

REPAIR MANUAL

R754EU6C



Print notes

Product Family: R750
Model:
• R754EU6C
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INTRODUCTION

INTRODUCTION

This document provides data, specifications, instructions and methods to perform repair interventions on the engine and its components.

This document is, in any case, intended for qualified and specialised personnel.

Before performing any operation, check that the document relevant to the engine model on which the operation is carried out is available and check that all accident prevention devices including - but not limited to - goggles, helmets, gloves, work shoes and equipment, lifting and transport means, etc., are available and efficient. Check also that the unit is in safety conditions before carrying out any operation.

Operations performed in full compliance with the indications here described, as well as the use of the indicated specific equipment, ensure that repair works are carried out correctly, respecting the times and safety of the operator.

Each repair intervention must be aimed at the recovery of the functionalities, the efficiency and the safety conditions provided by VM Motori.

Each operation on the unit that results in a change, alteration or other that has not been authorised by VM Motori, releases VM Motori from any liability and, in particular, when the engine is covered by a warranty, each intervention will immediately void the warranty.

VM Motori declines any responsibility for the repair interventions.

VM Motori is available to provide all the information required for carrying out the interventions and to provide instructions for any case scenarios and situations not covered in this publication.






The data contained in this publication could not be up to date due to possible changes made by the Manufacturer for technical or commercial reasons, or due to adaptations required by current laws in different countries.

In case of differences between the information listed in this publication and the current engine, contact VM Motori technical assistance department before proceeding with any operation.

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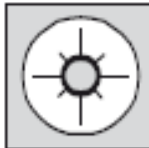
The manual uses appropriate symbols in its descriptions; the aim of these symbols is to classify the information. In particular, a series of symbols has been defined to classify the warnings, while another set of symbols has been specified for service operations.

SYMBOLS - WARNINGS

	Hazard to people Failure to observe these prescriptions may result in serious injuries
	Risk of serious damages to the engine unit Failure to observe these instructions, also in part, may result in serious damages to the engine unit and may void the warranty.
	General hazard It includes the hazards of both signs described above.
	Environmental protection It indicates the correct behaviour to have during assembly to respect the environment as much as possible.
	Notes: It indicates an additional information.

SYMBOLS - SERVICE OPERATIONS

	Removal Disconnection		Intake
	Refitting Connection		Exhaust
	Disassembly		Operation
	Assembled Layout		Compression Ratio
	Tightening to the specified torque		Tolerance Weight difference
	Tightening to the specified torque + angle		Tightening to the specified angle
	Press or caulking		Rotation
	Adjustment		Angle
	Visual Inspection Assembly check position		Pre-load

	Measurement Value to be measured Check		Revolutions per minute
	Equipment		Temperature
	Machining surface Machined finished product		Pressure
	Interference Forced assembly		Increased thickness Larger than ... Maximum
	Thickness Clearance		Decreased thickness Smaller than ... Minimum
	Lubricated Wet Grease		Selection Class Increase
	Sealant Glue		Temperature < 0 °C Cold Winter
	Air bleed		Temperature > 0 °C Hot Summer

GENERAL WARNINGS



The warnings shown may not represent all hazardous situations that may occur. Therefore, the surveillance authorities must be contacted any time that a hazardous situation that is not described occurs.

Use the general and specific equipment according to what stated in the relevant use and maintenance manuals. Check the operating conditions and the suitability of the tools that do not undergo periodical maintenance.

The manual handling of loads must be previously assessed taking into consideration weight, size and path.

The handling with mechanical equipment must be carried out using suitable lifts and hoists, taking into consideration weight, shape and volume. The used lifts, ropes and hooks must bear clear indications about maximum admissible load capacity. The use of these tools is strictly allowed to authorised personnel only. Keep at a safe distance from the load and never stand below it.

During disassembly operations, always follow the instructions provided and prevent any of the mechanical part about to be disassembled from accidentally hitting other people in the area.

The activities carried out by two technicians must be always carried out with care; avoid operations that may be dangerous for any collaborator due to hindered view or wrong position.

Keep any person not entrusted with the operations outside the working area.

Learn the required operation and safety concepts of the vehicle before working on it.

Thoroughly observe all engine safety warnings.

Do not leave the engine running during the repair operations.




When working on an assembly not anchored to the ground, make sure that it is firmly resting on the relevant supports and that the manual / automatic safety devices are active in case of lifting with hydraulic lift.

Remove the expansion reservoir plug only when the engine is cold, unscrewing it with care to allow the residual pressure in the system to come out.

Flammable fuels and all fluids and liquids must be handled with care, following the indications supplied in the 12-point harmful material data sheets. Filling must be carried out outside with engine off, avoiding lit cigarettes, open flames or sparks in order to prevent fires or sudden explosions. Store flammable, corrosive and polluting fluids and liquids in general appropriately and in accordance with current regulations. Avoid using food containers to store harmful fluids. Avoid piercing or burning pressurised containers and dispose of cloths soaked with flammable substances in suitable containers.

Worn, damaged parts or consumables must be replaced with original spare parts.

During the repair activities, keep the working area always clean; immediately clean the floor in case of accidental spillage and stains of fluids and oils. The electric sockets and electrical equipment required to carry out repair operations must comply with the safety standards.

	<p>Wear, when required, protective clothes and protections as provided for by the accident prevention rules; contact with moving parts may cause serious injuries. Use suitable clothes, preferably tight-fitting, and avoid wearing jewels, scarves, etc.</p> <p>Do not leave the engine running inside workshops not equipped with the tube to extract exhaust fumes outside.</p> <p>Do not inhale the fumes caused by the heating or welding of paint as they are harmful; work outside or in well ventilated areas. Wear a suitable breathing apparatus with paint powders.</p> <p>Avoid contact with the hot water or vapour coming from the engine, radiator or flexible hoses as they may cause serious burns. Avoid the direct contact with liquids and fluids of the vehicle; refer to the 12 point remedy sheet in the event of accidental contact.</p>
	<p>Before the overhaul, clean the units and make sure they are complete and in good conditions. Position the removed or disassembled parts with the relevant fastening elements (screws, nuts, etc.) neatly and in the appropriate containers.</p> <p>Check the integrity of the parts that prevent screws from becoming loose: washer, pins, clips, etc. Self-locking nuts with nylon inserts must always be replaced.</p> <p>Avoid rubber from getting into contact with diesel fuel, gasoline or other incompatible substances.</p> <p>Before proceeding with the pressure wash, protect the electrical connectors and the control units.</p> <p>Screw and nut tightening should be always carried out according to the indications; VM Motori's technical assistance department will provide the required clarifications to perform any repair operation not covered by this document.</p> <p>Before welding:</p> <ul style="list-style-type: none"> ● Disconnect all electronic control units and disconnect the power cord from the battery positive terminal (connecting it to the ground of the vehicle frame) and the connectors. ● Remove the paint using suitable solvents or detergents and clean the concerned surfaces with soap and water. ● Wait for approx. 15 minutes before welding. ● Use adequate fire prevention protections to protect pipes or other components in which fluids or other flammable materials flow during welding. <p>If the vehicle is subjected to temperatures higher than 80°C (ovens for drying), remove the electronic control units.</p>
	<p>The disposal of all liquids and fluids should be carried out by strictly complying with the current regulations.</p>

ELECTRIC SYSTEM GENERAL WARNINGS

When operating on the electrical / electronic circuit, disconnect the batteries from the circuit, disconnecting first the ground cable of the frame from the battery negative terminal.

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

Disconnect the external recharge equipment from the mains supply before removing the terminals of the equipment from the battery terminals.

Do not cause spark to check voltage presence in a circuit.

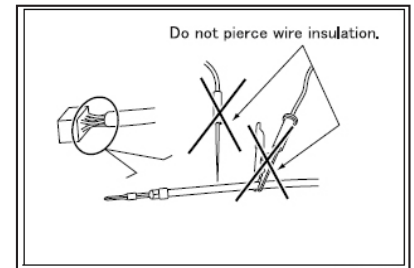
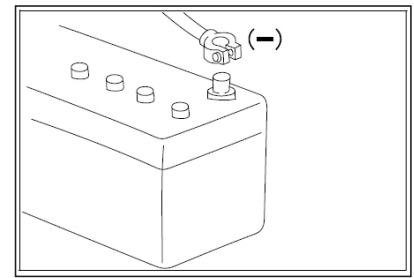
Do not use a test lamp to check circuit continuity, but only the suitable check equipment.

Make sure that the derivations of the electronic devices (length, cable type, position, strapping, shielding braided connection, grounding...) are compliant with the installation standards of VM Motori and that are completely restored after repair or maintenance operations.

Measurements on the engine control units (ECU), on the connectors and on the electrical connections can be carried out on suitable test lines only, through special plugs. Never use inappropriate means such as metallic wires, screwdrivers, clips or similar.

Do not drill the insulating material with ferrules or clips during electrical inspections.

Besides the risk of causing a short-circuit, this could damage the connections/connectors and give origin to contact issues.





Do not use fast battery chargers to start the engine. Ignition must be carried out only with separated batteries or special vehicles. The wrong polarisation of the voltage supply to the electronic control units (such as wrong polarisation of the batteries) may damage them.

Disconnect the batteries from the system before charging them through an external unit.

Isolate the circuit before disconnecting the junction connector from an electronic control unit.

Do not directly power the components supplied by the electronic control units with vehicle rated voltage.

When voltage is supplied to a circuit for inspection purposes, check that the cable (+) and the cable (-) are correctly connected, then gradually increase the voltage from zero. Do NOT exceed the voltage specifications.

Remember that the control unit and the sensors do not operate necessarily with the battery voltage.

The cables must be routed so that they are parallel to the reference surface, as much close as possible to the frame / bodywork.

At the end of the operations on the electric circuit, restore the electrical connectors and the wirings to their original position.

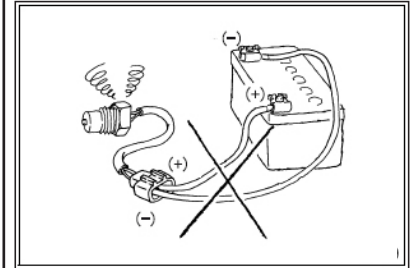


Note: To identify and check the fuses, follow the indications present in the vehicle, since their identification or position may be subject to changes.



Important: IN ORDER TO AVOID DAMAGES TO THE ENGINE ELECTRONIC CONTROL UNIT PAY ATTENTION TO THE FOLLOWING INSTRUCTIONS:

- DO NOT CUT THE VOLTAGE TO THE ENGINE DURING ITS OPERATION
- BEFORE CUTTING THE VOLTAGE THROUGH ELECTRIC DEVICES (SWITCHES, DISCONNECTING SWITCHES, ETC.) WAIT FOR AT LEAST 30 SECONDS SO THAT THE ENGINE ELECTRONIC CONTROL UNIT CAN PERFORM THE “**AFTER - RUN**” PROCEDURE





When performing an arc welding, the current of the welding machine flows to the ground through the metal parts of the vehicle, i.e. the frame. Unless adequate measures are taken, this current **could damage the engine electronic control unit**, as well as the electric devices and wirings.



Important: IT IS RECOMMENDED TO REMOVE THE ENGINE CONTROL UNIT FROM THE VEHICLE

Any electric device close to the point where the negative cable (-) of the welding machine is connected can get damaged.

The direction of the current of the circuit is shown in the figure.

Before starting an electric welding proceed as follows:

From the battery negative cable (-)

To avoid damaging the battery and the electric devices that are directly connected to the battery, it is necessary to disconnect the battery negative cable (-).

Procedure

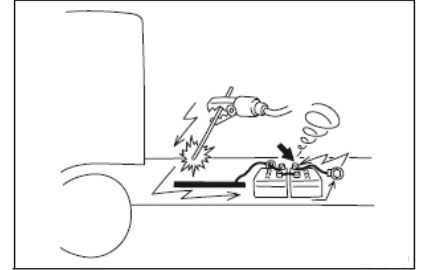
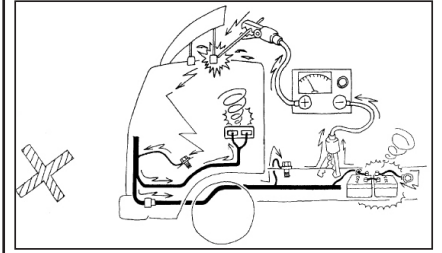
Turn the electric panel of the vehicle off.

Disconnect the battery negative cable (-).

Cover all parts of the vehicle that can get damaged by the electric arc.

Connect the negative cable of the welding machine (-) to the vehicle as much close as possible to the area that you are welding. Do not connect the negative cable of the welding machine (-) to the cabin of the vehicle if the frame is subject to welding, and vice versa.

Adjust the amperage of the current of the welding machine according to the parts that must be welded.





MANUAL UPDATES

Section	Chapter	Change description	Overhaul date

ENGINE MODEL IDENTIFICATION	2
Engine serial number and identification plate.....	2
Engine model abbreviation definition.....	3

ENGINE MODEL IDENTIFICATION

ENGINE SERIAL NUMBER AND IDENTIFICATION PLATE

1 - VM engine serial number stamped on the crankcase

2 - VM engine nameplate

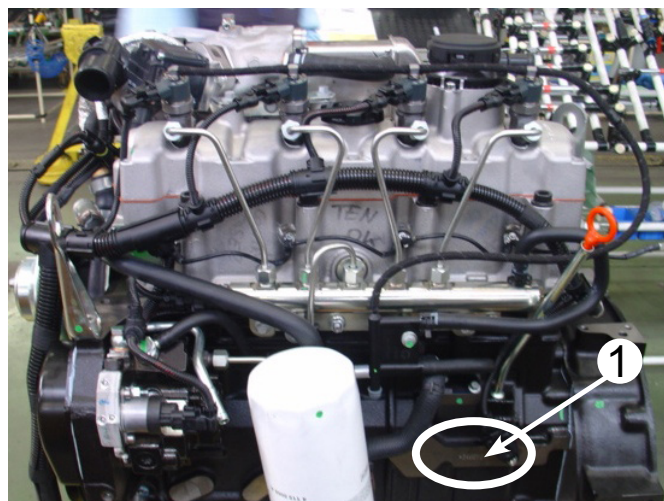
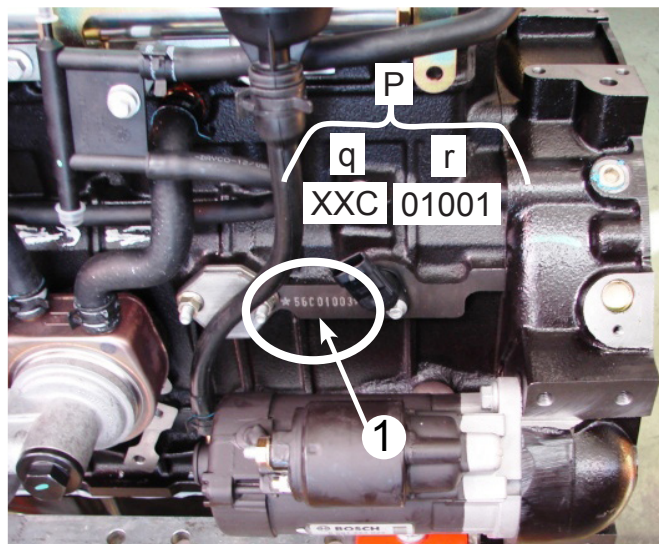
P) Engine serial number stamped on the crankcase

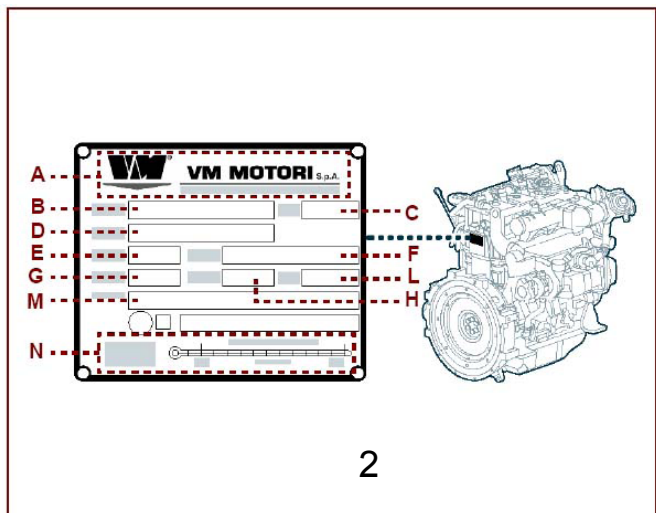
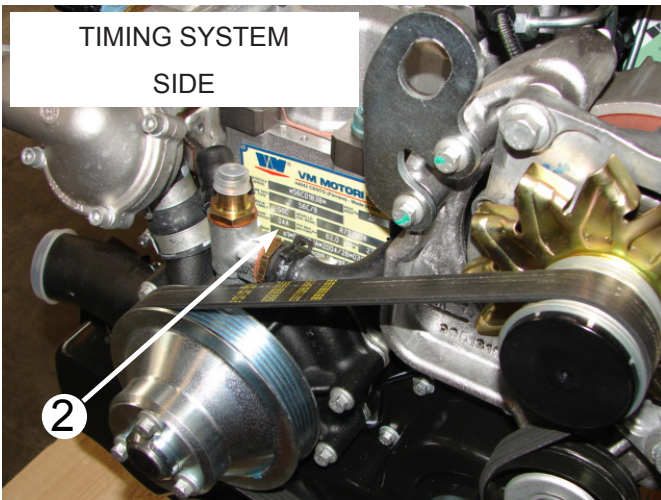
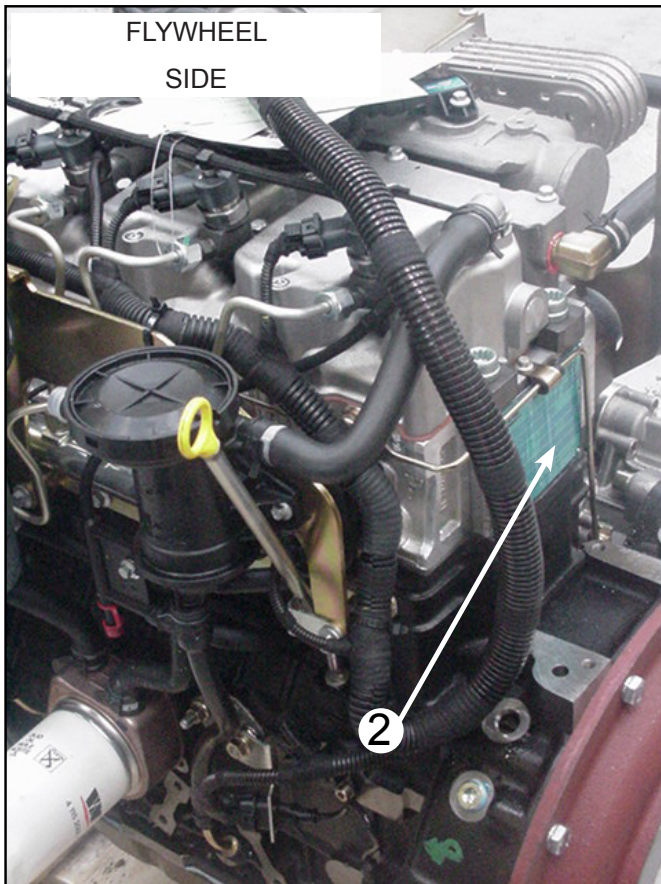
q) Engine code

r) Production serial number

The table helps identify the engine model through the engine code.

Engine code	Engine model
60D	R754EU6 - R754EU6C





- | | |
|--------------------------------|---|
| A) Manufacturer identification | M) Approval |
| B) Engine serial number | N) Engine lubricating oil characteristics |
| C) Dry weight | |
| D) Engine type | |
| E) Family | |
| F) Model | |
| G) Version | |
| H) Max power (kW) | |
| L) Max rpm | |

ENGINE MODEL ABBREVIATION DEFINITION

Model R754EU6

R754EU6.19A - Common rail

R754EU6.19A - unitary displacement (750 cu.cm/ cylinder)

R754EU6.19A - cylinder number

R754EU6.19A - Euro 6 (polluting emission standard)

R754EU6.19A - engine version

Model R754EU6C

R754EU6C.19A - Common rail

R754EU6C.19A - unitary displacement (750 cu.cm/ cylinder)

R754EU6C.19A - cylinder number

R754EU6C.19A - Euro 6 (polluting emission standard)





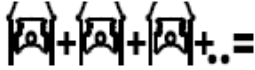











R754EU6C.19A - Approval level

R754EU6C.19A - engine version



TECHNICAL DATA	2
General features.....	2





TECHNICAL DATA

GENERAL FEATURES

		Type			
	Cycle Power output Injection			4 strokes Turbocharger with intercooler Direct common rail	
	Cylinder number			4	
	Bore	mm		94	
	Travel	mm		107	
	Total displacement	cu.cm		2970	
	Compression ratio			17.5 ± 0.5: 1	
	Maximum power	KW(HP)		84 (112.6)	
		rpm		3000	
	Maximum torque	Nm (kgm)		420 (42.82)	
		rpm		1100	
	Rpm at idle without load	rpm		800 ± 150	
	Maximum rpm without load	rpm		/	
	Maximum permanent transversal inclination (A)	degrees / %		30° / 57 %	
	Maximum permanent longitudinal inclination (with high flywheel) (B)	degrees / %		30° / 57 %	
	Maximum permanent longitudinal inclination (with low flywheel) (B)	degrees / %		35° / 70 %	
	Dry weight	Kg		260 ± 20	
	Rotation direction (from the flywheel)			counter-clockwise	

Type			
TIMING SYSTEM			
	To check timing system		
	mm	hydraulic tappets with clearance recovery	
	mm	hydraulic tappets with clearance recovery	
	Operation		
	mm	hydraulic tappets with clearance recovery	
	mm	hydraulic tappets with clearance recovery	
	start before TDC		A = 26°
	end after BDC		B = 58°
	start before BDC		C = 36°
	end after TDC		D = 66°
SUPPLY			
	Injection system	The high pressure injection system is controlled by the BOSCH EDC 17 control unit. It is made up of the CP3 high pressure pump, the electro-injectors, hydraulic accumulator (rail), engine management control unit EDC 17 and the pressure and temperature sensors.	
	Electro-injectors, type	CR 2.2	
	Combustion order	1-3-4-2	
	Injection variable pressure	bar	2200
	Minimum absolute intake pressure after fuel filter	mbar	500
	Maximum supply flow rate	litres/h	70
TURBOCHARGER			
	Compressor type	fixed geometry with pneumatic control	


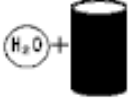


		Type		
COOLING				
	Type		Through centrifugal pump, thermostat for thermal regulation, water/oil heat exchanger, fan and radiator	
	Water pump control		belt	
	thermostat		quantity 1	
	opening start		88 °C	
	opening end		95 °C	
	circuit pressure	bar	1 - 1.2	
	expansion reservoir plug opening pressure	bar	1.1	
	maximum water temperature during operation	°C	105	
INTAKE				
	Admissible vacuum with new air filter	kPa / mbar	4.7 / 47	
EXHAUST				
	Maximum counter-pressure at the exhaust complete with new DOC/DPF and SCR	mbar	600	

		Type		
LUBRICATION				
	Type		forced from gear pump, maximum pressure valve, oil filter	
	Oil pressure with hot engine (80°C)			
	at idle	bar	2	
	at maximum rpm	bar	4	
	Maximum admissible temperature - continuous	°C	135	
	Maximum admissible temperature - peak	°C	135	
	Minimum oil pressure alarm	bar	0.8	

FILLINGS																																																																		
	Total capacity of first filling	litres / Kg																																																																
	minimum oil sump level	litres / Kg																																																																
	maximum oil sump level	litres / Kg	7.4 ÷ 11.5 Kg 8.5 ÷ 13 L																																																															
			<table border="1"> <thead> <tr> <th>Engine version</th> <th>Oil sump capacity (kg)</th> </tr> </thead> <tbody> <tr><td>R754EU6.08A</td><td>7.4</td></tr> <tr><td>R754EU6.18A</td><td>7.4</td></tr> <tr><td>R754EU6.19A</td><td>7.4</td></tr> <tr><td>R754EU6.20A</td><td>7.4</td></tr> <tr><td>R754EU6C.02A</td><td>7.4</td></tr> <tr><td>R754EU6C.08A</td><td>7.4</td></tr> <tr><td>R754EU6C.18A</td><td>7.4</td></tr> <tr><td>R754EU6C.19A</td><td>7.4</td></tr> <tr><td>R754EU6C.28A</td><td>7.4</td></tr> <tr><td>R754EU6.01A</td><td>8.7</td></tr> <tr><td>R754EU6.11A</td><td>8.7</td></tr> <tr><td>R754EU6.12A</td><td>8.7</td></tr> <tr><td>R754EU6.14A</td><td>8.7</td></tr> <tr><td>R754EU6.16A</td><td>8.7</td></tr> <tr><td>R754EU6.17A</td><td>8.7</td></tr> <tr><td>R754EU6.21A</td><td>8.7</td></tr> <tr><td>R754EU6.22A</td><td>8.7</td></tr> <tr><td>R754EU6.23A</td><td>8.7</td></tr> <tr><td>R754EU6.24A</td><td>8.7</td></tr> <tr><td>R754EU6.25A</td><td>8.7</td></tr> <tr><td>R754EU6.26A</td><td>8.7</td></tr> <tr><td>R754EU6C.01A</td><td>8.7</td></tr> <tr><td>R754EU6C.13A</td><td>8.7</td></tr> <tr><td>R754EU6C.21A</td><td>8.7</td></tr> <tr><td>R754EU6C.22A</td><td>8.7</td></tr> <tr><td>R754EU6C.23A</td><td>8.7</td></tr> <tr><td>R754EU6C.25A</td><td>8.7</td></tr> <tr><td>R754EU6.05A</td><td>11.5</td></tr> <tr><td>R754EU6C.04A</td><td>11.5</td></tr> <tr><td>R754EU6C.05A</td><td>11.5</td></tr> <tr><td>R754EU6C.30A</td><td>11.5</td></tr> </tbody> </table>	Engine version	Oil sump capacity (kg)	R754EU6.08A	7.4	R754EU6.18A	7.4	R754EU6.19A	7.4	R754EU6.20A	7.4	R754EU6C.02A	7.4	R754EU6C.08A	7.4	R754EU6C.18A	7.4	R754EU6C.19A	7.4	R754EU6C.28A	7.4	R754EU6.01A	8.7	R754EU6.11A	8.7	R754EU6.12A	8.7	R754EU6.14A	8.7	R754EU6.16A	8.7	R754EU6.17A	8.7	R754EU6.21A	8.7	R754EU6.22A	8.7	R754EU6.23A	8.7	R754EU6.24A	8.7	R754EU6.25A	8.7	R754EU6.26A	8.7	R754EU6C.01A	8.7	R754EU6C.13A	8.7	R754EU6C.21A	8.7	R754EU6C.22A	8.7	R754EU6C.23A	8.7	R754EU6C.25A	8.7	R754EU6.05A	11.5	R754EU6C.04A	11.5	R754EU6C.05A	11.5	R754EU6C.30A
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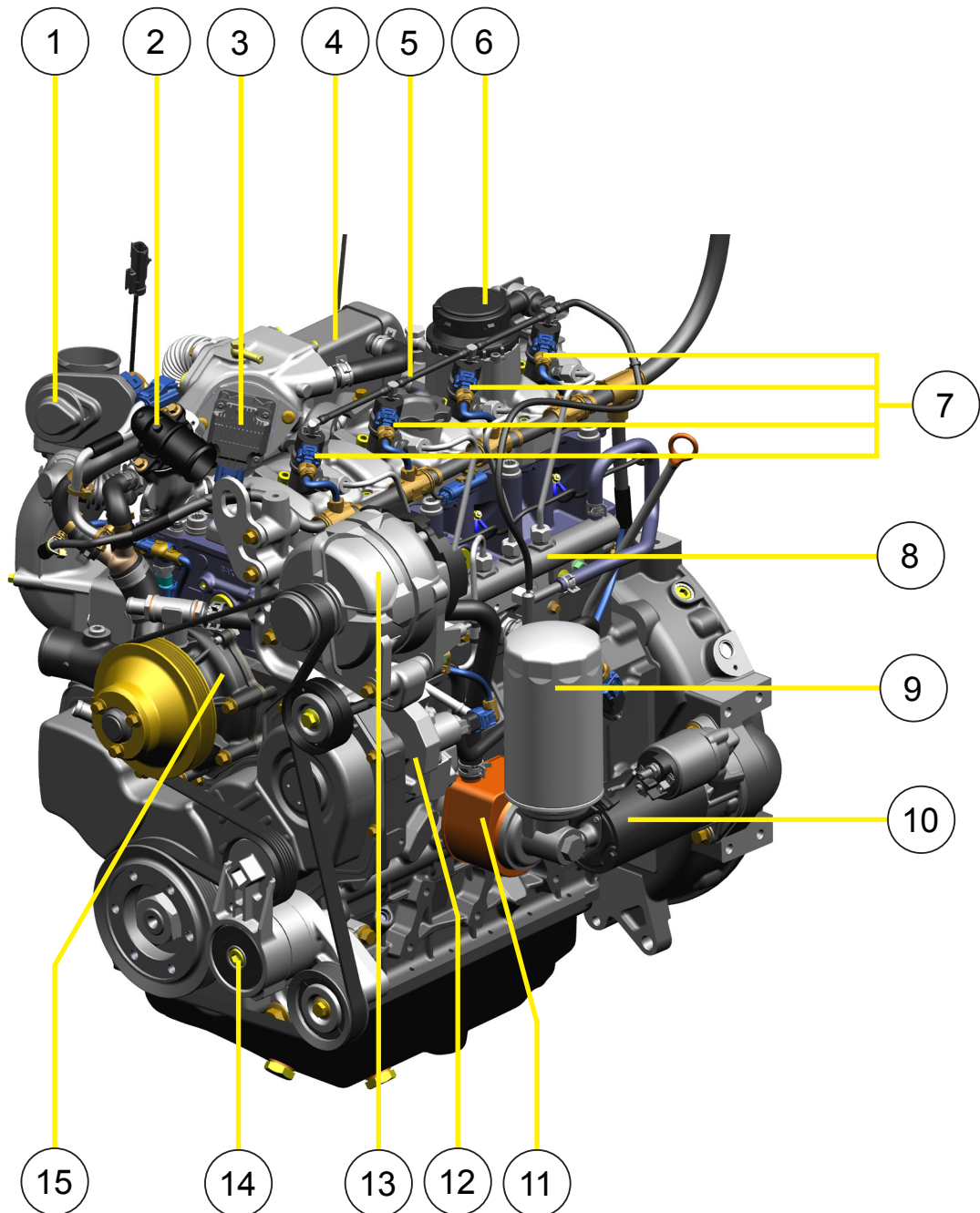


Important: refer to chapter "Engine identification" to check the engine version stated in the identification nameplate.

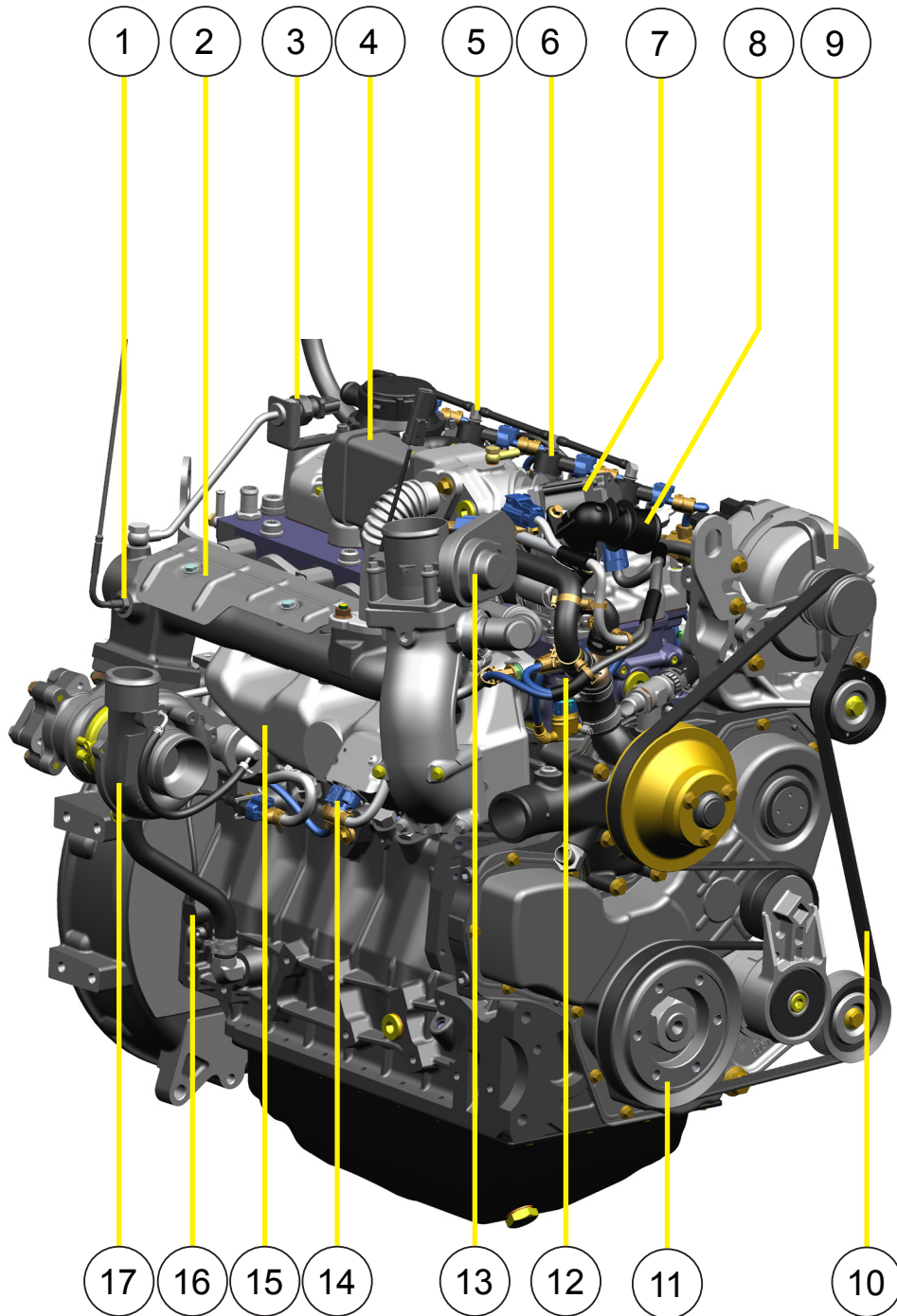
	engine oil		ACEA E6 - E9 - synthetic-based SAE 10W - 40	
			Q8 T 905	
	coolant		50% of monoethylene glycol based protective fluid for radiators with concentration formulated with organic inhibitors based on OAT, compliant with standards ASTM D 3306 type 1, and 50% of purified or distilled water (PARAFLU UP is recommended)	
	cooling circuit capacity (engine only)	litres	5	
	fuel		The engine has been designed to be supplied with standard fuels available in Europe (according to DIN EN 590 specifications). In case of supply with BIODIESEL fuel (according to UNI EN 14214 specifications), it can be mixed, up to 7% , with fuel available in Europe (according to standard DIN EN 590).	
	AdBlue reagent fluid		Water-based urea solution (AUS32) compliant with ISO 22241 specifications	
	Capacity	litres	14	

