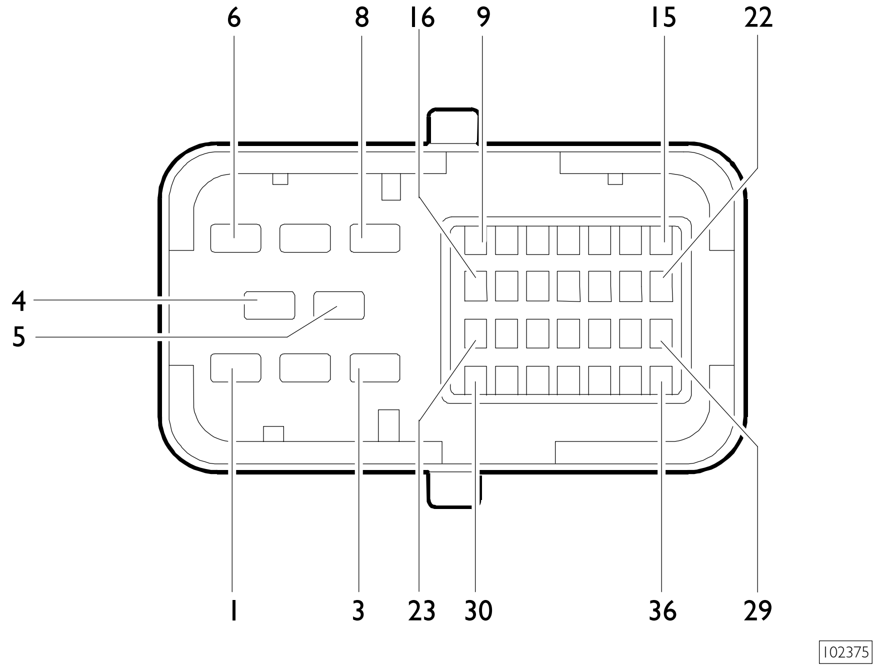
B black
R red
U blue
W white
P purple
G green
N brown
Y yellow
O orange e
E grey
K pink

ECU Pin	Colour legend	Function
1	Black	Solenoid valve for electronic cylinder 5 injection
2	Black	Solenoid valve for electronic cylinder 6 injection
3	Bleu	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	Brown	Solenoid valve for electronic cylinder 5 injection

EDC control unit PIN-OUT

Sensor connector "C"

Figure 12



Colour legend

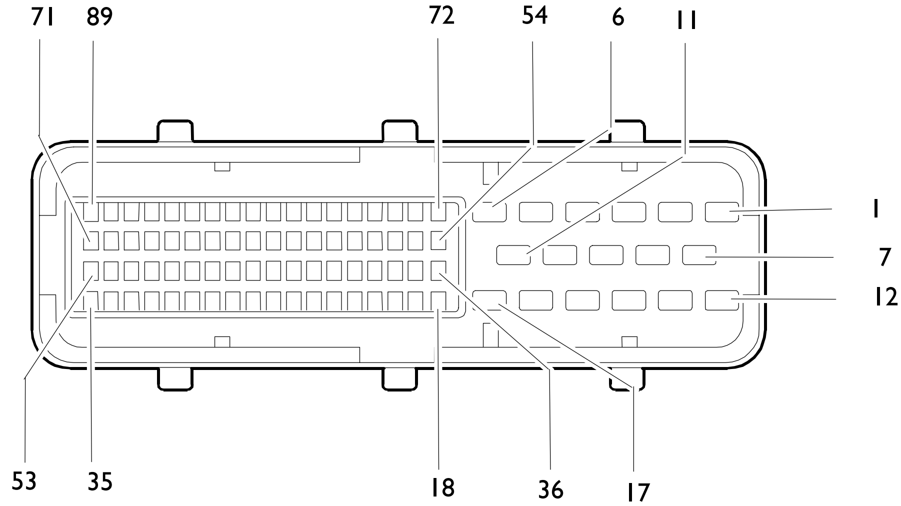
B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange e
E	grey
K	pink

ECU Pin	Cable colour	Function
1	-	Free
2	-	Free
3	-	Free
4÷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
		Free
18	O/B	Fuel temperature sensor
19	B	Flywheel sensor
20	-	Free
21÷22	-	Free
23	W	Flywheel sensor
24	N	Engine oil temperature/pressure sensor ground
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	-	Free
30	-	Free
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”

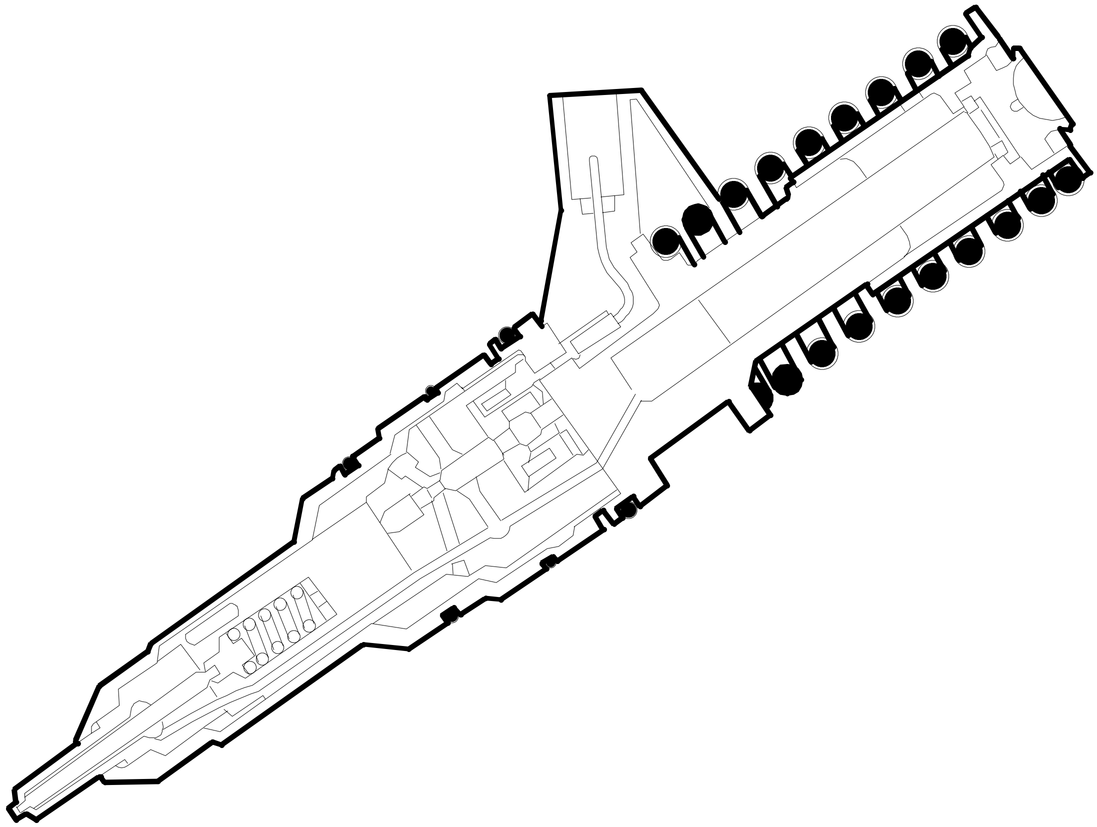
Figure 13



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	-	H_2O present in fuel oil sensor signal
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

Pump injector

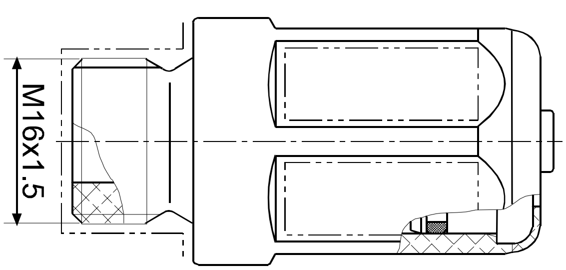
Figure 14



N3.1 INJECTOR SECTION

The new N 3.1 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 15



FUEL PRESSURE DAMPER

The function of the fuel pressure damper located on the delivery pipe between the fuel filter and the cylinder head is to attenuate the supply return back pressure due to the increase of the injection pressure.

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.

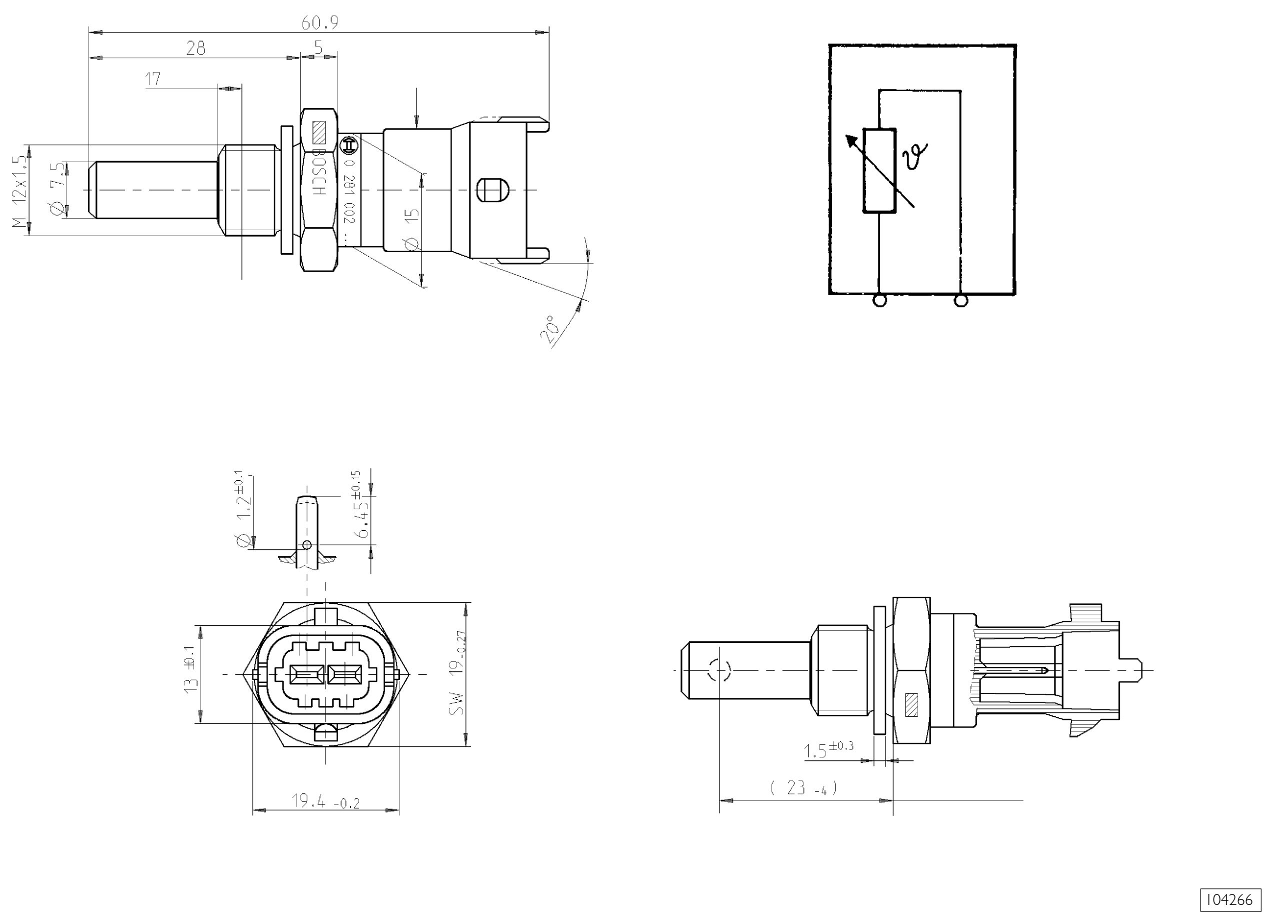
It is connected to electronic center pins 15/26.

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 16



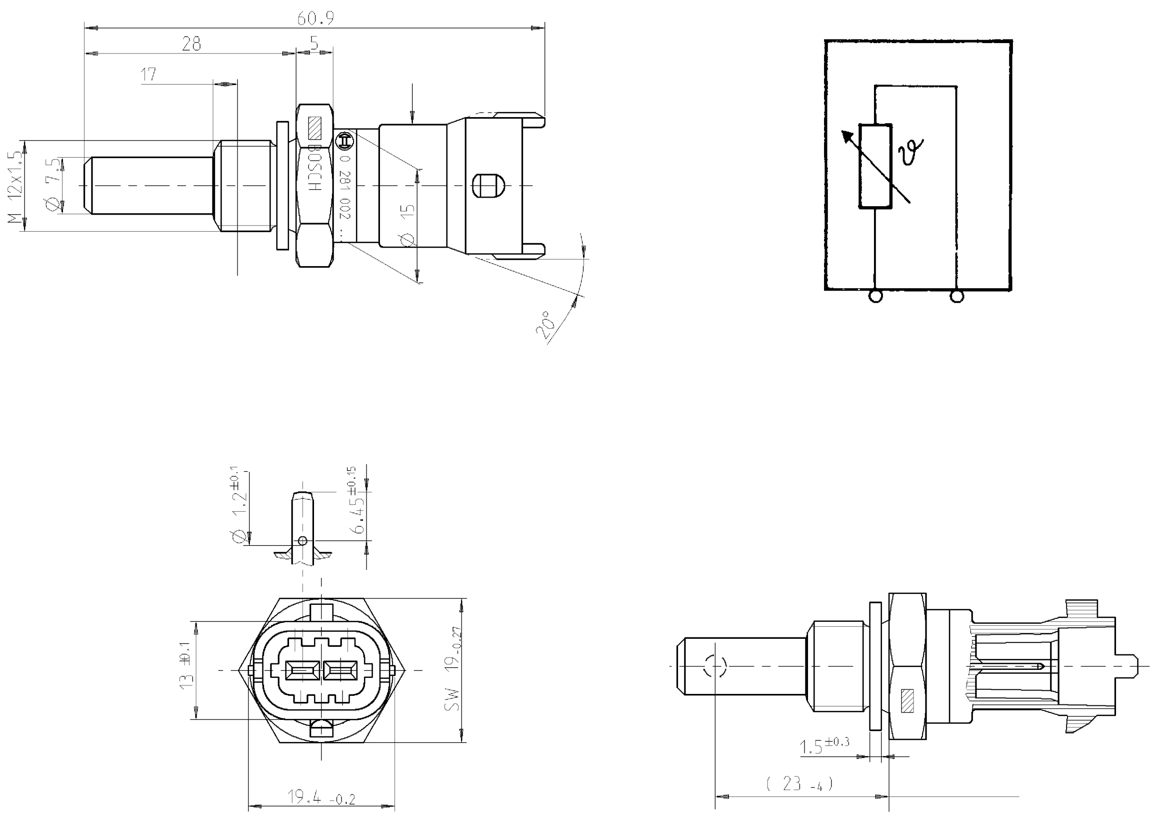
Description	Cable colour
To EDC center pin 15 (Sensor connector "C")	K
To EDC center pin 26 (Sensor connector "C")	Y

Fuel temperature sensor

Specifications

Supplier	BOSCH
Max. tightening torque	35 Nm

Figure 17



104267

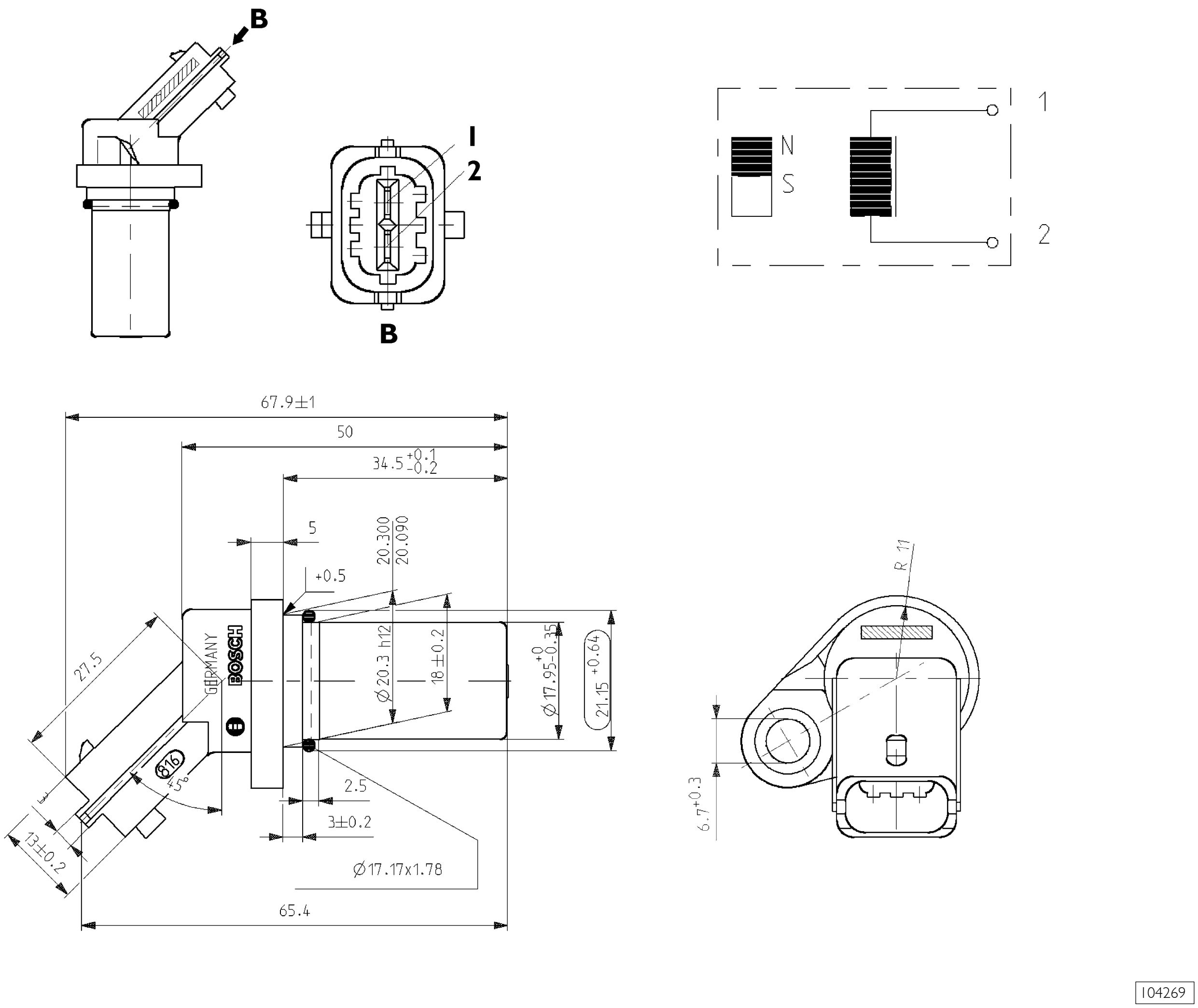
Description	Cable colour
To pin 18 of EDC control unit (Sensor connector "C")	O/B
To pin 35 of EDC control unit (Sensor connector "C")	W/R

Flywheel pulse transmitter

Specifications

Supplier	BOSCH
Max. tightening torque	8 ± 2 Nm

Figure 18



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 ± 2 Nm
Resistance	880 ÷ 920 Ω

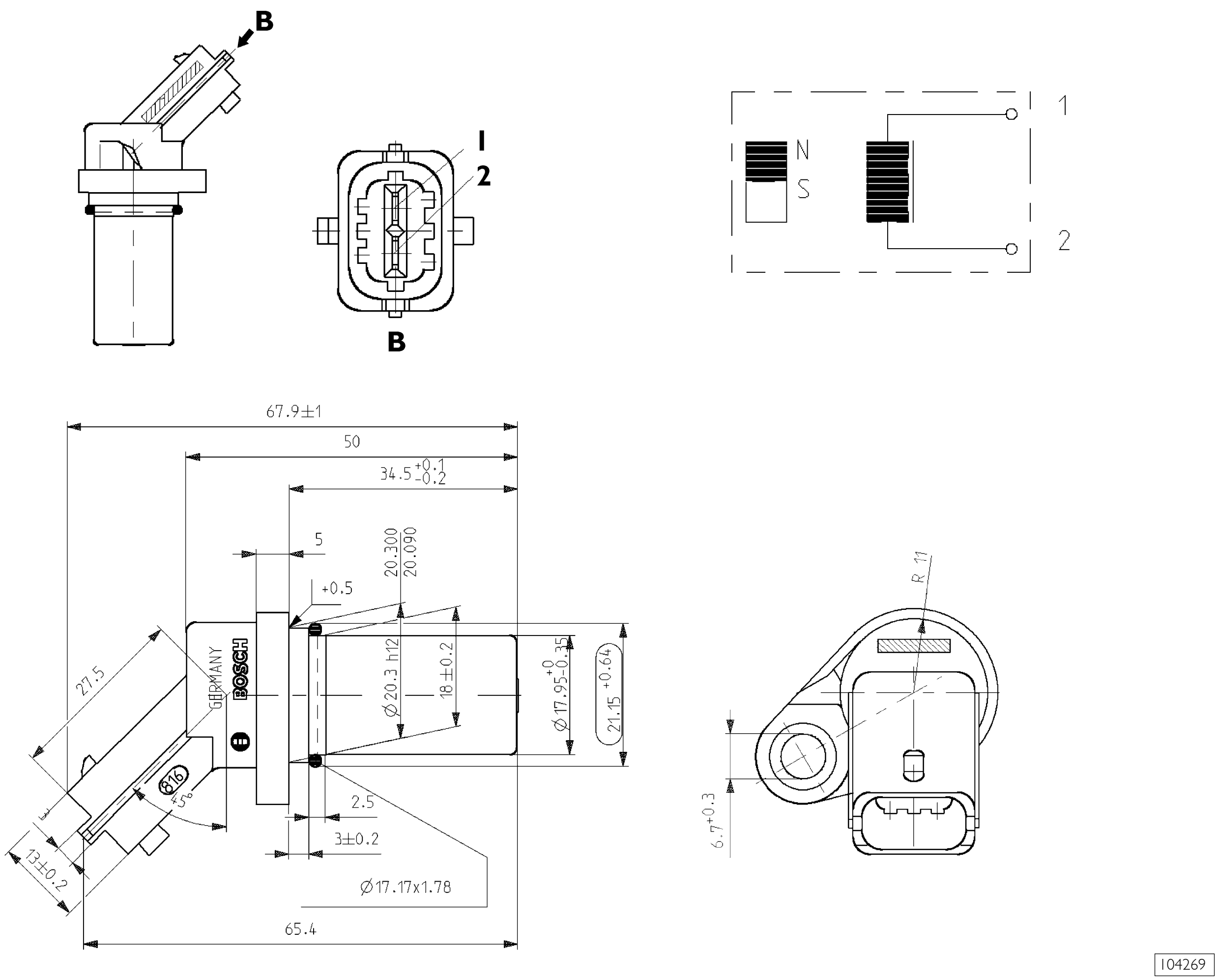
This induction type sensor located on the camshaft generates signals obtained from the magnetic flow lines that close through the 6 plus 1 phase teeth of a sound wheel mounted on the shaft.

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

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

This sensor's air gap is NOT ADJUSTABLE.

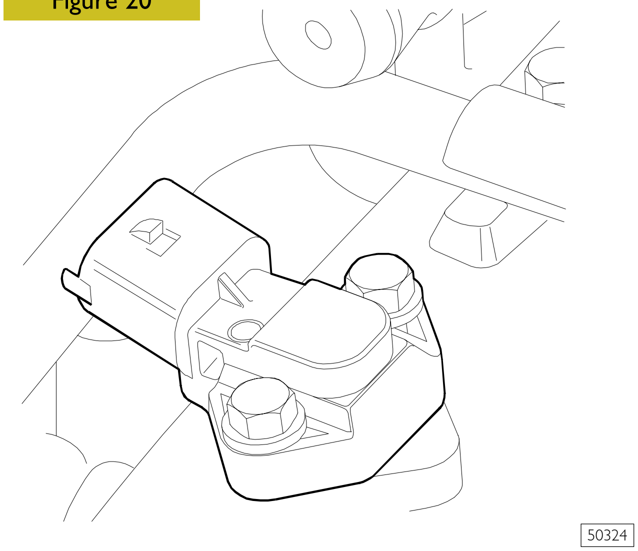
Figure 19



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

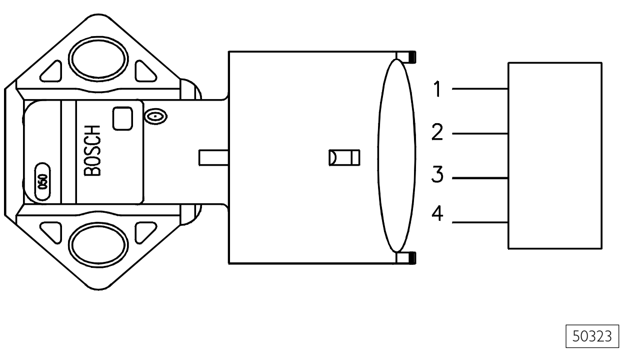
Print P2D32C003 E

Figure 20



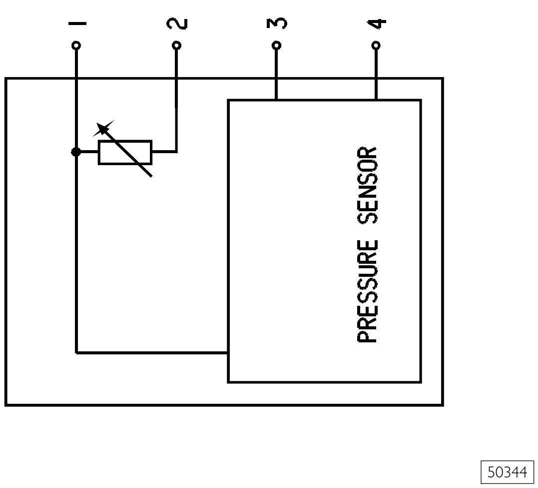
Sensor external view

Figure 21



Linking connector

Figure 22



Wiring diagram

Air pressure/temperature sensor (85156).

This component incorporates a temperature sensor and a pressure sensor.

IIt 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

Supplier	MITSUBISHI
Technical features	24V - 90A

Figure 23

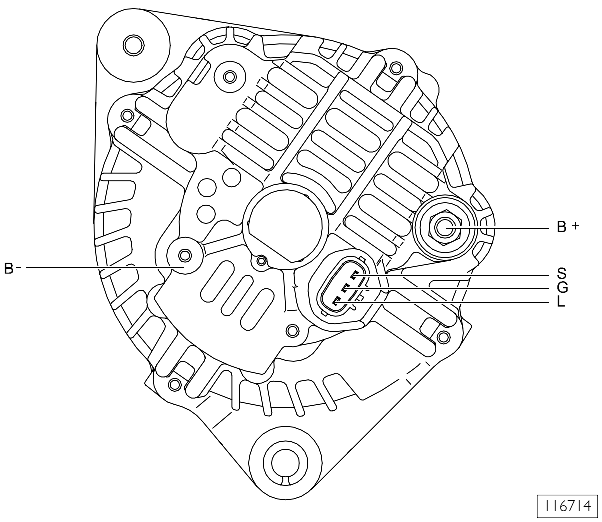


Figure 25

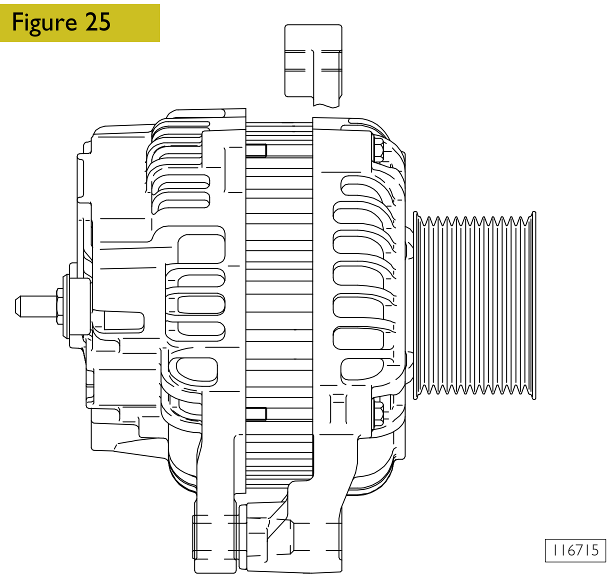


Figure 24

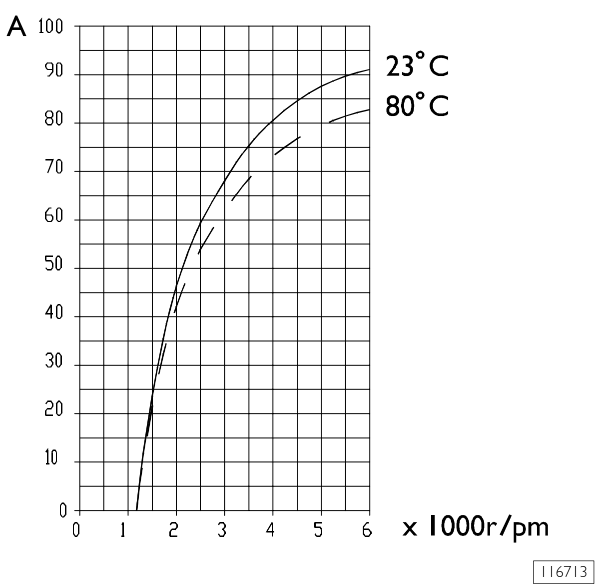
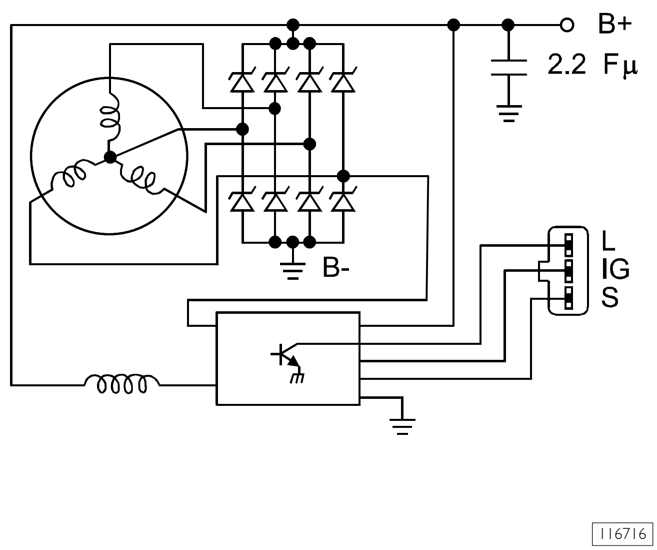


Figure 26



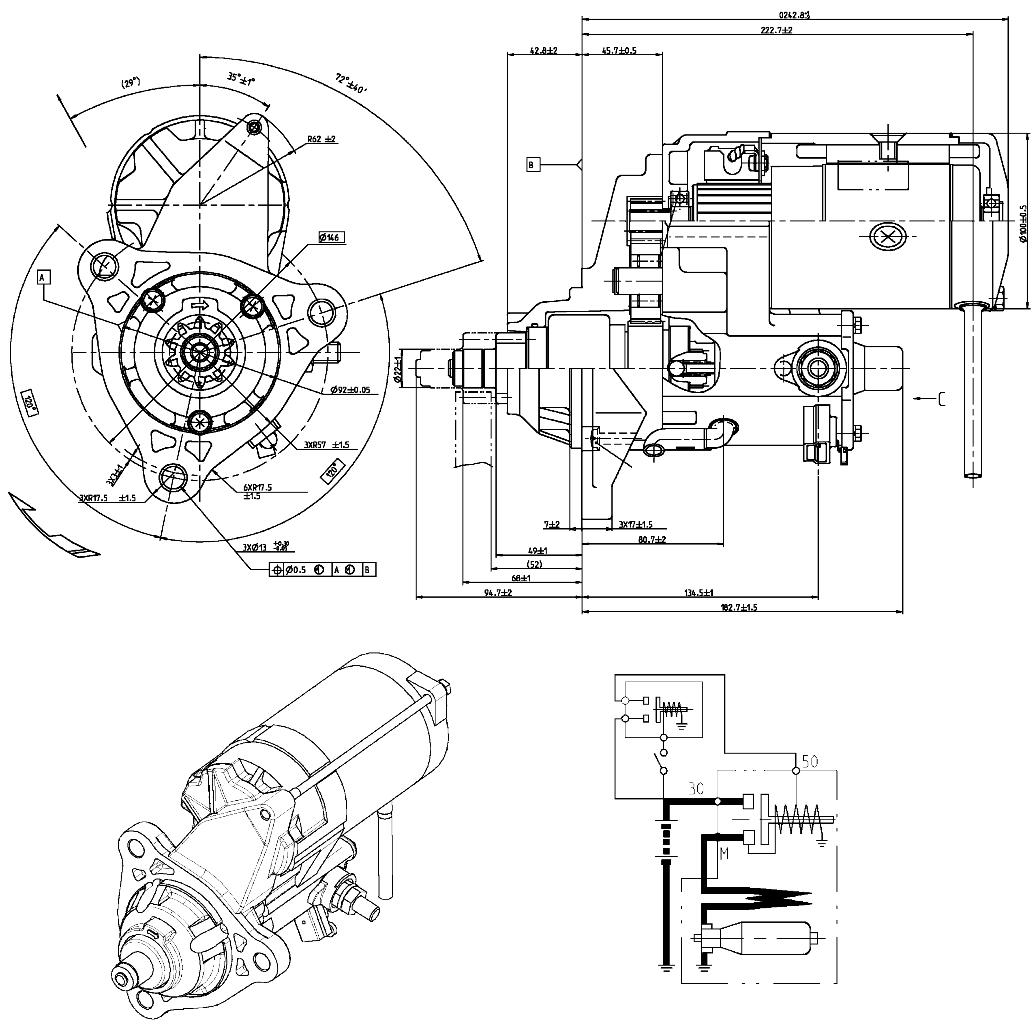
Pin	Description
S	+ 30
L	Battery recharge light
B-	Negative
B+	Positive
IG	+ 15

Starting motor

Specifications

Supplier	DENSO
Type	2280007550
Electrical system	24 Volt
Nominal output	5.5 Kw

Figure 27



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Pre/post-heating resistance

The resistance is ~ 0,7 Ohm.

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

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

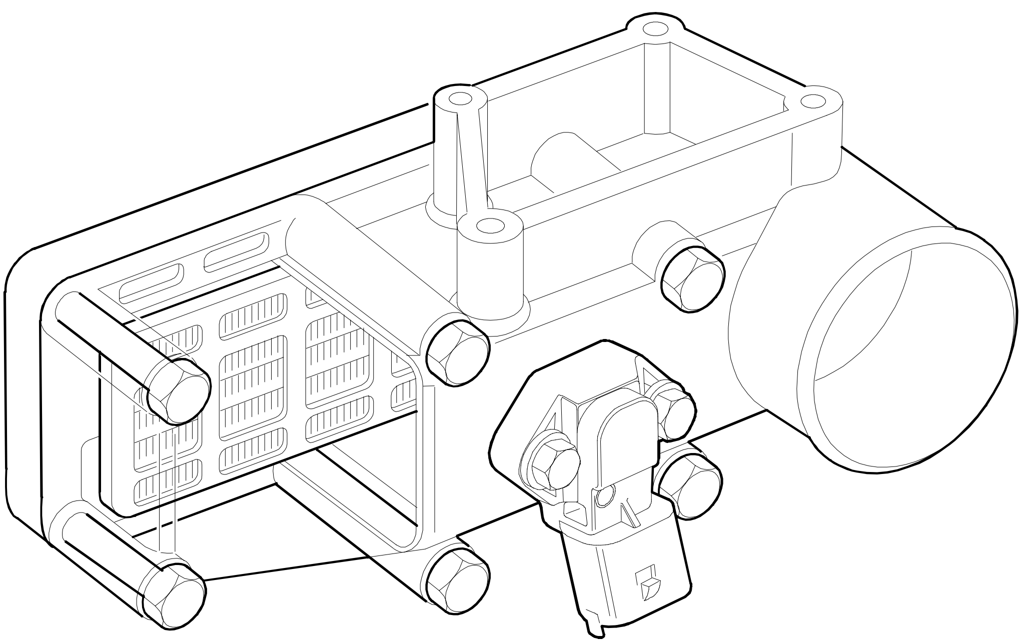
After that time, the warning light starts blinking thus informing the driver that the engine can be started.

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

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

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

Figure 28



104270

EDC SYSTEM FUNCTIONS

The EDC 7 UC31 electronic center manages the following main functions:

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

It also enables:

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

Fuel dosing

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

The result can be corrected based on:
- water temperature

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

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

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

Delivery correction based on water temperature

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

Delivery correction to prevent noise, fumes or overloads

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

De-rating

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

Injection lead electronic control

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

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

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

Engine start

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

Cold start

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

Hot start

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

Run Up

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

After Run

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

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

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

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

Repeated procedure interruptions could in fact lead to center damage.

Cut-off

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

Cylinder Balancing

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

Synchronization search

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

PART THREE - TROUBLESHOOTING

PREFACE

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

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

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

The continuous efficiency tests of the components connected to, and the check of working conditions of the entire system carried out during working, can offer an important diagnosis indication, available through the decoding of the "failure/anomaly" codes issued by blinking of the failure led: the "blink-code" (whether programmed).

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

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

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

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

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

The GUIDELINE is composed of three different parts:

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

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

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

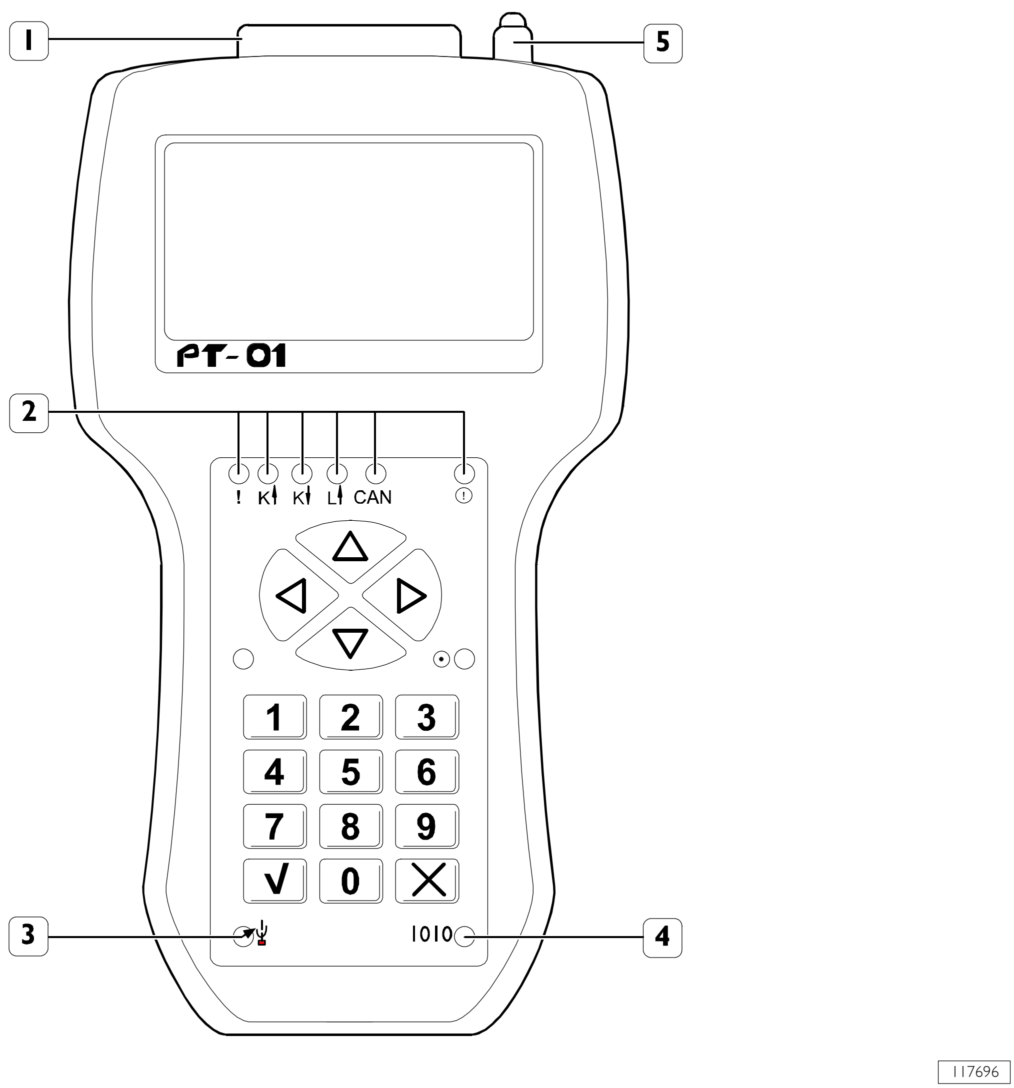
METHODS OF DIAGNOSIS

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).

PT-01 PORTABLE TESTER

Using PT-01 with portable tester it is possibile 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.

1	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)	
1.1.9	PLAUSIBILITY +15
1.1.A	PLAUSIBILITY +50
Vehicle 2 (Warning signals / Relays / Actuators)	
1.2.5	MAIN RELAY
1.2.6	BATTERY VOLTAGE
1.2.8	MAIN RELAY - BATTERY SHORTED
1.2.9	AIR CONDITIONER COMPRESSOR RELAY
1.2.B	RELAY OF THERMOSTARTER 1 (HEATER)
1.2.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)	
1.3.1	COOLANT TEMPERATURE SENSOR
1.3.2	COOLANT TEMPERATURE SENSOR (TEST)
1.3.3	AIR TEMPERATURE SENSOR SUPERCHARGE
1.3.4	AIR PRESSURE SENSOR SUPERCHARGE
1.3.5	FUEL TEMPERATURE SENSOR
1.3.8	OIL PRESSURE SENSOR
1.3.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)	
1.4.1	ENGINE SHAFT REV SENSOR
1.4.2	ENGINE RUNNING ONLY WITH CAMSHAFT SENSOR
1.4.3	CAMSHAFT SENSOR
1.4.4	PLAUSIBILITY BETWEEN FLYWHEEL SENSOR AND CAMSHAFT
Damage information	
1.4.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	
1.5.1	CYLINDER INJECTOR 1
1.5.2	CYLINDER INJECTOR 2
1.5.3	CYLINDER INJECTOR 3
1.5.4	CYLINDER INJECTOR 4
1.5.5	CYLINDER INJECTOR 5
1.5.6	CYLINDER INJECTOR 6

DTC	Component failure
Injectors 1	
1.6.1	CYLINDER INJECTOR 1 / SHORT CIRCUIT
1.6.2	CYLINDER INJECTOR 2 / SHORT CIRCUIT
1.6.3	CYLINDER INJECTOR 3 / SHORT CIRCUIT
1.6.4	CYLINDER INJECTOR 4 / SHORT CIRCUIT
1.6.5	CYLINDER INJECTOR 5 / SHORT CIRCUIT
1.6.6	CYLINDER INJECTOR 6 / SHORT CIRCUIT
1.6.7	CYLINDER INJECTOR 1 / OPEN CIRCUIT
1.6.8	CYLINDER INJECTOR 2 / OPEN CIRCUIT
1.6.9	CYLINDER INJECTOR 3 / OPEN CIRCUIT
1.6.A	CYLINDER INJECTOR 4 / OPEN CIRCUIT
1.6.B	CYLINDER INJECTOR 5 / OPEN CIRCUIT
1.6.C	CYLINDER INJECTOR 6 / OPEN CIRCUIT
1.6.E	THE LEAST NUMBER OF INJECTIONS HAS NOT BEEN REACHED : ENGINE SHUT DOWN
Injectors 2	
1.7.1	BENCH 1 CC
1.7.3	BENCH 2 CC
1.7.C	BENCH 1 INJECTOR CHECK (IN CONTROL UNIT)
1.7.F	INJECTED QUANTITY EVALUATION ERROR (NIMA PROGRAM)
2.7.C	BENCH 2 INJECTOR CHECK (IN CONTROL UNIT)
Supercharging system and turbine speed	
1.9.E	TORQUE RESTRICTION FOR SMOKE LIMITATION
Interfaces 1 (CAN-Bus)	
1.B.1	ERROR ON CAN CONTROLLER A
1.B.3	ERROR ON CAN CONTROLLER C
1.B.5	TIMEOUT CAN MESSAGE VM2EDC
2.B.4	TIMEOUT CAN MESSAGE BC2EDC2
Interfacce 2 (Can line timeout messages)	
1.C.6	MESSAGE CAN TSC1-PE ERROR
1.C.8	MESSAGE CAN TSC1-VE ERROR
2.C.6	MESSAGE CAN TSC1-VE ERROR
3.C.8	MESSAGE CAN TSC1-VE (passive) ERROR
ECU 1 (internal checks)	
1.D.1	CONTROL UNIT INTERNAL ERROR
1.D.2	CONTROL UNIT INTERNAL ERROR
1.D.3	CONTROL UNIT INTERNAL ERROR
1.D.4	CONTROL UNIT INTERNAL ERROR
1.D.5	CONTROL UNIT INTERNAL ERROR
1.D.6	CONTROL UNIT INTERNAL ERROR (TPU)
1.D.7	CONTROL UNIT INTERNAL ERROR (VARIANT AREA)
1.D.8	CONTROL UNIT INTERNAL ERROR
1.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)	
1.E.3	CONTROL UNIT INTERNAL MONITORING ERROR
1.E.4	CONTROL UNIT INTERNAL MONITORING ERROR
1.E.5	ERRORE SENSOR SUPPLY (12V)
1.E.6	SENSOR SUPPLY 1
1.E.7	SENSOR SUPPLY 2
1.E.8	SENSOR SUPPLY 3
1.E.9	CONTROL UNIT INTERNAL ERROR
1.E.A	CONTROL UNIT INTERNAL ERROR
1.E.B	ATM. PRESSURE SENSOR

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

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

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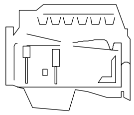
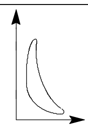
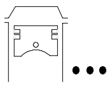
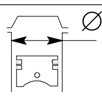
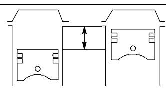
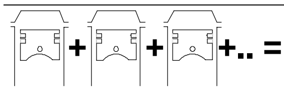
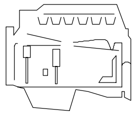
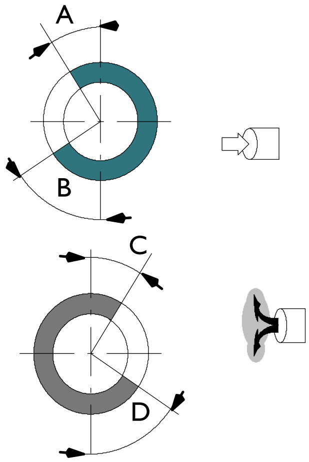
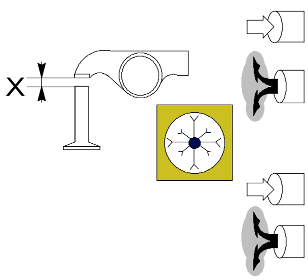
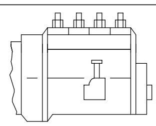
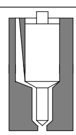
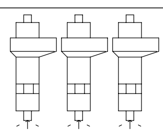
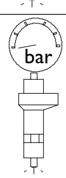
SECTION 4

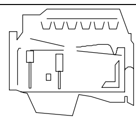
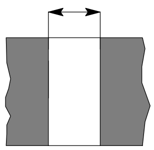
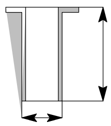
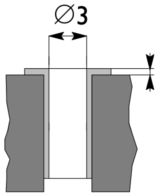
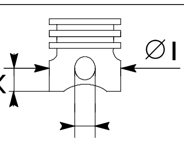
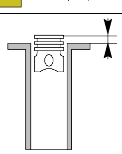
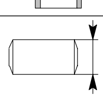
Overhaul and technical specifications

GENERAL CHARACTERISTICS

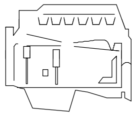
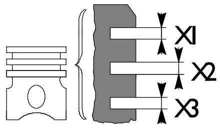
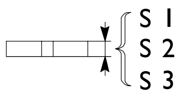
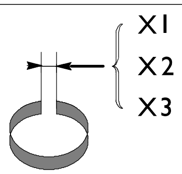
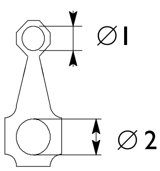
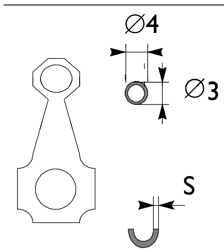
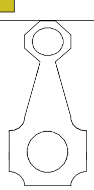
	Type		**F3A**
	Cycle		4-stroke Diesel engine
	Fuel feed		Turbocharged
	Injection		Direct
	No. of cylinders		6 in line
	Bore	mm	125
	Stroke	mm	140
	Total displacement	cm^3	10300

	Type		**F3A**
	VALVE TIMING		
	opens before T.D.C.	A	17°
	closes after B.D.C.	B	4°
	opens before B.D.C.	D	56°
	closes after T.D.C.	C	9°
	For timing check		
	X	mm	-
		mm	-
	Running		
	X	mm	0.35 to 0.45
		mm	0.45 to 0.55
	FEED		Through fuel pump - filters
	Injection type: Bosch		With electronically regulated injectors VIN 3.1 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

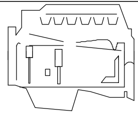
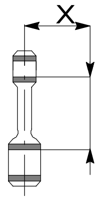
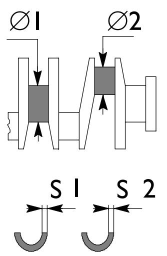
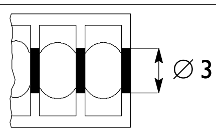
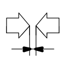
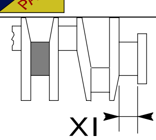
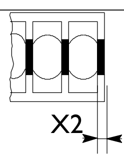
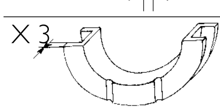
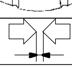
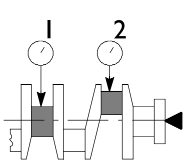
ASSEMBLY CLEARANCE DATA

	Type	**F3A**
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS		mm
Ø1 	Bores for cylinder liners: upper Ø1 lower	 142.000 to 142.025 140.000 to 140.025
 L Ø2	Cylinder liners: external diameter: upper Ø2 lower length L	 141.961 to 141.986 139.890 to 139.915 -
	Cylinder liners - crankcase bores upper lower	 0.014 to 0.064 0.085 to 0.135
	External diameter Ø2	-
Ø3  X * Selection class	Cylinder sleeve inside diameter Ø3A* inside diameter Ø3B* Protrusion X	 125.000 to 125.013 125.011 to 125.024 0.045 to 0.075
 X Ø1 Ø2	Pistons: measuring dimension X external diameter Ø1A● external diameter Ø1B●● pin bore Ø2	 18 124.861 to 124.873 124.872 to 124.884 50.010 to 50.016
* Selection class	Piston - cylinder sleeve A* B*	 0.104 to 0.129 0.104 to 0.128
	Piston diameter Ø1	-
 X	Pistons protrusion X	0.23 to 0.53
 Ø3	Gudgeon pin Ø3	49.994 to 50.000
	Gudgeon pin - pin housing	0.010 to 0.024

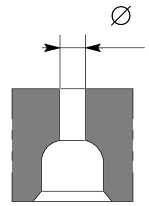
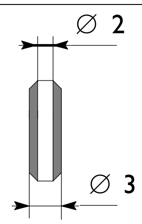
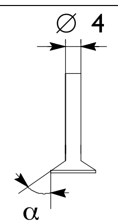
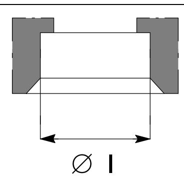
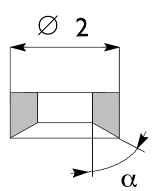
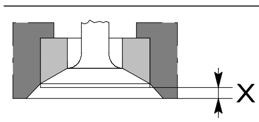
● Class A pistons supplied as spares.
●● Class B pistons are fitted in production only and are not supplied as spares.

	Type		F3A
			mm
	Piston ring grooves	X1 X2 X3	1.947 * 1.550 to 1.570 4.020 to 4.040
	Piston rings: trapezoidal seal lune seal milled scraper ring with slits and internal spring	 S1 S2 S3	 1.973 to 1.929 1.470 to 1.500 3.970 to 3.990
	Piston rings - grooves	1 2 3	- 0.050 to 0.100 0.030 to 0.070
IVECO PARTS	Piston rings		-
	Piston ring end gap in cylinder liners	X1 X2 X3	0.35 to 0.45 0.60 to 0.75 0.35 to 0.65
	Small end bush housing Big end bearing housing Selection classes	Ø1 Ø2 { 1 2 3	54.000 to 54.030 87.000 to 87.030 87.000 to 87.010 87.011 to 87.020 87.021 to 87.030
	Small end bush diameter outside inside Big end bearing shell Red Green Yellow ●	 Ø4 Ø3 S	 54.085 to 54.110 50.019 to 50.035 1.970 to 1.980 1.981 to 1.990 1.991 to 2.000
	Small end bush - housing		0.055 to 0.110
	Piston pin - bush		0.019 to 0.041
IVECO PARTS	Big end bearing		0.127 - 0.254 - 0.508
	Connecting rod weight	A	g.
	Connecting rod weight Class	A B C	g. 4043 to 4073 g. 4074 to 4104 g. 4105 to 4135

● Fitted in production only and not supplied as spares
* Measured on Ø120-0.15

	Type		F3A mm
	Measuring dimension	X	125
	Max. connecting rod axis misalignment tolerance		0.08
	Main journals	∅1	
	- nominal		92.970 to 93.000
	- class	1	92.970 to 92.979
	- class	2	92.980 to 92.989
	- class	3	92.990 to 93.000
	Crankpins	∅2	
	- nominal		82.970 to 83.000
	- class	1	82.970 to 82.979
	- class	2	82.980 to 82.989
	- class	3	82.990 to 83.000
	Main bearing shells	S1	
	Red		2.965 to 2.974
	Green		2.975 to 2.984
	Yellow*		2.985 to 2.995
	Big end bearing shells	S2	
	Red		1.970 to 1.980
	Green		1.981 to 1.990
	Yellow*		1.991 to 2.000
	Main bearing housings	∅3	
	- nominal		99.000 to 99.030
	- class	1	99.000 to 99.009
	- class	2	99.010 to 99.019
	- class	3	99.020 to 99.030
	Bearing shells - main journals		0.050 to 0.090
	Bearing shells - big ends		0.040 to 0.080
IVECO PARTS	Main bearing shells		0.127 - 2.254 - 0.508
	Big end bearing shells		0.127 - 2.254 - 0.508
	Main journal, thrust bearing	X1	45.95 to 46.00
	Main bearing housing, thrust bearing	X2	38.94 to 38.99
	Thrust washer halves	X3	3.38 to 3.43
	Crankshaft end float		0.10 to 0.30
	Alignment	1 - 2	≤ 0.025
	Ovalization	1 - 2	0.010
	Taper	1 - 2	0.010

* Fitted in production only and not supplied as spares

	Type	F3A
CYLINDER HEAD - VALVE TRAIN		mm
	Valve guide housings in cylinder head Ø1	14.980 to 14.997
	Valve guide Ø2 Ø3	9.015 to 9.030 15.012 to 15.025
	Valve guides - housings in the cylinder heads	0.015 to 0.045
IVECO PARTS	Valve guide	0.2 - 0.4
	Valves: Ø4 α Ø4 α	8.960 to 8.975 60° 30′ ± 7′ 30″ 8.960 to 8.975 45° 30′ ± 7′ 30″
	Valve stem and its guide	0.040 to 0.070
	Valve seat in head Ø1 Ø1	44.185 to 44.220 42.985 to 43.020
	Outside diameter of valve seat; angle of valve seat in cylinder head: Ø2 α Ø2 α	44.260 to 44.275 60° - 30′ 43.060 to 43.075 45° - 30′
	Recessing of valve X X	0.65 to 0.95 1.8 to 2.1
	Between valve seat and head	0.040 to 0.090

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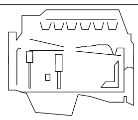
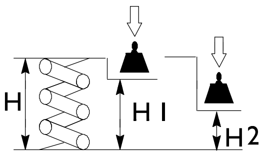
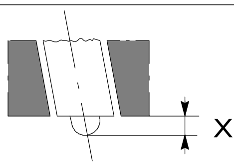
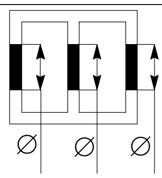
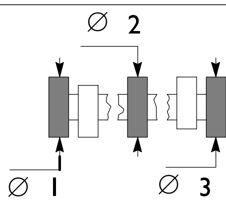
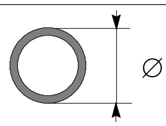
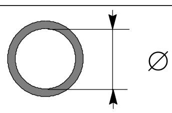
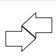
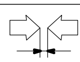
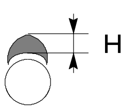
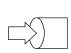
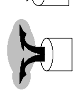
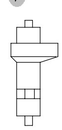
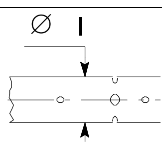
	Type	F3A mm
	Valve spring height: free height H under a load of: N 500 ±25 H1 N 972 ±48 H2	 76 62 48.8
	Injector protrusion X	1.14 to 1.4
	Camshaft bushing housing in the cylinder head: 1 ⇒ 7 Ø	88.000 to 88.030
	Camshaft bearing journals: 1 ⇒ 7 Ø	82.950 to 82.968
	Outer diameter of camshaft bushings: Ø	88.153 to 88.183
	Inner diameter of camshaft bushings: 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:   	 8.31 9.45 11.21
	Rocker shaft Ø1	41.984 to 42.000

Type	F3A mm
Bushing housing in rocker arms	45.000 to 45.016 59.000 to 59.019 46.000 to 46.016
Bushing outer diameter for rocker arms	45.090 to 45.130 59.100 to 59.140 46.066 to 46.091
Bushing inner diameter for rocker arms	42.025 to 42.041 56.030 to 56.049 42.015 to 42.071
Between bushings and housings	0.074 to 0.130 0.081 to 0.140 0.050 to 0.091
Between bushings of rocker arms and shaft	0.025 to 0.057 0.025 to 0.057 0.015 to 0.087
TURBOCHARGER	
Type	HOLSET HX55
End float	-
Radial play	-

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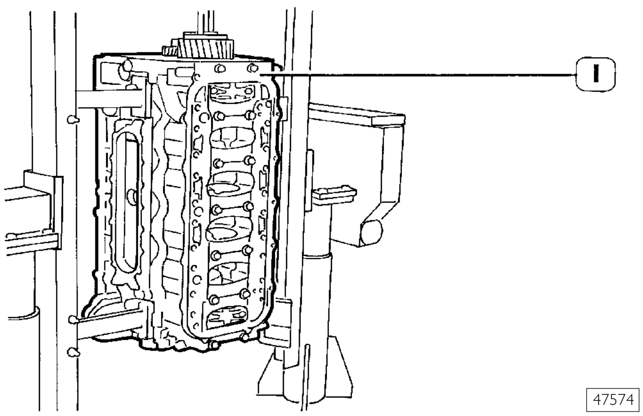
ENGINE OVERHAUL
ENGINE REMOVAL AT THE BENCH

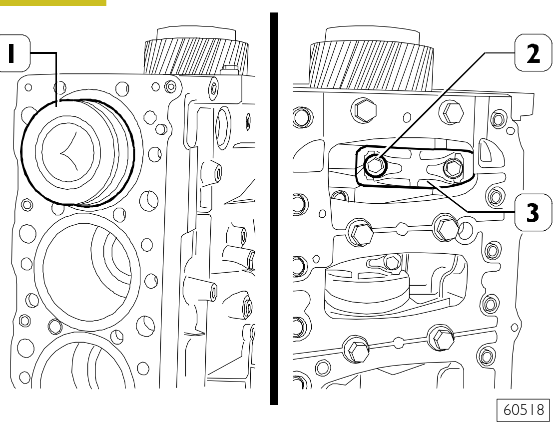
The following instructions are prescribed on the understanding that the engine has previously been placed on the rotating bench and that removal of all specific components of the equipment have been already removed as well. (See Section 3 of the manual herein).
The section illustrates therefore all the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

Figure 1



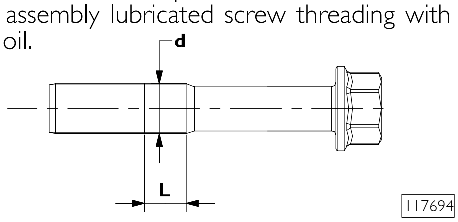
Rotate the block (1) to the vertical position.

Figure 2



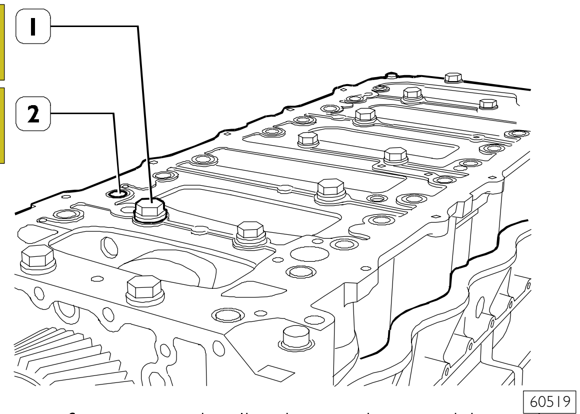
Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston (1) assembly from the upper side. Repeat these operations for the other pistons.

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.

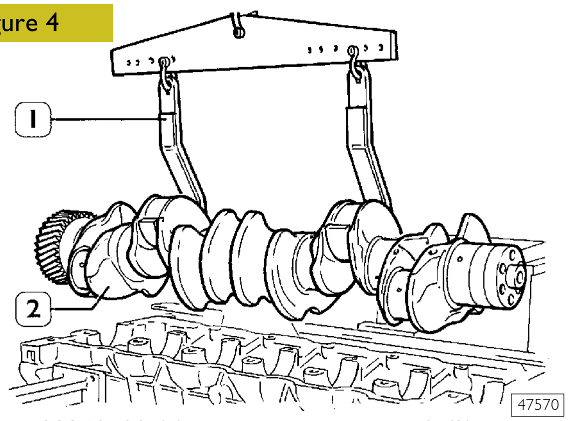
Figure 3



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

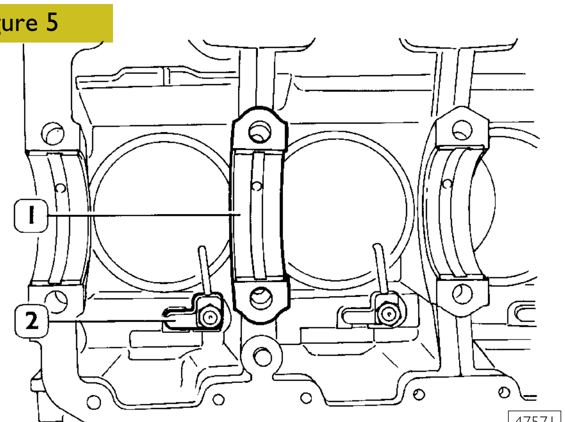
NOTE Note down the assembly position of the top and bottom main bearing shells since, if reusing them, they will need to be fitted in the position found upon removal.

Figure 4



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

Figure 5

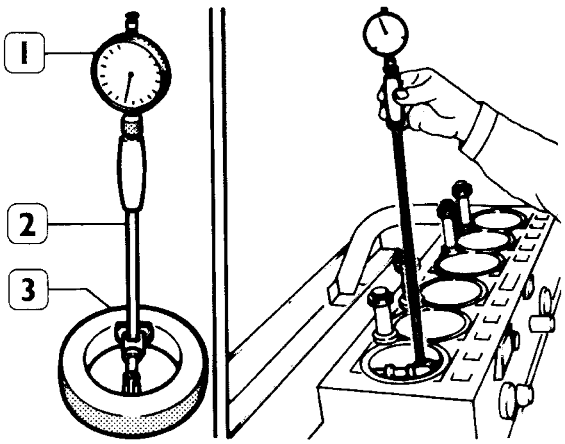


Remove the main bearing shells (1), unscrew the screws and take out the oil nozzles (2).
Remove the cylinder liners as described under the relevant subheading on page 14.

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

REPAIR OPERATIONS
CYLINDER BLOCK
Checks and measurements

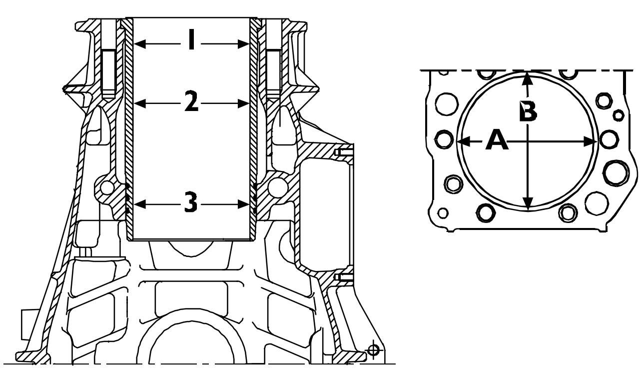
Figure 6 (Demonstration)



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

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

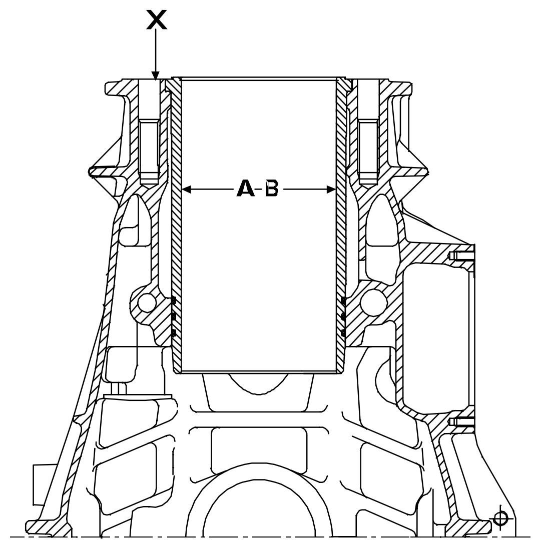
Figure 7



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

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

Figure 8

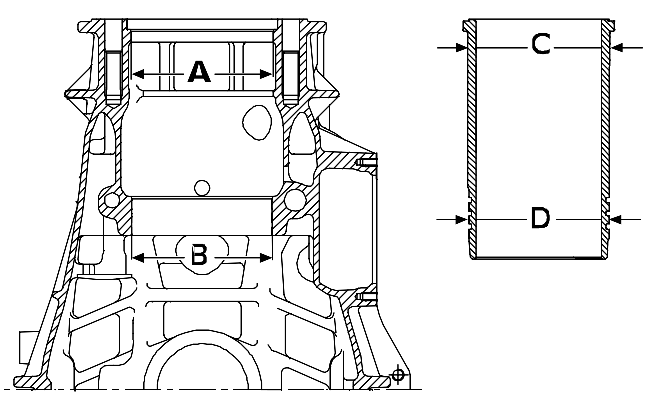


A = Selection class Ø 125 – 125.013 mm
B = Selection class Ø 125.011 – 125.024 mm
X = Selection class marking area

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

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

Figure 9



A = Ø 142.000 to 142.025 mm
B = Ø 140.000 to 140.025 mm
C = Ø 141.961 to 141.986 mm
D = Ø 139.890 to 139.915 mm

The figure shows the outer diameters of the cylinder liners and the relative seat inner diameters.
The cylinder liners can be extracted and installed several times in different seats, if necessary.
Check the state of the cylinder assembly machining plugs: if they are rusty or there is any doubt at all about their seal, change them.

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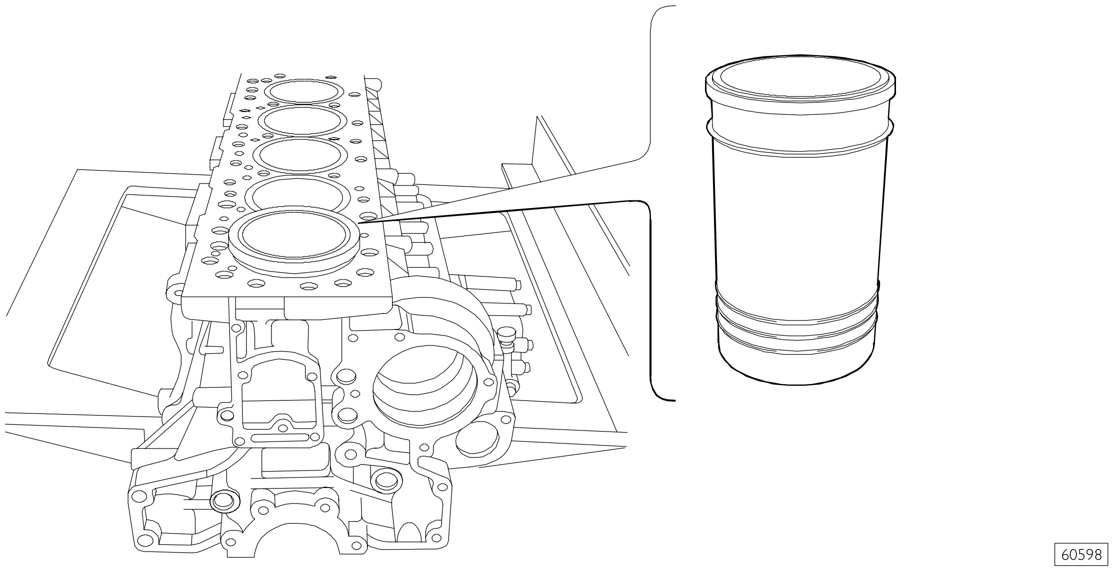
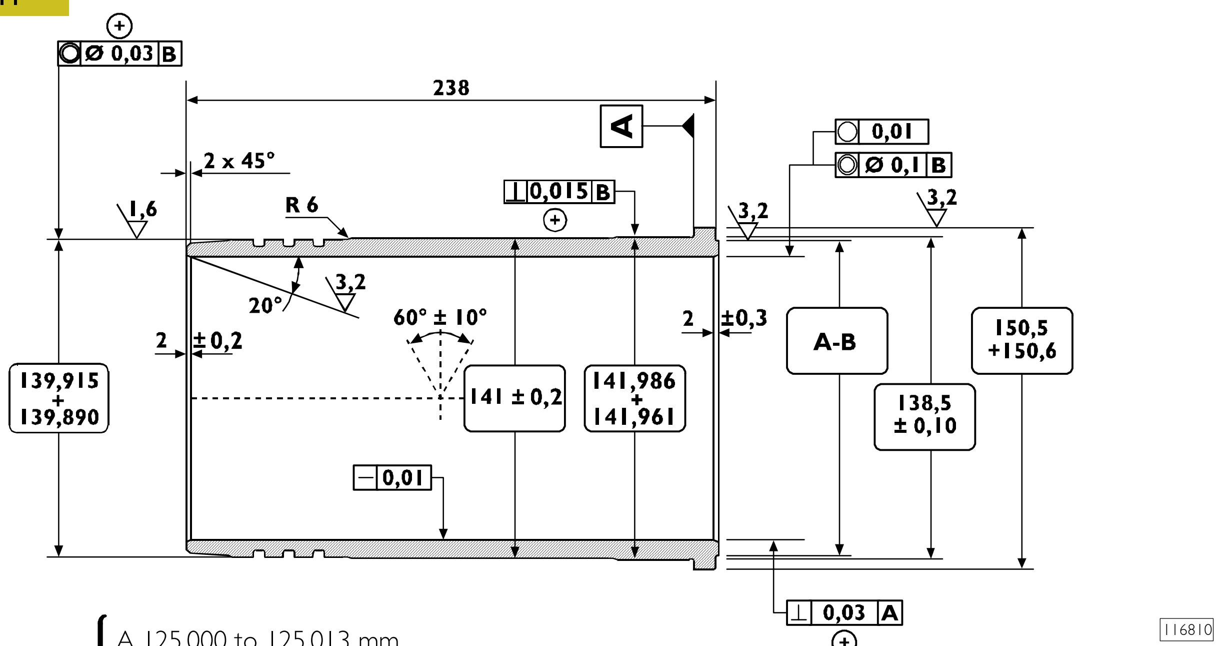
Cylinder liners

Figure 10



BLOCK WITH CYLINDER LINERS

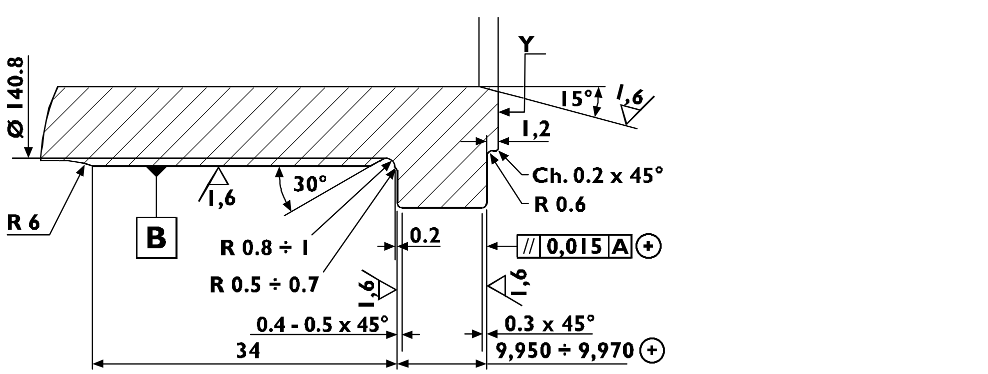
Figure 11



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

CYLINDER LINERS MAIN DATA

Figure 12

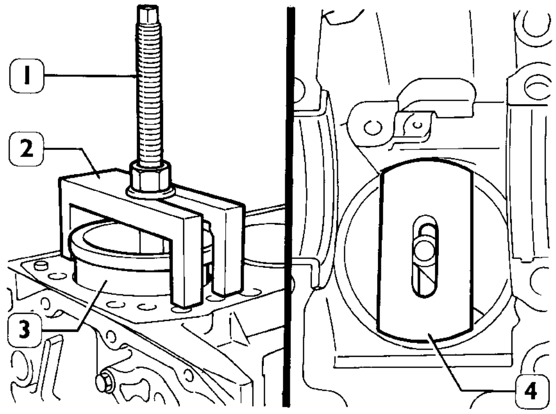


DETAIL "X"
"Y" - Selection class marking area

Replacing cylinder liners

Refitting

Figure 13

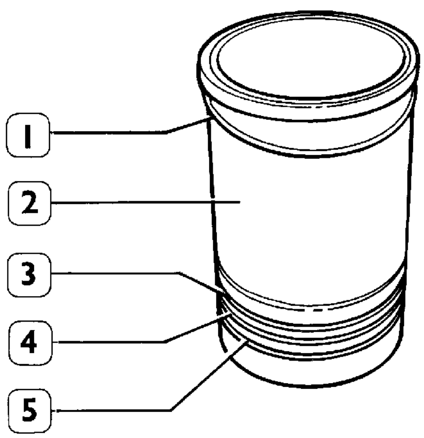


47577

Place details 99360706 (2) and plate 99360726 (4) as shown in the figure, by making sure that the plate (4) is properly placed on the cylinder liners.
Tighten the screw nut (1) and remove the cylinder liner (3) from the block.

Fitting and checking protrusion

Figure 14

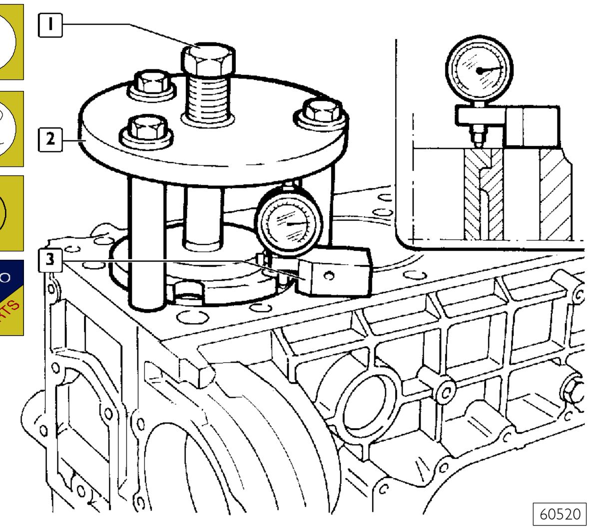


16798

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

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

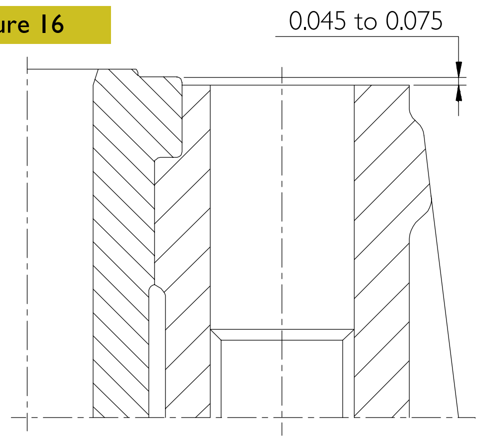
Figure 15



60520

Check the protrusion of the cylinder liners, using tool 99360334 (2) and tightening screw (1) to 225 Nm torque. Using a dial gauge (3), measure the cylinder liner protrusion, from the cylinder head supporting surface, it must be 0.045 to 0.075 (Figure 16); otherwise, replace the adjustment ring (1, Figure 14) supplied as spare parts having different thicknesses.

Figure 16



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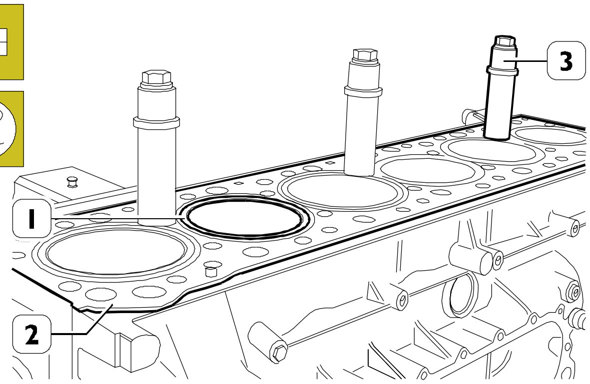
CYLINDER LINER PROTRUSION

Figure 17



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

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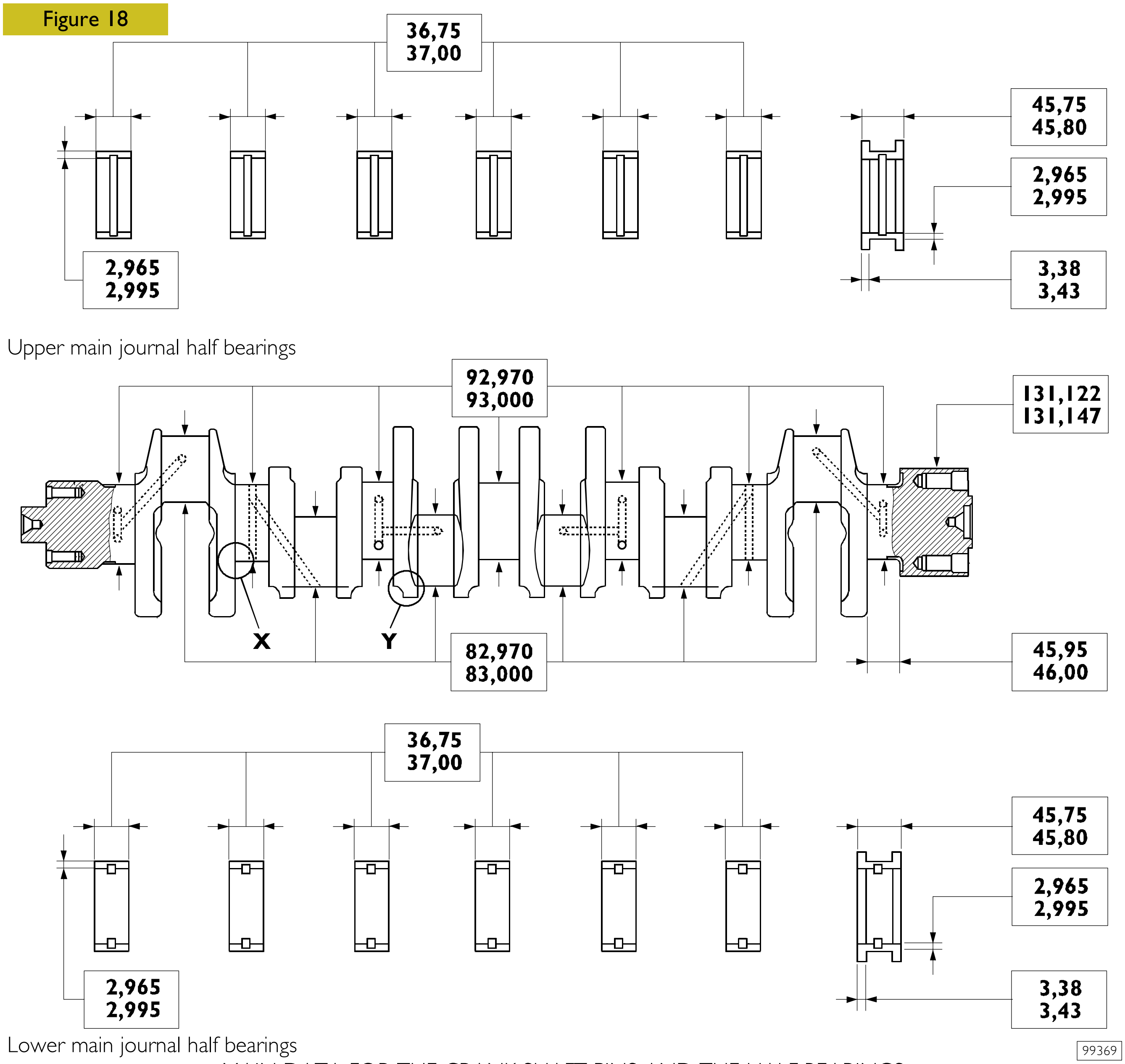
CRANKSHAFT

Figure 18



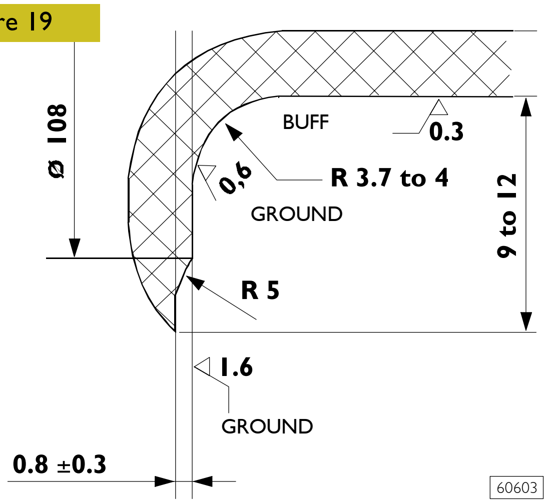
Upper main journal half bearings

Lower main journal half bearings

MAIN DATA FOR THE CRANK SHAFT PINS AND THE HALF BEARINGS

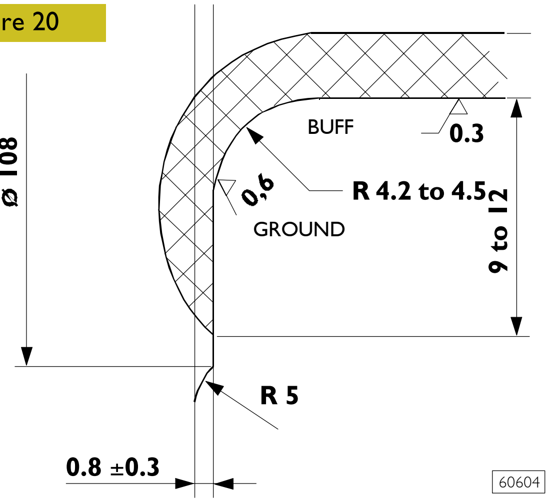
Check the condition of the journals and the big end pins; there must no be signs of scoring, ovalization or excessive wear. The data given refer to the normal diameter of the pins.

Figure 19



X. Detail of main journals connections

Figure 20

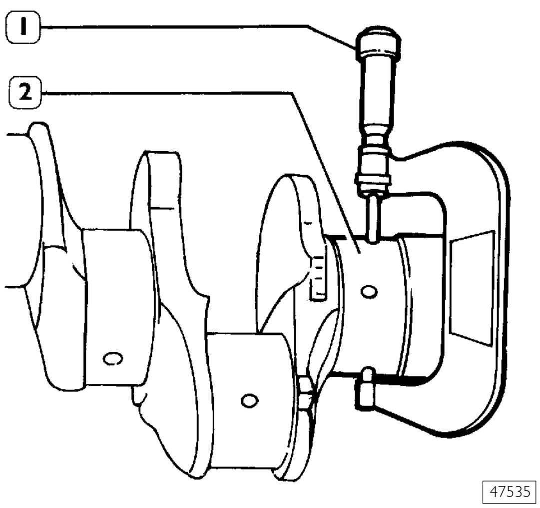


Y. Detail of crank pins connections

Measuring the main journals and crankpins

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

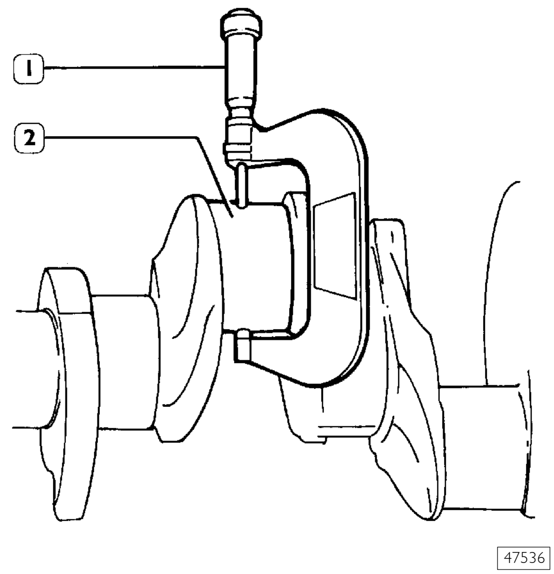
Figure 21



MEASURING THE MAIN JOURNALS

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

Figure 23



MEASURING CRANK PINS

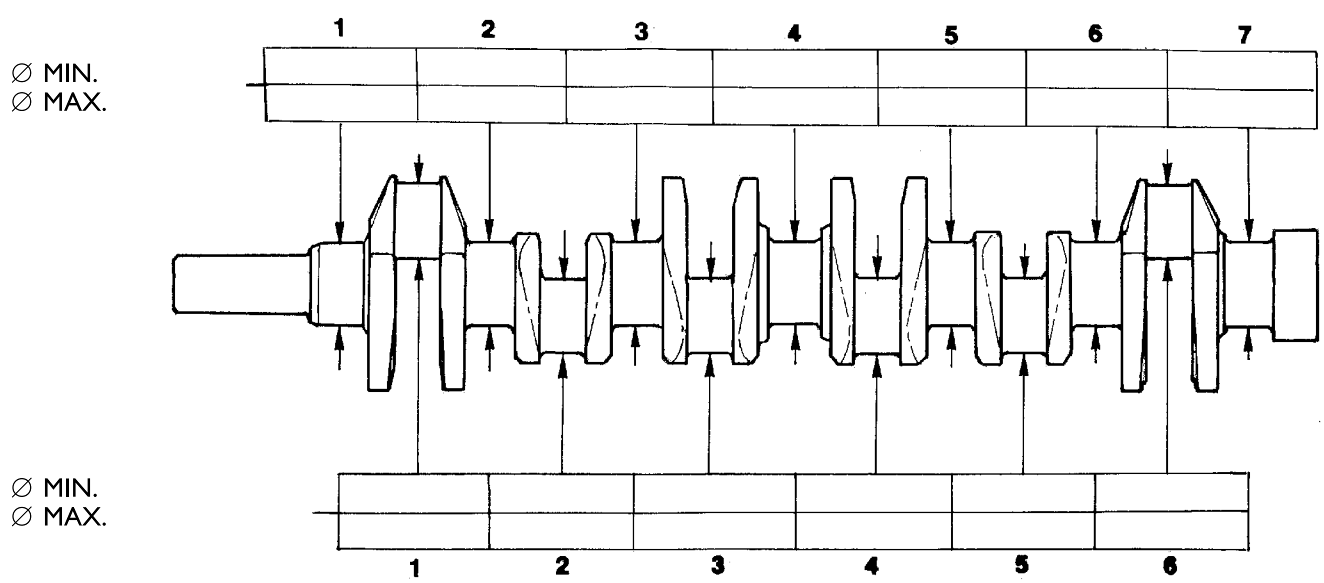
During grinding, pay attention to journal and crank pins values specified in Figure 19 and Figure 20.

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

Figure 22

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

MAIN JOURNALS



CRANK PINS

Preliminary measurement of main and big end bearing shell selection data

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

MAIN JOURNALS:

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

CRANKPINS:

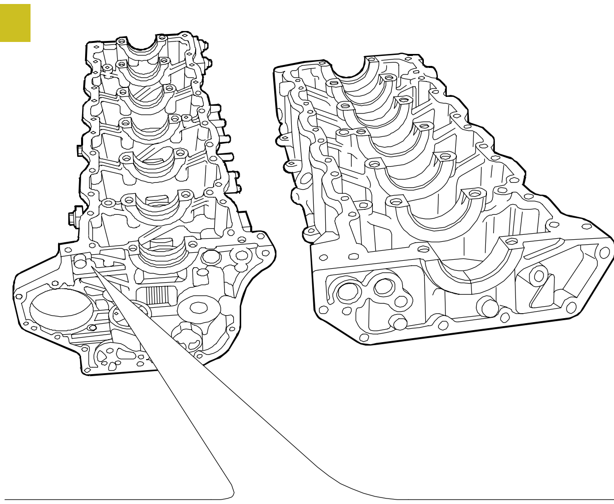
- ❑ Determine the class of diameter of the seat in the connecting rod.
- ❑ Determine the class of diameter of the crankpin.
- ❑ Select the class of the bearing shells to mount.

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

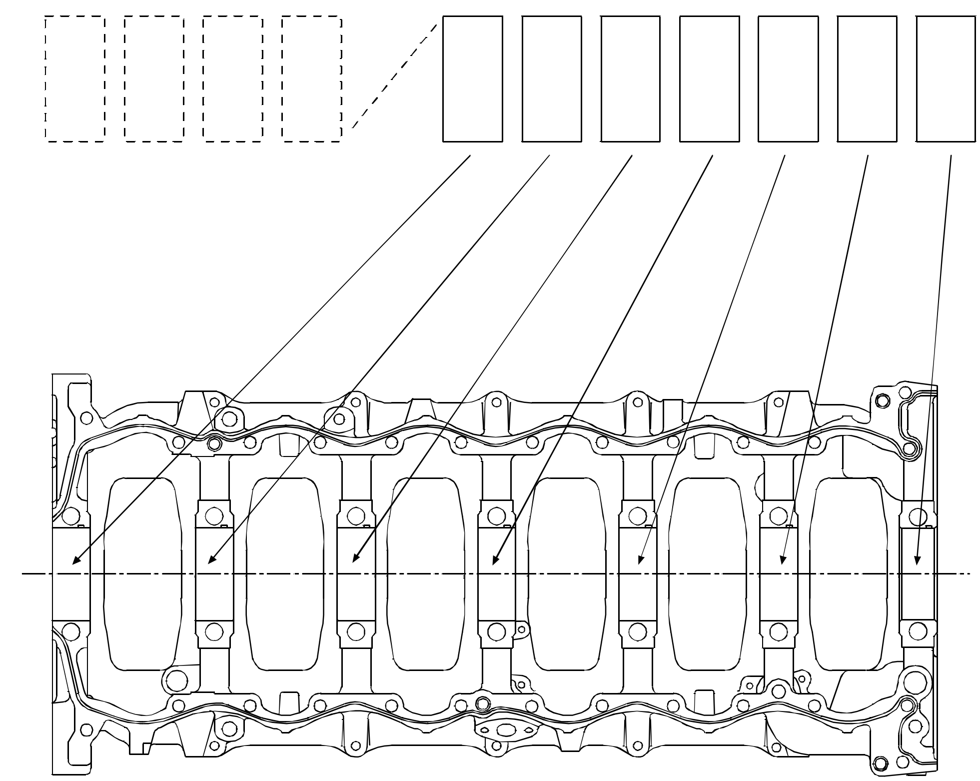
On the front of the crankcase, two sets of numbers are marked in the position shown (Figure 24 at top).

- ❑ The first set of digits (four) is the coupling number of the crankcase with its base.
- ❑ The following seven digits, taken singly, are the class of diameter of each of the seats referred to (Figure 24 at bottom).
- ❑ Each of these digits may be **1**, **2** or **3**.

Figure 24



CLASS	MAIN BEARING HOUSING NOMINAL DIAMETER
1	**99.000 to 99.009**
2	**99.010 to 99.019**
3	**99.020 to 99.030**



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Selecting the main and big end bearing shells

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

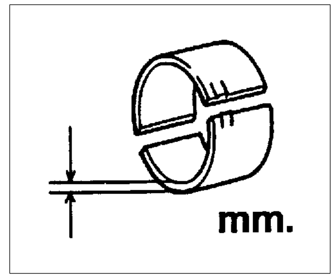
This operation makes it possible to identify the most suitable bearing shells for each of the journals (the bearing shells, if necessary, can have different classes from one journal to another).

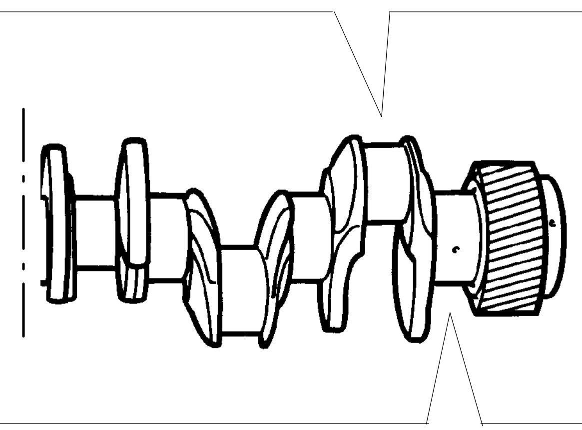
Depending on the thickness, the bearing shells are selected in classes of tolerance marked by a coloured sign (red-green – red/black – green/black).

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

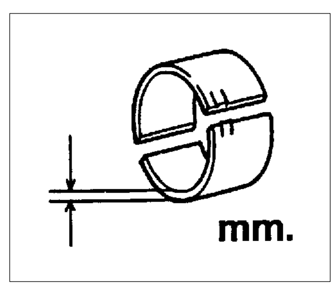
Figure 25

	STD	+0.127	+0.254	+0.508
red	1.970 to 1.980		2.097 to 2.107	2.224 to 2.234
red/black		2.033 to 2.043		
green	1.981 to 1.990		2.108 to 2.117	2.235 to 2.244
green/black		2.044 to 2.053		
yellow*	1.991 to 2.000			
yellow/black*		2.054 to 2.063		





	STD	+0.127	+0.254	+0.508
red	2.965 to 2.974		2.097 to 2.107	2.224 to 2.234
red/black		3.028 to 3.037		
green	2.975 to 2.984		2.108 to 2.117	2.235 to 2.244
green/black		3.038 to 3.047		
yellow*	2.985 to 2.995			
yellow/black*		3.048 to 3.058		



* Fitted in production only and not supplied as spares

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

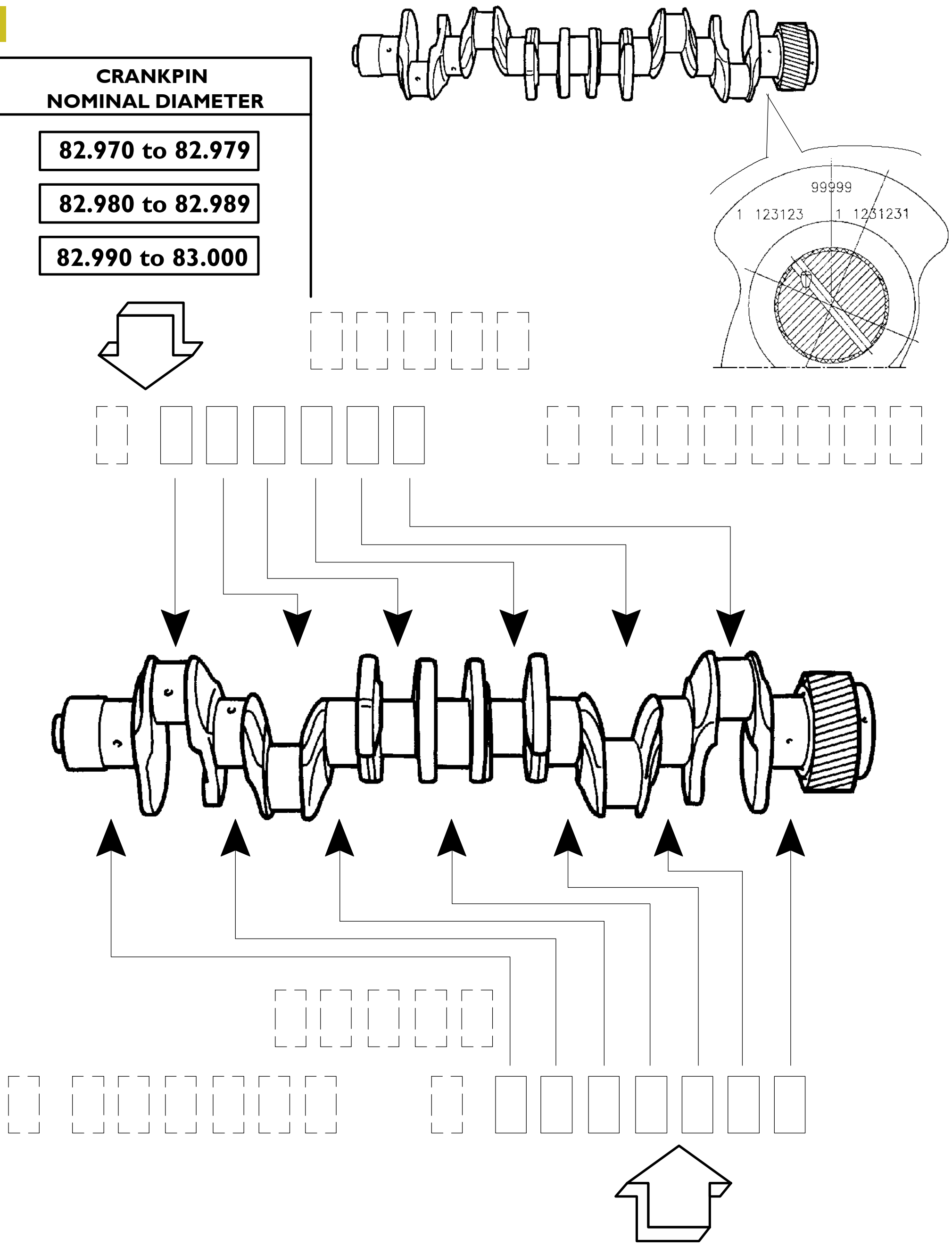
Main journals and crankpins: determining the class of diameter of the journals.

Three sets of numbers are marked on the crankshaft in the position shown by the arrow (Figure 26 at top):

- The first number, of five digits, is the part number of the shaft.
- Under this number, on the left, a set of six digits refers to the crankpins and is preceded by a single digit showing the status of the journals (1 = STD, 2 = -0.127), the other six digits, taken singly, give the class of diameter of each of the crankpins they refer to (Figure 26 at top).
- The set of seven digits, on the right, refers to the main journals and is preceded by a single digit: the single digit shows the status of the journals (1 = STD, 2 = -0.127), the other seven digits, taken singly, give the class of diameter of each of the main journals they refer to (Figure 26 at bottom).

