CURSOR TIER 3 SERIES

Industrial application

C87

C87 ENT X - CURSOR 87 TE X

Technical and Repair manual

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

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

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

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

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

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

FPT is not liable for repairing interventions.

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

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

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

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F2C CURSOR ENGINES

Introduction

PREFACE

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.

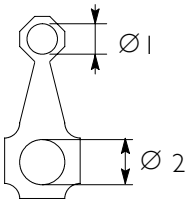
Environment protection

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 = Seat of small end bush

Ø 2 = Seat of connecting rod bearings.

Close applying the required torque
Close applying the required 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; FPT commercial and assistance network is available to give all clarifications necessary to perform repair interventions not provided in this document.

Before welding:

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

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

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

GENERAL WARNINGS ON THE ELECTRIC SYSTEM

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

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

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

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

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

Make sure that the electronic devices wiring harnesses (length, lead type, location, strapping, connection to screening braiding, bonding, etc.) comply with FPT 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.

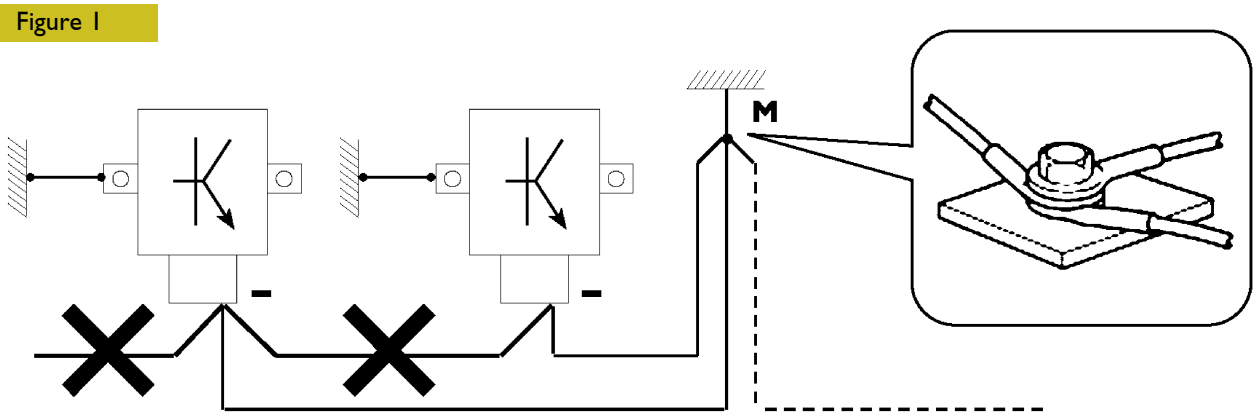
Bonding and screening

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:

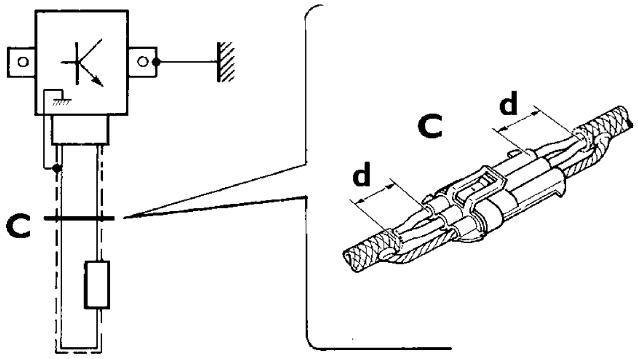
- Electronic central units must be connected to system bonding when they are provided with a metallic shell.
- Electronic central units negative cables must be connected both to a system bonding point such as the dashboard opening bonding (avoiding "serial" or "chain" connections), and to battery negative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

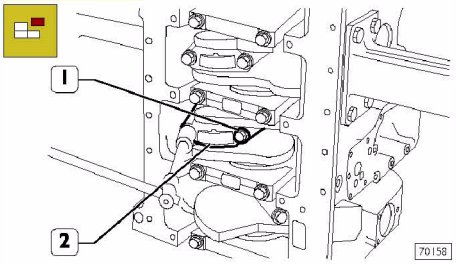
REVISIONE MOTORE 4 E 6 CIL. SMONTAGGIO DEL MOTORE AL BANCO

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.

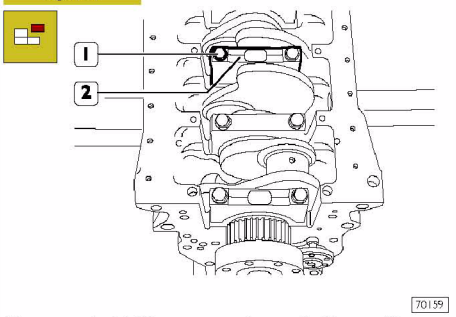
Figura 1



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

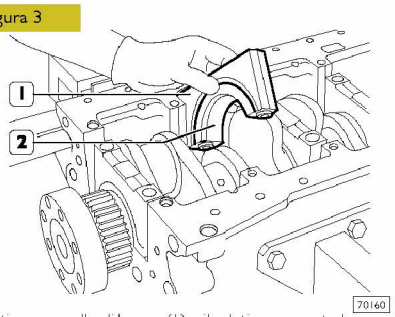
NOTA Mantenere i semicuscinetti nei rispettivi alloggiamenti, poiché, in caso di un loro utilizzo, dovranno essere montati nella posizione riscontrata allo smontaggio.

Figura 2



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

Figura 3

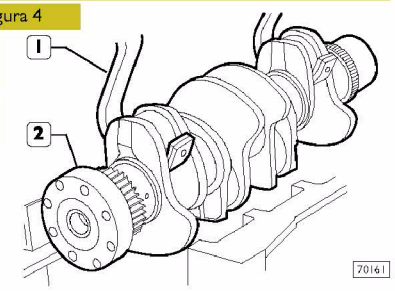


Il penultimo cappello di banco (1) e il relativo supporto hanno il semicuscinetto (2) dotato di spallamento.

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.

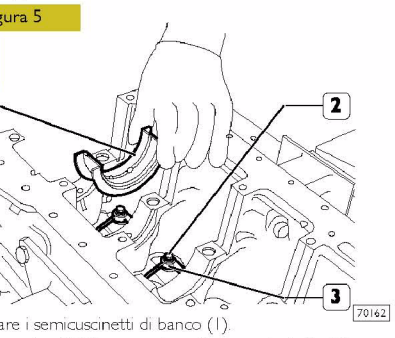
NOTA Annotare la posizione di montaggio dei semicuscinetti inferiori e superiori, poiché in caso di un loro riutilizzo, dovranno essere montati nella posizione riscontrata allo smontaggio.

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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Part 1
F2C CURSOR ENGINES

UPDATING

Section	Description	Page	Date of revision

SECTION 1

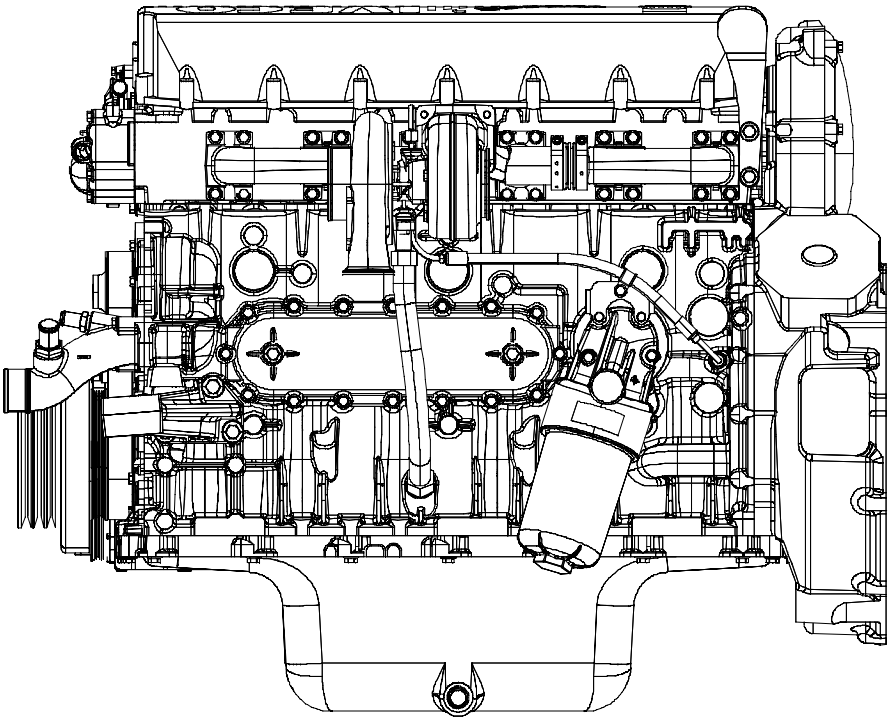
General Specifications

MAPPING BETWEEN TECHNICAL AND COMMERCIAL CODING

Technical Code	Commercial Code
F2CE9687B*E001 F2CE9687A*E001	C87 ENT X

VIEWS OF THE ENGINE

Figure 1



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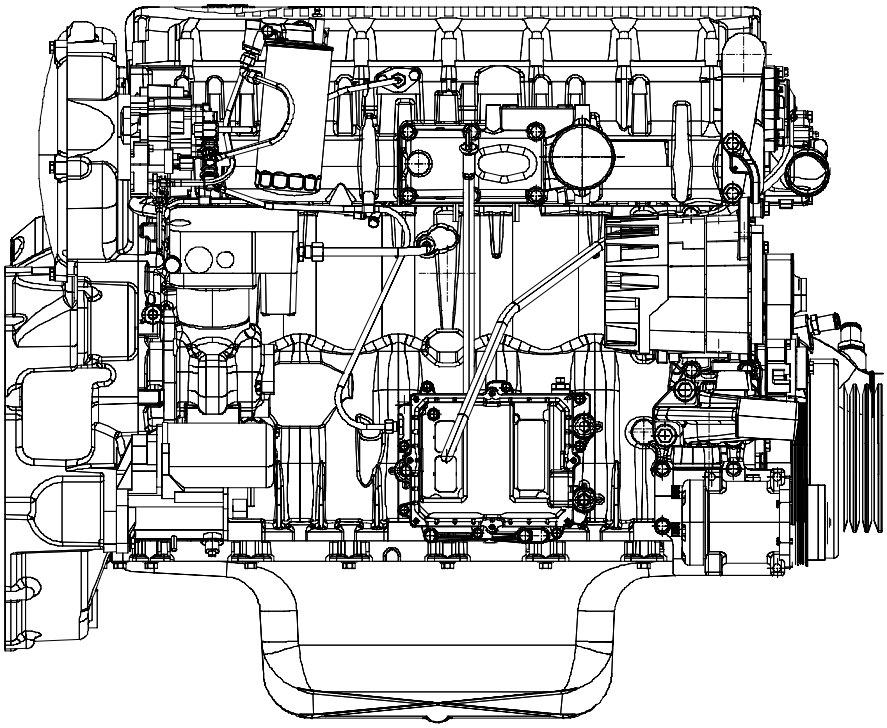
LEFT-HAND SIDE VIEW

Figure 2



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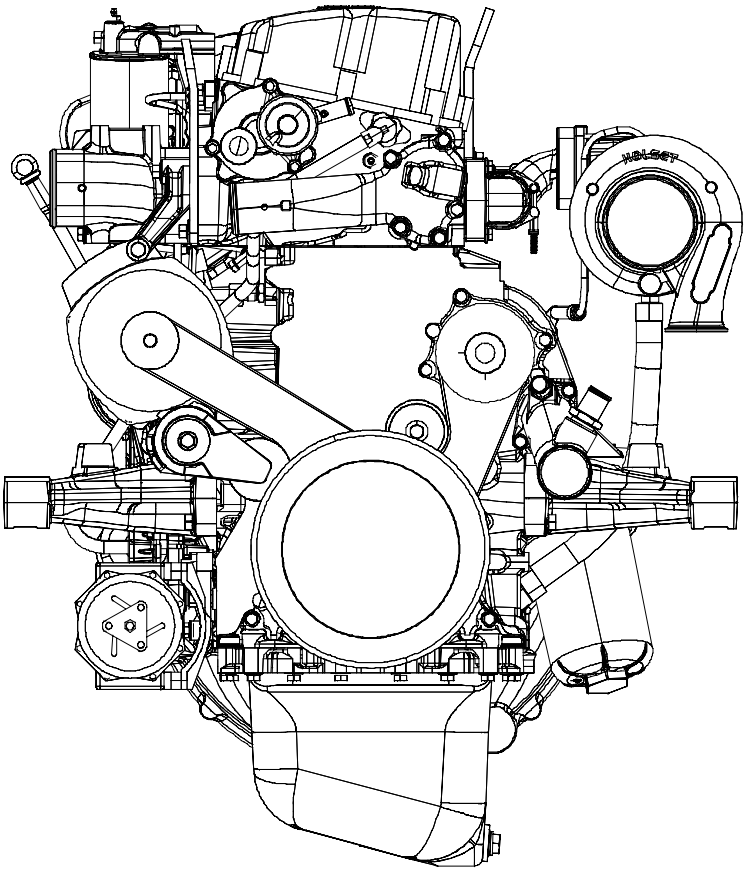
RIGHT-HAND SIDE VIEW

Figure 3



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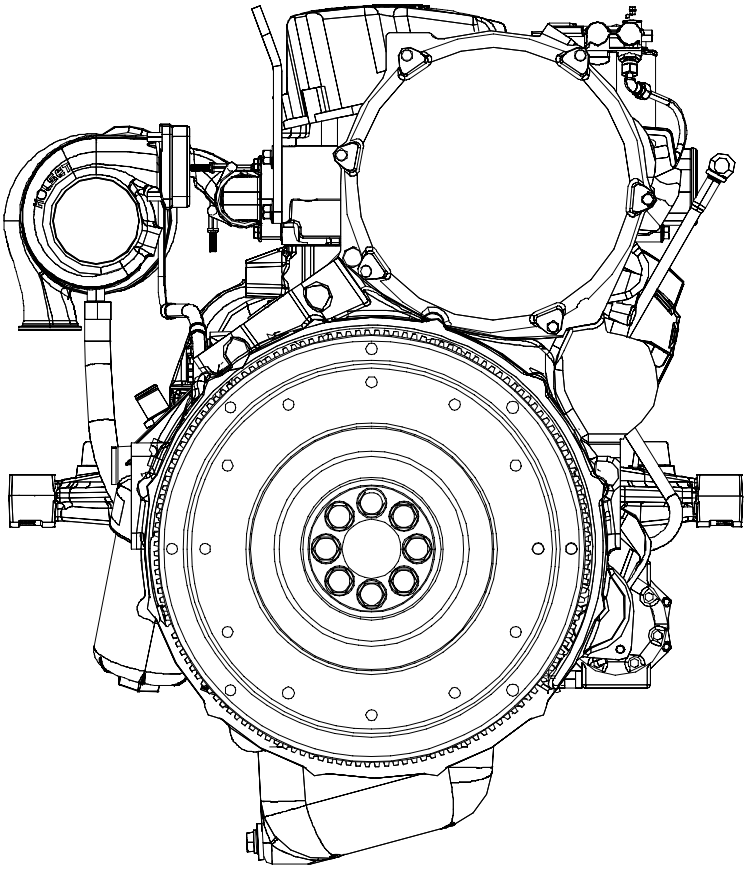
FRONT HAND SIDE VIEW

Figure 4



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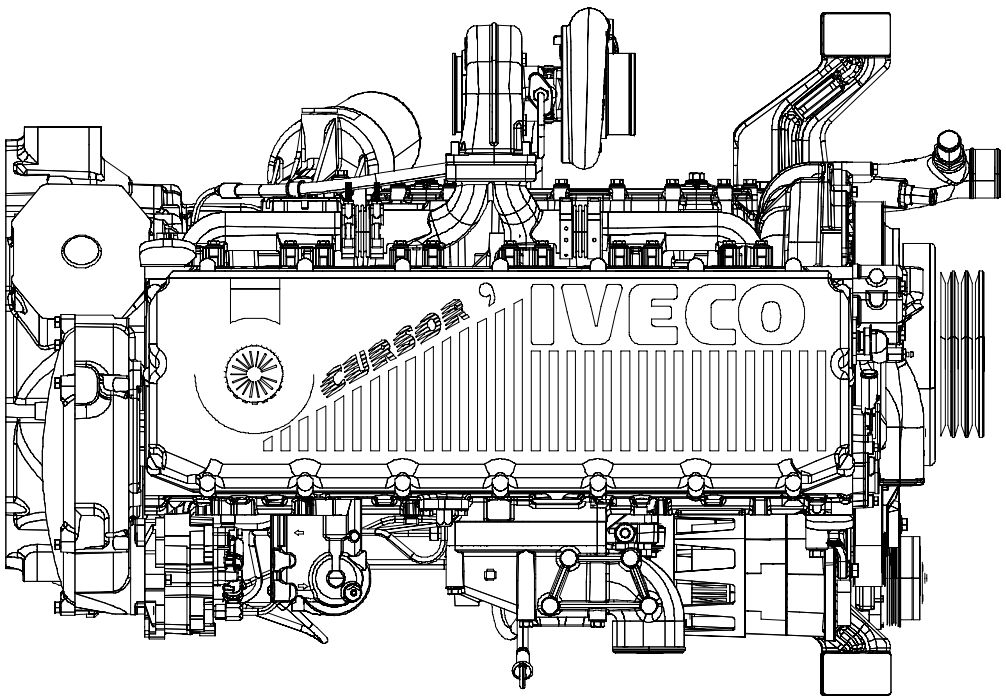
REAR HAND SIDE VIEW

Figure 5



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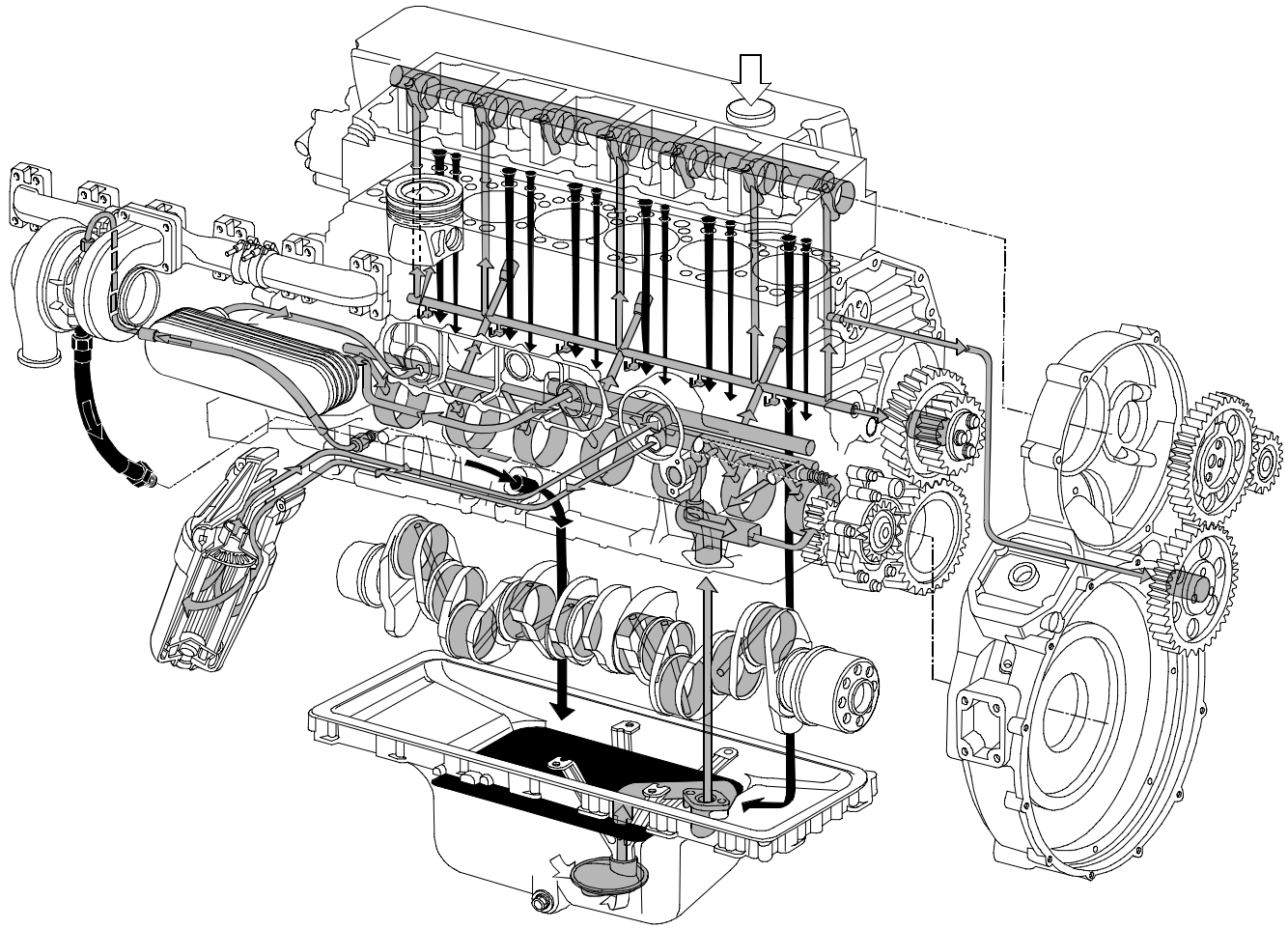
TOP VIEW

LUBRICATION DIAGRAM

Figure 6



Dropping oil

Pressure oil

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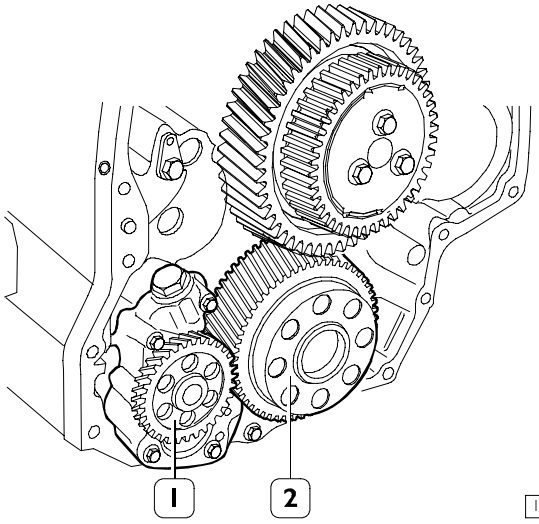
Oil pump

Figure 7

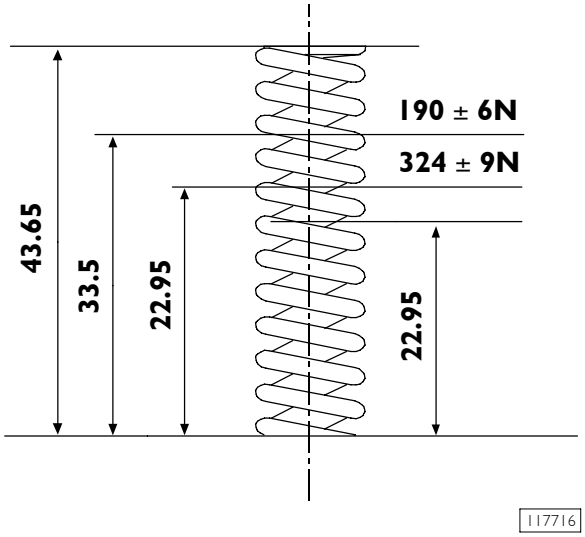


The oil pump (1) cannot be overhauled. On finding any damage, replace the oil pump assembly.

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

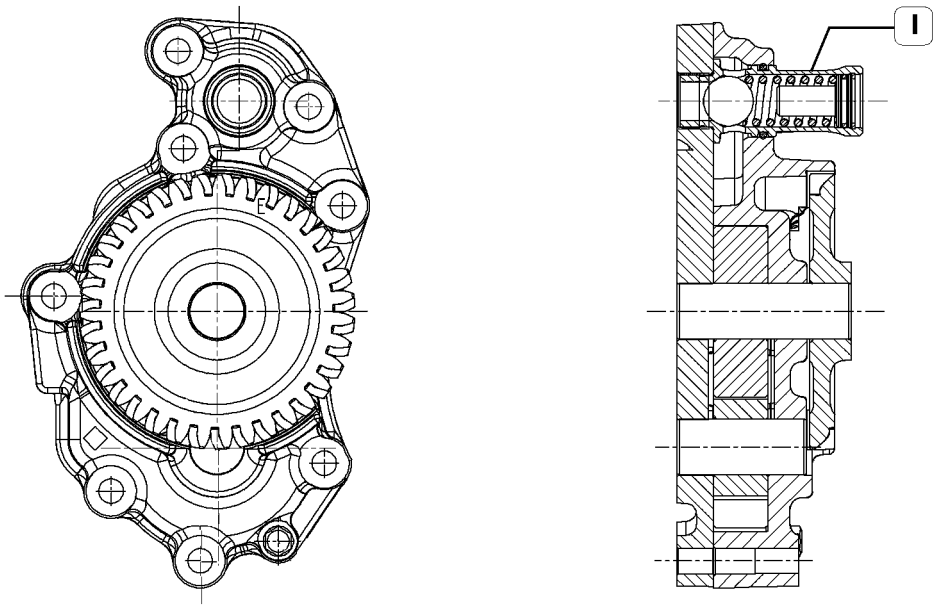
Overpressure valve

Figure 9



MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

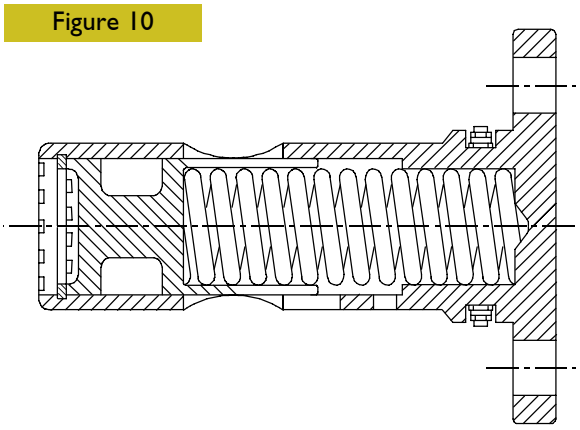
Figure 8



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

Oil pressure control valve

Figure 10



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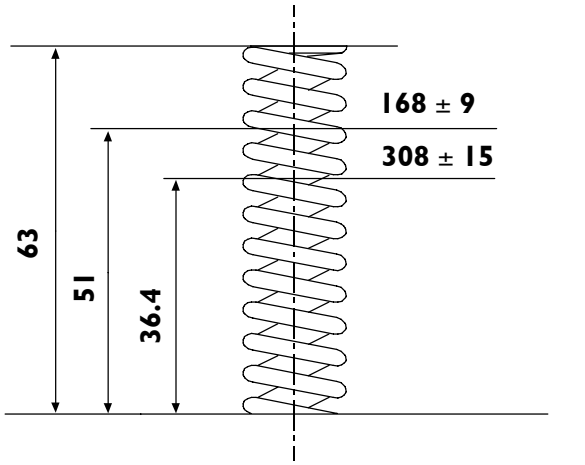
The oil pressure control valve is located on the left-hand side of the crankcase.
Start of opening pressure 5 bars.

Figure 11



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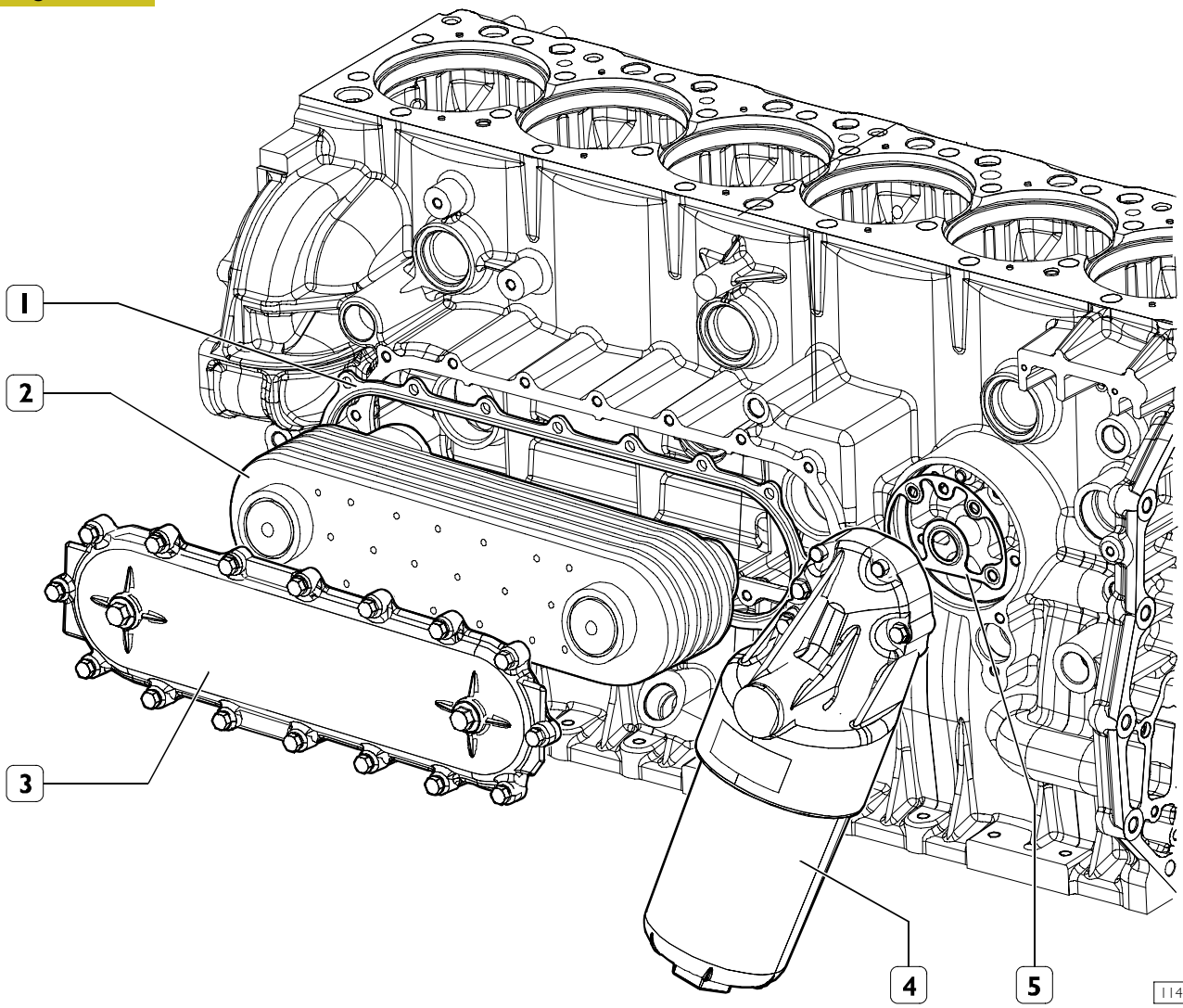
MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

Heat exchanger

Figure 12



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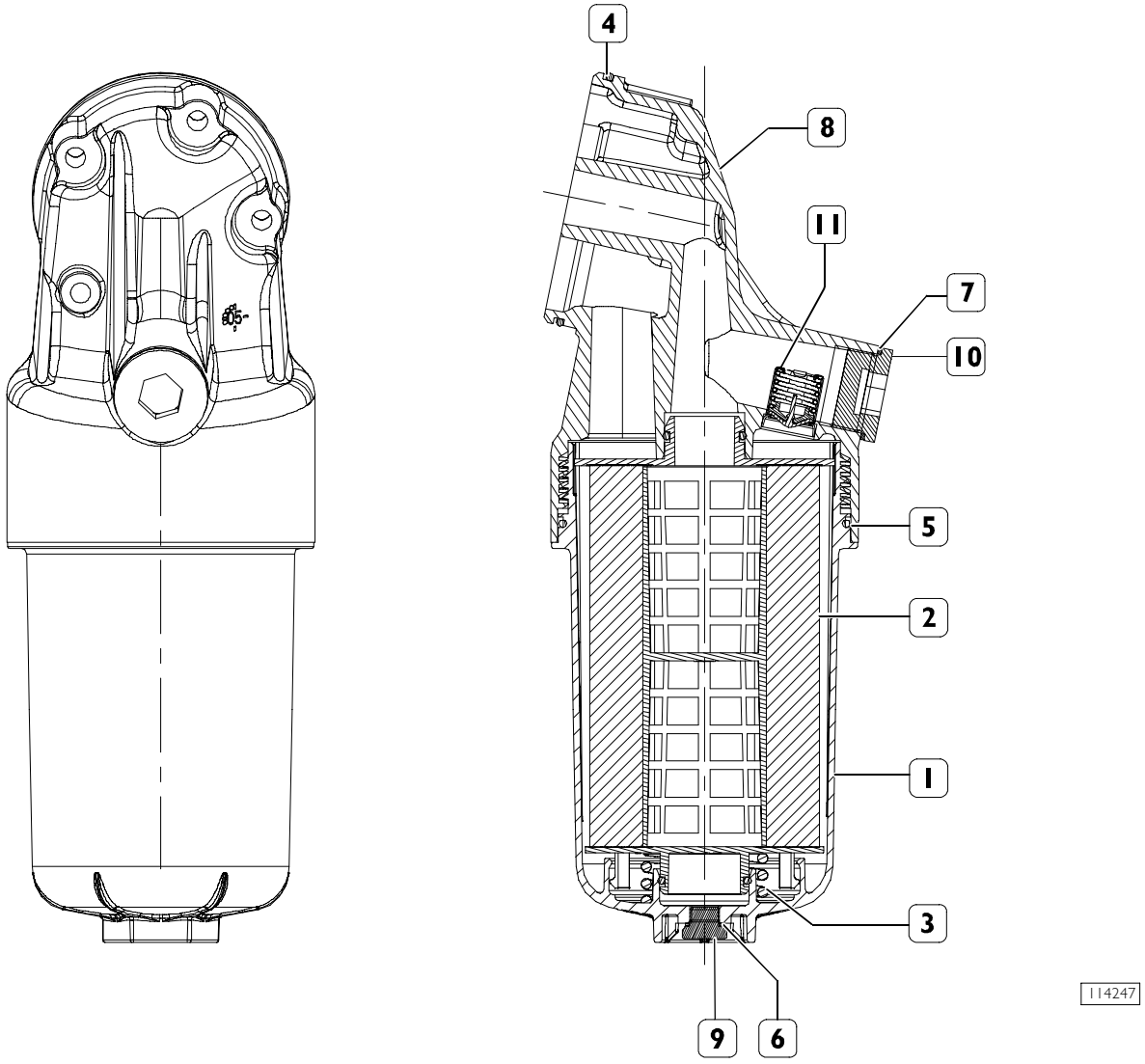
1. Exchanger seal - 2. Internal heat exchanger element - 3. Cover - 4.Oil filter - 5. Oil filter seal

ENGINE OIL FILTER

Figure 13



1. Closure cap - 2. Cartridge - 3. Spring - 4. Support O-ring - 5. Tank O-ring - 6. Washer - 7. Washer - 8. Support - 9. Plug M14x1.5 - 10. Plug M38x1.5 - 11. By-pass valve 3.4 bars.

Characteristics

1. Max working pressure: 13 bars
2. Working temperature: - 30° C ÷ + 120° C
3. By-pass valve opening value: 3,4 ± 0,3 bar

Lock torques

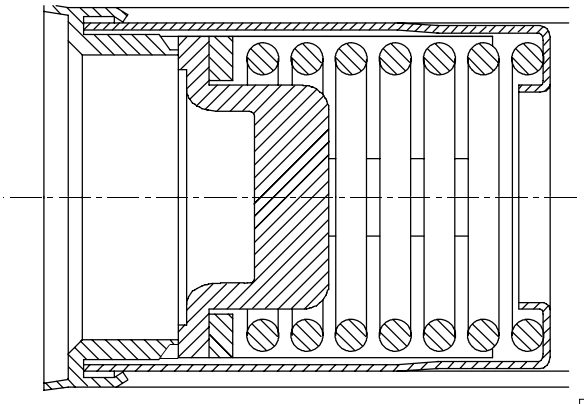
Cap (part 1):	60 ± 5 Nm
Plug (part 9):	30 ± 5 Nm
Plug (part 10):	90 ± 5 Nm

Installation rule

Use threadlock for plug (part 10).

Filter by-pass valve

Figure 14

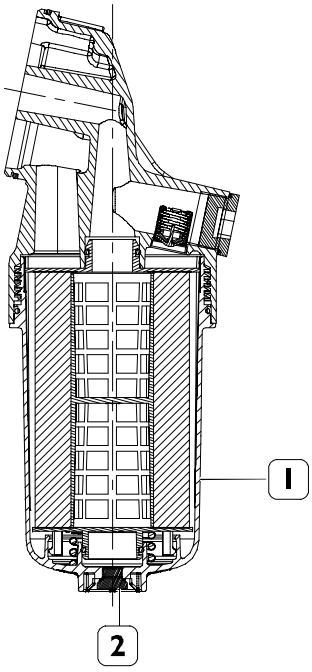


Valve opens quickly at 3,4 ± 0,3 bar pressure.

Replacing oil filter cartridge

Dismantling

Figure 15



Remove the plug (2).

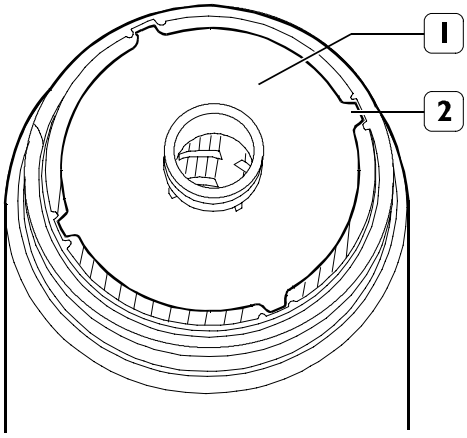
Undo the filter casing (1) by a couple of turns and wait for a few minutes.

In this way the remaining oil in the casing starts firstly to drip and then to flow smoothly out.

Completely undo the casing and then replace the cartridge.

Refitting

Figure 16

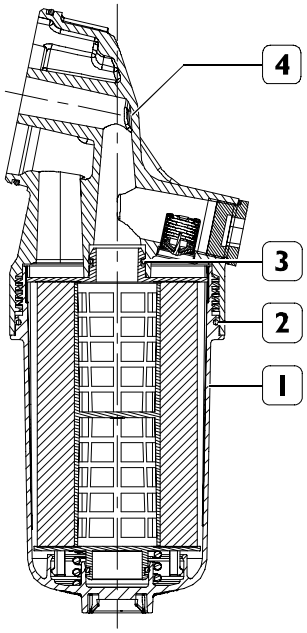


Insert the cartridge in the casing aligning the centering tabs (2) on the upper plate (1) with the seats.

The cartridge should be pushed into the container until the action of the attachment system at the bottom of the casing is overcome.

At the same time, the tabs on the upper plate should slide into the housings.

Figure 17



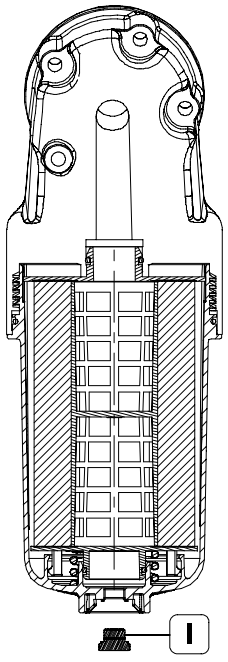
Move the upper part of the casing thread close to the first lower thread of the support (the cartridge cover element should be in contact with the oil outlet duct on the support.

Proceed with tightening the cartridge-casing assembly (1) on the support (4).

During this stage both the seal (3) for the oil outlet duct-cartridge element and the casing-support seal (2) will gradually be involved.

Tighten the filter casing to a torque of 65 Nm.

Figure 18



Tighten the protective cap (1) on the filter casing.

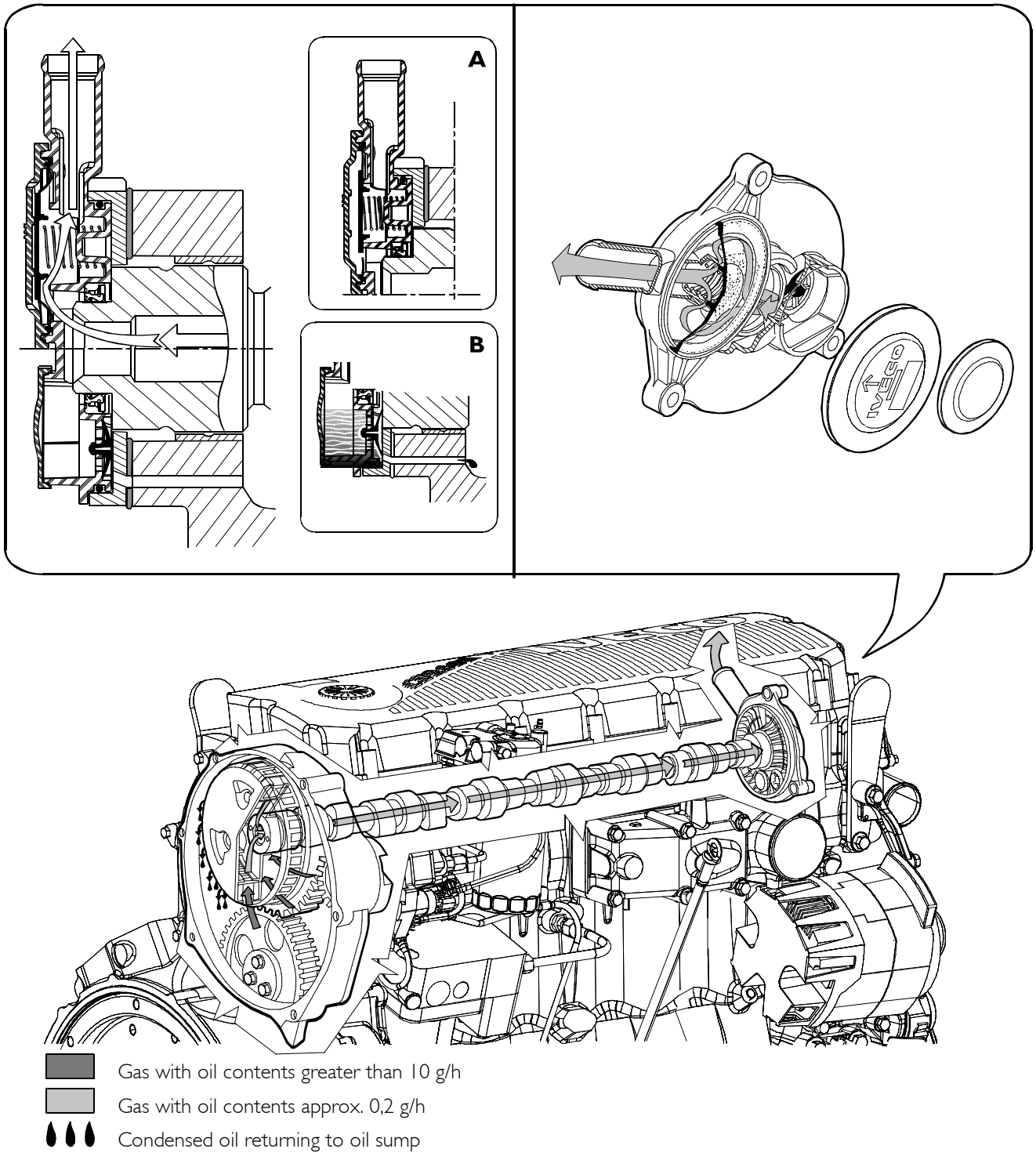
Oil fume recycle (Blow-by)

Part of gas produced by combustion during engine operation leaks through piston elastic ring openings into sump, mixing with oil fumes in sump.

This mixture, conveyed upward, is partially separated from oil by a device located in timing cover upper part and introduced in air intake circuit.

The device mainly consists of a rotary filter secured on propeller shaft and by a front cover housing normally closed valves controlling mixture flow.

Figure 19



114248

COOLING

Description

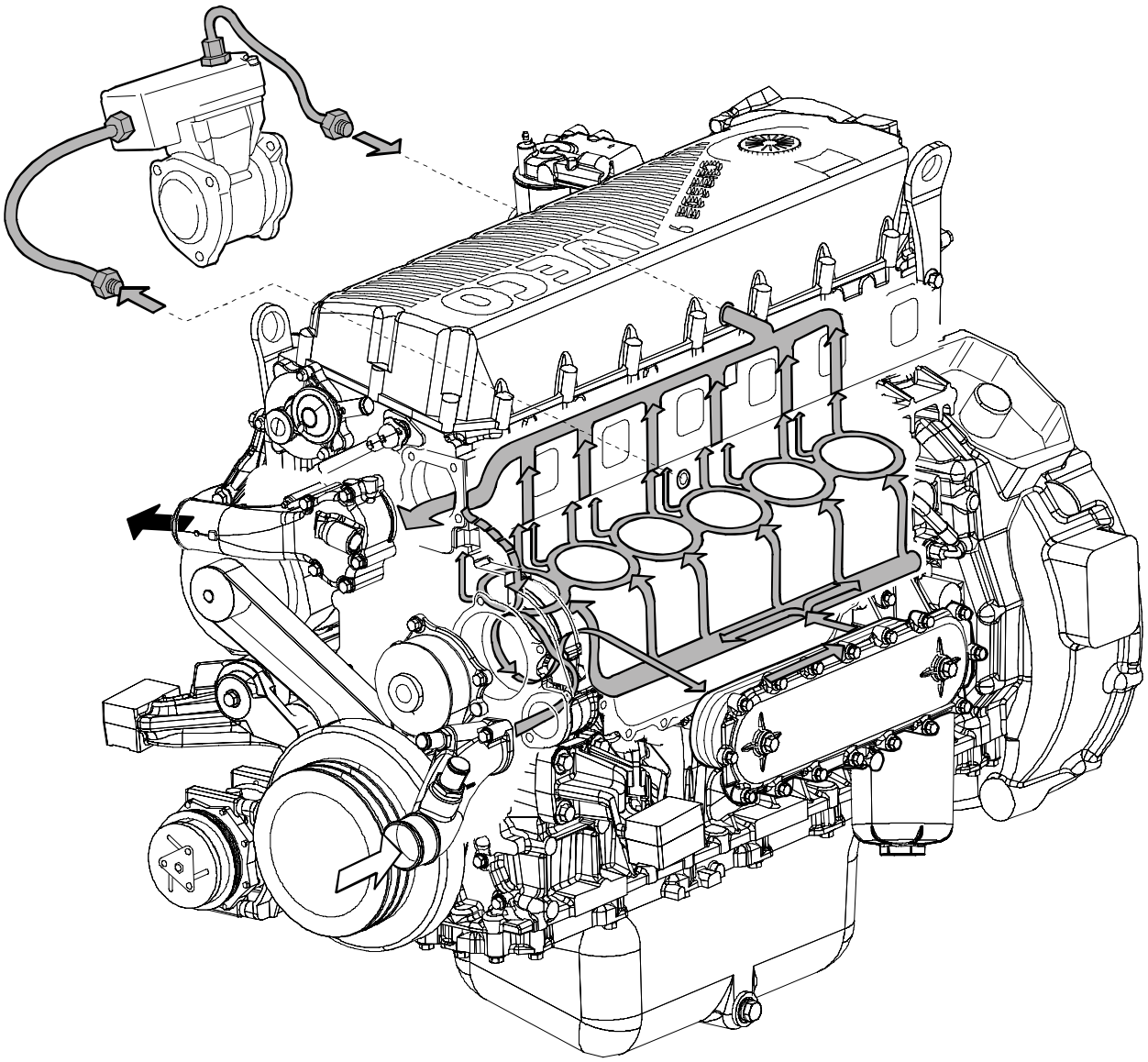
The engine cooling system is of the closed-circuit, forced circulation type.
It consists mainly of the following components:

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

Operation

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

Figure 20



Water flowing out of the thermostat

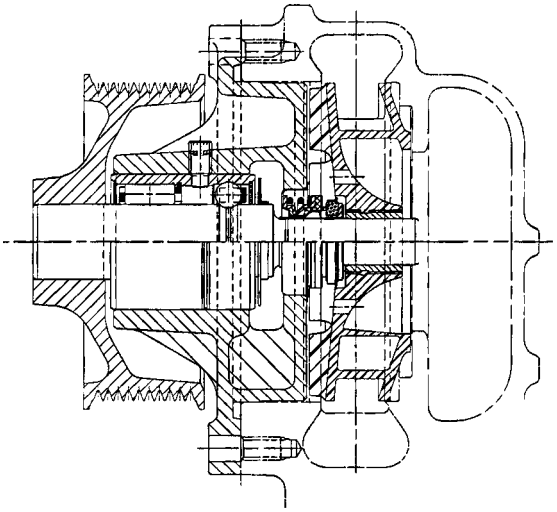
Water circulating in the engine

Water flowing into the pump

114249

Water pump

Figure 21



114250

CROSS-SECTION OF THE WATER PUMP

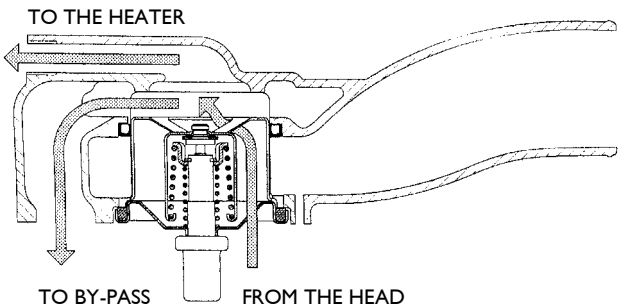
The water pump consists of: rotor, shaft with bearing, T-gasket and drive pulley with dust shield.

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

Thermostat

View of thermostat operation

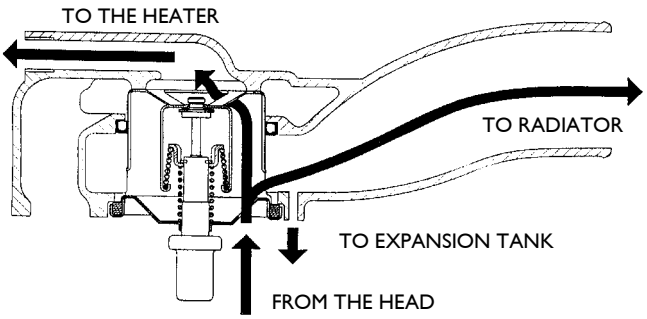
Figure 22



45357

Water circulating in the engine

Figure 23



45358

Water leaving the thermostat

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

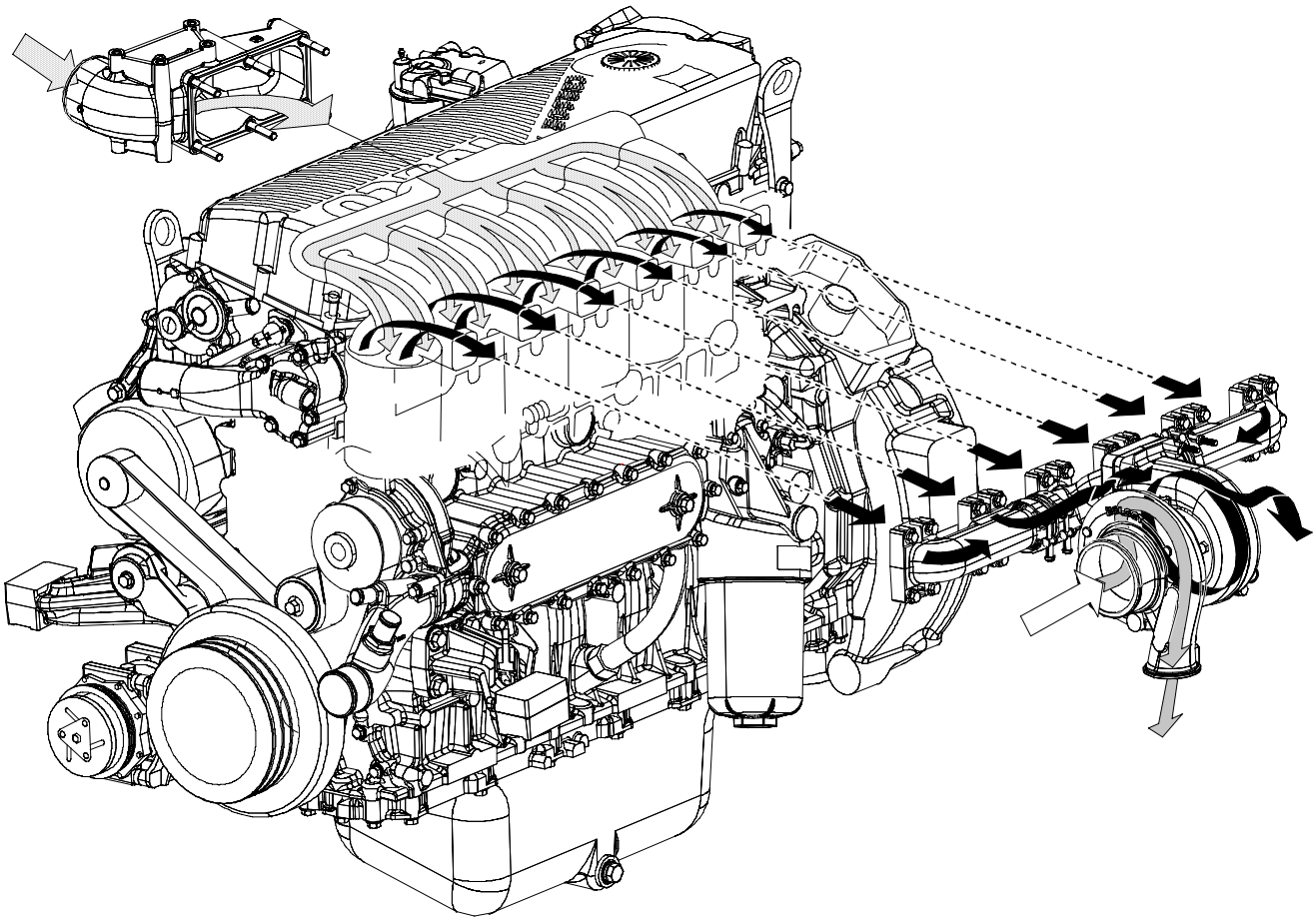
Temperature of start of travel 84°C ±2°C.
Minimum travel 15 mm at 94°C ±2°C.

TURBOCHARGING

The turbocharging system consists of:

- ❑ air filter;
- ❑ Wastegate turbocharger.

Figure 24



Exhaust gas

Compressed air (hot)

Inlet air

Intake compressed air

114251

EGR EXHAUST GAS RECYCLE SYSTEM

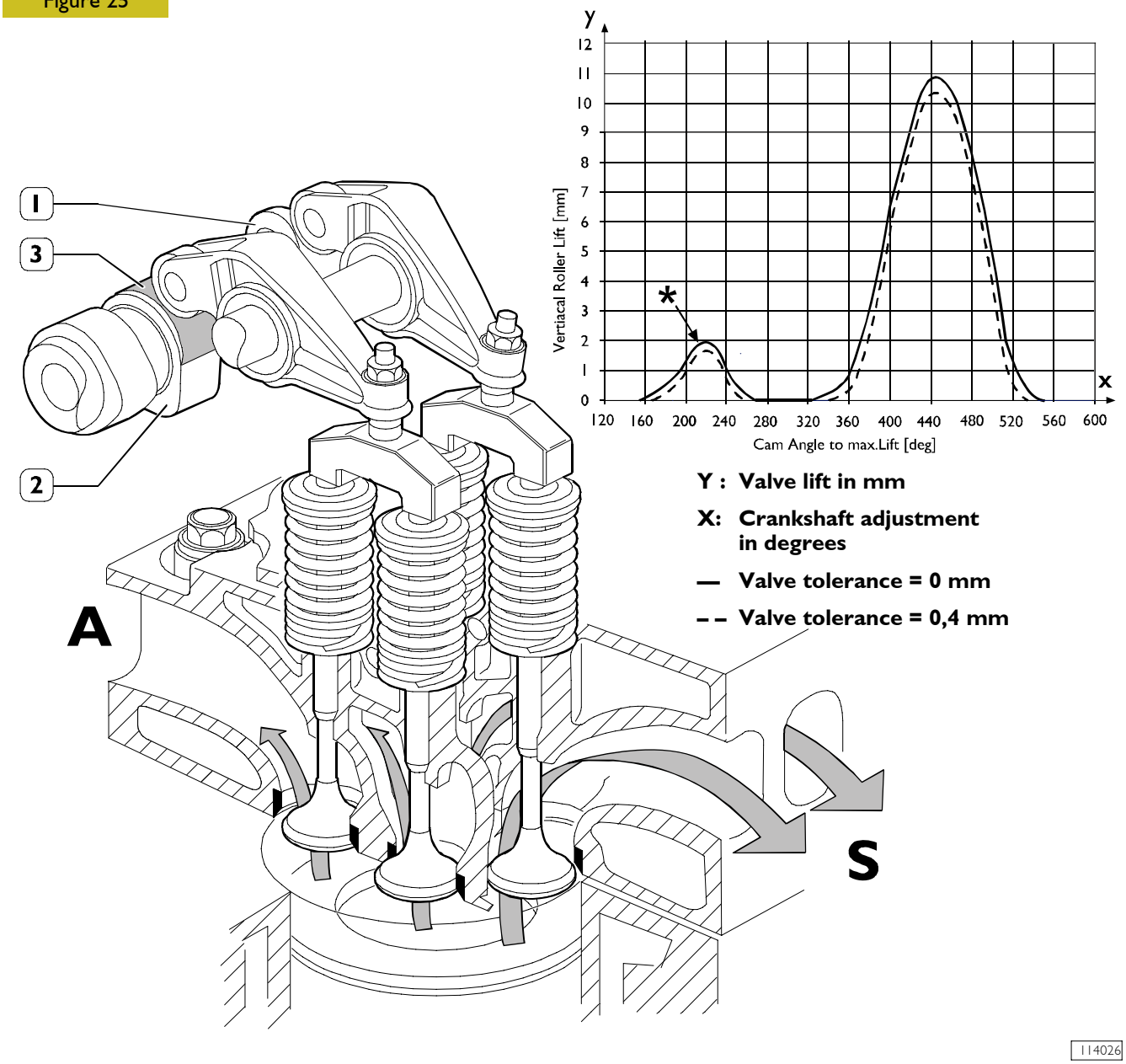
The exhaust gas can be partially recycled to cylinders to reduce maximum temperature values of combustion that produce nitrogen oxides (NOx).

The exhaust gas recycle system (EGR) reduces combustion temperature and therefore is an efficient NOx emission control system.

INTERNAL EGR OPERATING ON SUCTION VALVES

The specific design of suction cams of the internal EGR system allows part of exhaust gas to be recycled to engine cylinders. This type of EGR, called internal EGR, is not equipped with any electronic control, the system is always active. Its configuration requires no additional parts such as control valves, pipelines or heat exchangers therefore engine profile remains unchanged Besides main lobe, suction cam has an additional lobe (3) as to configuration without EGR. During concerned cylinder exhaust phase, this lobe allows a shaft advanced opening of intake valve (*). In this way, part of the exhaust gas is trapped in the suction duct and later, during cylinder suction phase, this gas is recycled to cylinder inlet for combustion phase..

Figure 25



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

SECTION 2

Fuel

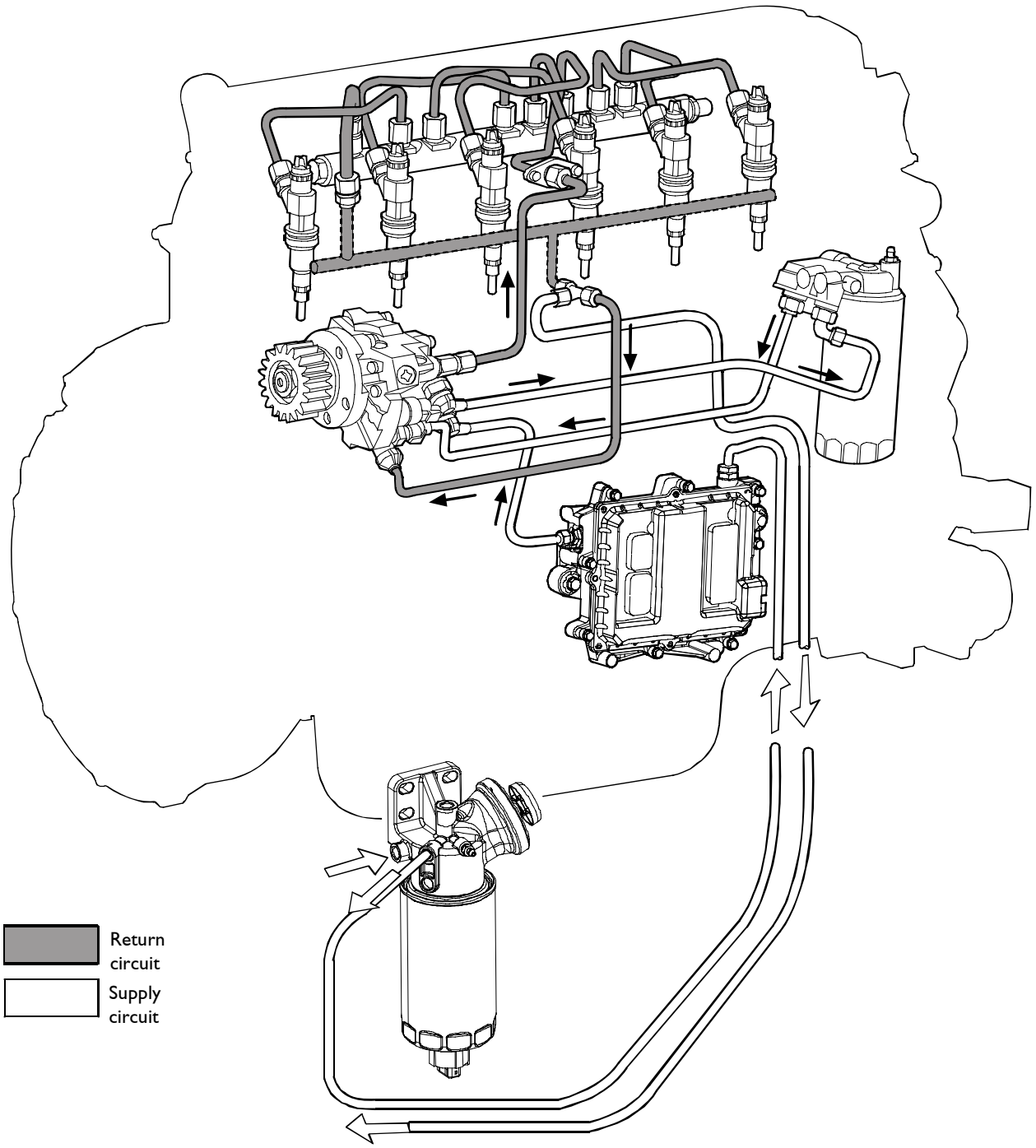
SUPPLY

The Common Rail supply system is equipped with a special pump that maintains fuel at constant high pressure regardless from phase and cylinder under injection and accumulated in an common duct shared by all electric injectors.

Therefore, fuel at injection pressure, calculated by ECU, is always available at electric injection inlet.

When the solenoid valve of an injector is energized by ECU, in related cylinder the injection of fuel taken directly from the rail takes place.