ENGINE VIEWS2

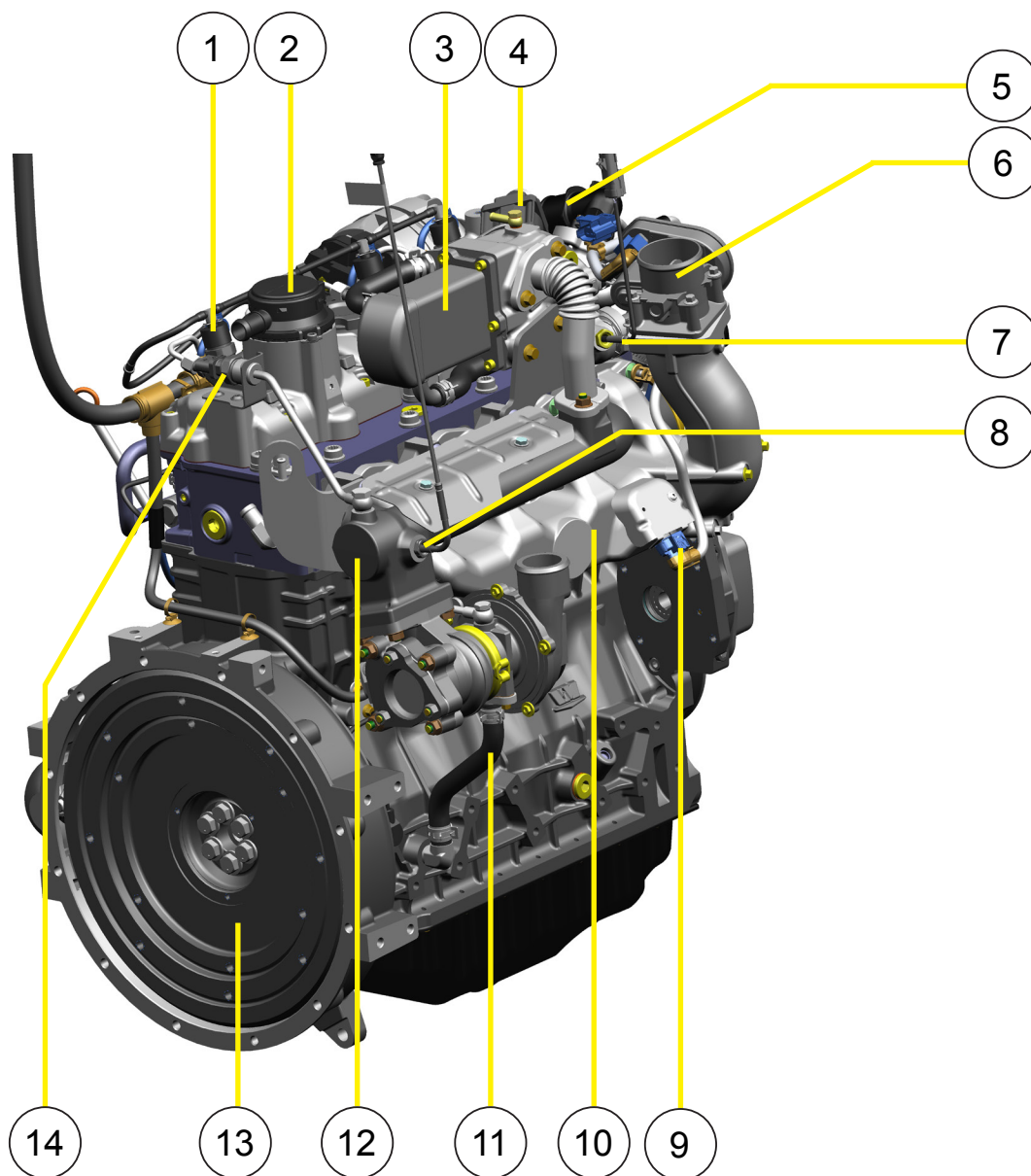
ENGINE VIEWS



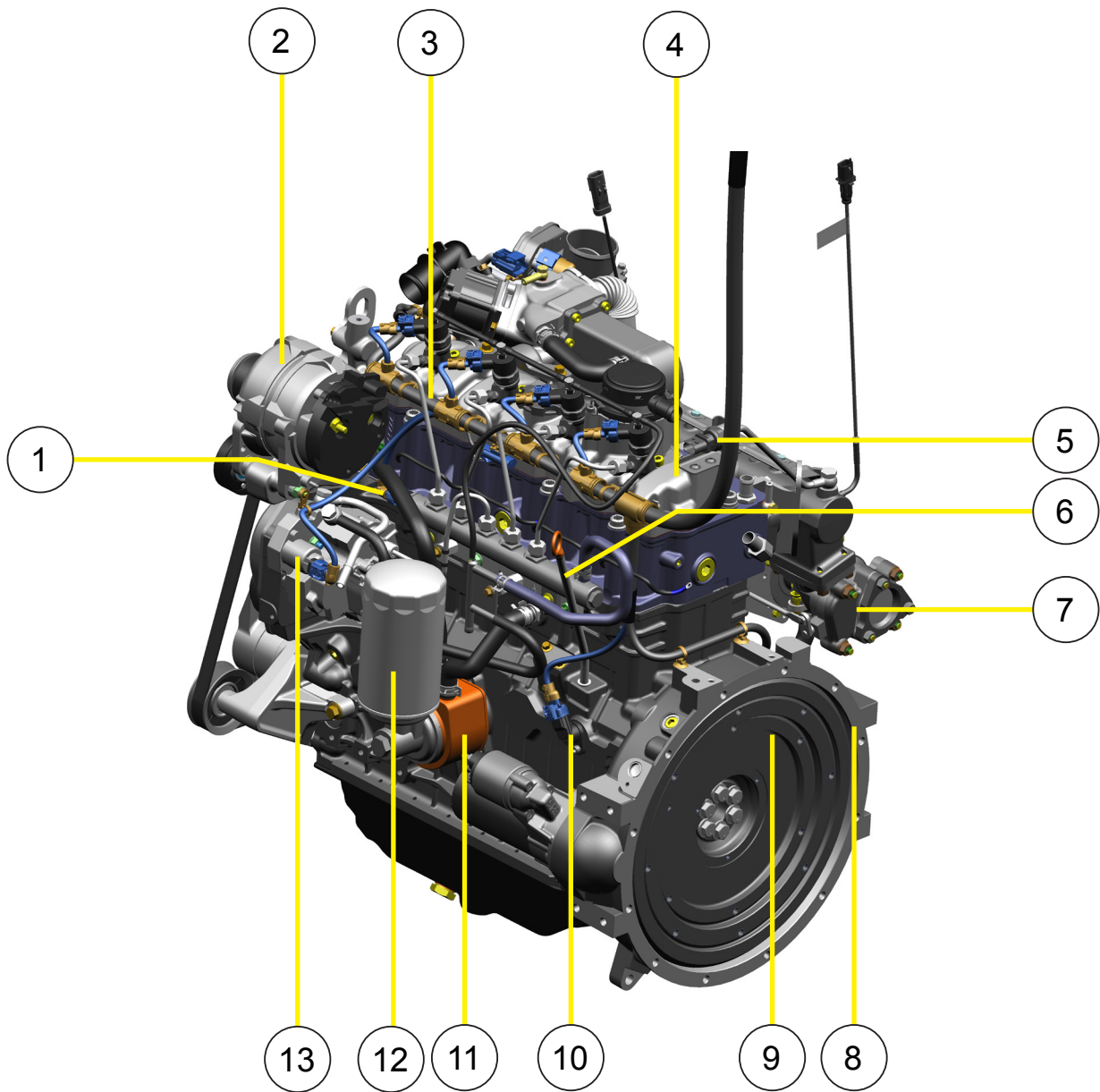
1 - TVA AIR INTAKE VALVE	8 - RAIL HYDRAULIC ACCUMULATOR
2 - THERMOSTATIC VALVE	9 - OIL FILTER
3 - EGR VALVE	10 - STARTER MOTOR
4 - EGR HEAT EXCHANGER	11 - OIL/WATER HEAT EXCHANGER
5 - INJECTOR FUEL WASTE PIPE	12 - HIGH PRESSURE INJECTION PUMP
6 - OIL VAPOUR SEPARATOR	13 - ALTERNATOR
7 - INJECTORS	14 - BELT TENSIONER
	15 - WATER PUMP



1 - EXHAUST GAS T3 TEMPERATURE SENSOR	10 - ALTERNATOR BELT
2 - EXHAUST MANIFOLD	11 - CRANKSHAFT PULLEY
3 - EXHAUST GAS PRESSURE SENSOR	12 - WATER TEMPERATURE SENSOR
4 - EGR HEAT EXCHANGER	13 - TVA AIR INTAKE VALVE
5 - INJECTOR FUEL WASTE PIPE	14 - AIR TEMPERATURE/PRESSURE SENSOR
6 - INJECTORS	15 - INTAKE MANIFOLD
7 - EGR VALVE	16 - ENGINE RPM SENSOR
8 - THERMOSTATIC VALVE	17 - TURBO
9 - ALTERNATOR	



1 - INJECTOR	8 - EXHAUST GAS T3 TEMPERATURE SENSOR
2 - OIL VAPOUR SEPARATOR	9 - AIR TEMPERATURE/PRESSURE SENSOR
3 - EGR HEAT EXCHANGER	10 - INTAKE MANIFOLD
4 - EGR VALVE	11 - OIL DRAIN PIPE FROM TURBO
5 - THERMOSTATIC VALVE	12 - EXHAUST MANIFOLD
6 - TVA AIR INTAKE VALVE	13 - FLYWHEEL
7 - EGR TEMPERATURE SENSOR	14 - EXHAUST GAS PRESSURE SENSOR



1 - RAIL PRESSURE SENSOR	8 - FLYWHEEL HOUSING
2 - ALTERNATOR	9 - FLYWHEEL
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4 - ROCKER ARM COVER	11 - OIL/WATER HEAT EXCHANGER
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SCHEDULED MAINTENANCE



Important: If no hour counter is present, the frequency must be calculated according to the solar day: one solar day corresponds to 12 operating hours.

The engine running-in period is to be considered equal to 50 hours: at the end of this period the engine oil must be changed.

COMPONENT	OPERATING HOURS							
	Every 10 hours (everyday)	After 50 hours (running-in end)	Every 300 hours	Every 600 hours	Every 900 hours	Every 1500 hours	Every 4000 hours	Every 8000 hours
Engine oil*	CL	S	S / T1					
Fuel filter *				S / T1				
Engine oil filter			S / T1					
Coolant	CL			CF			S / T4	
Air filter (dust exhaust)	CV / P		P					
Air filter (cyclone)	CV / P		P					
Air filter (main and secondary cartridge)	CV / P		S					
Air filter clogging indicator	CV				S			
TVA throttle intake valve			P					
Air intake circuit and intercooler pipes			P / CT					
Engine cooling system (radiator, intercooler, fan)	CV / P							
Engine oil vapour separation circuit			CT					
Water pump-alternator belt					S / T2			
Fuel tank					P			
DEF/ADBLUE fluid dosing unit module filter						S / T2		
Engine overhaul							RP	RT

CL= LEVEL CHECK	RP = PARTIAL/LIGHT OVERHAUL
CF = CHEMICAL FORMULATION CHECK	RT = COMPLETE OVERHAUL
CT = PIPE LEAKAGE CHECK	T1 =Every year
CV = VISUAL CHECK	T2 =Every 2 years
P = CLEANING	T4 = every 4 years
S = REPLACEMENT	

For the engine versions R754EU6.05A, R754EU6C.04A, R754EU6C.05A, R754EU6C.30A, oil and fuel filter should be changed every 500 hours.

In particularly heavy conditions of use, such as in dusty environments and operation with heavy loads, change engine oil and oil filter every 150 hours of operation.

OIL CHANGE

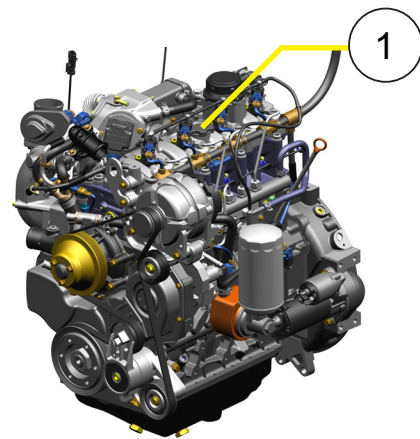
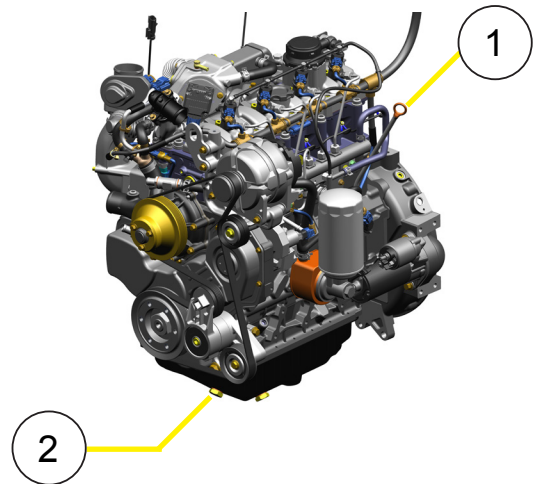
1. Remove the oil dip stick **(1)**.
2. Unscrew plug **(2)** from the oil sump and drain the oil in a specific container.
3. Screw plug **(2)** back in the sump and tighten it.

Oil plug	78.5 Nm
----------	---------

**Attention!**

- Collect the oil in a container.
- Avoid any contact with the skin: in case of contact wash with water.
- The engine oil is highly polluting: it must be disposed of in accordance with current laws on disposal.

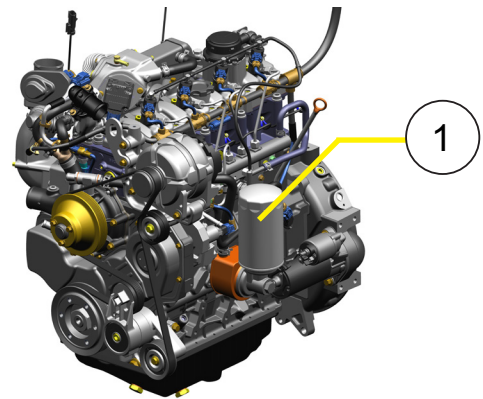
4. Refill the engine with oil based on the quantity and technical specifications described in the relevant section, through the relevant filling plug **(1)**.



OIL FILTER CHANGE

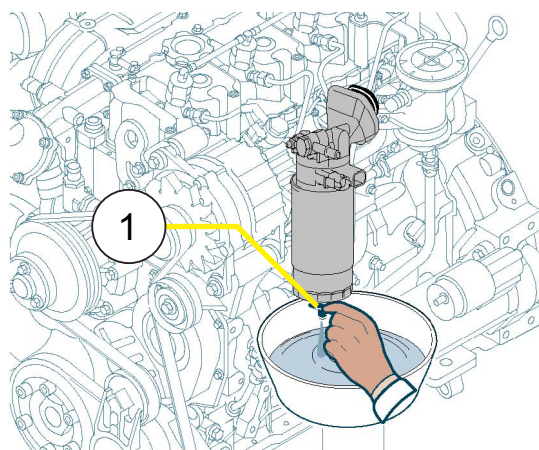
1. Unscrew the filter cartridge **(1)** and drain the oil contained in the filter.
2. Take the new cartridge and smear the O-ring of the cartridge with oil.
3. Manually screw the cartridge in the support until it rests against the support base.
4. Tighten the filter.

Oil filter	12.7 Nm
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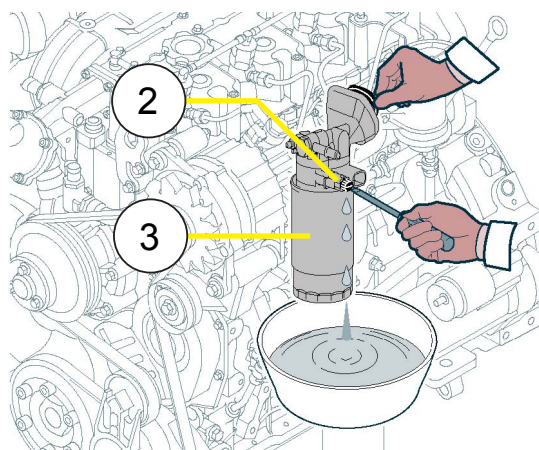
FUEL FILTER CHANGE

1. Place a container under the filter.
2. Unscrew the plug (1).
3. Loosen the bleed screw (2) and drain the fuel contained in the filter.
4. Unscrew the cartridge (3) using a key commonly available on the market and remove it.
5. Before reinstalling the new cartridge, smear the O-ring of the cartridge with oil or fuel.
6. Manually screw the cartridge and tighten it to the specific torque value.



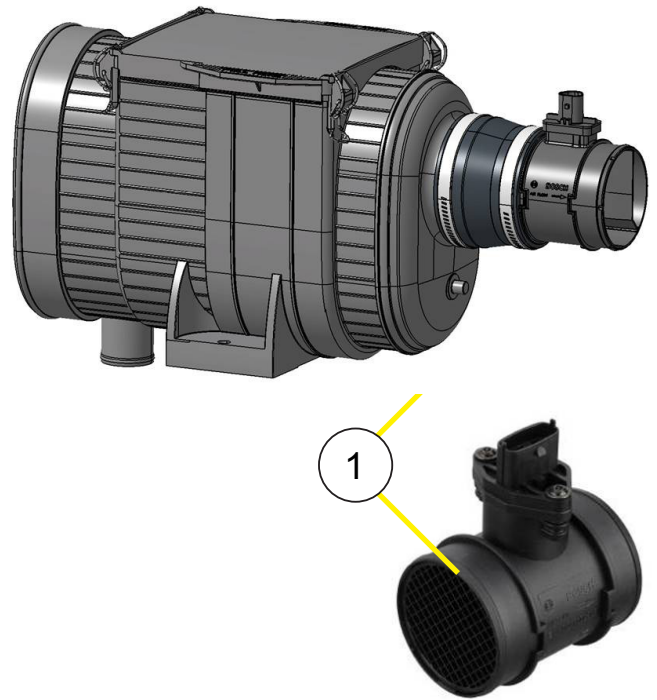
Fuel filter	18 Nm
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7. Bleed the air from the injection system.



AIR FILTER CHANGE

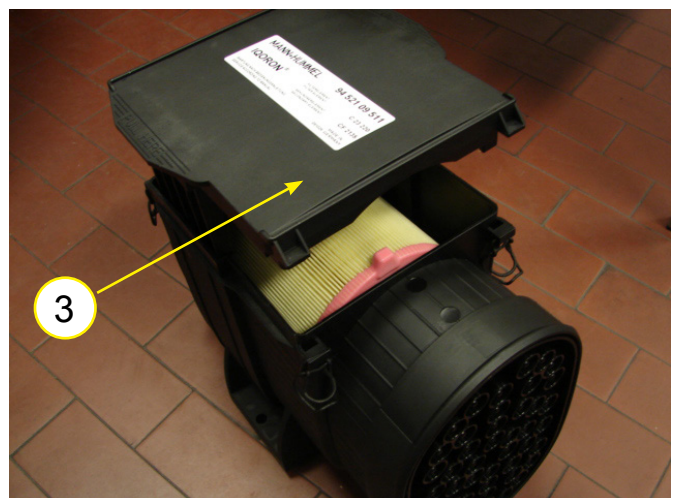
- 1 - airbox
- 2 - mass flow sensor (where present)



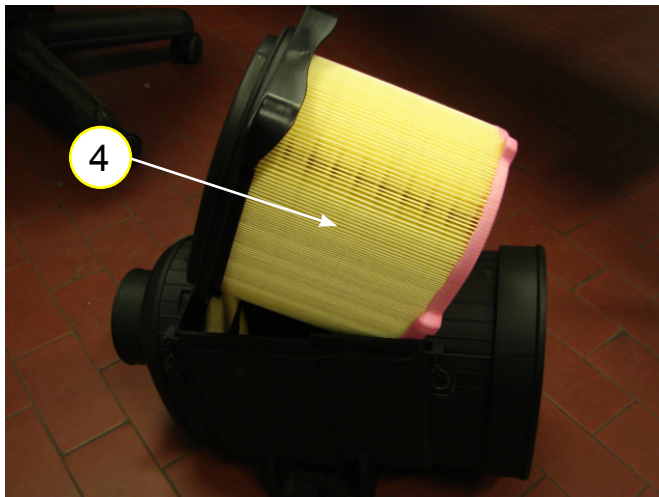
Release the clips 2.



Remove the cover 3.

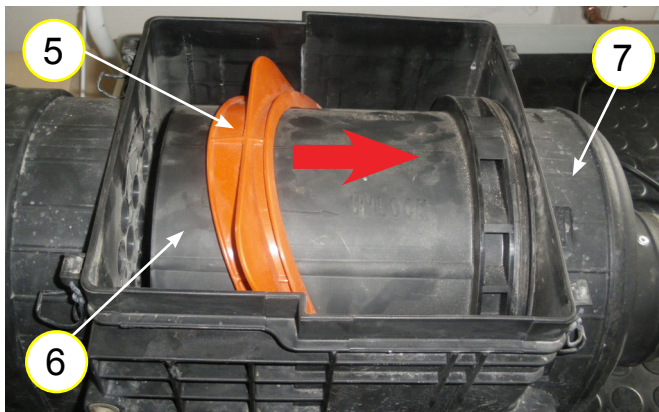


Replace the main filtering cartridge 4.



In some versions, it is necessary to pull the orange lever 5 in the direction indicated by the arrow to release the filter 6.

Extract the filter from the airbox 7.



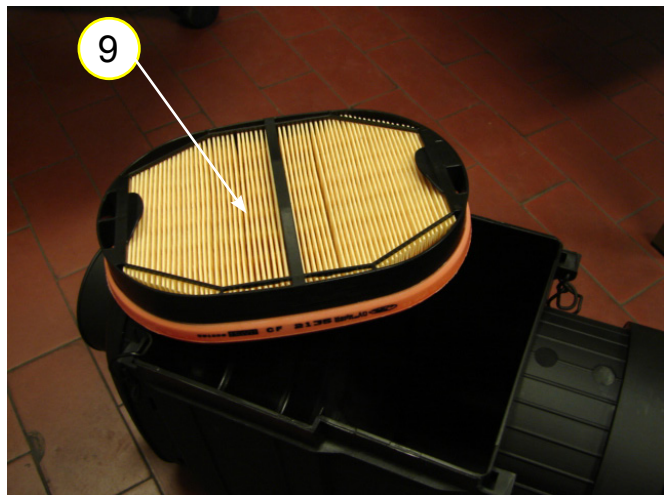
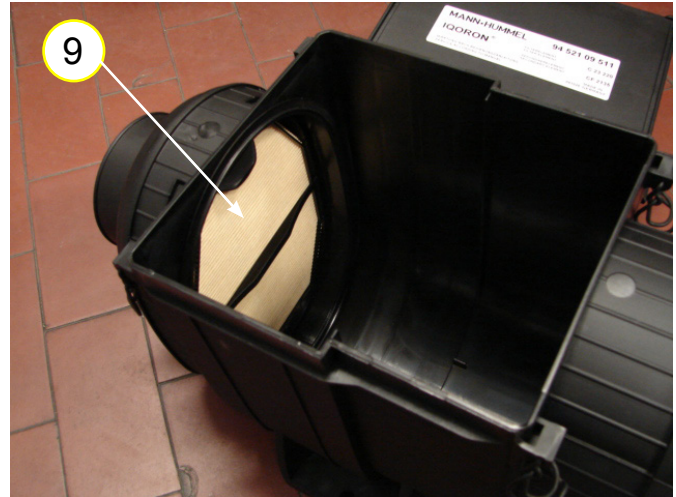
Replace the main filtering cartridge 8.



Replace the secondary/safety filtering cartridge 9 (pre-filter).

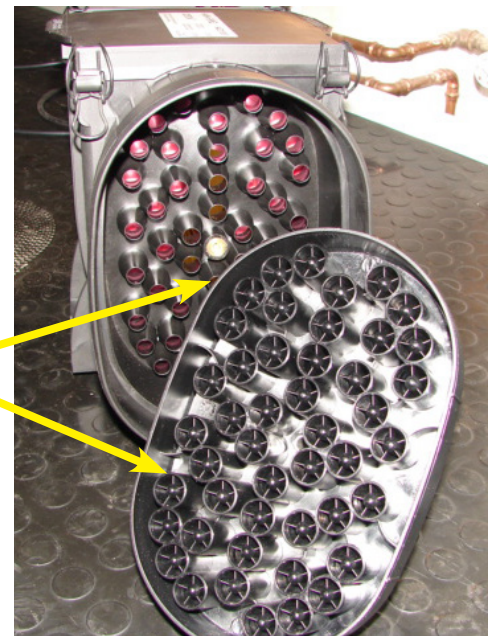


NOTES: After replacing the main cartridge (4) two or three times it is important to replace also the secondary/safety filtering cartridge (9).



Clean the CYCLONE area.

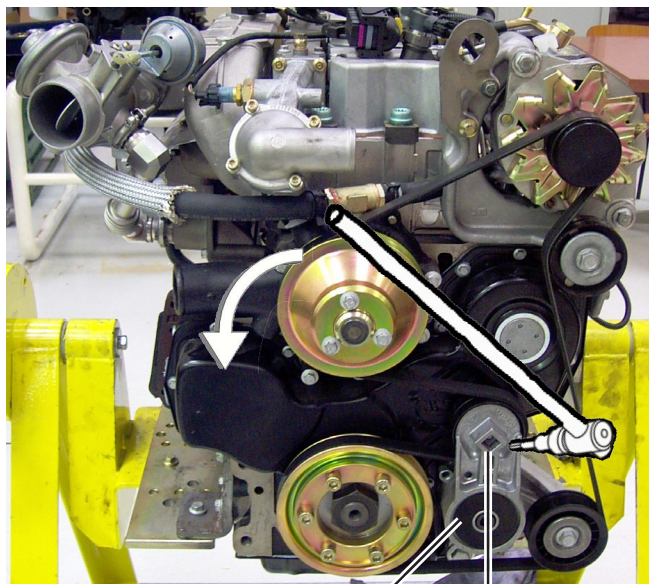
CYCLONE AREA



WATER PUMP-ALTERNATOR BELT REPLACEMENT

Version with automatic tensioner**DISASSEMBLY**

1. Place a suitable tool available on the market in the seat **1** of tensioner **2**.
2. Rotate the tensioner counter-clockwise to release the tension of the belt.
3. Remove the belt.



Version with automatic tensioner

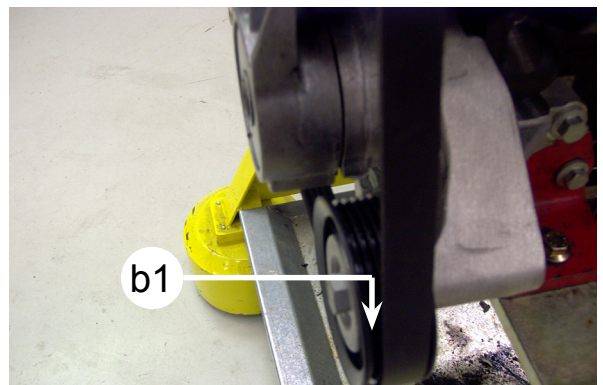
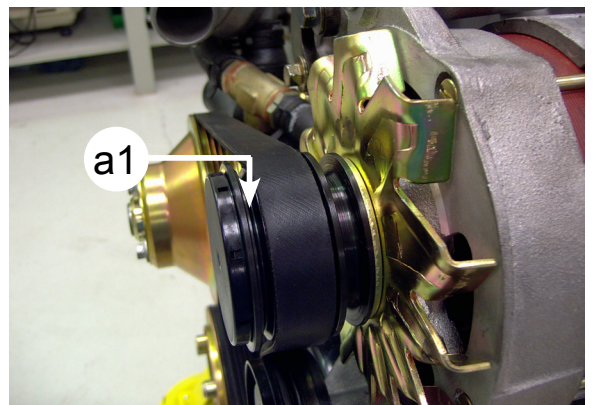
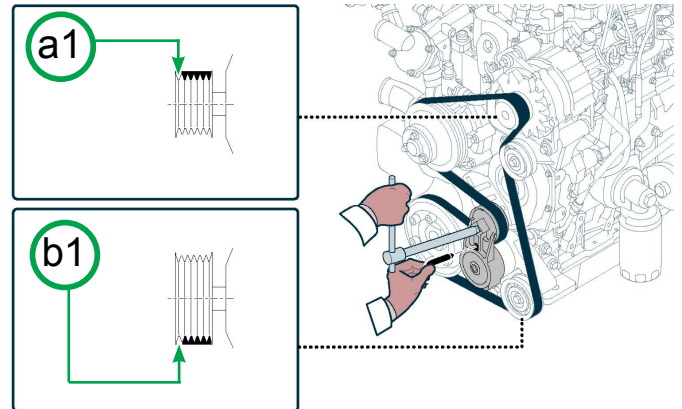
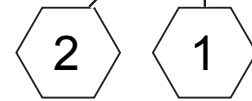
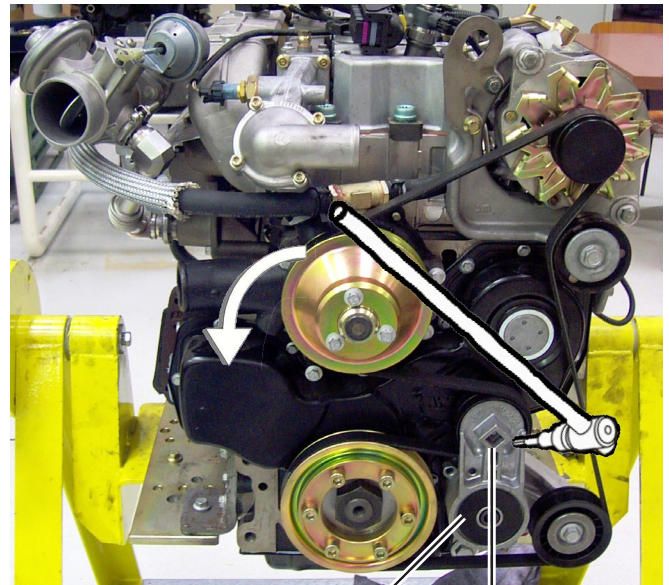
REFITTING

With tensioner installed insert a key commonly available on the market in the seat **1** and rotate the tensioner **2** following the direction of the arrow.

Install the belt and release the tensioner.



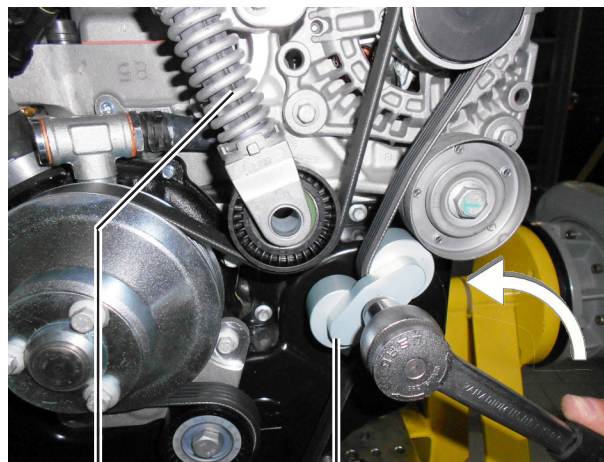
IMPORTANT: To correctly align the belt, it must be positioned in the most inner grooves of the alternator pulley (**a1**) and transmission pulley (**b1**).



Version with linear tensioner

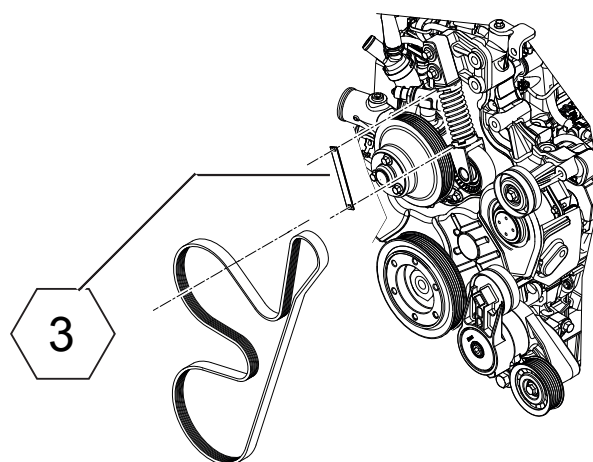
DISASSEMBLY

1. Rotate the special tool **1** counter-clockwise so that the tensioner **2** will compress.
2. Insert the fastening bracket **3**.
3. Remove the belt.



2

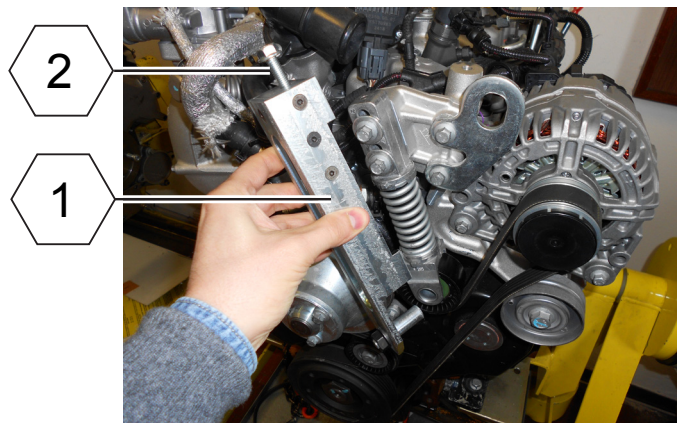
1



3

If belt removal proves difficult with the special tool applied to the belt, it is possible to use another tool applied to the tensioner.

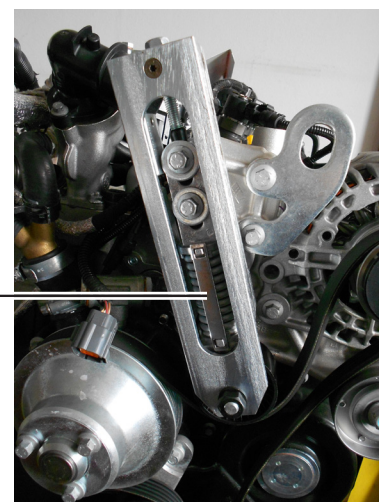
1. Apply tool **(1)** to the tensioner.
2. Tighten screw **(2)** until it is possible to insert the fastening bracket **(3)**.
3. Extract the belt.



2

1

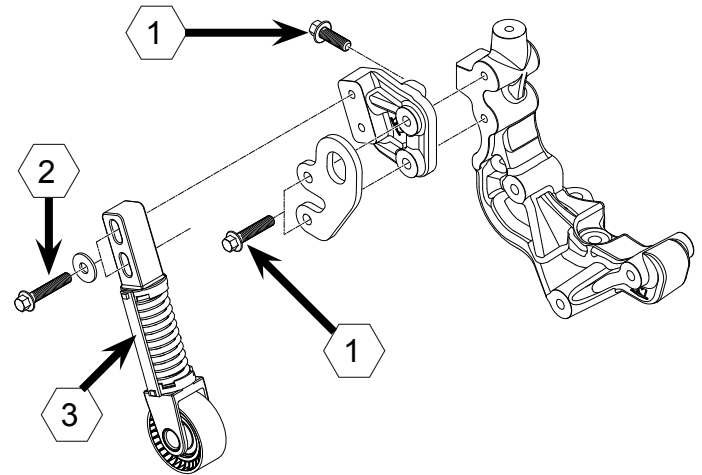
3



Version with linear tensioner
REFITTING


IMPORTANT: To correctly align the belt, loosen the screws **2** of the tensioner.

Start the screws **2** without tightening them.



Make sure the tensioner is locked with the bracket **3**.

Drive the screws **2** fully home by hand.

Position the belt.

Move the tensioner with care to bring the tensioner pulley against the belt.

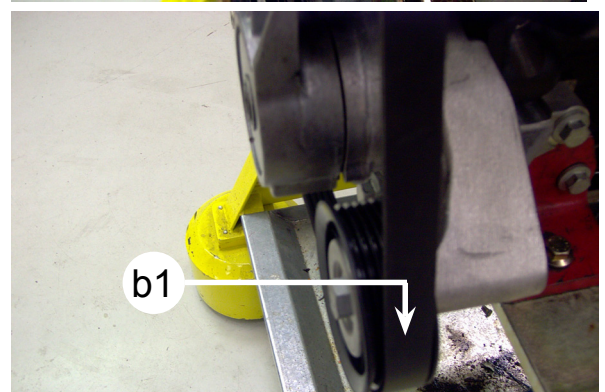
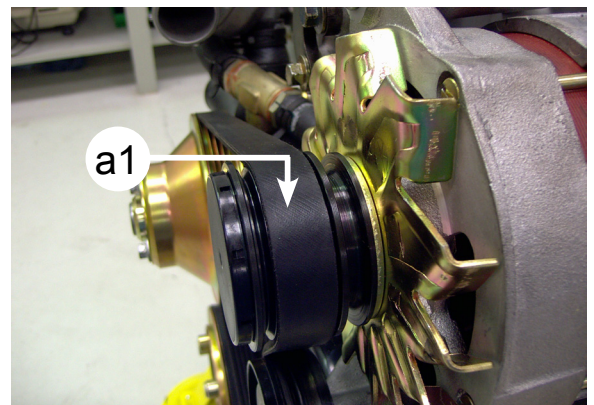
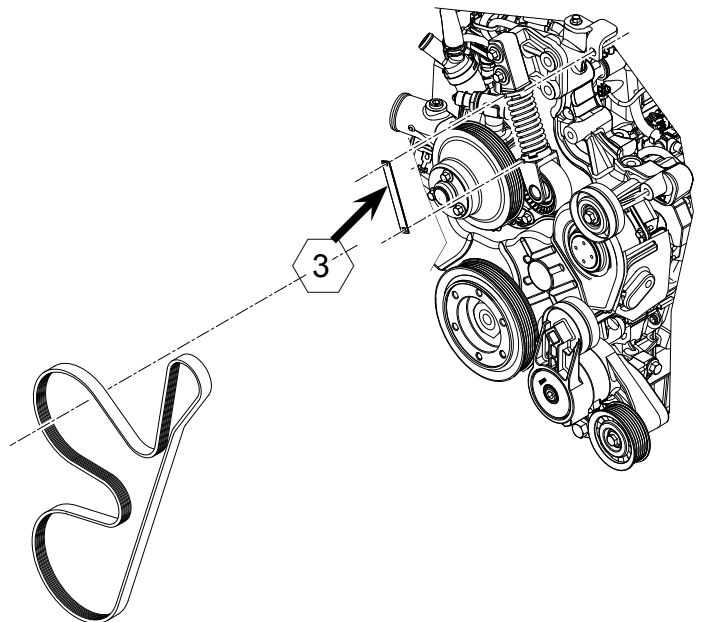
Tighten the screws **2** of the tensioner

Screw 2	32.4 Nm
----------------	----------------

Remove the bracket **3**.



IMPORTANT: To correctly align the belt, it must be positioned in the most inner grooves of the alternator pulley (**a1**) and transmission pulley (**b1**).

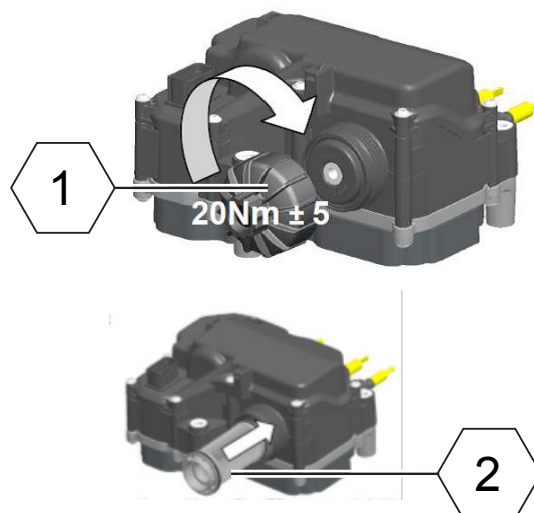


UREA DOSING UNIT FILTER

1. Loosen the plug 1.
2. Extract the filter cartridge B and replace it with a new one.
3. Insert the new filter cartridge inside the DCU box dosing unit.
4. Tighten the plug 1.



Tighten the plug using a tightening torque of 20 Nm.



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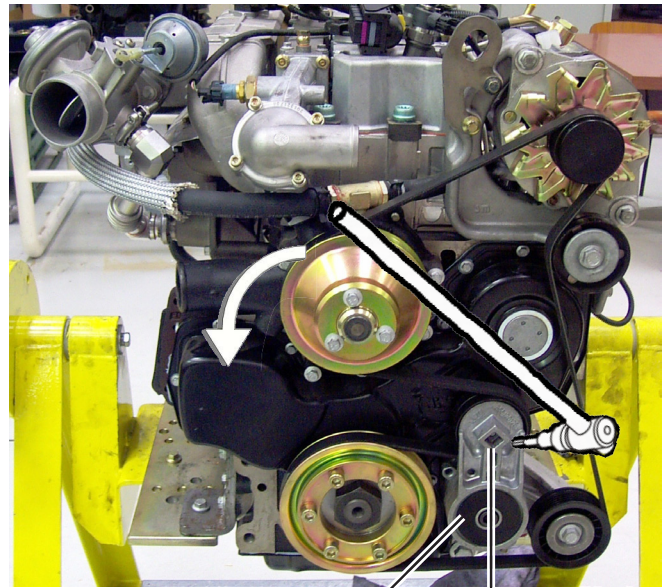
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ENGINE DISASSEMBLY

ALTERNATOR / WATER PUMP BELT

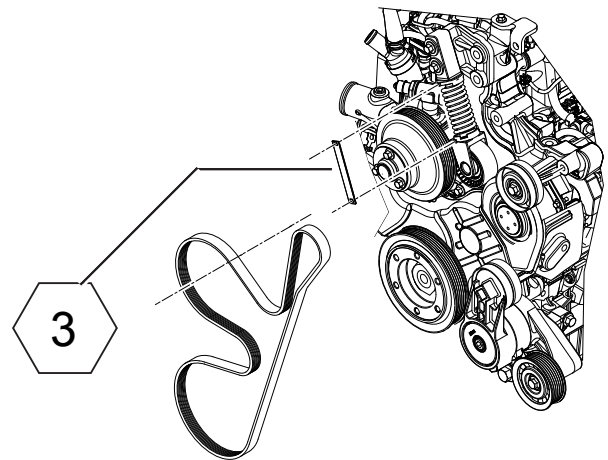
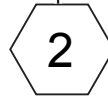
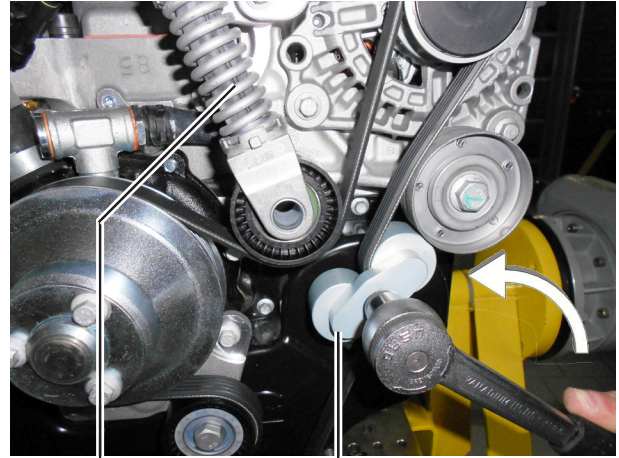
Version with automatic tensioner

1. Place a suitable tool available on the market in the seat **1** of tensioner **2**.
2. Rotate the tensioner counter-clockwise to release the tension of the belt.
3. Remove the belt.



