CURSOR TIER 3 SERIES

Industrial application

C13 TURBOCOMPOUND

Technical and Repair manual

This publication contains data, features, instructions and methods for performing repair interventions on the assembly and its components.

This publication is addressed to qualified, specialised personnel.

Check that you have the publication related to the assembly on which you are about to work available before you start. Make sure that you have all the necessary safety apparatuses, such as, for example, protective eyewear, helmet, gloves, footwear, etc. Check that the working, lifting and transport equipment etc. is available and in working order. Make sure that the vehicle is prepared and secured.

Proceed by carefully observing the instructions contained herein and use the indicated specific tools to ensure correct repair procedures, observance of time schedules and safety of operators.

All repair interventions are aimed at restoring the conditions of operation, efficiency and safety contemplated by FPT.

All on-vehicle interventions, aimed at implementing changes, alterations or other not authorised by FPT will relieve FPT from responsibility. Specifically, the warranty (where applicable) will be immediately cancelled.

FPT cannot be held responsible for repair interventions.

FPT is available to provide any additional information needed for performing the inventions and indications in the cases and situations not contemplated in this publication.

The data contained in this publication may not be up-to-date if changes are made by the manufacturer at any time for technical or commercial reasons or if required to meet legal requirements of countries worldwide.

Contact a FPT dealership before proceeding in the event of differences between the contents of this publication and the actual assembly.

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13 CURSOR ENGINES TURBOCOMPOUND (F3C)

Introduction

PREFACE TO USER'S GUIDELINE MANUAL

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.
Section 1 describes the engines 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.
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.

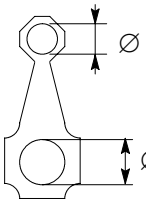
Environment protection

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.

Service operations

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

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

	Intake
	Exhaust
	Operation
ϱ	Compression ratio
	Tolerance Weight difference
	Rolling torque
	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

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.

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; IVECO Motors 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 IVECO Motors 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.

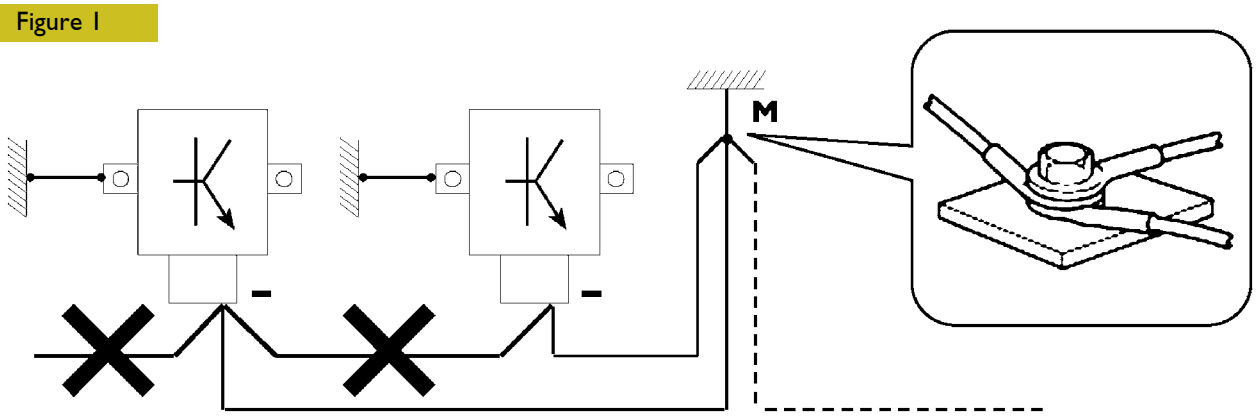
Bonding and screening

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:

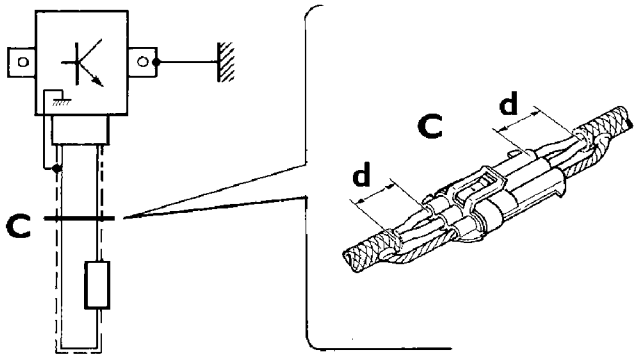
- Electronic central units must be connected to system bonding when they are provided with a metallic shell.
- Electronic central units negative cables must be connected both to a system bonding point such as the dashboard opening bonding (avoiding "serial" or "chain" connections), and to battery negative 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



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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.
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

KEY OF LECTURE OF THE HEADINGS AND FOOTNOTES

Type of vehicle

Section title

Page number

MOTORI NEF F4HE

SEZIONE 4 - REVISIONE MECCANICA GENERALE 11

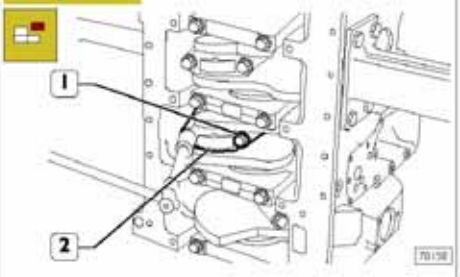
REVISIONE MOTORE 4 E 6 CIL. SMONTAGGIO DEL MOTORE AL BANCO

La trattazione seguente prevede che il motore sia stato montato sul cavalletto rotativo e si sia proceduto alla rimozione di tutti i componenti specifici dell'applicazione Iveco Motors (vedere la Sezione 3 del presente manuale)

La sezione riguarda quindi tutte le più importanti procedure di revisione del basamento motore.

Le operazioni seguenti riguardano il motore 4 cilindri, ma risultano analoghe per il 6 cilindri

Figura 1



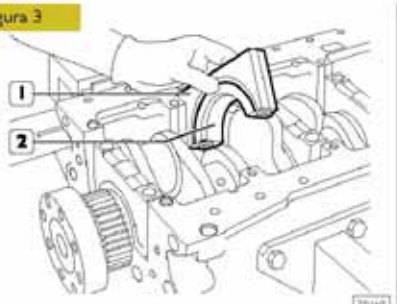
Svitare le viti di fissaggio (1) e rimuovere i cappelli di biella (2). Sfilare gli stantuffi completi di bielle dalla parte superiore del basamento.

NOTA Mantenere i semicuscinetti nei rispettivi alloggiamenti, poiché, in caso di un loro utilizzo, dovranno essere montati nella posizione riscontrata allo smontaggio.

Figura 2

Rimuovere le viti (1) e smontare i cappelli di banco (2).

Figura 3

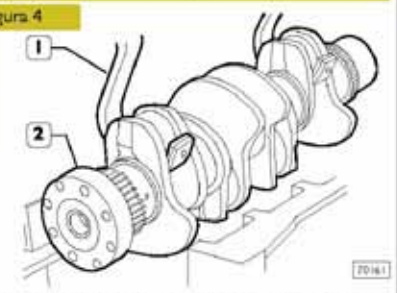


Il penultimo cappello di banco (1) e il relativo supporto hanno il semicuscinetto (2) dotato di spallamento.

NOTA Le viti M12 dei cappelli di banco, devono essere sostituite se il diametro nominale della parte filettata che non lavora, presenta un diametro < 0,1 mm rispetto al valore nominale.

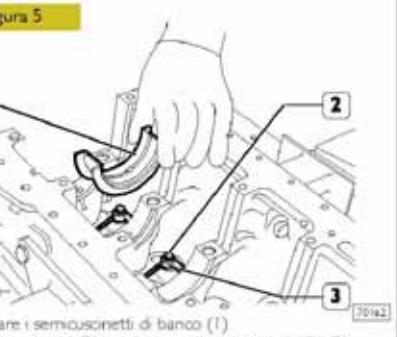
NOTA Annotare la posizione di montaggio dei semicuscinetti inferiori e superiori, poiché in caso di un loro riutilizzo, dovranno essere montati nella posizione riscontrata allo smontaggio.

Figura 4



Con l'attrezzo 99360500 (1) e sollevatore rimuovere l'albero motore (2) dal basamento.

Figura 5



Smontare i semicuscinetti di banco (1).
Rimuovere le viti (2) e smontare gli spruzzatori olio (3).

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UPDATING

Section	Description	Page	Date of revision

SECTION 1

General specifications

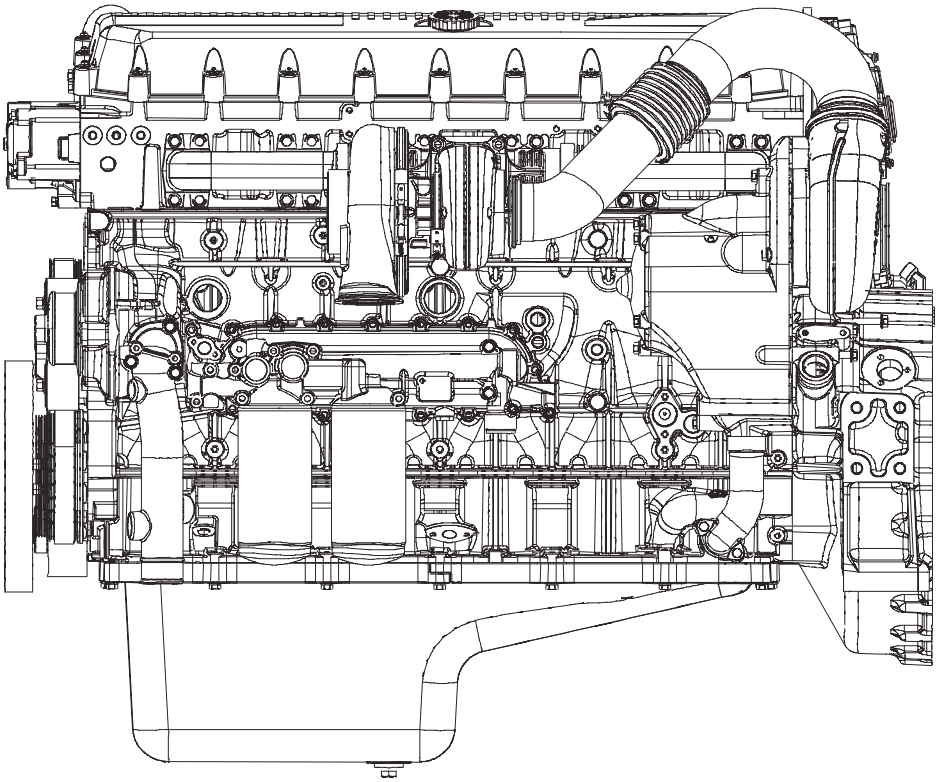
Page

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F3CE0684A*E001	-
F3CE0684B*E003	-

VIEWS OF ENGINE F3CE0684A*E001

Figure 1



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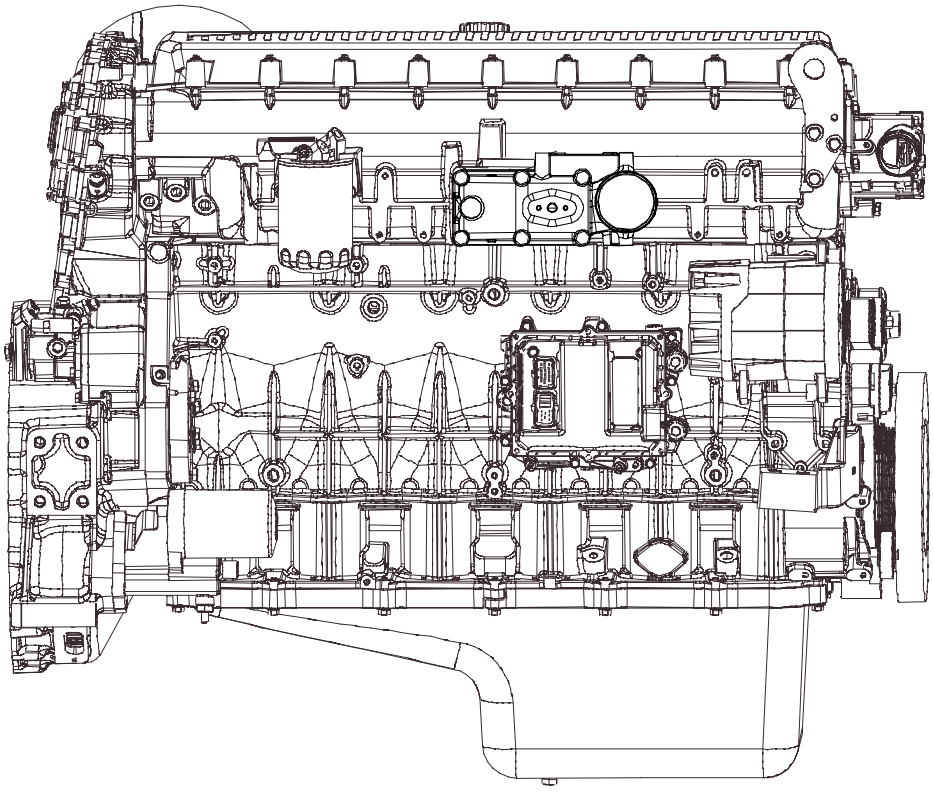
LEFT-HAND SIDE VIEW

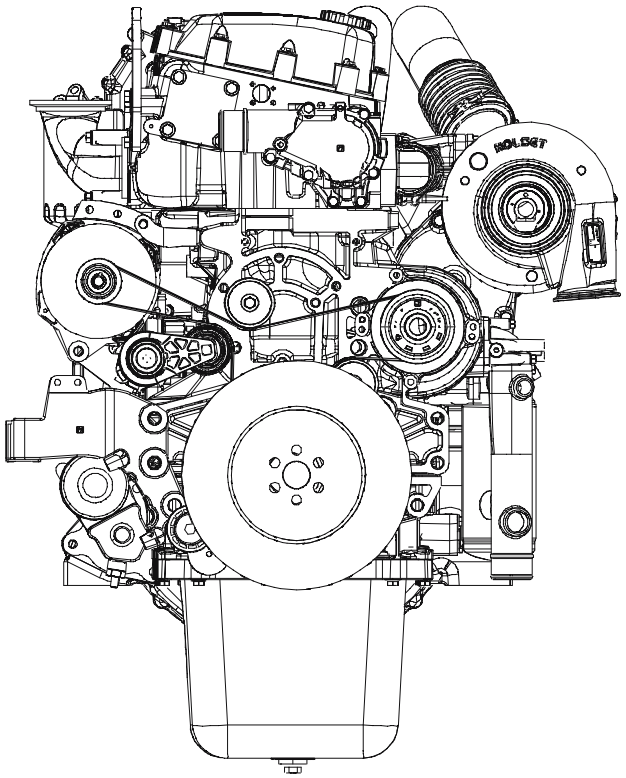
Figure 2



110588

RIGHT-HAND SIDE VIEW

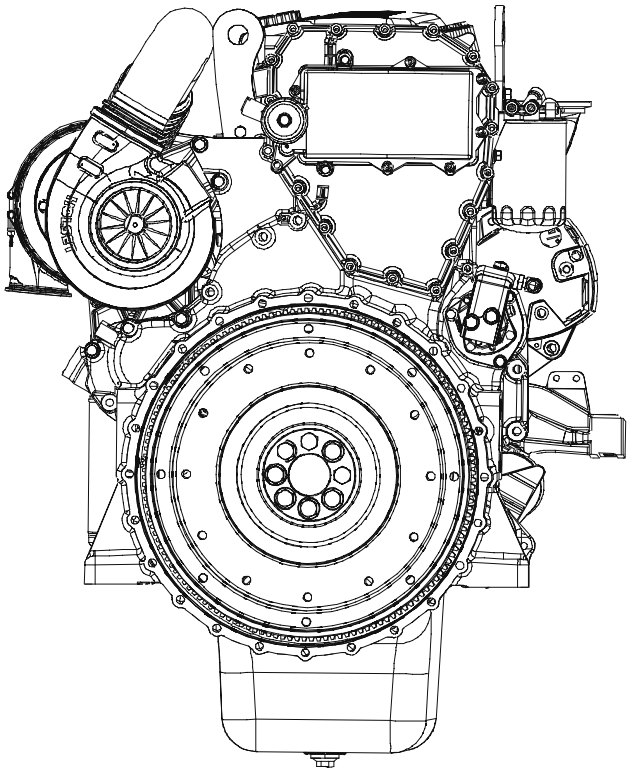
Figure 3



110589

FRONT VIEW

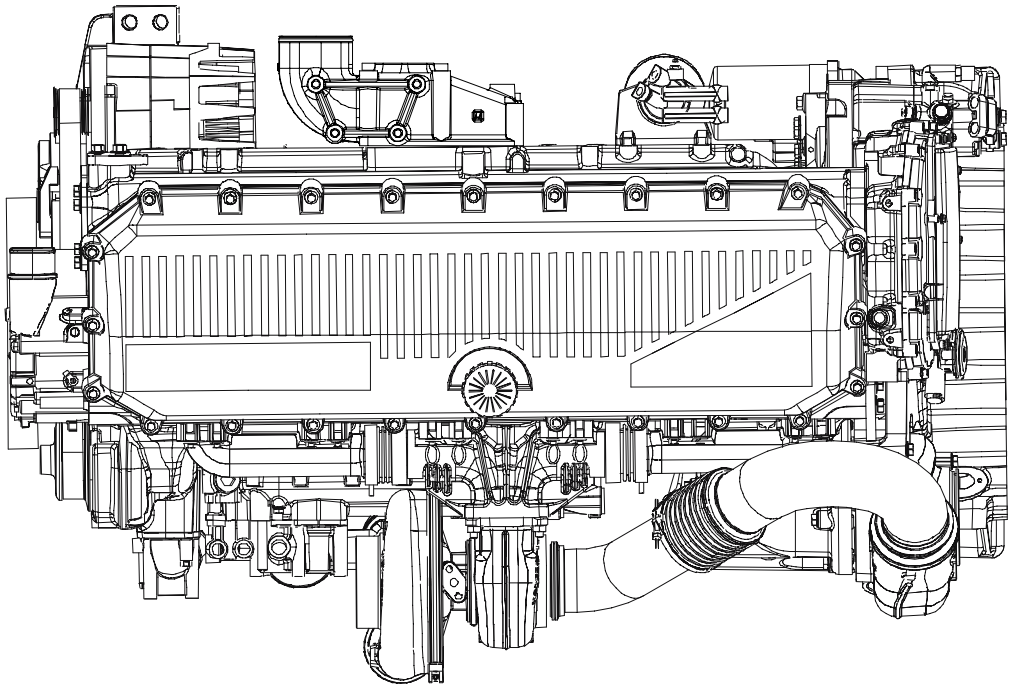
Figure 4



110590

REAR VIEW

Figure 5



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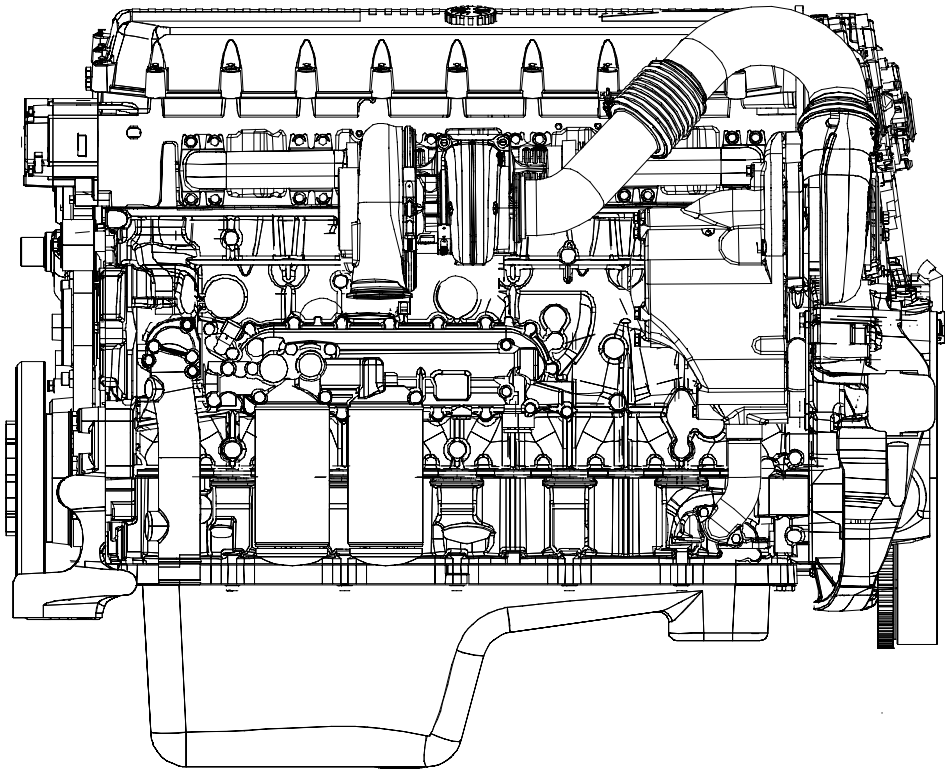
TOP VIEW

VIEWS OF ENGINE F3CE0684B*E003

Figure 6



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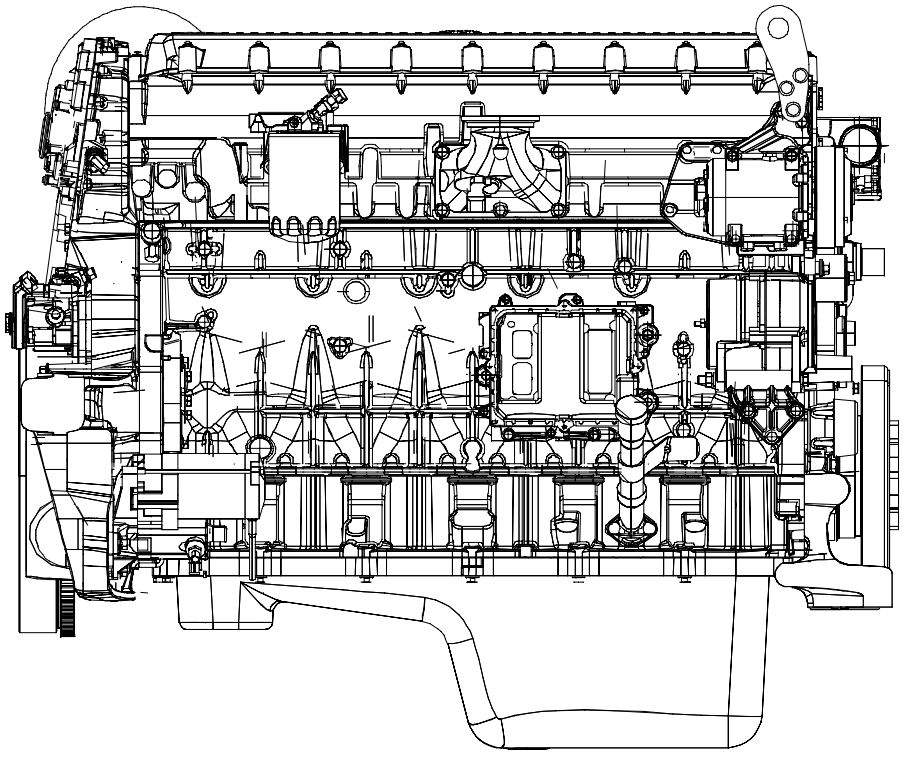
LEFT-HAND SIDE VIEW

Figure 7



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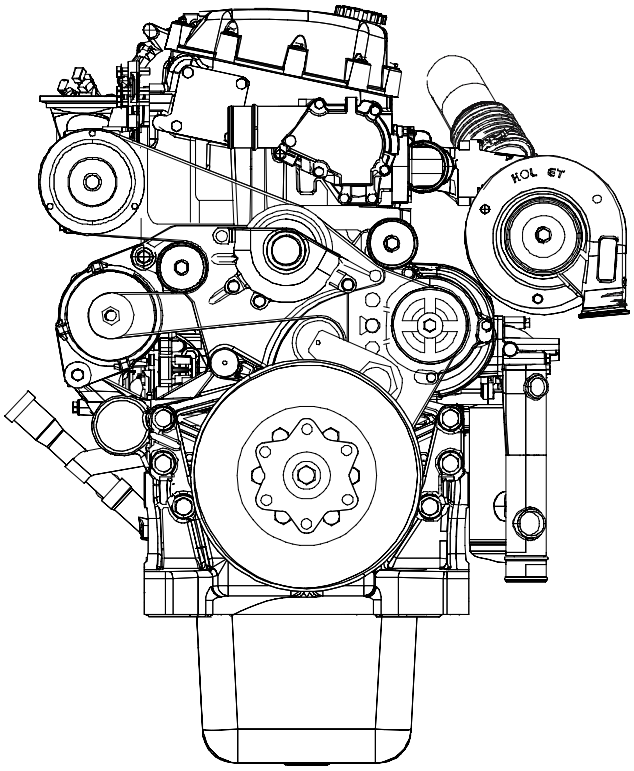
RIGHT-HAND SIDE VIEW

Figure 8



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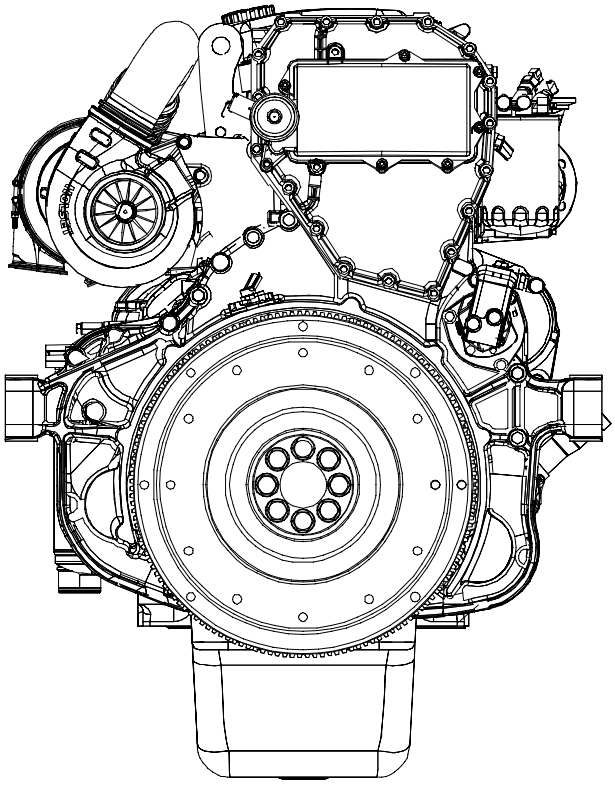
FRONT VIEW

Figure 9



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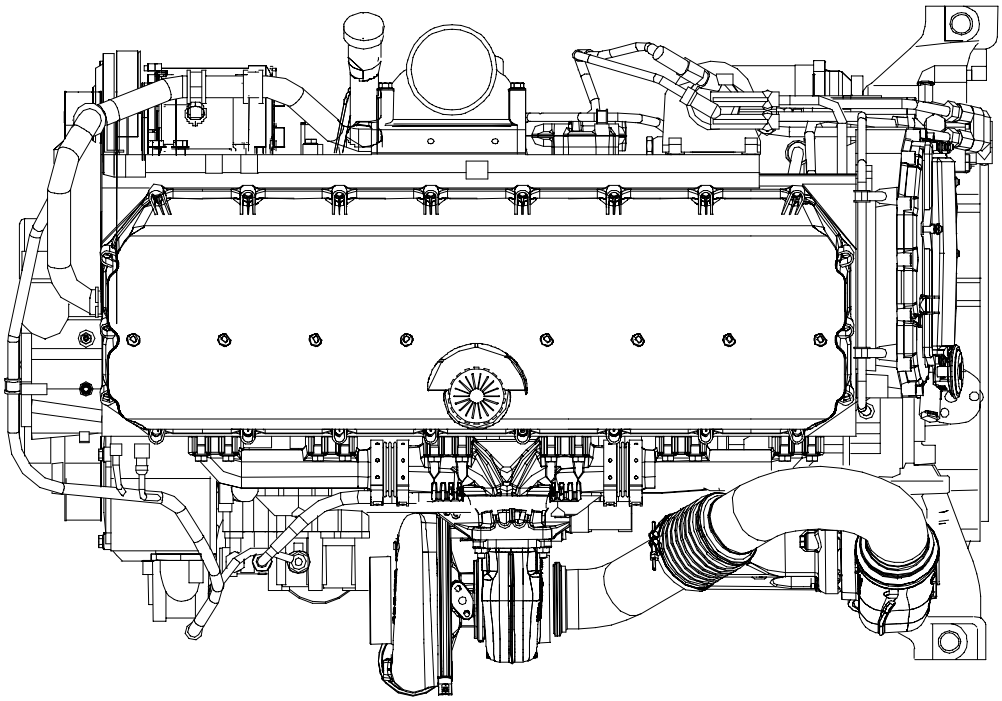
REAR VIEW

Figure 10



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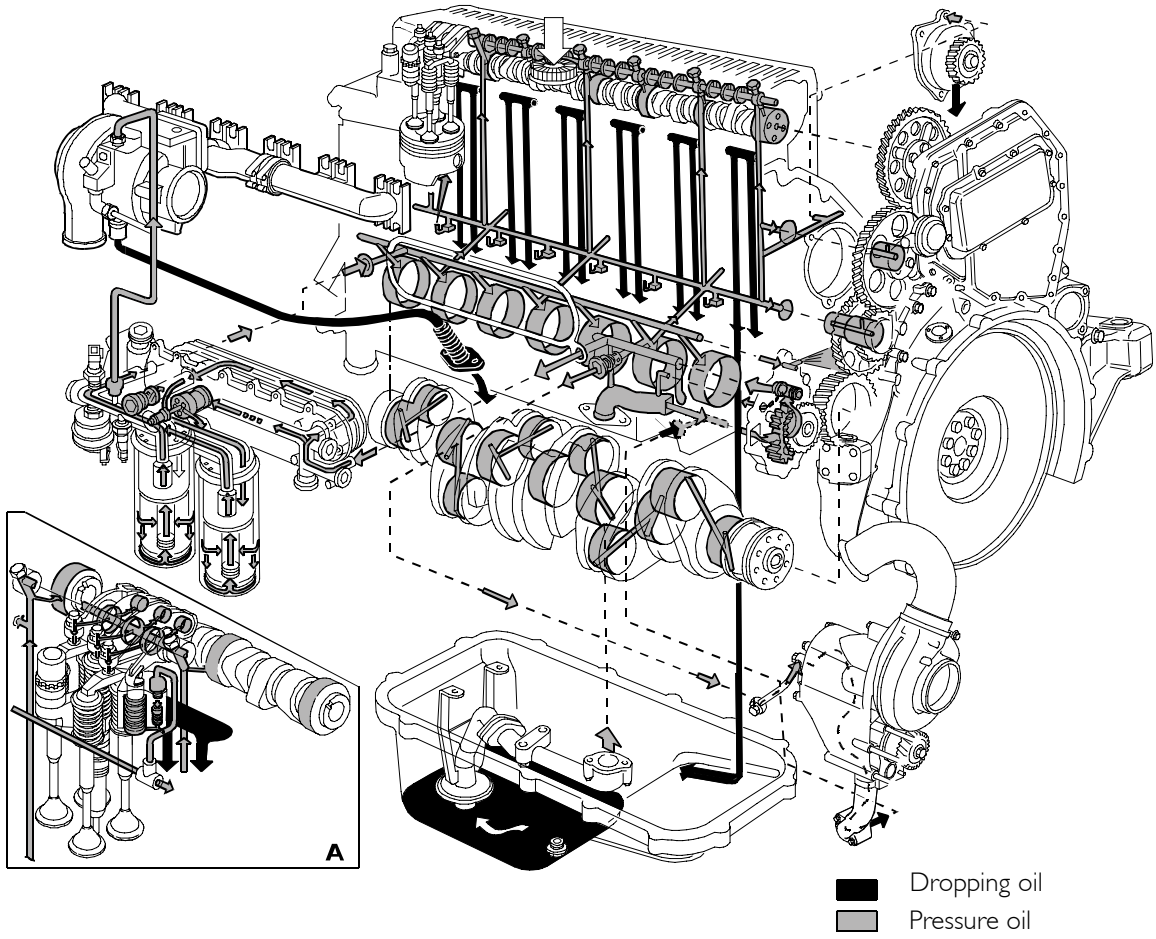
TOP VIEW

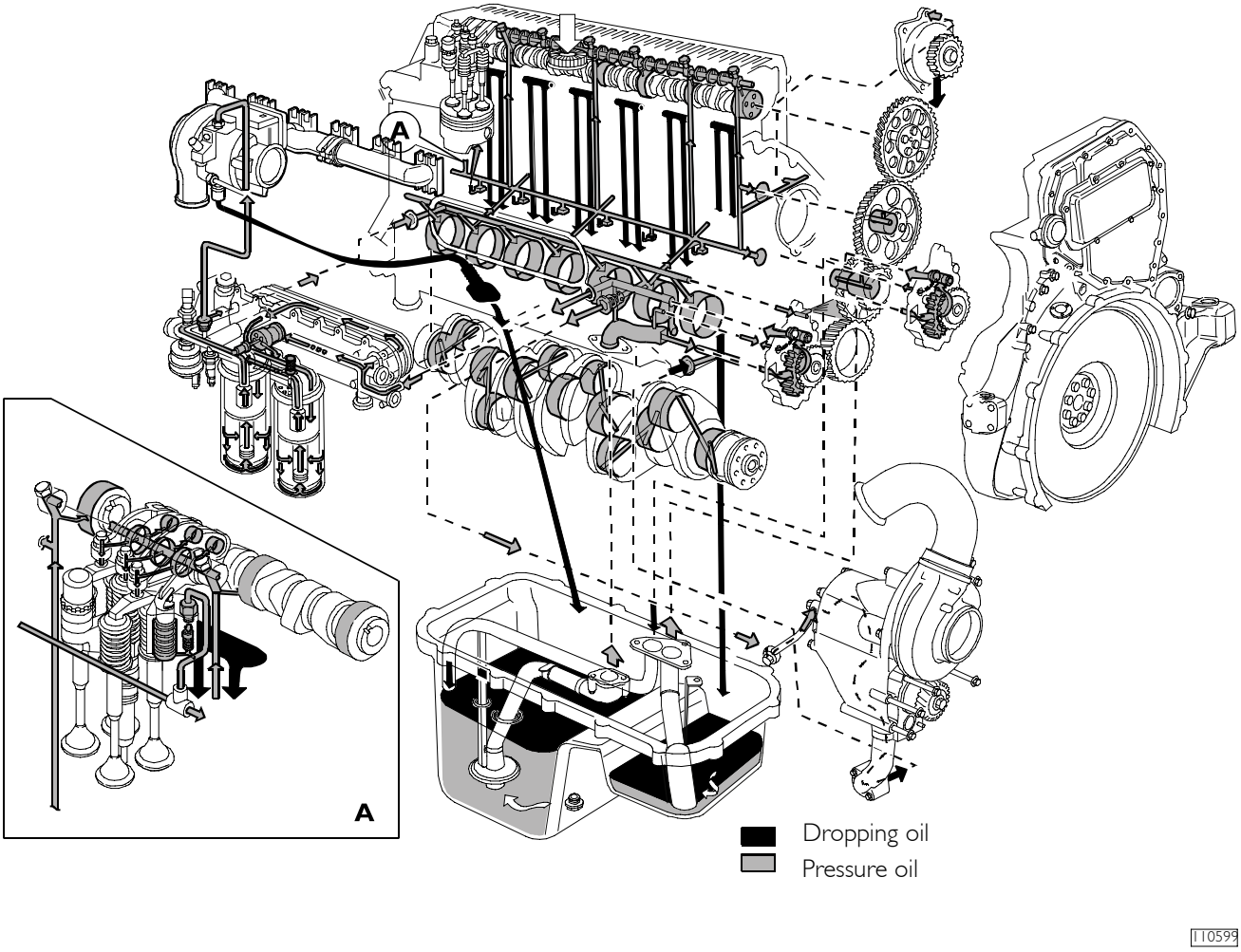
LUBRICATION DIAGRAM
F3CE0684A*E001 Engine

Figure 11



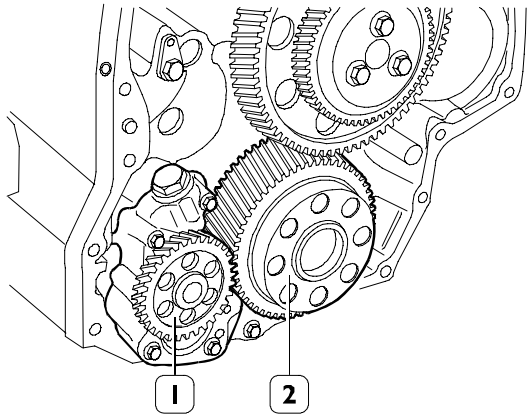
F3CE0684B*E003 Engine

Figure 12



Oil pump

Figure 13



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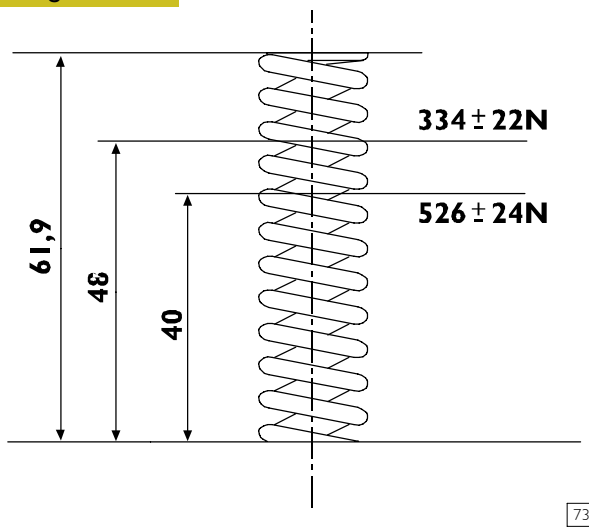
The oil pump (1) cannot be overhauled. On finding any damage, replace the oil pump assembly.

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

Overpressure valve

Figure 15



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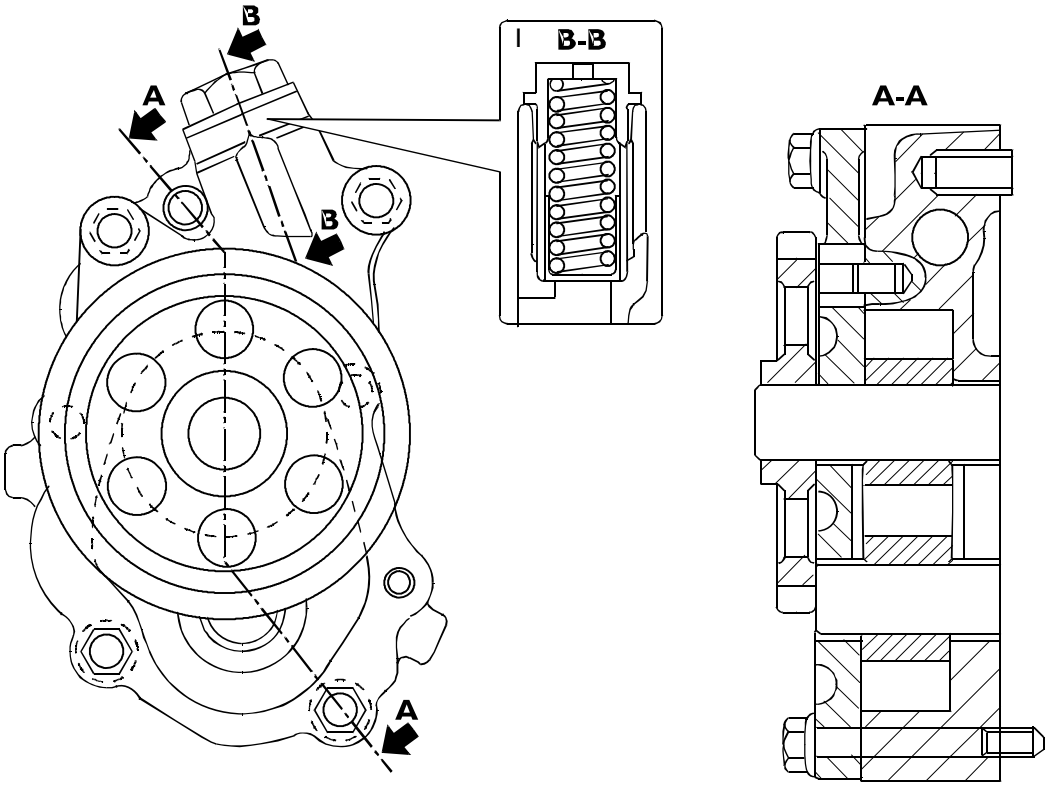
MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

Figure 14



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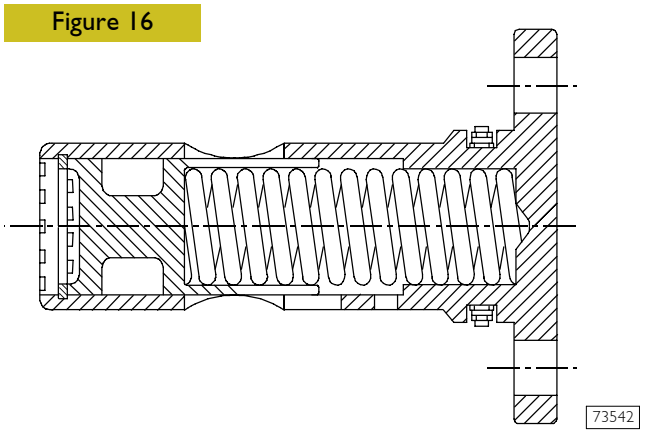
OIL PUMP CROSS-SECTION
1. Overpressure valve – Start of opening pressure 10 ± 1 bars.

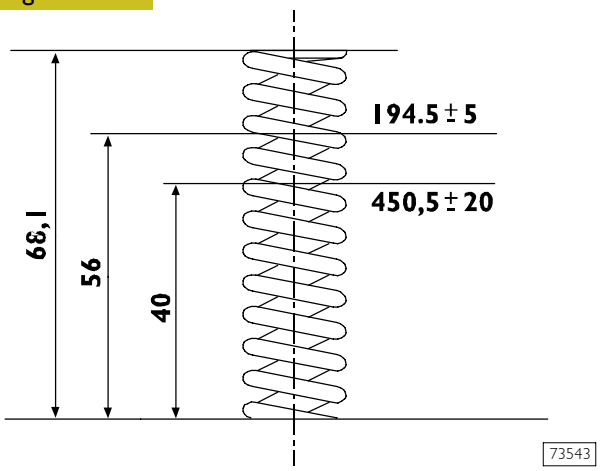
Oil pressure control valve

Figure 16



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

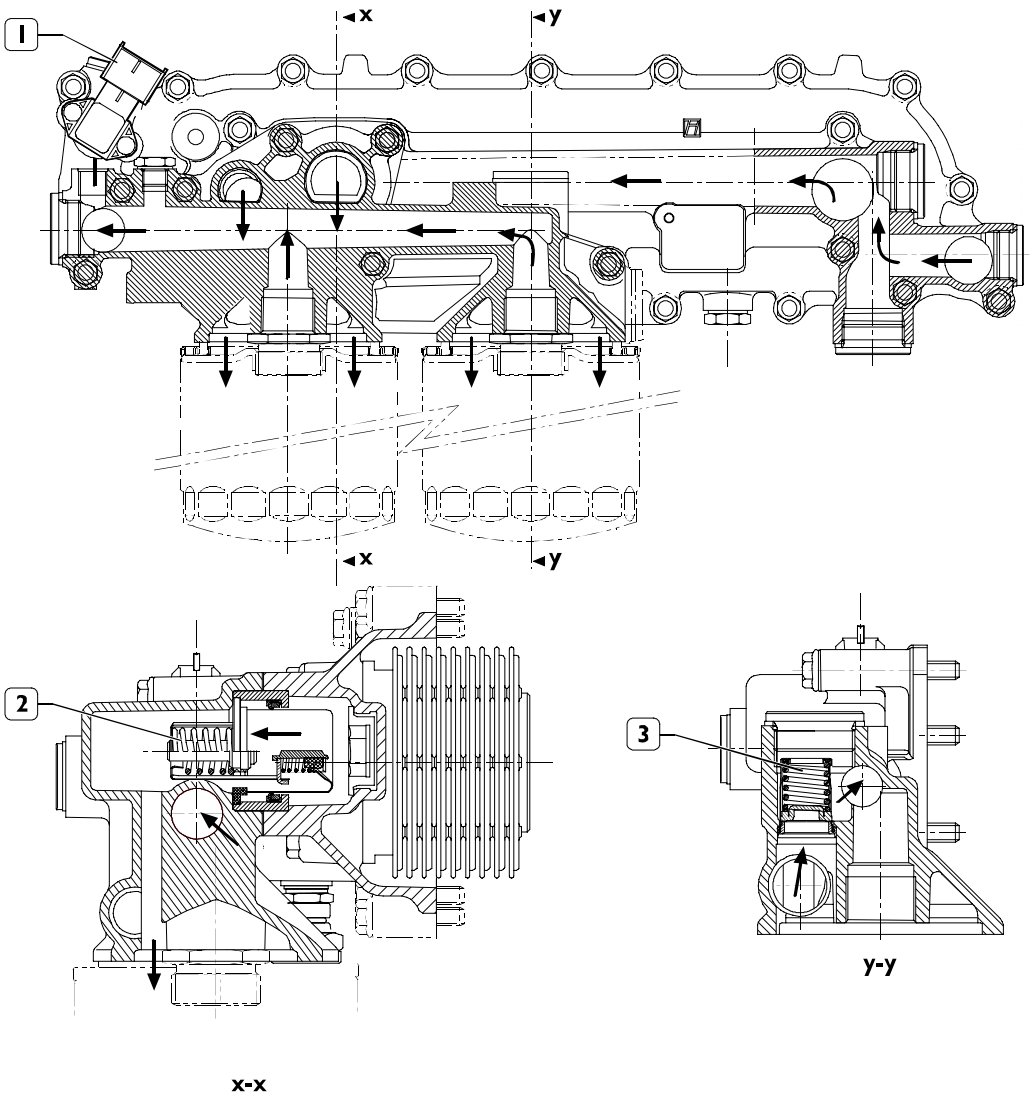
Figure 17



MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

Heat exchanger

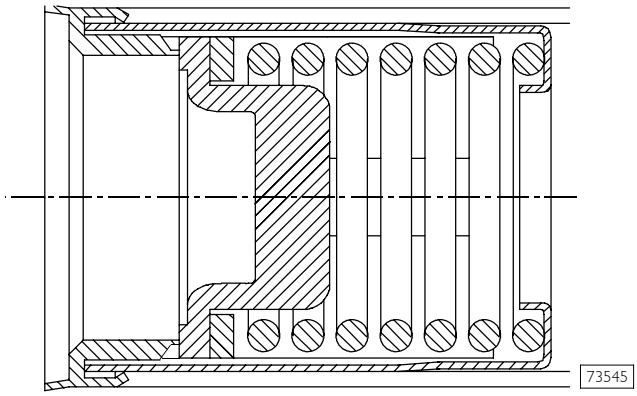
Figure 18



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

By-pass valve

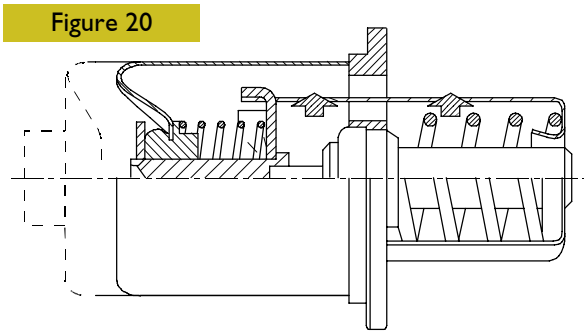
Figure 19



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

Thermostatic valve

Figure 20



Start of opening:

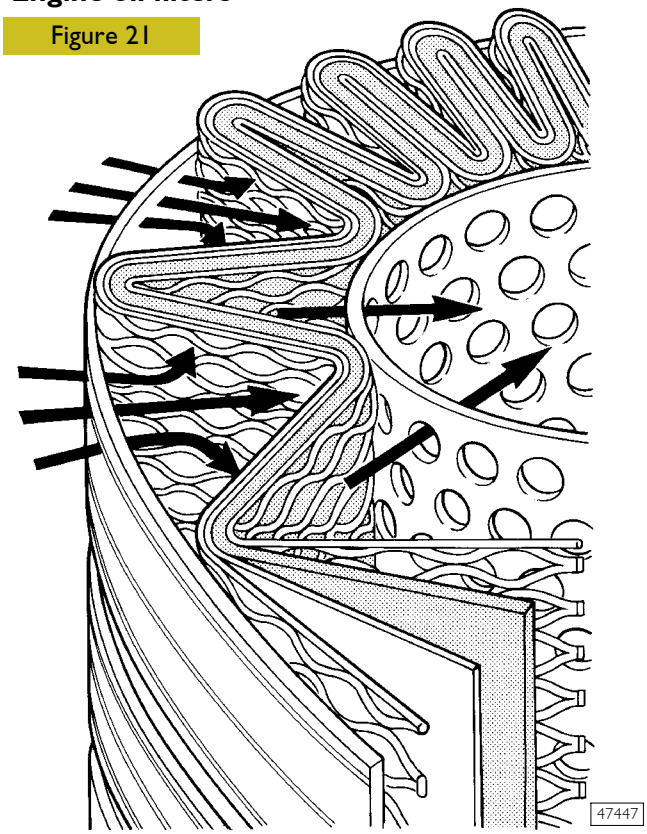
- travel 0.1 mm at a temperature of 82 ±2°C.

End of opening:

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

Engine oil filters

Figure 21



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

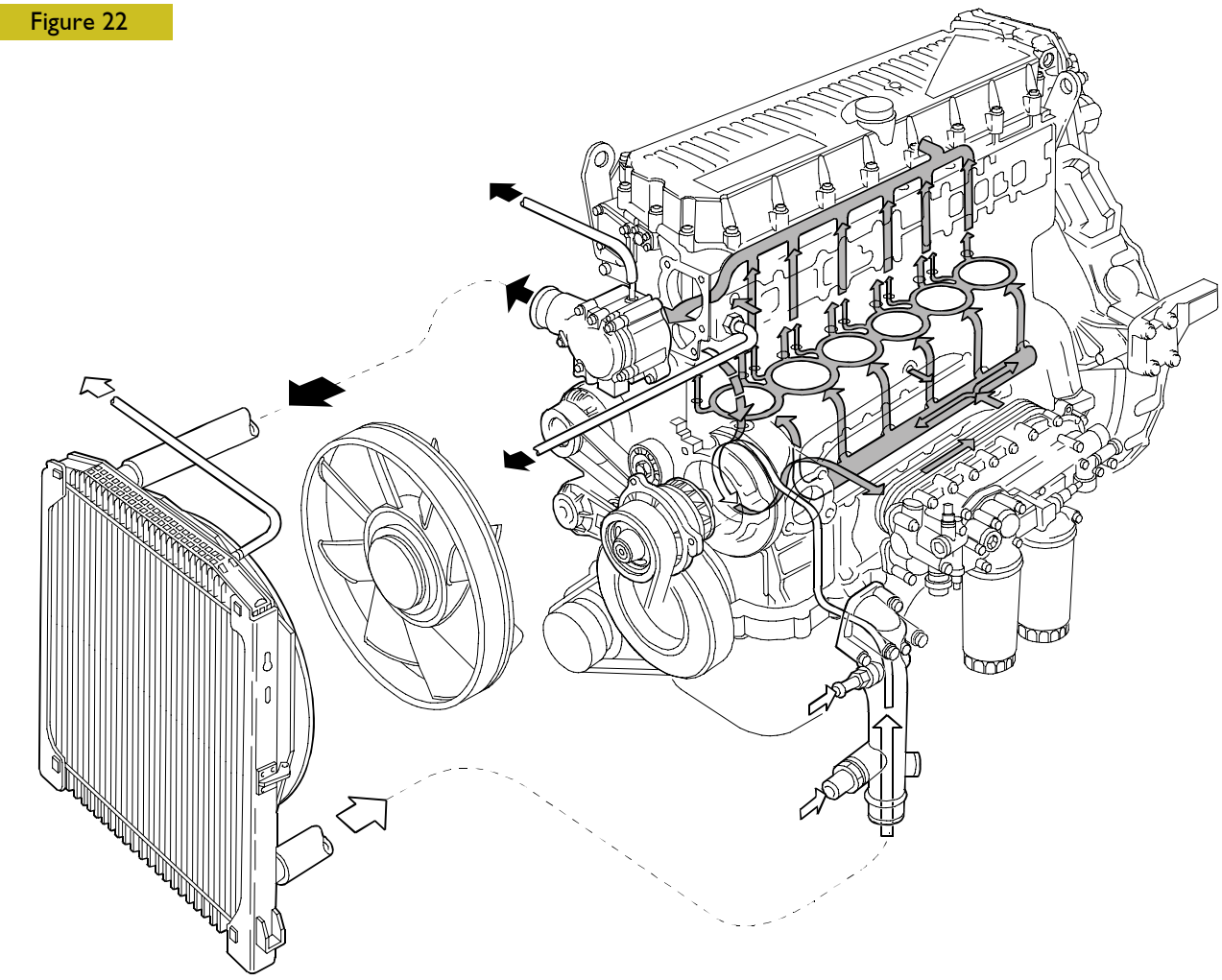
The o-rings equipping the filtering element ensure a perfect seal between it and the container, eliminating by-pass risks and keeping filter performance constant. Strong corrosion-proof bottoms and a sturdy internal metal core complete the structure of the filtering element.

