NEF TIER 3 SERIES

Industrial application

N45

N45 ENT

N67

N67 ENT

Technical and Repair manual

This publication describes the characteristics, data and correct methods for repair operations on each component of the vehicle.

If the instructions provided are followed and the specified equipment is used, correct repair operations in the programmed time will be ensured, safeguarding against possible accidents.

Before starting to perform whatever type of repair, ensure that all accident prevention equipment is available and efficient.

All protections specified by safety regulations, i.e.: goggles, helmet, gloves, boot, etc. must be checked and worn.

All machining, lifting and conveying equipment should be inspected before use.

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PRELIMINARY REMARKS

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

SYMBOLS - WARNINGS

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

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

General danger
It includes the dangers of above described signals.

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

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

GENERAL WARNINGS

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

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

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

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

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

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

Keep personnel not authorised to operations clear of working area.

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

Do not leave the running assembly unattended when making repairs.

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

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

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

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

Worn out, damaged or consumable parts must be replaced by IVECO Motors 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.

GENERAL WARNINGS

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

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

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

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

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

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

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

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

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

Before welding:

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

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

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

GENERAL WARNINGS ON THE ELECTRIC SYSTEM

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

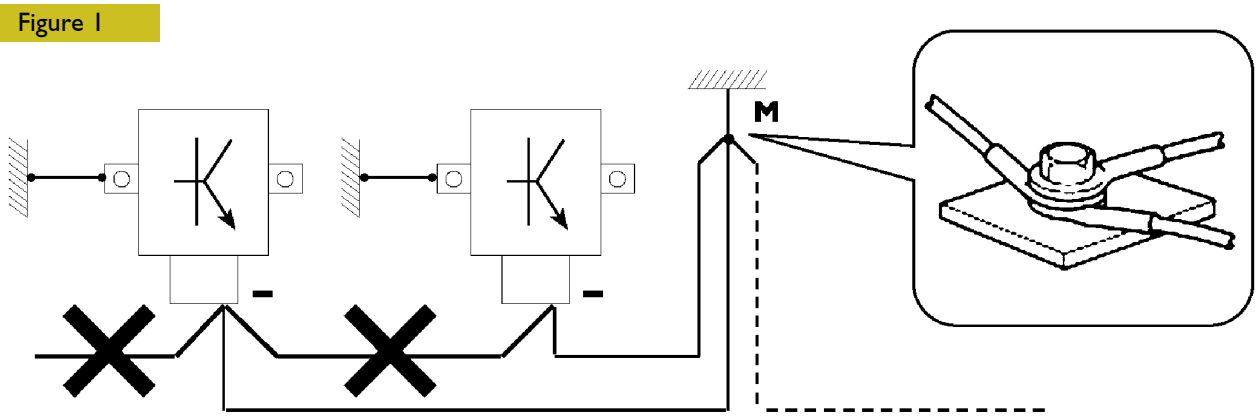
Bonding and screening

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

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

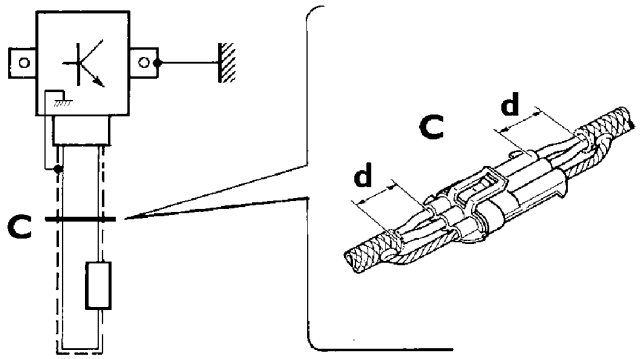
- Electronic central units must be connected to system bonding when they are provided with a metallic shell.
- Electronic central units negative cables must be connected both to a system bonding point such as the dashboard opening bonding (avoiding "serial" or "chain" connections), and to battery negative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

Figure 1



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

Figure 2



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

OPTIONAL ELECTRICAL AND MECHANICAL PARTS INSTALLATIONS

Assemblies shall be modified and equipped with additions - and their accessories shall be fitted - in accordance with the assembling directives issued by IVECO Motors.
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

NEF TIER 3 ENGINES

Part 1
F4HE NEF ENGINES

PREFACE TO USER'S GUIDELINE MANUAL

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

Section 2 describes the type of fuel feed.

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

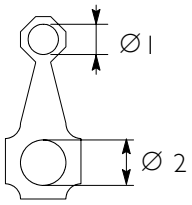
1. Mechanical part, related to the engine overhaul, limited to those components with different characteristics based on the relating specific duty.
2. Electrical part, concerning wiring harness, electrical and electronic equipment with different characteristics based on the relating specific duty.
3.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

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

SPECIAL REMARKS

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

Example



Ø 1 = housing for connecting rod small end bush

Ø 2 = housing for connecting rod bearings

Tighten to torque
Tighten to torque + angular value

SYMBOLS - ASSISTANCE OPERATIONS

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

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

UPDATING

Section	Description	Page	Date of revision

SECTION 1

General specifications

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F4HE9484A*J101	N45 ENT
F4HE9684P*J101	N67 ENT

LUBRICATION

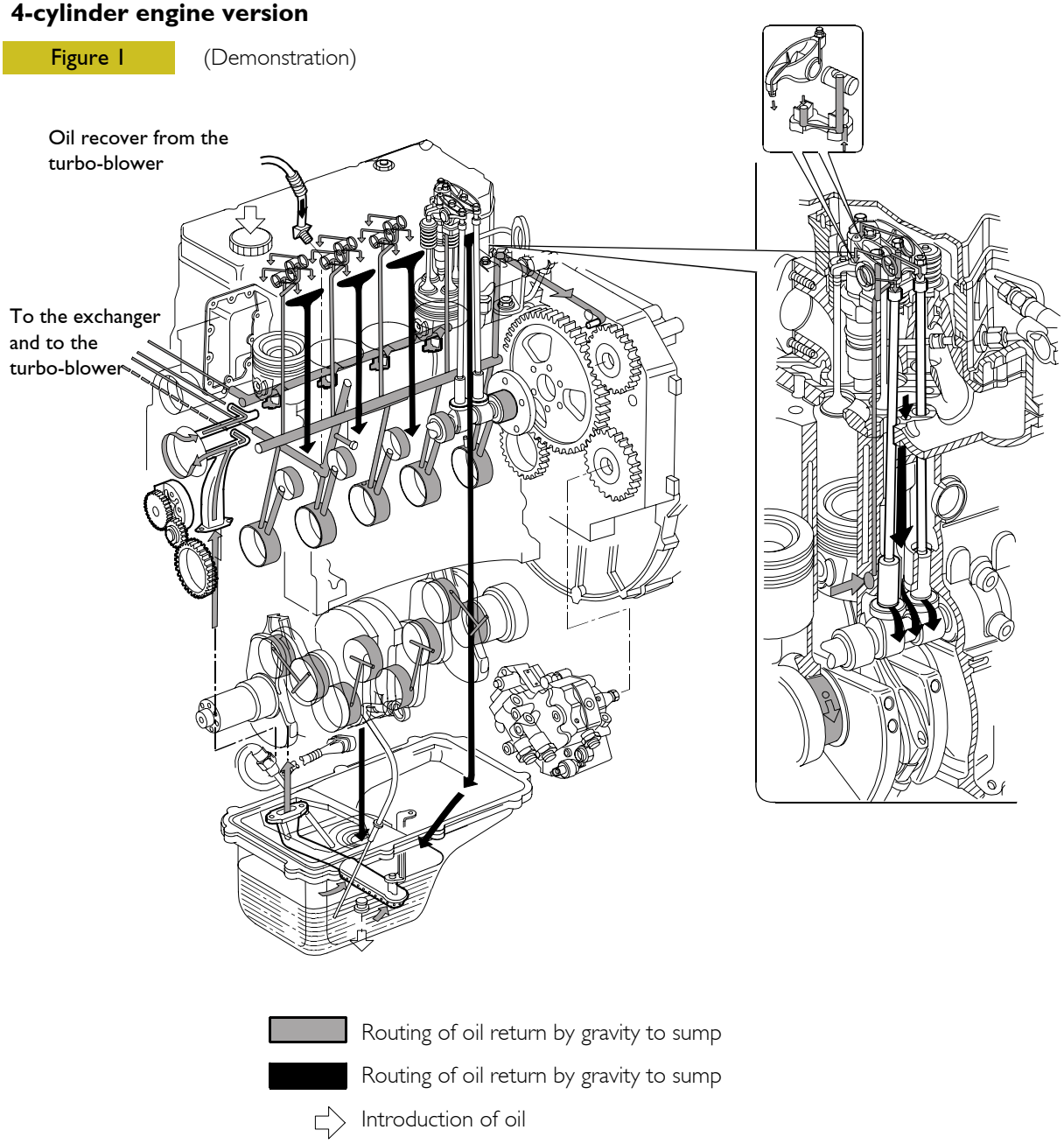
Lubrication by forced circulation is achieved through oil rotary expansion pump (1), placed in the front part of the basement, driven by the straight-tooth gear splined to the shaft's bar hold.

From the pan, the lubrication oil flows to the driving shaft, to the camshaft and to the valve drive.

Lubrication involves the heat exchanger as well, the turbo-blower and the eventual compressor for any eventual compressed air system. All these components may often vary according to the specific duty and will therefore be examined in the specific section.

4-cylinder engine version

Figure 1 (Demonstration)



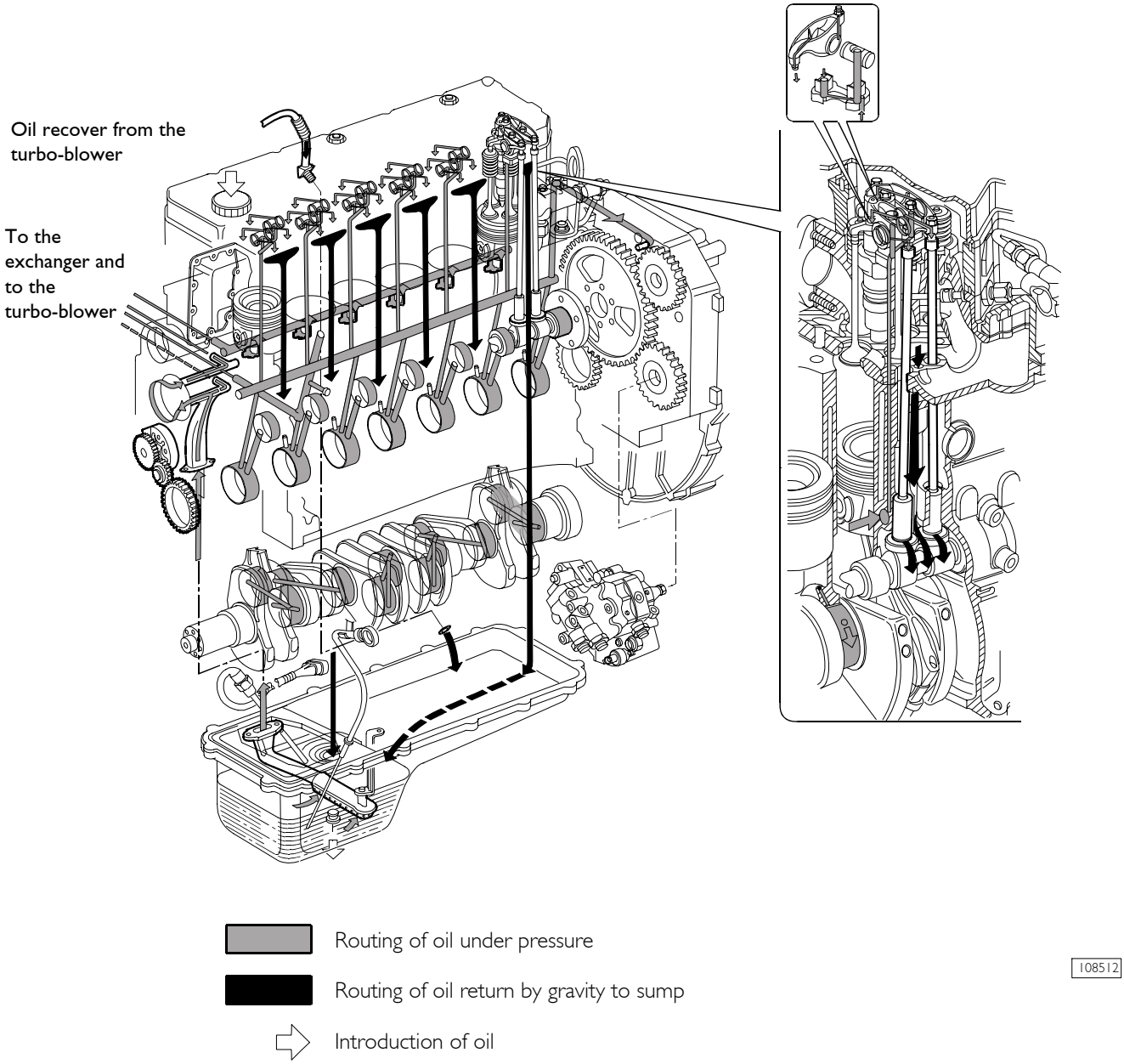
LUBRICATION SYSTEM LAYOUT
4-cylinder engines

6-cylinder engine version

Even for the 6 cylinders version lubrication is obtained by forced circulation and achieved through an oil rotary expansion pump similar to the 4 cylinders' one.

Also in this case, the components such as the oil exchanger, the turbo-blower and the eventual compressor are specifically studied and made out to suit the equipment or the duty for which the engine has been developed.

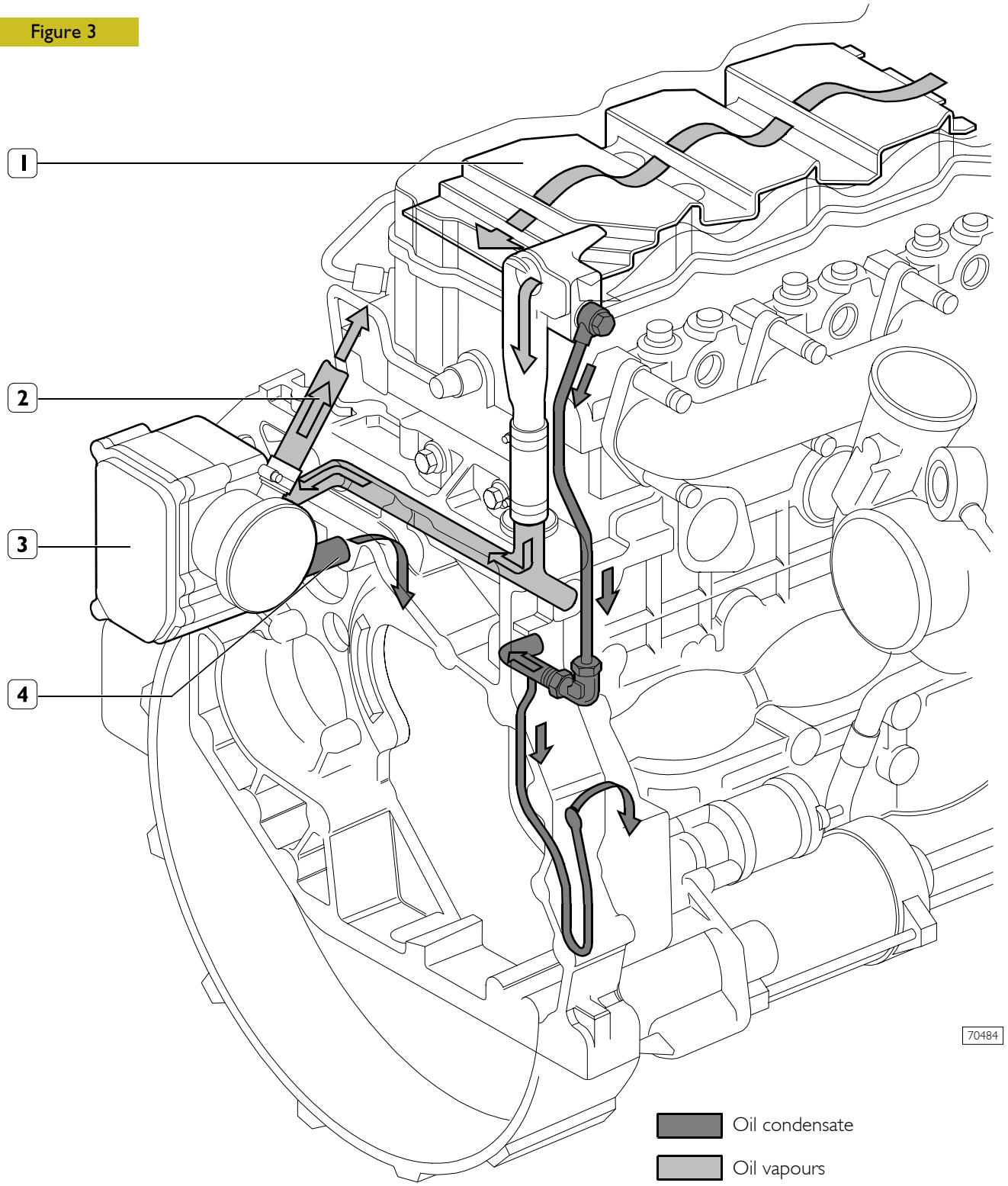
Figure 2 (Demonstration)



LUBRICATION SYSTEM LAYOUT
6-cylinder engines

OIL VAPOUR RECYCLING

Figure 3



1. Pre-separator - 2. Exhaust to the outside (temporary) - 3. Filter - 4. Return to engine.

The tappet cover houses the pre-separator (1), whose shape and position determines an increase in oil vapour outlet speed and condenses a part of vapours at the same time.

Condensate oil returns to the oil sump whereas the residual vapours are ducted, collected and filtered in the blow-by (3).

In the blow-by (3), part of the vapours condense and return to the oil sump whereas the remaining part is put into cycle again through pipe (2).

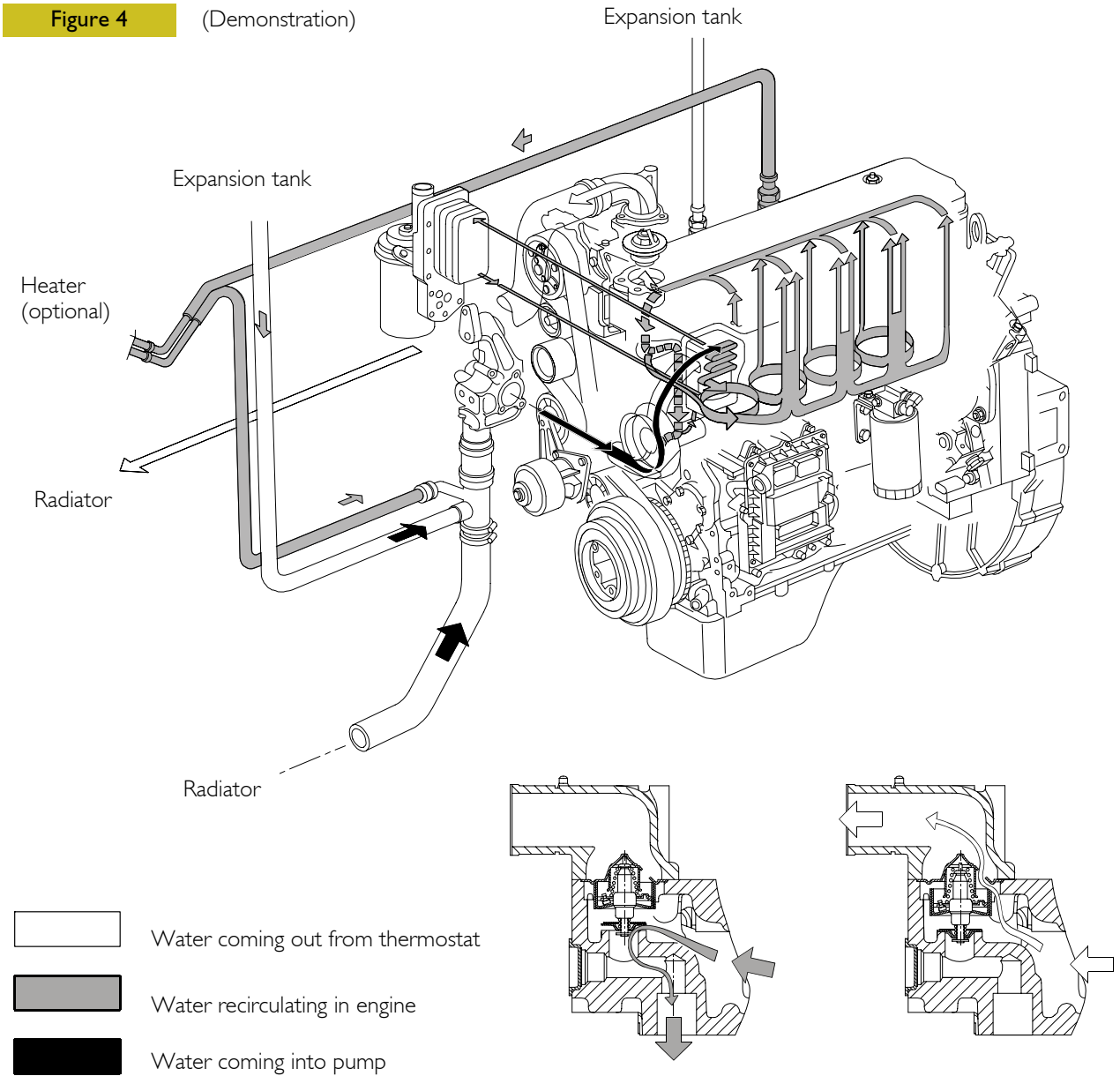
COOLING SYSTEM

The engine cooling system, closed circuit forced circulation type, generally incorporates the following components:

- ❑ Expansion tank; placement, shape and dimensions are subject to change according to the engine's equipment.
- ❑ Radiator, which has the duty to dissipate the heat subtracted to the engine by the cooling liquid. Also this component will have specific peculiarities based on the equipment developed, both for what concerns the placement and the dimensions.
- ❑ Viscous pusher fan, having the duty to increase the heat dissipating power of the radiator. This component as well will be specifically equipped based on the engine's development.
- ❑ Heat exchanger to cool the lubrication oil: even this component is part of the engine's specific equipment.
- ❑ Centrifugal water pump, placed in the front part of the engine block.
- ❑ Thermostat regulating the circulation of the cooling liquid.
- ❑ The circuit may eventually be extended to the compressor, if this is included in the equipment.

4-cylinder engine version

Figure 4 (Demonstration)



COOLING SYSTEM LAYOUT
4-cylinder engines

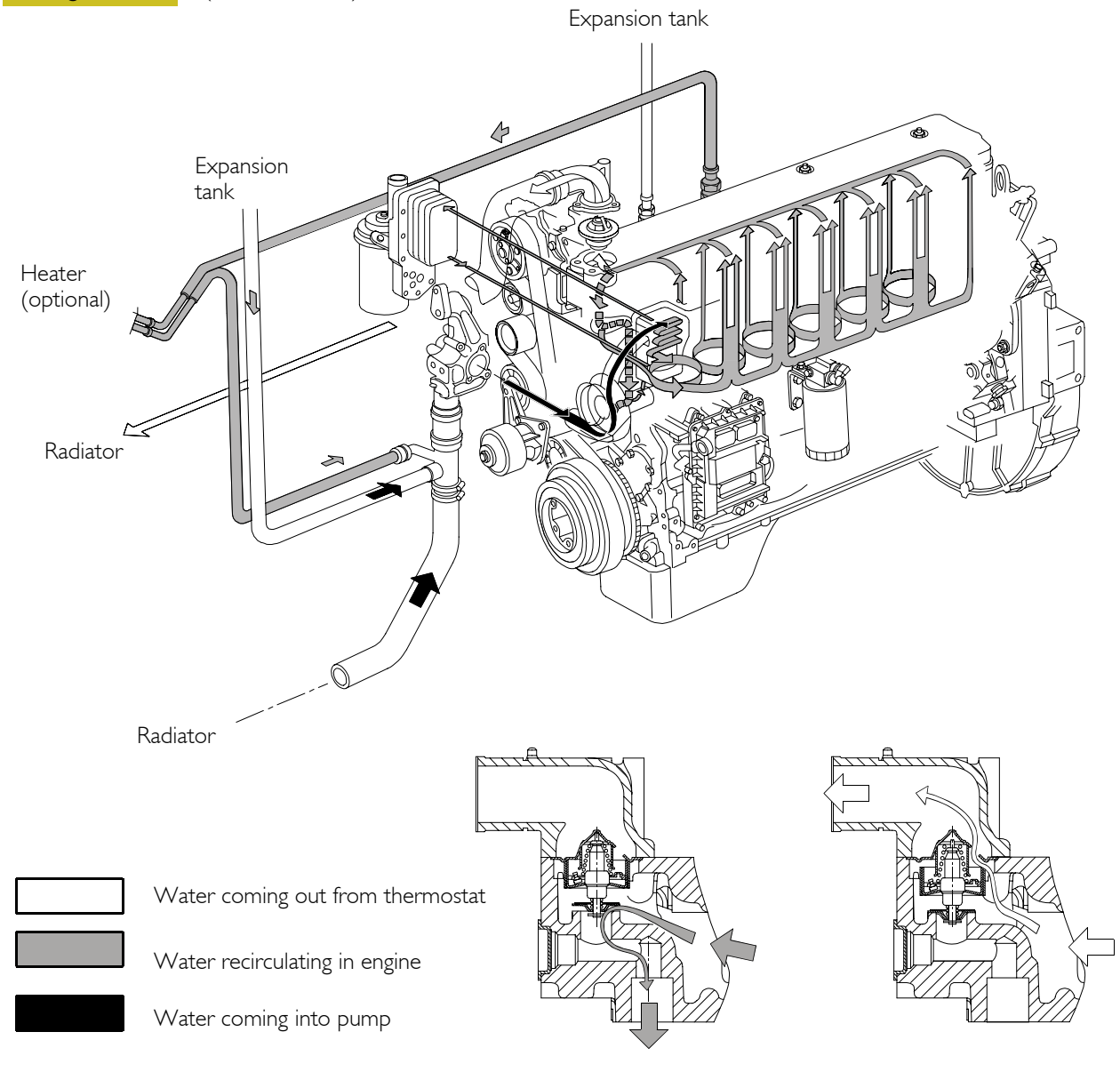
6-cylinder engine version

The engine cooling system, closed circuit forced circulation type, is of a similar design as the 4 cylinders engine.

It incorporates necessary components such as the radiator, the heat exchanger, the expansion tank and some ancillary components such as the heater or the compressor for the compressed air.

Such components always vary according to the engine's equipment and duty.

Figure 5 (Demonstration)

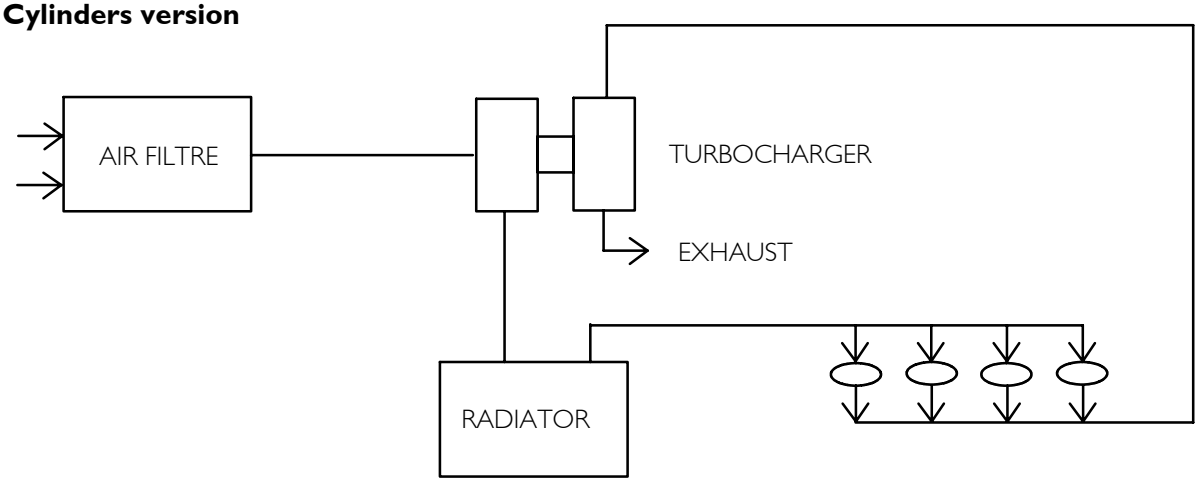


COOLING SYSTEM LAYOUT
6-cylinder engines

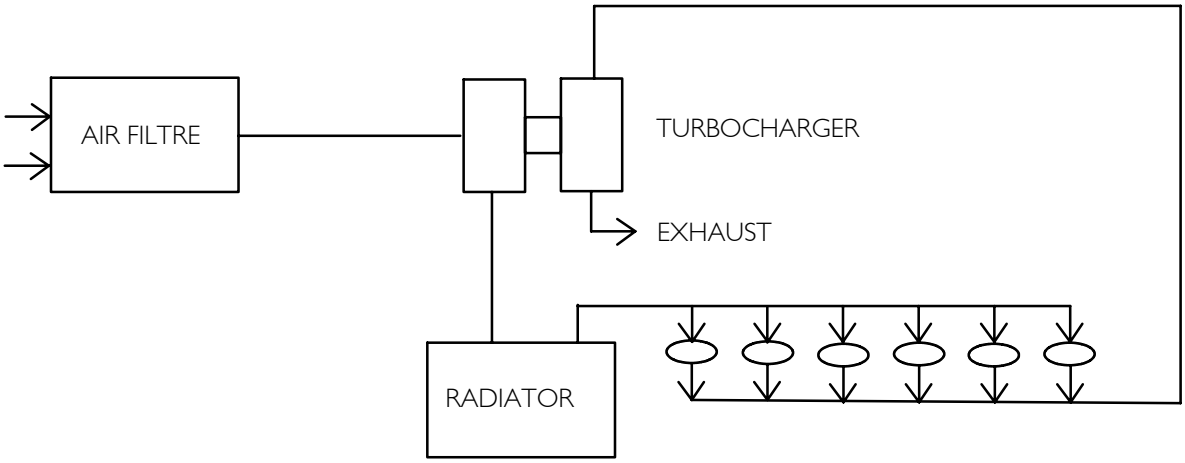
AIR INDUCTION - BOOST DIAGRAM

Figure 6

4 Cylinders version



6 Cylinders version



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Description

The turbocharger is composed by the following main parts: one turbine, one transforming valve to regulate the boost feeding pressure , one main body and one compressor.

During engine working process, the exhaust emissions flow through the body of the turbine, causing the turbine disk wheel's rotation.

The compressor rotor, being connected by shaft to the turbine disk wheel, rotates as long as this last one rotates, compressing the drawn air through the air filter.

The above mentioned air is then cooled by the radiator and flown through the piston induction collector.

The turbocharger is equipped with a transforming valve to regulate the pressure , that is located on the exhaust collector before the turbine and connected by piping to the induction collector.

It's funchon is to restrict the exhaust of the emissions , releasing part of them directly to the exhaust tube when the boost feeding pressure, over the compressor, reaches the prescribed bar value.

The cooling process and the lubrication of the turbocharger and of the bearings is made by the oil of the engine.

SECTION 2

Fuel

HIGH PRESSURE ELECTRONIC INJECTION SYSTEM (COMMON RAIL)

Introduction

Extremely high injection pressures are necessary in order to reduce PARTICULATE emissions.

The common rail system makes it possible to inject fuel at pressures of up to 1450 - 1600 bar, while the injection precision obtained by electronic control of the system serves to optimise operation of the engine while limiting emissions and fuel consumption.

For engines more powerful than 152 kW, the CRIN2 injectors have DLLA nozzles that work up to a pressure of 1600 bar, whilst for engines less powerful than 152 kW, DSLA nozzles are fitted which work a pressures up to 1450 bar.

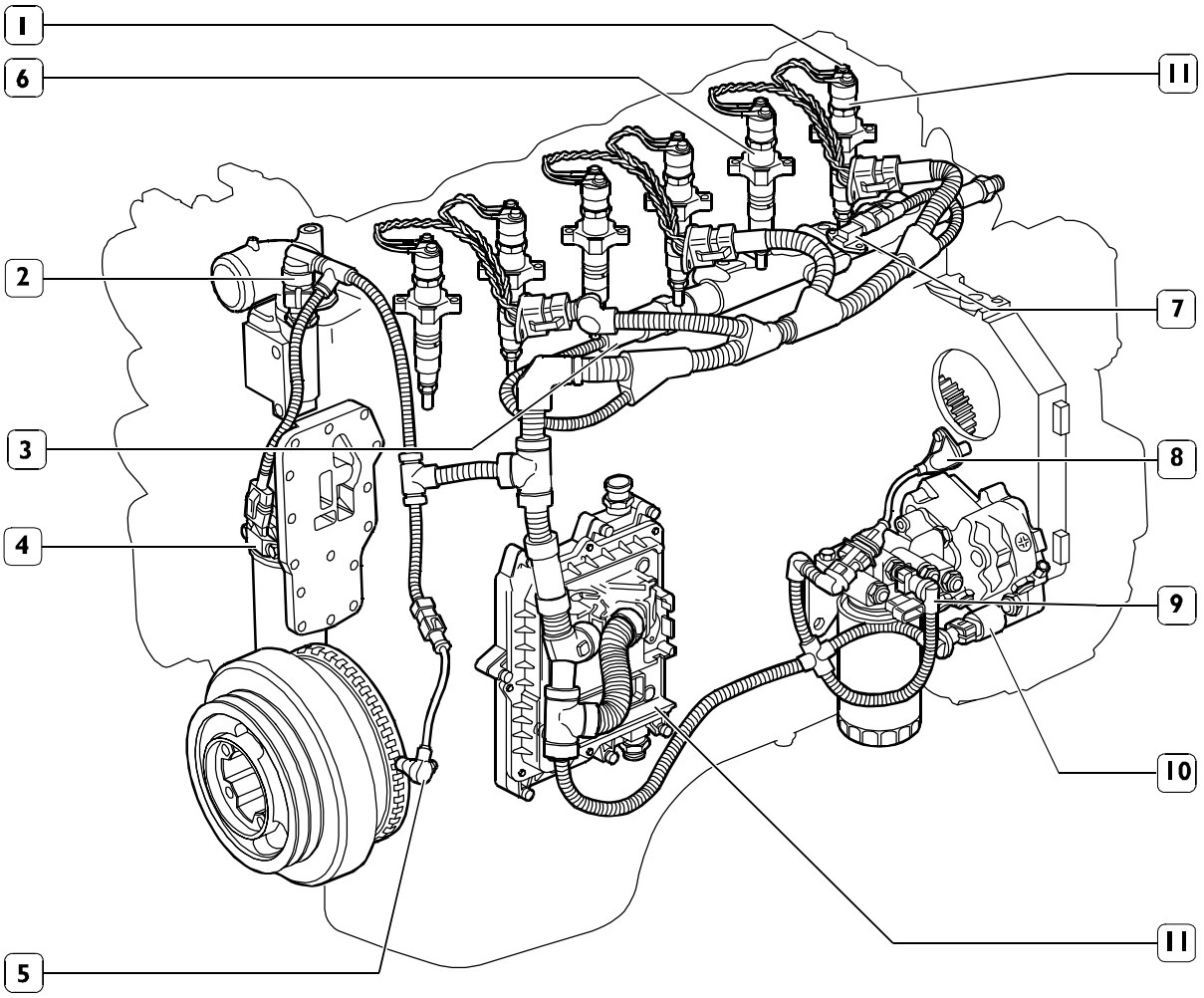
Description of system

The injection system is composed of an electrical part and a hydraulic part.

Electrical system

The electronic control unit monitors engine control parameters by means of the various sensors on the engine.

Figure 1



1. Connection to Electro-injectors - 2. Sensor monitoring temperature of engine's cooling liquid - 3. Fuel pressure sensor cable - 4. Sensor of engine's oil temperature and pressure -
5. Driving shaft sensor - 6. Electro-injector - 7. Temperature and air pressure sensor -
8. Camshaft sensor - 9. Fuel heater cable and fuel temperature sensor -
10. Pressure gauge cabling - 11. EDC 7 gearbox.

EDC 7 OPERATION

Engine preheating element control

Pre-post heating is activated when even just one of the water, air or fuel temperature sensors detects a temperature ≤ 5 °C.

Phase recognition

By means of signals transmitted by the camshaft and crankshaft sensors, the cylinder into which fuel must be injected is determined at the time of starting.

Injection control

On the basis of information transmitted by the sensors, the control unit administrates the pressure regulator and modifies the pre-injection and main injection mode.
On F4 engines pre-injection is activated at all engine speeds.

Injection pressure closed loop control

On the basis of the engine load, as determined by processing of data transmitted by the various sensors, the control unit administrates the regulator to maintain injection pressure at constantly optimal values.

Pilot and main injection advance control

On the basis of signals transmitted by the various sensors, the control unit determines the optimum injection point on the basis of internal mapping.

Idle speed control

The control unit processes signals transmitted by the various sensors and adjusts the quantity of fuel injected.
It also controls the pressure regulator and modulates injection duration of the electro-injectors.
Within specific limits, the control unit also monitors battery voltage.

Overheating protection

If the water temperature reaches 110 °C, the control unit reduces engine performance.
When the temperature returns below 100 °C, the engine resumes normal operation, (in some applications, the over boosting temperature is the reference temperature).

Maximum engine speed limiting

Depending on the application, the control unit memory can contain appropriate engine speed limits. When the engine speed surpasses these limits the control unit activates power reduction strategies by controlling energization time of the electro-injectors. In some applications the maximum limiting response consists in stopping the engine.

Cut Off

Fuel cut-off in release phases is managed by the control unit with the following logical interventions:

- ❑ disactivation of the electro-injectors;
- ❑ reactivation of electro-injectors immediately prior to arrival at idle speed;
- ❑ control of fuel pressure regulator.

Smoke control under acceleration

With intense load demands, in accordance with signals received from the air inlet meter and the engine speed sensor, the control unit manages the pressure regulator and modulates the activation time of the electro-injectors to prevent the emission of smoke from the exhaust.

After Run

After the engine is stopped, the control unit microprocessor saves various parameters to the EEPROM memory, including the faults log so that they will be available the next time the engine is started.

Control of working speed in normal operating conditions

Each time work load varies, the control unit adjusts torque so as to maintain the engine in maximum power conditions. If the load causes a reduction in power, the control unit increases torque i.e. it increases the amount of fuel injected in order to restore the engine to maximum power.

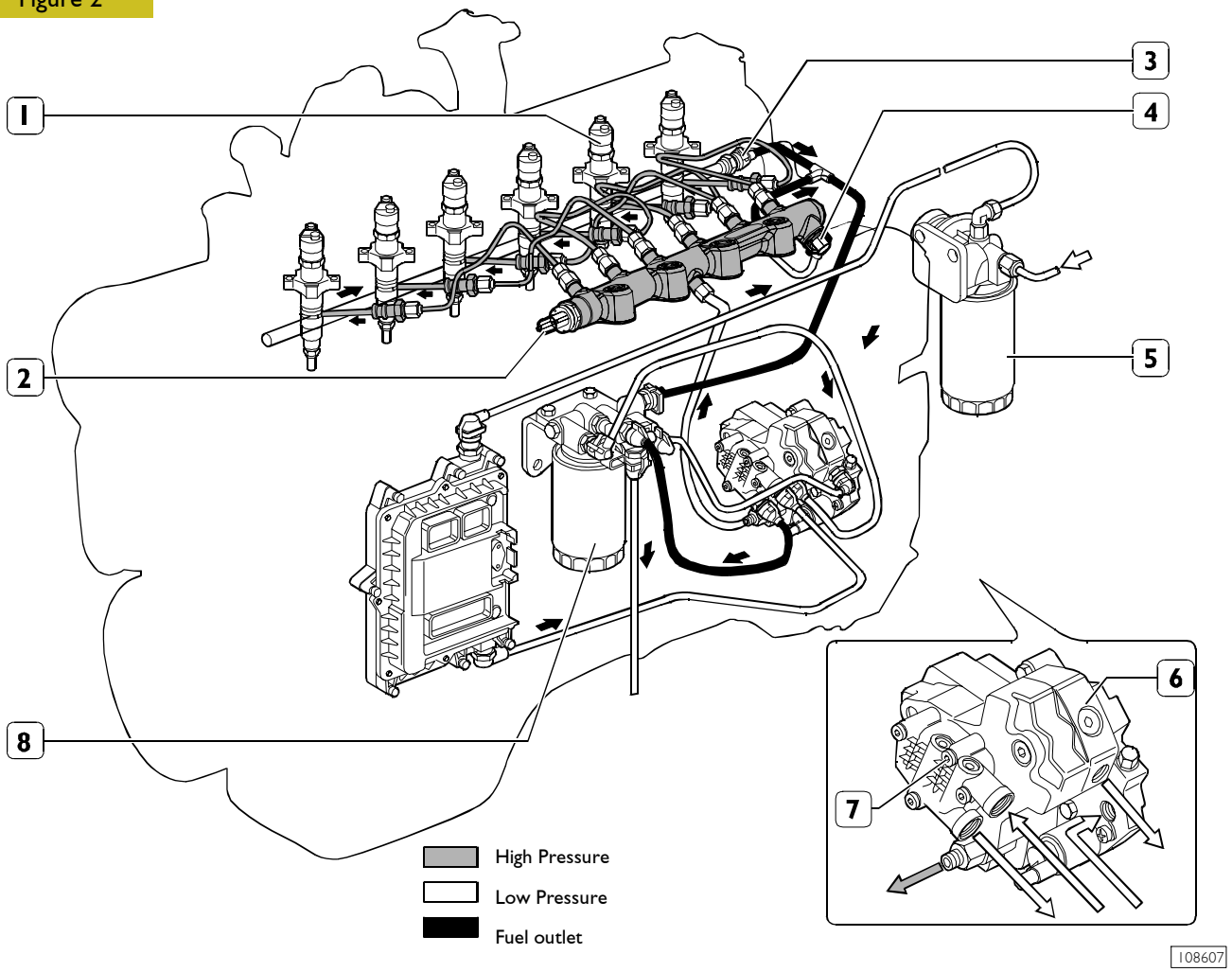
Recovery strategies

Recovery strategies are characterized by certain differences as application varies, i.e.

- ❑ Control of fuel leaks
  In the case of fuel supply problems, the system controls the engine with suitable constant power values obtained with a low number of revs and high torque values in order to inject the maximum quantity of fuel.
- ❑ Control of pressure in the rail
  When the pressure in the rail exceeds safety values, the engine reduces power.
- ❑ Synchronism problems
  In the case of synchronism problems, faulty rev sensors, the system controls the engine by increasing the number of revs in order to improve interpretation of the signals.
- ❑ Power restrictions as operating temperature increases
  When the temperature of the supercharging air rises above 88 °C, power reduction is started; when a temperature of 120 °C is reached, performance is further reduced and is comparable to that of the same engine if it were aspirated.
- ❑ Reduction of power as reference temperature varies
  In normal operating conditions, the system knows the supercharging air, oil and water temperatures.
  If the temperature of the engine water is not available, the system takes the temperature of the oil as reference and when this reaches the threshold of 103 °C, it starts to reduce the power available. On reaching 113 °C, power is reduced to 50%.

WORKING PROCESS

Figure 2



1. Electro-injector - 2. Common Rail - 3. Pressure limiting device for fuel return - 4. Common rail pressure relief valve - 5. Pre-filter mounted on the frame - 6. High-pressure pump - 7. Mechanical vane pump - 8. Fuel filter.

The Common Rail system has a special pump that continuously keeps fuel at high pressure, independently from stroke and cylinder that has to receive the injection and accumulates fuel in a common duct for all injectors.

Therefore, fuel at the injection pressure computed by the ECU is always available at the injectors inlet.

When an injector solenoid valve is energised by the electronic control unit, the injection of fuel directly taken from rail takes place in the related cylinder.

The hydraulic system is implemented by a low-pressure circuit and a high-pressure circuit.

The high-pressure circuit is composed of the following pipings:

- ❑ piping connecting high-pressure pump outlet to rail;
- ❑ pipings supplying injectors from rail.

The low-pressure circuit is composed of the following pipings:

- ❑ fuel suction piping from tank to prefilter;
- ❑ pipings supplying the mechanical supply pump through the control unit heat exchanger, manual priming pump and prefilter;
- ❑ pipings supplying the high-pressure pump through the fuel filter.

The fuel draining circuit from rail and from injectors and the high-pressure pump cooling circuit complete the system.

FUEL SYSTEM LAYOUT

This fuel system is a Common Rail injection with CP3 high pressure pump and this layout is for 4 cylinder version. (The 6 cylinder version is similar design as the 4 cylinder engine).

The pressure regulator, placed upstream of the high-pressure pump, adjusts the fuel flow that is necessary on the low-pressure system. Afterwards, the high-pressure pump takes care of supplying the rail properly. This arrangement, by pressurising the necessary fuel only, improves the energetic efficiency and limits fuel heating in the system.

Function of the pressure relief valve (2), assembled on the high-pressure pump, is keeping the pressure, at the pressure regulator inlet, constant at 5 bars, independently from the efficiency of the fuel filter and of the system set upstream.

The pressure relief valve (2) intervention brings about a fuel flow increase in the high-pressure pump cooling circuit, through inlet and drain piping (16) from piping (8).

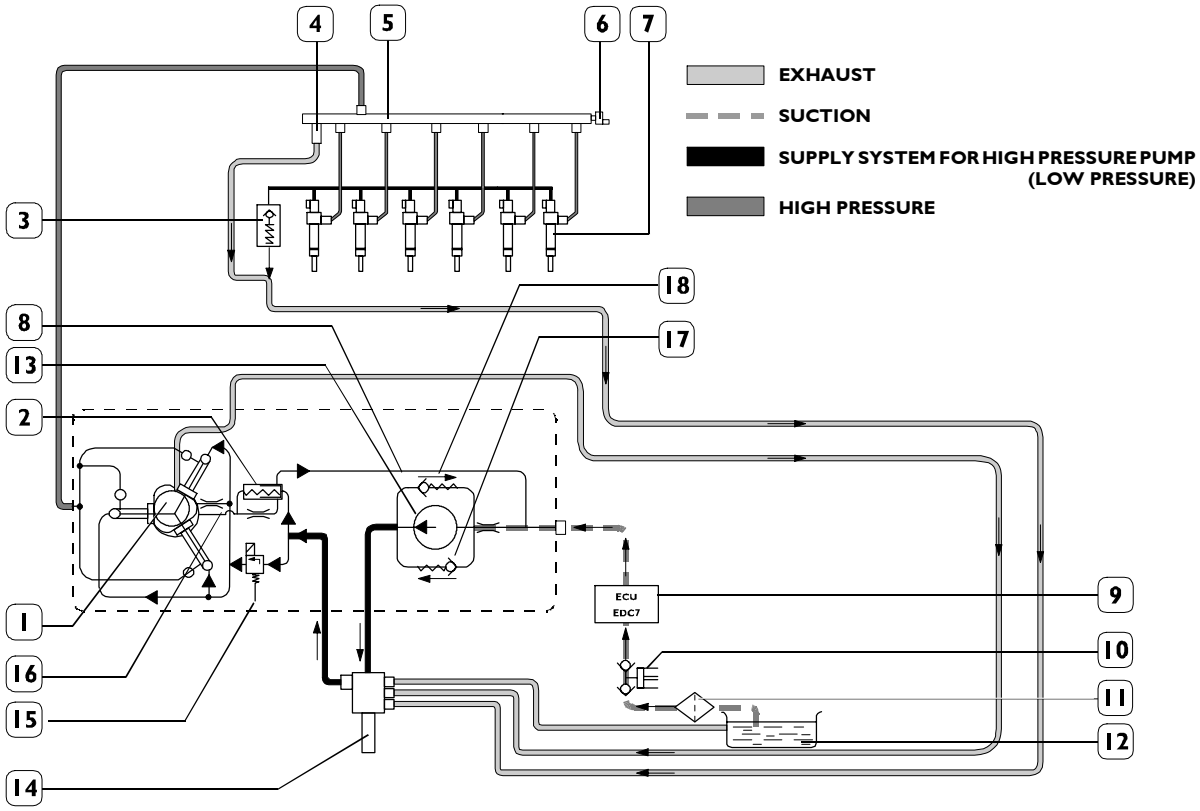
The pressure relief valve housed on the cylinder head, assembled on injector return (3), limits the fuel return flow from injectors at a pressure of 1.3 to 2 bars.

Two by-pass valves are placed in parallel with the mechanical supply pump.

The by-pass valve (18) allows fuel to flow from mechanical pump outlet to its inlet, when the fuel filter inlet pressure exceeds the allowed threshold value.

The by-pass valve (17) allows filling the supply system through the manual priming pump (10).

Figure 3



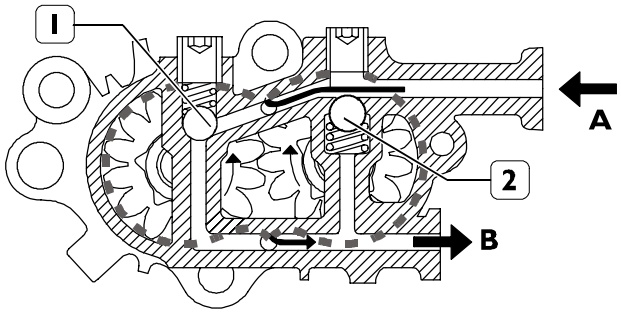
1. High-pressure pump. – 2. Pressure relief valve on high-pressure pump, 5 bars. – 3. Pressure relief valve assembled on fuel return from injectors, 1.3 to 2 bars. – 4. Rail overpressure valve. – 5. Common Rail. – 6. Pressure sensor. – 7. Injector. – 8. Return piping. – 9. Control unit heat exchanger. – 10. Mechanical priming pump. – 11. Prefilter assembled on chassis. – 12. Fuel tank. – 13. Mechanical supply pump. – 14. Fuel filter. – 15. Pressure regulator. – 16. High-pressure pump cooling piping. – 17. By-pass valve. – 18. By-pass valve.

MECHANICAL FEEDING PUMP

Gear pump, placed on rear part of the high pressure pump, whose function is to feed the high pressure pump. It is driven by the high pressure pump's shaft.

Ordinary working condition

Figure 4

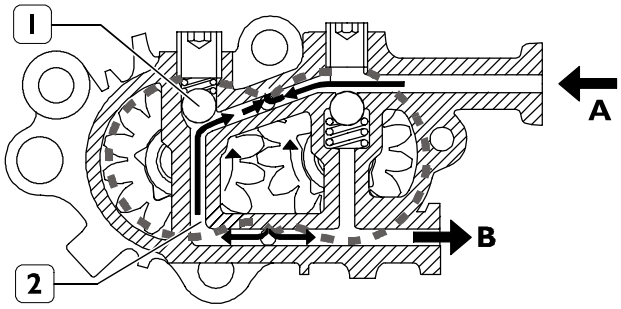


72592

A- Fuel entry flowing from the tank. B- Fuel exhaust to filter, 1 - 2 By-pass valves in close position.

Overpressure condition in Exhaust unit

Figure 5

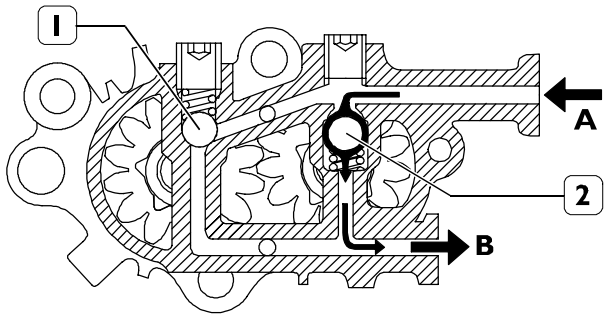


72593

The by-pass valve (1) is activated in case of overpressure on B Exhaust unit. The actual pressure, overcoming the resistance of the valve's spring (1), connects the exhaust with the entry through the gallery (2).

Jettison condition

Figure 6



72594

The dump by-pass valve (2) is activated in case, when the engine is off, it is necessary to fill the feeding system through the priming pump. In this condition the by pass valve (1) keeps closed while the dump by-pass valve (2) opens up due to the pressure effect on the entry unit so the fuel flows to the exhaust unit B.

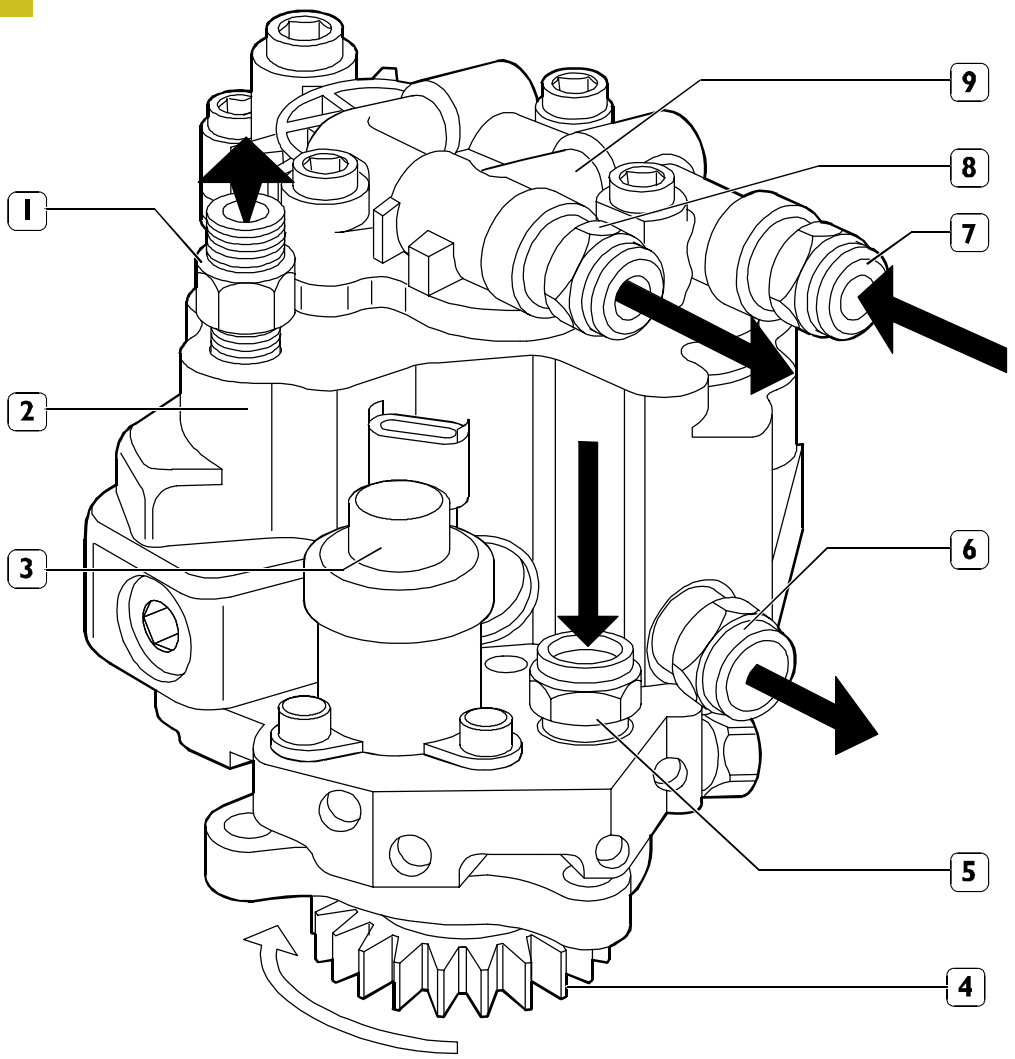
The mechanical feeding pump cannot be replaced separately, therefore it must not be disassembled from the high pressure pump.

CP3 HIGH PRESSURE PUMP

Pump provided with 3 radial pumping elements driven by the timing system gear, no need of timing. The mechanical feeding pump driven by the high pressure pump's shaft is assembled to the rear side of the high pressure pump.

The high pressure pump unit - feeding pump is not subject to overhaul , therefore it must not be disassembled neither the fixing screws must be tampered.
The only allowed interventions concern control gear and pressure regulator replacement.

