N SERIES
TIER 3

G-Drive applications

N45

NEF45 SM1X
NEF45 SM2X

N67

NEF67 TE1X
NEF67 TE2X
NEF67 TM1X

Technical and Repair manual

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

This publication is addressed to qualified, specialised personnel.

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

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

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

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

FPT cannot be held responsible for repair interventions.

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

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

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

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G-Drive Tier 3 N SERIES

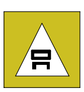
Introduction

PREFACE TO USER'S GUIDELINE MANUAL

Manuals for repairs are split into Parts and Sections, each one of which is marked by a numeral; the contents of these sections are indicated in the general table of contents.
The sections dealing with things mechanic introduce the specifications, tightening torque values, tool lists, assembly detaching/reattaching operations, bench overhauling operations, diagnosis procedures and maintenance schedules.
The sections (or parts) of the electric/electronic system include the descriptions of the electric network and the assembly's electronic systems, wiring diagrams, electric features of components, component coding and the diagnosis procedures for the control units peculiar to the electric system.
Section 1 describes the engine illustrating its features and working in general.
Section 2 describes the type of fuel feed.
Section 3 relates to the specific duty and is divided in four separate parts:
1. Mechanical part, related to the engine overhaul, limited to those components with different characteristics based on the relating specific duty.
2. Electrical part, concerning wiring harness, electrical and electronic equipment with different characteristics based on the relating specific duty.
3. Maintenance planning and specific overhaul.
4. Troubleshooting part dedicated to the operators who, being entitled to provide technical assistance, shall have simple and direct instructions to identify the cause of the major inconveniences.
Sections 4 and 5 illustrate the overhaul operations of the engine overhaul on stand and the necessary equipment to execute such operations.
The appendix contains a list of the general safety regulations to be respected by all installation and maintenance engineers in order to prevent serious accidents taking place.
The manual uses proper symbols in its descriptions; the purpose of these symbols is to classify contained information. In particular, there have been defined a set of symbols to classify warnings and a set for assistance operations.

SYMBOLS - Warnings

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



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

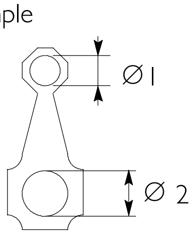
General danger
It includes the dangers of above described signals.

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

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

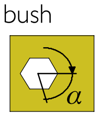
Service operations

Example



Ø 1 = housing for connecting rod small end bush

Ø 2 = housing for connecting rod bearings



Tighten to torque
Tighten to torque + angular value

	Removal Disconnection
	Refitting Connection
	Removal Disassembly
	Fitting in place Assembly
	Tighten to torque
	Tighten to torque + angle value
	Press or caulk
	Regulation Adjustment
	Visual inspection Fitting position check
	Measurement Value to find Check
	Equipment
	Surface for machining Machine finish
	Interference Strained assembly
	Thickness Clearance
	Lubrication Damp Grease
	Sealant Adhesive
	Air bleeding
	Intake
	Exhaust
	Operation
ϱ	Compression ratio
	Tolerance Weight difference
	Rolling torque
	Rotation
	Angle Angular value
	Preload
	Number of revolutions
	Temperature
bar	Pressure
>	Oversized Higher than…. Maximum, peak
<	Undersized Less than…. Minimum
	Selection Classes Oversizing
	Temperature < 0 °C Cold Winter
	Temperature > 0 °C Hot Summer

GENERAL WARNINGS

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

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

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

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

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

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

Keep personnel not authorised to operations clear of working area.

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

Do not leave the running assembly unattended when making repairs.

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

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

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

Inflammable fuel and all inflammable fluids and liquids must be handled with care, according to what contained on harmful materials 16-point cards. Refuelling must be performed outdoors with the engine off, avoiding lit cigarettes, free flames or sparks in order to prevent sudden fires/bursts. Adequately store inflammable, corrosive and polluting fluids and liquids according to what provided by regulations in force. Compulsorily avoid to use food containers to store harmful liquids. Avoid to drill or bore pressurised containers, and throw cloths impregnated with inflammable substances into suitable containers.

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

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

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

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

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

Avoid contact with hot water or steam coming from the engine, radiator and pipings because they could cause serious burns. Avoid direct contact with liquids and fluids present in vehicle systems; where an accidental contact has occurred, refer to 16-point cards for provisions to make.

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

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

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

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

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

Before welding:

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

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

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

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GENERAL WARNINGS ON THE ELECTRIC SYSTEM

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

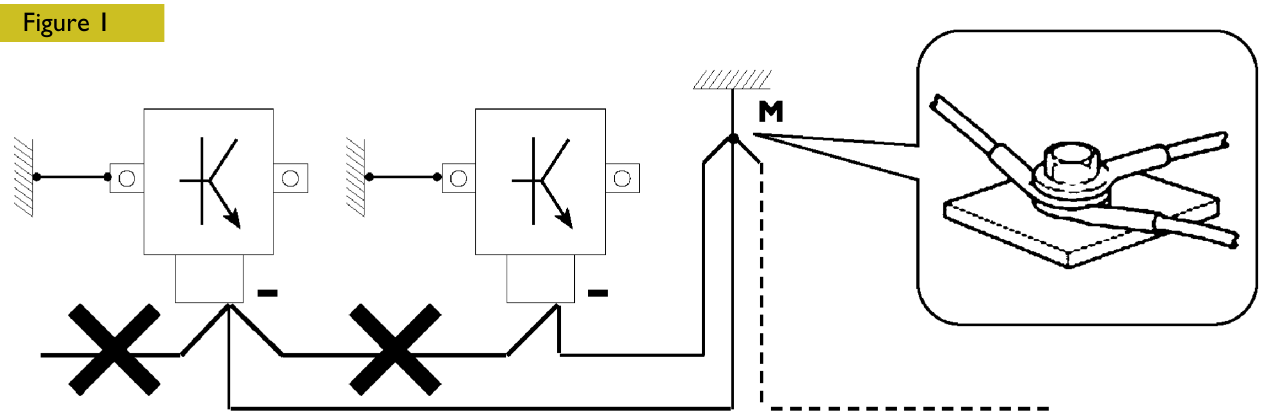
Bonding and screening

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

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

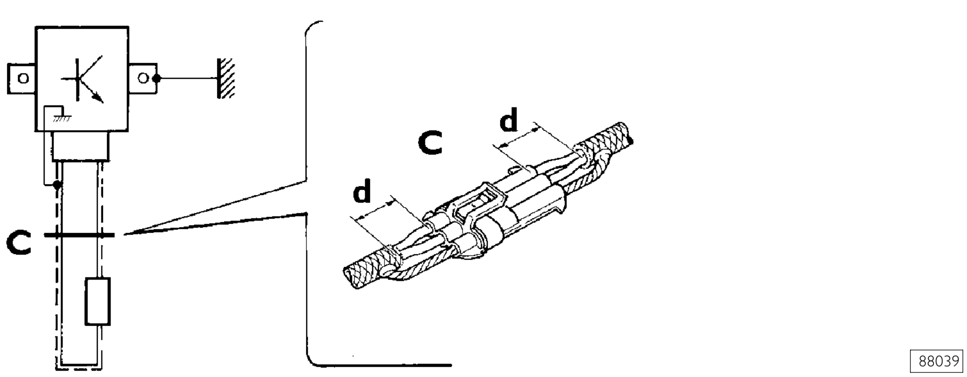
- Electronic central units must be connected to system bonding when they are provided with a metallic shell.
- Electronic central units negative cables must be connected both to a system bonding point such as the dashboard opening bonding (avoiding "serial" or "chain" connections), and to battery negative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

Figure 1



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

Figure 2



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

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

Power

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

Torque

1 Nm	=	0.1019 kgm
1 kgm	=	9.81 Nm

Revolutions per time unit

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

Pressure

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

Where accuracy is not particularly needed:

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

1 kgm = 10 Nm;

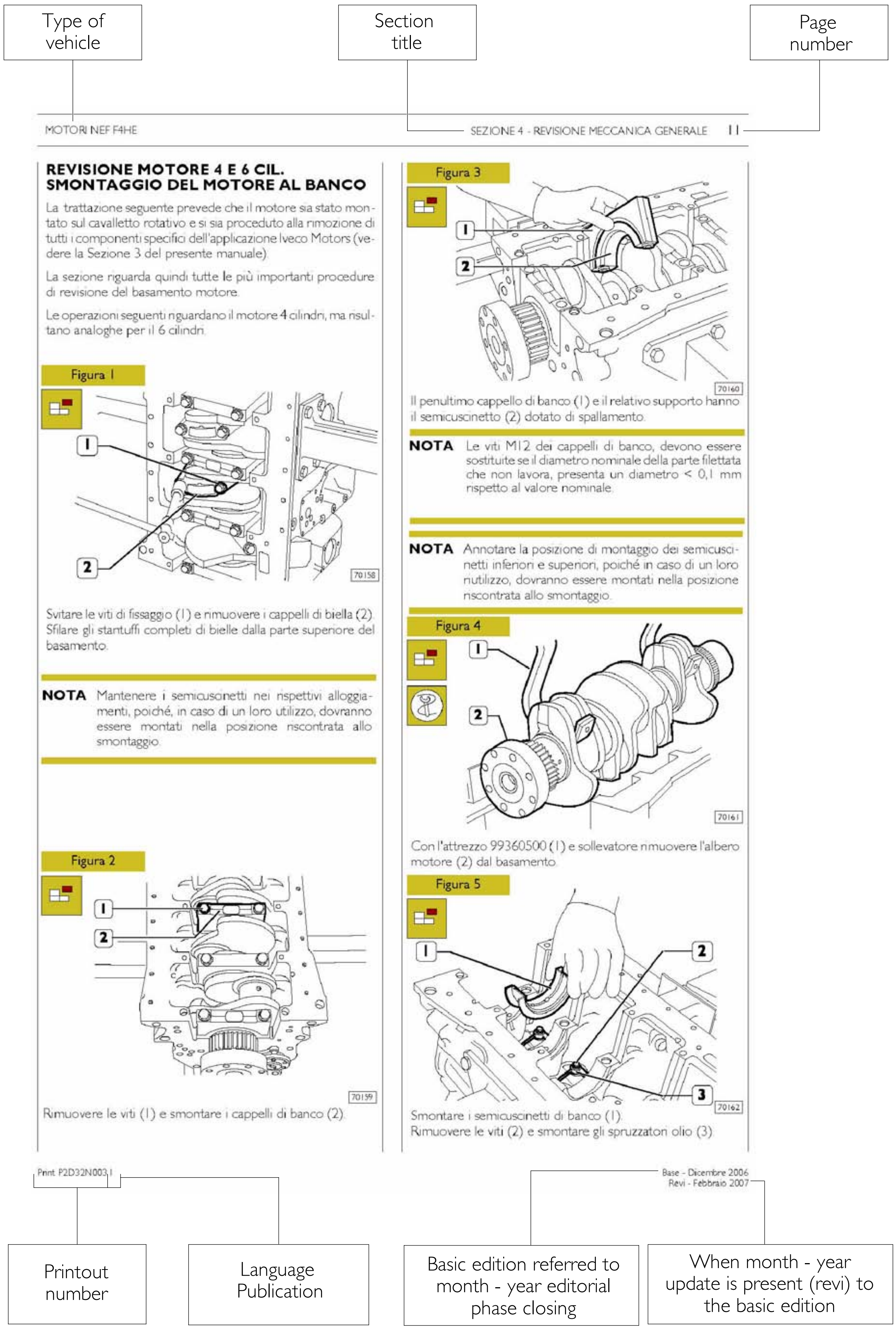
- ❑ bar unit is for the sake of simplicity converted into kg/cm^2 according to ratio 1:1

1 kg/cm^2 = 1 bar.

Temperature

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

KEY OF LECTURE OF THE HEADINGS AND FOOTNOTES



MOTORI NEF F4HE SEZIONE 4 - REVISIONE MECCANICA GENERALE 11

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

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

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

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

Figura 1 — 70158

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

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

Figura 2 — 70159

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

Figura 3 — 70160

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

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

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

Figura 4 — 70161

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

Figura 5 — 70162

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

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Base - Dicembre 2006
Revi - Febbraio 2007

Part 1
F4GE N SERIES

UPDATING

Section	Description	Page	Date of revision

SECTION 1

General Specifications

Page

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F4GE9455A*J600	NEF45 SM1X
F4GE9455B*J600	NEF45 SM2X
F4GE9685A*J600	NEF67 TM1X

LUBRICATION

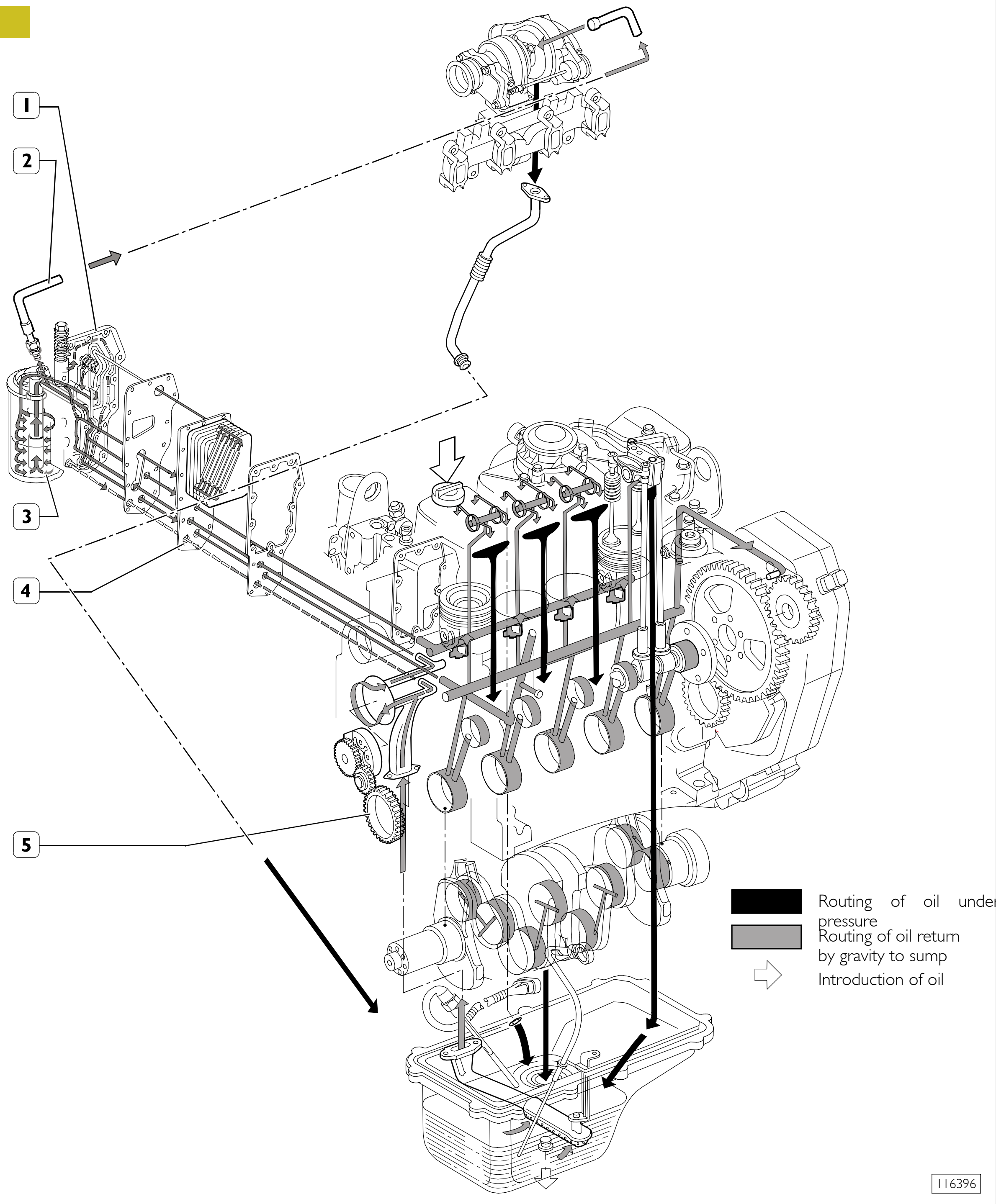
Lubrication by forced circulation is achieved through oil rotary expansion pump, placed in the front part of the basement, driven by the straight-tooth gear splined to the shaft's bar hold.

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

Lubrication involves the heat exchanger (2,3), the turboblower for turbocompressed versions, and for any compressed air system.

All these components may often vary according to the specific duty.

Figure 1



LUBRICATION SYSTEM LAYOUT (4 cylinder engine)

1. Heat exchanger body - 2. Lubrication oil pipe to supercharger - 3. Oil filter - 4. Heat exchanger - 5. Oil rotary expansion pump.

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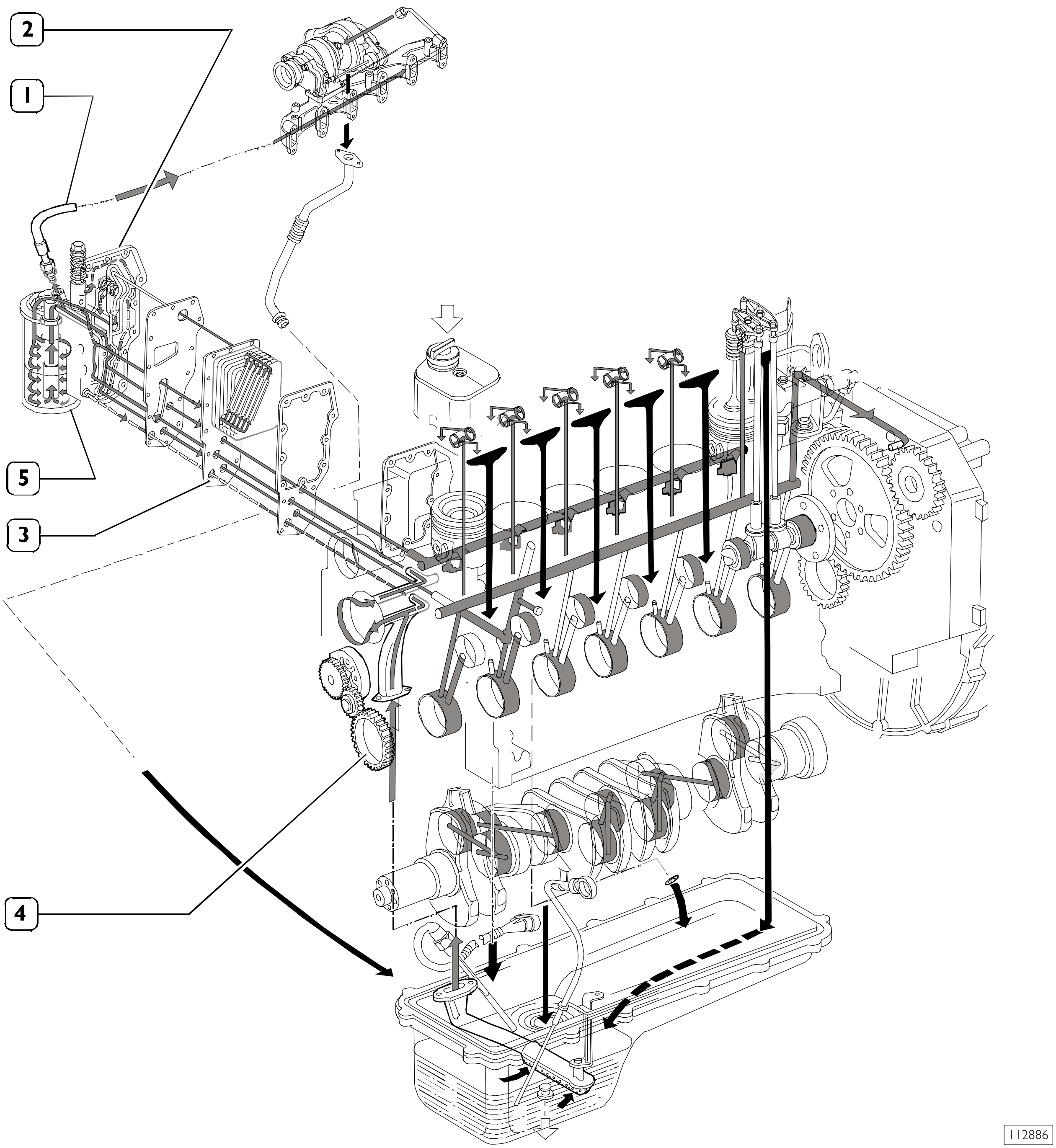
Figure 2

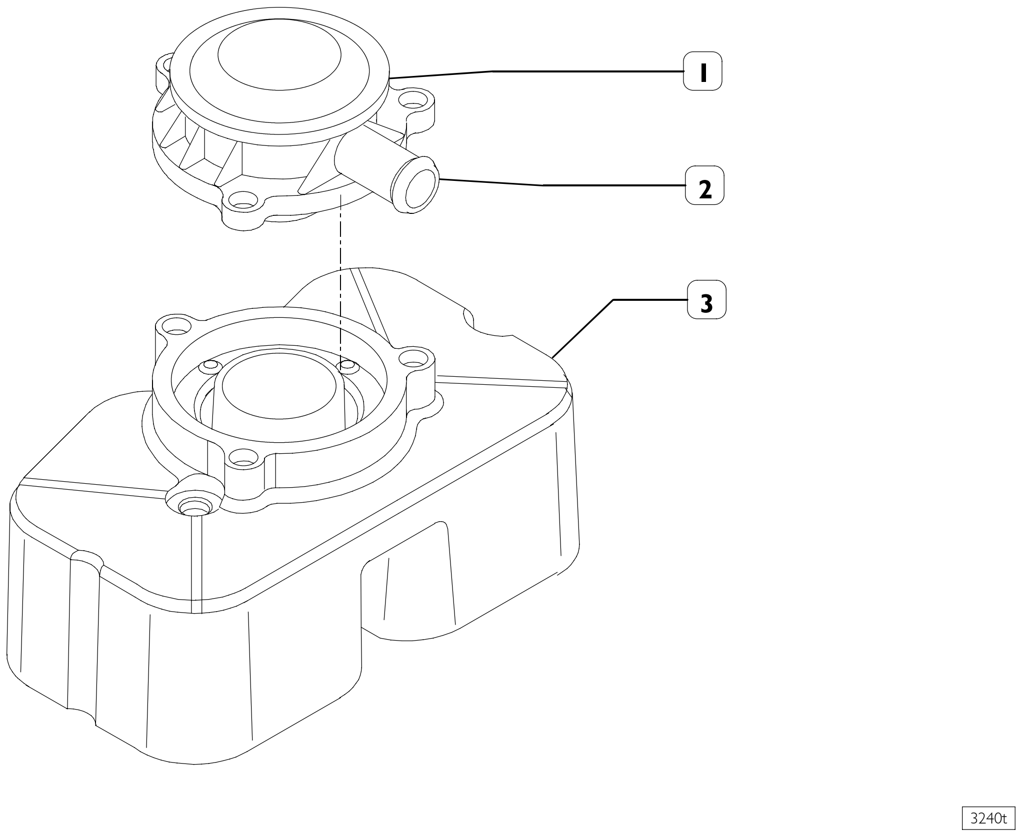


LUBRICATION SYSTEM LAYOUT (6 cylinder engines)

1. Lubrication oil pipe to supercharger - 2. Heat exchanger body - 3. Heat exchanger - 4. Oil rotary expansion pump - 5. Oil filter.

OIL VAPOUR RECIRCULATING SYSTEM

Figure 3



1. Valve - 2. Breather pipe - 3. Tappet Cap

On the tappet cap (3) there is a valve (1) whose duty is to condense oil vapour inducing these to fall down because of gravity, to the Tappet cap underneath.

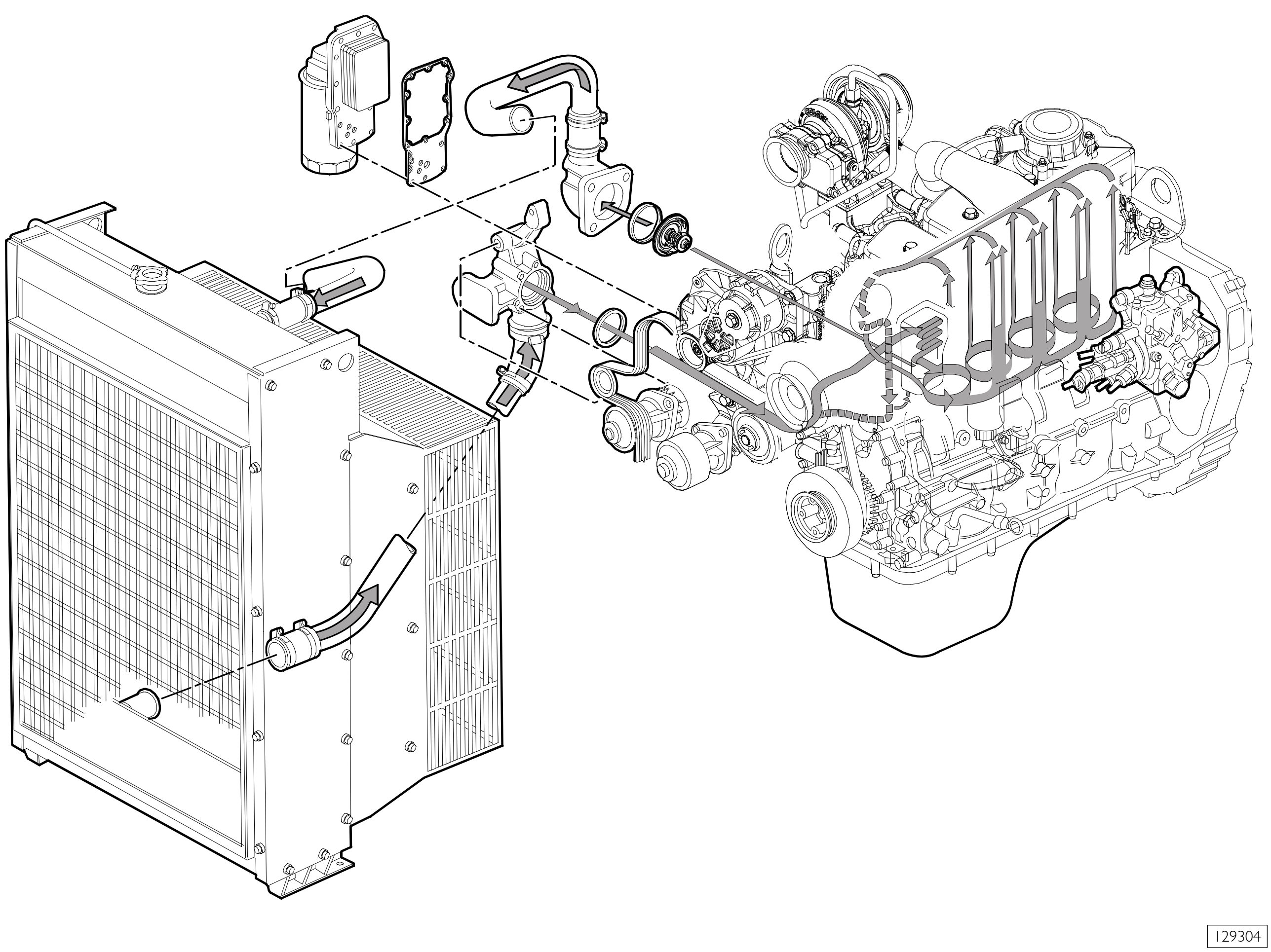
The remaining non-condensed vapours shall be properly conveyed through the breather pipe (2), by suction as an example (connection towards these vapours shall be designed by the Engineer).

COOLING SYSTEM

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

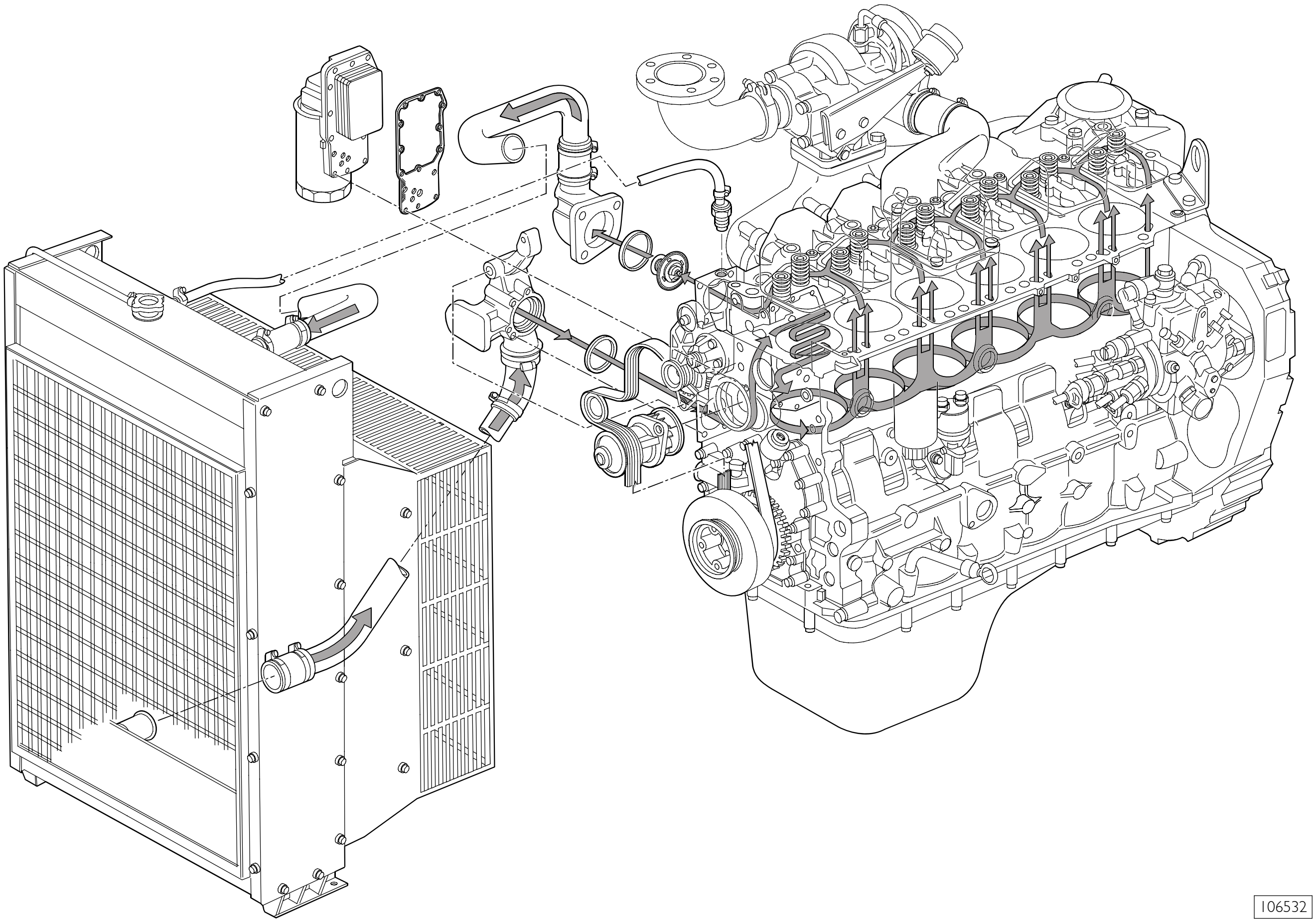
- Expansion tank; placement, shape and dimensions are subject to change according to the engine's equipment.
- Radiator, which has the duty to dissipate the heat subtracted to the engine by the cooling liquid. Also this component will have specific peculiarities based on the equipment developed, both for what concerns the placement and the dimensions.
- Visc 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 4



COOLING SYSTEM LAYOUT (4 cyl. engines)

Figure 5

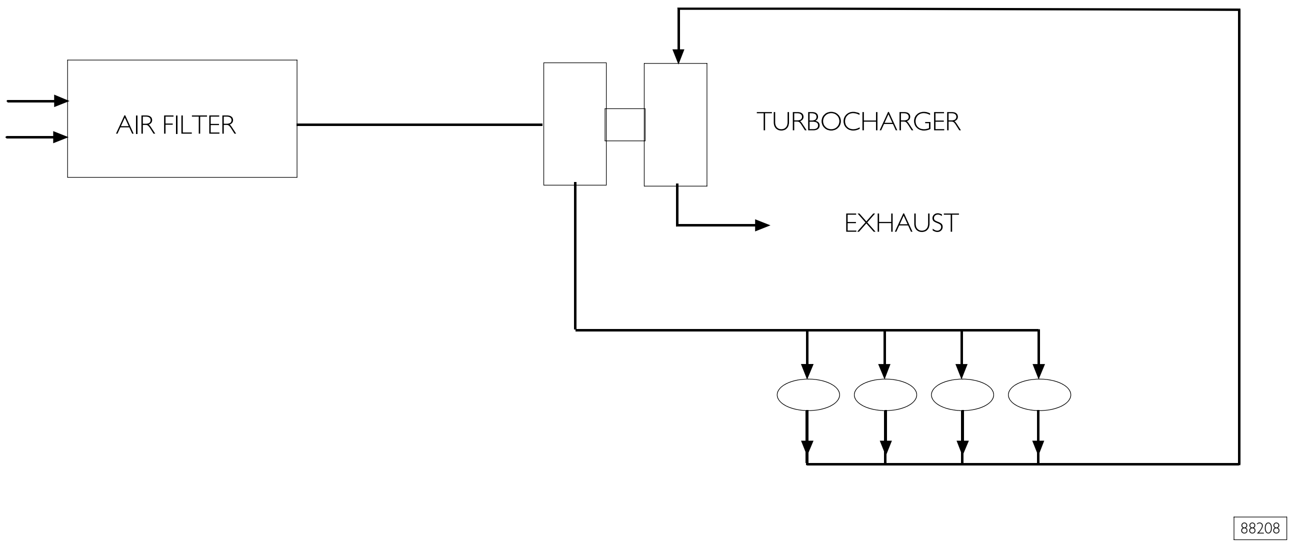


COOLING SYSTEM LAYOUT (6 cyl. engines)

AIR INDUCTION BOOST DIAGRAM

Boosting version engines

Figure 6



4 cylinders version

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 emission flow through the body of the turbine, provoking 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 sucked air through the air filter.

The air coming out of the compressor is sent via the intake manifold directly to the pistons.

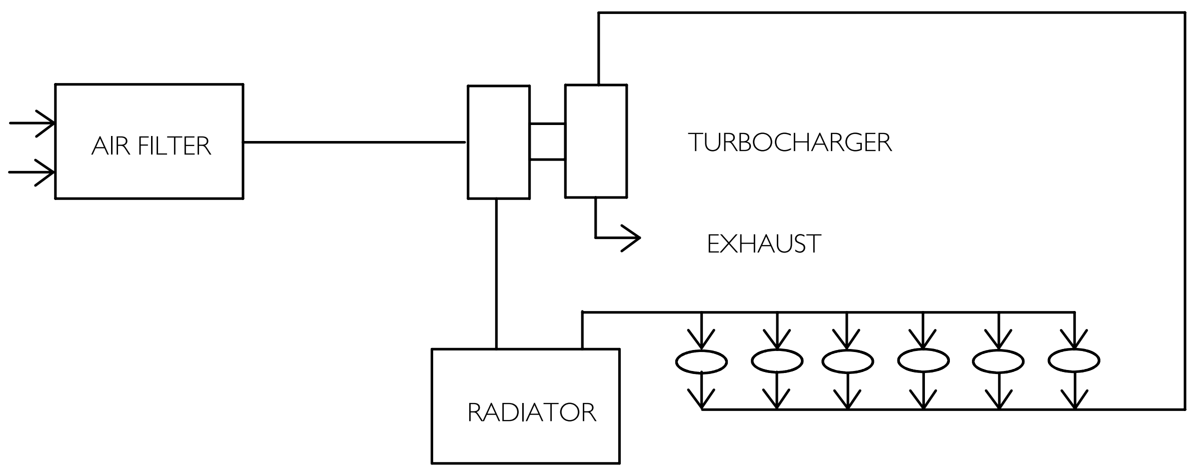
The turbocharger is equipped with a transforming valve to regulate the pressure , that is located on the exhaust collector before the turbine and connected by piping to the induction collector.

It's duty is to choke 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.

Inter-cooled engine version

Figure 7



6 cylinders version

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 emission flow through the body of the turbine, provoking 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 sucked 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 duty is to choke 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.

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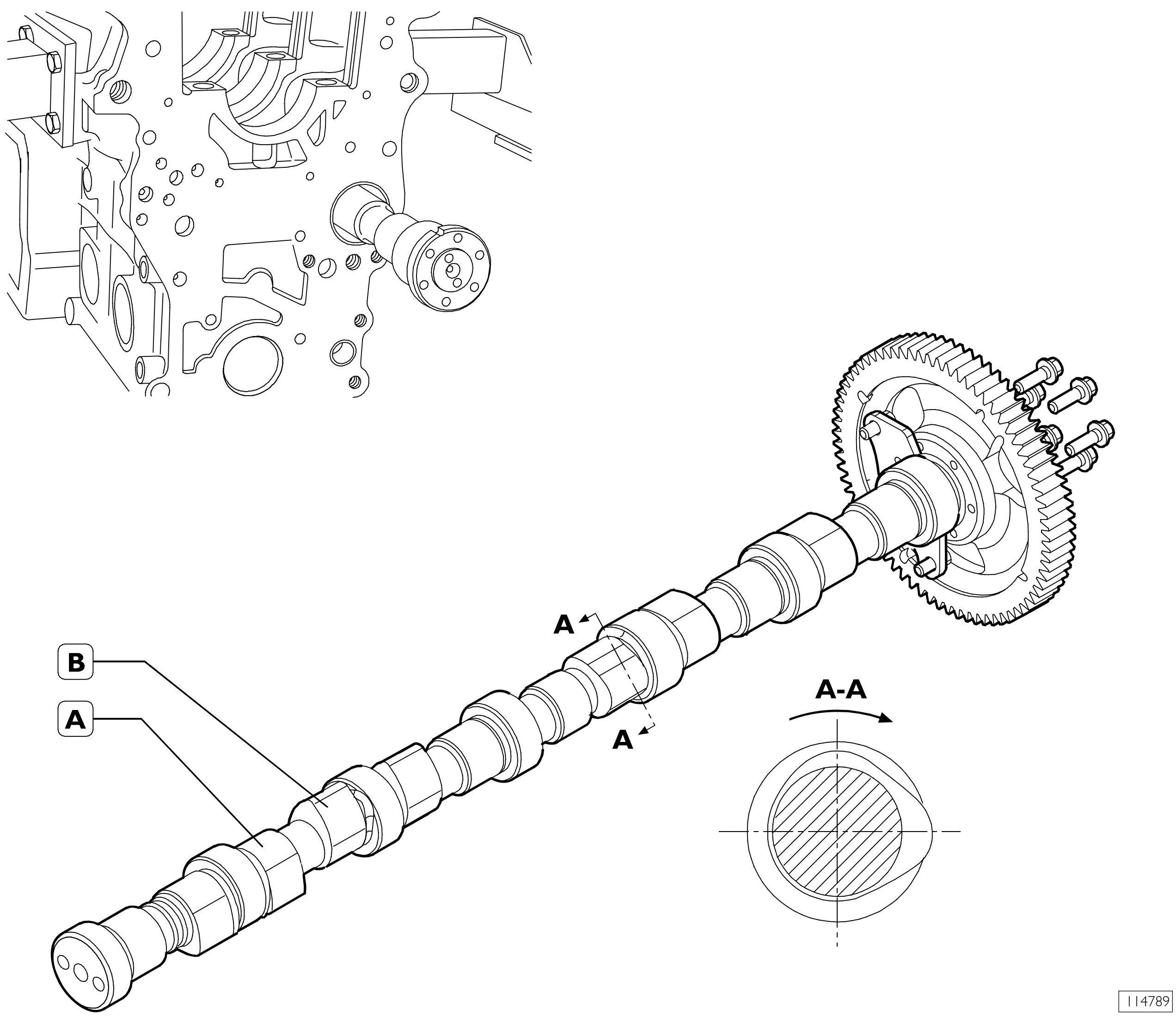
EXHAUST GAS RE-CIRCULATION SYSTEM (EGR)

In the TIER 3 version, the profile of the exhaust cam has been modified in order to allow the partial opening of the relative valve during the aspiration phase (re-circulation of EGR exhaust gas) with the subsequent re-introduction of part of the exhaust gas into the engine cylinders.
The exhaust gases can partially be re-directed into the cylinders so as to reduce the maximum combustion temperature values responsible for the production of nitric acid (NO_x).
The exhaust gas re-circulation system (EGR), reducing the combustion temperature by means of the diminishing of the concentration of oxygen in the combustion chamber, represents therefore an efficient control system of the emission of NO_x.

The internal EGR system is not equipped with any electronically controlled elements: the system is always active. Its configuration does not need additional elements i.e.checking valves, piping or heat exchangers.

The exhaust cam (B) has another lobe apart from the major lobe (see Section. A-A fig.) with respects to the configuration without EGR.
The additional lobe, during the aspiration phase in the cylinder in question, allows a brief opening of the exhaust valve generating re-circulation due to the intake of the exhaust gases caused by depression which is created in the aspiration phase inside the cylinder.

Figure 8



A. Aspiration valve control - B. Exhaust valve control.

SECTION 2

Fuel

Page

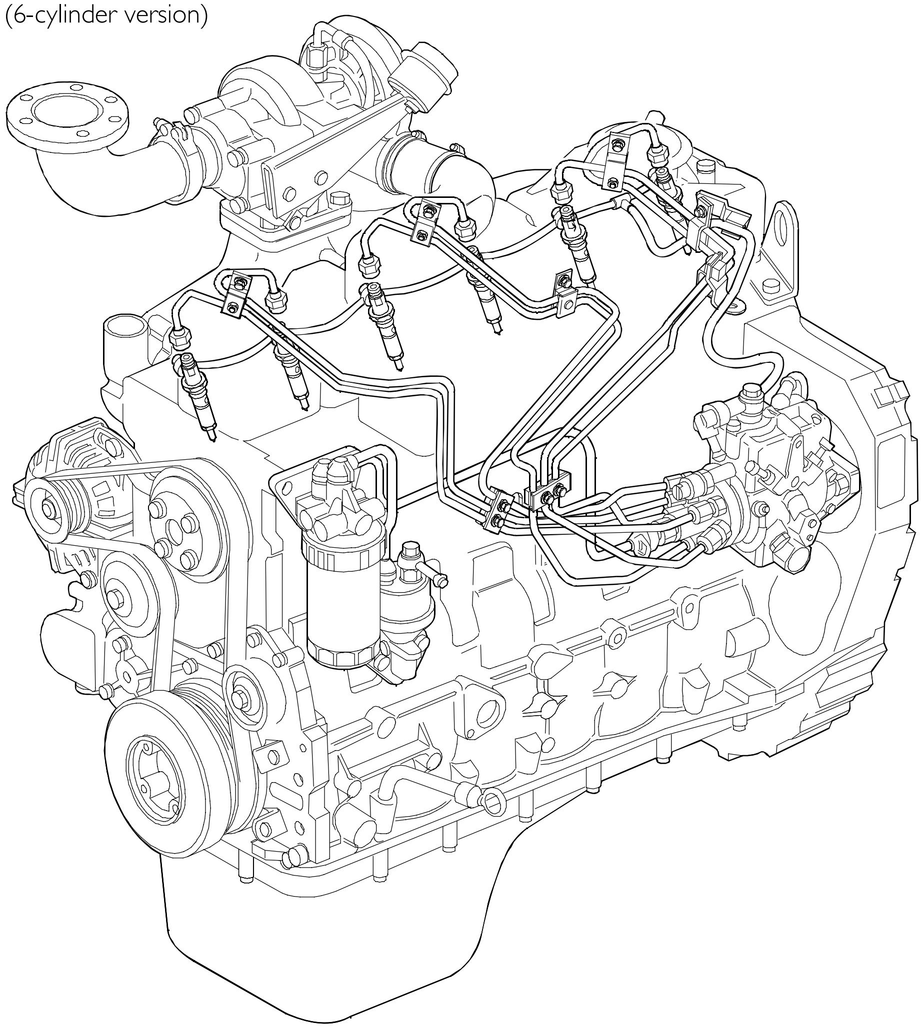
FUEL-INJECTION SYSTEM WITH STANADYNE DB4 ROTARY PUMP

General information

Fuel feed system is composed by:

- Fuel tank
- Fuel delivery and back-flow to tank
- Fuel pre-filter
- Priming pump, assembled to the engine and driven by the camshaft
- Fuel filter
- Fuel feed rotary pump
- Injector feed pipeline
- Injectors

Figure 1 (6-cylinder version)



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Description of working principles

Fuel is sucked from the fuel tank by the priming pump. This last one is placed on the engine basement and is driven by the camshaft.

Throughout the filter, the fuel is piped to the union fitting vacuum chamber of the transfer pump.

Transfer pump is placed inside the feed pump, and is bladed type; its duty is to increase fuel pressure in correspondence with the increase of the number of revolutions.

The fuel arrives therefore to the valve gauging the pressure inside feed pump.

The distribution plunger further increases this pressure and delivers fuel throughout the delivery pipe fitting to the injectors.

The fuel drawing from the injectors is recovered and delivered to the tank again.

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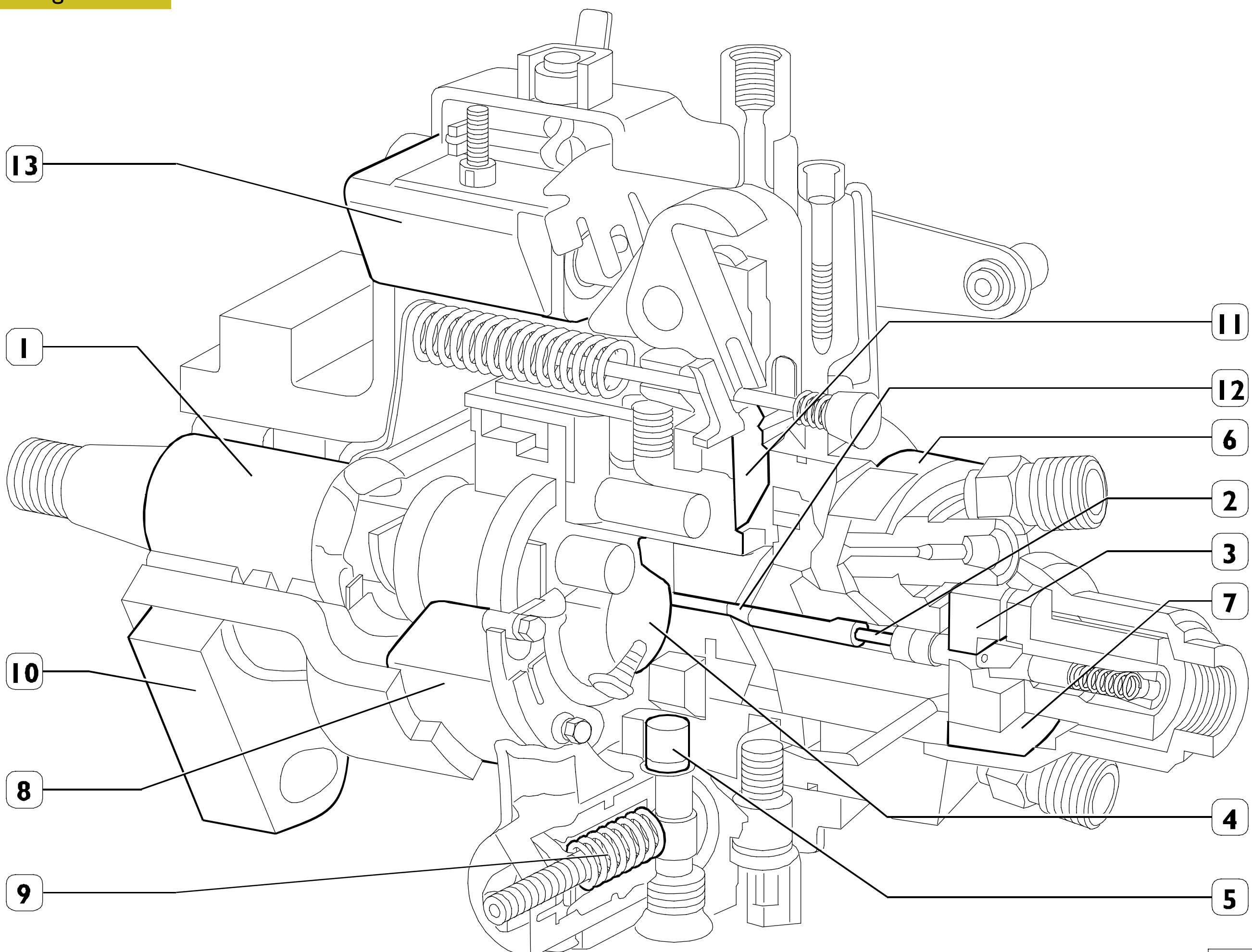
FEED PUMP

The rotary type pump is driven by a gear mating the camshaft's one.

Figure 2



1. Propeller shaft - 2. Timing gear rotor - 3. Transfer pump vanes - 4. Pumping pistons (4) - 5. Cam inner ring - 6. Hydraulic head - 7. Pressure regulator assembly - 8. Regulator - 9. Automatic advance - 10. Seat - 11. Metering valve - 12. Delivery valve - 13. Electric power supply cut-off solenoid.

Description of operation

The main rotation components are the propeller shaft (1), timing gear rotor (2), transfer pump vanes (3) and the regulator (8). Referring to Figure 2, the propeller shaft engages the timing gear rotor inside the hydraulic head.

The four pistons are actuated towards each other simultaneously by the internal ring of the cam via the rollers and sliding blocks that are conveyed in the holes on the end portion of the rotor.

The number of cam lobes is equal to that of the engine cylinders.

The transfer pump on the rear of the rotor is the positive displacement type and is closed inside the end plug. The end plug also contains the inlet filter screen and the pressure regulator of the transfer pump. The top of the regulator assembly is pressed against the timing gear rotor and forms an end seal for the transfer pump.

The timing gear rotor contains two inlet ports, a single axial hole and a discharge port serving all the outlets to the injection lines.

The hydraulic head contains the hole in which the rotor turns, the hole of the metering valve, inlet opening and the unions for the delivery outlet. The high pressure injection lines that are connected to the injectors are secured to the above-mentioned outlet unions.

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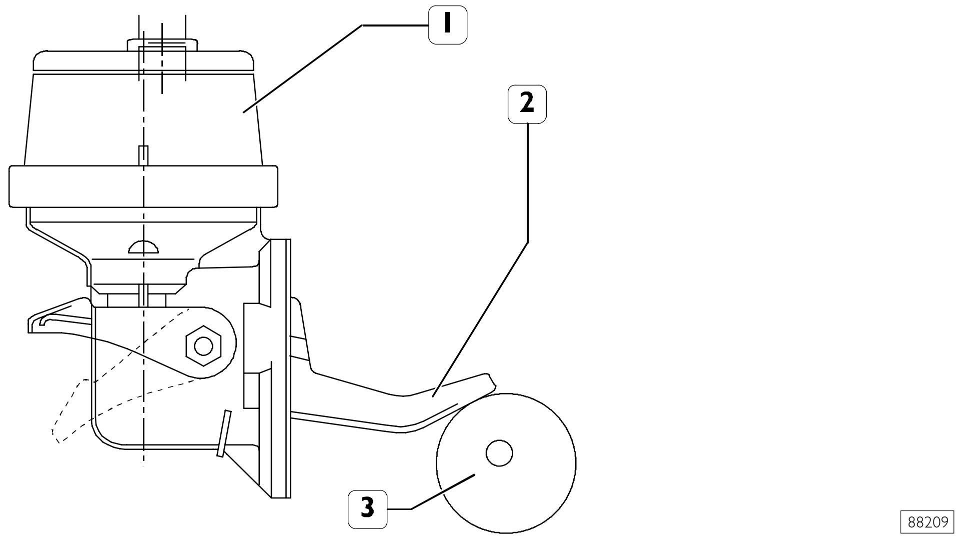
PRIMING PUMP

This pump has the specific duty to prime the fuel available in the tank and convey it to the feed pump inlet. It is assembled to the engine basement and driven by the camshaft.

Figure 3



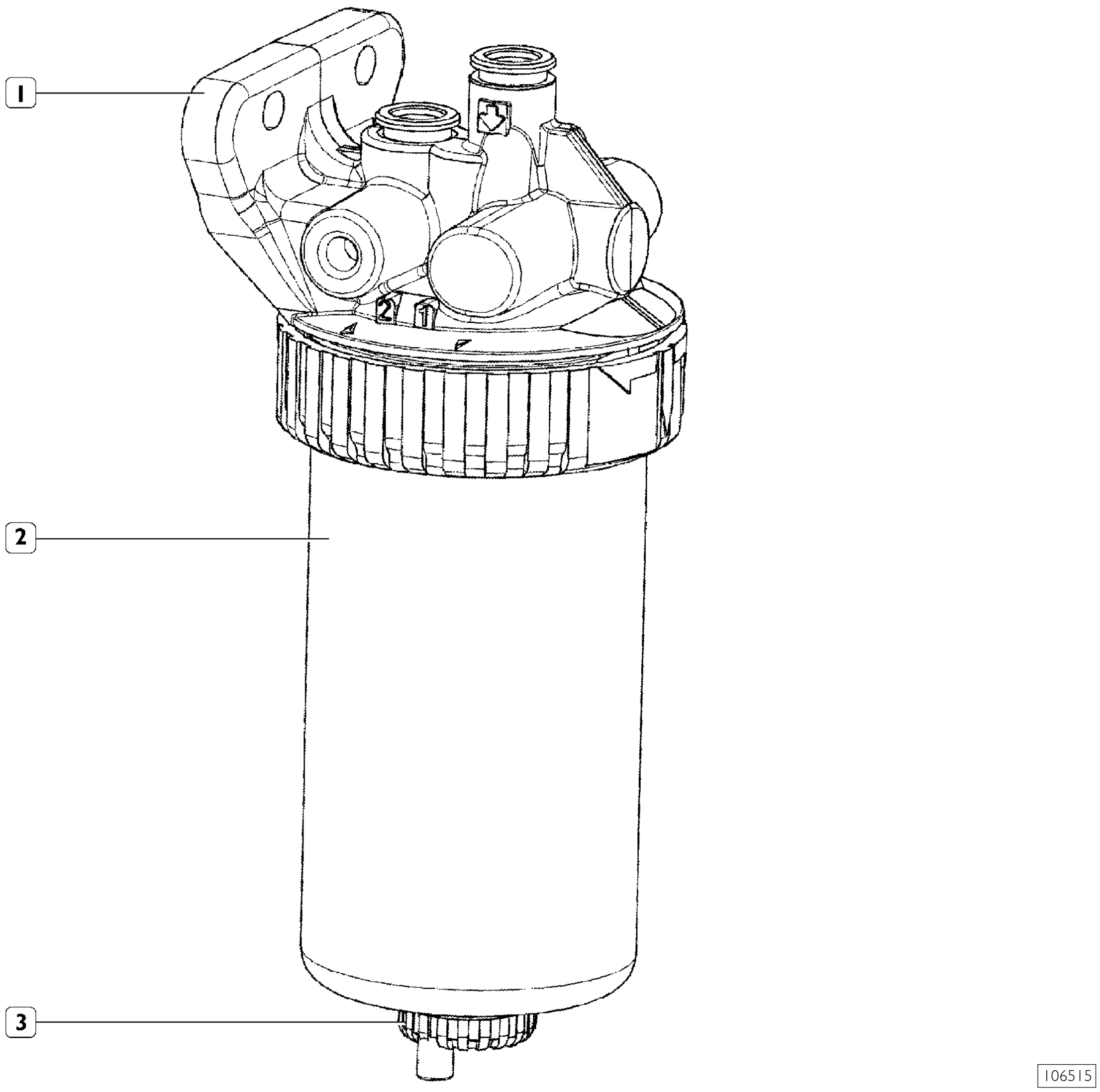
1. Priming pump - 2. Drive lever - 3. Camshaft.

FUEL FILTER

The filter is assembled close to the feed and priming pump and has the specific duty to provide barrier to the impurities and separation of water from fuel.

On the filter cartridge base there is a water dump screw, throughout which it is possible to provide regular drainage; on the bearing for those equipment applications requiring it (cold climate areas), there can be a heater assembled to and a temperature sensor. On some versions, a water presence sensor is present at filtering cartridge base.

Figure 4



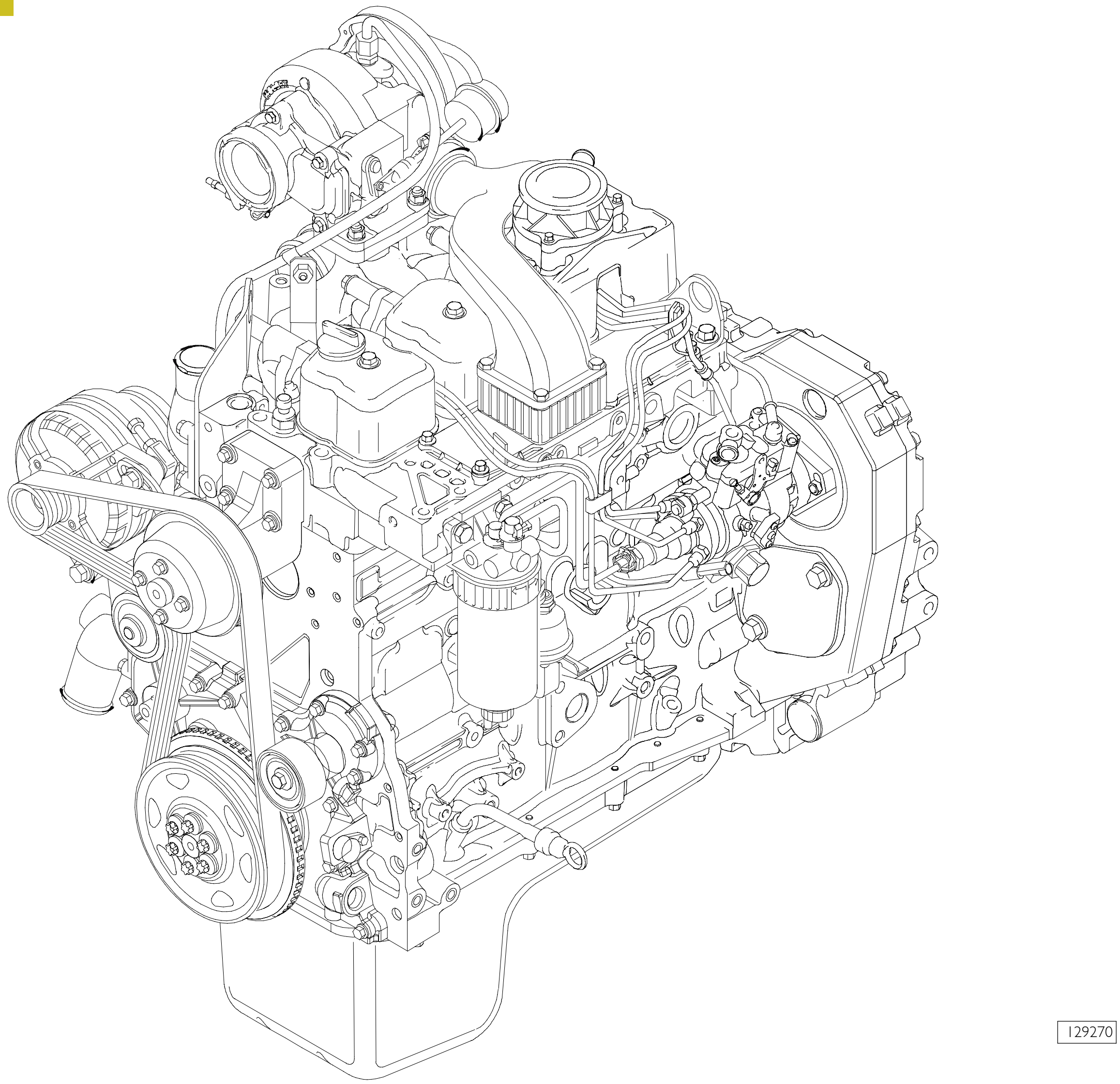
1. Fuel filter bearing- - 2. Filter cartridge - 3. Water dump screw.

SECTION 3

G-DRIVE application

GENERAL INFORMATION

Figure 1



F4GE9455A*J600 engine

F4GE

They are characterised by diesel cycle 4 stroke atmospheric or supercharged 4 and 6 cylinders each with 2 valves.

Feed is provided by rotary mechanical pump or on line according to the equipment application.

NOTE Data, technical specifications and performances granted shall be valid only if the Setter will follow and comply with all installation prescriptions provided by FPT.

Furthermore, the expanders assembled by the Setter must always comply with couple, power and number of revolutions based on which the engine has been designed.

The section herein described is composed or four directories:

- directory of mechanical overhaul prescribed in accordance to the engine's specific duty, illustrating all necessary operations 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 directory, describing the connections of the different components, of the pre-post heating gearbox (only for some versions) and of the sensors assembled to the engine;
- troubleshooting directory;
- directory of preventive and regular maintenance operations, providing instructions for the execution of the main operations.

GENERAL FEATURES
4-cylinder engines

Type		F4GE9455A*J600	F4GE9455B*J600
Compression ratio		17.5:1	
Working power	kW (CV) rpm	69 (94) 1800	59 (80) 1800
Working torque	Nm (kgm) rpm	366 (97) 1800	313 (32) 1500
Loadless engine idling	rpm	.	-
Loadless engine peak rpm	rpm	-	-
Bore x stroke Displacement	mm cm^3	104 x 132 4485	
SUPERCHARGING		Without intercooler direct injection	
Turbocharger type		HOLSET HX25 W	
LUBRICATION		Forced by gear pump, relief valve single action oil filter	
Oil pressure (warm engine)			
- idling	bar	-	
- peak rpm	bar	-	
COOLING		By liquid	
Water pump control		Through belt	
Thermostat - start of opening	°C	81 ± 2	
FILLING			
engine sump	liters	-	
engine sump + filter	liters	-	

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

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

6-cylinder engines

Type		**F4GE9685A*J600**
Compression ratio		17.5:1
Working power	kW (CV) rpm	148 (201) 1800
Working torque	Nm (kgm) rpm	785 (80) 1800
Loadless engine idling	rpm	-
Loadless engine peak	rpm	-
Bore x stroke Displacement	mm cm^3	104 x 132 6728
SUPERCHARGING		With intercooler direct injection
Turbocharger type		HOLSET HX35W
LUBRICATION		Forced by gear pump, relief valve single action oil filter
Oil pressure (warm engine)		
- idling	bar	-
- peak rpm	bar	-
COOLING		
Water pump control		Liquid
Thermostat		Through belt
- start of opening	°C	81 ± 2
FILLING		
engine sump*	liters	-
engine sump + filter*	liters	-
* First filling operation		

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

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

PART ONE -

MECHANICAL COMPONENTS

OVERHAUL ENGINE

Part of the operations illustrated within this section can be partially executed while the engine is assembled on the vehicle, depending on the room available for access to the engine and on the equipment application as well.

NOTE With regard to the engine disassembly operations, please apply for information consulting the specific manual. All operations of engine disassembly operations as well as overhaul operations must be executed by qualified engineers provided with the specific tooling and equipment required.

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

NOTE For specific application exigencies, some units can be assembled to the engine in different positions.

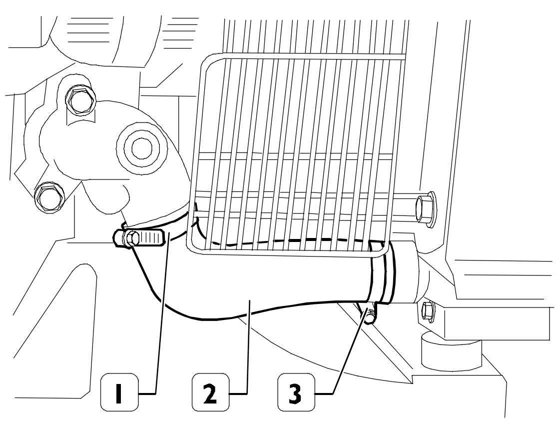
Within "General overhaul" section, all the operations of engine block overhaul have been contemplated. Therefore the above mentioned section is to be considered as following the part hereby described.

Removing engine from radiator

- ❑ Remove the electrical wiring from all the components indicated in the electrical equipment section.

For 4 cylinder engines

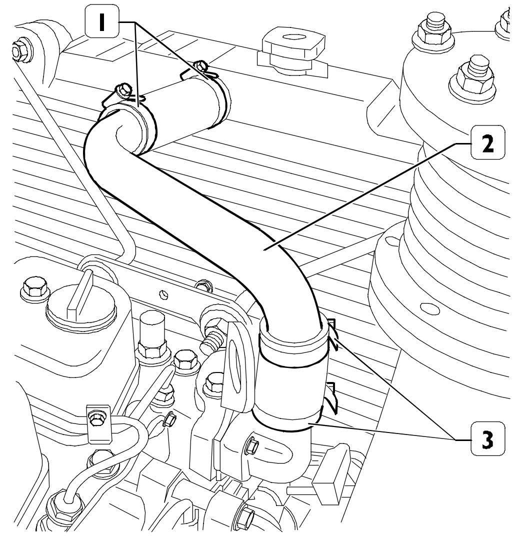
Figure 2



129284

- ❑ Have a special container ready by the pipe (2) for collecting the coolant. Disconnect and pipe (2) and remove it complete with hoses adjusting the bands (1) and (3).

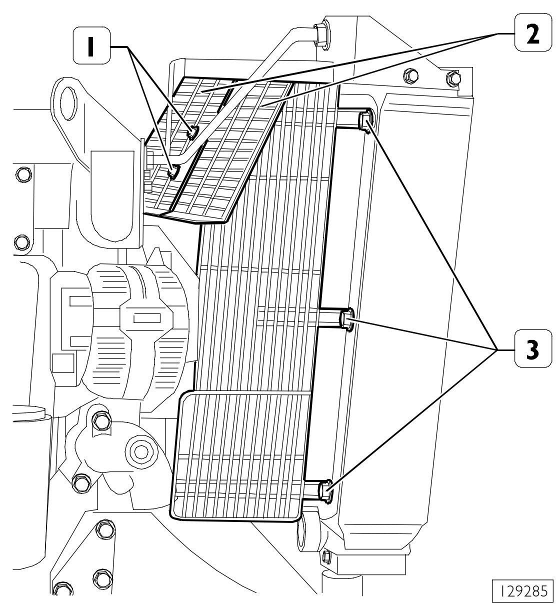
Figure 3



129283

- ❑ Disconnect and pipe (2) and remove it complete with hoses adjusting the bands (1) and (3).

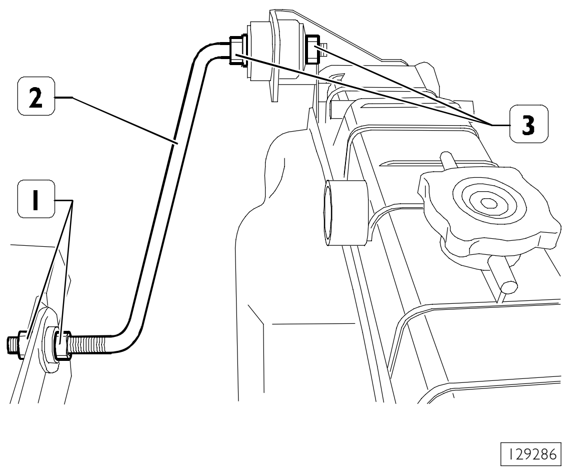
Figure 4



129285

- ❑ Remove the protective grilles (2) for the fan adjusting the fastenings (1) and (3).

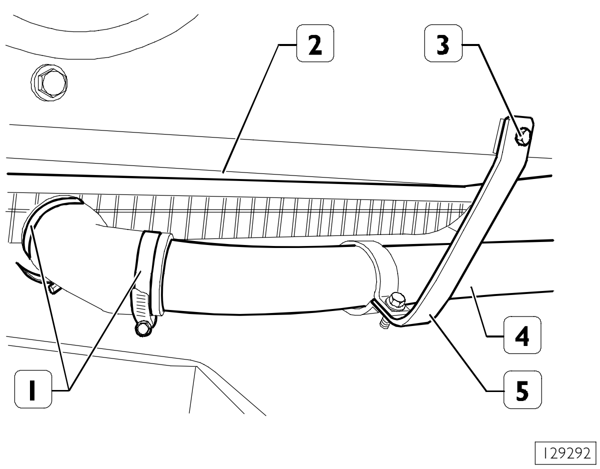
Figure 5



- ❑ Undo the nuts (1) and (3) and remove the bracket (2). Repeat the operation for the second bracket.

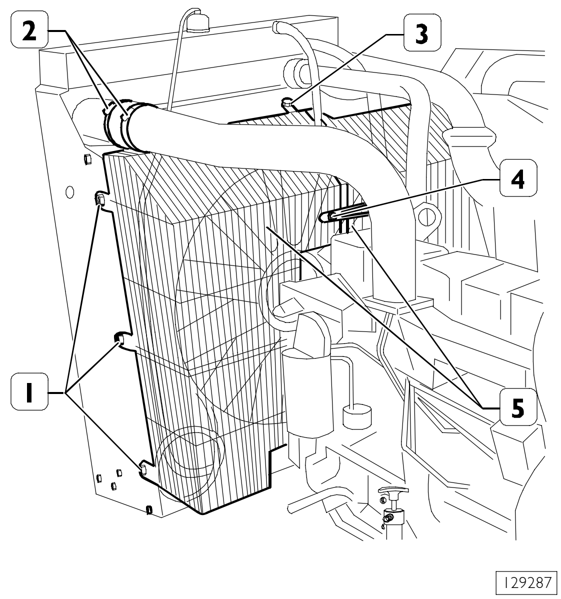
For 6 cylinder engines

Figure 6



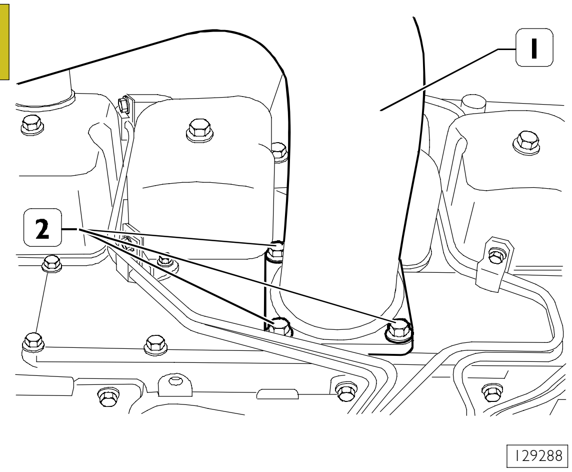
- ❑ Have a special container ready by the pipe (4) for collecting the coolant. Disconnect the pipe (4) adjusting the bands (1).
- ❑ Undo the bolt (3) and release the pipe (4) complete with bracket (5) from the radiator assembly (2).

Figure 7



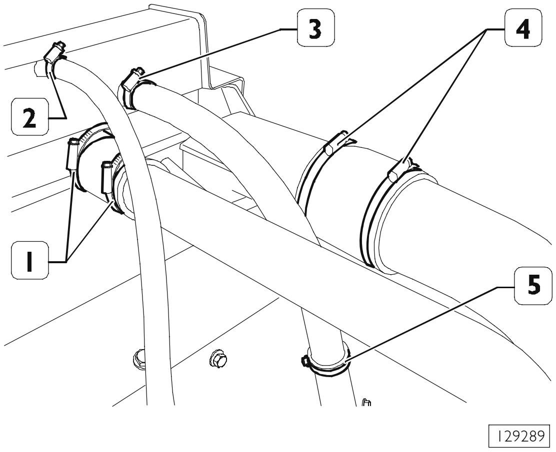
- ❑ Remove the protective grilles (5) for the fan adjusting the fastenings (1), (3) and (4).
- ❑ Open the bands (2).

Figure 8



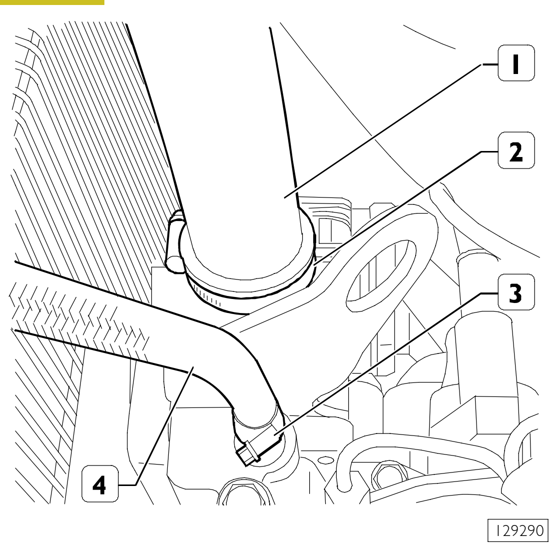
- ❑ Undo the bolts (2) and remove the pipe (1) from the intake manifold.

Figure 9



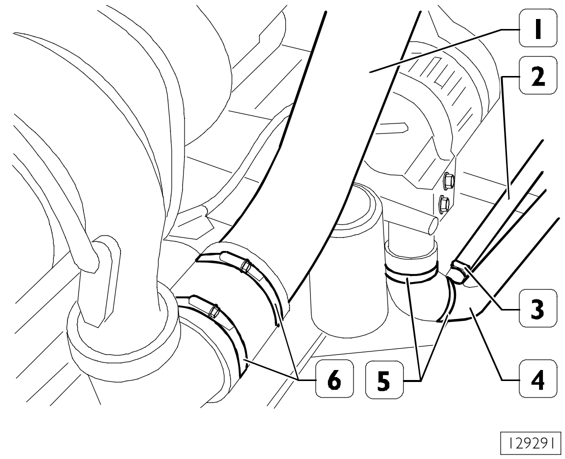
- ❑ Disconnect the air and water pipes from the radiator assembly adjusting the bands (1), (2), (3) and (4) and the mounting bracket (5).

Figure 10



- ❑ Disconnect the pipes (1) and (4) and remove them, complete with hoses, on the engine side adjusting the bands (2) and (3).

Figure 11

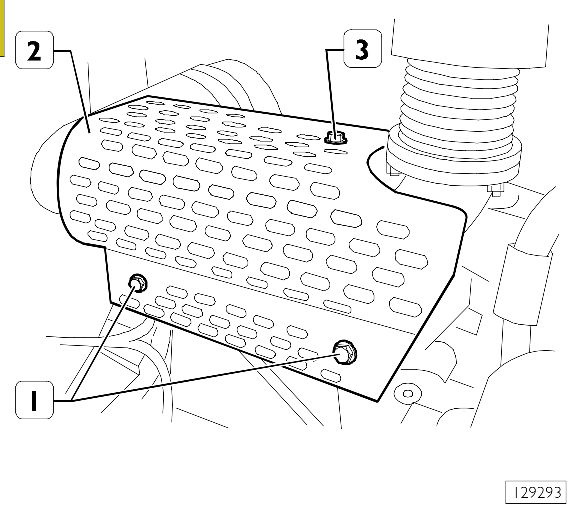


- ❑ Disconnect and pipe (1) and remove it complete with hoses, on the engine side, adjusting the bands (6).
- ❑ Disconnect the pipe (2) and remove it, adjusting the band (3).
- ❑ Disconnect and pipe (4) and remove it complete with hoses, on the engine side, adjusting the bands (5).

For all engines

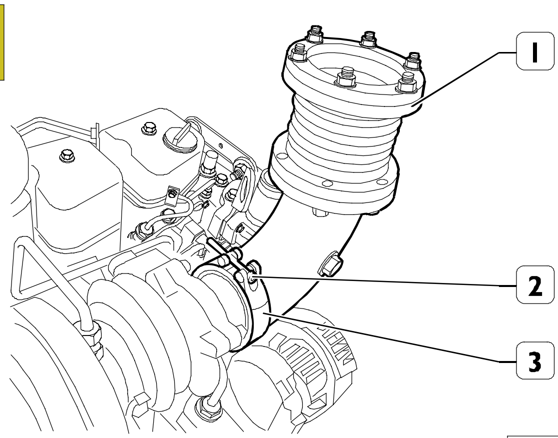
- ❑ Lock the radiator assembly appropriately, then release it from the crankcase adjusting the fastenings on both sides.
- ❑ Remove the radiator assembly from its housing paying attention to any possible interference with the fan.

Figure 12



- ❑ If present, remove the turbine guard grille (2), adjusting the bolts (1) and (3).
- ❑ Then remove the mounting brackets.

Figure 13

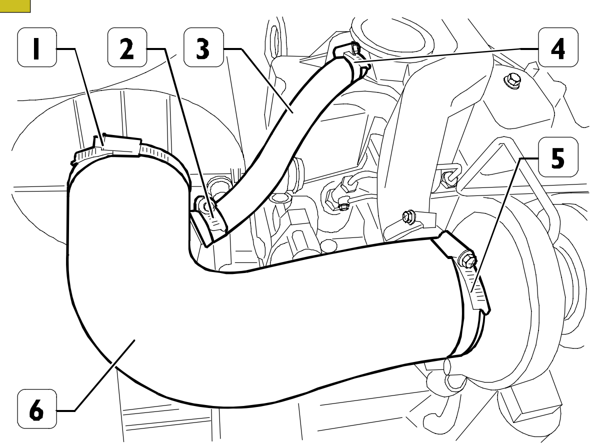


129294

❑ Disconnect the drainage pipe (1) from the system, adjusting the bolt (2) to open the band (3).

NOTE The shape and the size of the drainage pipe vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out.
The procedures described can, however, be applied.

Figure 14

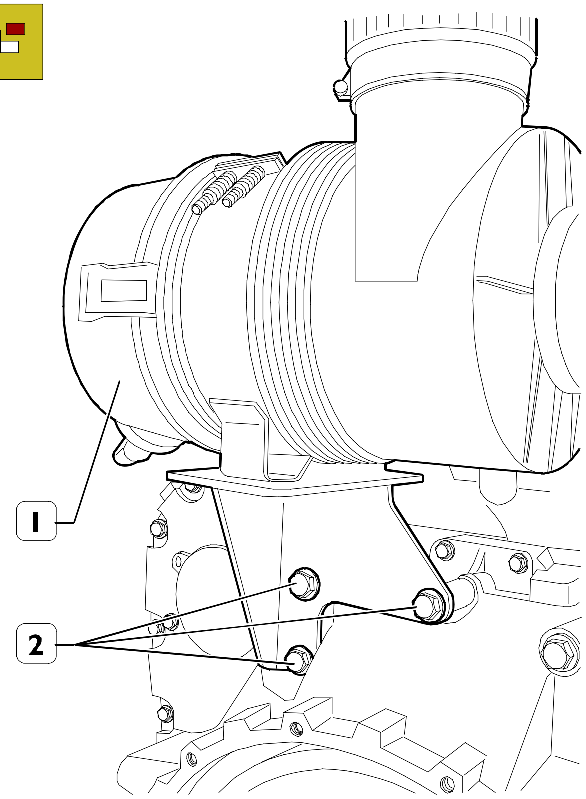


129295

❑ Disconnect and oil vapour recovery pipe (3) and remove it adjusting the bands (2) and (4).

❑ Disconnect and air intake pipe (6) and remove it adjusting the bands (1) and (5).

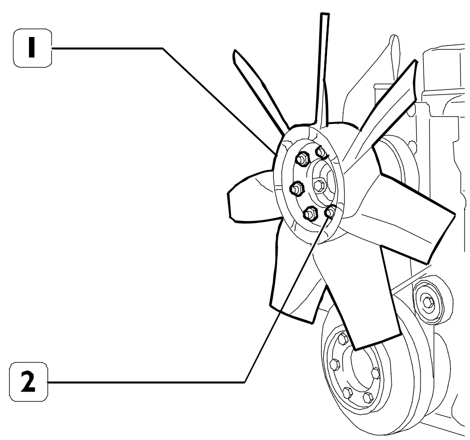
Figure 15



129296

❑ Remove the air filter (1) adjusting the fastenings (2) and remove it from its housing complete with support.

Figure 16



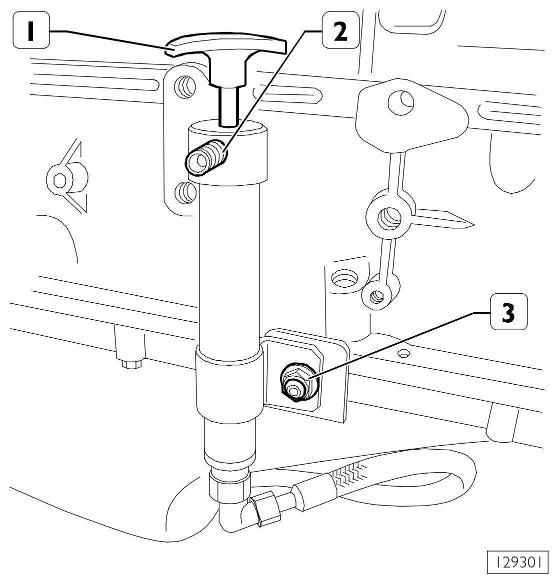
129297

❑ Remove the fan (1), complete with spacer, adjusting the bolts (2).

NOTE The shape and the size of the fan vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out.
The procedures described can, however, be applied.

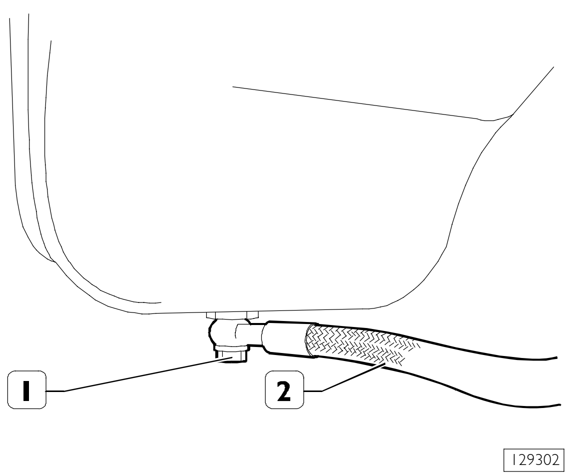
For versions with an oil drainage pump

Figure 17



- ❑ Extract the dipstick and the filler plug to facilitate the lubrication oil flow.
- ❑ Connect the special pipe for draining the pump (2) fitted in the engine to the outside.
- ❑ Remove the oil in the engine oil sump using the drainage pump (1).
- ❑ Remove the pump adjusting the nut (3).

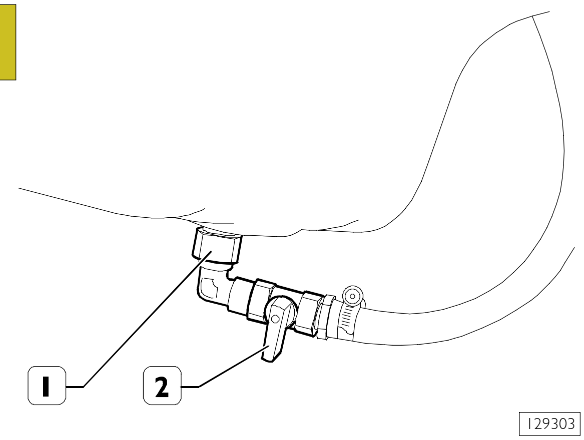
Figure 18



- ❑ Disconnect the pipe (2) and remove it, adjusting the bolt (1).

For versions with an oil drainage tap

Figure 19

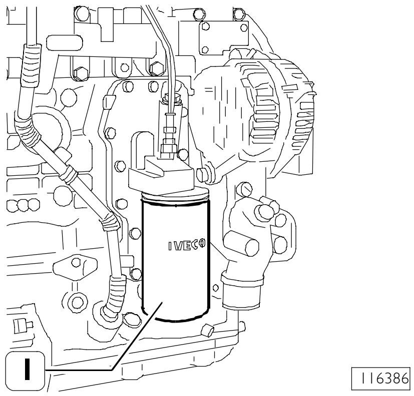


- ❑ Extract the dipstick and the filler plug to facilitate the lubrication oil flow.
- ❑ Remove the oil in the engine oil sump using the tap (1).
- ❑ Disconnect the pipe and remove it, adjusting the bolt (2).

NOTE Some versions have a plug for draining the oil from the sump.
The procedure involves opening this plug located underneath the engine sump after having extracted the dipstick and the filler plug to facilitate the flow of lubrication oil.

Engine setting operations for the assembly on turning stand

Figure 20



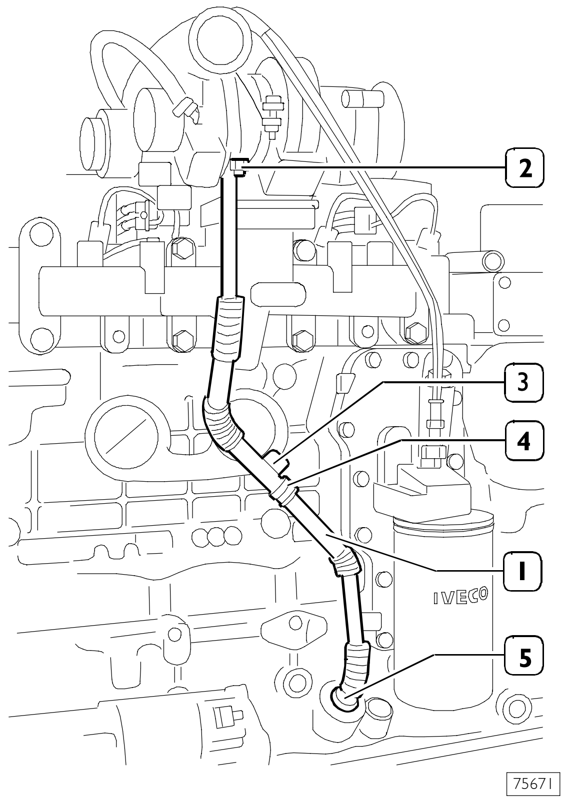
In order to apply the brackets 99361037 to the engine block to fix it on to the stand 99322205 for the overhaul, it is necessary to perform the following operations:

On the right hand side:

- ❑ disassemble the oil filter (1) from the support using tool 99360076;

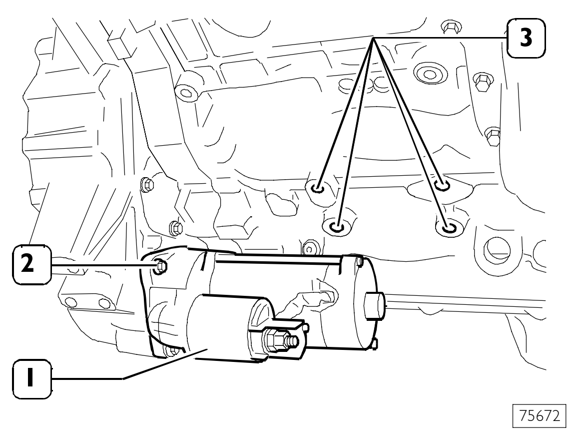
Warning: the oil filter contains inside aprx. 1 kg. of engine oil. Provide for oil recovery and disposal in compliance with the law and regulations in force.

Figure 21



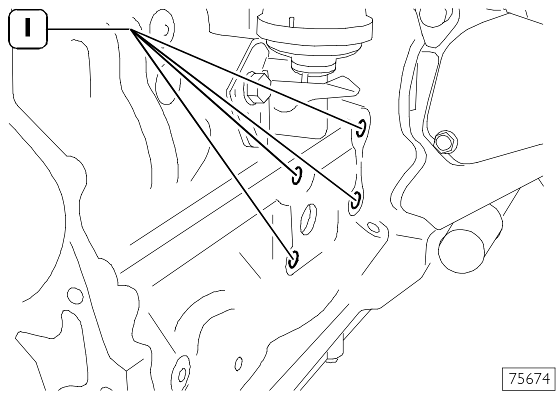
- ❑ disassemble lubrication oil exhaust pipe from the turbo-blower:
  Underneath the turbo-blower loosen the two screws (2), loosen the screw (3) fixing the pipe throughout the stop collar (4) fixing the block; finally loosen and remove the union (5) from the block; plug the pipe ends and the exhaust of the turbo-blower.

Figure 22



- ❑ Disassemble the starter;
  Properly hold the starter (1) and loosen the fixing screws (2);
- ❑ assemble the bracket bearing 99361037 using the four screw threaded ports (3).

Figure 23



From the left-hand side:

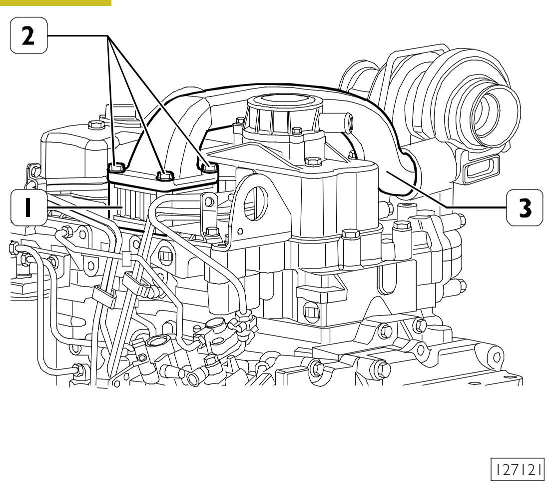
- ❑ Assemble the second bracket 99361037 throughout the screw-threaded ports (1).
- ❑ Lift the engine using the rocker arm 99360595 and put it on the turning stand 99322205.
- ❑ Drain the oil through the cap underneath the plug.

Warning: avoid contact of engine oil with the skin: in case of skin contamination, rinse in running water.

Engine oil is highly pollutant: provide for disposal in compliance with the law and regulations in force.

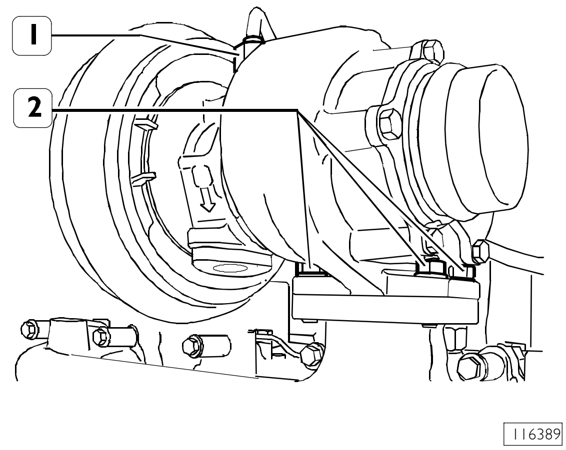
Disassembly of application components

Figure 24



Loosen the screws (2), remove the duct (3) and the heater (1) (if present).

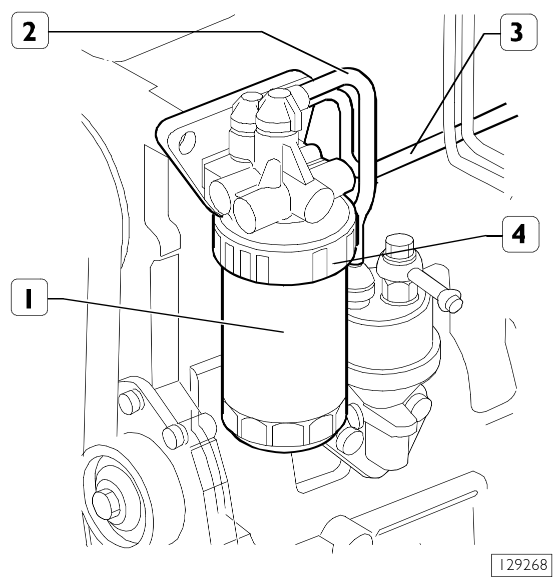
Figure 25



Proceed disassembling the supercharger:

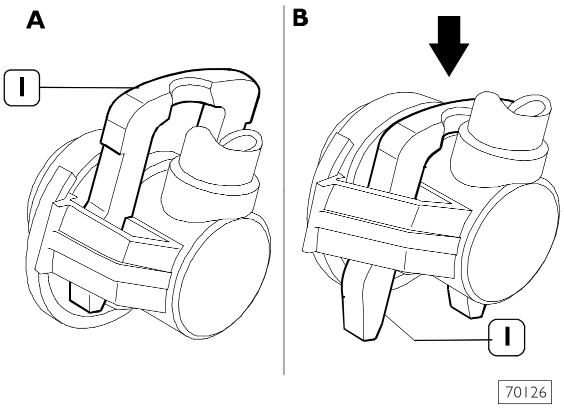
- ❑ loosen the fixing nut (1) and remove the lubrication pipe from the supercharger. Analogously carry out the same operation on the other end of the pipe and remove it from the upper part of the heat exchanger.
- ❑ Loosen the screw nuts fixing (2) the supercharger on the exhaust manifold.
- ❑ Hold up the supercharger and after lifting it remove the gasket.

Figure 26



- ❑ Place a container under the fuel filter and screw out the condense drain faucet underneath said filter. Carry out complete drainage of the fuel contained therein.
- ❑ Screw out completely the faucet and, using equipment 99360076 disassemble oil filter (1).
- ❑ Disconnect fuel pipelines (2 and 3) respectively from priming pump to filter bearing and from this last one to the feed pump.
- ❑ Remove the fuel filter bearing (4) from the bracket fixed to the engine head.

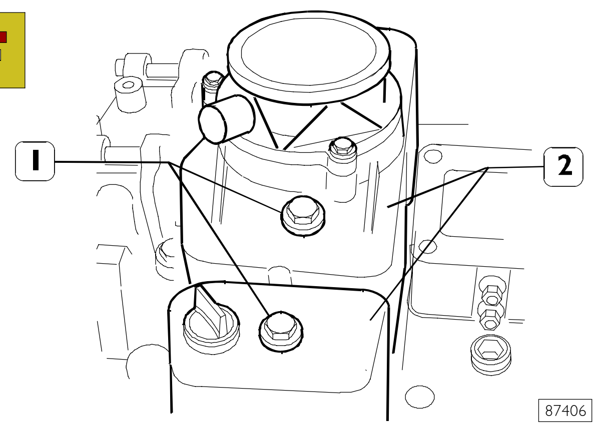
Figure 27



NOTE To disconnect fuel pipelines (3 and 4, Figure 26), in low pressure from the relating pipe fittings, it is Necessary to press the locking fastener (1) as shown in picture **B**.

After having disconnected the pipeline, reset the locking fastener (1) in lock position as shown in. picture **A**, to avoid any possible deformation of the fastener itself.

Figure 28



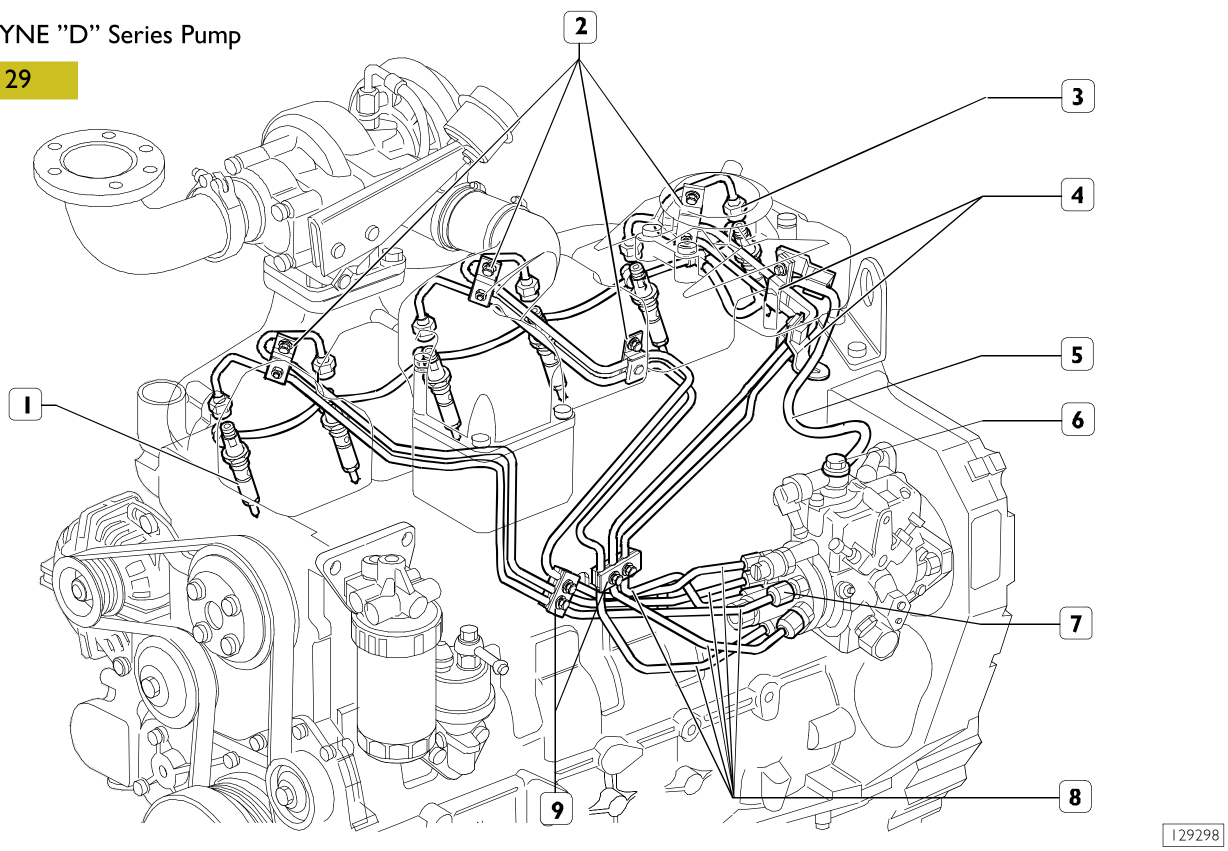
❑ Remove tappet caps:
Loosen the four fixing screws (1) and lift the caps (2); remove the gaskets.

NOTE On the cap there is a blow-by valve for the lubrication oil vapours.

All the gaskets shall always be replaced during assembly.

STANADYNE "D" Series Pump

Figure 29

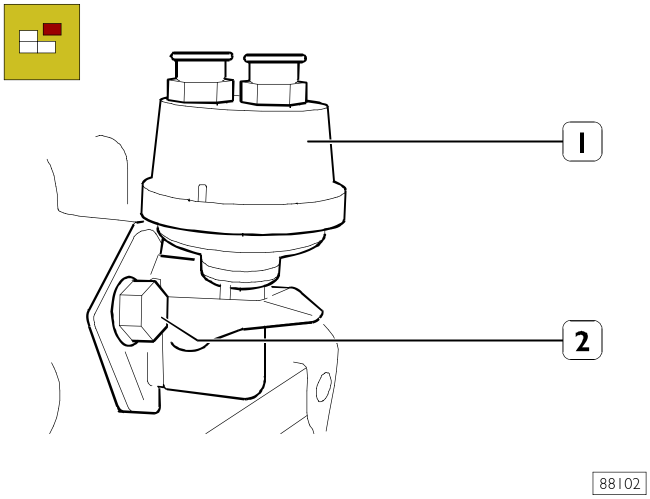


❑ Remove the pipes forming the fuel supply (8) and recovery (5) between the pump and the injectors (1):unscrew the ring nuts (7) securing the pipes to the pumping elements;free the collar (6) of the fuel recovery pipe returning to the injection pump;undo the ring nuts (7) fitted on the injectors and unscrew the bolts securing the fuel recovery pipe; unscrew the bolts retaining the brackets (2, 4, 9) securing the above-mentioned pipes.Put plugs on the ends of the pipes.

❑ Remove the injectors (1) and take them out of their seat: retrieve the seals.

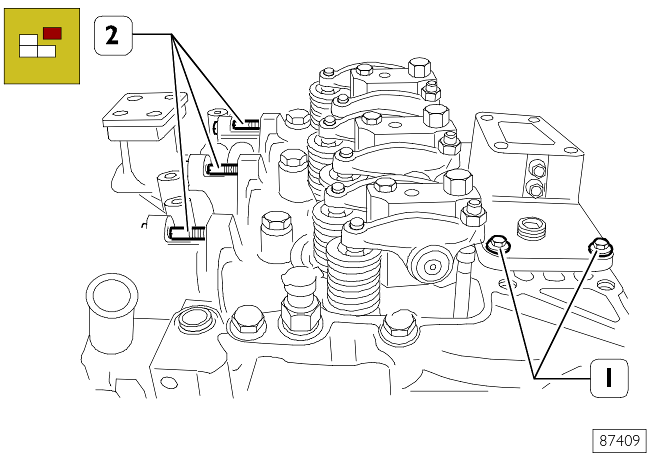
Print P4D32N003 E

Figure 30



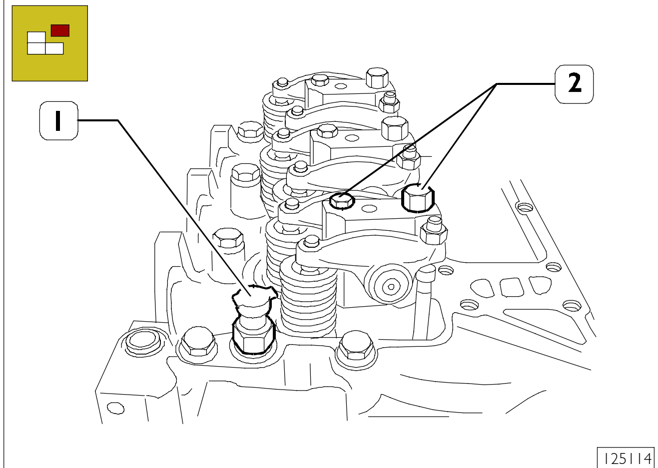
❑ Loosen the two fixing screws (2) and disassemble priming pump (1).

Figure 31



❑ Disassemble suction and exhaust manifolds: loosen the 8 screws (1) fixing the suction manifold plate to the cylinder head (two of them have already been screwed-out since fixing the pipe brackets to the injectors); from the exhaust manifold side;
loosen the (2) fixing screws; remove the gaskets.

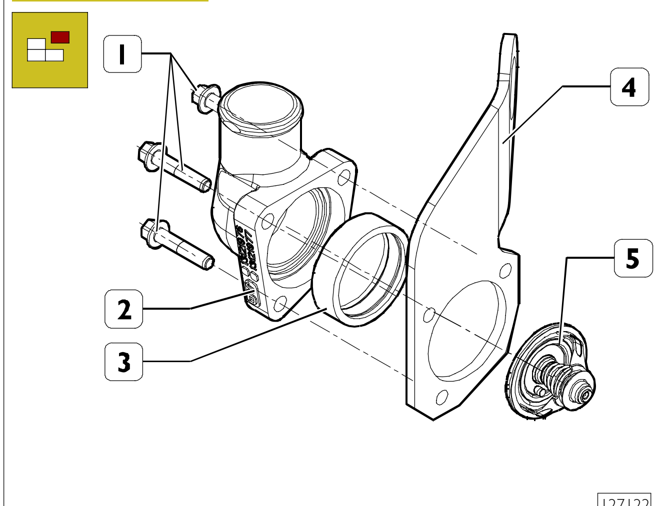
Figure 32



❑ Disassemble rocker arm bearings; loosen the two fixing screws (2) and remove the complete rocker arm bearing; withdraw tappet rods. Repeat the operation for all the remaining rocker arm bearings.

❑ Disassemble water temperature transmitter (1).

Figure 33

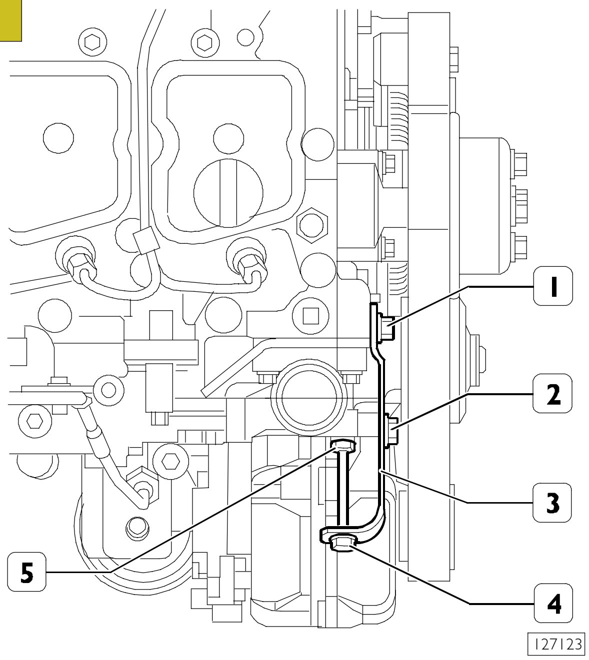


❑ Disassemble thermostat unit; loosen the three fixing screws (1) and disassemble the thermostat unit (2) together with the bracket (4); remove the gasket (3) and the thermostat (5).

❑ Assemble the bracket in the original position fixing it with the screws of the thermostat unit.

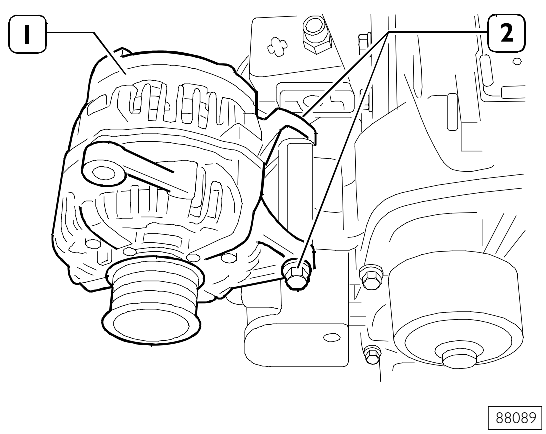
For engines with a traditional belt tensioner

Figure 34



- Loosen the screw nut (5) and the screw (2)
- Loosen the screw (2, figure 18)
- Reduce belt tension operating on the screw (4)
- Loosen the screw (2) on the belt tensioning bracket (3)
- Withdraw the POLY-V belt
- Remove the belt tensioning bracket loosening the screw (1)
- Disassemble the pulleys and the guide rollers.

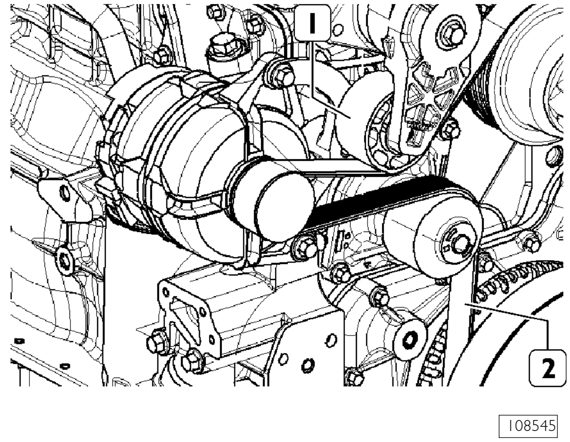
Figure 35



- Properly hold the alternator (1) separating it from its bearing by loosening the screw (2); remove screw nut and washer.

For engines with an automatic belt tensioner

Figure 36

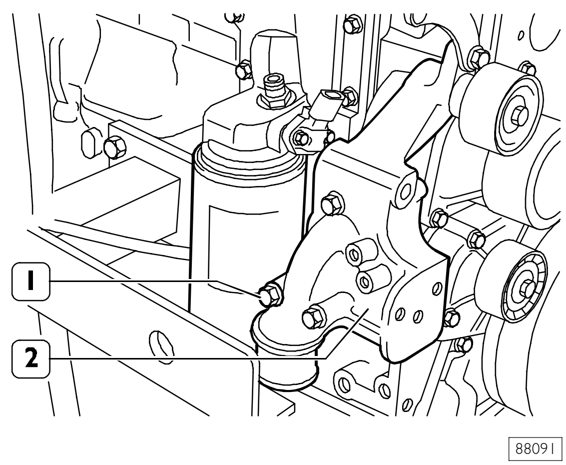


Release on the drive belt tensioner (1) and extract the belt (2) from the belt pulleys from the water pump ones and from the belt rebound pulleys;

Disassemble the belt tensioner (1).

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

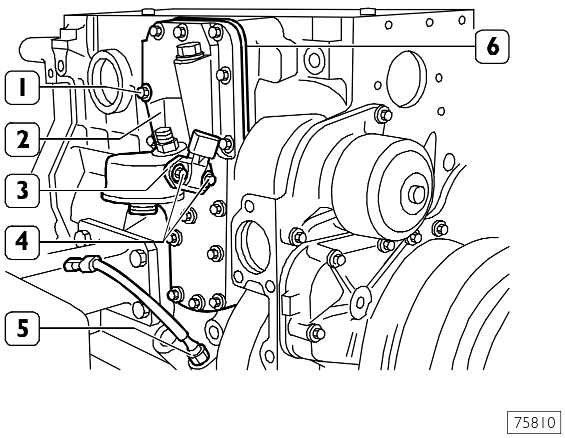
Figure 37



- Loosen the screws (1) and withdraw the alternator bearing (2).

NOTE The shape and the dimensions of the support of the alternator vary according to the use of the engine. The relevant pictures provide a general trace of the intervention that is to be carried out. The procedures described are always applicable.

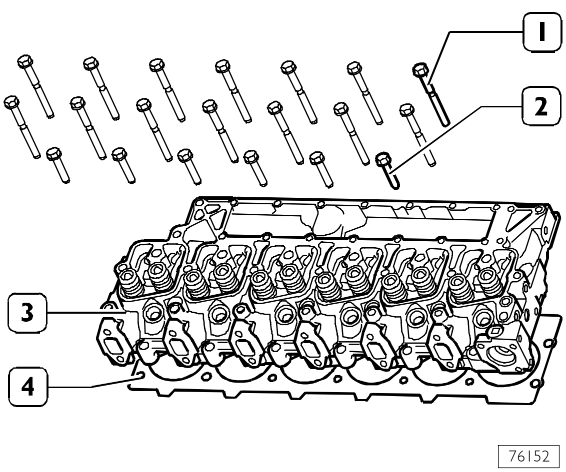
Figure 38



- ❑ Loosen the screws (4) and disassemble the oil pressure/temperature sensor (3) (if fitted).
- ❑ Loosen the screws (1) and disassemble the oil filter/heat exchanger bearing (2), interlayer plate (6) and relating gaskets.
- ❑ Disassemble oil level sensor (5) (whether provided).
- ❑ Disassemble injection pump (see specific procedure) and the power take-off underneath.

For 6 cylinder engines

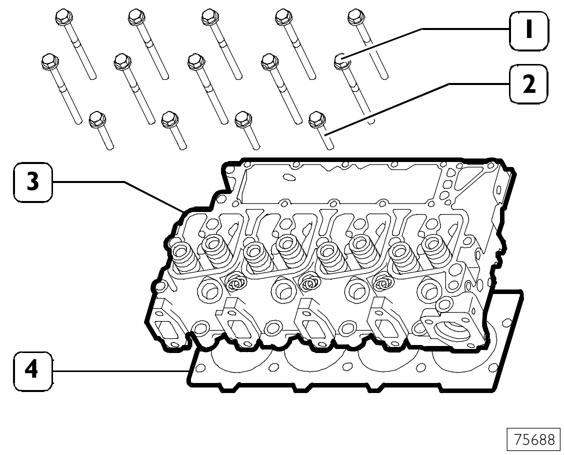
Figure 39



- ❑ Disassemble cylinder head;
  loosen the screws (1) and (2) fixing the cylinder head (3); hook the brackets with metal ropes and, throughout a hoist withdraw cylinder head from the block.

For 4 cylinder engines

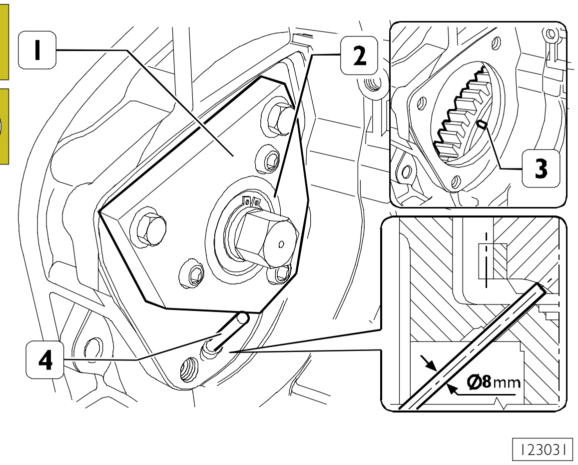
Figure 40



- ❑ Disassemble cylinder head;
  loosen the screws (1) and (2) fixing the cylinder head (3); hook the brackets with metal ropes and, throughout a hoist withdraw cylinder head from the block.

Engine versions with tool (99360339)

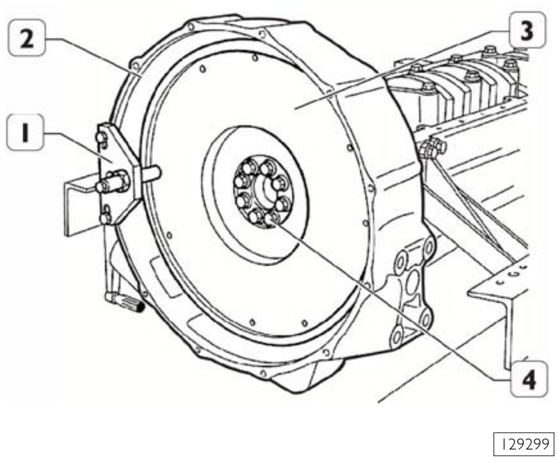
Figure 41



- ❑ Apply tool 99360339 (1) on the flywheel housing cover to block rotation of the flywheel (3) using a spanner on the nut (2) and a pin (4). (use the stud bolts and the nuts fixing the starter motor).
- ❑ Loosen the flywheel fixing screws to engine drive shaft.

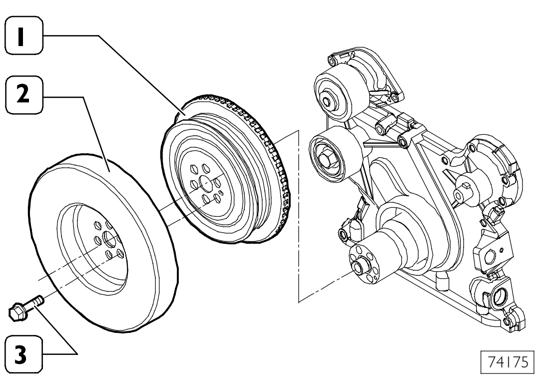
Engine versions with tool (99360351)

Figure 42



- Use the tool 99360351 (1) to operate on the flywheel cover box (2) in order to block flywheel rotation (3).

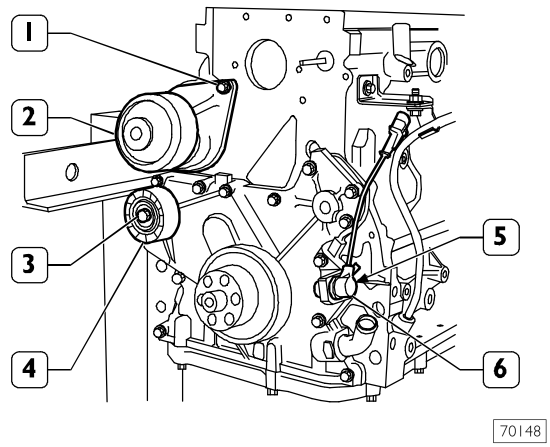
Figure 43



- Unloose the screws (3) and disassemble the damping flywheel (2) and the pulley (1).
- The engine flywheel locking tool can help when removing the damper flywheel (2) fitted on the pulley (1).

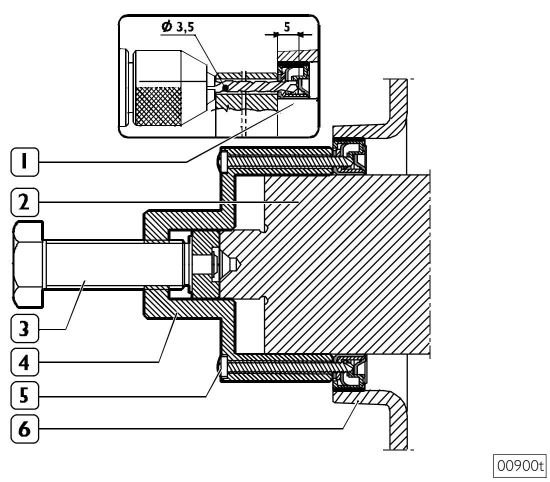
NOTE In some versions, the phonic wheel mounted on pulley (1) may be not present and pulley (1) can be different from the pulley shown in Figure.