Figure 26

CLASS	CRANKPIN NOMINAL DIAMETER
1	82.970 to 82.979
2	82.980 to 82.989
3	82.990 to 83.000



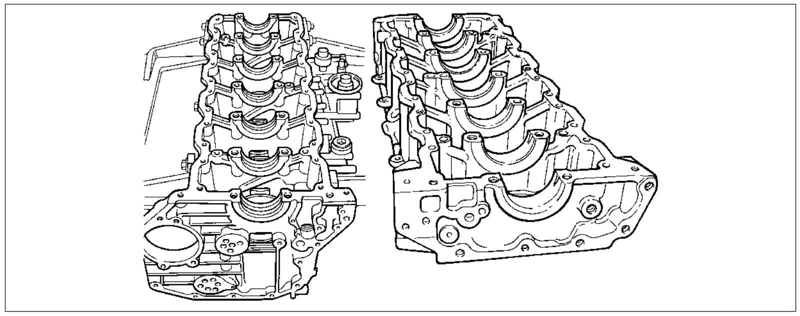
CLASS	MAIN JOURNALS NOMINAL DIAMETER
1	92.970 to 92.979
2	92.980 to 92.989
3	92.990 to 93.000

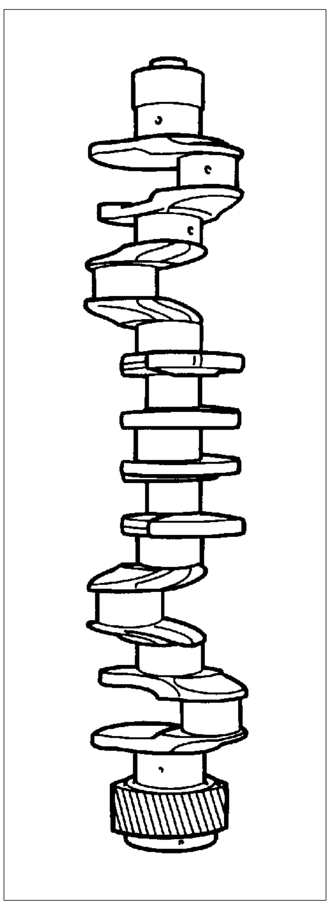
SELECTING THE MAIN BEARING SHELLS (Journals with nominal diameter)

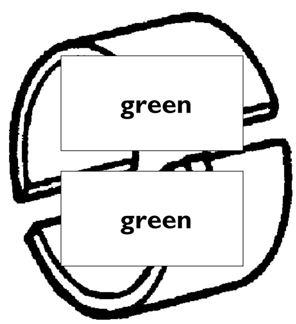
After reading off the data, for each of the main journals, on the crankcase and crankshaft, you choose the type of bearing shells to use according to the following table:

Figure 27

STD.







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

SELECTING THE MAIN BEARING SHELLS (GROUND JOURNALS)

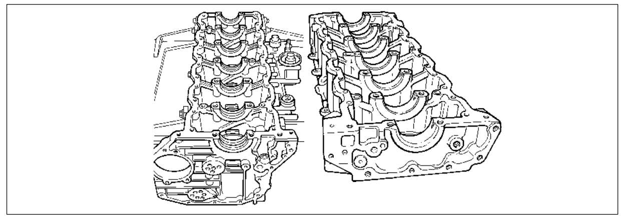
If the journals have been ground, the procedure described so far cannot be applied.
In this case, it is necessary to check that the new diameter of the journals is as shown in the table and to mount the only type of bearing shell envisaged for the relevant undersizing.

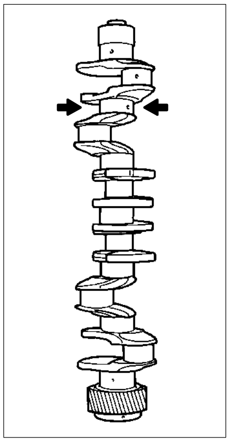
Figure 28

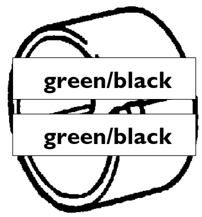
red/black =
3.028 to 3.037 mm

green/black =
3.038 to 3.047 mm

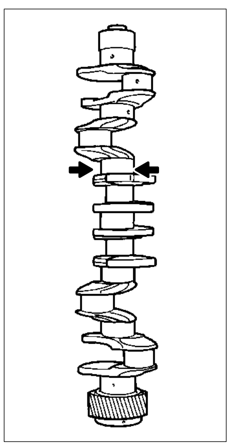
-0.127





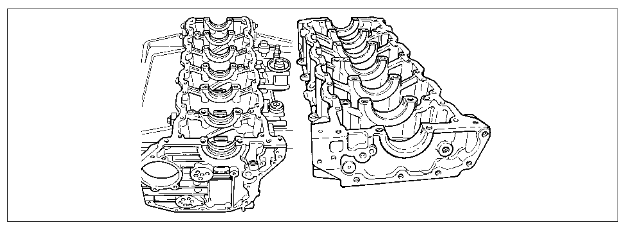


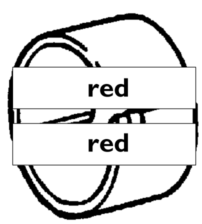
		1	2	3
99.843 99.852	1	green/black green/black	green/black green/black	green/black green/black
99.853 99.862	2	red/black red/black	green/black green/black	green/black green/black
99.863 99.873	3	red/black red/black	red/black red/black	green/black green/black



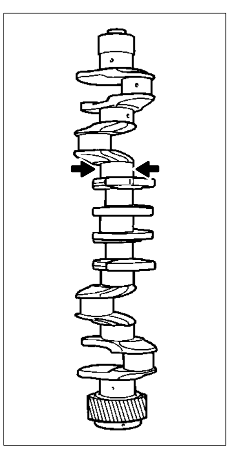
-0.254

red =
3.092 to 3.102 mm



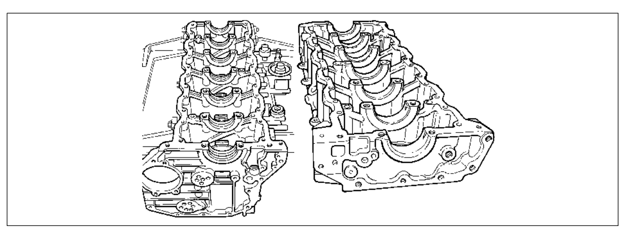


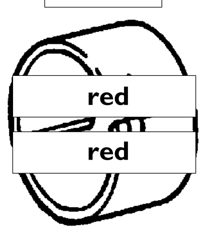
	1	2	3
99.726 99.746	red red	red red	red red



-0.508

red =
3.219 to 3.229 mm





	1	2	3
93.468 93.508	red red	red red	red red

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

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

1 Letter indicating the class of weight:

A = 4043 to 4073 g.
B = 4074 to 4104 g.
C = 4105 to 4135 g.

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

1 = 87.000 to 87.010 mm
2 = 87.011 to 87.020 mm
3 = 87.021 to 87.030 mm

3 Numbers identifying the cap-connecting rod coupling.

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

Determine the type of big end bearing to fit on each journal by following the indications in the table (Figure 30).

Figure 29

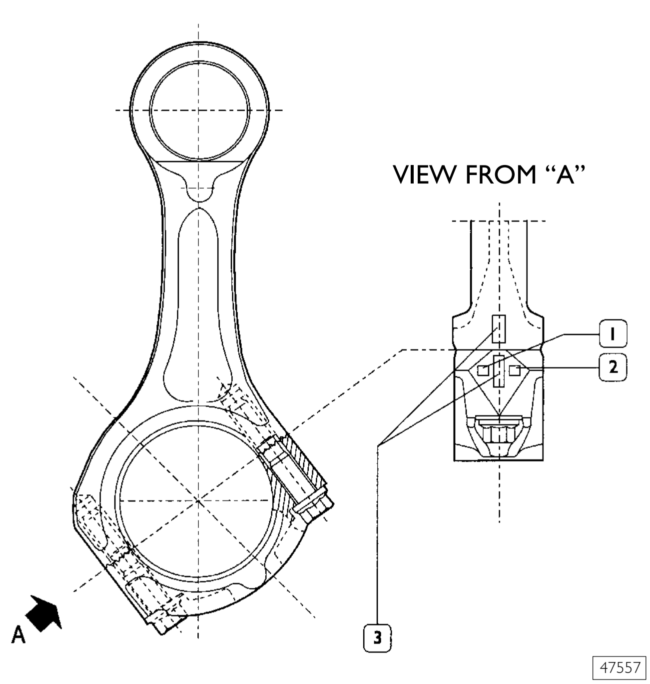
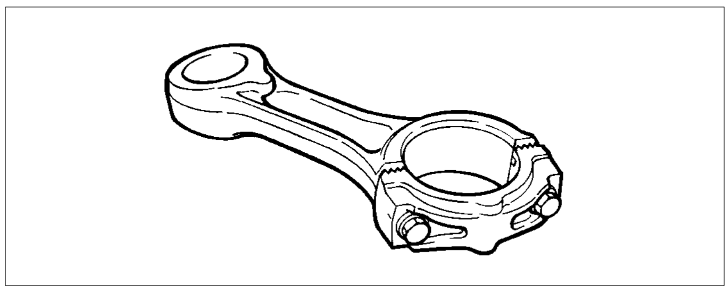
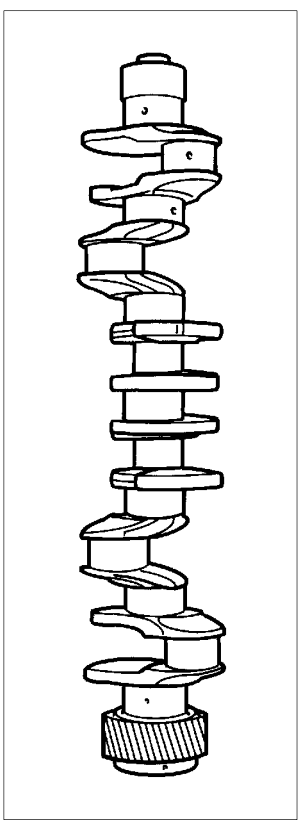


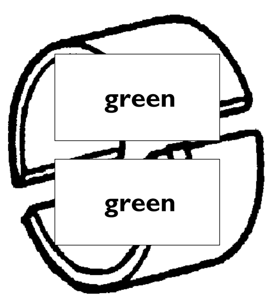
Figure 30

STD.





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



SELECTING BIG END BEARING SHELLS (GROUND JOURNALS)

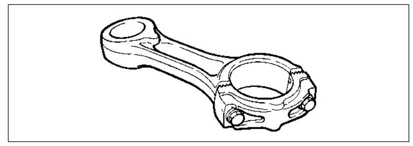
If the journals have been ground, the procedure described so far cannot be applied.
In this case, it is necessary to check (for each of the undersizings) which field of tolerance includes the new diameter of the crankpins and to mount the bearing shells identified with the relevant table.

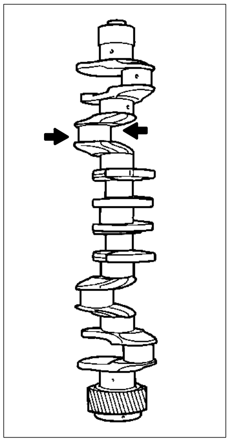
Figure 31

red/black = 2.044 to 2.053 mm

green/black = 2.033 to 2.043 mm

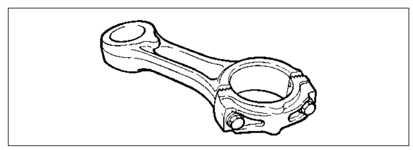
-0.127



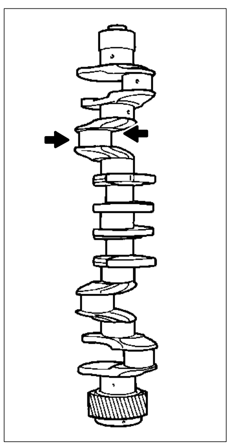


		1	2	3
82.843 – 82.852	1	green/black green/black	green/black green/black	green/black green/black
82.853 – 82.862	2	green/black red/black	green/black green/black	green/black green/black
82.863 – 82.873	3	red/black red/black	green/black red/black	green/black green/black

-0.254

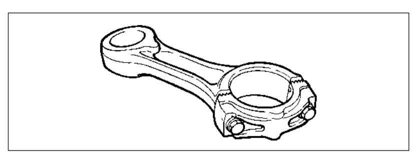


red = 2.097 to 2.107 mm
green = 2.108 to 2.117 mm

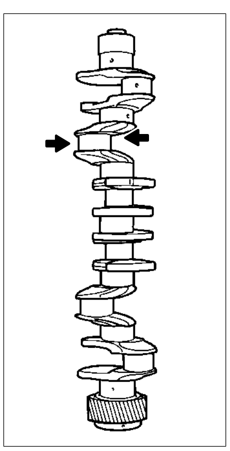


	1	2	3
82.726 – 82.735	red red	green green	green green
82.736 – 82.746	red red	red red	green green

-0.508



red = 2.224 to 2.234 mm
green = 2.235 to 2.244 mm

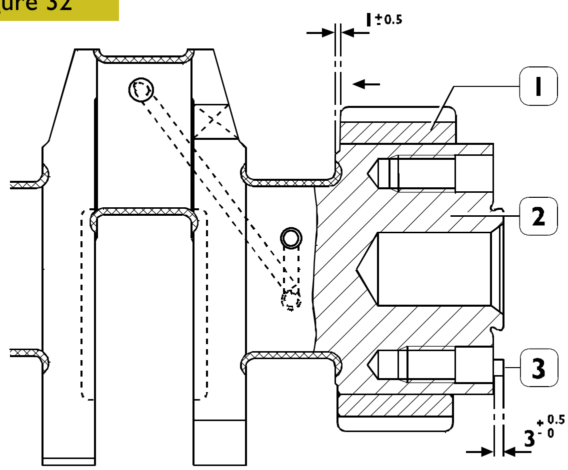


	1	2	3
82.472 – 82.481	red red	green green	green green
82.482 – 82.492	red red	red red	green green

Replacing the timing gear and oil pump

Check that the toothing of the gear is neither damaged nor worn; if it is, take it out with an appropriate extractor and replace it.

Figure 32

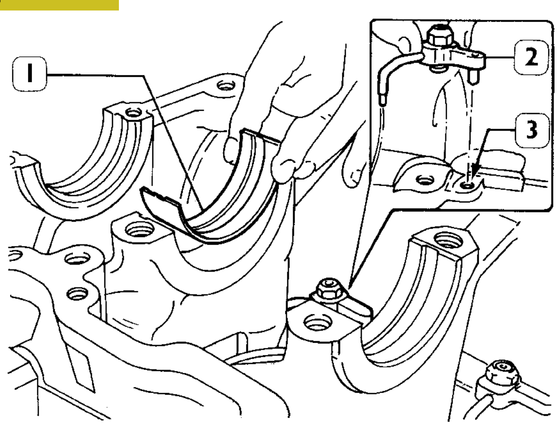


73534

When fitting the gear (1) on the crankshaft (2), heat it for no longer than 2 hours in an oven at a temperature of 180°C.
After heating the gear (1), fit it on the shaft by applying a load of 6000 N to it, positioning it at the distance shown in Figure 32.
After cooling, the gear must have no axial movement under a load of 29100 N.
If changing the pin (3), after fitting it on, check it protrudes from the crankshaft as shown in the figure.

Checking main journal assembly clearance

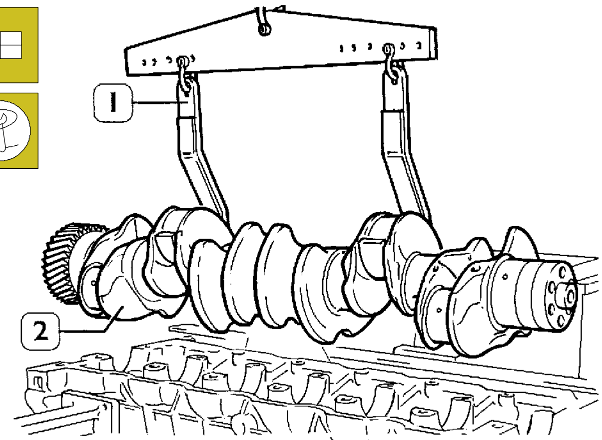
Figure 33



47579

Mount the oil nozzles (2), making the grub screw match the hole (3) on the crankcase.
Arrange the bearing shells (1) on the main bearing housings.

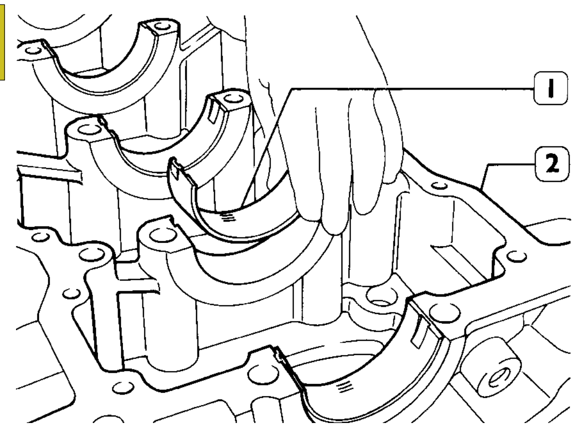
Figure 34



47578

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

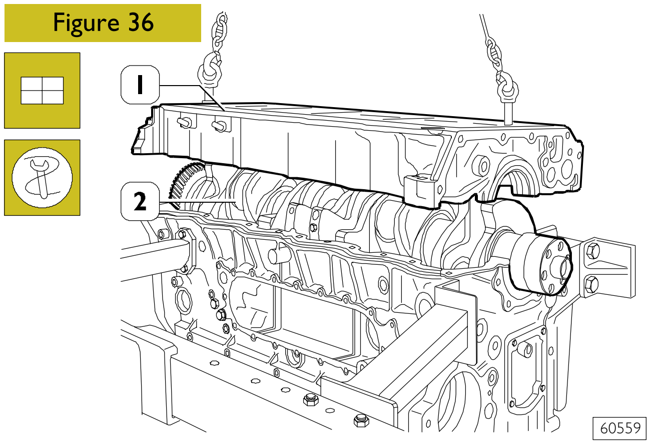
Figure 35



49021

Arrange the bearing shells (1) on the main bearing housings in the crankcase base (2).
Check the assembly clearance between the main journals of the crankshaft and their bearings, proceeding as illustrated on the following pages.

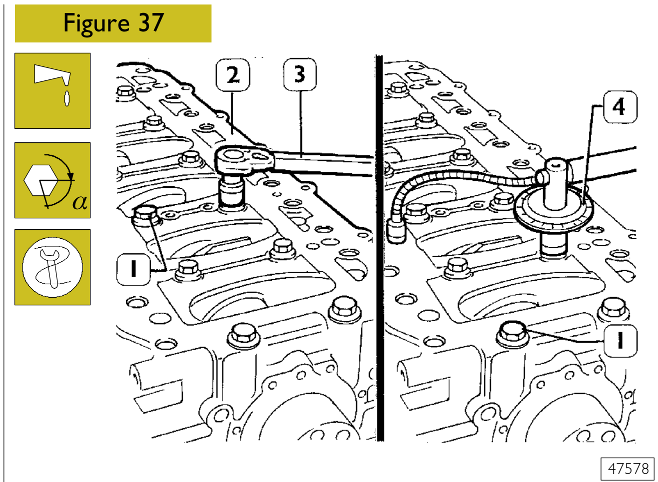
Figure 36



Set two journals of the crankshaft (2) parallel to the longitudinal axis, a section of calibrated wire. Using appropriate hooks and tackle, mount the crankcase base (1).

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 90°, following the diagram of Figure 38.

Figure 38

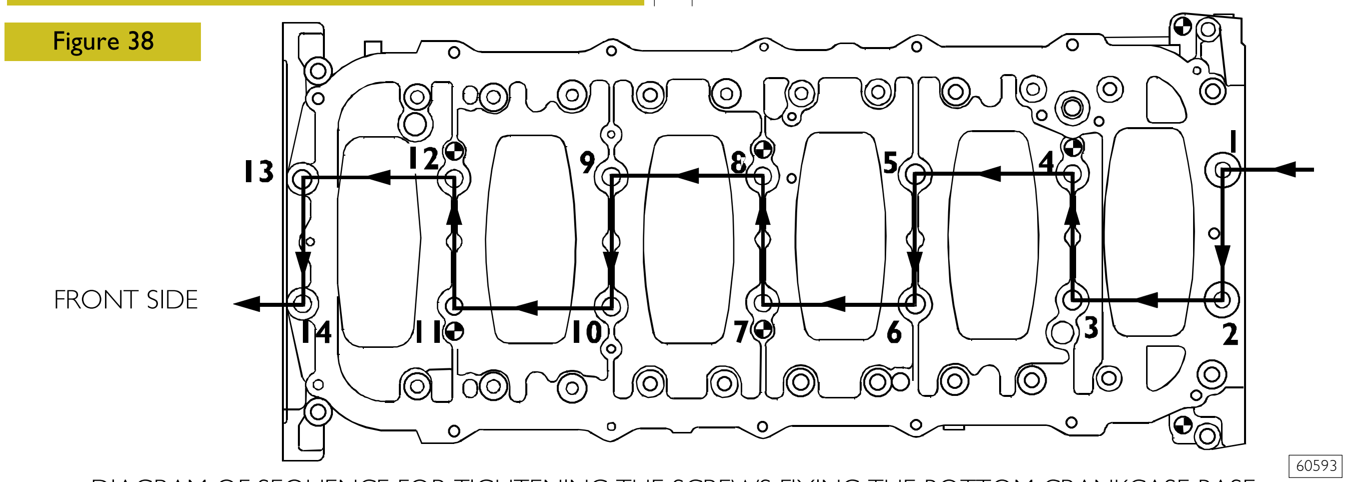
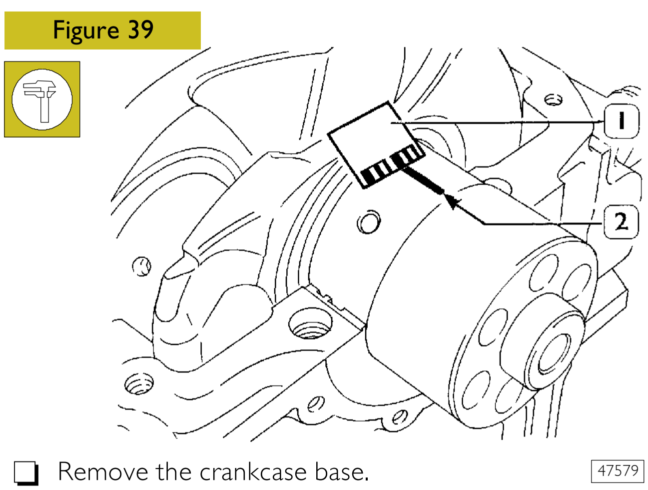


DIAGRAM OF SEQUENCE FOR TIGHTENING THE SCREWS FIXING THE BOTTOM CRANKCASE BASE TO THE CRANKCASE

Figure 39

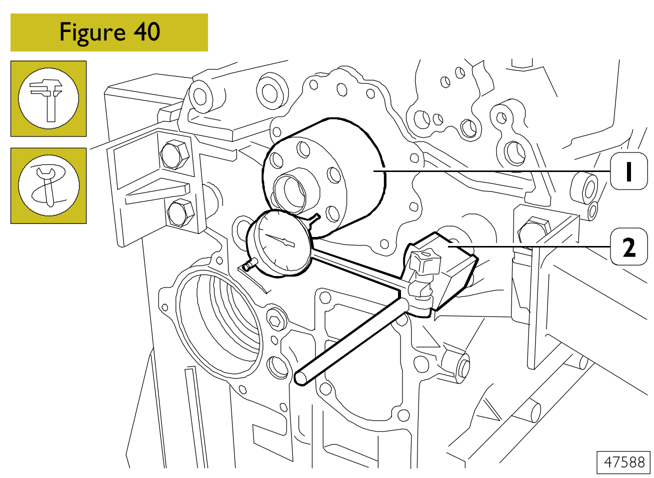


❑ Remove the crankcase base.

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

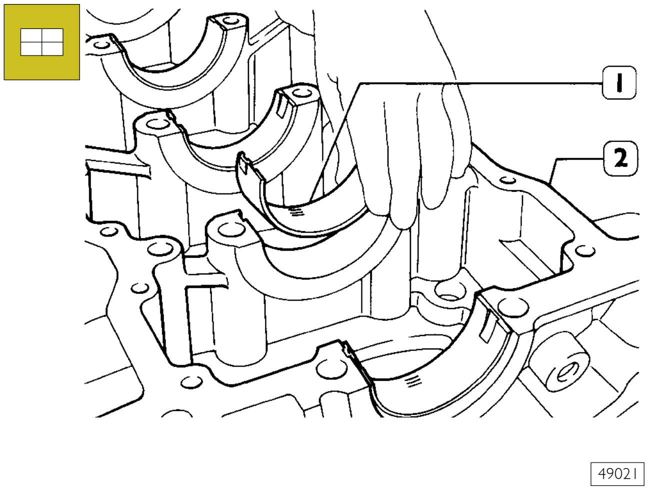
Figure 40



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

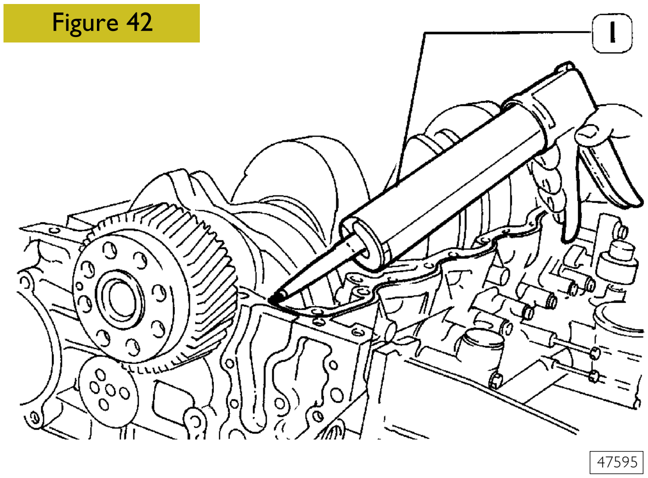
ASSEMBLING THE ENGINE ON THE BENCH

Figure 41



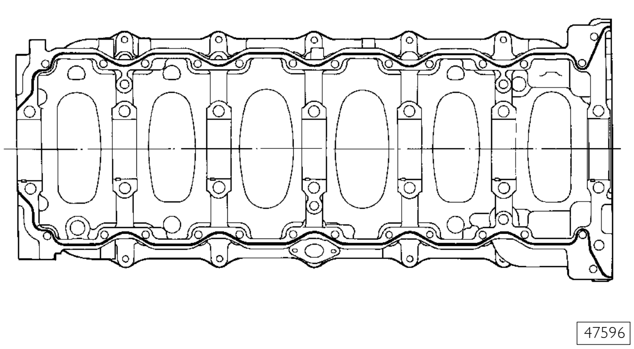
Place the half-bearings (1) on the main bearings in the underblock (2).
Remove the underblock.

Figure 42



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

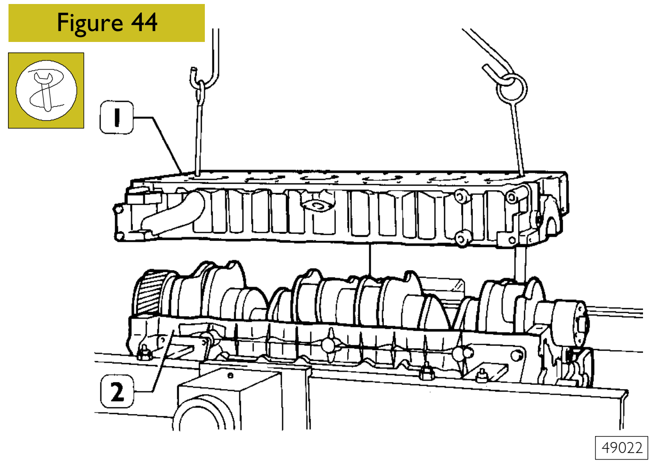
Figure 43



Sealant application diagram

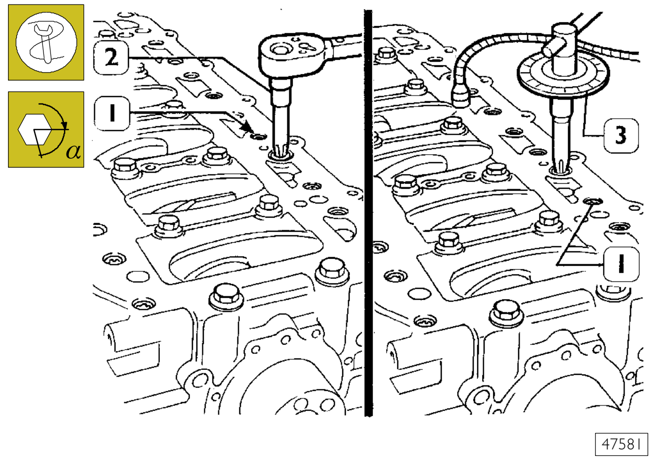
NOTE Fit the underblock within 10' of the application of the sealant.

Figure 44



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

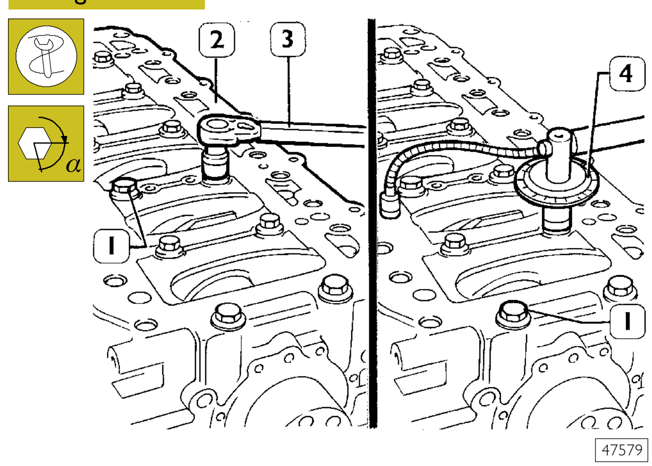
Figure 45



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

NOTE Use new screws every time for head.

Figure 46



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

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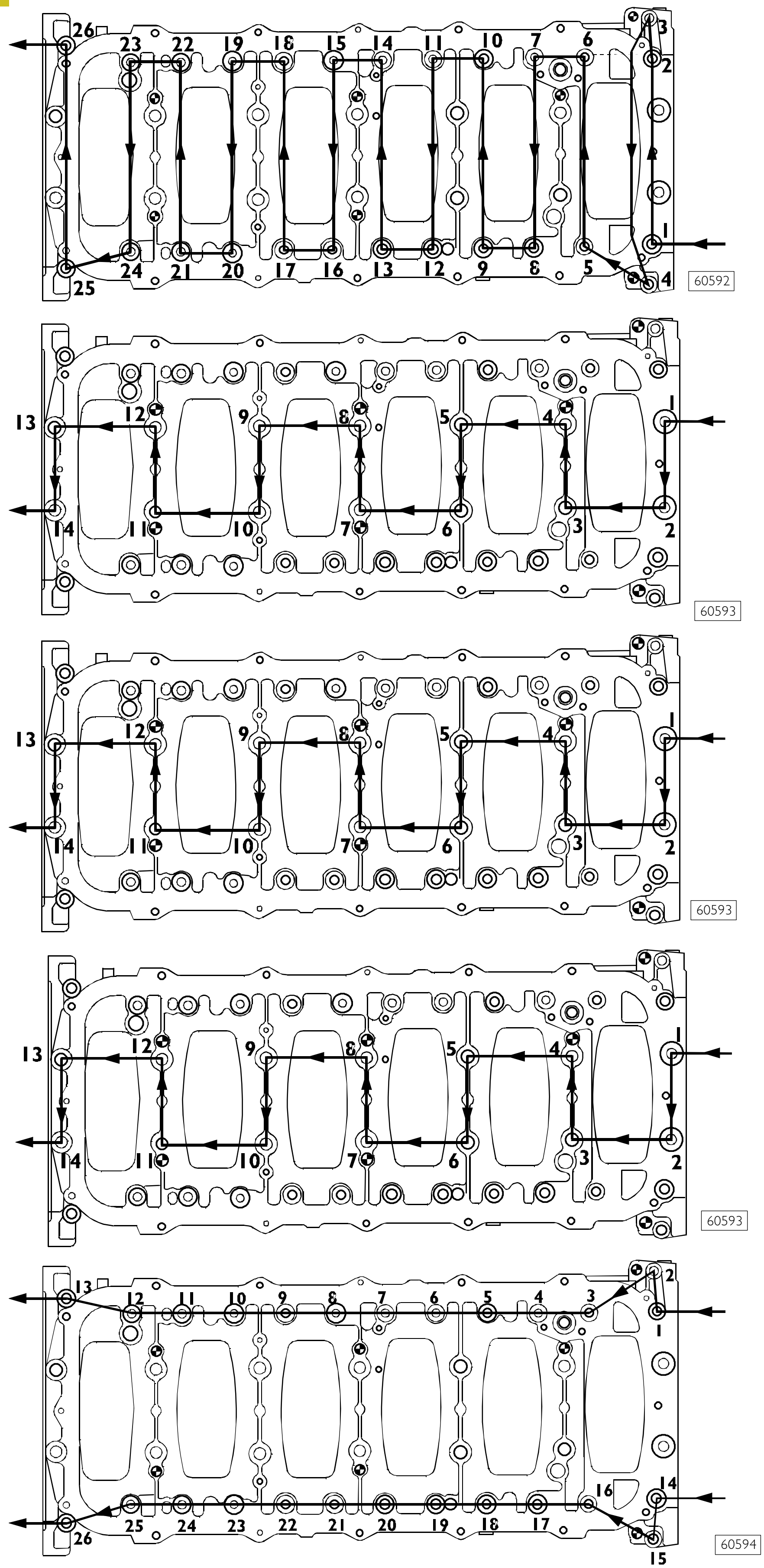
Figure 47



FRONT SIDE — stage 1: pretightening outer screws (30 Nm)

FRONT SIDE — stage 2: pretightenig inner screws (120 Nm)

FRONT SIDE — stage 3: angle inner screws (90°)

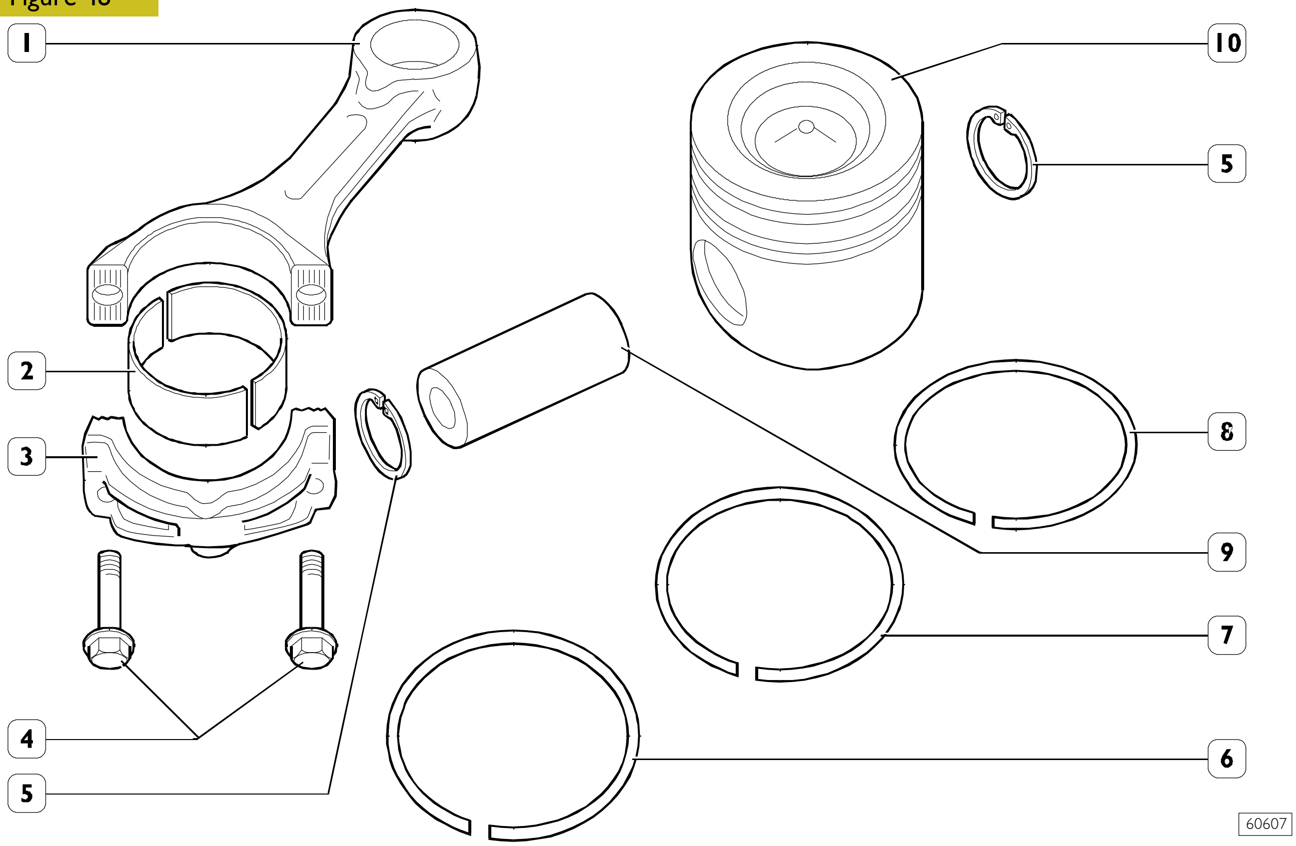
FRONT SIDE — stage 4: angle inner screws (45°)

FRONT SIDE — stage 5: angle outer screws (60°)

DIAGRAM OF TIGHTENING SEQUENCE OF CRANKCASE BASE FIXING SCREWS

Piston connecting rod assembly

Figure 48



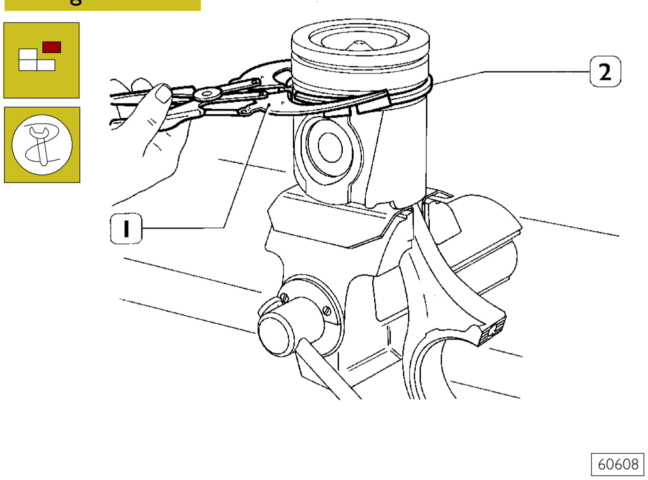
PISTON CONNECTING ROD ASSEMBLY

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 show any trace of seizing, scoring, cracking; replace as necessary.

Removal

Figure 49

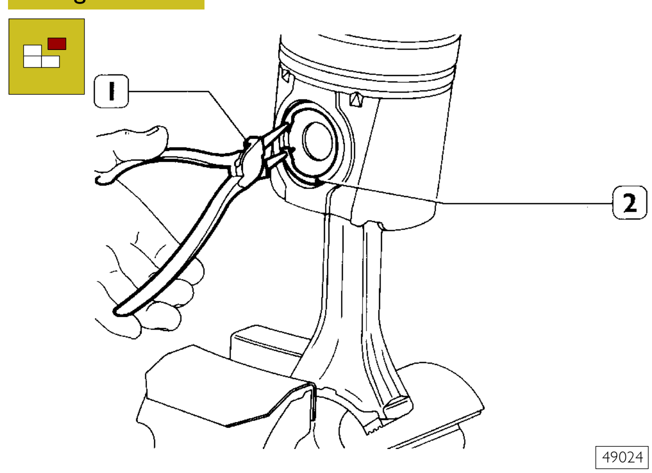


Removal of the piston split rings (2) using the pliers 99360184 (1).

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

Pistons are grouped into classes A and B for diameter.

Figure 50



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

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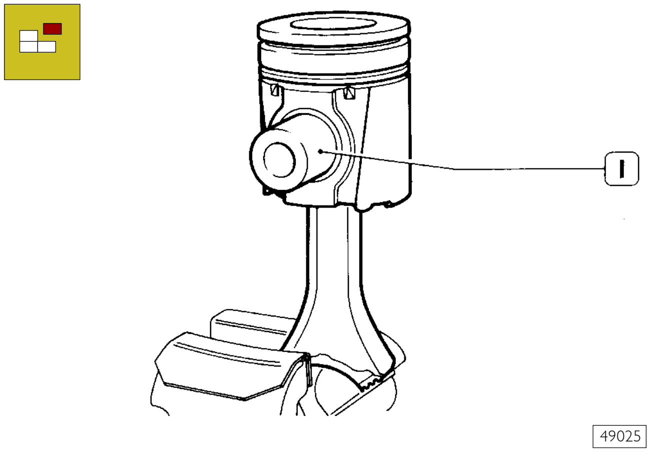
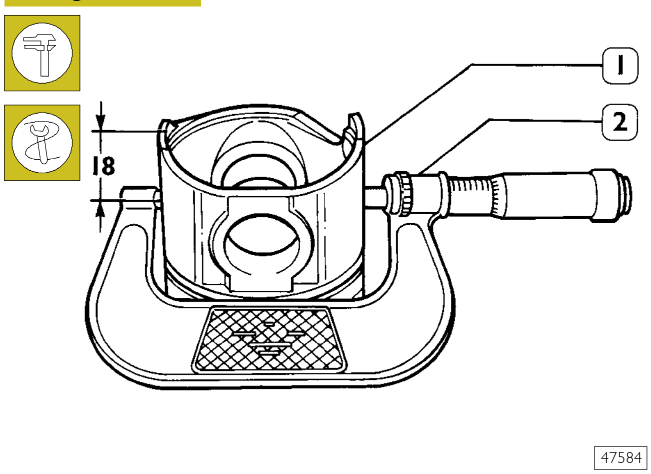
Figure 51



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

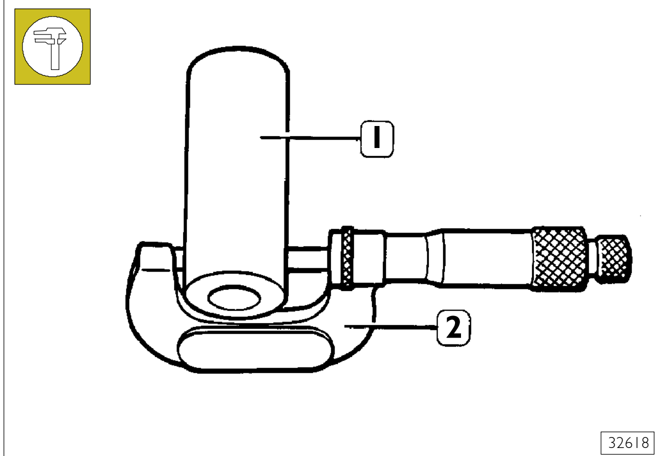
Measuring the diameter of the pistons

Figure 52



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 shown.

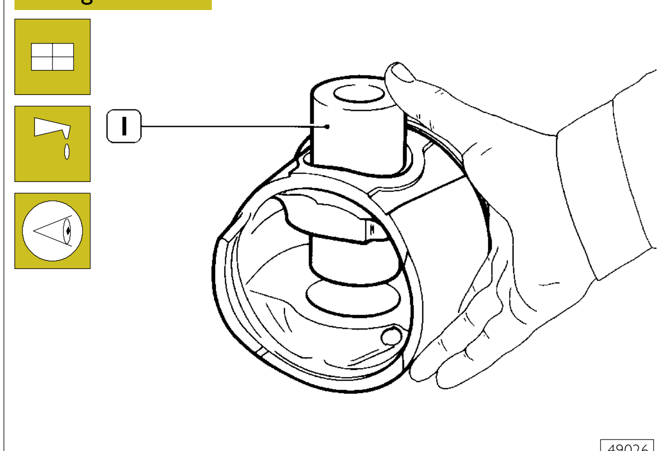
Figure 53



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

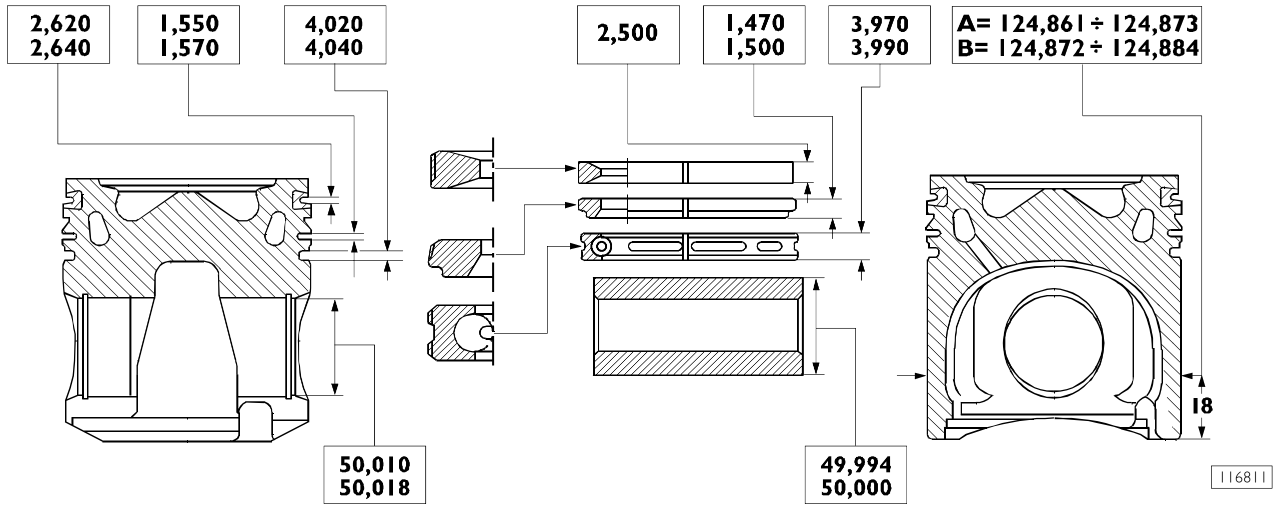
Conditions for correct gudgeon pin-piston coupling

Figure 54



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

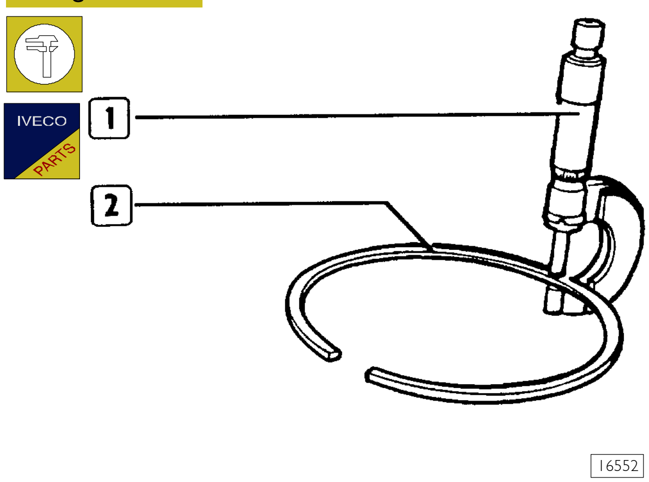
Figure 55



MAIN DATA OF THE PISTON, PISTON RINGS AND PIN

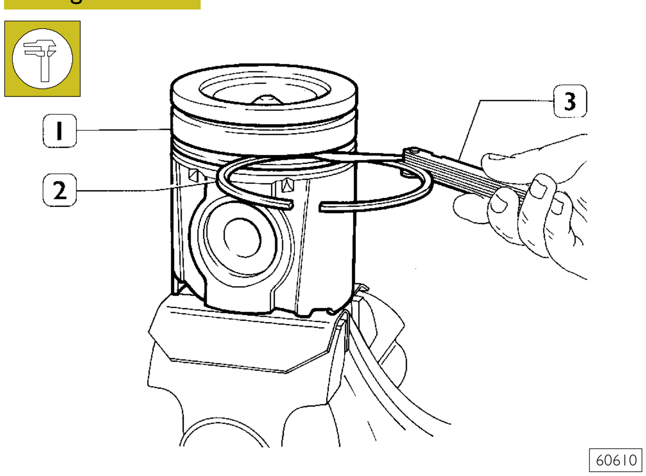
Piston rings

Figure 56



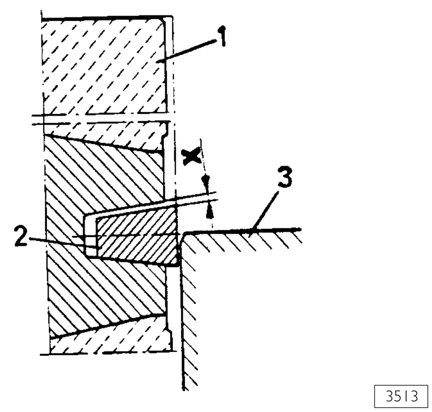
Check the thickness of the piston ring (2) using a micrometer (1).

Figure 57



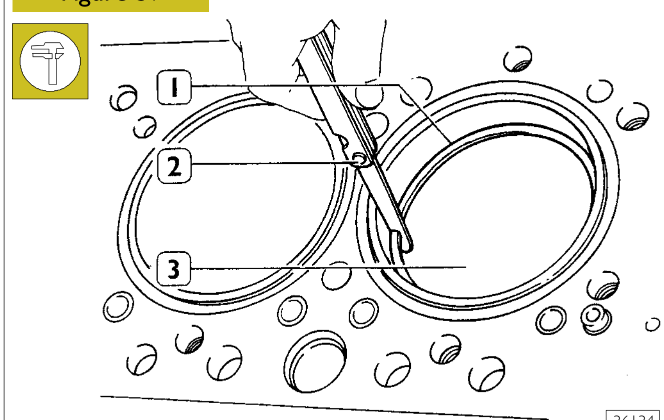
Check the clearance between the sealing rings (2) and the relative piston housings (1) using a thikness gauge (3).

Figure 58



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

Figure 59



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

Connecting rods

Figure 60

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

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

DIAGRAM OF THE CONNECTING ROD MARKS

1 Letter indicating the weight class:

A = 4043 to 4073 g.
B = 4074 to 4104 g.
C = 4105 to 4135 g.

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

1 = 87.000 to 87.010 mm
2 = 87.011 to 87.020 mm
3 = 87.021 to 87.030 mm

3 Numbers identifying cap-connecting rod coupling.

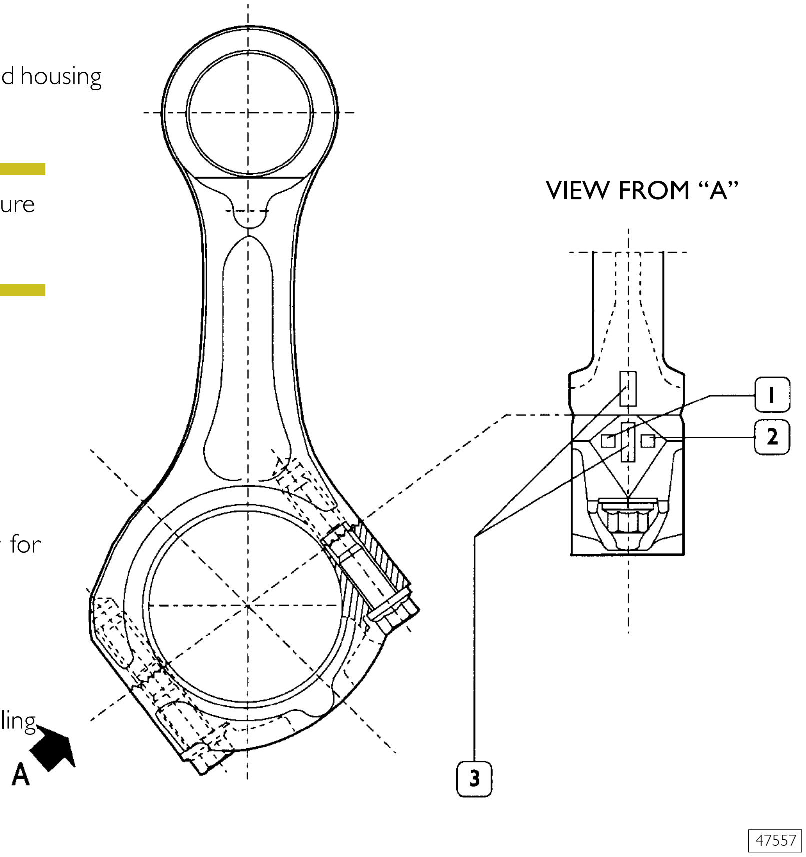
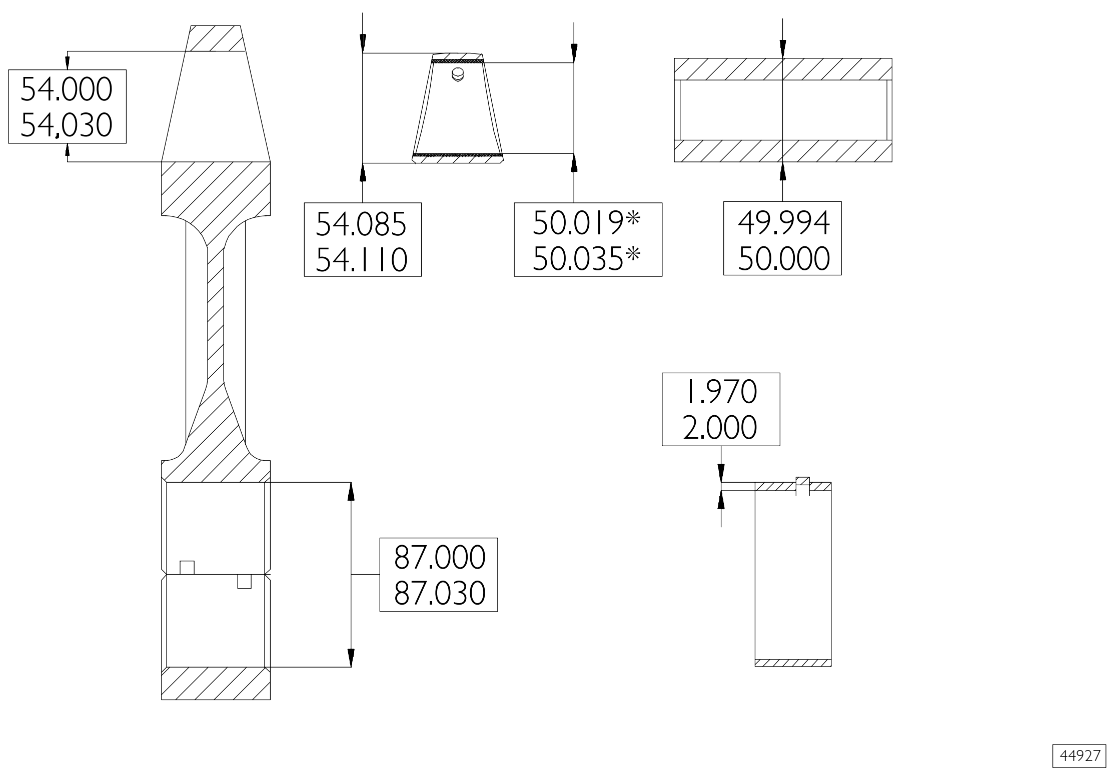


Figure 61

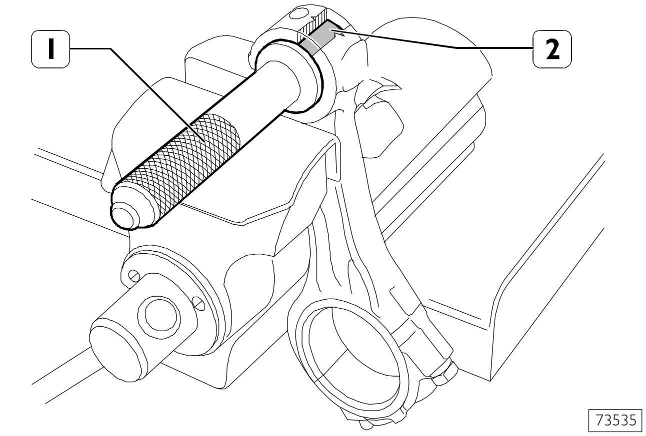


MAIN DATA - BUSH, CONNECTING ROD, PIN AND HALF-BEARINGS

* Values to be obtained after installing the bush.

Bushings

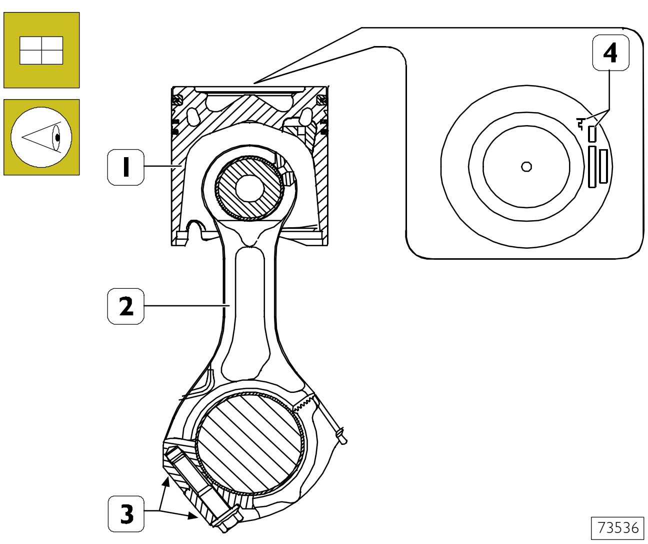
Figure 62



Check the bushing in the small end has not come loose and shows no sign of scoring or seizure; replace it if it does.
The bushing (2) is removed and fitted with a suitable drift (1).
When driving it in, make absolutely sure that the holes for the oil to pass through in the bushing and small end coincide.
Using a boring machine, rebore the bushing so as to obtain a diameter of 50.019 – 50.035.

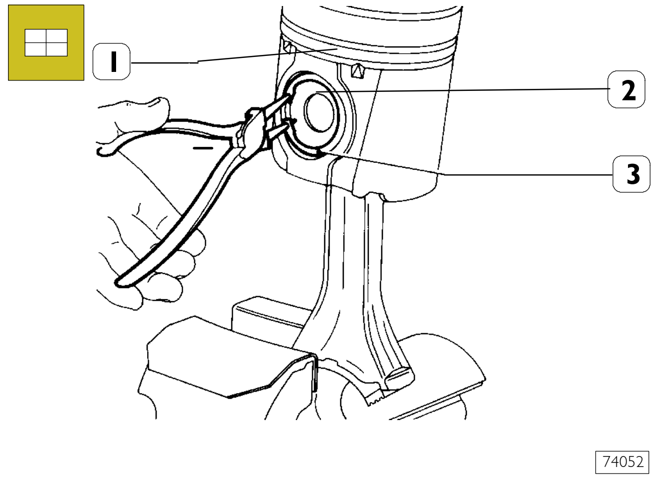
Mounting the connecting rod – piston assembly

Figure 63



The piston (1) has to be fitted on the connecting rod (2) so that the graphic symbol (4), showing the assembly position in the cylinder liner, and the punch marks (3) on the connecting rod are observed as shown in the figure.

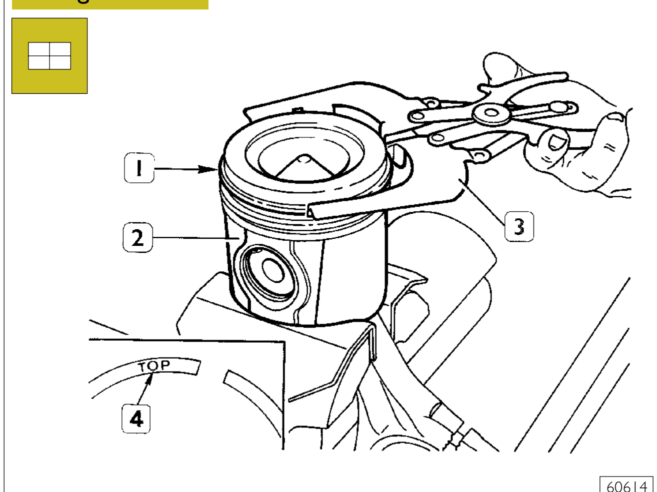
Figure 64



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

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.

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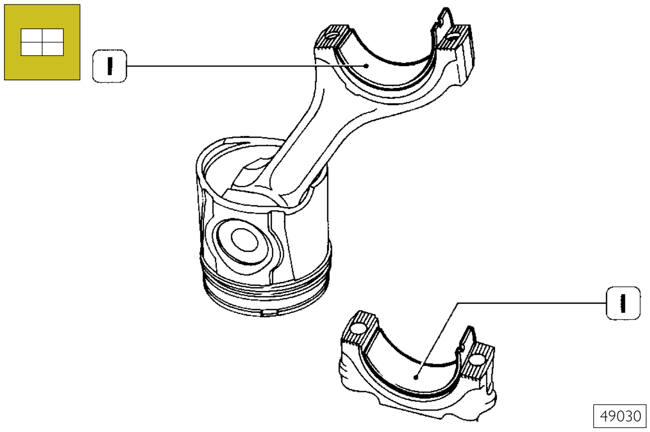
Fitting the big end bearing shells

Figure 66



Fit the bearing shells (1), selected as described under the heading "Selecting the main and big end bearing shells", on both the connecting rod and the cap.

If reusing bearing shells that have been removed, fit them back into their respective seats in the positions marked during removal.

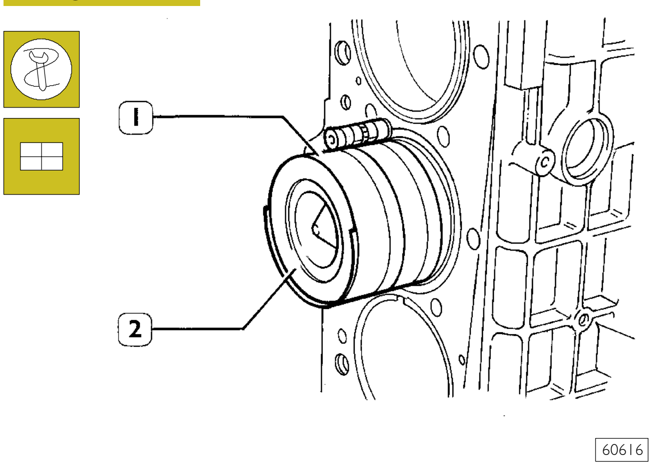
Fitting connecting rod - piston assemblies in the cylinder liners

With the aid of the clamp 99360605 (1, Figure 67), fit the connecting rod – piston assembly (2) in the cylinder liners, according to the diagram of Figure 68, checking that:

- The openings of the piston rings are staggered 120° apart.
- The pistons are all of the same class, A or B.
- The symbol punched on the top of the pistons faces the engine flywheel, or the recess in the skirt of the pistons tallies with the oil nozzles.

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

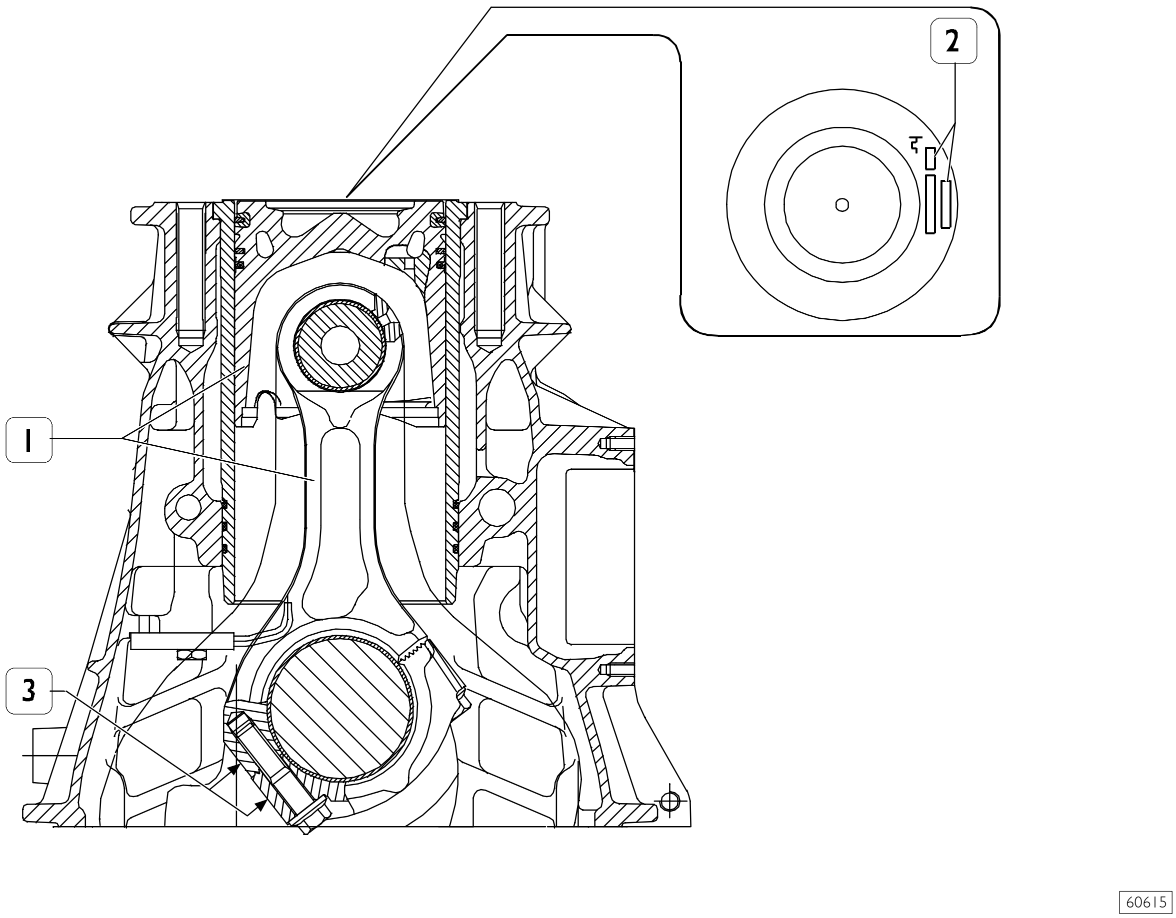
Figure 67



Checking piston protrusion

On completing assembly, check the protrusion of the pistons from the cylinder liners; it must be 0.23 – 0.53 mm.

Figure 68



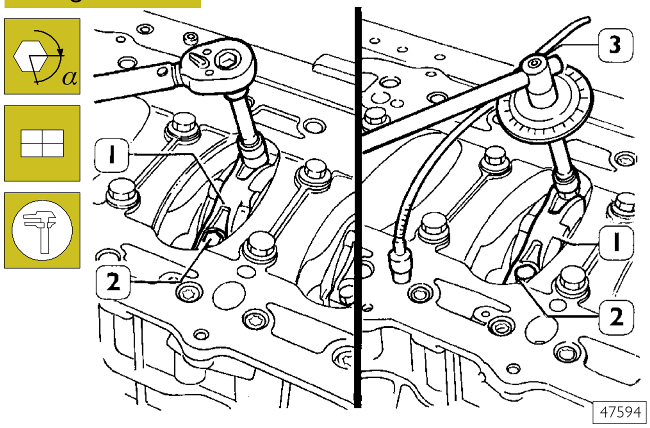
ASSEMBLY DIAGRAM OF CONNECTING ROD – PISTON ASSEMBLY IN CYLINDER LINER

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

Checking crankpin assembly clearance

To 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 69



Mount the connecting rod caps (1) together with the bearing shells. Tighten the screws (2) fixing the connecting rod caps to a torque of 60 Nm (6 kgm). Using tool 99395216 (3), further tighten the screws with an angle of 60°.

NOTE The thread of the screws (2), before assembly, has to be lubricated with engine oil.

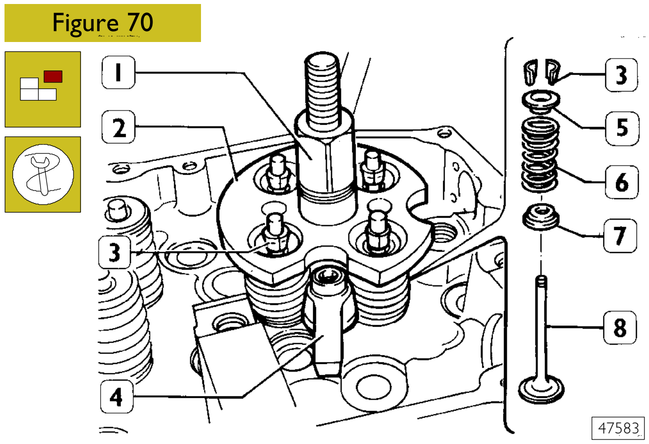
Remove the caps and determine the clearance by comparing the width of the calibrated wire with the graduated scale on the case containing the calibrated wire.
Definitive assembly: check the diameter of screw threading (2) it must not be less than 13.4mm along the entire length, otherwise the screw is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

CYLINDER HEAD

Before removing the cylinder head, check it is leakproof using appropriate equipment. Replace the cylinder head if there is any leakage.

Removing valves

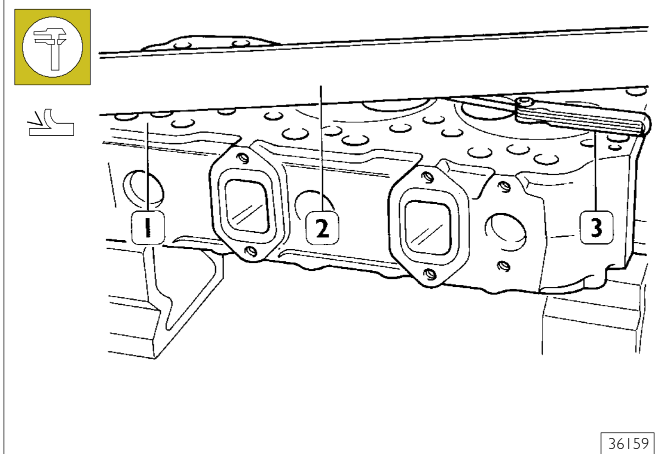
Figure 70



Install and fix tool 99360261 (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 71 (Demonstration)

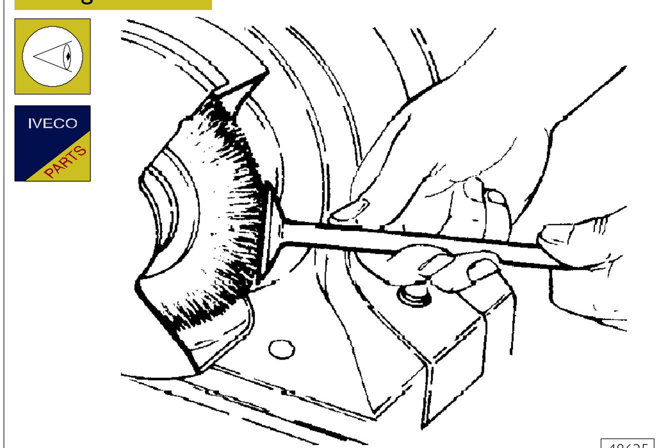


The planarity (1) is checked using a ruler (2) and a thikness gauge (3). If deformations exist, surface the head using proper surface grinder; the maximum amount of material to be removed is 0.3 mm.

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

Removing deposits and checking the valves

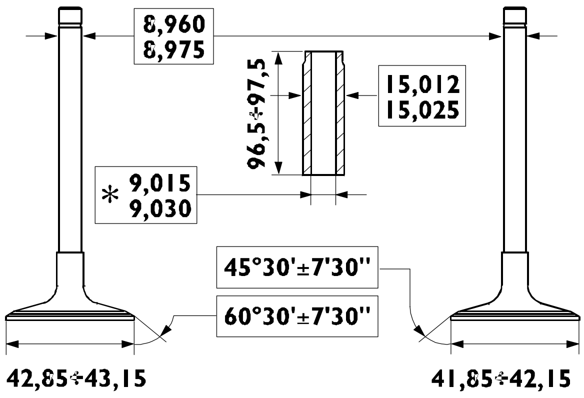
Figure 72



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 OF VALVES AND VALVE GUIDES

* Measurement to be made after driving in the valve guides

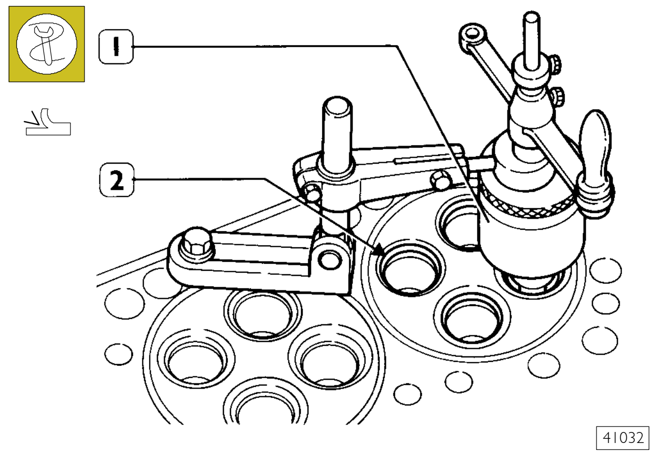
Check with a micrometer that the diameter of the valve stems is as indicated. If necessary, grind the valve seats with a grinding machine, removing as little material as possible.

Valve seats

Regrinding – replacing valve seats

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

Figure 74



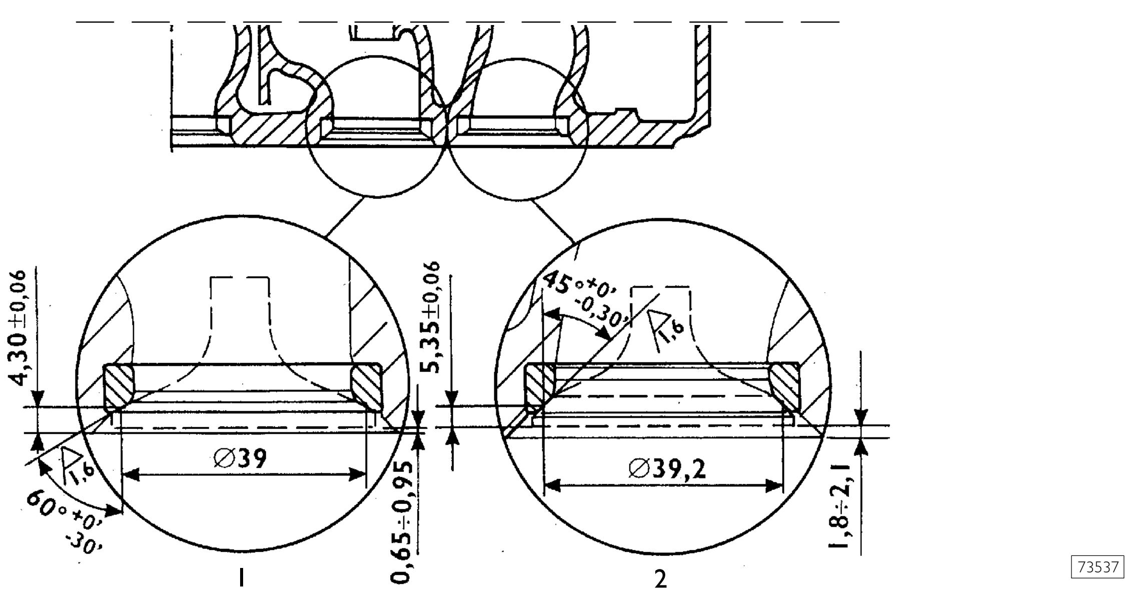
Check the valve seats (2). If you find any slight scoring or burns, regrind the surfaces (1) according to the angles shown in Figure 73 and Figure 75. If it is necessary to replace them, and taking care not to affect the cylinder head, remove as much material as possible from the valve seats so that, 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. Regrind the valve seats according to the angles shown in Figure 75.

After regrinding the valve seats, using tool 99370415 and dial gauge 99395603, check that the position of the valves in relation to the plane of the cylinder head is:

- -0.65 to -0.95 mm (recessing) intake valves;
- -1.8 to -2.1 mm (recessing) exhaust valves.

Figure 75



MAIN DATA OF VALVE SEATS

1. Intake valve seat – 2. Exhaust valve seat.

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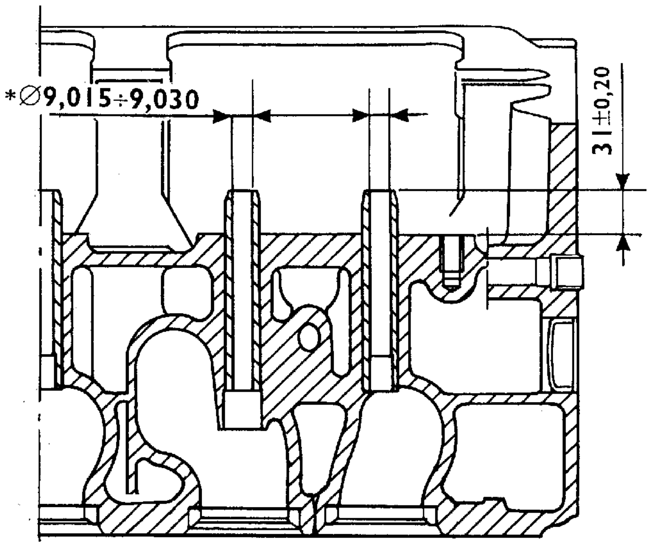
Checking clearance between valve-stem and associated valve guide

Using a dial gauge with a magnetic base, check the clearance between the valve stem and the associated guide. If the clearance is too great, change the valve and, if necessary, the valve guide.

Valve guides

Replacing valve guides

Figure 76



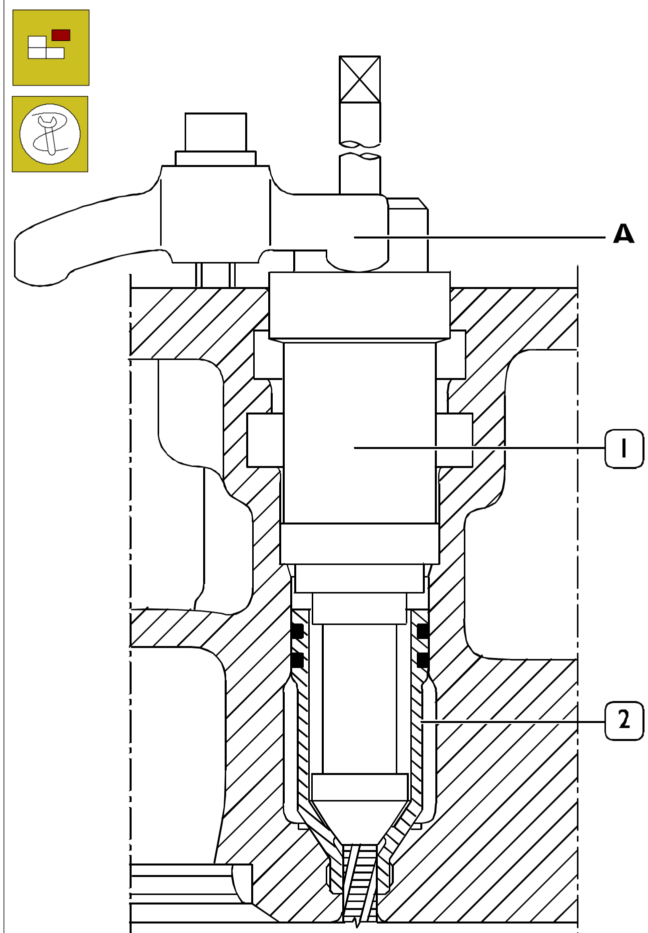
* Measurement to be made after driving in the valve guides

The valve guides are removed with the drift 99360481.
They are fitted with the drift 99360481 equipped with part 99360295.
Part 99360295 determines the exact position of assembly of the valve guides in the cylinder head. If they are not available, you need to drive the valve guides into the cylinder head so they protrude by 30.8-31.2 mm.
After driving in the valve guides, rebore their holes with the smoother 99390311.

Replacing injector cases

Removal

Figure 77

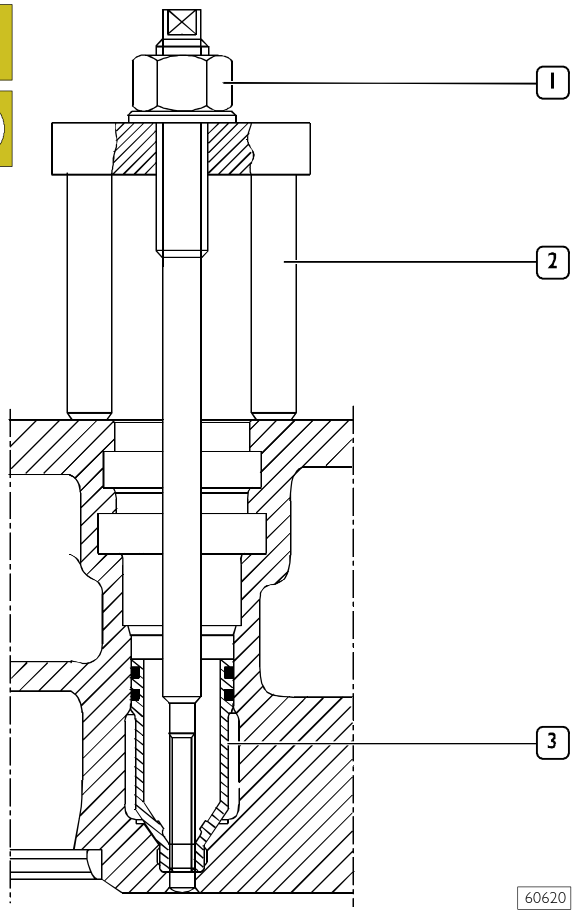


To replace the injector case (2), proceed as follows:

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

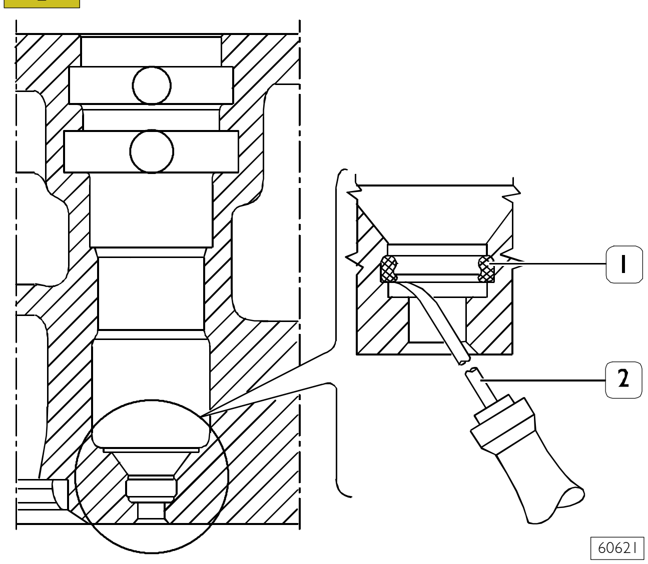
The steps described in Figs. 74 - 76 - 77 - 78 need to be carried out by fixing the tools, with the bracket A, to the cylinder head.

Figure 78



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

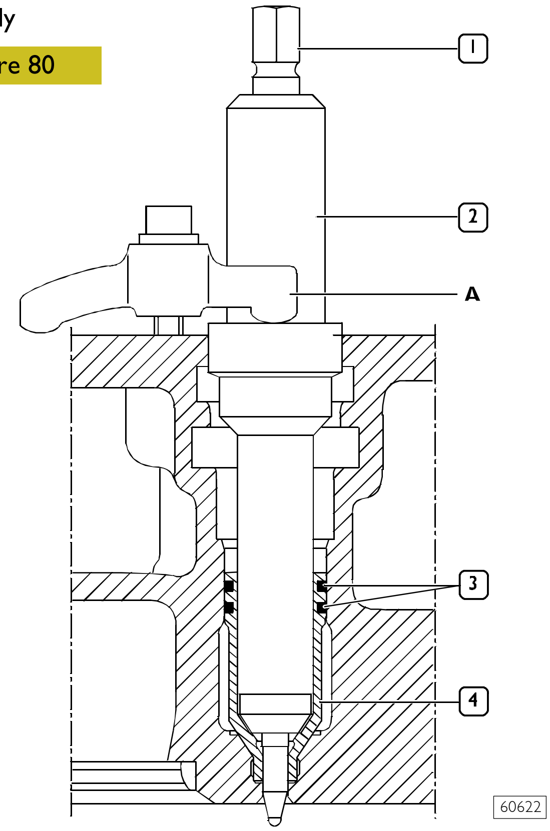
Figure 79



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

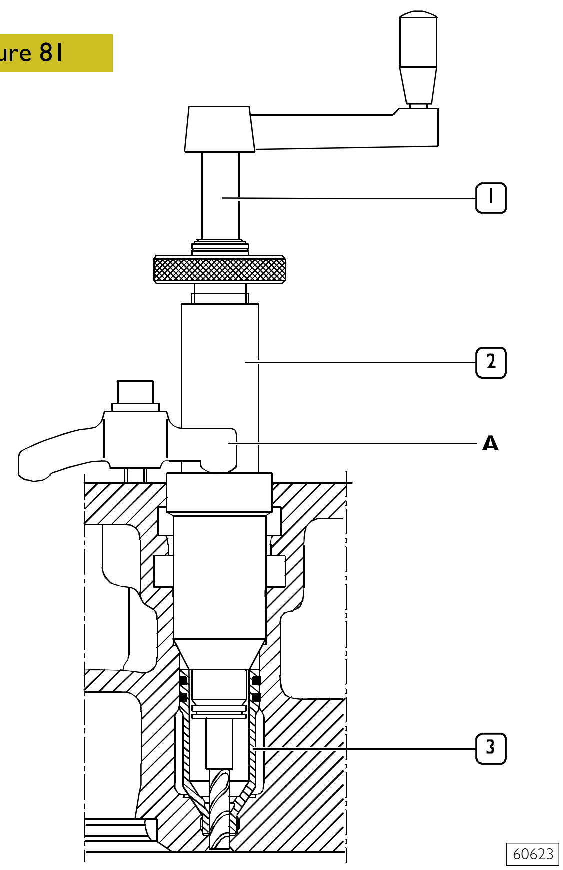
Assembly

Figure 80



❑ 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 81



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

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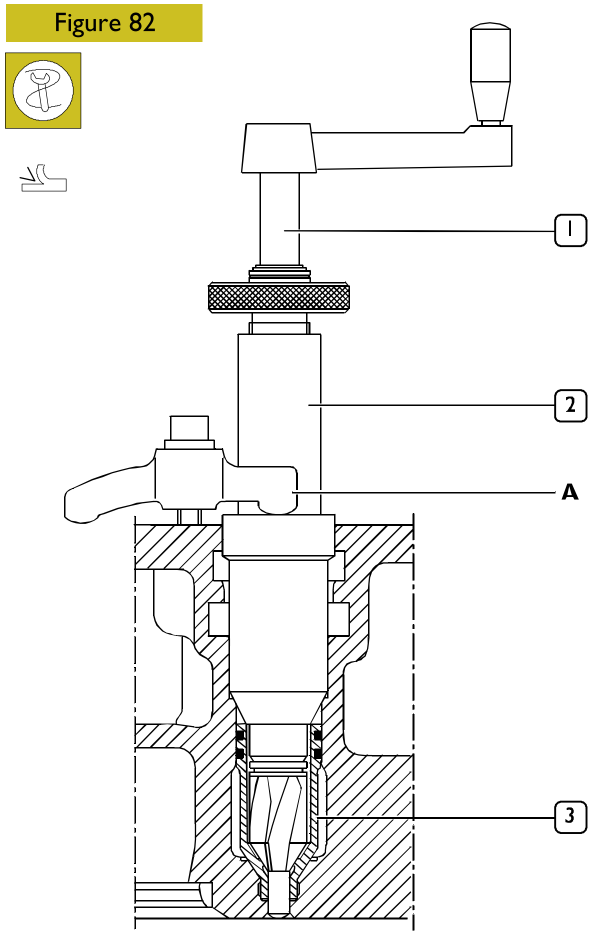
Figure 82



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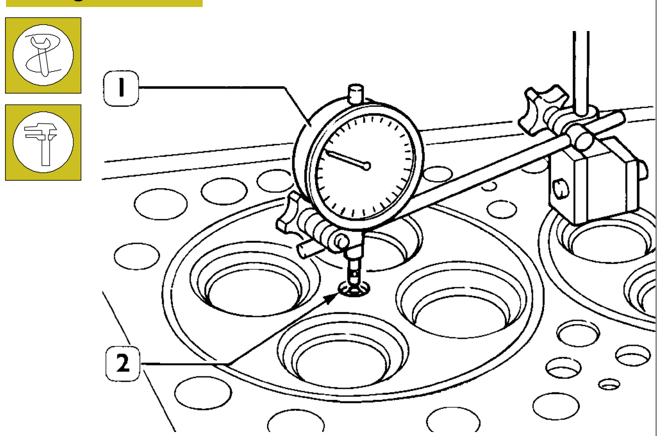
- Using grinder 99394041 (1-2), ream the injector seat in the case (3), check the injector protrusion from the cylinder head plane which must be 1.14 to 1.4 mm.

Checking injector protrusion

Figure 83



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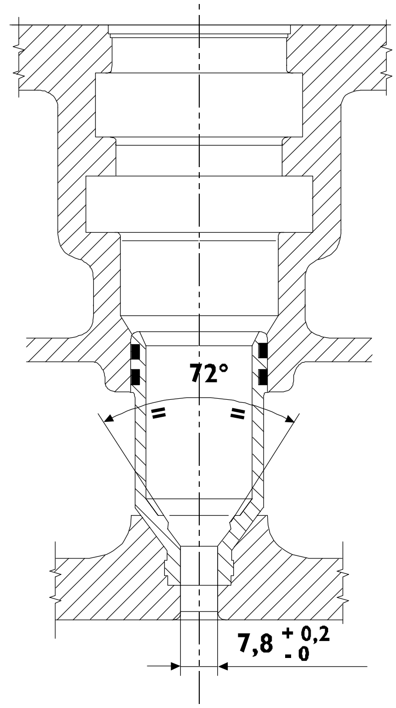
Check injector protrusion (2) with the dial gauge (1).
The protrusion must be 1.14 to 1.4 mm.

Figure 84



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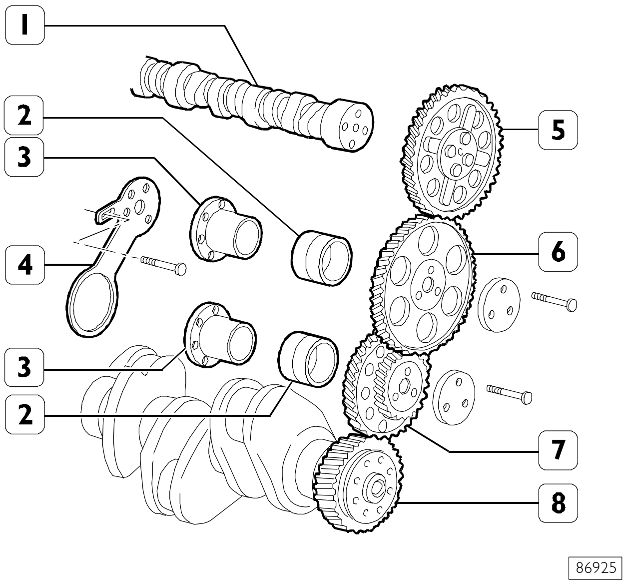
INJECTOR CASE ASSEMBLY DIAGRAM

TIMING GEAR
Camshaft drive

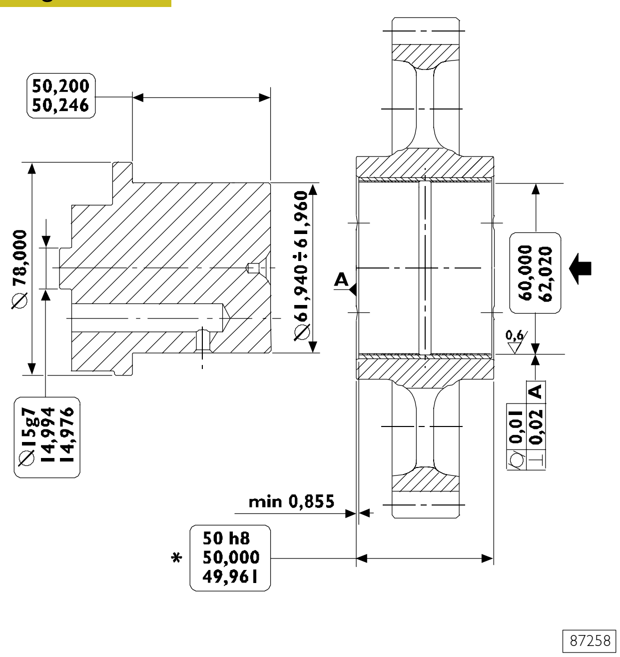
Figure 85



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.

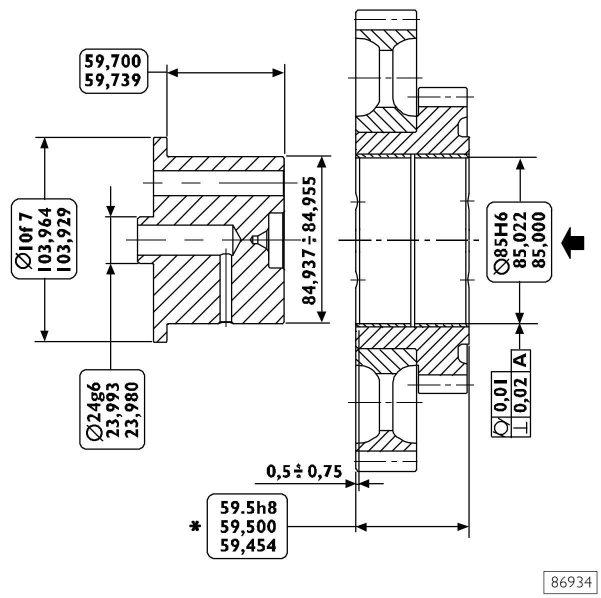
Idler gear pin
Idler gear

Figure 86



Twin intermediate gear pin
Twin idler gear

Figure 87



Replacing the bushings

Gear bushings shown on Figures 86 - 87 can be replaced when they are worn. Put up the bushing, then bore it to obtain the diameter shown on Figure 86 or Figure 87.

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 86 or Figure 87.

Rated assembling play between gear bushings and pins:
Figure 86 – 0.040 ÷ 0.080 mm
Figure 87 – 0.045 ÷ 0.085 mm.

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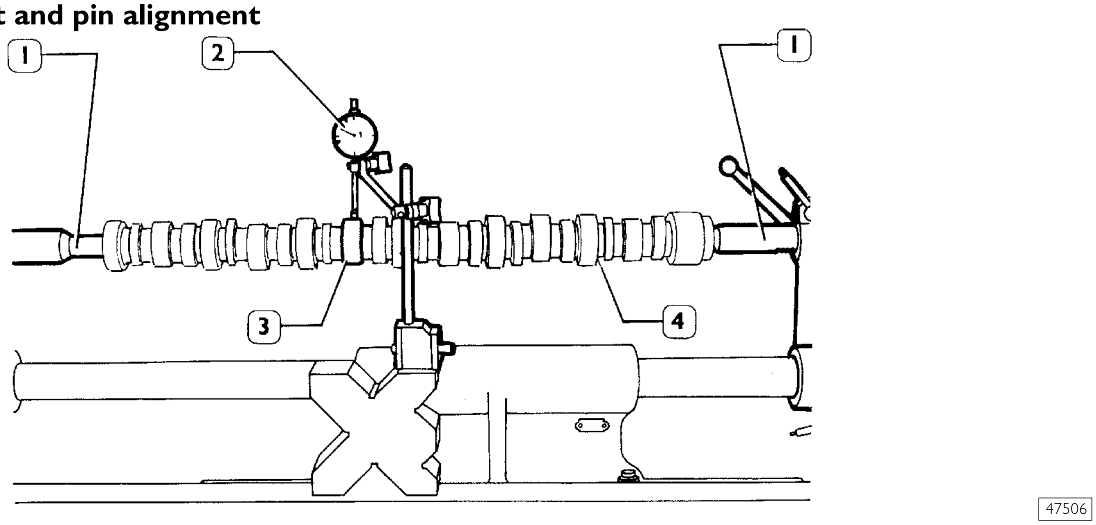
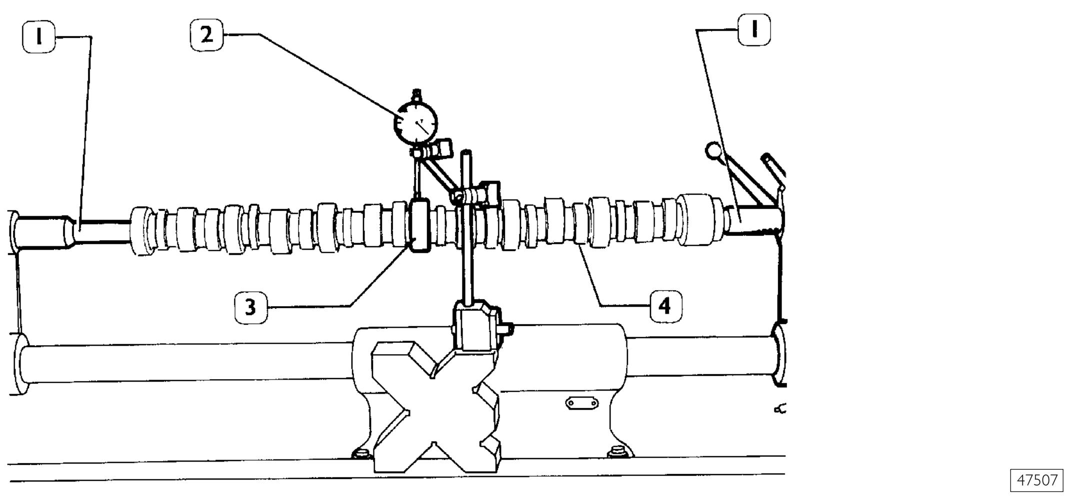
Camshaft
Checking cam lift and pin alignment

Figure 88



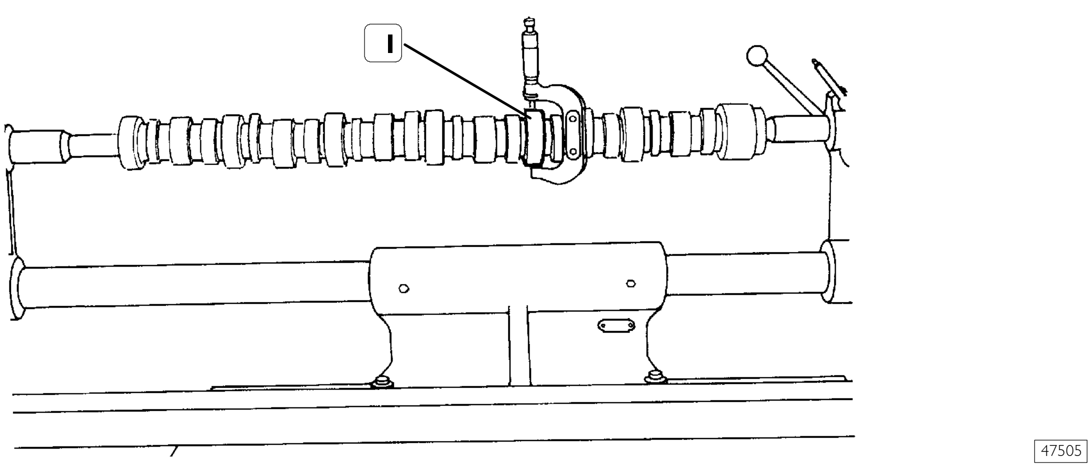
Place the camshaft (4) on the tailstock (1) and check cam lift (3) using a centesimal gauge (2).

Figure 89



When the camshaft (4) is on the tailstock (1), check alignment of supporting pin (3) using a centesimal gauge (2); it must not exceed 0.035 mm. If misalignment exceeds this value, replace the shaft.