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 22



Water flowing out of the thermostat

Water circulating in the engine

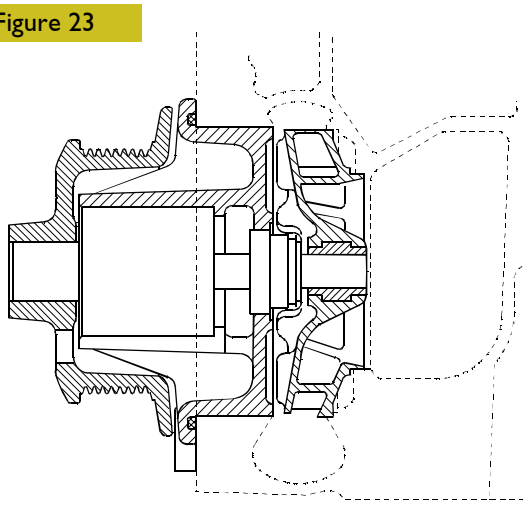
Water flowing into the pump

104278

ILLUSTRATIVE DIAGRAM

Water pump

Figure 23



104239

CROSS-SECTION OF THE WATER PUMP

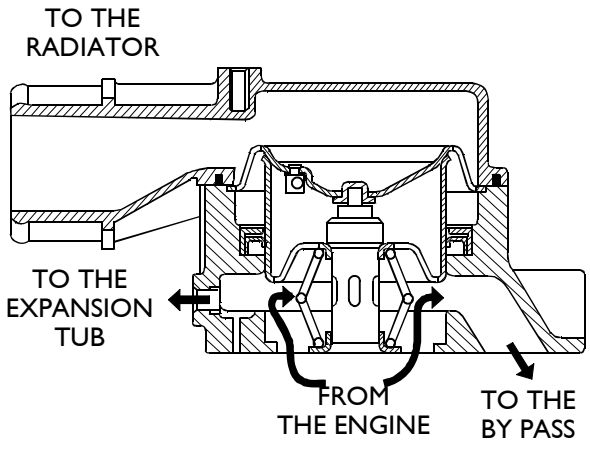
The water pump comprises: rotor, shaft with bearing. T-gasket and drive pulley.

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

Thermostat

View of thermostat operation

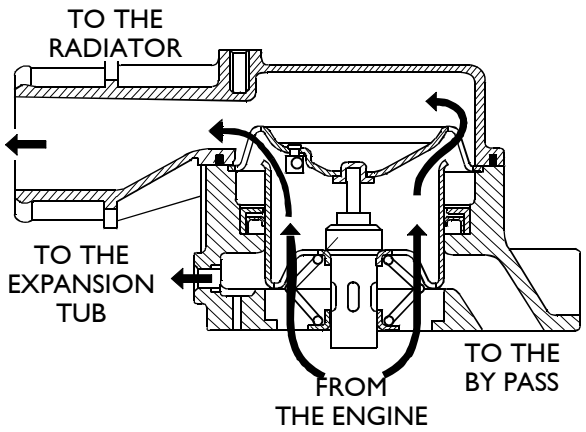
Figure 24



60747

Water circulating in the engine

Figure 25



60748

Water leaving the thermostat

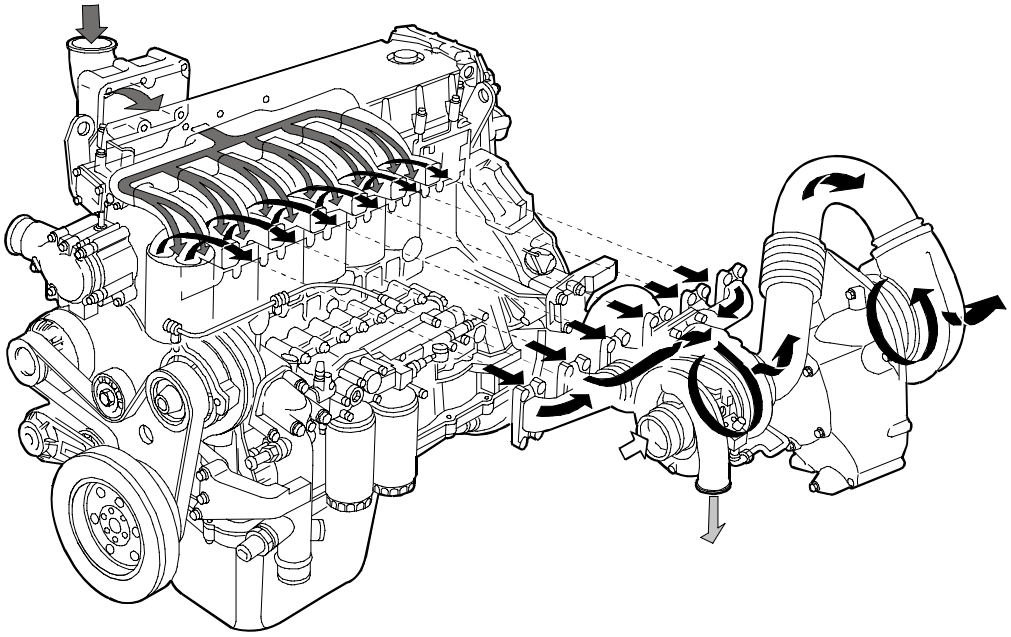
Check the thermostat works properly; replace it if in doubt.

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

TURBOCHARGER

The turbocharger increases the air flow rate during the suction stroke of the combustion cycle. The contribution of extra air improves combustion and increases engine efficiency.
The exhaust gases are conveyed towards the turbocharger turbine where they give part of their energy and turn the turbine itself. During this step, the exhaust gas temperature drops to approximately 600°C.
A centrifuge compressor is mounted coaxially to the turbine with the task of aspirating and comprising the previous cleaned air from the external environment.
During compression, the air temperature increases and is thus cooled by a heat exchanger (intercooler) before being conveyed to the intake manifold.

Figure 26

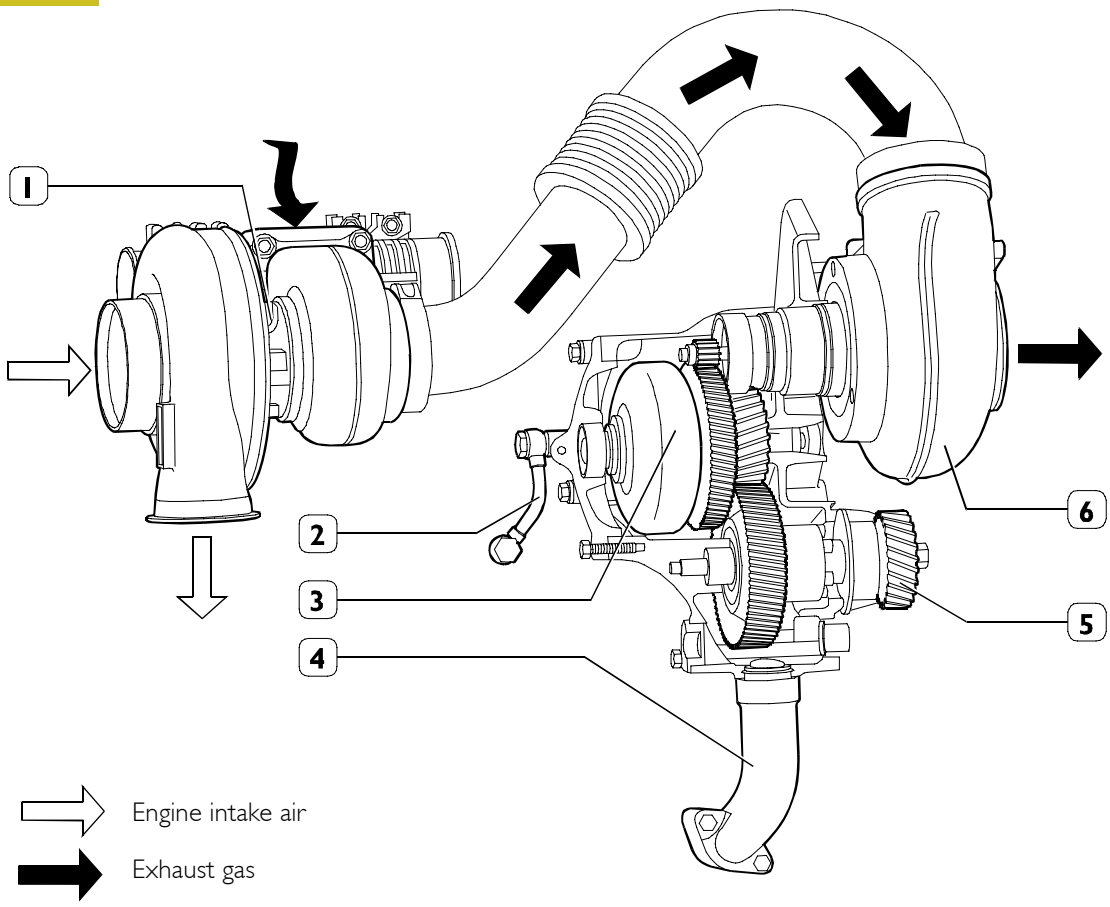


119991

TURBOCOMPOUND SYSTEM

In a turbocompound system, a second "power" turbine is mounted in series to the normal engine turbocharger and coupled to a Voith hydraulic coupling.
The "power" turbine, via a gear set, transmits energy to the crankshaft obtaining a power increase of approximately 8% without increasing fuel consumption.
The Voith hydraulic coupling uses engine oil and is required balance and adjust the engine rate variation between power turbine and crankshaft.
The exhaust gases produced by the combustion are conveyed to the turbocharger turbine; here, they expand and give part of their energy by operating the turbocharger and compressing the engine intake air: this increases both engine power and torque.
At first turbo outlet, the exhaust gases reach a temperature of approximately 600°C.
At this point, the exhaust gases are directed to the second "power" turbine which is capable of reaching a revolution speed of approximately 52.000 rpm at the maximum output power (70 kW).
Also in this case, the exhaust gases give part of their energy and by expanding their temperature drops to about 500°C. After the power turbine, the exhaust gases return to the normal exhaust system.
In addition to further abating the temperature of the exhaust gases, this system allows to contain emissions to level Tier 3, without using other technologies.

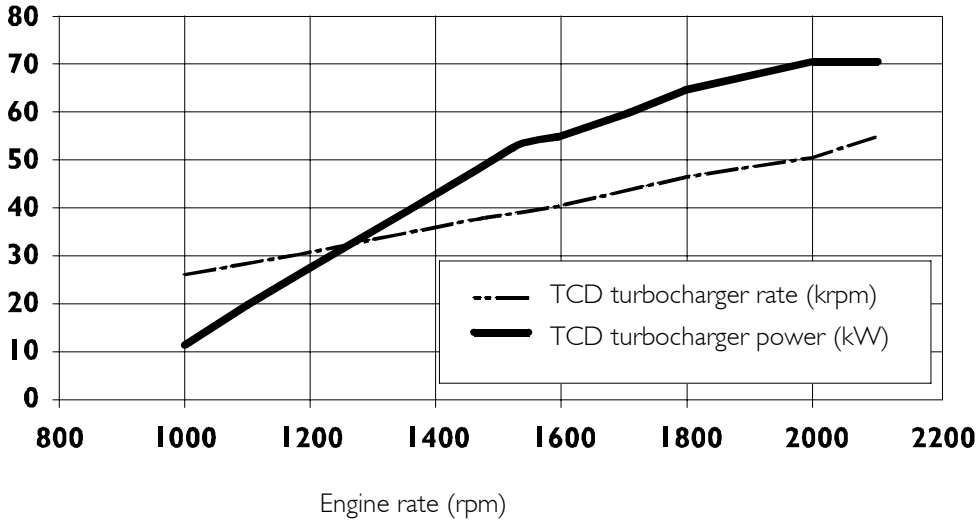
Figure 27



110601

TURBOCOMPOUND PRINCIPLE DIAGRAM
1. Turbocharger - 2. Lubrication delivery to Voith coupling - 3 Voith hydraulic coupling - 4. Lubrication return circuit from Voith coupling - 5. Motion output gear from Voith coupling - 6. Power turbine.

Figure 28



110602

The graph shows the power curve pattern and "power" turbine rate according to engine rpm.

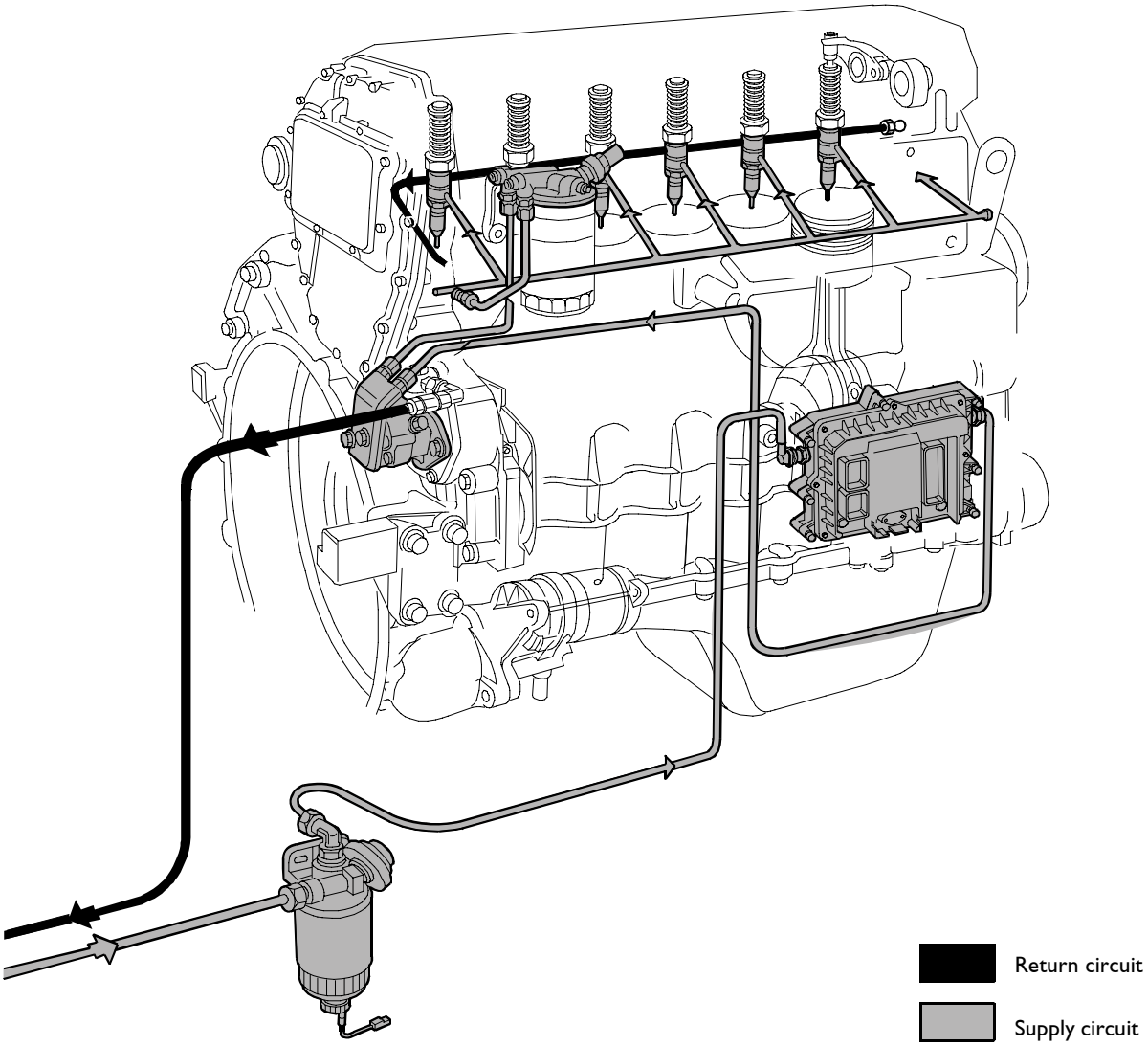
SECTION 2

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.

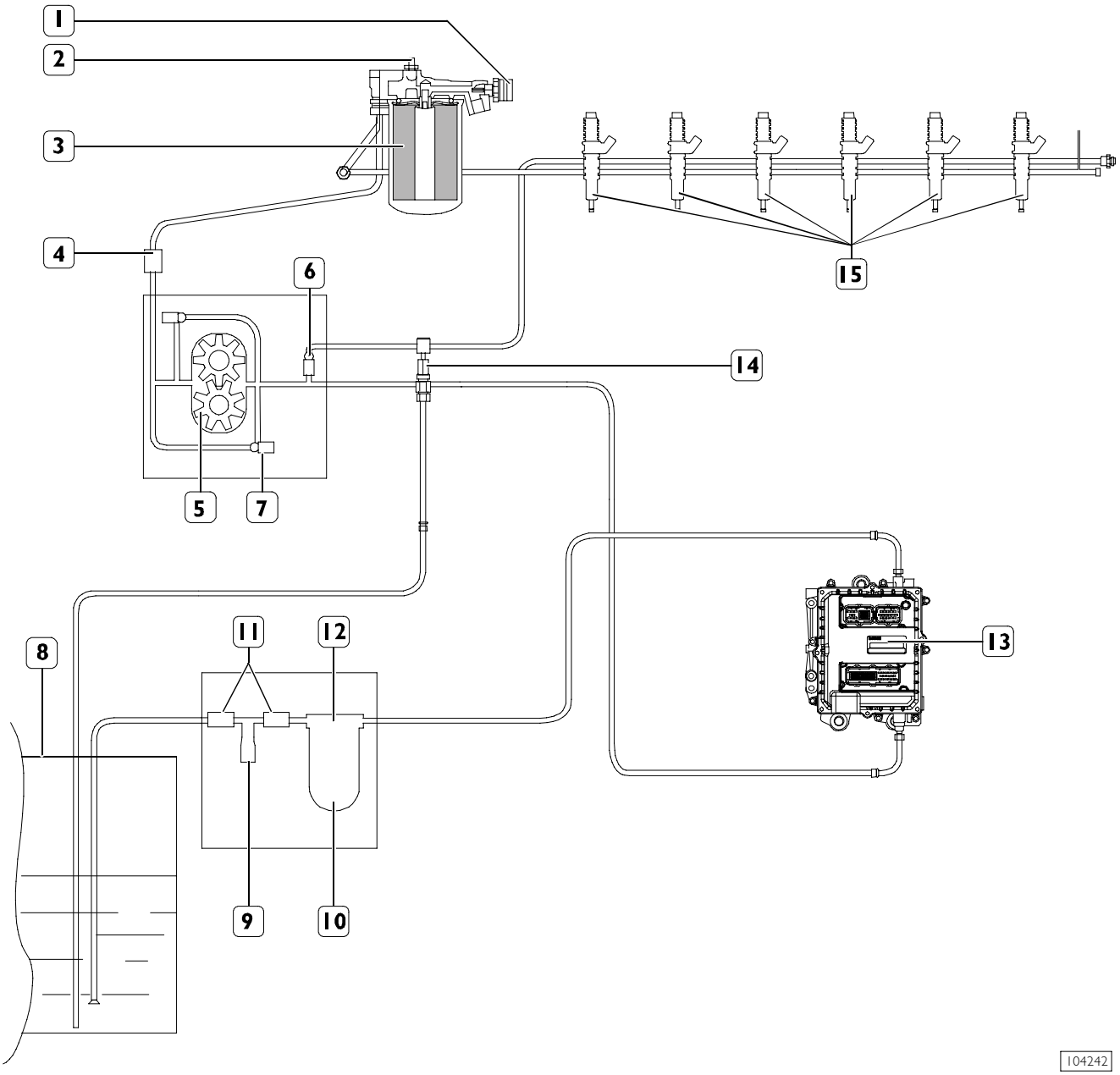
Figure 1



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

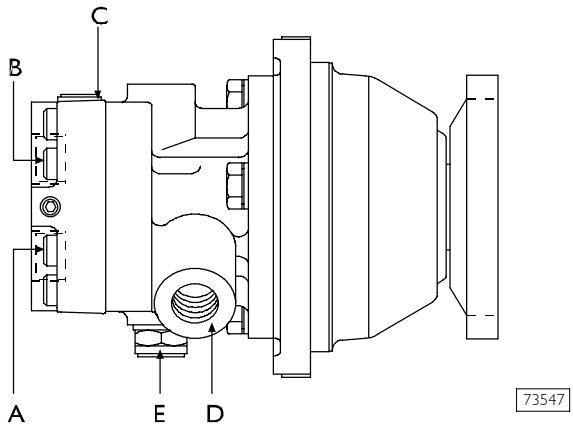
Figure 2



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.

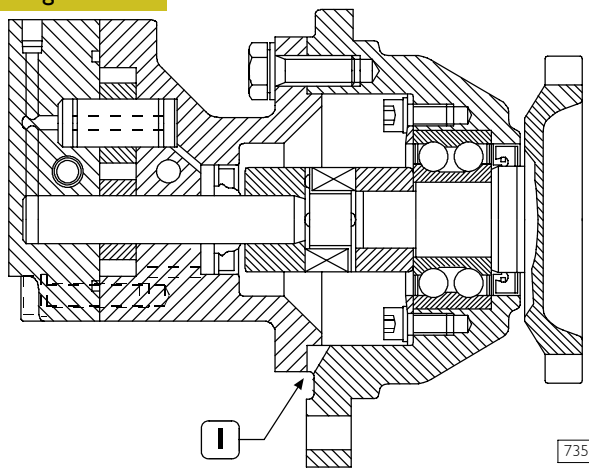
Fuel pump

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.

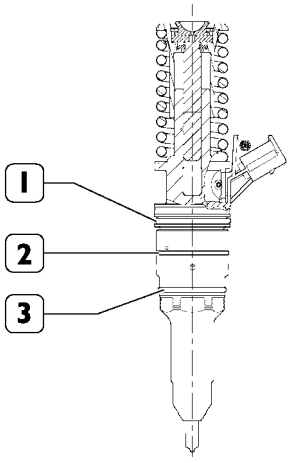
Figure 4



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.

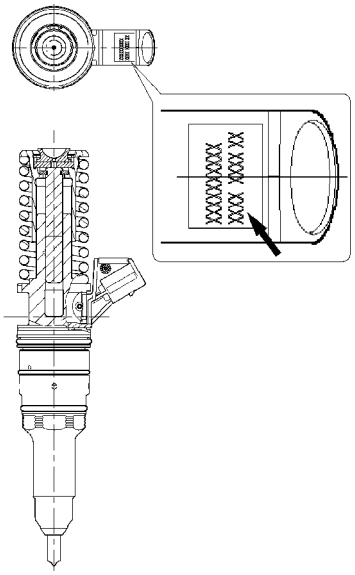
Nozzle

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



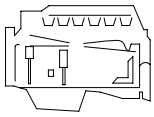
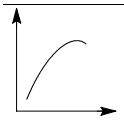
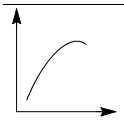
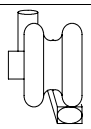
104245

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.

SECTION 3

Industrial application

CLEARANCE DATA

	Type		F3CE0684A*E001	F3CE0684B*E003
ϱ	Compression ratio		16.5 ± 0.8	
 	Max. output	kW (HP) rpm	425 (578) 1800	402 (547) 1800
 	Max. torque	Nm (kgm) rpm	2450 (245) 1500	2442 (244) 1400
	Loadless engine idling	rpm	600	875
	Loadless engine peak	rpm	2110	2350
	Bore x stroke Displacement	mm cm^3	135 x 150 12880	
	SUPERCHARGING Turbocharger type		Intercooler Direct injection HOLSET HE551	
	LUBRICATION Oil pressure (warm engine) - idling - peak rpm	 bar bar	Forced by gear pump, relief valve single action oil filter 3 4.5	
	COOLING Water pump control **Thermostat** - start of opening	 °C	Liquid Through belt 81	

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

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

PART ONE -

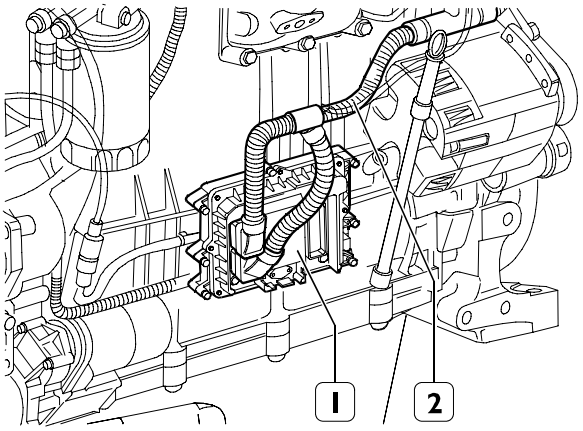
MECHANICAL COMPONENTS

ENGINE OVERHAUL PROCEDURE
Disassembling

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.

Figure 7

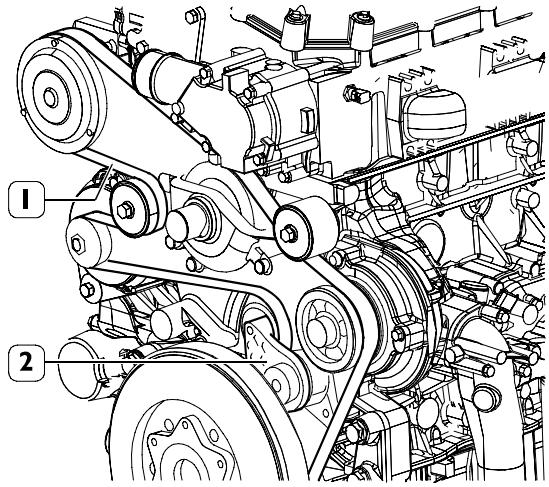


119479

Before securing the engine to the rotary stand, remove: the electrical cable of the engine (2) by unplugging it from the control unit (1) and from all sensors transmitters to which it is connected.

Only for F3CE0684B*E003 engine

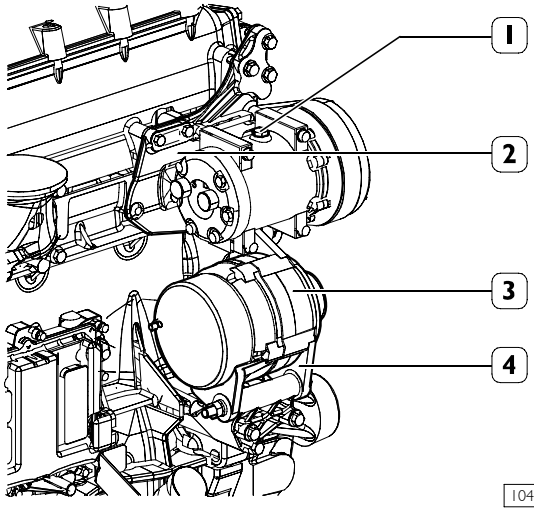
Figure 8



104780

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

Figure 9



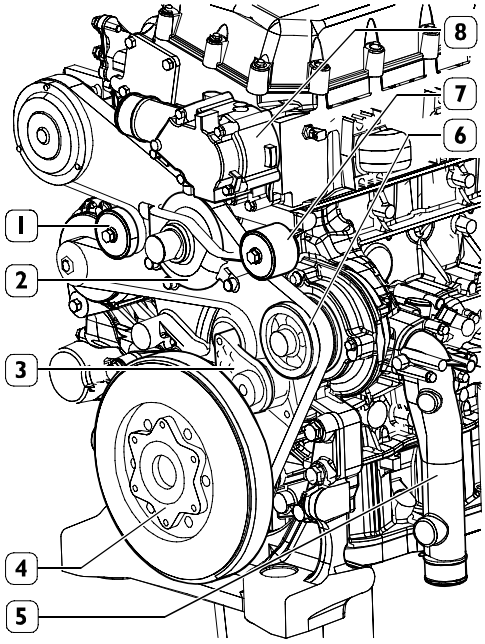
104781

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 10



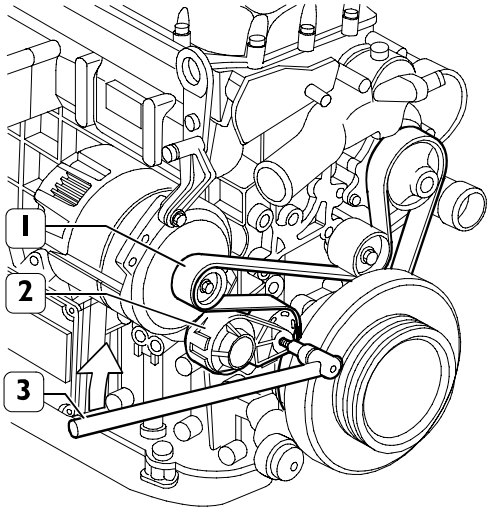
104782

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).

Only for F3CE0684A*E001 engine

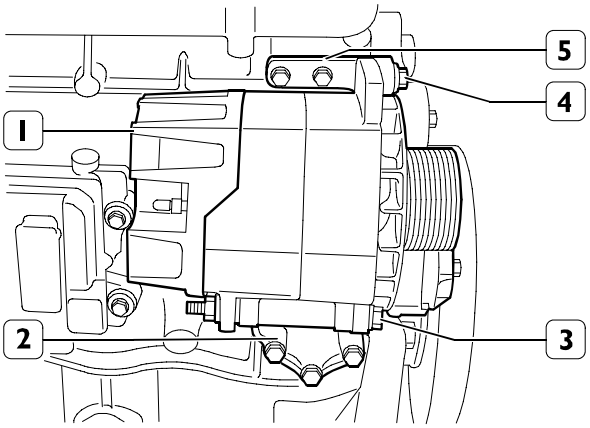
Figure 11



104249

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

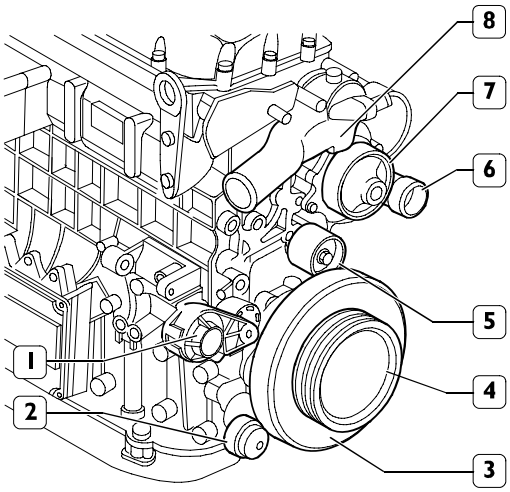
Figure 12



119478

Loosen and remove the screws (3) and (4) fastening the alternator (1) to the supporting brackets (2) and (5).
Remove the supporting brackets (2) and (5) from the crankcase.

Figure 13

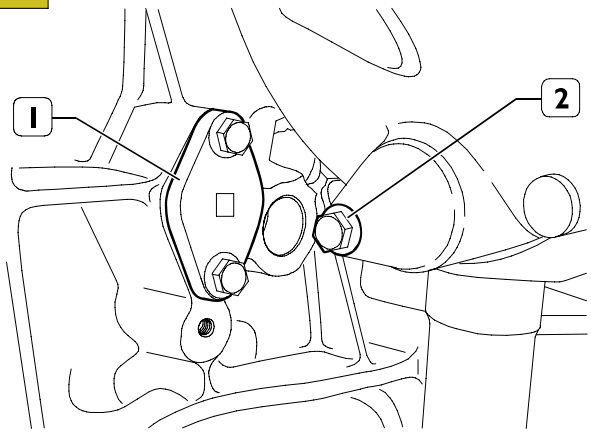


104251

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);

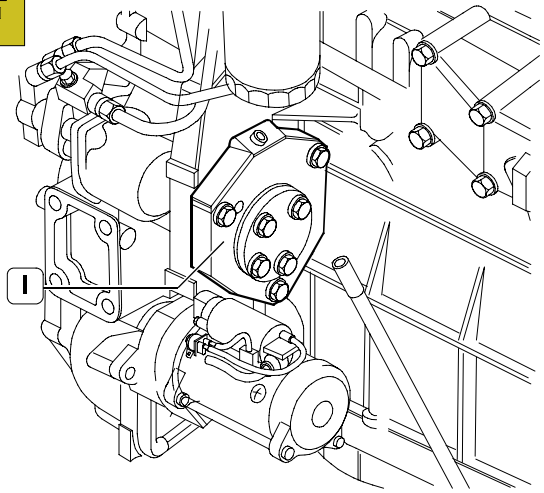
Figure 14



119487

Remove the oil pressure adjustment valve (1).
Loosen and remove the screw (2) fastening the hydraulic coupling to the flywheel casing.

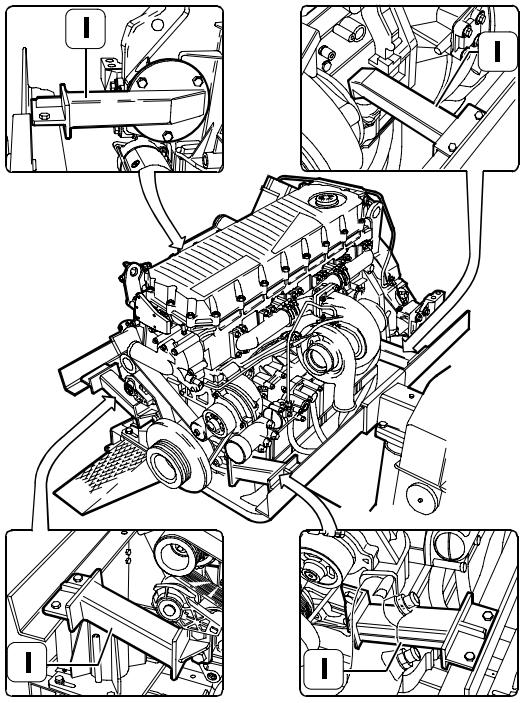
Figure 15



104247

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

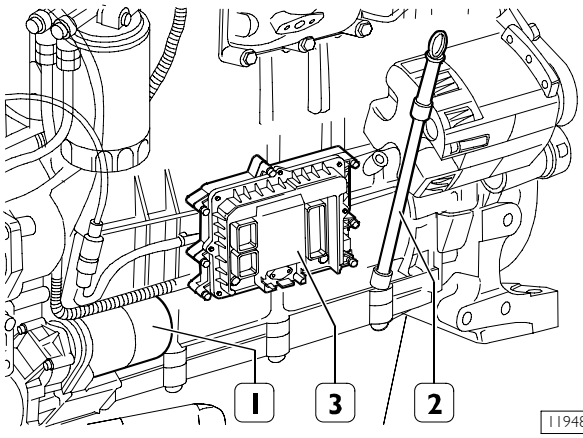
Figure 16



104248

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

Figure 17

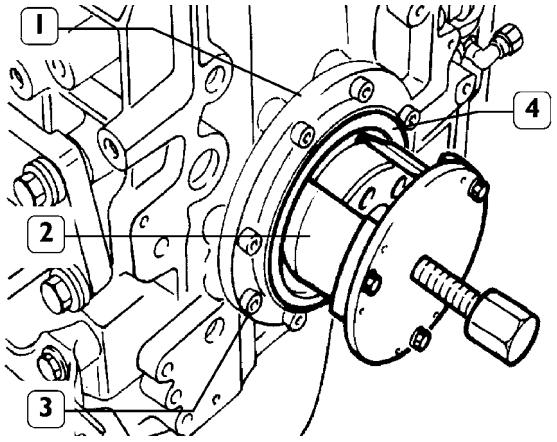


119480

Remove:

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

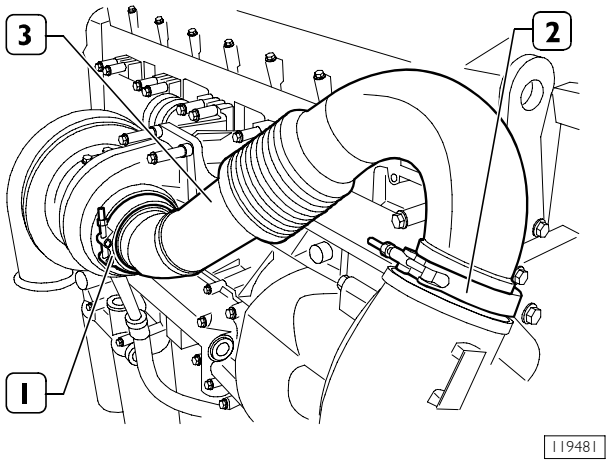
Figure 18



99361

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).

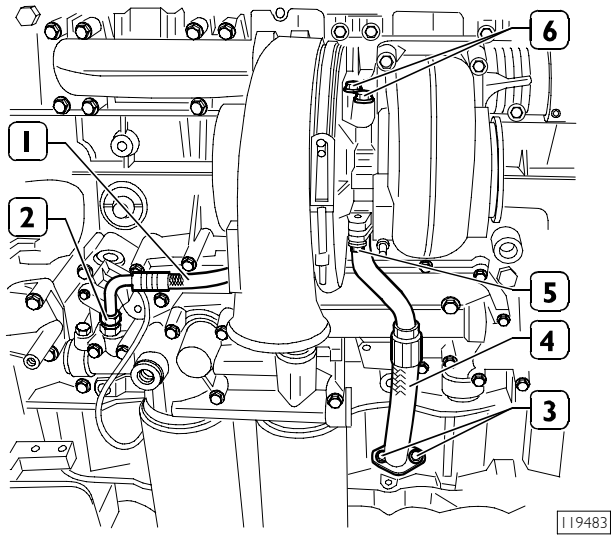
Figure 19



On exhaust side of the engine:

- ❑ loosen the clamps (1 and 2);
- ❑ remove the connection manifold (3) between turbocharger and power turbine.

Figure 20



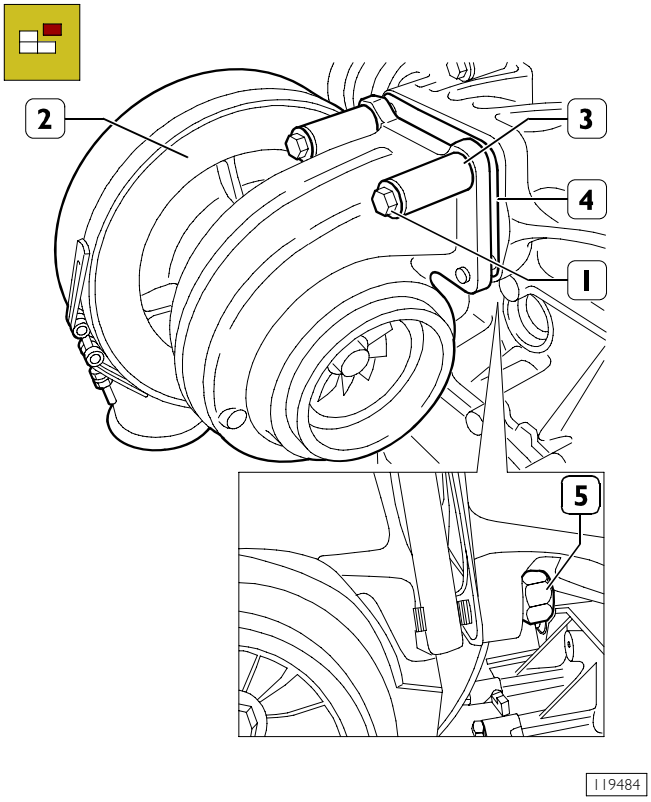
In order to remove the oil delivery pipe (1) from the turbocharger:

- ❑ loosen the fitting (2) on the oil filter assembly;
- ❑ loosen and remove the turbocharger fastening screws (6).

Remove the oil return tube (4) from the turbocharger:

- ❑ - loosen the screws (3 and 5) fastening the pipe to the crankcase and to the turbocharger itself.

Figure 21

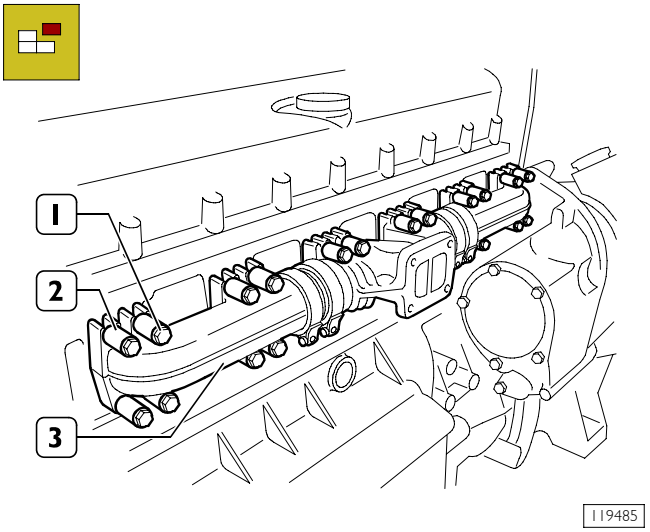


In order to remove the turbocharger (2):

- ❑ remove the screws (1) and recover the shims (3);
- ❑ remove the two nuts (5);

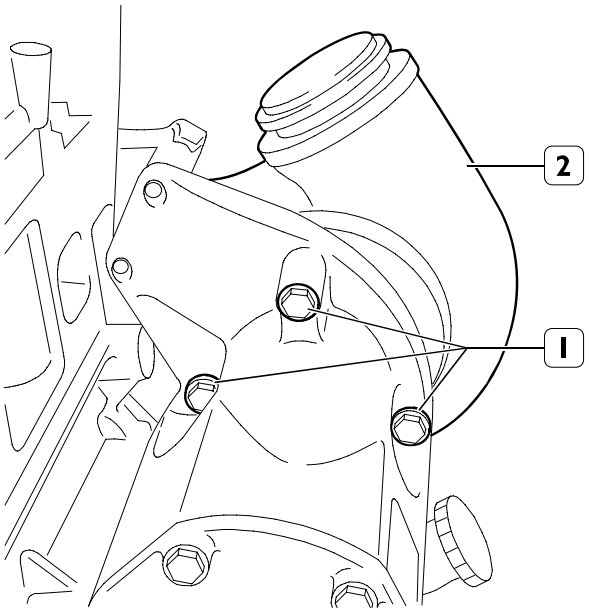
Recover the seal (4) after removing the turbocharger (2)

Figure 22



Loosen and remove the screws (1) fastening the exhaust manifold (3) to the crankcase.
Remove the shims (2).
Detach the exhaust manifold (2) from the crankcase and recover the seals.

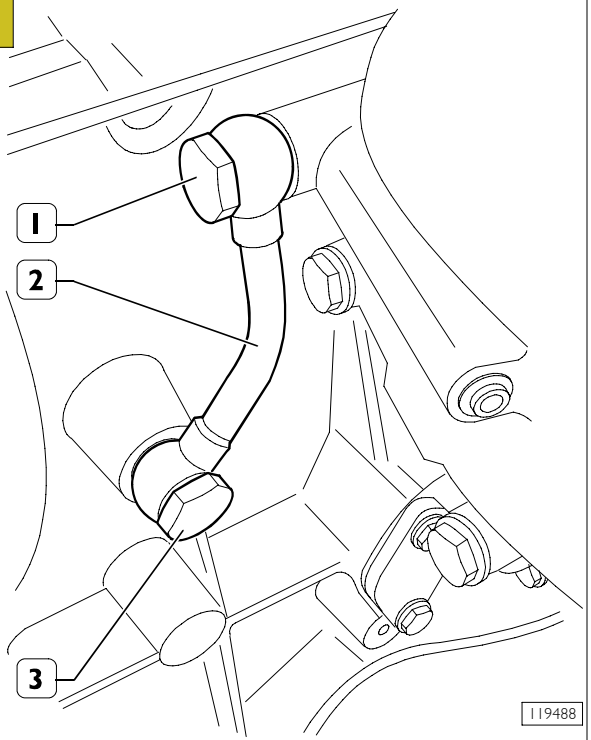
Figure 23



Loosen and remove the screws (1) fastening the power turbine (2) to the hydraulic coupling.

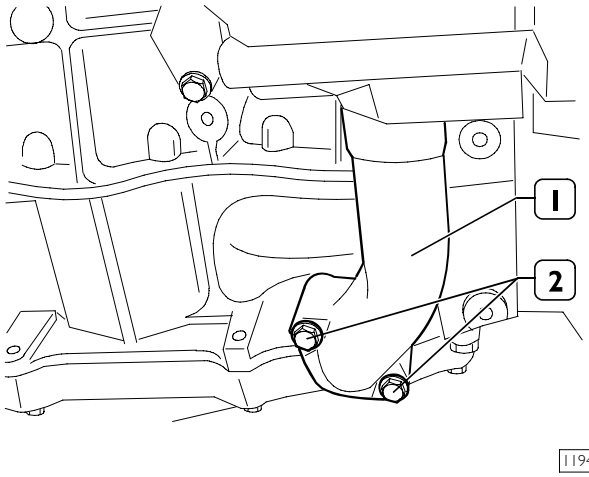
Detach the power turbine (2) from the hydraulic coupling.

Figure 24



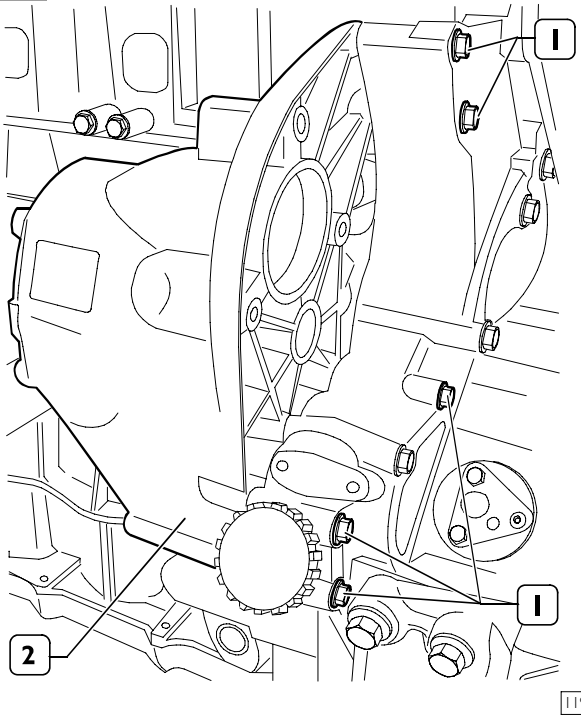
Loosen the unions (1 and 2) and remove the oil delivery pipe from the hydraulic coupling.

Figure 25



Loosen and remove the screws (1) fastening the oil return pipe (2) to the hydraulic coupling.

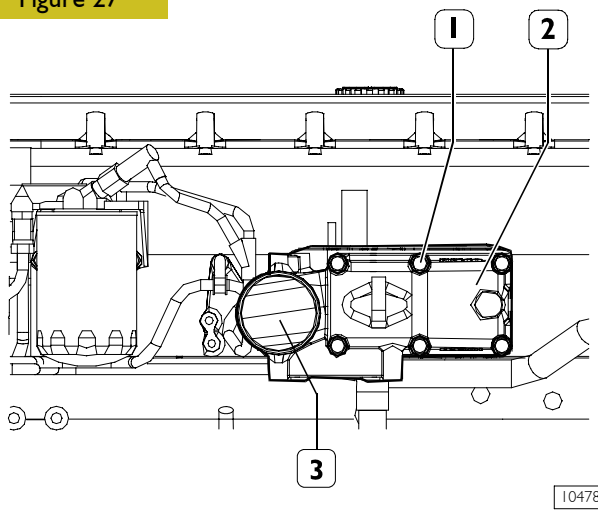
Figure 26



Loosen and remove the screws (1) fastening the hydraulic coupling (2) to the flywheel casing.

Detach the hydraulic coupling (2) from the flywheel casing.

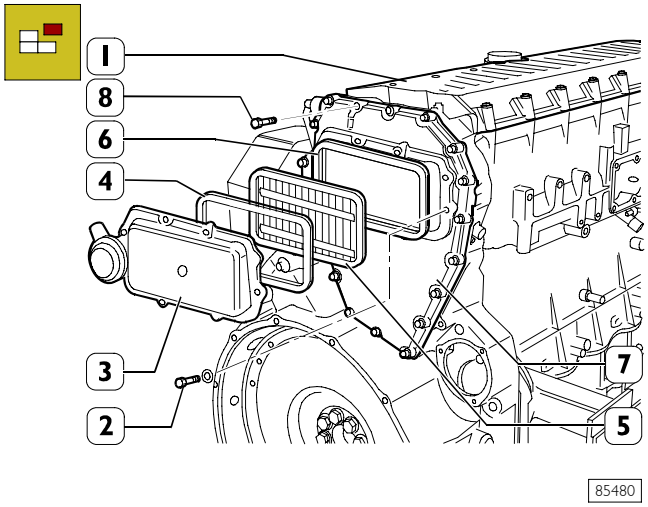
Figure 27



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

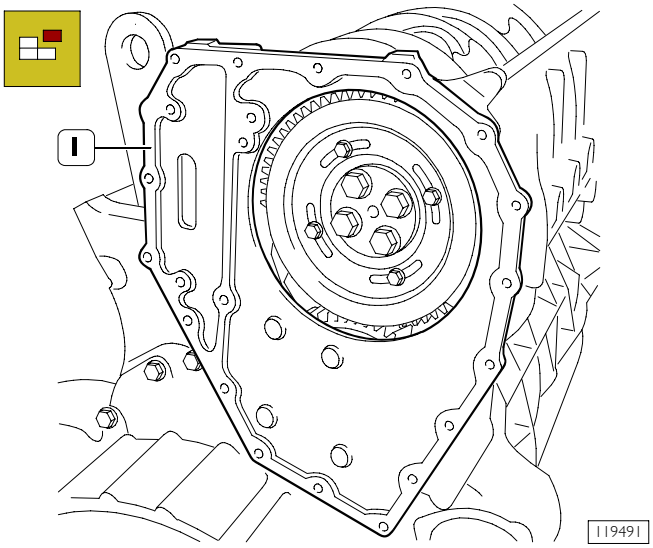
NOTE The air intake joint (3) may have different positions depending on the type of engine.

Figure 28



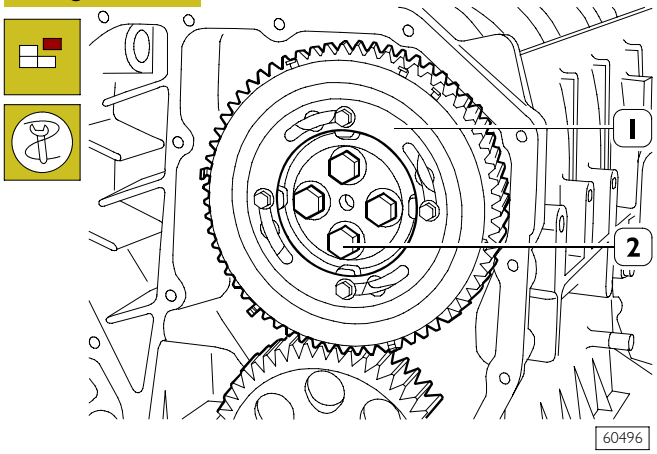
Remove the rocker arm cover (1), take off the screws (2) and remove: the cover (3), the filter (5) and the gaskets (4 and 6). Take off the screws (8) and remove the blow-by case (7).

Figure 29



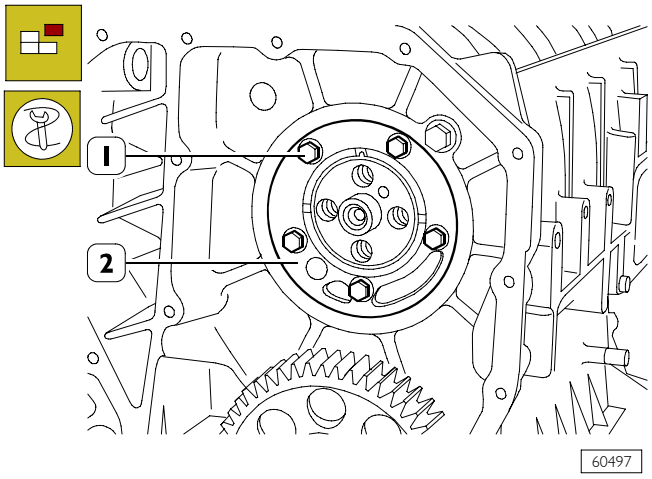
Remove the plate (1) and remove traces of sealant from the part in contact with the flywheel casing.

Figure 30



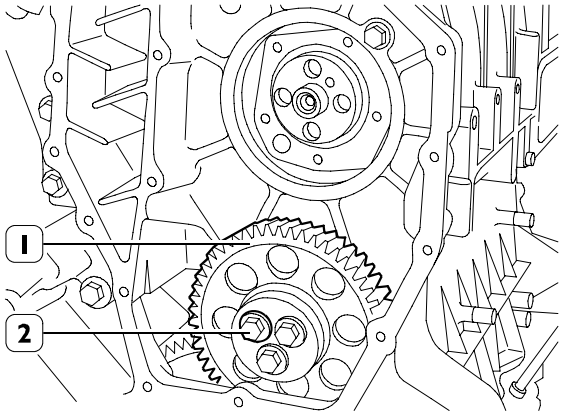
- Unscrew the screws (2) and remove the gear (1) fitted with phonic wheel.