Figure 44



- Remove the screws (1) and disconnect the water pump (2).
- Remove the screw (3) and the roller (4).
- Remove the screw (5) and disconnect the engine speed sensor (6).

Figure 45



- Remove the engine drive shaft fixing ring from the front cover. Use the tool 99340055 (4) to operate on the front tang (2) of the engine drive shaft. Throughout the tool guide ports, drill the internal holding ring (1) using ∅ 3,5 mm drill for a 5mm depth. Fix the tool to the ring tightening the 6 screws specially provided.
Proceed withdrawing the ring (1) tightening the screw (3).

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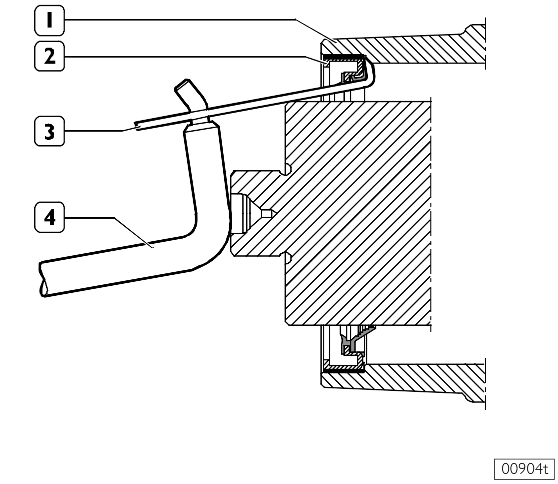
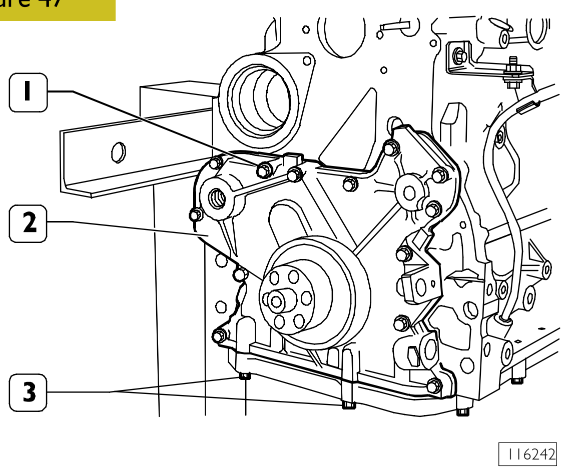
Figure 46



- ❑ Using the specially provided tie rod (3) for the tool 99363204 and the lever (4), withdraw the external holding ring (2) from the front cover (1).

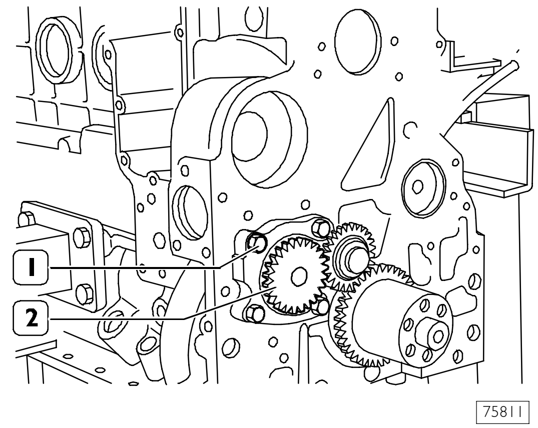
Figure 47



- ❑ Loosen the screws (1 and 3) and remove the front cover (2).

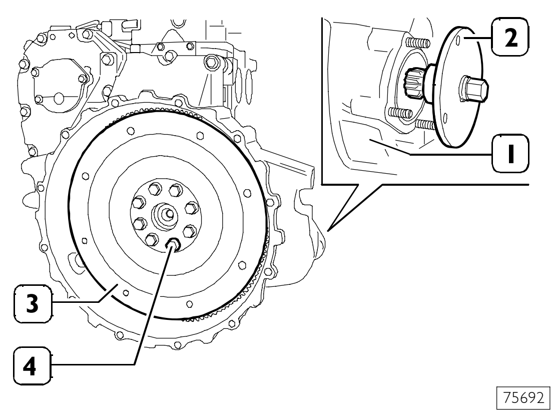
NOTE Take note of the screw (1 and 3) assembly position, since the screws have different length.

Figure 48



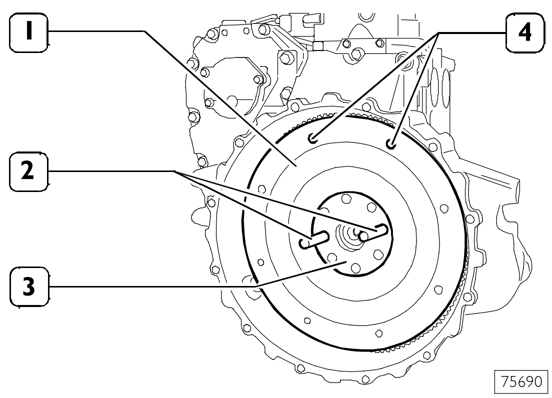
- ❑ Loosen the screws (1) and remove oil pump (2).

Figure 49



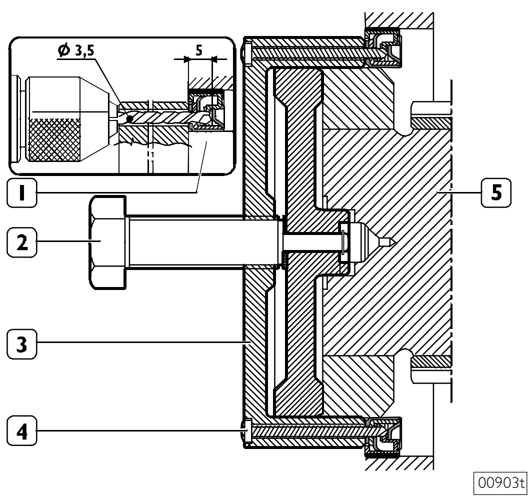
- ❑ Screw out the opposite screws (2) from the ports where the withdrawal pins shall be introduced (see picture following).
- ❑ Loosen remaining flywheel fixing screws (1) to the engine drive shaft.
- ❑ Remove the flywheel block tool (2).

Figure 50



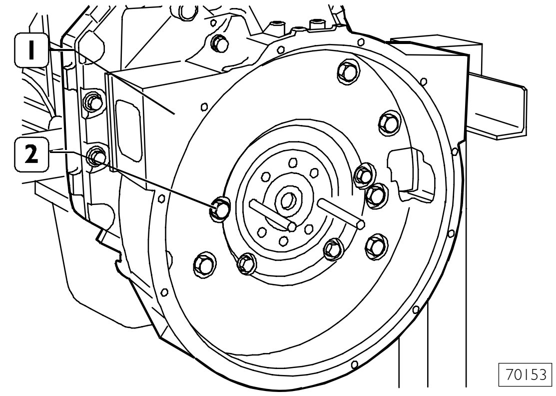
- Screw up two medium length screws in the ports (4) to sling the flywheel with a hoist.
  Throughout two guide pins (2) previously screwed up into the engine drive shaft ports (3) control the engine flywheel withdrawal by means of a hoist.

Figure 51



- Remove the flywheel cover box fixing ring using the tool 99340056 (3) to operate on the back tang (5) of the engine drive shaft. Throughout the tool guide ports, drill the internal holding ring using ∅ 3,5 mm drill for a 5mm depth.
- Fix the tool 99340056 (3) to the ring (1) tightening the 6 screws specially provided (4).
- Proceed with drawing the ring (1) tightening the screw (2).
- Using the specially provided tie rod (3) for the tool 99363204 and the lever (4), withdraw the external holding ring of the flywheel cover box.

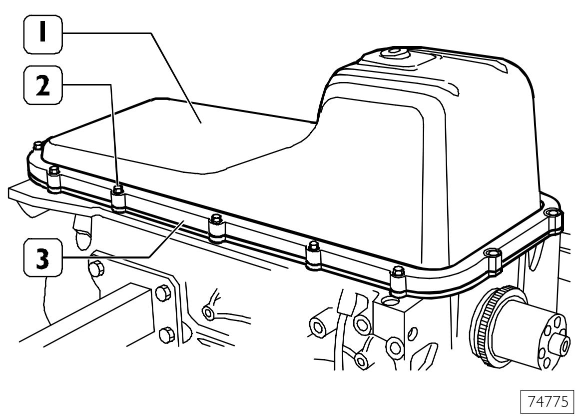
Figure 52



- Loosen the screws (2) and remove the flywheel cover box (1).

NOTE Take note of the screw (1) assembly position, since the screws have different length.

Figure 53

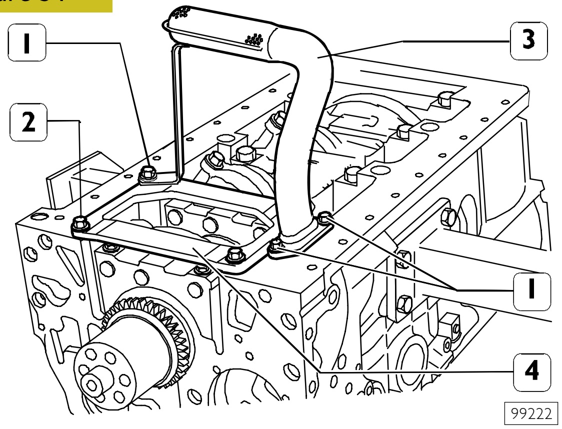


- Turn the engine upside-down.
- Loosen the screws (2), disassemble the plate (3) and remove the oil pan (1).

NOTE The shape and dimensions of the pan and of the rose pipe may vary according to the engine application. The relating illustrations provide general guidelines of the operation to be performed. The procedures described are applicable anyway.

For 4 cylinder engines

Figure 54

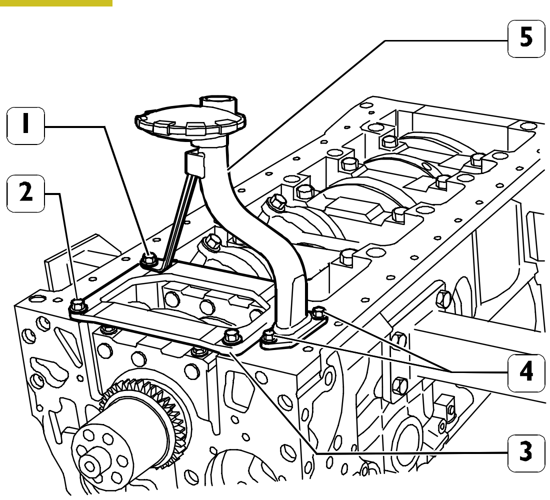


99222

- ❑ Loosen the screws (1) and disassemble the oil suction rose pipe (3).
- ❑ Loosen the screws (2) and remove the stiffening plate (4).

For 6 cylinder engines

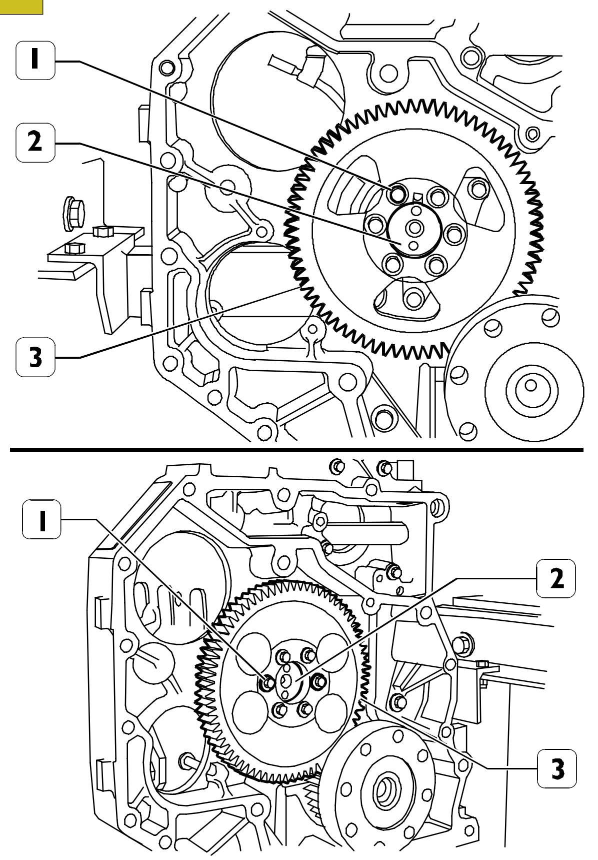
Figure 55



86516

- ❑ Remove the screws (1) and (4) and disassembled the suction rose (5).
- ❑ Remove the screws (2) and disassemble the stiffening plate (3)

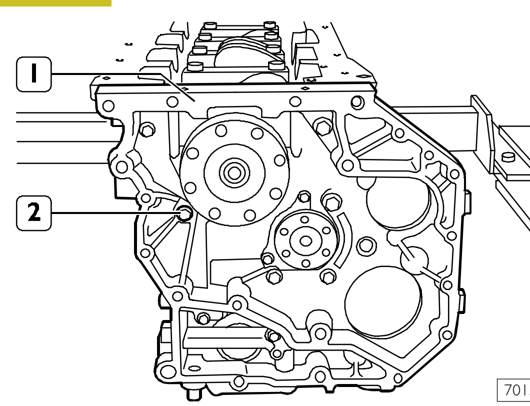
Figure 56



90505

- ❑ Loosen the screws (1) and disassemble the gear from the camshaft (2).

Figure 57



70157

- ❑ Loosen the screws (2) and disassemble the timing gearbox (1).

NOTE Take note of the screw (2) assembly position, since the screws have different length.

Installation of rear components

Figure 58

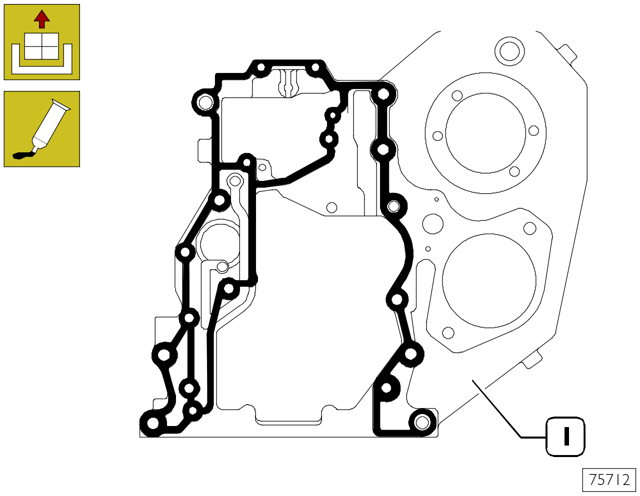


DIAGRAM SHOWING SEALING LOCTITE 5205 APPLICATION WITHIN GEARBOX AREAS

- ❑ Accurately clean the timing gearbox (1) and the engine block.

⚠ It is necessary and essential to clean the surface to be sealed in order to achieve excellent tight seal.

Apply sealing LOCTITE 5205 on the box in order to form a kerbstone of a few mm. Diameter.

It must be uniform (no crumbs), with no air blisters, thinner or irregular zones.

Any eventual imperfection shall be correct as soon as possible.

Avoid using material in excess to seal the joint. Too much sealing material would drop out on both sides of the joint and obstruct lubricant passages.

Couplings must be assembled within 10 minutes after completing the sealing operation.

Figure 59

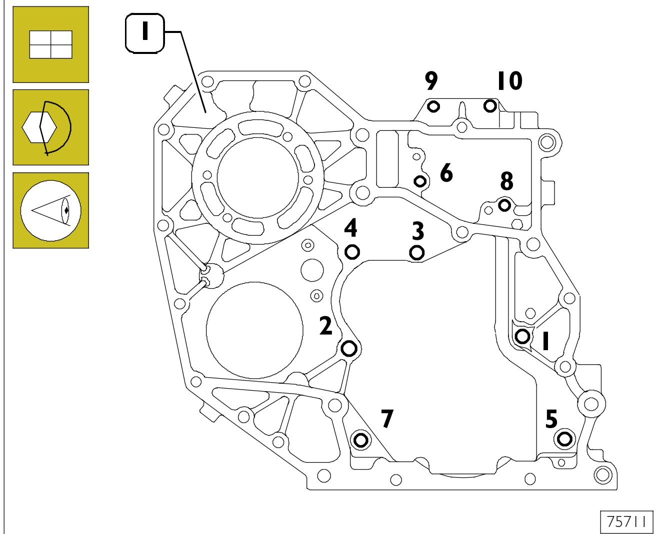


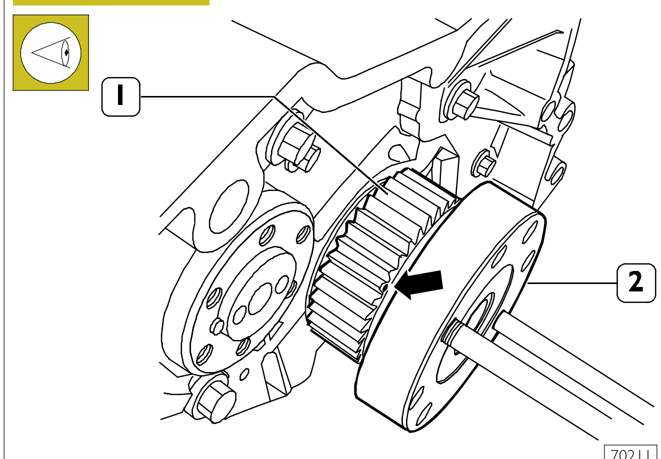
DIAGRAM SHOWING SCREW TIGHTENING TO FIX REAR GEARBOX

- ❑ Reassemble to box (1) to the engine block.
- ❑ Tighten the fixing screws in the same position as found out during disassembly and fix the screws to the locking couples listed here below, following the order as shown in the picture.

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

NOTE Before assembly, always check that the threads of the ports and of the screws have no evidence of tear and wear nor dirt.

Figure 60



- ❑ With a felt-tip pen, highlight the conducting gear tooth (1) mounted on the engine shaft (2) upon the upright surface on which a groove has been created for the ignition timing.

NOTE Screw up two pins to facilitate operation of engine drive shaft rotation.

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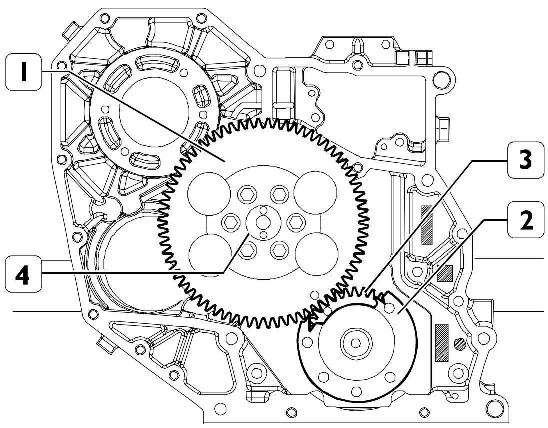
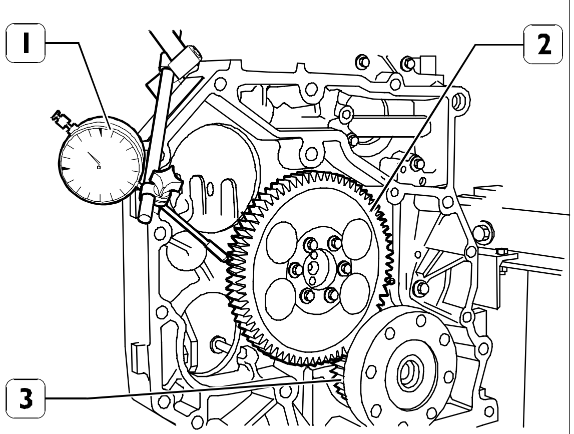
Figure 61



129300

❑ Turn the engine shaft (3) and the distribution shaft (4) so that by mounting the bevel gear on the latter (1) the stencilled mark on the gear (1) coincides with the groove on the gear tooth (2).

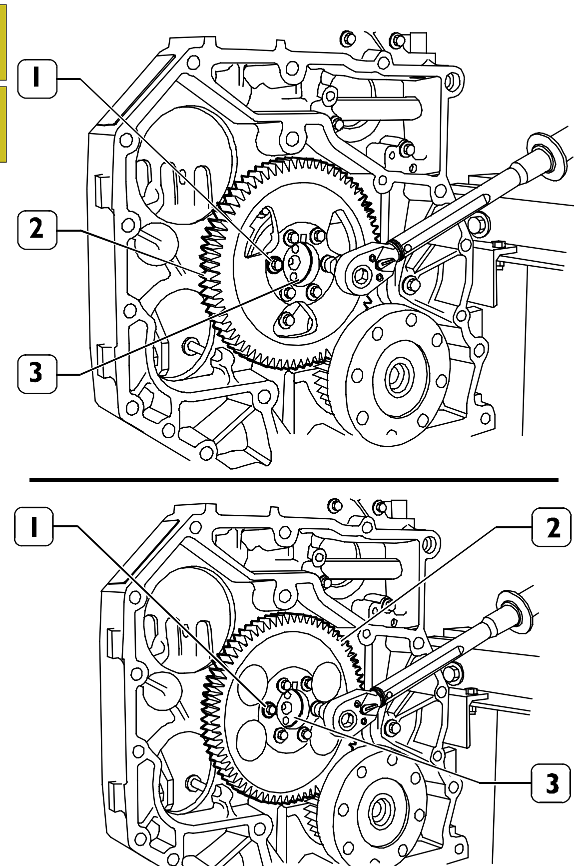
Figure 62



90507

❑ Position comparator (1) on timing system gear (2) and check that the clearance between gears (2) and (3) is within 0.076 ÷ 0.280 mm range.

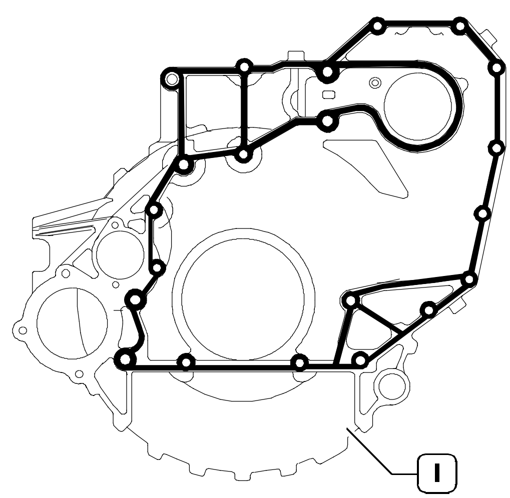
Figure 63



90508

❑ Tighten the screws (1) fixing the gear to the camshaft (3) and lock them to the prescribed couple.

Figure 64



75708

DIAGRAM SHOWING SEALING LOCTITE 5205 APPLICATION.

NOTE It is necessary and essential to clean the surface to be sealed in order to achieve excellent tight seal.

Apply sealing LOCTITE 5205 on the box in order to form a kerbstone of a few mm. Diameter. It must be uniform (no crumbs), with no air blisters, thinner or irregular zones.

Any eventual imperfection shall be correct as soon as possible.

Avoid using material in excess to seal the joint. Too much sealing material would drop out on both sides of the joint and obstruct lubricant passages.

Couplings must be assembled within 10 minutes after completing the sealing operation.

Figure 65

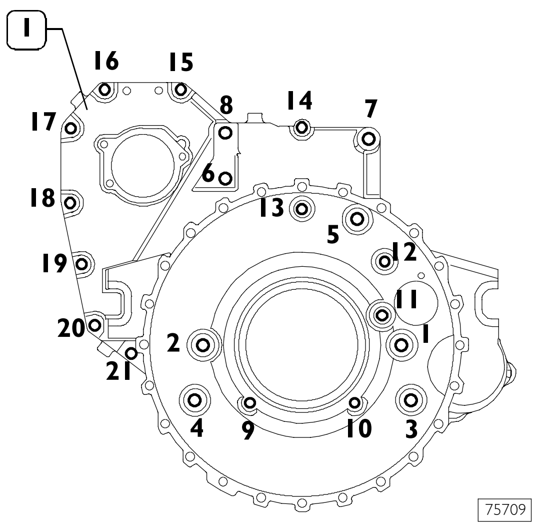


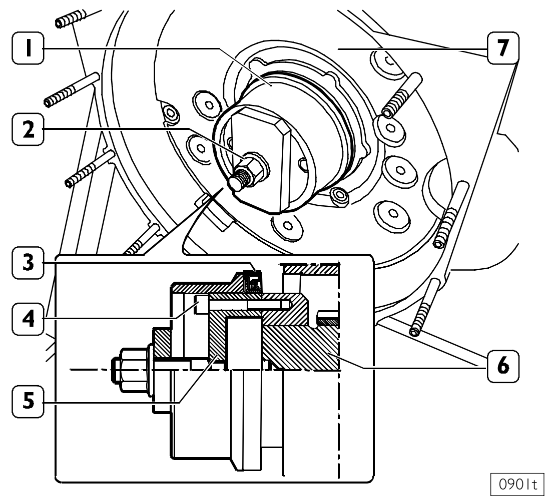
DIAGRAM SHOWING SCREW TIGHTENING TO FIX FLYWHEEL COVER BOX.

- Reassemble the box (1) to the engine block, tighten the fixing screws in the same position as found out during disassembly and fix the screws to the locking couples listed here below, following the order as shown in the picture.

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

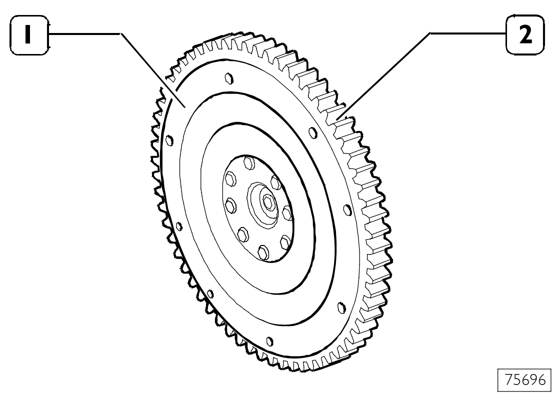
Before assembly, always check that the threads of the ports and of the screws have no evidence of tear and wear nor dirt.

Figure 66



- Apply to engine drive shaft rear tang (6), the detail (5) of the tool 99346252, fix it tightening the screws (4) and key the new holding ring on it (3).
- Place detail (1) on detail (5), tighten the screw nut (2) until complete assembly of the fixing ring (3) into the flywheel cover box (7).

Figure 67



- Check the contact surface (1) of the clutch plate and if it is scratched, proceed with turning.
- Check ring gear teeth (2), if breakage or excessive wear is found remove the ring gear from the engine flywheel (1) 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.

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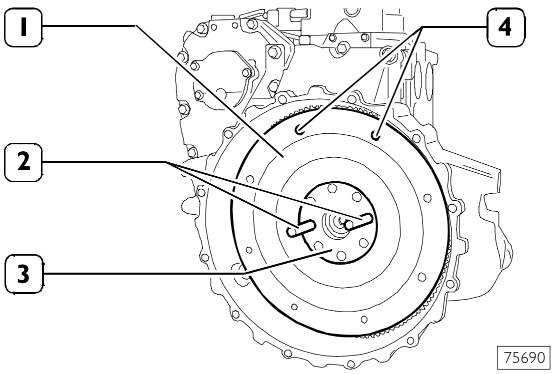
Flywheel installation

Figure 68



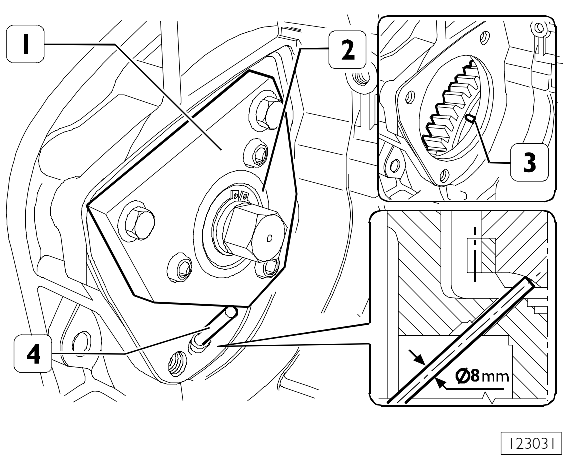
❑ Screw up two hooks or trail rings in the flywheel (1) threaded ports (4) for handling .

❑ Using a hoist, handle the flywheel to place it in its housing inside the flywheel cover box.

❑ Screw up to pins (2) having appropriate length, in the shaft ports (3) and using them as guide, assemble the engine flywheel (1) properly placing it inside the flywheel cover box.

Engine versions with tool (99360339)

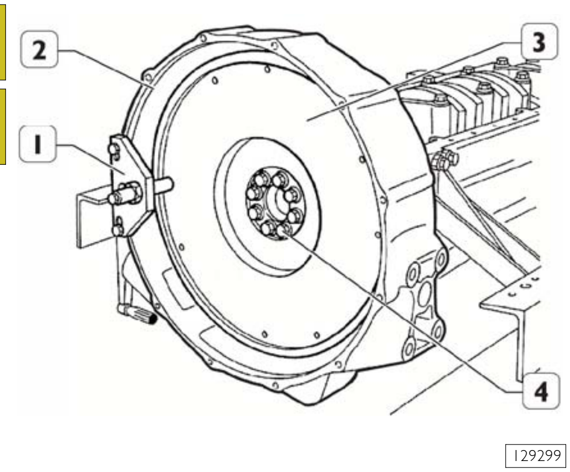
Figure 69



❑ Apply tool 99360339 (1) on the flywheel housing cover to block rotation of the flywheel (3) using a spanner on the nut (2) and a pin (4). (use the stud bolts and the nuts fixing the starter motor).

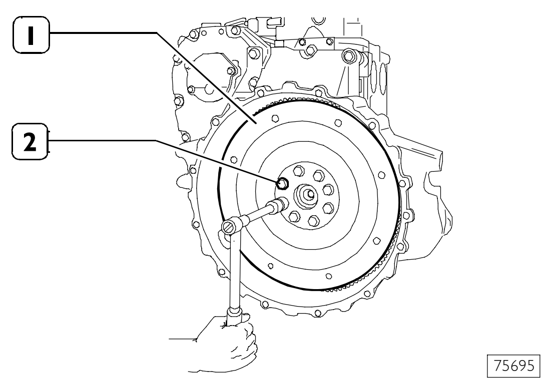
Engine versions with tool (99360330)

Figure 70



❑ Use the tool 99360351 (1) to operate on the flywheel cover box (2) in order to block flywheel rotation (3).

Figure 71



Tighten the engine flywheel (1) fixing screws (2) in two phases:

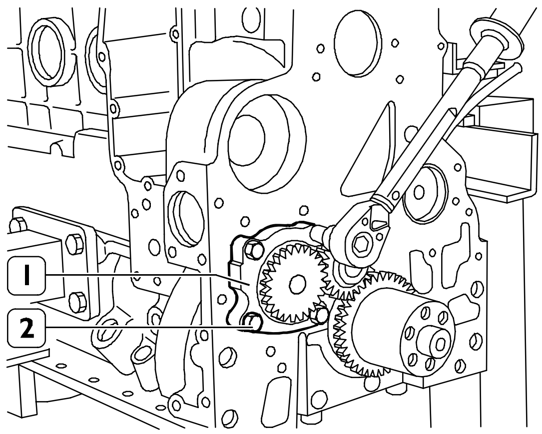
❑ 1st phase; tightening by means of dynamometric wrench to couple 30 ± 4 Nm;

❑ 2nd phase, 60° ± 5° angle dwell with tool 99395216.

NOTE Before assembly, always check that the threads of the ports and of the screws have no evidence of tear and wear nor dirt.

Installation of front components

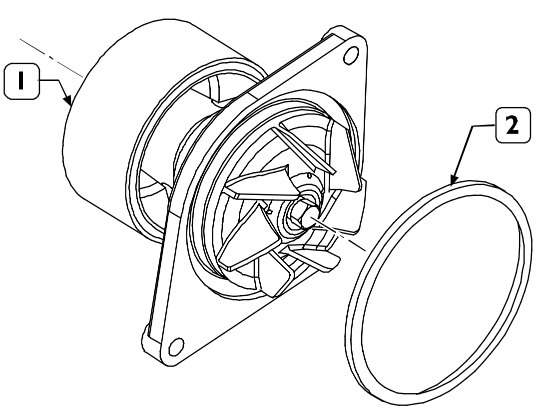
Figure 72



70220

- Assemble oil pump (1).
- Tighten fixing screws (2) and lock them to the prescribed couple.

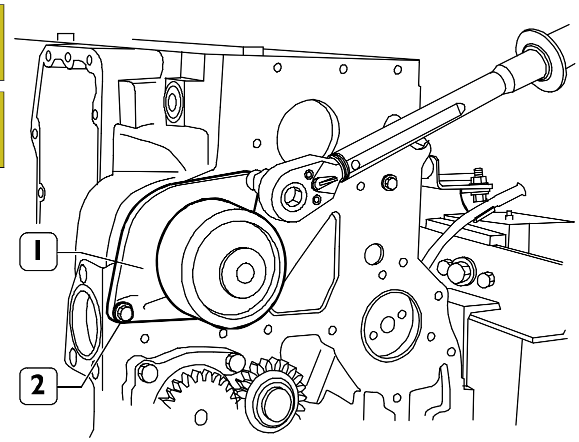
Figure 73



70221

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

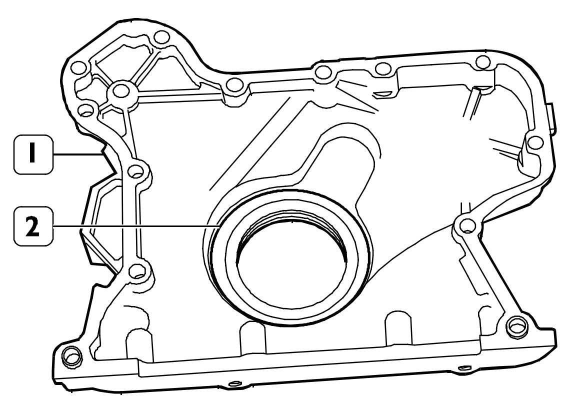
Figure 74



76112

- Assemble the water pump (1).
- Tighten the screws (2) and lock them to the prescribed couple.

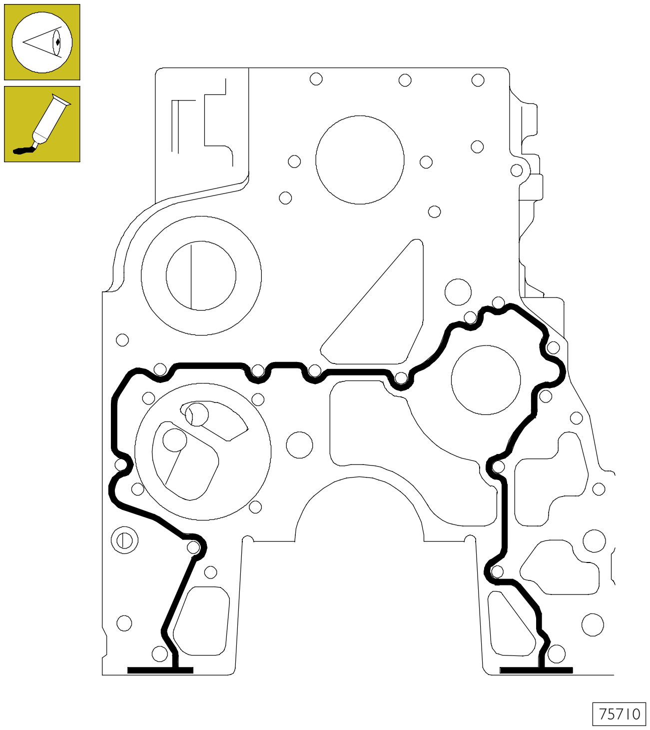
Figure 75



106549

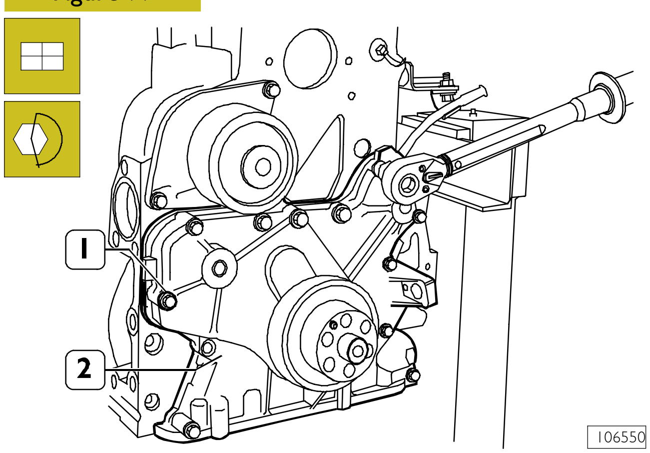
- Remove the fixing ring (2) from the front cover (1), accurately clean the plug surface.

Figure 76



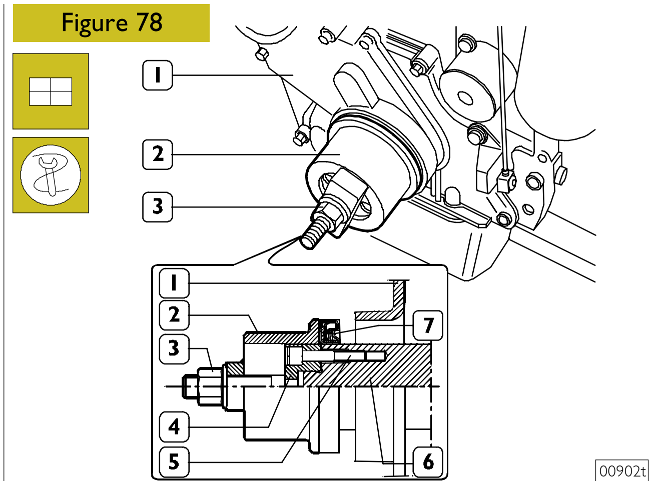
- ❑ Accurately clean the contact surface of engine block and apply sealing LOCTITE 5205 on it in order to form a uniform and continuous kerbstone with no crumbs.

Figure 77



- ❑ Assemble the front cover (2) to the block and tighten the screws (1) fixing them to the prescribed couple.

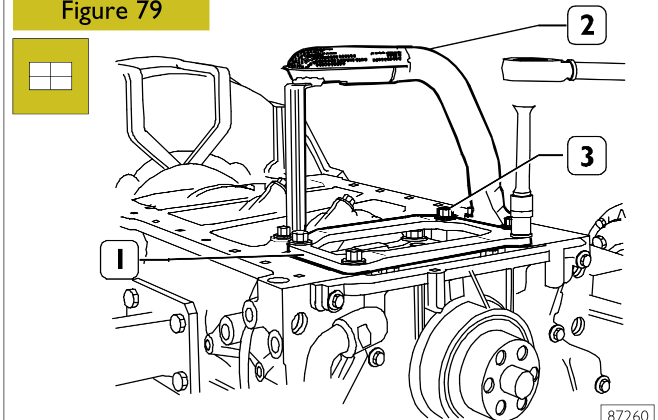
Figure 78



- ❑ Apply on engine drive shaft front tang (6) the detail (4) of the tool 99346252, fix it with the screws (5) and key the new holding ring on it (7).
- ❑ Place the detail (2) on the detail (4), screw-up the threaded nut until carrying out the complete assembly of the holding ring (7) to the front cover.

4 cylinder engines

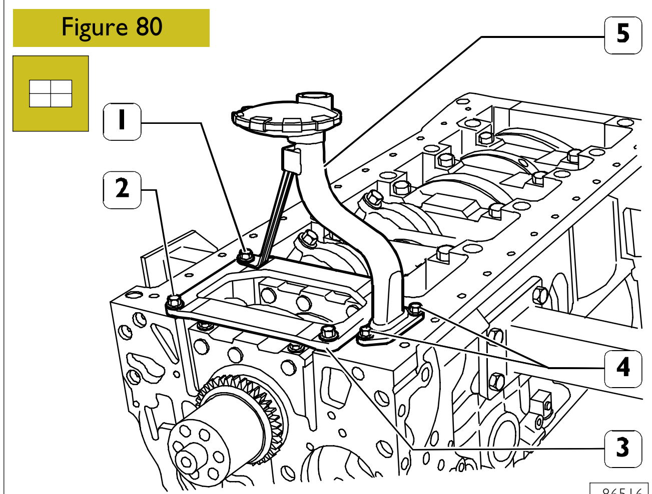
Figure 79



- ❑ Assemble the plate (1), the rose pipe (2), tighten the fixing screws (3) and fix them to the prescribed couple.

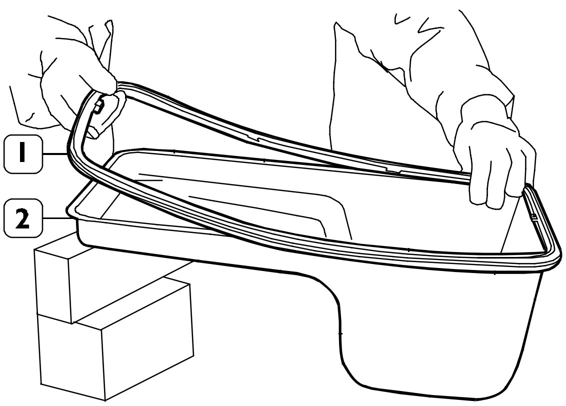
6 cylinder engines

Figure 80



- ❑ Assemble the plate (3), the suction rose (5) and tighten the fixing screws (1, 2 and 4) to the prescribed torque.

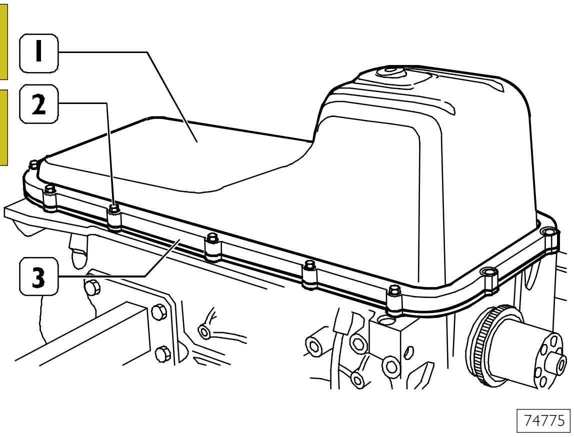
Figure 81



❑ Provide for new gasket replacement (1) of the oil pan (2).

NOTE The pictures illustrating the pan and of the rose pipe may not correspond to the ones of your model. However the procedures described are applicable anyway.

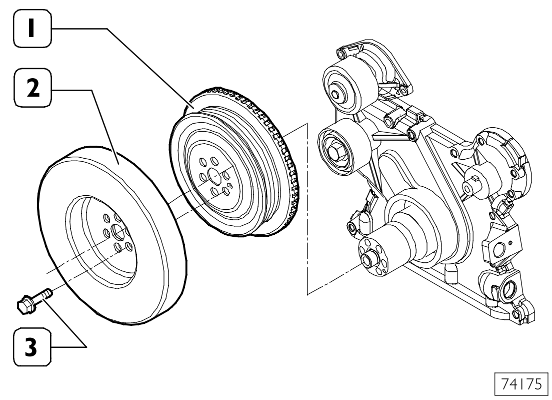
Figure 82



❑ Assemble oil pan (1), apply the plate over it (2). Tighten the screws (2) and lock them to the prescribed couple.

NOTE Before assembly, always check that the threads of the ports and of the screws have no evidence of tear and wear nor dirt.

Figure 83

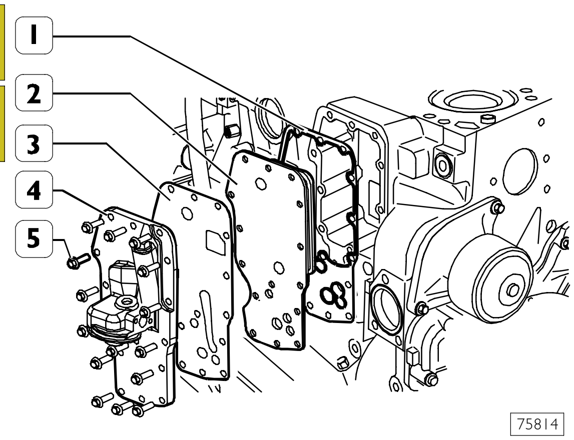


❑ Assemble the pulley (1) and the dumping flywheel (2) to the driving shaft.

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

NOTE In some versions, the phonic wheel mounted on pulley (1) may be not present and pulley (1) can be different from the pulley shown in Figure.

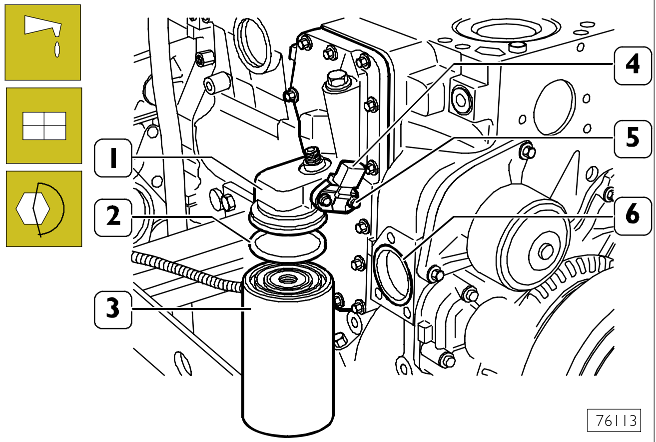
Figure 84



❑ Assemble the following elements to the block: new gasket (1), heat exchanger (2), new gasket (3), oil filter bearing (4).
Tighten the screws (5) and lock them to the prescribed couple.

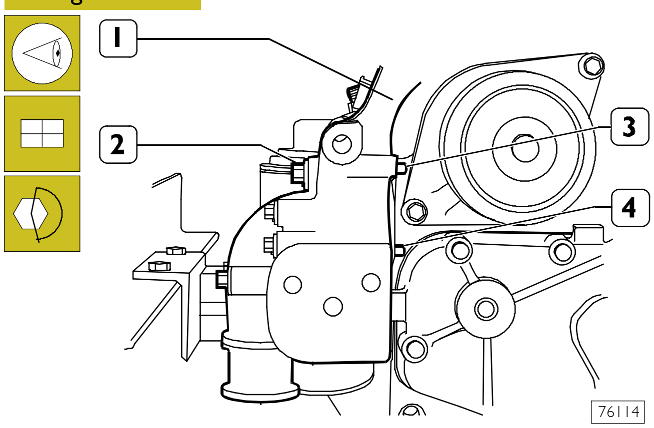
NOTE Before assembly, always check that the threads of the ports and of the screws have no evidence of tear and wear nor dirt.

Figure 85



- ❑ Lubricate the fixing ring (2) using engine oil and place it on the oil filter (3).
- ❑ Manually start the oil filter (3) on the bearing union (1) until counter-boring, further screw up the oil filter (3) by 3/4 turn.
- ❑ Place a new fixing ring on the block housing (6).
- ❑ Apply, (if needed) new fixing ring on the oil temperature/pressure sensor (4) and assemble it to the bearing (1) tightening the fixing screws to the prescribed couple.

Figure 86

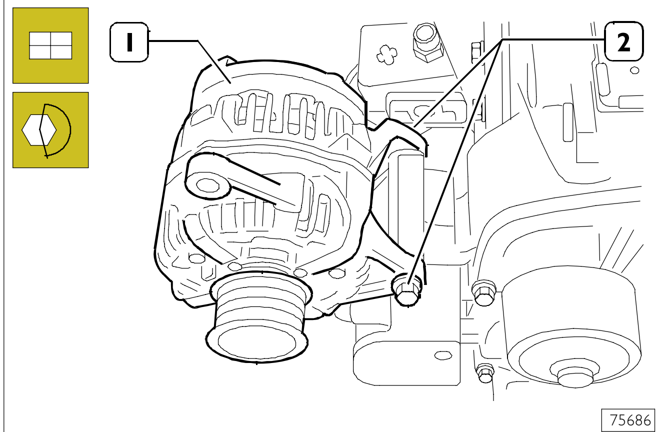


- ❑ Assemble the alternator bearing (1) ensuring that the pins (3 and 4) are against the engine block.
- ❑ Tighten the screws (2) and lock them to the prescribed couple.

NOTE The shape and the dimensions of the alternator support vary according to the use of the engine. Therefore the relevant pictures provide a general guideline of the intervention that is to be carried out. However the procedures described are applicable.

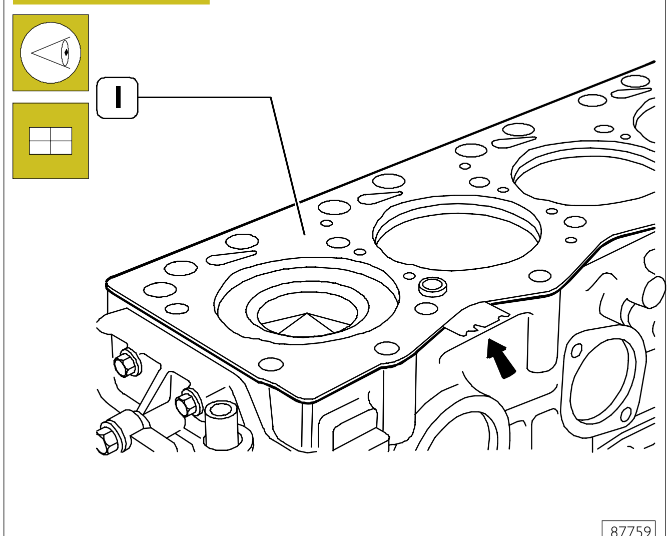
NOTE Before assembly, always check that the threads of the ports and of the screws have no evidence of tear and wear nor dirt.

Figure 87



- ❑ Connect the alternator (1) to the support.
- ❑ Tighten the screw without locking it (2).

Figure 88



- ❑ Place the gasket (1) over the block.

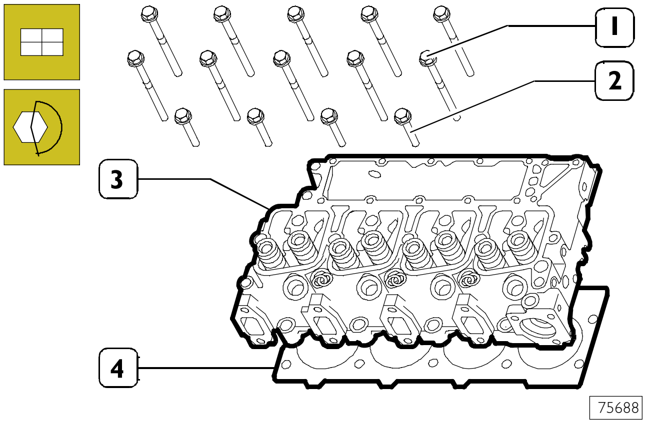
NOTE Verify that the engine block stand is clean.

Do not grease the gasket. It is recommended to keep the gasket inside packaging until assembly to the cylinder head.

Gasket assembly shall be made following the direction of wording printed on the gasket itself so that this will be readable as indicated in the picture.

4 cylinder engines

Figure 89



❑ Place the head (3) over the block and insert screws (1) and (2).

NOTE If the valves have been removed from the head, it is necessary to assemble them before assembling the head itself on the engine block.

NOTE Before using the fixing screws again, measure them twice as indicated in the picture, checking D1 and D2 diameters:
if D1 - D2 < 0,1 mm the screw can be utilised again;
if D1 - D2 > 0,1 mm the screw must be replaced.

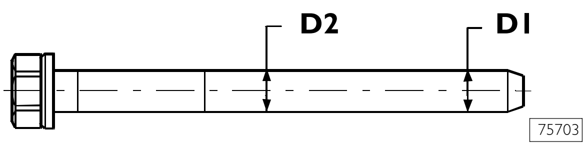
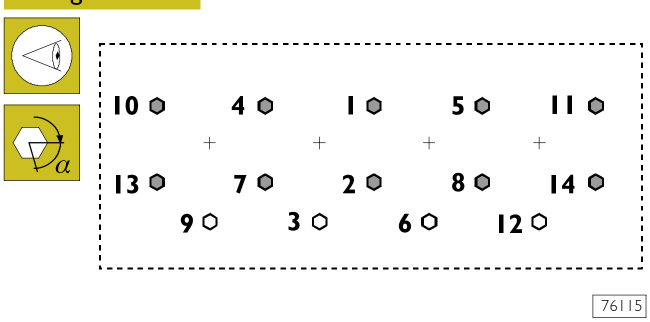


Figure 90



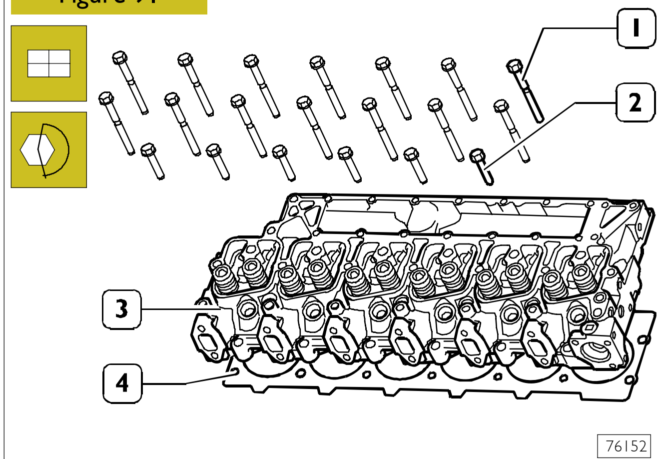
❑ Lubricate cylinder head bolts and install to head.

❑ Bolts must be torqued using stitching pattern starting with the centre bolts and moving out. Bolts to be torqued in stages: all bolts torqued to snug torque, then 90 degrees rotation for all bolts. Then a further 90 degrees for the M12 x 140.

M12 x 70	50 Nm + 90 deg's
M12 x 140	40 Nm + 180 deg's

6 cylinder engines

Figure 91



❑ Place the head (3) over the block and insert screws (1) and (2).

NOTE If the valves have been removed from the head, it is necessary to assemble them before assembling the head itself on the engine block.

NOTE Before using the fixing screws again, measure them twice as indicated in the picture, checking D1 and D2 diameters:
if D1 - D2 < 0,1 mm the screw can be utilised again;
if D1 - D2 > 0,1 mm the screw must be replaced.

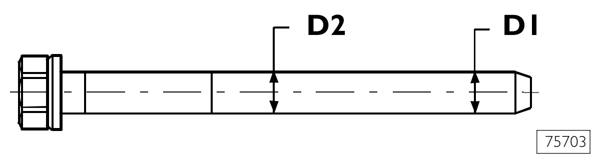
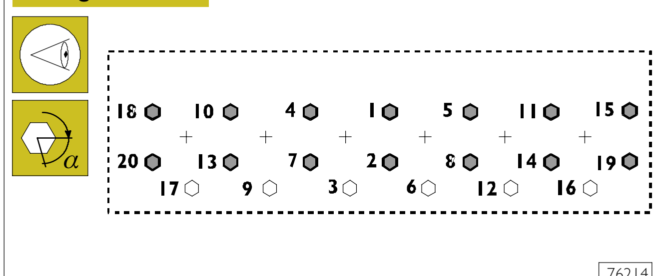


Figure 92

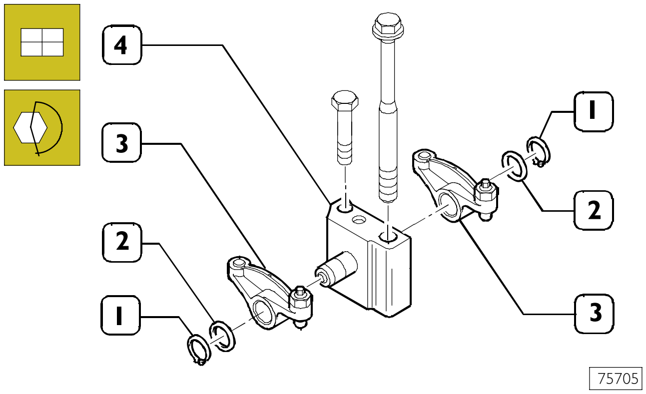


❑ Lubricate cylinder head bolts and install to head.

❑ Bolts must be torqued using stitching pattern starting with the centre bolts and moving out. Bolts to be torqued in stages: all bolts torqued to snug torque, then 90 degrees rotation for all bolts. Then a further 90 degrees for the M12 x 140.

M12 x 70	50 Nm + 90 deg's
M12 x 140	40 Nm + 180 deg's

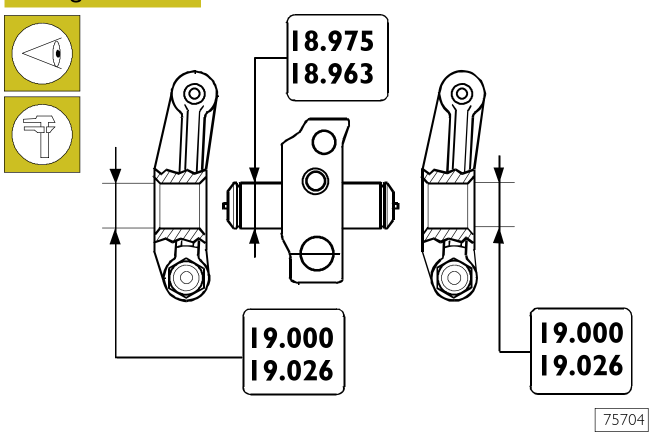
Figure 93



❑ Carry out the assembly of the rocker arms after previous check of the components.

ROCKER ARM UNIT COMPONENTS:
1. Elastic ring - 2. Spacer- 3. Rocker arms-
4. Support.

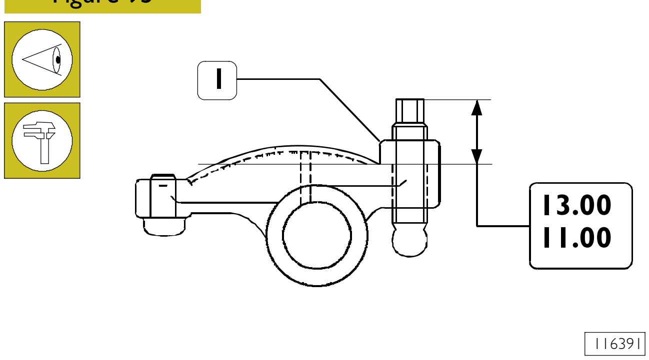
Figure 94



SHAFT AND ROCKER ARM BASIC DATA

Check the coupling surfaces of bearing and shaft: no evidence of excessive wear shall be detected or damages.
Replace if necessary.

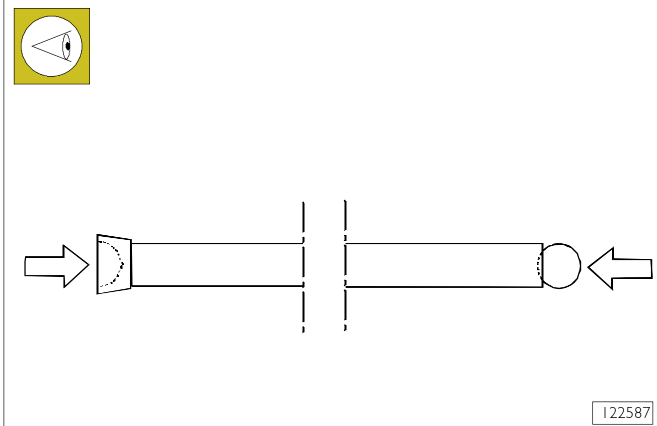
Figure 95



ROCKER ARM ADJUSTMENT SCREW

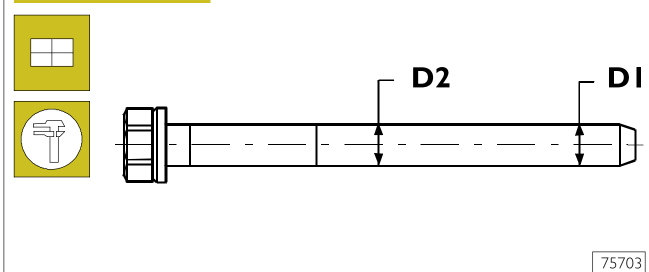
If unscrewed, check adjustment quota.
Tighten the screw-threaded nut (1) to the i 4 - 6 Nm couple.

Figure 96



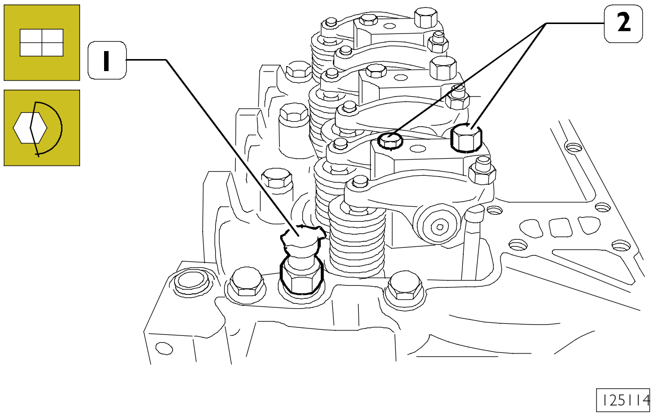
Before executing assembly, check the Rocker Arm driving rods: these shall not be deformed; the spherical ends in contact with the Rocker Arm adjustment screw and with the tappet (arrows) shall not present evidence of seizure or wear: in case of detection proceed replacing them.
The rods driving the suction and exhaust valves are identical and therefore interchangeable.

Figure 97



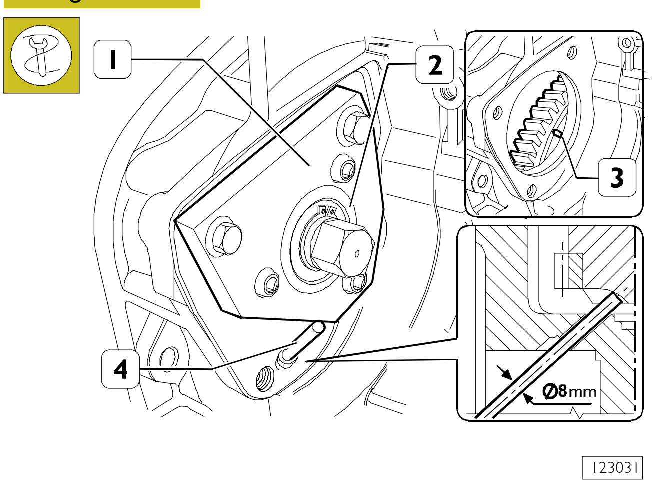
❑ Insert the tappet driving rods and the Rocker Arm unit. Before using the fixing screws again, measure them twice as indicated in the picture, checking D1 and D2 diameters:
if D1 - D2 < 0,1 mm the screw can be utilised again;
if D1 - D2 > 0,1 mm the screw must be replaced;

Figure 98



❑ Tighten the screws (2) to the prescribed couple and assemble water temperature sensor (1).

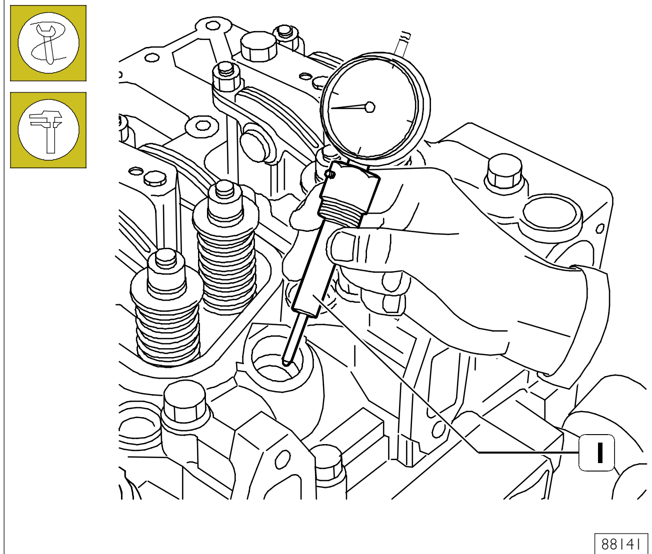
Figure 99



❑ Fit tool 99360339 (1) in order to be able to rotate the flywheel using an Allen key.

Find the top dead centre with the tool (99395097) - False injector

Figure 100



To find the top dead centre position of the cylinder, end of compression stage:

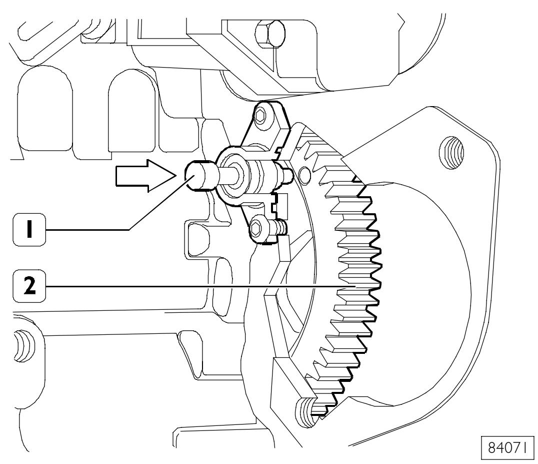
❑ remove the cover of the cylinder rocker arms;

❑ remove the injector and position tool 99395097 (1); preload the dial gauge.

To obtain this condition, turn the crankshaft to the dial gauge's maximum reading; check that the cylinder's intake and exhaust valves are both closed, and not balanced.

Finding the TDC position of cylinder n. 1 under full compression with the camshaft lock pin (99360616)

Figure 101



To find the position of cylinder n. 1 at top dead centre under full compression:

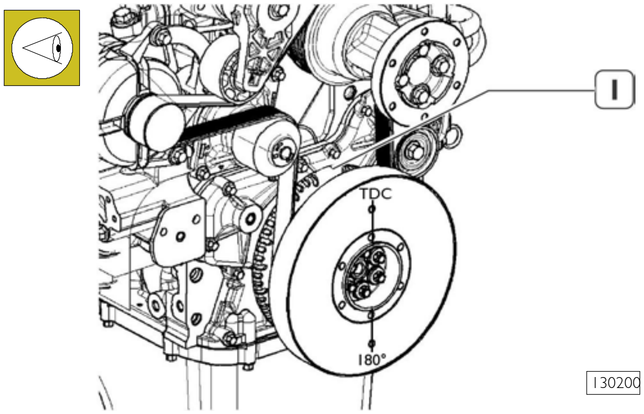
❑ remove the cylinder's rocker arm cover;

❑ turn the flywheel until the pin 99360616 (1) locks the gear (2) when it is pushed in;

❑ check that cylinder n. 1's intake and exhaust valves are both closed and not balanced.

For 4 cylinder engines

Figure 102



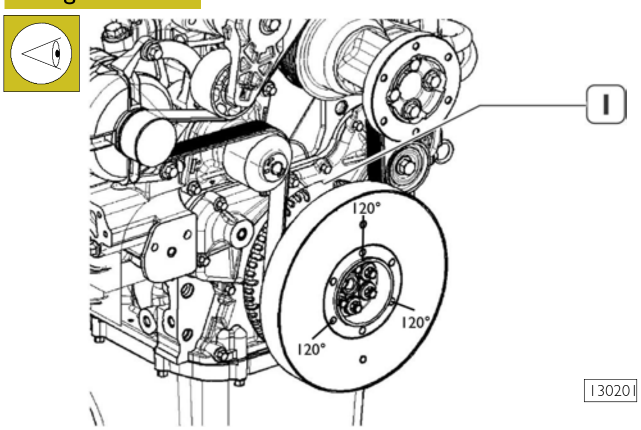
- ❑ Also check that the unperforated part (1) of the phonic wheel is positioned uppermost (cylinder n. 1 at TDC) and the valves of cylinder n. 4 are balanced. If cylinder n. 1 is balanced, rotate the engine through one revolution to obtain the specified condition.
- ❑ Adjust the clearance of cylinder n. 1's valves as indicated in the relevant paragraph.
- ❑ Now rotate the crankshaft as shown in the table to adjust the clearance of the rocker arms of the other cylinders.

IFIRING ORDER: 1 – 3 – 4 - 2

Start and crankshaf rotation	Adjusting intake and exhaust valve rocker arm clearance on cylinder n.
Cylinder n. 1 at TDC	1
Rotate through 180°	3
Rotate through 180°	4
Rotate through 180°	2

For 6 cylinder engines

Figure 103



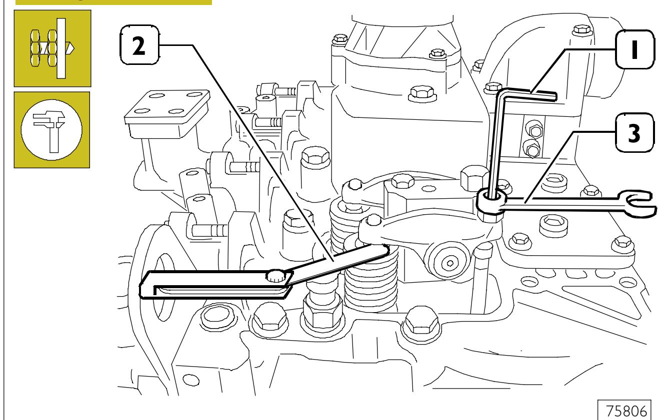
- ❑ Also check that the unperforated part (1) of the phonic wheel is positioned uppermost (cylinder n. 1 at TDC) and the valves of cylinder n. 4 are balanced. If cylinder n. 1 is balanced, rotate the engine through one revolution to obtain the specified condition.
- ❑ Adjust the clearance of cylinder n. 1's valves as indicated in the relevant paragraph.
- ❑ Now rotate the crankshaft as shown in the table to adjust the clearance of the rocker arms of the other cylinders.

FIRING ORDER:: 1 – 5 – 3 – 6 – 2 – 4

Start and crankshaft rotation	Adjusting intake and exhaust valve rocker arm clearance on cylinder n.
Cylinder n. 1 at TDC	1
Rotate through 120°	5
Rotate through 120°	3
Rotate through 120°	6
Rotate through 120°	2
Rotate through 120°	4

Adjusting the rocker arm clearance

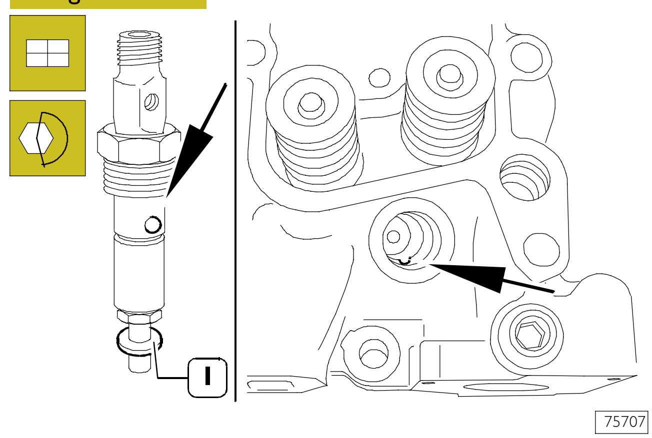
Figure 104



Adjust the play between the rocker arms and valves using a hex key (1), polygonal key (3) and feeler gauge (2).
Play is:

- ❑ intake valves: 0.25 ± 0.05 mm
- ❑ exhaust valves: 0.50 ± 0.05 mm

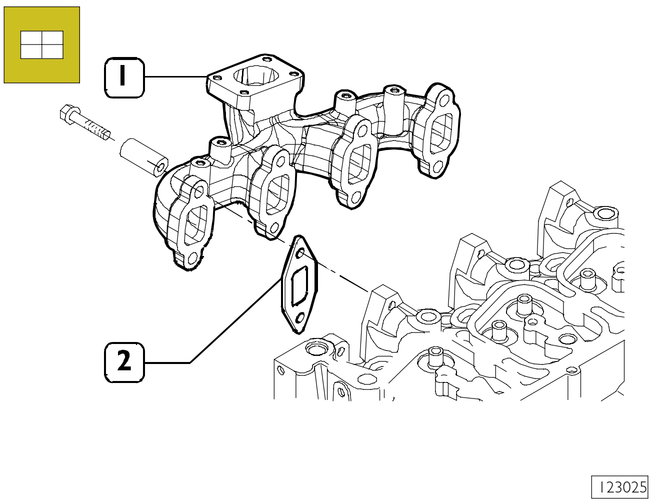
Figure 105



- ❑ Assemble injectors after having replaced the sealing gasket (1).

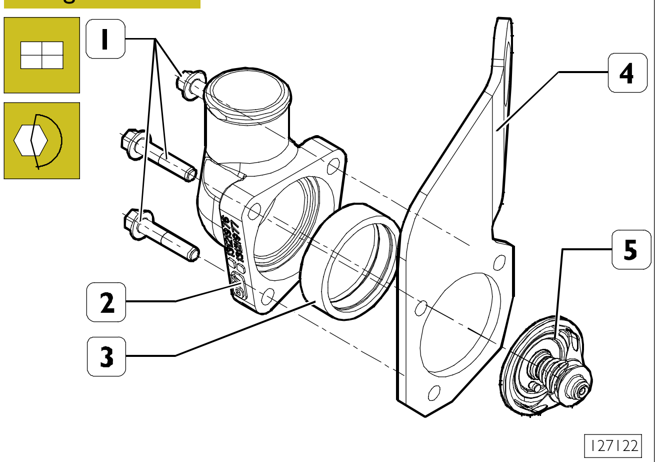
NOTE During assembly of injectors, verify that the injector sphere is correctly positioned on the head housing.

Figure 106



- Assemble exhaust manifold (1) providing new gaskets (2).

Figure 107



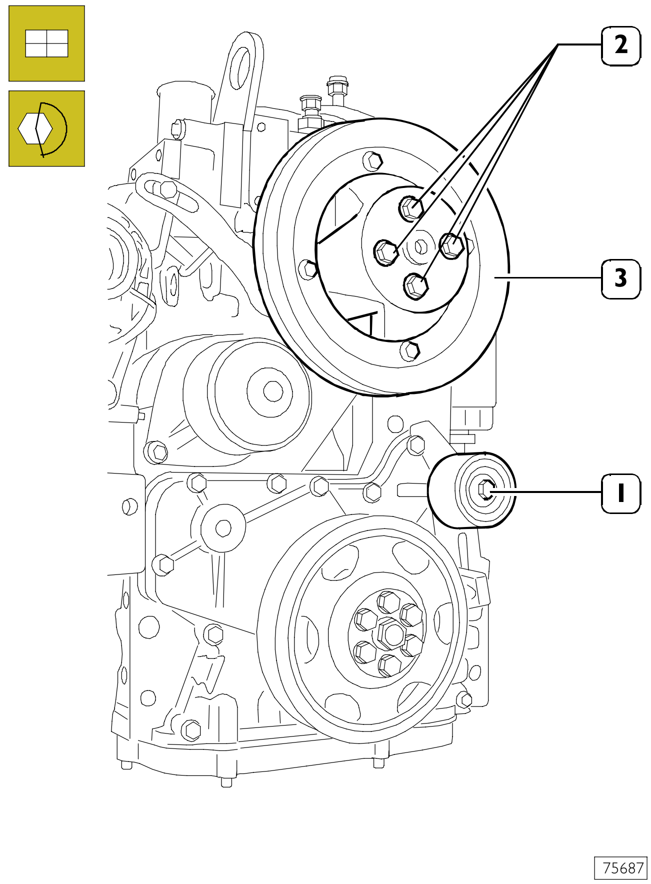
- Assemble thermostat unit (2) including thermostat (5) and gasket (3).
- Tighten the screws to the prescribed couple.

NOTE The screws (1) have been have been utilised to fix the bracket (4).

Disassemble the bracket and reassemble components from 1 to 5 as shown in the picture.

The gasket (3) must be new.

Figure 108

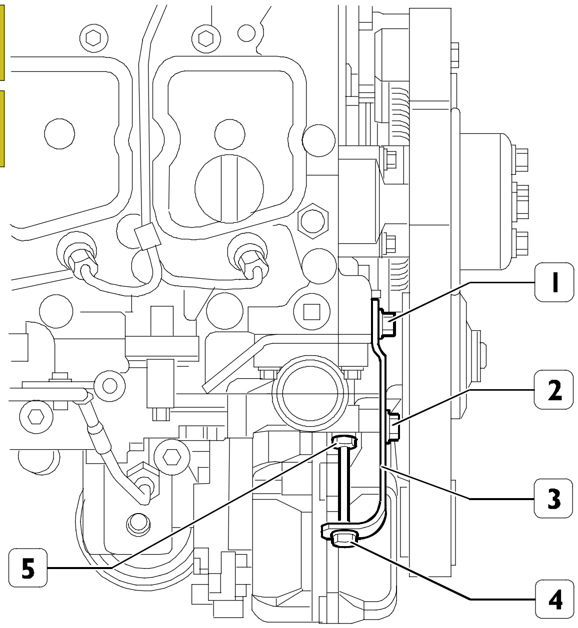


- Assemble the pulley fan bearing tightening the screws to the prescribed couple.
- Mount pulley (3) and secure it to support through screws (2).
- Assemble the transmission pulley (1).
- Fit the new belt onto the pulleys and guide rollers.

NOTE If not faulty the gasket can be reused.

For engines with a traditional belt tensioner

Figure 109

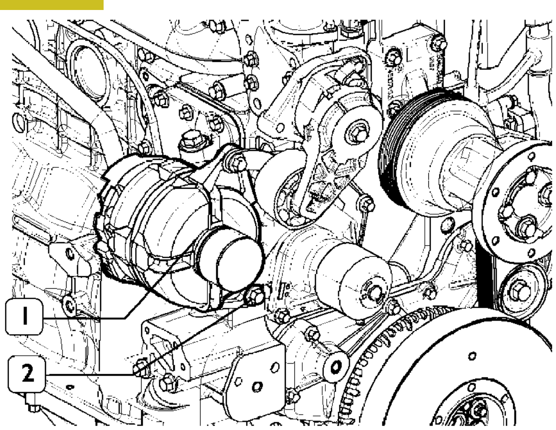


127123

- Tighten the screw (2), the screwnut (5) and the screwnut fastening the alternator to the support.
- Assemble the alternator tensioning bracket (3) and secure it through screw (1)
- Tighten the screw (2) without locking it
- Tension drive belt operating on the screw (4)

For engines with an automatic belt tensioner

Figure 110

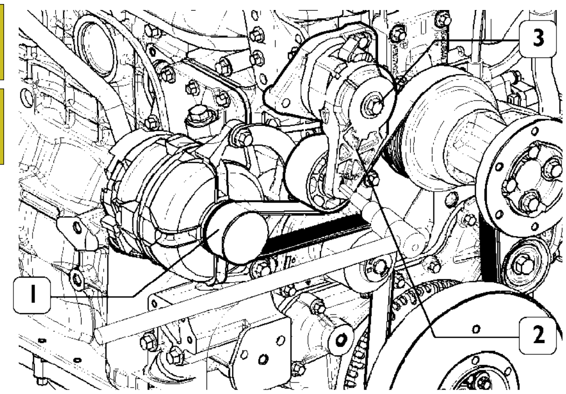


114792

Refit the alternator (1).

Tighten the screw (2) to the specified torque.

Figure 111

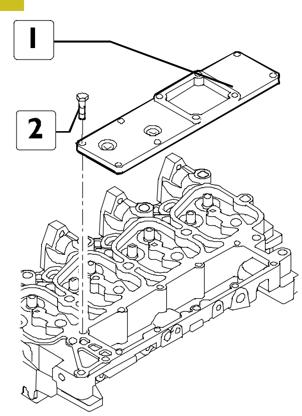


114793

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.

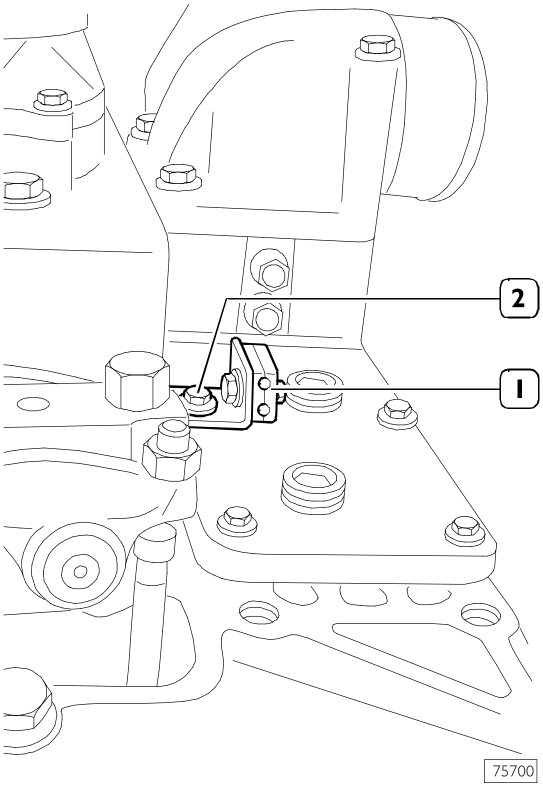
Figure 112



127127

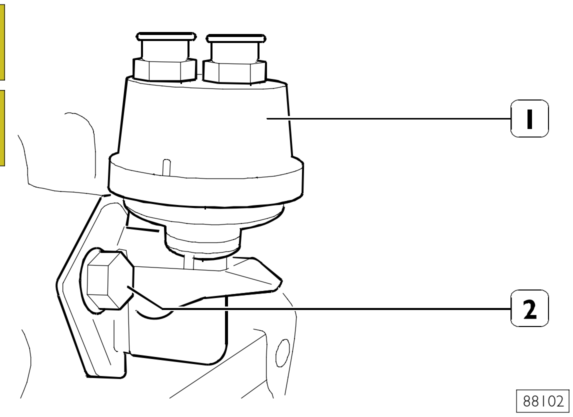
- Apply on the surface joining the suction manifold plate (1) a sufficient coat of Loctite 5999 and provide. fixing the screws (2) to the prescribed couple.

Figure 113



❑ Assemble the brackets (1) fixing the fuel pipelines to the injectors: use the same screws (2) fixing the manifold plate as shown in the picture.

Figure 114



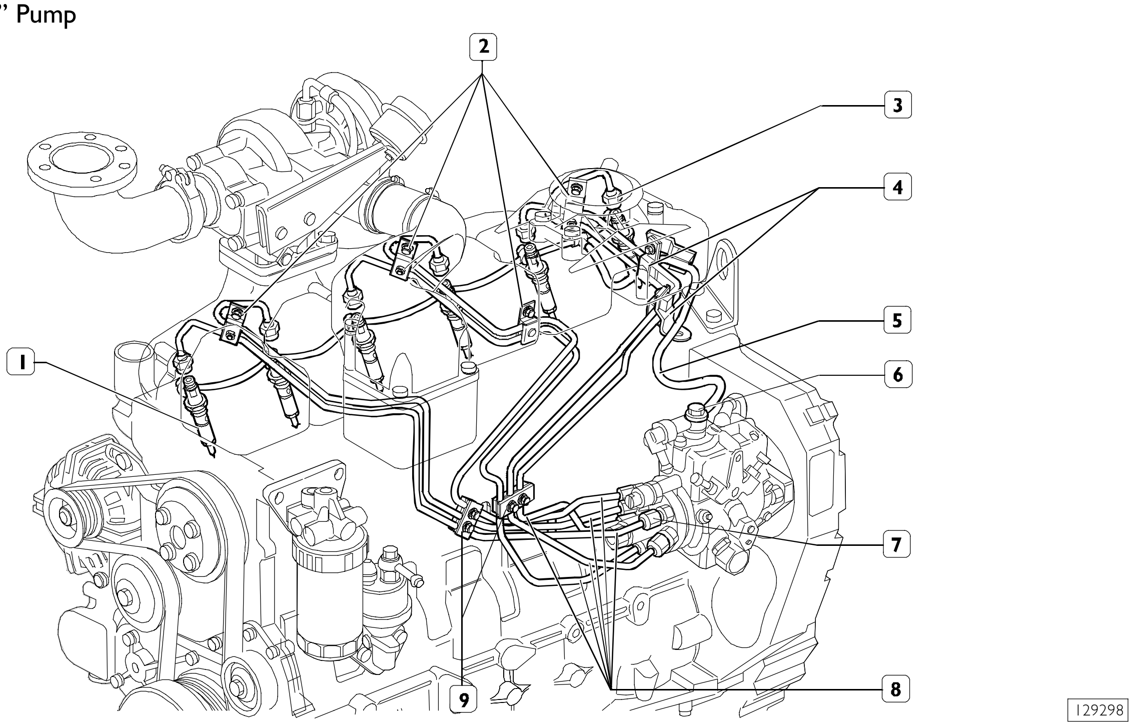
❑ Assemble priming pump (1) providing new gasket and tighten the screws (2) to the prescribed couple.

❑ Also assemble feed pump (see specific procedure) and the power take-off underneath.

NOTE Pump mounting requires specific procedure contained in this section.

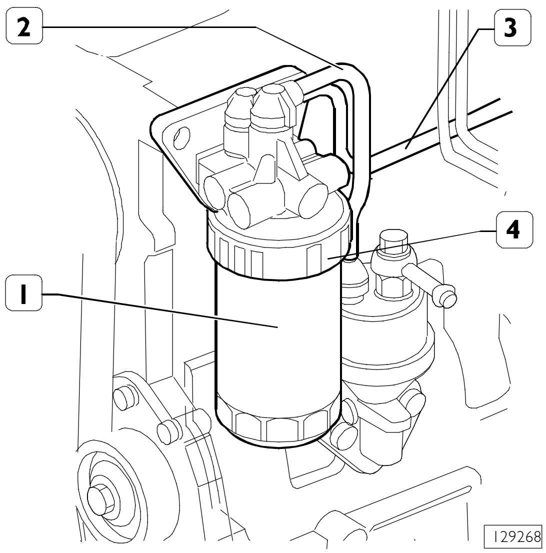
STANADYNE "D" Pump

Figure 115



❑ Fit the pipes (5) and (8) forming the fuel supply and recovery between the pump and the injectors:screw on the ring nuts (7) securing the pipes to the pumping elements;fasten the collar of the fuel recovery pipe returning to the injection pump (6);tighten the ring nuts (3) on the injectors (1) and screw on the bolts securing the fuel recovery pipe;
secure the pipes (2, 4 and 9) with the brackets fitted beforehand.

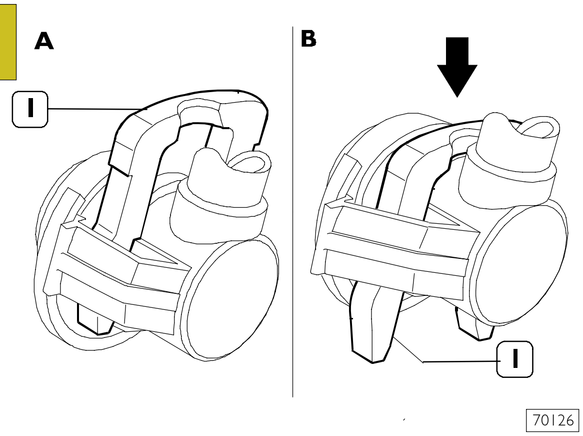
Figure 116



- ❑ Assemble the fuel filter bearing (1) to the bracket fixed to the engine head.
- ❑ Connect the fuel pipelines (4 and 3) respectively from priming pump to filter bearing and from this last one to feed pump.
- ❑ Using 99360076 equipment assemble fuel filter (2).

NOTE The filter shall be priory filled with fuel to facilitate feed system bleed operations.

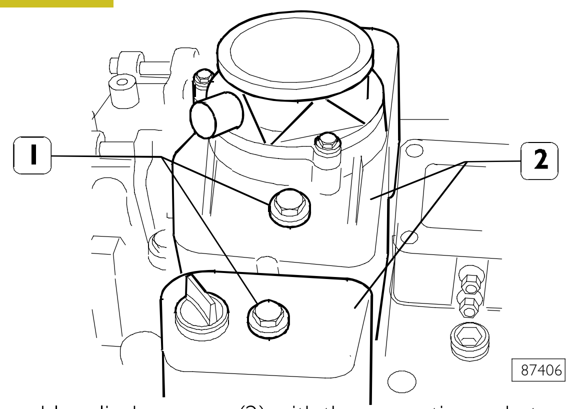
Figure 117



NOTE To connect fuel pipelines (3 and 4, Figure 116) in low pressure from the relating connection unions it is necessary to press the locking fastener (1) as shown in picture B.

After having connected the pipeline, reset the fastener (1) into block position as shown in picture A.

Figure 118



- ❑ Assemble cylinder covers (2) with the respective gaskets;
- ❑ Fit the seal nods and tighten the screws fixing them to the prescribed couple.

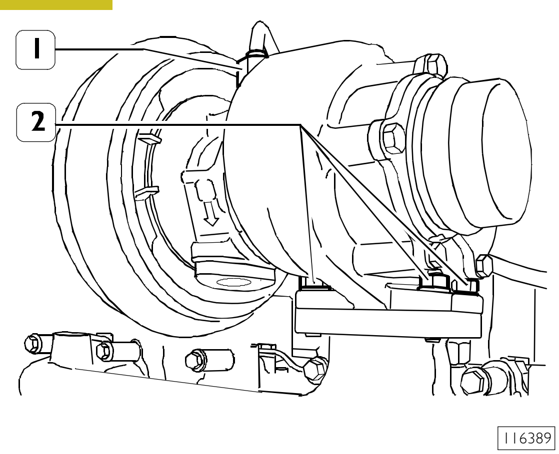
NOTE Always replace the gaskets using new ones.

Check the threads of the fixing screws: there shall be no evidence of wear or dirt deposit.

Seal nods shall have no visible deformation. In such case provide for replacement with new nods.

If not faulty the gasket can be reused.

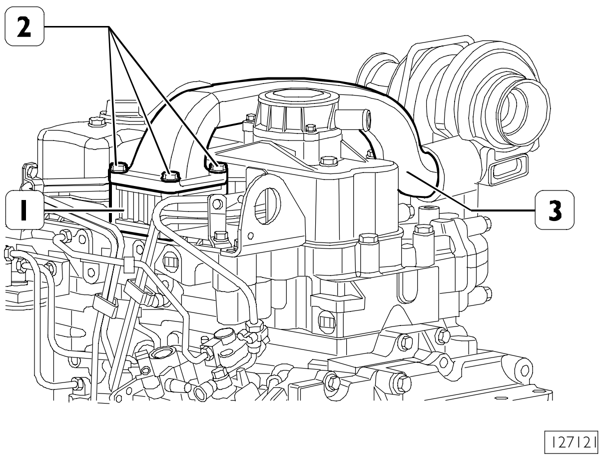
Figure 119



Proceed assembling the turbocharger:

- ❑ Hold the turbocharger and place it on the exhaust manifold after having interposed the gasket.
- ❑ Screw up the fixing (2) nuts of the turbocharger to the exhaust manifold tightening them to the prescribed couple.
- ❑ Tighten the lubrication pipe fixing ring. Operate in the same way on the other end of the pipe. Connect it to the upper part of the heat exchanger.

Figure 120



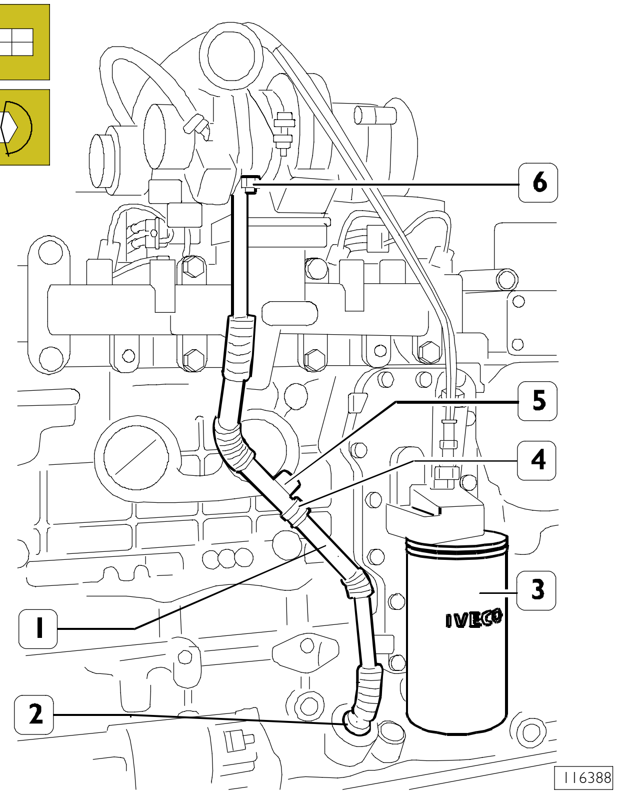
- Refit the duct (3) and thje heater (1), after having fitted new gaskets, and thighten the screws (2) (if present).

To complete engine assembly it is necessary to remove it from the turning stand.

- Using rocker arm 99360595 hold the engine and loosen the screws fixing the brackets to the turning stand 99322205.
- Disassemble the brackets 99361037 from the engine after having properly put it on a wooden bearing.

Completion of engine re-assembly

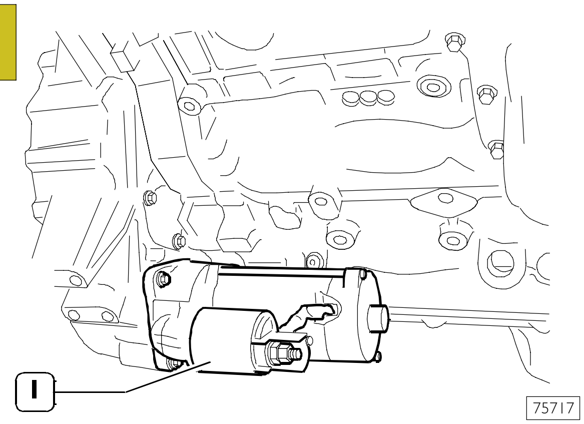
Figure 121



From the right-hand side:

- Re-assemble the lubrifying oil discharge pipe (1) from the turbo-blower by inserting the joint (2) into the engine crankcase and tightening the two fastening (6) screws underneath the turbo blower;
- Tighten the screw (5) which holds the piping to the (1) monoblock by means of the cylinder bracket (4);
- Re-assemble the oil filter (3) onto the heat exchanger with tool 99360076;

Figure 122



- re-assemble the starting engine (1); opportunely support the starting engine (1) and tighten the two fastening screws to the prescribed torque.

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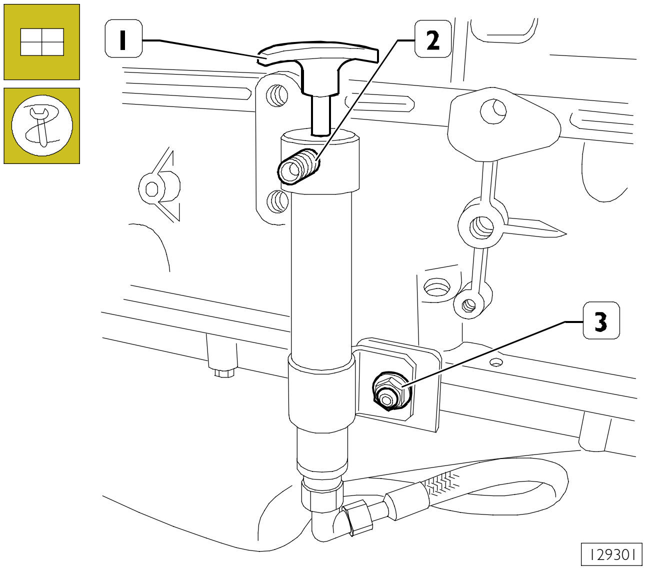
Refitting engine to radiator

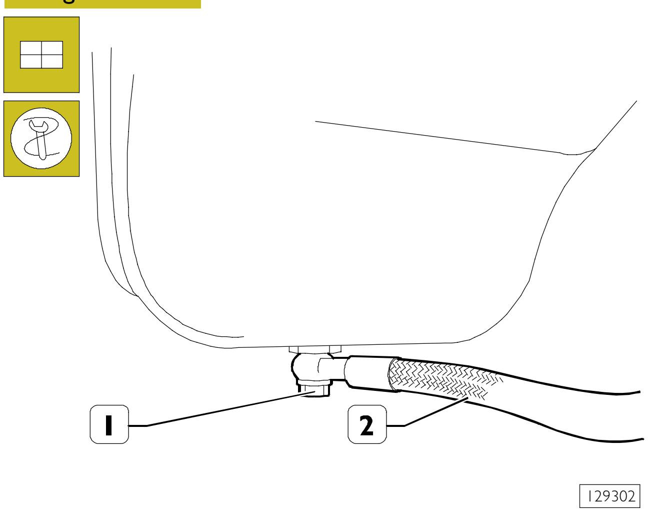
For versions with an oil drainage pump

Figure 123



- ❑ Reposition the dipstick and the oil filler plug;
- ❑ Refit the pump tightening the nut (3) to the recommended torque.

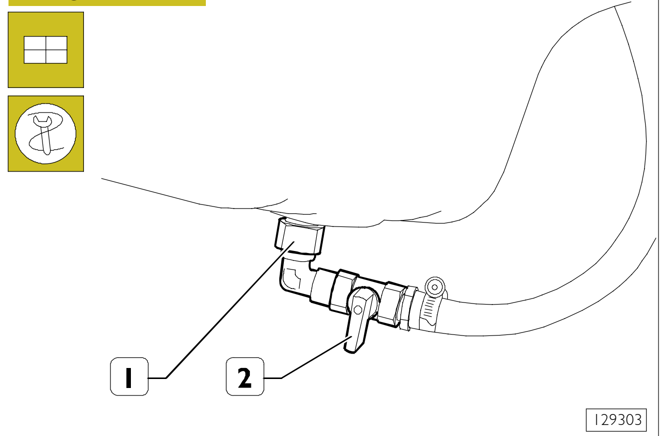
Figure 124



- ❑ Refit the pipe (2), tightening the bolt (1) to the recommended torque.

For versions with an oil drainage tap

Figure 125

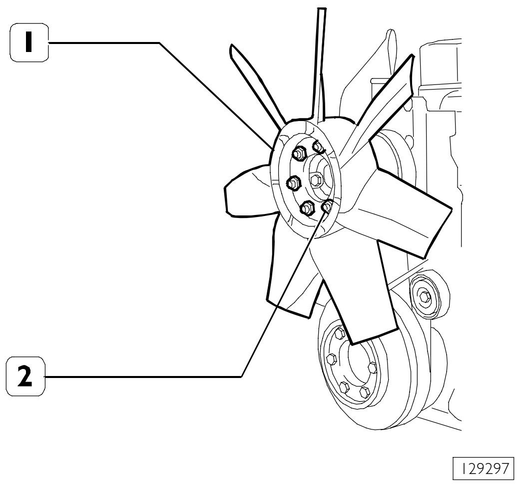


- ❑ Reposition the dipstick and the oil filler plug;
- ❑ Refit the pipe, tightening the bolt (2) to the recommended torque.

NOTE Some versions have a plug for draining the oil from the sump.
Proceed with closing the plug under the sump, after having repositioned the dipstick and the oil filler plug.

For all engines

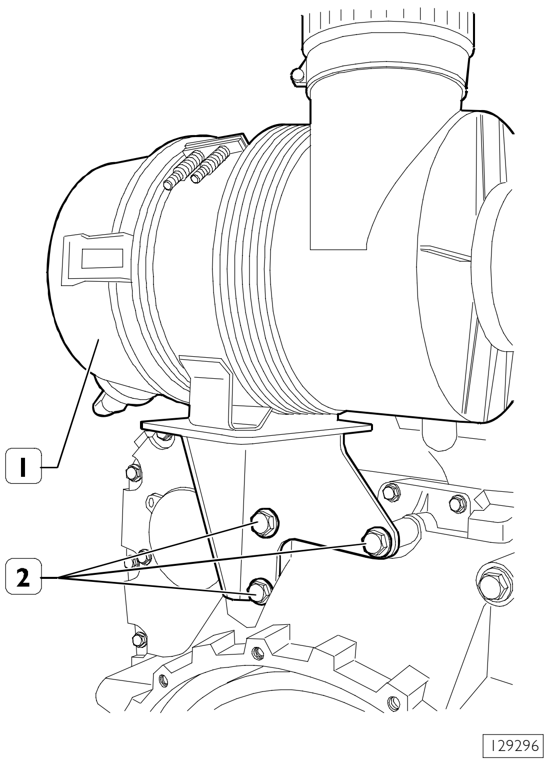
Figure 126



❑ Refit the fan (1), complete with spacer and tighten the bolts (2) to the recommended torque.

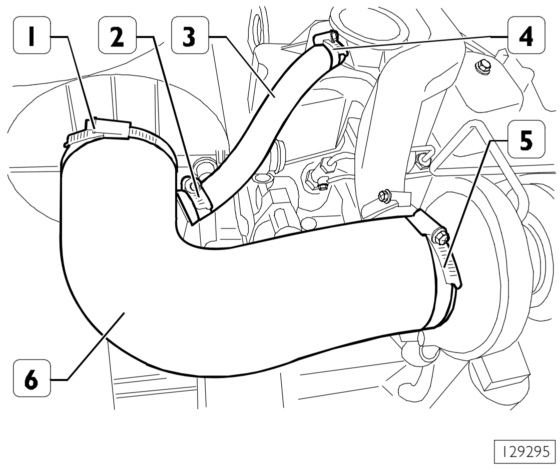
NOTE The shape and the size of the drainage pipe vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out.
The procedures described can, however, be applied.

Figure 127



❑ Fit the air filter complete with mounting (1) and tighten the bolts (2) to the recommended torque.

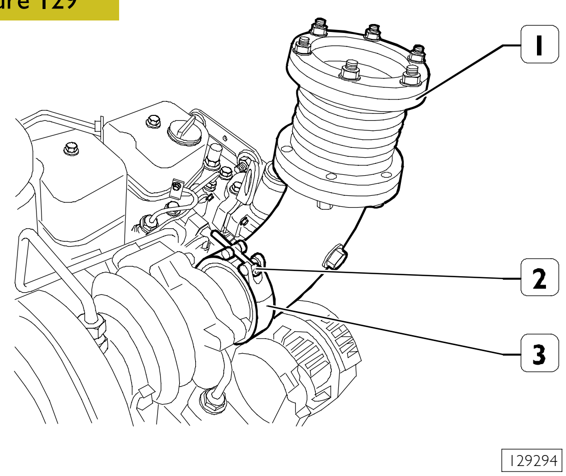
Figure 128



❑ Connect and air intake pipe (6), closing the bands (1) and (5).

❑ Connect and oil vapour recovery pipe (3) closing the bands (2) and (4).

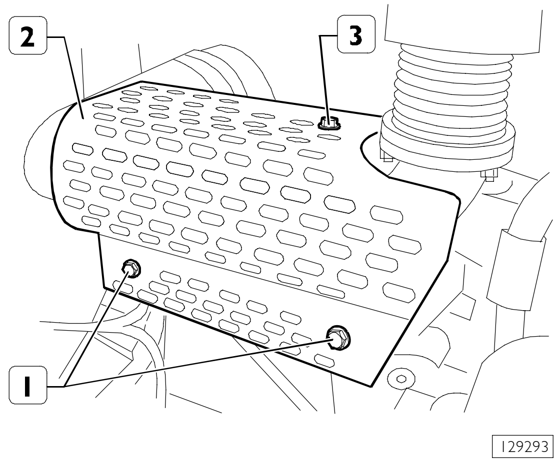
Figure 129



❑ Connect the drainage pipe (1) tightening the bolt (2) to close the band (3).

NOTE The shape and the size of the drainage pipe vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out.
The procedures described can, however, be applied.

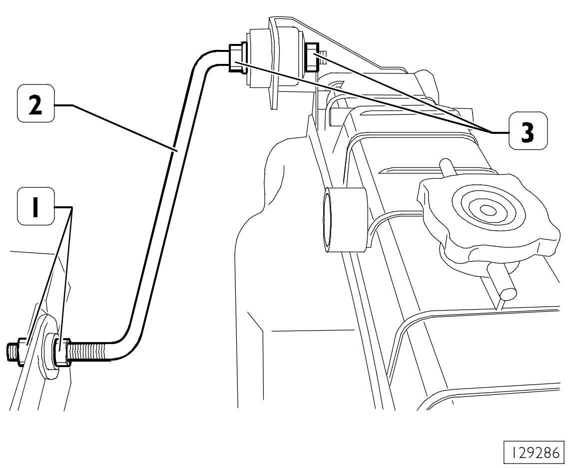
Figure 130



- If present, refit the turbine guard grille (2), restoring the mounting brackets and adjusting the bolts (1) and (3).
- Refit the radiator assembly on the crankcase, paying attention to any interference with the fan and tighten the fixing bolts on both sides to the recommended torque.

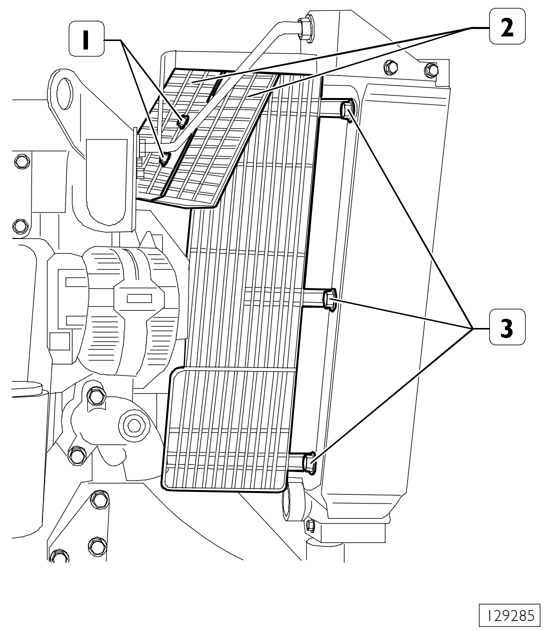
For 4 cylinder engines

Figure 131



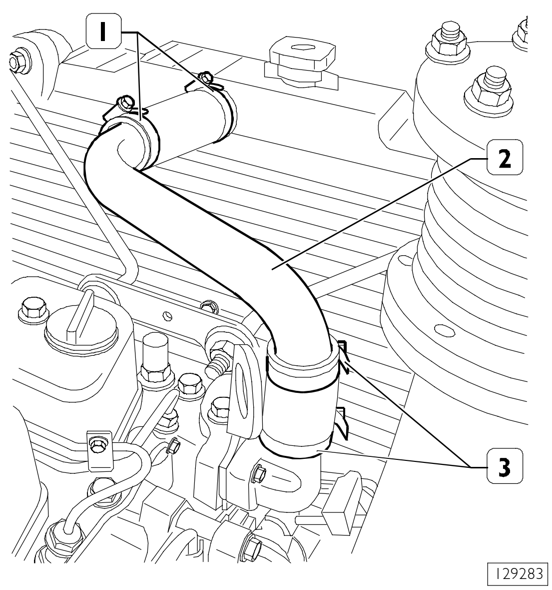
- Fit the bracket (2) and tighten the nuts (1) and (3) to the recommended torque.
  Repeat the operation for the second bracket.

Figure 132



- Fit the protective grilles (2) for the fan tightening the fastenings (1) and (3) to the recommended torque.

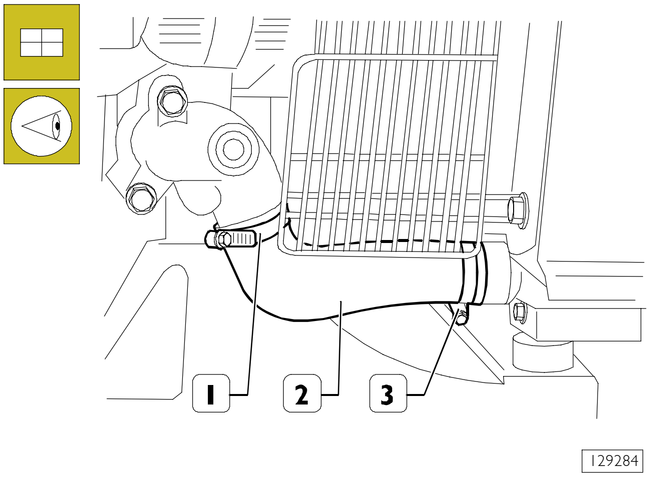
Figure 133



- Fit the pipe (2) complete with hoses adjusting the bands (1) and (3).

NOTE Check the rubber hoses for wear.

Figure 134

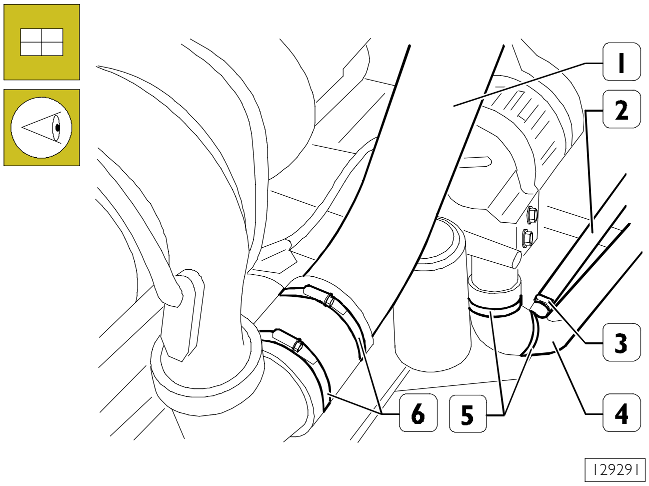


❑ Fit the pipe (2) complete with hoses adjusting the bands (1) and (3).

NOTE Check the rubber hoses for wear.

For 6 cylinder engines

Figure 135



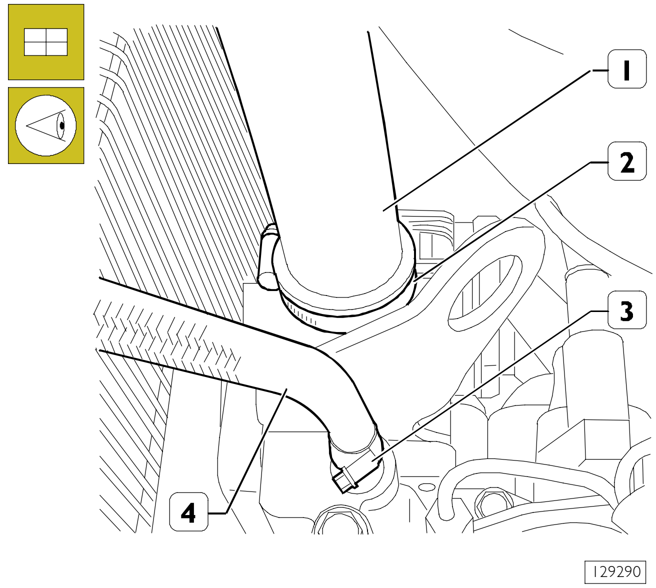
❑ Fit and pipe (4) complete with hoses, on the engine side, adjusting the bands (5).

❑ Fit the pipe (2) complete with hoses adjusting the band (3).

❑ Fit and pipe (1) complete with hoses, on the engine side, adjusting the bands (6).

NOTE Check the rubber hoses for wear.

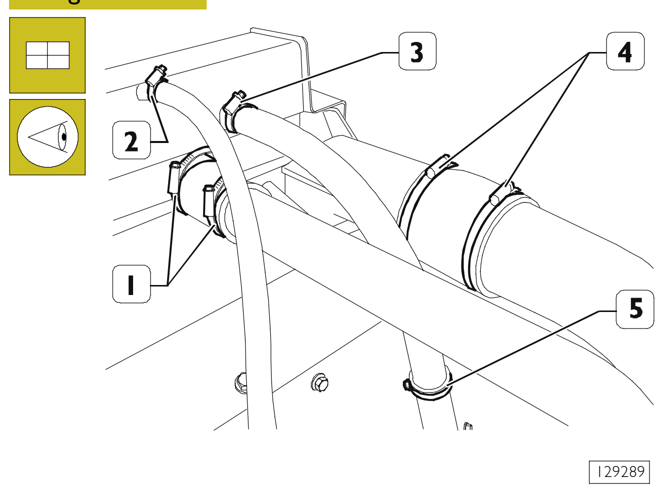
Figure 136



❑ Fit the pipes (1) and (4) complete with hoses adjusting the bands (2) and (3).

NOTE Check the rubber hoses for wear.

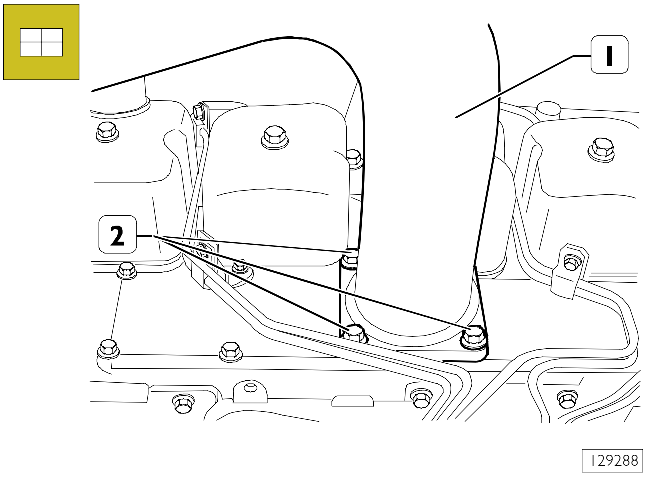
Figure 137



❑ Connect the air and water pipes to the radiator assembly adjusting the bands (1), (2), (3) and (4) and the mounting bracket (5).

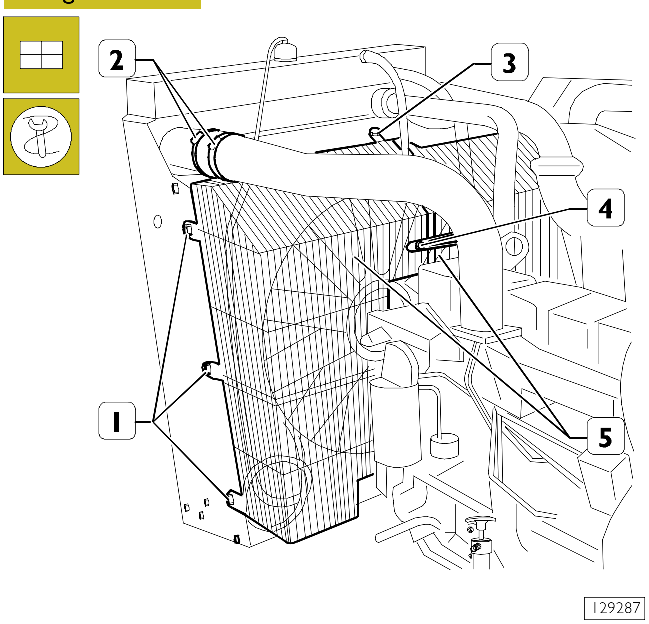
NOTE Check the rubber hoses for wear.

Figure 138



❑ Fit the pipe (1) and tighten the bolts (2) to the recommended torque.

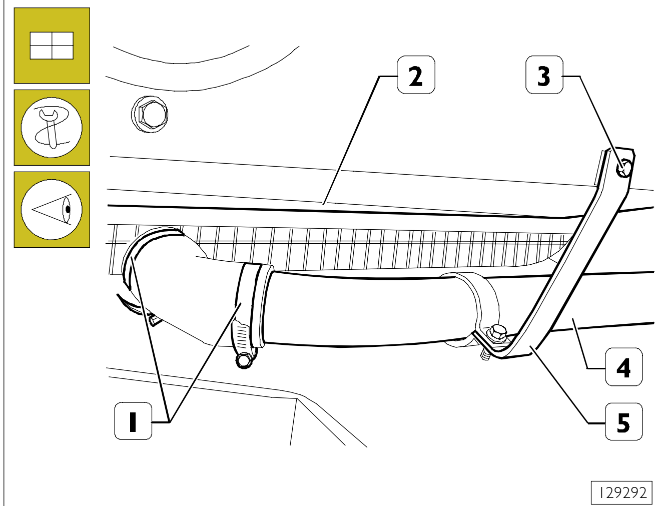
Figure 139



❑ Fit the protective grilles (5) for the fan tightening the fastenings (1), (3) and (4) to the recommended torque.