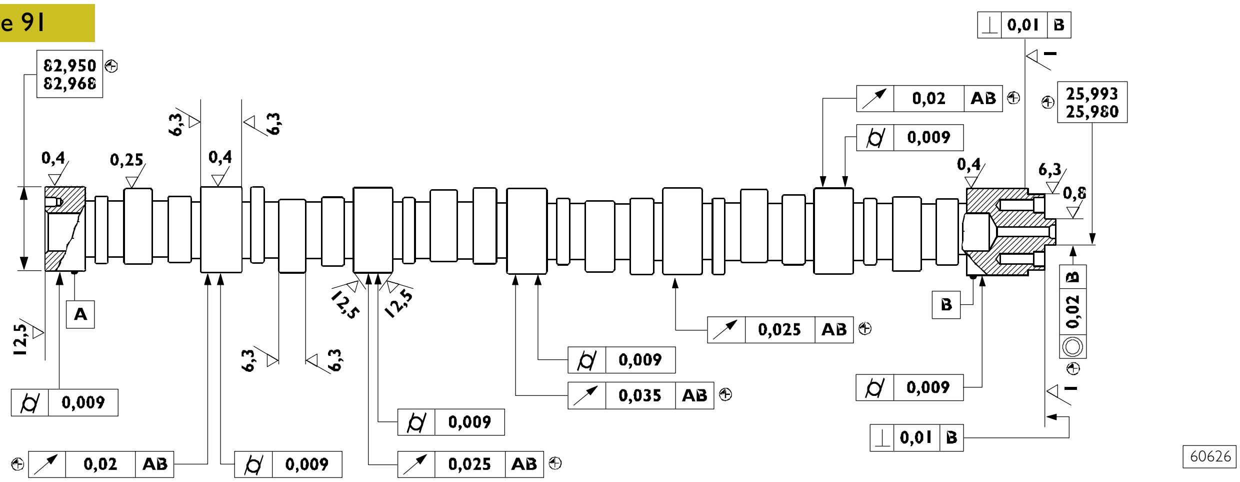
Figure 90



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

Camshaft

Figure 91

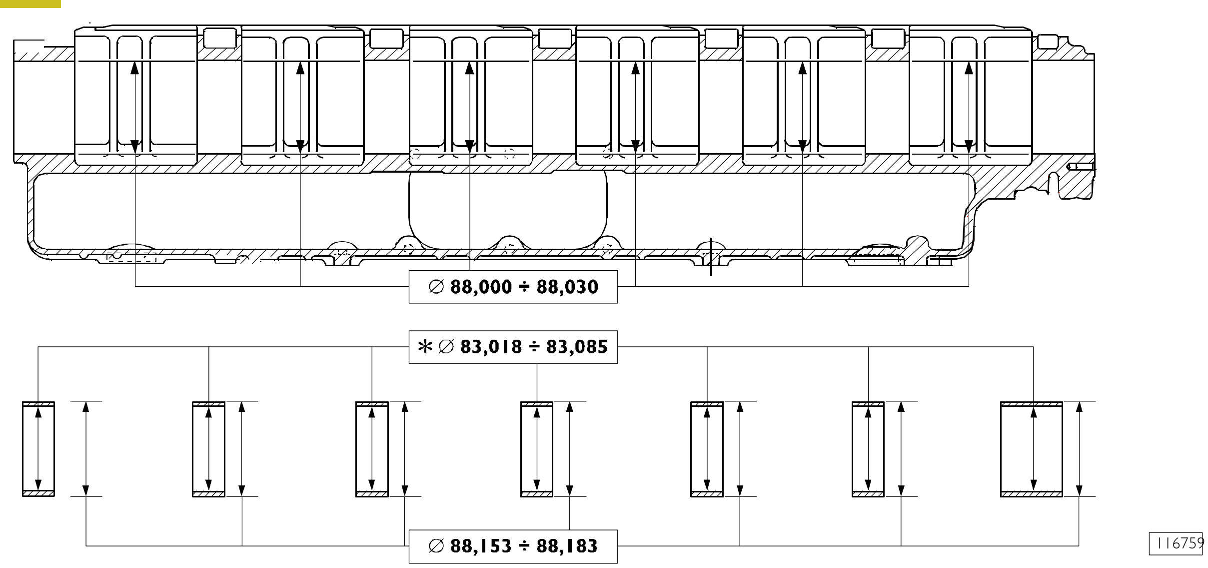


MAIN DATA - CAMSHAFT AND TOLERANCES
The surfaces of shaft supporting pin and cams must be extremely smooth; if you see any sign of seizing or scoring, replace the shaft and the relative bushes.

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

Bushings

Figure 92



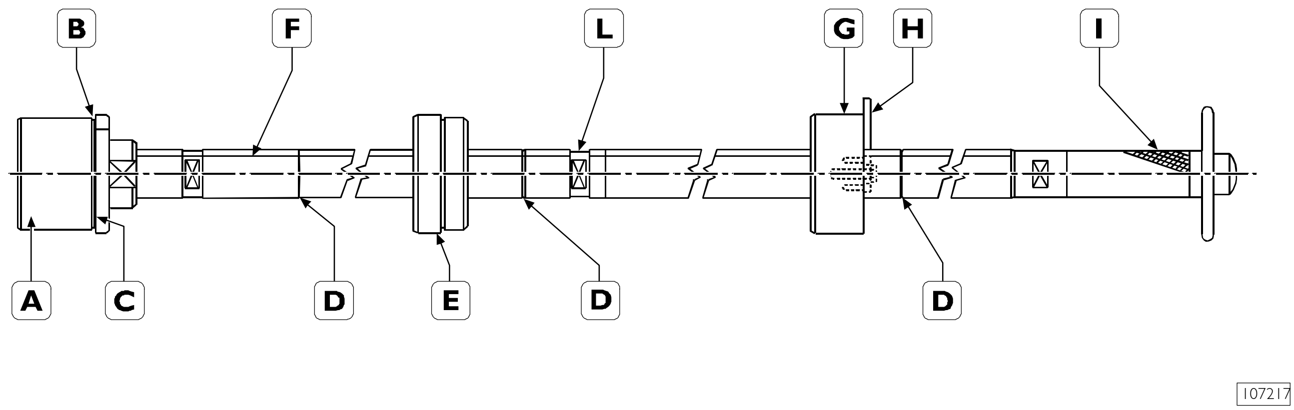
MAIN DATA OF CAMSHAFT BUSHES AND RELEVANT HOUSINGS ON CYLINDER HEAD
∗ Bush inner diameter after installation

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

Measure the bush inner diameters with a baremeter and replace them, if the value measured exceeds the tolerance value.
To take down and fit back the bushes, use the proper tool 99360499.

Replacing camshaft bushings with drift 99360499

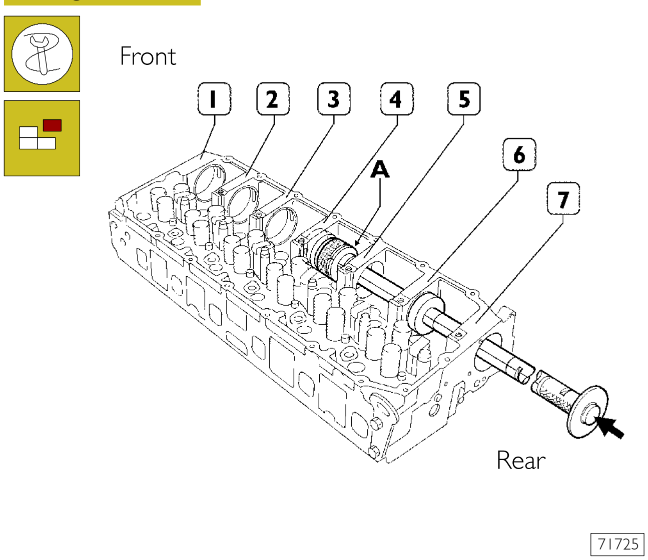
Figure 93



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

Removal

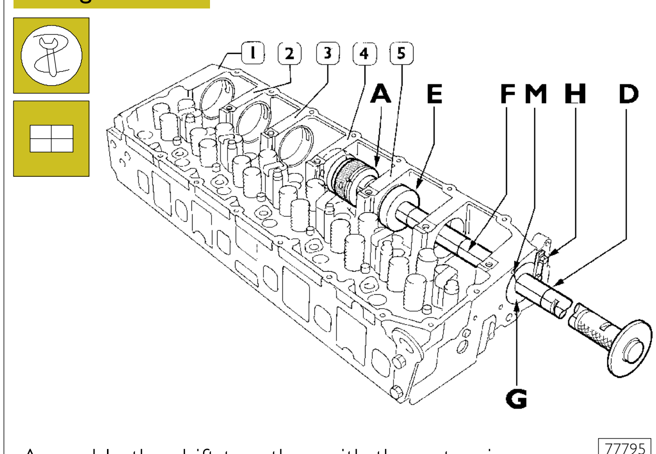
Figure 94



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

Assembly

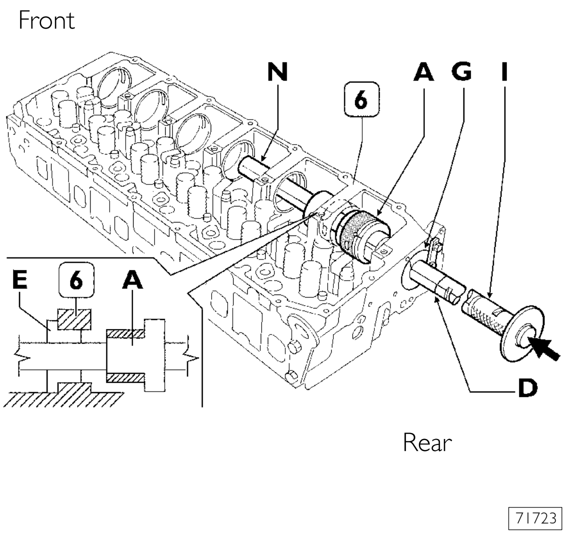
Figure 95



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 93) on the bushing.
2 position the guide bushing (E) and secure the guide bushing (G) (Figure 93) 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).

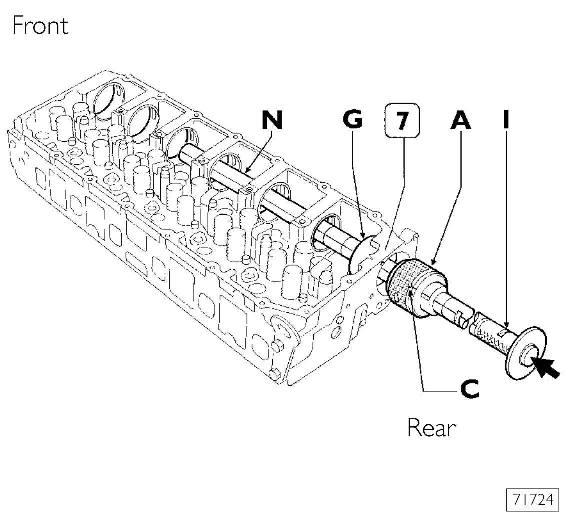
Figure 96



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 97

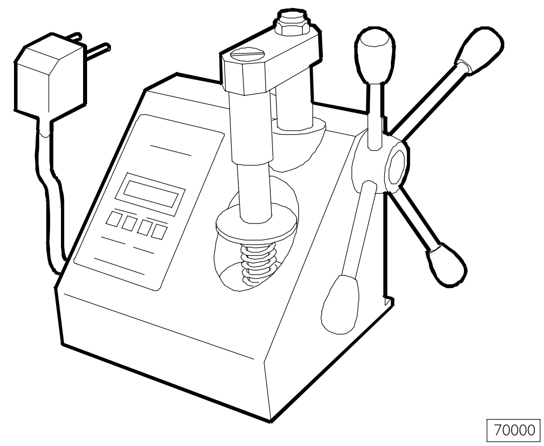


To insert bushing (7), proceed as follows:

- ❑ 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.

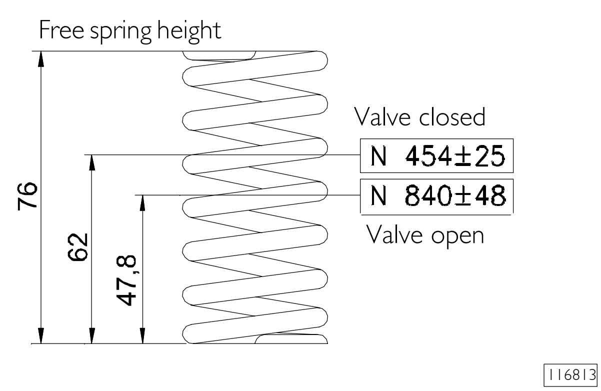
Valve springs

Figure 98



Indicative figure. Before assembly, check the efficiency of the spring.
Compare the load and elastic deformation data with those of the new springs given in the following figure.

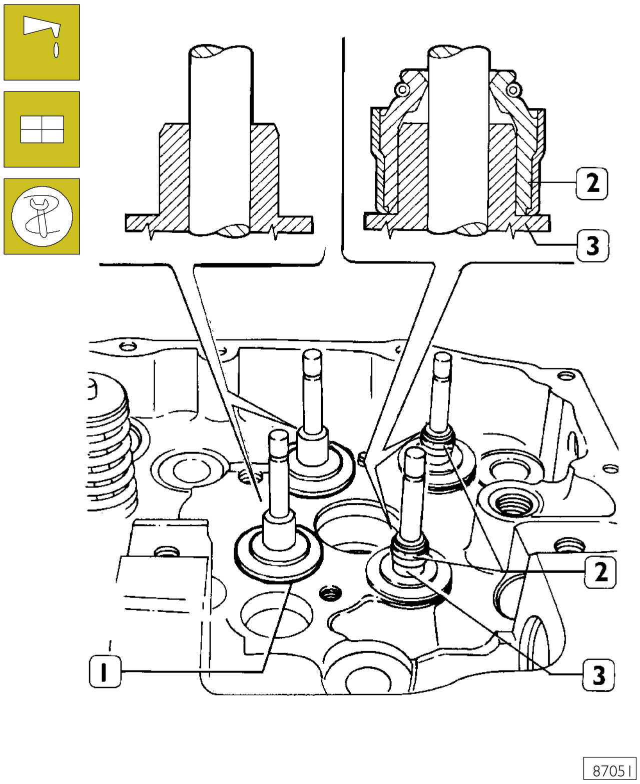
Figure 99



MAIN DATA TO CHECK THE SPRING FOR INTAKE AND EXHAUST VALVES

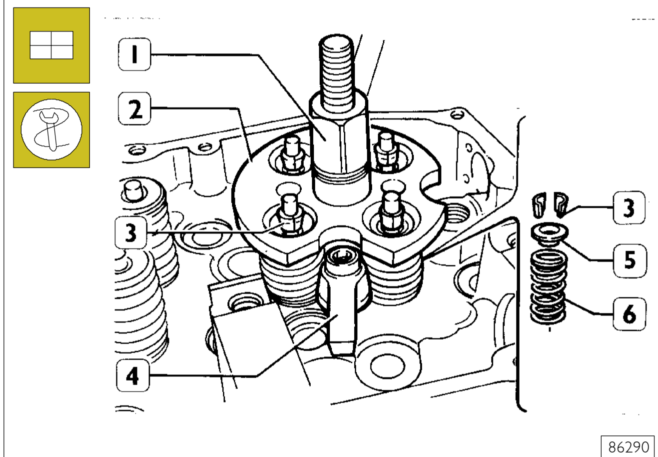
Fitting valves and oil seal

Figure 100



Lubricate the valve stem and insert the valves in the respective valve guides; fit the lower caps (1). Use tool 99360328 to fit the oil seal (2) on the valve guides (3) of the exhaust valves; then, to fit the valves, proceed as follows.

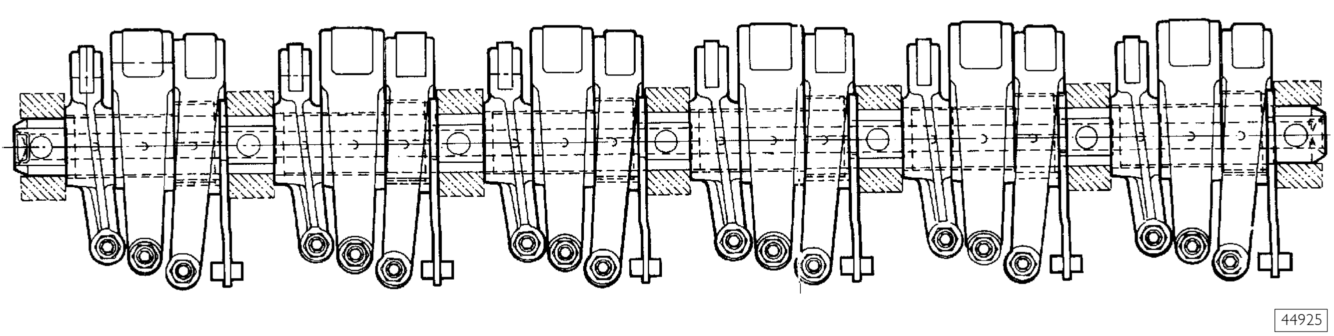
Figure 101



- Mount the springs (6) and the top plate (5).
- Fit the tool 99360262 (2) and secure it with the bracket (4). Screw down the lever (1) to be able to fit on the cotters (3). Take off the tool (2).

ROCKER SHAFT

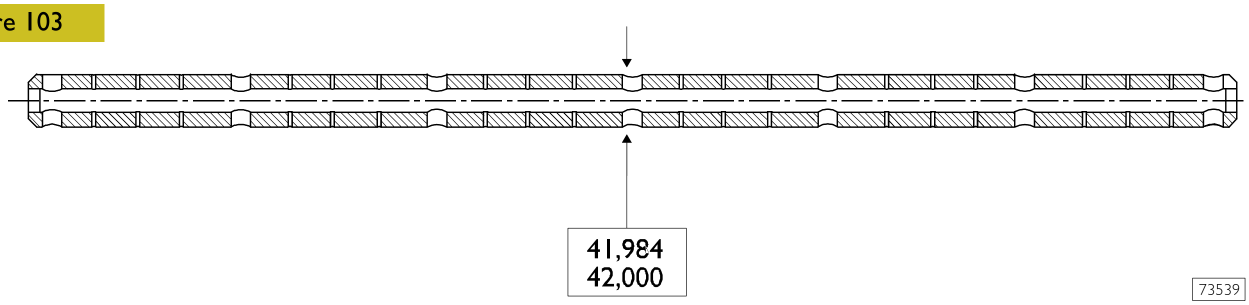
Figure 102



The cams of the camshaft control the rocker arms directly: 6 for the injectors and 12 for the valves.
The rocker arms run directly on the profiles of the cams by means of rollers.
The other end acts on a crosspiece that rests on the stem of the two valves.
There is a pad between the rocker arm adjustment screw and the crosspiece.
There are two lubrication ducts inside the rocker arms.
The length of the rocker arm shaft is basically the same as that of the cylinder head. It has to be detached to be able to reach all the parts beneath.

Shaft

Figure 103

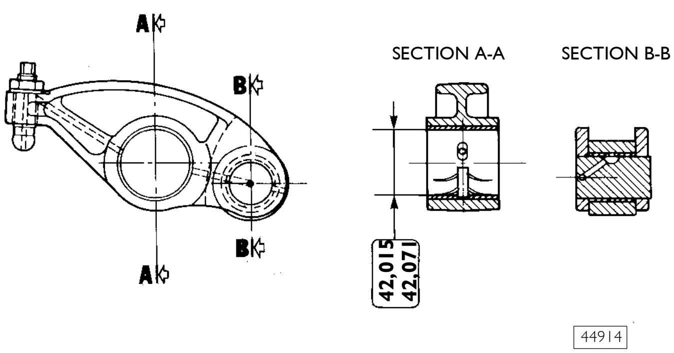


MAIN DATA OF THE ROCKER ARM SHAFT

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

Rocker arms

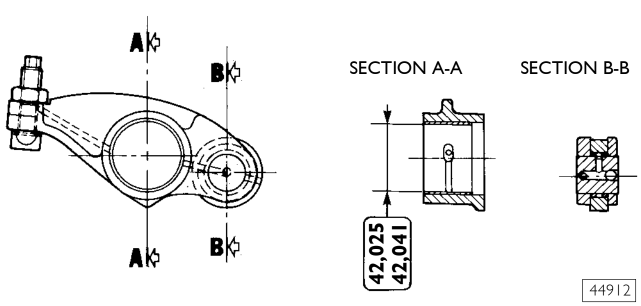
Figure 104



PUMP INJECTOR ROCKER ARMS

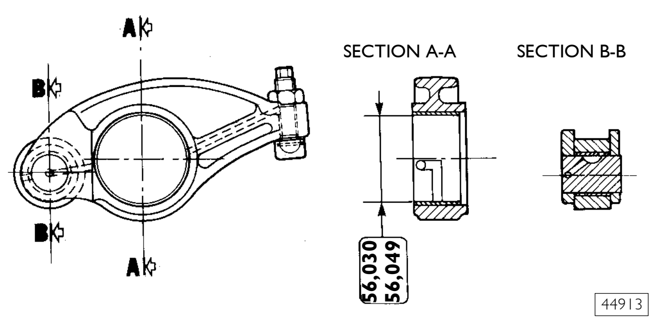
Check the surfaces of the bushings, which must show no signs of scoring or excessive wear; if they do, replace the rocker arm assembly.

Figure 105



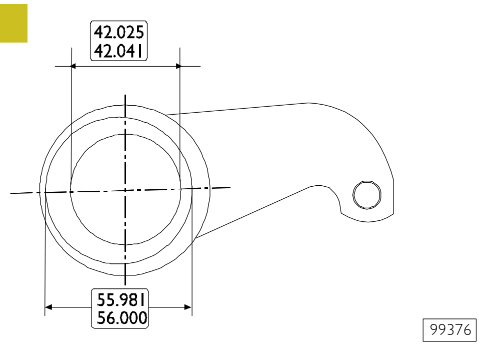
INTAKE VALVE ROCKER ARMS

Figure 106



EXHAUST VALVE ROCKER ARMS

Figure 107



EXHAUST VALVE ROCKER ARM HOLDER LEVER

TIGHTENING TORQUE

PART		TORQUE Nm	TORQUE kgm
Capscrews, undercrankcase to crankcase ♦			
M12x1.75 outer screws	Stage 1: pretightening	30	3
M 17x2 inner screws	Stage 2: pretightening	120	12
Inner screws	Stage 3: angle	90°	
Inner screws	Stage 4: angle	45°	
Outer screws	Stage 5: angle	60°	
Piston cooling nozzle union ♦		35 ± 2	3.5 ± 2
Capscrews, heat exchanger to crankcase ♦			
pretightening		11.5	1.15
tightening		19	1.9
Spacer and oil sump capscrews ♦			
pretightening		38	3.8
tightening		45	4.5
M 12x1.75 screws, gear case to crankcase ♦		63 ± 2	6.3 ± 0.7
Cylinder head capscrews ♦			
Stage 1:	pretightening	60	6
Stage 2	pretightening	120	12
Stage 3:	angle	120°	
Stage 4:	angle	60°	
Air compressor capscrews		100	10
Rocker shaft capscrew ♦			
Stage 1:	pretightening	80	8
Stage 2:	angle	60°	
Locknut, rocker adjusting screw ♦		39 ± 5	3.9 ± 0.5
Capscrews, injector securing brackets ♦		26	2.6
Capscrews, thrust plates to head ♦		19	1.9
Screw fastening the engine supporting bracket to the cylinder head			
Stage 1:	pretightening	120	12
Stage 2:	angle	45°	
Screw fastening the engine supporting bracket to the flywheel case			
Stage 1:	pretightening	100	10
Stage 2:	angle	60°	
Camshaft gear capscrews ♦			
Stage 1:	pretightening	60	6
Stage 2:	angle	60°	
Screw fixing phonic wheel to timing system gear ♦		8.5 ± 1.5	0.8 ± 0.1
Exhaust manifold capscrews •			
pretightening		32.5 ± 7.5	3.2 ± 0.7
tightening		45 ± 5	4.5 ± 0.5
Capscrews, connecting rod caps ♦			
Stage 1:	pretightening	60	6
Stage 2:	angle	60°	
Engine flywheel capscrews ♦			
Stage 1:	pretightening	120	12
Stage 2:	angle	60°	
Stage 3:	angle	30°	

♦ Before assembly, lubricate with engine oil
● Before assembly, lubricate with graphitized oil

PART			TORQUE	
			Nm	kgm
Screws fixing damper flywheel: ♦				
First phase	pre-tightening		70	7
Second phase	closing to angle		50°	
Screws fixing intermediate gear pins: ♦				
First phase	pre-tightening		30	3
Second phase	closing to angle		90°	
Screw fixing connecting rod for idle gear			25 ± 2.5	2.5 ± 0.2
Screws fixing oil pump			25 ± 2.5	2.5 ± 0.2
Screw fixing suction strainer and oil pump pipe to crankcase			25 ± 2.5	2.5 ± 0.2
Screws fixing crankshaft gasket cover			25 ± 2.5	2.5 ± 0.2
Screws fixing fuel pump/filter			37 ± 3	3.7 ± 0.3
Screw fixing control unit mount to crankcase			19 ± 3	1.9 ± 0.3
Screw fixing fuel pump to flywheel cover box			19 ± 3	1.9 ± 0.3
Screw fixing thermostat box to cylinder head			22 ± 2	2.2 ± 0.2
Screw fixing rocker cover			8.5 ± 1.5	0.8 ± 0.1
Screws and nuts fixing turbocharger •				
pre-tightening			33.5 ± 7.5	3.3 ± 0.7
tightening			46 ± 2	4.6 ± 0.2
Screws fixing water pump to crankcase			25 ± 2.5	2.5 ± 0.2
Screw fixing automatic tensioner to crankcase			50 ± 5	5 ± 0.5
Screw fixing fixed tensioner to crankcase			105 ± 5	10.5 ± 0.5
Screws fixing starter motor			74 ± 8	7.4 ± 0.8
Screws fixing air heater to cylinder head			37 ± 3	3.7 ± 0.3
Screw fixing air compressor			74 ± 8	7.4 ± 0.8
Nut fixing gear driving air compressor			170 ± 10	17 ± 10
Screw fixing alternator bracket to crankcase		L = 35 mm	30 ± 3	3 ± 0.3
		L = 60 mm	44 ± 4	4.4 ± 0.4
		L = 30 mm	24.5 ± 2.5	2.4 ± 0.2
Screws fixing guard			24.5 ± 25	2.5 ± 0.25
Filter clogging sensor fastening			55 ± 5	5.5 ± 0.5

♦ Before assembly, lubricate with engine oil
● Before assembly, lubricate with graphitized oil

PART	TORQUE	
	Nm	kgm
Pressure transmitter fastener	8 ± 2	0.8 ± 0.2
Water/fuel temperature sensor fastener	32.5 ± 2.5	3.2 ± 0.2
Thermometric switch/transmitter fastener	23 ± 2.5	2.5 ± 0.2
Air temperature transmitter fastener	32.5 ± 2.5	3.2 ± 0.2
Pulse transmitter fastener	8 ± 2	0.8 ± 0.2
Injector-pump connections fastener	1.36 ± 1.92	0.13 ± 0.19
Screw fixing electric cables	8 ± 2	0.8 ± 0.2

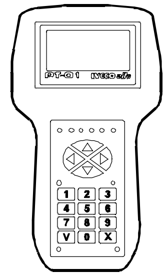
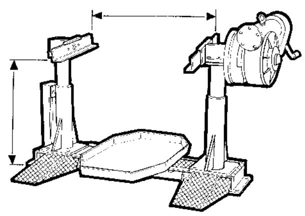
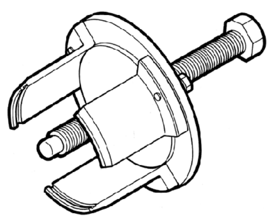
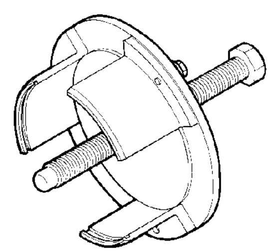
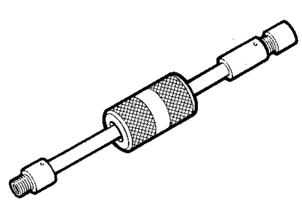
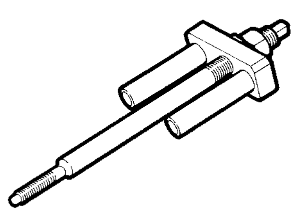
♦ Before assembly, lubricate with engine oil
● Before assembly, lubricate with graphitized oil

SECTION 5

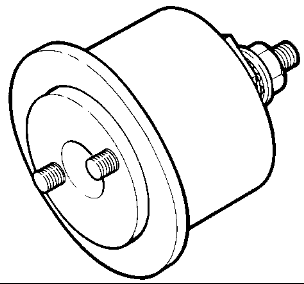
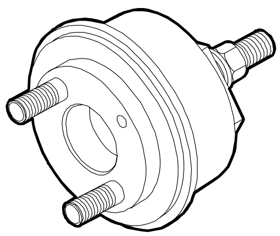
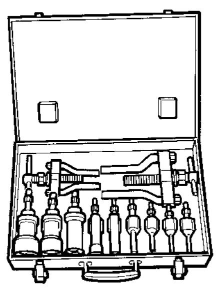
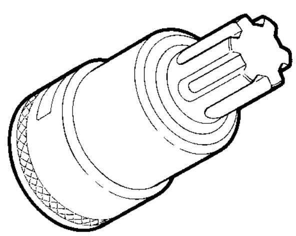
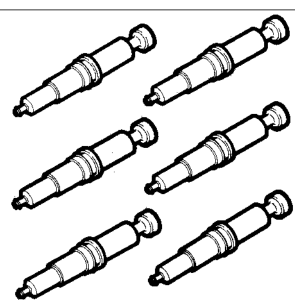
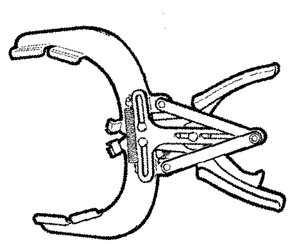
Tools

Page

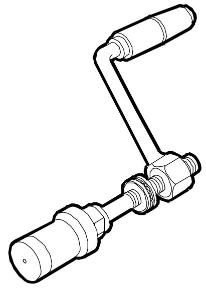
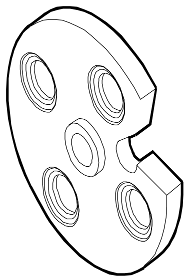
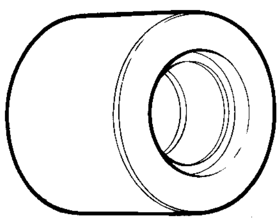
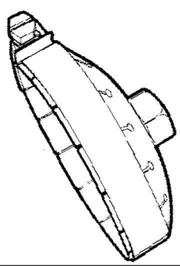
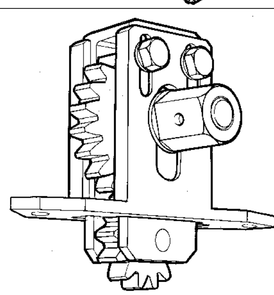
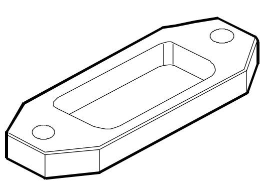
TOOLS

TOOL NO.		DESCRIPTION
8093731		Tester PT01
99322230		Rotary telescopic stand (range 2000 daN, torque 375 daNm)
99340053		Extractor for crankshaft front gasket
99340054		Extractor for crankshaft rear gasket
99340205		Percussion extractor
99342149		Extractor for injector-holder

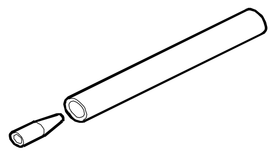
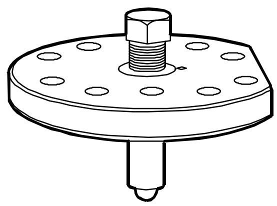
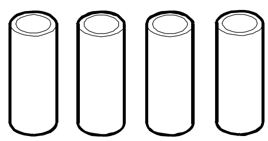
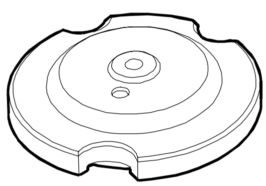
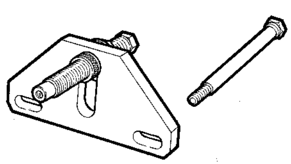
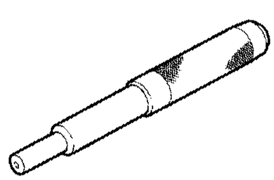
TOOLS

TOOL NO.		DESCRIPTION
99346250		Tool to install the crankshaft front gasket
99346251		Tool to install the crankshaft rear gasket
99348004		Universal extractor for 5 to 70 mm internal components
99350072		Box wrench for block junction bolts to the underblock
99360180		Injector housing protecting plugs (6)
99360184		Pliers for assembling and disassembling piston split rings (105-106 mm)

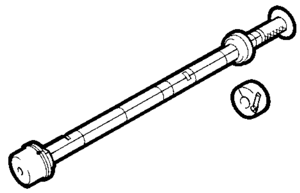
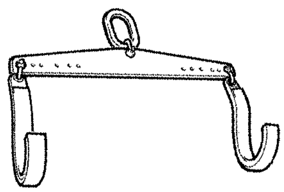
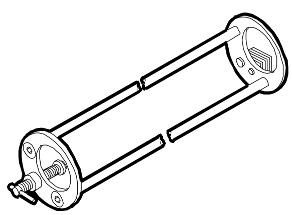
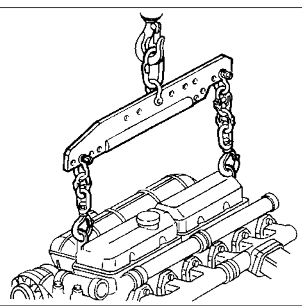
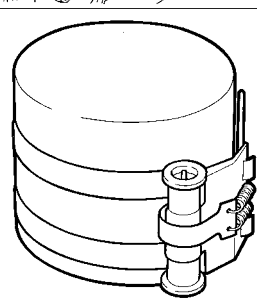
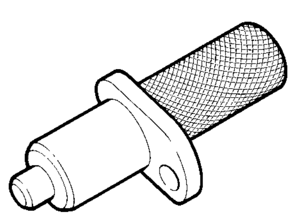
TOOLS

TOOL NO.		DESCRIPTION
99360261		Tool to take down-fit engine valves (to be used with special plates)
99360262		Plate for take down-fit engine valves (to be used with 99360261)
99360295		Tool to fit back valve guide (to be used with 99360481)
99360314		Tool to remove oil filter (engine)
99360321		Tool to rotate engine flywheel (to be used with 99360325)
99360325		Spacer (to be used with 99360321)

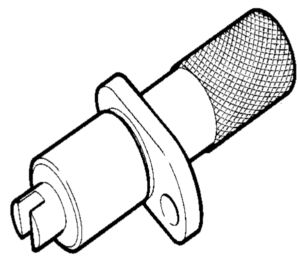
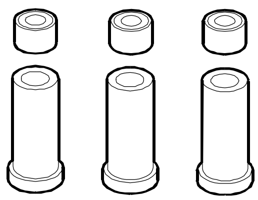
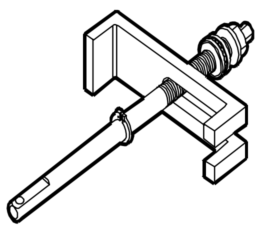
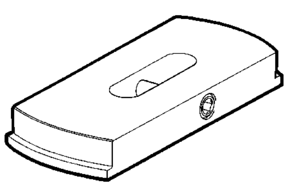
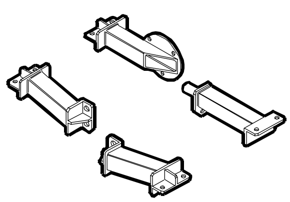
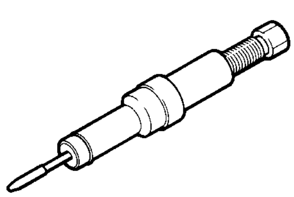
TOOLS

TOOL NO.		DESCRIPTION
99360328		Tool to install gasket on valve guide
99360334		Compression tool for checking the protrusion of cylinder liners (to be used with 99370415-99395603 and special plates)
99360336		Spacer (to be used with 99360334)
99360337		Cylinder liner compression plate (to be used with 99360334-99360336)
99360351		Tool to stop engine flywheel
99360481		Tool to remove valve guide

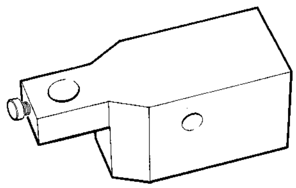
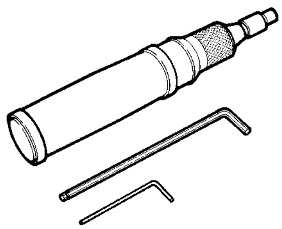
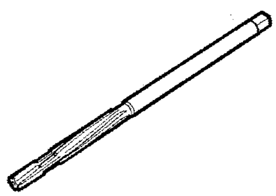
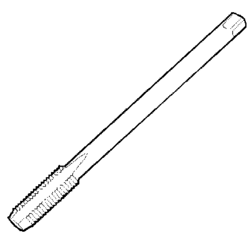
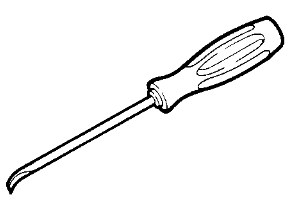
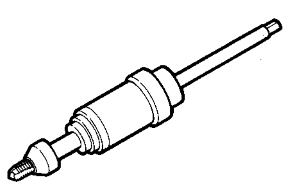
TOOLS

TOOL NO.		DESCRIPTION
99360499		Tool to take down and fit back camshaft bushes
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.

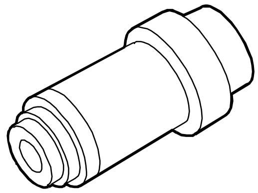
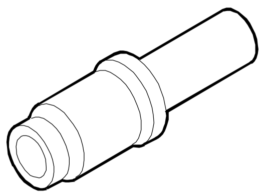
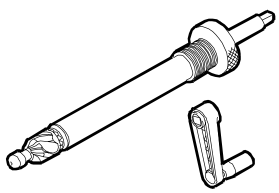
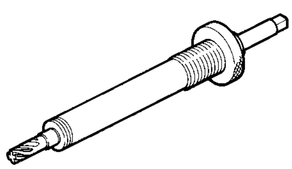
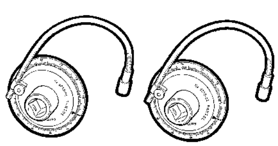
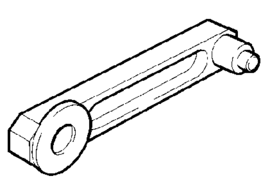
TOOLS

TOOL NO.		DESCRIPTION
99360613		Tool for timing of phonic wheel on timing gear
99360703		Tool to stop cylinder liners
99360706		Tool to extract cylinder liners (to be used with specific rings)
99360726		Ring (125 mm) (to be used with 99360706)
99361036		Brackets fixing the engine to rotary stand 99322230
99365056		Tool for injector holder heading

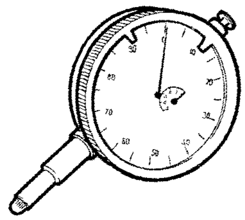
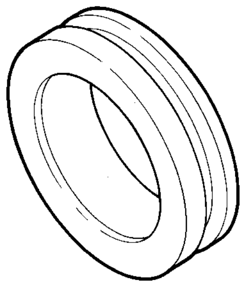
TOOLS

TOOL NO.		DESCRIPTION
99370415		Base supporting the dial gauge for checking cylinder liner protrusion (to be used with 99395603)
99389834		Torque screwdriver for calibrating the injector solenoid valve connector check nut
99390311		Valve guide sleeker
99390426		Male (M 17 x 2) - for a revision of threaded holes screw joint of cylinder heads/crank case as well as crank case/under crank case (of motor)
99390772		Tool for removing injector holding case deposits
99390804		Tool for threading injector holding cases to be extracted (to be used with 99390805)

TOOLS

TOOL NO.		DESCRIPTION
99390805		Guide bush (to be used with 99390804)
99394015		Guide bush (to be used with 99394041 or 99394043)
99394041		Cutter to rectify injector holder housing (to be used with 99394015)
99394043		Reamer to rectify injector holder lower side (to be used with 99394015)
99395216		Measuring pair for angular tightening with 1/2" and 3/4" square couplings
99395218		Gauge for defining the distance between the centres of camshaft and transmission gear

TOOLS

TOOL NO.		DESCRIPTION
99395603		Dial gauge (0 - 5 mm)
99396035		Centering ring of crankshaft front gasket cap

Appendix

SAFETY PRESCRIPTIONS
Standard safety prescriptions

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

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

- ❑ Keep working areas as clean as possible, ensuring adequate aeration.
- ❑ Ensure that working areas are provided with emergency boxes, that must be clearly visible and always provided with adequate sanitary equipment.
- ❑ Provide for adequate fire extinguishing means, properly indicated and always having free access. Their efficiency must be checked on regular basis and the personnel must be trained on intervention methods and priorities.
- ❑ Organize and displace specific exit points to evacuate the areas in case of emergency, providing for adequate indications of the emergency exit lines.
- ❑ Smoking in working areas subject to fire danger must be strictly prohibited.
- ❑ Provide Warnings throughout adequate boards signaling danger, prohibitions and indications to ensure easy comprehension of the instructions even in case of emergency.

Prevention of injury

- ❑ Do not wear unsuitable cloths for work, with fluttering ends, nor jewels such as rings and chains when working close to engines and equipment in motion.
- ❑ Wear safety gloves and goggles when performing the following operations:
  - filling inhibitors or anti-frost
  - lubrication oil topping or replacement
  - utilization of compressed air or liquids under pressure (pressure allowed: ≤ 2 bar)
- ❑ Wear safety helmet when working close to hanging loads or equipment working at head height level.
- ❑ Always wear safety shoes when and cloths adhering to the body, better if provided with elastics at the ends.
- ❑ Use protection cream for hands.
- ❑ Change wet cloths as soon as possible
- ❑ In presence of current tension exceeding 48-60 V verify efficiency of earth and mass electrical connections. Ensure that hands and feet are dry and execute working operations utilizing isolating foot-boards. Do not carry out working operations if not trained for.
- ❑ Do not smoke nor light up flames close to batteries and to any fuel material.
- ❑ Put the dirty rags with oil, diesel fuel or solvents in anti-fire specially provided containers.
- ❑ Do not execute any intervention if not provided with necessary instructions.
- ❑ Do not use any tool or equipment for any different operation from the ones they've been designed and provided for: serious injury may occur.
- ❑ In case of test or calibration operations requiring engine running, ensure that the area is sufficiently aerated or utilize specific vacuum equipment to eliminate exhaust gas. Danger: poisoning and death.

During maintenance

- ❑ Never open filler cap of cooling circuit when the engine is hot. Operating pressure would provoke high temperature with serious danger and risk of burn. Wait unit the temperature decreases under 50ºC.
- ❑ Never top up an overheated engine with cooler and utilize only appropriate liquids.
- ❑ Always operate when the engine is turned off: whether particular circumstances require maintenance intervention on running engine, be aware of all risks involved with such operation.
- ❑ Be equipped with adequate and safe containers for drainage operation of engine liquids and exhaust oil.
- ❑ Keep the engine clean from oil tangles, diesel fuel and or chemical solvents.
- ❑ Use of solvents or detergents during maintenance may originate toxic vapors. Always keep working areas aerated. Whenever necessary wear safety mask.
- ❑ Do not leave rags impregnated with flammable substances close to the engine.
- ❑ Upon engine start after maintenance, undertake proper preventing actions to stop air suction in case of runaway speed rate.
- ❑ Do not utilize fast screw-tightening tools.
- ❑ Never disconnect batteries when the engine is running.
- ❑ Disconnect batteries before any intervention on the electrical system.
- ❑ Disconnect batteries from system aboard to load them with the battery loader.
- ❑ After every intervention, verify that battery clamp polarity is correct and that the clamps are tight and safe from accidental short circuit and oxidation.
- ❑ Do not disconnect and connect electrical connections in presence of electrical feed.
- ❑ Before proceeding with pipelines disassembly (pneumatic, hydraulic, fuel pipes) verify presence of liquid or air under pressure. Take all necessary precautions bleeding and draining residual pressure or closing dump valves. Always wear adequate safety mask or goggles. Non fulfillment of these prescriptions may cause serious injury and poisoning.

- Avoid incorrect tightening or out of couple. Danger: incorrect tightening may seriously damage engine's components, affecting engine's duration.
- Avoid priming from fuel tanks made out of copper alloys and/or with ducts not being provided with filters.
- Do not modify cable wires: their length shall not be changed.
- Do not connect any user to the engine electrical equipment unless specifically approved by 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 priory removed electronic gearbox.
- Remove electronic gearbox in case of any intervention requiring heating over 80°C temperature.
- Do not paint the components and the electronic connections.
- Do not vary or alter any data filed in the electronic gearbox driving the engine. Any manipulation or alteration of electronic components shall totally compromise engine assistance warranty and furthermore may affect engine correct working and duration.

Respect of the Environment

- Respect of the Environment shall be of primary importance: all necessary precautions to ensure personnel's safety and health shall be adopted.
- Be informed and inform the personnel as well of laws in force regulating use and exhaust of liquids and engine exhaust oil. Provide for adequate board indications and organize specific training courses to ensure that personnel is fully aware of such law prescriptions and of basic preventive safety measures.
- Collect exhaust oils in adequate specially provided containers with hermetic sealing ensuring that storage is made in specific, properly identified areas that shall be aerated, far from heat sources and not exposed to fire danger.
- Handle the batteries with care, storing them in aerated environment and within anti-acid containers. Warning: battery exhalation represent serious danger of intoxication and environment contamination.

Part 2
F3B CURSOR ENGINES

PREFACE TO USER'S GUIDELINE MANUAL

Section 1 describes the F3B engine illustrating its features and working in general.

Section 2 describes the type of fuel feed.

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

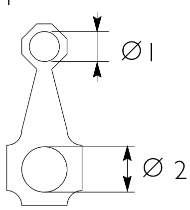
1. Mechanical part, related to the engine overhaul, limited to those components with different characteristics based on the relating specific duty.
2. Electrical part, concerning wiring harness, electrical and electronic equipment with different characteristics based on the relating specific duty.
3.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

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

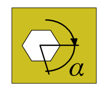
Diagrams and symbols have been widely used to give a clearer and more immediate illustration of the subject being dealt with, (see next page) instead of giving descriptions of some operations or procedures.

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

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

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UPDATING

Section	Description	Page	Date of revision

SECTION 1

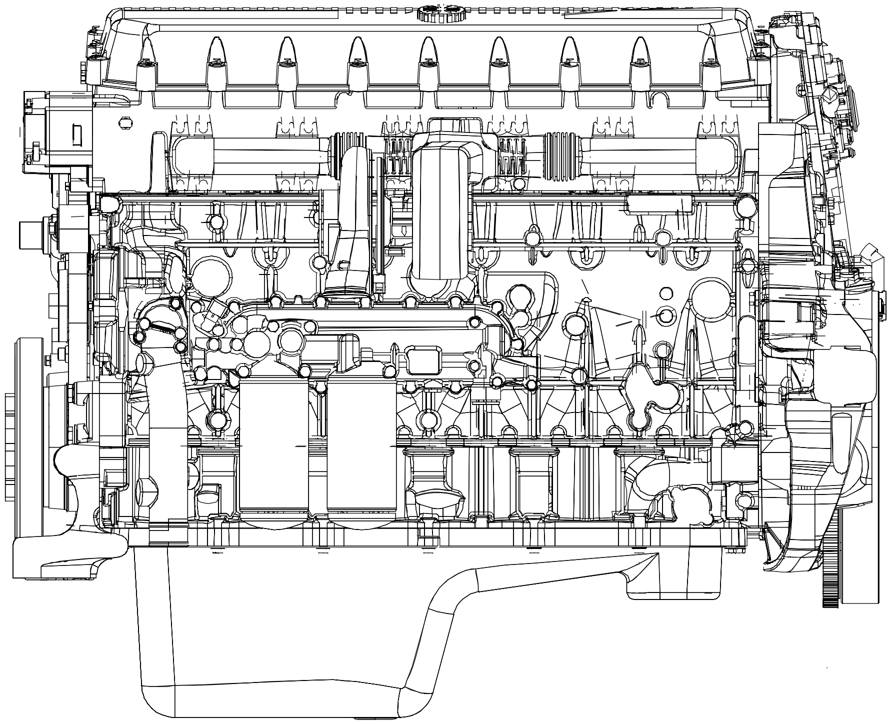
General specifications

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F3BE0684H*E901 F3BE0684G*E901 F3BE0684J*E902 F3BE9687A*E001 F3BE9687B*E001 F3BE9687C*E001	C13 ENT X

VIEWS OF ENGINE (FOR TYPES: F3BE0684H*E901 - F3BE0684G*E901)

Figure 1



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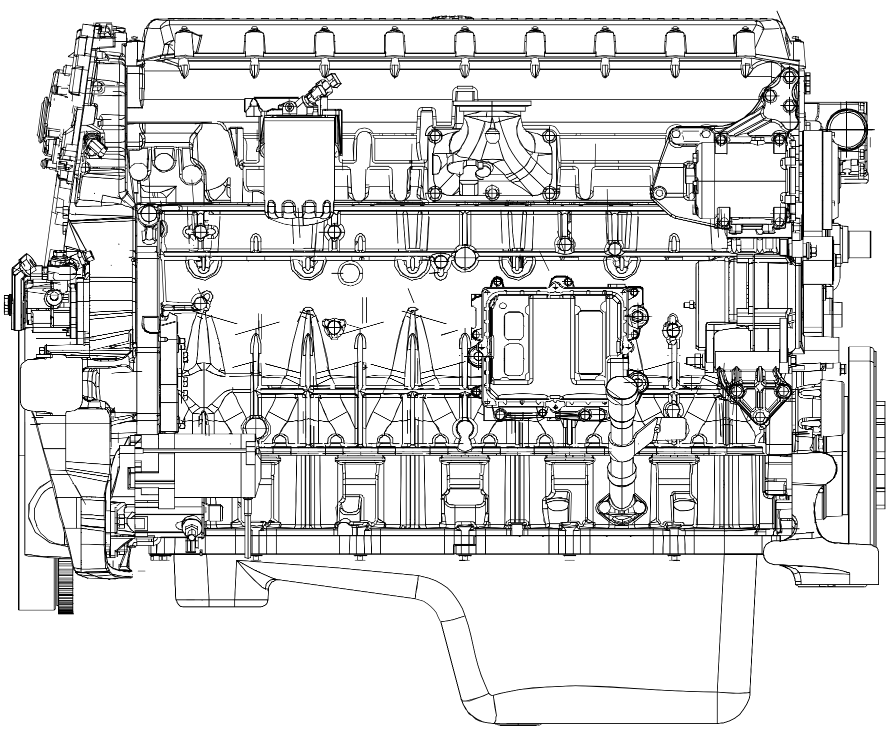
LEFT-HAND SIDE VIEW

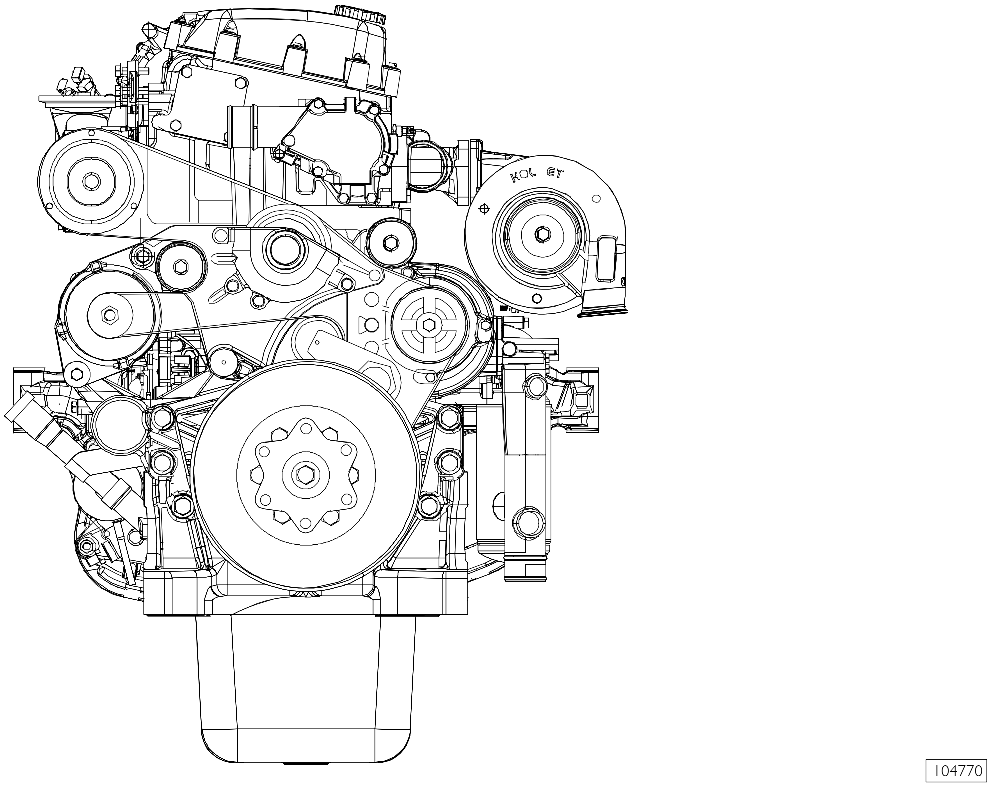
Figure 2



104769

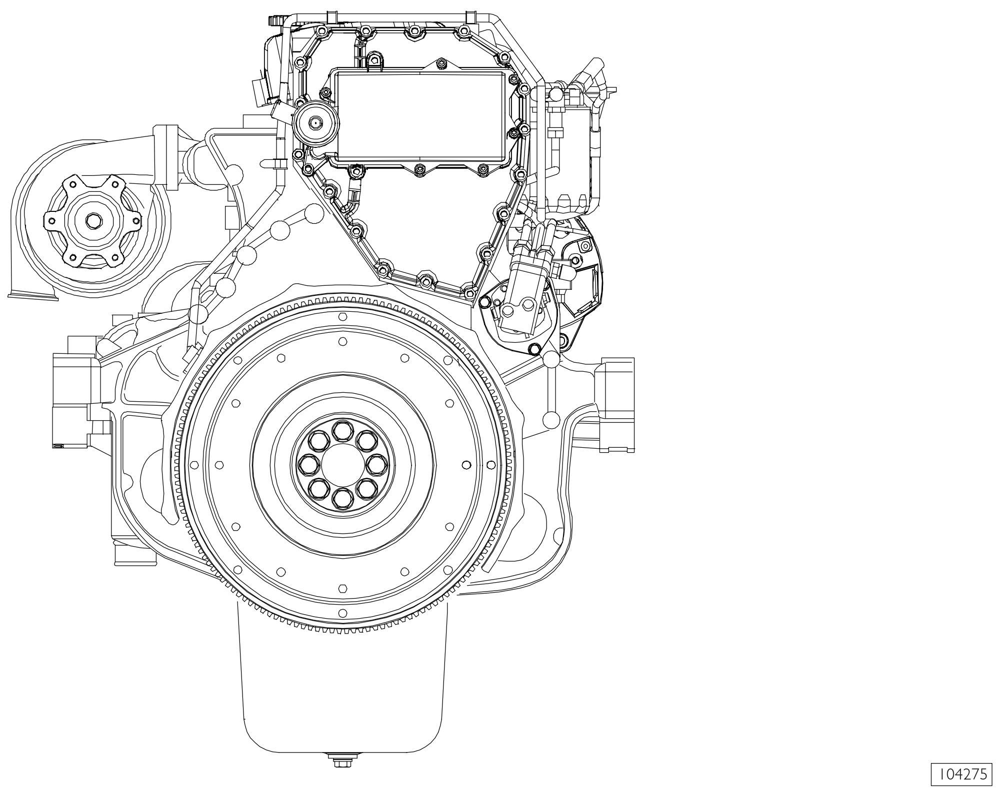
RIGHT-HAND SIDE VIEW

Figure 3



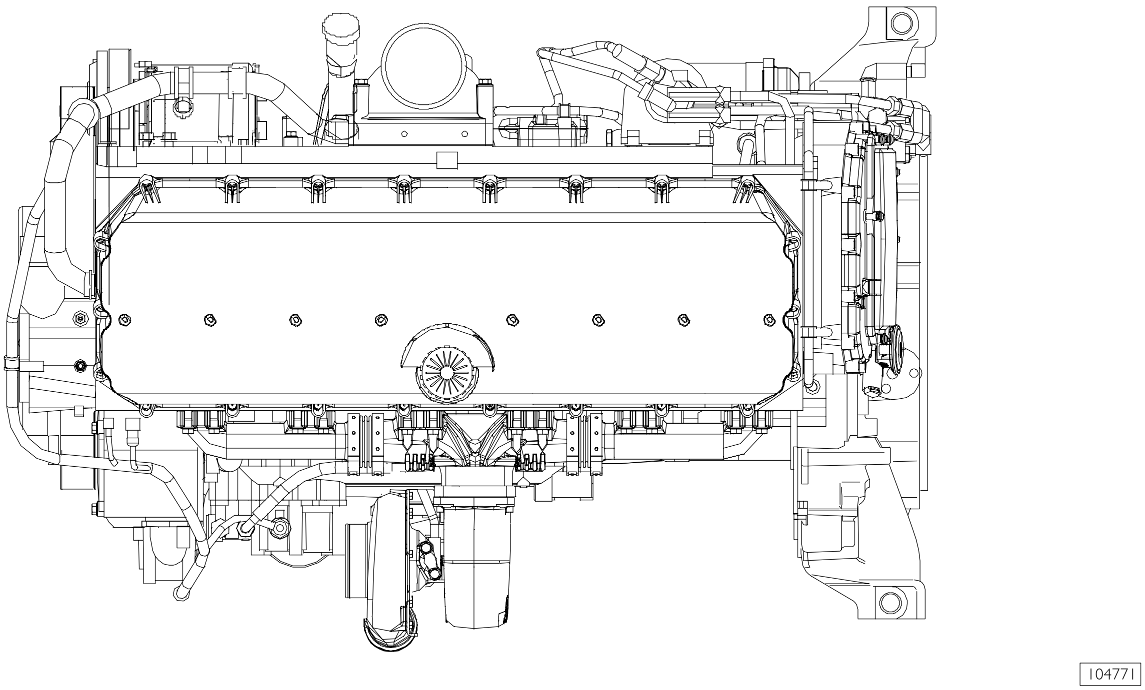
FRONT VIEW

Figure 4



REAR VIEW

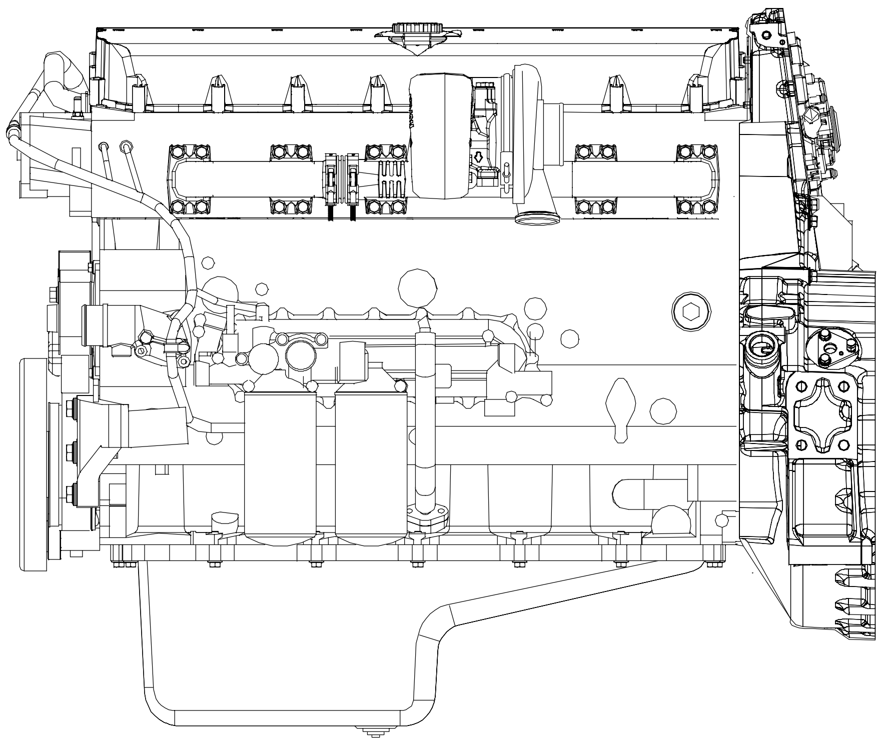
Figure 5



TOP VIEW

VIEWS OF ENGINE (ONLY FOR TYPE F3BE0684J*E902)

Figure 6



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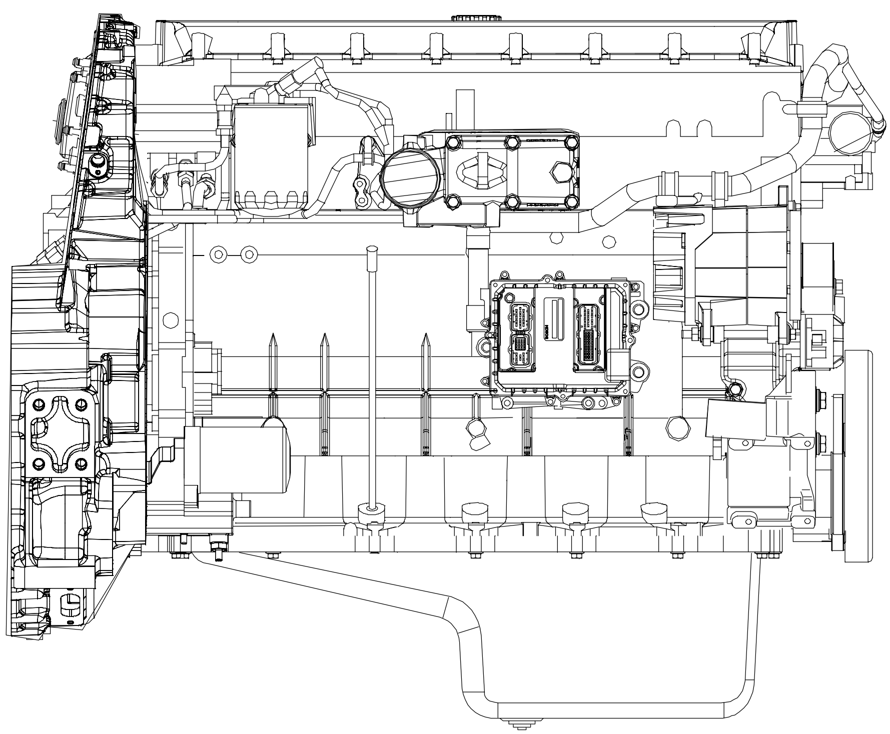
LEFT-HAND SIDE VIEW

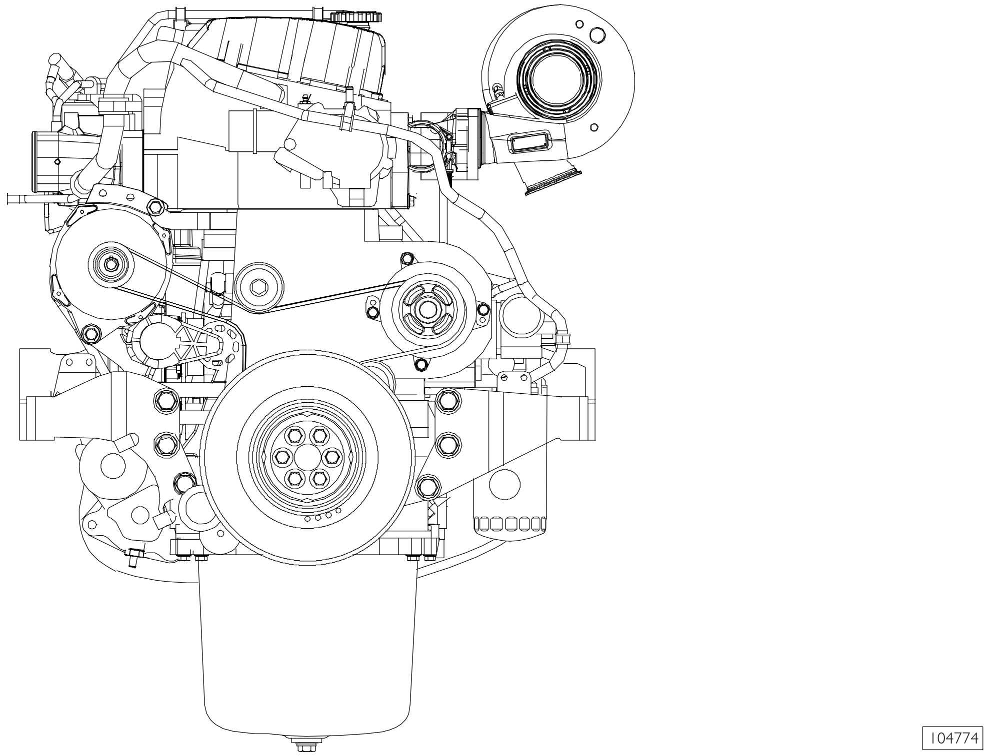
Figure 7



104773

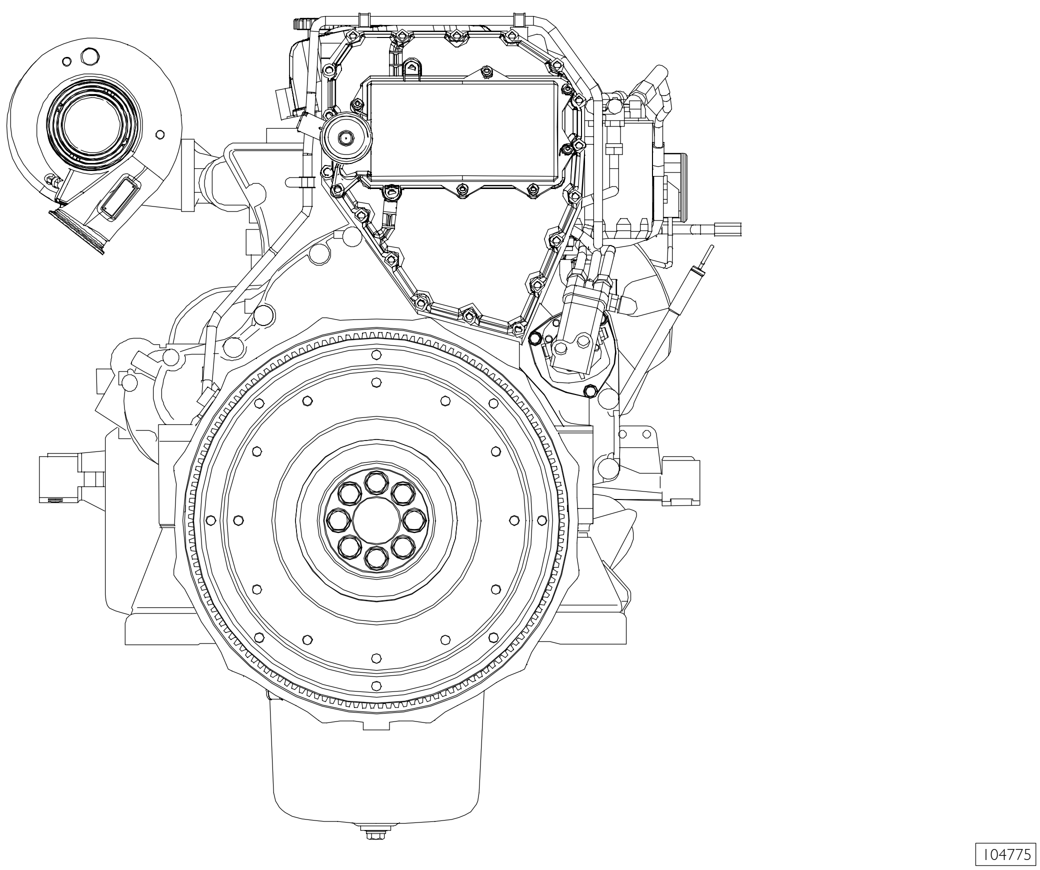
RIGHT-HAND SIDE VIEW

Figure 8



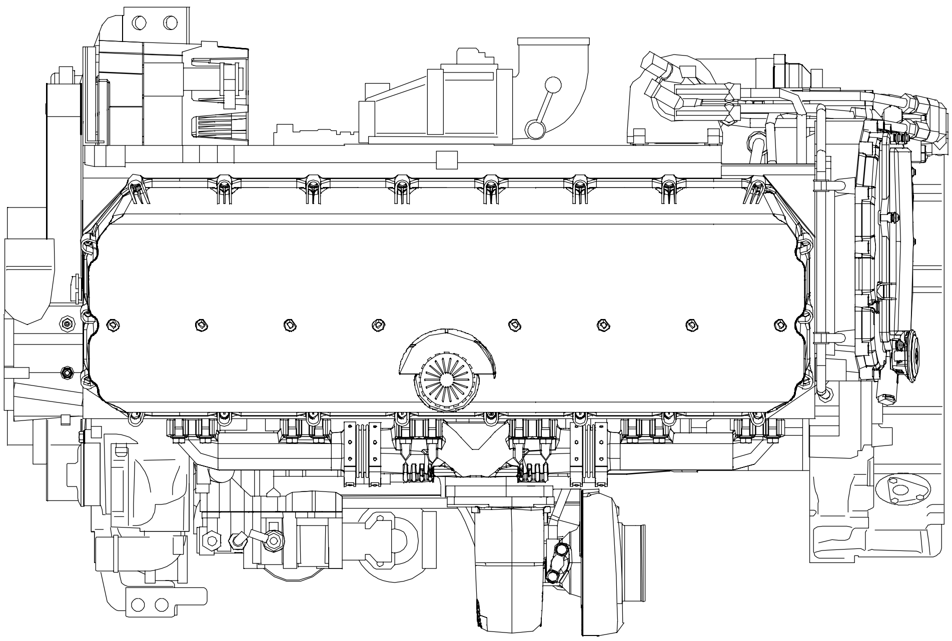
FRONT VIEW

Figure 9



REAR VIEW

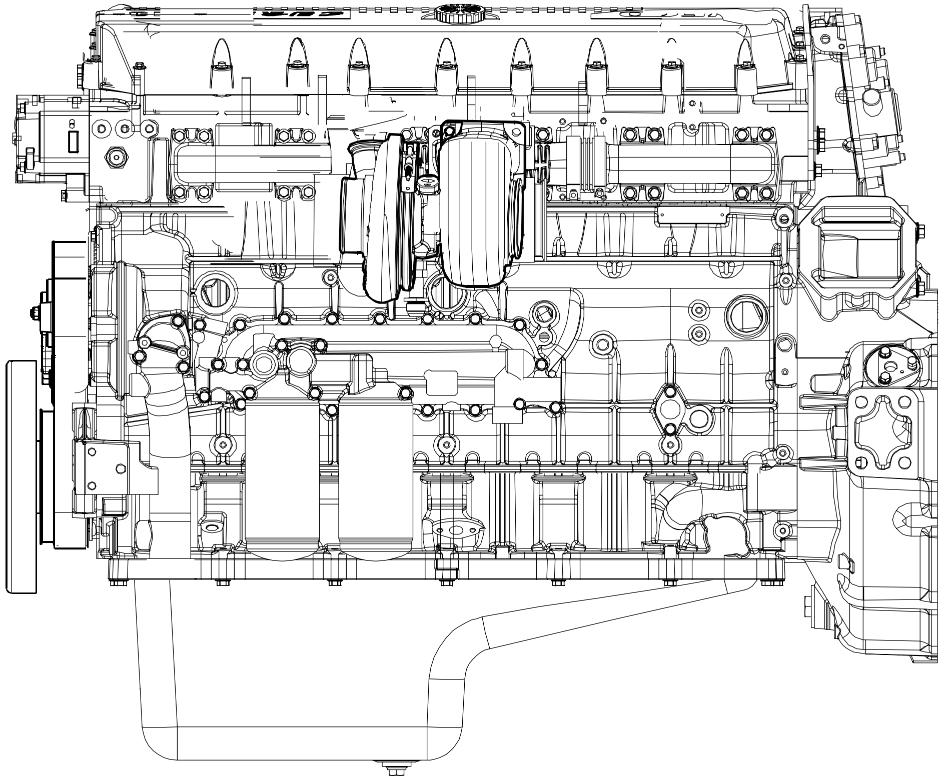
Figure 10



TOP VIEW

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

Figure 11



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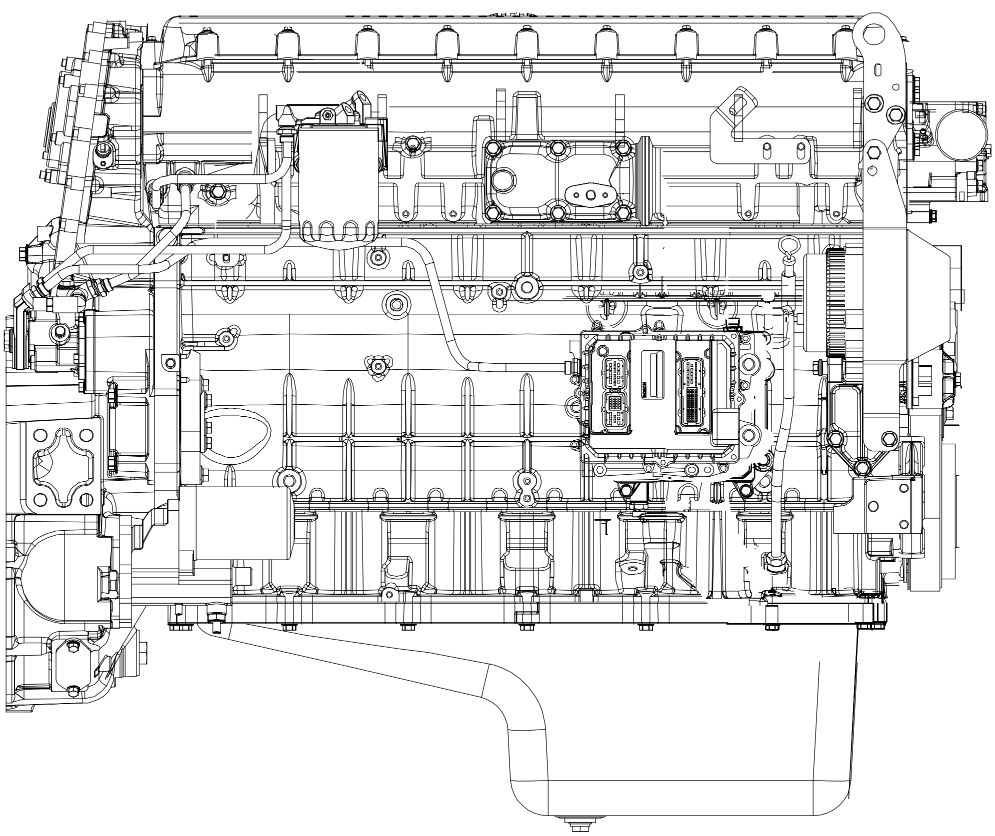
LEFT-HAND SIDE VIEW

Figure 12



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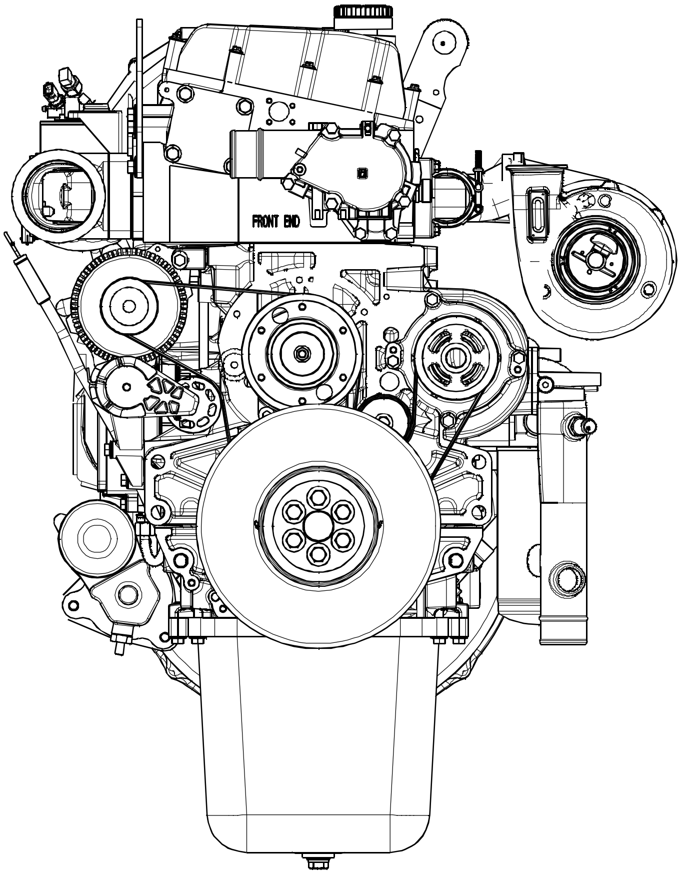
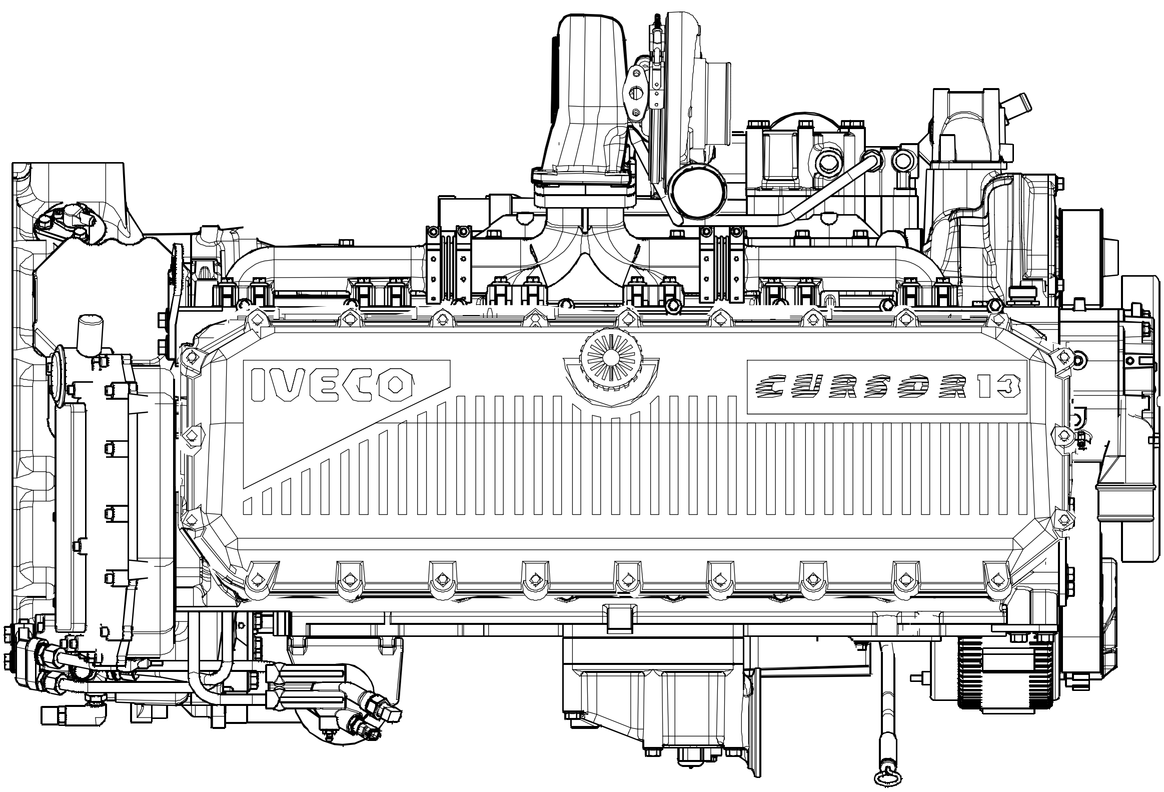
RIGHT-HAND SIDE VIEW

Figure 13



FRONT VIEW

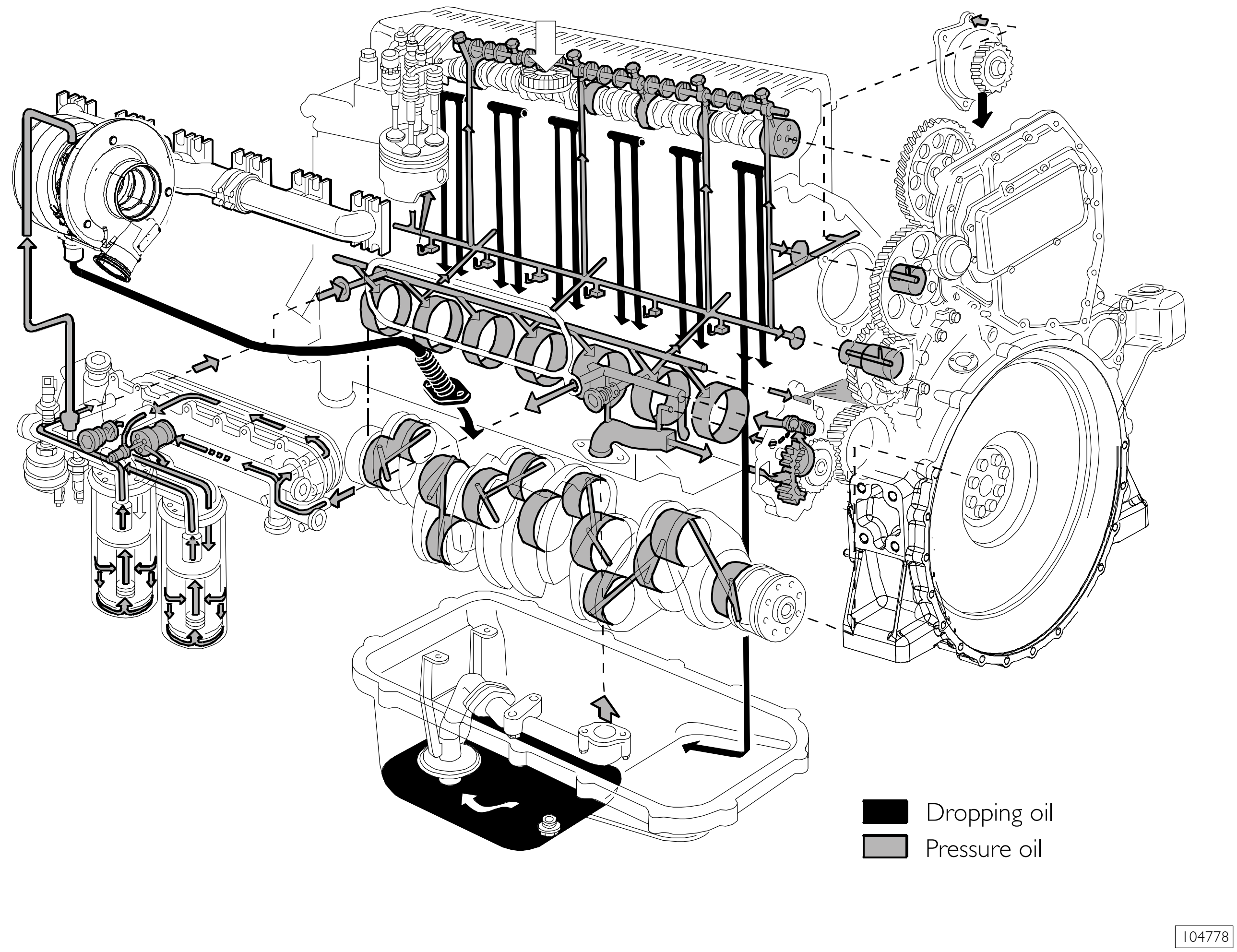
Figure 14



TOP VIEW

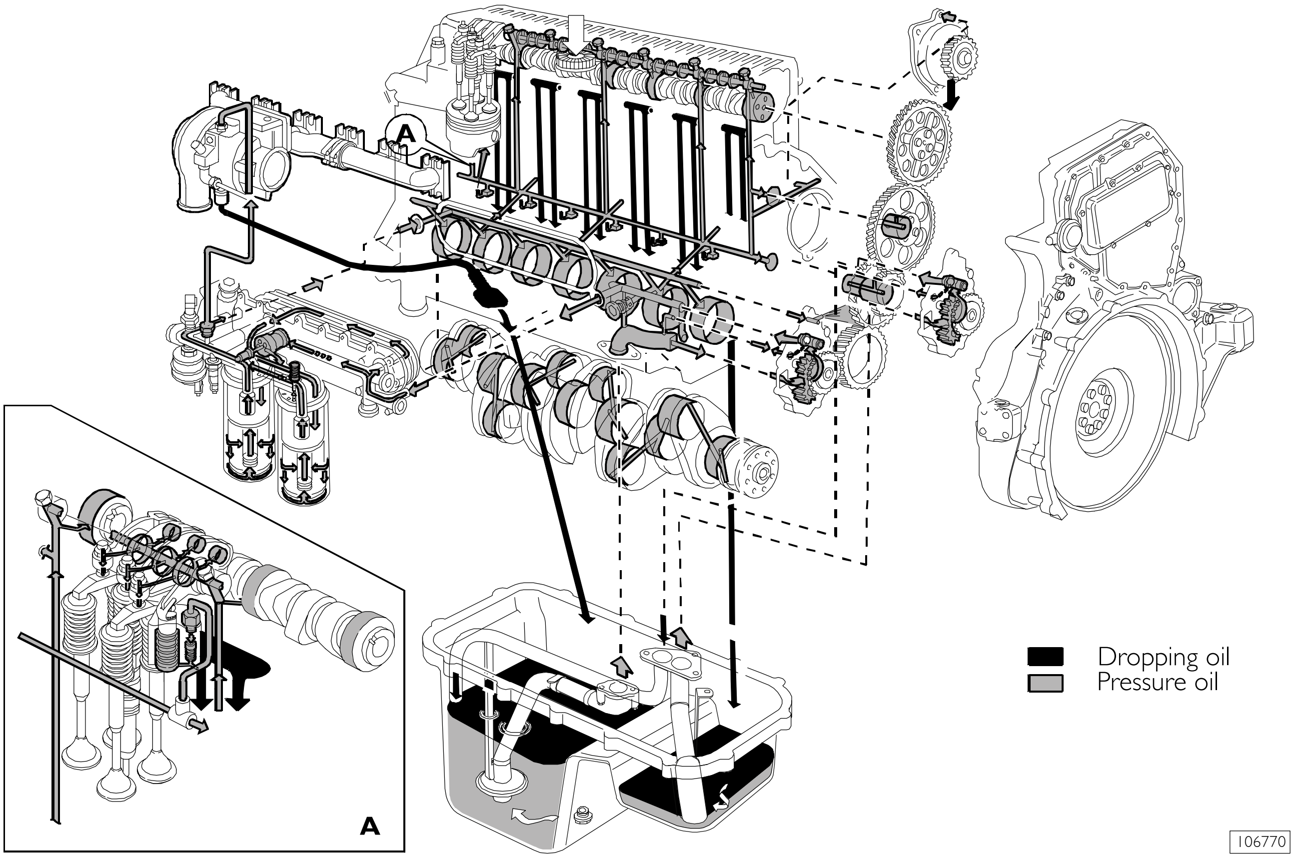
LUBRICATION DIAGRAM (ONLY FOR TYPES F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001)

Figure 15



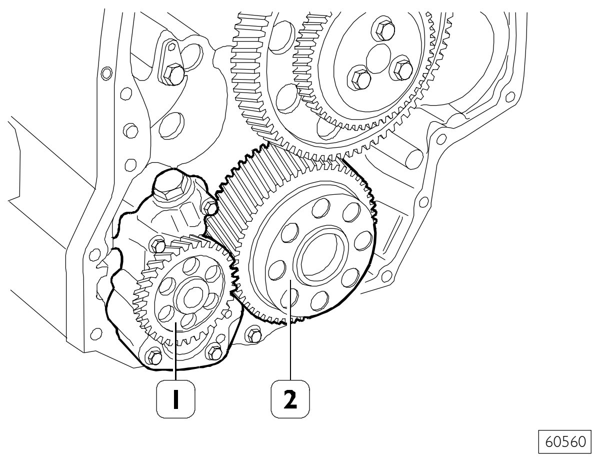
For types: (F3BE0684G*E901 - F3BE0684H*E901)

Figure 16



Oil pump

Figure 17

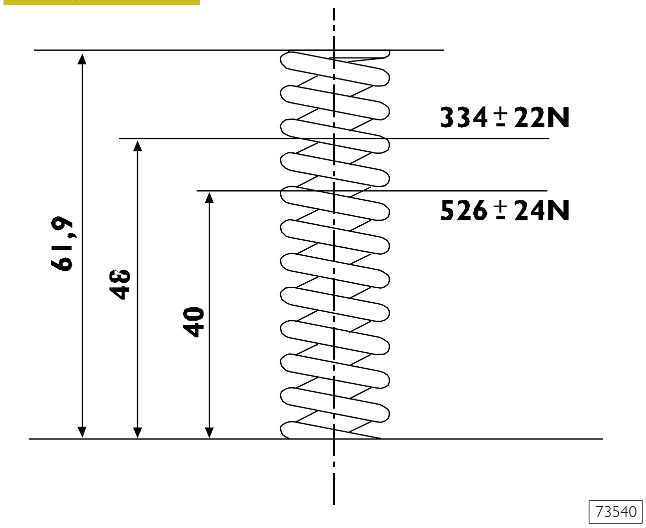


The oil pump (1) cannot be overhauled. On finding any damage, replace the oil pump assembly.

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

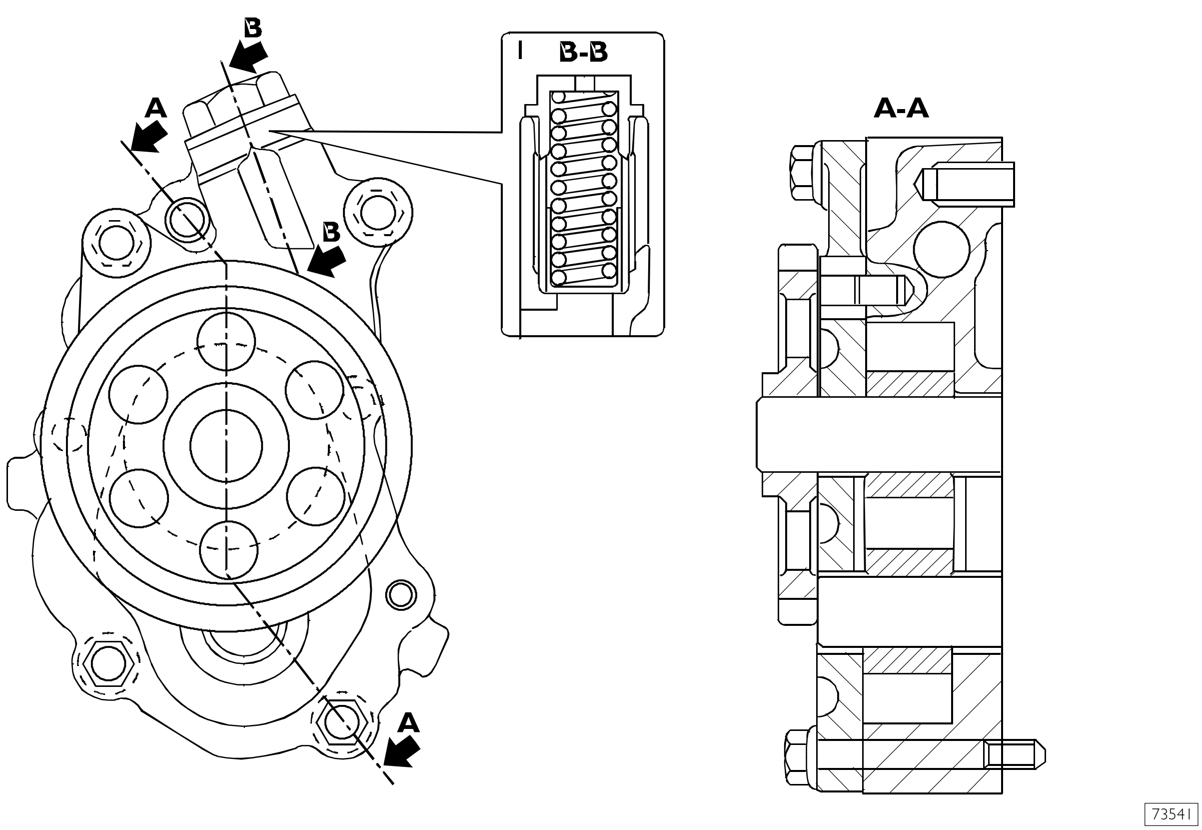
Overpressure valve

Figure 19



MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

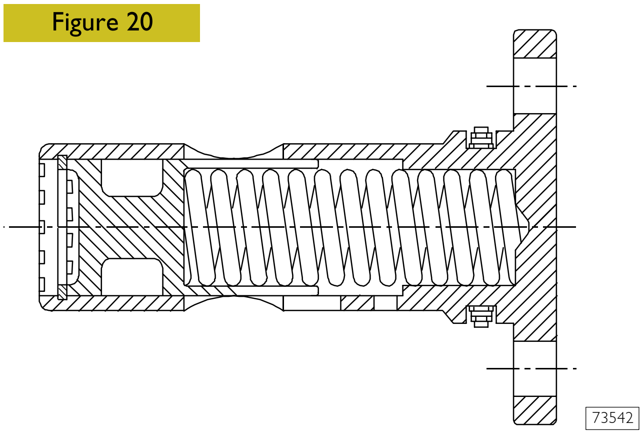
Figure 18



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

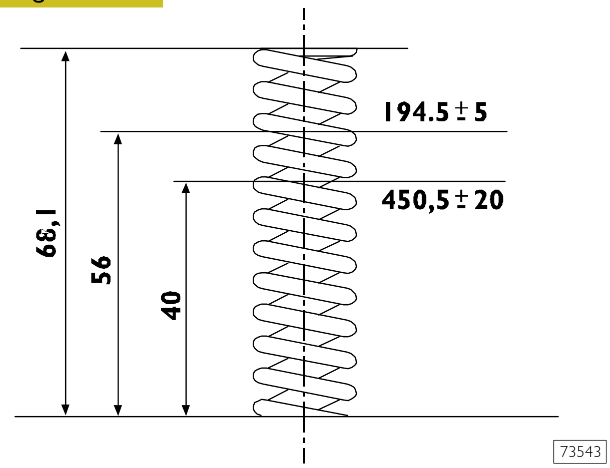
Oil pressure control valve

Figure 20



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

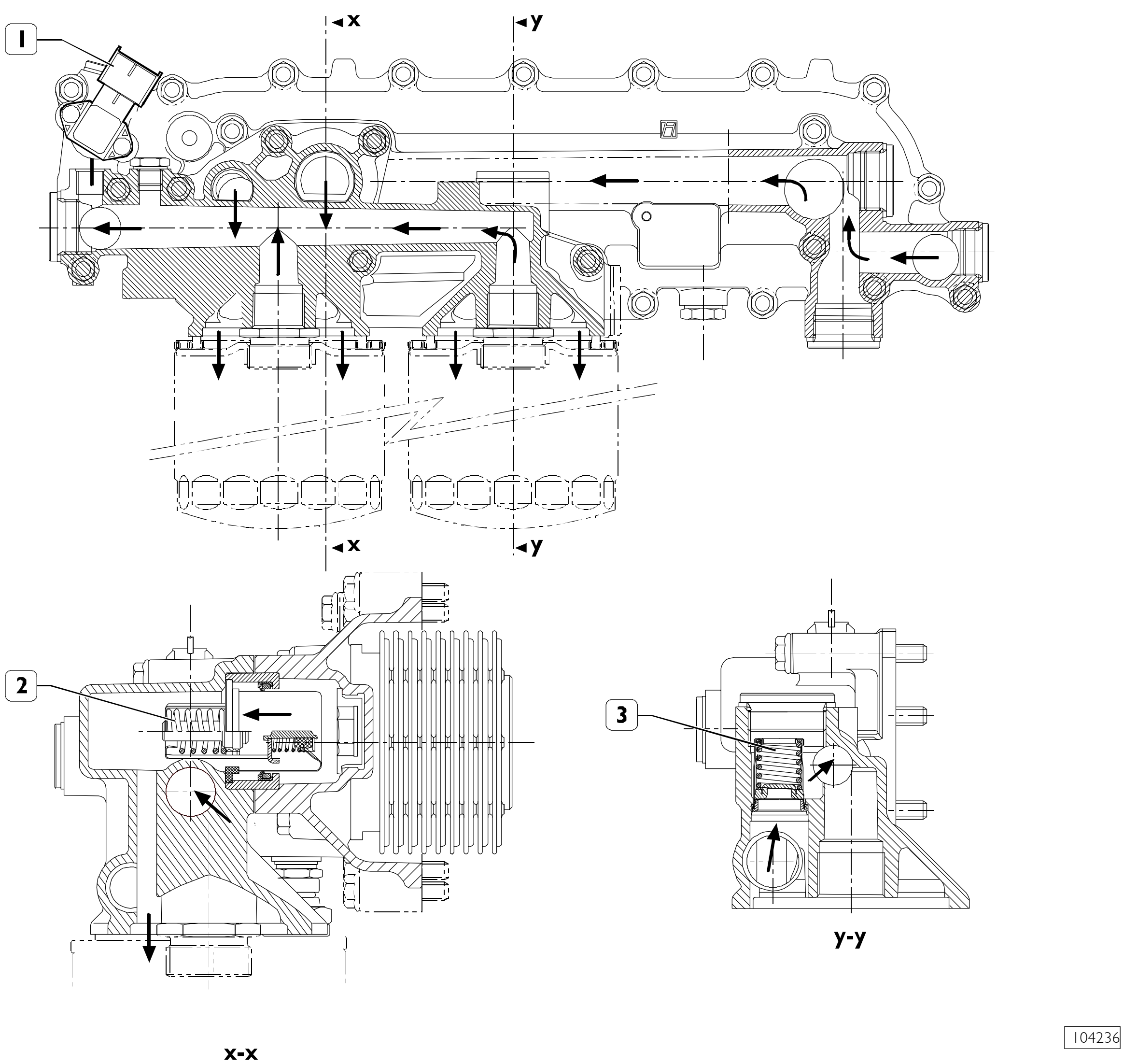
Figure 21



MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

Heat exchanger

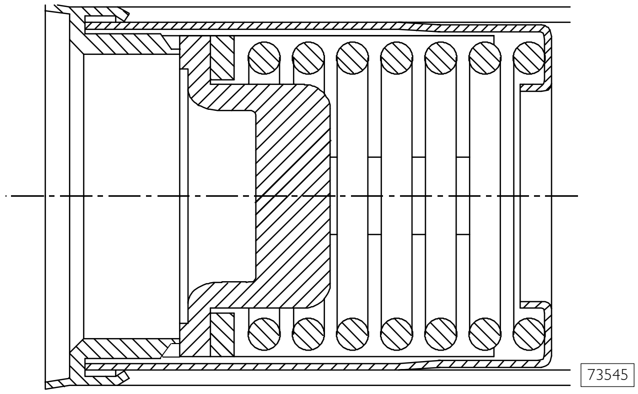
Figure 22



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

By-pass valve

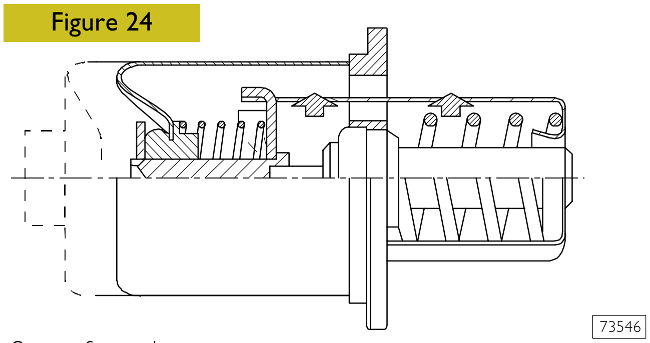
Figure 23



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

Thermostatic valve

Figure 24



Start of opening:

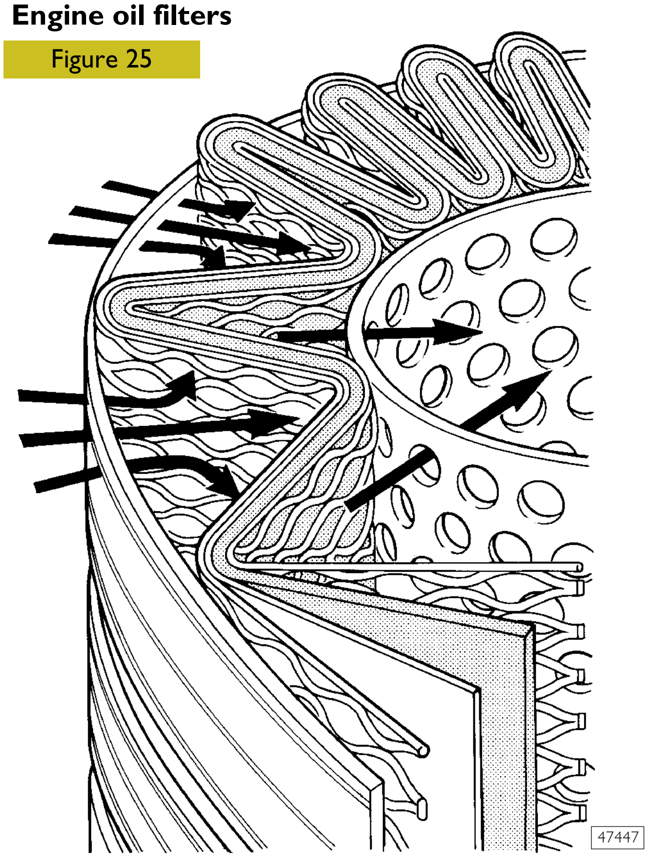
- travel 0.1 mm at a temperature of 82 ±2°C.

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 holder back a greater amount of particles of smaller dimensions than those held back by conventional filters with a paper filtering element.

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

- reduce the wear of engine components over time;
- maintain the performance/specifications of the oil and thereby lengthen the time intervals between changes.