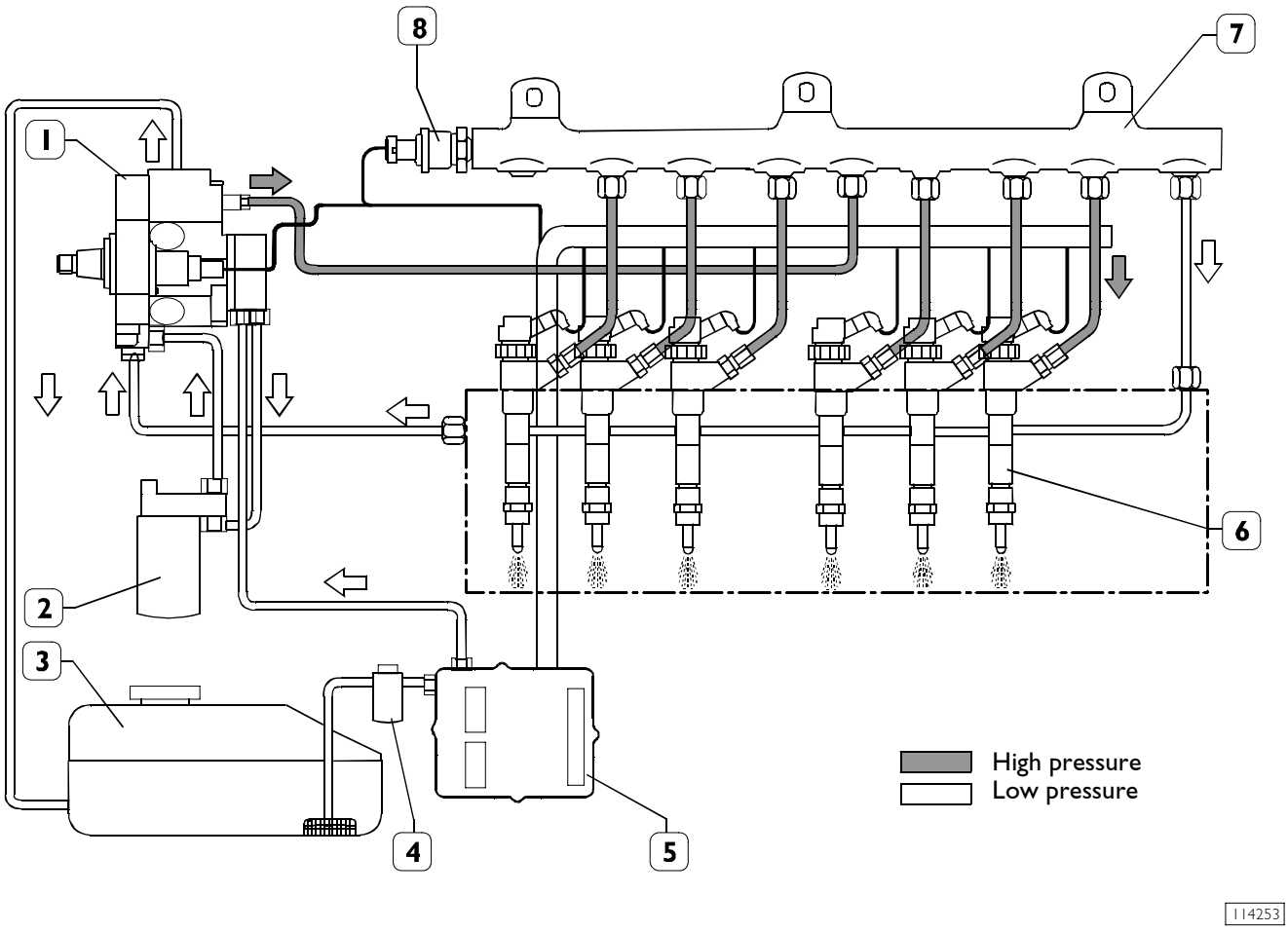
Figure 1



114252

FUEL SUPPLY DIAGRAM

Figure 2



1. High-pressure pump - 2. Fuel filter - 3.Tank - 4. Fuel pre-filter - 5.ECU - 6. Electric injectors - 7.Common Rail - 8. Pressure sensor

After high-pressure pipeline installation, during the following 20 hours of work, frequently check engine oil level. (IT MUST NOT INCREASE).

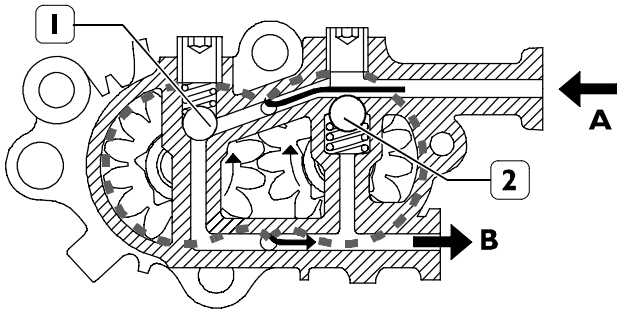
MECHANICAL SUPPLY PUMP

Gear pump, fitted on the rear side of the high pressure pump and used to supply it.

It is controlled by high pressure pump shaft.

Normal operating conditions

Figure 3

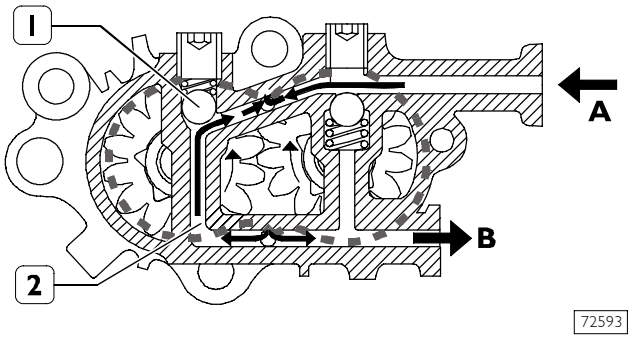


72592

A Fuel inlet from tank, B fuel outlet to filter, 1-2 by-pass valves in close position

Overpressure condition at outlet

Figure 4

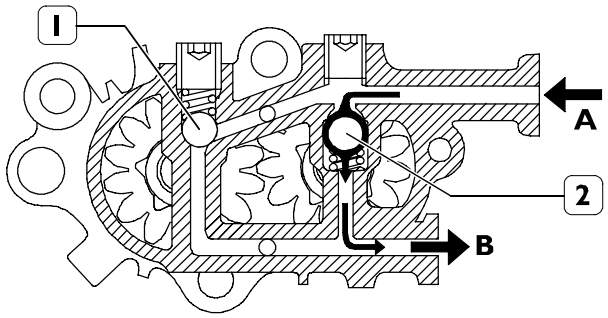


72593

The by-pass valve (1) cuts in when overpressure is generated at outlet B. The existing pressure, overcoming valve spring (1) elastic strength, makes inlet and outlet communicating through duct (2).

Drain conditions

Figure 5



72594

The by-pass valve (2) cuts in when, with engine off, the fuel system shall be filled through the priming pump. In this situation the by-pass valve (1) stays closed whereas by-pass valve (2) opens due to inlet pressure, and fuel is drained out through **B**.

NOTE The mechanical supply pump cannot be replaced individually, therefore it cannot be removed from the high pressure pump.

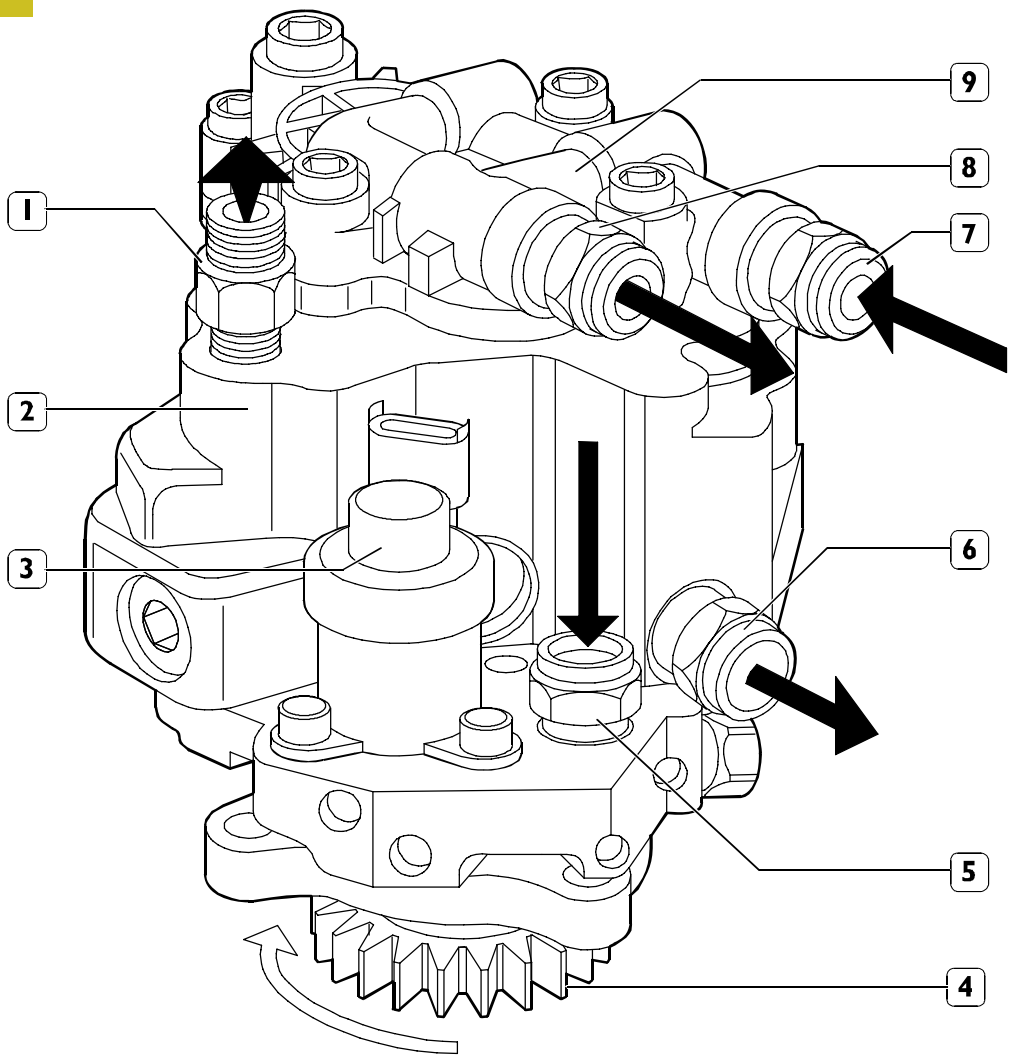
CP3 HIGH-PRESSURE PUMP

Pump with 3 radial pistons controlled by the timing gear, without needing any setting. On the rear side of the high pressure pump is fitted the mechanical supply pump controlled by the high pressure pump shaft.

The following work must be carried out on the feed pump / high-pressure pump assembly:

- ❑ replacing the drive gear;
- ❑ replacing the pressure regulator.

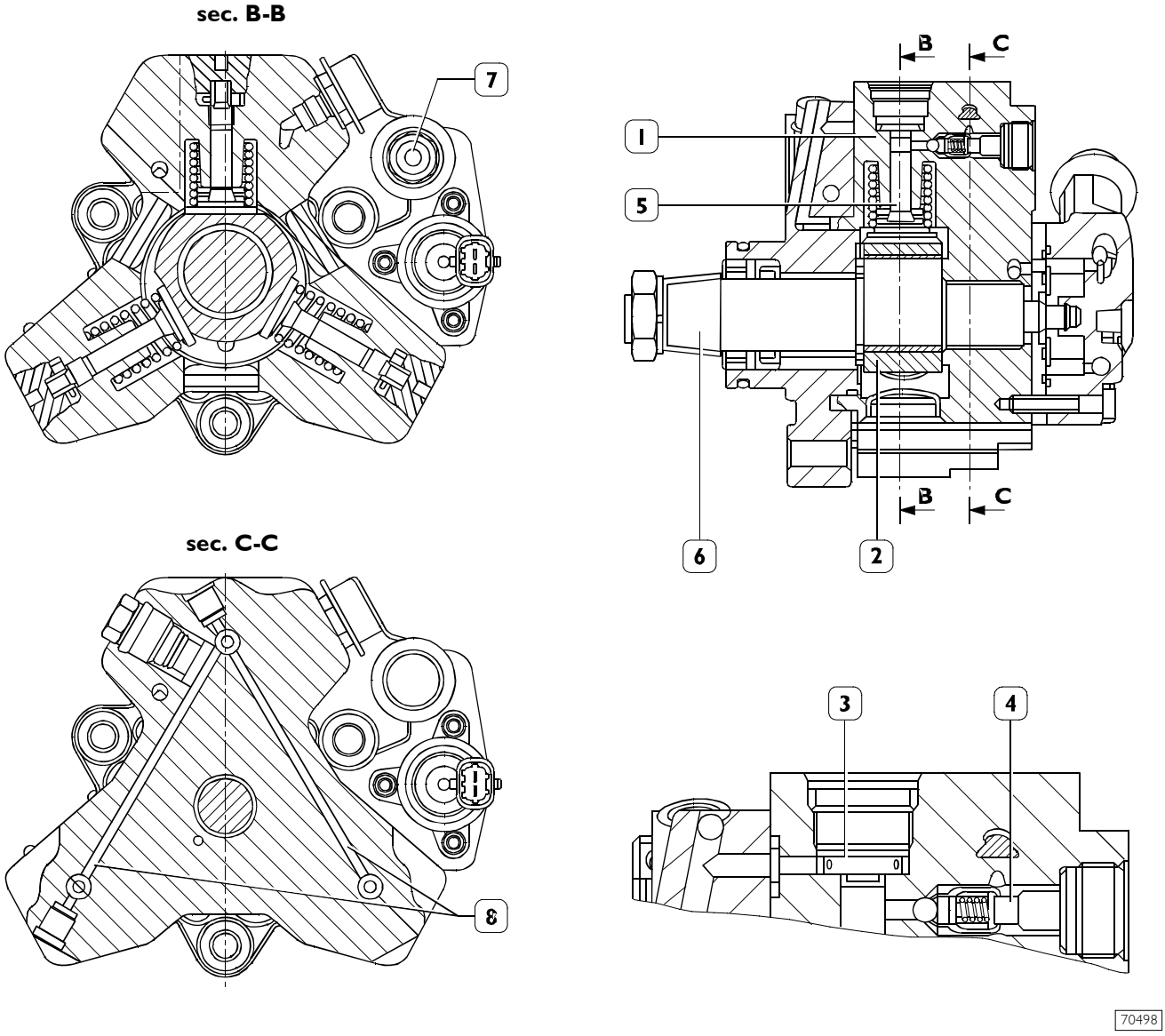
Figure 6



1. Fuel outlet fitting to rail - 2. High-pressure pump - 3. Pressure regulator - 4. Control gear - 5. Fuel inlet fitting from filter - 6. Fuel outlet fitting to filter support - 7. Fuel inlet fitting from control unit heat exchanger - 8. Fuel outlet fitting from supply pump to filter - 9. Mechanical supply pump

HIGH-PRESSURE PUMP - INSIDE STRUCTURE

Figure 7



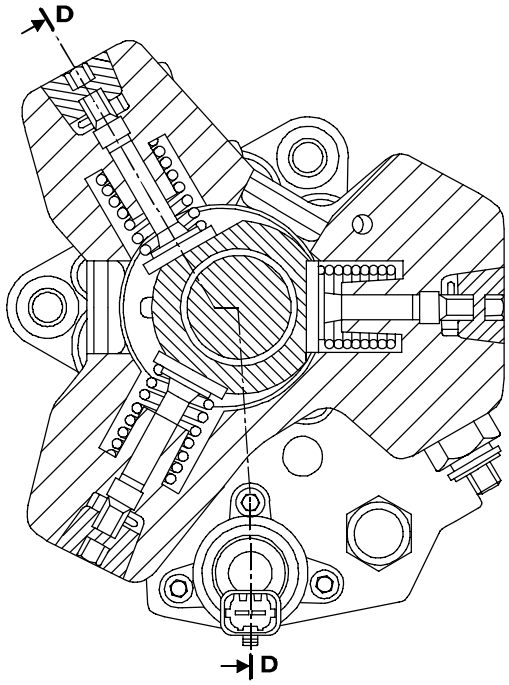
1. Cylinder – 2. Three-lobe element – 3. Cap intake valve – 4. Ball delivery valve – 5. Piston – 6. Pump shaft – 7. Low-pressure fuel inlet – 8. Pumping elements supplying fuel ducts

Every pumping unit is composed of:

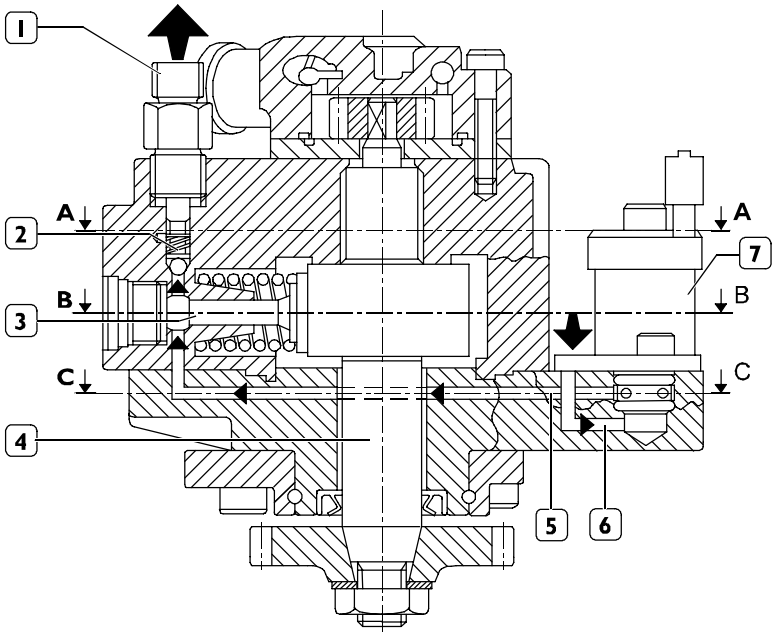
- a piston (5) actuated by a three-lobe element (2) floating on the pump shaft (6). The element (2), being floating on a misaligned part of the shaft (6), when the shaft rotates, does not rotate therewith but is only translated in a circular movement along a wider radius, with the resulting alternate actuation of the three pumping elements;
- cap intake valve (3);
- ball delivery valve (4).

Operating principle

Figure 8



Sec. B – B



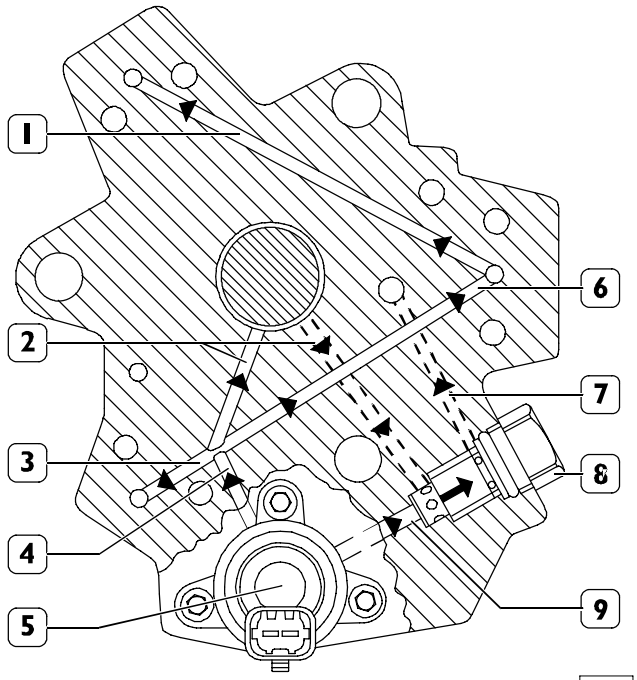
Sec. D – D

72597

1. Fuel outlet fitting to rail - 2. Delivery valve to rail - 3. Pumping element - 4. Pump shaft - 5. Pumping element supply duct - 6. Pressure regulator supply duct - 7. Pressure regulator

Pumping element (3) is oriented to pump shaft (4) cam. During intake, the pumping element is supplied through supply duct (5). The fuel amount to be sent to the pumping element is set by the pressure regulator (7). The pressure regulator meters fuel flow to pumping element according to the PWM signal received from ECU. During pumping element compression stage, fuel reaches the pressure required to open the delivery valve to common rail (2) and to feed it through outlet (1).

Figure 9



Sec. C – C

1. Pumping element inlet - 2. Pump lubrication ducts - 3. Pumping element inlet - 4. Main pumping element supply duct - 5. Pressure regulator - 6. Pumping element inlet - 7. Regulator exhaust duct - 8. 5 bar pressure relief valve - 9. Fuel drain from regulator inlet

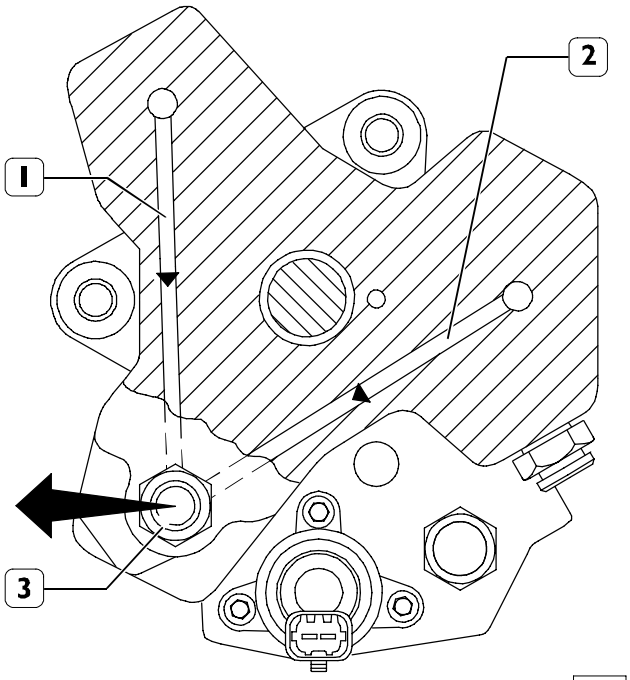
Figure 9 shows low pressure fuel paths inside the path and highlights: main pumping element supply duct (4), pumping element supply ducts (1 – 3 – 6), pump lubrication ducts (2), pressure regulator (5), 5 bar pressure relief valve (8) and fuel drain duct (7).

Pump shaft is lubricated by fuel through delivery and return ducts (2).

Pressure regulator (5) establishes the fuel amount to send to pumping elements; excess fuel is drained out through duct (9).

5 bar pressure relief valve acts as fuel exhaust manifold and keeps 5 bar constant pressure at regulator inlet.

Figure 10



Sec. A – A

1. Fuel outlet duct - 2. Fuel outlet duct - 3. Fuel outlet from pump with high pressure pipe fitting for common rail

Figure 10 shows high pressure fuel flow through pumping element outlet ducts.

Operation

The cylinder is filled through the cap intake valve only if the supply pressure is suitable to open the delivery valves set on the pumping elements (about 2 bars).

The amount of fuel supplying the high-pressure pump is metered by the pressure regulator, placed on the low-pressure system; the pressure regulator is controlled by the EDC7 control unit through a PWM signal.

When fuel is sent to a pumping element, the related piston is moving downwards (suction stroke). When the piston stroke is reversed, the intake valve closes and the remaining fuel in the pumping element chamber, not being able to come out, is compressed above the supply pressure value existing in the rail.

The thereby-generated pressure makes the exhaust valve open and the compressed fuel reaches the high-pressure circuit.

The pumping element compresses the fuel till the top dead center (delivery stroke) is reached. Afterwards, the pressure decreases till the exhaust valve is closed.

The pumping element piston goes back towards the bottom dead center and the remaining fuel is decompressed.

When the pumping element chamber pressure becomes less than the supply pressure, the intake valve is again opened and the cycle is repeated.

The delivery valves must always be free in their movements, free from impurities and oxidation.

The rail delivery pressure is modulated by the electronic control unit, through the pressure regulator solenoid valve.

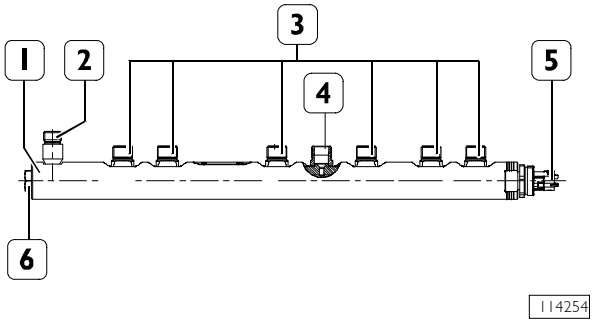
The pump is lubricated and cooled by the fuel.

The radialjet pump disconnection – reconnection time on the engine is highly reduced in comparison with traditional injection pumps, because it does not require setting.

If the pipe between fuel filter and high-pressure pump is to be removed-refitted, be sure that hands and components are absolutely clean.

RAIL (PRESSURE ACCUMULATOR)

Figure 11



1. Rail - 2. Fuel return - 3.Pipelines to injectors - 4. Fuel supply to high pressure pump - 5. Pressure sensor - 6. Overpressure valve

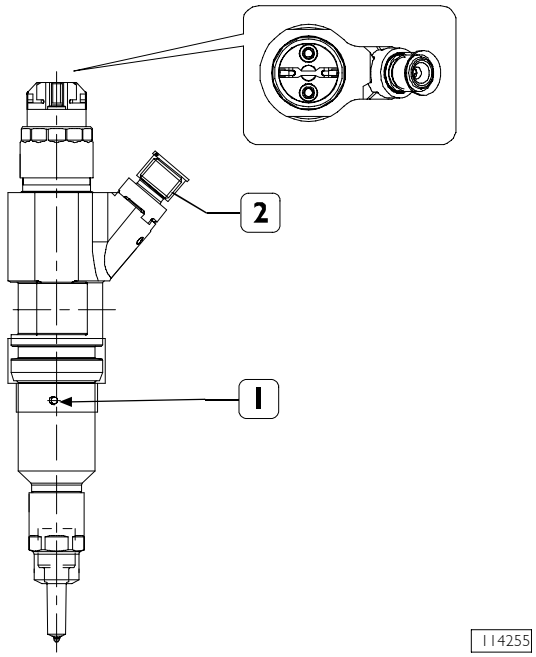
The rail volume is of reduced sizes to allow a quick pressurisation at startup, at idle and in case of high flow-rates.

It anyway has enough volume as to minimise use of plenum chambers caused by injectors openings and closings and by the high-pressure pump operation. This function is further enabled by a calibrated hole being set downstream of the high-pressure pump.

A fuel pressure sensor (5) is screwed to the rail. The signal sent by this sensor to the electronic control unit is a feed-back information, depending on which the rail pressure value is checked and, if necessary, corrected.

Electroinjector

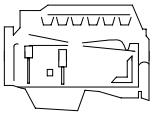
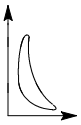
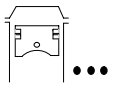
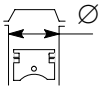
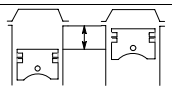
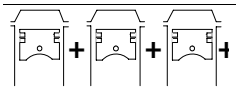
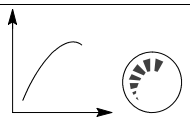
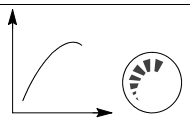
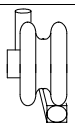
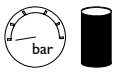
Figure 12



1. Fuel return hole - 2. Fuel supply

SECTION 3

Industrial application

CLEARANCE DATA			TECHNICAL CODE	
	Type		**F2CE9687**	
			A*E	B*E
	Cycle		4-stroke Diesel engine	4-stroke Diesel engine
	Fuel feed		Turbocharged	Turbocharged
	Injection		Direct	
	No. of cylinders		6 in line	
	Bore	mm	117	
	Stroke	mm	135	
	Total displacement	cm^3	8710	
	Compression ratio		1: 15.9 ± 0.8	
	Maximum power	kW (HP) rpm	260 314 2100	230 305 2100
	Max. torque	Nm (kgm) rpm	1500 1400	1400 1400
	Loadless engine idling	rpm	-	
	Loadless engine peak	rpm	-	
	**SUPERCHARGING** Turbocharger type		Intercooler Direct injection HX40	
	**LUBRICATION** Oil pressure (warm engine) - idling - peak rpm	 bar bar	 Forced by gear pump, relief valve single action oil filter - -	
	COOLING Water pump control **Thermostat** - start of opening	 °C	Liquid Through belt 85	

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

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

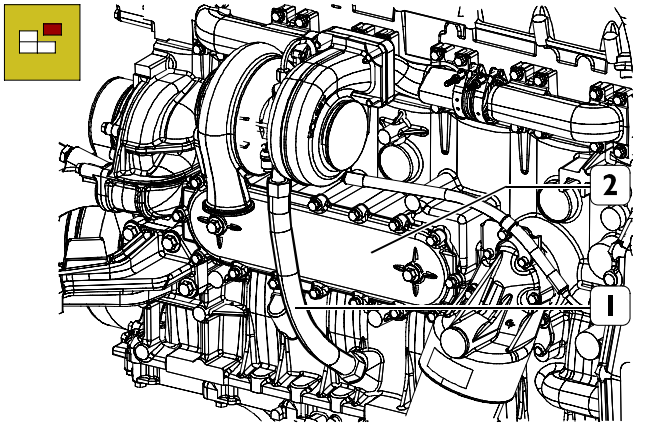
PART ONE -
MECHANICAL COMPONENTS

540110 ENGINE DISASSEMBLY ON BENCH

NOTE Before installing engine on rotary stand 99322230, remove parts that might interfere with the installation of brackets 99361042.

Therefore, remove heat exchanger and oil line as shown below.

Figure 1



114017

Under heat exchanger (2) place a container for engine coolant drain.

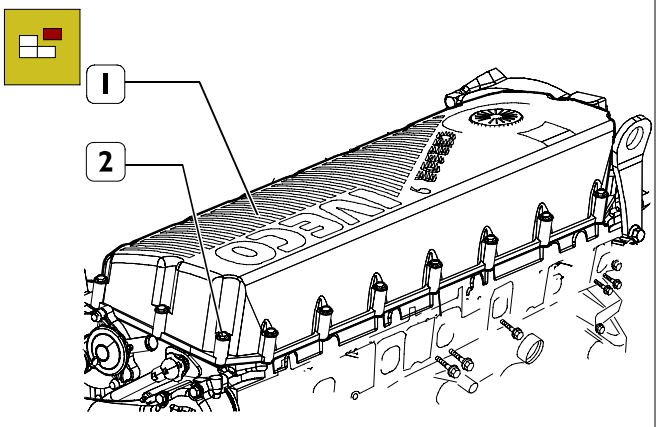
Unlock retaining screws and remove heat exchanger assembly (2).

Remove oil outlet line (1).

Install engine on rotary stand 99322230.

Drain sump oil in specific container.

Figure 2

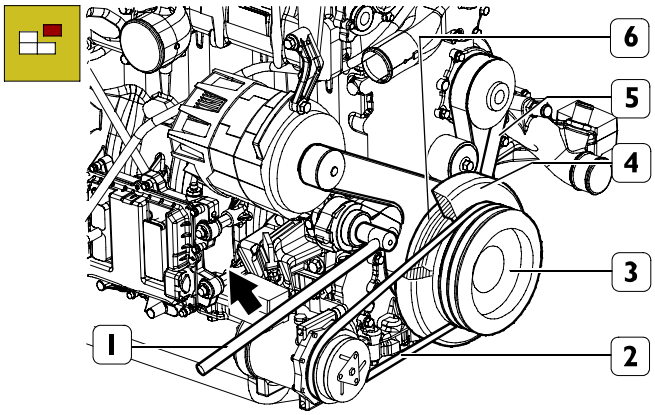


114016

Unlock retaining screws (2) and remove head cover (1) to reach injector and rail wiring.

Remove wiring from all components shown in "Electric equipment" section.

Figure 3



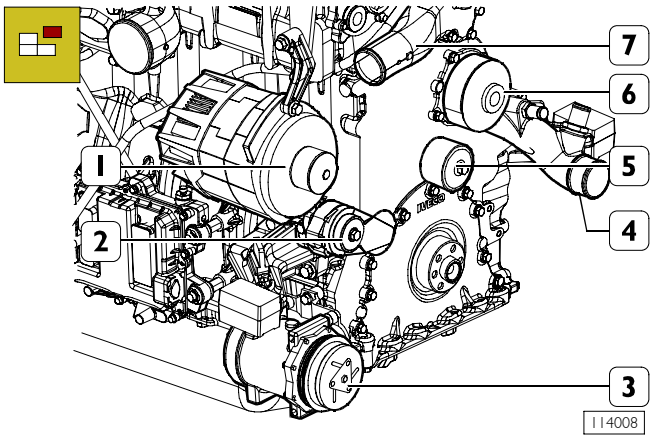
114007

If air conditioner compressor is installed, cut belt (2) as it must not be reused.

Use specific tool (1) and operate in the arrow direction to remove water pump and alternator control belt (5).

Remove screws and separate pulleys (3) and (6) with damping flywheel (4).

Figure 4

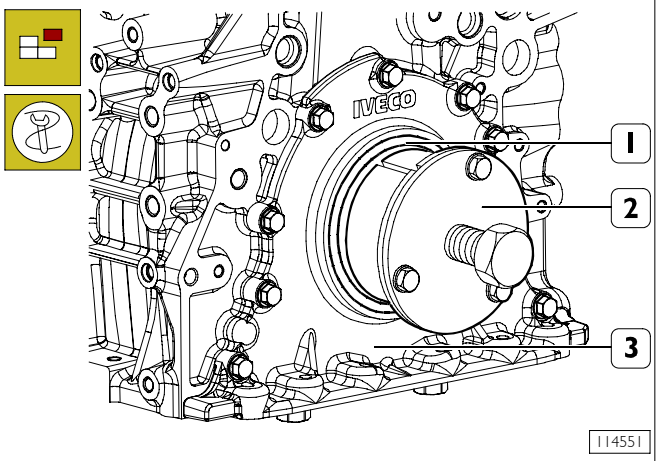


114008

Remove parts below:

- ❑ alternator (1);
- ❑ belt tensioner (2);
- ❑ if present, air conditioner compressor (3);
- ❑ water pump (6);
- ❑ flanged pipe (4);
- ❑ fixed belt tensioner (5);
- ❑ thermostat assembly (7).

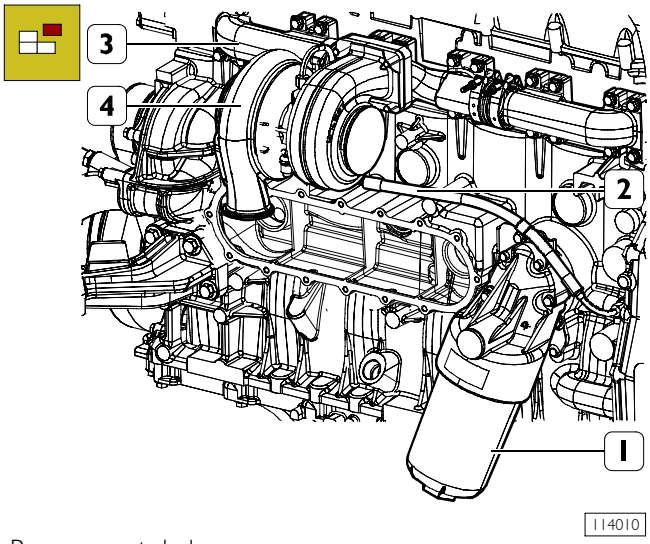
Figure 5



Apply extractor 99340051 (2) and remove seal (1).

Unlock screws and remove front cover (3).

Figure 6

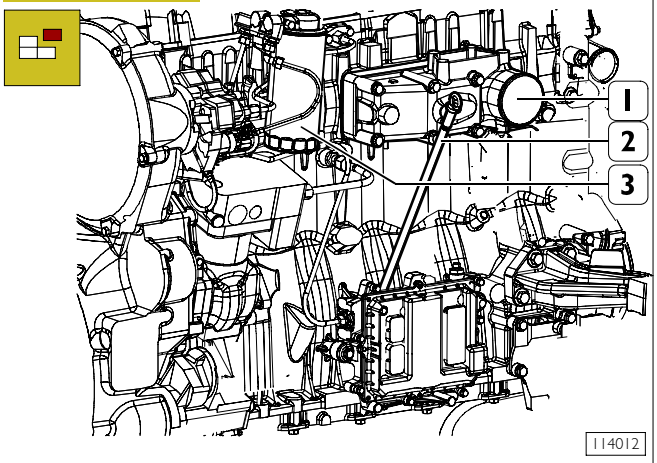


Remove parts below:

- ❑ oil filter (1);
- ❑ oil inlet line (2);
- ❑ turbocompressor (4) and exhaust manifold (3).

On opposite engine side, remove start-up motor.

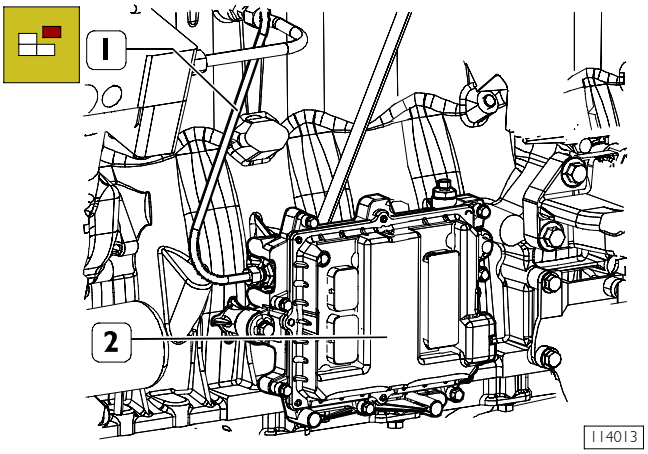
Figure 7



Remove parts below:

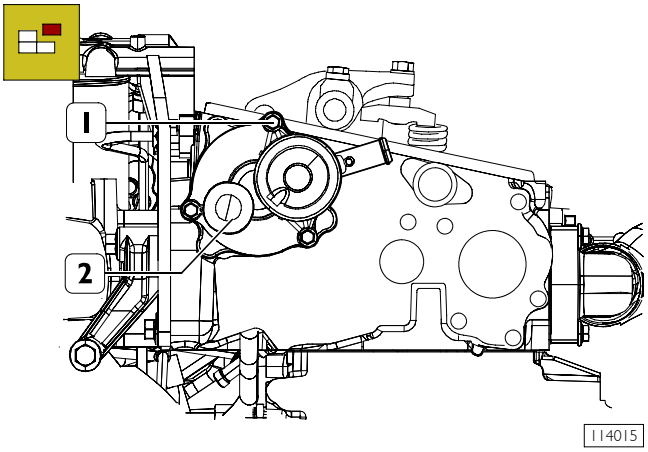
- ❑ fuel filter (3);
- ❑ oil level rod (2);
- ❑ intake manifold (1).

Figure 8



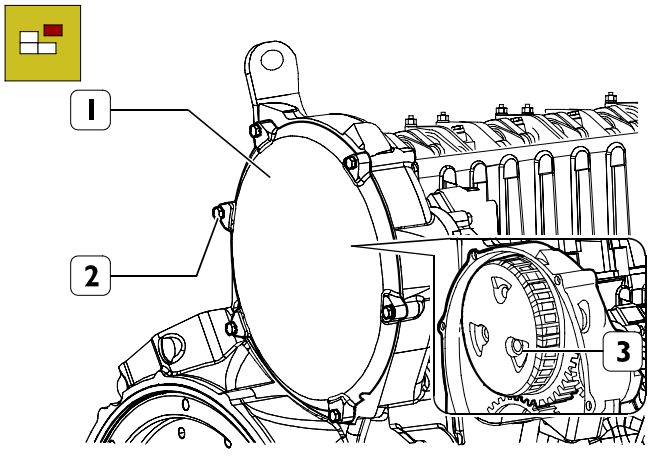
Disconnect line (1) from high pressure pump support and remove ECU (2) with support below.

Figure 9



Remove screws (1) and blow-by box (2).

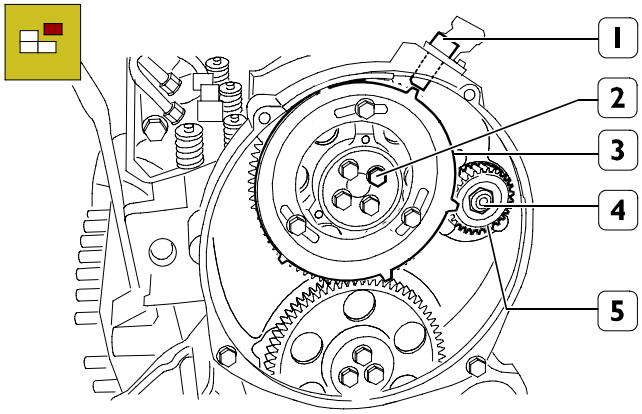
Figure 10



114018

Unlock screws (1) and remove cover (2). Remove centrifugal filter (3) below.

Figure 11



114019

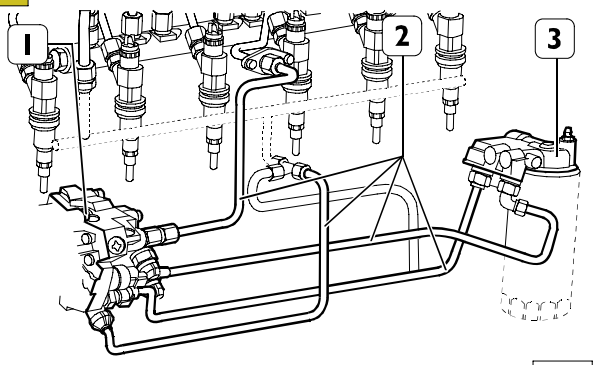
Use specific spanner to unlock screws (2) and remove gear (3) complete with tune wheel.

Unlock nut (4) and remove control gear (5) of high pressure pump.

Remove rpm sensor (1).

NOTE In case removal of gear (5) is difficult, release high pressure pump screws with light beater strokes on control shaft and remove gear (5).

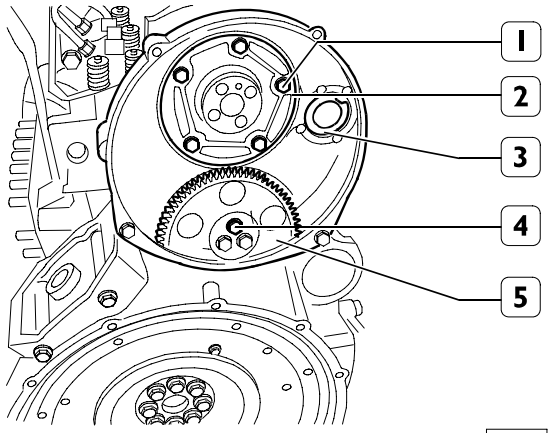
Figure 12



114014

Disconnect fuel lines (2), unlock retaining screws and remove high pressure pump (1). Remove fuel filter support (3) complete with pipeline.

Figure 13



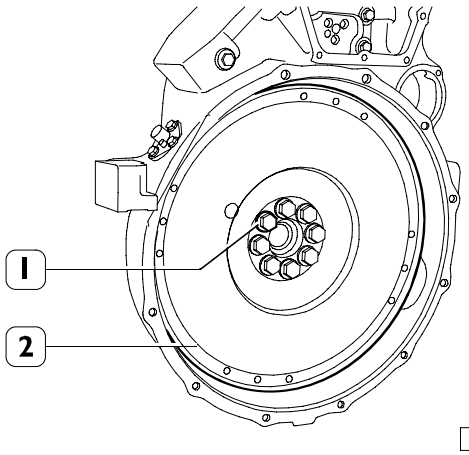
114020

Unlock screws (1) and remove thrust plate (2).

Use specific spanner to unlock screws (4) and remove relay gear (5).

Remove high pressure pump mount flange (3).

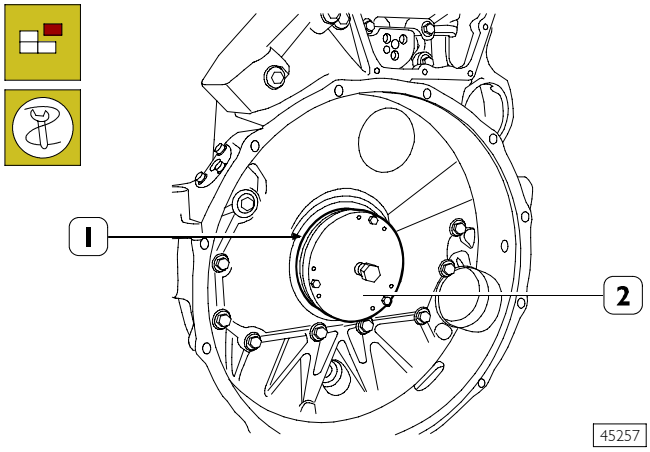
Figure 14



114009

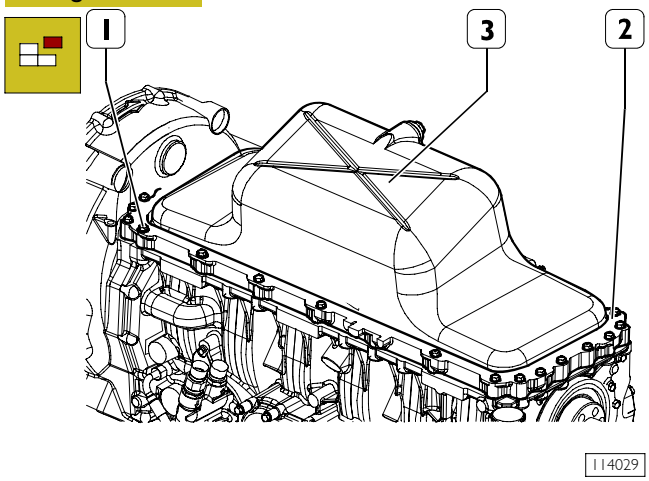
Use specific tool lock engine flywheel (2) rotation, unlock retaining screws (1) and remove engine flywheel.

Figure 15



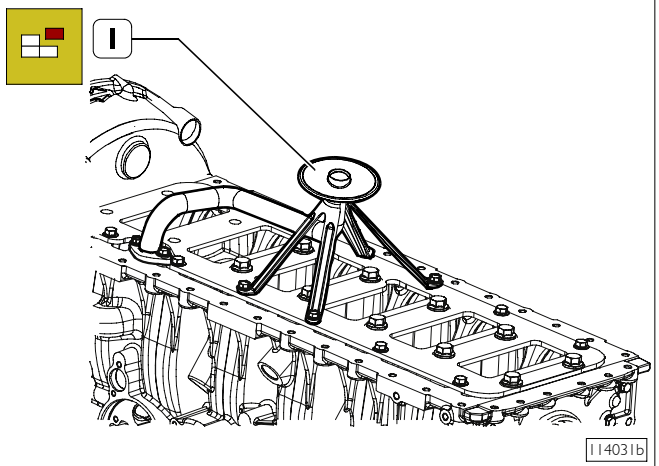
Apply extractor 99340054 (2) and remove seal (1).

Figure 16



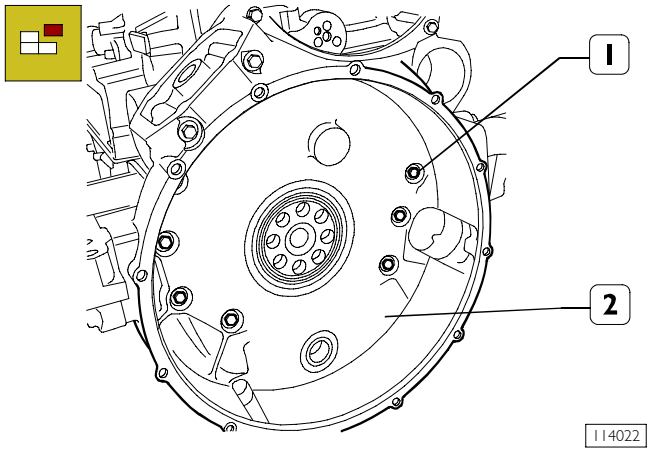
Unlock screws (1) and remove engine oil sump (3) complete with spacer (2) and seal.

Figure 17



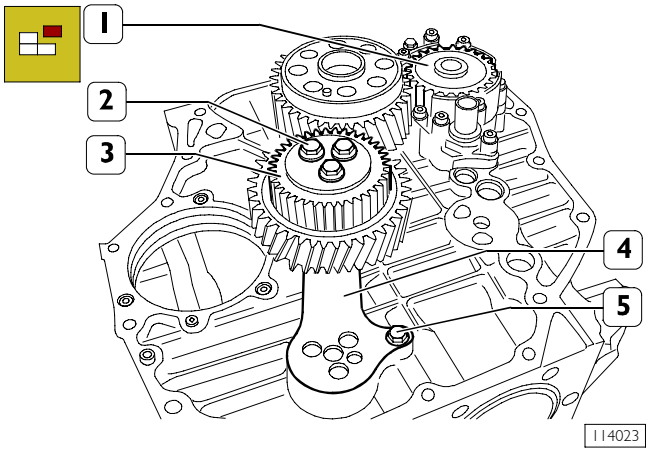
Unlock screws and remove suction rose (1).

Figure 18



Unlock screws (1) and remove flywheel box (2).

Figure 19

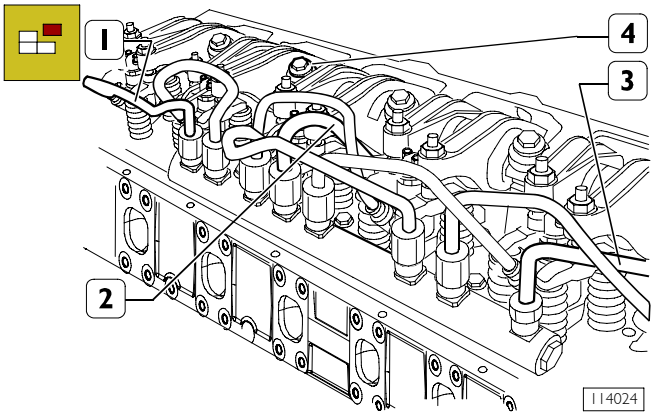


Remove screws (2) and double gear (3).

Remove retaining screw (5) and connecting rod (4).

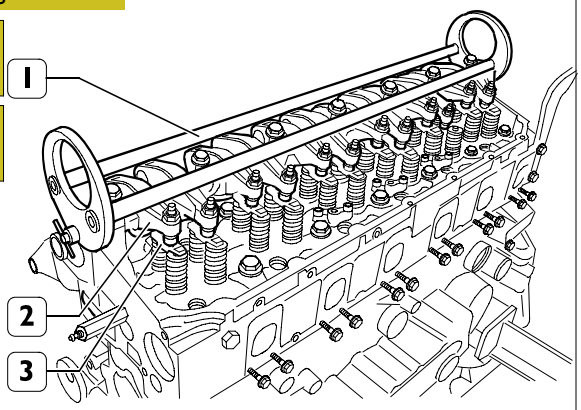
Remove oil pump (1).

Figure 20



- ❑ Unlock rocker arm shaft retaining screws (4).
- ❑ Disconnect fuel pipelines (1) from injector rail, fuel supply line (2) of high pressure pump to rail and return line (3).

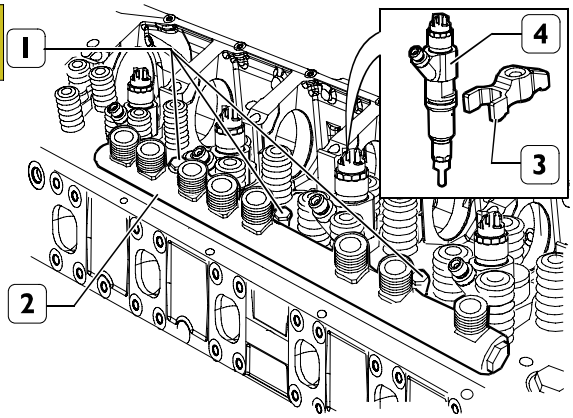
Figure 21



114025

Apply tool 99360558 (1) to rocker arm shaft and remove shaft, remove crosspieces (3) from cylinder head.

Figure 22

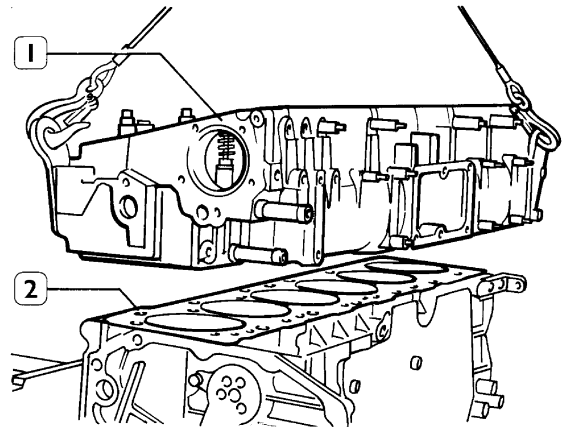


114027

Remove retaining brackets (3) and remove injectors (4).

Remove retaining screws (1) and remove rail (2).

Figure 23

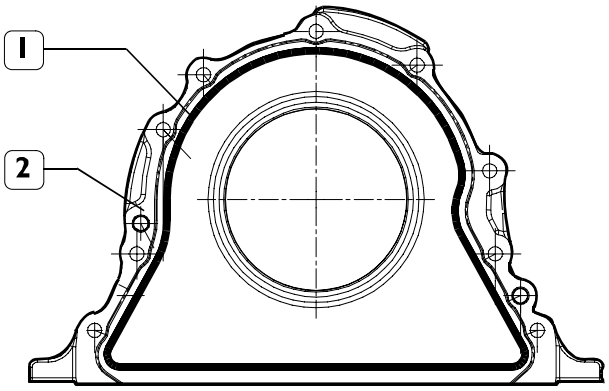


45266

Remove camshaft and remove cylinder head retaining screws.

Use metallic ropes to lift cylinder head (1) and remove seal (2).

Figure 24



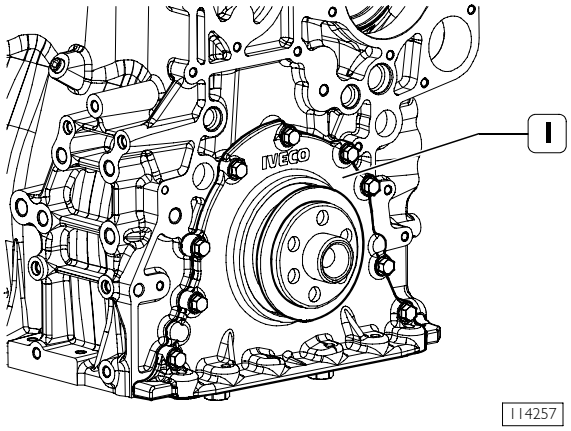
117690

Install front cover (1) and lock retaining screw at required torque.

Check that the injectors (2) are equidistant from the springs (1). Distance "**X**" which separates them should always be the same.

ASSEMBLY

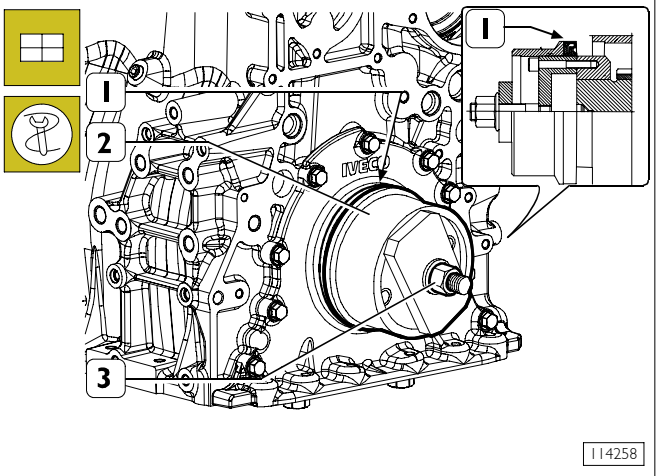
Figure 25



114257

Install front cover (1) and lock retaining screw at required torque.

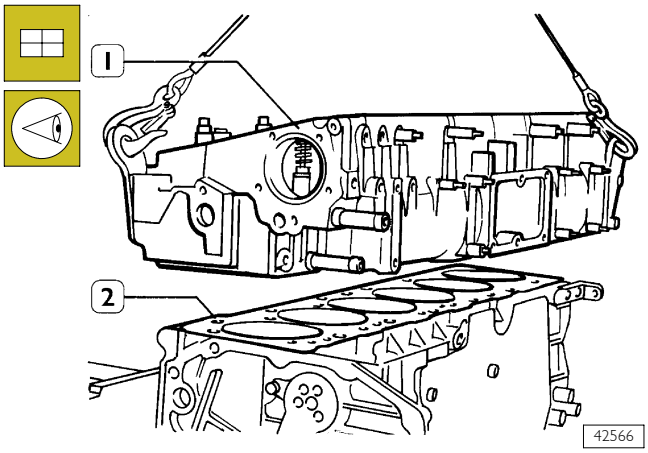
Figure 26



114258

Secure seal (1), install special tool 99346260 (2), lock nut (3) to secure seal (1).

Figure 27



42566

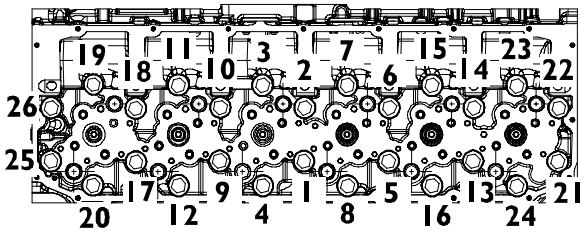
Check that pistons 1-6 are exactly at T.D.C.

Place seal (2) on cylinder block.

Install cylinder head (1) and lock screws as shown in figures below.

Check that the injectors (2) are equidistant from the springs (1). Distance "X" which separates them should always be the same.

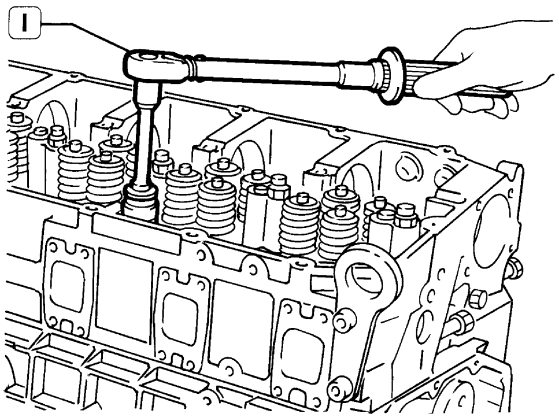
Figure 28



114259

Cylinder head retaining screw locking sequence diagram.

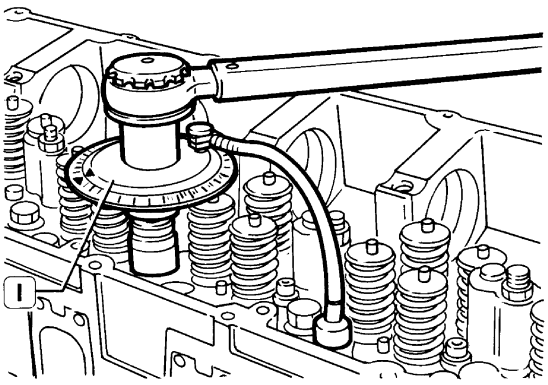
Figure 29



45267

- ❑ Pre-lock by torque wrench (1):
  1st phase: 50 Nm (5 kgm);
  2nd phase: 100 Nm (10 kgm).

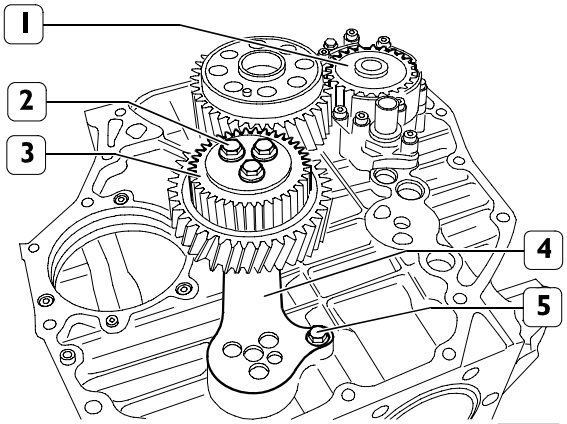
Figure 30



45268

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

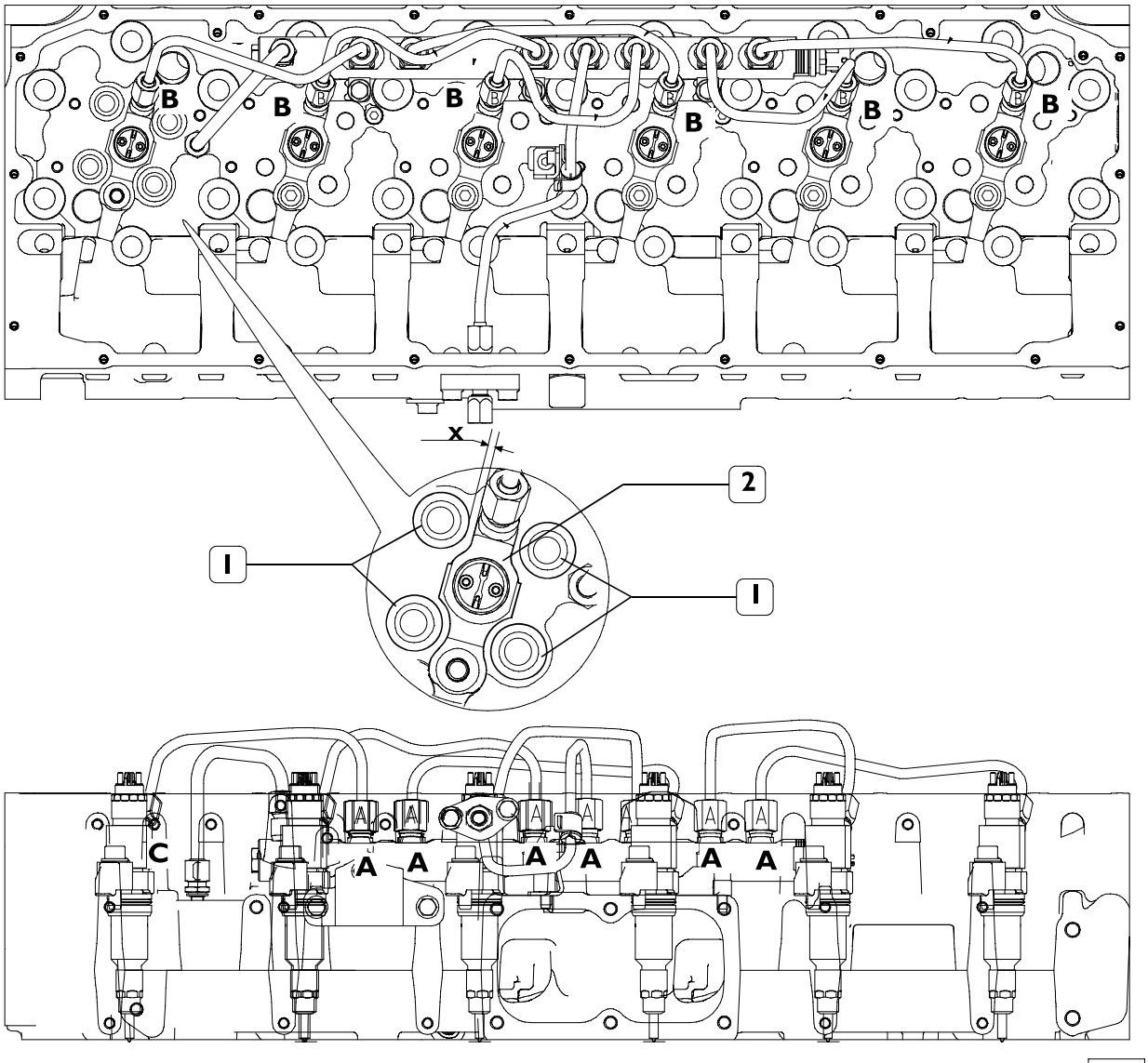
Figure 31



114023

Install oil pump (1), double gear (3) complete with connecting rod (4) and lock screws (2) in two phases:
pre-lock 30 Nm
90° angle lock

Figure 32



The previously removed pipes ca no longer be refit and must be replaced.