Figure 31



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

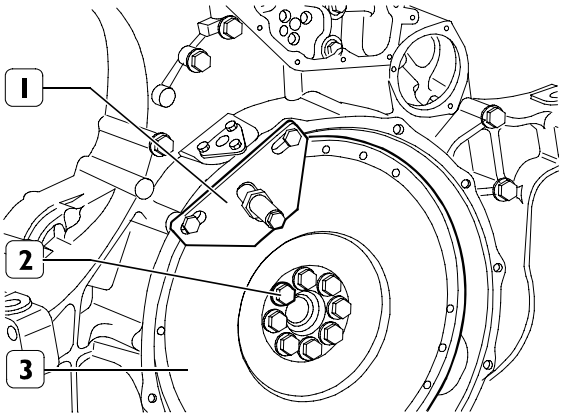
Figure 32



60498

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

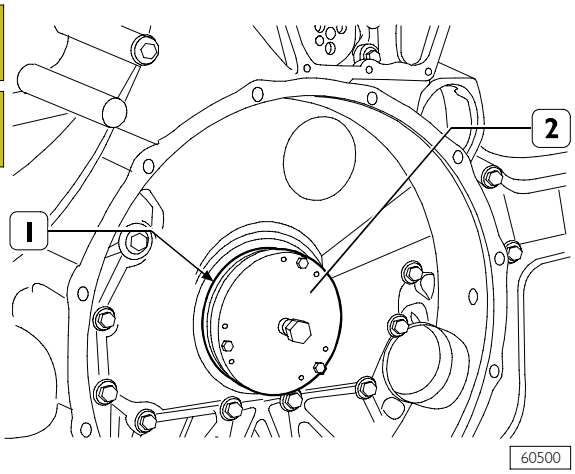
Figure 33



60499

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

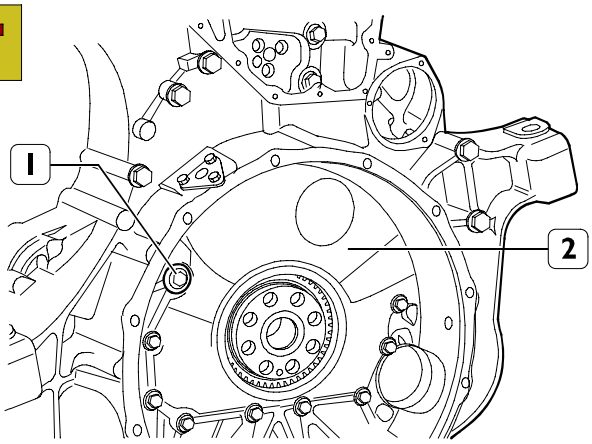
Figure 34



60500

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

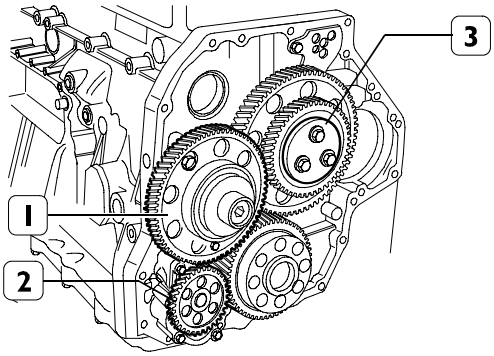
Figure 35



60501

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

Figure 36

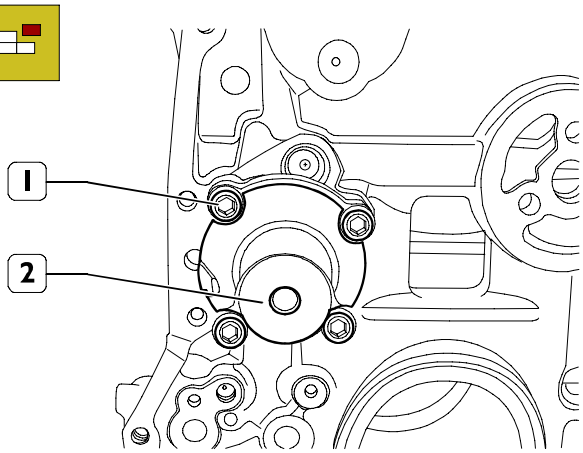


119492

In sequence, take out the:

- ❑ idle gear (1);
- ❑ oil pump gear (2)
- ❑ transmission gear (3);.

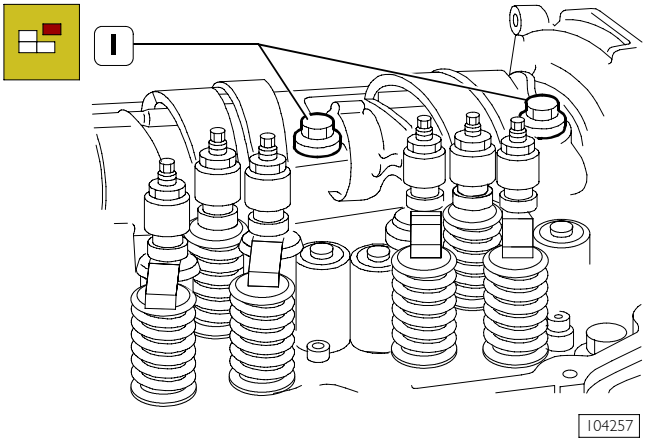
Figure 37



119493

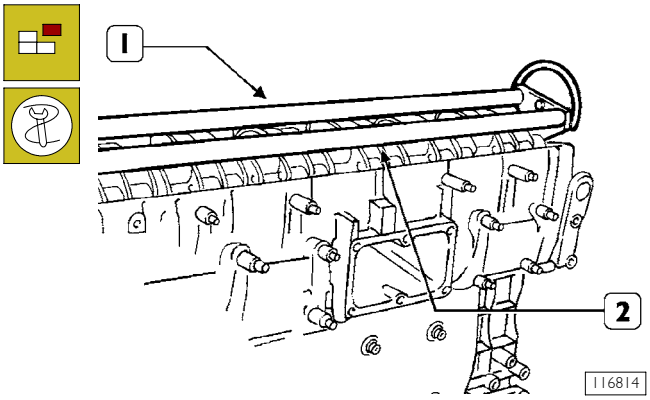
Loosen and remove the screws (1).
Remove the intermediate gear support shaft. .

Figure 38



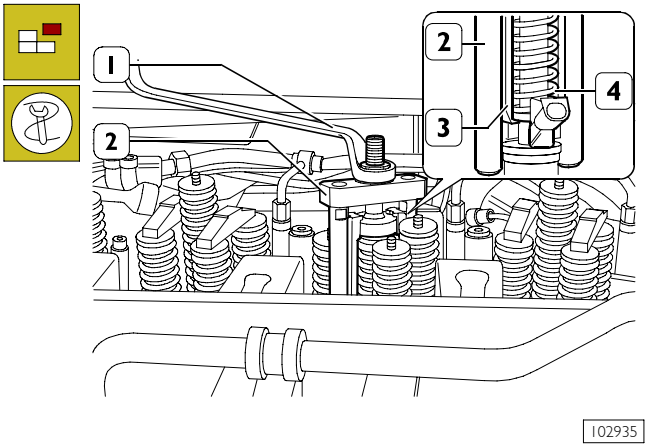
- ❑ Disconnect the electrical connections from the pump injectors.
- ❑ Unscrew the screws (1) fixing the rocker arm shaft.

Figure 39



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

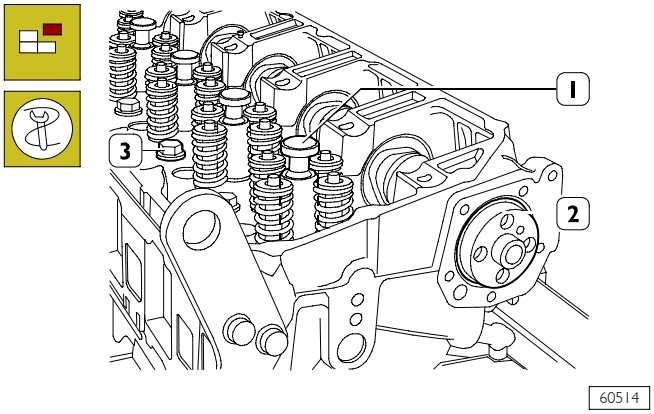
Figure 40



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

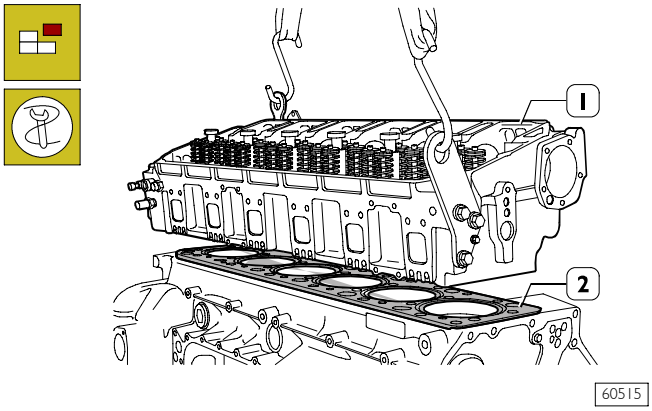
- ❑ Hook up the detail (3) of the tool illustrated in the figure to the injector pump (4);
- ❑ fit part (2) on part (3), resting the former on the cylinder head;
- ❑ tighten the nut (1) and extract the pump injector (4) from the engine block

Figure 41



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

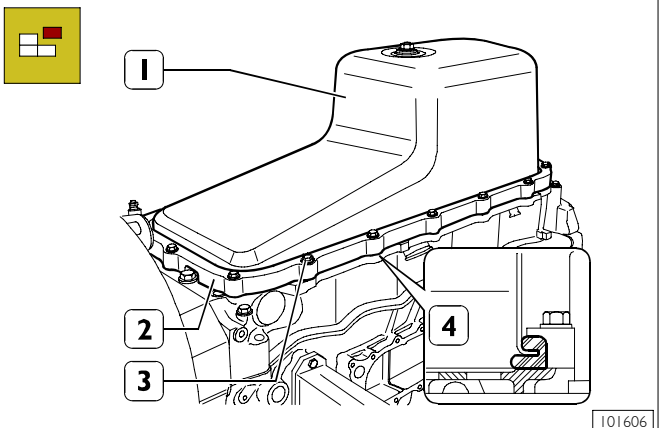
Figure 42



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

Only for F3BC0684A*E001 engine

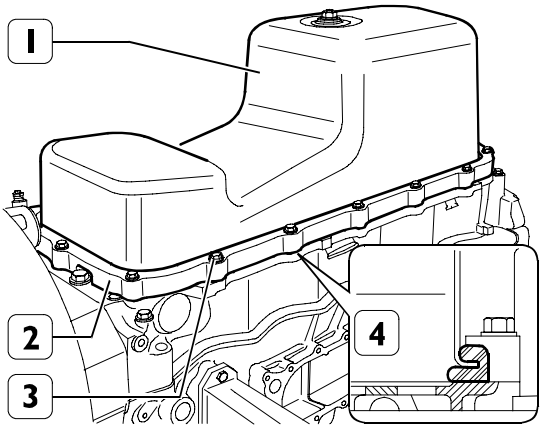
Figure 43



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

Only for F3BC0684A*E001 engine

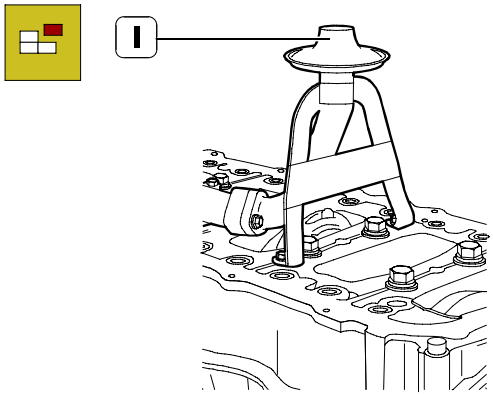
Figure 44



104784

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

Figure 45

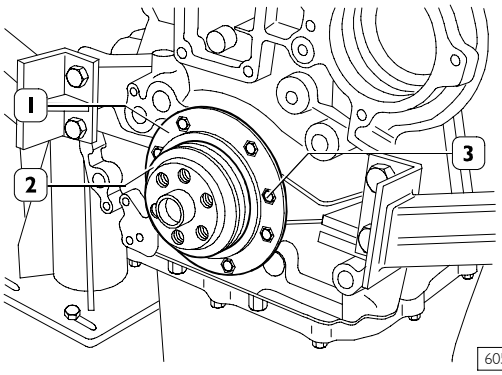


101607

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

Engine assembly

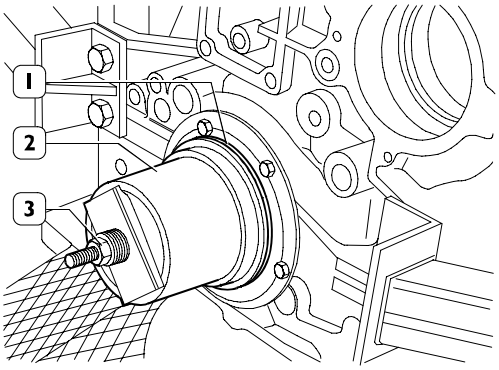
Figure 46



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).

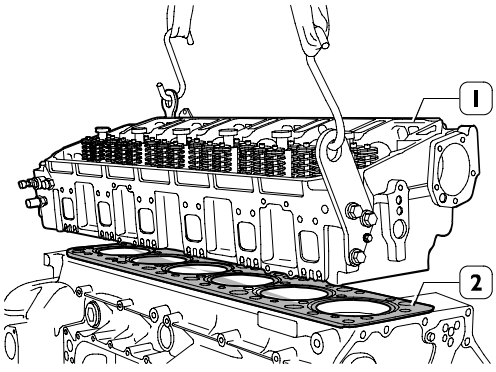
Figure 47



60564

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

Figure 48

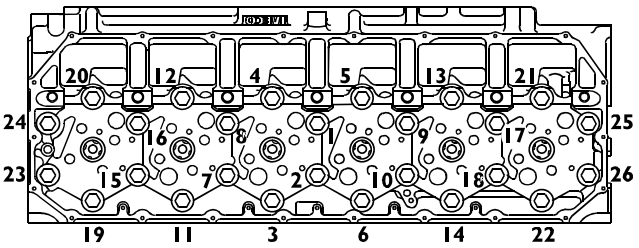


60515

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. 43 - 44 - 45.

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

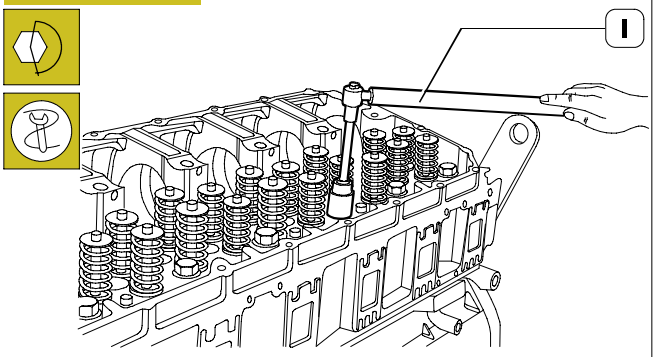
Figure 49



61270

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

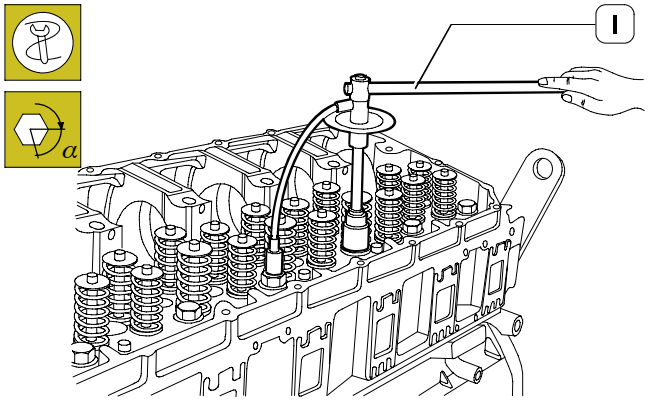
Figure 50



60565

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

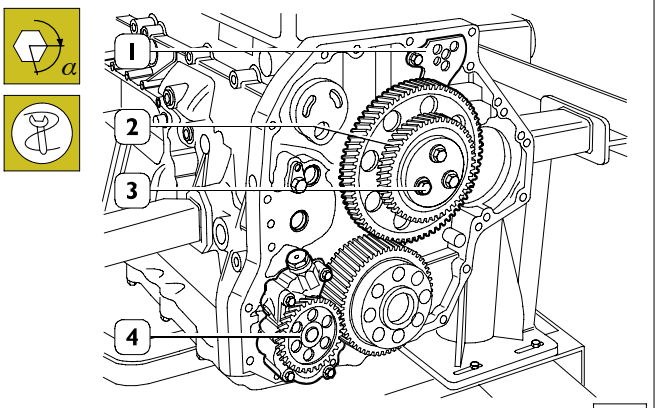
Figure 51



60566

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

Figure 52



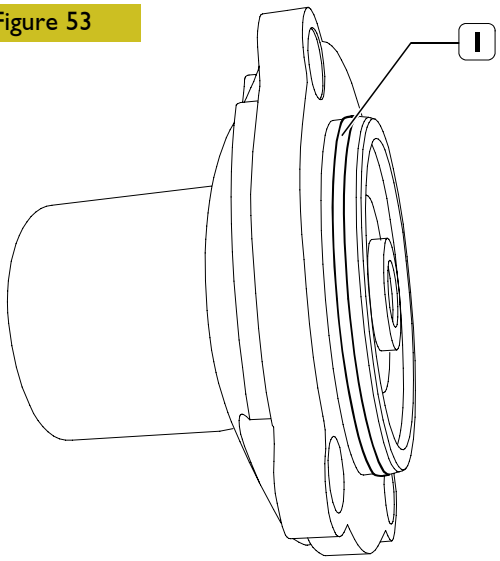
60567

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°.

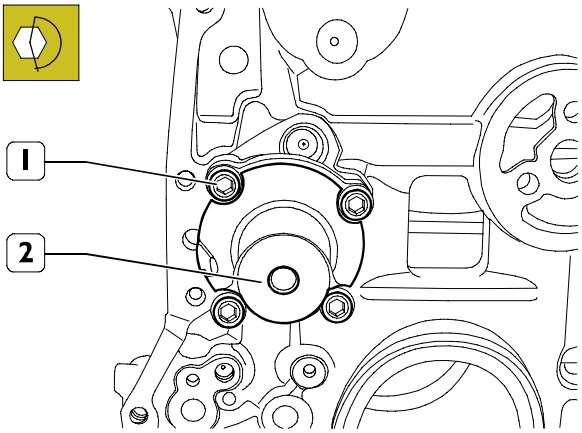
Figure 53



119495

Replace the o-ring (1) if the support shaft of the intermediate gear was removed.

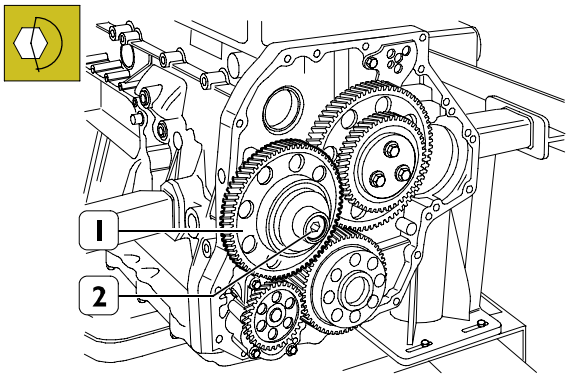
Figure 54



119493

Fit the support shaft (2) of the intermediate gear in its seat. Fasten the fastening screws (1) and tighten at a torque of 115 Nm.

Figure 55

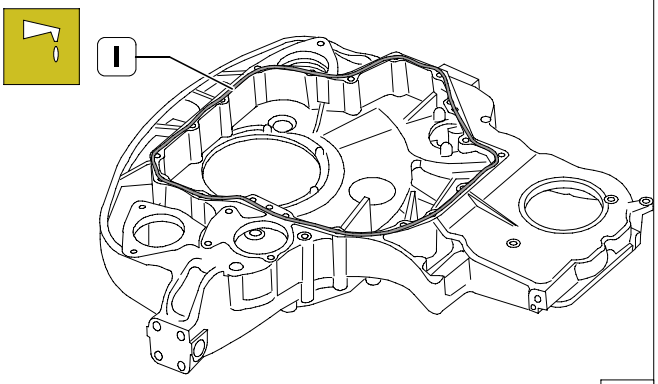


119496

Fit the intermediate gear (1) on the support shaft. Fasten the fastening screws (2) and tighten at a torque of 115 Nm.

Only for F3BC0684B*E003 engine

Figure 56



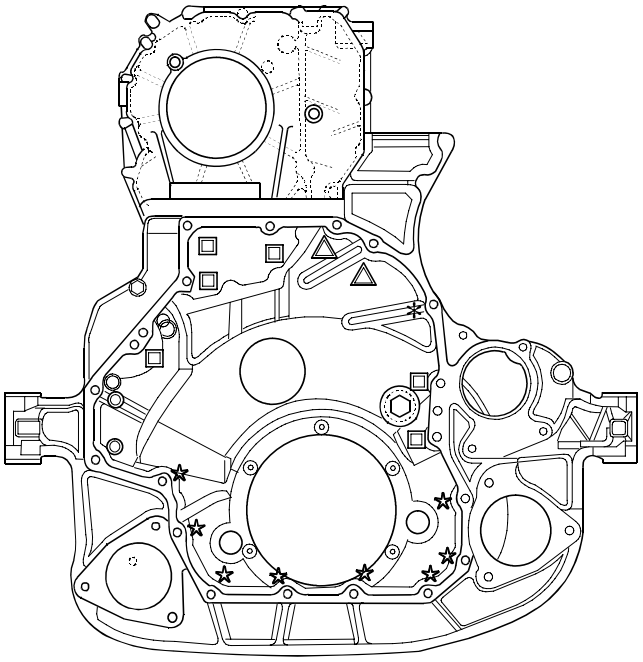
104311

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.

NOTE The assembly of the gear casing may be hindered by the intermediate gear. In this case, move the gear casing beyond the intermediate gear being careful not to damage the sealant on the part already fitted on the crankcase.

Figure 57

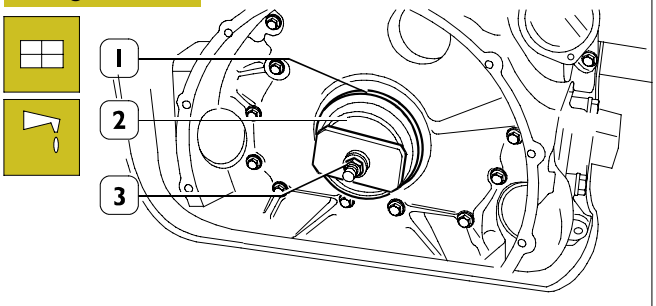


119497

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

✡	8 screws M12 x 1.75 x 100	63 Nm
◎	2 screws M12 x 1.75 x 160	63 Nm
◻	6 screws M12 x 1.75 x 35	63 Nm
△	2 screws M12 x 1.75 x 120	63 Nm
✳	1 screw M12 x 1.75 x 130	63 Nm

Figure 58

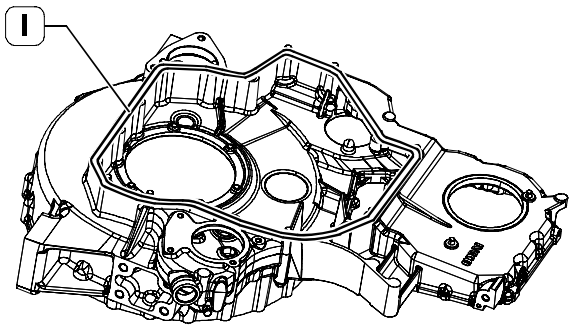


104282

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

Only for F3BC0684A*E001 engine

Figure 59



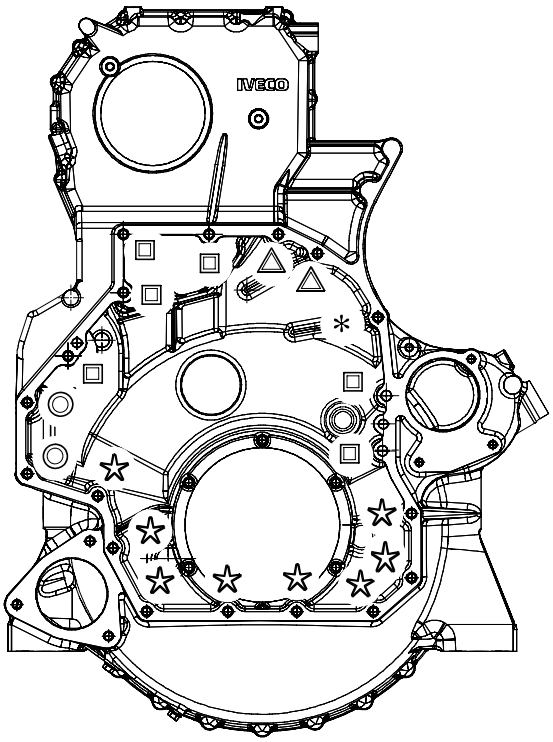
104785

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 $\pm^{0.5}_{0.2}$

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

NOTE The assembly of the gear casing may be hindered by the intermediate gear. In this case, move the gear casing beyond the intermediate gear being careful not to damage the sealant on the part already fitted on the crankcase.

Figure 60

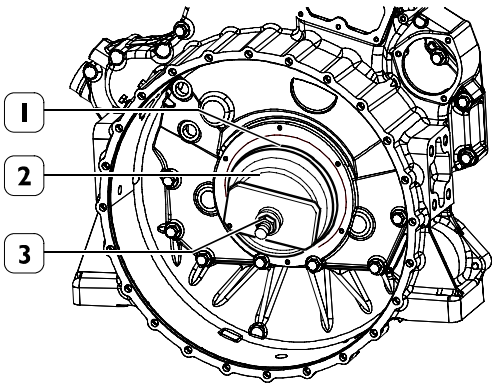


119498

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

✡	8 screws M12 x 1.75 x 100	63 Nm
◎	2 screws M12 x 1.75 x 160	63 Nm
❐	6 screws M12 x 1.75 x 35	63 Nm
△	2 screws M12 x 1.75 x 120	63 Nm
✳	1 screw M12 x 1.75 x 130	63 Nm

Figure 61



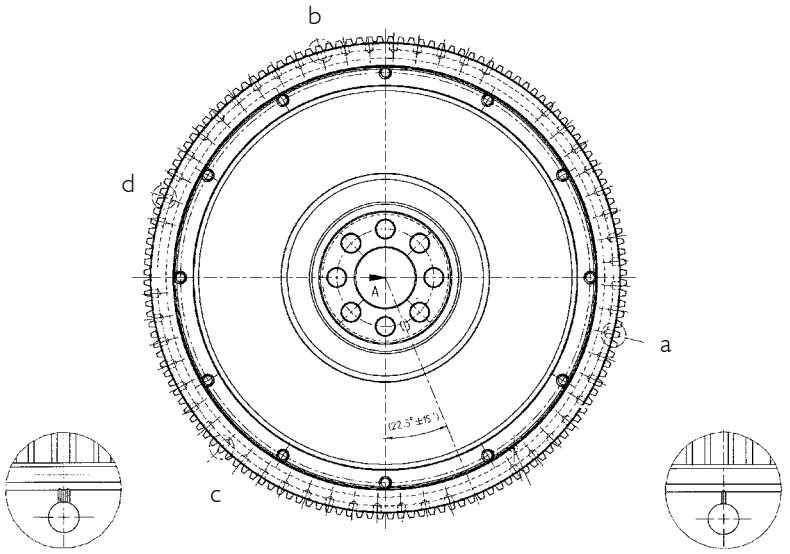
104787

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 F3CE0684B*E003 engines)

Figure 62



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.

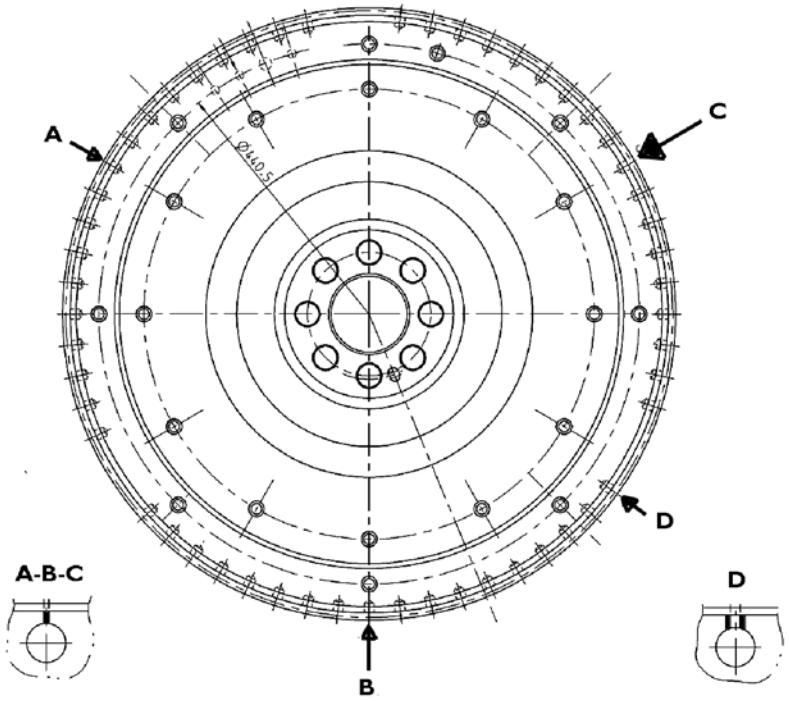
B = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6.

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 F3CE0684A*E001 engines)

Figure 63



DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS

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

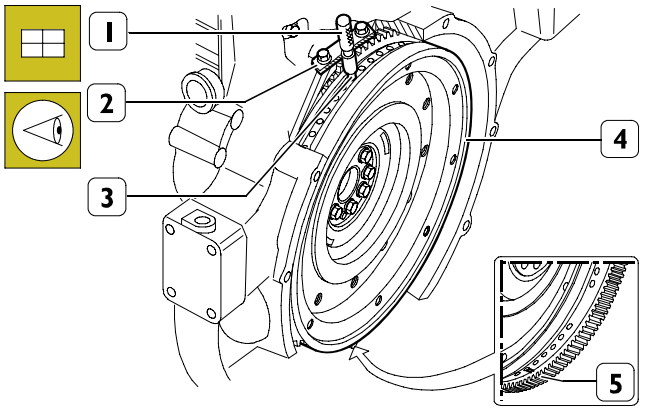
B = Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6.

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

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

Fitting camshaft

Figure 64



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

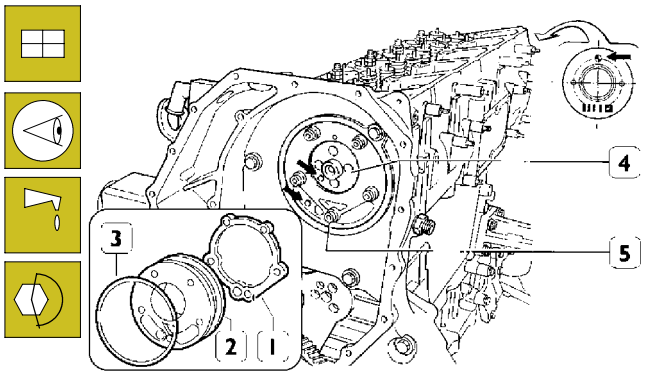
This situation occurs when:

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 65

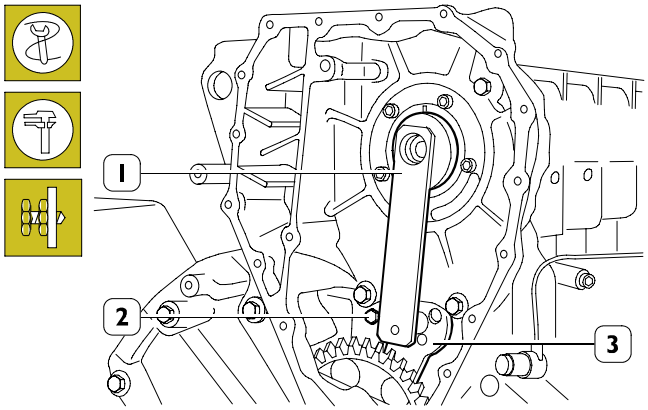


Fit the camshaft (4), positioning it observing the reference marks (→) as shown in the figure.

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

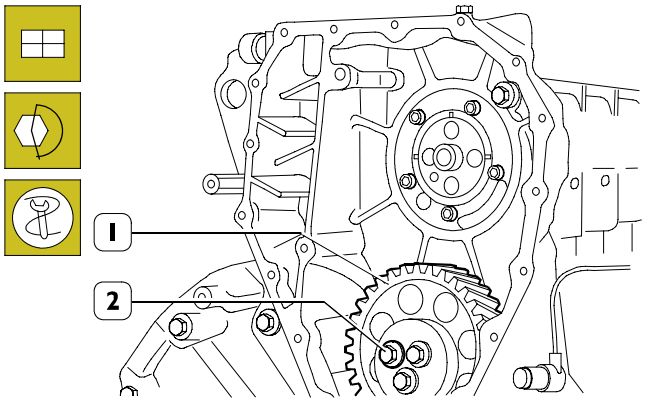
Mount the shoulder plate (2) with the sheet metal gasket (1) and tighten the screws (5) to the required torque.

Figure 66



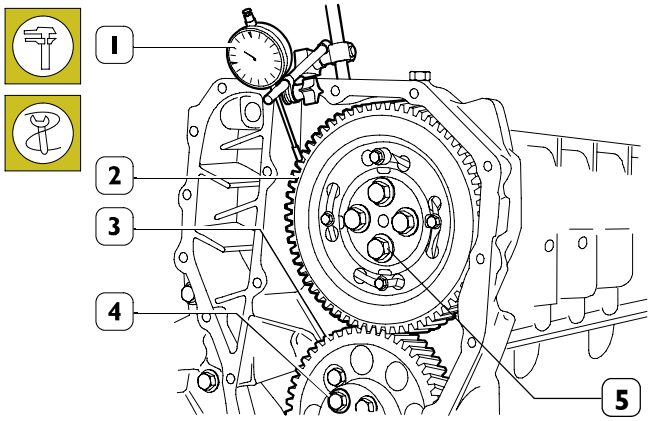
❑ Apply the gauge 99395219 (1). Check and adjust the position of the link rod (3) for the idle gear. Lock the screw (2) to the required torque.

Figure 67



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

Figure 68



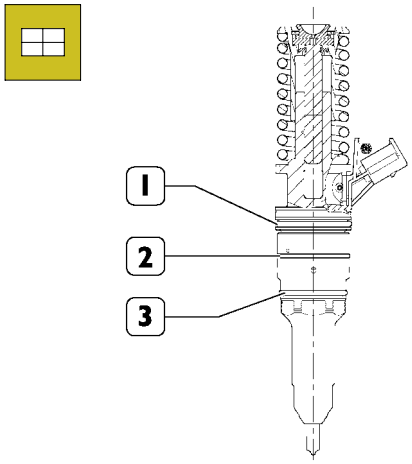
60572

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 65) fixing the link rod. Shift the link rod (3, Figure 65) to obtain the required clearance.
- ❑ Lock the screw (2, Figure 65) fixing the link rod and screws (4, Figure 68) fixing the idle gear to the required torque.

Fitting pump-injectors

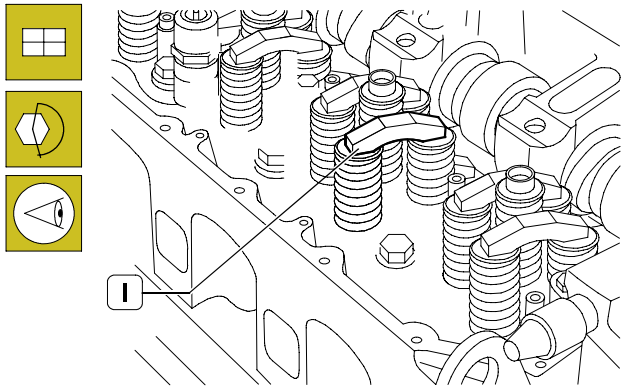
Figure 69



104243

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

Figure 70



104260

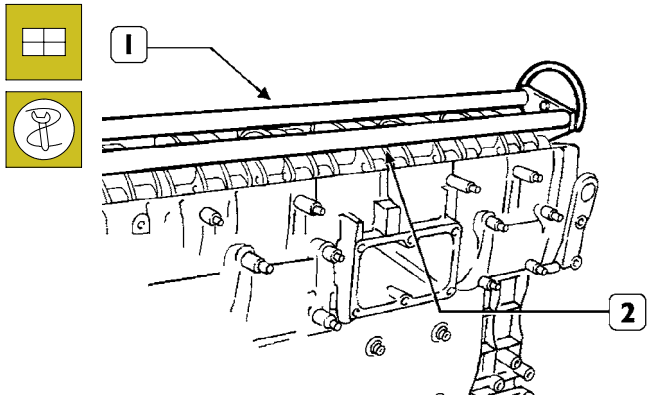
Mount:

- ❑ 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 71

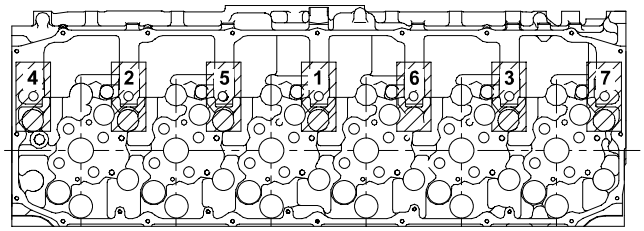
NOTE Before refitting the rocker-arm shaft assembly, make sure that all the adjustment screws have been fully unscrewed.



116814

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

Figure 72

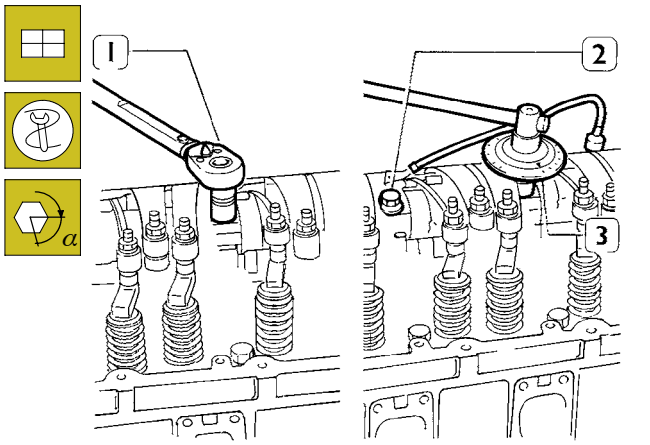


70567A

SCHEME OF SCREW TIGHTENING SEQUENCE SECURING ROCKER ARMS

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

Figure 73



104261

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

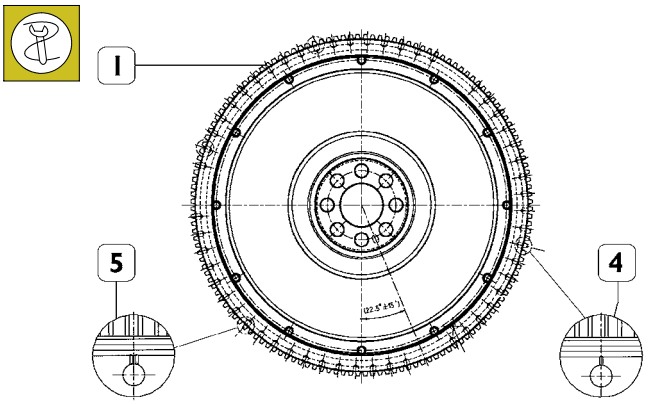
- ❑ 1st phase: tightening to a torque of 80 Nm (8 kgm) with the torque wrench (1);
- ❑ 2nd phase: closing with an angle of 60° using the tool 99395216 (3).

Mount the electric wiring on the electro-injectors.

Camshaft timing

(For F3CE0684B*E003)

Figure 74



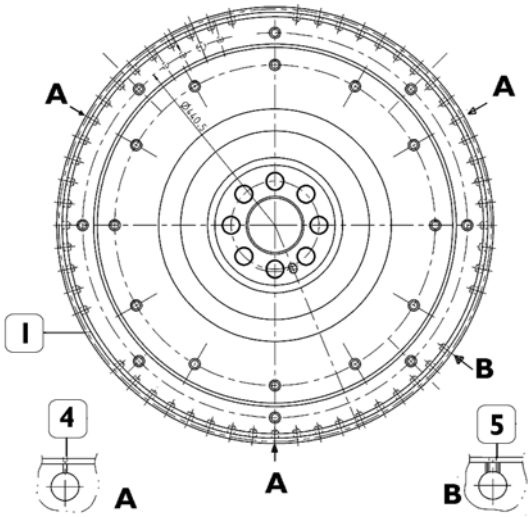
104316

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

Camshaft timing

(For F3CE0684A*E001)

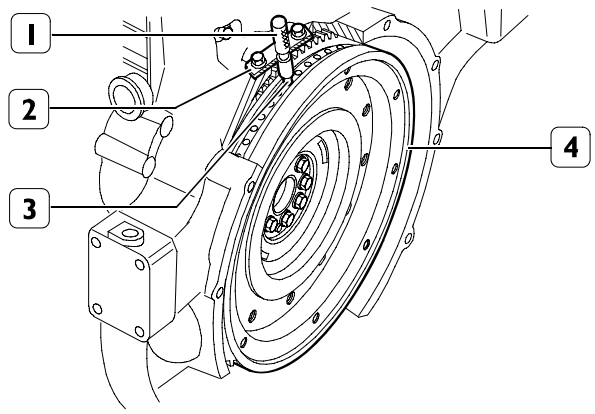
Figure 75



104789

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

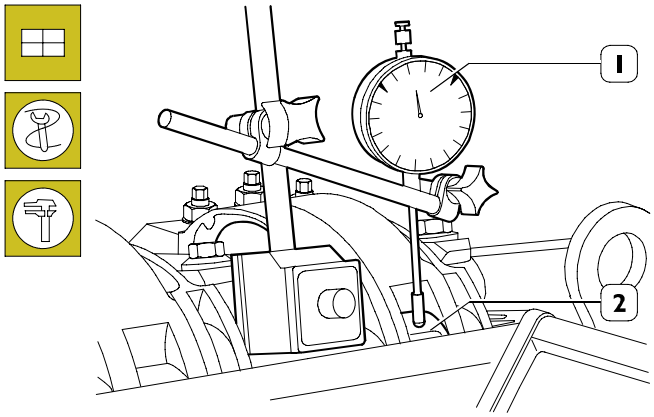
Figure 76



104288

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

Figure 77



60573

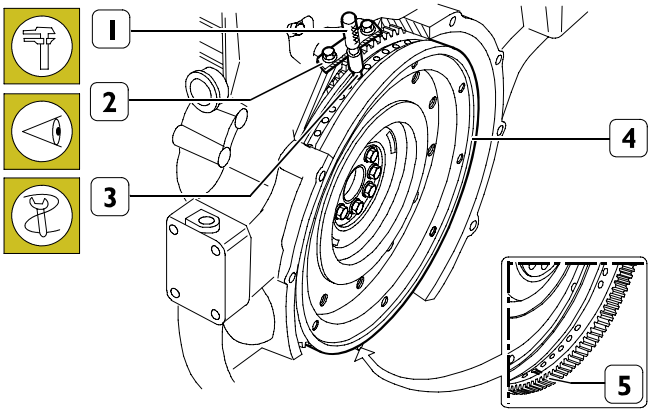
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

With tool 99360321, 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 5.31 ±0.05 mm.

Figure 78

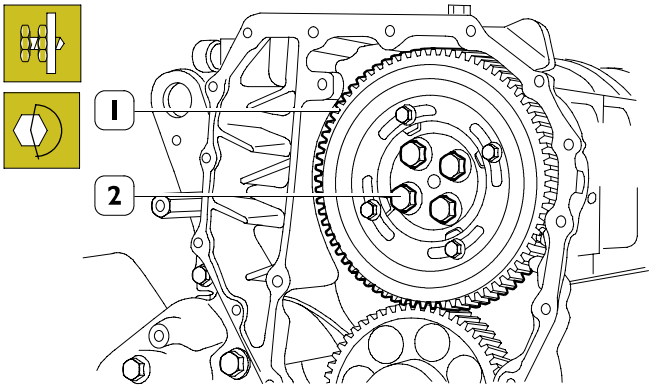


104286

The camshaft is in step if at the cam lift values of 5.31 ±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 79



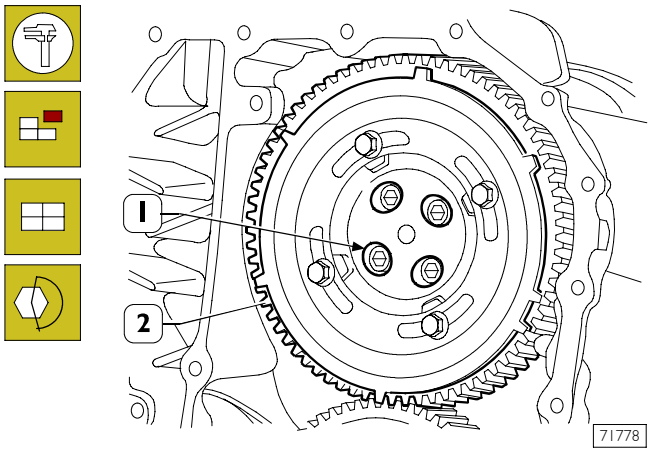
60575

If you do not obtain the conditions illustrated in Figure 78 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 80) on the gear (1);
2) turn the engine flywheel appropriately so as to bring about the conditions described in points 1 and 2 Figure 78, it being understood that the cam lift must not change at all;
3) lock the screws (2) and repeat the check as described above.

Tighten the screws (2) to the required torque.

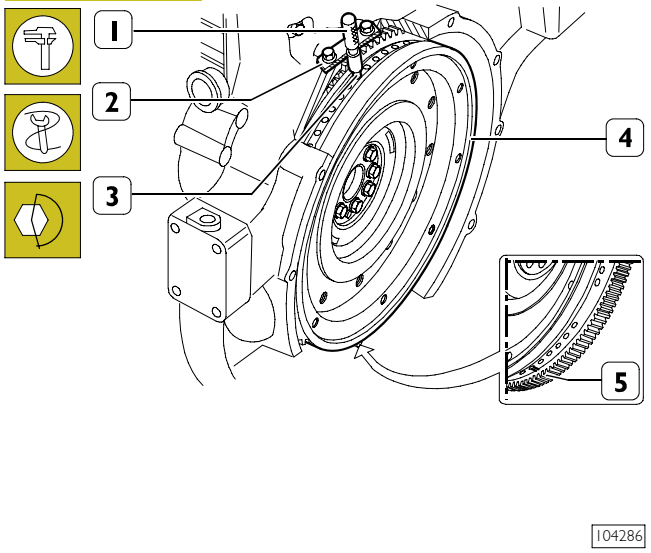
Figure 80



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 79) 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 5.31 ± 0.05 mm;
3) take out the screws (2, Figure 79) and remove the gear (1) from the camshaft.

Figure 81



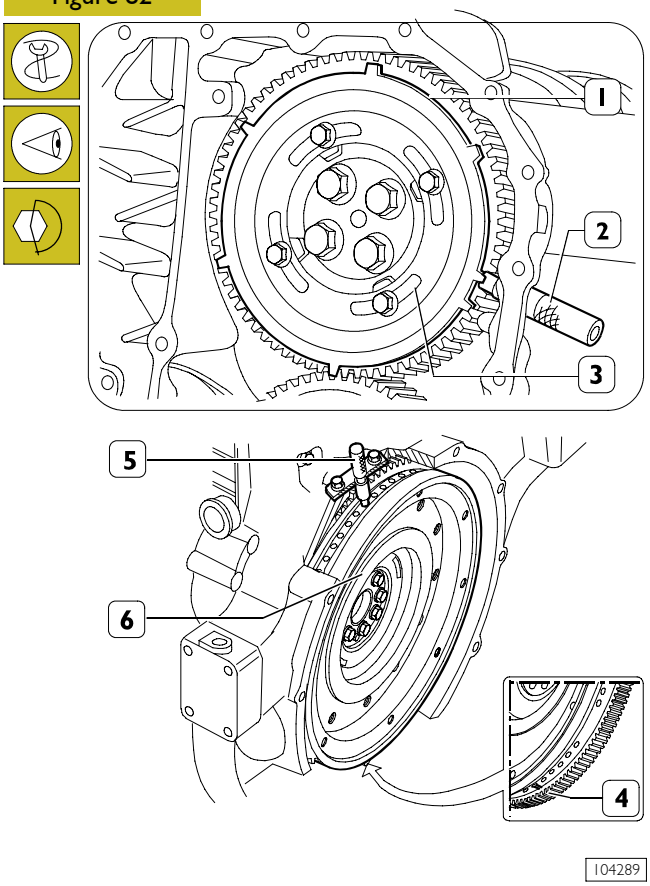
Turn the flywheel (4) again to bring about the following conditions:

- ❑ 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 80 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 5.31 ± 0.05.
Check the timing conditions described in Figure 78.

Phonic wheel timing

Figure 82



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.

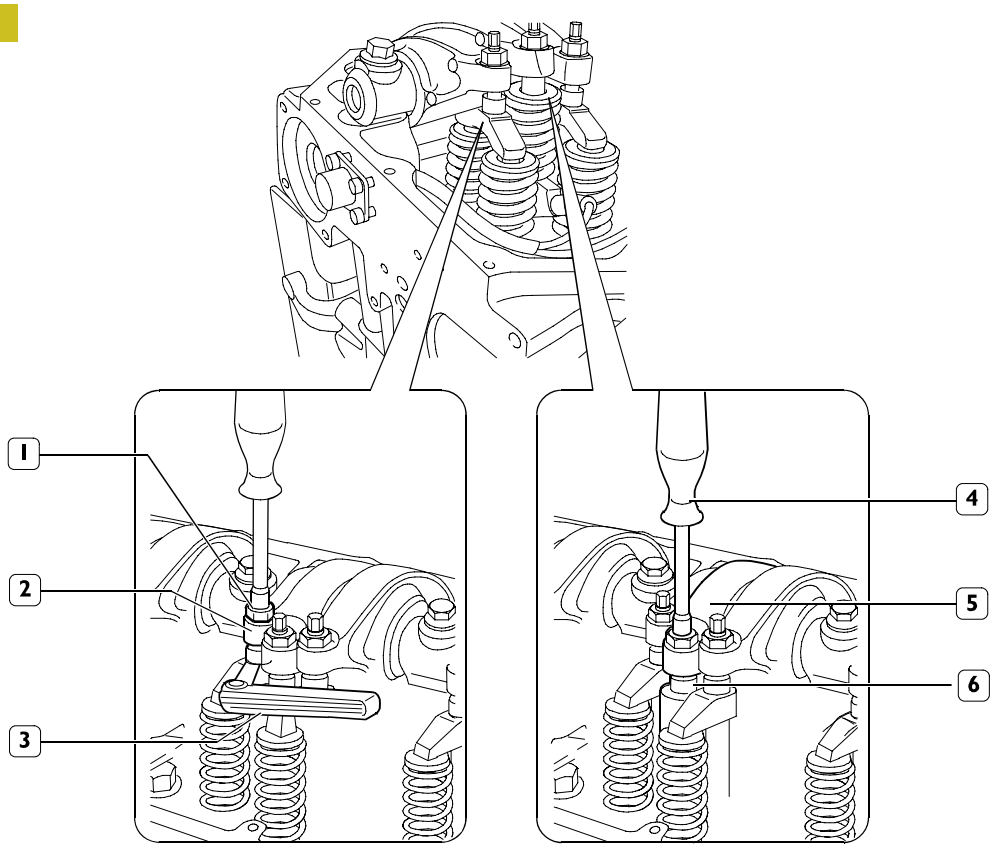
Again turn the flywheel in its normal direction of rotation until you see the hole marked with the double notch (4) through the inspection hole under the flywheel housing. Insert tool 99360612 (5) into the seat of the flywheel sensor (6).

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 83



ADJUSTING INTAKE/EXHAUST ROCKERS AND INJECTION

Adjustment of clearances between rockers and valve studs and preloading of pump injector rockers should be carried out with extreme care.
Bring the cylinder under examination to the firing stage, the valves of this cylinder remain closed while the valves of the other cylinder in the pair can be adjusted.
The cylinder pairs are 1-6,2-5,3-4.
Strictly adhere to directions and data given on the table below.

Adjusting clearances between rockers and intake/exhaust/valve studs:

- ❑ Use a box wrench to loosen the adjusting screw locking nut (1).
- ❑ Insert the feeler gauge blade (3).
- ❑ Use a suitable wrench to screw the adjusting screw in or out as required.
- ❑ Ensure the feeler gauge blade (3) can slide between the parts concerned with a slight friction.
- ❑ Hold the screw still while tightening the nut (1).