❑ Close the bands (2).

Figure 140



❑ Connect the pipe (4), complete with hoses and bracket (5) to the radiator assembly adjusting the bands (1) and tightening the bolt (3) to the recommended torque.

NOTE Check the rubber hoses for wear.

For all engines

❑ Refit and connect the electrical wiring;

❑ refill the cooling system with coolant;

❑ bleed the air from the supply system as described in the relevant paragraph;

❑ check the engine oil level;

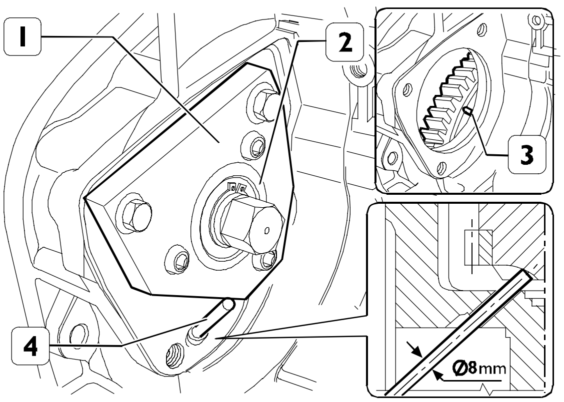
❑ carry out the tests and checks described in the relevant chapter.

Rotary feed pump disassembly and assembly procedure

NOTE This procedure prescribes that:

- the fuel pipes (from the pumping elements to the injectors, recovering blow-by from the injectors to the pump and the supply from the priming pump) have all been removed;
- the electrical connections have been disconnected.
- Accelerator cable shall be disconnected.

Figure 141



123031

Disassemble the starter from the flywheel box and use tool 99360339 (1) to rotate the flywheel.

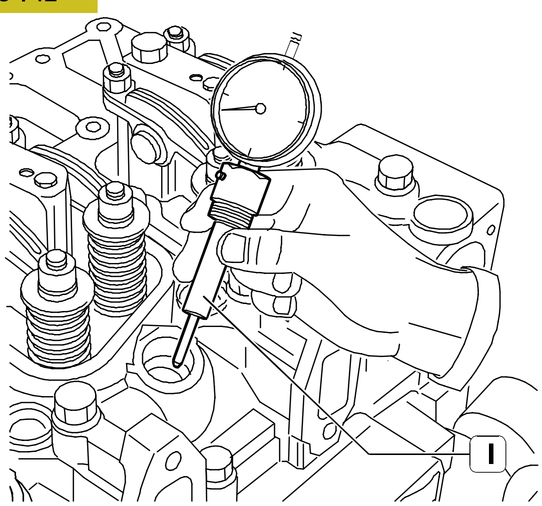
In case feed pump replacement is necessary, this shall be supplied pre-set already as spare part.

On the other hand, in case the pump shall be disassembled and reassembled later on without being repaired it will be necessary to pr-set it while it is still assembled to the engine and disassemble it only afterwards.

The following procedure analyses this second hypothesis since it is the more complex.

Find the top dead centre with the tool (99395097) - False injector

Figure 142

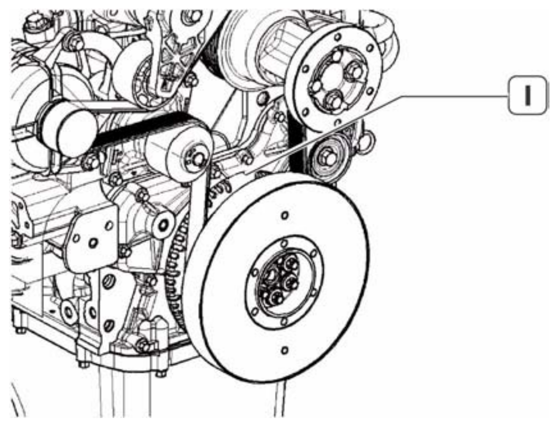


88141

Remove the rocker covers of the 1st cylinder; remove the 1st injector and place the tool (1) to set the 1st cylinder top dead centre position (end-of-compression phase). Pre-load the gauge.

The searched condition is obtained by rotating the engine shaft properly until you find the maximum value on the comparator and then checking that the intake and exhaust valves are both closed.

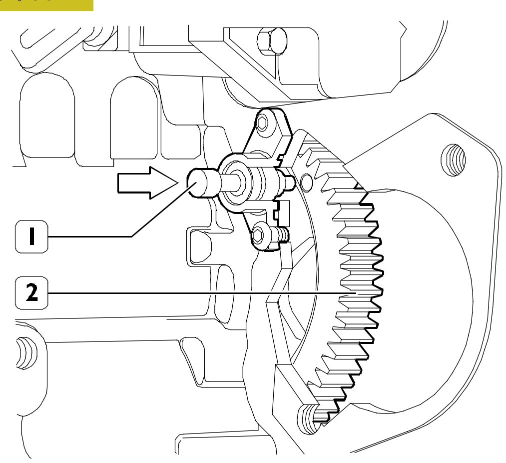
Figure 143



130192

- Check that the part of the flywheel that is not perforated (1) is positioned at the top along the vertical axis.

Figure 144

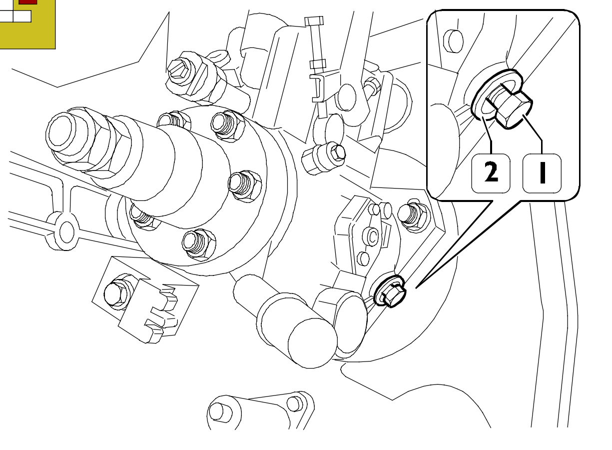


84071

Turn the flywheel until, when pushing the pin 99360616 (1), it blocks the gear (2) obtaining the TDC of the 1° cylinder.

Disassembly

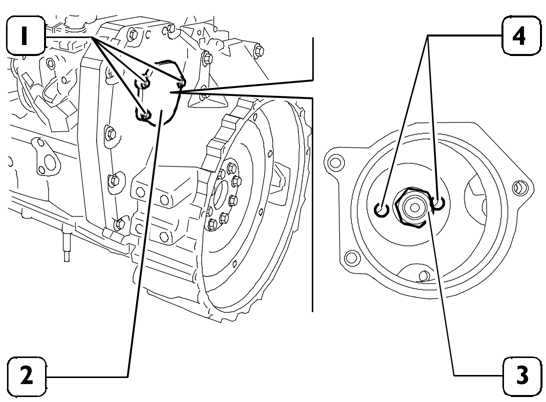
Figure 145



106659

- Partially unlock pump shaft retaining screw (1) and move spacer with slot (2) in area with lager size hole for complete screw passage.
- Lock applying a torque ranging between 11,9 and 12,4 Nm retaining screw (1) till reaching spacer, thus locking pump shaft rotation.

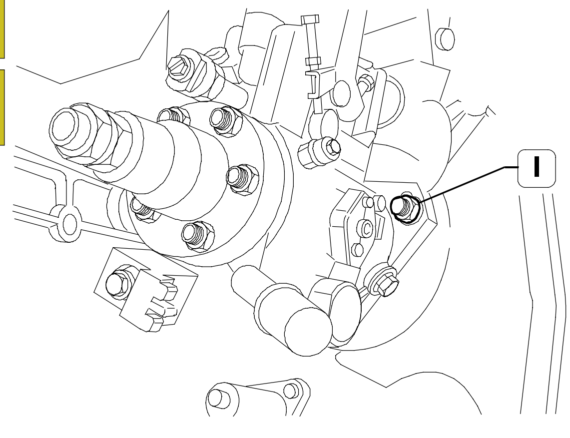
Figure 146



75693

- From timing side, remove the cover (2) loosening the screws (1) in order to have access to the union fixing nut (3) to the pump driving gear.
- Loosen the fixing nut (3) and remove the relating washer.

Figure 147



106658

- From the pump side, loosen the fixing nuts (1) without removing them in order to enable moving the pump backwards using 99340035 extractor.
- Assemble the 99340035 extractor throughout the two threaded ports (4, Figure 146) and withdraw the gear from the pump shaft.
- Properly hold the feed pump and loosen completely the fixing nuts.
- Withdraw the pump from the studs, together with the gasket.

NOTE Hold the pump driving gear to avoid interference or crawling during timing gear rotation.

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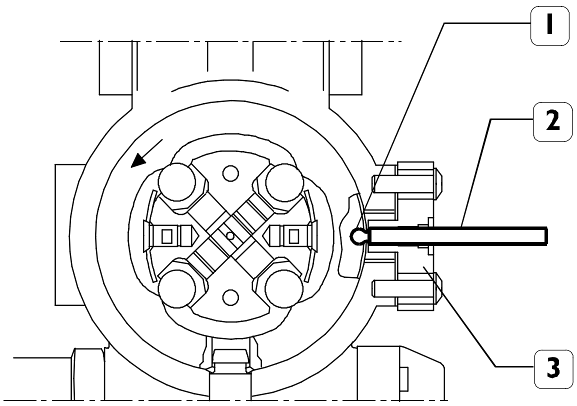
Rotary feed pump setting check

Figure 148



106660

1. Slot on the hub of the hydraulic rotor - 2. Synchronization pin 99365196 - 3. Plate.

The synchronization pin 99365196 (2) has been designed for use in the event of the rotor shaft being inadvertently released.
The correct synchronization of the pump with the engine is obtained when the synchronization pin 99365196 (2), fitted in the hole on the plate (3), enters the slot (1) on the exterior of the hydraulic rotor hub.

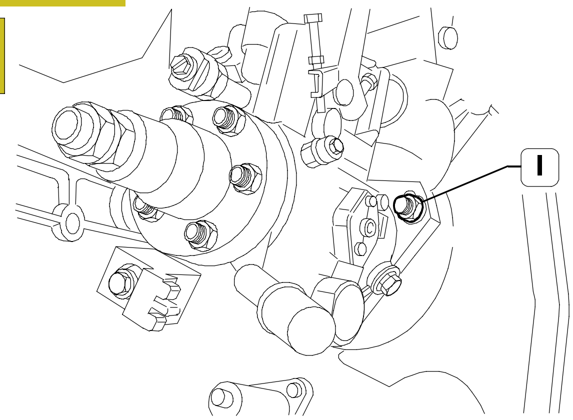
Therefore:

- ❑ Remove the screw cap (3) at the centre of the plate.
- ❑ Insert the synchronization pin (1) 99365196 in the hole on the plate (3). The synchronization position is obtained when the synchronization pin (2) enters the slot on the hydraulic rotor hub.
- ❑ Lock the control shaft in the correct position by means of the screw (1, Figure 145).
- ❑ Remove the synchronization pin and fit the screw cap of the plate (3). Tighten the cap using a torque of 2.3 ÷ 3.4 Nm.

NOTE Support the pump gear to prevent interference or sticking when the timing system gears turn.

Assembly

Figure 149



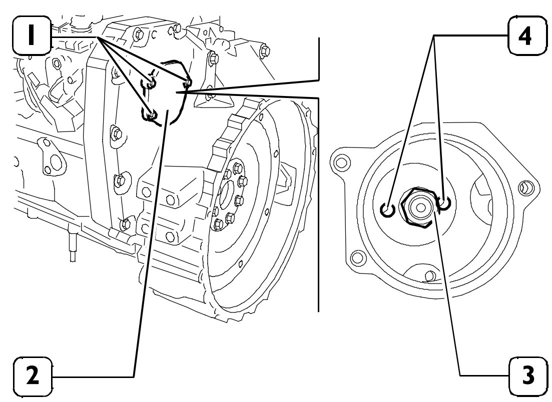
106658

When installing supplì pump on engine, cylinder no.1 must be at TDC, end of compression phase.

- ❑ Assemble the pump pre-set in its housing on the engine, fitting the shaft into the gear port (not provided with wrench).
- ❑ Tighten the fixing nuts (1) locking the pump flange in the slot centre.

NOTE The gasket removed during pump disassembly shall not be utilised again.
Always use original spare parts.

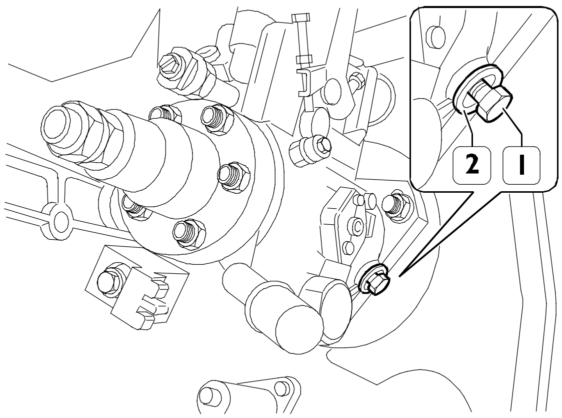
Figure 150



75693

- ❑ On the timing side, throughout the specially appointed port, fit the washer and screw up the fixing nut (3) to the pump shaft. Lock the nut to the 190-203 Nm couple.
- ❑ Assemble the cover (2) including gasket and tighten the screws (1).

Figure 151



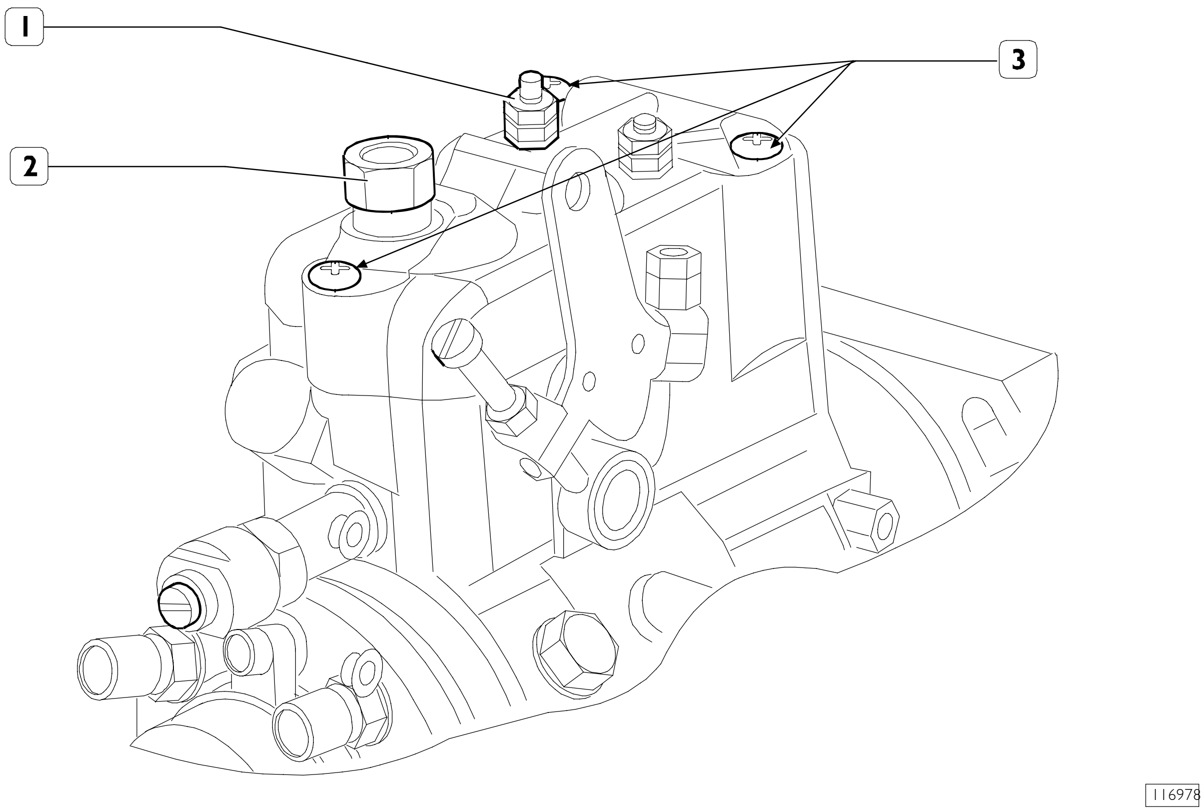
106659

- - Svitare, senza rimuovere, la vite (1) di bloccaggio rotazione dell'alberino della pompa e spostare il distanziale con asola nella zona del foro di dimensioni minori. Avvitare fino a battuta la vite bloccando il suddetto distanziale: in questo modo l'alberino della pompa di alimentazione è libero di ruotare.
- Disassemble the flywheel rotation/locking tool 99360339 or 99360330; arrange the starting motor in its seat.
- Connect all the pipes (from the pumping elements to the injectors, recovering blow-by from the injectors to the pump and the supply from the priming pump).
- Connect the electrical connections.

NOTE In case pump removal has been carried out while the engine was assembled, connect acceleration cable.

ASSEMBLY PROCEDURE OF THE ”ADC100” ELECTRONIC ACTIVATOR ON STANADYNE SERIES ”D” INJECTION PUMPS

Figure 152



Before proceeding in the removal of the Injection Pump cover and then to the replacement with the electronic actuator, it is important to clean the external part of the pump, if necessary, using solvents. This prevents contamination of the internal part of the pump.

- ❑ Disconnect the wire of the stop electro-valve from the clamp (l) positioned on the pump cover, being careful to isolate it.
- ❑ Remove the fuel return pipe from the connection (2)
- ❑ Remove the three screws (3) of the pump cover. The screws will then be replaced assembling the screws supplied with the ADC100 actuator
- ❑ Remove the cover of the injection pump very carefully so that the dirt won't penetrate inside the pump.
- ❑ Remove the connection (2) of the fuel return pipe and the sealing from the injection pump cover. Keep the connection (2) and the sealing that will have to be assembled on the electronic actuator.

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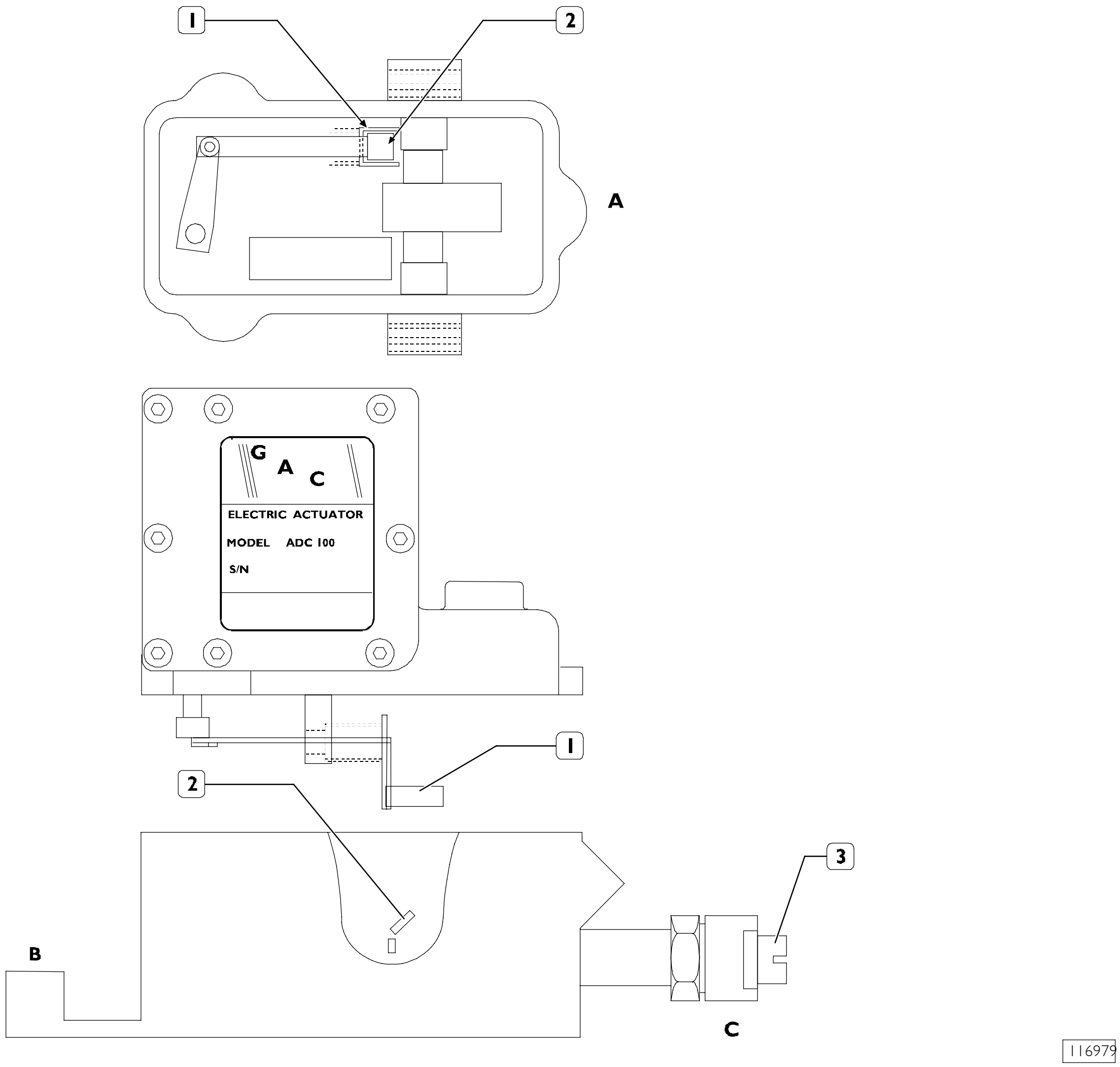
Figure 153



A. The injection pump open seen from above - B. Front (carter side) - C Rear (injector side)
1. The "U" shaped hook of the electronic actuator - 2. Injection pump lever - 3. Droop adjustment screws

Assembly of the actuator

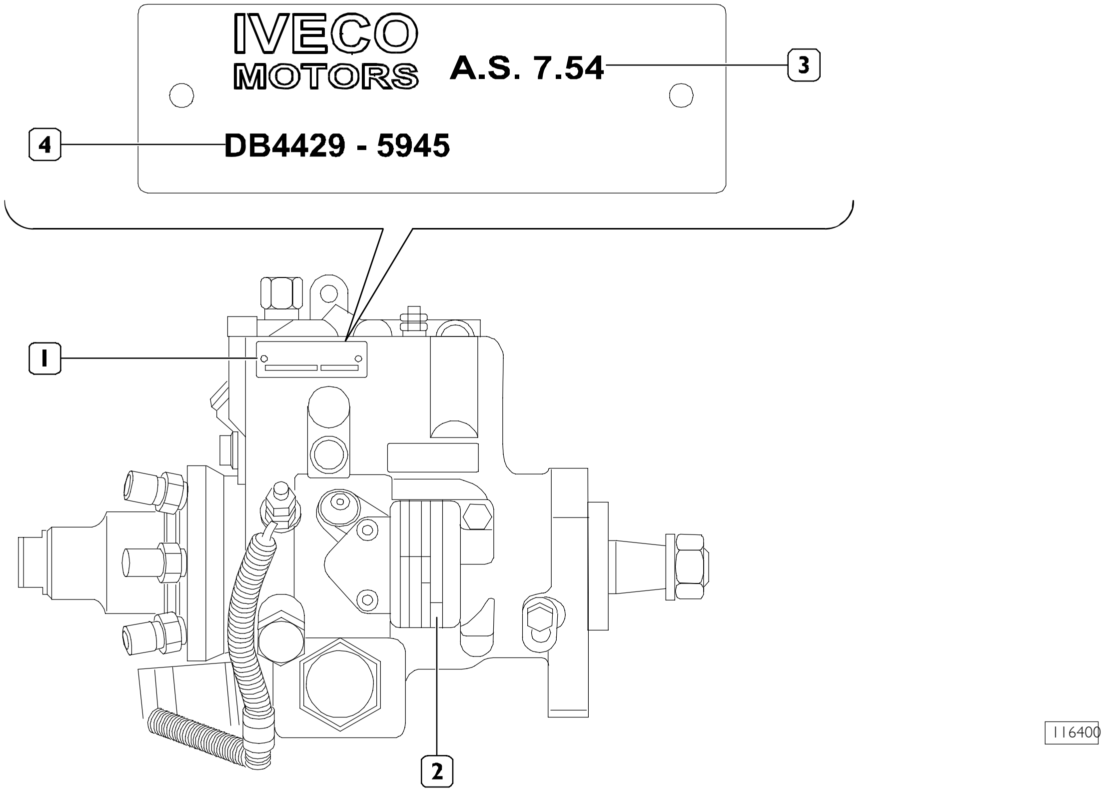
- Reassemble the connection for the fuel return pipe and the pump cover's original dealing, on the ADC100 electronic actuator.
- Position the electronic actuator on the injection pump with the highest part slightly titled upwards.
- Slide the electronic actuator towards the rear part of the pump (injectors' side) until the "U" shape hook (1) of the actuator engages the lever of the injection pump (2). Once engaged, align the holes of the pump and the electronic actuator.

NOTE Couplings mistakes between the actuator's hook (1) and the lever (2) of the injection pump cancause motor over speed conditions.

- Tighten the ADC100 actuator to the injection pump, using the screws supplied with the actuator.
- Reconnect the fuel return pipe to the connection placed on the actuator.

PASSAGE FROM 50 HZ TO 60 HZ FOR NEF MOTORS WITH STANADYNE PUMP

Figure 154



According to the specific needs of the motor employment it is possible that a request to vary the adjustment of the Stanadyne pump be made to obtain a different use frequency:

- 1500rpm/50Hz
- 1800rpm/60Hz

The necessary procedures will be described in order to execute the following adjustments:

- passage from 50 Hz to 60 Hz and vice versa.
- stabilizing of the rotation regime.

NOTE If only the Stanadyne identification tag (2) is present, this means that the injection pump presents a setting of 50 Hz.
In case of modification of the setting from 50 Hz to 60 Hz done in the factory, an identification tag (1) is applied by FPT

On the FPT tag (I) reported are:

- the model of the injection pump (4);
- an identification code (3) of the specific application of the setting of the injection pump, for example: A.S. 7.54 identifies the setting at 1800 rpm of 60 Hz.

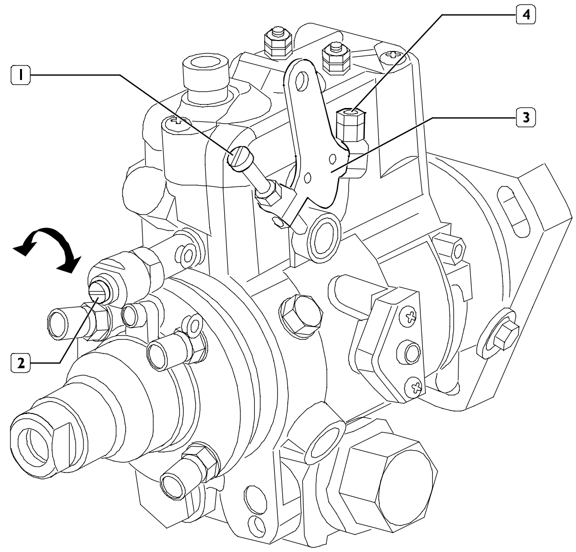
Passage from 50 Hz to 60 Hz

To carry out the passage from 50 Hz to 60 Hz you must, first of all:

- identify the code of the injection pump from the Stanadyne tag (2).

Print P4D32N003 E

Figure 155



Type of injection pump (Stanadyne tag)	Screw rotations at 50 Hz from the final position (clockwise)	Screw rotations at 60 Hz from the final position (clockwise)	Difference of rotations from 50 Hz to 60 Hz (clockwise)
DB 4629 - 5927	2	6	4
DB 4629 - 5932	2	9	7
DB 4629 - 5944	2.5	8.5	6
DB 4429 - 5945	3	6	3
DB 4429 - 5954	2	8.5	6.5
DB 4427 - 5955	3	9	6

❑ Act on the droop setting adjustment screw (2), rotating it clockwise the number of rotations indicated in the chart figure, starting from the position in which the screw is.

NOTE In case of doubt you can always unscrew the droop setting register screw (2) counterclockwise till you get to the final position - do not force it further in order to not damage the adjustment system. At this point, always referring to the chart figure, rotate the droop setting screw clockwise (2), the number of rotations indicated for the regime of 60 Hz from the final position.

❑ After starting the motor you must operate the maximum (I) and minimum (4) register screws in order to block the accelerator lever (3) in the position to obtain the desired regime, considering the frequency fall in the passage from empty to full of the motor (about 2 Hz).

If, for example, for a motor with an injection pump with code DB 4429 - 5945, originally set at 50 Hz, you want to pass to 60 Hz, it is sufficient to act on the droop setting adjustment screw (2) rotating it 3 times clockwise from the position in which it is, start the motor, loosen the adjustment screw of the maximum regime and accelerate with the accelerator lever, till you obtain the empty rotation regime equal to 62 Hz (l860 rpm),

❑ Then regulate the screw of the minimum regime (4) so to block the accelerator lever in the newly obtained position and finally block both adjustment screws (I and 4) using the appropriate lock nuts (tightening torque 3,5 ÷ 4 Nm).

NOTE The adjustment screw of the minimum regime (4) does not allow the attainment of the minimum intended in the "classical" meaning of the term because the injection pump regulator imposes a superior rotation regime since it is about an injection pump for the application of a generator

Passage from 60 Hz to 50 Hz

To pass from a 60 Hz regime to the 50 Hz regime, operate analogously to what seen above, remembering to act on the droop setting adjustment screw (2, Figure 155), rotating the same of 3 counterclockwise rotations from the position in which it is for the functioning at 60 Hz

Stabilization of the rotation regime

In case of instability of the rotation regime, act on the droop setting adjustment screw (2, Figure 5) rotating lightly the same clockwise/counterclockwise till the stabilization of the motor rotation regime

NOTE Attention! Some motors cannot undergo the passage from 50 Hz to 60 Hz and vice versa, as they need a specific injection pump to work at the required regimes.
Make reference to the SI 191 I "Service Information" to verify which motors cannot undergo the passage from 50 Hz to 60 Hz and vice versa.

Identification tag

Figure 156

116976

In case the FPT tag is not present because it is a motor with an injection pump that has a setting of 50 Hz, it is necessary to proceed in the application of a tag in the illustrated area as in Figure 4 stamping it as the figure example.

The blank tag can be ordered at the Part Replacement Service.

Figure 157

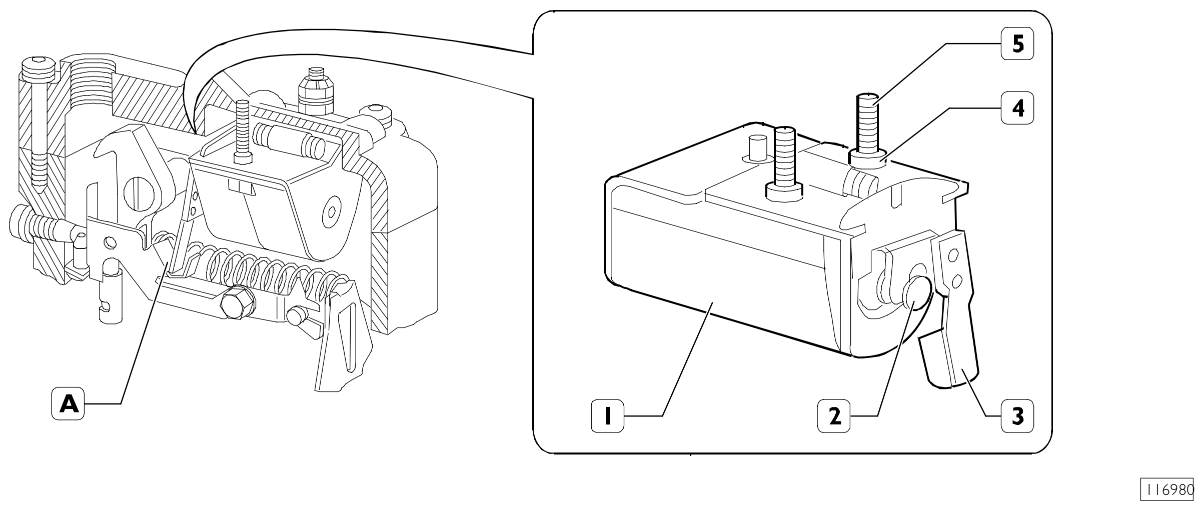
116977

If the FPT tag is already on the injection pump, you must proceed stamping the new identification suffix of the newly obtained setting and strikethrough the identification of the preceding setting, as illustrated in the figure example.

REPLACEMENT OF THE ELECTRO-VALVE AND THE SOLENOID VALVE THROTTLE ON STANADYNE PUMPS

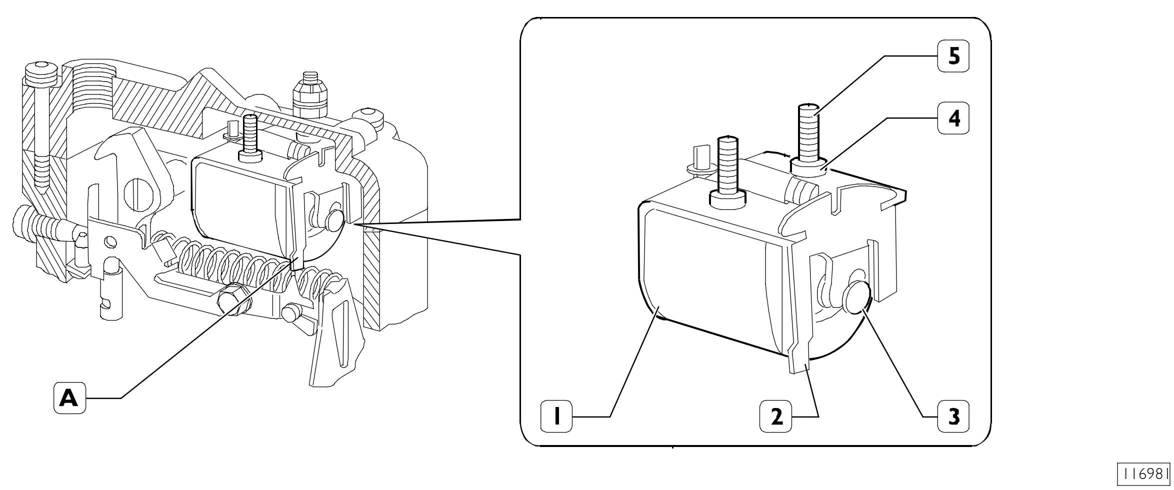
Figure 158

ETR



A. Position of the electro-valve arm - 1. Encapsulated coil - 2. Mobile nucleus of the electro-valve - 3. Electro-valve arm - 4. Isolator - 5. Solenoid valve ends

ETSO



A. Position of the electro-valve arm - 1. Encapsulated coil - 2. Mobile nucleus of the electro-valve - 3. Electro-valve arm - 4. Isolator - 5. Solenoid valve ends

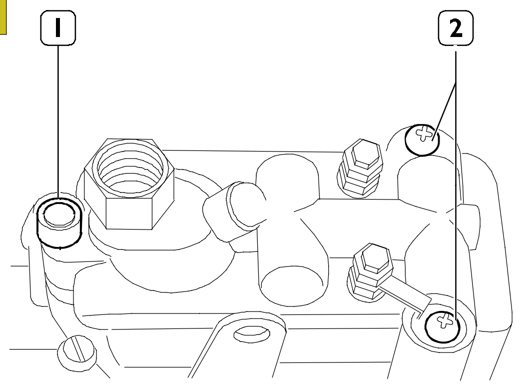
Two types of electro-valves can be used on Stanadyne injection pumps:

- ETR (Energize To Run)
- ETSO (Energize To Stop).

Please note, in the figure, the different assembling position of the electro-valve according to the ETR - ETSO functions.

Electro-valve replacement

Figure 159

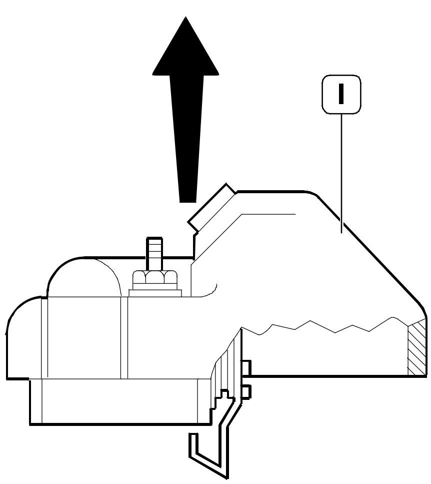


116982

To replace the electro-valve remove the cover of the injection pump loosening and removing the three fixing screws (1 and 2) of the cover and the relative washers.

NOTE Check the state of wear of the rubber couplings.

Figure 160

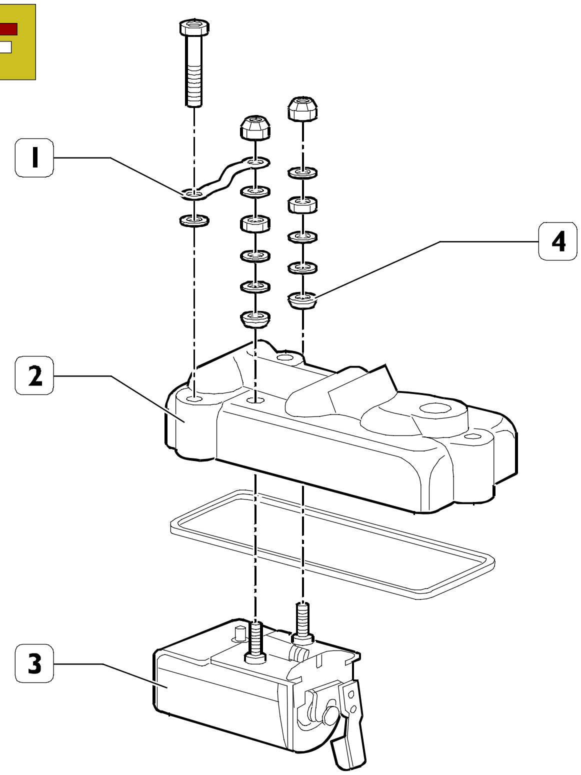


116983

Remove the entire cover of the electro-valve (1), pulling it upwards perpendicularly to the injection pump.

Be careful that nothing falls into the injection pump.

Figure 161



116985

Remove the electro-valve (3) from the cover (2).

NOTE Since the ends of the component are electrically isolated from the cover, make sure to remember the assembling order of the nuts, of the washers and of the components, for the electrical connection of the electro-valve ends; one end is earthed through an appropriate element (1).
Pay attention to the position of the isolating element (4).

Assemble of the new electro-valve on the injection pump's cover, using the appropriate kits:

- ❑ 12V-ETR
- ❑ 24V-ETR
- ❑ 12V-ETSO
- ❑ 24V-ETSO

The kits contain the indicated type Check the state of wear of the rubber couplings.of electro-valve and all that is needed for its assembling.
The nuts fixing the electro-valve (3) to the cover (2) must be tightened to a 1,1 ÷ 1,7 Nm torque.

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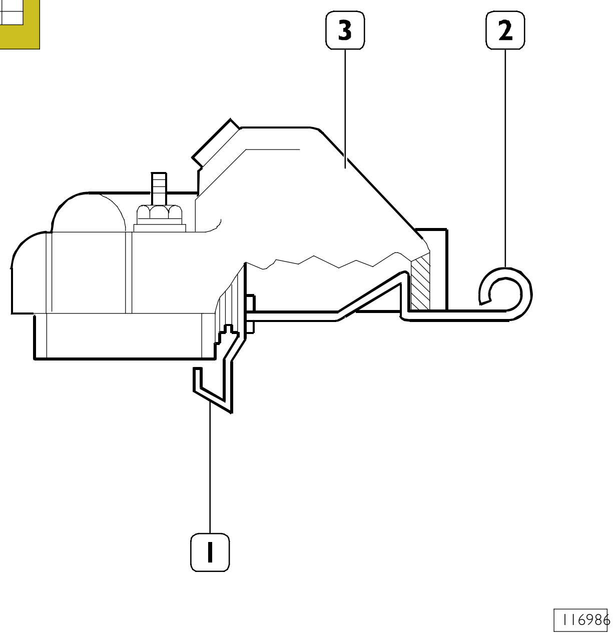
Figure 162

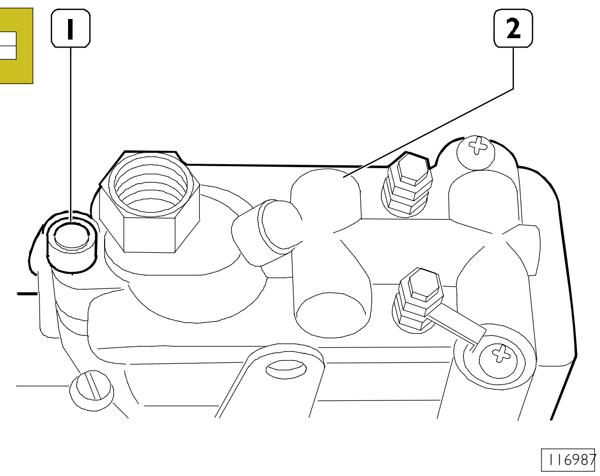


In the electro-valve ETR kit there is the joint tool (1) which must be used to position the electro-valve's arm (2) and to reassemble the cover on the injection pump.

NOTE This tool (1) allows to keep in the excitation position the arm of the electro-valve (2), allowing the correct assembling of the cover and avoiding dangerous over rotations at the starting of the motor.

Once the cover is put on the assembling seat and the relative screws are pointed on the injection pump, rotate the joint tool (1) and then pull it carefully from underneath the cover (3), making sure not to move or damage its sealing .
Then tighten the screws with a 4,0 ÷ 5,1 Nm tightening torque, making sure not to damage the connection earthed element of the electro-valve end.

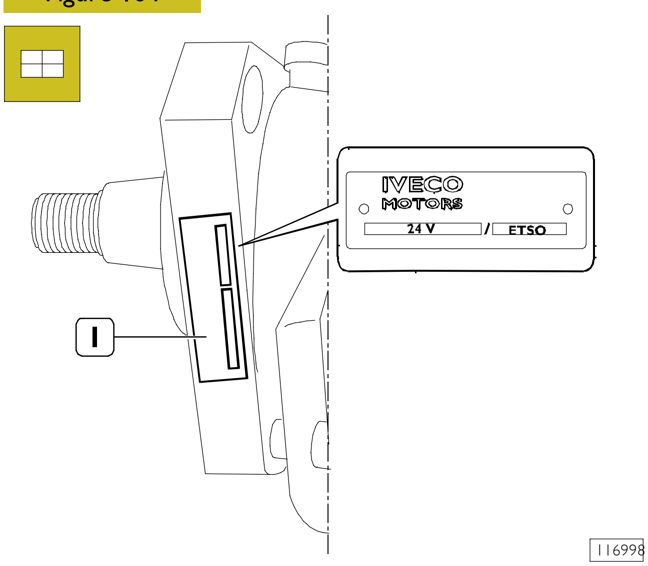
Figure 163



The repositioning of the cover (2) must be done proceeding in reverse to what described for its disassembling, making sure that it corresponds perfectly to the assembling seat without forcing it (for the ETR version the cover of the pump will correspond to the assembling seat only after the joint tool has been removed).

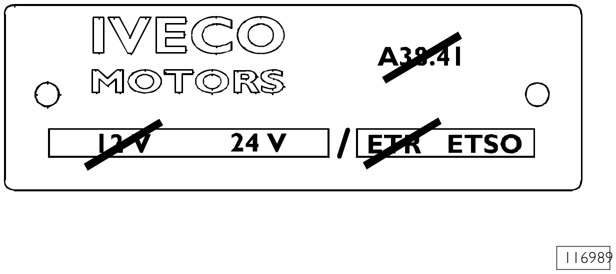
NOTE A blue seal is included in the kit and it has to be positioned on the screw (l), after the cover reassembling operations (2): when new, the seal is not blue.

Figure 164



In case the original electro-valve should be replaced and its characteristics modified (different voltage, ETR instead of ETSO, eco), it is necessary the application of an identification tag (1) in the indicated place.
The tag must be stamped (1) as shown in details in the figure.

Figure 165

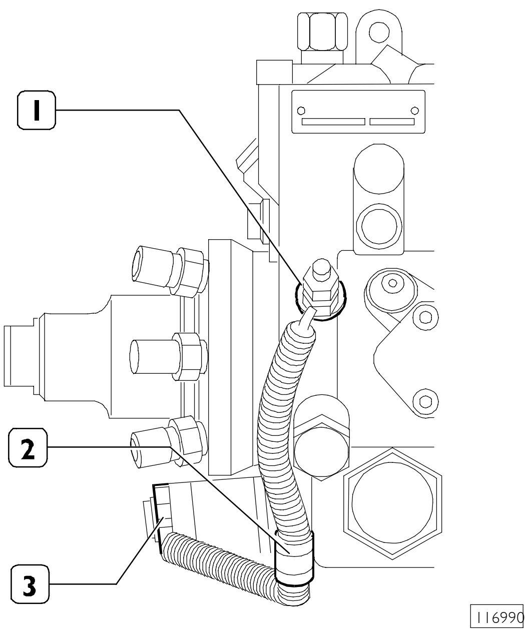


In some cases the tag may already be present.
If the tag is already present, it is necessary to strikethrough the old identification elements and stamping the new ones, as shown in the example in the figure.

The electro-valve and the solenoid valve throttle on the same injection pump, must have the same operating voltage, so in case of a change in the motor's operating voltage, both must be replaced.

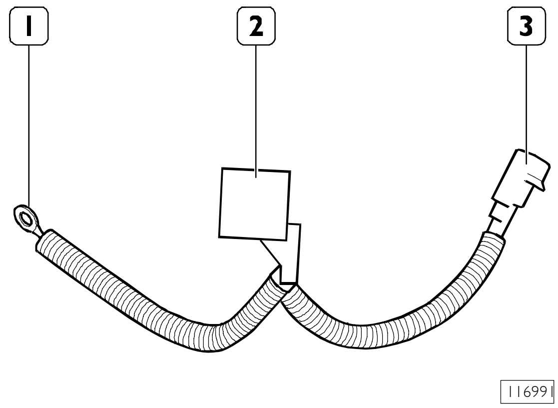
Replacement of the solenoid valve throttle

Figure 166



Disconnect the linkage connector from the temperature sensor on the motor, and then remove the fixing nut of the socket clamp (2) and the nut (1) of the cable group end, so to release the electrical lead assembly of the solenoid valve throttle.
Remove the fixing nut (3) from the magnet and remove the component from its seat.

Figure 167



Insert the connection cable socket (1) in the cable group end and screw the nut (I, Figure 166) tightening it to a 5, 7 ÷ 6,8 Nm torque.
Position the socket clamp (2, Figure 166) and screw the fixing nut tightening it to a 7,9 ÷ 9,0 Nm torque.
Position the magnet in its seat and screw the self-blocking fixing nut, supplied with the replacement kit, tightening it to a 5,1 ÷ 5,7 Nm torque.

NOTE The operating voltage of the device is easy to find looking at the colors of the supply wires of the solenoid:

- BLACK: for the 12V device
- RED: for the 24V device

The electro-valve and the solenoid valve throttle on the same injection pump, must have the same operating voltage, so in case of a change in the motor's operating voltage, both must be replaced.

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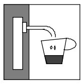
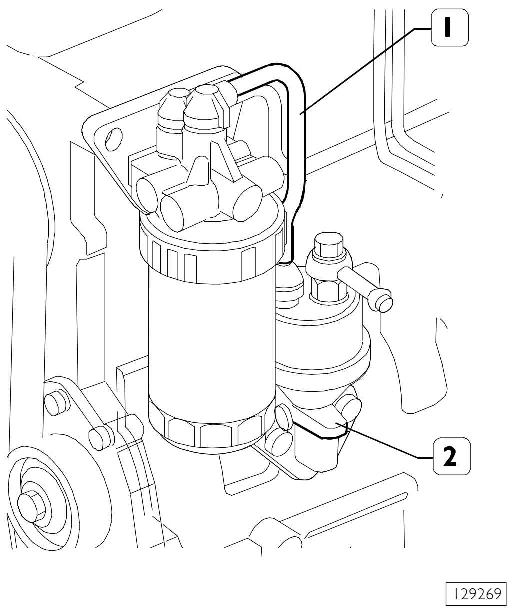
Feed system bleed procedure

Figure 168

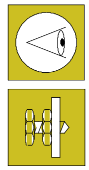




- ❑ Disconnect the fuel pipe (1) of the filter and repeat working on the drain lever (2) of the priming pump.
- ❑ Continue the operation until when fuel outflows.
- ❑ Connect the (1) to the filter.

Checks and controls

NOTE The following tests shall be made after engine assembly to the vehicle.
Preventively check that the liquid levels have been correctly restored.



Start the engine, let it run at revolution regimen slightly higher than idling and wait that the cooling liquid temperature reaches the value enabling thermostat opening, then check that:

- ❑ There is no water bleeding from the manifolds connecting engine cooling circuit pipelines and cabin internal heating, eventually providing to further tighten the locking rings.
- ❑ Carefully check the fuel connection pipes to the respective unions.
- ❑ There is no oil leakage from the lubrication circuit of the various pipelines connecting cover and cylinder head, oil pan and bearing, oil filter and heat exchanger as well as relating housings.
- ❑ There is no fuel leakage from fuel pipelines.
- ❑ There is no blow-by from pneumatic pipes (if provided).
- ❑ Verify correct working of the lighting leds of the dashboard containing the tools as well as of the equipment that was disconnected during engine disconnection.
- ❑ Check and blow by with care the engine cooling system, carrying out frequent drainage.

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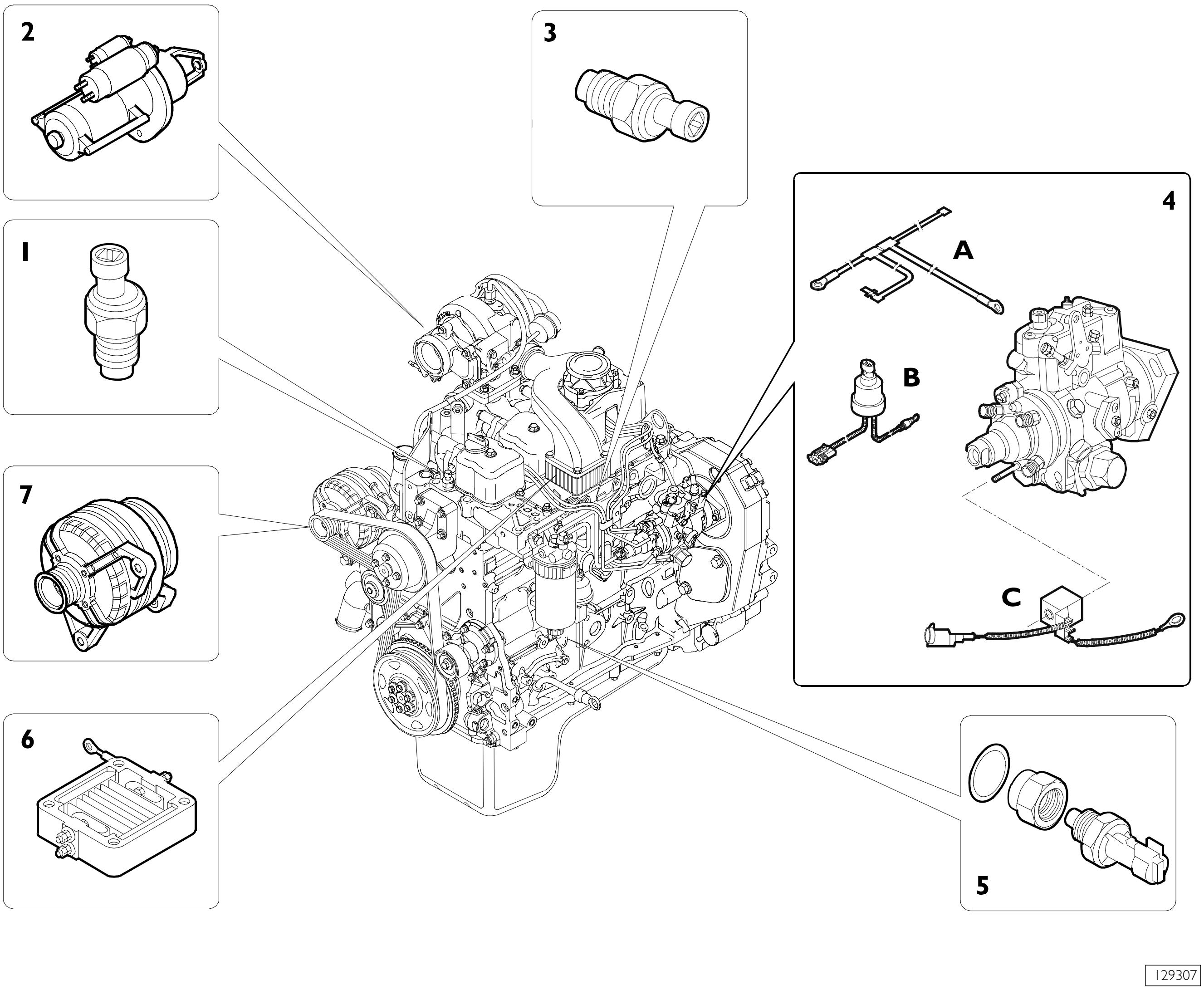
PART TWO -
ELECTRICAL EQUIPMENT

LOCATION OF ELECTRIC COMPONENTS ON ENGINE

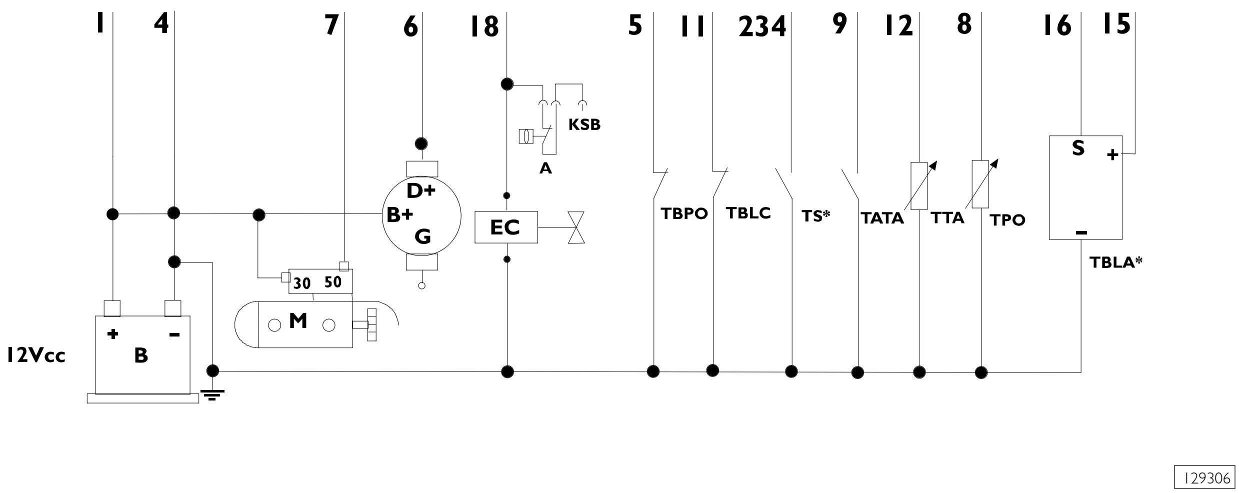
Figure 169



1. Cooling liquid temperature sensor (where provided for);
2. Starter;
3. KSB Water temperature sensor;
4. (A) Connecting cable KSB - stanadyne pump
   (B) Timer (where applicable)
   (C) CSA solenoid valve
5. Oil pressure sensor;
6. Resistance for cold start up (where provided for);
7. Alternator;

PRINCIPLE WIRING DIAGRAM

Figure 170

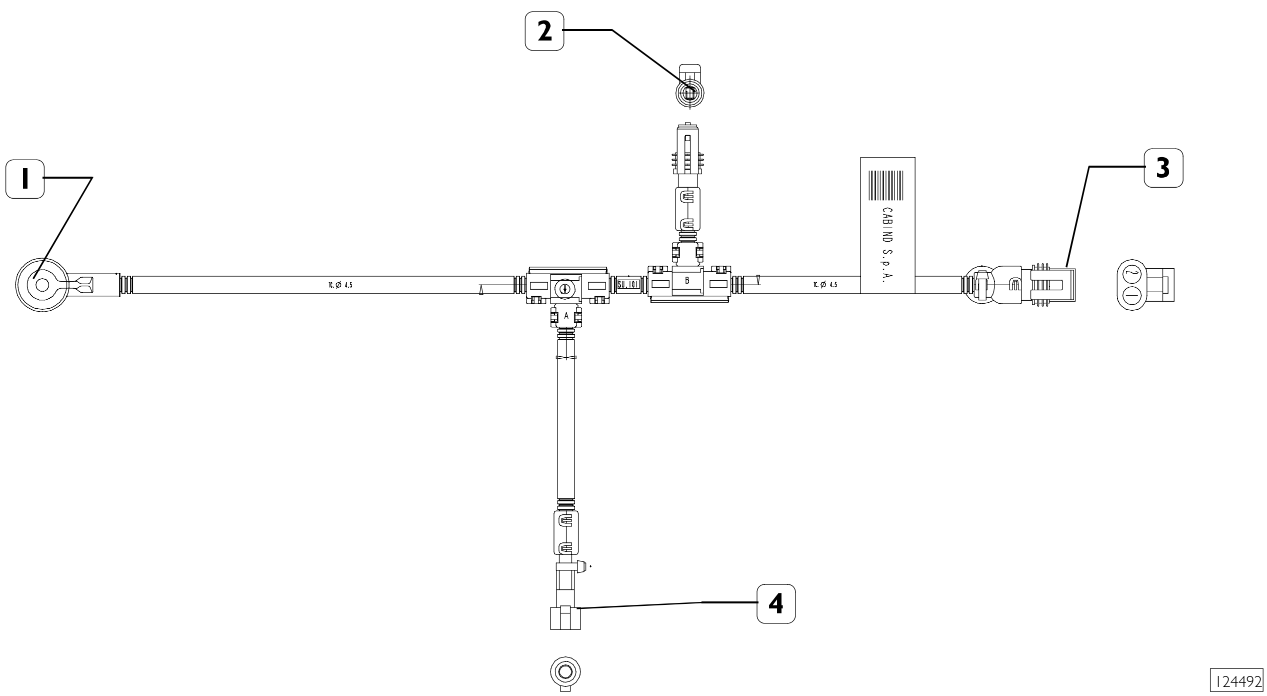


* If present

A. Air sensor
B. Engine battery
M. Starter motor
EC. De-energizing cut out solenoid
TS. Heater thermostat
TBLC. Low fuel level gauge sender unit
G. Battery charger alternator
TTA. Water temperature sender unit
TPO. Oil pressure switch
TATA. Water high temperature thermostat
TBPO. Low oil pressure sender unit
TBLA. Water level sender unit
KSB. KSB signal

KSB - Stanadyne pump connection cable

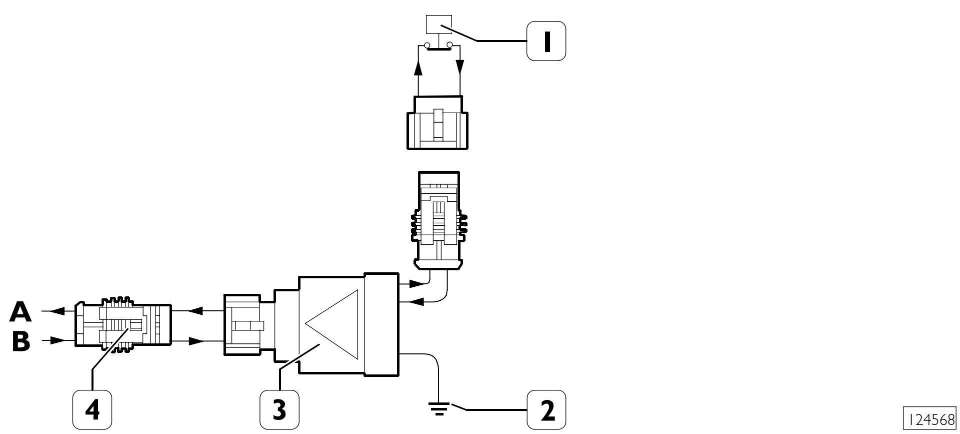
Figure 171



1. Electrostop - 2. CSA - 3. 24V Timer - 4. KSB

Timer (if present)

Figure 172

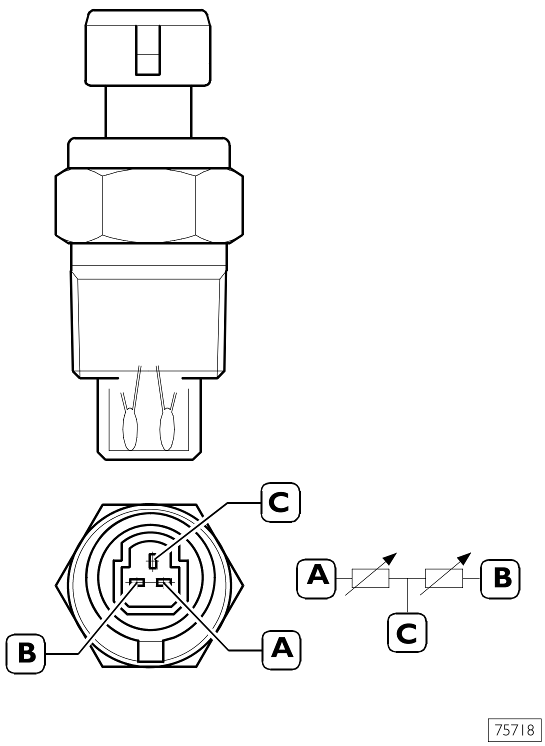


1. Sensor (TAK) - 2. Engine ground - 3. 24V Timer - 4. KSB-Stanadyne pump cable
A. Electrostop 24V output - B. 24V input (from CSA)

After ignition, the engine is immediately taken (without a transient state) to top speed. The KSB would not work with the engine warm, and would cause a high level of "white" smoke; the timer then starts it for 30-35 seconds, eliminating the ignition smoke.

Cooling liquid temperature sensor (if present)

Figure 173



It is a component integrating a temperature sensor.

It is assembled to the engine head close to the thermostat unit and its duty is to detect engine cooling liquid temperature.

Specifications:

Range of working temperatures:

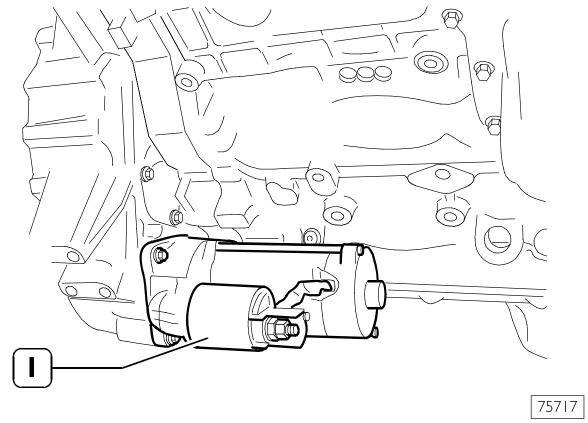
Connection side	-40 ÷ +150 °C for < 10 min.
Bulb side on engine:	-40 ÷ +140 °C
Working tensions:	6 ÷ 28 V

Settings:

80 °C	0.304 ÷ 0.342 kΩ
20 °C	2.262 ÷ 2.760 kΩ
-10 °C	8.244 ÷ 10.661 kΩ

Starter

Figure 174



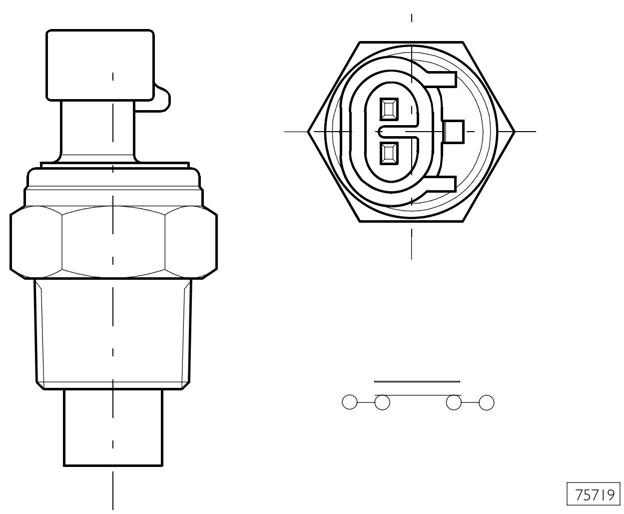
Starter is usually driven by starting unit placed on the vehicle dashboard and provides positive tension to the tele-switch assembled to the starter itself.

Specifications:

BOSCH 12V

KSB Water temperature sensor

Figure 175



It is assembled to the cylinder head on the engine left hand side.

Specifications:

Working tensions:12 ÷ 24 V

Electrical Power load:	2.5 A (induction) 5.0 A (resistance)
Setting:	63±3 °C Contact opening upon increasing temperature 53±3 °C Contact closure upon decreasing temperature

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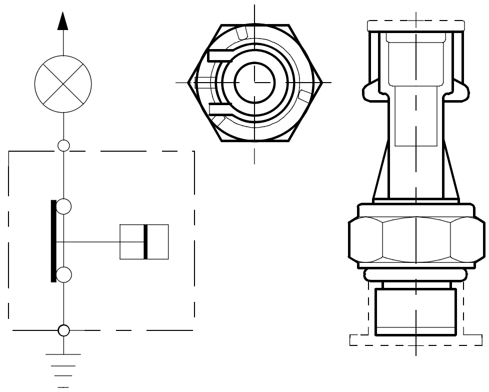
Oil pressure sensor

Figure 176



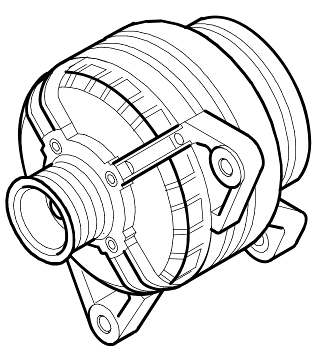
It is assembled to the block on the engine's left hand side.

Specifications:

Working tensions:	12 ÷ 24 V
Contact closure upon lower pressure:	0.6 bar
Contact opening upon higher pressure:	0.9 bar

Alternator

Figure 177



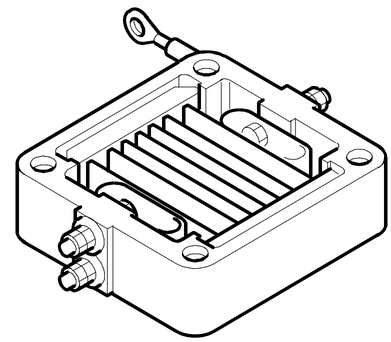
It is place front view on the right hand side of the engine, and is driven by tooth belt.

Specifications:

Working tension:	12 V
Current delivered:	90A (at 6000 rpm)
Absorption in stand-by:	≤ 1mA
Sense of rotation:	clockwices

Pre-post heating resistor (if present)

Figure 178



It is a resistor assembled to the suction collector and is utilised to heat the air during pre-post heating operations.

It is fed by a tele-switch usually placed very close to the engine.

Specifications:

Working tension:	12 V
Maximum possible air flow:	2 cc / min (pressure 138 kPa)

PART THREE - TROUBLESHOOTING

ANOMALY	POSSIBLE CAUSE	REMEDY	NOTE
The engine does not start	Battery flat or faulty.	Check and recharge battery. Replace battery if necessary.	
	Connections to battery terminals corroded or loose.	Clean, examine and tighten the nuts on the battery terminals. Replace the cable terminals and the nuts if excessively corroded.	
	Incorrect timing of injection pump.	Check and correctly time the injection pump.	See your FPT dealer.
	Deposits or water in the fuel tank.	Disconnect the hoses and clean them using a jet of compressed air. Dismantle and clean the injection pump. Remove water from tank and refuel.	Drain feed system.
	No fuel in tank.	Refuel.	
	No power supply.	Overhaul or replace the fuel or transfer pump.	
	Air bubbles in the fuel lines or injection pump.	Check the hoses to ensure that air is in fact present and also check the fuel pump. Eliminate the air from the injection pump by unscrewing the cap and working the fuel pump by hand.	
	Faulty starter motor.	Repair or replace the starter motor.	

ANOMALY	POSSIBLE CAUSE	REMEDY	NOTE
The engine does not start at low temperatures	Fuel system clogged with paraffin crystals forming due to the use of unsuitable fuel.	Replace the fuel with fuel suitable for use at low temperatures. Replace the fuel filters.	
	K.S.B. device for cold spark advance control operating incorrectly.	Check or replace the injection pump.	See your FPT dealer.
The engine cuts out.	Idle rpm too low.	Adjust with adjustment screw.	
	Irregular flow of injection pump.	Adjust flow.	See your FPT dealer.
	Impurities or water in the fuel lines.	Disconnect the hoses and clean them using a jet of compressed air. Dismantle and clean the injection pump. Remove water from fuel tank and refuel.	Drain feed system.
	Clogged fuel filter.	Dismantle and replace if necessary.	
	Presence of air in the fuel and injection system.	Check that the hoses are not cracked or the unions loose. Replace worn parts, remove the air from the hoses and deaerate the injection pump and fuel filter by unscrewing the caps and working the primer pump by hand.	
	Broken injection pump controls.	Replace the faulty parts.	
	Abnormal clearance between camshaft cams and tappets.	Adjust clearance by replacing shims.	
	Burnt, corroded or chalky valves.	Replace the valves, rectify or replace the cylinder head seatings.	

ANOMALY	POSSIBLE CAUSE	REMEDY	NOTE
The engine overheats	Faulty water pump.	Check the unit and replace if necessary. Replace the gasket.	
	Malfunctioning thermostat.	Replace the thermostat.	
	Fouling in coolant openings in the cylinder head and cylinder groups.	Wash following the standards specified for the type of descaling product used.	
	Water pump drive belt slack.	Check and adjust the tightness of the belt.	On applications provided with automatic tensioner, check corret worching of such device.
	Coolant level too low.	Top-up radiator with coolant.	
	Incorrect engine timing.	Check timing and tune correctly.	
	Incorrect calibration of injection pump.	Correct the delivery rate of the pump on a bench so that the injection is at the specified rate.	See your FPT dealer.
	Dry air cleaner blocked.	Clean the air filter or replace if necessary.	
Engine operation is irregular and lacks power	Incorrect timing of injection pump.	Check timing and correctly set pump.	
	Faulty automatic advance variator.	Check operation on injection pump test setup; if values found do not correspond to requirements, change variator spring.	See your FPT dealer.
	K.S.B. automatic cold advance device malfunctioning.	Check or replace injection pump.	
	Excessive piston wear.	Overhaul the engine and replace any worn parts.	
	Incorrect calibration of speed regulator.	Check and correctly calibrate the regulator.	See your FPT dealer.

ANOMALY	POSSIBLE CAUSE	REMEDY	NOTE
Engine operation is irregular and lacks power	Partial blockage of nozzles or faulty operation of injectors.	Clean the nozzles of the atomisers using the appropriate tools and completely overhaul the injectors.	
	Impurities or water in the fuel and injection system.	Carefully clean the system and refuel.	If necessary drain feed system.
	Incorrect play between camshaft cams and tappets.	Check and correct play	
	Faulty turbocharger.	Replace complete unit.	
	Air cleaner blocked.	Clean or replace air cleaner.	
	Faulty operation of L.D.A. device	Check that the diaphragm is not perforated, that the counter spring is suitable and that it has the correct loading (check on test bench). Check that there is adequate air pressure inside the intake manifold in relation to the engine rpm under full-load conditions.	See your FTP dealer.
	Tie rods between accelerator pedal and regulation lever incorrectly adjusted.	Adjust the tie-rods so that the command lever can be moved to the full delivery position.	See your FTP dealer.
Engine running with abnormal knocking	Faulty operation of injectors.	Replace all injectors.	
	Fuel lines blocked.	Dismantle the hoses, clean them and replace those that are seriously dented.	
	Incorrect set-up of injection pump.	Correct the set-up of the pump so that injection occurs at the specified angle.	See your FTP dealer.

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ANOMALY	POSSIBLE CAUSE	REMEDY	NOTE
Engine running with abnormal knocking	Knocking of crankshaft causing excessive play on one or more main or rod bearings or excessive play on shoulders.	Rectify the pins of the crankshaft and install smaller bearings. Replace the thrust half-rings.	
	Crankshaft unbalanced.	Check alignment of crankshaft.	
	Loosening of screws securing flywheel.	Replace the loosened screws and tighten all the screws to the specified torque.	
	Misalignment of rods.	Replace the rods.	
	Noise from piston journals due to excessive play of piston hubs and in the rod bushing. Loose bushings in the rod seatings.	Replace the piston journal and/or the piston and rod bushing. Replace with new bushings.	
	Noisy timing.	Adjust the play between camshaft cams and tappets and check that there are no broken springs, that there is no excessive play between the valve stems and the valve guides, tappets and seatings.	
The engine smokes abnormally. Black or dark grey smoke.	Excessive maximum pump output.	Disconnect the pump and adjust delivery in accordance with the data given in the calibration table.	See your FTP dealer.
	K.S.B. device out of calibration or malfunctioning.	Check operation by a tester and adjust correctly as described in the manual.	See your FTP dealer.
	There is an excessive delay on the injection pump.	Correct the set-up.	

ANOMALY	POSSIBLE CAUSE	REMEDY	NOTE
The engine smokes abnormally. Black or dark grey smoke.	The injection pump has an excessive advance.	Correct the set-up.	
	The holes in the atomisers (or some of them) are partially or entirely blocked.	Replace the injectors with a series of new injectors or clean and rectify the original ones using suitable equipment.	
	Air cleaner blocked or deteriorated.	Clean or replace the filter element.	
	Loss of compression in the engine due to: stuck or worn flexible rings; worn cylinder liners; valves deteriorated or badly adjusted.	Overhaul the engine or limit the interventions to the relative parts.	
	Unsuitable injectors, different types of injectors or incorrectly calibrated.	Replace or calibrate the injectors.	
	Injection hoses with an unsuitable internal diameter, end of hoses pinched due to repeated blocking.	Check conditions of the end or unions and where necessary replace the hoses.	
Blue, grey-blue, grey smoke tending to white.	Excessive delay in injection pump.	Correct the set-up of the pump.	See your FTP dealer.
	K.S.B. automatic cold advance device malfunctioning.	Check or replace injection pump.	See your FTP dealer.
	Faulty injector.	Replace the injector.	
	Leaking of oil from the piston rings caused by glued or worn rings or wearing of cylinder liner walls.	Overhaul the engine.	
	Engine oil passing through the intake guides-valves following wearing of guides or valve stems.	Recondition the cylinder head.	
	Engine too cold (thermostat blocked or inefficient).	Replace the thermostat.	

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.

Planning of controls and periodical intervention

Controls and periodical intervention	Frequency (hours)
Visual check of engine	Daily
Check presence of water in fuel filter or pre-filter	Daily
Check of belt wear status	-
Check and setting of tappet clearance	-
Replacement of engine's oil and filter	-
Replacement of fuel pre-filter	-
Replacement of fuel filter	-
Replacement of belt	-

NOTE 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 FPT.

Checks not included in maintenance planning-daily checks

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

- Level controls and checks of any eventual leakage from the fuel, cooling and lubricating circuits.

- Notify the maintenance if any inconvenience is detected of if any filling is necessary.

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

- check presence of any eventual leakage from the fuel, cooling and lubricating circuits.

- Verify absence of noise or unusual rattle during engine working.

- Verify, using the vehicle devices, the prescribed pressure temperature and other parameters.

- Visual check of fumes (colour of exhaust emissions)

- Visual check of cooling liquid level, in the expansion tank.

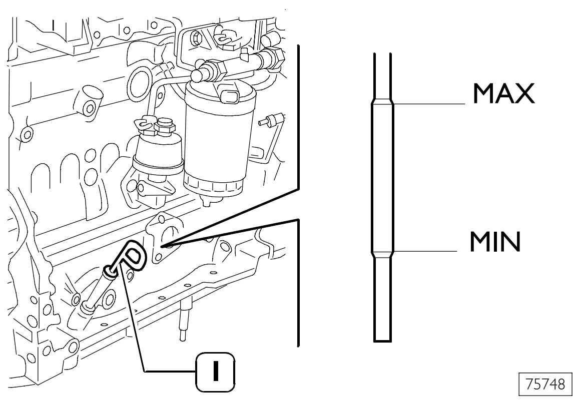
MAINTENANCE PROCEDURES
Checks and controls

Engine oil level check

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

The check can be made using the specially provided flexible rod (1).

Figure 179 (Demonstration)

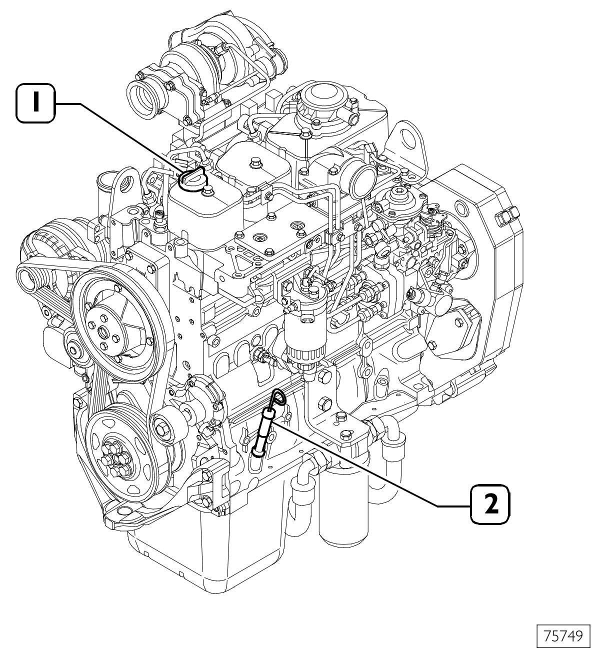


Draw off the rod from its slot and check that the level is within the etched tags of minimum and maximum level.

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 180 (Demonstration)



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".

Some applications are equipped with a level transmitter alerting dashboard instruments in case of insufficient lubrication oil within the pan.

The engine oil is highly polluting and harmful.

In case of contact with the skin, rinse well with water and detergent.

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

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

Check of fuel system

The check must be executed both when the engine disconnected and when it is running.
The check 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 injection pump and to the injectors.

Cooling system check

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

Check the 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 check

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

Verify the presence of any oil leakage or blow-by from the head, from the engine pan of from the heat exchanger.

The engine oil is highly polluting and harmful.

In case of contact with the skin, rinse well with water and detergent.

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

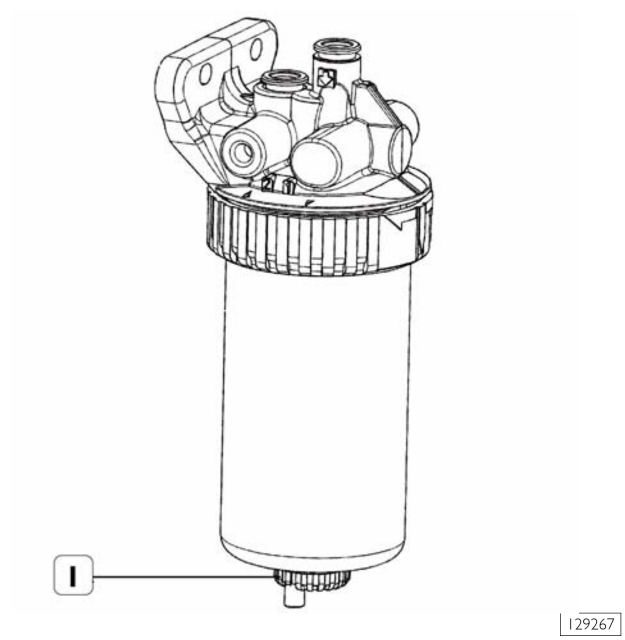
Disposal must be carried out properly, and in full compliance with the law and regulations in force.

Check of water presence within fuel filter or pre-filter

NOTE The components of the 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.

Figure 181



Fuel filter is equipped with pump screw-valve to drain (1) the water eventually mixed with fuel.

Place a container underneath the filter and slightly loosen the screw (1). Drain the water eventually contained in the filter's bottom.

Lock the screw (1) (max 0.5 Nm locking couple) as soon as fuel starts bleeding.

Check of drive belt tensioning

Some applications are equipped with an automatic tensioner that provides correcting belt tensioning.

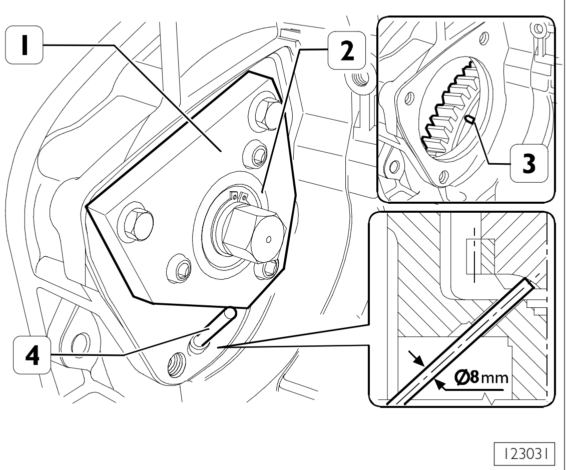
Check of belt's tear and wear status

Carefully verify the belt's surface in order to detect any sign of incision, crack, excessive wear in correspondence of toothing; check end and surface grinding.

Danger: if the engine is switched off but is still hot, unexpected motion of the belt may occur.

Wait for engine temperature cooling as a precaution in order to avoid serious danger injury.

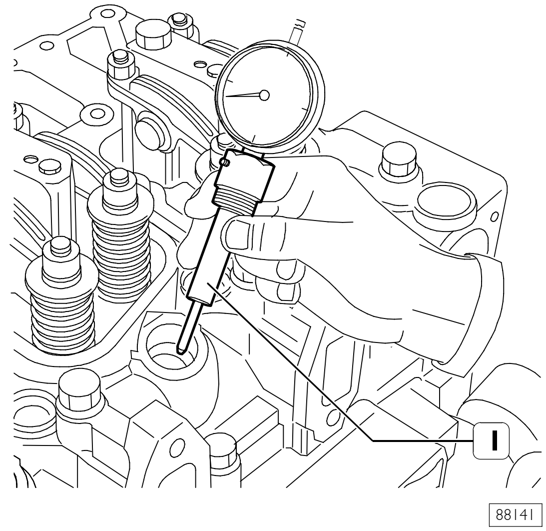
Figure 182



- ❑ Fit tool 99360339 (1) in order to be able to rotate the flywheel using an Allen key.

Find the top dead centre with the tool (99395097) - False injector

Figure 183



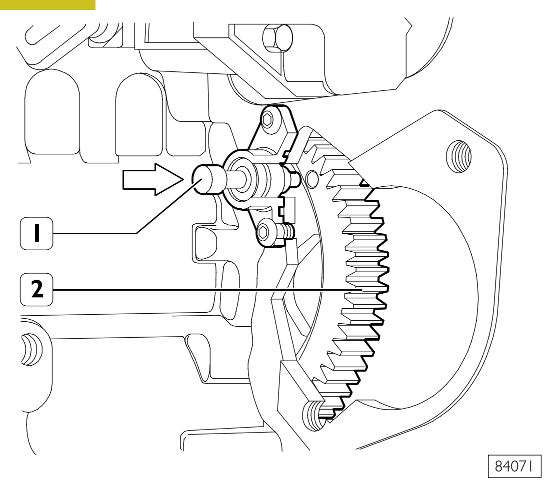
To find the top dead centre position of the cylinder, end of compression stage:

- ❑ remove the cover of the cylinder rocker arms;
- ❑ remove the injector and position tool 99395097 (1); preload the dial gauge.

To obtain this condition, turn the crankshaft to the dial gauge's maximum reading; check that the cylinder's intake and exhaust valves are both closed, and not balanced.

Finding the TDC position of cylinder n. 1 under full compression with the camshaft lock pin (99360616)

Figure 184

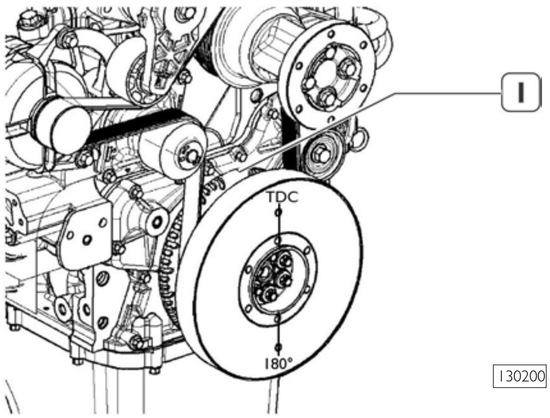


To find the position of cylinder n. 1 at top dead centre under full compression:

- ❑ remove the cylinder's rocker arm cover;
- ❑ turn the flywheel until the pin 99360616 (1) locks the gear (2) when it is pushed in;
- ❑ check that cylinder n. 1's intake and exhaust valves are both closed and not balanced.

For 4 cylinder engines

Figure 185



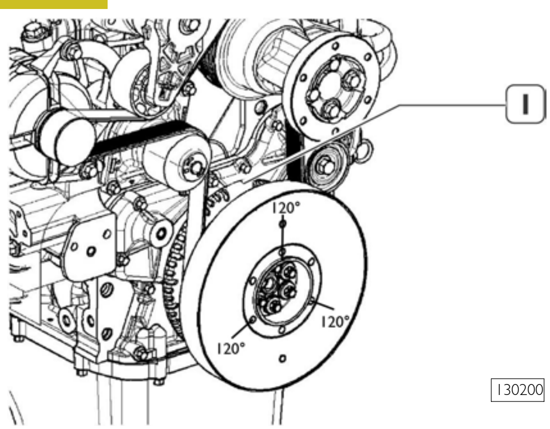
- ❑ Also check that the unperforated part (1) of the phonic wheel is positioned uppermost (cylinder n. 1 at TDC) and the valves of cylinder n. 4 are balanced. If cylinder n.1 is balanced, rotate the engine through one revolution to obtain the specified condition.
- ❑ Adjust the clearance of cylinder n. 1's valves as indicated in the relevant paragraph.
- ❑ Now rotate the crankshaft as shown in the table to adjust the clearance of the rocker arms of the other cylinders.

IFIRING ORDER: 1 – 3 – 4 - 2

Start and crankshaf rotation	Adjusting intake and exhaust valve rocker arm clearance on cylinder n.
Cylinder n. 1 at TDC	1
Rotate through 180°	3
Rotate through 180°	4
Rotate through 180°	2

For 6 cylinder engines

Figure 186



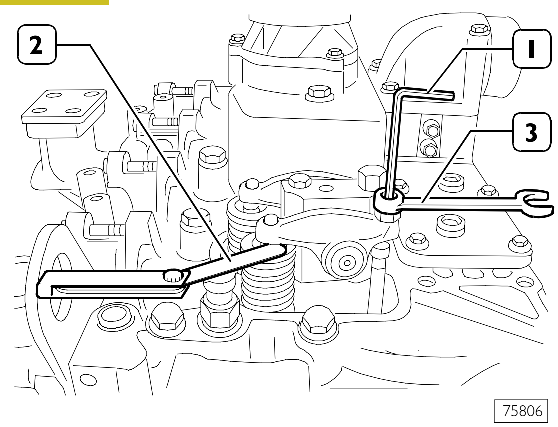
- ❑ Also check that the unperforated part (1) of the phonic wheel is positioned uppermost (cylinder n. 1 at TDC) and the valves of cylinder n. 4 are balanced. If cylinder n.1 is balanced, rotate the engine through one revolution to obtain the specified condition.
- ❑ Adjust the clearance of cylinder n. 1's valves as indicated in the relevant paragraph.
- ❑ Now rotate the crankshaft as shown in the table to adjust the clearance of the rocker arms of the other cylinders.

FIRING ORDER:: 1 – 5 – 3 – 6 – 2 – 4

Start and crankshaft rotation	Adjusting intake and exhaust valve rocker arm clearance on cylinder n.
Cylinder n. 1 at TDC	1
Rotate through 120°	5
Rotate through 120°	3
Rotate through 120°	6
Rotate through 120°	2
Rotate through 120°	4

Adjusting the rocker arm clearance

Figure 187



Adjust the play between the rocker arms and valves using a hex key (1), polygonal key (3) and feeler gauge (2).
Play is:

- ❑ intake valves: 0.25 ± 0.05 mm
- ❑ exhaust valves: 0.50 ± 0.05 mm

Check of cooling liquid level

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.

- ❑ Make sure that, with a cold engine, the liquid level in the cooler is such as to cover all the internal elements of the cooler.
- ❑ If necessary, top up with clean water. Do not use distilled water.

NOTE If the refill operations occur frequently a diagnosis of the cooling circuit is necessary.

In the event that the heat exchanger is available on the vehicle, refill it if necessary, paying attention that the fluid does not saturate the internal volume of the exchanger in order to enable any increase in volume of the fluid caused by the temperature increase.

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.

NOTE Some applications are equipped with a device or tap for draining the oil to be used to drain the sump

- ❑ 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.

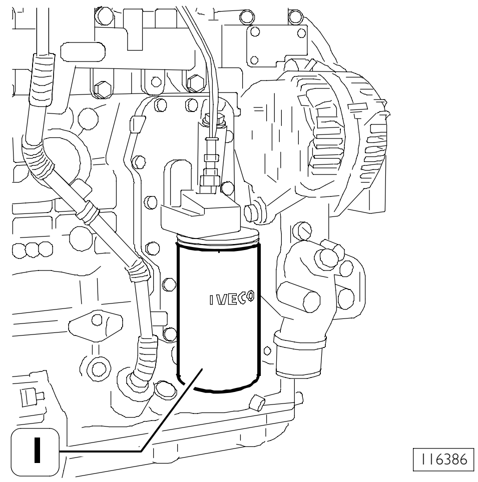
In case of topping up, don't mix oils having different features.

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.

Figure 188



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 cartridge 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.

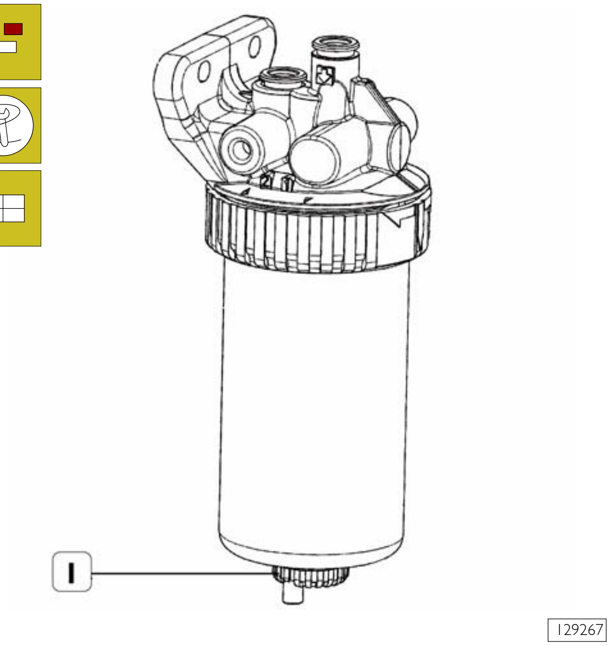
Fuel filter replacement

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

Avoid to breathe the vapors coming from filter.

After filters replacement the supply equipment deaeration must be carried out.

Figure 189



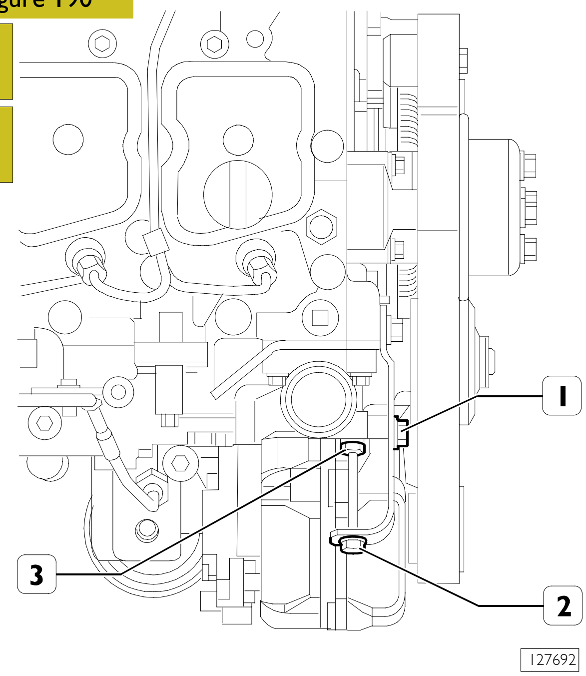
- ❑ Drain the fuel inside the filter by operating the water release screw (1). Collect the fuel in a container without impurities.
- ❑ Unscrew the cartridge by using the 99360076-tool.
- ❑ Collect the eventual fuel inside the filtering cartridge.
- ❑ Clean the gasket seat on the support and oil slightly 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 10-5 Nm torque.

Alternator belt replacement

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.

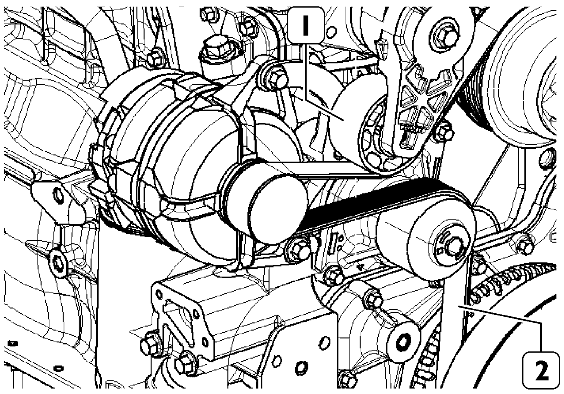
Figure 190



- ❑ Loosen the screw nut (3) and the screw (1)
- ❑ Loosen the screwnut fastening the alternator to the support
- ❑ Reduce belt tension operating on the screw (2)
- ❑ Withdraw the POLY-V belt
- ❑ Place the belt on the pulleys and the guide rollers.
- ❑ Tension drive belt operating on the screw (2)
- ❑ Tighten the screw (1), the screwnut (3)and the screwnut fastening the alternator to the support.

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

Figure 191



- 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.

Check exhaust pipe/s for damage

Visually check that the exhaust system is not blocked or damaged.

- Make sure that there is no risk of dangerous fumes within the machine. Contact the Manufacturer if necessary.

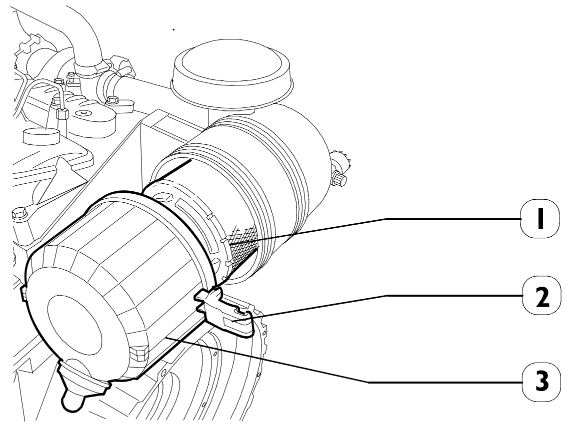
Clean heat exchangers

Check that the radiator air inlets are free from dirt (dust, mud, straw, etc.).
Clean them if necessary, using compressed air or steam.

The use of compressed air makes it necessary to use suitable protective equipment for the hands, face and eyes.

Cleaning the air filter

Figure 192



Only proceed with the engine stopped.

- Remove the filter cover (3) after first unscrewing the locking handle (2).
- Remove the external cartridge (1). During this operation, take care to ensure that no dust get into the sleeve.
- Check that there is no dirt. If there is, clean the filter element as indicated below.
- Blow dry compressed air through the filter element, from the inside outward (maximum pressure 200 kPa). Do not use detergents; do not use diesel.
- Never use tools to beat the filter element, and check its condition before replacing it.
- Replace the filter if any breakages or tears are found.
- Check that the gasket at its base is in good condition.
- Reassemble by repeating the above operations in reverse order.

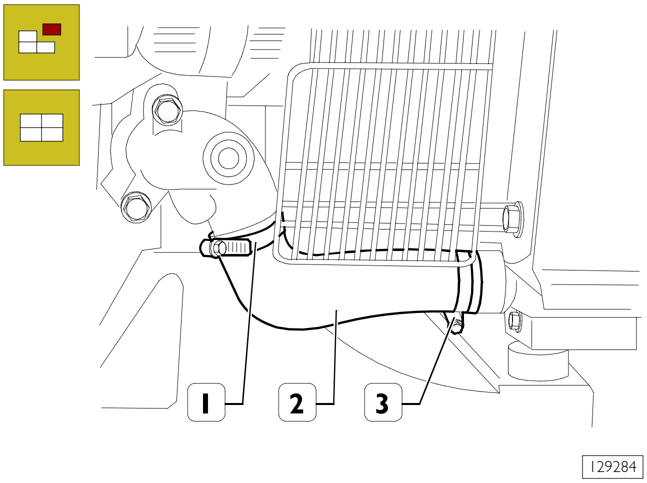
NOTE Take care to ensure that the parts are reassembled correctly. Imperfect assembly might result in unfiltered air being sucked into the engine, causing serious damage.

Air filter replacement

Refer to the instructions provided for air filter cleaning.

Change coolant

Figure 193



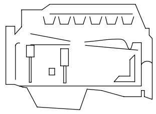
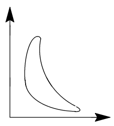
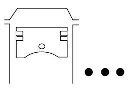
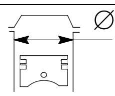
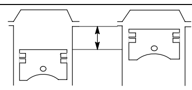
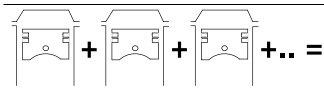
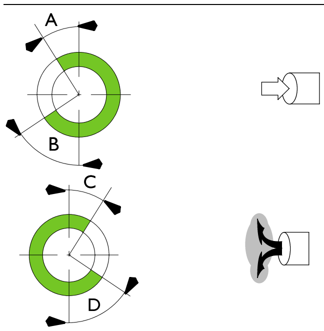
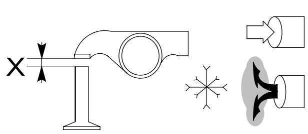
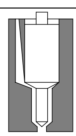
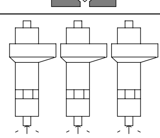
Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.

- Provide suitable containers to ensure that no coolant is dispersed into the environment.
- Loosen the retaining elements (1) and (3) and remove the sleeves (2) connecting the engine circuit to the heat exchanger and wait until it has emptied completely. When empty, repair the circuit making sure that the sleeves are perfectly sealed.
- Fill up the circuit.
- Refill the engine and the heat exchanger until complete top up.
- With the filler cap open, start the engine and keep it idling for nearly one minute. This phase facilitates the cooling liquid air bleed.
- Stop the engine and top up again.

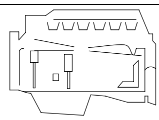
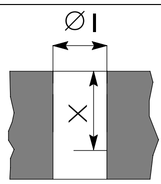
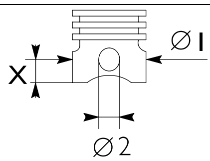
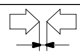
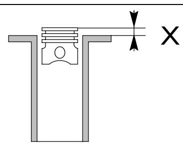
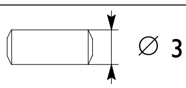
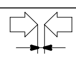
SECTION 4

Overhaul and technical specification

SPECIFICATIONS
F4GE94/F4GE96 Engines

	Type		**4 CYLINDERS**	**6 CYLINDERS**
	Cycle		Four-stroke diesel engine	
	Power		Supercharged with intercooler	
	Injection		Direct	
	Number of cylinders		4 in-line	6 in-line
	Bore	mm	104	
	Stroke	mm	132	
	Total displacement	cm^3	4485	6728
	**TIMING**			
	start before T.D.C.	A	-	
	end after B.D.C.	B	-	
	start before B.D.C.	D	-	
	end after T.D.C.	C	-	
	Checking timing			
	X	mm	0.25 to 0.05	
		mm	0.50 to 0.05	
	FUEL FEED			
	Injection Type:	rotary	STANADYNE DB 4	
	Nozzle type		-	
	Injection sequence		1 - 3 - 4 - 2	1 - 5 - 3 - 6 - 2 - 4

CLEARANCE DATA
F4GE94/F4GE96 Engines

	Type		4 CYLINDERS	6 CYLINDERS
CYLINDER UNIT AND CRANKSHAFT COMPONENTS			mm	
	Cylinder barrels	Ø1	104.000 to 104.024	
	Spare pistons type: Size Outside diameter Pin housing	 X Ø 1 Ø 2	 55.9 103.714 to 103.732 38.010 to 38.016	
	Piston – cylinder barrels		0.268 to 0.310	
	Piston diameter	Ø 1	0.4	
	Piston protrusion	X	0.28 to 0.52	
	Piston pin	Ø 3	37.994 to 38.000	
	Piston pin – pin housing		0.010 to 0.022	

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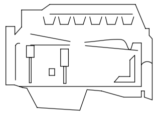
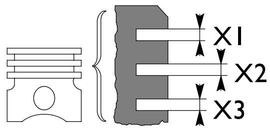
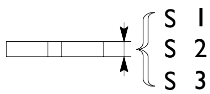
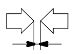
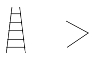
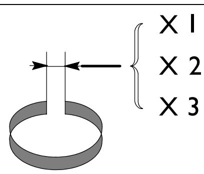
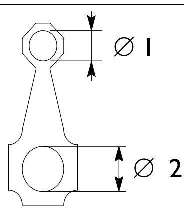
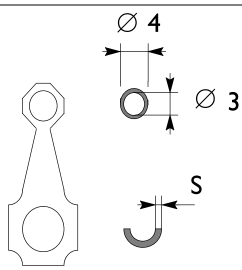
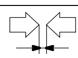
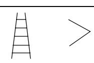
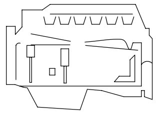
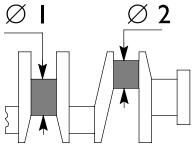
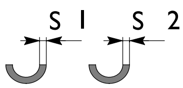
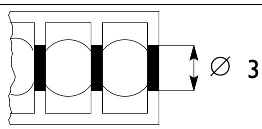
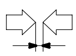
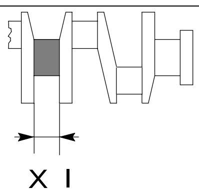
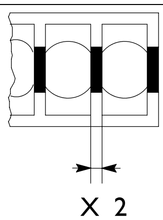
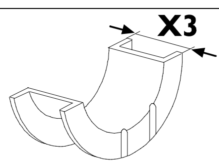
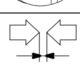
	Type		4 CYLINDERS	6 CYLINDERS
				
CYLINDER UNIT AND CRANKSHAFT COMPONENTS			mm	
	Split ring slots * measured on a Ø of 98.75 ÷ 99.00 mm	X1* X 2 X 3	2,705 to 2,735 2,440 to 2,460 4,030 to 4,050	
	Split rings	S 1* S 2 S 3	2.560 to 2.605 2.350 to 2.380 3.970 to 3.990	
	Split rings - slots	1 2 3	0.100 to 0.175 0.060 to 0.110 0.040 to 0.080	
	Split rings		0.4	
	Split ring end opening in cylinder barrel:	X 1 X 2 X 3	0.30 to 0.40 0.60 to 0.80 0.30 to 0.55	
	Small end bush housing Big end bearing housing	Ø 1 Ø 2	40.987 to 41.013 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	
	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	
	Journals ∅ 1 Crankpins ∅ 2	82.99 to 83.01 68.987 to 69.013	
	Main half bearings S 1 Big end half bearings S 2	2.456 to 2.464 1.955 to 1.968	
	Main bearings No. 1–5 / 1-7 ∅ 3 No. 2–3–4 / 2-3-4-5-6 ∅ 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	 0.044 to 0.106 0.039 to 0.111	
	Half bearings - Crankpins	0.030 to 0.116	
	Main half bearings Big end half bearings	0.250; 0.500	
	Shoulder journal X 1	37.350 to 37.650	37.424 to 37.576
	Shoulder main bearing X 2	32.180 to 32.280	
	Shoulder half-rings X 3	37.28 to 37.38	
	Output shaft shoulder	0.095 to 0.270	0.095 to 0.265

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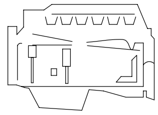
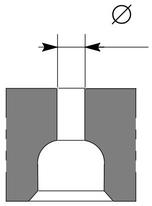
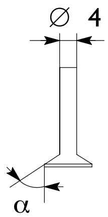
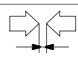
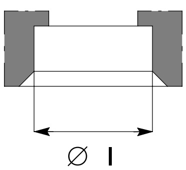
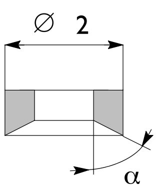
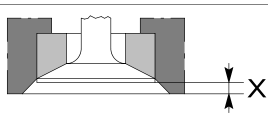
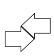
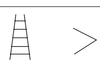
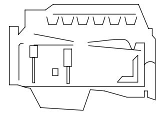
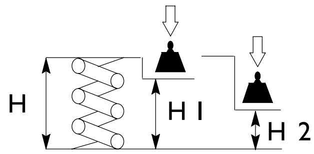
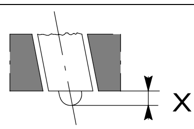
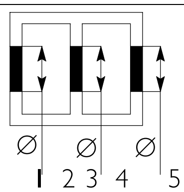
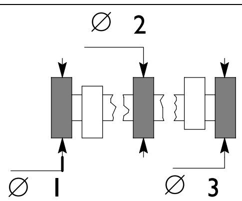
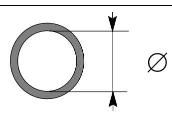
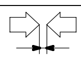
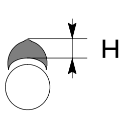
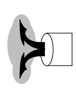
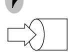
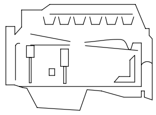
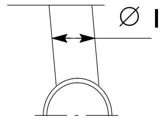
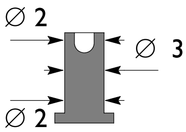
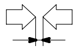
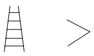
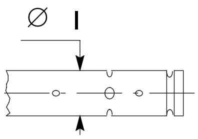
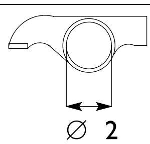
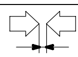
	Type		4 CYLINDERS	6 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM			mm	
	Valve guide seats on cylinder head	∅ 1	8.019 to 8.039	
	Valves:			
	(intake)	∅ 4 α	7.960 to 7.980 60°	
	(exhaust)	∅ 4 α	7.960 to 7.980 45°	
	Valve stem and guide		0.039 to 0.076	
	Housing on head for valve seat:			
	(intake)	∅1	46.987 to 47.013	
	(exhaust)	∅1	43.637 to 43.663	
	Valve seat outside diameter; valve seat angle on cylinder head:			
	(intake)	∅ 2 α	47.063 to 47.089 60°	
	(exhaust)	∅ 2 α	43.713 to 43.739 45°	
	Sinking	X (intake)	0.336 to 1.072	
		X (exhaust)	0.104 to 0.840	
	Between valve seat and head	(intake)	0.050 to 0.102	
		(exhaust)	0.050 to 0.102	
	Valve seats		-	

	Type		4 CYLINDERS	6 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM			mm	
	Valve spring height: free spring under a load equal to: 329 N 641 N	 H H1 H2	 63.50 / 65.69* 49.02 38.20	
	Injector protrusion	X	Not adjustable	
	Camshaft bush housings No. 1 Camshaft housings No. 2-3-4-5/2-3-4-5-6-7		59.222 to 59.248 54.089 to 54.139	
	Camshaft journals: 1 ⇒ 5 1 ⇒ 7	 Ø Ø	53.995 to 54.045	
	Bush inside diameter	Ø	54.083 to 54.147	
	Bushes and journals		0.038 to 0.152	
	Cam lift:  	 H H	 - -	

* Installed as an alternative

	Type	4 CYLINDERS	6 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM		mm	
	Tappet cap housing on block Ø 1	16,000 ÷ 16,030	
	Tappet cap outside diameter: Ø 2 Ø 3	15.929 to 15.959 15.965 to 15.980	
	Between tappets and housings	-	
	Tappets	-	
	Rocker shaft Ø 1	18.963 to 18.975	
	Rockers Ø 2	19.000 to 19.026	
	Between rockers and shaft	0.025 to 0.063	

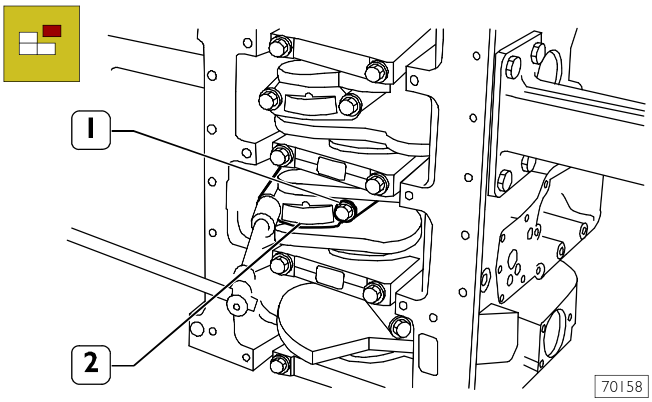
ENGINE OVERHAUL
ENGINE REMOVAL AT THE BENCH

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

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

The following operations are relating to the 4 cylinders engine but are analogously applicable for the 6 cylinders.

Figure 1

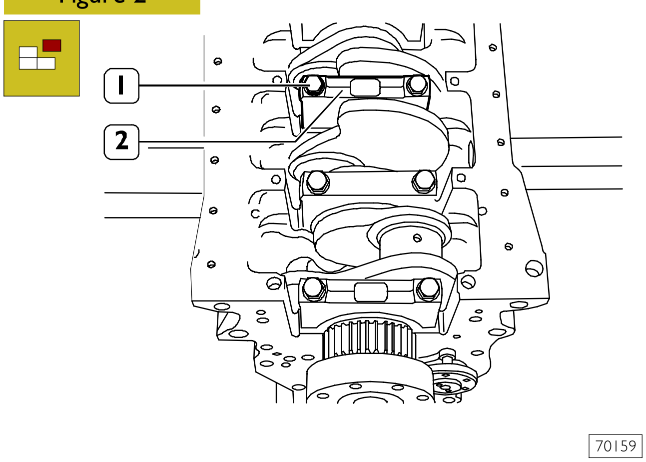


Remove the screws (1) fastening the connecting rod caps (2) and remove them.

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

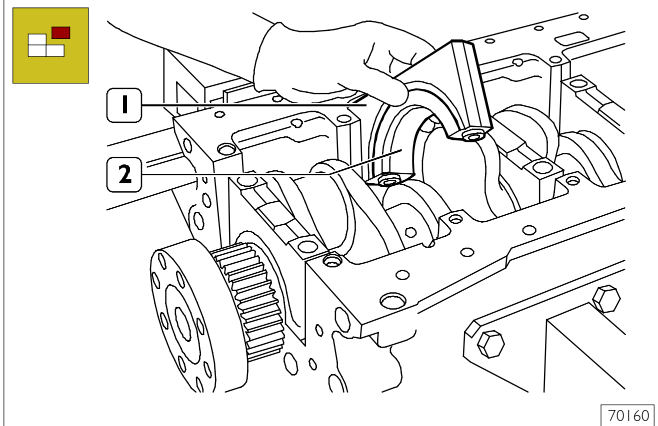
NOTE Keep the half-bearings into their housings since in case of use they shall be fitted in the same position found at removal.

Figure 2



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

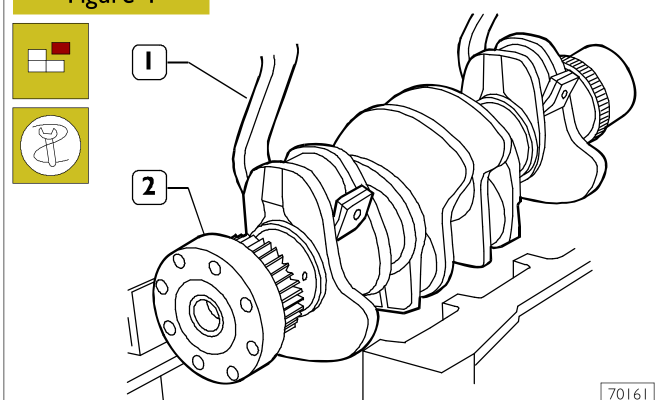
Figure 3



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

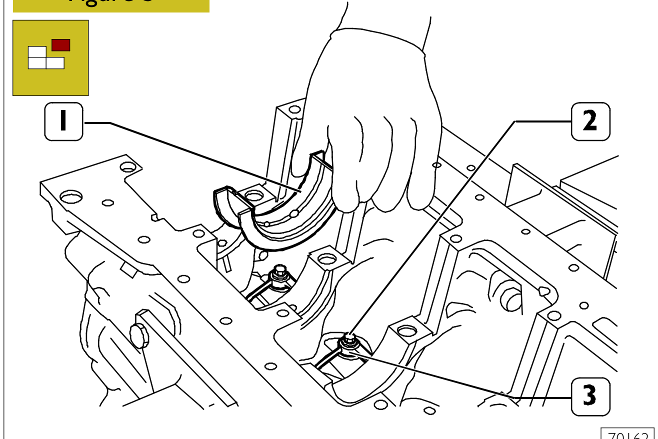
NOTE Take note of lower and upper half-bearing assembling positions since in case of reuse they shall be fitted in the same position found at removal.

Figure 4



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

Figure 5



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

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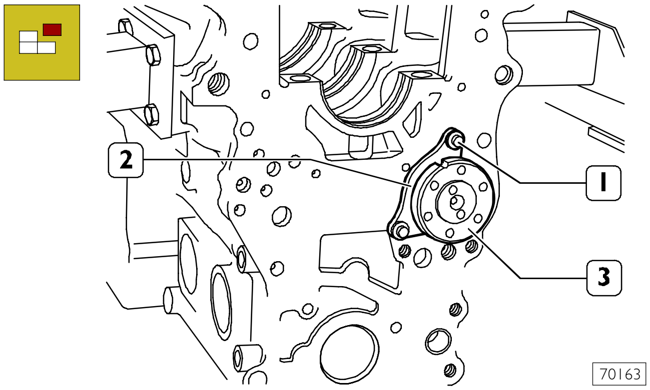
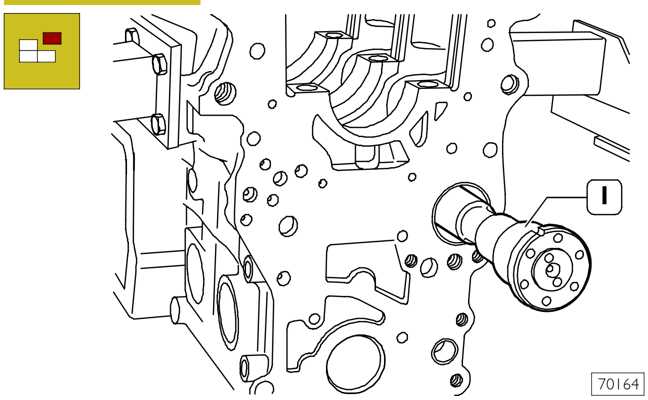
Figure 6



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

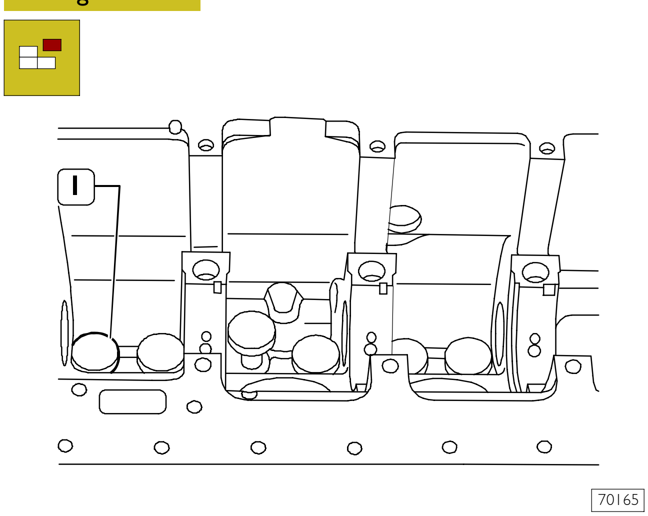
NOTE Take note of plate (2) assembling position.