The previously removed pipes ca no longer be refit and must be replaced.

1. Install rail on cylinder head and lock retaining screws by hand.
2. Install injectors in correct position and lock to required torque.

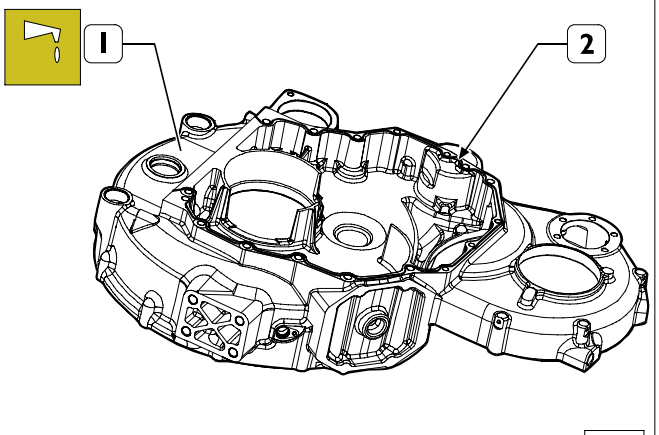
Check that the injectors (2) are equidistant from the springs (1). Distance "X" which separates them should always be the same.

3. Install pipes on rail and lock fittings by hand.
4. Lock rail to cylinder head retaining screws at required torque.
5. Fit pipes on injectors and head locking fittings by hand.
6. Lock fittings on rail (A, C) at required torque .
7. Lock fittings on injectors and head (B, C) at required torque.

TYPE	DESCRIPTION	LOCK TORQUE
A	M18 x 1.5	40 ± 2 Nm
B	M14 x 1.5	35 ± 2 Nm
C	M16 x 1.5	40 ± 2 Nm

After fitting the high-pressure pipelines, during the following 20 hours of work, frequently check engine oil level (IT MUST NOT INCREASE).

Figure 33

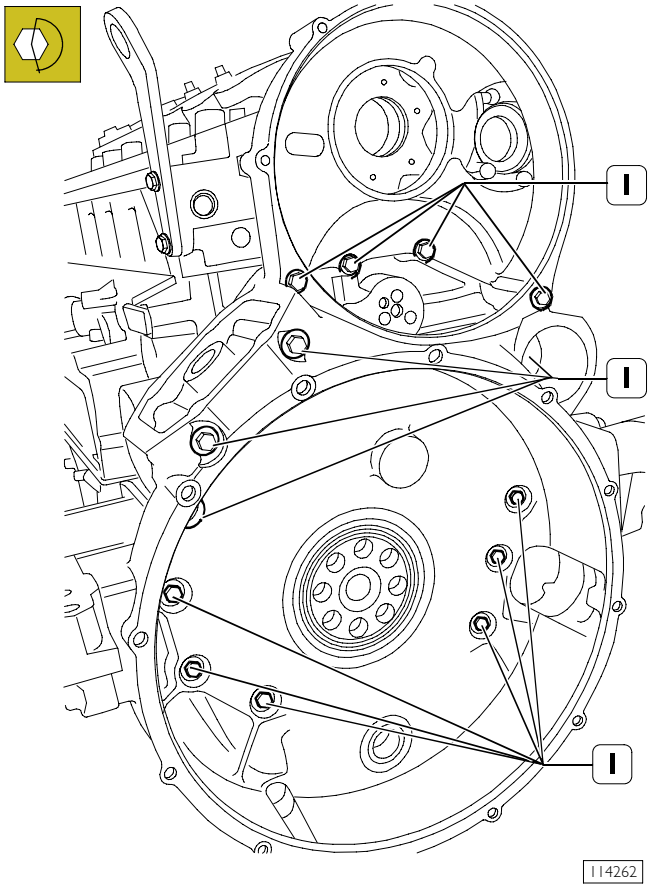


Clean surfaces to be coupled to remove dirt and oil residuals. Apply LOCTITE 275 silicone on gear casing (1) as shown in the figure.

The sealant seam diameter must be 1.5 ± 0.5/0.2.

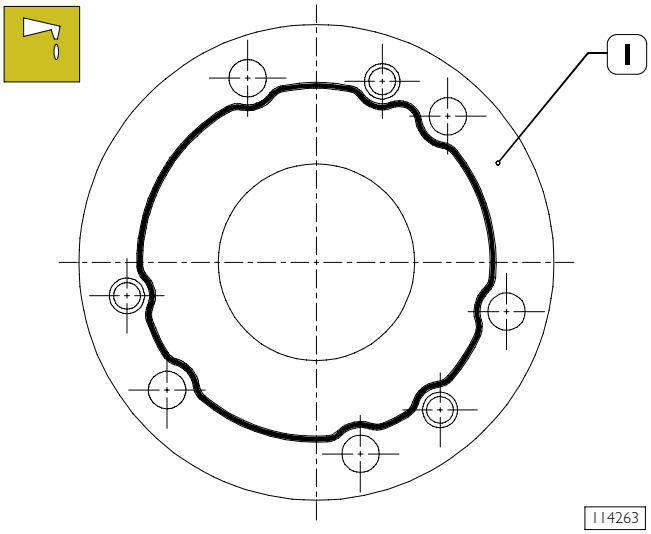
NOTE Install gear casing within 10 min. from sealant application.

Figure 34



Use torque wrench to lock screws (1) at required torque.

Figure 35

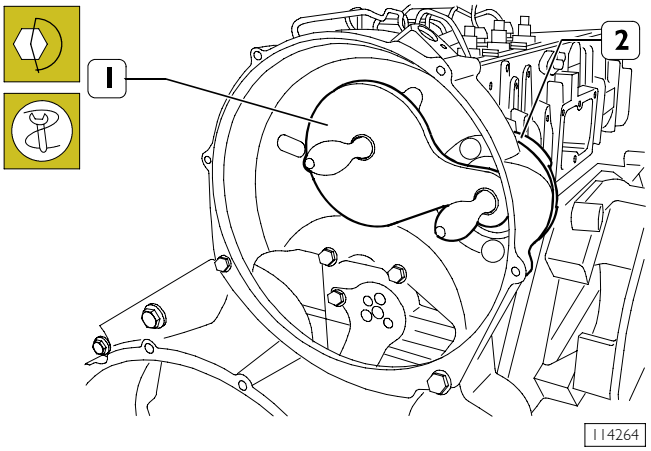


Clean surfaces to be coupled to remove dirt and oil residuals. Apply LOCTITE 275 silicone on gear casing (1) as shown in the figure.

The sealant seam diameter must be 1.5 ± 0.5/0.2.

NOTE Install gear casing within 10 min. from sealant application.

Figure 36

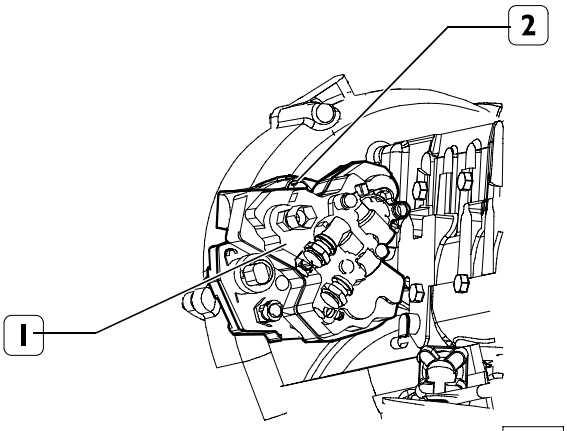


Apply gage 99395221 (1) to check and adjust position of high-pressure pump connection flange (2).

Fix flange screws (2) at required torque.

High pressure pump installation

Figure 37



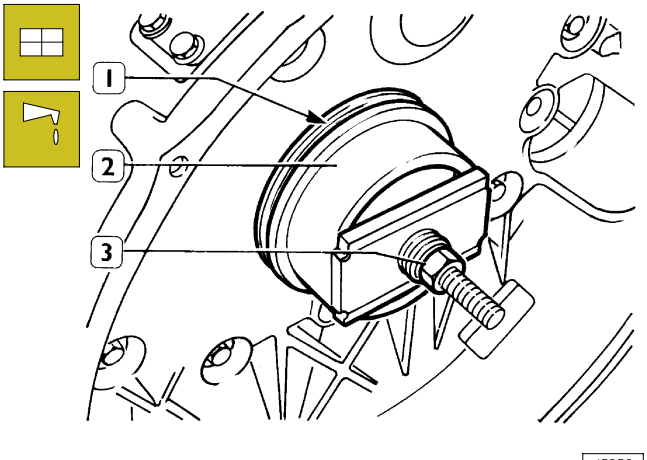
Install high-pressure pump (1) on flange (2).

540850 ENGINE FLYWHEEL

NOTE If toothing on engine flywheel for engine start-up is very damaged, change crown wheel.

Refit crown wheel after heating up at approx. 200°C.

Figure 38

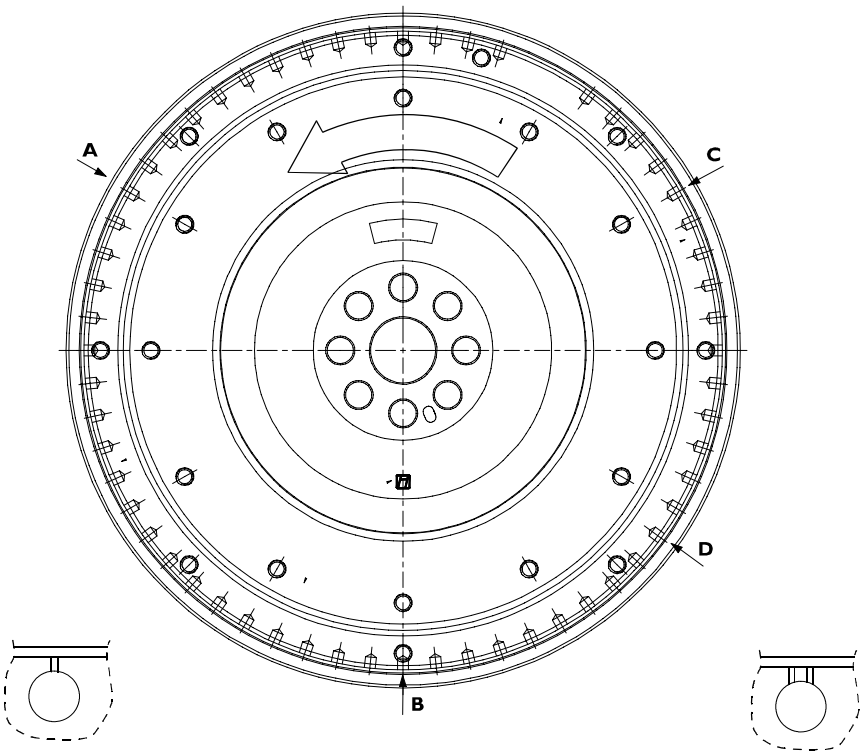


Secure seal (1), install special tool 99346260 (2), lock nut (3) to secure seal.

Engine flywheel installation

NOTE Crankshaft has a reference pin that must match with related housing on engine flywheel.

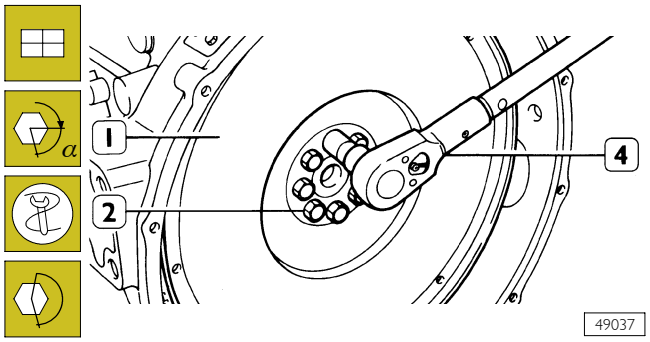
Figure 39



DETAIL OF PISTON POSITION STAMPING ON ENGINE FLYWHEEL

A. Hole on flywheel with a notch corresponding to pistons 3-4 TDC - B. Hole on flywheel with a notch, corresponding to piston 1-6 TDC - C. Hole on flywheel with a notch corresponding to pistons 2-5 TDC - D. Hole on flywheel with 2 notches, position corresponding to 54°.

Figure 40



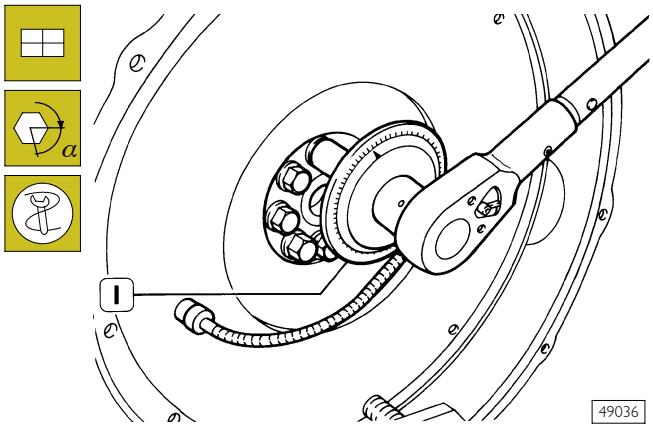
Position flywheel (1) on crankshaft, lubricate screws (2) threading with engine oil and lock them.

Stop rotation using specific tool.

Lock screws (2) in three phases.

1st phase: pre-lock with torque wrench (4) at 100 Nm torque (10 kgm).

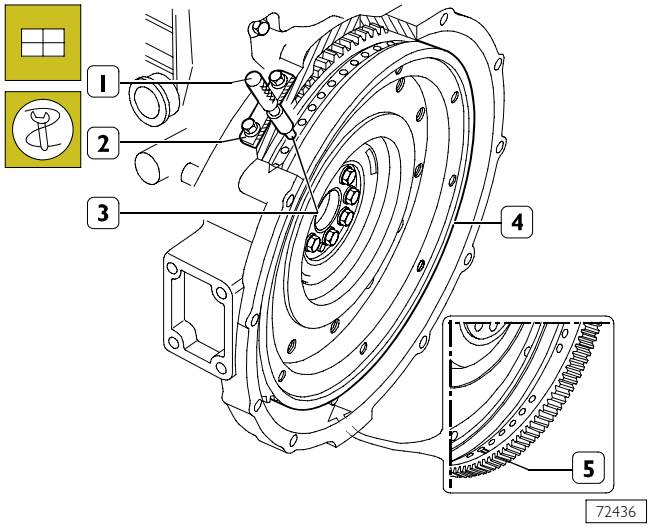
Figure 41



2nd phase: 60° angle locking using tool 99395216 (1).

Camshaft installation

Figure 42



Position crankshaft with pistons 1 and 6 at TDC.

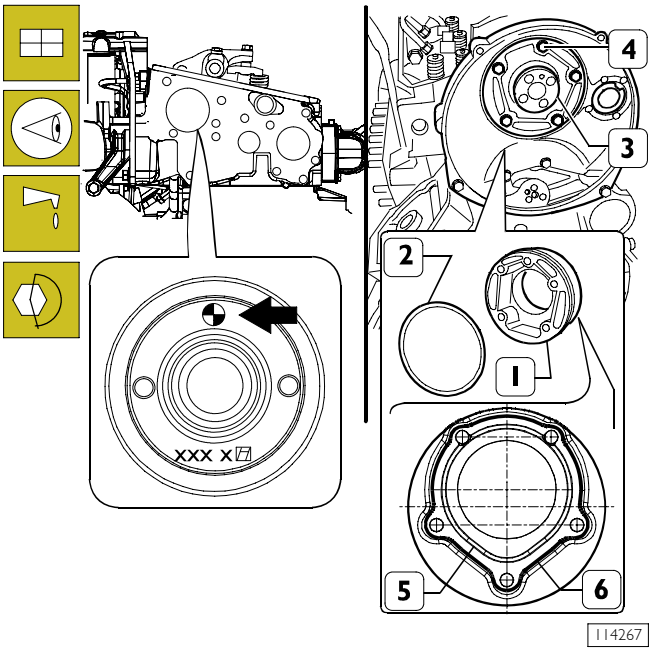
This condition is obtained when:

1. the opening with one reference (5) for the engine flywheel (4) is visible from the inspection window;
2. tool 99360612 (1), through housing (2) of engine rpm sensor, inserts in hole (3) drilled on engine flywheel (4).

Otherwise, adjust engine flywheel orientation (4).

Remove too 99360612 (1).

Figure 43



Install camshaft (3) and orient it with references (→) positioned as in the figure.

Clean the matching surfaces of the plate (1) to remove impurities and oil residues.

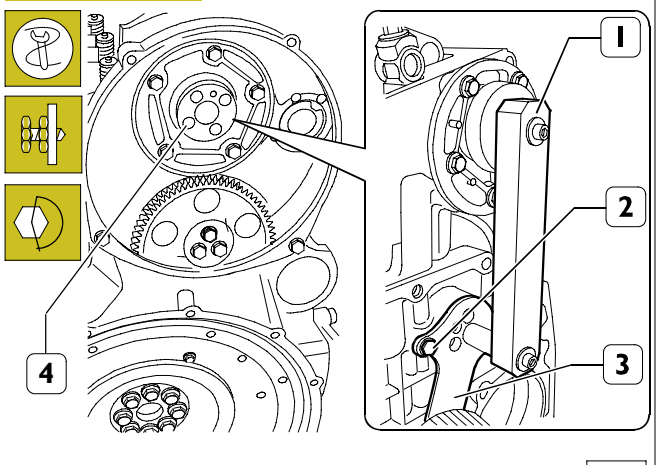
Apply silicon (6) to the plate (1) as illustrated in the diagram.

NOTE Take care NOT to get sealant on the inner groove (5).

The diameter of the sealant bead should be 1.5 - 0.5/0.2 mm.

Fit the plate (1) within 10 mins of applying the sealant with the gasket (2) and tighten the bolts (4) to the recommended torque.

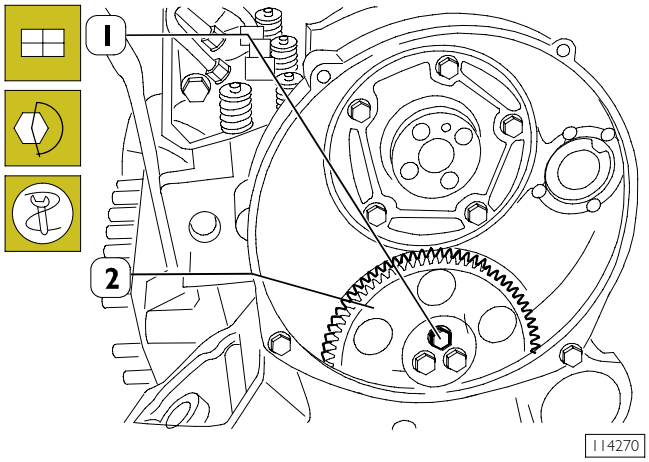
Figure 44



114269

Apply gage 99395222 (1), check and adjust position of connecting rod (3) for relay gear, lock screw (2) at required torque.

Figure 45



114270

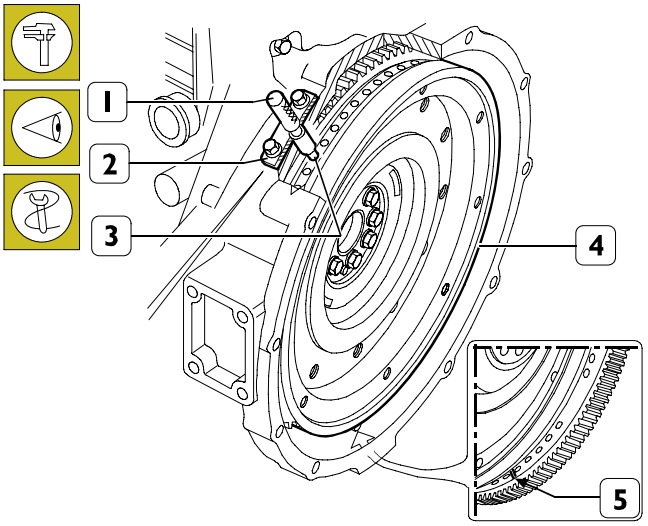
Refit relay gear (2) and lock screws (1) using six-splined spanner at required torque.

NOTE The relay gear (1) bushing can be replaced when worn out. After securing bushing, grind it to reach dia. 58.010 ± 0.10 mm.

TIMING CAMSHAFT AND FLYWHEEL USING TOOL 99395223

Timing camshaft

Figure 46

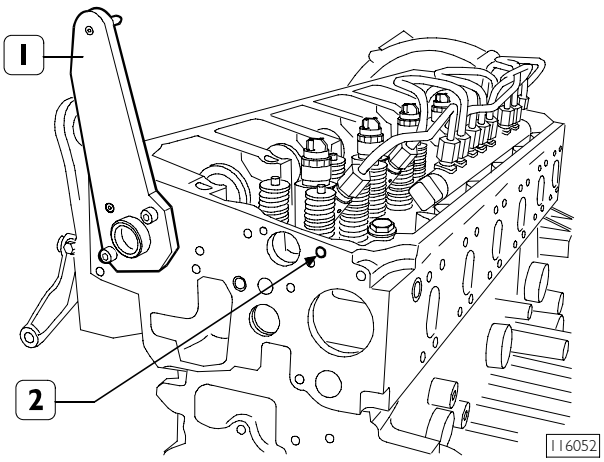


115064

Rotate the crankshaft with the tool 99360341 (3, Figure 53) so that the opening marked with two references (5) is visible from the lower inspection window in the flywheel cover casing.

In this condition, insert the tool 99360612 (1) via the housing (2) for the engine rpm sensor in the opening (3) in the engine flywheel (4).

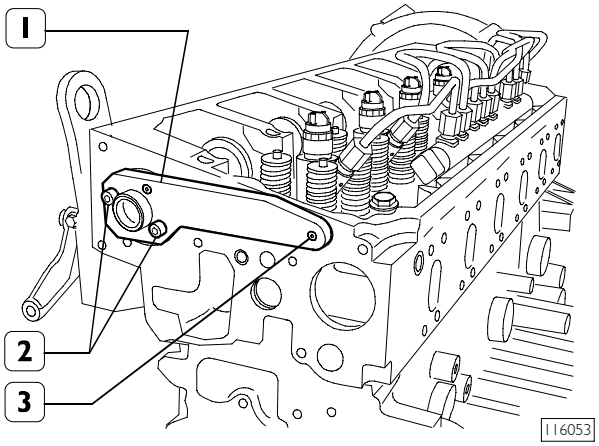
Figure 47



116052

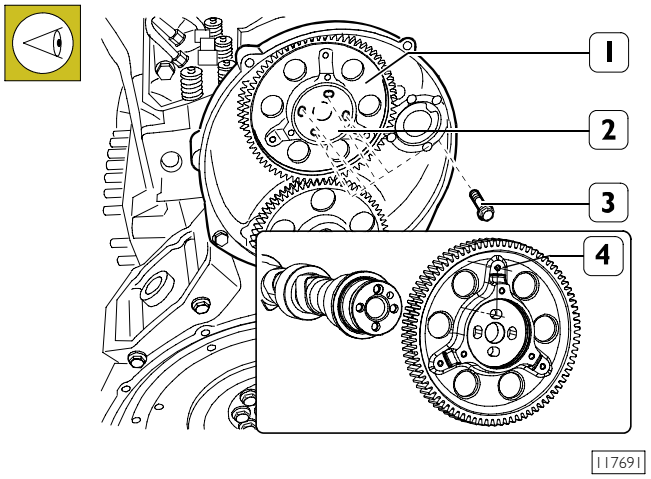
Fit the tool 99395223 (1) at the front of the camshaft.

Figure 48



Rotate the tool (1) 99395223 in order to insert the pin (3) in the opening (2, Figure 47) in the head. Fasten the tool (1) 99395223 using two M8x1.25 bolts (2).

Figure 49

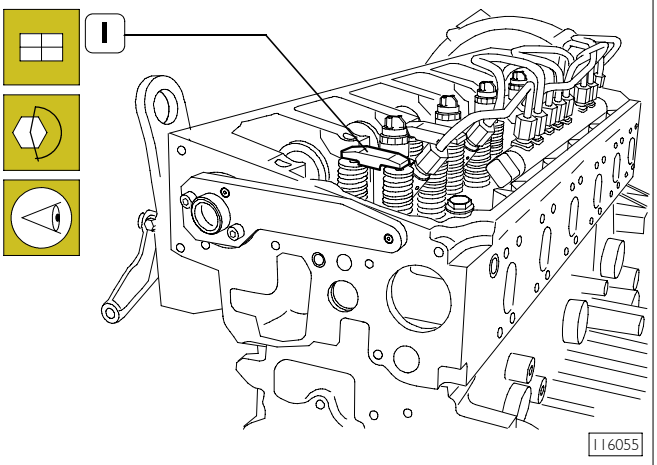


Fit the camshaft drive gear (1) so that the fastening openings in the shaft are aligned with the slots (2) in the drive gear.

Position the gear (1) taking care to position the spokes (4) as illustrated. This operation is necessary in order to be able to fit the flywheel correctly which can only be fitted in one position in relation to the gear.

Tighten the fixing bolts (3).

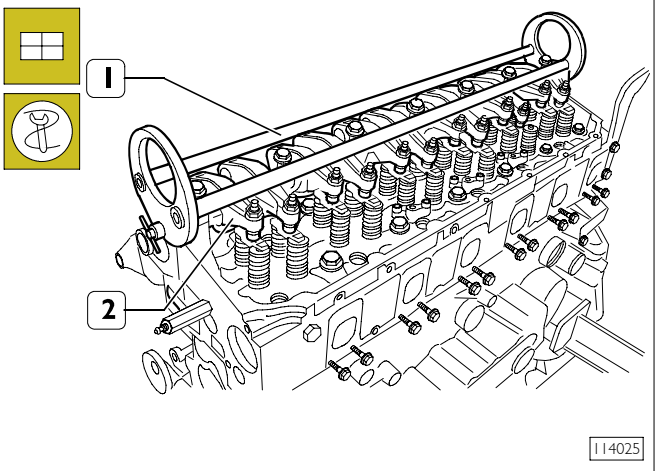
Figure 50



Install crosspieces (1) on valve rod.

NOTE Before refitting rocker arm shaft assembly, check that all adjustment screws have been fully unlocked.

Figure 51

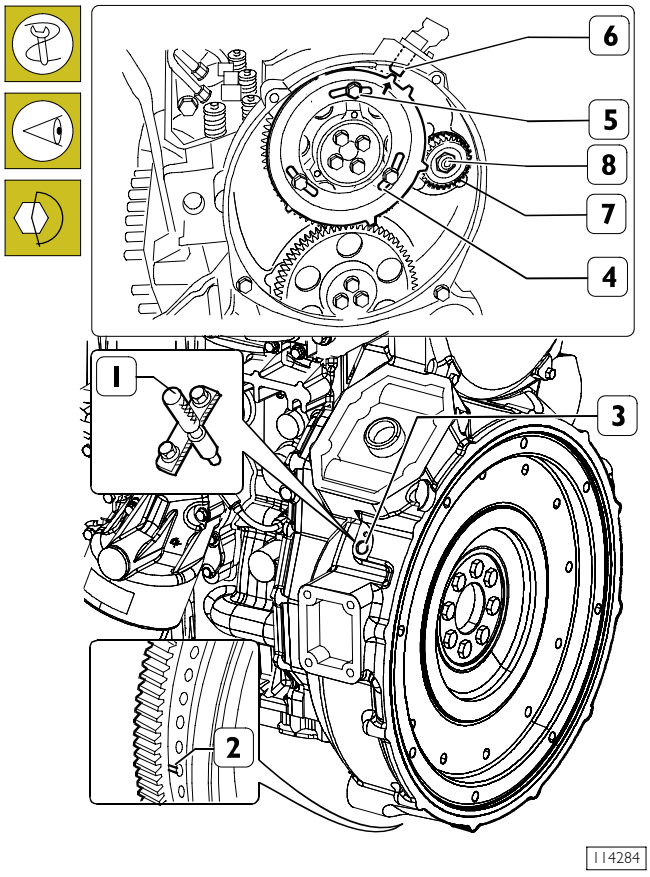


Apply tool 99360558 (1) to rocker arm shaft (2) and install shaft on cylinder head.

Lock retaining screws at required torque.

Timing flywheel

Figure 52



Fit the high pressure pump gear (7)tightening the nut (8) to torque.

Use the flat washer (PN 17095914) in conjunction with the nut replacing the one supplied with the Bosch CP3 pump.

Fit the flywheel (4) so that the toothe marked with the arrow (→) is in line with the sensor housing (6).

To check that the position is correct, insert tool 99360613 in the timing sensor (6) housing.

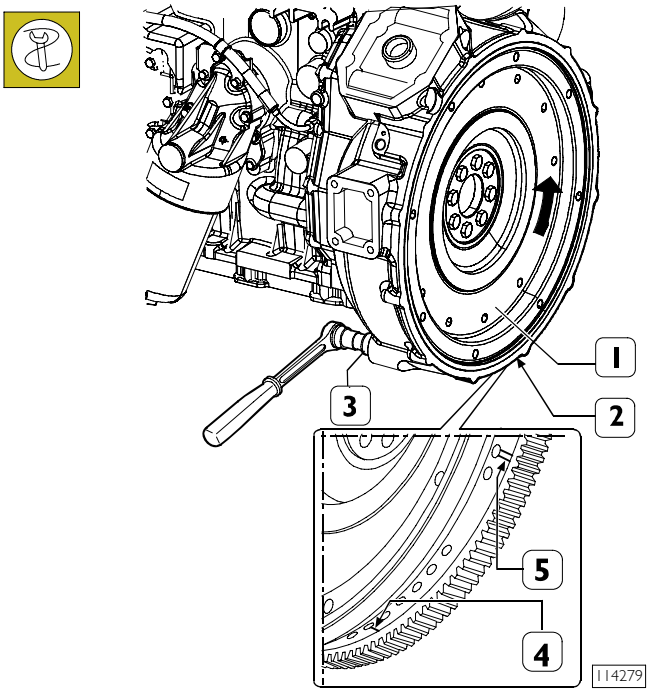
Proceed with tightening the bolts (5).

Remove the tools 99395223, 99360612 and 99360613.

TIMING CAMSHAFT AND FLYWHEEL WITHOUT TOOL 99395223

Timing camshaft

Figure 53



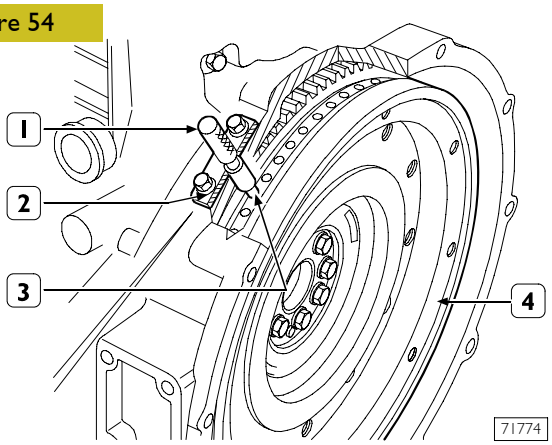
Secure special tool 99360341 (3) to gear casing.

NOTE The arrow indicated engine rotation direction.

Use tool above to rotate engine flywheel (1) in engine rotation direction to bring cylinder 1 piston approx. to TDC in blast phase.

This condition is reached when hole with notch (4), following hole with two notches (5) drilled on engine flywheel (1), is visible through manhole (2).

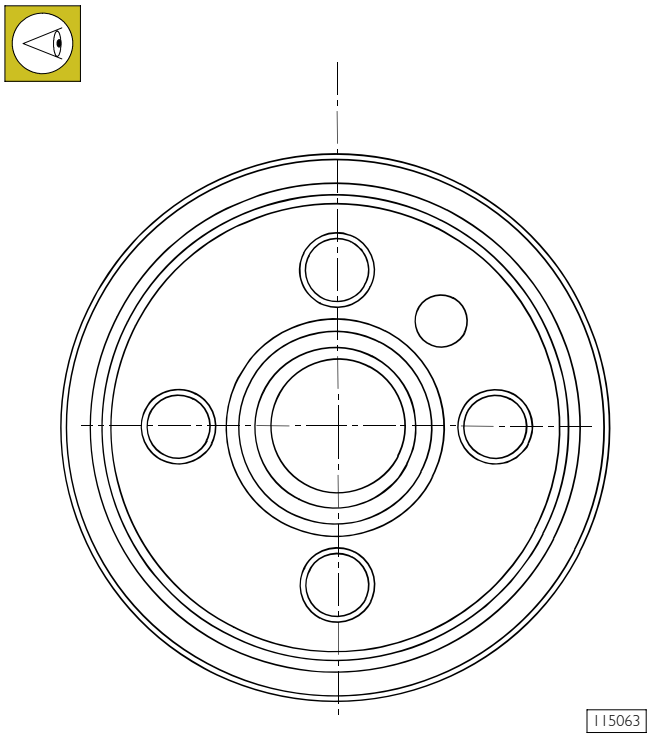
Figure 54



The exact position of piston no.1 at TDC is obtained when, in conditions described above, tool 99360612 (1), through engine rpm sensor housing (2), inserts in hole (3) drilled on engine flywheel (4).

Otherwise, rotate engine flywheel (4) to adjust its orientation.

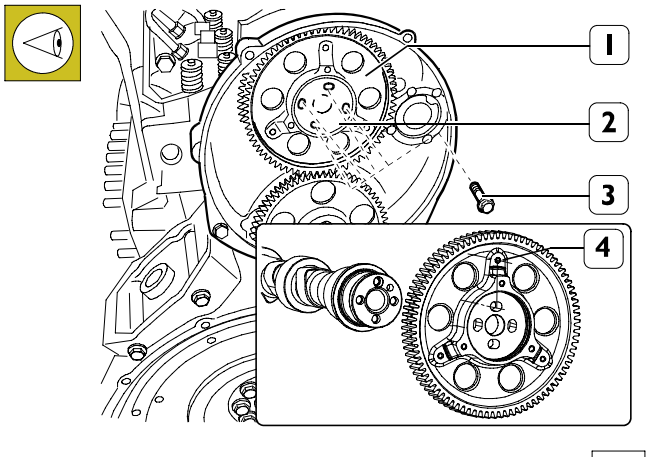
Figure 55



115063

Rotate the camshaft so that the openings at the rear of the engine are arranged in the configuration illustrated in the diagram.

Figure 56



117691

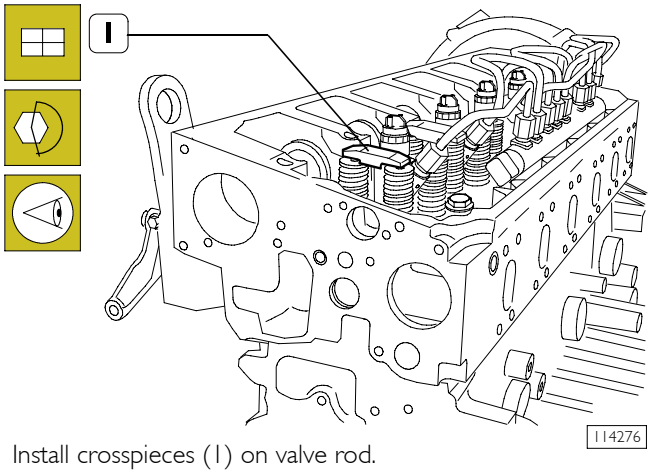
Install gear (1) controlling camshaft so that fastening holes on shaft coincide with slots (2) on control gear.

NOTE Position the gear (1) taking care to position the spokes (4) as illustrated.

This operation is necessary in order to be able to fit the flywheel correctly which can only be fitted in one position in relation to the gear.

Lock retaining screws (3).

Figure 57

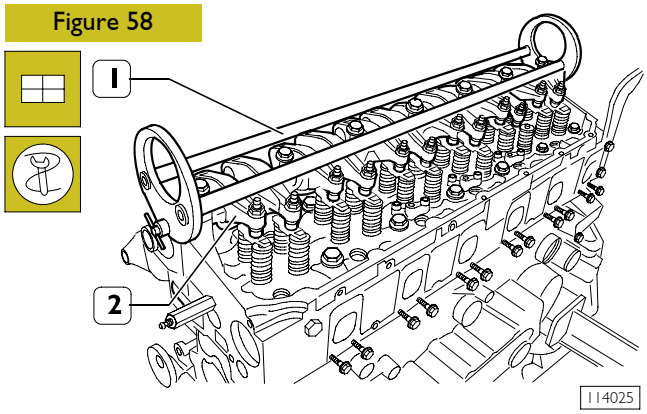


114276

Install crosspieces (1) on valve rod.

NOTE Before refitting rocker arm shaft assembly, check that all adjustment screws have been fully unlocked.

Figure 58



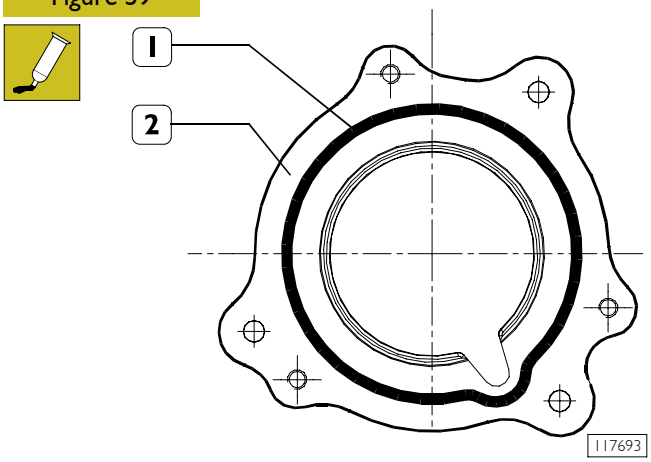
114025

Apply tool 99360558 (1) to rocker arm shaft (2) and install shaft on cylinder head.

Lock retaining screws at required torque.

Remove tool 99360612 (1, Figure 54).

Figure 59



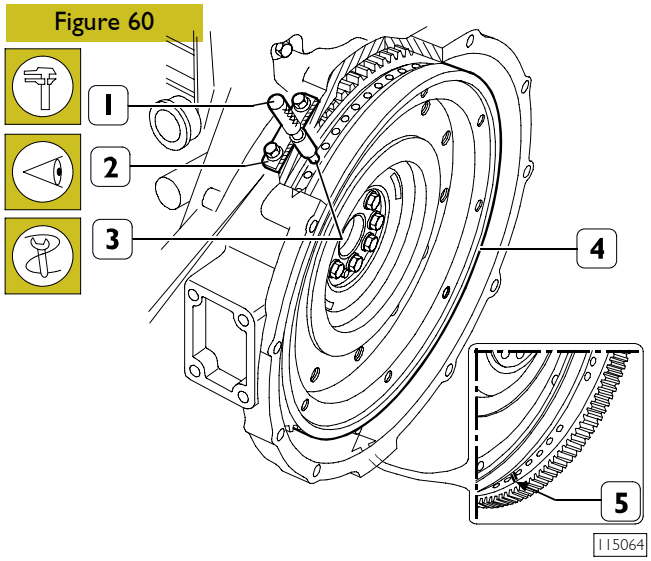
117693

Apply tool 99360558 (1) to rocker arm shaft (2) and install shaft on cylinder head.

Lock retaining screws at required torque.

Remove tool 99360612 (1, Figure 54).

Figure 60

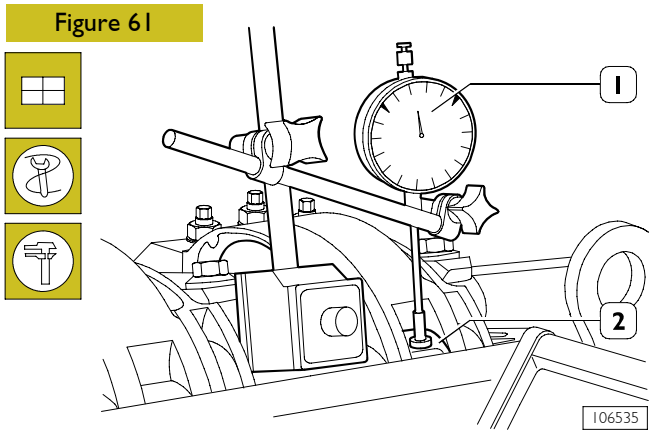


Rotate crankshaft to check conditions below:

1) hole identified with two notches (5) is visible through manhole;
2) fixture 99360612 (1) through housing (2) of engine rpm sensor inserts in hole (3) on engine flywheel (4).

NOTE To recover the clearances, rotate the crankshaft in a clockwise direction until the opening with the two references is passed and then rotate in the opposite direction to produce the conditions described above.

Figure 61



Position the dial gauge with a magnetic base (1) with the (flat-based) rod positioned on the roller (2) for the rocker arms which controls the exhaust valve for cylinder no. 3 and apply a pre-loading of 6 mm.

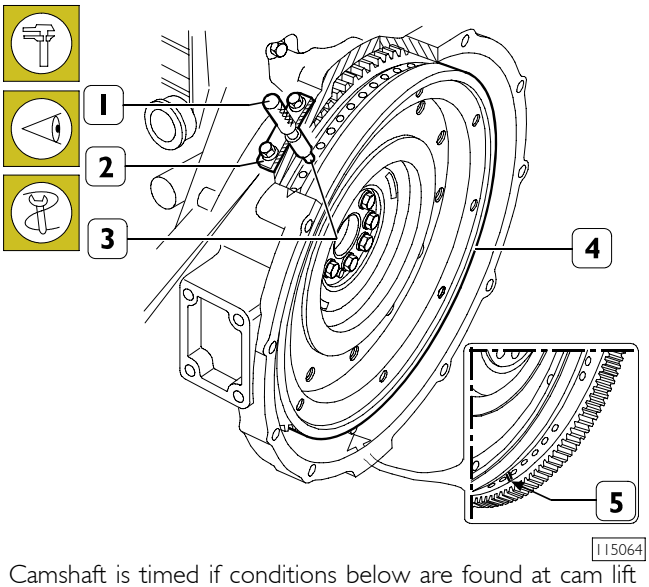
NOTE During the measurement the rod for the dial gauge should always be perpendicular to the engine axis and NOT to the surface of the head.

Using tool 99360341 (3, Figure 46), rotate crankshaft clockwise till dial gage arrow reaches minimum value (max cam lift), after which it no longer varies.

Zero set dial gage.

Rotate engine flywheel anticlockwise till dial gage reads camshaft cam lift value = 4.70 ± 0.05 mm.

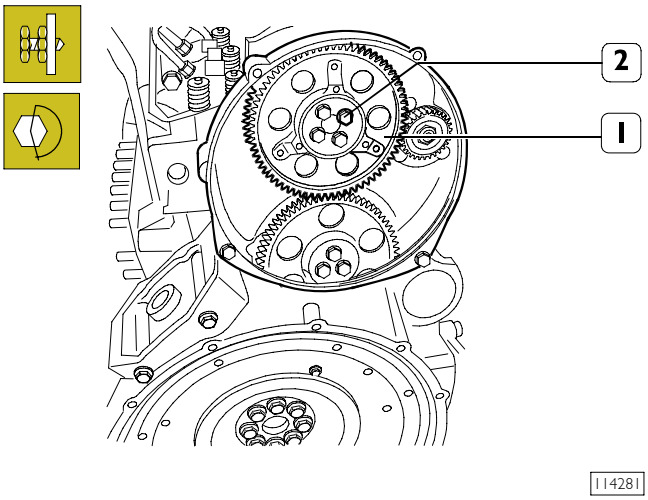
Figure 62



Camshaft is timed if conditions below are found at cam lift values 4.70 ± 0.05:

1) hole identified with two notches (5) is visible through manhole;
2) fixture 99360612 (1) through housing (2) of engine rpm sensor inserts in hole (3) on engine flywheel (4).

Figure 63

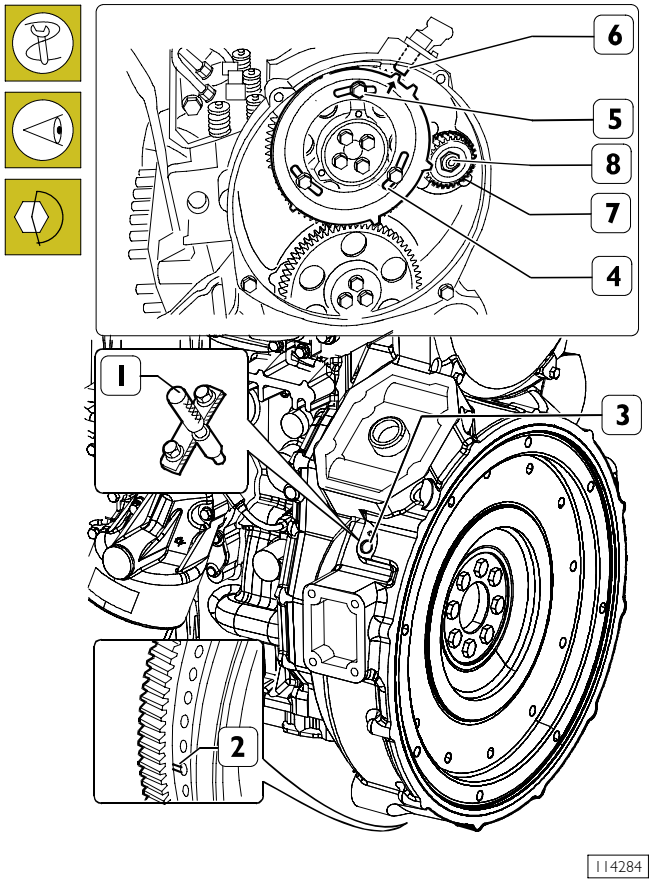


In case conditions shown in Figure 61 and shown at paras 1 and 2 are not found, operate as follows:

1) release screws (2) securing gear (1) of camshaft to as to make control gear and camshaft independent;
2) conveniently operate on engine flywheel so as to obtain conditions indicated at paras 1 and 2, Figure 61, considering that cam lift value must remain unchanged;
3) lock screws (2) and repeat control as already described;
4) lock screws (2) at required torque.

Timing flywheel

Figure 64



Install gear (7) of high pressure pump and lock nut (8) at required torque.

NOTE When refitting, use the flat washer (PN 17095914) in conjunction with the nut (8) replacing the one supplied with BOSCH pump CP3.

Fit the flywheel (4) so that the tooth marked with the arrow (↑) is in line with the sensor housing (6).

Rotate crankshaft and bring cylinder n. 1 piston to compression phase at TDC: Rotate flywheel opposite to regular rotation direction by 1/4 of rev.

Rotate flywheel again in regular rotation direction till hole identified by double notch (2) shows through inspection hole under flywheel cover box.

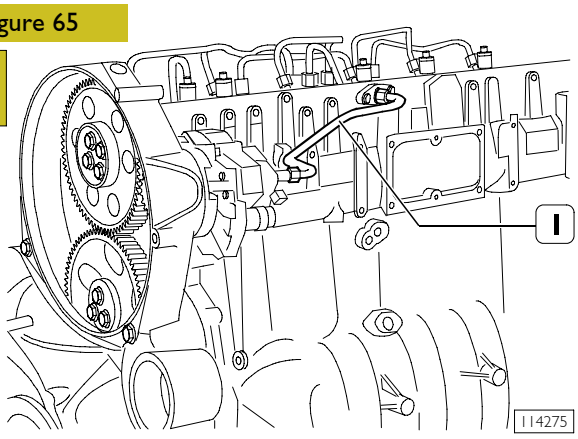
Insert tool 99360612 (1) in flywheel sensor housing (3).

Insert tool 99360613 through phase sensor housing (6) on tooth machined on tune wheel.

In case tool (6) is difficult to insert, unlock screws (5) and orient tune wheel (4) to properly match the tooth.

Lock screws (5).

Figure 65



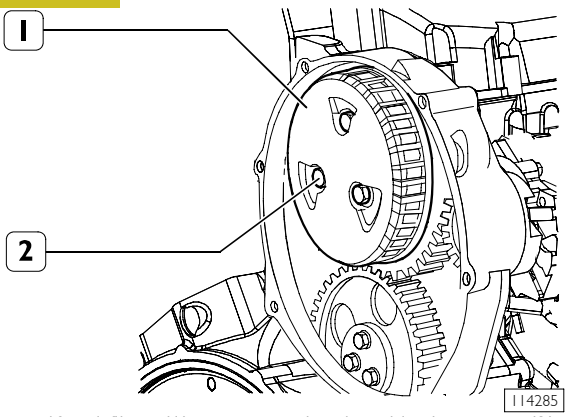
NOTE Pipes previously removed ca no longer be refit. Change them.

Install fuel supply pipeline (1) from high pressure pump to rail.

Lock nuts at 35 Nm torque.

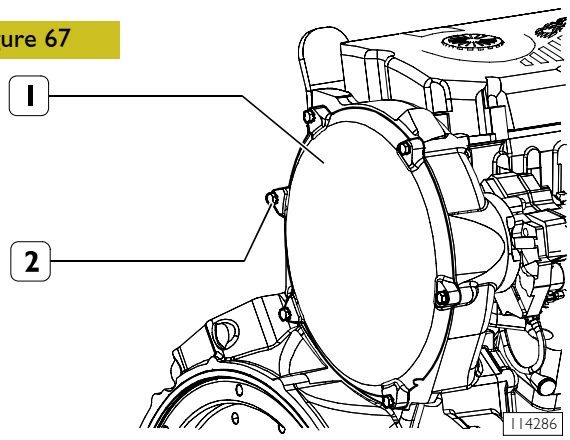
After high-pressure pipe installation, during the following 20 hours of work, frequently check engine oil level (IT MUST NOT INCREASE).

Figure 66



Install centrifugal filter (1) on tune wheel and lock screws (2) at required torque.

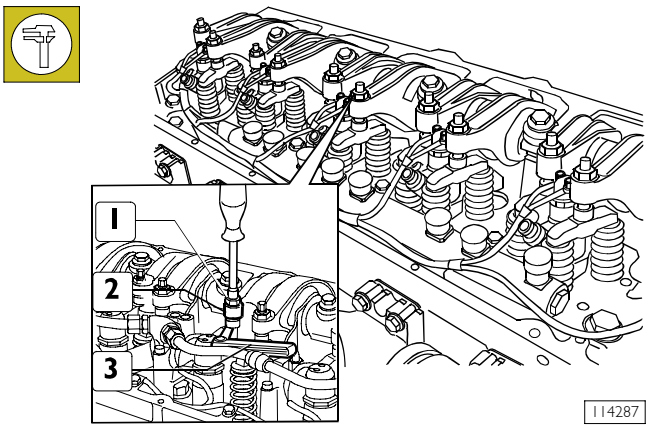
Figure 67



Install timing cover (1) and lock retaining screws (2) at required torque.

Intake and exhaust rocker arm clearance adjustment

Figure 68



Adjustment of clearance between rocker arms and intake/exhaust valve control crosspieces must be performed with utmost care. Bring to blast phase cylinder to be adjusted; the valves of this cylinder are closed while the symmetric cylinder valves are balanced. Symmetric cylinders are 1-6; 2-5 and 3-4.

In order to perform these operations correctly, refer to procedure and table below.

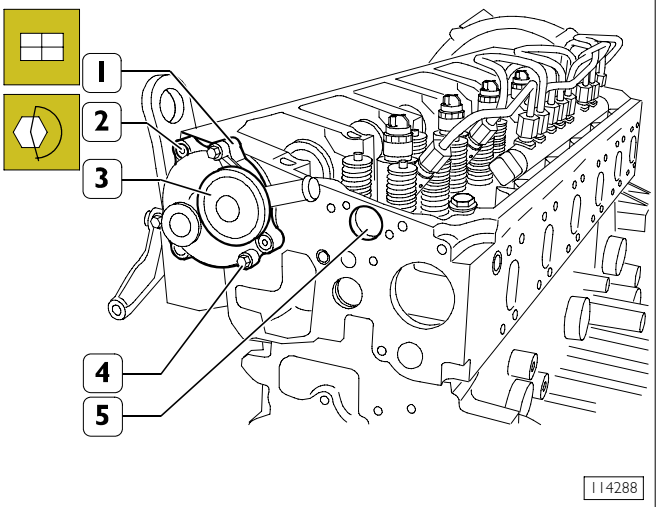
- Use a polygonal spanner to release lock nut (1) of rocker arm adjustment screw (2).
- Insert filler gage (3) having same value of operating clearance shown in "Characteristic and data" tables.
- Use special spanner to lock/unlock adjustment screw.
- Check that filler gage (3) slides with a low friction.
- Lock nut (1) retaining the adjustment screw.

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

START AND ROTATION CLOCKWISE	BALANCE VALVES OF CYLINDER No.	ADJUST CLEARANCE OF VALVES CYLINDER No.
1 and 6 at TDC	6	1
120°	3	4
120°	5	2
120°	1	6
120°	4	3
120°	2	5

NOTE In order to correctly carry out adjustments above, it is mandatory to perform the sequence indicated in the table, checking exact positioning at each phase by means of pin 99360612.

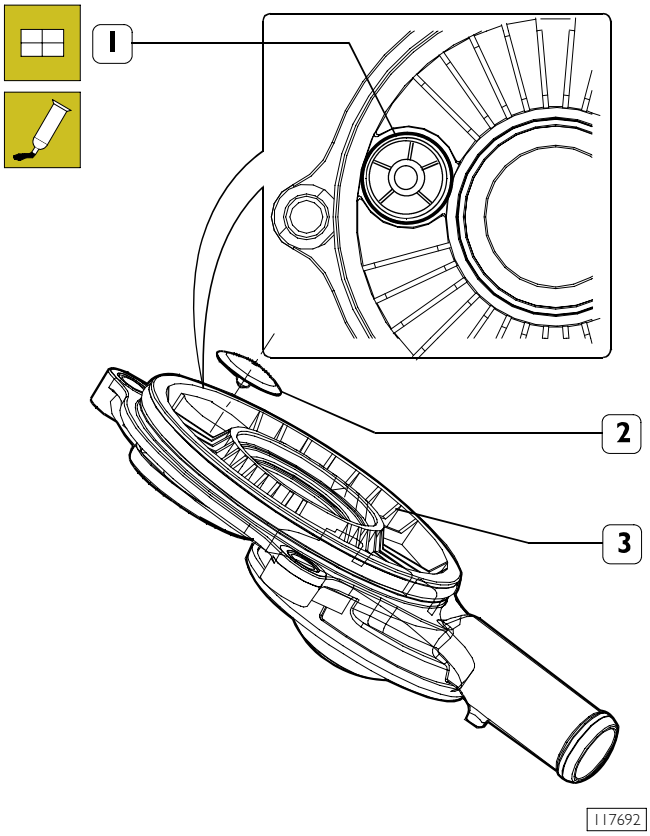
Figure 69



Install blow-by body (1) with related seal and lock screws (2) at required torque.

Install cover (3) and lock screws (4) at required torque.

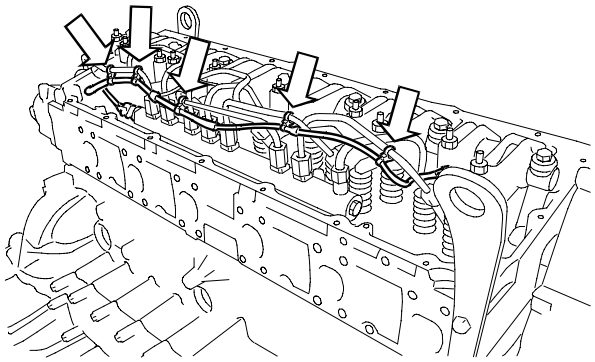
Figure 70



Install blow-by body (1) with related seal and lock screws (2) at required torque.

Install cover (3) and lock screws (4) at required torque.

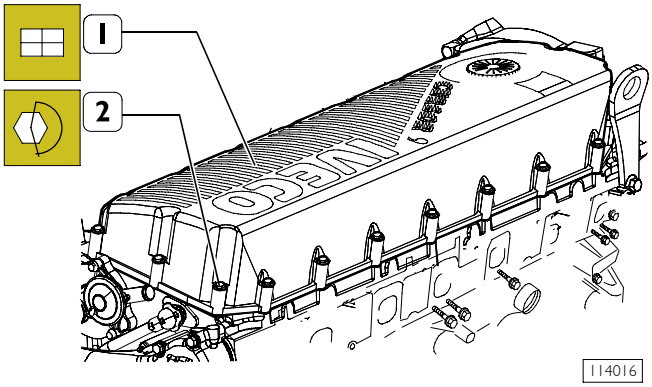
Figure 71



115880

Fit the head internal electric wire (injectors+pressure sensor) passing it through the opening (5, Figure 70) and securing it using bands as illustrated in the diagram (↓).

Figure 72



114016

Install cylinder head cover (1) and lock screws (2) at required torque following order shown in Figure 71 diagram.

Figure 73

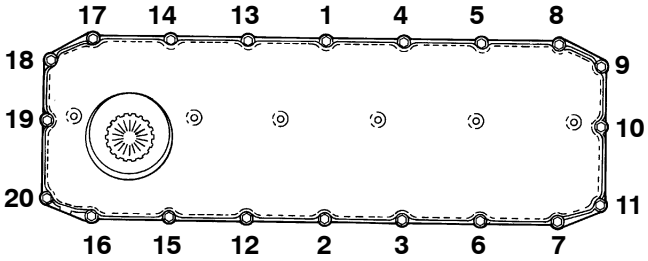
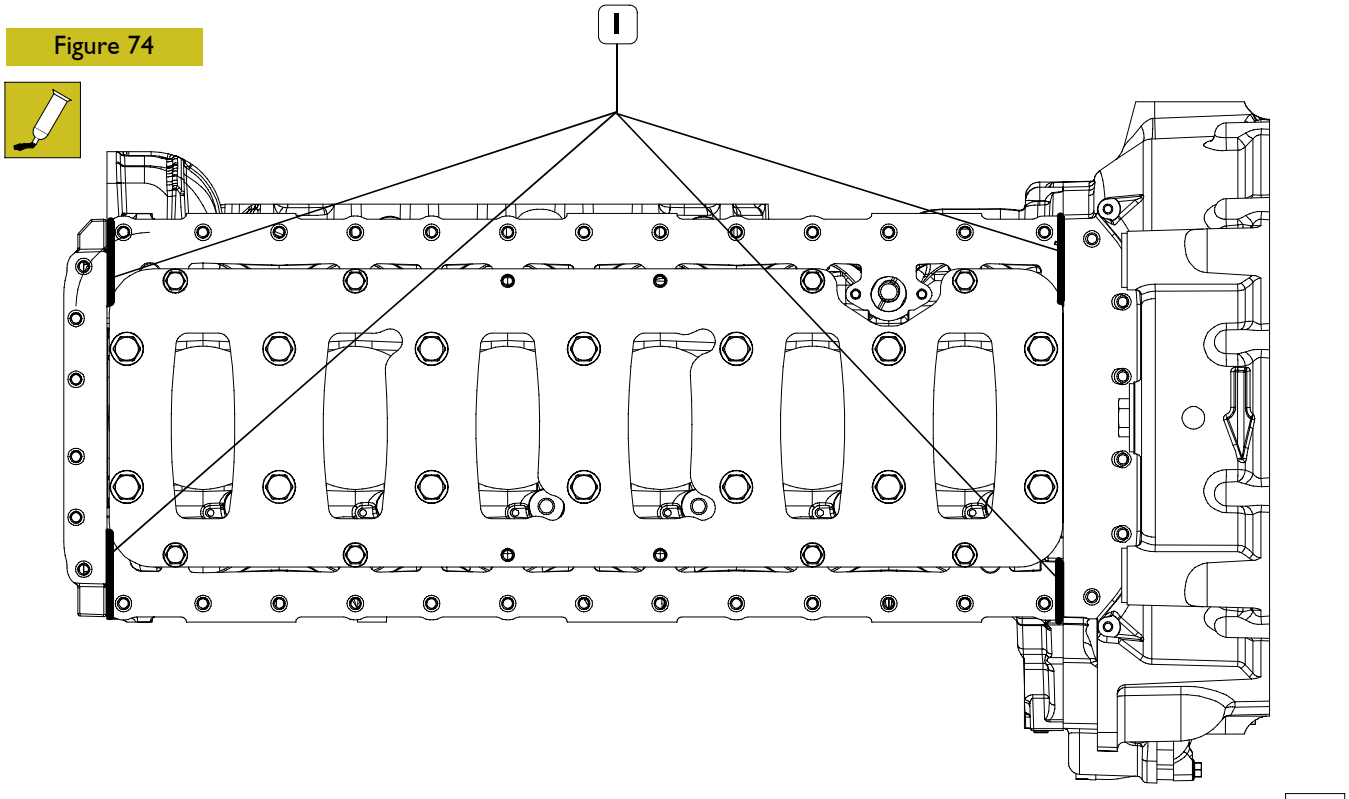


Figure 74



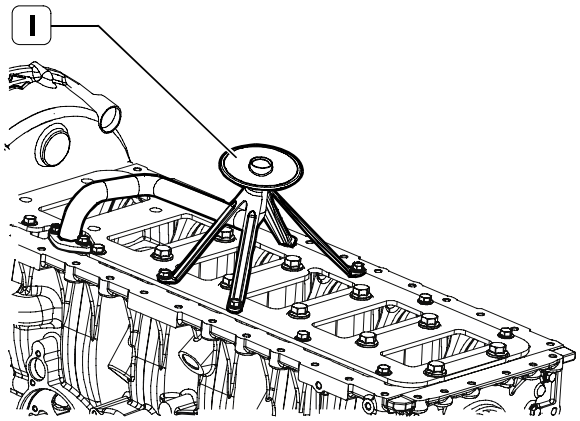
117695

Apply tool 99360558 (1) to rocker arm shaft (2) and install shaft on cylinder head.

Lock retaining screws at required torque.

Remove tool 99360612 (1, Figure 54).

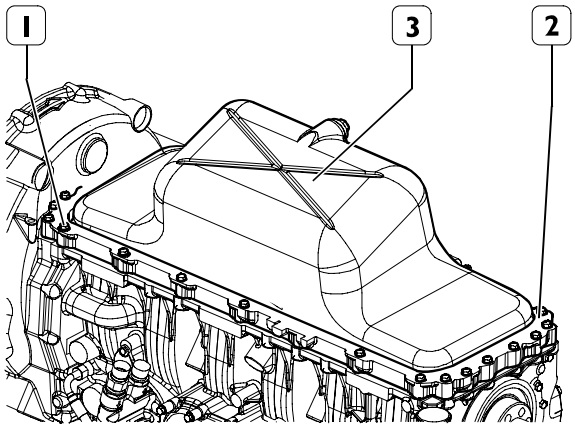
Figure 75



114031b

Install suction rose (1).