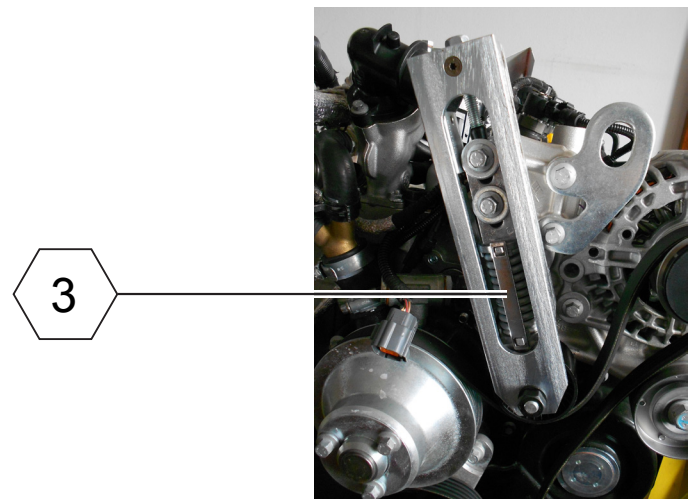
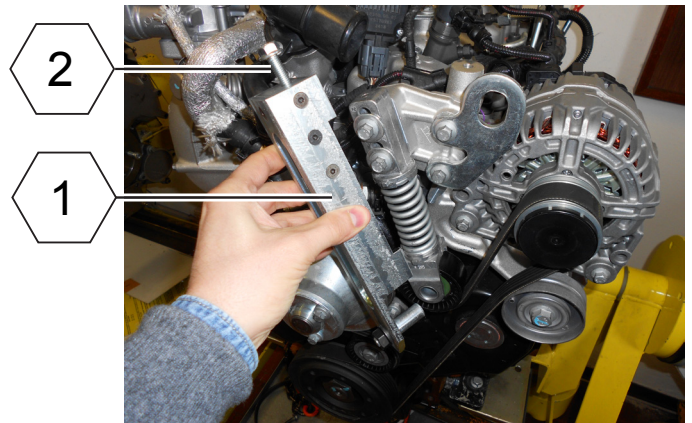
Version with linear tensioner

1. Rotate the special tool **1** counter-clockwise so that the tensioner **2** will compress.
2. Insert the fastening bracket **3**.
3. Remove the belt.



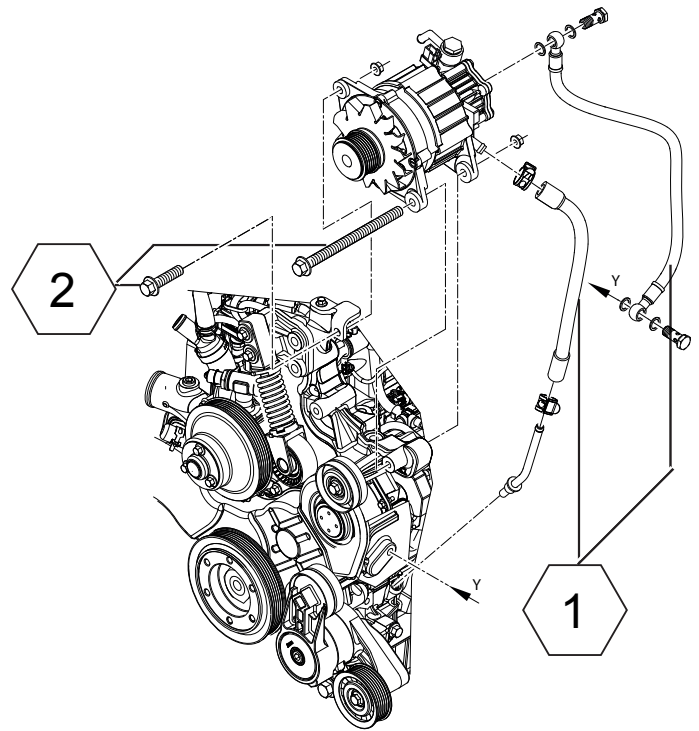
If belt removal proves difficult with the special tool applied to the belt, it is possible to use another tool applied to the tensioner.

1. Apply tool **(1)** to the tensioner.
2. Tighten screw **(2)** until it is possible to insert the fastening bracket **(3)**.
3. Extract the belt.



ALTERNATOR

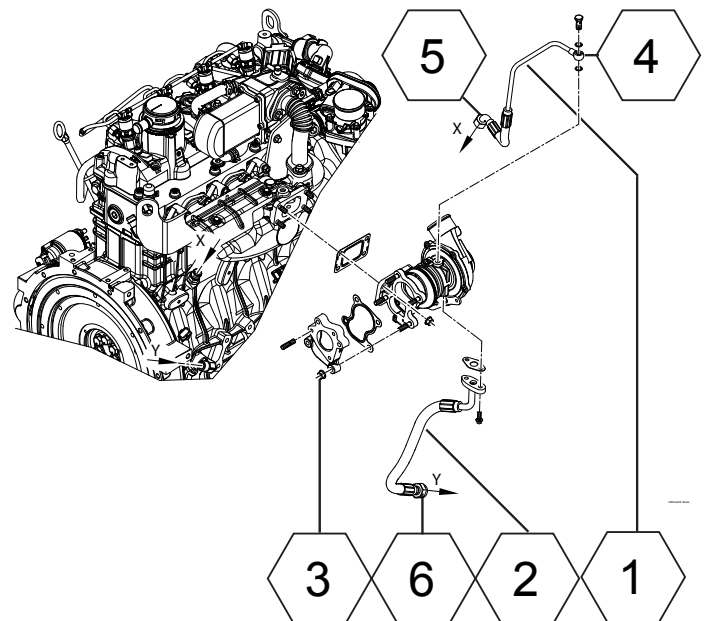
1. Remove the alternator control belt.
2. Disconnect the alternator electric connections.
3. Disconnect all pipes from the vacuum pump **1**
4. Loosen and remove the screws **2** retaining the alternator.



TURBOCHARGER

- Loosen the oil delivery fitting to the turbo.
- Loosen the oil drain pipe retainer from the turbo.
- Remove the nuts fastening the turbo.
- Remove the old gasket.

- 1 - oil delivery pipe to turbo
- 2 - oil drain pipe from turbo
- 3 - turbo fastening nuts
- 4 - oil delivery fitting to turbo
- 5 - oil delivery fitting to turbo from crankcase
- 6 - oil drain fitting from turbo to crankcase

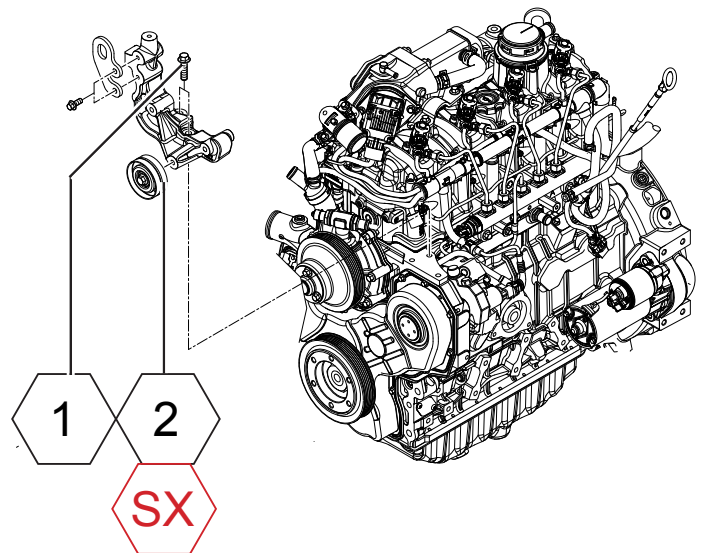


ALTERNATOR BRACKET - IDLE PULLEYS

- Loosen the bolts 1 of the alternator bracket.
- Remove the bracket.
-

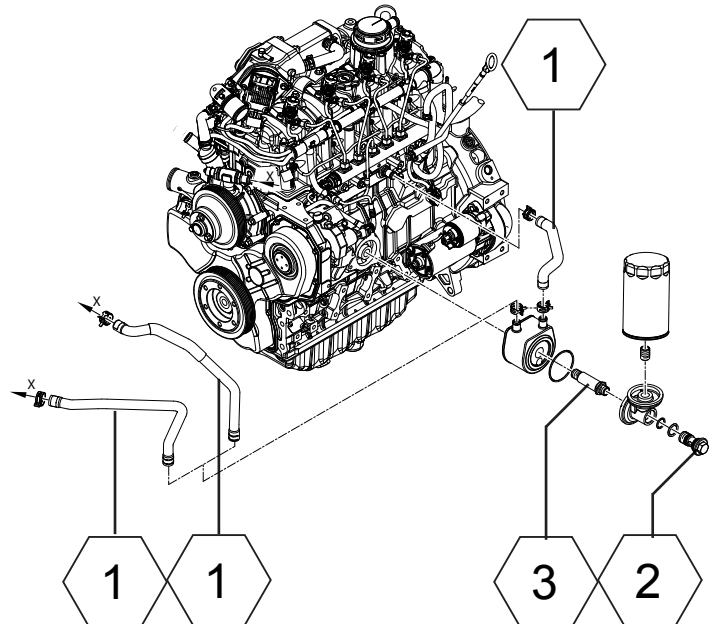


IMPORTANT: the screw threading of the pulley 2 installed on the alternator bracket is of the left-hand type.



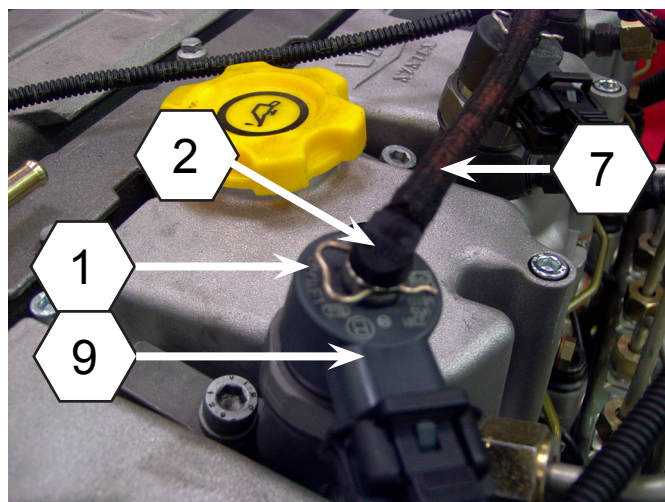
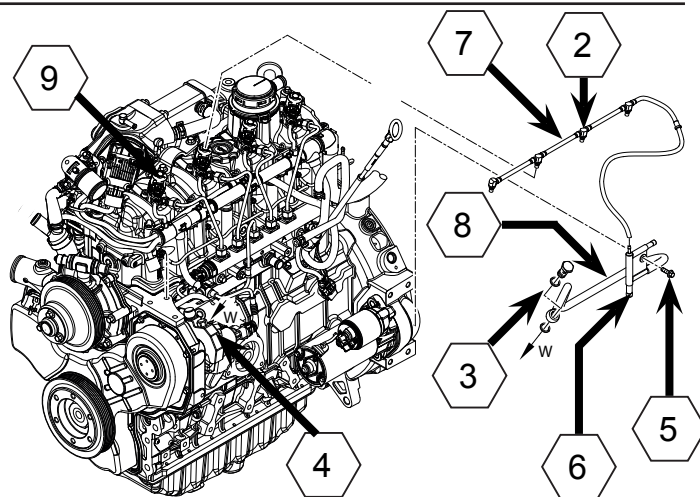
OIL/WATER HEAT EXCHANGER

- Disconnect the water pipes 1 connected to the crankcase and the exchanger.
- Loosen bolt 2 of the oil filter support
- Loosen bolt 3 of the oil exchanger



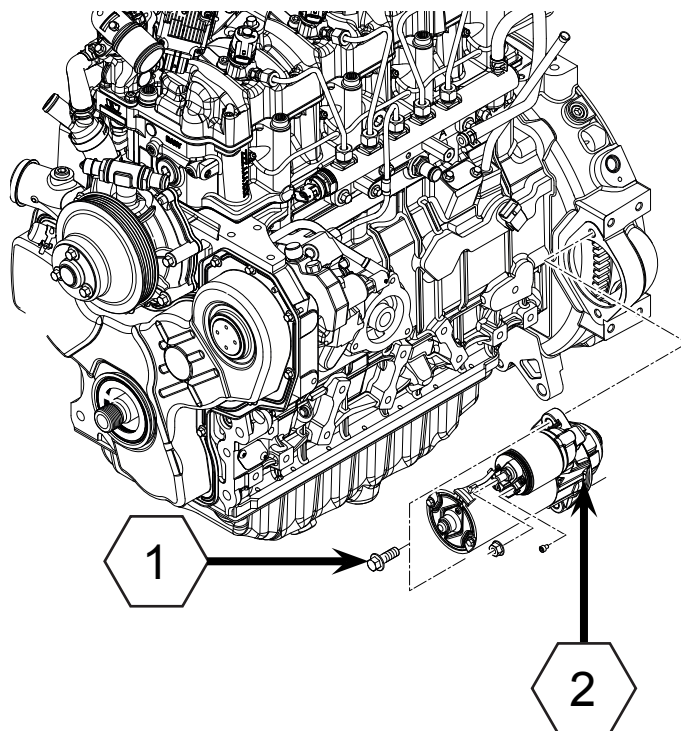
WASTE PIPE FROM INJECTORS AND INJECTION PUMP

Press tab **1** to extract the fittings **2** from the injector **9**.
 Loosen union **3** on the high pressure injection pump **4**.
 Loosen screw **5** of the fuel waste block **6**.
 Remove the fuel waste pipe assembly **7** from injectors **9** and from injection pump **8**.



STARTER MOTOR

Loosen screw **1** and remove the starter motor **2**.



CRANKSHAFT FRONT PULLEY



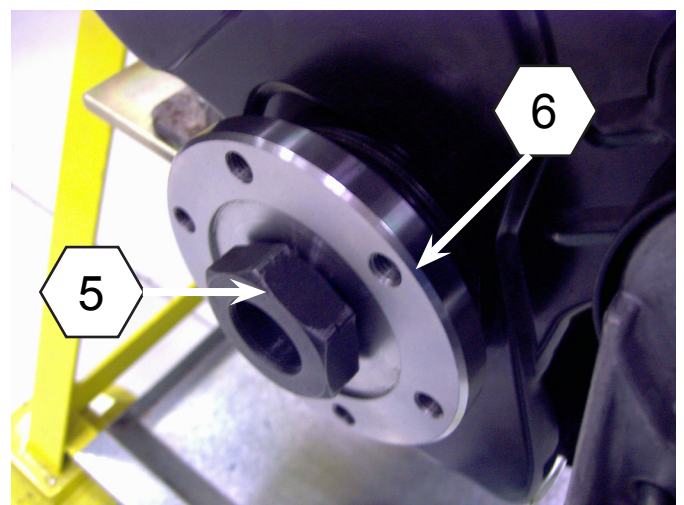
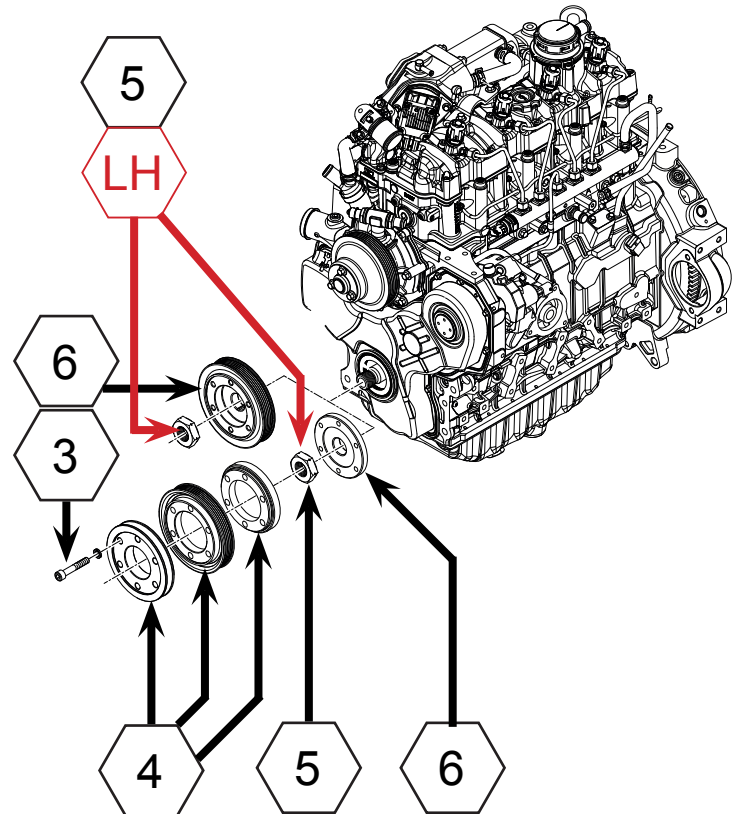
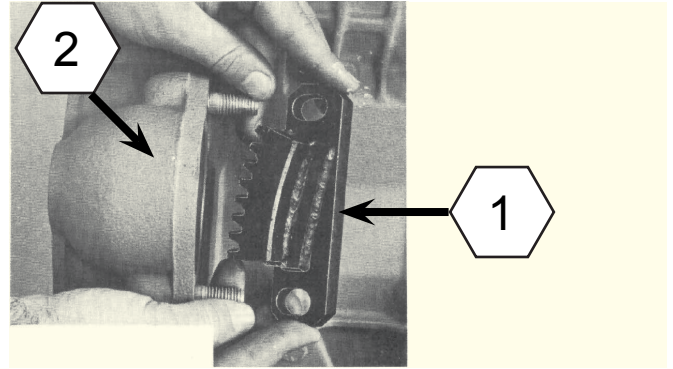
IMPORTANT: before loosening the nut retaining the crankshaft pulley hub, block the rotation of the crankshaft by means of the special tool that replaces the starter motor.

Install the special tool **1** on the flywheel housing **2**.
Remove the screws **3** of the pulley **4** and remove the pulley.



IMPORTANT: the nut retaining the crankshaft pulley hub has a left-hand type threading.

Loosen the nut **5** of the crankshaft pulley/hub **6**.

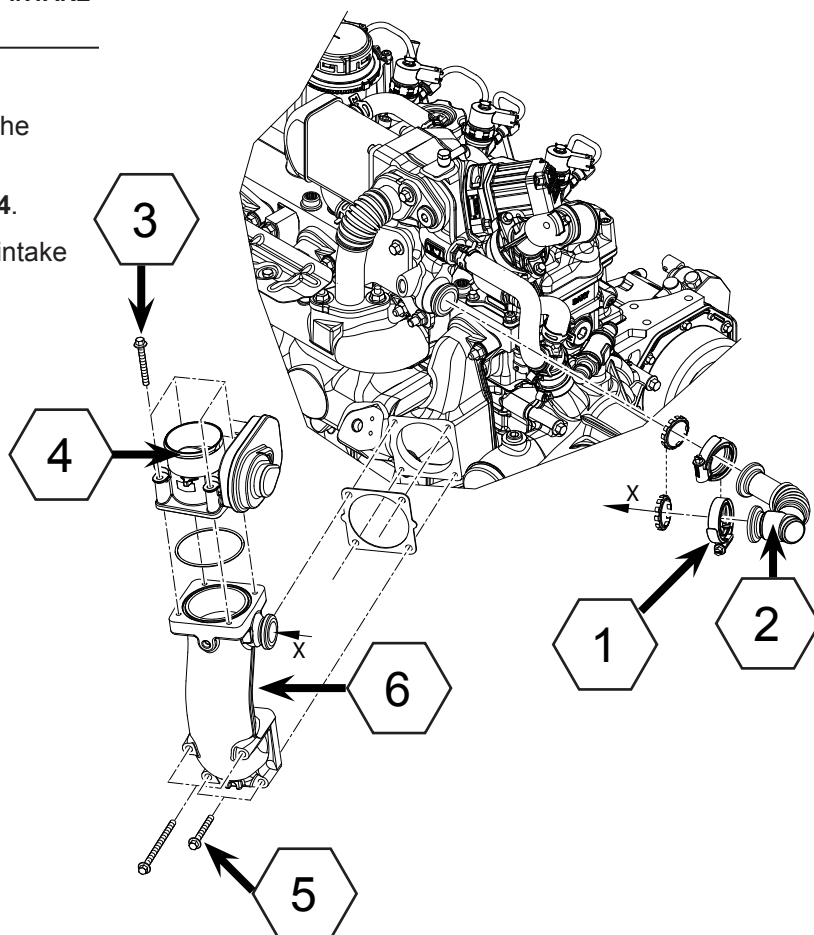


EGR VALVE PIPE AND SLEEVE - TVA THROTTLE INTAKE VALVE

Loosen the clips **1** and remove the exhaust gas recirculation pipe **2** from the EGR valve body to the TVA valve intake sleeve **6**.

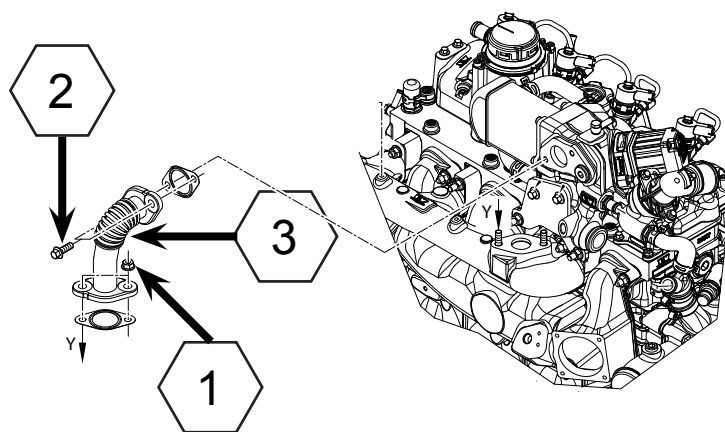
Loosen the screws **3** and remove the TVA valve **4**.

Loosen the screws **5** and remove the TVA valve intake sleeve **6**.



Loosen the nuts **1** and the screws **2**.

Remove the sleeve **3** between exhaust manifold and EGR valve body.



INJECTORS - RAIL HYDRAULIC ACCUMULATOR



IMPORTANT: Each time that the injectors are removed, they must be kept in order and numbered. During their installation, they must be installed in the same original position, because each injector has its IMA code.



IMPORTANT: When loosening the injection pipe on the injector, block the fitting on the injector with a 13 mm wrench.

Disconnect the electric connections from the injectors **1**.

Loosen the injection pipes **2** from the rail to the injectors.

Loosen the screw **3** and remove the injector fastening bracket **4**.

Remove the injectors.

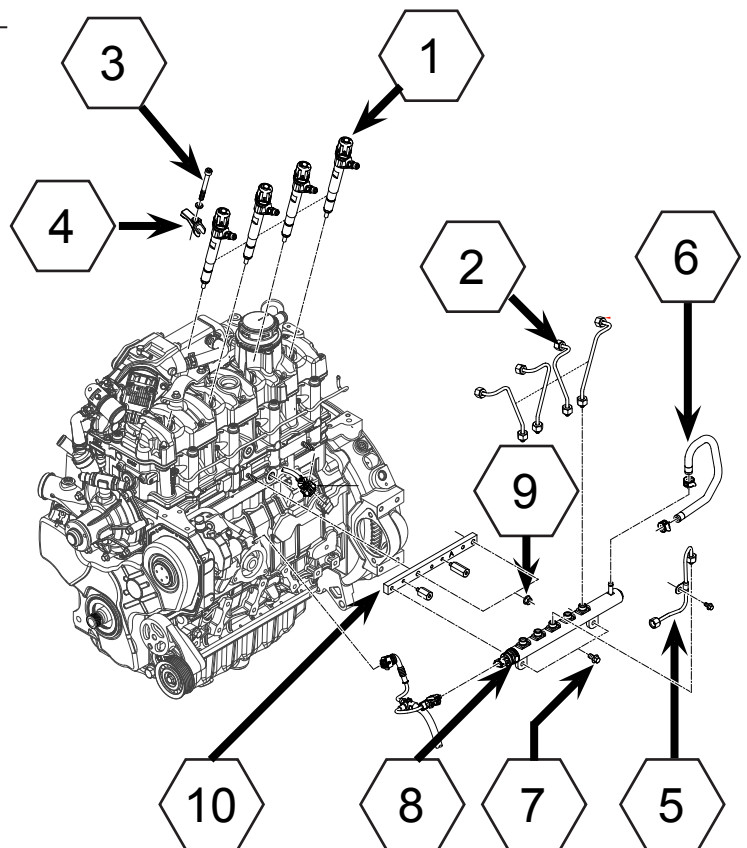
Disconnect the electrical connections from the rail.

Loosen and remove the injection pipe **5** from the rail to the high pressure pump.

Remove the fuel waste pipe **6** from the rail.

Loosen the screws **7** and remove the rail **8**.

Loosen the nuts **9** and remove the rail fastening bracket **10**.

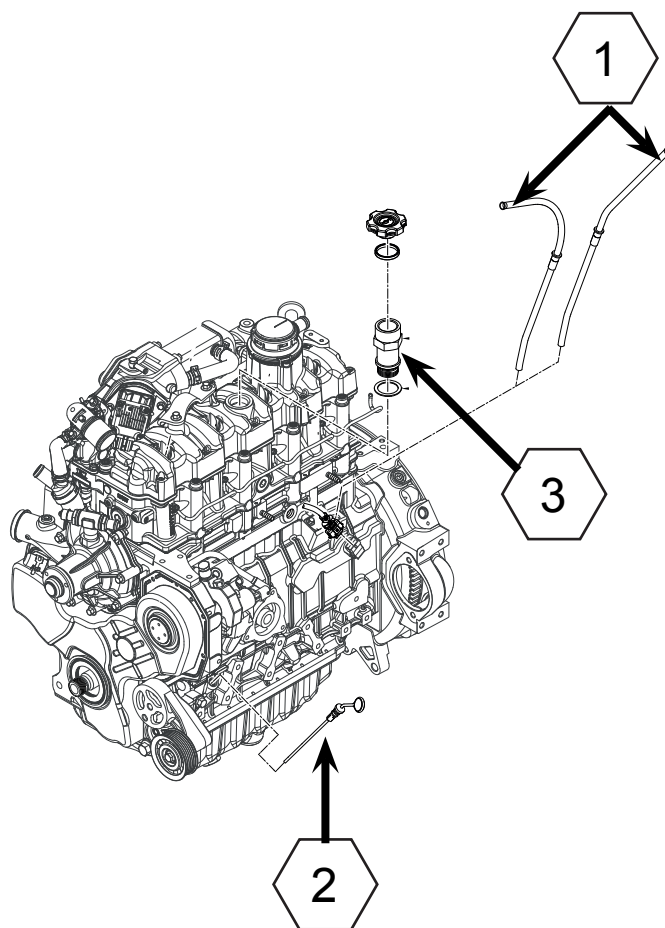


ENGINE OIL DIP STICK - ENGINE OIL FILLING PLUG ADAPTER

Use a tool commonly available on the market to remove the stick holder tube 1.

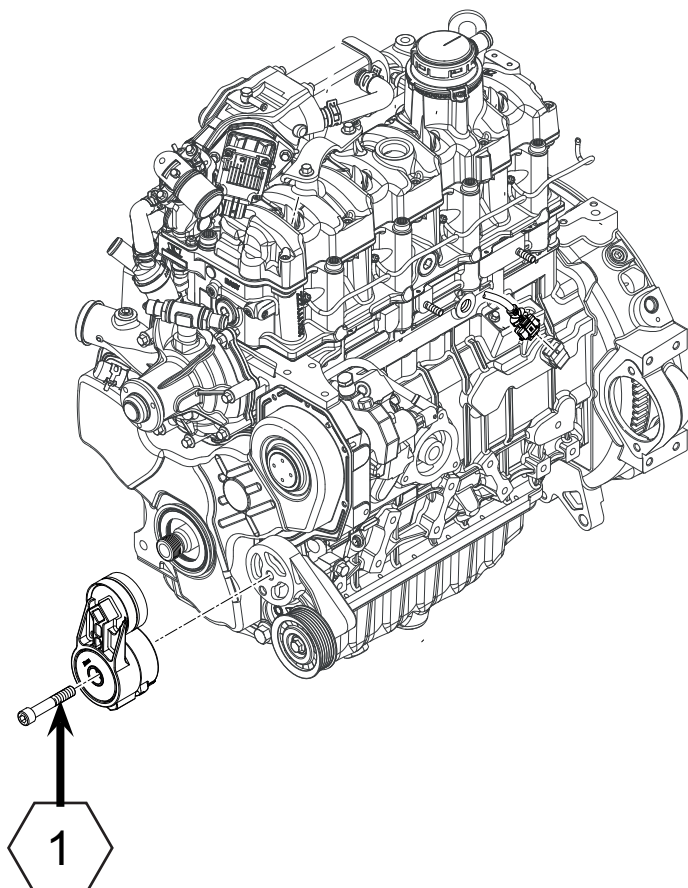
Remove the stick 2 manually.

Loosen the engine oil filling plug adapter 3.



ALTERNATOR BELT TENSIONER (AUTOMATIC TYPE)

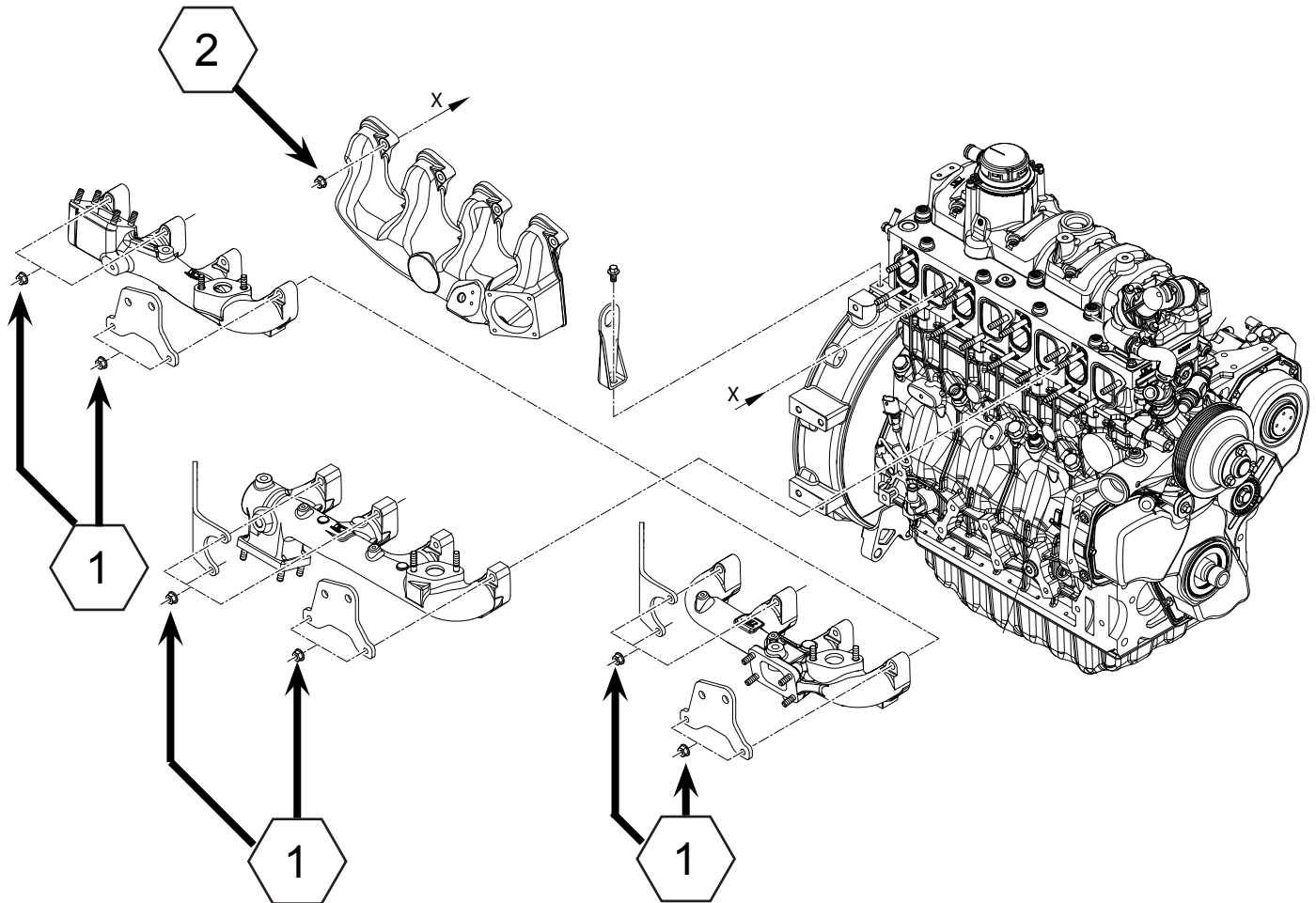
Loosen the screw 1 and remove the automatic tensioner.



EXHAUST AND INTAKE MANIFOLDS

Loosen the nuts **1** and remove the exhaust manifold.

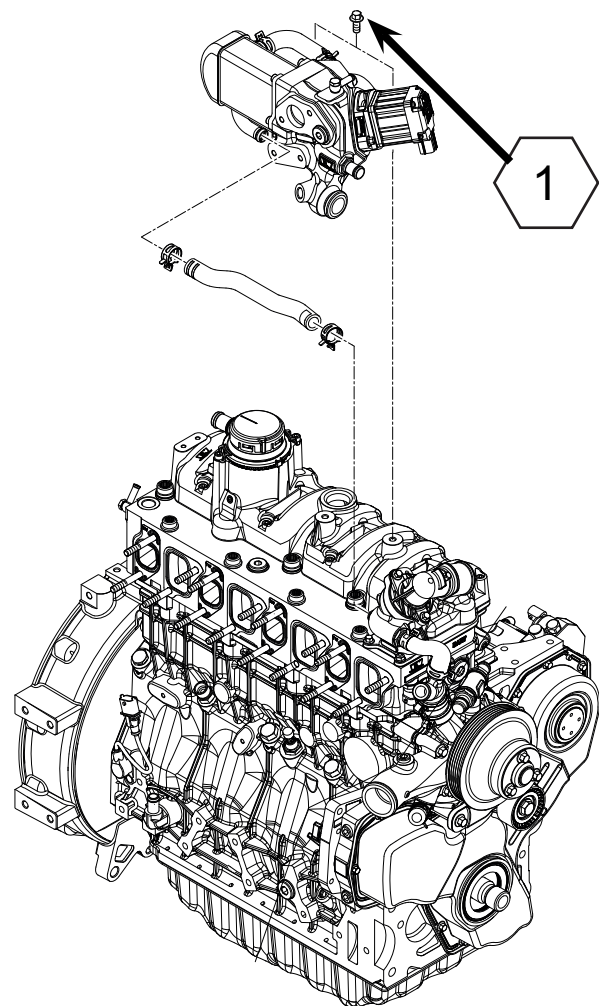
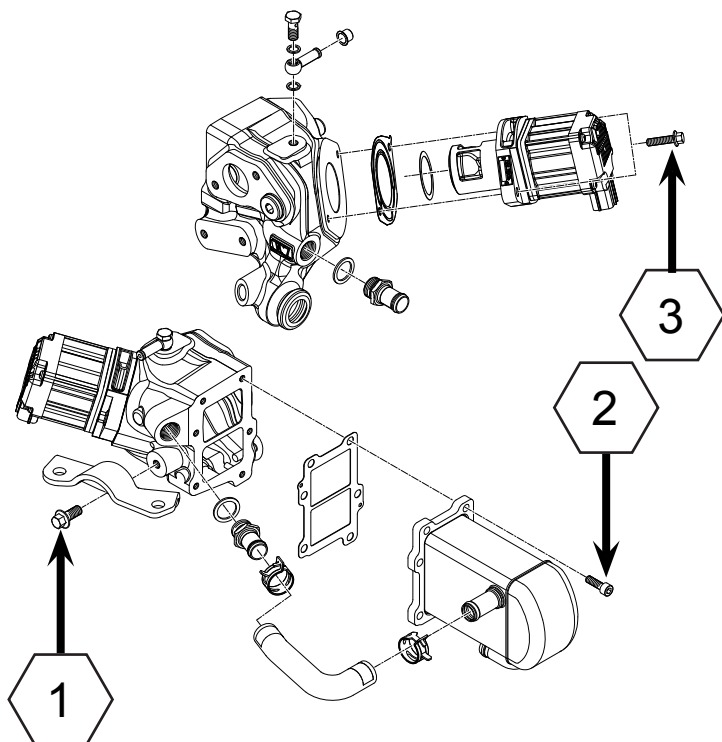
Loosen the nuts **2** and remove the intake manifold.



HEAT EXCHANGER UNIT - EGR VALVE

Remove the rubber hoses connected to the heat exchanger unit.

Loosen the screws **1** and remove the heat exchanger unit.



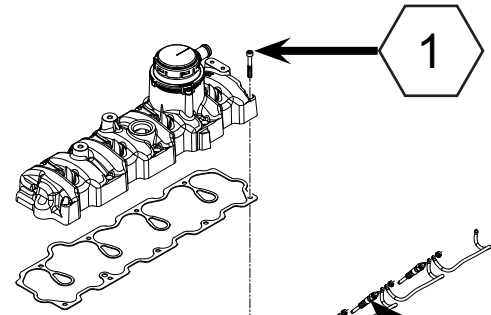
Remove the rubber hoses connected to the heat exchanger.

Loosen the screws **2** and remove the heat exchanger.

Loosen the screws **3** and remove the EGR valve.