Setting pump-injector rocker preloading:

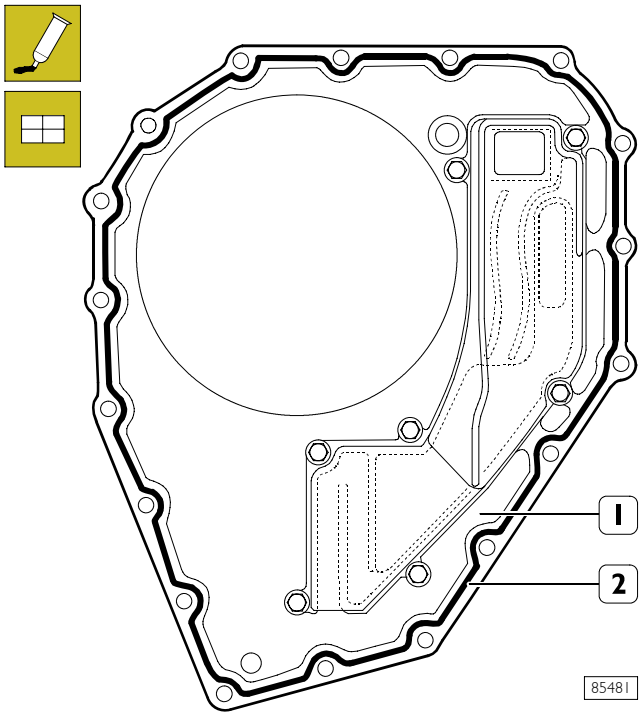
- ❑ Use a box wrench to loosen the nut fastening the adjusting screw for rocker arm (5) controlling pump-injector (6).
- ❑ With a suitable wrench (4) tighten the adjusting screw until the pumping element reaches its-end-of-stroke point.
- ❑ Lock the adjusting screw to a torque of 5 Nm (0.5 kgm) by means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

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

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

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.

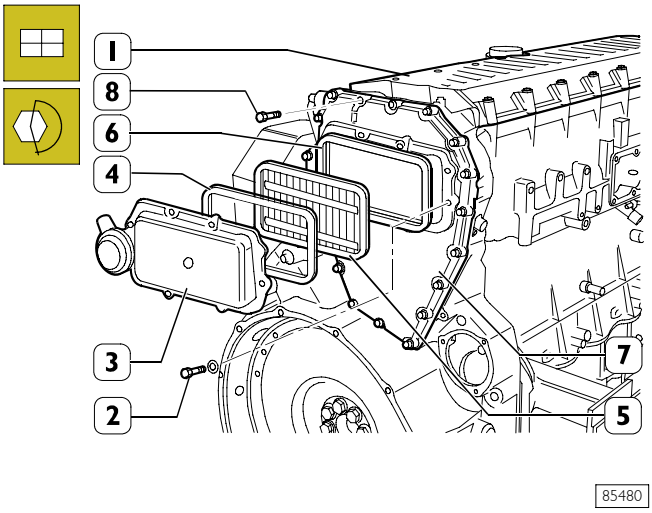
Figure 84



Apply LOCTITE 5970 on the breather body (1) forming a bead (2) as shown in figure Ø 1,5 $^{0,5}_{0,2}$

NOTE Fit the breather body (1) within 10 after applying the sealant.

Figure 85



Fit the timing cover (1).

Tighten the fastening screws on the rocker arm cover (1) in the order shown in figure 79.

Fit the blow-by casing (7) with corresponding seal and tighten the screws (8) at the specified torque.
Fit the filter (5) with the corresponding seals (4 and 6).

The one-way filter (5) must be fitted with the two reinforcement bars visible as shown in the figure.

Fasten the cover (3) and fasten the screws (2) at the specified torque.

Figure 86

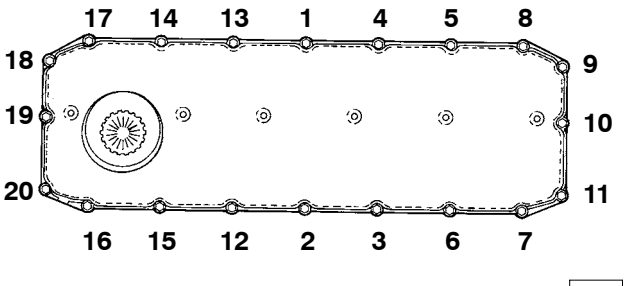
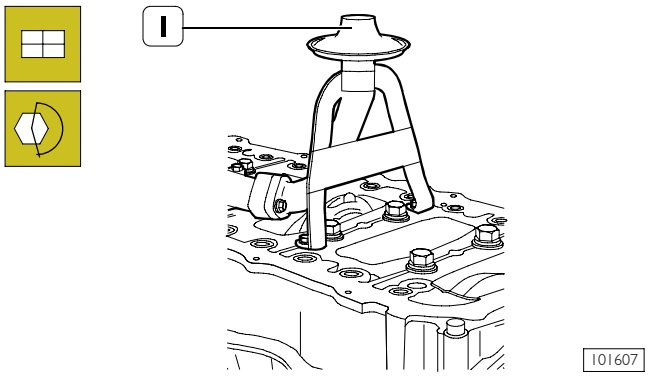


DIAGRAM OF ROCKER ARM CAP FIXING SCREWS TIGHTENING SEQUENCE

ENGINE COMPLETION

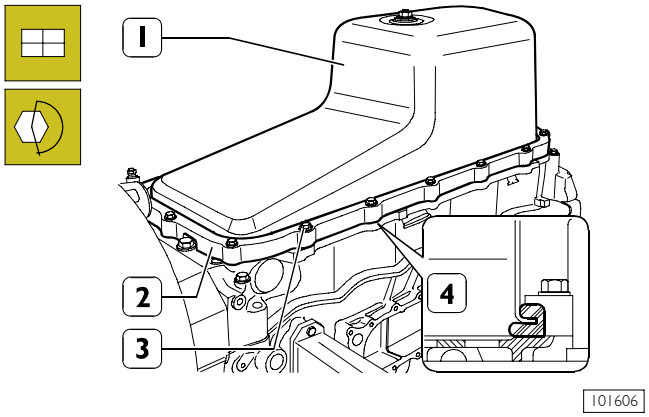
Figure 87



Fit the suction rose (1) and tighten the fastening screws at the specified torque.

Only for engine F3CE0684A*E001

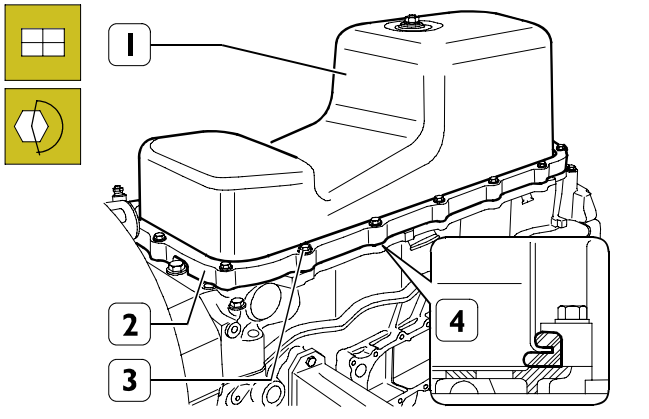
Figure 88



Arrange the seal (4) on the oil sump (1), arrange the shim (2), fit the sump on the crankcase and tighten the screws (3) at the specified torque.

Only for engine F3CE0684B*E003

Figure 89



Arrange the seal (4) on the oil sump (1), arrange the shim (2), fit the sump on the crankcase and tighten the screws (3) at the specified torque.

Figure 90

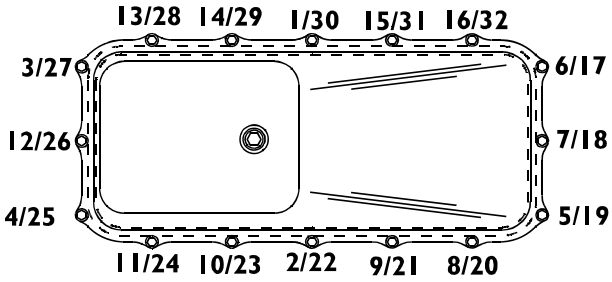
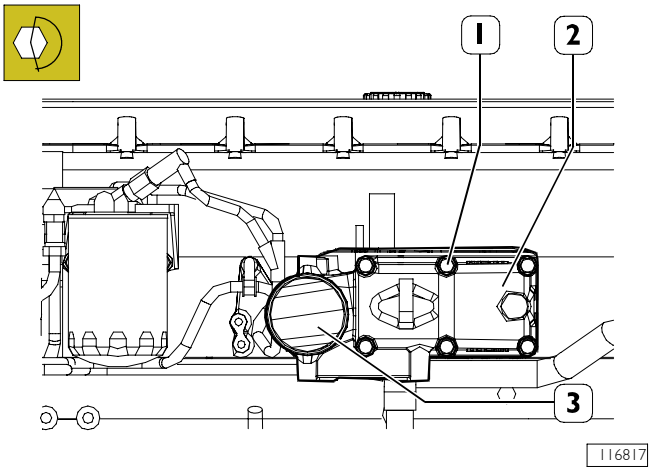


DIAGRAM OF ENGINE OIL SUMP FIXING SCREWS TIGHTENING SEQUENCE

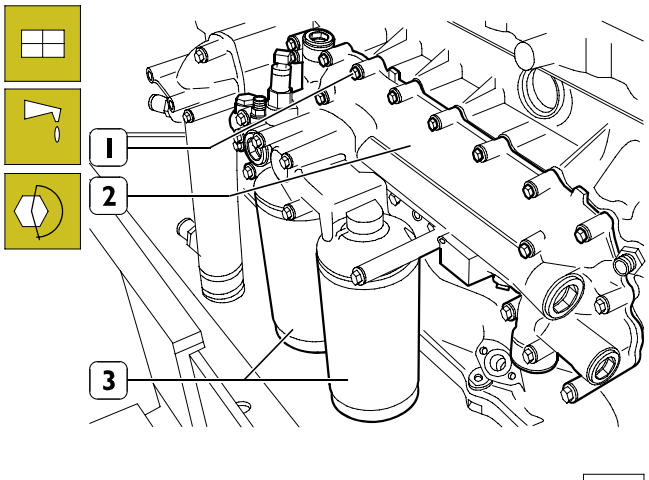
Figure 91



Fasten the intake manifold (1) and tighten the screws (2) at the specified torque.

NOTE The inlet fitting may have different positions according to the engine type.

Figure 92



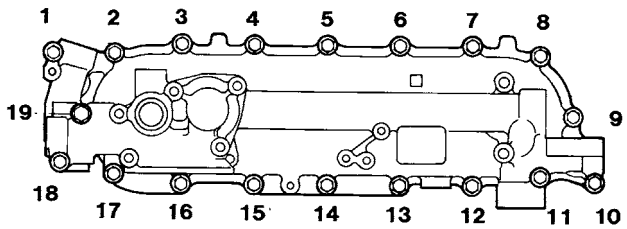
101605

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 92.

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.

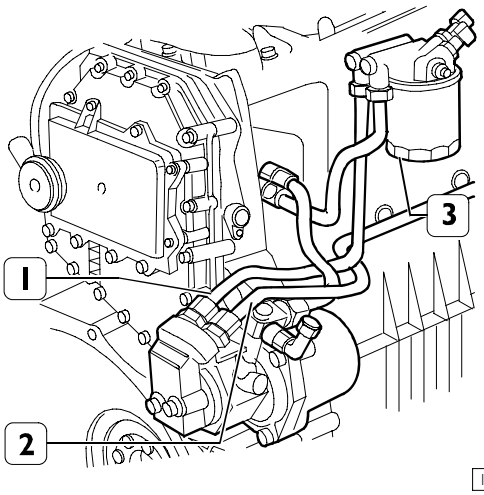
Figure 93



45361

DIAGRAM OF HEAT EXCHANGER FIXING SCREWS TIGHTENING SEQUENCE

Figure 94

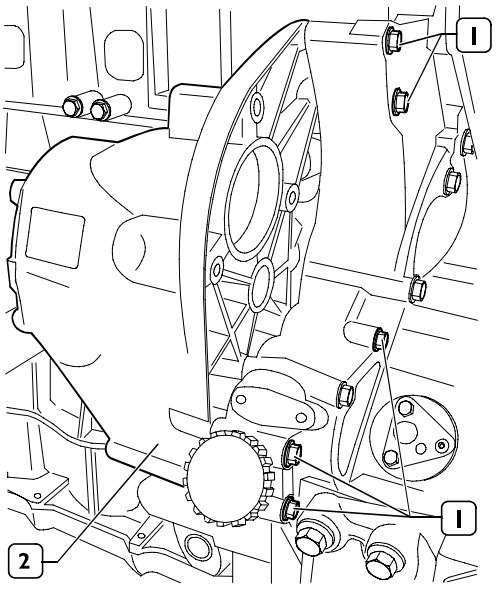


104254

Fit, with the respective gaskets.

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

Figure 95

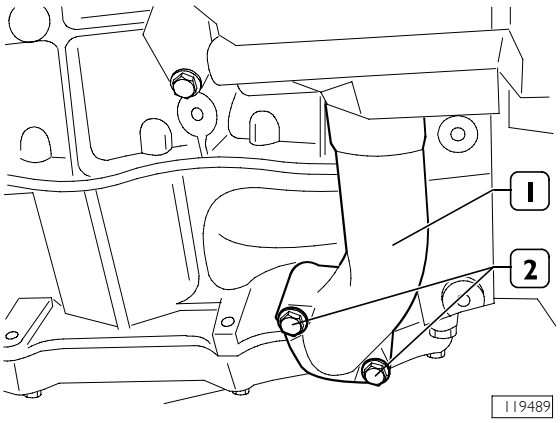


119490

Fit the hydraulic coupling (2) onto the flywheel casing.

Tighten the fastening screws (1).
Tighten the screws (1) at a torque of 45 Nm.

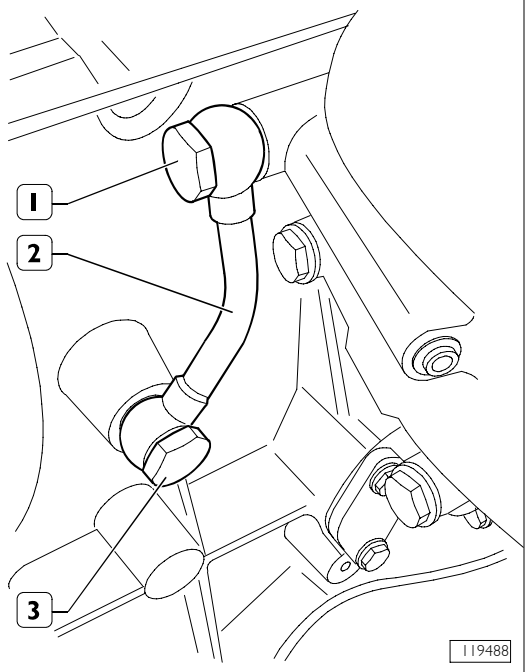
Figure 96



Fit the oil return pipe (1).

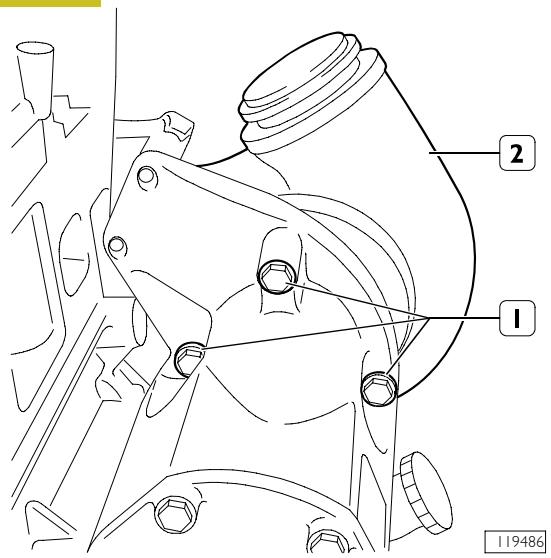
Fasten the screws (2) fastening the pipe (1) to the crankcase. Tighten the screws (2) at a torque of 23 Nm.

Figure 97



Fit the oil delivery pipe (2) to the hydraulic coupling fastening it with fittings (1) and (3).

Figure 98



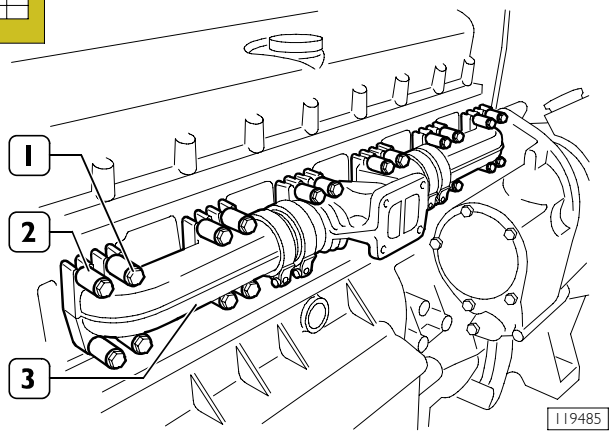
Fit the power turbine (2) onto the hydraulic coupling.

NOTE Lubricate the accommodation seat on the hydraulic coupling with Loctite AS600 before fitting the power turbine.

When fitting the power turbine on the hydraulic coupling, pay attention to the meshing of the gears which transmit motion from one element to the other.

Tighten the fastening screws (1).
Tighten the screws (1) at a torque of 40 Nm.

Figure 99

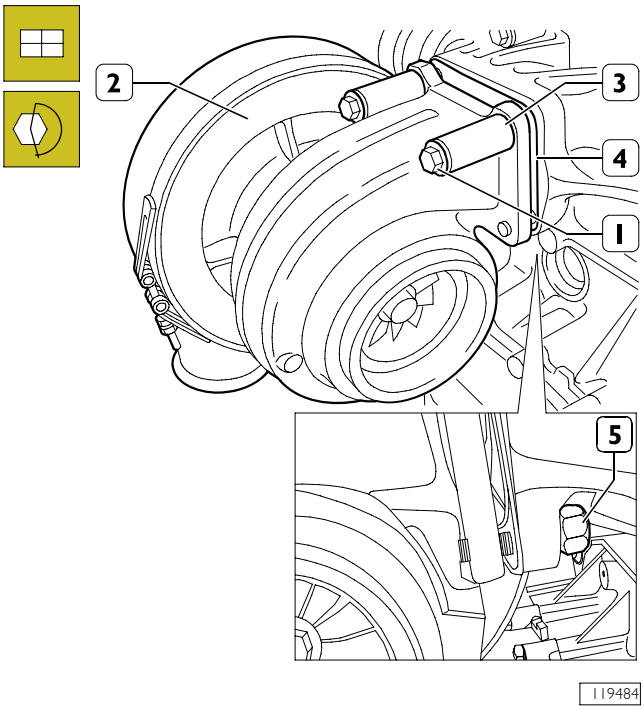


Fit the exhaust manifold.

NOTE Remove the seals between the exhaust manifold and the crankcase

Insert the seals (2) between the fastening screws (1) and the intake manifold.

Figure 100

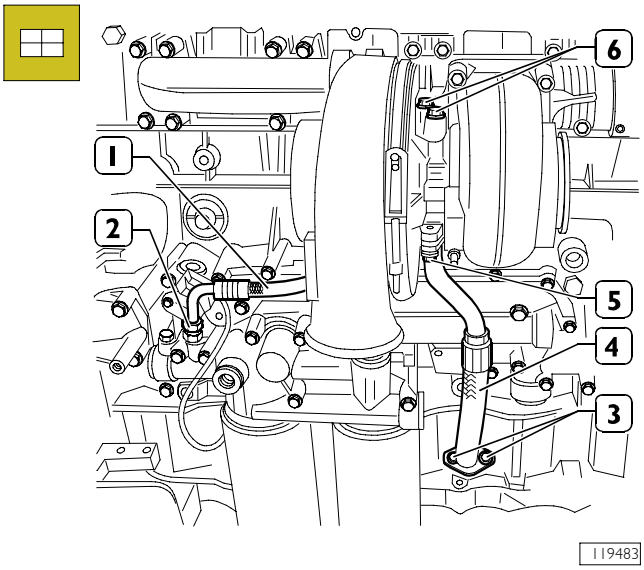


Fit the turbocharger (2) on the exhaust manifold making sure that the seal (4) is positioned between the two parts.

Position the shims (3) on the fastening screws (1) and tighten them at a torque of 70 Nm

Fasten the nuts (5) and tighten them at a torque of 45 Nm.

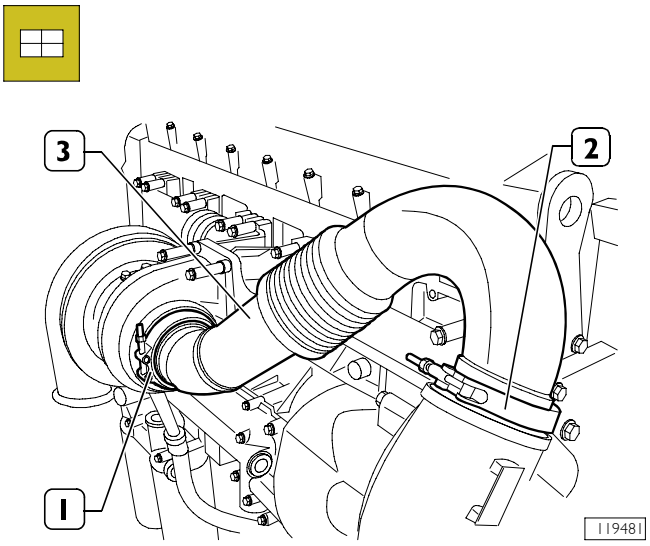
Figure 101



Fit the oil delivery pipe (1) onto the turbocharger and fasten with the fitting (2) on the filter unit and with the screws (6) to the turbocharger itself.

Insert the oil return pipe (4) in the crankcase and fasten it with the screws (3).
The fasten the pipe (4) to the turbocharger by means of the screws (5).

Figure 102

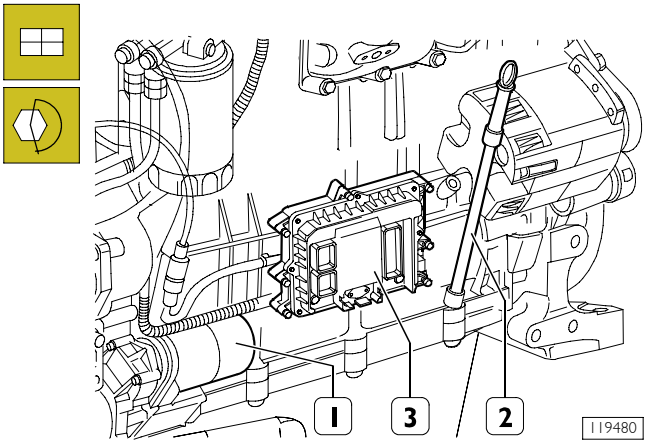


Position the clamps (1) and (2) respectively on the turbocharger and on the power turbine.

Fit the connection manifold (3) between turbocharger and power turbine.

Fasten the manifold to the two turbines by means of the clamps (1) and (2).

Figure 103



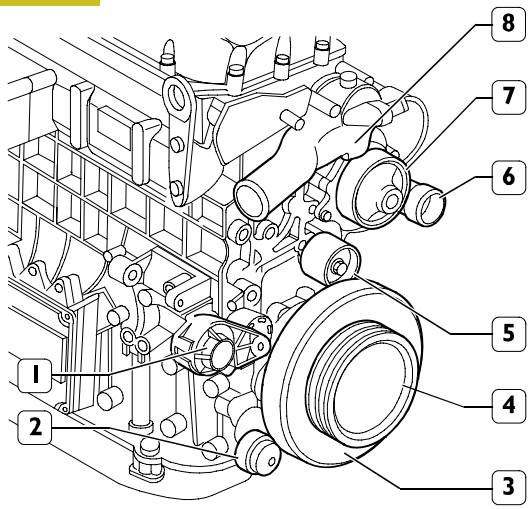
Tightening the fixing screws to the prescribed torque, mount:

- ❑ 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.

Only for engine: F3CE0684A*E001

Figure 104

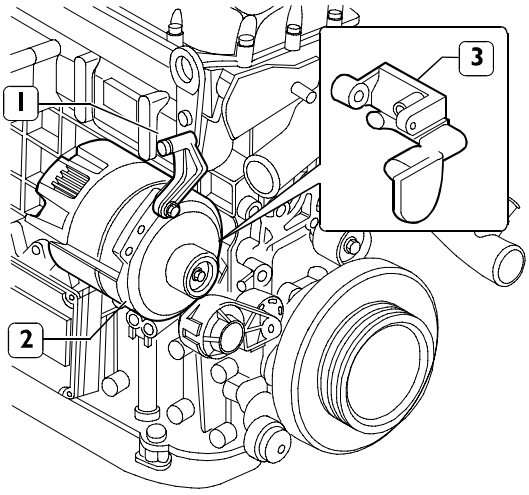


104251

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 105

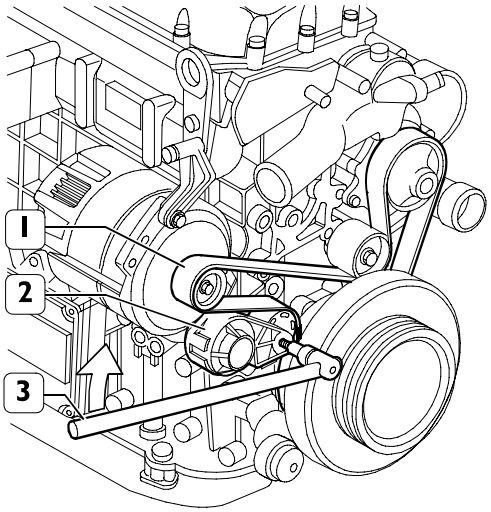


99360

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

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

Figure 106



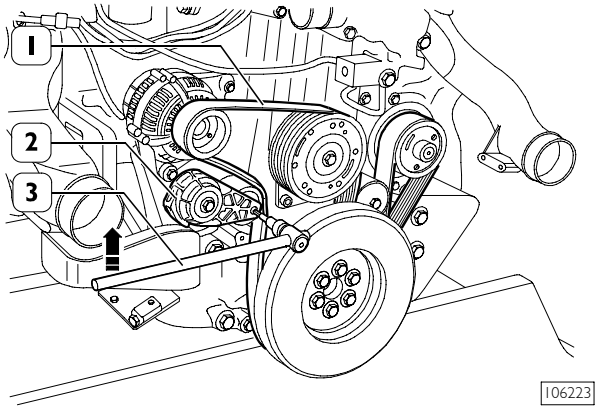
104249

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.

Only for engine: F3CE0684B*E003

Figure 107



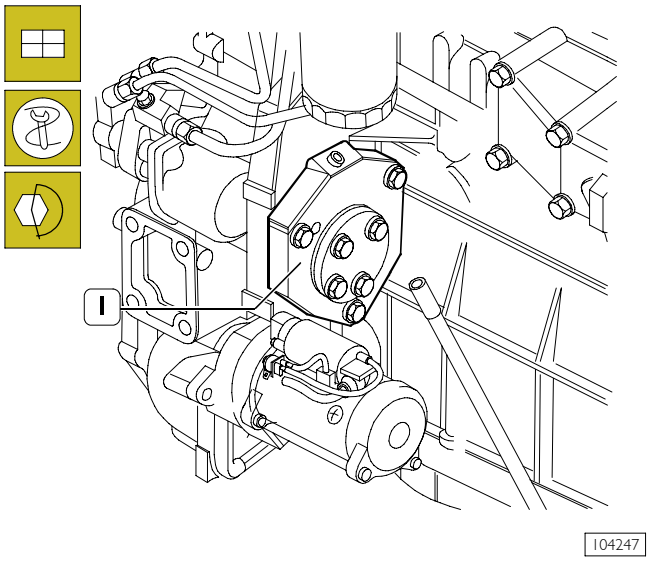
106223

- ❑ driving belt.

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

For all types

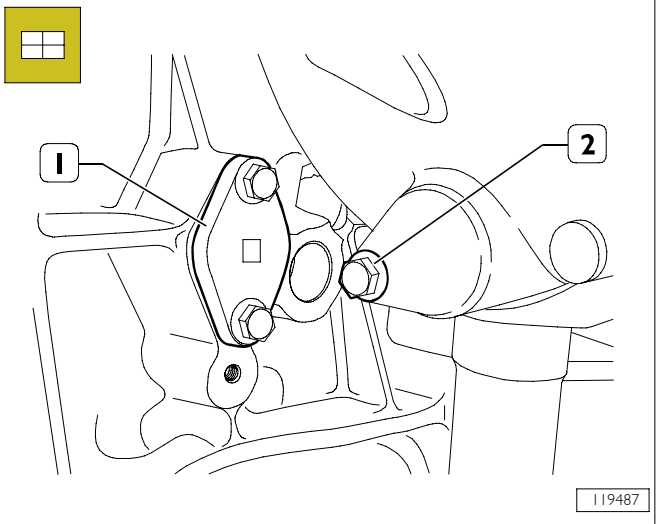
Figure 108



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;

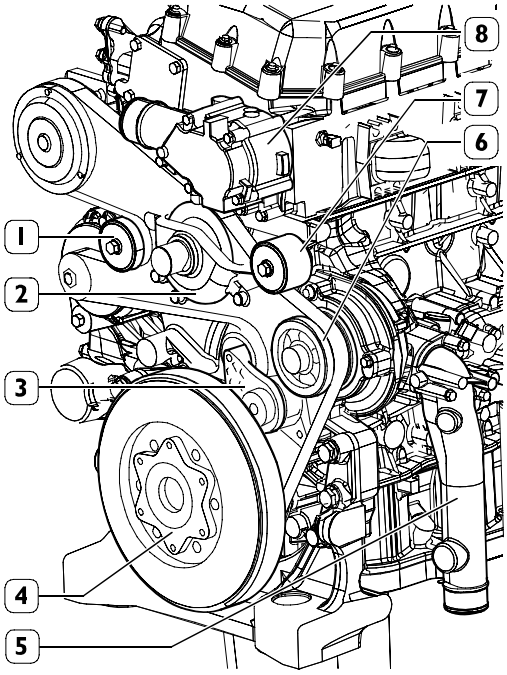
Figure 109



Mount the oil pressure adjuster valve (1).
Fasten and tighten the screw (2) fastening the hydraulic coupling to the flywheel casing.

Only for F3CE0684B*E003

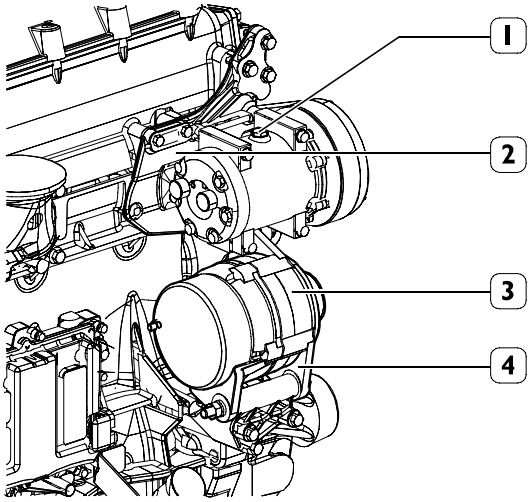
Figure 110



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).

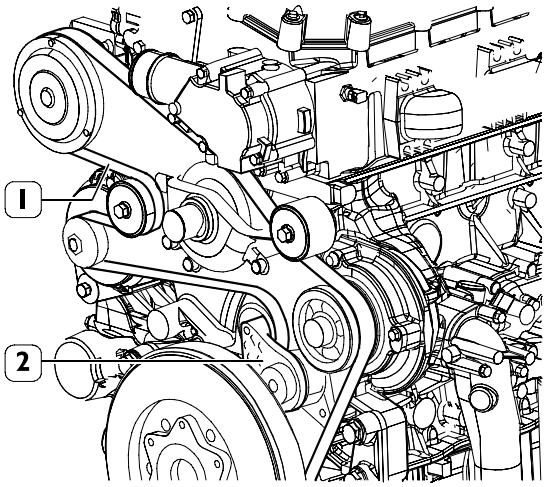
Figure 111



104781

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

Figure 112



104780

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

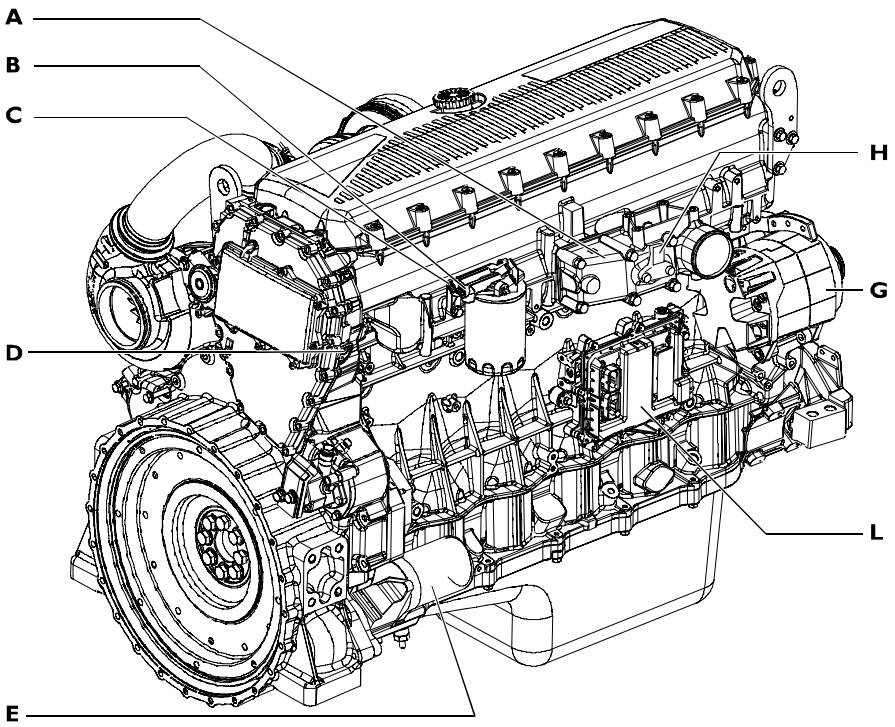
The belt tighteners are of the automatic type and so no further adjustment is required after assembly.

PART TWO -

ELECTRICAL EQUIPMENT

Components on the engine F3CE0684A*E001

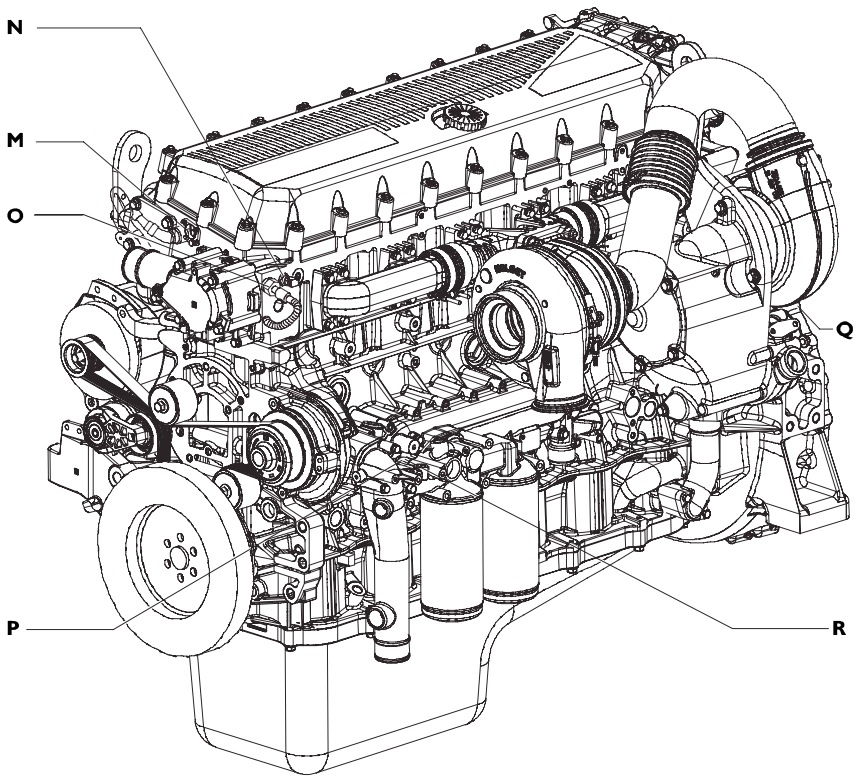
Figure 1



ENGINE RIGHT-HAND SIDE VIEW

110586

Figure 2



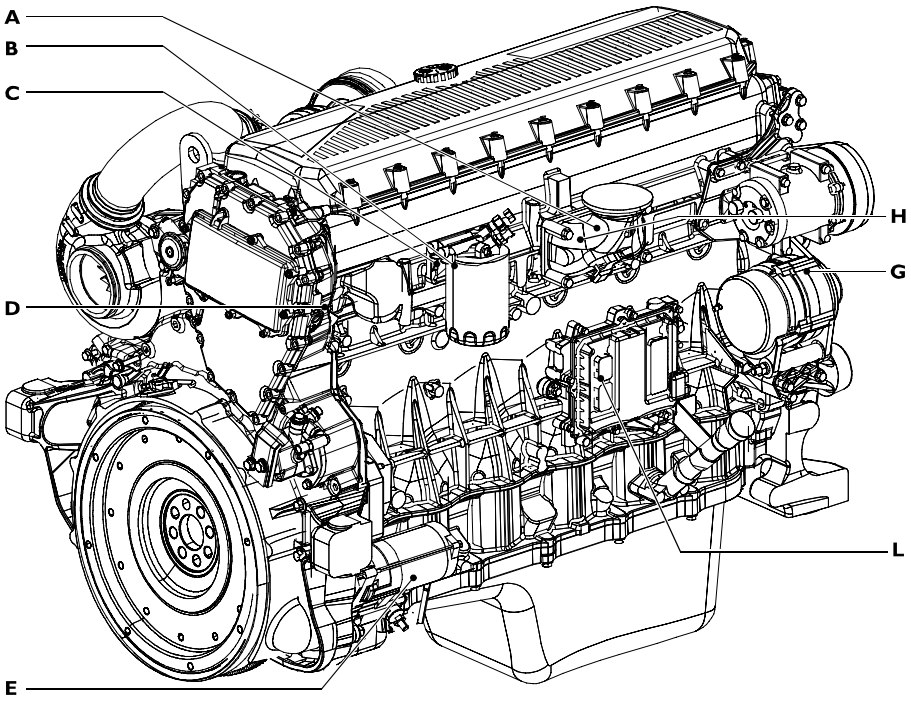
110585

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 F3CE0684B*E003

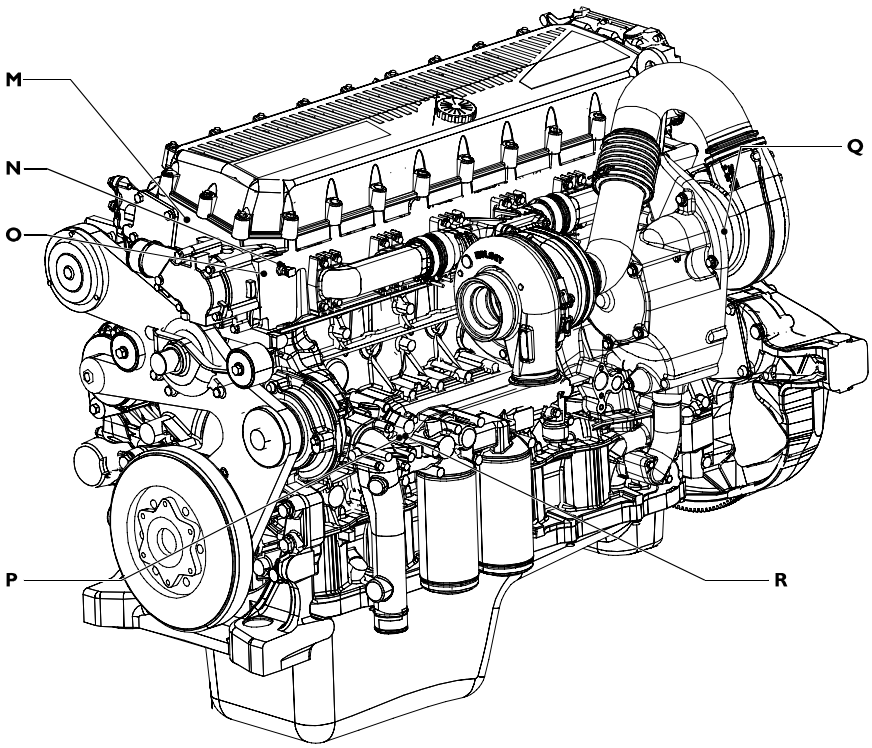
Figure 3



ENGINE RIGHT-HAND SIDE VIEW

110593

Figure 4



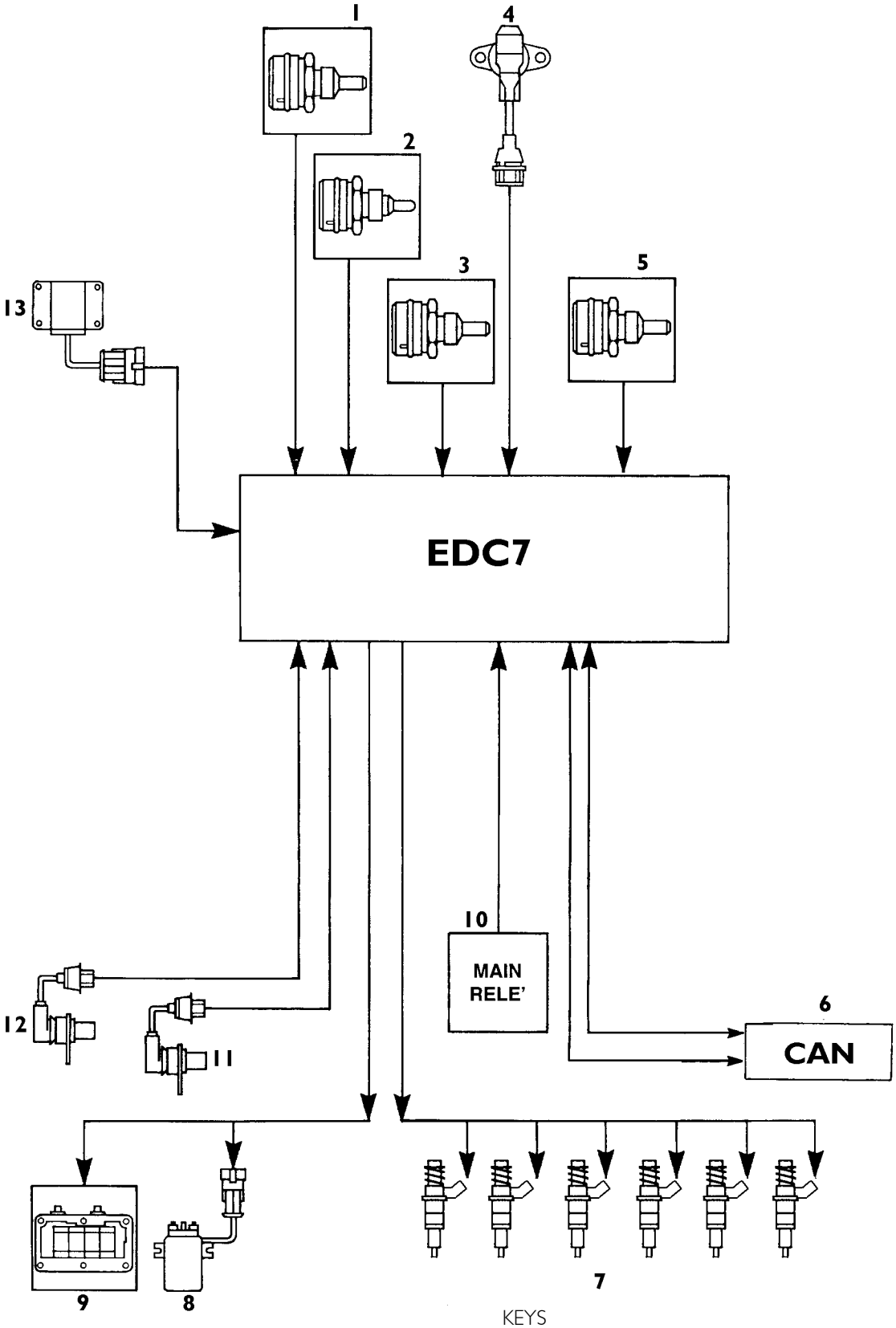
ENGINE LEFT-HAND SIDE VIEW

110592

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 5

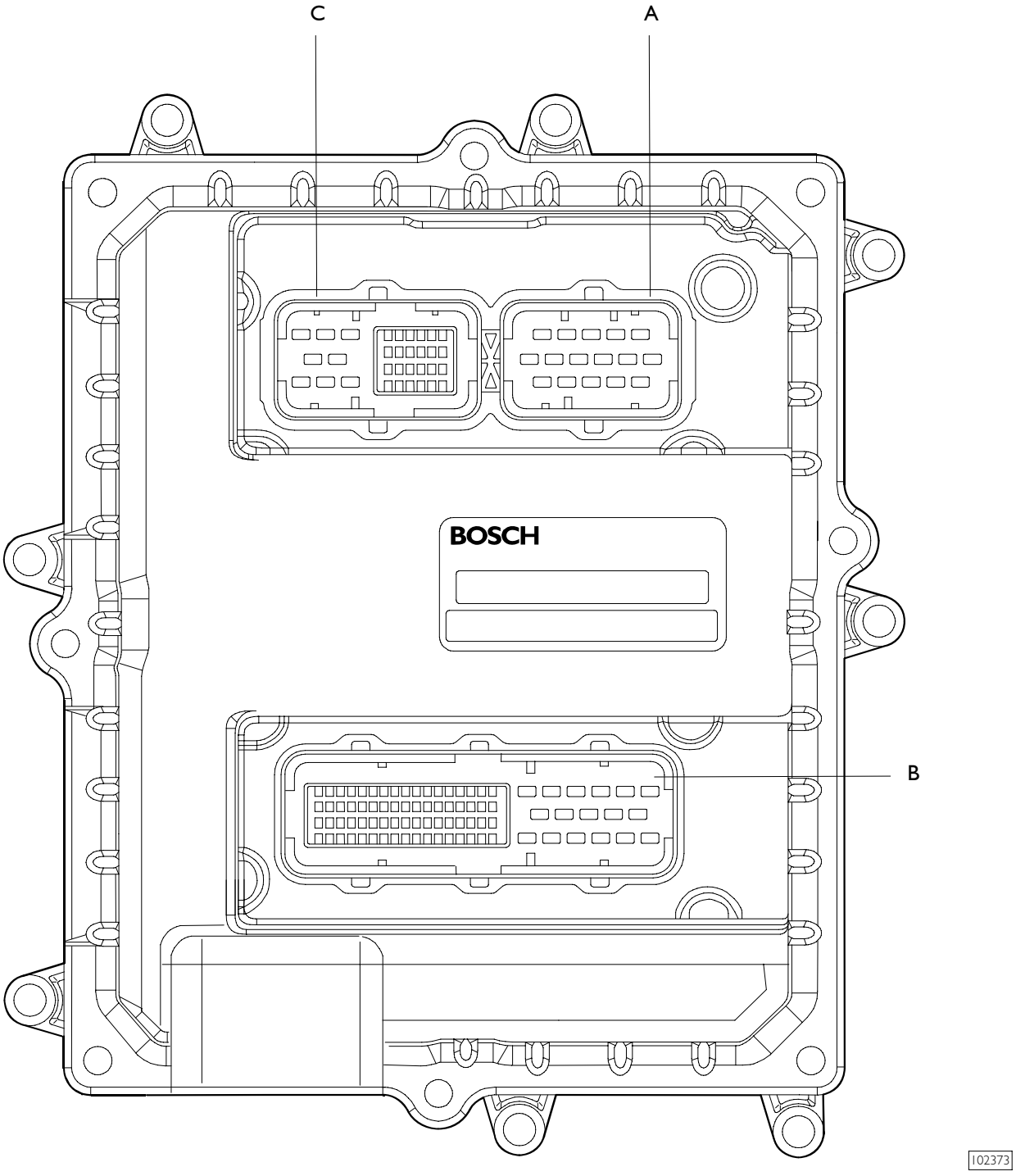


KEYS

1. Engine coolant temperature sensor – 2. Oversupply air 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 6

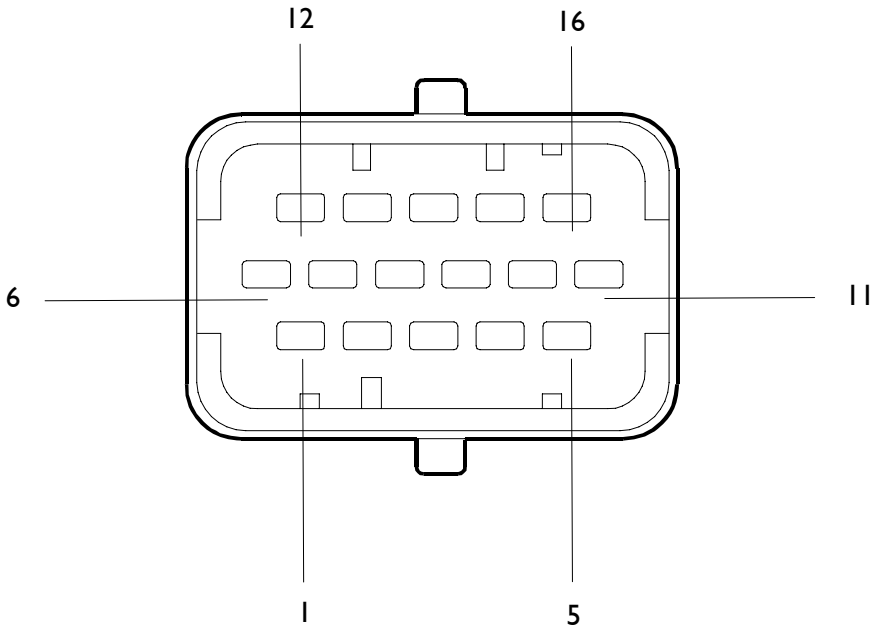


A. Electro-injector connector - B. Chassis connector - C. Sensor connector.

EDC control unit PIN-OUT

Electric injector connector "A"

Figure 7



Colour legend

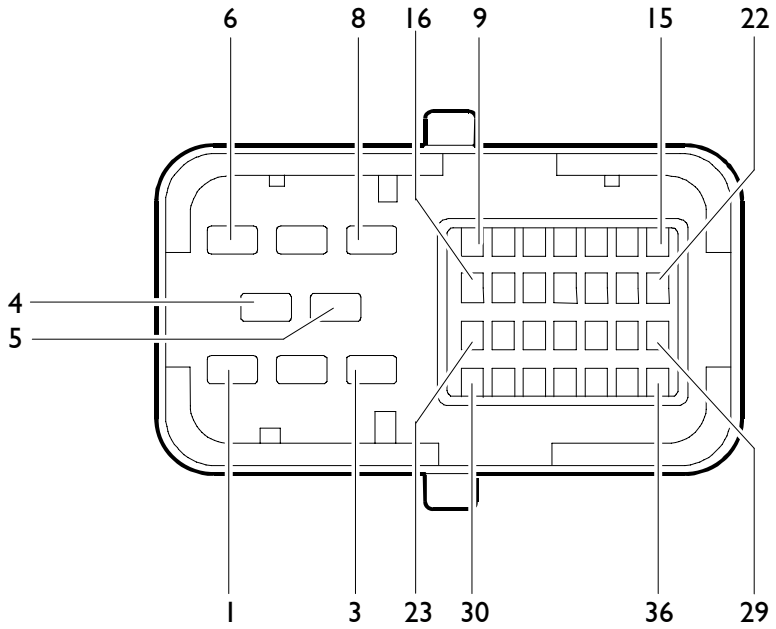
B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange
E	grey
K	pink

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

EDC control unit PIN-OUT

Sensor connector "C"

Figure 8



Colour legend

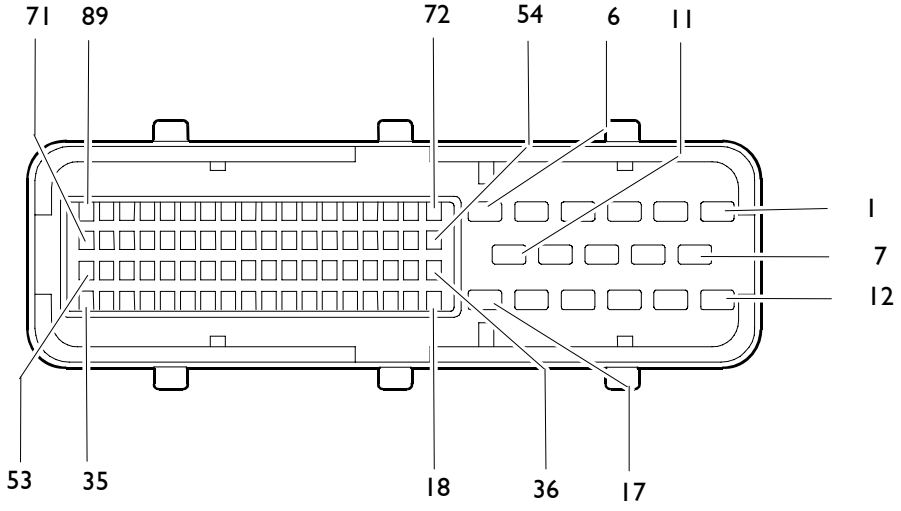
B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange
E	grey
K	pink

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"

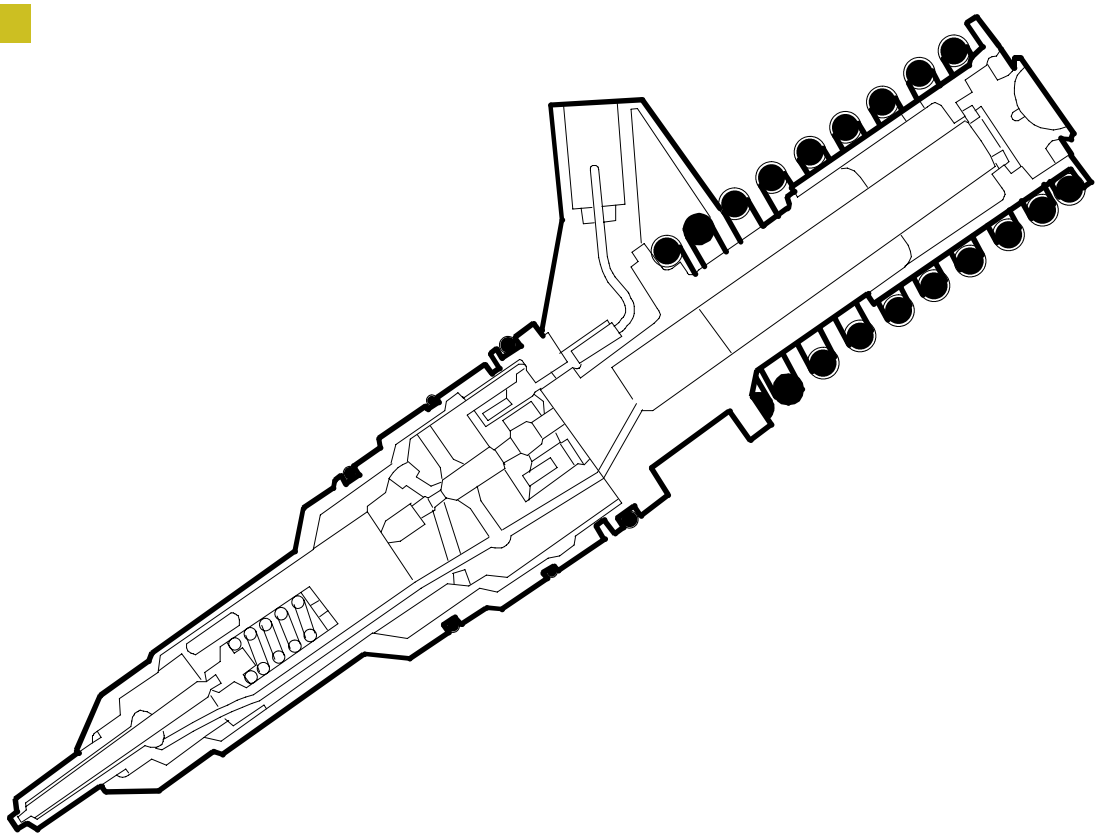
Figure 9



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

INJECTOR PUMP

Figure 10

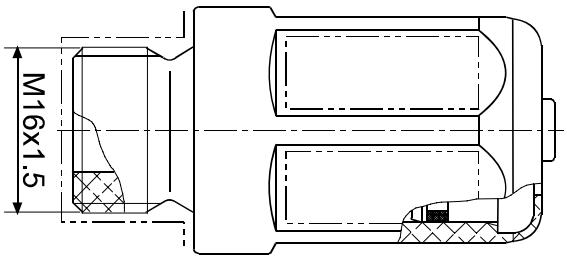


102405

INJECTOR SECTION

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

Figure 11



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.