Figure 76



114029

Rotate engine.

Fit seal (4) on oil sump (1), fit spacer (3) and install sump on engine block locking screws (2) at required torque.

ENGINE ASSEMBLY COMPLETION

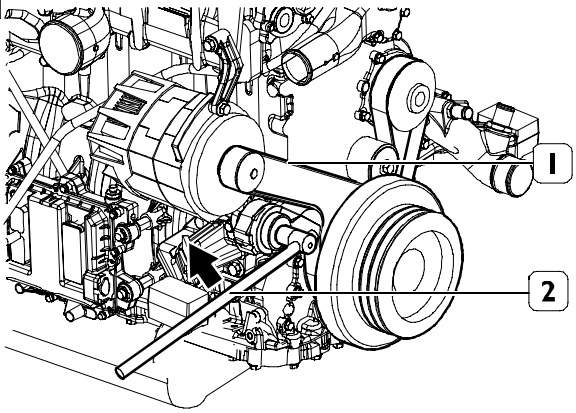
Complete engine assembly fitting or connecting parts below:

- complete fuel filter support and pipelines;
- EDC ecu;
- intake manifold with pre-heating resistor;
- heat exchanger;
- exhaust manifold;
- turbocharger and related water and oil;
- pulley and damper flywheel assy (install fixed guide pulley 5, Figure 3, before assy);
- thermostat assy;
- belt tensioner, water pump, alternator;
- oil level rod;
- start-up motor;
- oil filter;
- electric connections and sensors (See diagram on page 30).

NOTE Fittings of pipelines, cooling water and turbocharger lube oil must be locked at:

- 35 ± 5Nm, water pipeline fittings;
- 55 ± 5Nm, oil pipeline female fitting;
- 20-25 Nm, oil pipeline make fitting.

Figure 77



114291

Use specific equipment (2) to install belt (1) on belt tensioner, in direction shown by arrow.

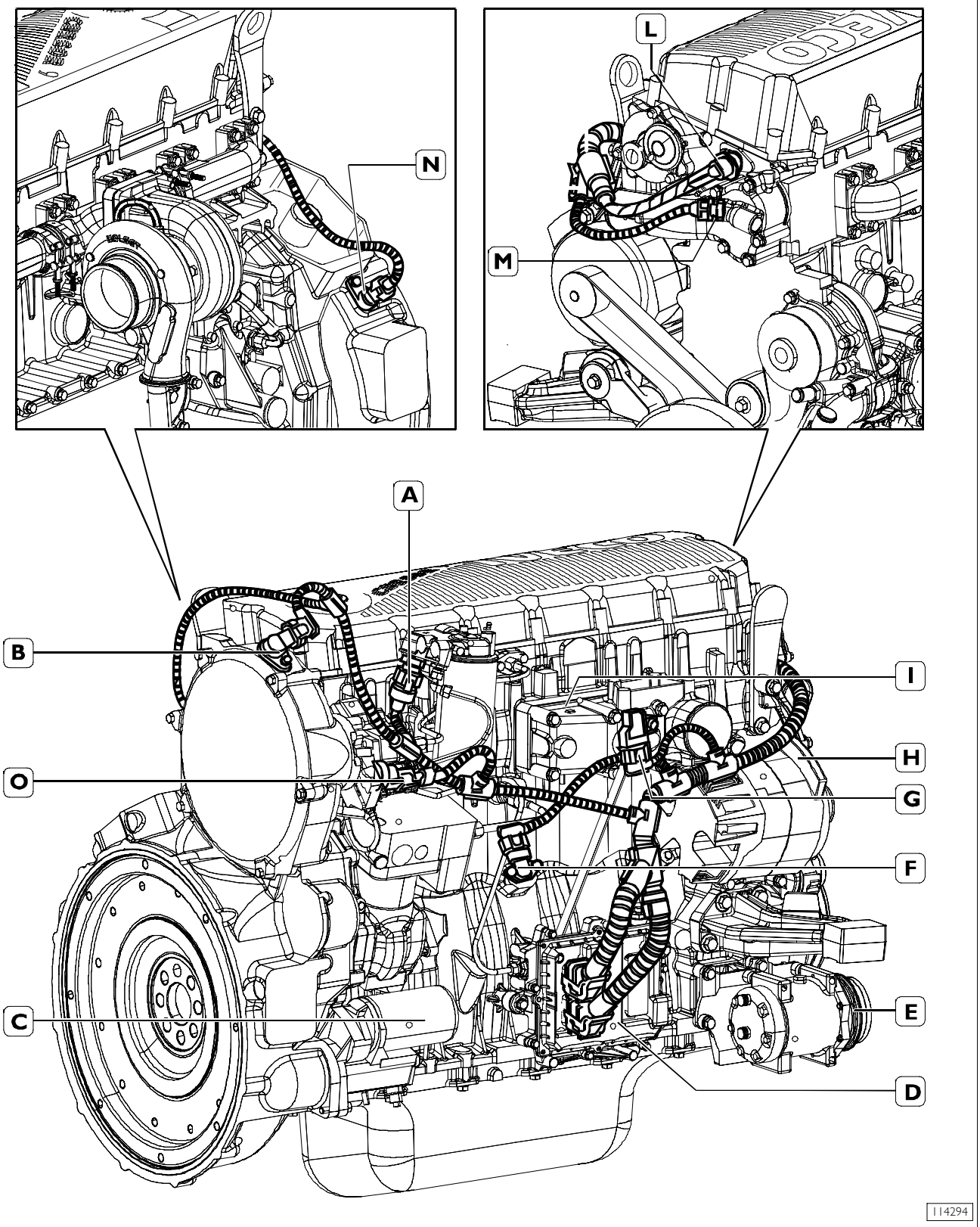
NOTE Belt tensioner is automatic, therefore no further adjustments are required after installation.

PART TWO -

ELECTRICAL EQUIPMENT

Components on the engine F2C

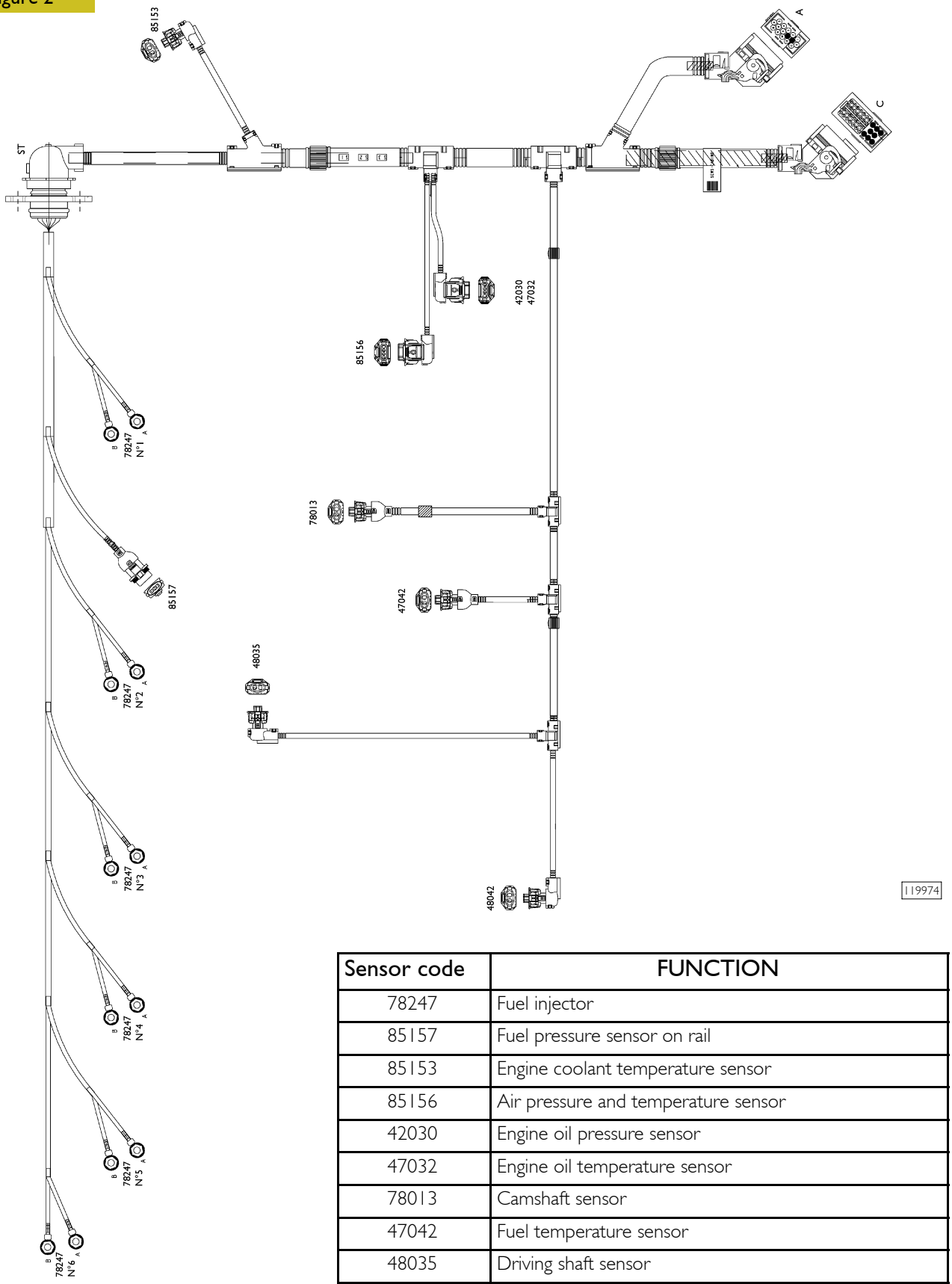
Figure 1



A. Fuel temperature sensor - B. Engine rpm sensor on camshaft - C. Starter motor - D. EDC 7 control unit - E. Conditioner compressor - F. Pressure/temperature transmitter - G. Temperature/air pressure sensor - H. Alternator - I. Resistance for engine warming - L. Connector on engine block for connection with electro-injectors - M. Water temperature sensor - N. Engine speed on flywheel sensor - O. Fuel adjustment valve on high pressure pump

Engine cable

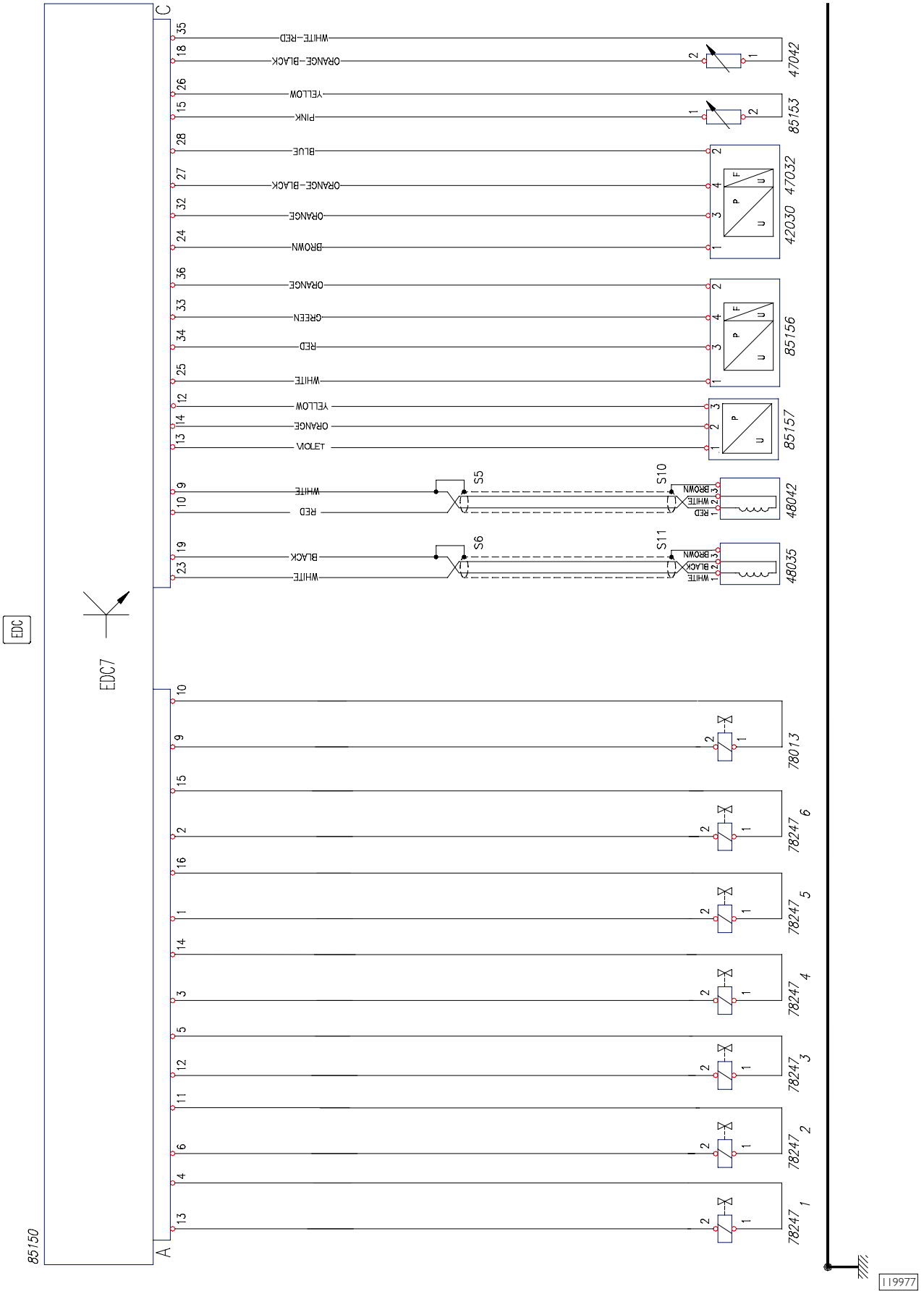
Figure 2



Sensor code	FUNCTION
78247	Fuel injector
85157	Fuel pressure sensor on rail
85153	Engine coolant temperature sensor
85156	Air pressure and temperature sensor
42030	Engine oil pressure sensor
47032	Engine oil temperature sensor
78013	Camshaft sensor
47042	Fuel temperature sensor
48035	Driving shaft sensor
48042	Camshaft sensor
ST	Cable routing inside head

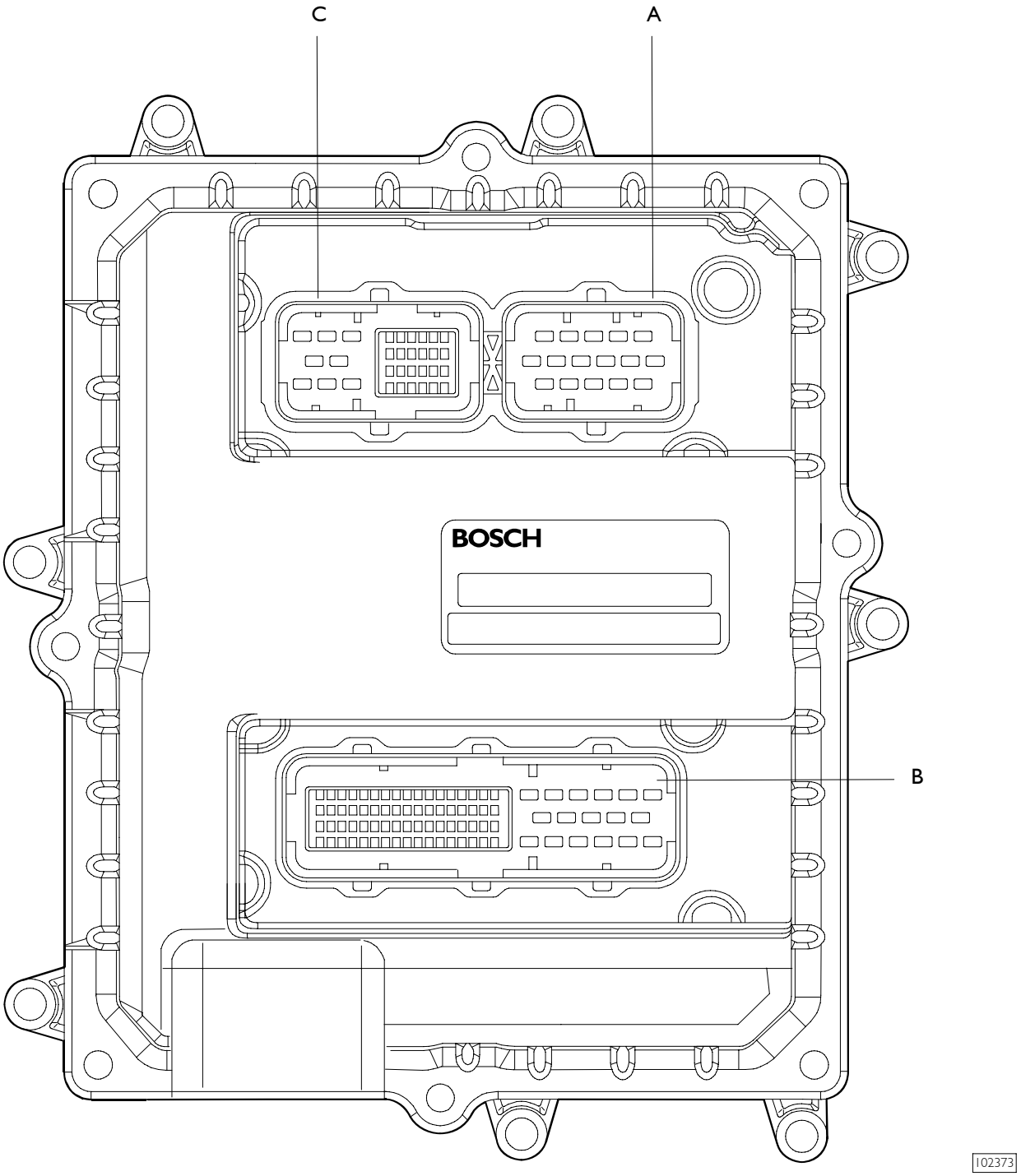
EDC 7 UC31 control unit pin-out

Figure 3



EDC 7 UC31 electronic control unit

Figure 4

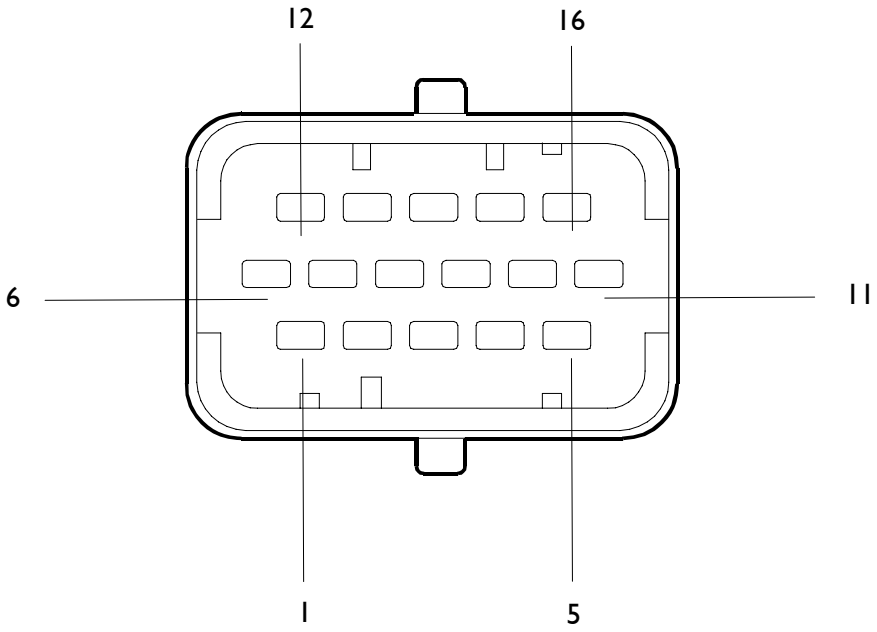


A. Electro-injector connector - B. Chassis connector - C. Sensor connector

EDC control unit PIN-OUT

Electric injector connector "A"

Figure 5



Colour legend

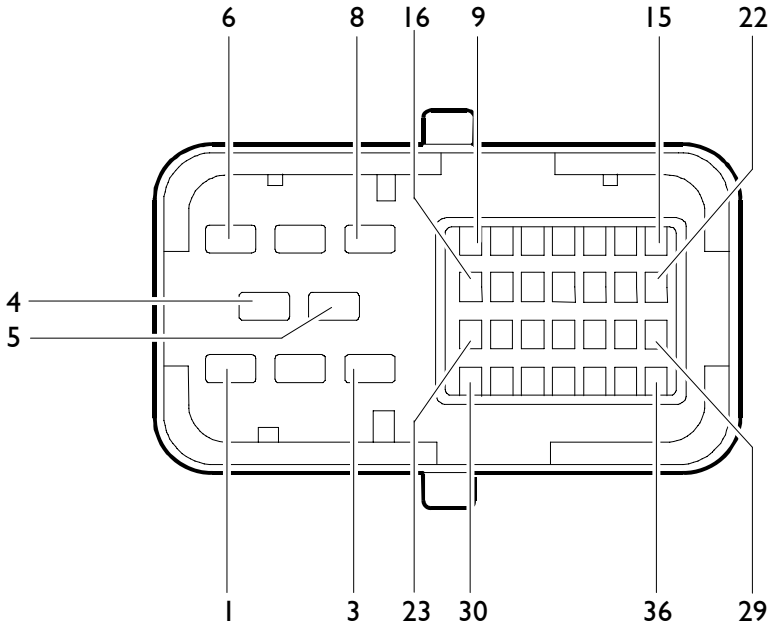
B	black
R	red
U	blue
W	white
P	purple
G	green
N	brown
Y	yellow
O	orange
E	grey
K	pink

Pin	Function
1	Solenoid valve for electronic cylinder 5 injection
2	Solenoid valve for electronic cylinder 6 injection
3	Solenoid valve for electronic cylinder 4 injection
4	Solenoid valve for electronic cylinder 1 injection
5	Solenoid valve for electronic cylinder 3 injection
6	Solenoid valve for electronic cylinder 2 injection
7	-
8	-
9	-
10	-
11	Solenoid valve for electronic cylinder 2 injection
12	Solenoid valve for electronic cylinder 3 injection
13	Solenoid valve for electronic cylinder 1 injection
14	Solenoid valve for electronic cylinder 4 injection
15	Solenoid valve for electronic cylinder 6 injection
16	Solenoid valve for electronic cylinder 5 injection

EDC control unit PIN-OUT

Sensor connector "C"

Figure 6



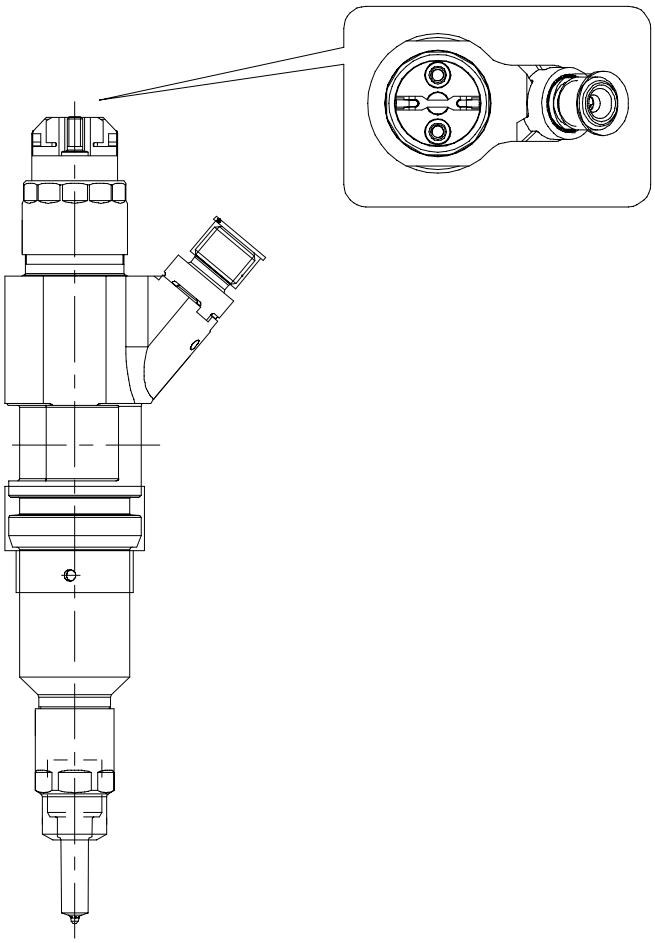
Colour legend

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

Pin	Function
1÷8	-
9	Engine speed sensor (timing)
10	Engine speed sensor (timing)
11	-
12	Pressure sensor on rail
13	Pressure sensor on rail
14	Pressure sensor on rail
15	Coolant temperature sensor
16	-
17	-
18	Fuel temperature sensor
19	Engine speed sensor (flywheel)
20	-
21	-
22	-
23	Engine speed sensor (flywheel)
24	Engine oil pressure/temperature sensor
25	Air pressure/temperature sensor supply
26	Coolant temperature sensor
27	Engine oil temperature/pressure sensor
28	Engine oil temperature/pressure sensor
29	-
30	-
31	-
32	Engine oil temperature/pressure sensor
33	Air pressure signal from air pressure/temperature sensor
34	Air temperature signal from air pressure/temperature sensor
35	Fuel temperature sensor
36	Air temperature signal from air pressure/temperature sensor

Electroinjectors

Figure 7



114255

It is a N.O. solenoid valve.

They are connected to the EDC ECU on connector A.

The resistance of each injector coil is 0.56 - 0.57 Ohm.

The electroinjector can be considered as consisting of 2 parts:

- actuator - atomizer including pressure rod, needle and nozzle;
- control solenoid valve including coil and pilot valve.

The solenoid valve controls atomizer needle lift.

INJECTION START

When coil is energized, lock pin moves upward.

The control volume fuel flows to return duct causing control volume pressure drop.

At the same time, fuel pressure in pressure chamber causes needle uplift and therefore fuel injection in cylinder.

END OF INJECTION

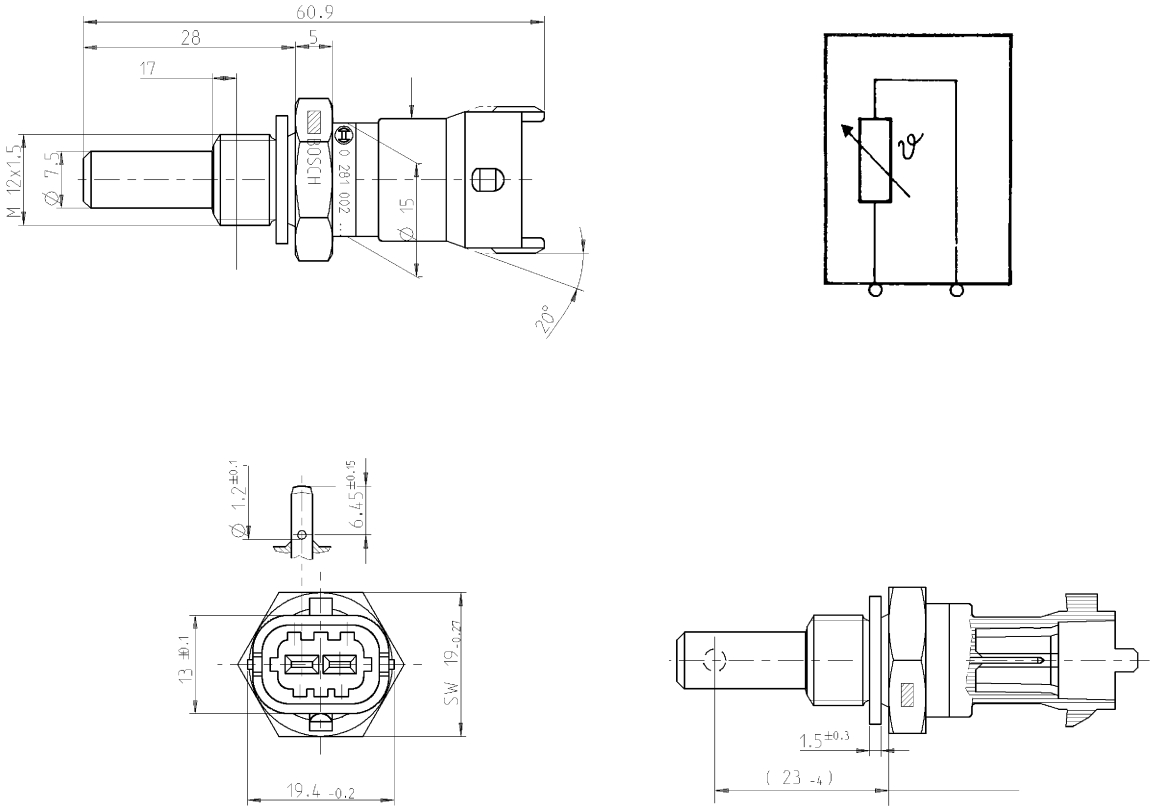
When coil is de-energized, lock pin returns to lock position to look for a force balance such to return to needle close position and stop injection.

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.

Figure 8



104266

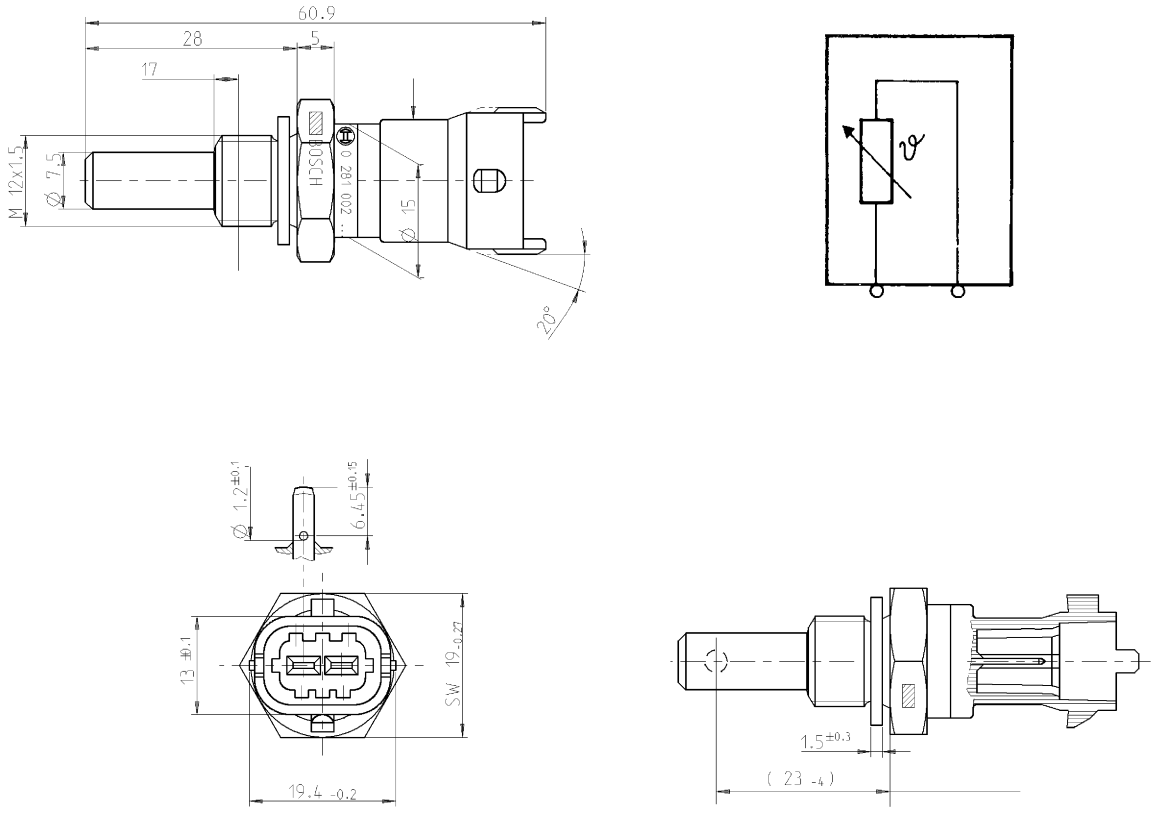
Description	Cable colour
To EDC center pin 15 (Sensor connector "C")	K
To EDC center pin 26 (Sensor connector "C")	Y

Fuel temperature sensor

Specifications

Supplier	BOSCH
Max. tightening torque	35 Nm

Figure 9



104267

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

High pressure pump (pressure regulator)

Pump with 3 radial pistons commanded by timing gear, requiring no tuning, with rotor supply pump applied on rear end.

A. Fuel drain outlet fitting to filter support

B. Fuel inlet fitting from ECU heat exchanger

C. Fuel inlet fitting from fuel filter

D. Fuel outlet fitting from supply pump to filter

E. Fuel outlet fitting to rail

1. High-pressure pump

2. Supply pump

3. Pressure regulator (NO solenoid valve modulated by ECU with PWM signal).

Pressure regulator

Located at high-pressure pump inlet, on low pressure system, it modulates the amount of fuel for high-pressure pump supply based on commands received from ECU.

It mainly consists of parts below:

- ❑ trapezoidal-section lock pin;
- ❑ valve control pin;
- ❑ pre-load valve;
- ❑ coils.

When no control signal is present, the pressure regulator is normally open, therefore the high pressure pump is in max delivery condition.

The ECU modulates a PWM control signal to extend or reduce section of fuel supply line to high-pressure pump.

The component cannot be replaced as an individual part, therefore it cannot be removed.

The quantity of high-pressure supply fuel is metered by a proportional valve positioned on low-pressure system and it is managed by the ECDC 7 ECU.

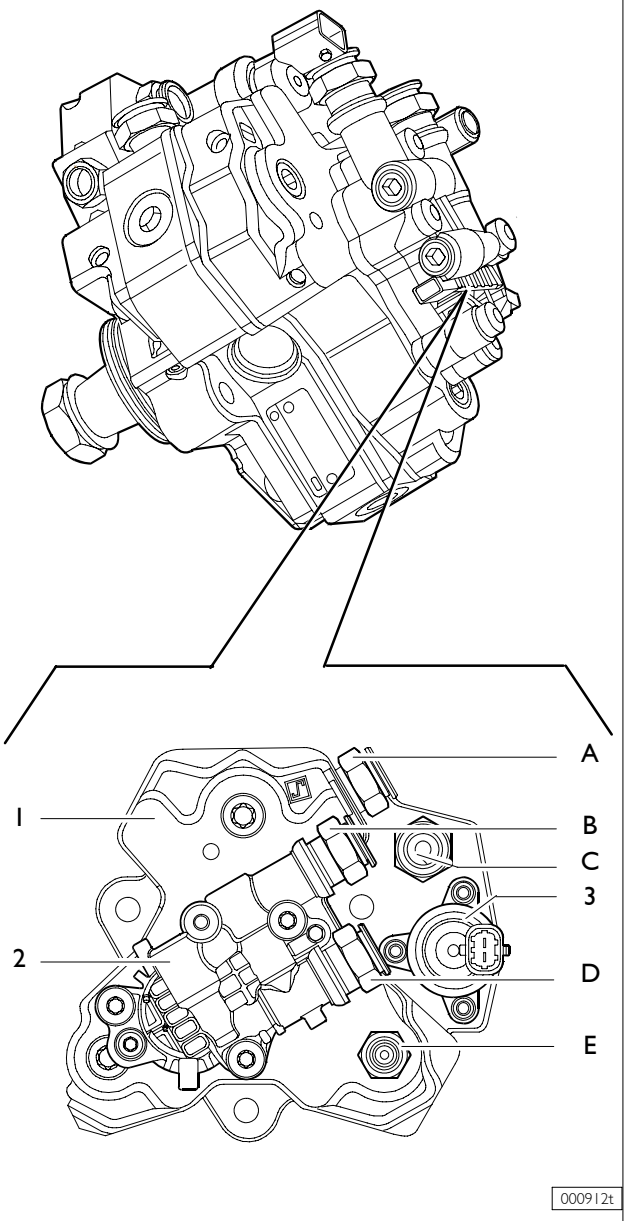
The delivery pressure to rail is modulated between 250 and 1400 bars by ECU operating on pressure regulator solenoid valve.

It is a NO solenoid valve.

Its resistance is ~ 3,2 Ω.

It is connected to ECU pins C5 - C7.

Figure 10

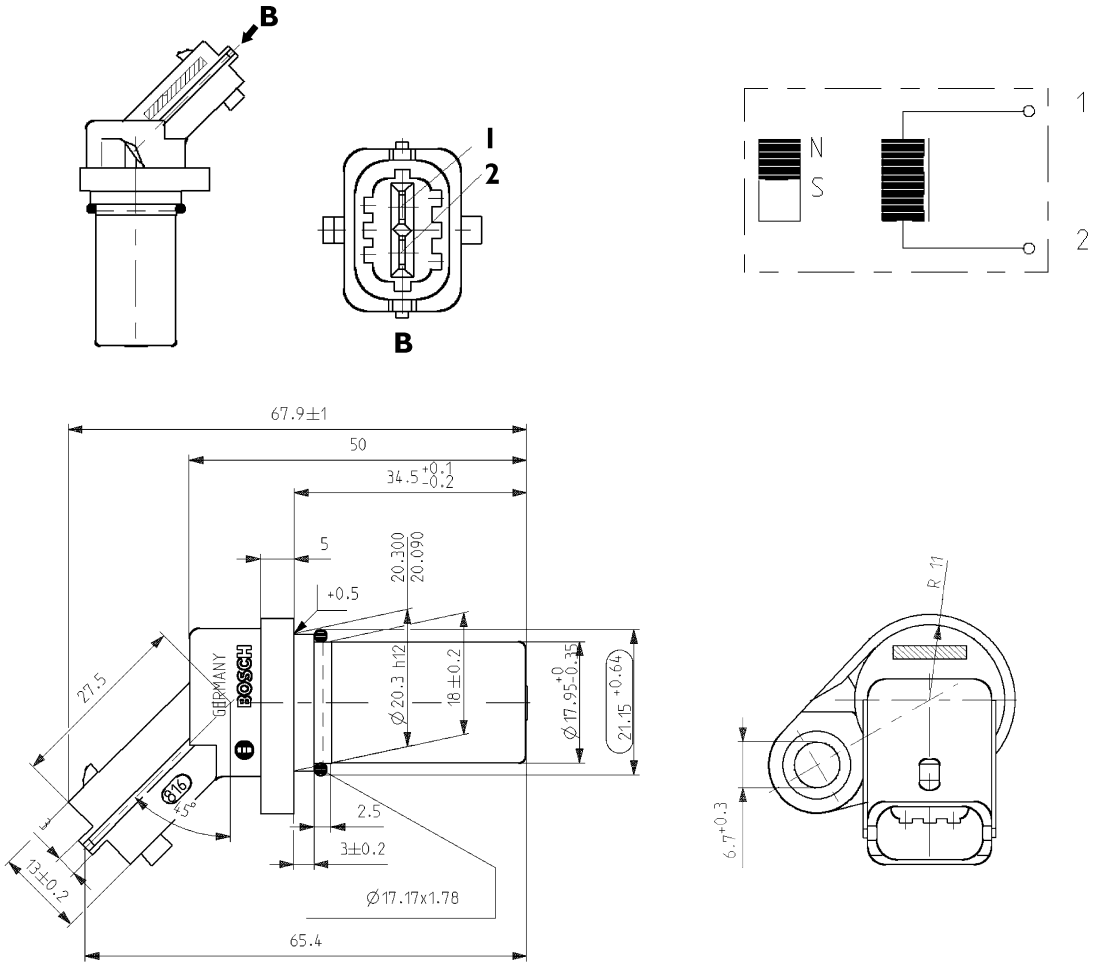


Flywheel pulse transmitter

Specifications

Supplier	BOSCH
Max. tightening torque	8 ± 2 Nm

Figure 11



104269

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

Distribution pulse transmitter

Features

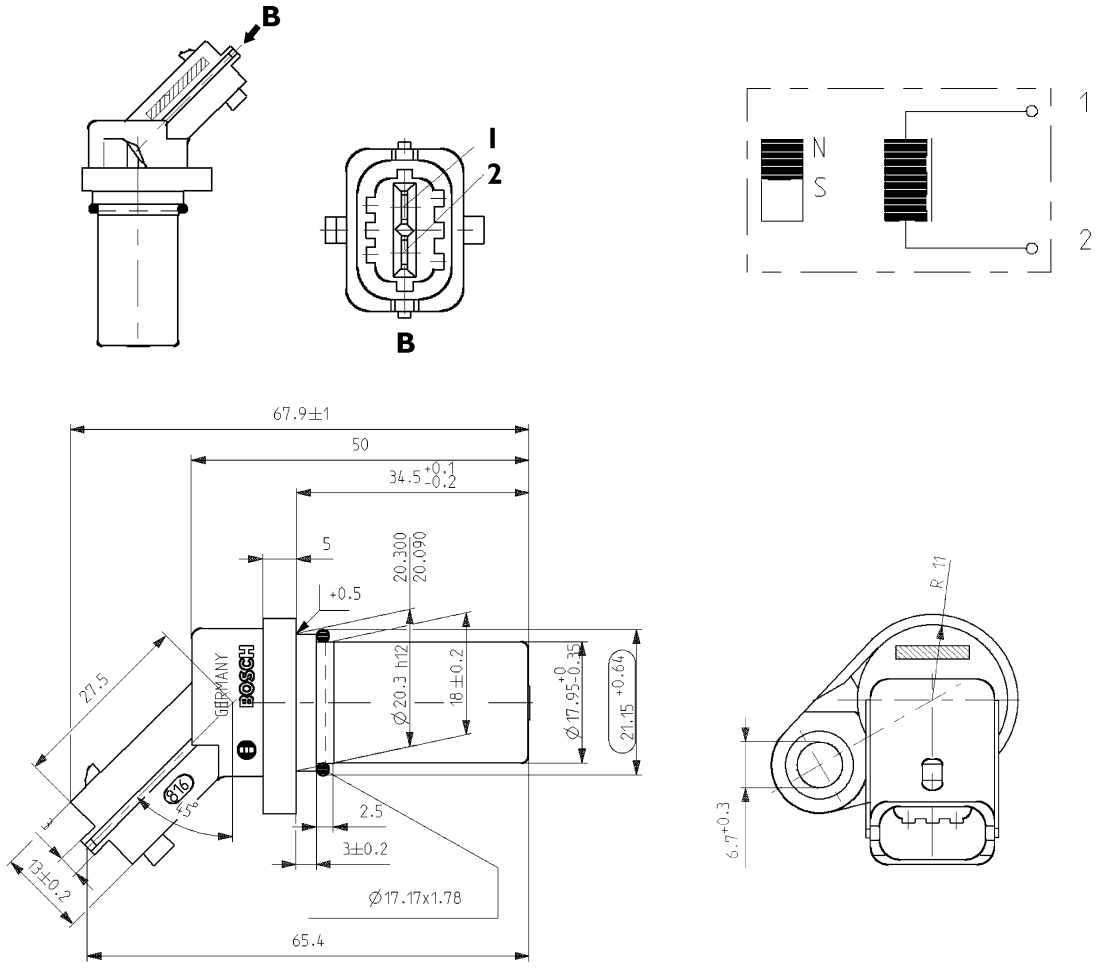
Vendor	BOSCH
Torque	8 ± 2 Nm
Resistance	880 ÷ 920 Ω

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.

This sensor's air gap is NOT ADJUSTABLE.

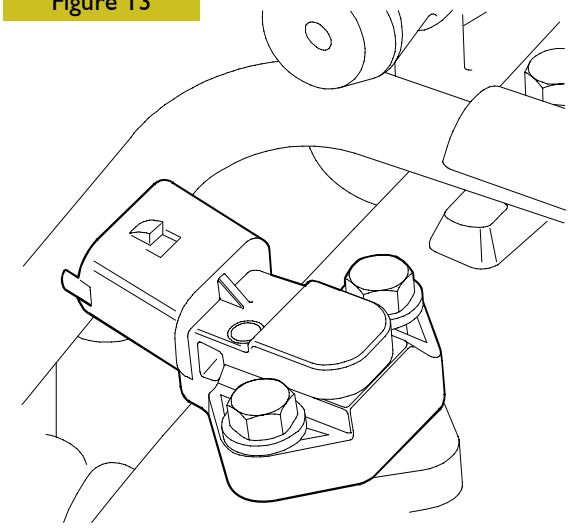
Figure 12



104269

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

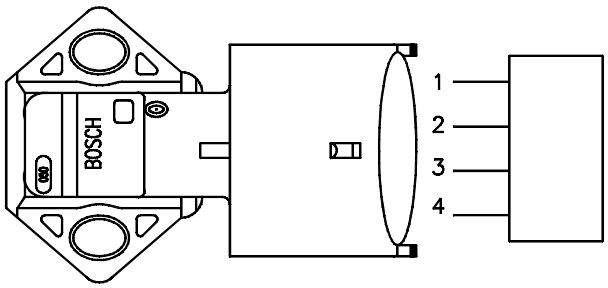
Figure 13



50324

Sensor external view

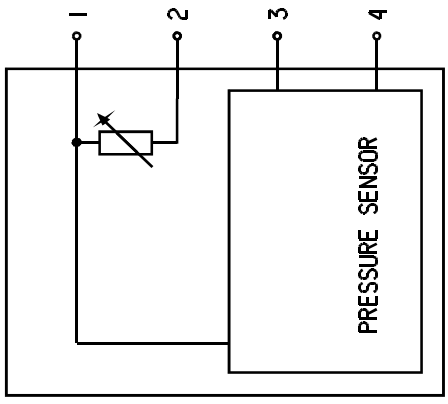
Figure 14



50323

Linking connector

Figure 15



50344

Wiring diagram

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.

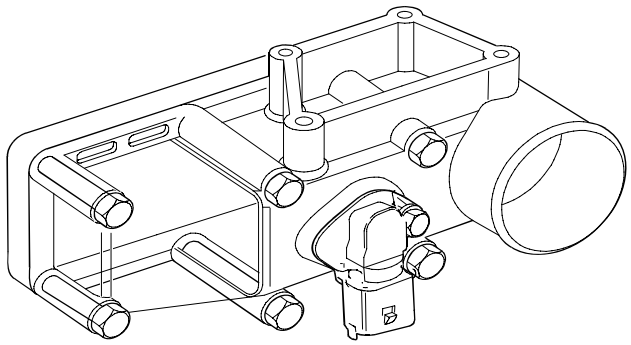
The measured signal is sent to the EDC control unit which controls, in turn, the indicator instrument on the dashboard (low pressure warning lights / gauge).

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
1	Ground	24C
2	Temp. Sign.	27C
3	+5	32C
4	Press. Sign.	28C

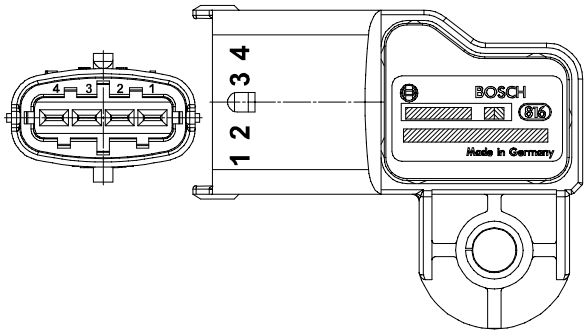
Figure 16



114266

Sensor external view

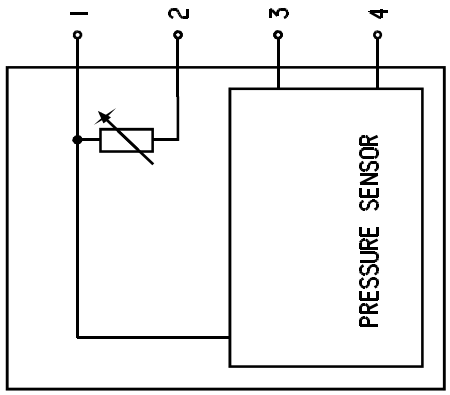
Figure 17



114273

Linking connector

Figure 18



50344

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

Ref.	Description	Control unit pin
1	Ground	25C
2	Temp. Sign.	36C
3	+5	33C
4	Press. Sign.	34C

Fuel pressure sensor on rail

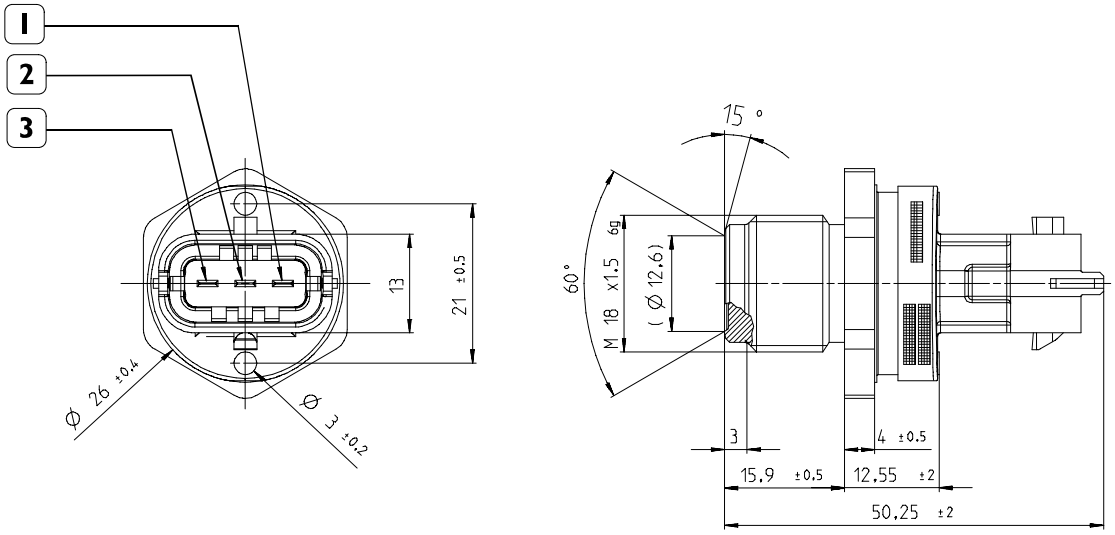
Installed on one rail end, it measures actual fuel pressure in order to determine injection pressure.

The injection pressure value is used for pressure check and to determine the injection electric command duration.

It is supplied with 5 volts.

It is connected to ECU on pins 12C - 13C - 14C.

Figure 19



114620

Ref.	Description	Pin ecu
1	ECU pin	12C
2	Ground	13C
3	Supply Pressure	14C

Alternator

Supplier MITSUBISHI
Technical features 24V - 90A

Figure 20

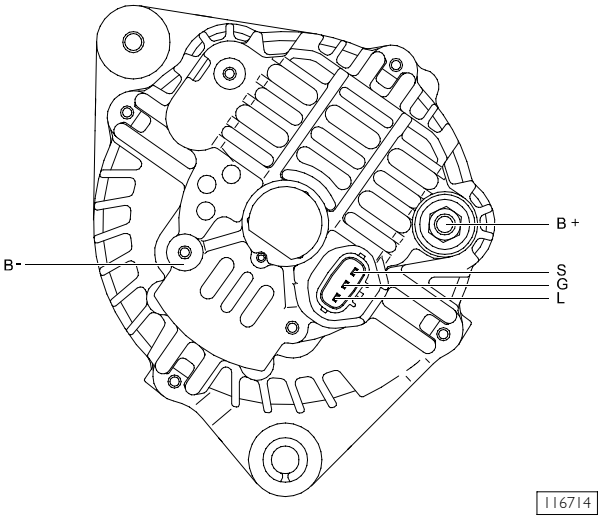


Figure 22

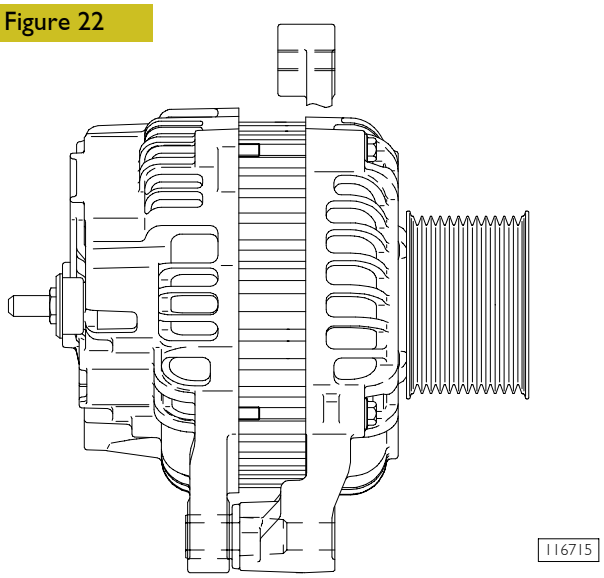


Figure 21

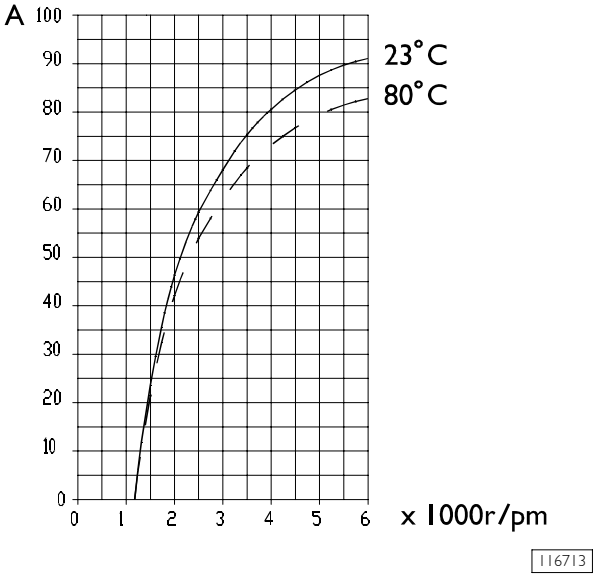
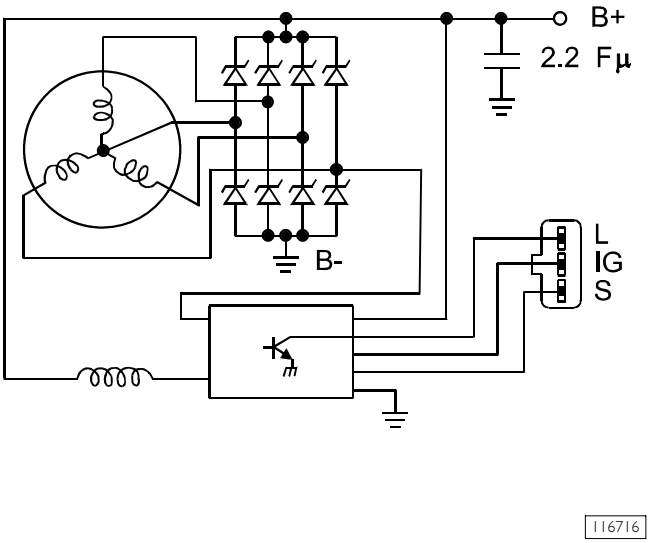


Figure 23



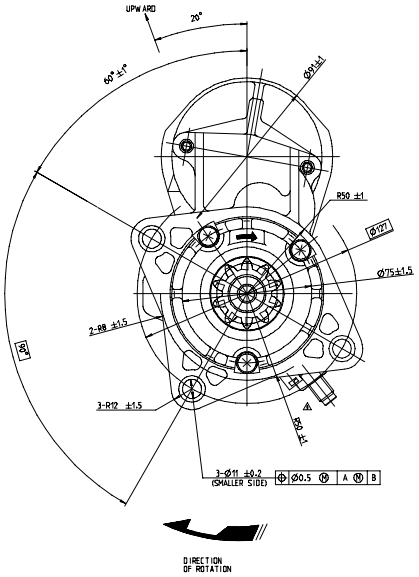
Pin	Description
S	+ 30
L	Battery recharge light
B-	Negative
B+	Positive
IG	+ 15

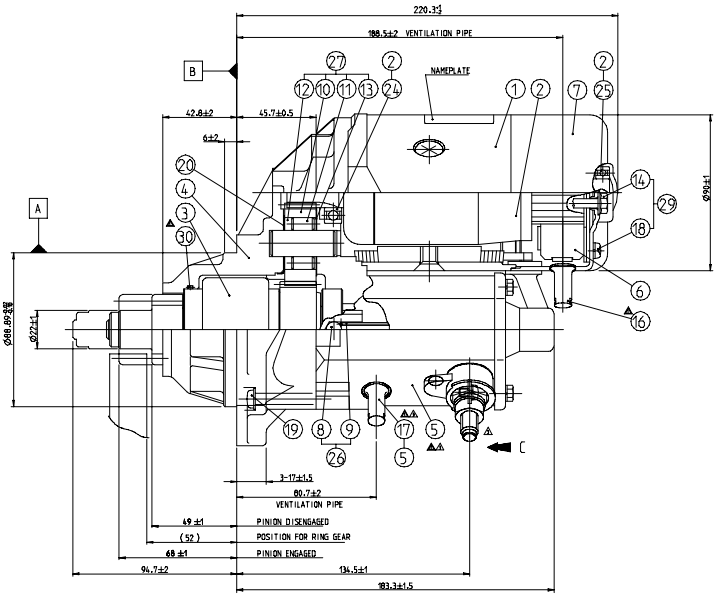
Starting motor

Specifications

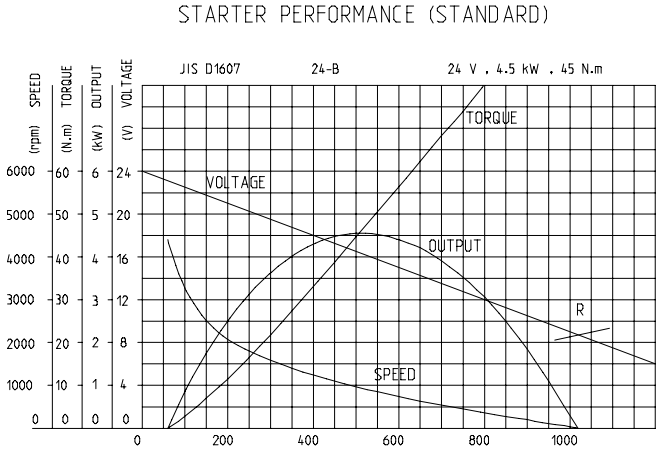
Supplier	DENSO
Type	2280005641
Electrical system	24 Volt
Nominal output	4.5 Kw

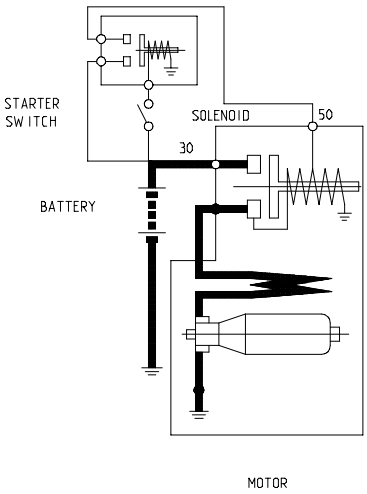
Figure 24





CONNECTING DIAGRAM
RELAY





114283

EDC SYSTEM FUNCTIONS

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

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

It also enables:

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

Diagnosis

Fuel dosing

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

The result can be corrected based on:
- water temperature

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

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

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

Delivery correction based on water temperature

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

Delivery correction to prevent noise, fumes or overloads

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

De-rating

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

Injection lead electronic control

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

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

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

Engine start

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

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.

NOTE Not present on agricultural versions.

Synchronization search

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

PART THREE - TROUBLESHOOTING

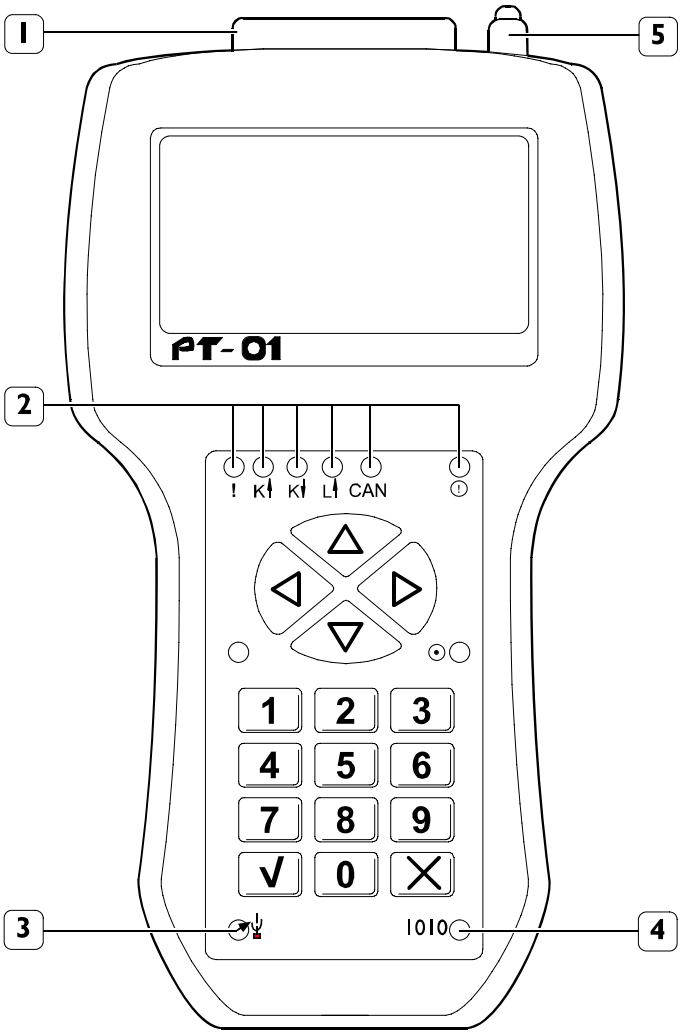
METHODS OF DIAGNOSIS

The available diagnosis systems are currently:

- ❑ PT-01
- ❑ SYMPTOMS

PT-01

Figure 1



1. Connector with 19-pin diagnosis socket - 2. LED signalling communication between the instrument - control unit and correct power supply - 3. USB indicator light - 4. Serial port indicator light - 5. Power supply connector (power only to update SW with serial port).