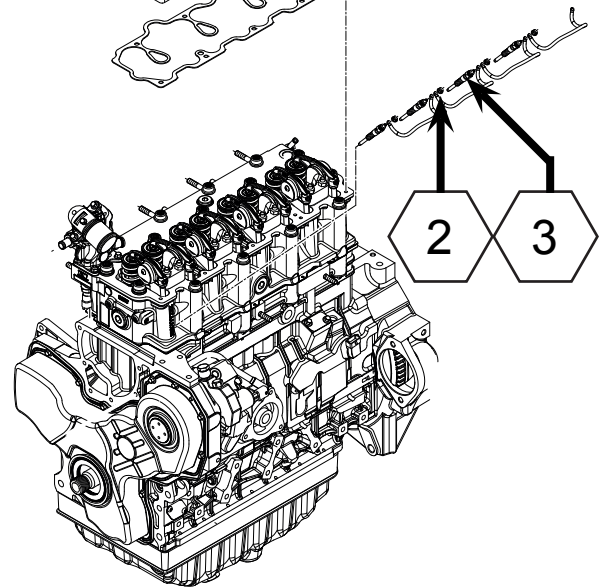
ROCKER ARM COVER

Loosen the screws **1** and remove the cover.



SPARK PLUGS

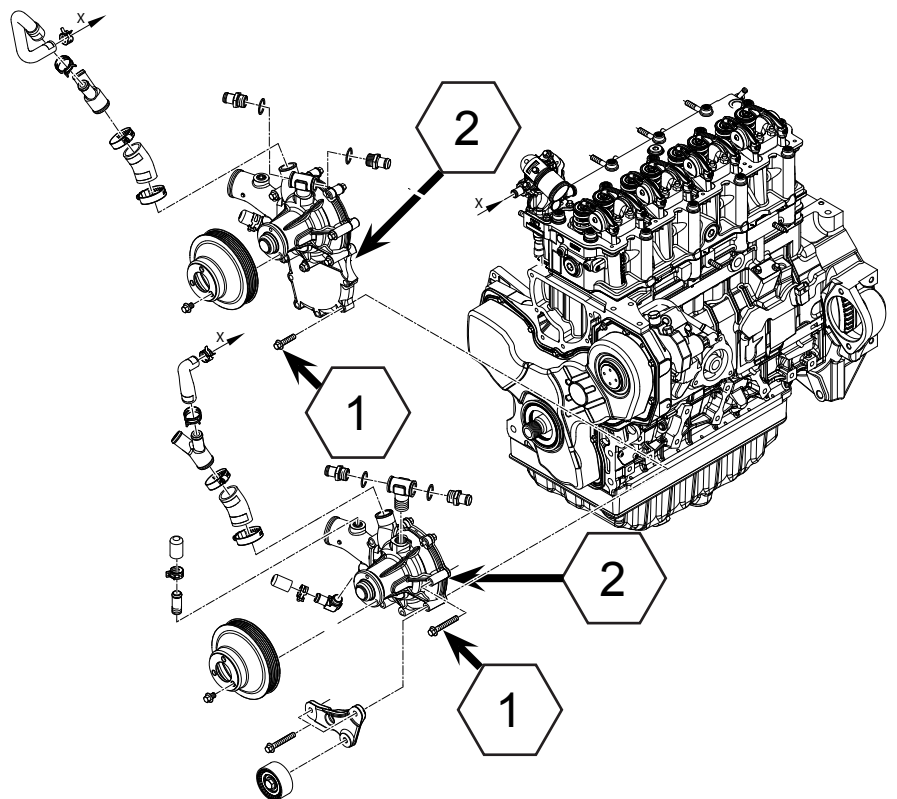
Loosen the nuts **2** of the electrical connections and remove the spark plugs **3**.



WATER PUMP

Remove the sleeves connected to the water pump.

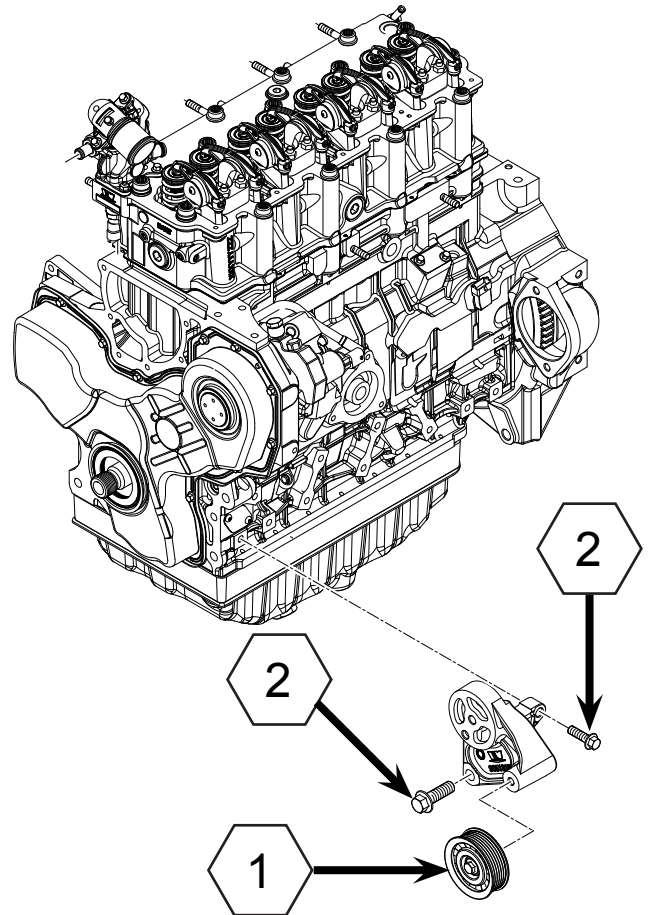
Loosen the screws **1** and remove the water pump **2**.



IDLE PULLEYS - IDLE PULLEY BRACKET

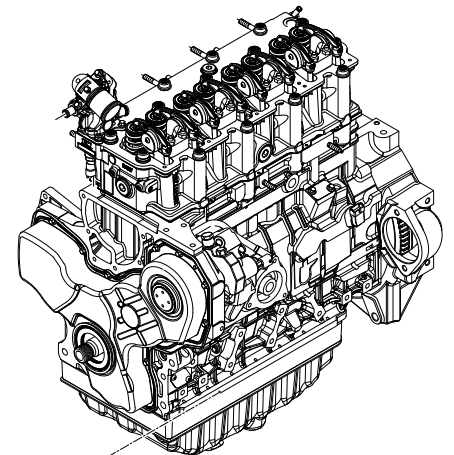
Remove the pulley 1.

Loosen the screws 2 and remove the bracket.

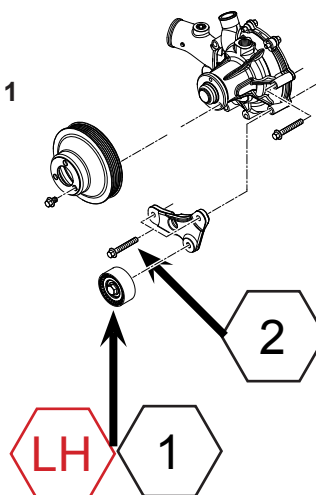


Remove the pulley 1.

Loosen the screws 2 and remove the bracket.



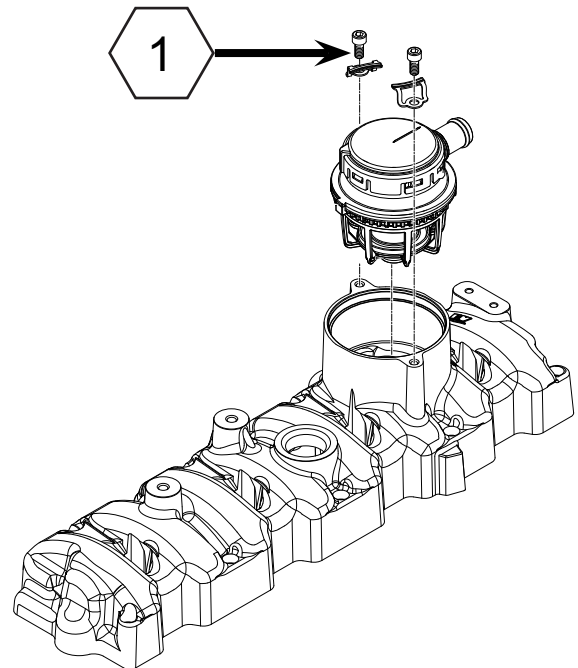
IMPORTANT: the screw threading of the pulley 1 installed on the bracket is of the left-hand type.



OIL VAPOUR SEPARATOR

Remove the screws 1.

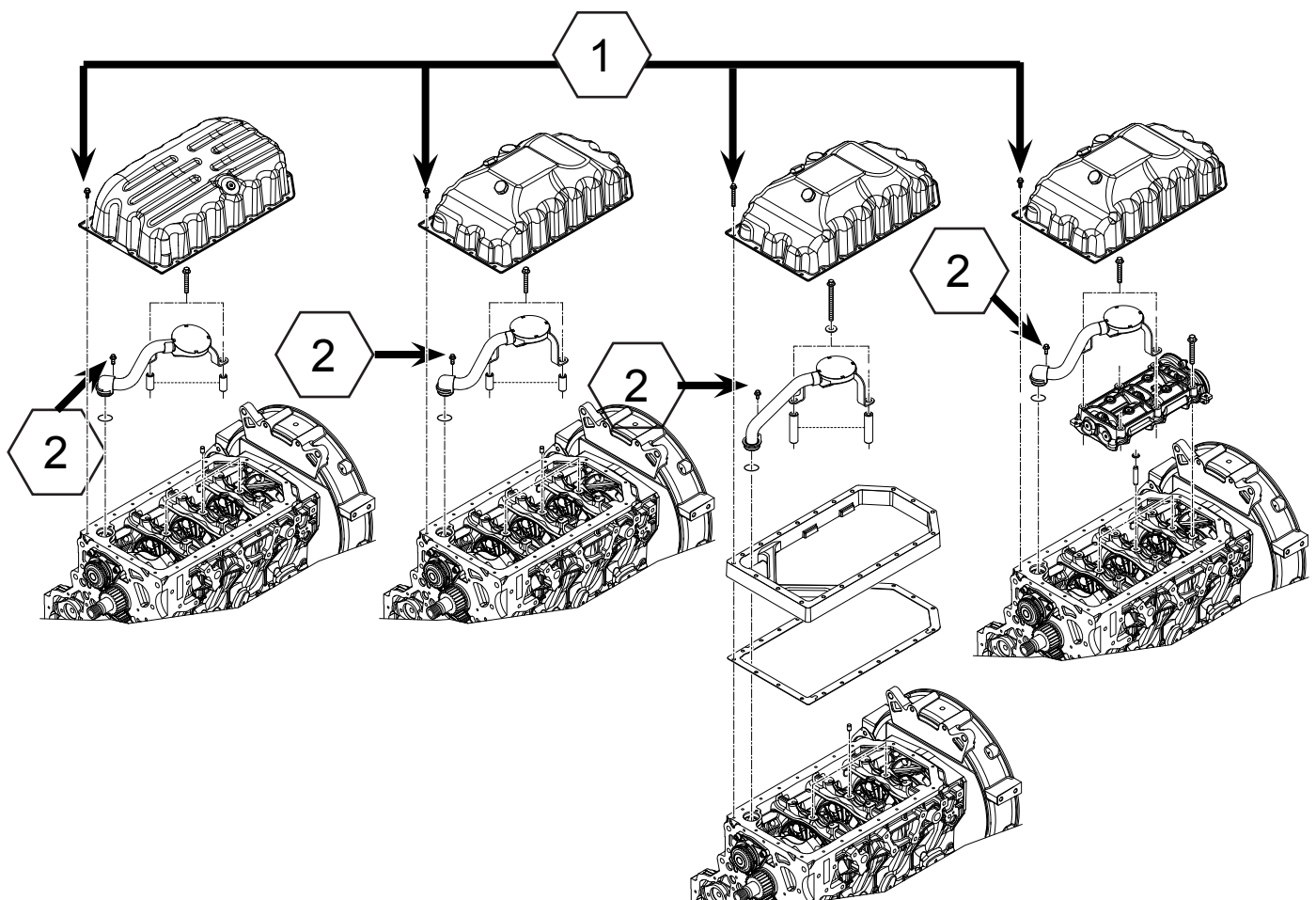
Remove the separator.



OIL SUMP - ENGINE OIL INTAKE PIPE

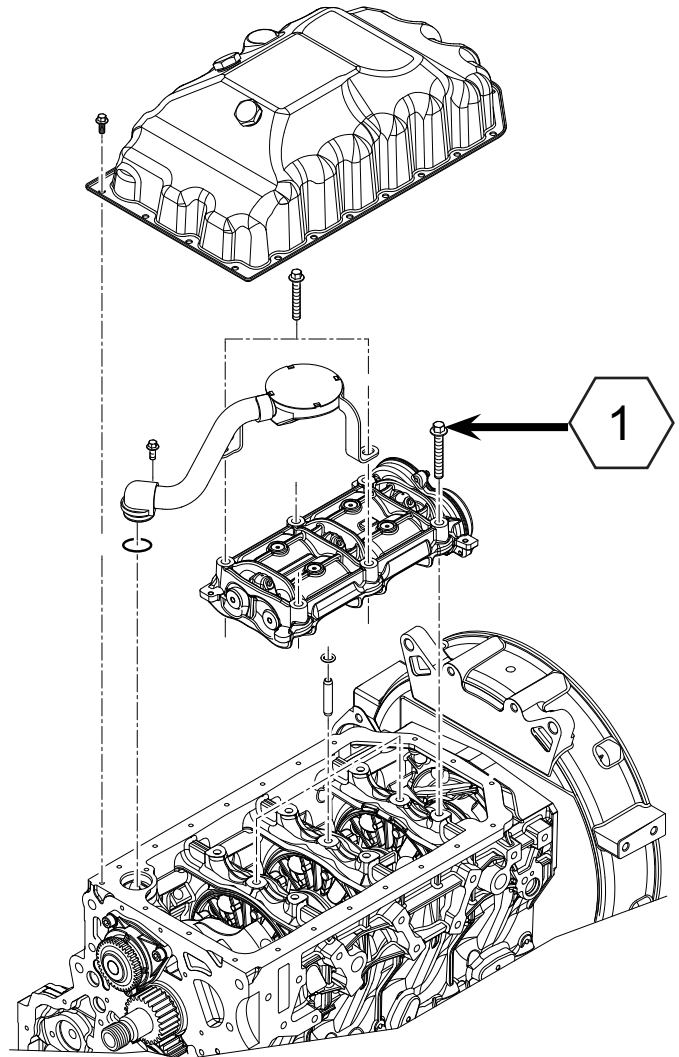
Remove the screws 1 and remove the sump.

Remove the screws 2 and remove the oil intake pipe.



BALANCING WEIGHTS

Remove the screws 1 and remove the weights.

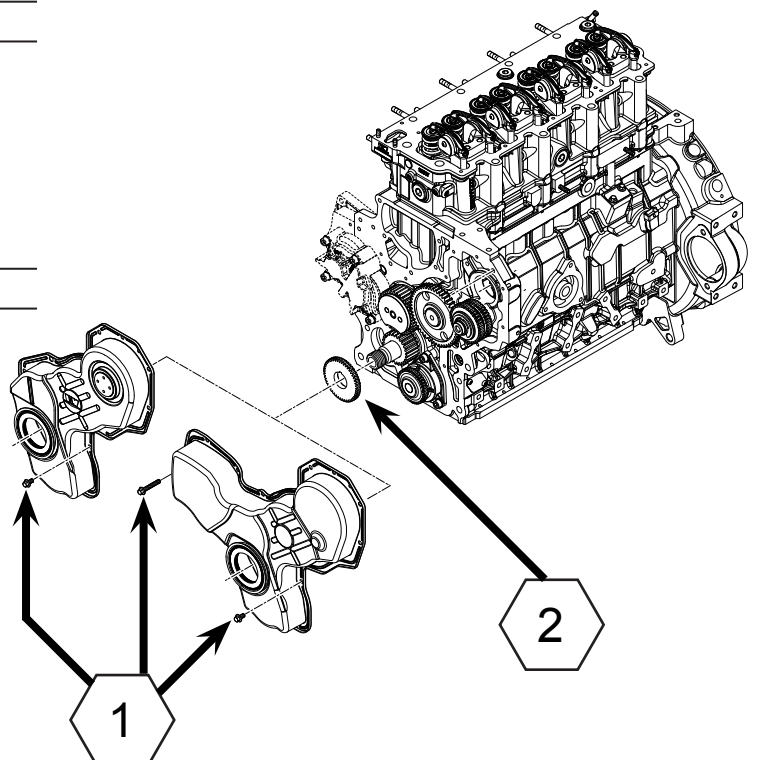


TIMING SYSTEM COVER

Remove the screws 1 and remove the cover.

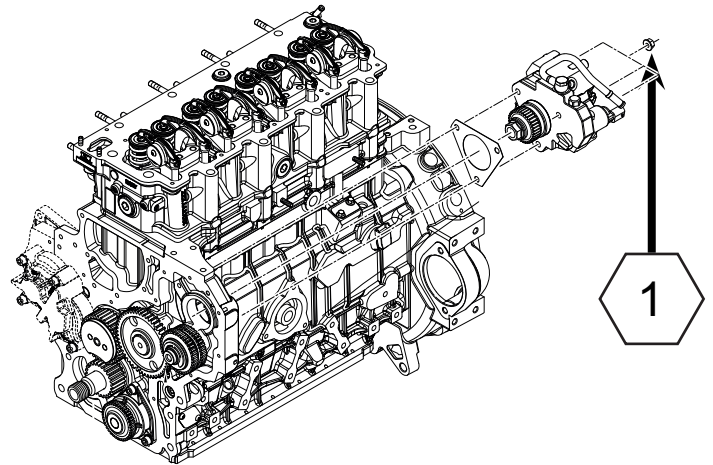
OIL PUMP CONTROL GEAR

Remove the gear 2.

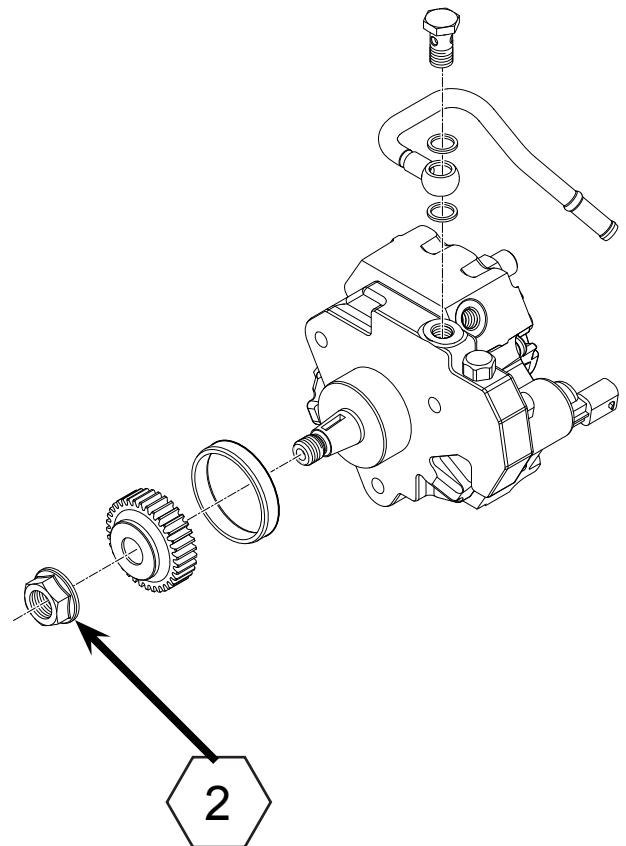


HIGH PRESSURE INJECTION PUMP

Remove the nuts **1** and remove the pump.

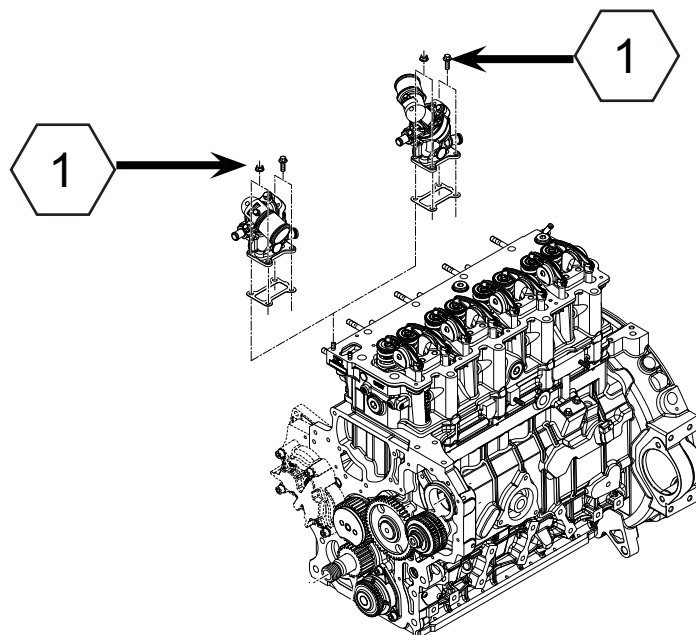


Remove the nut **2** and remove the pump gear using a puller.

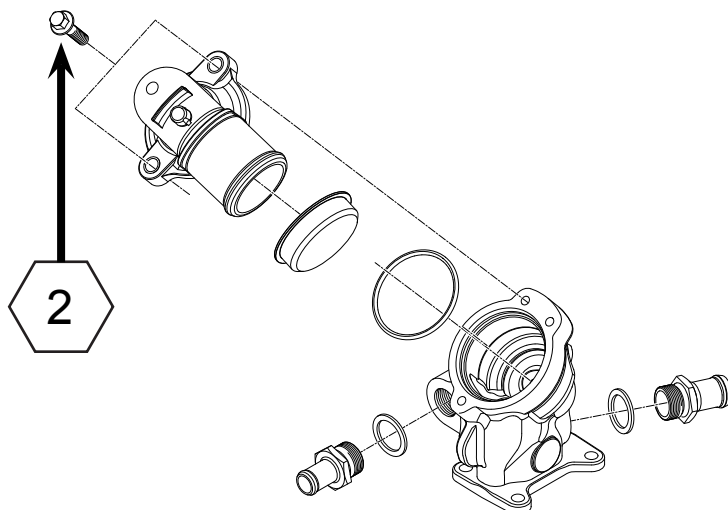


THERMOSTATIC VALVE

Remove the nuts and screws **1** and remove the thermostatic valve unit.

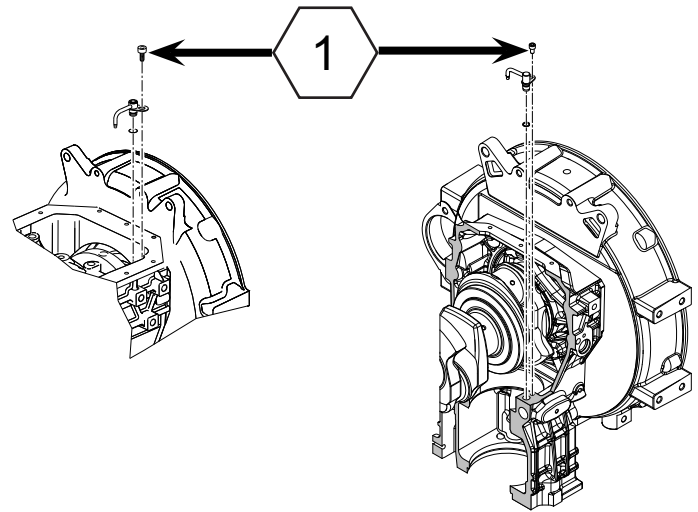
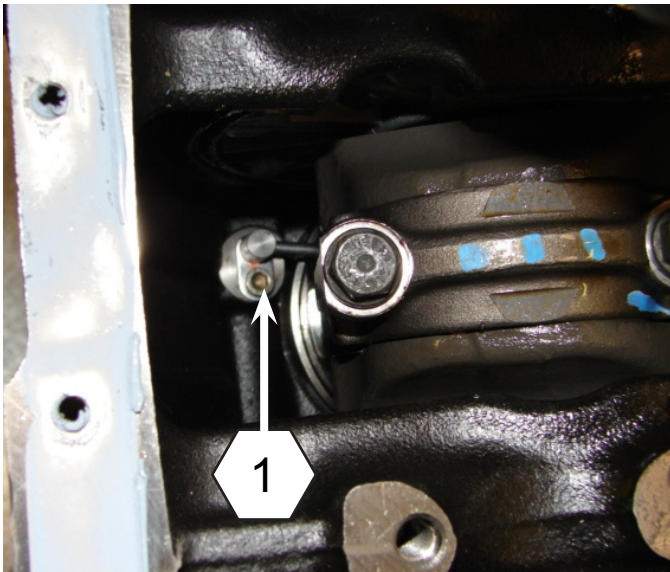


Remove the screws **2** and remove the thermostatic valve.



PISTON COOLING-LUBRICATION JET

Remove the screws 1 and remove the oil jet.

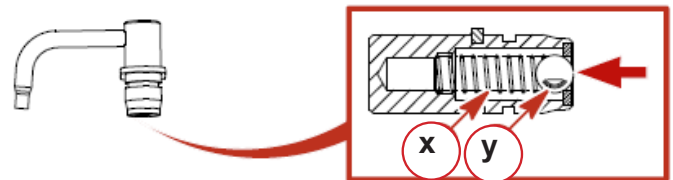


Check that the ball valve can move freely against the spring inside it.

2. Check the jet for cracks, for pipe or nozzle bends.

x - Spring

y - Ball valve



FLYWHEEL - HOUSING - REAR SUPPORT



IMPORTANT: before loosening the nuts retaining the flywheel, block the rotation of the crankshaft by means of the special tool that replaces the starter motor.

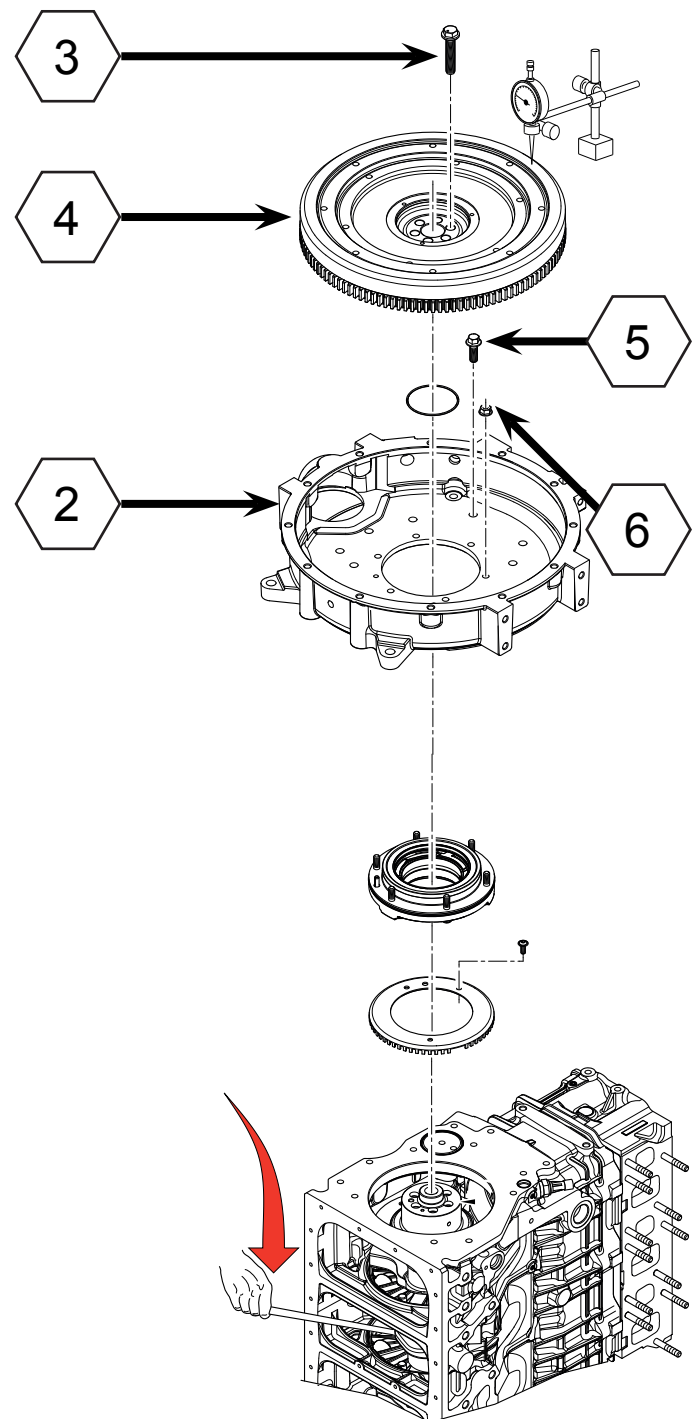
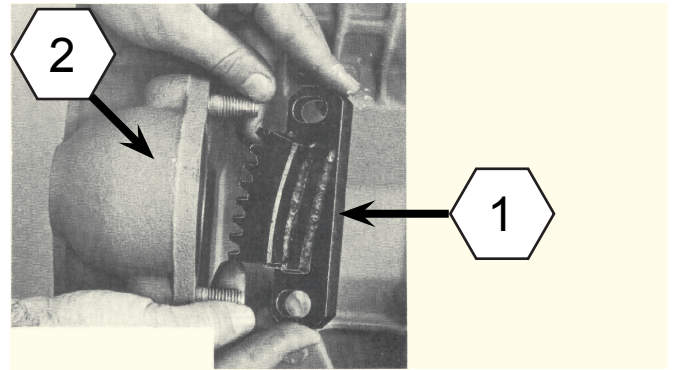
Install the special tool **1** on the flywheel housing **2**.
Remove the screws **3** of the flywheel **4** and remove it.

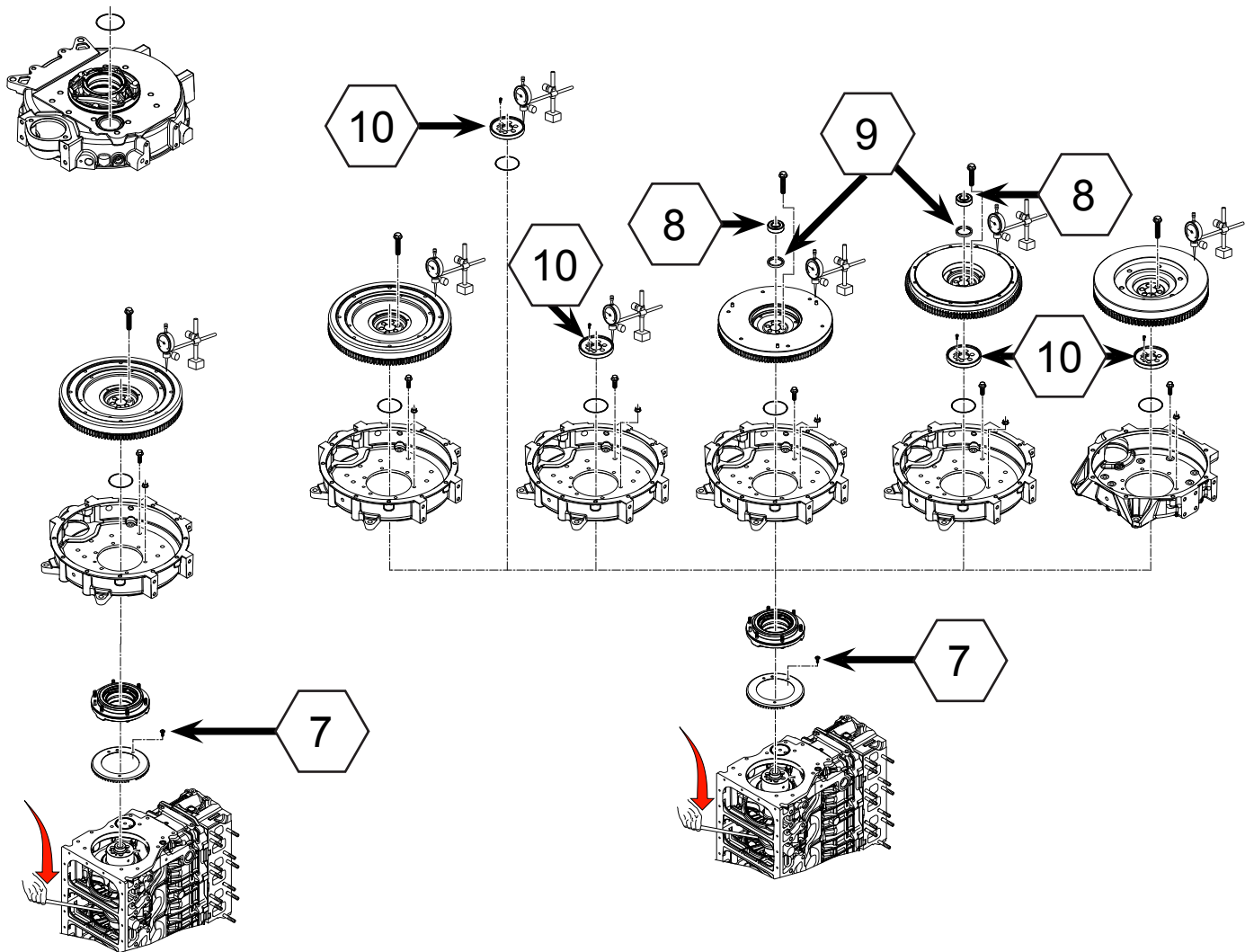


IMPORTANT: in some engine versions bearings **8**, spacers **9** or shim application ring **10** can be installed.

Remove the screws **5** of the housing and remove it.

After removing the housing, loosen the nuts **6** and remove the rear support.





PHONIC WHEEL

Remove the screws 7 of the phonic wheel and remove it.

ROCKER ARMS - TAPPETS RODS

1. Remove the rocker arm cover.



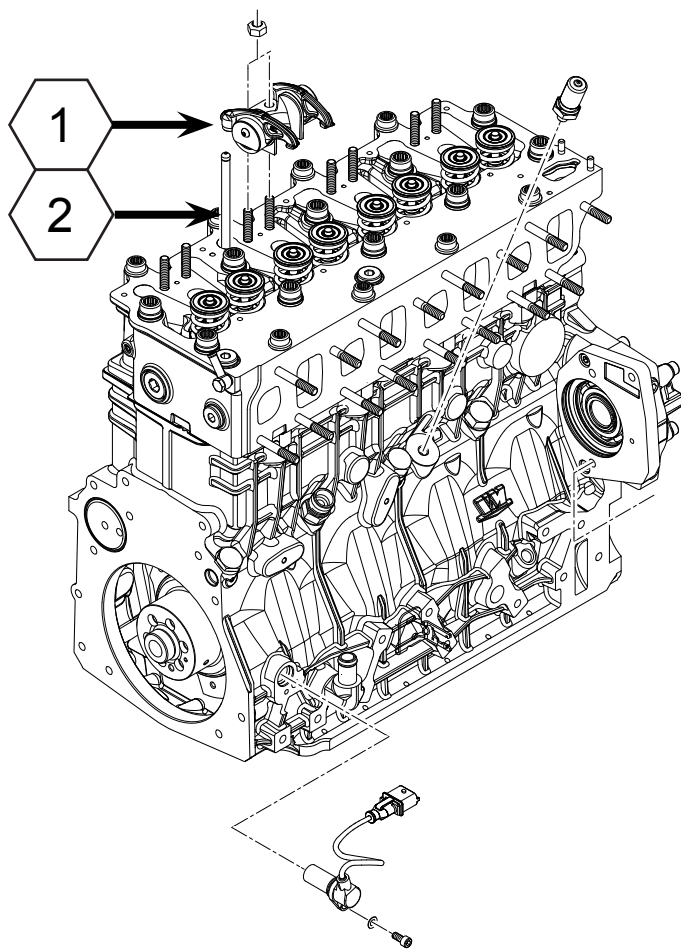
IMPORTANT: Mark or store the components during the removal in order to refit them in their original position.

2. Loosen the nuts and remove the rocker arm unit 1 and the rocker arm rods 2. Number the components according to their positions in the engine or mark the parts in order to refit them in their original positions.

CHECK

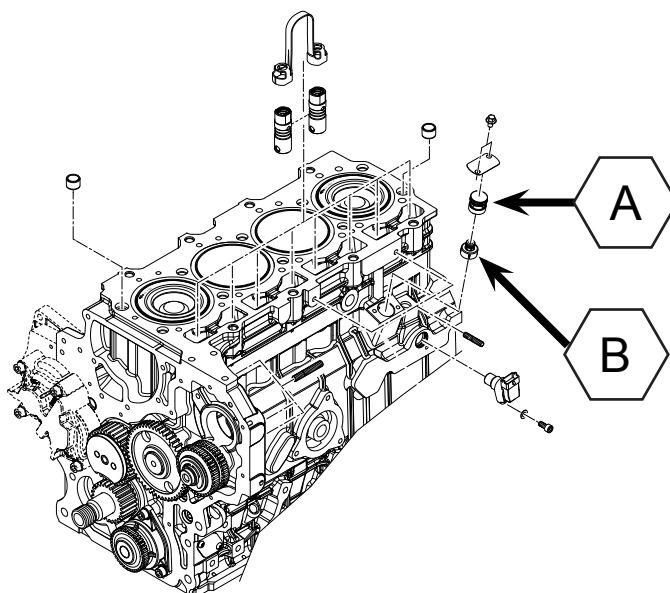
1. Check the components for wear, cracks or damage.

NOTES: Rocker arm rods are drilled along their length as they supply oil to lubricate each rocker arm unit.



OIL DRAIN VALVE FROM SEPARATOR

The complete valve is made up of the body A and the valve B.



HEADS - HYDRAULIC TAPPETS

IMPORTANT: it is recommended to replace the head screws any time the heads are removed: new screws must not be lubricated as they come already lubricated with an anti-seize lubricant.

If you are reusing the screws, lubricate the thread and underhead of all M12 screws (12 mm) (side screws) and M14 screws (14 mm) (central screws) with Molykote G Rapid Plus grease.

The head gasket must be installed dry. Do not use any type of sealant or adhesive on the gasket.

IMPORTANT: Camshafts and tappets cause combined wears during engine operation. A wrong matching of the worn camshaft with the relevant worn tappet or the use of worn components with new components can lead to a rapid and excessive wear, thus damaging the engine. Always use new camshafts with new tappets any time a component is replaced.

The hydraulic tappets are kept in position and prevent the rotation thanks to a special bracket. One single bracket will be installed per cylinder. Pay attention when installing the brackets: make sure that the flanged section of the anti-rotation bracket is properly positioned in the flanged section of the tappet.