External spiral winding

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

Mount upstream

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

Filtering element

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

Mount downstream

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

Structural parts

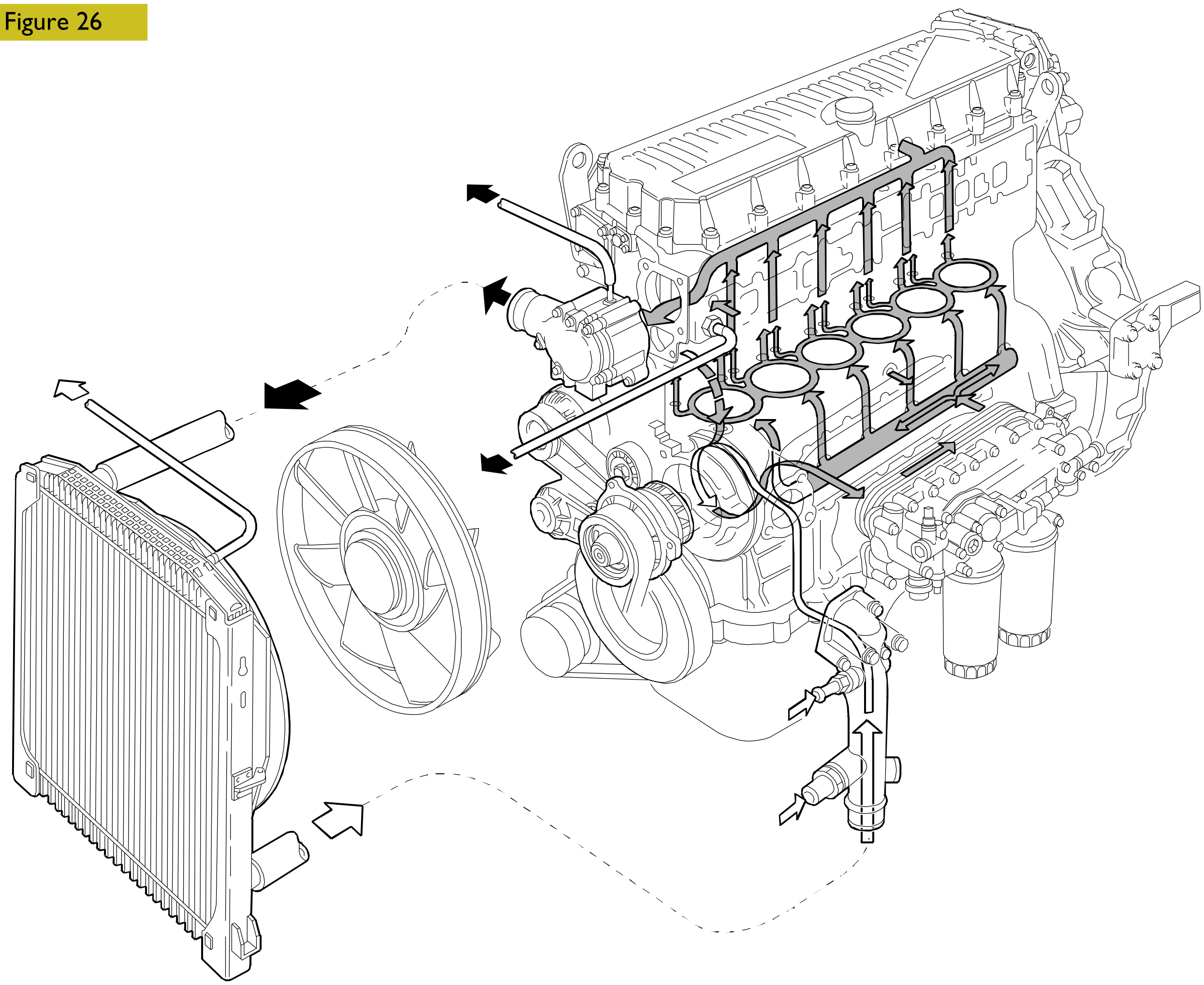
The o-rings equipping the filtering element ensure a perfect seal between it and the container, eliminating by-pass risks and keeping filter performance constant. Strong corrosion-proof bottoms and a sturdy internal metal core complete the structure of the filtering element.

When mounting the filters, keep to the following rules:

- Oil and fit new seals.
- Screw down the filters to bring the seals into contact with the supporting bases.
- Tighten the filter to a torque of 35-40 Nm.

COOLING

Figure 26



Water flowing out of the thermostat

Water circulating in the engine

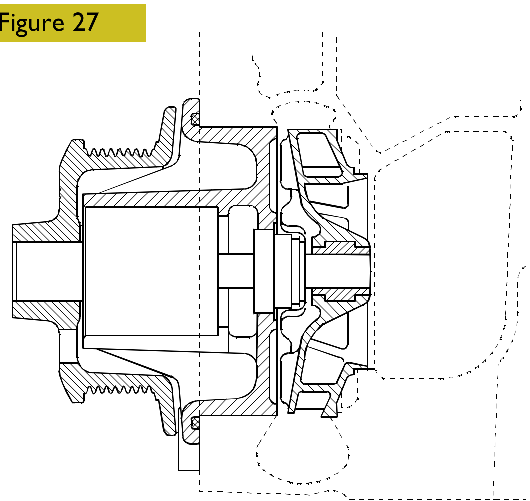
Water flowing into the pump

104278

ILLUSTRATIVE DIAGRAM

Water pump

Figure 27



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CROSS-SECTION OF THE WATER PUMP

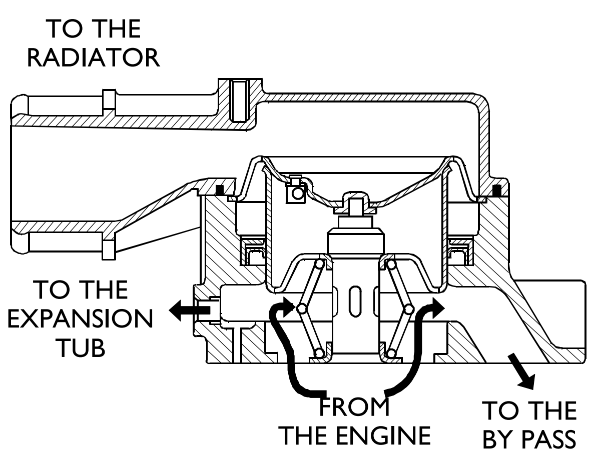
The water pump comprises: rotor, shaft with bearing. T-gasket and drive pulley.

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



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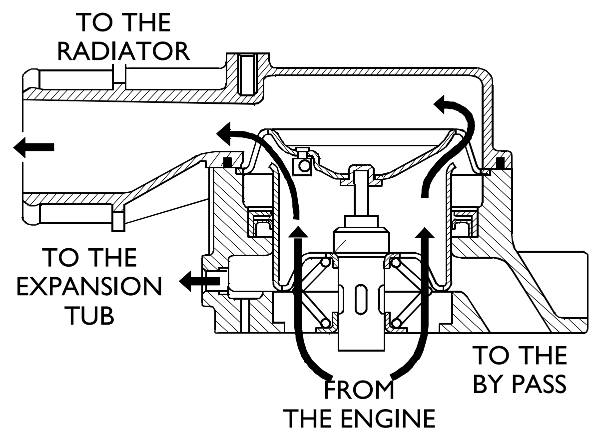
Water circulating in the engine

Figure 29



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Water leaving the thermostat

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

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

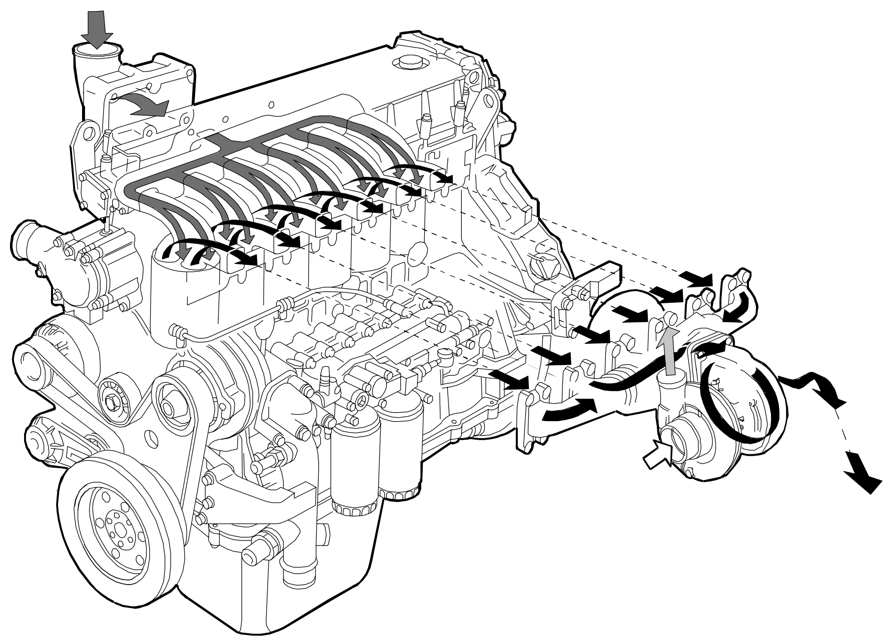
TURBOCHARGING

The turbocharging system consists of:

- ❑ air filter;
- ❑ turbocharger.

ILLUSTRATIVE DIAGRAM

Figure 30



- Exhaust gas
- Inlet air
- Compressed air (hot)
- Intake compressed air

116769

TURBOCHARGER HX55

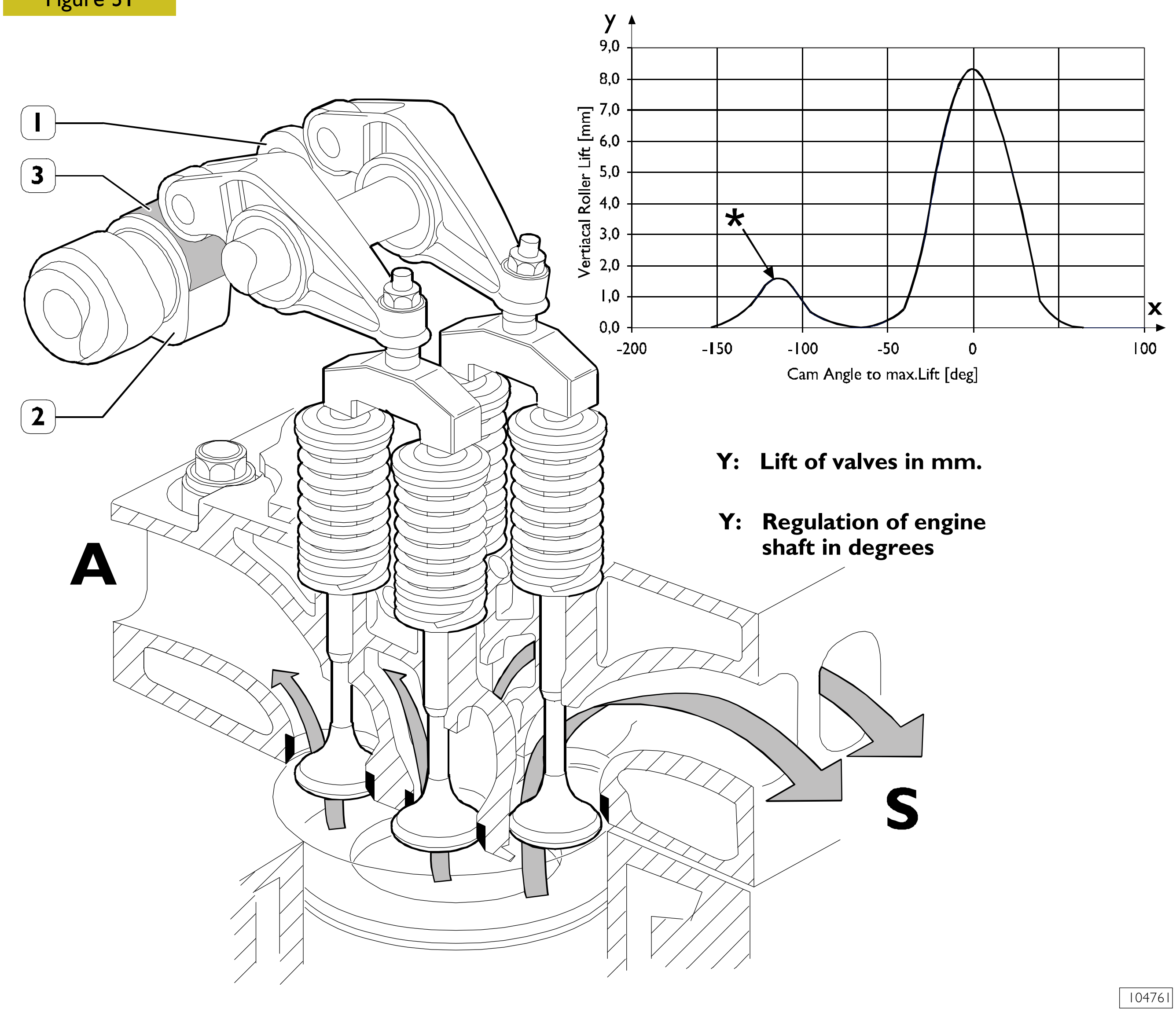
EGR EXHAUST GAS RECIRCULATION SYSTEM (ONLY FOR F3BE0684J*E902)

The exhaust gases may be partially conveyed back into the cylinders to reduce the maximum combustion temperature responsible for producing nitrogen oxides (NOx).
The exhaust gas recirculation (EGR) system, by reducing the combustion temperature, thus represents an effective NOx 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

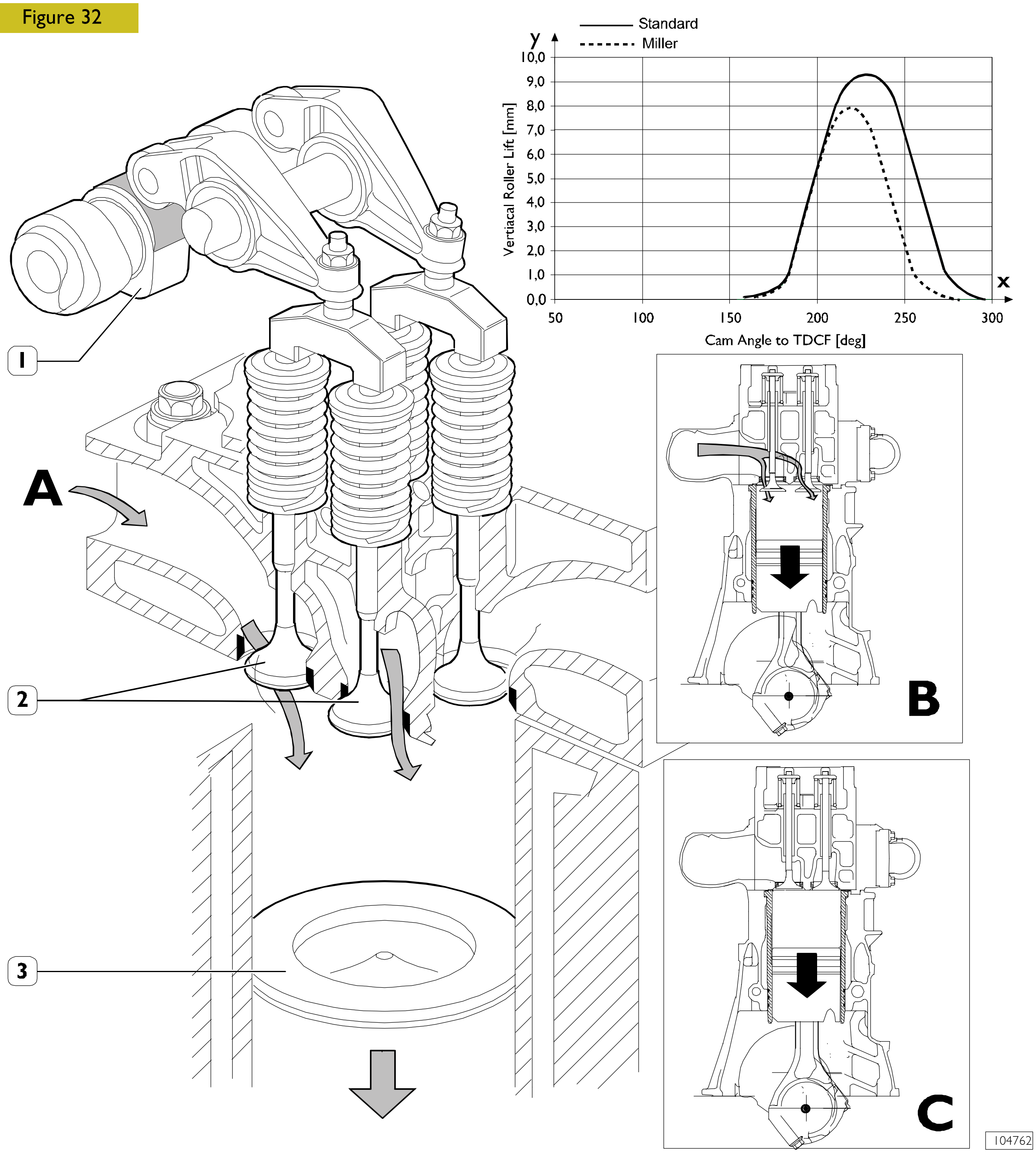


1. Exhaust cams - 2. Intake cams - 3. EGR lobe - S. Exhaust pipes - A. Intake pipes.

EARLY CLOSING SYSTEM FOR THE INTAKE VALVES ("MILLER" CYCLE) - (FOR TYPES F3BE0684H*E901 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001)

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

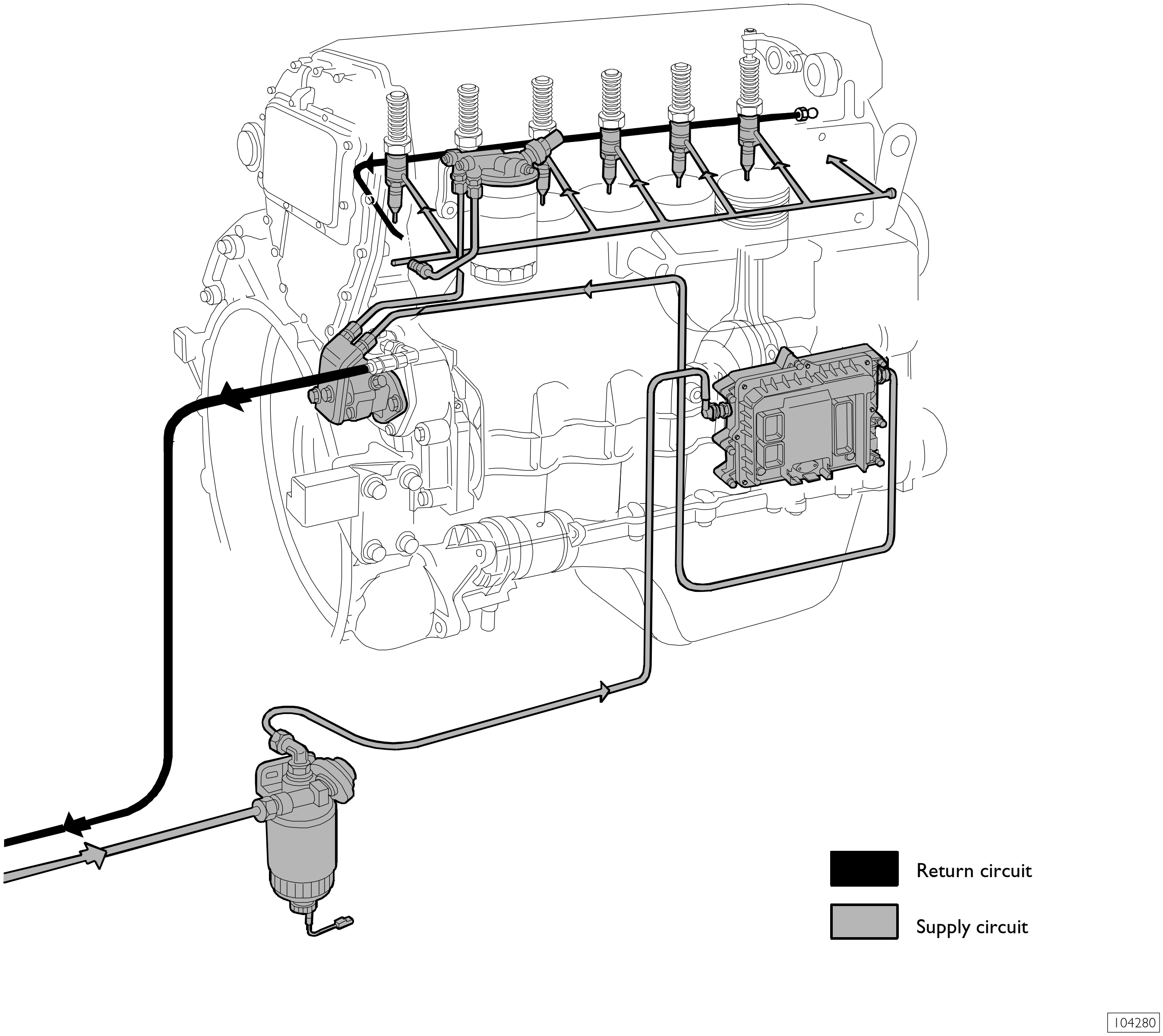
SECTION 2

Fuel

FEEDING

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

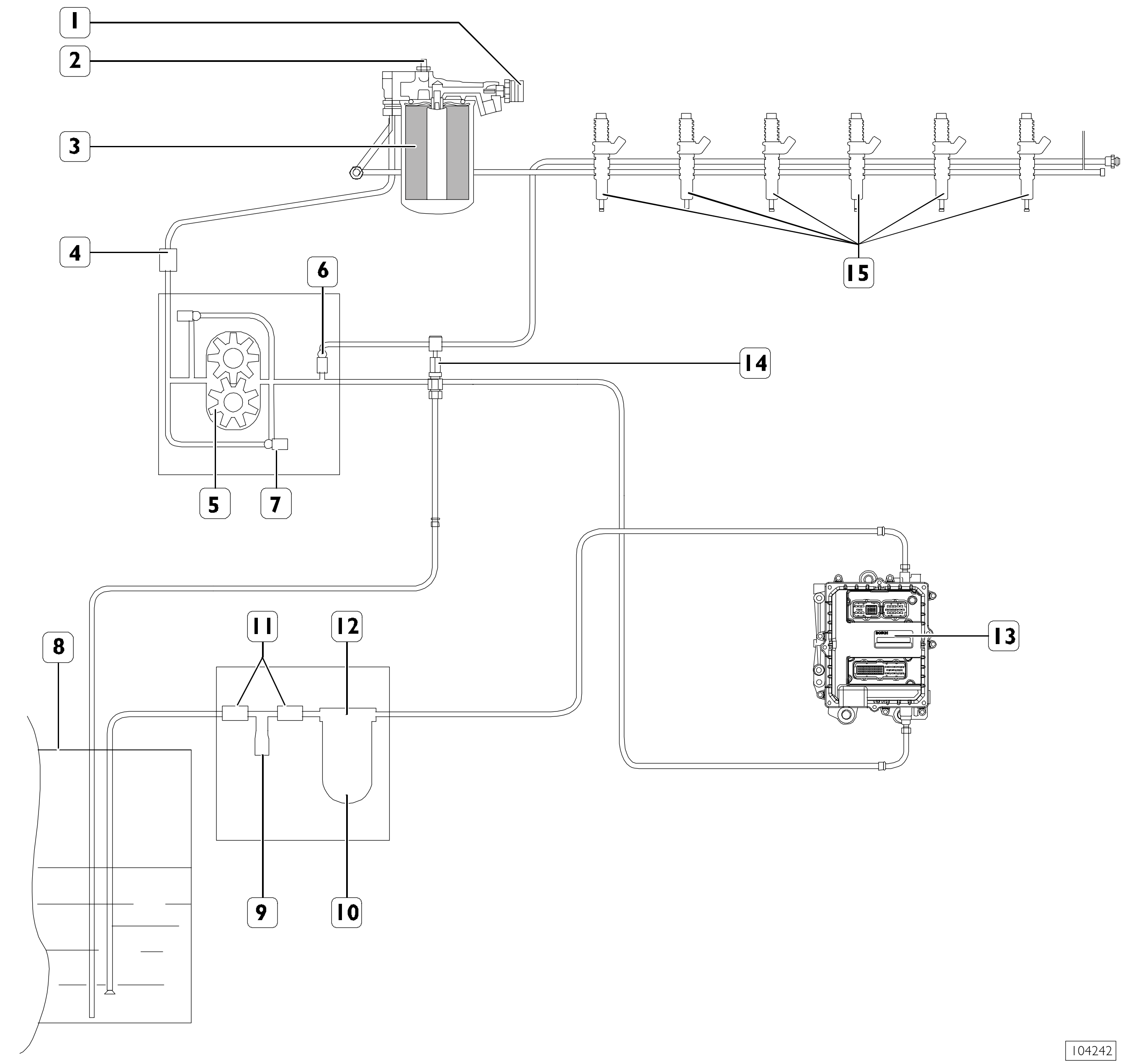
Figure 1



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

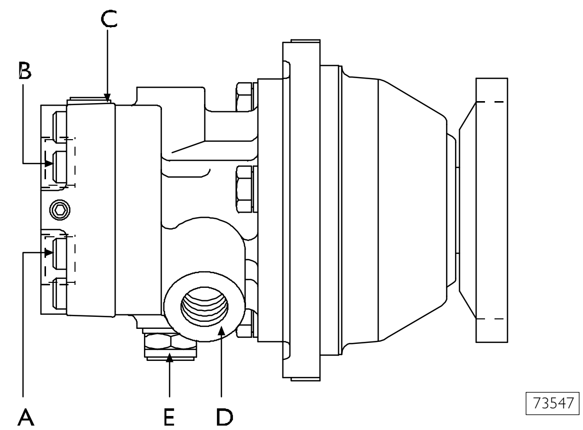
Figure 2



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.

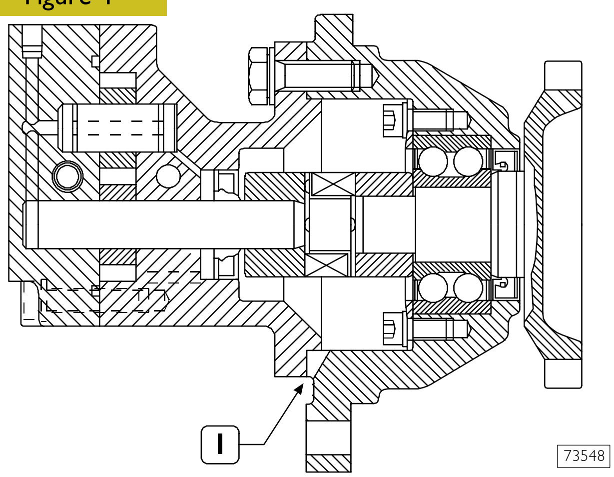
Fuel pump

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.

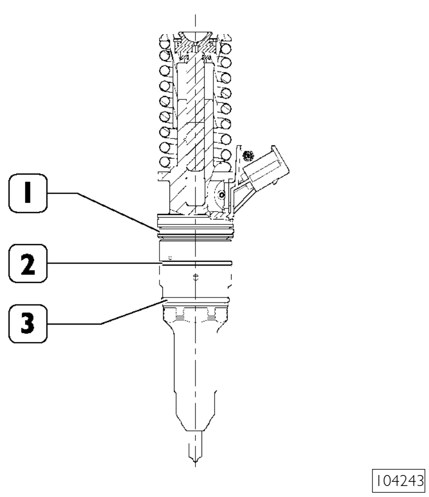
Figure 4



CROSS-SECTION OF THE FUEL PUMP
1. 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.

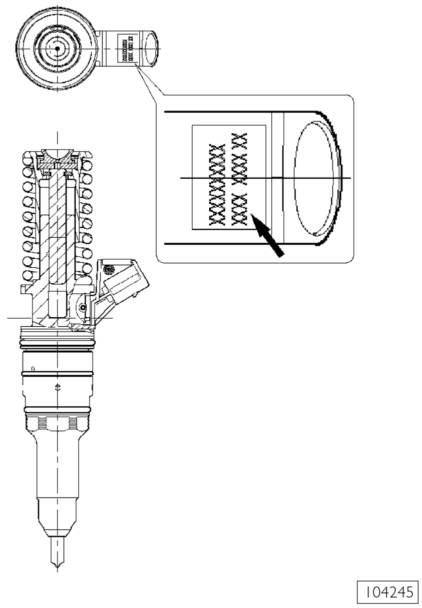
Nozzle

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



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.

SECTION 3

Industrial application

Page

CLEARANCE DATA

Type		F3BE0684H*E901	F3BE0684G*E901	F3BE0684J*E902
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 Displacement	mm cm^3	135 x 150 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

		F3BE9687		
	Type	A*E001	B*E001	C*E001
ρ	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 Displacement cm^3	135 x 150 12880		
	SUPERCHARGING	DIRECT INJECTION INTERCOOLER		
	Turbocharger type	HOLSET HX 55		
bar	**LUBRICATION**	Forced by means of gear pump, pressure relief valve, oil filter		
	Oil pressure (warm engine)			
	- idling bar	-		
	- peak rpm bar	-		
	COOLING Water pump control	Liquid 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.

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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.

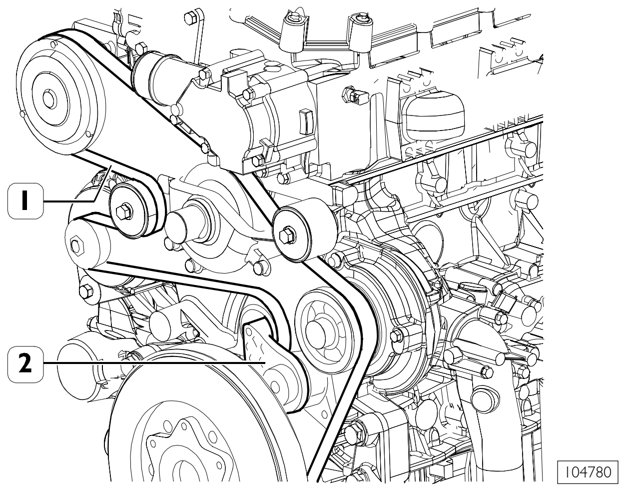
Cover all electrical components before washing with high-pressure water jets.

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.

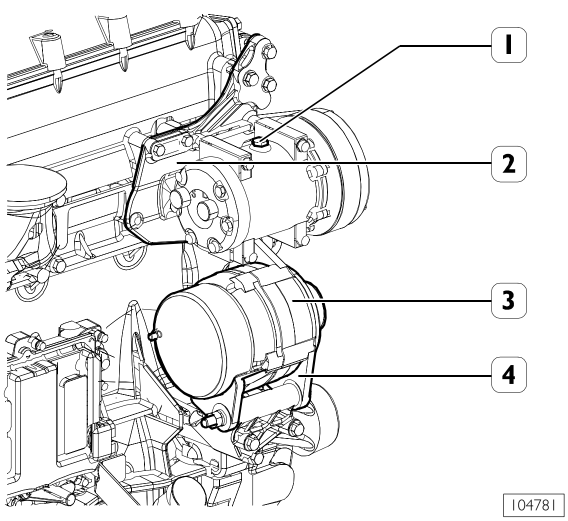
Only for the types: F3BE0684H*E901 and F3BE0684G*E901

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

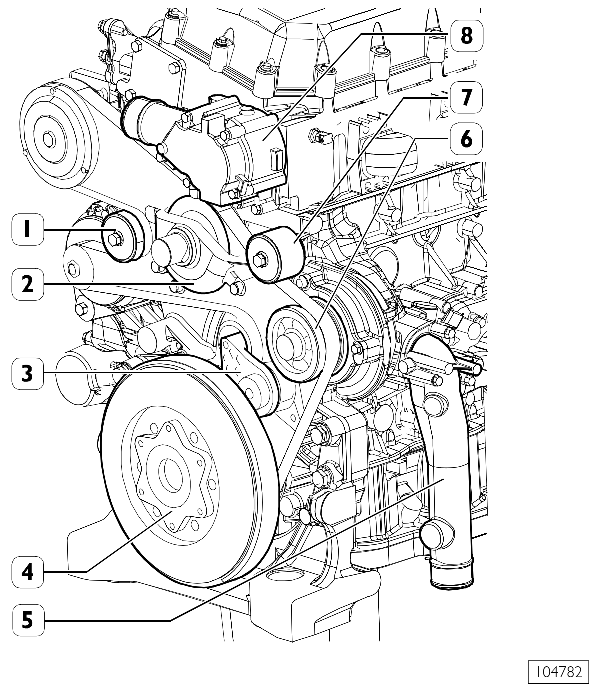


Loosen the locking screws and remove the compressor (1) complete with its support (2) from the engine.

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

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

Figure 3

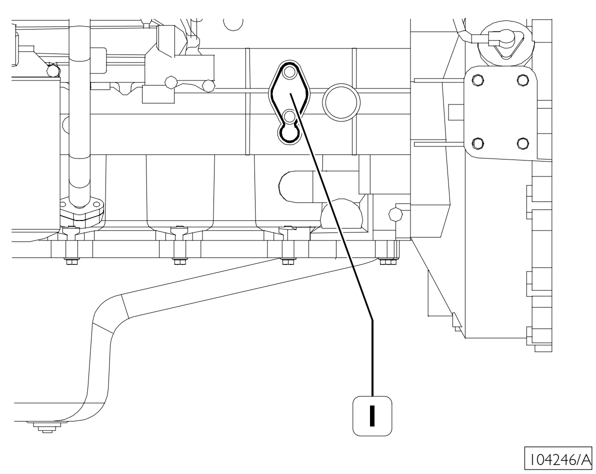


Remove:

- 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).

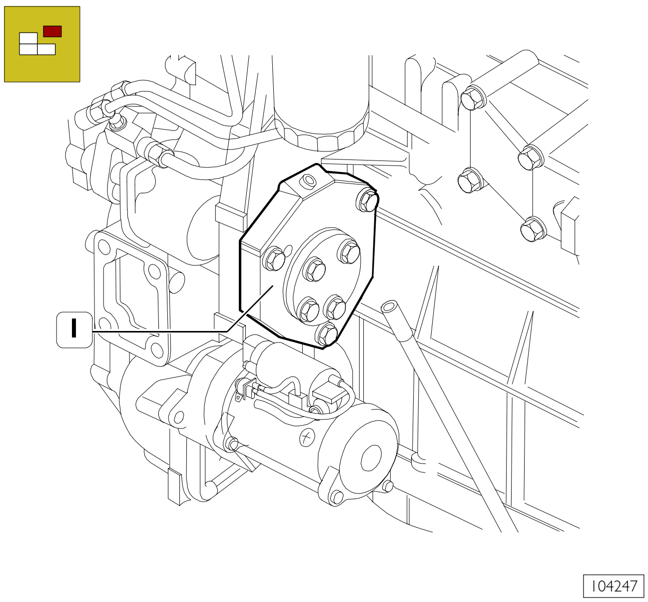
For all types

Figure 4



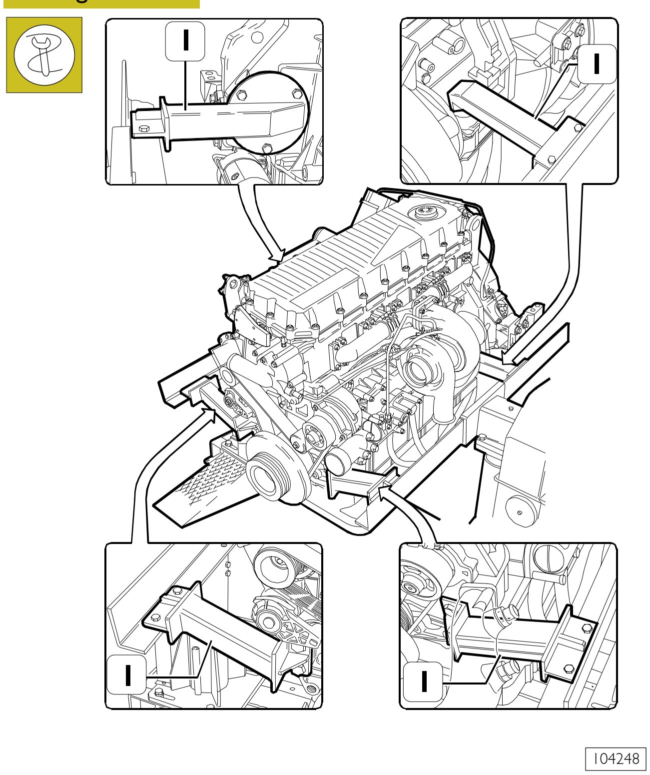
- Remove the oil pressure regulating valve (1).

Figure 5



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

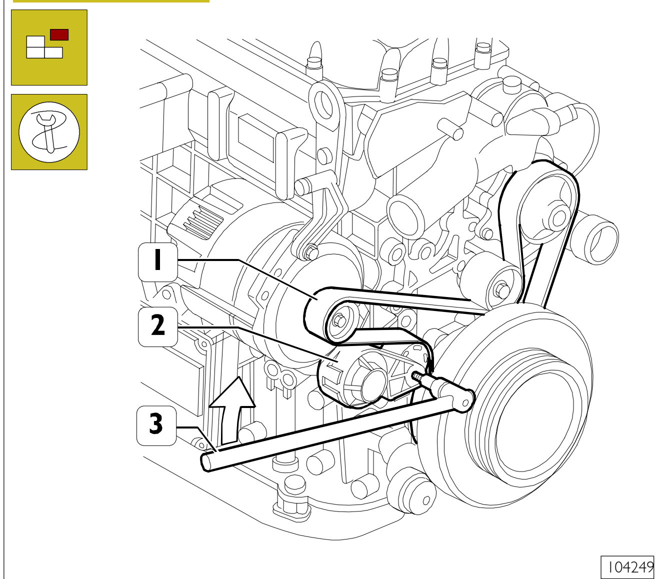
Figure 6



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

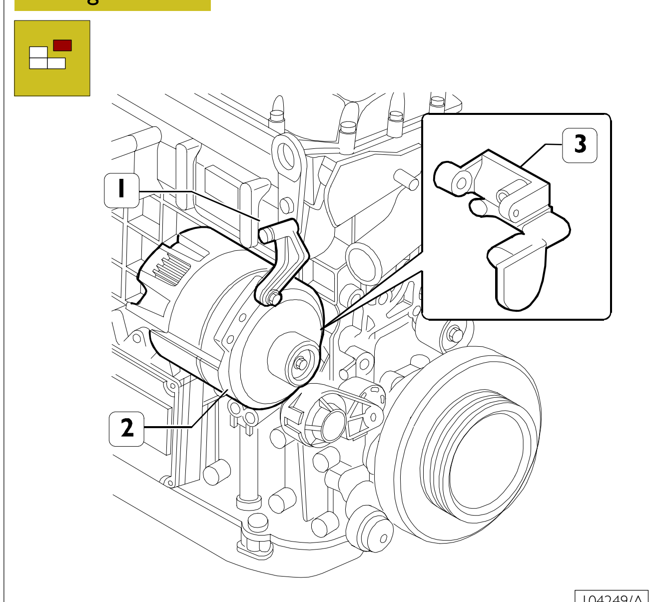
Only for types: F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001

Figure 7



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

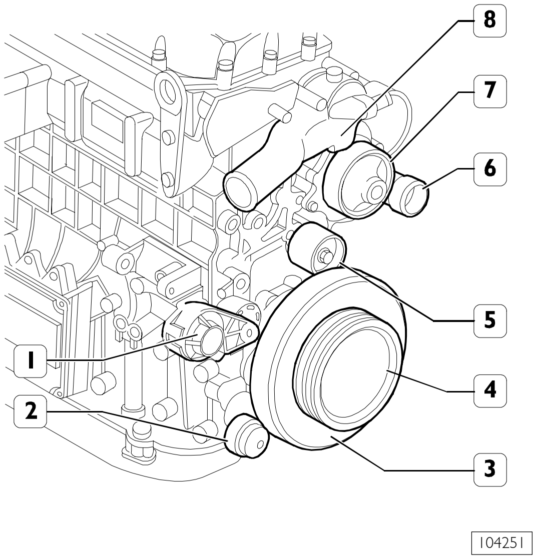
Figure 8



Remove:

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

Figure 9

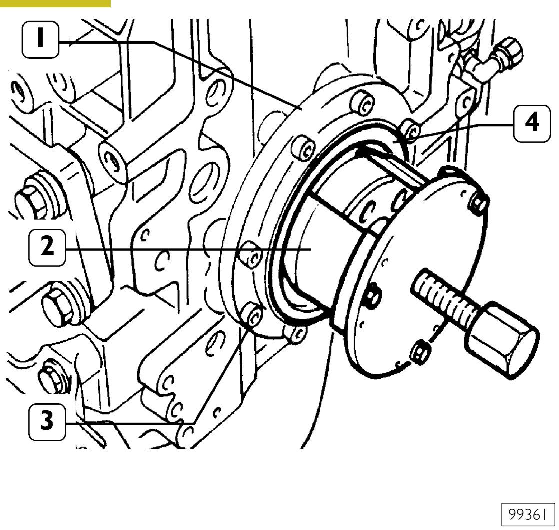


Remove:

- 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);

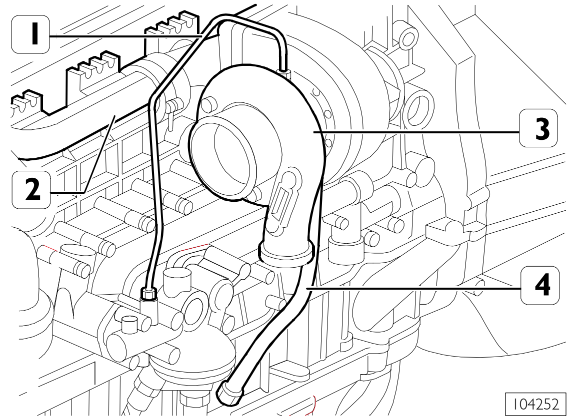
For all types except F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001

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.

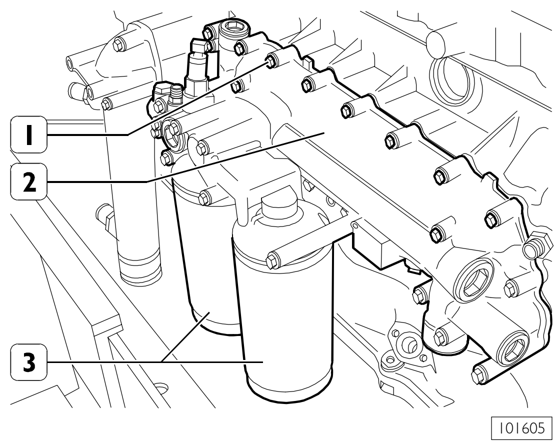
Figure 11



On the engine exhaust side, remove the following parts:

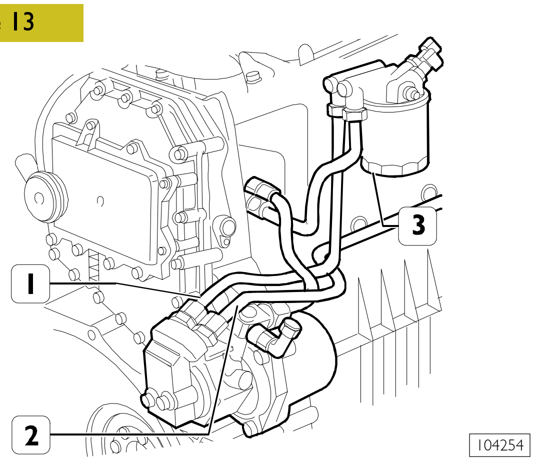
- oil delivery pipe (1);
- oil return pipe (4);
- turbocharger (3);
- exhaust manifold (2).

Figure 12



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

Figure 13

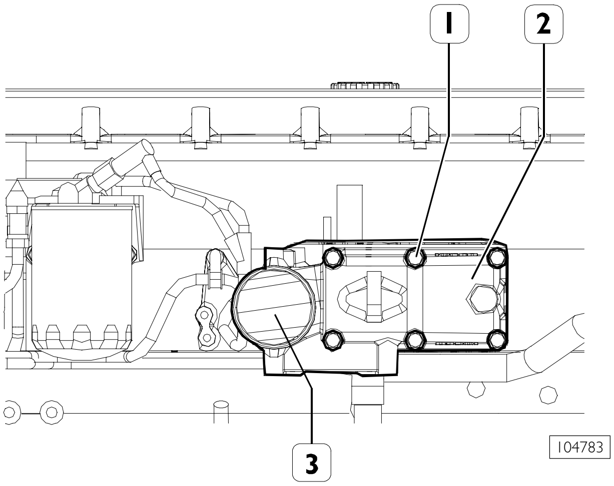


Disconnect the fuel pipes (1) from the fuel pump (2).

Remove:

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

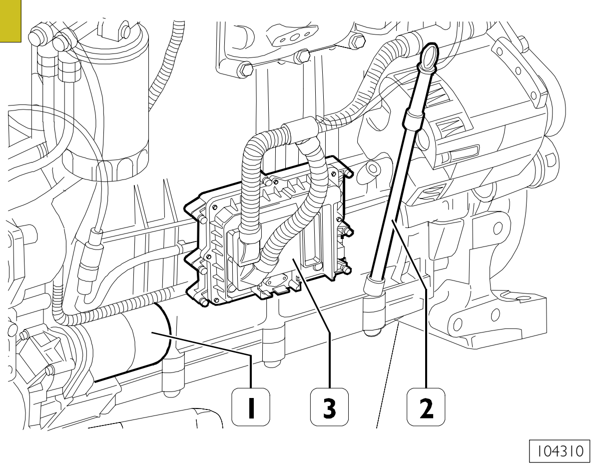
Figure 14



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.

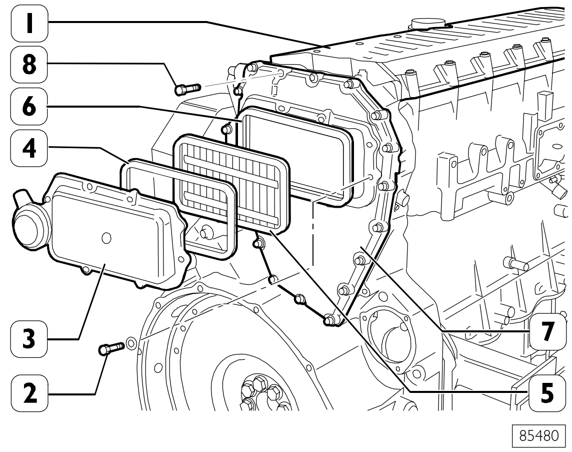
Figure 15



Remove:

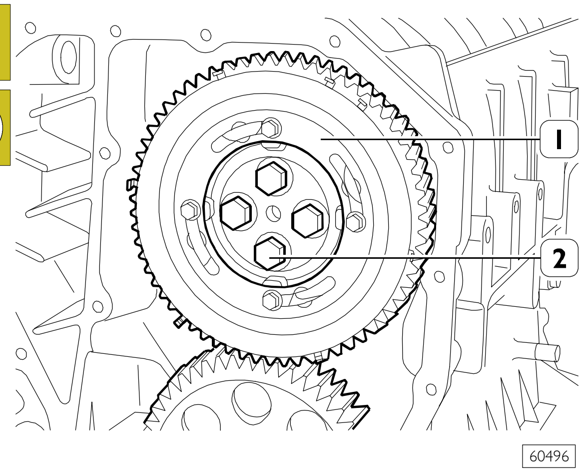
- the starter motor (1);
- the control unit (2) and its support;
- the oil dipstick (3) from the crankcase.

Figure 16



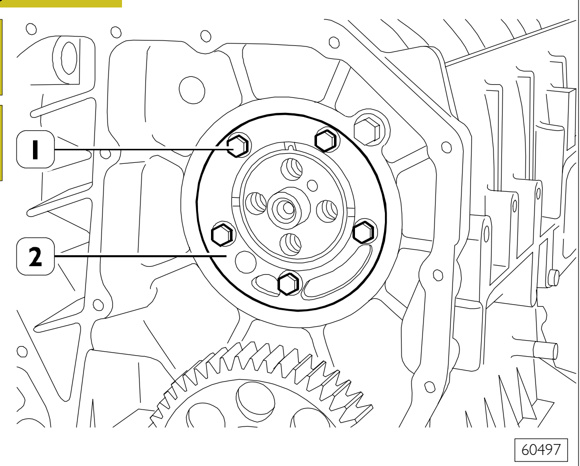
Remove the rocker arm cover (1), take off the screws (2) and remove: the cover (3), the filter (5) and the gaskets (4 and 6). Take off the screws (8) and remove the blow-by case (7).

Figure 17



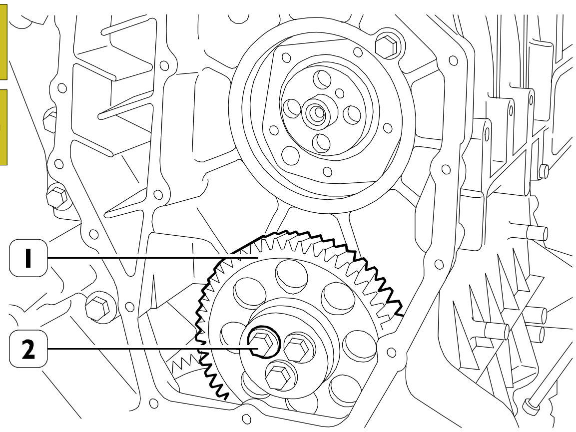
- Unscrew the screws (2) and remove the gear (1) fitted with phonic wheel.

Figure 18



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

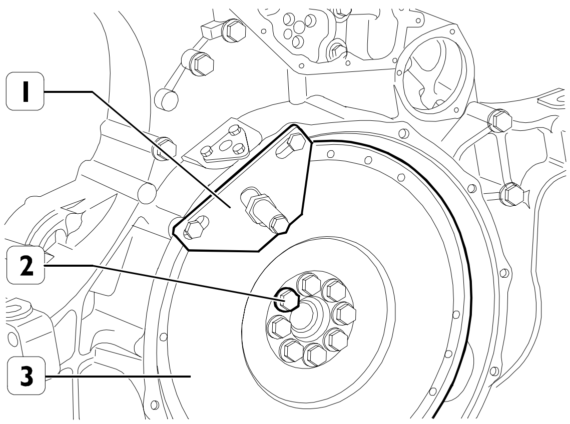
Figure 19



60498

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

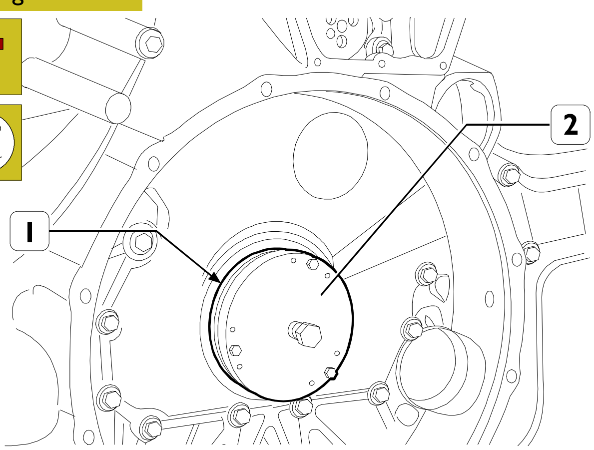
Figure 20



60499

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

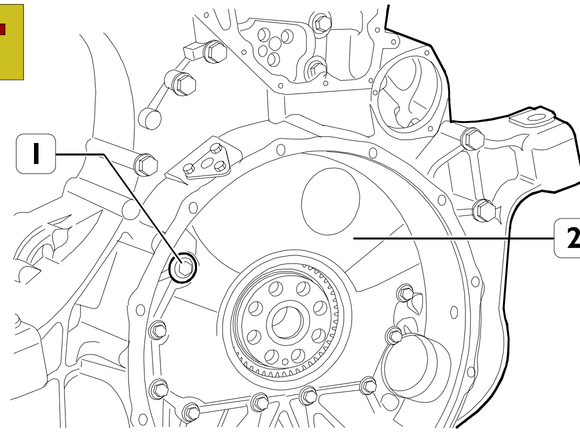
Figure 21



60500

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

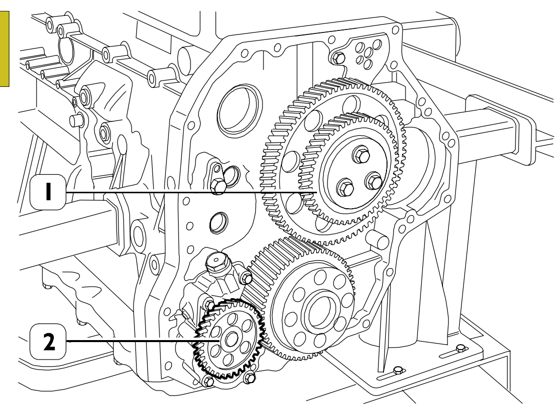
Figure 22



60501

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

Figure 23

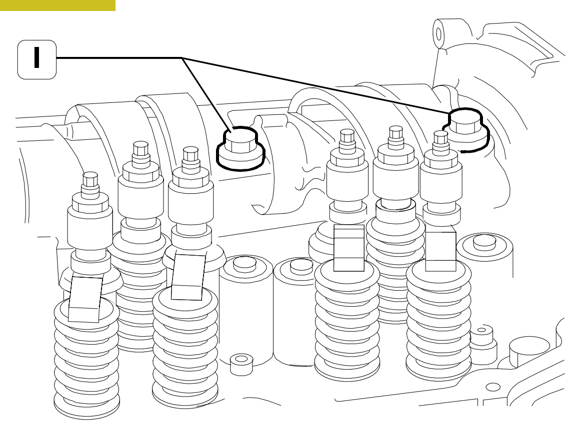


99364

In sequence, take out the:

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

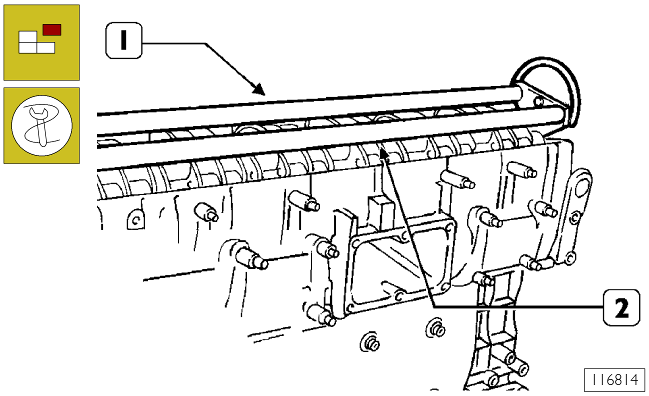
Figure 24



104257

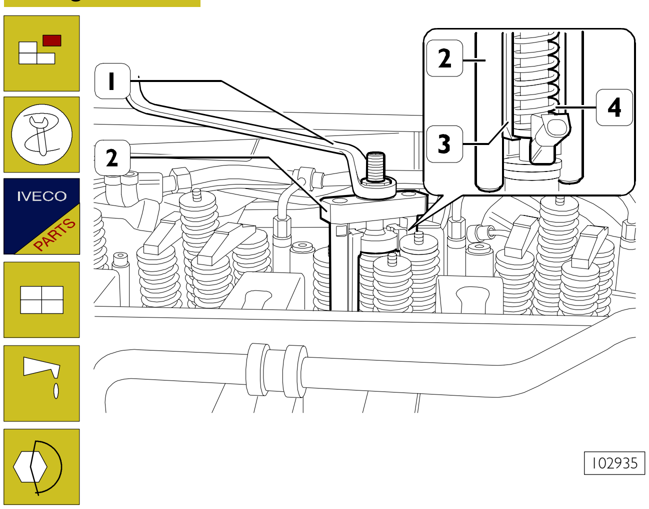
- ❑ Disconnect the electrical connections from the pump injectors.
- ❑ Unscrew the screws (1) fixing the rocker arm shaft.

Figure 25



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

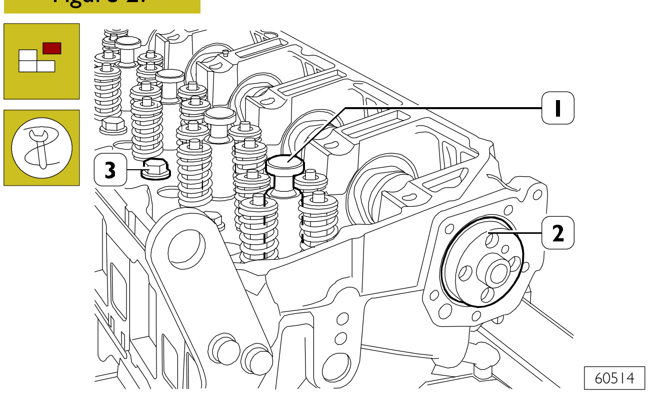
Figure 26



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

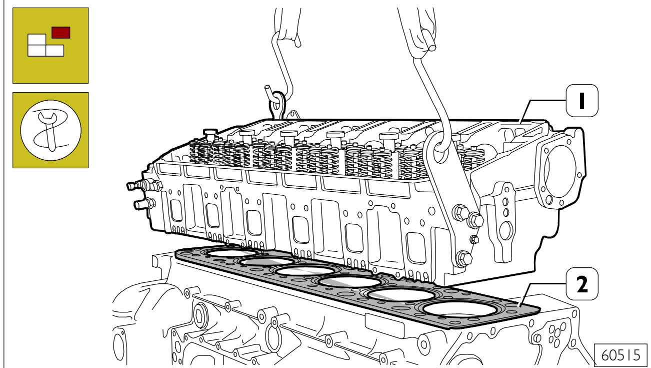
- ❑ Hook up the detail (3) of the tool illustrated in the figure to the injector pump (4);
- ❑ fit part (2) on part (3), resting the former on the cylinder head;
- ❑ tighten the nut (1) and extract the pump injector (4) from the engine block

Figure 27



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

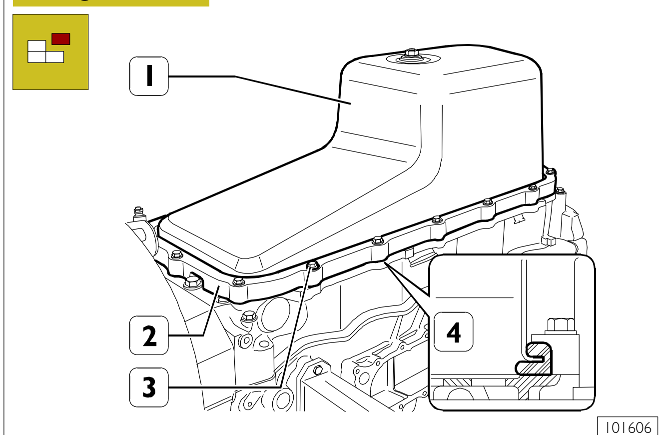
Figure 28



- ❑ 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

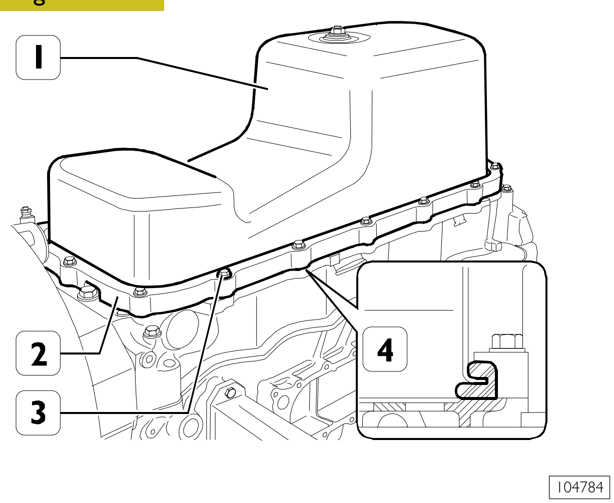
Figure 29



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

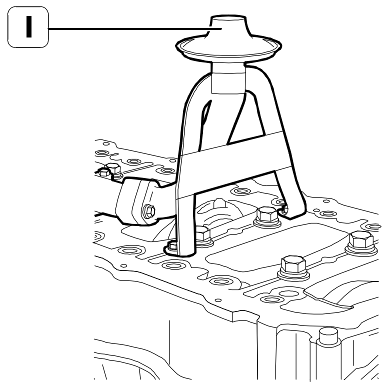
For all types except: F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001

Figure 30



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

Figure 31

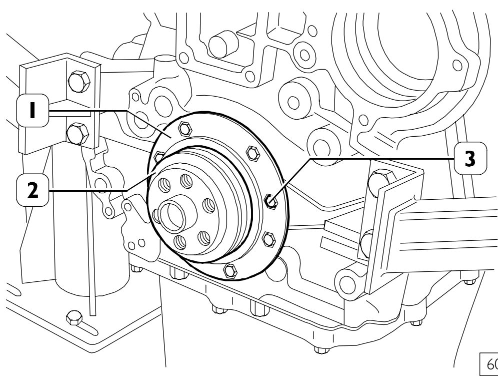


101607

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

ENGINE ASSEMBLY

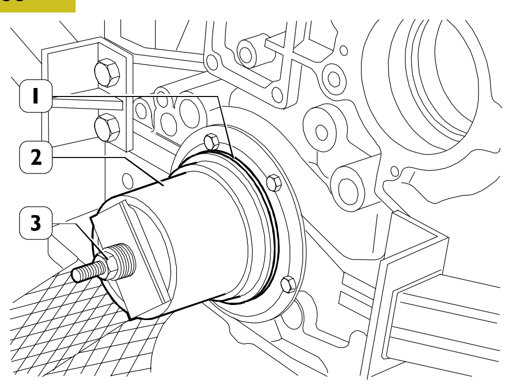
Figure 32



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).

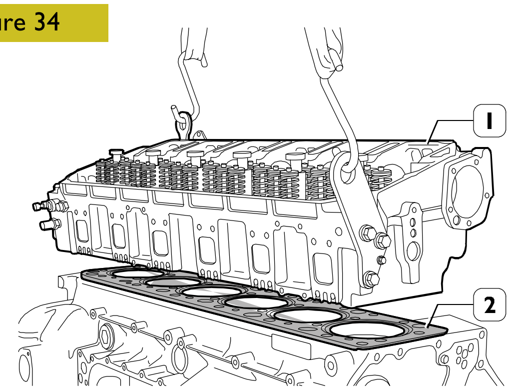
Figure 33



60564

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

Figure 34



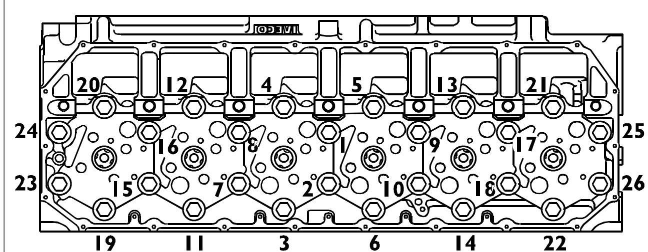
60515

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.

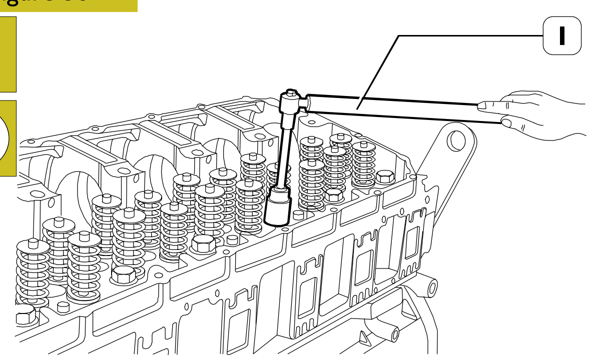
Figure 35



61270

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

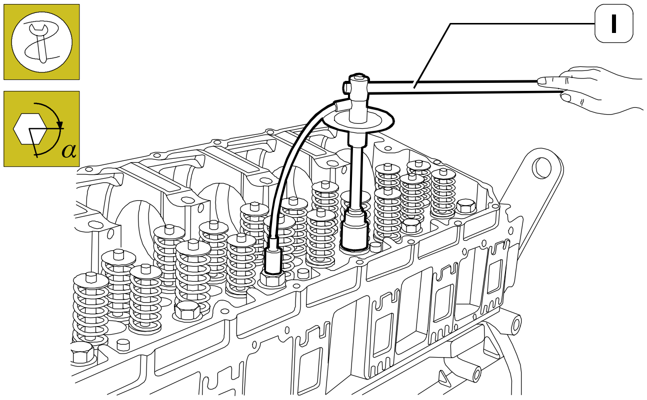
Figure 36



60565

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

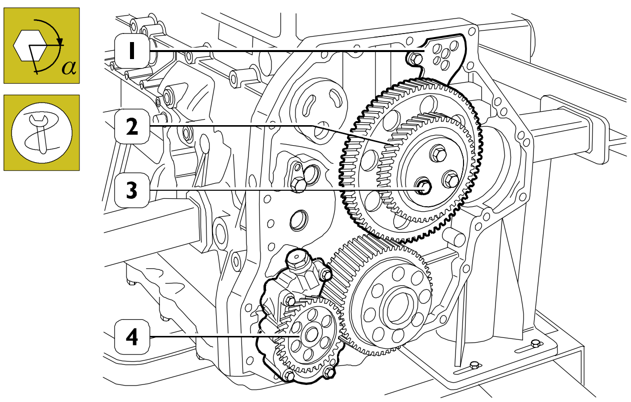
Figure 37



60566

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

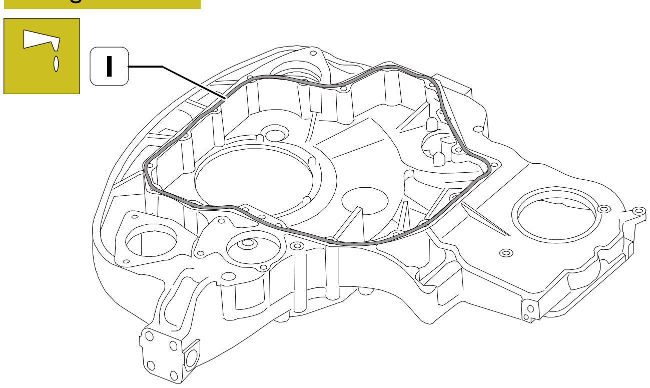
Figure 38



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

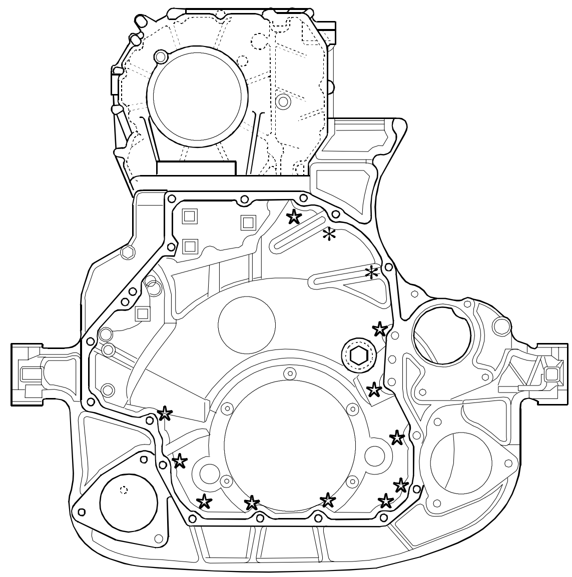


104311

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 $1{,}5 \pm {}^{0.5}_{0.2}$

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

Figure 40

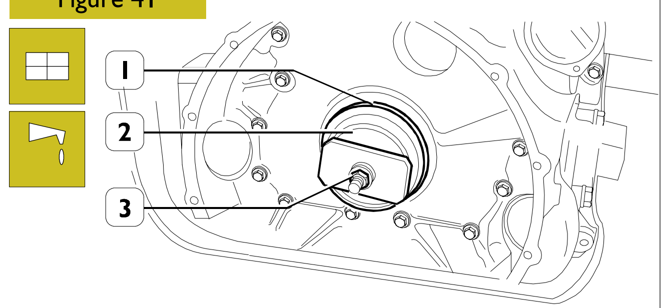


104281

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.

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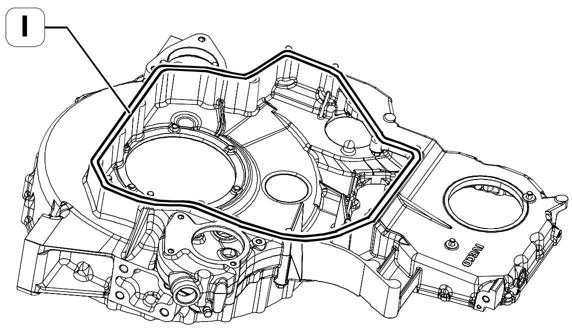
Only for types: F3BE0684J*E902 - F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001

Figure 42

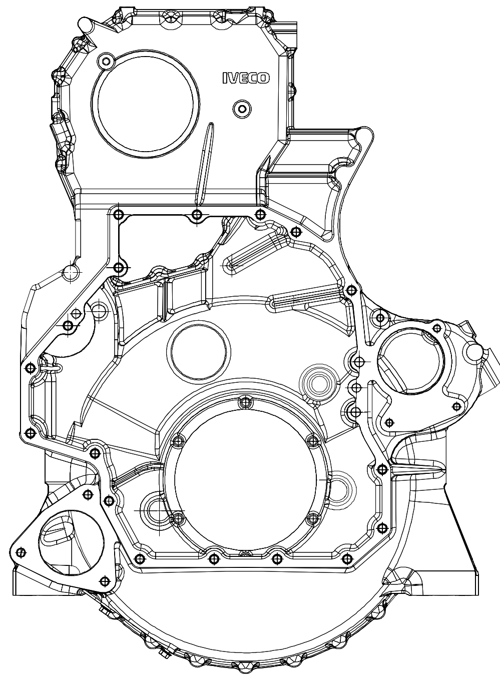


104785

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

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

Figure 43

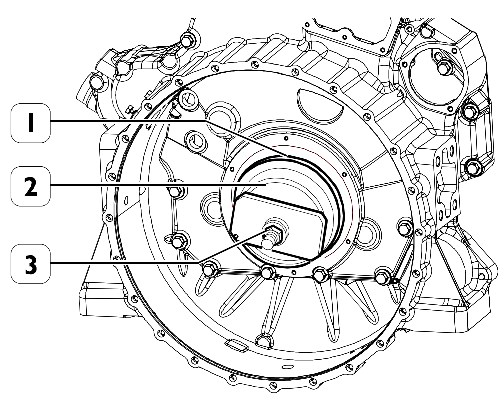


104786

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



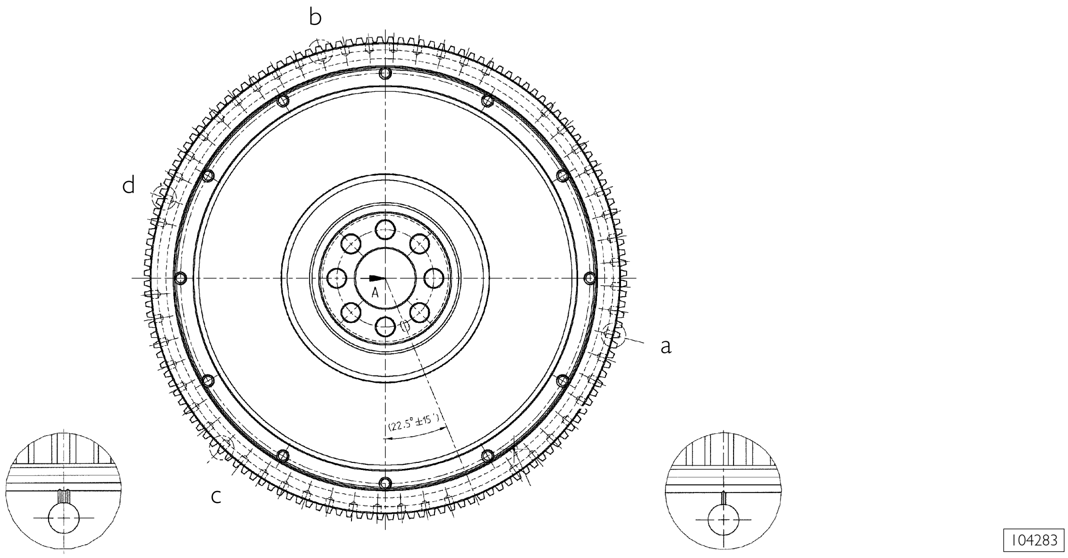
104787

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*E901 - F3BE0684G*E901)

Figure 45



VIEW OF HOLES: A – B – C

VIEW OF HOLE: D

DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS

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

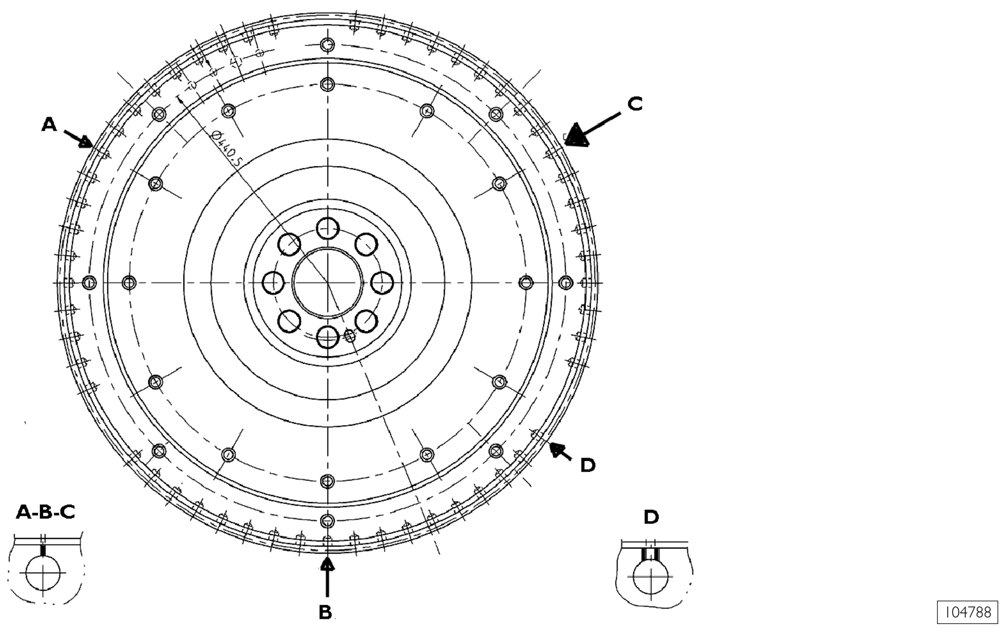
B = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6.

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

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

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

Figure 46



DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS

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

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

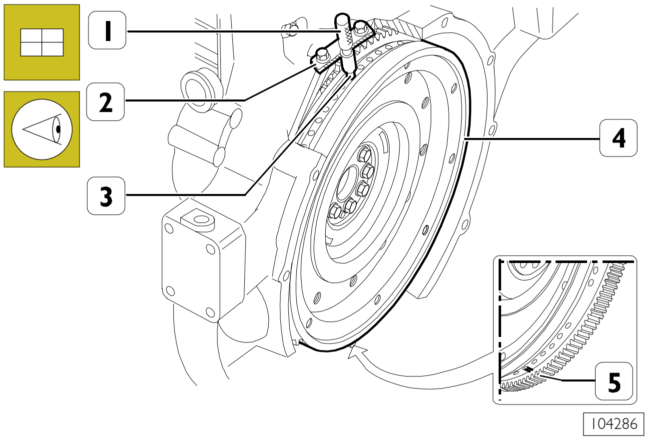
C = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 2-5.

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

Fitting camshaft

For all types

Figure 47



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

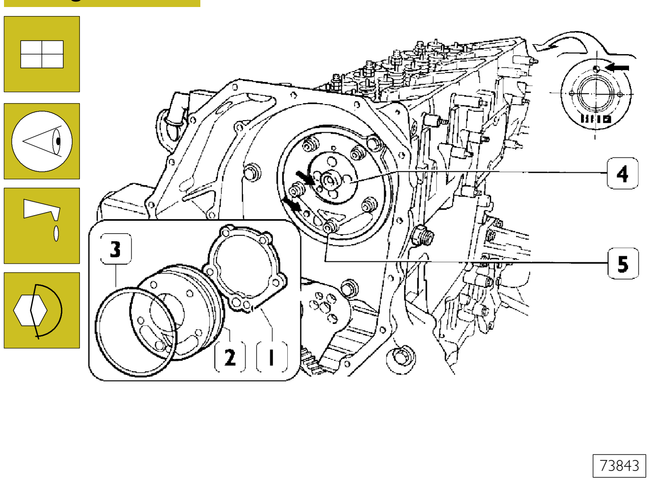
This situation occurs when:

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

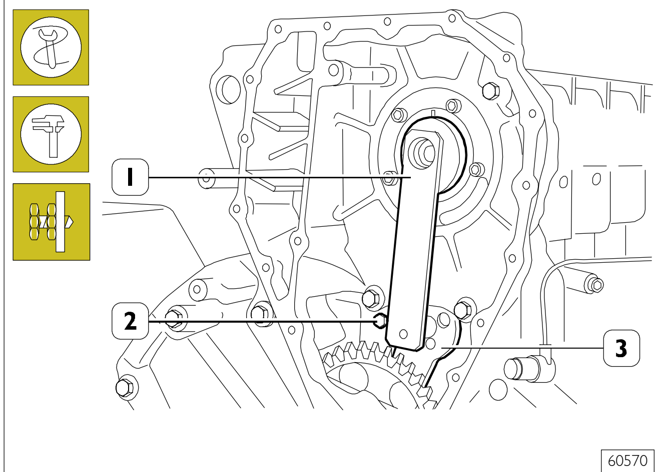


Fit the camshaft (4), positioning it observing the reference marks (→) as shown in the figure.

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

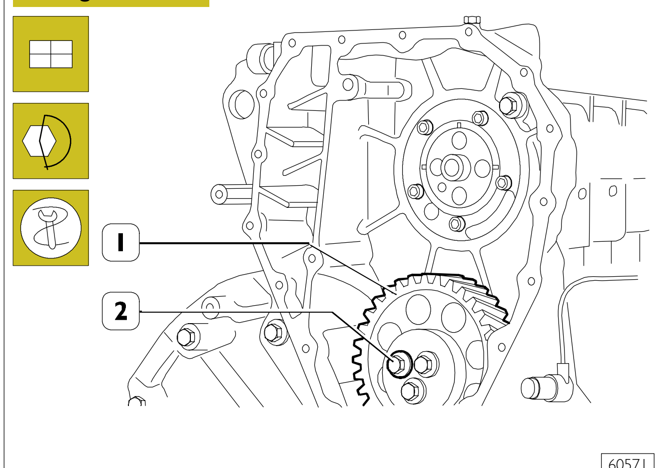
Mount the shoulder plate (2) with the sheet metal gasket (1) and tighten the screws (5) to the required torque.

Figure 49



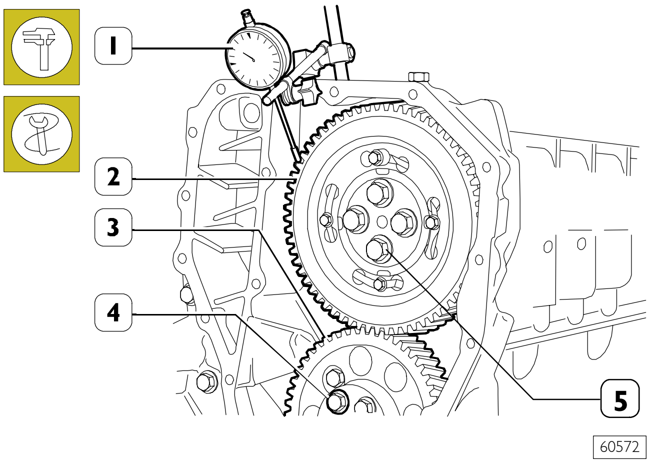
- Apply the gauge 99395219 (1). Check and adjust the position of the link rod (3) for the idle gear. Lock the screw (2) to the required torque.

Figure 50



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

Figure 51

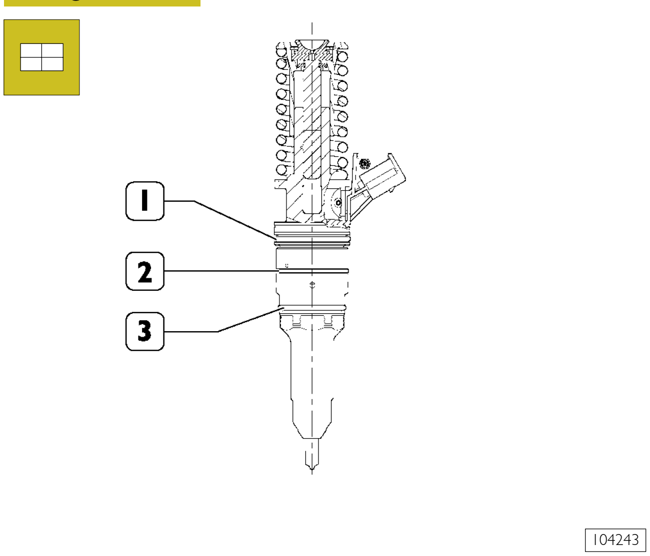


Position the gear (2) on the camshaft so that the 4 slots are centred with the holes for fixing the camshaft, without fully locking the screws (5).
Using the dial gauge with a magnetic base (1), check that the clearance between the gears (2 and 3) is 0.073 – 0.195 mm; if this is not so, adjust the clearance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

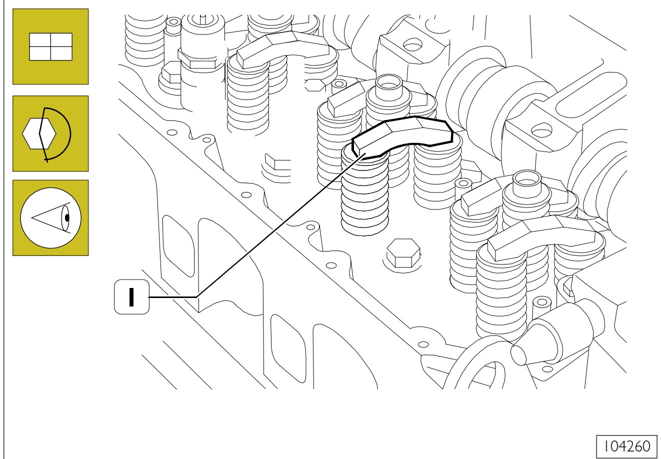
Fitting pump-injectors

Figure 52



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

Figure 53



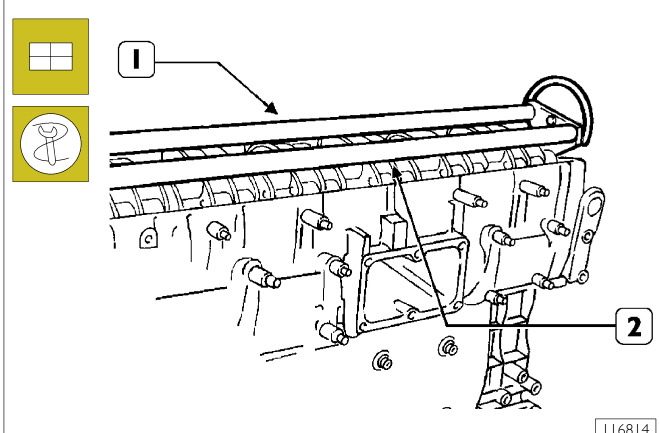
Mount:

- ❑ 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

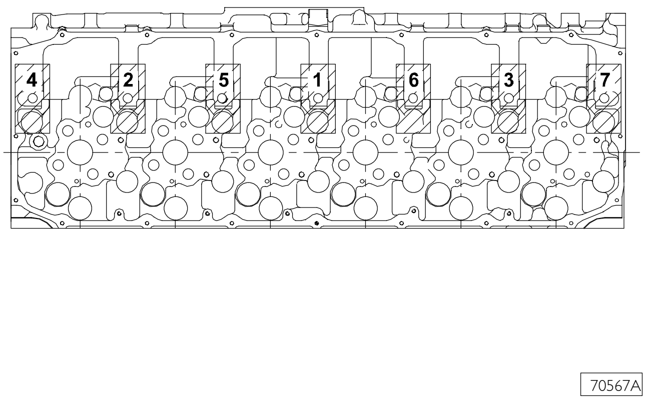
Figure 54

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.

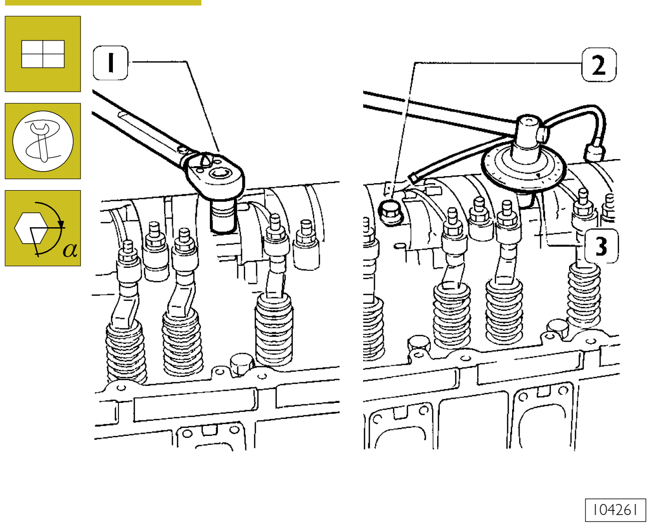
Figure 55



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



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

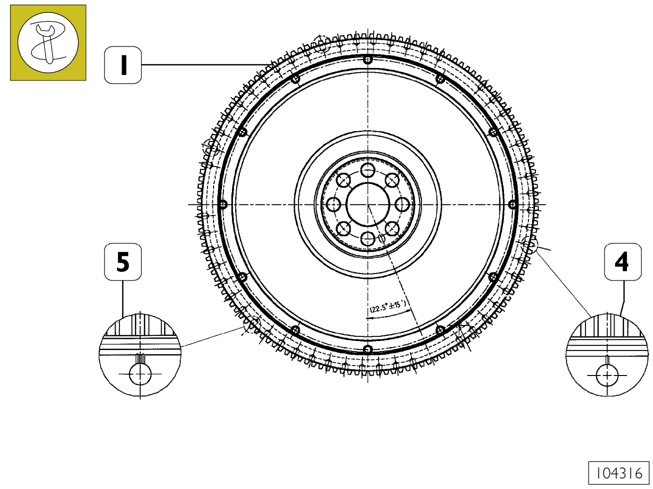
- 1st phase: tightening to a torque of 80 Nm (8 kgm) with the torque wrench (1);
- 2nd phase: closing with an angle of 60° using the tool 99395216 (3).

Mount the electric wiring on the electro-injectors.

Camshaft timing

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

Figure 57

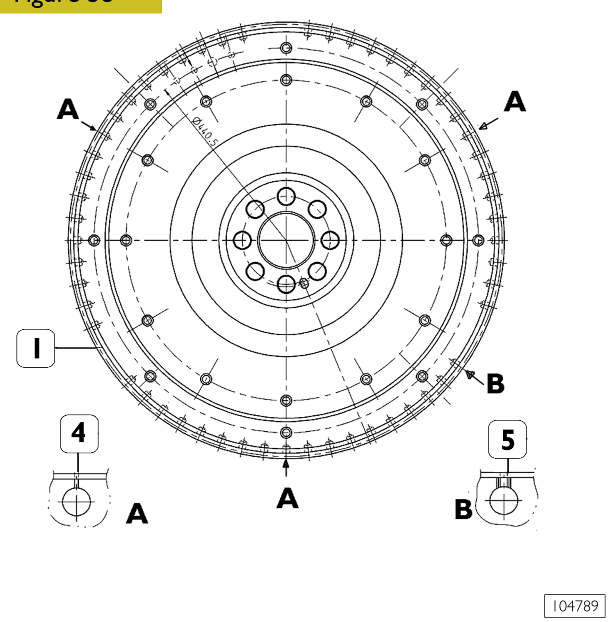


Using the tool, turn the engine flywheel (1) in the direction of rotation of the engine so as to take the piston of cylinder no.1 to approximately the T.D.C. in the phase of combustion.
This condition occurs when the hole with one reference mark (4), after the hole with two reference marks (5) on the engine flywheel (1), can be seen.

Camshaft timing

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

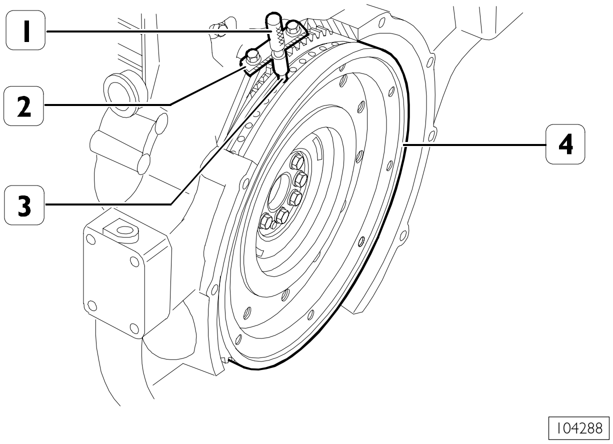
Figure 58



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.

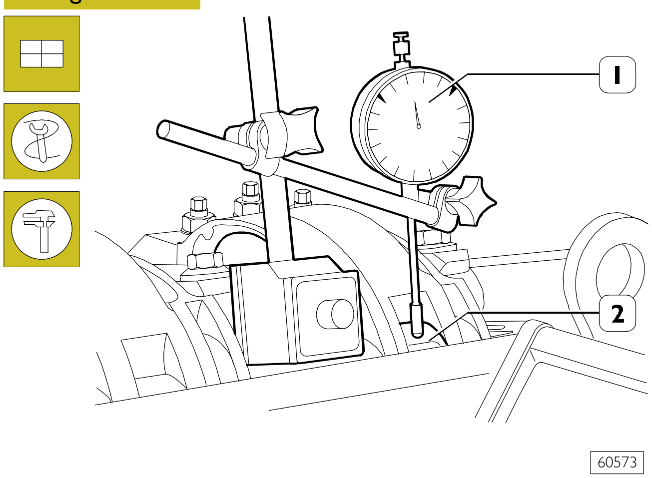
For all types

Figure 59



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



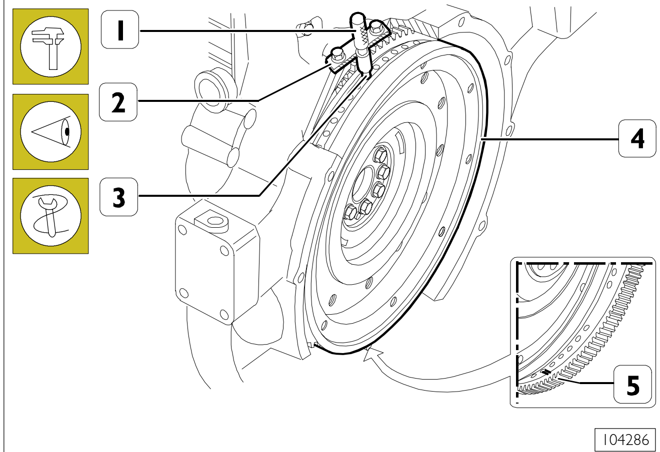
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

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

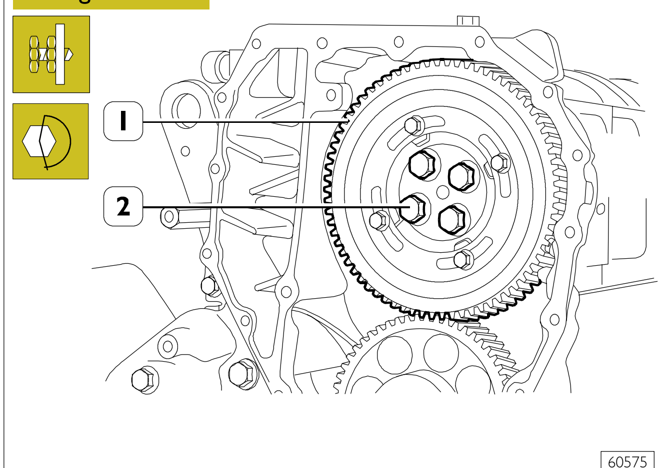


The camshaft is in step if at the cam lift values of 5.45 ±0.05 mm there are the following conditions:

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



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.

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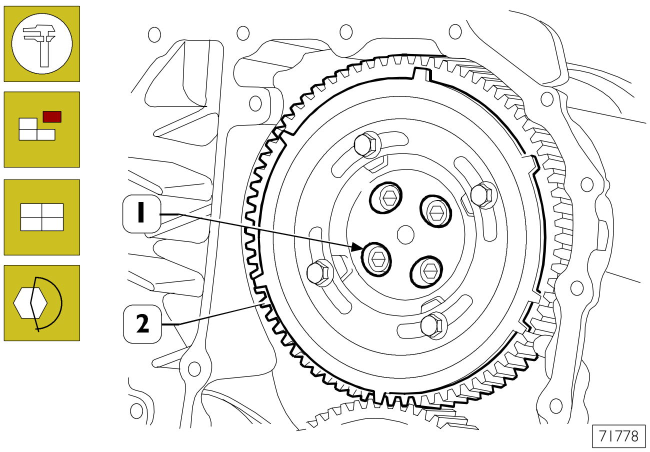
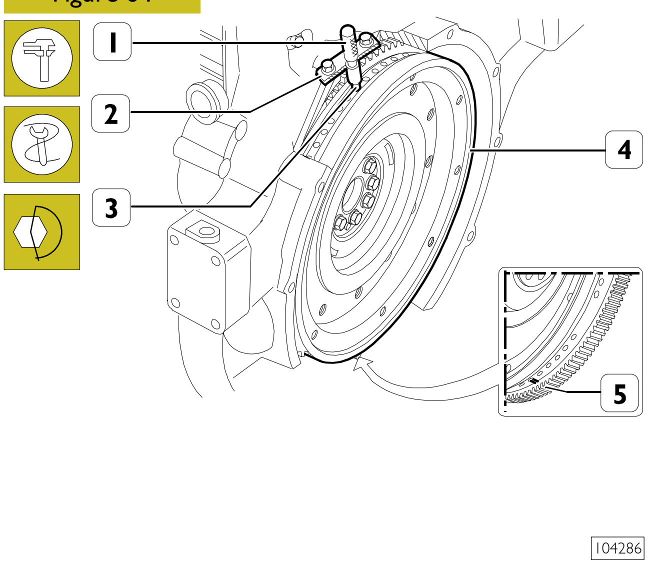
Figure 63



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



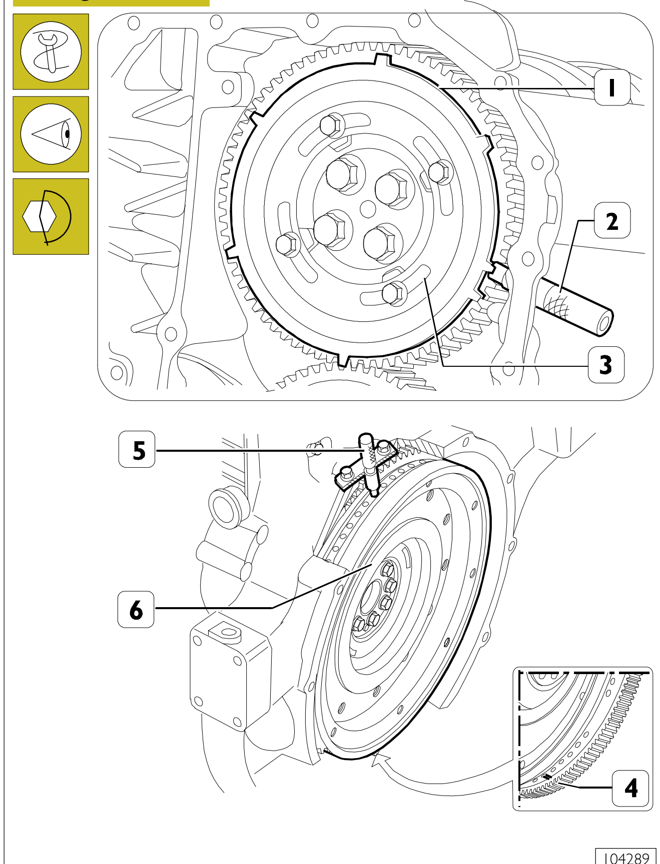
Turn the flywheel (4) again to bring about the following conditions:

- 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.

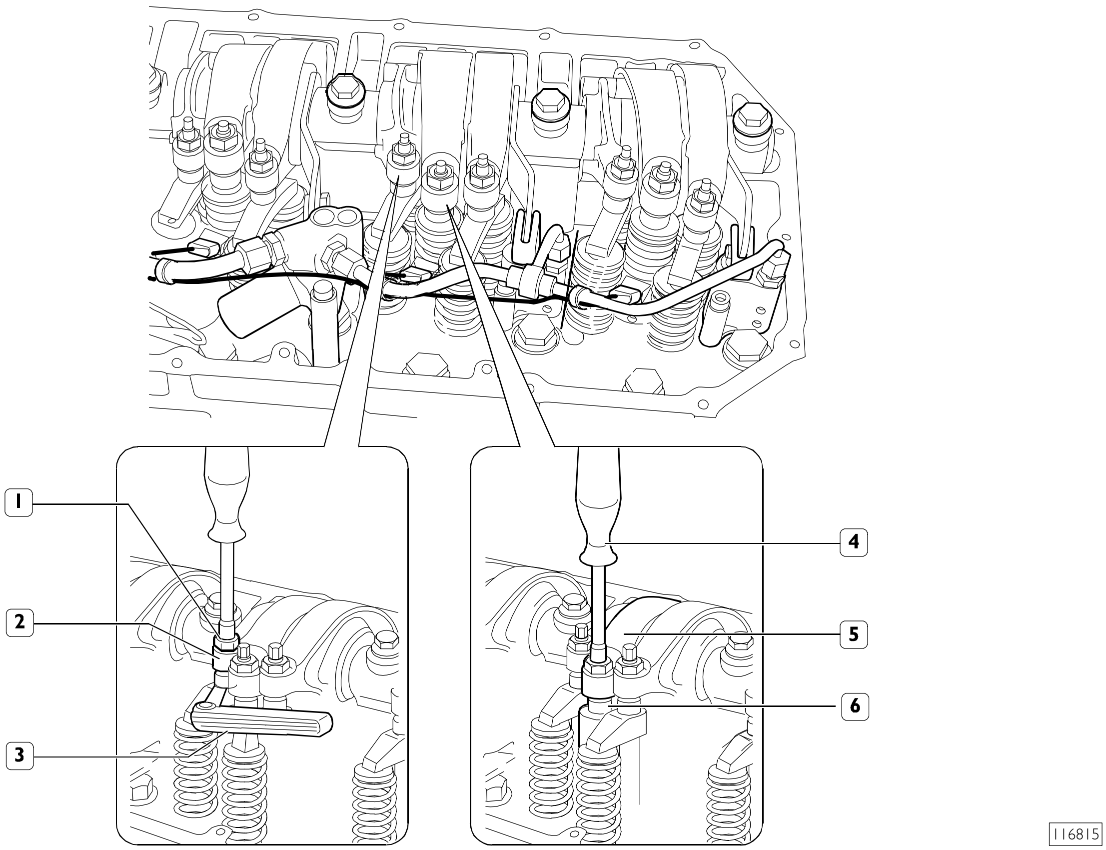
Again turn the flywheel in its normal direction of rotation until you see the hole marked with the double notch (4) through the inspection hole under the flywheel housing. Insert tool 99360612 (5) into the seat of the flywheel sensor (6).

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



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.

<u>Adjusting clearances between rockers and intake/exhaust/valve studs:</u>

- ❑ 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).

<u>Setting pump-injector rocker preloading:</u>

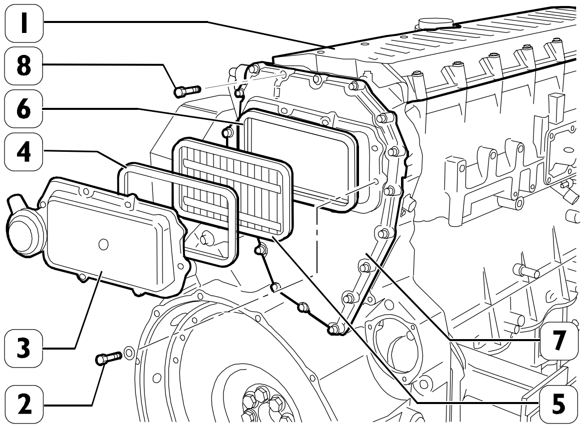
- ❑ Use a box wrench to loosen the nut fastening the adjusting screw for rocker arm (5) controlling pump-injector (6).
- ❑ With a suitable wrench (4) tighten the adjusting screw until the pumping element reaches its-end-of-stroke point.
- ❑ Lock the adjusting screw to a torque of 5 Nm (0.5 kgm) by means of a torque wrench.
- ❑ Back off the adjusting screw 1/2 to 3/4 turn.
- ❑ Tighten the lock nut.