Figure 7



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

Figure 8

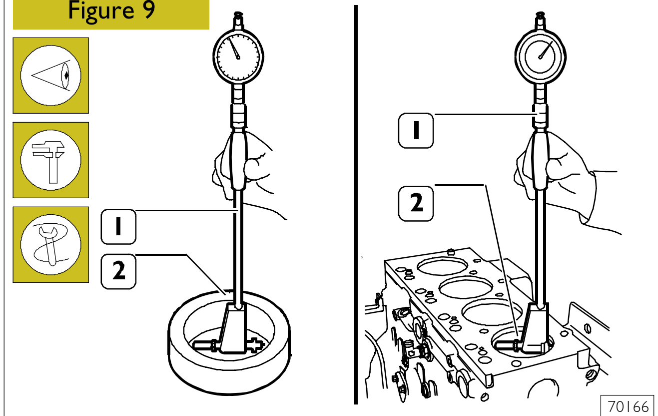


Withdraw the tappets (1) from the engine block.

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.

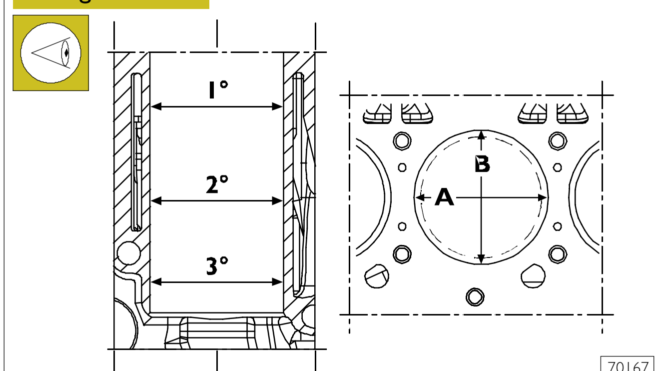
Check operating plug conditions and replace them in case of uncertain seal or if rusted.

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 99395687 (1) fitted with the dial gauge previously set to zero on the ring gauge (2) of the cylinder barrel diameter.

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

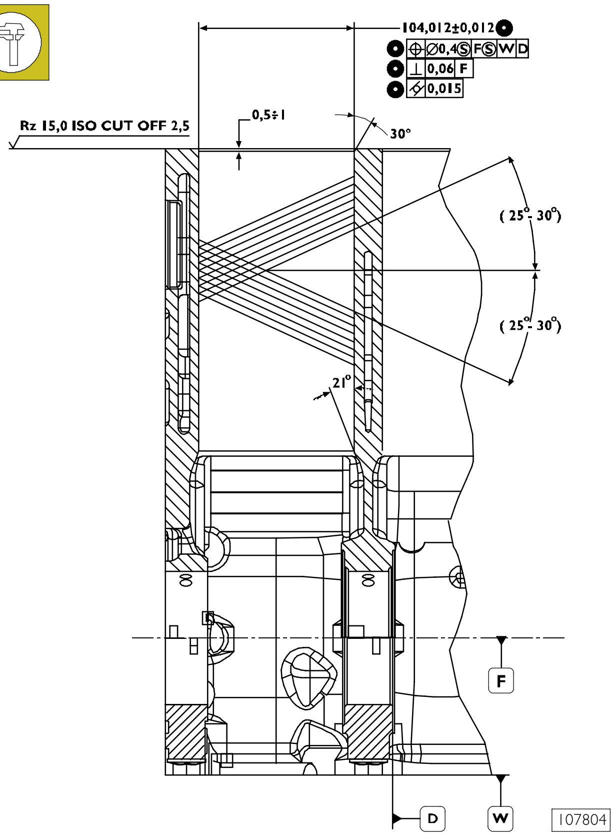
Figure 10



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



NOTE In case of regrinding, all barrels shall have the same oversize (0.4 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

Check absence of distortions on the head supporting surface on the cylinder unit.

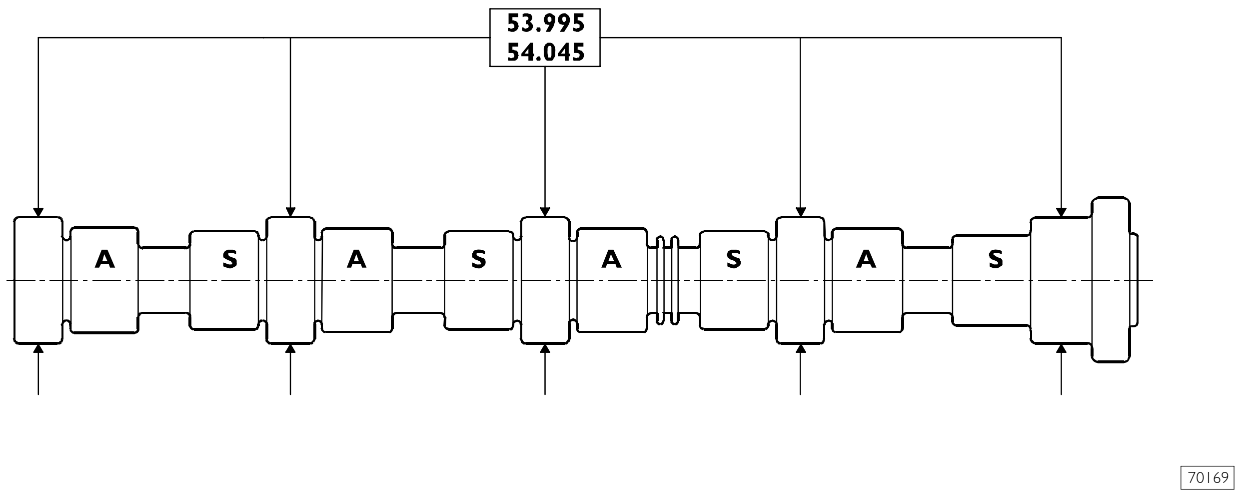
This check can be performed after removing dowels (4), with a calibrated rule (2) and a feeler gauge (3).

After finding the distortion areas, level the surface using a grinder.

Planarity error shall not exceed 0.075 mm.

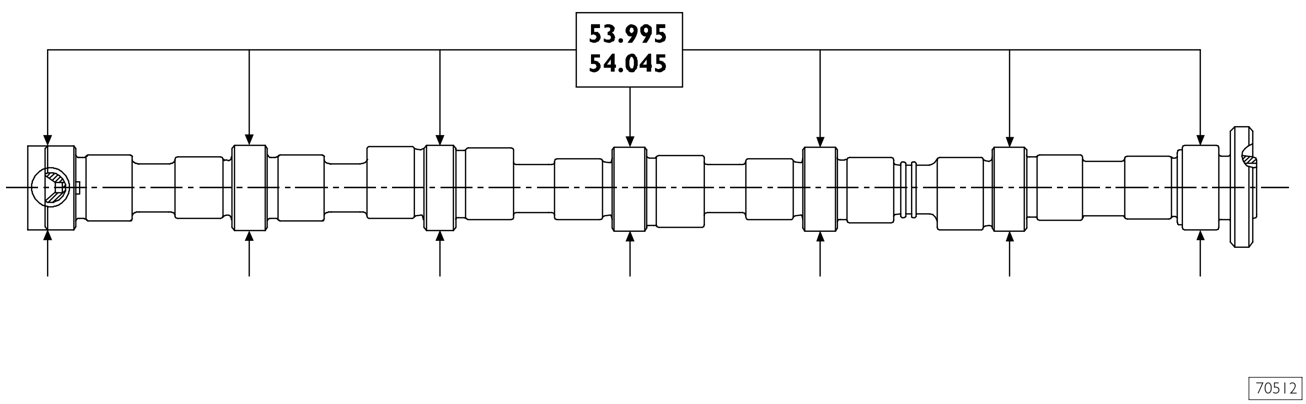
TIMING SYSTEM
Camshaft

Figure 12



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

Figure 13



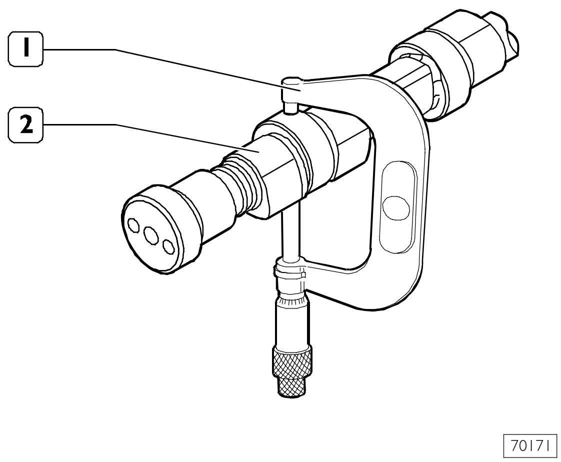
MAIN DATA ABOUT CAMSHAFT PINS (6 CYL.)

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.

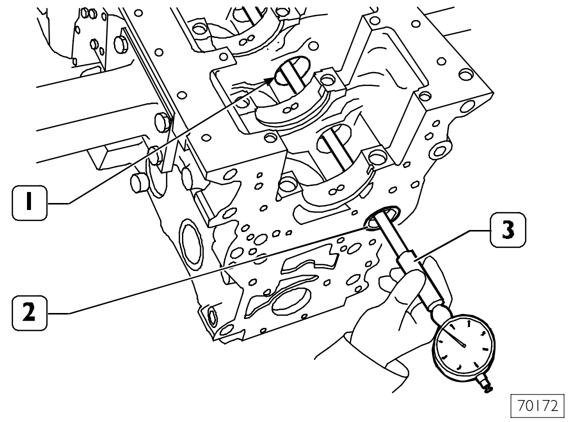
Figure 14



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

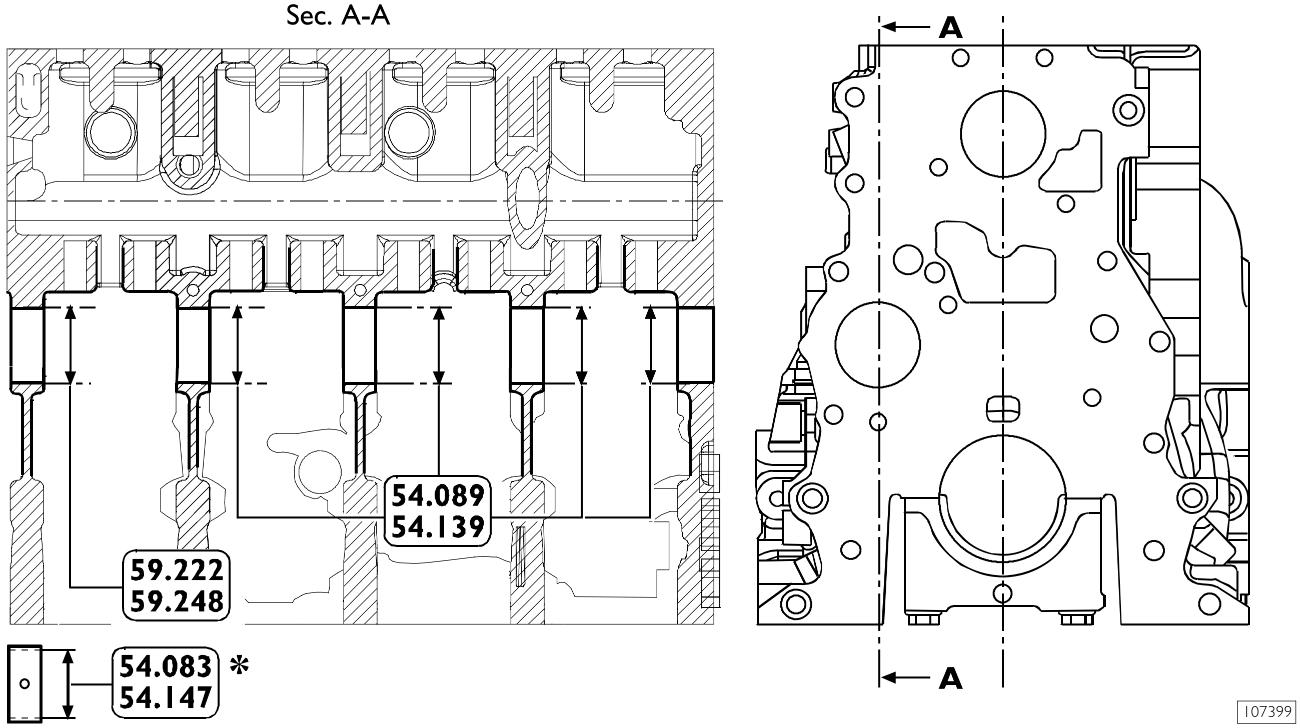
BUSHES

Figure 15



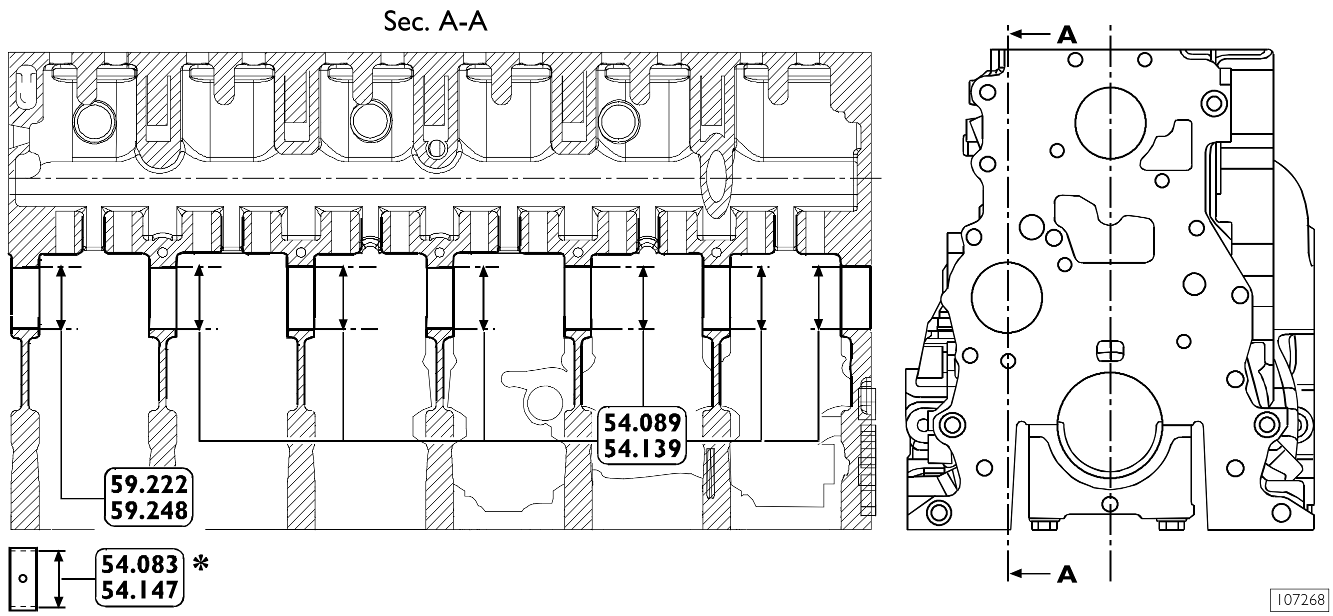
Camshaft bushes (2) shall be pressed into their housings. Internal surfaces must not show seizing or wear.
Use bore dial gauge (3) to measure camshaft front and rear bush (2) and intermediate housing (1) diameter.
Measurements shall be performed on two perpendicular axes.

Figure 16



MAIN SPECIFICATIONS OF THE CAMSHAFT BEARING BUSH AND ITS SEAT (4-cylinder engines)
* Dimension to be measured after inserting the bearing bush.

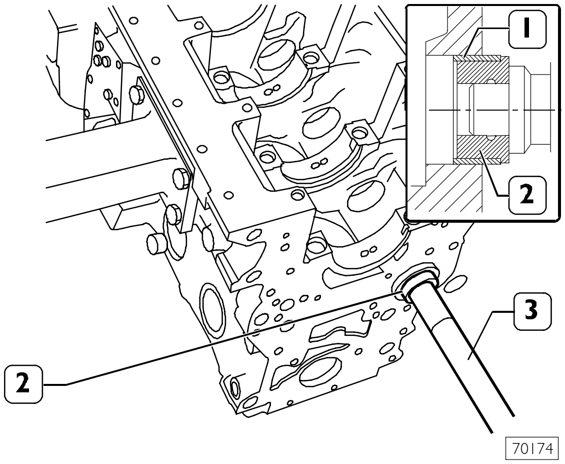
Figure 17



MAIN SPECIFICATIONS OF THE CAMSHAFT BEARING BUSH AND ITS SEAT (6-cylinder engines)
* Dimension to be measured after inserting the bearing bush.

Bush replacement

Figure 18

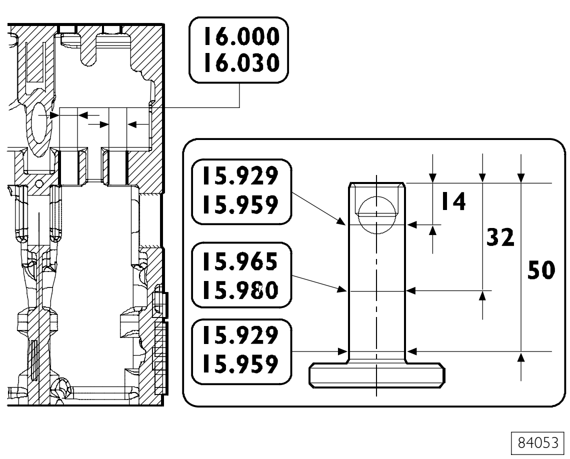


To replace the bearing (1) use tool 99360362 (2) and handle 99370006 (3) to remove and install it.

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

Tappets

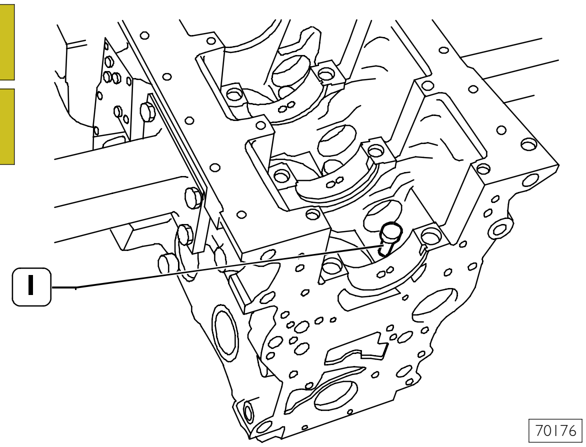
Figure 19



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

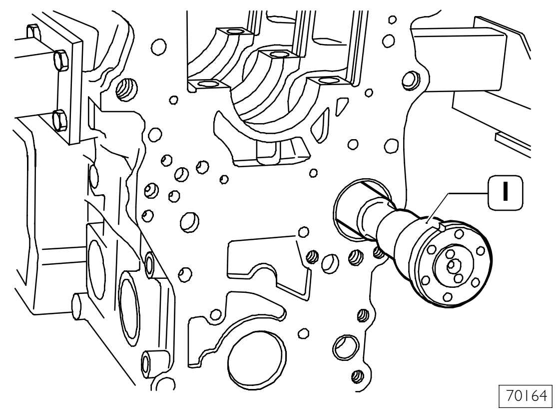
Fitting tappets – camshaft

Figure 20



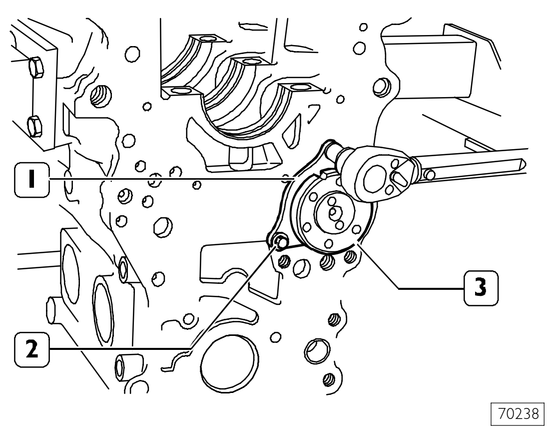
Lubricate the tappets (1) and fit them into the relevant housings on the engine block.

Figure 21



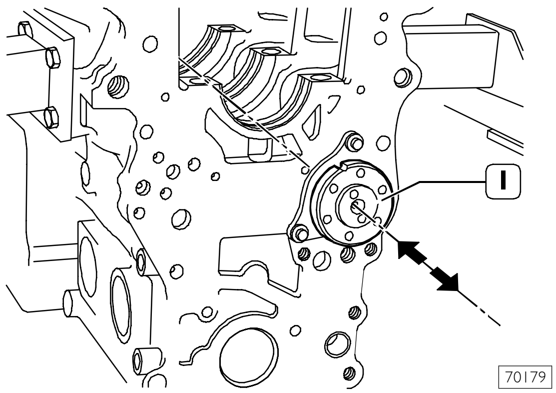
Lubricate the camshaft support bearing and install the camshaft (1) being careful to ensure that the bearing or the shaft support seats are not damaged during the operation.

Figure 22



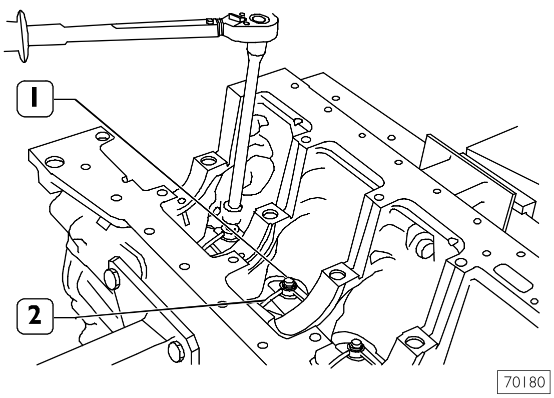
Set camshaft (3) retaining plate (1) with the slot facing the top of the engine block and the marking facing the operator, then tighten the screws (2) to the specified torque.

Figure 23



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

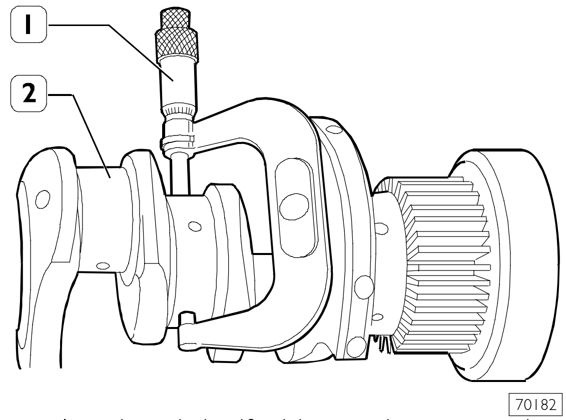
Figure 24



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

OUTPUT SHAFT
Measuring journals and crankpins (4 cylinders)

Figure 25



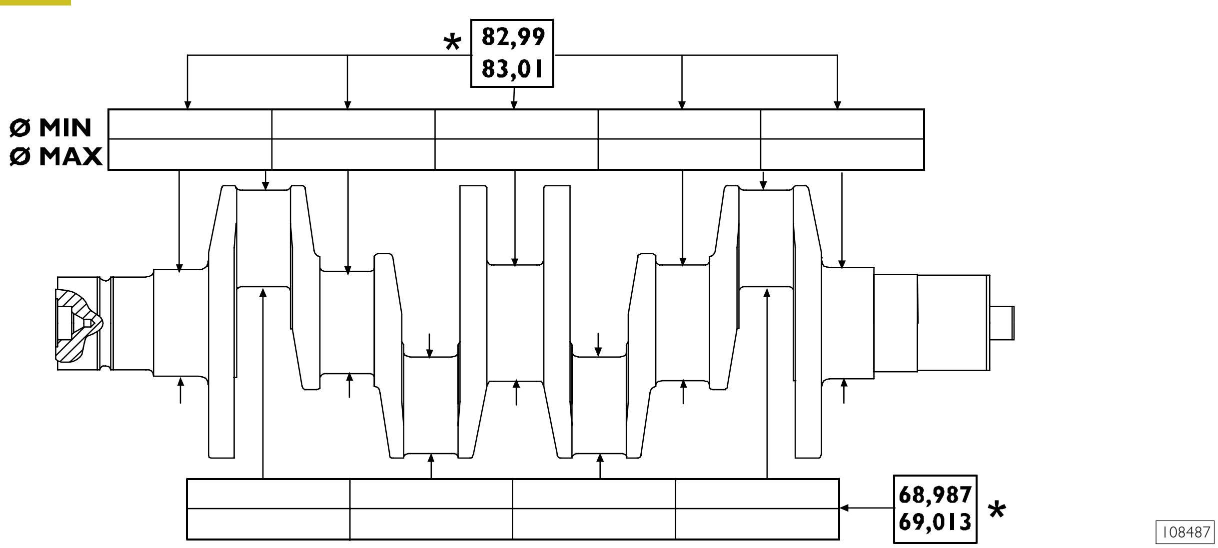
Grind journals and crankpins if seizing, scoring or excessive ovalisation are found. Before grinding the pins (2) measure them with a micrometer (1) to decide the final diameter to which the pins are to be ground.

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

Undersize classes are:

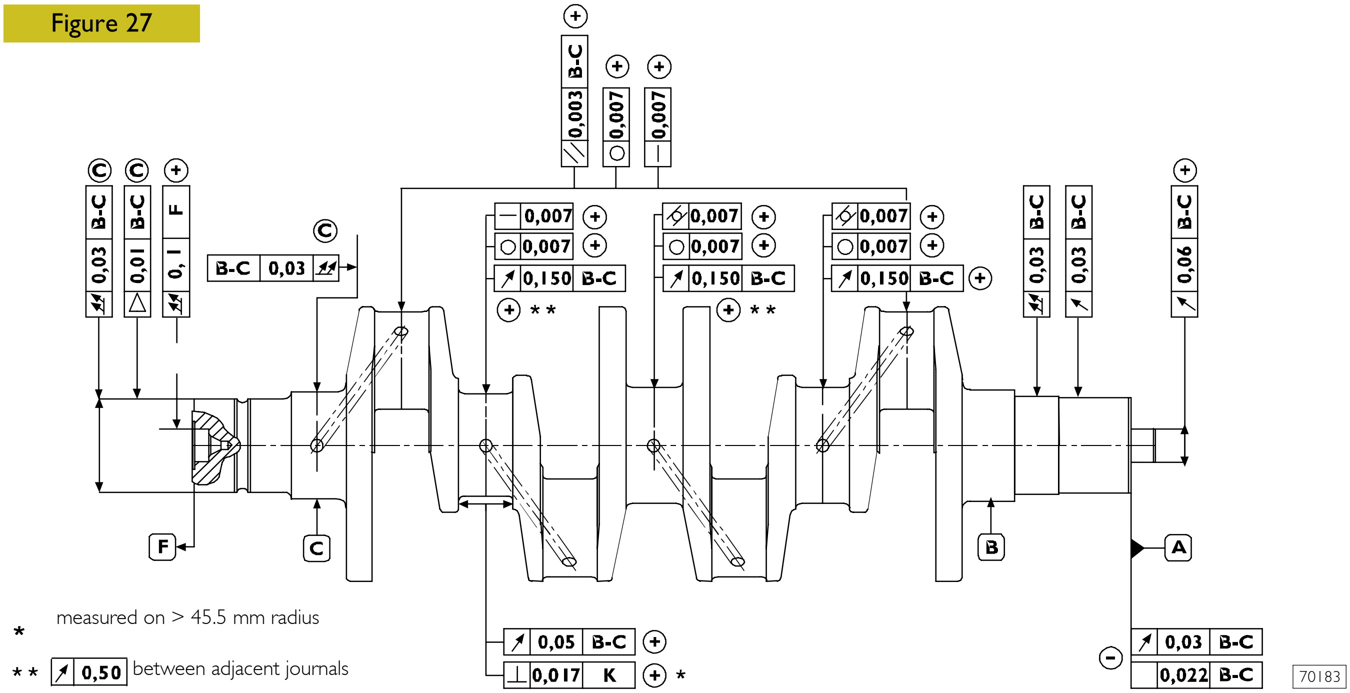
NOTE Journals and crankpins shall always be ground to the same undersize class.
Journals and crankpins undersize shall be marked on the side of the crank arm No.1.
For undersized crankpins: letter M
For undersized journals: letter B
For undersized crankpins and journals: letters MB

Figure 26



FILL THIS TABLE WITH OUTPUT SHAFT JOURNAL AND CRANKPIN MEASURED VALUES

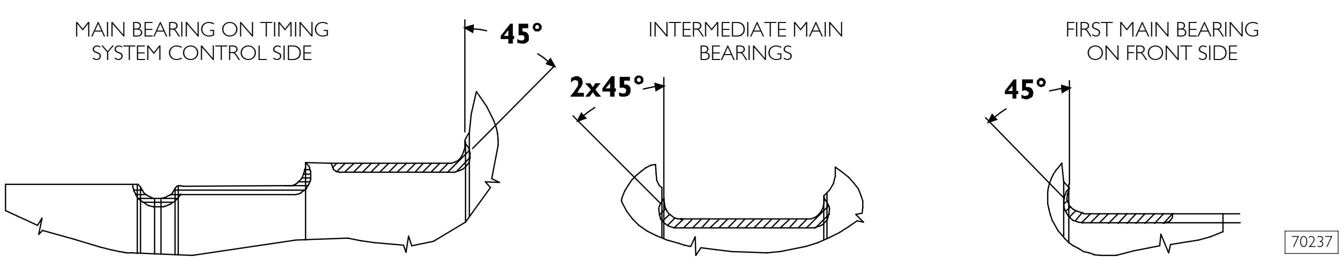
Figure 27



OUTPUT SHAFT MAIN TOLERANCES

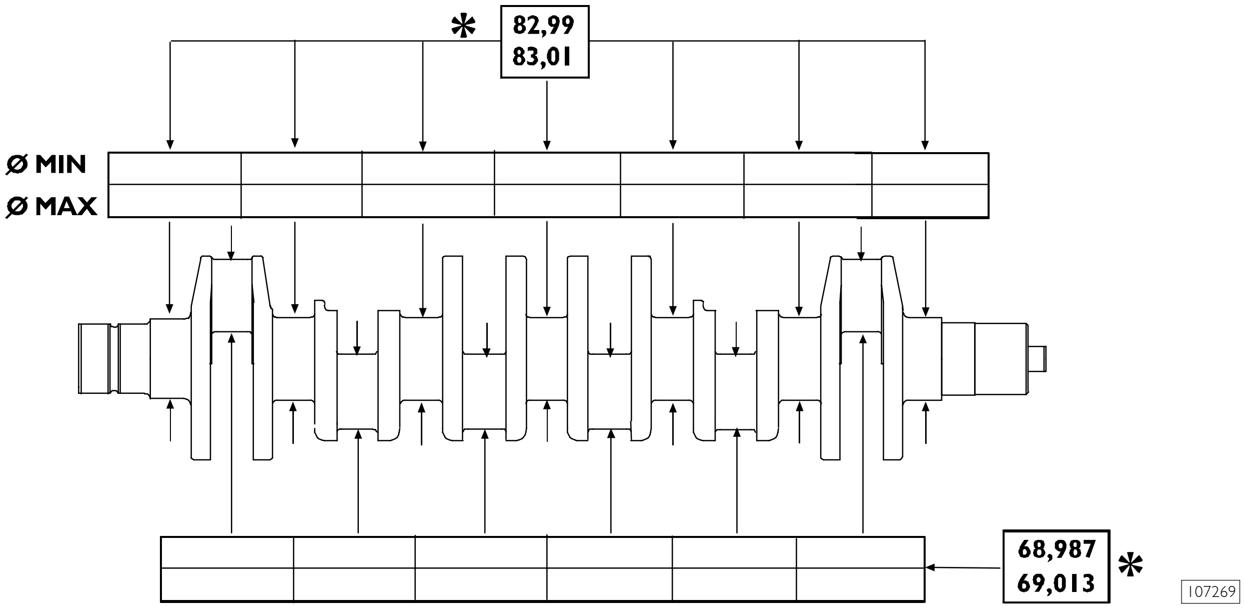
TOLERANCES	TOLERANCE CHARACTERISTIC	GRAPHIC SYMBOL
SHAPE	Roundness	○
	Cilindricity	/○/
DIRECTION	Parallelism	//
	Verticality	⊥
	Straightness	—
POSITION	Concentricity or coaxiality	◎
OSCILLATION	Circular oscillation	↗
	Total oscillation	⇗

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



Measuring journals and crankpins (6 cylinders)

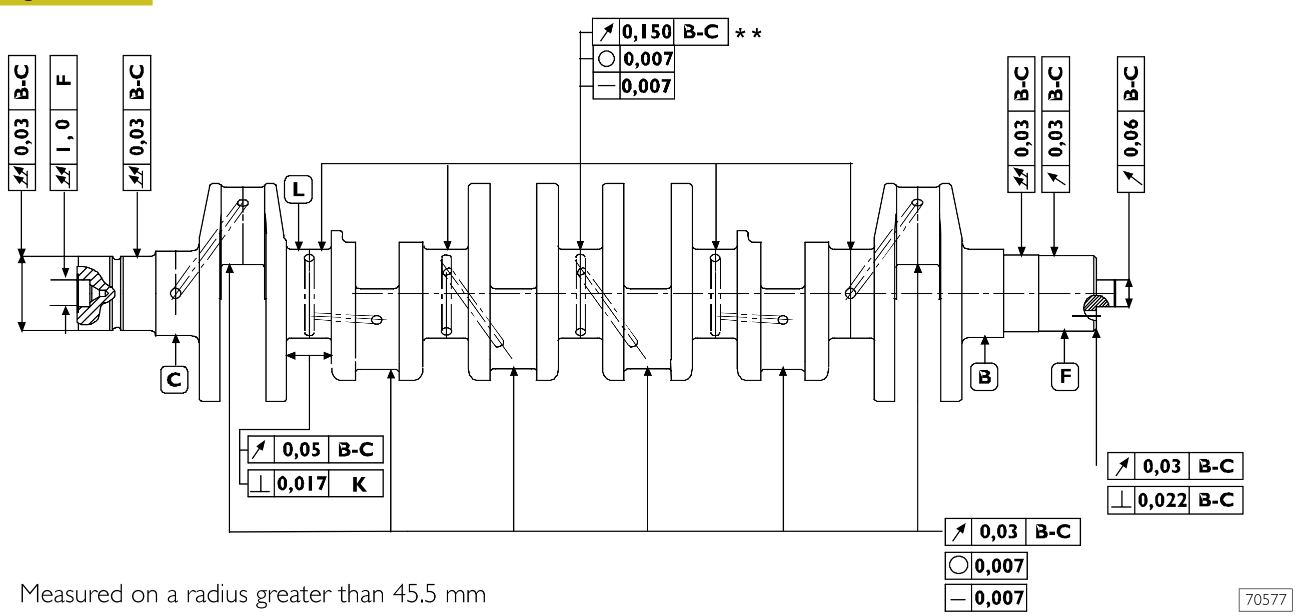
Figure 28



FILL THIS TABLE WITH OUTPUT SHAFT JOURNAL AND CRANKPIN MEASURED VALUES

*Rated value

Figure 29

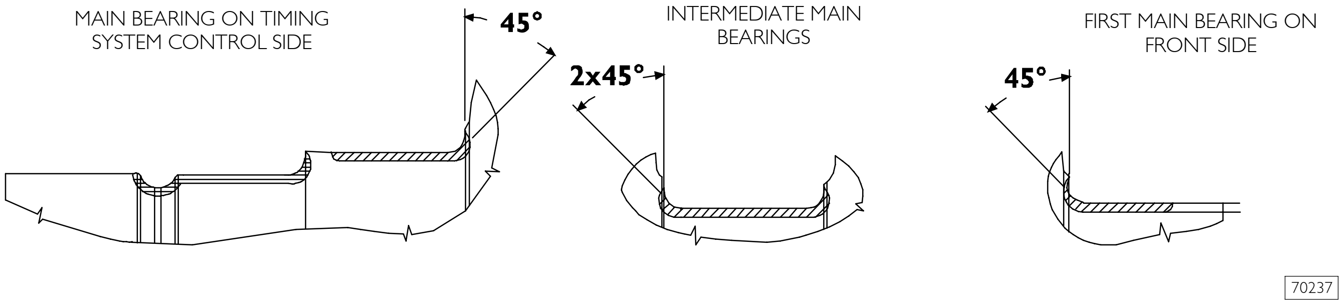


* Measured on a radius greater than 45.5 mm

** 0.500 between adjacent main journals

MAIN OUTPUT SHAFT TOLERANCES

Figure 30

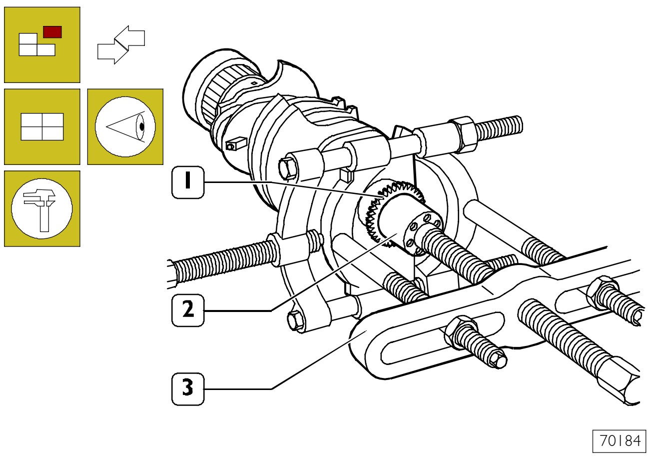


TOLERANCES	TOLERANCE CHARACTERISTIC	GRAPHIC SYMBOL
SHAPE	Roundness	○
	Cilindricity	/○/
DIRECTION	Parallelism	//
	Verticality	⊥
	Straightness	—
POSITION	Concentricity or coaxiality	◎
OSCILLATION	Circular oscillation	↗
	Total oscillation	↗↗

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

Replacing oil pump control gear

Figure 31

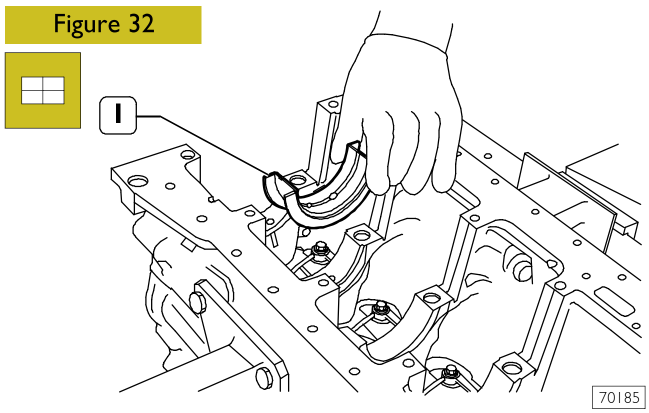


Check that gear toothing (1) is not damaged or worn, otherwise remove it using the proper puller (3).

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

Fitting main bearings

Figure 32



NOTE 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.

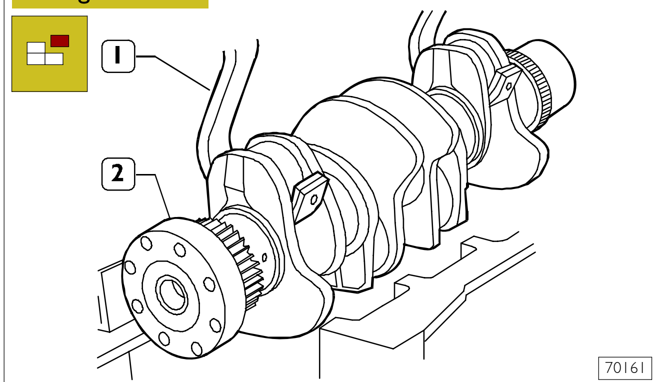
NOTE Do not try to adapt the bearings.

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

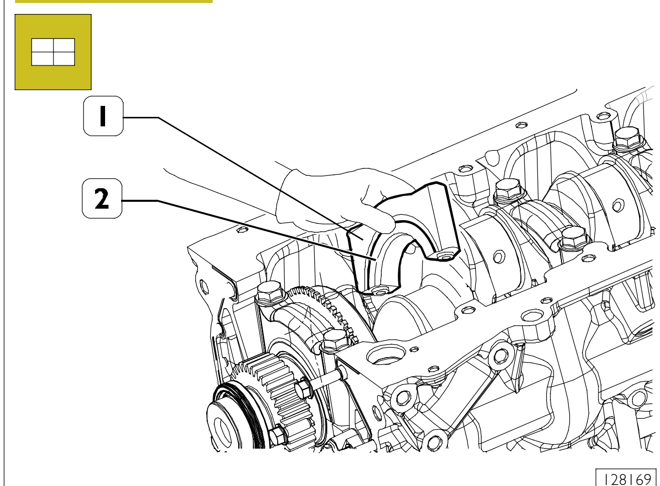
Figure 33



Refit the output shaft (2).

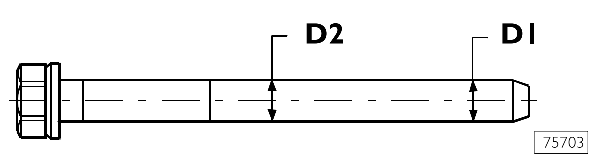
Check the backlash between output shaft main journals and the relevant bearings as follows:

Figure 34



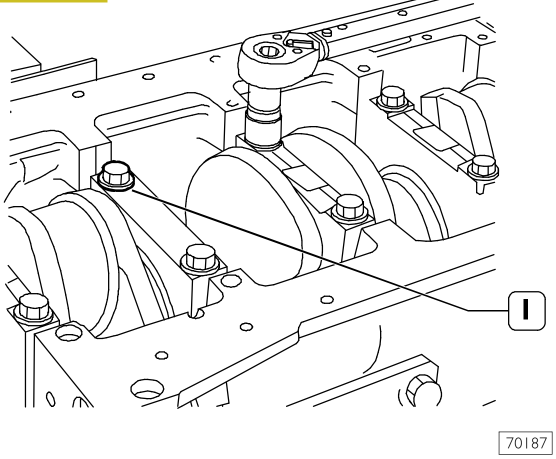
- ❑ clean accurately the parts and remove any trace of oil;
- ❑ fit caps (1), including the half bearings (2) on the relevant supports.

NOTE Before using the fixing screws again, measure them twice as indicated in the picture, checking D1 and D2 diameters:
if D1 - D2 < 0,1 mm the screw can be utilised again;
if D1 - D2 > 0,1 mm the screw must be replaced.



 Print P4D32N003 E

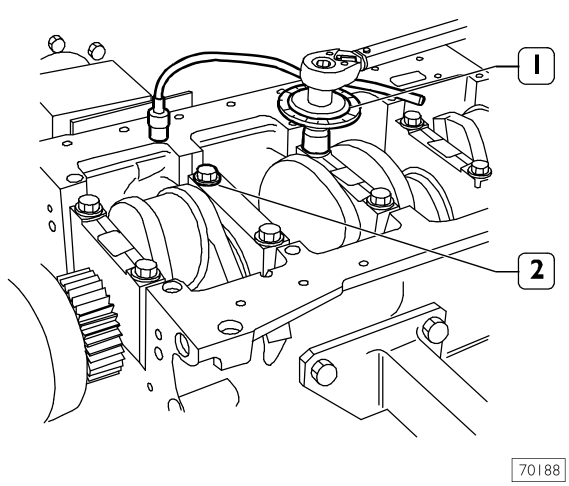
Figure 35



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

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

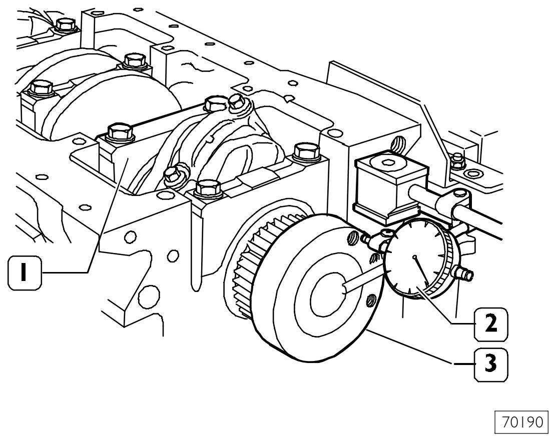
Figure 36



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

Checking output shaft shoulder clearance

Figure 37

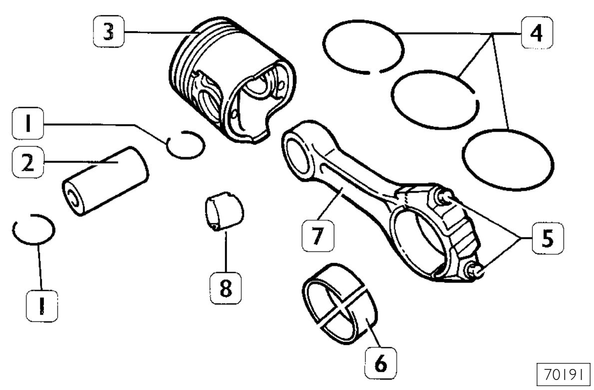


This check is performed by setting a magnetic-base dial gauge (2) on the output shaft (3) as shown in the figure, standard value is 0.068 to 0.41.

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

CONNECTING ROD – PISTON ASSEMBLY

Figure 38



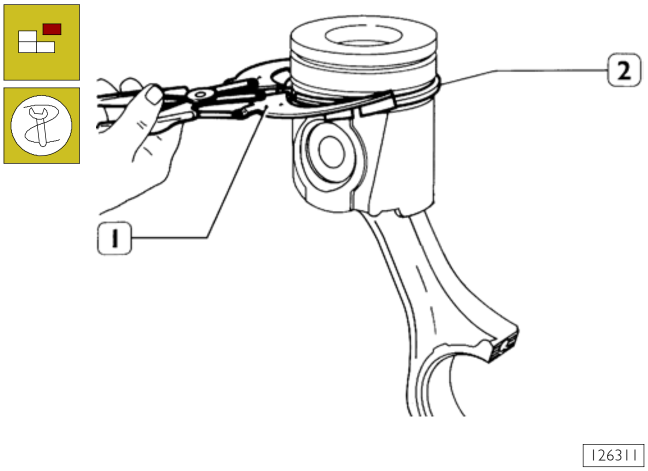
CONNECTING ROD – PISTON ASSEMBLY COMPONENTS

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

NOTE The pistons supplied spare with the following sizes:

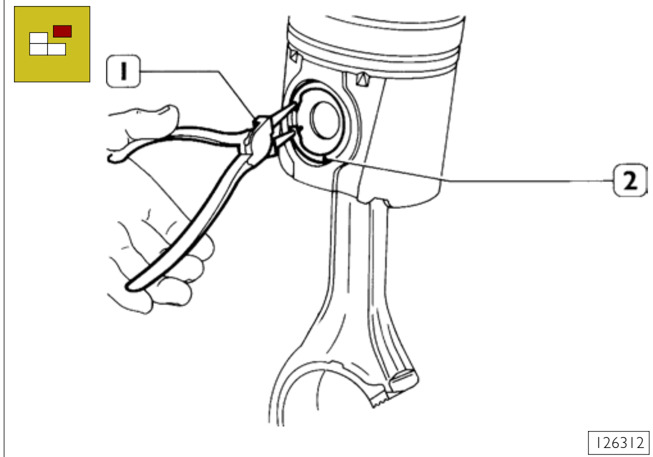
- standard;
- 0.4 mm oversize.

Figure 39



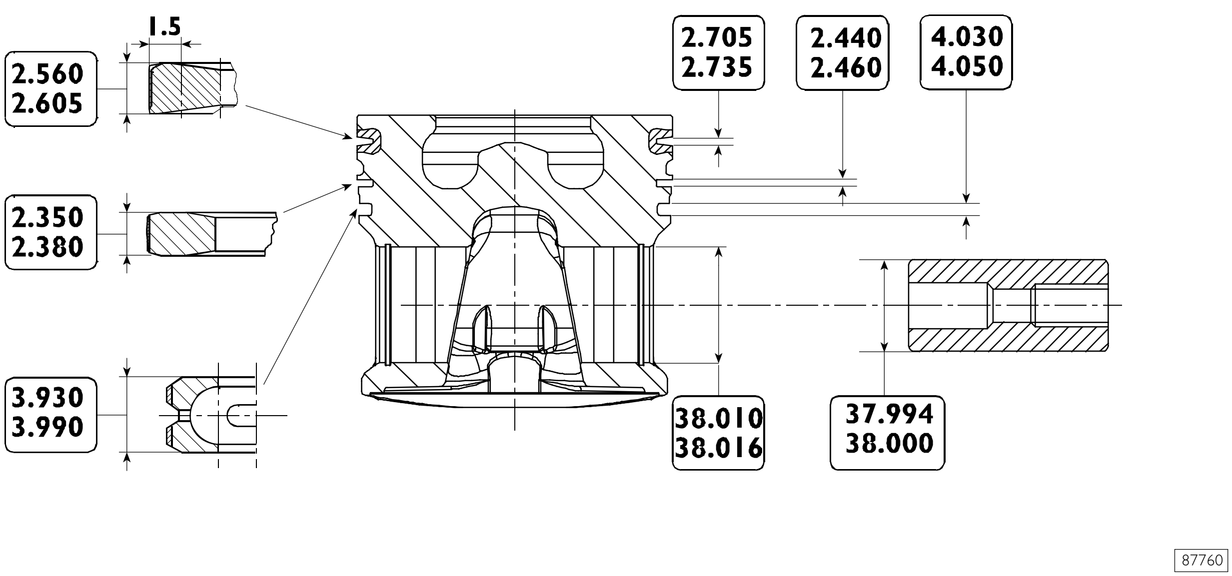
Remove split rings (2) from piston using pliers 99360183 (1).

Figure 40



The circlips (2) retaining the gudgeon pin are removed using round-nose pliers (1).

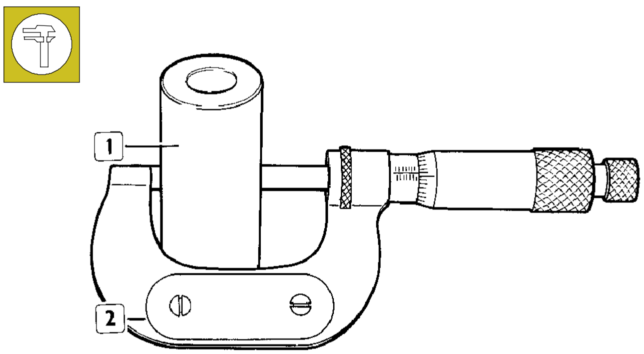
Figure 41



MAIN DATA CONCERNING KS. PISTON, PINS AND SPLIT RINGS

Piston pins

Figure 42

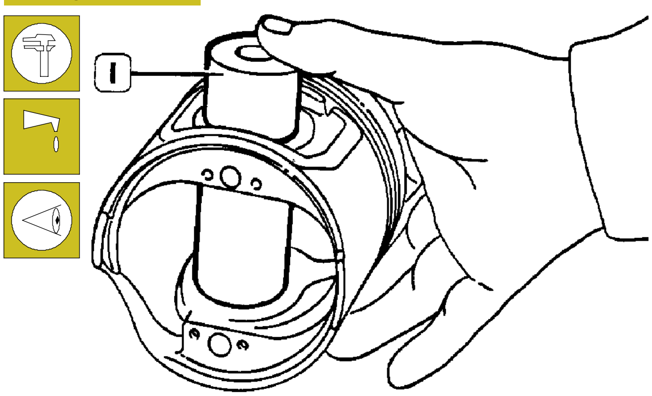


18857

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

Conditions for proper pin-piston coupling

Figure 43

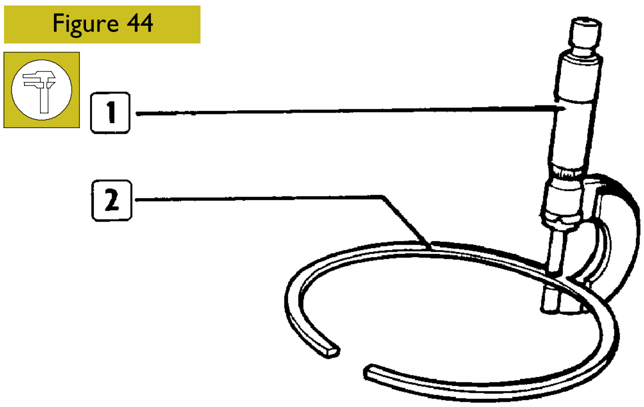


32619

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.

Split rings

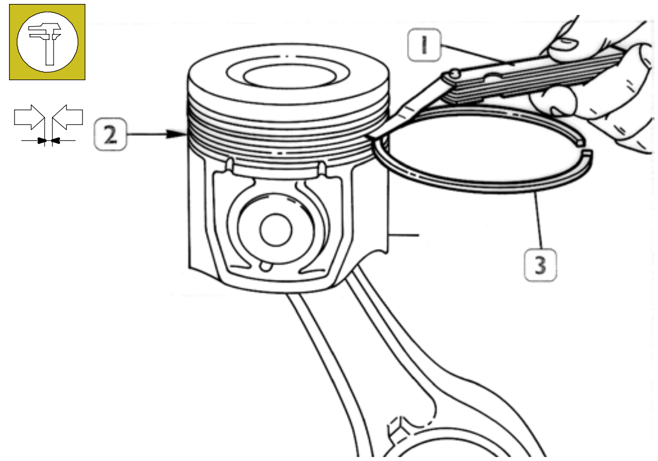
Figure 44



16552

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

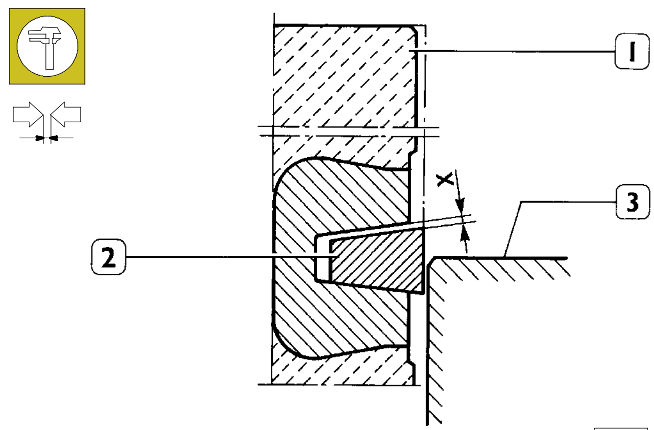
Figure 45



128140

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 46



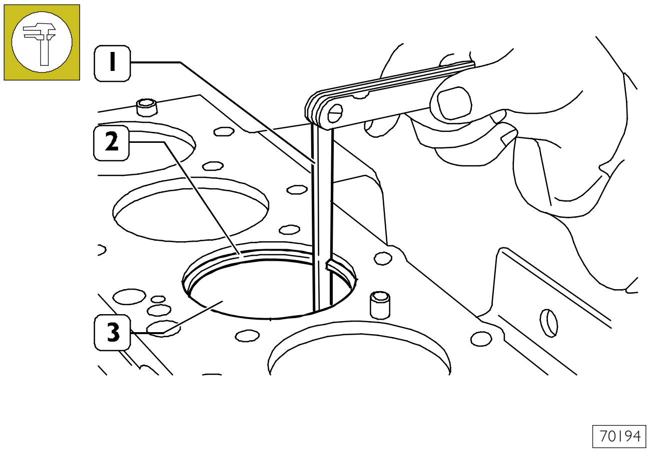
41104

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.

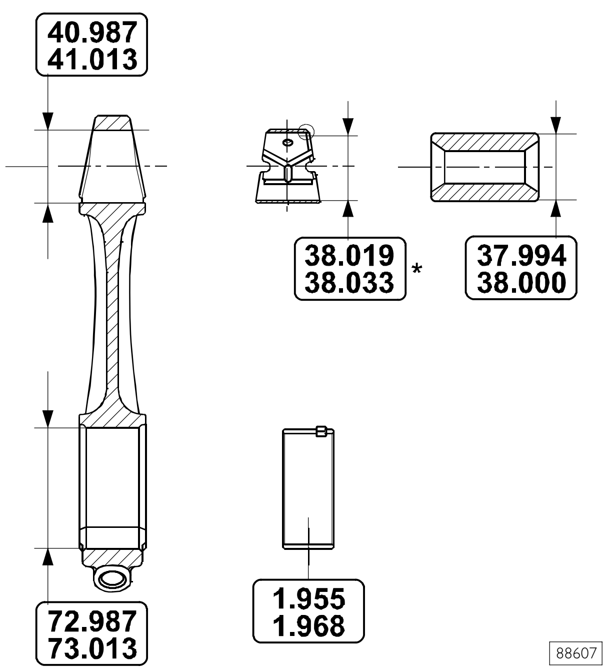
Figure 47



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

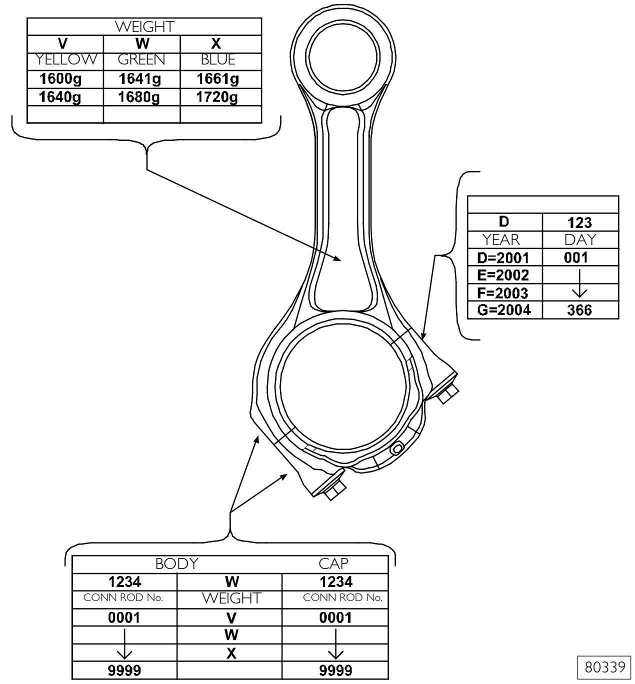
Connecting rods

Figure 48



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

Figure 49 (Demonstrative)



NOTE 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, 1560 to 1600 (yellow marking);
  - W, 1601 to 1640 (green marking);
  - X, 1641 to 1680 (blue marking);

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

Material removal is not allowed.

Bushes

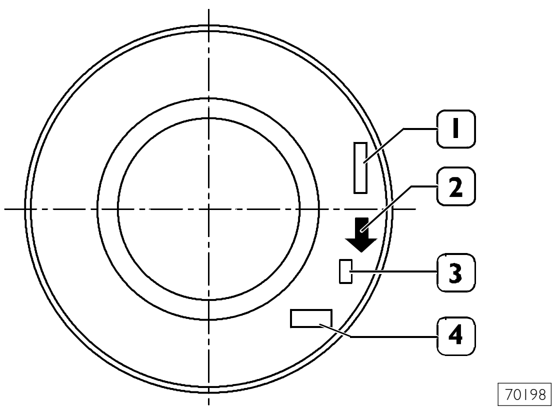
Check that the bush in the connecting rod small end is free from scoring or seizing and that it is not loosen. Otherwise replace.

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.

Fitting connecting rod-piston assembly
Connecting rod-piston coupling

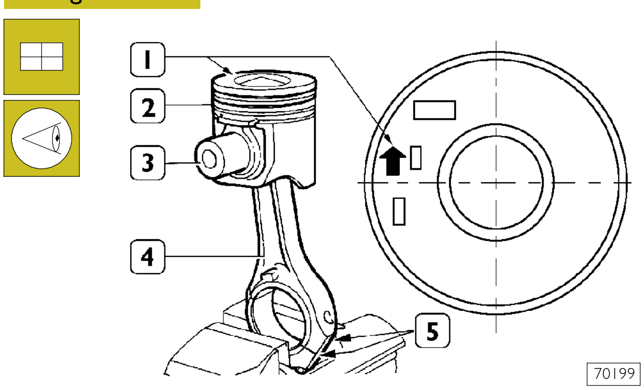
Figure 50



The piston crown is marked as follows:

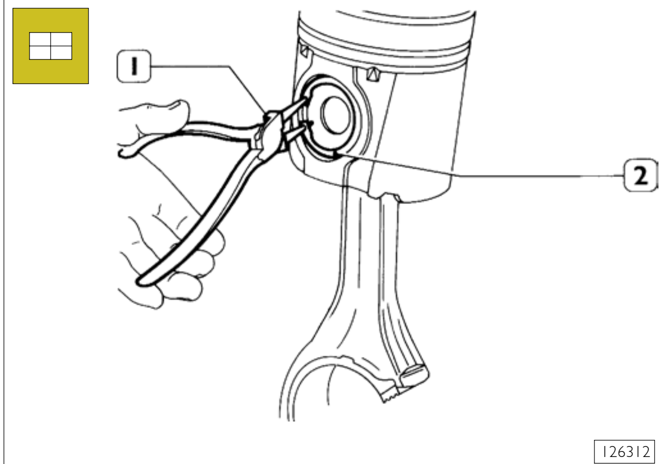
1. Part number and design modification number;
2. Arrow showing piston assembling direction into cylinder barrel, this arrow shall face the front key of the engine block;
3. Marking showing 1st slot insert testing;
4. Manufacturing date.

Figure 51



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.

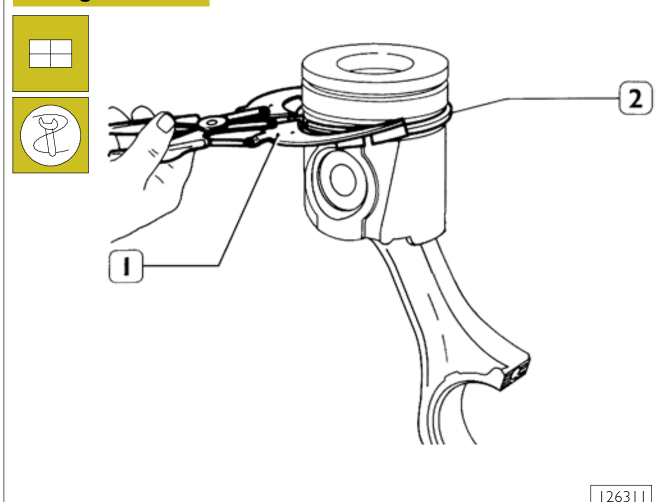
Figure 52



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

Fitting split rings

Figure 53

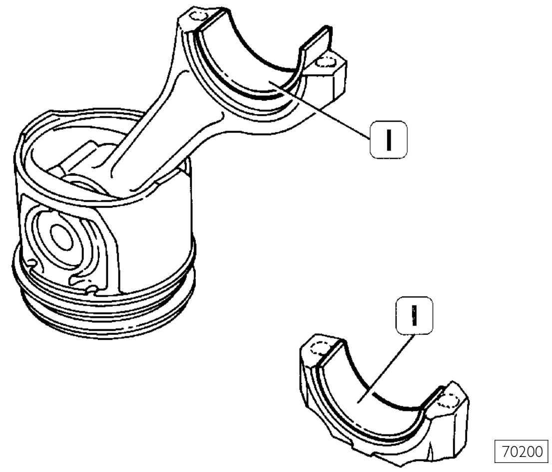


Use pliers 99360183 (1) to fit the split rings (2) on the piston. Split rings shall be fitted with the marking "TOP" facing upwards and their openings shall be displaced with each other by 120°.

NOTE Split rings are supplied spare with the following sizes:

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

Figure 54

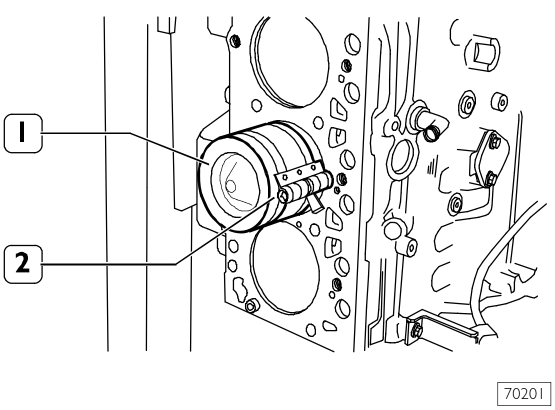


Fit half bearings (1) on connecting rod and cap.

NOTE 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 55



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 56

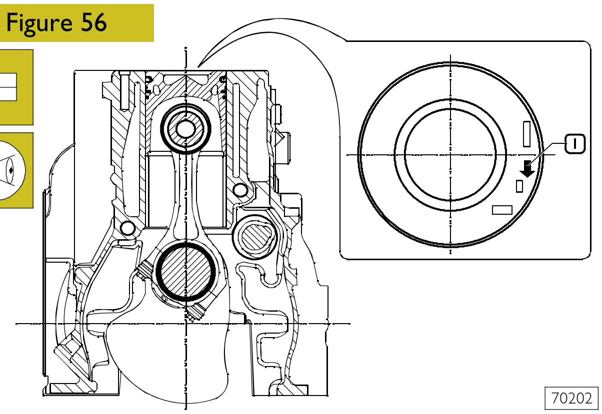
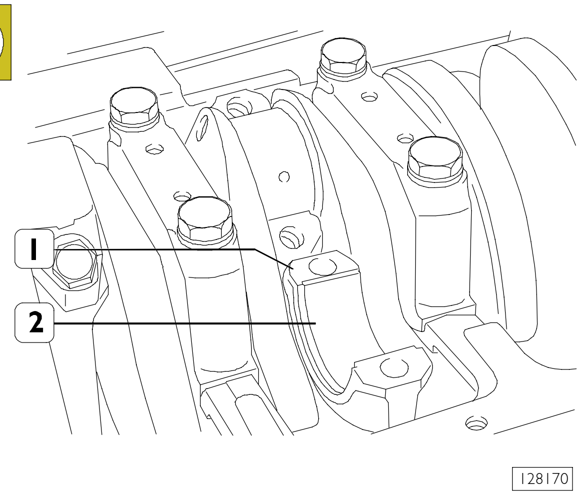


DIAGRAM FOR CONNECTING ROD-PISTON ASSEMBLY FITTING INTO BARREL

- 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 57



To measure the clearance proceed as follows:

- clean the parts accurately and remove any trace of oil;
- fit the connecting rod caps (1) with the relevant half bearings (2).

NOTE Before using the fixing screws again, measure them twice as indicated in the picture, checking D1 and D2 diameters:
if D1 - D2 < 0,1 mm the screw can be utilised again;
if D1 - D2 > 0,1 mm the screw must be replaced.

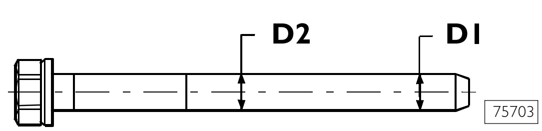
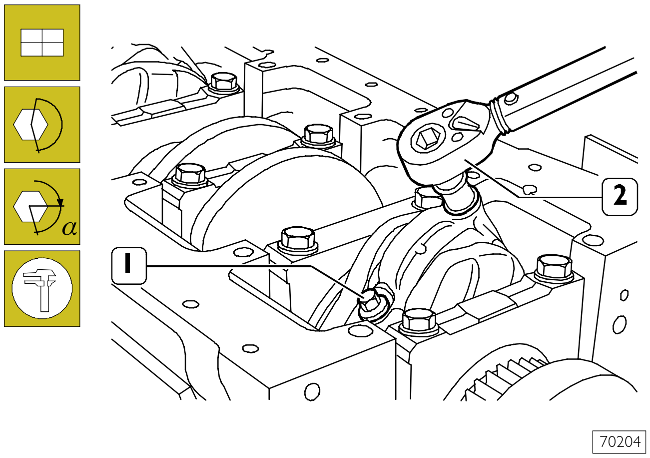
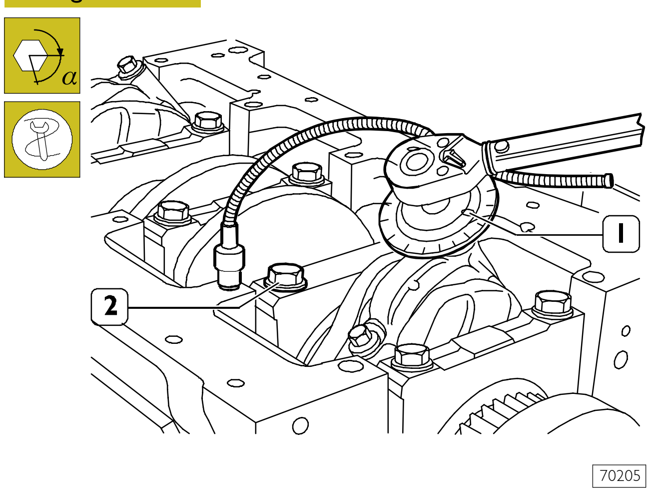


Figure 58



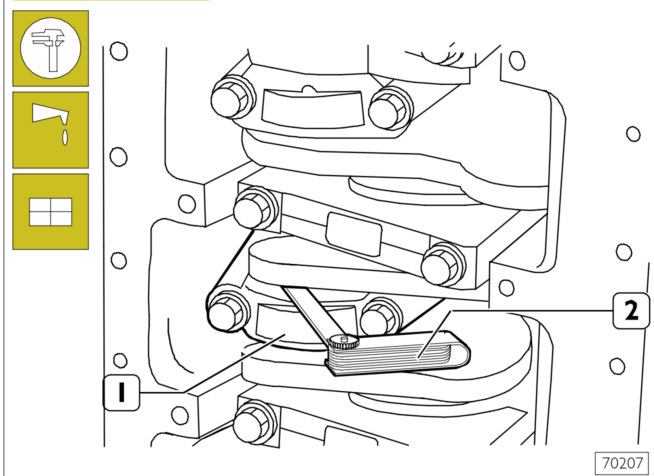
- ❑ Lubricate the screws (1) with engine oil and then tighten them to the specified torque using the dynamometric wrench (2).

Figure 59



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

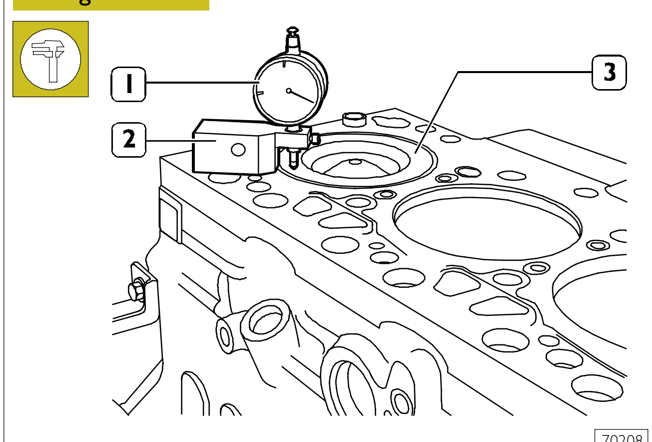
Figure 60



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 0.250 to 0.275 mm.

Checking piston protrusion

Figure 61

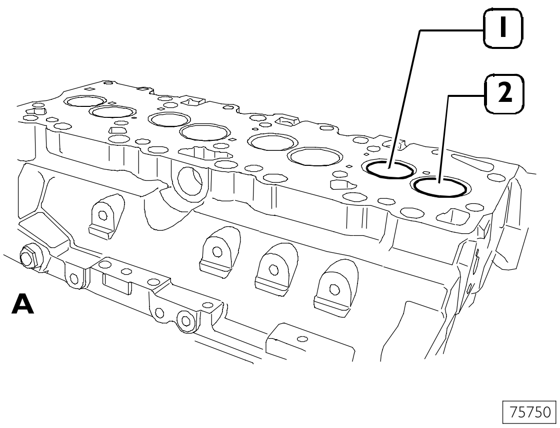


Once connecting rod-piston assemblies refitting is over, use dial gauge 39395603 (1) fitted with base 99370415 (2) to check piston (3) protrusion at T.D.C. with respect to the top of the engine block.

Protrusion shall be 0.28 to 0.52 mm.

CYLINDER HEAD
Removing the valves

Figure 28



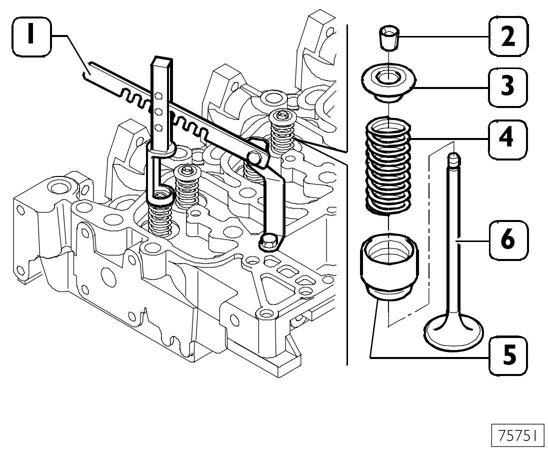
Intake (1) and exhaust (2) valves have heads with the same diameter.

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

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

A = intake side

Figure 29

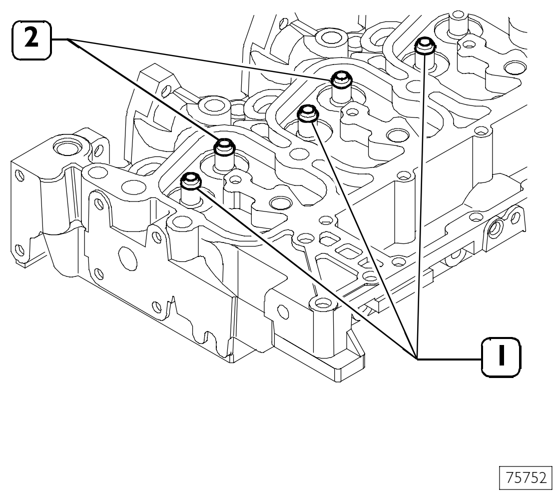


Valve removal shall be performed using tool 99360268 (1) and pressing the cap (3) so that when compressing the springs (4) the cotters (2) can be removed. Then remove the cap (3) and the springs (4).

Repeat this operation for all the valves.

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

Figure 30



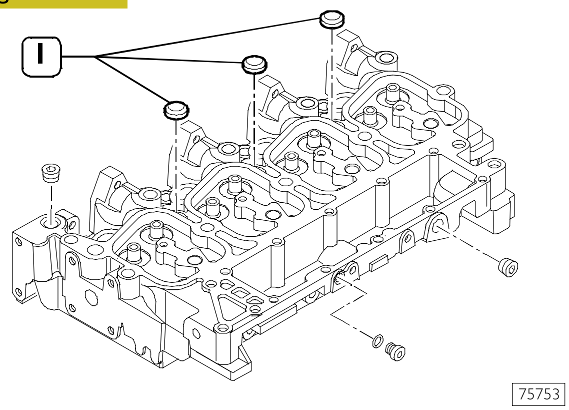
Remove the seals (1 and 2) from the valve guides.

NOTE Sealing rings (1) for intake valves are yellow.

Sealing rings (2) for exhaust valves are green.

Checking cylinder head wet seal

Figure 65



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 cup plugs (1) if leaks are found, use the proper beater for their removal/refitting.

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

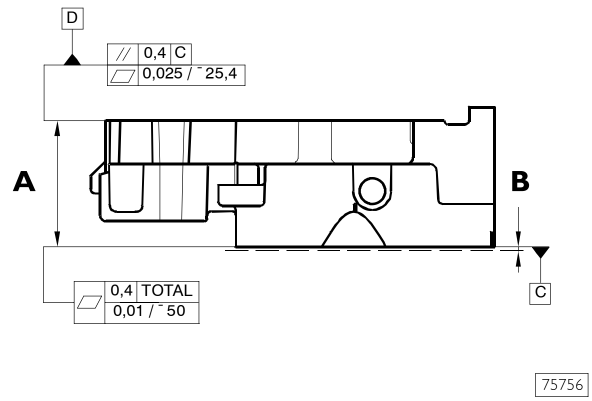
Replace the cylinder head if leaks are found.

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 66

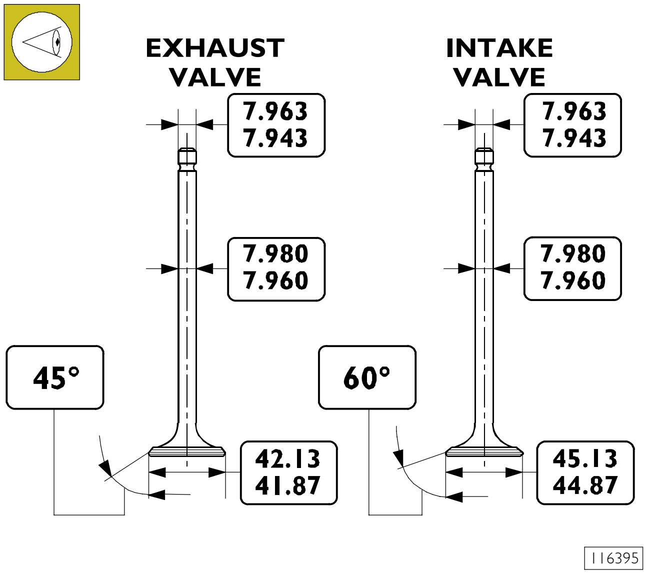


The rated thickness A for the cylinder head is 95 ± 0.25 mm, max. metal removal shall not exceed thickness B by 1 mm.

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

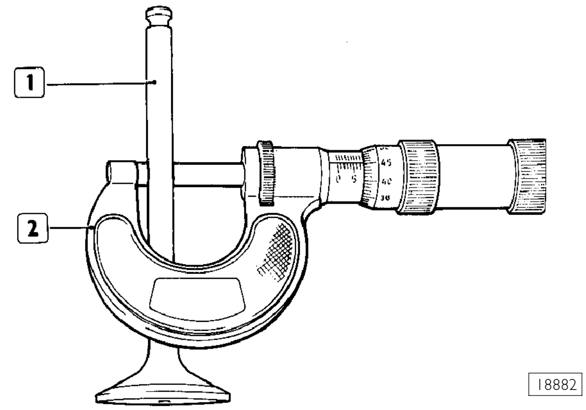
VALVES

Figure 67



INTAKE AND EXHAUST VALVE MAIN DATA

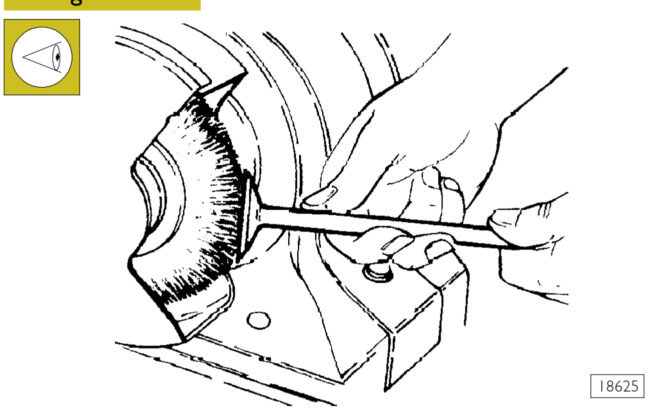
Figure 69



Check the valve stem (1) using a micrometer (2), it shall be 7.943 to 7.963.

Removing carbon deposits, checking and grinding valves

Figure 68



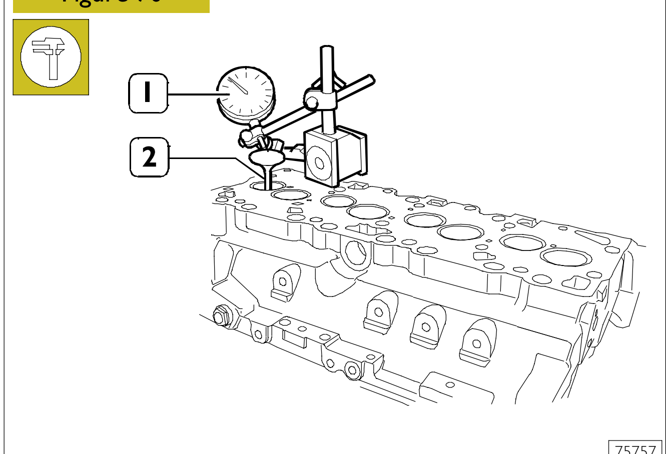
Remove carbon deposits from valves using the proper metal brush.

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

Regrind the valve seats, if required, removing as less material as possible.

Checking clearance between valve stem and valve guide and valve centering

Figure 70

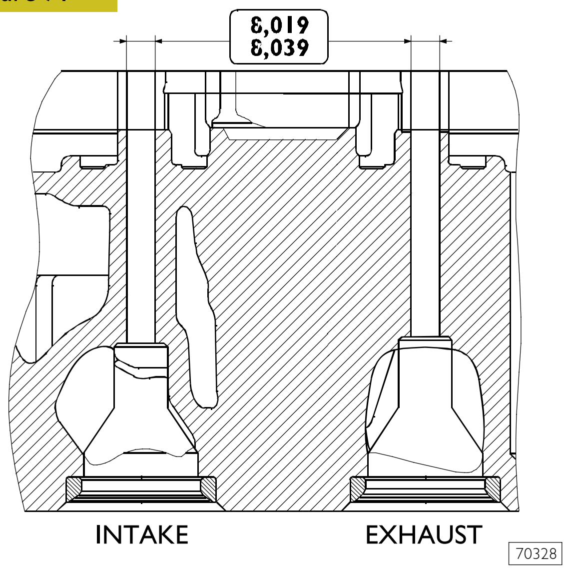


Use a magnetic base dial gauge (1) set as shown in the figure, the assembling clearance shall be 0.056 ± 0.096 mm.

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

VALVE GUIDE

Figure 71

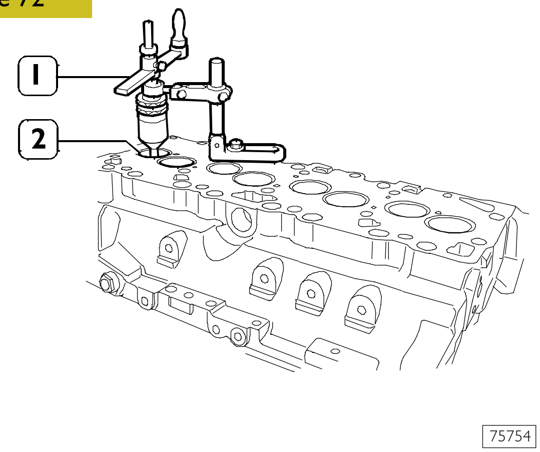


Use a bore dial gauge to measure the inside diameter of the valve guides, the read value shall comply with the value shown in the figure.

VALVE SEATS

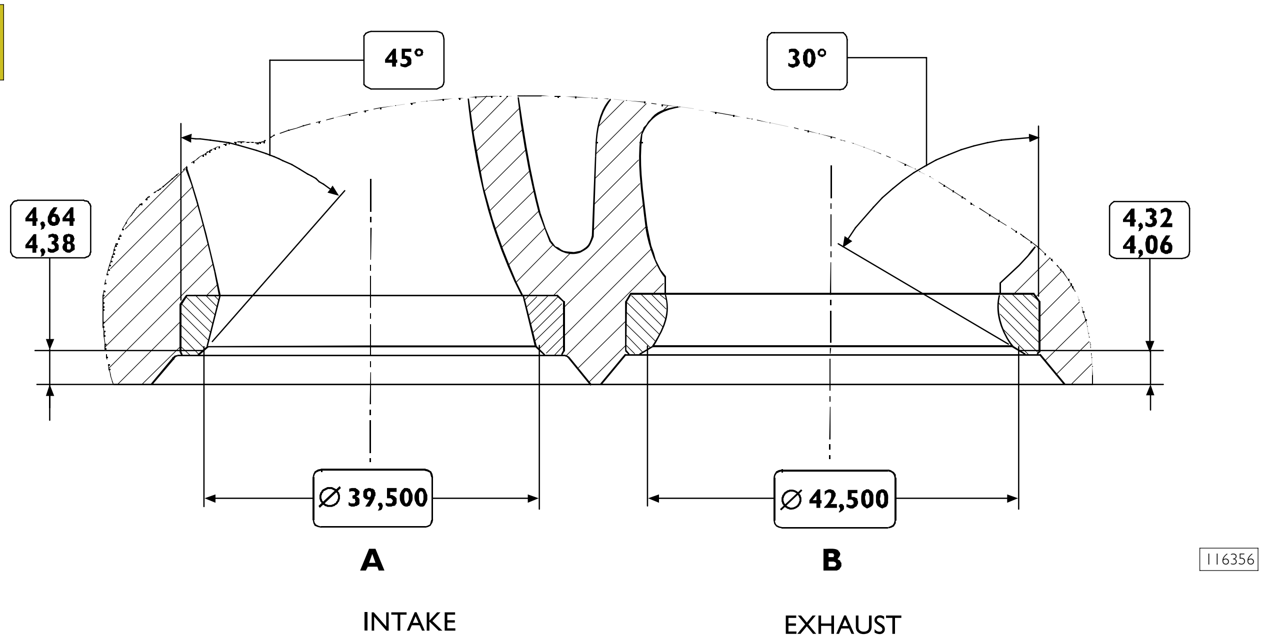
Regrinding – replacing the valve seats

Figure 72



Check the valve seats (2). If slight scoring or burnout is found, regrind seats using adequate tool (1) according to the angle values shown in Figure 73.

Figure 73



VALVE SEAT MAIN DATA

Should valve seats be not reset just by regrinding, replace them with the spare ones. Use adequate tool 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 beater, fit the new valve seats, previously cooled, into the cylinder head.

Use adequate tool to regrind the valve seats according to the values shown in Figure 73.

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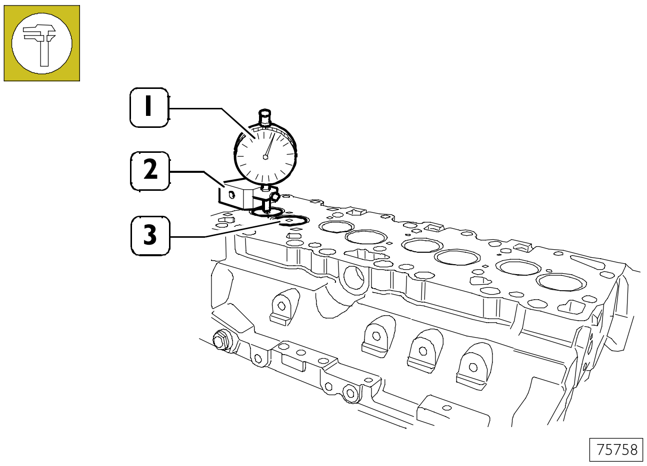
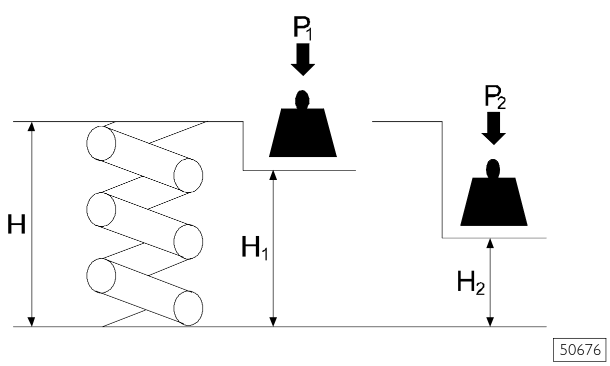
Figure 74



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 75



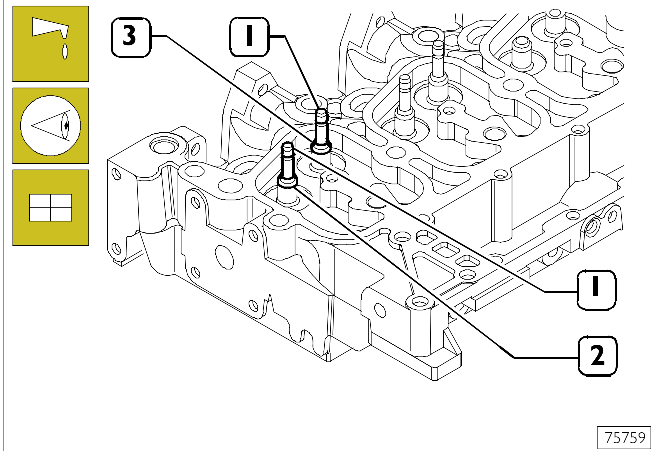
MAIN DATA TO CHECK INTAKE AND EXHAUST VALVE SPRINGS

Before refitting use adequate tool 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		N
H (free)	63.50/65,69*	0
H_1	49.02	329
H_2	38.20	641

FITTING CYLINDER HEAD

Figure 76

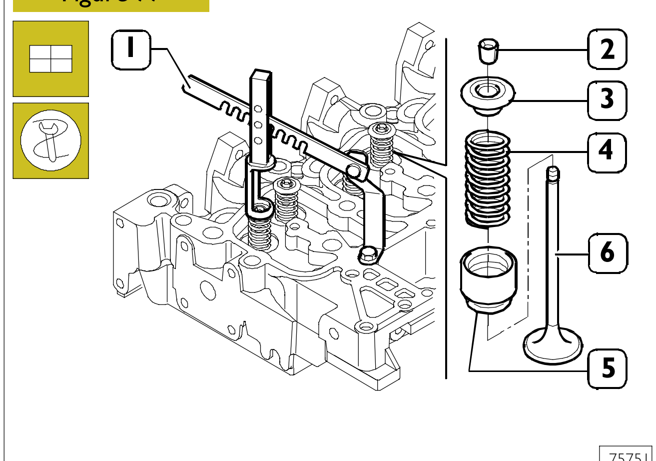


Lubricate the valve stems (1) and fit them into the relevant valve guides according to the position marked at removal.

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

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

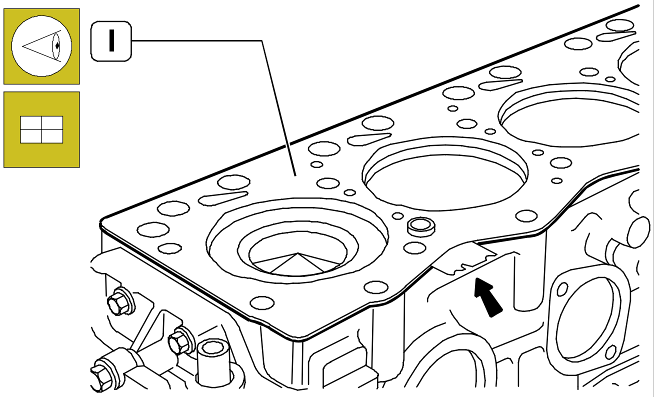
Figure 77



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 78



87759

Check cleanness of cylinder head and engine block coupling surface.

Take care not to foul the cylinder head gasket.

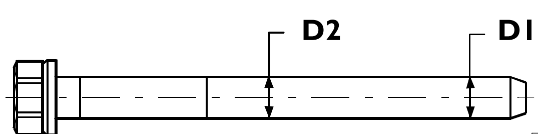
Set the cylinder head gasket (1) with the marking "N. of component" (1) facing the head.

The arrow shows the point where the gasket thickness is given.

NOTE Before using the fixing screws again, measure them twice as indicated in the picture, checking D1 and D2 diameters:

if D1 - D2 < 0,1 mm the screw can be utilised again;

if D1 - D2 > 0,1 mm the screw must be replaced.



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TIGHTENING TORQUE (FOR 4 AND 6 CYL.)

COMPONENT		TORQUE Nm	TORQUE kgm
Cooling Nozzles (M8x1.25x10)		15 ± 3	1.5 ± 0.3
Main bearing cap	1st stage 2nd stage 3rd stage	50 ± 6 80 ± 6 90° ± 5°	5.0 ± 0.6 8.0 ± 0.6
Rear gear housing assembly (M8x1.25x40) (M8x1.25x25) (M10x1.5)		 24 ± 4 24 ± 4 49 ± 5	 2.4 ± 0.4 2.4 ± 0.4 4.9 ± 0.5
Oil pump (M8x1.25x30)		8 ± 1	0.8 ± 0.1
Front cover assembly (M8x1.25x45) (M8x1.25x30)		 24 ± 4 24 ± 4	 2.4 ± 0.4 2.4 ± 0.4
Connecting rod bolts (M11x1.25)	1st stage 2nd stage 3rd stage	30 ± 3 60 ± 5 60° ± 5°	3.0 ± 0.3 6.0 ± 0.5
Ladder frame assembly (M10x1.25x25)		43 ± 5	4.3 ± 0.5
Oil rifle plugs (M10x1) (M14x1.5)		 6 ± 1 11 ± 2	 0.6 ± 0.1 1.1 ± 0.2
Assemble oil suction tube (M8x1.25x20)		24 ± 4	2.4 ± 0.4
Oil pan assembly (M8x1.25x25) (M18x1.50)		 24 ± 4 60 ± 9	 2.4 ± 0.4 6.0 ± 0.9
Set timing pin		5 ± 1	0.5 ± 0.1
Fuel pump assembly M8 screw		 25 ± 2.5	 2.5 ± 0.25
Fuel pump gear (drive gear nut)		196.5 ± 6.5	19.65 ± 0.65
Timing pin cap of fuel pump		30 - 35	3.0 - 3.5
Rocker assys (M8)		24 ± 4	2.4 ± 0.4
Cylinder head bolts (M12x70) (M12x140) (M12x180)		 50 + 90° 40 + 180° 70 + 180°	 5.0 + 90° 4.0 + 180° 7.0 + 180°
Assy rocker covers (M8x1.25x25)		24 ± 4	2.4 ± 0.4
Intake manifold (M8x1.25)		24 ± 4	2.4 ± 0.4
Assy air intake connection (M8x1.25)		24 ± 4	2.4 ± 0.4
Oil bypass valve into lube filter head (M22x1.5x10)		80 ± 8	8.0 ± 0.8
Plug (M12x1.5x12)		10 ± 1	1.0 ± 0.1
Exhaust manifold (M10x1.5x65)		43 ± 6	4.3 ± 0.6
Water pump (M8x1.25x25)		24 ± 4	2.4 ± 0.4
Water outlet connection (M8x1.25x35) (M8x1.25x70)		 24 ± 4 24 ± 4	 2.4 ± 0.4 2.4 ± 0.4
Fan support (M10x1.5x20)		33 ± 5	3.3 ± 0.5
Fan pulley (M6) (M10)		 10 ± 2 43 ± 6	 1.0 ± 0.2 4.3 ± 0.6

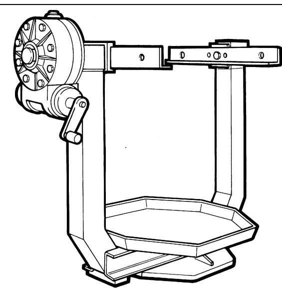
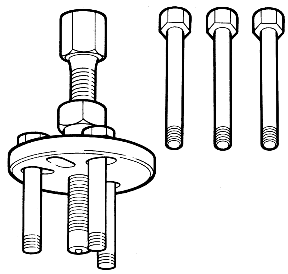
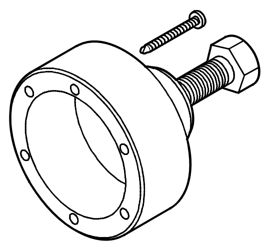
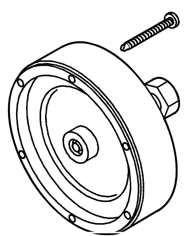
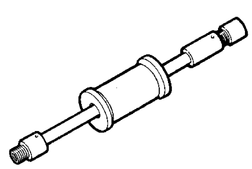
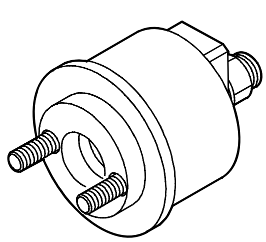
COMPONENT		TORQUE	
		Nm	kgm
Rear lifting bracket (M12x1.75x30)		77 ± 12	7.7 ± 1.2
Crankshaft pulley (M12x1.75x10.9)		110 ± 5	11.0 ± 0.5
Flywheel housing (M12x120) (M12x80) (M10x80) (M10x40)		 85 ± 10 85 ± 10 49 ± 5 49 ± 5	 8.5 ± 1.0 8.5 ± 1.0 4.9 ± 0.5 4.9 ± 0.5
Flywheel housing (M12x1.25)	1st stage 2nd stage	30 ± 4 60° ± 5°	3.0 ± 0.4
Assy rear cover plate to flywheel housing (M8x1.25x16)		24 ± 4	2.4 ± 0.4
Fuel lift pump		24 ± 4	2.4 ± 0.4
Turbocharger to exhaust manifold (M10)		43 ± 6	4.3 ± 0.6
Oil feed to oil filter head		24 ± 4	2.4 ± 0.4
Oil feed to turbocharger (M12x1.5)		35 ± 5	3.5 ± 0.5
Oil drain (M8x1.25x16)		24 ± 4	2.4 ± 0.4
Alternator to alternator support (M8x1.25x30)		24 ± 4	2.4 ± 0.4
Alternator to water inlet conn. assy (M8x1.25x30)		24 ± 4	2.4 ± 0.4
Lower alternator mounting (M10x1.25x25)		24 ± 4	2.4 ± 0.4
Alternator upper pivot to support (M10)		49 ± 5	4.9 ± 0.5
Alternator mounting hardware (M12x1.75x120)		43 ± 6	4.3 ± 0.6
Alternator wiring (M6x1.0 nut)		10 ± 2	1.0 ± 0.2
Starter motor to gear case (M10)		49 ± 5	4.9 ± 0.5
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 90° ± 5°	5 ± 0.6 8 ± 0.6
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 connecting rod caps	1st stage 2nd stage	60 ± 5 60° ± 5°	6 ± 0.5

SECTION 5

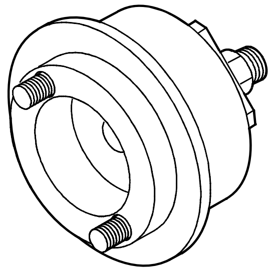
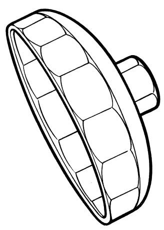
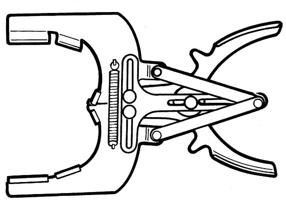
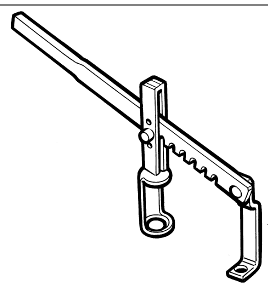
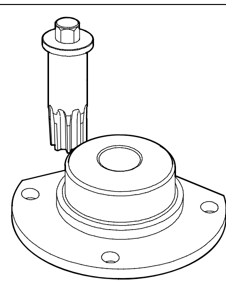
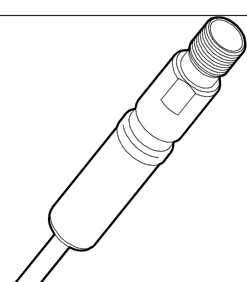
Tools

Page

TOOLS

TOOL NO.		DESCRIPTION
99322205		Revolving stand for overhauling units (700 daN/m capacity, 120 daN/m torque)
99340035		Injection pump gear extractor.
99340055		Tool to remove output shaft front gasket
99340056		Tool to remove output shaft rear gasket
99340205		Tool to remove injectors
99346252		Tool for fitting output shaft front gasket

TOOLS

TOOL NO.		DESCRIPTION
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
99360339		Tool for stopping the engine flywheel
99360344		Adapter, cylinder compression test (use with 99395682)

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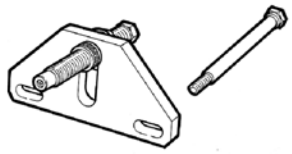
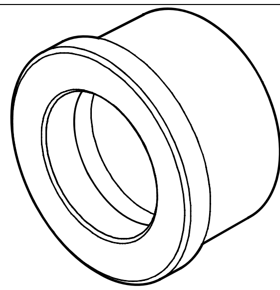
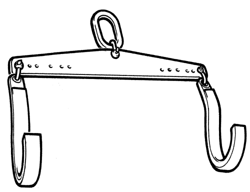
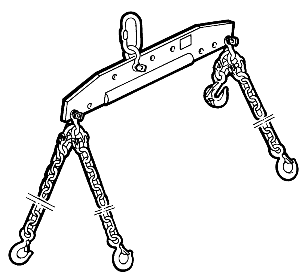
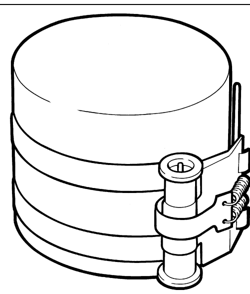
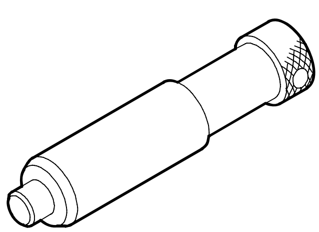
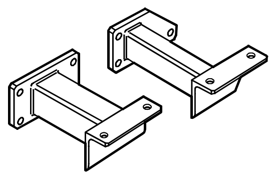
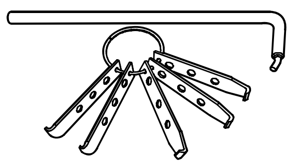
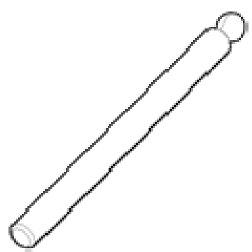
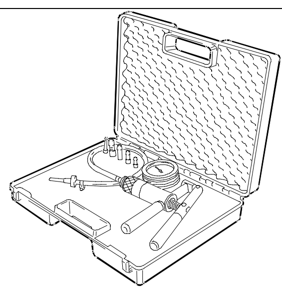
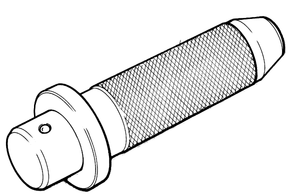
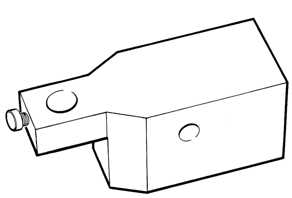
TOOLS

TOOL NO.		DESCRIPTION
99360351		Tool 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)
99360616		Engine TDC positioning tool

TOOLS

TOOL NO.		DESCRIPTION
99361037		Brackets for fastening engine to revolving stand 99322205
99363204		Tool to remove gaskets
99365196		Tool for positioning of injection pump at start of discharge
99367121		Manual pump for pressure and depression measures
99370006		Interchangeable willow handgrip
99370415		Gauge base for different measurements (to be used with 99395603)

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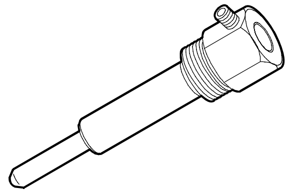
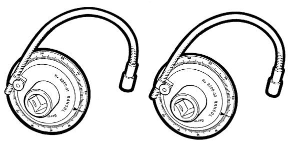
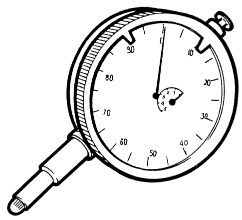
TOOLS

TOOL NO.		DESCRIPTION
99395097		Tool to check top dead centre (use with 99395604)
99395216		Pair of gauges with ½" and ¾" square head for angle tightening
99395603		Dial gauge (0 – 5 mm)
99395604		Dial gauge (0 – 10 mm)
99395682		Diesel fuel engine cylinder compression control device

Appendix

SAFETY PRESCRIPTIONS
Standard safety prescriptions

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

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

Prevention of injury

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

During maintenance

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

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

For engines equipped with electronic gearbox:

- Do not execute electric arc welding without having priory removed electronic gearbox.
- Remove electronic gearbox in case of any intervention requiring heating over 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.

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Part 2
F4HE N SERIES

UPDATING

Section	Description	Page	Date of revision

SECTION 1

General Specifications

Page

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F4HE9685A*J100	NEF67 TE1X
	NEF67 TE2X

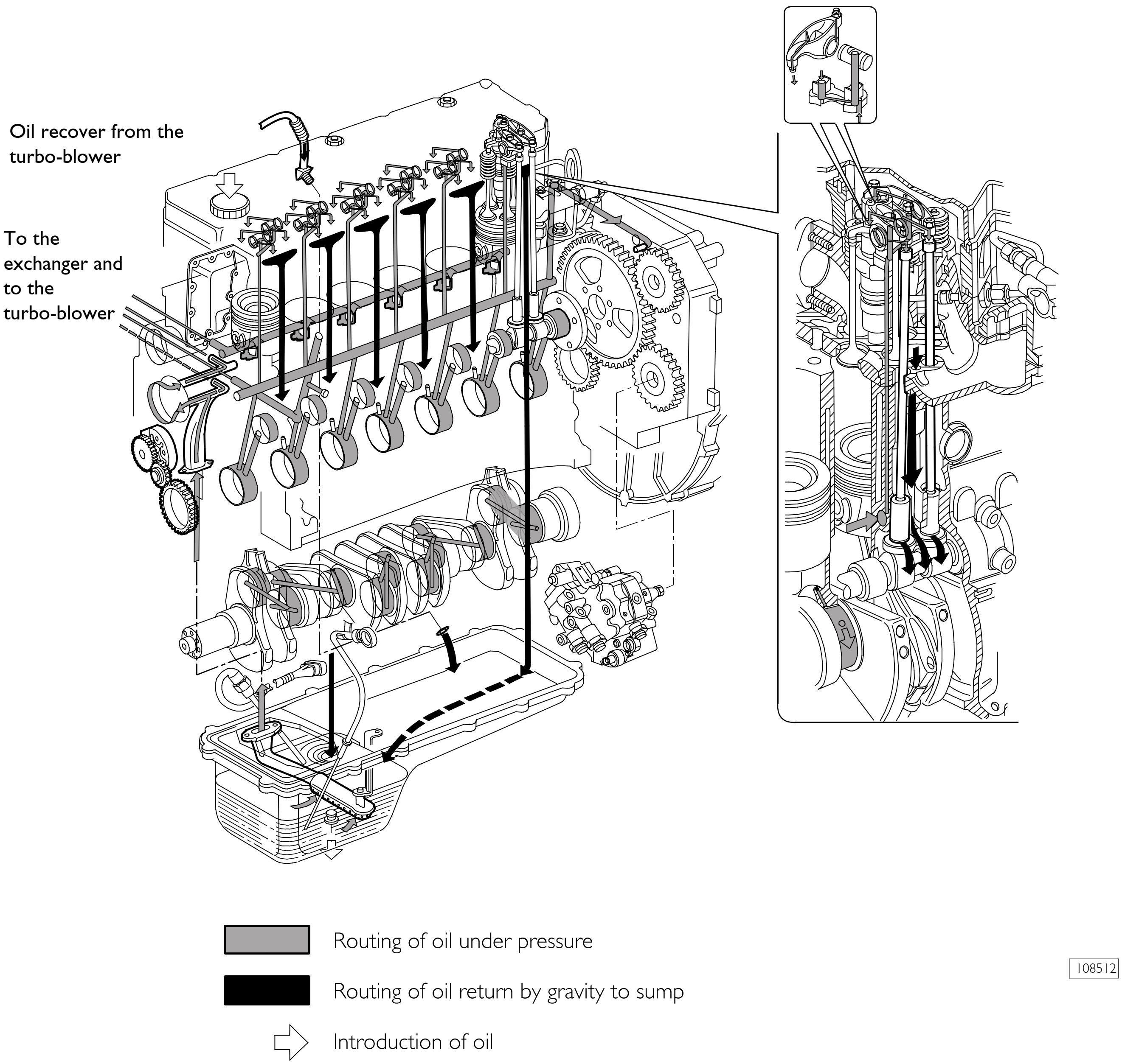
LUBRICATION

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.

Figure 1



LUBRICATION SYSTEM LAYOUT

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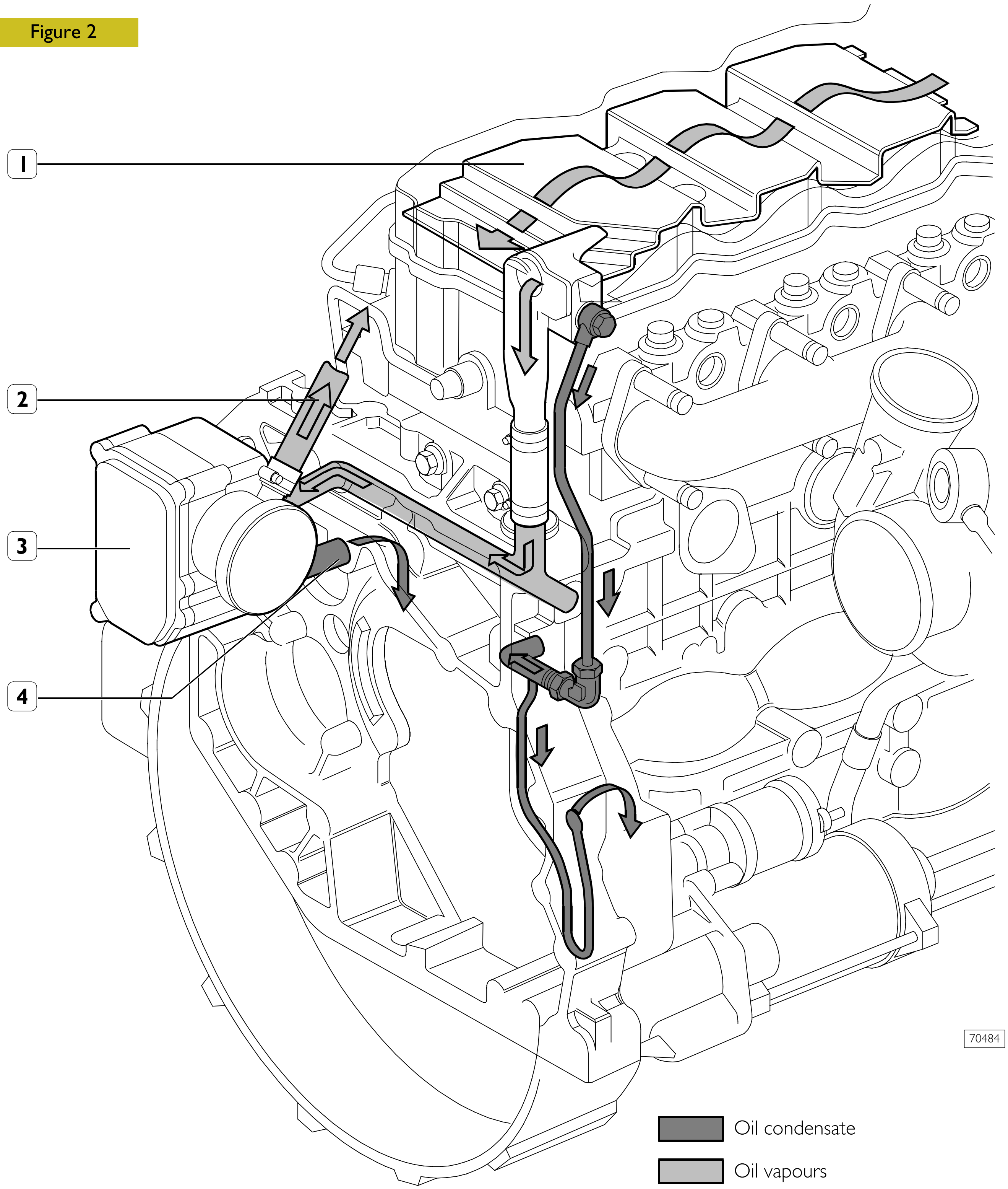
OIL VAPOUR RECYCLING

Figure 2



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.