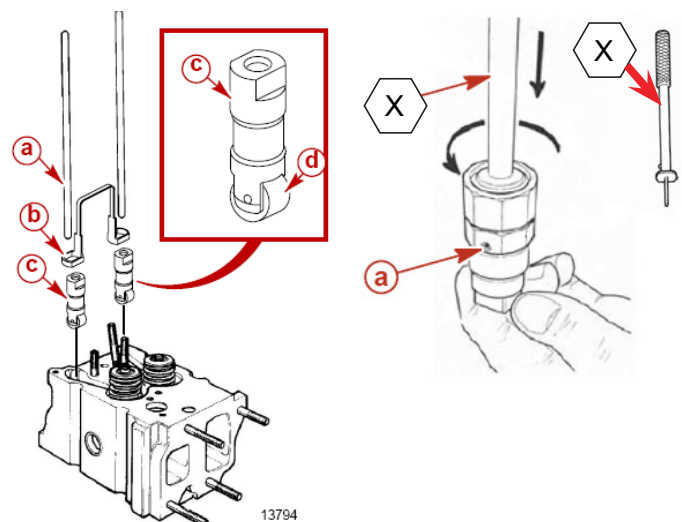
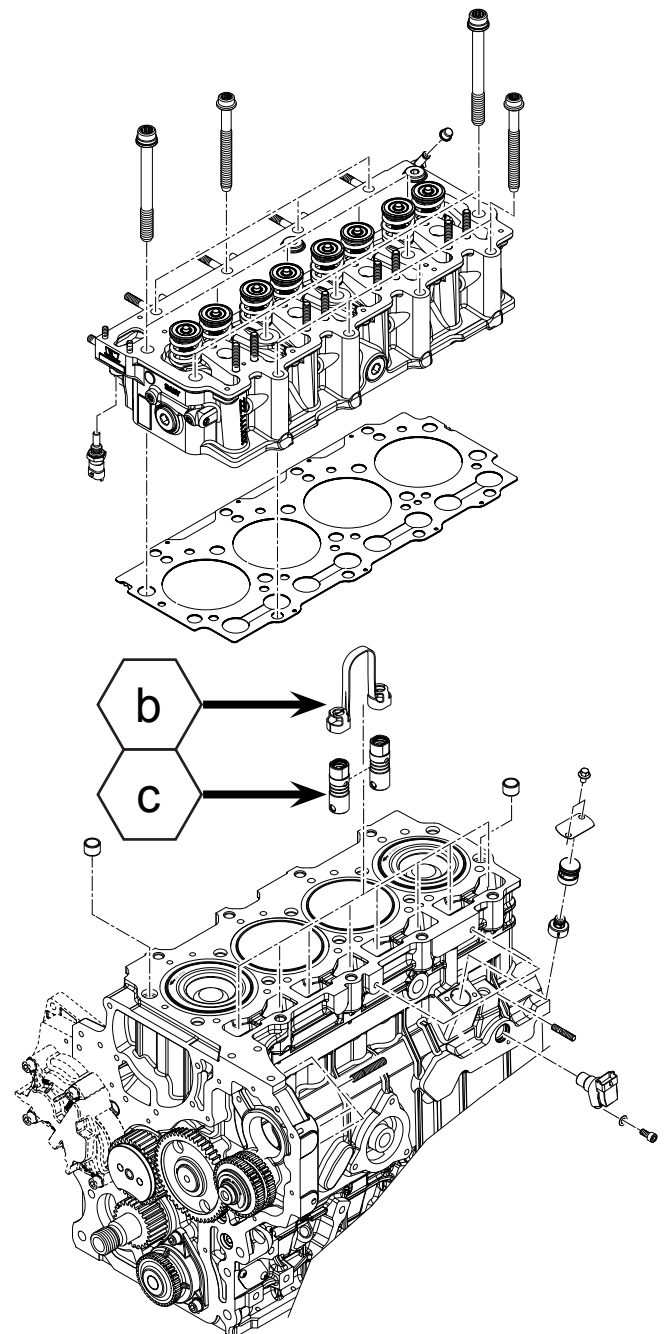
Loosen the head screws and lift the head.

Remove the head gasket.

Lift the brackets **b** vertically in order to make tappet **c** removal easier.

Insert the special tool **x** in the tappet. Press the inner spring of the tappet and rotate the tool by 90°, then lift the tappet.

Remove the remaining tappets keeping them numbered and in order for their reassembly.



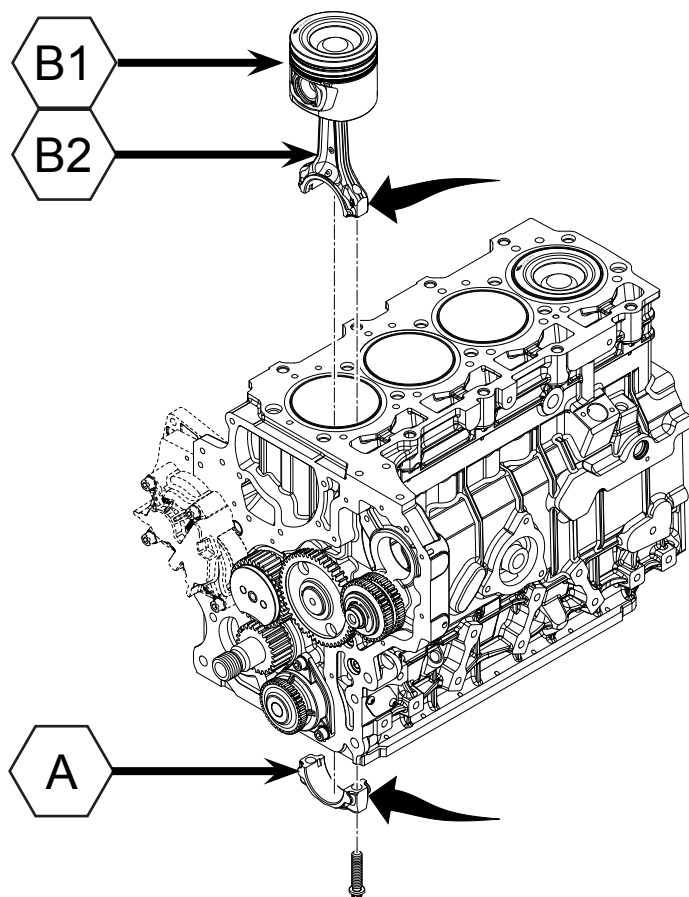
13794

PISTONS

IMPORTANT: Each connecting rod - cap unit must be refitted in the same original position. Mark or identify each connecting rod - cap assembly to ensure they are refitted in their original positions and in the same cylinder. Keep the cap and plain bearings assembled with the piston - connecting rod unit. Do not mix the components. Remove the con-rod plain bearings. Keep the plain bearings with the original connecting rod and cap.

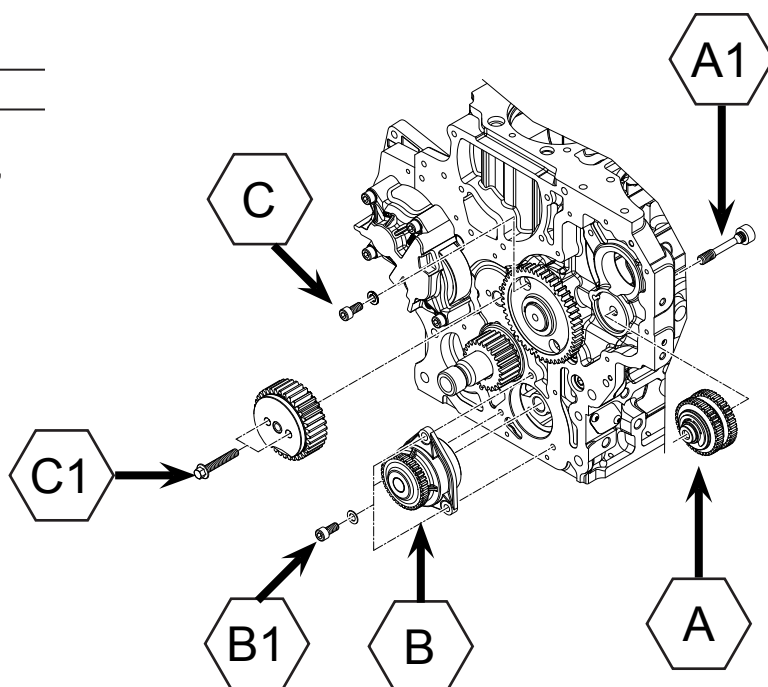
IMPORTANT: it is recommended to replace the connecting rod screws any time they are removed: if they are reused lubricate the thread and underhead of the screw with engine oil. If replaced, the new screws do not require lubrication as they are already smeared with an anti-seize treatment.

Loosen the screws of the connecting rod cap **A**. Push the piston **B1**- connecting rod **B2** outside the cylinder. Remove the connecting rod plain bearings from the connecting rod stem **B2** and from the cap **A**.



OIL PUMP - TIMING SYSTEM GEARS

Remove the injection pump timing gear **A** loosening the screw **A1**, the oil pump **B**, loosening the screw **B1**, and the timing gear **C** between the crankshaft and the camshaft loosening the screws **C1**.



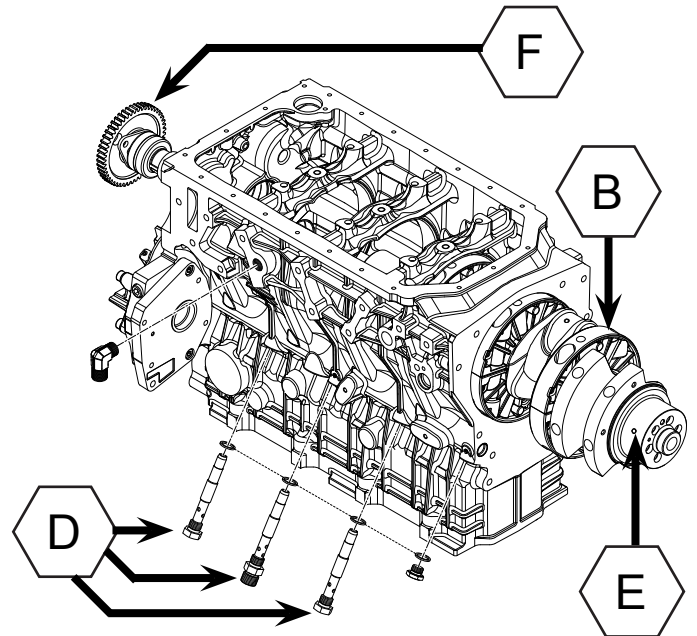
CRANKSHAFT

Remove the unions **D** .
Remove the crankshaft **E** together with the main bearings **B** .



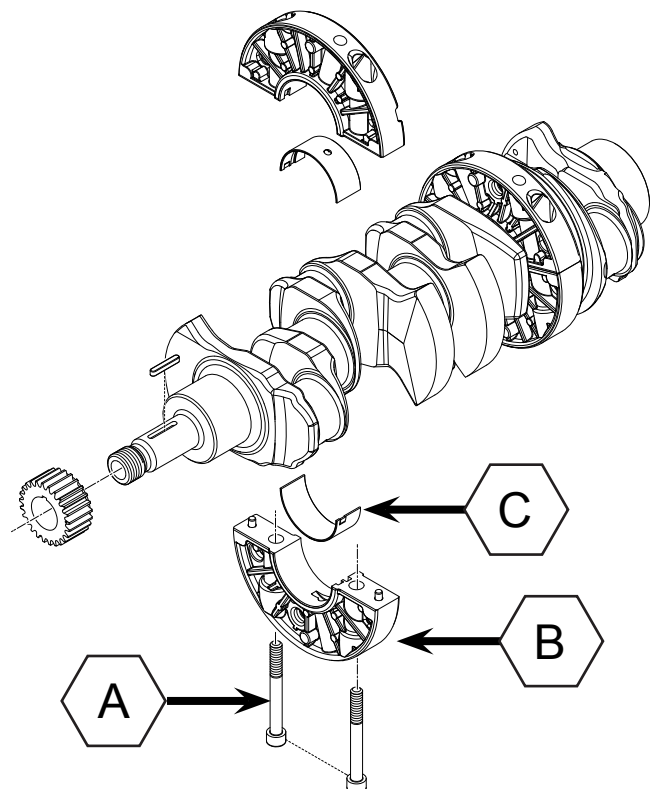
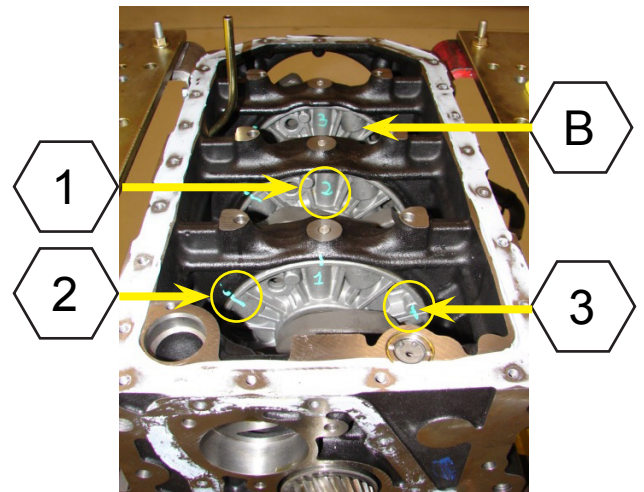
IMPORTANT: Before removing the shaft complete with main bearings from the crankcase, number the bearings (1) according to the relevant main journal and make some reference marks (2) between the bearings and the crankcase, to make unions and bearings alignment easier during assembly.
Make also a reference mark (3) between the half-bearings.

Remove the camshaft **F** .



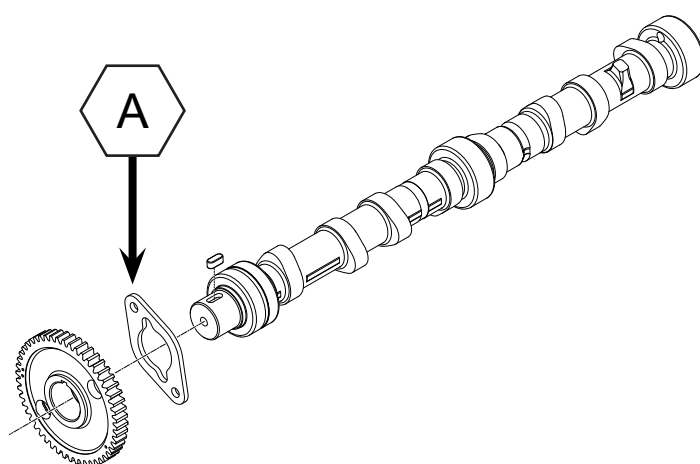
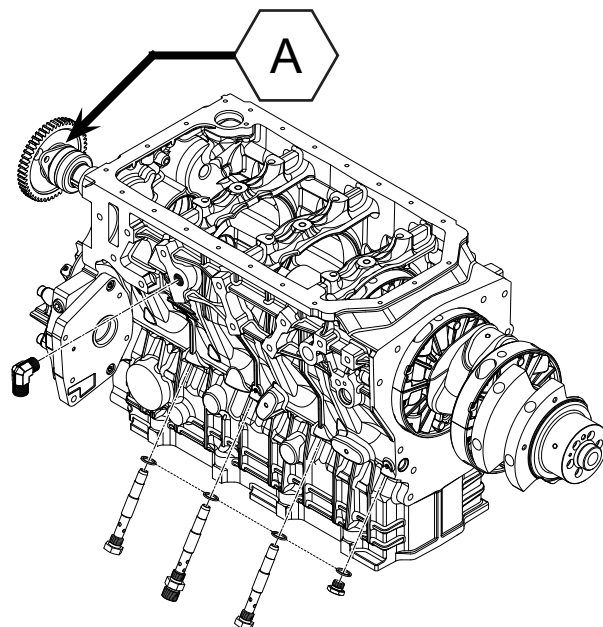
CRANKSHAFT MAIN BEARINGS

Loosen the screws **A** .
Remove the main bearings **B** .
Remove the bushings **C** .



CAMSHAFT

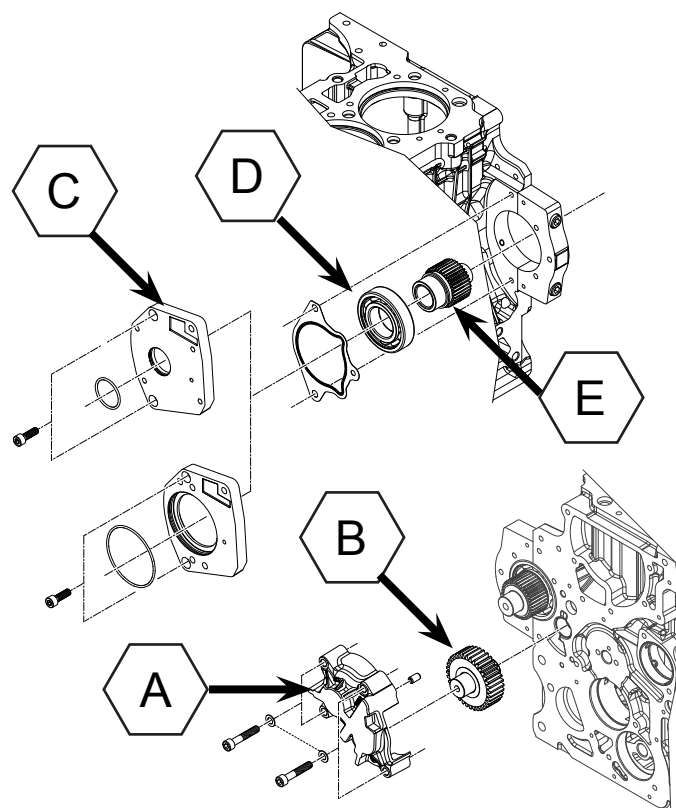
Loosen the screws retaining the camshaft flange **A** to the crankcase.
Remove the camshaft.




POWER TAKE OFF GEARS

Loosen the screws retaining the cover **A**.
Remove the gear **B**.


Loosen the screws retaining the flange **C**.
Remove the bearing **D** and gear **E**.

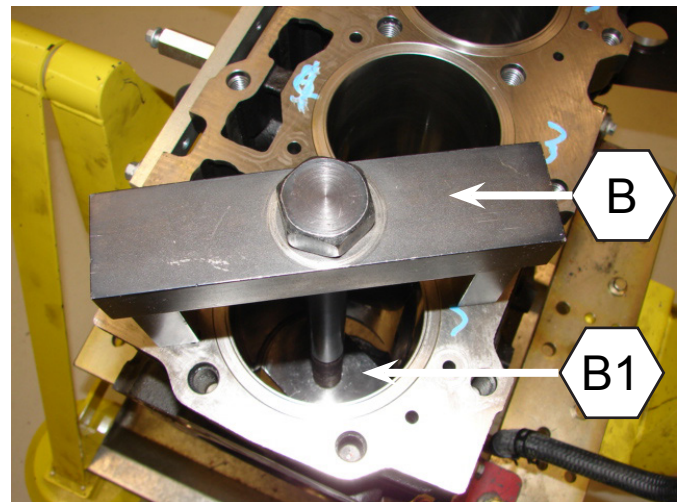
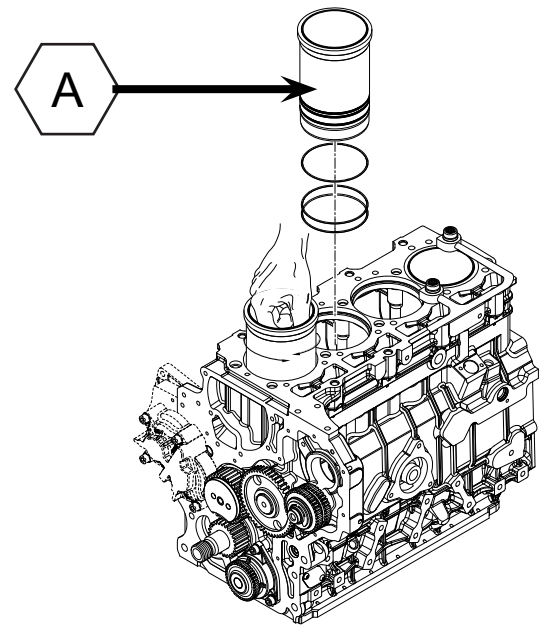


CYLINDER LINER - DISASSEMBLY

 **IMPORTANT:** to avoid wrong connections between liners and pistons, mark the liners according to their position on the crankcase.

Remove the liners **A** using the special tool **B/B1**.
Install tool **B** in the liner and plate **B1** in the lower side of the liner. Screw the nut of the tool and extract the liner **A**.

 **IMPORTANT:** take note of the position of the O-rings in the lowest side of the liner.



CYLINDER LINER - PROJECTION



IMPORTANT: The projection of the liner from the crankcase can be only measured with the liner housed correctly in the crankcase.



IMPORTANT: The liner must rotate freely inside the crankcase before taking the measurement. Install the liners without the O-rings.

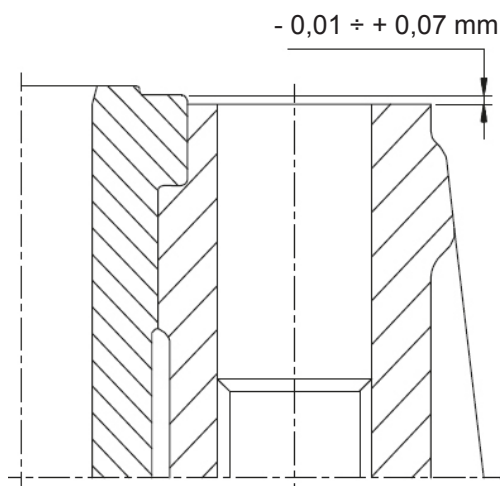
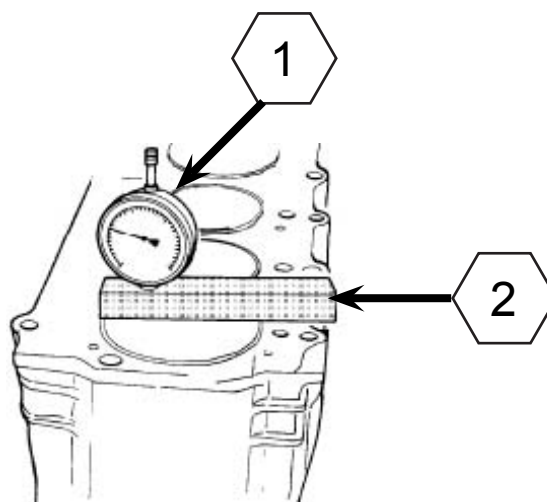
Using a dial indicator measure and record the value of the projection/indentation of each liner compared to the crankcase surface.

1. Use a dial indicator **1** and the special tool **2** to measure the projection.
2. Position the tool with the installed dial indicator so that the feeler pin of the dial indicator is resting against the crankcase.
3. Set the indicator to zero (0).
4. Move the tool towards the liner collar. Record the measurement.
5. Measure the projection of all liners.
6. Check that the projection of each liner for each cylinder falls within the specified limit:

Liner projection	- 0.01 ÷ + 0.07 mm
------------------	--------------------

If the projection is not correct, extract the liner and install another one.

If the value is correct proceed with the installation of all liners as follows:



CYLINDER LINER - INSTALLATION

Install the two O-rings **1** of the same colour in the grooves at the bottom of the liner and an O-ring **2** of a different colour in the lower groove (see picture).



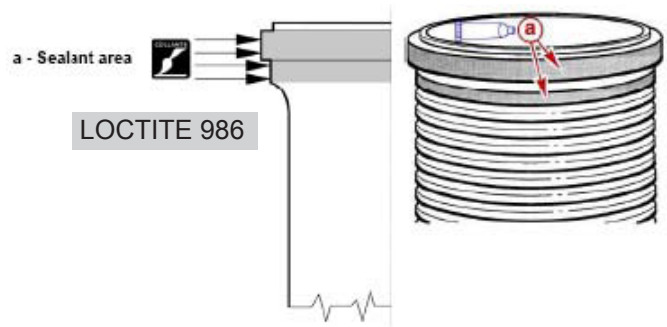
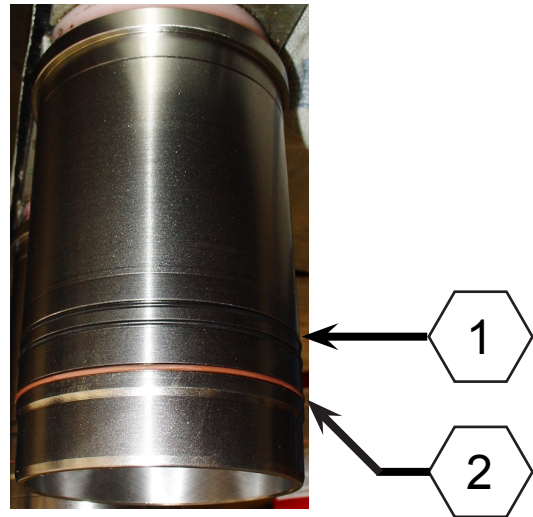
IMPORTANT: the first two O-rings **1** have different thickness and colour compared to the second one **2**. Do not mix up the O-rings.

Lubricate and grease the O-rings and their seat inside the crankcase.



IMPORTANT: Do not lubricate the higher part of the crankcase where LOCTITE 986 will be applied.

Select and apply LOCTITE 986 on the surface of the liner as indicated in the figure.



Install the liners in the crankcase, paying attention not to damage the O-rings.

Once the liners **A** are installed keep them in position using bolts **B** and spacers **C**.

Temporarily tighten the bolts in order to allow the Loctite to dry.

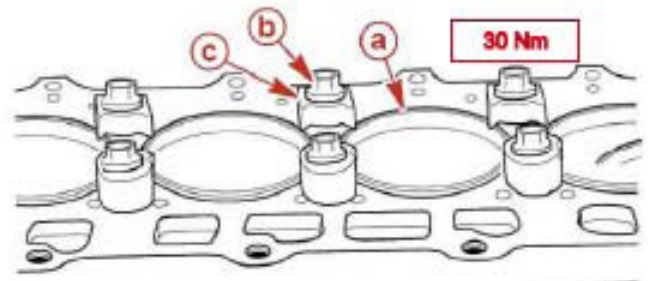
Liner tightening	30 Nm
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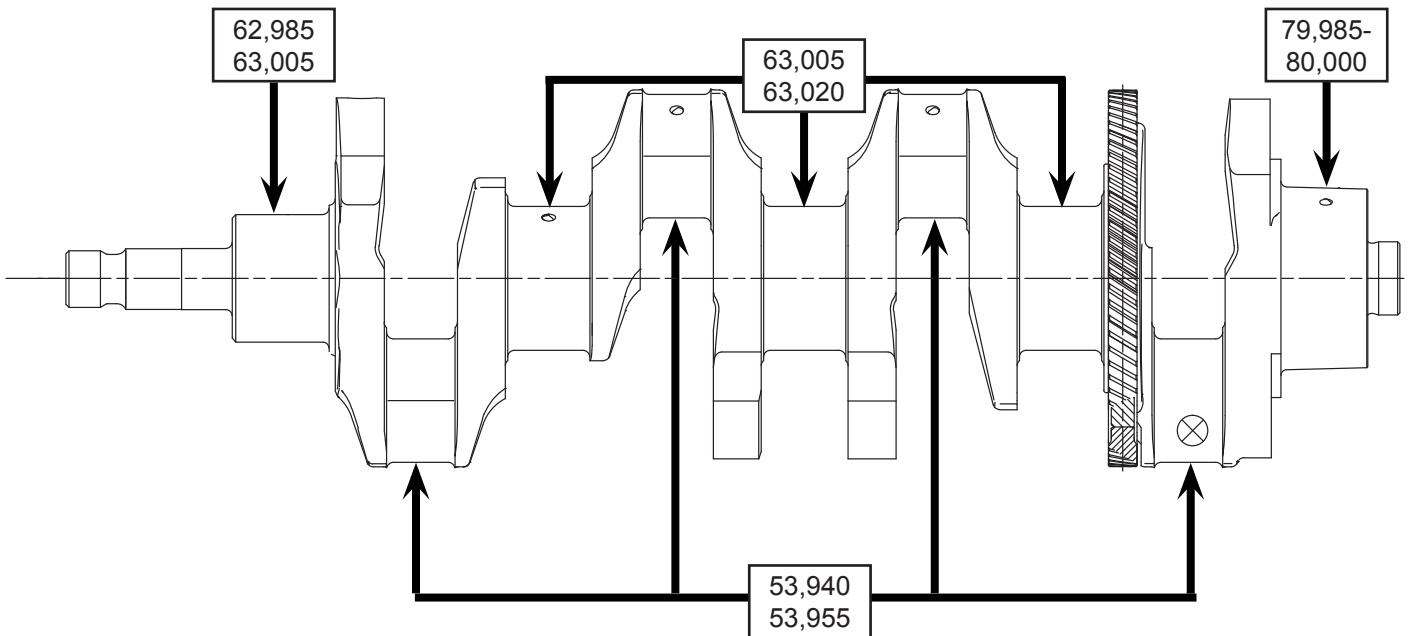
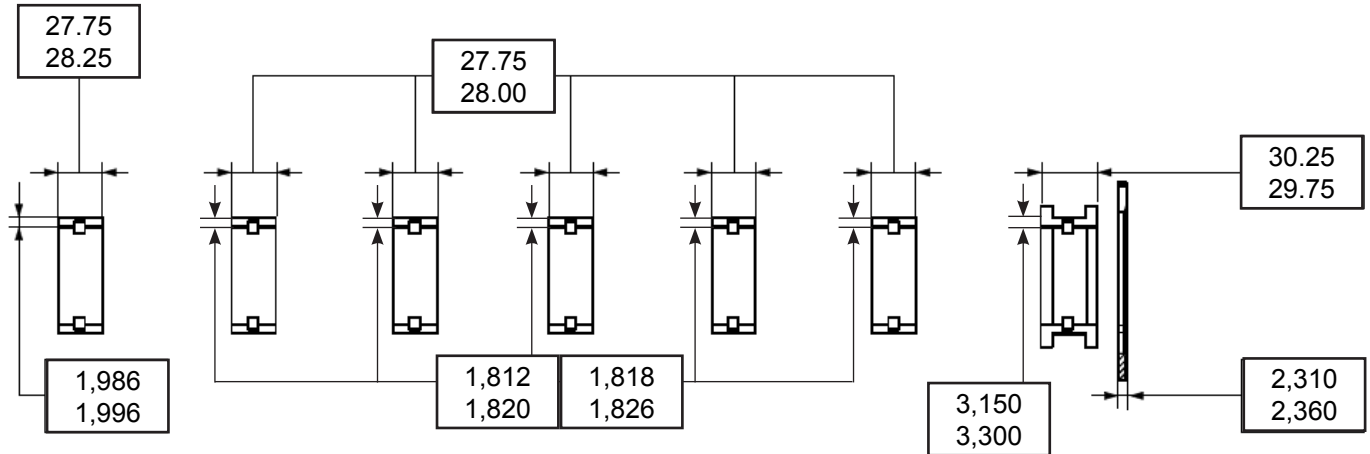
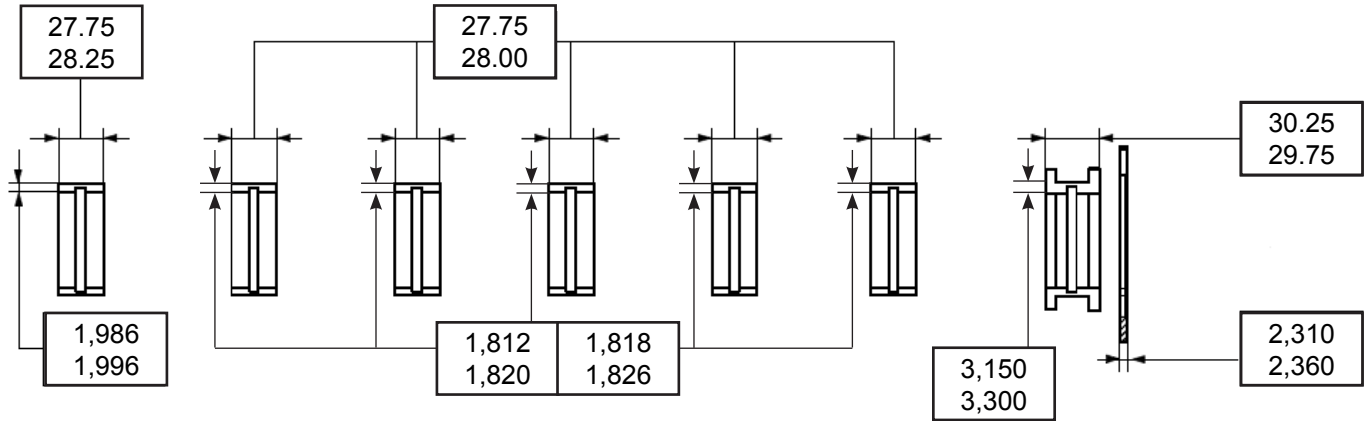
IMPORTANT: If the heads are not installed within 1 hour, the liners must remain tightened with bolts and spacers for 8 hours to allow the Loctite to dry. After 8 hours the bolts and relevant spacers can be removed and the heads installed.

Once the Loctite is dry, check the liner projection as previously specified.

If the projection is correct, carry on with engine assembly.



CRANKSHAFT - MEASUREMENTS



Check conditions of the main journals; there should be no sign of ovalisation or excessive wear.

The values shown above refer to nominal values.

CRANKSHAFT - GRINDING

After seizing, overheating or grinding, the crankshaft must be checked with Magnaflux to verify that on its surfaces there are no cracks.

After grinding perform the "SURSULF" treatment (hardness HV 587 with load of 500 g corresponding to HRc 53). After the "SURSULF" treatment lap all surfaces with roughness Ra 0.18 / 0.22.

IMPORTANT: It is prohibited to grind the shaft after the SURSULF treatment. No material can be removed, by hand or through grinder, from the surfaces of the rear shims and from the rear tail of the shaft where the shims are in contact with them. Replace the crankshaft if the machined surfaces in the front and rear tail or the areas with the threaded holes are outside the cylindricity value, worn or damaged.

CRANKSHAFT AXIAL CLEARANCE

Install a dial indicator **1** to the crankcase to check the crankshaft axial clearance.

Measurements can be taken by leaning the feeler pin of the dial indicator to the cranks of the shaft **2** or to the external surface of the flywheel, if installed.

Pry and move the crankshaft towards the flywheel.

Record the measurement.

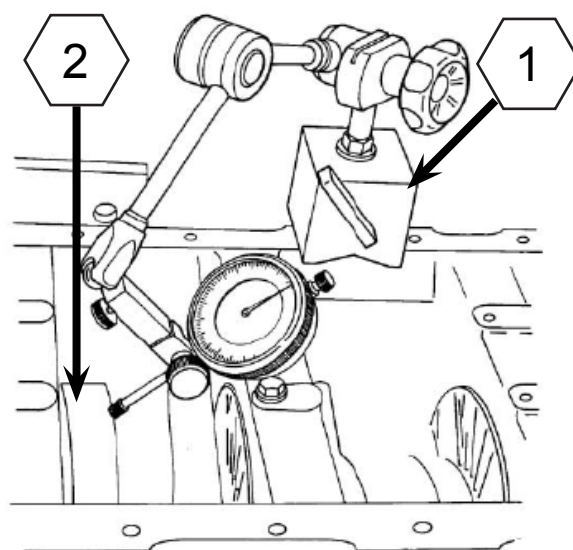
Pry and move the crankshaft towards the timing system.

Record the measurement.

Subtract the measurements to determine the axial clearance of the crankshaft.

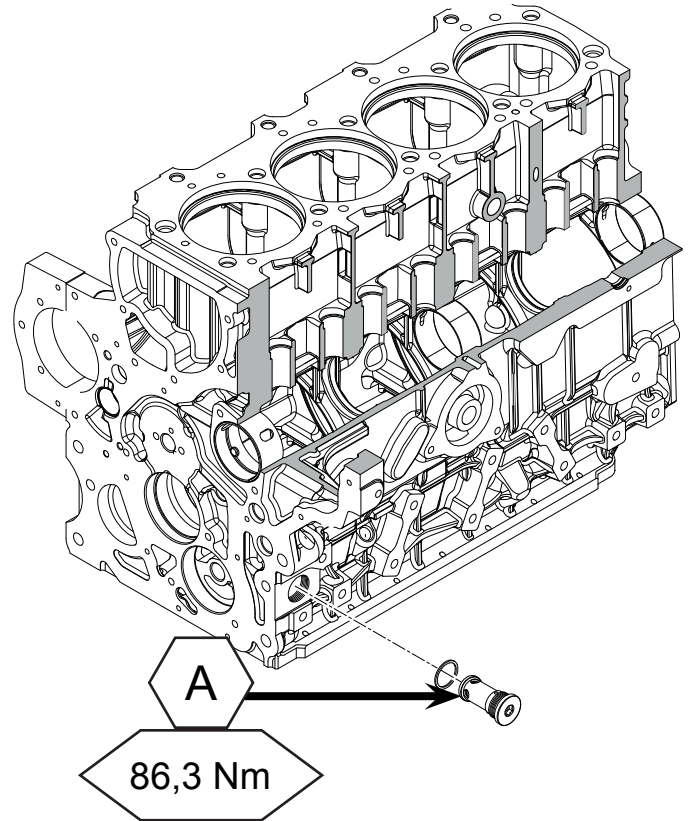
Crankshaft axial clearance	0,080 - 0,230 mm
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If the crankshaft axial clearance is not correct, calculate the correct or required thickness of the rear shim. Install a different rear shim in the rear support and check the crankshaft axial clearance again.



OIL MAXIMUM PRESSURE VALVE - REPLACEMENT

Disassemble the valve **A**.
Install the valve.



OIL MAXIMUM PRESSURE VALVE - MEASUREMENTS

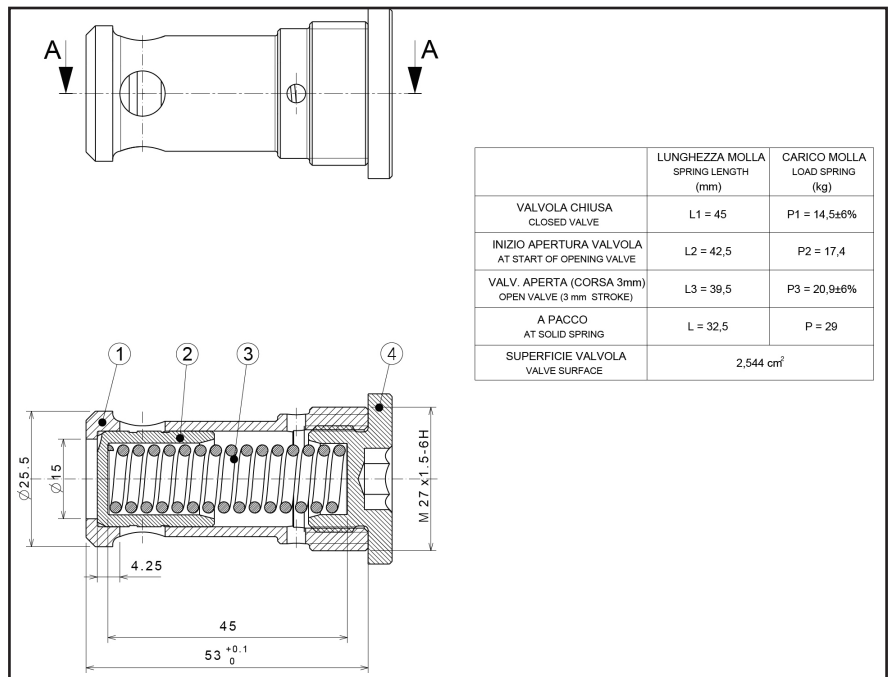
The valve is made up of 4 components:

- 1 - body
- 2 - valve
- 3 - spring
- 4 - plug

Fit the components using a torque of 23 - 30 Nm and Loctite 270.