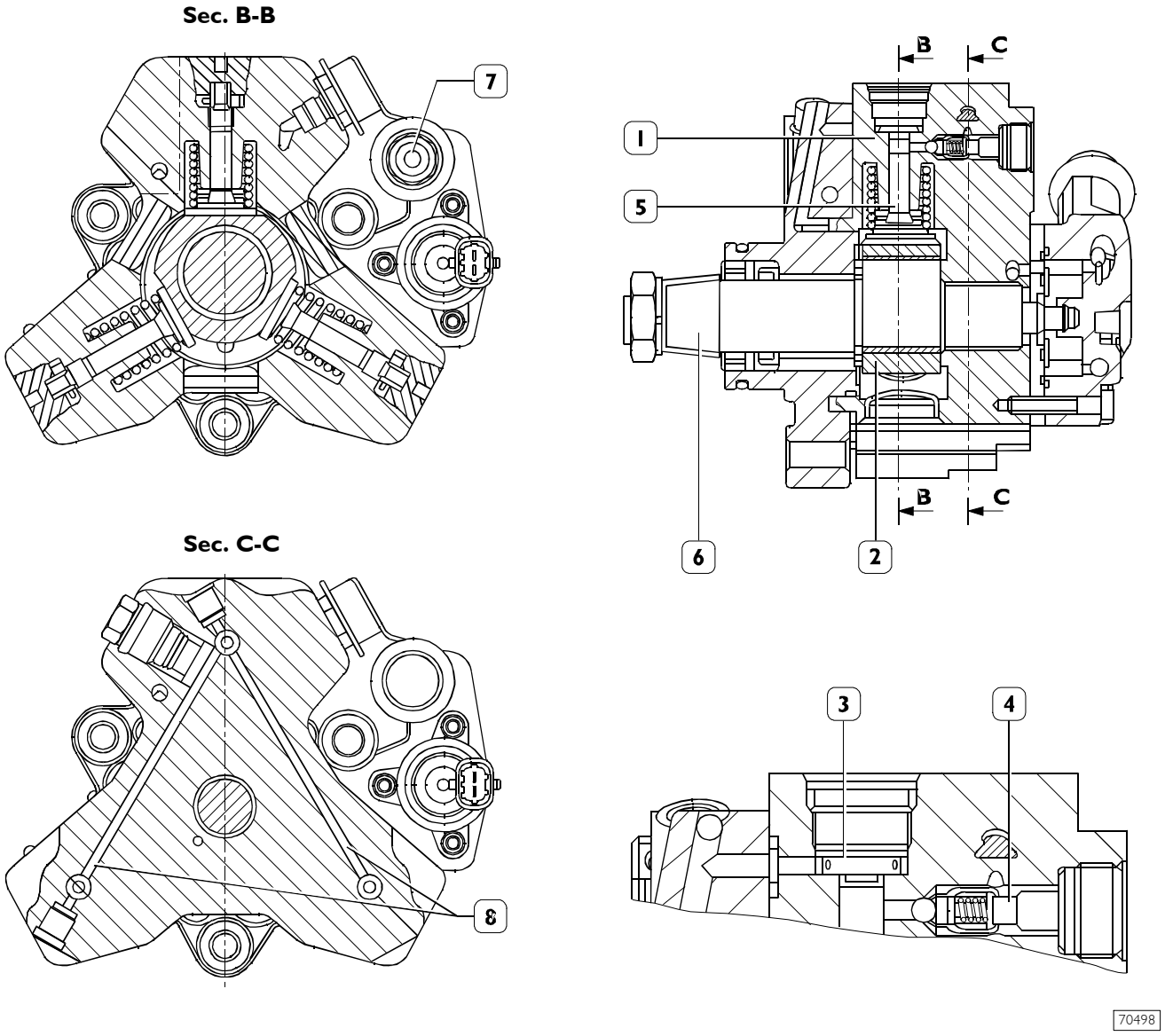
Figure 7



1. Fuel exhaust connector to rail - 2. High pressure pump - 3. Pressure regulating gauge - 4. Driving gear - 5. Connector to fuel entry flowing from filter - 6. Connector to fuel exhaust to filter support - 7. Connector to fuel entry flowing from engine control module heat exchanger - 8. Connector to fuel exhaust flowing from mechanic pump to filter - 9. Mechanical feeding pump.

High pressure pump-inside structure

Figure 8



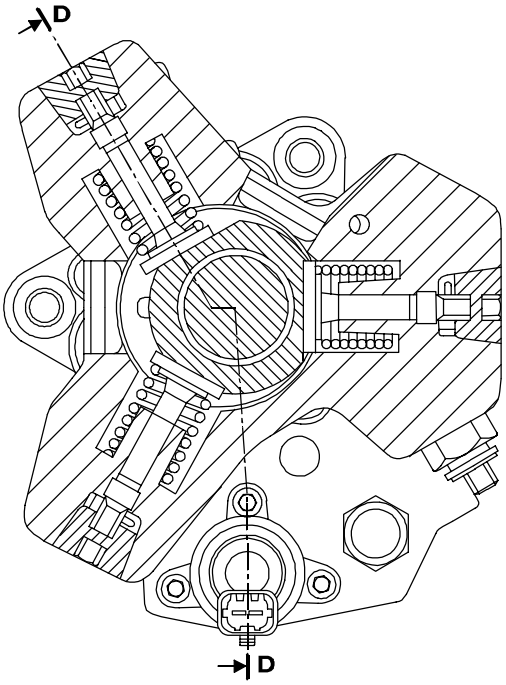
1. Cylinder. – 2. Three-lobe element. – 3. Cap intake valve. – 4. Ball delivery valve. – 5. Piston. – 6- Pump shaft. – 7. Low-pressure fuel inlet. – 8. Pumping elements supplying fuel ducts.

Every pumping unit is composed of:

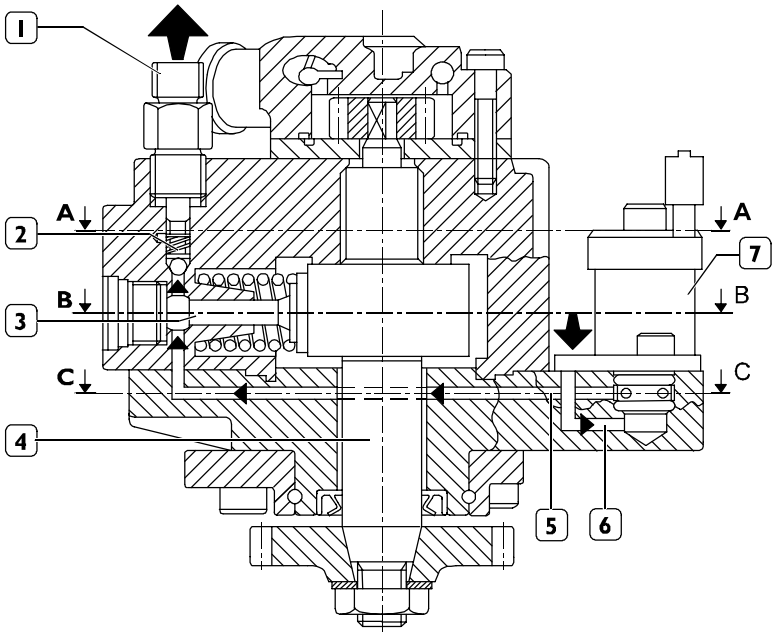
- a piston (5) actuated by a three-lobe element (2) floating on the pump shaft (6). The element (2), being floating on a misaligned part of the shaft (6), when the shaft rotates, does not rotate therewith but is only translated in a circular movement along a wider radius, with the resulting alternate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

Working principle

Figure 9



Sec. B-B



Sec. D-D

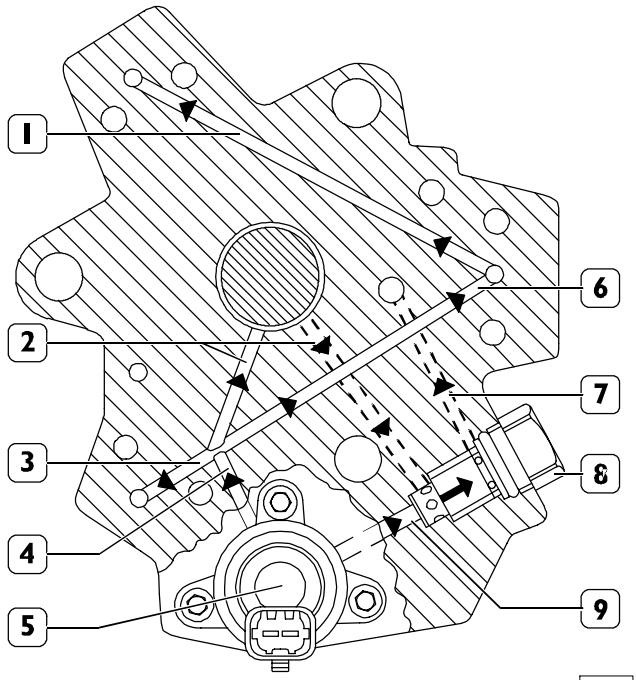
72597

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.

The pumping element (3) is orientated towards the pump's camshaft (4). During the intake phase, the pumping element is fed through the feeding line (5). The quantity of fuel to flow to the pumping element is determined by the pressure regulating gauge (7). The pressure regulating gauge, according to the PWM command received by the engine control module, stops the fuel flow to the pumping element.

During compression phase of the pumping element, the fuel achieves the level of pressure determining the opening of the by-pass valve to common rail (2), feeding it through the exhaust unit (1).

Figure 10



Sec. C - C

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.

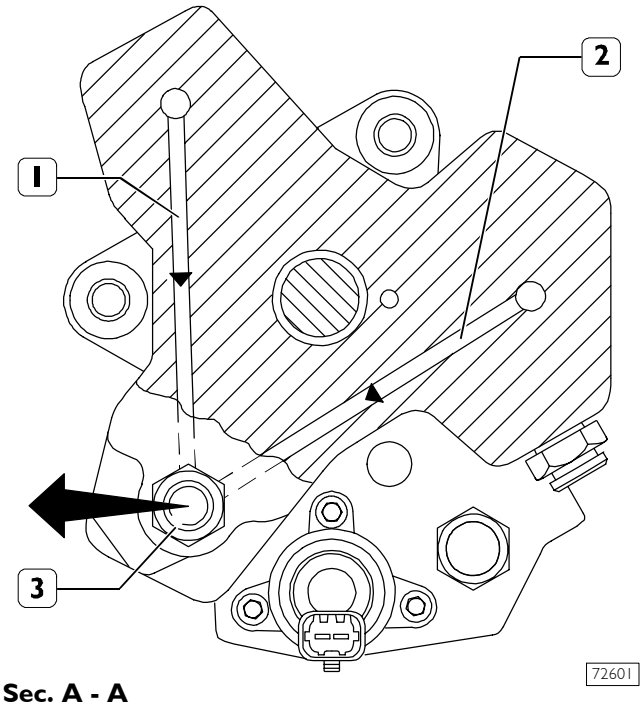
Figure 10 shows the fuel runs at low pressure inside the pump; the following elements are clearly visible: the main feeding line to the pumping elements (4); the feeding lines to the pumping elements (1-3-6), the duct lines run for the pump lubrication (2), the pressure gauge (5), the flow limiting valve to 5 bar (8) and the fuel exhaust flue (7).

The pump shaft is lubricated by the fuel through the feeding and recovery lines.

The pressure gauge (5) determines the quantity of fuel to feed the pumping elements: the fuel in excess flows through the exhaust gallery (9).

The limiting valve to 5 bar, in addition to recovering fuel exhaust as a collector has also function to keep the pressure constant to 5 bar limit at gauge entry.

Figure 11



Sec. A - A

1. Fuel exhaust flue - 2. Fuel exhaust gallery - 3 Fuel exhaust flowing from pump with connector to high pressure pipe for common rail.

Figure 11 shows the fuel flow under high pressure running through the exhaust galleries of the pumping elements.

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 between **250** and **1600** bars by the electronic control unit, through the pressure regulator solenoid valve.

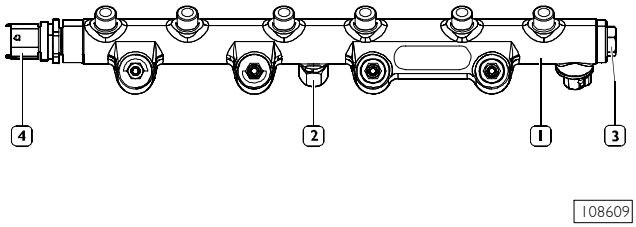
The pump is lubricated and cooled by the fuel.

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

Figure 12



1. Rail – 2. Fuel inlet from high-pressure pump – 3. Overpressure valve - 4. Pressure sensor.

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

It anyway has enough volume as to minimise system spikes and the 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 (4) 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.

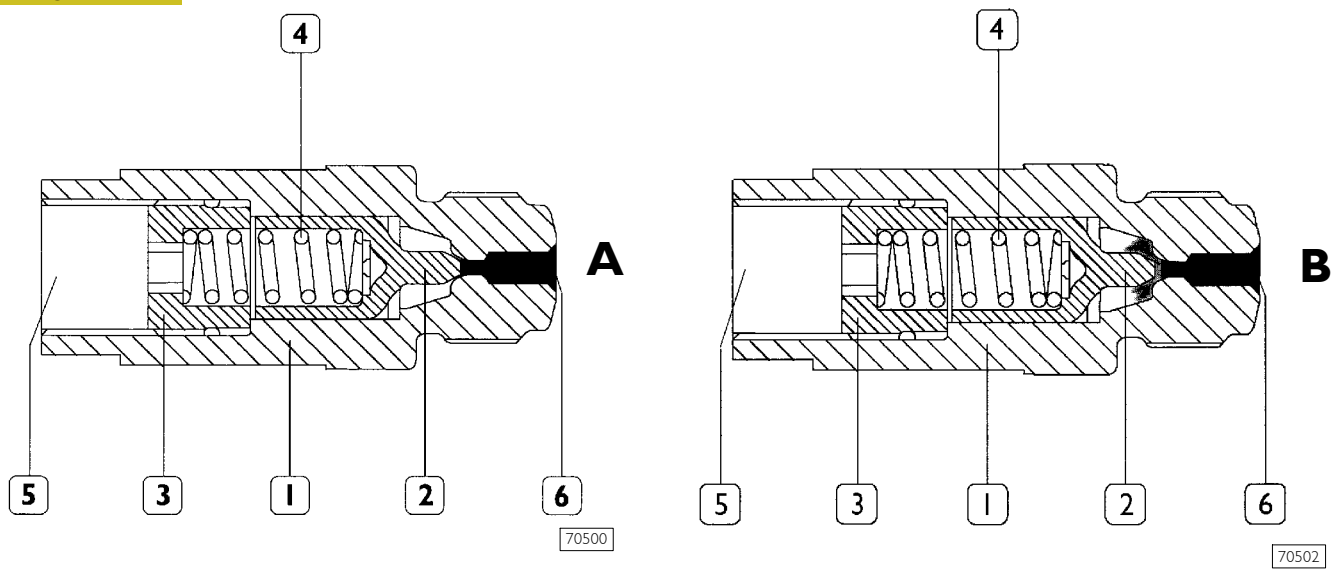
BOOST GAUGE VALVE

The boost valve (1750 bars) is assembled to the rail with the purpose to protect the system's components in case of excessive increase of pressure within the high pressure system. Pressure limiter.

The valve can be single-stage (as the one showed in the picture) or double-stage with double working limit (1750 bars and 800 bars).
In the second case, when the pressure within the high pressure system reaches 1750 bars, the valve is activated as a single-stage one to exhaust the fuel and consequently reduce the pressure until reaching safety parameters. Then it provides mechanically gauging the pressure into rail to aprx. 800 bars. This way the valve enables working of the engine for extended timing at limited performances, avoiding the fuel's overheating and preserving the exhaust galleries.

If the above mentioned valve is activated, the engine control module excludes by isolation the pressure gauge and records the errore code 8.4.
The pump will flow the maximum delivery to the rail.

Figure 13



1. Body – 2. Small piston – 3. Stop – 4. Spring – 5. Direct tank discharge – 6. Seat on rail.

A Normally, the tapered piston end keeps closed the discharge towards the tank.

B If the 1750 bar fuel pressure is exceeded in rail, the small piston is displaced and the excess pressure is discharged into the tank.

ELECTRO-INJECTOR

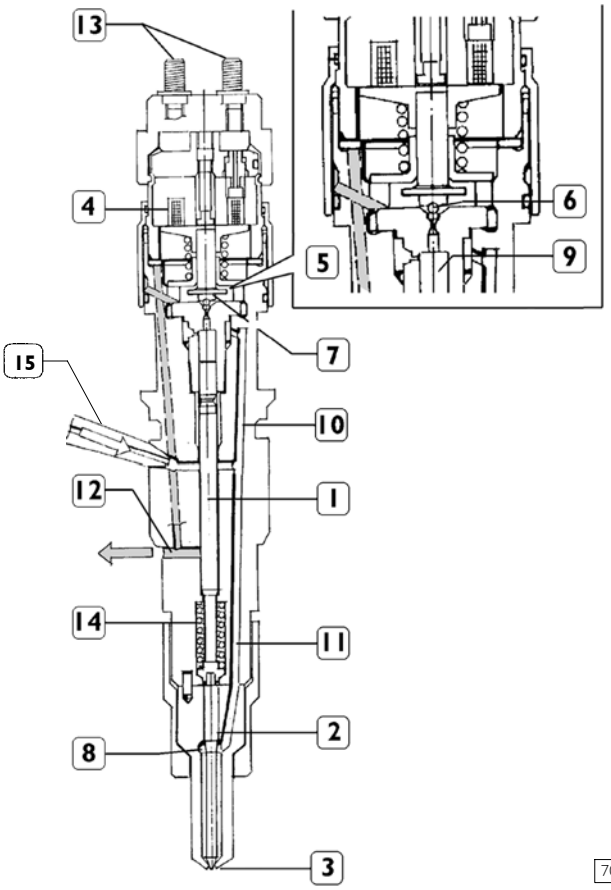
The injector is similar as construction to the traditional ones, apart from the absence of plunger return springs.
The injector can be deemed as composed of two parts:

- actuator – spray nozzle composed of pressure rod (1), plunger (2) and nozzle (3);
- control solenoid valve composed of coil (4) and pilot valve (5).

The solenoid valve controls spray nozzle plunger lift.

Injector in rest position

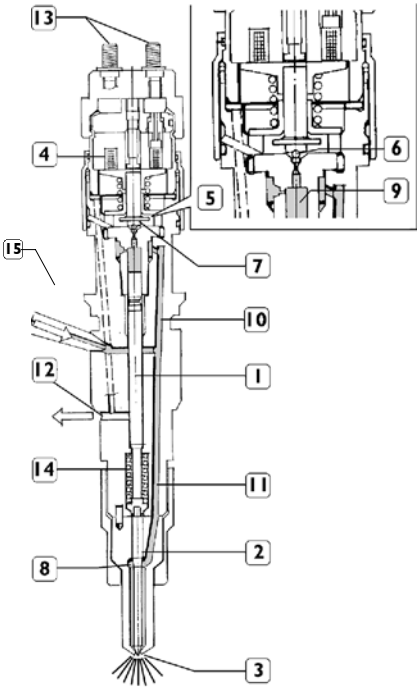
Figure 14



1. Pressure rod – 2. Plunger – 3. Nozzle – 4. Coil – 5. Pilot valve – 6. Ball shutter – 7. Control area – 8. Pressure chamber – 9. Control volume – 10. Control duct – 11. Supply duct – 12. Control fuel outlet – 13. Electric connection – 14. Spring – 15. High-pressure fuel inlet.

Injection start

Figure 15



When coil (4) is energised, it makes shutter (6) move upwards. The control volume (9) fuel flows towards flow duct (12) making a pressure drop occur in control volume (9). Simultaneously the fuel pressure into pressure chamber (8) makes plunger (2) lift, with following fuel injection into the cylinder.

Injection end

When coil (4) is de-energised, shutter (6) goes back to its closing position, in order to re-create such a force balance as to make plunger (2) go back to its closing position and end the injection.

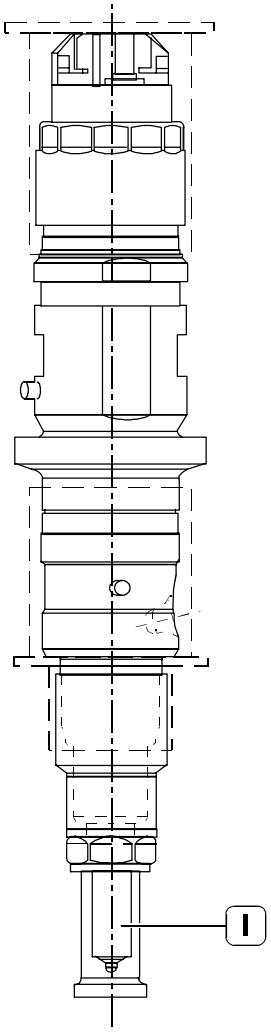
The injector cannot be overhauled and therefore it must not be disassembled.

Electro-injector

The injectors fitted on the NEF TIER 3 engines are the CRIN 2 - BOSCH versions. Depending on the power developed by the engine (more than or less than 152 kW) different nozzles (1) are fitted (DLLA or DSLA).

Jet	Powers	Pressures
DLLA	Up to 152 kW	250 ÷ 1600 bar
DSLA	Lower to 152 kW	250 ÷ 1450 bar

Figure 16

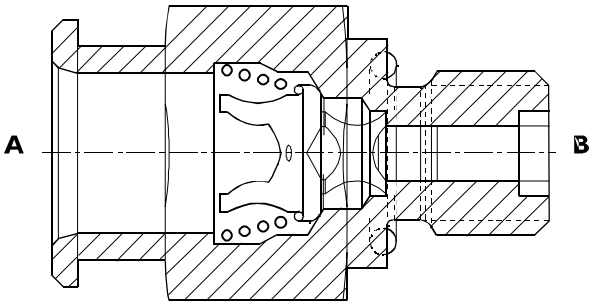


1. Jet.

PRESSURE LIMITER FOR FUEL RETURN

It is housed on the rear of the cylinder head, and adjusts the pressure of fuel returning from injectors at a pressure 1.3 and 2 bars. By guaranteeing this pressure to the return fuel, the fuel vapours formation inside injectors is avoided, optimising fuel spraying and combustion.

Figure 17



A To tank – **B** From injectors

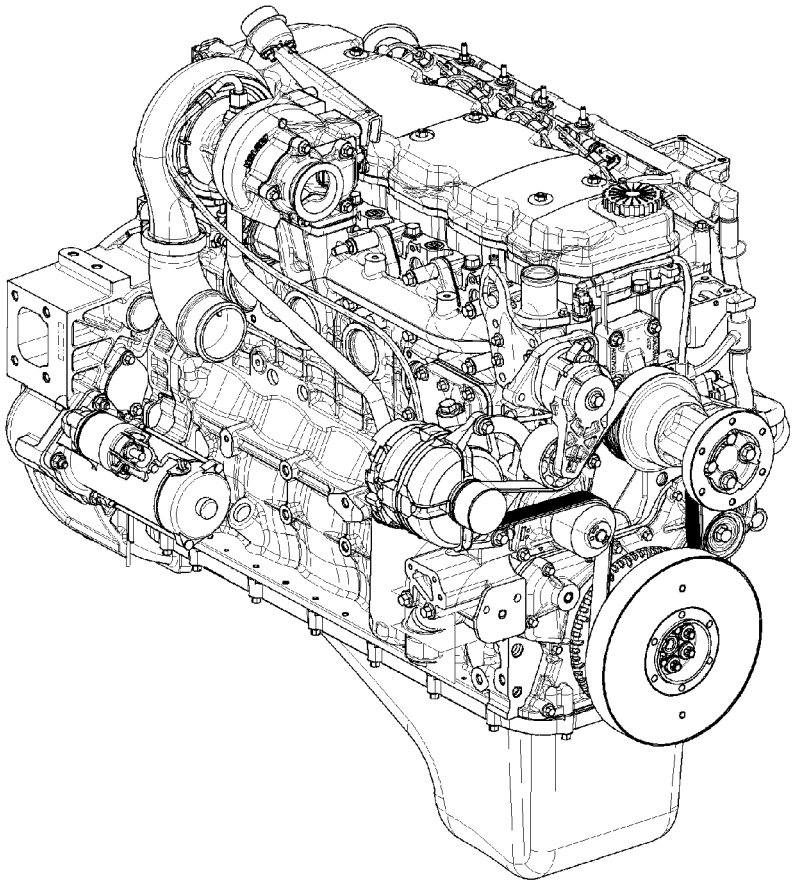
SECTION 3

Duty-industrial application

GENERAL SPECIFICATIONS

Section pictures of complete engine - common rail version

Figure 1



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The NEF F4HE engines are characterised by four-stroke diesel cycles supercharged with 4 or 6 cylinders with 4 valves per cylinder.

They have high pressure injection fuelling (common rail) and are entirely electronically driven in order to optimise the working process in accordance to the operation, limiting as much as possible the pollution emissions and consumption.

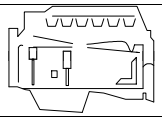
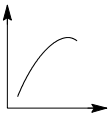
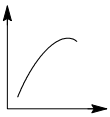
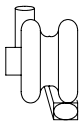
Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

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

The section herein described is composed or four sections:

- Section of mechanical overhaul prescribed in accordance to the engine's specific duty, illustrating all necessary operation to remove and assembly the external components of the engine, including cylinder heads, gearbox of the timing system and of the front part cover;
- Electrical section, describing the connections to the different components of the engine control module and of the sensors assembled to the engine;
- Diagnosis section;
- Section of preventive maintenance operations, providing instructions for the execution of the main operations.

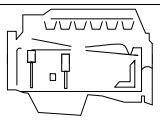
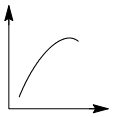
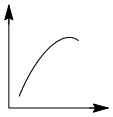
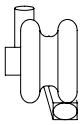
Clearance data - 4 cyl.

	Type		**F4HE9484A**
ϱ	Compression ratio		16.5 : 1
 	Max. output	kW (HP) rpm	104 141 2200
 	Max. torque	Nm (kgm) rpm	560 56 1400
	Loadless engine idling	rpm	-
	Loadless engine peak	rpm	-
	Bore x stroke		104 x 132
	Displacement		4485
	**TURBOCHARGING**		with intercooler
	Turbocharger type		HOLSET HX27W
	**LUBRICATION**		Forced by gear pump, relief valve single action oil filter
	Oil pressure (warm engine)		
	- idling	bar	0.7
	- peak rpm	bar	4.0
	COOLING		By liquid
	Water pump control		Through belt
	Thermostat		
	- start of opening	°C	82.2
 15W40 ACEA E3	**FILLING**		
	engine sump	liters	5.3
	engine sump + filter	liters	6.3

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

Furthermore, the use of the unit after overhaul showd conform to the original specified power and engine rev/min for which the engine has been designed.

Clearance data - 6 cyl.

	Type		**F4HE9684P**
ϱ	Compression ratio		17.5 : 1
 	Max. output	kW (HP) rpm	175 234 2300
 	Max. torque	Nm (kgm) rpm	1020 102 1500
	Loadless engine idling	rpm	-
	Loadless engine peak rpm	rpm	-
	Bore x stroke Displacement		104 x 132 6728
	**TURBOCHARGING** Turbocharger type		with intercooler HOLSET HX35W
 	**LUBRICATION** **Oil pressure (warm engine)** - idling - peak rpm	 bar bar	Forced by gear pump, relief valve single action oil filter 2 4
	COOLING **Water pump control** **Thermostat** - start of opening	 °C	By liquid Through belt 81 ± 2
 15W40 ACEA E3	**FILLING** engine sump engine sump + filter	 liters liters	 15 15 + 1

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

Furthermore, the use of the unit after overhaul showd conform to the original specified power and engine rev/min for which the engine has been designed.

PART ONE - MECHANICAL COMPONENTS

ENGINE OVERHAUL

Preface

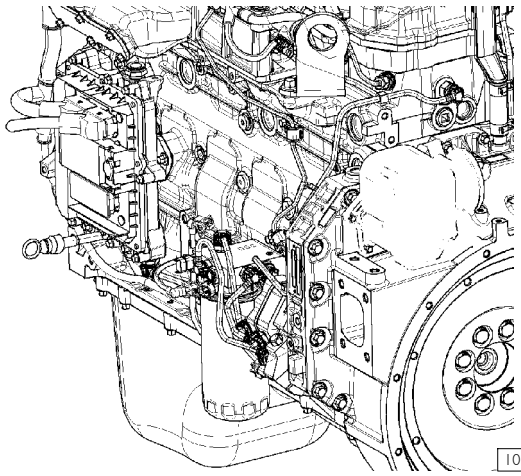
With regard to the engine disassembly operations from the machine, please apply for Information consulting the specific manual.
All operations of Engine disassembly operations as well as overhaul operations must be executed by qualified technicians provided with the specific tooling and equipment required.

The following information relates to the engine overhaul operations only for what concerns the different components customising the engine, according to its specific duties.

In section "General overhaul", all the operations of engine block overhaul have been contemplated. Therefore the above mentioned section is to be considered as following the part hereby described.

Engine setting operations for the assembly on turning stand

Figure 2



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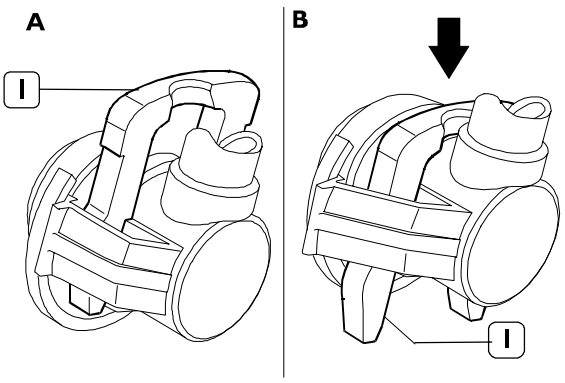
In order to apply the brackets 99341009 to the engine block to fix it on to the stand for the overhaul, it is necessary to perform the following operations on the left hand side of the engine:

- ❑ Using the tool 99360073 disassembly the fuel filter (6) and remove it from the support (1);
- ❑ Disconnect the electrical connection (2) from the support (1) and the heater's one (placed on the filter support as well);
- ❑ Disconnect the fuel low pressure pipelines (3-4-5) from the support (1);
- ❑ Disconnect pipeline (9) from the support (1);
- ❑ Remove the sustaining support bracket (1) from the block.

Figure 3



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Press clamp (1), as shown in Figure **B,** to disconnect the low pressure fuel pipes (3 – 4 – 5, Figure 2) from the corresponding connections.

After disconnecting the pipe, reset the clamp (1) in locking position (Figure **A**) to prevent distortions.

Disconnect the high pressure fuel pipeline (10, Figure 2) from the rail diffuser and from the high pressure pump (8) and disassemble it from the engine block removing the fixing clamps.

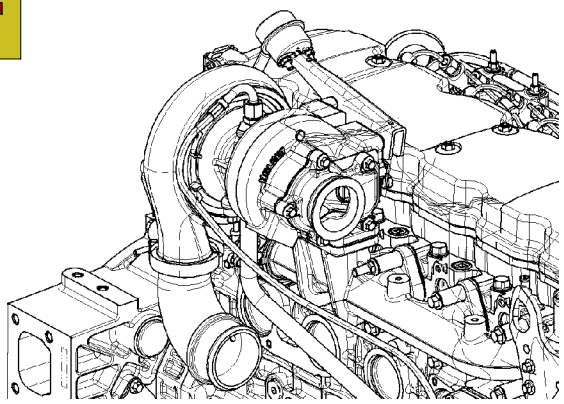
Disconnect the pipeline (7) feeding the mechanic pump that is combined to the high pressure pump through the exchanger of the engine control module.

Because of the high pressure in the pipelines running from the high pressure pump to the rail and from this last one to the electro-injectors, it is absolutely required NOT to:

- ❑ disconnect the pipelines when the engine is working;
- ❑ re-use the disassembled pipelines.

On the right hand side of the engine:

Figure 4



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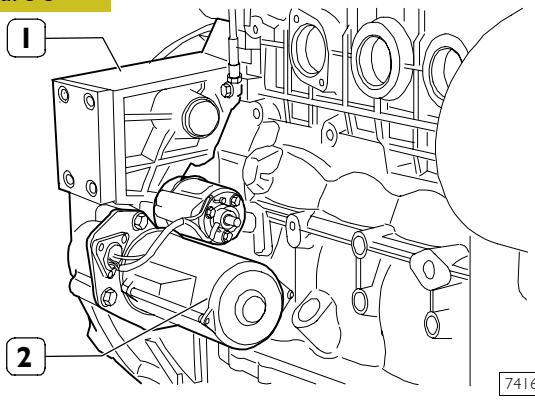
Remove the screws and remove the oil pipe (1) from the turbocharger pipe (2) and from the engine block.

Figure 5



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Disconnect the oil feed pipeline unlocking the three screws M12x25. Remove the O-ring from the pipe.

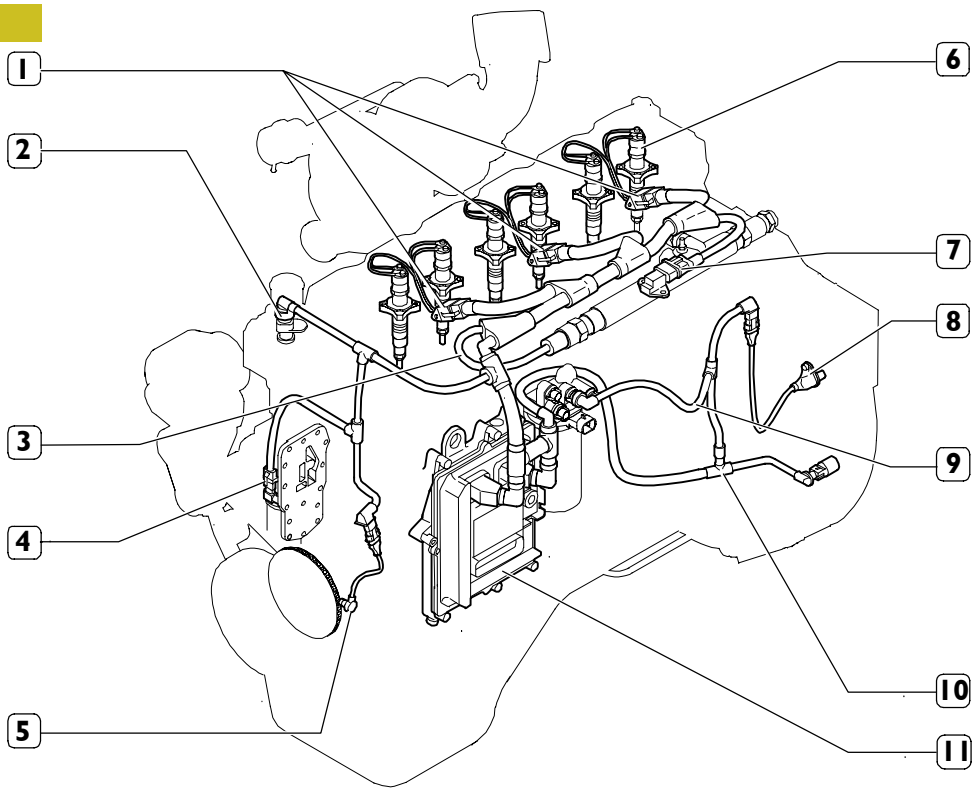
Remove the starter (2) from the flywheel housing (1).

Apply brackets 99361037 to engine block and use them to secure the engine to the revolving stand 99322205. Remove sump cap and drain out oil.

Remove the fan from the output shaft pulley.

Disassembly of application components

Figure 6

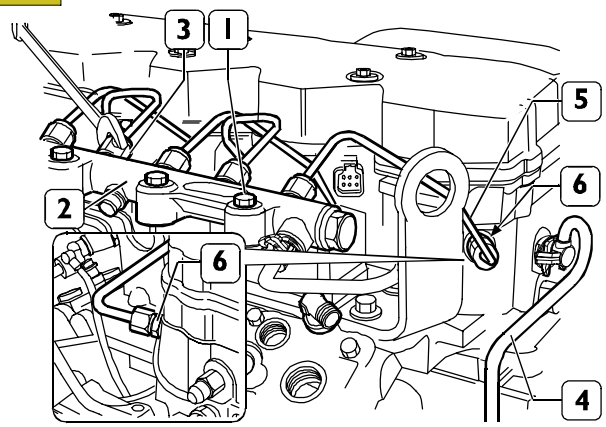


74168

1. Connections for Electro-injectors - 2. Engine cooling liquid temperature's sensor - 2. Cable of the fuel pressure sensor - 4. Sensor of engine's oil temperature and pressure - 5. Driving shaft sensor - 6. Electro-injector - 7. Temperature - air pressure sensor - 8. Timing system sensor - 9. Cable of fuel heater and fuel temperature's sensor - 10. Cable of pressure regulating gauge - 11. EDC 7 gearbox.

Disconnect the engine's cable from the connectors (1. Figure 6) wiring harness to
Electro-injectors (6); (7) air pressure/temperature sensor; (3) fuel pressure sensor;
(11) engine control module; (10) high pressure pump sensor; (8) timing system sensor; (2) Thermostat sensor of engine cooling liquid's temperature; (5) sensor of engine's revolutions.

Figure 7



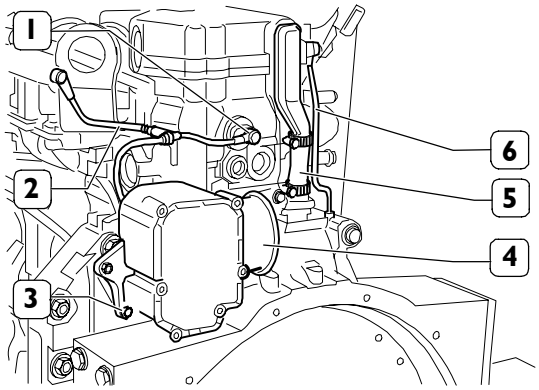
108543

Disconnect from the rail (2): the fuel pipe (7) according to procedures described in Figure 3. Disconnect fuel pipes (5) from rail (2) and injector manifolds (6).

When releasing pipe (6) connections (4) to rail (2), use the proper wrench to avoid rotation of flow limiters (3).

Remove the screws (1) and disconnect the rail (2).

Figure 8



74170

Disconnect the pipeline (2) from the fuel recover pressure-limiter, working on the connections as described in Figure 3.

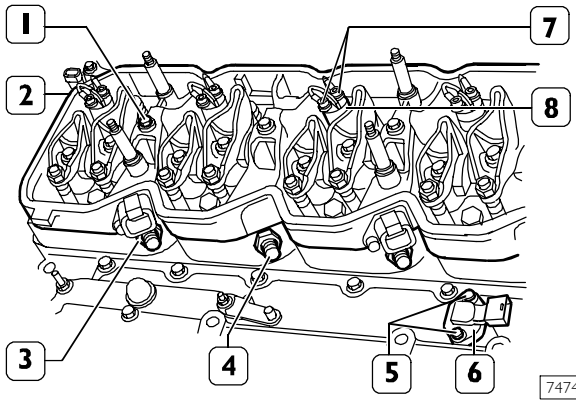
Unscrew the nut and loosen the clamp tightening the oil vapour pipe.

Remove the pipe (6).

Loosen the screws (3) and disassemble the blow-by filter (4).

Remove on the nuts and tappet cover.

Figure 9



74744

Remove nuts (7) and disconnect the electrical cables from injectors (8).

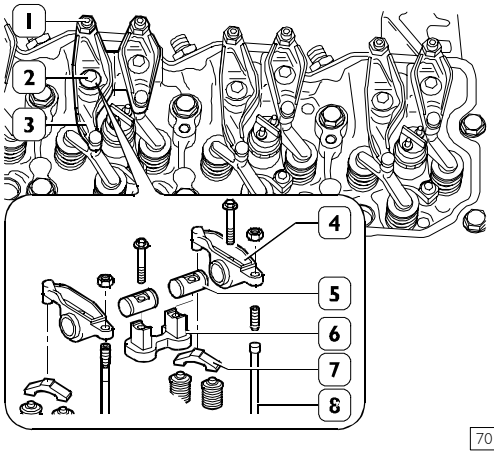
Remove screws (1) and disconnect injector wiring support (2) including the gasket.

Remove screws (5), disconnect air pressure/temperature sensor (6).

Remove nuts (3) and remove fuel manifolds (4).

Disassembled fuel manifolds (4) must not be used again, replace with new ones during reassembly.

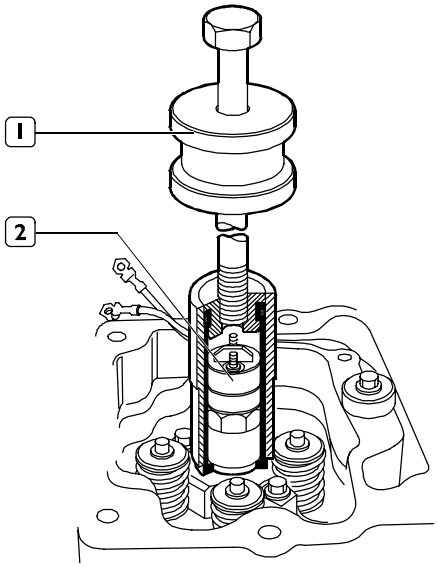
Figure 10



70132

Loosen tappet adjustment fastening nuts (1) and unscrew the adjusters.
Remove the screws (2), remove the rocker assembly (3), consisting of: bracket (6), rockers (4), shafts (5) and remove jumpers (7) from valves.
Remove rods (8).

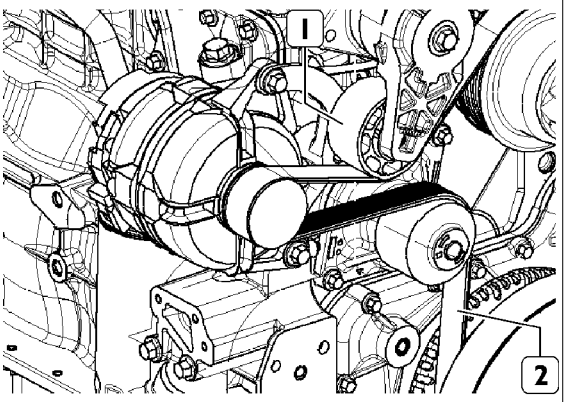
Figure 11



70133

Remove injector fastening screws. Use tool 99342101 (1) to remove injectors (2) from the cylinder head.

Figure 12



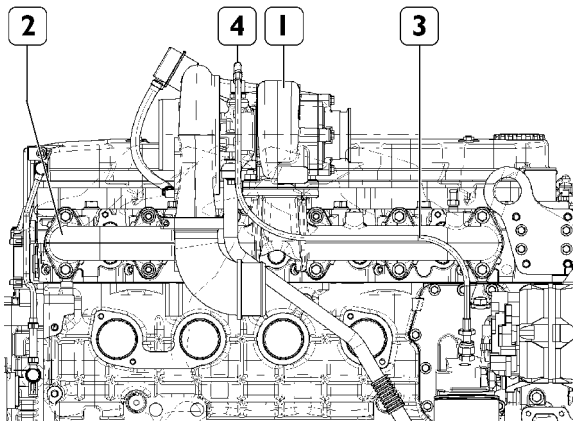
108545

Release on the drive belt tensioner (1) and extract the belt (2) from the belt pulleys from the water pump ones and from the belt rebound pulleys;

Disassemble the belt tensioner;

Loosen the screws fixing the alternator to the support and disassemble it.

Figure 13



108546

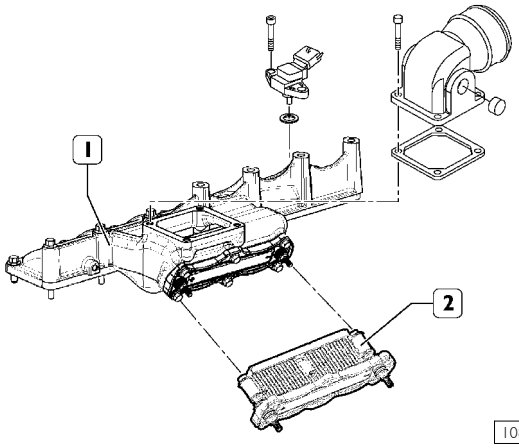
Remove the screw (4) holding the fixing clamp of the turbocharger's lubricating oil pipeline.

Disconnect the oil pipeline (3) from the supports of the heat exchanger / oil filter and from the pipe fitting (5) to the turbine.

Remove the fixing nuts and disassemble the turbocharger (1) from the exhaust collector (2).

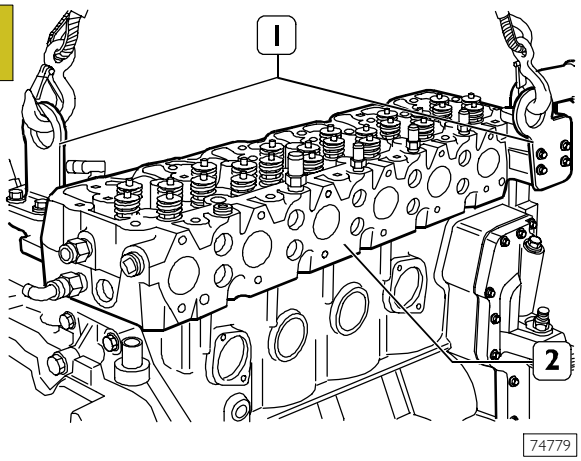
Loosen the screws and disassemble the exhaust collector (2) from the cylinder head.

Figure 14



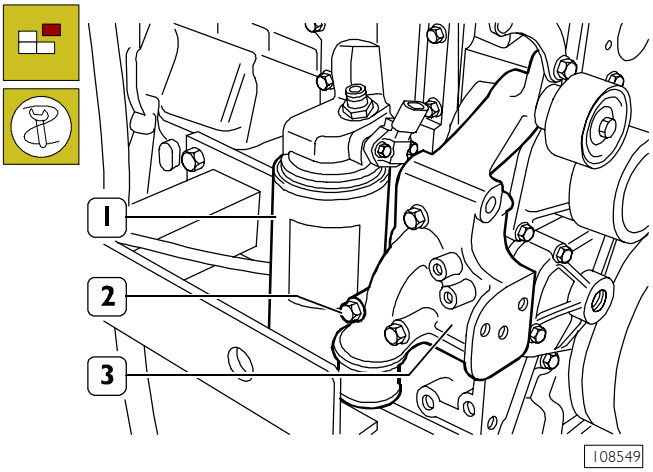
On the opposite side, loosen the fixing screws of the inlet manifold (1) and disassemble the joint to the air heater (2) for the cold start.

Figure 15



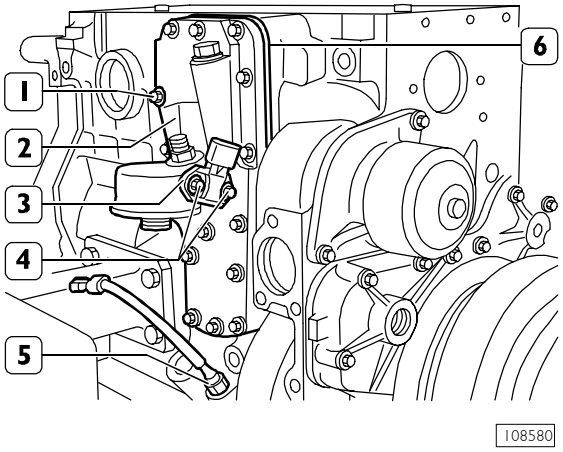
Hook brackets (1) with suitable lifting chains and remove cylinder head (2) from block using hoist.

Figure 16



Remove the screws (2) and disconnect the alternator support (3).
Use tool 99360076 to remove the oil filter (1).

Figure 17

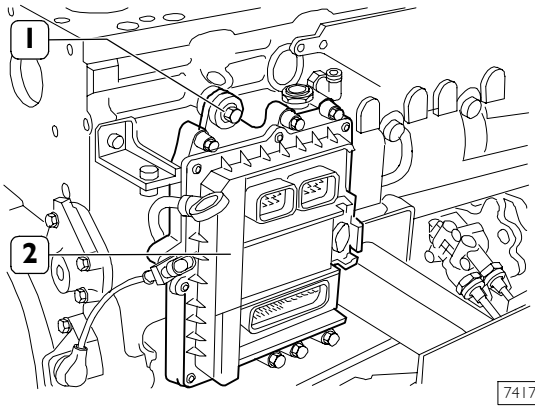


Remove the screws (4) and disconnect the oil temperature/pressure sensor (3).

Remove the screws (1) and then remove: heat exchanger/oil filter support (2), intermediate plate (6) and relevant gaskets.

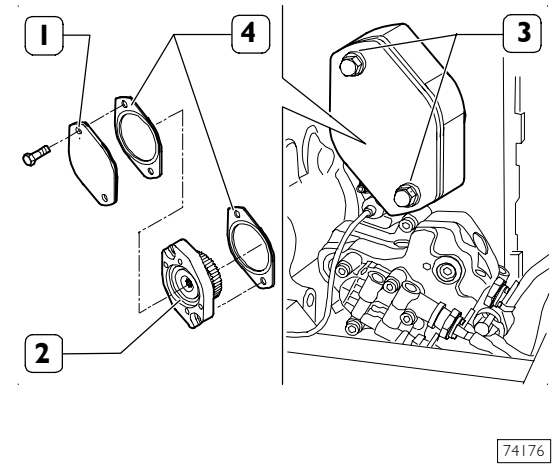
Remove the oil level sensor (5).

Figure 18



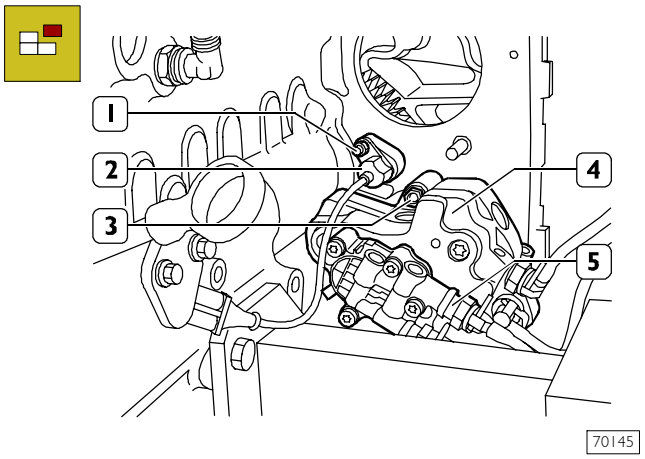
Remove the screws (1) and disconnect the ECU (2) including the heat exchanger.

Figure 19



Unloose the screws (3) and remove the cap (1). Keep the gasket (4), the power take-off (2) and the second gasket (4).

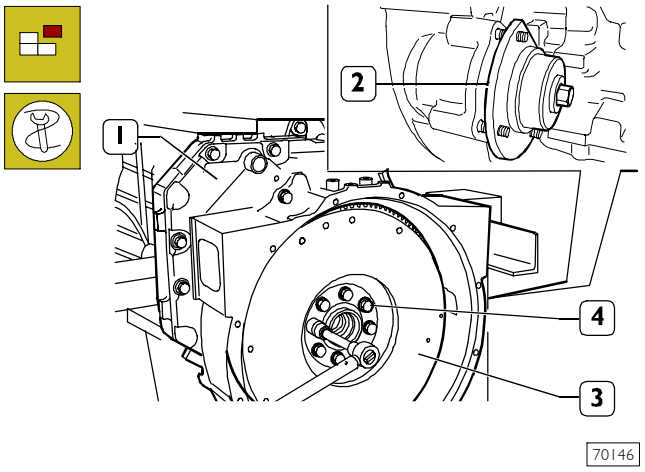
Figure 20



Remove the nut (1) and disconnect the timing sensor (2).

Remove the nuts (3) and disconnect the high pressure pump (4) including the feed pump (5).

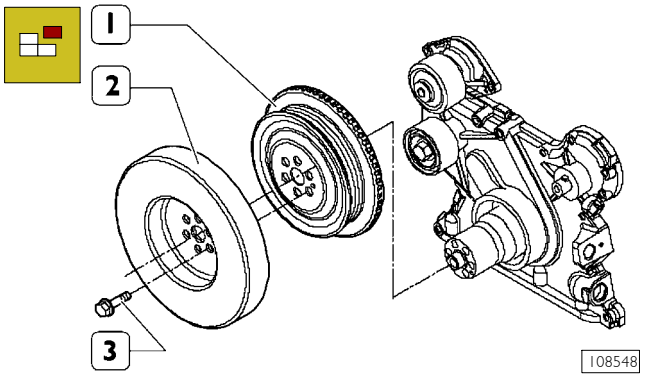
Figure 21



Fit tool 99360339 (2) to the flywheel housing (1) to stop flywheel (3) rotation.

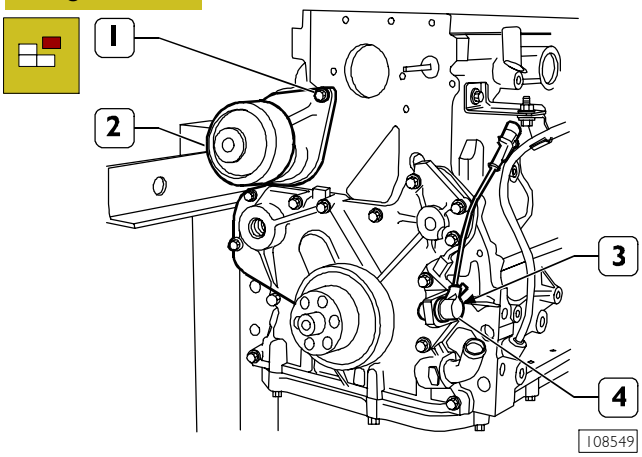
Loosen the screws (4).

Figure 22



Remove the screws (3) and disassemble the damping flywheel (2) and the pulley (1).

Figure 23

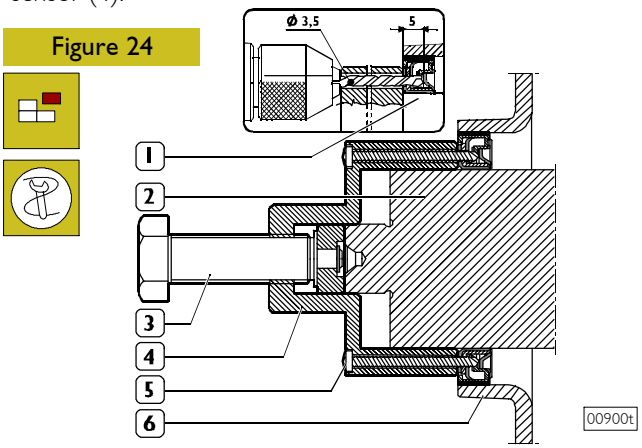


Remove the screws (1) and disconnect the water pump (2).

Remove the screw (3) and the roller (4).

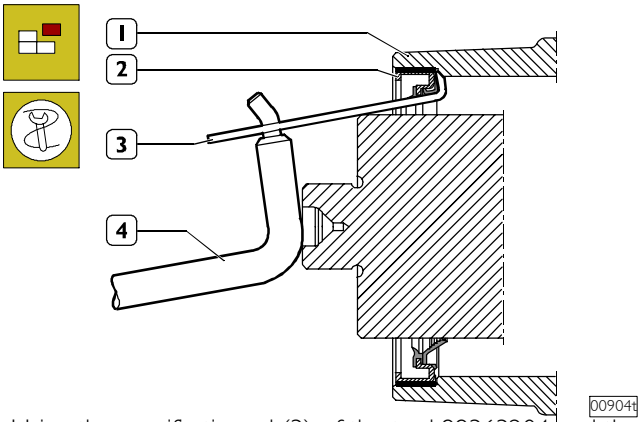
Remove the screw (3) and disconnect the engine speed sensor (4).

Figure 24



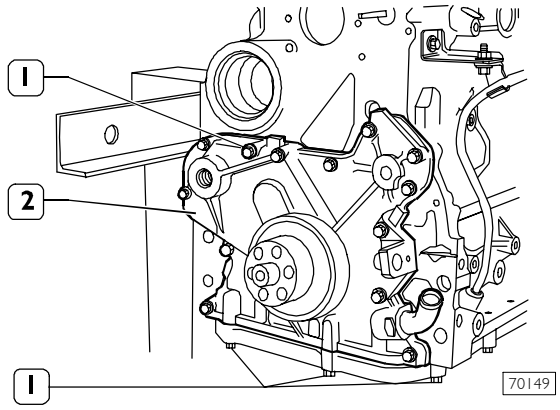
Remove the ring sealing the engine's driving shaft from the front cover. Use the tool 99340055 (4) to operate on the front bar hold of the driving shaft. Through the steering holes of the tool, perforate the inside holding ring (1) with a straight way drill (diam. 3,5mm) for the depth of 5mm. Fix the tool to the ring tightening the 6 screws provided with the equipment. Then proceed removing the ring (2) by tightening the screw (3).

Figure 25



Using the specific tie rod (3) of the tool 99363204 and the ancillary lever (4), remove the external holding ring (2) from the front cover (1).

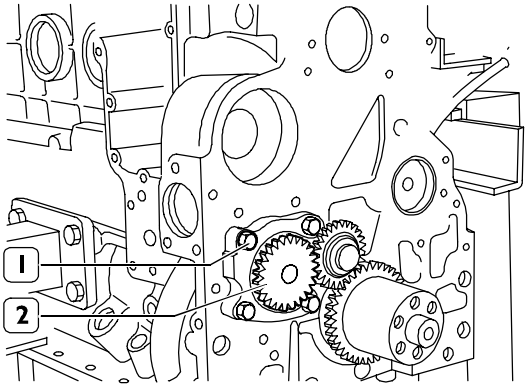
Figure 26



Remove the screws (1) and take out the front cover (2).

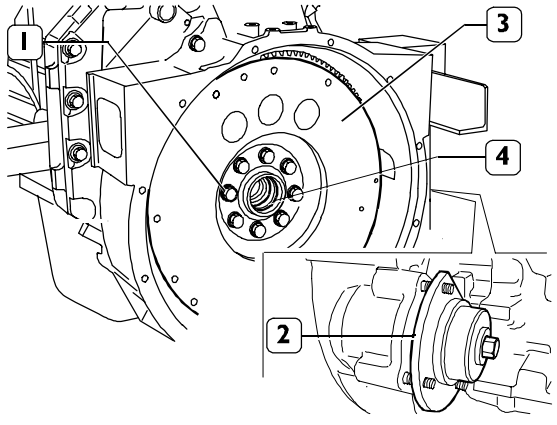
Take note of screw (1) assembling positions since they have different lengths.

Figure 27



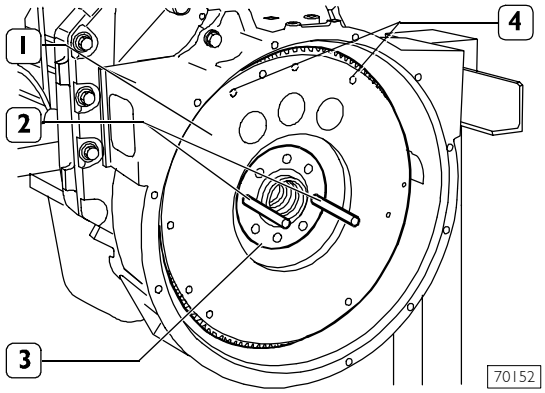
Remove the screws (1) and disconnect the oil pump (2).