Figure 3

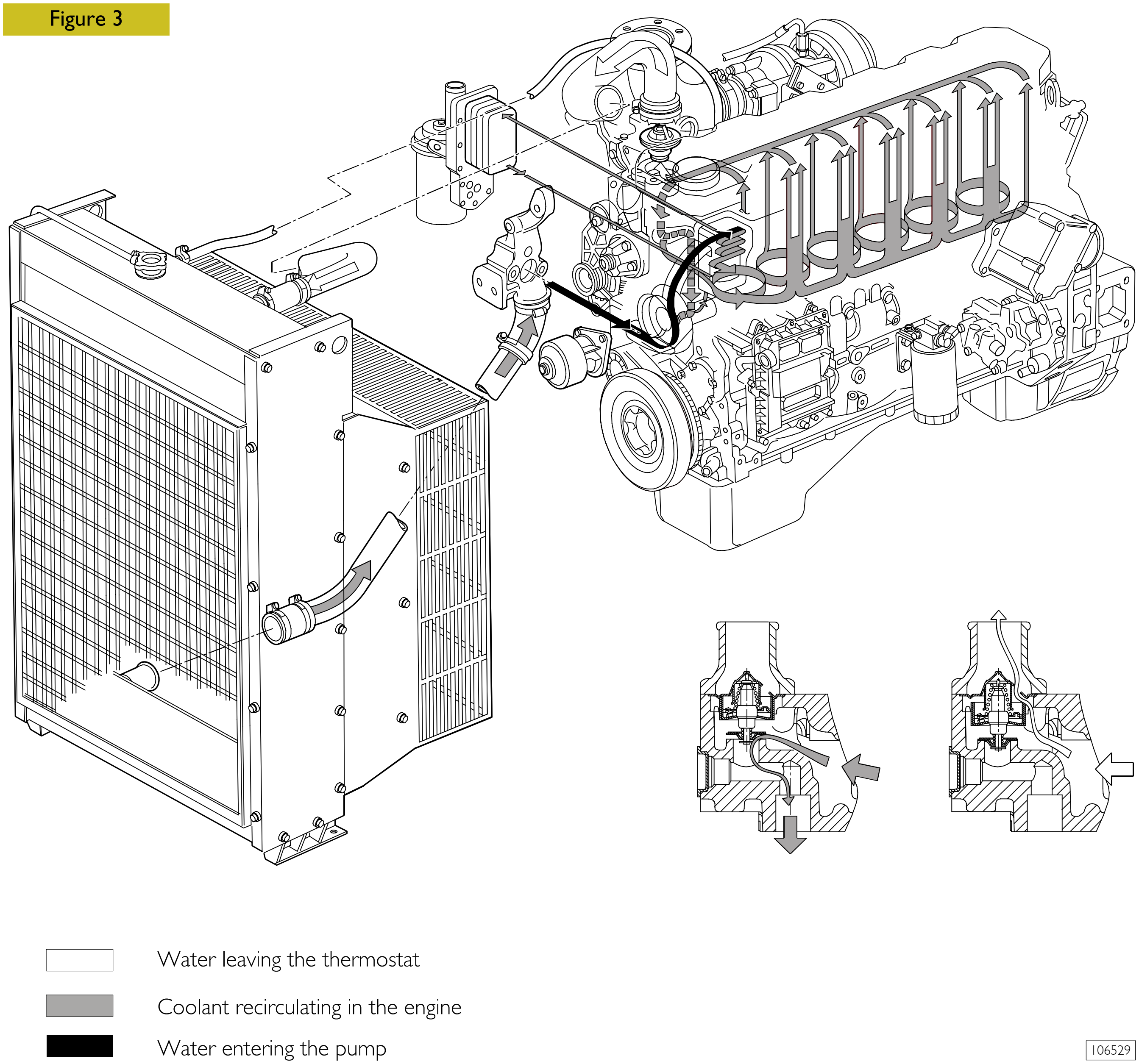
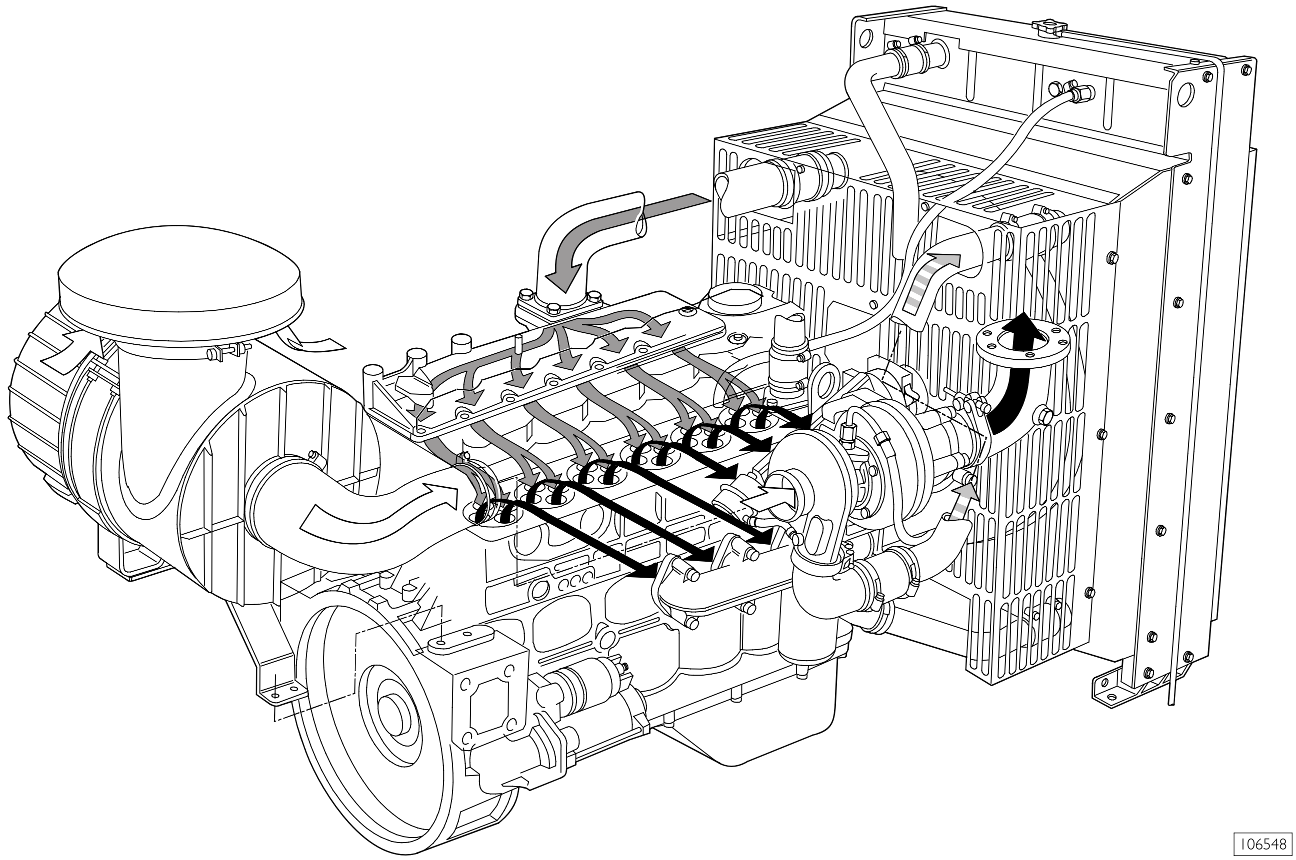


DIAGRAM OF THE COOLING SYSTEM

AIR INDUCTION - BOOST DIAGRAM

Figure 4



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 compressed air is cooled by the radiator and sent through the intake manifold to the pistons.

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.

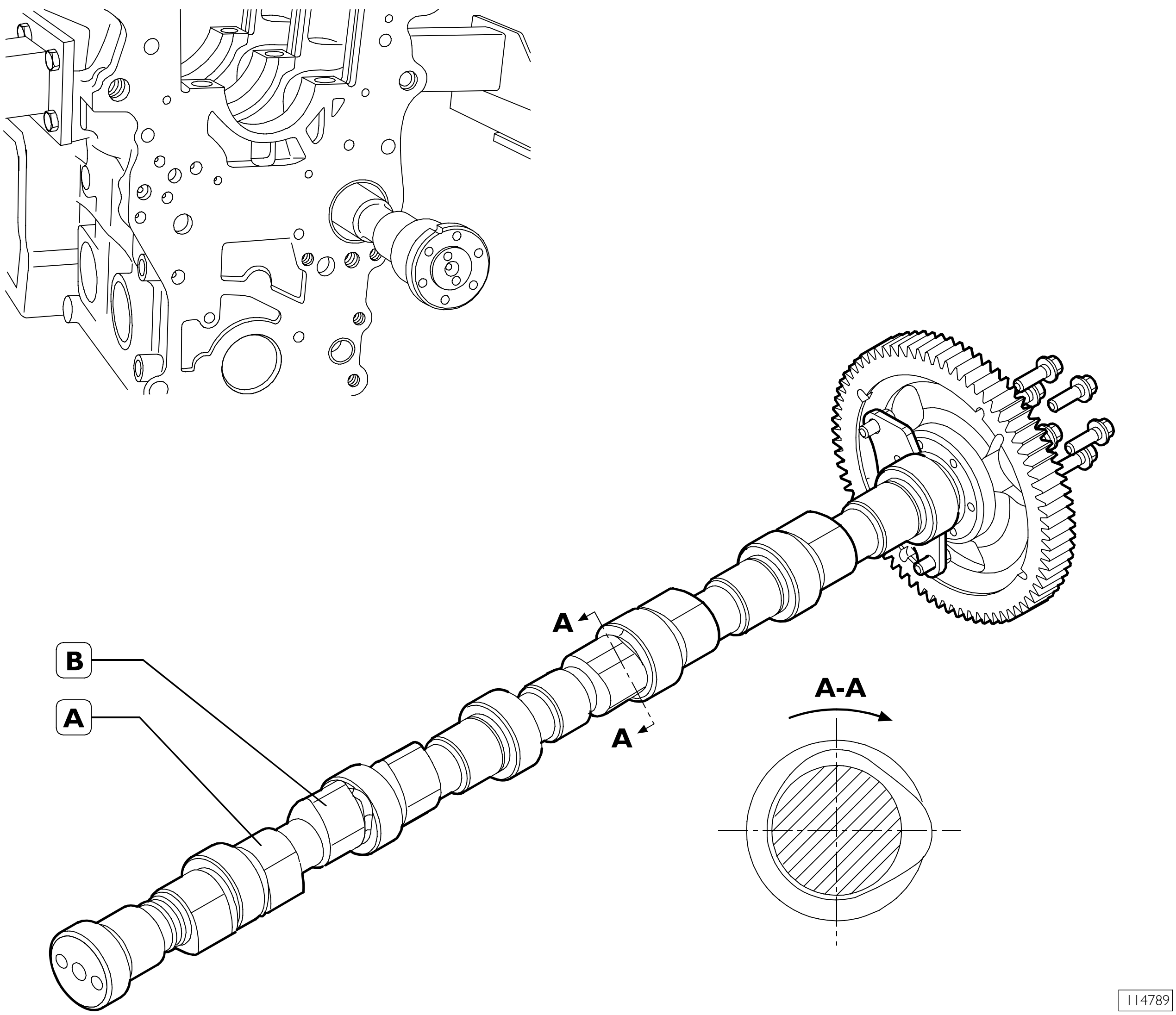
EXHAUST GAS RE-CIRCULATION SYSTEM (EGR)

In the TIER 3 version, the profile of the exhaust cam has been modified in order to allow the partial opening of the relative valve during the aspiration phase (re-circulation of EGR exhaust gas) with the subsequent re-introduction of part of the exhaust gas into the engine cylinders.
The exhaust gases can partially be re-directed into the cylinders so as to reduce the maximum combustion temperature values responsible for the production of nitric acid (NO_X).
The exhaust gas re-circulation system (EGR), reducing the combustion temperature by means of the diminishing of the concentration of oxygen in the combustion chamber, represents therefore an efficient control system of the emission of NO_X.

The internal EGR system is not equipped with any electronically controlled elements: the system is always active. Its configuration does not need additional elements i.e.checking valves, piping or heat exchangers.

The exhaust cam (B) has another lobe apart from the major lobe (see Section. A-A fig.) with respects to the configuration without EGR.
The additional lobe, during the aspiration phase in the cylinder in question, allows a brief opening of the exhaust valve generating re-circulation due to the intake of the exhaust gases caused by depression which is created in the aspiration phase inside the cylinder.

Figure 5



A. Aspiration valve control - B. Exhaust valve control.

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SECTION 2

Fuel

COMMON RAIL

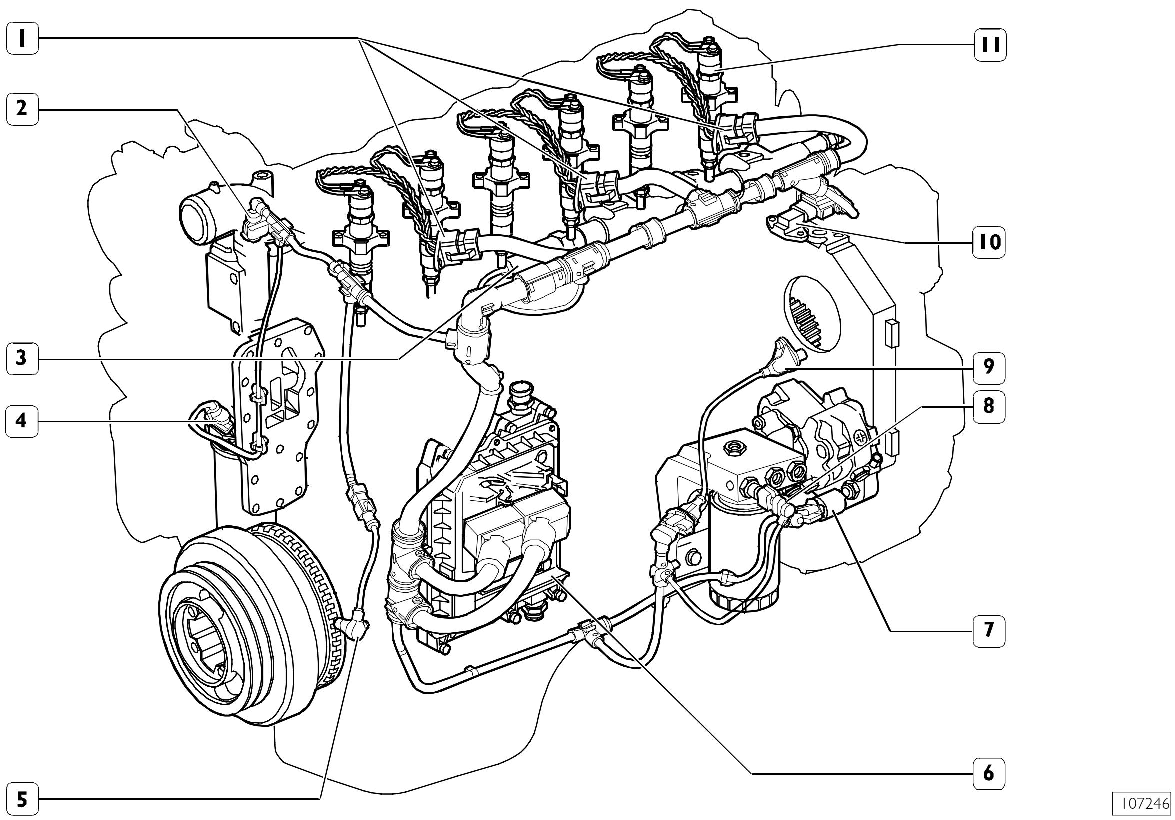
General Specifications

In order to reduce PARTICULATES emissions, very high injection pressures are required.
The Common Rail system allows injecting the fuel up to pressures reaching 1450 bar, at the same time, the injection precision, obtained by the electronic system control, optimizes the engine performance, reducing emissions and consumption.

System description

Electric system

Figure 1



1. Connections for Electro-injectors - 2. Engine cooling liquid temperature's sensor - 3. Cable of the fuel pressure sensor - 4. Sensor of engine's oil temperature and pressure - 5. Driving shaft sensor - 6. EDC 7 gearbox - 7. Cable of pressure regulating gauge - 8. Cable of fuel heater and fuel temperature's sensor - 9. Timing system sensor - 10. Temperature - air pressure sensor - 11. Electro-injector.

Through the sensors, present on the engine, the ECU controls the engine operation.

Air pressure/temperature sensor

It is a component integrating a temperature sensor and a pressure sensor.

Fitted on the intake manifold, it measures the max. inlet air capacity to calculate precisely the fuel quantity to inject at every cycle.

The outlet voltage is proportional to the pressure or temperature obtained by the sensor.

Engine oil temperature and pressure sensor

Same as air pressure/temperature sensor, it is fitted on the engine oil filter, in a horizontal position.

It measures engine oil temperature and pressure.

Fuel pressure sensor

Assembled on a rail end, it measures the fuel pressure in the rail in order to determine the injection pressure.

The injection pressure value is used to control the pressure and to determine the electric injection control length.

Fuel temperature sensor

It is a sensor that is equal to the previous one.

It measures fuel temperature to provide the control unit with an index of the diesel fuel thermal state.

Coolant temperature sensor

It is a variable-resistance sensor suitable to measure the coolant temperature to provide the control unit with an index of the engine thermal state.

Output shaft sensor

It is an inductive sensor placed on the front engine part. Signals generated through the magnetic flow that is closed on the phonic wheel, change their frequencies depending on output shaft rotation speed.

Timing sensor

It is an inductive sensor placed on the engine rear left part. It generates signals obtained from magnetic flow lines that are closed through holes obtained on the keyed gear on the camshaft. The signal generated by this sensor is used by the ECU as injection phase signal.

Though being equal to the flywheel sensor, it is NOT interchangeable since it has a different outside shape.

System functionality

Self-diagnosis

The ECU self-diagnostic system checks signals coming from sensors by comparing them with threshold data.

IVECO Code recognition

The EDC7 control unit communicates with the Immobilizer control unit (if fitted) to obtain the startup consent.

Engine pre-heating resistance check

The pre-post heating is activated when even only one of the water, air or fuel temperature sensors signals a temperature that is less than 5 °C.

Phase recognition

By means of signals coming from camshaft sensor and flywheel sensor, the cylinder on which fuel must be injected is recognised upon startup.

Injection control

The control unit, depending on information coming from sensors, controls the pressure regulator, and changes pre-injection and main injection modes.

Closed-loop control for injection pressure

Depending on engine load, measured by processing signals coming from various sensors, the control unit controls the regulator in order to always have the optimum pressure.

Pilot and main injection spark advance control

The control unit, depending on signals coming from various sensors, computes the optimum injection point according to an internal mapping.

Idle speed control

The control unit processes signals coming from various sensors and adjusts the amount of injected fuel.
It controls the pressure regulator and changes the injection time of injectors.
Within certain thresholds, it also takes into account the battery voltage.

Maximum speed limiting

At 2700 rpm, the controlunit limits fuel flow-rate by reducing the injectors opening time.
Over 3000 rpm it deactivates the injectors.

Cut Off

Fuel cut off upon release is controlled by the control unit performing the following logics:

- it cuts off injectors supply;
- it re-activates the injectors shortly before idle speed is reached;
- it controls fuel pressure regulator.

Smoke control upon acceleration

With strong load requests, the control unit, depending on signals received by air inlet meter and engine speed sensor, controls the pressure regulator and changes the injectors actuation time, in order to avoid exhaust smoke.

Fuel temperature control

When the fuel temperature exceeds 75 °C (measured by the sensor placed on fuel filter) the control unit intervenes by reducing injection pressure.
If the temperature exceeds 90 °C, the power is reduced to 60%.

AC compressor engagement control (if fitted)

The control unit is able to drive engagement and disengagement of the electromagnetic compressor clutch depending on coolant temperature.
If the coolant temperature reaches about 105 °C, it disengages the clutch.

After Run

The control unit microprocessor allows storing certain EPROM data, among which failure memory and Immobilizer information, in order to make them available upon the following startup.

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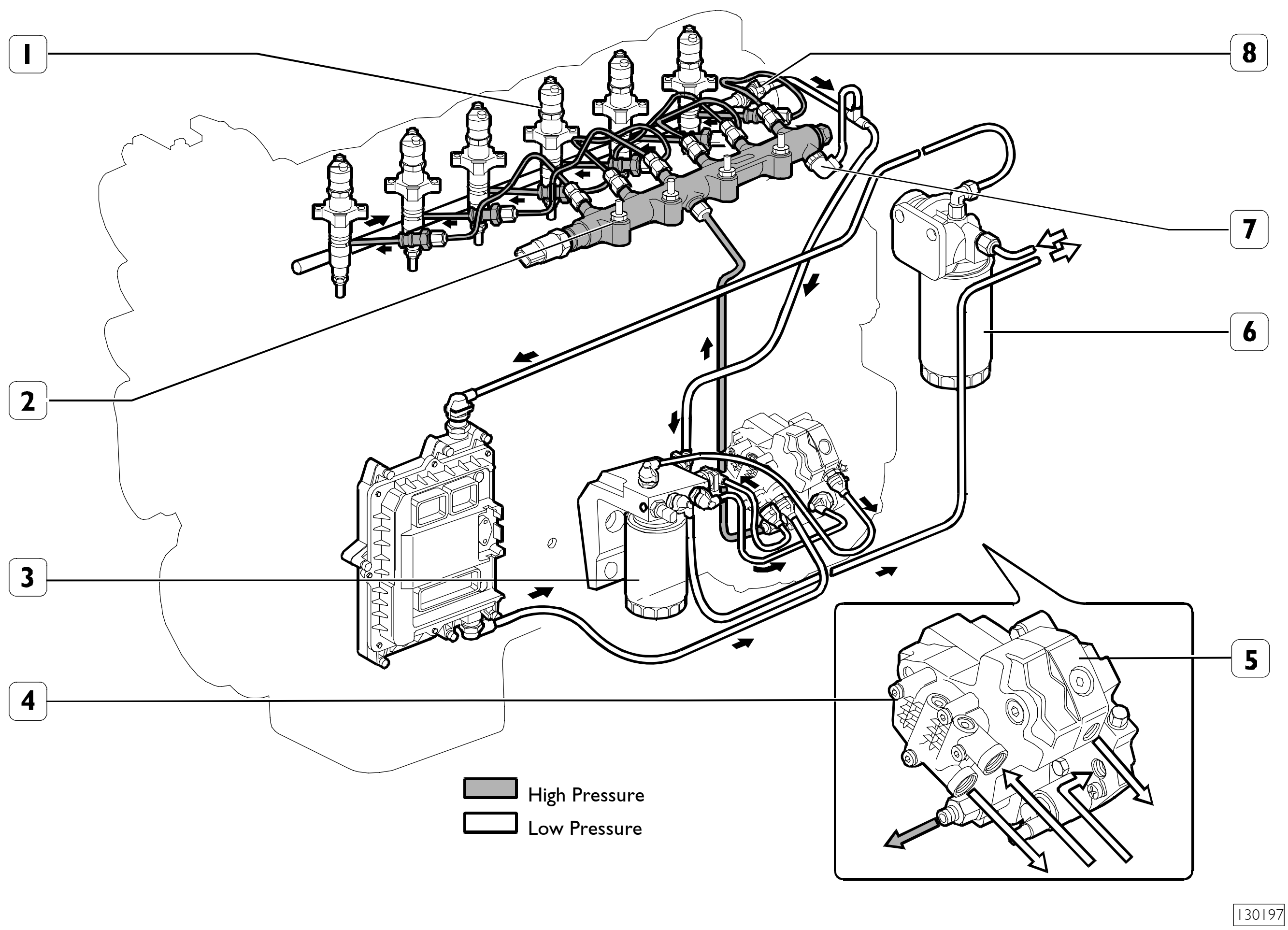
WORKING PROCESS

Figure 2



1. Injector - 2. Common Rail - 3. Fuel filter - 4. Mechanical rotor pump - 5. High-pressure pump - 6. Prefilter assembled on chassis - 7. Rail overpressure valve - 8. Pressure limiter for fuel return

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).

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.

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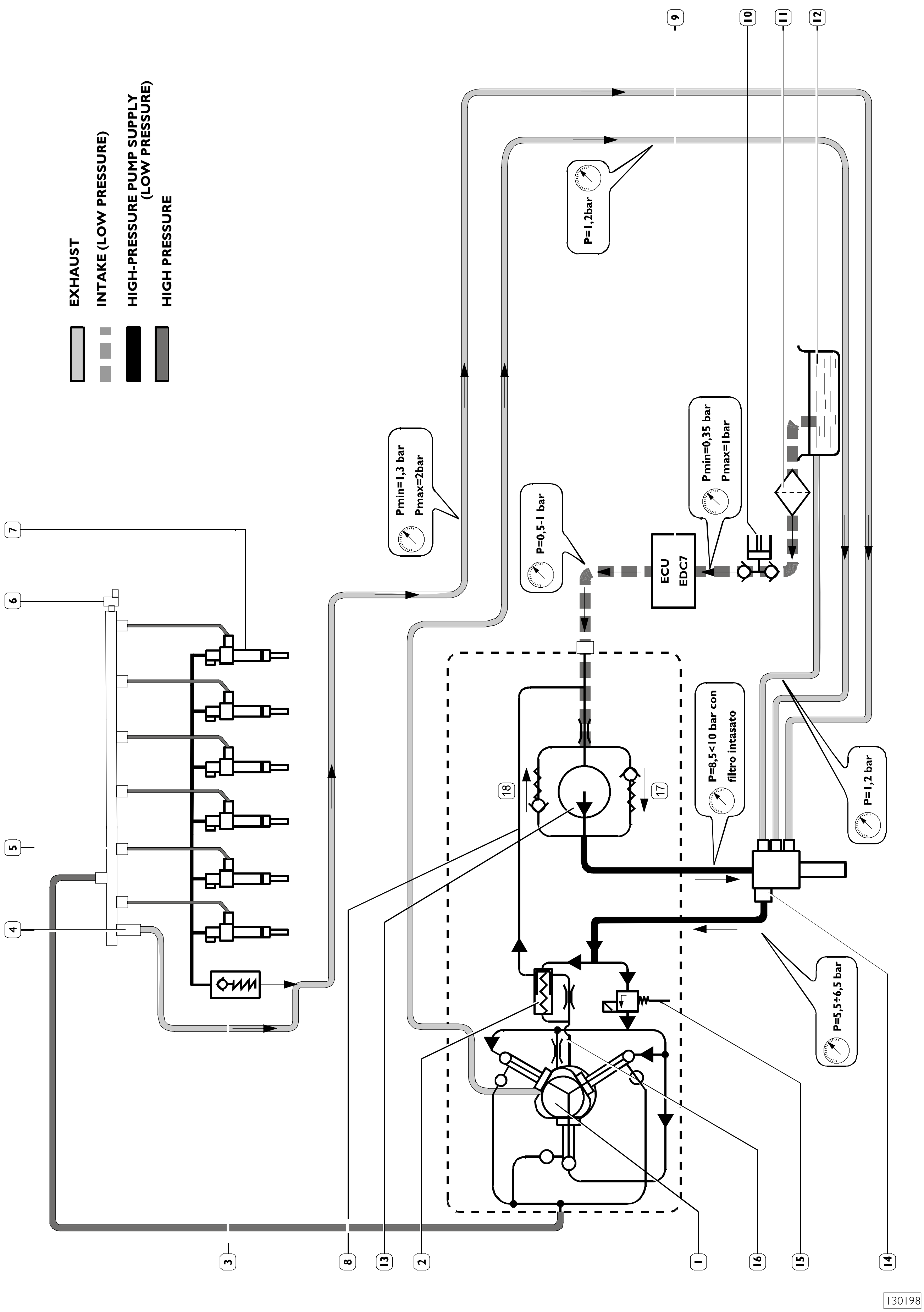
Figure 3

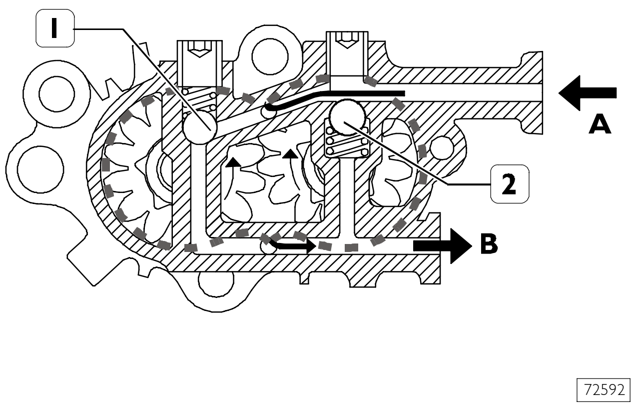

EXHAUST
INTAKE (LOW PRESSURE)
HIGH-PRESSURE PUMP SUPPLY (LOW PRESSURE)
HIGH PRESSURE
P=1,2bar
Pmin=1,3 bar Pmax=2bar
P=0,5-1 bar
Pmin=0,35 bar Pmax=1bar
ECU EDC7
P=8,5<10 bar con filtro intasato
P=1,2 bar
P=5,5÷6,5 bar
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
130198

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

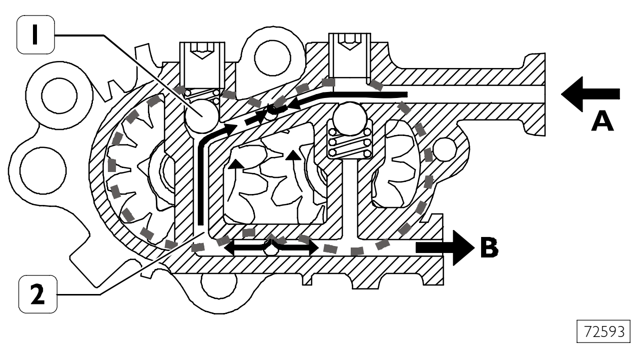
Figure 4



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

Overpressure condition in Exhaust unit

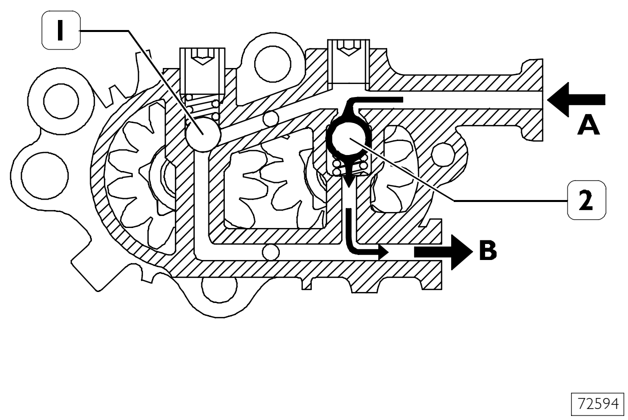
Figure 5



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

Jettison condition

Figure 6



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 (I) 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.

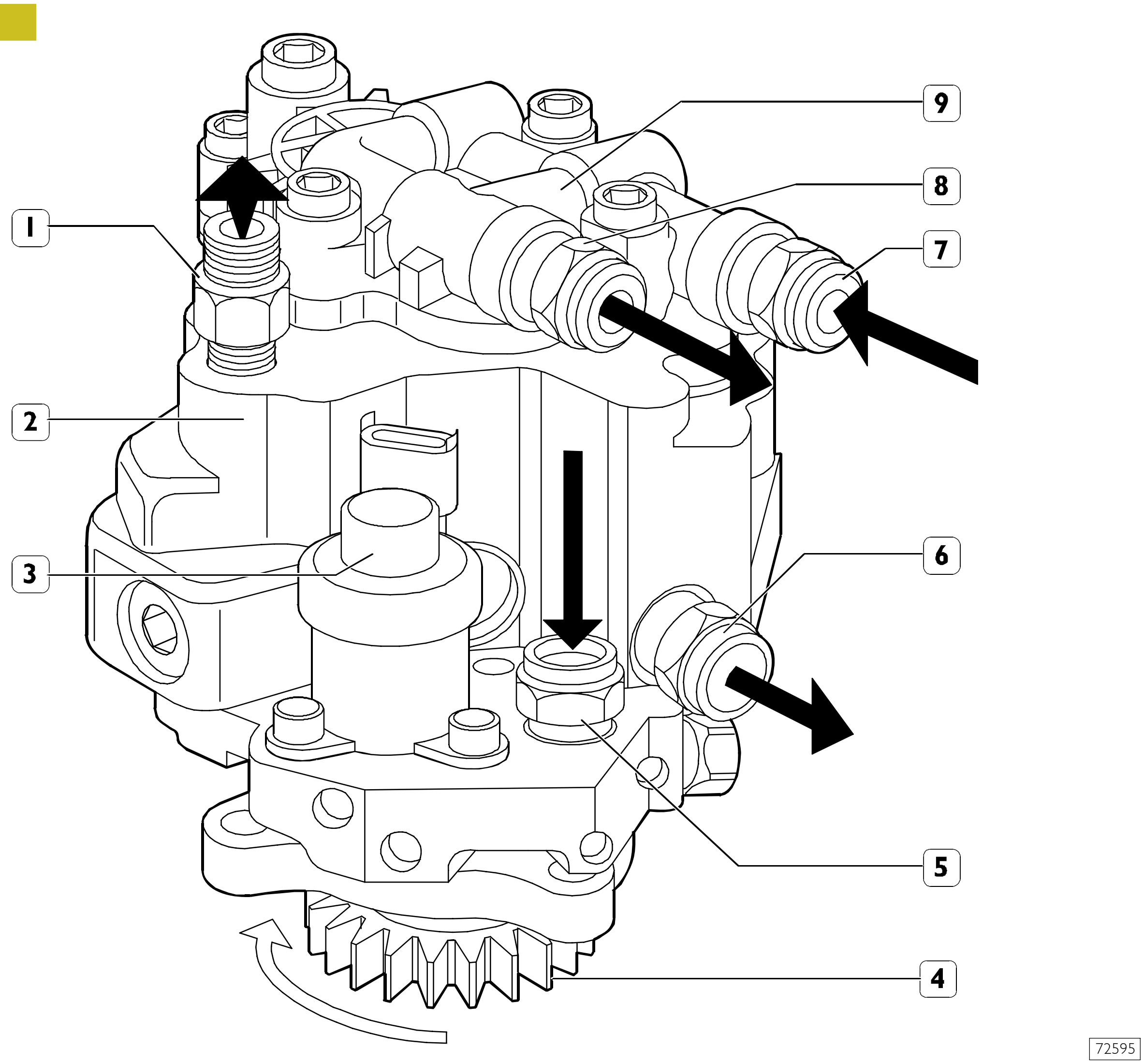
NOTE The mechanical feeding pump cannot be replaced separately, therefore it must not be disassembled from the high pressure pump.

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.

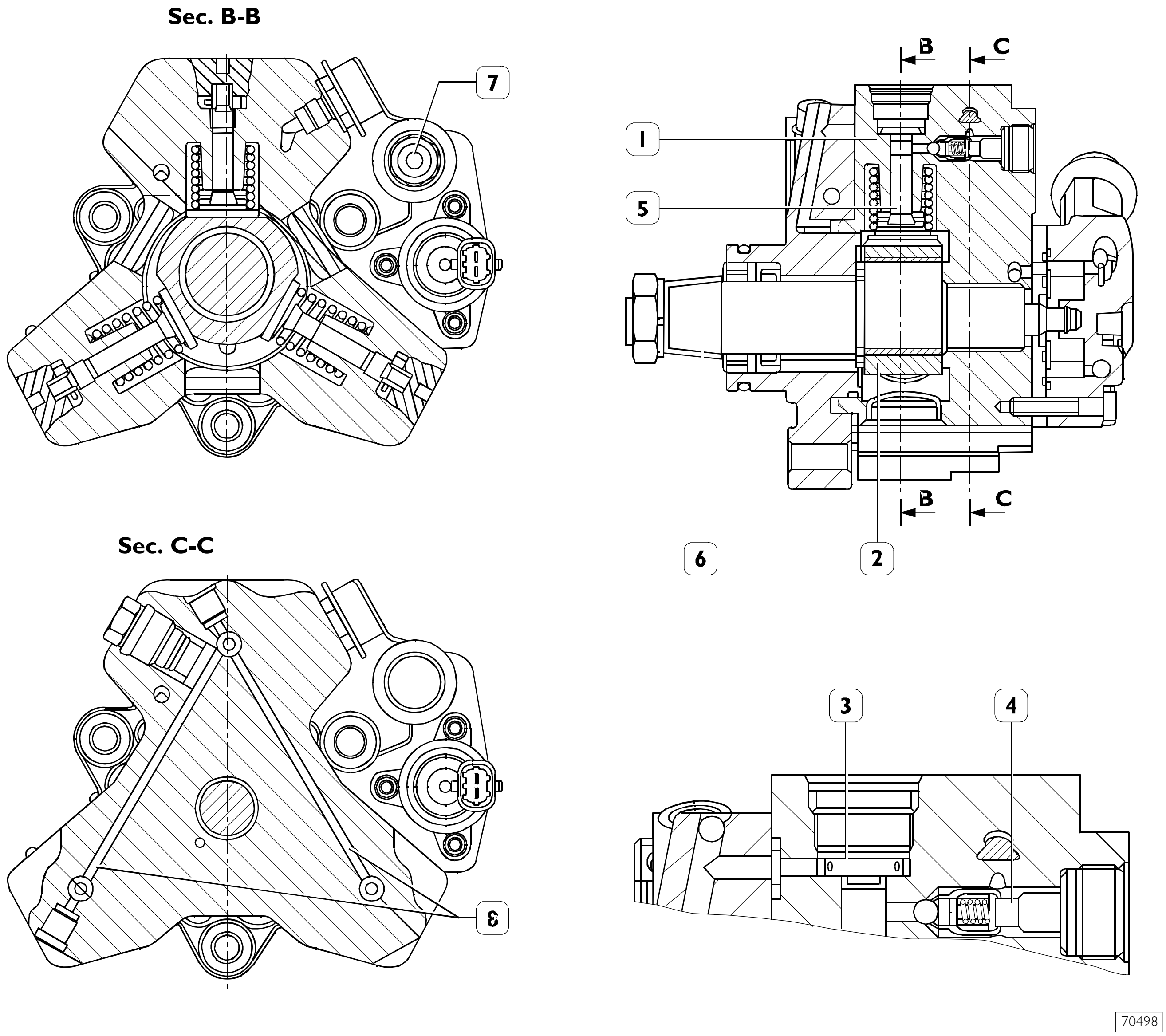
Figure 7



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).

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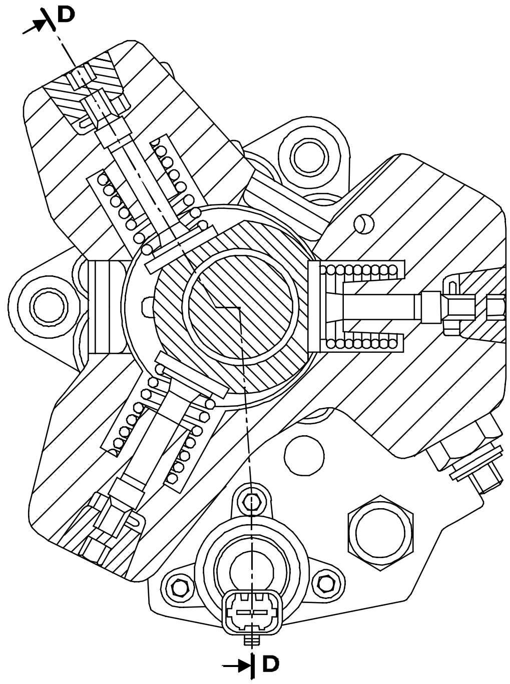
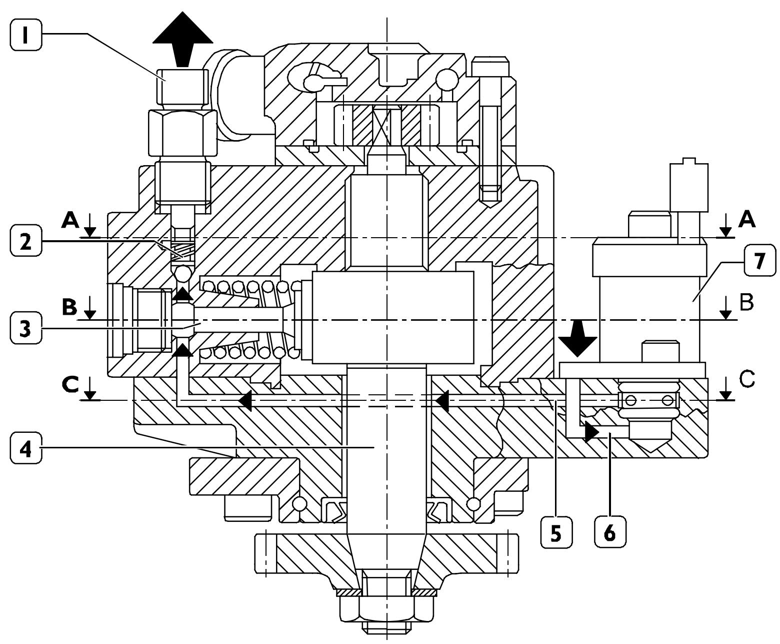
Working principle

Figure 9



Sec. B - B



Sec. D - D

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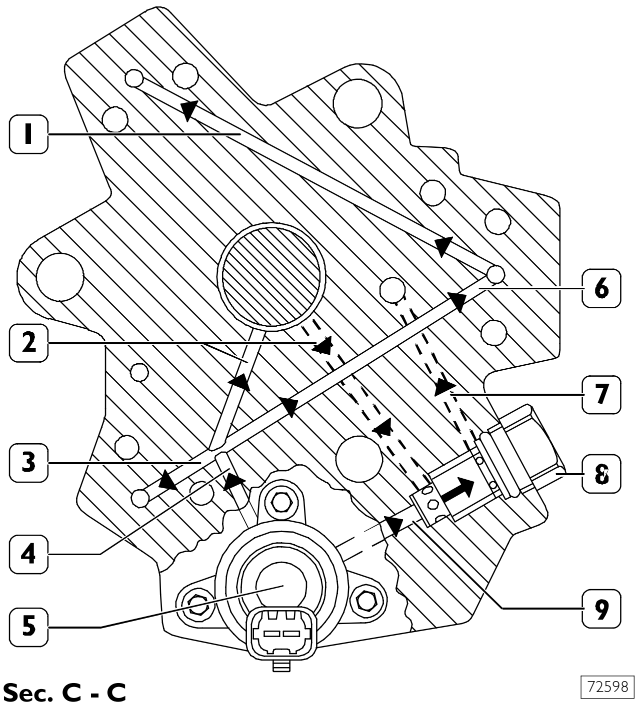
1. Cylinder. – 2. Three-lobe element. – 3. Cap intake valve. – 4. Ball delivery valve. – 5. Piston. – 6- Pump shaft. – 7. Low-pressure fuel inlet. – 8. Pumping elements supplying fuel ducts.

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.

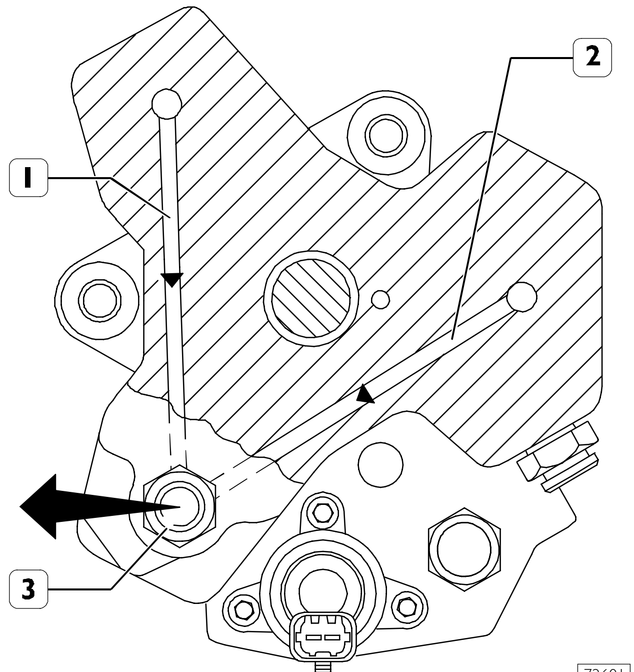
Picture 10 shows the fuel runs at low pressure inside the pump; the following elements are clearly visible: the main feeding line to the pumping elements (4); the feeding lines to the pumping elements (1-3-6), the duct lines run for the pump lubrication (2), the pressure gauge (5), the flow limiting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

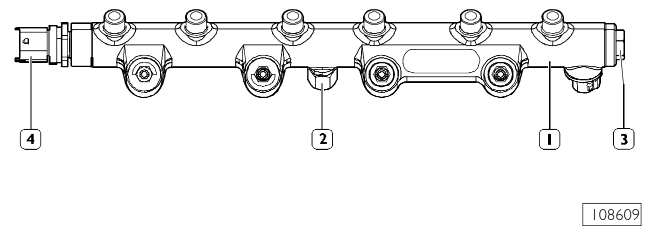
The pump is lubricated and cooled by the fuel.

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.

RELIEF VALVE

Mounted on the end of the rail, it has the function of protecting the system's components in case the failure of the rail pressure sensor or the pressure regulator of pump CP3 causes an excessive pressure increase in the high-pressure plant.

When the rail pressure reaches 1800 bars, the valve initially intervenes in order to allow the fuel to flow and subsequently to reduce the pressure within safety limits and then it mechanically regulates the rail pressure to approx. 800 bars.

This valve allows the engine to work for long periods at a limited efficiency and avoids the excessive overheating of the fuel preserving the return pipes to the tank.

ELECTRO-INJECTOR

The injector is similar as construction to the traditional ones, apart from the absence of plunger return springs.

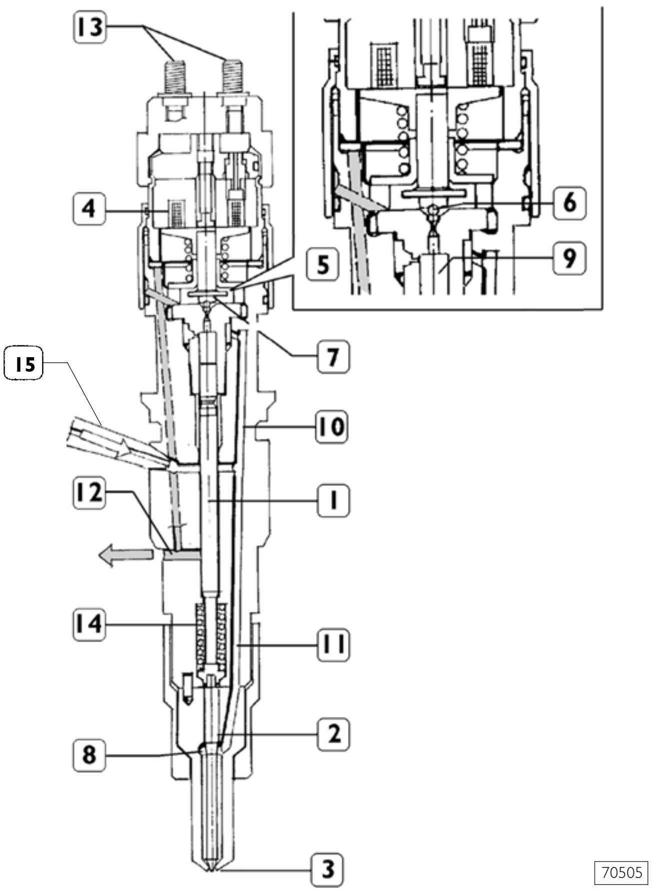
The injector can be deemed as composed of two parts:

- 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

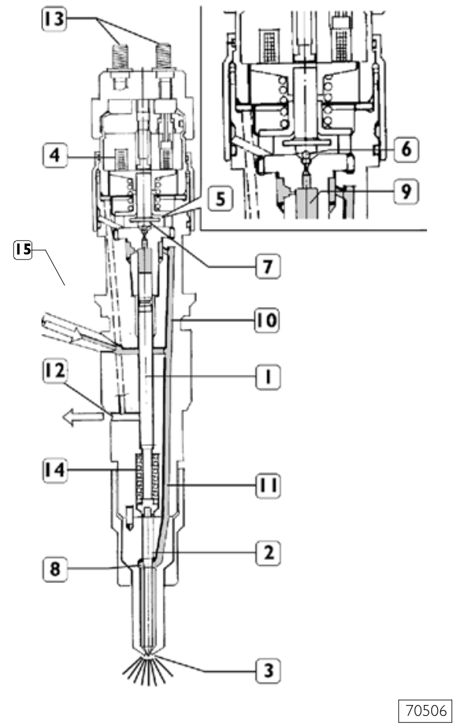
Figure 13



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 14



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.

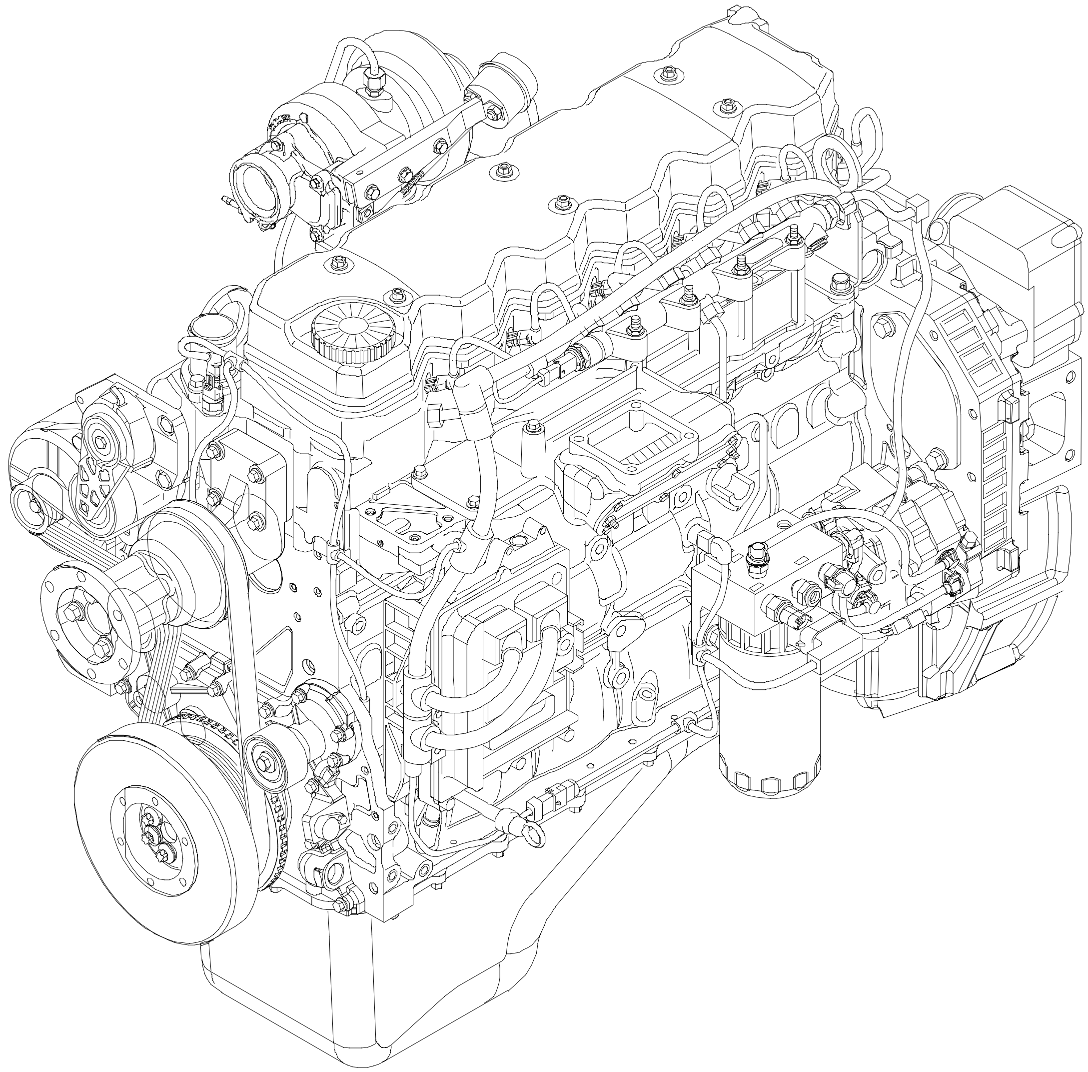
NOTE The injector cannot be overhauled and therefore it must not be disassembled.

SECTION 3

G-DRIVE application

GENERAL SPECIFICATIONS

Figure 1



130196

The NEF F4HE9685 engines are characterised by four-stroke diesel cycles supercharged with 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.

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

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

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 - 6 cyl.

Type		**F4HE9685A*J100**
Compression ratio		16.5 : 1
Max. output	kW (HP) rpm	208 (283) 1800
Max. torque	Nm (kgm) rpm	1103 (112) 1800
Loadless engine idling	rpm	-
Loadless engine peak rpm	rpm	-
Bore x stroke Displacement	 cm^3	104 x 132 6728
TURBOCHARGING Turbocharger type		with intercooler HOLSET HX35W
LUBRICATION		Forced by gear pump, relief valve single action oil filter
Oil pressure (warm engine) - idling - peak rpm	 bar bar	 - -
COOLING **Water pump control** **Thermostat** - start of opening	 °C	By liquid Through belt 81 ± 2
FILLING - engine sump - engine sump + filter	 liters liters	 - -

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

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

Part of the operations illustrated within this section can be partially executed while the engine is assembled on the vehicle, depending on the room available for access to the engine and on the equipment application as well.

NOTE 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.

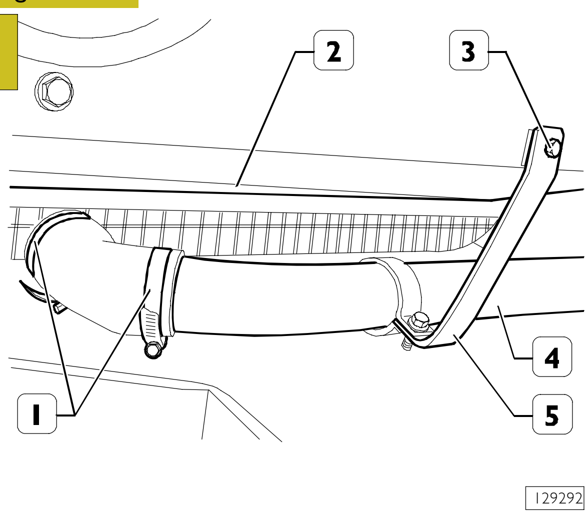
The following information relates to the engine overhaul operations only for what concerns the different components customising the engine, according to its specific duties.

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.

Removing engine from radiator

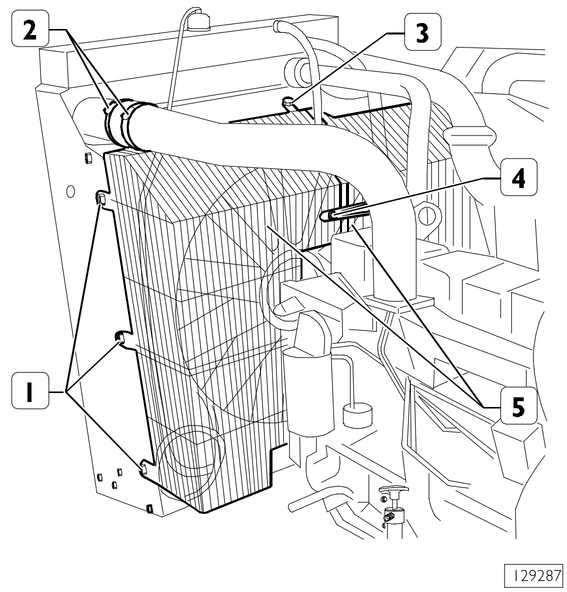
Remove the electrical wiring from all the components indicated in the electrical equipment section.

Figure 2



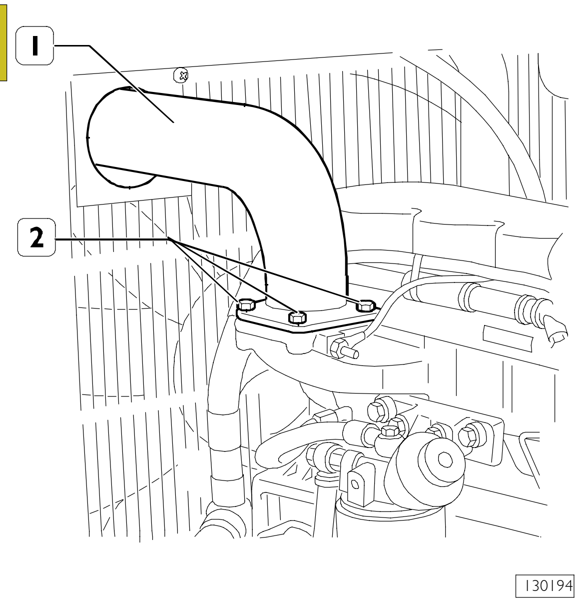
- ❑ Have a special container ready by the pipe (4) for collecting the coolant. Disconnect the pipe (4) adjusting the bands (1).
- ❑ Undo the bolt (3) and release the pipe (4) complete with bracket (5) from the radiator assembly (2).

Figure 3



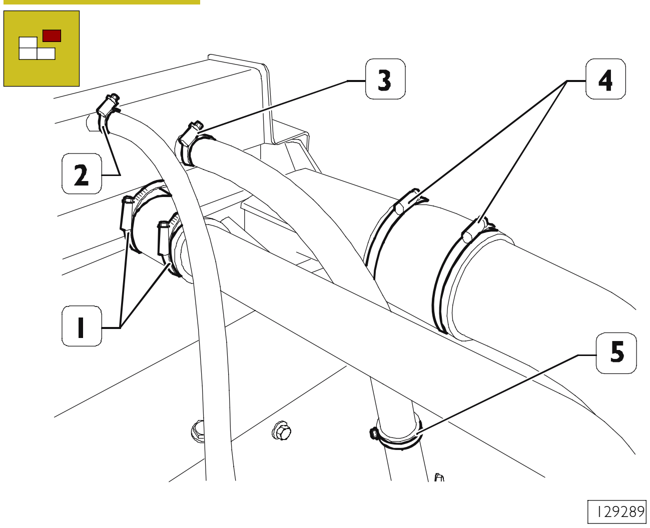
- ❑ Remove the protective grilles (5) for the fan adjusting the fastenings (1), (3) and (4).
- ❑ Open the bands (2).

Figure 4



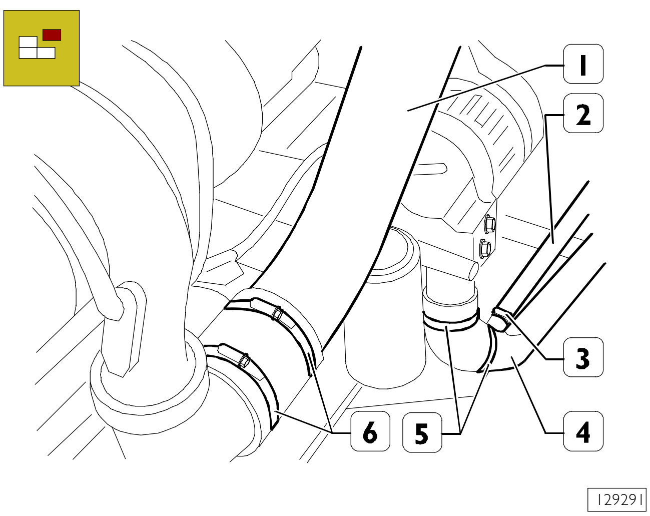
- ❑ Undo the bolts (2) and remove the pipe (1) from the intake manifold.

Figure 5



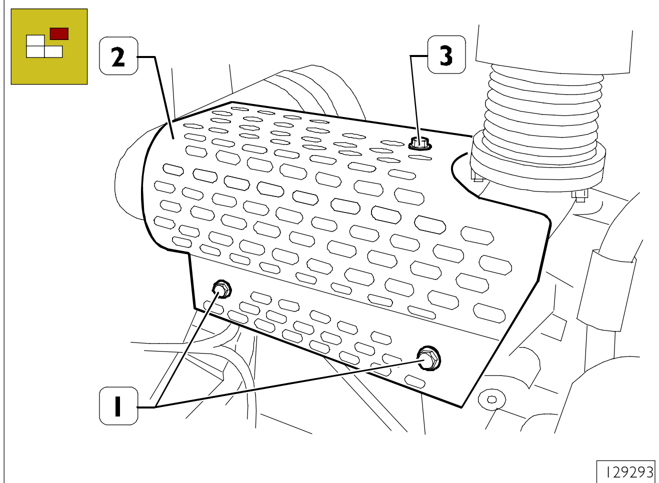
- Disconnect the air and water pipes from the radiator assembly adjusting the bands (1), (2), (3) and (4) and the mounting bracket (5).
- The above-described operations must be carried out on the engine side too.

Figure 6



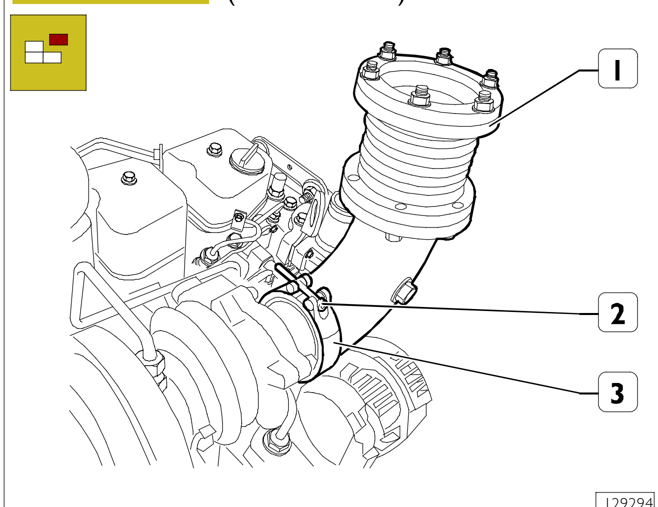
- Disconnect and pipe (1) and remove it complete with hoses, on the engine side, adjusting the bands (6).
- Disconnect the pipe (2) and remove it, adjusting the band (3).
- Disconnect and pipe (4) and remove it complete with hoses, on the engine side, adjusting the bands (5).
- Lock the radiator assembly appropriately, then release it from the crankcase adjusting the fastenings on both sides.
- Remove the radiator assembly from its housing paying attention to any possible interference with the fan.

Figure 7



- If present, remove the turbine guard grille (2), adjusting the bolts (1) and (3).
- Then remove the mounting brackets.

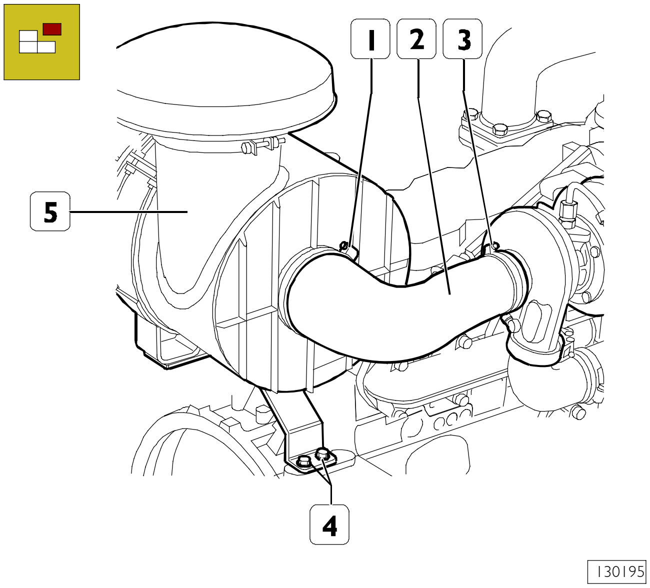
Figure 8 (Demonstrative)



- Disconnect the drainage pipe (1) from the system, adjusting the bolt (2) to open the band (3).

NOTE The shape and the size of the drainage pipe vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out.
The procedures described can, however, be applied.

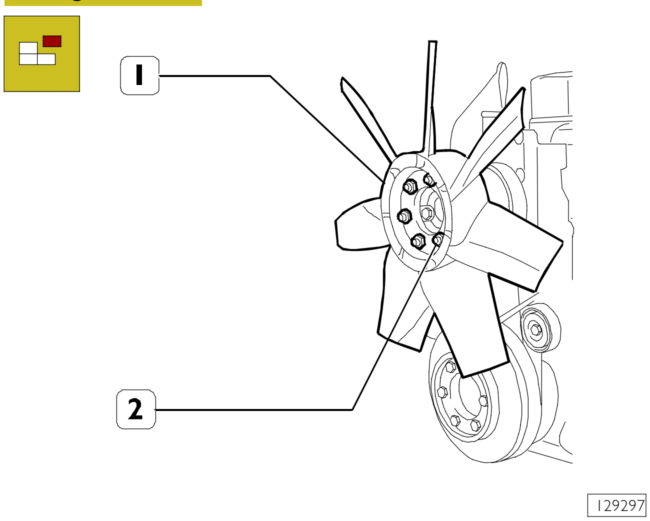
Figure 9



❑ Disconnect and oil vapour recovery pipe (2) and remove it adjusting the bands (1) and (3).

❑ Remove the air filter (5) adjusting the fastenings (4) and remove it from its housing complete with support.

Figure 10

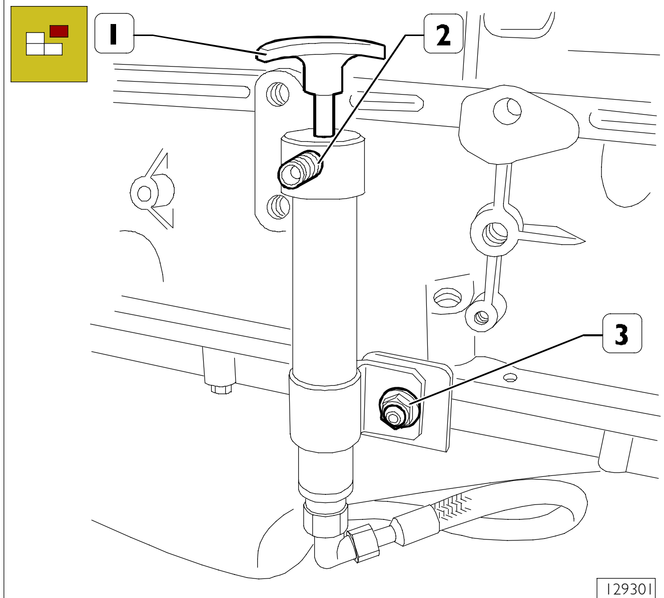


❑ Remove the fan (1), complete with spacer, adjusting the bolts (2).

NOTE The shape and the size of the fan vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out.
The procedures described can, however, be applied.

For versions with an oil drainage pump

Figure 11



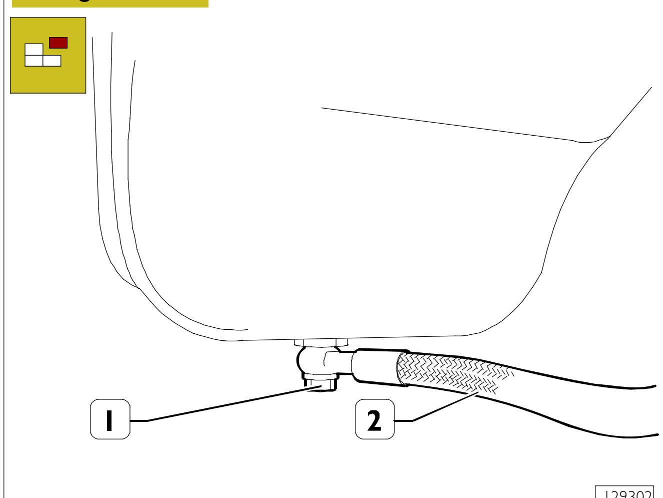
❑ Extract the dipstick and the filler plug to facilitate the lubrication oil flow.

❑ Connect the special pipe for draining the pump (2) fitted in the engine to the outside.

❑ Remove the oil in the engine oil sump using the drainage pump (1).

❑ Remove the pump adjusting the nut (3).

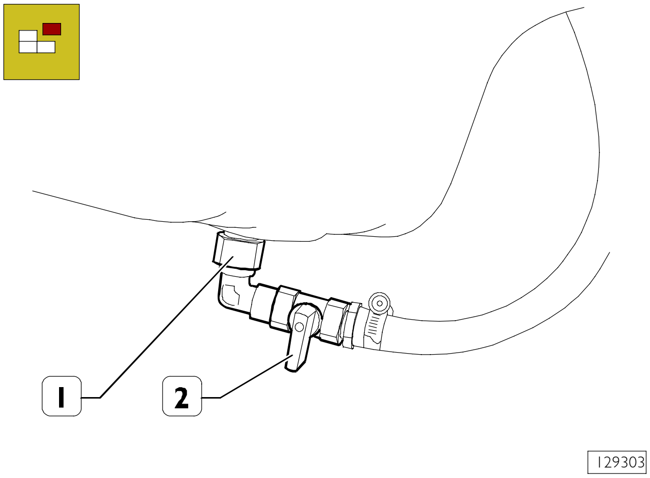
Figure 12



❑ Disconnect the pipe (2) and remove it, adjusting the bolt (1).

For versions with an oil drainage tap

Figure 13

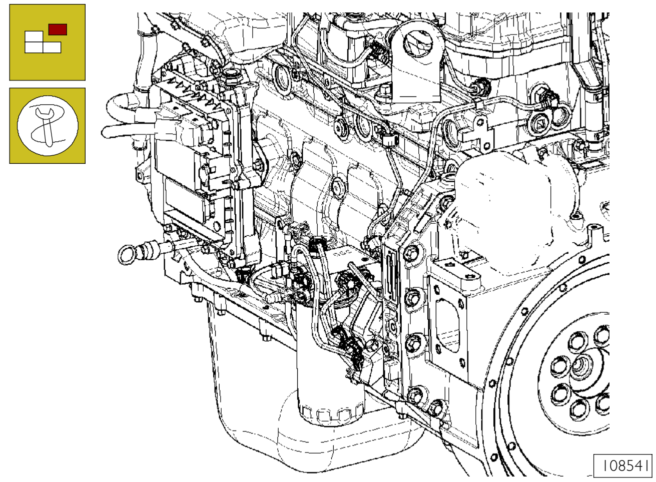


- Extract the dipstick and the filler plug to facilitate the lubrication oil flow.
- Remove the oil in the engine oil sump using the tap (1).
- Disconnect the pipe and remove it, adjusting the bolt (2).

NOTE Some versions have a plug for draining the oil from the sump.
The procedure involves opening this plug located underneath the engine sump after having extracted the dipstick and the filler plug to facilitate the flow of lubrication oil.

Engine setting operations for the assembly on turning stand

Figure 14



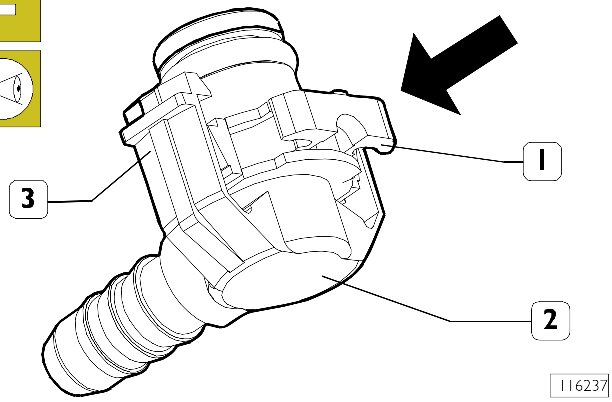
In order to apply the brackets 99361037 to the engine block to fix it on to the stand for the overhaul, it is necessary to perform the following operations on the left hand side of the engine:

- using the tool 99360073 disassembly the fuel filter and remove it from the support;
- disconnect the electrical connection from the support and the heater's one (placed on the filter support as well);
- disconnect the fuel low pressure pipelines from the support;
- disconnect pipeline from the support;
- remove the sustaining support bracket from the block;
- disconnect the high pressure fuel pipeline from the rail diffuser and from the high pressure pump and disassemble it from the engine block removing the fixing clamps.
- disconnect the pipeline feeding the mechanic pump that is combined to the high pressure pump through the exchanger of the engine control module;
- disassemble the oil introduction tube (if present) by undoing and removing the fixing screws. Remove the O-ring from the tube.

NOTE 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.

Figure 15

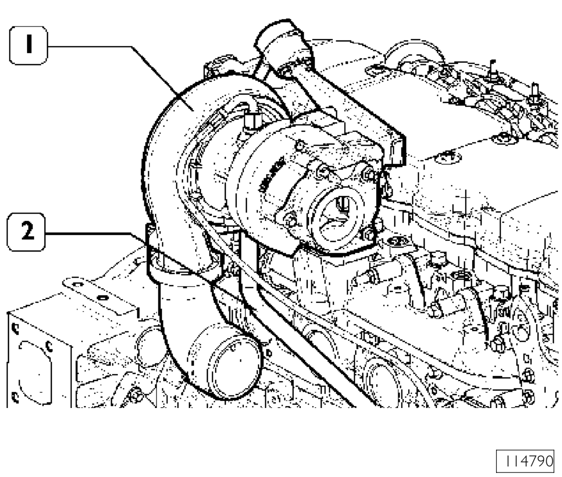


To disconnect the low pressure fuel pipe from the relevant connecting joint, you need to hold the clasp (1) pressed, and release the quick fitting joint (2).

To connect the low pressure fuel pipe to the connecting joint, insert the quick fitting joint (2) into the connecting joint, and push until the clip (3) is fastened.

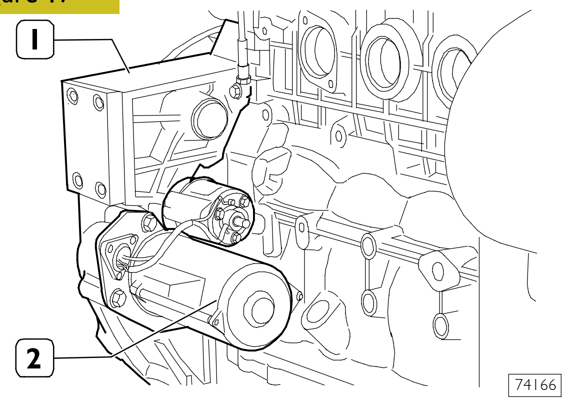
On the right hand side of the engine:

Figure 16



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

Figure 17



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

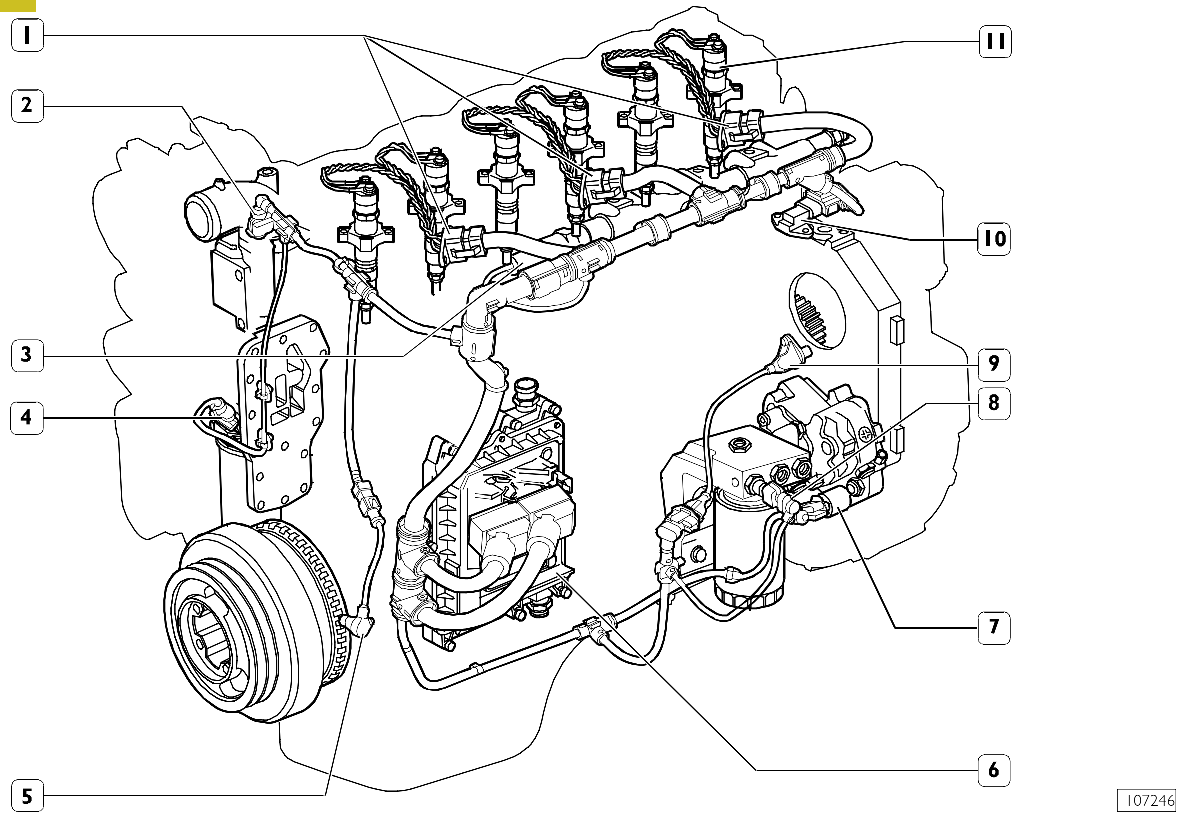
Apply brackets 99361037 to engine block and use them to secure the engine to the revolving stand 99322205. Remove sump cap and drain out oil.

Remove the fan from the output shaft pulley.

Collect and dispose of engine oil according to rules in force.

Disassembly of application components

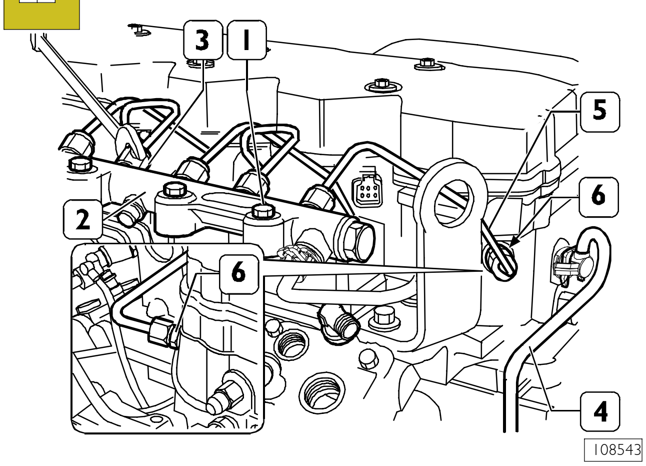
Figure 18



1. Connections for Electro-injectors - 2. Engine cooling liquid temperature's sensor - 3. Cable of the fuel pressure sensor - 4. Sensor of engine's oil temperature and pressure - 5. Driving shaft sensor - 6. EDC 7 gearbox - 7. Cable of pressure regulating gauge - 8. Cable of fuel heater and fuel temperature's sensor - 9. Timing system sensor - 10. Temperature - air pressure sensor - 11. Electro-injector.

Disconnect the engine's cable from the connectors wiring harness to
Electro-injectors (1); (10) air pressure/temperature sensor;
(3) fuel pressure sensor;
(6) engine control module; (9) timing system sensor; (2) Thermostat sensor of engine cooling liquid's temperature; (5) sensor of engine's revolutions.

Figure 19



Disconnect from the rail (2): the fuel pipe (7) according to procedures described in Figure 15. Disconnect fuel pipes (5) from rail (2) and injector manifolds (6).

NOTE 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).

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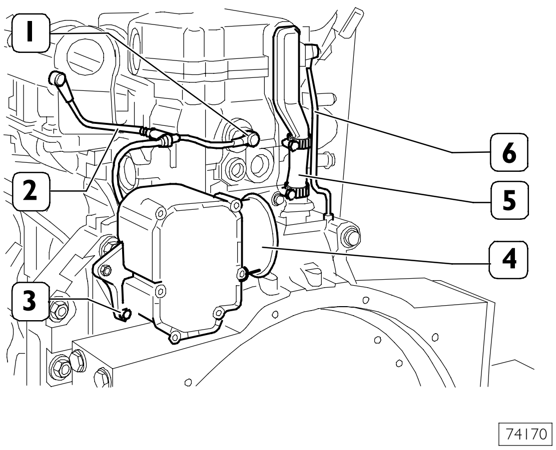
Figure 20



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

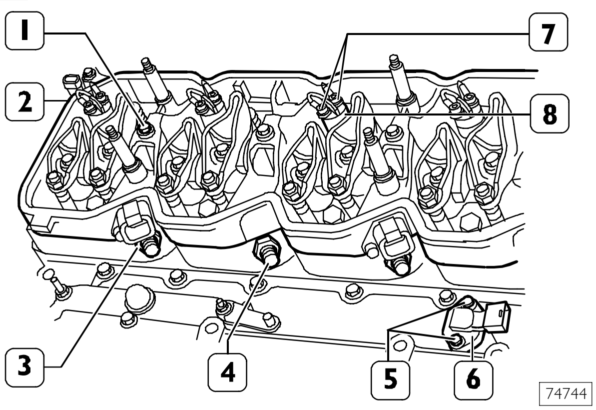
Unscrew the nut and loosen the clamp tightening the oil vapour pipe.

Remove the pipe (6).

Undo the screws (3) and, if present, disassemble the blow-by filter (4).

Remove on the nuts and tappet cover.

Figure 21



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

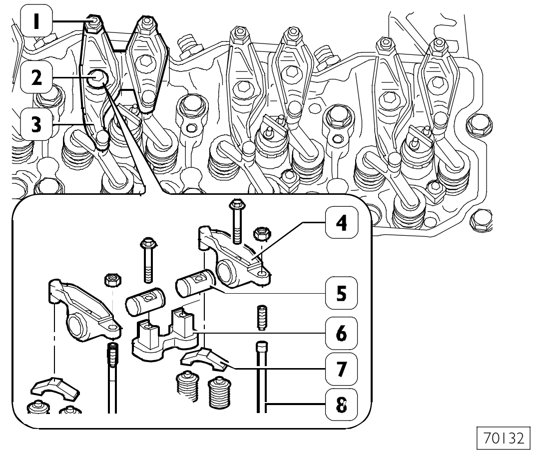
Remove screws (1) and disconnect injector wiring support (2) including the gasket.

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

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

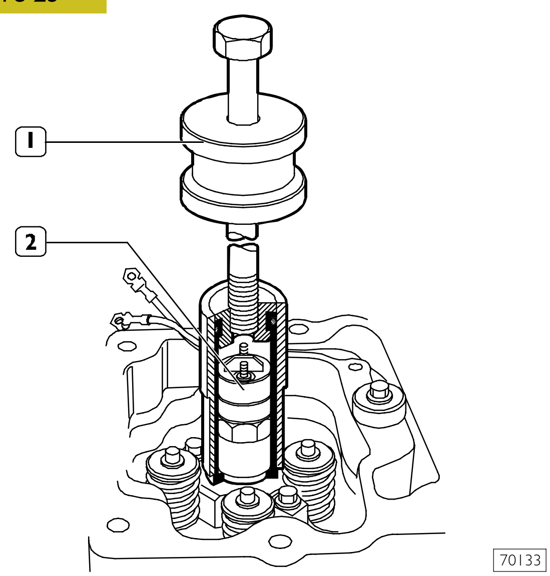
NOTE Disassembled fuel manifolds (4) must not be used again, replace with new ones during reassembly.

Figure 22



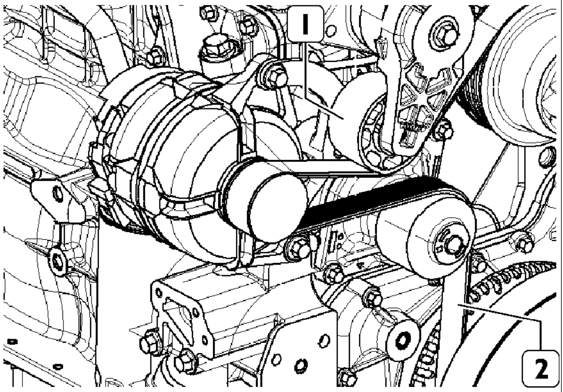
Loosen tappet adjustment fastening nuts (1) and unscrew the adjusters.
Remove the screws (2), remove the rocker assembly (3), consisting of: bracket (6), rockers (4), shafts (5) and remove jumpers (7) from valves.
Remove rods (8).

Figure 23



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

Figure 24



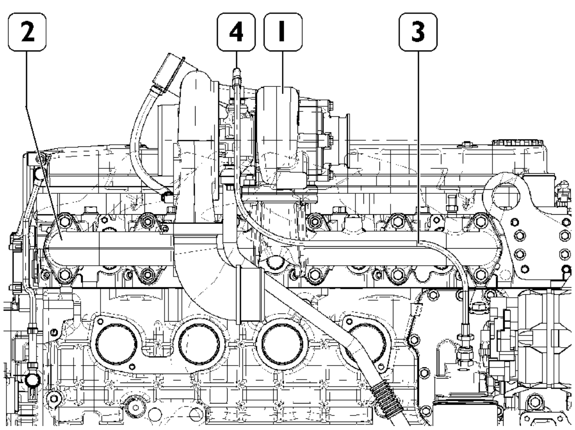
108545

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 (1).

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

Figure 25



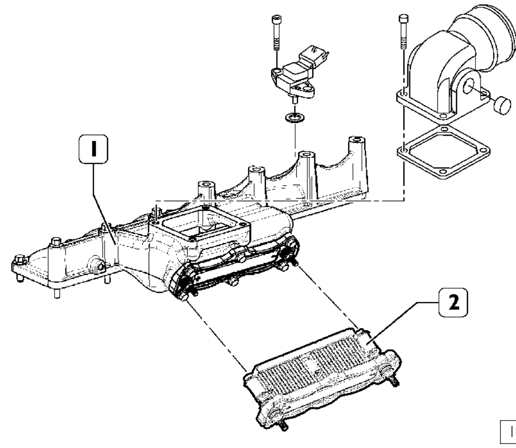
108546

Disconnect the oil pipeline (3) from the supports of the heat exchanger / oil filter and from the pipe fitting (4) 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.

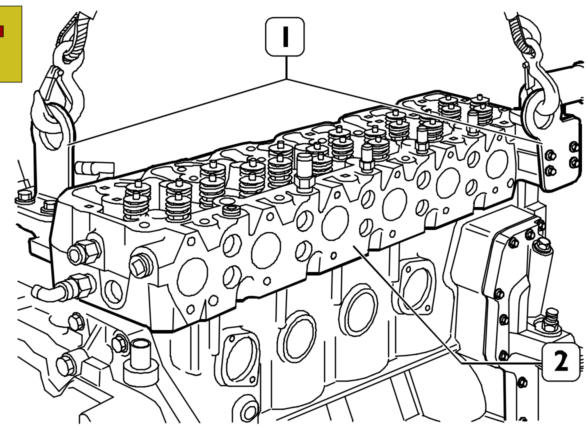
Figure 26



108547

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.

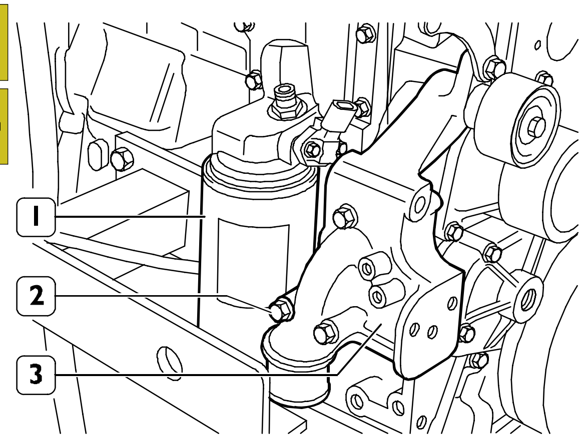
Figure 27



74779

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

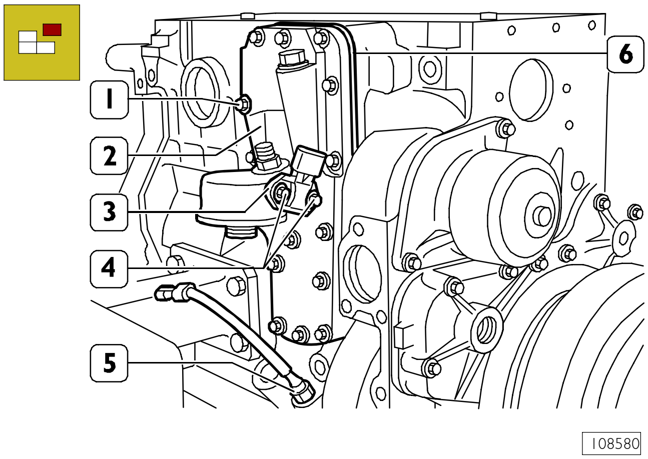
Figure 28



108549

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

Figure 29

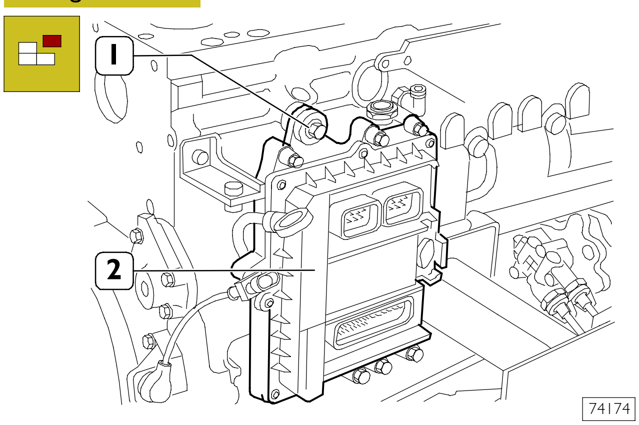


Remove the screws (4) and disconnect the oil temperature/pressure sensor (3).

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

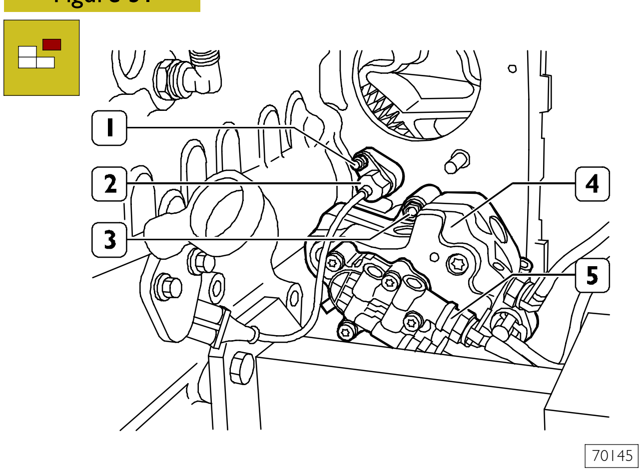
Remove the oil level sensor (5).

Figure 30



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

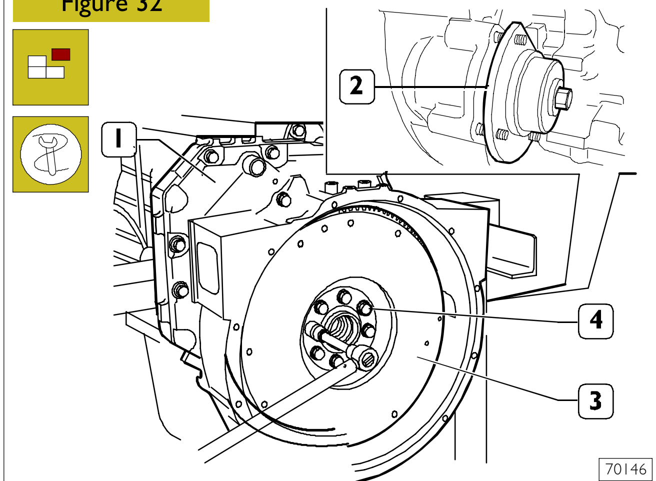
Figure 31



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).

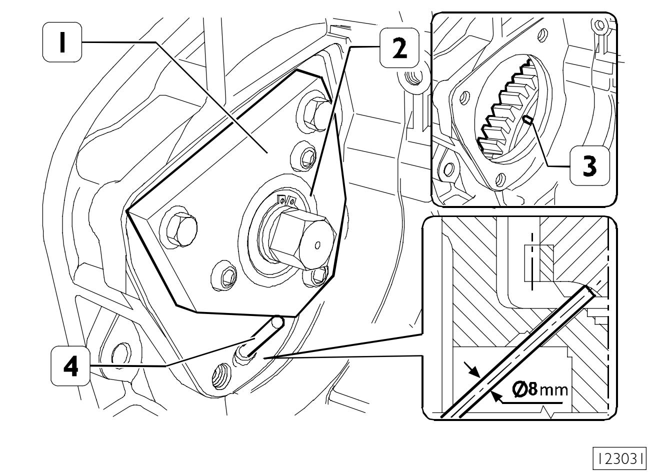
Figure 32



Fit tool 99360339 (2) to the flywheel housing (1) to stop flywheel (3) rotation.
Loosen the screws (4).

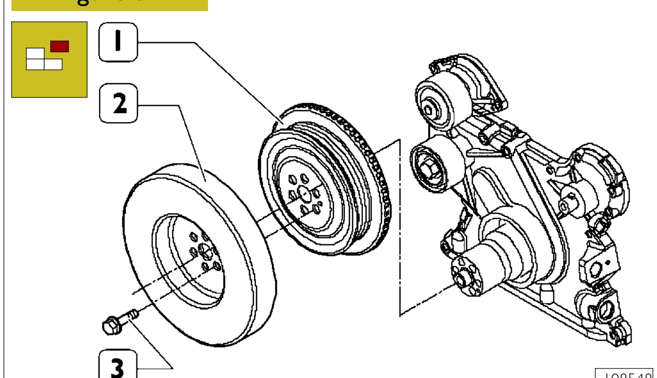
Versions with tool 99360351

Figure 33



Fit tool 99360351 (2) to the flywheel housing (1) to stop flywheel (3) rotation.
Loosen the screws (4).

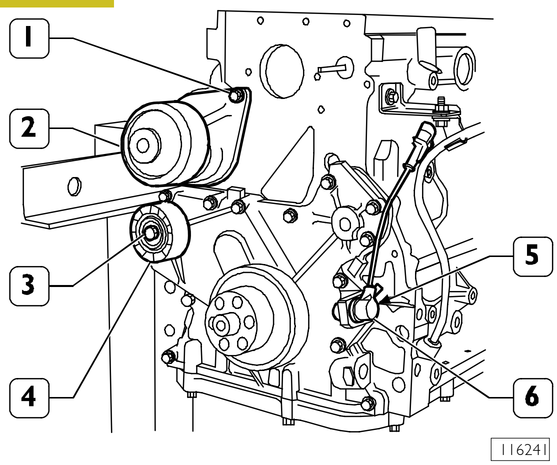
Figure 34



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

The engine flywheel locking tool can help when removing the damper flywheel (2) fitted on the pulley (1).

Figure 35

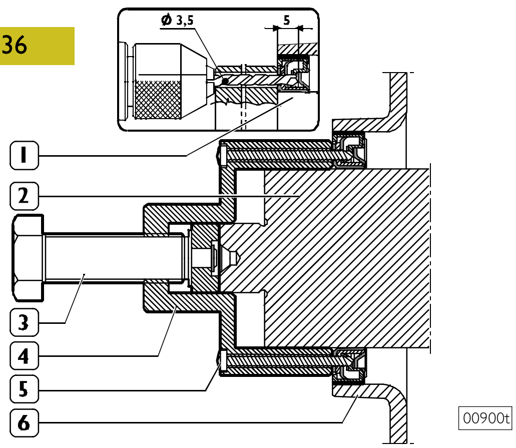


Remove the screws (1) and disconnect the water pump (2).

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

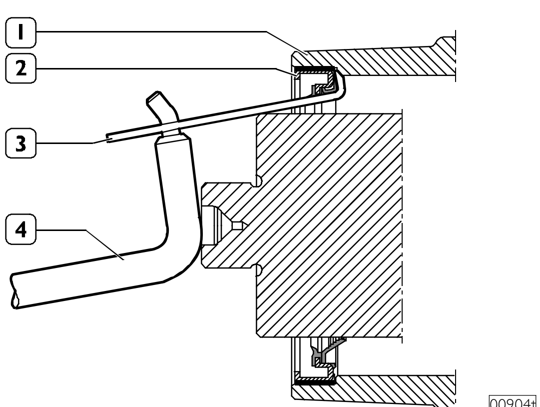
Remove the screw (5) and disconnect the engine speed sensor (6).

Figure 36



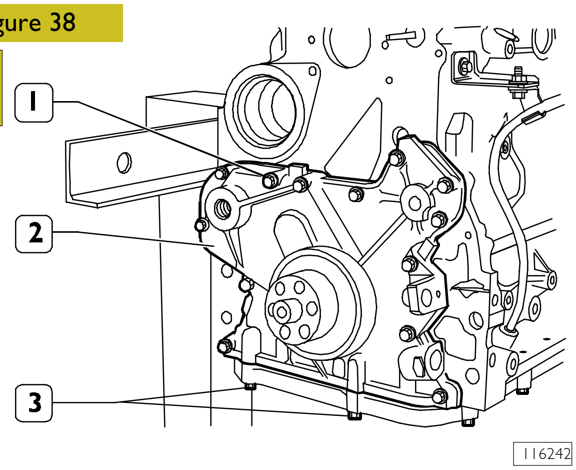
Remove the ring sealing the engine's driving shaft from the front cover. Use the tool 99340055 (4) to operate on the front bar hold of the driving shaft. Through the steering holes of the tool, perforate the inside holding ring (1) with a straight way drill (diam. 3,5mm) for the depth of 5mm. Fix the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

Figure 37



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).

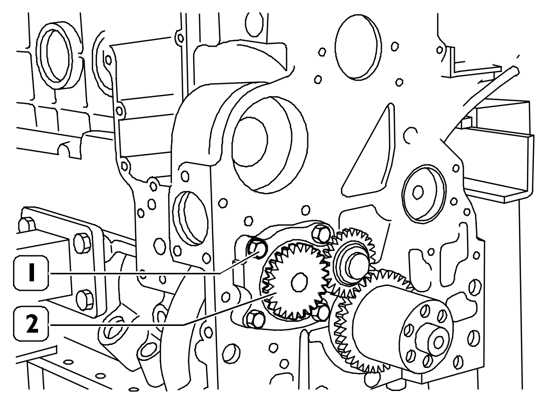
Figure 38



Remove the screws (1 and 3) and take out the front cover (2).

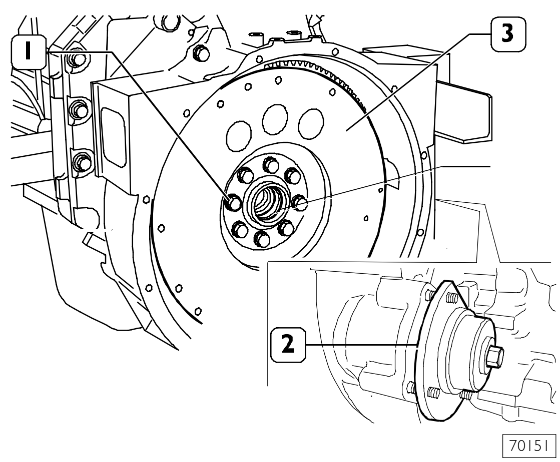
NOTE Take note of screw (1) assembling positions since they have different lengths.

Figure 39



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

Figure 40



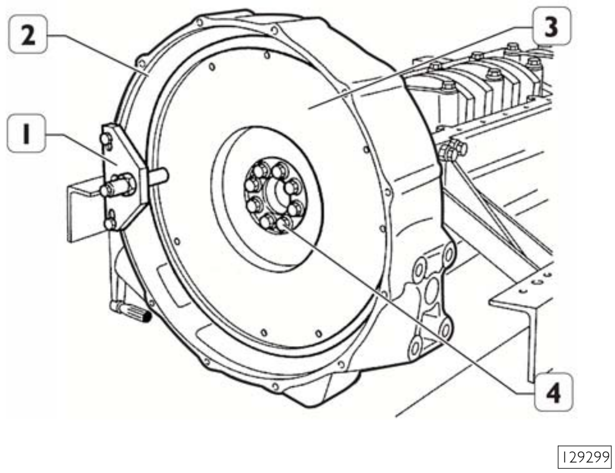
Remove two opposite screws (1) from the area where the withdrawal pins will be introduced (2, Figure 41).

Loosen the remaining flywheel fixing screws (3) from the driving shaft (4).

Remove the flywheel locking tool 99360339.

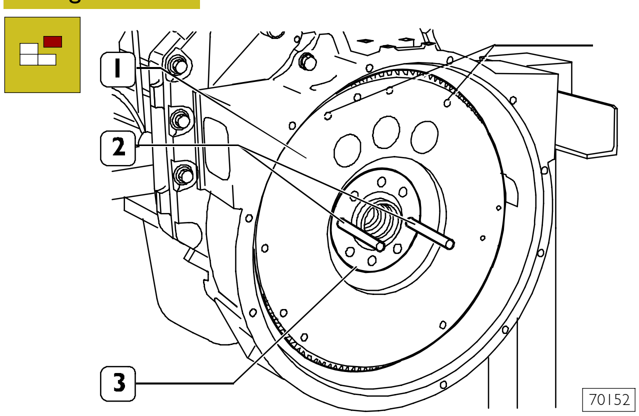
Versions with tool 99360351

Figure 41



Remove two opposite screws (1) from the area where the withdrawal pins will be introduced (2, Figure 41).
Loosen the remaining flywheel fixing screws (3) from the driving shaft (4).
Remove the flywheel locking tool 99360351.

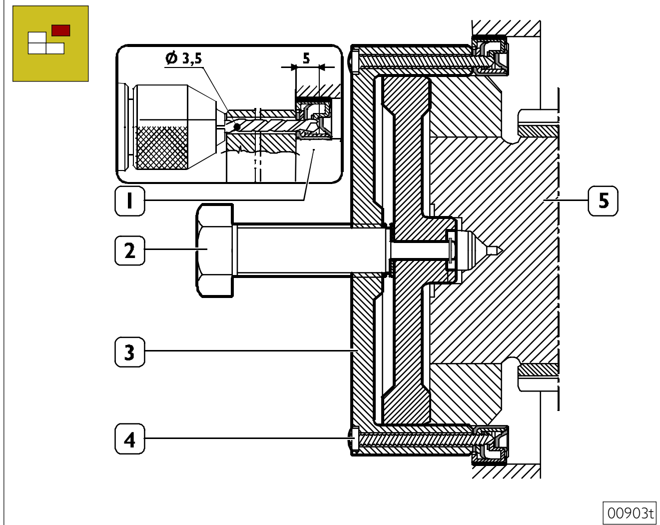
Figure 42



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

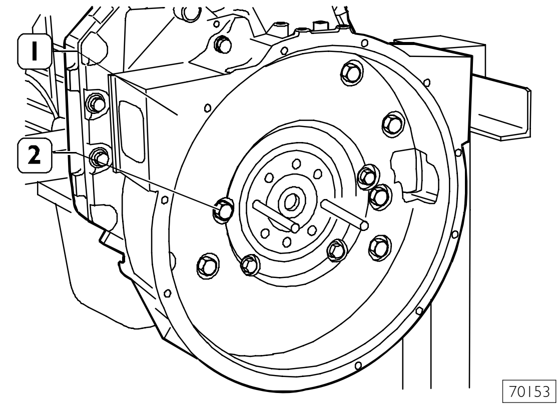
Throughout the two guide pins (2) previously screw into the driving shaft holes (3) withdraw the engine flywheel (1) after slinging it with the hoist.

Figure 43



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.

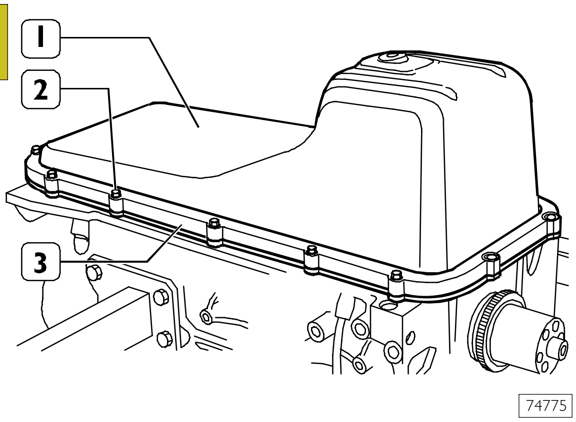
Figure 44



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

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

Figure 45



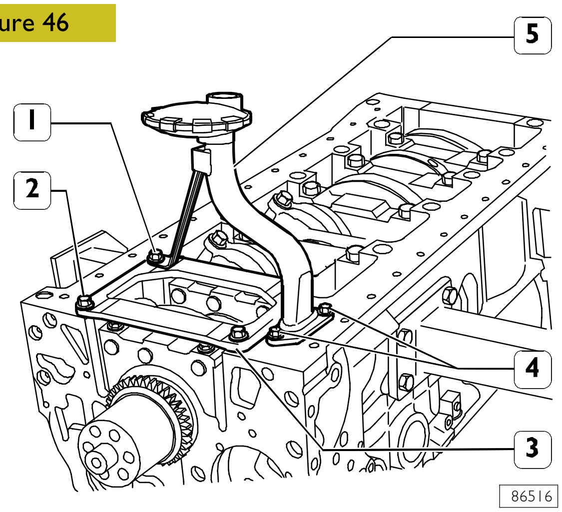
Overturn the engine.

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

NOTE 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.

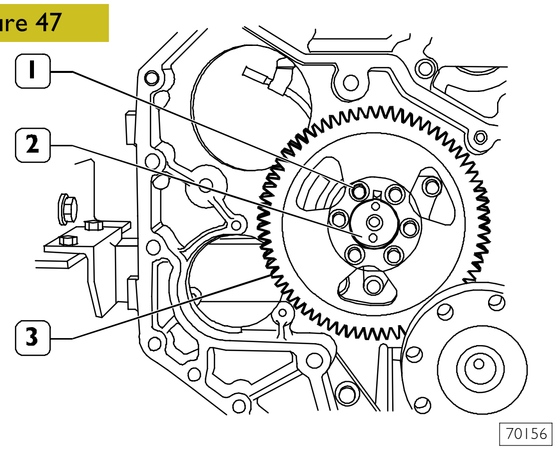
Figure 46



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

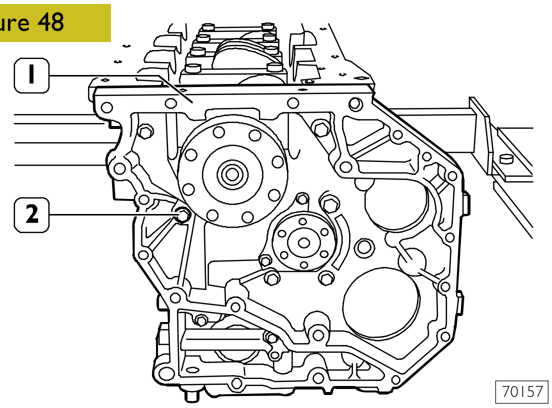
NOTE For engines the stiffening plate (4) has a single element.

Figure 47



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

Figure 48



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

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

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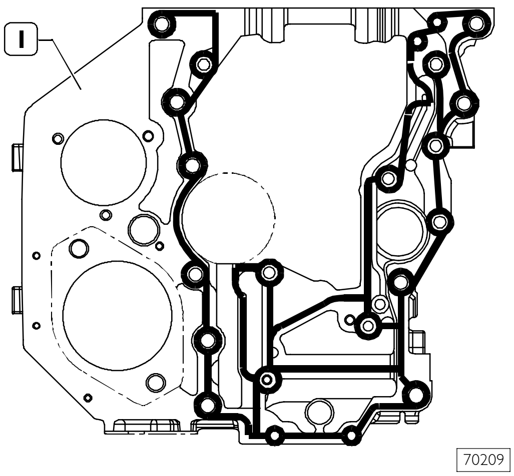
Assembly of application components

Figure 49



LOCTITE 5205 SEALANT APPLICATION AREAS

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

NOTE 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 50

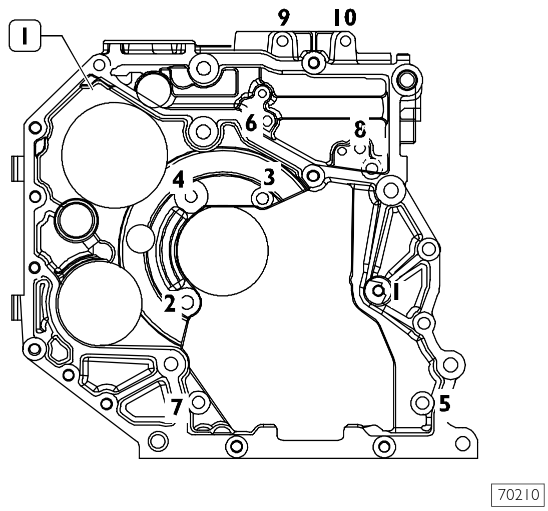


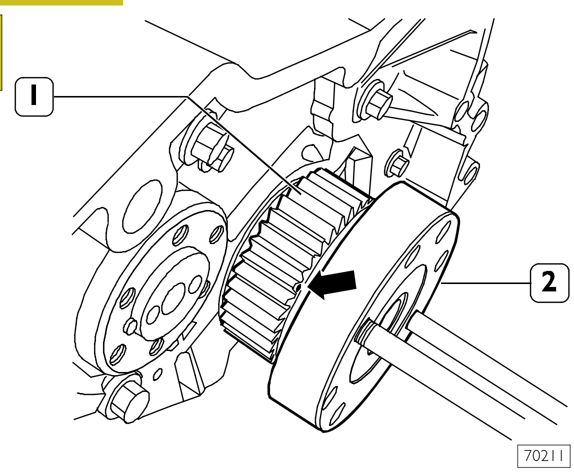
DIAGRAM FOR TIGHTENING THE REAR TIMING GEAR CASE FASTENING SCREWS

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

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

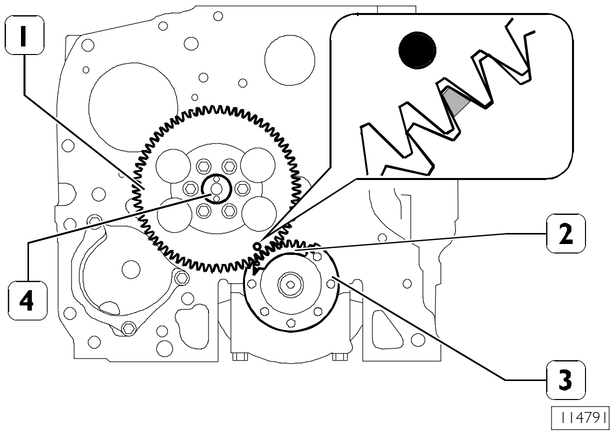
Figure 51



With a felt-tip pen, highlight the conducting gear tooth (1) mounted on the engine shaft (2) upon the side surface of which a groove has been created for the ignition timing.

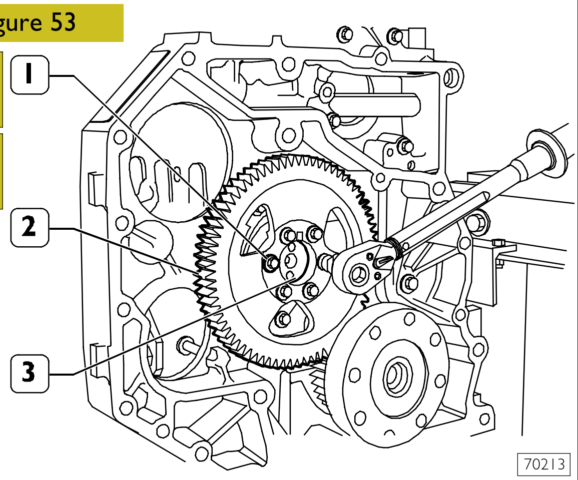
NOTE Fasten screwing of the two pins to facilitate the operation of engine driving shaft rotation.

Figure 52



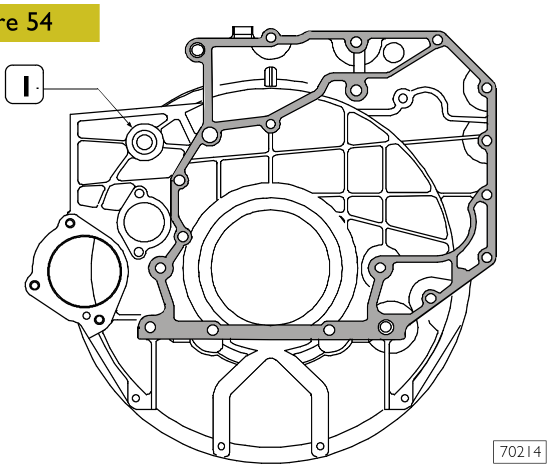
Turn the engine shaft (3) and the distribution shaft (4) so that by mounting the bevel gear on the latter (1) the stencilled mark on the gear (1) coincides with the groove on the gear tooth (2).

Figure 53



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

Figure 54



LOCTITE 5205 SEALANT APPLICATION AREAS

NOTE 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.

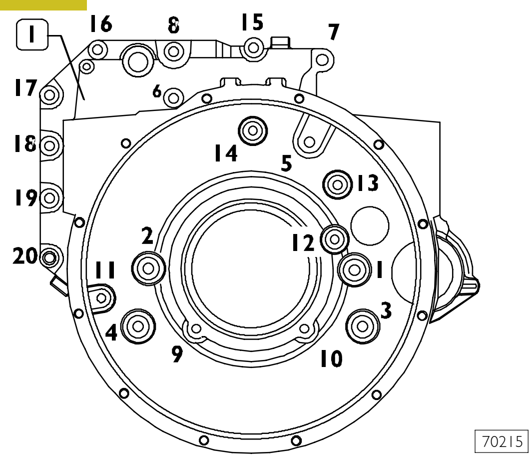
Any imperfection shall be corrected as soon as possible.

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 55



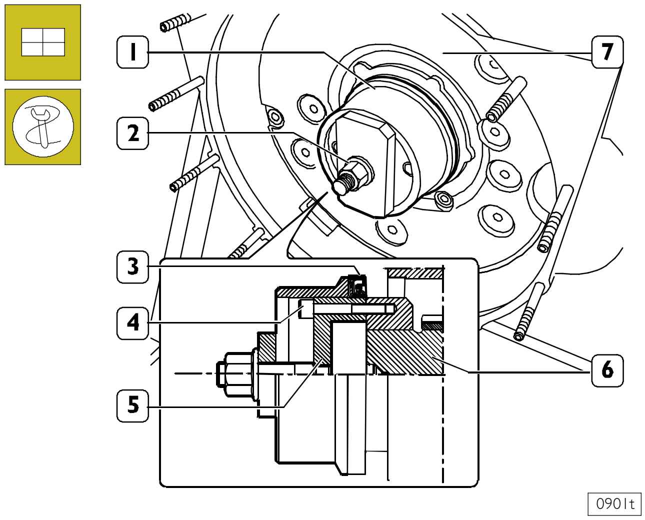
SEQUENCE FOR TIGHTENING THE FLYWHEEL HOUSING FASTENING SCREWS

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

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

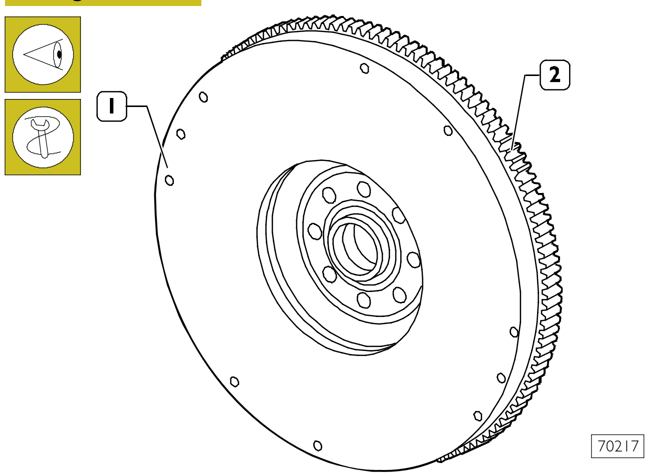
Figure 56



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).

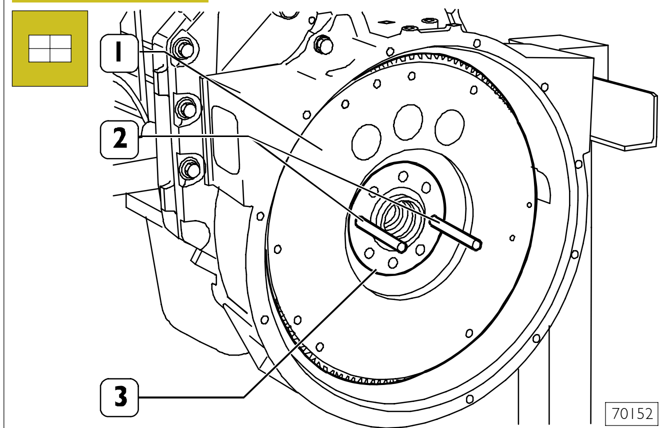
Figure 57



Check the supporting surface (1) of the clutch plate and if it is scratched, it is necessary to carry out turning.

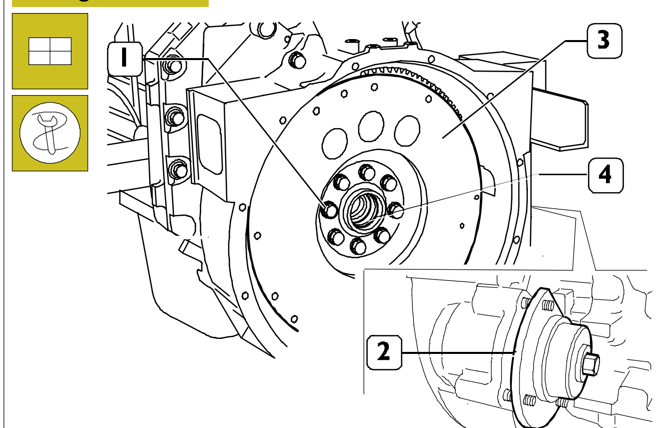
Check ring gear teeth (2), if breakage or excessive wear is found remove the ring gear from the engine flywheel (1, Figure 56) using a suitable hammer and fit the new one, previously heated to 150°C for 15 to 20 minutes. Chamfering on ring gear inside diameter shall be facing the engine flywheel.

Figure 58



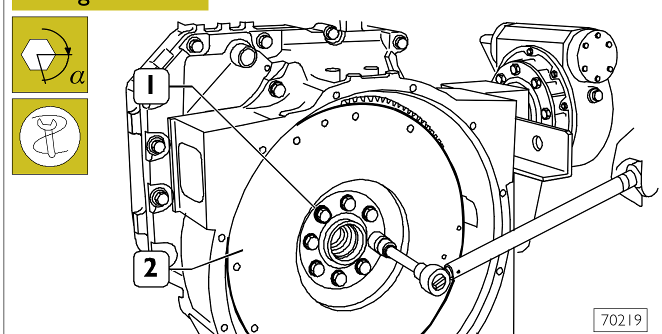
Screw two pins (2) having suitable length into shaft holes (3) and remove the engine flywheel (1) using proper sling and hoister.