Upon assembly, check that the valve can slide freely for the whole length of the seat.

P2 opening pressure (total) = 6.84 bar



OIL PUMP - MEASUREMENTS

1. Check pump shaft, rotors and body for excessive wear or damage. Replace the complete oil pump if the damage or wear is excessive.
2. Check the clearance between the internal and external rotor.
3. Check the clearance between the external rotor and the body.
4. Check the indentation of the external rotor compared to the internal one. (External rotor indentation from the pump body)
5. If the measured values are higher than those specified, the pump must be replaced as complete unit.
6. Check the snug torque between rotor and gear.

a - Shaft

b - Internal rotor

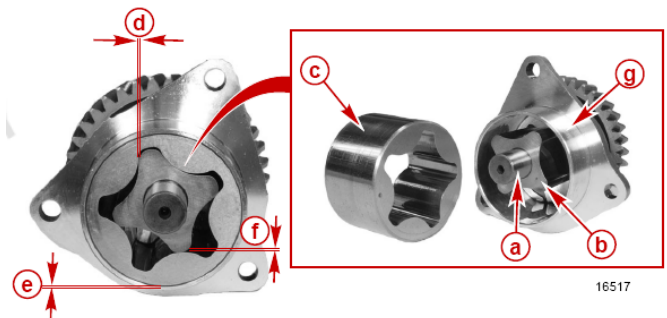
c - External rotor

d - Clearance between rotors

e Clearance between body and external rotor

f - Indentation of the external rotor compared to the internal one.

g - Oil pump body



1 - Oil pump gear

2 - Body

3 - External rotor

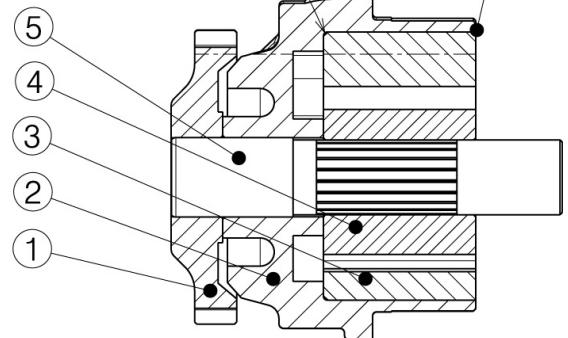
4 - Internal rotor

5 - Shaft

RIENTRANZA ROTORE ESTERNO DAL CORPO POMPA
Reentering of outer rotor from pump body

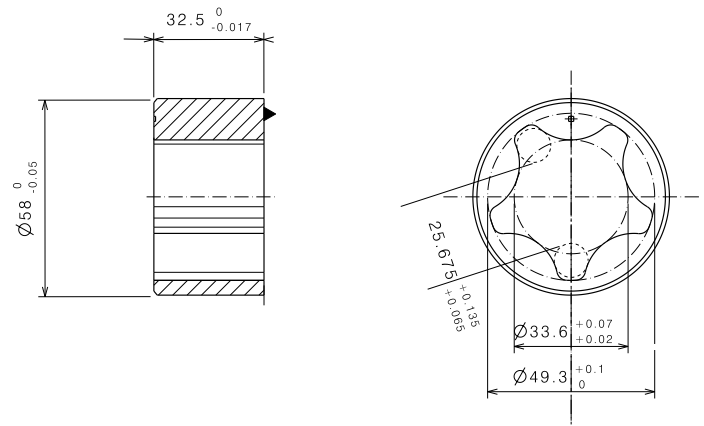
SMUSSO ROTORE ESTERNO
Chamfer outer rotor

0,030 - 0,087
mm

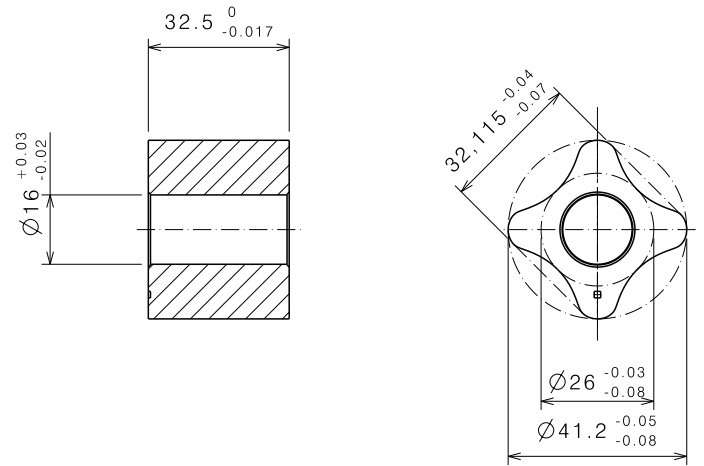


Axial clearance between gear and body	0.150 - 0.250 mm
Snug torque between rotor and gear	9 kgm
Indentation of the external rotor compared to the internal one	0,030 - 0,087 mm

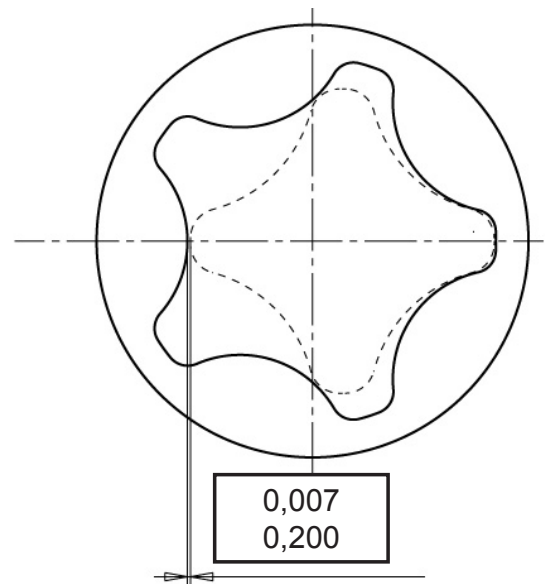
EXTERNAL ROTOR



INTERNAL ROTOR

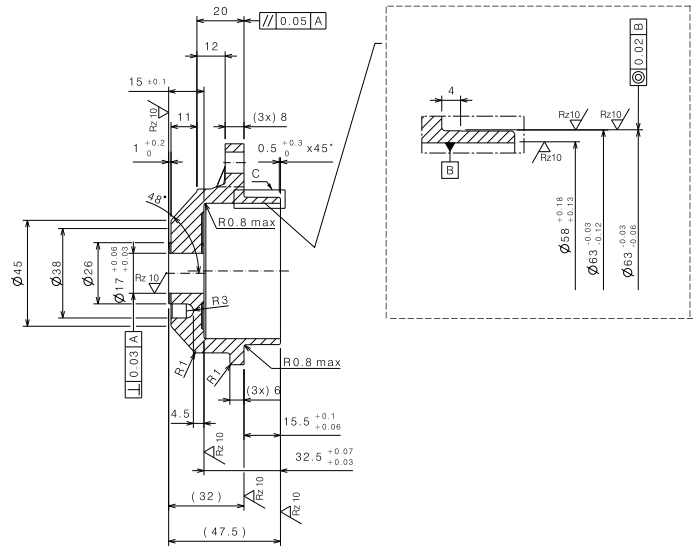


Clearance between rotors	0.07 - 0.20 mm
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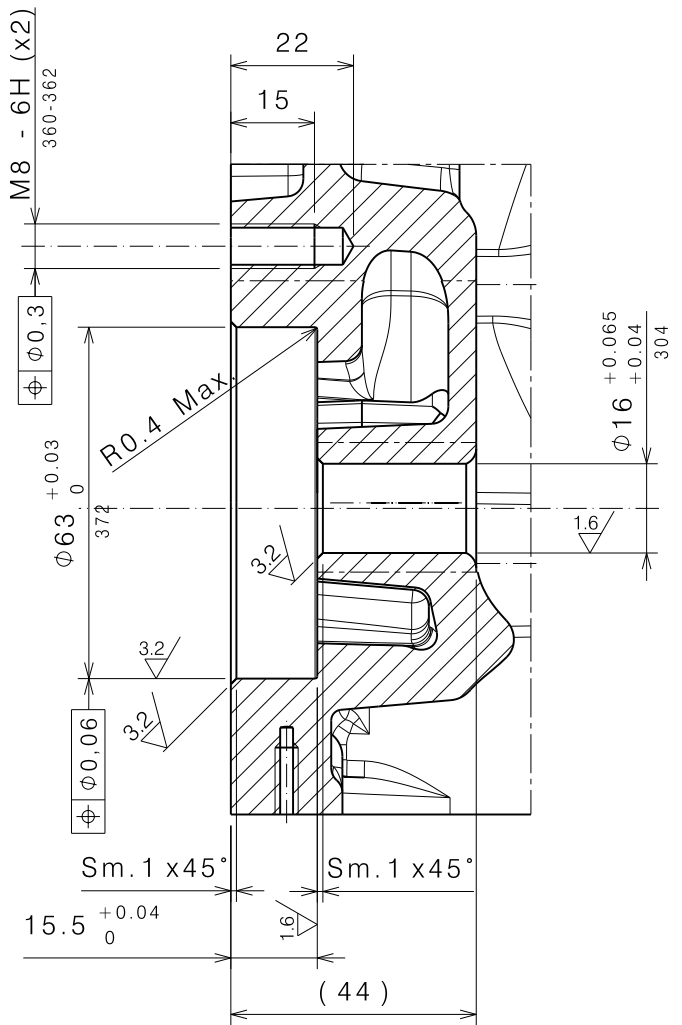


INTERNAL ROTOR

Clearance between body and external rotor	0.13 - 0.23 mm
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OIL PUMP SEAT IN CRANKCASE



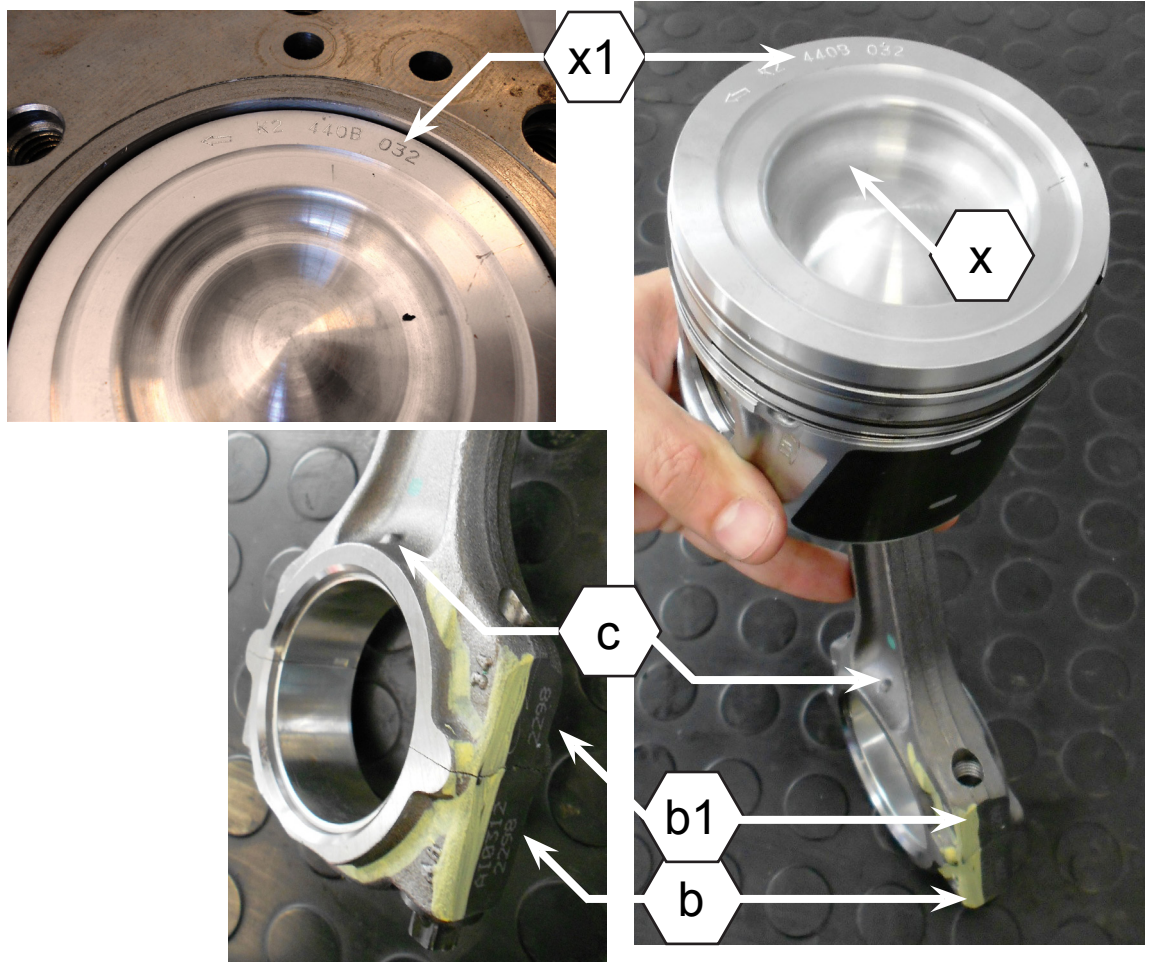
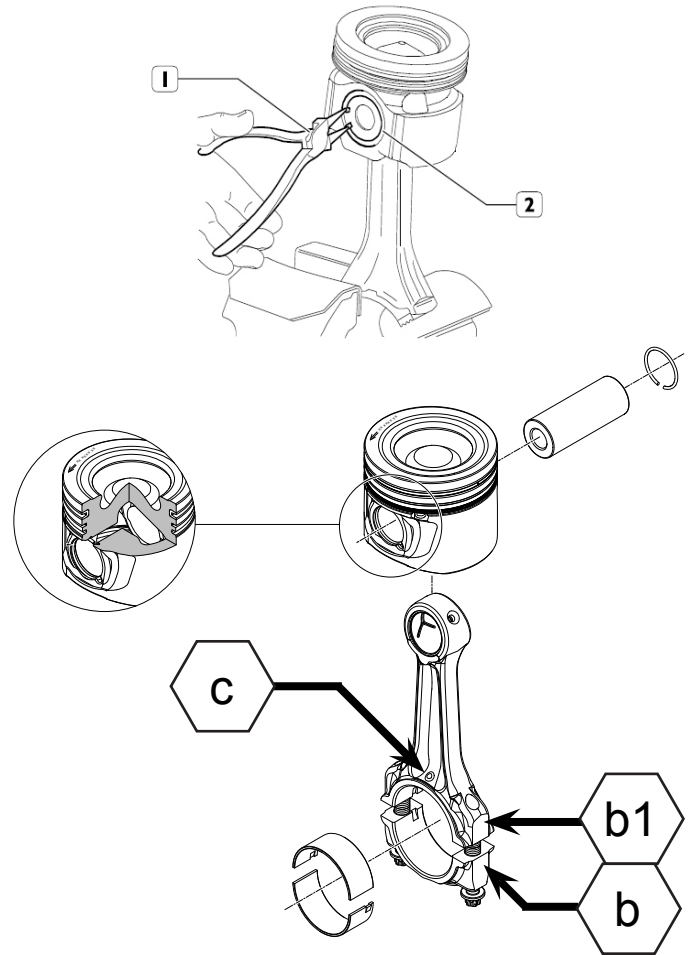
CONNECTING ROD - PISTON UNIT OVERHAUL

PISTON - DISASSEMBLY

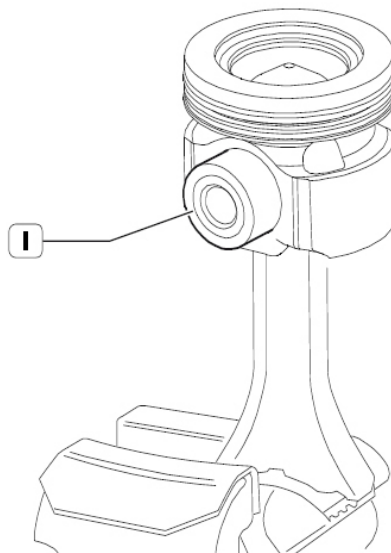
 **IMPORTANT:** before proceeding with piston removal from the connecting rod take note of the orientation of the combustion chamber in relation to the nipple, the paint dot on the connecting rod stem, and the connecting rod numbering.

Remove the circlips **2** using specific pliers **1**.
Push the gudgeon pin outside the connecting rod and piston.

- x - Combustion chamber
- x1 - Piston identification
- b - Connecting rod identification
- b1 - Connecting rod identification
- c - nipple



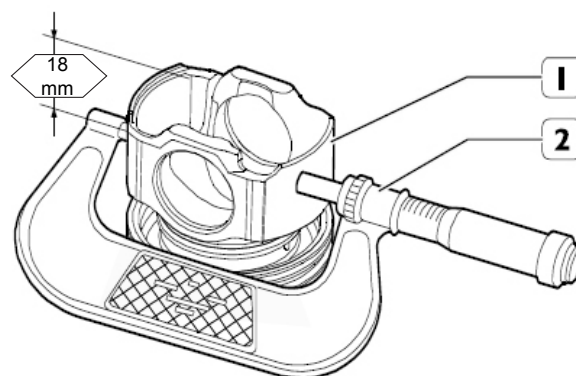
Remove the gudgeon pin of the piston 1.



PISTON - MEASUREMENT

By means of a micrometer 2 measure the diameter of the piston 1 to the value indicated, as shown in the figure.

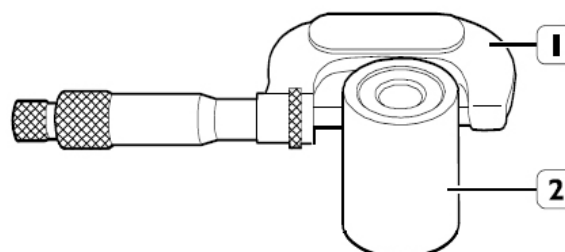
Diameter	93.897 - 93.913 mm
Wear limit	0.10 mm



PISTON GUDGEON PIN - MEASUREMENT

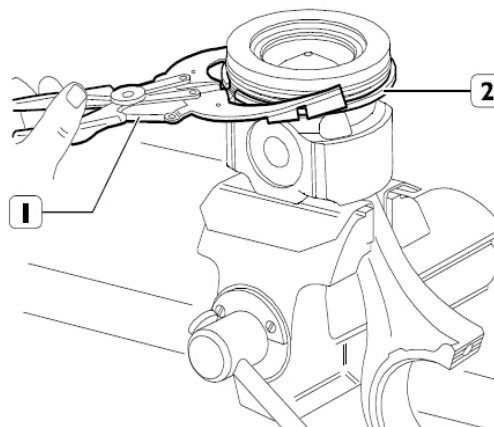
By means of a micrometer 1 measure the diameter of the gudgeon pin 2.

Gudgeon pin external diameter	31.992 - 31.996 mm
-------------------------------	--------------------



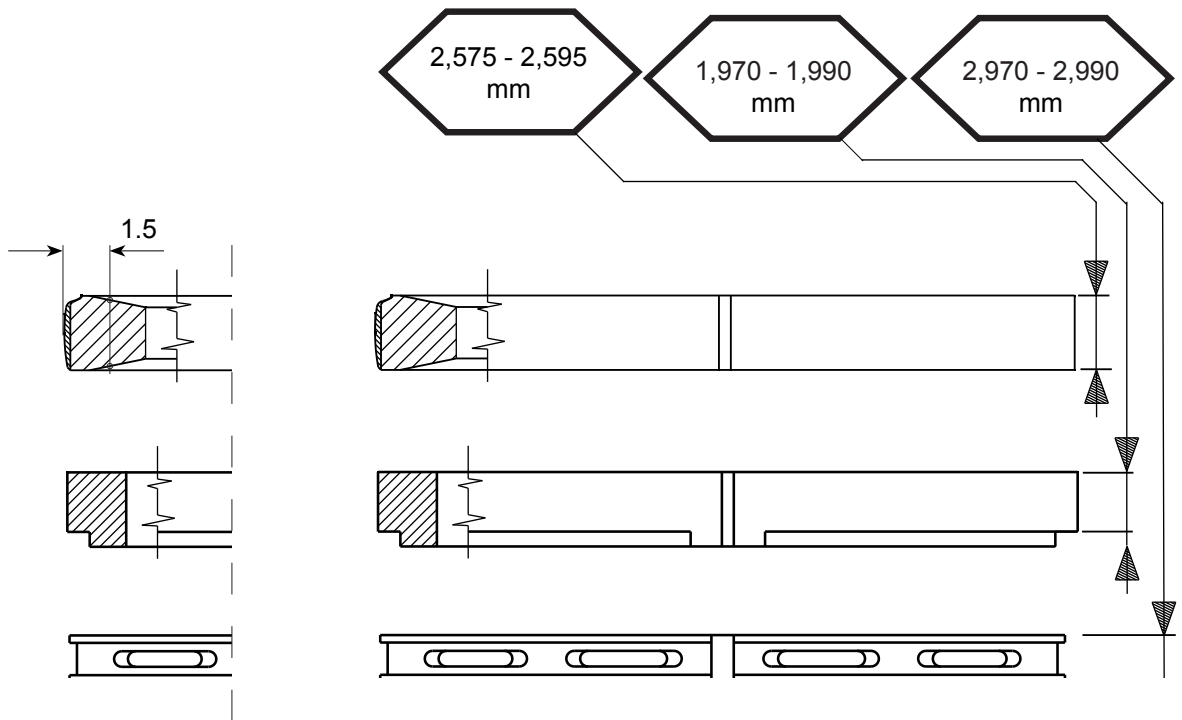
PISTON RINGS - REMOVAL

Remove the piston rings from the piston 2 using specific pliers 1.

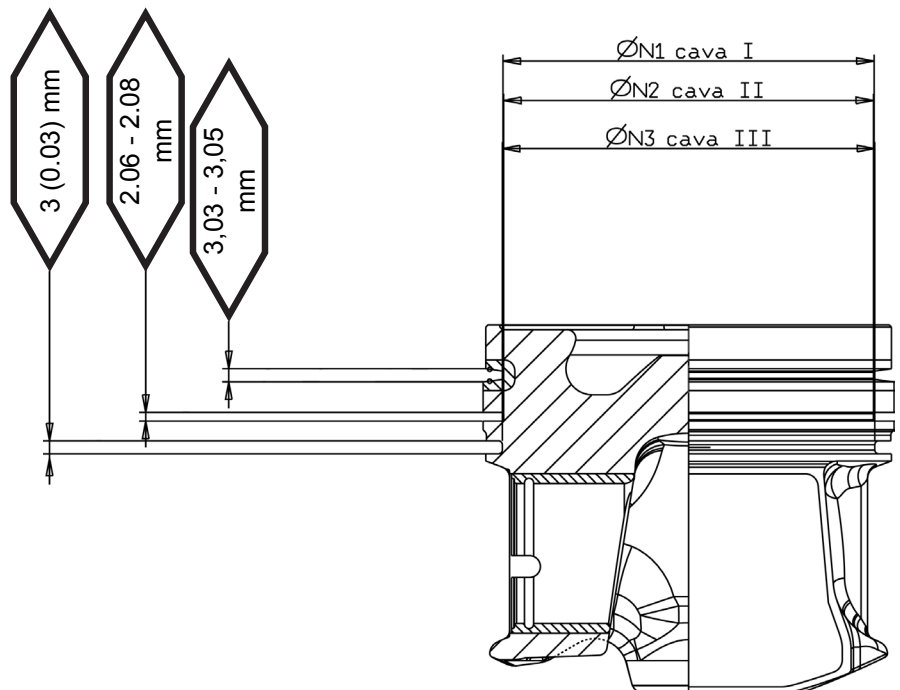


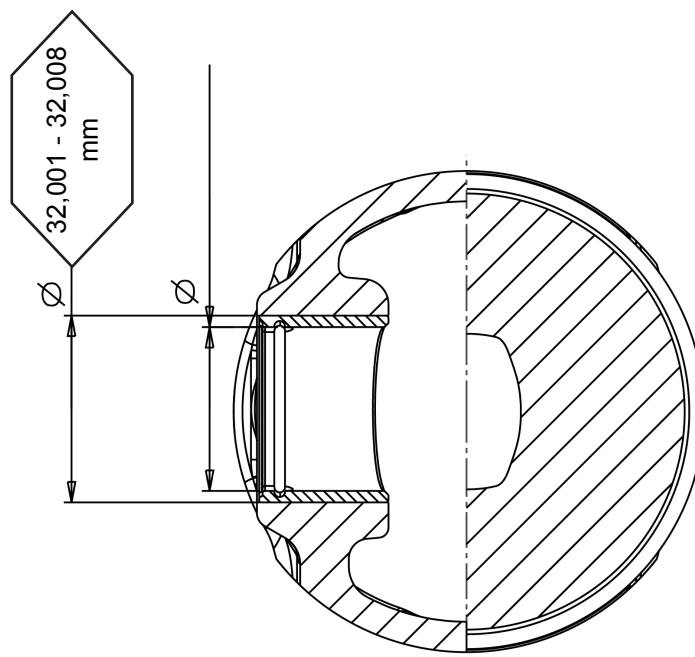
PISTON RINGS - MEASUREMENT

Measure the thickness of the rings and their seats in the piston. Check the clearance using a feeler gauge.



- Ø N1 = 84,7 - 84,9 mm
- Ø N2 = 84,7 - 84,9 mm
- Ø N3 = 84,8 - 85 mm





Position the ring 1 to be measured in the cylinder 3.



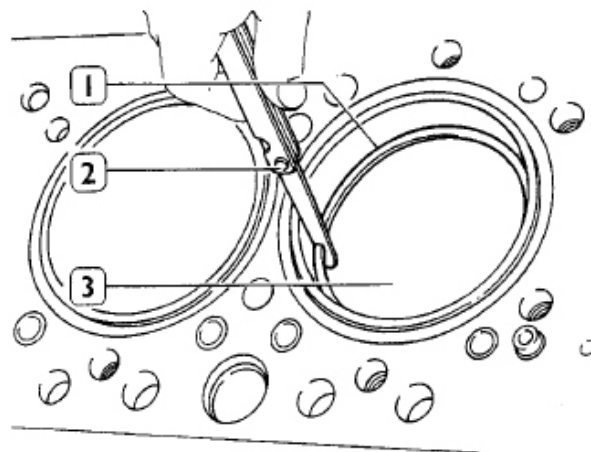
IMPORTANT: The ring must be levelled for the measurement. Push the ring 6 mm inside the cylinder.

Measure the gap between the ends of the ring using a feeler gauge 2.

Ring gap (Production)	
First ring	0.30 - 0.50 mm
Second ring	0.30 - 0.50 mm
Oil scraper	0.30 - 0.60 mm

Ring gap	
First ring	0.5 mm maximum
Second ring	0.5 mm maximum
Oil scraper	0.7 mm maximum

If the gap is less than what specified, remove the ring and fit another one. If new rings are used and even with these ones it is not possible to comply with the values, check the liner. Refer to section "Cylinder liner".

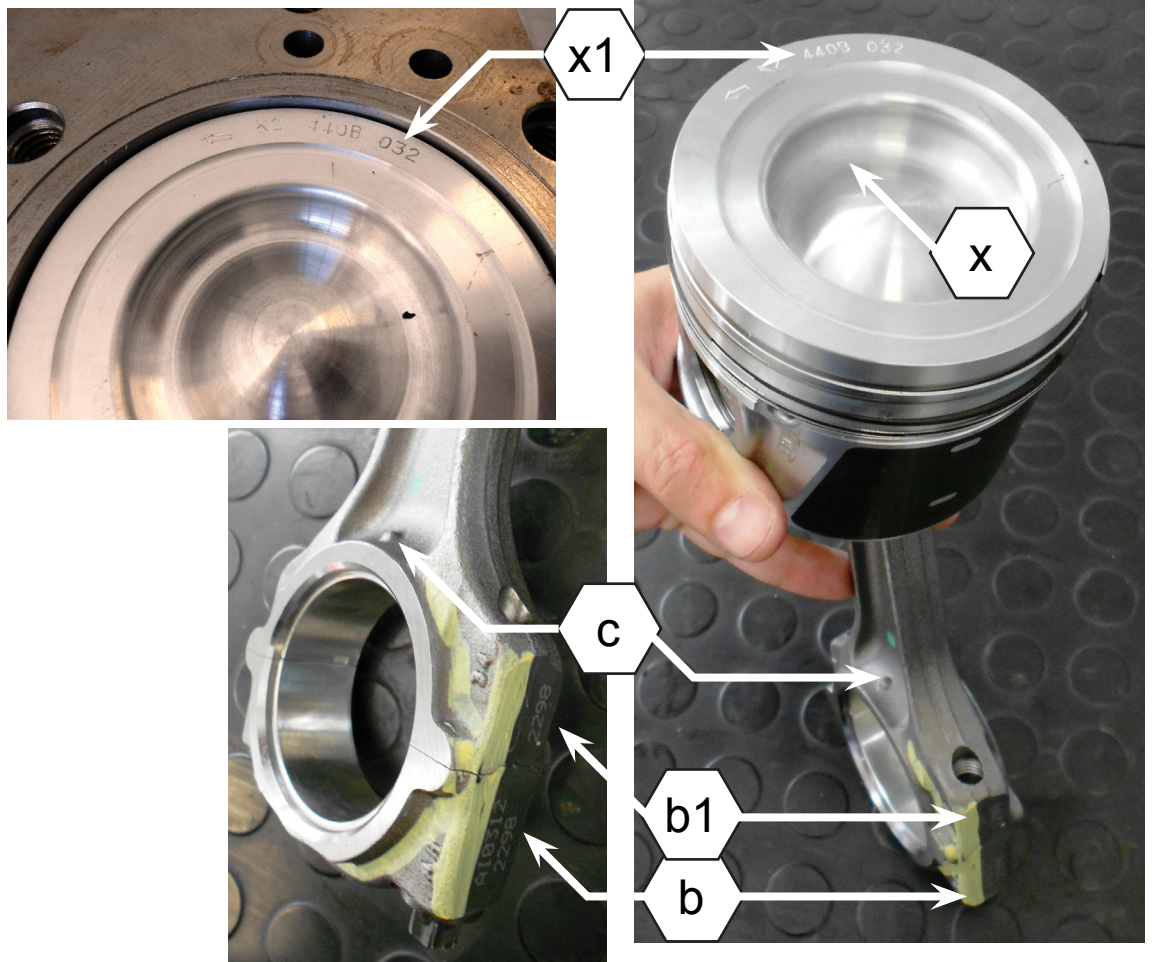
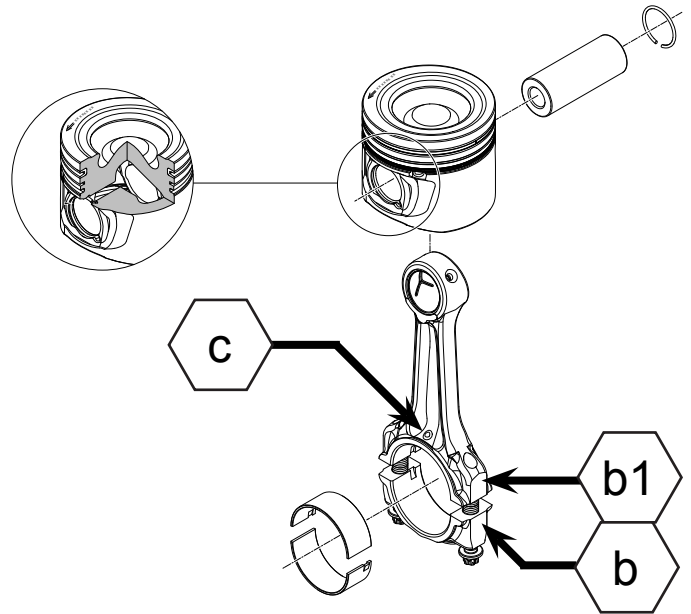


CONNECTING ROD (FRACTURE-SPLIT TYPE) - REMOVAL

IMPORTANT: before proceeding with piston removal from the connecting rod take note of the orientation of the combustion chamber in relation to the nipple, the paint dot on the connecting rod stem, and the connecting rod numbering.

Remove the circlip retaining the gudgeon pin. Push the gudgeon pin outside the connecting rod and piston.

- x - Combustion chamber
- x1 - Piston identification
- b - Connecting rod identification
- b1 - Connecting rod identification
- c - nipple





CONNECTING ROD - MEASUREMENTS

Check the connecting rods for torsion or bending.
In case of doubt, check all connecting rods using the Magnaflux.



NOTE: Temporarily tighten the con-rod screws to 88 Nm.

Check the parallelism of the con-rod axis using the specific tool.

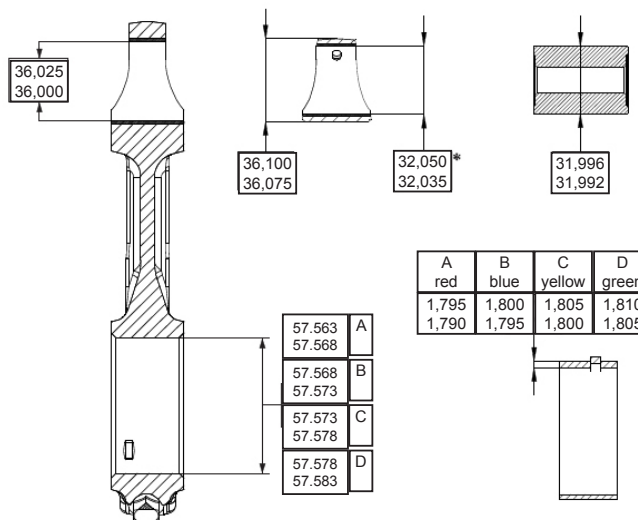
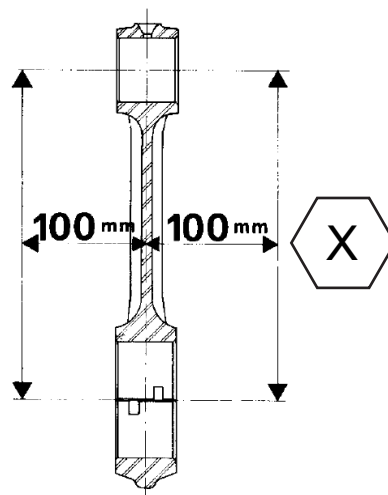
Parallelism/shift between con-rod little and big end.	0.08 mm
x - length	162,975 - 163,025 mm

Check the dimensions shown in the figure.

* Dimension with bushing installed in the con-rod little end.

CON-ROD LITTLE END BUSHING - ASSEMBLY

IMPORTANT: In service, when replacing the bushing of the piston gudgeon pin, it must be bored once installed in the connecting rod. Install the bushing aligning the lubrication hole for the passage of the engine oil present on the bushing with the hole present on the connecting rod.
Bore the bushing to obtain the previously specified diameter.



PISTON - ASSEMBLY

Install the piston on the connecting rod so that the marking **X1**, the arrow **Z**, the nipple **C** and the markings **B/B1** are aimed as shown in the figure.



NOTE: the **Z** arrow must be aimed towards the timing system side.

Paint marks on the stem/cap of the connecting rod identify the weight classification. Make sure that all connecting rods have the same colour. Check also the weight class **B/B1** marked on the stem and cap.

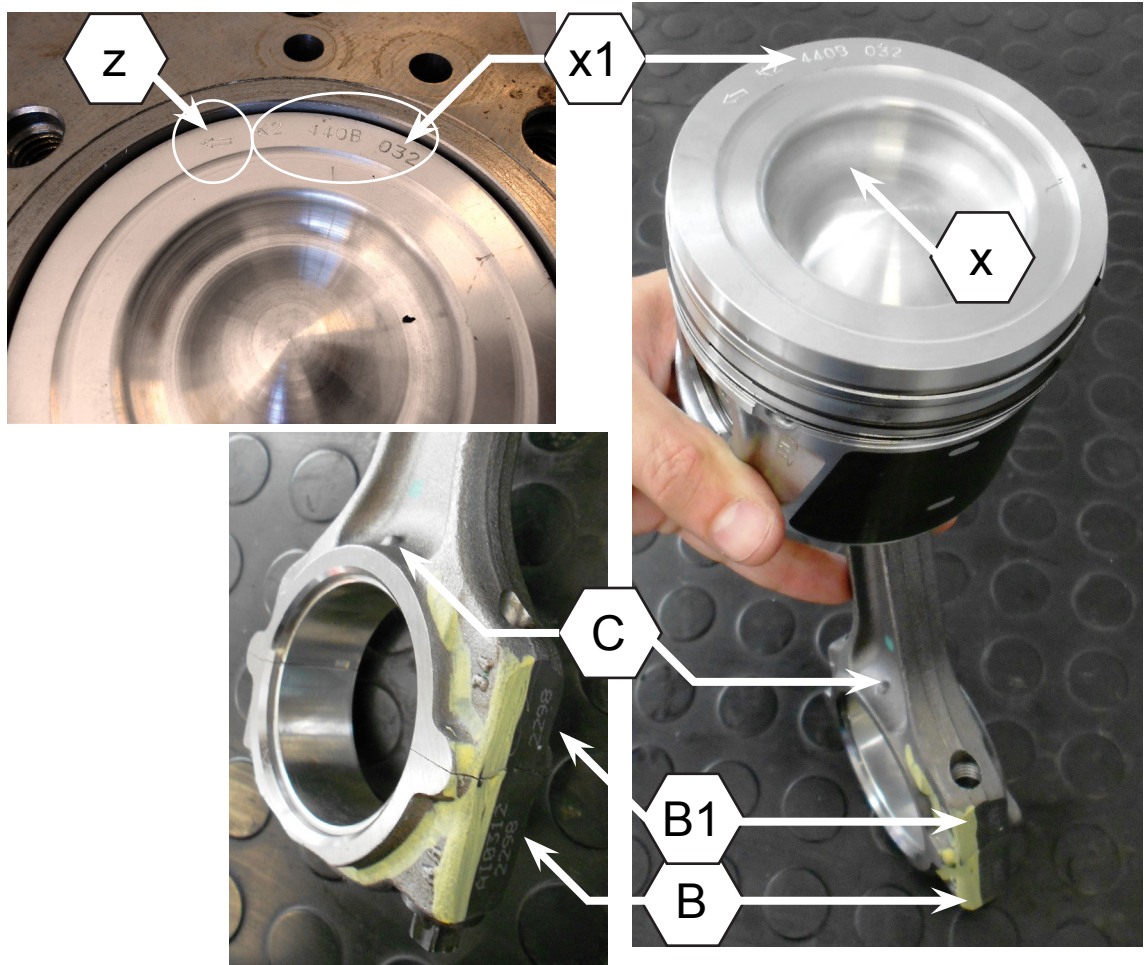
- X - combustion chamber
- X1 - piston identification
- B - connecting rod identification
- B1 - connecting rod identification
- C - nipple

Connecting rod identification example:
 " CA B2 "

- CA: supplier's initials
- B: con-rod big end diameter selection
- 2: weight selection

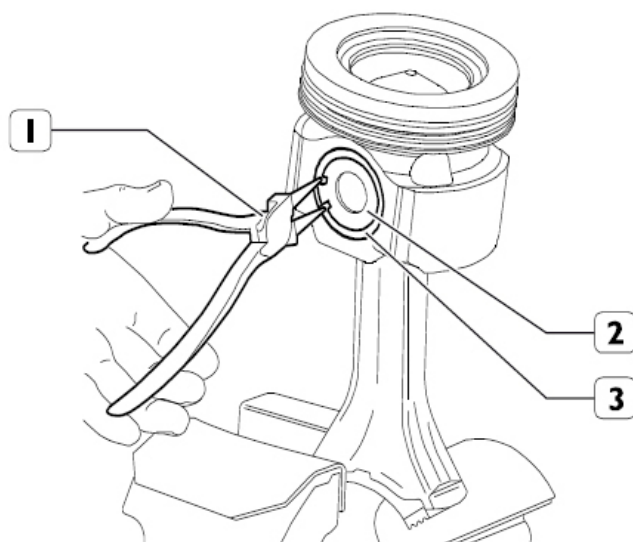
CONNECTING ROD IDENTIFICATION IN RELATION TO THE WEIGHT SELECTION

≥ 995.0 gr.	> 1009.9 gr.	> 1024.9 gr.	> 1039.9 gr.
↓	↓	↓	↓
≤ 1009.9 gr.	≤ 1024.9 gr.	≤ 1039.9 gr.	≤ 1055.0 gr.
1	2	3	4



PISTON GUDGEON PIN - ASSEMBLY

Install the gudgeon pin **2** and insert the circlip **3** using the pliers **3**.