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

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

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

Figure 67



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

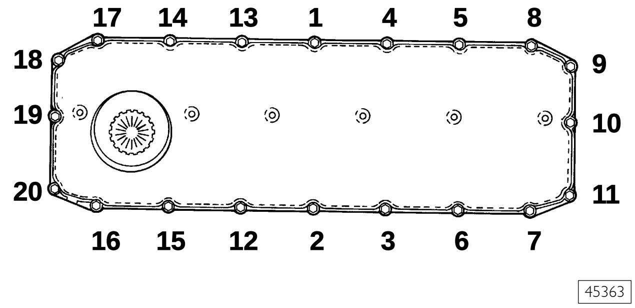
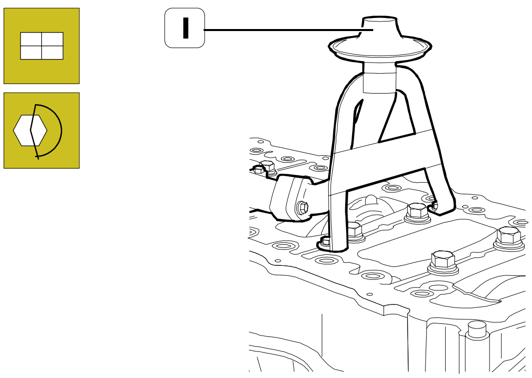


DIAGRAM OF ROCKER ARM CAP FIXING SCREWS TIGHTENING SEQUENCE

ENGINE COMPLETION

Figure 69

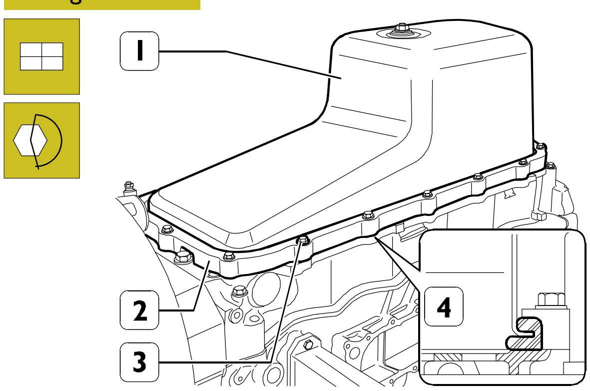


101607

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

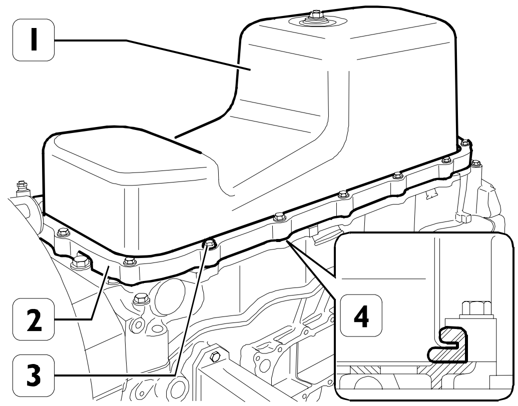


101606

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



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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

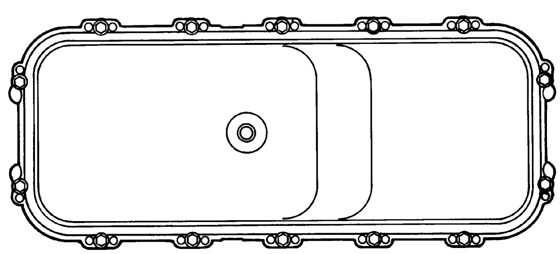

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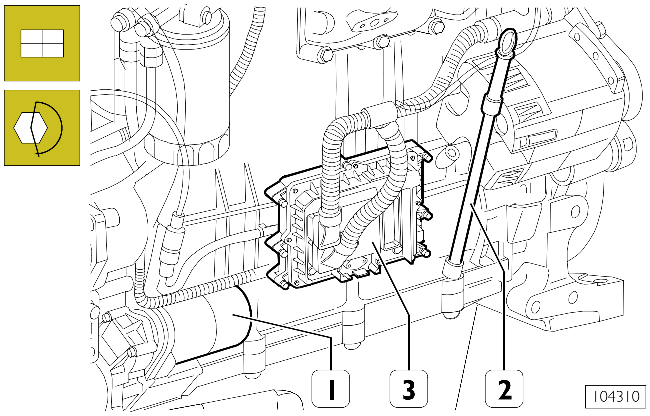
DIAGRAM OF ENGINE OIL SUMP FIXING SCREWS TIGHTENING SEQUENCE

Figure 73

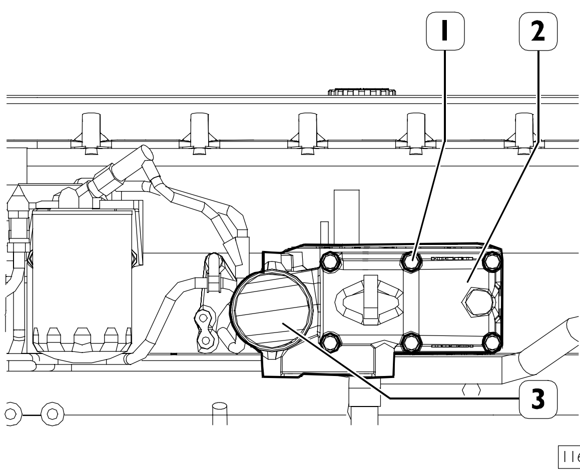


Tightening the fixing screws to the prescribed torque, mount:

- 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.

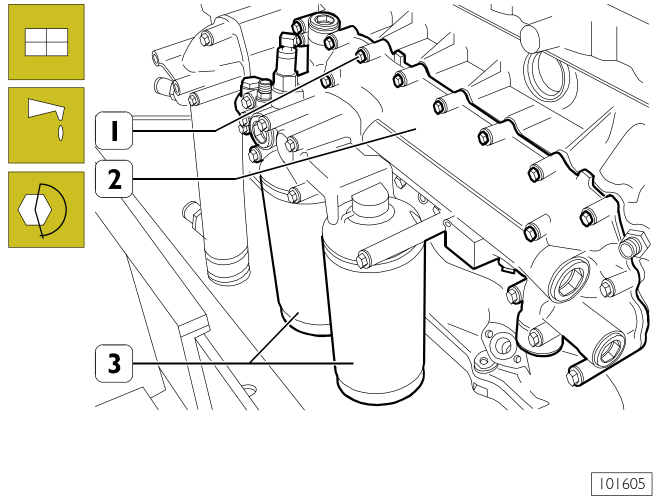
Figure 74



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

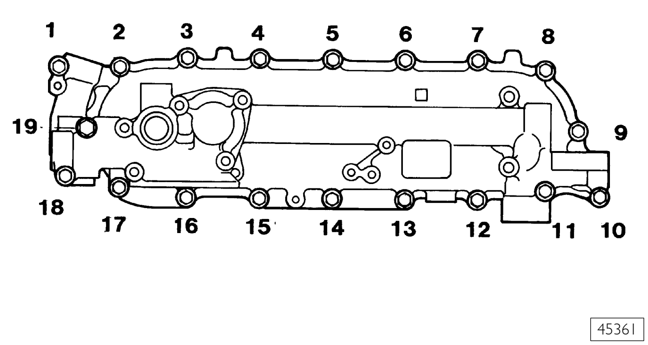
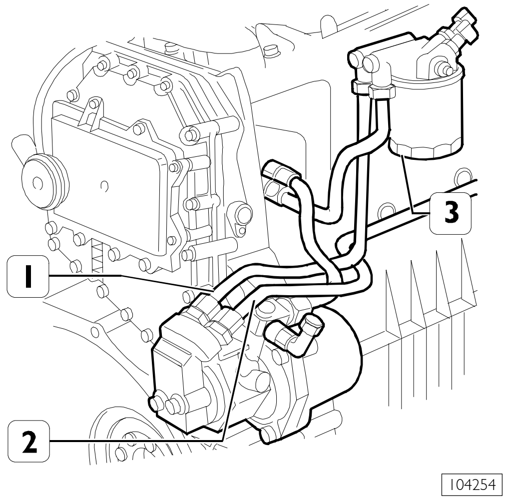


DIAGRAM OF HEAT EXCHANGER FIXING SCREWS TIGHTENING SEQUENCE

Figure 77



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

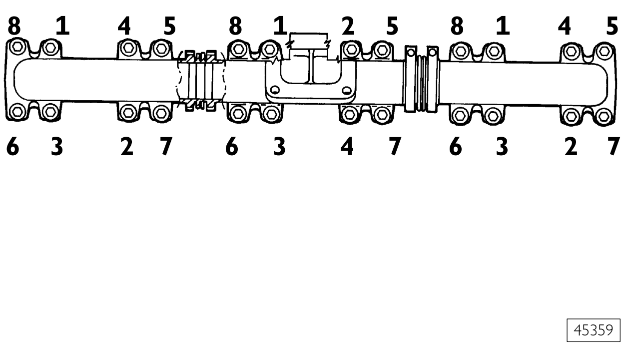


DIAGRAM OF EXHAUST MANIFOLD FIXING SCREWS TIGHTENING SEQUENCE

Figure 79

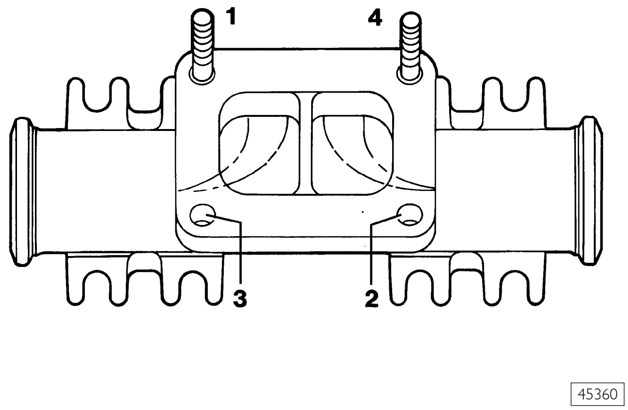
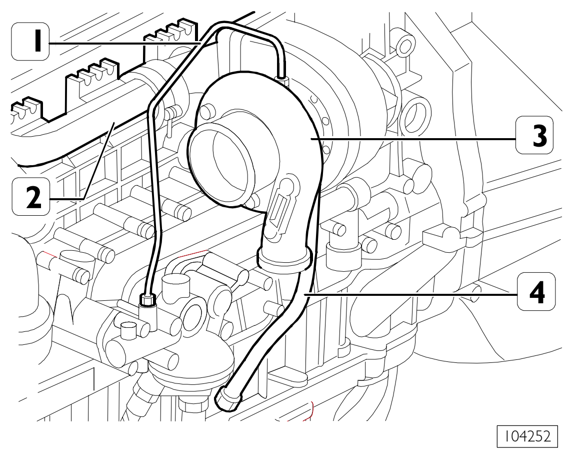


DIAGRAM OF TURBOCHARGER FIXING SCREWS AND NUTS TIGHTENING SEQUENCE

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

Figure 80



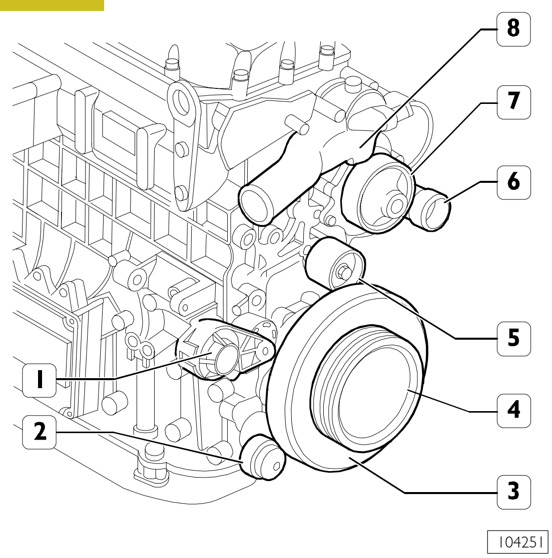
Mount the following with new seals:

- 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

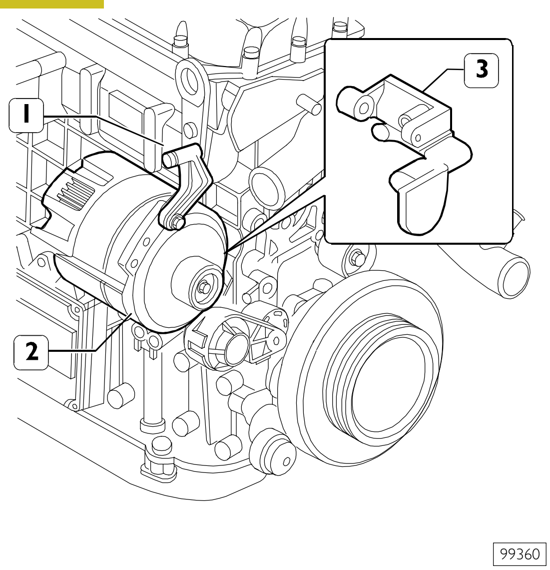
Figure 81



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).

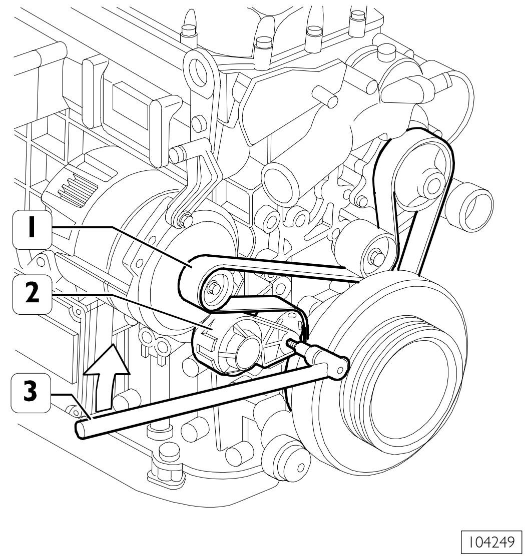
Figure 82



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

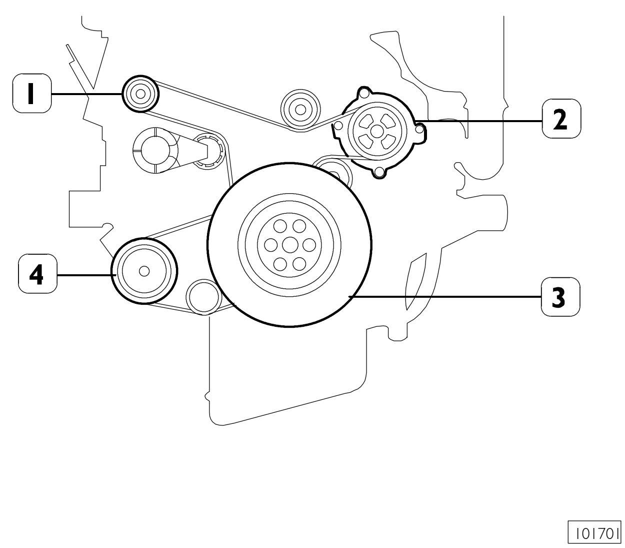
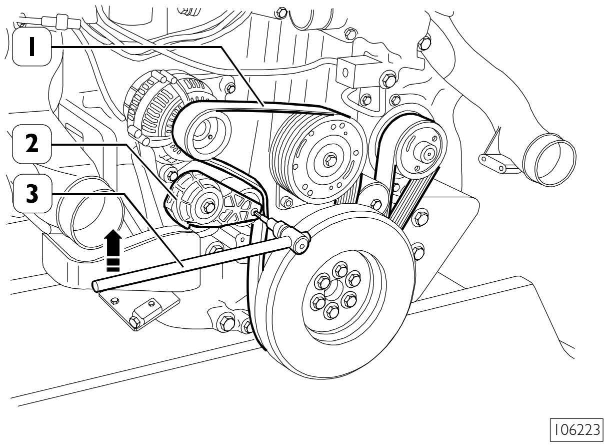


DIAGRAM FOR FITTING BELT DRIVING FAN - WATER PUMP - ALTERNATOR

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

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

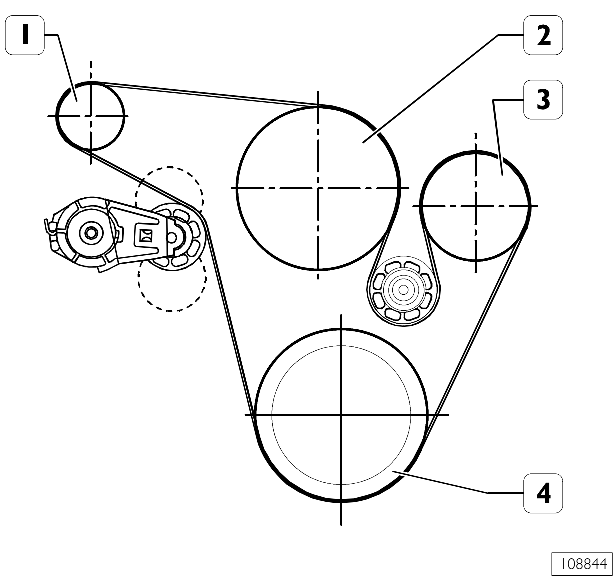
Figure 86



❑ 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.

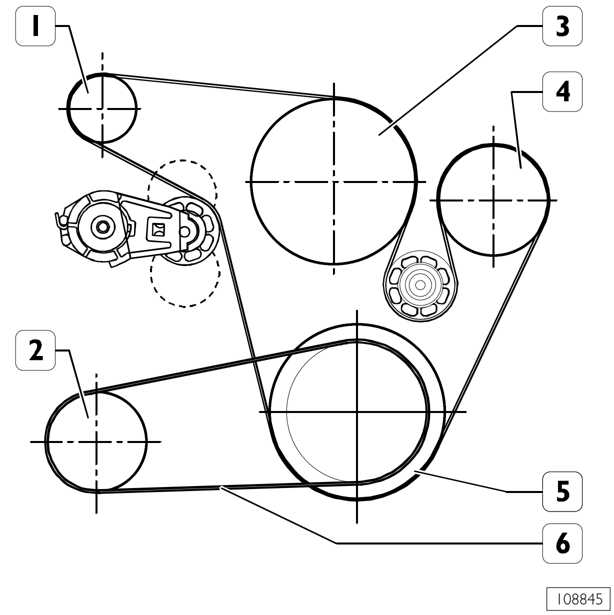
Figure 85



ASSEMBLY DIAGRAM OF FAN – WATER PUMP – ALTERNATOR DRIVE BELT

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

Figure 87

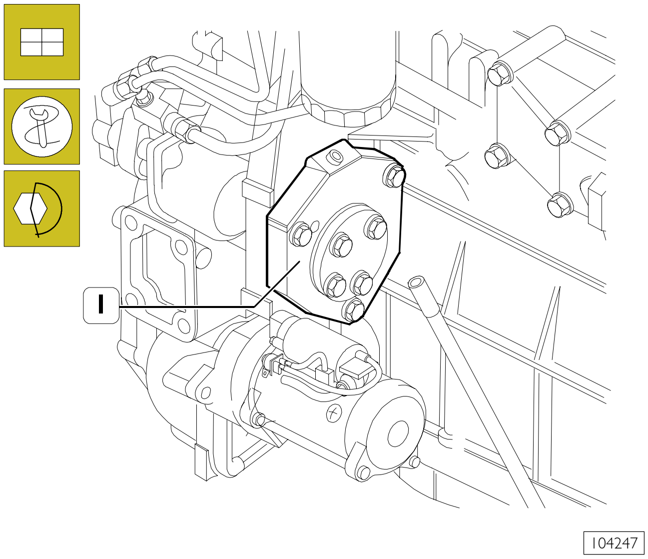


COMPRESSOR CONTROL BELT ASSEMBLY DIAGRAM

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

For all types

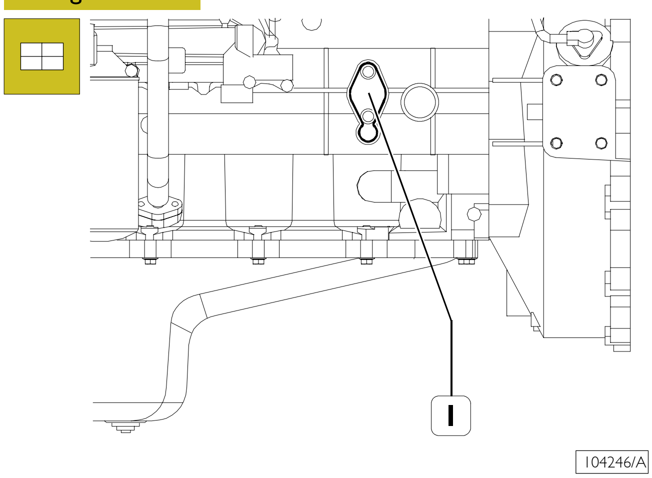
Figure 88



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;

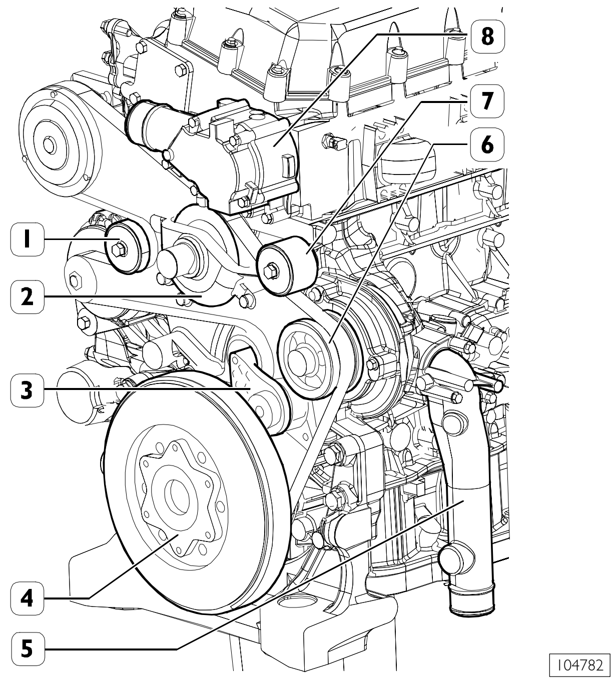
Figure 89



- mount the oil pressure adjuster valve (1).

Only for types: F3BE0684H*E901 and F3BE0684G*E901

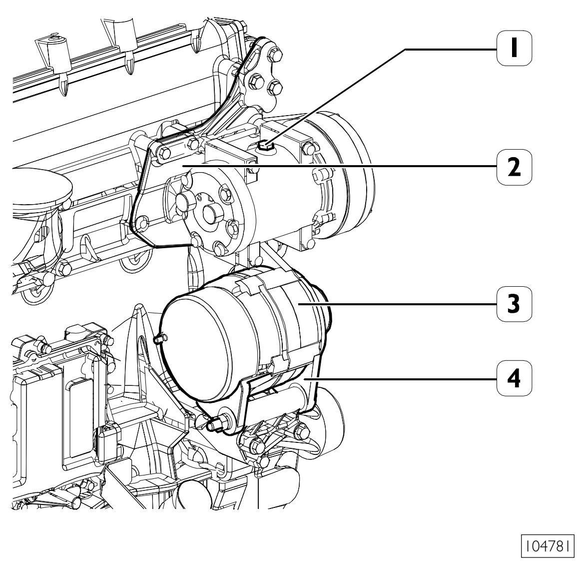
Figure 90



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

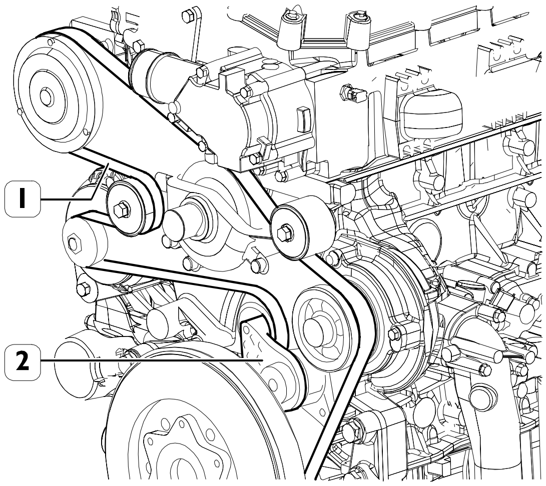
- the fixed belt tightening roller (1);
- the support (2);
- the automatic belt tightener (3);
- the damping flywheel (4) and the pulley beneath it;
- all the coolant pipes (5);
- the water pump (6);
- the fixed belt tightening roller (7);
- the thermostat assembly (8).

Figure 91



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



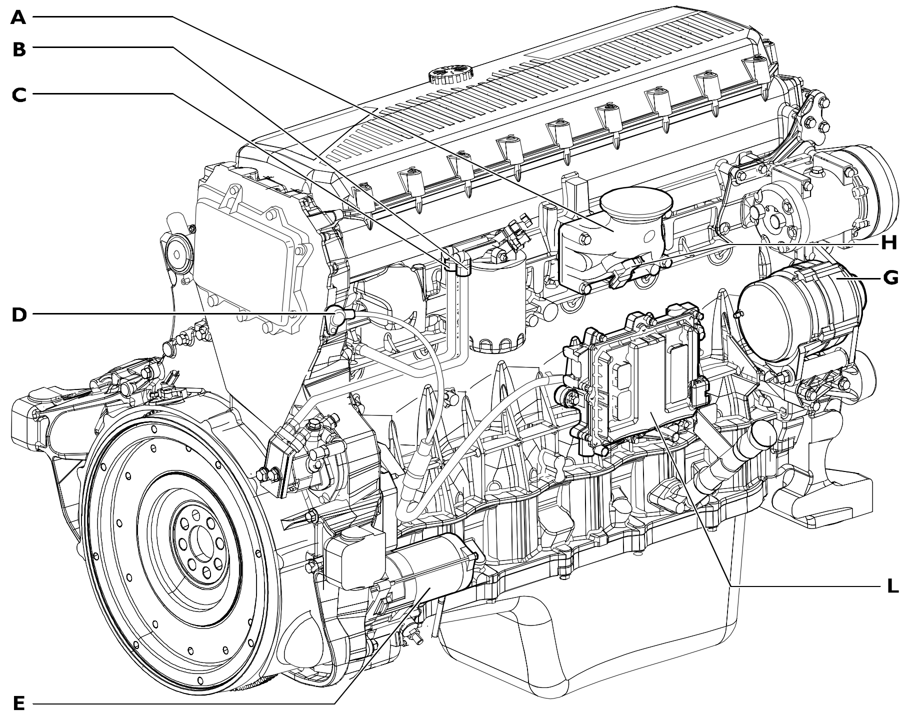
Assemble the belt on the pulleys and tightening rollers, making sure that it is correctly inserted in its seats.

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*E901 - F3BE0684G*E901)

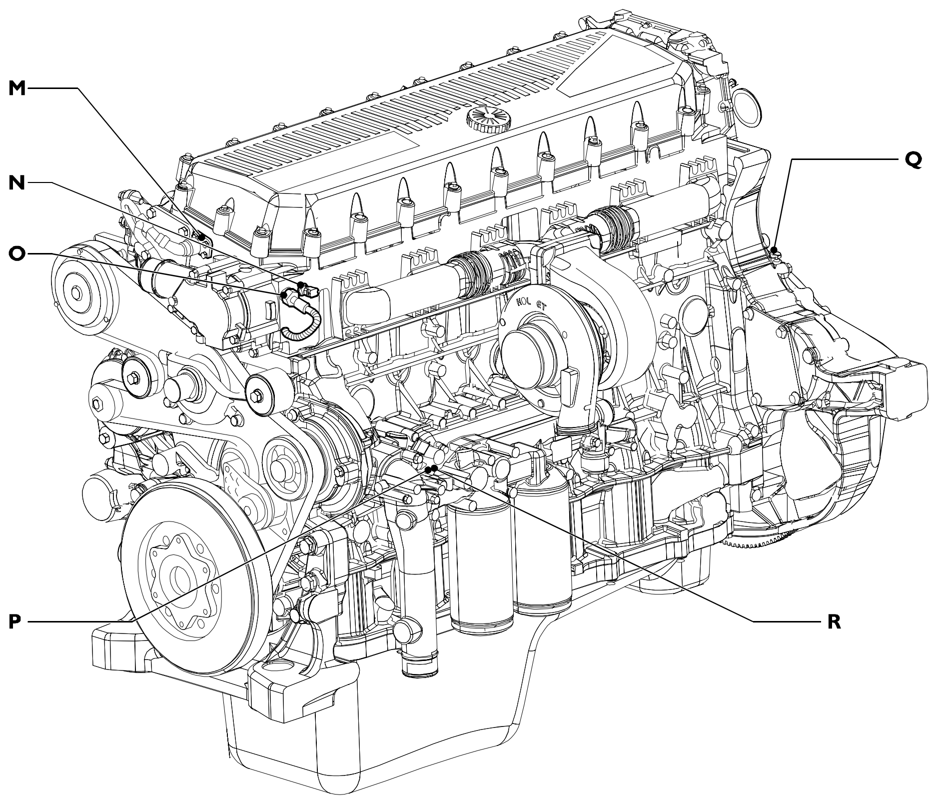
Figure 1



ENGINE RIGHT-HAND SIDE VIEW

104790

Figure 2



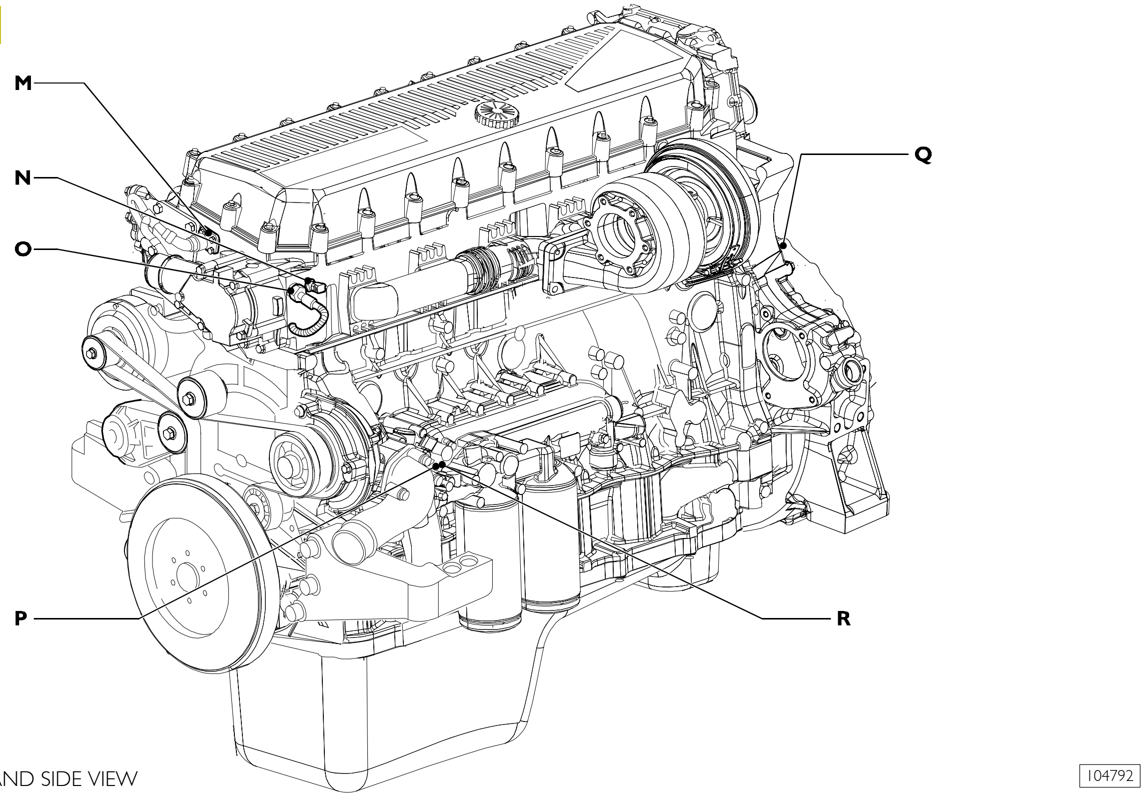
104791

ENGINE LEFT-HAND SIDE VIEW

A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - 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.

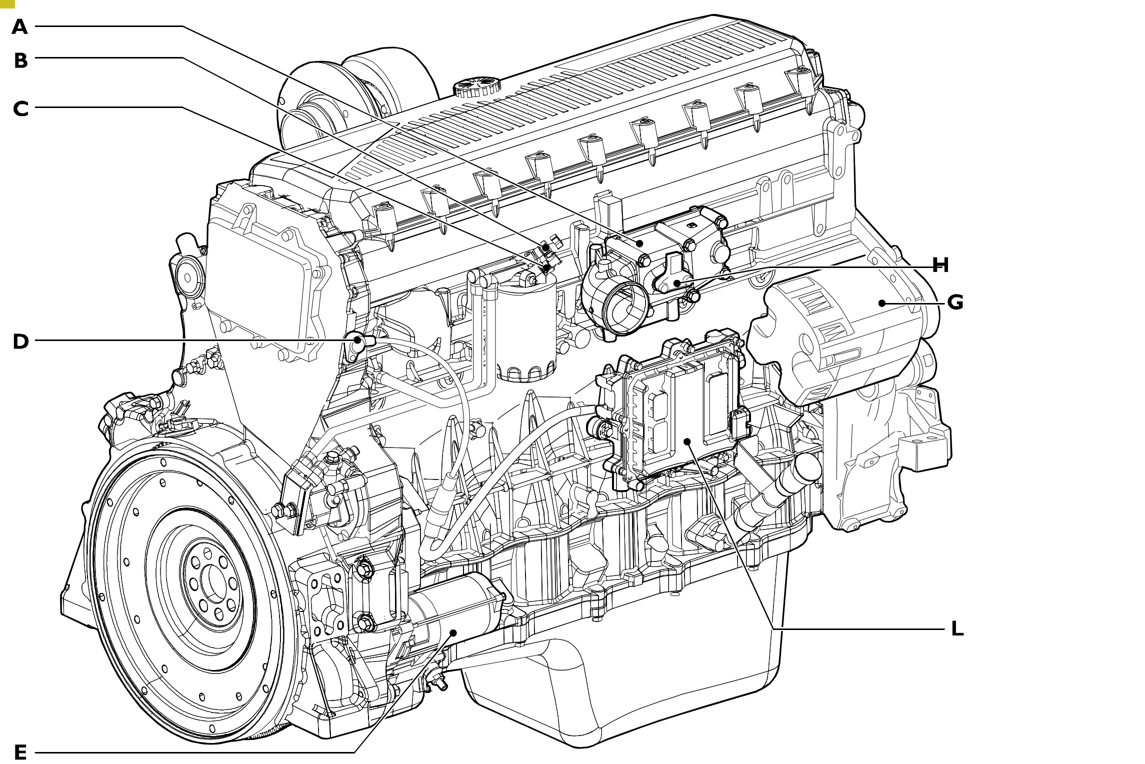
Components on the engine F3B (Only for type: F3BE0684J*E902)

Figure 3



ENGINE RIGHT-HAND SIDE VIEW

Figure 4

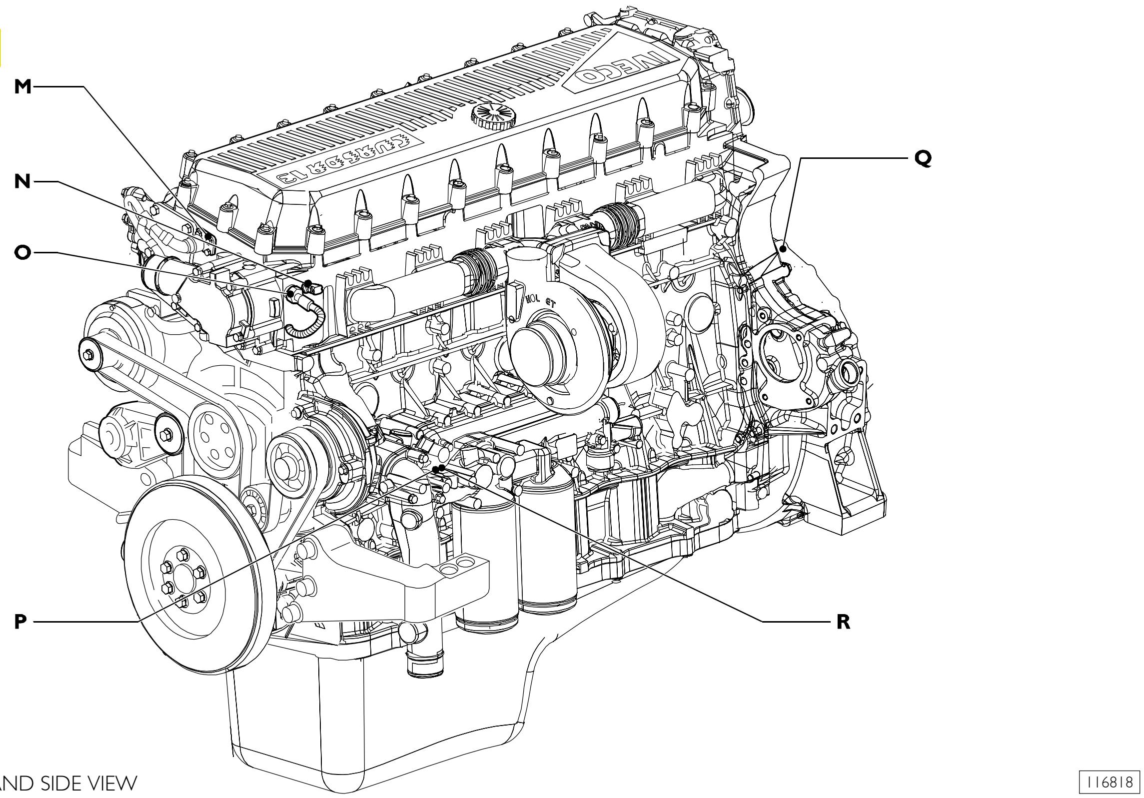


ENGINE LEFT-HAND SIDE VIEW

A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - 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.

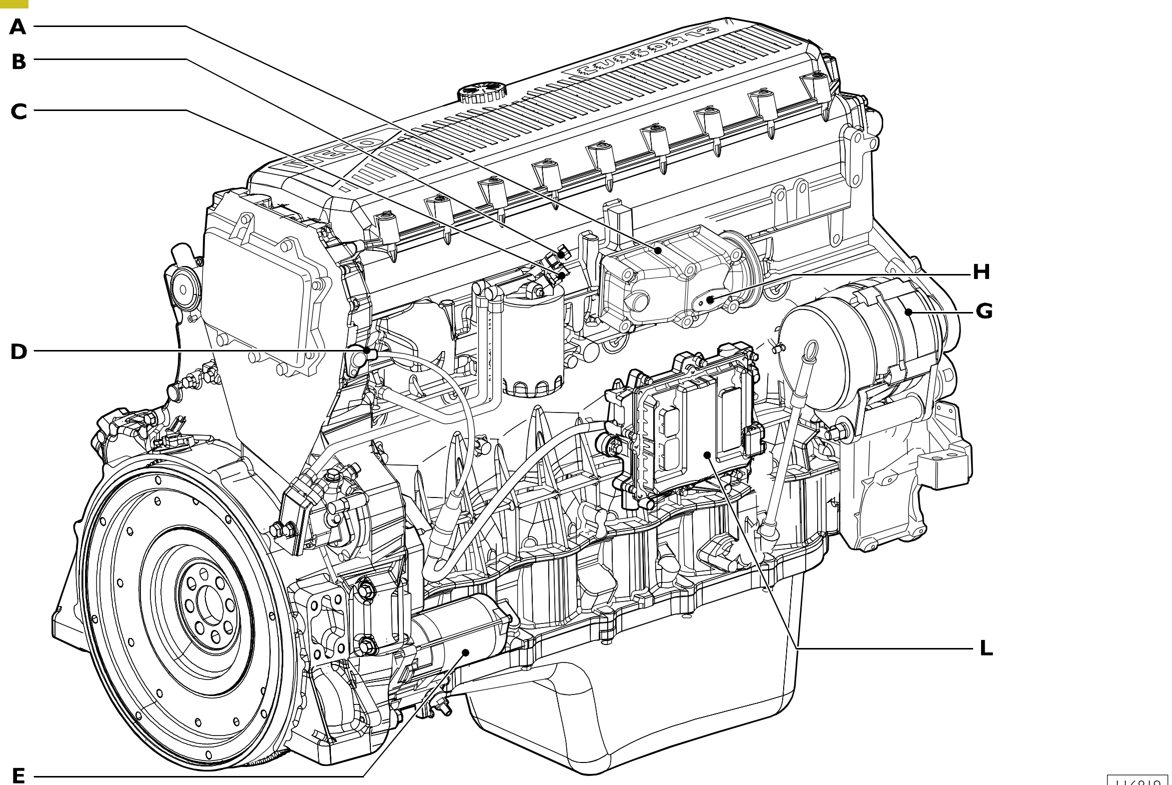
Components on the engine F3B (F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001)

Figure 5



ENGINE RIGHT-HAND SIDE VIEW

Figure 6

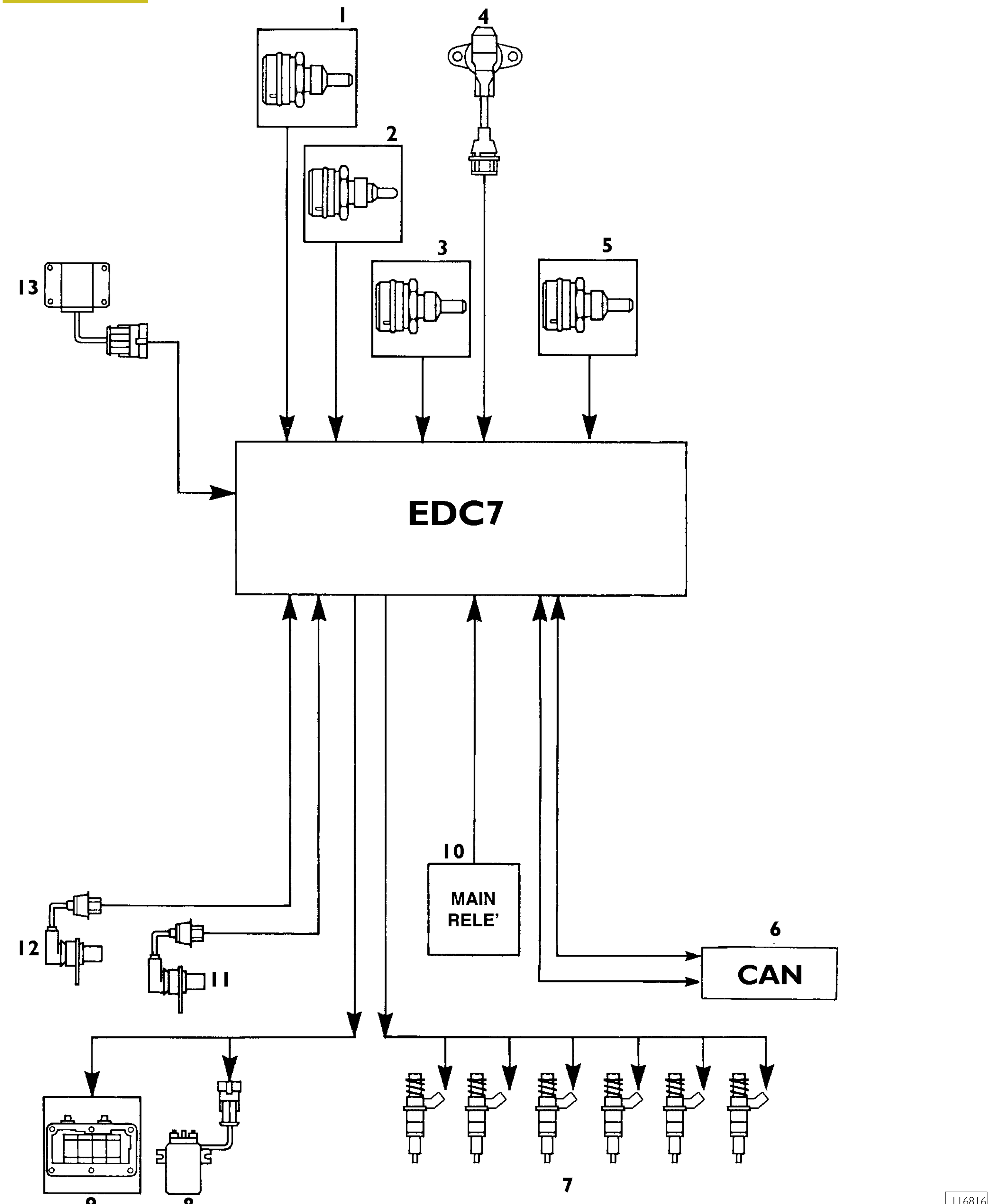


ENGINE LEFT-HAND SIDE VIEW

A. Resistance for engine warming - B. Fuel filter clogged signalling switch - C. Fuel temperature sensor - D. Engine rpm sensor on camshaft - E. Starter motor - 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

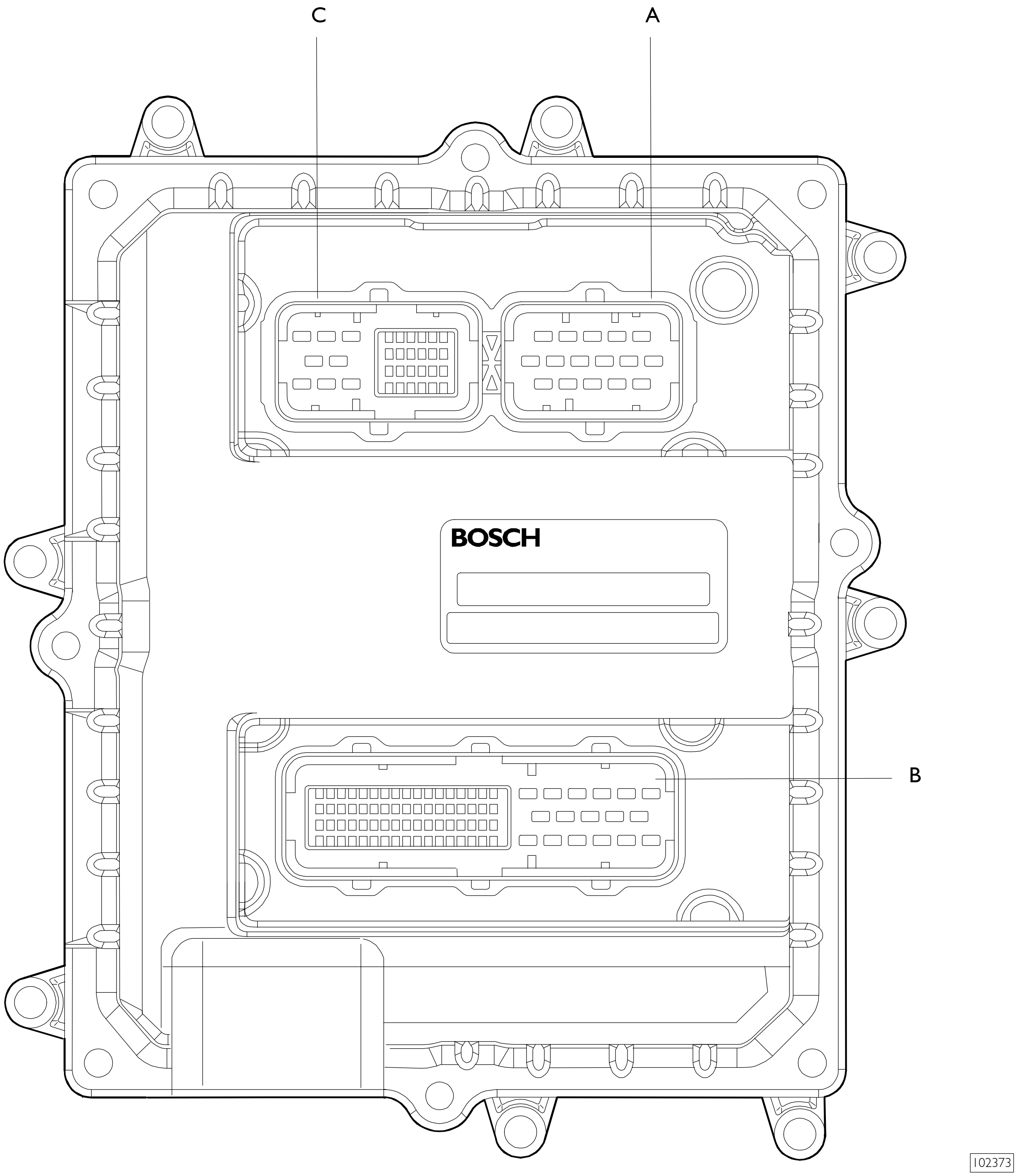


KEYS

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 UC31 electronic control unit

Figure 8

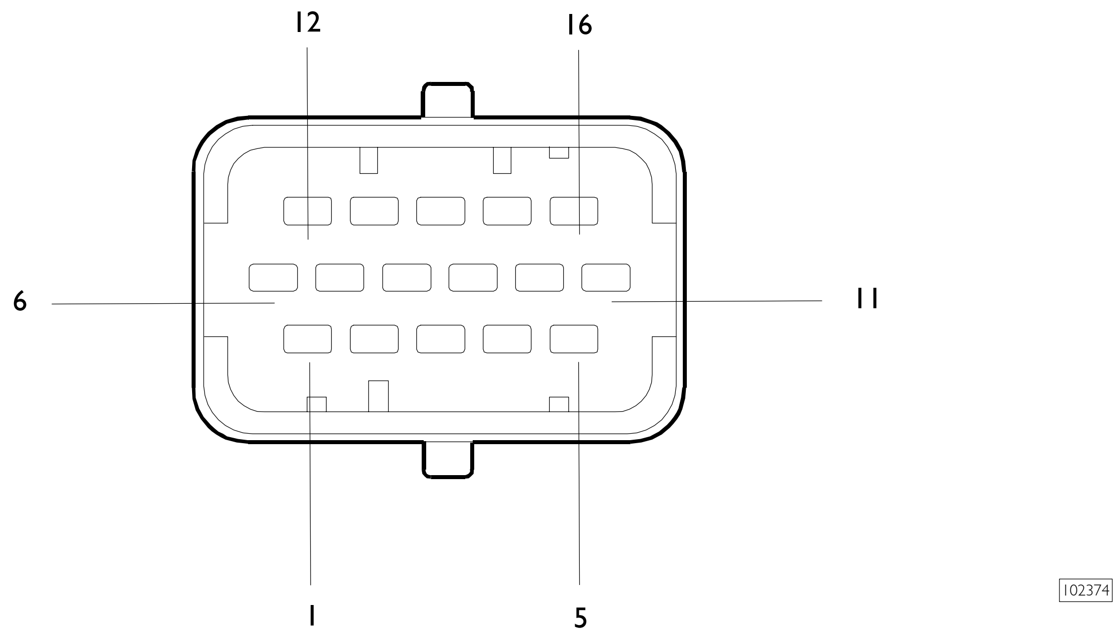


A. Electro-injector connector - B. Chassis connector - C. Sensor connector.

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

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

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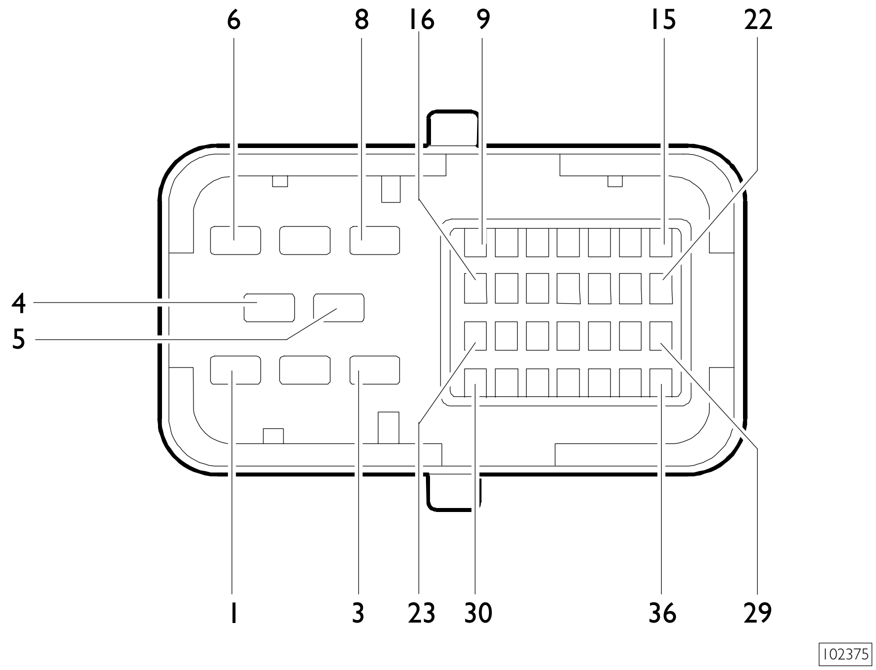
EDC control unit PIN-OUT

Sensor connector ”C”

Figure 10



Colour legend

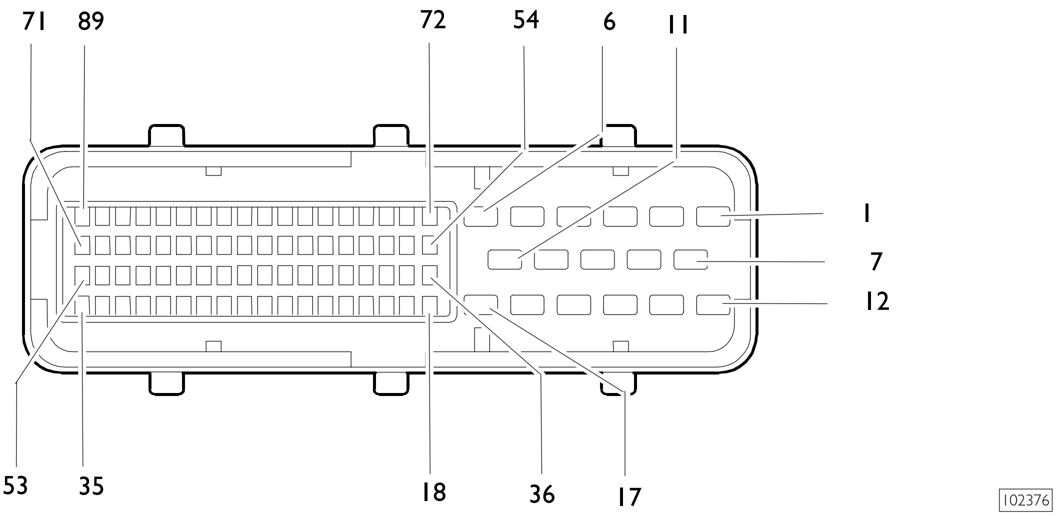
B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange
E	grey
K	pink

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

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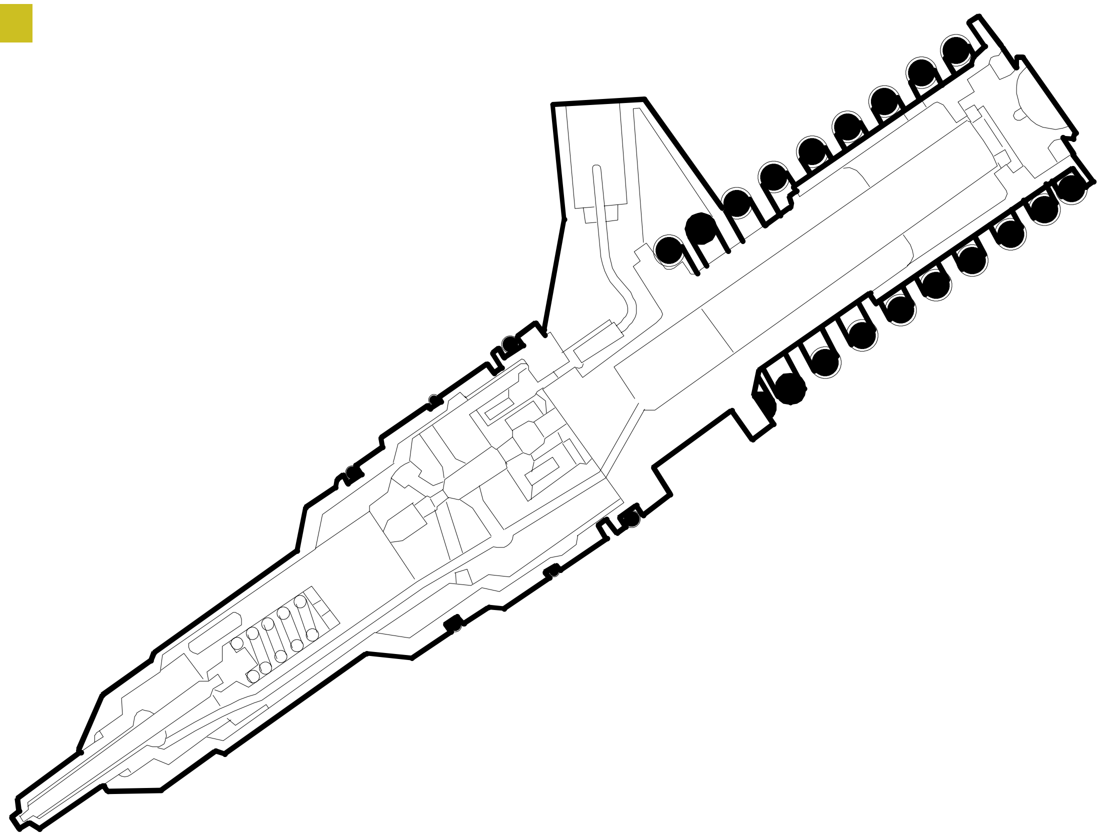
INJECTOR PUMP

Figure 12

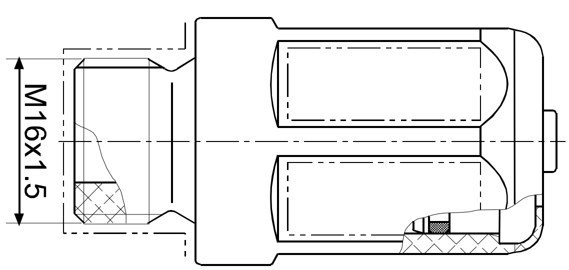


102405

N3.1 INJECTOR SECTION

The new N 3.1 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.

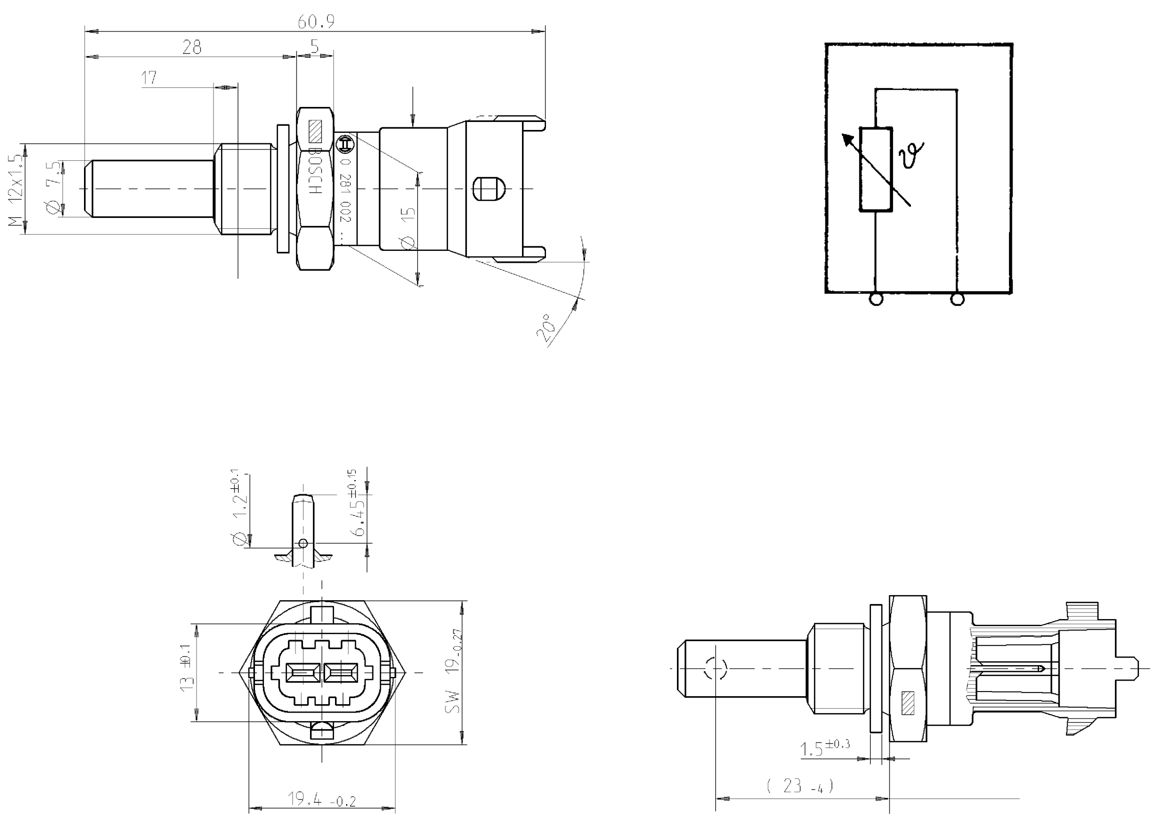
It is connected to electronic center pins 15/26.

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



104266

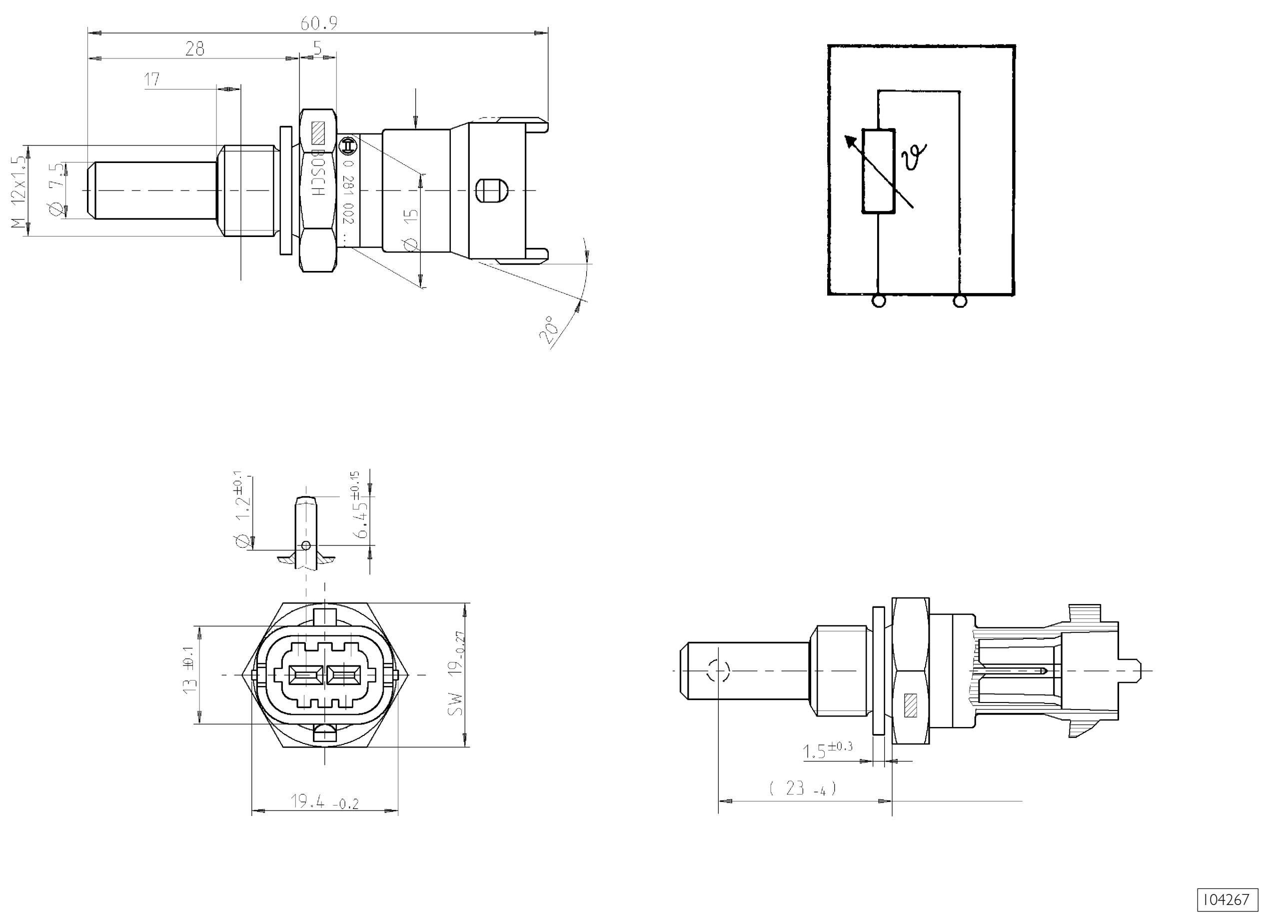
Description	Cable colour
To EDC center pin 15 (Sensor connector "C")	K
To EDC center pin 26 (Sensor connector "C")	Y

Fuel temperature sensor

Specifications

Supplier	BOSCH
Max. tightening torque	35 Nm

Figure 15



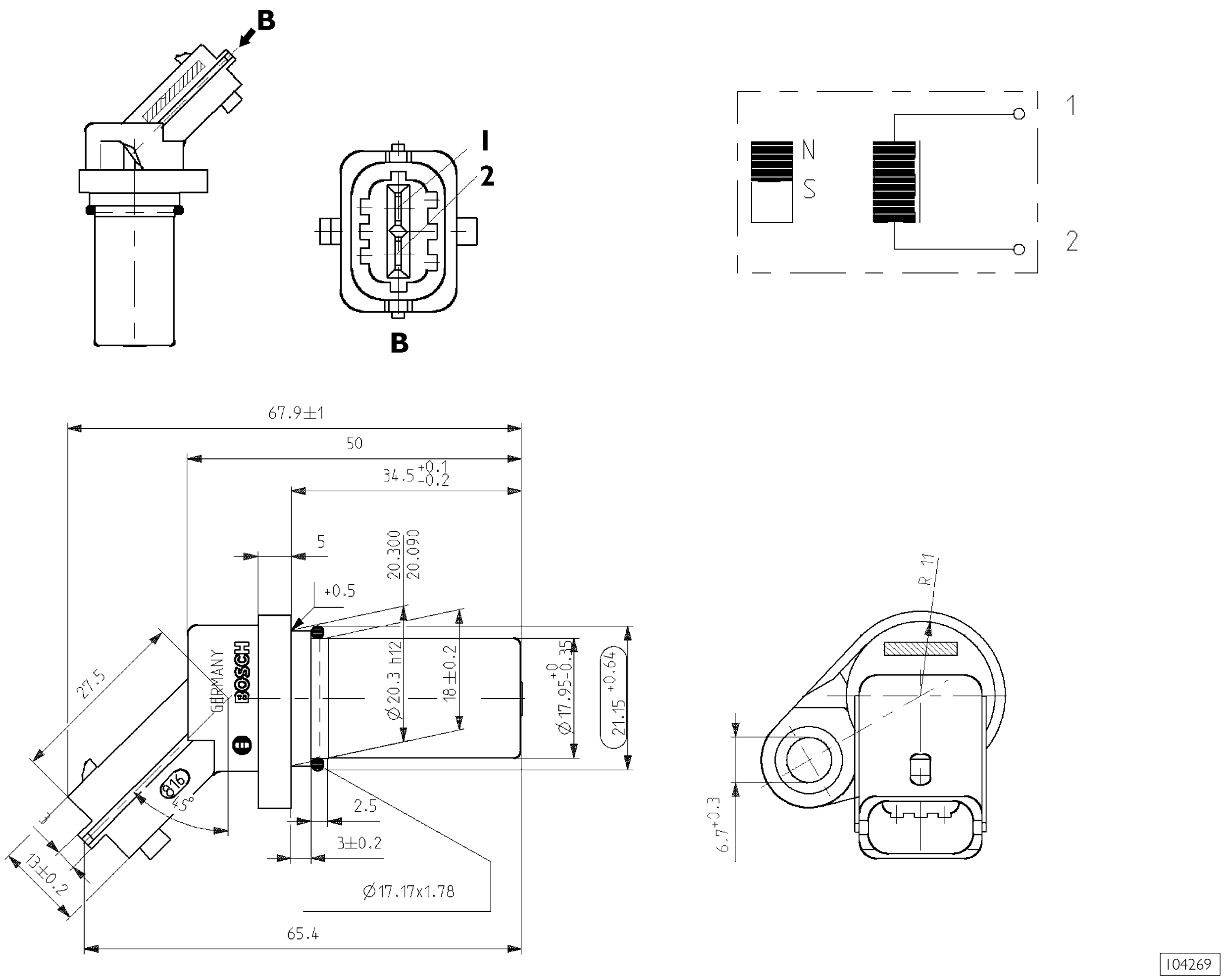
Description	Cable colour
To pin 18 of EDC control unit (Sensor connector "C")	O/B
To pin 35 of EDC control unit (Sensor connector "C")	W/R

Flywheel pulse transmitter

Specifications

Supplier	BOSCH
Max. tightening torque	8 ± 2 Nm

Figure 16



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 ± 2 Nm
Resistance	880 ÷ 920 Ω

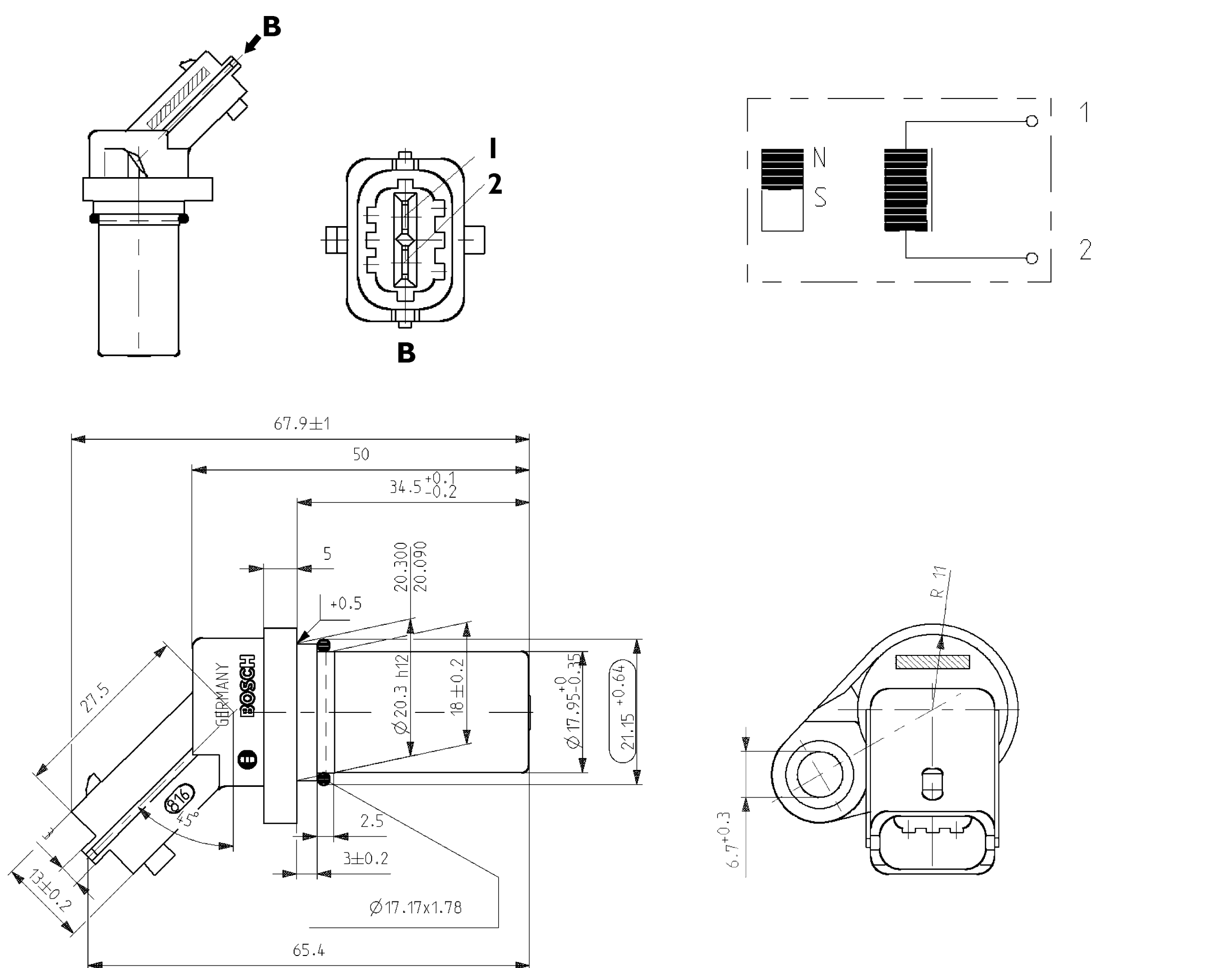
This induction type sensor located on the camshaft generates signals obtained from the magnetic flow lines that close through the 6 plus 1 phase teeth of a sound wheel mounted on the shaft.

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

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

This sensor's air gap is NOT ADJUSTABLE.

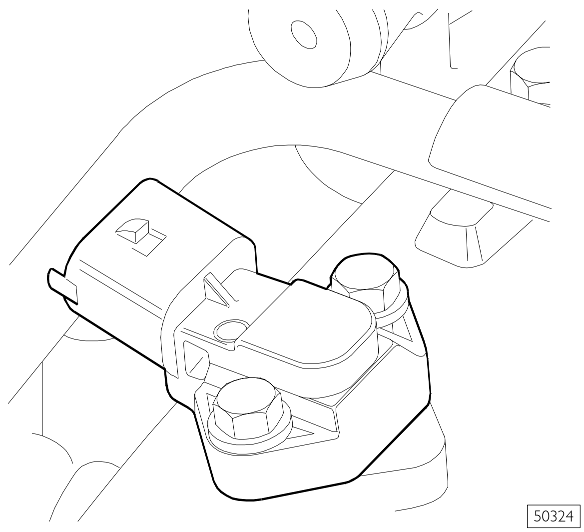
Figure 17



104269

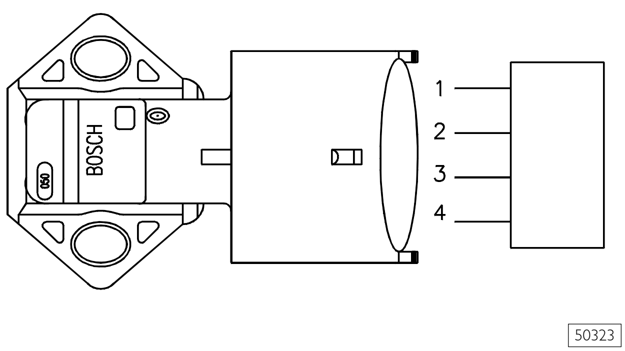
Description	Cable colour
To EDC center pin 9 (Sensor connector "C")	W
To EDC center pin 10 (Sensor connector "C")	R

Figure 18



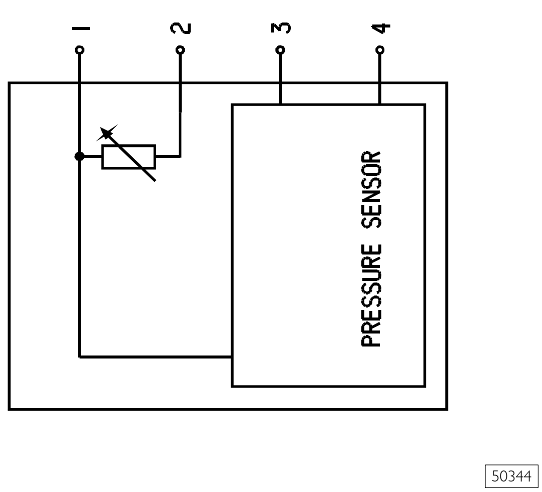
Sensor external view

Figure 19



Linking connector

Figure 20



Wiring diagram

Air pressure/temperature sensor (85156).

This component incorporates a temperature sensor and a pressure sensor.

IIt 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

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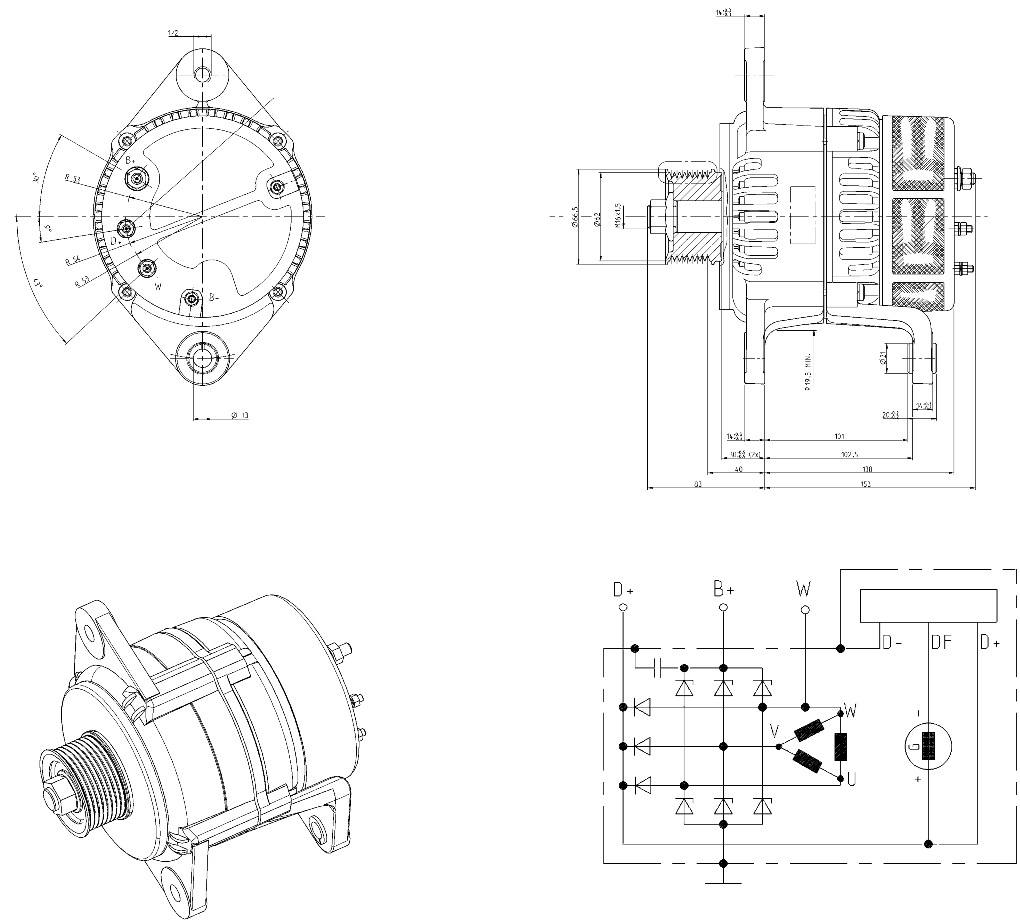
Alternator (For types: F3BE0684H*E901 - F3BE0684G*E901)

Supplier	ISKRA
Technical features	14V - 175A

Figure 21

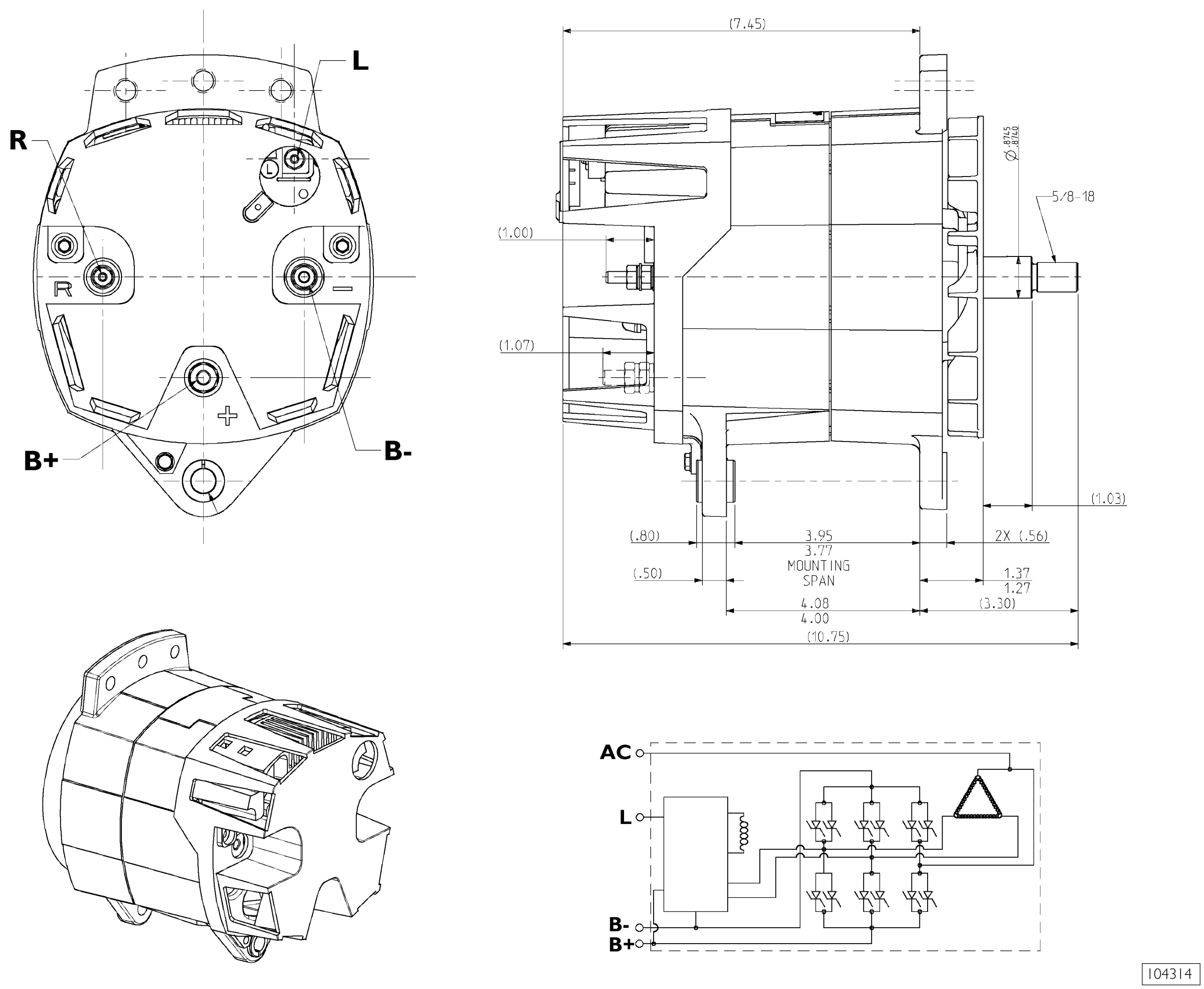


104313

Alternator (For type: F3BE0684J*E902)

Supplier	LEECE NEVILLE
Technical features	12V - 185A

Figure 22



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

Alternator (For types: F3BE9687A*E001 - F3BE9687B*E001 - F3BE9687C*E001)

Supplier	MITSUBISHI
Technical features	24V - 90A

Figure 23

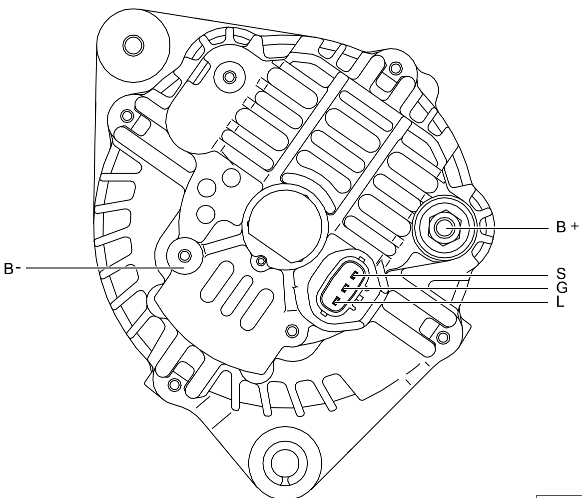


Figure 25

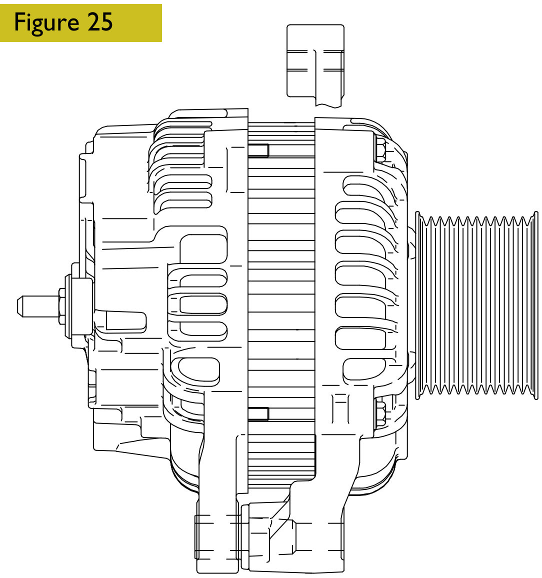


Figure 24

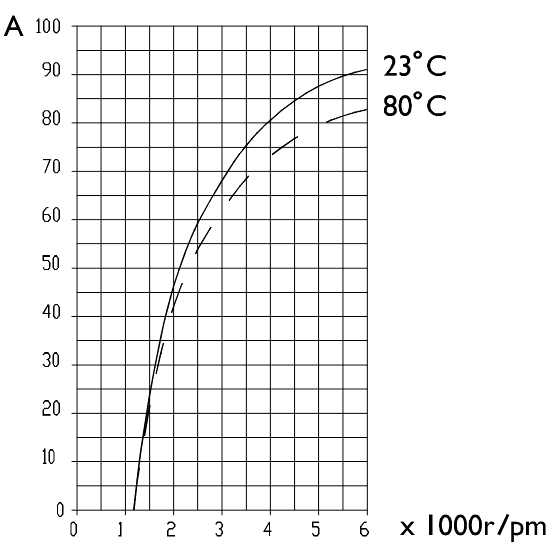
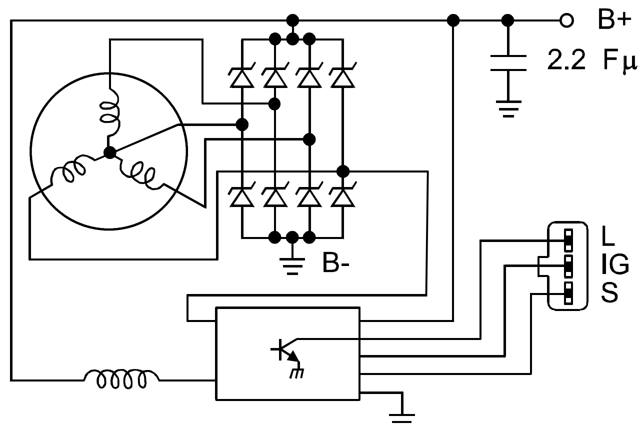


Figure 26



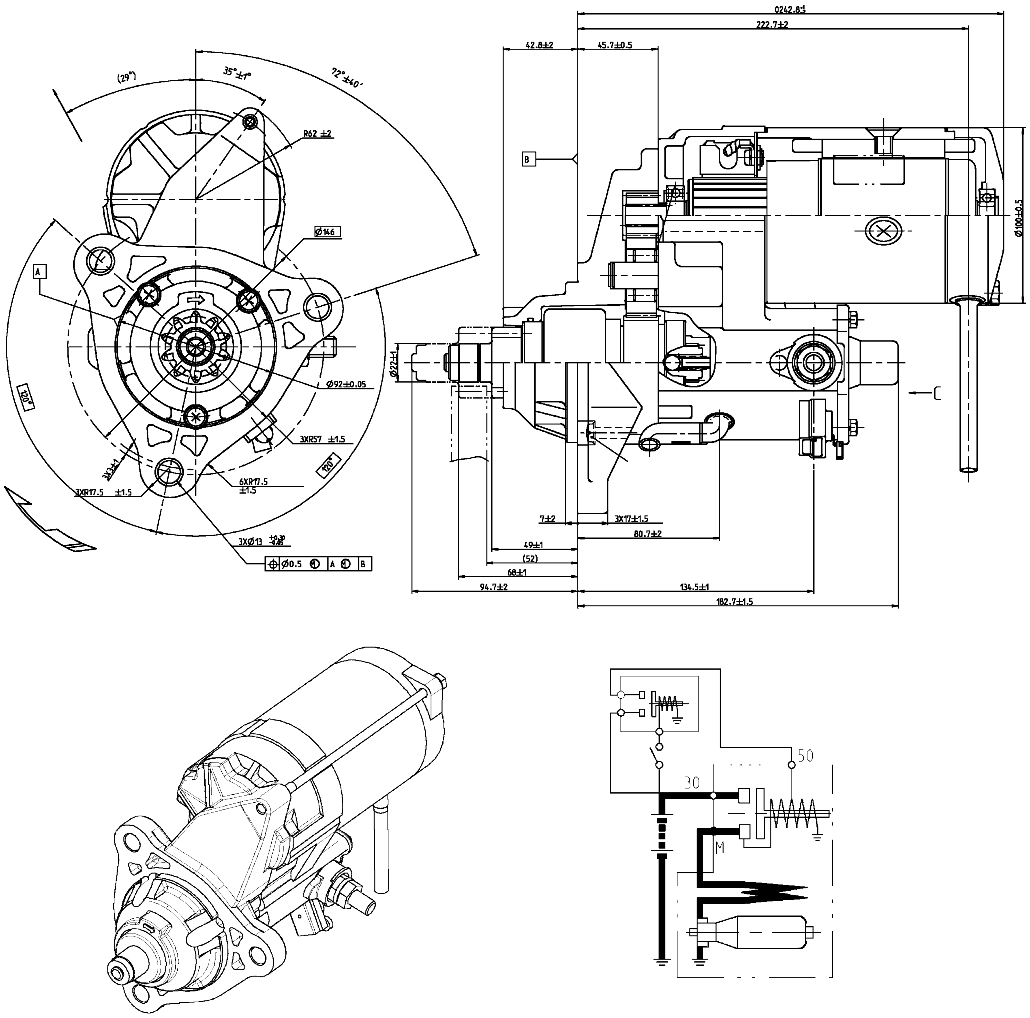
Pin	Description
S	+ 30
L	Battery recharge light
B-	Negative
B+	Positive
IG	+ 15

Starting motor

Specifications

Supplier	DENSO
Type	2280007550
Electrical system	24 Volt
Nominal output	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.

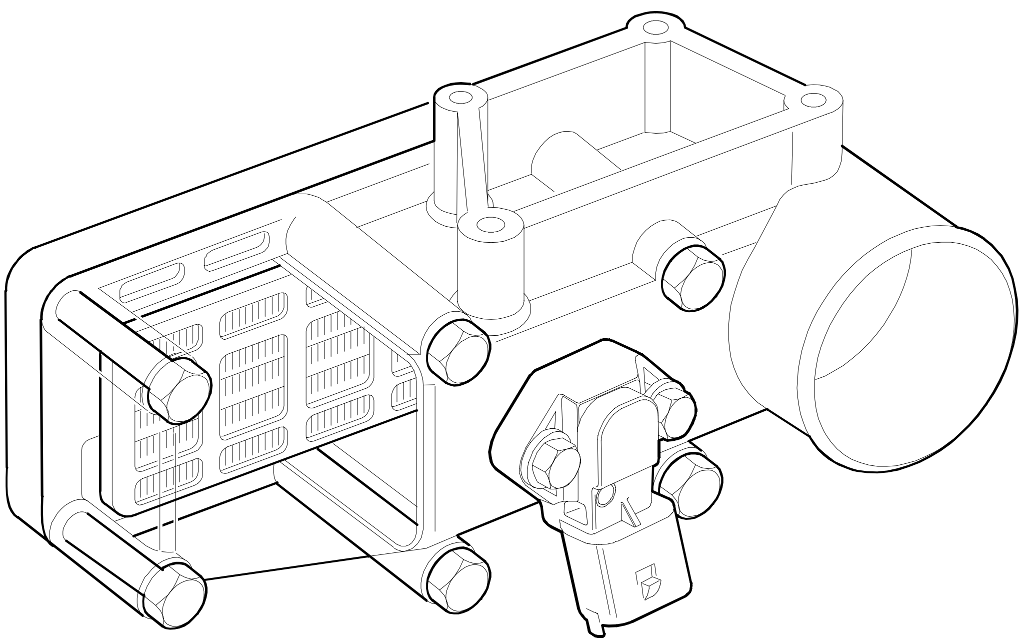
When the engine is running the warning light goes off, while the resistance is being fed for a certain time as a result of post-heating.

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 UC31 electronic center manages the following main functions:

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

It also enables:

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

Fuel dosing

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

The result can be corrected based on:
- water temperature

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

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

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

Delivery correction based on water temperature

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

Delivery correction to prevent noise, fumes or overloads

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

De-rating

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

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Injection lead electronic control

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

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

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

Engine start

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

Cold start

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

Hot start

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

Run Up

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

After Run

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

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

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

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

Repeated procedure interruptions could in fact lead to center damage.

Cut-off

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

Cylinder Balancing

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

Synchronization search

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

PART THREE - TROUBLESHOOTING

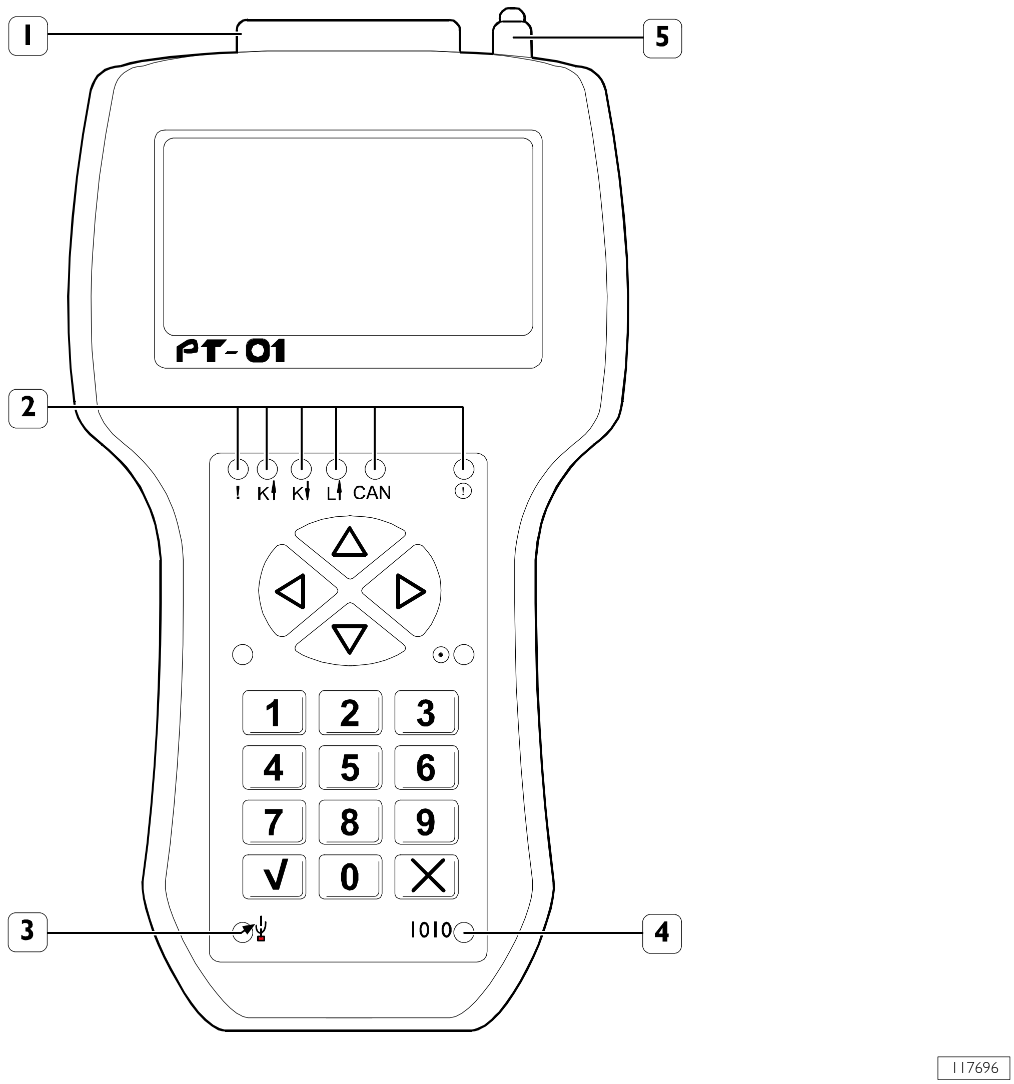
METHODS OF DIAGNOSIS

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).

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.