Figure 59



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 60

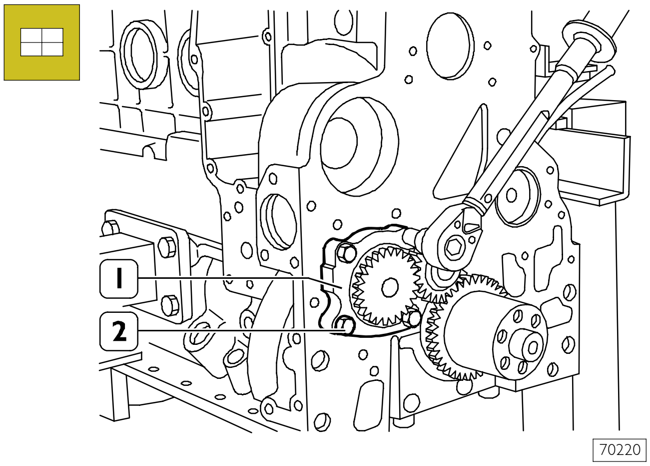


Tighten engine flywheel (2) fastening screws (1) in two stages:

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

NOTE 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.

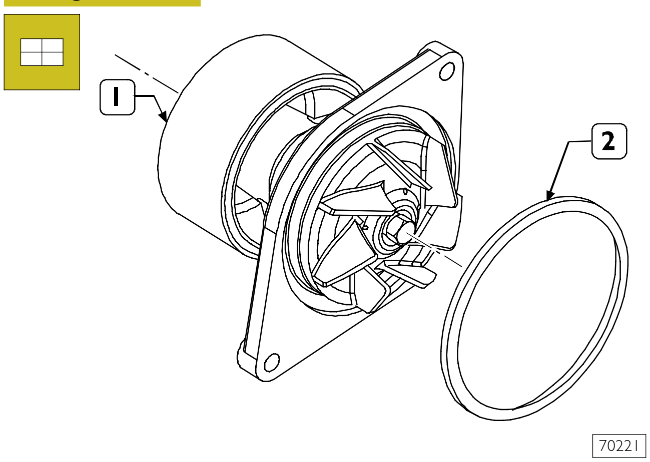
Figure 61



Fit the oil pump (1).

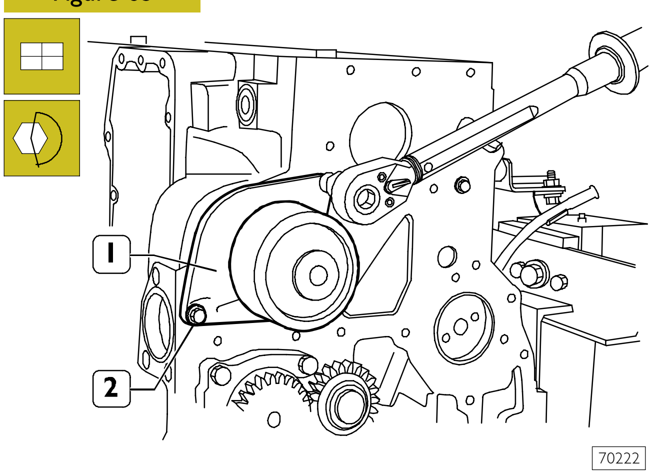
Tighten the fastening screws (2) to the specified torque.

Figure 62



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

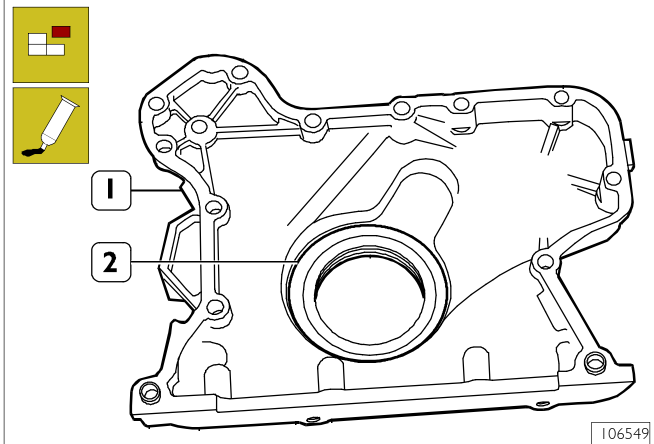
Figure 63



Fit the water pump (1).

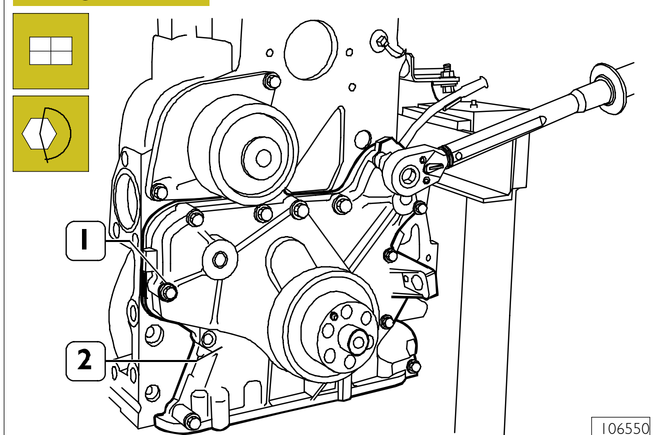
Tighten the screws (2) to the specified torque.

Figure 64



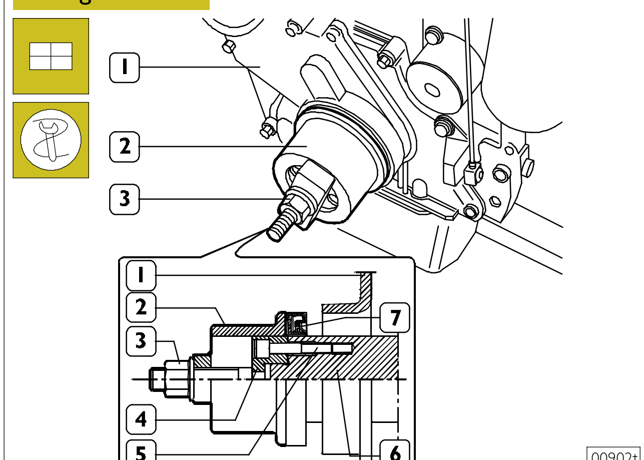
Remove the sealing ring (2) from the front cover (1), clean accurately the coupling surfaces and smear them with LOCTITE 5205.

Figure 65



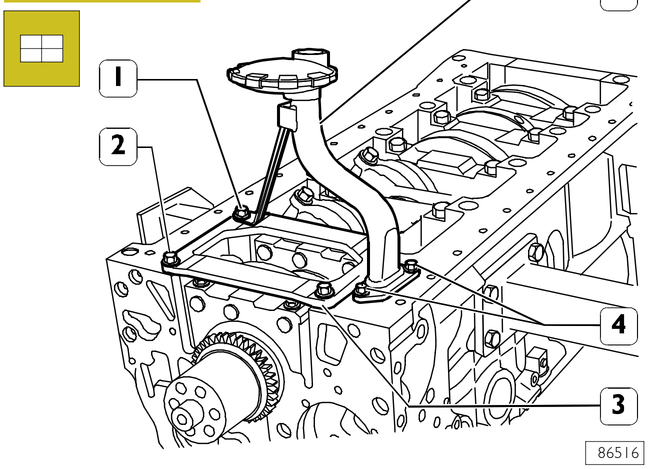
Clean accurately the front cover (2) surface and refit it. Tighten the screws (1) to the specified torque.

Figure 66



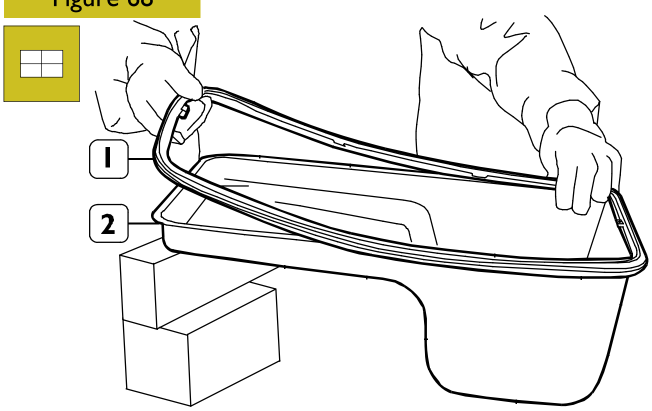
Apply tool 99346252 part (4) to the front output shaft tang (6), secure it by screws (5) and fit the new sealing ring (7). Position part (2) on part (4), screw nut (3) until completing sealing ring (7) fitting into front cover (1).

Figure 67



Fit the plate (3), the oil pick up tube (5) and tighten the fastening screws (1, 2, 4) to the specified torque.

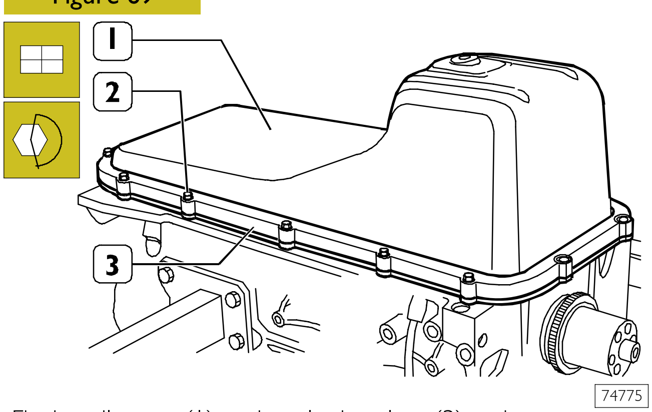
Figure 68



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

NOTE 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.

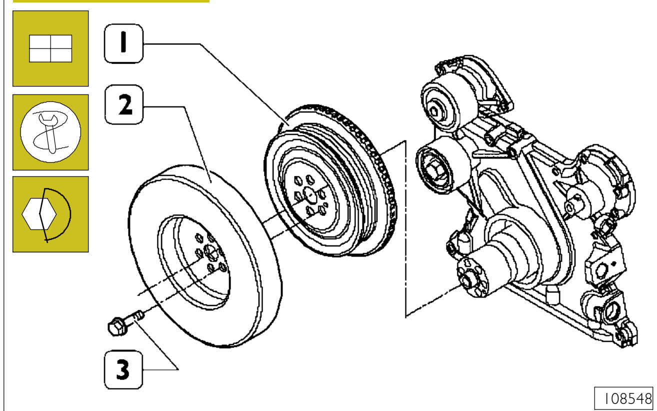
Figure 69



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

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

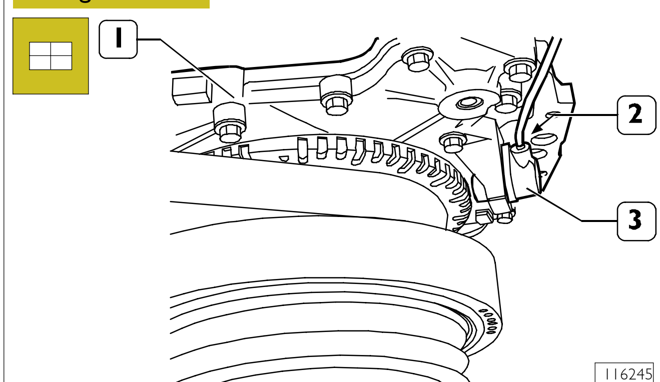
Figure 70



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.

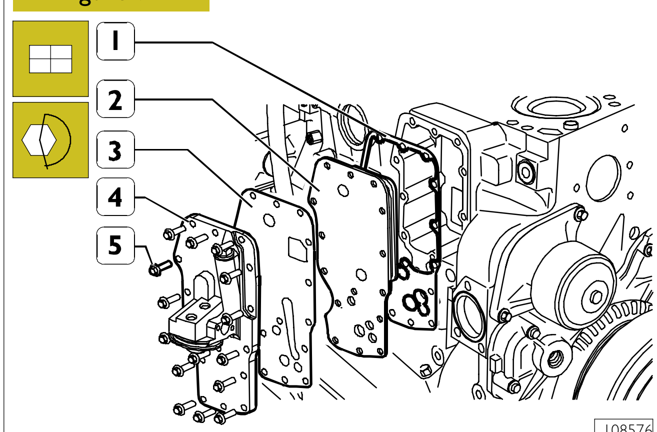
Figure 71



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 72

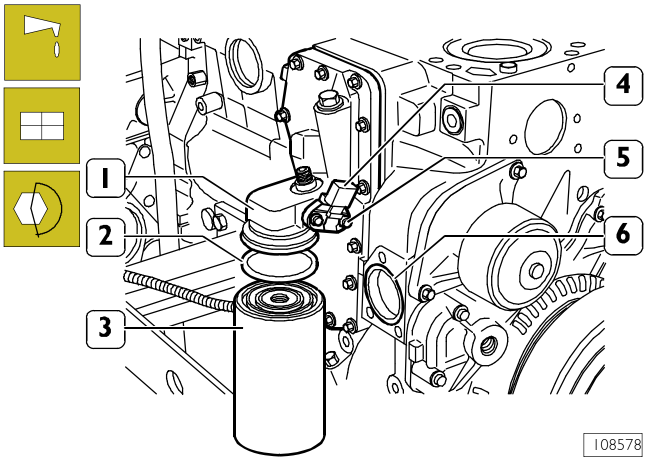


Fit on the engine block: a new gasket (1), the heat exchanger (2) a new gasket (3) and the oil filter support (4).

Tighten the screws (5) to the specified torque.

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

Figure 73



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

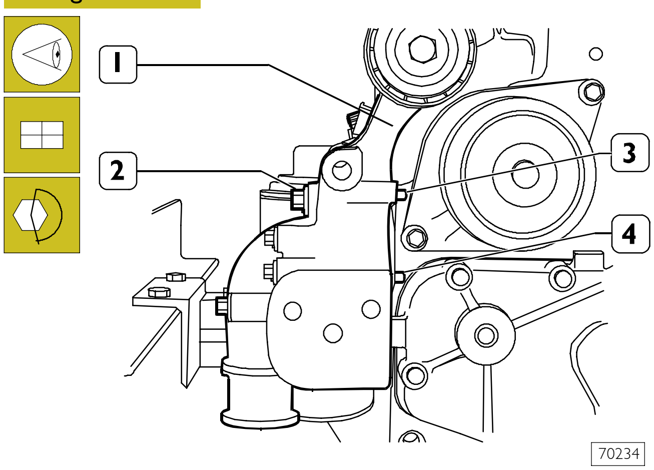
Screw manually to seat the oil filter (3) on the support connection (1) and then screw again the oil filter (3) by ¾ turn.

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 74

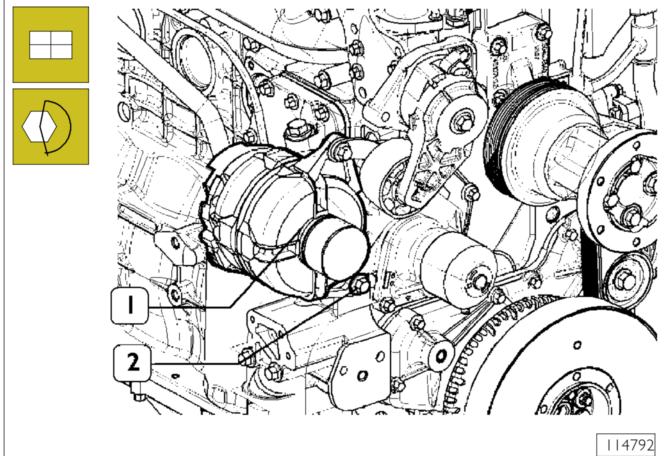


Position the alternator support (1) so that pins (3 and 4) are set against the engine block.

Tighten the screws (2) to the specified torque.

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

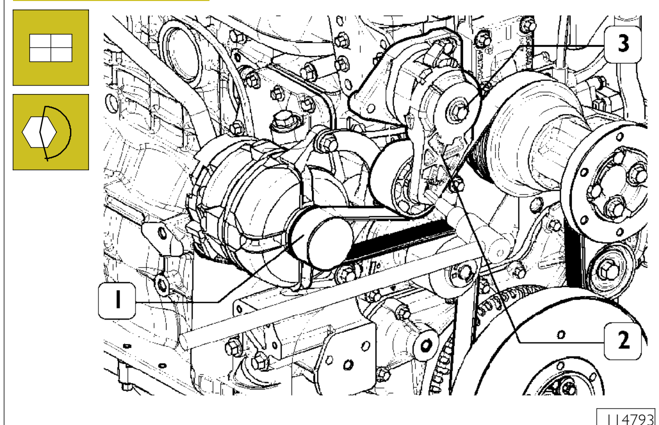
Figure 75



Refit the alternator (1).

Tighten the screw (2) to the specified torque.

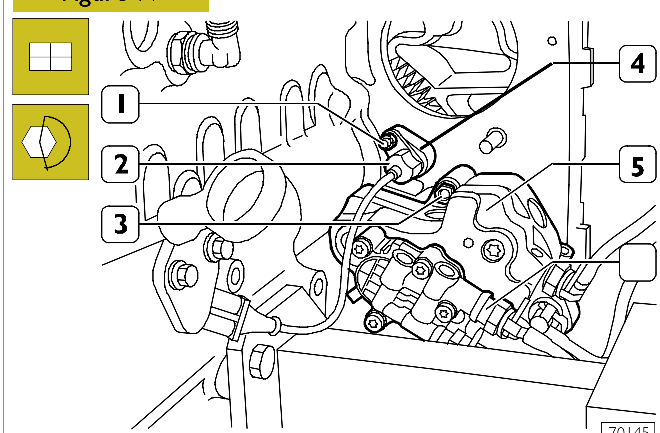
Figure 76



Refit the automatic belt tensioner (2).

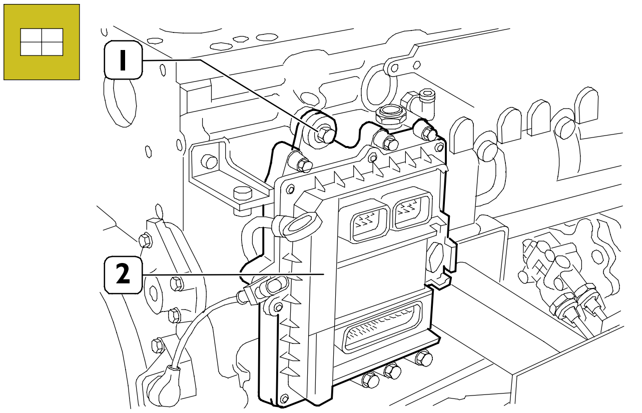
Tighten the screw (3) to the specified torque using a wrench, turn the automatic belt tensioner (2) to fit the belt (1) on pulleys and guide rollers.

Figure 77



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.

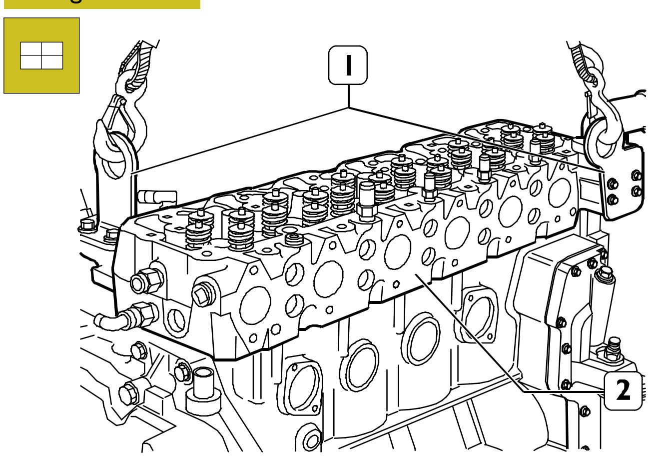
Figure 78



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.

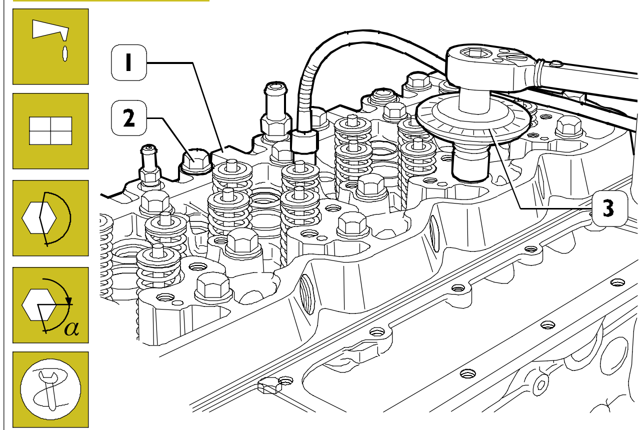
Figure 79



74779

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

Figure 80



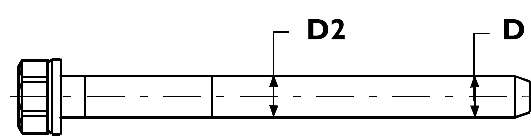
70336

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

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

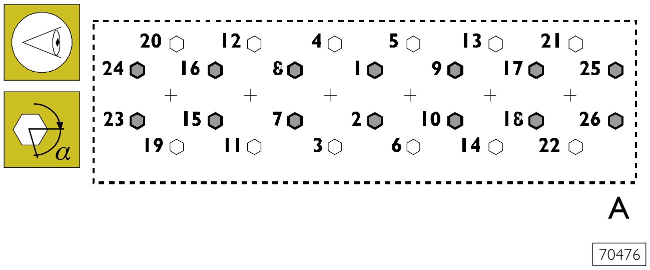
NOTE Before any assembly operation always verify that the hole and screw threads have no evidence of wear or dirt.

NOTE Before using the fixing screws again, measure them twice as indicated in the picture, checking D1 and D2 diameters:
if D1 - D2 < 0,1 mm the screw can be utilised again;
if D1 - D2 > 0,1 mm the screw must be replaced.



75703

Figure 81

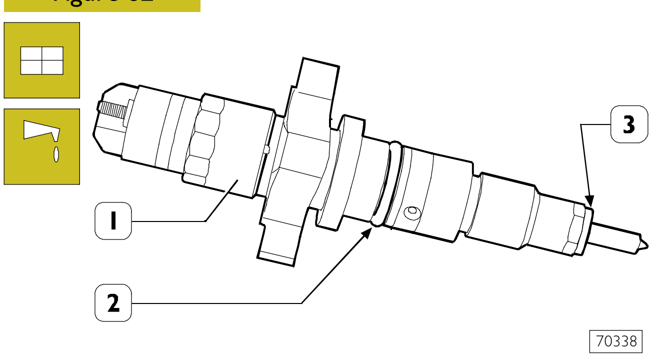


Tightening order layout for cylinder head fastening screws:

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

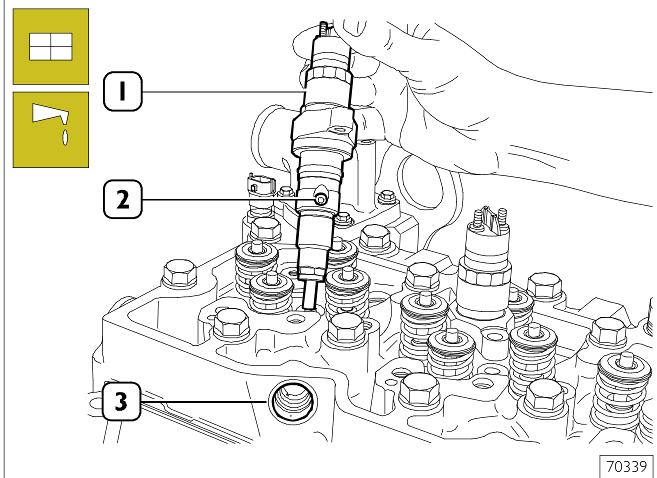
A = Front side

Figure 82



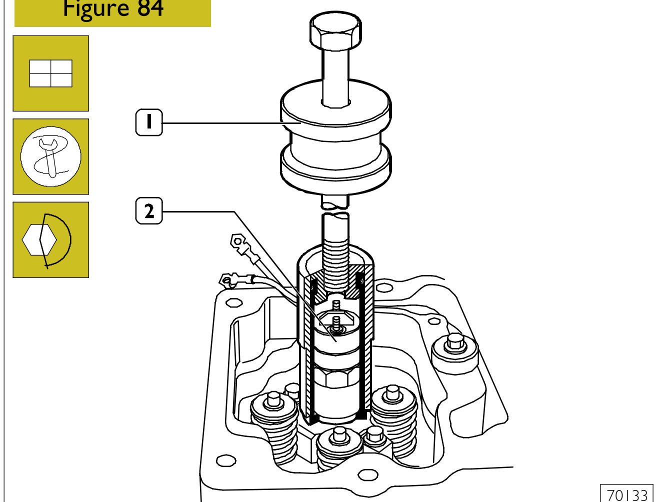
Fit a new sealing ring (2) lubricated with petroleum jelly and a new sealing washer (3) on injector (1).

Figure 83



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

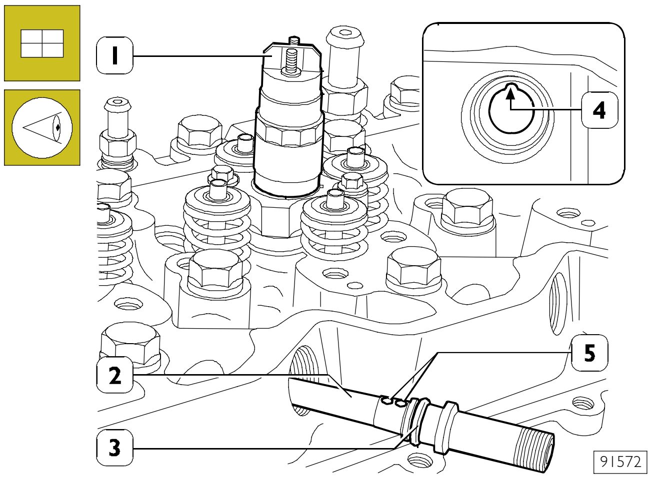
Figure 84



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

Screw injector fastening screws without tightening them.

Figure 85



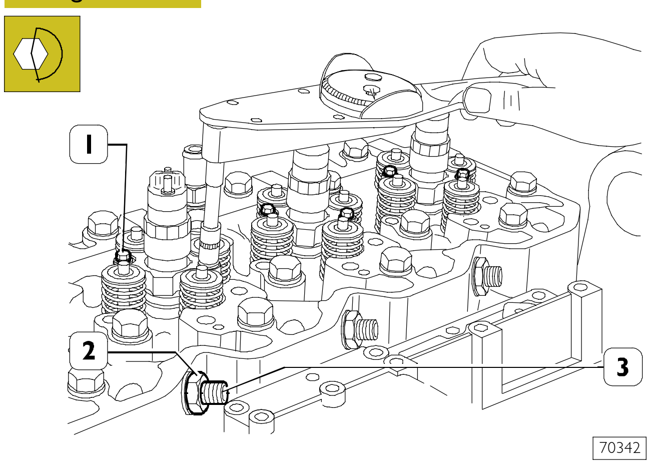
Fit a new sealing ring (3) lubricated with petroleum jelly on the fuel manifold (2) and fit it into the cylinder head seat so that the positioning ball (5) is coinciding with the relevant housing (4).

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

Screw the fastening nuts (2, Figure 86) without locking them.

NOTE During this operation, the injector (1) shall be moved so that the manifold (2, Figure 82) is properly inserted into the fuel inlet hole (2, Figure 85).

Figure 86

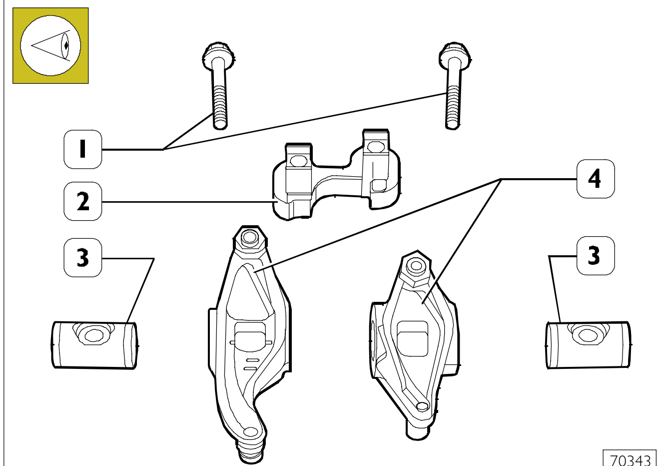


Use the torque wrench to tighten gradually and alternately the injector fastening screws (1) to 8.5 ± 0.8 Nm torque.

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

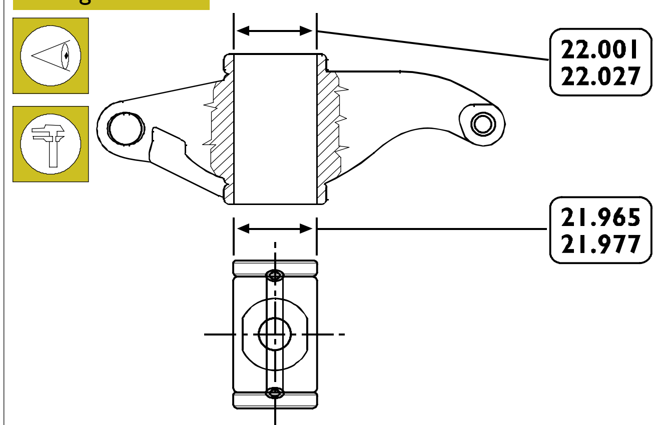
Carry out the assembly of the equalisers' unit , after previous check of the components.

Figure 87



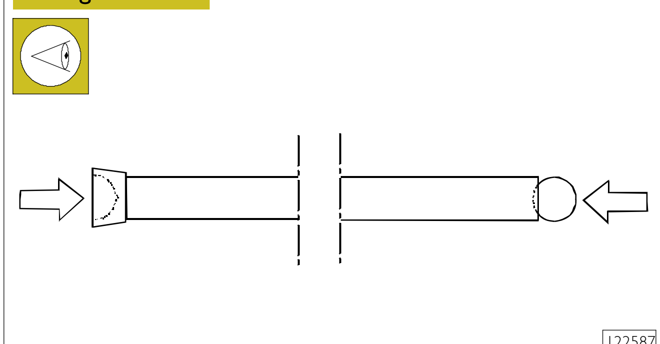
ROCKER ASSEMBLY COMPONENTS:
1. Screws - 2. Bracket - 3. Shafts - 4. Rockers.

Figure 88



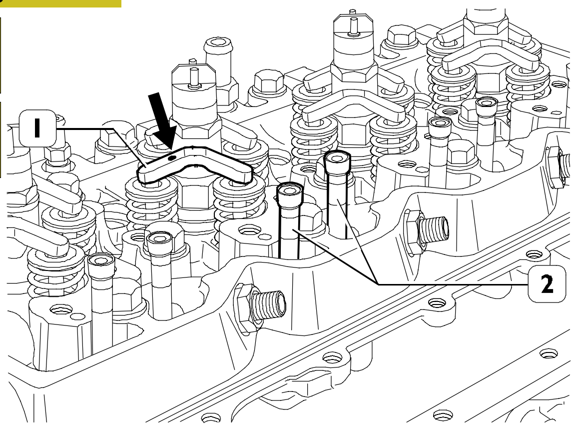
SHAFT-ROCKER MAIN DATA
Check that shaft/rocker coupling surfaces are not showing excessive wear or damages.

Figure 89



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 90

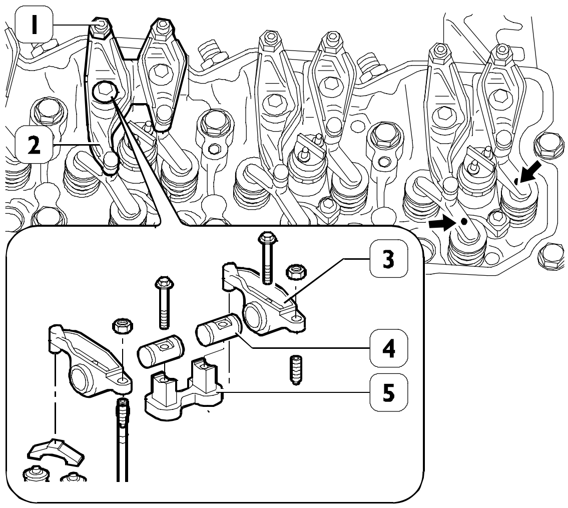


70345

Fit the rods (2).

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

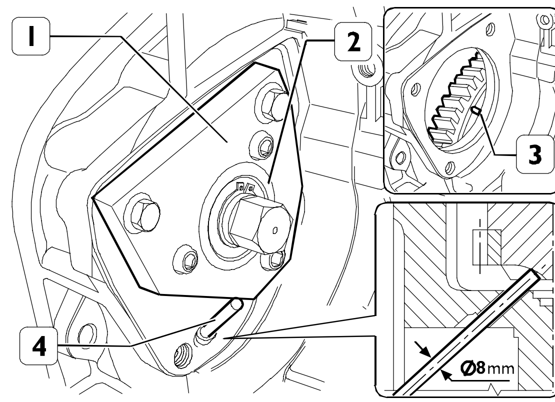
Figure 91



70346

Check that tappet adjusters (1) are loose to prevent their balking on the rods (2, Figure 90) 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.

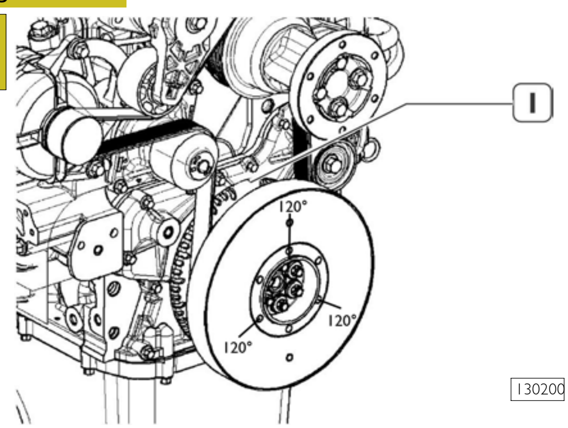
Figure 92



123031

- Fit tool 99360339 (1) in order to be able to rotate the flywheel using an Allen key.
- Place cylinder no. 1 at TDC (top dead centre) at the end of the compression stroke.

Figure 93

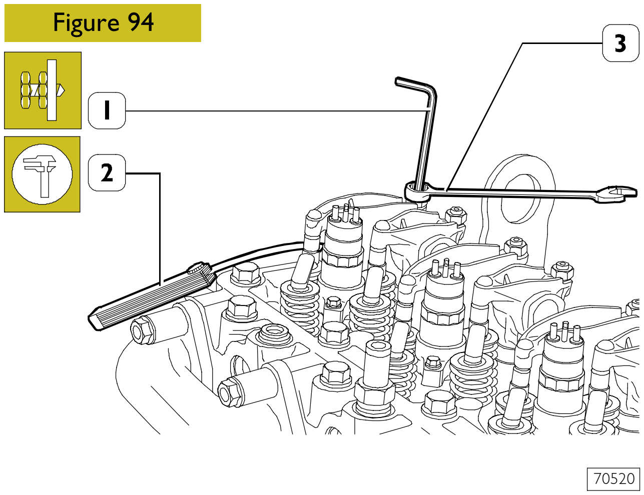


- Also check that the unperforated part (1) of the phonic wheel is positioned uppermost (cylinder n. 1 at TDC) and the valves of cylinder n. 4 are balanced. If cylinder n. 1 is balanced, rotate the engine through one revolution to obtain the specified condition.
- Adjust the clearance of cylinder n. 1's valves as indicated in the relevant paragraph.
- Now rotate the crankshaft as shown in the table to adjust the clearance of the rocker arms of the other cylinders.

FIRING ORDER:: 1 – 5 – 3 – 6 – 2 – 4

Start and crankshaft rotation	Adjusting intake and exhaust valve rocker arm clearance on cylinder n.
Cylinder n. 1 at TDC	1
Rotate through 120°	5
Rotate through 120°	3
Rotate through 120°	6
Rotate through 120°	2
Rotate through 120°	4

Figure 94

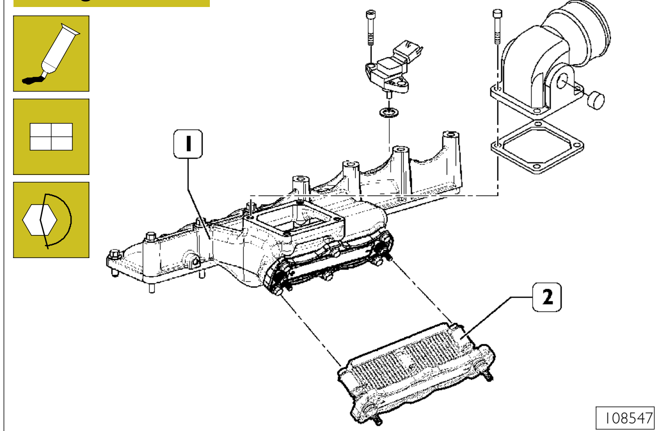


Adjust clearance between rockers and valves using setscrew wrench (1), box wrench (3) and feeler gauge (2).

Clearance shall be as follows:

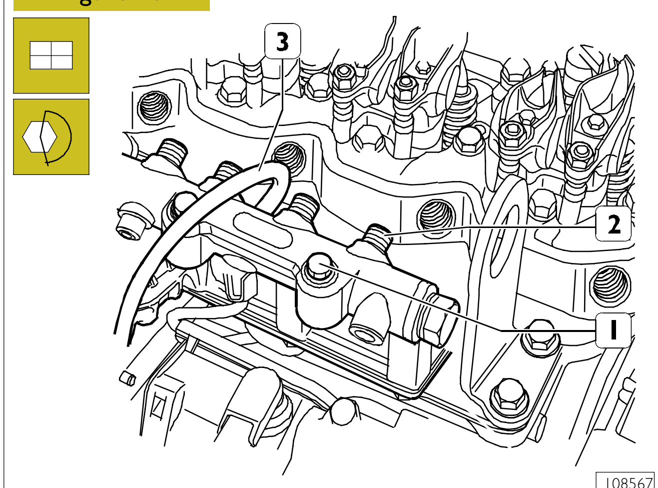
- intake valves 0.25 ± 0.05 mm
- exhaust valves 0.50 ± 0.05 mm.

Figure 95



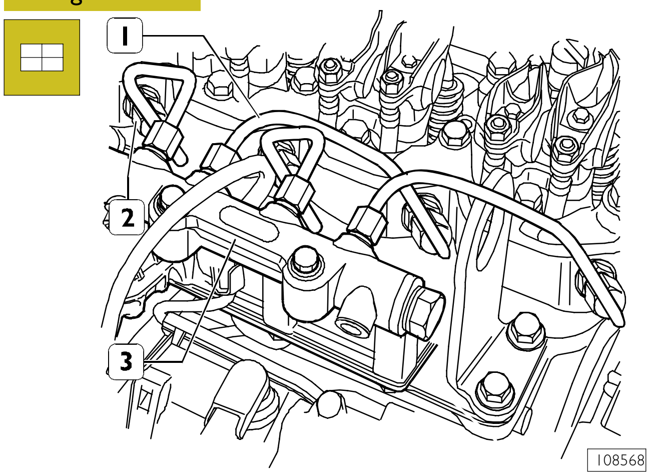
Apply to the coupling surface of the intake manifold (1) equipped with heater (2) a sufficient coat of LOCTITE 5999 and provide tightening the screws to the prescribed matching couple.

Figure 96



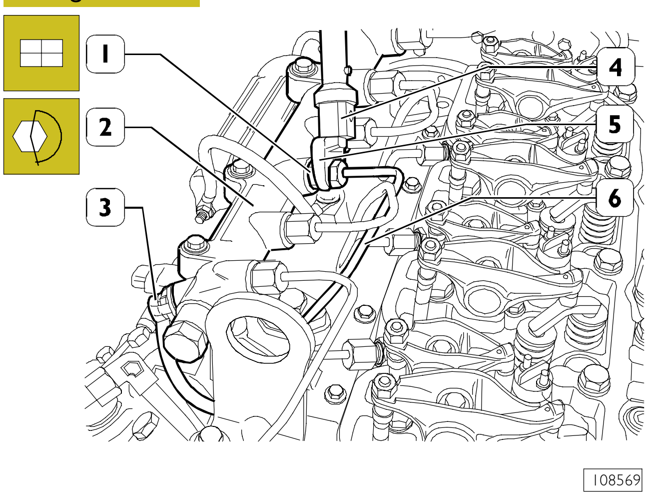
Fit the rail (2) and tighten the screws (1) to the specified torque, connect the ground cable (3) to the intake manifold (4) and tighten the fastening nut to the specified torque.

Figure 97



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

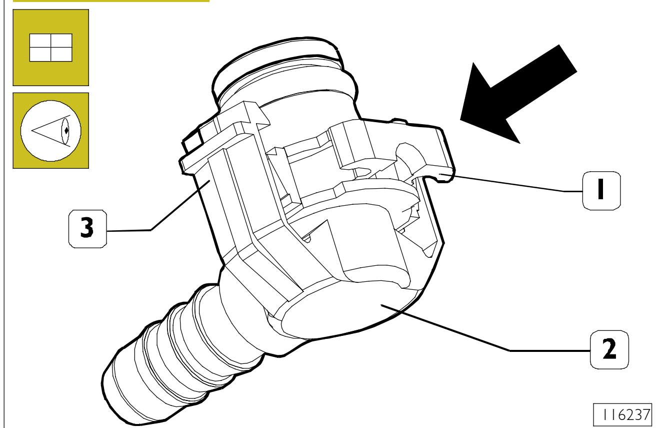
Figure 98



NOTE Pipe (7) connections shall be tightened to 20 Nm torque, using the proper wrench (5) and the torque wrench 99389829 (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.

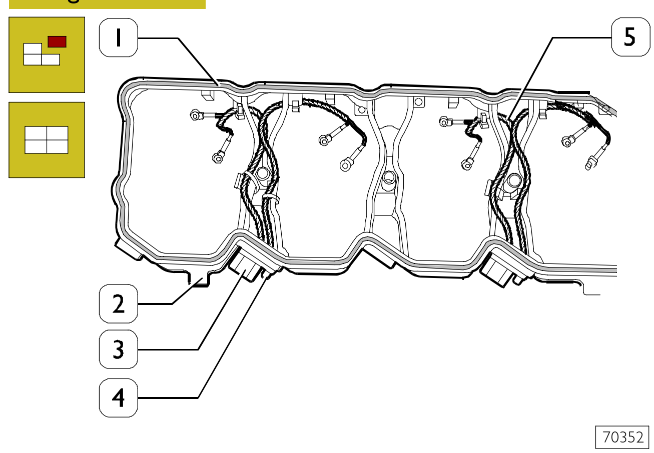
Figure 99



In order to connect the low-pressure fuel pipes to the connection joint, insert the rapid fitting joint into the latter, (2) and press until the clip fastens securely (3).

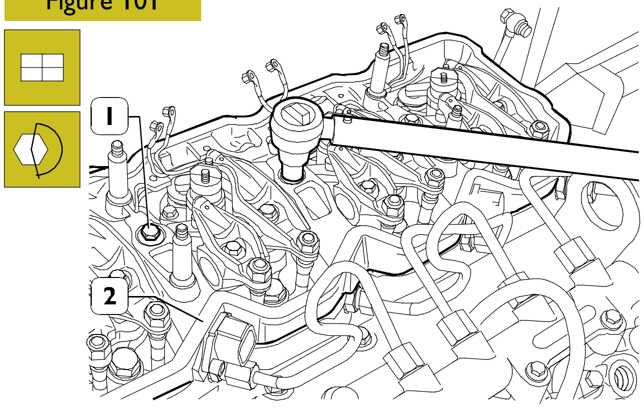
NOTE Check proper fuel pipe connection.

Figure 100



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 101

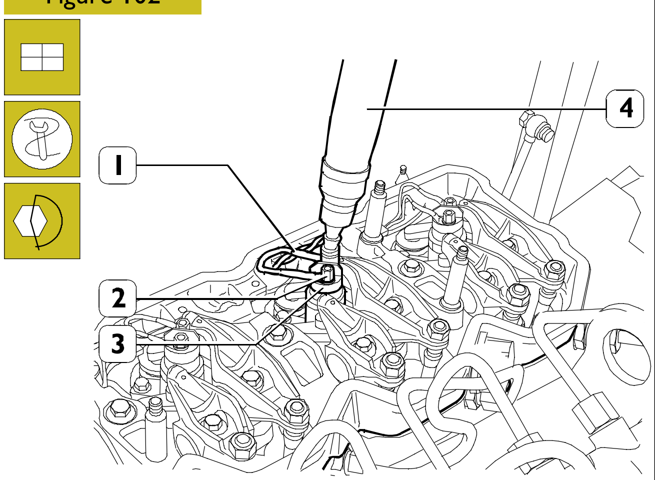


108570

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

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

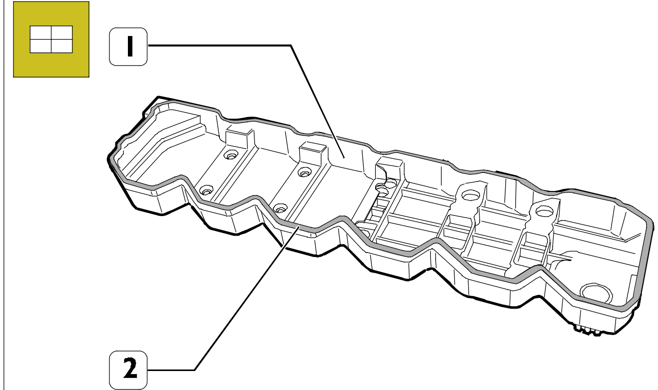
Figure 102



108571

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 103

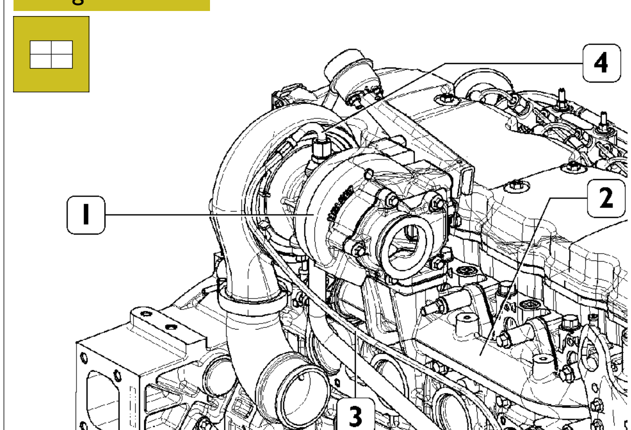


74757

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 104



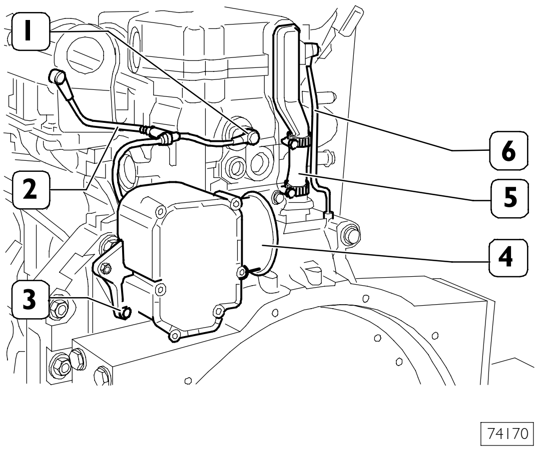
108572

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 105



If present, insert blow-by filter (4) and tighten the screws (3).

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.

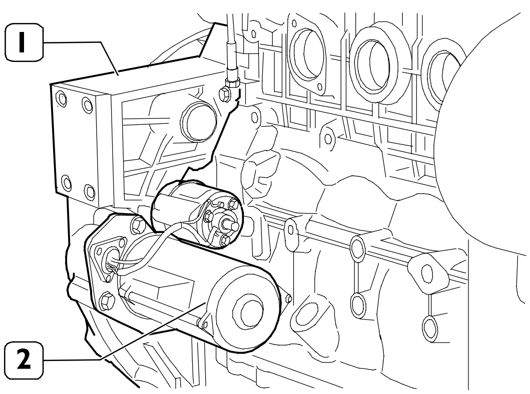
Connect the pipeline (2) to the pressure- limiter (1).

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.

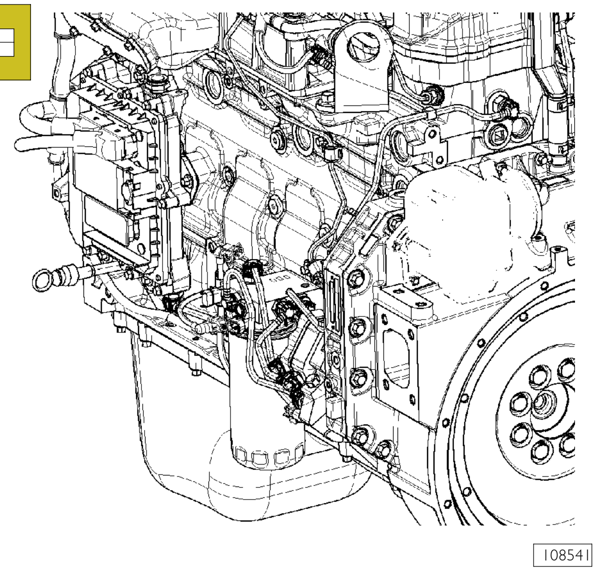
Figure 106



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

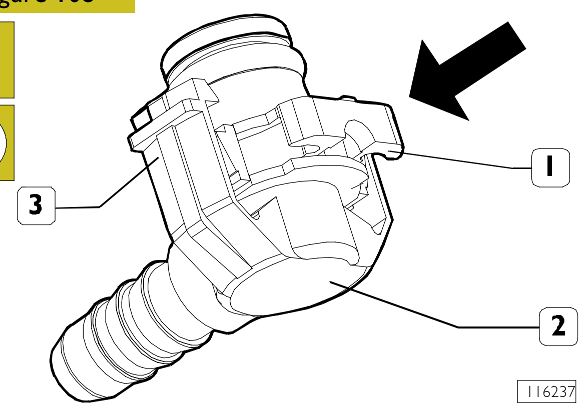
Assemble the oil feeding pipe using a new O-ring. Fix with three M12x25 screws.

Figure 107



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

Figure 108



All the low-pressure fuel pipes are fastened with clips shown in the picture.

In order to connect the low-pressure fuel pipes to the connection joint, insert the rapid fitting joint into the latter, (2) and press until the clip fastens securely (3).

NOTE 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, page 10).

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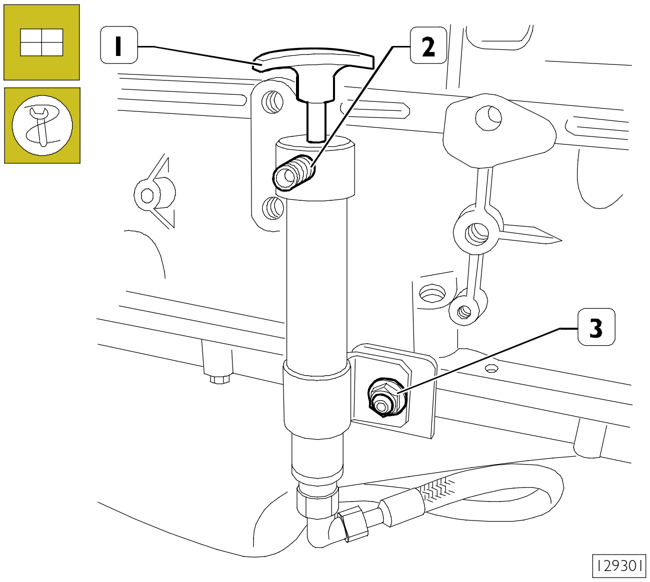
Refitting engine to radiator

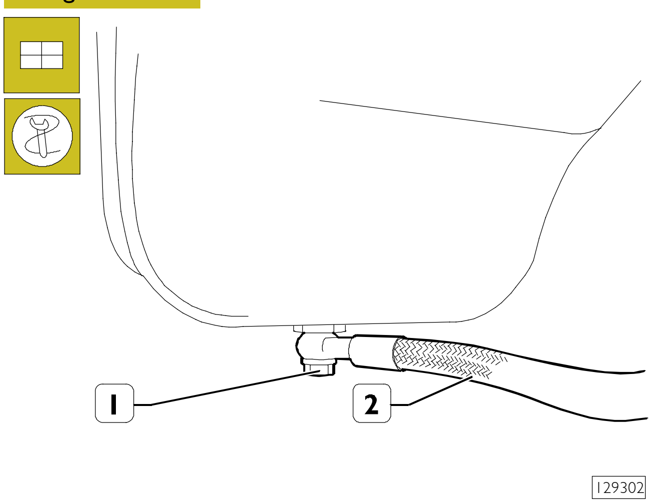
For versions with an oil drainage pump

Figure 109



- ❑ Reposition the dipstick and the oil filler plug;
- ❑ Refit the pump tightening the nut (3) to the recommended torque.

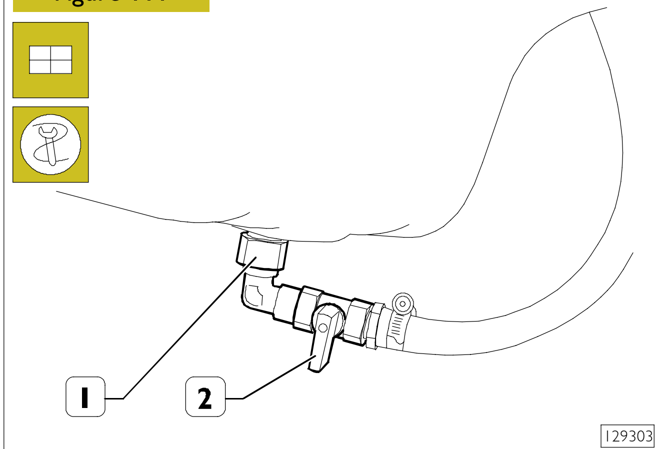
Figure 110



- ❑ Refit the pipe (2), tightening the bolt (1) to the recommended torque.

For versions with an oil drainage tap

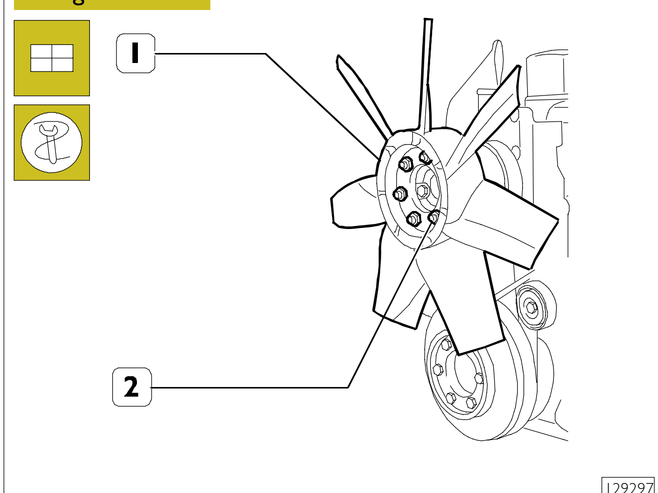
Figure 111



- ❑ Reposition the dipstick and the oil filler plug;
- ❑ Refit the pipe, tightening the bolt (2) to the recommended torque.

NOTE Some versions have a plug for draining the oil from the sump.
Proceed with closing the plug under the sump, after having repositioned the dipstick and the oil filler plug.

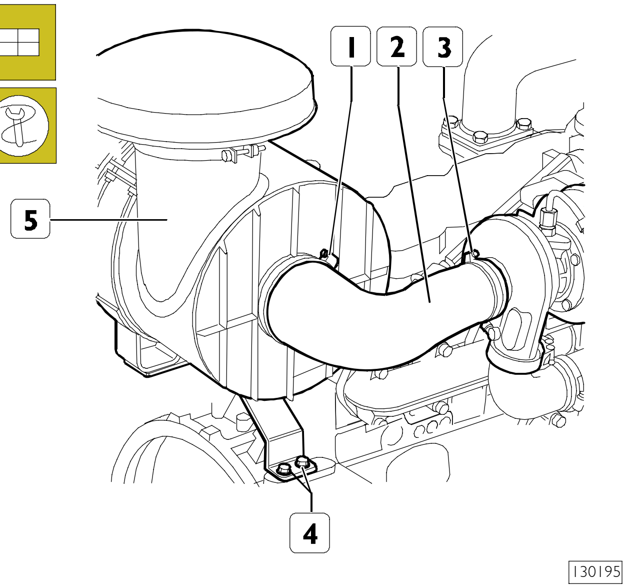
Figure 112



- ❑ Refit the fan (1), complete with spacer and tighten the bolts (2) to the recommended torque.

NOTE The shape and the size of the drainage pipe vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out. The procedures described can, however, be applied.

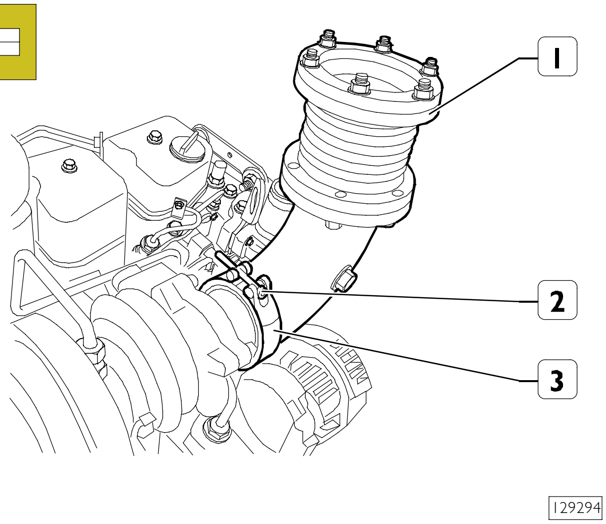
Figure 113



❑ Fit the air filter (5) complete with mounting and tighten the bolts (4) to the recommended torque.

❑ Connect and air intake pipe (2), closing the bands (1) and (3).

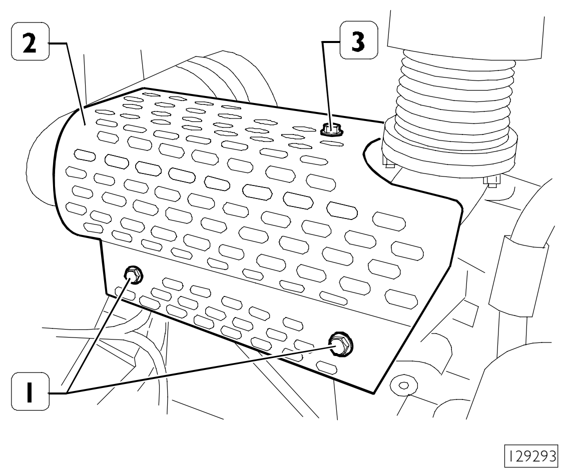
Figure 114 (Demonstrative)



❑ Connect the drainage pipe (1) tightening the bolt (2) to close the band (3).

NOTE The shape and the size of the drainage pipe vary depending on the usage of the engine.
The illustrations therefore provide guidelines for the operation to be carried out. The procedures described can, however, be applied.

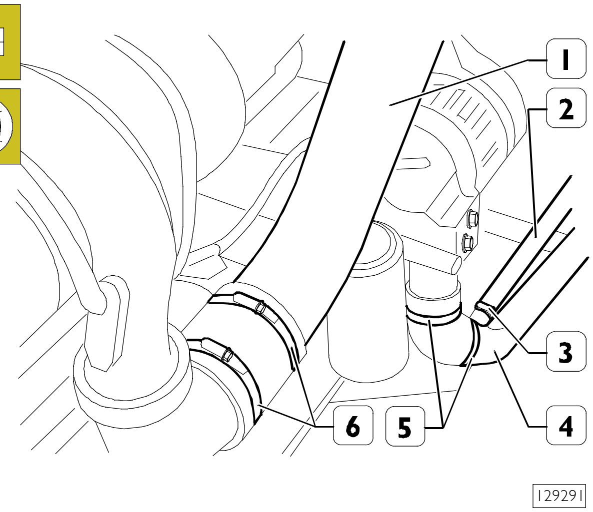
Figure 115



❑ If present, refit the turbine guard grille (2), restoring the mounting brackets and adjusting the bolts (1) and (3).

❑ Refit the radiator assembly on the crankcase, paying attention to any interference with the fan and tighten the fixing bolts on both sides to the recommended torque.

Figure 116



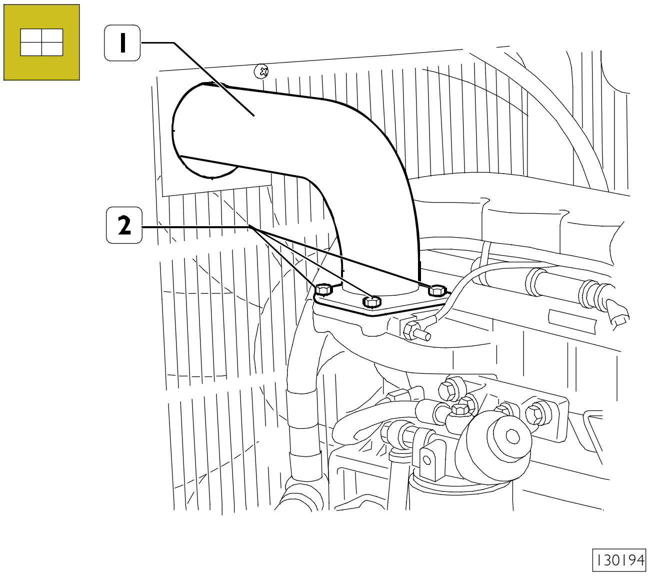
❑ Fit and pipe (4) complete with hoses, on the engine side, adjusting the bands (5).

❑ Fit the pipe (2) complete with hoses adjusting the band (3).

❑ Fit and pipe (1) complete with hoses, on the engine side, adjusting the bands (6).

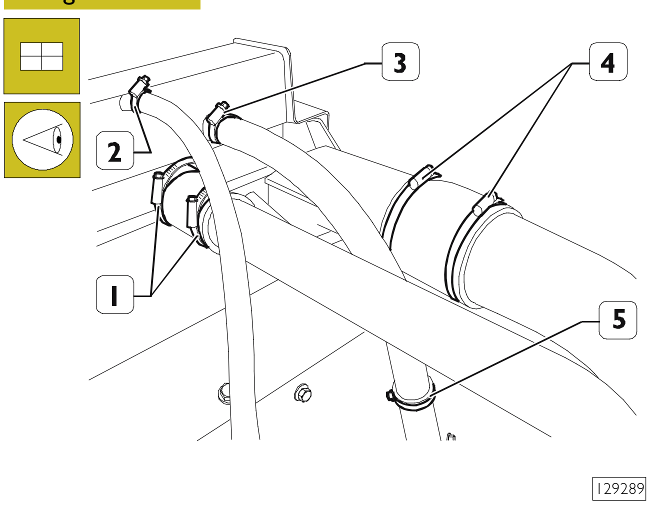
NOTE Check the rubber hoses for wear.

Figure 117



❑ Refit the pipe (1) to the intake manifold using the fixing screws (2).

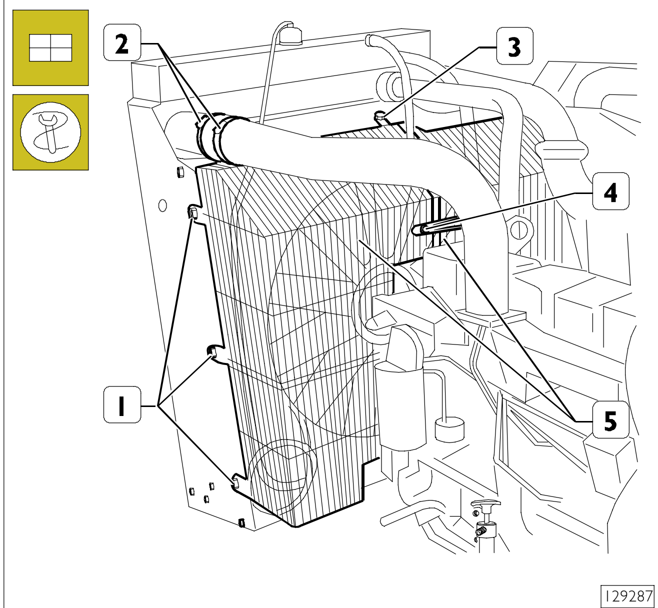
Figure 118



❑ Connect the air and water pipes to the radiator assembly adjusting the bands (1), (2), (3) and (4) and the mounting bracket (5).

NOTE Check the rubber hoses for wear.

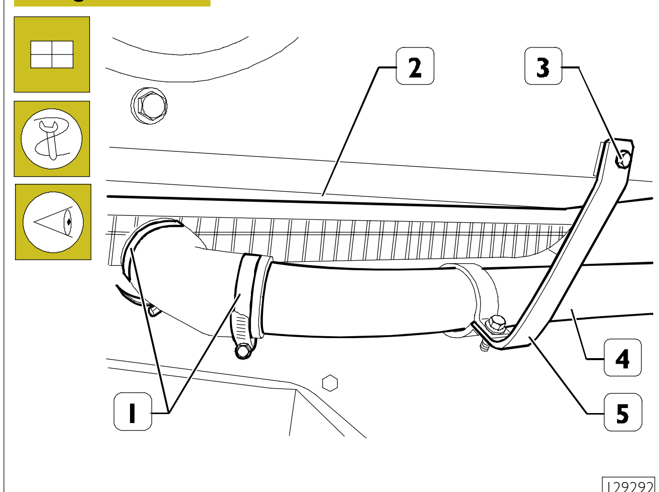
Figure 119



❑ Fit the protective grilles (5) for the fan tightening the fastenings (1), (3) and (4) to the recommended torque.

❑ Close the bands (2).

Figure 120



❑ Connect the pipe (4), complete with hoses and bracket (5) to the radiator assembly adjusting the bands (1) and tightening the bolt (3) to the recommended torque.

NOTE Check the rubber hoses for wear.

- ❑ Refit and connect the electrical wiring;
- ❑ refill the cooling system with coolant;
- ❑ bleed the air from the supply system as described in the relevant paragraph;
- ❑ check the engine oil level;
- ❑ carry out the tests and checks described in the relevant chapter.

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.

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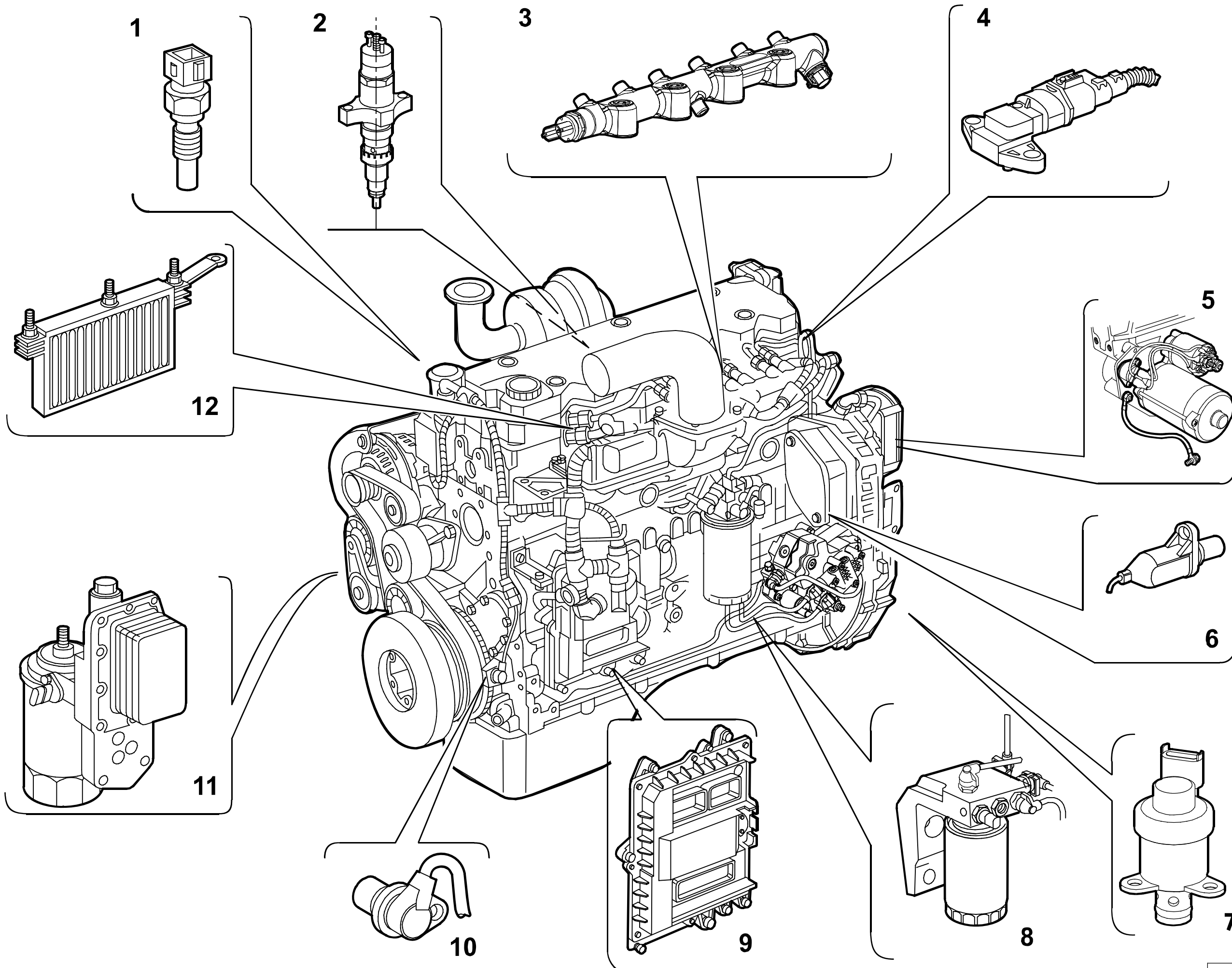
PART TWO -

ELECTRICAL EQUIPMENT

LOCATION OF MAIN ELECTRIC COMPONENTS ON ENGINE

Figure 121 (Demonstration)



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.

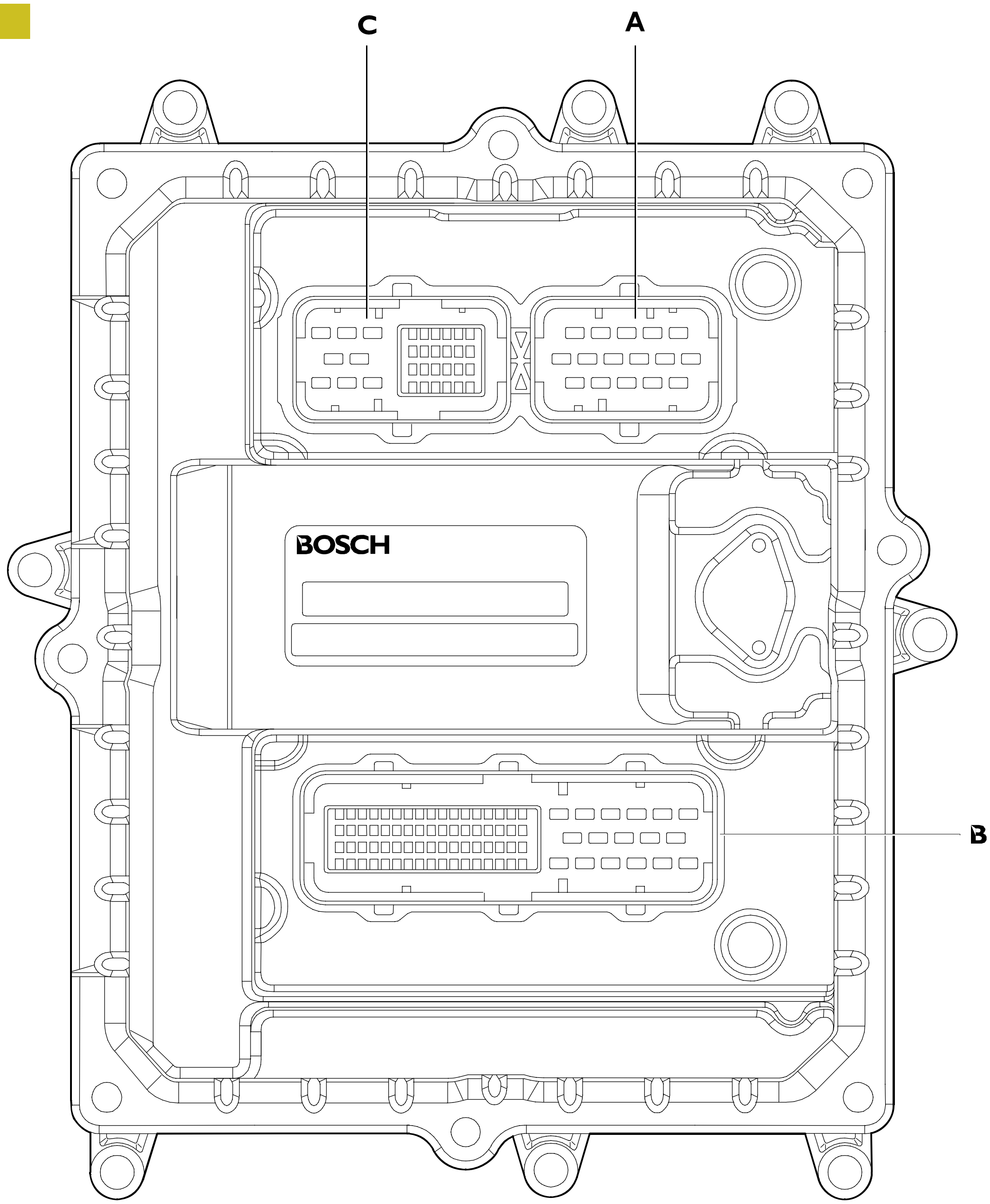
Through the engine control module it is possible to verify the correct working of the engine. (See part three of the hereby user's guide specifically dedicated to diagnostic).

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 122



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

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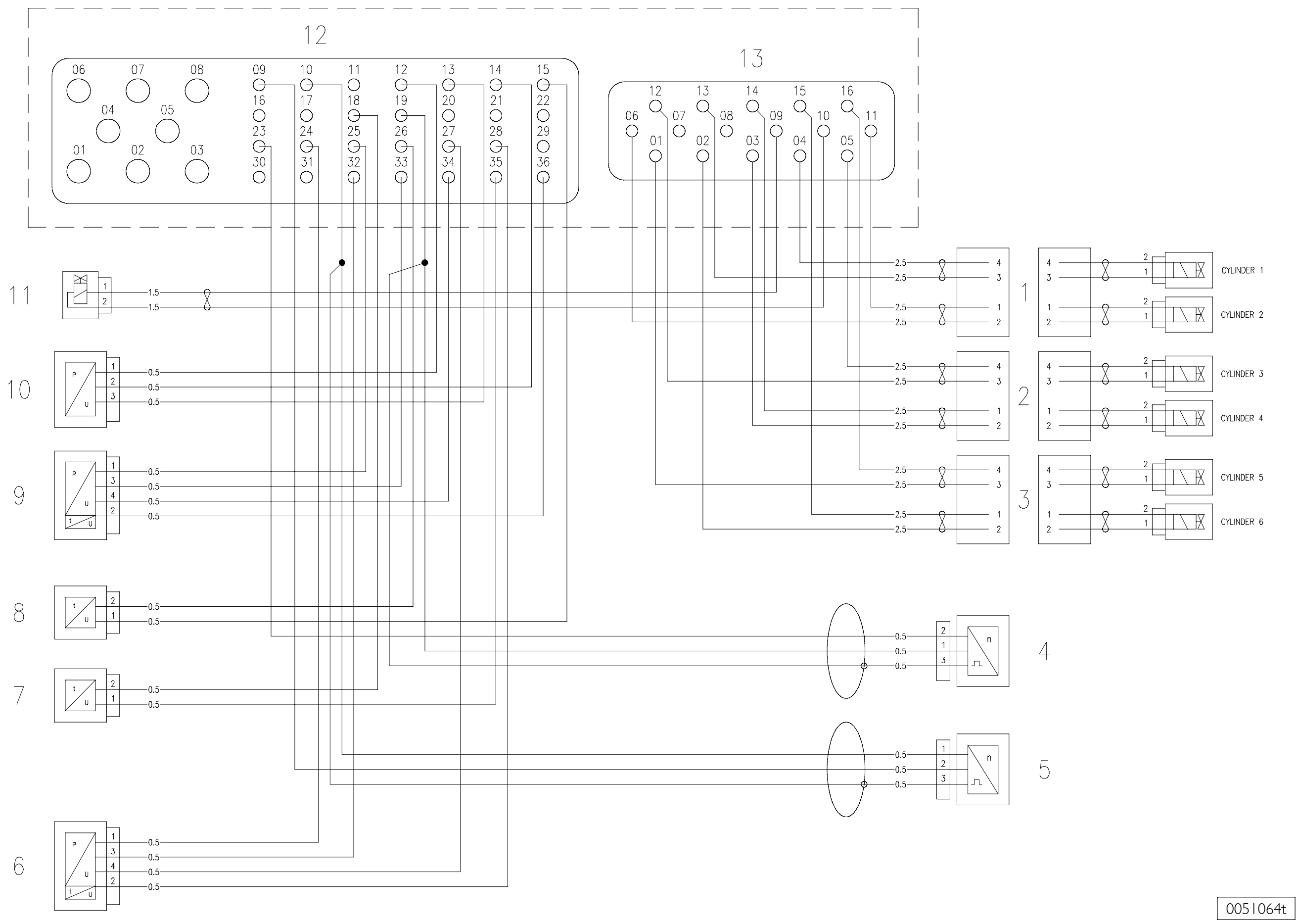
Cable on engine

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 123



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

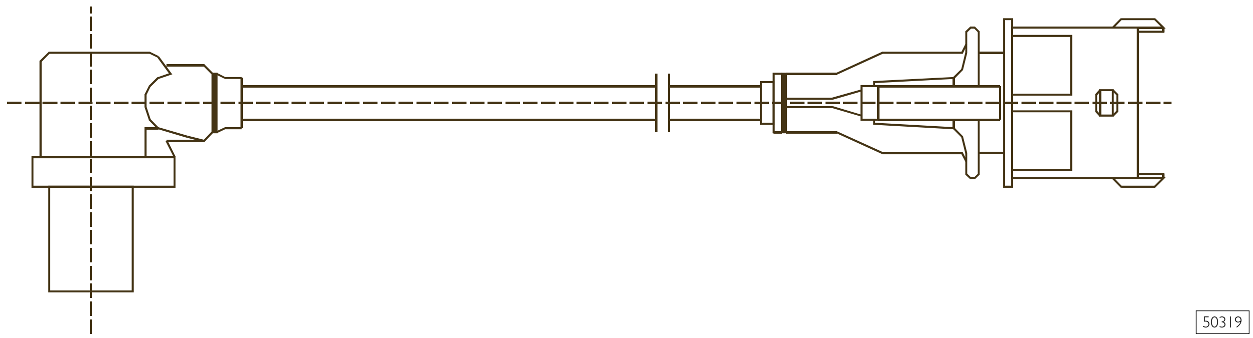
Sensors connector (C)

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 124

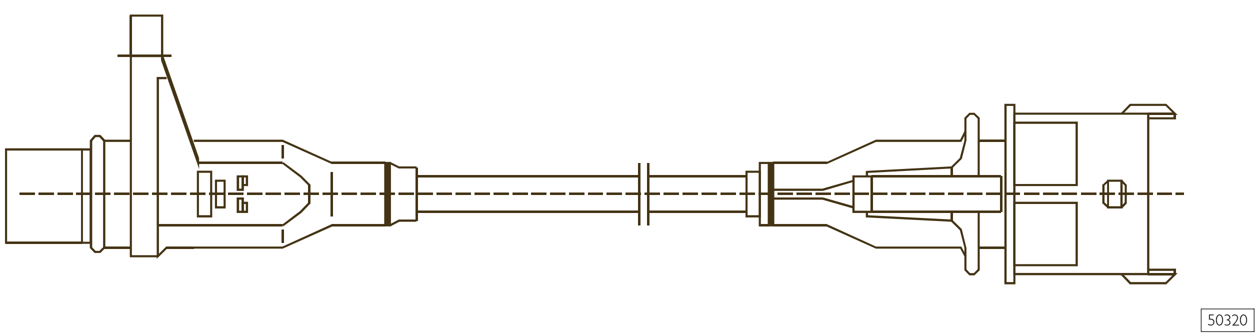


Crankshaft sensor

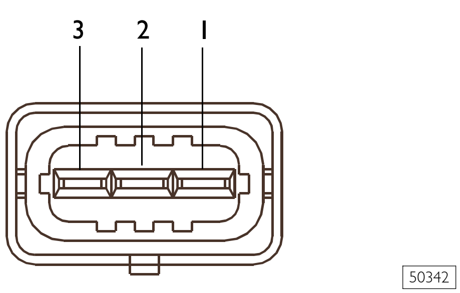
Timing sensor

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.

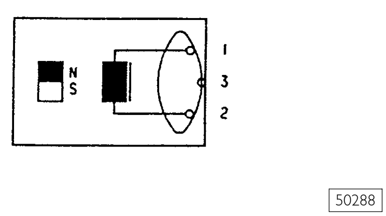
Figure 125



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.

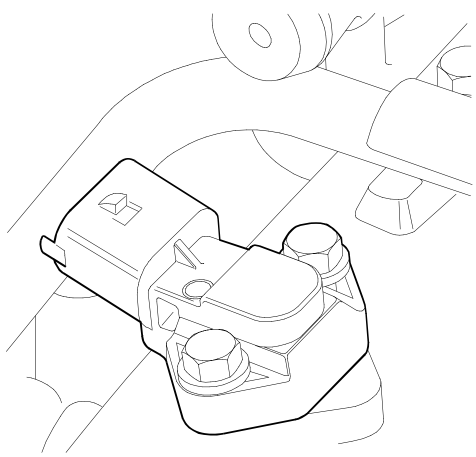
Pin 25C - 36C Temperature
Pin 33C - 34C Pressure

Engine oil temperature-pressure sensor

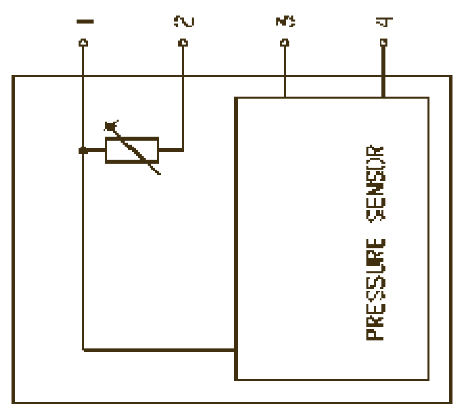
This component is analogous to the air temperature-pressure sensor.
The engine oil temperature-pressure sensor is installed on the engine oil filter support in a vertical position.
This sensor measures the engine oil temperature and pressure.
The sensor is connected to the control unit on pins 24C - 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 126



50324



50344

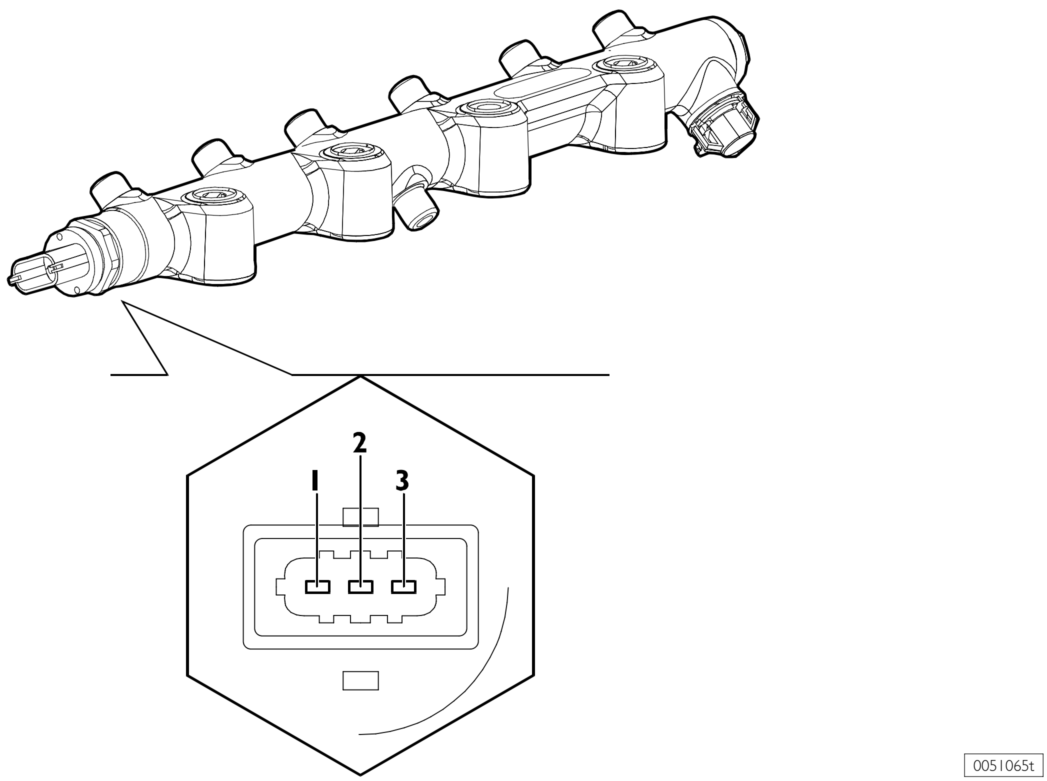
Wiring diagram

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 127



Fuel pressure sensor connector

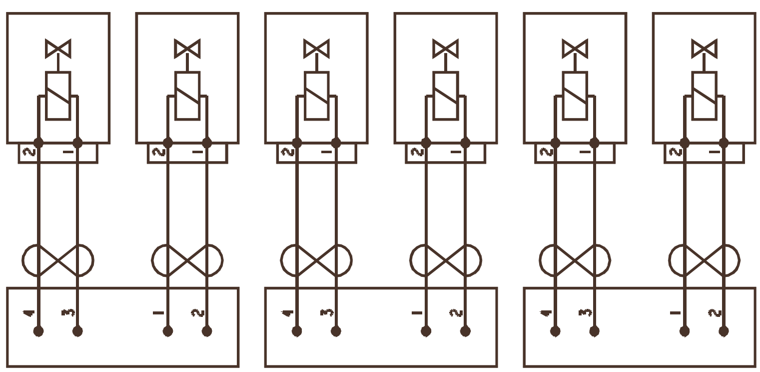
Ref.	Description	ECU pin
1	Ground	12C
2	Signal	14C
3	Power supply	13C

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.

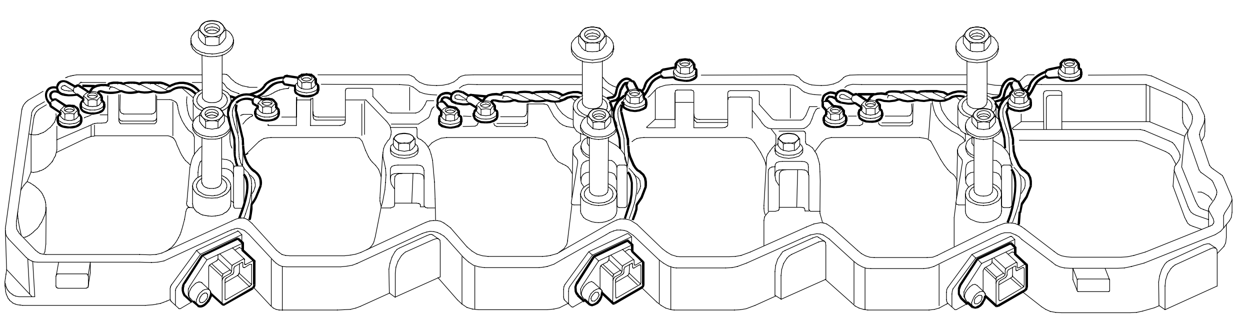
Ref.		Description	ECU pin
CONNECTOR 1	1	Cylinder 2 injector	11 A
	2	Cylinder 2 injector	6 A
	3	Cylinder 1 injector	13 A
	4	Cylinder 1 injector	4 A
CONNECTOR 2	1	Cylinder 4 injector	14 A
	2	Cylinder 4 injector	3 A
	3	Cylinder 3 injector	12 A
	4	Cylinder 3 injector	5 A
CONNECTOR 3	1	Cylinder 6 injector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

Figure 128



50343

Figure 129

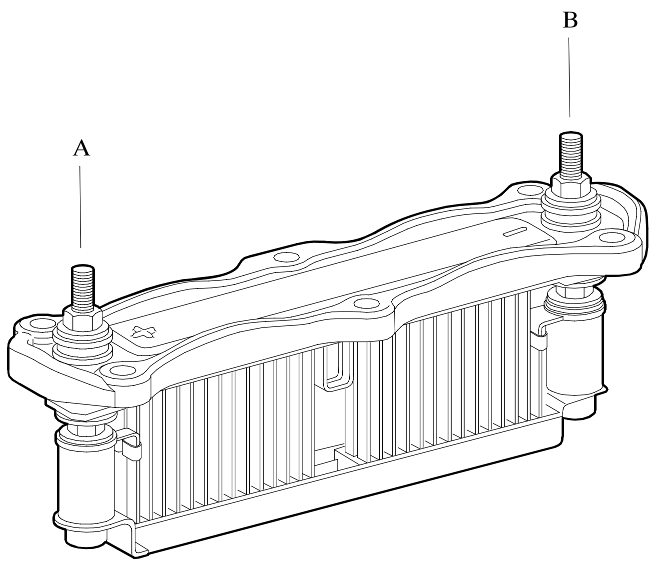


50349

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.
The resistance impedance is approximately 0.5 Ω.

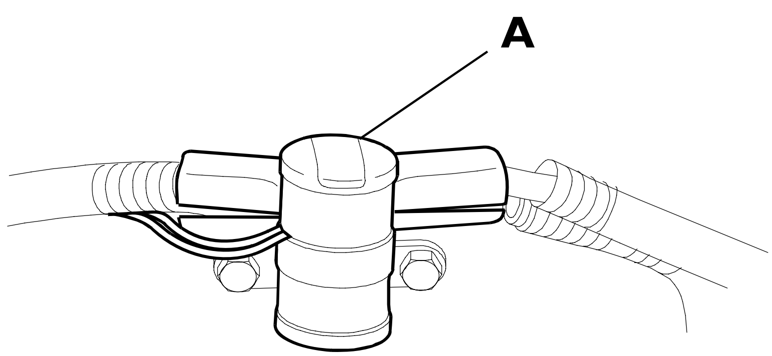
Figure 130



108909

A. - B. Connection terminals

Figure 131



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.

Do not use flammable gases or liquids to provoke the engine ignition.
These substances in contact with the resistance could easily become inflamed creating situations of serious danger.

Coolant temperature sensor

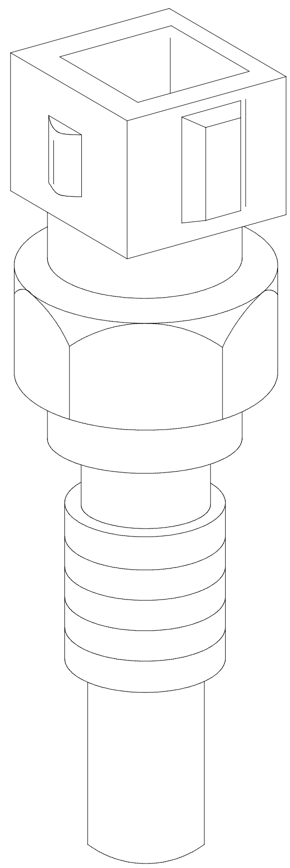
This is a variable resistance sensor able to read the coolant temperature in order to provide the control unit with an indication of the thermal status of the engine.

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 132

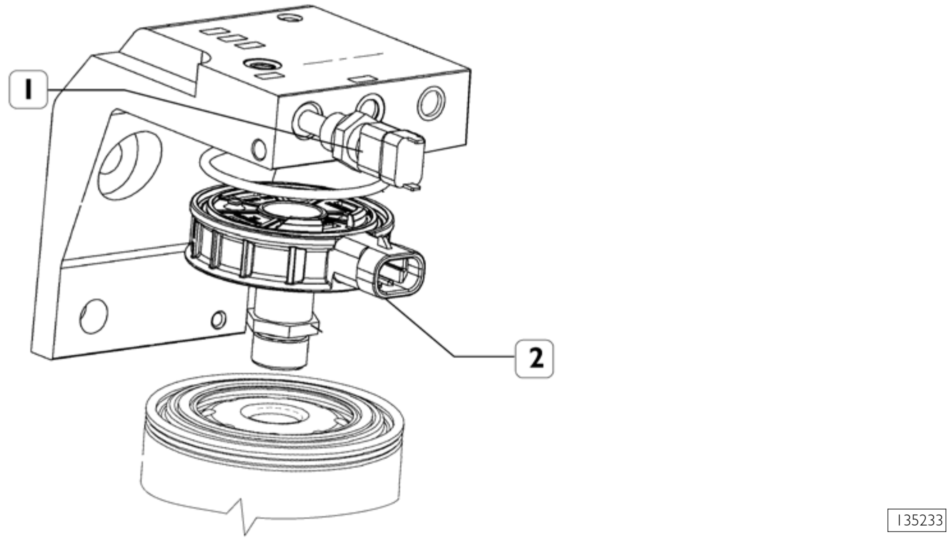


107471

Fuel temperature sensor

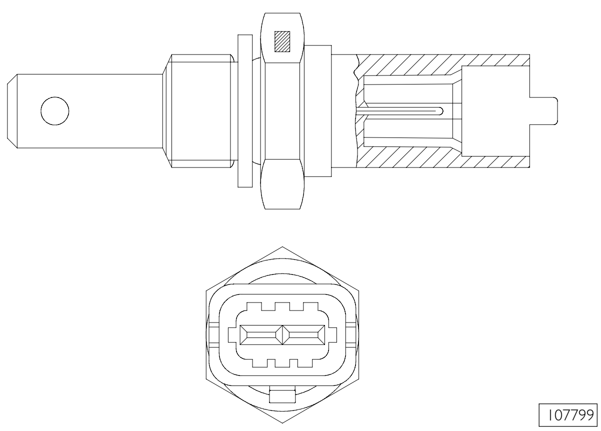
This sensor is identical to the coolant temperature sensor.
This sensor detects the fuel temperature to provide the control unit with a parameter defining the thermal status of the fuel.
The fuel temperature sensor is connected to the control unit on pins 35C -18C.
The sensor impedance at 20 °C is approximately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

Figure 133

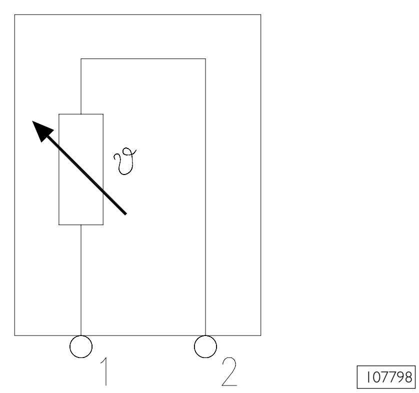


1. Fuel temperature sensor - 2. Filter heating resistance.

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



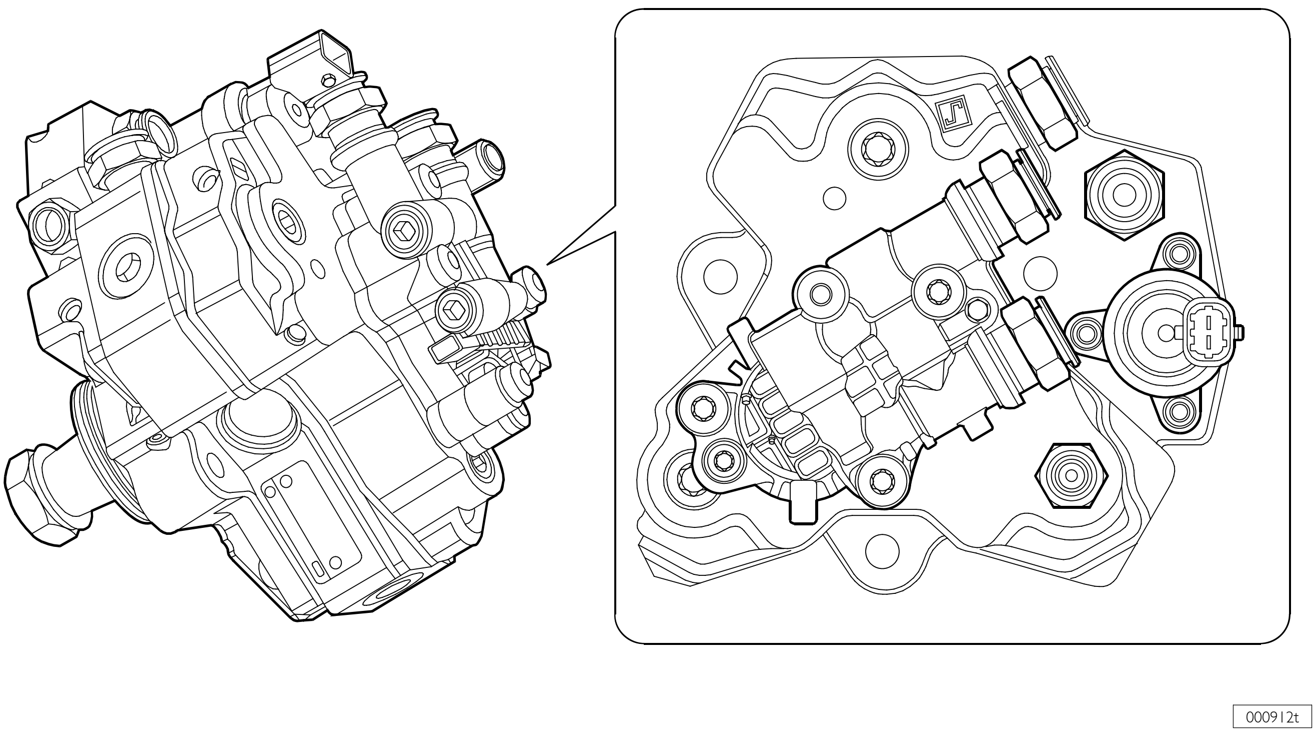
Connector



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

High pressure pump - pressure regulator

Figure 134



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 - TROUBLESHOOTING

PREFACE

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

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

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

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

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

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

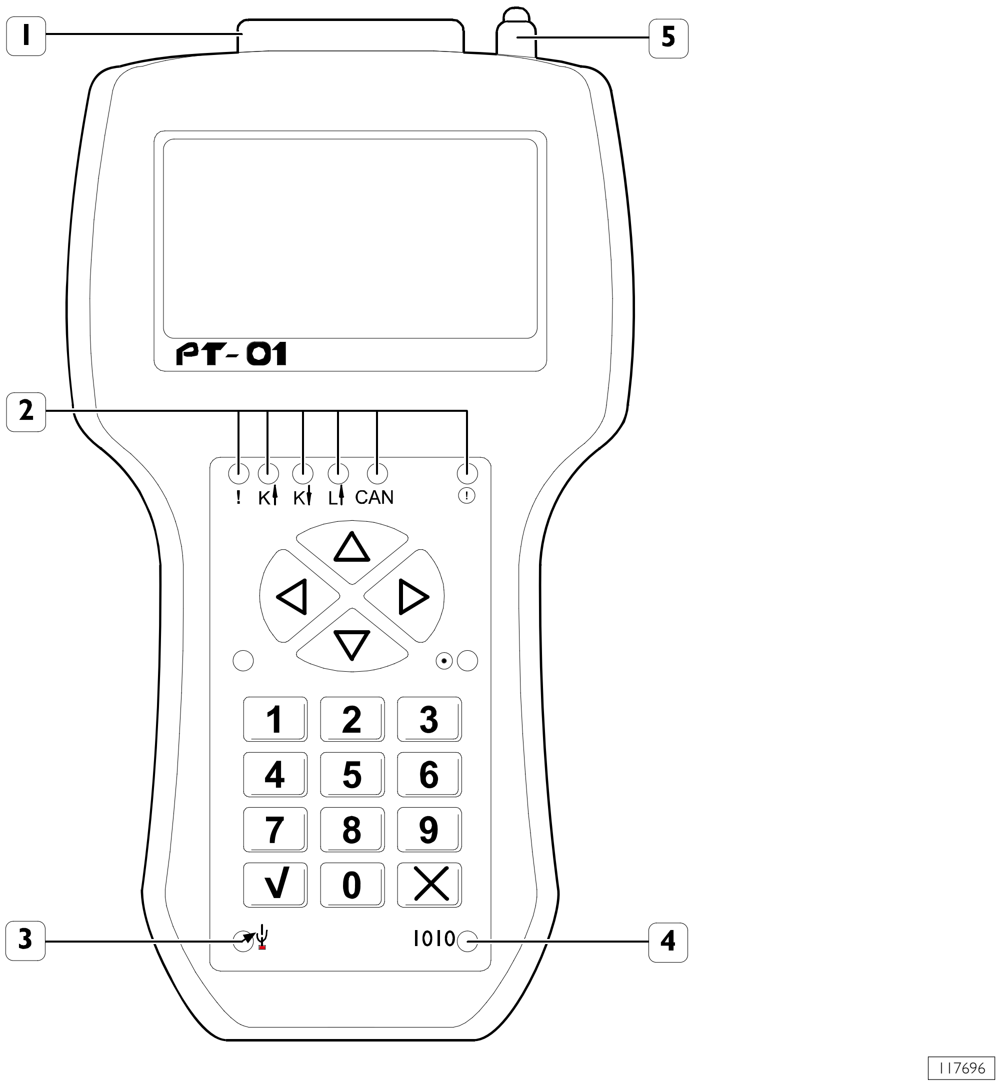
Any unauthorized tamper will involve decay of after-sales service in warranty.

DIAGNOSTIC EQUIPMENT

PT-01

PT-01 tester should be used with a Laptop but can be also used singly.

Figure 135



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

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

- ECU ID reading;
- Failure memory reading;
- Flight recorder reading;
- Parameters reading;
- Failure memory cleaning;
- Active diagnosis: actuators activation/testing

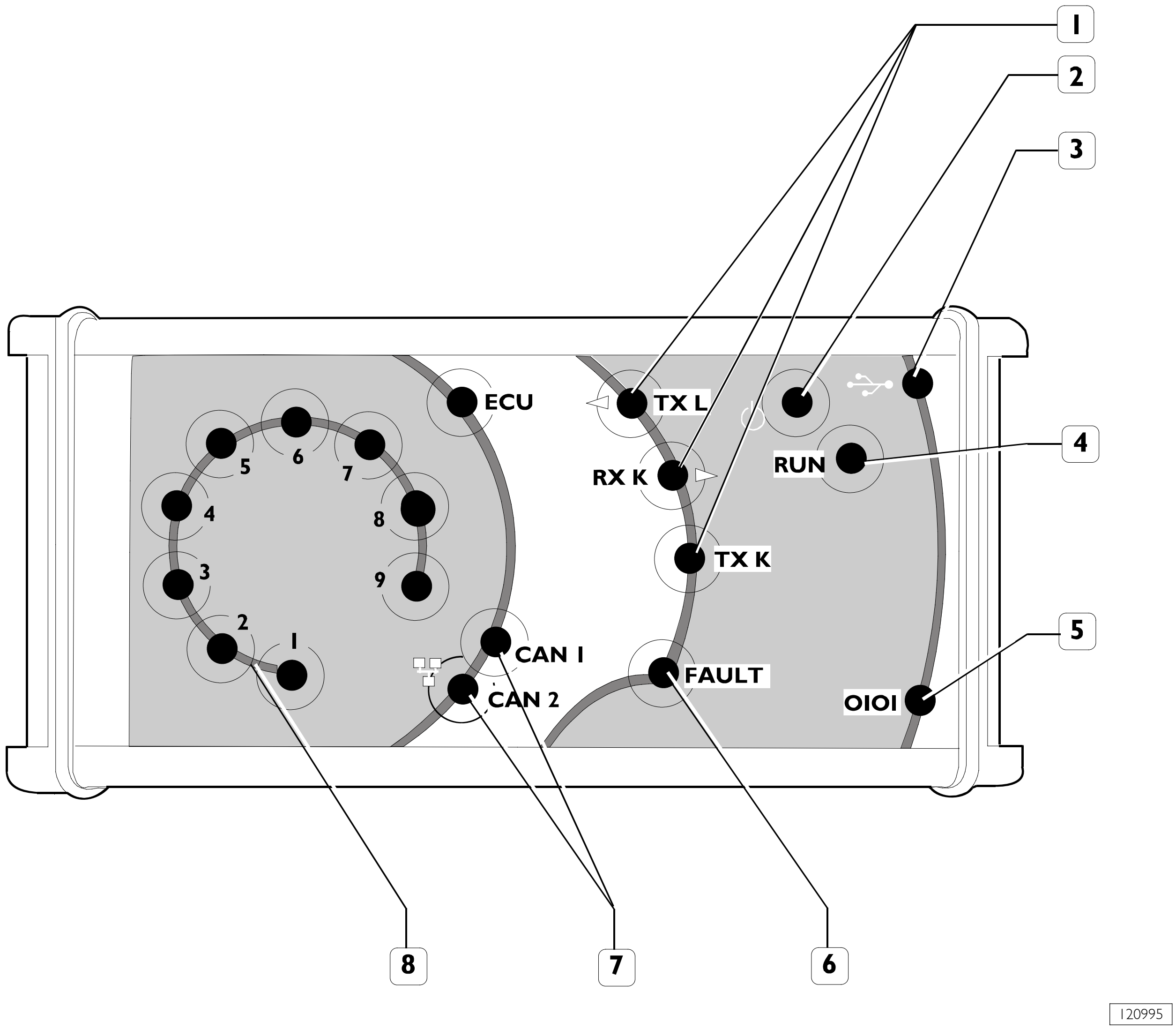
Operation without a personal computer

When the connection between the instrument and the diagnosis socket has been establish, the instrument displays the available applications.
Select the application on the numerical keyboard (0 ÷ 9) and confirm with . ☑

PT - BOX

PT - BOX is a test tool to be connected to a Personal Computer .

Figure 136



1. Data flow lamps (blinking) - 2. Ignition indicator - 3. USB indicator - 4. Operation indicator - 5. Serial port indicator - 6. "Error" indicator - 7. CAN line indicator - 8. Line K indicator for automatic management

With the PT-BOX you can perform:

- Basic testing: central unit ID reading, failure memory reading, parameter reading, failure memory clearing and "Flight Recorder" memory reading;
- Active testing: main component testing (actuators, contactors, etc..);
- "Flight Recorder" reading;
- ECU acknowledgement of replaced electronic components;
- 2nd level and PTO programming;
- Parameter acquisition during operation tests.

FAULT CODES

NOTE The fault codes depend on the application, therefore some may never be displayed during diagnosis.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
	00	00			Insufficient fuel level in the tank.	Check the fuel level	The possible grade of smoke is due to the fact that, in case of insufficient fuel, the gearcase tries to compensate by extending the excitation time of the injectors; when the fuel arrives too much of it is used.
	00	00			Fuel suction pipe in the tank partially clogged due to impurities or distortion caused by overheating.	Check whether the priming pump on the prefilter works properly. If the pump knob remains sucked downwards because of the suction pressure, disassemble and check the tank suction pipe. If the suction pipe is all right, replace the prefilter.	In case some shavings have been sucked (due to works carried out by the producer on the fuel tank) perform an accurate cleaning of the tank. As a matter of fact the problem might occur again because of other shavings remained inside the tank.
	00	00			Air intake upstream of the fuel gear pump.	Check the O-Rings and the proper connection of the pipe unions between the tank and the fuel pump (fasteners must be out and unions well hooked).	
	00	00			Fuel leaks from the unions or low- pressure pipes downstream of the fuel pump.	Check the O-Rings and the proper connection of the pipe unions downstream of the fuel pump (fasteners must be out and unions well hooked). Check visually that the low-pressure pipes are not damaged.	Unless the leak is significant, no performance anomalies are detected To check that the O-Rings are all right, extract the fuel return piping from the tank, plug its end hermetically and operate the priming pump by pressurizing the low pressure circuit.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
	00	00			Excessive fuel blow-by from rail overpressure valve.	Disconnect the fuel return piping and check visually if there is significant blow-by from the overpressure valve.	
	00	00			Signal from key to gearcase EDC cuts off.	Check the wiring.	
	00	00			Fuel filter clogged.	Replace the fuel filter.	Remove the cause of the filter clogging (empty and clean the tank and the part of hydraulic circuit upstream of the filter, perform a replenishment with clean fuel).
	00	00			Inefficient high-pressure pump.	Engine test with diagnostic instrument.	Replace the high-pressure pump after having excluded all the other possible causes.
	00	00			Injector with shutter or solenoid core (mechanical part) locked in open position.	Engine test with PT-BOX. In case of lack of diagnostic instruments, the injector not working is easily detectable feeling by hand the absence of pulsations in the relevant high pressure pipe.	
	00	00			Injector locks in open position (now and then).	In case of lack of diagnostic instruments, the injector not working is detectable feeling by hand the absence of pulsations in the relevant high pressure pipe.	

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
	00	00			Injector locked in open position (irreversibly).	In case of lack of diagnostic instruments, the injector not working is detectable feeling by hand the absence of pulsations in the relevant high pressure pipe.	Generally, in presence of these symptoms, it is instinctive to give up starting the engine. By keeping on trying, however, it is possible to start the vehicle in order to reach an FPT workshop. By insisting the engine starts with one cylinder missing and little by little the grade of smoke decreases and it disappears.
	00	00			Injector locked in closed position.	In case of lack of diagnostic instruments, the injector not working is detectable feeling by hand the absence of pulsations in the relevant high pressure pipe.	
	00	00			Significant fuel blow-by inside the cylinder head from one or more high pressure pipes and almost total absence of pressure in the rail.	After having excluded all the other system electrical/electronic anomalies, disconnect (from the filter support) the injector blow-by return piping, put its end in a transparent container and try starting. If the fuel flow in the injector return is significantly much higher than the normal one, and at the same time the parameter reading displays the lack of pressurization of the rail, replace the damaged high pressure pipe.	This problem might be due to the lack of replacement of a pipe after disassembling, or to a wrong assembly of the pipe that have damaged its sealing end on the injector. After having positioned a new pipe in its seat (with the injector fastening screws loosen), it is necessary to progressively and alternatively tighten to the prescribed torque the injector screws and the pipe ring nut, making sure to ease the correct mating of the pipe end with the fuel arrival seat in the injector.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - COOLANT TEMPERATURE	02	00	NO AVAILABLE SYMPTOM	Indication on the water temperature instrument fixed at limit stop and pilot light lighted up.	Positively short-circuited, ground-short-circuited or open-circuited water tem?perature sensor	Reading of measurable parameters: in presence of this error, the water temperature read on the gearcase will be the same of the engine oil one. Check by means of a multimeter that the sensor is all right (R = approx. 2,5 kOhm at 20 °C) between pins 1 and 2 of sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C18, between sensor connector (wiring side) pin 2 and connector EDC pin C36.	EDC pilot light on.
SENSORS - COOLANT TEMPERATURE	02	01	SHORT CIRCUIT TO POSITIVE	Indication on the water temperature instrument fixed at limit stop and pilot light lighted up.	Positively short-circuited, ground-short-circuited or open-circuited water tem?perature sensor	Reading of measurable parameters: in presence of this error, the water temperature read on the gearcase will be the same of the engine oil one. Check by means of a multimeter that the sensor is all right (R = approx. 2,5 kOhm at 20 °C) between pins 1 and 2 of sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C18, between sensor connector (wiring side) pin 2 and connector EDC pin C36.	EDC pilot light on.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - COOLANT TEMPERATURE	02	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Indication on the water temperature instrument fixed at limit stop and pilot light lighted up.	Positively short-circuited, ground-short-circuited or open-circuited water tem?perature sensor	Reading of measurable parameters: in presence of this error, the water temperature read on the gearcase will be the same of the engine oil one. Check by means of a multimeter that the sensor is all right (R = approx. 2,5 kOhm at 20 °C) between pins 1 and 2 of sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C18, between sensor connector (wiring side) pin 2 and connector EDC pin C36.	EDC pilot light on.
SENSORS - COOLANT TEMPERATURE	02	03	NO SIGNAL	Indication on the water temperature instrument fixed at limit stop and pilot light lighted up.	Positively short-circuited, ground-short-circuited or open-circuited water tem?perature sensor	Reading of measurable parameters: in presence of this error, the water temperature read on the gearcase will be the same of the engine oil one. Check by means of a multimeter that the sensor is all right (R = approx. 2,5 kOhm at 20 °C) between pins 1 and 2 of sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C18, between sensor connector (wiring side) pin 2 and connector EDC pin C36.	EDC pilot light on.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - COOLANT TEMPERATURE	02	04	SIGNAL NOT PLAUSIBLE	Indication on the water temperature instrument fixed at limit stop and pilot light lighted up.	Positively short-circuited, ground-short-circuited or open-circuited water tem?perature sensor	Reading of measurable parameters: in presence of this error, the water temperature read on the gearcase will be the same of the engine oil one. Check by means of a multimeter that the sensor is all right (R = approx. 2,5 kOhm at 20 °C) between pins 1 and 2 of sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C18, between sensor connector (wiring side) pin 2 and connector EDC pin C36.	EDC pilot light on.
SENSORS - COOLANT TEMPERATURE	02	05	SUPPLY OVER THE NORMAL RANGE	Indication on the water temperature instrument fixed at limit stop and pilot light lighted up.	Positively short-circuited, ground-short-circuited or open-circuited water tem?perature sensor	Reading of measurable parameters: in presence of this error, the water temperature read on the gearcase will be the same of the engine oil one. Check by means of a multimeter that the sensor is all right (R = approx. 2,5 kOhm at 20 °C) between pins 1 and 2 of sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C18, between sensor connector (wiring side) pin 2 and connector EDC pin C36.	EDC pilot light on.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - COOLANT TEMPERATURE	02	06	SUPPLY BELOW THE RANGE	Indication on the water temperature instrument fixed at limit stop and pilot light lighted up.	Positively short-circuited, ground-short-circuited or open-circuited water tem?perature sensor	Reading of measurable parameters: in presence of this error, the water temperature read on the gearcase will be the same of the engine oil one. Check by means of a multimeter that the sensor is all right (R = approx. 2,5 kOhm at 20 °C) between pins 1 and 2 of sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C18, between sensor connector (wiring side) pin 2 and connector EDC pin C36.	EDC pilot light on.
SENSORS - COOLANT TEMPERATURE	02	07	VALUE OVER THE NORMAL LIMIT	Indication on the water temperature instrument fixed at limit stop and pilot light lighted up.	Positively short-circuited, ground-short-circuited or open-circuited water tem?perature sensor	Reading of measurable parameters: in presence of this error, the water temperature read on the gearcase will be the same of the engine oil one. Check by means of a multimeter that the sensor is all right (R = approx. 2,5 kOhm at 20 °C) between pins 1 and 2 of sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C18, between sensor connector (wiring side) pin 2 and connector EDC pin C36.	EDC pilot light on.