PT-01 PORTABLE TESTER

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

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

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

Main functions

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

1	2	3	4	5	6	7	8	.	A	B	C
u	m	m	k	a	a	*	*	.	v	a	0

a a software 3.3_1
a b software 4.1_2

Easy access to different functions is available through the menu:

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

Test parameters

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

PREFACE

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

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

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

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

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

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

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

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

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

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

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

FAULT CODES

Failure code	Failure description
	Vehicle 1 ((Sensors / Consistency tests)
1.1.2	ACCELERATOR PEDAL
1.1.9	PLAUSIBILITY +15
1.1.A	PLAUSIBILITY +50
	Vehicle 2 (Indicator lamps / Relais / Actuators)
1.2.3	EDC LAMP
1.2.5	MAIN RELAY DEFECT
1.2.6	BATTERY VOLTAGE
1.2.8	MAIN RELAY - SHORT CIRCUIT TO BATTERY
1.2.9	AIR-CONDITIONER COMPRESSOR RELAY
1.2.B	THERMOSTARTER RELAY 1 (HEATER)
1.2.E	MANAGEMENT SYSTEM PRE/POST-HEATING (ACTIVE)
2.2.5	INTERRUPTED AFTER-RUN
2.2.8	MAIN RELAY - SHORT CIRCUIT TO GROUND
	Engine 1 (Temperature and pressure sensors)
1.3.1	COOLANT TEMPERATURE SENSOR
1.3.2	COOLANT TEMPERATURE SENSOR (TEST)
1.3.3	AIR TEMPERATURE SENSOR BOOST AIR
1.3.4	BOOST PRESSURE SENSOR
1.3.5	FUEL TEMPERATURE SENSOR
1.3.6	RAIL PRESSURE SENSOR OR SIGNAL ERROR
1.3.7	DBV VALVE MANAGEMENT (BOOST PRESSURE)
1.3.8	OIL PRESSURE SENSOR
1.3.A	OIL TEMPERATURE SENSOR
2.3.2	COOLANT TEMPERATURE SENSOR ABSOLUTE TEST
2.3.6	RAIL PRESSURE SENSOR OFFSET
2.3.8	OIL LOW PRESSURE
2.3.A	OIL TEMPERATURE ABOVE NORMAL
	Engine 2 (Speed sensors/actuators)
1.4.1	CRANKSHAFT SPEED
1.4.2	ENGINE WORKING ONLY WITH CAMSHAFT SENSOR
1.4.3	CAMSHAFT SENSOR
1.4.4	FAULT BETWEEN FLYWHEEL SENSOR AND CAMSHAFT
	Damage information
1.4.D	ENGINE OVERSPEED
1.5.B	HIGH PRESSURE TEST (DEACTIVATES RAIL PRESS.MONITORING)
1.9.D	INDICATES TORQUE LIMITATION DUE TO PERFORMANCE LIMITER
4.9.E	INDICATES THE TORQUE LIMITATION DUE TO ENGINE PROTECTION
6.9.E	INDICATES TORQUE LIMITATION DUE TO FUEL QUANTITY LIMITATION

Failure code	Failure description
	Fuel metering
1.5.1	HIGH PRESSURE SYSTEM
1.5.2	FAULT ON THE FUEL PRESSURE CONTROL OF THE RAIL (POSITIVE DEVIATION)
1.5.3	FAULT ON THE FUEL PRESSURE CONTROL OF THE RAIL (NEGATIVE DEVIATION)
1.5.4	RAIL PRESSURE ERROR: TOO LOW
1.5.5	RAIL PRESSURE ERROR: TOO HIGH
1.5.6	HIGH PRESSURE SYSTEM
1.5.7	ERROR ON THE RAIL PRESSURE (EXCESSIVE DUTY CYCLE)
1.5.8	HIGH PRESSURE SYSTEM
1.5.9	PRESSURE MPROP REGULATOR ERROR
2.5.9	PRESSURE MPROP REGULATOR ERROR (SHORT CIRCUIT TO POSITIVE)
3.5.9	SHORT CIRCUIT TO GROUND OF METERING UNIT OUTPUT
	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 / OPEN CIRCUIT
1.6.8	INJECTOR CYLINDER 2 / OPEN CIRCUIT
1.6.9	INJECTOR CYLINDER 3 / OPEN CIRCUIT
1.6.A	INJECTOR CYLINDER 4 / OPEN CIRCUIT
1.6.B	INJECTOR CYLINDER 5 / OPEN CIRCUIT
1.6.C	INJECTOR CYLINDER 6 / OPEN CIRCUIT
1.6.E	THE MINIMUM NUMBER OF INJECTIONS WAS NOT REACHED: STOP THE ENGINE
	Injectors 2
1.7.1	BENCH 1 CC
1.7.3	BENCH 2 CC
1.7.C	BENCH 1 INJECTORS CHECK (INTERNAL ECU)
2.7.C	BENCH 2 INJECTORS CHECK (INTERNAL ECU)
	Boosting system and turbine speed
1.9.E	TORQUE REDUCTION DUE TO SMOKE LIMITATION
	Interfaces 1 (CAN-Bus)
1.B.1	ERROR ON CAN CONTROLLER A
1.B.3	ERROR ON CAN CONTROLLER C
1.B.4	TIMEOUT CAN MESSAGE BC2EDC1
1.B.5	TIMEOUT CAN MESSAGE VM2EDC
1.B.D	TIMEOUT CAN MESSAGE CCVS
2.B.4	TIMEOUT CAN MESSAGE BC2EDC2
	Interfaces 2 (CAN line timeout messages)
1.C.6	ERROR MESSAGE CAN TSC1-PE

Failure code	Failure description
1.C.8	ERROR MESSAGE CAN TSC1-VE
1.C.9	ERROR MESSAGE CAN TF
2.C.6	TIMEOUT OF CAN MESSAGE TSC1-PE PASSIVE
3.C.8	TIMEOUT OF CAN MESSAGE TSC1-VE PASSIVE
	ECU 1 (internal checks)
1.D.1	ECU OVERRUN MONITORING ERROR
1.D.2	ECU OVERRUN MONITORING ERROR
1.D.3	ECU OVERRUN MONITORING ERROR
1.D.4	ECU OVERRUN MONITORING ERROR
1.D.5	ECU OVERRUN MONITORING ERROR
1.D.6	ECU INTERNAL ERROR (TPU)
1.D.7	INTERNAL ECU ERROR (VARIANT AREA)
1.D.8	ECU OVERRUN MONITORING ERROR
1.D.9	ECU OVERRUN MONITORING ERROR
2.D.3	ECU OVERRUN MONITORING ERROR
3.D.3	ERRORE INTERNO CENTRALINA
	ECU 2 (Power supply / Immobilizer / Runaway / Sensor power supply)
1.E.1	ECU: SHORT CIRCUIT OR OPEN CIRCUIT
1.E.3	ERROR FOR ECU INTERNAL MONITORING
1.E.4	ERROR FOR ECU INTERNAL MONITORING
1.E.5	SENSORS POWER SUPPLY FAULT (12V)
1.E.6	SENSOR POWER SUPPLY 1
1.E.7	SENSOR POWER SUPPLY 2
1.E.8	SENSOR POWER SUPPLY 3
1.E.9	ECU OVERRUN MONITORING ERROR
1.E.A	ECU OVERRUN MONITORING ERROR
1.E.B	ATMOSPHERIC PRESSURE SENSOR
2.E.1	SHORT CIRCUIT TO BATT OR GROUND, NO LOAD, EXCESS.TEMP. FOR LOW SIDE POWER STAGE

PART FOUR -
MAINTENANCE PLANNING

MAINTENANCE

Maintenance services chart

The covered distances indicated in this schedule are typical of engines used in vehicles.

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

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

Use engine oil: **ACEA E3 - 96**

- In the case of very low annual mileage of less than 600 hours, the engine oil and filters must be changed every 12 months.
- Premature clogging of the air cleaner is generally due to the operating conditions. The filter should therefore be renewed whenever clogging is signalled by the sensor regardless of the prescribed time interval, which should in any case be respected in the absence of any specific indications.

The covered distances specified in this schedule are provided purely as indications, owing to their being typical of average use of vehicle engines related to their displacement.

CHECKS AND/OR MAINTENANCE WORK

Type of operation	Every 150 hours	Every 300 hours	Every 600 hours	Every 1200 hours
Engine				
Engine oil topping up	•			
Change engine oil			•	
Change engine oil filters			•	
Change of blow-by filter			•	
Replacing fuel filter		•		
Adjustment of valve clearance				• •
Change miscellaneous drive belts				•
Chassis and mechanical assemblies				
Change fuel pre-filter (if available)		•		

OFF-PLANE OPERATIONS

Every year – Before winter

and possibly when a maintenance operation is carried out

Check the antifreeze percentage in the engine cooling water

Every two year

and possibly when a maintenance operation is carried out

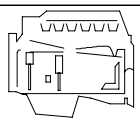
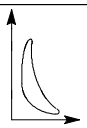
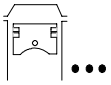
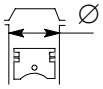
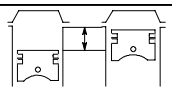
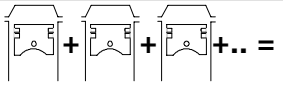
Change engine coolant

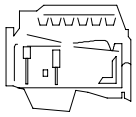
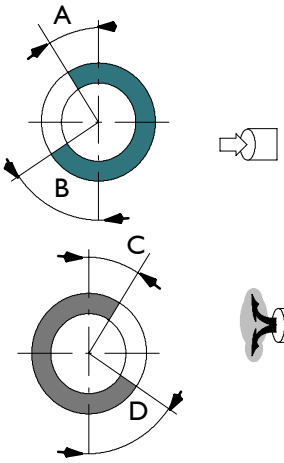
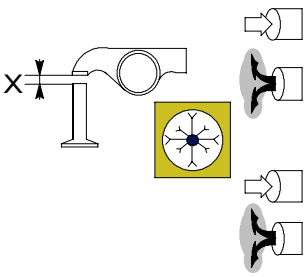
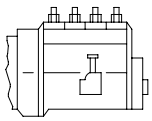
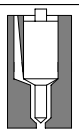
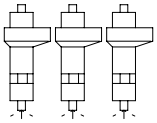
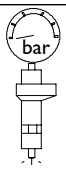
NOTE Early air filter clogging is usually due to environmental conditions. For this reason, the filter should be changed if clogging is signalled by the related sensor, regardless of the prescriptions that shall be observed if no specific indications have been provided.

SECTION 4

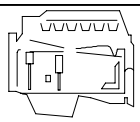
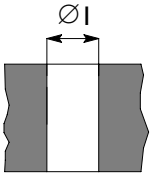
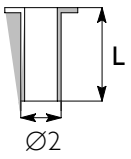
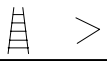
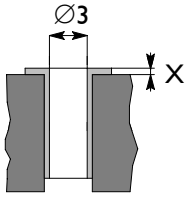
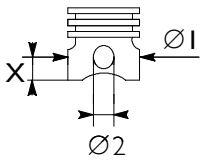
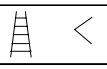
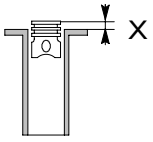
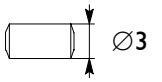
Overhaul and technical specifications

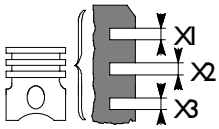
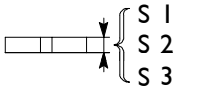
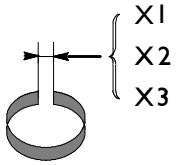
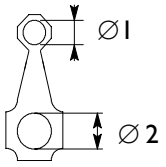
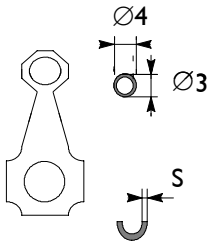
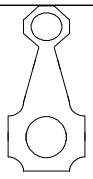
GENERAL CHARACTERISTICS

	Type		F2C
	Cycle		4-stroke Diesel engine
	Fuel feed		Turbocharged
	Injection		Direct
	No. of cylinders		6 in line
	Bore	mm	117
	Stroke	mm	135
	Total displacement	cm^3	8710

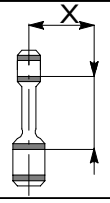
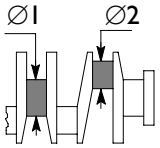
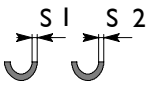
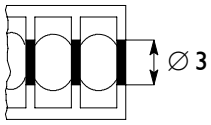
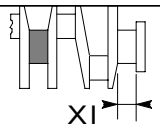
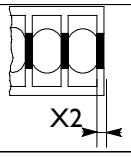
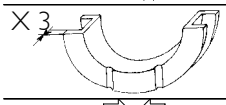
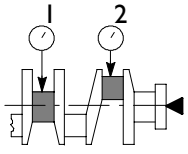
	Type	**F2C**
	VALVE TIMING opens before T.D.C. A closes after B.D.C. B opens before B.D.C. D closes after T.D.C. C	 17° 31° 48° 9°
	For timing check X mm X mm Running X mm X mm	 - - 0.35 to 0.45 0.55 to 0.65
	FEED	Bosch Common Rail with CRIN2 injectors and high pressure pump CP3.3
	Nozzle type	DLLA 137
	Injection order	1 - 4 - 2 - 6 - 3 - 5
	Injection pressure bar Injector calibration bar	1800

ASSEMBLY CLEARANCE DATA

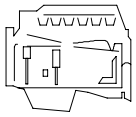
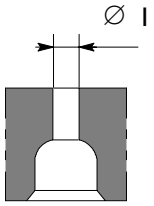
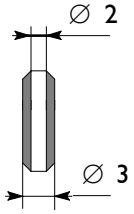
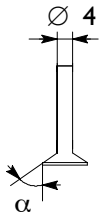
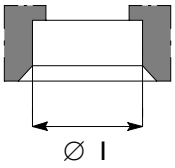
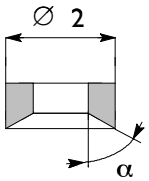
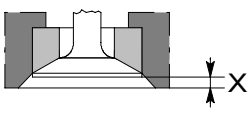
	Type	F2C
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS		mm
	Bores for cylinder liners: Ø1 upper lower	130.500 to 130.525 129.510 to 129.535
	Cylinder liners: external diameter: Ø2 upper lower length L	130.461 to 130.486 129.475 to 129.500 226,15 226.15
	Cylinder liners - crankcase bores upper lower	0.014 to 0.064 0.010 to 0.060
	External diameter Ø2	-
 * Selection class	Cylinder sleeve inside diameter Ø3A* inside diameter Ø3B* Protrusion X	 117.000 to 117.012 117.010 to 117.022 0.035 to 0.065
 * Selection class	Pistons: measuring dimension X external diameter Ø1A external diameter Ø1B pin bore Ø2	 15 116.894 to 116.906 116.904 to 116.916 52.010 to 52.016
 * Selection class	Piston - cylinder sleeve A* B*	0.094 to 0.118 0.094 to 0.118
	Piston diameter Ø1	-
	Pistons protrusion X	0.873 to 1.117
	Gudgeon pin Ø3	51.994 to 52.000
	Gudgeon pin - pin housing	0.010 to 0.022

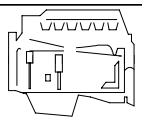
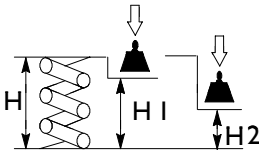
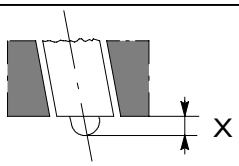
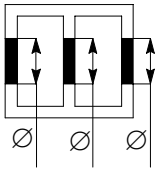
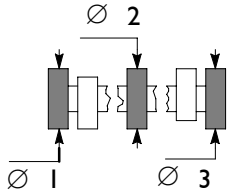
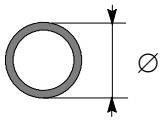
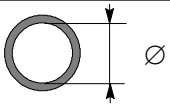
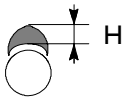
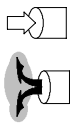
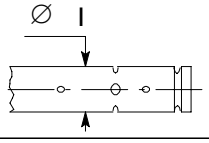
	Type		F2C
			mm
	Piston ring grooves	X1	3,120 ÷ 3,140
		X1	3.120 to 3.140
		X2	2.550 to 2.570
		X3	4.020 to 4.040
	Piston rings: trapezoidal seal	S1	3.000
	lune seal	S2	2.470 to 2.500
	milled scraper ring with slits and internal spring	S3	3.970 to 3.990
	Piston rings - grooves	1	-
		2	0.050 to 0.100
		3	0.030 to 0.070
	Piston rings		-
	Piston ring end gap in cylinder liners		
		X1	0.3 to 0.4
		X2	0.60 to 0.75
		X3	0.35 to 0.65
	Small end bush housing	Ø1	55.700 to 55.730
	Big end bearing housing	Ø2	85.987 to 86.013
	Selection classes	1	85.987 to 85.996
		2	85.997 to 86.005
		3	86.006 to 86.013
	Small end bush diameter		
	outside	Ø4	55.780 to 55.820
	inside	Ø3	52.015 to 52.030
	Big end bearing shell	S	
	Red		1.994 to 2.002
	Green		2.002 to 2.010
	Yellow ●		2.010 to 2.018
	Small end bush - housing		0.05 to 0.08
	Piston pin - bush		0.015 to 0.036
	Big end bearing		0.127 - 0.254 - 0.508
	Connecting rod weight	A	g
	Class	A	3450 to 3470
		B	3471 to 3490
		C	3491 to 3510

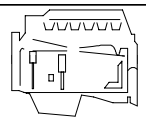
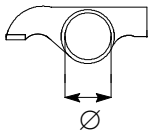
● Fitted in production only and not supplied as spares

	Type	F2C
		mm
	Measuring dimension X	125
	Max. connecting rod axis misalignment tolerance ⏥	0.08
	Main journals Ø1	
	- nominal	92.970 to 93.000
	- class 1	92.970 to 92.980
	- class 2	92.980 to 92.990
	- class 3	92.990 to 93.000
	Crankpins Ø2	
	- nominal	81.915 to 81.945
	- class 1	81.915 to 81.925
	- class 2	81.925 to 81.935
	- class 3	81.935 to 81.945
	Main bearing shells S1	
	Red	2.968 to 2.978
	Green	2.978 to 2.988
	Yellow*	2.988 to 2.998
	Big end bearing shells S2	
	Red	1.994 to 2.002
	Green	2.002 to 2.010
	Yellow*	2.010 to 2.018
	Main bearing housings Ø3	
	- nominal	99.000 to 99.030
	- class 1	99.000 to 99.009
	- class 2	99.010 to 99.019
	- class 3	99.020 to 99.030
	Bearing shells - main journals	0.050 to 0.090
	Bearing shells - big ends	0.040 to 0.080
	Main bearing shells	0.127 - 2.254 - 0.508
	Big end bearing shells	0.127 - 2.254 - 0.508
	Main journal, thrust bearing X1	39.96 to 40.04
	Main bearing housing, thrust bearing X2	38.94 to 38.99
	Thrust washer halves X3	3.38 to 3.43
	Crankshaft end float	0.10 to 0.30
	Alignment ⏥ 1 - 2	-
	Ovalization ◯ 1 - 2	0.04
	Taper ⟋ 1 - 2	-

* Fitted in production only and not supplied as spares

	Type	**F2C**
CYLINDER HEAD - VALVE TRAIN		mm
	Valve guide housings in cylinder head Ø1	12.9800 to 12.997
	Valve guide Ø2 Ø3	8.023 to 8.038 13.012 to 13.025
	Valve guides - housings in the cylinder heads	0.015 to 0.045
 >	Valve guide	0.2 - 0.4
	Valves: Ø4 α Ø4 α	7.970 to 7.985 60° 30′ ± 7′ 30″ 7.970 to 7.985 45° $^{+15'}_{-0'}$
	Valve stem and its guide	0.040 to 0.070
	Valve seat in head Ø1 Ø1	41.985 to 42.020 40.985 to 41.020
	Outside diameter of valve seat; angle of valve seat in cylinder head: Ø2 α Ø2 α	$^{0'}_{-0,5'}$ 42.060 to 42.075 60° - 30′ $^{0'}_{-0,5'}$ 41.060 to 41.075 45° - 30′
	Recessing of valve X X	0.5 to 0.8 1.6 to 1.9
	Between valve seat and head	0.040 to 0.090

		F2C	
	Type		
		mm	
	Valve spring height:		
	free height H	70.77	71.34
	under a load of:		
	N 460 ± 23 H1A N 460 ± 22 H1B	51	
	N 740 ± 33 H2A N 731,4 ± 42 H2B	39	
	Injector protrusion X	1.2 to 1.5	
	Camshaft bushing housing in the cylinder head: 1 ⇒ 7 Ø	69.000 to 69.030	
	Camshaft bearing journals: 1 ⇒ 7 Ø	64.924 to 64.080	
	Outer diameter of camshaft bushings: Ø	69.090 to 69.130	
	Inner diameter of camshaft bushings: Ø	65.080 to 65.116	
	Bushings and housings in the cylinder head	0.060 to 0.130	
	Bushings and bearing journals	0.100 to 0.192	
	Cam lift: 	7.4034 8.2108	
	Rocker shaft Ø1	31.964 to 31.980	

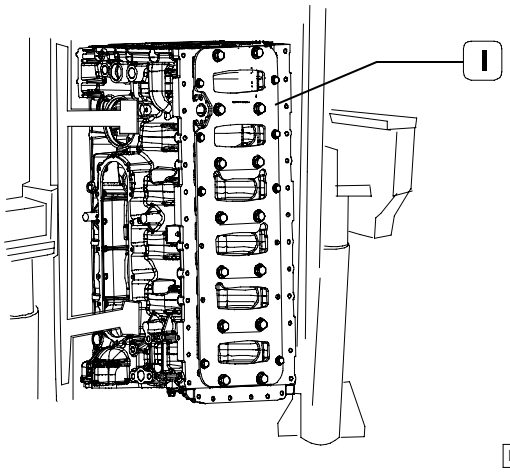
	Type	F2C
		mm
	Bushing housing in rocker arms	
		32.025 to 32.041
		32.025 to 32.041
	Between bushings and housings	
		0.045 to 0.077
		0.045 to 0.077
TURBOCHARGER		
Type		HX40
End float		0.025 to 0.127
Radial play		0.330 to 0.508

ENGINE OVERHAUL
ENGINE REMOVAL AT THE BENCH

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

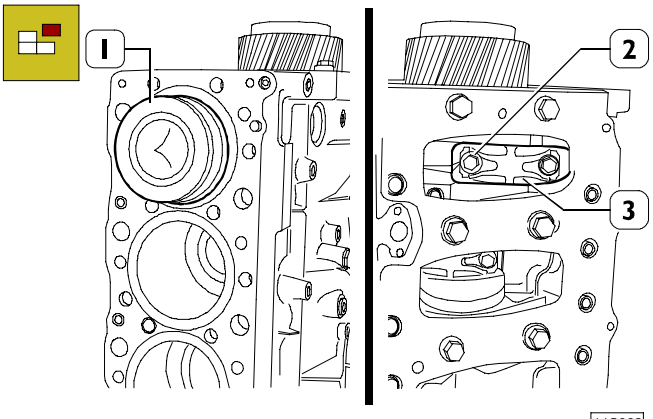
The section illustrates therefore all the most important engine overhaul procedures.

Figure 1



Rotate the block (1) to the vertical position.

Figure 2

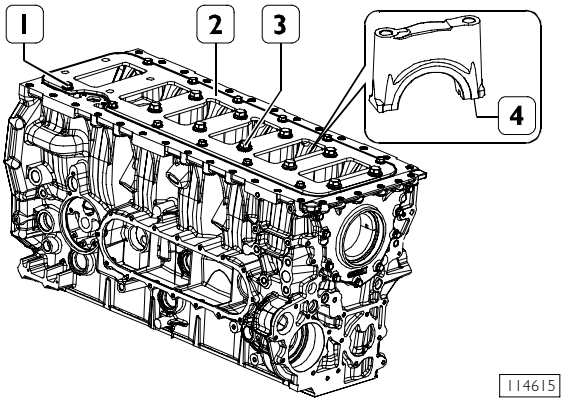


Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston (1) assembly from the upper side.

Repeat these operations for the other pistons.

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

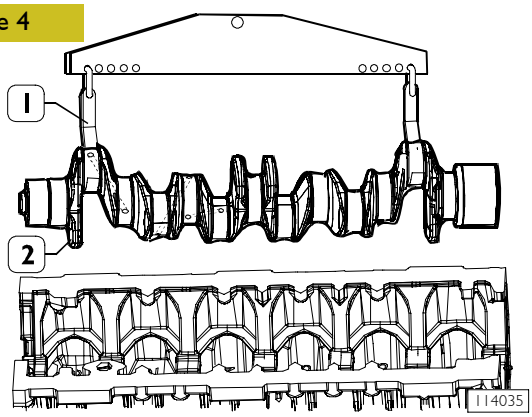
Figure 3



Use adequate hexagonal spanner, unlock screws (1 and 3) and remove stiffening plate (2) as well as main journals (4).

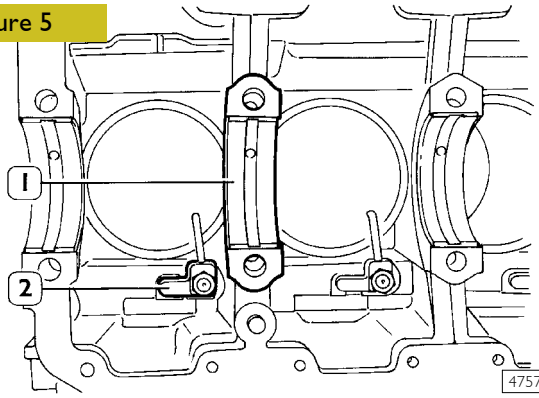
NOTE Note down the assembly position of the top and bottom main bearing shells since, if reusing them, they will need to be fitted in the position found upon removal.

Figure 4



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

Figure 5



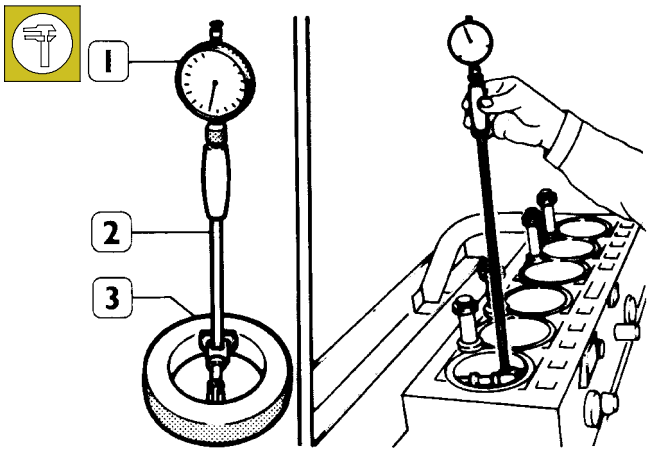
Remove the main bearing shells (1), unscrew the screws and take out the oil nozzles (2).
Remove the cylinder liners as described under the relevant subheading on page 15.

After disassembling the engine, thoroughly clean disassembled parts and check their integrity.

Instructions for main checks and measures are given in the following pages, in order to determine whether the parts can be re-used.

REPAIR OPERATIONS
CYLINDER BLOCK
Checks and measurements

Figure 6 (Demonstration)

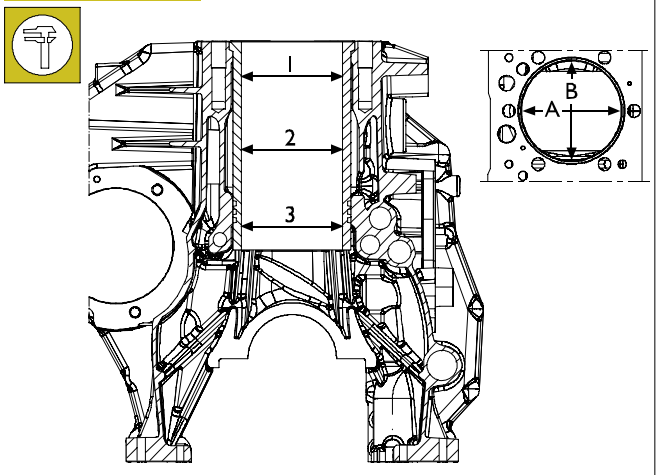


34994

Internal diameter of the cylinder liners is checked for ovalization, taper and wear, using a bore dial (1) centesimal gauge 99395687 (2) previously reset to ring gauge (3), diameter 117 mm.

NOTE If dia.117 mm ring gage is not available, use a micrometer.

Figure 7

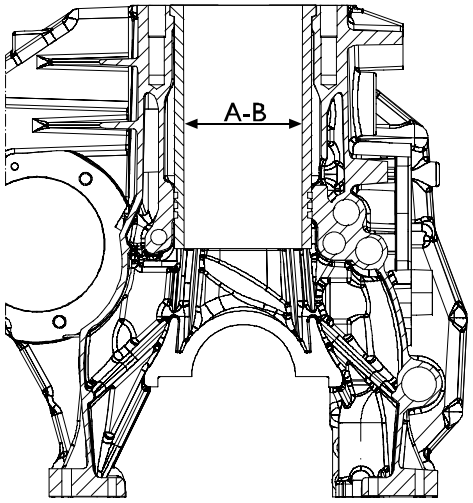


114035

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

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

Figure 8



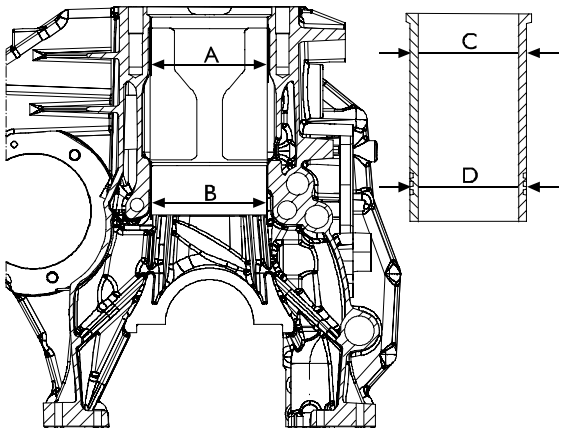
225036

A = Selection class Ø 117 – 117.012 mm
B = Selection class Ø 117.010 – 117.022 mm
X = Selection class marking area

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

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

Figure 9



114037

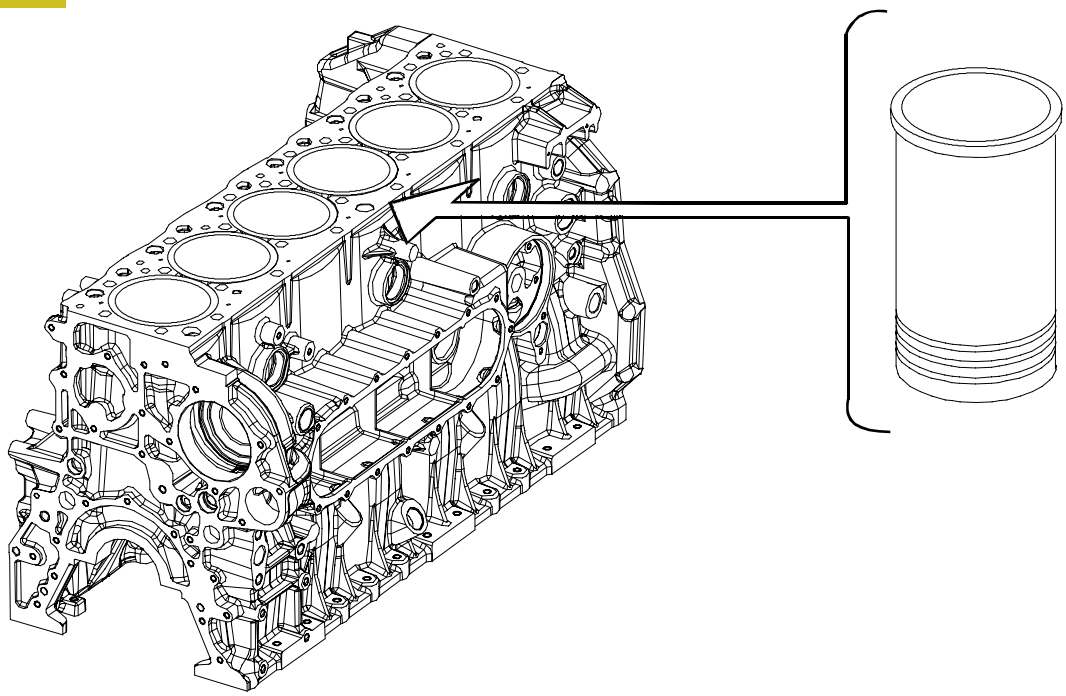
A = Ø 130.500 to 130.525 mm
B = Ø 129.510 to 129.535 mm
C = Ø 130.461 to 130.486
D = Ø 129.475 to 129.500 mm

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

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

CYLINDER LINERS

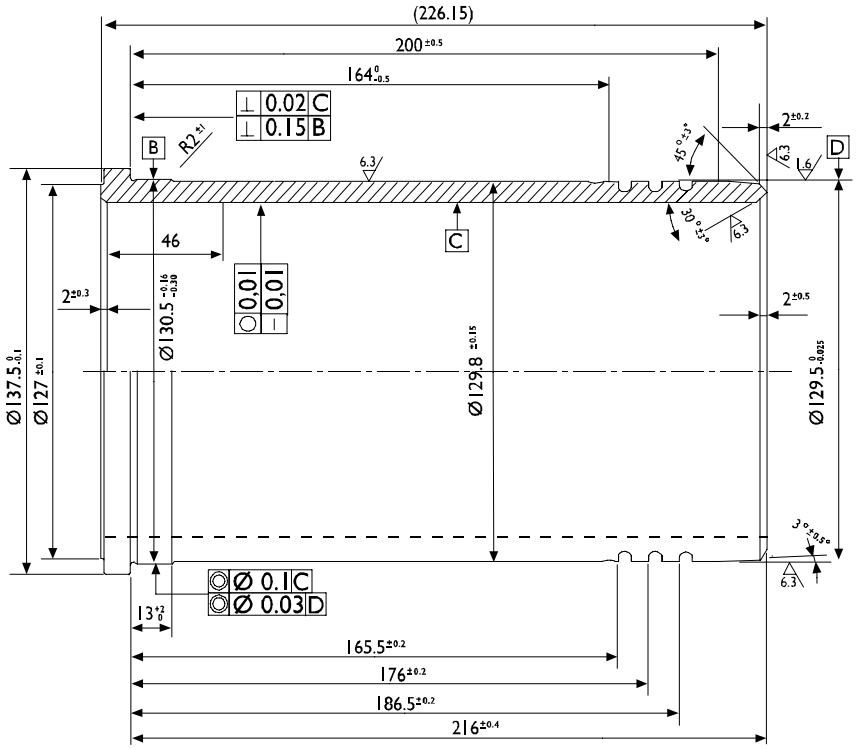
Figure 10



114038

CYLINDER BLOCK ASSEMBLY WITH CHROME-PLATED CYLINDER LINERS

Figure 11

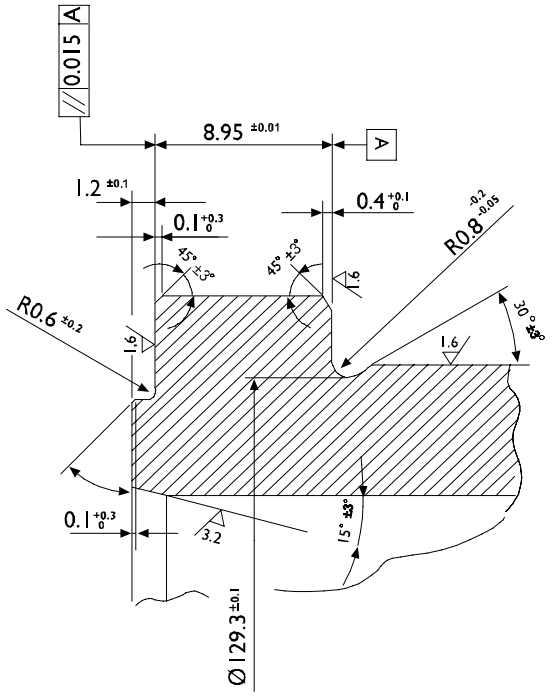


114039

CYLINDER LINERS MAIN DATA

Selection class { A mm 117.000 to 117.012
B mm 117.010 to 117.022

Figure 12



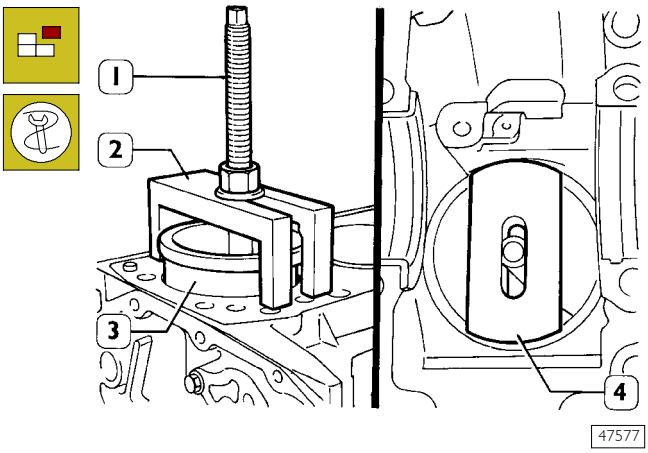
114040

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

540420 Replacing cylinder liners

Removal

Figure 13

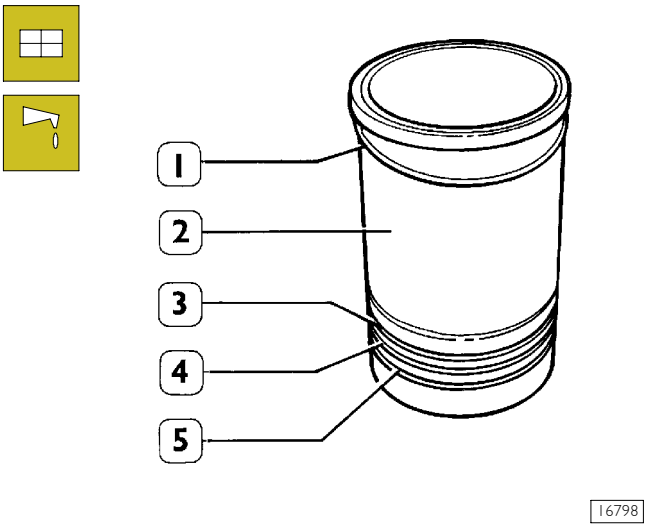


Place details 99360706 (1 and 2) and plate 99360724 (4) as shown in the figure, by making sure that the plate (4) is properly placed on the cylinder liners.

Tighten the screw nut (1) and remove the cylinder liner (3) from the block.

Fitting and checking protrusion

Figure 14

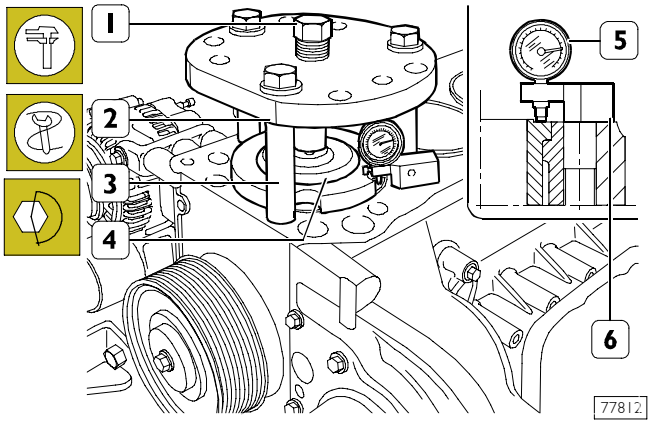


Always replace water sealing rings (3, 4 and 5).

Install the adjustment ring (1) on the cylinder liner (2); lubricate lower part of liner and install it in the cylinder unit using the proper tool.

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

Figure 15

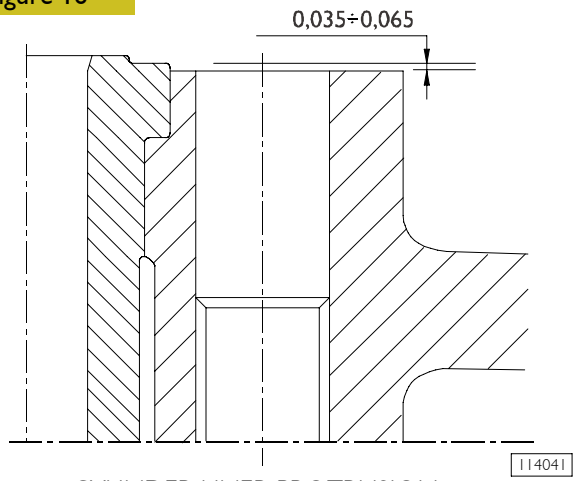


Check cylinder barrel protrusion with tool 99360334 (1-2-3-4) and tighten screw (1) to 170 Nm.

With dial gauge 99395603 (5) placed on base 99370415 (6).

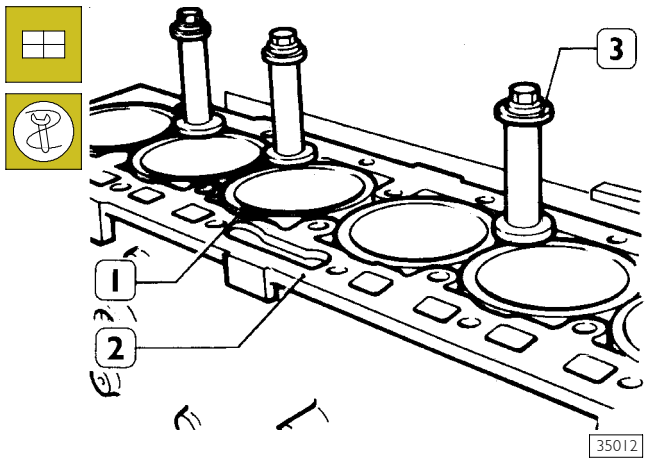
Measure the cylinder barrel protrusion compared to the cylinder head supporting plane, it must be 0,035 to 0,065 mm (Figure 16); otherwise replace the adjusting ring (1, Figure 14) fitted with spare parts having different thickness.

Figure 16



CYLINDER LINER PROTRUSION

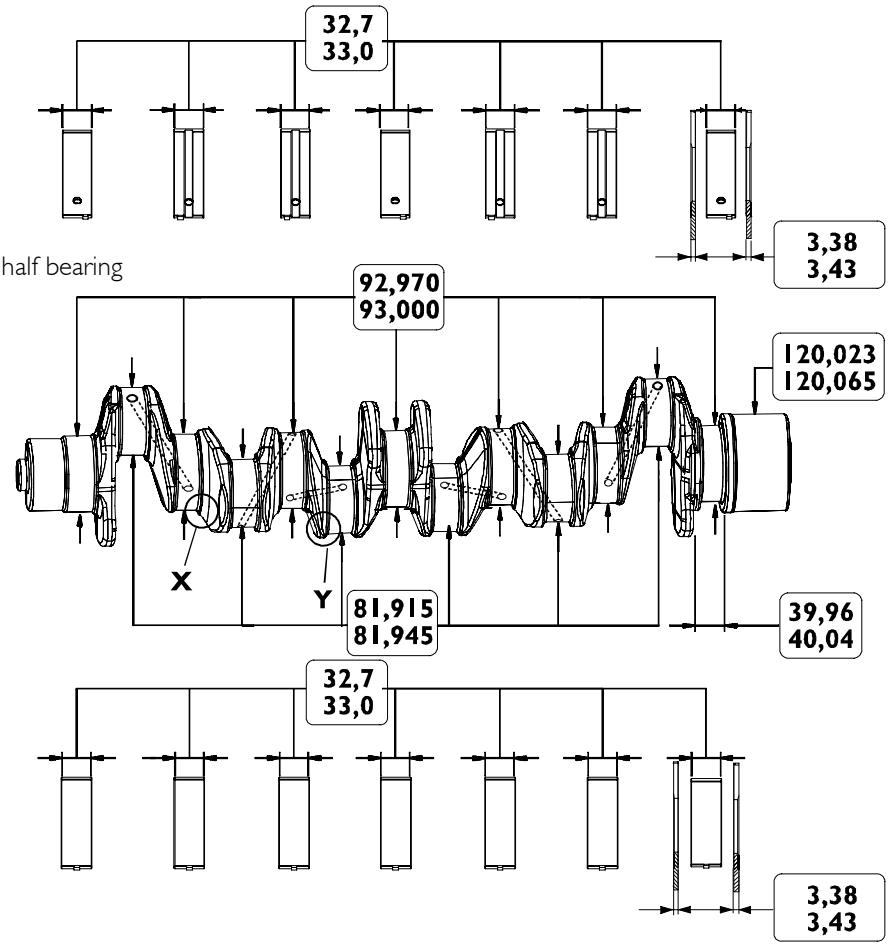
Figure 17 (Demonstration)



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

5408 CRANKSHAFT

Figure 18



Upper main journal half bearing

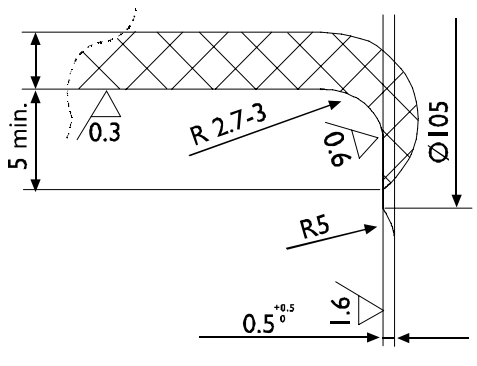
Lower main journal half bearings

114042

MAIN DATA FOR THE CRANK SHAFT PINS AND THE HALF BEARINGS

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

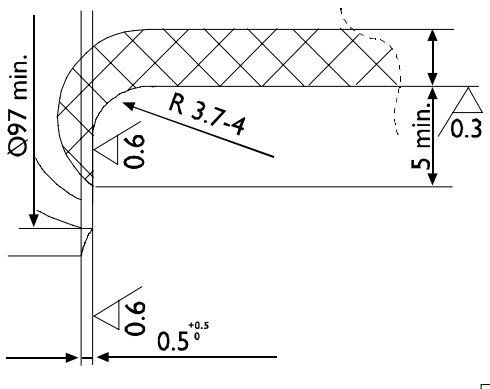
Figure 19



114043

X. Detail of main journals connections

Figure 20



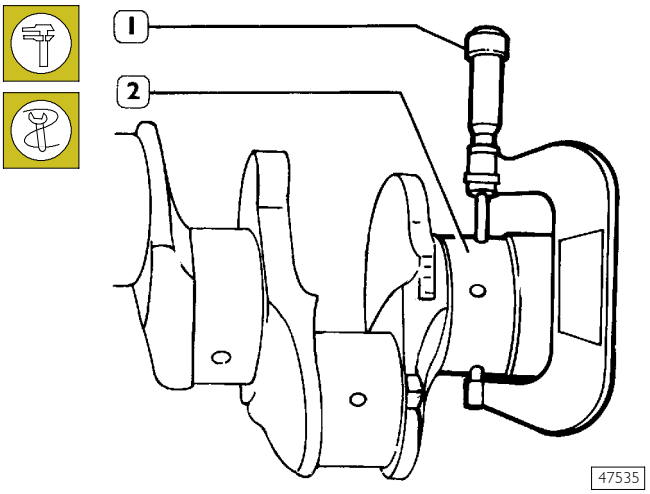
114044

Y. Detail of crank pins connections

540812 Measuring main journals and crank pins

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

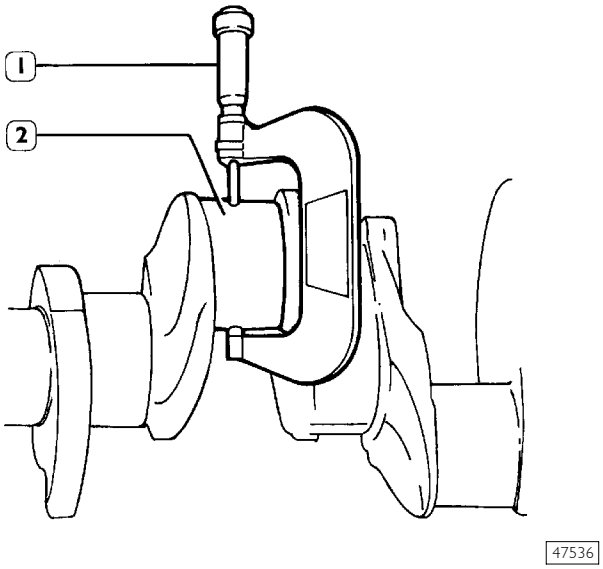
Figure 21



MEASURING THE MAIN JOURNALS

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

Figure 22



MEASURING CRANK PINS

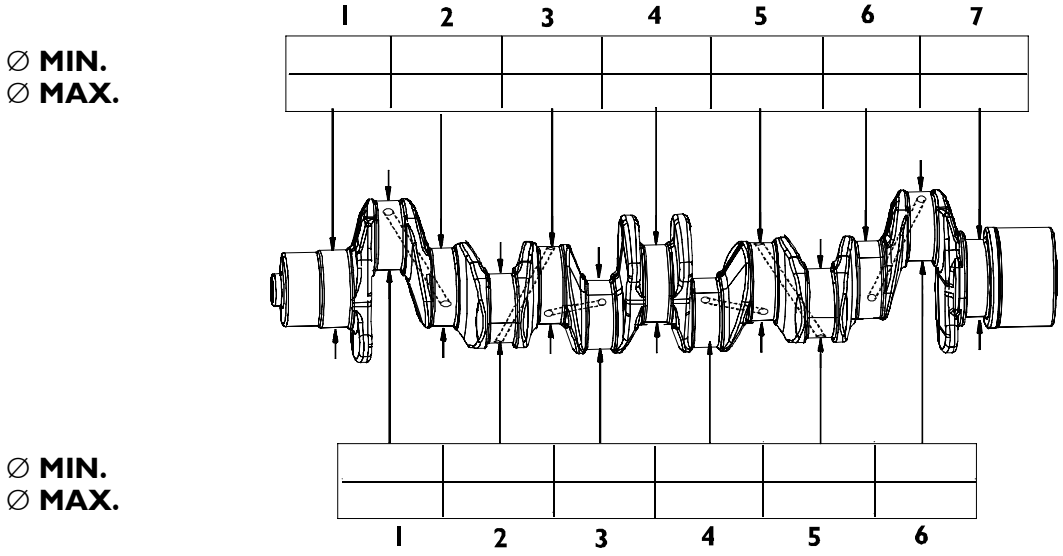
During grinding, pay attention to journal and crank pins values specified in figures 68 and 69.

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

Figure 23

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

MAIN JOURNALS



CRANK PINS

PRELIMINARY MEASUREMENT OF MAIN AND BIG END BEARING SHELL SELECTION DATA

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

MAIN JOURNALS:

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

CRANKPINS:

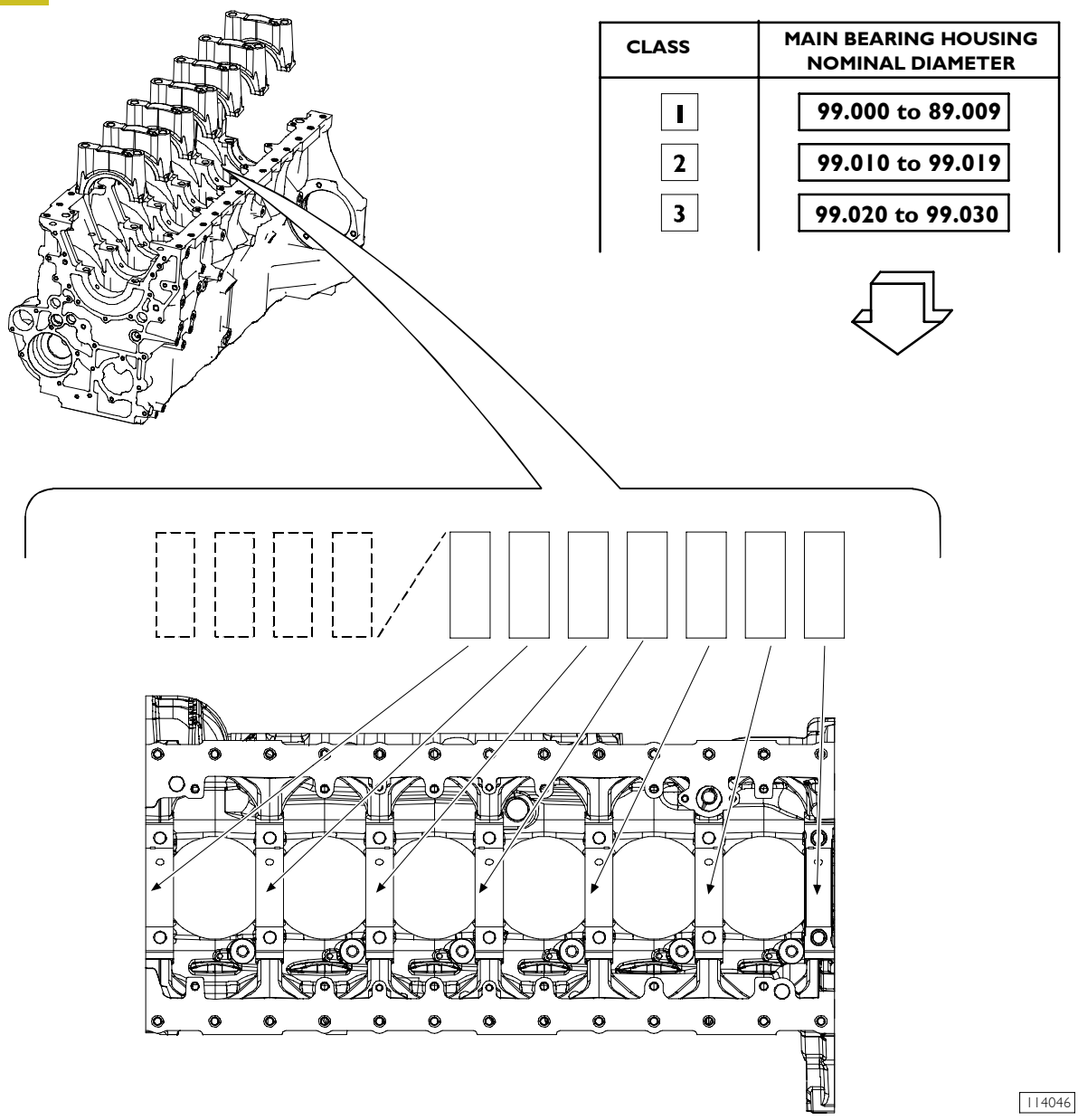
- ❑ Determine the class of diameter of the seat in the connecting rod.
- ❑ Determine the class of diameter of the crankpin.
- ❑ Select the class of the bearing shells to mount.

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

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

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

Figure 24



Selecting the main and big end bearing shells

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

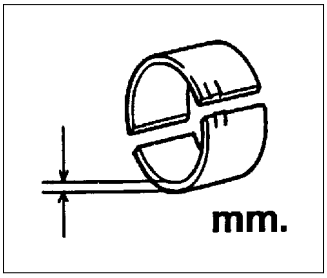
This operation makes it possible to identify the most suitable bearing shells for each of the journals (the bearing shells, if necessary, can have different classes from one journal to another).

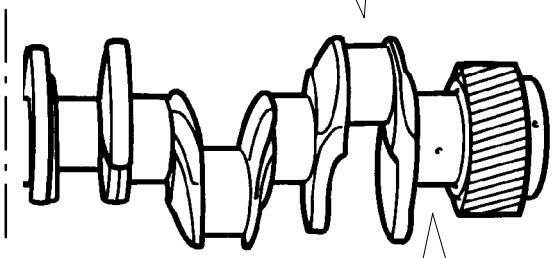
Depending on the thickness, the bearing shells are selected in classes of tolerance marked by a coloured sign (red-green – red/black – green/black).

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

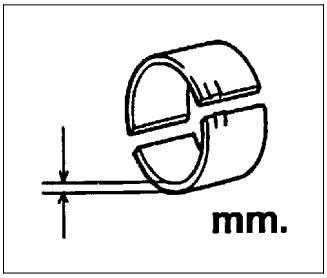
Figure 25

	STD	+0.127
red	1.994 to 2.002	
red/black		2.057 to 2.065
green	2.002 to 2.010	
green/black		2.065 to 2.073
yellow*	2.010 to 2.018	
yellow/black*		2.073 to 2.081





	STD	+0.127
red	2.968 to 2.978	
red/black		3.031 to 3.041
green	2.978 to 2.988	
green/black		3.041 to 3.051
yellow*	2.988 to 2.998	
yellow/black*		3.051 to 3061



* Fitted in production only and not supplied as spares

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

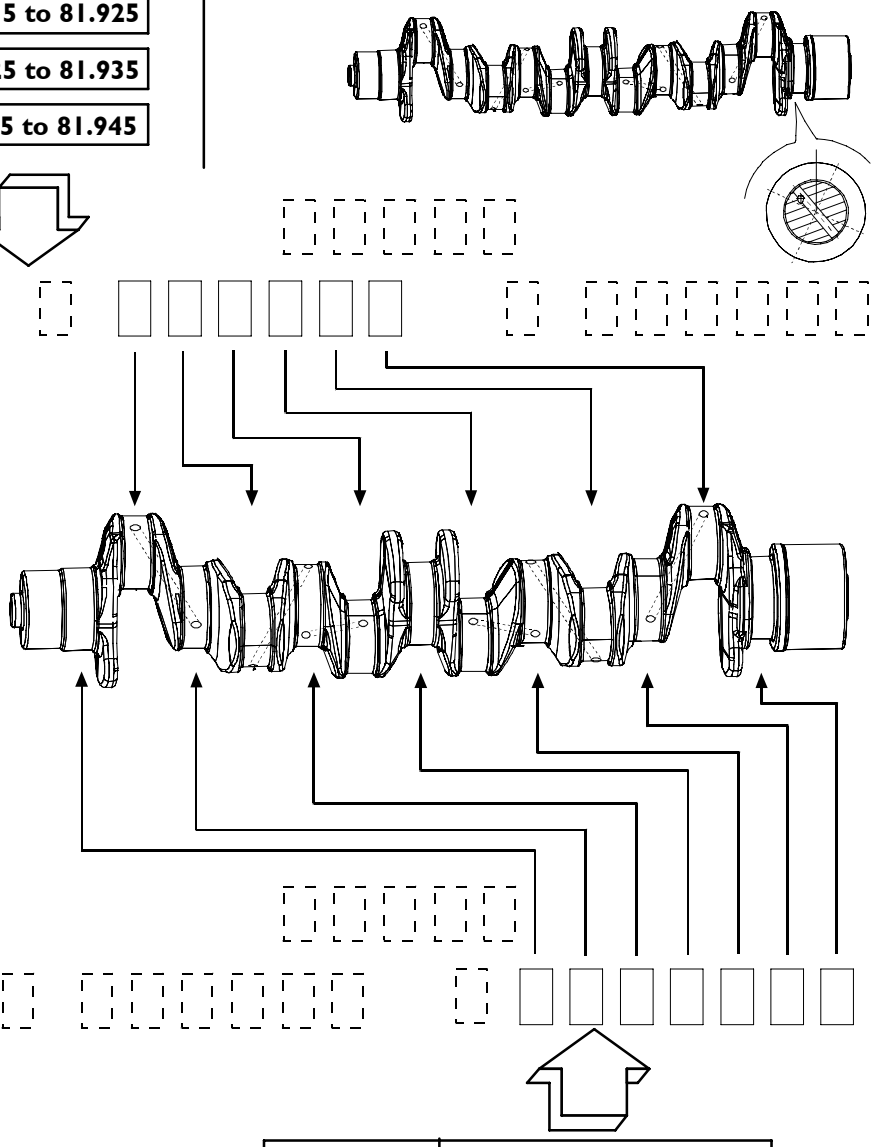
Main journals and crankpins: determining the class of diameter of the journals.

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

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

Figure 26

CLASS	CRANKPIN NOMINAL DIAMETER
1	81.915 to 81.925
2	81.925 to 81.935
3	81.935 to 81.945



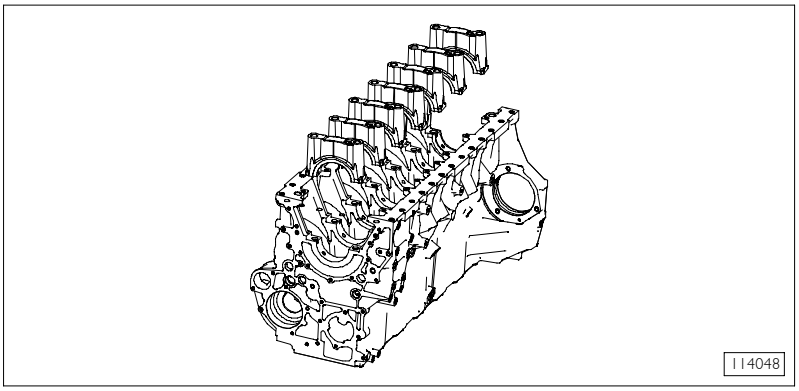
CLASS	MAIN JOURNALS NOMINAL DIAMETER
1	92.970 to 92.980
2	92.980 to 92.990
3	92.990 to 93.000

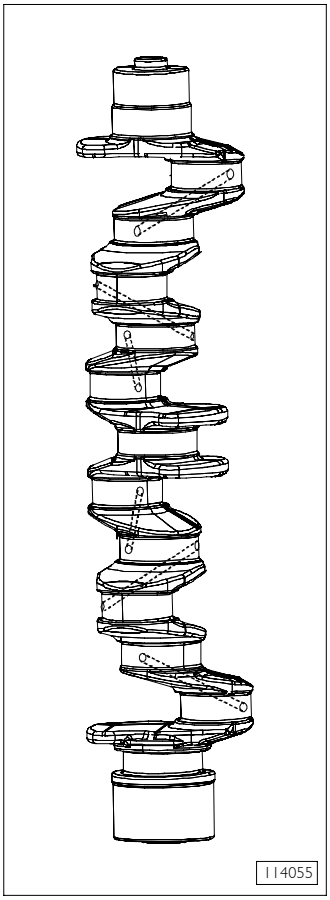
Selection of main half-bearings (nominal diameter pins)

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

Figure 27

STD.





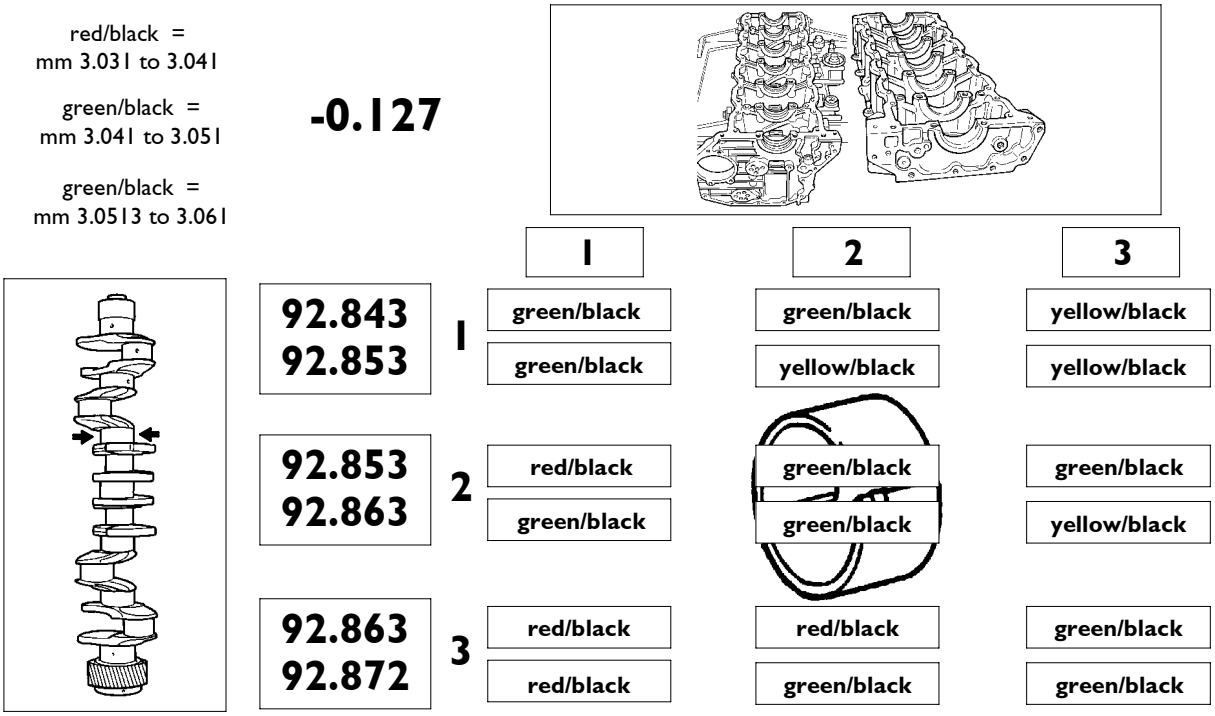
	1	2	3
1	green	green	yellow
	green	yellow	yellow
2	red	green	green
	green	green	yellow
3	red	red	green
	red	green	green

Selection of main half-bearings (rectified pins)

If the journals have been rectified, the procedure described cannot be applied.