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PT-01 PORTABLE TESTER

Using PT-01 with portable tester it is possibile 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.

```
1 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)	
1.1.9	PLAUSIBILITY +15
1.1.A	PLAUSIBILITY +50
Vehicle 2 (Warning signals / Relays / Actuators)	
1.2.5	MAIN RELAY
1.2.6	BATTERY VOLTAGE
1.2.8	MAIN RELAY - BATTERY SHORTED
1.2.9	AIR CONDITIONER COMPRESSOR RELAY
1.2.B	RELAY OF THERMOSTARTER 1 (HEATER)
1.2.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)	
1.3.1	COOLANT TEMPERATURE SENSOR
1.3.2	COOLANT TEMPERATURE SENSOR (TEST)
1.3.3	AIR TEMPERATURE SENSOR SUPERCHARGE
1.3.4	AIR PRESSURE SENSOR SUPERCHARGE
1.3.5	FUEL TEMPERATURE SENSOR
1.3.8	OIL PRESSURE SENSOR
1.3.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)	
1.4.1	ENGINE SHAFT REV SENSOR
1.4.2	ENGINE RUNNING ONLY WITH CAMSHAFT SENSOR
1.4.3	CAMSHAFT SENSOR
1.4.4	PLAUSIBILITY BETWEEN FLYWHEEL SENSOR AND CAMSHAFT
Damage information	
1.4.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	
1.5.1	CYLINDER INJECTOR 1
1.5.2	CYLINDER INJECTOR 2
1.5.3	CYLINDER INJECTOR 3
1.5.4	CYLINDER INJECTOR 4
1.5.5	CYLINDER INJECTOR 5
1.5.6	CYLINDER INJECTOR 6

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DTC	Component failure
Injectors 1	
1.6.1	CYLINDER INJECTOR 1 / SHORT CIRCUIT
1.6.2	CYLINDER INJECTOR 2 / SHORT CIRCUIT
1.6.3	CYLINDER INJECTOR 3 / SHORT CIRCUIT
1.6.4	CYLINDER INJECTOR 4 / SHORT CIRCUIT
1.6.5	CYLINDER INJECTOR 5 / SHORT CIRCUIT
1.6.6	CYLINDER INJECTOR 6 / SHORT CIRCUIT
1.6.7	CYLINDER INJECTOR 1 / OPEN CIRCUIT
1.6.8	CYLINDER INJECTOR 2 / OPEN CIRCUIT
1.6.9	CYLINDER INJECTOR 3 / OPEN CIRCUIT
1.6.A	CYLINDER INJECTOR 4 / OPEN CIRCUIT
1.6.B	CYLINDER INJECTOR 5 / OPEN CIRCUIT
1.6.C	CYLINDER INJECTOR 6 / OPEN CIRCUIT
1.6.E	THE LEAST NUMBER OF INJECTIONS HAS NOT BEEN REACHED : ENGINE SHUT DOWN
Injectors 2	
1.7.1	BENCH 1 CC
1.7.3	BENCH 2 CC
1.7.C	BENCH 1 INJECTOR CHECK (IN CONTROL UNIT)
1.7.F	INJECTED QUANTITY EVALUATION ERROR (NIMA PROGRAM)
2.7.C	BENCH 2 INJECTOR CHECK (IN CONTROL UNIT)
Supercharging system and turbine speed	
1.9.E	TORQUE RESTRICTION FOR SMOKE LIMITATION
Interfaces 1 (CAN-Bus)	
1.B.1	ERROR ON CAN CONTROLLER A
1.B.3	ERROR ON CAN CONTROLLER C
1.B.5	TIMEOUT CAN MESSAGE VM2EDC
2.B.4	TIMEOUT CAN MESSAGE BC2EDC2
Interfacce 2 (Can line timeout messages)	
1.C.6	MESSAGE CAN TSC1-PE ERROR
1.C.8	MESSAGE CAN TSC1-VE ERROR
2.C.6	MESSAGE CAN TSC1-VE ERROR
3.C.8	MESSAGE CAN TSC1-VE (passive) ERROR
ECU 1 (internal checks)	
1.D.1	CONTROL UNIT INTERNAL ERROR
1.D.2	CONTROL UNIT INTERNAL ERROR
1.D.3	CONTROL UNIT INTERNAL ERROR
1.D.4	CONTROL UNIT INTERNAL ERROR
1.D.5	CONTROL UNIT INTERNAL ERROR
1.D.6	CONTROL UNIT INTERNAL ERROR (TPU)
1.D.7	CONTROL UNIT INTERNAL ERROR (VARIANT AREA)
1.D.8	CONTROL UNIT INTERNAL ERROR
1.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)	
1.E.3	CONTROL UNIT INTERNAL MONITORING ERROR
1.E.4	CONTROL UNIT INTERNAL MONITORING ERROR
1.E.5	ERRORE SENSOR SUPPLY (12V)
1.E.6	SENSOR SUPPLY 1
1.E.7	SENSOR SUPPLY 2
1.E.8	SENSOR SUPPLY 3
1.E.9	CONTROL UNIT INTERNAL ERROR
1.E.A	CONTROL UNIT INTERNAL ERROR
1.E.B	ATM. PRESSURE SENSOR

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

SIGNALLED ANOMALY	BLINK CODE	EDC WAR-NING LIGHT	POSSIBLE CAUSE	POSSIBLE RELATED ANOMALIES	RECOMMENDED TESTS OR MEASURES	REMARKS
The engine does not reach the other speeds under load conditions.	-	-	The boosting pressure sensor provides too high values, which, in any case, fall within the range.	Smoke.		
The driver feels that the engine is not working correctly like it did before.	-	-	Impaired hydraulic performance of an injector.		Engine test: check-up	Replace the injector of the cylinder in which Modus detects lower performance levels (compared with the others) only after verify-ing 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 adjust-ment, 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 de-tects lower performance levels (compared with the others).
Replace the injector of the cylinder in which the diagnosis instrument de-tects 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 de-tects 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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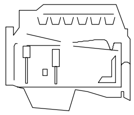
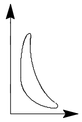
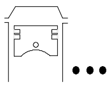
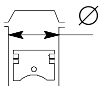
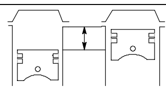
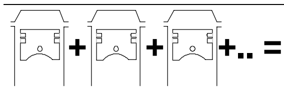
GENERAL CHARACTERISTICS

	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

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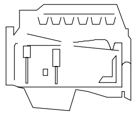
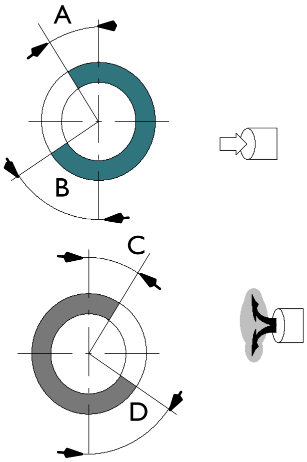
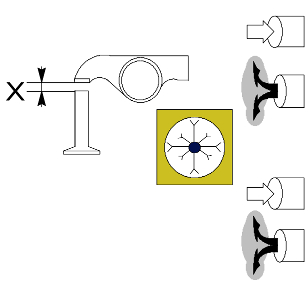
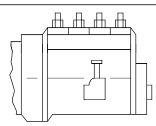
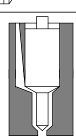
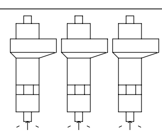
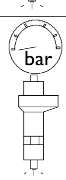
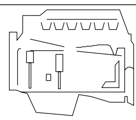
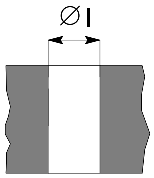
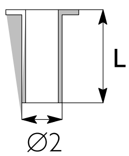
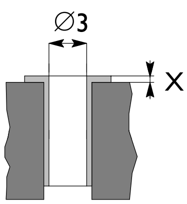
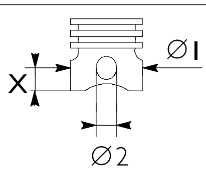
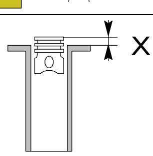
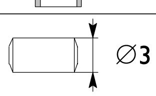
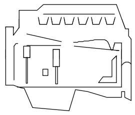
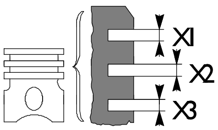
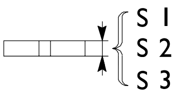
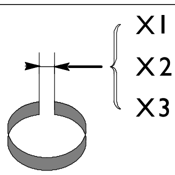
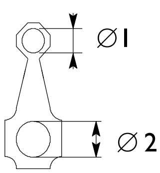
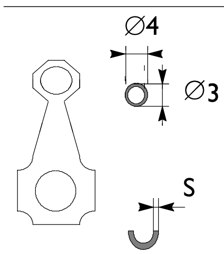
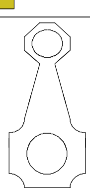
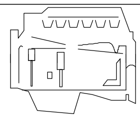
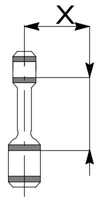
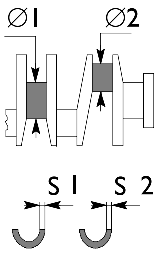
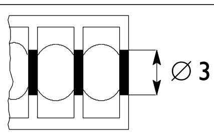
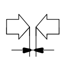
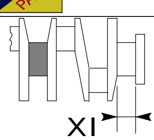
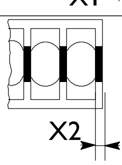
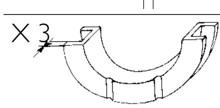
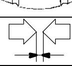
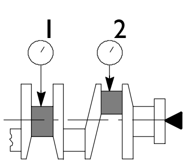
	Type	**F3B**
	VALVE TIMING opens before T.D.C. A closes after B.D.C. B opens before B.D.C. D closes after T.D.C. C	 17° 30° 50° 9°
	For timing check X { mm mm Running X { mm mm	 - - 0.35 to 0.45 0.45 to 0.55
	FEED	Through fuel pump - filters
	Injection type: Bosch	With electronically regulated injectors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

ASSEMBLY CLEARANCE DATA

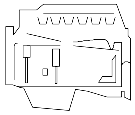
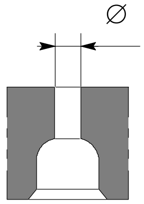
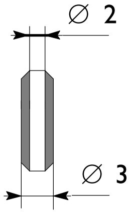
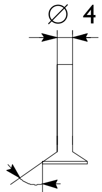
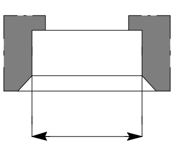
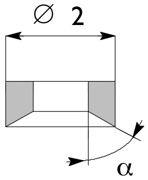
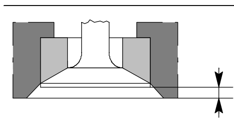
	Type		**F3B**
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS			mm
	Bores for cylinder liners: Ø1	upper lower	153.500 to 153.525 152.000 to 152.025
	Cylinder liners: external diameter: Ø2 length	upper lower L	153.461 to 153.486 151.890 to 151.915 -
	Cylinder liners - crankcase bores	upper lower	0.014 to 0.039 0.085 to 0.135
IVECO PARTS >	External diameter	Ø2	-
 * Selection class * Under a load of 800 N	Cylinder sleeve inside diameter inside diameter Protrusion	Ø3A* Ø3B* X	135.000 to 135.013 135.011 to 135.024 0.045 to 0.075
	Pistons: measuring dimension external diameter external diameter pin bore	X Ø1A● Ø1B●● Ø2	18 134.861 to 134.873 134.872 to 134.884 54.010 to 54.018
* Selection class	Piston - cylinder sleeve	A* B*	0.127 to 0.151 0.127 to 0.151
IVECO PARTS <	Piston diameter	Ø1	-
	Pistons protrusion	X	0.12 to 0.42
	Gudgeon pin	Ø3	53.994 to 54.000
	Gudgeon pin - pin housing		0.010 to 0.024

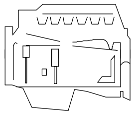
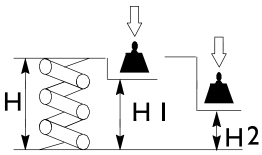
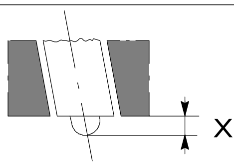
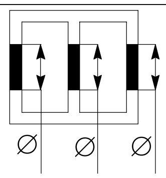
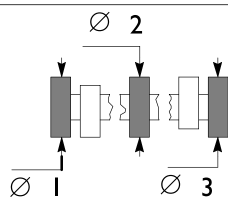
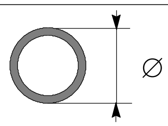
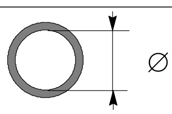
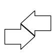
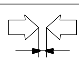
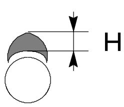
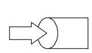
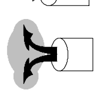
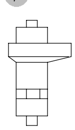
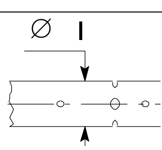
● Class A pistons supplied as spares.
●● Class B pistons are fitted in production only and are not supplied as spares.

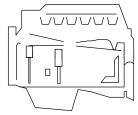
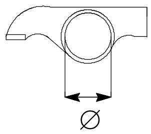
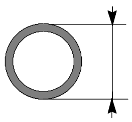
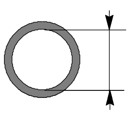
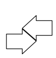
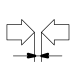
	Type		F3B mm
	Piston ring grooves	X1 X2 X3	3.100 to 3.120 1.550 to 1.570 5.020 to 5.040
	Piston rings: trapezoidal seal lune seal milled scraper ring with slits and internal spring * measured on Ø of 130 mm	S1* S2 S3	3.000 1.470 to 1.500 4.970 to 4.990
	Piston rings - grooves	1 2 3	0.100 to 0.120 0.050 to 0.100 0.030 to 0.070
IVECO PARTS	Piston rings		-
	Piston ring end gap in cylinder liners	X1 X2 X3	0.40 to 0.50 0.65 to 0.80 0.40 to 0.75
	Small end bush housing nominal Big end bearing housing nominal - Class - Class - Class	Ø1 Ø2 1 2 3	59.000 to 59.030 94.000 to 94.030 94.000 to 94.010 94.011 to 94.020 94.021 to 94.030
	Small end bush diameter outside inside Big end bearing shell Red Green Yellow	Ø4 Ø3 S	59.085 to 59.110 54.019 to 54.035 1.965 to 1.975 1.976 to 1.985 1.986 to 1.995
	Small end bush - housing		0.055 to 0.110
	Piston pin - bush		0.019 to 0.041
IVECO PARTS	Big end bearing		0.127 - 0.254 - 0.508
	Connecting rod weight		g.
	Class	A B C	4756 to 4795 4796 to 4835 4836 to 4875

	Type		F3B mm
	Measuring dimension	X	125
	Max. connecting rod axis misalignment tolerance	═	0.08
	Main journals - rated value - class - class - class	Ø1 1 2 3	 99.970 to 100.000 99.970 to 99.979 99.980 to 99.989 99.990 to 100.000
	Crankpins - rated value - class - class - class	Ø2 1 2 3	 89.970 to 90.000 89.970 to 89.979 89.980 to 89.989 89.990 to 90.000
	Main bearing shells Red Green Yellow*	S1	 3.110 to 3.120 3.121 to 3.130 3.131 to 3.140
	Big end bearing shells Red Green Yellow*	S2	 1.965 to 1.975 1.976 to 1.985 1.986 to 1.995
	Main bearing housings - rated value - class - class - class	Ø3 1 2 3	 106.300 to 106.330 106.300 to 106.309 106.310 to 106.319 106.320 to 106.330
	Bearing shells - main journals		0.060 to 0.100
	Bearing shells - big ends		0.050 to 0.090
IVECO PARTS	Main bearing shells		0.127 - 2.254 - 0.508
	Big end bearing shells		0.127 - 2.254 - 0.508
	Main journal, thrust bearing	X1	47.95 to 48.00
	Main bearing housing, thrust bearing	X2	40.94 to 40.99
	Thrust washer halves	X3	3.38 to 3.43
	Crankshaft end float		0.10 to 0.30
	Alignment	═ 1 - 2	≤ 0.025
	Ovalization	⬭ 1 - 2	0.010
	Taper	1 - 2	0.010

* Fitted in production only and not supplied as spares

	Type	**F3B**
CYLINDER HEAD - VALVE TRAIN		mm
 Ø 1	Valve guide housings in cylinder head Ø1	15.980 to 15.997
 Ø 2 Ø 3	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
IVECO PARTS	Valve guide	-
 Ø 4 α	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
 Ø 1	Valve seat in head Ø1 Ø1	 49.185 to 49.220 46.985 to 47.020
 Ø 2 α	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′
 X	Recessing of valve X X	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 under a load of: 575 ± 28 N 1095 ± 54 N	 H H1 H2	 73.40 59 45
	Injector protrusion	X	0.53 to 1.34
	Camshaft bushing housing in the cylinder head: 1 ⇒ 7	Ø	88.000 to 88.030
	Camshaft bearing journals: 1 ⇒ 7	Ø	82.950 to 82.968
	Outer diameter of camshaft bushings:	Ø	88.153 to 88.183
	Inner diameter of camshaft bushings:	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
 Ø	Bushing outer diameter for rocker arms	45.090 to 45.130 59.100 to 59.140 46.066 to 46.091
 Ø	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		HOLSET HX55
End float		-
Radial play		-

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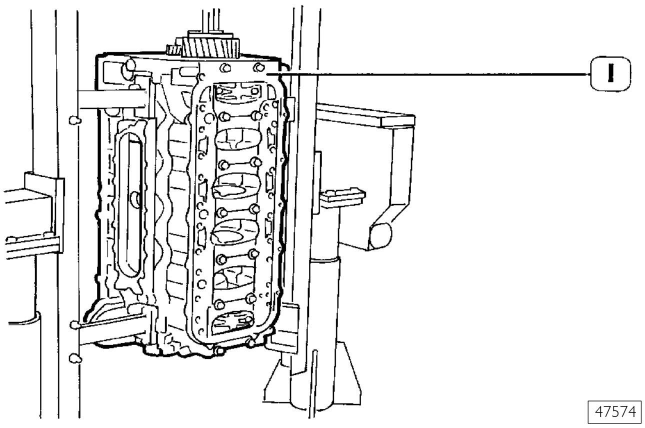
ENGINE OVERHAUL
ENGINE REMOVAL AT THE BENCH

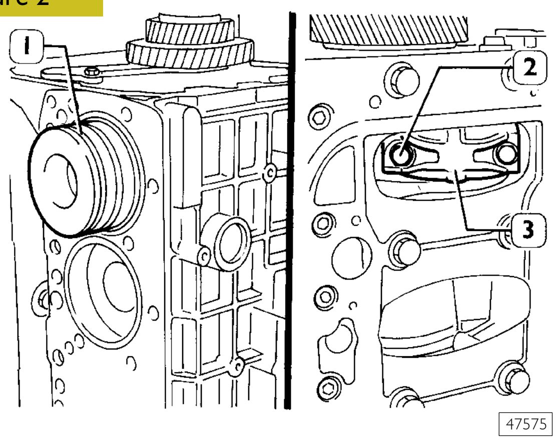
The following instructions are prescribed on the understanding that the engine has previously been placed on the rotating bench and that removal of all specific components of the equipment have been already removed as well. (See Section 3 of the manual herein).
The section illustrates therefore all the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

Figure 1



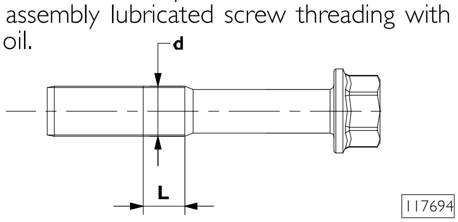
Rotate the block (1) to the vertical position.

Figure 2



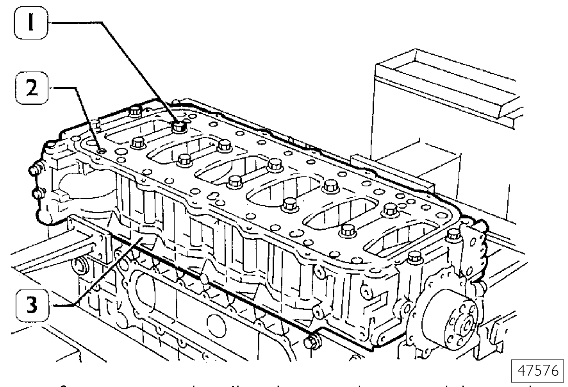
Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston assembly from the upper side. Repeat these operations for the other pistons.

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.

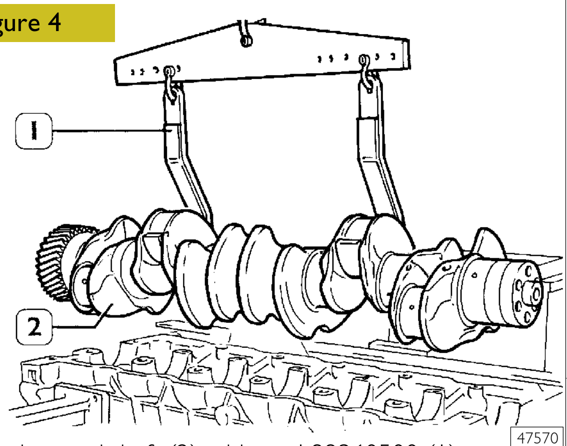
Figure 3



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

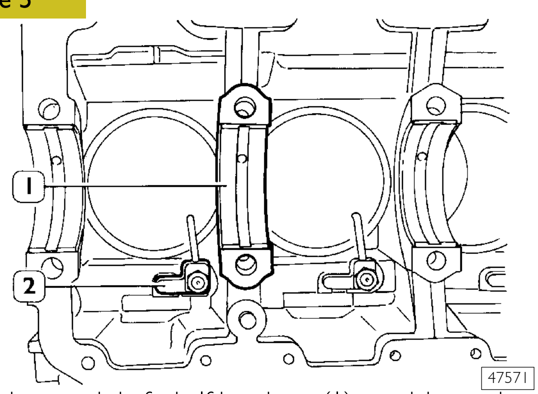
NOTE Note down the assembly position of the top and bottom main bearing shells since, if reusing them, they will need to be fitted in the position found upon removal.

Figure 4



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

Figure 5

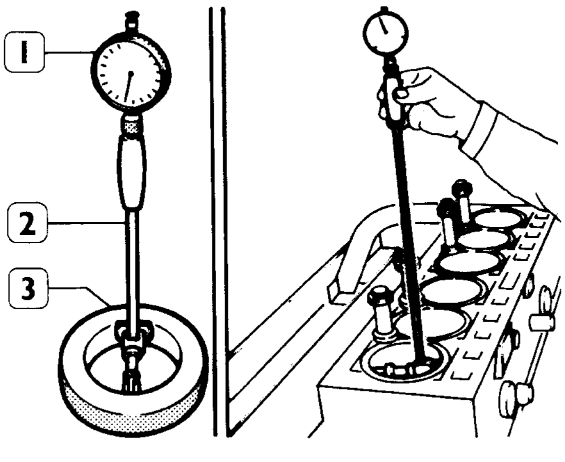


Remove the crankshaft half-bearings (1), untighten the screws and remove oil spray nozzles (2).
Take down cylinder liners as specified in the relative paragraph on page 14.

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)

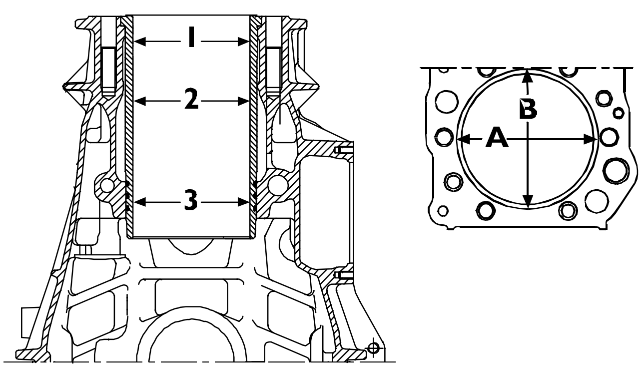


34994

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

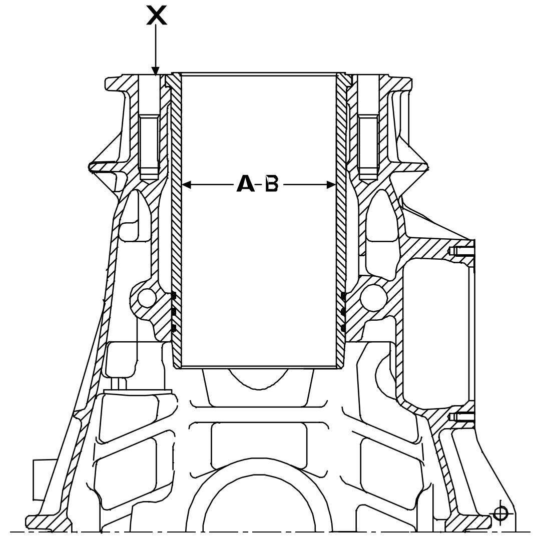


60596

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



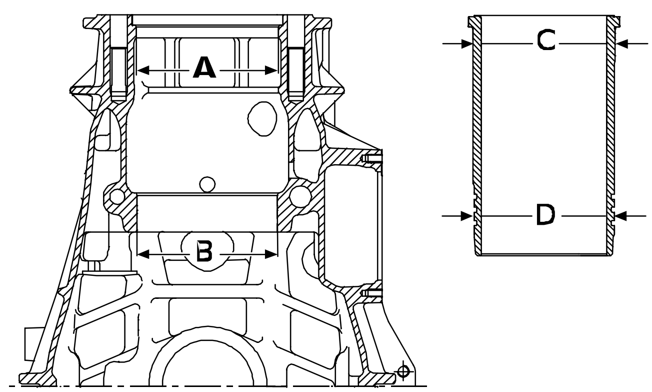
60595

A = Selection class Ø 135.000 to 135.012 mm
B = Selection class Ø 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 = Ø 153.500 to 153.525 mm
B = Ø 152.000 to 152.025 mm
C = Ø 153.461 to 153.486 mm
D = Ø 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.

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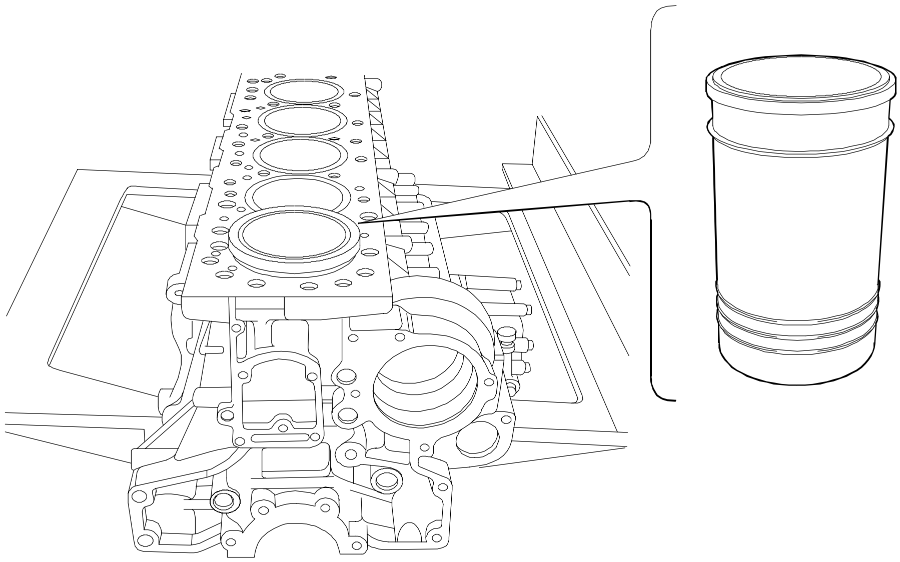
Cylinder liners

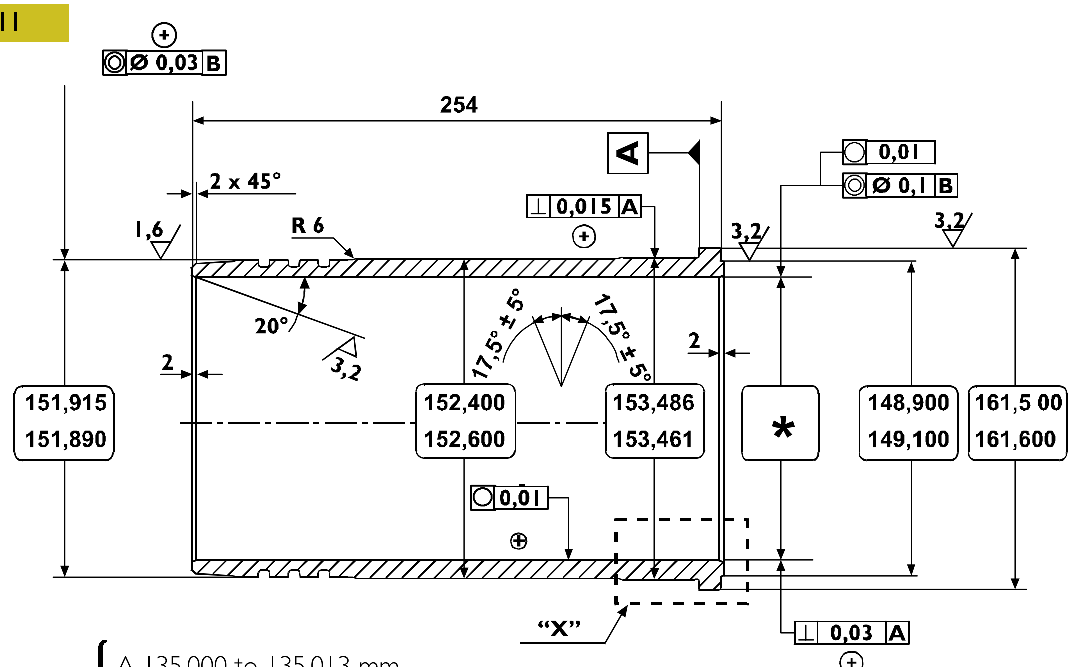
Figure 10



60598

CRANKCASE ASSEMBLY WITH CYLINDER LINERS

Figure 11

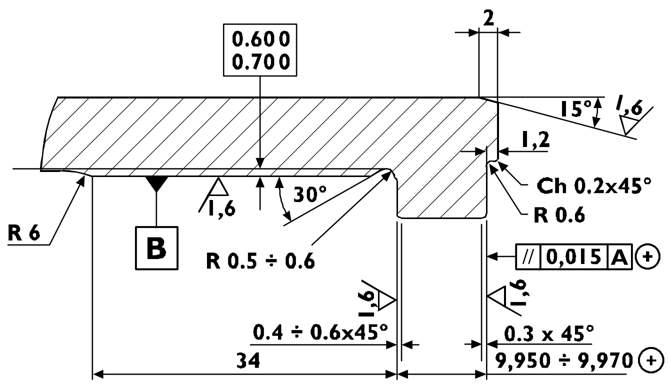


101503

Selection class A 135.000 to 135.013 mm
B 135.011 to 135.024 mm

MAIN CYLINDER LINER DATA

Figure 12

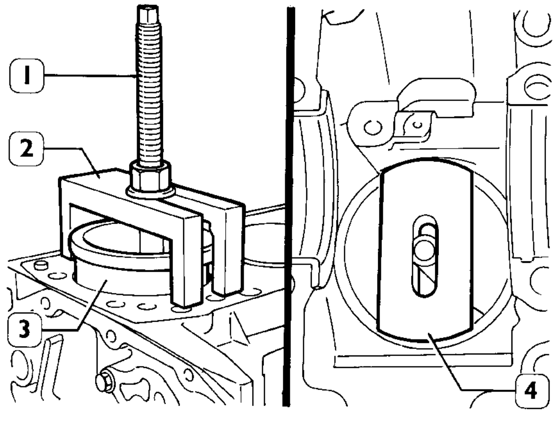


101502

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

Replacing cylinder liners
Removal

Figure 13

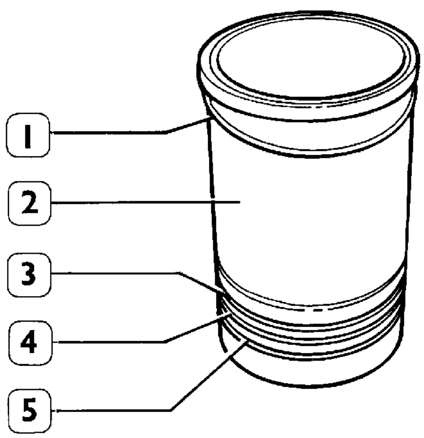


47577

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

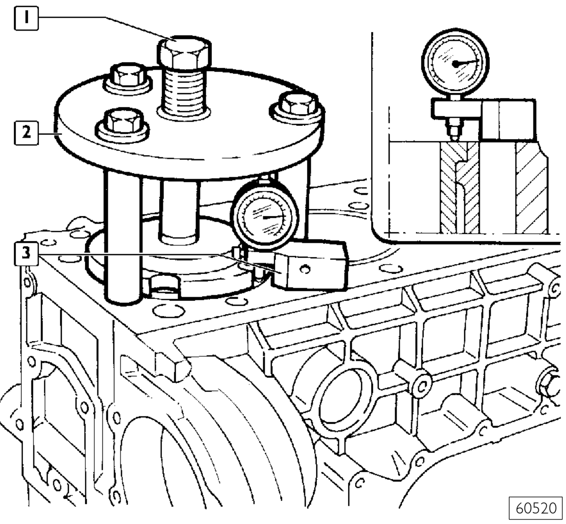


16798

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.

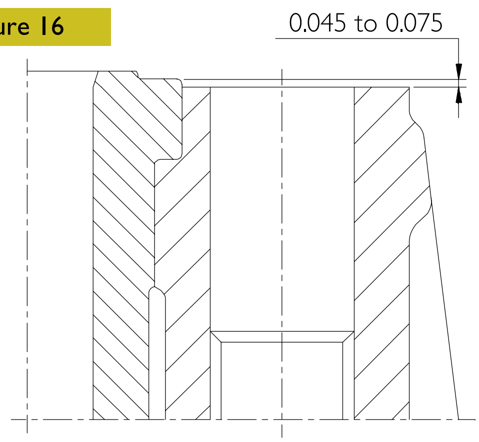
Figure 15



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.

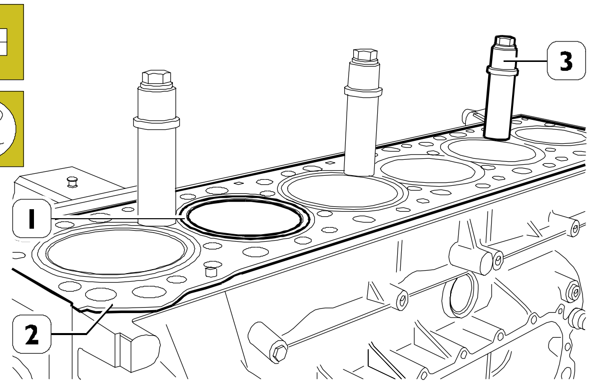
Figure 16



49017

CYLINDER LINER PROTRUSION

Figure 17

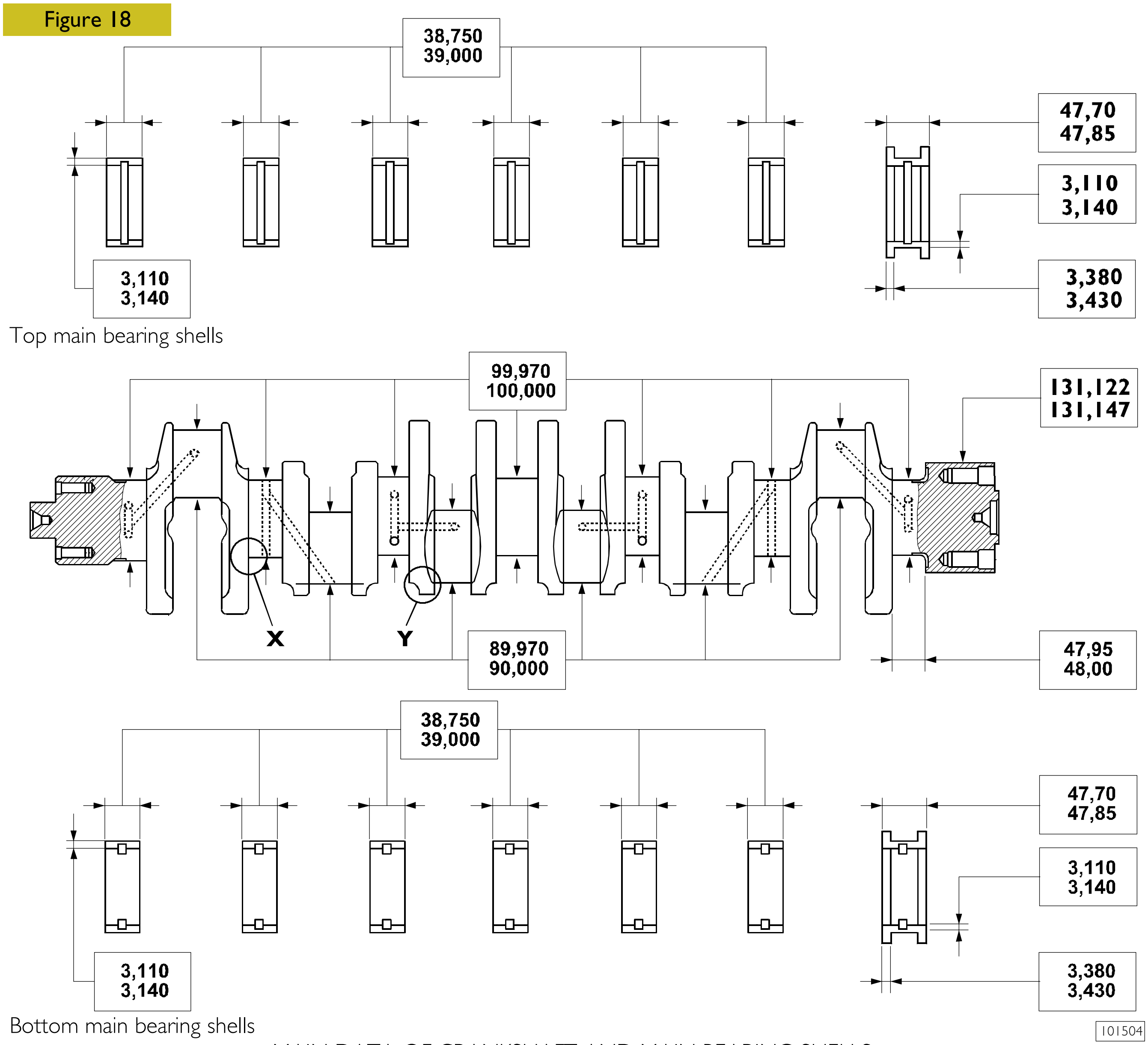


60521

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

Crankshaft

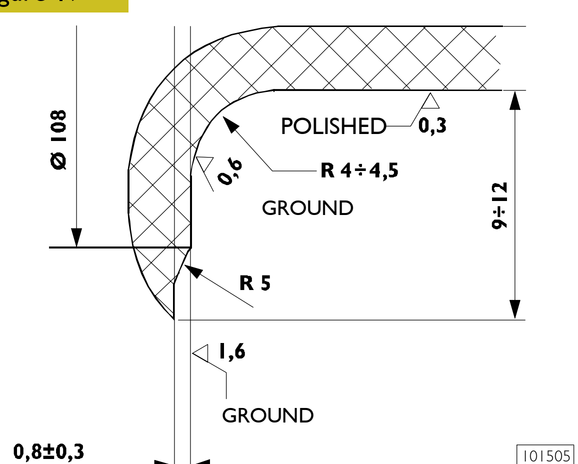
Figure 18



MAIN DATA OF CRANKSHAFT AND MAIN BEARING SHELLS

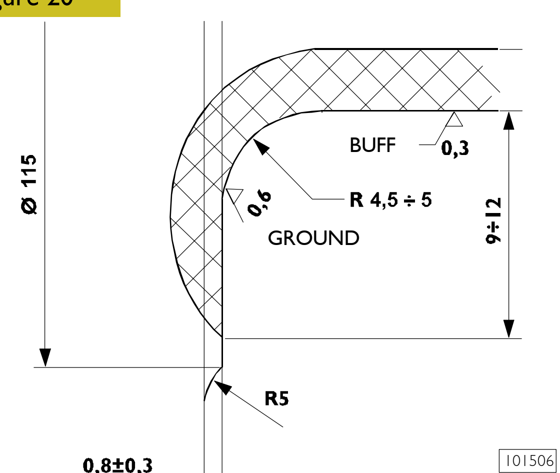
Check the state of the main journals and crankpins of the crankshaft. They must not be scored or be too ovalized or worn. The data given refer to the normal diameter of the journals.

Figure 19



X. Detail of the main journal unions

Figure 20

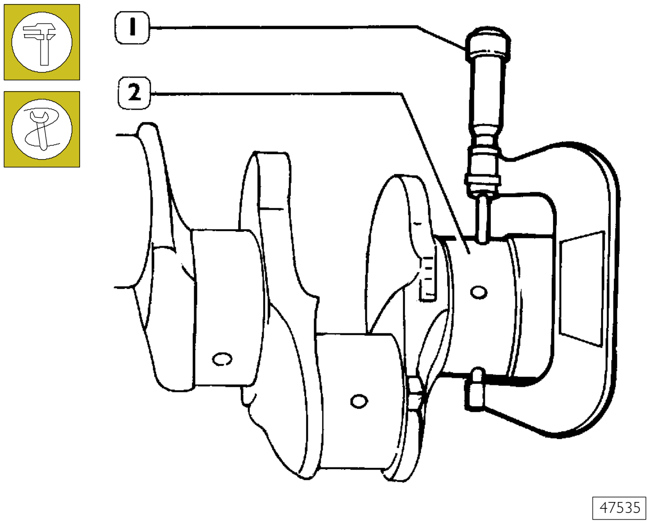


Y. Detail of the crankpin unions

Measuring the main journals and crankpins

Before grinding the journals, use a micrometric gauge (1) to measure the journals of the shaft (2) and establish, on the basis of the undersizing of the spare bearing shells, to what diameter it is necessary to reduce the journals.

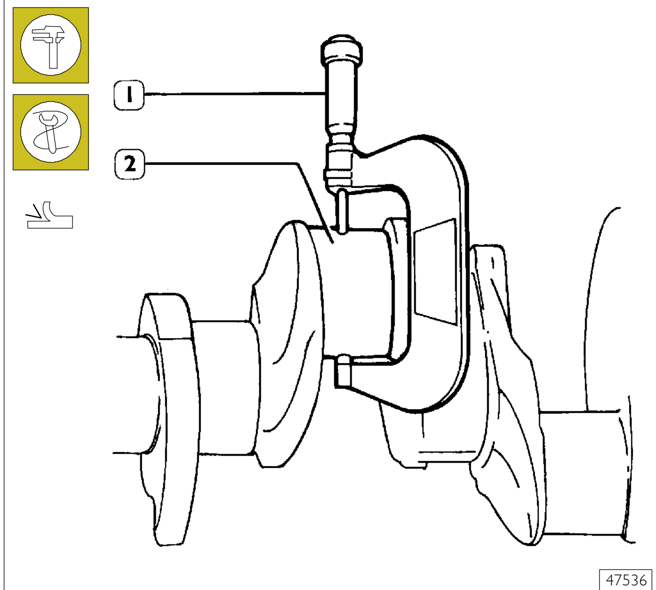
Figure 21



MEASURING THE MAIN JOURNALS

NOTE It is advisable to note the measurements in a table (Figure 22).

Figure 22



MEASURING CRANKPINS

When grinding, pay the utmost attention to the values of the unions of the main journals and of the crankpins given in Figure 19 and Figure 20.

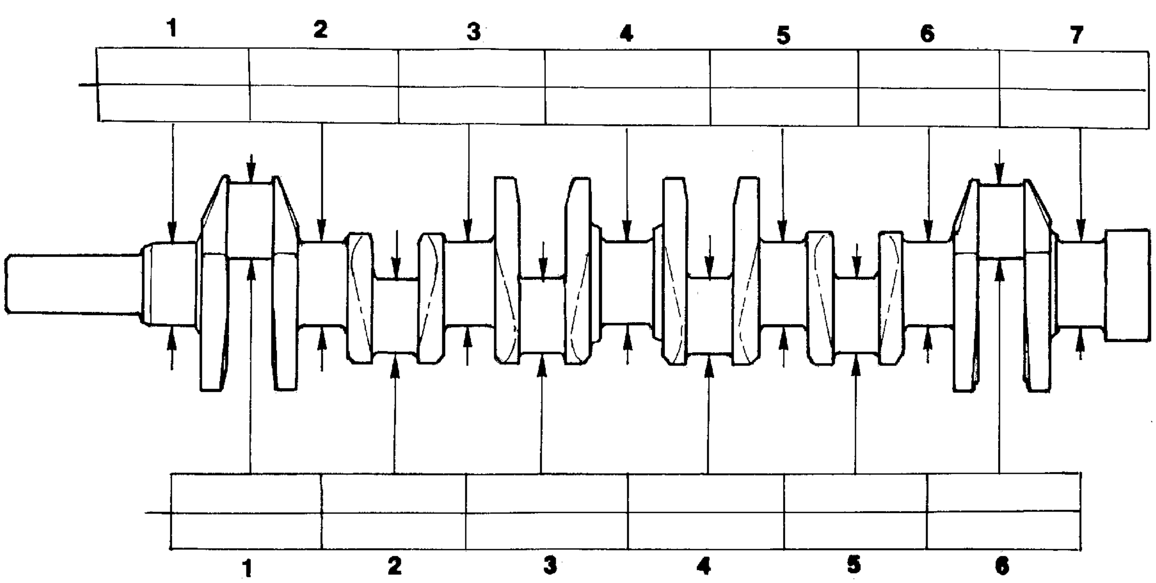
NOTE All the main journals and crankpins should always be ground to the same undersizing class so as not to alter the balance of the shaft.

Figure 23

Table for noting down the measurements of the main journals and crankpins of the crankshaft.

MAIN JOURNALS

Ø MIN.
Ø MAX.



Ø MIN.
Ø MAX.

CRANKPINS

36061

Preliminary measurement of main and big end bearing shell selection data

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

MAIN JOURNALS:

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

CRANKPINS:

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

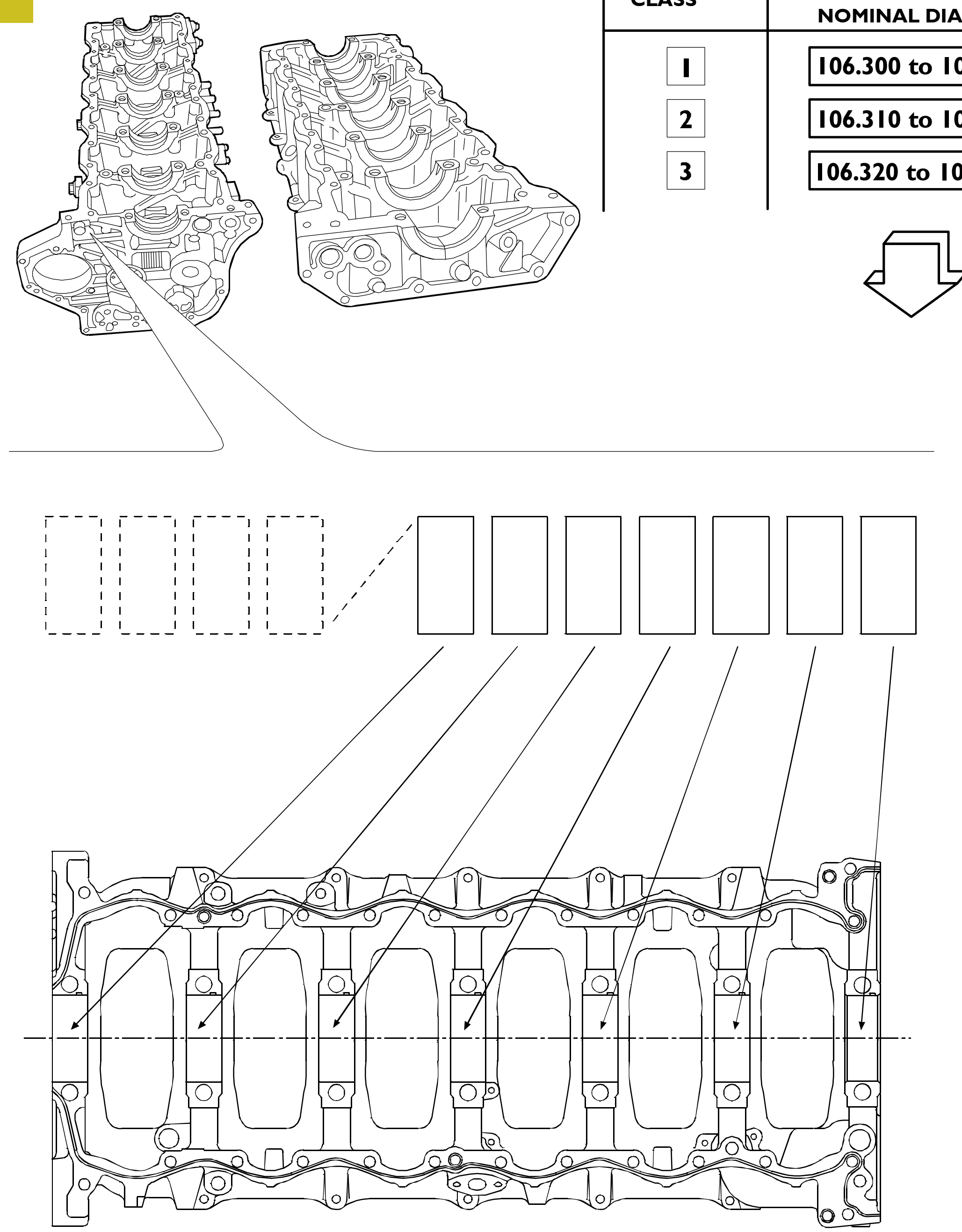
DEFINING THE CLASS OF DIAMETER OF THE SEATS FOR BEARING SHELLS ON THE CRANKCASE

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

- The first set of digits (four) is the coupling number of the crankcase with its base.
- The following seven digits, taken singly, are the class of diameter of each of the seats referred to (Figure 24 at bottom).
- Each of these digits may be **1**, **2** or **3**.

Figure 24

CLASS	MAIN BEARING HOUSING NOMINAL DIAMETER
1	106.300 to 106.309
2	106.310 to 106.319
3	106.320 to 106.330



47535

Selecting the main bearing and big end bearing shells

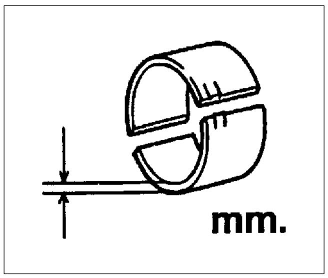
NOTE To obtain the required assembly clearances, the main bearing and big end bearing shells have to be selected as described hereunder.

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).

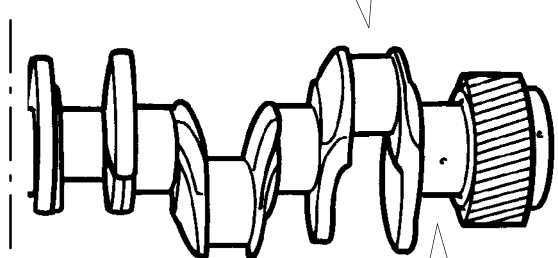
Depending on the thickness, the bearing shells are selected in classes of tolerance marked by a colour (red-green - red/black - green/black).

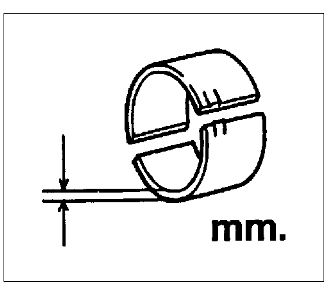
Figure 25 gives the specifications of the main bearing and big end bearing shells available as spare parts in the standard sizes (STD) and in the permissible oversizes (+0.127, +0.254, +0.508).

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		

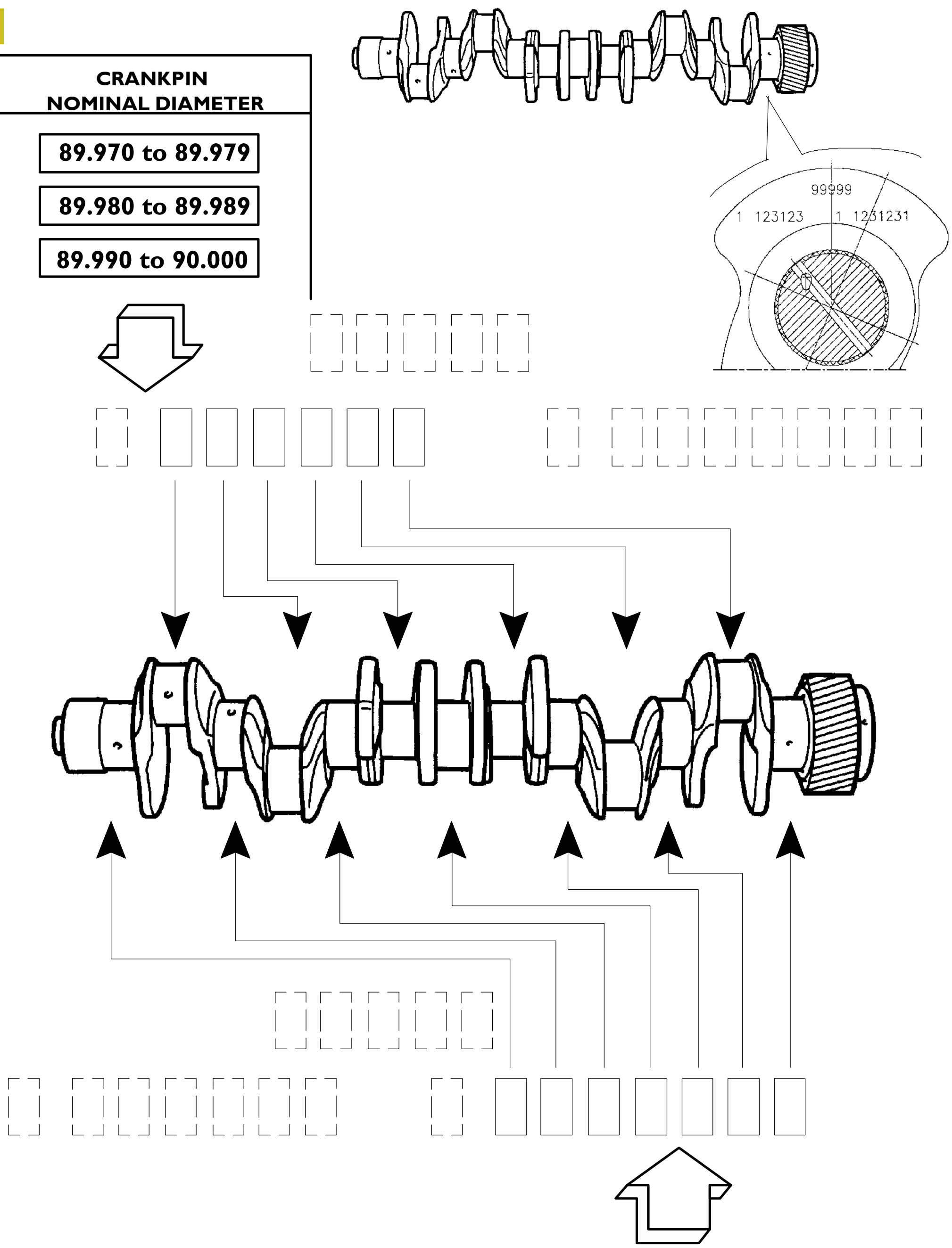
DEFINING THE CLASS OF DIAMETER OF THE MAIN JOURNALS AND CRANKPINS (Journals with nominal diameter)

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

CLASS	CRANKPIN NOMINAL DIAMETER
1	89.970 to 89.979
2	89.980 to 89.989
3	89.990 to 90.000



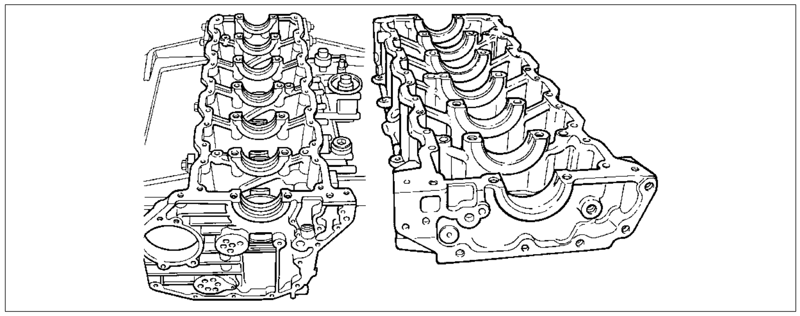
CLASS	MAIN JOURNALS NOMINAL DIAMETER
1	99.970 to 99.979
2	99.980 to 99.989
3	99.990 to 100.000

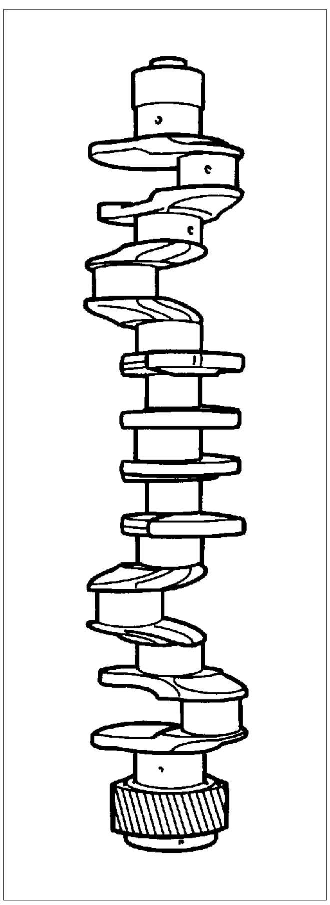
Selecting the main bearing shells (Journals with nominal diameter)

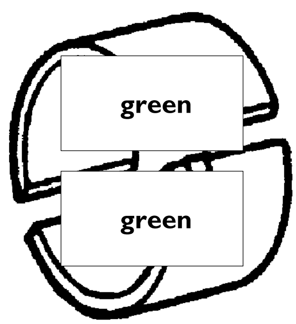
After reading off the data, for each of the main journals, on the crankcase and crankshaft, you choose the type of bearing shells to use according to the following table:

Figure 27

STD.







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

SELECTING THE MAIN BEARING SHELLS (GROUND JOURNALS)

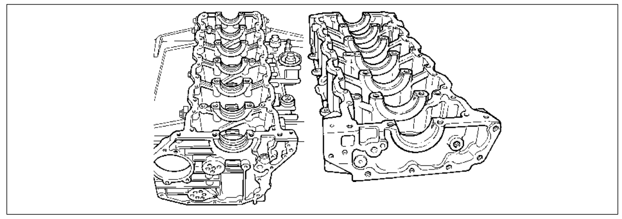
If the journals have been ground, the procedure described so far cannot be applied.
In this case, it is necessary to check that the new diameter of the journals is as shown in the table and to mount the only type of bearing shell envisaged for the relevant undersizing.

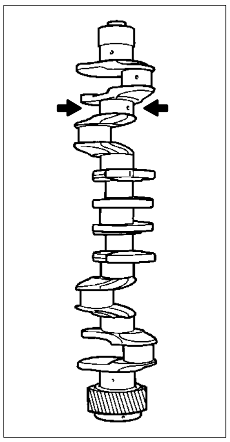
Figure 28

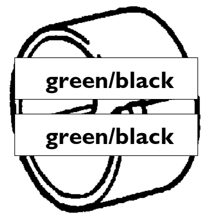
red/black = 3.173 to 3183 mm

green/black = 3.184 to 3.193 mm

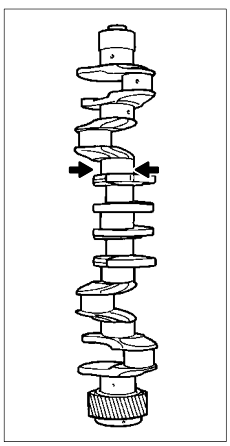
-0.127





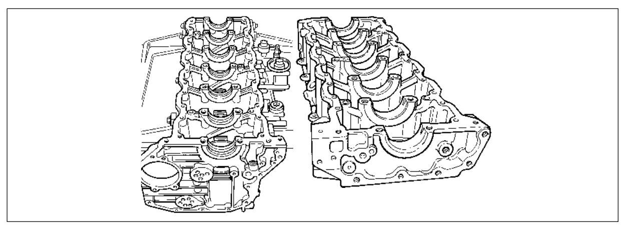


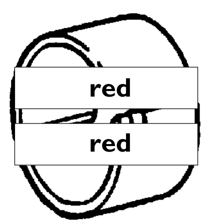
Journal diameter		1	2	3
99.843 – 99.852	1	green/black green/black	green/black green/black	green/black green/black
99.853 – 99.862	2	red/black red/black	green/black green/black	green/black green/black
99.863 – 99.873	3	red/black red/black	red/black red/black	green/black green/black



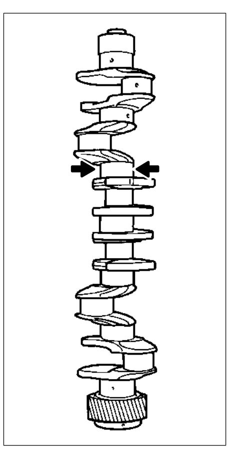
-0.254

red = 3.237 to 3.247 mm



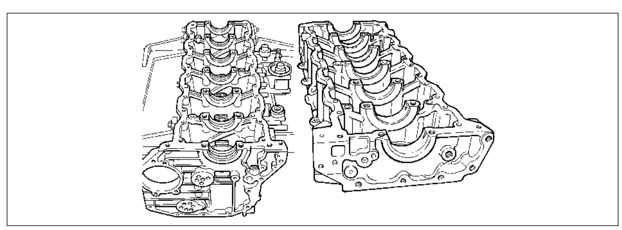


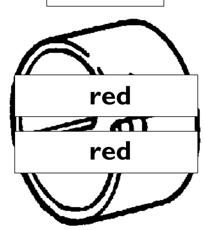
Journal diameter	1	2	3
99.726 – 99.746	red red	red red	red red



-0.508

red = 3.364 to 3.374 mm





Journal diameter	1	2	3
99.468 – 99.508	red red	red red	red red

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

There are three markings on the body of the connecting rod in the position indicated as "A":

1 Letter indicating the class of weight:

A = 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** o **3**.

Determine the type of big end bearing to fit on each journal by following the indications in the table (Figure 30).

Figure 29

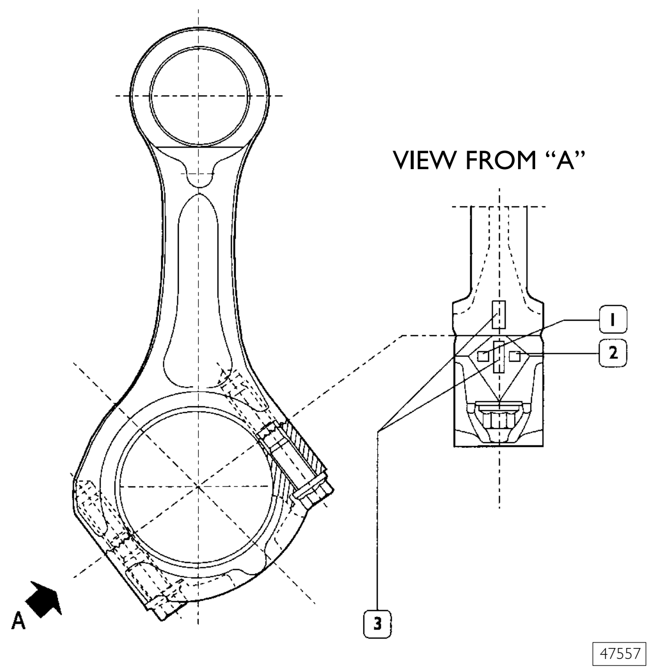
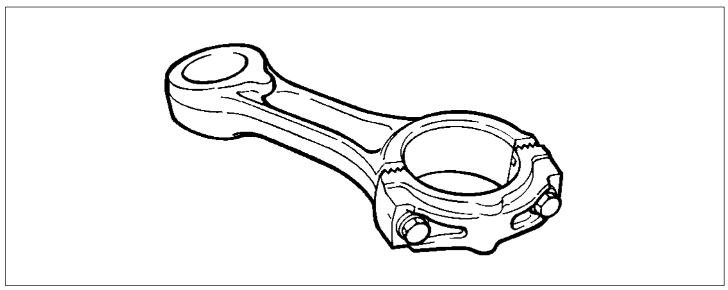
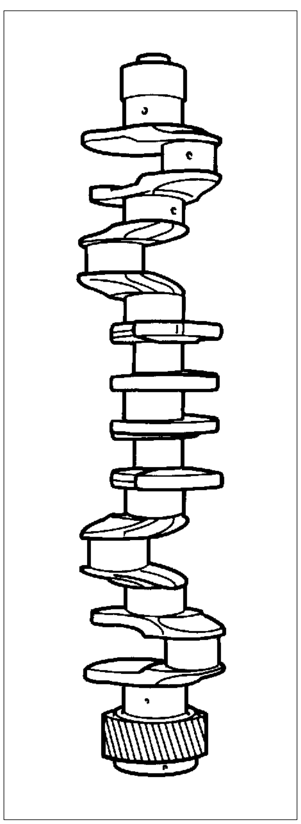
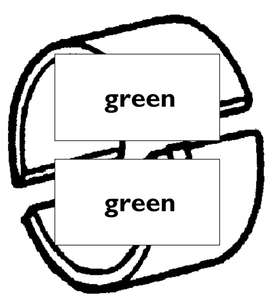


Figure 30

STD.







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

Selecting big end bearing shells (ground journals)

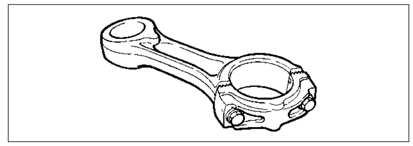
If the journals have been ground, the procedure described so far cannot be applied.
In this case, it is necessary to check (for each of the undersizings) which field of tolerance includes the new diameter of the crankpins and to mount the bearing shells identified with the relevant table.

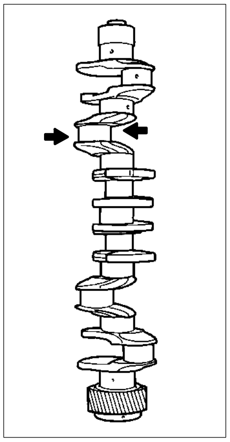
Figure 31

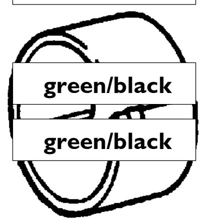
red/black =
2.028 to 2.038 mm

green/black =
2.039 to 2.048 mm

-0.127



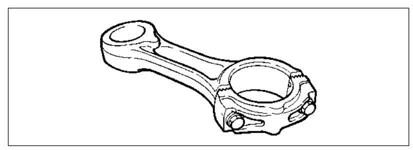


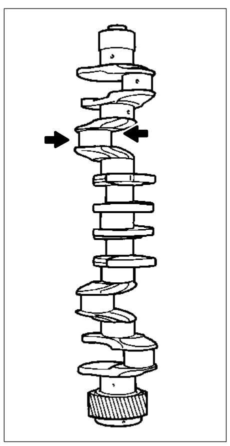


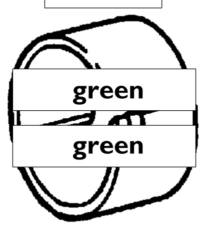
		1	2	3
89.843 89.852	**1**	**green/black green/black**	**green/black green/black**	**green/black green/black**
89.853 89.862	**2**	**red/black red/black**	**green/black green/black**	**green/black green/black**
89.863 89.873	**3**	**red/black red/black**	**red/black red/black**	**green/black green/black**

-0.254

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



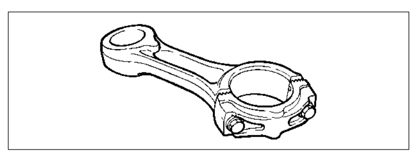


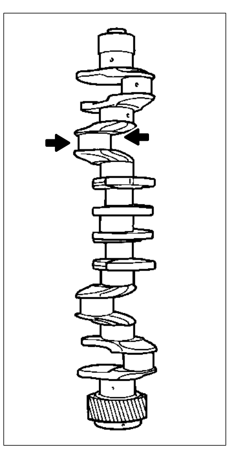


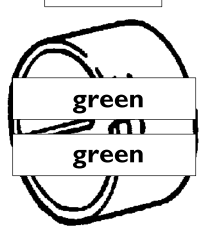
	1	2	3
89.726 89.735	**red red**	**green green**	**green green**
89.736 89.746	**red red**	**red red**	**green green**

-0.508

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





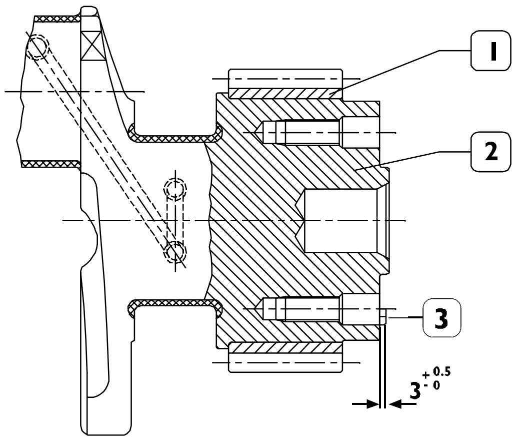


	1	2	3
89.472 89.481	**red red**	**green green**	**green green**
89.482 89.492	**red red**	**red red**	**green green**

Replacing the timing gear and oil pump

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

Figure 32



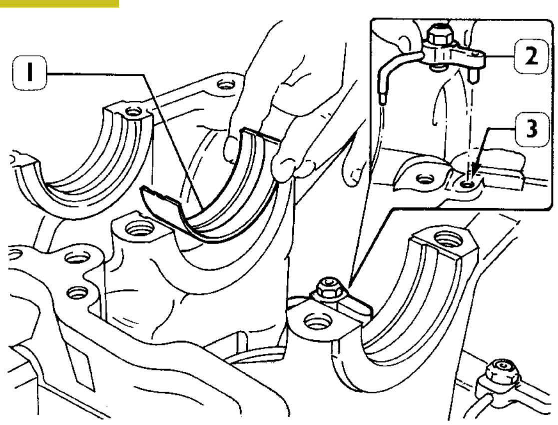
49020

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

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

Checking main journal installation clearance

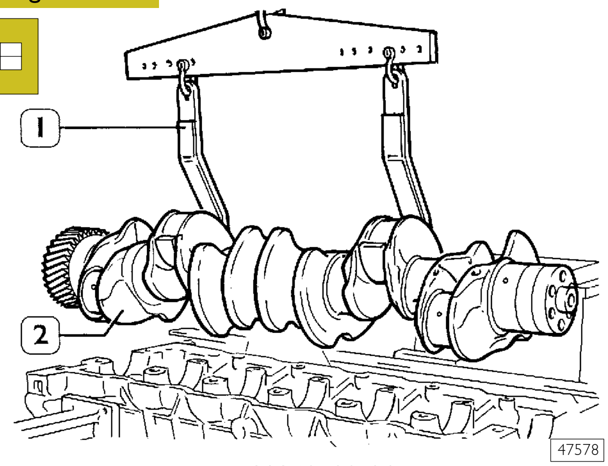
Figure 33



47579

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

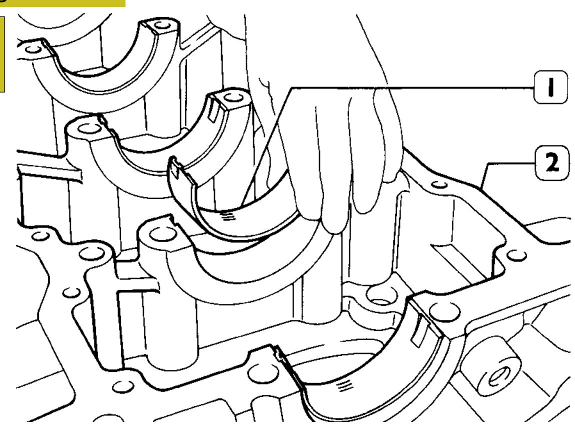
Figure 34



47578

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

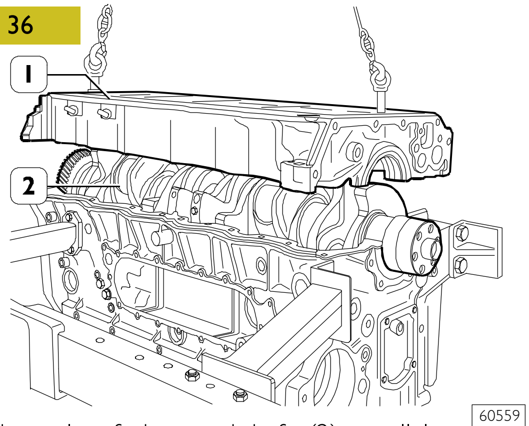
Figure 35



49021

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

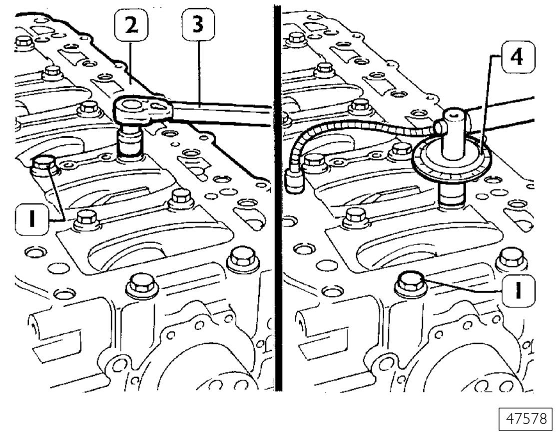
Figure 36



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

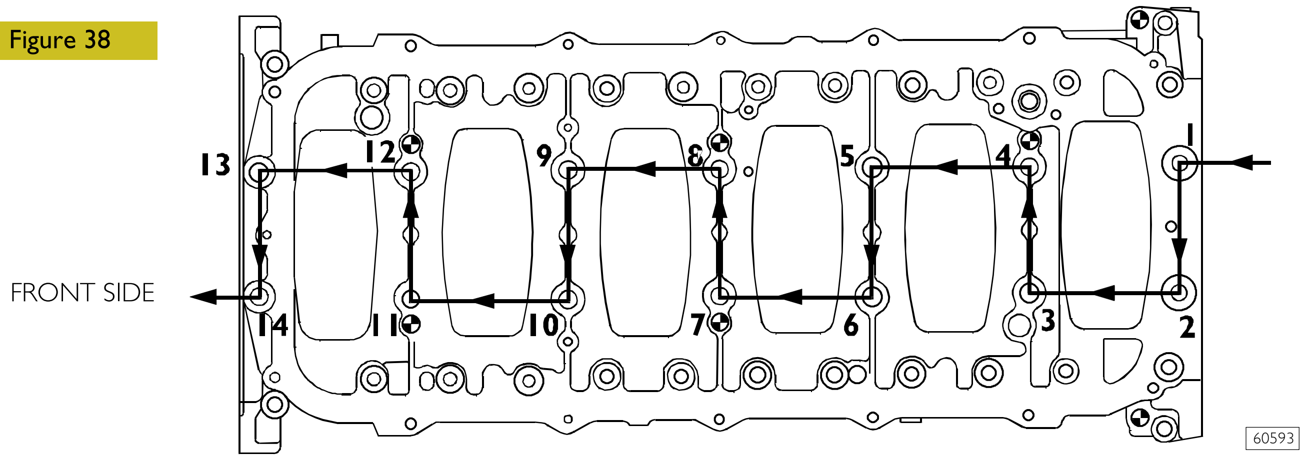
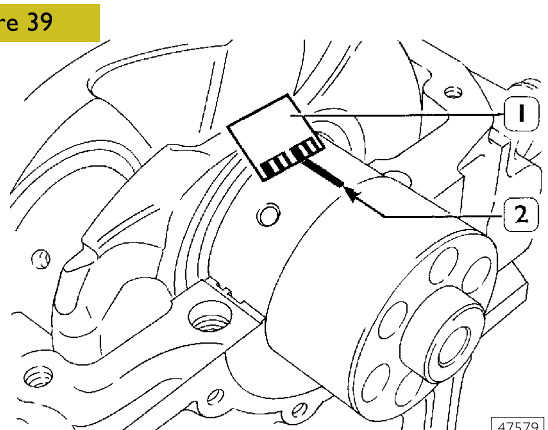


DIAGRAM OF SEQUENCE FOR TIGHTENING THE SCREWS FIXING THE BOTTOM CRANKCASE BASE TO THE CRANKCASE

Figure 39



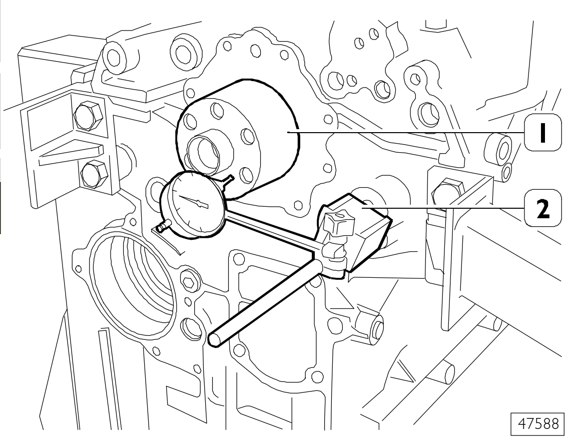
❑ Remove the crankcase base.

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

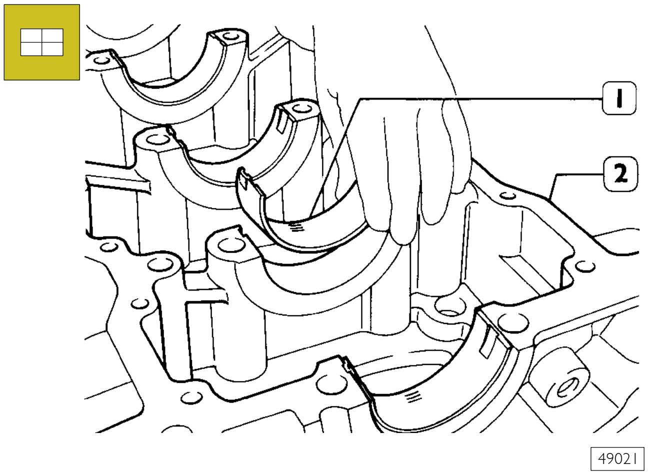
Figure 40



The end float is checked by setting a dial gauge (1) 99395603 with a magnetic base on the crankshaft (2) as shown in the figure. If you find the clearance to be greater than as required, replace the rear main bearing shells carrying the thrust bearings and repeat the clearance check.

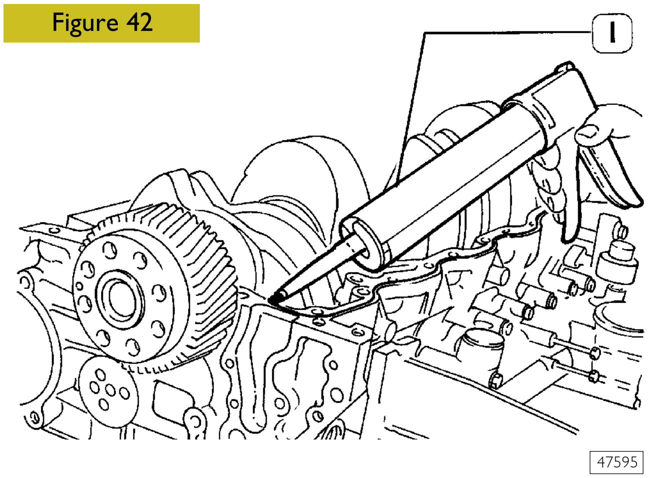
ASSEMBLING THE ENGINE ON THE BENCH

Figure 41



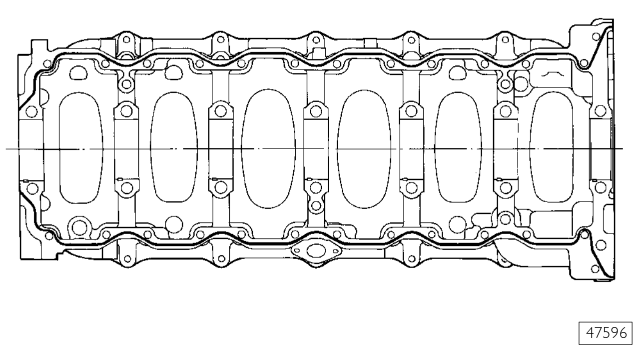
Place the half-bearings (1) on the main bearings in the underblock (2).

Figure 42



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

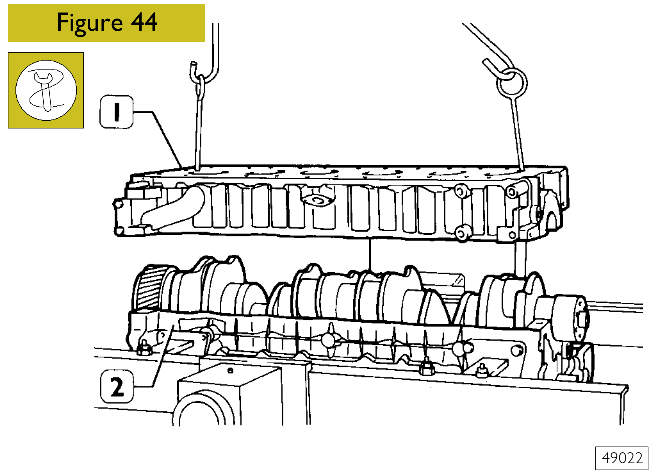
Figure 43



Sealant application diagram

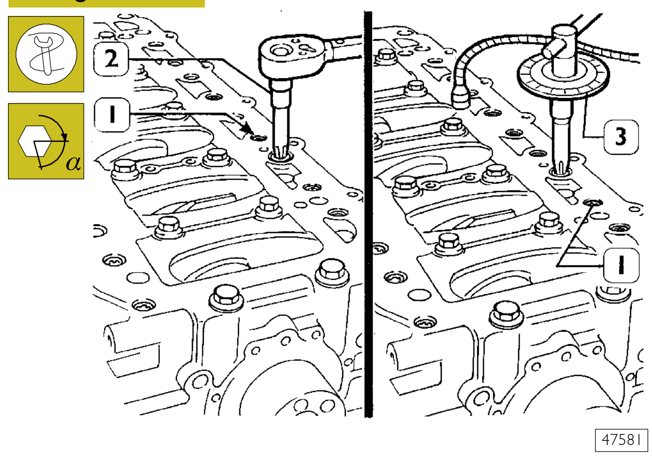
NOTE Fit the underblock within 10' of the application of the sealant.

Figure 44



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

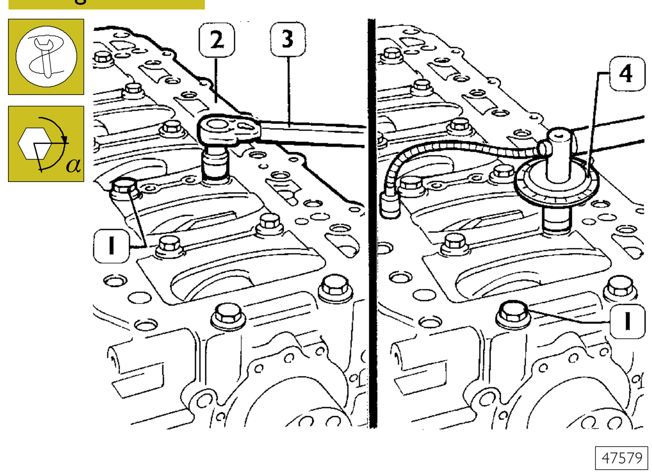
Figure 45



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° + 55°, using tool 99395216 (4). Tighten again the outer screws (1, Figure 45) with 60° angular closing, using tool 99395216 (3, Figure 45).

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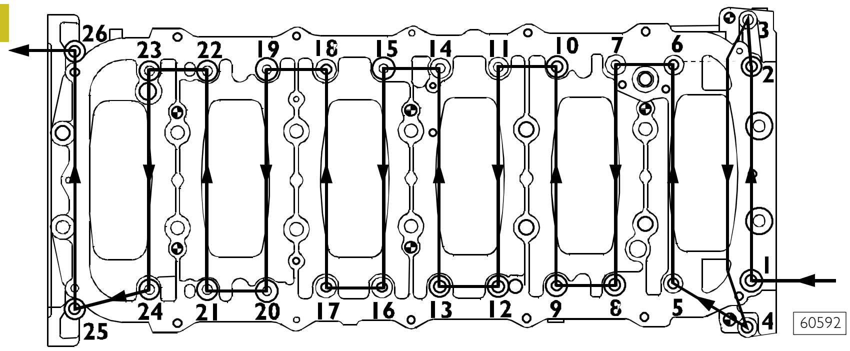
DIAGRAM SHOWING THE UNDERBLOCK FIXING SCREWS TIGHTENING ORDER

Figure 47

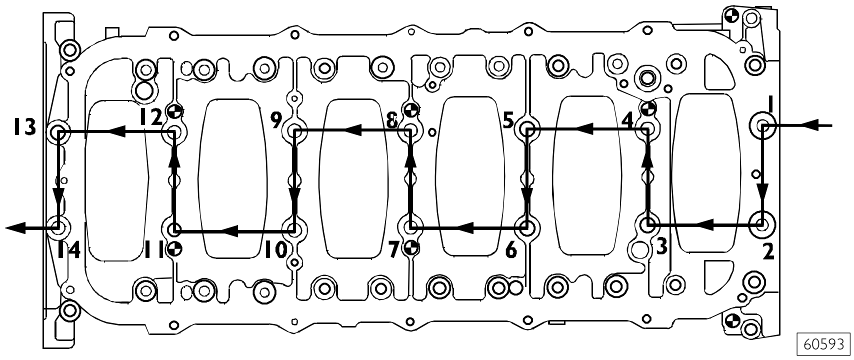
FRONT SIDE



stage 1:
pretightening
outer screws

(30 Nm)

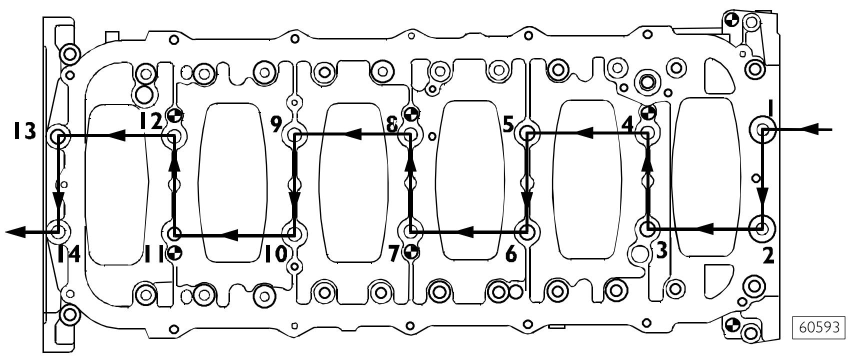
FRONT SIDE



stage 2:
pretightenig
inner screws

(120 Nm)

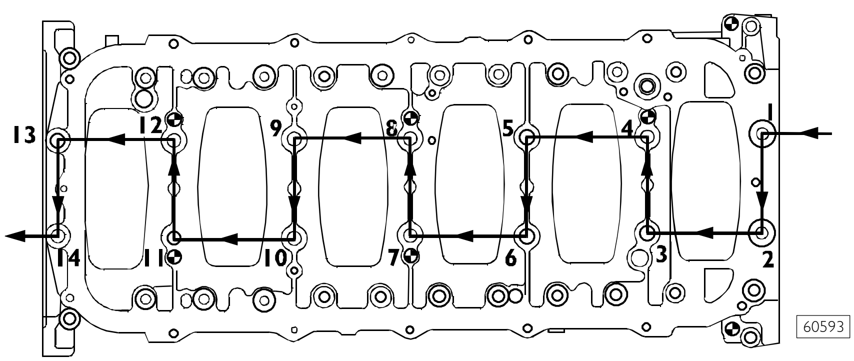
FRONT SIDE



stage 3:
angle
inner
screws

(60º)

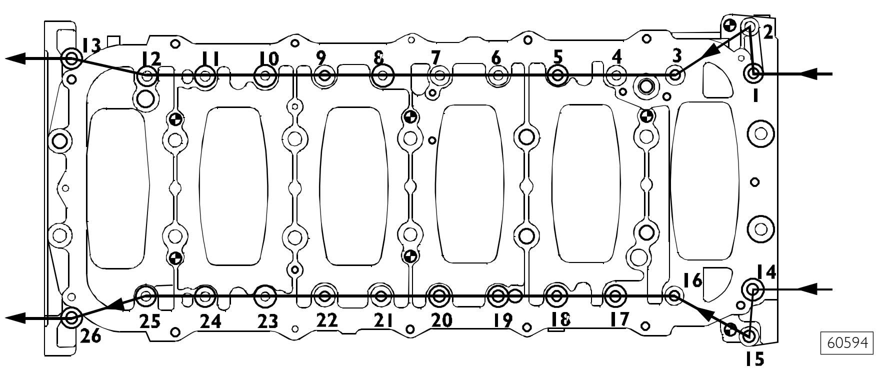
FRONT SIDE



stage 4:
angle
inner
screws

(55º)

FRONT SIDE

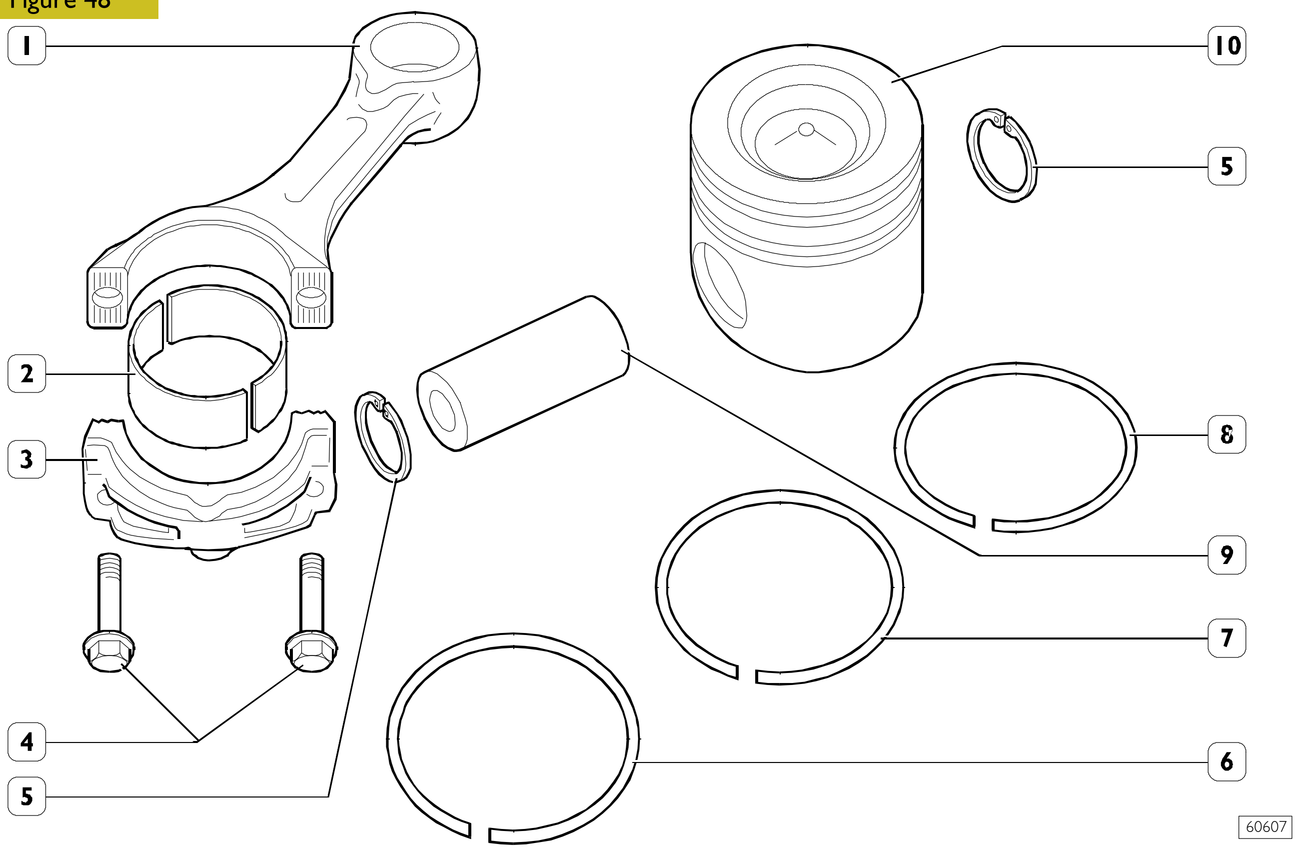


stage 5:
angle
outer
screws

(60º)

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.

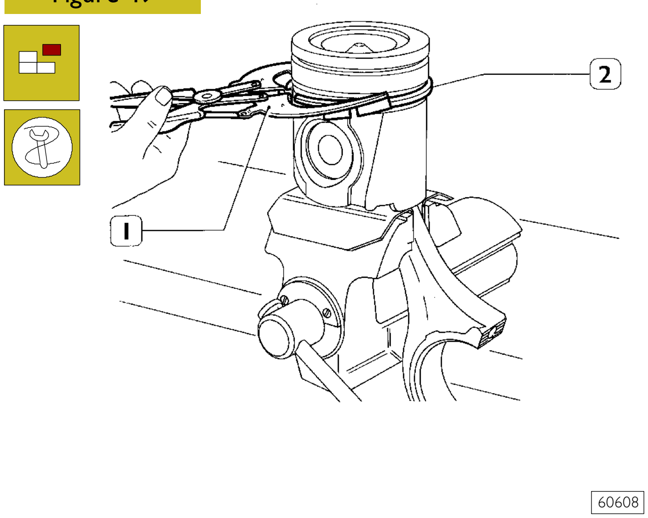
Make sure the piston does show any trace of seizing, scoring, cracking; replace as necessary.

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.

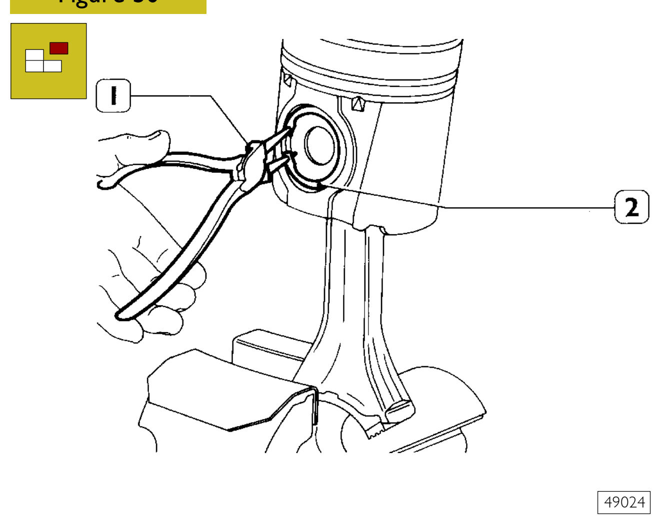
Removal

Figure 49



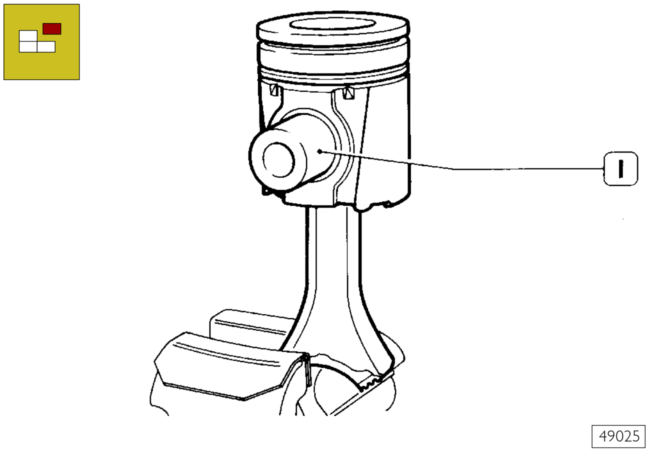
Removal of the piston split rings (2) using the pliers 99360184 (1).

Figure 50



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

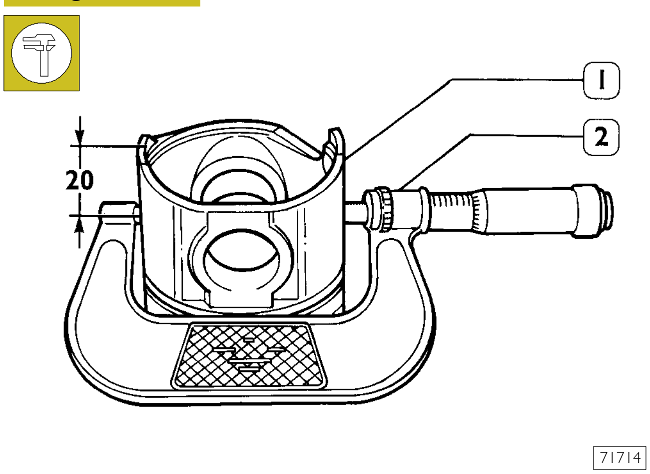
Figure 51



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

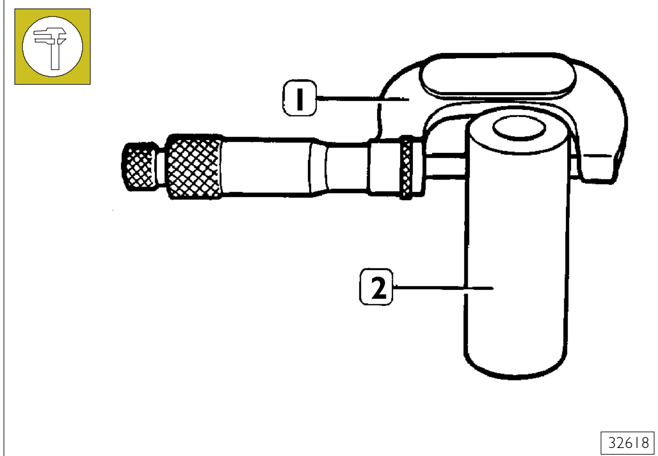
Measuring the diameter of the pistons

Figure 52



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:

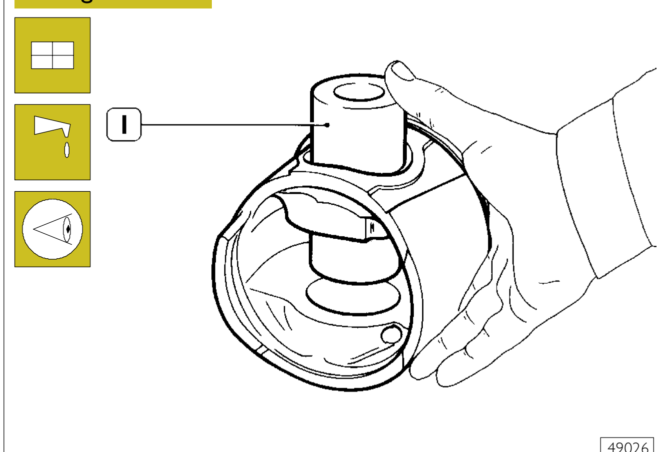
Figure 53



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

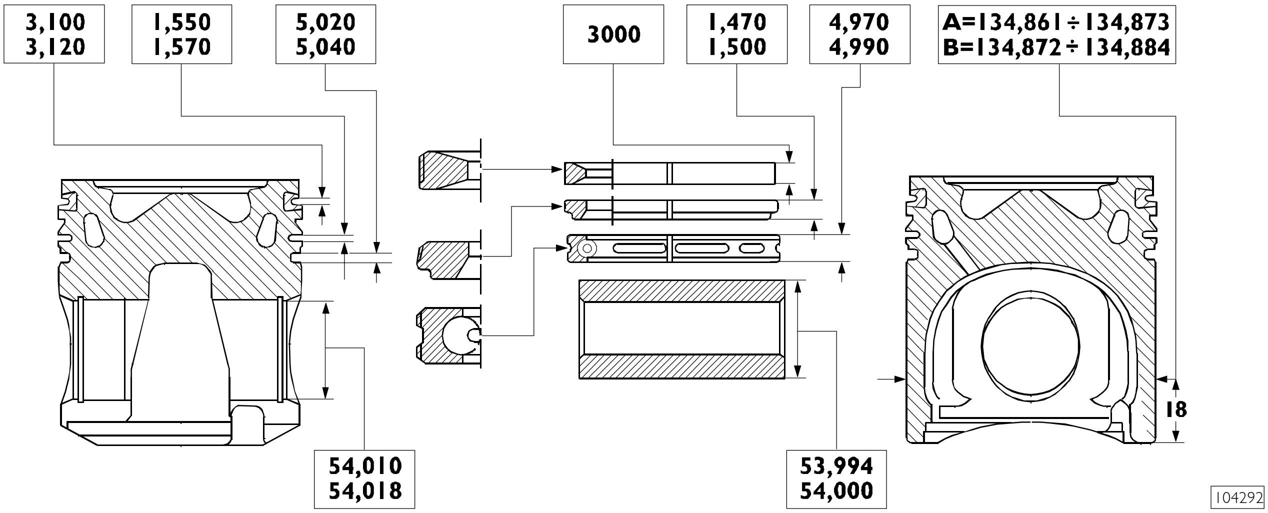
Conditions for correct gudgeon pin-piston coupling

Figure 54



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

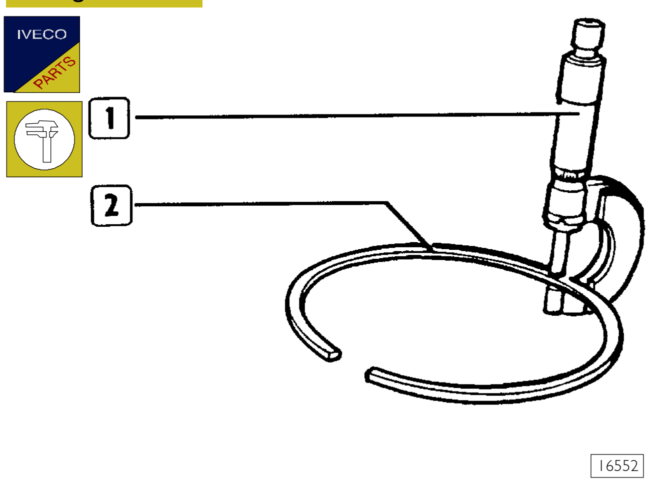
Figure 55



MAIN DATA OF THE PISTON, PISTON RINGS AND PIN

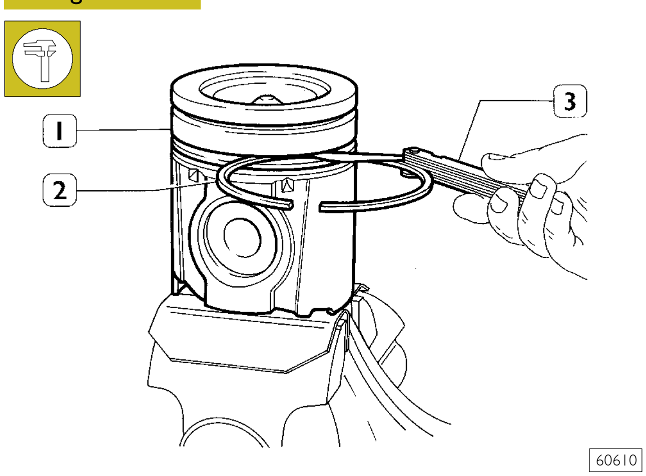
Piston rings

Figure 56



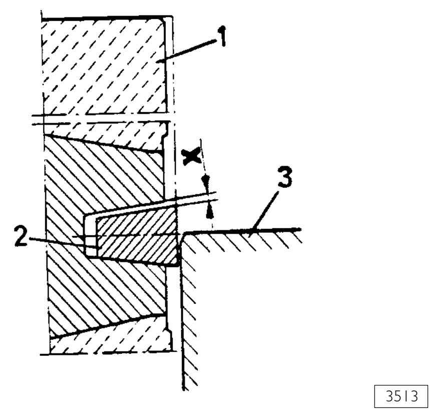
Check the thickness of the piston ring (2) with a micrometer (1).

Figure 57



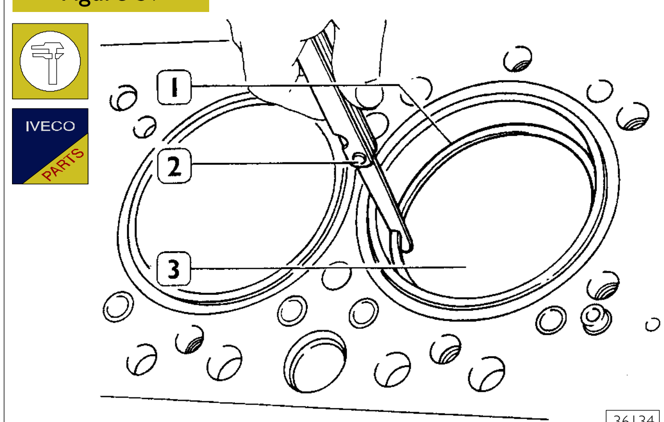
Check the clearance between the seals (2) and their seats on the piston (1) with a feeler gauge (3).

Figure 58



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



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:

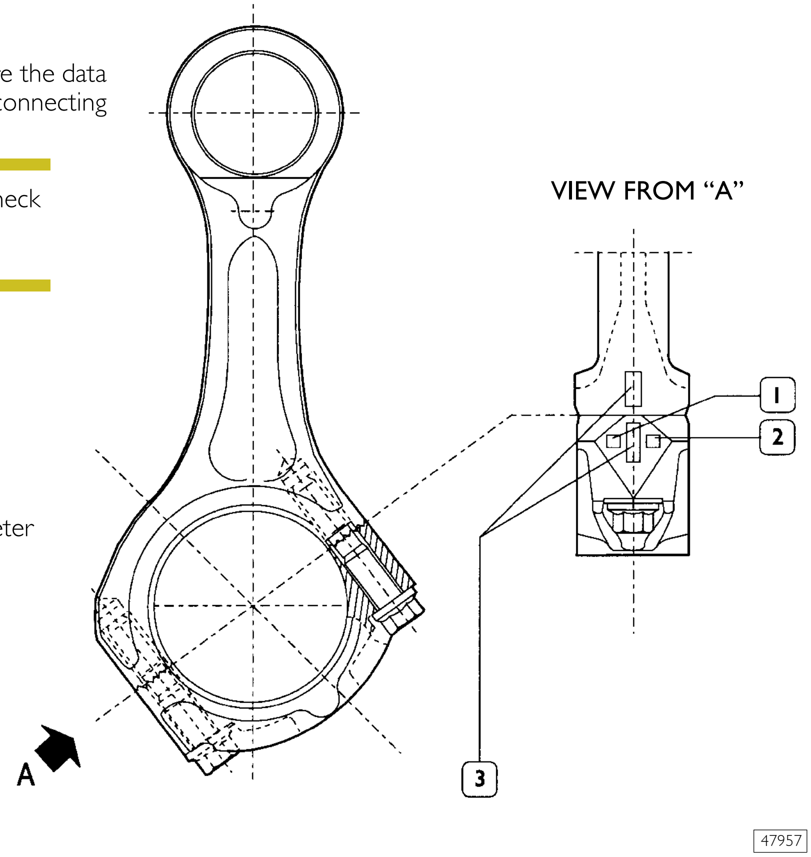
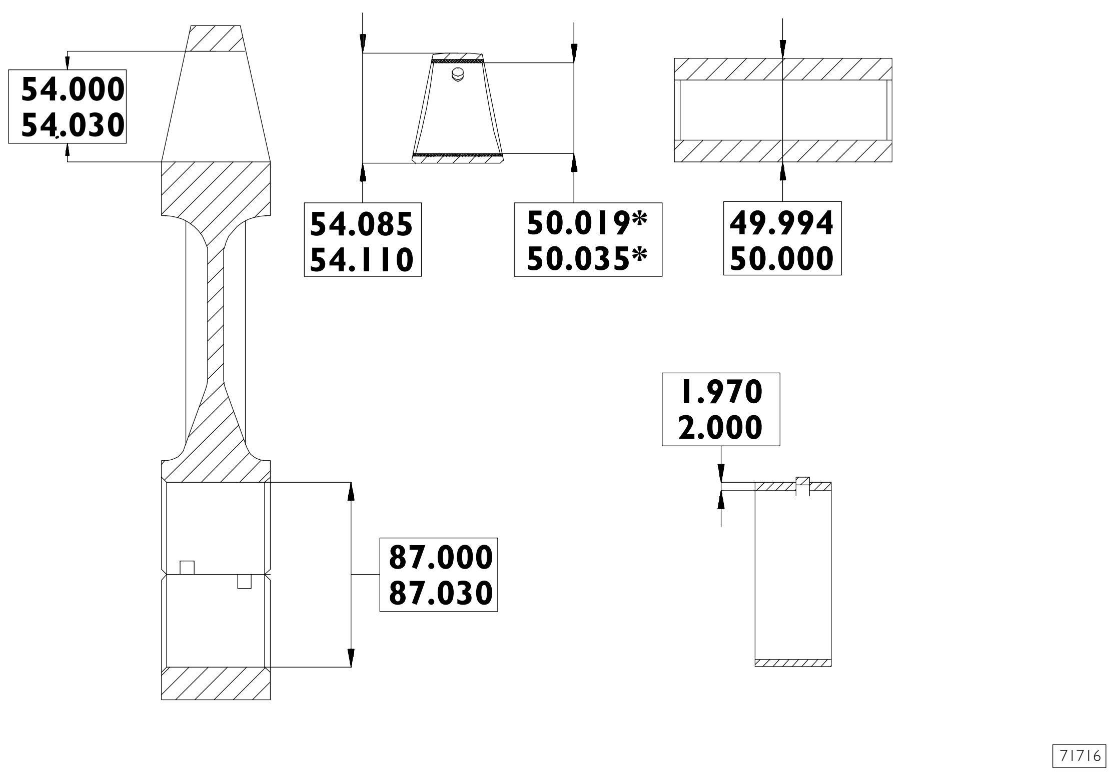


Figure 61

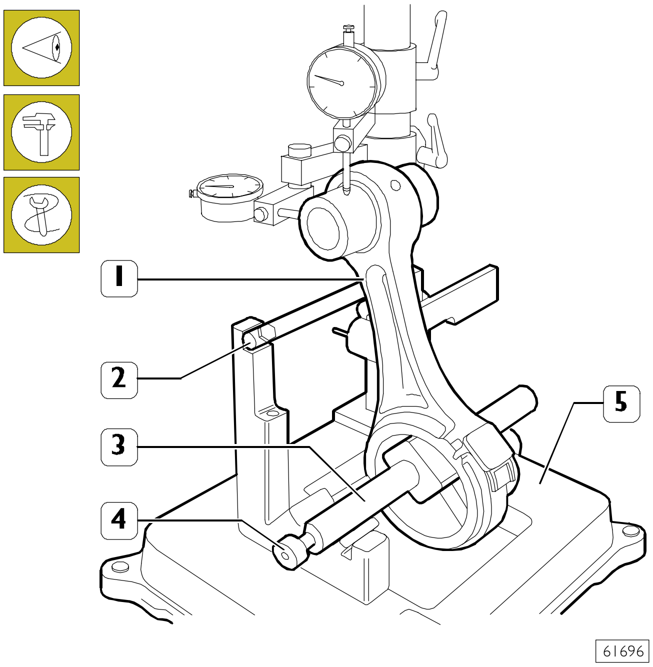


MAIN DATA OF THE BUSHING, CONNECTING ROD, PIN AND BEARING SHELLS

* Measurement to be made after driving in the bushing.

Checking connecting rod alignment

Figure 62 (Demonstration)



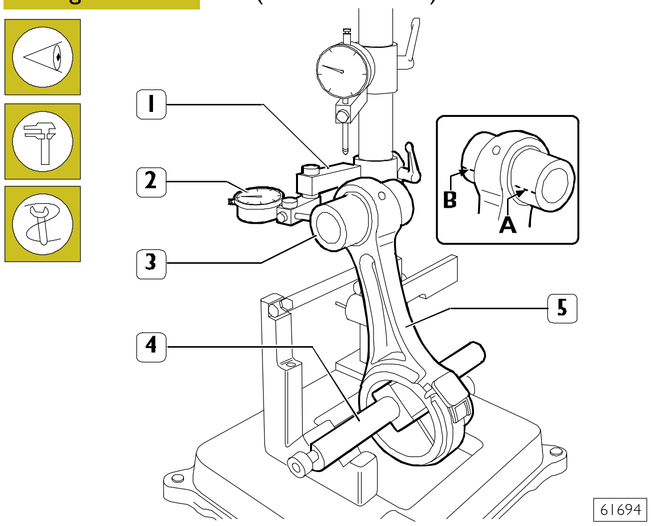
Checking axis alignment

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

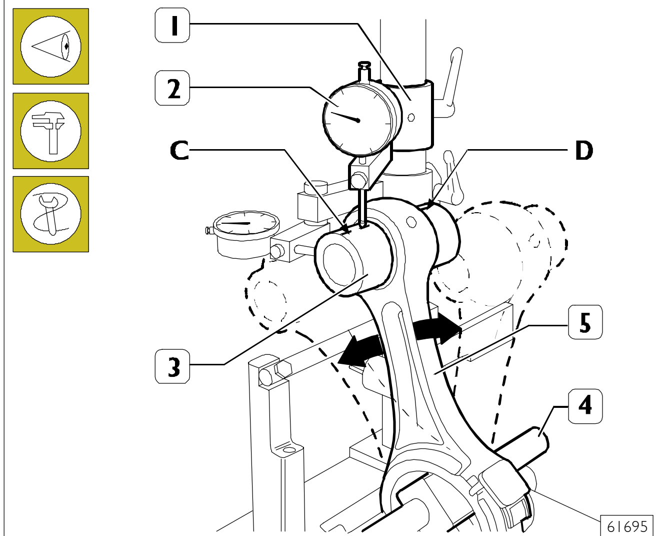
Figure 63 (Demonstration)



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.

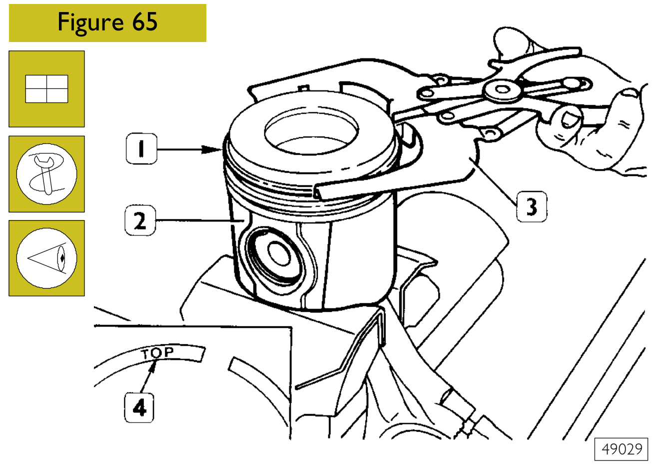
Mounting the connecting rod - piston assembly

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

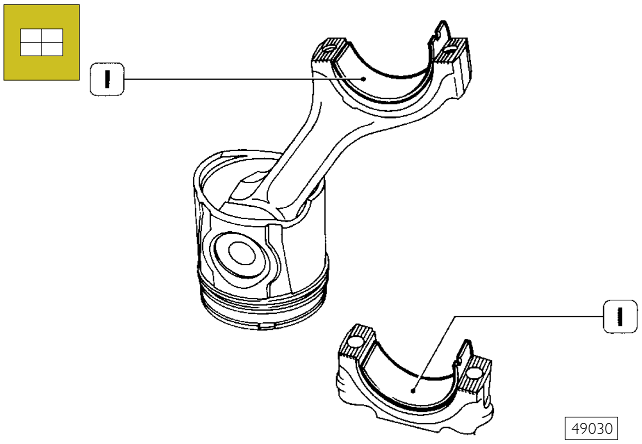
Figure 65



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



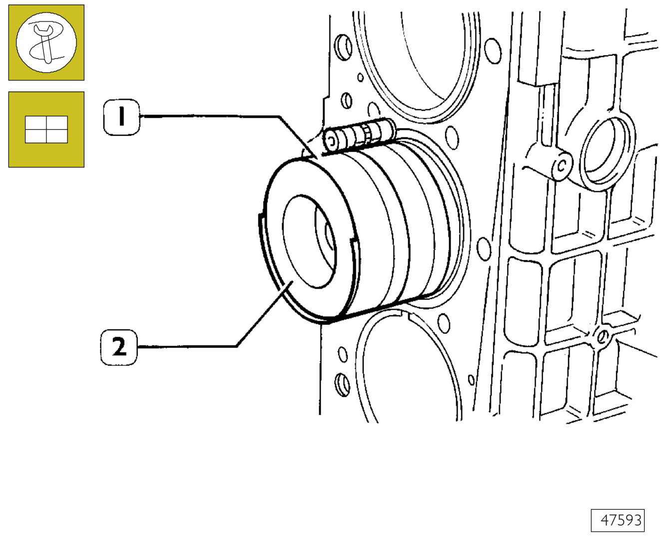
Fit the half-bearings (1), selected as described on pages 22 to 23, both on the connecting rod and on the stand.

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 68

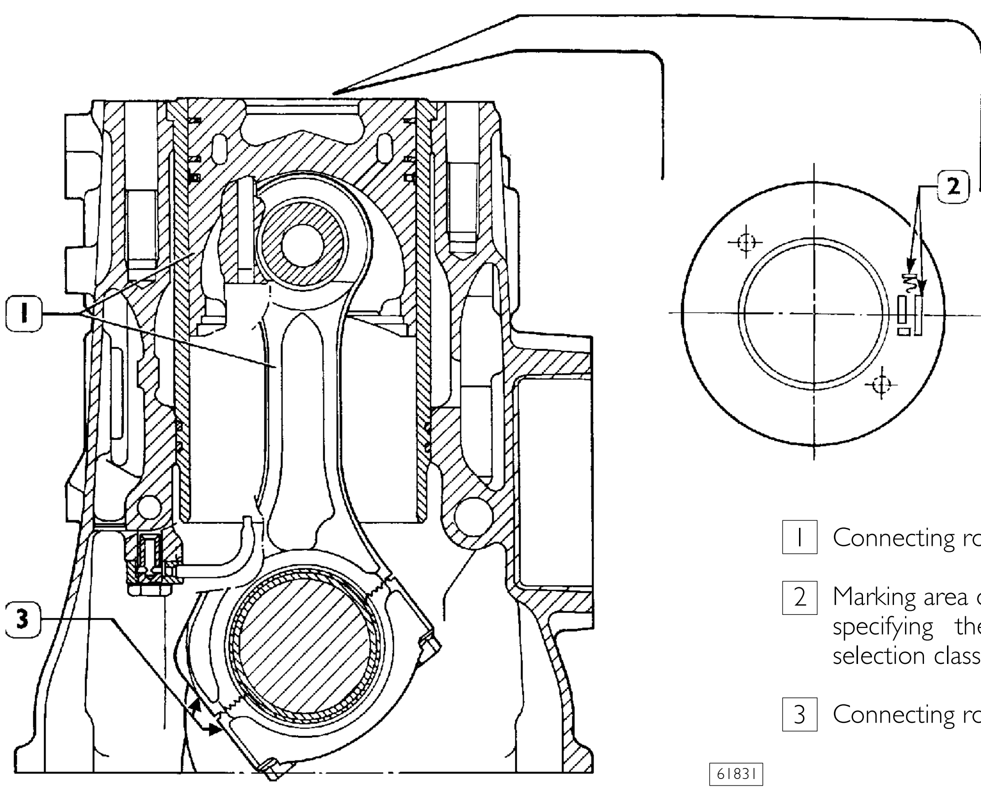


- all pistons belong to the same class, A or B;
- ideogram stamped on the piston crown is placed toward the engine flywheel, or the cavity, on the piston cover, corresponds to the position of the oil spray nozzles.

Piston protrusion check

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

Figure 67



1 Connecting rod-piston assembly

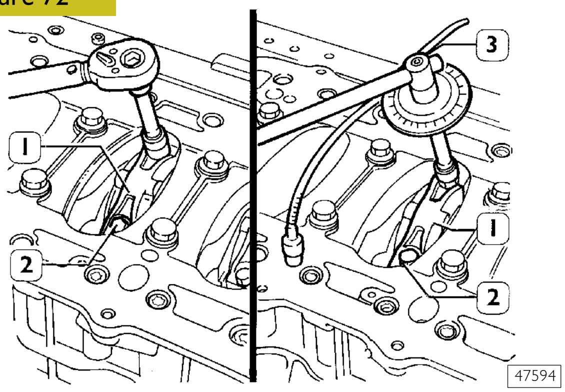
2 Marking area on the piston crown of ideogram specifying the assembly position and the selection class

3 Connecting rod marking area (see Figure 60).

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.

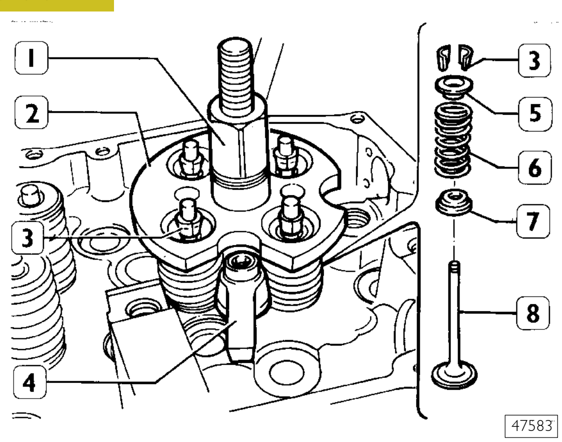
Remove the caps and determine the clearance by comparing the width of the calibrated wire with the graduated scale on the case containing the calibrated wire.
Definitive assembly: check the diameter of screw threading (2) it must not be less than 13.4mm along the entire length, otherwise the screw is 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

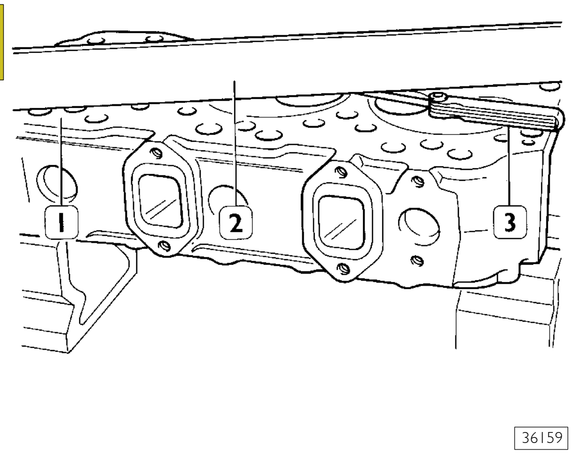
Figure 69



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)

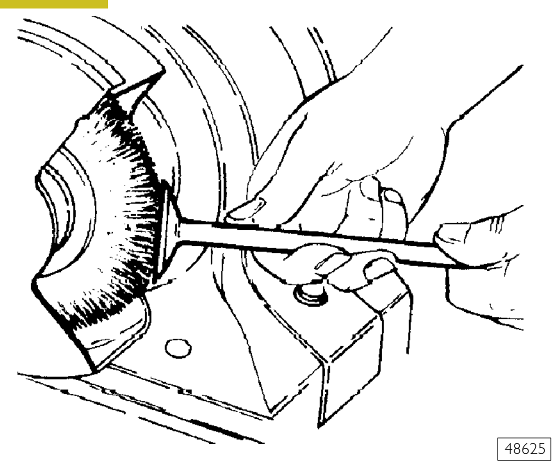


The planarity (1) is checked using a ruler (2) and a thikness gauge (3). If deformations exist, surface the head using proper surface grinder; the maximum amount of material to be removed is 0.2 mm.

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

Removing deposits and checking the valves

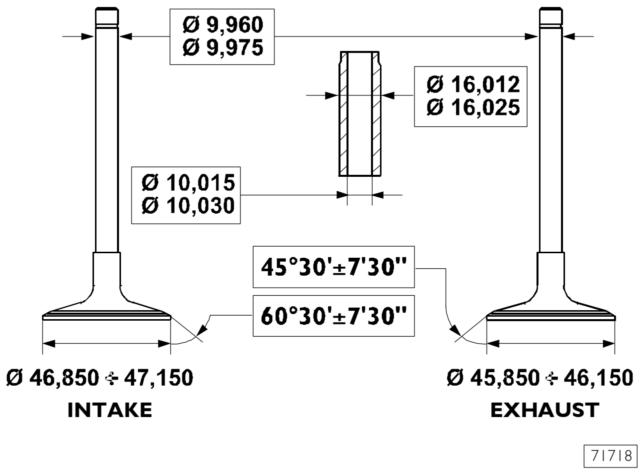
Figure 71



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



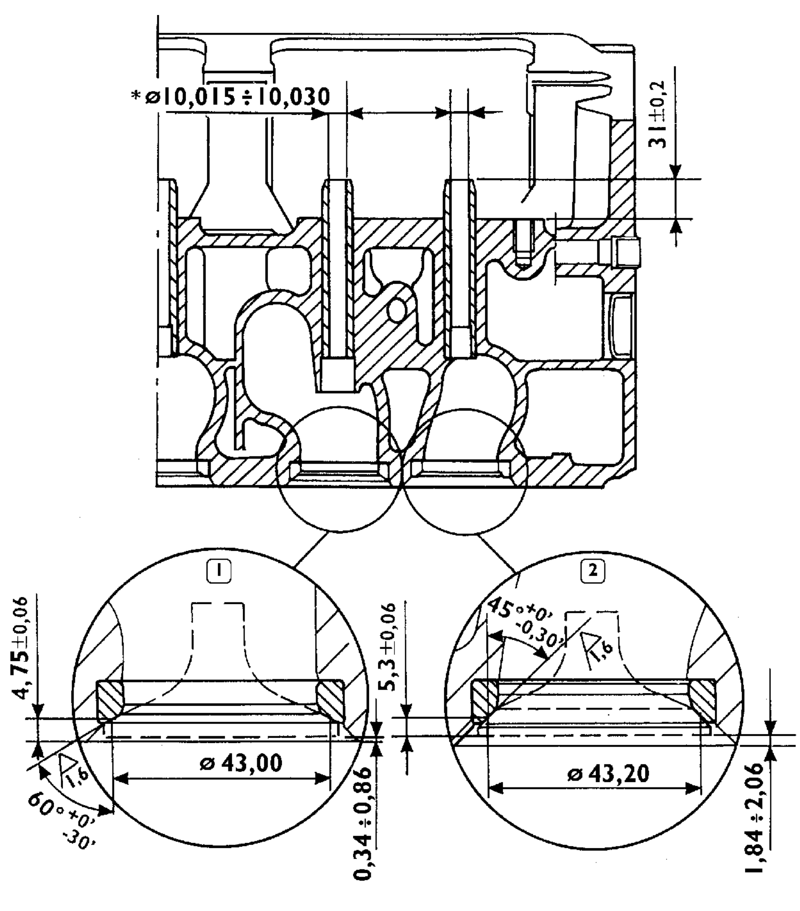
MAIN DATA - VALVES AND VALVE GUIDES

* Values to be obtained after installing the valve guides

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

Valve guides

Figure 74



INSTALLATION DIAGRAM FOR VALVE GUIDES AND VALVES