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Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - FUEL TEMPERATURE	03	00	NO AVAILABLE SYMPTOM	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited fuel temperature sensor	Reading of measurable parameters: in presence of this error, the fuel temperature will be fixed at 20 °C Check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C17, between sensor connector (wiring side) pin 2 and connector EDC pin C34.	EDC pilot light off
SENSORS - FUEL TEMPERATURE	03	01	SHORT CIRCUIT TO POSITIVE	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited fuel temperature sensor	Reading of measurable parameters: in presence of this error, the fuel temperature will be fixed at 20 5C Check the sensor is all right (R = approx. 2,5 kOhm at 20 5C) If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C17, between sensor connector (wiring side) pin 2 and connector EDC pin C34.	EDC pilot light off
SENSORS - FUEL TEMPERATURE	03	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited fuel temperature sensor	Reading of measurable parameters: in presence of this error, the fuel temperature will be fixed at 20 °C Check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C17, between sensor connector (wiring side) pin 2 and connector EDC pin C34.	EDC pilot light off

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - FUEL TEMPERATURE	03	03	NO SIGNAL	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited fuel temperature sensor	Reading of measurable parameters: in presence of this error, the fuel temperature will be fixed at 20 °C Check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C17, between sensor connector (wiring side) pin 2 and connector EDC pin C34.	EDC pilot light off
SENSORS - COOLANT TEMPERATURE	03	08	VALUE BELOW THE LIMIT	Indication on the water temperature instrument fixed at limit stop and pilot light lighted up.	Positively short-circuited, ground-short-circuited or open-circuited water tem?perature sensor	Reading of measurable parameters: in presence of this error, the water temperature read on the gearcase will be the same of the engine oil one. Check by means of a multimeter that the sensor is all right (R = approx. 2,5 kOhm at 20 °C) between pins 1 and 2 of sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C18, between sensor connector (wiring side) pin 2 and connector EDC pin C36.	EDC pilot light on.
SENSORS - FUEL PRESSURE	04	00	NO AVAILABLE SYMPTOM	Significant power reduction	Positively short-circuited, ground short-circuited or open-circuited rail pressure sensor	Check the wiring between sensor connector (wiring side) pin 1 and connector EDC pin C20, between sensor connector (wiring side) pin 2 and connector EDC pin C27, between sensor connector (wiring side) pin 3 and connector EDC pin C12. Replace the sensor after having excluded all the other possibilities.	EDC pilot light winking.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - FUEL PRESSURE	04	01	SHORT CIRCUIT TO POSITIVE	Significant power reduction	Positively short-circuited, ground short-circuited or open-circuited rail pressure sensor	Check the wiring between sensor connector (wiring side) pin 1 and connector EDC pin C20, between sensor connector (wiring side) pin 2 and connector EDC pin C27, between sensor connector (wiring side) pin 3 and connector EDC pin C12. Replace the sensor after having excluded all the other possibilities.	EDC pilot light winking.
SENSORS - FUEL PRESSURE	04	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Significant power reduction	Positively short-circuited, ground short-circuited or open-circuited rail pressure sensor	Check the wiring between sensor connector (wiring side) pin 1 and connector EDC pin C20, between sensor connector (wiring side) pin 2 and connector EDC pin C27, between sensor connector (wiring side) pin 3 and connector EDC pin C12. Replace the sensor after having excluded all the other possibilities.	EDC pilot light winking.
SENSORS - FUEL PRESSURE	04	03	NO SIGNAL	Significant power reduction	Positively short-circuited, ground short-circuited or open-circuited rail pressure sensor	Check the wiring between sensor connector (wiring side) pin 1 and connector EDC pin C20, between sensor connector (wiring side) pin 2 and connector EDC pin C27, between sensor connector (wiring side) pin 3 and connector EDC pin C12. Replace the sensor after having excluded all the other possibilities.	EDC pilot light winking.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - FUEL TEMPERATURE	04	04	SIGNAL NOT PLAUSIBLE	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited fuel temperature sensor	Reading of measurable parameters: in presence of this error, the fuel temperature will be fixed at 20 °C Check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C17, between sensor connector (wiring side) pin 2 and connector EDC pin C34.	EDC pilot light off
SENSORS - FUEL PRESSURE	04	04	SIGNAL NOT PLAUSIBLE	Significant power reduction	Positively short-circuited, ground short-circuited or open-circuited rail pressure sensor	Check the wiring between sensor connector (wiring side) pin 1 and connector EDC pin C20, between sensor connector (wiring side) pin 2 and connector EDC pin C27, between sensor connector (wiring side) pin 3 and connector EDC pin C12. Replace the sensor after having excluded all the other possibilities.	EDC pilot light winking.
SENSORS - FUEL TEMPERATURE	04	05	SUPPLY OVER THE NORMAL RANGE	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited fuel temperature sensor	Reading of measurable parameters: in presence of this error, the fuel temperature will be fixed at 20 °C Check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C17, between sensor connector (wiring side) pin 2 and connector EDC pin C34.	EDC pilot light off

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - FUEL PRESSURE	04	05	SUPPLY OVER THE NORMAL RANGE	Significant power reduction	Positively short-circuited, ground short-circuited or open-circuited rail pressure sensor	Check the wiring between sensor connector (wiring side) pin 1 and connector EDC pin C20, between sensor connector (wiring side) pin 2 and connector EDC pin C27, between sensor connector (wiring side) pin 3 and connector EDC pin C12. Replace the sensor after having excluded all the other possibilities.	EDC pilot light winking.
SENSORS - FUEL TEMPERATURE	04	06	SUPPLY BELOW THE RANGE	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited fuel temperature sensor	Reading of measurable parameters: in presence of this error, the fuel temperature will be fixed at 20 °C Check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C17, between sensor connector (wiring side) pin 2 and connector EDC pin C34.	EDC pilot light off
SENSORS - FUEL PRESSURE	04	06	SUPPLY BELOW THE RANGE	Significant power reduction	Positively short-circuited, ground short-circuited or open-circuited rail pressure sensor	Check the wiring between sensor connector (wiring side) pin 1 and connector EDC pin C20, between sensor connector (wiring side) pin 2 and connector EDC pin C27, between sensor connector (wiring side) pin 3 and connector EDC pin C12. Replace the sensor after having excluded all the other possibilities.	EDC pilot light winking.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - FUEL TEMPERATURE	04	07	VALUE OVER THE NORMAL LIMIT	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited fuel temperature sensor	Reading of measurable parameters: in presence of this error, the fuel temperature will be fixed at 20 °C Check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C17, between sensor connector (wiring side) pin 2 and connector EDC pin C34.	EDC pilot light off
SENSORS - FUEL PRESSURE	04	07	VALUE OVER THE NORMAL LIMIT	Significant power reduction	Positively short-circuited, ground short-circuited or open-circuited rail pressure sensor	Check the wiring between sensor connector (wiring side) pin 1 and connector EDC pin C20, between sensor connector (wiring side) pin 2 and connector EDC pin C27, between sensor connector (wiring side) pin 3 and connector EDC pin C12. Replace the sensor after having excluded all the other possibilities.	EDC pilot light winking.
SENSORS - FUEL TEMPERATURE	04	08	VALUE BELOW THE LIMIT	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited fuel temperature sensor	Reading of measurable parameters: in presence of this error, the fuel temperature will be fixed at 20 °C Check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C17, between sensor connector (wiring side) pin 2 and connector EDC pin C34.	EDC pilot light off

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Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - FUEL PRESSURE	04	08	VALUE BELOW THE LIMIT	Significant power reduction	Positively short-circuited, ground short-circuited or open-circuited rail pressure sensor	Check the wiring between sensor connector (wiring side) pin 1 and connector EDC pin C20, between sensor connector (wiring side) pin 2 and connector EDC pin C27, between sensor connector (wiring side) pin 3 and connector EDC pin C12. Replace the sensor after having excluded all the other possibilities.	EDC pilot light winking.
SENSORS - OIL TEMPERATURE SIGNAL	05	00	NO AVAILABLE SYMPTOM	No perceptible reaction.	Oil temperature sensor short-circuited or open-circuited	Reading of measurable parameters: in presence of this error, the engine oil temperature will be fixed at 120 °C. Check that the sensor is all right (R = approx. 2,5 kOhm at 20 °C). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C19, between sensor connector (wiring side) pin 2 and connector EDC pin C33.	EDC pilot light on. If the oil temperature is too low, a limitation of the engine rpm, depending upon the temperature itself, takes place immediately after starting, (engine protection strategy).

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 1	05	00	NO AVAILABLE SYMPTOM	The engine runs at 5 cylinders.	Electrical part of cylinder n°1 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on the cylinder head between connector 1 pins 3 and 4 and electro-injector. If the head cylinder wiring is all right, check the engine cable between cylinder head connector 1 pin 3 and connector EDC pin A13, between cylinder head connector 1 pin 4 and connector EDC pin A9.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also the error 5.7 can be stored.
SENSORS - OIL TEMPERATURE SIGNAL	05	01	SHORT CIRCUIT TO POSITIVE	No perceptible reaction.	Oil temperature sensor short-circuited or open-circuited	Reading of measurable parameters: in presence of this error, the engine oil temperature will be fixed at 120 °C. Check that the sensor is all right (R = approx. 2,5 kOhm at 20 °C). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C19, between sensor connector (wiring side) pin 2 and connector EDC pin C33.	EDC pilot light on. If the oil temperature is too low, a limitation of the engine rpm, depending upon the temperature itself, takes place immediately after starting, (engine protection strategy).

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 1	05	01	SHORT CIRCUIT TO POSITIVE	The engine runs at 5 cylinders.	Electrical part of cylinder n°1 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on the cylinder head between connector 1 pins 3 and 4 and electro-injector. If the head cylinder wiring is all right, check the engine cable between cylinder head connector 1 pin 3 and connector EDC pin A13, between cylinder head connector 1 pin 4 and connector EDC pin A9.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also the error 5.7 can be stored.
SENSORS - OIL TEMPERATURE SIGNAL	05	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	No perceptible reaction.	Oil temperature sensor short-circuited or open-circuited	Reading of measurable parameters: in presence of this error, the engine oil temperature will be fixed at 120 °C. Check that the sensor is all right (R = approx. 2,5 kOhm at 20 °C). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C19, between sensor connector (wiring side) pin 2 and connector EDC pin C33.	EDC pilot light on. If the oil temperature is too low, a limitation of the engine rpm, depending upon the temperature itself, takes place immediately after starting, (engine protection strategy).

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 1	05	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	The engine runs at 5 cylinders.	Electrical part of cylinder n°1 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on the cylinder head between connector 1 pins 3 and 4 and electro-injector. If the head cylinder wiring is all right, check the engine cable between cylinder head connector 1 pin 3 and connector EDC pin A13, between cylinder head connector 1 pin 4 and connector EDC pin A9.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also the error 5.7 can be stored.
ENGINE - INJECTOR CYLINDER 1	05	03	NO SIGNAL	The engine runs at 5 cylinders.	Electrical part of cylinder n°1 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on the cylinder head between connector 1 pins 3 and 4 and electro-injector. If the head cylinder wiring is all right, check the engine cable between cylinder head connector 1 pin 3 and connector EDC pin A13, between cylinder head connector 1 pin 4 and connector EDC pin A9.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also the error 5.7 can be stored.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - OIL TEMPERATURE SIGNAL	05	03	NO SIGNAL	No perceptible reaction	Oil temperature sensor short-circuited or open-circuited	Reading of measurable parameters: in presence of this error, the engine oil temperature will be fixed at 120 °C. Check that the sensor is all right (R = approx. 2,5 kOhm at 20 °C). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C19, between sensor connector (wiring side) pin 2 and connector EDC pin C33.	EDC pilot light on. If the oil temperature is too low, a limitation of the engine rpm, depending upon the temperature itself, takes place immediately after starting, (engine protection strategy).
ENGINE - INJECTOR CYLINDER 1	05	04	SIGNAL NOT PLAUSIBLE	The engine runs at 5 cylinders.	Electrical part of cylinder n°1 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on the cylinder head between connector 1 pins 3 and 4 and electro-injector. If the head cylinder wiring is all right, check the engine cable between cylinder head connector 1 pin 3 and connector EDC pin A13, between cylinder head connector 1 pin 4 and connector EDC pin A9.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also the error 5.7 can be stored.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - OIL TEMPERATURE SIGNAL	05	04	SIGNAL NOT PLAUSIBLE	No perceptible reaction.	Oil temperature sensor short-circuited or open-circuited	Reading of measurable parameters: in presence of this error, the engine oil temperature will be fixed at 120 °C. Check that the sensor is all right (R = approx. 2,5 kOhm at 20 °C). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C19, between sensor connector (wiring side) pin 2 and connector EDC pin C33.	EDC pilot light on. If the oil temperature is too low, a limitation of the engine rpm, depending upon the temperature itself, takes place immediately after starting, (engine protection strategy).
SENSORS - OIL TEMPERATURE SIGNAL	05	05	SUPPLY OVER THE NORMAL RANGE	No perceptible reaction.	Oil temperature sensor short-circuited or open-circuited	Reading of measurable parameters: in presence of this error, the engine oil temperature will be fixed at 120 °C. Check that the sensor is all right (R = approx. 2,5 kOhm at 20 °C). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C19, between sensor connector (wiring side) pin 2 and connector EDC pin C33.	EDC pilot light on. If the oil temperature is too low, a limitation of the engine rpm, depending upon the temperature itself, takes place immediately after starting, (engine protection strategy).

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Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 1	05	05	SUPPLY OVER THE NORMAL RANGE	The engine runs at 5 cylinders.	Electrical part of cylinder n°1 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on the cylinder head between connector 1 pins 3 and 4 and electro-injector. If the head cylinder wiring is all right, check the engine cable between cylinder head connector 1 pin 3 and connector EDC pin A13, between cylinder head connector 1 pin 4 and connector EDC pin A9.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also the error 5.7 can be stored.
SENSORS - OIL TEMPERATURE SIGNAL	05	06	SUPPLY BELOW THE RANGE	No perceptible reaction.	Oil temperature sensor short-circuited or open-circuited	Reading of measurable parameters: in presence of this error, the engine oil temperature will be fixed at 120 °C. Check that the sensor is all right (R = approx. 2,5 kOhm at 20 °C). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C19, between sensor connector (wiring side) pin 2 and connector EDC pin C33.	EDC pilot light on. If the oil temperature is too low, a limitation of the engine rpm, depending upon the temperature itself, takes place immediately after starting, (engine protection strategy).

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - OIL TEMPERATURE SIGNAL	05	07	VALUE OVER THE NORMAL LIMIT	No perceptible reaction.	Oil temperature sensor short-circuited or open-circuited	Reading of measurable parameters: in presence of this error, the engine oil temperature will be fixed at 120 °C. Check that the sensor is all right (R = approx. 2,5 kOhm at 20 °C). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C19, between sensor connector (wiring side) pin 2 and connector EDC pin C33.	EDC pilot light on. If the oil temperature is too low, a limitation of the engine rpm, depending upon the temperature itself, takes place immediately after starting, (engine protection strategy).
SENSORS - OIL TEMPERATURE SIGNAL	05	08	VALUE BELOW THE LIMIT	No perceptible reaction.	Oil temperature sensor short-circuited or open-circuited	Reading of measurable parameters: in presence of this error, the engine oil temperature will be fixed at 120 °C. Check that the sensor is all right (R = approx. 2,5 kOhm at 20 °C). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C19, between sensor connector (wiring side) pin 2 and connector EDC pin C33.	EDC pilot light on. If the oil temperature is too low, a limitation of the engine rpm, depending upon the temperature itself, takes place immediately after starting, (engine protection strategy).

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 5	06	00	NO AVAILABLE SYMPTOM	The engine runs at 5 cylinders.	Electrical part of cylinder n°5 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .
ENGINE - INJECTOR CYLINDER 3	06	00	NO AVAILABLE SYMPTOM	The engine runs at 5 cylinders.	Electrical part of cylinder n°3 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 2 pins 3 and 4 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 2 pin 3 and connector EDC pin A12, between cylinder head connector 2 pin 4 and connector EDC pin A4.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 5	06	01	SHORT CIRCUIT TO POSITIVE	The engine runs at 5 cylinders.	Electrical part of cylinder n°5 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .
ENGINE - INJECTOR CYLINDER 3	06	01	SHORT CIRCUIT TO POSITIVE	The engine runs at 5 cylinders.	Electrical part of cylinder n°3 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 2 pins 3 and 4 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 2 pin 3 and connector EDC pin A12, between cylinder head connector 2 pin 4 and connector EDC pin A4.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 5	06	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	The engine runs at 5 cylinders.	Electrical part of cylinder n°5 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .
ENGINE - INJECTOR CYLINDER 5	06	03	NO SIGNAL	The engine runs at 5 cylinders.	Electrical part of cylinder n°5 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 5	06	04	SIGNAL NOT PLAUSIBLE	The engine runs at 5 cylinders.	Electrical part of cylinder n°5 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .
ENGINE - INJECTOR CYLINDER 5	06	05	SUPPLY OVER THE NORMAL RANGE	The engine runs at 5 cylinders.	Electrical part of cylinder n°5 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 1	06	06	SUPPLY BELOW THE RANGE	The engine runs at 5 cylinders.	Electrical part of cylinder n°1 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on the cylinder head between connector 1 pins 3 and 4 and electro-injector. If the head cylinder wiring is all right, check the engine cable between cylinder head connector 1 pin 3 and connector EDC pin A13, between cylinder head connector 1 pin 4 and connector EDC pin A9.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also the error 5.7 can be stored.
ENGINE - INJECTOR CYLINDER 5	06	06	SUPPLY BELOW THE RANGE	The engine runs at 5 cylinders.	Electrical part of cylinder n°5 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 1	06	07	VALUE OVER THE NORMAL LIMIT	The engine runs at 5 cylinders.	Electrical part of cylinder n°1 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on the cylinder head between connector 1 pins 3 and 4 and electro-injector. If the head cylinder wiring is all right, check the engine cable between cylinder head connector 1 pin 3 and connector EDC pin A13, between cylinder head connector 1 pin 4 and connector EDC pin A9.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also the error 5.7 can be stored.
ENGINE - INJECTOR CYLINDER 5	06	07	VALUE OVER THE NORMAL LIMIT	The engine runs at 5 cylinders.	Electrical part of cylinder n°5 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 1	06	08	VALUE BELOW THE LIMIT	The engine runs at 5 cylinders.	Electrical part of cylinder n°1 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on the cylinder head between connector 1 pins 3 and 4 and electro-injector. If the head cylinder wiring is all right, check the engine cable between cylinder head connector 1 pin 3 and connector EDC pin A13, between cylinder head connector 1 pin 4 and connector EDC pin A9.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also the error 5.7 can be stored.
ENGINE - INJECTOR CYLINDER 5	06	08	VALUE BELOW THE LIMIT	The engine runs at 5 cylinders.	Electrical part of cylinder n°5 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 6	07	00	NO AVAILABLE SYMPTOM	The engine runs at 5 cylinders.	Electrical part of cylinder n°6 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .
ENGINE - INJECTOR CYLINDER 6	07	01	SHORT CIRCUIT TO POSITIVE	The engine runs at 5 cylinders.	Electrical part of cylinder n°6 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 3	07	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	The engine runs at 5 cylinders.	Electrical part of cylinder n°3 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 2 pins 3 and 4 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 2 pin 3 and connector EDC pin A12, between cylinder head connector 2 pin 4 and connector EDC pin A4.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 6	07	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	The engine runs at 5 cylinders.	Electrical part of cylinder n°6 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 3	07	03	NO SIGNAL	The engine runs at 5 cylinders.	Electrical part of cylinder n°3 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 2 pins 3 and 4 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 2 pin 3 and connector EDC pin A12, between cylinder head connector 2 pin 4 and connector EDC pin A4.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 2 (3) cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 6	07	03	NO SIGNAL	The engine runs at 5 cylinders.	Electrical part of cylinder n°6 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 3	07	04	SIGNAL NOT PLAUSIBLE	The engine runs at 5 cylinders.	Electrical part of cylinder n°3 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 2 pins 3 and 4 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 2 pin 3 and connector EDC pin A12, between cylinder head connector 2 pin 4 and connector EDC pin A4.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 6	07	04	SIGNAL NOT PLAUSIBLE	The engine runs at 5 cylinders.	Electrical part of cylinder n°6 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 3	07	05	SUPPLY OVER THE NORMAL RANGE	The engine runs at 5 cylinders.	Electrical part of cylinder n°3 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 2 pins 3 and 4 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 2 pin 3 and connector EDC pin A12, between cylinder head connector 2 pin 4 and connector EDC pin A4.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 6	07	05	SUPPLY OVER THE NORMAL RANGE	The engine runs at 5 cylinders.	Electrical part of cylinder n°6 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 3	07	06	SUPPLY BELOW THE RANGE	The engine runs at 5 cylinders.	Electrical part of cylinder n°3 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 2 pins 3 and 4 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 2 pin 3 and connector EDC pin A12, between cylinder head connector 2 pin 4 and connector EDC pin A4.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 6	07	06	SUPPLY BELOW THE RANGE	The engine runs at 5 cylinders.	Electrical part of cylinder n°6 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 3	07	07	VALUE OVER THE NORMAL LIMIT	The engine runs at 5 cylinders.	Electrical part of cylinder n°3 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 2 pins 3 and 4 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 2 pin 3 and connector EDC pin A12, between cylinder head connector 2 pin 4 and connector EDC pin A4.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 6	07	07	VALUE OVER THE NORMAL LIMIT	The engine runs at 5 cylinders.	Electrical part of cylinder n°6 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 3	07	08	VALUE BELOW THE LIMIT	The engine runs at 5 cylinders.	Electrical part of cylinder n°3 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 2 pins 3 and 4 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 2 pin 3 and connector EDC pin A12, between cylinder head connector 2 pin 4 and connector EDC pin A4.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 4	08	00	NO AVAILABLE SYMPTOM	The engine runs at 5 cylinders.	Electrical part of cylinder n°4 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 2	08	00	NO AVAILABLE SYMPTOM	The engine runs at 5 cylinders.	Cylinder n°2 injector electrical part short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm Check the continuity and resistance of the injector solenoid valve (R = approx. 0,5 Ohm) If the solenoid valve is all right, check the wiring on cylinder head between connector 1 pins 1 and 2 and electro-injector If the cylinder head wiring is all right, check the engine cable between cylinder head connector 1 pin 1 and connector EDC pin A3, between cylinder head connector 1 pin 2 and connector EDC pin A6.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 4	08	01	SHORT CIRCUIT TO POSITIVE	The engine runs at 5 cylinders.	Electrical part of cylinder n°4 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 2	08	01	SHORT CIRCUIT TO POSITIVE	The engine runs at 5 cylinders.	Cylinder n°2 injector electrical part short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm Check the continuity and resistance of the injector solenoid valve (R = approx. 0,5 Ohm) If the solenoid valve is all right, check the wiring on cylinder head between connector 1 pins 1 and 2 and electro-injector If the cylinder head wiring is all right, check the engine cable between cylinder head connector 1 pin 1 and connector EDC pin A3, between cylinder head connector 1 pin 2 and connector EDC pin A6.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 2	08	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	The engine runs at 5 cylinders.	Cylinder n°2 injector electrical part short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm Check the continuity and resistance of the injector solenoid valve (R = approx. 0,5 Ohm) If the solenoid valve is all right, check the wiring on cylinder head between connector 1 pins 1 and 2 and electro-injector If the cylinder head wiring is all right, check the engine cable between cylinder head connector 1 pin 1 and connector EDC pin A3, between cylinder head connector 1 pin 2 and connector EDC pin A6.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 4	08	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	The engine runs at 5 cylinders.	Electrical part of cylinder n°4 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 2	08	03	NO SIGNAL	The engine runs at 5 cylinders.	Cylinder n°2 injector electrical part short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm Check the continuity and resistance of the injector solenoid valve (R = approx. 0,5 Ohm) If the solenoid valve is all right, check the wiring on cylinder head between connector 1 pins 1 and 2 and electro-injector If the cylinder head wiring is all right, check the engine cable between cylinder head connector 1 pin 1 and connector EDC pin A3, between cylinder head connector 1 pin 2 and connector EDC pin A6.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 4	08	03	NO SIGNAL	The engine runs at 5 cylinders.	Electrical part of cylinder n°4 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 2	08	04	SIGNAL NOT PLAUSIBLE	The engine runs at 5 cylinders.	Cylinder n°2 injector electrical part short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm Check the continuity and resistance of the injector solenoid valve (R = approx. 0,5 Ohm) If the solenoid valve is all right, check the wiring on cylinder head between connector 1 pins 1 and 2 and electro-injector If the cylinder head wiring is all right, check the engine cable between cylinder head connector 1 pin 1 and connector EDC pin A3, between cylinder head connector 1 pin 2 and connector EDC pin A6.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 2	08	05	SUPPLY OVER THE NORMAL RANGE	The engine runs at 5 cylinders.	Cylinder n°2 injector electrical part short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm Check the continuity and resistance of the injector solenoid valve (R = approx. 0,5 Ohm) If the solenoid valve is all right, check the wiring on cylinder head between connector I pins 1 and 2 and electro-injector If the cylinder head wiring is all right, check the engine cable between cylinder head connector 1 pin 1 and connector EDC pin A3, between cylinder head connector 1 pin 2 and connector EDC pin A6.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 2	08	06	SUPPLY BELOW THE RANGE	The engine runs at 5 cylinders.	Cylinder n°2 injector electrical part short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm Check the continuity and resistance of the injector solenoid valve (R = approx. 0,5 Ohm) If the solenoid valve is all right, check the wiring on cylinder head between connector I pins 1 and 2 and electro-injector If the cylinder head wiring is all right, check the engine cable between cylinder head connector 1 pin 1 and connector EDC pin A3, between cylinder head connector 1 pin 2 and connector EDC pin A6.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE INJECTOR CYLINDER 2 -	08	07	VALUE OVER THE NORMAL LIMIT	The engine runs at 5 cylinders.	Cylinder n°2 injector electrical part short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm Check the continuity and resistance of the injector solenoid valve (R = approx. 0,5 Ohm) If the solenoid valve is all right, check the wiring on cylinder head between connector 1 pins 1 and 2 and electro-injector If the cylinder head wiring is all right, check the engine cable between cylinder head connector 1 pin 1 and connector EDC pin A3, between cylinder head connector 1 pin 2 and connector EDC pin A6.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE INJECTOR CYLINDER 6 -	08	08	VALUE BELOW THE LIMIT	The engine runs at 5 cylinders.	Electrical part of cylinder n°6 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.8 can be stored .

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 2	08	08	VALUE BELOW THE LIMIT	The engine runs at 5 cylinders.	Cylinder n°2 injector electrical part short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm Check the continuity and resistance of the injector solenoid valve (R = approx. 0,5 Ohm) If the solenoid valve is all right, check the wiring on cylinder head between connector 1 pins 1 and 2 and electro-injector If the cylinder head wiring is all right, check the engine cable between cylinder head connector 1 pin 1 and connector EDC pin A3, between cylinder head connector 1 pin 2 and connector EDC pin A6.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - ENGINE OVERSPEED	09	00	NO AVAILABLE SYMPTOM	No reaction noticeable on behalf of the driver.	Excessive engine revolutions	Flight Recorder (Stored Data) reading with Modus IWT-IT2000Driver sensibilization	EDC pilot light winking. Make sure the driver understands the importance of proper driving.
ENGINE - ENGINE OVERSPEED	09	01	ENGINE OVERSPEED	No perceptible reaction.	Excessive engine revolutions	Flight Recorder (Stored Data) reading with Modus IWT-IT2000Driver sensibilization	EDC pilot light winking. Make sure the driver understands the importance of proper driving.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 4	09	04	SIGNAL NOT PLAUSIBLE	The engine runs at 5 cylinders.	Electrical part of cylinder n°4 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 4	09	05	SUPPLY OVER THE NORMAL RANGE	The engine runs at 5 cylinders.	Electrical part of cylinder n°4 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 4	09	06	SUPPLY BELOW THE RANGE	The engine runs at 5 cylinders.	Electrical part of cylinder n°4 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
ENGINE - INJECTOR CYLINDER 4	09	07	VALUE OVER THE NORMAL LIMIT	The engine runs at 5 cylinders.	Electrical part of cylinder n°4 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - INJECTOR CYLINDER 4	09	08	VALUE BELOW THE LIMIT	The engine runs at 5 cylinders.	Electrical part of cylinder n°4 injector short-circuited or open-circuited.	Check that the nuts fixing the cables on the injector solenoid valve are properly tightened to the torque of 1,5 Nm. Check the injector solenoid valve continuity and resistance (R = approx. 0,5 Ohm). If the solenoid valve is all right, check the wiring on cylinder head between connector 3 pins 1 and 2 and electro-injector. If the cylinder head wiring is all right, check the engine cable between the cylinder head connector 3 pin 1 and connector EDC pin A10, between cylinder head connector 3 pin 2 and connector EDC pin A15.	EDC pilot light on. It is possible that immediately afterwards the engine keeps on running at 3 cylinders, because the injectors are driven by two power stages. In this case also error 5.7.
SENSORS - BOOST PRESSURE	0B	00	NO AVAILABLE SYMPTOM	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air pressure sensor on suction manifold, or sensor supplied by a current that exceeds the minimum or maximum limit	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the overcharging pressure will be fixed at 1600 mbar. Check the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C10, between sensor connector (wiring side) pin 4 and connector EDC pin C28.	EDC pilot light on. The pressure sensor is incorporated in the temperature one. If the electrical part is all right, check the functionality of the wastegate valve of the turbocompressor.
SENSORS - BOOST PRESSURE	0B	01	SHORT CIRCUIT TO POSITIVE	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air pressure sensor on suction manifold, or sensor supplied by a current that exceeds the minimum or maximum limit	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the overcharging pressure will be fixed at 1600 mbar. Check the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C10, between sensor connector (wiring side) pin 4 and connector EDC pin C28.	EDC pilot light on. The pressure sensor is incorporated in the temperature one. If the electrical part is all right, check the functionality of the wastegate valve of the turbocompressor.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - BOOST PRESSURE	0B	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air pressure sensor on suction manifold, or sensor supplied by a current that exceeds the minimum or maximum limit	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the overcharging pressure will be fixed at 1600 mbar. Check the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C10, between sensor connector (wiring side) pin 4 and connector EDC pin C28.	EDC pilot light on. The pressure sensor is incorporated in the temperature one. If the electrical part is all right, check the functionality of the wastegate valve of the turbocompressor.
SENSORS - BOOST PRESSURE	0B	03	NO SIGNAL	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air pressure sensor on suction manifold, or sensor supplied by a current that exceeds the minimum or maximum limit	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the overcharging pressure will be fixed at 1600 mbar. Check the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C10, between sensor connector (wiring side) pin 4 and connector EDC pin C28.	EDC pilot light on. The pressure sensor is incorporated in the temperature one. If the electrical part is all right, check the functionality of the wastegate valve of the turbocompressor.
SENSORS - BOOST PRESSURE	0B	04	SIGNAL NOT PLAUSIBLE	No reaction noticeable on behalf of the driver.	Positively short-circuited, ground-short-circuited or open-circuited air pressure sensor on suction manifold, or sensor supplied by a current that exceeds the minimum or maximum limit	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the overcharging pressure will be fixed at 1600 mbar. Check the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C10, between sensor connector (wiring side) pin 4 and connector EDC pin C28.	EDC pilot light on. The pressure sensor is incorporated in the temperature one. If the electrical part is all right, check the functionality of the wastegate valve of the turbocompressor.
SENSORS - BOOST PRESSURE	0B	05	SUPPLY OVER THE NORMAL RANGE	No reaction noticeable on behalf of the driver.	Positively short-circuited, ground-short-circuited or open-circuited air pressure sensor on suction manifold, or sensor supplied by a current that exceeds the minimum or maximum limit	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the overcharging pressure will be fixed at 1600 mbar. Check the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C10, between sensor connector (wiring side) pin 4 and connector EDC pin C28.	EDC pilot light on. The pressure sensor is incorporated in the temperature one. If the electrical part is all right, check the functionality of the wastegate valve of the turbocompressor.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - BOOST PRESSURE	0B	06	SUPPLY BELOW THE RANGE	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air pressure sensor on suction manifold, or sensor supplied by a current that exceeds the minimum or maximum limit	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the overcharging pressure will be fixed at 1600 mbar. Check the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C10, between sensor connector (wiring side) pin 4 and connector EDC pin C28.	EDC pilot light on. The pressure sensor is incorporated in the temperature one. If the electrical part is all right, check the functionality of the wastegate valve of the turbocompressor.
SENSORS - BOOST PRESSURE	0B	07	VALUE OVER THE NORMAL LIMIT	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air pressure sensor on suction manifold, or sensor supplied by a current that exceeds the minimum or maximum limit	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the overcharging pressure will be fixed at 1600 mbar. Check the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C10, between sensor connector (wiring side) pin 4 and connector EDC pin C28.	EDC pilot light on. The pressure sensor is incorporated in the temperature one. If the electrical part is all right, check the functionality of the wastegate valve of the turbocompressor.
SENSORS - BOOST PRESSURE	0B	08	VALUE BELOW THE LIMIT	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air pressure sensor on suction manifold, or sensor supplied by a current that exceeds the minimum or maximum limit	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the overcharging pressure will be fixed at 1600 mbar. Check the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C10, between sensor connector (wiring side) pin 4 and connector EDC pin C28.	EDC pilot light on. The pressure sensor is incorporated in the temperature one. If the electrical part is all right, check the functionality of the wastegate valve of the turbocompressor.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - CRANKSHAFT	0F	00	NO AVAILABLE SYMPTOM	The engine doesn't start. Light power reduction.	Drive shaft sensor: lack of signal or unfeasible signal	Check the cleaning and the proper fastening of the sensor. Check the phonic wheel is not damaged and verify its cleaning. Check the sensor is all right (R = approx. 920 Ohm). If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C25, between sensor connector (wiring side) pin 2 and connector EDC pin C24.	EDC pilot light on. Error 6.1 is always combined with 6.3 The engine doesn't start because after a few revolutions the gearcase disables the starter.
SENSORS - CRANKSHAFT	0F	03	NO SIGNAL	The engine doesn't start. Light power reduction.	Drive shaft sensor: lack of signal or unfeasible signal	Check the cleaning and the proper fastening of the sensor. Check the phonic wheel is not damaged and verify its cleaning. Check the sensor is all right (R = approx. 920 Ohm). If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C25, between sensor connector (wiring side) pin 2 and connector EDC pin C24.	EDC pilot light on. Error 6.1 is always combined with 6.3 The engine doesn't start because after a few revolutions the gearcase disables the starter.
SENSORS - CRANKSHAFT	0F	04	SIGNAL NOT PLAUSIBLE	The engine doesn't start. Light power reduction.	Drive shaft sensor: lack of signal or unfeasible signal	Check the cleaning and the proper fastening of the sensor. Check the phonic wheel is not damaged and verify its cleaning. Check the sensor is all right (R = approx. 920 Ohm). If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C25, between sensor connector (wiring side) pin 2 and connector EDC pin C24.	EDC pilot light on. Error 6.1 is always combined with 6.3 The engine doesn't start because after a few revolutions the gearcase disables the starter.

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Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - CRANKSHAFT	0F	05	NOISY SIGNAL ON WUP 1	The engine doesn't start. Light power reduction.	Drive shaft sensor: lack of signal or unfeasible signal	Check the cleaning and the proper fastening of the sensor. Check the phonic wheel is not damaged and verify its cleaning. Check the sensor is all right (R = approx. 920 Ohm). If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C25, between sensor connector (wiring side) pin 2 and connector EDC pin C24.	EDC pilot light on. Error 6.1 is always combined with 6.3 The engine doesn't start because after a few revolutions the gearcase disables the starter.
SENSORS - CAMSHAFT	10	00	NO AVAILABLE SYMPTOM	Difficult starting in every condition. False injections and grade of smoke at the exhaust during starting.	Distribution shaft sensor: lack of signal or unfeasible signal	Check the correct sensor fastening and its cleaning. Check that the sensor is not damaged (R = approx. 890 Ohm). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C23, between sensor connector (wiring side) pin 2 and connector EDC pin C30.	EDC pilot light on. This error is always combined with 6.3.
SENSORS - CAMSHAFT	10	03	NO SIGNAL	Difficult starting in every condition. False injections and grade of smoke at the exhaust during starting.	Distribution shaft sensor: lack of signal or unfeasible signal	Check the correct sensor fastening and its cleaning. Check that the sensor is not damaged (R = approx. 890 Ohm). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C23, between sensor connector (wiring side) pin 2 and connector EDC pin C30.	EDC pilot light on. This error is always combined with 6.3.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - CAMSHAFT	10	04	SIGNAL NOT PLAUSIBLE	Difficult starting in every condition. False injections and grade of smoke at the exhaust during starting.	Distribution shaft sensor: lack of signal or unfeasible signal	Check the correct sensor fastening and its cleaning. Check that the sensor is not damaged (R = approx. 890 Ohm). If the sensor is all right, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C23, between sensor connector (wiring side) pin 2 and connector EDC pin C30.	EDC pilot light on. This error is always combined with 6.3.
SENSORS - CRANKSHAFT	10	06	NOISY SIGNAL ON WUP 2	The engine doesn't start. Light power reduction.	Drive shaft sensor: lack of signal or unfeasible signal	Check the cleaning and the proper fastening of the sensor. Check the phonic wheel is not damaged and verify its cleaning. Check the sensor is all right (R = approx. 920 Ohm). If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C25, between sensor connector (wiring side) pin 2 and connector EDC pin C24.	EDC pilot light on. Error 6.1 is always combined with 6.3 The engine doesn't start because after a few revolutions the gearcase disables the starter.
VOLTAGE	12	00	NO AVAILABLE SYMPTOM	Idling accelerated (depending upon the detected voltage), up to a maximum of 200 rpm over the standard idling speed.	Too low battery voltage signal.	Reading of measurable parameters to check the battery voltage Carry out the appropriate checks on voltage regulator, batteries and recharge system.	
VOLTAGE	12	01	VOLTAGE TOO HIGH	Idling accelerated (depending upon the detected voltage), up to a maximum of 200 rpm over the standard idling speed.	Too low battery voltage signal.	Reading of measurable parameters to check the battery voltage Carry out the appropriate checks on voltage regulator, batteries and recharge system.	
VOLTAGE	12	02	VOLTAGE TOO LOW	Idling accelerated (depending upon the detected voltage), up to a maximum of 200 rpm over the standard idling speed.	Too low battery voltage signal.	Reading of measurable parameters to check the battery voltage Carry out the appropriate checks on voltage regulator, batteries and recharge system.	

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	13	00	NO AVAILABLE SYMPTOM	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Erase the failure memory and retry. If the problem persists, contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on. Possible defect warning regarding various sensors powered by the gearcase.
ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	13	01	SHORT CIRCUIT TO POSITIVE	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Erase the failure memory and retry. If the problem persists, contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on. Possible defect warning regarding various sensors powered by the gearcase.
ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	13	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Erase the failure memory and retry. If the problem persists, contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on. Possible defect warning regarding various sensors powered by the gearcase.
ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	13	03	NO SIGNAL	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Erase the failure memory and retry. If the problem persists, contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on. Possible defect warning regarding various sensors powered by the gearcase.
ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	13	04	SIGNAL NOT PLAUSIBLE	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Erase the failure memory and retry. If the problem persists, contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on. Possible defect warning regarding various sensors powered by the gearcase.
ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	13	05	SUPPLY OVER THE NORMAL RANGE	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Erase the failure memory and retry. If the problem persists, contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on. Possible defect warning regarding various sensors powered by the gearcase.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	13	06	SUPPLY BELOW THE RANGE	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Erase the failure memory and retry. If the problem persists, contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on. Possible defect warning regarding various sensors powered by the gearcase.
VOLTAGE	13	07	VOLTAGE HIGH	Idling accelerated (depending upon the detected voltage), up to a maximum of 200 rpm over the standard idling speed.	Too low battery voltage signal.	Reading of measurable parameters to check the battery voltage Carry out the appropriate checks on voltage regulator, batteries and recharge system.	
ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	13	07	VALUE OVER THE NORMAL LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Erase the failure memory and retry. If the problem persists, contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on. Possible defect warning regarding various sensors powered by the gearcase.
VOLTAGE	13	08	VOLTAGE LOW	Idling accelerated (depending upon the detected voltage), up to a maximum of 200 rpm over the standard idling speed.	Too low battery voltage signal.	Reading of measurable parameters to check the battery voltage Carry out the appropriate checks on voltage regulator, batteries and recharge system.	
ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	13	08	VALUE BELOW THE LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Erase the failure memory and retry. If the problem persists, contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on. Possible defect warning regarding various sensors powered by the gearcase.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS AFTER-RUN	1A	00	NO AVAILABLE SYMPTOM	Significant power reduction.	Failure of the internal test procedure that takes place in the control unit each time the engine stops.	It might occur if the engine is stopped but it keeps on running. Check the wiring between +15 of the key and gearcase connector pin B39. Erase the failure memory and retry: if in case of engine normal stop the error signal persists, contact the Help Desk for the possible replacement of the gearcase.	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS AFTER-RUN	1A	01	SHORT CIRCUIT TO POSITIVE	Significant power reduction.	Failure of the internal test procedure that takes place in the control unit each time the engine stops.	It might occur if the engine is stopped but it keeps on running. Check the wiring between +15 of the key and gearcase connector pin B39. Erase the failure memory and retry: if in case of engine normal stop the error signal persists, contact the Help Desk for the possible replacement of the gearcase.	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS AFTER-RUN	1B	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Significant power reduction.	Failure of the internal test procedure that takes place in the control unit each time the engine stops.	It might occur if the engine is stopped but it keeps on running. Check the wiring between +15 of the key and gearcase connector pin B39. Erase the failure memory and retry: if in case of engine normal stop the error signal persists, contact the Help Desk for the possible replacement of the gearcase.	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS AFTER-RUN	1B	03	NO SIGNAL	Significant power reduction.	Failure of the internal test procedure that takes place in the control unit each time the engine stops.	It might occur if the engine is stopped but it keeps on running. Check the wiring between +15 of the key and gearcase connector pin B39. Erase the failure memory and retry: if in case of engine normal stop the error signal persists, contact the Help Desk for the possible replacement of the gearcase.	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS AFTER-RUN	1B	04	SIGNAL NOT PLAUSIBLE	Significant power reduction.	Failure of the internal test procedure that takes place in the control unit each time the engine stops.	It might occur if the engine is stopped but it keeps on running. Check the wiring between +15 of the key and gearcase connector pin B39. Erase the failure memory and retry: if in case of engine normal stop the error signal persists, contact the Help Desk for the possible replacement of the gearcase.	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS AFTER-RUN	1B	05	SUPPLY OVER THE NORMAL RANGE	Significant power reduction.	Failure of the internal test procedure that takes place in the control unit each time the engine stops.	It might occur if the engine is stopped but it keeps on running. Check the wiring between +15 of the key and gearcase connector pin B39. Erase the failure memory and retry: if in case of engine normal stop the error signal persists, contact the Help Desk for the possible replacement of the gearcase.	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS AFTER-RUN	1B	06	SUPPLY BELOW THE RANGE	Significant power reduction.	Failure of the internal test procedure that takes place in the control unit each time the engine stops.	It might occur if the engine is stopped but it keeps on running. Check the wiring between +15 of the key and gearcase connector pin B39. Erase the failure memory and retry: if in case of engine normal stop the error signal persists, contact the Help Desk for the possible replacement of the gearcase.	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS AFTER-RUN	1B	07	VALUE OVER THE NORMAL LIMIT	Significant power reduction.	Failure of the internal test procedure that takes place in the control unit each time the engine stops.	It might occur if the engine is stopped but it keeps on running. Check the wiring between +15 of the key and gearcase connector pin B39. Erase the failure memory and retry: if in case of engine normal stop the error signal persists, contact the Help Desk for the possible replacement of the gearcase.	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS AFTER-RUN	1B	08	VALUE BELOW THE LIMIT	Significant power reduction.	Failure of the internal test procedure that takes place in the control unit each time the engine stops.	It might occur if the engine is stopped but it keeps on running. Check the wiring between +15 of the key and gearcase connector pin B39. Erase the failure memory and retry: if in case of engine normal stop the error signal persists, contact the Help Desk for the possible replacement of the gearcase.	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTRONIC CONTROL UNIT - BOOSTER 1	1D	00	NO AVAILABLE SYMPTOM	The engine rotates with 3 cylinders	Power stage for the electro-injectors of cylinders 1-2-3 faulty.	Delete failure memory and try again.If the error remains, and only after having excluded an injector failure (see 5.x note), contact the Help Desk and comply with its instructions for possible unit replacement.	EDC pilot light on.
ELECTRONIC CONTROL UNIT - BOOSTER 1	1D	01	VOLTAGE TOO HIGH	The engine rotates with 3 cylinders	Power stage for the electro-injectors of cylinders 1-2-3 faulty.	Delete failure memory and try again.If the error remains, and only after having excluded an injector failure (see 5.x note), contact the Help Desk and comply with its instructions for possible unit replacement.	EDC pilot light on.
ELECTRONIC CONTROL UNIT - BOOSTER 1	1D	02	VOLTAGE TOO LOW	The engine rotates with 3 cylinders	Power stage for the electro-injectors of cylinders 1-2-3 faulty.	Delete failure memory and try again.If the error remains, and only after having excluded an injector failure (see 5.x note), contact the Help Desk and comply with its instructions for possible unit replacement.	EDC pilot light on.
ELECTRONIC CONTROL UNIT - BOOSTER 2	1E	00	NO AVAILABLE SYMPTOM	The engine runs at 3 cylinders.	Power stage for the electro-injectors of cylinders 4-5-6 faulty.	Erase the failure memory and retry. In case the error persists, and only after having excluded the injector defect (see note of 5.x) contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on.
ELECTRONIC CONTROL UNIT - BOOSTER 2	1E	01	VOLTAGE TOO HIGH	The engine runs at 3 cylinders.	Power stage for the electro-injectors of cylinders 4-5-6 faulty.	Erase the failure memory and retry. In case the error persists, and only after having excluded the injector defect (see note of 5.x) contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTRONIC CONTROL UNIT - BOOSTER 2	1E	02	VOLTAGE TOO LOW	The engine runs at 2 (3) cylinders.	Power stage for the electro-injectors of cylinders 2-3 (four-cylinder engine) or 4-5-6 (six-cylinder engine) faulty.	Erase the failure memory and retry. In case the error persists, and only after having excluded the injector defect (see note of 5.x) contact the Help Desk and follow the instructions for the possible replacement of the gearcase.	EDC pilot light on.
RELAY - MAIN	21	01	SHORT CIRCUIT TO POSITIVE	The unit remains always supplied and the EDC warning light remains on also with an Off keyThe battery discharges.	Main relay is not disconnected	Check wiring and connections(note: the main relay is embedded into the EDC unit).Try and remove the fuse and put it again in place. If the inconvenience remains, contact the Help Desk for possible unit replacement.	EDC pilot light on. The main relay is incorporated in the EDC gearcase and can't be individually replaced
RELAY - MAIN	21	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	The unit remains always supplied and the EDC warning light remains on also with an Off keyThe battery discharges.	Main relay is not disconnected	Check wiring and connections(note: the main relay is embedded into the EDC unit).Try and remove the fuse and put it again in place. If the inconvenience remains, contact the Help Desk for possible unit replacement.	EDC pilot light on. The main relay is incorporated in the EDC gearcase and can't be individually replaced
RELAY - MAIN	21	03	NO SIGNAL	The unit remains always supplied and the EDC warning light remains on also with an Off keyThe battery discharges.	Main relay is not disconnected	Check wiring and connections(note: the main relay is embedded into the EDC unit).Try and remove the fuse and put it again in place. If the inconvenience remains, contact the Help Desk for possible unit replacement.	EDC pilot light on. The main relay is incorporated in the EDC gearcase and can't be individually replaced
RELAY - MAIN	22	04	SIGNAL NOT PLAUSIBLE	The unit remains always supplied and the EDC warning light remains on also with an Off keyThe battery discharges.	Main relay is not disconnected	Check wiring and connections(note: the main relay is embedded into the EDC unit).Try and remove the fuse and put it again in place. If the inconvenience remains, contact the Help Desk for possible unit replacement.	EDC pilot light on. The main relay is incorporated in the EDC gearcase and can't be individually replaced

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
RELAY - MAIN	22	05	SUPPLY OVER THE NORMAL RANGE	The unit remains always supplied and the EDC warning light remains on also with an Off keyThe battery discharges.	Main relay is not disconnected	Check wiring and connections(note: the main relay is embedded into the EDC unit).Try and remove the fuse and put it again in place. If the inconvenience remains, contact the Help Desk for possible unit replacement.	EDC pilot light on. The main relay is incorporated in the EDC gearcase and can't be individually replaced
RELAY - MAIN	22	06	SUPPLY BELOW THE RANGE	The unit remains always supplied and the EDC warning light remains on also with an Off keyThe battery discharges.	Main relay is not disconnected	Check wiring and connections(note: the main relay is embedded into the EDC unit).Try and remove the fuse and put it again in place. If the inconvenience remains, contact the Help Desk for possible unit replacement.	EDC pilot light on. The main relay is incorporated in the EDC gearcase and can't be individually replaced
RELAY - MAIN	22	07	VALUE OVER THE NORMAL LIMIT	The unit remains always supplied and the EDC warning light remains on also with an Off keyThe battery discharges.	Main relay is not disconnected	Check wiring and connections(note: the main relay is embedded into the EDC unit).Try and remove the fuse and put it again in place. If the inconvenience remains, contact the Help Desk for possible unit replacement.	EDC pilot light on. The main relay is incorporated in the EDC gearcase and can't be individually replaced
RELAY - MAIN	22	08	VALUE BELOW THE LIMIT	The unit remains always supplied and the EDC warning light remains on also with an Off keyThe battery discharges.	Main relay is not disconnected	Check wiring and connections(note: the main relay is embedded into the EDC unit).Try and remove the fuse and put it again in place. If the inconvenience remains, contact the Help Desk for possible unit replacement.	EDC pilot light on. The main relay is incorporated in the EDC gearcase and can't be individually replaced
WARNING LIGHTS - PRE-POSTHEATING	24	00	NO AVAILABLE SYMPTOM	a)Preheating pilot light always on b)Preheating pilot light always off.		1) The pre-heater warning light should come on for a few seconds at key-on (lamp test). 2) Run Cluster active diagnostic procedure (pre-heater warning light) with a diagnostic tool.	EDC pilot light off. Possible cold start difficult because preheating is working, but no indications are received from the pilot light.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
WARNING LIGHTS - PRE-POSTHEATING	24	01	SHORT CIRCUIT TO POSITIVE	a)Preheating pilot light always on b)Preheating pilot light always off.		1) The pre-heater warning light should come on for a few seconds at key-on (lamp test). 2) Run Cluster active diagnostic procedure (pre-heater warning light) with a diagnostic tool.	EDC pilot light off. Possible cold start difficult because preheating is working, but no indications are received from the pilot light.
WARNING LIGHTS - PRE-POSTHEATING	24	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	a)Preheating pilot light always on b)Preheating pilot light always off.		1) The pre-heater warning light should come on for a few seconds at key-on (lamp test). 2) Run Cluster active diagnostic procedure (pre-heater warning light) with a diagnostic tool.	EDC pilot light off. Possible cold start difficult because preheating is working, but no indications are received from the pilot light.
WARNING LIGHTS - PRE-POSTHEATING	24	03	NO SIGNAL	a)Preheating pilot light always on b)Preheating pilot light always off.		1) The pre-heater warning light should come on for a few seconds at key-on (lamp test). 2) Run Cluster active diagnostic procedure (pre-heater warning light) with a diagnostic tool.	EDC pilot light off. Possible cold start difficult because preheating is working, but no indications are received from the pilot light.
WARNING LIGHTS - PRE-POSTHEATING	24	04	SIGNAL NOT PLAUSIBLE	a)Preheating pilot light always on b)Preheating pilot light always off.		1) The pre-heater warning light should come on for a few seconds at key-on (lamp test). 2) Run Cluster active diagnostic procedure (pre-heater warning light) with a diagnostic tool.	EDC pilot light off. Possible cold start difficult because preheating is working, but no indications are received from the pilot light.

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Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
WARNING LIGHTS - PRE-POSTHEATING	24	05	SUPPLY OVER THE NORMAL RANGE	a)Preheating pilot light always on b)Preheating pilot light always off.		1) The pre-heater warning light should come on for a few seconds at key-on (lamp test). 2) Run Cluster active diagnostic procedure (pre-heater warning light) with a diagnostic tool.	EDC pilot light off. Possible cold start difficult because preheating is working, but no indications are received from the pilot light.
WARNING LIGHTS - PRE-POSTHEATING	24	06	SUPPLY BELOW THE RANGE	a)Preheating pilot light always on b)Preheating pilot light always off.		1) The pre-heater warning light should come on for a few seconds at key-on (lamp test). 2) Run Cluster active diagnostic procedure (pre-heater warning light) with a diagnostic tool.	EDC pilot light off. Possible cold start difficult because preheating is working, but no indications are received from the pilot light.
WARNING LIGHTS - PRE-POSTHEATING	24	07	VALUE OVER THE NORMAL LIMIT	a)Preheating pilot light always on b)Preheating pilot light always off.		1) The pre-heater warning light should come on for a few seconds at key-on (lamp test). 2) Run Cluster active diagnostic procedure (pre-heater warning light) with a diagnostic tool.	EDC pilot light off. Possible cold start difficult because preheating is working, but no indications are received from the pilot light.
WARNING LIGHTS - PRE-POSTHEATING	24	08	VALUE BELOW THE LIMIT	a)Preheating pilot light always on b)Preheating pilot light always off.		1) The pre-heater warning light should come on for a few seconds at key-on (lamp test). 2) Run Cluster active diagnostic procedure (pre-heater warning light) with a diagnostic tool.	EDC pilot light off. Possible cold start difficult because preheating is working, but no indications are received from the pilot light.
RELAY - GLOW PLUG	26	00	NO AVAILABLE SYMPTOM	A) the pre-post heating resistance is not powered, possible cold start difficult and grade of smoke when starting B)the pre-post heating resistance is always powered: early wear of the resistance, the batteries become rapidly discharged.	Pre-post heating resistance control relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B4, between relay pin 86 and connector EDC pin B16.	EDC pilot light on.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
RELAY - GLOW PLUG	26	01	SHORT CIRCUIT TO POSITIVE	A) the pre-post heating resistance is not powered, possible cold start difficult and grade of smoke when starting B)the pre-post heating resistance is always powered: early wear of the resistance, the batteries become rapidly discharged.	Pre-post heating resistance control relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B4, between relay pin 86 and connector EDC pin B16.	EDC pilot light on.
RELAY - GLOW PLUG	26	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	A) the pre-post heating resistance is not powered, possible cold start difficult and grade of smoke when starting B)the pre-post heating resistance is always powered: early wear of the resistance, the batteries become rapidly discharged.	Pre-post heating resistance control relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B4, between relay pin 86 and connector EDC pin B16.	EDC pilot light on.
RELAY - GLOW PLUG	26	03	NO SIGNAL	A) the pre-post heating resistance is not powered, possible cold start difficult and grade of smoke when starting B)the pre-post heating resistance is always powered: early wear of the resistance, the batteries become rapidly discharged.	Pre-post heating resistance control relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B4, between relay pin 86 and connector EDC pin B16.	EDC pilot light on.
RELAY - GLOW PLUG	27	04	SIGNAL NOT PLAUSIBLE	A) the pre-post heating resistance is not powered, possible cold start difficult and grade of smoke when starting B)the pre-post heating resistance is always powered: early wear of the resistance, the batteries become rapidly discharged.	Pre-post heating resistance control relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B4, between relay pin 86 and connector EDC pin B16.	EDC pilot light on.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
RELAY - GLOW PLUG	27	05	SUPPLY OVER THE NORMAL RANGE	A) the pre-post heating resistance is not powered, possible cold start difficult and grade of smoke when starting B)the pre-post heating resistance is always powered: early wear of the resistance, the batteries become rapidly discharged.	Pre-post heating resistance control relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B4, between relay pin 86 and connector EDC pin B16.	EDC pilot light on.
RELAY - GLOW PLUG	27	06	SUPPLY BELOW THE RANGE	A) the pre-post heating resistance is not powered, possible cold start difficult and grade of smoke when starting B)the pre-post heating resistance is always powered: early wear of the resistance, the batteries become rapidly discharged.	Pre-post heating resistance control relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B4, between relay pin 86 and connector EDC pin B16.	EDC pilot light on.
RELAY - GLOW PLUG	27	07	VALUE OVER THE NORMAL LIMIT	A) the pre-post heating resistance is not powered, possible cold start difficult and grade of smoke when starting B)the pre-post heating resistance is always powered: early wear of the resistance, the batteries become rapidly discharged.	Pre-post heating resistance control relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B4, between relay pin 86 and connector EDC pin B16.	EDC pilot light on.
RELAY - GLOW PLUG	27	08	VALUE BELOW THE LIMIT	A) the pre-post heating resistance is not powered, possible cold start difficult and grade of smoke when starting B)the pre-post heating resistance is always powered: early wear of the resistance, the batteries become rapidly discharged.	Pre-post heating resistance control relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B4, between relay pin 86 and connector EDC pin B16.	EDC pilot light on.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
RELAY - HEATED FUEL FILTER	2A	00	NO AVAILABLE SYMPTOM	a) Heater always engaged. The battery becomes discharged. b)Heater never engaged. Possible filter clogging due to paraffin traces in the fuel in presence of too low external temperatures (< -15 °C).	Fuel filter heater relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B2 , between relay pin 86 and connector EDC pin B36.	EDC pilot light off. a)Possible storage of 2.3 because the fuel overheats.
RELAY - HEATED FUEL FILTER	2A	01	SHORT CIRCUIT TO POSITIVE	a) Heater always engaged. The battery becomes discharged. b)Heater never engaged. Possible filter clogging due to paraffin traces in the fuel in presence of too low external temperatures (< -15 °C).	Fuel filter heater relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B2, between relay pin 86 and connector EDC pin B36.	EDC pilot light off. a)Possible storage of 2.3 because the fuel overheats.
RELAY - HEATED FUEL FILTER	2A	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	a) Heater always engaged. The battery becomes discharged. b)Heater never engaged. Possible filter clogging due to paraffin traces in the fuel in presence of too low external temperatures (< -15 °C).	Fuel filter heater relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B2, between relay pin 86 and connector EDC pin B36.	EDC pilot light off. a)Possible storage of 2.3 because the fuel overheats.
RELAY - HEATED FUEL FILTER	2A	03	NO SIGNAL	a) Heater always engaged. The battery becomes discharged. b)Heater never engaged. Possible filter clogging due to paraffin traces in the fuel in presence of too low external temperatures (< -15 °C).	Fuel filter heater relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B2, between relay pin 86 and connector EDC pin B36.	EDC pilot light off. a)Possible storage of 2.3 because the fuel overheats.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
RELAY - HEATED FUEL FILTER	2A	04	SIGNAL NOT PLAUSIBLE	a) Heater always engaged. The battery becomes discharged. b)Heater never engaged. Possible filter clogging due to paraffin traces in the fuel in presence of too low external temperatures (< -15 °C).	Fuel filter heater relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B2, between relay pin 86 and connector EDC pin B36.	EDC pilot light off. a)Possible storage of 2.3 because the fuel overheats.
RELAY - HEATED FUEL FILTER	2A	05	SUPPLY OVER THE NORMAL RANGE	a) Heater always engaged. The battery becomes discharged. b)Heater never engaged. Possible filter clogging due to paraffin traces in the fuel in presence of too low external temperatures (< -15 °C).	Fuel filter heater relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B2, between relay pin 86 and connector EDC pin B36.	EDC pilot light off. a)Possible storage of 2.3 because the fuel overheats.
RELAY - HEATED FUEL FILTER	2A	06	SUPPLY BELOW THE RANGE	a) Heater always engaged. The battery becomes discharged. b)Heater never engaged. Possible filter clogging due to paraffin traces in the fuel in presence of too low external temperatures (< -15 °C).	Fuel filter heater relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B2, between relay pin 86 and connector EDC pin B36.	EDC pilot light off. a)Possible storage of 2.3 because the fuel overheats.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
RELAY - HEATED FUEL FILTER	2A	07	VALUE OVER THE NORMAL LIMIT	a) Heater always engaged. The battery becomes discharged. b)Heater never engaged. Possible filter clogging due to paraffin traces in the fuel in presence of too low external temperatures (< -15 °C).	Fuel filter heater relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B2, between relay pin 86 and connector EDC pin B36.	EDC pilot light off. a)Possible storage of 2.3 because the fuel overheats.
RELAY - START	2B	00	NO AVAILABLE SYMPTOM	The engine doesn't start. In case it is already running, it stops.	Starter relay short-circuited or open-circuited.	Check the component is all right. Check the wiring between relay and connector EDC pin B37.	EDC pilot light on.
ENGINE - CONTROL SYSTEM PRE-POSTHEATI NG	2B	00	NO AVAILABLE SYMPTOM	Possible grade of smoke after starting.	Pre-post heating procedure monitoring.	Check that the cables are properly connected to the pre-post heating resistance terminals. Check that the pre-post heating resistance is all right (R = approx. 0,5 Ohm) Check wiring and connections between the pre-post heating resistance remote control switch pin 87 and the terminal (+) of the resistance. Check wiring and connections between terminal (-) of the resistance and earth.	EDC pilot light on. The gearcase doesn't detect, by means of the air temperature sensor in the suction manifold, the increase in the temperature due to the operation of the resistance.
RELAY - START	2B	01	SHORT CIRCUIT TO POSITIVE	The engine doesn't start. In case it is already running, it stops.	Starter relay short-circuited or open-circuited.	Check the component is all right. Check the wiring between relay and connector EDC pin B37.	EDC pilot light on.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - CONTROL SYSTEM PRE-POSTHEATI NG	2B	01	SHORT CIRCUIT TO POSITIVE	Possible grade of smoke after starting.	Pre-post heating procedure monitoring.	Check that the cables are properly connected to the pre-post heating resistance terminals. Check that the pre-post heating resistance is all right (R = approx. 0,5 Ohm) Check wiring and connections between the pre-post heating resistance remote control switch pin 87 and the terminal (+) of the resistance. Check wiring and connections between terminal (-) of the resistance and earth.	EDC pilot light on. The gearcase doesn't detect, by means of the air temperature sensor in the suction manifold, the increase in the temperature due to the operation of the resistance.
RELAY - START	2B	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	The engine doesn't start. In case it is already running, it stops.	Starter relay short-circuited or open-circuited.	Check the component is all right. Check the wiring between relay and connector EDC pin B37.	EDC pilot light on.
ENGINE - CONTROL SYSTEM PRE-POSTHEATI NG	2B	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Possible grade of smoke after starting.	Pre-post heating procedure monitoring.	Check that the cables are properly connected to the pre-post heating resistance terminals. Check that the pre-post heating resistance is all right (R = approx. 0,5 Ohm) Check wiring and connections between the pre-post heating resistance remote control switch pin 87 and the terminal (+) of the resistance. Check wiring and connections between terminal (-) of the resistance and earth.	EDC pilot light on. The gearcase doesn't detect, by means of the air temperature sensor in the suction manifold, the increase in the temperature due to the operation of the resistance.
RELAY - START	2B	03	NO SIGNAL	The engine doesn't start. In case it is already running, it stops.	Starter relay short-circuited or open-circuited.	Check the component is all right. Check the wiring between relay and connector EDC pin B37.	EDC pilot light on.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE CONTROL SYSTEM - PRE-POSTHEATING	2B	03	NO SIGNAL	Possible grade of smoke after starting.	Pre-post heating procedure monitoring.	Check that the cables are properly connected to the pre-post heating resistance terminals. Check that the pre-post heating resistance is all right (R = approx. 0,5 Ohm) Check wiring and connections between the pre-post heating resistance remote control switch pin 87 and the terminal (+) of the resistance. Check wiring and connections between terminal (-) of the resistance and earth.	EDC pilot light on. The gearcase doesn't detect, by means of the air temperature sensor in the suction manifold, the increase in the temperature due to the operation of the resistance.
RELAY - START	2B	04	SIGNAL NOT PLAUSIBLE	The engine doesn't start. In case it is already running, it stops.	Starter relay short-circuited or open-circuited.	Check the component is all right. Check the wiring between relay and connector EDC pin B37.	EDC pilot light on.
RELAY - START	2B	05	SUPPLY OVER THE NORMAL RANGE	The engine doesn't start. In case it is already running, it stops.	Starter relay short-circuited or open-circuited.	Check the component is all right. Check the wiring between relay and connector EDC pin B37.	EDC pilot light on.
RELAY - START	2B	06	SUPPLY BELOW THE RANGE	The engine doesn't start. In case it is already running, it stops.	Starter relay short-circuited or open-circuited.	Check the component is all right. Check the wiring between relay and connector EDC pin B37.	EDC pilot light on.
RELAY - START	2B	07	VALUE OVER THE NORMAL LIMIT	The engine doesn't start. In case it is already running, it stops.	Starter relay short-circuited or open-circuited.	Check the component is all right. Check the wiring between relay and connector EDC pin B37.	EDC pilot light on.
RELAY - HEATED FUEL FILTER	2B	08	VALUE BELOW THE LIMIT	a) Heater always engaged. The battery becomes discharged. b)Heater never engaged. Possible filter clogging due to paraffin traces in the fuel in presence of too low external temperatures (< -15 °C).	Fuel filter heater relay faulty.	Active diagnosis. Check the wiring between relay pin 85 and connector EDC pin B2, between relay pin 86 and connector EDC pin B36.	EDC pilot light off. a)Possible storage of 2.3 because the fuel overheats.
RELAY - START	2B	08	VALUE BELOW THE LIMIT	The engine doesn't start. In case it is already running, it stops.	Starter relay short-circuited or open-circuited.	Check the component is all right. Check the wiring between relay and connector EDC pin B37.	EDC pilot light on.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - BOOST AIR TEMPERATURE	2C	00	NO AVAILABLE SYMPTOM	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air tempe?rature sensor on suction manifold	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the supercharging air temperature will be fixed at 30 °C. If the temperature is fixed at 30 °C, check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) pins 1 and 2 of the sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C21, between sensor connector (wiring side) pin 2 and connector EDC pin C29.	EDC pilot light off. The temperature sensor is incorporated in the pressure one.
SENSORS - BOOST AIR TEMPERATURE	2C	01	SHORT CIRCUIT TO POSITIVE	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air tempe?rature sensor on suction manifold	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the supercharging air temperature will be fixed at 30 °C. If the temperature is fixed at 30 °C, check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) pins 1 and 2 of the sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C21, between sensor connector (wiring side) pin 2 and connector EDC pin C29.	EDC pilot light off. The temperature sensor is incorporated in the pressure one.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - BOOST AIR TEMPERATURE	2C	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Slight power reduction	Positively short-circuited, ground-short-circuited or open-circuited air tempe?rature sensor on suction manifold	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the supercharging air temperature will be fixed at 30 °C. If the temperature is fixed at 30 °C, check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) pins 1 and 2 of the sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C21, between sensor connector (wiring side) pin 2 and connector EDC pin C29.	EDC pilot light off. The temperature sensor is incorporated in the pressure one.
SENSORS - BOOST AIR TEMPERATURE	2C	03	NO SIGNAL	Slight power reduction	Positively short-circuited, ground-short-circuited or open-circuited air tempe?rature sensor on suction manifold	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the supercharging air temperature will be fixed at 30 °C. If the temperature is fixed at 30 °C, check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) pins 1 and 2 of the sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C21, between sensor connector (wiring side) pin 2 and connector EDC pin C29.	EDC pilot light off. The temperature sensor is incorporated in the pressure one.

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Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE CONTROL SYSTEM - PRE-POSTHEATING	2C	04	SIGNAL NOT PLAUSIBLE	Possible grade of smoke after starting.	Pre-post heating procedure monitoring.	Check that the cables are properly connected to the pre-post heating resistance terminals. Check that the pre-post heating resistance is all right (R = approx. 0,5 Ohm) Check wiring and connections between the pre-post heating resistance remote control switch pin 87 and the terminal (+) of the resistance. Check wiring and connections between terminal (-) of the resistance and earth.	EDC pilot light on. The gearcase doesn't detect, by means of the air temperature sensor in the suction manifold, the increase in the temperature due to the operation of the resistance.
SENSORS - BOOST AIR TEMPERATURE	2C	04	SIGNAL NOT PLAUSIBLE	Slight power reduction	Positively short-circuited, ground-short-circuited or open-circuited air tempe?rature sensor on suction manifold	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the supercharging air temperature will be fixed at 30 °C. If the temperature is fixed at 30 °C, check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) pins 1 and 2 of the sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C21, between sensor connector (wiring side) pin 2 and connector EDC pin C29.	EDC pilot light off. The temperature sensor is incorporated in the pressure one.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - CONTROL SYSTEM PRE-POSTHEATI NG	2C	05	SUPPLY OVER THE NORMAL RANGE	Possible grade of smoke after starting.	Pre-post heating procedure monitoring.	Check that the cables are properly connected to the pre-post heating resistance terminals. Check that the pre-post heating resistance is all right (R = approx. 0,5 Ohm) Check wiring and connections between the pre-post heating resistance remote control switch pin 87 and the terminal (+) of the resistance. Check wiring and connections between terminal (-) of the resistance and earth.	EDC pilot light on. The gearcase doesn't detect, by means of the air temperature sensor in the suction manifold, the increase in the temperature due to the operation of the resistance.
SENSORS - BOOST AIR TEMPERATURE	2C	05	SUPPLY OVER THE NORMAL RANGE	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air tempe?rature sensor on suction manifold	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the supercharging air temperature will be fixed at 30 °C. If the temperature is fixed at 30 °C, check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) pins 1 and 2 of the sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C21, between sensor connector (wiring side) pin 2 and connector EDC pin C29.	EDC pilot light off. The temperature sensor is incorporated in the pressure one.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE CONTROL SYSTEM - PRE-POSTHEATING	2C	06	SUPPLY BELOW THE RANGE	Possible grade of smoke after starting.	Pre-post heating procedure monitoring.	Check that the cables are properly connected to the pre-post heating resistance terminals. Check that the pre-post heating resistance is all right (R = approx. 0,5 Ohm) Check wiring and connections between the pre-post heating resistance remote control switch pin 87 and the terminal (+) of the resistance. Check wiring and connections between terminal (-) of the resistance and earth.	EDC pilot light on. The gearcase doesn't detect, by means of the air temperature sensor in the suction manifold, the increase in the temperature due to the operation of the resistance.
SENSORS - BOOST AIR TEMPERATURE	2C	06	SUPPLY BELOW THE RANGE	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air tempe?rature sensor on suction manifold	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the supercharging air temperature will be fixed at 30 °C. If the temperature is fixed at 30 °C, check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) pins 1 and 2 of the sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C21, between sensor connector (wiring side) pin 2 and connector EDC pin C29.	EDC pilot light off. The temperature sensor is incorporated in the pressure one.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE CONTROL SYSTEM - PRE-POSTHEATING	2C	07	VALUE OVER THE NORMAL LIMIT	Possible grade of smoke after starting.	Pre-post heating procedure monitoring.	Check that the cables are properly connected to the pre-post heating resistance terminals. Check that the pre-post heating resistance is all right (R = approx. 0,5 Ohm) Check wiring and connections between the pre-post heating resistance remote control switch pin 87 and the terminal (+) of the resistance. Check wiring and connections between terminal (-) of the resistance and earth.	EDC pilot light on. The gearcase doesn't detect, by means of the air temperature sensor in the suction manifold, the increase in the temperature due to the operation of the resistance.
SENSORS - BOOST AIR TEMPERATURE	2C	07	VALUE OVER THE NORMAL LIMIT	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air tempe?rature sensor on suction manifold	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the supercharging air temperature will be fixed at 30 °C. If the temperature is fixed at 30 °C, check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) pins 1 and 2 of the sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C21, between sensor connector (wiring side) pin 2 and connector EDC pin C29.	EDC pilot light off. The temperature sensor is incorporated in the pressure one.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE CONTROL SYSTEM - PRE-POSTHEATING	2C	08	VALUE BELOW THE LIMIT	Possible grade of smoke after starting.	Pre-post heating procedure monitoring.	Check that the cables are properly connected to the pre-post heating resistance terminals. Check that the pre-post heating resistance is all right (R = approx. 0,5 Ohm) Check wiring and connections between the pre-post heating resistance remote control switch pin 87 and the terminal (+) of the resistance. Check wiring and connections between terminal (-) of the resistance and earth.	EDC pilot light on. The gearcase doesn't detect, by means of the air temperature sensor in the suction manifold, the increase in the temperature due to the operation of the resistance.
SENSORS - BOOST AIR TEMPERATURE	2C	08	VALUE BELOW THE LIMIT	No perceptible reaction.	Positively short-circuited, ground-short-circuited or open-circuited air tempe?rature sensor on suction manifold	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the supercharging air temperature will be fixed at 30 °C. If the temperature is fixed at 30 °C, check the sensor is all right (R = approx. 2,5 kOhm at 20 °C) pins 1 and 2 of the sensor itself. If the sensor is not damaged, check the wiring between the sensor connector (wiring side) pin 1 and connector EDC pin C21, between sensor connector (wiring side) pin 2 and connector EDC pin C29.	EDC pilot light off. The temperature sensor is incorporated in the pressure one.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - ENGINE SPEED SENSING	2D	00	NO AVAILABLE SYMPTOM	Light power reduction.	No plausibility between the flywheel sensor and the camshaft sensor signals.	Presence of error 6.3 alone is not significant: clear failure memory and pass the vehicle in this case. Error 6.3 is significant when it appears along with error 6.1 and/or 6.2. Read failure memory: check environmental conditions associated to error. Delete error if stored at engine speed less than 650 rpm, clear failure memory and pass the vehicle. Otherwise, check integrity of damper flywheel and camshaft phonic wheel, cleanness and correct fastening of the two sensors.	EDC pilot light on. Sometimes only the error 6.3 is stored, whereas actually it is the camshaft signal that is faulty. In this case carry out the inspections foreseen to solve problem 6.2 This error might be stored now and then in case of engine stop using the under-cabin push-button. If the damper flywheel is worn, it will be locally deformed and, if the case mating areas have begun yielding, signs of silicone will the visible in the surrounding zone. Check that on the phonic wheel there are no shreds of adhesive tape and that it turns with no axial oscillations due to possible impact-strains.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - ENGINE SPEED SENSING	2D	01	SHORT CIRCUIT TO POSITIVE	Light power reduction.	No plausibility between the flywheel sensor and the camshaft sensor signals.	Presence of error 6.3 alone is not significant: clear failure memory and pass the vehicle in this case. Error 6.3 is significant when it appears along with error 6.1 and/or 6.2. Read failure memory: check environmental conditions associated to error. Delete error if stored at engine speed less than 650 rpm, clear failure memory and pass the vehicle. Otherwise, check integrity of damper flywheel and camshaft phonic wheel, cleanness and correct fastening of the two sensors.	EDC pilot light on. Sometimes only the error 6.3 is stored, whereas actually it is the camshaft signal that is faulty. In this case carry out the inspections foreseen to solve problem 6.2 This error might be stored now and then in case of engine stop using the under-cabin push-button. If the damper flywheel is worn, it will be locally deformed and, if the case mating areas have begun yielding, signs of silicone will the visible in the surrounding zone. Check that on the phonic wheel there are no shreds of adhesive tape and that it turns with no axial oscillations due to possible impact-strains.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - ENGINE SPEED SENSING	2D	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Light power reduction.	No plausibility between the flywheel sensor and the camshaft sensor signals.	Presence of error 6.3 alone is not significant: clear failure memory and pass the vehicle in this case. Error 6.3 is significant when it appears along with error 6.1 and/or 6.2. Read failure memory: check environmental conditions associated to error. Delete error if stored at engine speed less than 650 rpm, clear failure memory and pass the vehicle. Otherwise, check integrity of damper flywheel and camshaft phonic wheel, cleanness and correct fastening of the two sensors.	EDC pilot light on. Sometimes only the error 6.3 is stored, whereas actually it is the camshaft signal that is faulty. In this case carry out the inspections foreseen to solve problem 6.2 This error might be stored now and then in case of engine stop using the under-cabin push-button. If the damper flywheel is worn, it will be locally deformed and, if the case mating areas have begun yielding, signs of silicone will the visible in the surrounding zone. Check that on the phonic wheel there are no shreds of adhesive tape and that it turns with no axial oscillations due to possible impact-strains.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - ENGINE SPEED SENSING	2D	03	NO VALID SIGNAL FROM CRK SENSOR	Light power reduction.	No plausibility between the flywheel sensor and the camshaft sensor signals.	Presence of error 6.3 alone is not significant: clear failure memory and pass the vehicle in this case. Error 6.3 is significant when it appears along with error 6.1 and/or 6.2. Read failure memory: check environmental conditions associated to error. Delete error if stored at engine speed less than 650 rpm, clear failure memory and pass the vehicle. Otherwise, check integrity of damper flywheel and camshaft phonic wheel, cleanness and correct fastening of the two sensors.	EDC pilot light on. Sometimes only the error 6.3 is stored, whereas actually it is the camshaft signal that is faulty. In this case carry out the inspections foreseen to solve problem 6.2 This error might be stored now and then in case of engine stop using the under-cabin push-button. If the damper flywheel is worn, it will be locally deformed and, if the case mating areas have begun yielding, signs of silicone will the visible in the surrounding zone. Check that on the phonic wheel there are no shreds of adhesive tape and that it turns with no axial oscillations due to possible impact-strains.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - ENGINE SPEED SENSING	2D	04	SIGNAL NOT PLAUSIBLE	Light power reduction.	No plausibility between the flywheel sensor and the camshaft sensor signals.	Presence of error 6.3 alone is not significant: clear failure memory and pass the vehicle in this case. Error 6.3 is significant when it appears along with error 6.1 and/or 6.2. Read failure memory: check environmental conditions associated to error. Delete error if stored at engine speed less than 650 rpm, clear failure memory and pass the vehicle. Otherwise, check integrity of damper flywheel and camshaft phonic wheel, cleanness and correct fastening of the two sensors.	EDC pilot light on. Sometimes only the error 6.3 is stored, whereas actually it is the camshaft signal that is faulty. In this case carry out the inspections foreseen to solve problem 6.2 This error might be stored now and then in case of engine stop using the under-cabin push-button. If the damper flywheel is worn, it will be locally deformed and, if the case mating areas have begun yielding, signs of silicone will the visible in the surrounding zone. Check that on the phonic wheel there are no shreds of adhesive tape and that it turns with no axial oscillations due to possible impact-strains.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - ENGINE SPEED SENSING	2D	05	SUPPLY OVER THE NORMAL RANGE	Light power reduction.	No plausibility between the flywheel sensor and the camshaft sensor signals.	Presence of error 6.3 alone is not significant: clear failure memory and pass the vehicle in this case. Error 6.3 is significant when it appears along with error 6.1 and/or 6.2. Read failure memory: check environmental conditions associated to error. Delete error if stored at engine speed less than 650 rpm, clear failure memory and pass the vehicle. Otherwise, check integrity of damper flywheel and camshaft phonic wheel, cleanness and correct fastening of the two sensors.	EDC pilot light on. Sometimes only the error 6.3 is stored, whereas actually it is the camshaft signal that is faulty. In this case carry out the inspections foreseen to solve problem 6.2 This error might be stored now and then in case of engine stop using the under-cabin push-button. If the damper flywheel is worn, it will be locally deformed and, if the case mating areas have begun yielding, signs of silicone will the visible in the surrounding zone. Check that on the phonic wheel there are no shreds of adhesive tape and that it turns with no axial oscillations due to possible impact-strains.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - ENGINE SPEED SENSING	2D	06	SUPPLY BELOW THE RANGE	Light power reduction.	No plausibility between the flywheel sensor and the camshaft sensor signals.	Presence of error 6.3 alone is not significant: clear failure memory and pass the vehicle in this case. Error 6.3 is significant when it appears along with error 6.1 and/or 6.2. Read failure memory: check environmental conditions associated to error. Delete error if stored at engine speed less than 650 rpm, clear failure memory and pass the vehicle. Otherwise, check integrity of damper flywheel and camshaft phonic wheel, cleanness and correct fastening of the two sensors.	EDC pilot light on. Sometimes only the error 6.3 is stored, whereas actually it is the camshaft signal that is faulty. In this case carry out the inspections foreseen to solve problem 6.2 This error might be stored now and then in case of engine stop using the under-cabin push-button. If the damper flywheel is worn, it will be locally deformed and, if the case mating areas have begun yielding, signs of silicone will the visible in the surrounding zone. Check that on the phonic wheel there are no shreds of adhesive tape and that it turns with no axial oscillations due to possible impact-strains.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - ENGINE SPEED SENSING	2D	07	VALUE OVER THE NORMAL LIMIT	Light power reduction.	No plausibility between the flywheel sensor and the camshaft sensor signals.	Presence of error 6.3 alone is not significant: clear failure memory and pass the vehicle in this case. Error 6.3 is significant when it appears along with error 6.1 and/or 6.2. Read failure memory: check environmental conditions associated to error. Delete error if stored at engine speed less than 650 rpm, clear failure memory and pass the vehicle. Otherwise, check integrity of damper flywheel and camshaft phonic wheel, cleanness and correct fastening of the two sensors.	EDC pilot light on. Sometimes only the error 6.3 is stored, whereas actually it is the camshaft signal that is faulty. In this case carry out the inspections foreseen to solve problem 6.2 This error might be stored now and then in case of engine stop using the under-cabin push-button. If the damper flywheel is worn, it will be locally deformed and, if the case mating areas have begun yielding, signs of silicone will the visible in the surrounding zone. Check that on the phonic wheel there are no shreds of adhesive tape and that it turns with no axial oscillations due to possible impact-strains.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - ENGINE SPEED SENSING	2D	08	NO VALID SIGNAL FROM CAM SENSOR	Light power reduction.	No plausibility between the flywheel sensor and the camshaft sensor signals.	Presence of error 6.3 alone is not significant: clear failure memory and pass the vehicle in this case. Error 6.3 is significant when it appears along with error 6.1 and/or 6.2. Read failure memory: check environmental conditions associated to error. Delete error if stored at engine speed less than 650 rpm, clear failure memory and pass the vehicle. Otherwise, check integrity of damper flywheel and camshaft phonic wheel, cleanness and correct fastening of the two sensors.	EDC pilot light on. Sometimes only the error 6.3 is stored, whereas actually it is the camshaft signal that is faulty. In this case carry out the inspections foreseen to solve problem 6.2 This error might be stored now and then in case of engine stop using the under-cabin push-button. If the damper flywheel is worn, it will be locally deformed and, if the case mating areas have begun yielding, signs of silicone will the visible in the surrounding zone. Check that on the phonic wheel there are no shreds of adhesive tape and that it turns with no axial oscillations due to possible impact-strains.

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Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTROVALVES - FUEL PRESSURE REGULATION	2E	00	NO AVAILABLE SYMPTOM	Significant power reduction.	Positively short-circuited, ground short-circuited or open-circuited pressure regulator	Check that the connector is properly connected to the pressure regulator. Check by means of a multimeter that the pressure regulator solenoid valve is all right (r = APPROX. 3,2 Ohm). If the component is all right, check the wiring between the pressure regulator connector and the connector EDC pin C5-C7.	EDC pilot light on. The pressure regulator, which can be replaced on its own, is available as a spare.
ELECTROVALVES - FUEL PRESSURE REGULATION	2E	01	SHORT CIRCUIT TO POSITIVE	Significant power reduction.	Positively short-circuited, ground short-circuited or open-circuited pressure regulator	Check that the connector is properly connected to the pressure regulator. Check by means of a multimeter that the pressure regulator solenoid valve is all right (r = APPROX. 3,2 Ohm). If the component is all right, check the wiring between the pressure regulator connector and the connector EDC pin C5-C7.	EDC pilot light on. The pressure regulator, which can be replaced on its own, is available as a spare.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTROVALVES - FUEL PRESSURE REGULATION	2F	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Significant power reduction.	Positively short-circuited, ground short-circuited or open-circuited pressure regulator	Check that the connector is properly connected to the pressure regulator. Check by means of a multimeter that the pressure regulator solenoid valve is all right (r = APPROX. 3,2 Ohm). If the component is all right, check the wiring between the pressure regulator connector and the connector EDC pin C5-C7.	EDC pilot light on. The pressure regulator, which can be replaced on its own, is available as a spare.
ELECTROVALVES - FUEL PRESSURE REGULATION	2F	03	NO SIGNAL	Significant power reduction.	Positively short-circuited, ground short-circuited or open-circuited pressure regulator	Check that the connector is properly connected to the pressure regulator. Check by means of a multimeter that the pressure regulator solenoid valve is all right (r = APPROX. 3,2 Ohm). If the component is all right, check the wiring between the pressure regulator connector and the connector EDC pin C5-C7.	EDC pilot light on. The pressure regulator, which can be replaced on its own, is available as a spare.
ELECTROVALVES - FUEL PRESSURE REGULATION	2F	04	SIGNAL NOT PLAUSIBLE	Significant power reduction.	Positively short-circuited, ground short-circuited or open-circuited pressure regulator	Check that the connector is properly connected to the pressure regulator. Check by means of a multimeter that the pressure regulator solenoid valve is all right (r = APPROX. 3,2 Ohm). If the component is all right, check the wiring between the pressure regulator connector and the connector EDC pin C5-C7.	EDC pilot light on. The pressure regulator, which can be replaced on its own, is available as a spare.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTROVALVES - FUEL PRESSURE REGULATION	2F	05	SUPPLY OVER THE NORMAL RANGE	Significant power reduction.	Positively short-circuited, ground short-circuited or open-circuited pressure regulator	Check that the connector is properly connected to the pressure regulator. Check by means of a multimeter that the pressure regulator solenoid valve is all right (r = APPROX. 3,2 Ohm). If the component is all right, check the wiring between the pressure regulator connector and the connector EDC pin C5-C7.	EDC pilot light on. The pressure regulator, which can be replaced on its own, is available as a spare.
ELECTROVALVES - FUEL PRESSURE REGULATION	2F	06	SUPPLY BELOW THE RANGE	Significant power reduction.	Positively short-circuited, ground short-circuited or open-circuited pressure regulator	Check that the connector is properly connected to the pressure regulator. Check by means of a multimeter that the pressure regulator solenoid valve is all right (r = APPROX. 3,2 Ohm). If the component is all right, check the wiring between the pressure regulator connector and the connector EDC pin C5-C7.	EDC pilot light on. The pressure regulator, which can be replaced on its own, is available as a spare.
ELECTROVALVES - FUEL PRESSURE REGULATION	2F	07	VALUE OVER THE NORMAL LIMIT	Significant power reduction.	Positively short-circuited, ground short-circuited or open-circuited pressure regulator	Check that the connector is properly connected to the pressure regulator. Check by means of a multimeter that the pressure regulator solenoid valve is all right (r = APPROX. 3,2 Ohm). If the component is all right, check the wiring between the pressure regulator connector and the connector EDC pin C5-C7.	EDC pilot light on. The pressure regulator, which can be replaced on its own, is available as a spare.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTROVALVES - FUEL PRESSURE REGULATION	2F	08	VALUE BELOW THE LIMIT	Significant power reduction.	Positively short-circuited, ground short-circuited or open-circuited pressure regulator	Check that the connector is properly connected to the pressure regulator. Check by means of a multimeter that the pressure regulator solenoid valve is all right (r = APPROX. 3,2 Ohm). If the component is all right, check the wiring between the pressure regulator connector and the connector EDC pin C5-C7.	EDC pilot light on. The pressure regulator, which can be replaced on its own, is available as a spare.
ENGINE - POWER STAGE FOR SYNC. SIGNAL PT-BOX	31	00	NO AVAILABLE SYMPTOM		EDC to diagnostic instrument synchronization signal short-circuited or open-circuited.	Check that the wiring between connector EDC pin B48 and diagnosis plug pin 23.	EDC pilot light off
ENGINE - POWER STAGE FOR SYNC. SIGNAL PT-BOX	31	01	SHORT CIRCUIT TO POSITIVE		EDC to diagnostic instrument synchronization signal short-circuited or open-circuited.	Check that the wiring between connector EDC pin B48 and diagnosis plug pin 23.	EDC pilot light off
ENGINE - POWER STAGE FOR SYNC. SIGNAL PT-BOX	31	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND		EDC to diagnostic instrument synchronization signal short-circuited or open-circuited.	Check that the wiring between connector EDC pin B48 and diagnosis plug pin 23.	EDC pilot light off
ENGINE - POWER STAGE FOR SYNC. SIGNAL PT-BOX	31	03	NO SIGNAL		EDC to diagnostic instrument synchronization signal short-circuited or open-circuited.	Check that the wiring between connector EDC pin B48 and diagnosis plug pin 23,	EDC pilot light off
ENGINE - POWER STAGE FOR SYNC. SIGNAL (PT-BOX)	31	04	SIGNAL NOT PLAUSIBLE		EDC to diagnostic instrument synchronization signal short-circuited or open-circuited.	Check that the wiring between connector EDC pin B48 and diagnosis plug pin 23.	EDC pilot light off
ENGINE - POWER STAGE FOR SYNC. SIGNAL PT-BOX	31	05	SUPPLY OVER THE NORMAL RANGE		EDC to diagnostic instrument synchronization signal short-circuited or open-circuited.	Check that the wiring between connector EDC pin B48 and diagnosis plug pin 23.	EDC pilot light off

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - POWER STAGE FOR SYNC. SIGNAL PT-BOX	31	06	SUPPLY BELOW THE RANGE		EDC to diagnostic instrument synchronization signal short-circuited or open-circuited.	Check that the wiring between connector EDC pin B48 and diagnosis plug pin 23.	EDC pilot light off
ENGINE - POWER STAGE FOR SYNC. SIGNAL PT-BOX	31	07	VALUE OVER THE NORMAL LIMIT		EDC to diagnostic instrument synchronization signal short-circuited or open-circuited.	Check that the wiring between connector EDC pin B48 and diagnosis plug pin 23.	EDC pilot light off
ENGINE - POWER STAGE FOR SYNC. SIGNAL PT-BOX	31	08	VALUE BELOW THE LIMIT		EDC to diagnostic instrument synchronization signal short-circuited or open-circuited.	Check that the wiring between connector EDC pin B48 and diagnosis plug pin 23.	EDC pilot light off
ENGINE - MONITORING OF PRESSURE RELIEF VALVE	33	00	NO AVAILABLE SYMPTOM	Significant power reduction.	Intervention of the double-stage overpressure valve.	Carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.
ENGINE - MONITORING OF PRESSURE RELIEF VALVE	33	01	SHORT CIRCUIT TO POSITIVE	Significant power reduction.	Intervention of the double-stage overpressure valve.	Carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	00	NO AVAILABLE SYMPTOM		Air intake upstream of the fuel gear pump.	Check the O-Rings and the proper connection of the pipe unions between the tank and the fuel pump (fasteners must be out and unions well hooked).	EDC pilot light winking.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - FUEL PRESSURE MONITORING	34	00	NO AVAILABLE SYMPTOM		Fuel leaks from the pipe unions or low-pressure pipes downstream of the fuel pump. Possible defect of the signal of the rail pressure sensor	Check the O-Rings and the proper connection of the pipe unions downstream of the fuel pump (fasteners must be out and unions well hooked). Check visually that the low-pressure pipes are not damaged. Carry out the inspections of 8.2.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	00	NO AVAILABLE SYMPTOM		Fuel suction pipe in the tank partially clogged due to impurities or distortion caused by overheating.	Check whether the priming pump on the prefilter works properly. If the pump knob remains sucked downwards because of the suction pressure, disassemble and check the tank suction pipe. If the suction pipe is all right, replace the filter.	EDC pilot light winking. In case some shavings have been sucked (due to works carried out by the producer on the fuel tank) perform an accurate cleaning of the tank. As a matter of fact the problem might occur again because of other shavings remained inside the tank.
ENGINE - FUEL PRESSURE MONITORING	34	00	NO AVAILABLE SYMPTOM		Insufficient fuel level in the tank.	Check fuel level.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	00	NO AVAILABLE SYMPTOM	Significant power reduction.	Fuel pressure adjustment: pressure in the rail is lower or higher than the one evaluated by the gearcase.	Reading of measurable parameters: ?Duty Cycle rail pressure solenoid valve? (with release 2-2001 and subsequent ones): in normal conditions, at idling speed, loadless, and steady state engine, the value must be lower than 5%.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	01	TOO HIGH RAIL PRESSURE	Engine stop.	Max-min pressure error in the rail Check that suction and return lines of gasoil are not inverted (tank sensor)	Replace the overpressure valve If the problem persists, carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.

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Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - FUEL PRESSURE MONITORING	34	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Significant power reduction.	Fuel pressure adjustment: pressure in the rail is lower or higher than the one evaluated by the gearcase.	Reading of measurable parameters: ?Duty Cycle rail pressure solenoid valve? (with release 2-2001 and subsequent ones): in normal conditions, at idling speed, loadless, and steady state engine, the value must be lower than 5%.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND		Air intake upstream of the fuel gear pump.	Check the O-Rings and the proper connection of the pipe unions between the tank and the fuel pump (fasteners must be out and unions well hooked).	EDC pilot light winking.
ENGINE - MONITORING OF PRESSURE RELIEF VALVE	34	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Significant power reduction.	Intervention of the double-stage overpressure valve.	Carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND		Fuel leaks from the pipe unions or low-pressure pipes downstream of the fuel pump. Possible defect of the signal of the rail pressure sensor	Check the O-Rings and the proper connection of the pipe unions downstream of the fuel pump (fasteners must be out and unions well hooked). Check visually that the low-pressure pipes are not damaged. Carry out the inspections of 8.2.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND		Fuel suction pipe in the tank partially clogged due to impurities or distortion caused by overheating.	Check whether the priming pump on the prefilter works properly. If the pump knob remains sucked downwards because of the suction pressure, disassemble and check the tank suction pipe. If the suction pipe is all right, replace the filter.	EDC pilot light winking. In case some shavings have been sucked (due to works carried out by the producer on the fuel tank) perform an accurate cleaning of the tank. As a matter of fact the problem might occur again because of other shavings remained inside the tank.
ENGINE - FUEL PRESSURE MONITORING	34	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND		Insufficient fuel level in the tank.	Check fuel level.	EDC pilot light winking.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - MONITORING OF PRESSURE RELIEF VALVE	34	03	NO SIGNAL	Significant power reduction.	Intervention of the double-stage overpressure valve.	Carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	03	TOO LOW RAIL PRESSURE	Engine stop.	Max-min pressure error in the rail Check that suction and return lines of gasoil are not inverted (tank sensor)	Replace the overpressure valve If the problem persists, carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.
ENGINE - MONITORING OF PRESSURE RELIEF VALVE	34	04	SIGNAL NOT PLAUSIBLE	Significant power reduction.	Intervention of the double-stage overpressure valve.	Carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	04	NEGATIVE FUEL PRESSURE DEVIATION	Significant power reduction.	Fuel pressure adjustment: pressure in the rail is lower or higher than the one evaluated by the gearcase.	Reading of measurable parameters: ?Duty Cycle rail pressure solenoid valve? (with release 2-2001 and subsequent ones): in normal conditions, at idling speed, loadless, and steady state engine, the value must be lower than 5%.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	04	NEGATIVE FUEL PRESSURE DEVIATION		Insufficient fuel level in the tank.	Check fuel level.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	04	NEGATIVE FUEL PRESSURE DEVIATION		Fuel suction pipe in the tank partially clogged due to impurities or distortion caused by overheating.	Check whether the priming pump on the prefilter works properly. If the pump knob remains sucked downwards because of the suction pressure, disassemble and check the tank suction pipe. If the suction pipe is all right, replace the filter.	EDC pilot light winking. In case some shavings have been sucked (due to works carried out by the producer on the fuel tank) perform an accurate cleaning of the tank. As a matter of fact the problem might occur again because of other shavings remained inside the tank.
ENGINE - FUEL PRESSURE MONITORING	34	04	NEGATIVE FUEL PRESSURE DEVIATION		Air intake upstream of the fuel gear pump.	Check the O-Rings and the proper connection of the pipe unions between the tank and the fuel pump (fasteners must be out and unions well hooked).	EDC pilot light winking.

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Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - FUEL PRESSURE MONITORING	34	04	NEGATIVE FUEL PRESSURE DEVIATION		Fuel leaks from the pipe unions or low-pressure pipes downstream of the fuel pump. Possible defect of the signal of the rail pressure sensor	Check the O-Rings and the proper connection of the pipe unions downstream of the fuel pump (fasteners must be out and unions well hooked). Check visually that the low-pressure pipes are not damaged. Carry out the inspections of 8.2.	EDC pilot light winking.
ENGINE - MONITORING OF PRESSURE RELIEF VALVE	34	05	SUPPLY OVER THE NORMAL RANGE	Significant power reduction.	Intervention of the double-stage overpressure valve.	Carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	05	POSITIVE FUEL PRESSURE DEVIATION		Air intake upstream of the fuel gear pump.	Check the O-Rings and the proper connection of the pipe unions between the tank and the fuel pump (fasteners must be out and unions well hooked).	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	05	POSITIVE FUEL PRESSURE DEVIATION	Significant power reduction.	Fuel pressure adjustment: pressure in the rail is lower or higher than the one evaluated by the gearcase.	Reading of measurable parameters: ?Duty Cycle rail pressure solenoid valve? (with release 2-2001 and subsequent ones): in normal conditions, at idling speed, loadless, and steady state engine, the value must be lower than 5%.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	05	POSITIVE FUEL PRESSURE DEVIATION		Fuel leaks from the pipe unions or low-pressure pipes downstream of the fuel pump. Possible defect of the signal of the rail pressure sensor	Check the O-Rings and the proper connection of the pipe unions downstream of the fuel pump (fasteners must be out and unions well hooked). Check visually that the low-pressure pipes are not damaged. Carry out the inspections of 8.2.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	05	POSITIVE FUEL PRESSURE DEVIATION		Insufficient fuel level in the tank.	Check fuel level.	EDC pilot light winking.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - FUEL PRESSURE MONITORING	34	05	POSITIVE FUEL PRESSURE DEVIATION		Fuel suction pipe in the tank partially clogged due to impurities or distortion caused by overheating.	Check whether the priming pump on the prefilter works properly. If the pump knob remains sucked downwards because of the suction pressure, disassemble and check the tank suction pipe. If the suction pipe is all right, replace the filter.	EDC pilot light winking. In case some shavings have been sucked (due to works carried out by the producer on the fuel tank) perform an accurate cleaning of the tank. As a matter of fact the problem might occur again because of other shavings remained inside the tank.
ENGINE - MONITORING OF PRESSURE RELIEF VALVE	34	06	SUPPLY BELOW THE RANGE	Significant power reduction.	Intervention of the double-stage overpressure valve.	Carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	06	FUEL PRESSURE DROP WITH ENGINE RUNNING		Air intake upstream of the fuel gear pump.	Check the O-Rings and the proper connection of the pipe unions between the tank and the fuel pump (fasteners must be out and unions well hooked).	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	06	FUEL PRESSURE DROP WITH ENGINE RUNNING		Fuel leaks from the pipe unions or low-pressure pipes downstream of the fuel pump. Possible defect of the signal of the rail pressure sensor	Check the O-Rings and the proper connection of the pipe unions downstream of the fuel pump (fasteners must be out and unions well hooked). Check visually that the low-pressure pipes are not damaged. Carry out the inspections of 8.2.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	06	FUEL PRESSURE DROP WITH ENGINE RUNNING		Fuel suction pipe in the tank partially clogged due to impurities or distortion caused by overheating.	Check whether the priming pump on the prefilter works properly. If the pump knob remains sucked downwards because of the suction pressure, disassemble and check the tank suction pipe. If the suction pipe is all right, replace the filter.	EDC pilot light winking. In case some shavings have been sucked (due to works carried out by the producer on the fuel tank) perform an accurate cleaning of the tank. As a matter of fact the problem might occur again because of other shavings remained inside the tank.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - FUEL PRESSURE MONITORING	34	06	FUEL PRESSURE DROP WITH ENGINE RUNNING		Insufficient fuel level in the tank.	Check fuel level.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	06	FUEL PRESSURE DROP WITH ENGINE RUNNING	Significant power reduction.	Fuel pressure adjustment: pressure in the rail is lower or higher than the one evaluated by the gearcase.	Reading of measurable parameters: ?Duty Cycle rail pressure solenoid valve? (with release 2-2001 and subsequent ones): in normal conditions, at idling speed, loadless, and steady state engine, the value must be lower than 5%.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	07	FUEL PRESSURE DROP WITH ENGINE IDLING		Fuel suction pipe in the tank partially clogged due to impurities or distortion caused by overheating.	Check whether the priming pump on the prefilter works properly. If the pump knob remains sucked downwards because of the suction pressure, disassemble and check the tank suction pipe. If the suction pipe is all right, replace the filter.	EDC pilot light winking. In case some shavings have been sucked (due to works carried out by the producer on the fuel tank) perform an accurate cleaning of the tank. As a matter of fact the problem might occur again because of other shavings remained inside the tank.
ENGINE - FUEL PRESSURE MONITORING	34	07	FUEL PRESSURE DROP WITH ENGINE IDLING		Insufficient fuel level in the tank.	Check fuel level.	EDC pilot light winking.
ENGINE - MONITORING OF PRESSURE RELIEF VALVE	34	07	VALUE OVER THE NORMAL LIMIT	Significant power reduction.	Intervention of the double-stage overpressure valve.	Carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	07	FUEL PRESSURE DROP WITH ENGINE IDLING	Significant power reduction.	Fuel pressure adjustment: pressure in the rail is lower or higher than the one evaluated by the gearcase.	Reading of measurable parameters: ?Duty Cycle rail pressure solenoid valve? (with release 2-2001 and subsequent ones): in normal conditions, at idling speed, loadless, and steady state engine, the value must be lower than 5%.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	34	07	FUEL PRESSURE DROP WITH ENGINE IDLING		Air intake upstream of the fuel gear pump.	Check the O-Rings and the proper connection of the pipe unions between the tank and the fuel pump (fasteners must be out and unions well hooked).	EDC pilot light winking.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - FUEL PRESSURE MONITORING	34	07	FUEL PRESSURE DROP WITH ENGINE IDLING		Fuel leaks from the pipe unions or low-pressure pipes downstream of the fuel pump. Possible defect of the signal of the rail pressure sensor	Check the O-Rings and the proper connection of the pipe unions downstream of the fuel pump (fasteners must be out and unions well hooked). Check visually that the low-pressure pipes are not damaged. Carry out the inspections of 8.2.	EDC pilot light winking.
ENGINE - MONITORING OF PRESSURE RELIEF VALVE	34	08	VALUE BELOW THE LIMIT	Significant power reduction.	Intervention of the double-stage overpressure valve.	Carry out the checks foreseen for 8.2 and 8.3.	EDC pilot light winking.
SENSORS - OIL PRESSURE	35	00	NO AVAILABLE SYMPTOM	Power reduction	Oil pressure sensor short-circuited or open-circuited.	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the oil pressure will be fixed at 60 mbar. Verify the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C9, between sensor connector (wiring side) pin 4 and connector EDC pin C35.	EDC pilot light on. The pressure sensor is incorporated in the temperature one.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS START-UP	35	00	NO AVAILABLE SYMPTOM	Significant power reduction.	The internal ECU test which occurs when the engine is switched on does not succeed.	Check wiring between +15 of the key and ecu connector pin B39 coming from passaparete connector B pin 2. Erase fault memory and retry: if after engines shuts down the fault persists, contact the Help Desk for a possible ecu change	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - OIL PRESSURE	35	01	SHORT CIRCUIT TO POSITIVE	Power reduction	Oil pressure sensor short-circuited or open-circuited.	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the oil pressure will be fixed at 60 mbar. Verify the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C9, between sensor connector (wiring side) pin 4 and connector EDC pin C35.	EDC pilot light on. The pressure sensor is incorporated in the temperature one.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS START-UP	35	01	SHORT CIRCUIT TO POSITIVE	Significant power reduction.	The internal ECU test which occurs when the engine is switched on does not succeed.	Check wiring between +15 of the key and ecu connector pin B39 coming from passaparete connector B pin 2. Erase fault memory and retry: if after engines shuts down the fault persists, contact the Help Desk for a possible ecu change	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.
SENSORS - OIL PRESSURE	35	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Power reduction	Oil pressure sensor short-circuited or open-circuited.	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the oil pressure will be fixed at 60 mbar. Verify the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C9, between sensor connector (wiring side) pin 4 and connector EDC pin C35.	EDC pilot light on. The pressure sensor is incorporated in the temperature one.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS START-UP	35	02	OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND	Significant power reduction.	The internal ECU test which occurs when the engine is switched on does not succeed.	Check wiring between +15 of the key and ecu connector pin B39 coming from passaparete connector B pin 2. Erase fault memory and retry: if after engines shuts down the fault persists, contact the Help Desk for a possible ecu change	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - OIL PRESSURE	35	03	NO SIGNAL	Power reduction	Oil pressure sensor short-circuited or open-circuited.	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the oil pressure will be fixed at 60 mbar. Verify the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C9, between sensor connector (wiring side) pin 4 and connector EDC pin C35.	EDC pilot light on. The pressure sensor is incorporated in the temperature one.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS START-UP	35	03	NO SIGNAL	Significant power reduction.	The internal ECU test which occurs when the engine is switched on does not succeed.	Check wiring between +15 of the key and ecu connector pin B39 coming from passaparete connector B pin 2. Erase fault memory and retry: if after engines shuts down the fault persists, contact the Help Desk for a possible ecu change	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.
SENSORS - OIL PRESSURE	35	04	SIGNAL NOT PLAUSIBLE	Power reduction	Oil pressure sensor short-circuited or open-circuited.	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the oil pressure will be fixed at 60 mbar. Verify the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C9, between sensor connector (wiring side) pin 4 and connector EDC pin C35.	EDC pilot light on. The pressure sensor is incorporated in the temperature one.
SENSORS - OIL PRESSURE	35	05	SUPPLY OVER THE NORMAL RANGE	Power reduction	Oil pressure sensor short-circuited or open-circuited.	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the oil pressure will be fixed at 60 mbar. Verify the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C9, between sensor connector (wiring side) pin 4 and connector EDC pin C35.	EDC pilot light on. The pressure sensor is incorporated in the temperature one.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
SENSORS - OIL PRESSURE	35	06	SUPPLY BELOW THE RANGE	Power reduction	Oil pressure sensor short-circuited or open-circuited.	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the oil pressure will be fixed at 60 mbar. Verify the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C9, between sensor connector (wiring side) pin 4 and connector EDC pin C35.	EDC pilot light on. The pressure sensor is incorporated in the temperature one.
SENSORS - OIL PRESSURE	35	07	VALUE OVER THE NORMAL LIMIT	Power reduction	Oil pressure sensor short-circuited or open-circuited.	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the oil pressure will be fixed at 60 mbar. Verify the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C9, between sensor connector (wiring side) pin 4 and connector EDC pin C35.	EDC pilot light on. The pressure sensor is incorporated in the temperature one.
ENGINE - FUEL PRESSURE MONITORING	35	08	LEAKAGE IN LOWIDLE		Fuel leaks from the pipe unions or low-pressure pipes downstream of the fuel pump. Possible defect of the signal of the rail pressure sensor	Check the O-Rings and the proper connection of the pipe unions downstream of the fuel pump (fasteners must be out and unions well hooked). Check visually that the low-pressure pipes are not damaged. Carry out the inspections of 8.2.	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	35	08	LEAKAGE IN LOWIDLE	Significant power reduction.	Fuel pressure adjustment: pressure in the rail is lower or higher than the one evaluated by the gearcase.	Reading of measurable parameters: ?Duty Cycle rail pressure solenoid valve? (with release 2-2001 and subsequent ones): in normal conditions, at idling speed, loadless, and steady state engine, the value must be lower than 5%.	EDC pilot light winking.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ENGINE - FUEL PRESSURE MONITORING	35	08	LEAKAGE IN LOWIDLE		Fuel suction pipe in the tank partially clogged due to impurities or distortion caused by overheating.	Check whether the priming pump on the prefilter works properly. If the pump knob remains sucked downwards because of the suction pressure, disassemble and check the tank suction pipe. If the suction pipe is all right, replace the filter.	EDC pilot light winking. In case some shavings have been sucked (due to works carried out by the producer on the fuel tank) perform an accurate cleaning of the tank. As a matter of fact the problem might occur again because of other shavings remained inside the tank.
ENGINE - FUEL PRESSURE MONITORING	35	08	LEAKAGE IN LOWIDLE		Air intake upstream of the fuel gear pump.	Check the O-Rings and the proper connection of the pipe unions between the tank and the fuel pump (fasteners must be out and unions well hooked).	EDC pilot light winking.
ENGINE - FUEL PRESSURE MONITORING	35	08	LEAKAGE IN LOWIDLE		Insufficient fuel level in the tank.	Check fuel level.	EDC pilot light winking.
SENSORS - OIL PRESSURE	35	08	VALUE BELOW THE LIMIT	Power reduction	Oil pressure sensor short-circuited or open-circuited.	Reading of measurable parameters by means of the diagnostic instrument: in presence of this error, the oil pressure will be fixed at 60 mbar. Verify the wiring between the sensor connector (wiring side) pin 3 and connector EDC pin C9, between sensor connector (wiring side) pin 4 and connector EDC pin C35.	EDC pilot light on. The pressure sensor is incorporated in the temperature one.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS START-UP	36	04	SIGNAL NOT PLAUSIBLE	Significant power reduction.	The internal ECU test which occurs when the engine is switched on does not succeed.	Check wiring between +15 of the key and ecu connector pin B39 coming from passaparete connector B pin 2. Erase fault memory and retry: if after engines shuts down the fault persists, contact the Help Desk for a possible ecu change	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS START-UP	36	05	SUPPLY OVER THE NORMAL RANGE	Significant power reduction.	The internal ECU test which occurs when the engine is switched on does not succeed.	Check wiring between +15 of the key and ecu connector pin B39 coming from passaparete connector B pin 2. Erase fault memory and retry: if after engines shuts down the fault persists, contact the Help Desk for a possible ecu change	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS START-UP	36	06	SUPPLY BELOW THE RANGE	Significant power reduction.	The internal ECU test which occurs when the engine is switched on does not succeed.	Check wiring between +15 of the key and ecu connector pin B39 coming from passaparete connector B pin 2. Erase fault memory and retry: if after engines shuts down the fault persists, contact the Help Desk for a possible ecu change	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.

Component failure	DTC	FMI	Error type	Visible anomaly	Possible cause	Recommended repairs	Notes
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS START-UP	36	07	VALUE OVER THE NORMAL LIMIT	Significant power reduction.	The internal ECU test which occurs when the engine is switched on does not succeed.	Check wiring between +15 of the key and ecu connector pin B39 coming from passaparete connector B pin 2. Erase fault memory and retry: if after engines shuts down the fault persists, contact the Help Desk for a possible ecu change	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.
ELECTRONIC CONTROL UNIT - SELF TEST SHUTOFF PATHS START-UP	36	08	VALUE BELOW THE LIMIT	Significant power reduction.	The internal ECU test which occurs when the engine is switched on does not succeed.	Check wiring between +15 of the key and ecu connector pin B39 coming from passaparete connector B pin 2. Erase fault memory and retry: if after engines shuts down the fault persists, contact the Help Desk for a possible ecu change	EDC pilot light on. The engine doesn't stop in the foreseen times when the key +15 is OFF-positioned.

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.

0If there is an engine malfunction, for example excessive exhaust fumes, high coolant temperature or low oil pressure, the cause of the problem must be established quickly.

It should also be remembered that all maintenance operations, even the most banal, should be carried out in accordance with the safety instructions to protect personnel from accidents and injury.

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	-
EDC	In case of trouble
Replacement of engine's oil and filter	-
Replacement of pre-filter	-
Replacement of fuel filter	-
Replacement of blow by filter	-
Replacement of belt	-

NOTE 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 FPT.

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

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

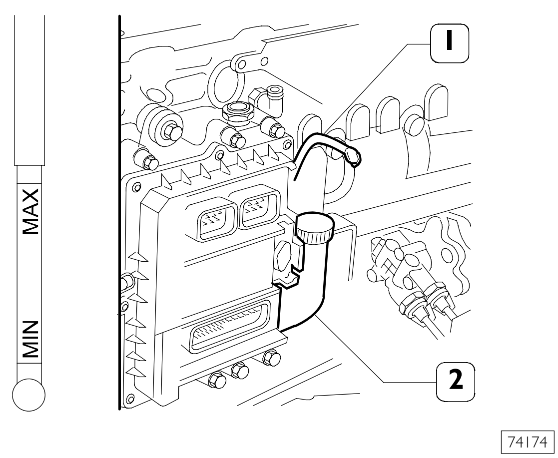
Checks and inspections

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 137

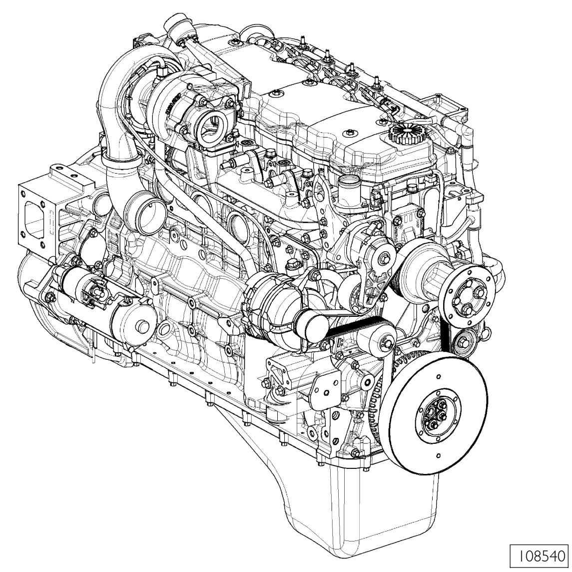


Draw off the rod from its slot and check that the level is within the etched tags of minimum and maximum level.

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 138



To provide filling, operate through the upper top or through the lateral top (2, Figure 137). 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

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

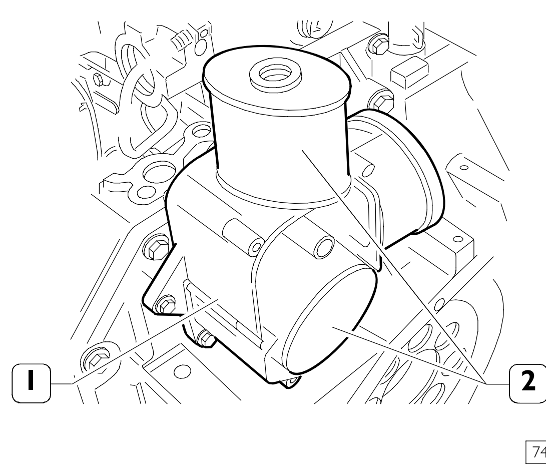
Timely proceed operating on the pre-filter (not available on the engine block) to carry out the drainage of the water within the feed circuit.

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 139



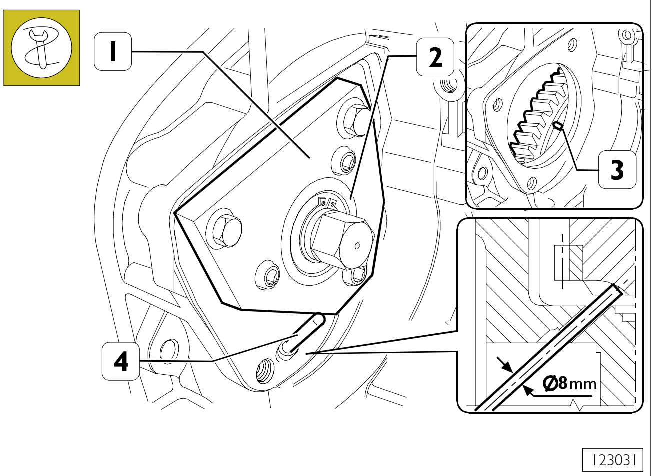
The check of the filtering element is carried out by removing the cover and drawing off the cartridges (2).

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.