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

Figure 28



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

There are 4 references on the connecting rod casing in the positions illustrated:

1. Coloured mark for identifying the weight
2. Coloured mark for identifying the diameter grade
3. Positioning stud visible from the front of the engine
4. Progressive number for identifying the connecting rod

NOTE The identification colours of the marks are given in the table on page 31.

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

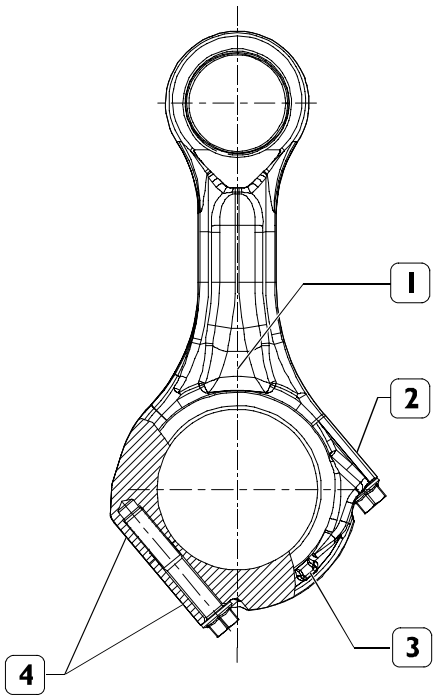
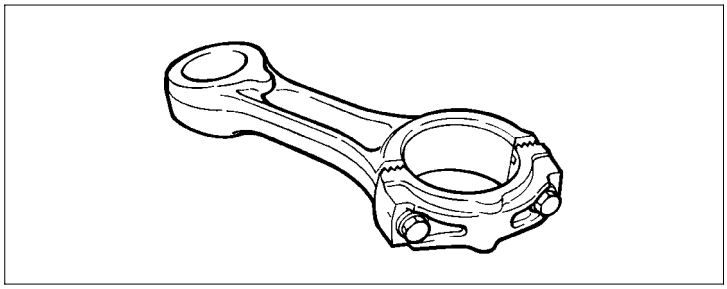
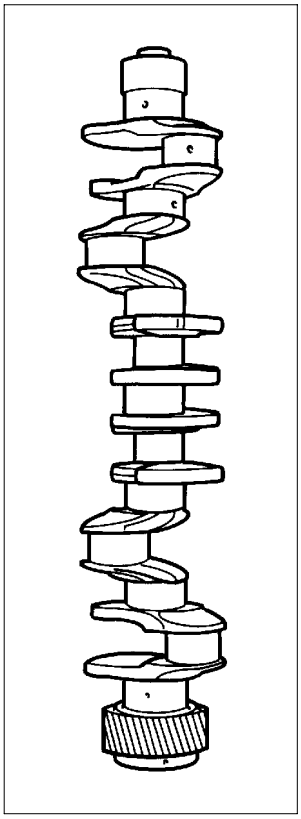


Figure 30

STD.





Class	1 yellow	2 green	3 blue
1	green	green	yellow
	green	yellow	yellow
2	red	green	green
	green	green	yellow
3	red	red	green
	red	green	green

Selection of connecting rod half-bearings (rectified pins)

If pins have been rectified, the procedure described must be applied.

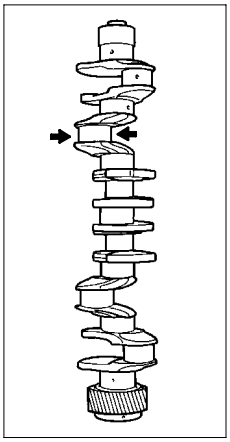
In this case, (for each undersizing) determine the tolerance field the new big end pins belong to, and install the half-bearings identified according to the relative table.

Figure 31

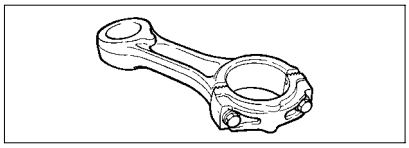
red/black = mm 2.057 to 2.065

green/black = mm 2.065 to 2.073

green/black = mm 2.073 to 2.081



-0.127

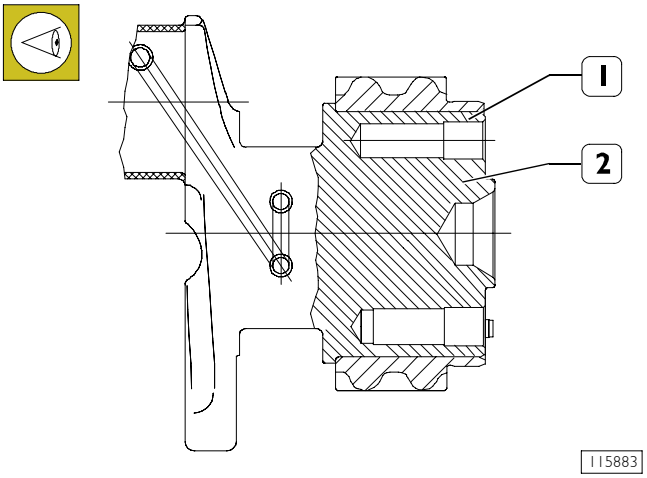


		1	2	3
81.789 81.799	1	green/black	green/black	yellow/black
		green/black	yellow/black	yellow/black
81.799 81.809	2	red/black	green/black	green/black
		green/black	green/black	yellow/black
81.809 81.819	3	red/black	red/black	green/black
		red/black	green/black	green/black

540815 Replacing the timing control gear and the oil pump

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

Figure 32



NOTE Before fitting the gear, spread Loctite type 603 on approx. 5 mm wide band on crankshaft, at 30 mm from contact surface.

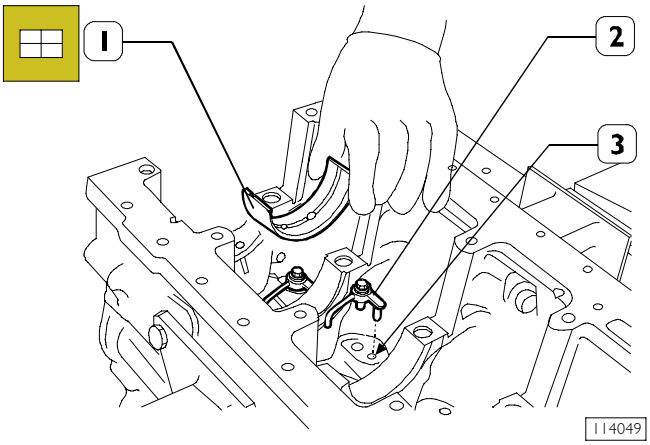
After fitting the gear (1) on the crankshaft (2), heat it for ~15 minutes in an oven at temperature not higher than 180°C.

Let them cool down after the installation.

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

540811 Checking main journal installation clearance

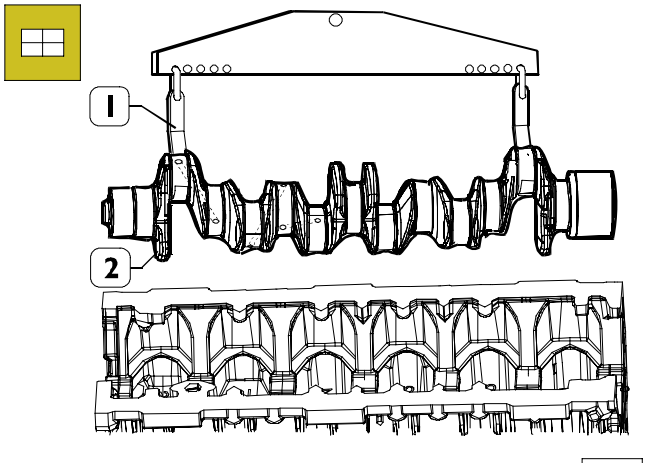
Figure 33



Fit the oil jets (2) aligning the dowel with the opening (3) in the crankcase.

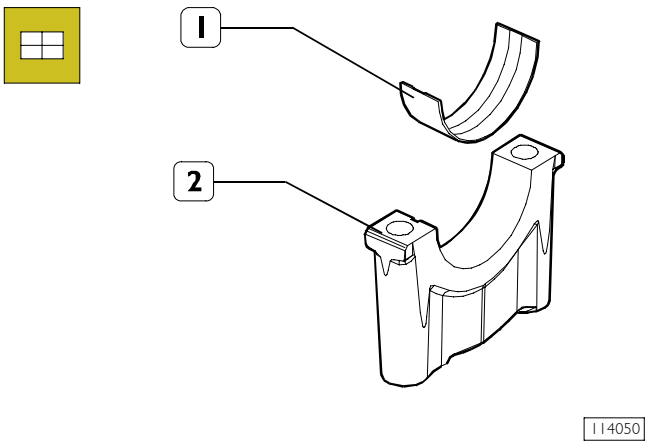
Position the half-bearings (1) and the thrust washers on the main journal supports as illustrated in Figure 18.

Figure 34



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

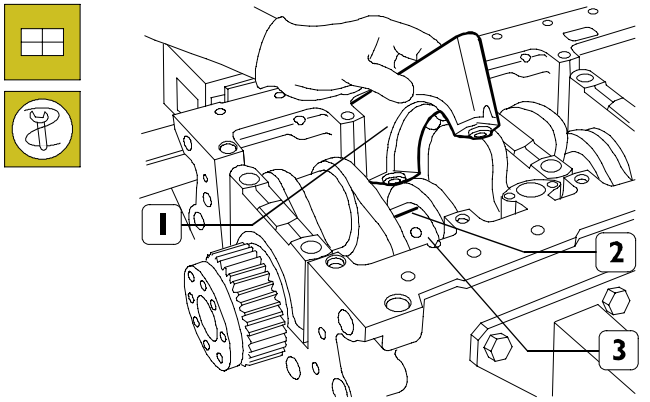
Figure 35



Place bearing halves (1) on main journals (2).

Check the installation clearance between the main journals and the relative bearings as follows.

Figure 36

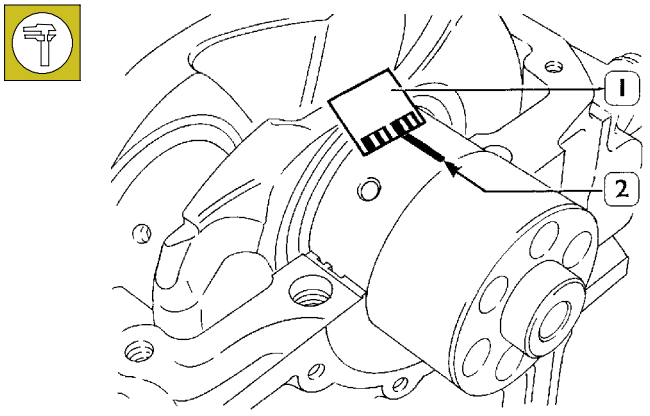


114051

Fit sized wire sections (2) on crankshaft (3) parallel to longitudinal axis.

Install main journals (1).

Figure 37



47579

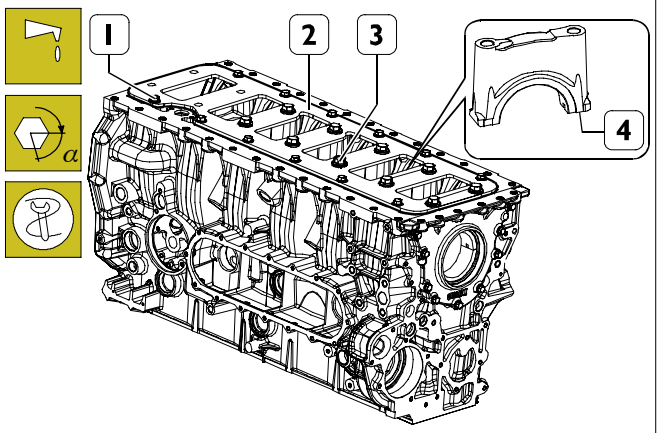
❑ Remove main journals.

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

Numbers shown on the scale specify the clearance in coupling millimeters.

If the clearance obtained is different from the clearance required, replace the half-bearings and repeat this check.

Figure 38



114615

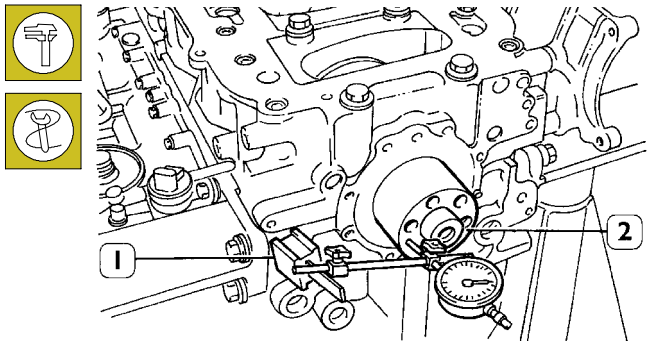
❑ Position the main journal caps (4) and fit the strengthening plate (2) following the procedure described:

❑ Tighten the inner bolts and then the outer bolts by hand starting from main journal "7" and continuing until main journal "1".

❑ Tightening the bolts using torque wrench always starting from main journal "7" and continuing until main journal "1":
1st stage: 140 Nm
2nd stage 60°+60°

Checking crankshaft end float

Figure 39



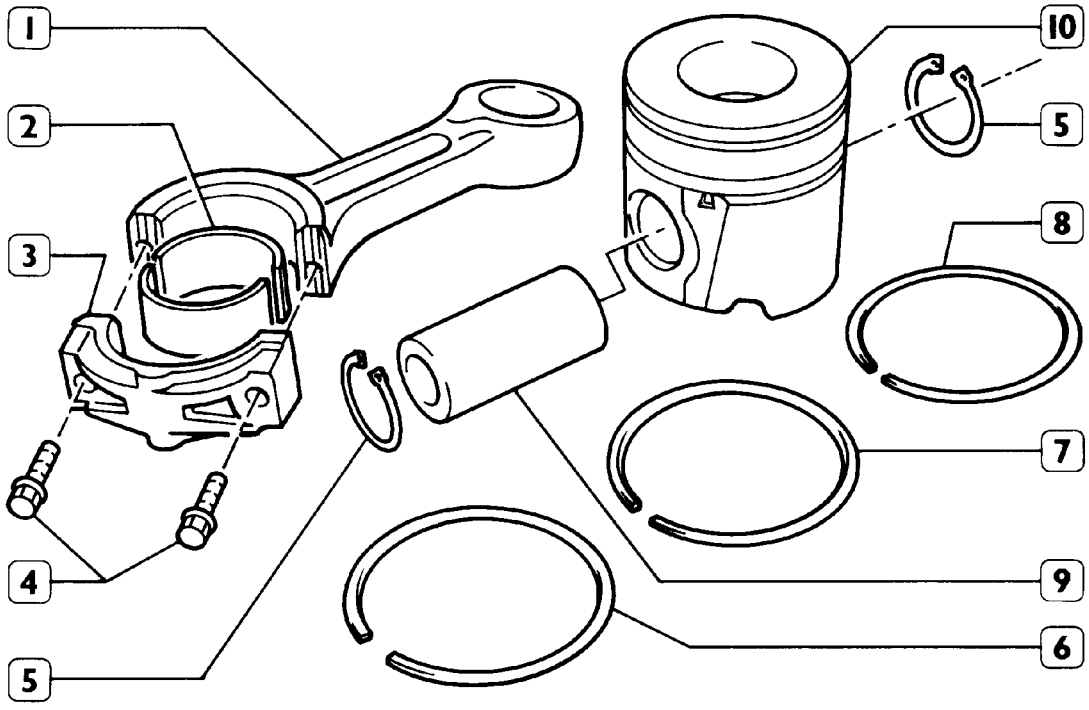
47588

End float is checked by placing a magnetic dial gauge (1) on the crankshaft (2), as shown in the figure.

If the value obtained is higher than specified, replace the rear thrust half-bearings and repeat this check.

5408 PISTON-CONNECTING ROD ASSEMBLY

Figure 40



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

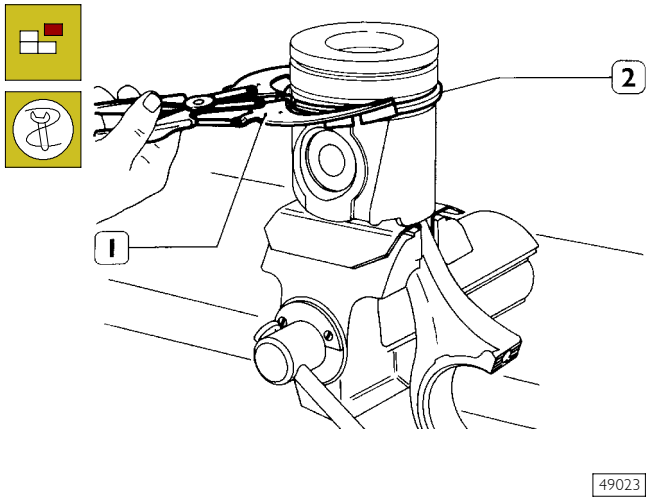
Make sure the piston does show any trace of seizing, scoring, cracking; replace as necessary.

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.

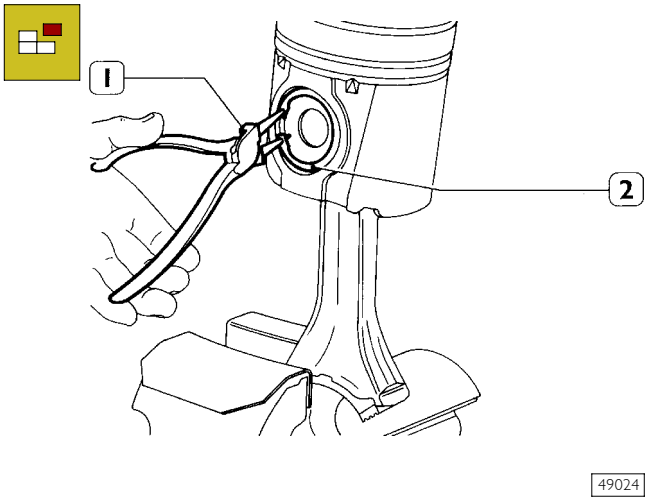
Removal

Figure 41



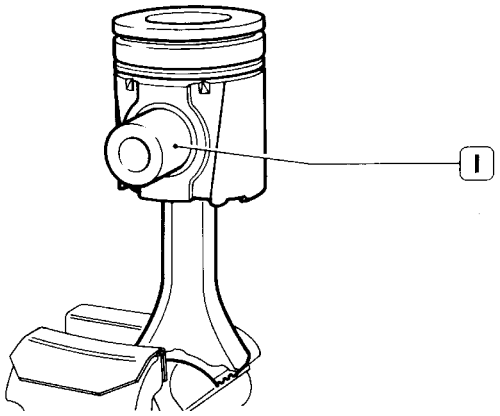
Removal of the piston split rings (2) using the pliers 99360184 (1).

Figure 42



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

Figure 43



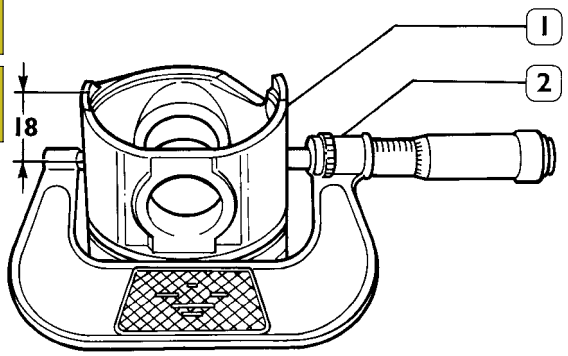
49025

Remove the piston pin (1).

If removal is difficult use the appropriate beater.

Measuring the diameter of the pistons

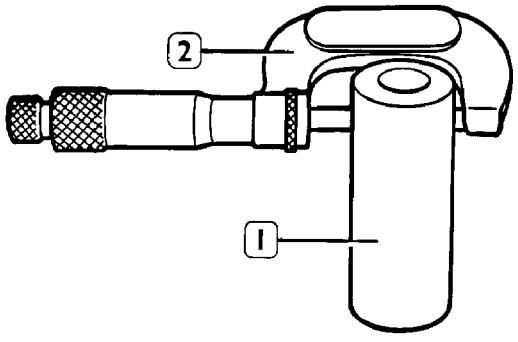
Figure 44



47584

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

Figure 45

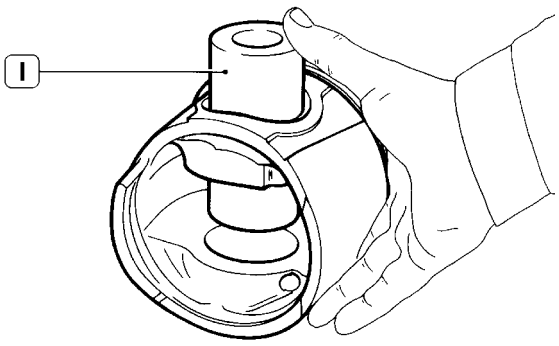


32618

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

Conditions for correct gudgeon pin-piston coupling

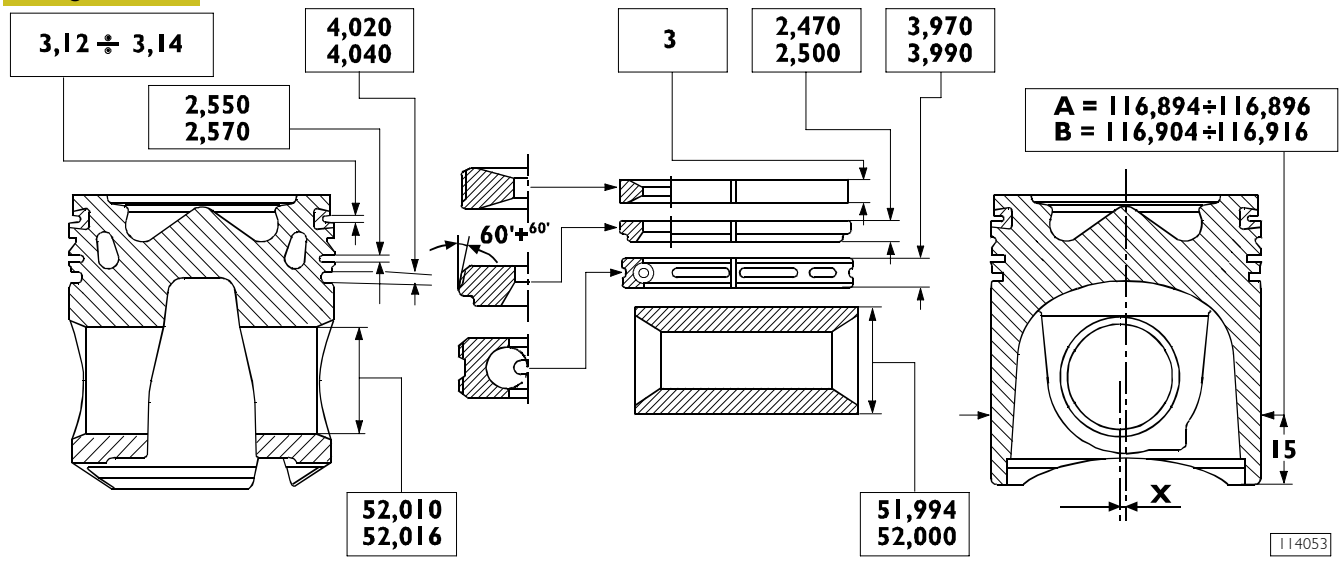
Figure 46



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 47



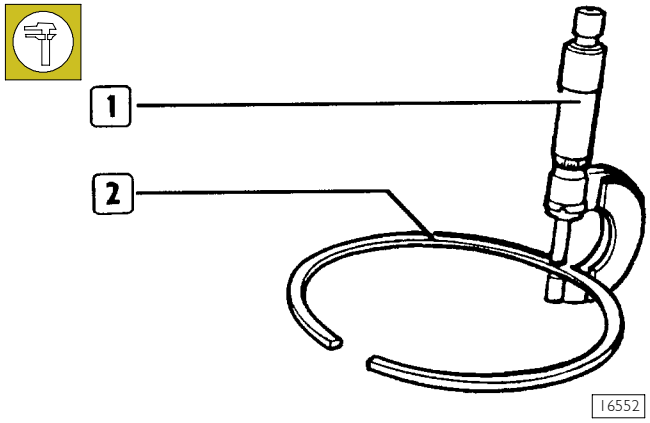
MAIN DATA OF PISTON, SNAP RINGS AND PIN

X = 0,6 ± 0,15

- The dimension is measured on a ∅ of 113 mm

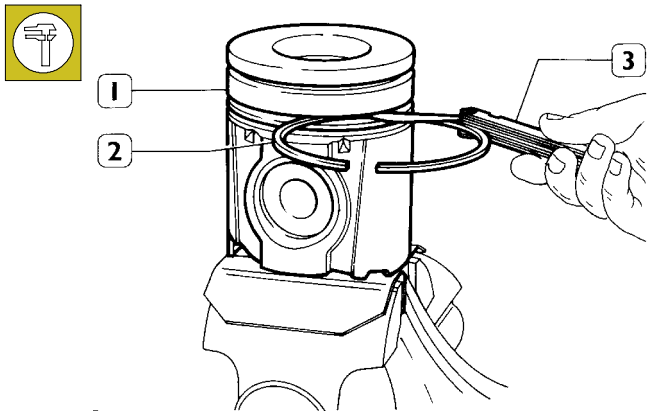
540842 Piston rings

Figure 48



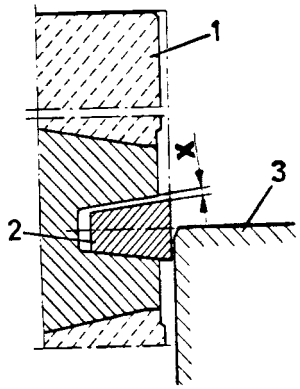
Check the thickness of the piston ring (2) using a micrometer (1).

Figure 49



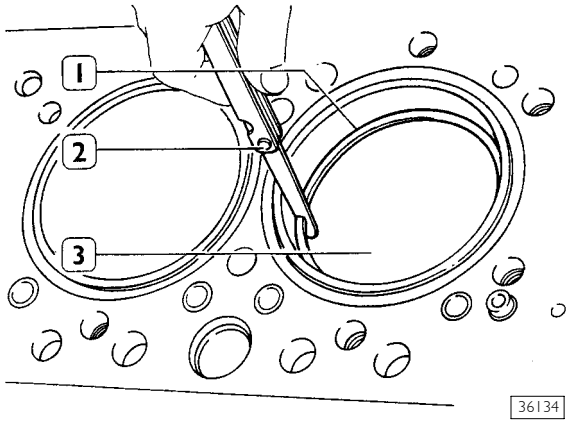
Check the clearance between the sealing rings (2) and the relative piston housings (1) using a thikness gauge (3).

Figure 50



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

Figure 51



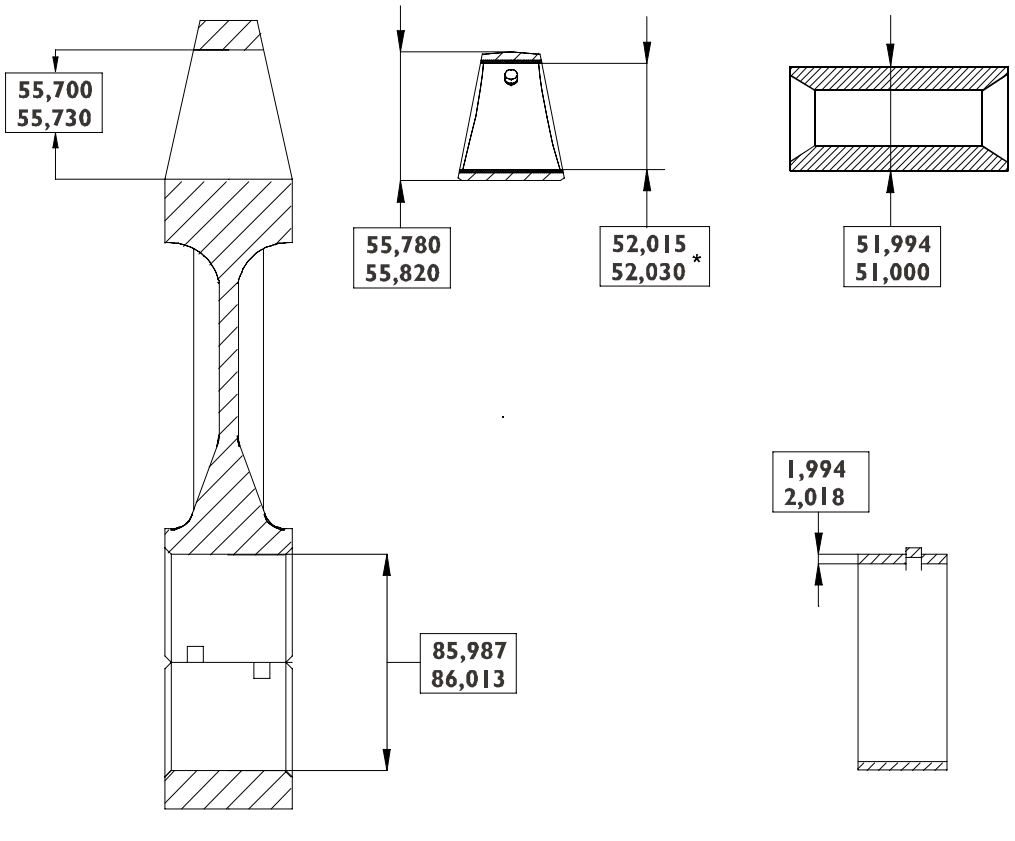
Check the opening between the ends of the sealing rings (1), using a thickness gauge (2), entered in the cylinder barrel (3).

If the distance between ends is lower or higher than the value required, replace split rings.

540830 CONNECTING ROD

When fitting the connecting rods, check that all of them are of same weight class and from the same supplier. The connecting rod/cap is of "torn" type; before assembly verify that the connecting rod is not damaged. Each connecting rod can assembled with the relative cap only. If the cap is assembled on the reverse side, the connecting rod must be rejected.

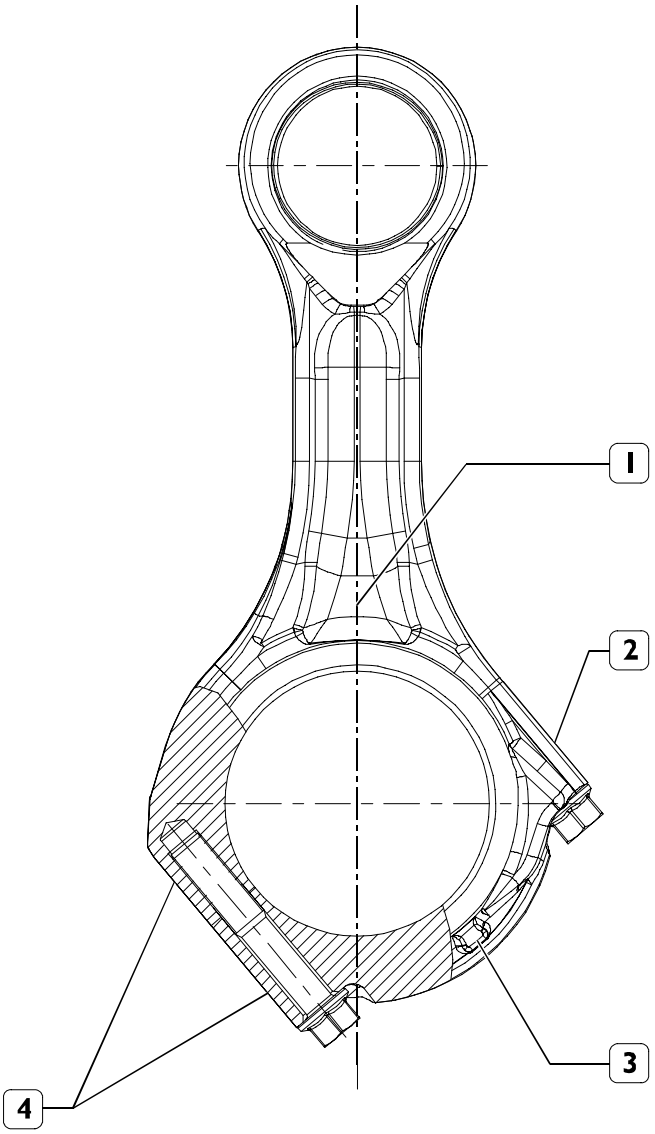
Figure 52



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

1 Between the connecting rod bush and the connecting rod profile there must be a distance > 0.4 mm.
2 On the external breaking line, gap area allowed must be < 5 mm^2.
3 No cracks are allowed in the threaded area.

Figure 53

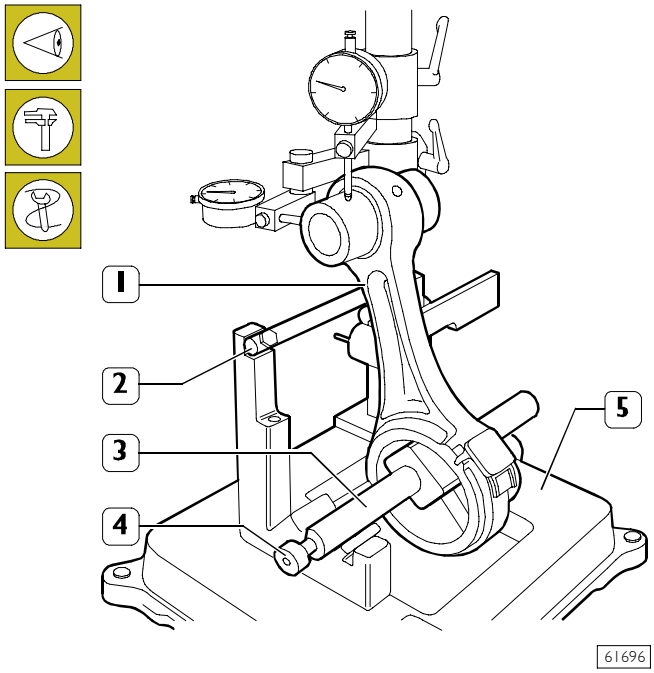


1. Coloured mark for identifying weight - 2. Coloured mark for identifying diameter grade - 3. Positioning stud visible from the front of the engine - 4. Progressive number for identifying connecting rod

WEIGHT		DIAMETER	
GRADE A Yellow	3450 g - 3470 g	Ø 85.987-85.996	Yellow
		Ø 85.997-86.005	Green
		Ø 86.006-86.013	Blue
GRADE B Green	3471 g - 3490 g	Ø 85.987-85.996	Yellow
		Ø 85.997-86.005	Green
		Ø 86.006-86.013	Blue
GRADE C Blue	3491 g - 3510 g	Ø 85.987-85.996	Yellow
		Ø 85.997-86.005	Green
		Ø 86.006-86.013	Blue

Checking connecting rod alignment

Figure 54 (demonstrative)



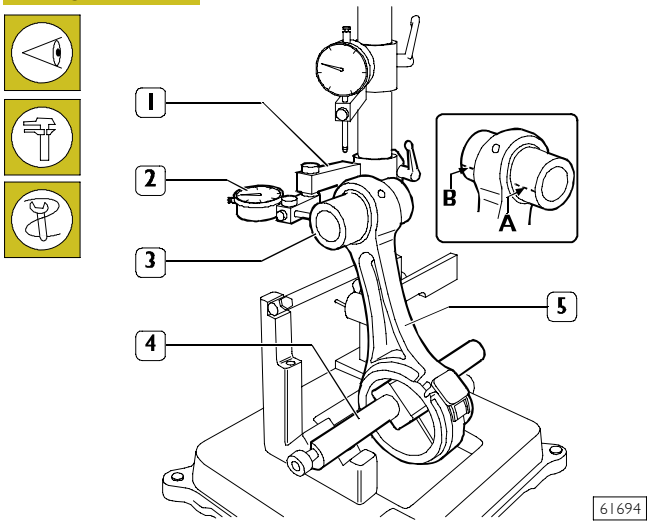
Checking axis alignment

Check the alignment of the axes of the connecting rods (1) with device (5), proceeding 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

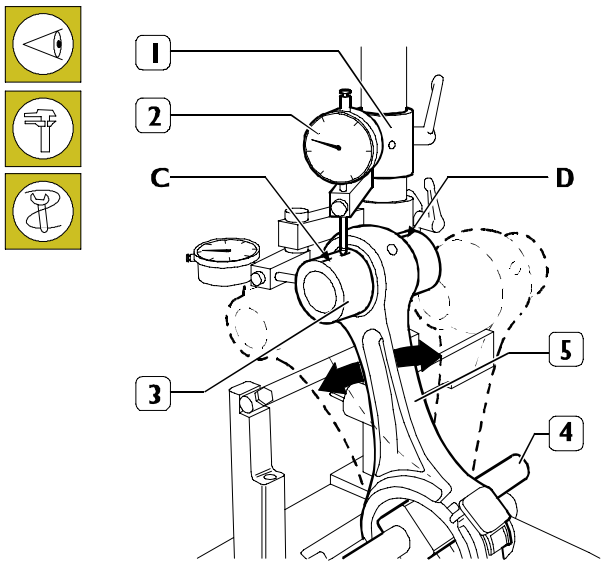
Figure 55 (demonstrative)



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 56 (demonstrative)

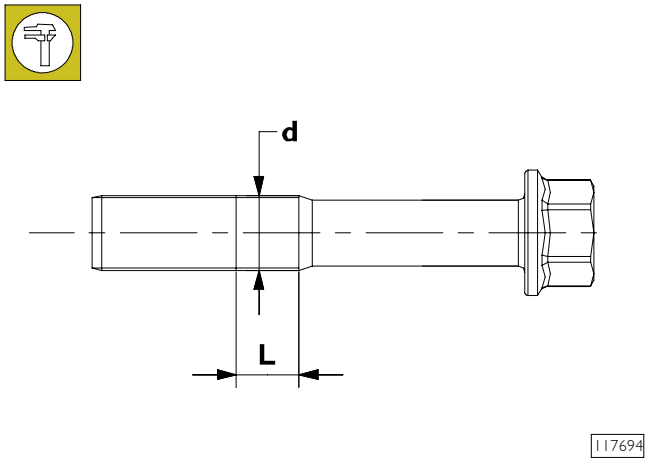


Check the bending of the connecting rod (5) by comparing two points **C** and **D** of the pin (3) on the vertical plane of the axis of the connecting rod.
Position the vertical mount (1) of the dial gauge (2) so that this rests on the pin (3) at point **C**.
Swing the connecting rod backwards and forwards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

Mounting the connecting rod - piston assembly

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

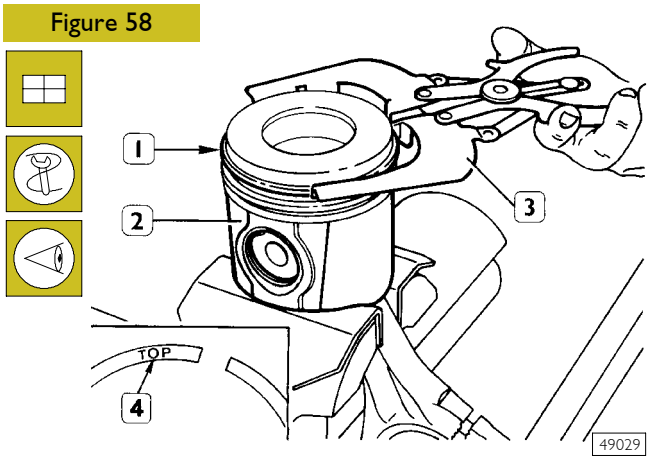
Figure 57



NOTE The connecting rod screws can be reused as long as the diameter of the thread is not less than 11.4 mm.

Mounting the piston rings

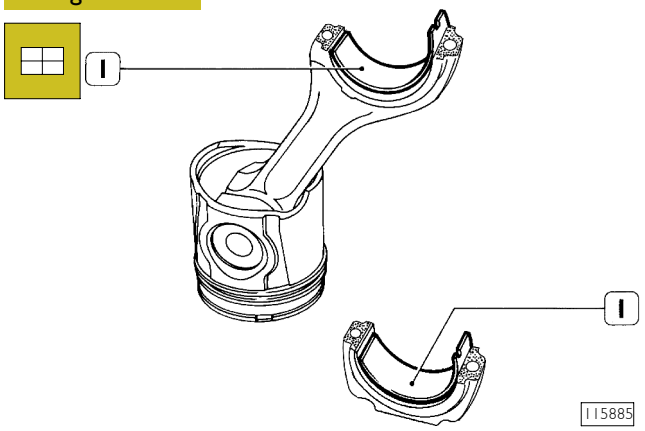
Figure 58



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 59



Fit the half-bearings (1), selected as described on pages 19 to 24, both on the connecting rod and on the stand.

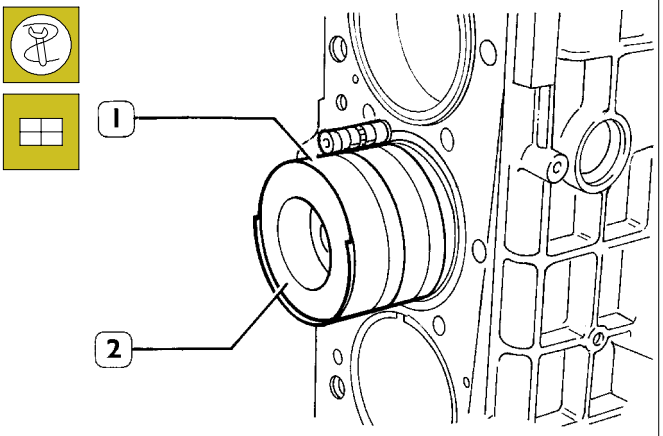
If the cap (1) is fitted upsidedown, the connecting rod should be discarded.

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 61). 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.

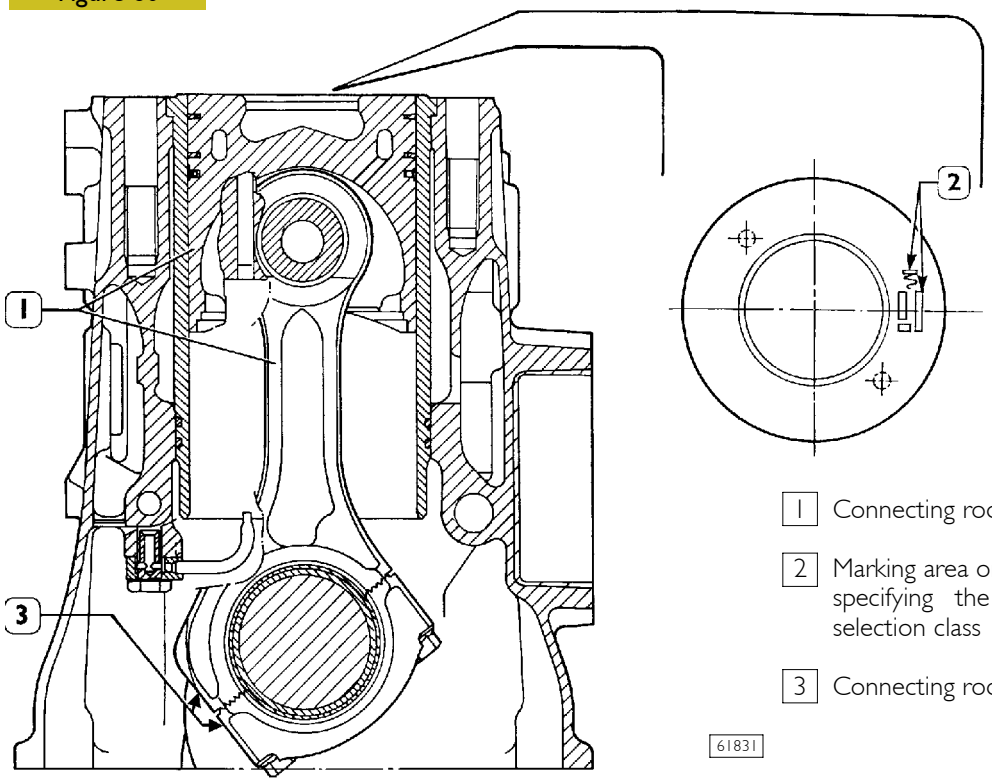
Figure 61



Piston protrusion check

Once assembly is complete, check piston protrusion from cylinder barrels: it must be 0.873 to 1.177 mm.

Figure 60



1 Connecting rod-piston assembly

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

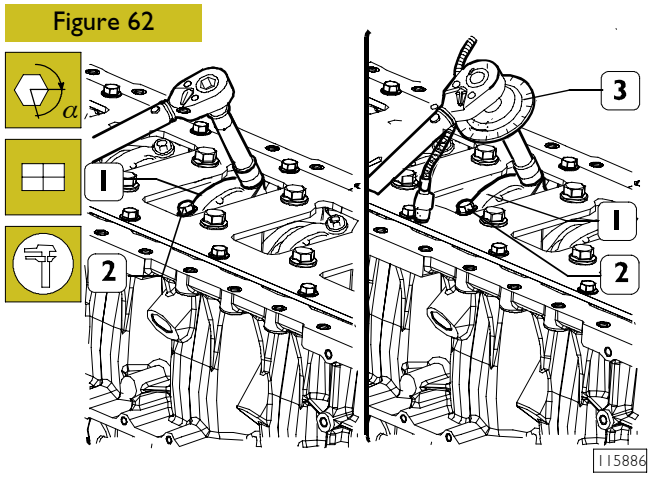
3 Connecting rod marking area (see Figure 53).

540831 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 62



Install the connecting rod caps (1) with half-bearings; tighten the connecting rod cap fixing screws (2) to 50 Nm (5 kgm) torque. By tool 99395216 (3), tighten the screws further at 90° 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.

540610 CYLINDER HEAD

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

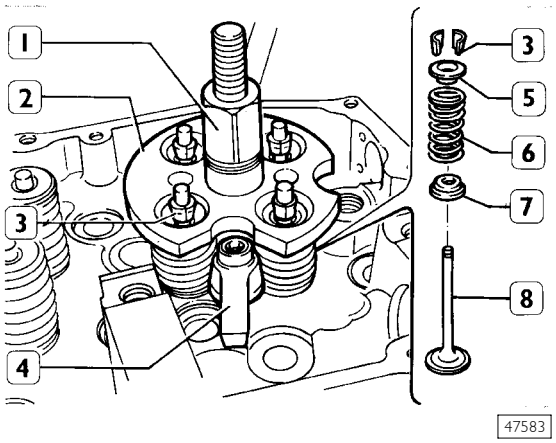
NOTE In case of plugs dismounting/replacement, on mounting, apply sealant Loctite 270 on plugs.

Dismounting the valves

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

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

Figure 63



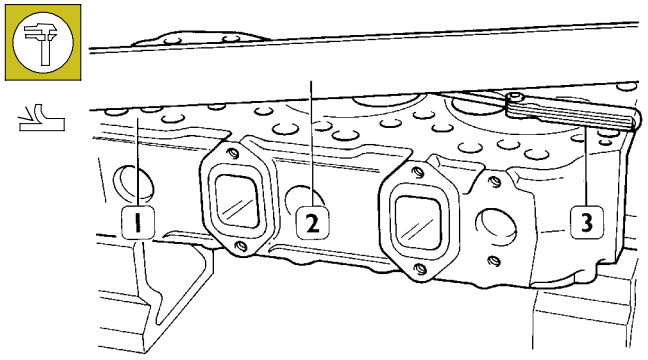
Install and fix tool 99360264 (2) with bracket (4); tighten by lever (1) until cotters are removed (3); remove the tool (2) and the upper plate (5), the spring (6) and the lower plate (7).

Repeat the operation on all the valves.

Turn the cylinder head upside down and remove the valves (8).

Checking the planarity of the head on the cylinder block

Figure 64 (Demonstration)

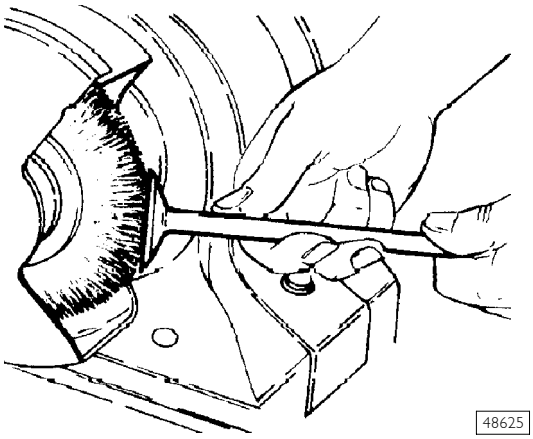


The planarity (1) is checked using a ruler (2) and a thikness gauge (3). If deformations exist, surface the head using proper surface grinder; the maximum amount of material to be removed is 0.2 mm.

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

540622 VALVE
Removing deposits and checking the valves

Figure 65

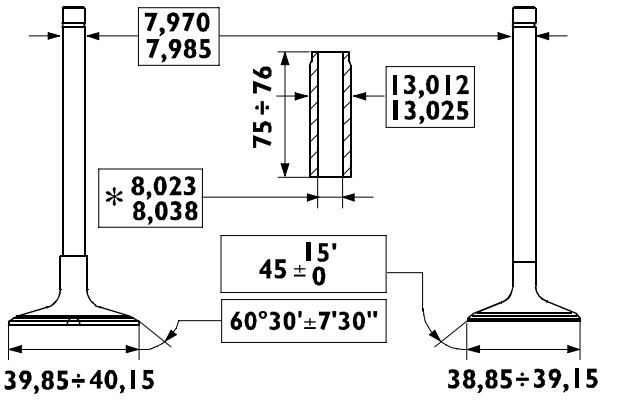


48625

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 66) and replace if necessary.

Figure 66



92841

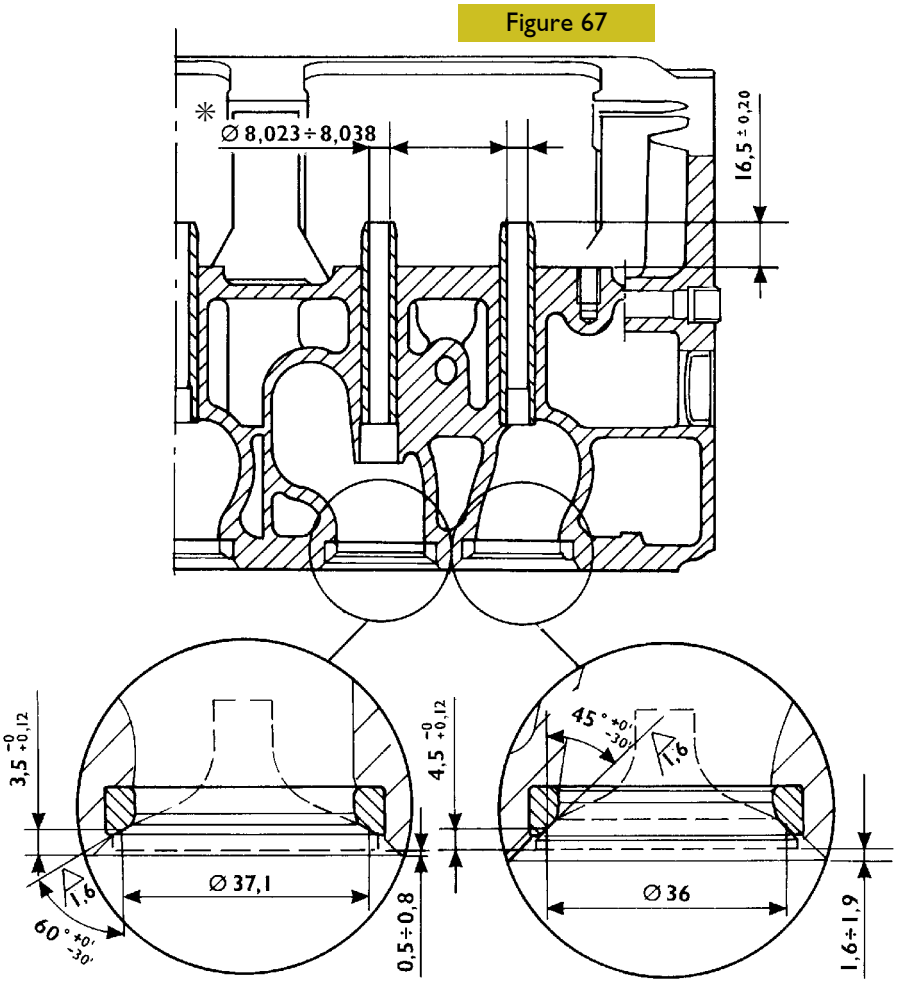
MAIN DATA - VALVES AND VALVE GUIDES

* 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.

540667 VALVE GUIDES

Figure 67



47509

INSTALLATION DIAGRAM FOR VALVE GUIDES AND VALVES

* Values to be obtained after installing the guide valves

Replacing of valve guides

Remove valve guides by means of tool 99360288.

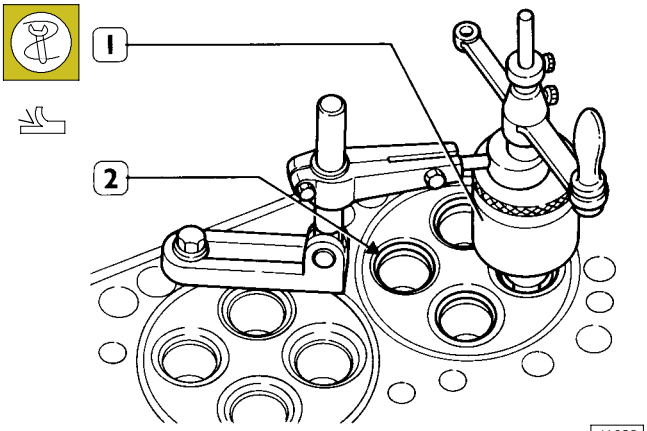
Install by means of tool 99360288 equipped with part 99360294, which determines the exact installation position of valve guides into the cylinder heads; if they are not available, install the valve guides in the cylinder head so that they project out by mm 16.3 to 16.7 (Figure 66).

After installing the valve guides, smooth their holes with sleeker 99390310.

Replacing - Reaming the valve seats

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

Figure 68



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

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

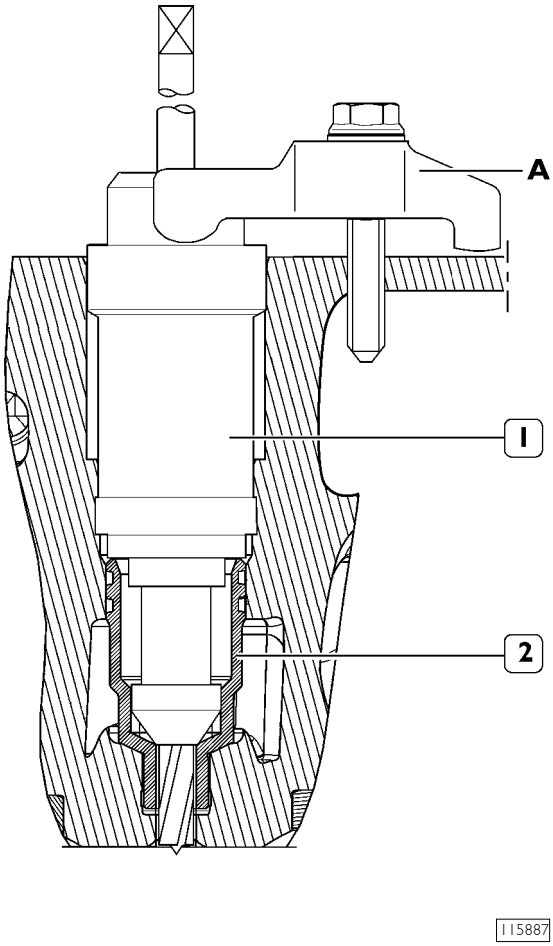
After reaming the valve seats, use tool 99370415, to make sure that the valve position, with respect to the cylinder head surface, is the following:

- ❑ -0.5 to -0.8 mm (recessing) of exhaust valves;
- ❑ -1.6 to 1.9 mm (recessing) of discharge valves.

540613 REPLACING INJECTOR HOLDER CASES

Removal

Figure 69

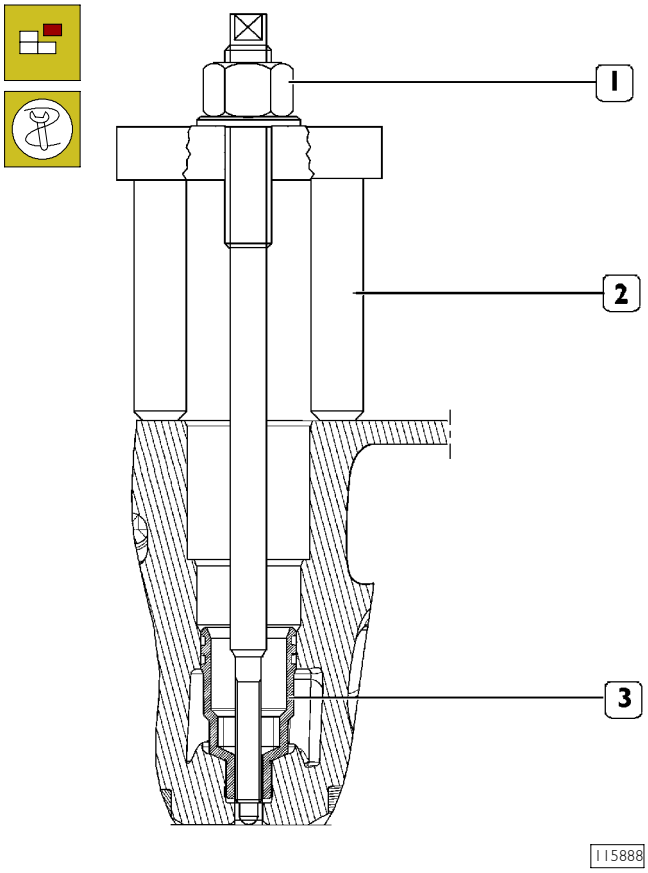


To replace the injector case (2), act as follows:

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

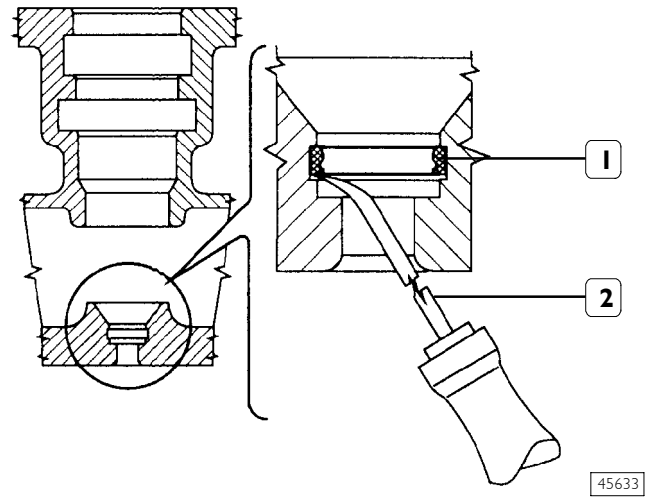
Carry out operations described in the following figs. by fixing tools to the cylinder head by means of braket A.

Figure 70



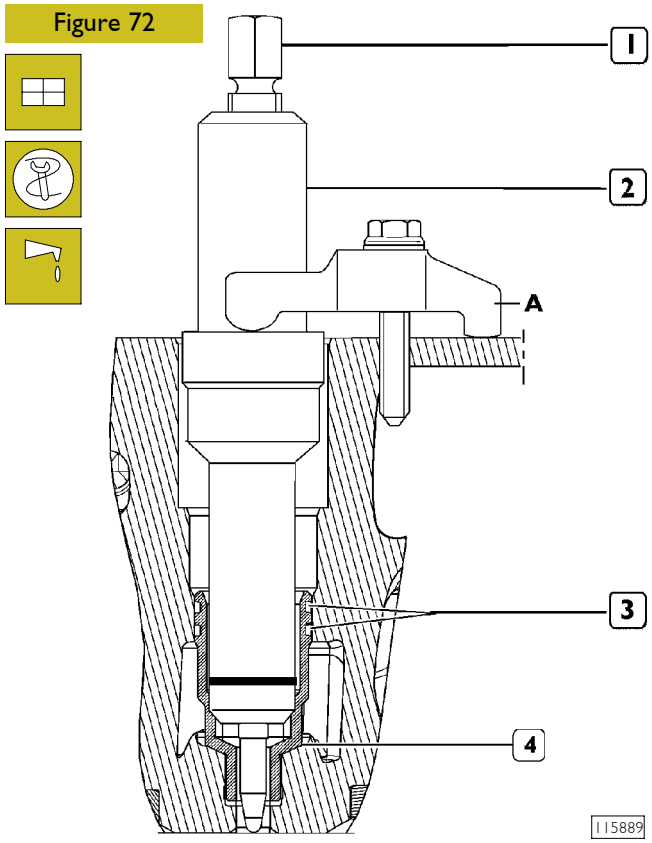
❑ fasten extractor 99342149 (2) to case (3), by tightening the nut (1), and pull out the case from cylinder head.

Figure 71



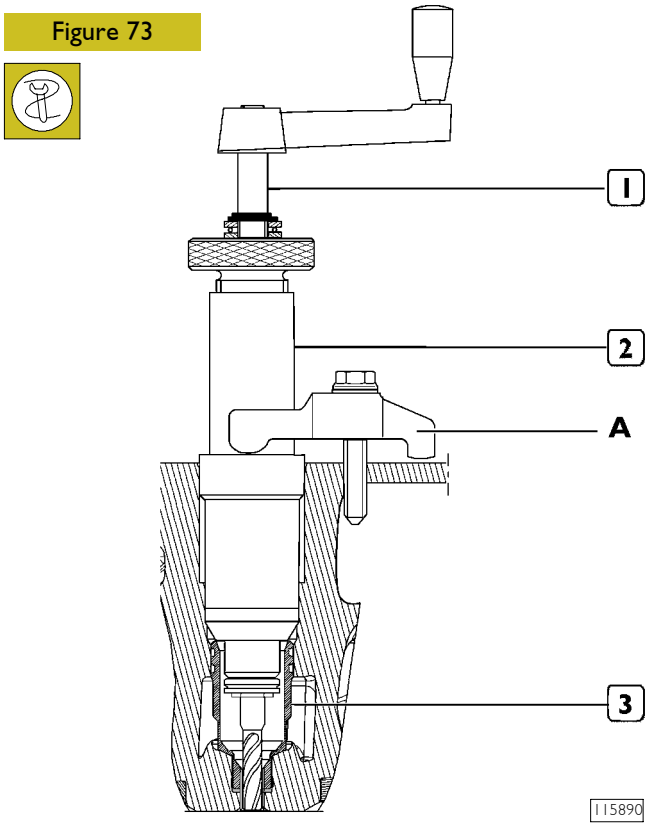
❑ Remove any residue (1), with tool 99390772 (2), from the cylinder head groove.