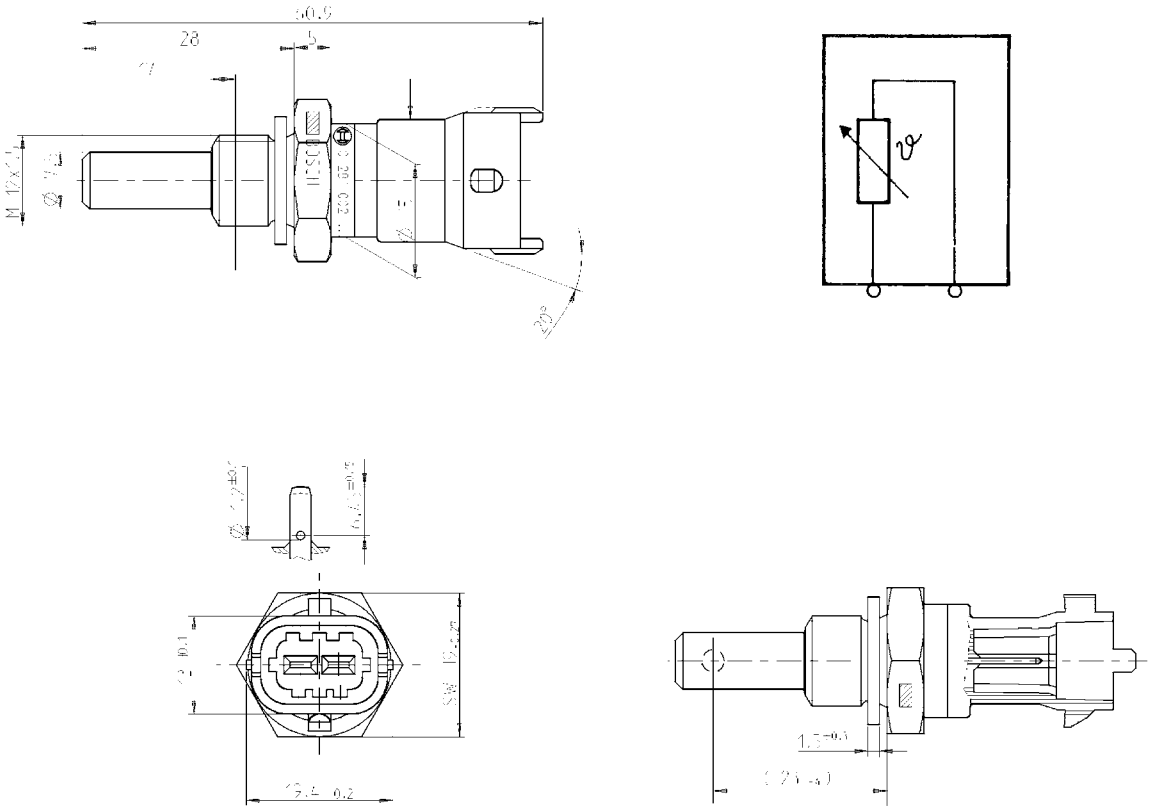
It is connected to electronic center pins 15/26.

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 12



104266

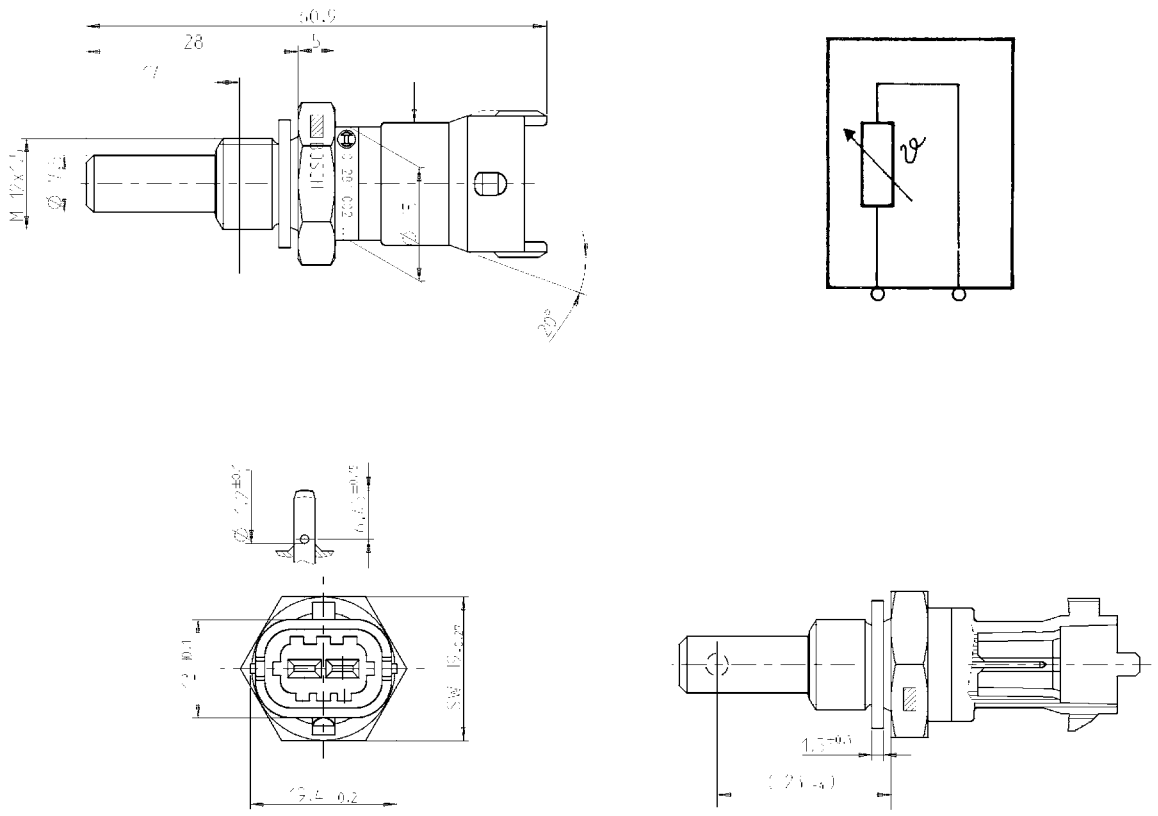
Description	Cable colour
To EDC center pin 15 (Sensor connector "C")	K
To EDC center pin 26 (Sensor connector "C")	Y

Fuel temperature sensor

Specifications

Supplier	BOSCH
Max. tightening torque	35 Nm

Figure 13



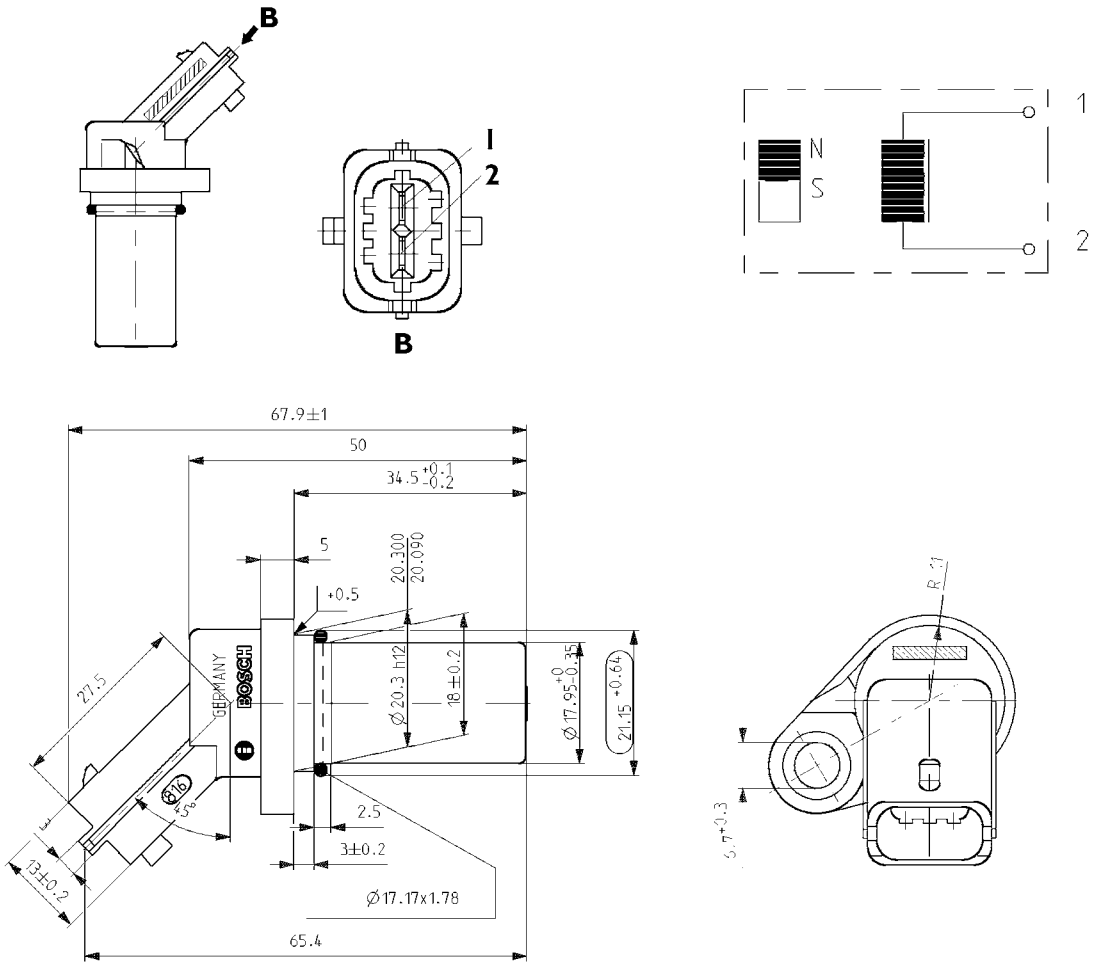
Description	Cable colour
To pin 18 of EDC control unit (Sensor connector "C")	O/B
To pin 35 of EDC control unit (Sensor connector "C")	W/R

Flywheel pulse transmitter

Specifications

Supplier	BOSCH
Max. tightening torque	8 ± 2 Nm

Figure 14



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

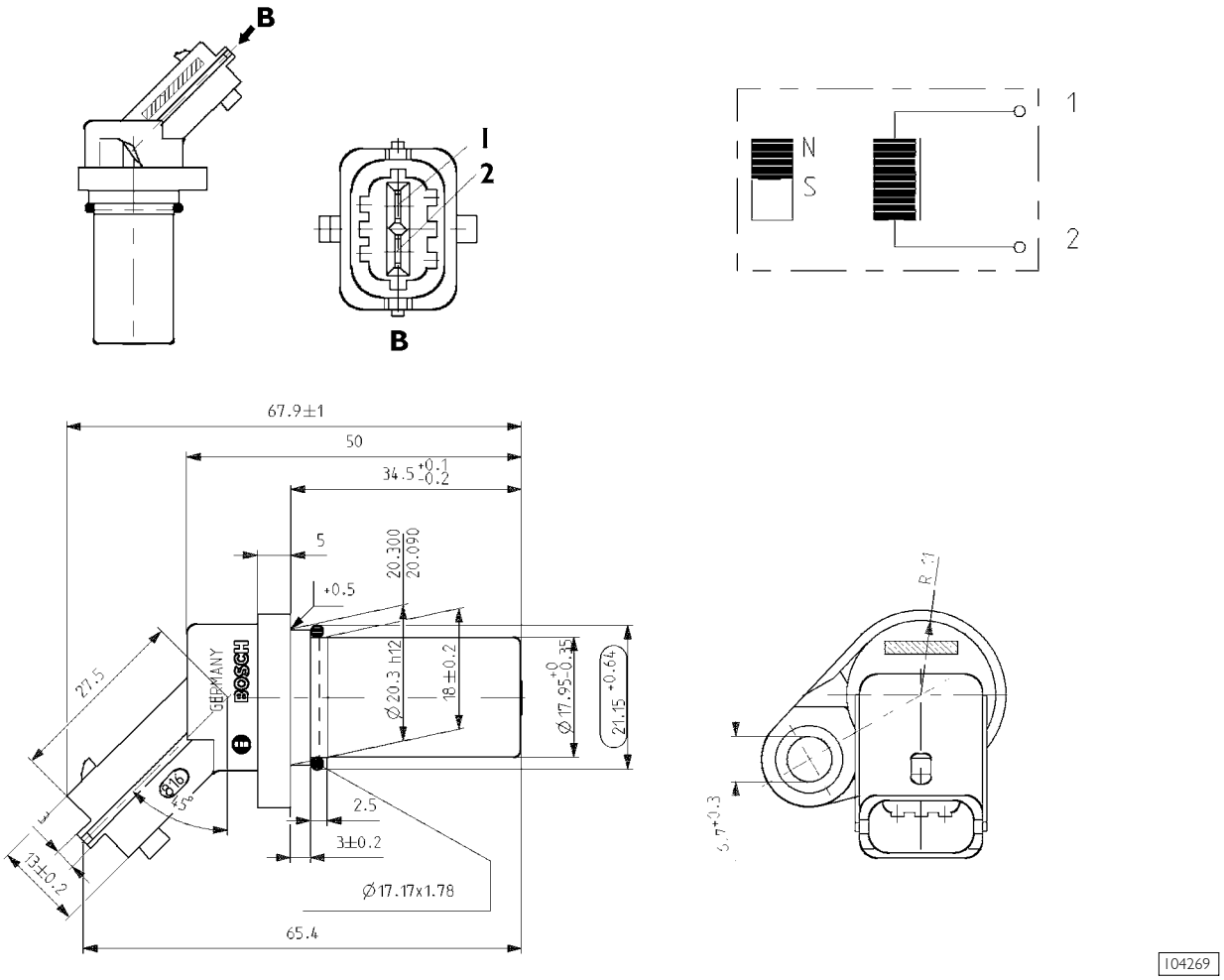
This induction type sensor located on the camshaft generates signals obtained from the magnetic flow lines that close through the 6 plus 1 phase teeth of a sound wheel mounted on the shaft.

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.

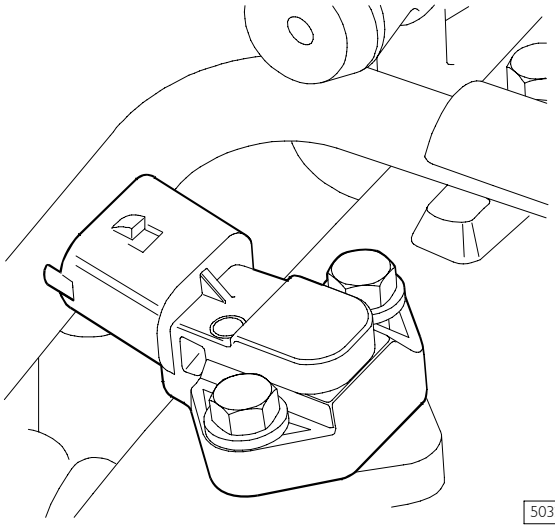
This sensor's air gap is NOT ADJUSTABLE.

Figure 15



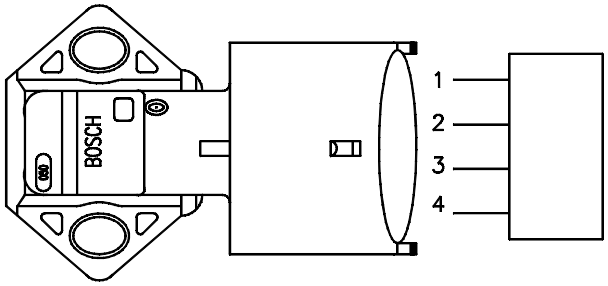
Description	Cable colour
To EDC center pin 9 (Sensor connector "C")	W
To EDC center pin 10 (Sensor connector "C")	R

Figure 16



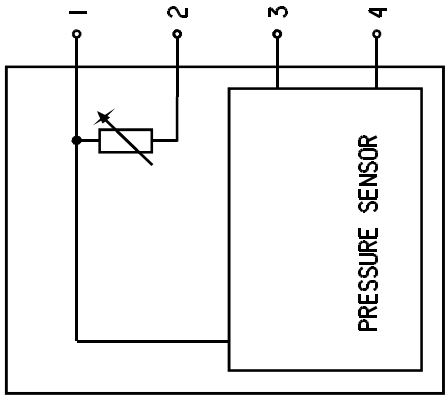
Sensor external view

Figure 17



Linking connector

Figure 18



Wiring diagram

Air pressure/temperature sensor (85156).

This component incorporates a temperature sensor and a pressure sensor.

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

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

The sensor is powered with 5 V.

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

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

Oil temperature/pressure sensor (42030 / 47032)

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

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

It measures the engine oil temperature and pressure.

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

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

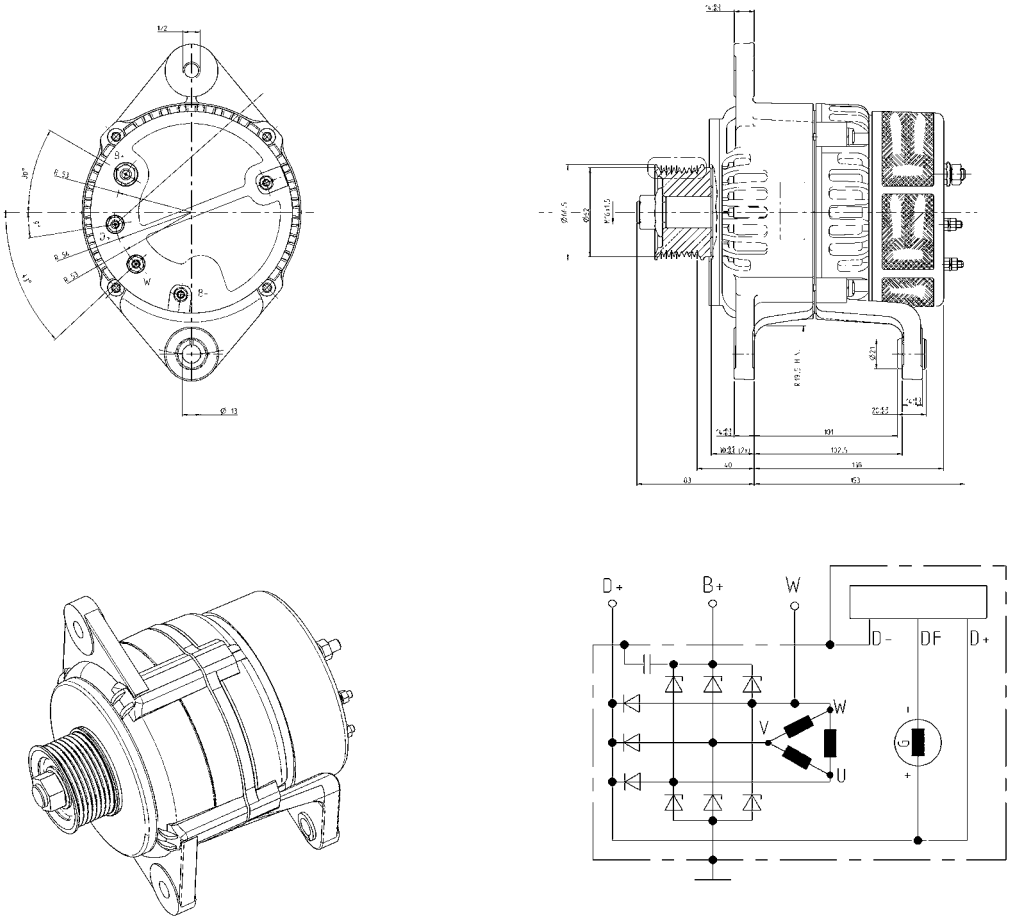
The engine oil temperature is used only by the EDC control unit.

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

Alternator for F3CE0684B*E003

Supplier ISKRA
Technical features 14V - 175A

Figure 19

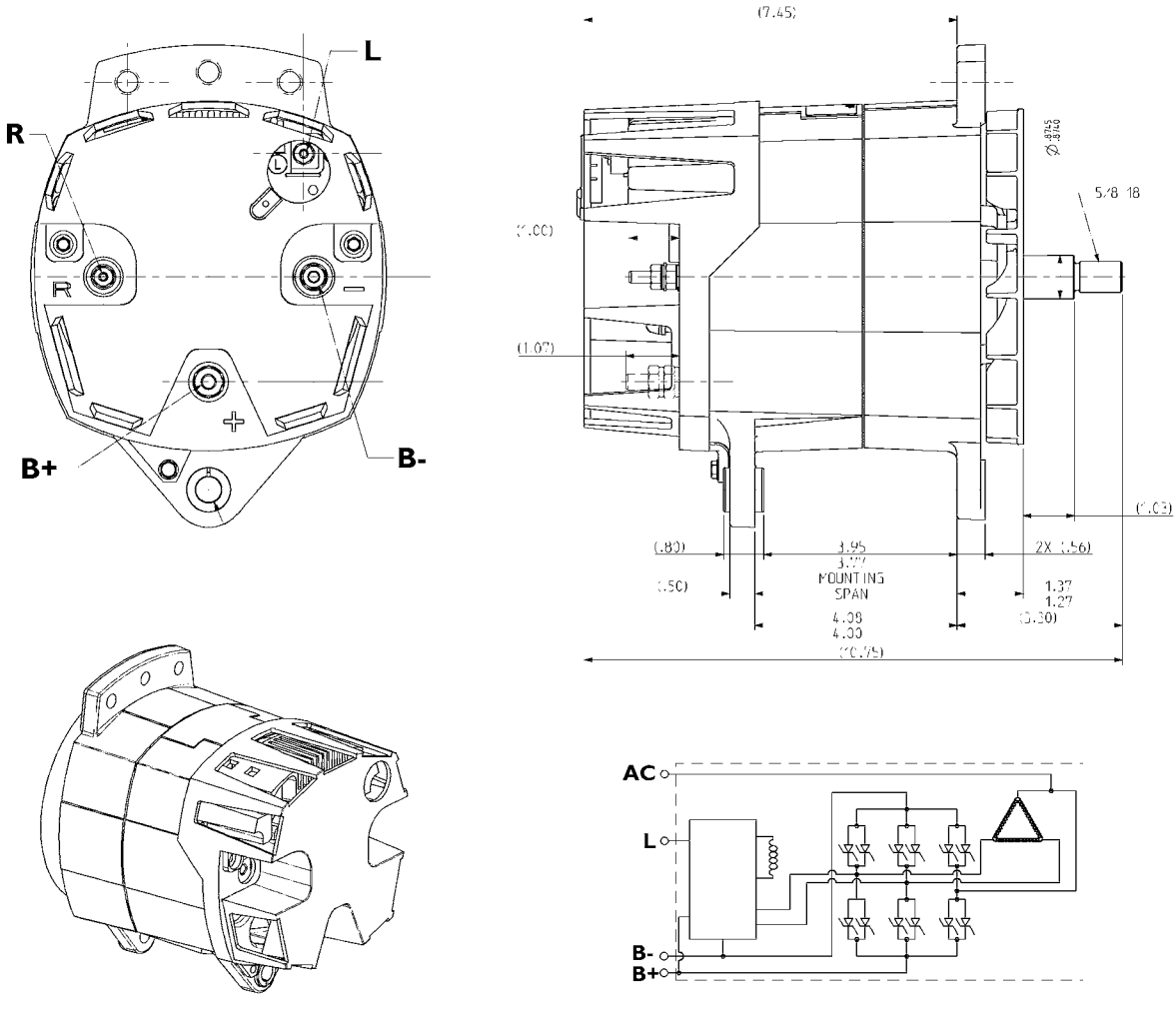


104313

Alternator for F3CE0684A*E001

Supplier LEECE NEVILLE
Technical features 12V - 185A

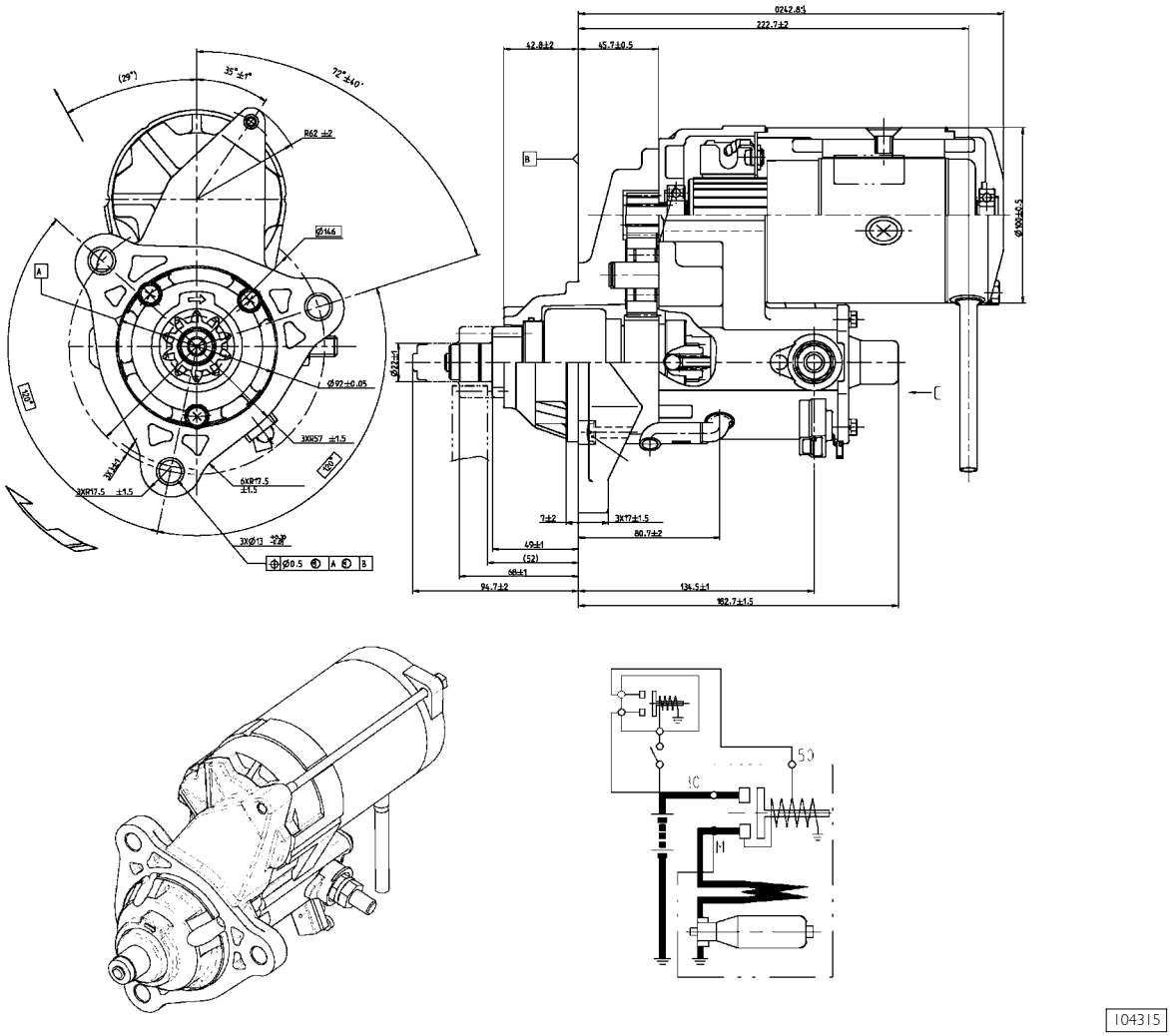
Figure 20



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

Starting motor

Figure 21



	F3CE0684A*E001	F3CE0684B*E003
Supplier	DENSO	
Type	428000 - 4250	228000 - 7550
Voltage	24 V	
Nominal output	5.5 kW	7.8 kW

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.

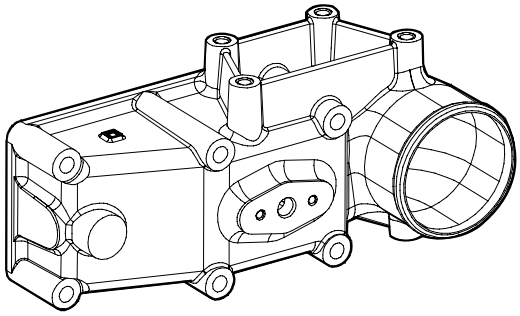
When the engine is running the warning light goes off, while the resistance is being fed for a certain time as a result of post-heating.

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.

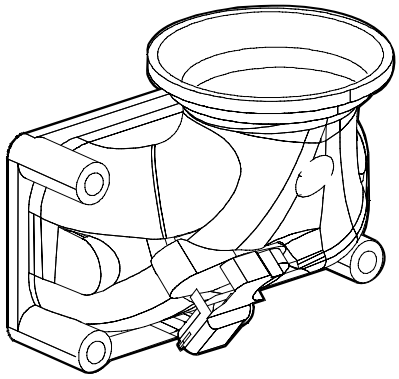
Figure 22

(F3CE0684A*E001)



119966

(F3CE0684AB*E003)



119967

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.

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.

Use of appropriate diagnostic tools allows to decode the error codes, to exploit the internal database and to obtain other information for identifying the origin of the fault.

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.

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

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

FAULT CODE

DTC	Faulty component
	Vehicle 1 (Sensors/Plausibility checks)
1.1.9	PLAUSIBILITY +15
1.1.A	PLAUSIBILITY +50
	Vehicle 2 (Warning lights/Relays/Actuators)
1.2.5	MAIN RELAY
1.2.6	BATTERY VOLTAGE
1.2.8	MAIN RELAY - SHORT CIRCUIT TO BATTERY
1.2.9	CONDITIONER COMPRESSOR RELAY
1.2.B	THERMO STARTER RELAY 1 (HEATER)
1.2.E	PRE/POST-HEATER CONTROL SYSTEM (ACTIVE)
2.2.5	INTERRUPTED AFTER-RUN
2.2.8	MAIN RELAY - SHORT CIRCUIT TO EARTH
	Engine 1 (temperature and pressure sensors)
1.3.1	COOLANT TEMPERATURE SENSOR
1.3.2	COOLANT TEMPERATURE SENSOR (TEST)
1.3.3	TURBOCHARGER AIR TEMPERATURE SENSOR
1.3.4	SUPERCHARGER AIR PRESSURE SENSOR
1.3.5	FUEL TEMPERATURE
1.3.8	OIL PRESSURE SENSOR
1.3.A	OIL TEMPERATURE SENSOR
2.3.2	COOLANT TEMPERATURE SENSOR ABSOLUTE TEST
2.3.8	LOW OIL PRESSURE
2.3.A	HIGH OIL TEMPERATURE
	Engine 2 (speed sensors/actuators)
1.4.1	CRANKSHAFT SPEED SENSOR
1.4.2	ENGINE OPERATION WITH CAMSHAFT SENSOR ONLY
1.4.3	CAMSHAFT SENSOR
1.4.4	PLAUSIBILITY BETWEEN FLYWHEEL SENSOR AND CAMSHAFT
	Damage information
1.4.D	ENGINE OVERSPEED
3.9.E	TURBO PROTECTION TORQUE LIMITER
4.9.E	ENGINE PROTECTION TORQUE LIMITER
6.9.E	TORQUE LIMITER DUE TO LIMITED INJECTED QUANTITY
	Fuel metering
1.5.1	INJECTOR CYLINDER 1
1.5.2	INJECTOR CYLINDER 2
1.5.3	INJECTOR CYLINDER 3
1.5.4	INJECTOR CYLINDER 4
1.5.5	INJECTOR CYLINDER 5
1.5.6	INJECTOR CYLINDER 6

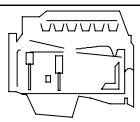
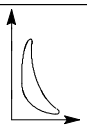
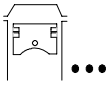
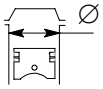
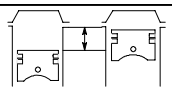
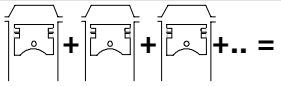
DTC	Faulty component
	Injectors 1
1.6.1	INJECTOR CYLINDER 1 / SHORT CIRCUIT
1.6.2	INJECTOR CYLINDER 2 / SHORT CIRCUIT
1.6.3	INJECTOR CYLINDER 3 / SHORT CIRCUIT
1.6.4	INJECTOR CYLINDER 4 / SHORT CIRCUIT
1.6.5	INJECTOR CYLINDER 5 / SHORT CIRCUIT
1.6.6	INJECTOR CYLINDER 6 / SHORT CIRCUIT
1.6.7	INJECTOR CYLINDER 1 / SHORT CIRCUIT
1.6.8	INJECTOR CYLINDER 2 / SHORT CIRCUIT
1.6.9	INJECTOR CYLINDER 3 / SHORT CIRCUIT
1.6.A	INJECTOR CYLINDER 4 / SHORT CIRCUIT
1.6.B	INJECTOR CYLINDER 5 / SHORT CIRCUIT
1.6.C	INJECTOR CYLINDER 6 / SHORT CIRCUIT
1.6.E	MINIMUM NUMBER OF INJECTIONS NOT REACHED: SWITCHING THE ENGINE OFF
	Injectors 2
1.7.1	ROW 1 SC
1.7.3	ROW 2 SC
1.7.C	ROW 1 INJECTOR CONTROL (IN ECU)
1.7.F	ESTIMATED INJECTED QUANTITY ERROR (NIMA PROGRAM)
2.7.C	ROW 2 INJECTOR CONTROL (IN ECU)
	Turbocharger and turbine speed system
1.9.E	TORQUE LIMITER FOR LIMITING SMOKINESS
	Interfaces 1 (CAN-Bus)
1.B.1	ERROR ON CAN CONTROLLER A
1.B.3	ERROR ON CAN CONTROLLER C
1.B.5	CAN TIMEOUT MESSAGE VM2EDC
2.B.4	CAN TIMEOUT MESSAGE BC2EDC2
	Interfaces 2 (CAN line timeout messages)
1.C.6	CAN MESSAGE ERROR TSC1-PE
1.C.8	CAN MESSAGE ERROR TSC1-VE
2.C.6	CAN MESSAGE ERROR TSC1-VE
3.C.8	CAN MESSAGE ERROR TSC1-VE (passive)
	ECU 1 (internal controls)
1.D.1	ERROR IN ECU
1.D.2	ERROR IN ECU
1.D.3	ERROR IN ECU
1.D.4	ERROR IN ECU
1.D.5	ERROR IN ECU
1.D.6	ERROR IN ECU (TPU)
1.D.7	ERROR IN ECU (VARIANT AREA)
1.D.8	ERROR IN ECU
1.D.9	ERROR IN ECU
2.D.3	ERROR IN ECU
3.D.3	ERROR IN ECU

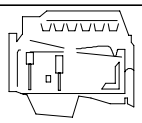
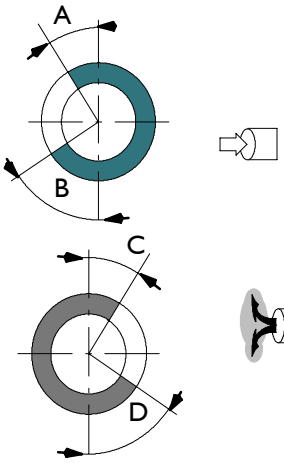
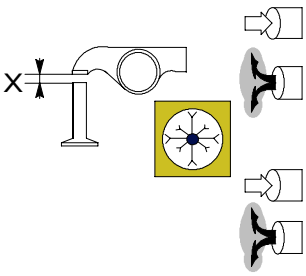
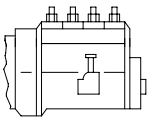
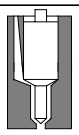
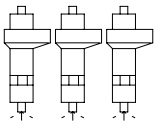
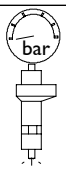
DTC	Faulty component
ECU 2 (power unit/Immobilizer/overspeed/sensor power)	
1.E.3	MONITORING ERROR IN ECU
1.E.4	MONITORING ERROR IN ECU
1.E.5	SENSOR POWER ERROR (12V)
1.E.6	POWER SUPPLY SENSORS 1
1.E.7	POWER SUPPLY SENSORS 2
1.E.8	POWER SUPPLY SENSORS 3
1.E.9	ERROR IN ECU
1.E.A	ERROR IN ECU
1.E.B	ATMOSPHERIC PRESSURE SENSOR

SECTION 4

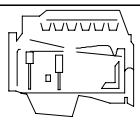
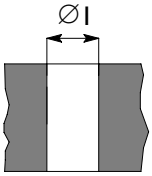
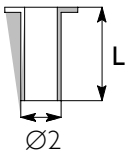
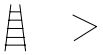
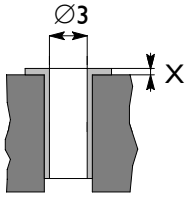
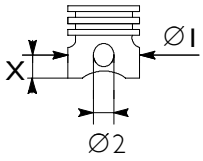
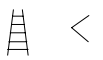
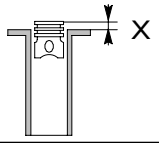
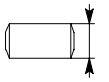
Overhaul and technical specifications

GENERAL CHARACTERISTICS

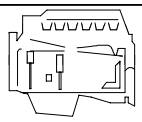
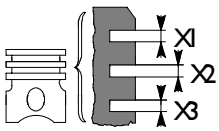
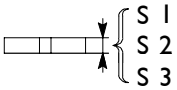
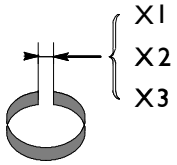
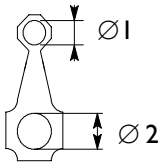
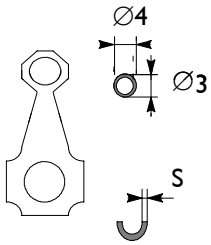
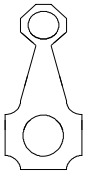
	Type		**F3C**
	Cycle		4-stroke Diesel engine
	Fuel feed		Turbocharged
	Injection		Direct
	No. of cylinders		6 in line
	Bore	mm	135
	Stroke	mm	150
	Total displacement	cm^3	12880

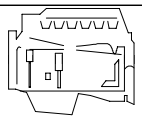
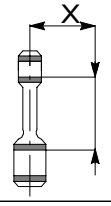
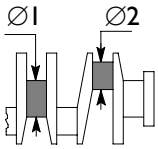
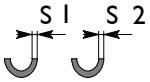
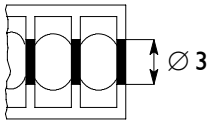
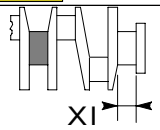
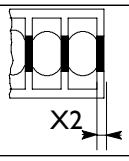
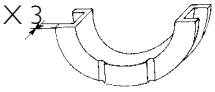
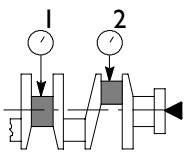
	Type	**F3C**
	VALVE TIMING opens before T.D.C. A closes after B.D.C. B opens before B.D.C. D closes after T.D.C. C	 17° 30° 50° 9°
	For timing check X { mm mm Running X { mm mm	 0.4 0.6 - -
	FEED	Through fuel pump - filters
	Injection type: Bosch	With electronically regulated injectors UIN3 pump injectors 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

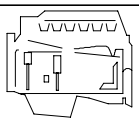
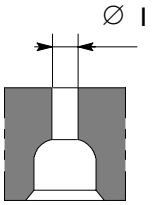
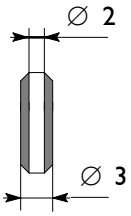
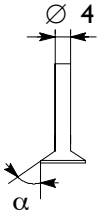
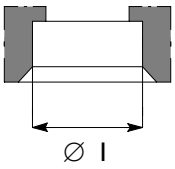
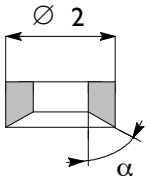
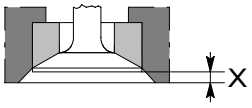
	Type		F3C
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS			mm
	Bores for cylinder liners: Ø1	upper	153.500 to 153.525
		lower	152.000 to 152.025
	Cylinder liners: external diameter: Ø2	upper	153.461 to 153.486
		lower	151.890 to 151.915
	length	L	-
	Cylinder liners - crankcase bores	upper	0.014 to 0.039
		lower	0.085 to 0.135
IVECO PARTS 	External diameter	Ø2	-
 * Selection class * Under a load of 800 N	Cylinder sleeve inside diameter	Ø3A*	135.000 to 135.013
	inside diameter	Ø3B*	135.011 to 135.024
	Protrusion	X	0.045 to 0.075
	Pistons: measuring dimension	X	18
	external diameter	Ø1A●	134.861 to 134.873
	external diameter	Ø1B●●	134.872 to 134.884
	pin bore	Ø2	54.010 to 54.018
 * Selection class	Piston - cylinder sleeve	A*	0.127 to 0.151
		B*	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

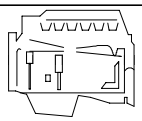
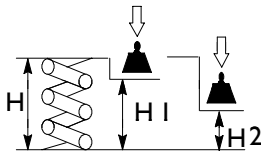
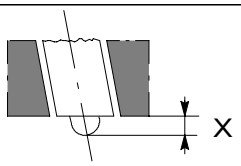
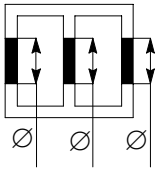
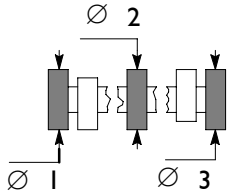
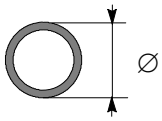
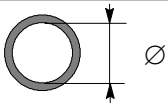
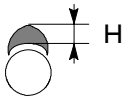
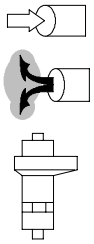
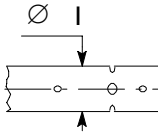
● Class A pistons supplied as spares.
●● Class B pistons are fitted in production only and are not supplied as spares.

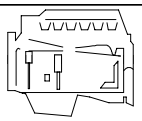
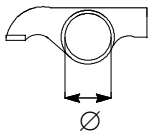
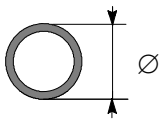
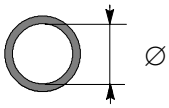
	Type		F3C
			mm
	Piston ring grooves	X1 X2 X3	3.100 to 3.120 1.550 to 1.570 5.020 to 5.040
	Piston rings: trapezoidal seal lune seal milled scraper ring with slits and internal spring * measured on Ø of 130 mm	S1* S2 S3	3.000 1.470 to 1.500 4.970 to 4.990
	Piston rings - grooves	1 2 3	0.100 to 0.120 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	Ø1	59.000 to 59.030
	Big end bearing housing nominal	Ø2	94.000 to 94.030
	- Class - Class - Class	1 2 3	94.000 to 94.010 94.011 to 94.020 94.021 to 94.030
	Small end bush diameter		
	outside	Ø4	59.085 to 59.110
	inside	Ø3	54.019 to 54.035
	Big end bearing shell	S	
	Red Green Yellow		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		F3C
			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
	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	**F3C**
CYLINDER HEAD - VALVE TRAIN		mm
	Valve guide housings in cylinder head Ø1	15.980 to 15.997
	Valve guide Ø2 Ø3	10.015 to 10.030 16.012 to 16.025
	Valve guides - housings in the cylinder heads	0.015 to 0.045
IVECO PARTS	Valve guide	-
	Valves: Ø4 α Ø4 α	 9.960 to 9.975 60° 30' ± 7' 30" 9.960 to 9.975 45° 30' ± 7' 30"
	Valve stem and its guide	0.040 to 0.070
	Valve seat in head Ø1 Ø1	 49.185 to 49.220 46.985 to 47.020
	Outside diameter of valve seat; angle of valve seat in cylinder head: Ø2 α Ø2 α	 49.260 to 49.275 60° - 30' 47.060 to 47.075 45° - 30'
	Recessing of valve	0.54 to 0.85 1.75 to 2.05
	Between valve seat and head	0.040 to 0.090

			F3C
	Type		mm
	Valve spring height:		
	free height	H	73.40
	under a load of:		
	575 ± 28 N	H1	59
	1095 ± 54 N	H2	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

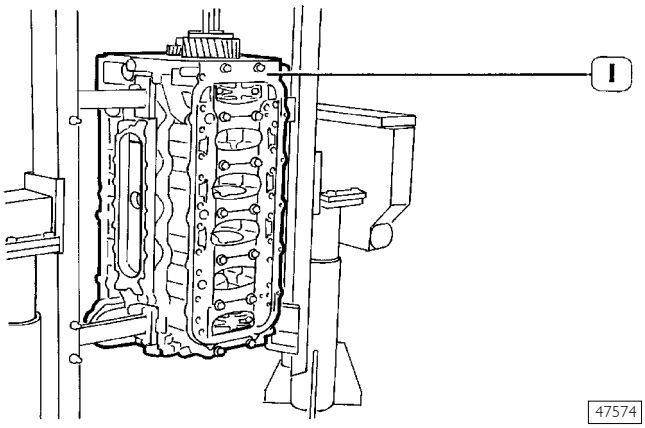
	Type	F3C
		mm
	Bushing housing in rocker arms	45.000 to 45.016 59.000 to 59.019 46.000 to 46.016
	Bushing outer diameter for rocker arms	45.090 to 45.130 59.100 to 59.140 46.066 to 46.091
	Bushing inner diameter for rocker arms	42.025 to 42.041 56.030 to 56.049 42.015 to 42.071
	Between bushings and 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 HE551
End float		-
Radial play		-

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).

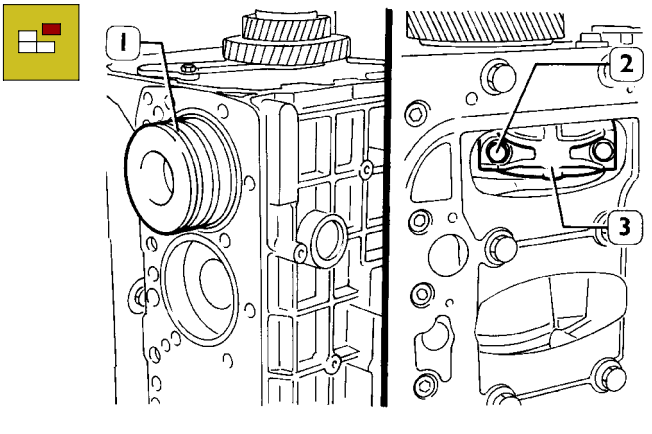
The section illustrates therefore all the most important engine overhaul procedures.

Figure 1



Rotate the block (1) to the vertical position.

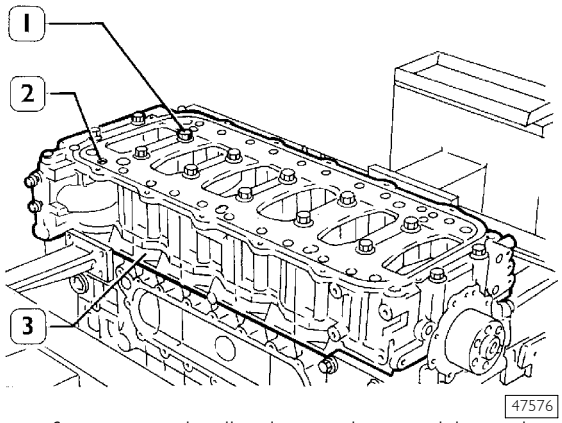
Figure 2



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.

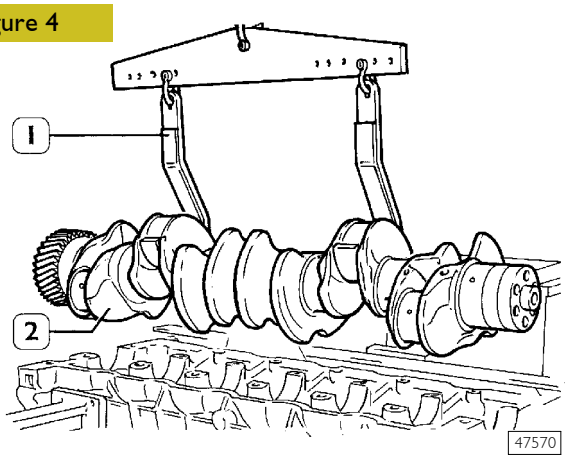
NOTE Keep the connecting rod half bearings in the corresponding housings and/or take note of their assembly position because they must need to be refitted in the original position if they are reused.

Figure 3



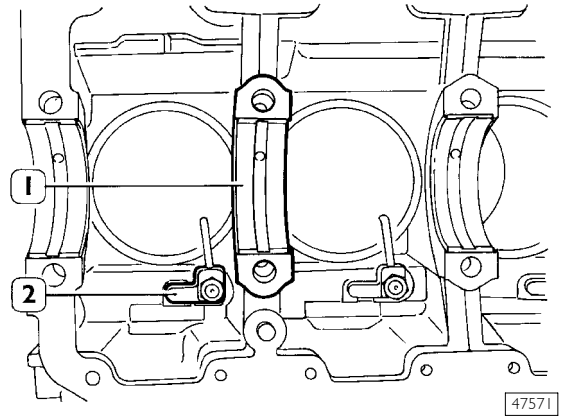
By means of proper and splined wrenches, untighten the screws (1) and (2) and remove the under-block (3).

Figure 4



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

Figure 5

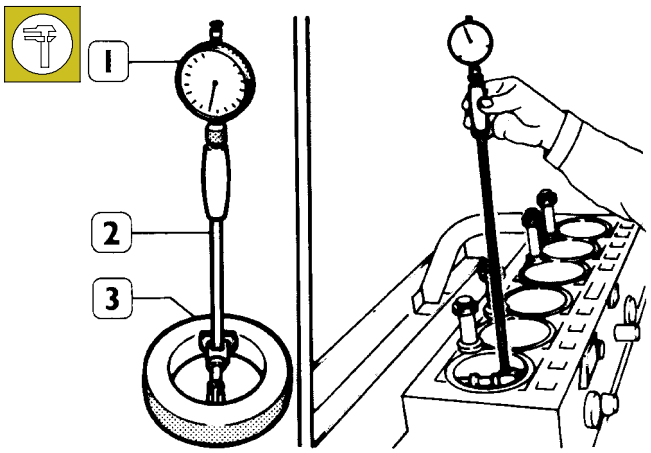


Remove the crankshaft half-bearings (1), untighten the screws and remove oil spray nozzles (2).
Take down cylinder liners as specified in the relative paragraph on page 14.