Figure 28



Remove two opposite screws (1) from the area where the withdrawal pins will be introduced (2, Figure 29).
Loosen the remaining flywheel fixing screws (3) from the driving shaft (4).
Remove the flywheel locking tool 99360351.

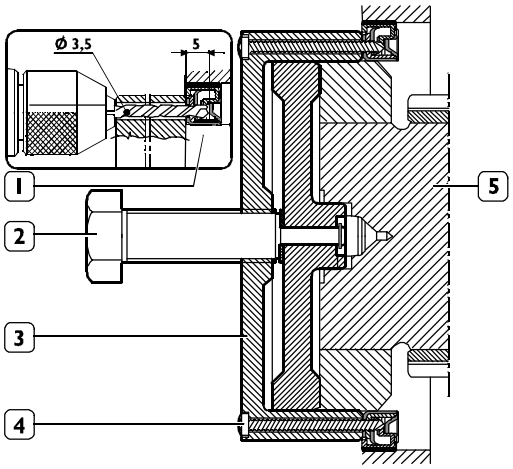
Figure 29



Tighten two screws of medium length into the holes (4) to sling the flywheel with the hoist.

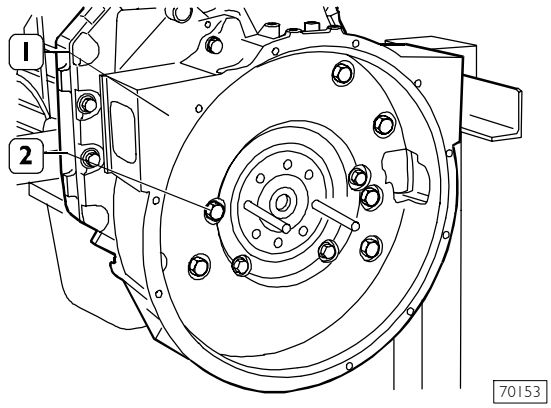
Throughout the two guide pins (2) previously screw into the driving shaft holes (3) withdraw the engine flywheel (1) after slinging it with the hoist.

Figure 30



Remove the holding ring of the flywheel cover box using the tool 99340056 (3) to operate on the driving shaft's back bar hold (5).
Through the steering holes of the tool, perforate the inside holding ring with a straight way drill (diam. 3,5mm) for the depth of 5mm.
Fix the tool 99340056 (3) to the ring tightening the 6 screws provided with the equipment.(4)
Then proceed removing the ring (1) by tightening the screw (2).
Using a specific tie rod of the tool 99363204 and an ancillary lever, remove the external holding ring (2) from the front cover.

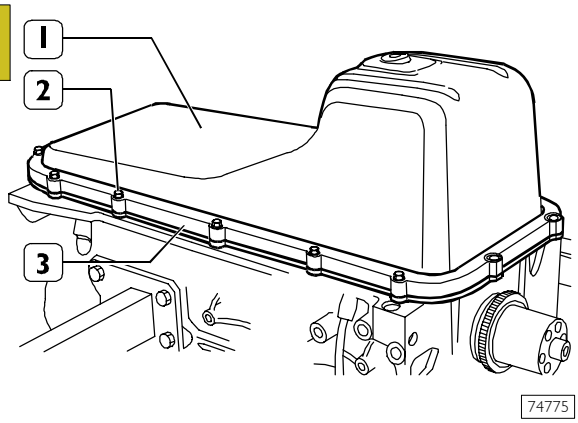
Figure 31



Remove the screws (2) and take out the rear cover (1).

Take note of screw (2) assembling positions since they have different sizes.

Figure 32



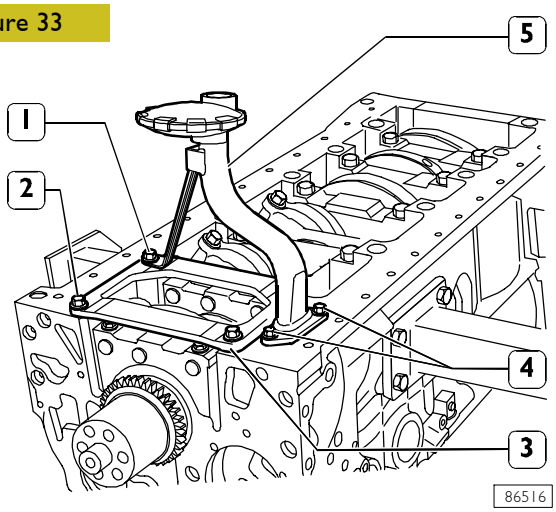
Overturn the engine.

Remove the screws (2), disassemble the plate (3) and disconnect the oil sump (1).

The shape and the dimensions of the oil pan and of the suction tube may vary according to the duty of the engine. The relevant pictures of the instructions are therefore providing an outline of the intervention to be executed.

However the procedures described are still applicable.

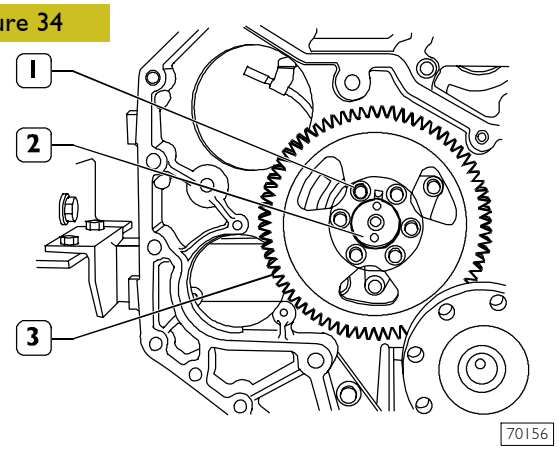
Figure 33



Remove the screws (1 and 4) and disassemble the oil suction tube (5). Remove the screws (2) and disassemble the stiffening plate (3).

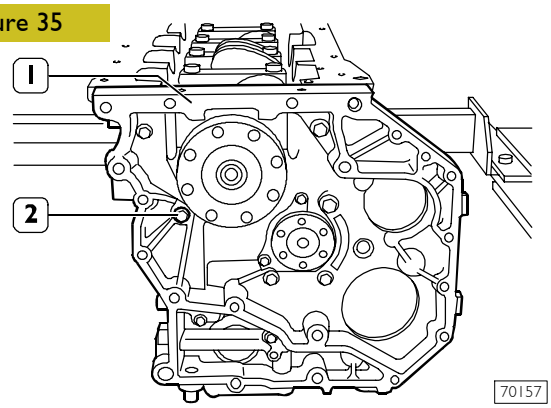
For F4HE0684 engines the stiffening plate (4) has a single element.

Figure 34



Remove the screws (1) and remove the gear (3) from the camshaft (2).

Figure 35

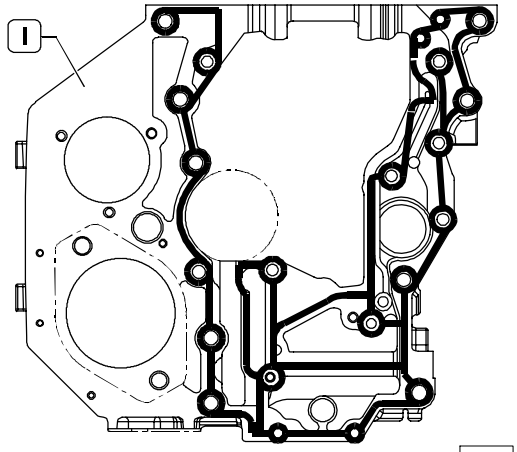


Remove the screws (2) and disconnect the timing gear case (1).

Take note of screw (2) assembling positions since they have different sizes.

Assembly of application components

Figure 36



LOCTITE 5205 SEALANT APPLICATION AREAS

Clean accurately the timing gear case (1) and the engine block.

Perfect seal is only obtained by cleaning accurately the surface to seal.

Smear the case with LOCTITE 5205 to obtain a bead of few mm diameter.

It shall be uniform (no clots), without air bubbles, thin areas or discontinuities.

Any imperfection shall be corrected as soon as possible.

Avoid to use excess material to seal the joint.

Excessive sealant could come out from joint sides and cause lubricant passage clogging.

After applying the sealant, the joint shall be assembled immediately (10 – 20 minutes).

Figure 37

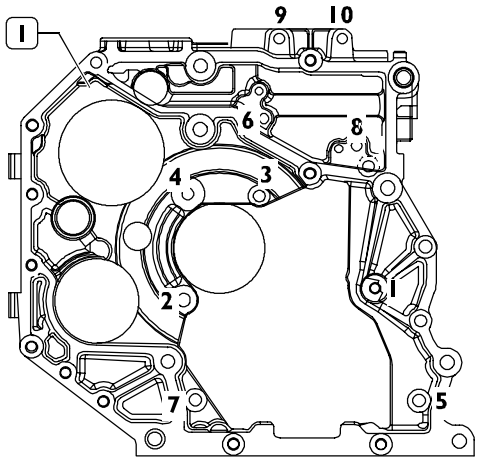


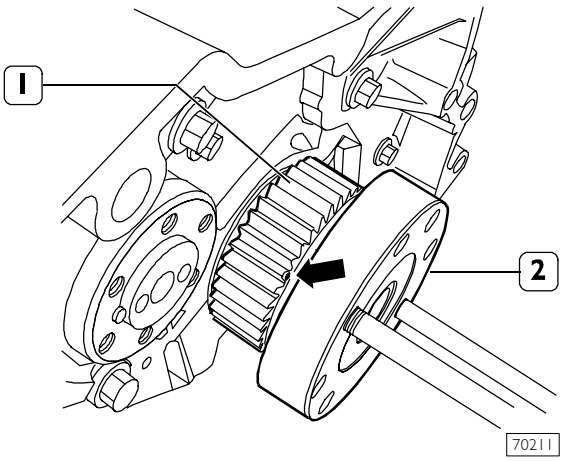
DIAGRAM FOR TIGHTENING THE REAR TIMING GEAR CASE FASTENING SCREWS

Refit the case (1) to the engine block.
Screw the fastening screws in the same position found at removal and tighten them to the following torque values in the sequence shown in the figure:

Screws M12	65 to 89 Nm
Screws M8	20 to 28 Nm
Screws M10	42 to 52 Nm

Before any assembly operation always verify that the hole and screw threads have no evidence of wear or dirt.

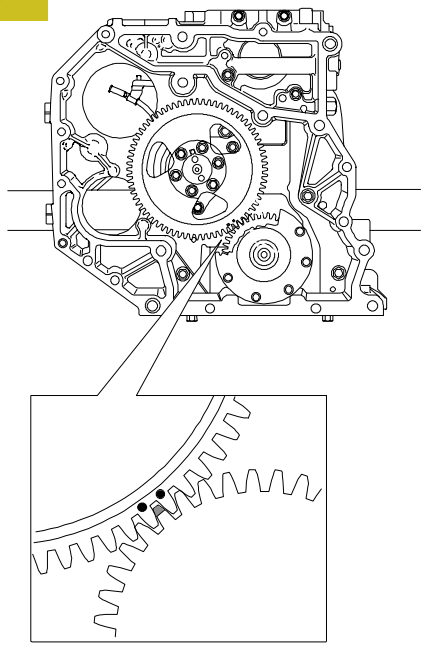
Figure 38



Use a felt pen to mark the driving gear (1) tooth fitted on the output shaft (2) having the mark (→) for timing on the side surface.

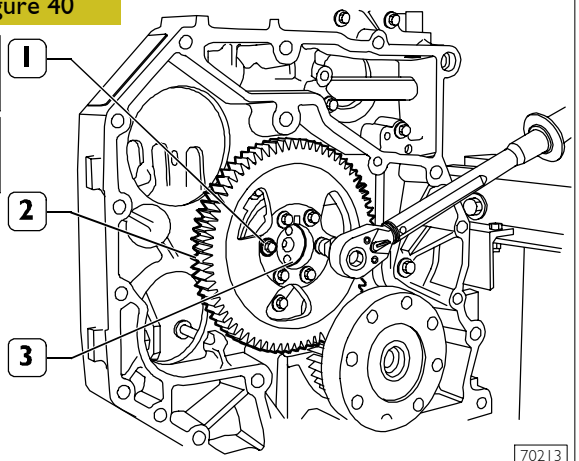
Fasten screwing of the two pins to facilitate the operation of engine driving shaft rotation.

Figure 39



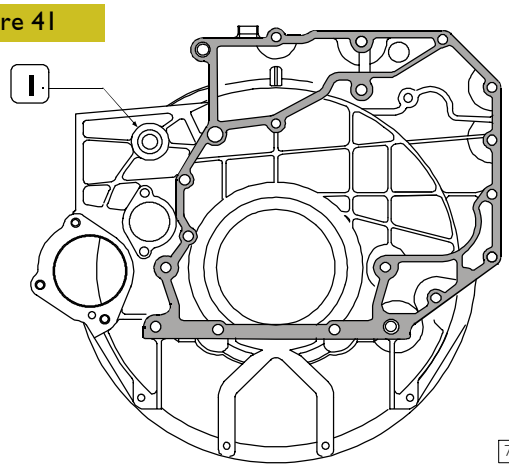
Rotate the output shaft (4) and the camshaft (2) so that when fitting the driven gear (1) on the camshaft the marks on the gears (1 and 3) are coinciding.

Figure 40



Tighten the screws (1) fastening gear (2) to camshaft (3) to the specified torque.

Figure 41



LOCTITE 5205 SEALANT APPLICATION AREAS

Perfect seal is only obtained by cleaning accurately the surface to seal.

Smear the case with LOCTITE 5205 to obtain a bead of few mm diameter.

It shall be uniform (no clots), without air bubbles, thin areas or discontinuities.

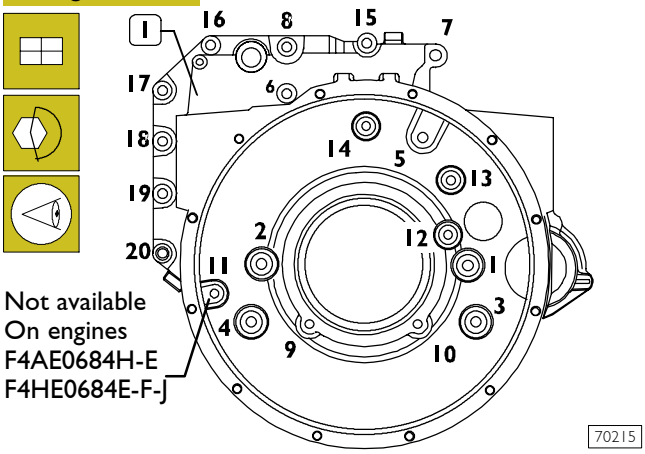
Any imperfection shall be corrected as soon as possible.

Avoid to use excess material to seal the joint.

Excessive sealant could come out from joint sides and cause lubricant passage clogging.

After applying the sealant, the joint shall be assembled immediately (10 – 20 minutes).

Figure 42



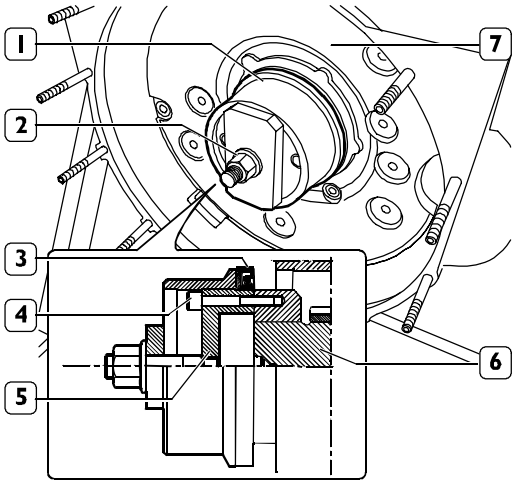
SEQUENCE FOR TIGHTENING THE FLYWHEEL HOUSING FASTENING SCREWS

Refit the housing (1) to the engine block and screw the fastening screws in the same position found at removal and tighten them to the following torque values in the sequence shown in the figure:

Screws M12	75 to 95 Nm
Screws M10	44 to 53 Nm

Before any assembly operation always verify that the hole and screw threads have no evidence of wear or dirt.

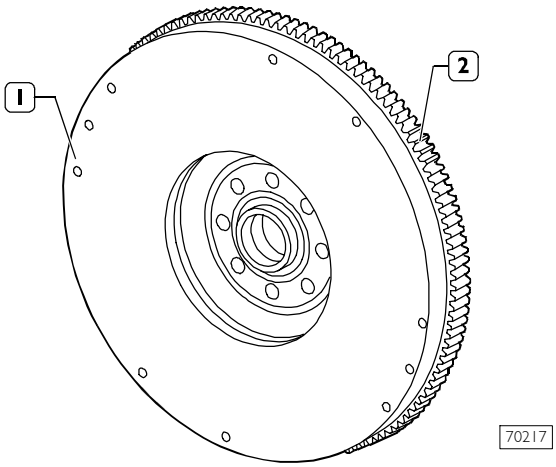
Figure 43



Apply tool 99346252 part (6) to the rear output shaft tang (5), secure it by screws (4) and fit the new sealing ring (3).

Position part (1) on part (5), screw nut (2) until completing sealing ring (3) fitting into flywheel housing (7).

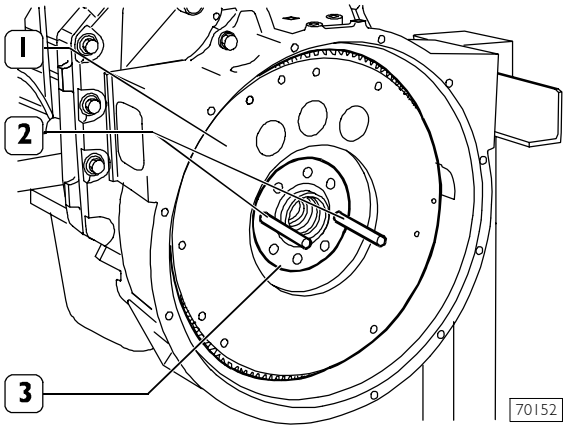
Figure 44



Where the engine is coupled to a mechanical clutch, verify that the flywheel nominal thickness of 49,6 ± 0,13 mm.

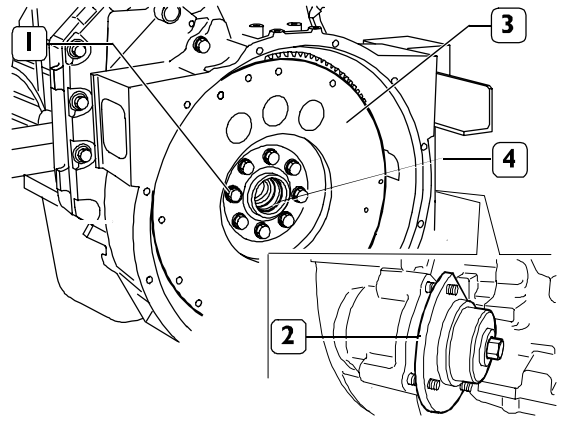
Check ring gear teeth (2), if breakage or excessive wear is found remove the ring gear from the engine flywheel (1, Figure 43) using a suitable hammer and fit the new one, previously heated to 150°C for 15 to 20 minutes. Chamfering on ring gear inside diameter shall be facing the engine flywheel.

Figure 45



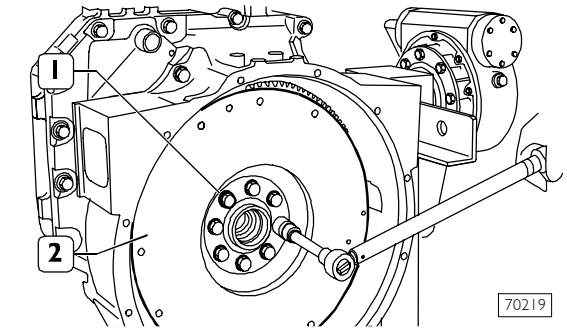
Screw two pins (2) having suitable length into shaft holes (3) and remove the engine flywheel (1) using proper sling and hoister.

Figure 46



Apply tool 99360339 (2) to the flywheel housing to stop engine flywheel (3) rotation. Tighten the screws (1) fastening the engine flywheel (3) to the output shaft.

Figure 47



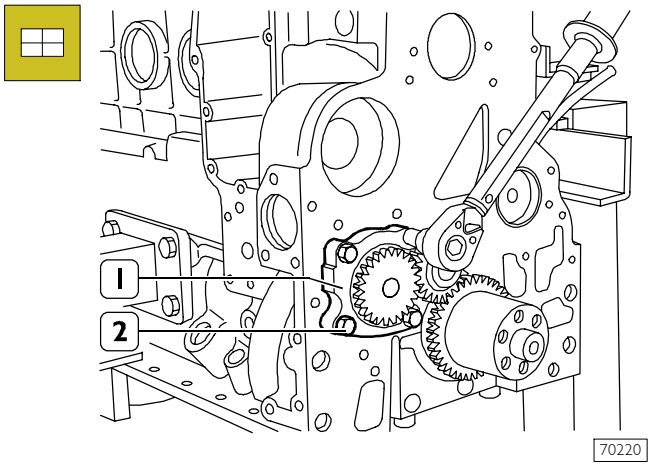
Tighten engine flywheel (2) fastening screws (1) in two stages:

- ❑ 1st stage, tightening to 30 ± 4 Nm torque with dynamometric wrench;
- ❑ 2nd stage, tightening to 60 ± 5° angle.

Tightening to angle is performed using tool 99395216.

Before any assembly operation always verify that the hole and screw threads have no evidence of wear or dirt.

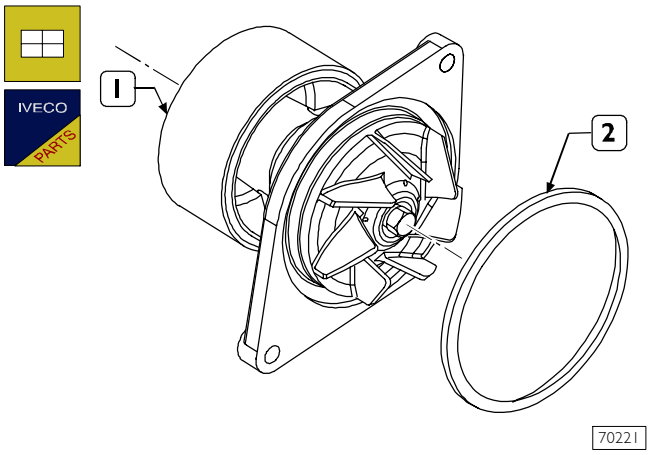
Figure 48



Fit the oil pump (1).

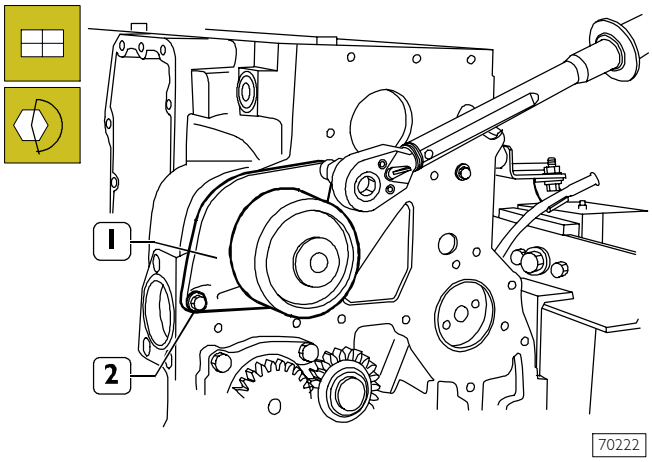
Tighten the fastening screws (2) to the specified torque.

Figure 49



Apply a new sealing ring (2) to the water pump (1).

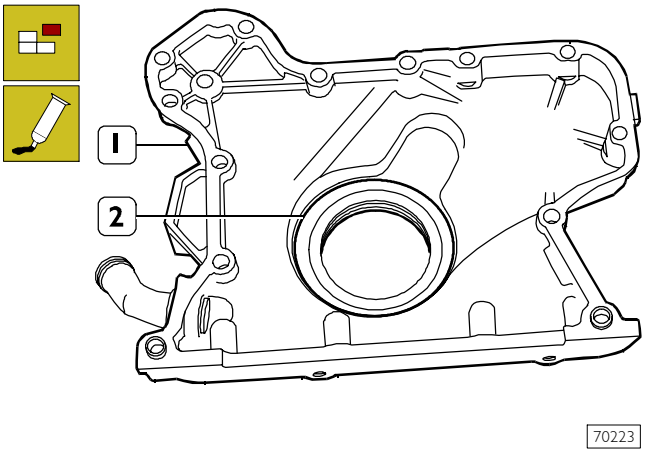
Figure 50



Fit the water pump (1).

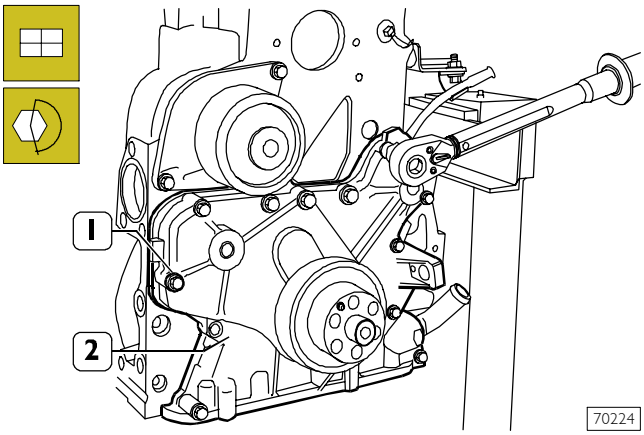
Tighten the screws (2) to the specified torque.

Figure 51



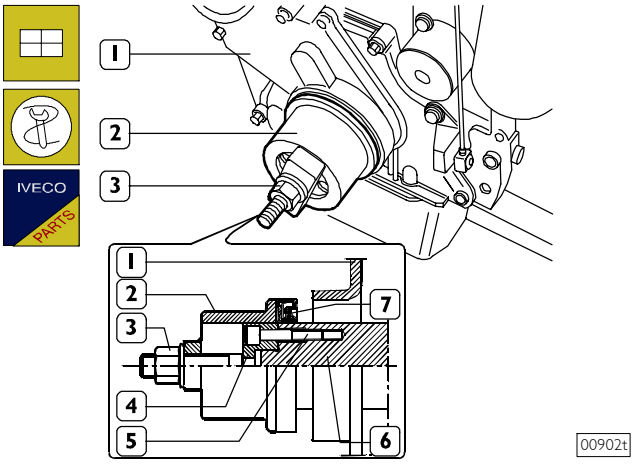
Remove the sealing ring (2) from the front cover (1), clean accurately the coupling surfaces and smear them with LOCTITE 5205.

Figure 52



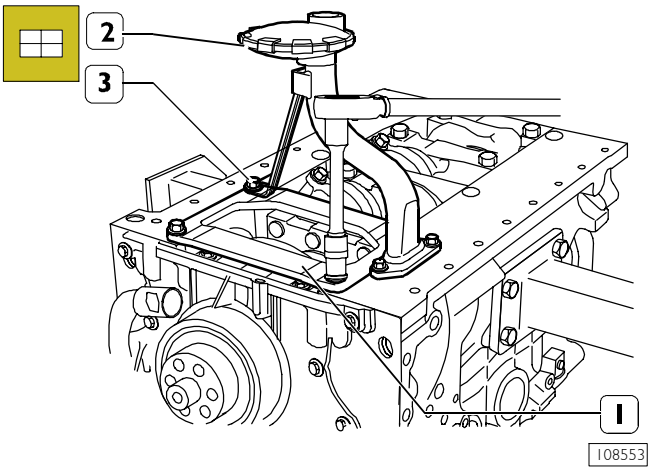
Clean accurately the front cover (2) surface and refit it.
Tighten the screws (1) to the specified torque.

Figure 53



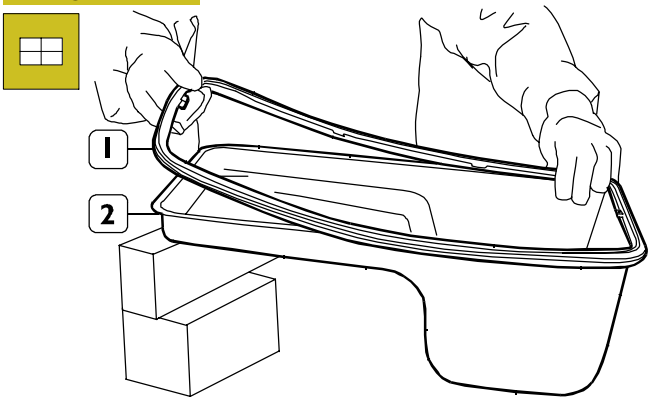
Apply tool 99346252 part (4) to the front output shaft tang (6), secure it by screws (5) and fit the new sealing ring (7). Position part (2) on part (4), screw nut (3) until completing sealing ring (7) fitting into front cover (1).

Figure 54



Fit the plate (1), the oil pick up tube (2) and tighten the fastening screws (3) to the specified torque.

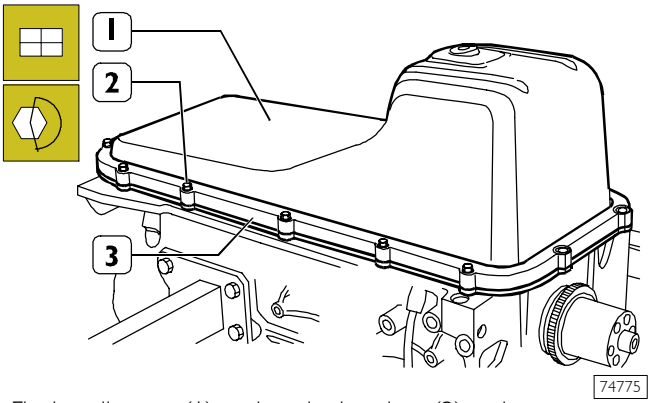
Figure 55



Set the gasket (1) on the oil sump (2).

The pictures of the instructions relating to the oil pan and to thesuction rose may not reflect the actual shape and dimensions of your engine equipment. However the procedures described are still applicable.

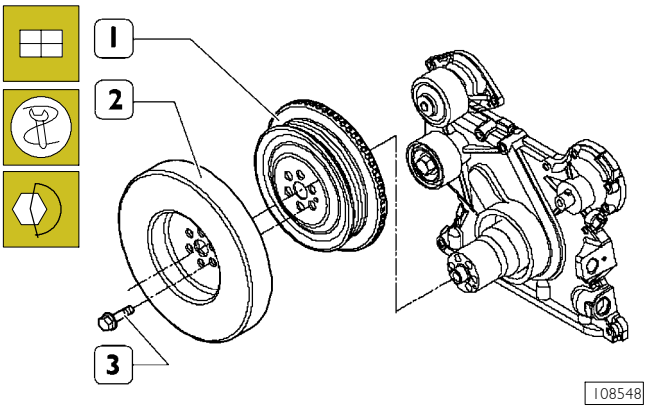
Figure 56



Fit the oil sump (1) and apply the plate (3) to it.
Tighten the screws (2) to the specified torque.

Before any assembly operation always verify that the hole and screw threads have no evidence of wear or dirt.

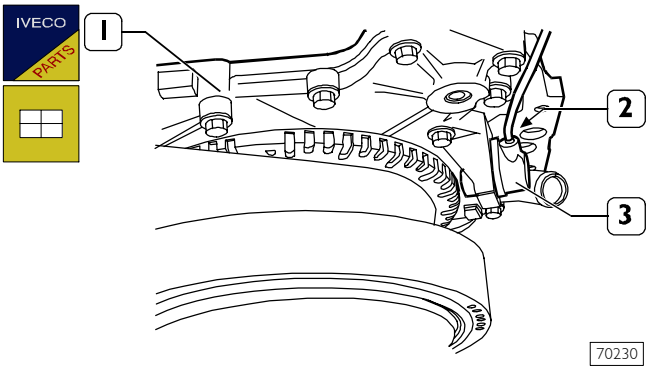
Figure 57



Assemble the pulley (1) and the damping flywheel (2) to the driving shaft.

Tighten the fixing screws (3) and clamp them to the couple 68 ± 7 Nm.

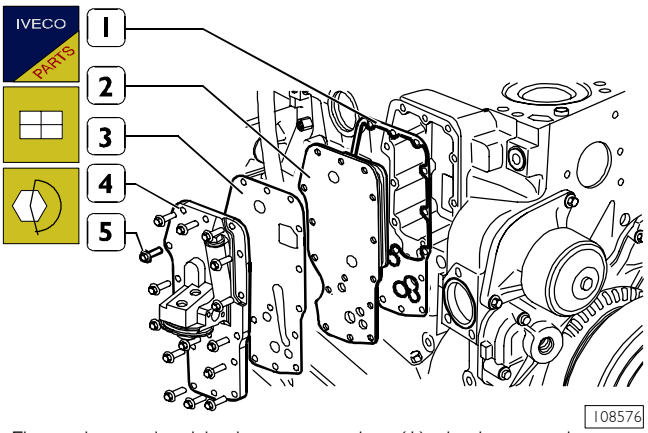
Figure 58



Fit a new sealing ring on the speed sensor (3).

Fit the speed sensor (3) on the front cover (1) and tighten the screw (2) to the specified torque.

Figure 59

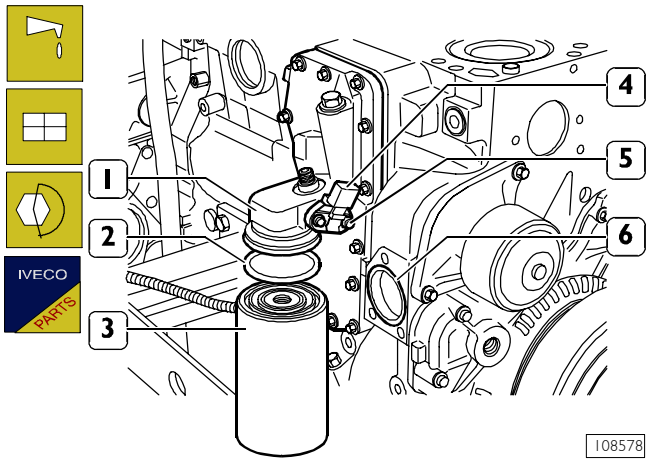


Fit on the engine block: a new gasket (1), the heat exchanger (2) a new gasket (3) and the oil filter support (4).

Tighten the screws (5) to the specified torque.

Before any assembly operation always verify that the hole and screw threads have no evidence of wear or dirt.

Figure 60



Lubricate the sealing ring (2) with engine oil and set it on the oil filter (3).

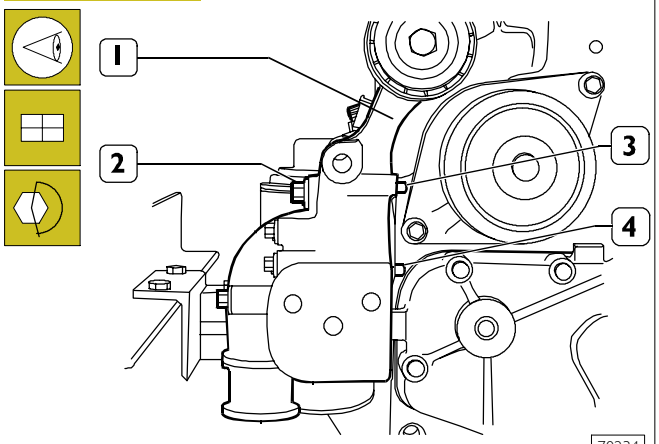
Screw manually to seat the oil filter (3) on the support connection (1) and then screw again the oil filter (3) by ¾ turn.

Apply a new sealing ring on the oil temperature/pressure sensor (4) and fit it on the support (1).

Tighten the screws (5) to the specified torque.

Fit a new sealing ring (6) in the engine block seat.

Figure 61

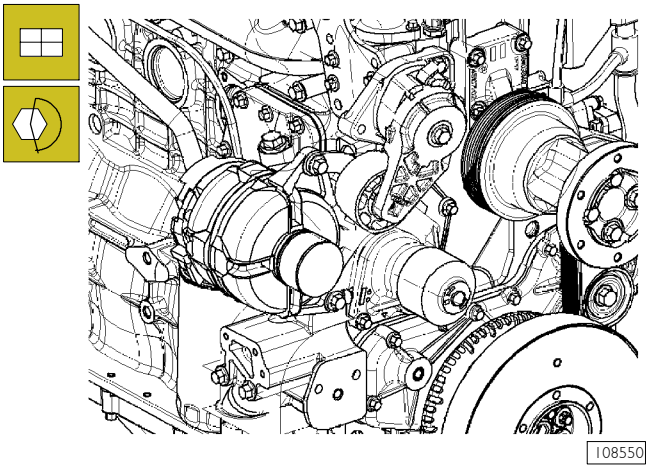


Position the alternator support (1) so that pins (3 and 4) are set against the engine block.

Tighten the screws (2) to the specified torque.

Before any assembly operation always verify that the hole and screw threads have no evidence of wear or dirt.

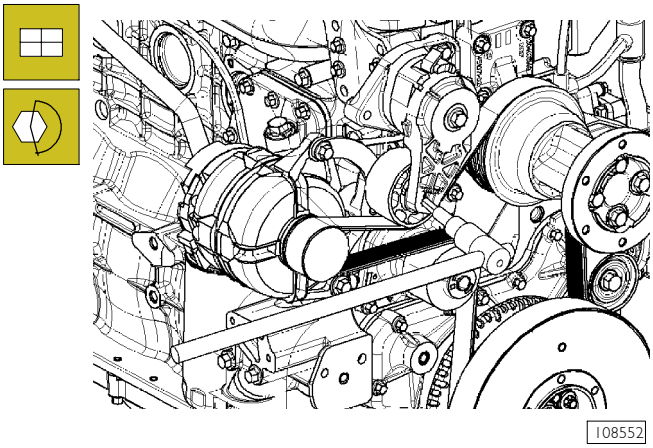
Figure 62



Refit the alternator (1).

Tighten the screw (2) to the specified torque.

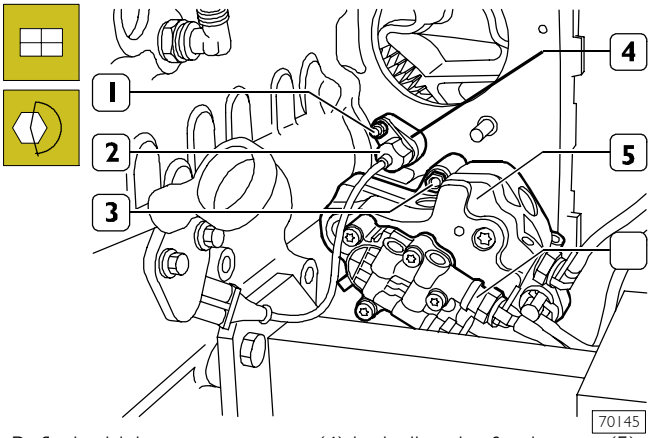
Figure 63



Refit the automatic belt tensioner (2).

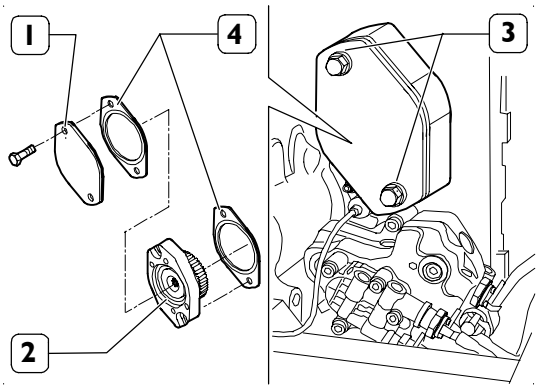
Tighten the screw (3) to the specified torque using a wrench, turn the automatic belt tensioner (2) to fit the belt (1) on pulleys and guide rollers.

Figure 64



Refit the high pressure pump (6) including the feed pump (5) and tighten the nuts (3) to the specified torque. Fit the support (4) with a new sealing ring, the timing sensor (2) with a new sealing ring and tighten the relevant fastening nut (1) to the specified torque.

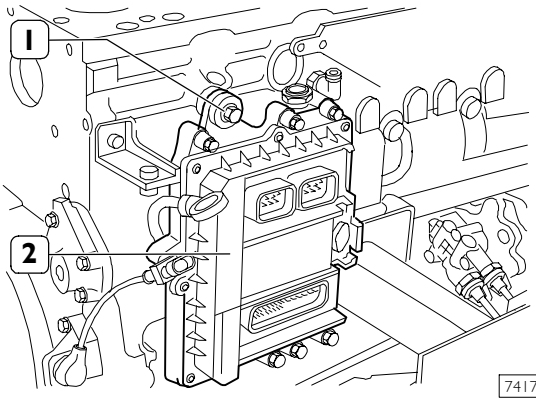
Figure 65



74176

Insert the power take-off (2) equipped with the gasket (4), the cover (1) and its gasket (4).
Tighten the screws (3) to the prescribed matching couple.

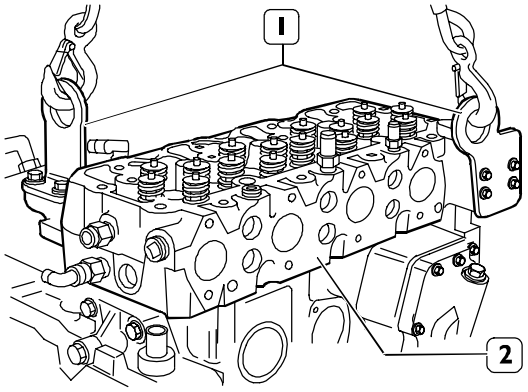
Figure 66



74174

Assemble the electronic gearbox (2) equipped with the exchanger to the engine, fixing it with the screws (1).
In case the rubber buffers are cracked or excessively deformed, provide replacing them.

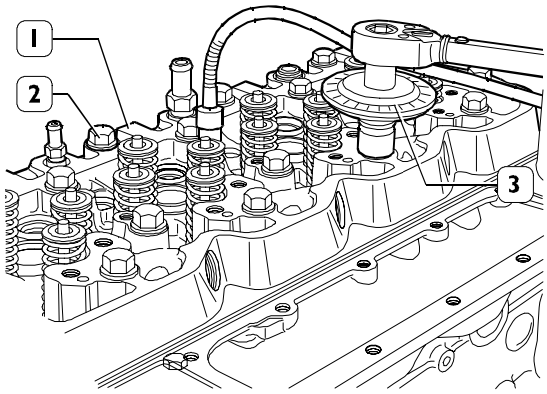
Figure 67



74779

Direct the output shaft (4) and the camshaft (2) so that when fitting the driven gear (1) on the camshaft the marks on the gears (1 and 3) are coinciding.

Figure 68



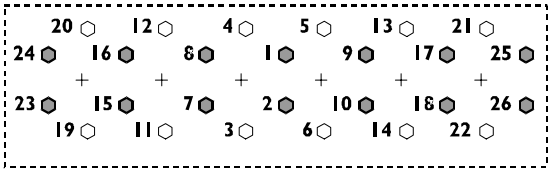
70336

Assemble cylinder head (1), tighten the screws (2) in three following steps, following order and mode shown in the figure below.

The angle tightening is carried out through tool 99395216 (3).

Before any assembly operation always verify that the hole and screw threads have no evidence of wear or dirt.

Figure 69



6-cylinder engine

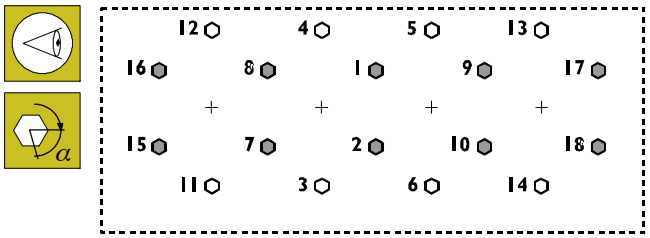
70476

Tightening order layout for cylinder head fastening screws:

- ❑ 1st step pre-tightening with dynamometric wrench:
  - Screw 12x1.75x130 (⬢) 35 ± 5 Nm
  - Screw 12x1.75 x 150 (⬡) 55 ± 5 Nm
- ❑ 2nd step tightening with a 90 ± 5° angle
- ❑ 3rd step tightening with a 90 ± 5° angle

A = Front side

Figure 70



4-cylinder engine A

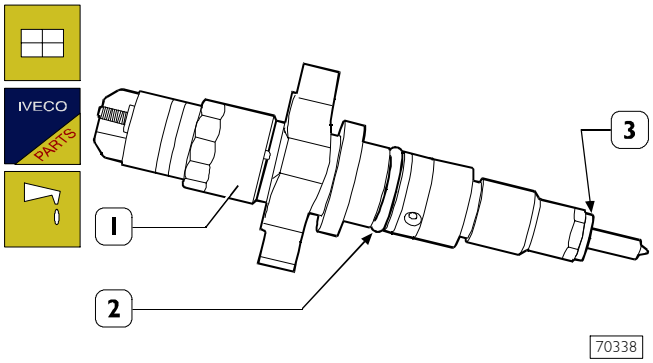
70337

Cylinder head fastening screws tightening sequence:

- ❑ 1st stage pre-tightening, with a torque wrench::
  - Screw 12x1.75x130 ( ) 35 ± 5 Nm
  - Screw12x1.75 x 150 ( ) 55 ± 5 Nm

  A = Lato anteriore
- ❑ 2nd stage tightening with angle 90 ± 5°
- ❑ 3rd stage tightening with angle 90 ± 5°

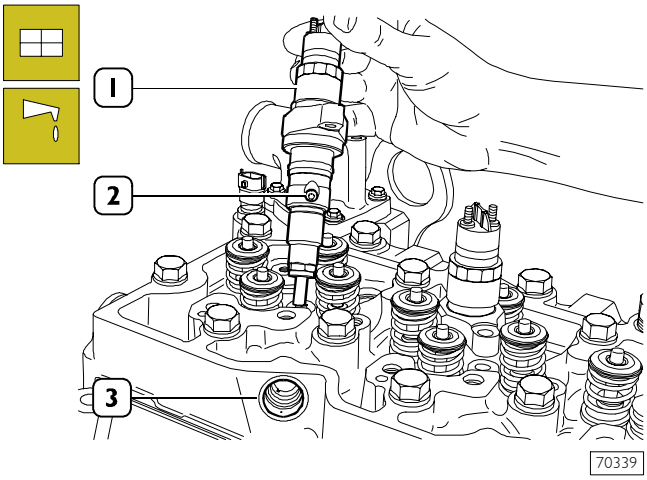
Figure 71



70338

Fit a new sealing ring (2) lubricated with petroleum jelly and a new sealing washer (3) on injector (1).

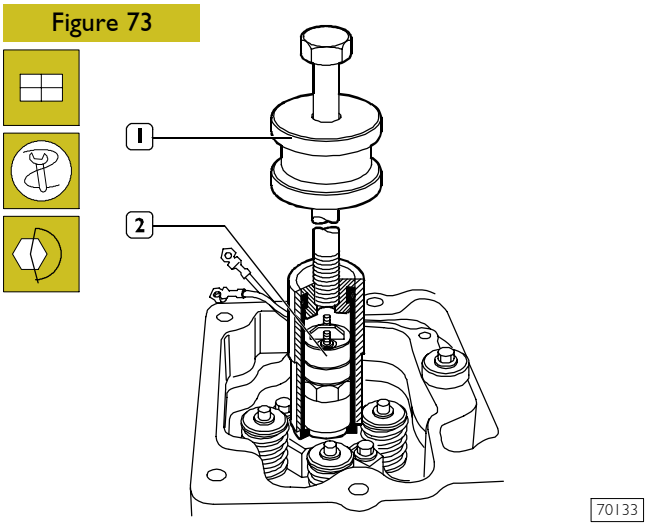
Figure 72



70339

Fit injectors (1) on the cylinder head seats, directed so that the fuel inlet hole (2) is facing the fuel manifold seat (3) side.

Figure 73

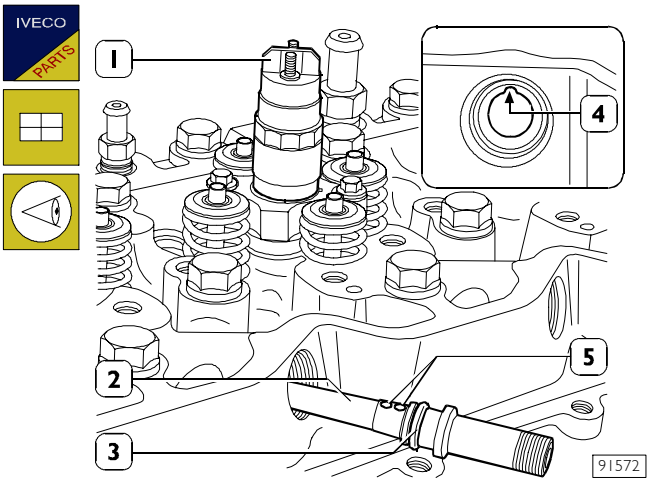


70133

Use tool 99342101 (1) to fit the injector (2) into its seat.

Screw injector fastening screws without tightening them.

Figure 74



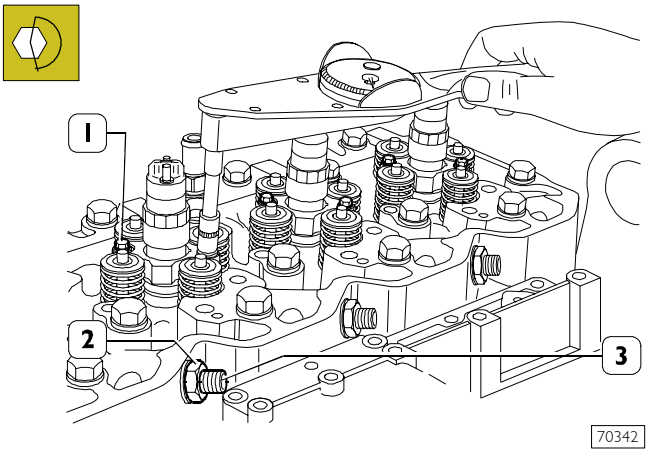
Fit a new sealing ring (3) lubricated with petroleum jelly on the fuel manifold (2) and fit it into the cylinder head seat so that the positioning ball (5) is coinciding with the relevant housing (4).

Disassembled fuel manifolds (2) must not be used again. Replace with new items.
The fuel manifolds (2) for F4HE0684 engines have 2 positioning spheres.

Screw the fastening nuts (2, Figure 75) without locking them.

During this operation, the injector (1) shall be moved so that the manifold (2, Figure 72) is properly inserted into the fuel inlet hole (2, Figure 74).

Figure 75

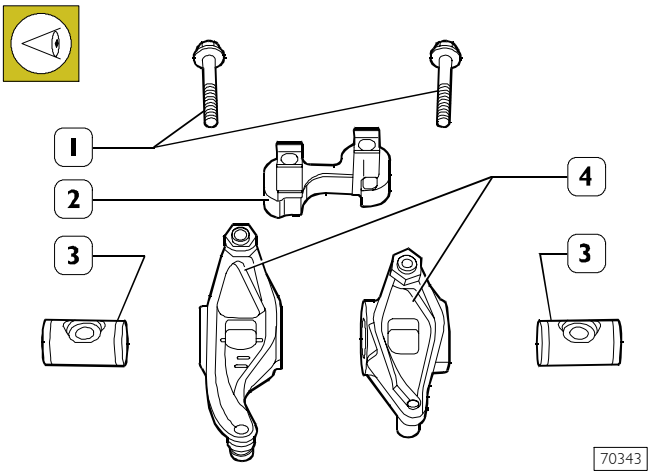


Use the torque wrench to tighten gradually and alternately the injector fastening screws (1) to 8.5 ± 0.8 Nm torque.

Tighten the fuel manifold (3) fastening nuts (2) to 50 Nm torque.

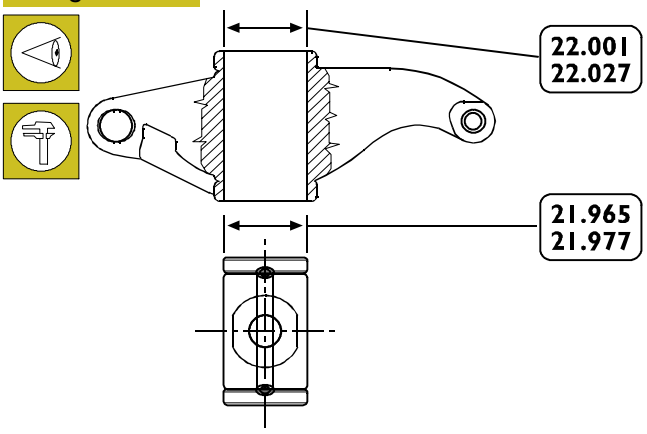
Carry out the assembly of the equalisers' unit , after previous check of the components.

Figure 76



ROCKER ASSEMBLY COMPONENTS:
1. Screws - 2. Bracket - 3. Shafts - 4. Rockers.

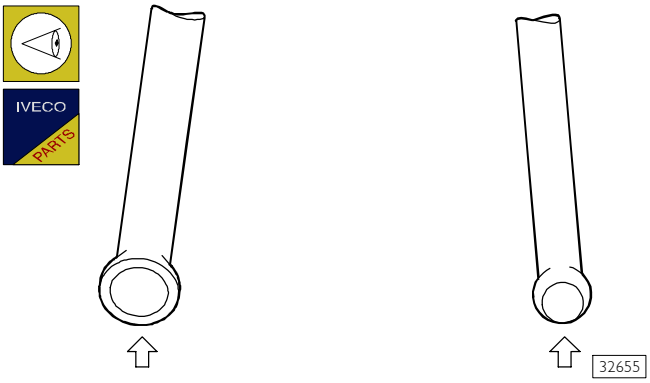
Figure 77



SHAFT-ROCKER MAIN DATA

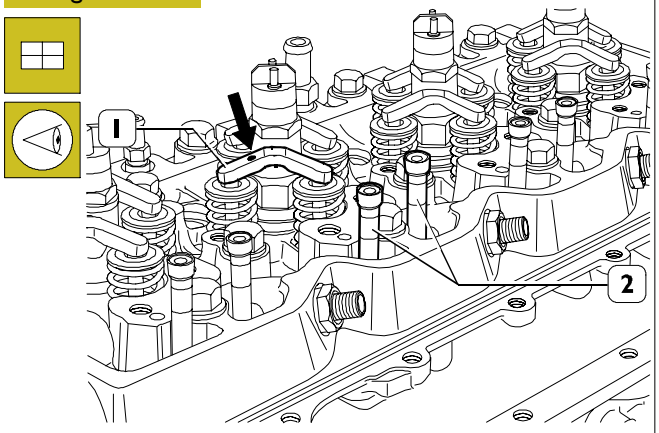
Check that shaft/rocker coupling surfaces are not showing excessive wear or damages.

Figure 78



Rocker control rods shall not be distorted; the ball seats in touch with the rocker adjusting screw and with tappets (arrows) shall not show seizing or wear; otherwise replace them. Intake and exhaust valve control rods are identical and are therefore interchangeable.

Figure 79

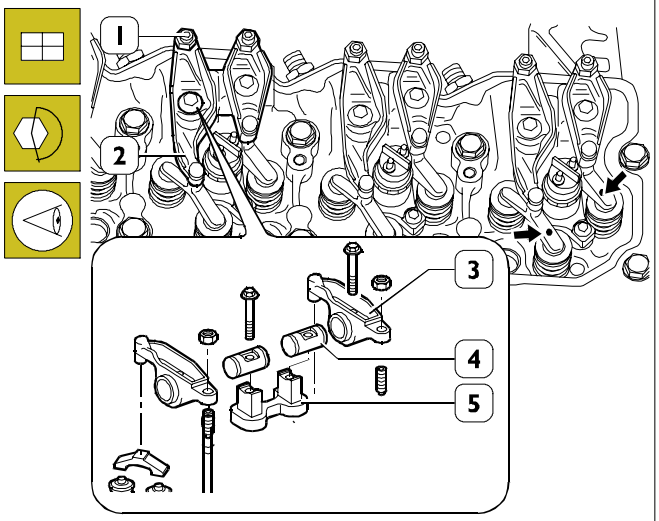


70345

Fit the rods (2).

Position jumpers (1) on valves with marks (→) facing the exhaust manifold.

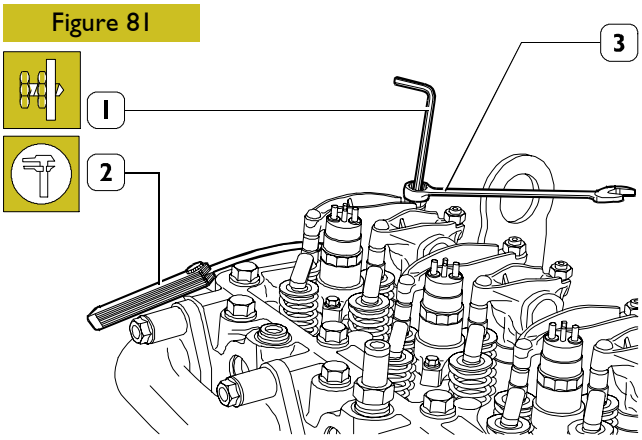
Figure 80



70346

Check that tappet adjusters (1) are loose to prevent their balking on the rods (2, Figure 79) when refitting the rocker assembly.
Then refit the rocker assembly consisting of: bracket (5), rockers (3), shafts (4) and secure them to the cylinder head by tightening the fastening screws (2) to 36 Nm torque.