Figure 72



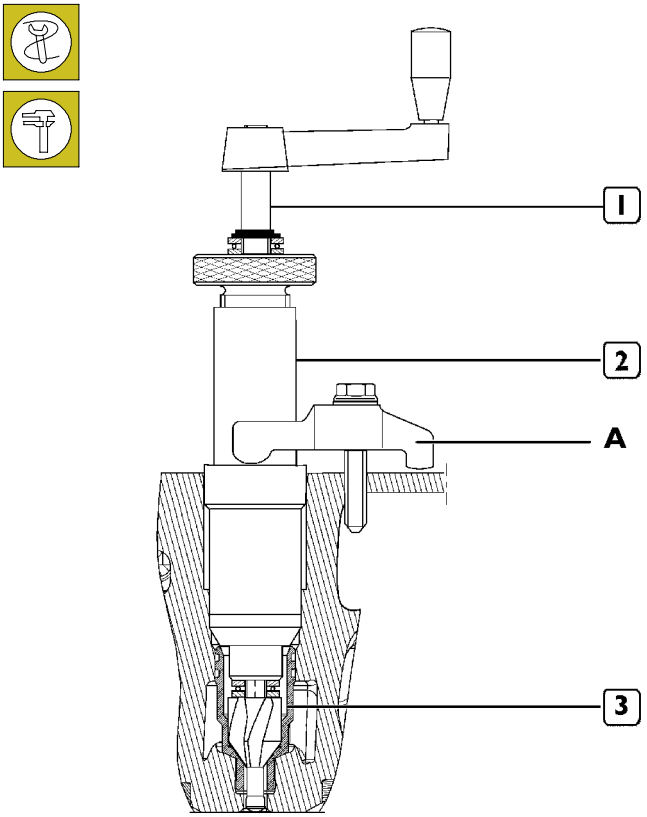
❑ Lubricate sealing rings (3) and fit them to the case (4); fix tool 99360554 (2) to the cylinder head by means of bracket **A**, install the new case, tighten the screw (1), upsetting the case lower part.

Figure 73



❑ Adjust the casing hole (3) with borer 99394043 (1) and guide bushing 99394045 (2).

Figure 74

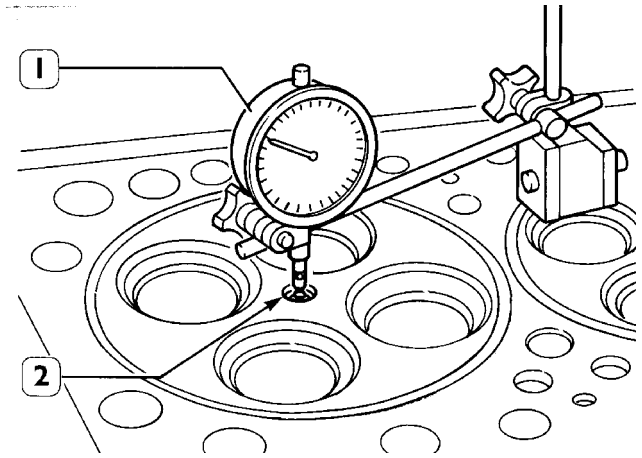


11589I

❑ Through miller 99394044 (1) and bushing 99394045 (2), ream the injector seat in the case (3), check the injector protrusion from the cylinder head plane which must be 1.2 to 1.5 mm.

Checking protrusion of injectors

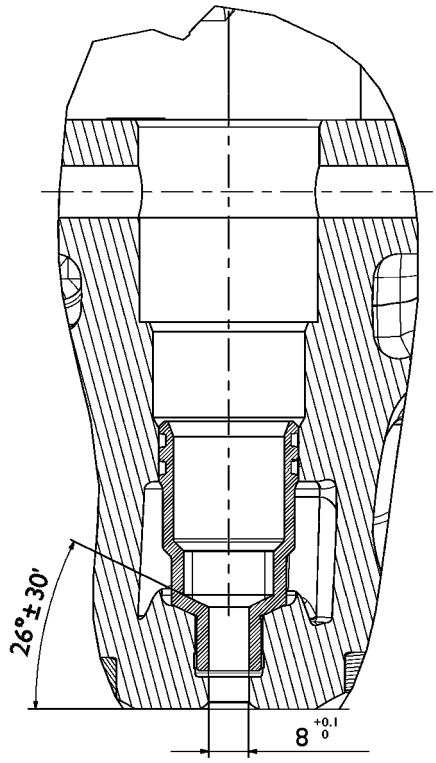
Figure 75



47585

Using dial gauge (1), check the protrusion of the injector (2) which must be 1.2 to 1.5 mm.

Figure 76

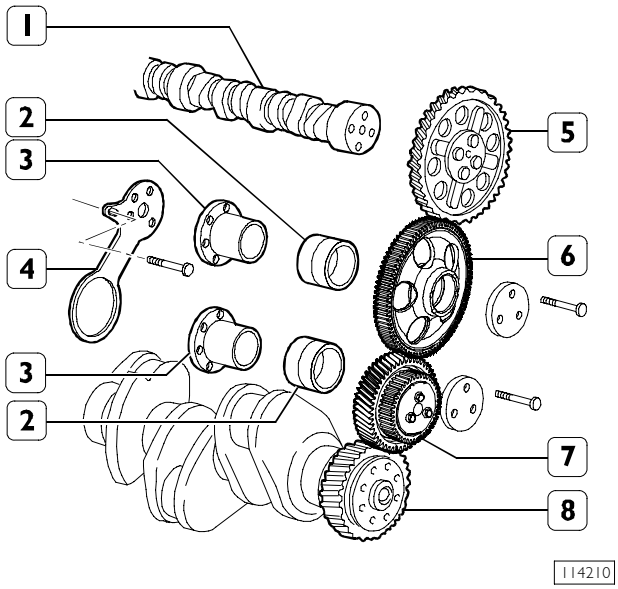


114056

INSTALLATION DIAGRAM FOR INJECTOR CASE

5412 TIMING GEAR
Camshaft drive

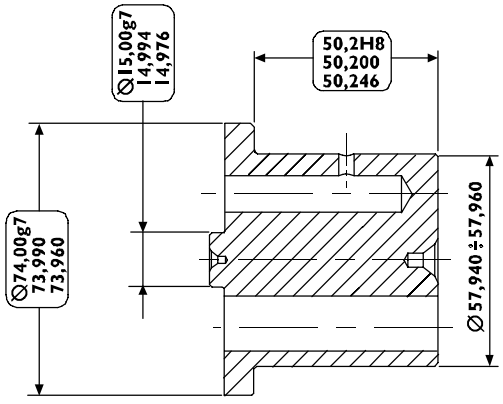
Figure 77



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.

541253 Intermediate gear pin

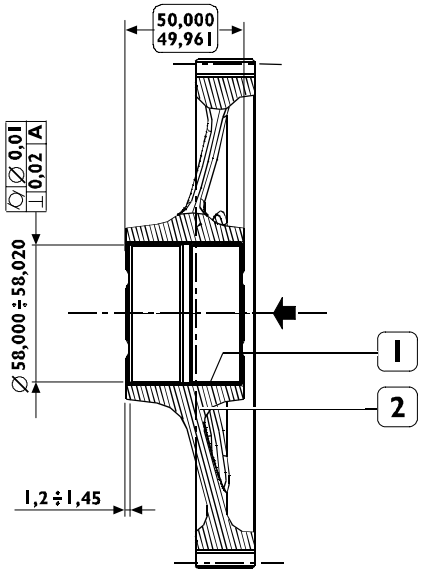
Figure 78



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

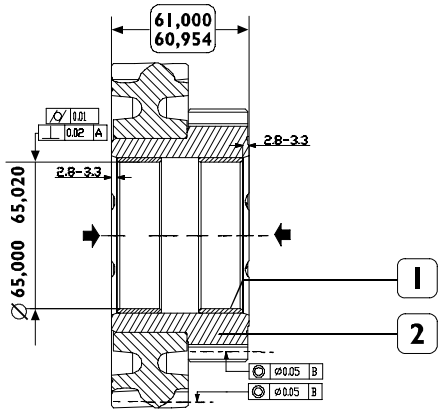
541252 Idler gear

Figure 79



541252 Twin idler gear

Figure 80



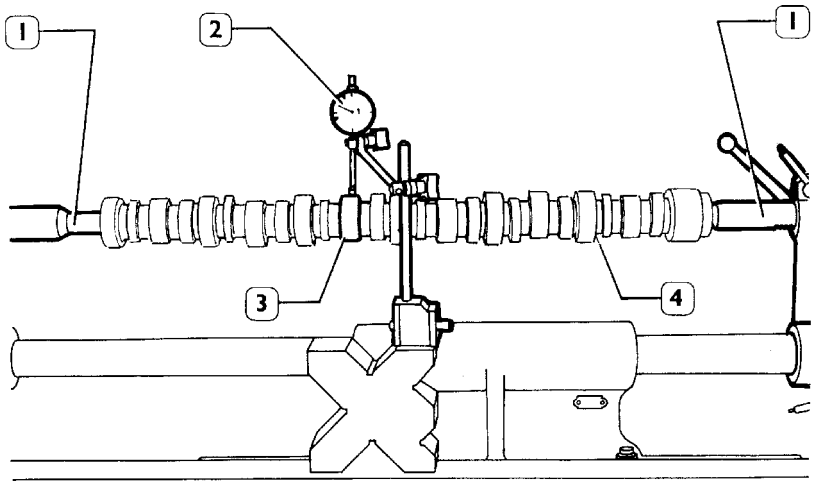
541254 Replacing the bushings

Bushings (1, Figures 78-79) can be replaced when they are worn. Put up the bushing, then grind it so as to bring it to a dimension of Ø 65.010 ± 0.10 mm.

NOTE Bushing fitting in gears (2, Figures 78-79) must be performed in arrow direction, placing them as shown in figures.

541210 Camshaft
541211 Checking cam lift and pin alignment

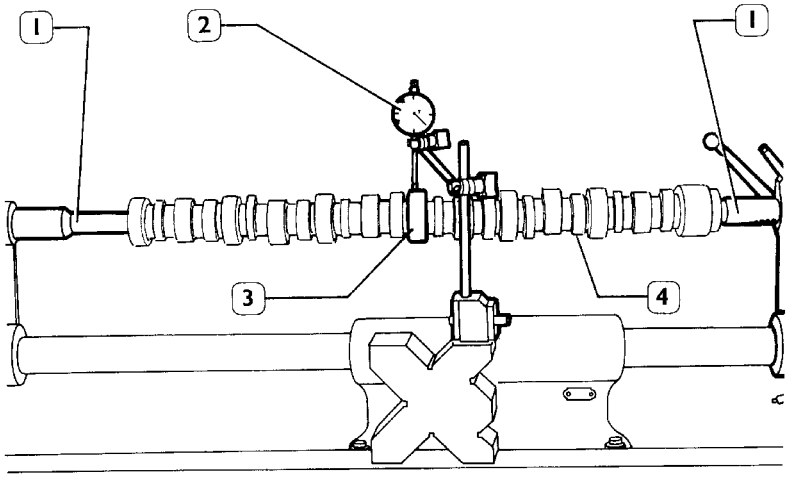
Figure 81



47506

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

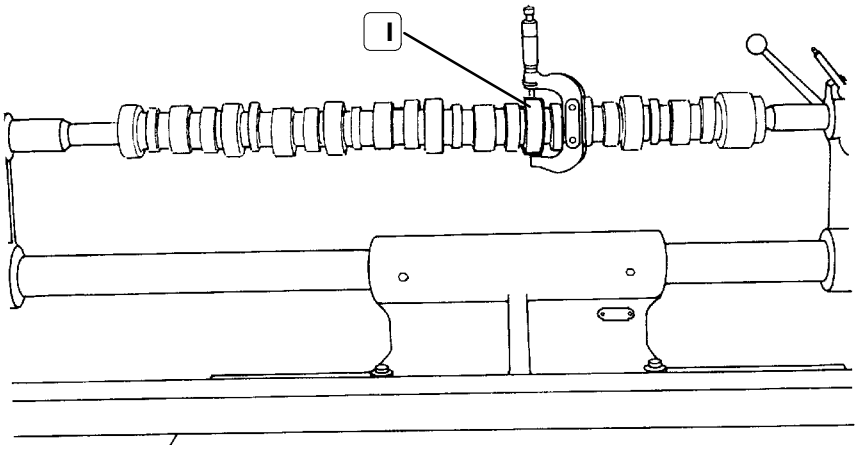
Figure 82



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.

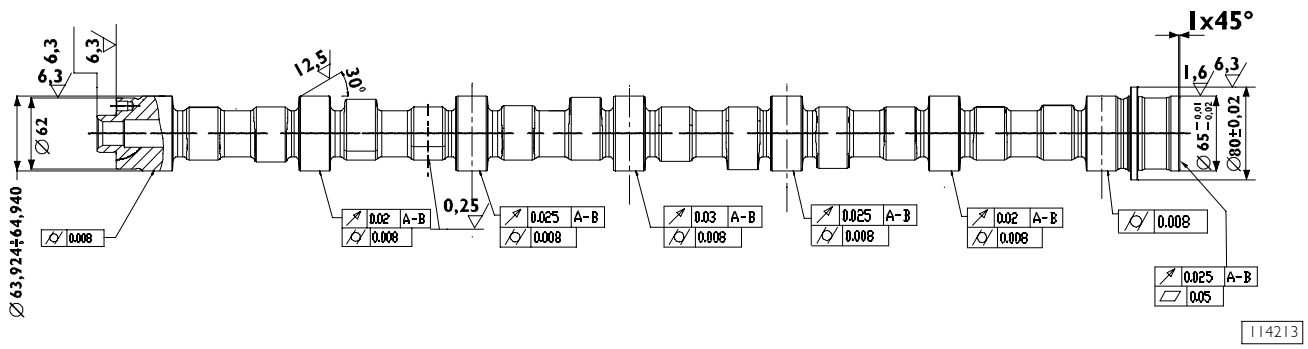
Figure 83



47505

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

Figure 84



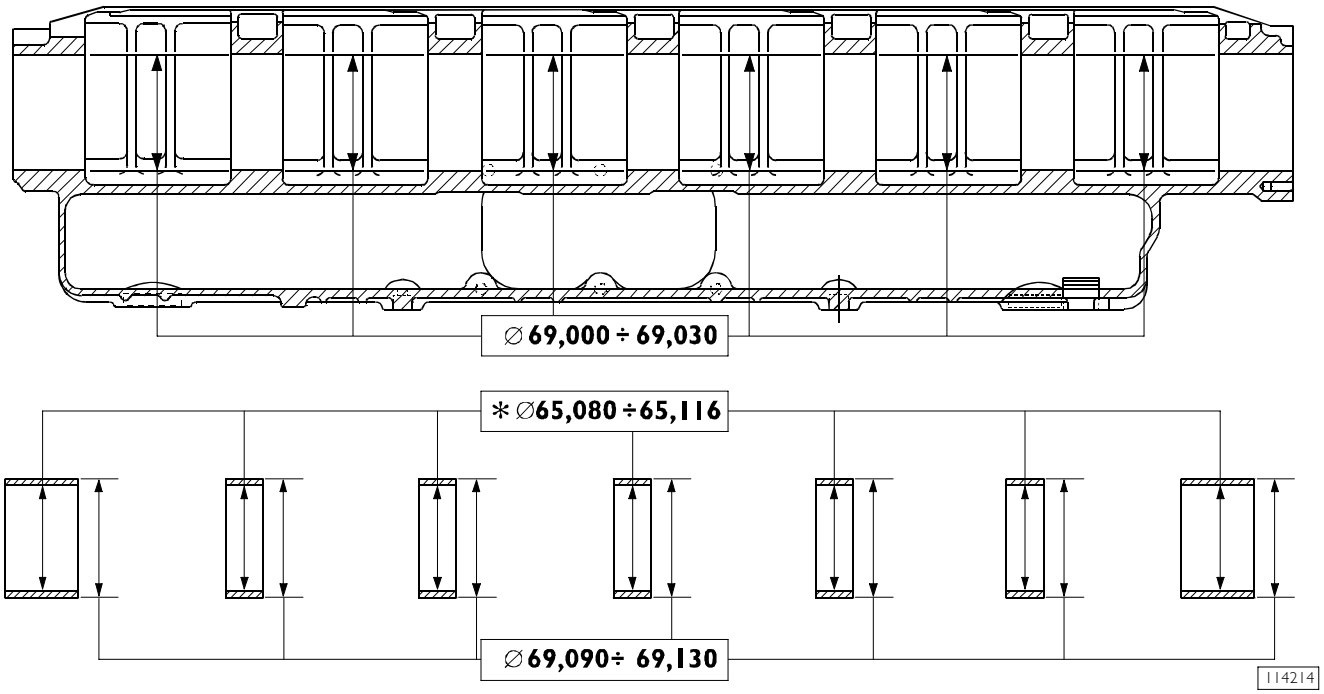
MAIN DATA - CAMSHAFT AND TOLERANCES

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

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

541213 Bushes

Figure 85



MAIN DATA - CAMSHAFT BUSHES AND RELATIVE BLOCK SEATS

* Bush inner diameter after installation

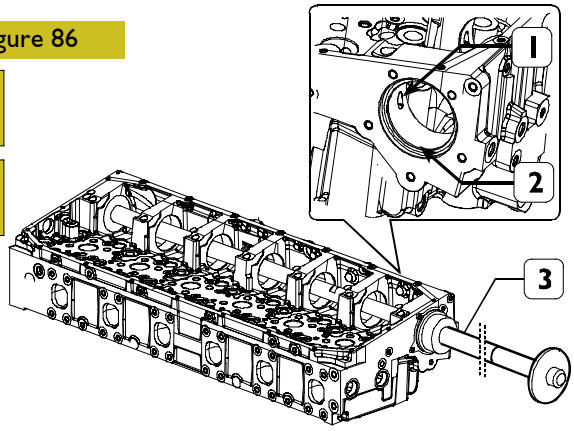
The bush surfaces must not show any sign of seizing or scoring; if they do replace them.

Measure the bush inner diameters with a baremeter and replace them, if the value measured exceeds the tolerance value.
To take down and fit back the bushes, use the proper tool 99360487.

Use beater 99360505 to change bushings

Removal

Figure 86



114280

Use tool 99360505 (3) fitted as shown in fig. to remove bushings (2).

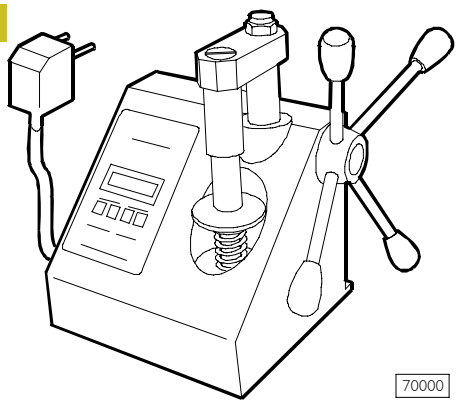
Accurately position beater during removal phase.

Fitting

For fitting, reverse operations performed for removal, with care to make lube hole (1), drilled on bushing, coincide with corresponding hole in housing.

540665 VALVE SPRINGS

Figure 87

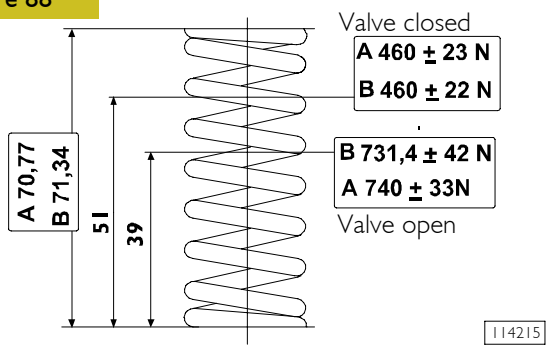


70000

Before fitting, check valve spring flexibility using specific tool.

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

Figure 88

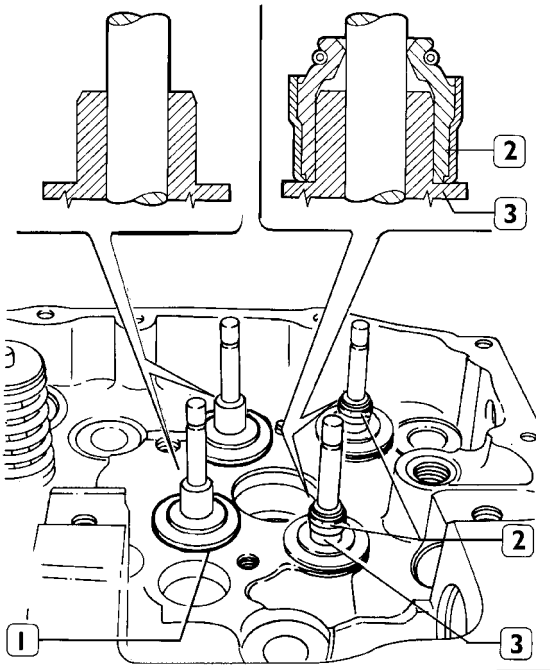


114215

MAIN DATA TO CONTROL EXHAUST AND DISCHARGE VALVE SPRING

Fitting the valves and oil seal ring

Figure 89



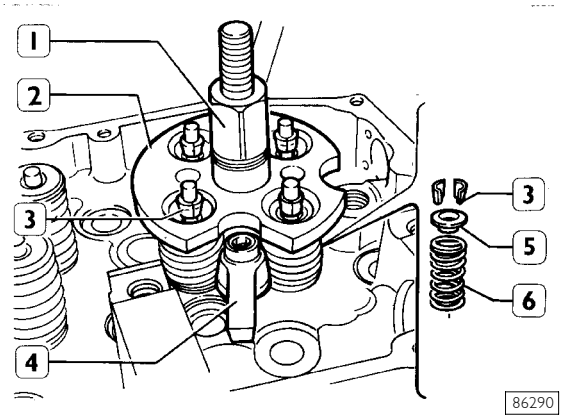
87051

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

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

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

Figure 90

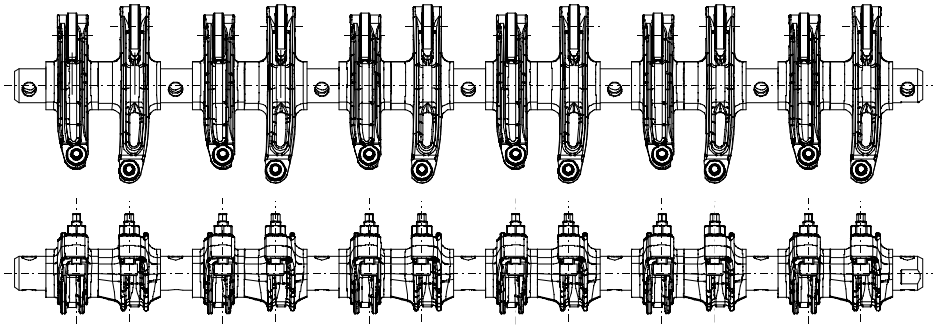


86290

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

5412 ROCKER SHAFT

Figure 91

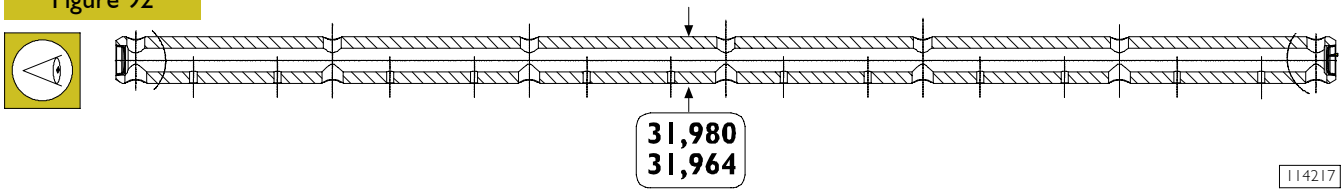


114216

The camshaft eccentric elements control the 12 valve rocker arms directly. Valve control rocker arms are fitted directly on rocker arm shaft. Rocker arms slide directly on cam profiles by rollers. The other end operates on a crosspiece laid directly on the two valve rods. A pad is placed between rocker arm adjustment screw and crosspiece. Two lube ducts are machined inside rocker a rms. Rocker arms shaft runs through the cylinder head; it must be removed to reach all units below.

Shaft

Figure 92



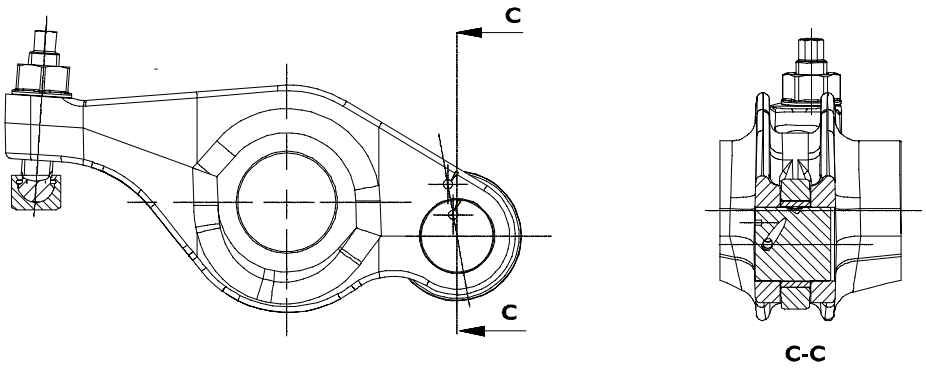
114217

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

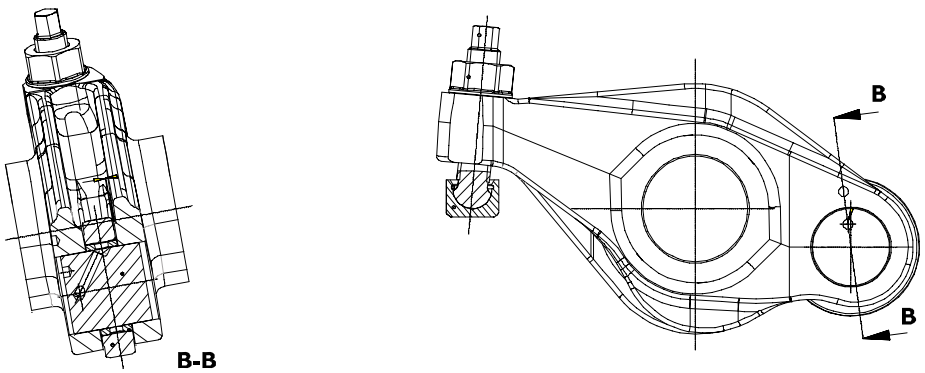
Figure 93



114219

DISCHARGE VALVE ROCKER

Figure 94



114218

EXHAUST VALVES ROCKER

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

TIGHTENING TORQUES

PART			TORQUE Nm	TORQUE kgm
Pipe union for piston cooling nozzle		M12X1.5	35 ± 2	3.5 ± 0.2
Heat exchanger retaining screws			63 ± 7	6.3 ± 0.7
Plug			125 ± 15	12.5 ± 1.5
Spacer and oil sump fastening screws				
		M10	41.5 ± 3.5	4.1 ± 0.3
Gearcase fastening screws to cylinder block:				
		M10x1.25	41.5 ± 3.5	4.1 ± 0.3
		M12x1.75	63 ± 7	6.3 ± 0.7
		M8x1.25	23.5 ± 1.5	2.3 ± 1.5
Cylinder head fastening screw ♦				
First stage	pre-tightening		50	5
Second stage	pre-tightening		100	10
Third stage	angle closing		90°	
Fourth stage	angle closing		75°	
Rocker arm shaft fastening screw			104,5 ± 10,5	10,4 ± 1
			104.5 ± 10.5	10.4 ± 1
Locknut for rocker arm adjusting screw ♦			39 ± 5	3.9 ± 5
Electroinjector retaining bracket screws ♦				
		M10	41.5 ± 3.5	4.1 ± 0.3
Shoulder plate fastening screws to head ♦			20 ± 2	2 ± 0.2
Engine support bracket fastening screws to cylinder head			74 ± 8	7.4 ± 0.8
Gear fastening screws to camshaft •				
First stage	pre-tightening		25	2.5
Second stage	pre-tightening		45°	
Phonic wheel fastening screws to distribution gear			8.5 ± 1.5	0.8 ± 0.1
Exhaust pipe fastening screws •				
pre-tightening			40 ± 5	4 ± 0.5
tightening			70 ± 5	7 ± 0.5
Connecting rod cap fastening screws: ♦				
First stage	pre-tightening		50	5
Second stage	pre-tightening		90°	
Engine flywheel fastening screws ♦		M18x1.5x72		
First stage	pre-tightening		120	12
Second stage	pre-tightening		90°	
Flywheel pulley fastening screws to crankshaft ♦				
First stage	pre-tightening		70	7
Second stage	pre-tightening		50°	
Main journal retaining screws ♦				
First stage	pre-tightening		140	14
Second stage	pre-tightening		60° + 60°	

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

PART		TORQUE	
		Nm	kgm
Damper flywheel fastening screws ♦		115 ± 15	11.5 ± 1.5
Idler gear pin fastening screws ♦			
First stage	pre-tightening	30	3
Second stage	angle closing	90°	
Idle gear link rod fastening screw		24.5 ± 2.5	2.4 ± 0.2
Oil pump fastening screw		24.5 ± 2.5	2.4 ± 0.2
Oil pump suction rose fastening screw		24.5 ± 2.5	2.4 ± 0.2
Front cover fastening screw to cylinder block		19 ± 3	1.9 ± 0.3
Control unit fastening screw to cylinder block		19 ± 3	1.9 ± 0.3
Fuel filter support fastening screw to cylinder head ♦		24.5 ± 2.5	2.4 ± 0.2
Screw securing the engine support to the wheelcase ♦			
First stage	pre-tightening	100	10
Second stage	angle closing	60°	
Turbo-compressor fastening screws and nuts •			
pre-tightening		35 ± 5	3.5 ± 0.5
tightening		46 ± 2	4.6 ± 0.2
Water pump fastening screw to cylinder block		24.5 ± 2.5	2.4 ± 0.2
Pulley fastening screw to hub		55 ± 5	5.5 ± 0.5
Rocker arm cover fastening screws		8.5 ± 1.5	0.8 ± 0.1
Thermostat box fastening screws to cylinder head		24.5 ± 2.5	2.4 ± 0.2
Automatic tightener fastening screws to cylinder block		45 ± 5	4.5 ± 0.5
Fixed tightener fastening screws to cylinder block		105 ± 5	10.5 ± 0.5
Fan support fastening screws to cylinder block		24.5 ± 2.5	2.4 ± 0.2
Starter fastening screws		44 ± 4	4 ± 0.4
Air heater on cylinder head		30 ± 3	5 ± 0.5
Hydraulic power steering pump gear fastening nut		105 ± 5	10.5 ± 0.5
Air conditioner compressor fastening screw to support		24.5 ± 2.5	2.4 ± 2.5
Alternator support superior fastening screw		71.5 ± 4.5	7.1 ± 0.4
Alternator bracket fastening screw to cylinder block		24.5 ± 2.5	2.4 ± 0.2
Water pipe unions		35	3.5
Water temperature sensor		32.5 ± 2.5	3.2 ± 0.2

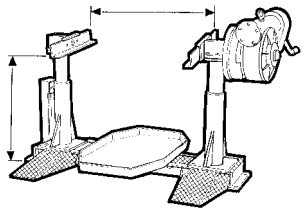
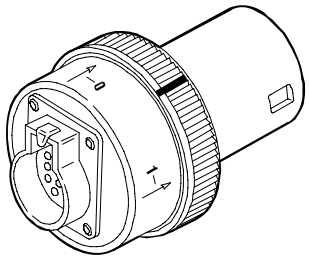
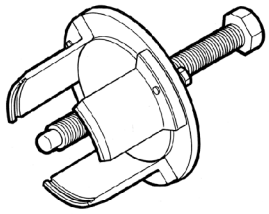
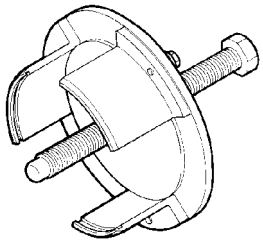
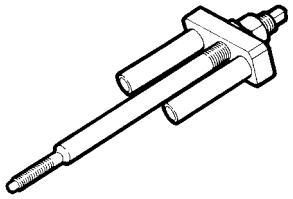
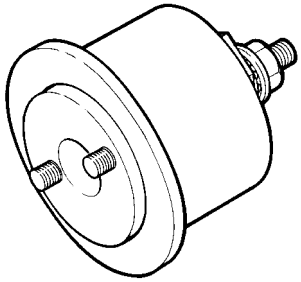
♦ Lubricate with oil MOLYKOTE before assembly
• Lubricate with graphitized oil before assembly

PART			TORQUE	
			Nm	kgm
Flywheel rev sensor fastening screw			8 ± 4	
Camshaft rev sensor fastening screw			8 ± 4	
P.D.E solenoid connector fastening screw				
Overboost pressure sensor fastening screw			8 ± 2	
Absolute pressure sensor fastening screw				
P.W.M. control valve fastening screw/nut			8 ± 2	
Fuel/coolant temperature sensor			35	3.5
Coolant temperature indicator				
Filter clogging sensor			10	1
Oil temperature switch			25 ± 1	
Oil pressure sensor			25 ± 1	
Electric wire fastening screw			8 ± 2	
Gear fastening screws to camshaft •				
First stage	pre-tightening		40	
Second stage	pre-tightening		30°	
Gear fastening screws to camshaft •				
First stage	pre-tightening		60	
Second stage	pre-tightening		45°	
Heater fastening screw				
Gear fastening screws to camshaft •				
First stage	pre-tightening		25	
Second stage	pre-tightening		9° ± 1°	
Gear fastening screws to camshaft •				
First stage	pre-tightening		25	
Second stage	pre-tightening		15° ± 1°	
Alternator positive retaining nut		M8x1,25		
Starter terminal nut 30		M10x1,5		
Starter terminal nut 50		M5x0,8		

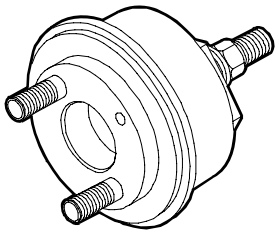
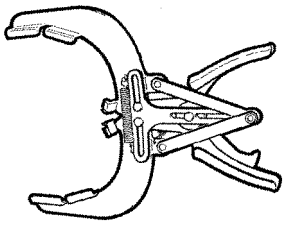
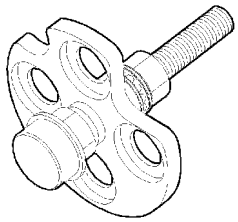
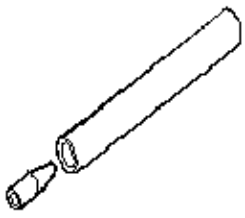
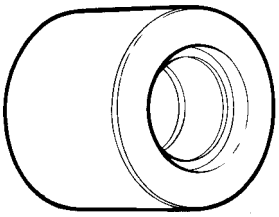
SECTION 5

Tools

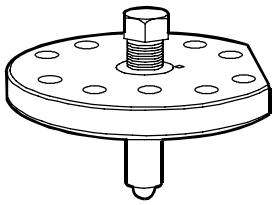
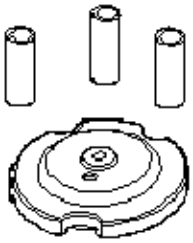
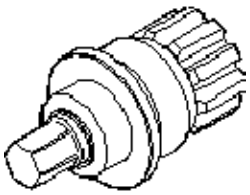
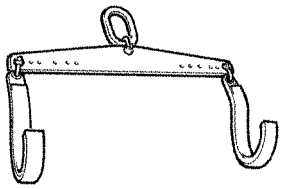
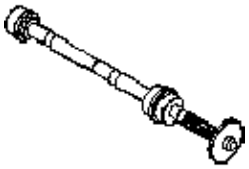
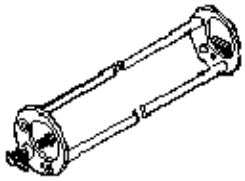
TOOLS

TOOL NO.		DESCRIPTION
99322230		Rotary telescopic stand (range 2000 daN, torque 375 daNm)
99331043		Tool to rotate engine flywheel (to be used with 99360325)
99340051		Extractor for crankshaft front gasket
99340054		Extractor for crankshaft rear gasket
99342149		Extractor for injector-holder
99346245		Tool to install the crankshaft front gasket

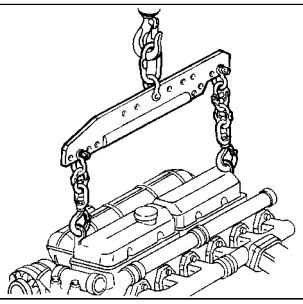
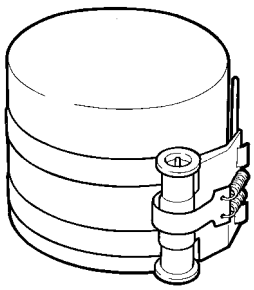
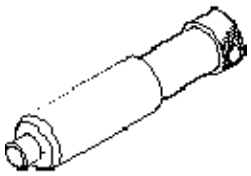
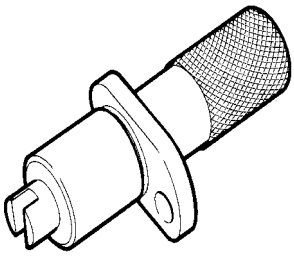
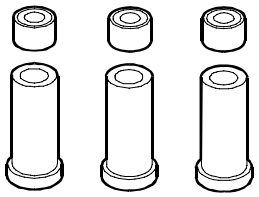
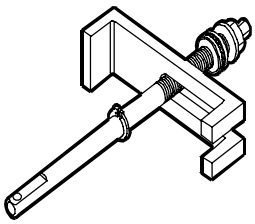
TOOLS

TOOL NO.		DESCRIPTION
99346260		Percussion extractor
99360184		Pliers for assembling and disassembling piston split rings (105-106 mm)
99360264		Universal extractor for 5 to 70 mm internal components
99360288		Box wrench for block junction bolts to the underblock
99360292		Box wrench for block junction bolts to the underblock
99360294		Tool to fit back valve guide (to be used with 99360481)

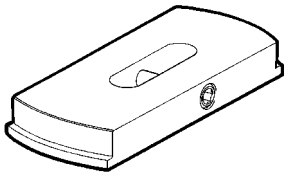
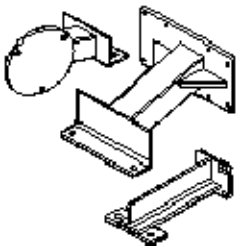
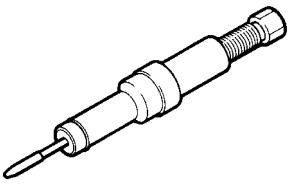
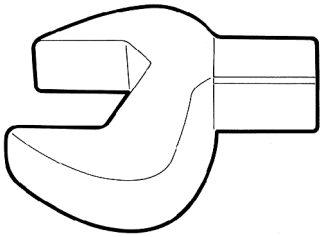
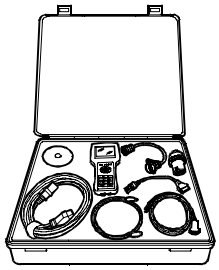
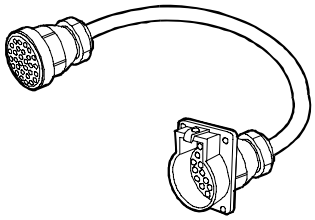
TOOLS

TOOL NO.		DESCRIPTION
99360334		Compression tool for checking the protrusion of cylinder liners (to be used with 99370415-99395603 and special plates)
99360335		Cylinder liner compression plate (to be used with 99360334-99360336)
99360341		Cylinder liner compression plate (to be used with 99360334-99360336)
99360500		Tool to lift crankshaft
99360505		Tool to lift crankshaft
99360558		Percussion extractor

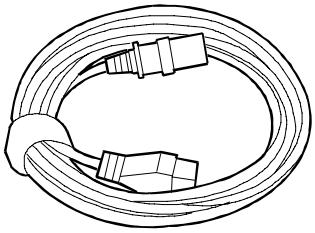
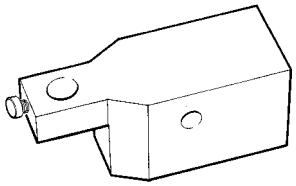
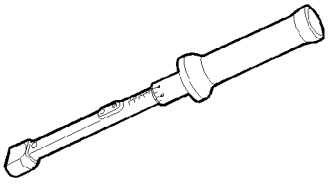
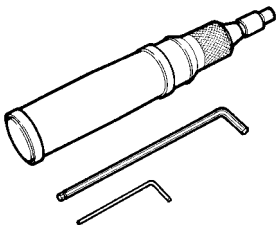
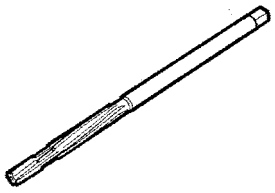
TOOLS

TOOL NO.		DESCRIPTION
99360585		Swing hoist for engine disassembly assembly
99360605		Belt to insert piston in cylinder liner (60 - 125 mm)
99360612		Tool for positioning engine P.M.S.
99360613		Tool for timing of phonic wheel on timing gear
99360703		Tool to stop cylinder liners
99360706		Tool to extract cylinder liners (to be used with specific rings)

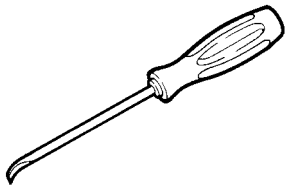
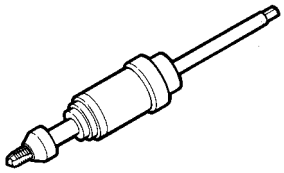
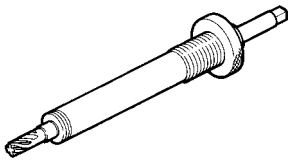
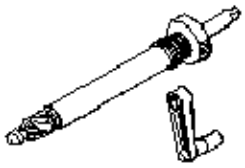
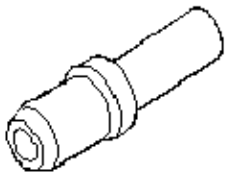
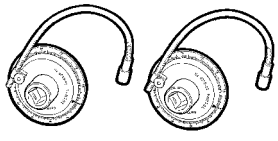
TOOLS

TOOL NO.		DESCRIPTION
99360724		Ring (135 mm) (to be used with 99360706)
99361042		Tool to take down-fit engine valves (to be used with special plates)
99365054		Tool for injector holder heading
99368542		Tool to take down-fit engine valves (to be used with special plates)
99368554		Tool to take down-fit engine valves (to be used with special plates)
99368555		Tool to take down-fit engine valves (to be used with special plates)

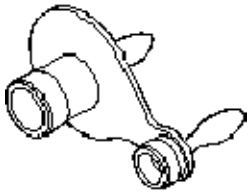
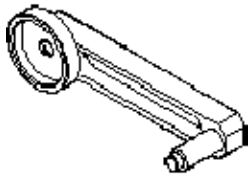
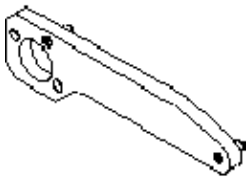
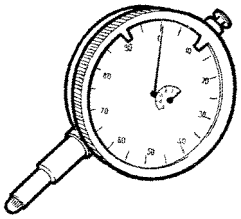
TOOLS

TOOL NO.		DESCRIPTION
99368556		Tool to take down-fit engine valves (to be used with special plates)
99368558		Tool to take down-fit engine valves (to be used with special plates)
99370415		Base supporting the dial gauge for checking cylinder liner protrusion (to be used with 99395603)
99389833		Base supporting the dial gauge for checking cylinder liner protrusion (to be used with 99395603)
99389834		Torque screwdriver (1-6 Nm) for calibrating the injector solenoid valve connector check nut
99390310		Valve guide sleeker

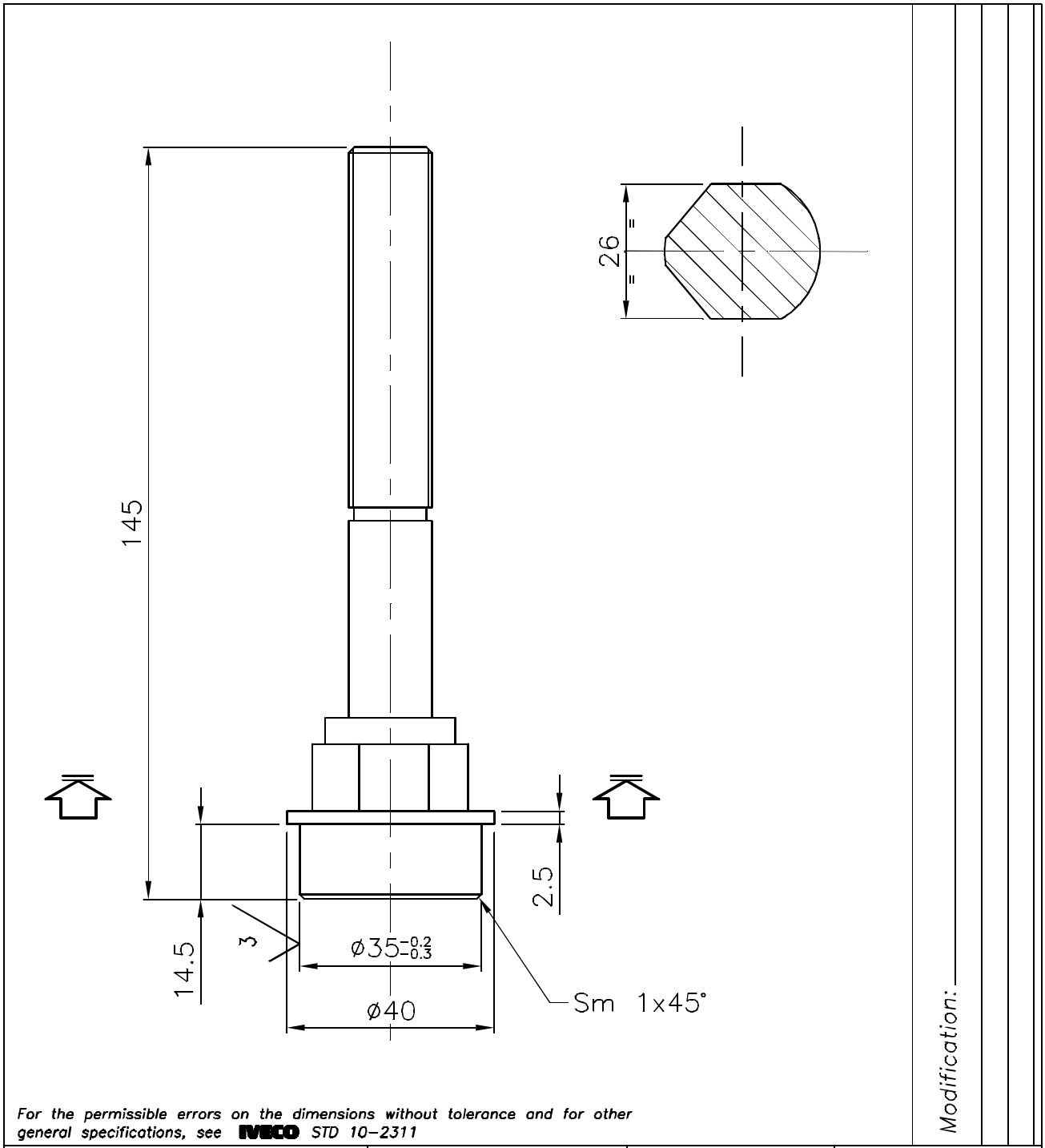
TOOLS

TOOL NO.		DESCRIPTION
99390772		Tool for removing injector holding case deposits
99390804		Tool for threading injector holding cases to be extracted (to be used with 99390805)
99394043		Reamer to rectify injector holder lower side (to be used with 99394015)
99394044		Reamer to rectify injector holder lower side (to be used with 99394015)
99394045		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

TOOLS

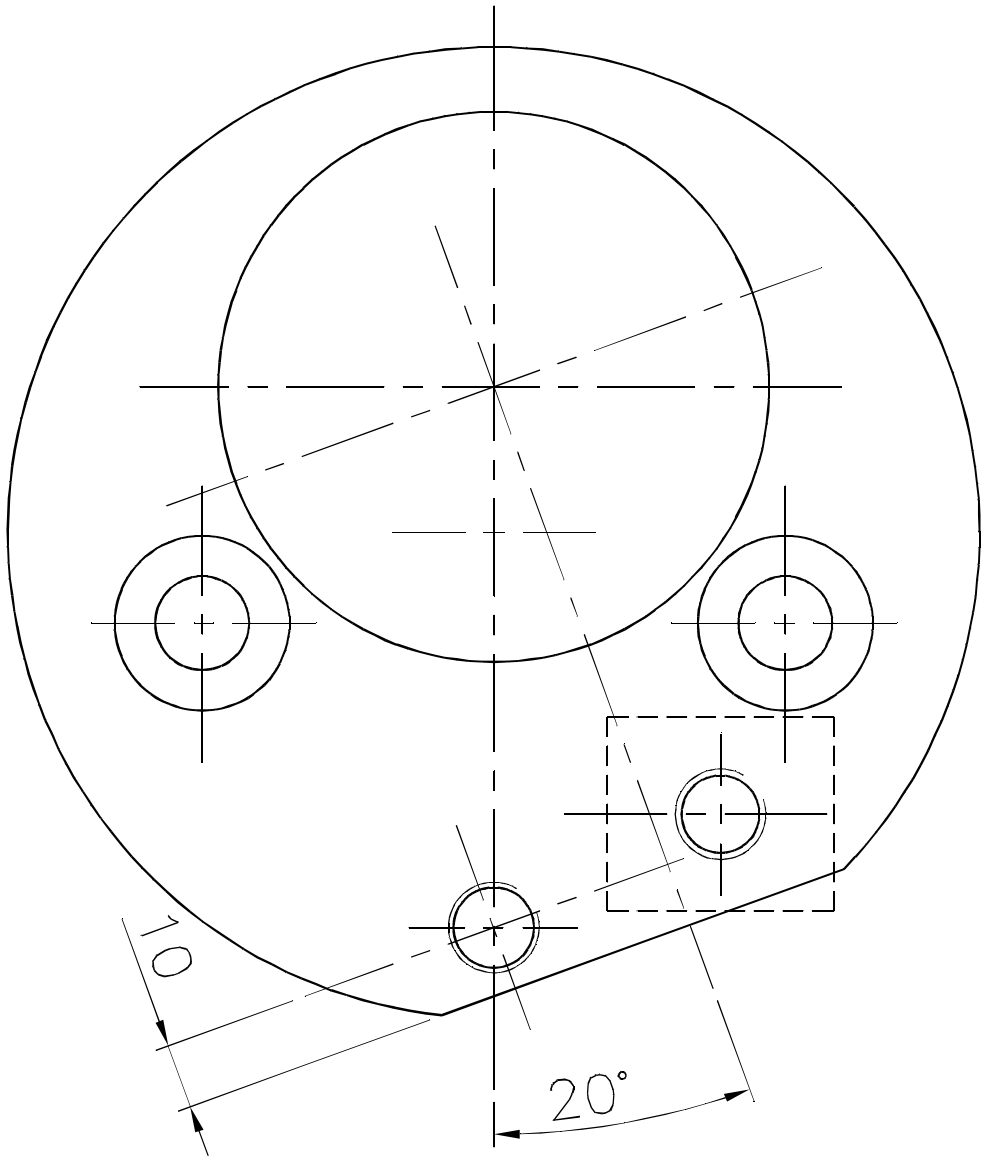
TOOL NO.		DESCRIPTION
99395221		Tool to take down-fit engine valves (to be used with special plates)
99395222		Plate for take down-fit engine valves (to be used with 99360261)
99395223		Tool to remove oil filter (engine)
99395603		Dial gauge (0 - 5 mm)

EQUIPMENT MODIFIED FOR ADAPTATION TO CURSOR 9 ENGINE



For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO *STD 10-2311*

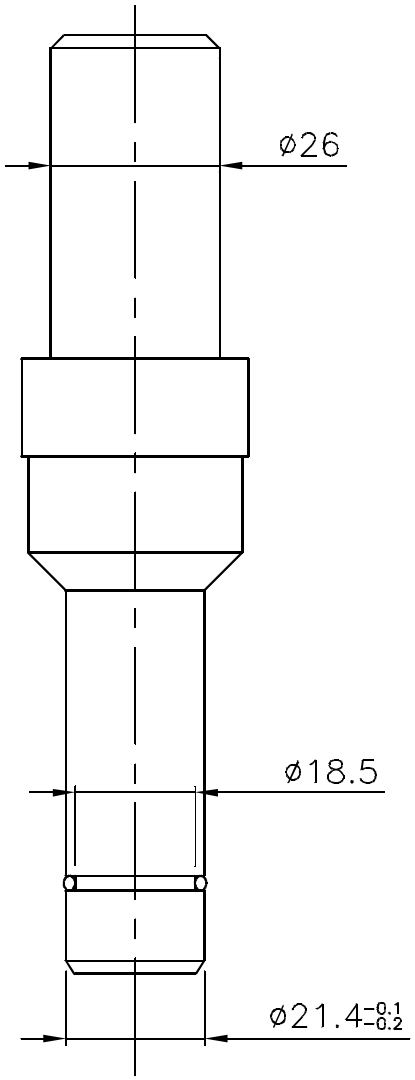
MAT.	COVER.	DRAWN UTS /	N°DRAWING 99360264
	Modifica per adeguamento	APPROVED	EXPER. / SIZE A4
	attrezzo a motore	DATE	SHEET
	CURSOR 9	SUPERSEDES	
C/=0 I.S. 18-0011		SCALE 1:1	IVECO
		Q.TY 1	02



Modification:

For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO *STD 10-2311*

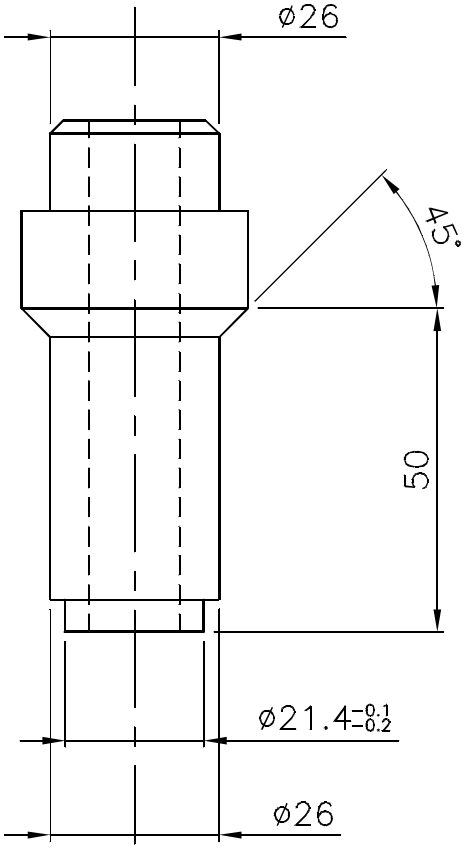
MAT.	COVER.	DRAWN UTS /	N°DRAWING 99360558	
	Modifica per adeguamento	APPROVED	EXPER.	SIZE A4
	attrezzo a motore	DATE	SHEET	
	CURSOR 9	SUPERSEDES		
C/=0 I.S. 18-0011		SCALE 1:1	IVECO	
		Q.TY 1		02



Modification:

For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO *STD 10-2311*

MAT.	COVER.	DRAWN UTS /	N°DRAWING 99365054	
		APPROVED	EXPER.	SIZE A4
Modifica per adeguamento		DATE	SHEET	
attrezzo a motore		SUPERSEDES		
CURSOR 9		SCALE 1:1	IVECO	
C/=0 I.S. 18-0011		Q.TY 1		02



Modification:

For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO *STD 10-2311*

MAT.	COVER.	DRAWN UTS /	N°DRAWING 99390804	
		APPROVED	EXPER.	SIZE A4
Modifica per adeguamento		DATE	SHEET	
attrezzo a motore		SUPERSEDES		
CURSOR 9		SCALE 1:1	IVECO	
C/=0 I.S. 18-0011		Q.TY 1		02

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.

Part 2
G-DRIVE CURSOR ENGINES

PREFACE TO USER'S GUIDELINE MANUAL

Section 1 describes engines F2C in their characteristics and general operation.

Section 2 is specific of use.

NOTE Part no. 2 is characterized by describing a particular industrial/agricultural application: G-Drive motors.

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

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

UPDATING

Section	Description	Page	Date of revision

SECTION 1

General specifications

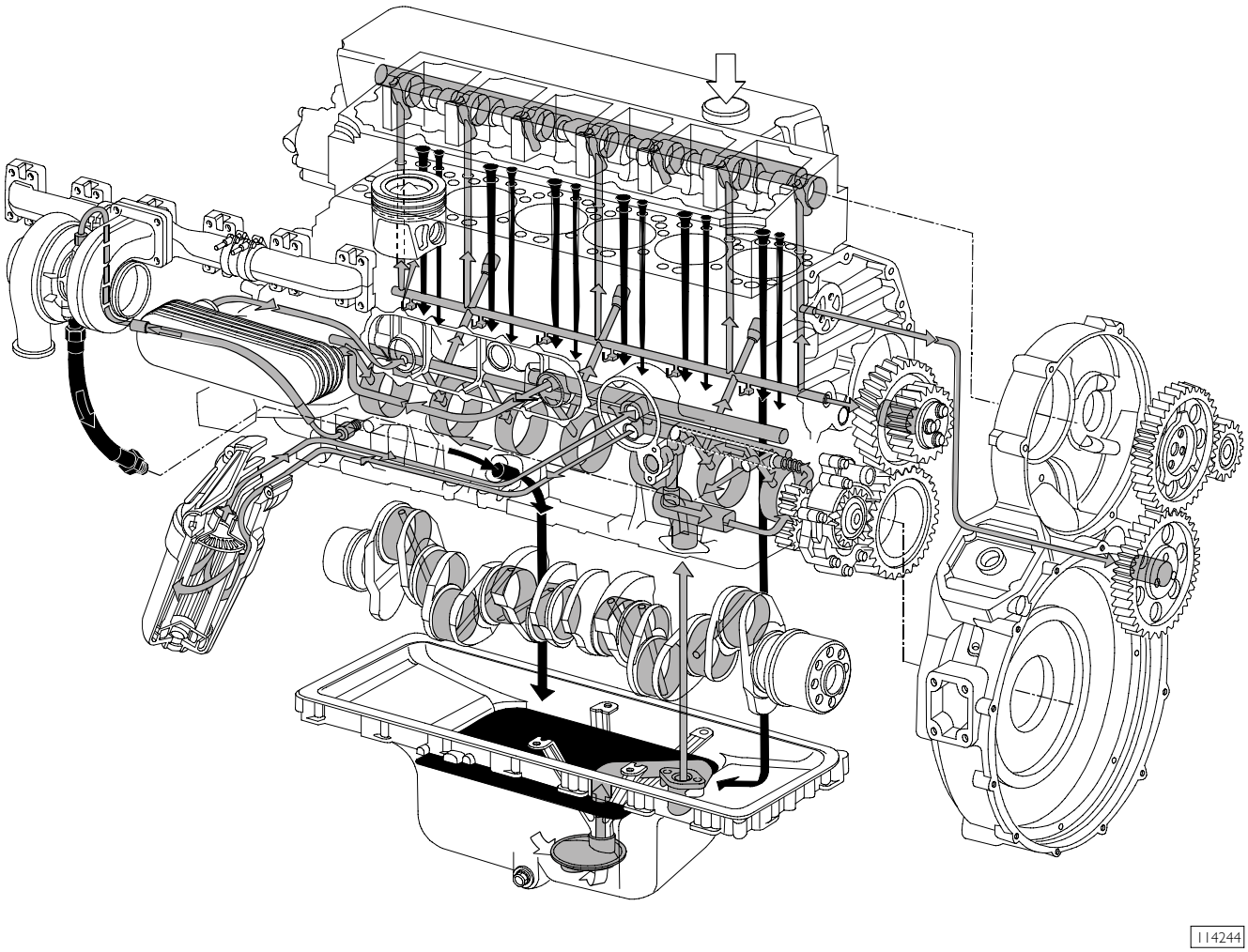
CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F2CE9685A*E001	CURSOR 87TE X
F2CE0685B*E002	

LUBRICATION

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

Figure 1 (Demonstration)



LUBRICATION DIAGRAM

COOLING

Description

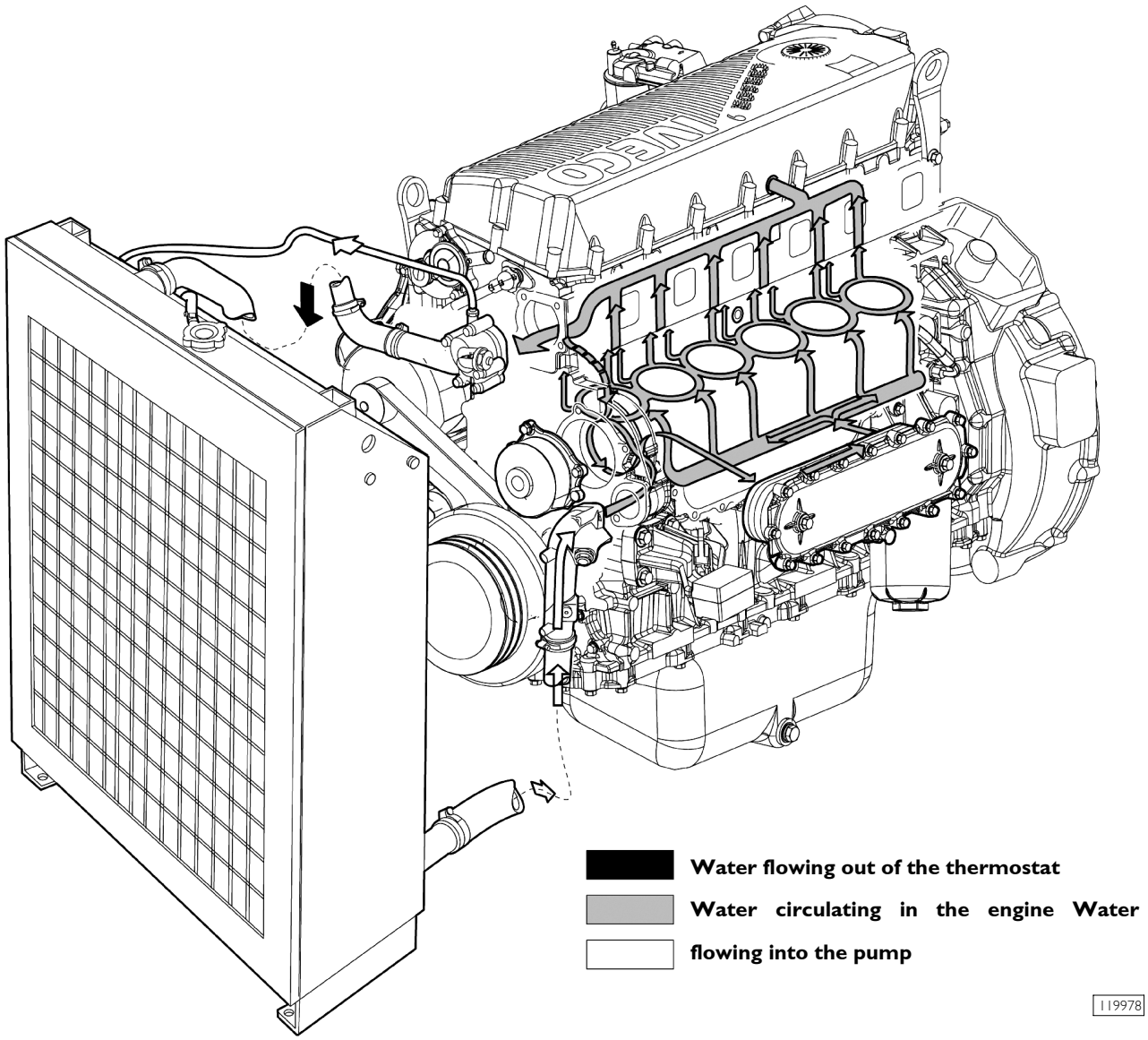
The engine cooling system is of the closed-circuit, forced circulation type.
It consists mainly of the following components:

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

Operation

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

Figure 2



COOLING SYSTEM DIAGRAM

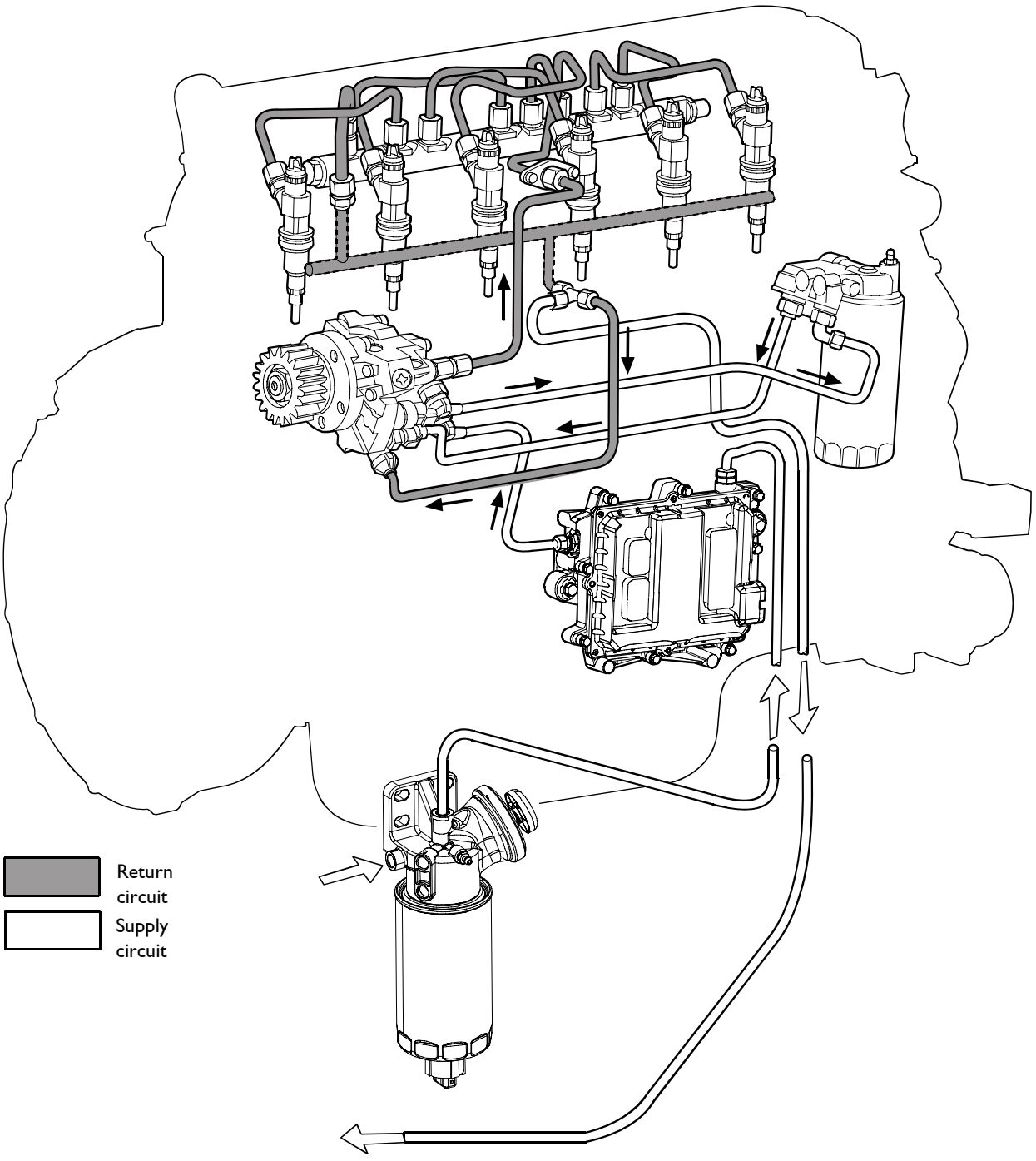
SUPPLY

The Common Rail supply system is equipped with a special pump that maintains fuel at constant high pressure regardless from phase and cylinder under injection and accumulated in an common duct shared by all electric injectors.