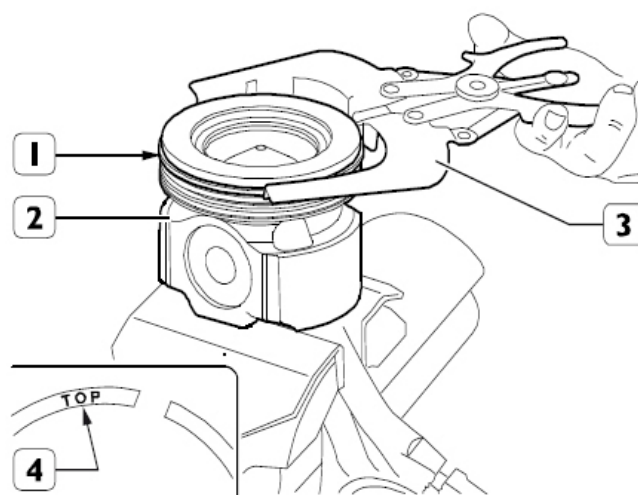


PISTON RINGS - ASSEMBLY

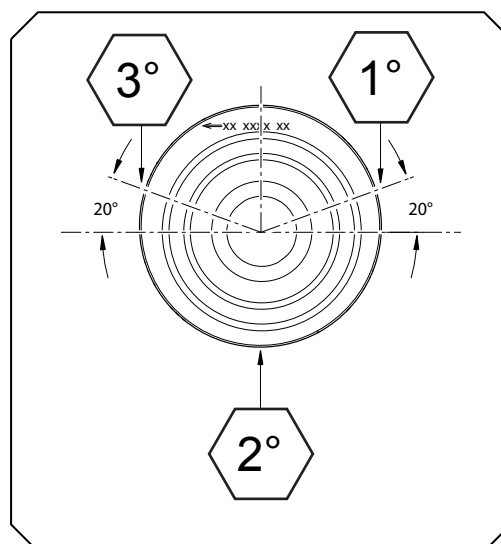
Use pliers **3** to install the rings **1** on the piston **2**.



NOTE: position the rings with the wording **TOP** (4) upwards. Aim the gaps of the rings as shown in the figure.



NOTE: aim the gaps of the rings as shown in the figure.

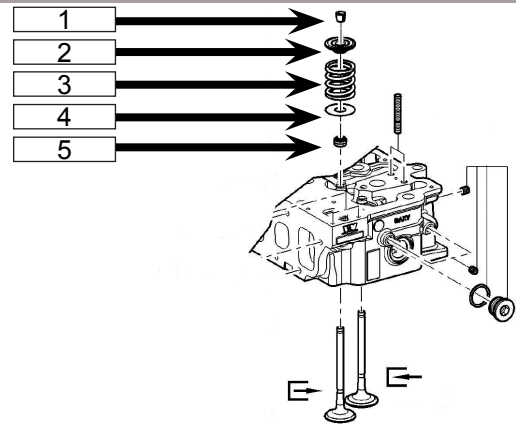


HEAD OVERHAUL

VALVE - DISASSEMBLY

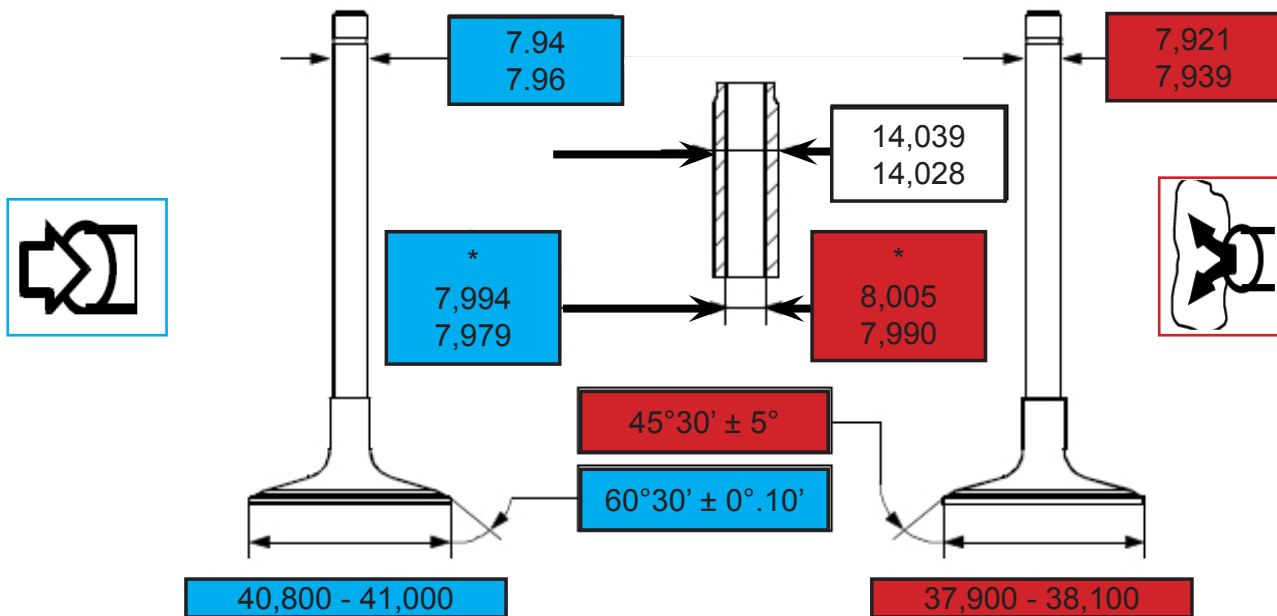
Use a tool commonly available on the market to remove valve springs **3**, plates **2-4**, valve cotters **1**, oil seal **5**.

Remove the valves from the heads and mark them in order to correctly refit them in their original positions.



VALVES - MEASUREMENTS

Remove the carbonaceous build-ups from the valves with an iron brush.



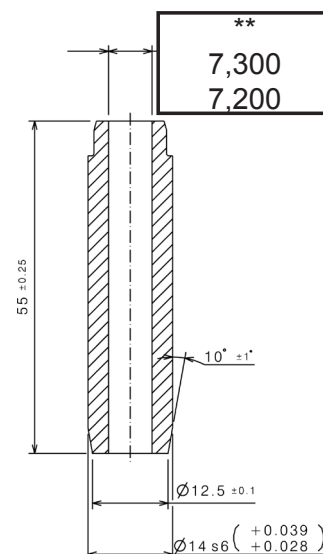
* Measurement obtained after installing the guide in the head.

** Measurement of free guide, not installed in the head.

Check that the valves do not show signs of seizing or cracks.

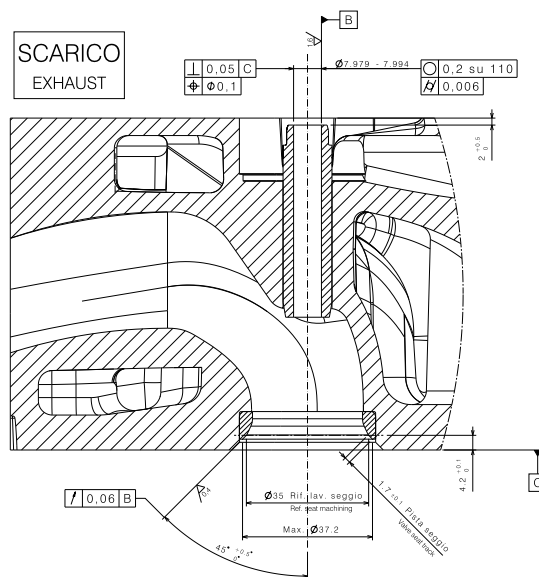
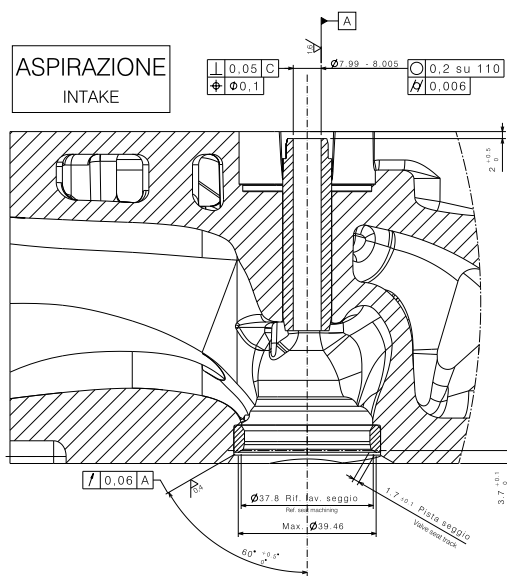
Check with a micrometer that the diameter of the valve stem falls within the specifications: replace the valves if this is not the case.

Grind the valve seats, if required, using a grinder and removing just enough material.



VALVE SEATS - GRINDING

The valve seats are ground any time that the valves or guides are ground and replaced.



When the valve seats are replaced/checked, refer to the technical data provided above.

Check the valve seats. If slight signs of burn or scratches are present, grind them with the specific tool according to the angles provided in the technical data, described above.

For the replacement of the valve seats, with the same tool and paying attention not to interact with heads, remove as much material as possible from the valve seats until they can be removed from the head with a drift.

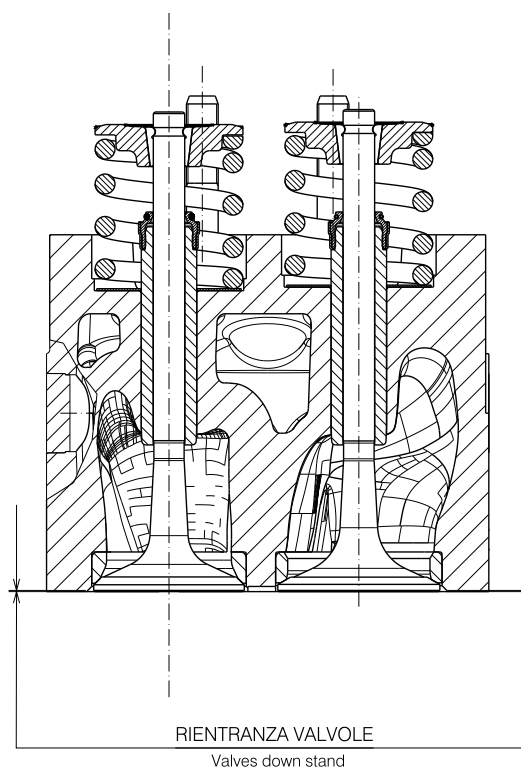
Install the housing after heating the head in an oven at 150°C or after cooling the housing at -170°C with nitrogen.

Grind the valve seats according to the angles provided in the technical data, described above.

head heating temperature (or cooling with nitrogen)	150 °C (- 170°C)
---	------------------

After boring the valve seats, use the specific tool and a dial indicator to make sure that the position of the valve, with respect to the head surface, is equal to the values specified below:

Valve indentation (service limit)	0 - 0.3 mm
-----------------------------------	------------



VALVE GUIDE - REPLACEMENT


NOTE: The heads are in aluminium: this material can deform or melt when improperly heated.

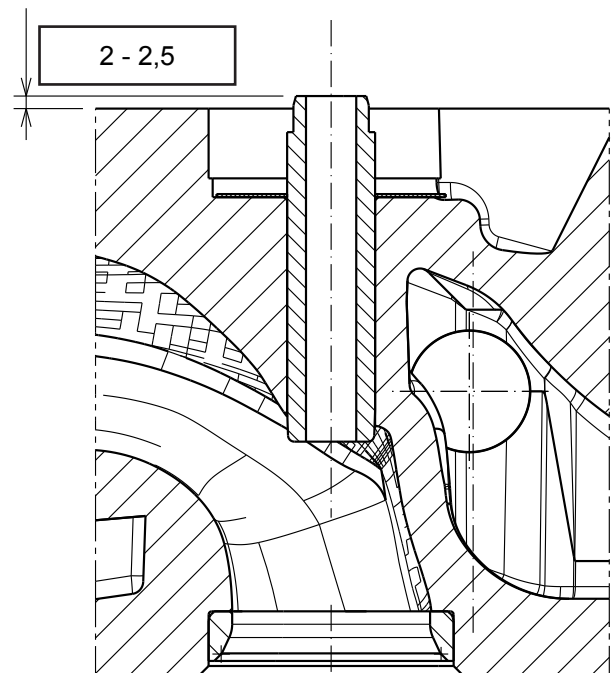
To heat an aluminium head during the replacement of a valve guide or of a valve housing, use an oven specifically designed for this purpose

1. Remove the oil seal.
2. Heat the head in an oven at 85 °C (185 °F).
3. Remove the old guide.
4. With the head at 85 °C (185 °F) press the new guide in the head in order to obtain the specified measurement.
5. After installing the valve guide, grind the bore with a polisher.

Indentation/projection of the guide compared to the head surface	2 - 2.5 mm
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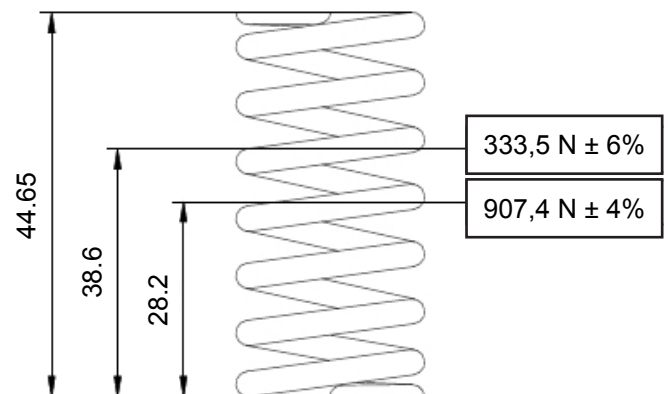
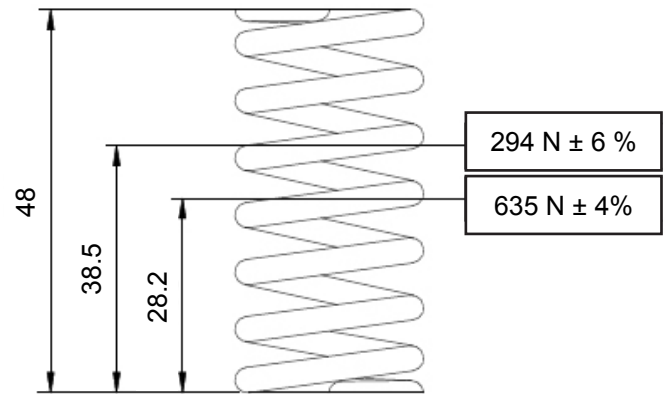
NOTE: If the valve guide has been removed, both valves and valve guides must be replaced as an assembly.



VALVE SPRINGS - MEASUREMENT

1. Check the springs for discolouring due to excessive heat.
2. Check the valve cotters, plates and springs for wear, alteration or cracks.
3. Measure the free height of each spring. Replace the spring if the measured values differ from those specified.
4. Measure the inclination (alteration). If the measured value exceeds the specified limit, the spring must be replaced.

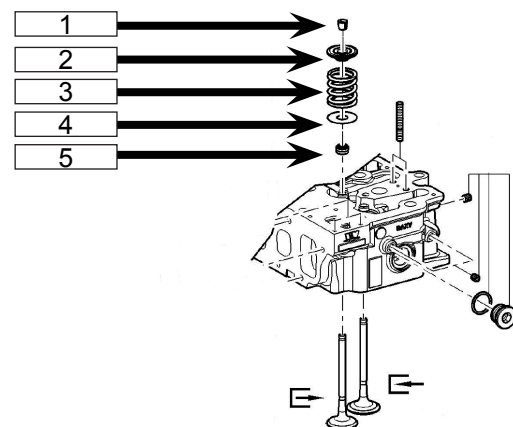
Inclination	Exhaust - Intake	Service limit 2 mm



VALVES - ASSEMBLY

Lubricate the valve stem and insert the valves in their guides; install the lower plate **4**.

Using a specific tool, install the oil seal **5** on the guide valve and then assemble the valves as follows. Install the springs **3** and upper plate **2**. Install a specific tool to fit the valves and pry on the springs to install the valve cotters **1**.



TIMING SYSTEM UNIT OVERHAUL

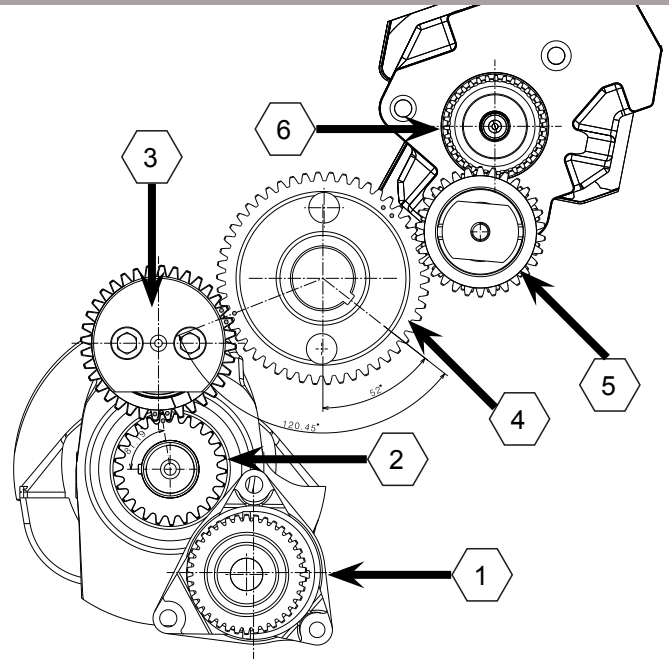
INTERMEDIATE GEAR - REPLACEMENT

Replace the bushing **6** if worn out.



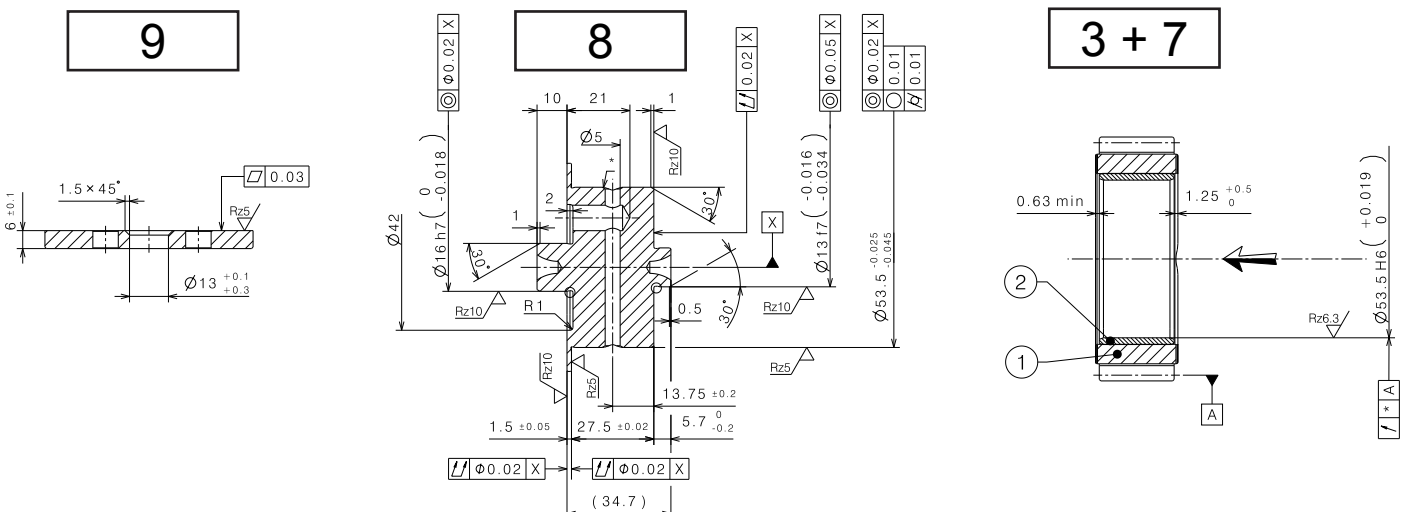
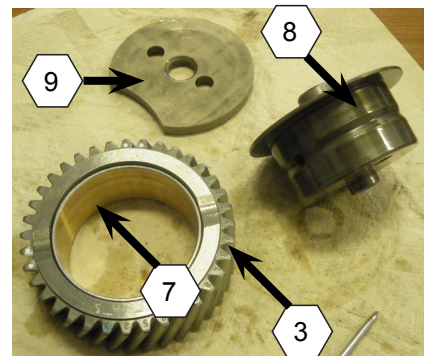
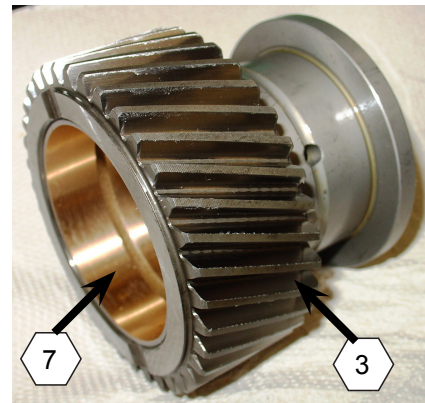
NOTE: gear and bushing are provided as an assembly.

- 1 - Oil pump
- 2 Crankshaft
- 3 Intermediate gear
- 4 Camshaft gear
- 5 Injection pump timing gear
- 6 Injection pump gear
- 7 Intermediate gear bushing
- 8 Support pin
- 9 Shim



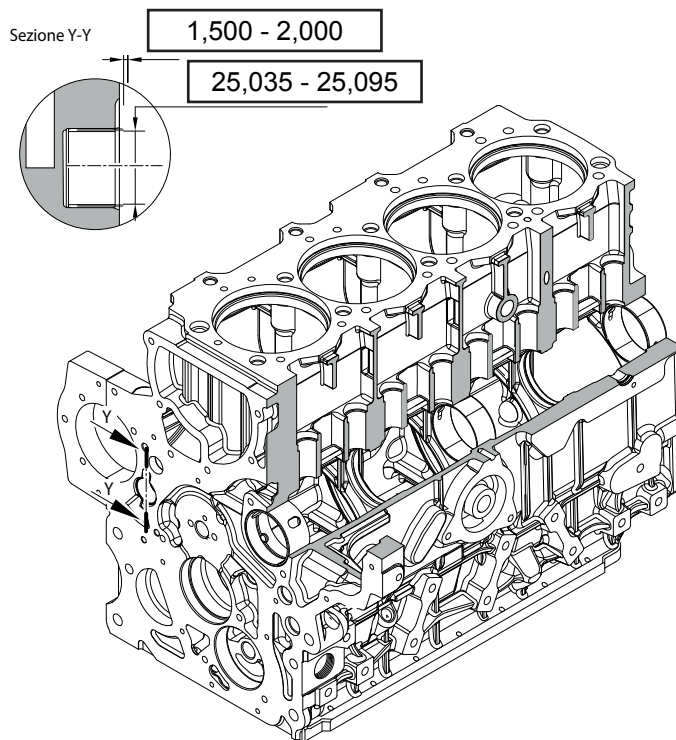
Check that the inner diameter of the bushing / support pin are equal to the indicated technical data.

Pin inner diameter	53,445 - 53,475 mm
Inner diameter of the bushing installed in the gear	53,500 - 53,519 mm
Clearance upon assembly	0,025 - 0,074 mm
Wear limit	0.2 mm



POWER TAKE OFF TRANSMISSION GEAR PIN BUSHING - REPLACEMENT

Fit the bushing with Loctite 601.
 Check the diameter of the bushing installed in the crankcase.
 Check the indentation of the projection compared to the crankcase surface.

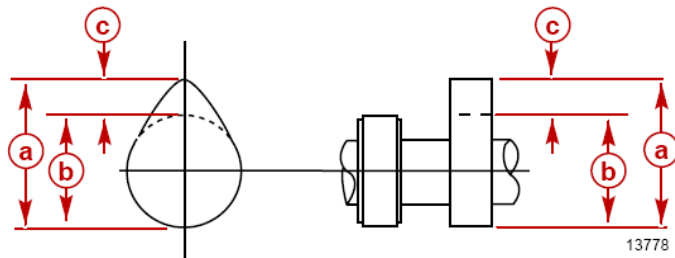


CAMSHAFT - MEASUREMENTS

Measure the height of the lobe **A** with a micrometer.
 Subtract the measure of the diameter of the lobe **B**.
 The difference is the rise of the lobe **C**. If the rise of the lobe is less than the value specified below, the camshaft must be replaced.

Lobe C rise	
Exhaust	7,303 mm
Intake	6,850 mm
Wear limit	0,050 mm

Lobe B diameter	
Exhaust	38.550 - 38.650 mm
Intake	39.450 - 39.550 mm
Wear limit	0,050 mm

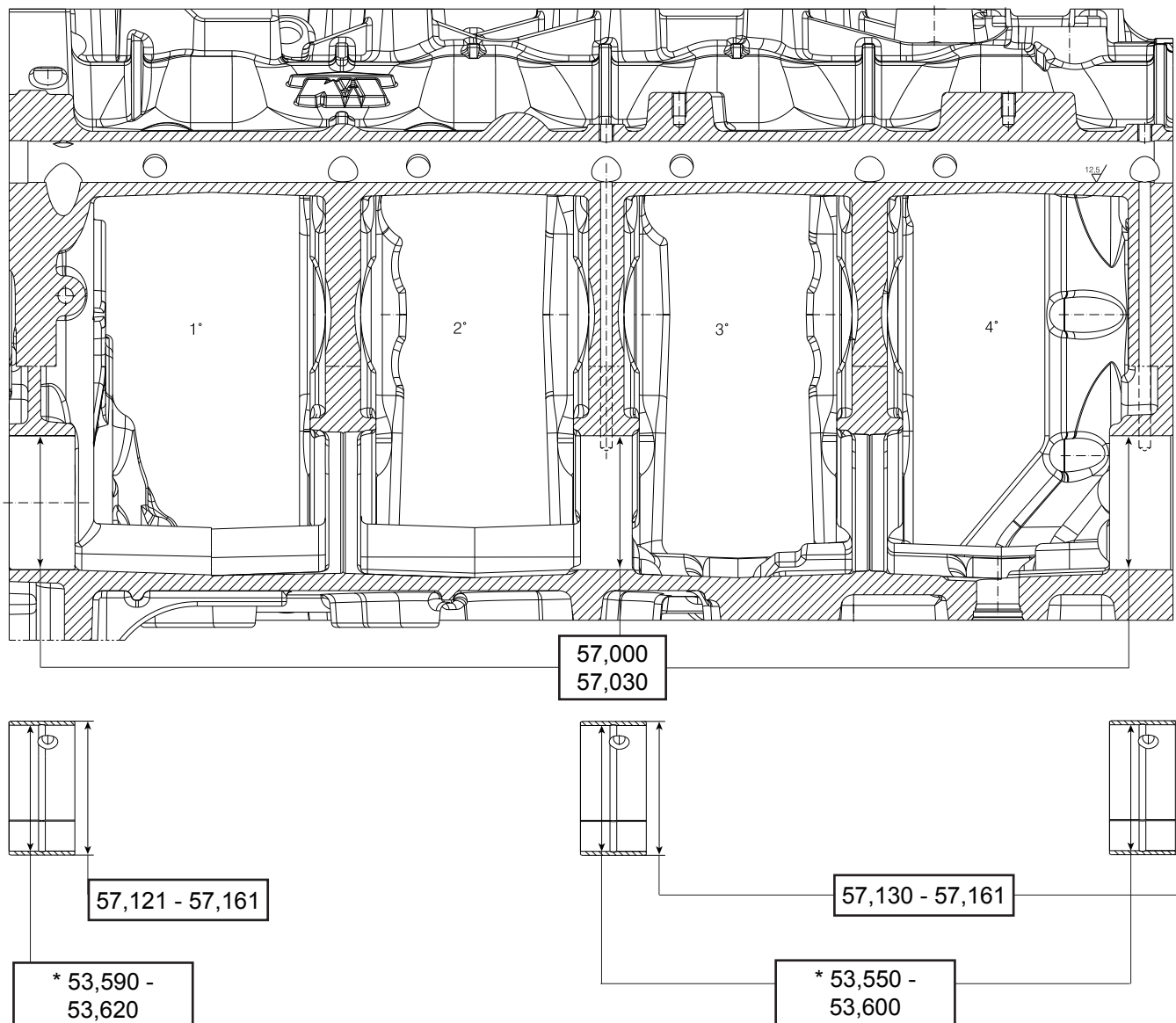


13778

Measure the inner diameter of the camshaft plain bearings installed in the crankcase and journals, in order to determine the clearance.



NOTES: 0.250 mm plain bearings are available as first selection of decreased size plain bearings.



* Inner diameter of the bushing installed in the crankcase.

CAMSHAFT AND CRANKSHAFT PLAIN BEARINGS - DISASSEMBLY

Install a new bushing **D** on the special tool **C**.
Align the oil passage hole in the crankcase **A** with the
bushing lubrication hole **B**.

Smear **Loctite 601 (E)** on the external surface of the
bushing.

Tighten the screw nut of the special tool until the old
bushing in the crankcase comes out of the crankcase.



IMPORTANT: when replacing the camshaft
front bushing and/or the crankshaft front bushing,
it must be bored after it is installed in its seat in the
crankcase.

Install the bushing aligning the lubrication hole
for the passage of the engine oil present on the
crankcase with the hole present in the bushing.

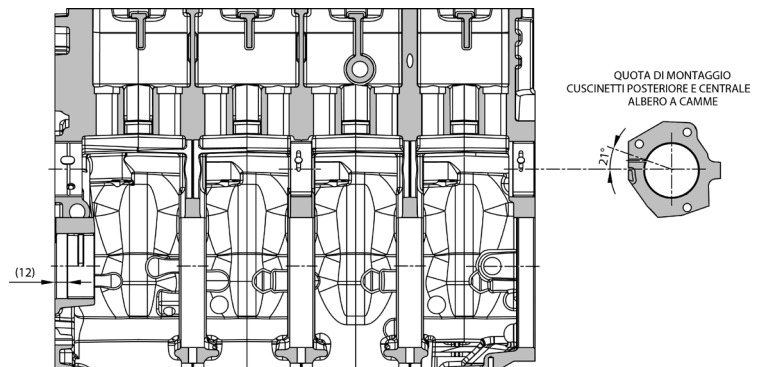
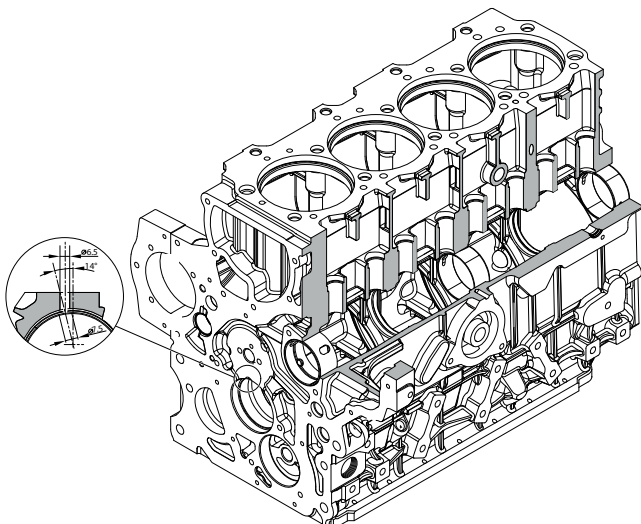
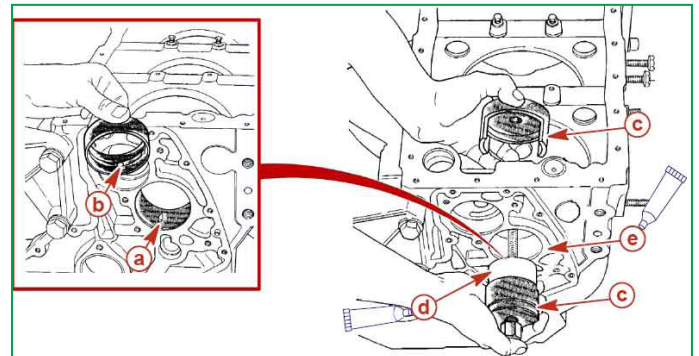
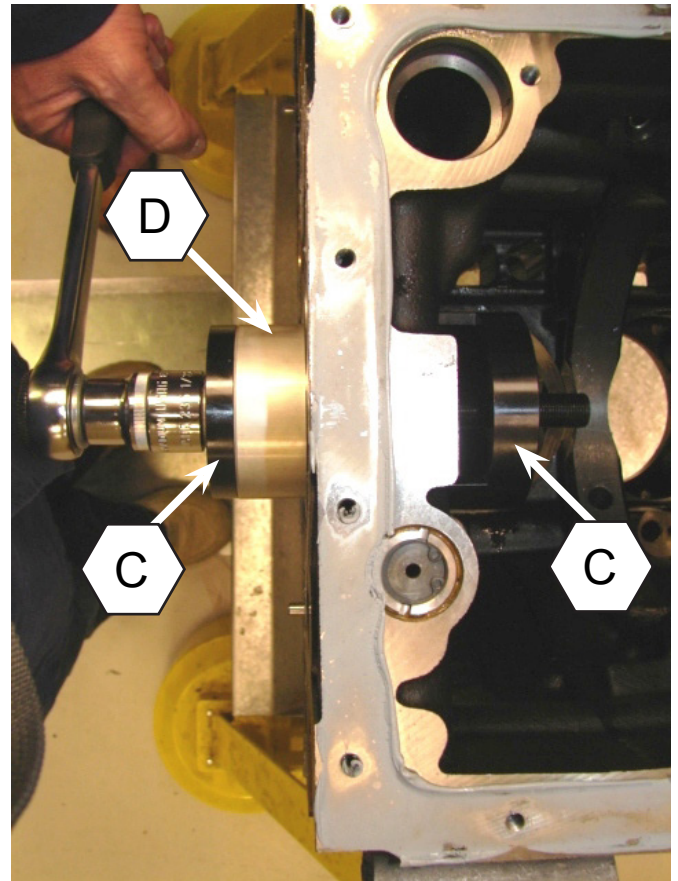


IMPORTANT: install the crankshaft front bushing
so that it is dented with respect to the crankcase
surface of the indicated value, aligning the $\varnothing 7.5$ mm
hole of the bushing with the $\varnothing 6.5$ mm hole on the
crankcase.

Indentation	12 mm
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The alignment angle between the lubrication hole for
the passage of the engine oil in the central and rear
bushing of the camshaft is 21° .

Angle	21 degrees
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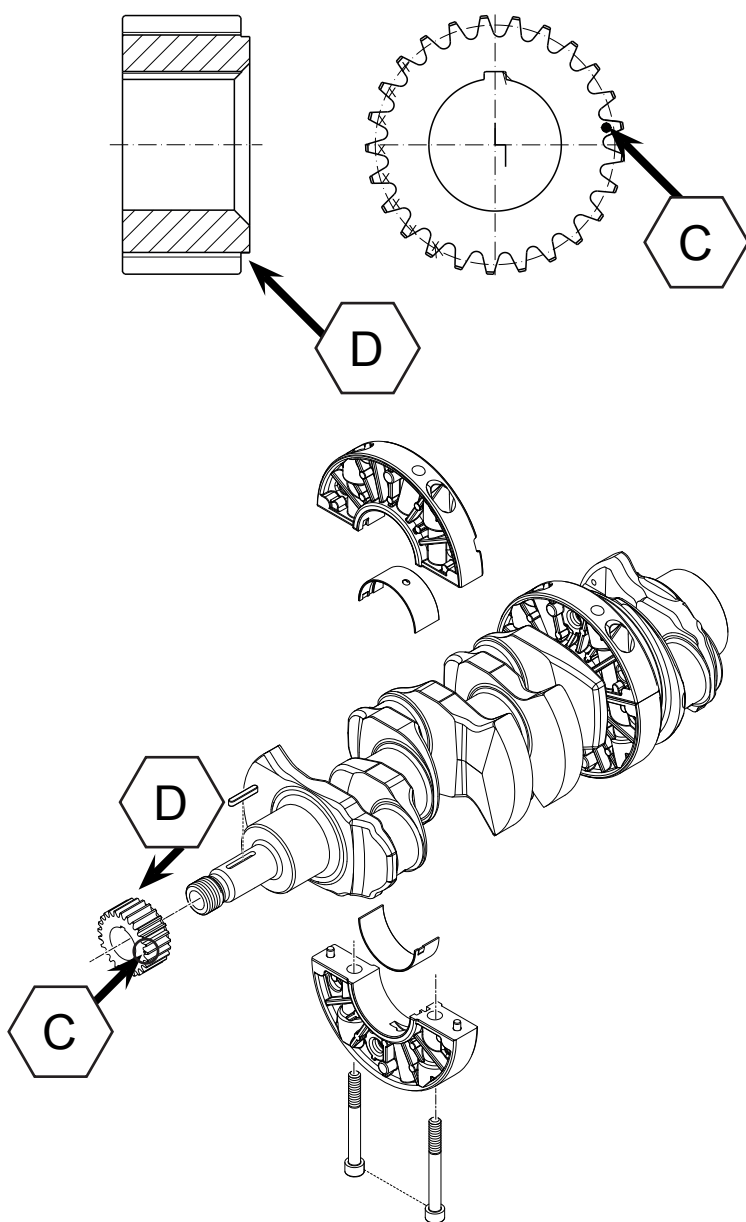
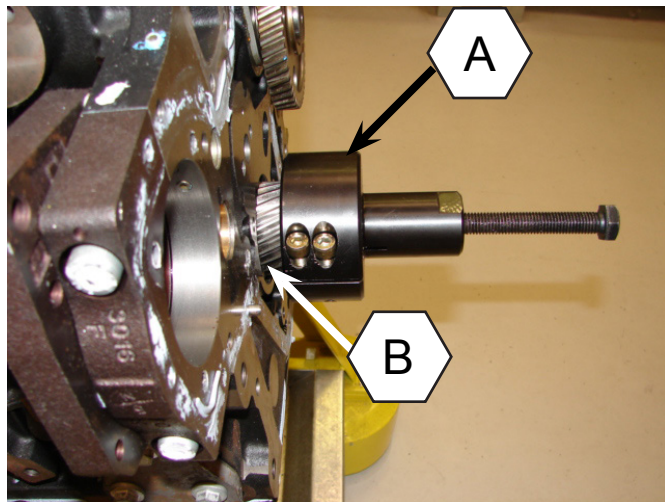
CRANKSHAFT GEAR - REPLACEMENT

Install puller **A** in gear **B** as shown in the picture.
Firmly tighten the screws of the puller.
Tighten the puller pin and extract the gear.