Figure 81



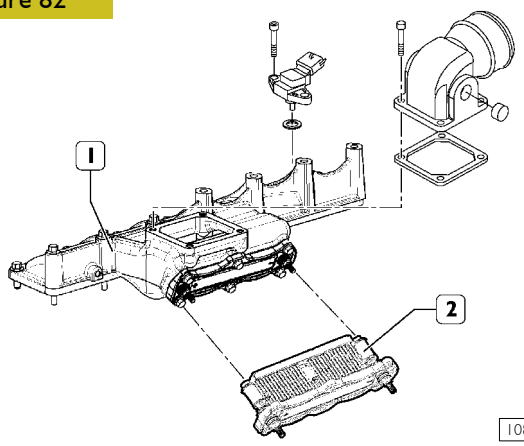
70520

Adjust clearance between rockers and valves using setscrew wrench (1), box wrench (3) and feeler gauge (2).

Clearance shall be as follows:
- intake valves 0.25 ± 0.05 mm
- exhaust valves 0.50 ± 0.05 mm.

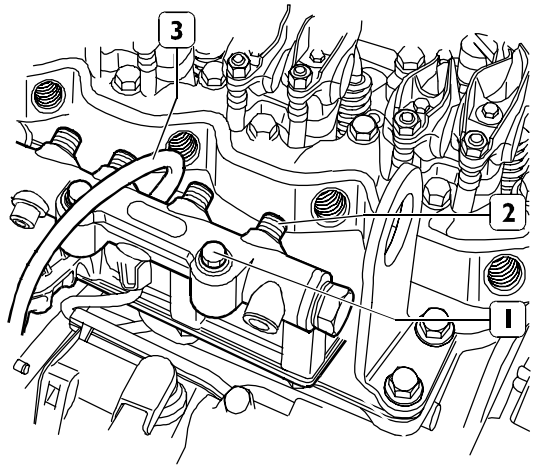
On TIER 3 engines, due to the additional lobe for the INTERNAL E.G.R., it is not possible to use the valve clearance adjustment procedure that requires adjusting the clearance of all the valves by positioning the crankshaft 2 times only.
Each cylinder must be checked by taking it to the T.D.C. (top dead centre) at the end of compression and adjusting the clearance of both valves on the cylinder in question.

Figure 82



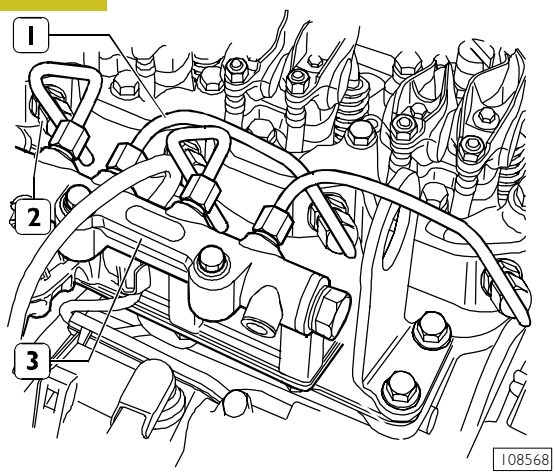
Apply to the coupling surface of the intake manifold (1) equipped with heater (2) a sufficient coat of LOCTITE 5999 and provide tightening the screws to the prescribed matching couple.

Figure 83



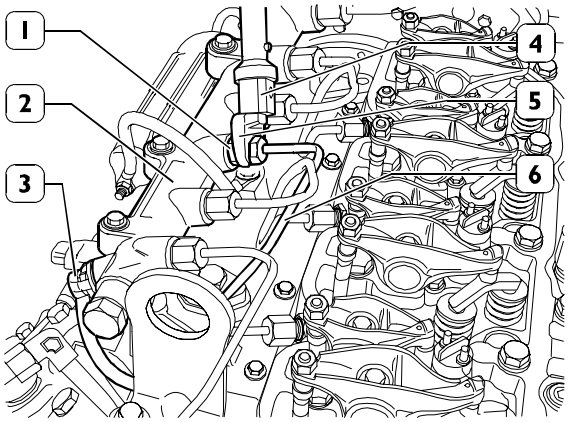
Fit the rail (2) and tighten the screws (1) to the specified torque, connect the ground cable (3) to the intake manifold (4) and tighten the fastening nut to the specified torque.

Figure 84



Connect new fuel pipes (1) to rail (3) and injector manifolds (2).

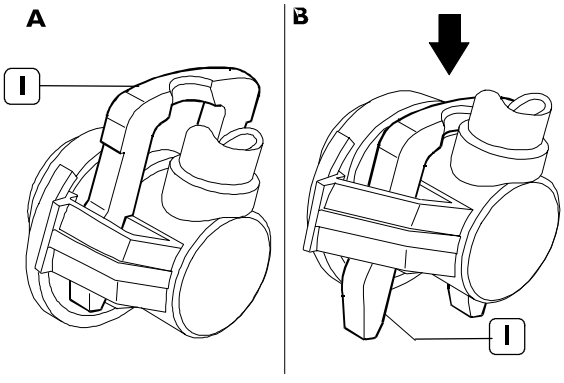
Figure 85



Pipe (7) connections shall be tightened to 20 Nm torque, using the proper wrench (5) and the torque wrench 99389833 (4).
Connections (6) shall be tightened by holding the flow limiting valve hexagon (1) with the proper wrench.

Connect the fuel pipe (3) to the rail (2) following the procedure shown in the following figure.

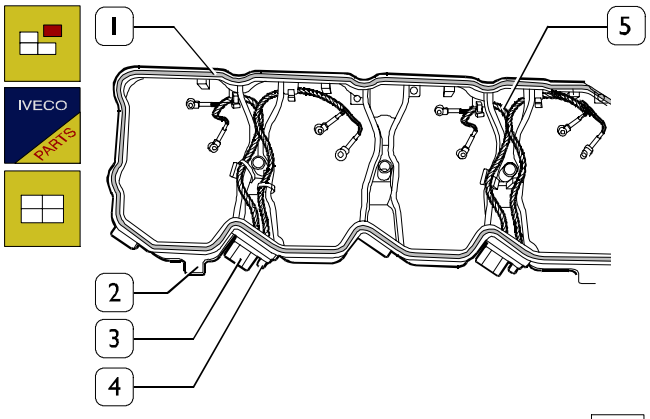
Figure 86



Press the clamp (1) in arrow direction (Figure B) and connect the pipe to the rail, reset the clamp to the initial locking position "A".

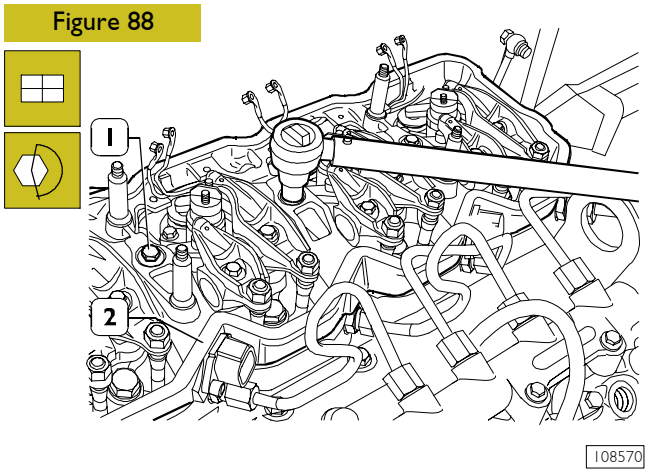
Check proper fuel pipe connection.

Figure 87



Check electrical cable (5) conditions, replace if damaged by cutting the support (2) clamps and removing the screws (4) that secure it to connections (3).
Fit a new gasket (1) on the support (2).

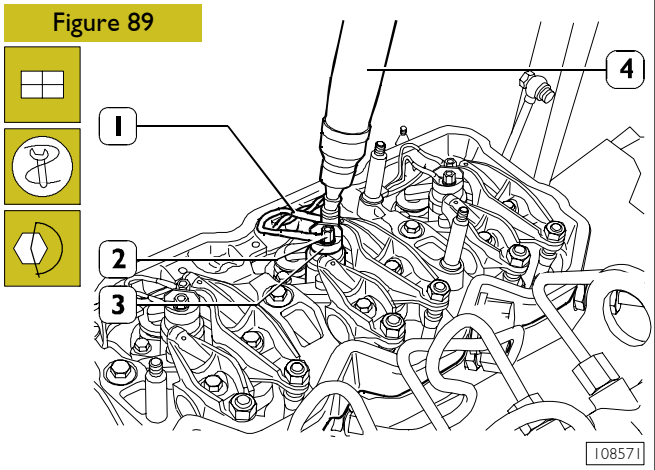
Figure 88



Fit the wiring support (2) and tighten the screws (1) to the specified torque.

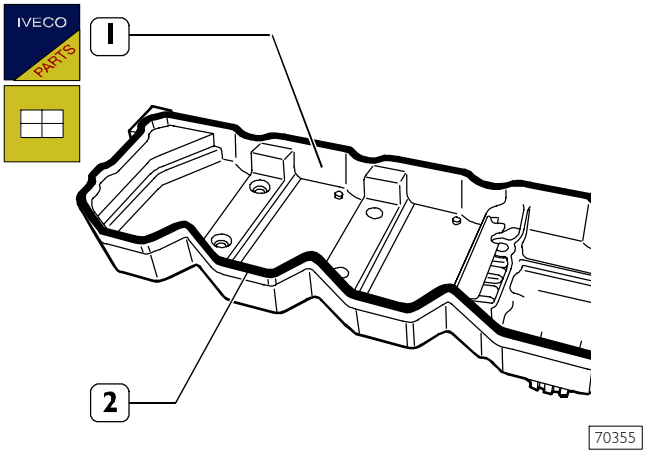
Before any assembly operation always verify that the hole and screw threads have no evidence of wear or dirt.

Figure 89



Connect the electrical cables (1) to the injectors (3) and use the torque wrench 99389834 (4) to tighten the fastening nuts (2) to the specified torque.

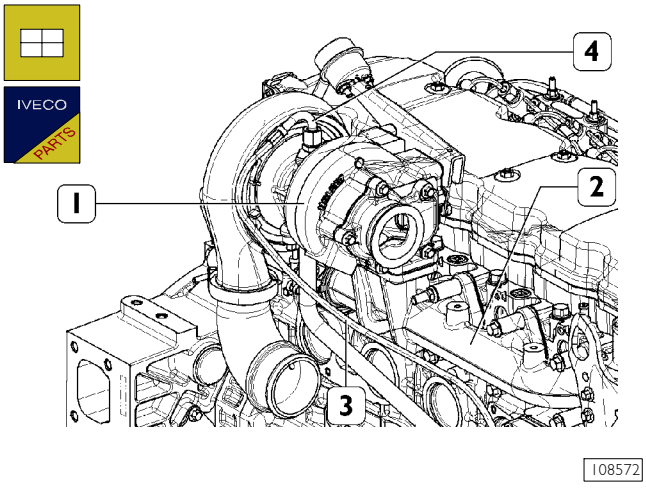
Figure 90



Fit a new gasket (2) on the tappet cover (1).

Place the tappet cover on, install the bolts in the correct position and tighten.

Figure 91

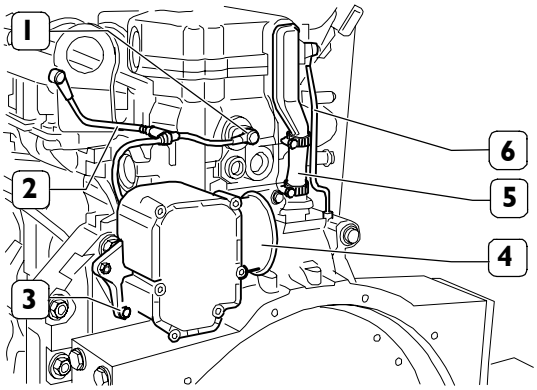


Reconnect the exhaust manifold (2) with new gaskets. Tighten the fastening screws (1) to the specified torque.

Sling the turbocharger (1) and place it over the manifold after having first inserted a new gasket.

Connect the oil pipeline (3) to the support of the heat exchanger /oil filter. Fix the pipe (3) to the pipe fitting on the turbocharger.

Figure 92



Insert the blow-by filter (4) tightening the screws.

Connect the pipeline (6) and fix the oil vapour recover pipe through the clamp (5); lock up the nut fixing it to the upper edge.

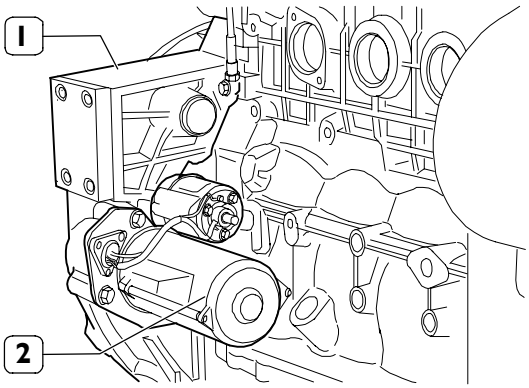
Connect the pipeline (2) to the pressure- limiter (1).

Completion of the engine

Properly handle the engine holding it by a lifter, remove it from the rotating shaft, remove the brackets 99341009 and place it on proper suitable support to carry out the completion.

Proceed assembling the oil filter.

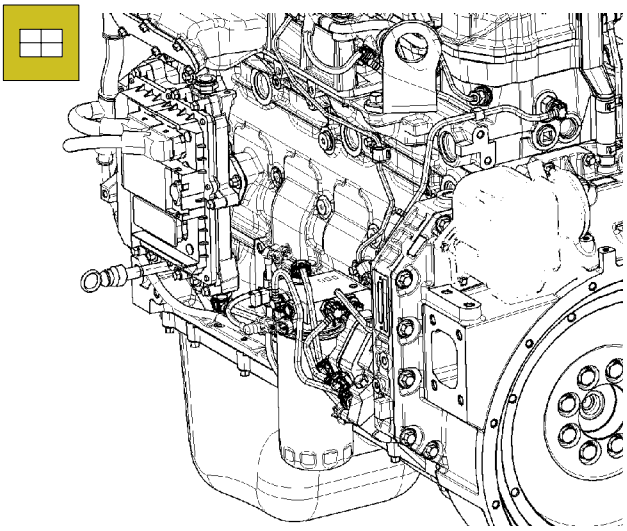
Figure 93



Assemble the starter (2) to the internal part of the flywheel cover.

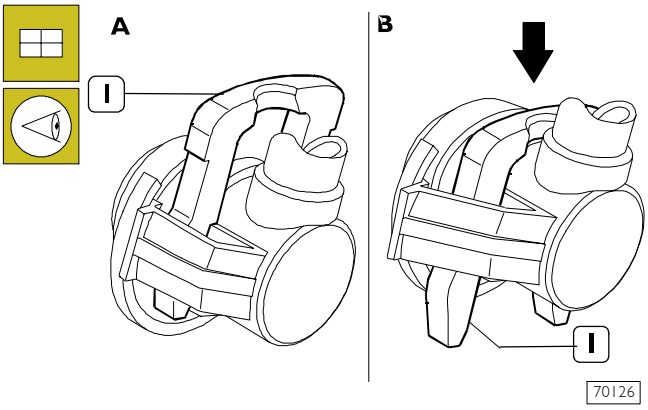
Assemble the oil feeding pipe using a new O-ring. Fix with three M12x25 screws.

Figure 94



Assemble the bracket and the support (1) of the fuel filter (6). Proceed connecting in sequence the pipelines (9,3,4 and 5) of the support (1) to the high pressure pump (8).
Connect the pipeline (7) from the high pressure pump to the engine control module heat exchanger.
Connect the pipeline (10) from the high pressure pump to the rail diffuser.

Figure 95



All the fuel pipelines are fixed using the clamps shown in the picture.

For the connection of the pipes, press the clamp (1) following the arrow's direction (Figure B) and connect the pipe to the clamp on the high pressure pump or on the support of the fuel filter.

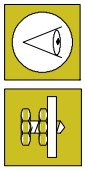
Reset the clamp in the initial locking "A" position.

In case the pipes are re-employed, they must keep the sealing tops at the edges.
Make sure that the fuel pipeline is correctly connected.

Reconnect the engine harness to all the sensors, the engine control module and the rail diffuser (see Figure 6)

Checks and inspections

The following checking inspections must be carried out after the engine assembly on the vehicle .



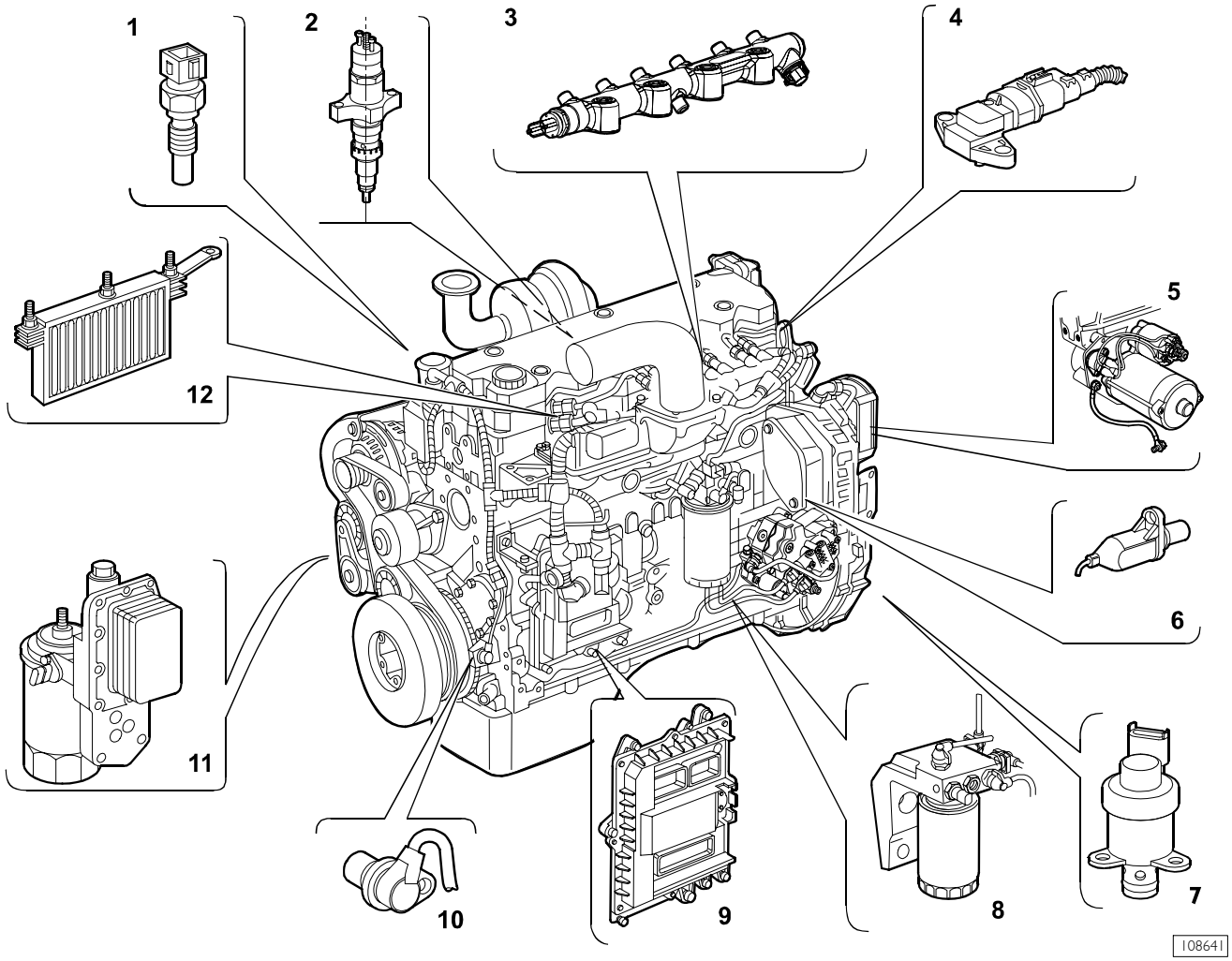
Start the engine and leave it running just above the idling speed, wait until the coolant reaches the temperature necessary to open the thermostat and then check:

- ❑ that there are no water leaks from the connecting sleeves of engine cooling circuit pipes and cab internal heating pipes, tighten the clamping collars if required;
- ❑ check carefully the connection between the low pressure fuel pipes and the relevant connectors;
- ❑ that there are no oil leaks between the cover and the cylinder head, between oil sump and engine block, between heat exchanger oil filter and the relevant housings and between the different pipes in the lubricating circuit;
- ❑ that there are no fuel leaks from the fuel pipes;
- ❑ that there are no air leaks from pneumatic pipes (if fitted);
- ❑ check also proper operation of the warning lights set on the instrument panel and of the equipment disconnected when engine was removed.
- ❑ Carefully check and bleed the engine cooling equipment by repeated draining operations.

PART TWO - ELECTRICAL EQUIPMENT

LOCATION OF THE MAIN ELECTRICAL COMPONENTS

Figure 96



The NEF F4HE engines are fully driven by the electronic engine control module, which is assembled directly to the engine by means of a heat exchanger enabling its cooling, utilising rubber buffers to reduce vibration originated by the engine.

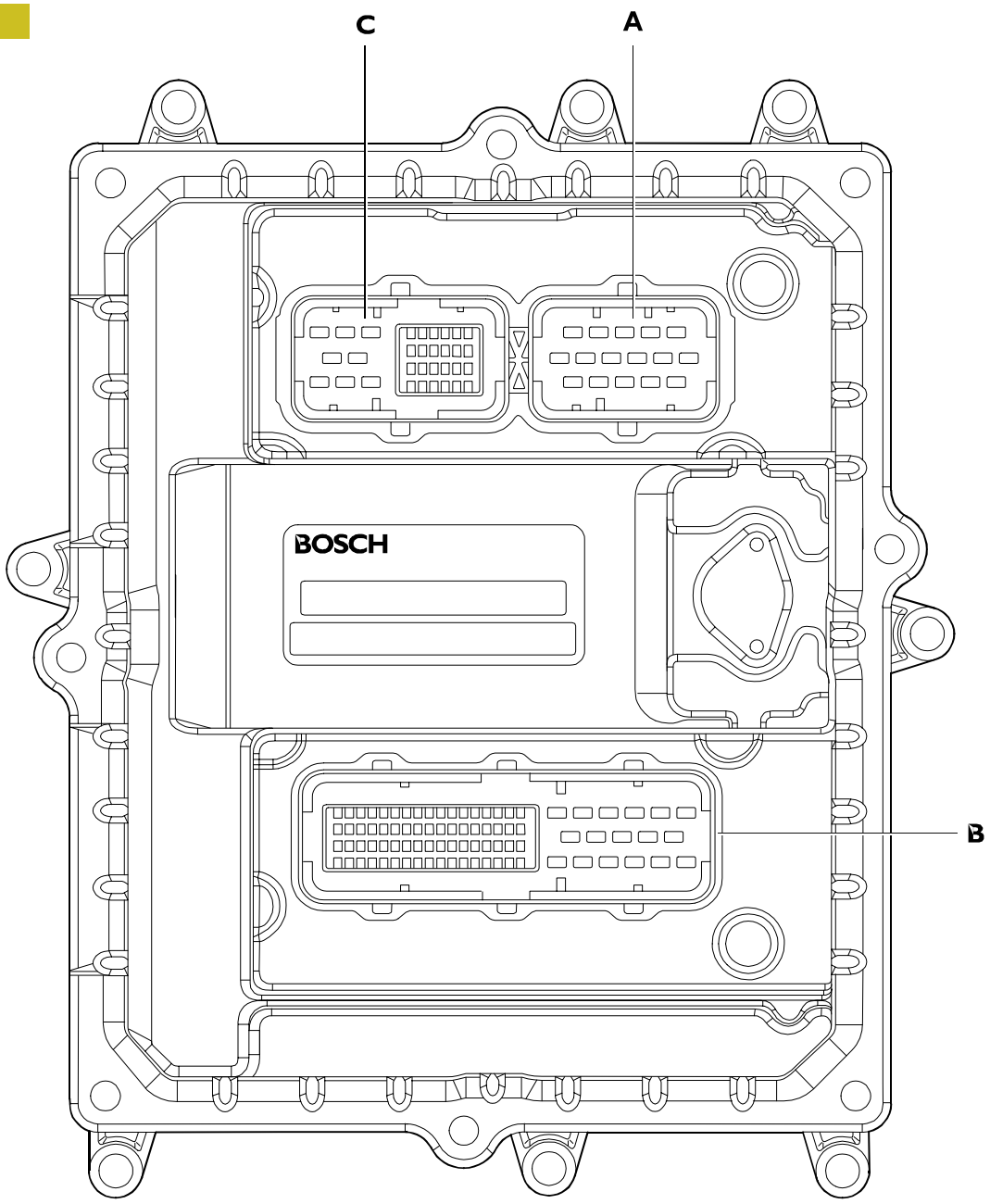
Through the engine control module it is possible to verify the correct working of the engine. (See part three of the hereby user's guide specifically dedicated to diagnostic).

The electrical and electronic components of the engine are listed here following:

1. Coolant temperature sensor.
2. Electro-injector.
3. RAIL pressure sensor.
4. Air temperature/pressure sensor.
6. Timing sensor.
7. Solenoid valve for pressure regulator.
8. Fuel temperature sensor.
9. EDC electronic control unit.
10. Crankshaft sensor.
11. Engine oil pressure/temperature sensor.
12. Heating element for pre-post heating.

EDC7 ECU

Figure 97

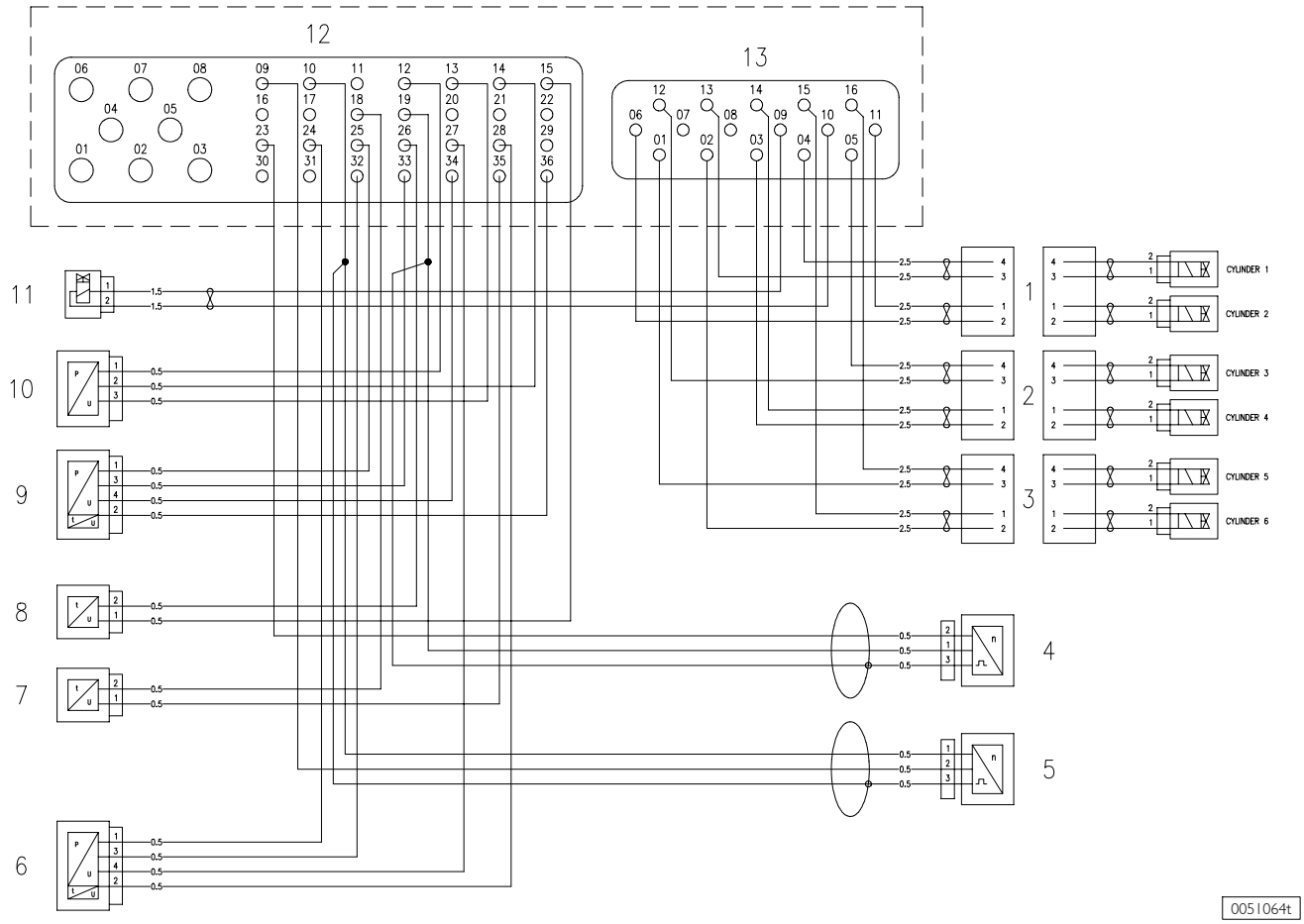


A - Connector to injectors; B - Connector to chassis (Provide reference of the vehicle to which the engine is assembled); C - Connector to sensors.

Cable on engine

All the components described below refer to the engine cable in question, therefore the connections to the pins are a preliminary version, in other words at the approval stage.

Figure 98



1. Injectors for cylinders 1-2 - 2 Injectors for cylinders 3-4 - 3. Injectors for cylinders 5-6 - 4. Engine rpm sensor - 5. Timing sensor - 6. Engine oil pressure and temperature sensor - 7. Fuel temperature sensor - 8. Coolant temperature sensor - 9. Air temperature and pressure sensor - 10. Rail temperature and pressure sensor - 11. Pressure regulator - 12. Connector C EDC control unit (signal) - 13. Connector A EDC control unit (power).

Injectors connector (A)

ECU PIN	FUNCTION
1	Cylinder 5 injector
2	Cylinder 6 injector
3	Cylinder 4 injector
4	Cylinder 1 injector
5	Cylinder 3 injector
6	Cylinder 2 injector
7	-
8	-
9	Pressure regulator
10	Pressure regulator
11	Cylinder 2 injector
12	Cylinder 3 injector
13	Cylinder 1 injector
14	Cylinder 4 injector
15	Cylinder 6 injector
16	Cylinder 5 injector

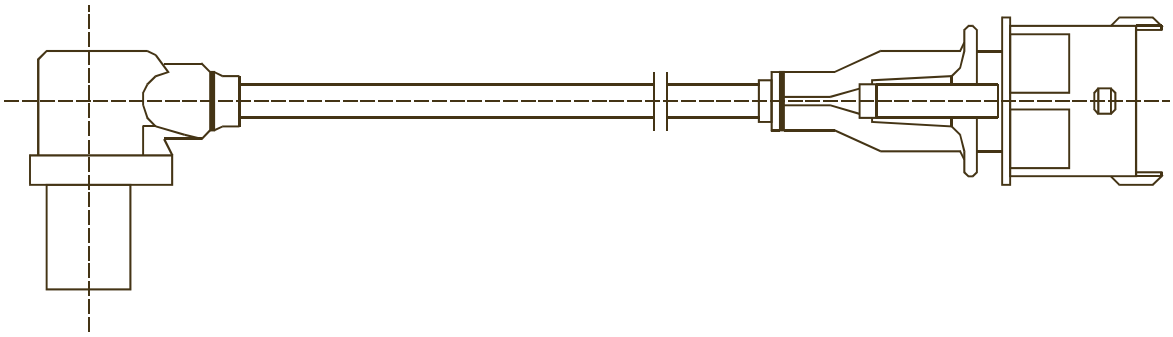
Sensors connector (C)

ECU PIN	ECU PIN
1	-
2	-
3	-
4	-
5	-
6	-
7	-
8	-
9	Timing sensor
10	Timing sensor
11	-
12	Negative for rail temperature and pressure sensor
13	Positive for rail temperature and pressure sensor
14	Signal from rail temperature and pressure sensor
15	Coolant temperature sensor
16	-
17	-
18	Signal from fuel temperature sensor
19	Engine rpm sensor
20	-
21	-
22	-
23	Engine rpm sensor
24	Negative for engine oil pressure and temperature sensor
25	Negative for air temperature and pressure sensor
26	Coolant temperature sensor
27	Signal from engine oil pressure sensor
28	Signal from engine oil temperature sensor
29	-
30	-
31	-
32	Positive for engine oil pressure and temperature sensor
33	Positive for air temperature and pressure sensor
34	Signal from air pressure sensor
35	Negative for fuel temperature sensor
36	Signal from air temperature sensor

Crankshaft sensor

This is an inductive sensor located at the front left hand side of the engine. The crankshaft sensor produces signals obtained from a magnetic flux field closing through the openings in a phonic wheel fitted on the crankshaft.
The crankshaft sensor is connected to the control unit on pins 19C - 23C. The sensor impedance is ~900 Ω.

Figure 99

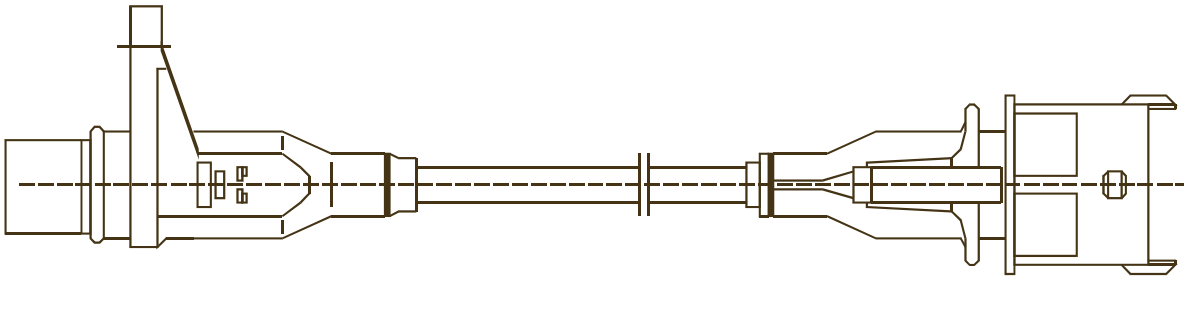


Crankshaft sensor

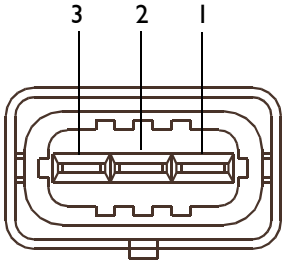
Timing sensor

This is an inductive sensor located at the rear left hand side of the engine. The timing sensor generates signals obtained from a magnetic flux field closing through the holes in the timing gear on the camshaft. The signal generated by this sensor is utilized by the electronic control unit as an injection phase signal.
Although it is similar to the flywheel sensor, these two devices are NOT interchangeable because of the different external shape.
The timing sensor is connected to the control unit on pins 9C - 10C. The sensor impedance
is ~900 Ω.

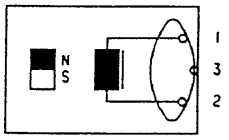
Figure 100



Timing sensor



Connector



Wiring diagram

Ref.	Description	ECU pin	
		Camshaft sensor	Timing sensor
1	Signal	19C	10C
2	Signal	23C	9C
3	Shield		

Supercharging air pressure - temperature sensor

This component incorporates a temperature sensor and a pressure sensor.
Mounted on the intake manifold, the sensor measures the maximum flow rate of air supplied, which serves to make an accurate calculation of the quantity of fuel to be injected in each cycle.
The sensor is connected to the control unit on pins 25C - 36C - 33C - 34C.
The power supply is 5 volt
Voltage at the sensor output is proportional to the detected pressure or temperature.

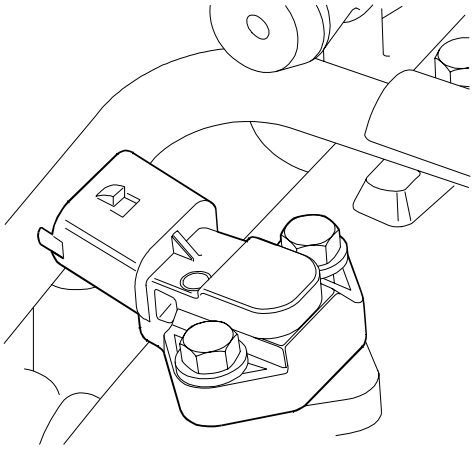
Pin 25C - 36C Temperature
Pin 33C - 34C Pressure

Engine oil temperature-pressure sensor

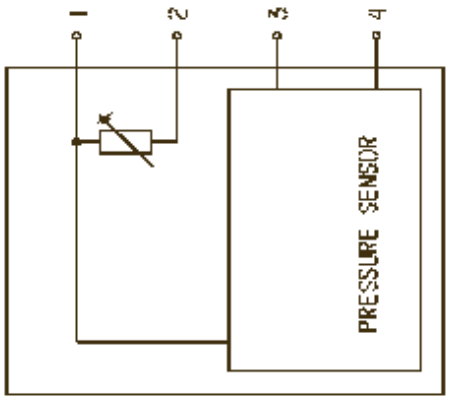
This component is analogous to the air temperature-pressure sensor.
The engine oil temperature-pressure sensor is installed on the engine oil filter support in a vertical position.
This sensor measures the engine oil temperature and pressure.
The sensor is connected to the control unit on pins 24C - 28C - 32C - 27C.
The sensor is supplied with 5 Volts. The signal detected is transmitted to the EDC control unit which, in turn, controls the relative device on the instrument panel (gauge + low pressure warning light).
The oil temperature is not displayed on any gauges - this value is used exclusively by the control unit.

Pin 24C - 28C Temperature
Pin 32C - 27C Pressure

Figure 101



50324



50344

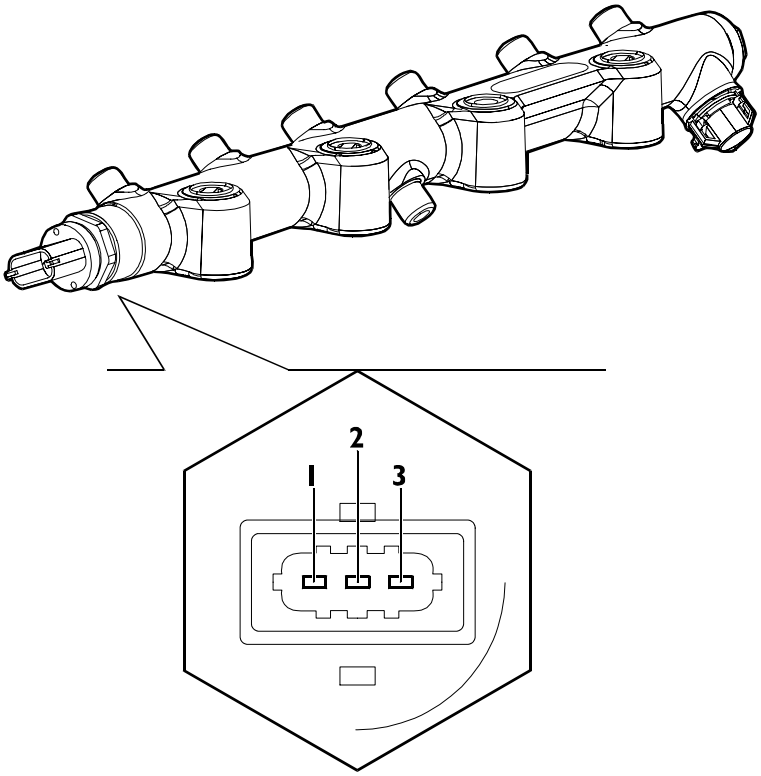
Wiring diagram

Ref.	Description	ECU Pin	
		Oil	Air
1	Ground	24C	25C
2	NTC signal (temperature)	28C	36C
3	+5 V power input	32C	34C
4	Signal (pressure)	27C	34C

Fuel temperature and pressure sensor

Mounted on one end of the rail, this sensor measures the internal fuel pressure and informs the control unit of the value (feedback). The injection pressure value is used as a pressure control feedback signal and to determine the duration of the electrical injection command.
This sensor is connected to the control unit on pins 12C - 14C- 13C.
The power supply is 5 Volt.

Figure 102



Fuel pressure sensor connector

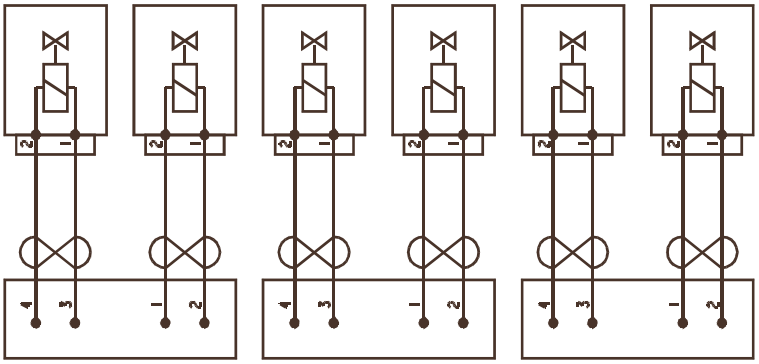
Ref.	Description	ECU pin
1	Ground	12C
2	Signal	14C
3	Power supply	13C

Electro-injectors

The electro-injectors are effectively N.O. solenoid valves.
Each injector is connected to the EDC control unit on connector A.
The impedance of the coil of each injector is 0.56 - 0.57 Ω.

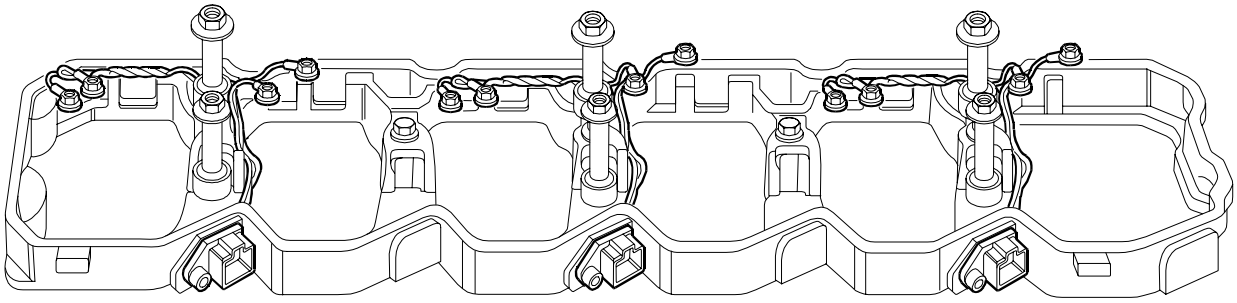
Ref.		Description	ECU pin
CONNECTOR 1	1	Cylinder 2 injector	11 A
	2	Cylinder 2 injector	6 A
	3	Cylinder 1 injector	13 A
	4	Cylinder 1 injector	4 A
CONNECTOR 2	1	Cylinder 4 injector	14 A
	2	Cylinder 4 injector	3 A
	3	Cylinder 3 injector	12 A
	4	Cylinder 3 injector	5 A
CONNECTOR 3	1	Cylinder 6 injector	15 A
	2	Cylinder 6 injector	2 A
	3	Cylinder 5 injector	1 A
	4	Cylinder 5 injector	16 A

Figure 103



50343

Figure 104

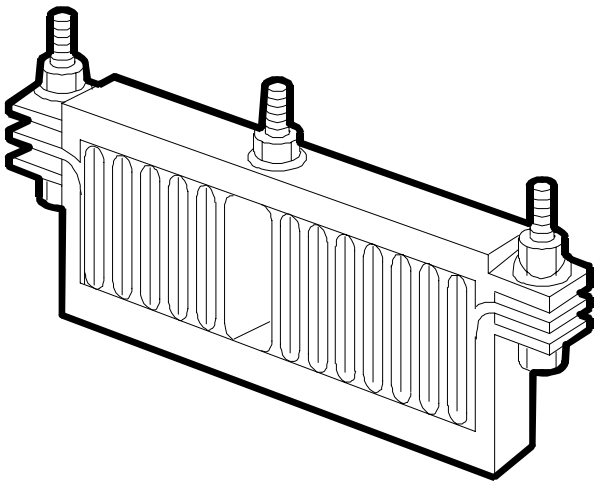


50349

Pre-post heating resistance and contactor

The pre-post heating resistance is located on the intake manifold.
The resistance serves to heat the air in pre / post heating operations. This resistance is powered by a contactor on the left hand side of the chassis.
The resistance impedance is approximately 0.5 Ω.

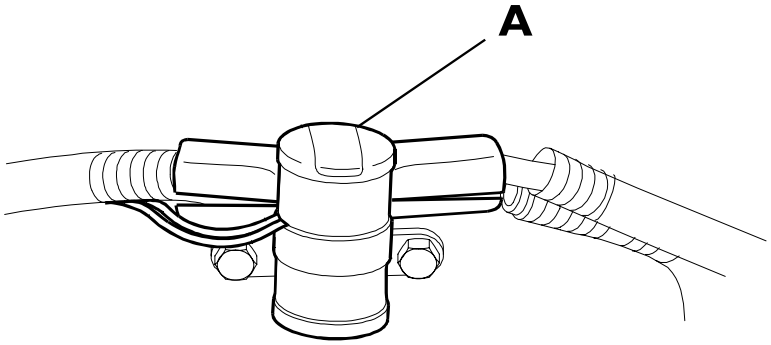
Figure 105



003215t

Resistance

Figure 106



002371t

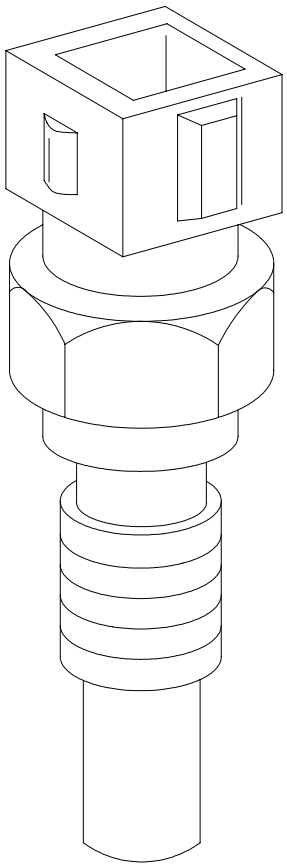
A. Control contactor

The control contactor is connected to the control unit B connector.
The contactor is tripped with water and/or fuel temperature below 5 °C.
The contactor impedance is approximately 15 Ω.

Coolant temperature sensor

This is a variable resistance sensor able to read the coolant temperature in order to provide the control unit with an indication of the thermal status of the engine.
The same signal is utilized by the control unit to drive an instrument panel gauge, if present.
This sensor is connected to the control unit on pins 15C - 26C.
The impedance of the coolant temperature sensor at 20 °C is approximately 2.50 Ω.

Figure 107

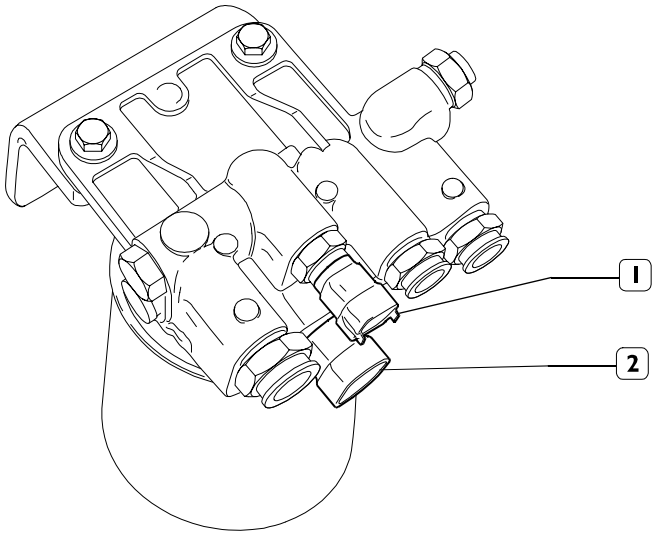


107471

Fuel temperature sensor

This sensor is identical to the coolant temperature sensor.
This sensor detects the fuel temperature to provide the control unit with a parameter defining the thermal status of the fuel.
The fuel temperature sensor is connected to the control unit on pins 35C -18C.
The sensor impedance at 20 °C is approximately 2.50 Ω.

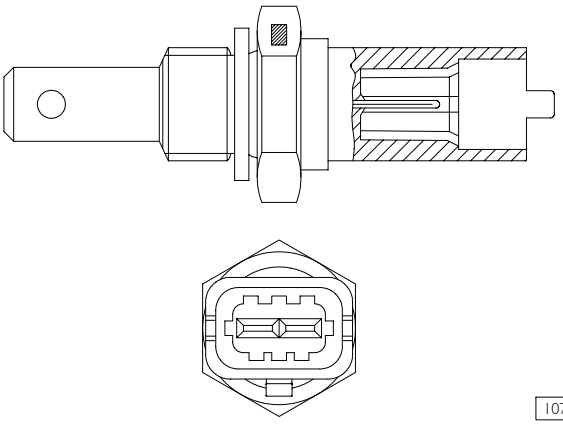
Figure 108



0051140t

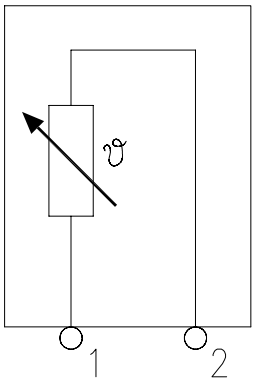
1. Fuel temperature sensor - 2. Filter heating resistance.

The ECU drives the filter heater contactor at fuel temperature ≤ 5 °C.



107799

Connector

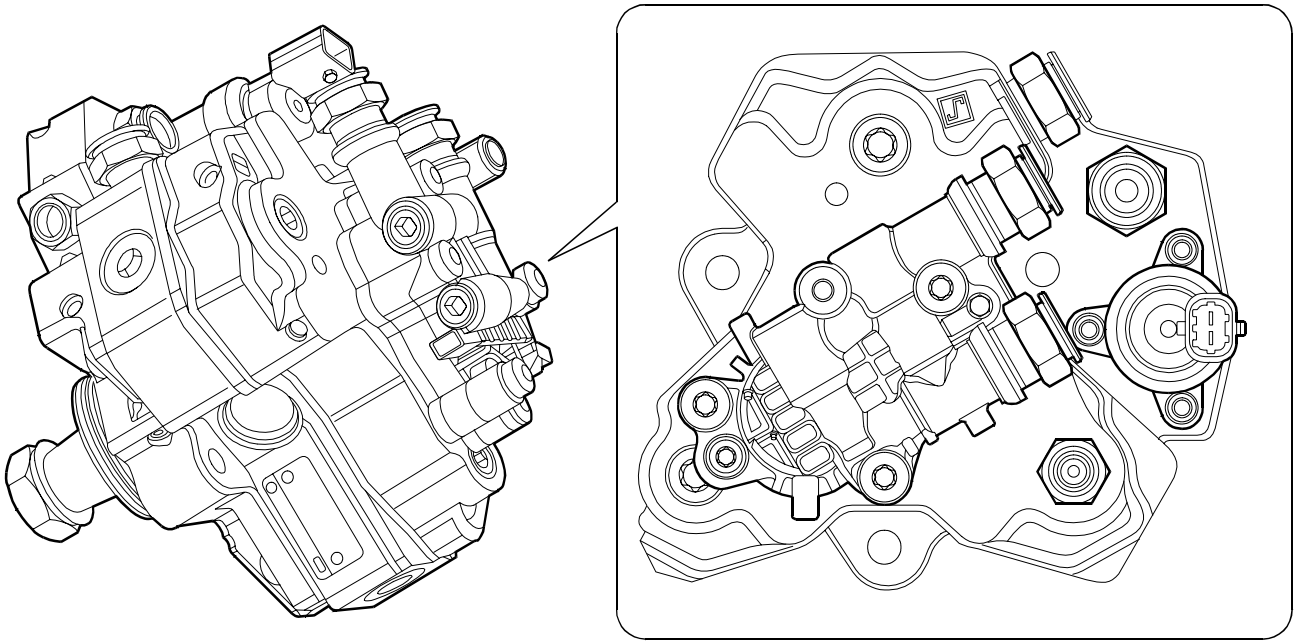


107798

Ref.	Description	ECU Pin	
		Coolant	Fuel
1	Ground	15C	35C
2	Temperature signal	26C	18C

High pressure pump - pressure regulator

Figure 109



000912t

A. Pressure regulator.

The quantity of fuel supplied to the high pressure pump is metered by the pressure regulator on the low pressure system; the pressure regulator is managed by the EDC7 control unit.

Delivery pressure to the rail is modulated between 250 and 1450 bar by the electronic control unit by controlling the pressure regulator solenoid valve.

- ❑ This component is a N.O. solenoid valve.
- ❑ The solenoid is connected to the control unit on pins 9A - 10A.
- ❑ The solenoid valve impedance is approximately 3.2 Ω.

PART THREE - TESTS - TROUBLESHOOTING

TESTS
CHECKING THE FUEL SYSTEM

This section analyses the tests for correctly troubleshooting and checking the fuel circuit and the common rail injection system. The stated procedure can be used in the event of trouble with the engine injection system correlated with error codes 8.x saved in the control unit, or not accompanied by any error code and the user notices a drop in performance. The following table gives descriptions of error codes 8.x.

Error	Description
8.1	- Negative deviation of the fuel pressure (actual pressure higher than the objective pressure). - Positive deviation of the fuel pressure (actual pressure lower than the objective pressure). - Drop in fuel pressure with vehicle in motion (lack of diesel). - Drop in fuel pressure with vehicle in motion: downhill with throttle pedal released (lack of diesel). - Drop in fuel pressure with the engine idling (lack of diesel).
8.2	- Fuel pressure sensor on rail.
8.4	- Backflow valve control (opening the pressure relief valve DBV).
8.5	- Fuel pressure in the rail too high. - Fuel pressure in the rail too low.

DESCRIPTION OF TESTS AND CHECKS THAT CAN BE PERFORMED

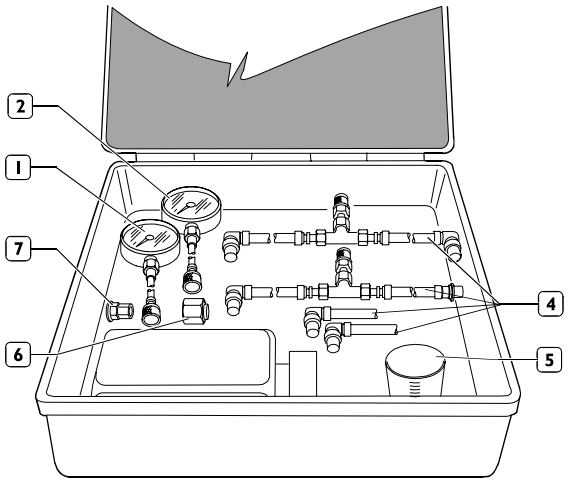
The contemplated tests are:

- ❑ Low pressure supply test
- ❑ Test on the pressure relief valve on the rail
- ❑ Test on fuel backflow from the injector return

Necessary equipment

Use the kit dwg. 99305453 described in the figure.

Figure 110



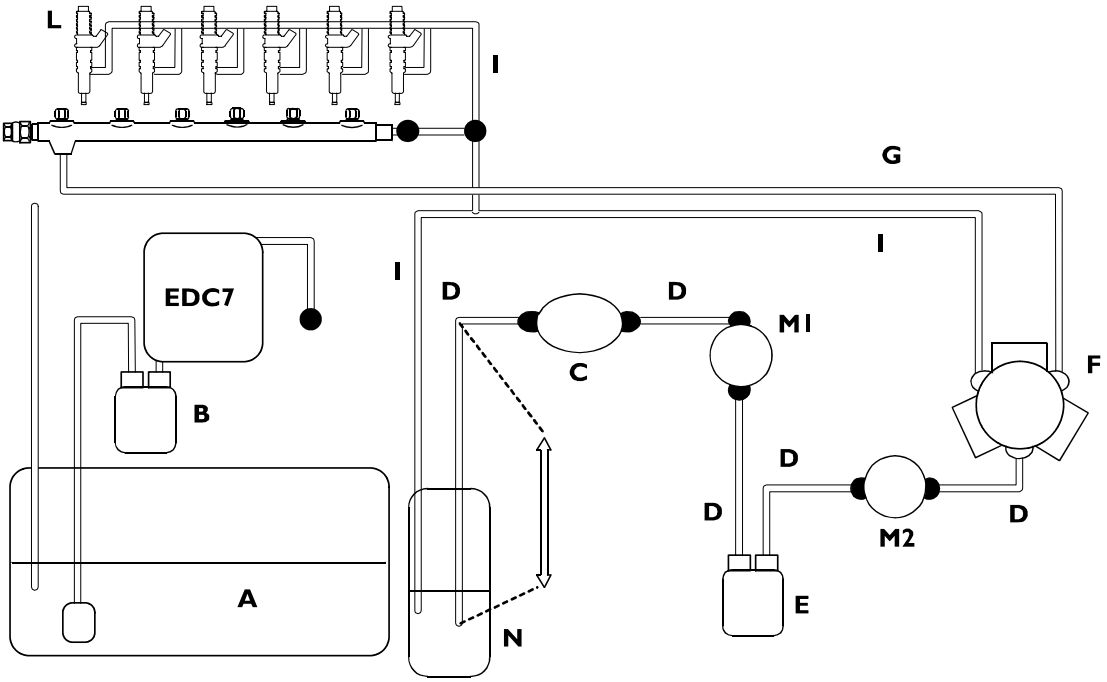
108599

1. Pressure gauge 1 (0 - 15bar) and standard couplings - 2. Pressure gauge 2 and standard couplings - 3. 2-litre container - 4. Pressure gauge pipes - 5. Graduated container of 100ml - 6. Plug for rail - 7. Closed Voss coupling.