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)

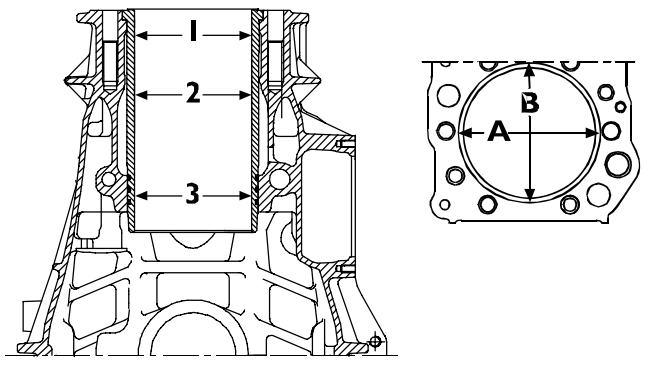


34994

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

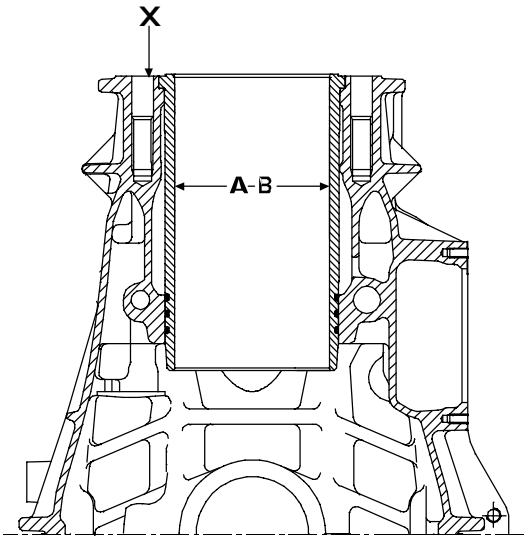


60596

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



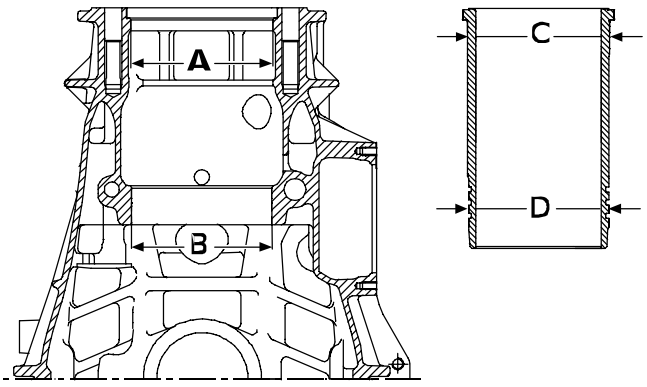
60595

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

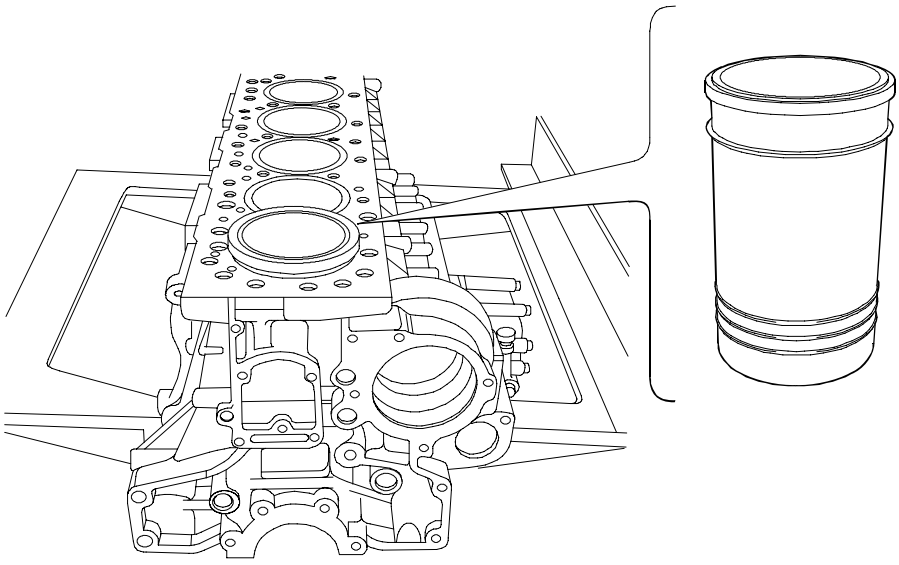
A = Ø 153.500 to 153.525 mm
B = Ø 152.000 to 152.025 mm
C = Ø 153.461 to 153.486 mm
D = Ø 151.890 to 151.915 mm

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.

Cylinder liners

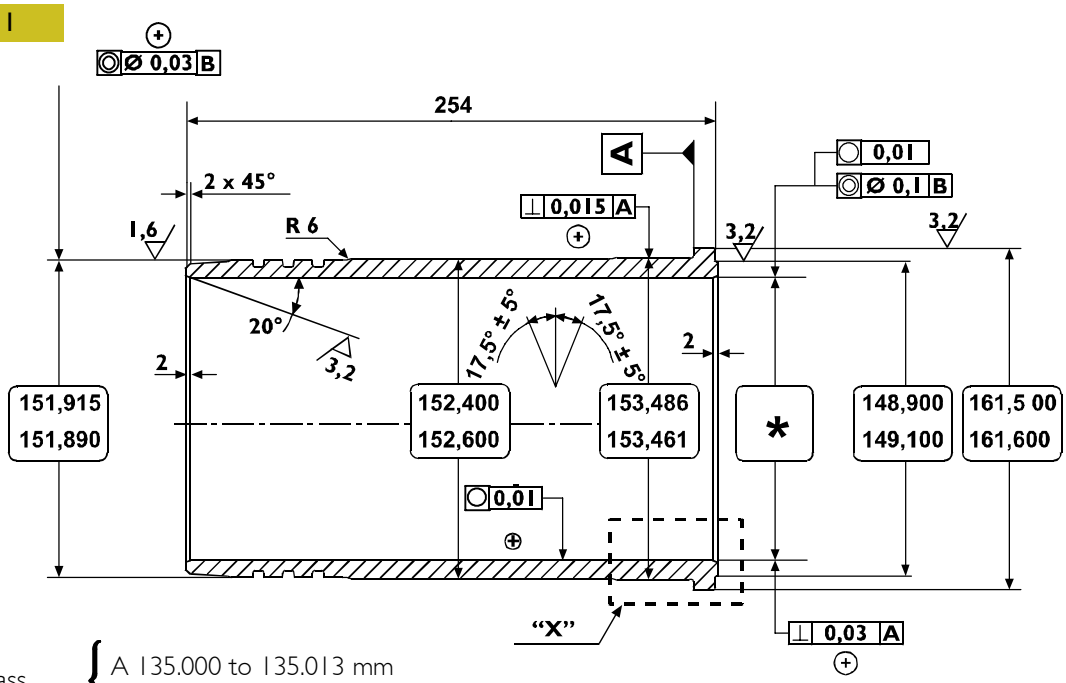
Figure 10



60598

CRANKCASE ASSEMBLY WITH CYLINDER LINERS

Figure 11

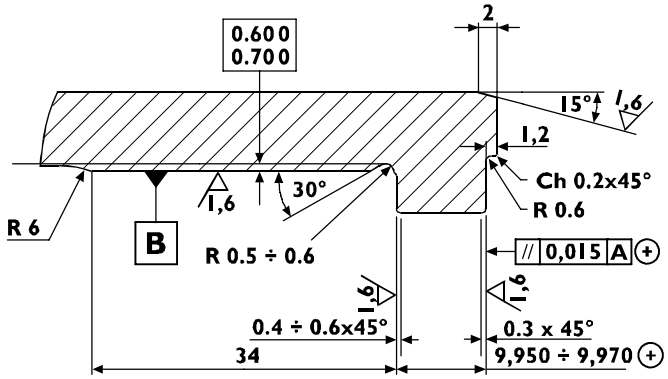


101503

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

MAIN CYLINDER LINER DATA

Figure 12

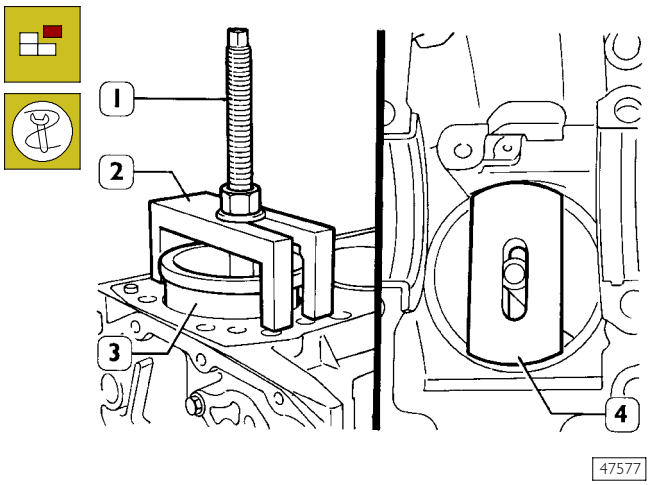


101502

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

Replacing cylinder liners
Removal

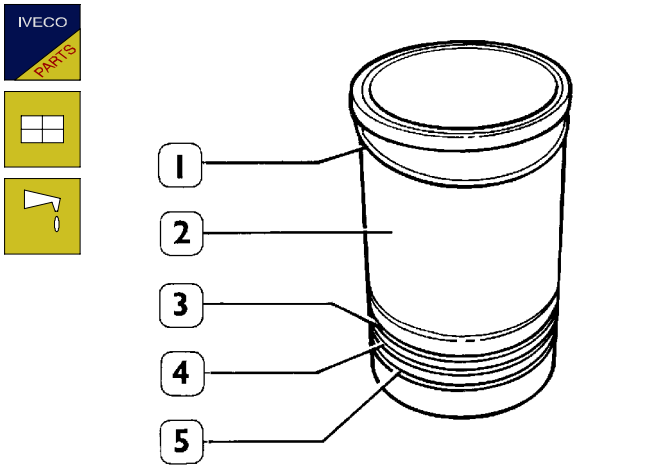
Figure 13



Position the parts 99360706 (2) and the plate 99360728 (4) as shown in the figure, checking that the plate (4) rests on the cylinder liner correctly.
Screw down the nut of screw (1) and extract the cylinder liner (3) from the crankcase.

Assembly and checking protrusion

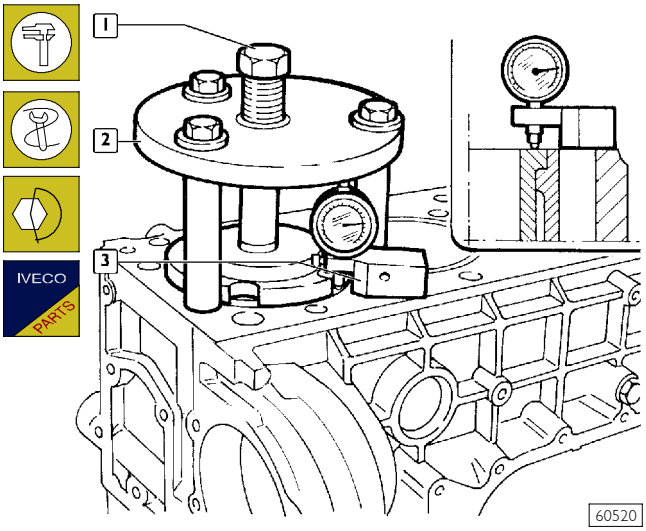
Figure 14



Always replace the water seals (3, 4 and 5).
Fit the adjustment ring (1) on the cylinder liner (2). Lubricate the bottom of it and mount it in the cylinder assembly using the appropriate tool.

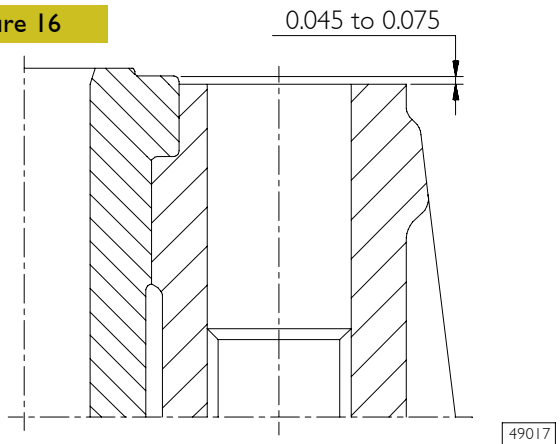
NOTE The adjustment ring (1) is supplied as a spare part with the following thicknesses: 0.08 mm - 0.10 mm - 0.12 mm - 0.14 mm.

Figure 15



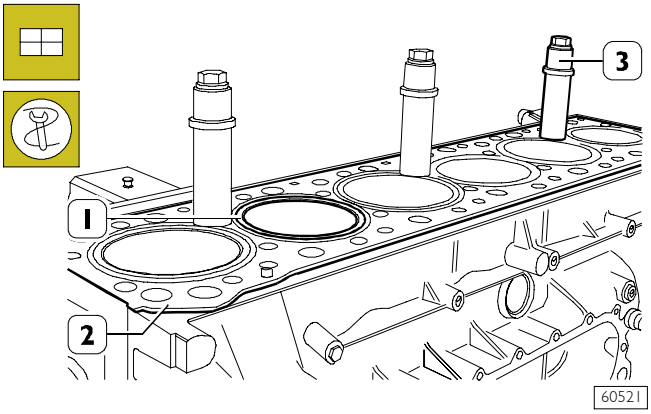
Check the protrusion of the cylinder liners with tool 99360334 (2) and tightening the screw (1) to a torque of 225 Nm.
Using the dial gauge 99395603 supplied as standard with the dial gauge base 99370415 (3), check that the protrusion of the cylinder liner over the supporting face of the cylinder head is 0.045 - 0.075 mm (Figure 16); if this is not so, replace the adjustment ring (1) (Figure 14), supplied as a spare part with several thicknesses.

Figure 16



CYLINDER LINER PROTRUSION

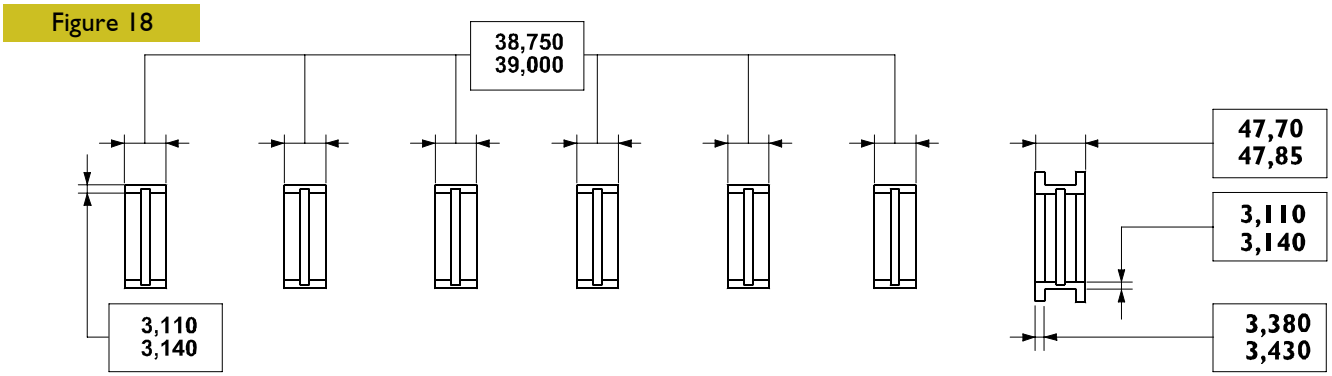
Figure 17



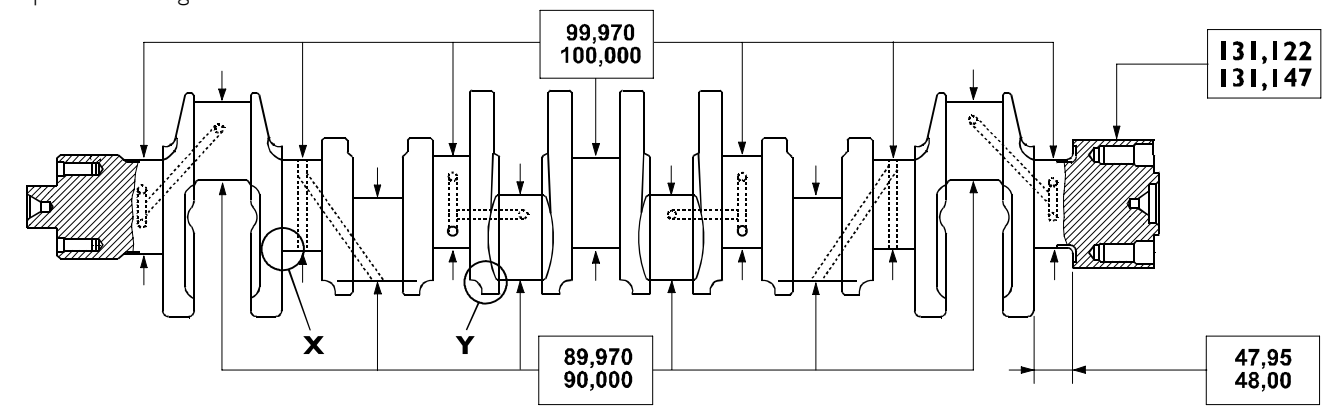
On completing assembly, lock the cylinder liners (1) to the crankcase (2) with the pins 99360703 (3).

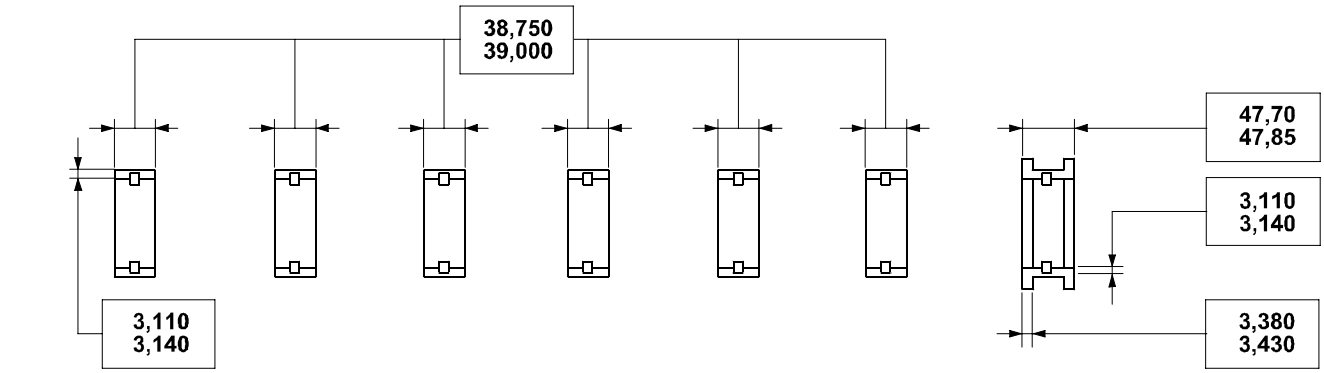
Crankshaft

Figure 18



Top main bearing shells





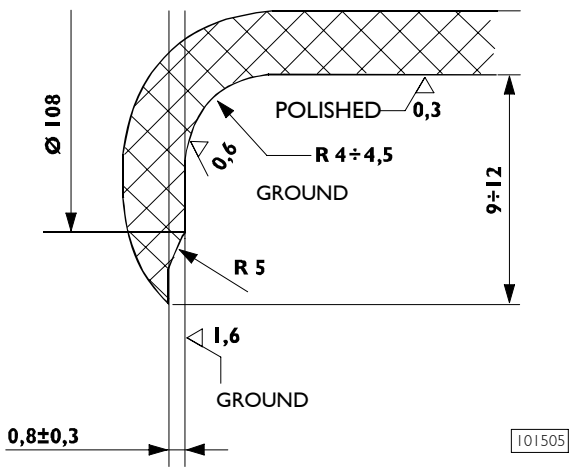
Bottom main bearing shells

101504

MAIN DATA OF CRANKSHAFT AND MAIN BEARING SHELLS

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

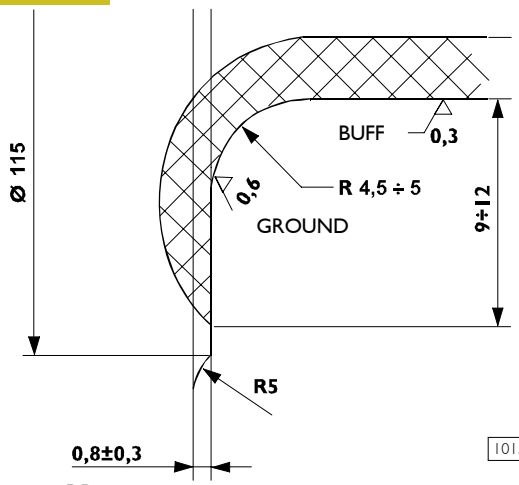
Figure 19



101505

X. Detail of the main journal unions

Figure 20



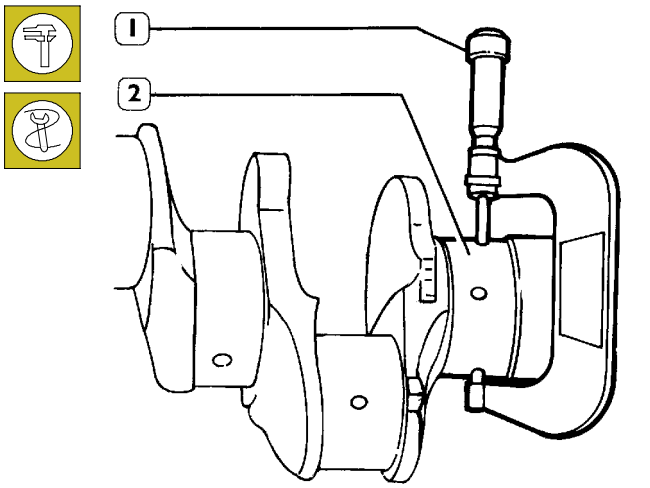
101506

Y. Detail of the crankpin unions

Measuring the main journals and crankpins

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

Figure 21

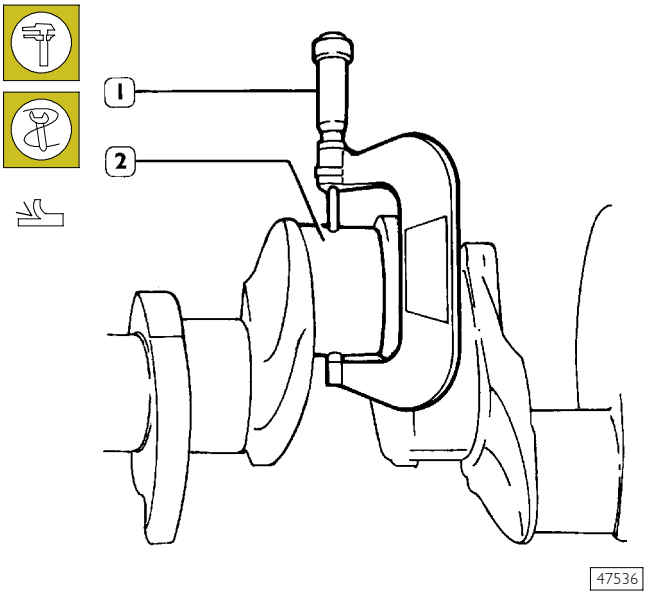


47535

MEASURING THE MAIN JOURNALS

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

Figure 22



47536

MEASURING CRANKPINS

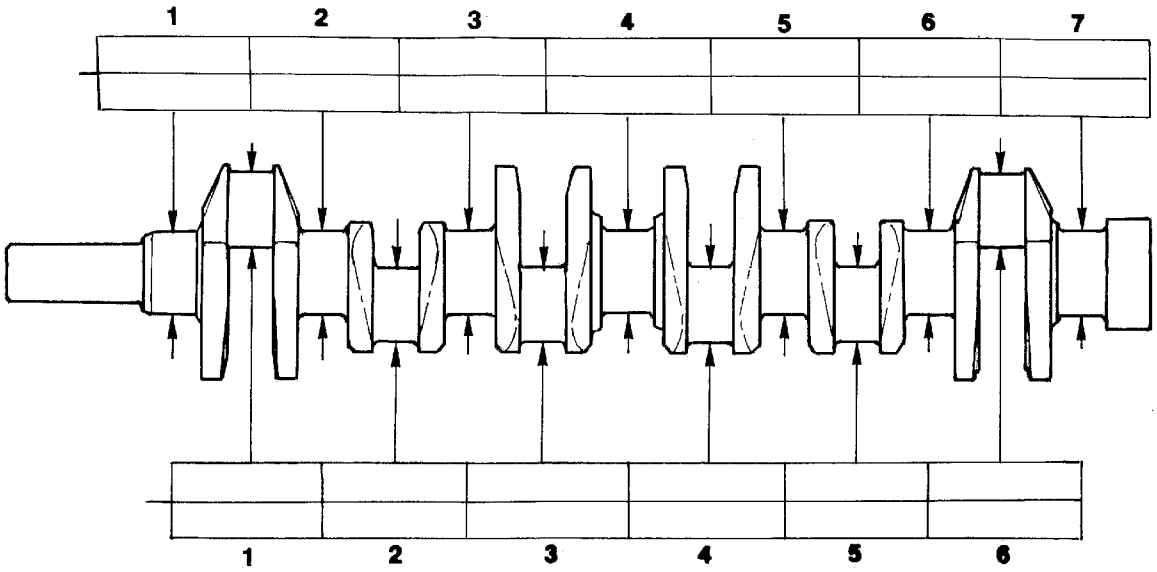
When grinding, pay the utmost attention to the values of the unions of the main journals and of the crankpins given in Figure 19 and Figure 20.

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

Figure 23

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

MAIN JOURNALS



CRANKPINS

36061

Preliminary measurement of main and big end bearing shell selection data

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

MAIN JOURNALS:

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

CRANKPINS:

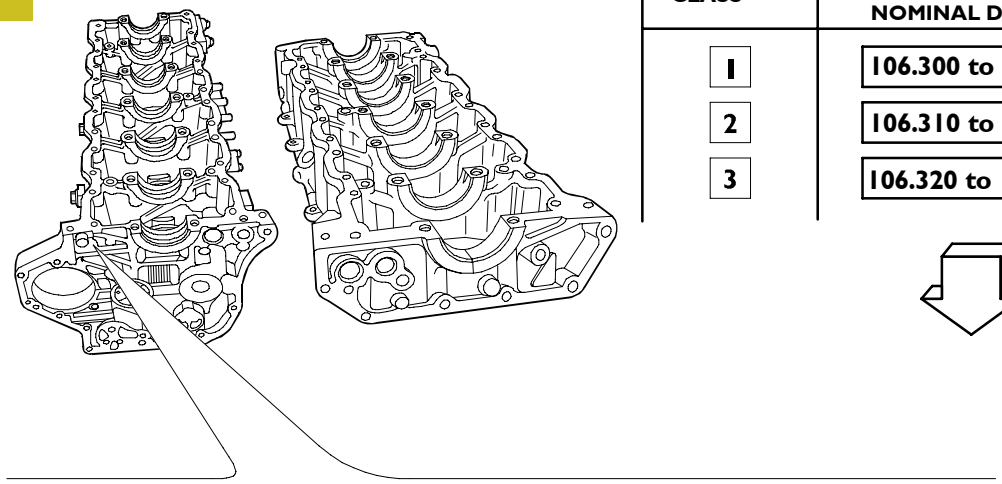
- ❑ Determine the class of diameter of the seat in the connecting rod.
- ❑ Determine the class of diameter of the crankpin.
- ❑ Select the class of the bearing shells to mount.

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

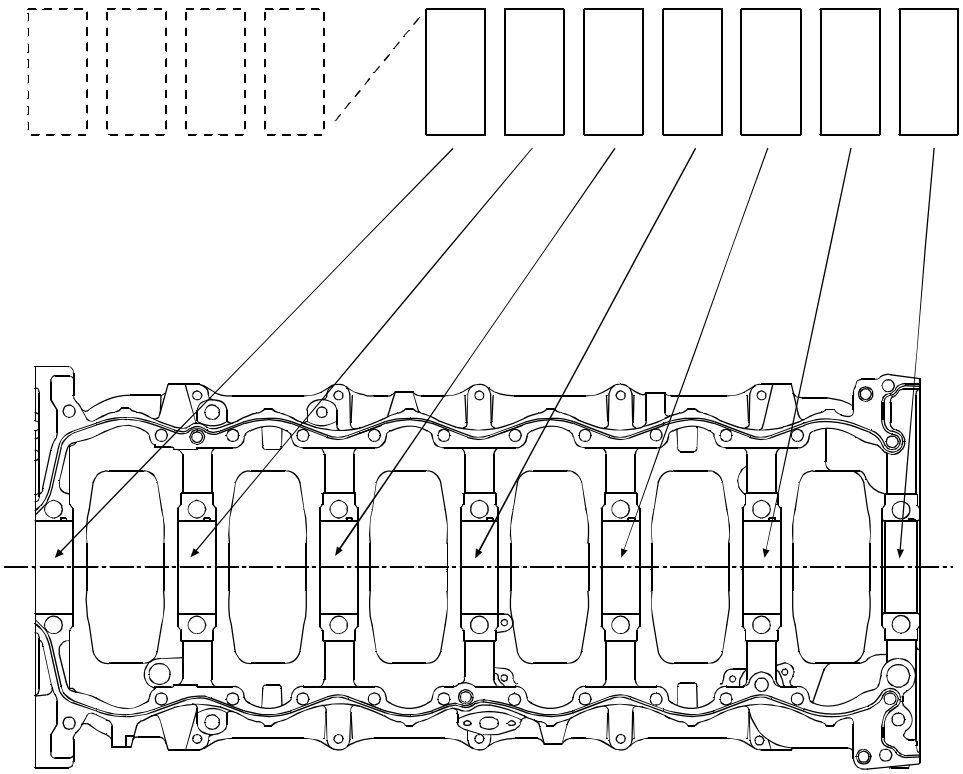
On the front of the crankcase, two sets of numbers are marked in the position shown (Figure 24 at top).

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

Figure 24



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

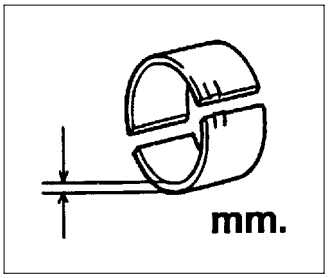
To obtain the required assembly clearances, the main bearing and big end bearing shells have to be selected as described hereunder.

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).

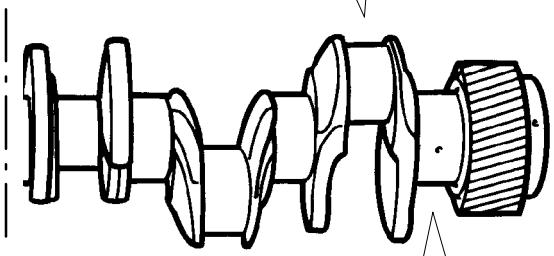
Depending on the thickness, the bearing shells are selected in classes of tolerance marked by a colour (red-green - red/black - green/black).

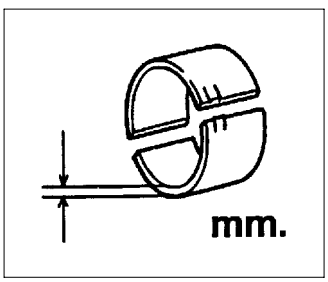
Figure 25 gives the specifications of the main bearing and big end bearing shells available as spare parts in the standard sizes (STD) and in the permissible oversizes (+0.127, +0.254, +0.508).

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		

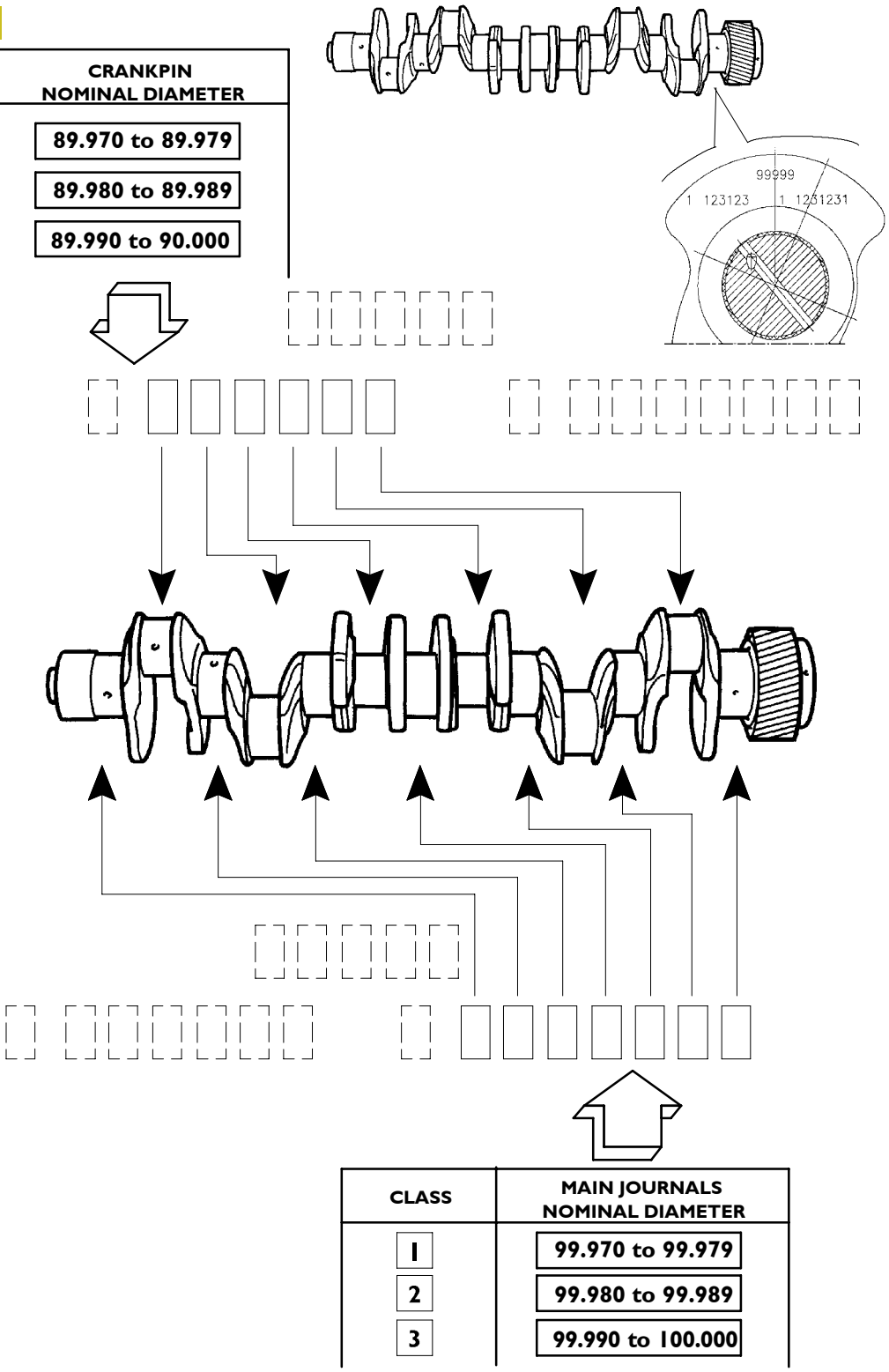
DEFINING THE CLASS OF DIAMETER OF THE MAIN JOURNALS AND CRANKPINS (Journals with nominal diameter)

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

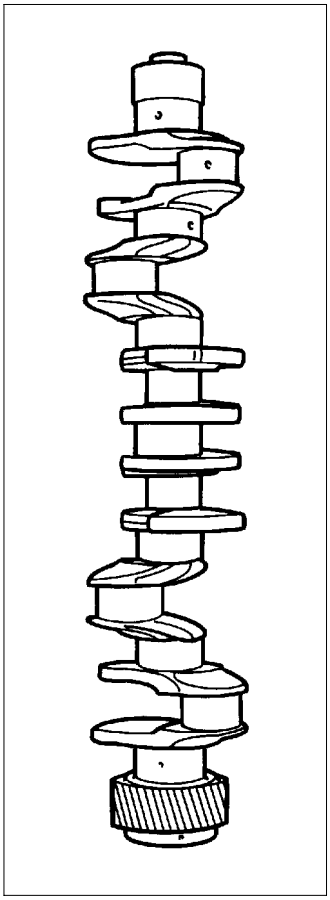


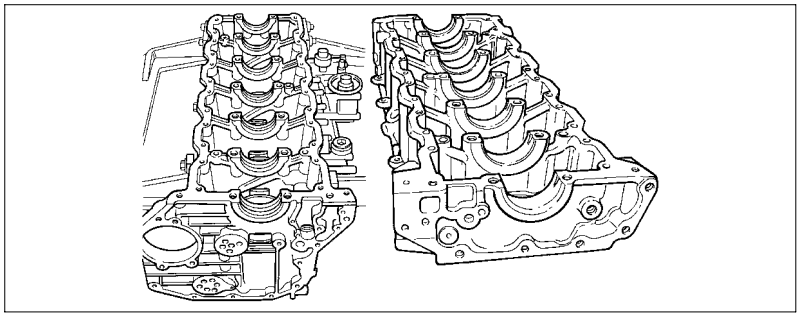
CLASS	MAIN JOURNALS NOMINAL DIAMETER
1	99.970 to 99.979
2	99.980 to 99.989
3	99.990 to 100.000

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



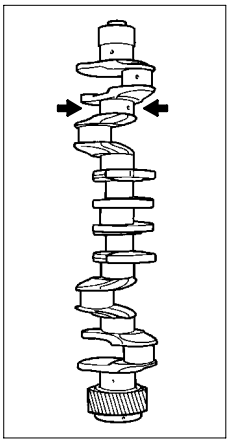


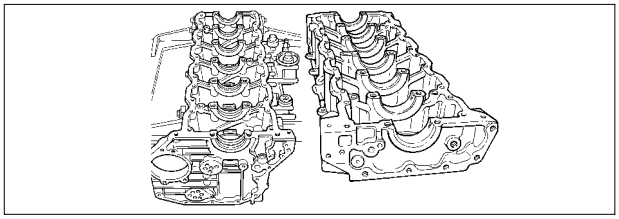
STD.	1	2	3
1	green	green	green
	green	green	green
2	red	green	green
	red	green	green
3	red	red	green
	red	red	green

SELECTING THE MAIN BEARING SHELLS (GROUND JOURNALS)

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

Figure 28



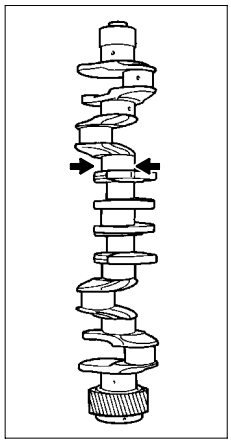


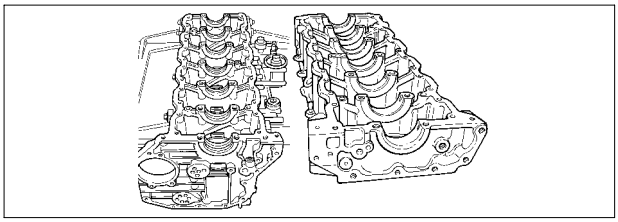
-0.127

red/black = 3.173 to 3183 mm

green/black = 3.184 to 3.193 mm

		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	green/black	green/black
		red/black	green/black	green/black
99.863 99.873	3	red/black	red/black	green/black
		red/black	red/black	green/black

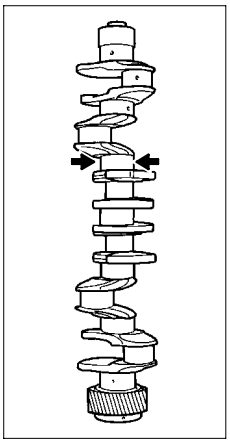


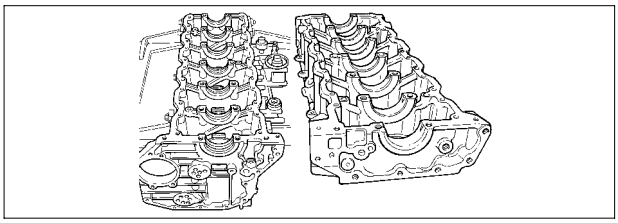


-0.254

red = 3.237 to 3.247 mm

	1	2	3
99.726 99.746	red	red	red
	red	red	red





-0.508

red = 3.364 to 3.374 mm

	1	2	3
99.468 99.508	red	red	red
	red	red	red

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

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

1 Letter indicating the class of weight:

A = 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

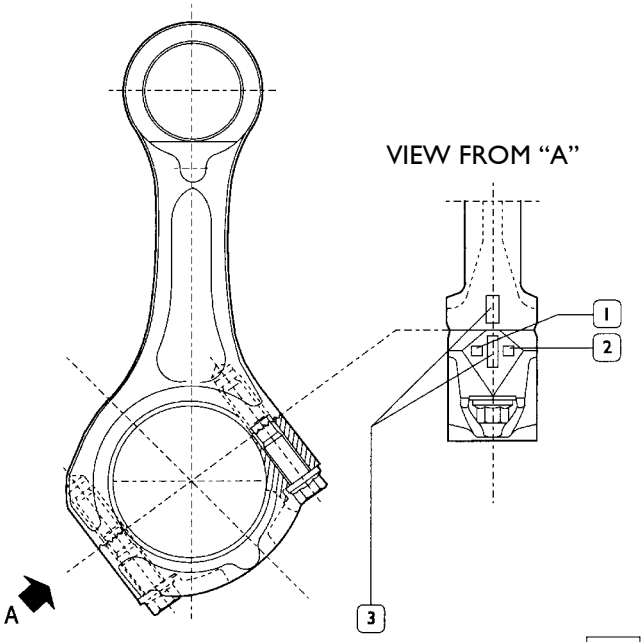
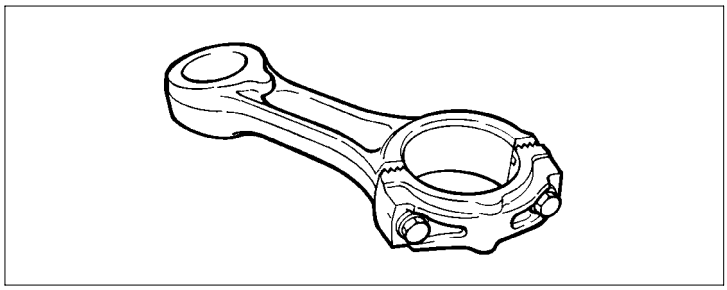
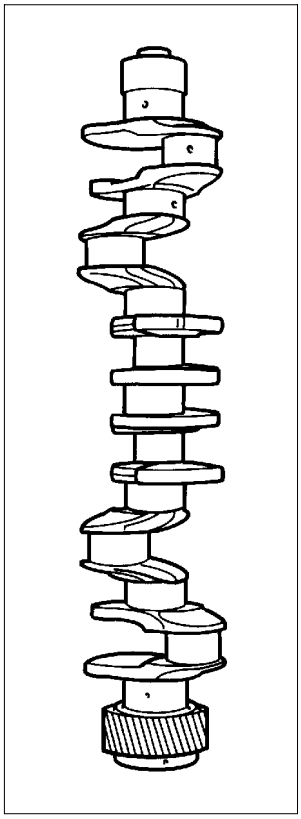


Figure 30

STD.



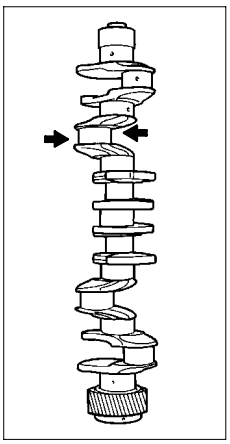


CLASS	1	2	3
1	green	green	green
	green	green	green
2	red	green	green
	red	green	green
3	red	red	green
	red	red	green

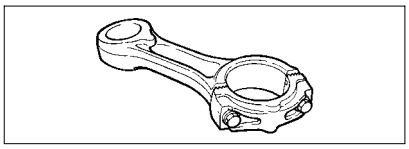
Selecting big end bearing shells (ground journals)

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

Figure 31



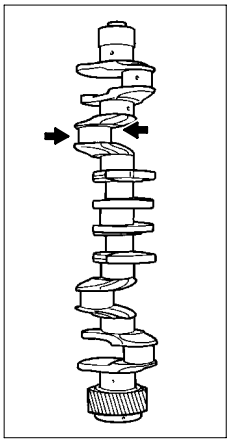
-0.127



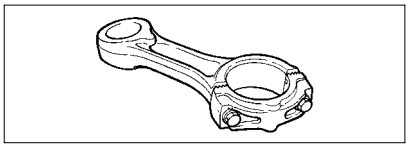
red/black = 2.028 to 2.038 mm

green/black = 2.039 to 2.048 mm

		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	green/black	green/black
		red/black	green/black	green/black
89.863 89.873	3	red/black	red/black	green/black
		red/black	red/black	green/black

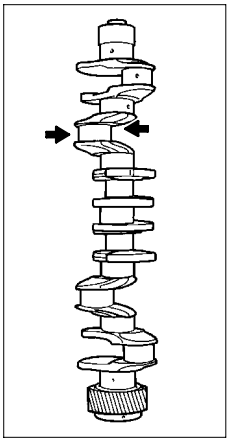


-0.254

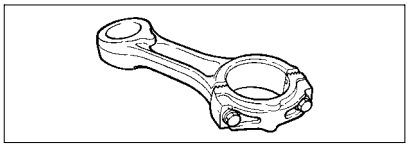


red = 2.092 to 2.102 mm
green = 2.103 to 2.112 mm

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



-0.508



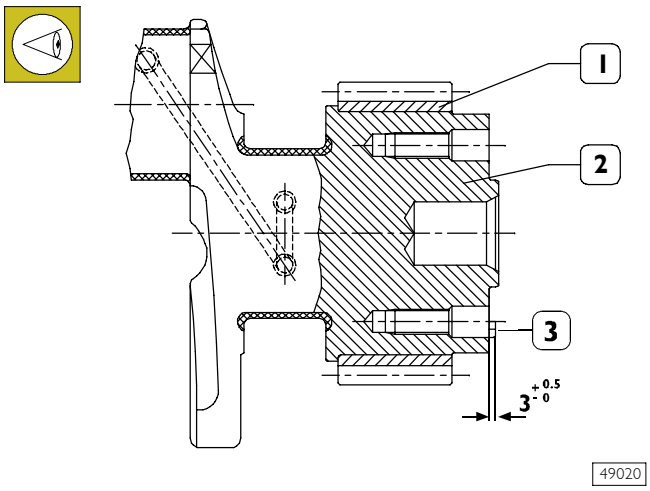
red = 2.219 to 2.229 mm
green = 2.230 to 2.239 mm

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



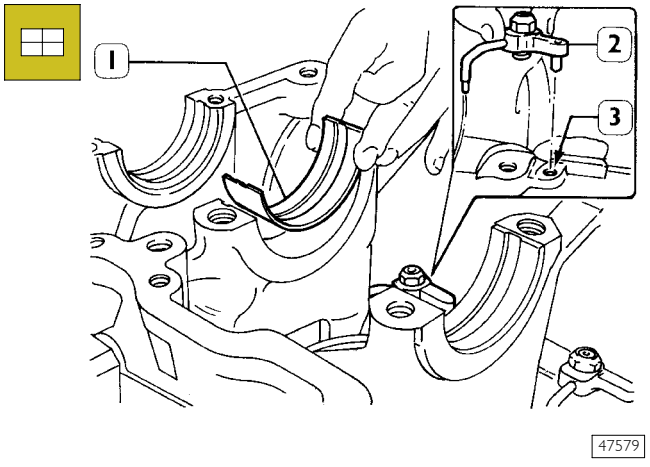
49020

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

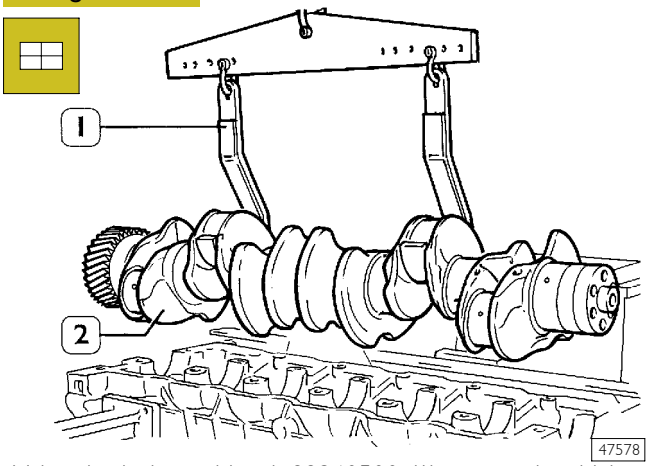
Figure 33



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.

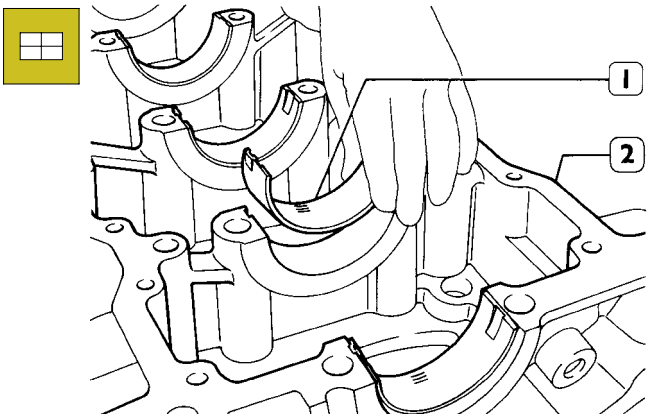
Figure 34



47578

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

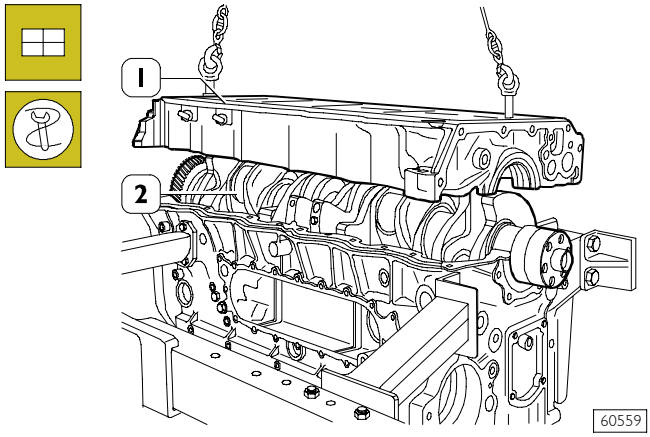
Figure 35



49021

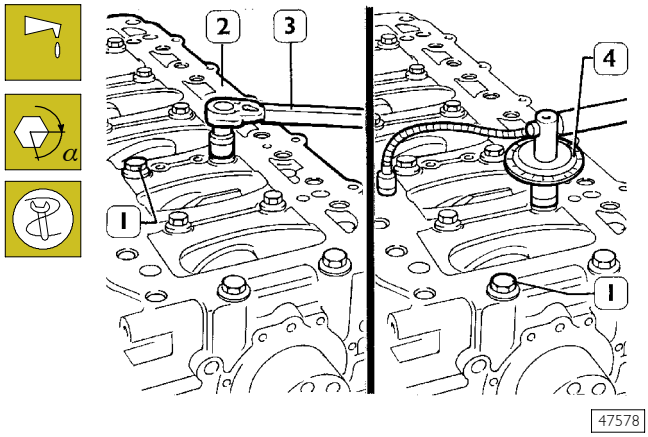
Install the half-bearings (1) on the main bearings in the underblock (2).
Check the installation clearance between the main journals and the relative bearings as follows:

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).