* Values to be obtained after installing the guide valves

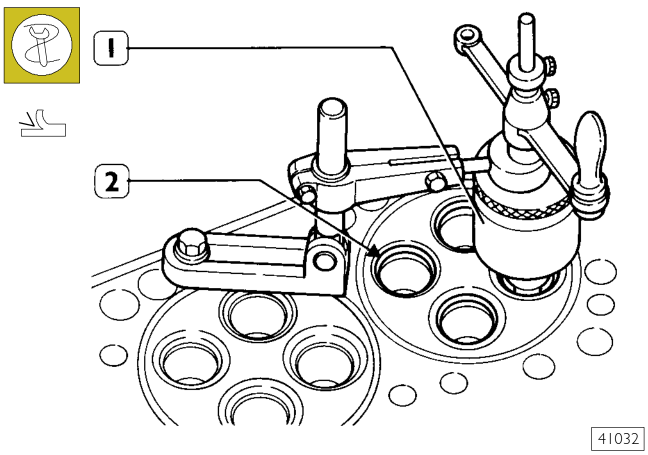
Replacing of valve guides

Remove valve guides by means of tool 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.

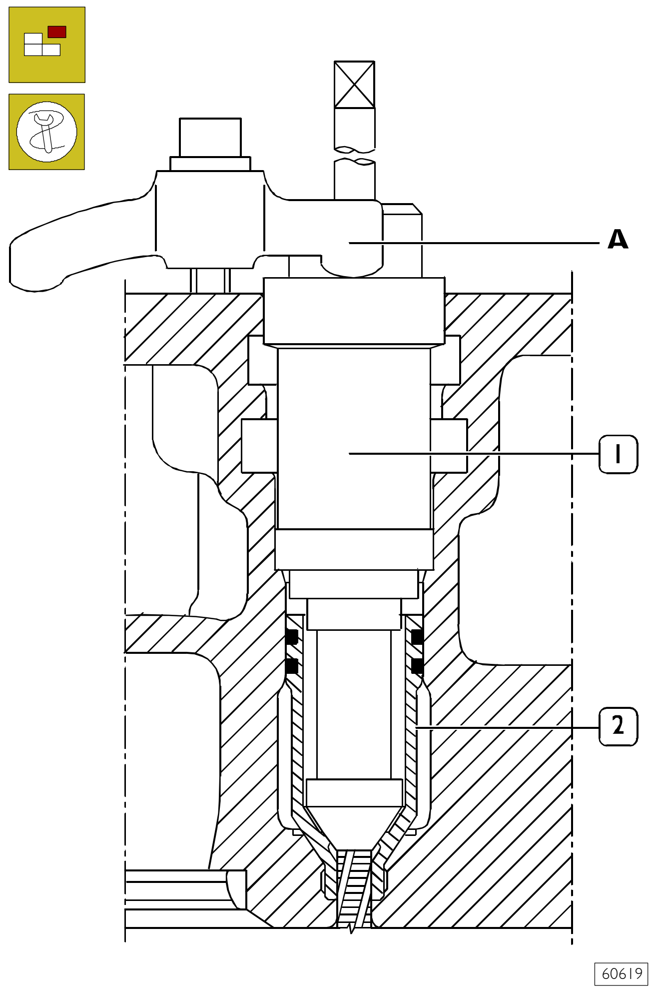
Heat the cylinder head to 80 – 100°C and, using a drift, fit in the new valve seats (2), chilled beforehand in liquid nitrogen. Using tool (1), regrind the valve seats according to the angles shown in Figure 74.

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:65

- -0.65 - -0.95 mm (recessing) intake valves
- -18 - -2.105 mm (recessing) exhaust valves.

Replacing injector cases
Removal

Figure 76

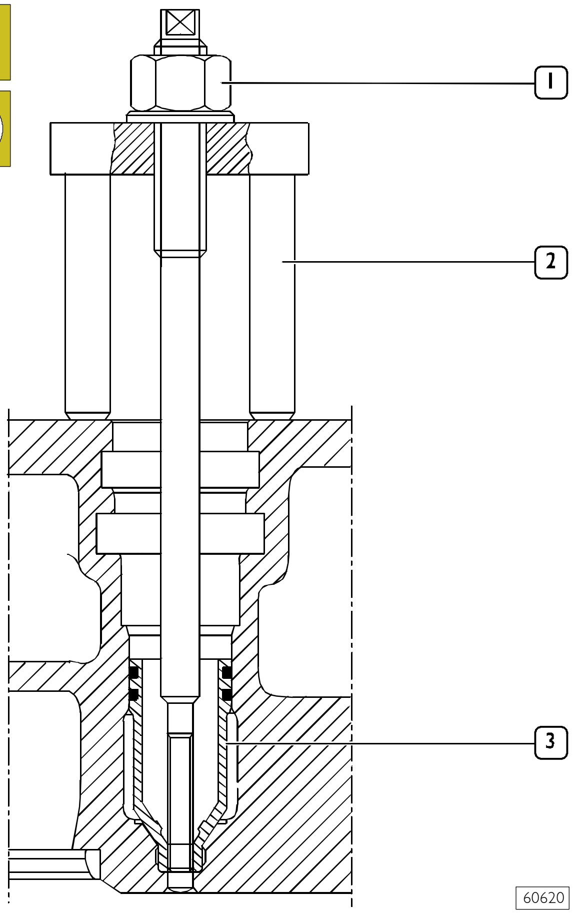


To replace the injector case (2), act as follows:

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

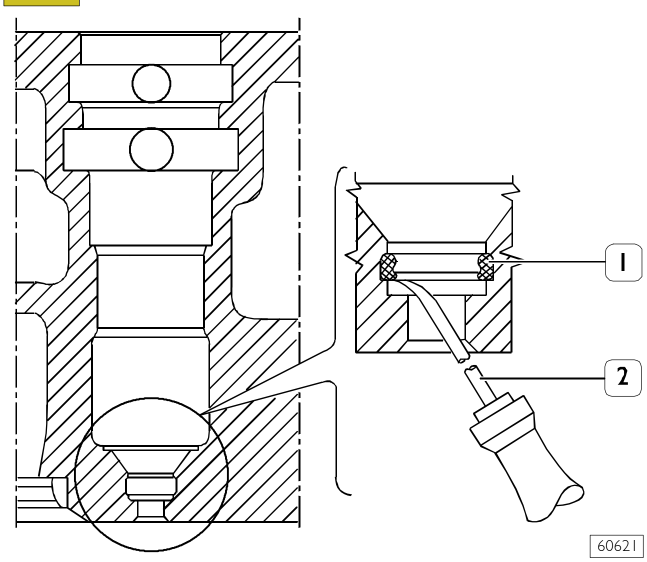
Carry out operations described in figs. 77 - 80 - 81 - 82 by fixing tools to the cylinder head by means of braket A.

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.

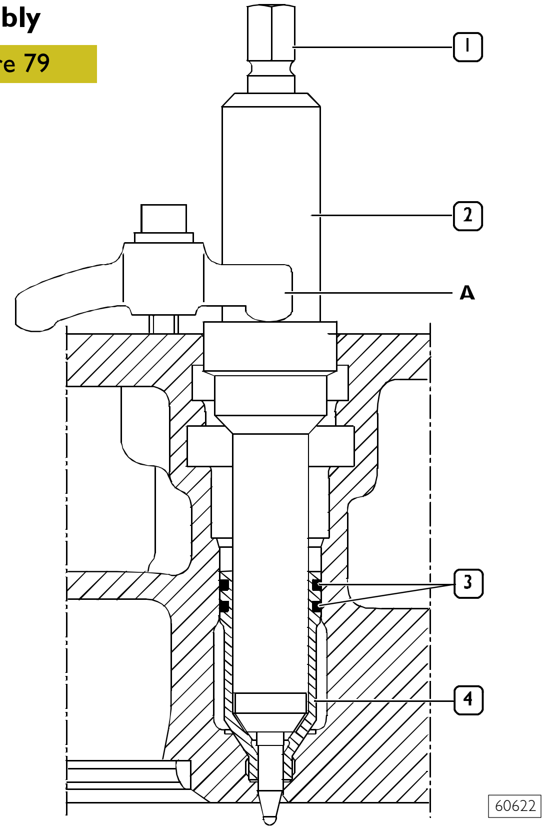
Figure 78



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

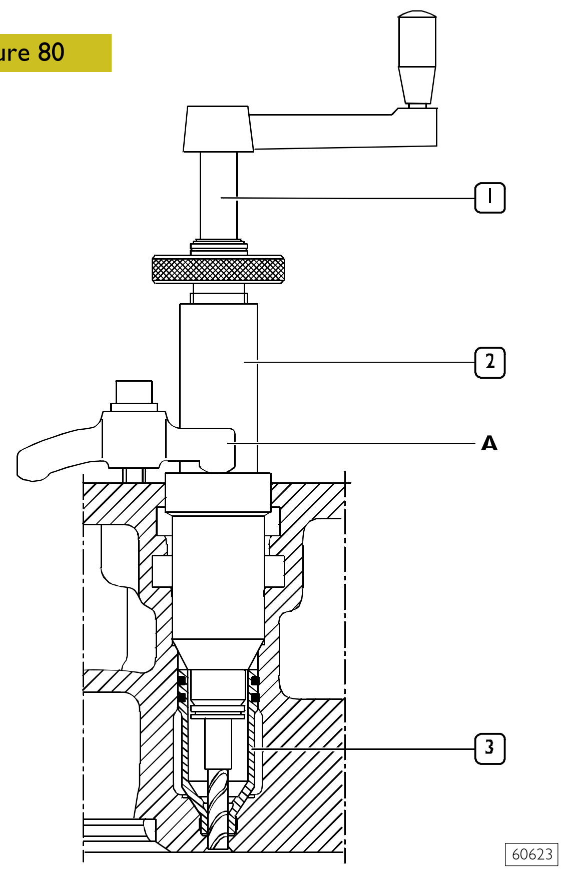
Assembly

Figure 79



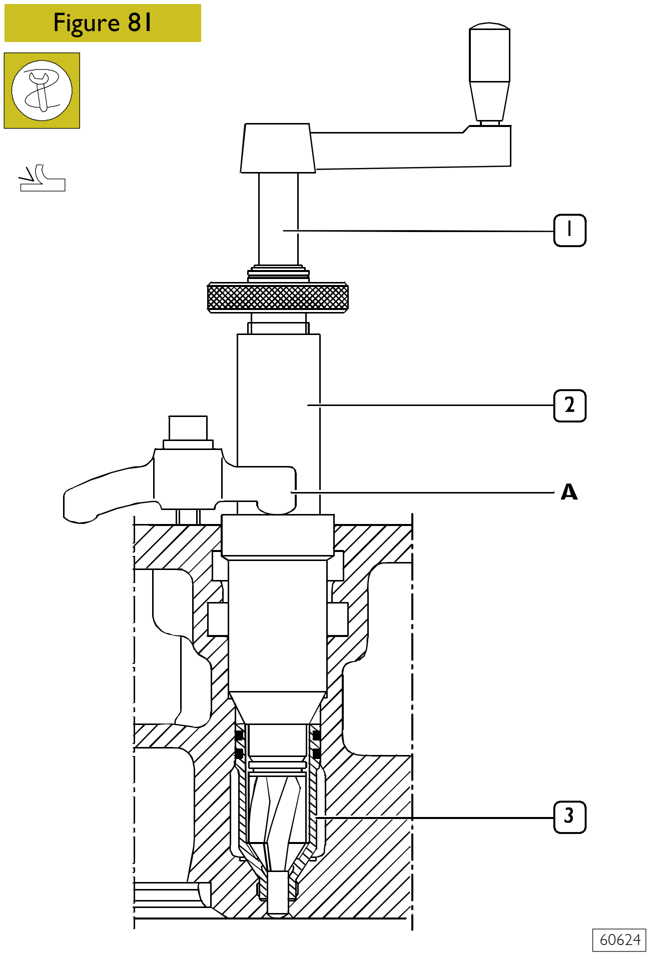
❑ Lubricate the seals (3) and fit them on the case (4). Using tool 99365056 (2) secured to the cylinder head with bracket **A**, drive in the new case, screwing down the screw (1) upsetting the bottom portion of the case.

Figure 80



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

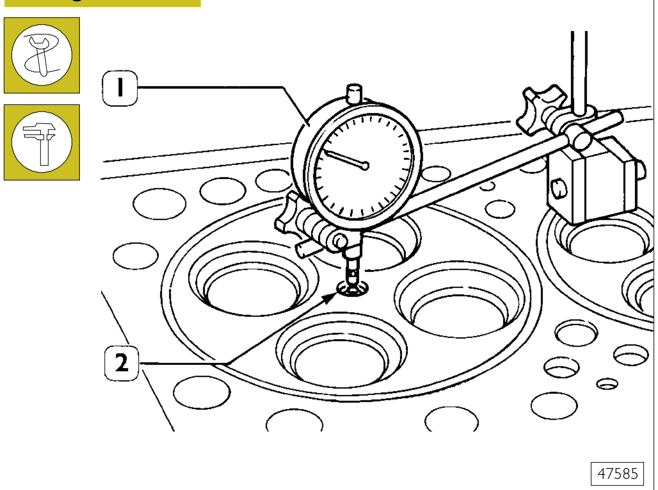
Figure 81



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

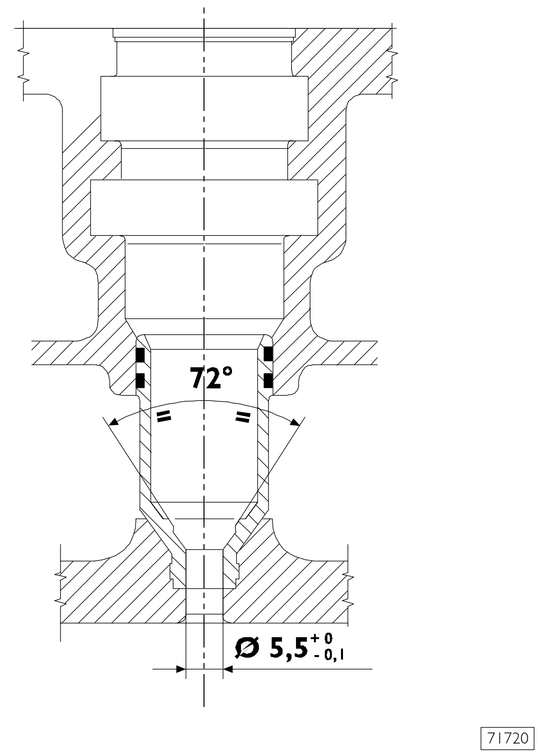
Checking injector protrusion

Figure 82



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

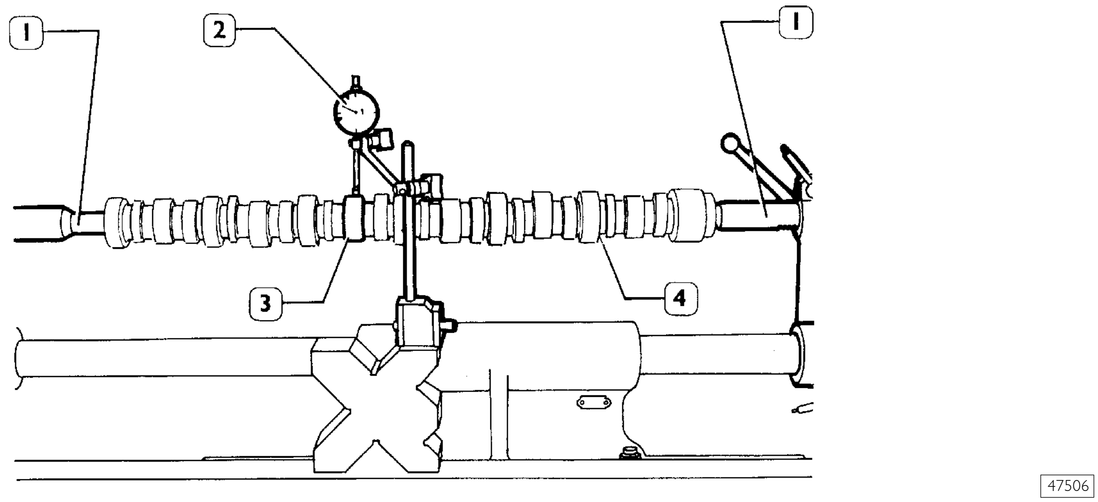
Figure 83



INJECTOR CASE ASSEMBLY DIAGRAM

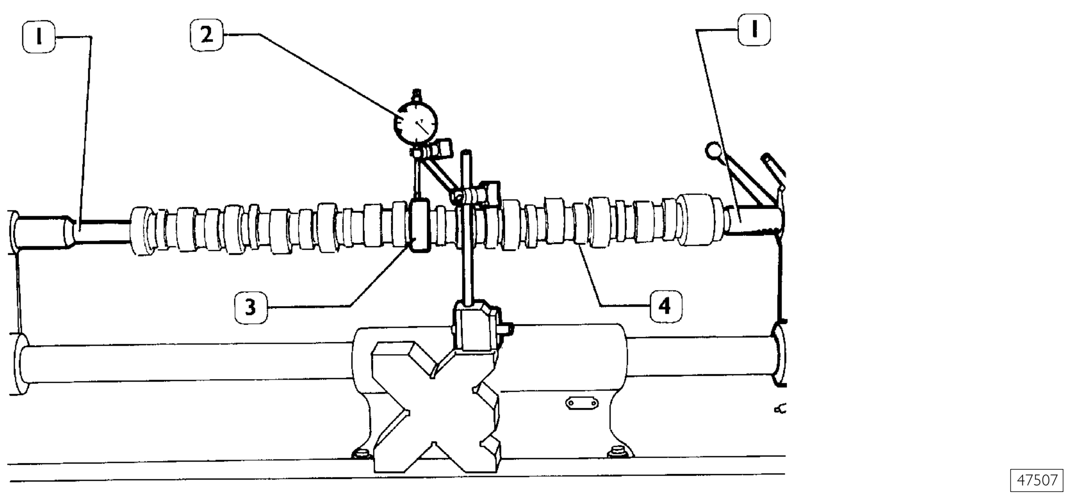
Camshaft
Checking cam lift and pin alignment

Figure 84



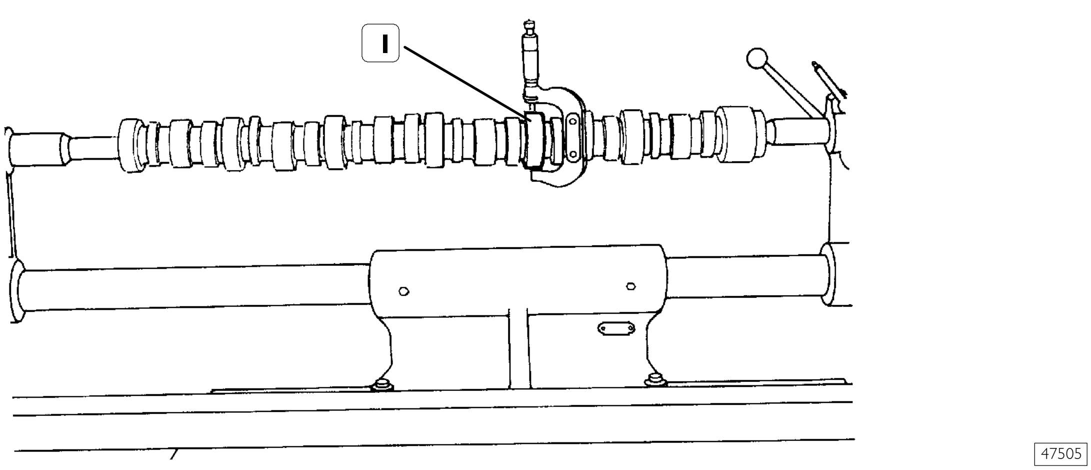
Place the camshaft (4) on the tailstock (1) and check cam lift (3) using a centesimal gauge (2).

Figure 85



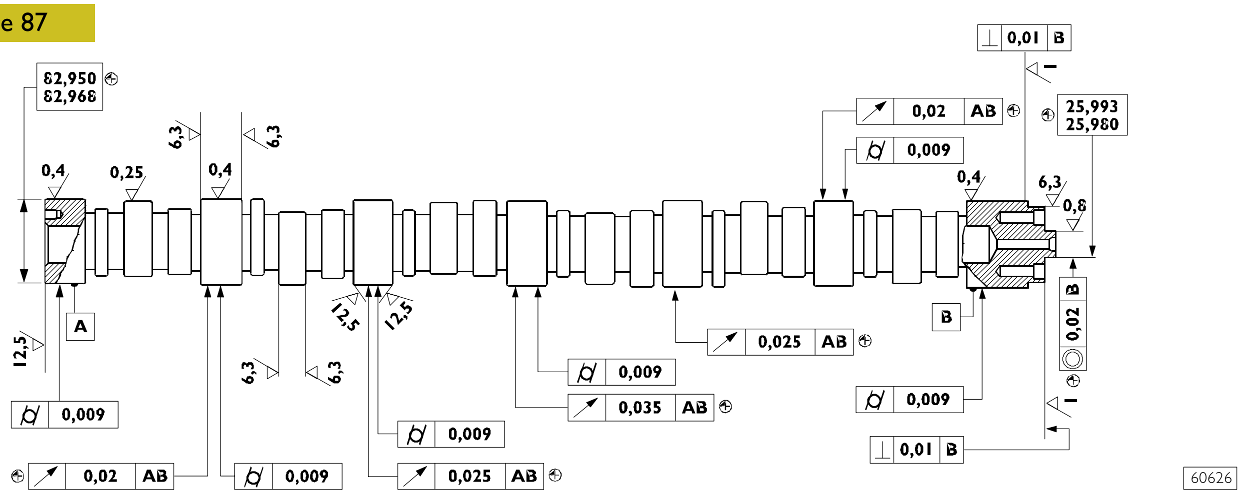
When the camshaft (4) is on the tailstock (1), check alignment of supporting pin (3) using a centesimal gauge (2); it must not exceed 0.030 mm. If misalignment exceeds this value, replace the shaft.

Figure 86



In order to check installation clearance, measure bush inner diameter and camshaft pin (1) diameter; the real clearance is obtained by their difference.
If clearance exceeds 0.135 mm, replace bushes and, if necessary, the camshaft.

Figure 87

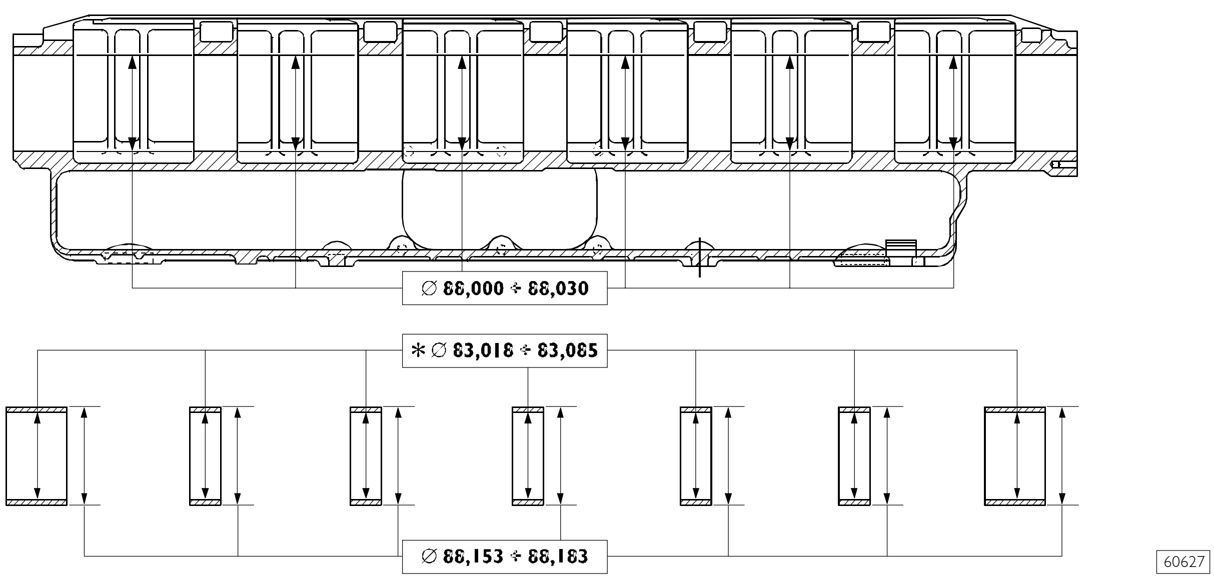


MAIN DATA OF THE CAMSHAFT AND TOLERANCES
The surfaces of the supporting pins of the shaft and those of the cams need to be extra smooth.
Whereas, if they show any signs of seizing or scoring, you should replace the shaft and the relevant bushings.

TOLERANCES	FEATURE SUBJECT OF TOLERANCE	SYMBOL
DIRECTION	Perpendicularity	⊥
POSITION	Concentricity or coaxiality	◎
SWING	Circular oscillation	↗
CLASS OF IMPORTANT ASCRIBED TO PRODUCT CHARACTERISTICS		SYMBOL
CRITICAL		©
IMPORTANT		⊕
SECONDARY		⊖

Bushings

Figure 88



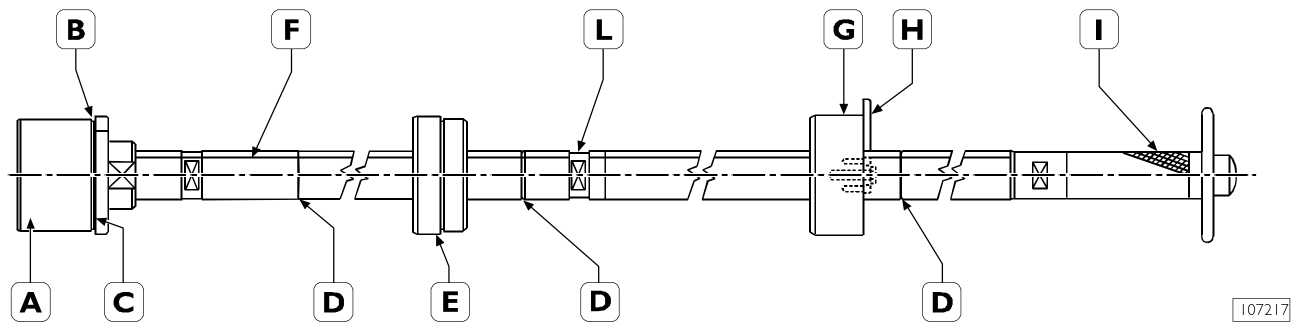
MAIN DATA OF THE BUSHINGS FOR THE CAMSHAFT AND SEATS ON THE CYLINDER HEAD
∗ Bushing inside diameter after driving in

The surface of the bushings must show no sign of seizing or scoring; replace them if they do.
Measure the inside diameter of the bushings with a bore gauge.

If you find a higher value than the tolerance, replace them.
To remove and fit the bushings, use the appropriate drift 99360499.

Replacing camshaft bushes using beater 99360499

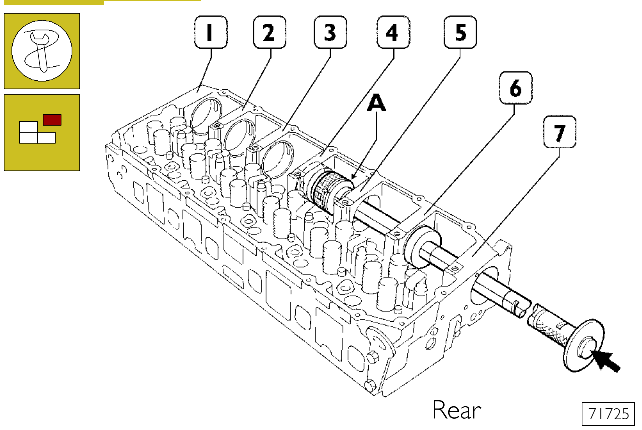
Figure 89



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

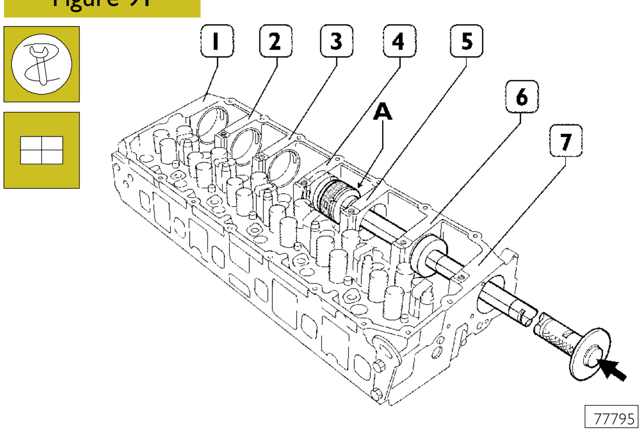
Figure 90



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

Assembly

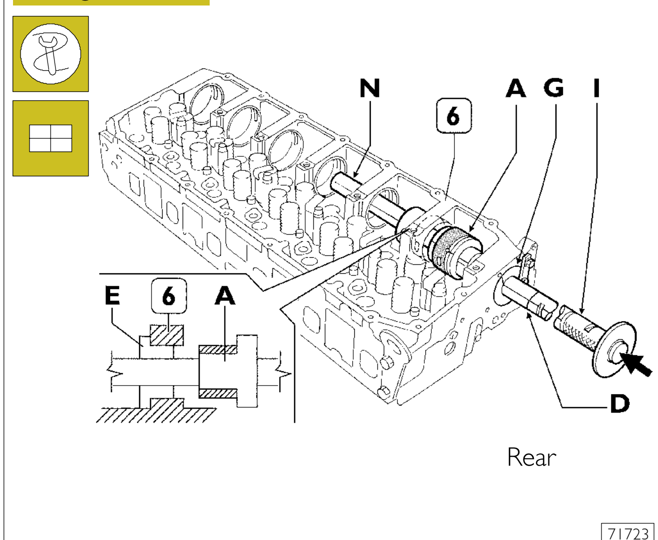
Figure 91



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).

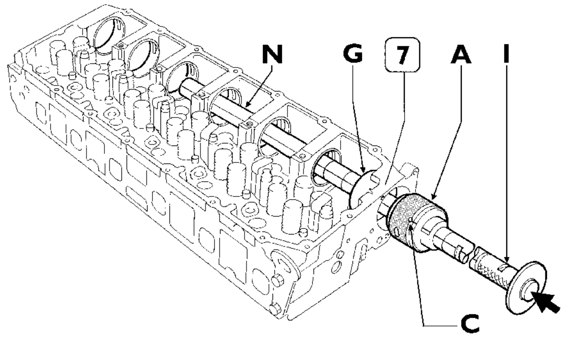
Figure 92



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

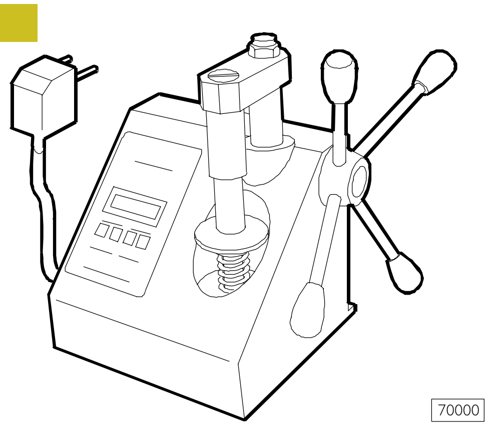


To insert bushing (7), proceed as follows:

- ❑ 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 7^{th} bushing is driven in when the reference mark (C) is flush with the bushing seat.

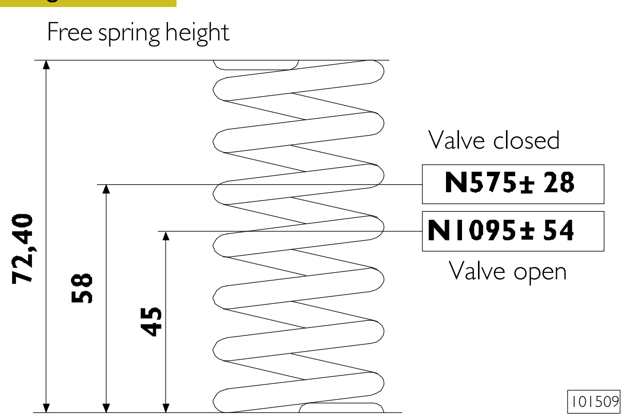
VALVE SPRINGS

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.

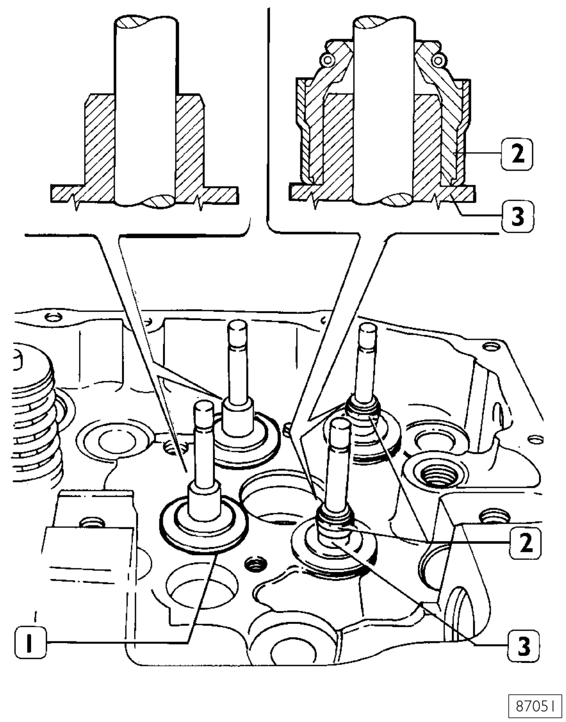
Figure 95



MAIN DATA TO CONTROL EXHAUST AND DISCHARGE VALVE SPRING

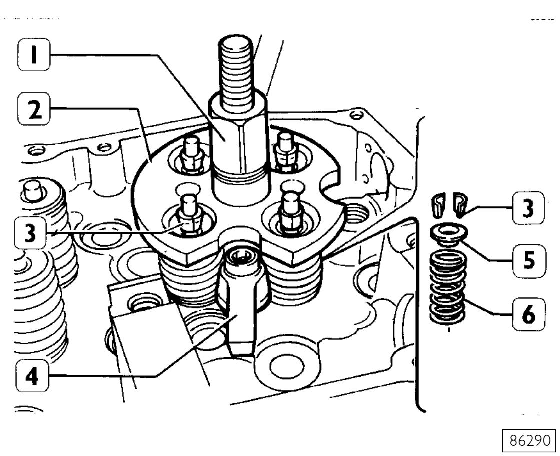
Fitting the valves and oil seal ring

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.

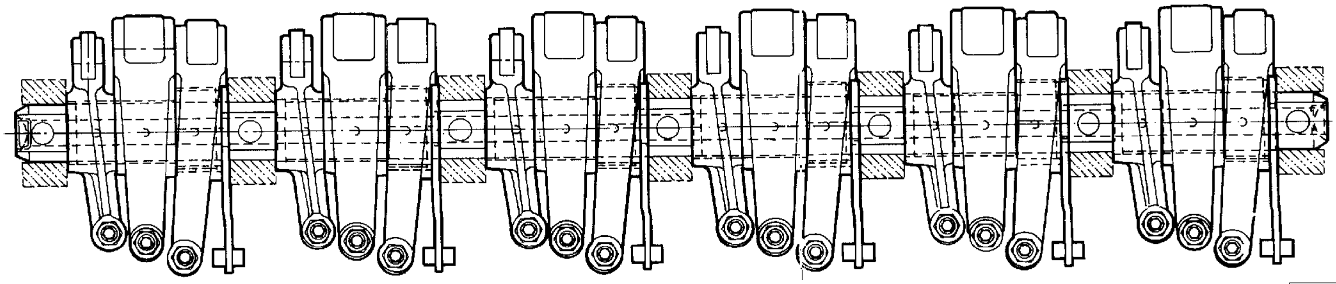
Figure 97



- ❑ fit springs (6) and the upper plate (5);
- ❑ apply tool 99360263 (2) and block it with bracket (4); tighten the lever (1) until cotters 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.

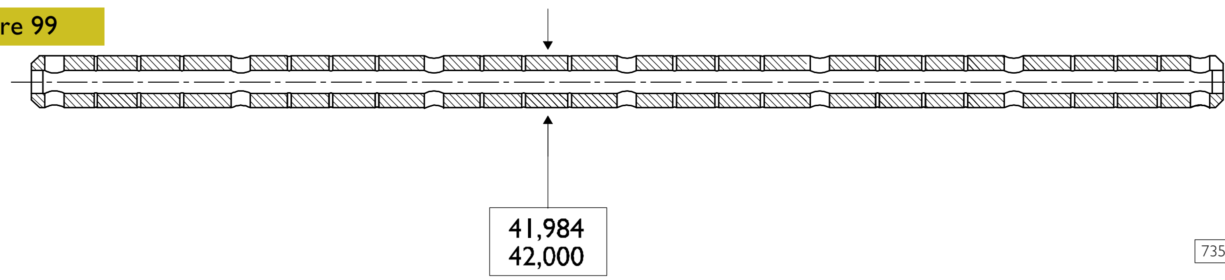
A pad is placed between the rocker adjusting screw and the bar.

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

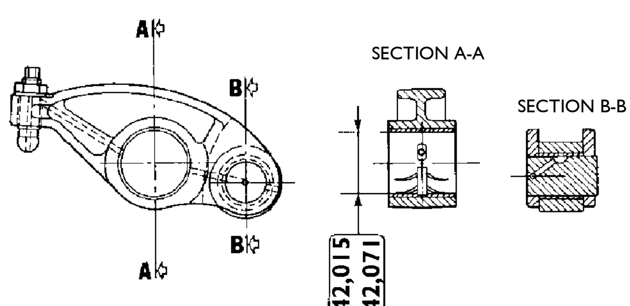


MAIN DATA OF THE ROCKER ARM SHAFT

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

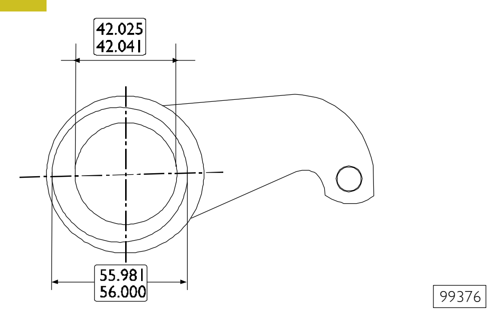
Rocker

Figure 100



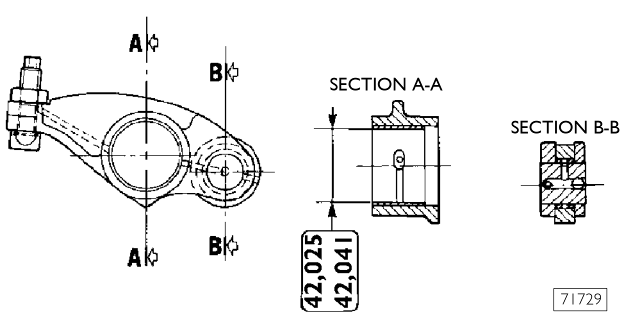
PUMP INJECTOR ROCKER

Figure 102



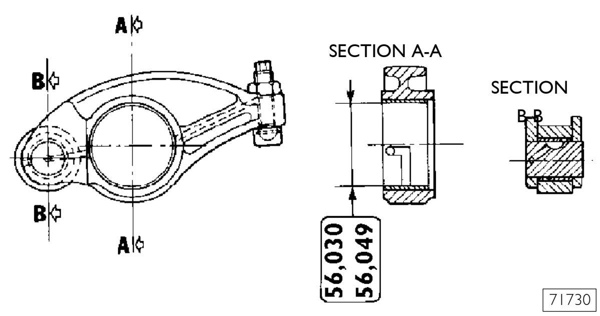
The bush surfaces must not show any trace of scoring of excessive wear; otherwise, replace bushes or the whole rocker.

Figure 101



EXHAUST VALVES ROCKER

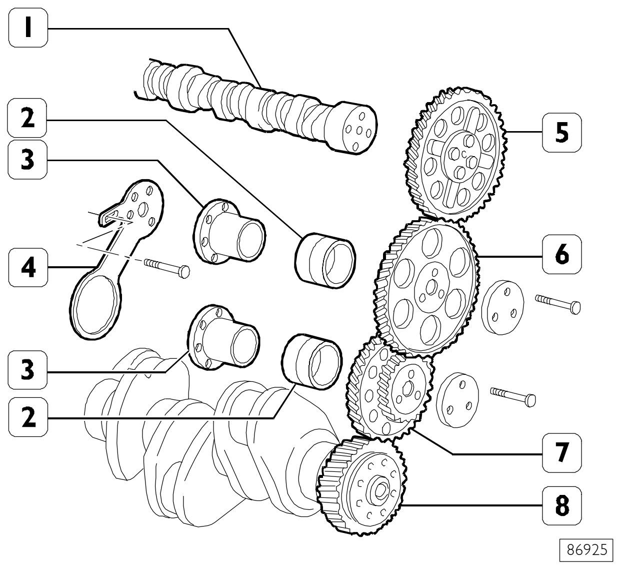
Figure 103



DISCHARGE VALVE ROCKER

TIMING GEAR
Camshaft drive

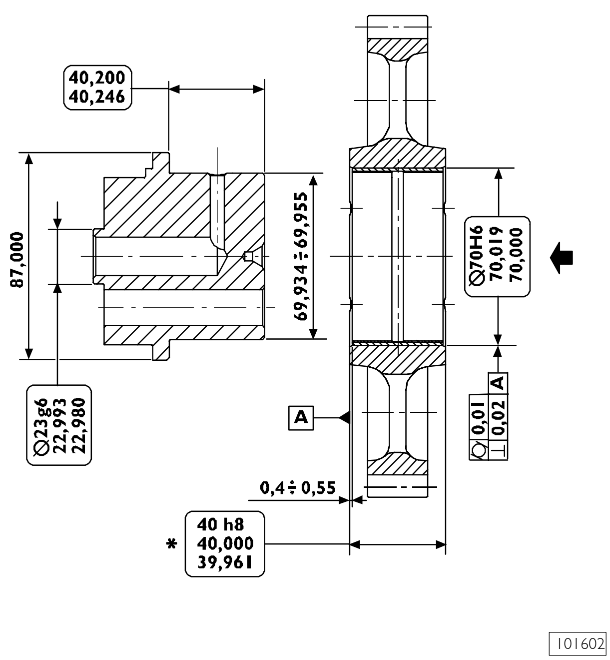
Figure 104



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

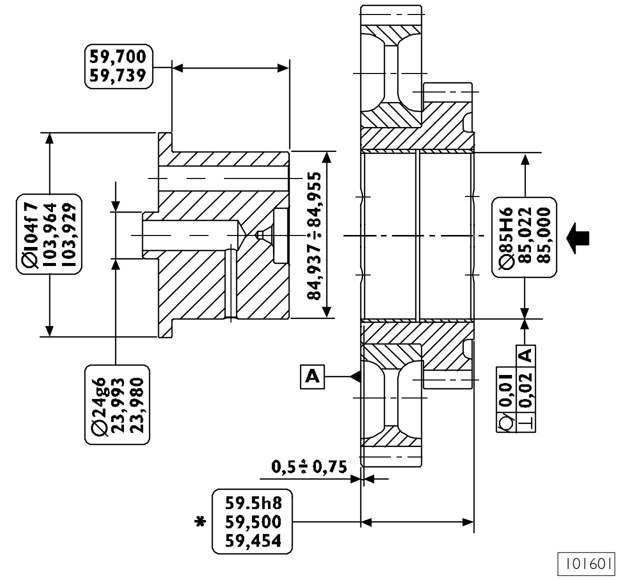
Figure 105



* 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.

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TIGHTENING TORQUE

PART		TORQUE Nm	TORQUE 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 tightening		 11.5 ± 3.5 19 ± ≤	 (1.15 ± 0.35) (1.9 ± 0.3)
Piston cooling nozzle union ♦		24,5 ± 2,5	(2.4 ± 0.25)
Spacer and oil sump capscrews ♦ pretightening tightening		 38 45	 (3.8) (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

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PART			TORQUE	
			Nm	kgm
Screw fixing alternator	M 10x1,5 M 10x1,5	l = 35 mm l = 60 mm	30 ± 3 44 ± 4	(3 ± 0.3) (4.4 ± 0.4)
Screws fixing air-conditioner compressor to mount			24.5 ± 2.5	(2.5 ± 0.25)
Screws fixing guard			24.5 ± 25	(2.5 ± 0.25)
Filter clogging sensor fastening			55 ± 5	(5.5 ± 0.5)
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)

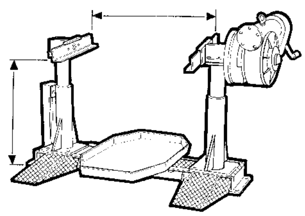
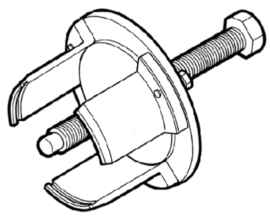
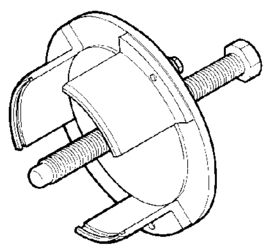
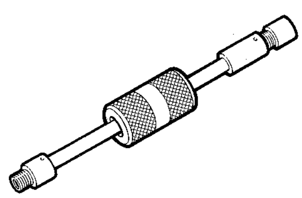
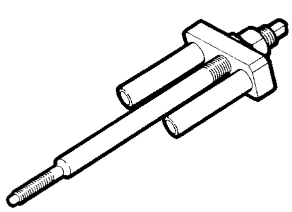
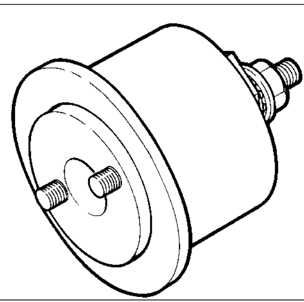
♦ Before assembly, lubricate with UTDM oil
• Before assembly, lubricate with graphitized oil

SECTION 5

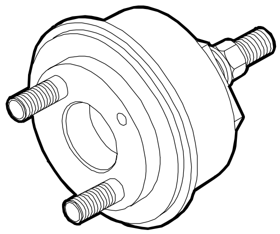
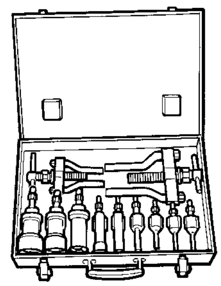
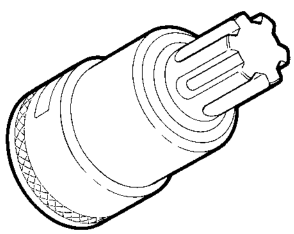
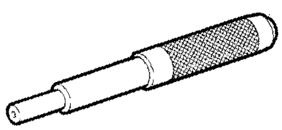
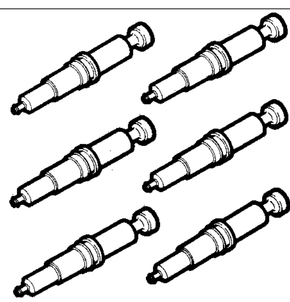
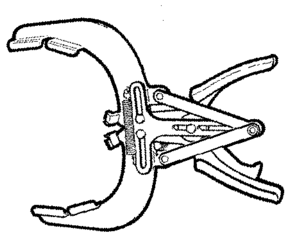
Tools

Page

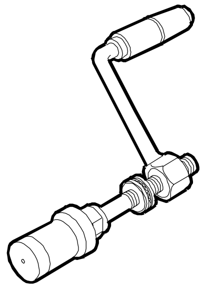
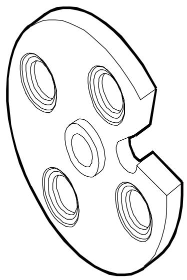
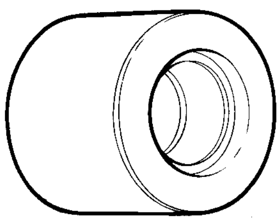
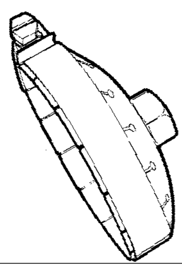
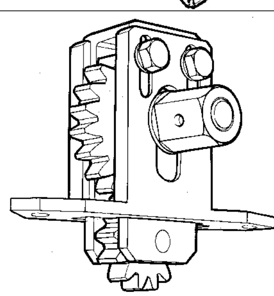
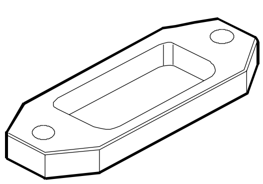
TOOLS

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

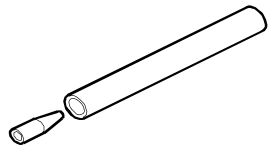
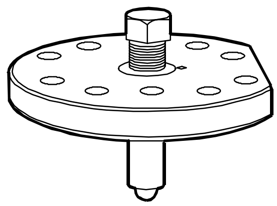
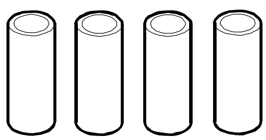
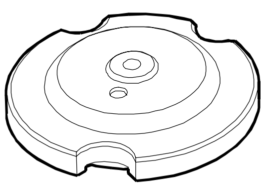
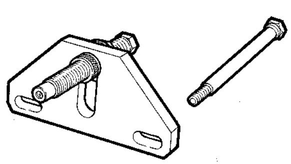
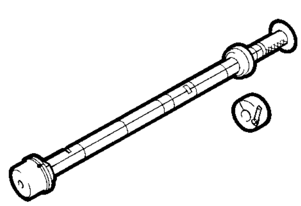
TOOLS

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
99360334		Compression tool for checking the protrusion of cylinder liners (to be used with 99370415-99395603 and special plates)
99360336		Spacer (to be used with 99360334)
99360338		Cylinder liner compression plate (to be used with 99360334-99360336)
99360351		Tool to stop engine flywheel
99360499		Tool to take down and fit back camshaft bushes

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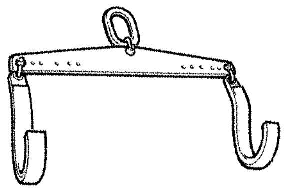
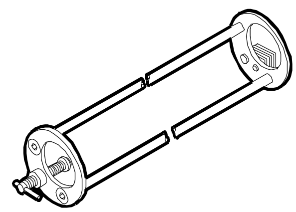
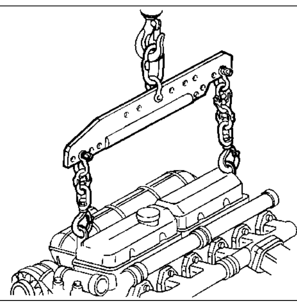
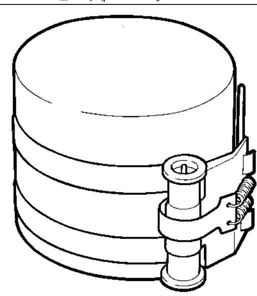
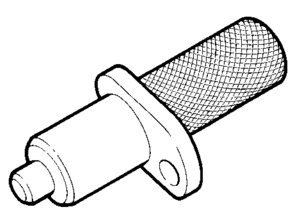
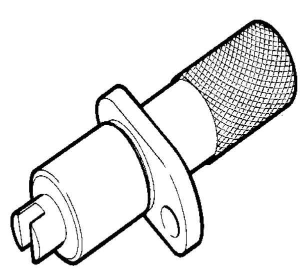
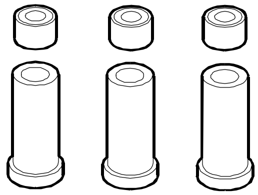
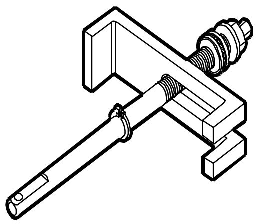
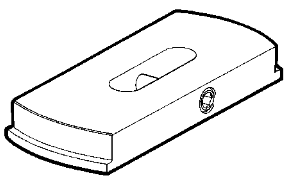
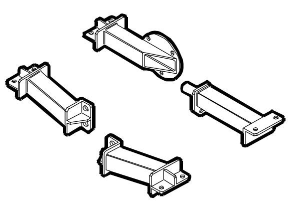
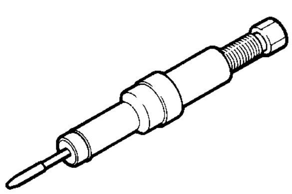
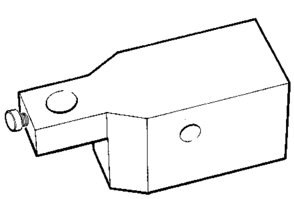
TOOLS

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)

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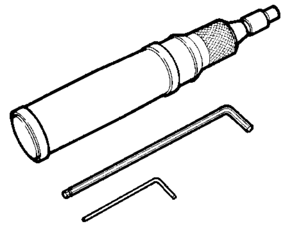
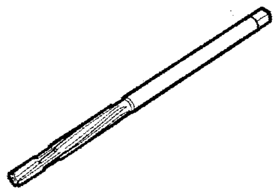
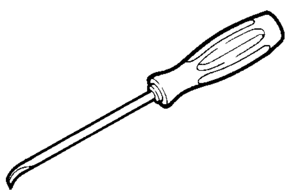
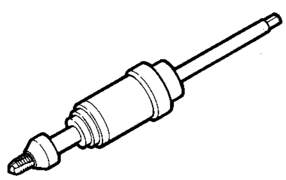
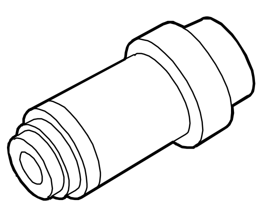
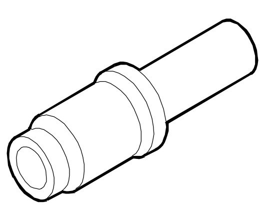
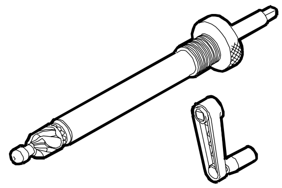
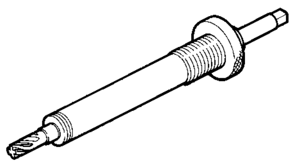
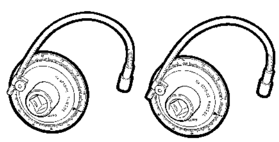
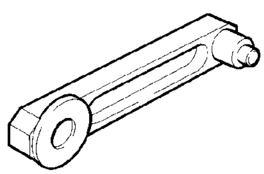
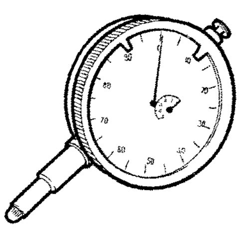
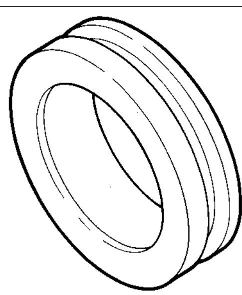
TOOLS

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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Appendix

SAFETY PRESCRIPTIONS

Standard safety prescriptions

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

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

- ❑ Keep working areas as clean as possible, ensuring adequate aeration.
- ❑ Ensure that working areas are provided with emergency boxes, that must be clearly visible and always provided with adequate sanitary equipment.
- ❑ Provide for adequate fire extinguishing means, properly indicated and always having free access. Their efficiency must be checked on regular basis and the personnel must be trained on intervention methods and priorities.
- ❑ Organize and displace specific exit points to evacuate the areas in case of emergency, providing for adequate indications of the emergency exit lines.
- ❑ Smoking in working areas subject to fire danger must be strictly prohibited.
- ❑ Provide Warnings throughout adequate boards signaling danger, prohibitions and indications to ensure easy comprehension of the instructions even in case of emergency.

Prevention of injury

- ❑ Do not wear unsuitable cloths for work, with fluttering ends, nor jewels such as rings and chains when working close to engines and equipment in motion.
- ❑ Wear safety gloves and goggles when performing the following operations:
  - filling inhibitors or anti-frost
  - lubrication oil topping or replacement
  - utilization of compressed air or liquids under pressure (pressure allowed: $\leq$ 2 bar)
- ❑ Wear safety helmet when working close to hanging loads or equipment working at head height level.
- ❑ Always wear safety shoes when and cloths adhering to the body, better if provided with elastics at the ends.
- ❑ Use protection cream for hands.
- ❑ Change wet cloths as soon as possible
- ❑ In presence of current tension exceeding 48-60 V verify efficiency of earth and mass electrical connections. Ensure that hands and feet are dry and execute working operations utilizing isolating foot-boards. Do not carry out working operations if not trained for.
- ❑ Do not smoke nor light up flames close to batteries and to any fuel material.
- ❑ Put the dirty rags with oil, diesel fuel or solvents in anti-fire specially provided containers.
- ❑ Do not execute any intervention if not provided with necessary instructions.
- ❑ Do not use any tool or equipment for any different operation from the ones they've been designed and provided for: serious injury may occur.
- ❑ In case of test or calibration operations requiring engine running, ensure that the area is sufficiently aerated or utilize specific vacuum equipment to eliminate exhaust gas. Danger: poisoning and death.

During maintenance

- ❑ Never open filler cap of cooling circuit when the engine is hot. Operating pressure would provoke high temperature with serious danger and risk of burn. Wait unit the temperature decreases under 50ºC.
- ❑ Never top up an overheated engine with cooler and utilize only appropriate liquids.
- ❑ Always operate when the engine is turned off: whether particular circumstances require maintenance intervention on running engine, be aware of all risks involved with such operation.
- ❑ Be equipped with adequate and safe containers for drainage operation of engine liquids and exhaust oil.
- ❑ Keep the engine clean from oil tangles, diesel fuel and or chemical solvents.
- ❑ Use of solvents or detergents during maintenance may originate toxic vapors. Always keep working areas aerated. Whenever necessary wear safety mask.
- ❑ Do not leave rags impregnated with flammable substances close to the engine.
- ❑ Upon engine start after maintenance, undertake proper preventing actions to stop air suction in case of runaway speed rate.
- ❑ Do not utilize fast screw-tightening tools.
- ❑ Never disconnect batteries when the engine is running.
- ❑ Disconnect batteries before any intervention on the electrical system.
- ❑ Disconnect batteries from system aboard to load them with the battery loader.
- ❑ After every intervention, verify that battery clamp polarity is correct and that the clamps are tight and safe from accidental short circuit and oxidation.
- ❑ Do not disconnect and connect electrical connections in presence of electrical feed.
- ❑ Before proceeding with pipelines disassembly (pneumatic, hydraulic, fuel pipes) verify presence of liquid or air under pressure. Take all necessary precautions bleeding and draining residual pressure or closing dump valves. Always wear adequate safety mask or goggles. Non fulfillment of these prescriptions may cause serious injury and poisoning.

- Avoid incorrect tightening or out of couple. Danger: incorrect tightening may seriously damage engine's components, affecting engine's duration.
- Avoid priming from fuel tanks made out of copper alloys and/or with ducts not being provided with filters.
- Do not modify cable wires: their length shall not be changed.
- Do not connect any user to the engine electrical equipment unless specifically approved by 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 priory removed electronic gearbox.
- Remove electronic gearbox in case of any intervention requiring heating over 80ºC temperature.
- Do not paint the components and the electronic connections.
- Do not vary or alter any data filed in the electronic gearbox driving the engine. Any manipulation or alteration of electronic components shall totally compromise engine assistance warranty and furthermore may affect engine correct working and duration.

Respect of the Environment

- Respect of the Environment shall be of primary importance: all necessary precautions to ensure personnel's safety and health shall be adopted.
- Be informed and inform the personnel as well of laws in force regulating use and exhaust of liquids and engine exhaust oil. Provide for adequate board indications and organize specific training courses to ensure that personnel is fully aware of such law prescriptions and of basic preventive safety measures.
- Collect exhaust oils in adequate specially provided containers with hermetic sealing ensuring that storage is made in specific, properly identified areas that shall be aerated, far from heat sources and not exposed to fire danger.
- Handle the batteries with care, storing them in aerated environment and within anti-acid containers. Warning: battery exhalation represent serious danger of intoxication and environment contamination.

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Part 3
G-DRIVE CURSOR ENGINES

PREFACE TO USER'S GUIDELINE MANUAL

Section 1 describes engines F3A and F3B in their characteristics and general operation.

Section 2 is specific of use.

NOTE Part no. 4 is characterized by describing a particular industrial/agricultural application: G-Drive motors.

These engines are marketed as an assembly that is also equipped with the air/coolant and possibly air/air (intercooler) cooling device.

The description of this application gives the differences with the industrial application (given in the preceding Parts) and reference must be made to it for all repair and maintenance work.

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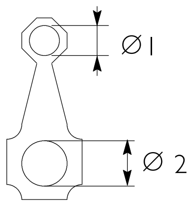
SPECIAL REMARKS

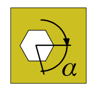
Diagrams and symbols have been widely used to give a clearer and more immediate illustration of the subject being dealt with, (see next page) instead of giving descriptions of some operations or procedures.

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

Graph and symbols

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

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

UPDATING

Section	Description	Page	Date of revision

SECTION 1

General specifications

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

F3A engine

Technical Code	Commercial Code
F3AE9685A*E001	CURSOR 10TE X
F3AE9685B*E002	

F3B engine

Technical Code	Commercial Code
F3BE9685A*E001	CURSOR 13TE X

VIEWS OF ENGINES (DEMONSTRATION)

Figure 1

LEFT-HAND SIDE VIEW

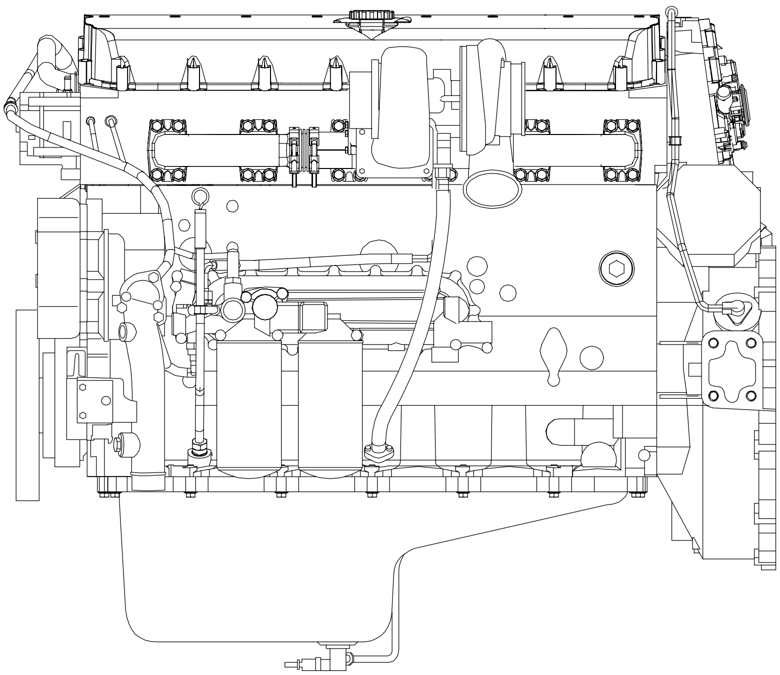


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Figure 2

RIGHT-HAND SIDE VIEW

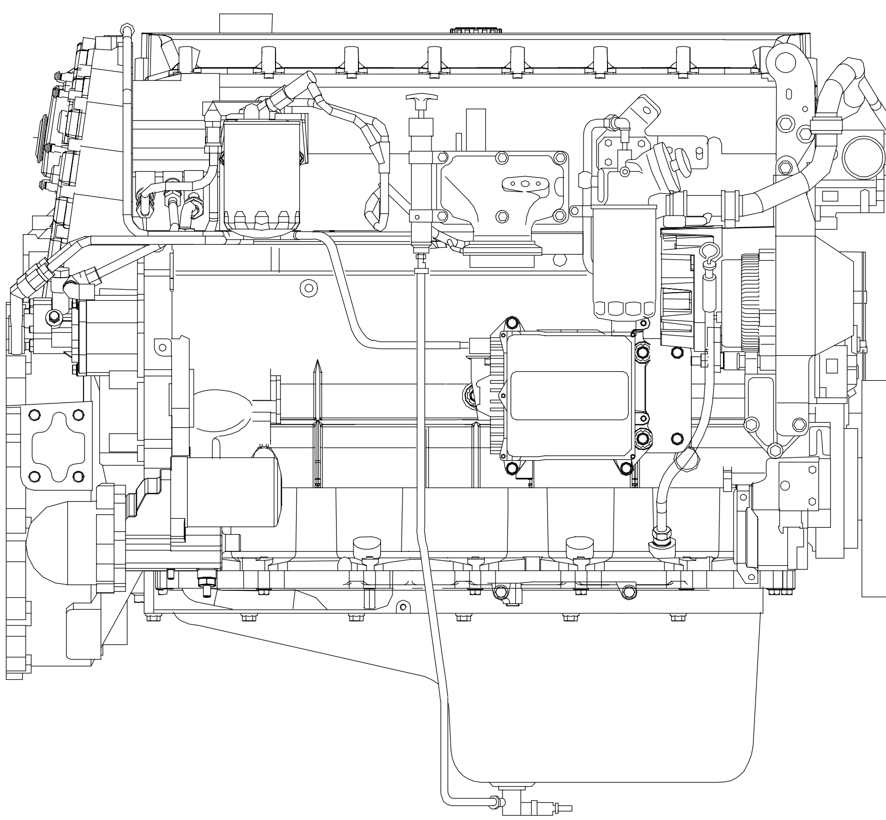

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Figure 3

FRONT VIEW

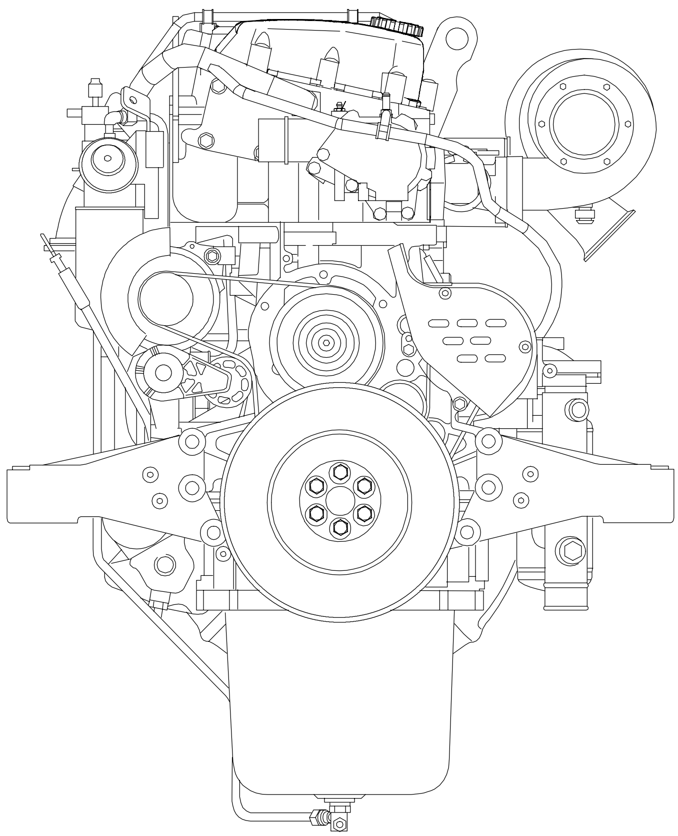


Figure 4

REAR VIEW

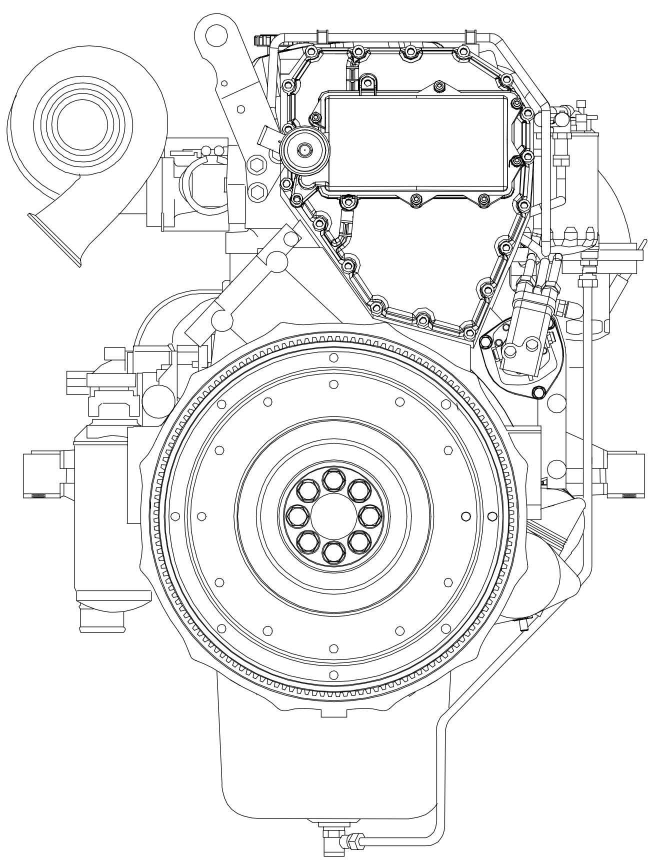
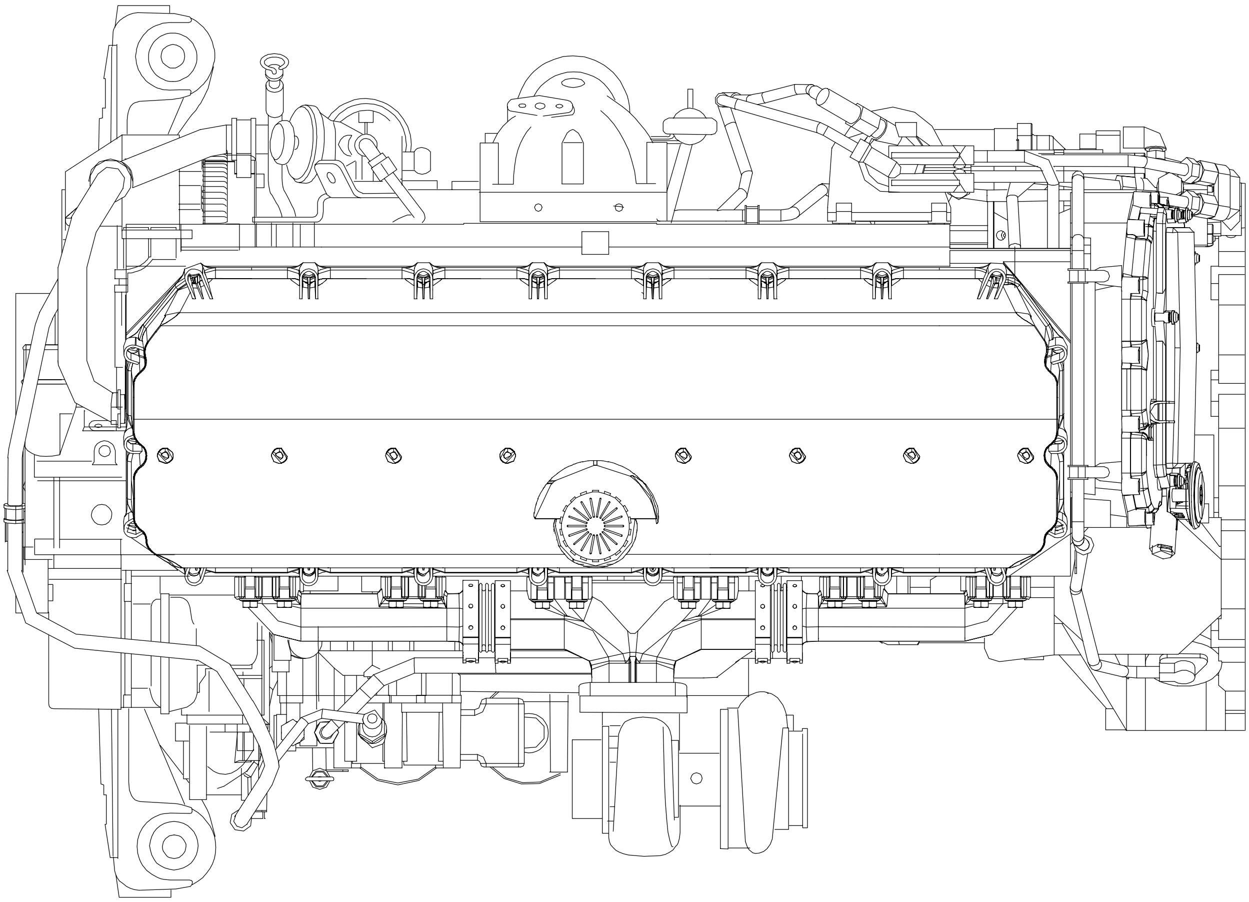


Figure 5

TOP VIEW



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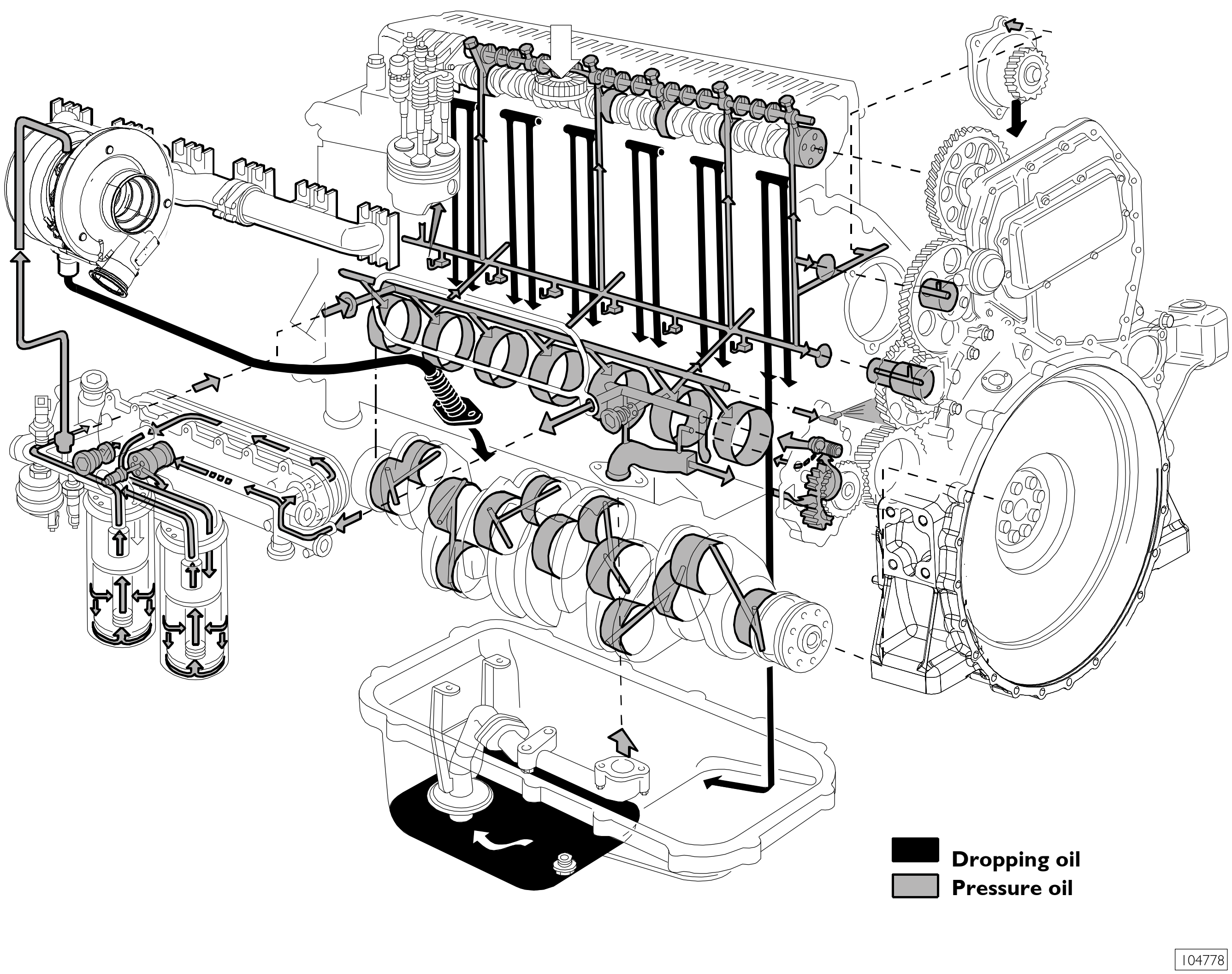
LUBRICATION

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

Figure 6 (Demonstration)



LUBRICATION DIAGRAM

COOLING

Description

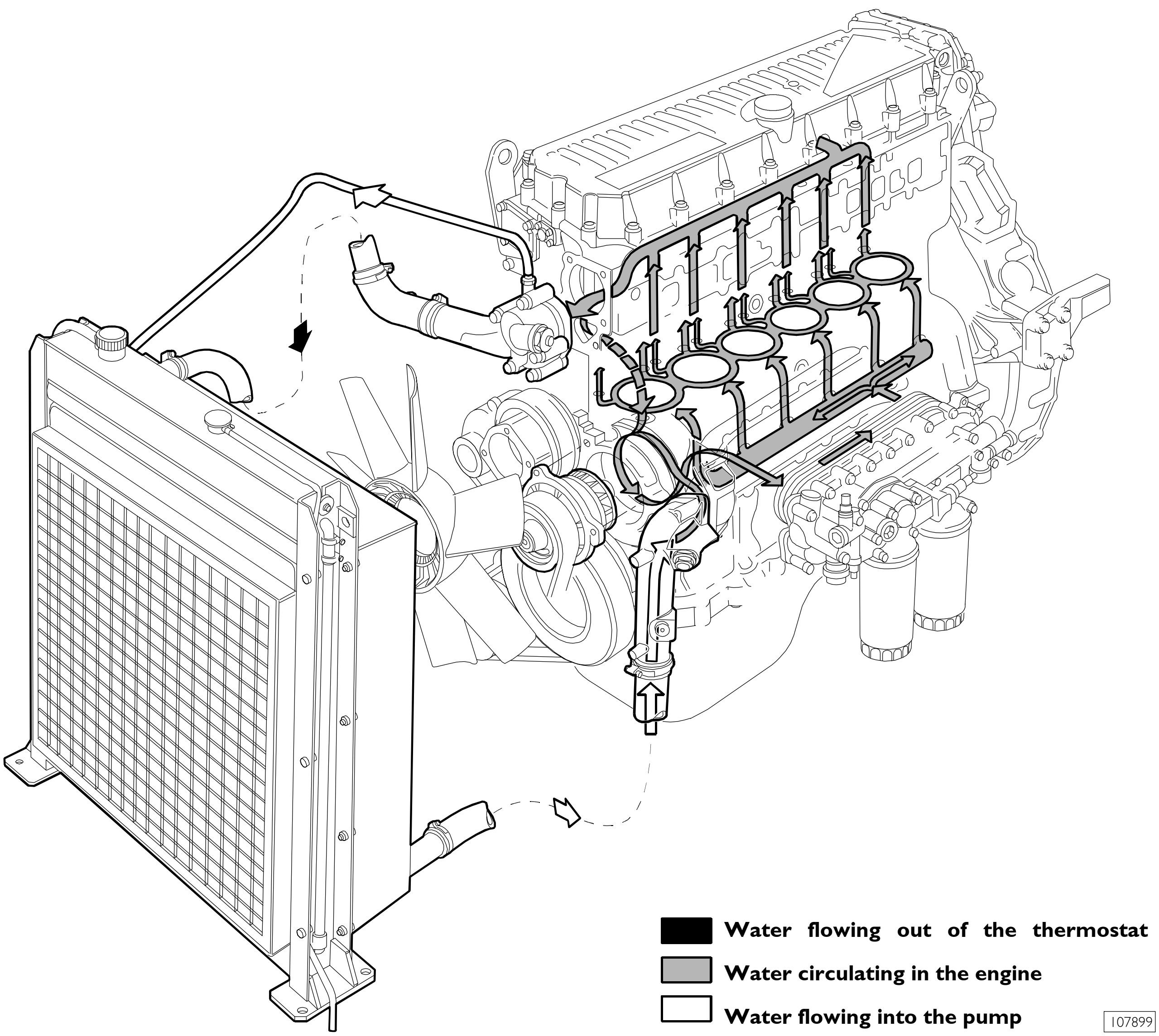
The engine cooling system is of the closed-circuit, forced circulation type.
It consists mainly of the following components:

- expansion tank,
- a heat exchanger to cool down lubrication oil;
- a water pump with centrifugal system incorporated in the cylinder block;
- fan;
- a 2-way thermostat controlling the coolant circulation.

Operation

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

Figure 7 (Demonstration)

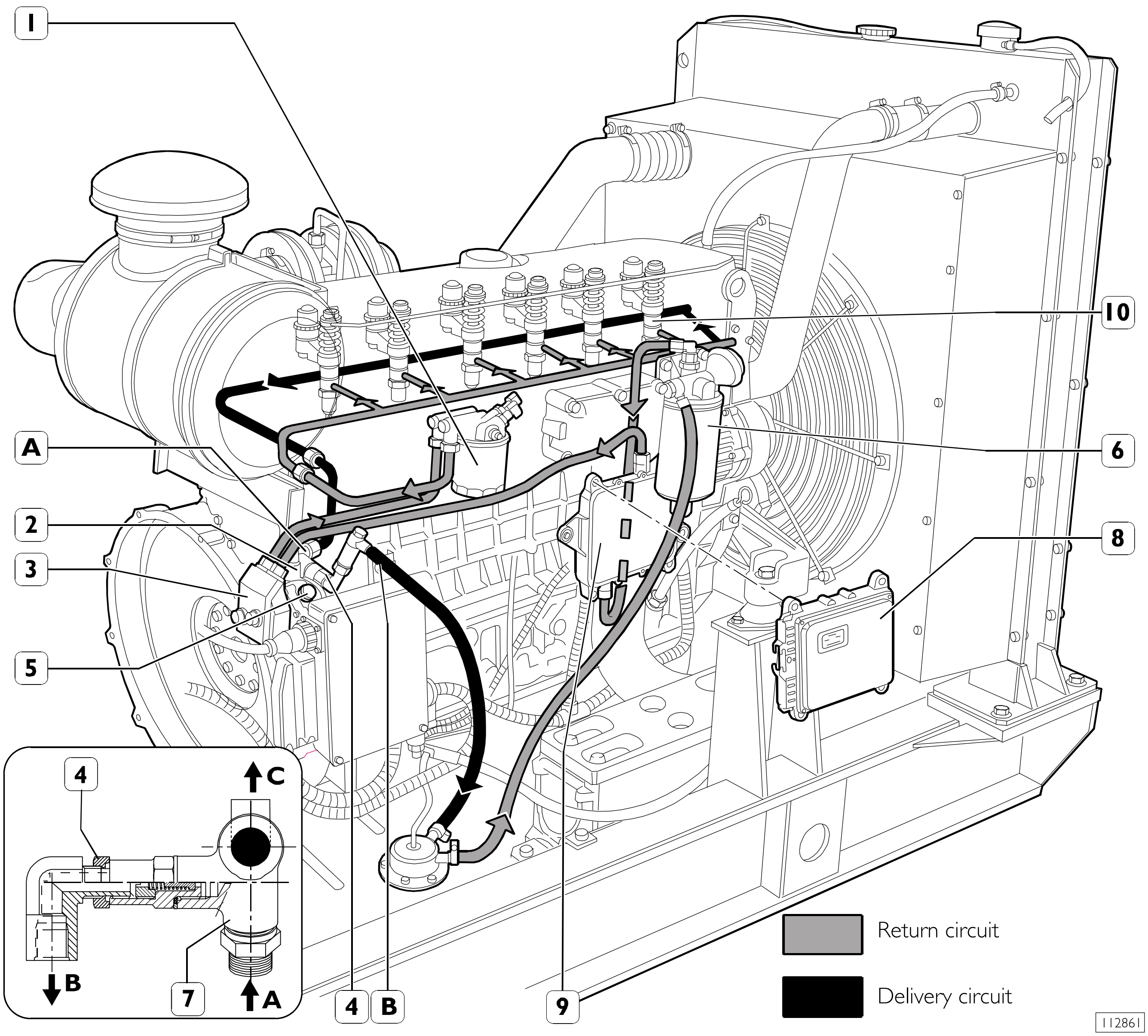


COOLING SYSTEM DIAGRAM

FUEL FEED

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

Figure 8 (Demonstration)



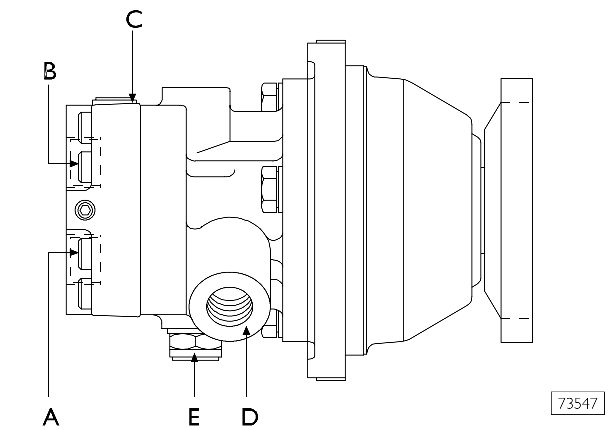
FEED SCHEME

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

A. Fuel arriving at injectors - B. Fuel returning to tank - C. Fuel entering from injectors into feed pump

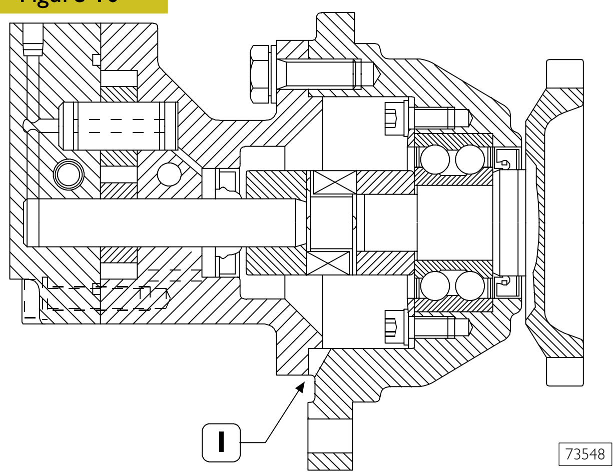
F3A engine fuel supply pump

Figure 9



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

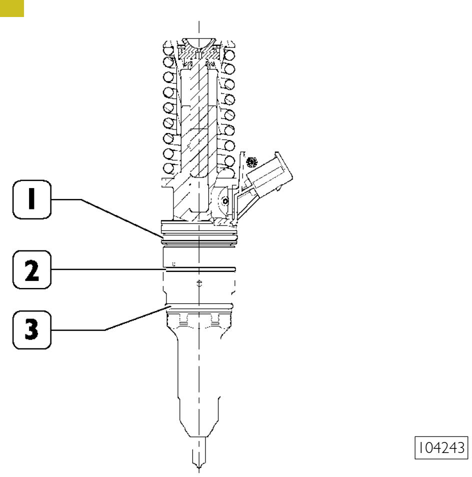
Figure 10



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

Injector-pump

Figure 11



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).

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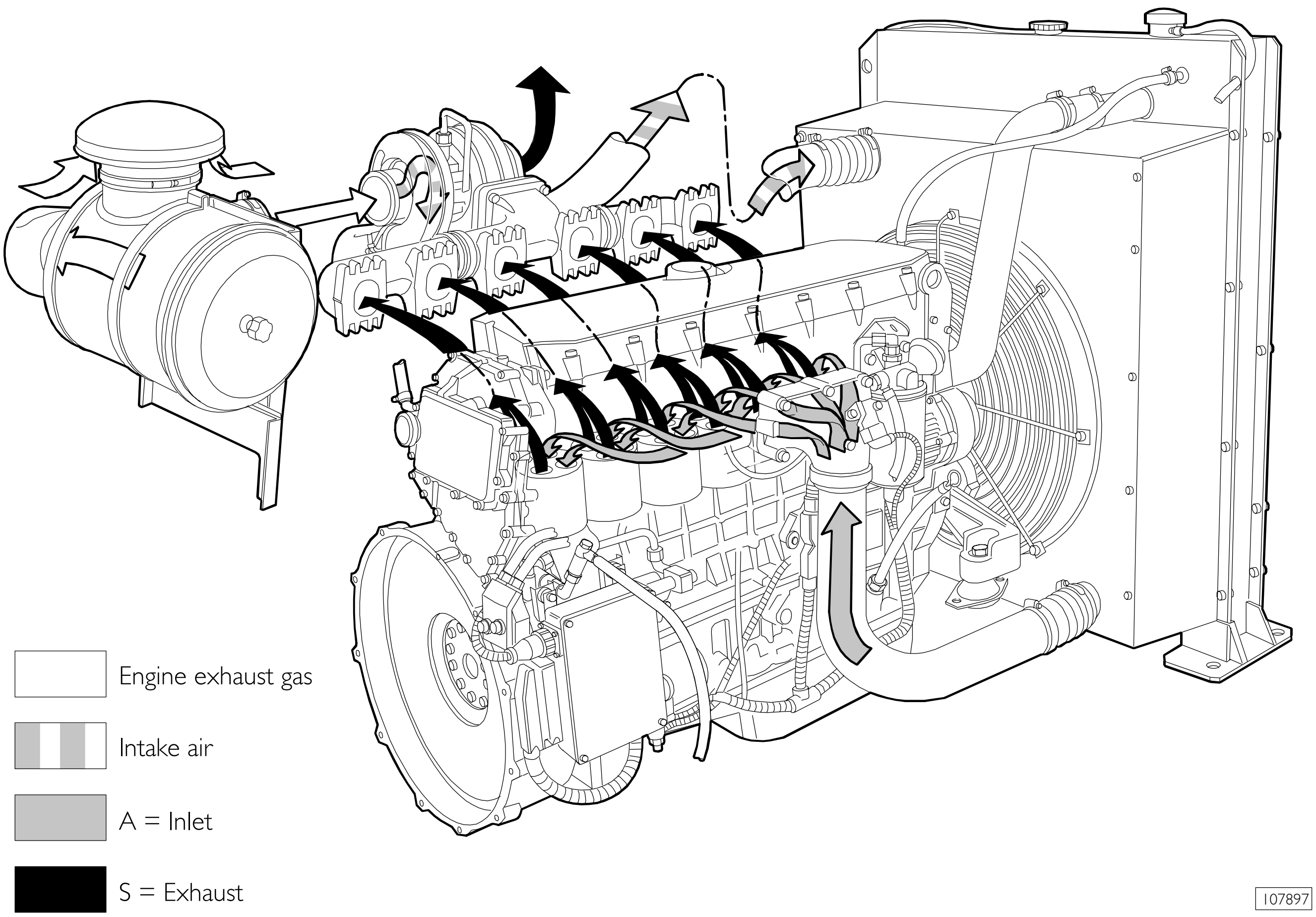
TURBOCHARGING

The turbocharging system consists of:

- ❑ air filter;
- ❑ Turbocharger.

Figure 12 (Demonstration)



SUPERCHARGING SYSTEM DIAGRAM

SECTION 2

G-Drive application

F3A ENGINE CLEARANCE DATA

Type		F3AE9685	
		A*E001	B*E002
Compression ratio		16.5 to 1	
Europe market Max. output	kW (HP) rpm	- - -	300 (407.8) 1500/50 Hz
Max. torque	Nm (kgm) rpm	- - -	- - -
USA market Max. output	kW (HP) rpm	335 (455.4) 1800/60 Hz	- - -
Max. torque	Nm (kgm) rpm	- - -	- - -
Bore x stroke Displacement	mm cm^3	125 x 140 10300	
SUPERCHARGING Turbocharger type		Intercooler Direct injection HOLSET HX455	
LUBRICATION Oil pressure (warm engine) - idling - peak rpm	 bar bar	Forced by gear pump, relief valve single action oil filter - -	

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.

F3B ENGINE CLEARANCE DATA

	Type		**F3BE9685A*E001**
ϱ	Compression ratio		16.5 to 1
	Europe market Max. output	kW (HP) rpm	- - -
	Max. torque	Nm (kgm) rpm	- - -
	USA market Max. output	kW (HP) rpm	395 (537) 1800/60 Hz
	Max. torque	Nm (kgm) rpm	- - -
	Bore x stroke Displacement	mm cm^3	135 x 150 12880
	SUPERCHARGING Turbocharger type		Direct injection HOLSET HX60W
bar	LUBRICATION Oil pressure (warm engine) - idling - peak rpm	 bar bar	Forced by gear pump, relief valve single action oil filter - -
	COOLING Water pump control **Thermostat** - start of opening	 °C	Liquid Through belt -

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.

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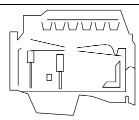
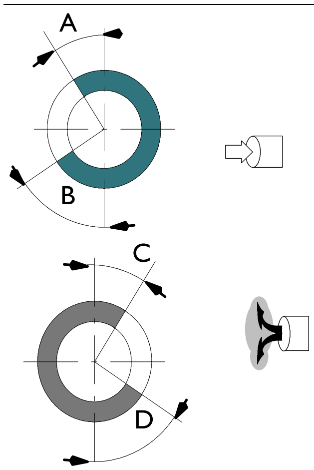
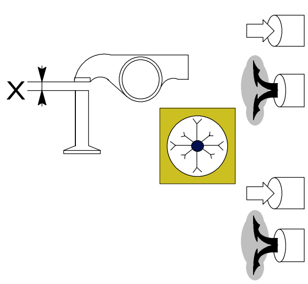
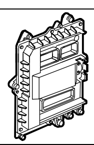
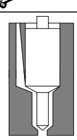
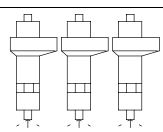
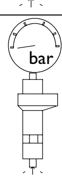
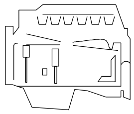
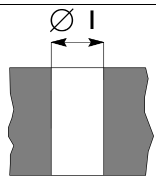
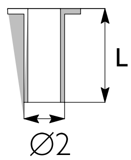
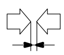
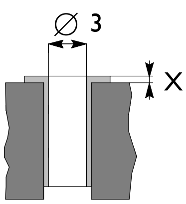
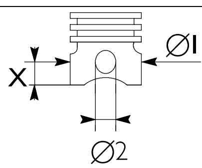
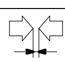
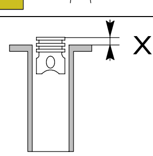
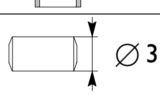
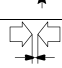
F3A GENERAL CHARACTERISTICS

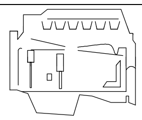
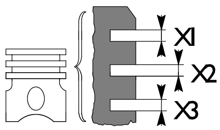
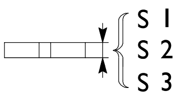
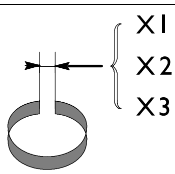
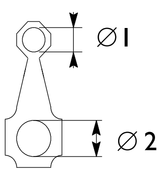
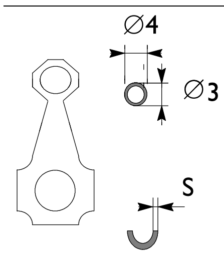
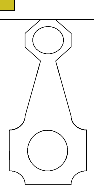
Type		F3A
Cycle		Diesel 4 strokes
Feeding		Turbocharged
Injection		Direct
N. of cylinders		6 on-line
Diameter	mm	125
Stroke	mm	140
Total displacement	cm^3	10300
Europe market Max. output	kW (HP) rpm	300 (407.8) 1500/50 Hz
Max. torque	Nm (kgm) rpm	- - -
USA market Max. output	kW (HP) rpm	335 (455.4) 1800/60 Hz
Max. torque	Nm (kgm) rpm	- - -

	Type		**F3A**
	VALVE TIMING		
	opens before T.D.C.	A	17°
	closes after B.D.C.	B	4°
	opens before B.D.C.	D	56°
	closes after T.D.C.	C	9°
	For timing check		
	X	mm	–
		mm	–
	Running		
	X	mm	0.35 to 0.45
		mm	0.45 to 0.55
	FEED		Through fuel pump - filters
	Injection type: Bosch		With electronically regulated injectors PDE/N3 pump injectors controlled by overhead camshaft
	Nozzle type		-
	Injection order		1 - 4 - 2 - 6 - 3 - 5
	Injection pressure	bar	1800
	Injector calibration	bar	296 to 6

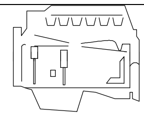
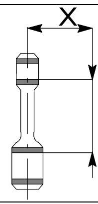
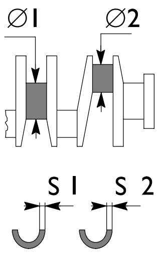
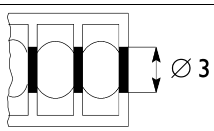
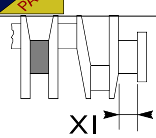
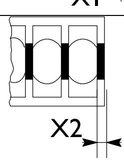
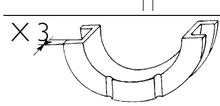
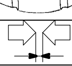
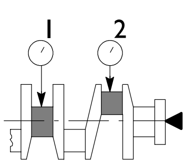
F3A ASSEMBLY CLEARANCE DATA

	Type	**F3A**
CYLINDER BLOCK AND CRANK MECHANISM COMPONENTS		mm
	Cylinder sleeve bore Ø 1 upper lower	 142.000 to 142.025 140.000 to 140.025
	Cylinder liners: outer diameter: Ø 2 upper lower length L	 141.961 to 141.986 139.890 to 139.915
	Cylinder sleeve - crankcase bore upper lower	 0.014 to 0.064 0.085 to 0.135
IVECO PARTS	Outside diameter Ø 2	
 * Available dia. class	Cylinder sleeve inside diameter Ø3 A* inside diameter Ø3 B* Protrusion X	 125.000 to 125.013 125.011 to 125.024 0.045 to 0.075
	Pistons: measuring dimension X outside diameter Ø 1 A• outside diameter Ø 1 B•• outside diameter Ø 2	 18 124.884 to 124.896 124.896 to 124.907 50.010 to 50.018
 * Available dia. class	Piston - cylinder sleeve A* B*	 0.104 to 0.129 0.104 to 0.128
IVECO PARTS	Piston diameter Ø 1	_
	Pistons protrusion X	0.23 to 0.53
	Gudgeon pin Ø 3	49.994 to 50.000
	Gudgeon pin - pin housing	0.010 to 0.024

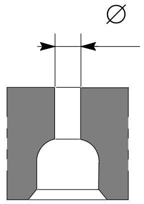
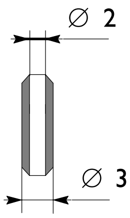
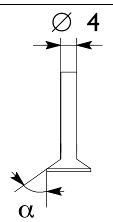
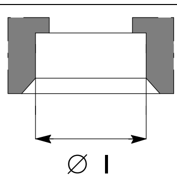
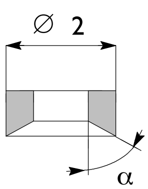
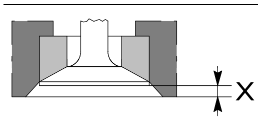
- • Class A pistons supplied as spares.
- •• Class B pistons are fitted in production only and are not supplied as spares.

	Type		F3A mm
	Piston ring grooves	X1 X2 X3	3.620 to 2.640 1.550 to 1.570 4.020 to 4.040
	Piston rings: trapezoidal seal lune seal milled scraper ring with slits and internal spring	 S1 S2 S3	 2.500 1.470 to 1.500 3.970 to 3.990
	Piston rings - grooves	1 2 3	0.120 to 0.140 0.050 to 0.100 0.030 to 0.070
IVECO PARTS	Piston rings		-
	Piston ring end gap in cylinder liners	X1 X2 X3	0.35 to 0.50 0.60 to 0.75 0.35 to 0.65
	Small end bush housing Big end bearing housing Selection classes	∅1 ∅2 1 2 3	54.000 to 54.030 87.000 to 87.030 87.000 to 87.010 87.011 to 87.020 87.021 to 87.030
	Small end bush diameter outside inside Big end bearing shell Red Green Yellow ●	 ∅4 ∅3 S	 54.085 to 54.110 50.019 to 50.035 1.970 to 1.980 1.981 to 1.990 1.991 to 2.000
	Small end bush - housing		0.055 to 0.110
	Piston pin - bush		0.019 to 0.041
IVECO PARTS	Big end bearing		0.127 - 0.254 - 0.508
	Connecting rod weight	A	g. 3973 to 4003
	Connecting rod weight Class	A B C	g. 3973 to 4003 g. 4004 to 4034 g. 4035 to 4065

● Fitted in production only and not supplied as spares

	Type		F3A
			mm
	Measuring dimension	X	125
	Max. connecting rod axis misalignment tolerance	—	0.08
	Main journals	Ø1	
	- nominal		92.970 to 93.000
	- class	1	92.970 to 92.979
	- class	2	92.980 to 92.989
	- class	3	92.990 to 93.000
	Crankpins	Ø2	
	- nominal		82.970 to 83.000
	- class	1	82.970 to 82.979
	- class	2	82.980 to 82.989
	- class	3	82.990 to 83.000
	Main bearing shells	S1	
	Red		2.965 to 2.974
	Green		2.975 to 2.984
	Yellow*		2.985 to 2.995
	Big end bearing shells	S2	
	Red		1.970 to 1.980
	Green		1.981 to 1.990
	Yellow*		1.991 to 2.000
	Main bearing housings	Ø3	
	- nominal		99.000 to 99.030
	- class	1	99.000 to 99.009
	- class	2	99.010 to 99.019
	- class	3	99.020 to 99.030
	Bearing shells - main journals		0.050 to 0.090
	Bearing shells - big ends		0.040 to 0.080
IVECO PARTS	Main bearing shells		0.127 - 2.254 - 0.508
	Big end bearing shells		0.127 - 2.254 - 0.508
	Main journal, thrust bearing	X1	45.95 to 46.00
	Main bearing housing, thrust bearing	X2	38.94 to 38.99
	Thrust washer halves	X3	3.38 to 3.43
	Crankshaft end float		0.10 to 0.30
	Alignment	1 - 2	≤ 0.025
	Ovalization	1 - 2	- 0.010
	Taper	1 - 2	0.010

* Fitted in production only and not supplied as spares

	Type	**F3A**
CYLINDER HEAD - VALVE TRAIN		mm
	Valve guide housings in cylinder head ∅1	14.980 to 14.997
	Valve guide ∅2 ∅3	9.015 to 9.030 15.012 to 15.025
	Valve guides - housings in the cylinder heads	0.015 to 0.045
	Valve guide	0.2 - 0.4
	Valves: ∅4 α ∅4 α	8.960 to 8.975 60° 30′ ± 7′ 30″ 8.960 to 8.975 45° 30′ ± 7′ 30″
	Valve stem and its guide	0.040 to 0.070
	Valve seat in head ∅1 ∅1	44.185 to 44.220 42.985 to 43.020
	Outside diameter of valve seat; angle of valve seat in cylinder head: ∅2 α ∅2 α	44.260 to 44.275 60° - 30′ 43.060 to 43.075 45° - 30′
	Recessing of valve X X	0.65 to 0.95 1.8 to 2.1
	Between valve seat and head	0.040 to 0.090

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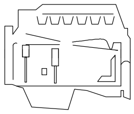
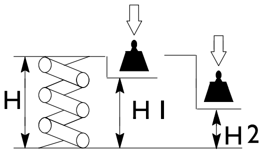
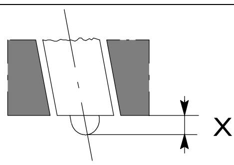
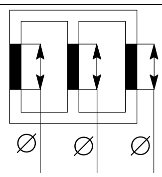
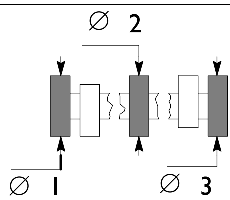
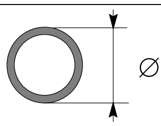
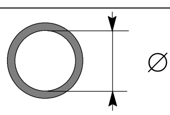
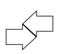
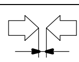
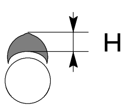
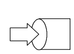
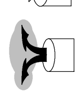
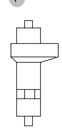
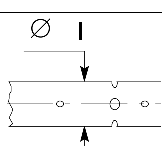
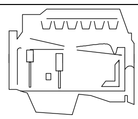
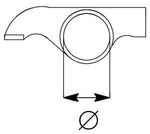
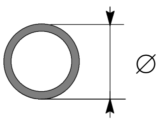
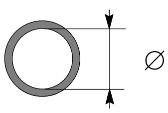
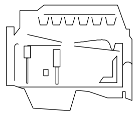
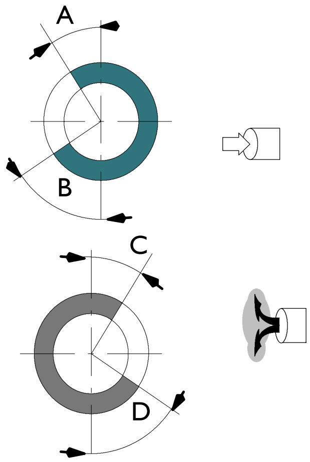
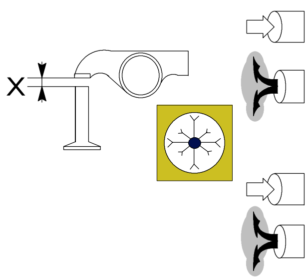
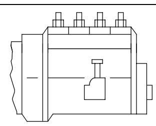
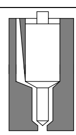
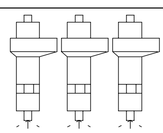
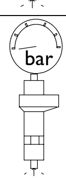
	Type		F3A mm
	Valve spring height: free height under a load of: N 500 ±25 N 972 ±48	 H H1 H2	 75 61 47.8
	Injector protrusion	X	0.14 to 1.4
	Camshaft bushing housing in the cylinder head: 1 ⇒ 7	Ø	88.000 to 88.030
	Camshaft bearing journals: 1 ⇒ 7	Ø	82.950 to 82.968
	Outer diameter of camshaft bushings:	Ø	88.153 to 88.183
	Inner diameter of camshaft bushings:	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 9.45 11.21
	Rocker shaft	Ø1	41.984 to 42.000

		F3A
	Type	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		HOLSET HX55
End float		-
Radial play		-

F3B GENERAL CHARACTERISTICS

	Type		**F3BE9685A*E001**
	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
ϱ	Compression ratio		16.5 ± 1
	Europe market Max. output	kW (HP) rpm	- - -
	Max. torque	Nm (kgm) rpm	- - -
	USA market Max. output	kW (HP) rpm	395 (537) 1800/60Hz
	Max. torque	Nm (kgm) rpm	- - -

	Type		**F3B**
	VALVE TIMING		
	opens before T.D.C.	A	17°
	closes after B.D.C.	B	30°
	opens before B.D.C.	D	50°