Low pressure supply test

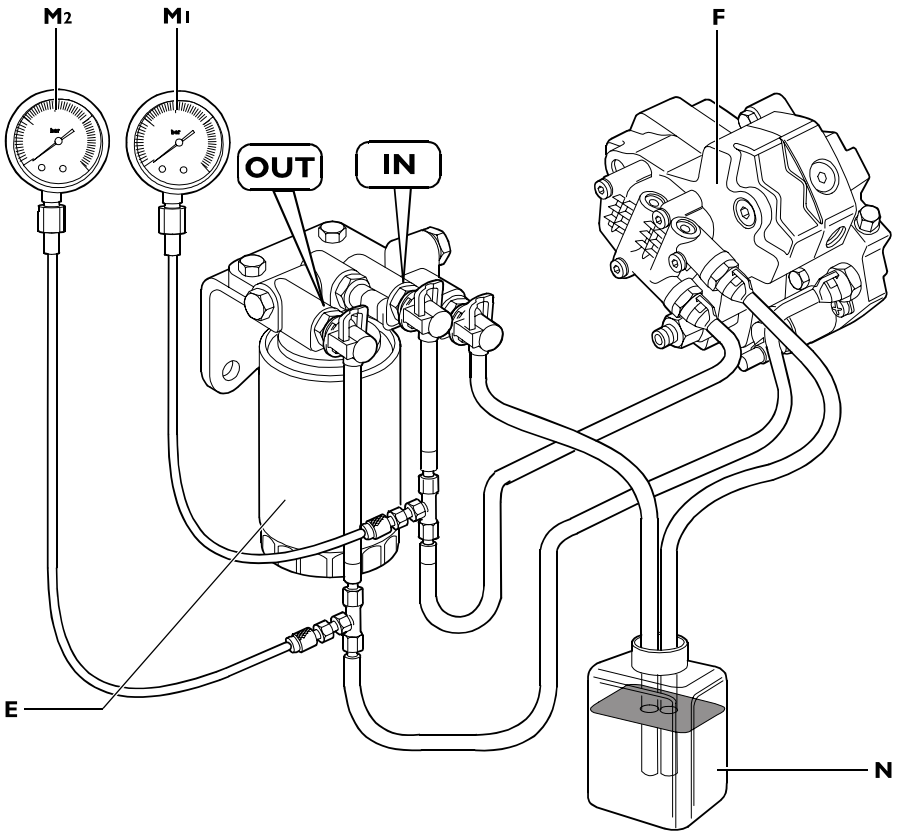
The figure shows the diagram for using the components available in the kit dwg. 99305453.

Figure 111



A. Fuel tank - B. Prefilter - C. Low-pressure pump - D. Fuel delivery circuit - E. Fuel filter - F. High-pressure pump CP3 - G. High-pressure circuit - H. Common rail - I. Fuel recirculation circuit - L. Injectors - M1. Pressure gauge 1 fuel filter inlet - M2. Pressure gauge 2 fuel filter outlet - N. External container.

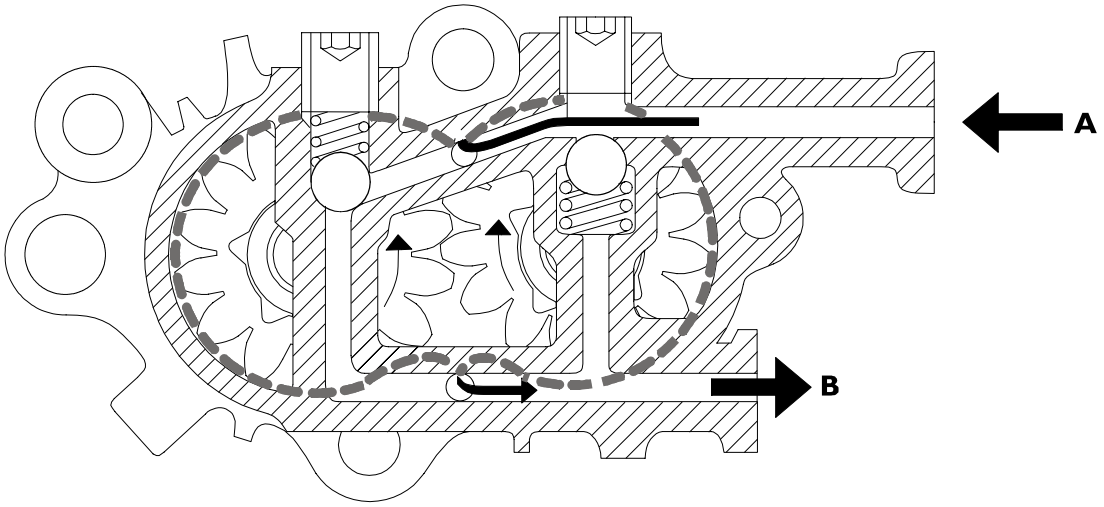
Figure 112



Low-Pressure Pump

The function of the gear pump is to supply the high-pressure pump CP3. It is driven by the shaft of the high-pressure pump and is fitted on its rear portion. Under normal operating conditions, the flow of fuel inside the pump is as shown in the figure.

Figure 113



On completing the fuel supply system and with the battery charged to 24.7V, the engine must start within the 20 seconds of activation of the starter motor, drawing fuel from the external container placed at most 1 metre lower than the engine. If the pump is not able to draw up fuel in the stated time and therefore start the engine, replace it.

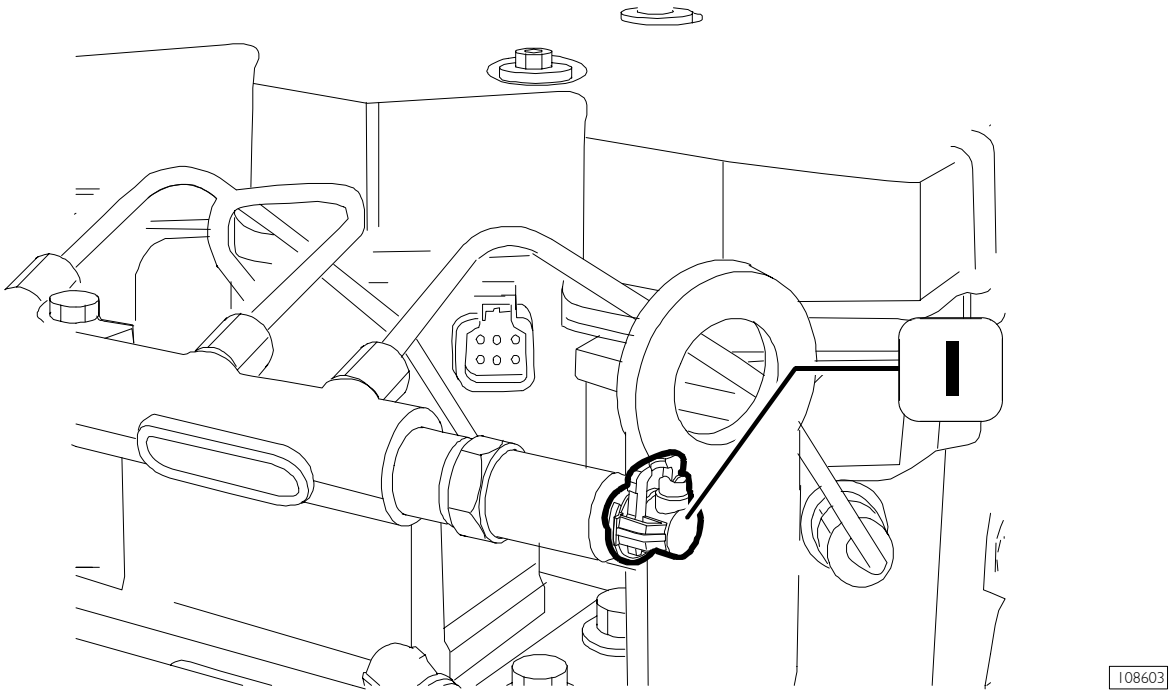
After starting the engine, check the pressure at 1500 rpm:

- ❑ On pressure gauge M1 it must be between 6 and 9 bar.
  f lower than 6 bar: replace the pump,
  if higher than 9 bar: replace the diesel filter.
- ❑ On pressure gauge M2 it must be greater than 5 bar:
  If lower, replace the diesel filter,
  if the trouble persists, check the seals of the couplings of the fuel filter support and of the high-pressure pump inlet.

Test on the pressure relief valve on the rail

Fitted at one end of the rail, its function is to protect the system's components if any malfunctioning causes an excessive increase in the pressure of the high-pressure system.

Figure 114



Disconnect the recirculation pipe (1) of the pressure relief valve and plug it with the Voss coupling of the kit dwg. 99305453. No diesel must come out of the valve at any engine speed. If the diagnosis system signals fault code 8.4 "Engine - backflow valve control", it means that the EDC control unit has recognised that the valve has opened after a significant change in the pressure of the rail (greater than 1700bar). Since its opening is to be considered a consequence of the abnormal increase in pressure, the valve is NOT defective even though a great amount of diesel flows out. Whereas, if the valve seeps diesel without fault code 8.4, then replace it.

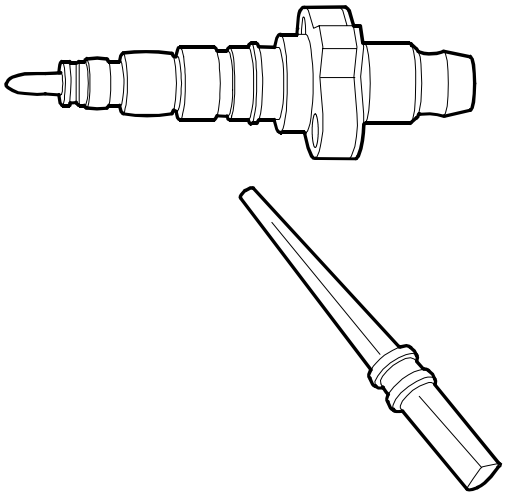
With the overpressure sensor disconnected or with a bundle of defective cables fault code 8.2 is generated and the rail pressure is set to 710bar (measurable with the diagnosis instrument). Therefore the trouble is to be found in the wiring and it is not necessary to replace the component.

The experience acquired to date shows that the defectiveness is RARELY due to the sensor.

Test on fuel backflow from the return

Permits establishing the operating status of the injectors. The engine speed and power are controlled through the injectors. The power required by the user, through the accelerator, is converted into the quantity of fuel injected per cycle. In its turn, this is converted into microseconds of injector opening according to the rail pressure.

Figure 115



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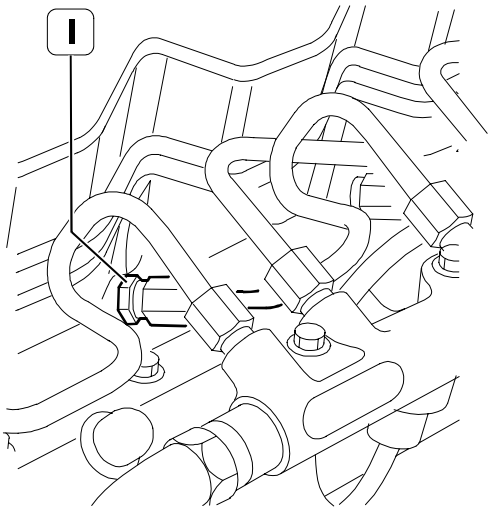
Notes:
The injectors may have problems of both a mechanical and an electrical nature; before proceeding with the following analysis, it is wise to rule out the presence of water in the tank and in the fuel prefilter.

When the EDC warning light comes on occasionally (fault code 8.1) in the phase of acceleration and/or cold start trouble, make the following checks.

- ❑ Possible incorrect tightening of the nut (1) locking the injector duct on the cylinder head. The prescribed torque setting is 50Nm ± 5Nm.

Figure 116



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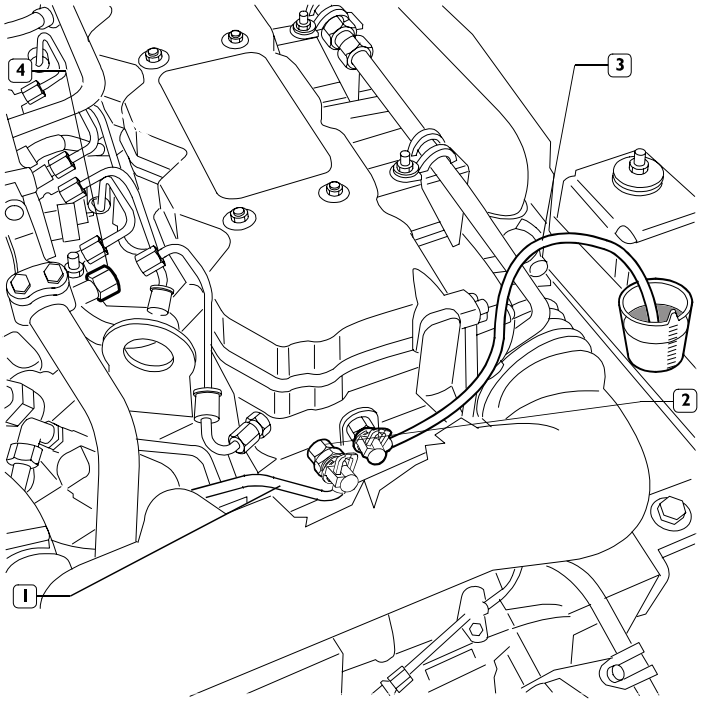
❑ Proceed with the injector fuel backflow tests.
Remove the duct (1) from the cylinder head, plug it (2) and fit on the coupled transparent pipe (3).

Figure 117



Make sure first of all that the engine idling speed is as set in the factory. Check the quantities of fuel recirculation from the cylinder head. The conditions for measuring the quantities of injector return fuel are:

❑ engine idling and without air compressor or air conditioner working;

❑ engine at temperature (> 50 °C).

The quantity that flows out must be no greater than 80ml of diesel in one minute. Excessive recirculation (more than 80ml of diesel a minute) could be caused by:

❑ incorrect coupling between one or more injectors and the related "needles";

❑ problem of internal leakage of the injector.

To identify the defective injector, follow the method described hereunder. Measure the quantity of fuel flowing out in one minute from the coupling on the cylinder head by means of a graduated container. After checking that the recirculation is greater than 80ml a minute, plug the rail outlet of one injector (4) at a time by using the rail plug in the kit dwg. 99305453. The defective injector is the one whose exclusion caused a significant reduction in recirculation. In addition, remember that when changing an injector it is necessary to change the duct. After identifying the injectors / ducts with a high recirculation, check that the tightness of the ducts is as designed (50Nm ± 5) and tighten them if they are loose and then check the recirculation values again. If on the other hand the tightness is correct, remove the pipe and check that the spherical end towards the injector is not out of shape; replace it if it is and then check the recirculation value again. If the duct is not out of shape either, then replace the injector and duct because there must be a leak inside the injector. Check the recirculation value again.

ANOMALY	POSSIBLE CAUSE (*) = if available in the equipment	RECOMMENDED TESTS OR INTERVENTION	REMARKS
Low performance at load request. Possible exessive smoke. Possible blink-code 8.1	Insufficient fuel level in the tank.	Check fuel level.	The excessive smoke is due to the fact that, in case of insufficient fuel feeding, the engine control module tries to compensate prolonging the injectors working time.
	Fuel tank device partially obstructed by impurities or deformed because of overheating.	Check if the priming pump of the pre-filter is working correctly. If the pump plunger is permanently depressed disassemble and check the tank pick.-up tube. If this is in order, replace the pre-filter.	
	Obstructed air filter.	Replace the air filter.	Solve the cause of the filter's obstruction.
	Excessive fuel blow-by from rail boost valve.	Check the O Rings and the correct connection of the pipe fittings under the feeding pump (the lockers must stay outside and the fittings must be well locked). Visually check the low pressure pipeline integrity.	Unless the leakage is significant, no performance failures will be detected. To verify O-rings integrity, extract from the tank the fuel recycling pipeline, seal the end and activate the priming pump driving the low pressure circuit.
	Excessive fuel blow-by from rail boost valve.	Disconnect the pipe and visually check if there are any significant blow-by from the boost gauge valve; in such case replace the valve.	
The engine suddenly stops (with no previous problems) and does not start again.	Obstructed fuel filter.	Replace the fuel filter.	Solve the cause of the filter's obstruction (empty and clean the tank and the part of the circuit over the filter, refill with clean fuel).

ANOMALY	POSSIBLE CAUSE (*) = if available in the equipment	RECOMMENDED TESTS OR INTERVENTION	REMARKS
The engine disconnects or does not start.	(*) EDC "burned" by short circuit on the wiring harness of the friction clutch.	Eliminate the short circuit and replace the EDC.	Verify that the wire line, close to the pedal, is not exposed to.
Difficult start and low performance in all conditions.	Inefficient high pressure pump.	After having excluded any other possible cause, replace the high pressure pump.	
Difficult start, low performance and engine running with one cylinder less.	Injector with obstructer or solenoid (mechanical part) blocked open.	The non-working injector is easily recognisable detecting by feeling the absence of pulsing within the relevant high pressure pipe.	In case of low entity blow-by, inficiating the mechanical working of the injector but not involving flow limiter activation, there is no error memorisation in the engine control module. If the flow limiter is activated. Check error code memory.
Starting requires in excess of ten seconds, followed by huge white exhaust fumes, and a fuel smell.	Injector blocked in open position (with no return).	The non-working injector is easily recognisable detecting by feeling the absence of pulsing within the relevant high pressure pipe.	Usually, whether such symptoms appear, it is instinctive to give up engine start. However, by insisting, it is possible to start the engine. As a matter of facts, by insisting, if within the rail the pressure makes the flow limiter close up, the engine starts with one cylinder less and gradually the grade of fumes reduces and disappears.
Breaking of high pressure pipeline from pump to rail.	Strange vibrations provoked by slack of pipe bracket.	Replace the pipeline ensuring the correct tightening of the anti-vibration bracket screws.	It is very important, in addition to correct blocking, to keep the brackets in the original position.
The engine works with one cylinder less, without memorising failure blink codes in the engine control module.	Injector blocked in closed position.	Identify the injector that is not working any more and the relating high pressure filler.	The non-working injector is easily recognisable detecting by feeling the absence of pulsing within the relevant high pressure pipe.

PART FOUR - MAINTENANCE PLANNING

MAINTENANCE PLANNING
Recovery

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

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

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

Regular maintenance and inspection planning

Checks and periodical inspections	Frequency (hours)
Visual check of engine	Daily
Inspection presence of water in fuel filter or pre-filter	Daily
Inspection blow-by filter elements	-
Inspection of belt wear status	-
Inspection and setting of tappet clearance	4000
EDC	When anomaly occurs
Replacement of engine's oil and filter	500
Replacement of pre-filter	1000
Replacement of fuel filter	500
Replacement of blow by filter	500
Replacement of belt	1500

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.

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

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

Checks not included in maintenance planning-daily checks

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

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

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

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

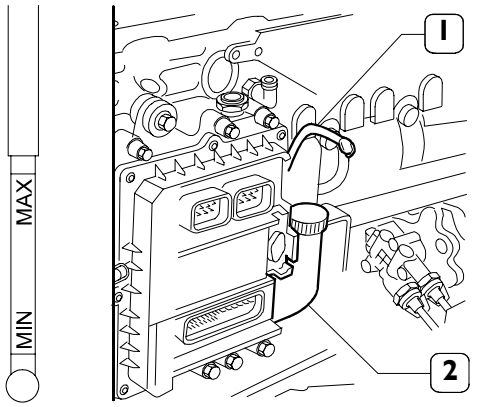
MAINTENANCE PROCEDURES
Checks and inspections

Engine oil level check

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

The check can be made using the specially provided flexible rod (1) placed on the right hand side of the EDC.

Figure 118

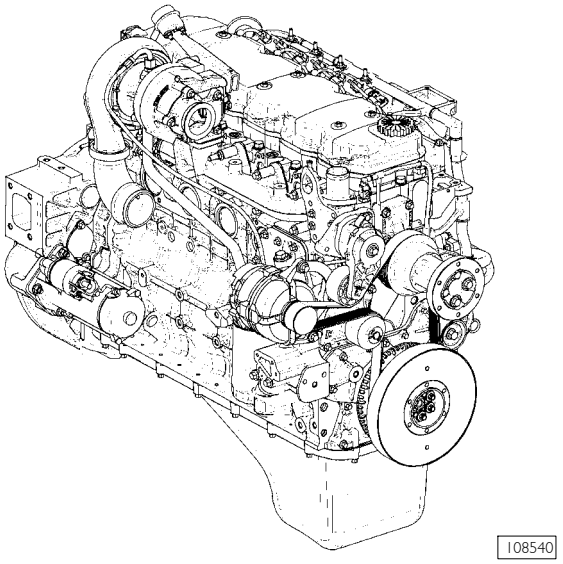


Draw off the rod from its slot and check that the level is within the etched tags of minimum and maximum level.

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.

Figure 119



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".

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.

Combustion system inspection

The check must be executed both when the engine disconnected and when it is running.
The check operation consists in examining the fuel pipelines running from the tank to the pre-filter (if provided in the specific equipment), to the filter, to the high pressure pump and to the rail diffuser and from this last one to the head.

Special attention must be paid to the connections on the high pressure pipelines.

Due to the high pressure within the pipelines running from the high-pressure pump to the rail diffuser and from this last one to the electro-injectors, special attention must be aid also in checking presence of any leakage or blow-by.

Protect the eyes and the skin from any eventual high pressure jet: these may deeply penetrate under the skin surface provoking serious poisoning.

Cooling system inspection

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

Check the pipelines from the engine to the radiator, from the expansion tank and vice-versa. Find out any blow-by, verify the status of the pipes specially close to the holding strips.

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.

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 inspection

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.

Inspection of water presence within fuel filter or pre-filter

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

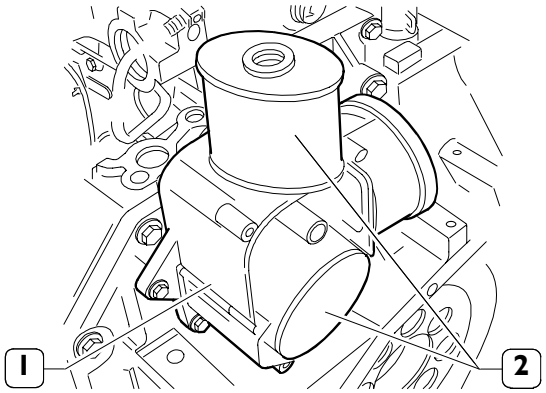
Timely proceed operating on the pre-filter (not available on the engine block) to carry out the drainage of the water within the feed circuit.

Inspection/replacement of blow-by filter

The filter in subject has been developed and equipped for the collection, filtering and condense of the lubricating oil vapours.

Within the filter unit (1) two cartridge filters are included (2).

Figure 120



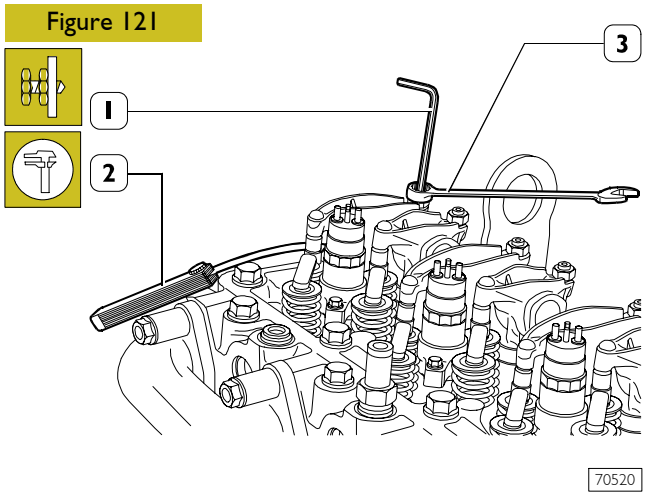
The check of the filtering element is carried out by removing the cover and drawing off the cartridges (2).

Inspection of drive belt tensioning

The drive belt tensioning control is made using an automatic tensioning device therefore no intervention is required apart from checking the wear status of the belt itself.

Inspection and setting of tappet clearance

Figure 121



Adjust clearance between rockers and valves using setscrew wrench (1), box wrench (3) and feeler gauge (2).

Clearance shall be as follows:

- intake valves 0.25 ± 0.05 mm
- exhaust valves 0.50 ± 0.05 mm.

On TIER 3 engines, due to the additional lobe for the INTERNAL E.G.R., it is not possible to use the valve clearance adjustment procedure that requires adjusting the clearance of all the valves by positioning the crankshaft 2 times only.
Each cylinder must be checked by taking it to the T.D.C. (top dead centre) at the end of compression and adjusting the clearance of both valves on the cylinder in question.

Oil motor and filter replacement

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.

Due to the several applications, the pan shape and the oil quantity can change slightly. However, the following operations are valid for all applications.

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

- ❑ Place a proper container for the oil collecting under the pan connected with the drain plug.
- ❑ Unscrew the plug and then take out the control dipsick and the inserting plug 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.

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

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.

Whereas you replace the lubrication oil, it is necessary to replace the filter.

According to the application the filter can be located in different positions: the following procedure is a valid guide for all applications.

- ❑ The filter is composed by a support and a filtering cartridge. For the cartridge replacement use the 9936076-tool.

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.

- ❑ Replace the filtering cartidge with a new one and screw manually until when the gasket is in contact with the support.
- ❑ Tigthen by means of the 99360076-tool of three fourth turn.
- ❑ Operate the motor for some minutes and check the level through the dipsick again. If it is necessary, carry out a topping up to compensate the quantity of oil used for the filling of the filtering cartridge.

Fuel filter replacement

During this operation don't smoke and don't use free flames.

Avoid to breathe the vapors coming from filter.

According to the applications the filters position and the quantity can change.

However the following operations are valid for all applications.

- ❑ Drain the fuel inside the filter by operating the water release screw. Collect the fuel in a container without impurities.
- ❑ Unscrew the cartridge by using the 99360076-tool.
- ❑ Collect the eventual fuel inside the filtering cartridge.
- ❑ Clean the gasket seat on the support and oil slightly the gasket on the new filtering cartridge.
- ❑ Screw manually the new filtering cartdrige until when the gasket is completely on its seat.
- ❑ Tigthen through the 99360076-tool at 10-15 Nm torque.

Alternator belt replacement

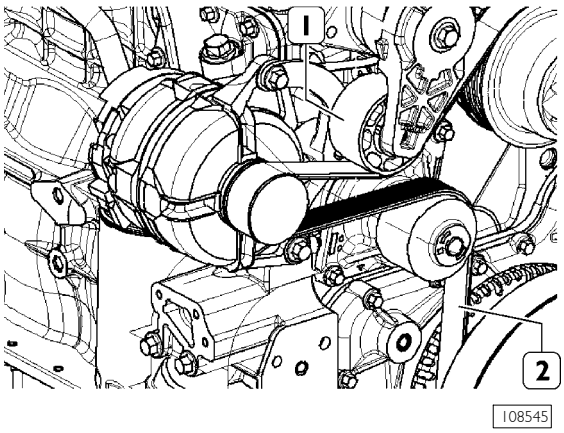
Due to several applications the belt run can change very much.

Warning: with switched off motor (but still hot) the belt can operate without advance notice.

Wait for the motor temperature lowering to avoid very serious accidents.

For applications with automatic belt stretcher, the procedure is the following:

Figure 122

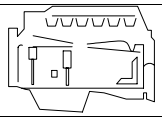
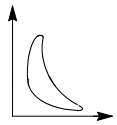
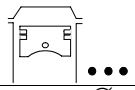
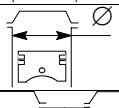
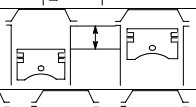
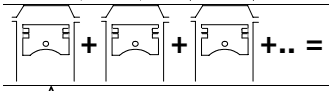
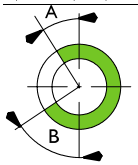
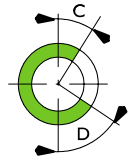
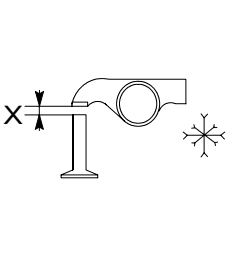
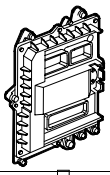
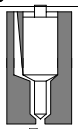
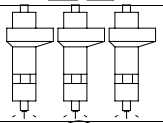
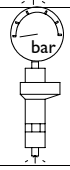


- ❑ Operate on the tightener (1) and withdraw the belt (2) from the alternator and water pumps from pulleys and from the returns pumps.
- ❑ Replace the worn belt with a new one.
- ❑ Place the belt on the pulleys and the guide rollers.
- ❑ Place the automatic tightener in order to key the belt in the functioning position.
- ❑ Further adjustments are not required.

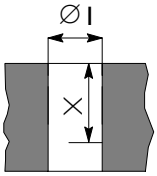
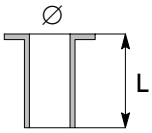
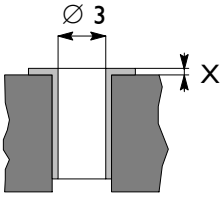
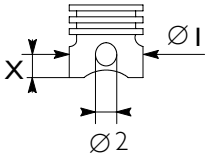
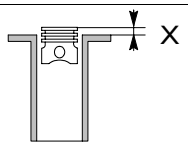
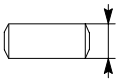
SECTION 4

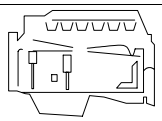
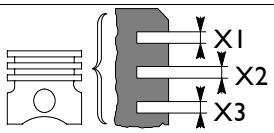
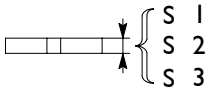
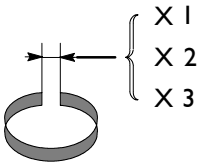
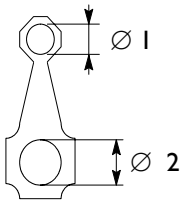
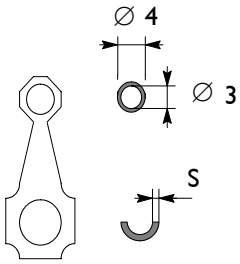
Overhaul and technical specifications

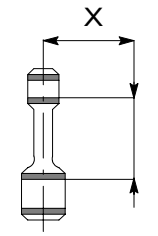
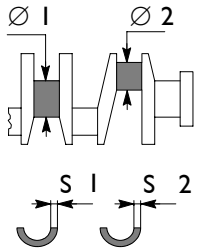
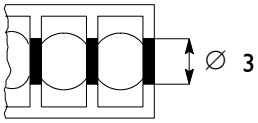
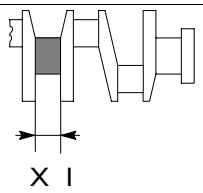
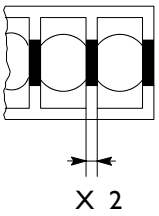
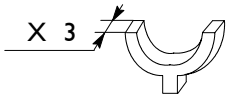
GENERAL SPECIFICATIONS

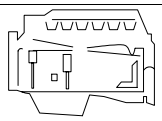
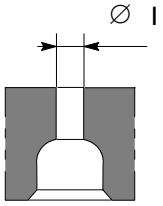
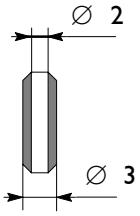
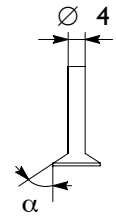
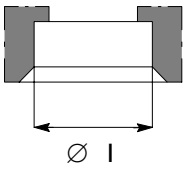
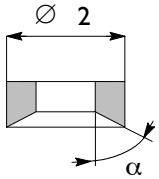
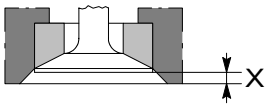
	Type		4 CYLINDERS	6 CYLINDERS
	Cycle		Four-stroke diesel engine	
	Power		Turbocharged with intercooler	
	Injection		Direct	
	Number of cylinders		4	6
	Bore	mm	104	
	Stroke	mm	132	
	Total displacement	cm^3	4485	6728
   	**TIMING** start before T.D.C. end after B.D.C. start before B.D.C. end after T.D.C.	 A B D C	 18.5° 29.5° 67° 35°	
	Checking timing mm X mm Checking operation mm X mm		 - - 0.20 to 0.30 0.45 to 0.55	
	**FUEL FEED** Injection Type: Bosch		 high pressure common rail EDC7 ECU	
	Injector		CRIU 2	
	Nozzle type		DSLA and DLLA	
	Injection sequence		1 - 3 - 4 - 2	1 - 5 - 3 - 6 - 2 - 4
	Injection pressure	bar	250 - 1450	250 - 1600

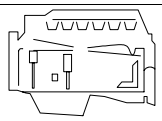
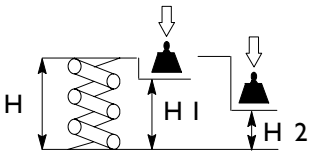
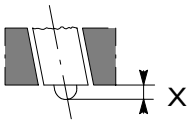
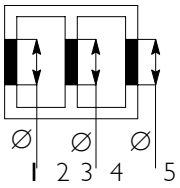
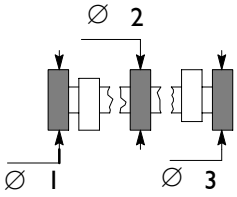
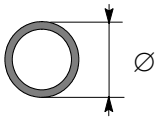
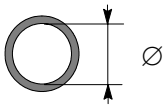
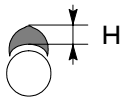
CLEARANCE DATA

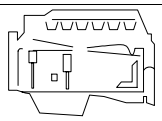
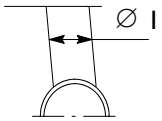
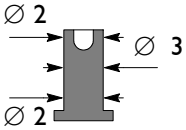
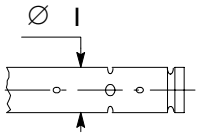
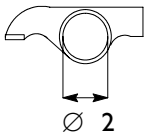
	Type	4 CYLINDERS	6 CYLINDERS
	CYLINDER UNIT AND CRANKSHAFT COMPONENTS	mm	
	Cylinder barrels Ø1	102.009 to 102.031	
	Cylinder barrels: outside diameter Ø 2 length L	 - -	
	Cylinder barrels – housings on engine block (interference)	-	
	Outside diameter Ø 2	0,5	
	Cylinder barrels: inside diameter Ø 2	-	
	Spare pistons type: Size X Outside diameter Ø 1 Pin housing Ø 2	 61 103.730 to 103.748 38.010 to 38.016	
	Piston – cylinder barrels	0.252 to 0.294	
	Piston diameter Ø 1	0.5	
	Piston protrusion X	0.28 to 0.52	
	Piston pin Ø 3	37.994 to 38.000	
	Piston pin – pin housing	0.01 to 0.022	

	Type	4 CYLINDERS	6 CYLINDERS
CYLINDER UNIT AND CRANKSHAFT COMPONENTS		**mm**	
	Split ring slots X1*	2.705 to 2.735	
	X 2	2.440 to 2.460	
	X 3	4.030 to 4.050	
	Split rings S 1*	2.560 to 2.605	
	S 2	2.350 to 2.380	
	S 3	3.977 to 3.990	
	* measured on 98 mm Ø 4 cyl. * measured on 99 mm Ø 6 cyl. * measured on 101 mm Ø F4HE		
	Split rings - slots 1	0.100 to 0.175	
	2	0.060 to 0.110	
	3	0.040 to 0.083	
	Split rings	0.5	
	Split ring end opening in cylinder barrel:		
	X 1	0.30 to 0.40	
	X 2	0.60 to 0.80	
	X 3	0.30 to 0.55	
	Small end bush housing Ø 1	40.987 to 41.013	
	Big end bearing housing Ø 2	72.987 to 73.013	
	Small end bush diameter		
	Outside Ø 4	41.279 to 41.553	
	Inside Ø 3	38.019 to 38.033	
	Spare big end half bearings S	1.955 to 1.968	
	Small end bush – housing	0.266 to 0.566	
	Piston pin – bush	0.019 to 0.039	
	Big end half bearings	0.250 to 0.500	

	Type	4 CYLINDERS	6 CYLINDERS
	CYLINDER UNIT AND CRANKSHAFT COMPONENTS	**mm**	
	Size X Max. tolerance on connecting rod axis alignment =	- -	
	Journals Ø 1 Crankpins Ø 2 Main half bearings S 1 Big end half bearings S 2 *provided as spare part	82.99 to 83.01 68.987 to 69.013 2.456 to 2.464 1.955 to 1.968	
	Main bearings No. 1 – 5 / 1- 7 Ø 3 No. 2 – 3 – 4 Ø 3	 87.982 to 88.008 87.977 to 88.013	
	Half bearings – Journals No. 1–5 / 1-7 No. 2–3–4 / 2-3-4-5-6	 0.041 to 0.119 0.041 to 0.103	
	Half bearings - Crankpins	0.033 to 0.041	
	Main half bearings Big end half bearings	0.250 to 0.500	
	Shoulder journal X 1	37.475 to 37.545	
	Shoulder main bearing X 2	25.98 to 26.48	
	Shoulder half-rings X 3	37.28 to 37.38	
	Output shaft shoulder	0.068 to 0.41	

		4 CYLINDERS	6 CYLINDERS
	Type		
CYLINDER HEAD – TIMING SYSTEM		mm	
	Valve guide seats on cylinder head Ø 1	7.042 to 7.062	
	Valve guides Ø 2	-	
	Ø 3	-	
	Valve guides and seats on head	-	
	Valve guides	-	
	Valves: Ø 4 α	6.970 to 6.999 60° ± 0.25°	
	Ø 4 α	6.970 to 6.999 45° ± 0.25°	
	Valve stem and guide	0.052 to 0.092	0.052 to 0.092
	Housing on head for valve seat: Ø1	34.837 to 34.863	
	Ø1	34.837 to 34.863	
	Valve seat outside diameter; valve seat angle on cylinder head: Ø 2 α	34.917 to 34.931 60°	
	Ø 2 α	34.917 to 34.931 45°	
	Sinking X	0.59 to 1.11	
	X	0.96 to 1.48	
	Between valve seat and head	0.054 to 0.094	0.054 to 0.094
	Valve seats	-	

	Type		4 CYLINDERS	6 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM			**mm**	
	Valve spring height: free spring under a load equal to: 339.8 ± 9 N 741 ± 39 N	 H H1 H2	 47.75 35.33 25.2	
	Injector protrusion	X	-	
	Camshaft bush housings No. 1-5/1-7 Camshaft housings No. 2-3-4/2-3-4-5-6		59.222 to 59.248 54.089 to 54.139	
	Camshaft journals: 1 ⇒ 5 1 ⇒ 7	 Ø Ø	53.995 to 54.045	53.995 to 54.045
	Camshaft bush outside diameter:	Ø	-	
	Bush inside diameter	Ø	54.083 to 54.147	
	Bushes and housings on block		-	
	Bushes and journals		0.038 to 0.162	
	Cam lift:  	 H H	 6.045 7.582	

	Type		4 CYLINDERS	6 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM			**mm**	
	Tappet cap housing on block	Ø 1	16.000 to 16.030	
	Tappet cap outside diameter:	Ø 2 Ø 3	15.924 to 15.954 15.960 to 15.975	
	Between tappets and housings		0.025 to 0.070	
	Tappets		-	
	Rocker shaft	Ø 1	21.965 to 21.977	
	Rockers	Ø 2	22.001 to 22.027	
	Between rockers and shaft		0.024 to 0.162	

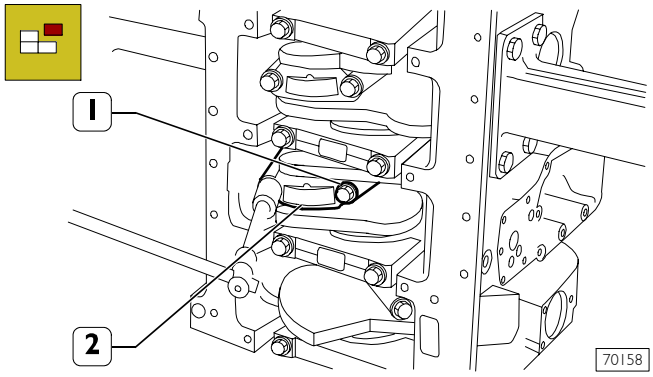
4 AND 6 ENGINE OVERHAUL
ENGINE REMOVAL AT THE BENCH

The following instructions assume that the engine has previously been placed on the rotating bench and that removal of all specific components of the Iveco Motors 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.

The following operations are relating to the 4 cylinder engine but are similar and applicable for the 6 cylinder.

Figure 1

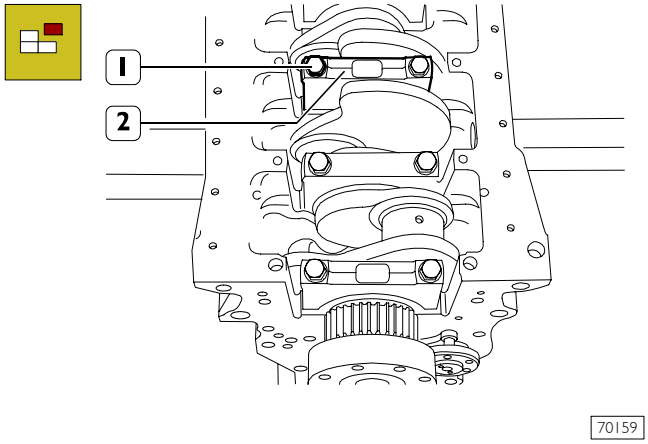


Loosen the fixing screws (1) and remove the rod caps (2).

Withdraw the pistons including the connecting rods from the top of the engine block.

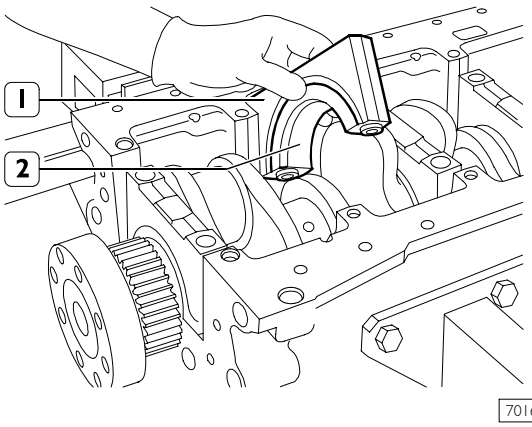
Keep the half-bearings into their housings since in case of use they shall be fitted in the same position found at removal.

Figure 2



Remove the screws (1) and the main bearing caps (2).

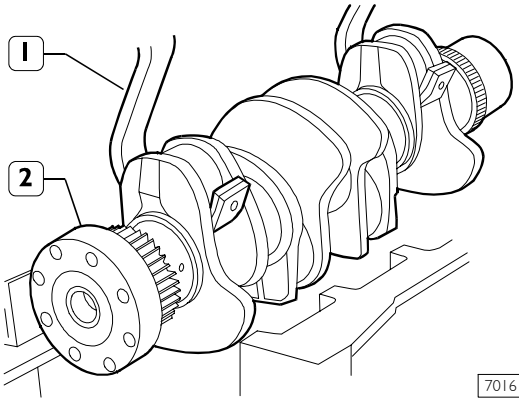
Figure 3



The second last main bearing cap (1) and the relevant support are fitted with shoulder half-bearing (2).

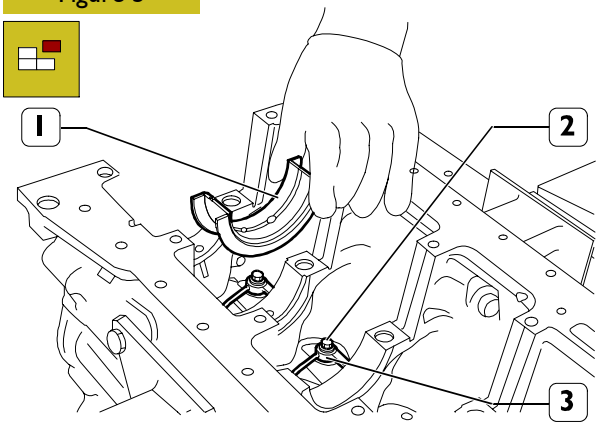
Take note of lower and upper half-bearing assembling positions since in case of reuse they shall be fitted in the same position found at removal.

Figure 4



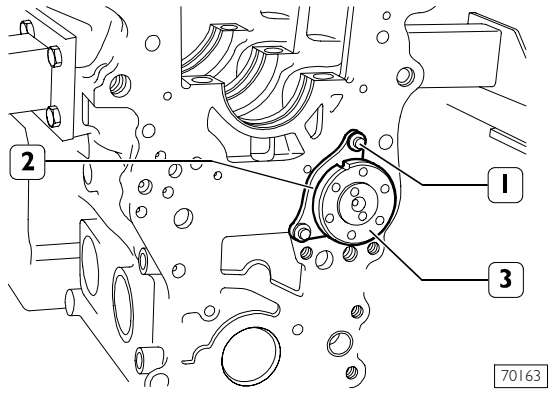
Use tool 99360500 (1) and hoist to remove the crankshaft (2) from the block.

Figure 5



Remove the main half-bearings (1).
Remove the screws (2) and remove the oil nozzles (3).

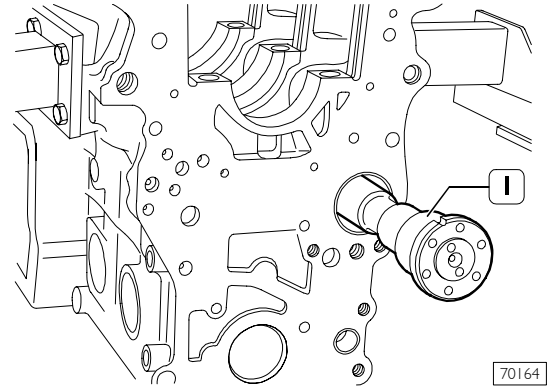
Figure 6



Remove the screws (1) and disconnect camshaft (3) retaining plate (2).

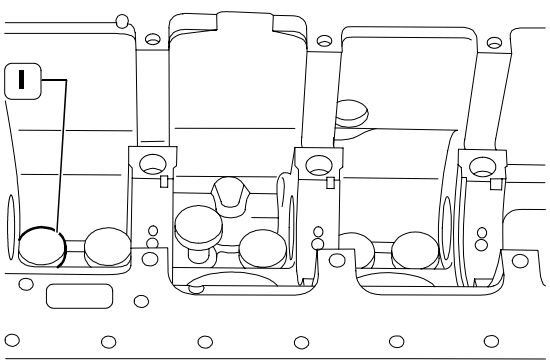
Take note of plate (2) assembling position.

Figure 7



Withdraw carefully the camshaft (1) from the engine block.

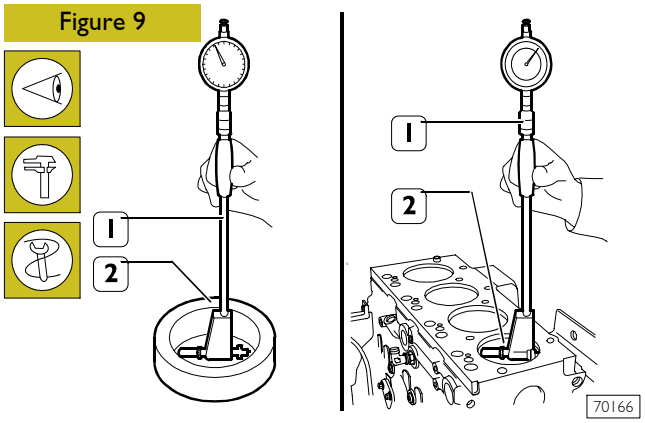
Figure 8



Withdraw the tappets (1) from the engine block.

REPAIR OPERATIONS
CYLINDER UNIT
Checks and measurements

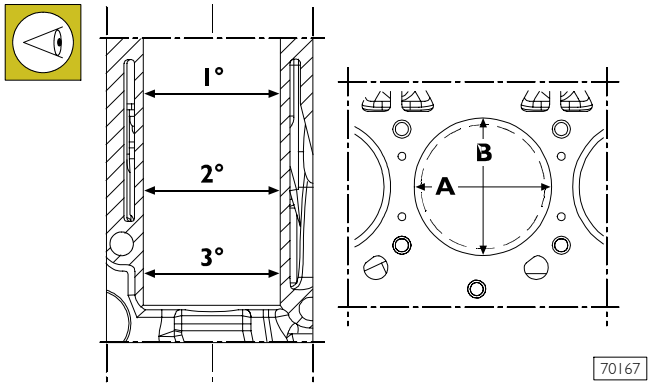
Figure 9



Once engine is disassembled, clean accurately the cylinder-block assembly.
Use the proper rings to handle the cylinder unit.
The engine block shall not show cracks.
Check operating plug conditions and replace them in case of uncertain seal or if rusted.
Inspect cylinder barrel surfaces; they shall be free from seizing, scores, ovalisation, taper or excessive wear.
Inspection of cylinder barrel bore to check ovalisation, taper and wear shall be performed using the bore dial gauge (1) fitted with the dial gauge previously set to zero on the ring gauge (2) of the cylinder barrel diameter.

Should the ring gauge be not available, use a micrometer for zero-setting.

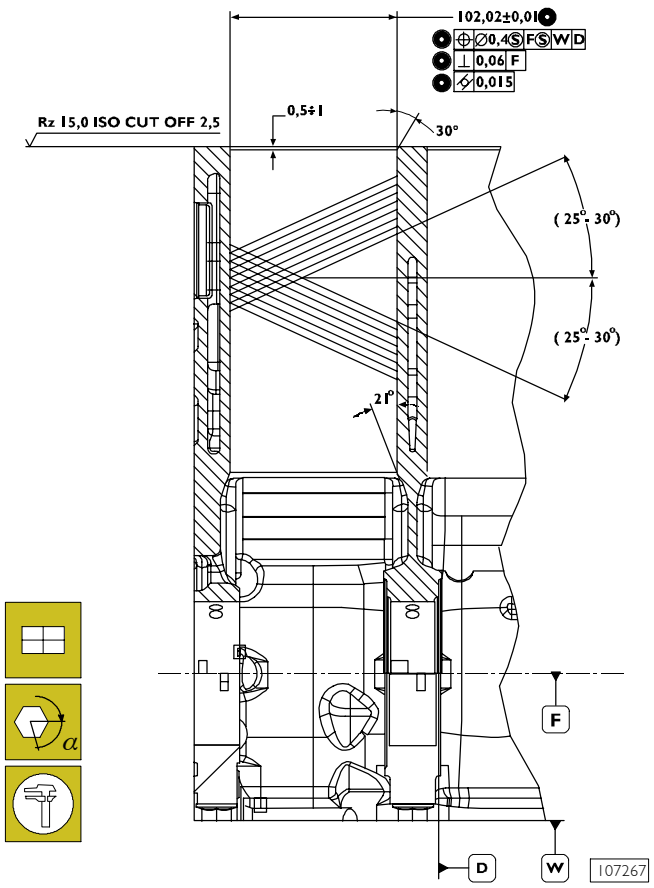
Figure 10



Measurements shall be performed on each cylinder, at three different heights in the barrel and on two planes perpendicular with each other: one parallel to the longitudinal axis of the engine (A), and the other perpendicular (B). Maximum wear is usually found on plane (B) in correspondence with the first measurement.

Should ovalisation, taper or wear be found, bore and grind the cylinder barrels. Cylinder barrel regrinding shall be performed according to the spare piston diameter oversized by 0.5 mm and to the specified assembling clearance.

Figure 11



In case of regrinding, all barrels shall have the same oversize (0.5 mm).

Check main bearing housings as follows:

- ❑ fit the main bearings caps on the supports without bearings;
- ❑ tighten the fastening screws to the specified torque;
- ❑ use the proper internal gauge to check whether the housing diameter is falling within the specified value.

Replace if higher value is found.

Checking head supporting surface on cylinder unit

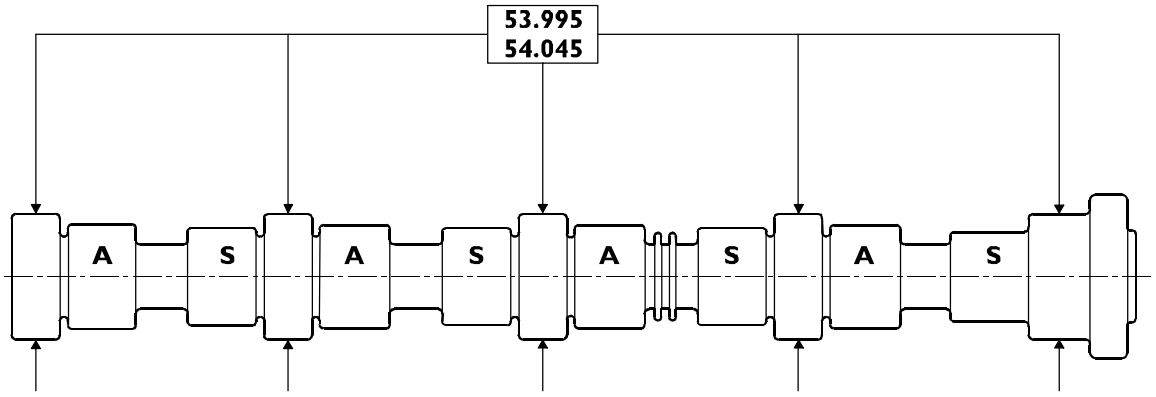
When finding the distortion areas, replace the cylinder unit.

Planarity error shall not exceed 0.075 mm.

Check cylinder unit operating plug conditions, replace them in case of uncertain seal or if rusted.

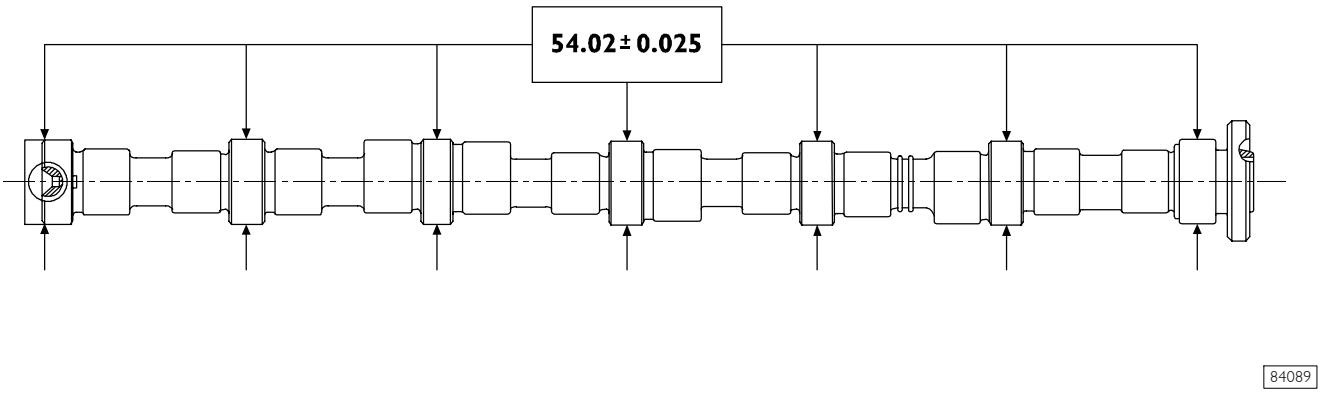
TIMING SYSTEM
Camshaft

Figure 12



CAMSHAFT MAIN DATA (4 cyl.)
Specified data refer to pin standard diameter

Figure 13



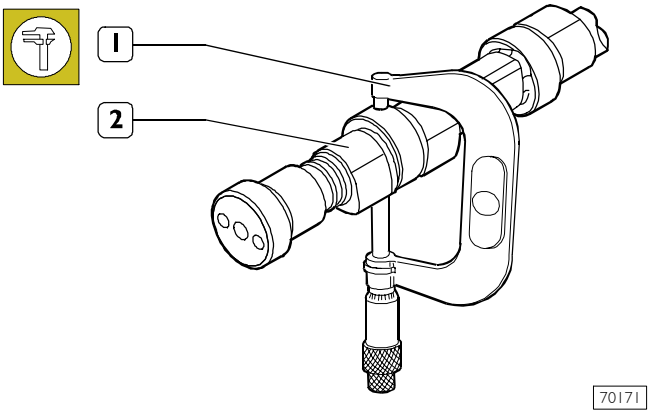
MAIN DATA ABOUT CAMSHAFT PINS (6 F4HE684 engine cylinders)
Specified data refer to pin standard diameter

Camshaft pin and cam surfaces shall be absolutely smooth; if they show any traces of seizing or scoring replace the camshaft and the bushes.

Checking cam lift and pin alignment

Set the camshaft on the tailstock and using a 1/100 gauge set on the central support, check whether the alignment error is not exceeding 0.04 mm, otherwise replace the camshaft. Check cam lift; found values shall be: 6.045 mm for exhaust cams and 7.582 mm for intake cams, in case of different values replace the camshaft.

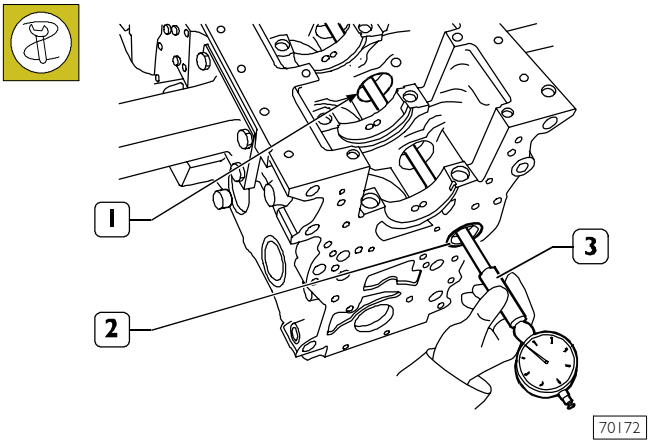
Figure 14



Check camshaft (2) pin diameter using micrometer (1) on two perpendicular axes.