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

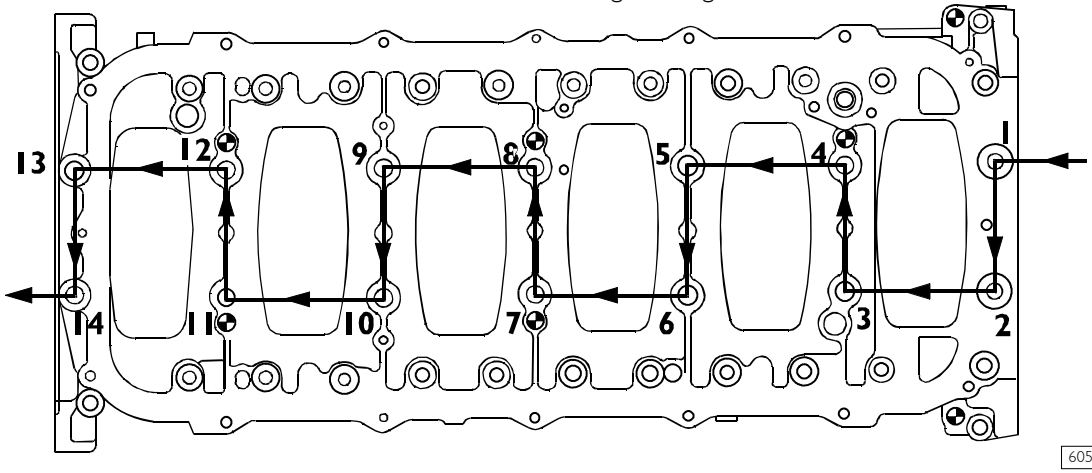
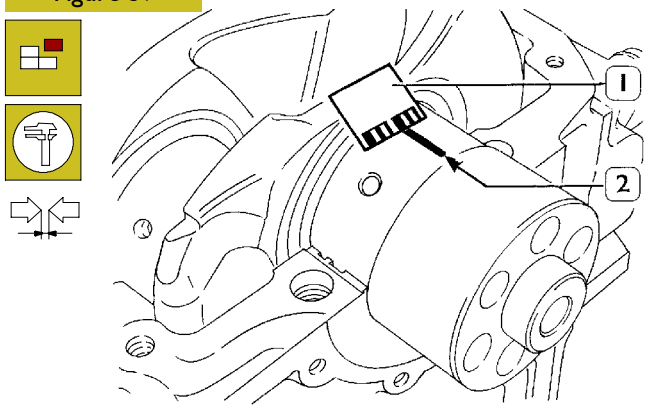


DIAGRAM OF SEQUENCE FOR TIGHTENING THE SCREWS FIXING THE BOTTOM CRANKCASE BASE TO THE CRANKCASE

Figure 39

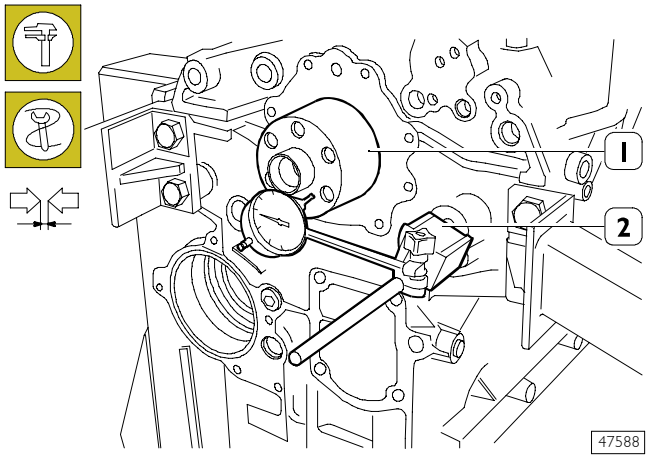


❑ Remove the crankcase base.

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

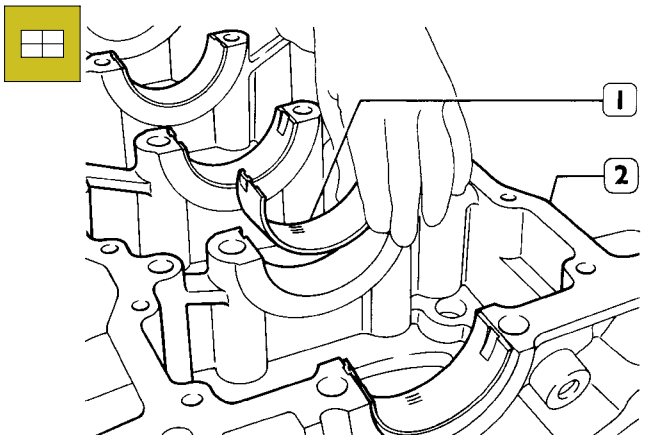
Figure 40



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

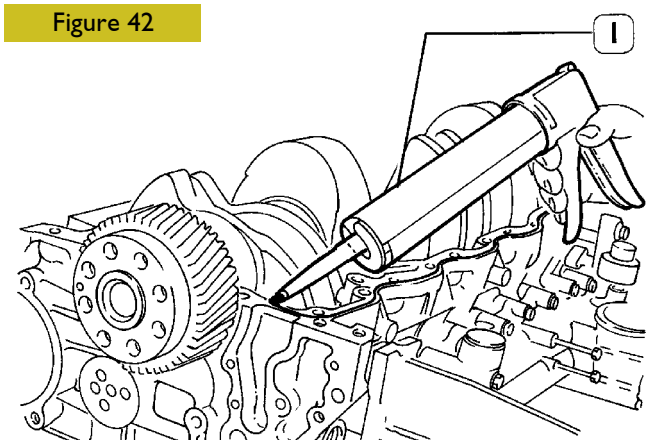
Figure 41



49021

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

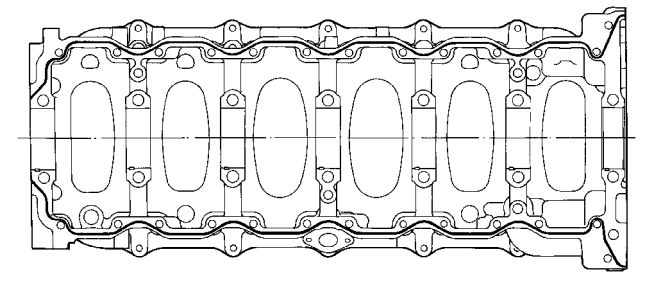
Figure 42



47595

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

Figure 43



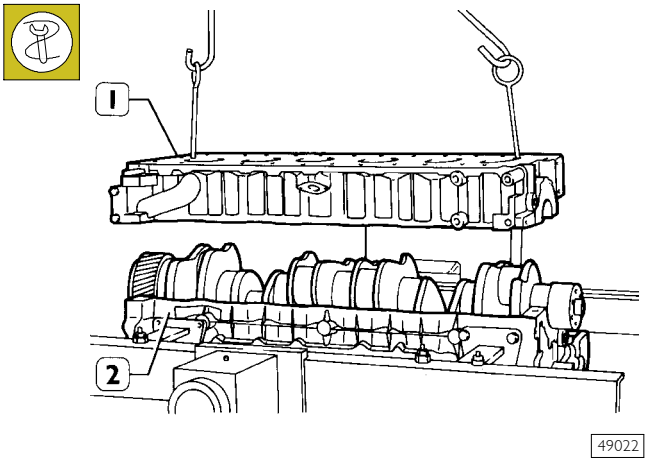
47596

Sealant application diagram

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

NOTE Use new screws whenever the crankcase is refitted.

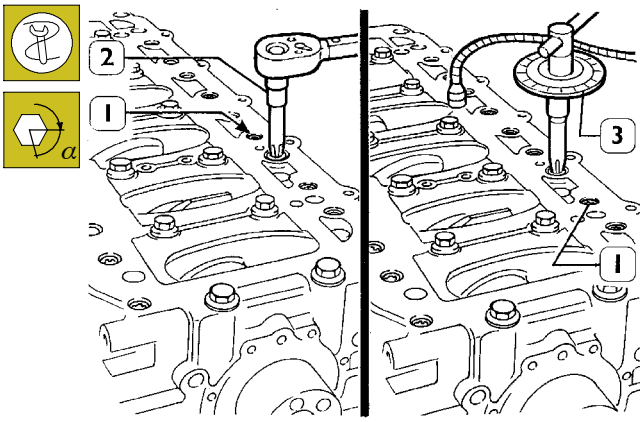
Figure 44



49022

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

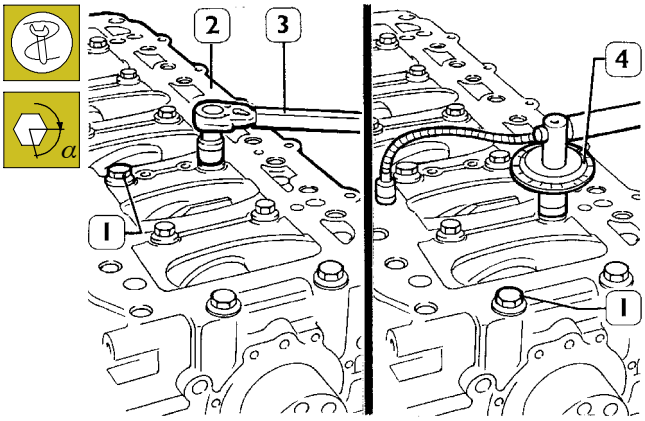
Figure 45



47581

Fit the sub-engine block and use a dynamometric wrench (2) to tighten the outer hexagonal-grooved screws (1) to 30 Nm according to the diagrams on the following page.

Figure 46



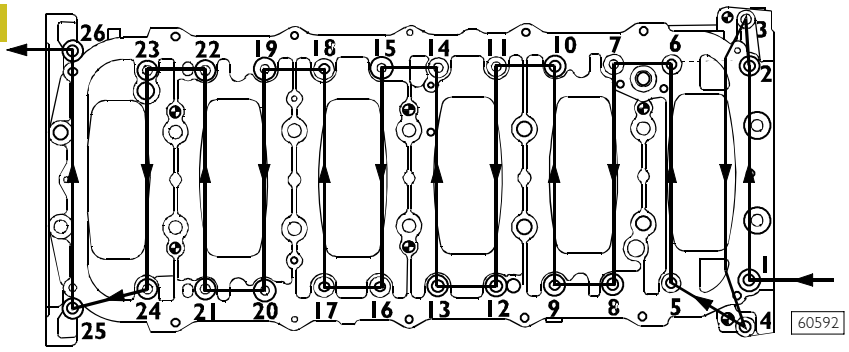
47579

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).

DIAGRAM SHOWING THE UNDERBLOCK FIXING SCREWS TIGHTENING ORDER

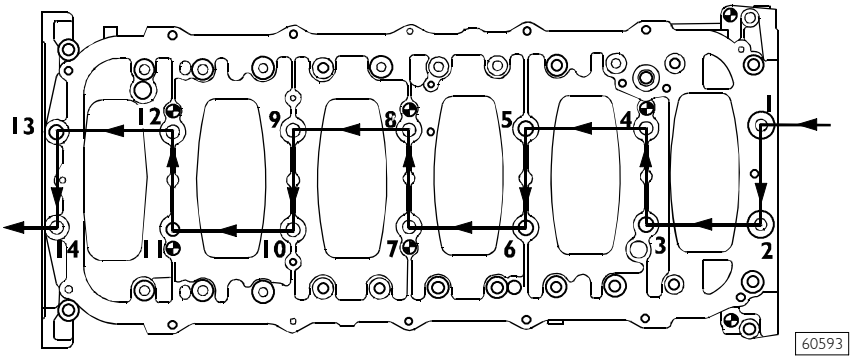
Figure 47

FRONT SIDE



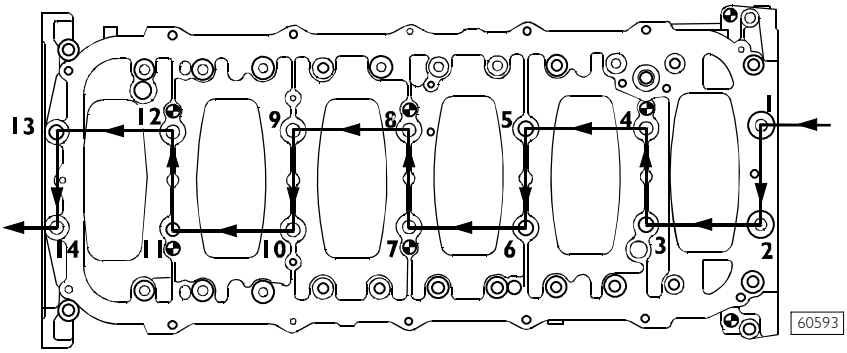
stage 1: pretightening outer screws (30 Nm)

FRONT SIDE



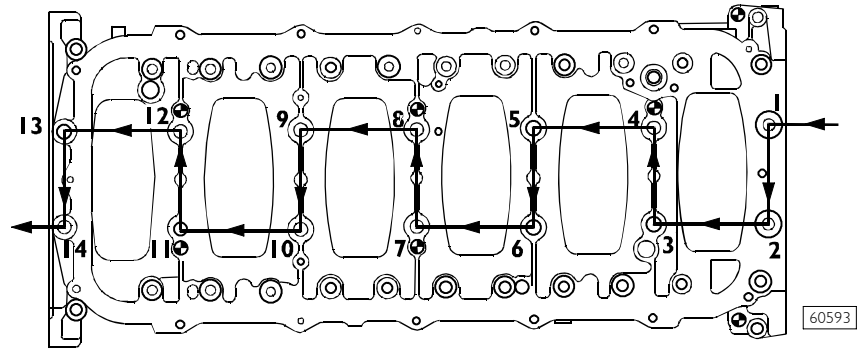
stage 2: pretightenig inner screws (120 Nm)

FRONT SIDE



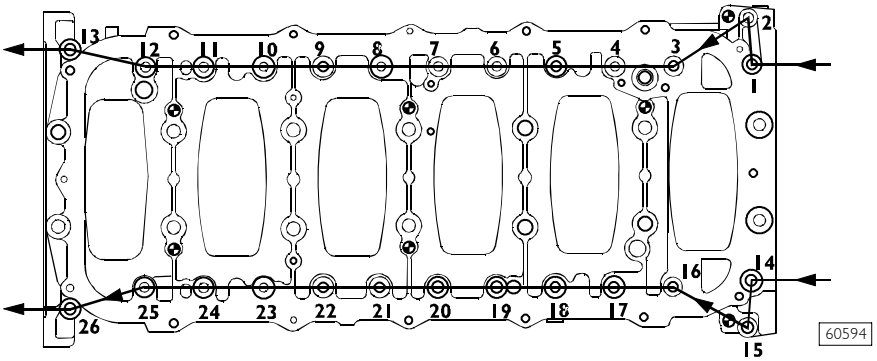
stage 3: angle inner screws (60°)

FRONT SIDE



stage 4: angle inner screws (55°)

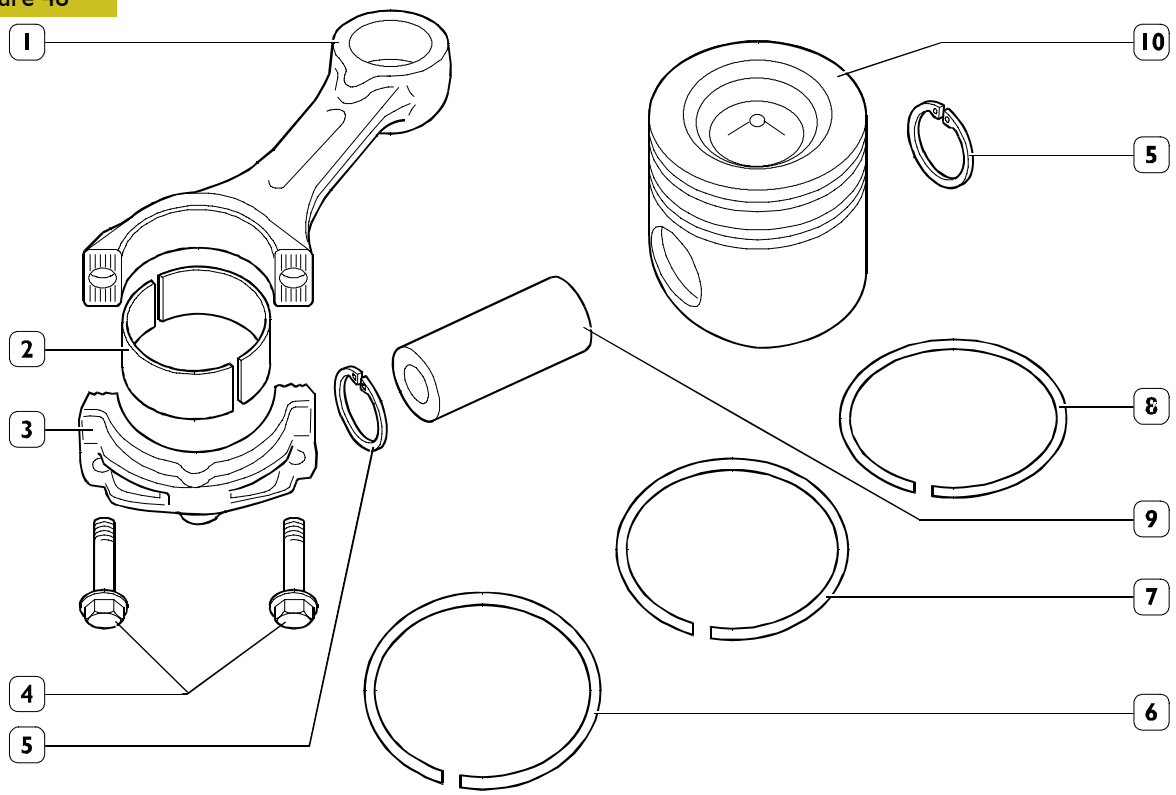
FRONT SIDE



stage 5: angle outer screws (60°)

PISTON CONNECTING ROD ASSEMBLY

Figure 48



60607

PISTON CONNECTING ROD ASSEMBLY

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

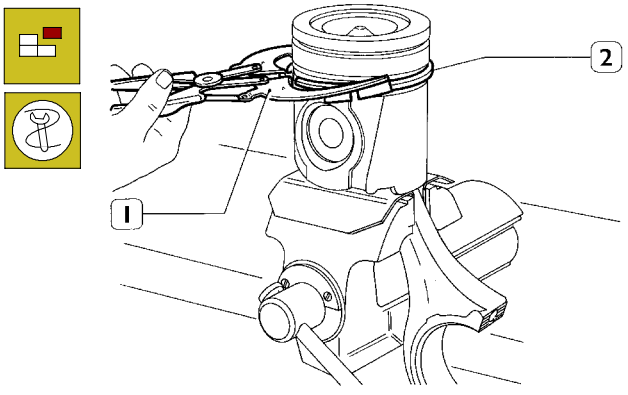
Make sure the piston does show any trace of seizing, scoring, cracking; replace as necessary.

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

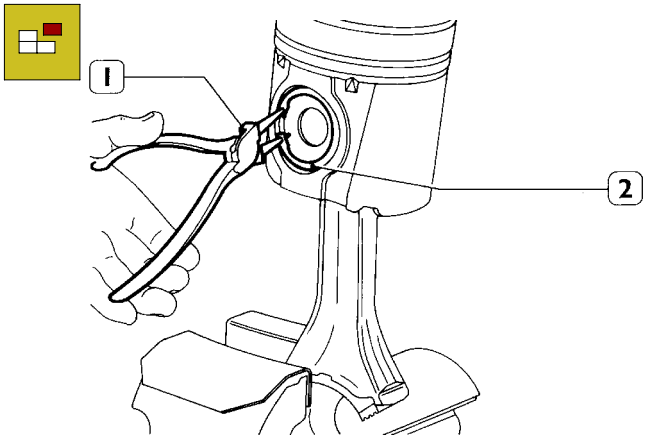
Figure 49



60608

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

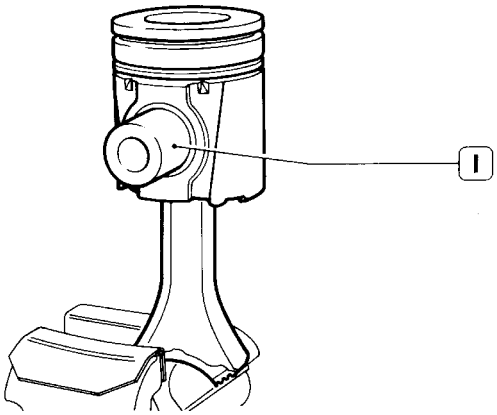
Figure 50



49024

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

Figure 51

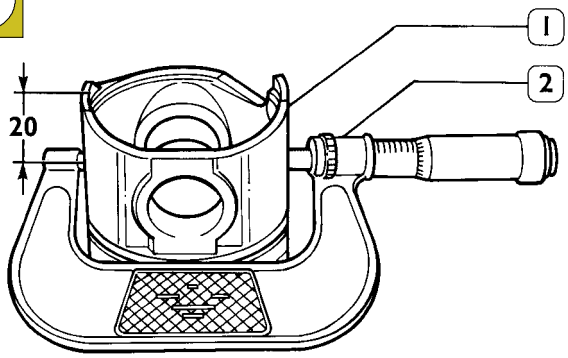


49025

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

Measuring the diameter of the pistons

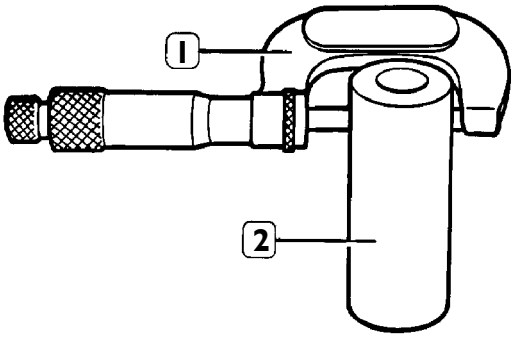
Figure 52



71714

Using a micrometer (2), measure the diameter of the piston (1) to determine the assembly clearance; the diameter has to be measured at the value X shown:

Figure 53

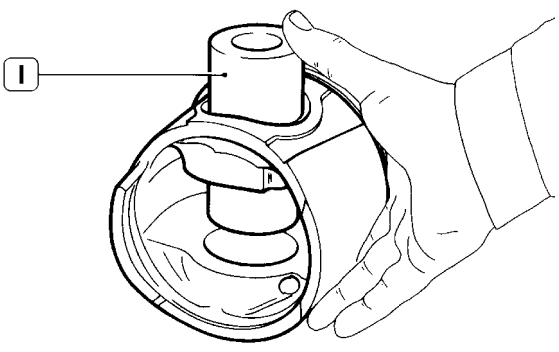


32618

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

Conditions for correct gudgeon pin-piston coupling

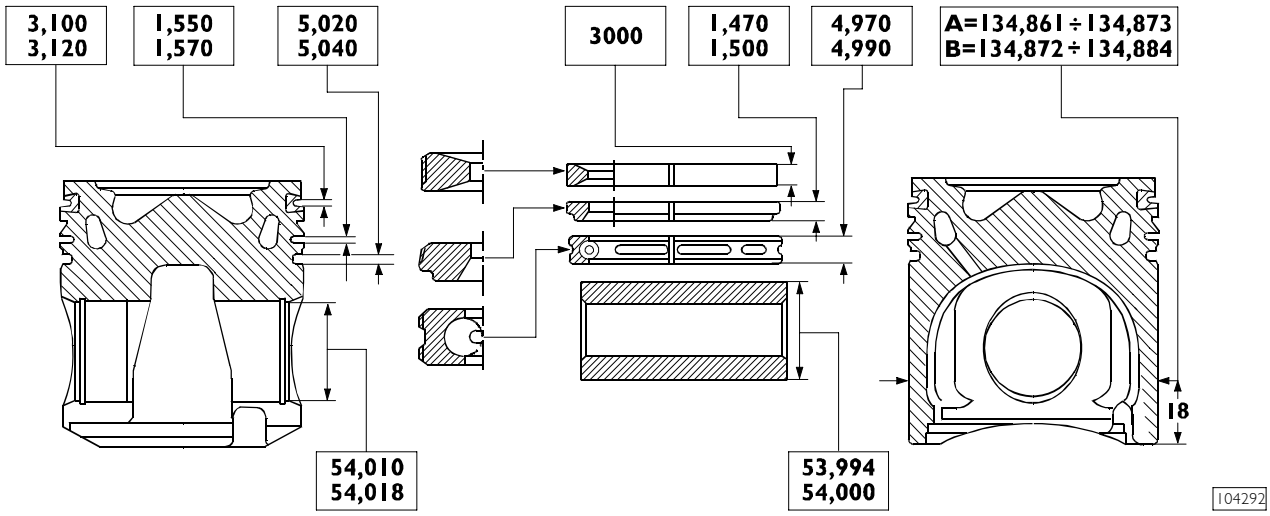
Figure 54



49026

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

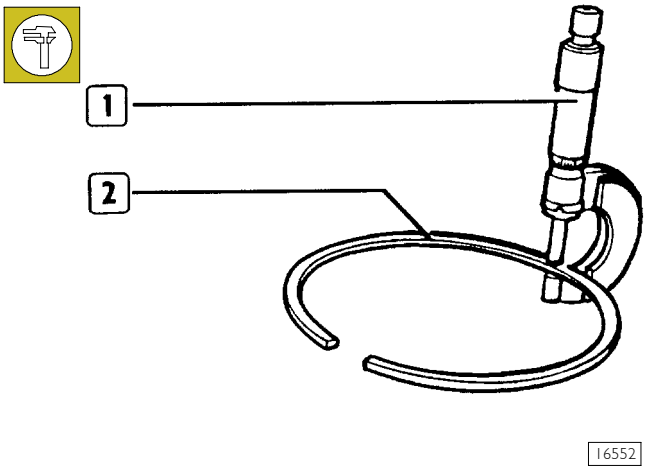
Figure 55



MAIN DATA OF THE PISTON, PISTON RINGS AND PIN

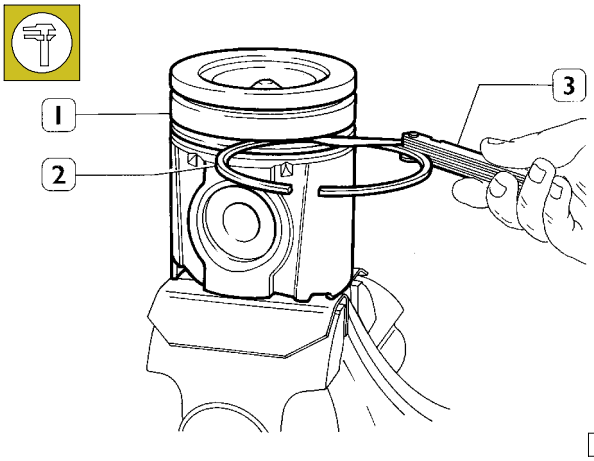
Piston rings

Figure 56



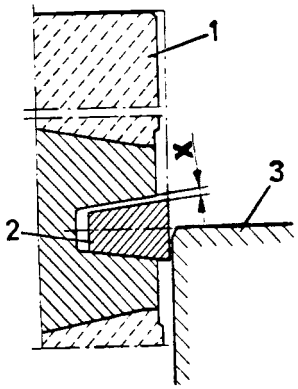
Check the thickness of the piston ring (2) with a micrometer (1).

Figure 57



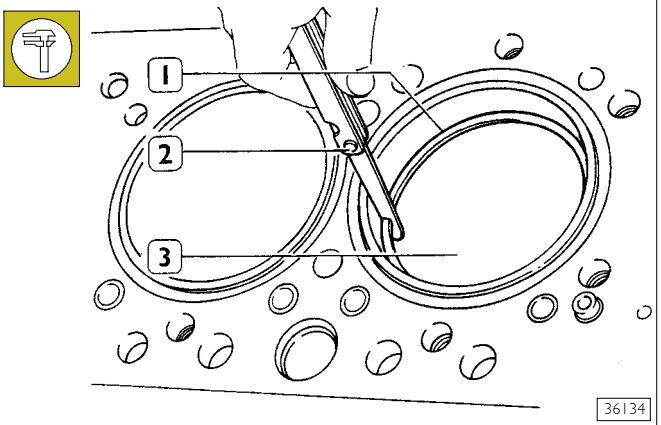
Check the clearance between the seals (2) and their seats on the piston (1) with a feeler gauge (3).

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

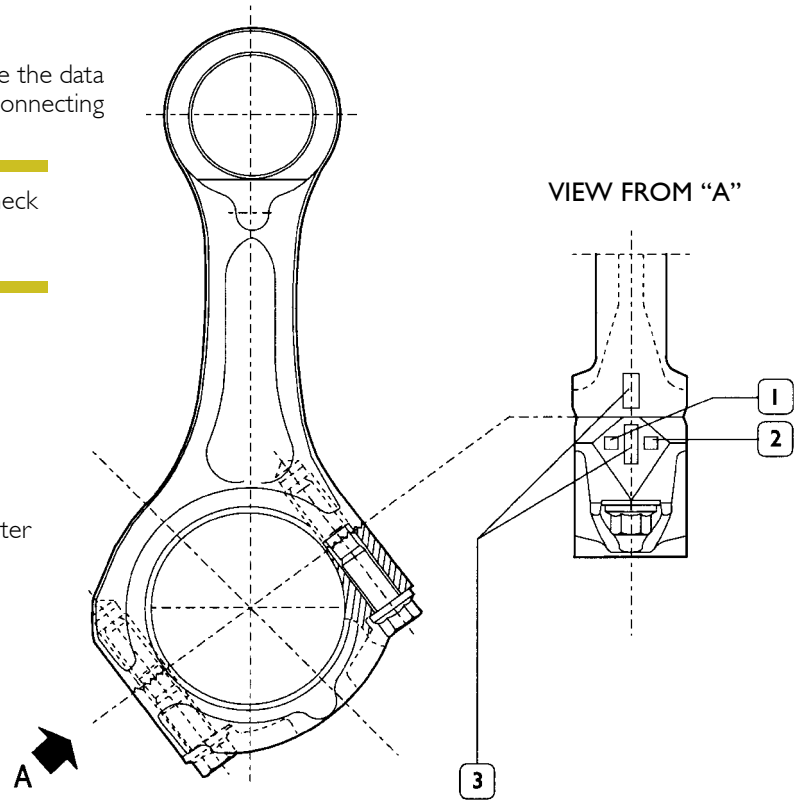
1 Letter indicating the class of weight:

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:

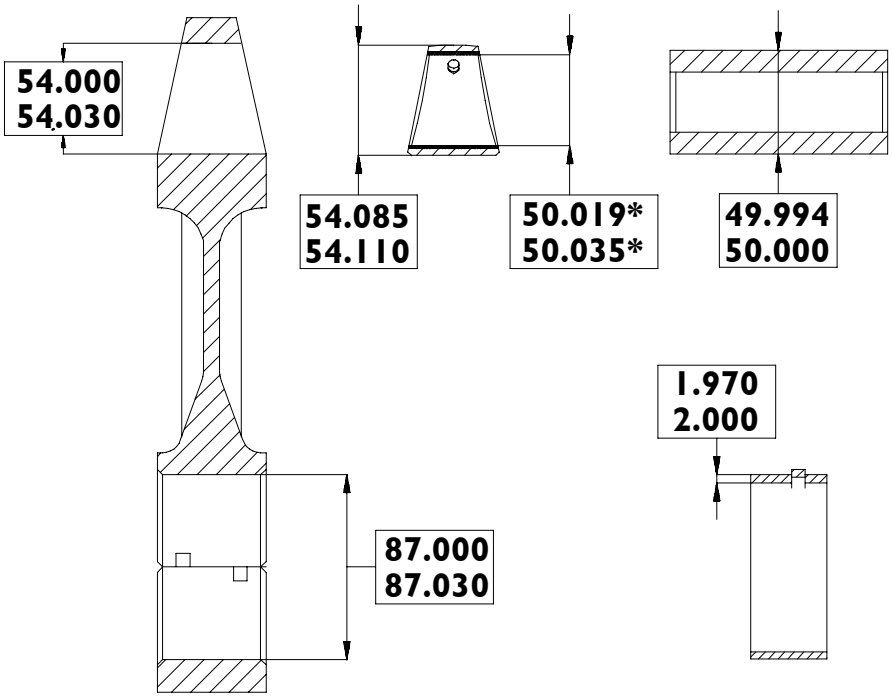
1 = 94.000 to 94.010 mm
2 = 94.011 to 94.020 mm
3 = 94.021 to 94.030 mm

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



47957

Figure 61



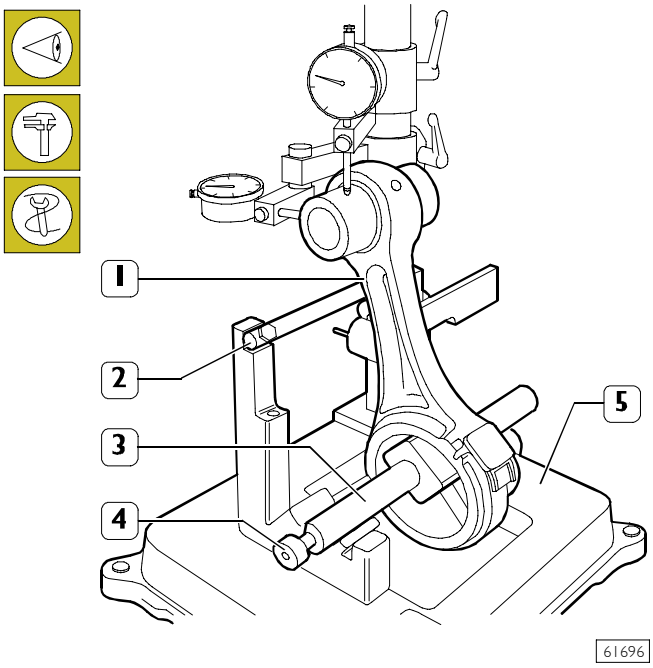
71716

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

* Measurement to be made after driving in the bushing.

Checking connecting rod alignment

Figure 62 (Demonstration)



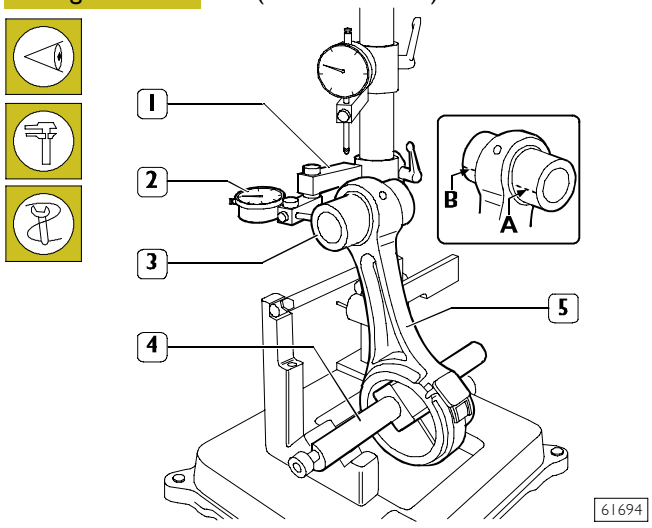
Checking axis alignment

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

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

Checking torsion

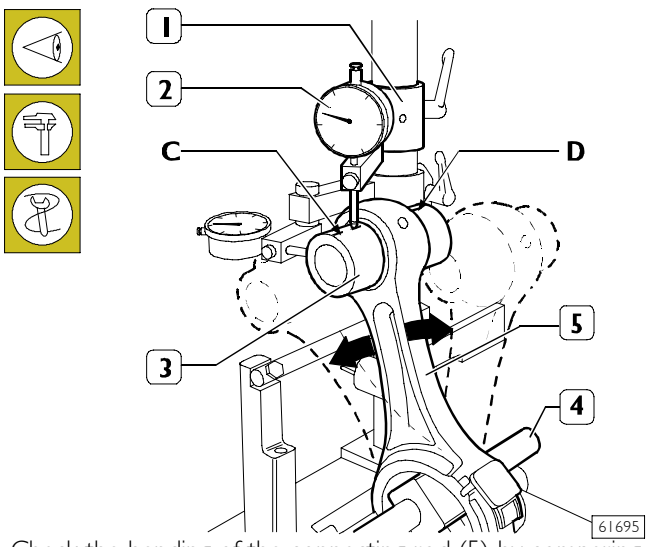
Figure 63 (Demonstration)



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

Checking bending

Figure 64 (Demonstration)



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

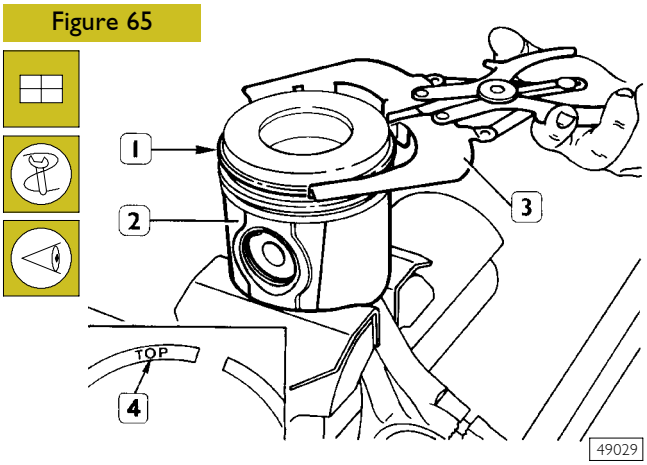
Mounting the connecting rod - piston assembly

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

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

Mounting the piston rings

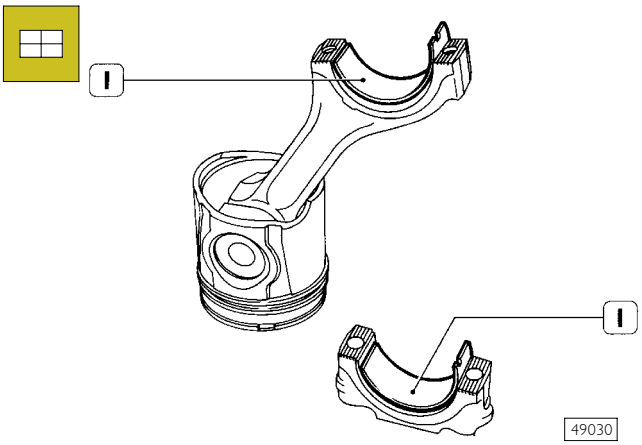
Figure 65



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

Fitting the connecting rod-piston assembly into the piston liners

Figure 66



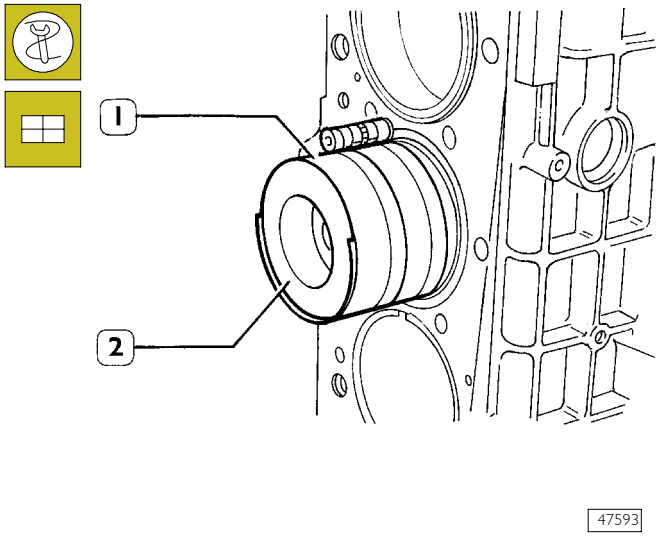
Fit the half-bearings (1), selected as described on pages 22 to 23, both on the connecting rod and on the stand.

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

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

- ❑ the openings of the split rings are offset by 120°;
- ❑ all pistons belong to the same class, A or B;
- ❑ ideogram stamped on the piston crown is placed toward the engine flywheel, or the cavity, on the piston cover, corresponds to the position of the oil spray nozzles.

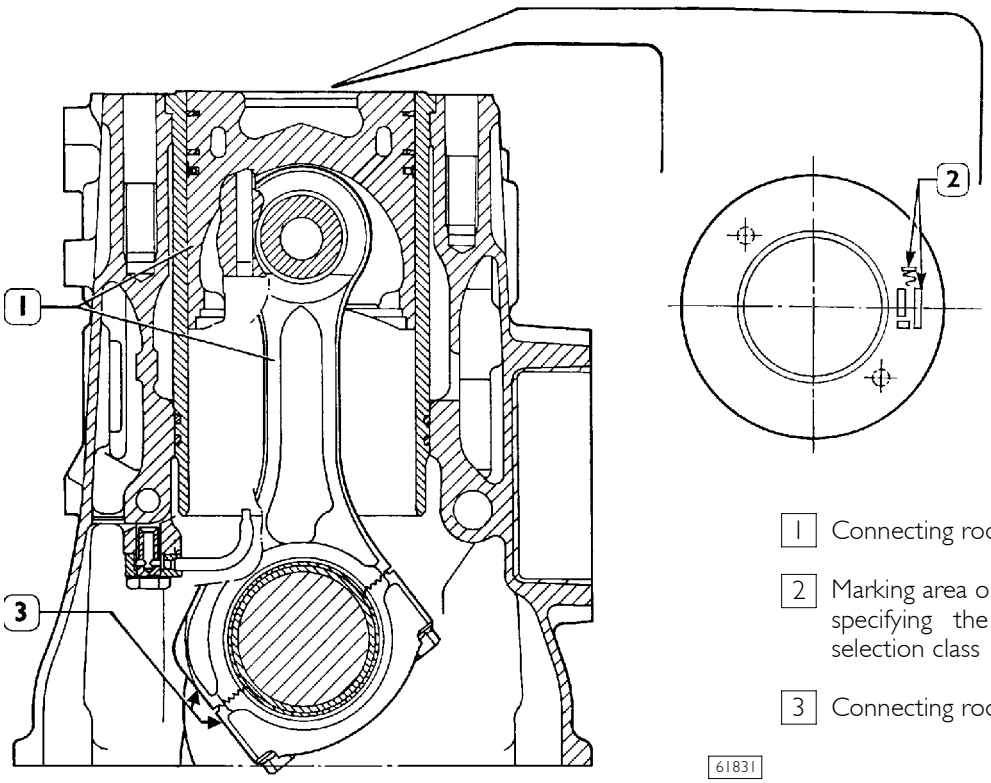
Figure 68



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

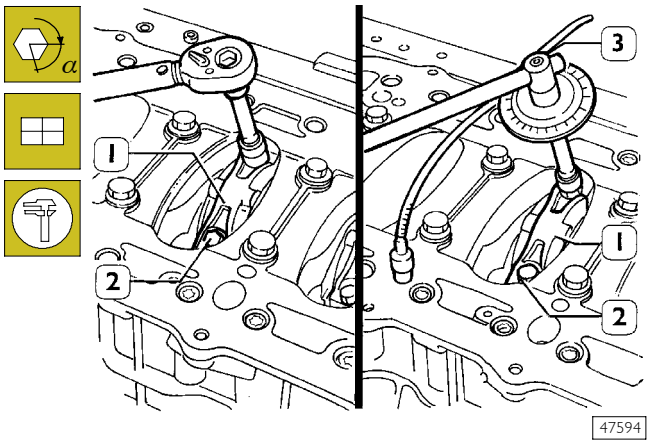
3 Connecting rod marking area (see Figure 60).

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.

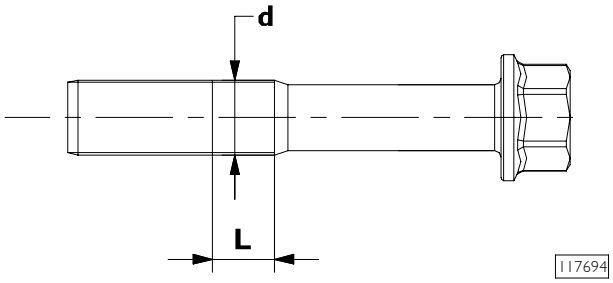
Figure 71



Install the connecting rod caps (1) with half-bearings; tighten the connecting rod cap fixing screws (2) to 60 Nm (6 kgm) torque. By tool 99395216 (3), tighten the screws further at 60° angle.

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

NOTE The connecting rod cap screws may be reused providing the thread diameter (d) measured in the (L) zone is at least 13.4 mm. Otherwise, replace the screw. Lubricate the screws with engine oil before refitting.



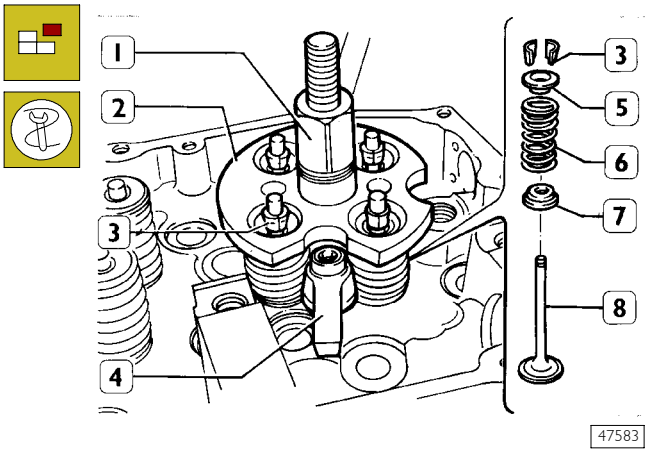
NOTE Lubricate the threads of the screws (2) with engine oil before assembly.

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

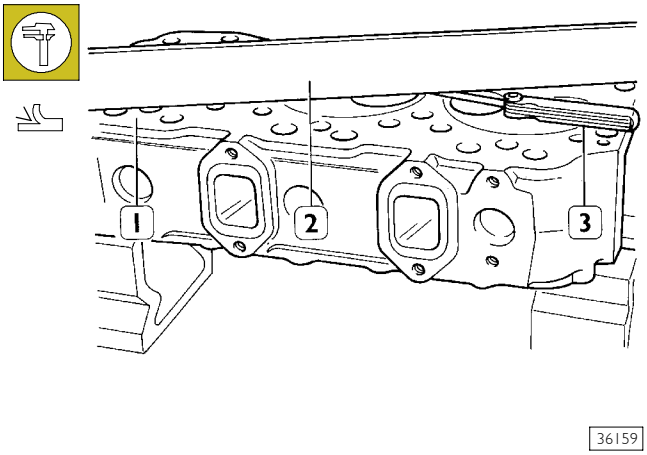
Figure 69



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)

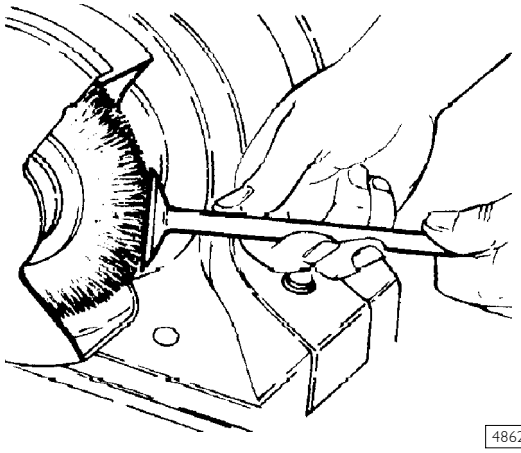


The planarity (1) is checked using a ruler (2) and a thikness gauge (3). If deformations exist, surface the head using proper surface grinder; the maximum amount of material to be removed is 0.2 mm.

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

Removing deposits and checking the valves

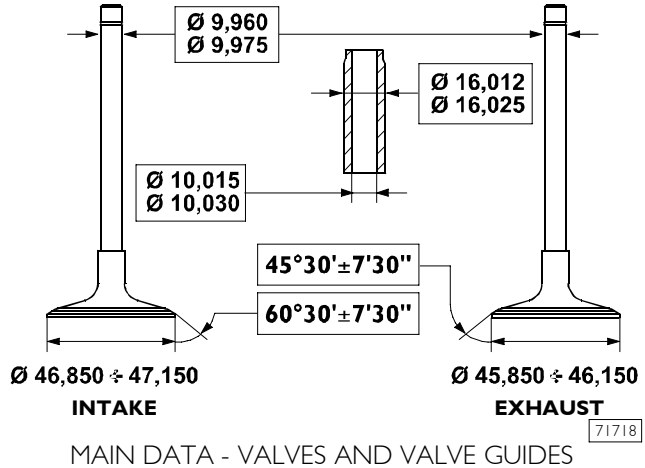
Figure 72



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



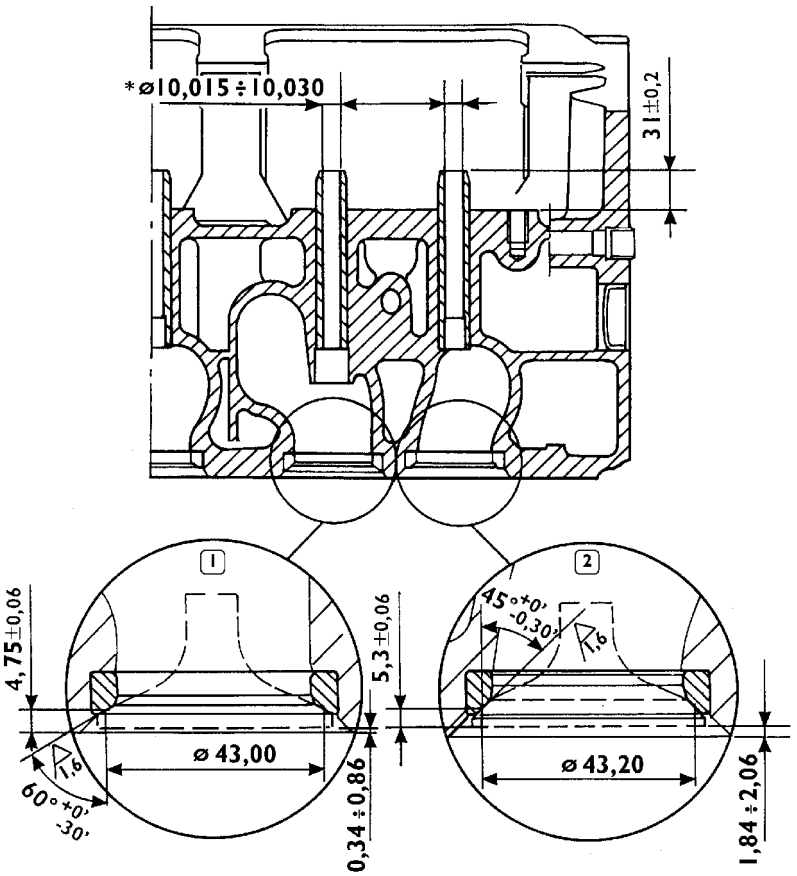
MAIN DATA - VALVES AND VALVE GUIDES

* 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

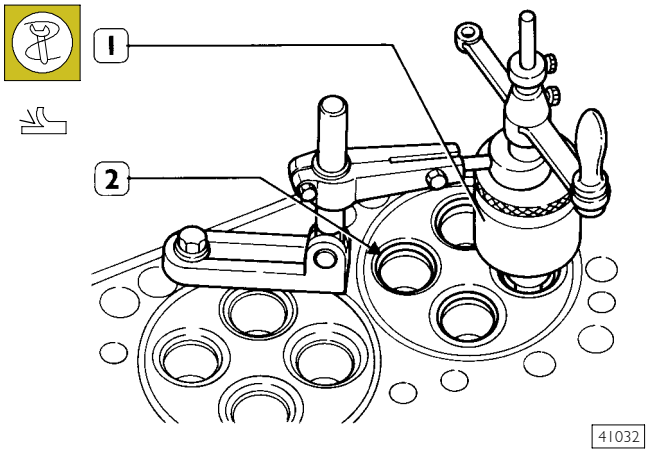
Replacing of valve guides

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 74. 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.

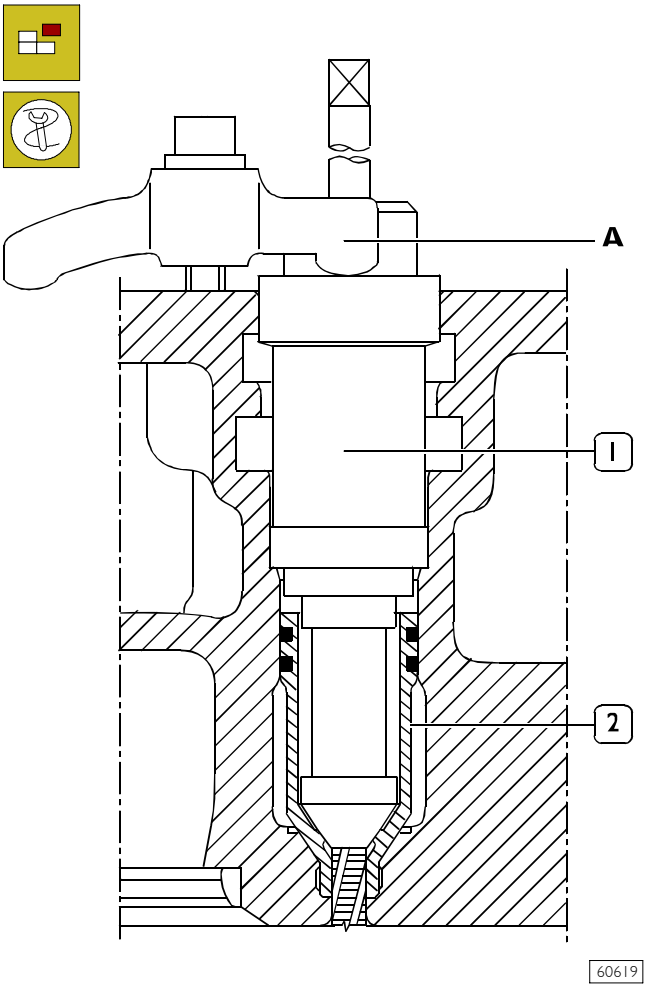
Heat the cylinder head to 80 – 100°C and, using a drift, fit in the new valve seats (2), chilled beforehand in liquid nitrogen. Using tool (1), regrind the valve seats according to the angles shown in Figure 73.

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 - -2.1 mm (recessing) exhaust valves.