Therefore, fuel at injection pressure, calculated by ECU, is always available at electric injection inlet.

When the solenoid valve of an injector is energized by ECU, in related cylinder the injection of fuel taken directly from the rail takes place.

Figure 3

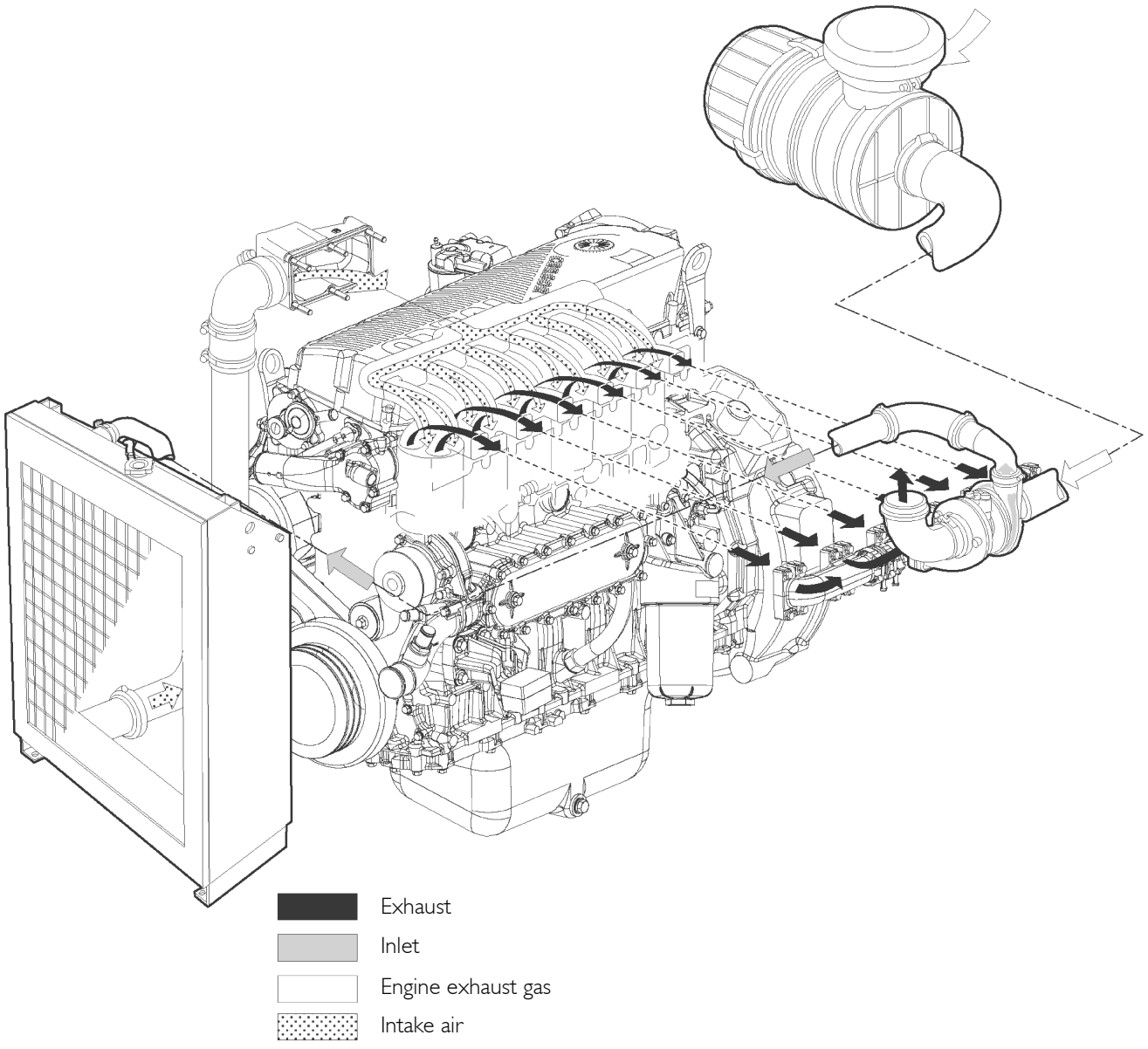


TURBOCHARGING

The turbocharging system consists of:

- ❑ air filter;
- ❑ Turbocharger.

Figure 4

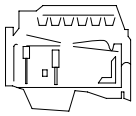
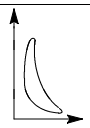
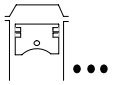
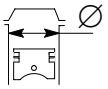
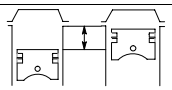
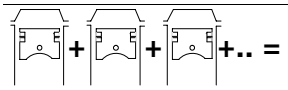
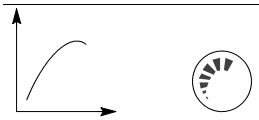
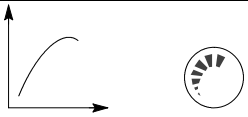
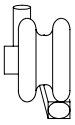


SUPERCHARGING SYSTEM DIAGRAM

SECTION 2

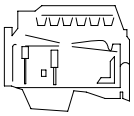
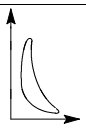
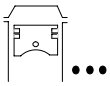
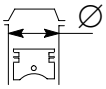
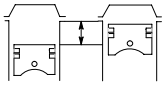
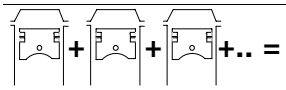
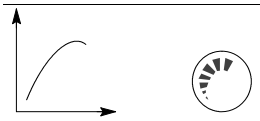
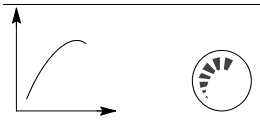
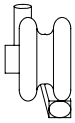
G-Drive application

GENERAL CHARACTERISTICS

	Type	**F2CE9685A*E001**
	Cycle	Diesel 4 strokes
	Feeding	Turbocharged
	Injection	Direct
	N. of cylinders	6 on-line
	Diameter mm	117
	Stroke mm	135
	Total displacement cm^3	8710
	Compression ratio	1:15.9 ± 0.8
	**Europe market** Max. output kW (HP) rpm	 263 (358) 1500
	Max. torque Nm (kgm) rpm	1675 (170.7) 1500
	**SUPERCHARGING** Turbocharger type	With intercooler HX 55
	**LUBRICATION** Oil pressure (warm engine) - idling bar - peak rpm bar	Forced by gear pump, relief valve single action oil filter - -
	COOLING Water pump control **Thermostat** - start of opening °C	Liquid Through belt 85 ± 1.5

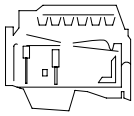
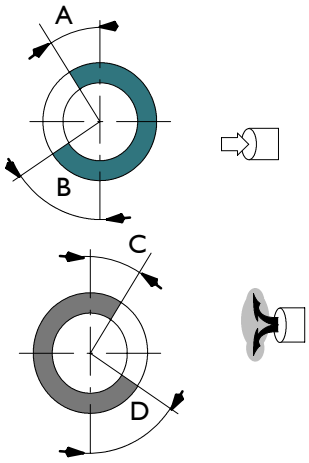
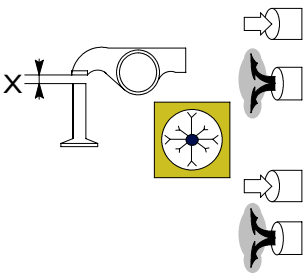
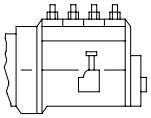
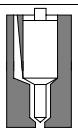
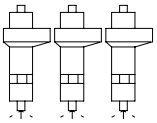
NOTE Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by FPT.

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

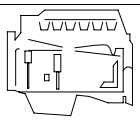
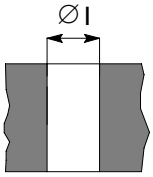
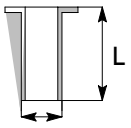
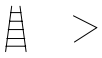
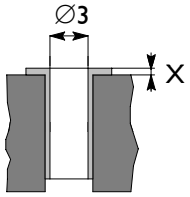
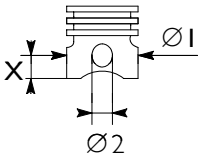
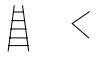
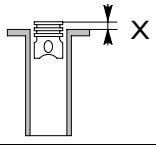
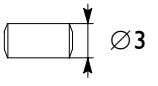
	Type	**F2CE0685B*E002**
	Cycle	Diesel 4 strokes
	Feeding	Turbocharged
	Injection	Direct
	N. of cylinders	6 on-line
	Diameter mm	117
	Stroke mm	135
	Total displacement cm^3	8710
	Compression ratio	1:15.9 ± 0.8
	**USA market** Max. output kW (HP) rpm	 290 (401) 1800
	Max. torque Nm (kgm) rpm	1539 (156.9) 1800
	**SUPERCHARGING** Turbocharger type	With intercooler HX 55
	**LUBRICATION** Oil pressure (warm engine) - idling bar - peak rpm bar	Forced by gear pump, relief valve single action oil filter - -
	COOLING Water pump control **Thermostat** - start of opening °C	Liquid Through belt 85 ± 1.5

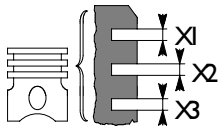
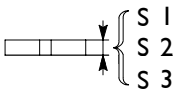
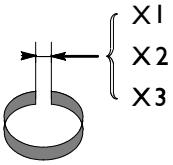
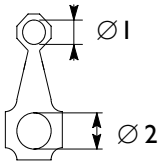
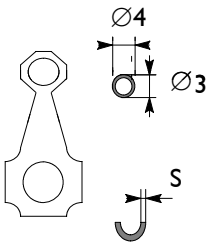
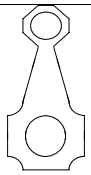
NOTE Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by FPT.

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

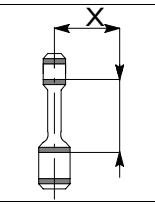
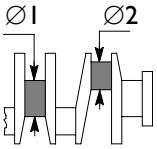
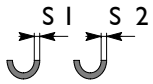
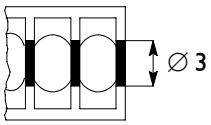
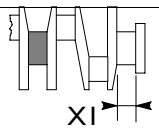
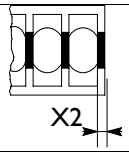
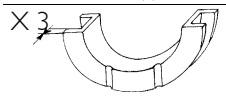
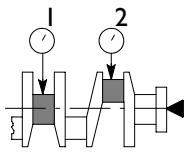
	Type	**F2C**
	VALVE TIMING	
	opens before T.D.C. A	17°
	closes after B.D.C. B	31°
	opens before B.D.C. D	48°
	closes after T.D.C. C	9°
	For timing check	
	X { mm	-
	X { mm	-
	Running	
	X { mm	0.35 to 0.45
	X { mm	0.55 to 0.65
	FEED	Bosch Common Rail with CRIN2 injectors and high pressure pump CP3.3
	Nozzle type	DLLA 137
	Injection order	1 - 4 - 2 - 6 - 3 - 5
	Injection pressure bar	1800
	Injector calibration bar	

ASSEMBLY CLEARANCE DATA

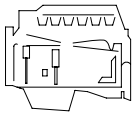
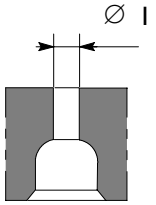
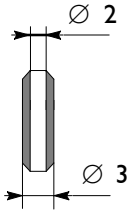
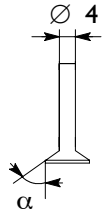
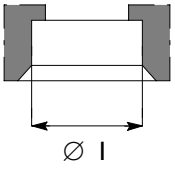
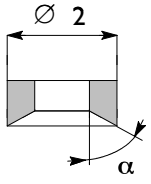
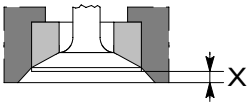
	Type	F2C
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS		mm
	Bores for cylinder liners: Ø1 upper lower	 130.500 to 130.525 129.510 to 129.535
	Cylinder liners: external diameter: Ø2 upper lower length L	 130.461 to 130.486 129.475 to 129.500 226,15 226.15
	Cylinder liners - crankcase bores upper lower	 0.014 to 0.064 0.010 to 0.060
	External diameter Ø2	-
 * Selection class	Cylinder sleeve inside diameter Ø3A* inside diameter Ø3B* Protrusion X	 117.000 to 117.012 117.010 to 117.022 0.035 to 0.065
	Pistons: measuring dimension X external diameter Ø1A external diameter Ø1B pin bore Ø2	 15 116.894 to 116.906 116.904 to 116.916 52.010 to 52.016
 * Selection class	Piston - cylinder sleeve A* B*	 0.094 to 0.118 0.094 to 0.118
	Piston diameter Ø1	-
	Pistons protrusion X	0.873 to 1.117
	Gudgeon pin Ø3	51.994 to 52.000
	Gudgeon pin - pin housing	0.010 to 0.022

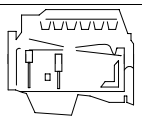
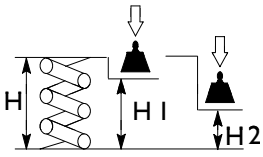
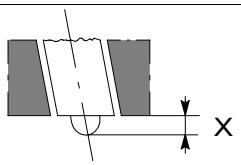
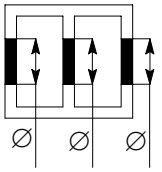
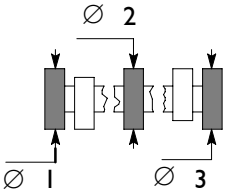
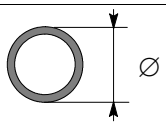
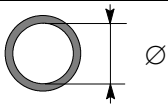
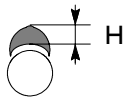
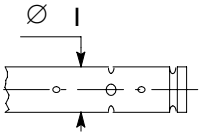
	Type		F2C
			mm
	Piston ring grooves	X1	3,120 ÷ 3,140 3.120 to 3.140
		X2	2.550 to 2.570
		X3	4.020 to 4.040
	Piston rings: trapezoidal seal	S1	3.000
	lune seal	S2	2.470 to 2.500
	milled scraper ring with slits and internal spring	S3	3.970 to 3.990
	Piston rings - grooves	1	-
		2	0.050 to 0.100
		3	0.030 to 0.070
	Piston rings		-
	Piston ring end gap in cylinder liners		
		X1	0.3 to 0.4
		X2	0.60 to 0.75
		X3	0.35 to 0.65
	Small end bush housing	Ø1	55.700 to 55.730
	Big end bearing housing	Ø2	85.987 to 86.013
	Selection classes	1	85.987 to 85.996
		2	85.997 to 86.005
		3	86.006 to 86.013
	Small end bush diameter		
	outside	Ø4	55.780 to 55.820
	inside	Ø3	52.015 to 52.030
	Big end bearing shell	S	
	Red		1.994 to 2.002
	Green		2.002 to 2.010
	Yellow ●		2.010 to 2.018
	Small end bush - housing		0.05 to 0.08
	Piston pin - bush		0.015 to 0.036
	Big end bearing		0.127 - 0.254 - 0.508
	Connecting rod weight	A	g
	Class	A	3450 to 3470
		B	3471 to 3490
		C	3491 to 3510

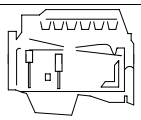
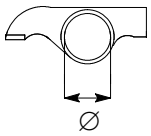
● Fitted in production only and not supplied as spares

	Type		F2C
			mm
	Measuring dimension	X	125
	Max. connecting rod axis misalignment tolerance	⫻	0.08
	Main journals	Ø1	
	- nominal		92.970 to 93.000
	- class	1	92.970 to 92.980
	- class	2	92.980 to 92.990
	- class	3	92.990 to 93.000
	Crankpins	Ø2	
	- nominal		81.915 to 81.945
	- class	1	81.915 to 81.925
	- class	2	81.925 to 81.935
	- class	3	81.935 to 81.945
	Main bearing shells	S1	
	Red		2.968 to 2.978
	Green		2.978 to 2.988
	Yellow*		2.988 to 2.998
	Big end bearing shells	S2	
	Red		1.994 to 2.002
	Green		2.002 to 2.010
	Yellow*		2.010 to 2.018
	Main bearing housings	Ø3	
	- nominal		99.000 to 99.030
	- class	1	99.000 to 99.009
	- class	2	99.010 to 99.019
	- class	3	99.020 to 99.030
	Bearing shells - main journals		0.050 to 0.090
	Bearing shells - big ends		0.040 to 0.080
	Main bearing shells		0.127 - 2.254 - 0.508
	Big end bearing shells		0.127 - 2.254 - 0.508
	Main journal, thrust bearing	X1	39.96 to 40.04
	Main bearing housing, thrust bearing	X2	38.94 to 38.99
	Thrust washer halves	X3	3.38 to 3.43
	Crankshaft end float		0.10 to 0.30
	Alignment	⫻ 1 - 2	-
	Ovalization	◯ 1 - 2	0.04
	Taper	⟋ 1 - 2	-

* Fitted in production only and not supplied as spares

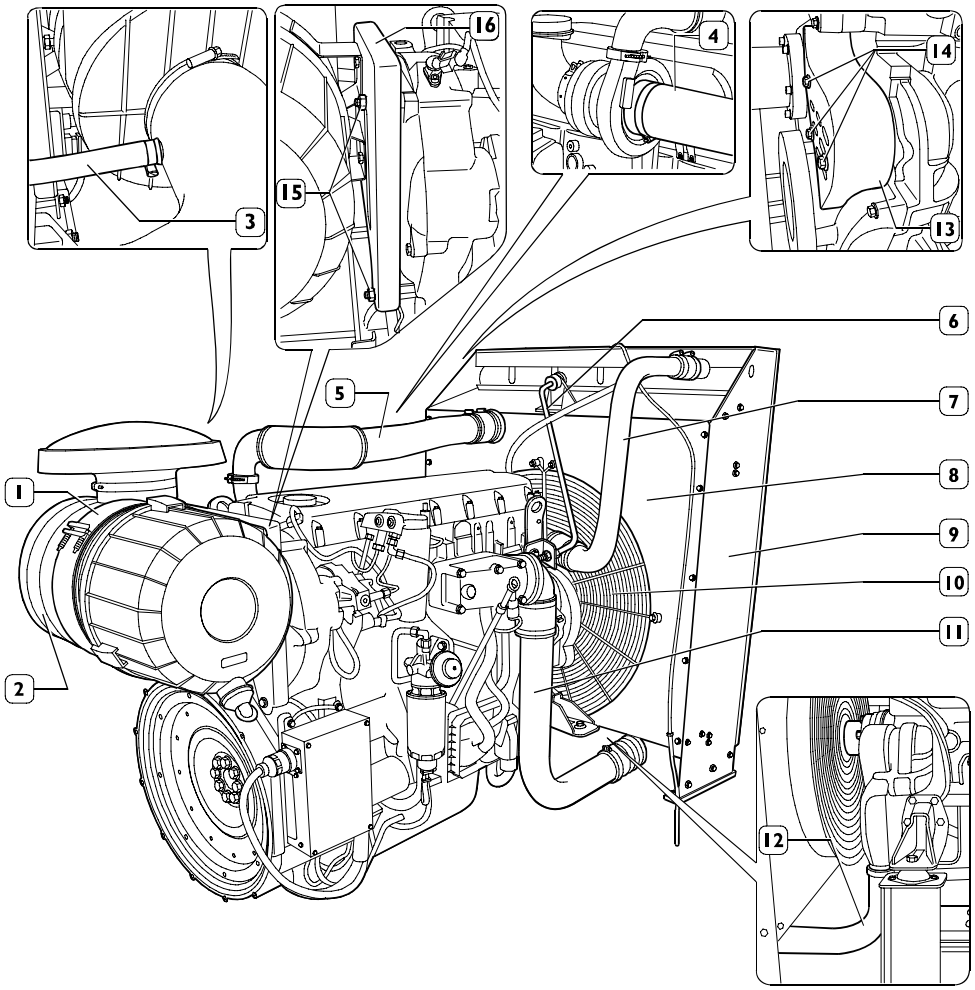
	Type	**F2C**
CYLINDER HEAD - VALVE TRAIN		mm
	Valve guide housings in cylinder head Ø1	12.9800 to 12.997
	Valve guide Ø2 Ø3	8.023 to 8.038 13.012 to 13.025
	Valve guides - housings in the cylinder heads	0.015 to 0.045
	Valve guide	0.2 - 0.4
	Valves: Ø4 α Ø4 α	 7.970 to 7.985 60° 30′ ± 7′ 30″ 7.970 to 7.985 45° +15′ -0′
	Valve stem and its guide	0.040 to 0.070
	Valve seat in head Ø1 Ø1	 41.985 to 42.020 40.985 to 41.020
	Outside diameter of valve seat; angle of valve seat in cylinder head: Ø2 α Ø2 α	 0′ -0,5′ 42.060 to 42.075 60° - 30′ 0′ -0,5′ 41.060 to 41.075 45° - 30′
	Recessing of valve X X	0.5 to 0.8 1.6 to 1.9
	Between valve seat and head	0.040 to 0.090

	Type	F2C	
		mm	
	Valve spring height:	**A**	**B**
	free height H	70.77	-
	under a load of:		
	N 460 ± 23 H1A N 460 ± 22 H1B	51	
	N 740 ± 33 H2A N 731,4 ± 42 H2B	39	
	Injector protrusion X	1.2 to 1.5	
	Camshaft bushing housing in the cylinder head: 1 ⇒ 7 Ø	69.000 to 69.030	
	Camshaft bearing journals: 1 ⇒ 7 Ø	64.924 to 64.080	
	Outer diameter of camshaft bushings: Ø	69.090 to 69.130	
	Inner diameter of camshaft bushings: Ø	65.080 to 65.116	
	Bushings and housings in the cylinder head	0.060 to 0.130	
	Bushings and bearing journals	0.100 to 0.192	
	Cam lift:  	7.4034 8.2108	
	Rocker shaft Ø1	31.964 to 31.980	

	Type	F2C
		mm
	Bushing housing in rocker arms	
		32.025 to 32.041
		32.025 to 32.041
	Between bushings and housings	
		0.045 to 0.077
		0.045 to 0.077
TURBOCHARGER		
Type		HX55
End float		0.025 to 0.127 0.025 to 0.127
Radial play		0.406 to 0.127 0.330 to 0.508

ENGINE CONNECTION AND DISCONNECTION FROM THE RADIATOR

Figure 1



Removal

Prepare a suitable container near the pipe coupling (12) to recover the coolant. Detach and remove the pipe couplings (12) and (7) operating the clamps.
Detach and remove from the engine and from the radiator the pipes (5) and (11) operating on their collars.
Remove the protection grilles (10) and the guard (8) of the fan operating on their fasteners.
Unscrew the engine side retaining nut of the fabric (6) so as to release it.
Suitably lock the radiator group (9), the detach it from the basement operating on the fasteners on both sides.
Detach the air filter from the engine (1) operating from collar (4) and the support (16) operating on the fasteners (15) after detaching the oil vapour hose (3) and the pipe coupling (4) from the turbocharger
Remove the screws which fasten the engine supports to the basement and detach the engine.
To access the engine belt, it is necessary to remove the protection guard (13), unscrewing the screws (14).

Refitting

For the connection operation repeat the described operations for the disconnection on the contrary and apply the following instructions:

- ❑ to control the engine elastic supports and to replace them in case of deterioration ;
- ❑ to control that the exhaust pipes are not deteriorated or are going to deteriorate; in this case you shall replace them;
- ❑ to clamp the screws and/or nuts to the described couple;
- ❑ to fill the cooling system with cooling liquid;
- ❑ to carry out bleeding operation from the fuel supply system as described in the suited paragraph.
- ❑ to control engine oil level;
- ❑ to carry out the tests and controls as described in the suited chapter.

MAINTENANCE PLANNING

MAINTENANCE PLANNING

Recovery

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

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

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

Inspection and/or maintenance interventions

Intervention type	Frequency (hours)
Engine	
Engine visual inspection	Daily
Check presence of water in fuel prefilter	Daily
Engine oil change	Every 600 hours
Engine oil filter change	Every 600 hours
Fuel prefilter change	Every 300 hours
Fuel filter change	Every 300 hours
Fuel Blow-by filter	Every 600 hours
Check condition of water pump/alternator control belt	Every 1200 hours
Check-up of EDC system by diagnostics tool	-
Check valve lash and adjust, if required	Every 1200 hours
Dry air filter change and container cleaning	-

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

OPERATIONS OUTSIDE THE PLAN

Daily checks

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

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

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

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

NOTE Early air filter clogging is usually due to environmental conditions. For this reason, the filter should be changed if clogging is signalled by the related sensor, regardless of the prescriptions that shall be observed if no specific indications have been provided.

Every year – Before winter

and possibly when a maintenance operation is carried out

Check the antifreeze percentage in the engine cooling water

Every two year

and possibly when a maintenance operation is carried out

Change engine coolant

MAINTENANCE PROCEDURES
Checks and controls

Engine oil level check.

The check must be executed when the engine is disconnected and possibly cool.
The check can be made using the specially provided flexible rod.

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

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

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

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

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

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

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

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

Check of fuel system

The check must be executed both when the engine disconnected and when it is running.
The check is made by observing the fuel pipes from the tank to the fuel pump and to the injectors.

Cooling system check

The check must be executed both when the engine disconnected and when it is running.
Check the pipes from the engine to the radiator and vice versa; note any seepage and the state of the pipes especially near the coupling clamps.
Verify that the radiator is clean, the correct working of the fan flywheels, the presence of any leakage from the connectors, from the manifold and from the radiating unit.

Due to the high temperatures achieved by the system, do not operate immediately after the engine's disconnection, but wait for the time deemed necessary for the cooling.
Protect the eyes and the skin from any eventual high pressure jet of cooling liquid.

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

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

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

Lubricating system check

The check must be executed both when the engine disconnected and when it is running.
Verify the presence of any oil leakage or blow-by from the head, from the engine pan of from the heat exchanger.

The engine oil is highly polluting and harmful.
In case of contact with the skin, rinse well with water and detergent.
Adequately protect the skin and the eyes, operate in full compliance with safety regulations.
Disposal must be carried out properly, and in full compliance with the law and regulations in force.

Check for any water in the fuel filter

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

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

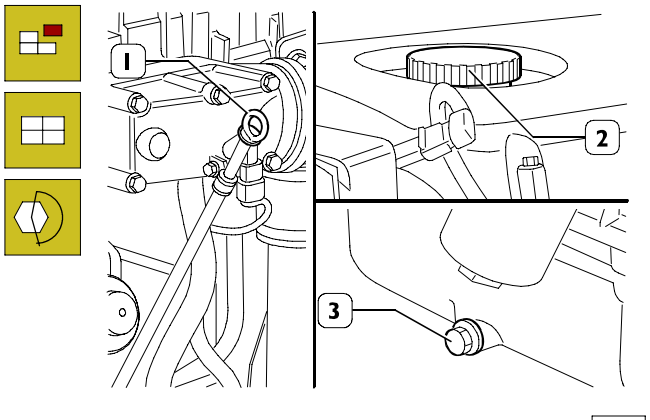
Fuel filter is equipped with pump screw-valve to drain the water eventually mixed with fuel.

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

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

Engine oil change

Figure 1



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

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

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

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

The oil motor is very pollutant and harmful.

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

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

Dispose of the residual properly following the rules.

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

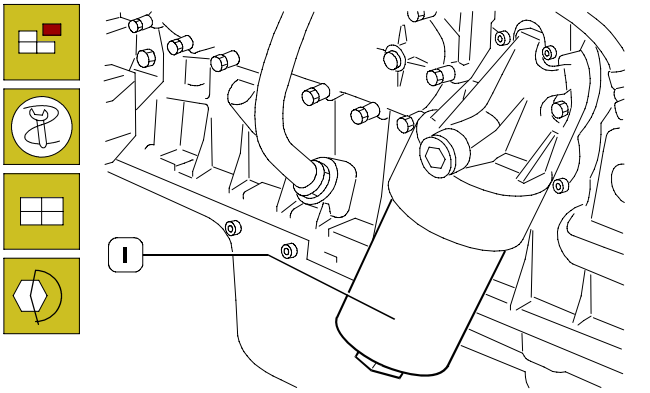
- ❑ After the complete drainage, screw the plug and carry out the clean oil filling.

NOTE Use only the recommended oil or oil having the requested features for the corrrect motor functioning.
In case of topping up, don't mix oils having different features.
If you don't comply with theses rules, the service warranty is no more valid.

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

Engine oil filter change

Figure 2



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Drain oil as described in "Engine oil change" chapter.
To disassemble oil filter (1).

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

Place properly a container for the liquid.

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

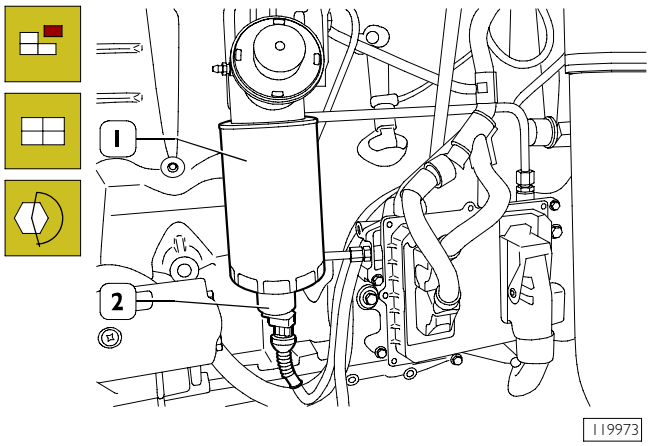
The motor oil is very pollutant: it must be disposed of according to the rules.

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

Lock oil filter (1) by hand till contact to support and then lock by ¾ of a rev. at prescribed tightening torque; pour oil in engine ad described in "Engine oil change" chapter.

Replace fuel tank prefilter

Figure 4

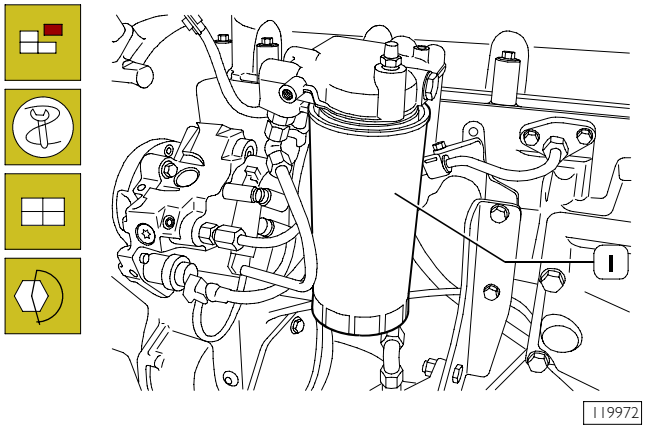


Disconnect electric connector (2). Unlock prefilter (1) and change it. Before refitting a new cartridge, wet seal with fuel oil or engine oil. Lock cartridge by hand till in contact with support, then lock it by ¾ of a rev. at predefined tightening torque.

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

Fuel filter change

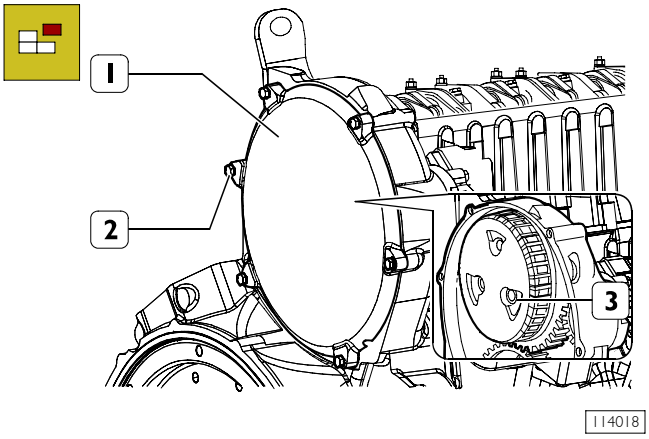
Figure 5



Use tool 99360314 to remove fuel filter (1).
Before fitting the new cartridge, wet seal with fuel oil or engine oil. Lock the new one by hand and carefully check that rubber seal and contact surface are clean and in perfect conditions. Lock cartridge by hand till contact with support and then lock it for ¾ of a rev. at prescribed tightening torque. Bleed air from supply system as described in paragraph below:

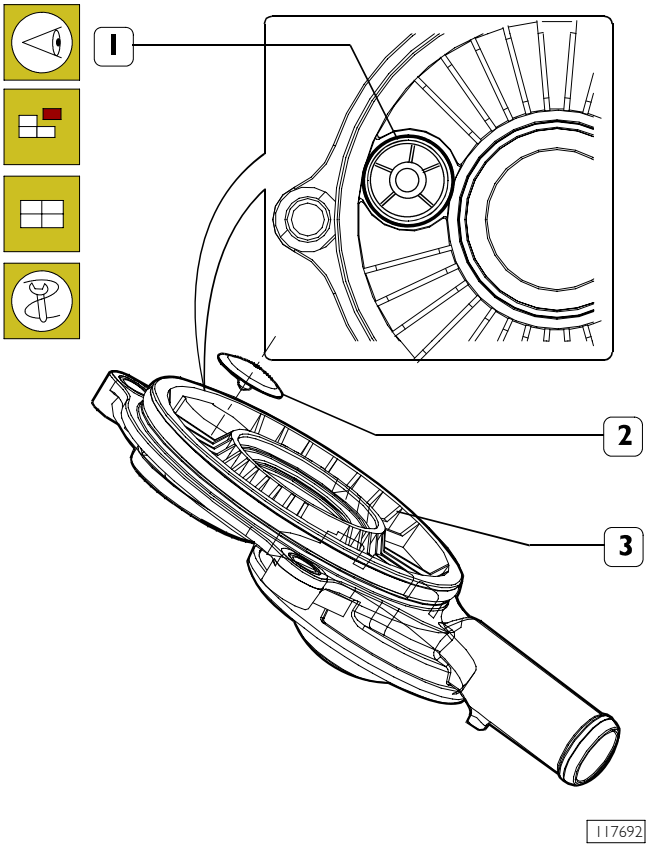
Fuel Blow-by filter

Figure 6



Unlock screws (1) and remove cover (2). Remove the centrifugal filter (3) underneath and replace it.

Figure 7

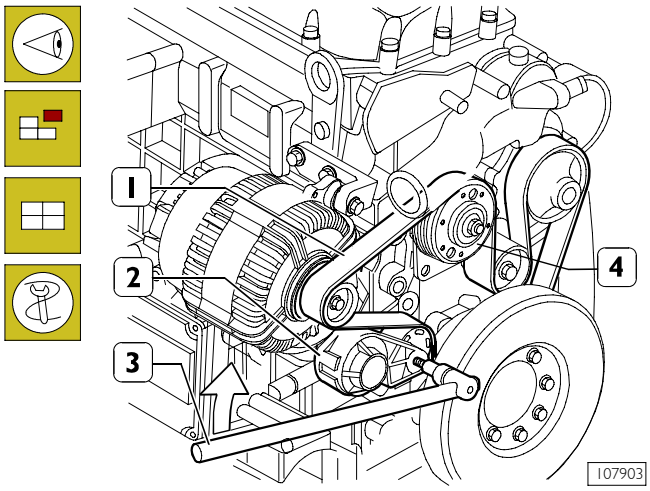


Install blow-by body (1) with related seal and lock screws (2) at required torque.

Install cover (3) and lock screws (4) at required torque.

Check of water pump/alternator control belt condition

Figure 8



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

NOTE To access the engine belt, it is necessary to remove the protection guard, unscrewing the screws.

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

NOTE Belt tensioner is automatic and requires no adjustment.

Valve lash check a adjustment

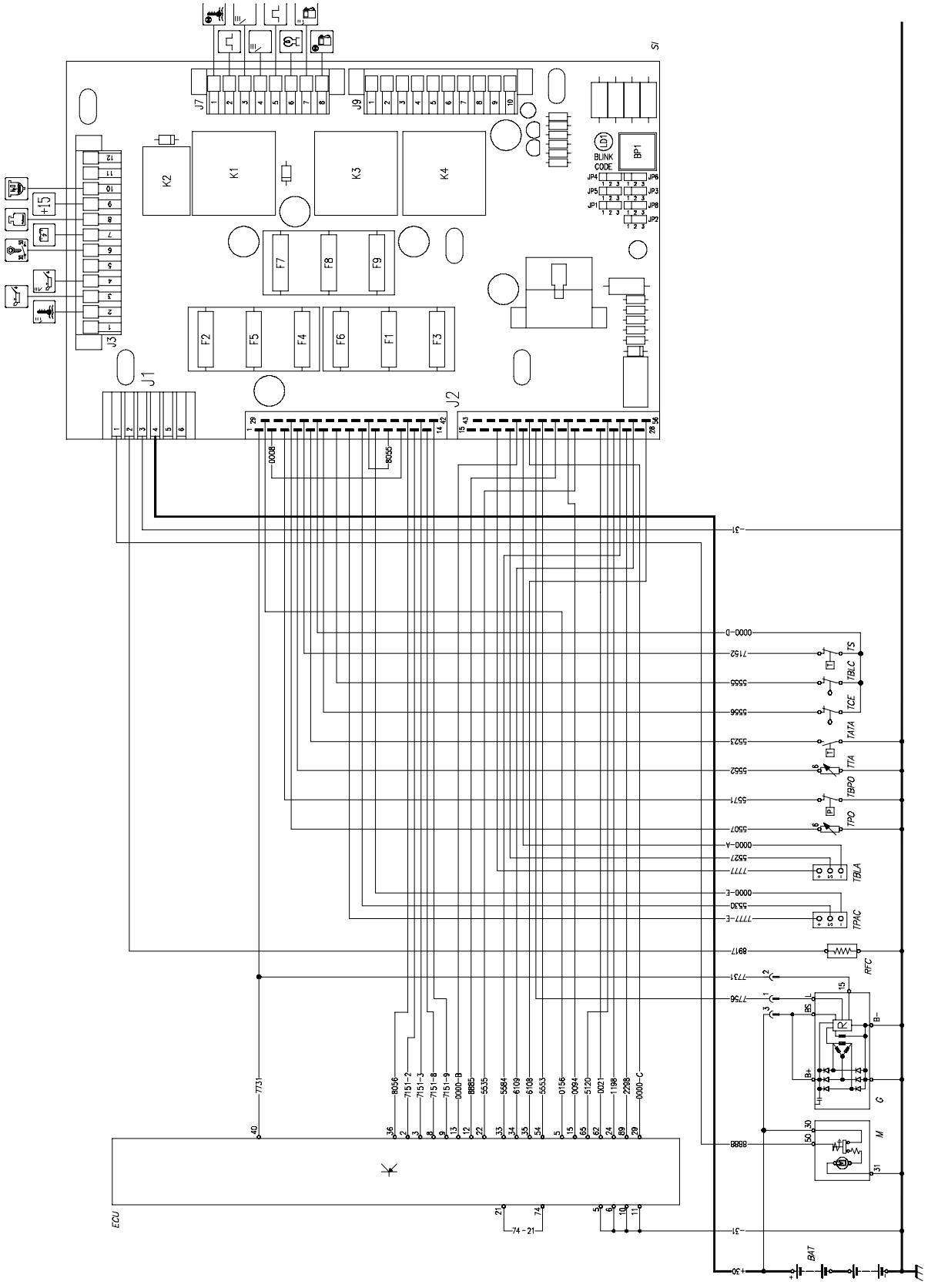
For correct operation, follow instructions contained in related chapter in section 3 – Industrial Application.

Change dry air filter and clean its container

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

PRINCIPLE ELECTRICAL DIAGRAM

Figure 9



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Key to components

BAT	Starter battery 12V
M	Starter motor
G	Battery charger alternator
RFC	Fuel filter heating resistor
TRFC	Fuel filter heating thermostat
TPAC	Water in the fuel filter transmitter
TBLA	Low engine water level transmitter
TPO	Engine oil pressure switch
TBPO	Low engine oil level pressure switch
TTA	Engine water temperature transmitter
TCE	No fuel transmitter (option)
TBLC	Float for fuel level
TS	Engine water heater thermostat
EDC	Engine electronic control unit
TATA	High engine water temperature thermostat
SI	Control panel - engine interface box

Function symbols for the control panel


ENGINE WATER TEMPERATURE THERMOMETER


LOW ENGINE OIL PRESSURE VISUAL WARNING


ENGINE OIL PRESSURE GAUGE

STARTING THE ENGINE (+50)


NO BATTERY CHARGING VISUAL WARNING


LOW ENGINE WATER LEVEL VISUAL WARNING

CAPTIVE KEY POSITIVE (+15)

WATER IN THE FUEL FILTER VISUAL WARNING


HIGH ENGINE WATER TEMPERATURE VISUAL WARNING


CAN LINE


CONTROL PANEL POWER SUPPLY


ENGINE PRE-HEATING

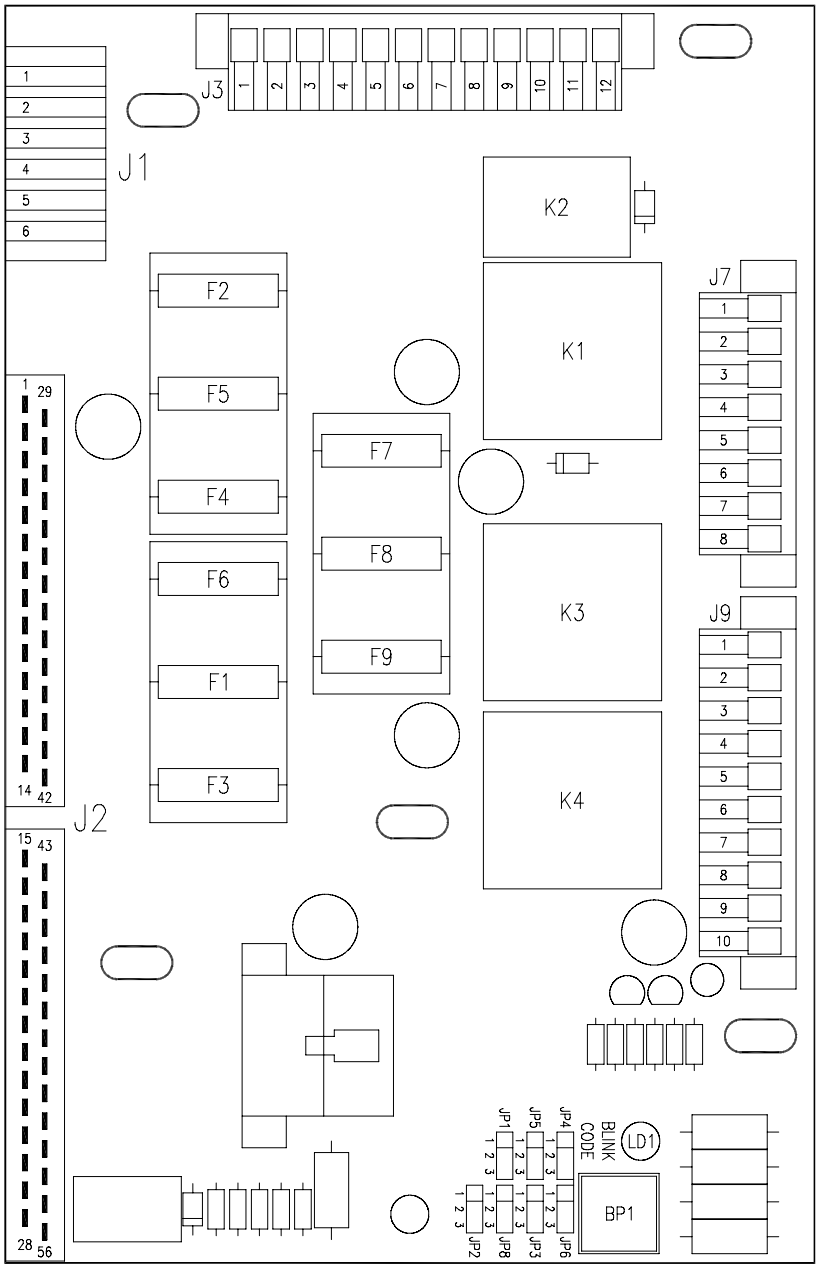

FUEL LEVEL VISUAL WARNING


NO FUEL VISUAL WARNING (OPTION)

ENGINE INTERFACE BOX

Description

Figure 10

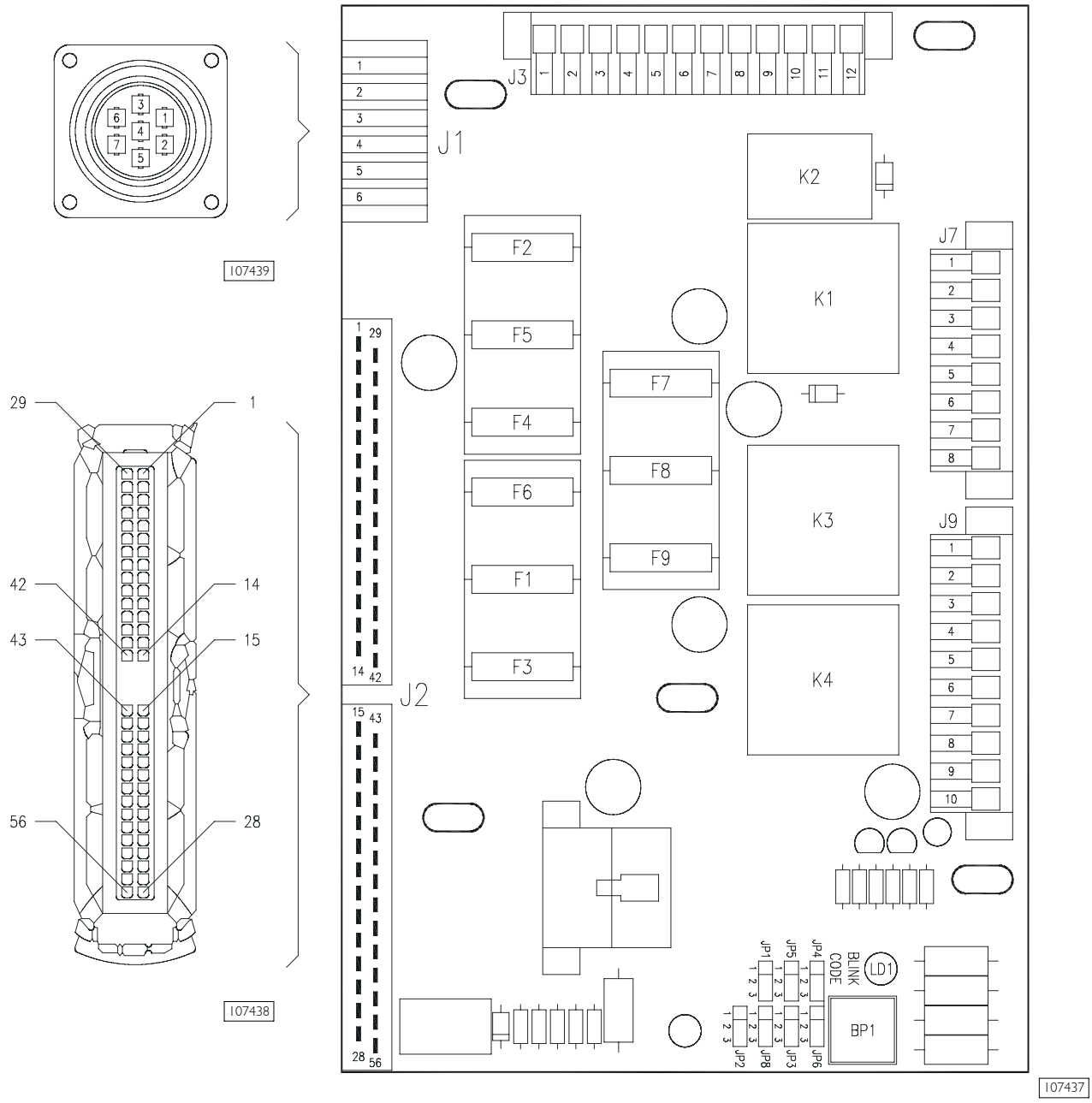


LIST OF COMPONENTS

K1. Power relay with key inserted (+15) - K2. Starting phase signal relay - K3. Starting relay - K4. Relay for pre-heating resistance enabling - JP1. Jumper to select frequency (jumper on 1-2= 60Hz - jumper on 2-3= 50Hz) - JP2. Jumper for operating mode selection (bond on 1-2= diagnosis - bond on 2-3= normal operation) - JP3. Jumper to select cold start signal connection (1-2= connected - 2-3= disconnected) - JP4. Jumper to select heat. function for cold starting (1-2= connected - 2-3= disconnected) - JP5. Jumper for Can Line selection (1-2= Can Line connected - 2-3= Can Line not connected) - JP6. Not used - JP8. Not used - BP1. Switch for blink-code signal request - LD1. LED signalling blink/code - F1. 10A fuse for starting engine - F2. 3A fuse for diagnostics - F3. 20A protection fuse for pre-heating resistance - F4. 30A fuse for electronic control unit - F5. 10A fuse for control panel - F6. 5A fuse for cut-in +15 ON ECU - F7. 20A protection fuse for fuel filter heater - F8. Not used - F9. Not used - J1. Connector for power connections - J2. Connector for interface with engine control unit - J3. Connector for interface with control panel - J7. Connector for interface with control panel - J9. Connector for interface with control panel.

Connectors

Figure 11



CONNECTOR J1 on engine – control panel interface box for power supply (GECURSOR300E/350E/400E)

1 To terminal 50 of starter motor
2 Supply from F3 for fuel filter heating resistance
3 Battery negative
4 Direct positive to battery
5 Spare
6 Spare

CONNECTOR J2 on engine – control panel interface box for EDC ECU connections

1	+15 from ignition key
2	12 jumper
3	Negative signal from oil low pressure pressure switch
4	Signal from water temperature sensor
5	Negative signal from water high temperature pressure switch
6	Signal from fuel zero level transmitter
7	Fuel low level signal
8	Supply of water presence in fuel sensor
9	Signal from water presence in fuel sensor
10	Ground of water presence in fuel sensor
11	Jumper with 37
12	Jumper with 2
13	Positive +30
14	Positive +30
17	Supply of water low level sensor
18	Signal from water low level sensor
19	Ground of water low level sensor
20	No recharge from alternator signal
22	Ground for diagnosis lamp
23	Positive signal for diagnosis lamp
25	Torque limiting resistance
27	Line K - diagnosis EDC
29	Negative signal from EDC system diagnostic switch
31	Signal from oil pressure sensor
32	Negative signal from water heater thermostat
33	Ground
37	Jumper with 11
40	Positive signal for excitation of contactor of fuel filter heater
41	Positive +30
42	Positive +30
46	Ground
47	Ground
48	Positive for cold start lamp
49	Positive for excitation of pre-heating contactor
50	Pre-heating contactor ground
53	Negative signal from EDC system diagnostic switch
54	Engine revs signal from EDC control unit
55	Line CAN L
56	Line CAN H

NOTA **Pins 1 and 2 of EDC ECU are connected to battery negative**

CONNECTOR J3 inside the engine interface box for signals to control panel

1 Free
2 From the engine water temperature transmitter for signal to thermometer on control panel
3 From the low engine oil pressure switch for visual warning on control panel
4 From engine oil pressure switch for signal to pressure gauge on control panel
5 Free
6 To the key switch (+50) on control panel
7 From the alternator for battery charging visual indicator on control panel
8 From the low engine water level transmitter for visual warning on control panel
9 +15
10 From the water in fuel filter transmitter for visual warning on control panel
11 Free
12 Free

CONNECTOR J7 inside the engine interface box for signals to control panel

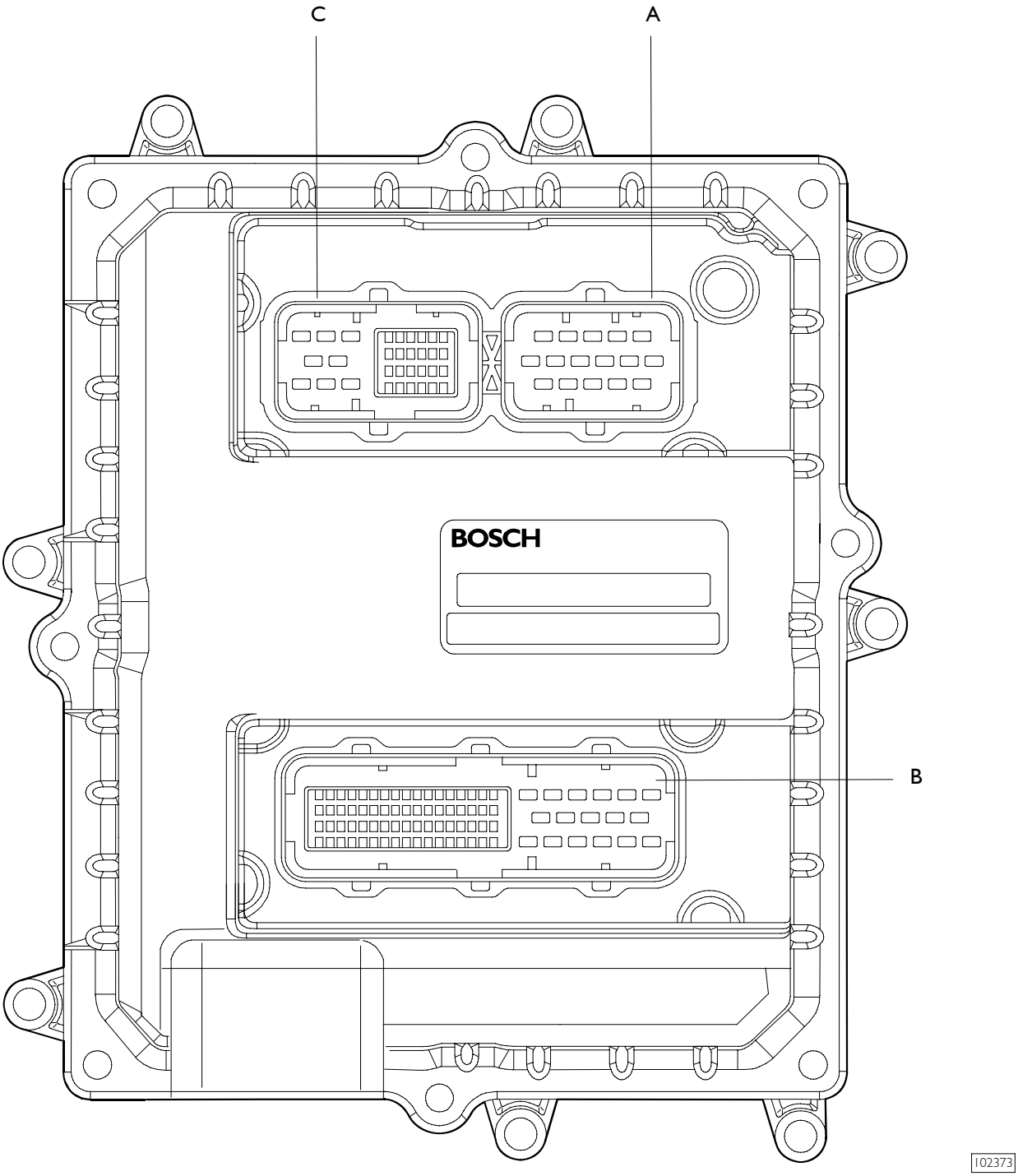
1 From the engine coolant high temp. thermostat for visual signal on control panel
2 CAN line L to the control panel
3 Positive to power control panel
4 Negative to power control panel
5 CAN line H to the control panel
6 From the engine water heater thermostat to the control panel
7 From the fuel level transmitter for visual warning on control panel
8 From the no fuel transmitter (opt)

CONNECTOR J9 inside the engine interface box

1 Cold start signal (option) if jumper JP3 set on 1-2
2 Cold start signal (option) if jumper JP3 set on 1-2
3 Cold start heater relay (option) if jumper JP4 set on 1-2
4 Cold start heater relay (option) if jumper JP4 set on 1-2
5 Free
6 Free
7 Free
8 Free
9 Free
10 Free

EDC 7 UC31 ELECTRONIC CONTROL UNIT

Figure 12

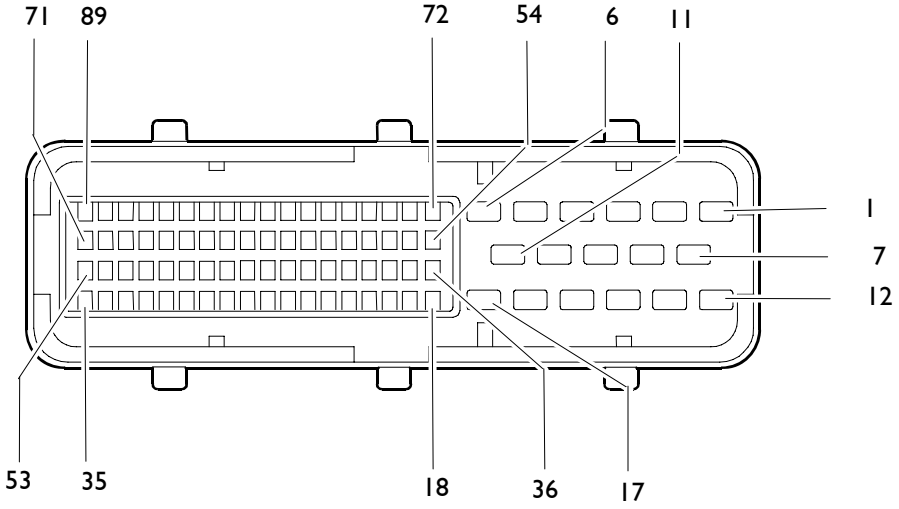


A. Electro-injector connector - B. Chassis connector - C. Sensor connector

EDC control unit PIN-OUT

Chassis connector "B"

Figure 13



ECU Pin	Cable	Function
2	7151	Positive +30
3	7151	Positive +30
5	0150	Ground
6	0150	Ground
8	7151	Positive +30
9	7151	Positive +30
10	0150	Ground
11	0150	Ground
12	8885	Positive for excitation of pre-heating contactor
13	0000	Ground
21	-	Jumper with 74
22	5535	Positive signal for diagnosis lamp
29	0000	Ground
30	0535	Ground for diagnosis lamp
33	5584	Engine revs signal from EDC control unit
34	6109	Line CAN L
35	6108	Line CAN H
36		Positive signal for excitation of contactor of fuel filter heater
40	7731	+15 from ignition key
56	5553	Positive for cold start lamp
62	0021	Torque limiting resistance
66	5120	Torque limiting resistance
74	-	Jumper with 21
75	0094	Pre-heating contactor ground
85	0156	Negative signal from EDC system diagnostic switch
89	2298	Line K - diagnosis EDC