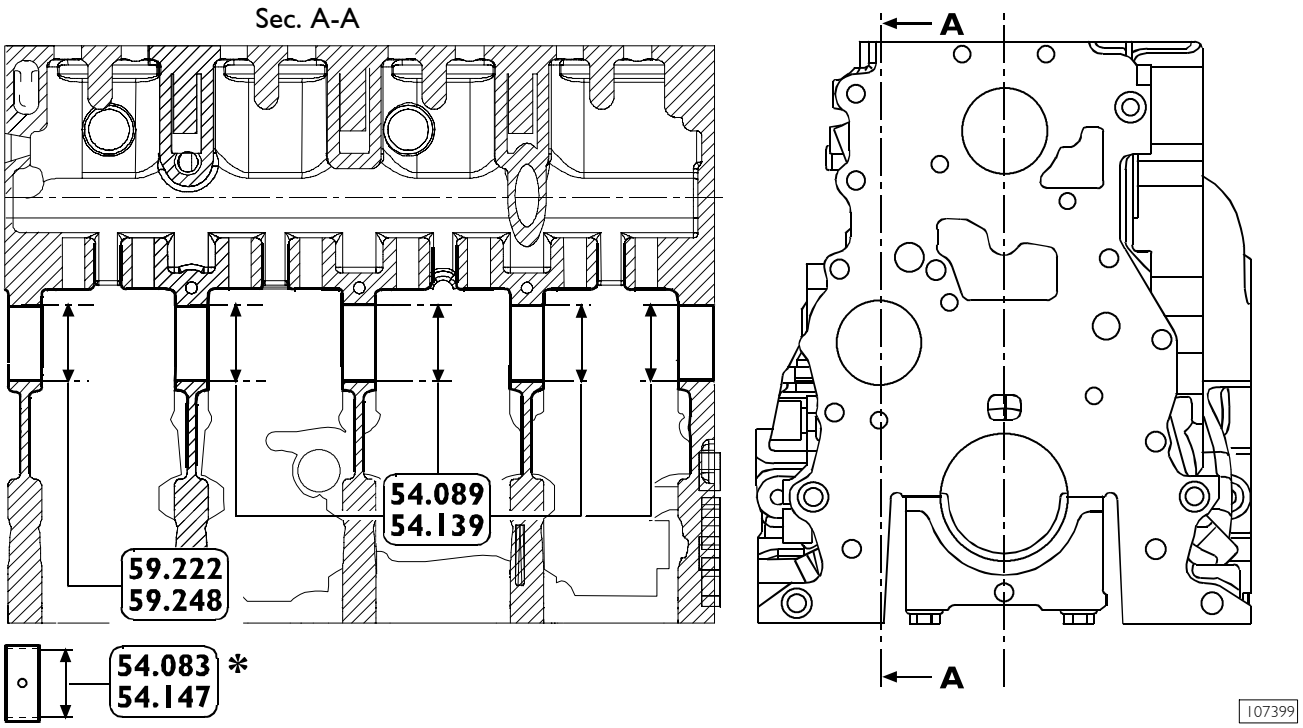
BUSHES

Figure 15



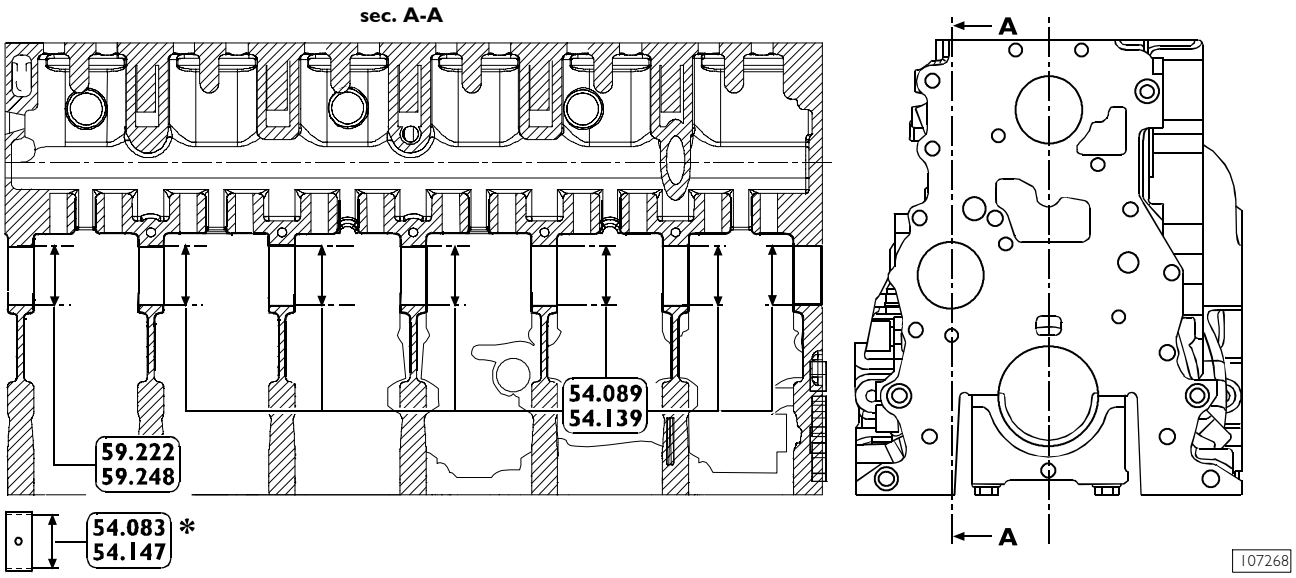
Camshaft bushes (2) shall be pressed into their housings. Internal surfaces must not show seizing or wear.
Use bore dial gauge (3) to measure camshaft front and rear bush (2) and intermediate housing (1) diameter.
Measurements shall be performed on two perpendicular axes.

Figure 16



CAMSHAFT BUSH AND HOUSING MAIN DATA (4 cyl.)
* Value to be obtained after driving the bushes.

Figure 17

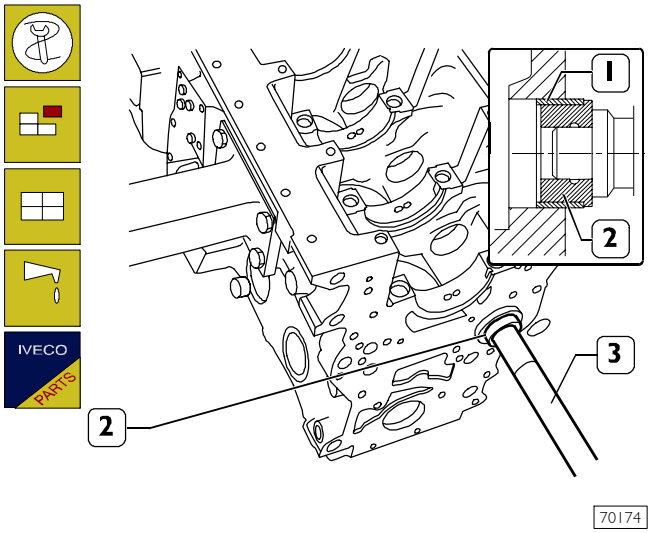


MAIN DATA ABOUT CAMSHAFT BUSHES AND RELATED HOUSINGS

*Height to be obtained after driving the bushes.

Bush replacement

Figure 18

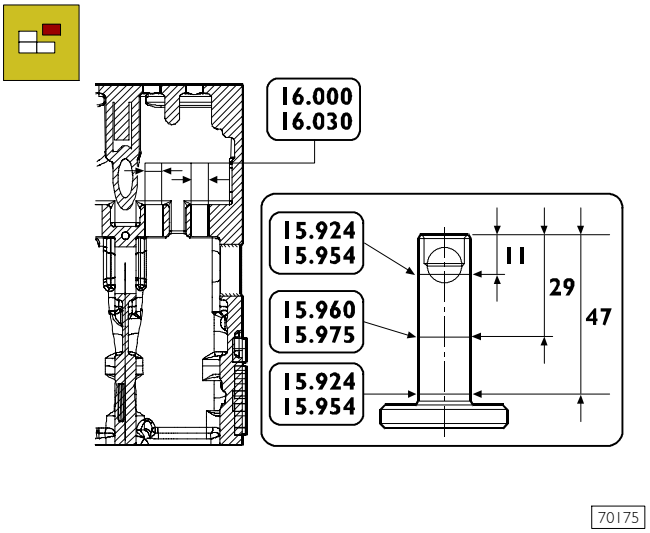


To replace front and rear bushes (1), remove and refit them using the beater 99360362 (2) and the handgrip 99370006 (3).

When refitting the bushes (1), direct them to make the lubricating holes (2) coincide with the holes on the block housings.

Tappets

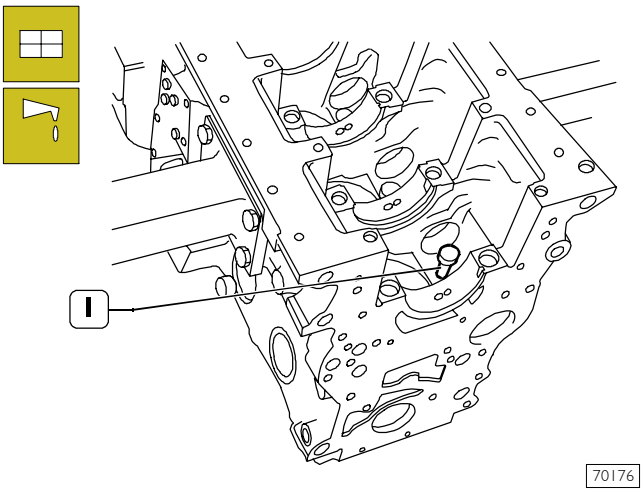
Figure 19



MAIN DATA CONCERNING THE TAPPETS AND THE RELEVANT HOUSINGS ON THE ENGINE BLOCK

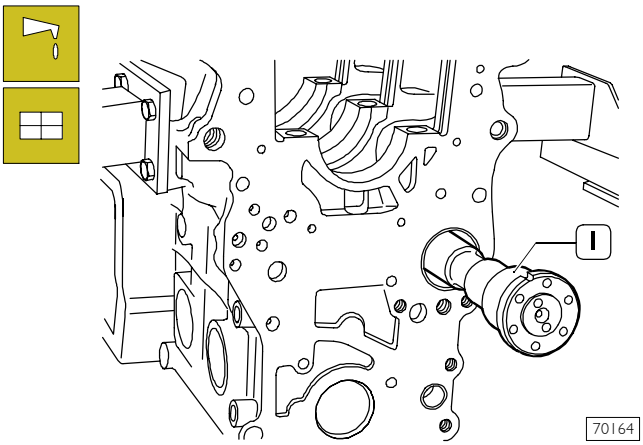
Fitting tappets – camshaft

Figure 20



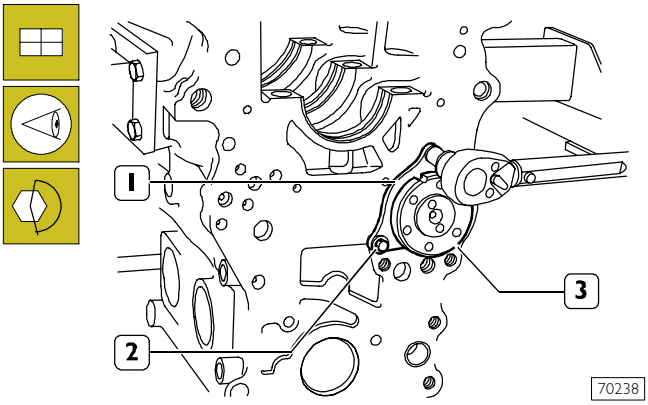
Lubricate the tappets (1) and fit them into the relevant housings on the engine block.

Figure 21



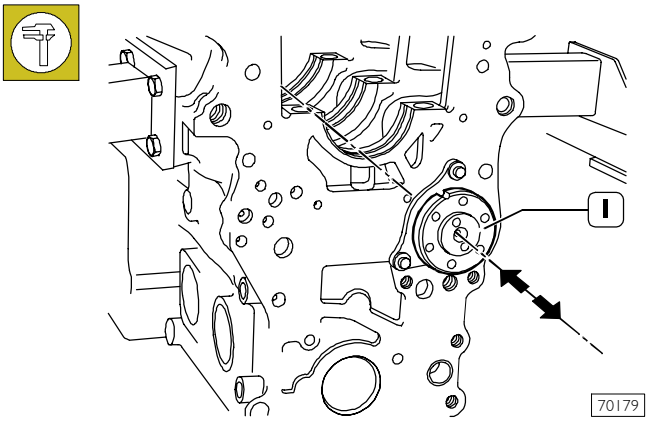
Lubricate the camshaft bushes and fit the camshaft (1) taking care not to damage the bushes or the housings.

Figure 22



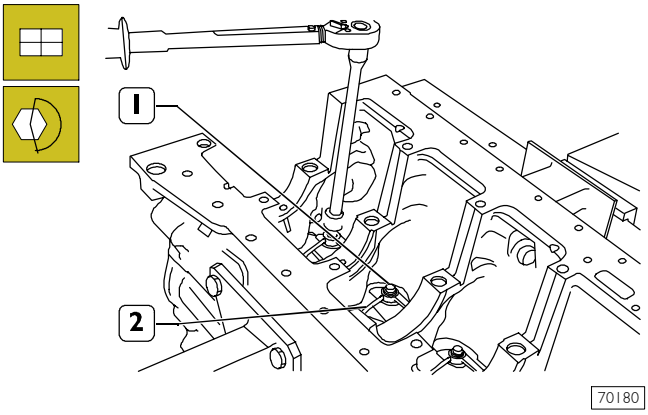
Set camshaft (3) retaining plate (1) with the slot facing the top of the engine block and the marking facing the operator, then tighten the screws (2) to the specified torque.

Figure 23



Check camshaft end float (1).
It shall be 0.23 ± 0.13 mm.

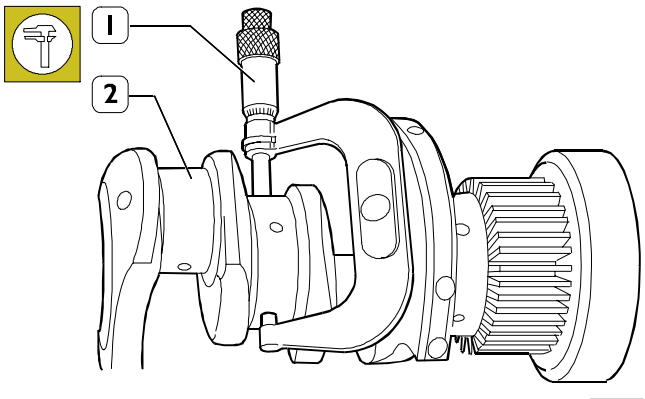
Figure 24



Fit nozzles (2) and tighten the fastening screws (1) to the specified torque.

OUTPUT SHAFT
Measuring journals and crankpins

Figure 25



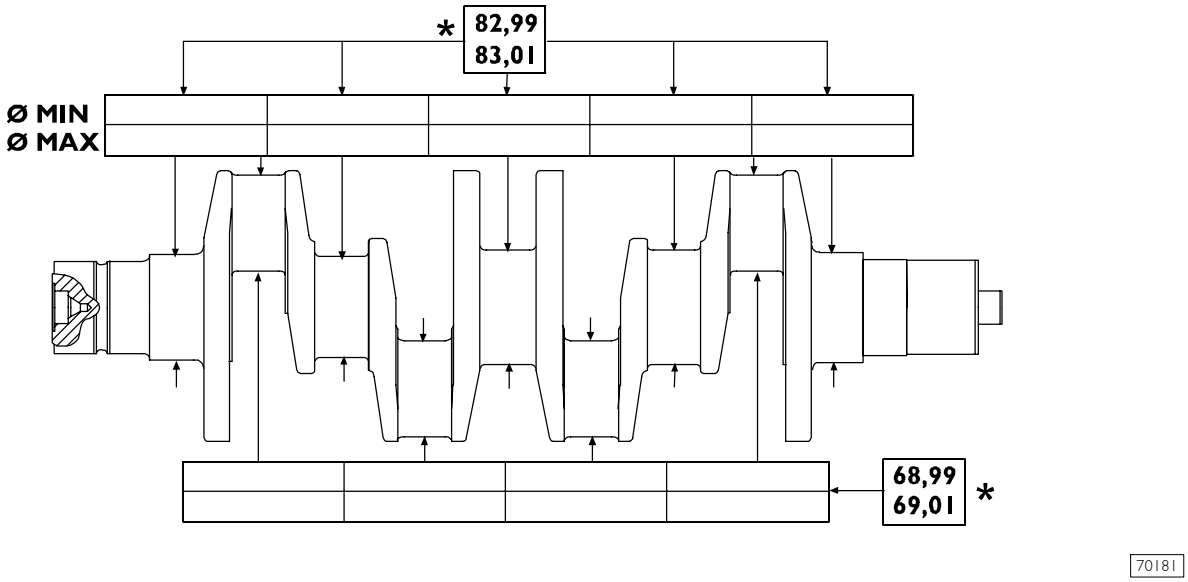
Grind journals and crankpins if seizing, scoring or excessive ovalisation are found. Before grinding the pins (2) measure them with a micrometer (1) to decide the final diameter to which the pins are to be ground.

It is recommended to insert the found values in the proper table.
See Figure 26.

Undersize classes are:

Journals and crankpins shall always be ground to the same undersize class.
Journals and crankpins undersize shall be marked on the side of the crank arm No.1.
For undersized crankpins: letter M
For undersized journals: letter B
For undersized crankpins and journals: letters MB.

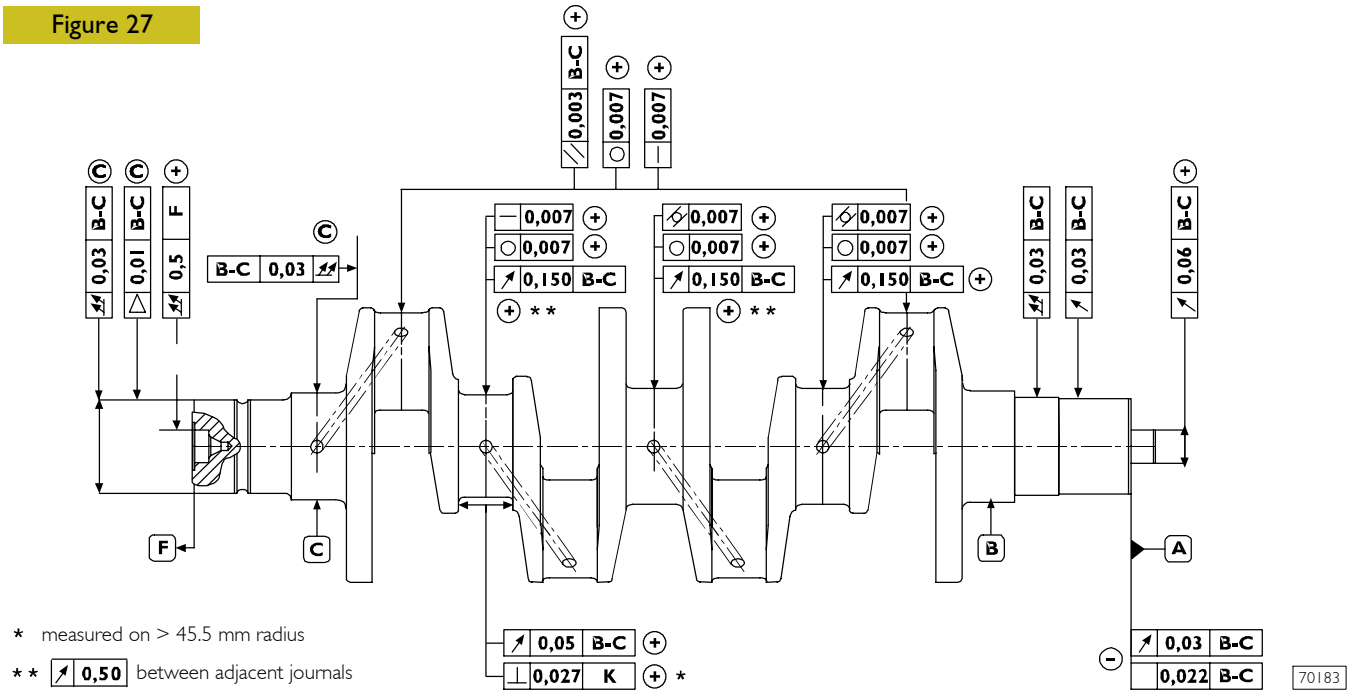
Figure 26



FILL THIS TABLE WITH OUTPUT SHAFT JOURNAL AND CRANKPIN MEASURED VALUES (4 CYL.)

*Rated value

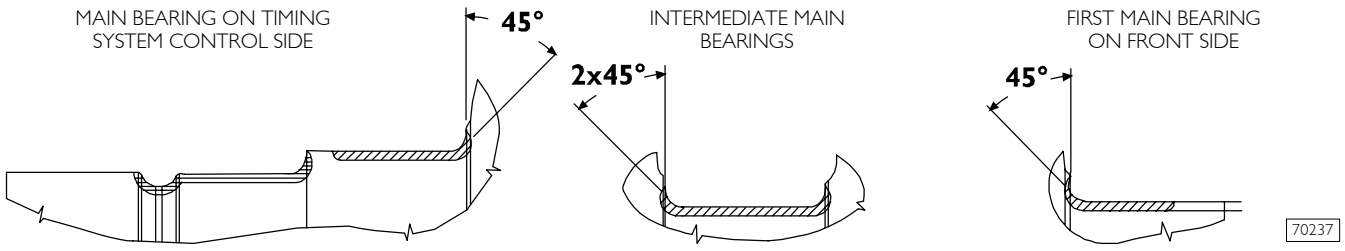
Figure 27



OUTPUT SHAFT MAIN TOLERANCES

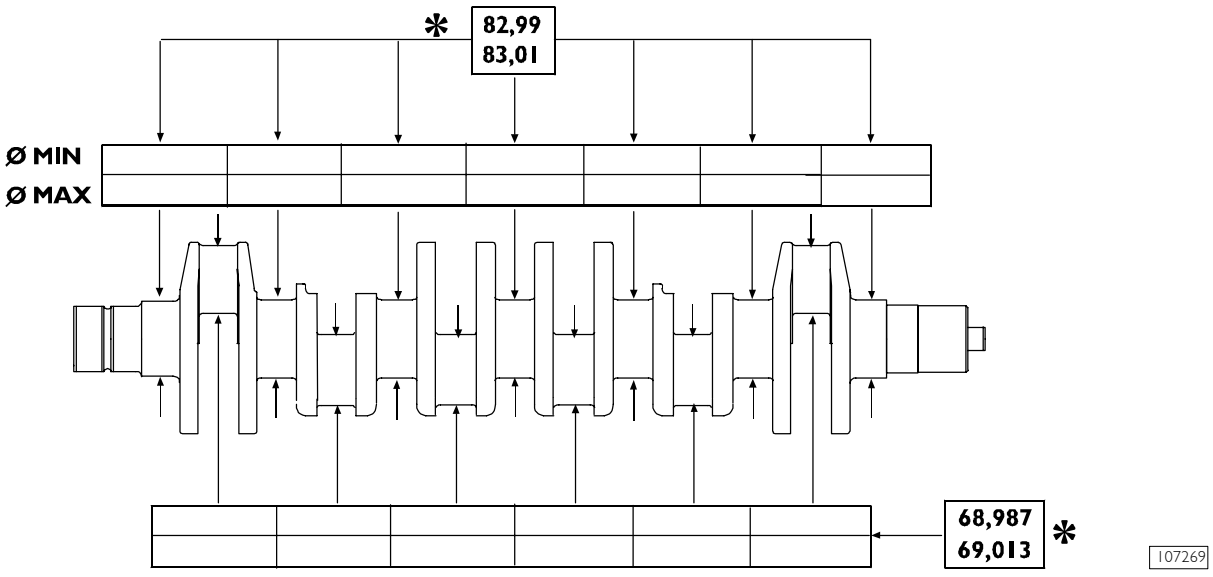
TOLERANCES	TOLERANCE CHARACTERISTIC	GRAPHIC SYMBOL
SHAPE	Roundness	○
	Cilindricity	/○/
DIRECTION	Parallelism	//
	Verticality	⊥
	Straightness	—
POSITION	Concentricity or coaxiality	◎
OSCILLATION	Circular oscillation	↗
	Total oscillation	⌰
	Taper	▷

LEVELS OF IMPORTANCE FOR PRODUCT CHARACTERISTICS	GRAPHIC SYMBOL
CRITICAL	©
IMPORTANT	⊕
SECONDARY	⊖



Measuring journals and crankpins (6 cyl.)

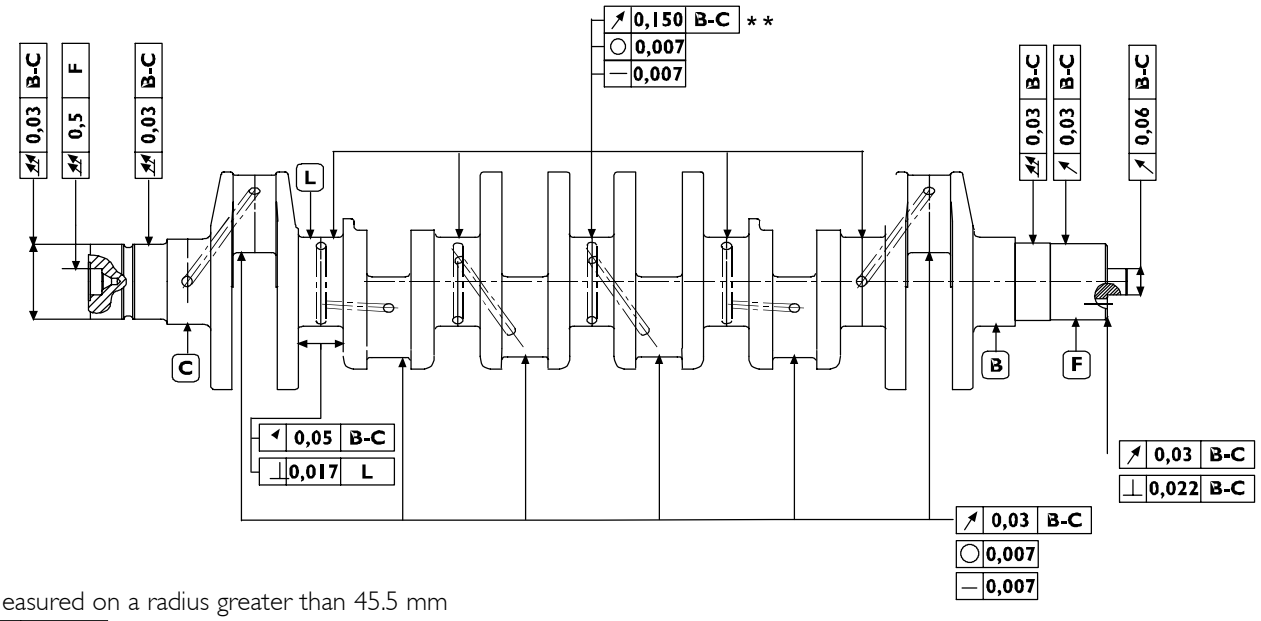
Figure 28



FILL THIS TABLE WITH OUTPUT SHAFT JOURNAL AND CRANKPIN MEASURED VALUES

*Rated value

Figure 29

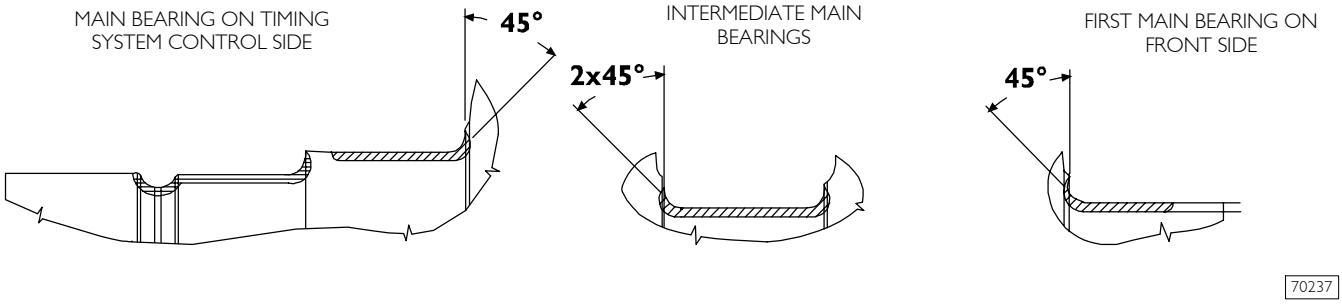


* Measured on a radius greater than 45.5 mm

** ⟋ 0.500 between adjacent main journals

MAIN OUTPUT SHAFT TOLERANCES

Figure 30

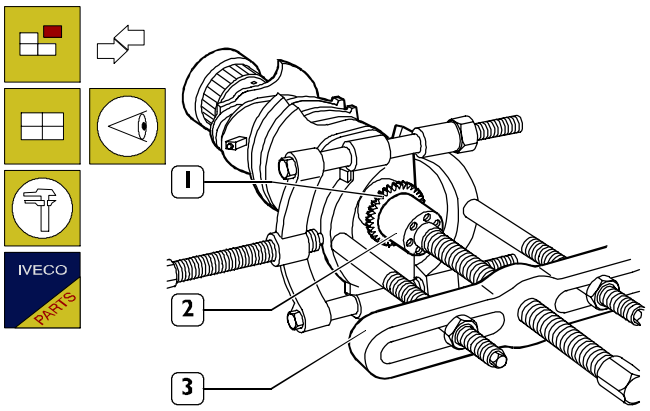


TOLERANCES	TOLERANCE CHARACTERISTIC	GRAPHIC SYMBOL
SHAPE	Roundness	○
	Cilindricity	/○/
DIRECTION	Parallelism	//
	Verticality	⊥
	Straightness	—
POSITION	Concentricity or coaxiality	◎
OSCILLATION	Circular oscillation	↗
	Total oscillation	⌰
	Taper	⌯

LEVELS OF IMPORTANCE FOR PRODUCT CHARACTERISTICS	GRAPHIC SYMBOL
CRITICAL	©
IMPORTANT	⊕
SECONDARY	⊖

Replacing oil pump control gear

Figure 31

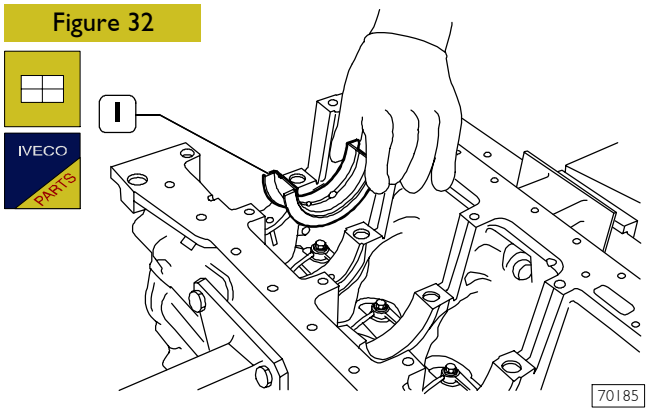


Check that gear toothing (1) is not damaged or worn, otherwise remove it using the proper puller (3).

When fitting the new gear, heat it to 180°C for 10 minutes in an oven and then key it to the crankshaft.

Fitting main bearings

Figure 32



Refit the main bearings that have not been replaced, in the same position found at removal.

Main bearings (1) are supplied spare with 0.250 – 0.500 mm undersize on the internal diameter.

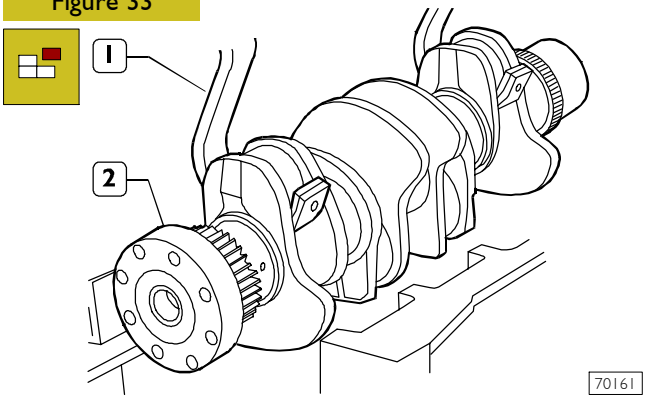
Do not try to adapt the bearings.

Clean accurately the main half bearings (1) having the lubricating hole and fit them into their housings.

The second last main half bearing (1) is fitted with shoulder half rings.

Finding journal clearance

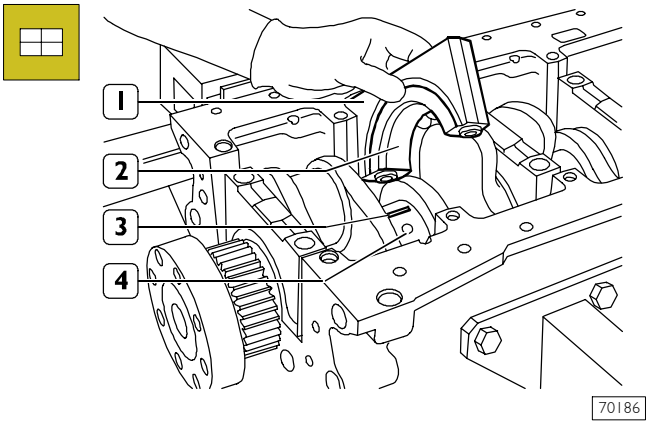
Figure 33



Refit the crankshaft (2).

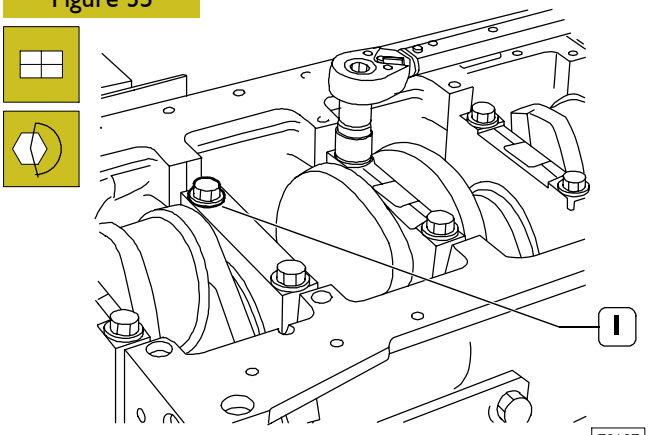
Check the backlash between crankshaf main journals and the relevant bearings as follows:

Figure 34



- ❑ clean accurately the parts and remove any trace of oil;
- ❑ position a piece of calibrated wire (3) on the crankshaft pins (4) so that it is parallel to the longitudinal axis;
- ❑ fit caps (1), including the half bearings (2) on the relevant supports.

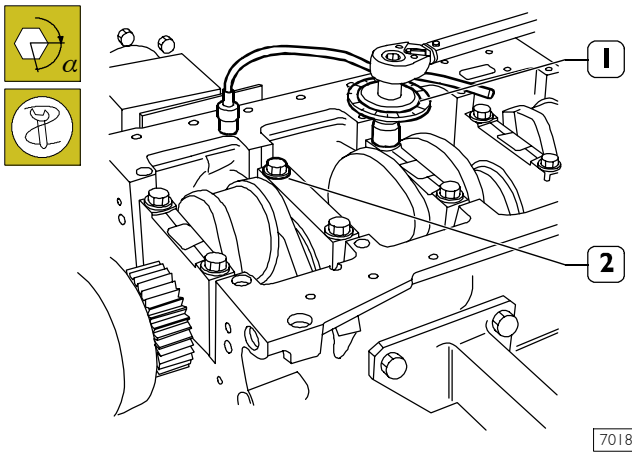
Figure 35



Tighten the pre-lubricated screws (1) in the following three successive stages:

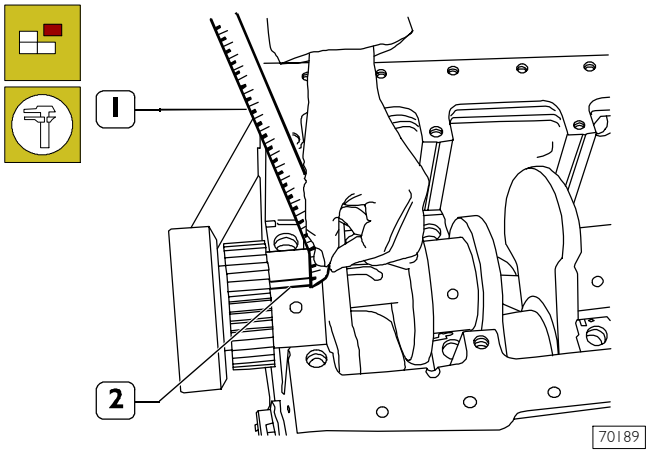
- ❑ 1st stage, with torque wrench to 50 ± 6 Nm.
- ❑ 2nd stage, with torque wrench to 80 ± 6 Nm.

Figure 36



❑ 3rd stage, with tool 99395216 (1) set as shown in the figure, tighten the screws (2) with 90 ± 5° angle.

Figure 37



❑ Remove caps from supports.

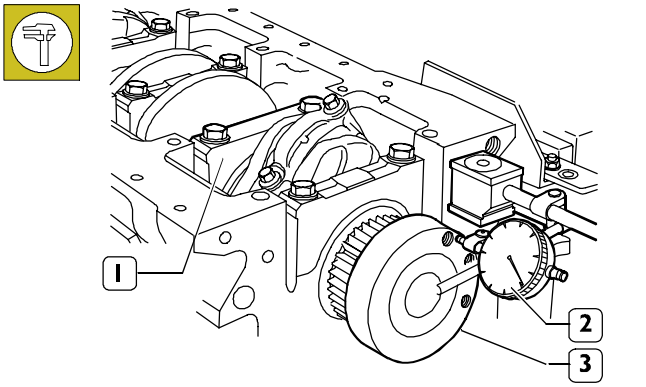
The backlash between the main bearings and the pins is found by comparing the width of the calibrated wire (2) at the narrowest point with the scale on the envelope (1) containing the calibrated wire.

The numbers on the scale indicate the backlash in mm.

Replace the half bearings and repeat the check if a different backlash value is found. Once the specified backlash is obtained, lubricate the main bearings and fit the supports by tightening the fastening screws as previously described.

Checking crankshaft shoulder clearance

Figure 38

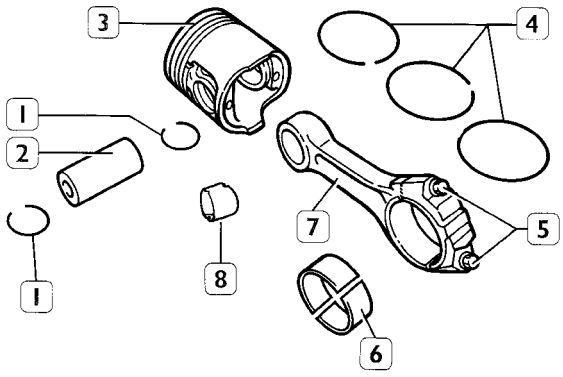


This check is performed by setting a magnetic-base dial gauge (2) on the crankshaft (3) as shown in the figure, standard value is 0.068 to 0.41.

If higher value is found, replace main thrust half bearings of the second last rear support (1) and repeat the clearance check between crankshaft pins and main half bearings.

CONNECTING ROD – PISTON ASSEMBLY

Figure 39

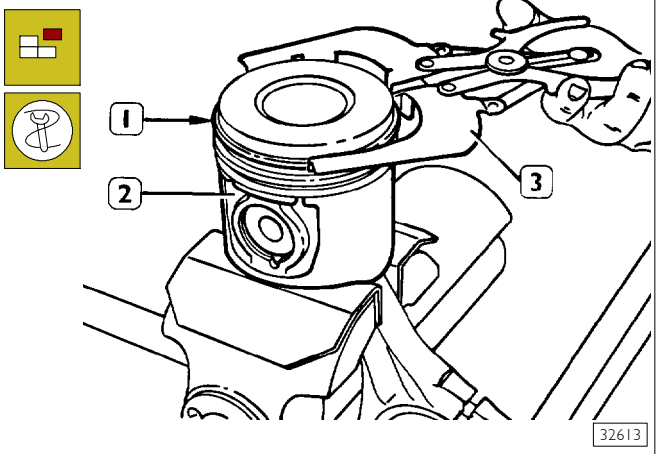


CONNECTING ROD – PISTON ASSEMBLY COMPONENTS

1. Stop rings - 2. Pin - 3. Piston - 4. Split rings - 5. Screws - 6. Half bearings - 7. Connecting rod - 8. Bush.

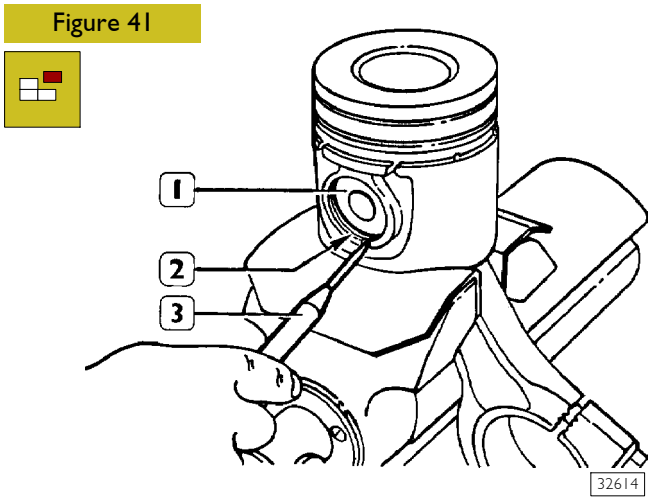
Pistons are supplied from parts with 0.5 mm oversize.

Figure 40



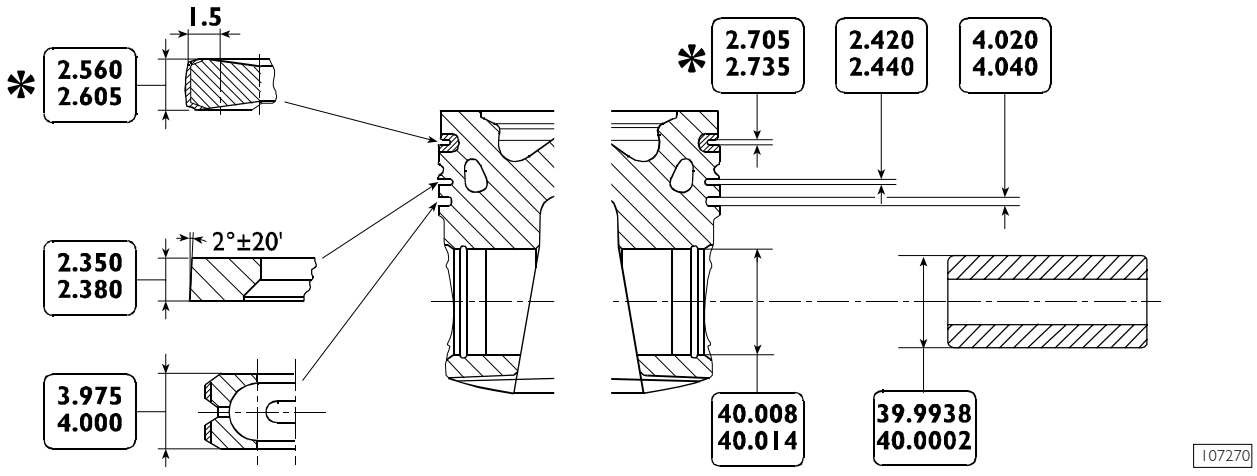
Remove split rings (1) from piston (2) using pliers 99360183 (3).

Figure 41



Piston pin (1) split rings (2) are removed using a scriber (3).

Figure 42

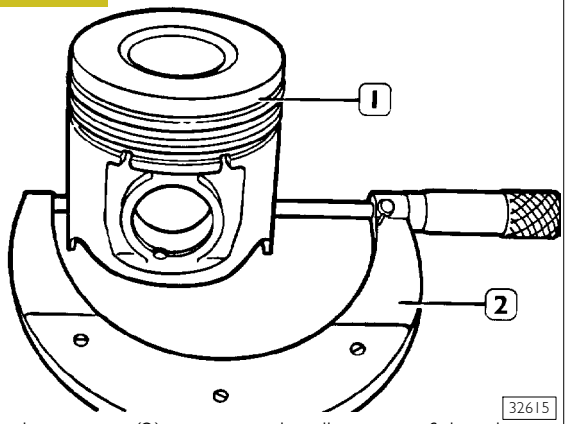


MAIN DATA CONCERNING KS. PISTON, PINS AND SPLIT RINGS

* Value measured on 99 mm diameter

Pistons
Measuring piston diameter

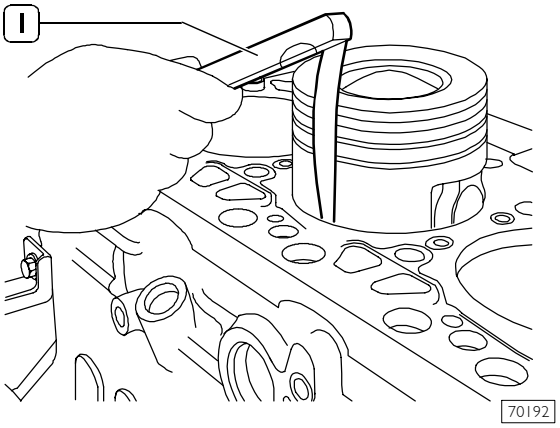
Figure 43



Using a micrometer (2), measure the diameter of the piston (1) to determine the assembly clearance.

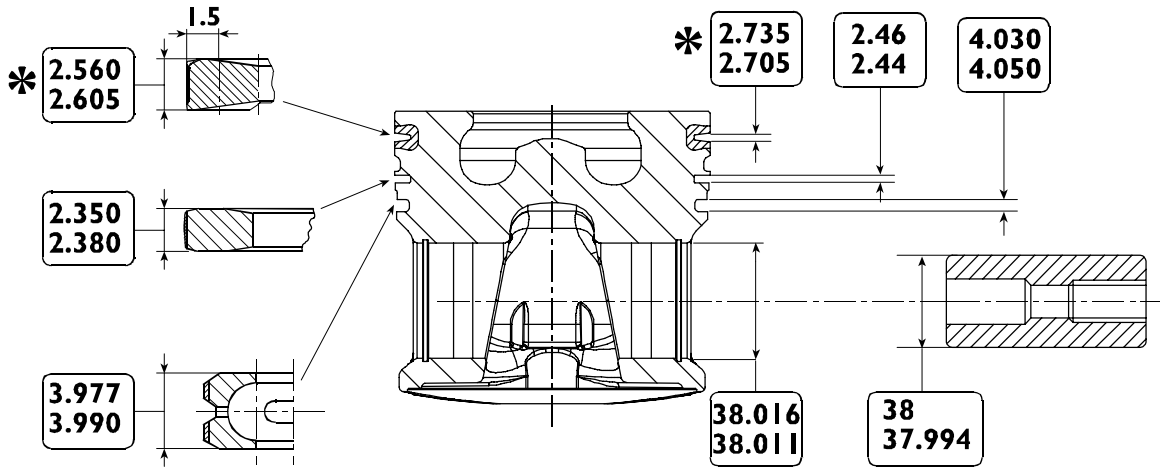
The diameter shall be measured at 12 mm from the piston skirt.

Figure 44



The clearance between the piston and the cylinder barrel can be checked also with a feeler gauge (1) as shown in the figure.

Figure 45

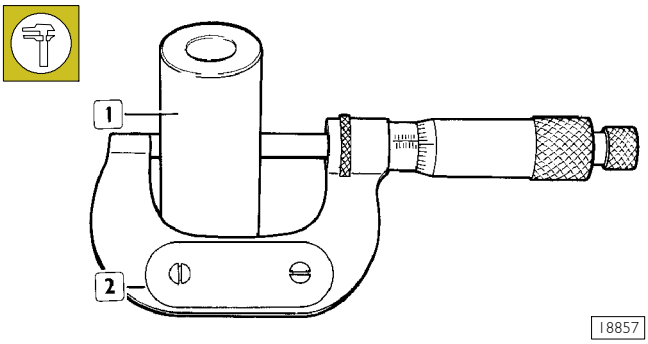


MAIN DATA CONCERNING MONDIAL MAHLE PISTON, PINS AND SPLIT RINGS

* Value measured on 101 mm diameter

Piston pins

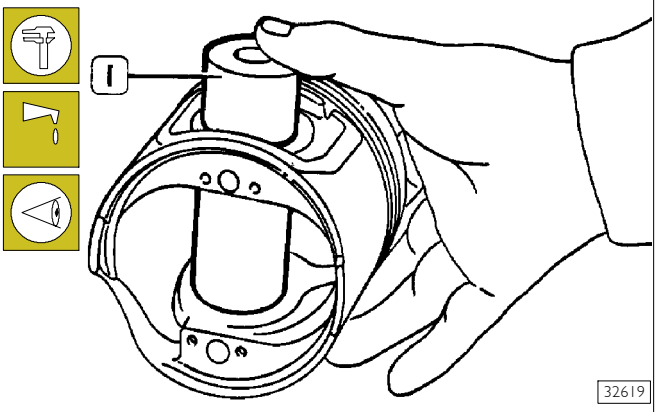
Figure 46



To measure the piston pin (1) diameter use the micrometer (2).

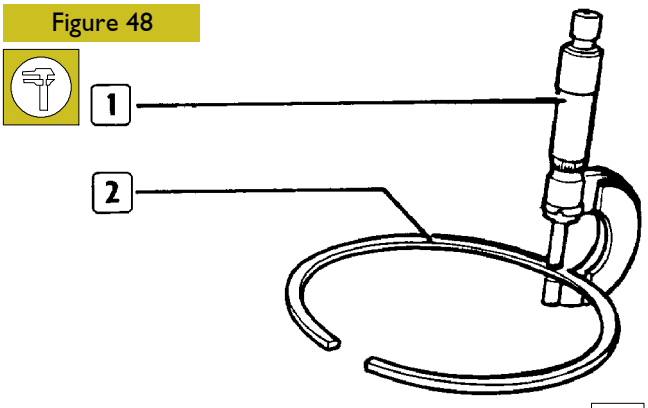
Conditions for proper pin-piston coupling

Figure 47



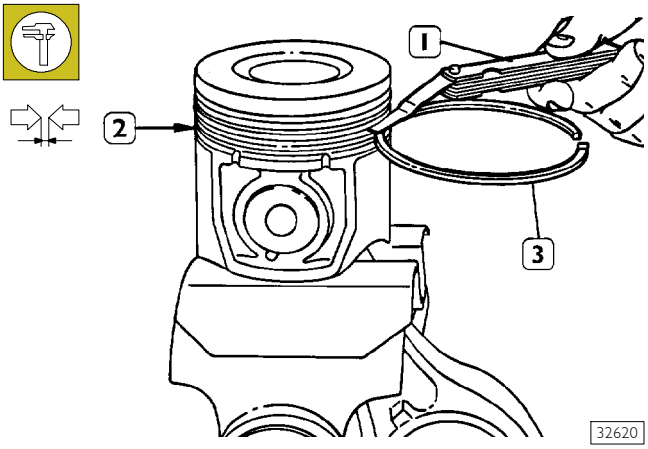
Lubricate the pin (1) and its seat on piston hubs with engine oil; the pin shall be fitted into the piston with a slight finger pressure and shall not be withdrawn by gravity.

Figure 48



Use a micrometer (1) to check split ring (2) thickness.

Figure 49



Check the clearance between the sealing rings (3) of the 2nd and 3rd slot and the relevant housings on the piston (2), using a feeler gauge (1).

Figure 50

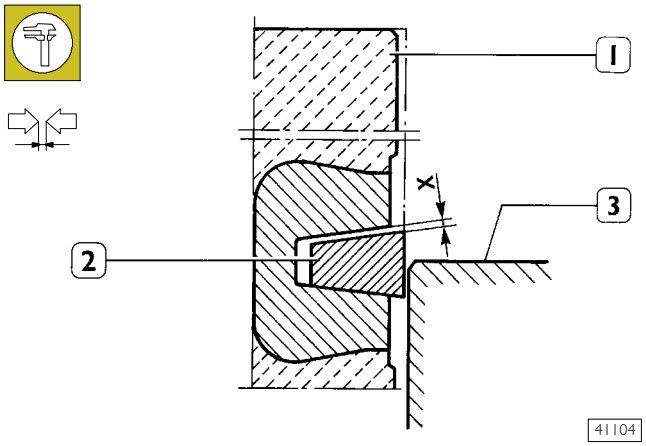
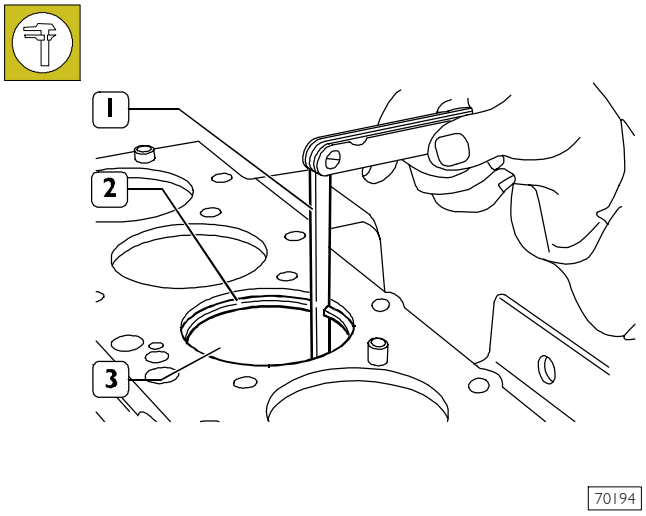


DIAGRAM FOR MEASURING THE CLEARANCE X BETWEEN THE FIRST PISTON SLOT AND THE TRAPEZOIDAL RING

Since the first sealing ring section is trapezoidal, the clearance between the slot and the ring shall be measured as follows: make the piston (1) protrude from the engine block so that the ring (2) protrudes half-way from the cylinder barrel (3).

In this position, use a feeler gauge to check the clearance (X) between ring and slot: found value shall be the specified one.

Figure 51

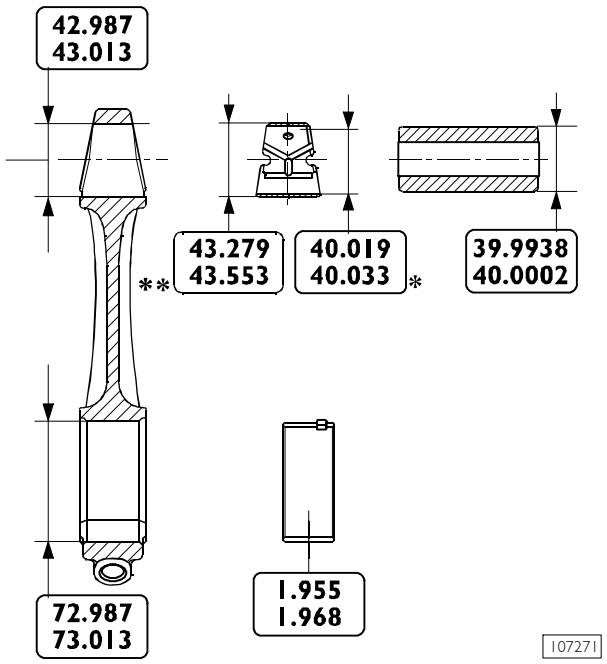


Use feeler gauge (1) to measure the clearance between the ends of the split rings (2) fitted into the cylinder barrel (3).

Use a micrometer (1) to check split ring (2) thickness.

Connecting rods

Figure 52

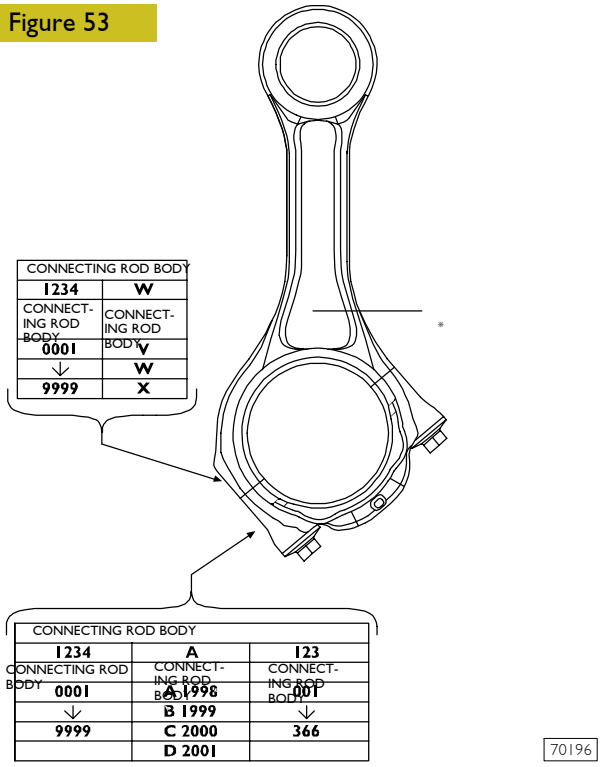


MAIN DATA FOR CONNECTING ROD, BUSH, PISTON PIN AND HALF BEARINGS

* Value for inside diameter to be obtained after driving in connecting rod small end and grinding.
** Value not measurable in released condition

The surface of connecting rod and rod cap are knurled to ensure better coupling.
Therefore, it is recommended not to smooth the knurls.