Replacing injector cases
Removal

Figure 76

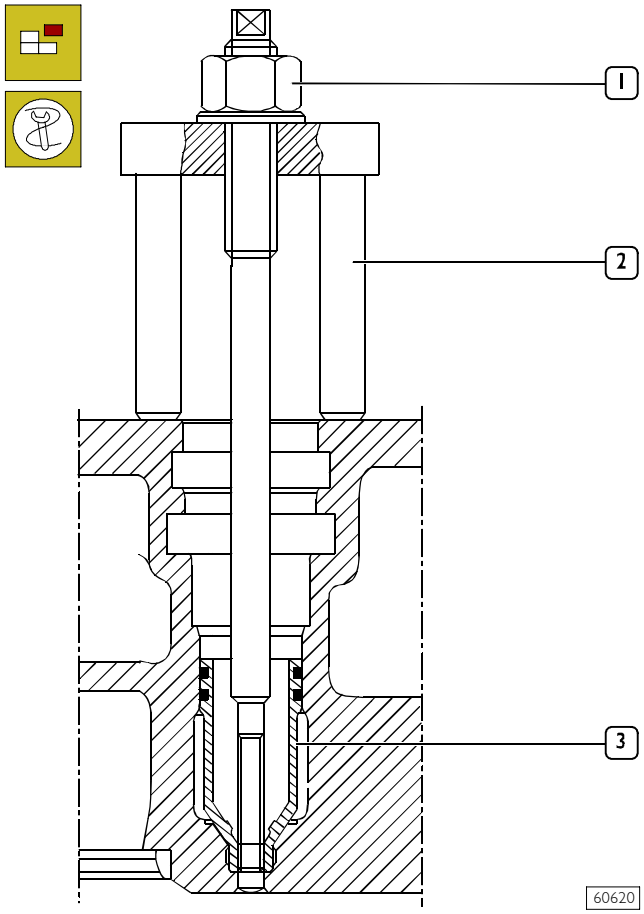


To replace the injector case (2), act as follows:

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

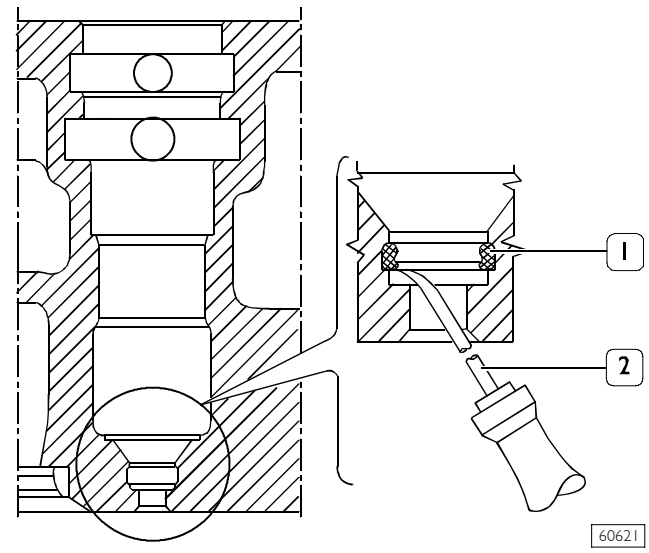
Carry out operations described in figs. 77 - 80 - 81 - 82 by fixing tools to the cylinder head by means of braket A.

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.

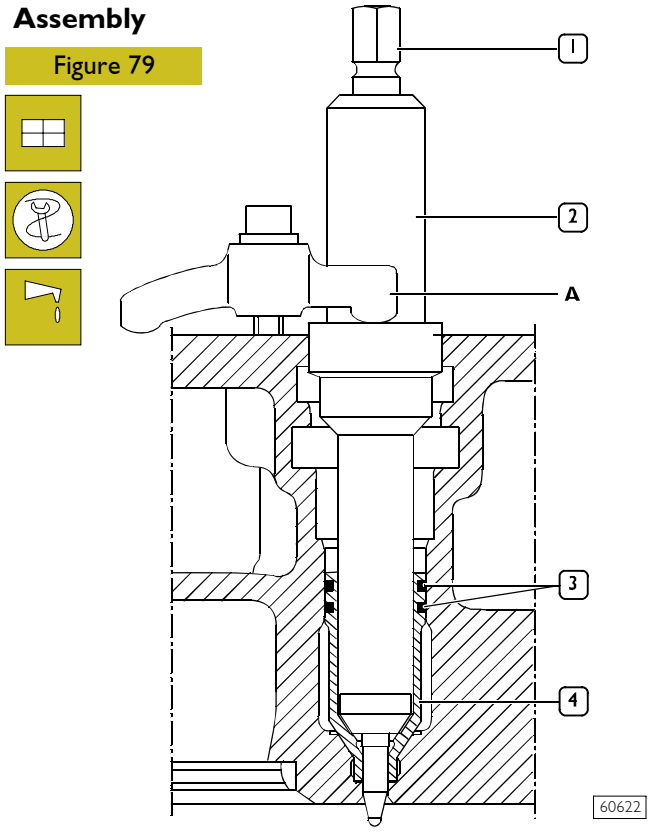
Figure 78



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

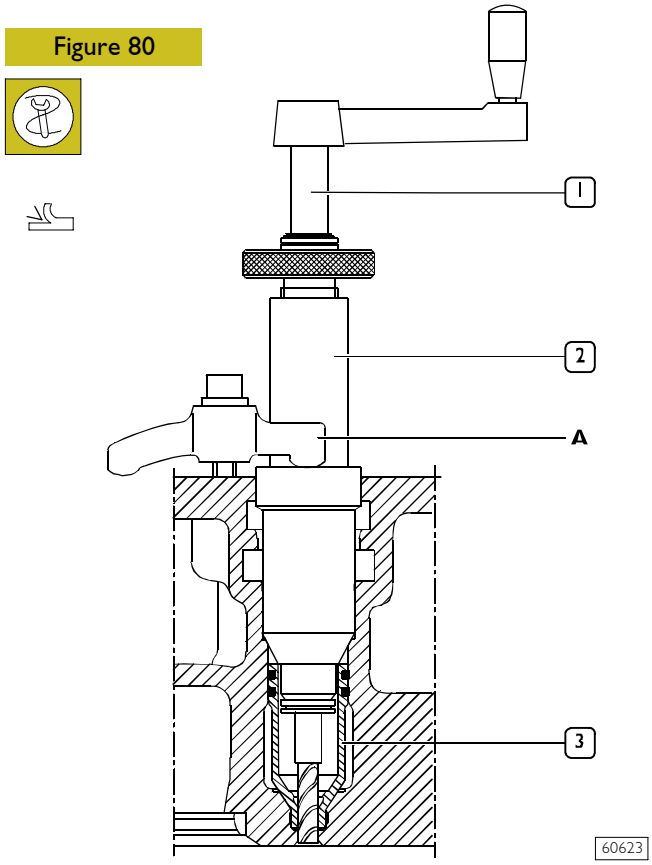
Assembly

Figure 79



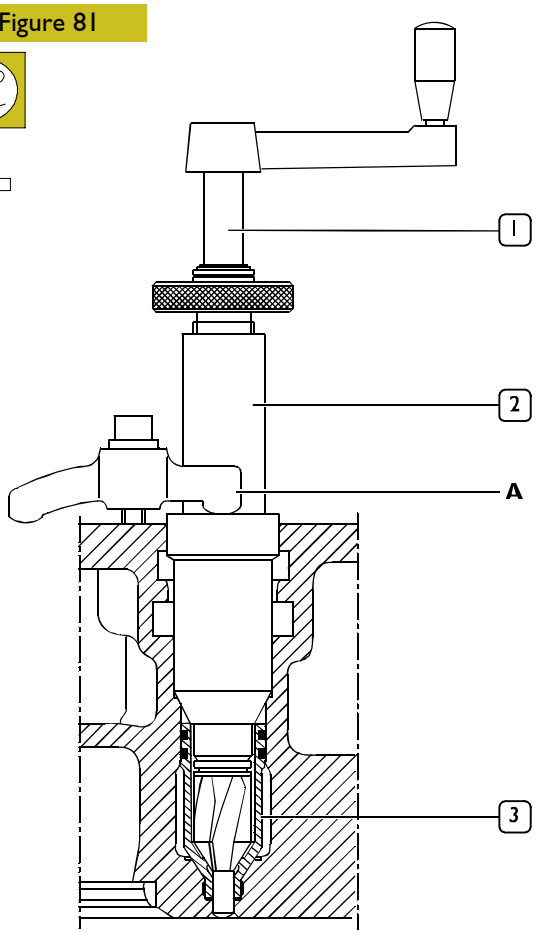
❑ Lubricate the seals (3) and fit them on the case (4). Using tool 99365056 (2) secured to the cylinder head with bracket **A**, drive in the new case, screwing down the screw (1) upsetting the bottom portion of the case.

Figure 80



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

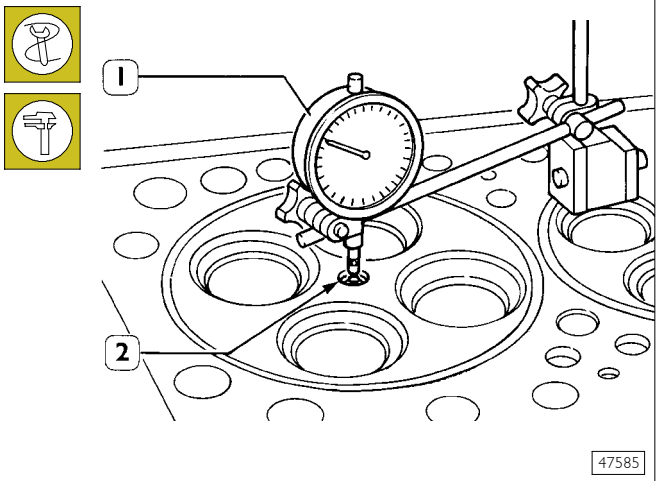
Figure 81



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

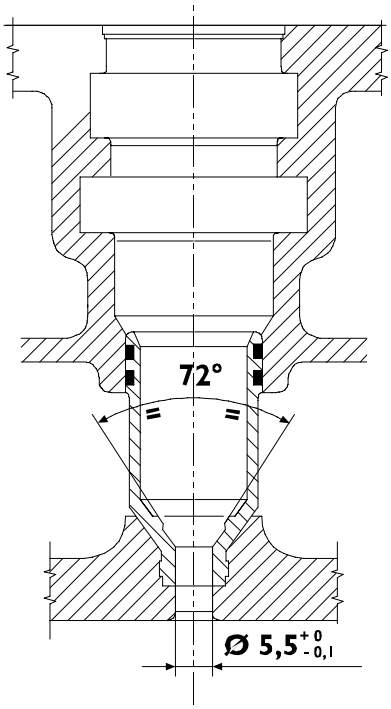
Checking injector protrusion

Figure 82



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

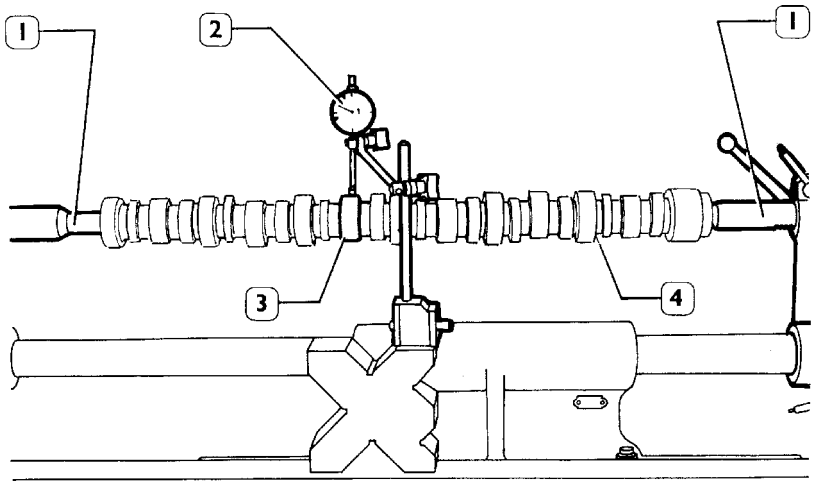
Figure 83



INJECTOR CASE ASSEMBLY DIAGRAM

Camshaft
Checking cam lift and pin alignment

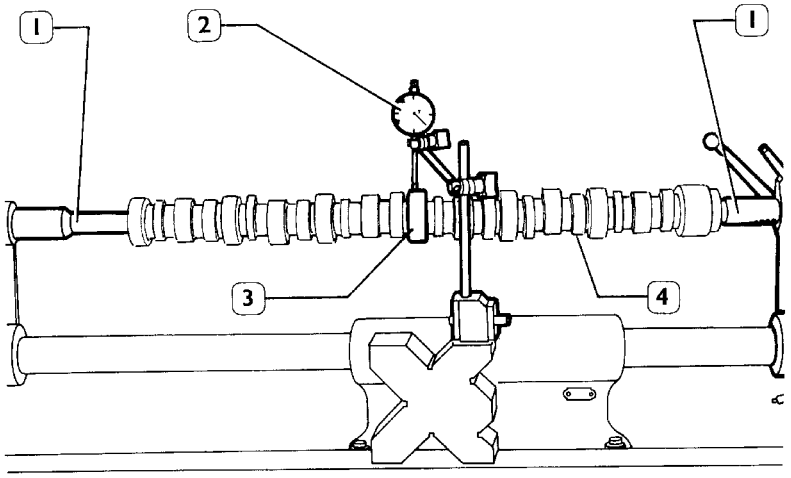
Figure 84



47506

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

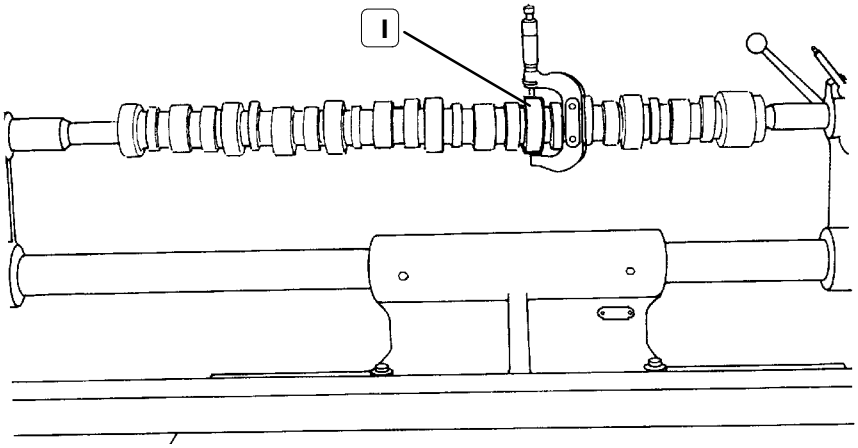
Figure 85



47507

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

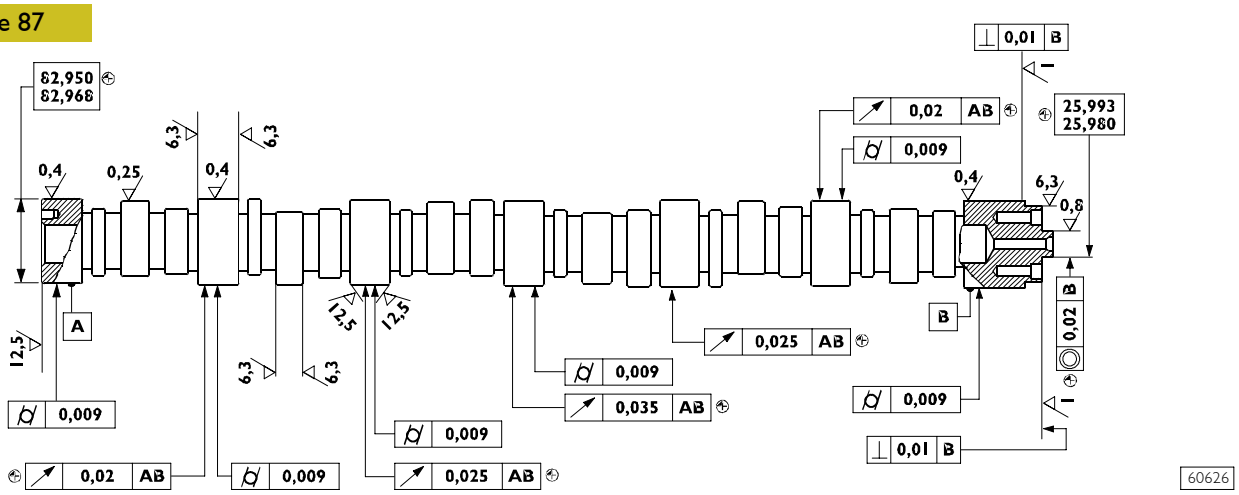
Figure 86



47505

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

Figure 87



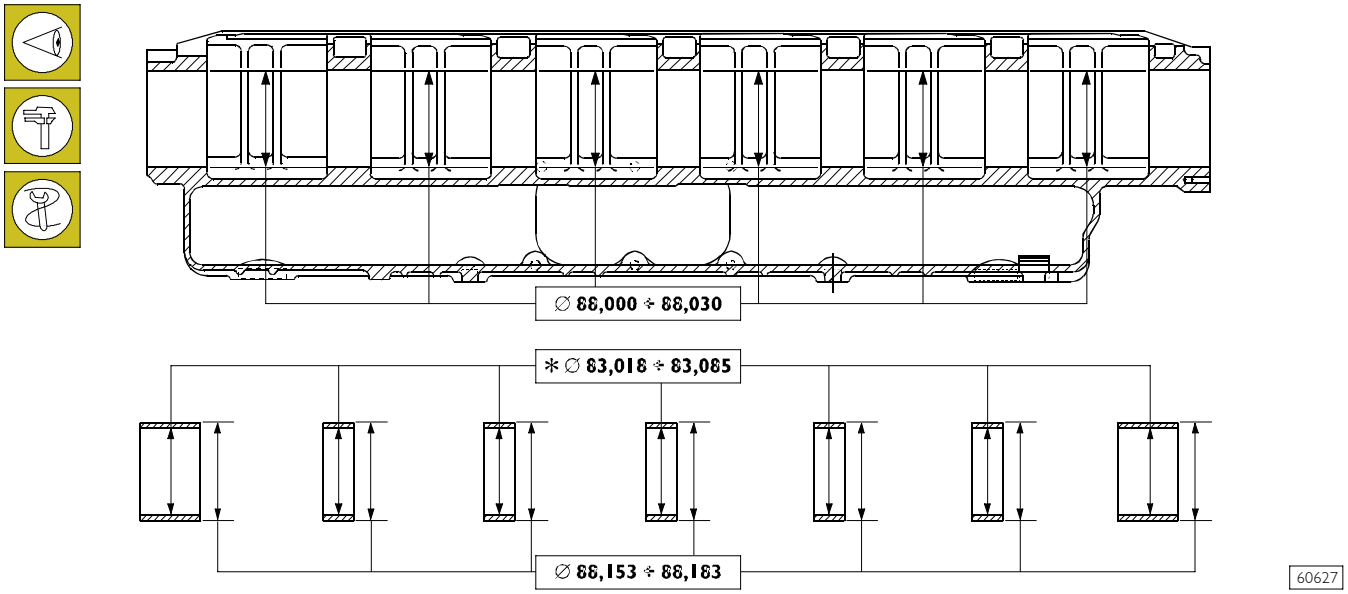
MAIN DATA OF THE CAMSHAFT AND TOLERANCES

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

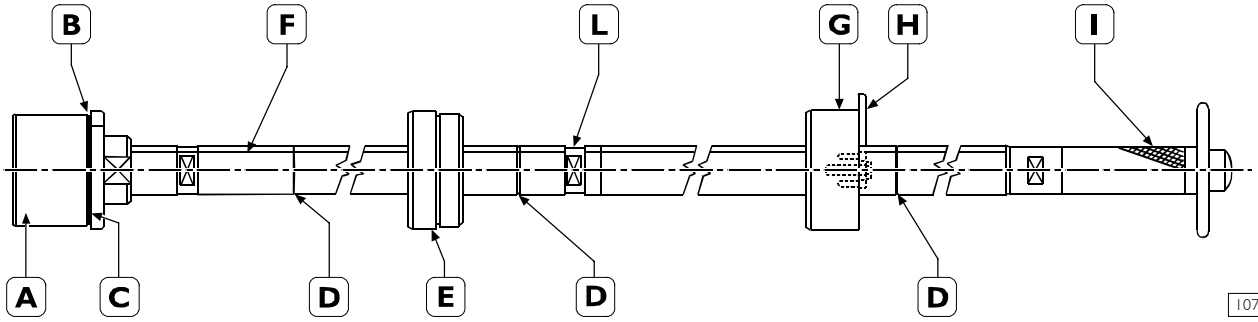
* Bushing inside diameter after driving in

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

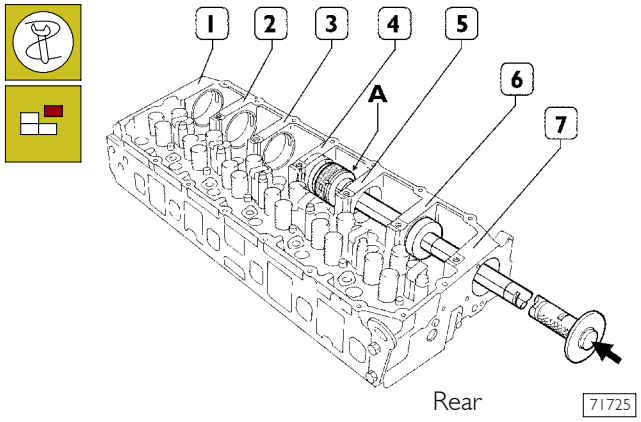
Figure 89



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

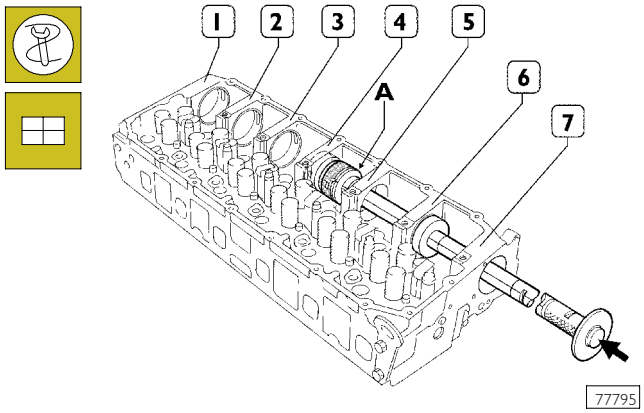
Figure 90



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

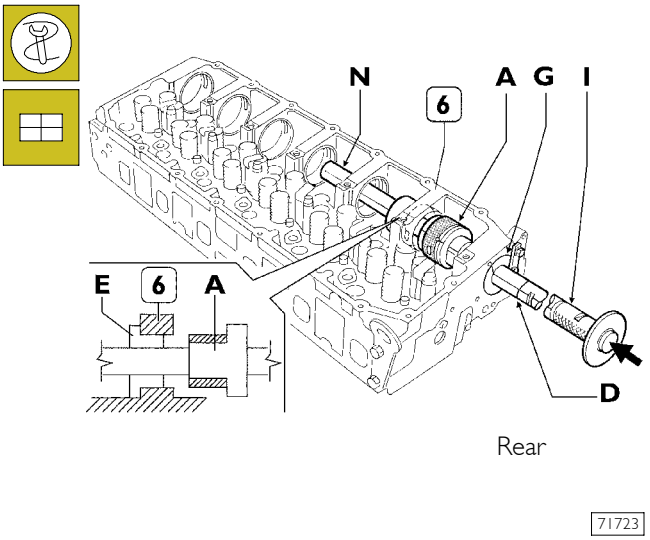
Figure 91



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).

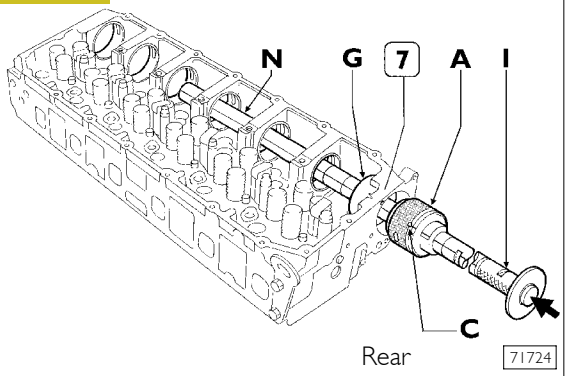
Figure 92



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

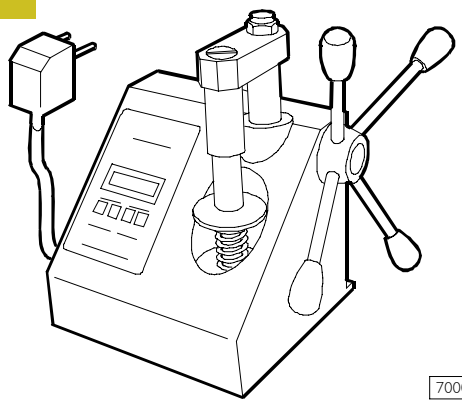


To insert bushing (7), proceed as follows:

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

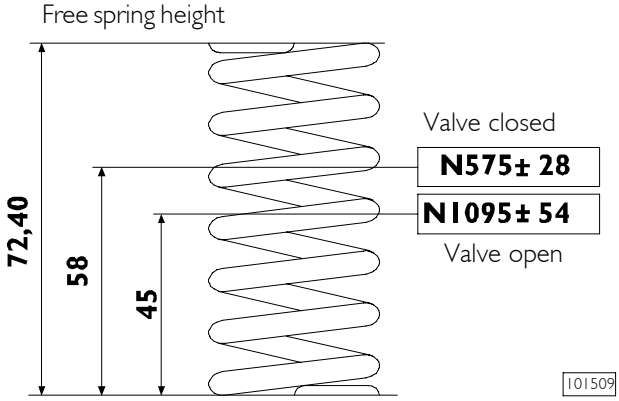
VALVE SPRINGS

Figure 94



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

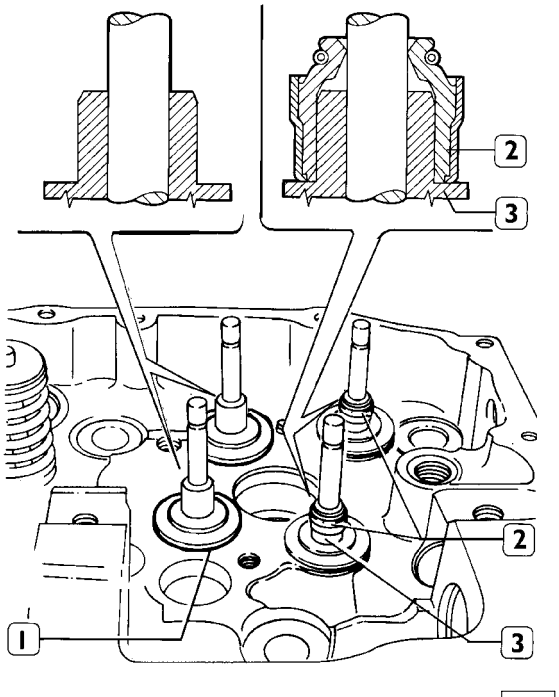
Figure 95



MAIN DATA TO CONTROL EXHAUST AND DISCHARGE VALVE SPRING

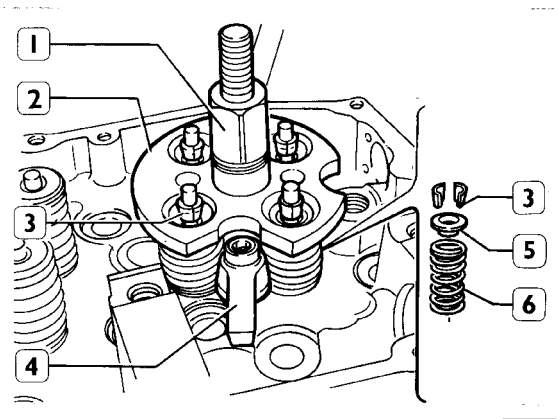
Fitting the valves and oil seal ring

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.

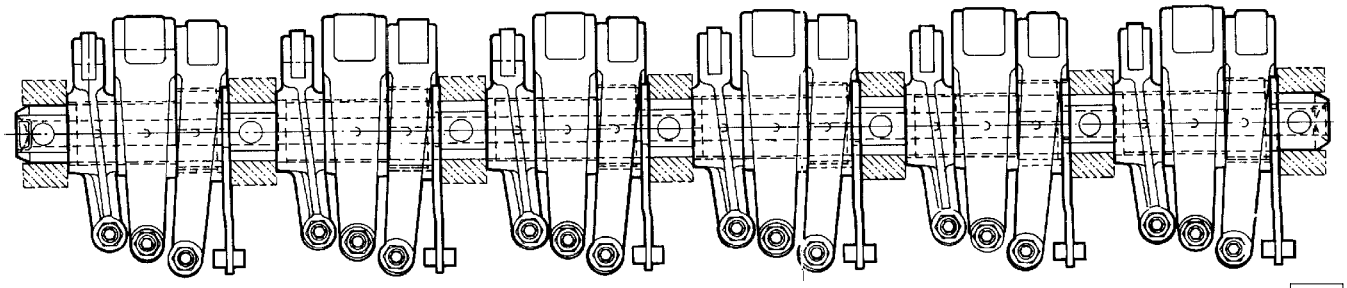
Figure 97



- ❑ 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



44925

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.

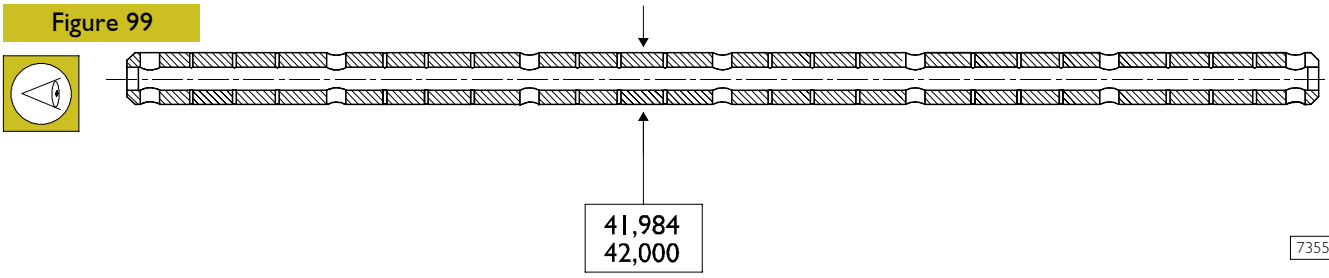
A pad is placed between the rocker adjusting screw and the bar.

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



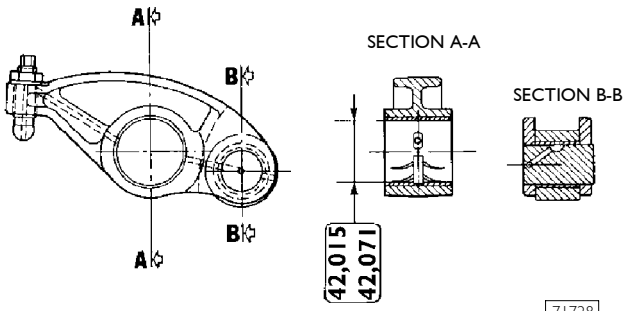
73557

MAIN DATA OF THE ROCKER ARM SHAFT

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

Rocker

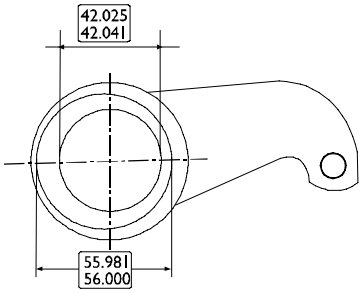
Figure 100



71728

PUMP INJECTOR ROCKER

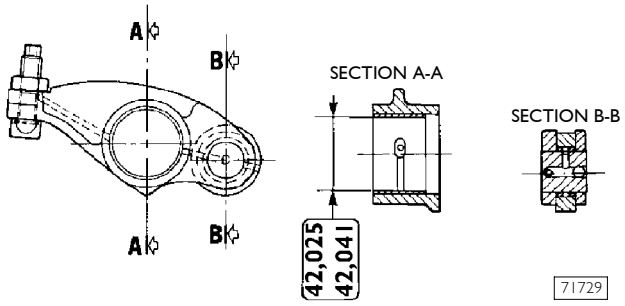
Figure 102



99376

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

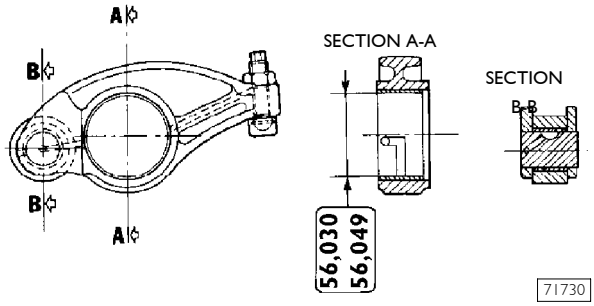
Figure 101



71729

EXHAUST VALVES ROCKER

Figure 103

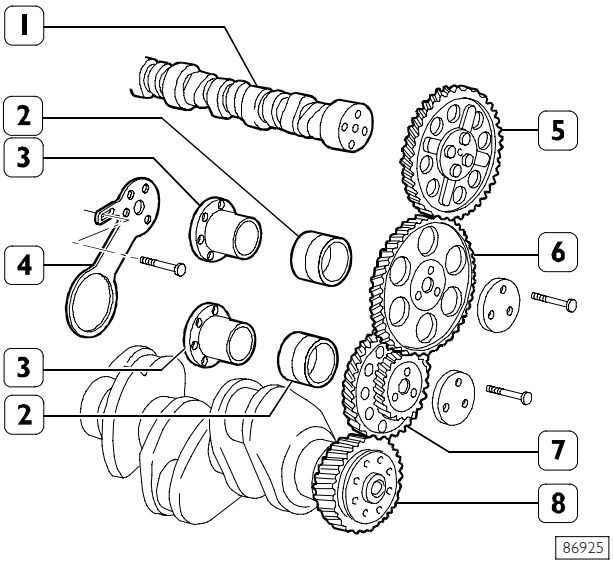


71730

DISCHARGE VALVE ROCKER

TIMING GEAR
Camshaft drive

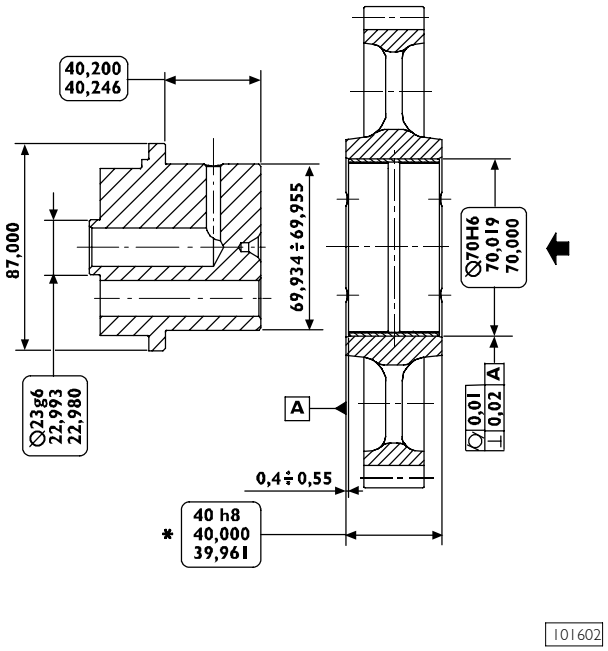
Figure 104



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

Idler gear pin
Idler gear

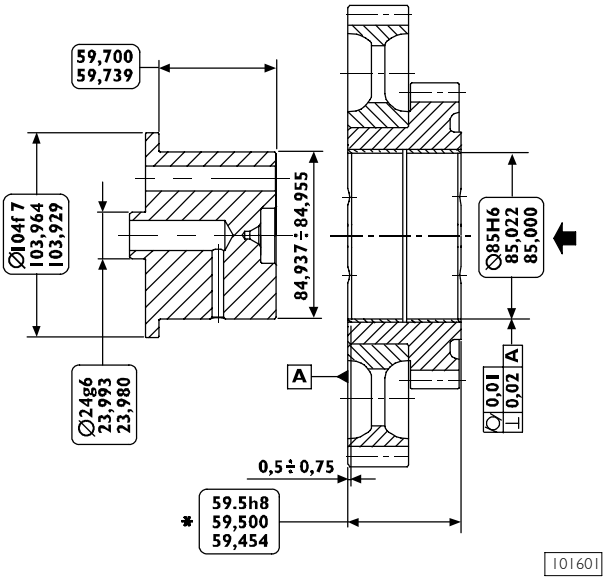
Figure 105



* This measurement is obtained after assembling.

Twin intermediate gear pin
Twin idler gear

Figure 106



* This measurement is obtained after assembling.

Replacing the bushings

Bushings (2) can be replaced when they are worn. Put up the bushing, then bore it to obtain the diameter shown on Figure 105 or Figure 106.

NOTE The bushing must be driven into the gear by following the direction of the arrow and setting the latter to the dimension shown on Figure 105 or Figure 106.

Rated assembling play between gear bushings and pins:
Figure 105 – 0.045 ÷ 0.075 mm
Figure 106 – 0.045 ÷ 0.085 mm.

TIGHTENING TORQUE

PART		TORQUE Nm	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		11.5 ± 3.5	(1.15 ± 0.35)
tightening		19 ± ≤	(1.9 ± 0.3)
Piston cooling nozzle union ♦		24,5 ± 2,5	(2.4 ± 0.25)
Spacer and oil sump capscrews ♦			
pretightening		38	(3.8)
tightening		45	(4.5)
M 12x1.75 screws, gear case to crankcase ♦		63 ± 7	(6.3 ± 0.7)
M 12x1.75 screws, gear case to crankcase ♦		24 ± 2,5	(2.4 ± 0.25)
Cylinder head capscrews ♦			
Stage 1:	pretightening	60	(6)
Stage 2	pretightening	120	(12)
Stage 3:	angle	90°	
Stage 4:	angle	65°	
Rocker shaft capscrew ♦			
Stage 1:	pretightening	100	(10)
Stage 2:	angle	60°	
Locknut, rocker adjusting screw ♦		39 ± 5	(3.9 ± 0.5)
Capscrews, injector securing brackets ♦		26	(2.6)
Capscrews, injector securing brackets ♦		8,5 ± 1,5	(0.8 ± 0.15)
Capscrews, thrust plates to head ♦		19 ± 3	(1.9 ± 0.3)
Screw fastening the engine supporting bracket to the cylinder head			
Stage 1:	pretightening	120	(12)
Stage 2:	angle	45°	

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

PART		TORQUE	
		Nm	kgm
Screw fastening the engine supporting bracket to the flywheel case			
Stage 1:	pretightening	100	(10)
Stage 2:	angle	60°	
Camshaft gear capscrews ♦			
Stage 1:	pretightening	60	(6)
Stage 2:	angle	60°	
Screw fixing phonic wheel to timing system gear ♦		8.5 ± 1.5	(0.85 ± 0.15)
Exhaust manifold capscrews •			
pretightening		40 ± 5	(4 ± 0.5)
tightening		70 ± 5	(7 ± 0.5)
Capscrews, connecting rod caps ♦			
Stage 1:	pretightening	60	(6)
Stage 2:	angle	60°	
Engine flywheel capscrews ♦			
Stage 1:	pretightening	120	(12)
Stage 2:	angle	90°	
Screws fixing damper flywheel: ♦			
First phase	pre-tightening	70	(7)
Second phase	closing to angle	50°	
Screws fixing intermediate gear pins: ♦			
First phase	pre-tightening	30	(3)
Second phase	closing to angle	90°	
Screw fixing connecting rod for idle gear		24.5 ± 2.5	(2.45 ± 0.25)
Screws fixing oil pump		24.5 ± 2.5	(2.45 ± 0.25)
Screws fixing crankshaft gasket cover		24.5 ± 2.5	(2.45 ± 0.25)
Screws fixing fuel pump/filter		19	(1.9)
Screw fixing control unit mount to crankcase		19 ± 3	(1.9 ± 0.3)
Screws and nuts fixing turbocharger •			
pre-tightening		35	(3.5
tightening		46	(4.6)
Screws fixing water pump to crankcase		22 ± 2	(2.2 ± 0.2)
Screws fixing water pump to crankcase		25	(2.5)
Screw fixing automatic tensioner to crankcase		26 ± 3	(2.6 ± 0.3)
Screw fixing fixed tensioner to crankcase		50 ± 5	(5 ± 0.5)
Screws fixing fan mount to crankcase		105 ± 5	(10.5 ± 0.5)
Screws fixing starter motor		74 ± 4	(7.4 ± 0.4)
Screws fixing air heater to cylinder head		30 ± 3	(3 ± 0.3)

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

PART			TORQUE	
			Nm	kgm
Screw fixing alternator	M 10x1,5	l = 35 mm	30 ± 3	(3 ± 0.3)
	M 10x1,5	l = 60 mm	44 ± 4	(4.4 ± 0.4)
Screws fixing air-conditioner compressor to mount			24.5 ± 2.5	(2.5 ± 0.25)
Screws fixing guard			24.5 ± 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)
Turbocompound Unit				
Intermediate gear support shaft fixing screws M12x30			115	(11.5)
Intermediate gear fixing screw M12x80			115	(11.5)
Screw that fixes the hydraulic joint to the flywheel box		M10x70	45	(4.5)
		M10x110	45	(4.5)
		M10x150	45	(4.5)
Oil return pipe to block fixing screws M8x70x1.25			23	(2.3)
Oil delivery pipe to hydraulic joint threaded fittings			55	(5.5)
Screws that fix the power turbine to hydraulic joint M10x50			40	(4.0)
Screws that fix the turbine to the exhaust manifold			70	(7.0)
Nuts that fix the turbine to the exhaust manifold			45	(4.5)
Clamps that fix the manifold to the turbines			8.5	(0.85)

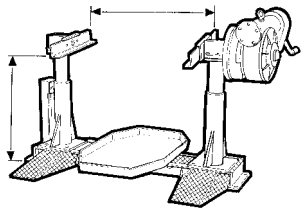
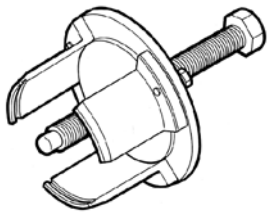
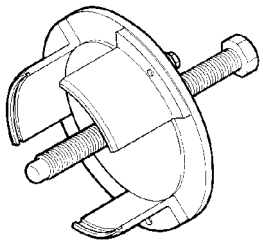
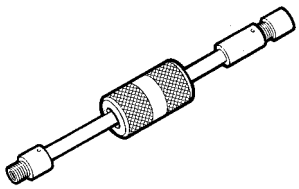
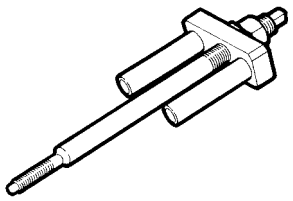
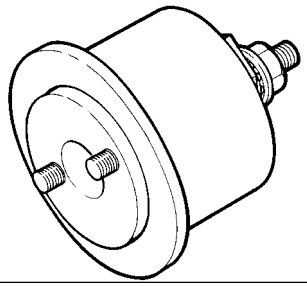
♦ Before assembly, lubricate with UTDM oil
• Before assembly, lubricate with graphitized oil

SECTION 5

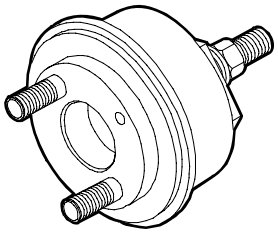
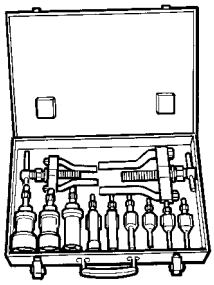
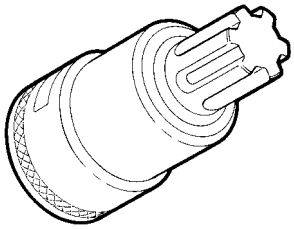
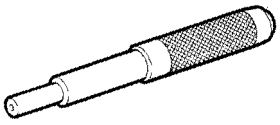
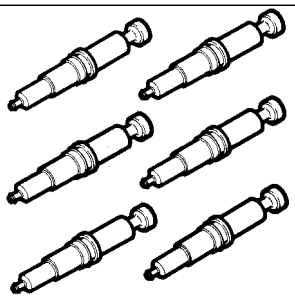
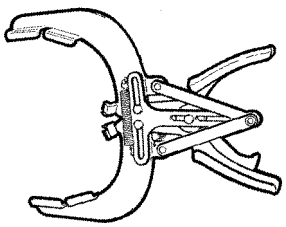
Tools

Page

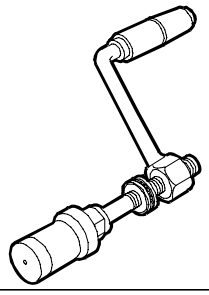
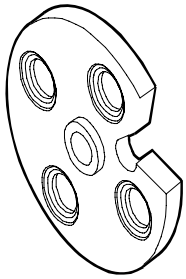
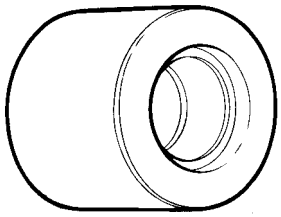
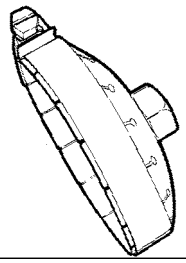
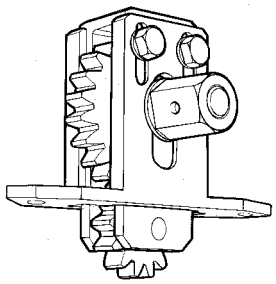
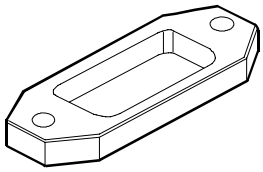
TOOLS

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

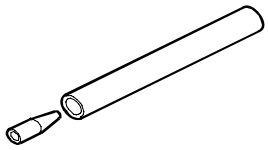
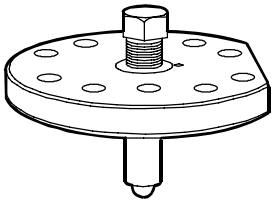
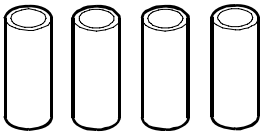
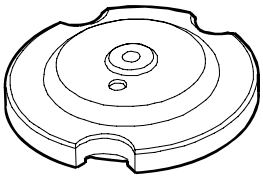
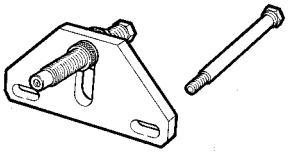
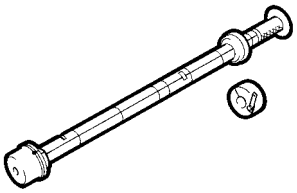
TOOLS

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)

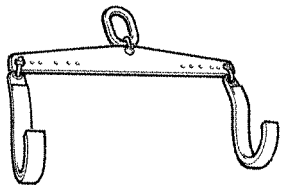
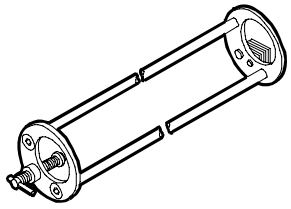
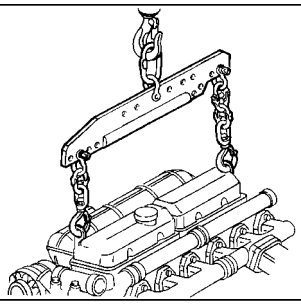
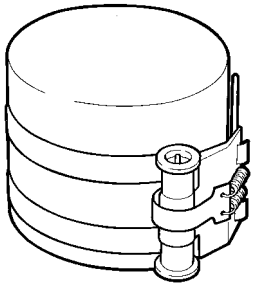
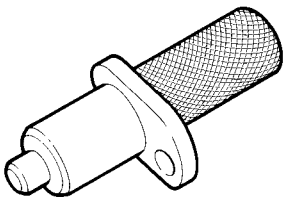
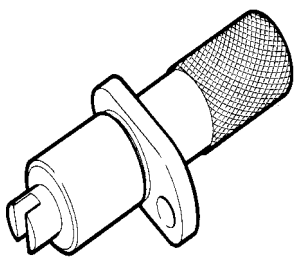
TOOLS

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)

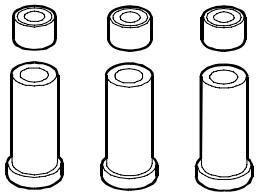
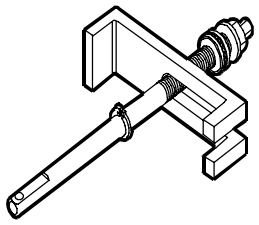
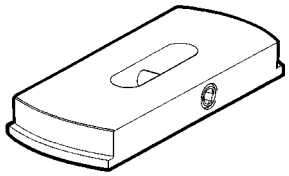
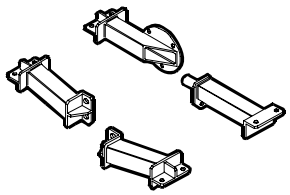
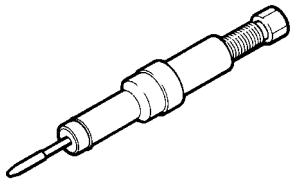
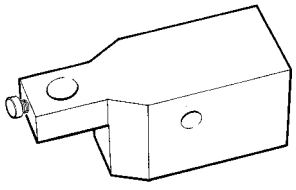
TOOLS

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

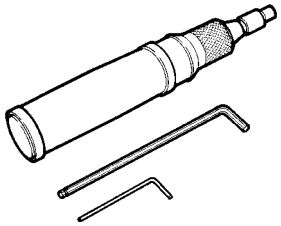
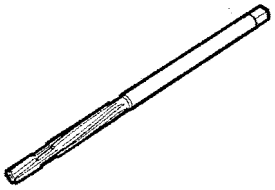
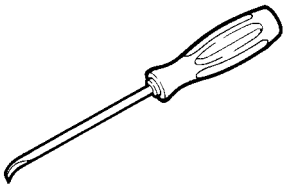
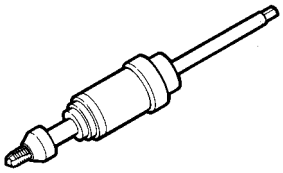
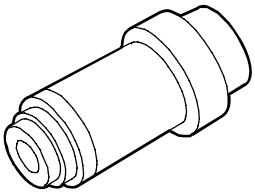
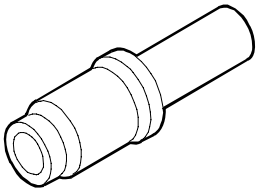
TOOLS

TOOL NO.		DESCRIPTION
99360500		Tool to lift crankshaft
99360553		Tool for assembling and installing rocker arm shaft
99360585		Swing hoist for engine disassembly assembly
99360605		Belt to insert piston in cylinder liner (60 - 125 mm)
99360612		Tool for positioning engine P.M.S.
99360613		Tool for timing of phonic wheel on timing gear

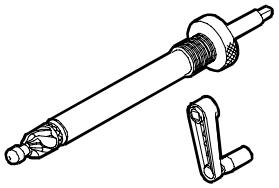
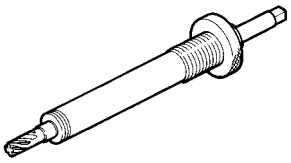
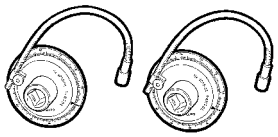
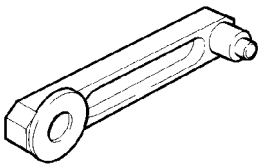
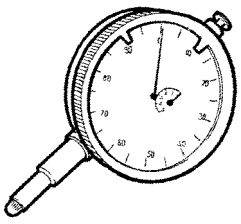
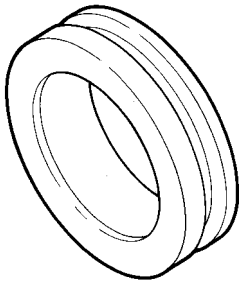
TOOLS

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

TOOLS

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

TOOLS

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

Appendix

SAFETY PRESCRIPTIONS

Standard safety prescriptions

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

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

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

Prevention of injury

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

During maintenance

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

- ❑ Avoid incorrect tightening or out of couple. Danger: incorrect tightening may seriously damage engine's components, affecting engine's duration.
- ❑ Avoid priming from fuel tanks made out of copper alloys and/or with ducts not being provided with filters.
- ❑ Do not modify cable wires: their length shall not be changed.
- ❑ Do not connect any user to the engine electrical equipment unless specifically approved by Iveco.
- ❑ Do not modify fuel systems or hydraulic system unless Iveco specific approval has been released. Any unauthorized modification will compromise warranty assistance and furthermore may affect engine correct working and duration.

For engines equipped with electronic gearbox:

- ❑ Do not execute electric arc welding without having priory removed electronic gearbox.
- ❑ Remove electronic gearbox in case of any intervention requiring heating over 80°C temperature.
- ❑ Do not paint the components and the electronic connections.
- ❑ Do not vary or alter any data filed in the electronic gearbox driving the engine. Any manipulation or alteration of electronic components shall totally compromise engine assistance warranty and furthermore may affect engine correct working and duration.

Respect of the Environment

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