	closes after T.D.C.	C	9°
	For timing check		
	X	mm	-
		mm	-
	Running		
	X	mm	0.35 to 0.45
		mm	0.55 to 0.65
	FEED		Through fuel pump - filters
	Injection type: Bosch		With electronically regulated injectors PDE N3 pump injectors controlled by overhead camshaft
	Nozzle type		–
	Injection order		1 - 4 - 2 - 6 - 3 - 5
	Injection pressure	bar	1800
	Injector calibration	bar	296 ± 6

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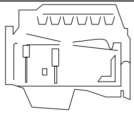
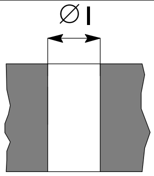
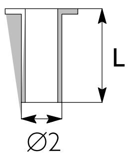
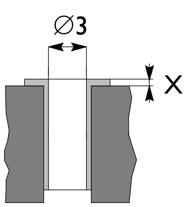
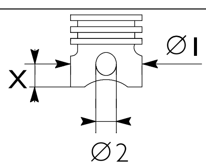
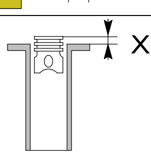
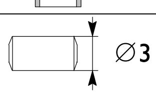
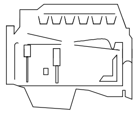
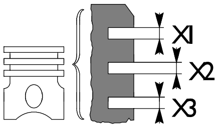
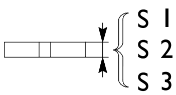
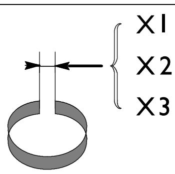
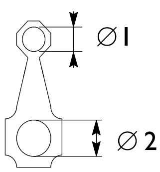
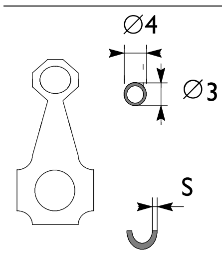
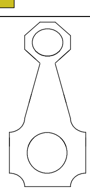
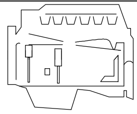
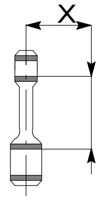
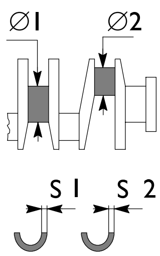
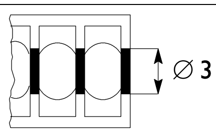
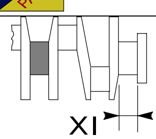
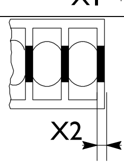
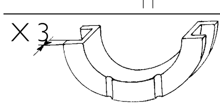
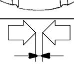
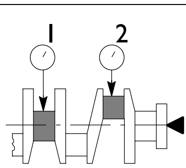
F3B ASSEMBLY CLEARANCE DATA

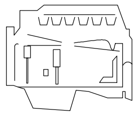
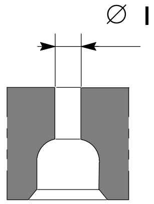
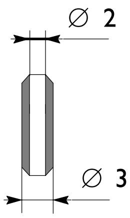
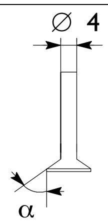
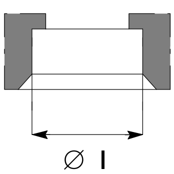
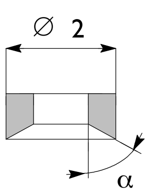
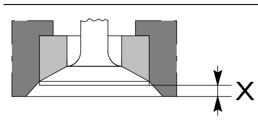
	Type		**F3B**
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS			mm
	Bores for cylinder liners: Ø1	upper lower	153.500 to 153.525 152.000 to 152.025
	Cylinder liners: external diameter: Ø2 length	upper lower L	153.461 to 153.486 151.890 to 151.915 -
	Cylinder liners - crankcase bores	upper lower	0.014 to 0.039 0.085 to 0.135
IVECO PARTS	External diameter	Ø2	-
	Cylinder sleeve inside diameter inside diameter Protrusion	 Ø3A* Ø3B* X	 135.000 to 135.012 135.011 to 135.023 0.045 to 0.075
* Selection class * Under a load of 800 N			
	Pistons: measuring dimension external diameter external diameter pin bore	 X Ø1A● Ø1B●● Ø2	 18 134.861 to 134.873 134.872 to 134.884 54.010 to 54.018
* Selection class	Piston - cylinder sleeve	A* B*	0.127 to 0.151 0.127 to 0.151
IVECO PARTS	Piston diameter	Ø1	-
	Pistons protrusion	X	0.12 to 0.42
	Gudgeon pin	Ø3	53.994 to 54.000
	Gudgeon pin - pin housing		0.010 to 0.024

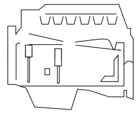
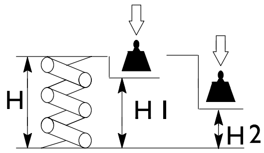
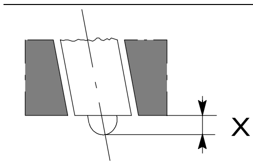
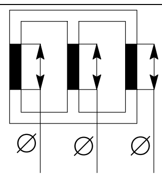
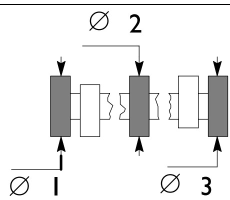
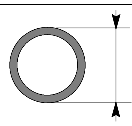
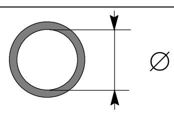
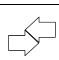
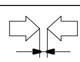
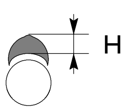
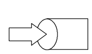
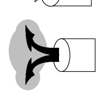
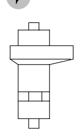
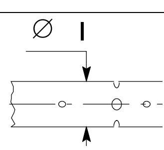
● Class A pistons supplied as spares.
●● Class B pistons are fitted in production only and are not supplied as spares.

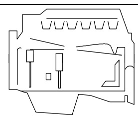
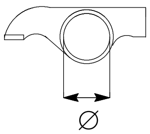
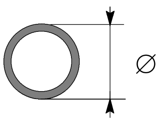
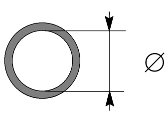
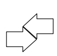
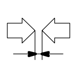
	Type		F3B mm
	Piston ring grooves	X1 X2 X3	3.100 to 3.120 1.550 to 1.570 5.020 to 5.040
	Piston rings: trapezoidal seal lune seal milled scraper ring with slits and internal spring * measured on ∅ of 130 mm	 S1* S2 S3	 3.000 1.470 to 1.500 4.970 to 4.990
	Piston rings - grooves	1 2 3	0.100 to 0.120 0.050 to 0.100 0.030 to 0.070
IVECO PARTS	Piston rings		-
	Piston ring end gap in cylinder liners	X1 X2 X3	0.40 to 0.50 0.65 to 0.80 0.40 to 0.75
	Small end bush housing nominal Big end bearing housing nominal - Class - Class - Class	∅1 ∅2 1 2 3	59.000 to 59.030 94.000 to 94.030 94.000 to 94.010 94.011 to 94.020 94.021 to 94.030
	Small end bush diameter outside inside Big end bearing shell Red Green Yellow	 ∅4 ∅3 S	 59.085 to 59.110 54.019 to 54.035 1.965 to 1.975 1.976 to 1.985 1.986 to 1.995
	Small end bush - housing		0.055 to 0.110
	Piston pin - bush		0.019 to 0.041
IVECO PARTS	Big end bearing		0.127 - 0.254 - 0.508
	Connecting rod weight		g.
	Class	A B C	4661 to 4694 4695 to 4728 4729 to 4762

	Type		F3B
			mm
	Measuring dimension	X	125
	Max. connecting rod axis misalignment tolerance		0.08
	Main journals	Ø1	
	- rated value		99.970 to 100.000
	- class	1	99.970 to 99.979
	- class	2	99.980 to 99.989
	- class	3	99.990 to 100.000
	Crankpins	Ø2	
	- rated value		89.970 to 90.000
	- 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	
	- rated value		106.300 to 106.330
	- 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
IVECO PARTS	Main bearing shells		0.127 - 2.254 - 0.508
	Big end bearing shells		0.127 - 2.254 - 0.508
	Main journal, thrust bearing	X1	47.95 to 48.00
	Main bearing housing, thrust bearing	X2	40.94 to 40.99
	Thrust washer halves	X3	3.38 to 3.43
	Crankshaft end float		0.10 to 0.30
	Alignment	1 - 2	≤ 0.025
	Ovalization	1 - 2	0.010
	Taper	1 - 2	0.010

* Fitted in production only and not supplied as spares

	Type		**F3B**
CYLINDER HEAD - VALVE TRAIN			mm
	Valve guide housings in cylinder head	∅1	15.980 to 15.997
	Valve guide	∅2 ∅3	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:	∅4 α ∅4 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	∅1 ∅1	49.185 to 49.220 46.985 to 47.020
	Outside diameter of valve seat; angle of valve seat in cylinder head:	∅2 α ∅2 α	49.260 to 49.275 60° - 30′ 47.060 to 47.075 45° - 30′
	Recessing of valve	X X	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 under a load of: 575 ± 28 N 1095 ± 54 N	 H H1 H2	 72,40 58 45
	Injector protrusion	X	0.53 to 1.34
	Camshaft bushing housing in the cylinder head: 1 ⇒ 7	Ø	88.000 to 88.030
	Camshaft bearing journals: 1 ⇒ 7	Ø	82.950 to 82.968
	Outer diameter of camshaft bushings:	Ø	88.153 to 88.183
	Inner diameter of camshaft bushings:	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:   		9.231 9.231 11.216
	Rocker shaft	Ø1	41.984 to 42.000

		F3B
	Type	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		HOLSET HX55
End float		-
Radial play		-

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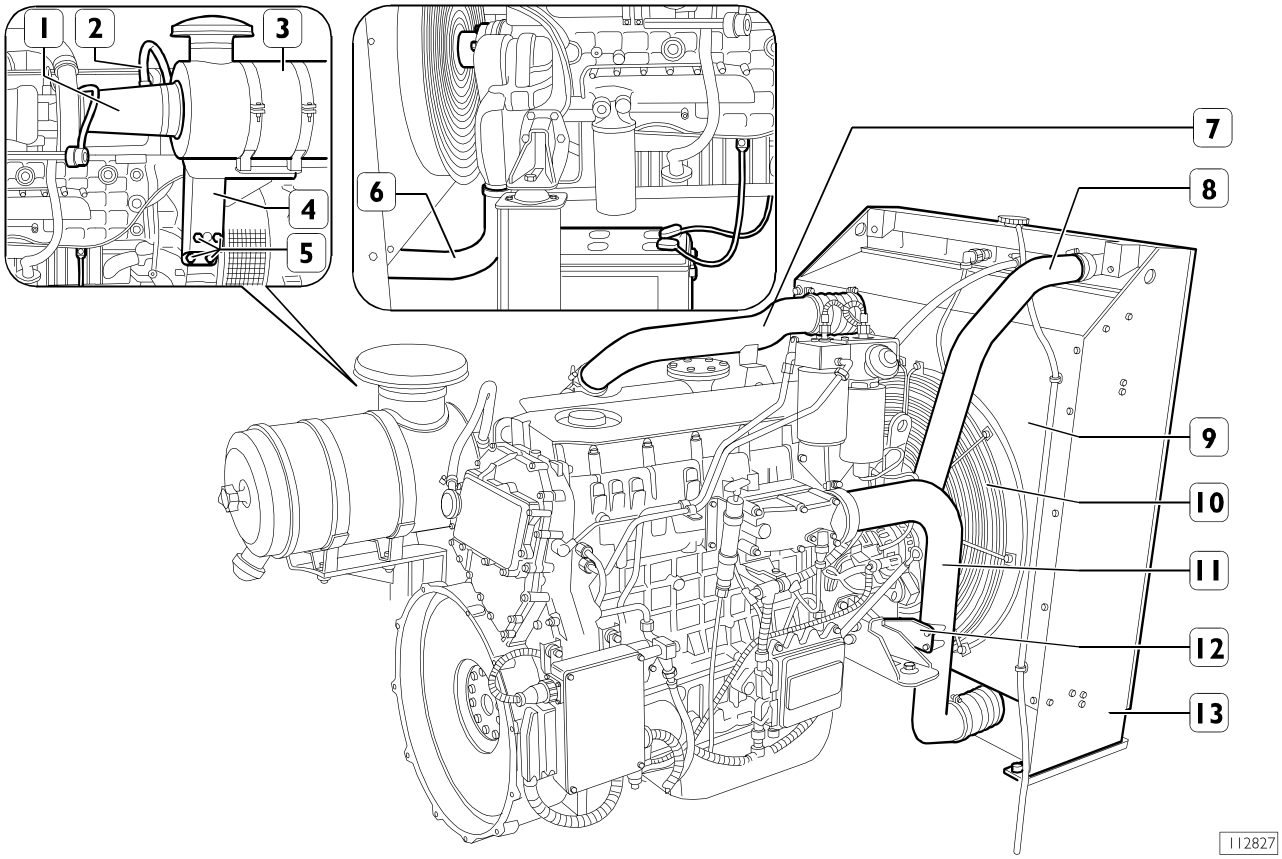
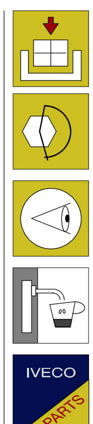
ENGINE CONNECTION AND DISCONNECTION FROM THE RADIATOR

Figure 1 (Demonstration)



Removal

To prearrange a suited container near the sleeve (6) to recover the cooling liquid. Disconnect and remove the sleeve (6) and (8) by means of suited hose clamps.
To disconnect and to remove pipes (7) and (11) from engine and radiator by means of the suited collars hanger. (12).
To remove the protection grids (10) and the ventilator guard (9) by means of clamps.
To block the radiator unit (13) and to release it form the mounting by means of the clamps operating by both sides. Detach the air filter (3) form the engine complete with support (4) by means of clamps(5) after disconnecting the oil vapour pipes (2) and the sleeve (1) from the turbocompressor.
To remove the engine fixing screws from the mounting and to disconnect the engine.



Refitting

For the connection operation repeat the described operations for the disconnection on the contrary and apply the following instructions:

- to control the engine elastic supports and to replace them in case of deterioration ;
- to control that the exhaust pipes are not deteriorated or are going to deteriorate; in this case you shall replace them;
- to clamp the screws and/or nuts to the described couple;
- to fill the cooling system with cooling liquid;
- to carry out bleeding operation from the fuel supply system as described in the suited paragraph.
- to control engine oil level;
- to carry out the tests and controls as described in the suited chapter.

ENGINE ASSEMBLY/DISASSEMBLY
F3A engine disassembly

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

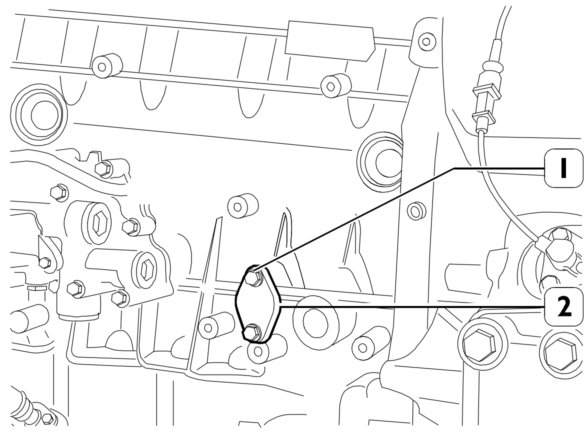
Protect the electric parts before doing any washing with high-pressure jets.

Here are described and illustrated the engine disassembly operation which are different form the operations for the industrial or agricultural applications engines.

Before securing the engine on the rotary stand, remove:

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

Figure 2



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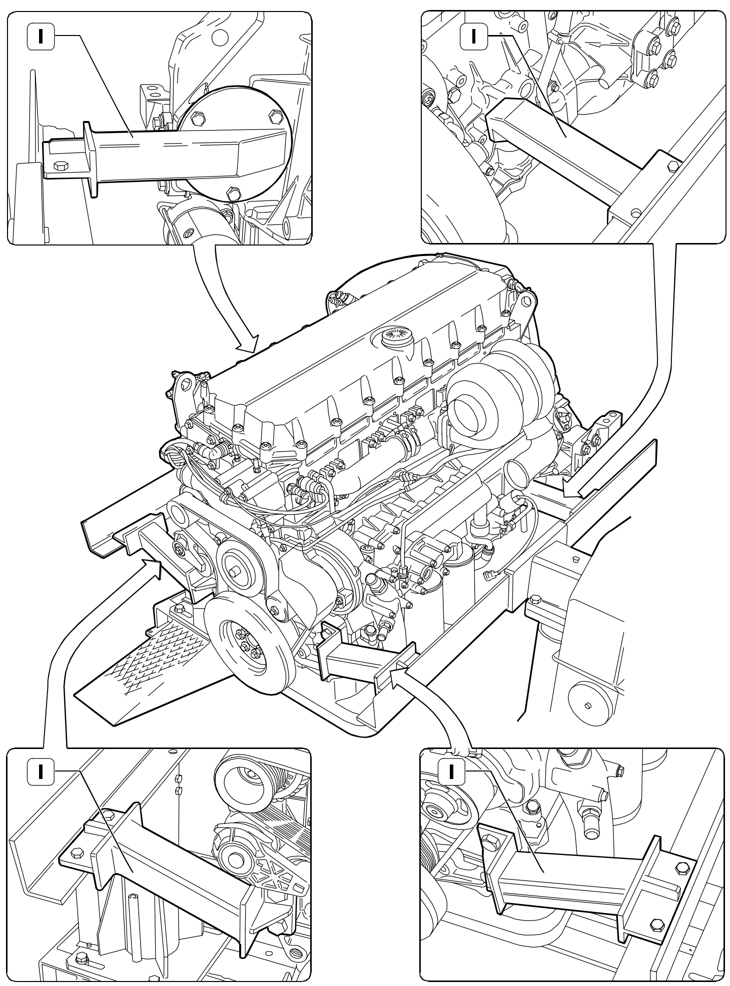
Remove screws (1) and remove oil pressure adjustment valve (2).

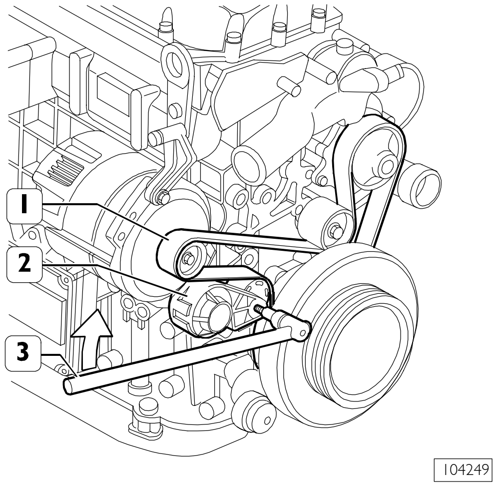
Figure 3



107971

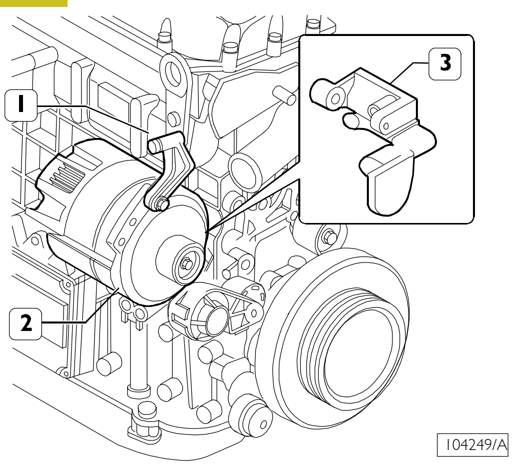
Secure the engine to the rotary stand with the brackets 99361036 (1).
To release the lubrication oil from the pan.

Figure 4



Use specific tool (3) to operate on belt tensioner (2) in direction of arrow, remove water pump alternator and ventilator control belt (1).

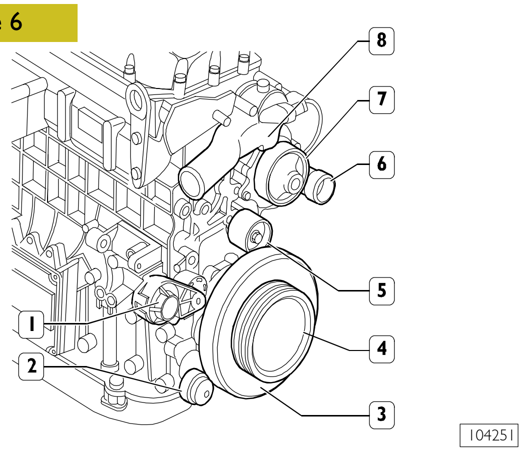
Figure 5



Disassemble:

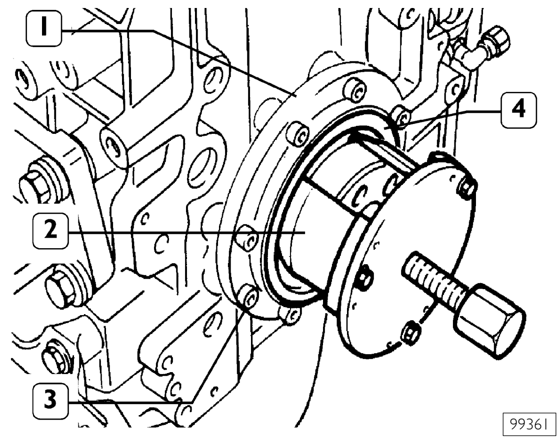
- the alternator (2);
- the supports (1 and 3).

Figure 6



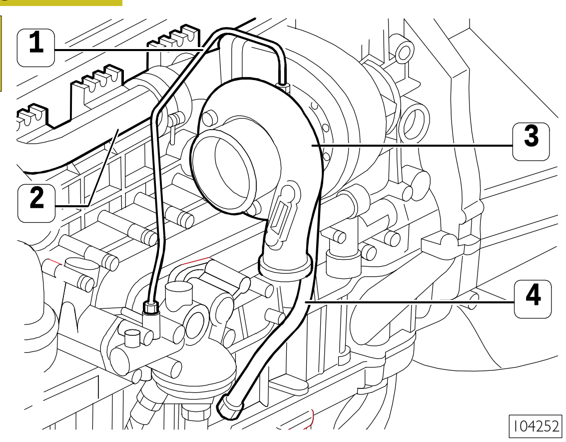
Disassemble: the thermostat group (8), the tubing together with the coolant (6), the pulley (4), the water pump (7), the automatic belt tightener (1), the fixed belt tightener (5), the silent flywheel (3) and the pulley below, the automatic belt tightener (2).

Figure 7



Apply the extractor 99340053 (2) as is illustrated in the figure and take off the sealing ring (4). Undo the screws (3) and take off the lid (1). Disconnect all the electrical connections and sensors.

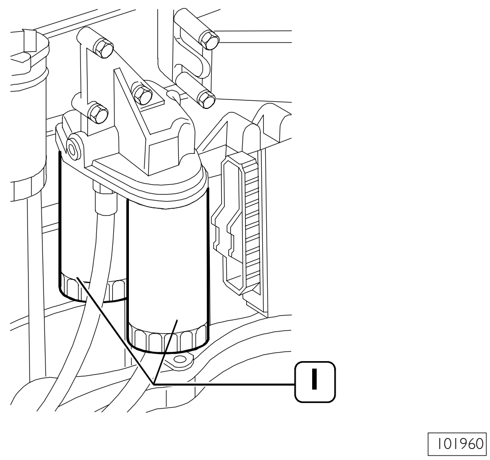
Figure 8



From the side of the engine exhaust, disassemble the following details:

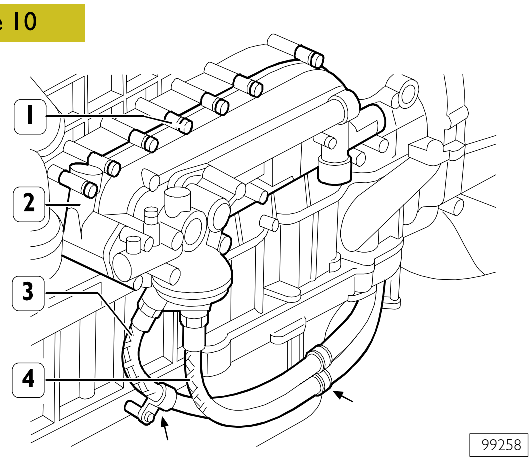
- clutch oil pipe (1);
- return oil pipe (4);
- turbo-compressor (3);
- discharge manifold (2).

Figure 9



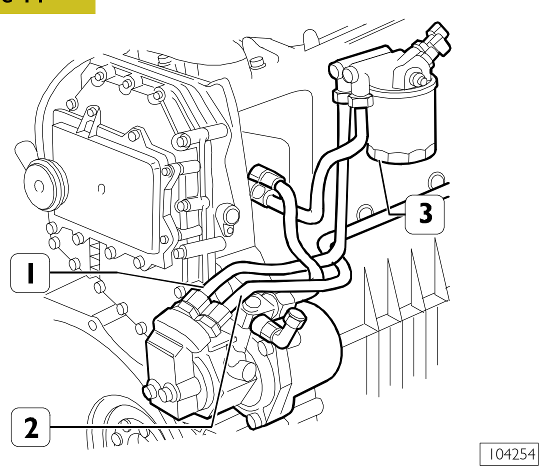
Unscrew the oil filters (1) by tool 99360314.

Figure 10



- disconnect the oil piping (3) and (4) and take off the clips (←);
- undo the fixing screws (1) and disassemble the heat exchanger (2).

Figure 11

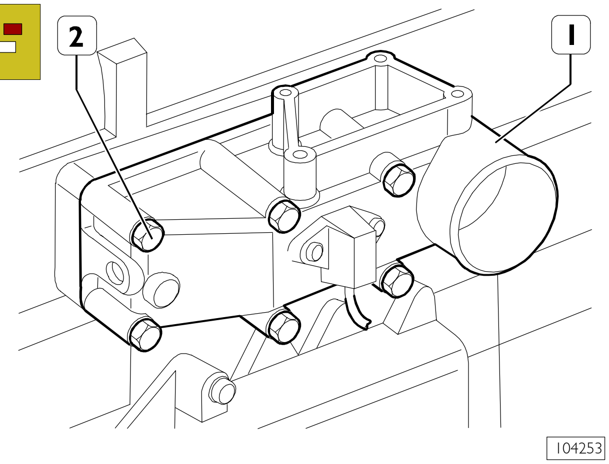


Disconnect the fuel piping (1) from the feeding pump (2).

Disassemble:

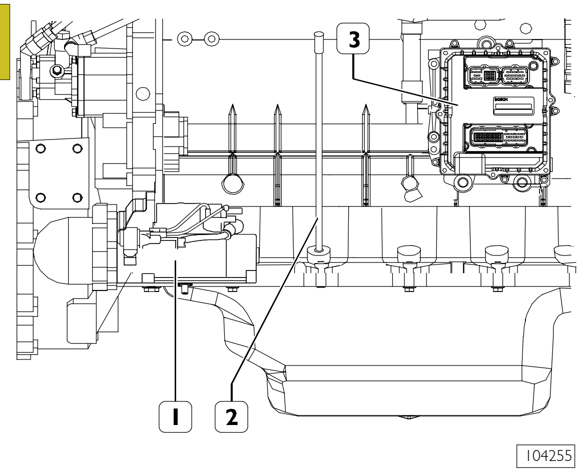
- the feeding pump (2);
- the fuel filter group (3) and the piping (1).

Figure 12



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

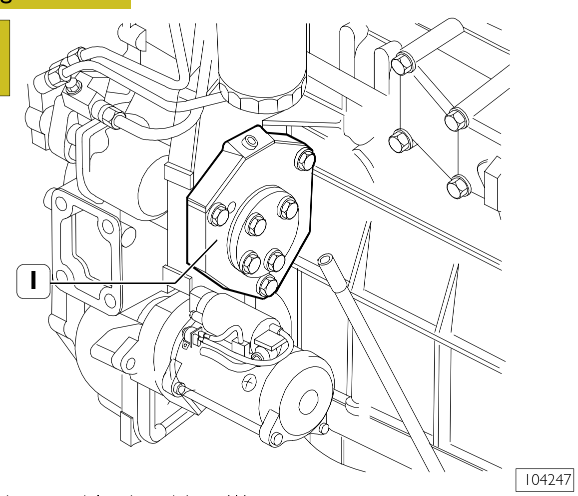
Figure 13



Disassemble:

- the starting engine (1);
- the power unit (2) and its relative support;
- the oil gauge dip stick (3) from the crankshaft.

Figure 14



- Disassemble the drive (1).

To go on with the engine disassembly as described for the industrial/agricultural applications engines.

F3A engine assembly

To assembly again the engine inverting the described operations for the disassembly.

F3B engine disassembly

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

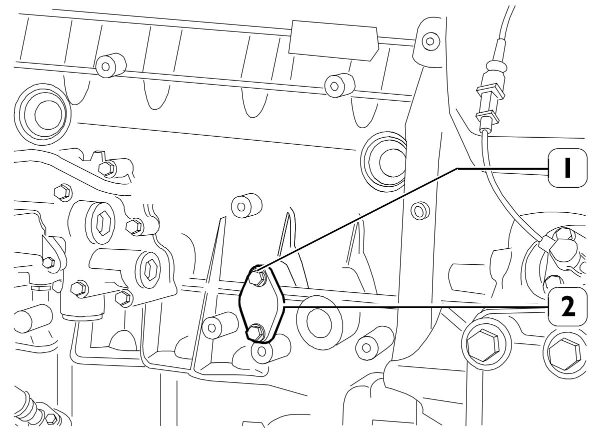
Protect the electric parts before doing any washing with high-pressure jets.

Here are described and illustrated the engine disassembly operations which are different from the operations for the industrial application engines.

Before securing the engine on the rotary stand, remove:

- the electric engine cable (1) by disconnecting it from the control unit and all the sensors/transmitters to which it is connected.
- Remove the engine supports.

Figure 15



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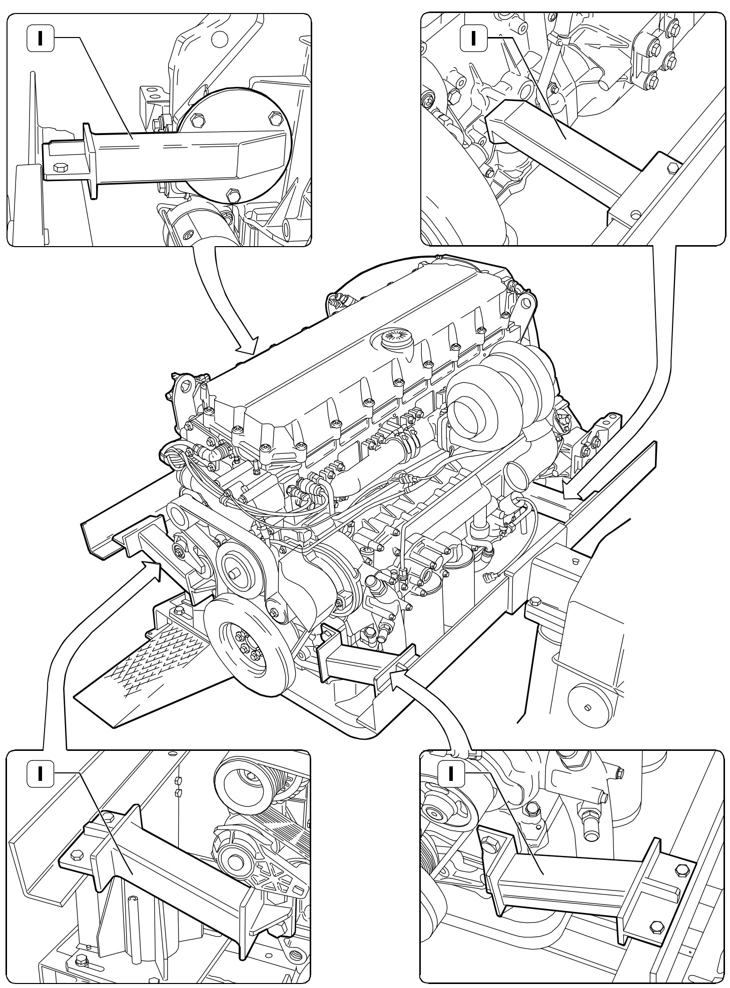
Remove screws (1) and remove oil pressure adjustment valve (2).

Figure 16



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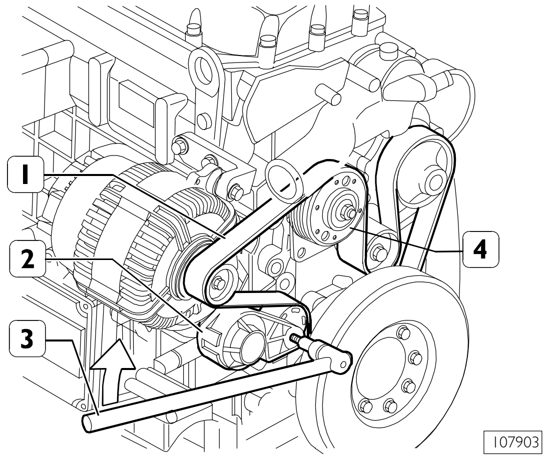
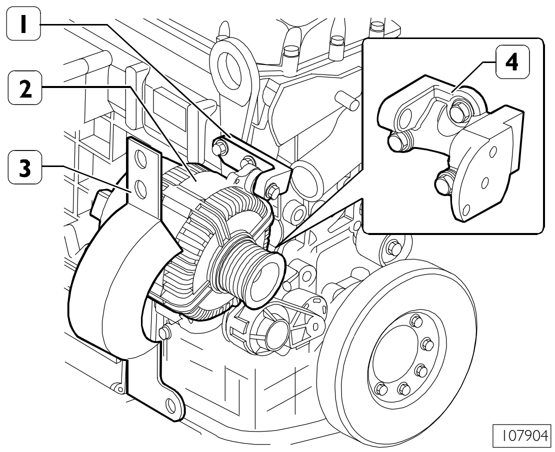
Secure the engine to the rotary stand with the brackets 99361036 (1).
To release the lubrication oil from the pan.

Figure 17



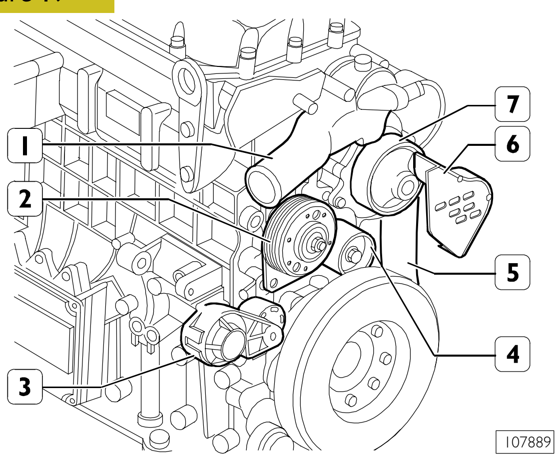
Use specific tool (3) to operate on belt tensioner (2) in direction of arrow, remove water pump alternator and ventilator control belt (1). Remove screws and disconnect electromagnetic ventilator coupling (4).

Figure 18



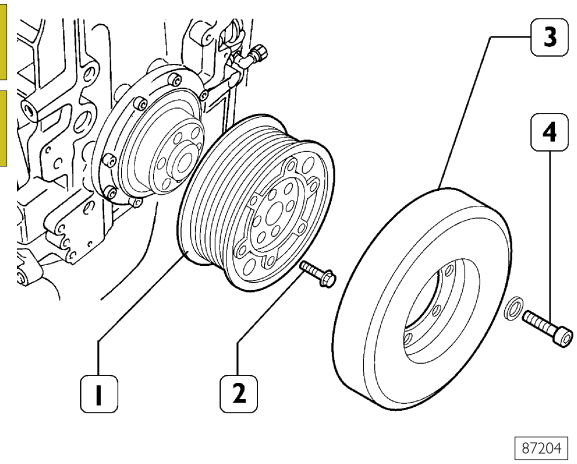
Remove guard (3).
Remove retaining screws and remove alternator (2) from bracket (1) and from support (4), then remove the latter from block.

Figure 19



Remove thermostat (1), ventilator support (2), automatic belt tensioner (3), fixed belt tensioner (4), pipeline (5),guard (6), water pump (7).

Figure 20

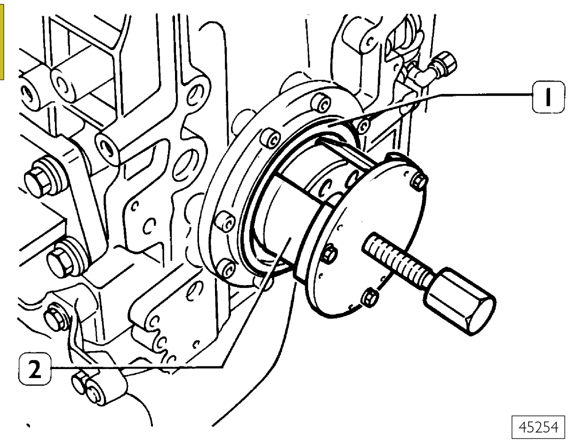


Block the flywheel rotation with tool 99360351.

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

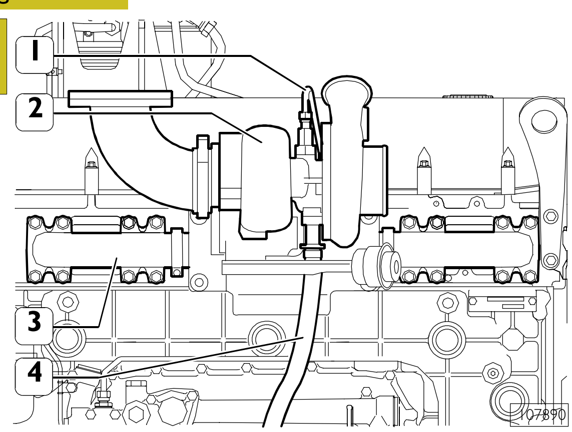
Remove the screws (2) and the pulley (1).

Figure 21



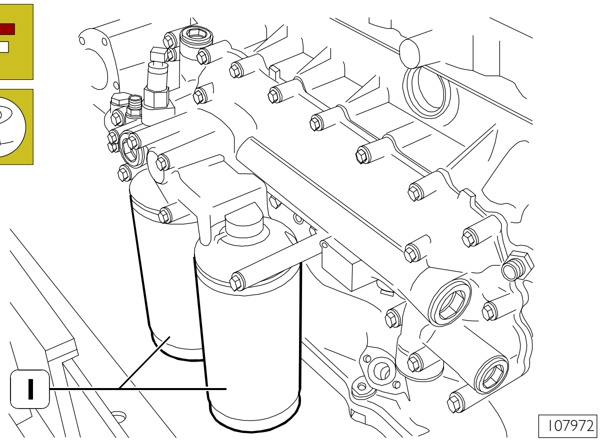
Install extractor 99340051 (2) and remove the seal gaskets (1). Unscrew the screws and remove the cover.
Disconnect all electric connections and sensors.

Figure 22



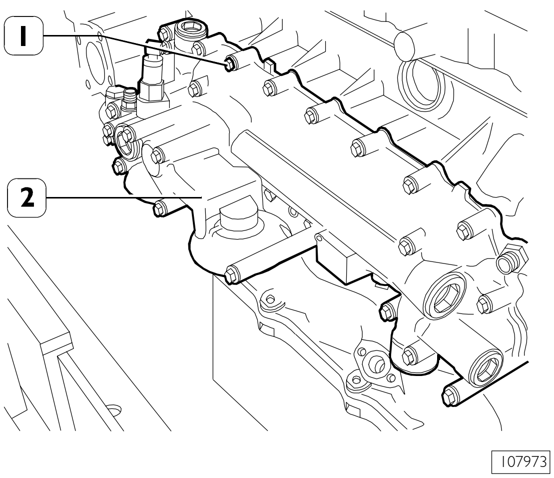
Disconnect oil pipes (1 and 4) of turbo compressor (2).
Disconnect turbo compressor (2) from exhaust manifold (3).

Figure 23



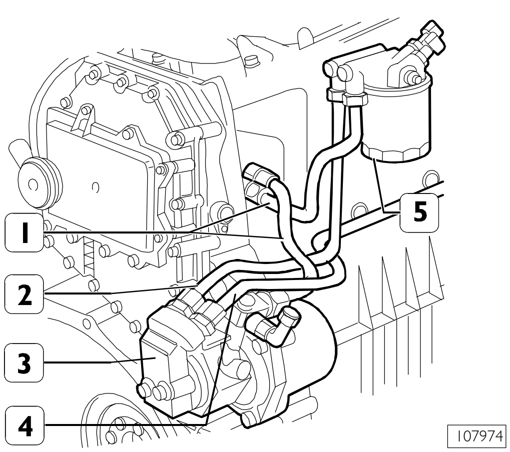
Unscrew the oil filter (1) by tool 99360314.

Figure 24



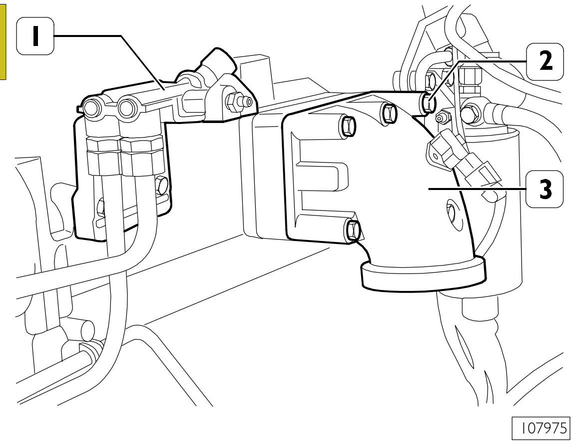
Unscrew the screws (1) and remove the heat exchanger (2).

Figure 25



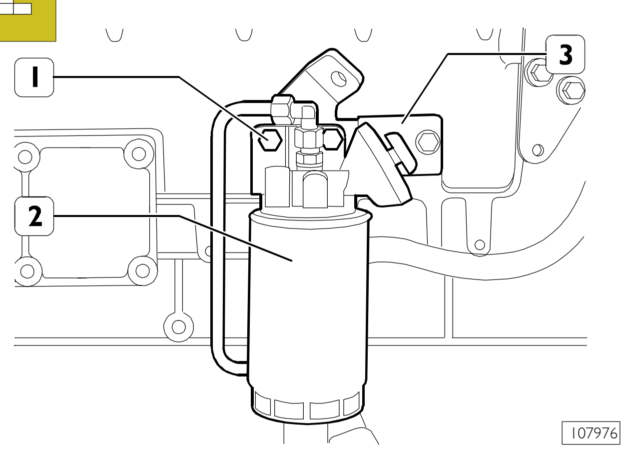
Disconnect the fuel pipes (1 and 4) from the fuel pump (2). Remove supply pump (3) and fuel filter (5).

Figure 26



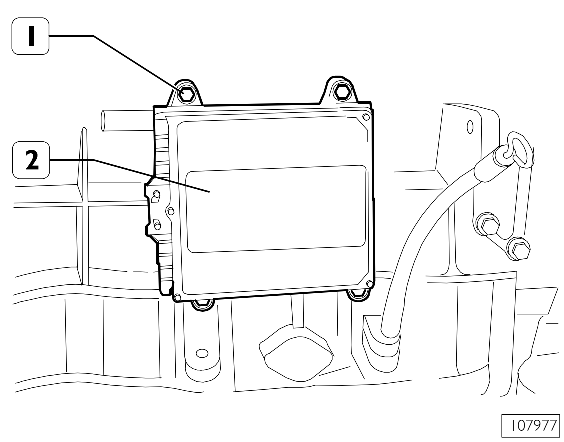
Remove retaining screws and support (1) of fuel filter. Remove screws (2) and remove intake manifold (3).

Figure 27



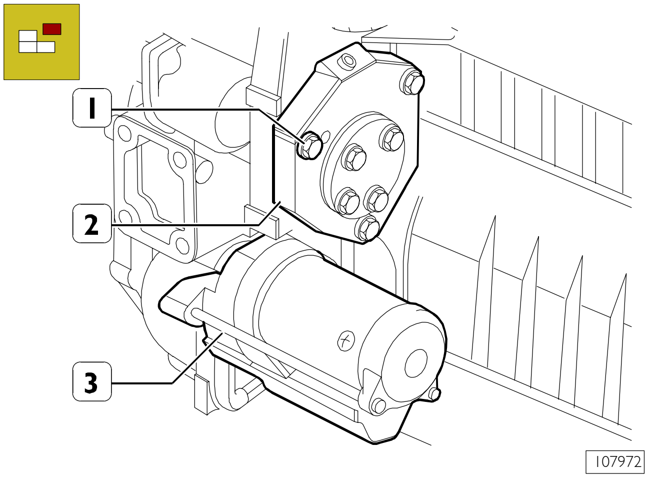
Remove screws (1) and bracket (3) supporting sedimentation tank prefilter (2).

Figure 28 (Demonstration)



Remove screws (1) and disconnect ECU (2).

Figure 29



Remove screws (1) and remove power takeoff (2).
Remove screws and remove starter motor (3).
Therefore, continue with the disassembly of the engine as described for engines used for industrial applications.

F3B engine assembly

To assembly again the engine inverting the described operations for the disassembly.

MAINTENANCE PLANNING

MAINTENANCE PLANNING

Recovery

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

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

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

NOTE Here are described the F3A engines control and/or maintenance operations which are similar to the operations for F3B engines. For this reason they are valid for F3B engines as well.

Inspection and/or maintenance interventions

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

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

Checks not included in maintenance planning-daily checks

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

- Level controls and checks of any eventual leakage from the fuel, cooling and lubricating circuits.

- Notify the maintenance if any inconvenience is detected of if any filling is necessary.

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

- check presence of any eventual leakage from the fuel, cooling and lubricating circuits.

- Verify absence of noise or unusual rattle during engine working.

- Verify, using the vehicle devices, the prescribed pressure temperature and other parameters.

- Visual check of fumes (colour of exhaust emissions)

- Checking the coolant level.

MAINTENANCE PROCEDURES
Checks and controls

Engine oil level check.

The check must be executed when the engine is disconnected and possibly cool.
The check can be made using the specially provided flexible rod (1).

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

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

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

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

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

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

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

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

Check of fuel system

The check must be executed both when the engine disconnected and when it is running.
The check is made by observing the fuel pipes from the tank to the fuel pump and to the injectors.

Cooling system check

The check must be executed both when the engine disconnected and when it is running.
Check the pipes from the engine to the radiator and vice versa; note any seepage and the state of the pipes especially near the coupling clamps.
Verify that the radiator is clean, the correct working of the fan flywheels, the presence of any leakage from the connectors, from the manifold and from the radiating unit.

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

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

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

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

Lubricating system check

The check must be executed both when the engine disconnected and when it is running.
Verify the presence of any oil leakage or blow-by from the head, from the engine pan of from the heat exchanger.

The engine oil is highly polluting and harmful.
In case of contact with the skin, rinse well with water and detergent.
Adequately protect the skin and the eyes, operate in full compliance with safety regulations.
Disposal must be carried out properly, and in full compliance with the law and regulations in force.

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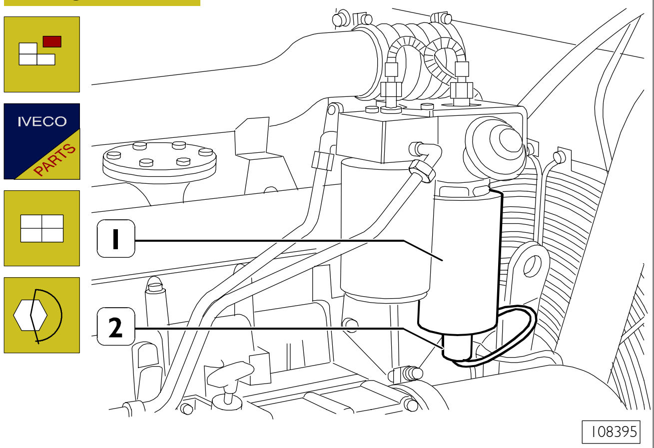
Replace fuel sedimentation tank prefilter

Figure 30

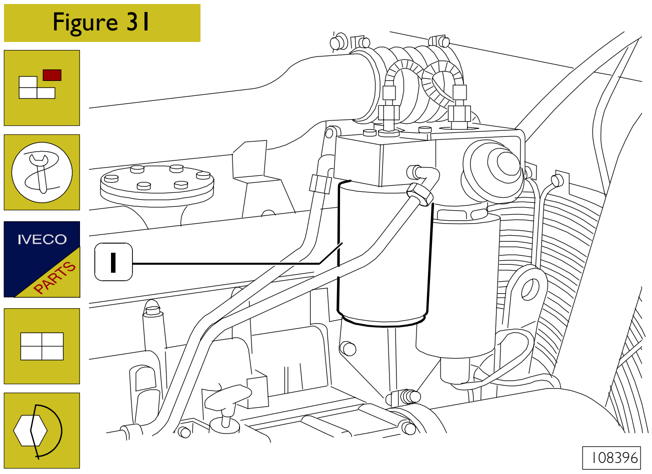


Disconnect electric connector. Unlock prefilter (1) and change it. Before refitting a new cartridge, wet seal with fuel oil or engine oil. Lock cartridge by hand till in contact with support, then lock it by ¾ of a rev. at predefined tightening torque.

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

Fuel filter change

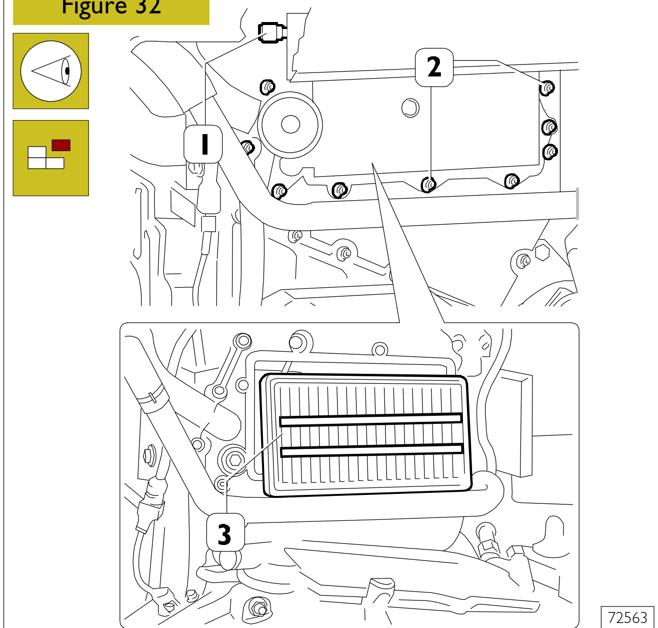
Figure 31



Use tool 99360314 to remove fuel filter (1).
Before fitting the new cartridge, wet seal with fuel oil or engine oil. Lock the new one by hand and carefully check that rubber seal and contact surface are clean and in perfect conditions. Lock cartridge by hand till contact with support and then lock it for ¾ of a rev. at prescribed tightening torque. Bleed air from supply system as described in paragraph below:

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

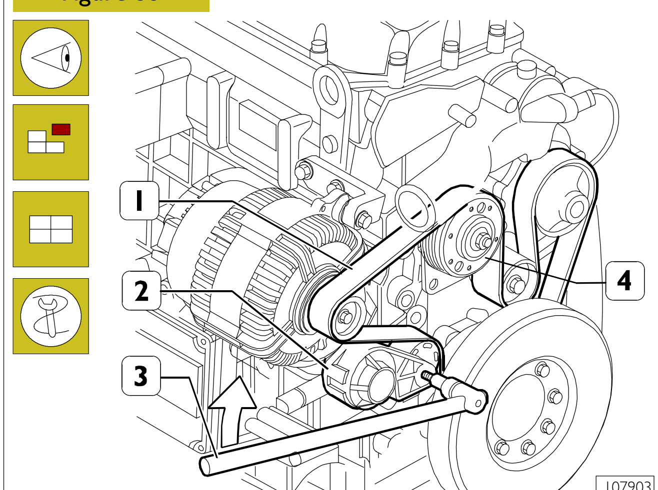
Figure 32



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

Check of water pump/alternator control belt condition

Figure 33



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

Water pump/alternator control belt change

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

NOTE Belt tensioner is automatic and requires no adjustment.

Check for any water in the fuel filter

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

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

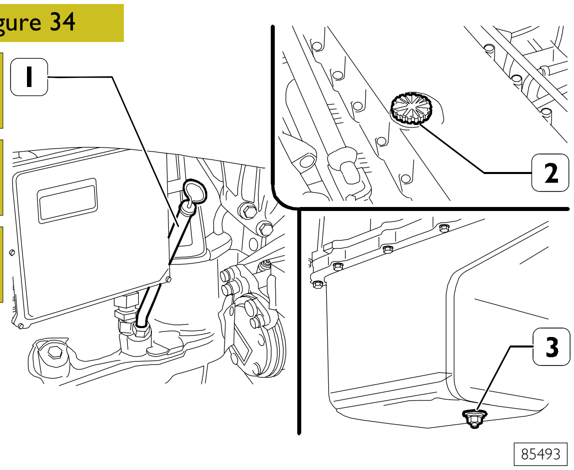
Fuel filter is equipped with pump screw-valve to drain the water eventually mixed with fuel.

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

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

Engine oil change

Figure 34



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

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

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

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

The oil motor is very pollutant and harmful.

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

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

Dispose of the residual properly following the rules.

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

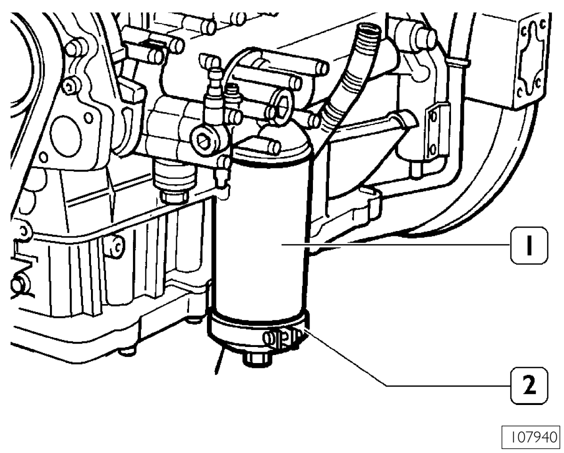
- ❑ After the complete drainage, screw the plug and carry out the clean oil filling.

NOTE Use only the recommended oil or oil having the requested features for the corrrect motor functioning.
In case of topping up, don't mix oils having different features.
If you don't comply with theses rules, the service warranty is no more valid.

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

Engine oil filter change

Figure 35



Drain oil as described in "Engine oil change" chapter.
By means of 99360314 tool (2) to disassemble oil filter (1) or filters for F3B engine .

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

Place properly a container for the liquid.

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

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

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

Lock oil filter (1) by hand till contact to support and then lock by ¾ of a rev. at prescribed tightening torque; pour oil in engine ad described in "Engine oil change" chapter.

Valve lash check a adjustment

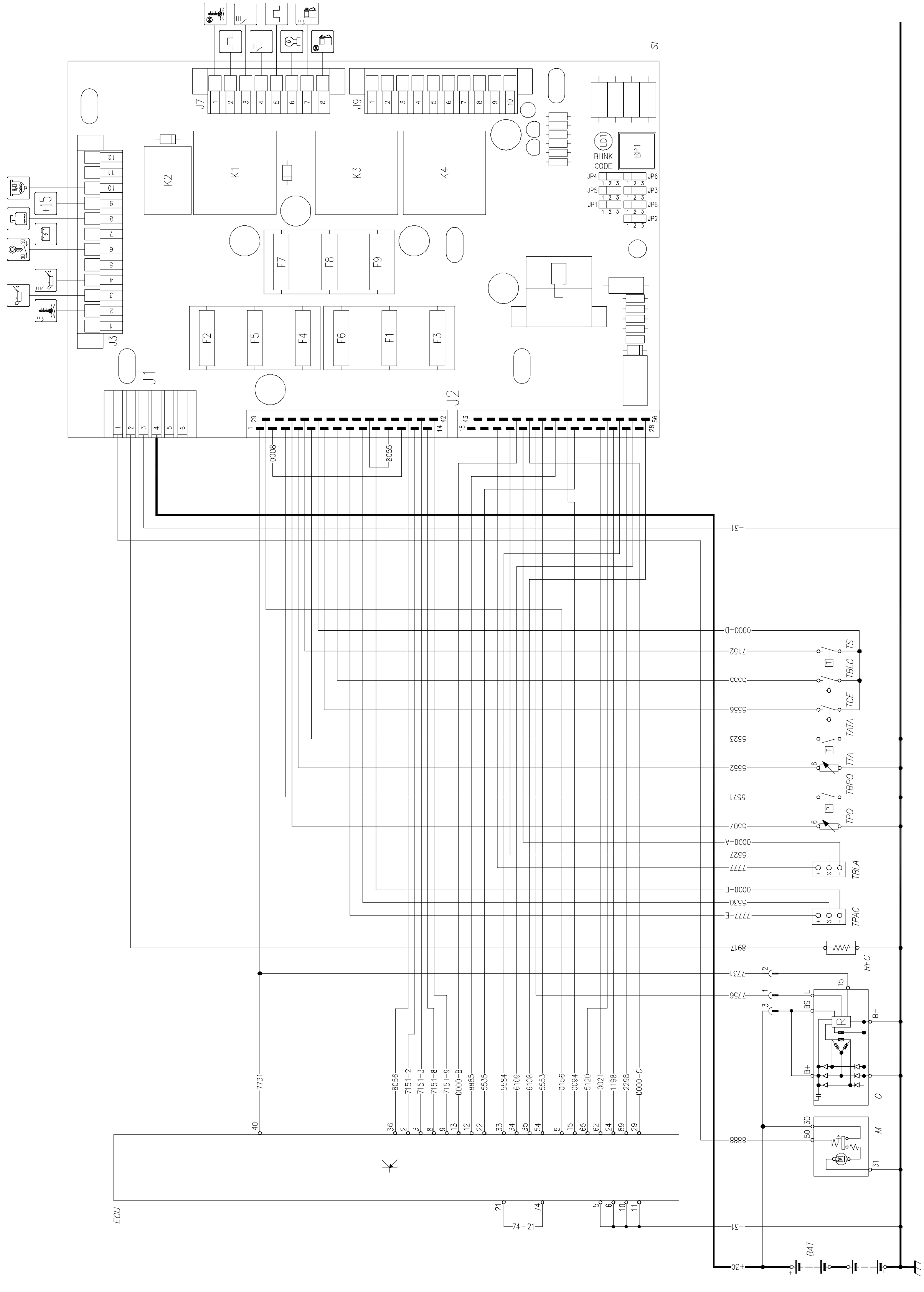
For correct operation, follow instructions contained in related chapter in section 3 – Industrial Application.

Change dry air filter and clean its container

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

PRINCIPLE ELECTRICAL DIAGRAM

Figure 36



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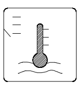
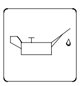
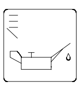
Key to components

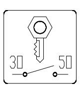
BAT	Starter battery 12V
M	Starter motor
G	Battery charger alternator
RFC	Fuel filter heating resistor
TRFC	Fuel filter heating thermostat
TPAC	Water in the fuel filter transmitter
TBLA	Low engine water level transmitter
TPO	Engine oil pressure switch
TBPO	Low engine oil level pressure switch
TTA	Engine water temperature transmitter
TCE	No fuel transmitter (option)
TBLC	Float for fuel level
TS	Engine water heater thermostat
EDC	Engine electronic control unit
TATA	High engine water temperature thermostat
SI	Control panel - engine interface box

Function symbols for the control panel

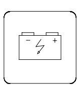

ENGINE WATER TEMPERATURE THERMOMETER

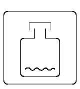

LOW ENGINE OIL PRESSURE VISUAL WARNING

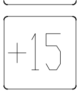

ENGINE OIL PRESSURE GAUGE



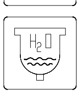
STARTING THE ENGINE (+50)


NO BATTERY CHARGING VISUAL WARNING

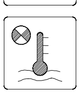

LOW ENGINE WATER LEVEL VISUAL WARNING

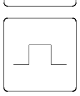


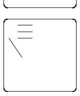
CAPTIVE KEY POSITIVE (+15)

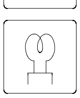


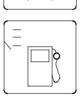
WATER IN THE FUEL FILTER VISUAL WARNING

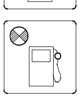

HIGH ENGINE WATER TEMPERATURE VISUAL WARNING


CAN LINE


CONTROL PANEL POWER SUPPLY


ENGINE PRE-HEATING

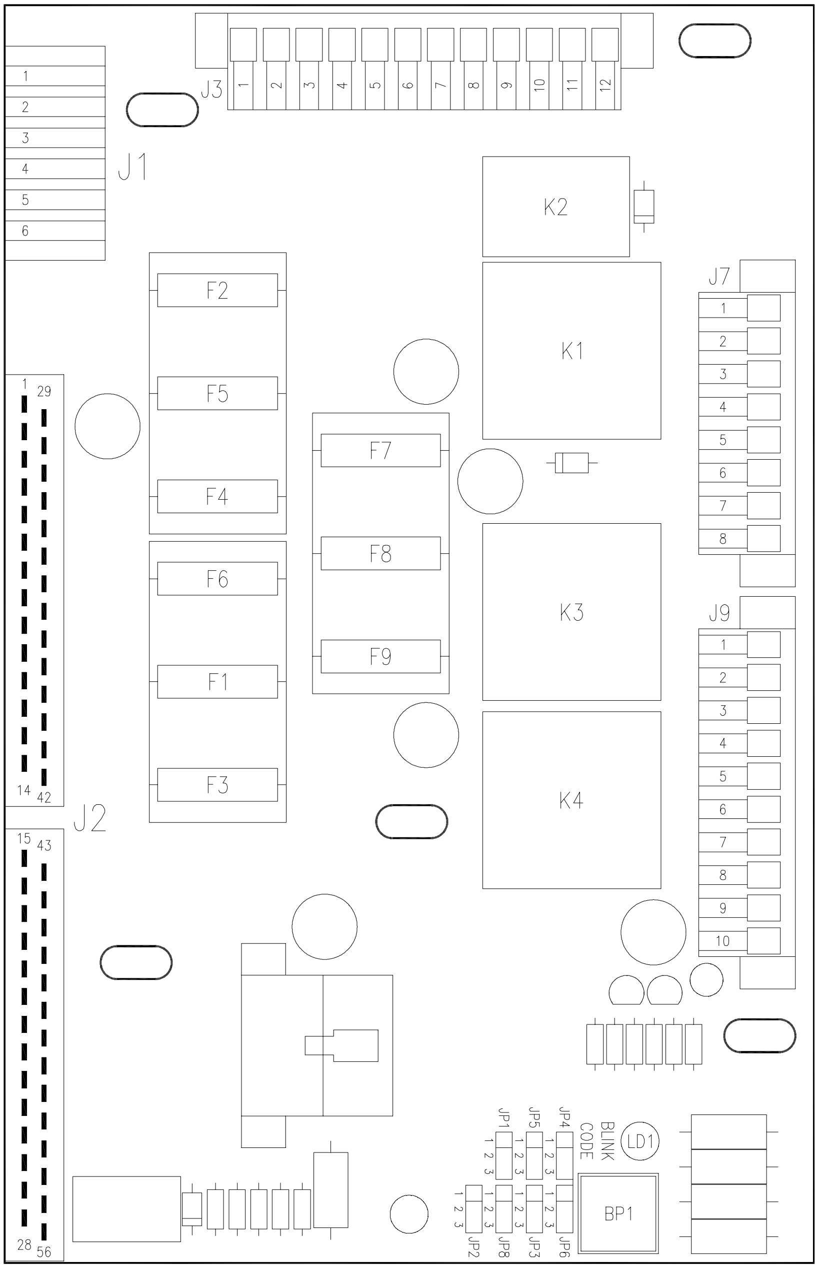

FUEL LEVEL VISUAL WARNING


NO FUEL VISUAL WARNING (OPTION)

ENGINE INTERFACE BOX

Description

Figure 37



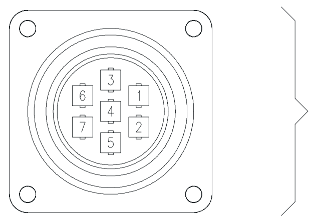
107437

LIST OF COMPONENTS

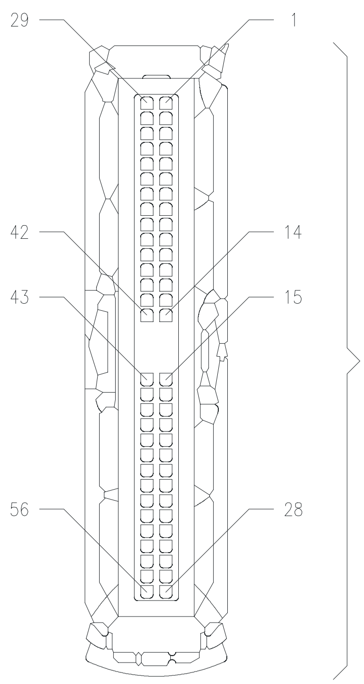
K1. Power relay with key inserted (+15) - K2. Starting phase signal relay - K3. Starting relay - K4. Relay for pre-heating resistance enabling - JP1. Jumper to select frequency (jumper on 1-2= 60Hz - jumper on 2-3= 50Hz) - JP2. Jumper for operating mode selection (bond on 1-2= diagnosis - bond on 2-3= normal operation) - JP3. Jumper to select cold start signal connection (1-2= connected - 2-3= disconnected) - JP4. Jumper to select heat. function for cold starting (1-2= connected - 2-3= disconnected) - JP5. Jumper for Can Line selection (1-2= Can Line connected - 2-3= Can Line not connected) - JP6. Not used - JP8. Not used - BP1. Switch for blink-code signal request - LD1. LED signalling blink/code - F1. 10A fuse for starting engine - F2. 3A fuse for diagnostics - F3. 20A protection fuse for pre-heating resistance - F4. 30A fuse for electronic control unit - F5. 10A fuse for control panel - F6. 5A fuse for cut-in +15 ON ECU - F7. 20A protection fuse for fuel filter heater - F8. Not used - F9. Not used - J1. Connector for power connections - J2. Connector for interface with engine control unit - J3. Connector for interface with control panel - J7. Connector for interface with control panel - J9. Connector for interface with control panel.

Connectors

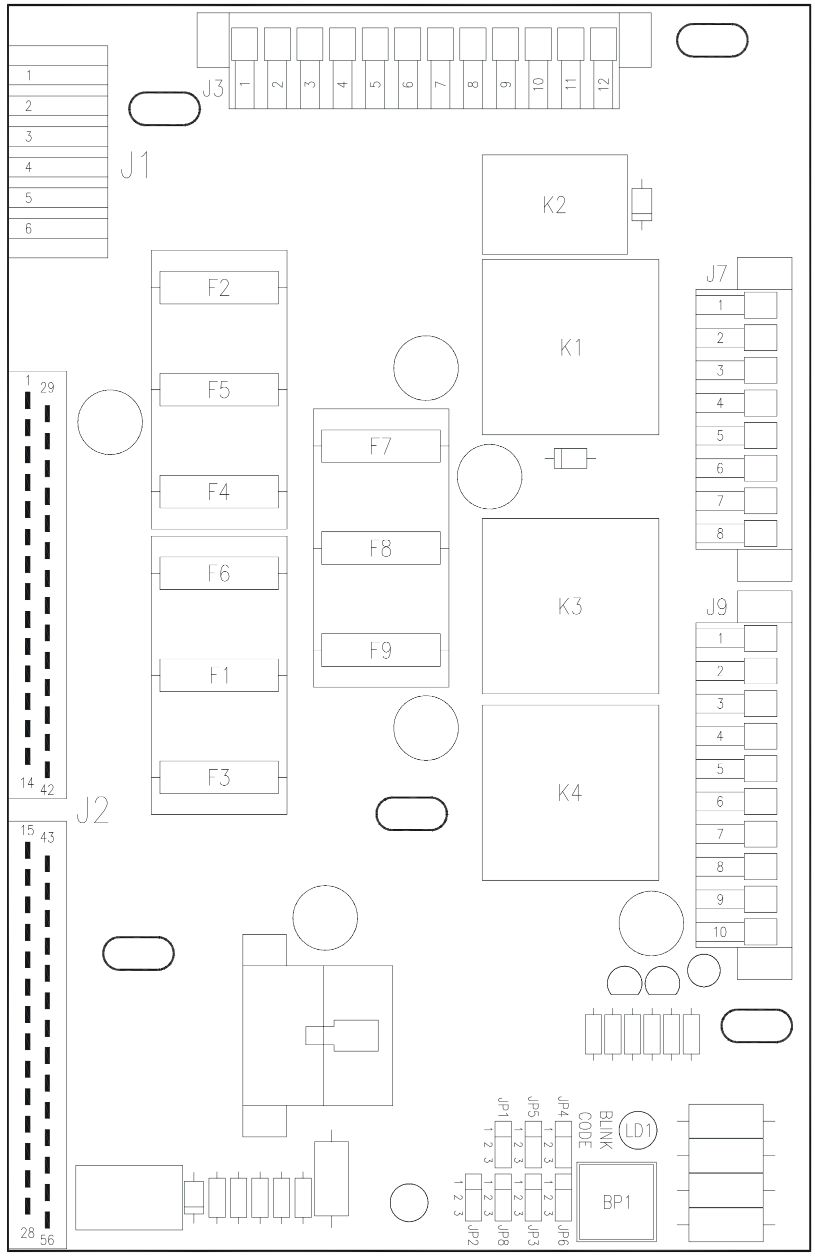
Figure 38



107439



107438



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CONNECTOR J1 on engine – control panel interface box for power supply (GECURSOR300E/350E/400E)

1	To terminal 50 of starter motor
2	Supply from F3 for fuel filter heating resistance
3	Battery negative
4	Direct positive to battery
5	Spare
6	Spare

CONNECTOR J2 on engine – control panel interface box for EDC ECU connections

1 Key- on positive (+15) for EDC ECU supply
2 Connection with J2 pin 12
3 Signal from engine oil low pressure switch for visual indication on panel (to connector J3 pin 3)
4 Signal from engine water temp. transmitter for thermometer on panel (to connector J3 pin 2)
5 Signal from engine water high temp thermostat for visual indication on panel (al connector J7 pin 1)
6 Signal from out of fuel transmitter (optional) to connector J7 pin 8)
7 Signal from comb. Level floater for visual indication on control panel (to connector J7 pin 7)
8 Positive for water present in fuel filter transmitter
9 Signal from water present in comb. Filter transmitter for visual ind. on panel (to conn. J3 pin 10)
10 Negative for water present in fuel filter transmitter
11 Connection with J2 pin 37
12 Connection with J2 pin 2
13 Battery positive for EDC supply (pin 2)
14 Battery positive for EDC supply (pin 8)
15 Spare
16 Spare
17 Positive for engine water low level transmitter
18 Signal from engine water low level transm. for visual indication on control panel (to connector J3 pin 8)
19 Negative for engine water low level transmitter
20 From alternator D+ for no battery recharge visual indication on control panel (to connector J3 pin 7)
21 Spare
22 Negative from EDC ECU (pin 30) for "BLINK-CODE"
23 Positive from EDC unit (pin 22) for "Blink-Code" optic indicator
24 Spare
25 From resistor module to EDC ECU (pin 62)
26 Spare
27 To diagnostics connector (line K) from EDC ECU (pin 89)
28 Spare
29 "Blink-Code" switch signal from EDC (pin 85)
30 Spare
31 Signal from engine oil pressure switch for pressure gage on control panel (to connector J3 pin 4)
32 Signal from engine water heater thermostat (to connector J7pin 6)
33 Negative for finished fuel transmitter (opt), for fuel level float and low engine oil level indication pressure switch and heater
34 Spare
35 Spare - Jumper with pin 6 of connector J9
36 Spare
37 Spare
38 Spare - Jumper with pin 11 of connector J3
39 Spare
40 Positive for diesel fuel heating relay from EDC unit (pin 36)
41 Battery positive for EDC unit (pin 3)
42 JBattery positive for EDC unit (pin 9)
43 Spare
44 Spare
45 Spare - Jumper with pin 5 of connector J9
46 Cold start signal positive from EDC (pin 13) (opt)
47 Connected with EDC (pin 29)
48 Negative for preheating visual indication from EDC ECU (pin 56)
49 Positive for pre-heating enabling relay from EDC (pin 13)
50 Negative for hearing on relay from EDCECU EDC (pin 16)
51 Spare
52 Spare
53 From resistor module to EDC ECU (pin 87)
54 To diagnostics connector (engine rpm signal) from EDC ECU (pin 33)
55 To diagnostics connector (line CAN L) from EDC ECU (pin 34)
56 To diagnostics connector (line CAN H) from EDC ECU (pin 35)

NOTA Pins 1 and 2 of EDC ECU are connected to battery negative

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CONNECTOR J3 inside the engine interface box for signals to control panel

1 Free
2 From the engine water temperature transmitter for signal to thermometer on control panel
3 From the low engine oil pressure switch for visual warning on control panel
4 From engine oil pressure switch for signal to pressure gauge on control panel
5 Free
6 To the key switch (+50) on control panel
7 From the alternator for battery charging visual indicator on control panel
8 From the low engine water level transmitter for visual warning on control panel
9 +15
10 From the water in fuel filter transmitter for visual warning on control panel
11 Free
12 Free

CONNECTOR J7 inside the engine interface box for signals to control panel

1 From the engine coolant high temp. thermostat (connector J2 - pin5) for visual signal on control panel
2 CAN line L to the control panel
3 Positive to power control panel
4 Negative to power control panel
5 CAN line H to the control panel
6 From the engine water heater thermostat (connector J2 - pin32) to the control panel
7 From the fuel level transmitter (connector J2 - pin7) for visual warning on control panel
8 From the no fuel transmitter (opt) (connector J2 - pin6)

CONNECTOR J9 inside the engine interface box

1 Cold start signal (option) if jumper JP3 set on 1-2
2 Cold start signal (option) if jumper JP3 set on 1-2
3 Cold start heater relay (option) if jumper JP4 set on 1-2
4 Cold start heater relay (option) if jumper JP4 set on 1-2
5 Free
6 Free
7 Free
8 Free
9 Free
10 Free