Figure 53



Every connecting rod is marked as follows:

- On body and cap with a number showing their coupling and the corresponding cylinder.
  In case of replacement it is therefore necessary to mark the new connecting rod with the same numbers of the replaced one.
- On body with a letter showing the weight of the connecting rod assembled at production:
  - V, 1820 to 1860 (yellow marking);
  - W, 1861 to 1900 (green marking);
  - X, 1901 to 1940 (blue marking);

Spare connecting rods are of the W class with green marking *.

Material removal is not allowed.

Bushes

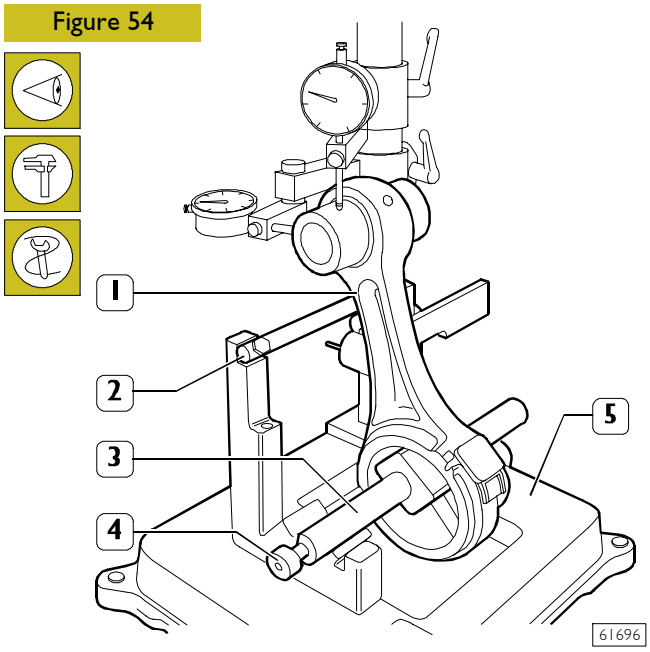
Check that the bush in the connecting rod small end is free from scoring or seizing and that it is not loosen. Otherwise replace.

Removal and refitting shall be performed using the proper beater.

When refitting take care to make coincide the oil holes set on the bush with those set on the connecting rod small end. Grind the bush to obtain the specified diameter.

Checking connecting rods

Figure 54

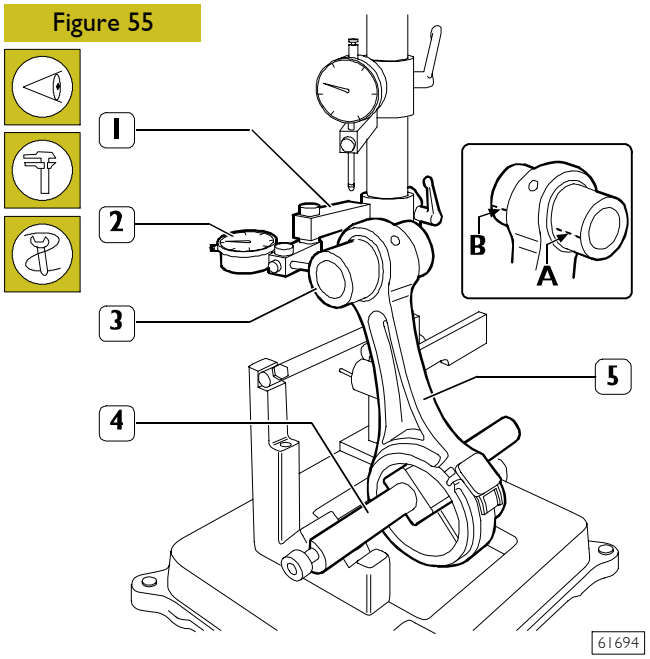


Check that the axis of the connecting rods (1) are parallel using tool 99395363 (5) as follows:

- ❑ fit the connecting rod (1) on tool 99395363 (5) spindle and lock it with screw (4);
- ❑ set the spindle (3) on V-blocks by resting the connecting rod (1) on the stop bar (2).

Checking torsion

Figure 55

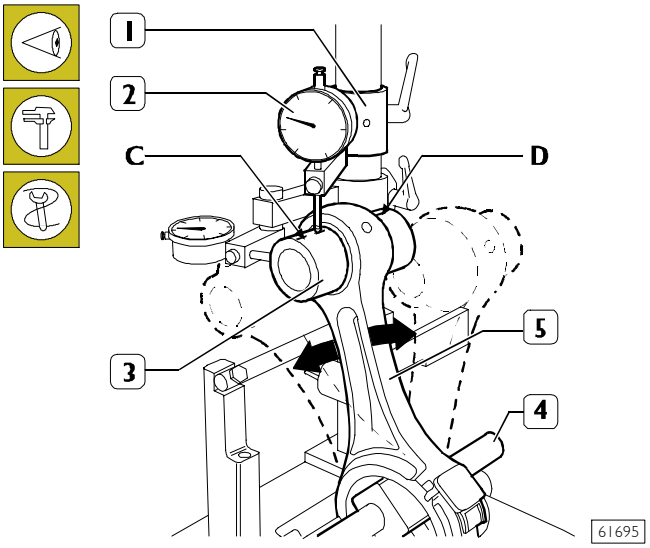


Check connecting rod (5) torsion by comparing two points (A and B) of pin (3) on the horizontal plane of the connecting rod axis.

Position the dial gauge (2) support (1) to obtain a preload of approx. 0.5 mm on the pin (3) in point A and then set the dial gauge (2) to zero. Move 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 shall not exceed 0.08 mm.

Checking bending

Figure 56



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

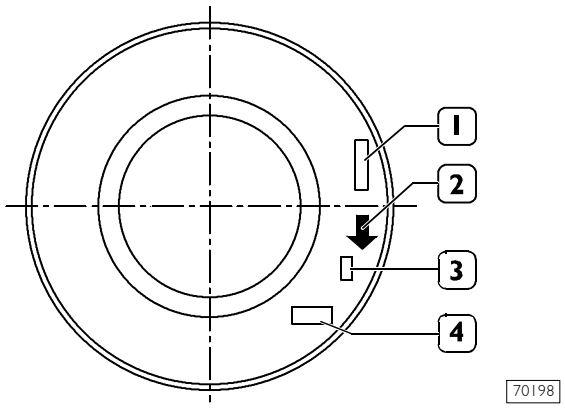
Position the vertical support (1) of the dial gauge (2) to rest the latter on pin (3), point C.

Move the connecting rod forwards and backwards to find pin top position, then in this condition reset the dial gauge (2).

Move the spindle with the connecting rod (5) and repeat the check of the top point on the opposite side D of the pin (3). The difference between point C and point D shall not exceed 0.08 mm.

Fitting connecting rod-piston assembly
Connecting rod-piston coupling

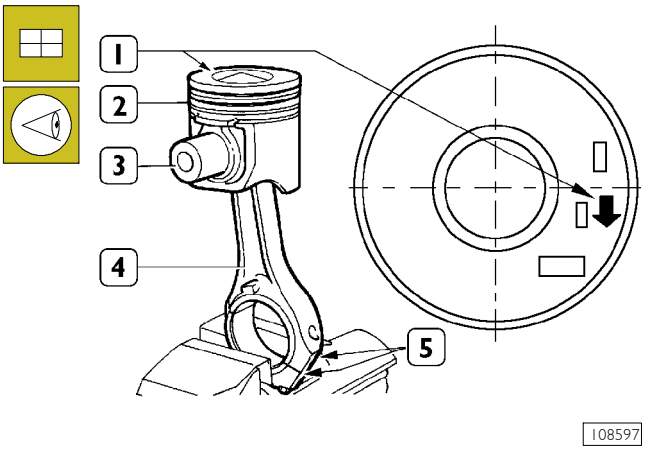
Figure 57



The piston crown is marked as follows:

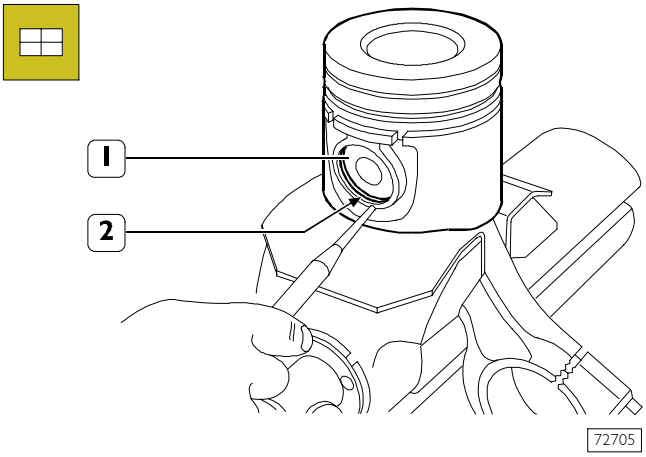
1. Part number and design modification number;
2. Arrow showing piston assembling direction into cylinder barrel, this arrow shall face the front key of the engine block;
3. Marking showing 1st slot insert testing;
4. Manufacturing date.

Figure 58



Connect piston (2) to connecting rod (4) with pin (3) so that the reference arrow (1) for fitting the piston (2) into the cylinder barrel and the numbers (5) marked on the connecting rod (5) are read as shown in the figure.

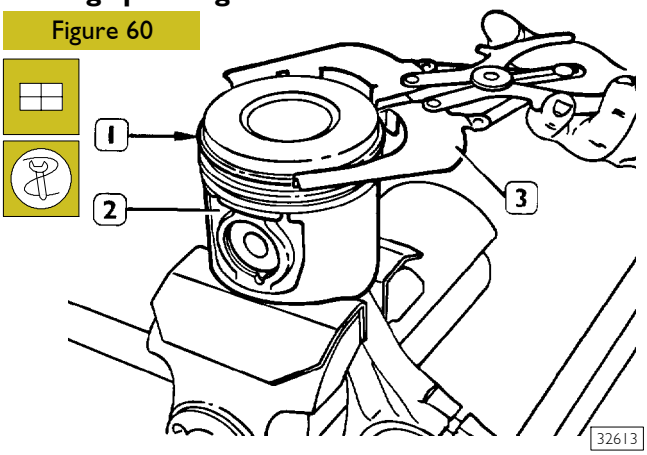
Figure 59



Position the piston (1) on the connecting rod according to the diagram shown in the figure, fit the pin (3) and stop it by the split rings (2).

Fitting split rings

Figure 60

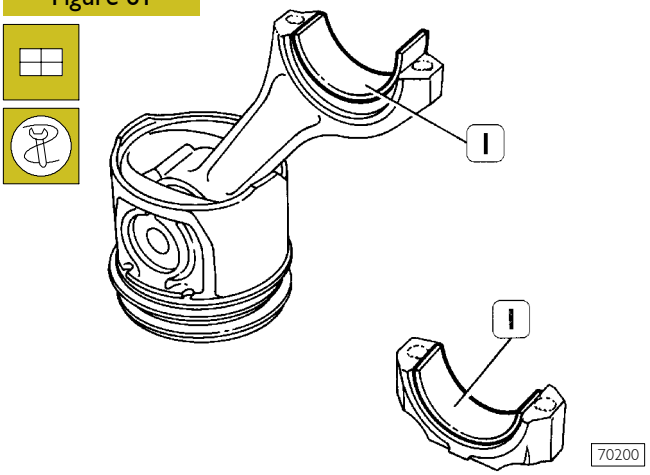


Use pliers 99360183 (3) to fit the split rings (1) on the piston (2).
Split rings shall be fitted with the marking "TOP" facing upwards and their openings shall be displaced with each other by 120°.

Split rings are supplied spare with the following sizes:

- standard, yellow marking;
- 0.5 mm oversize, yellow/green marking;

Figure 61

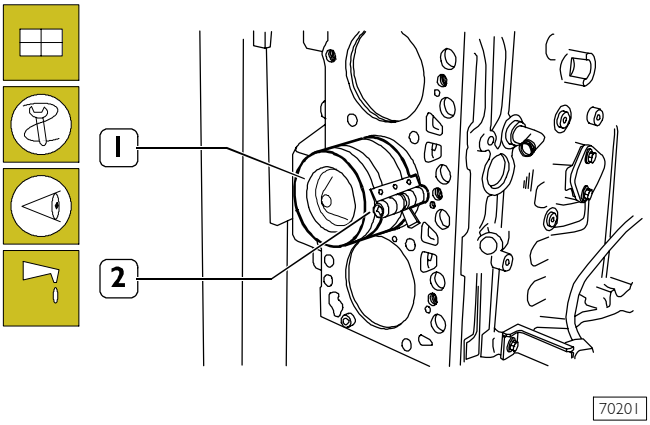


Fit half bearings (1) on connecting rod and cap.

Refit the main bearings that have not been replaced, in the same position found at removal.
Do not try to adapt the half bearings.

Fitting connecting rod-piston assembly into cylinder barrels

Figure 62



Lubricate accurately the pistons, including the split rings and the cylinder barrel inside.
Use band 99360605 (2) to fit the connecting rod-piston assembly (1) into the cylinder barrels and check the following:

- ❑ the number of each connecting rod shall correspond to the cap coupling number.

Figure 63

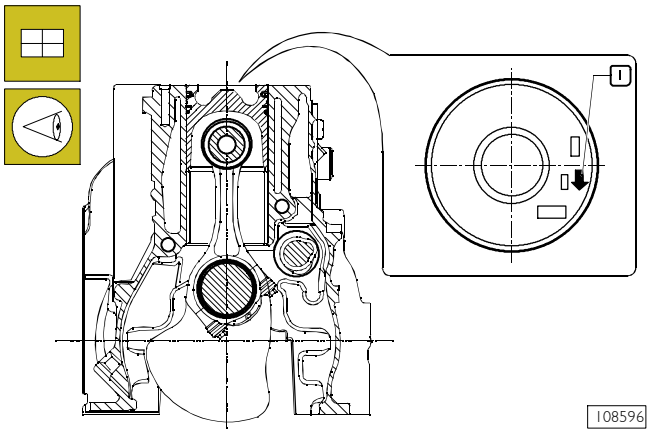
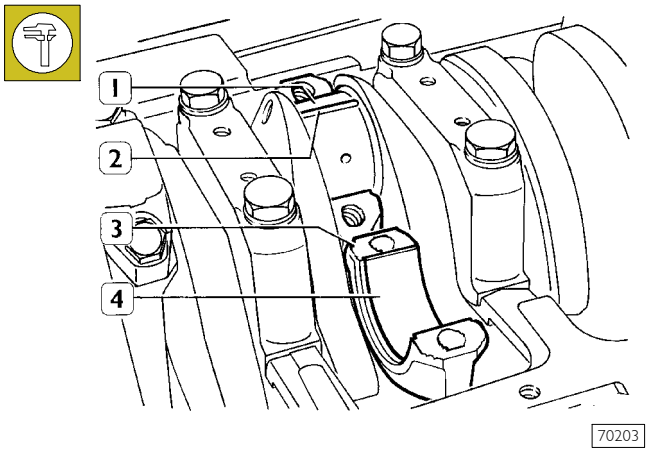


DIAGRAM FOR CONNECTING ROD-PISTON ASSEMBLY FITTING INTO BARREL

- ❑ Split ring openings shall be displaced with each other by 120°;
- ❑ connecting rod-piston assemblies shall have the same weight;
- ❑ the arrow marked on the piston crown shall be facing the front side of the engine block or the slot obtained on the piston skirt shall be corresponding to the oil nozzle position.

Finding crankpin clearance

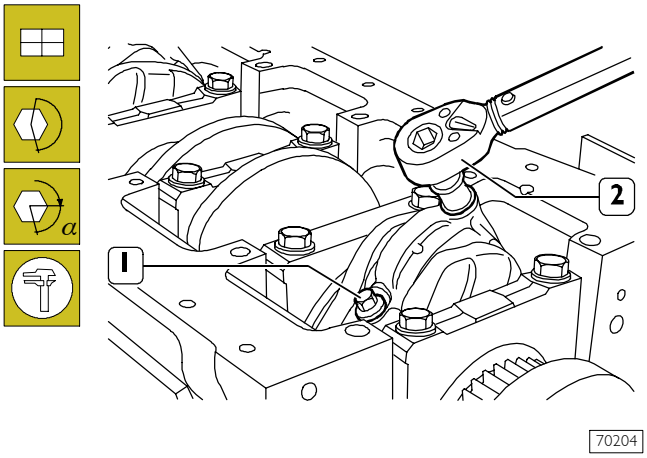
Figure 64



To measure the clearance proceed as follows:

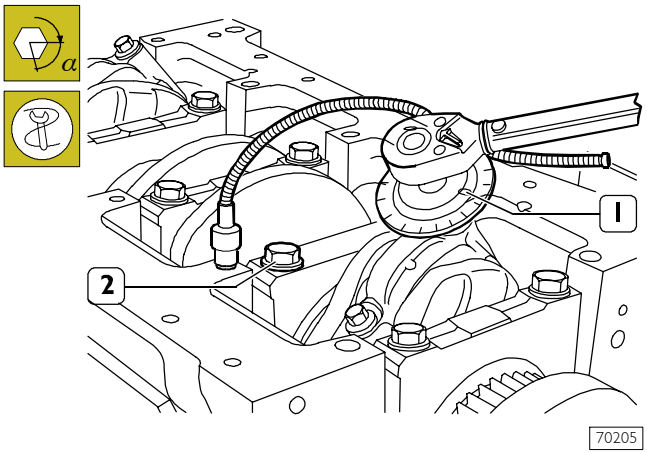
- ❑ clean the parts accurately and remove any trace of oil;
- ❑ set a piece of calibrated wire (2) on the output shaft pins (1);
- ❑ fit the connecting rod caps (3) with the relevant half bearings (4).

Figure 65



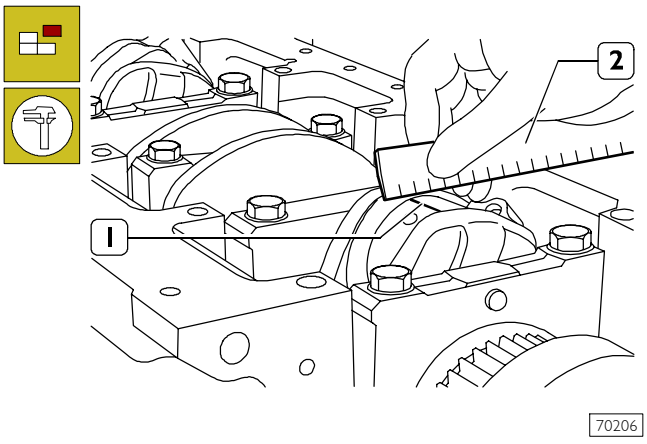
- ❑ Lubricate the screws (1) with engine oil and then tighten them to the specified torque using the torque wrench (2).

Figure 66



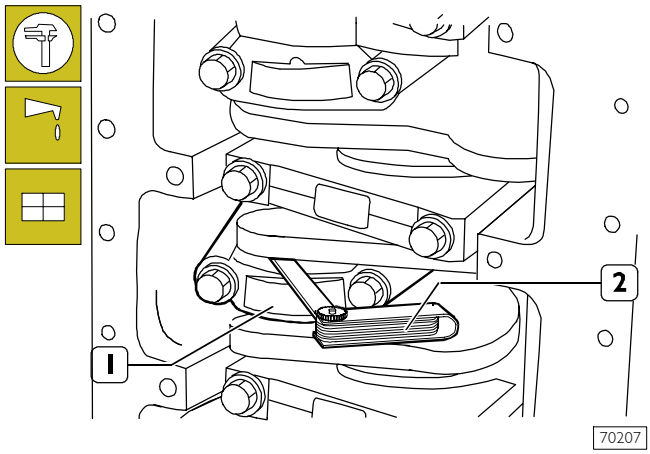
- ❑ Apply tool 99395216 (1) to the socket wrench and tighten screws (2) of 60°.

Figure 67



- ❑ Remove the cap and find the existing clearance by comparing the calibrated wire width (1) with the scale on the wire envelope (2).

Figure 68



If a different clearance value is found, replace the half bearings and repeat the check.

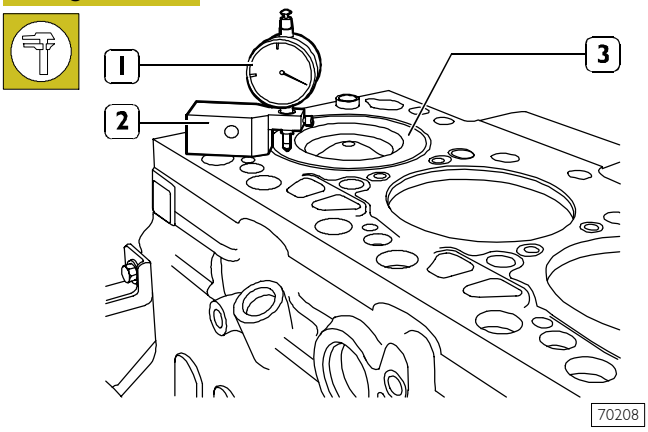
Once the specified clearance has been obtained, lubricate the main half bearings and fit them by tightening the connecting rod cap fastening screws to the specified torque.

Before the final fitting of the connecting rod cap fastening screws, check that their diameter measured at the centre of the thread length is not < 0.1 mm than the diameter measured at approx. 10 mm from screw end.

Check manually that the connecting rods (1) are sliding axially on the output shaft pins and that their end float, measured with feeler gauge (2) is 0.10 to 0.33 mm.

Checking piston protrusion

Figure 69

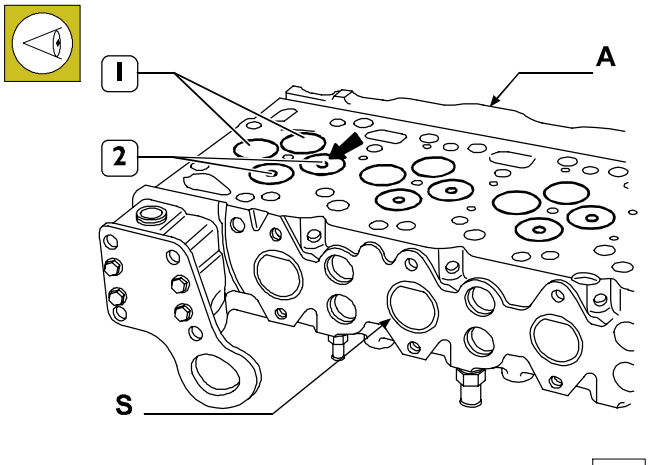


Once connecting rod-piston assemblies refitting is over, use dial gauge 39395603 (1) fitted with base 99370415 (2) to check piston (3) protrusion at T.D.C. with respect to the top of the engine block.

Protrusion shall be 0.28 to 0.52 mm.

CYLINDER HEAD
Removing the valves

Figure 70



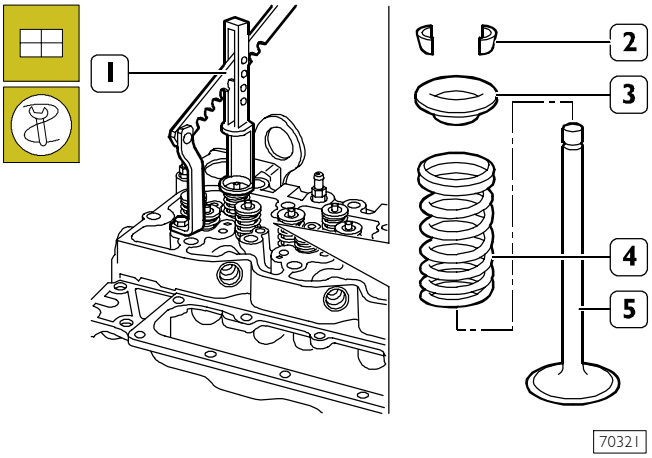
Intake (1) and exhaust (2) valves have heads with the same diameter.

The central notch (→) of the exhaust valve (2) head distinguishes it from the intake valve.

Should cylinder head valves be not replaced, number them before removing in order to refit them in the same position.

A = intake side – S = exhaust side

Figure 71

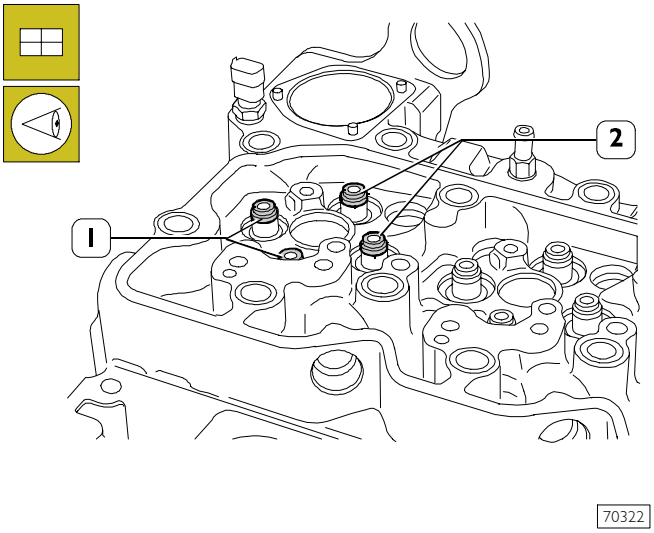


Valve removal shall be performed using tool 99360268 (1) and pressing the cap (3) so that when compressing the springs (4) the cotters (2) can be removed. Then remove the cap (3) and the springs (4).

Repeat this operation for all the valves.

Overturn the cylinder head and withdraw the valves (5).

Figure 72



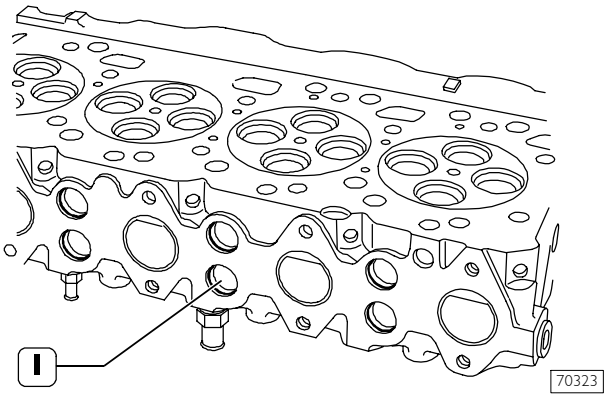
Remove sealing rings (1 and 2) from the valve guide.

Sealing rings (1) for intake valves are yellow.

Sealing rings (2) for exhaust valves are green.

Checking cylinder head wet seal

Figure 73



This check shall be performed using the proper tools.

Use a pump to fill with water heated to approx. 90°C and 2 to 3 bar pressure.

Replace the core plugs (1) if leaks are found, use the proper punch for their removal/refitting.

Before refitting, smear the plug surfaces with water-repellent sealant.

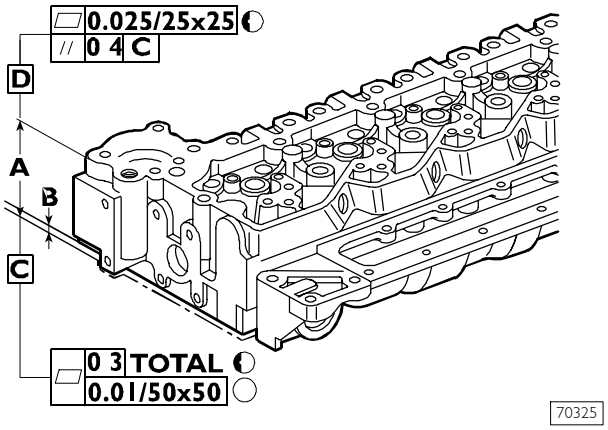
Replace the cylinder head if leaks are found.

Checking cylinder head supporting surface

Distortion found along the whole cylinder head shall not exceed 0.20 mm.

If higher values are found grind the cylinder head according to values and indications shown in the following figure.

Figure 74

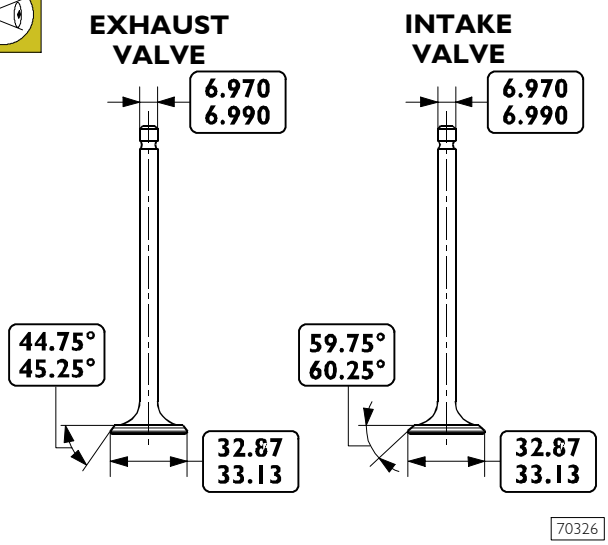


The rated thickness A for the cylinder head is 105 ± 0.25 mm, max. metal removal shall not exceed thickness B by 1 mm.

After grinding, check valve sinking. Regrind the valve seats, if required, to obtain the specified value.

VALVES

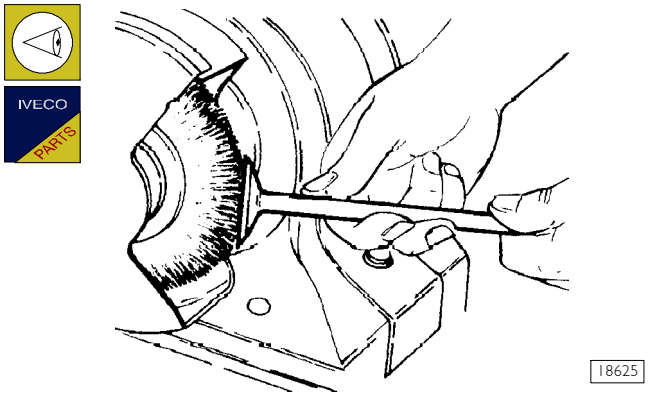
Figure 75



INTAKE AND EXHAUST VALVE MAIN DATA

Removing carbon deposits, checking and grinding valves

Figure 76

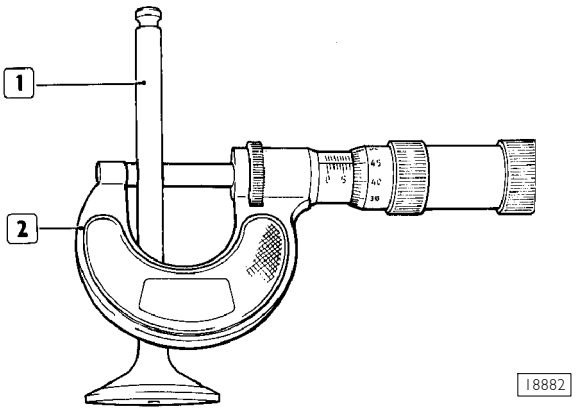


Remove carbon deposits from valves using the proper metal brush.

Check that the valves show no signs of seizing, scoring or cracking.

Regrind the valve seats, if required, using tool 99305018 and removing as less material as possible.

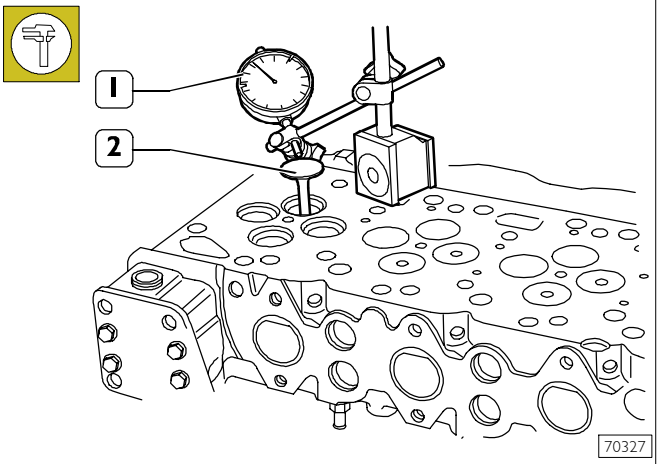
Figure 77



Check the valve stem (1) using a micrometer (2), it shall be 6.970 ÷ 6.999.

Checking clearance between valve stem and valve guide and valve centering

Figure 78

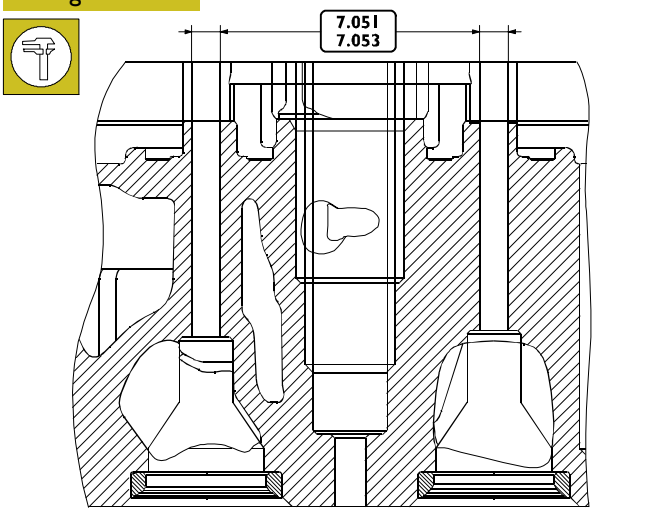


Use a magnetic base dial gauge (1) set as shown in the figure, the assembling clearance shall be 0.052 ÷ 0.092 mm.

Turn the valve (2) and check that the centering error is not exceeding 0.03 mm.

VALVE GUIDE

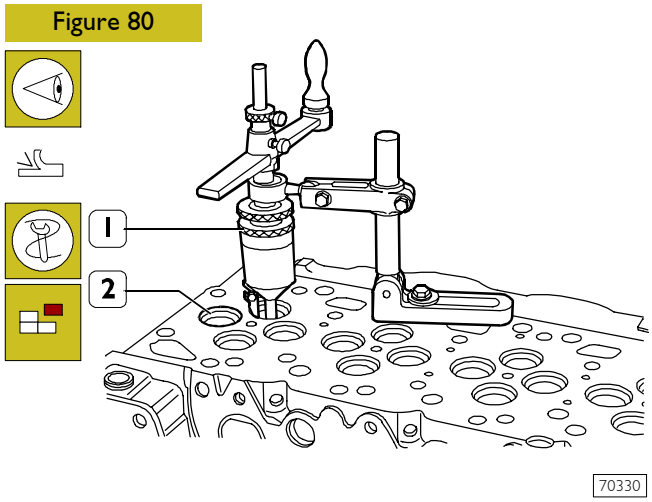
Figure 79



Use a bore dial gauge to measure the inside diameter of the valve guides, the read value shall comply with the value shown in the figure.

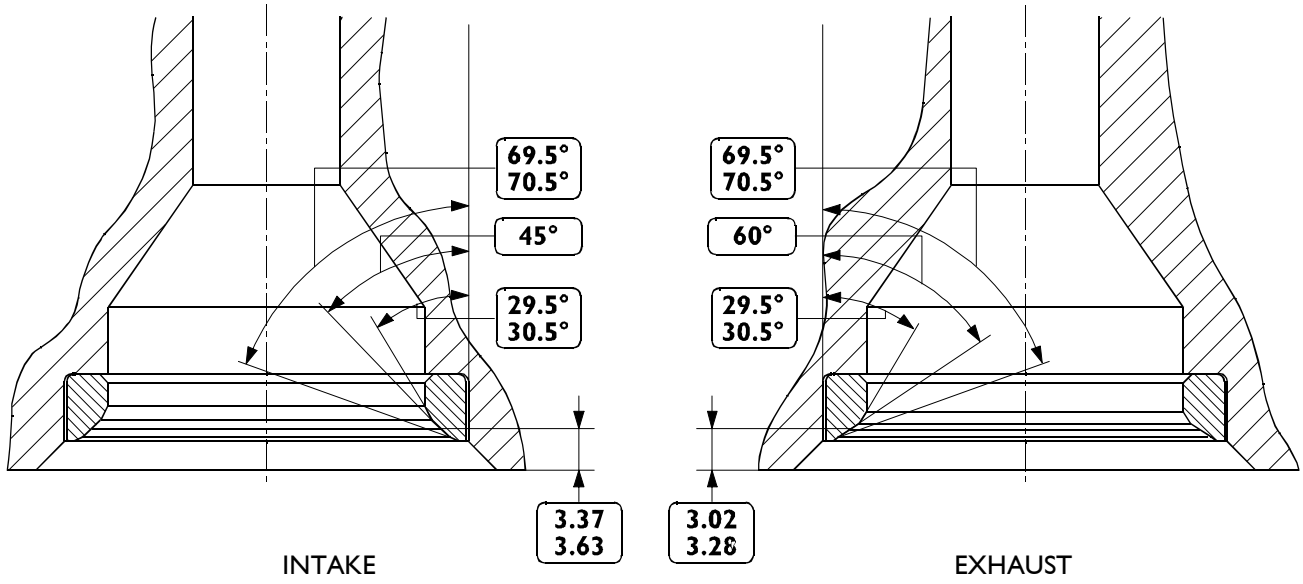
VALVE SEATS
Regrinding – replacing the valve seats

Figure 80



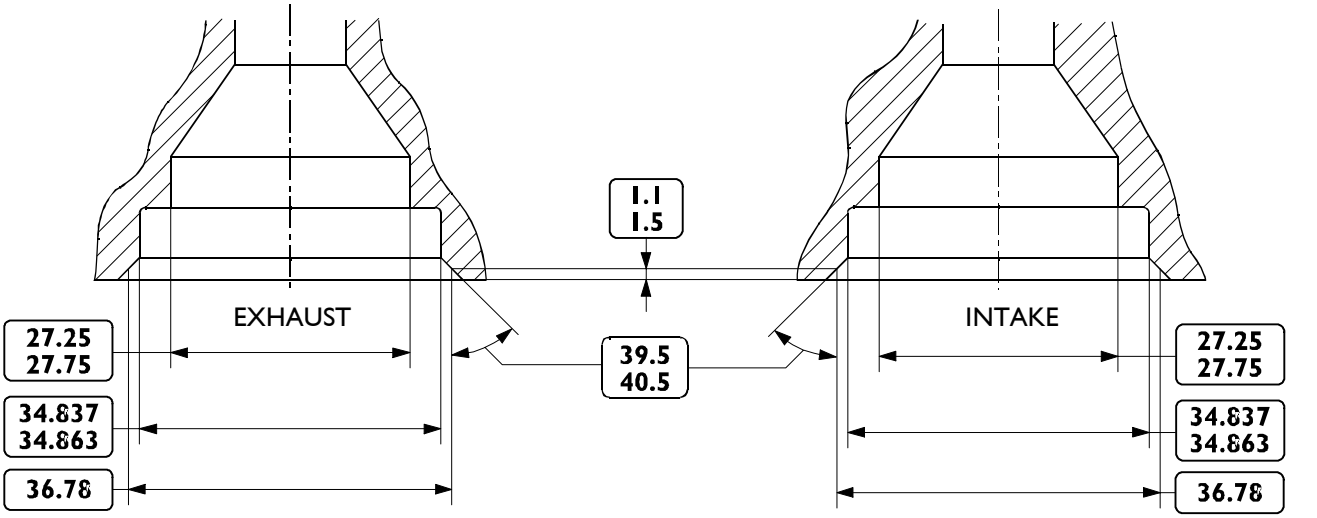
Check the valve seats (2). If slight scoring or burnout is found, regrind seats using tool 99305018 (1) according to the angle values shown in Figure 81.

Figure 81



VALVE SEAT MAIN DATA (4 CYL.)

Figure 82



MAIN DATA CONCERNING THE SEATS ON THE CYLINDER HEAD (4 CYL.)

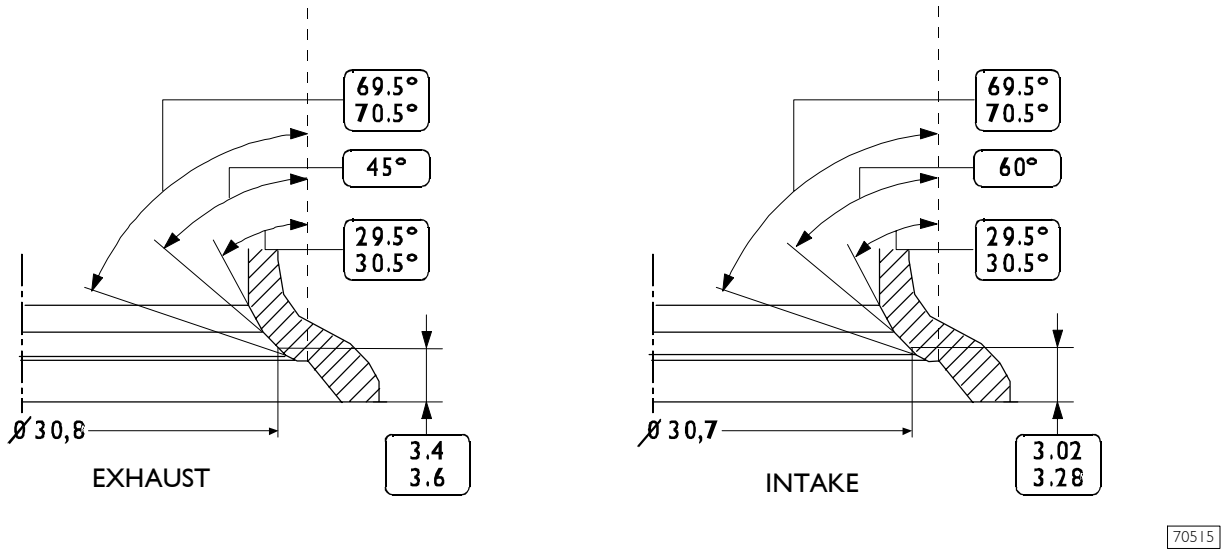
Should valve seats be not reset just by regrinding, replace them with the spare ones. Use tool 99305018 (Figure 80) to remove as much material as possible from the valve seats (take care not to damage the cylinder head) until they can be extracted from the cylinder head using a punch.

Heat the cylinder head to 80° - 100°C and using the proper punch, fit the new valve seats, previously cooled, into the cylinder head.

Use tool 99305018 to regrind the valve seats according to the values shown in Figure 81.

CYLINDER HEAD VALVE SEATS (6 CYL.)

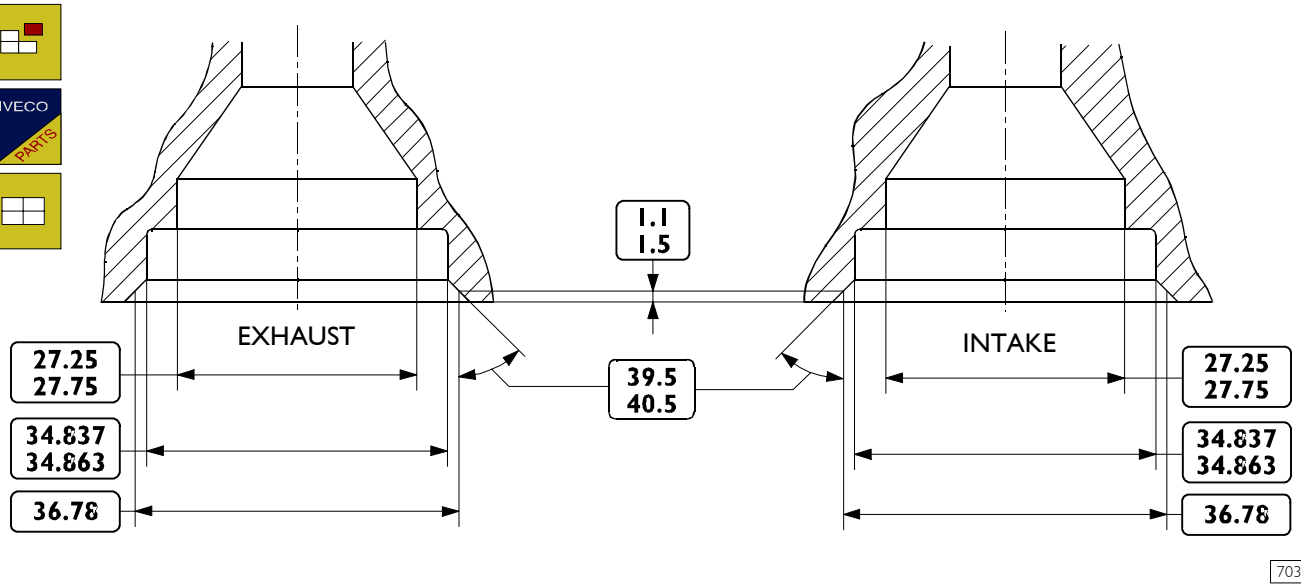
Figure 83



MAIN DATA ABOUT ENGINE VALVE SEATS

Valve seats are installed by cooling onto the cylinder head and machining to the correct dimension.

Figure 84



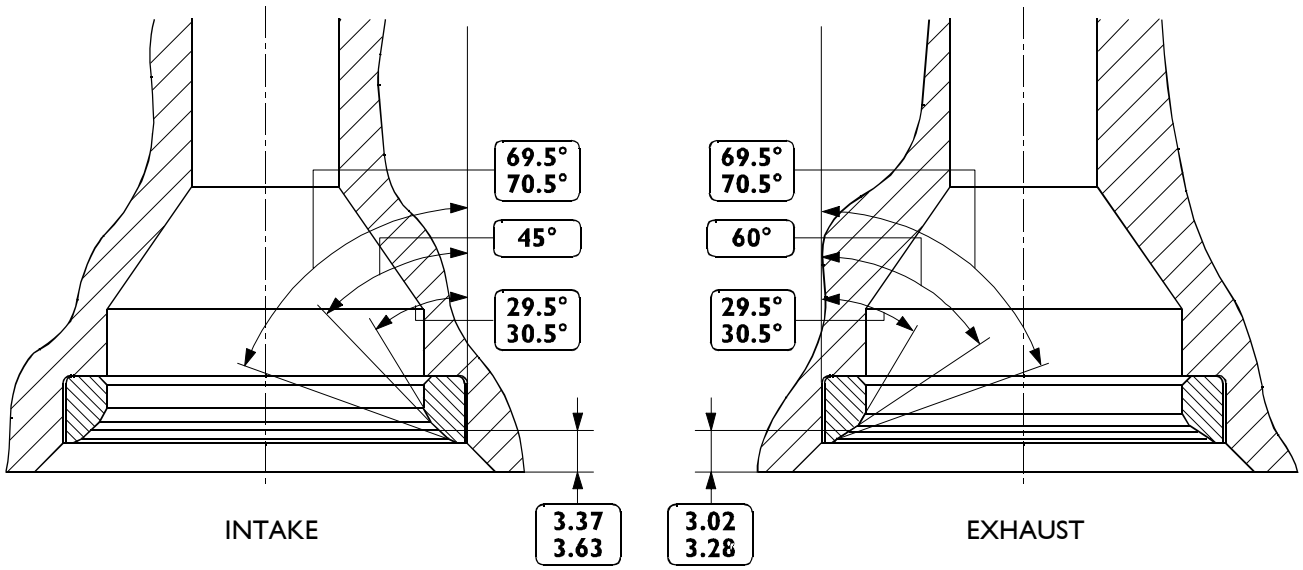
If valve seats cannot be restored just by regrinding, it is possible to assemble the spare inserts provided.

In this case, it is necessary to install seats into the cylinder head sized as shown in the figure and to assemble the valve seats.

In order to assemble the valve seats into the cylinder head, it is necessary to heat the cylinder head to 80 to 100°C and, through a suitable punch, to assemble the new, previously cooled valve seats (2) into the head.

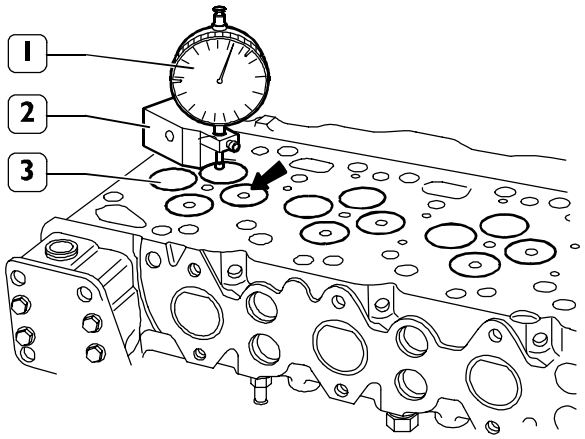
Then, with tool 99305018, adjust valve seats according to the values shown in Figure 85.

Figure 85



VALVE SEAT MAIN DATA (6 CYL.)

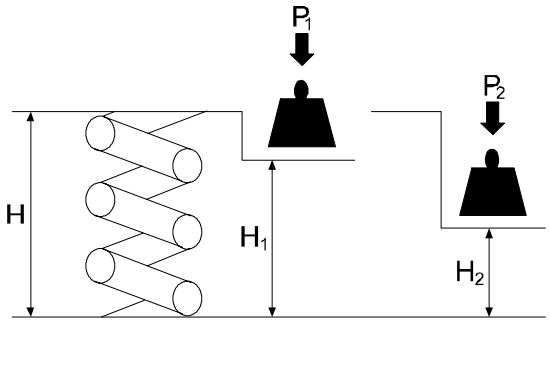
Figure 86



After regrinding, check that valve (3) sinking value is the specified one by using the base 99370415 (2) and the dial gauge 99395603 (1).

VALVE SPRINGS

Figure 87



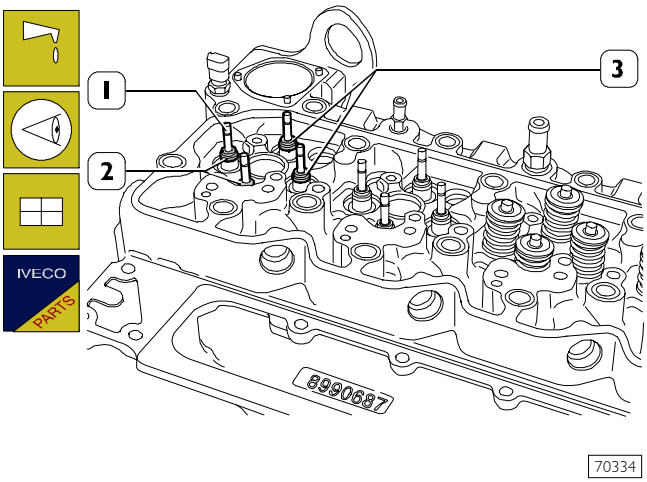
MAIN DATA TO CHECK INTAKE AND EXHAUST VALVE SPRINGS

Before refitting use tool 99305047 to check spring flexibility. Compare load and elastic deformation data with those of the new springs shown in the following table.

Height		Under a load of	
mm		kg	
H	47.75	Free	
H_1	35.33	P	339.8 ± 19 N
H_2	25.2	P1	741 ± 39 N

FITTING CYLINDER HEAD

Figure 88

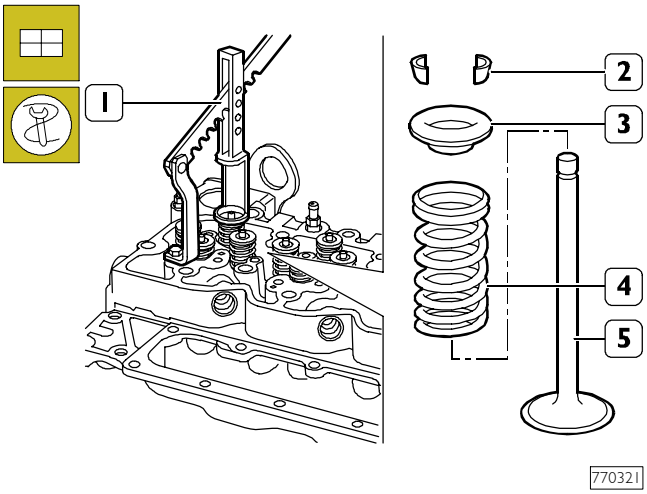


Lubricate the valve stems (1) and fit them into the relevant valve guides according to the position marked at removal.

Fit the sealing rings (2 and 3) on the valve guide.

Sealing rings (2) for intake valves are yellow and sealing rings (3) for exhaust valves are green.

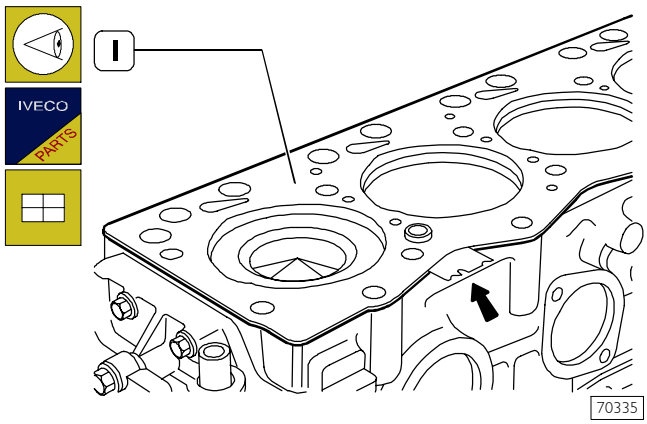
Figure 89



Position on the cylinder head: the spring (4), the upper cap (3); use tool 99360268 (1) to compress the spring (4) and lock the parts to the valve (5) by the cotters (2).

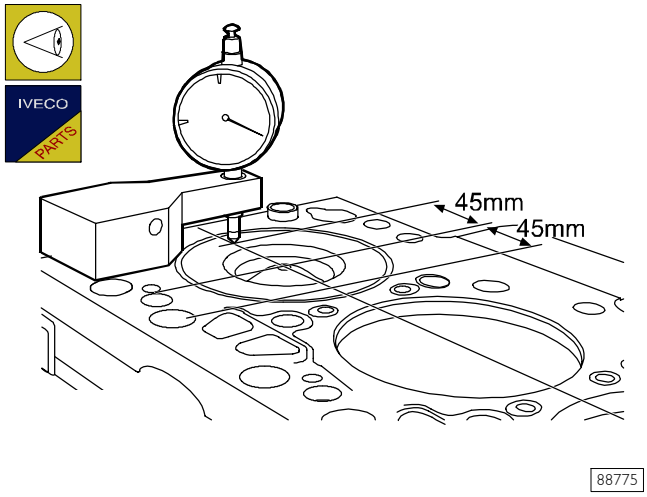
Refitting the cylinder head

Figure 90



Check cleanness of cylinder head and engine block coupling surface.
Take care not to foul the cylinder head gasket.
Set the cylinder head gasket (1) with the marking "TOP" (1) facing the head.
The arrow shows the point where the gasket thickness is given.

Figure 91



There are two types of head seals for F4AE04.., F4AE06.. and F4HE06.. engines, for the thickness (1.25 mm Type A and 1.15 mm Type B) take the following measures:

- for each piston detect, as indicated on NO TAG, at a distance of 45 mm from the centre of the piston overhandings S1 and S2 in relation to the engine base upper plane then calculate the average:

$$S_{cil1} = \frac{S1 + S2}{2}$$

For 4 cylinder versions:

Repeat the operation for pistons 2, 3 and 4 and calculate the average value.

$$S = \frac{S_{cil1} + S_{cil2} + S_{cil3} + S_{cil4}}{4}$$

For 6 cylinder versions:

Repeat the operation for pistons 2, 3, 4, 5 and 6 and calculate the average value.

$$S = \frac{S_{cil1} + S_{cil2} + S_{cil3} + S_{cil4} + S_{cil5} + S_{cil6}}{6}$$

If S is > 0,40 mm use seal type A.
If S is < 0,40 mm use seal type B.

Before re-utilising the fixing screws for the cylinder head, verify there is no evidence of wear or deformation and in that case replace them.