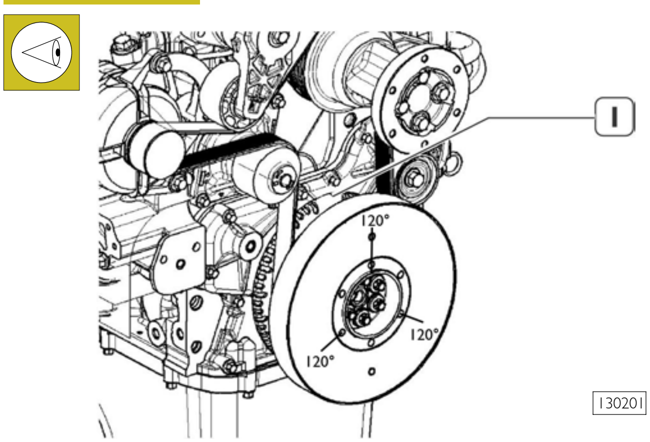
Inspection and setting of tappet clearance

Figure 140



- ❑ Fit tool 99360339 (1) in order to be able to rotate the flywheel using an Allen key.
- ❑ Place cylinder no. 1 at TDC (top dead centre) at the end of the compression stroke.

Figure 141

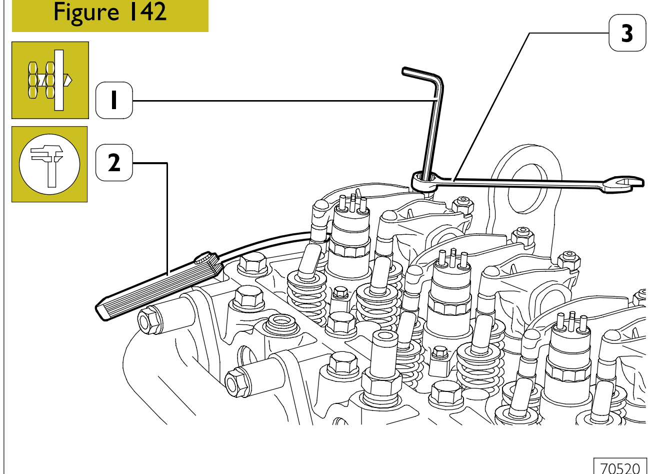


- ❑ Also check that the unperforated part (1) of the phonic wheel is positioned uppermost (cylinder n. 1 at TDC) and the valves of cylinder n. 4 are balanced. If cylinder n.1 is balanced, rotate the engine through one revolution to obtain the specified condition.
- ❑ Adjust the clearance of cylinder n. 1's valves as indicated in the relevant paragraph.
- ❑ Now rotate the crankshaft as shown in the table to adjust the clearance of the rocker arms of the other cylinders.

FIRING ORDER:: 1 – 5 – 3 – 6 – 2 – 4

Start and crankshaft rotation	Adjusting intake and exhaust valve rocker arm clearance on cylinder n.
Cylinder n. 1 at TDC	1
Rotate through 120°	5
Rotate through 120°	3
Rotate through 120°	6
Rotate through 120°	2
Rotate through 120°	4

Figure 142



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.

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.

NOTE Use only the recommended oil or oil having the requested features for the corrrect motor functioning.

In case of topping up, don't mix oils having different features.

If you don't comply with theses rules, the service warranty is no more valid.

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

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.

Check exhaust pipe/s for damage

Visually check that the exhaust system is not blocked or damaged.

- ❑ Make sure that there is no risk of dangerous fumes within the machine. Contact the Manufacturer if necessary.

Clean heat exchangers

Check that the radiator air inlets are free from dirt (dust, mud, straw, etc.).
Clean them if necessary, using compressed air or steam.

The use of compressed air makes it necessary to use suitable protective equipment for the hands, face and eyes.

Alternator belt replacement

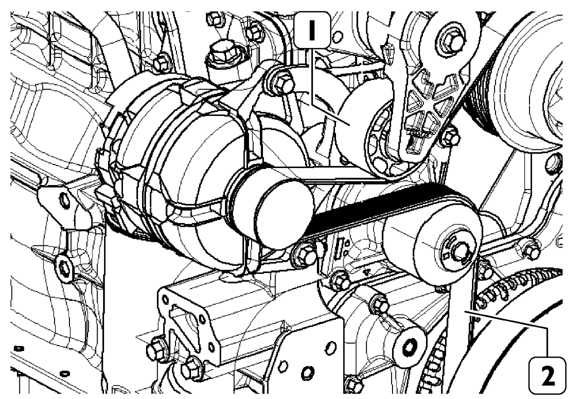
Due to several applications the belt run can change very much.

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 143

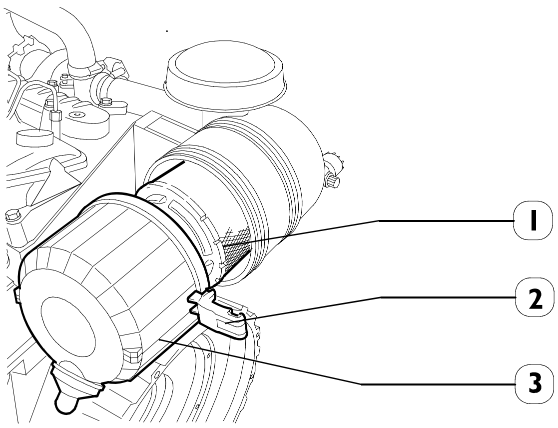


108545

- ❑ 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.

Cleaning the air filter

Figure 144



130193

Only proceed with the engine stopped.

- Remove the rear manoeuvring hook (1) if necessary.
- Remove the filter cover (3) after first unscrewing the locking handle(2).
- Remove the external cartridge (1). During this operation, take care to ensure that no dust get into the sleeve.
- Check that there is no dirt. If there is, clean the filter element as indicated below.
- Blow dry compressed air through the filter element, from the inside outward (maximum pressure 200 kPa). Do not use detergents; do not use diesel.
- Never use tools to beat the filter element, and check its condition before replacing it.
- Replace the filter if any breakages or tears are found.
- Check that the gasket at its base is in good condition.
- Reassemble by repeating the above operations in reverse order.

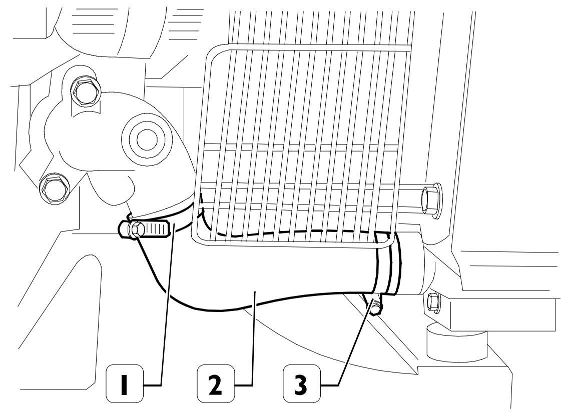
NOTE Take care to ensure that the parts are reassembled correctly. Imperfect assembly might result in unfiltered air being sucked into the engine, causing serious damage.

Air filter replacement

Refer to the instructions provided for air filter cleaning.

Change coolant

Figure 145



129284

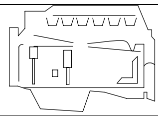
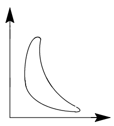
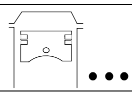
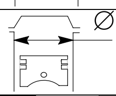
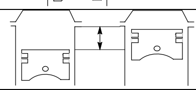
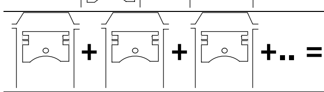
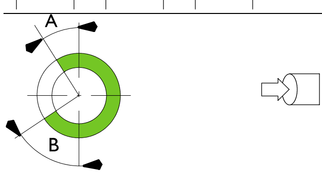
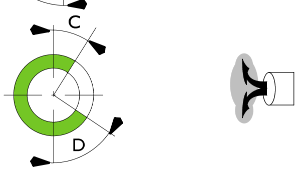
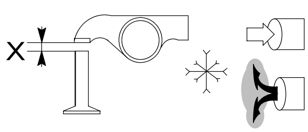
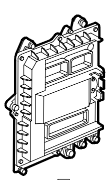
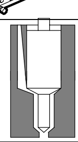
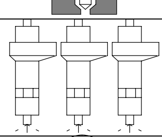
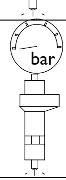
Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.

- Provide suitable containers to ensure that no coolant is dispersed into the environment.
- Loosen the seal elements (1) e (3), remove the sleeves (1) connecting the engine circuit to the heat exchanger and wait until it has emptied completely. When empty, repair the circuit making sure that the sleeves are perfectly sealed.
- Fill up the circuit.
- Refill the engine and the heat exchanger until complete top up.
- With the filler cap open, start the engine and keep it idling for nearly one minute. This phase facilitates the cooling liquid air bleed.
- Stop the engine and top up again.

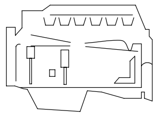
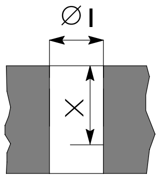
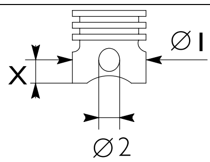
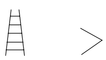
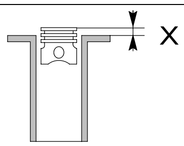
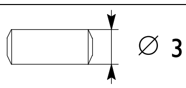
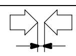
SECTION 4

Overhaul and technical specifications

GENERAL SPECIFICATIONS

	Type		6 CYLINDERS
	Cycle		Four-stroke diesel engine
	Power		Turbocharged 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.	A	-
	end after B.D.C.	B	-
	start before B.D.C.	D	-
	end after T.D.C.	C	-
	Checking timing		
	X	mm	0.20 to 0.30
		mm	0.45 to 0.55
	**FUEL FEED**		
	Injection		high pressure common rail
	Type:	Bosch	EDC7 C1
	Injector		-
	Nozzle type		DLLA 142P 1280
	Injection sequence		1 - 5 - 3 - 6 - 2 - 4
	Injection pressure	bar	1400

CLEARANCE DATA

	Type	6 CYLINDERS
CYLINDER UNIT AND CRANKSHAFT COMPONENTS		mm
	Cylinder barrels Ø1 > Ø1	104.00 to 104.024 0.4
	Spare pistons type: Size X Outside diameter Ø 1 Pin housing Ø 2	 49.5 103.739 to 103.757 38.010 to 38.016
	Piston diameter Ø 1	0.4
	Piston protrusion X	0.28 to 0.52
	Piston pin Ø 3	37.994 to 38.000
	Piston pin – pin housing	0.010 to 0.022

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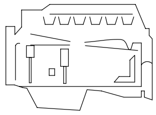
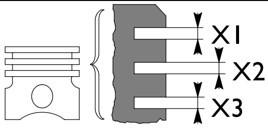
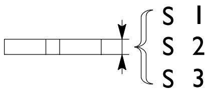
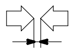
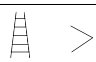
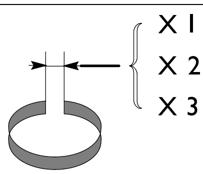
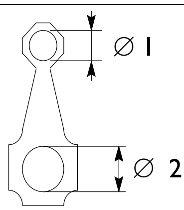
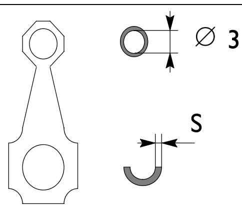
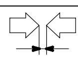
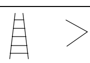
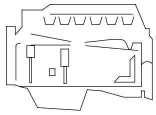
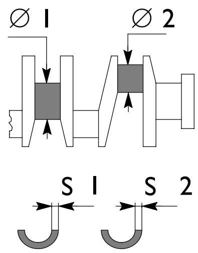
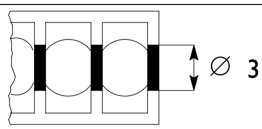
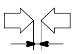
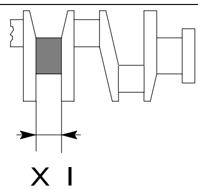
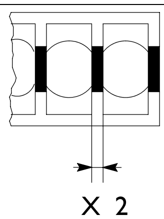
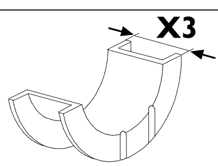
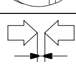
	Type		6 CYLINDERS
CYLINDER UNIT AND CRANKSHAFT COMPONENTS			**mm**
	Split ring slots * measured on 101 mm	X1* X 2 X 3	2.705 to 2.735 2.420 to 2.440 4.030 to 4.050
	Split rings	S 1* S 2 S 3	2.560 to 2.605 2.350 to 2.380 3.970 to 3.990
	Split rings - slots	1 2 3	0.100 to 0.175 0.040 to 0.090 0.040 to 0.080
	Split rings		0.4
	Split ring end opening	X 1 X 2 X 3	0.45 to 0.55 0.60 to 0.80 0.30 to 0.55
	Small end bush housing Big end bearing housing	Ø 1 Ø 2	40.987 to 41.013 72.987 to 73.013
	Small end bush diameter Inside  Big end half bearings	Ø 3 S	38.019 to 38.033 1.955 to 1.968
	Piston pin – bush		0.019 to 0.039
	Big end half bearings		0.250 ; 0.500

	Type		6 CYLINDERS
CYLINDER UNIT AND CRANKSHAFT COMPONENTS			**mm**
	Journals Crankpins Main half bearings Big end half bearings	Ø 1 Ø 2 S 1 S 2	82.99 to 83.01 68.987 to 69.013 2.456 to 2.464 1.955 to 1.968
	Main bearings No. 1- 7 No. 2-3-4-5-6	 Ø 3 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 to 0.500
	Shoulder journal	X 1	37.475 to 37.545
	Shoulder main bearing	X 2	32.180 to 32.280
	Shoulder half-rings	X 3	37.28 to 37.38
	Output shaft shoulder		0.095 to 0.265

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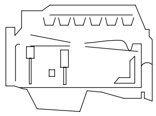
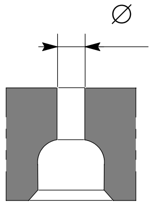
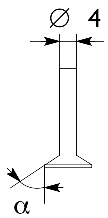
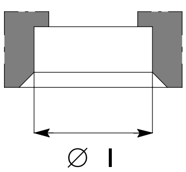
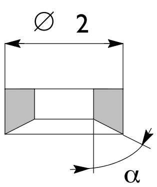
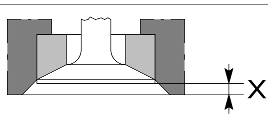
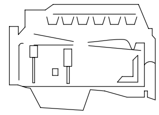
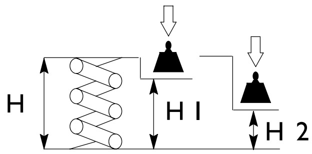
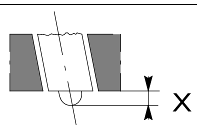
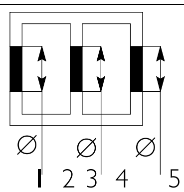
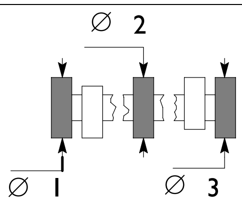
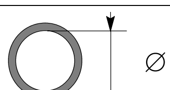
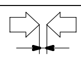
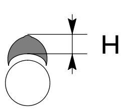
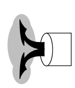
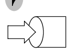
	Type	6 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM		**mm**
	Valve guide seats on cylinder head ∅ 1	7.042 to 7.062
	Valves: ∅ 4 α ∅ 4 α	6.970 to 6.990 60° ± 0.25° 6.970 to 6.990 45° ± 0.25°
	Valve stem and guide	0.052 to 0.092
	Housing on head for valve seat: ∅1 ∅1	34.837 to 34.863 34.837 to 34.863
	Valve seat outside diameter; valve seat angle on cylinder head: ∅ 2 α ∅ 2 α	34.917 to 34.931 60° 34.917 to 34.931 45°
	Sinking X X	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
	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 (flywheel side) Camshaft housings No. 2-3-4-5-6-7	 Ø	59.222 to 59.248 54.089 to 54.139
	Camshaft journals: 1 ⇒ 7	 Ø	53.995 to 54.045
	Bush inside diameter	Ø	54.083 to 54.147
	Bushes and journals		0.038 to 0.162
	Cam lift:  	 H H	 6.045 7.582

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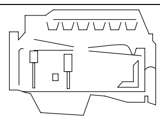
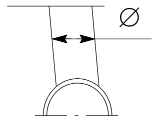
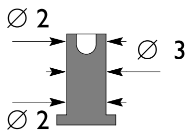
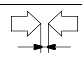
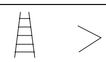
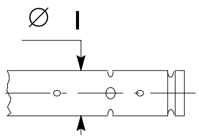
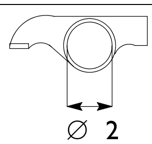
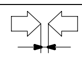
	Type	6 CYLINDERS
CYLINDER HEAD – TIMING SYSTEM		**mm**
	Tappet cap housing on block Ø 1	16.000 to 16.030
	Tappet cap outside diameter: Ø 2 Ø 3	15.924 to 15.954 15.960 to 15.975
	Between tappets and housings	0.025 to 0.070
	Tappets	-
	Rocker shaft Ø 1	21.965 to 21.977
	Rockers Ø 2	22.001 to 22.027
	Between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

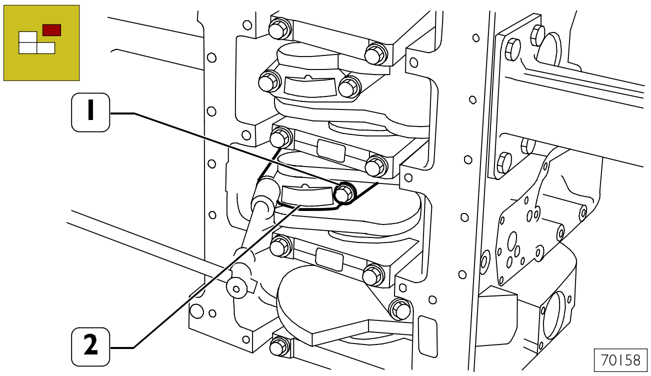
6 ENGINE OVERHAUL
ENGINE REMOVAL AT THE BENCH

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

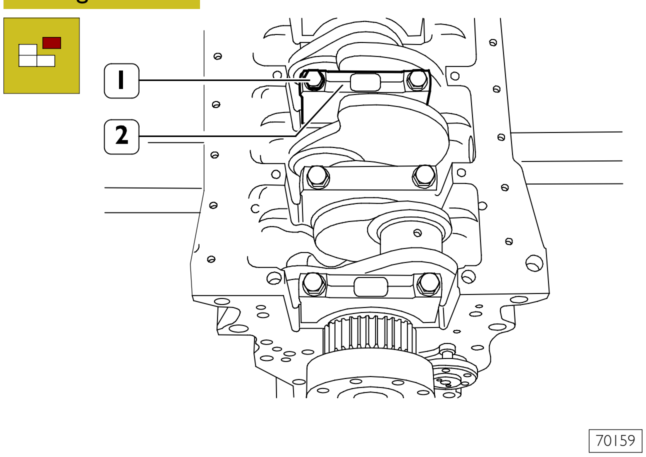


Loosen the fixing screws (1) and remove the rod caps (2).

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

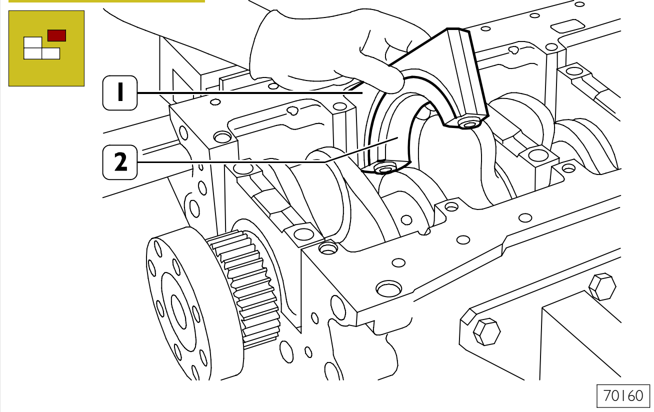
NOTE Keep the half-bearings into their housings since in case of use they shall be fitted in the same position found at removal.

Figure 2



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

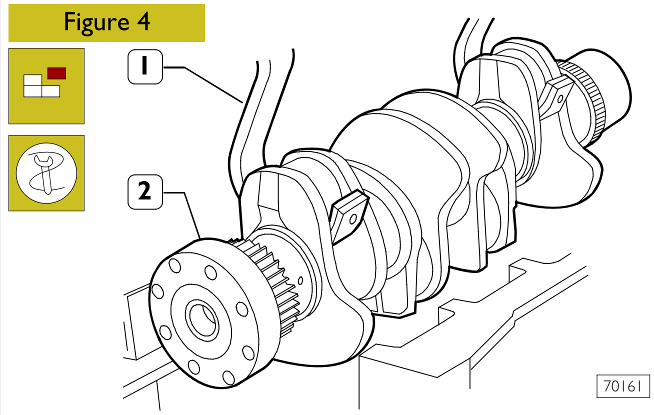
Figure 3



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

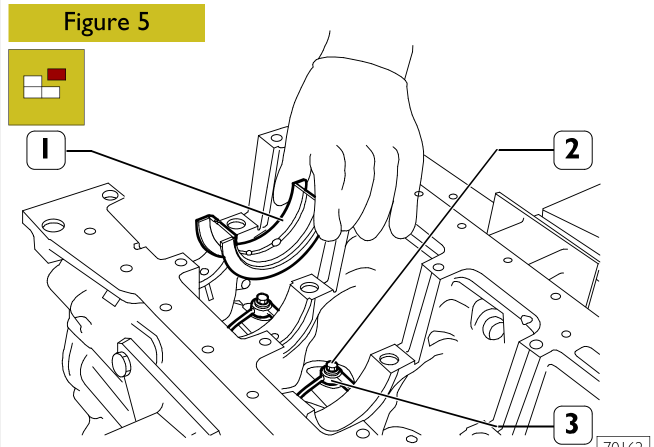
NOTE Take note of lower and upper half-bearing assembling positions since in case of reuse they shall be fitted in the same position found at removal.

Figure 4



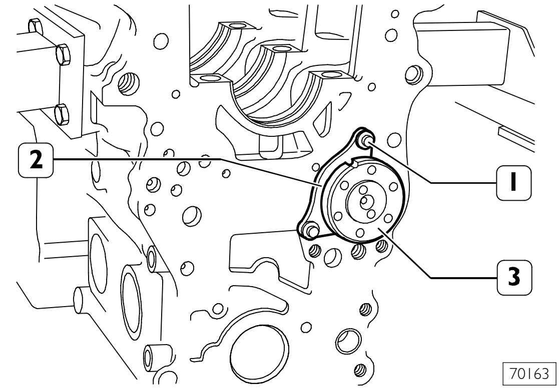
Use tool 99360500 (1) and hoist to remove the crankshaft (2) from the block.

Figure 5



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

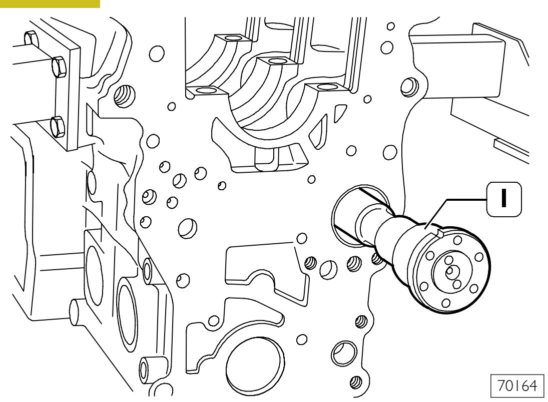
Figure 6



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

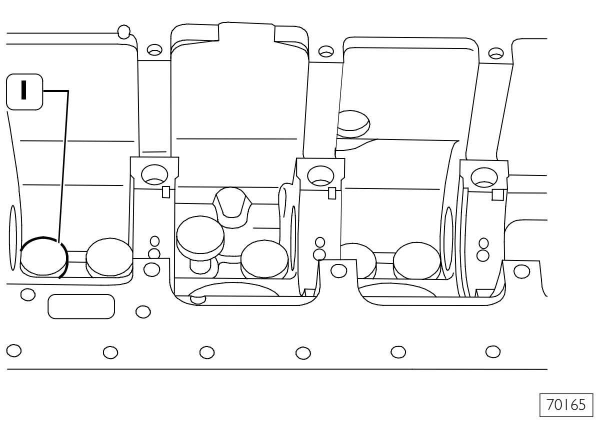
NOTE Take note of plate (2) assembling position.

Figure 7



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

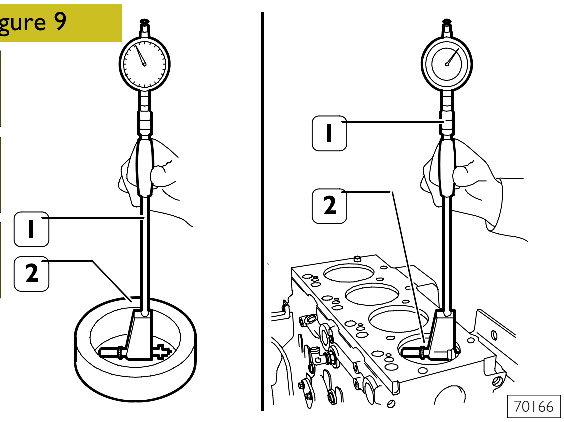
Figure 8



Withdraw the tappets (1) from the engine block.

REPAIR OPERATIONS
CYLINDER UNIT
Checks and measurements

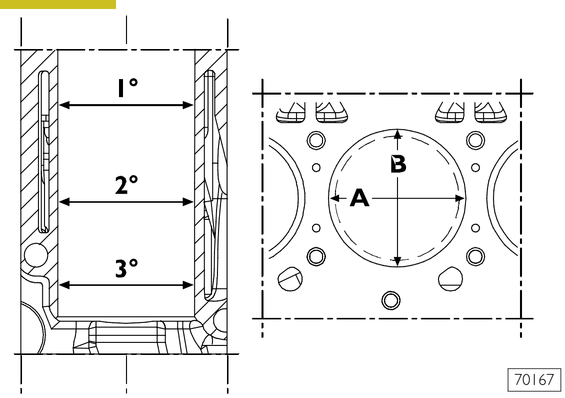
Figure 9



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.

NOTE 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 0.4 mm and to the specified assembling clearance.

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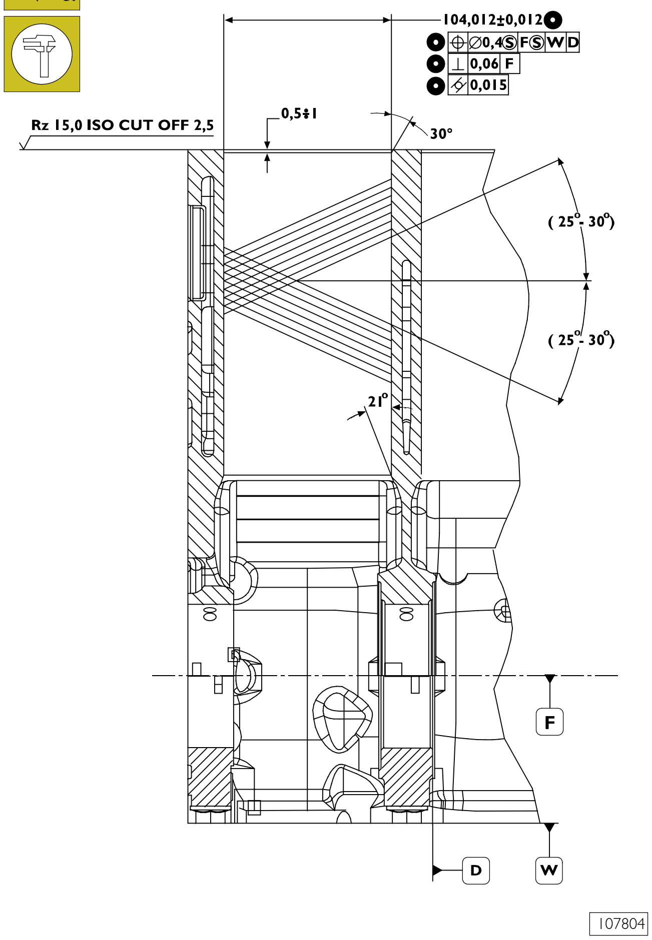
Figure 11



NOTE In case of regrinding, all barrels shall have the same oversize (0.4 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

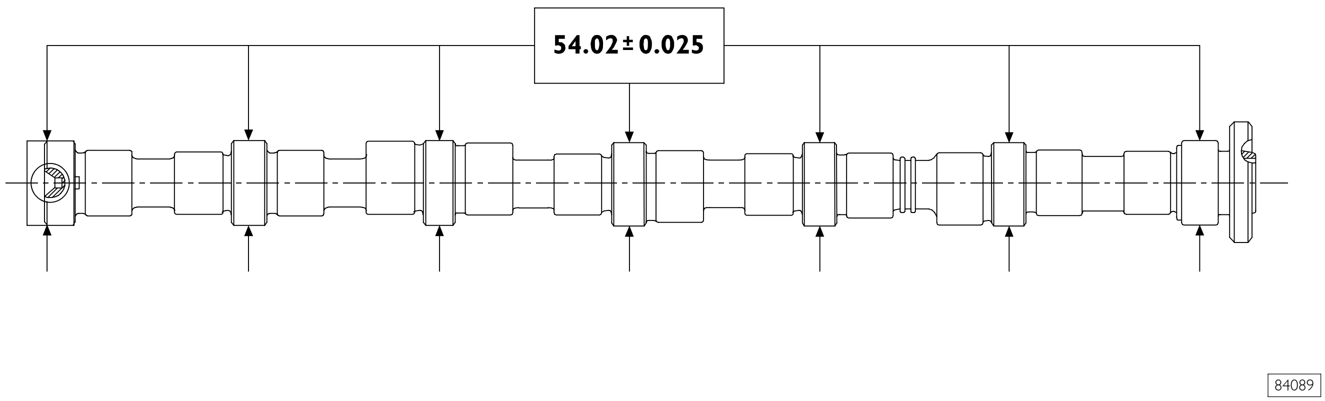
When finding the distortion areas, replace the cylinder unit.

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



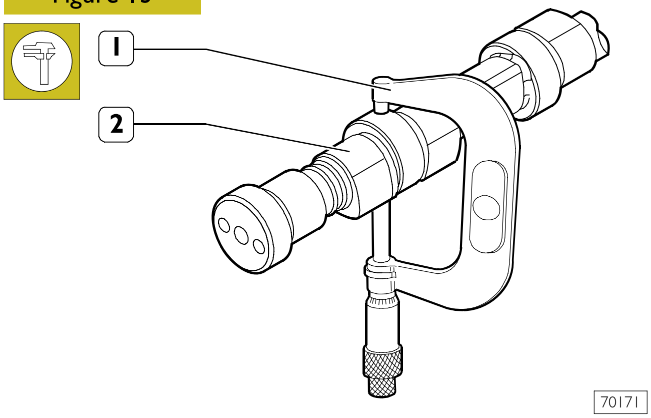
CAMSHAFT MAIN DATA (6 cyl.)
Specified data refer to pin standard diameter

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

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.

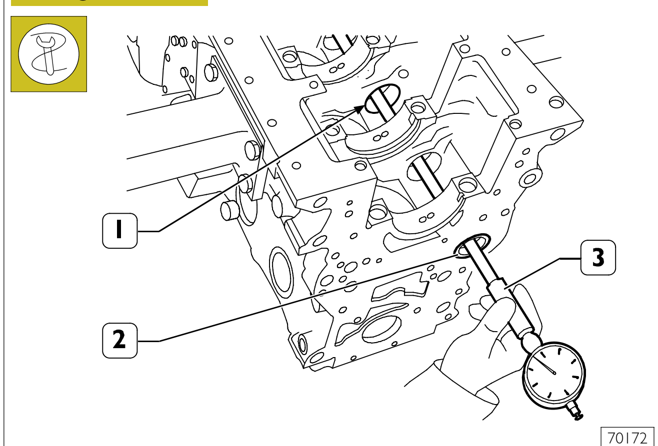
Figure 13



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

BUSHES

Figure 14



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

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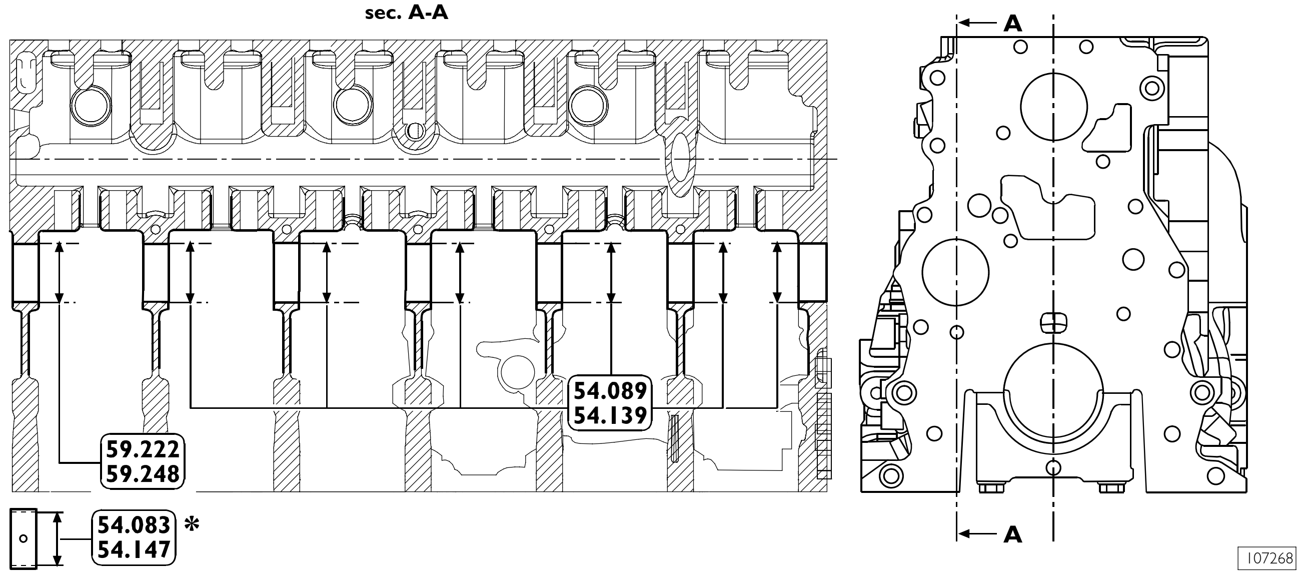
Figure 15

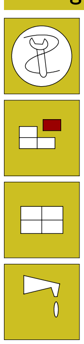


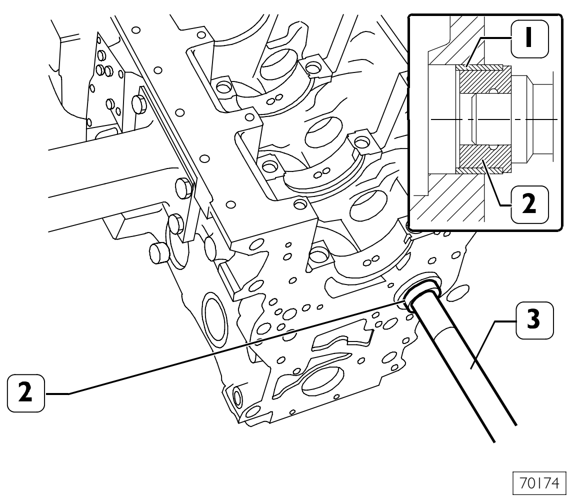
MAIN DATA ABOUT CAMSHAFT BUSH AND RELATED HOUSING

*Height to be obtained after driving the bush.

Bush replacement

Figure 16



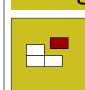


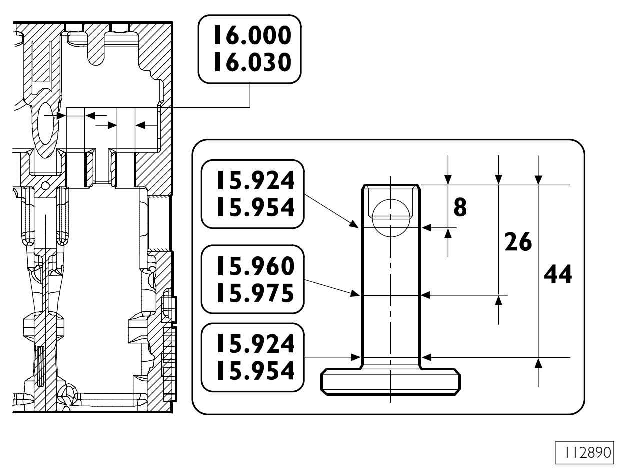
To replace bush (1), remove and refit them using the beater 99360362 (2) and the handgrip 99370006 (3).

NOTE When refitting the bush (1), direct them to make the lubricating holes (2) coincide with the holes on the block housing.

Tappets

Figure 17

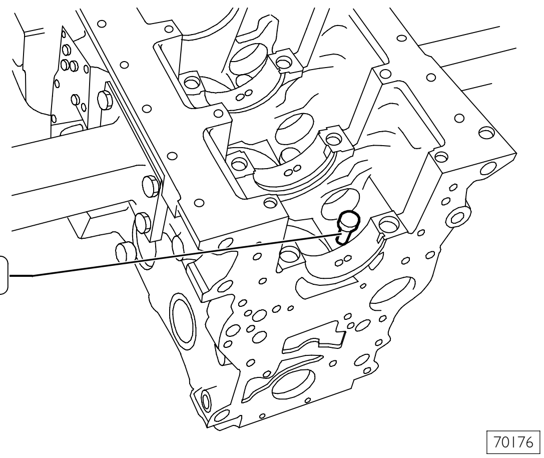




MAIN DATA CONCERNING THE TAPPETS AND THE RELEVANT HOUSINGS ON THE ENGINE BLOCK

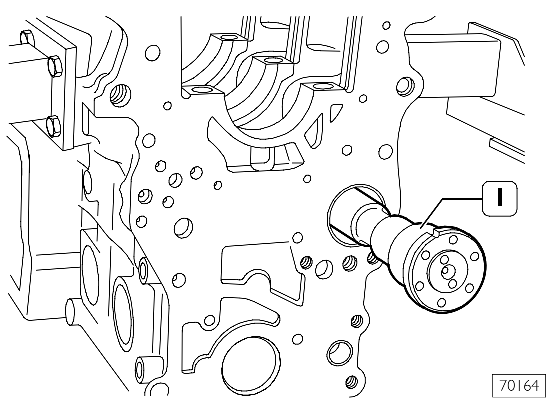
Fitting tappets – camshaft

Figure 18



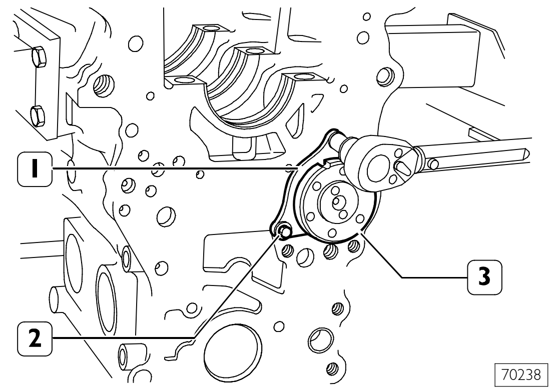
Lubricate the tappets (1) and fit them into the relevant housings on the engine block.

Figure 19



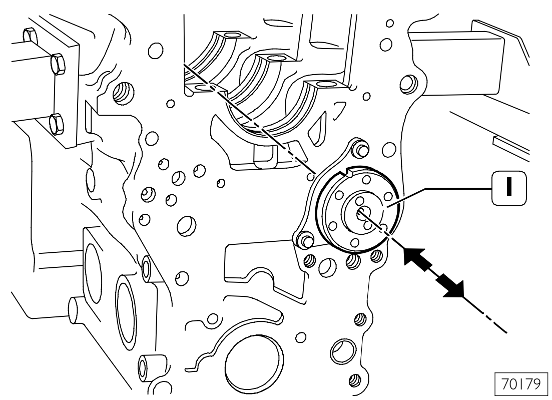
Lubricate the camshaft bush and fit the camshaft (1) taking care not to damage the bush or the housings.

Figure 20



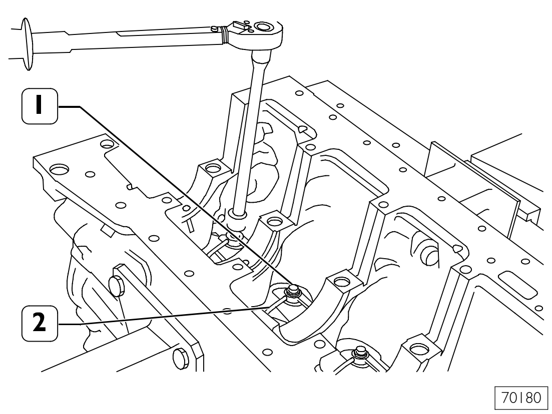
Set camshaft (3) retaining plate (1) with the slot facing the top of the engine block and the marking facing the operator, then tighten the screws (2) to the specified torque.

Figure 21



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

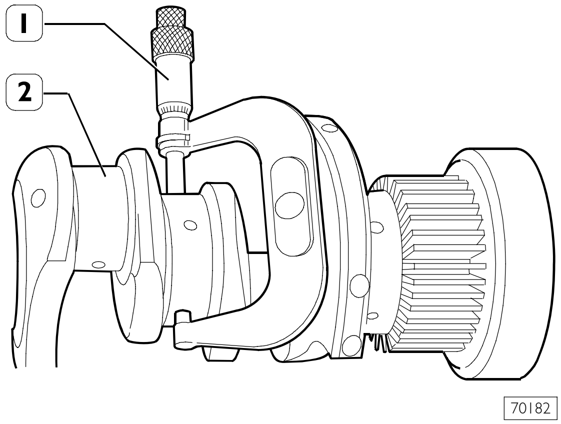
Figure 22



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

OUTPUT SHAFT
Measuring journals and crankpins

Figure 23



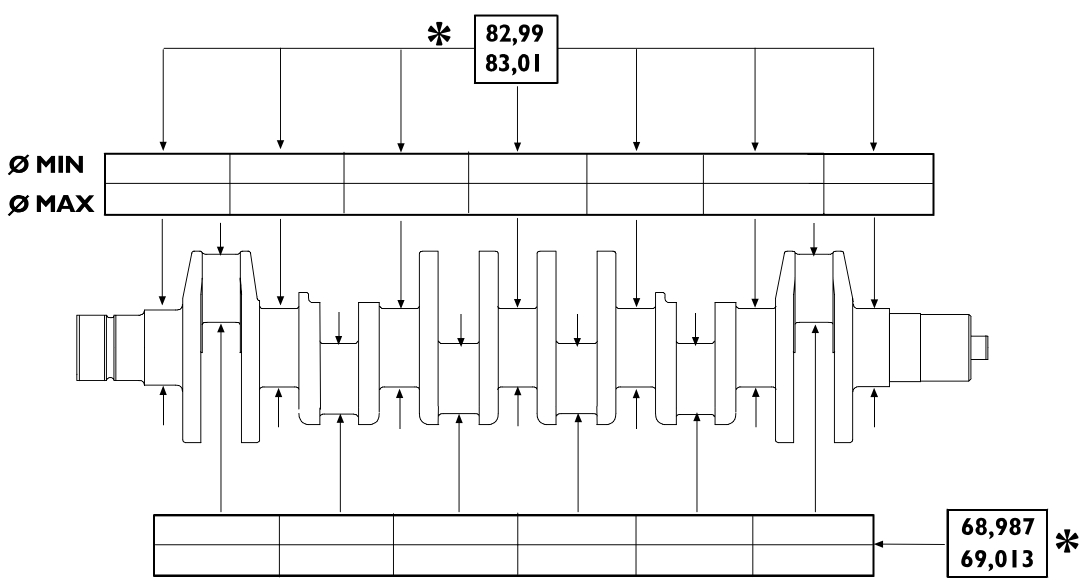
Grind journals and crankpins if seizing, scoring or excessive ovalisation are found. Before grinding the pins (2) measure them with a micrometer (1) to decide the final diameter to which the pins are to be ground.

NOTE It is recommended to insert the found values in the proper table. See Figure 24.

Undersize classes are: 0.250 - 0.500 mm.

NOTE 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 24



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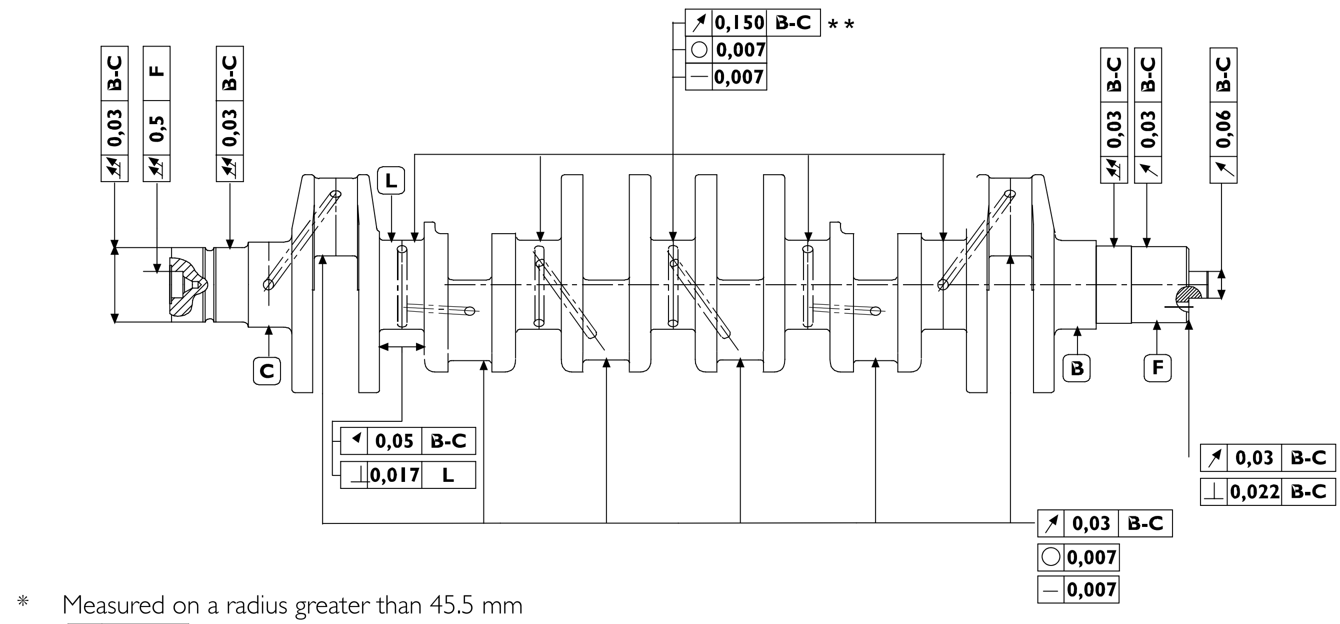
FILL THIS TABLE WITH OUTPUT SHAFT JOURNAL AND CRANKPIN MEASURED VALUES

*Rated value

Figure 25



* Measured on a radius greater than 45.5 mm

** ↗ 0.500 between adjacent main journals

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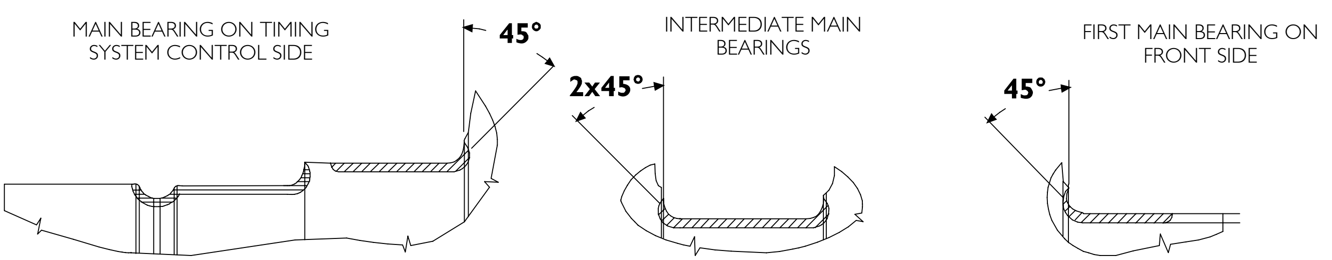
MAIN OUTPUT SHAFT TOLERANCES

Figure 26



70237

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

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

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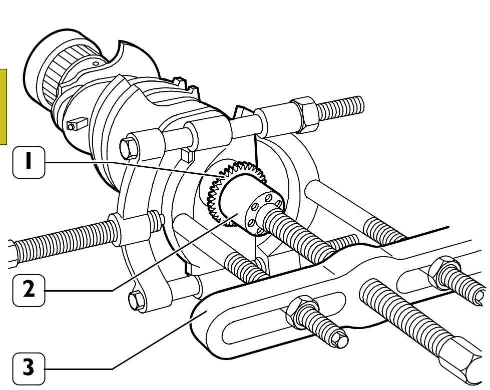
Replacing oil pump control gear

Figure 27



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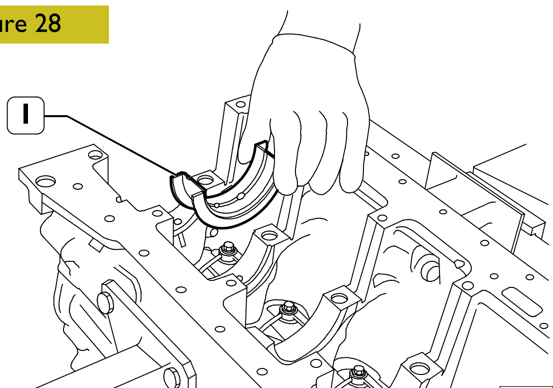
Check that gear toothing (1) is not damaged or worn, otherwise remove it using the proper puller (3).

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 28



70185

NOTE 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.

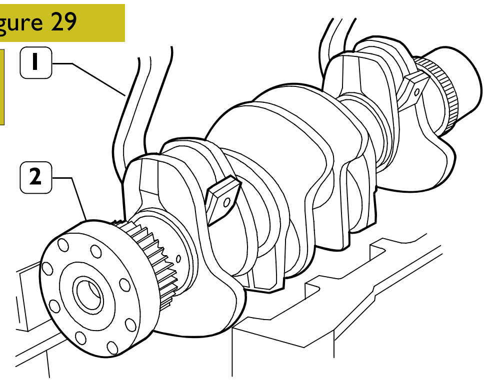
NOTE Do not try to adapt the bearings.

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 29



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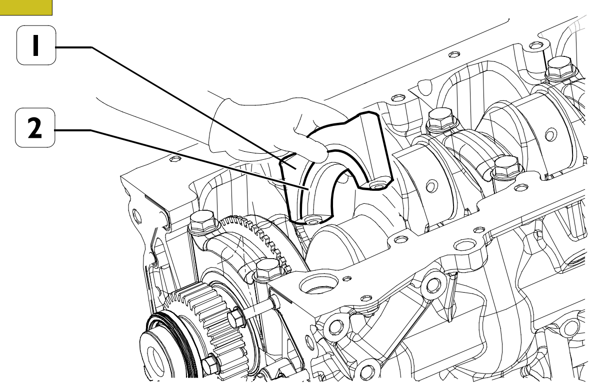
Refit the crankshaft (2).

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

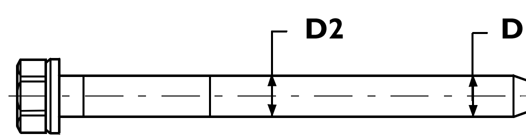
Figure 30



128169

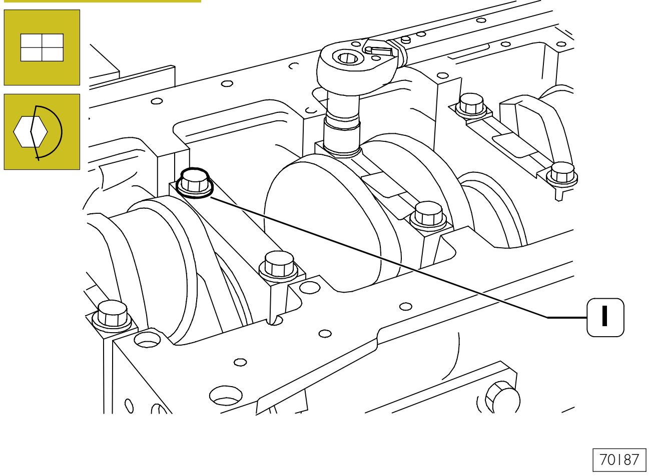
- clean accurately the parts and remove any trace of oil;
- fit caps (1), including the half bearings (2) on the relevant supports.

NOTE Before using the fixing screws again, measure them twice as indicated in the picture, checking D1 and D2 diameters:
if D1 - D2 < 0,1 mm the screw can be utilised again;
if D1 - D2 > 0,1 mm the screw must be replaced.



75703

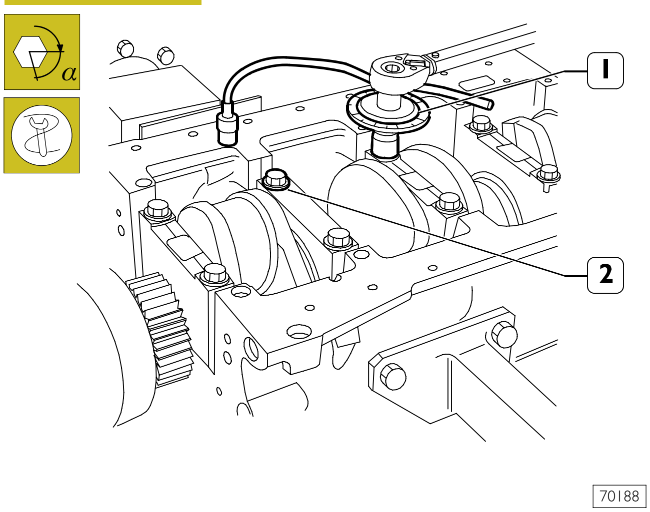
Figure 31



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

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

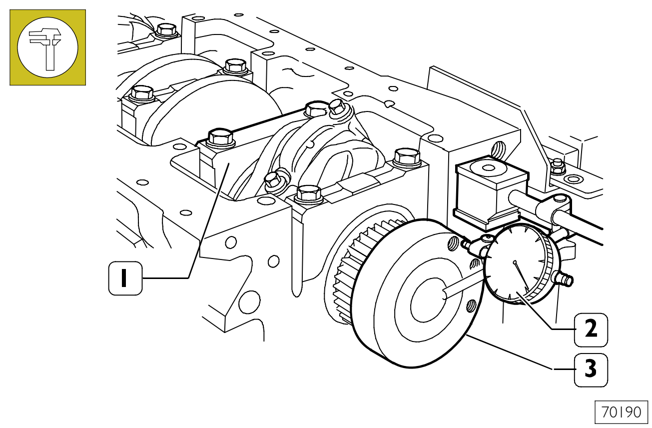
Figure 32



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

Checking crankshaft shoulder clearance

Figure 33

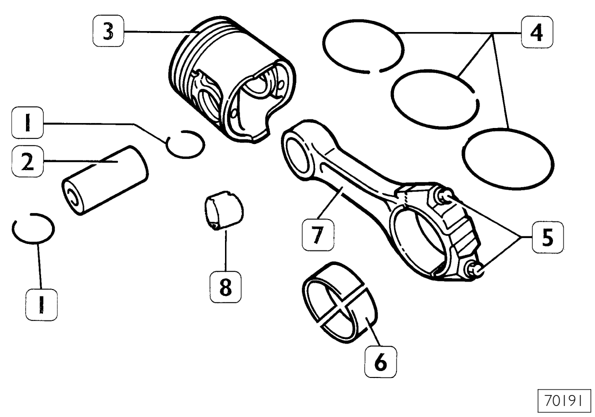


This check is performed by setting a magnetic-base dial gauge (2) on the crankshaft (3) as shown in the figure, standard value is 0.068 to 0.41.

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 34

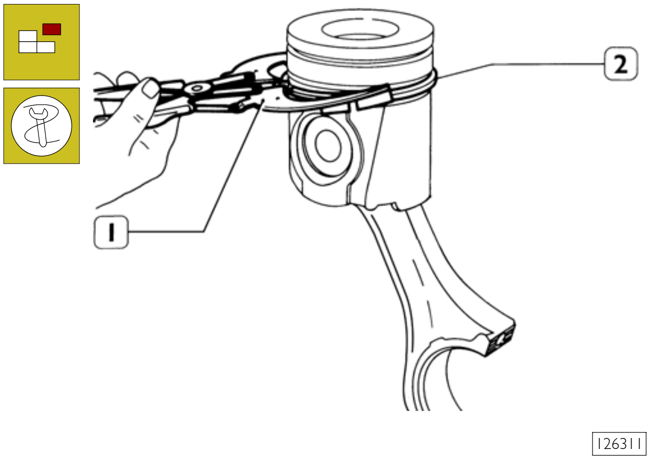


CONNECTING ROD – PISTON ASSEMBLY COMPONENTS

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

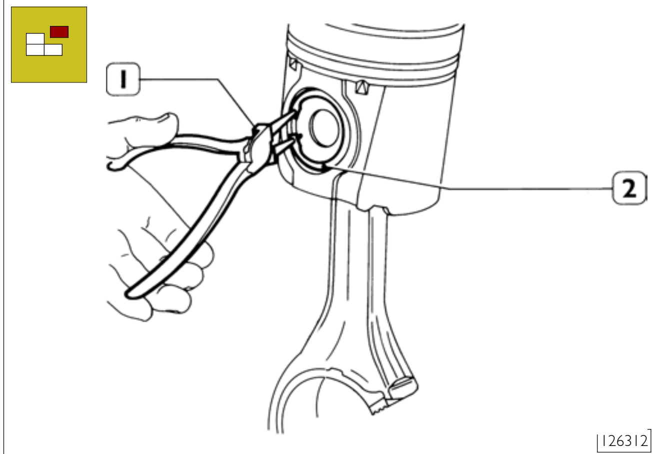
NOTE Pistons are supplied from parts with 0.4 mm oversize.

Figure 35



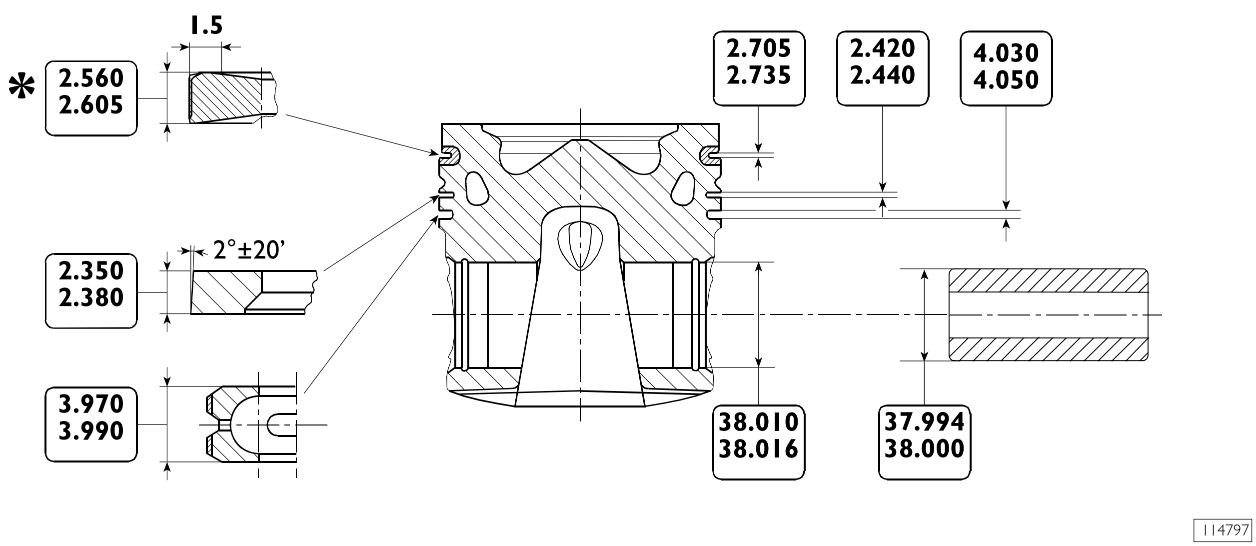
Remove split rings (2) from piston using pliers 99360183 (1).

Figure 36



The circlips (2) retaining the gudgeon pin are removed using round-nose pliers (1).

Figure 37

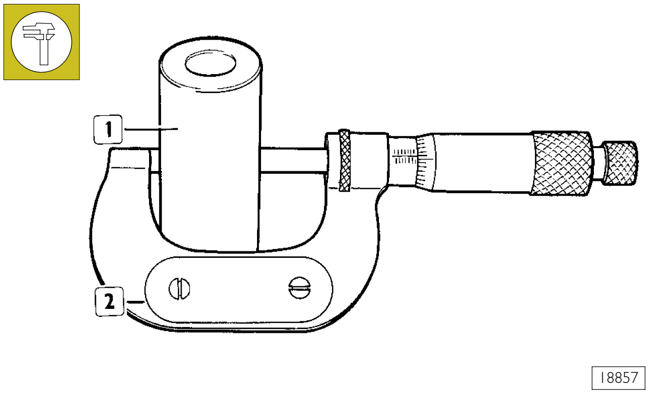


MAIN DATA OF THE PISTON WITH PIN TUNNEL AND PLASTIC RINGS

* Value measured on 101 mm diameter

Piston pins

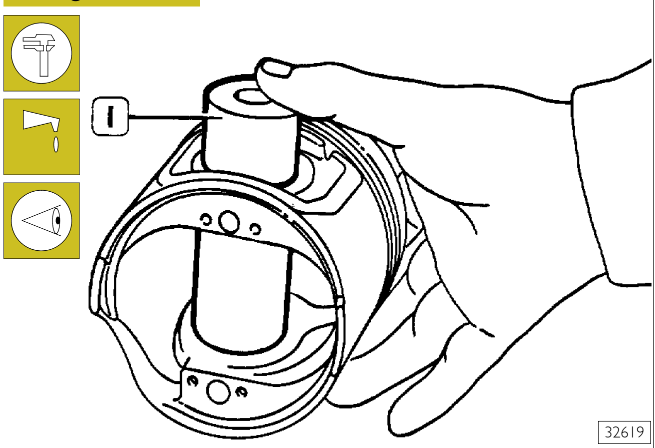
Figure 38



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

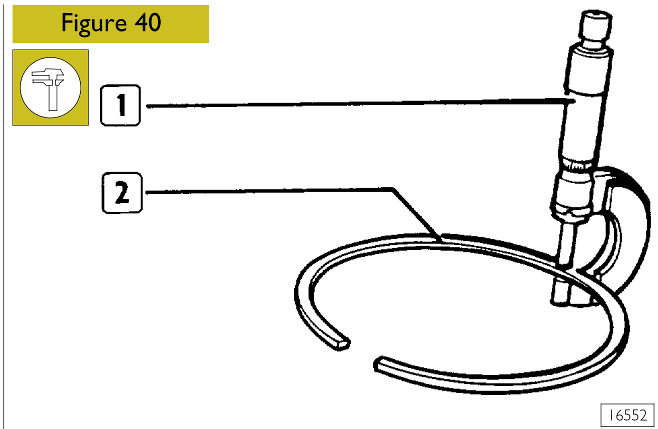
Conditions for proper pin-piston coupling

Figure 39



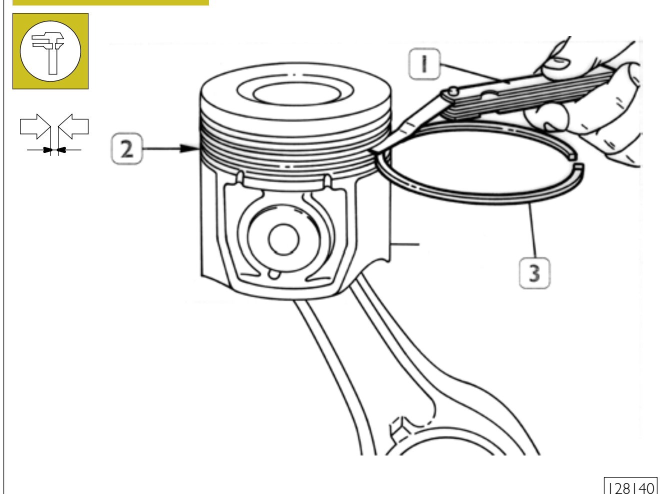
Lubricate the pin (1) and its seat on piston hubs with engine oil; the pin shall be fitted into the piston with a slight finger pressure and shall not be withdrawn by gravity.

Figure 40



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

Figure 41



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 42

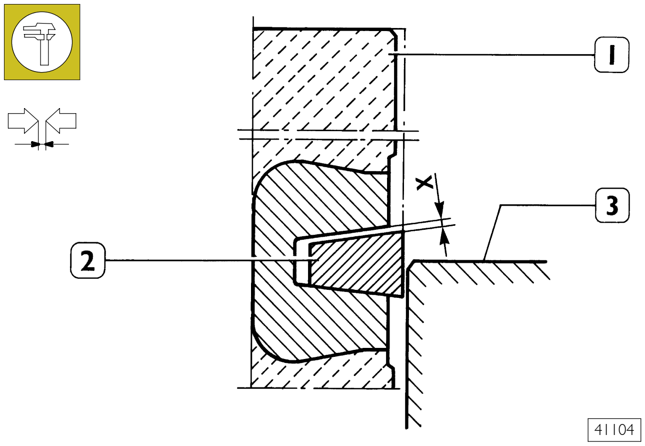
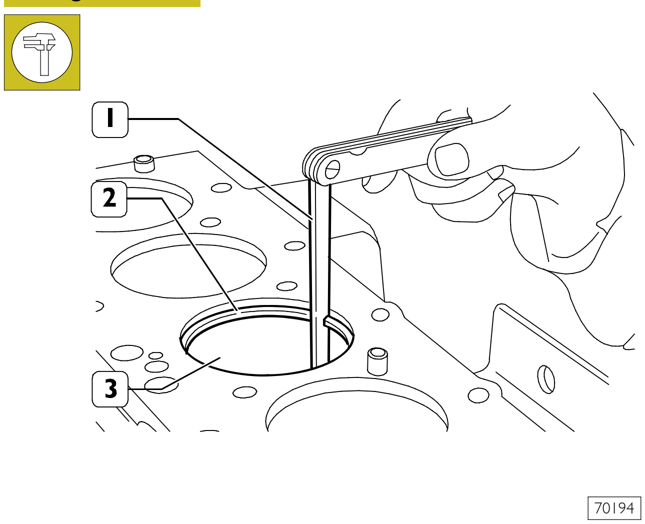


DIAGRAM FOR MEASURING THE CLEARANCE X BETWEEN THE FIRST PISTON SLOT AND THE TRAPEZOIDAL RING

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 43

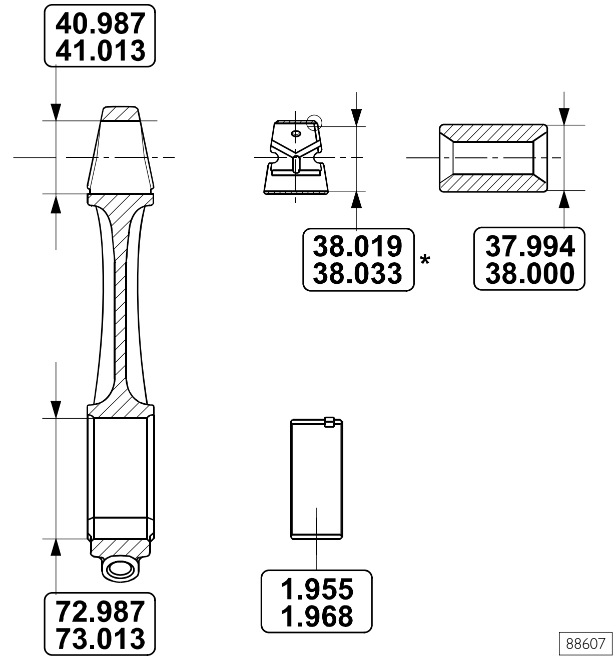


Use feeler gauge (1) to measure the clearance between the ends of the split rings (2) fitted into the cylinder barrel (3).

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

Connecting rods

Figure 44

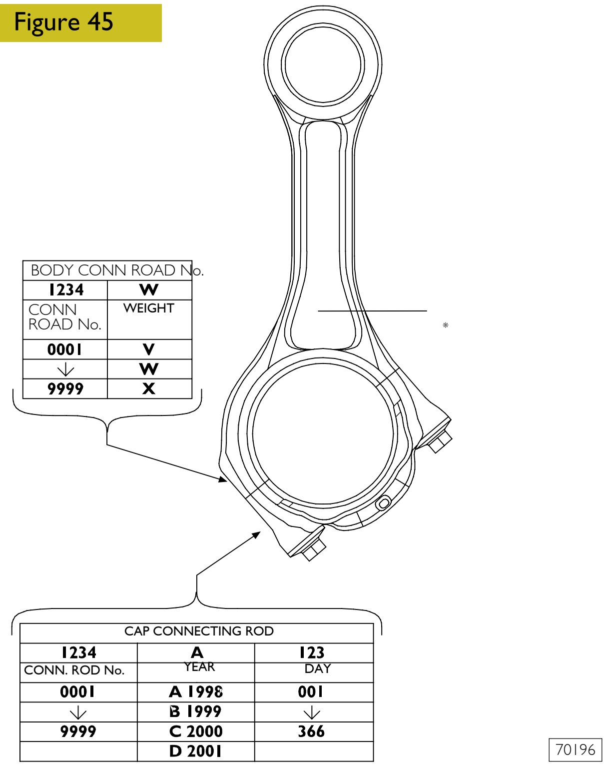


MAIN DATA FOR CONNECTING ROD, BUSH, PISTON PIN AND HALF BEARINGS

* Value for inside diameter to be obtained after driving in connecting rod small end and grinding.

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

Figure 45



NOTE 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

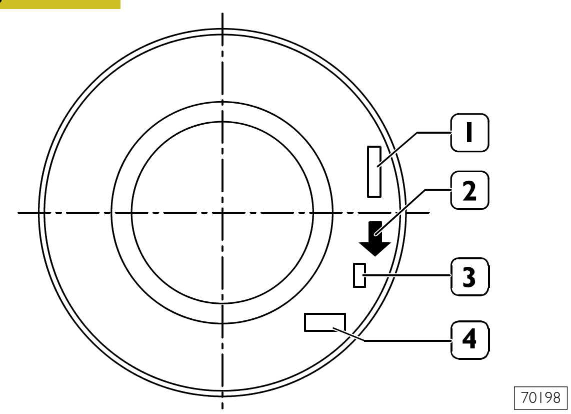
Check that the bush in the connecting rod small end is free from scoring or seizing and that it is not loosen. Otherwise replace.

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.

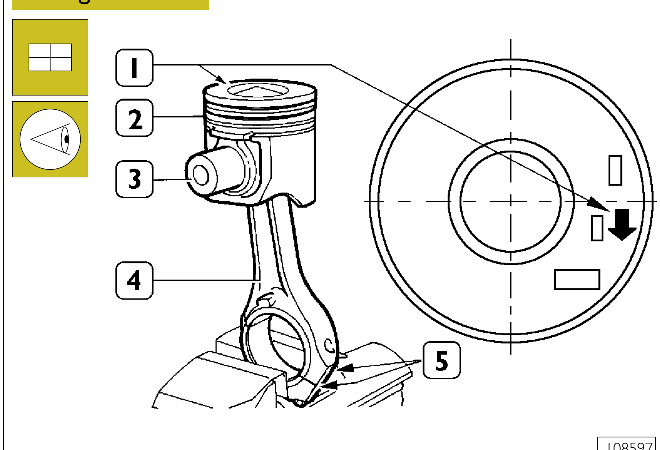
Fitting connecting rod-piston assembly
Connecting rod-piston coupling

Figure 46



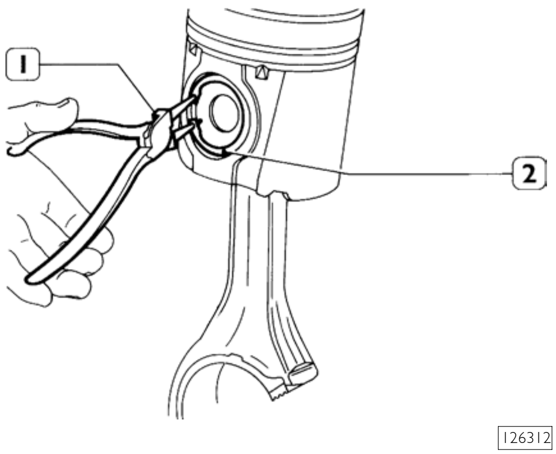
The piston crown is marked as follows:
1. Part number and design modification number;
2. Arrow showing piston assembling direction into cylinder barrel, this arrow shall face the front key of the engine block;
3. Manufacturing date.
4. Marking showing 1st slot insert testing;

Figure 47



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.

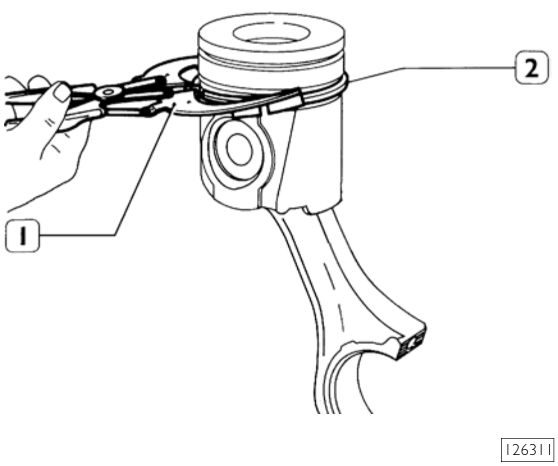
Figure 48



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

Fitting split rings

Figure 49

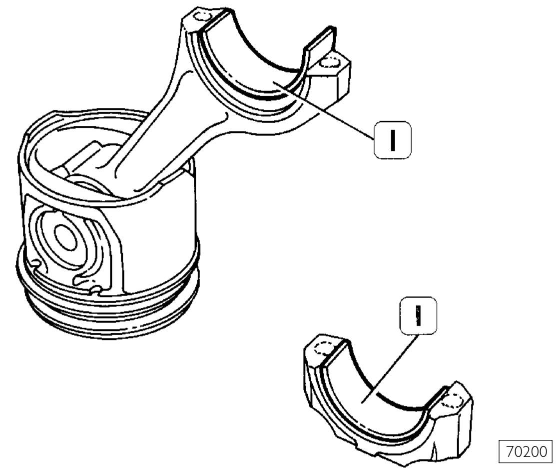


Use pliers 99360183 (1) to fit the split rings on the piston (2). Split rings shall be fitted with the marking "TOP" facing upwards and their openings shall be displaced with each other by 120°.

NOTE Split rings are supplied spare with the following sizes:

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

Figure 50

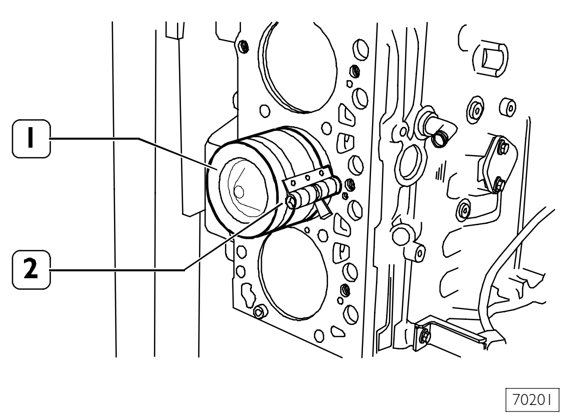


Fit half bearings (1) on connecting rod and cap.

NOTE 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 51



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 52

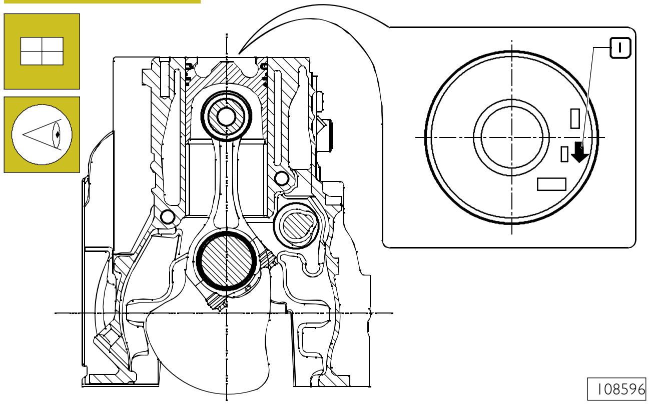
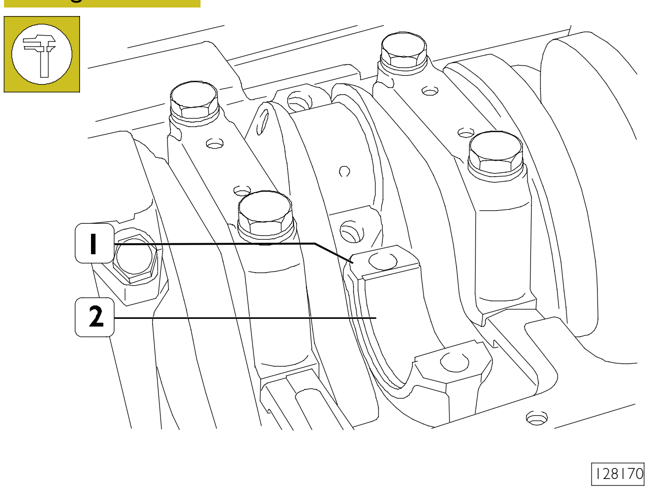


DIAGRAM FOR CONNECTING ROD-PISTON ASSEMBLY FITTING INTO BARREL

- 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 53

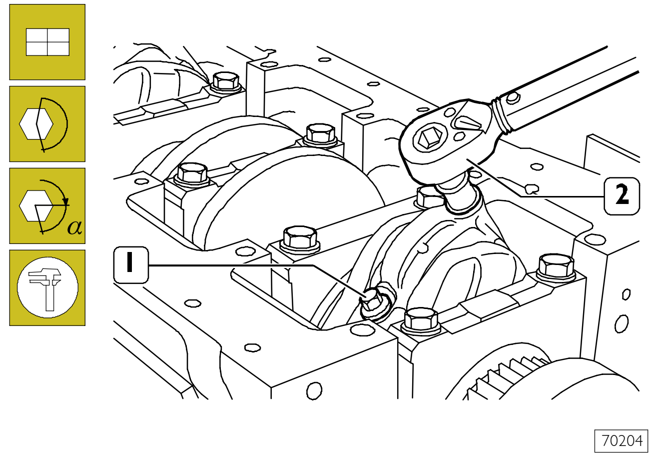


To measure the clearance proceed as follows:

- clean the parts accurately and remove any trace of oil;
- fit the connecting rod caps (1) with the relevant half bearings (2).

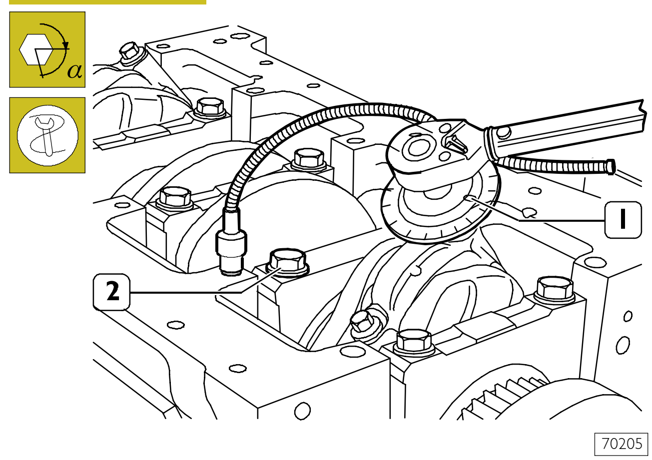
NOTE Before the final fitting of the connecting rod cap fastening screws, check that their diameter measured at the centre of the thread length is not < 0.1 mm than the diameter measured at approx. 10 mm from screw end.

Figure 54



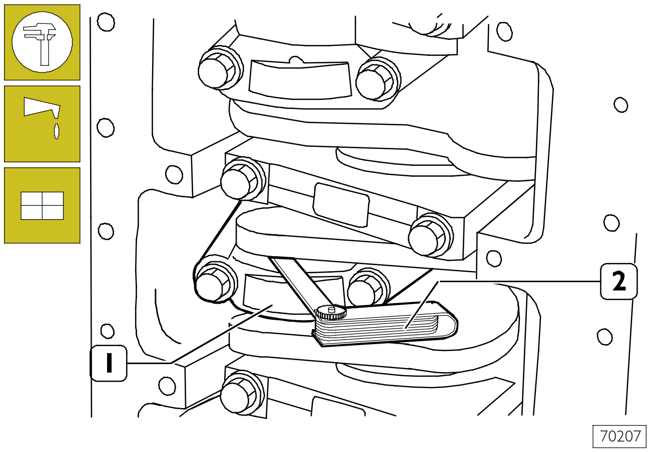
- Lubricate the screws (1) with engine oil and then tighten them to the specified torque using the torque wrench (2).

Figure 55



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

Figure 56



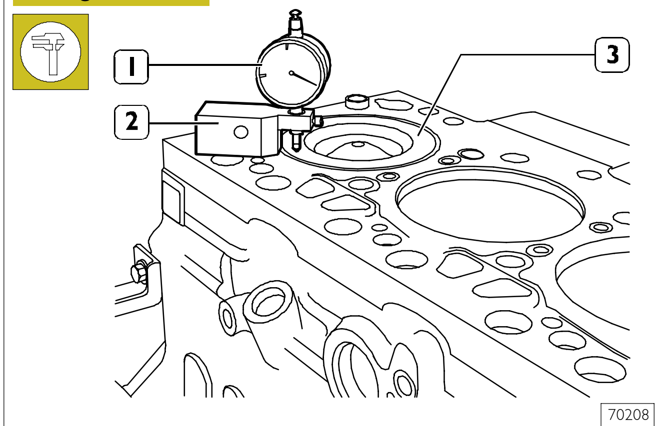
If a different clearance value is found, replace the half bearings and repeat the check.

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.

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 57



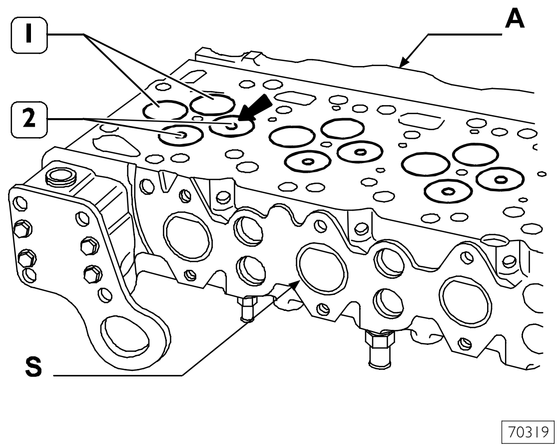
Once connecting rod-piston assemblies refitting is over, use dial gauge 99395603 (1) fitted with base 99370415 (2) to check piston (3) protrusion at T.D.C. with respect to the top of the engine block.

Protrusion shall be 0.28 to 0.52 mm.

CYLINDER HEAD

Removing the valves

Figure 58



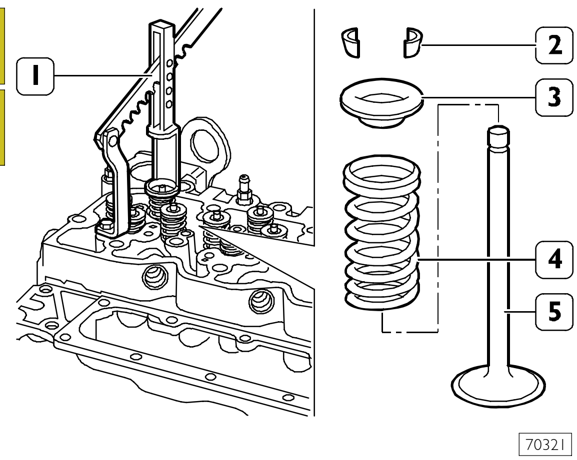
Intake (1) and exhaust (2) valves have heads with the same diameter.

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

NOTE 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 59

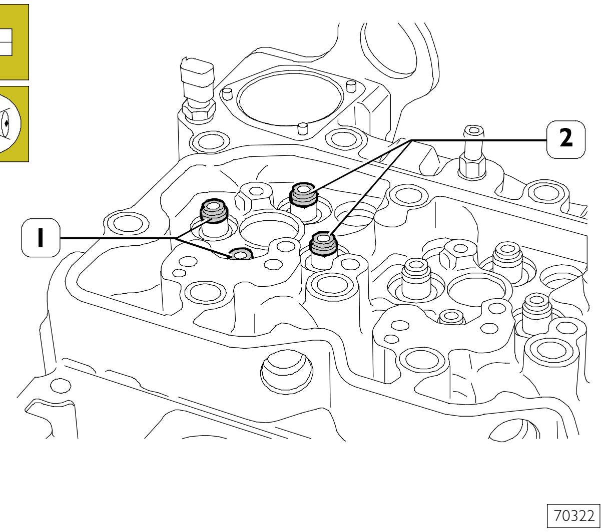


Valve removal shall be performed using tool 99360268 (1) and pressing the cap (3) so that when compressing the springs (4) the cotters (2) can be removed. Then remove the cap (3) and the springs (4).

Repeat this operation for all the valves.

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

Figure 60



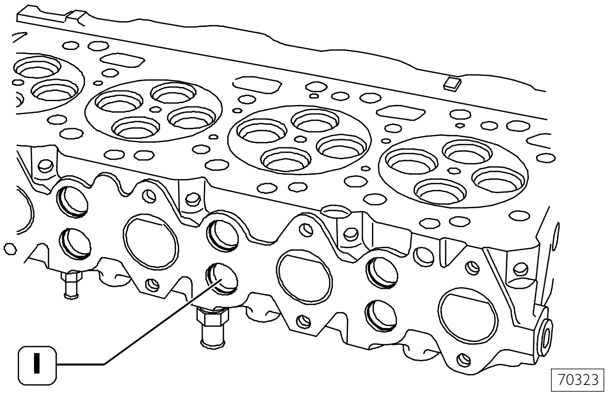
Remove sealing rings (1 and 2) from the valve guide.

NOTE Sealing rings (1) for intake valves are yellow.

Sealing rings (2) for exhaust valves are green.

Checking cylinder head wet seal

Figure 61



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.

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

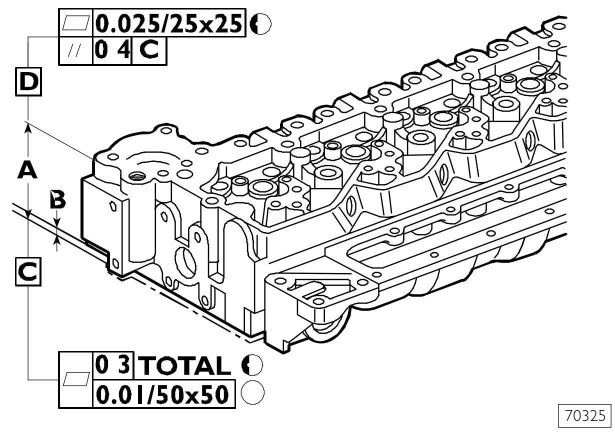
Replace the cylinder head if leaks are found.

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 62

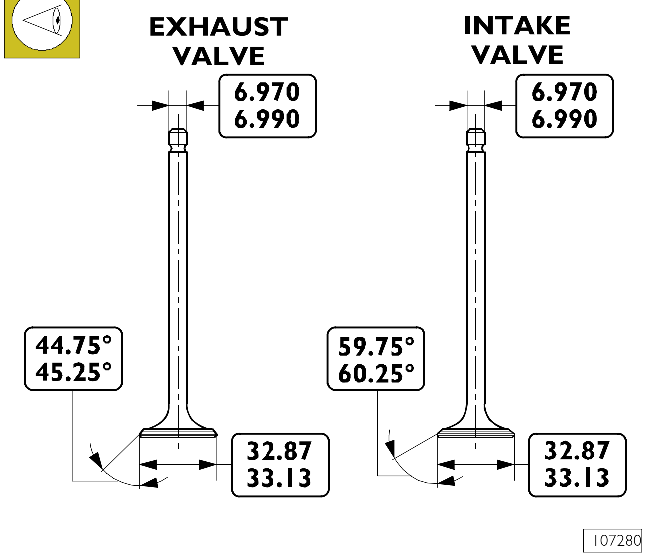


The rated thickness A for the cylinder head is 105 ± 0.25 mm, max. metal removal shall not exceed thickness B by 1 mm.

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

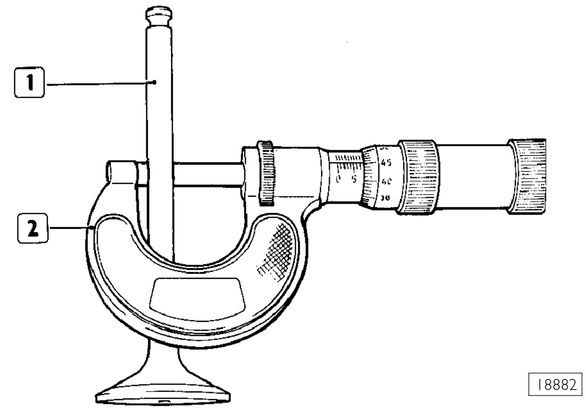
VALVES

Figure 63



INTAKE AND EXHAUST VALVE MAIN DATA

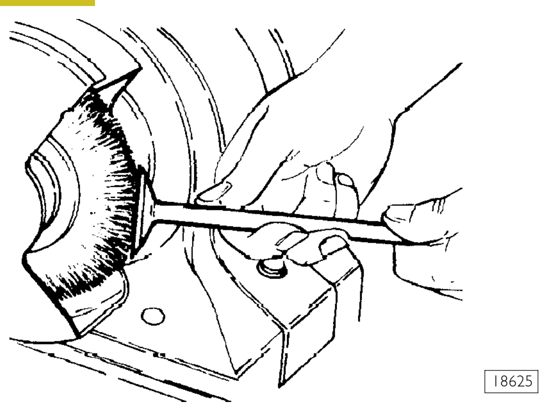
Figure 65



Check the valve stem (1) using a micrometer (2), it shall be 6.970 ÷ 6.990.

Removing carbon deposits, checking and grinding valves

Figure 64



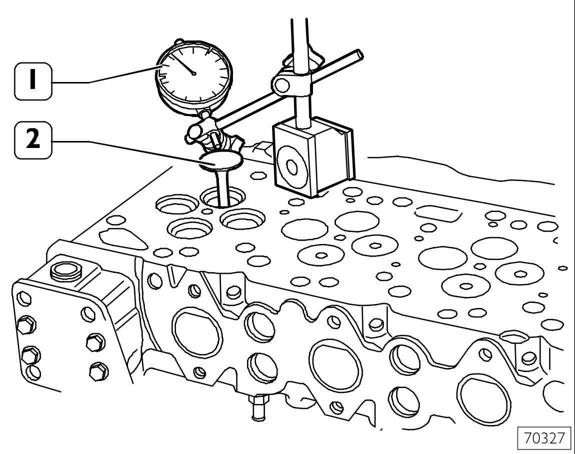
Remove carbon deposits from valves using the proper metal brush.

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

If necessary, rectify the valve seats, taking away the least amount of material possible.

Checking clearance between valve stem and valve guide and valve centering

Figure 66



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.

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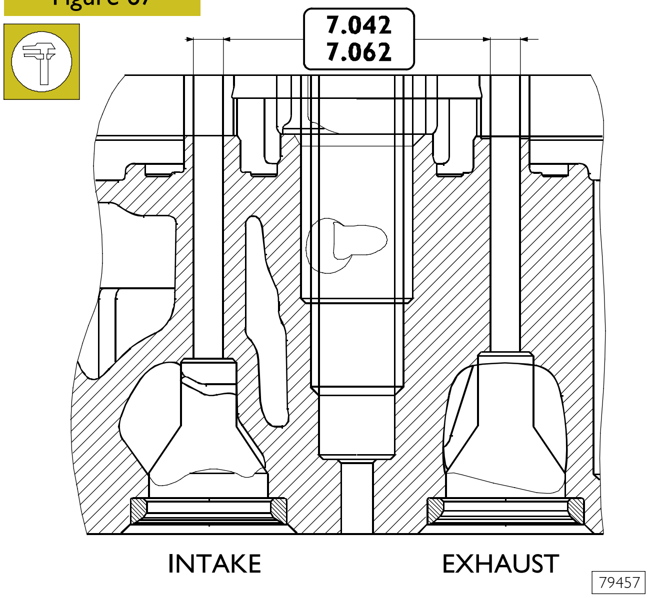
VALVE GUIDE

Figure 67

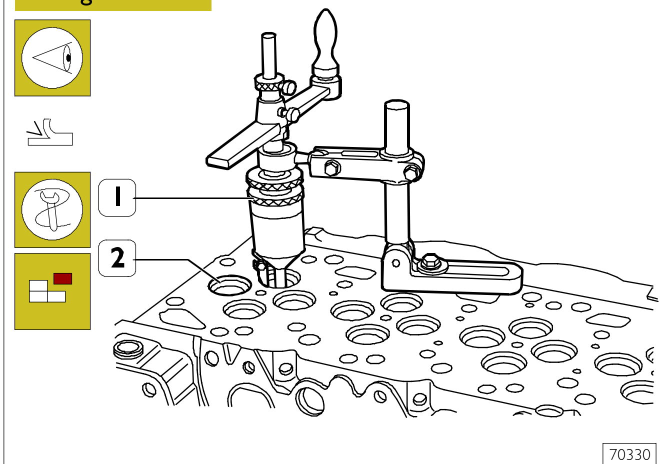


Use a bore dial gauge to measure the inside diameter of the valve guides, the read value shall comply with the value shown in the figure.

VALVE SEATS

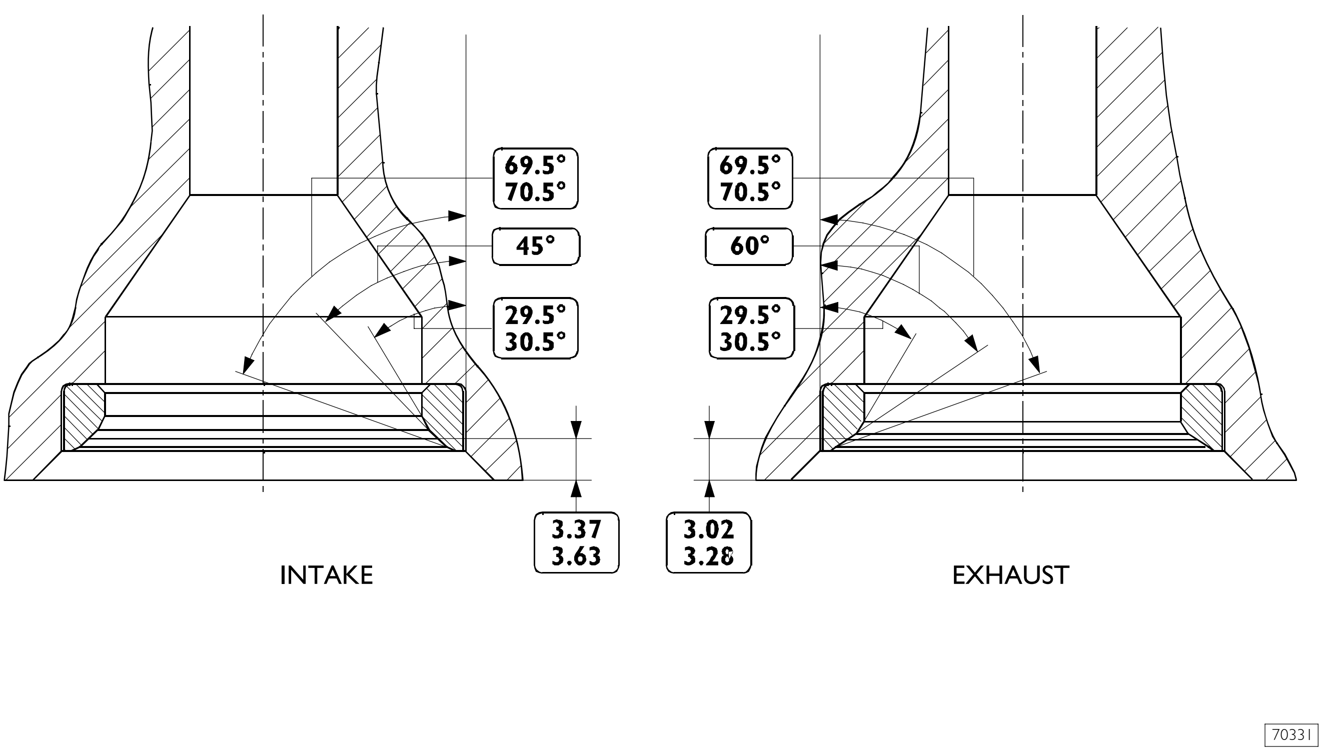
Regrinding – replacing the valve seats

Figure 68



Should slight scratches or burns be found, go over with the adequate tool (1) according to the inclination values indicated in the Figure 69.

Figure 69



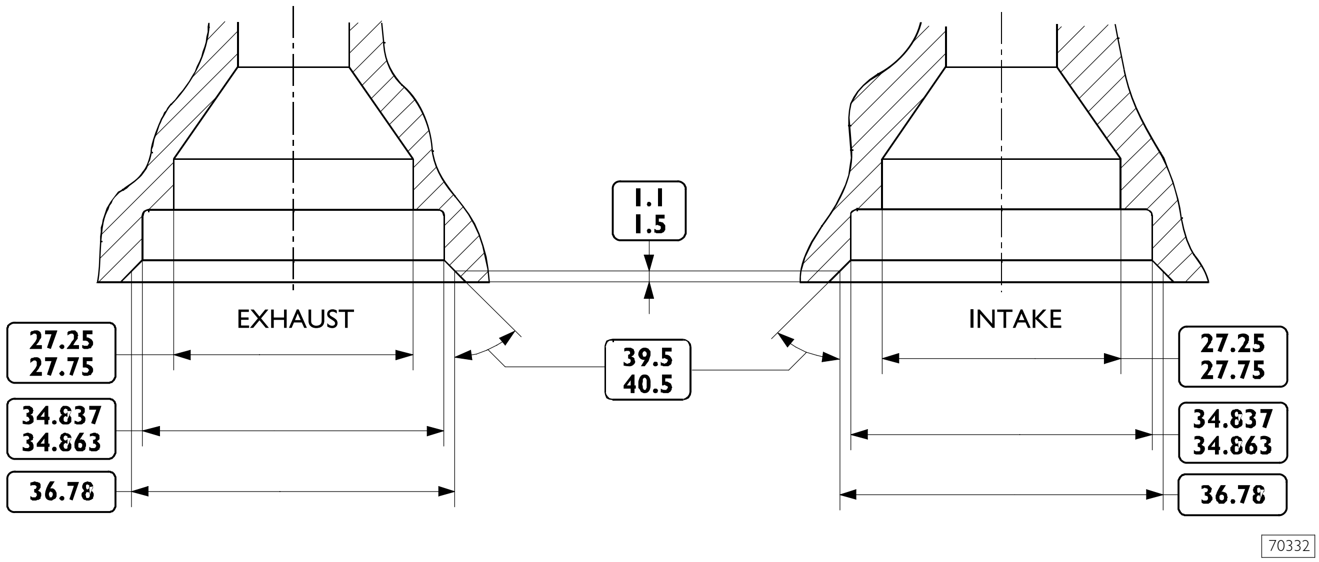
VALVE SEAT MAIN DATA (6 CYL.)

Should valve seats be not reset just by regrinding, replace them with the spare ones. Using a suitable tool, 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.

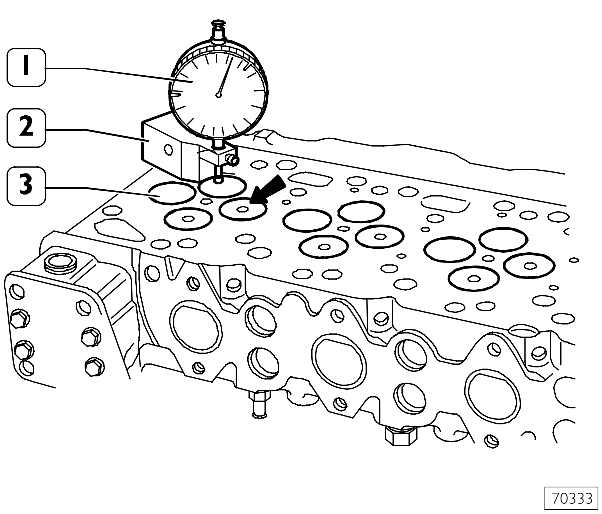
Therefore, with an adequate tool, go over the valve seats according to the values stated in the Figure 69.

Figure 70



MAIN DATA CONCERNING THE SEATS ON THE CYLINDER HEAD

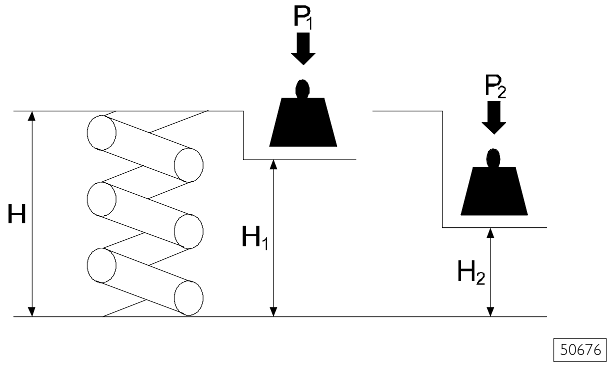
Figure 71



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 72



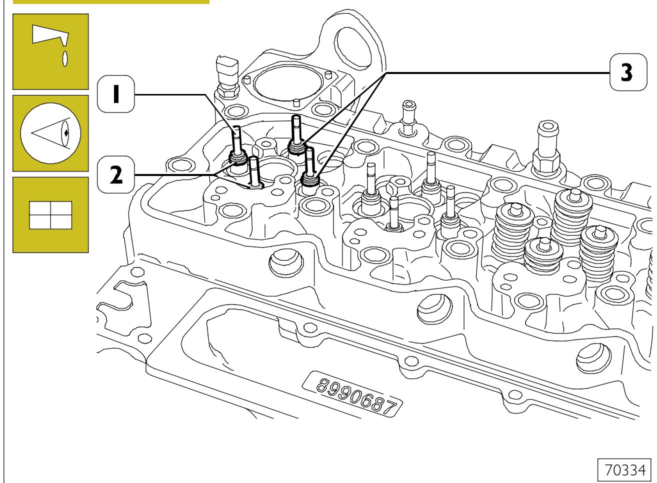
MAIN DATA TO CHECK INTAKE AND EXHAUST VALVE SPRINGS

Before refitting use tool 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		N	
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 73

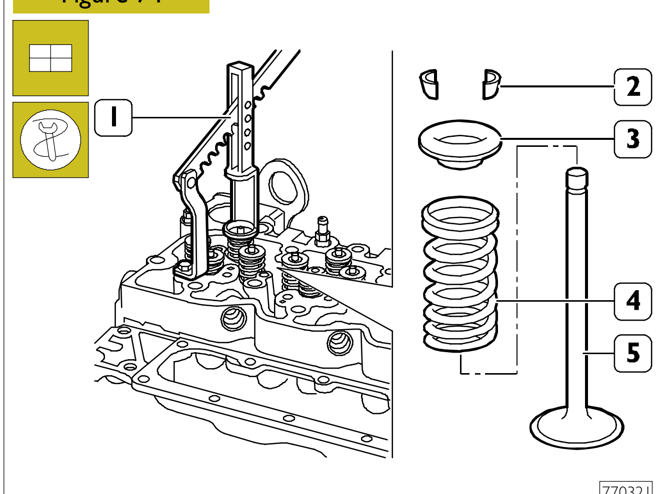


Lubricate the valve stems (1) and fit them into the relevant valve guides according to the position marked at removal.

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

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

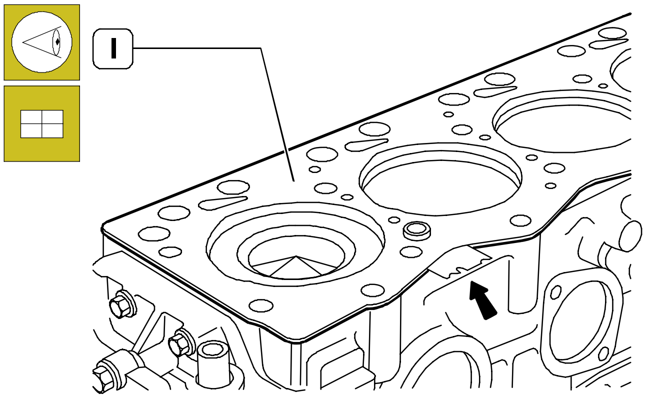
Figure 74



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 75



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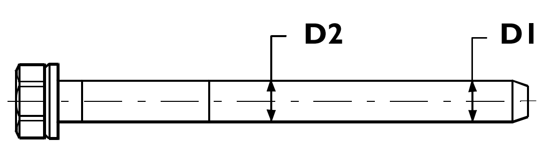
Check cleanness of cylinder head and engine block coupling surface.
Take care not to foul the cylinder head gasket.
Set the cylinder head gasket (1) with the marking "TOP" (1) facing the head.
The arrow shows the point where the gasket thickness is given.

NOTE Before using the fixing screws again, measure them twice as indicated in the picture, checking D1 and D2 diameters:
if D1 - D2 < 0,1 mm the screw can be utilised again;
if D1 - D2 > 0,1 mm the screw must be replaced.



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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

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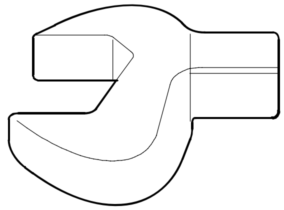
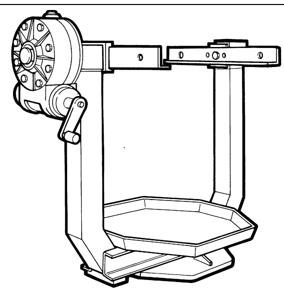
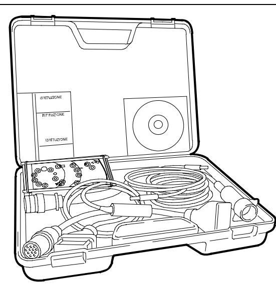
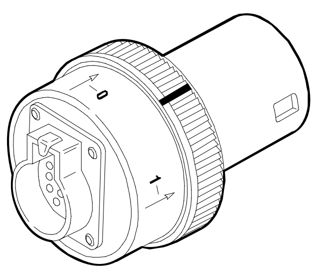
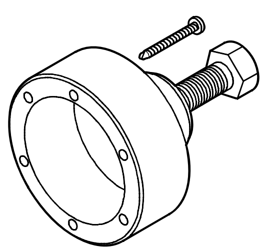
COMPONENT		TORQUE Nm	TORQUE kgm
Screw M6 for fastening engine coolant drain connector		10 ± 2	1 ± 0.2
Pin fastening on engine block for exhaust manifold		10 ± 2	1 ± 0.2
Screw M10 for fastening exhaust manifold on cylinder head		53 ± 5	5.3 ± 0.5
Screw M12 for fastening damper adapter and damper on output shaft	1st stage 2nd stage	50 ± 5 90°	5 ± 0.5
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 6-cyl. { nuts M8 4-cyl. { pins M8 4-cyl. { nuts M8	7 ± 1 43 ± 6 7 ± 1 24 ± 4	0.7 ± 0.1 4.3 ± 0.6 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 60° ± 5°	3 ± 0.4
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 90° ± 5°	5 ± 0.6 8 ± 0.6
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 60° ± 5°	6 ± 0.5
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

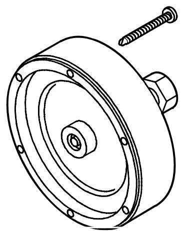
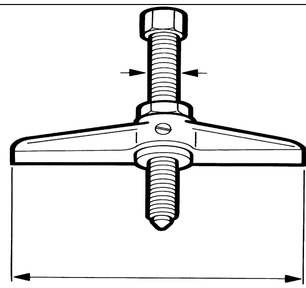
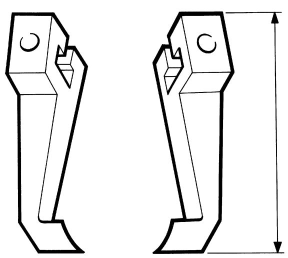
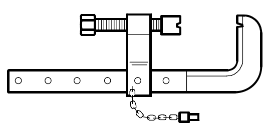
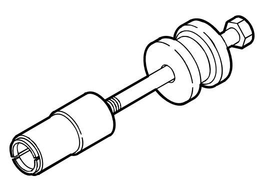
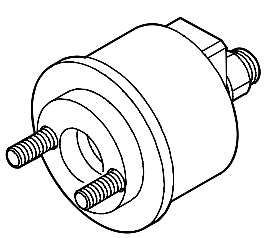
Tools

Page

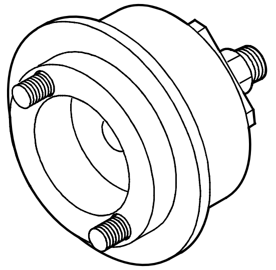
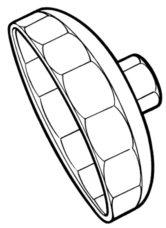
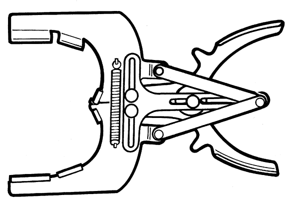
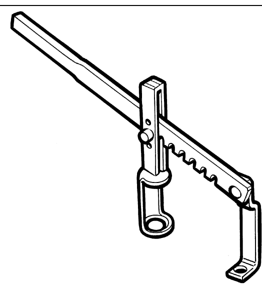
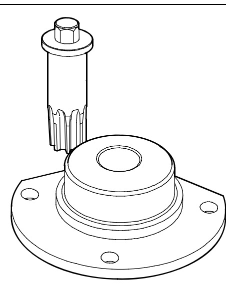
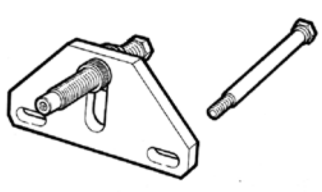
TOOLS

TOOL NO.		DESCRIPTION
99317915		Set of 3 pin wrenches (14 - 17 - 19 mm)
99322205		Revolving stand for overhauling units (700 daN/m capacity, 120 daN/m torque)
99327230		PT - Plus
99327281		PT - Box
99331043		Adaptors for 38 to 30 pin connectors (component of 99368554)
99340055		Tool to remove output shaft front gasket

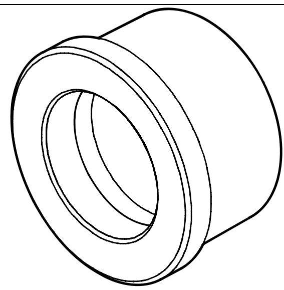
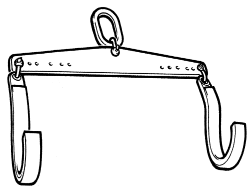
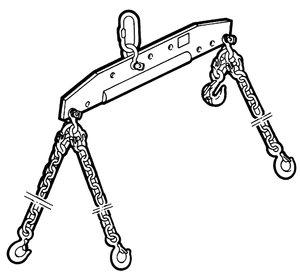
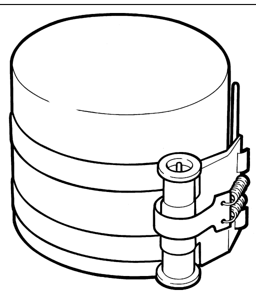
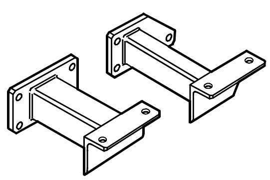
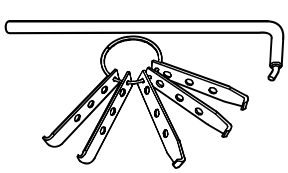
TOOLS

TOOL NO.		DESCRIPTION
99340056		Tool to remove output shaft rear gasket
99341001		Double acting puller
99341009		Pair of brackets
99341015		Press
99342101		Tool to remove injectors
99346252		Tool for fitting output shaft front gasket

TOOLS

TOOL NO.		DESCRIPTION
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
99360339		Tool for rotating/stopping the engine flywheel
99360351		Equipment for flywheel holding

TOOLS

TOOL NO.		DESCRIPTION
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)
99361037		Brackets for fastening engine to revolving stand 99322205
99363204		Tool to remove gaskets

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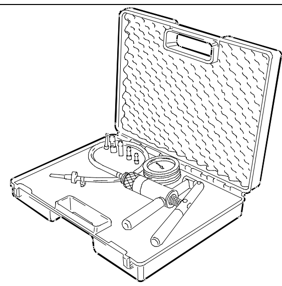
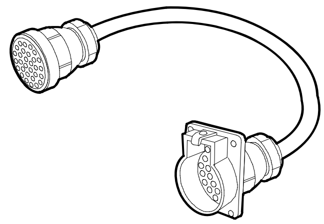
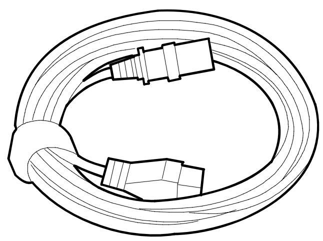
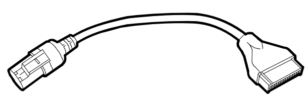
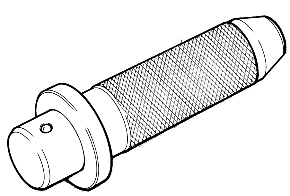
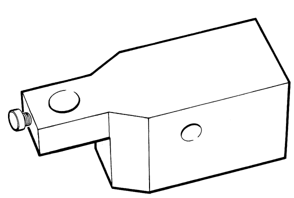
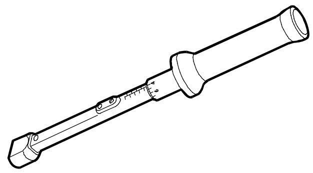
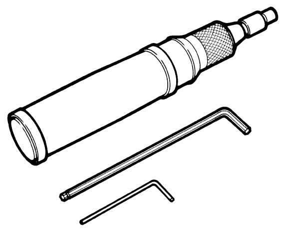
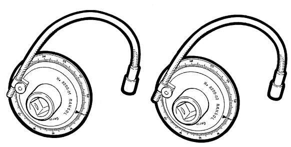
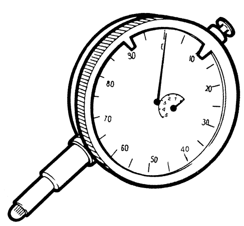
TOOLS

TOOL NO.		DESCRIPTION
99367121		Manual pump for pressure and depression measures
99368555		Adaptor for 30 to 19 in connectors (component of 99368554)
99368556		Adaptor (5m) for tester PT01 connection to 30 pin test socket (component of 99368554)
99368558		Adaptor (80cm) for tester PT01 connection to 30 pin test socket for Denox 2 (component of 99368554)
99370006		Handgrip for interchangeable beaters
99370415		Gauge base for different measurements (to be used with 99395603)

TOOLS

TOOL NO.		DESCRIPTION
99389829		Dog type dynamometric wrench 9x12 (5-60 Nm)
99389834		Torque screwdriver for injector solenoid valve connector stop nut setting
99395216		Pair of gauges with ½" and ¾" square head for angle tightening
99395603		Dial gauge (0 – 5 mm)

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Appendix

SAFETY PRESCRIPTIONS

Standard safety prescriptions

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

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

Prevention of injury

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

During maintenance

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

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

For engines equipped with electronic gearbox:

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

Respect of the Environment

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

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