TIGHTENING TORQUE

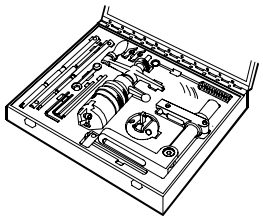
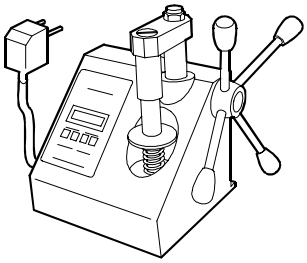
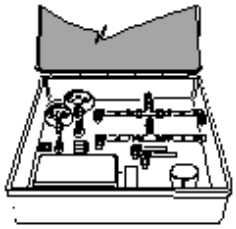
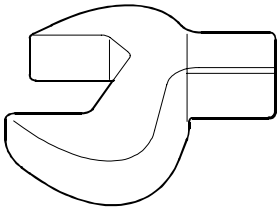
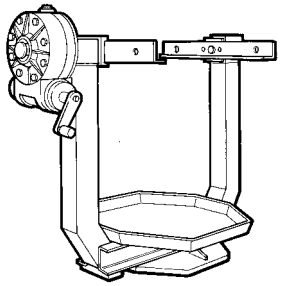
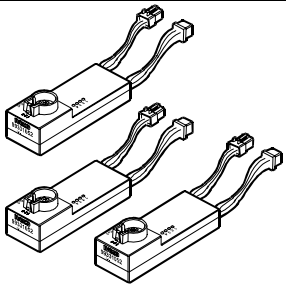
COMPONENT		TORQUE	
		Nm	kgm
Studs M6 for camshaft sensors		8 ± 2	0.8 ± 0.2
Studs M8 for feed pump		12 ± 2	1.2 ± 0.2
Screw M12 for fastening rear gear case		77 ± 12	7.7 ± 1.2
Screw M10 for fastening rear gear case		47 ± 5	4.7 ± 0.5
Screw M8 for fastening rear gear case		24 ± 4	2.4 ± 0.4
Nut M6 for fastening camshaft sensor		10 ± 2	1 ± 0.2
Screw M8 for fastening oil pump	1st stage	8 ± 1	0.8 ± 0.1
	2nd stage	24 ± 4	2.4 ± 0.4
Screw M8 for fastening front cover		24 ± 4	2.4 ± 0.4
Screw M8 for fastening camshaft longitudinal retaining plate		24 ± 4	2.4 ± 0.4
Screw M8 for fastening camshaft gear		36 ± 4	3.6 ± 0.4
Screw M10 for fastening crankcase plate		43 ± 5	4.3 ± 0.4
Nut M18 for fastening high pressure pump gear		105 ± 5	10.5 ± 0.5
Nuts M8 for fastening fuel pump		24 ± 4	2.4 ± 0.4
½ inch plug on cylinder head		24 ± 4	2.4 ± 0.4
¼ inch plug on cylinder head		36 ± 5	3.6 ± 0.5
¾ inch plug on cylinder head		12 ± 2	1.2 ± 0.2
Screw M6 for fastening injectors	1st stage	8.5 ± 0.35	0.85 ± 0.035
	2nd stage	75° ± 5°	
Nut fastening for injector feed connector		50 ± 5	5 ± 0.5
Nut M6 for flame start grille on intake manifold		8 ± 2	0.8 ± 0.2
Screw M8 for fastening intake manifold		24 ± 4	2.4 ± 0.4
Screw M12 for fastening rear brackets for engine lifting		77 ± 12	7.7 ± 1.2
Screws M8 for fastening Common Rail		24 ± 4	2.4 ± 0.4
Connectors M14 for high pressure fuel pipes		20 ± 2	2 ± 0.2
Screw M12 (12 x 1.75 x 130) for fastening cylinder head	1st stage	35 ± 5	3.5 ± 0.5
Screw M12 (12 x 1.75 x 150) for fastening cylinder head	1st stage	55 ± 5	5.5 ± 0.5
	2nd stage	90° ± 5°	
	3rd stage	90° ± 5°	
Screw for fastening rocker bracket		36 ± 5	3.6 ± 0.5
Valve clearance adjusting nuts		24 ± 4	2.4 ± 0.4
Nuts M14 for fastening fuel pipes from high pressure pump to Common Rail		20 ± 2	2 ± 0.2
Screw M8 for fastening high pressure pipe connector		24 ± 4	2.4 ± 0.4
Screw M6 for fastening wiring bulkhead		10 ± 2	1 ± 0.2
Screw M8 for fastening electric wiring support for injector feed		24 ± 4	2.4 ± 0.4
Nuts for fastening wiring on each injector		1.5 ± 0.25	0.15 ± 0.025
Screw M12 for fastening fuel filter bracket		77 ± 8	7.7 ± 0.8
Screw M8 for fastening fuel filter holder		24 ± 4	2.4 ± 0.4
Fuel filter		contact + ¾ turn	
Screw M22 for fastening oil pressure relief valve on oil filter support		80 ± 8	8 ± 0.8
Screw M8 for radiator seal and oil filter support		24 ± 4	2.4 ± 0.4
Oil filter		contact + ¾ turn	
11/8 inch connection on filter support for turbine lubrication		24 ± 4	2.4 ± 0.4
Nut M12 for fastening turbine lubrication pipe		10 ± 2	1 ± 0.2
Screw M10 for fastening engine coolant inlet connection		43 ± 6	4.3 ± 0.6
90° elbow fastening (if required) to engine coolant inlet connection		24 ± 4	2.4 ± 0.4
Pipe on cylinder head for compressor cooling		22 ± 2	2.2 ± 0.2

COMPONENT			TORQUE Nm	TORQUE kgm
Screw M6 for fastening engine coolant drain connector			10 ± 2	1 ± 0.2
Pin fastening on engine block for exhaust manifold			10 ± 2	1 ± 0.2
Screw M10 for fastening exhaust manifold on cylinder head			53 ± 5	5.3 ± 0.5
Screw M12 for fastening damper adapter and damper on output shaft		1st stage 2nd stage	50 ± 5	5 ± 0.5 90°
Screw M10 for fastening pulley on output shaft			68 ± 7	6.8 ± 0.7
Screw M8 for fastening water pump			24 ± 4	2.4 ± 0.4
Screw M10 for fastening auxiliary component control belt tensioners			43 ± 6	4.3 ± 0.6
Screw M10 for fastening fixed pulleys for auxiliary component control belt			43 ± 6	4.3 ± 0.6
Screw M10 for fastening flywheel housing Screw M12 for fastening flywheel housing			85 ± 10 49 ± 5	8.5 ± 1 4.9 ± 0.5
Screw M6 for fastening heat exchanger for control unit Screw M8 for fastening heat exchanger for control unit			10 ± 2 24 ± 4	1 ± 0.2 2.4 ± 0.4
Connection M12 for fuel inlet-outlet on heat exchanger			12 ± 2	1.2 ± 0.2
Nut M8 for fastening valve cover			24 ± 4	2.4 ± 0.4
Screw M6 for fastening camshaft sensor			8 ± 2	0.8 ± 0.2
Screw M6 for fastening output shaft sensor			8 ± 2	0.8 ± 0.2
Screw M14 for fastening coolant temperature sensor			20 ± 3	2 ± 0.3
Screw M5 for fastening oil pressure/temperature sensor			6 ± 1	0.6 ± 0.1
Screw for fastening fuel pressure sensor			35 ± 5	3.5 ± 0.5
Screw M14 for fastening fuel temperature sensor			20 ± 3	2 ± 0.3
Screw for fastening air temperature/pressure sensor on intake manifold			6 ± 1	0.6 ± 0.1
Screw M12 for fastening engine oil level sensor			12 ± 2	1.2 ± 0.2
Turbine fixing to exhaust manifold	6-cyl.	pins M8 nuts M8	7 ± 1 43 ± 6	0.7 ± 0.1 4.3 ± 0.6
	4-cyl.	pins M8 nuts M8	7 ± 1 24 ± 4	0.7 ± 0.1 2.4 ± 0.4
Adapter M12 on turbine for lubricant oil pipes (inlet)			35 ± 5	3.5 ± 0.5
Pipe fixing on adapter M10 for turbine lubrication			35 ± 5	3.5 ± 0.5
Oil pipe fixing on adapter M10 for turbine lubrication to block			43 ± 6	4.3 ± 0.6
Oil drain pipe fixing M8 on turbine			24 ± 4	2.4 ± 0.4
Connector fixing M6 for oil return from cylinder head to flywheel housing			10 ± 2	1 ± 0.2
Screw M12 for fastening engine flywheel		1st stage 2nd stage	30 ± 4	3 ± 0.4 60° ± 5°
Screw M8 for fastening front bracket for engine lifting			24 ± 4	2.4 ± 0.4
Screw for fastening engine oil sump			24 ± 4	2.4 ± 0.4
Screw M8 for fastening cylinder barrel lubricating nozzles			15 ± 3	1.5 ± 0.3
Screw M12 for fastening output shaft caps		1st stage 2nd stage 3rd stage	50 ± 6 80 ± 6	5 ± 0.6 8 ± 0.6 90° ± 5°
Screw M8 for fastening camshaft longitudinal retaining plate			24 ± 4	2.4 ± 0.4
Screw M8 for fastening camshaft gear			36 ± 4	3.6 ± 0.4
Screw M11 for fastening connecting rod caps		1st stage 2nd stage	60 ± 5	6 ± 0.5 60° ± 5°
Alternator				
M10 Screw, Bracket fixing on water feed pipefitting			43 ± 6	4.3 ± 0.6
M10 Screw, alternator locking			43 ± 6	4.3 ± 0.6
Starter				
Starter fixing screw			43 ± 6	4.3 ± 0.6

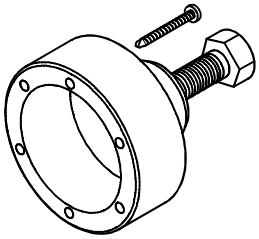
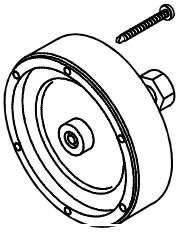
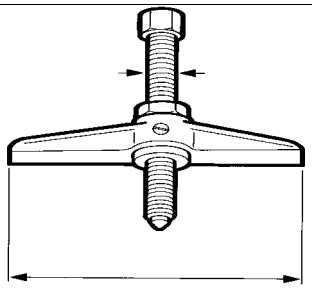
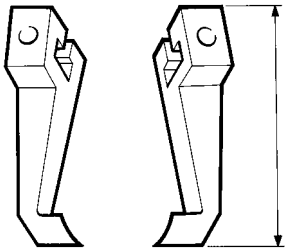
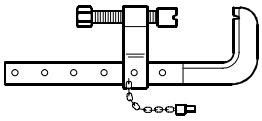
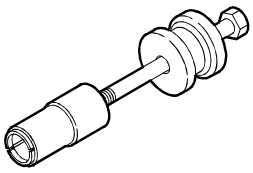
SECTION 5

Tools

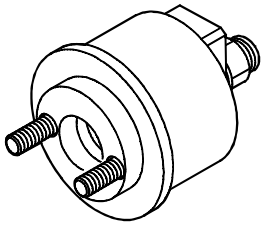
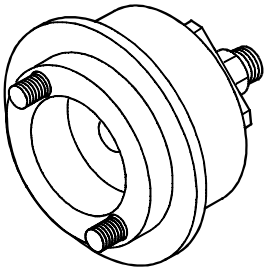
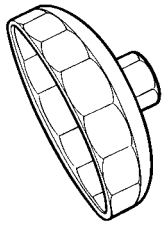
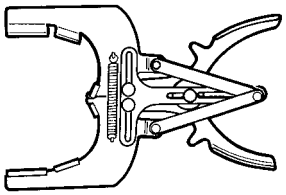
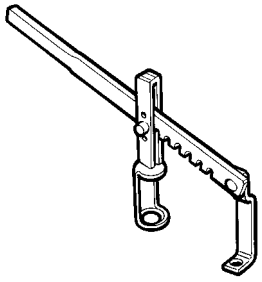
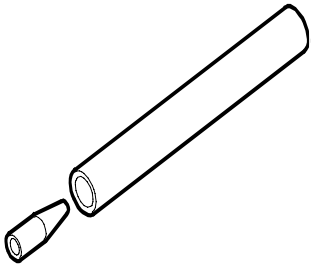
TOOLS

TOOL NO.		DESCRIPTION
99305018		Kit for valve seat regrinding
99305047		Spring load tester
99305453		Tool to check the diesel supply circuit and the common-rail injection system
99317915		Set of 3 pin wrenches (14 - 17 - 19 mm)
99322205		Revolving stand for overhauling units (700 daN/m capacity, 120 daN/m torque)
99331052		Adapter for measures on engine injectors (use with 99395872)

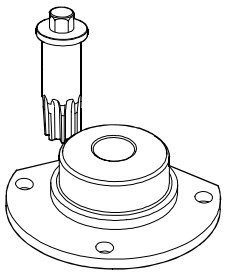
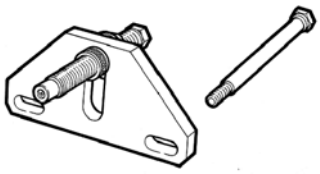
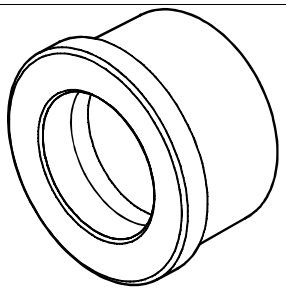
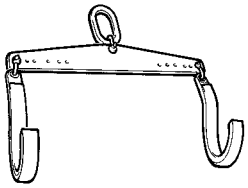
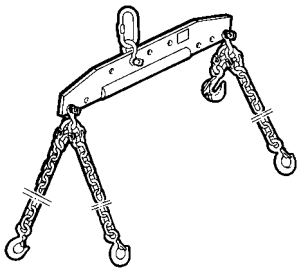
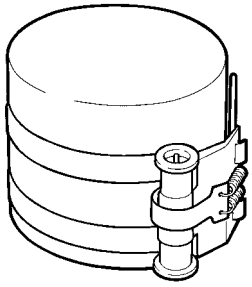
TOOLS

TOOL NO.		DESCRIPTION
99340055		Tool to remove output shaft front gasket
99340056		Tool to remove output shaft rear gasket
99341001		Double acting puller
99341009		Pair of brackets
99341015		Press
99342101		Tool to remove injectors

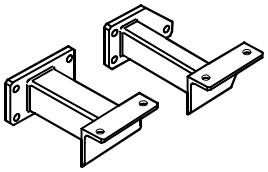
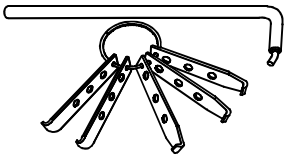
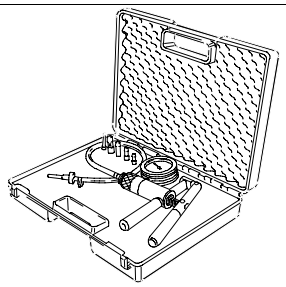
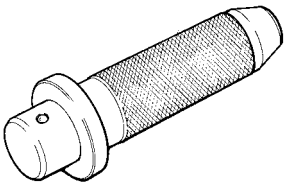
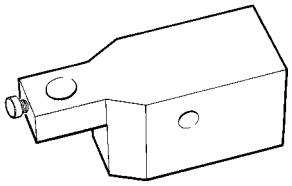
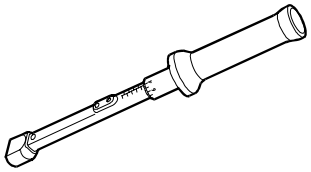
TOOLS

TOOL NO.		DESCRIPTION
99346252		Tool for fitting output shaft front gasket
99346253		Tool for fitting output shaft rear gasket
99360076		Tool to remove oil filter (engine)
99360183		Pliers for removing/refitting piston rings (65 – 110 mm)
99360268		Tool for removing/refitting engine valves
99360292		Keying device for seal assembly on the valve guide

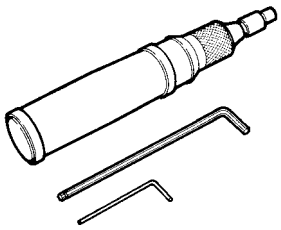
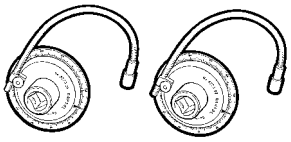
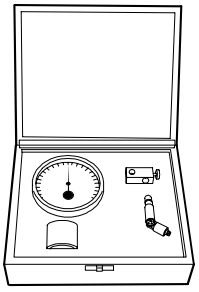
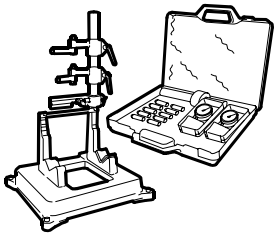
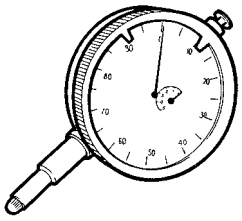
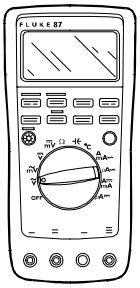
TOOLS

TOOL NO.		DESCRIPTION
99360339		Tool for rotating/stopping the engine flywheel
99360351		Equipment for flywheel holding
99360362		Beater for removing/refitting camshaft bushes (to be used with 993700069)
99360500		Tool for lifting the output shaft
99360595		Lifting rig for engine removal/refitting
99360605		Band for fitting piston into cylinder barrel (60 – 125 mm)

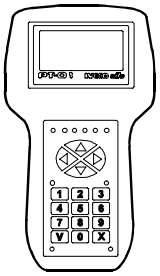
TOOLS

TOOL NO.		DESCRIPTION
99361037		Brackets for fastening engine to revolving stand 99322205
99363204		Tool to remove gaskets
99367121		Manual pump for pressure and depression measures
99370006		Handgrip for interchangeable beaters
99370415		Gauge base for different measurements (to be used with 99395603)
99389829		Dog type dynamometric wrench 9x12 (5-60 Nm)

TOOLS

TOOL NO.		DESCRIPTION
99389834		Torque screwdriver for injector solenoid valve connector stop nut setting
99395216		Pair of gauges with ½" and ¾" square head for angle tightening
99395220		Universal goniometer/inclinometer
99395363		Complete bush testing square
99395603		Dial gauge (0 – 5 mm)
99395872		Analog to digital multimeter for voltage, current intensity, resistance, diodes, frequencies, capacity and registration of the minimum, average and maximum values

TOOLS

TOOL NO.		DESCRIPTION
8093731		Tester PT01

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 APPLICATION ENGINES

Section 1 - General specifications

Section 2 - G-Drive application

Part 2 describes a specific industrial application: G-Drive engines.

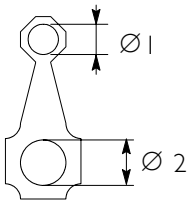
These engines are marketed as an assembly that is also equipped with the air/coolant and possibly air/air (intercooler) cooling device.

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

SPECIAL REMARKS

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

Example



Ø 1 = housing for connecting rod small end bush

Ø 2 = housing for connecting rod bearings

Tighten to torque
Tighten to torque + angular value

SYMBOLS - ASSISTANCE OPERATIONS

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

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

UPDATING

Section	Description	Page	Date of revision

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

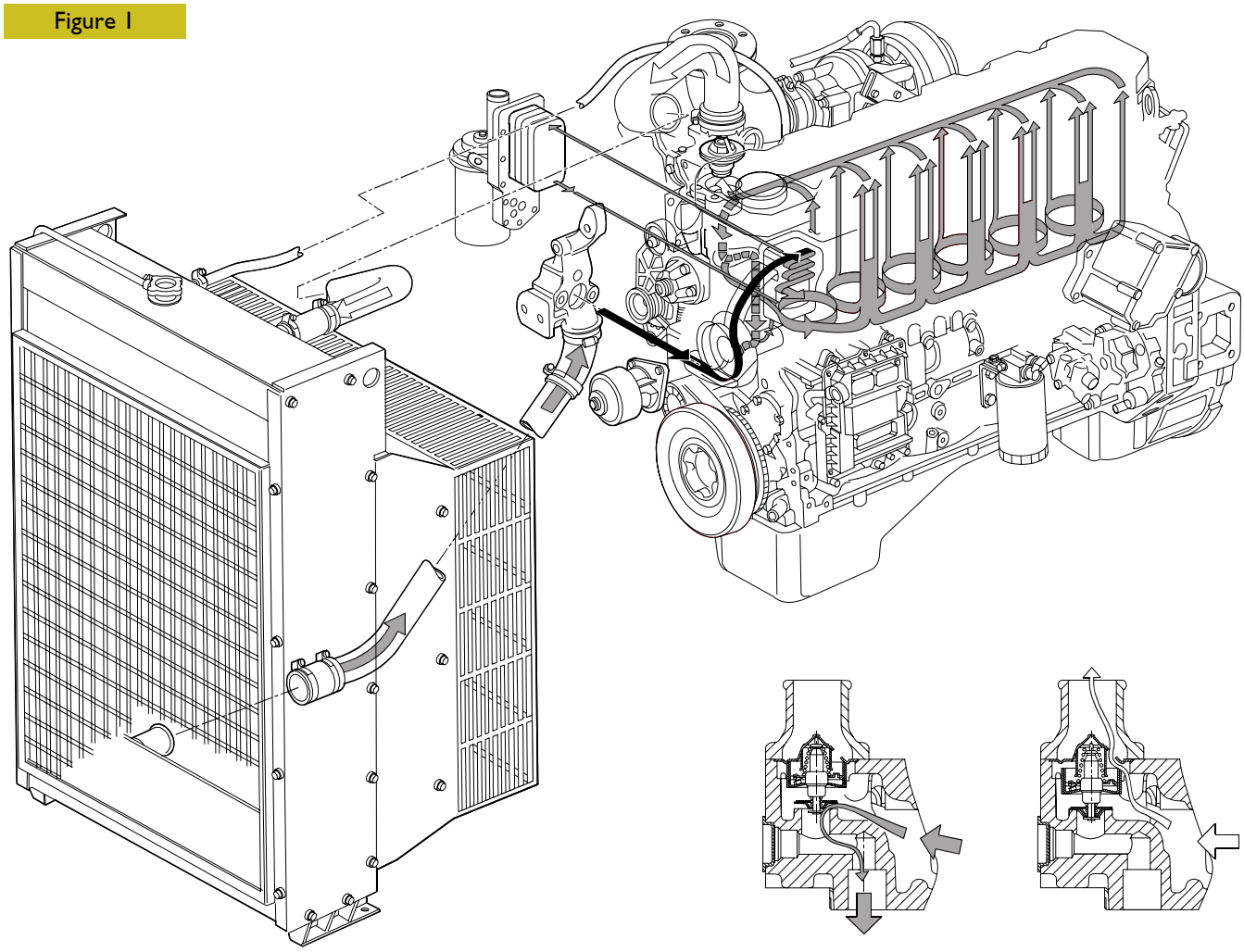
Technical Code	Commercial Code
F4HE9685A*J100	-

COOLING SYSTEM

The engine cooling system, closed circuit forced circulation type, generally incorporates the following components:

- ❑ Expansion tank; placement, shape and dimensions are subject to change according to the engine's equipment.
- ❑ Radiator, which has the duty to dissipate the heat subtracted to the engine by the cooling liquid. Also this component will have specific peculiarities based on the equipment developed, both for what concerns the placement and the dimensions.
- ❑ Viscous pusher fan, having the duty to increase the heat dissipating power of the radiator. This component as well will be specifically equipped based on the engine's development.
- ❑ Heat exchanger to cool the lubrication oil: even this component is part of the engine's specific equipment.
- ❑ Centrifugal water pump, placed in the front part of the engine block.
- ❑ Thermostat regulating the circulation of the cooling liquid.
- ❑ The circuit may eventually be extended to the compressor, if this is included in the equipment.

Figure 1



Water leaving the thermostat

Coolant recirculating in the engine

Water entering the pump

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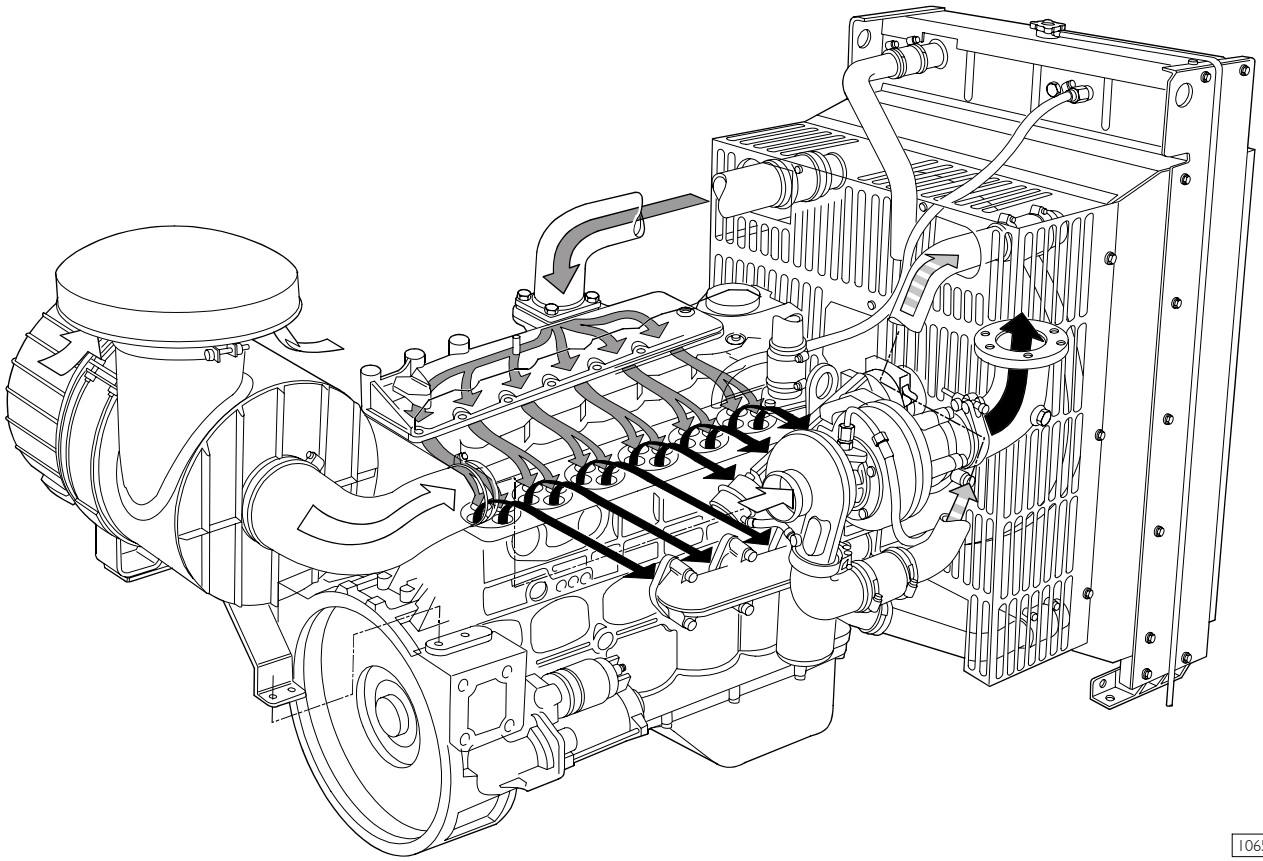
DIAGRAM OF THE COOLING SYSTEM

AIR INDUCTION - BOOST DIAGRAM

Figure 2



Intake air

Compressed air to the heat exchanger

Refrigerated compressed air to the pistons

Exhaust gas

TURBOCHARGING DIAGRAM

Description

The turbocharger is composed by the following main parts: one turbine, one transforming valve to regulate the boost feeding pressure , one main body and one compressor.

During engine working process, the exhaust emissions flow through the body of the turbine, causing the turbine disk wheel's rotation.

The compressor rotor, being connected by shaft to the turbine disk wheel, rotates as long as this last one rotates, compressing the drawn air through the air filter.

The above mentioned air is then cooled by the radiator and flown through the piston induction collector.

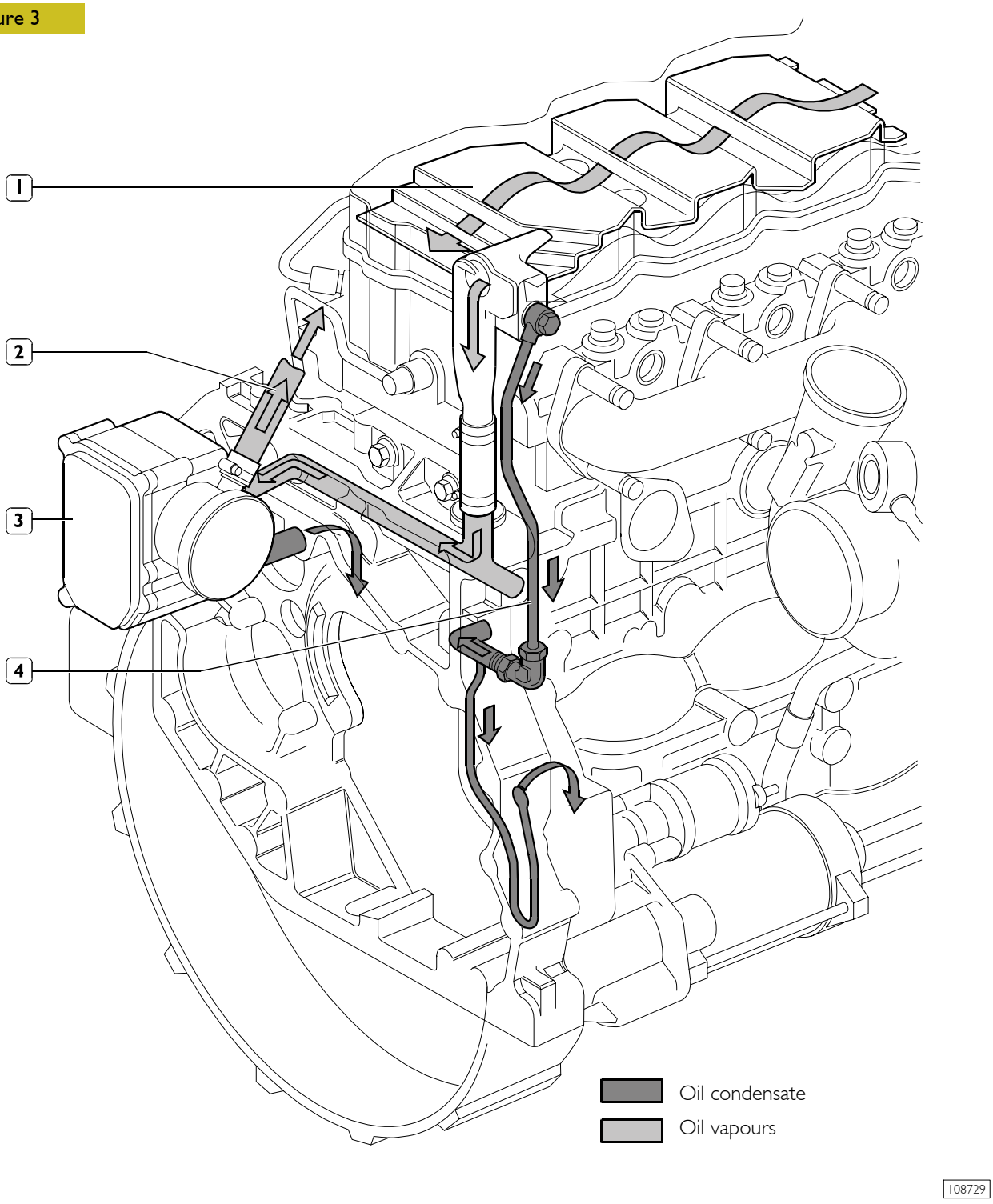
The turbocharger is equipped with a transforming valve to regulate the pressure , that is located on the exhaust collector before the turbine and connected by piping to the induction collector.

It's funchon is to restrict the exhaust of the emissions , releasing part of them directly to the exhaust tube when the boost feeding pressure, over the compressor, reaches the prescribed bar value.

The cooling process and the lubrication of the turbocharger and of the bearings is made by the oil of the engine.

OIL VAPOUR RECYCLING

Figure 3



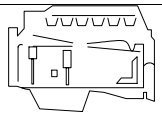
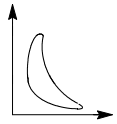
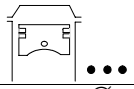
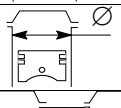
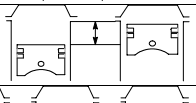
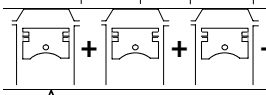
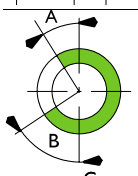
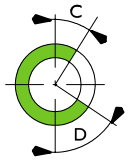
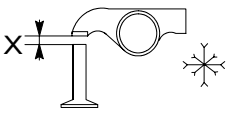
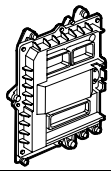
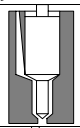
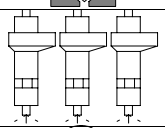
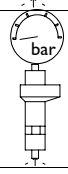
1. Pre-separator - 2. Exhaust to the outside (temporary) - 3. Filter - 4. Return to engine.

The tappet cover houses the pre-separator (1), whose shape and position determines an increase in oil vapour outlet speed and condenses a part of vapours at the same time.

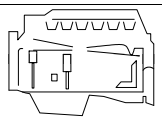
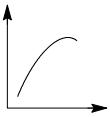
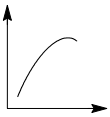
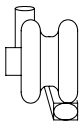
Condensate oil returns to the oil sump whereas the residual vapours are ducted, collected and filtered in the blow-by (3).

In the blow-by (3), part of the vapours condense and return to the oil sump whereas the remaining part is put into cycle again through pipe (2).

GENERAL SPECIFICATIONS

	Type		FAHE9685A
	Cycle		Four-stroke diesel engine
	Power		Supercharged with intercooler
	Injection		Direct
	Number of cylinders		6
	Bore	mm	104
	Stroke	mm	132
	Total displacement	cm^3	6728
	**TIMING**		
	start before T.D.C. end after B.D.C.	A B	18.5° 29.5°
	start before B.D.C. end after T.D.C.	D C	67° 35°
	Checking timing X	mm mm	- -
	Checking operation X	mm mm	0.20 to 0.30 0.45 to 0.55
	**FUEL FEED** Injection Type:	 Bosch	 high pressure common rail EDC7 ECU
	Nozzle type		Injectors
	Injection sequence		1 - 5 - 3 - 6 - 2 - 4
	Injection pressure	bar	250 ÷ 1450

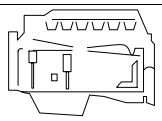
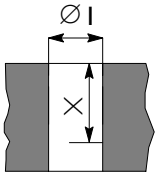
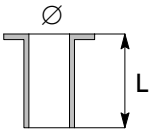
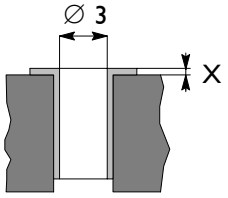
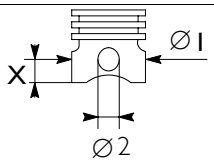
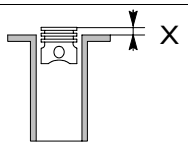
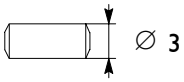
Clearance data - 6 cyl.

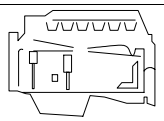
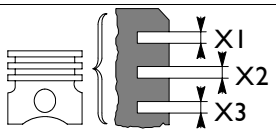
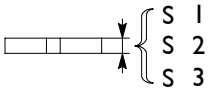
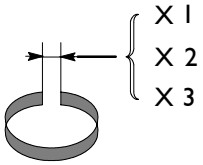
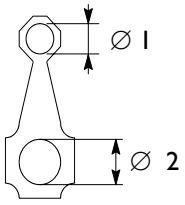
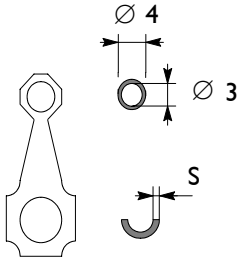
	Type		**FAHE9685A**
	Compression ratio		17 : 1
 	Max. output	kW (HP) rpm	215 292 1800
 	Max. torque	Nm (kgm) rpm	- - -
	Loadless engine idling	rpm	-
	Loadless engine peak rpm	rpm	-
	Bore x stroke Displacement		104 x 132 6728
	**TURBOCHARGING** Turbocharger type		with intercooler HOLSET HX35W
 	**LUBRICATION** **Oil pressure (warm engine)** - idling - peak rpm	 bar bar	Forced by gear pump, relief valve single action oil filter 2 4
	COOLING **Water pump control** **Thermostat** - start of opening	 °C	By liquid Through belt 81 ± 2
 15W40 ACEA E3	**FILLING** engine sump engine sump + filter	 liters liters	 15 15 + 1

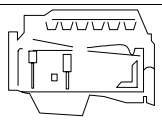
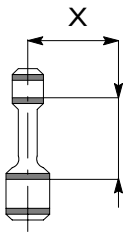
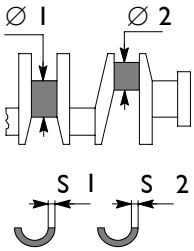
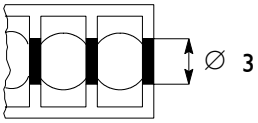
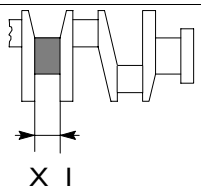
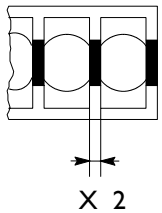
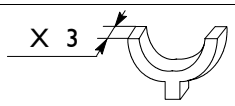
Data, features and performances are valid only if the technician fully complies with all the installation requirements provided by Iveco Motors.

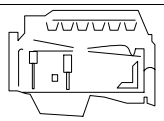
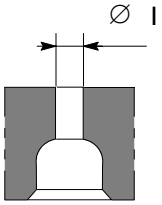
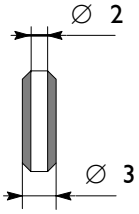
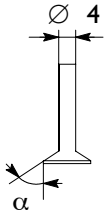
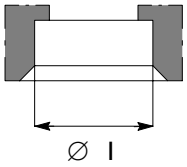
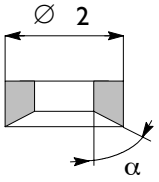
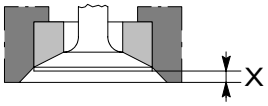
Furthermore, the use of the unit after overhaul showd conform to the original specified power and engine rev/min for which the engine has been designed.

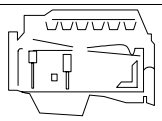
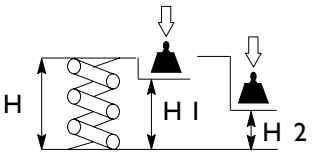
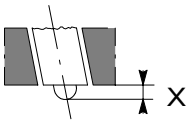
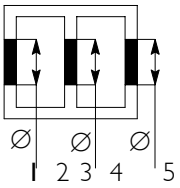
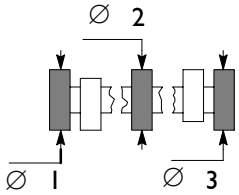
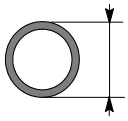
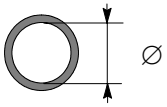
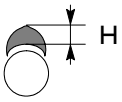
CLEARANCE DATA

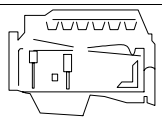
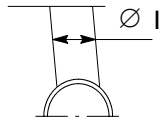
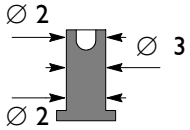
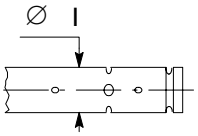
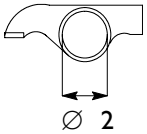
	Type	6 CYLINDERS
CYLINDER UNIT AND CRANKSHAFT COMPONENTS		mm
	Cylinder barrels Ø1	103.99 to 104.010
	Cylinder barrels: outside diameter Ø 2 length L	 - -
	Cylinder barrels – housings on engine block (interference)	-
IVECO PARTS >	Outside diameter Ø 2	0.5
	Cylinder barrels: inside diameter Ø 2	 -
	Spare pistons type: Size X Outside diameter Ø 1 Pin housing Ø 2	 12 103.851 to 103.865 40.00 to 40.25
	Piston – cylinder barrels	0.113 to 0.147
IVECO PARTS <	Piston diameter Ø 1	0.5
	Piston protrusion X	0.28 to 0.52
	Piston pin Ø 3	37.994 to 38
	Piston pin – pin housing	0.0006 to 0.0202

	Type	**6 CYLINDERS**
CYLINDER UNIT AND CRANKSHAFT COMPONENTS		**mm**
	Split ring slots * measured on 99 mm Ø	X1* X 2 X 3	3 2.42 to 2.44 4.03 to 4.05
	Split rings	S 1* S 2 S 3	3 2.350 to 2.380 4.030 to 4.050
	Split rings - slots	1 2 3	0.100 to 0.175 0.040 to 0.90 0.020 to 0.065
	Split rings		0.5
	Split ring end opening in cylinder barrel:	X 1 X 2 X 3	0.30 to 0.40 0.60 to 0.80 0.3 to 0.55
	Small end bush housing Big end bearing housing	Ø 1 Ø 2	42.987 to 43.013 72.987 to 73.013
	Small end bush diameter Outside Inside Spare big end half bearings	 Ø 4 Ø 3 S	 40.987 to 41.013 38.019 to 38.033 1.955 to 1.968
	Small end bush – housing		0.266 to 0.566
	Piston pin – bush		0.0188 to 0.0372
	Big end half bearings		0.250; 0.500; 0.750; 1.000

	Type	6 CYLINDERS
CYLINDER UNIT AND CRANKSHAFT COMPONENTS		mm
	Size X Max. tolerance on connecting rod axis alignment	- -
	Journals Ø 1 Crankpins Ø 2 Main half bearings S 1 Big end half bearings S 2 *provided as spare part	82.99 to 83.01 73.533 to 74.513 2.456 to 2.464 1.955 to 1.968
	Main bearings No. 1–7 Ø 3 No. 2–3–4–5–6 Ø 3	 87.982 to 88.008 87.977 to 88.013
	Half bearings – Journals No. 1–7 No. 2–3–4–5–6	 0.044 to 0.106 0.039 to 0.111
	Half bearings - Crankpins	0.038 to 0.116
	Main half bearings Big end half bearings	+0.250; +0.500; +0.750; +1.000
	Shoulder journal X 1	37.28 to 37.38
	Shoulder main bearing X 2	28.77 to 29.03
	Shoulder half-rings X 3	37.28 to 37.38
	Output shaft shoulder	0.095 to 0.265

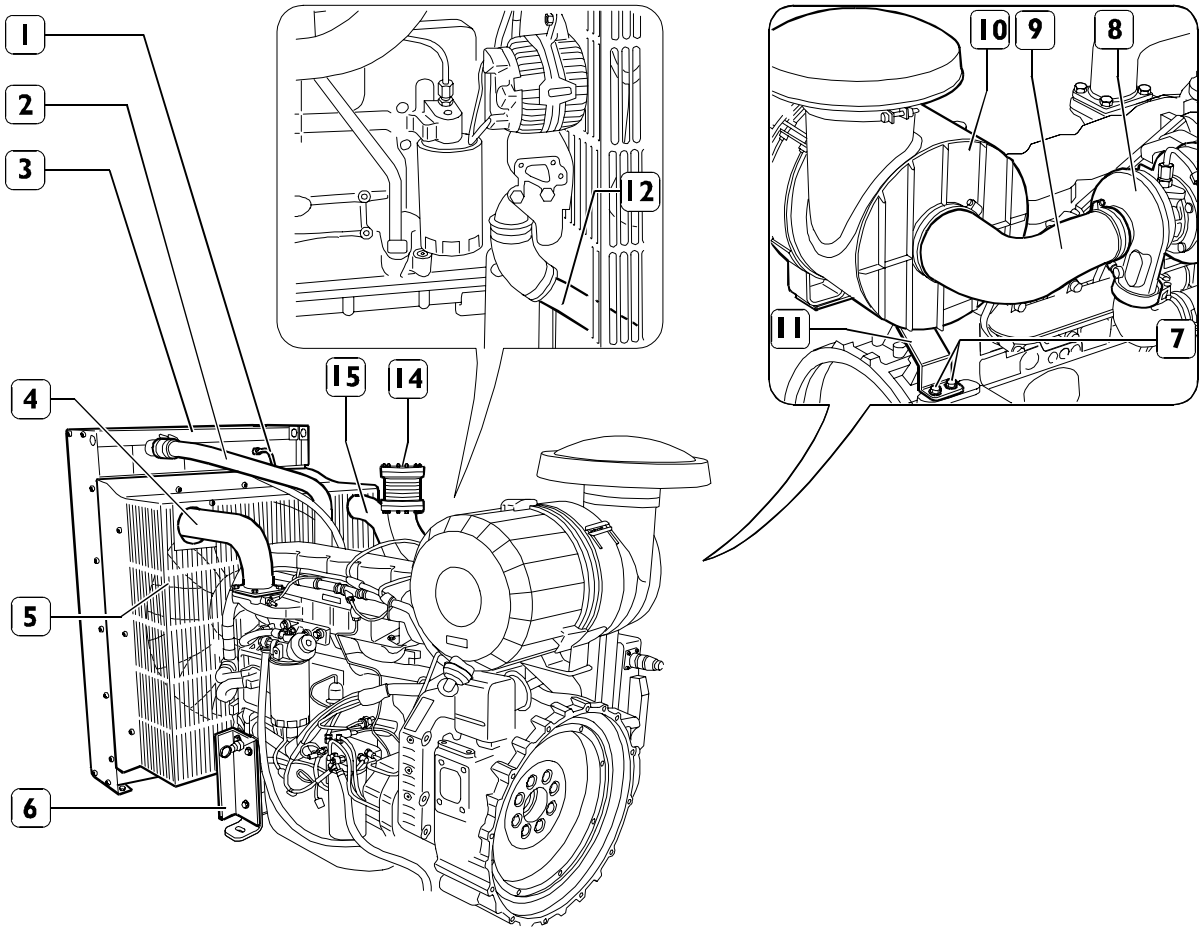
	Type	6 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM		mm
	Valve guide seats on cylinder head Ø 1	7.042 to 7.062
	Valve guides Ø 2	-
	Ø 3	-
	Valve guides and seats on head	-
IVECO PARTS >	Valve guides	-
	Valves: Ø 4 α	6.970 to 6.999 60 ± 0.25°
	Ø 4 α	6.970 to 6.999 45 ± 0.25°
	Valve stem and guide	0.043 to 0.092
	Housing on head for valve seat: Ø1	34.837 to 34.863
	Ø1	34.837 to 34.863
	Valve seat outside diameter; valve seat angle on cylinder head: Ø 2 α	34.917 to 34.931 60°
	Ø 2 α	34.917 to 34.931 45°
	Sinking	0.59 to 1.11
		0.96 to 1.48
	Between valve seat and head	0.054 to 0.094
		0.054 to 0.094
IVECO PARTS >	Valve seats	-

	Type		6 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM			**mm**
	Valve spring height: free spring under a load equal to: 339.8 ± 9 N 741 ± 39 N	 H H1 H2	 47.75 35.33 25.2
	Injector protrusion	X	-
	Camshaft bush housings No. 1 Camshaft housings No. 2-3-4-5-6-7		59.222 to 59.248 54.089 to 54.139
	Camshaft journals: 1 ⇒ 7	 Ø	 54.005 to 54.035
	Camshaft bush outside diameter:	Ø	-
	Bush inside diameter	Ø	54.083 to 54.147
	Bushes and housings on block		-
	Bushes and journals		0.038 to 0.162
	Cam lift:  	 H H	 6.045 7.582

	Type	6 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM		mm
	Tappet cap housing on block Ø 1	16.000 to 16.030
	Tappet cap outside diameter: Ø 2 Ø 3	15.924 to 15.954 15.960 to 15.975
	Between tappets and housings	0.025 to 0.070
	Tappets	-
	Rocker shaft Ø 1	21.965 to 21.977
	Rockers Ø 2	22.001 to 22.027
	Between rockers and shaft	0.024 to 0.162

REMOVING AND REFITTING ENGINE FROM RADIATOR

Figure 4



Removal

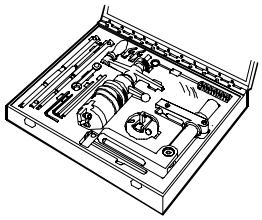
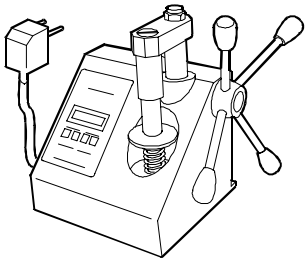
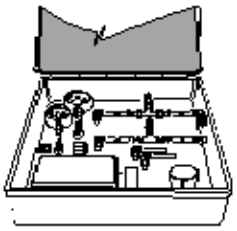
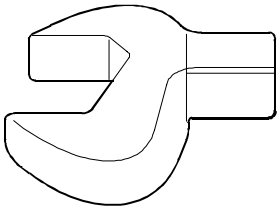
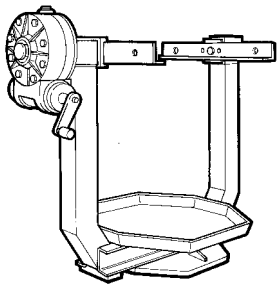
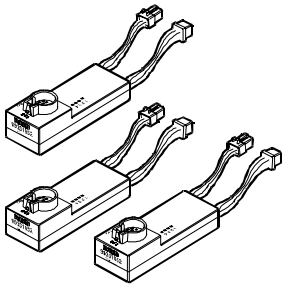
Remove the fan safety grilles (5) by undoing the relevant fasteners.
Place a container under the pipe (12) to collect the coolant.
Disconnect and remove the pipe (12) together with the sleeves by undoing the clamps.
Disconnect the air pipes (4) and (15) from the air exchanger and from the engine, then remove it from its seat. Disconnect the exhaust pipe (14) from the system.
Disconnect and remove the coolant pipes (1) and (2).
Block the radiator assembly (3) appropriately, then detach it from the crankcase by undoing the fasteners (6) on both sides.
Remove the radiator assembly from its seat, taking care over any interference with the fan.
Disconnect the air hose (9) from air filter (10) to the turbine (8).
Remove the air cleaner (10) by undoing the fasteners (7) and remove it from its seat together with the support (11).

Refitting

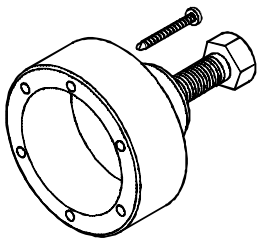
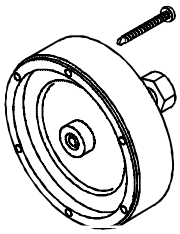
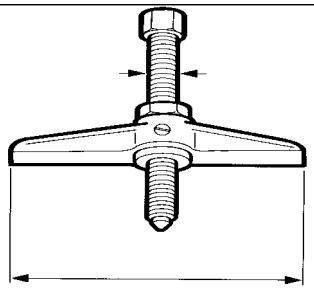
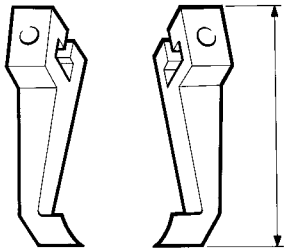
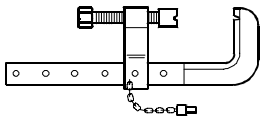
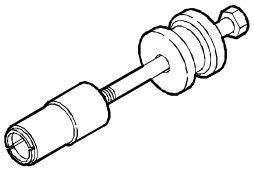
Proceed by reversing the operations described for removal; restore the coolant system.

NOTE Check the state of wear of the rubber couplings.

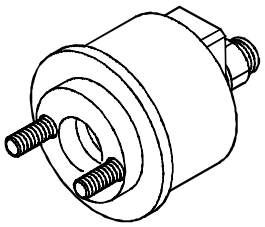
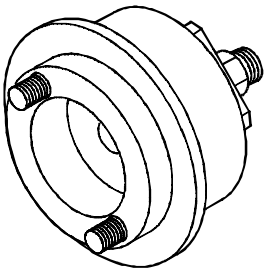
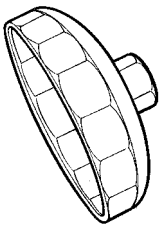
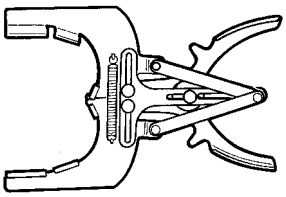
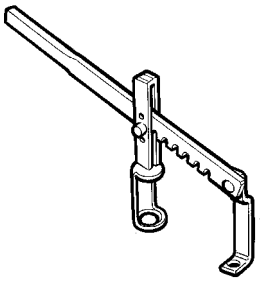
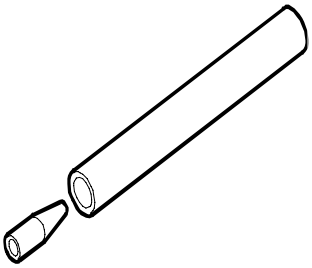
TOOLS

TOOL NO.		DESCRIPTION
99305018		Kit for valve seat regrinding
99305047		Spring load tester
99305453		Tool to check the diesel supply circuit and the common-rail injection system
99317915		Set of 3 pin wrenches (14 - 17 - 19 mm)
99322205		Revolving stand for overhauling units (700 daN/m capacity, 120 daN/m torque)
99331052		Adapter for measures on engine injectors (use with 99395872)

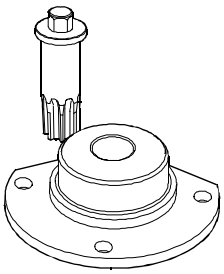
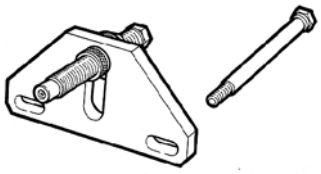
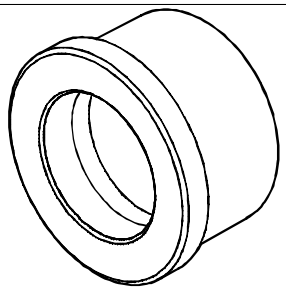
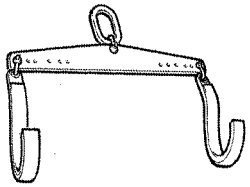
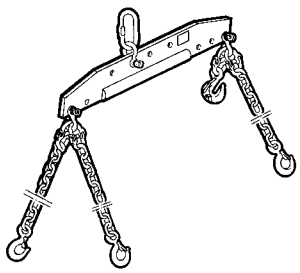
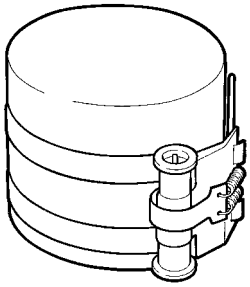
TOOLS

TOOL NO.		DESCRIPTION
99340055		Tool to remove output shaft front gasket
99340056		Tool to remove output shaft rear gasket
99341001		Double acting puller
99341009		Pair of brackets
99341015		Press
99342101		Tool to remove injectors

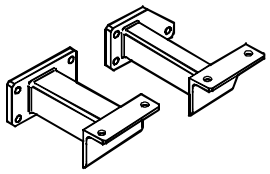
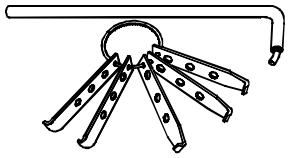
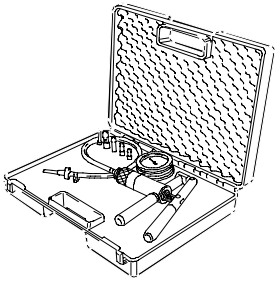
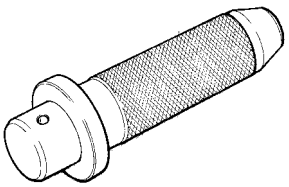
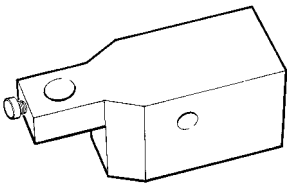
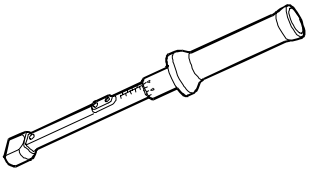
TOOLS

TOOL NO.		DESCRIPTION
99346252		Tool for fitting output shaft front gasket
99346253		Tool for fitting output shaft rear gasket
99360076		Tool to remove oil filter (engine)
99360183		Pliers for removing/refitting piston rings (65 – 110 mm)
99360268		Tool for removing/refitting engine valves
99360292		Keying device for seal assembly on the valve guide

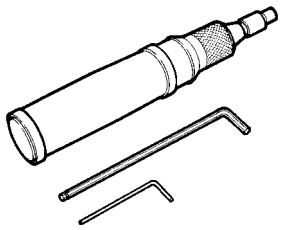
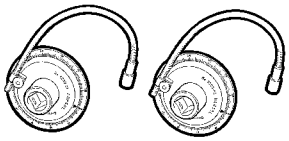
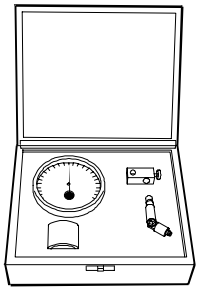
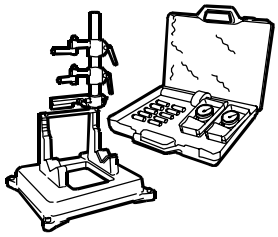
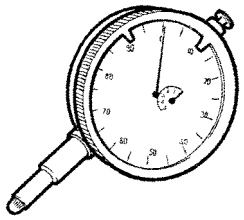
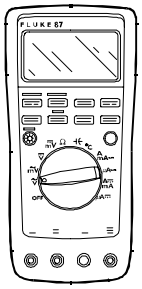
TOOLS

TOOL NO.		DESCRIPTION
99360339		Tool for rotating/stopping the engine flywheel
99360351		Equipment for flywheel holding
99360362		Beater for removing/refitting camshaft bushes (to be used with 993700069)
99360500		Tool for lifting the output shaft
99360595		Lifting rig for engine removal/refitting
99360605		Band for fitting piston into cylinder barrel (60 – 125 mm)

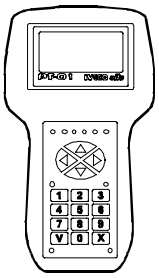
TOOLS

TOOL NO.		DESCRIPTION
99361037		Brackets for fastening engine to revolving stand 99322205
99363204		Tool to remove gaskets
99367121		Manual pump for pressure and depression measures
99370006		Handgrip for interchangeable beaters
99370415		Gauge base for different measurements (to be used with 99395603)
99389829		Dog type dynamometric wrench 9x12 (5-60 Nm)

TOOLS

TOOL NO.		DESCRIPTION
99389834		Torque screwdriver for injector solenoid valve connector stop nut setting
99395216		Pair of gauges with ½" and ¾" square head for angle tightening
99395220		Universal goniometer/inclinometer
99395363		Complete bush testing square
99395603		Dial gauge (0 – 5 mm)
99395872		Analog to digital multimeter for voltage, current intensity, resistance, diodes, frequencies, capacity and registration of the minimum, average and maximum values

TOOLS

TOOL NO.		DESCRIPTION
8093731		Tester PT01