NOTES: Before inserting the crankshaft gear on the shaft, heat the gear at 70°C and insert it until fully home against the shaft holding it in position for at least 10 seconds.

Insert the gear with timing mark **C** facing outwards, while the side with the chamfer **D** (exhaust side) must face the crankshaft.



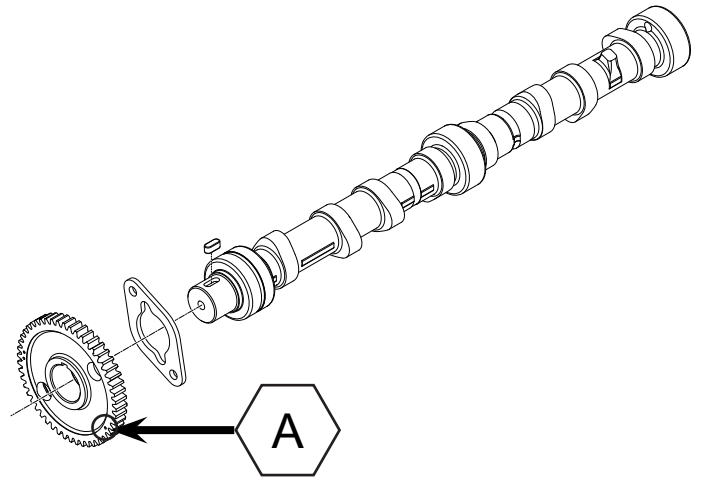
CAMSHAFT GEAR - REPLACEMENT



IMPORTANT: The camshaft gear is pressed on the shaft. Install the flange and key, press the gear so that it rests against the flange shoulder.

If gear replacement is required, it must be heated in the oven at a temperature of **200 °C (360-390 °F) for 10 minutes** and pressed against the shaft.

Insert the gear with the timing mark **A** facing outwards.



ROCKER ARMS - MEASUREMENTS

Visually inspect each rod for wear and residues. Check that the oil passage in the rods is not hindered or restricted.

Roll each rod on a flat surface and check if they are bent. Replace all damaged parts.

Use a micrometer to measure the outer diameter of the rocker arm pins.

Use a micrometer to measure the inner diameter of the rocker arm bushing.

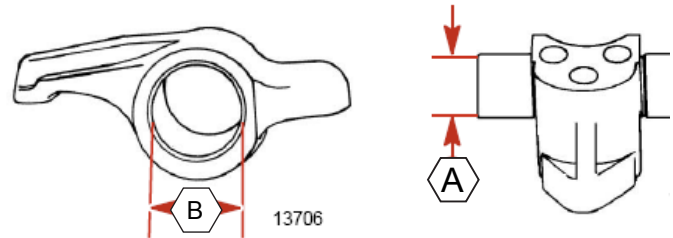
Replace the rocker arm if worn status is out of specified limits.

Rocker arm support outer diameter (A)	21,979 - 22 mm
--	-----------------------

Inner diameter with bushing installed (nominal) (B)	22.03 - 22.05 mm
--	-------------------------

Clearance upon assembly	0.030 - 0.071 mm
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Wear limit	
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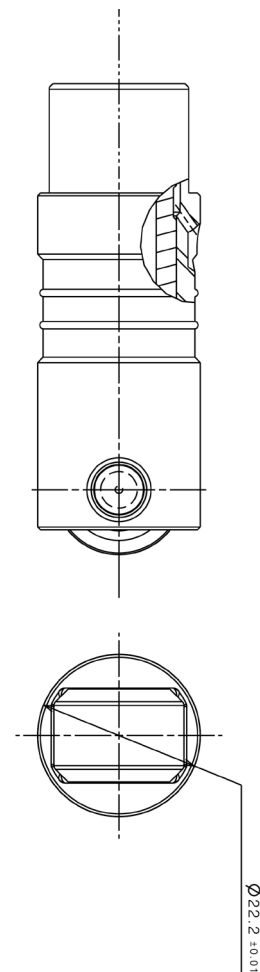


HYDRAULIC TAPPETS - MEASUREMENTS

1. Check the surface where the rod is housed **A**. If the seat is worn out, check also the rods. Check that the seat does not show signs of seizing or dents.
2. Check the outer surface of the tappet. If worn out or scratched, check the holes in the crankcase, where the seat is housed.
3. Check the tappet rollers. If the roller is worn out or scratched, check also the camshaft lobes.
4. Measure the outer diameter of the tappet **B**. If the value is lower than what specified replace the tappet.

Outer diameter	22.19 - 22.21 mm
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5. Check all parts thoroughly. If any part is damaged or worn out, it is necessary to replace the whole tappet.



ENGINE ASSEMBLY

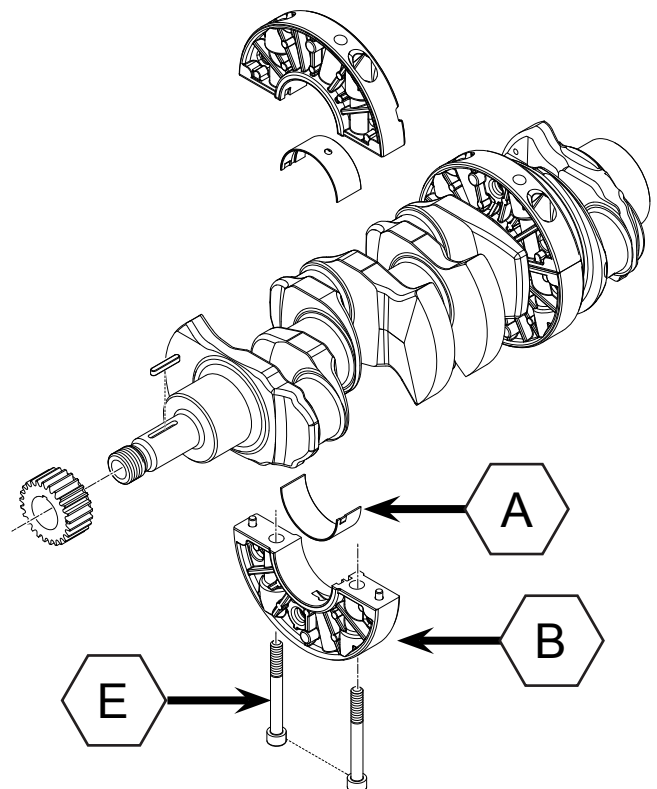
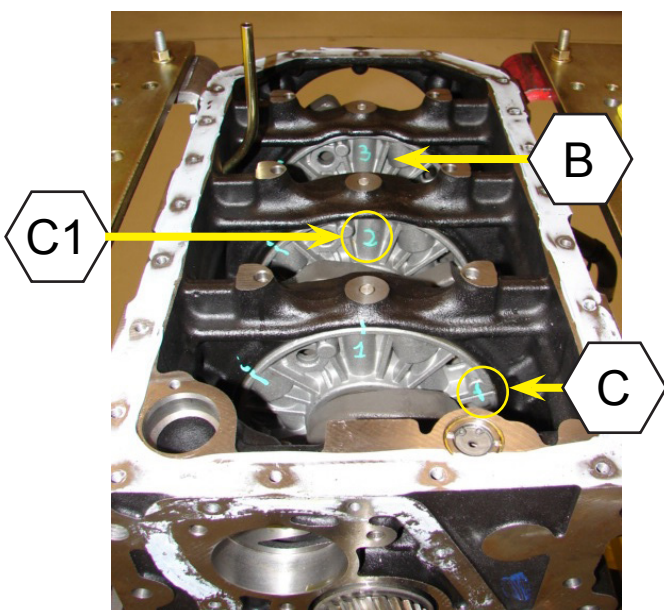
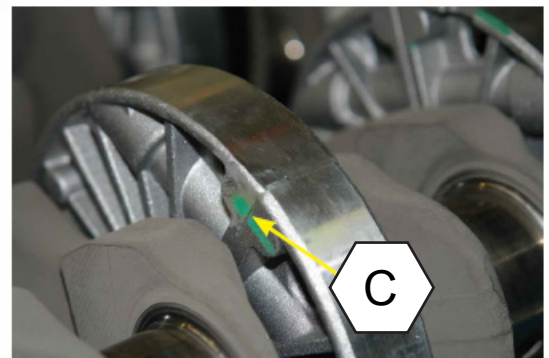
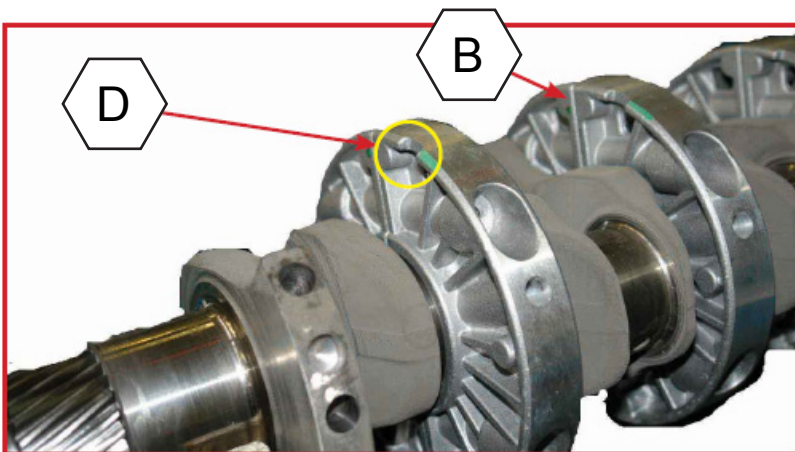
MAIN BEARINGS

Smear the bushings and main journals of the crankshaft with oil. After installing the bushings **A** in the relevant central bearings **B**, proceed with their installation in the main journals: install the bearings in their original position following the marking **C** and **C1** carried out during the disassembly procedure.

Make sure that the front part **D** of all central bearings is aimed towards the timing system.

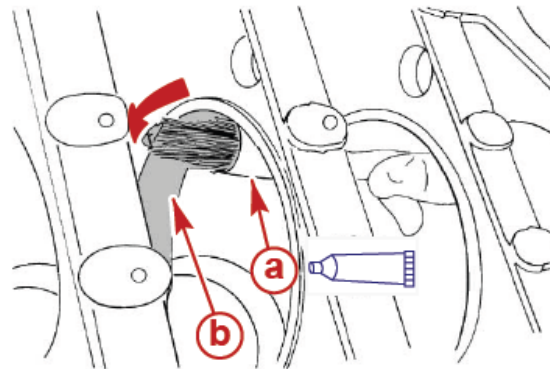
Lubricate the thread and underhead of the screw **E** with MOLYguard LMP 180 grease and tighten them.

central main bearing screw	44.1 Nm
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CRANKSHAFT

Lubricate/grease with grease **A** the seats of the bearings in the crankcase **B** and the outer surfaces of the central bearings.

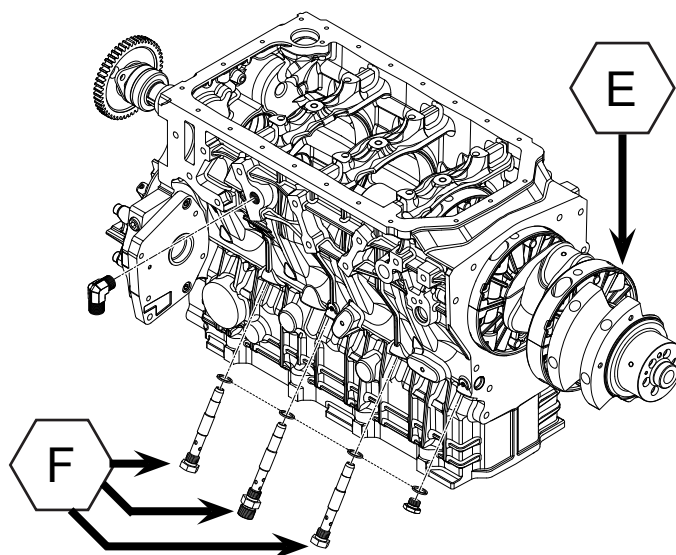
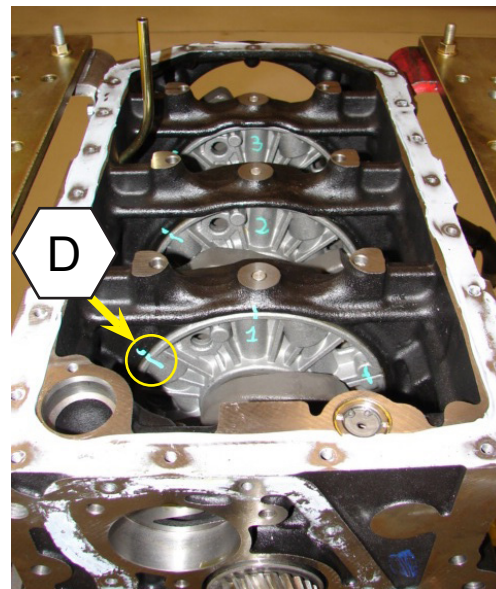
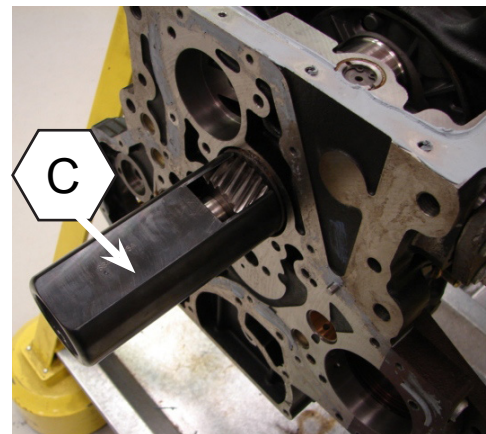


Install the special tool **C** on the gear of the crankshaft to avoid damaging the crankshaft front plain bearing. Fit the crankshaft with the central bearings **E** in the crankshaft tunnel with care.

After fitting the shaft in the tunnel check the alignment of the bearings **E** with the crankcase, following the reference marking **D** made during the disassembly procedure: this will make union **F** alignment/insertion easier.

Once the shaft is in its seat in the crankcase screw the unions by hand.

Tighten the unions.



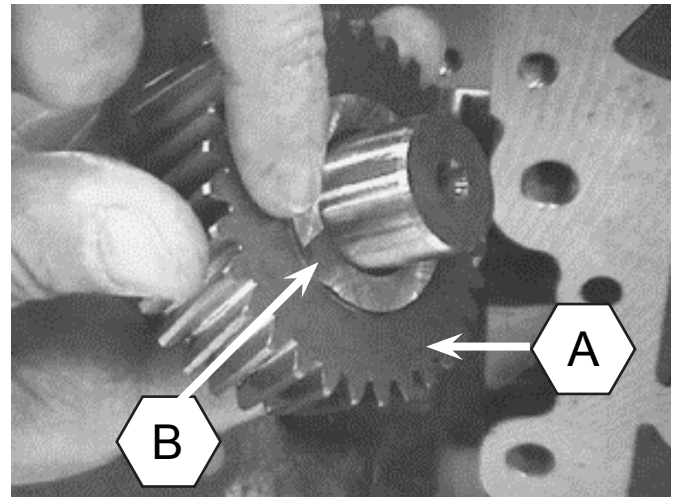
Unions	44.1 Nm
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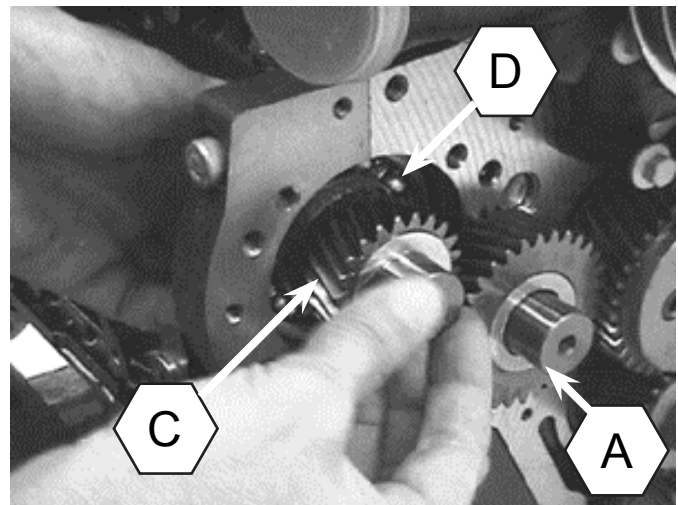
IMPORTANT: after installing the unions check that the crankshaft can slide smoothly.

POWER TAKE OFF GEARS

Smear with oil the gear transmission pin **A** of the power take off transmission.
Check that the grooves **B** are facing the crankcase.



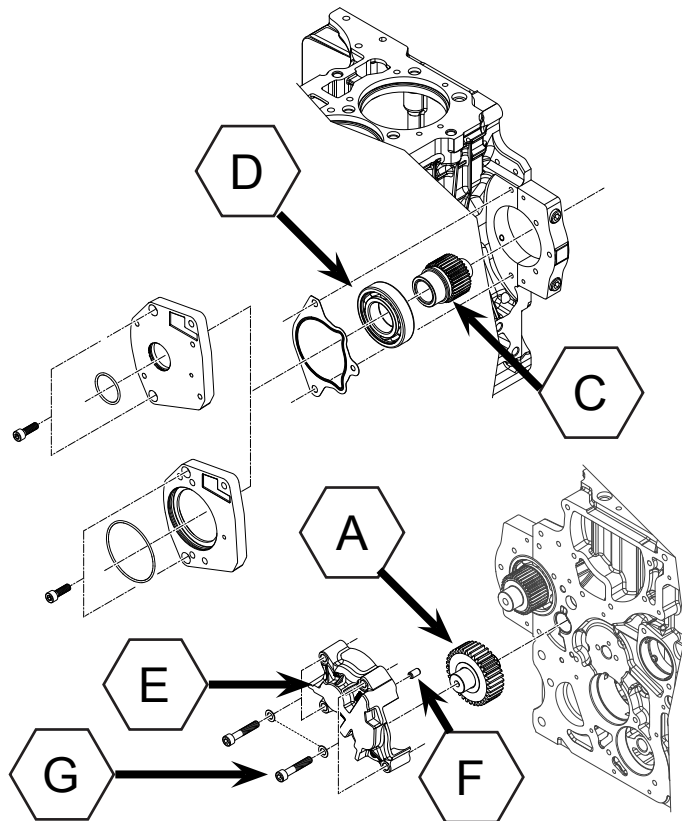
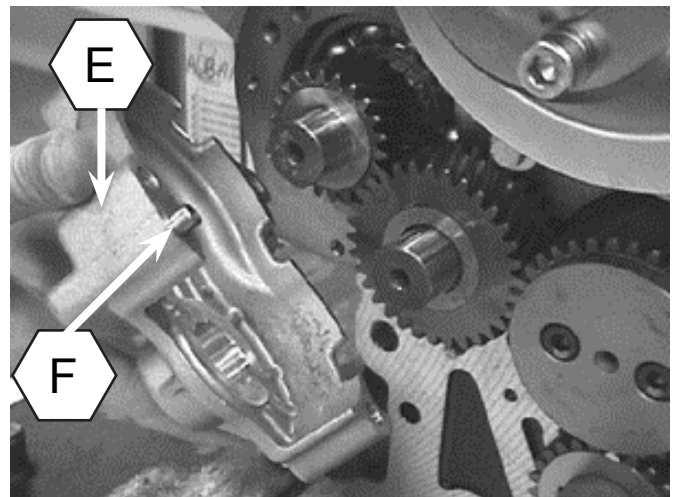
Smear the external surface of the ball bearing with oil.
Install the whole power take off control gear unit (gear **C** + ball bearing **D**) in the crankcase.



Install the cover **E** aligning the pins **F** with the holes of the crankcase.

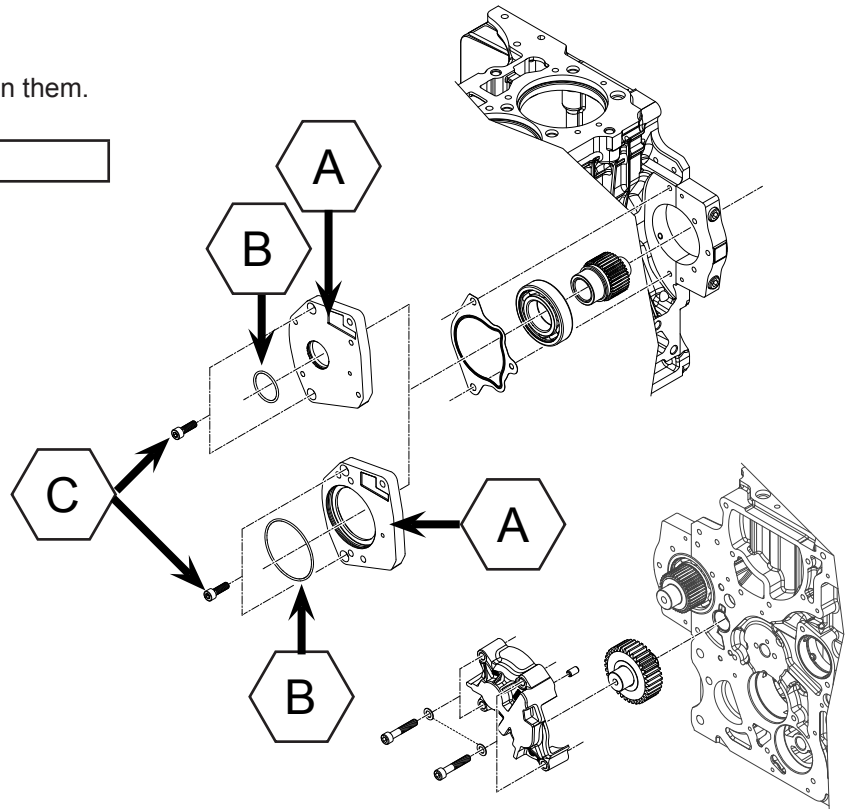
Smear Loctite 572 on the threads of the screws **G** and tighten them.

Cover fastening screw	24.5 Nm
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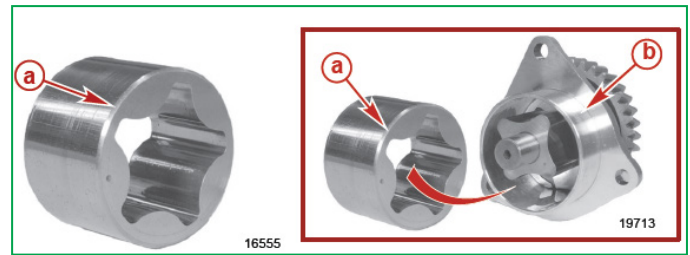
Install the O-rings **B** on the flange **A**
Install the rear flange **A**
Smear Loctite 572 on the screws **C** and tighten them.

rear flange screws	26 Nm
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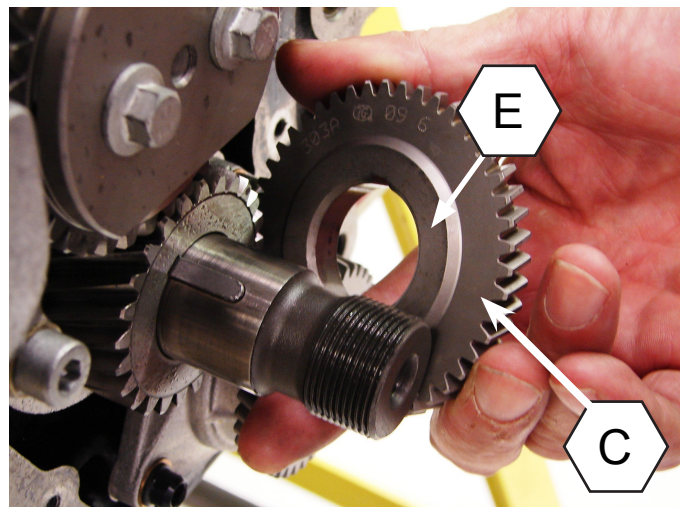
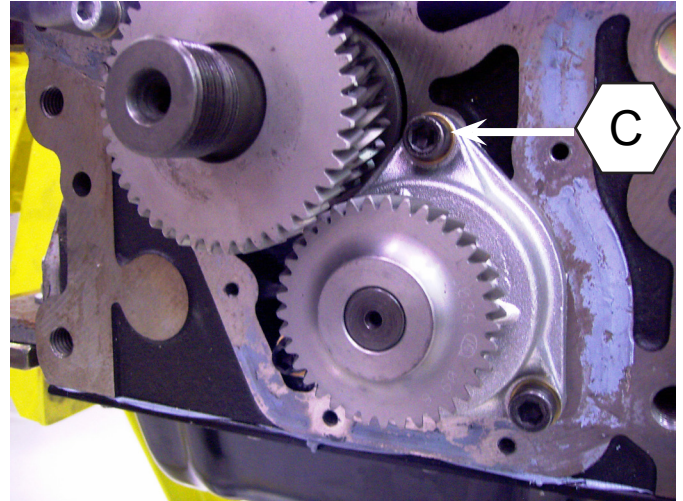
OIL PUMP

- Lubricate the body and inner and outer rotor with engine oil.
- Install the outer rotor with the chamfer **A** towards the body seat **B**.
- Install the pump in the crankcase with the 3 screws and washers.
- Tighten the screws **C** following a cross pattern.
-



Oil pump screws	27.5 Nm
-----------------	---------

-
- Install the gear that controls the oil pump **D** aligning its key seat with the crankshaft key and make sure that the side **E** with the flange is facing the crankshaft gear. The flat surface must be aimed towards the outside of the engine.
- Check that the oil pump gear is not locked making sure that there is clearance between the crankshaft gear teeth and the oil pump gear. Check again the installation looking for clearance between the gears.



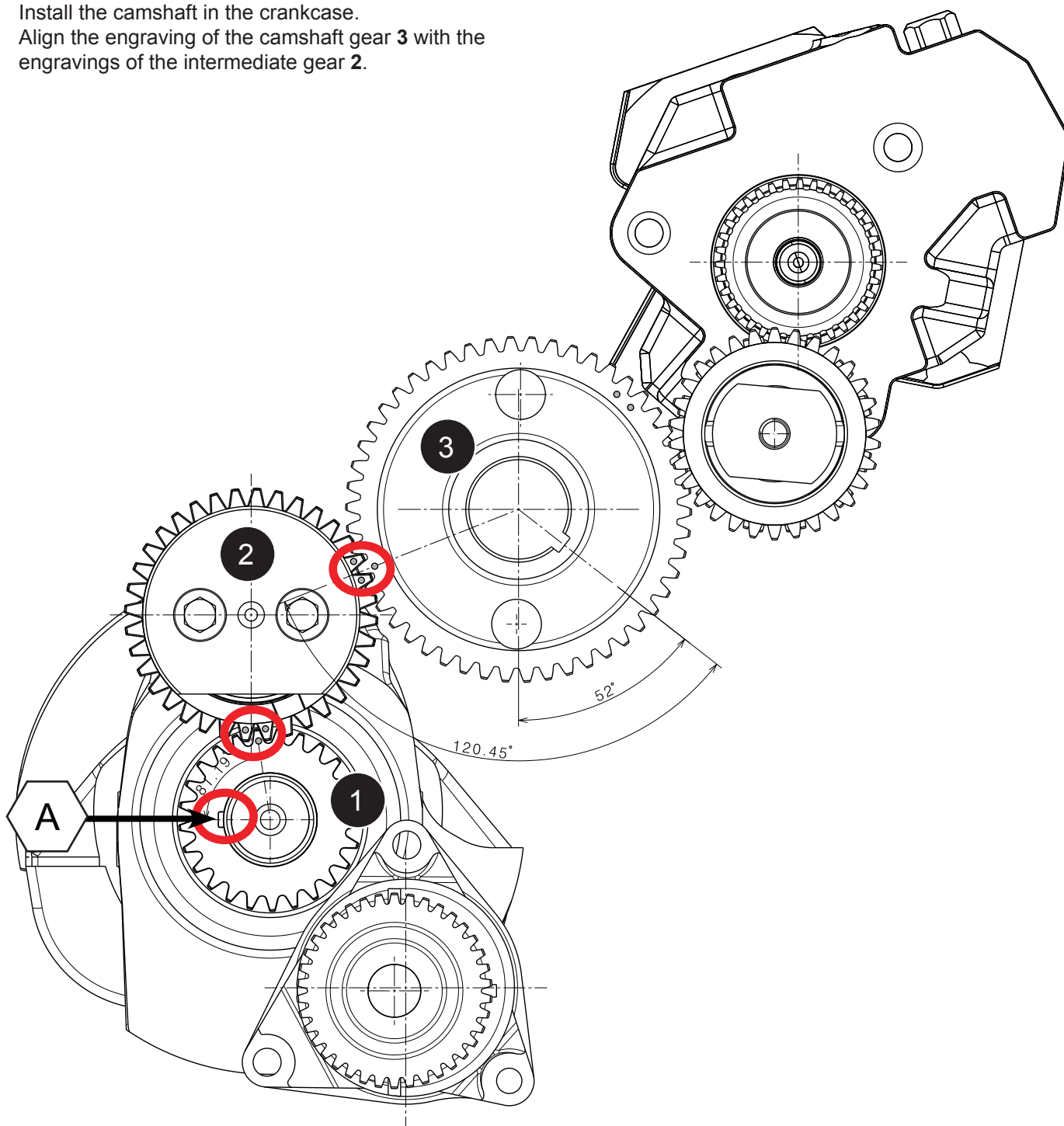
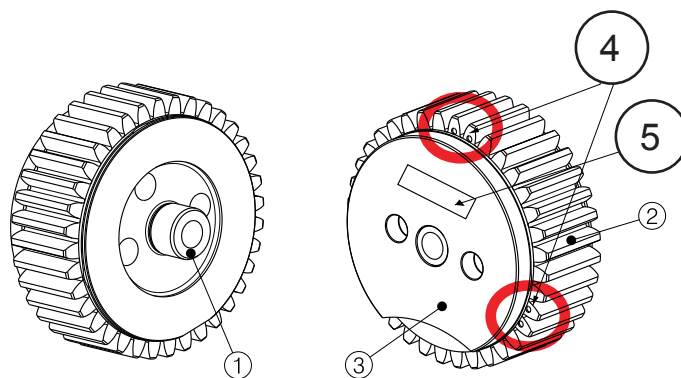
TIMING SYSTEM GEAR TIMING

Assemble the gear 2 complete with bushing on the pin 1 aiming the timing engravings 4 towards the shim 3: the marking area 5 (manufacturing date identification, supplier and VM code) must be visible on the outside. Position the crankshaft so that the key A is at "9" o'clock.

Install the gear 2 aligning its engravings with the one present on the crankshaft gear 1.
Tighten the fastening screws.

Transmission gear fastening screws	32.4 Nm
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Install the camshaft in the crankcase.
Align the engraving of the camshaft gear 3 with the engravings of the intermediate gear 2.

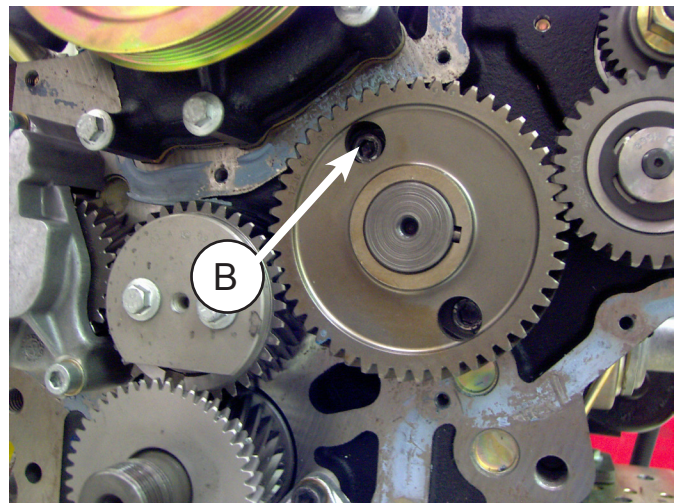
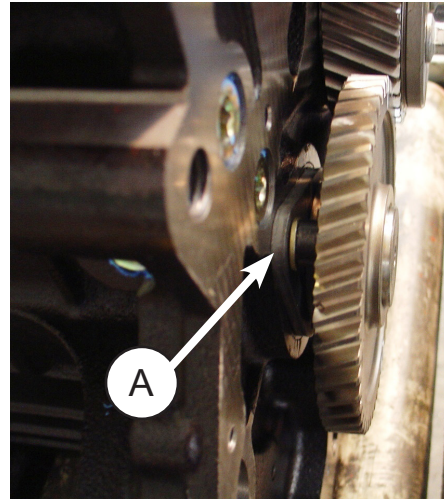


Align the holes of the flange **A** with the fastening holes in the crankcase.

Screw the screws **B** and tighten them.

fastening screws

27.5 Nm



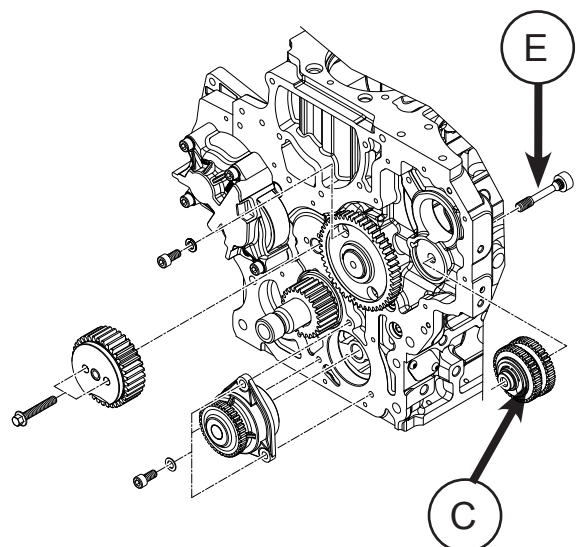
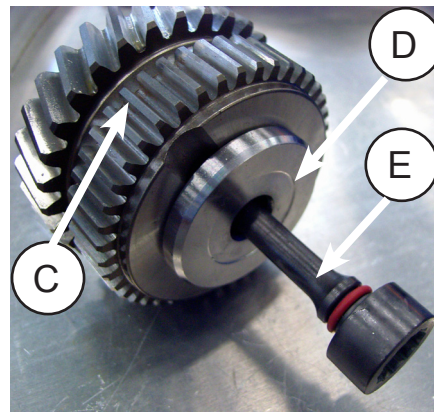
Install the camshaft transmission gear - high pressure pump. Check the smoothness of the gears **C** on the pin **D** before the installation.



IMPORTANT: the transmission gear must **NOT** be timed.

Tighten the screw **E** with a new O-ring, grease it with **Molykote 111**, and tighten the screw as follows:

1st Stage - tightening	35 Nm
Loosen the screw by an angle within	$30^\circ \div 90^\circ$
2nd Stage - re-tightening	35 Nm



PISTONS

Smear the inner surface of the liner with oil.
Smear pistons, rings, crank journals, con-rod bearings with oil.

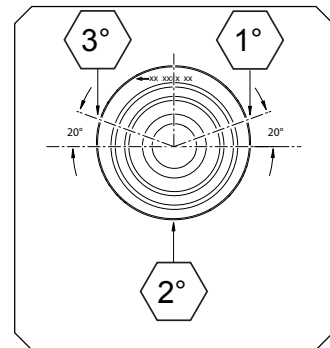
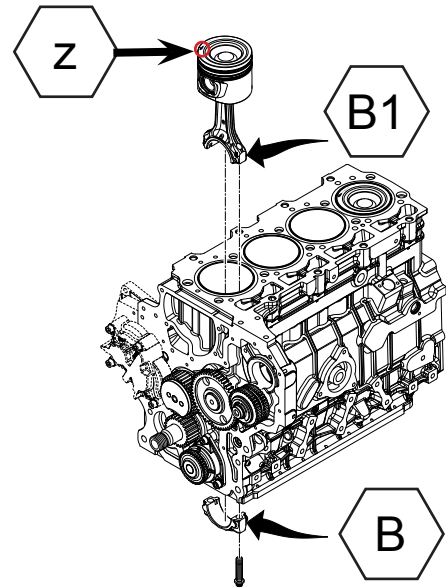
Fit the pistons with connecting rods having the same weight class **B** - **B1** stamped on the side opposite to the combustion chamber **X**.

Install the connecting rod half bearing making reference to the diameter class of the connecting rod big end seat - bearing thickness (see table below).

Install the pistons complete with connecting rods making sure that the arrow **Z** marked on the piston is facing towards the timing system.

Install the pistons aiming the rings as shown in the figure.

Diameter class of the connecting rod big end seat	diameter mm	colour bearing / Q.ty	bearing thickness mm
A	57.563	red / 2	1,795
	57.568		1,790
B	57.568	red / 2	1,795
	57.573		1,790
C	57.573	blue / 2	1,800
	57.578		1,795
D	57.578	blue / 2	1,800
	57.583		1,795



Connecting rod identification

example:

“ CA B2 “

CA: supplier's initials

B: con-rod big end diameter selection

2: weight selection



CONNECTING RODS

Install the cap and start the connecting rod screws by hand, then tighten them as specified below:

1st step	10 Nm
2nd step	30 Nm
Final step (angle)	+ 40°

Check with a torque wrench set to the value indicated in the table below. Do not apply further torque during this check stage.

Check con-rod screw tightening	88 Nm
---------------------------------------	-------

Make sure that there is a side clearance between the connecting rod assembly and the crank journals.



IMPORTANT: the new connecting rod screws do not require lubrication as a anti-seize treatment is applied by the manufacturer.

Usually screws are replaced: if the thread of the screw is not elongated and the head and underhead do not show signs of damage the screws can be reused. If they are reused lubricate the threading and underhead of the screw with engine oil.

HYDRAULIC TAPPETS



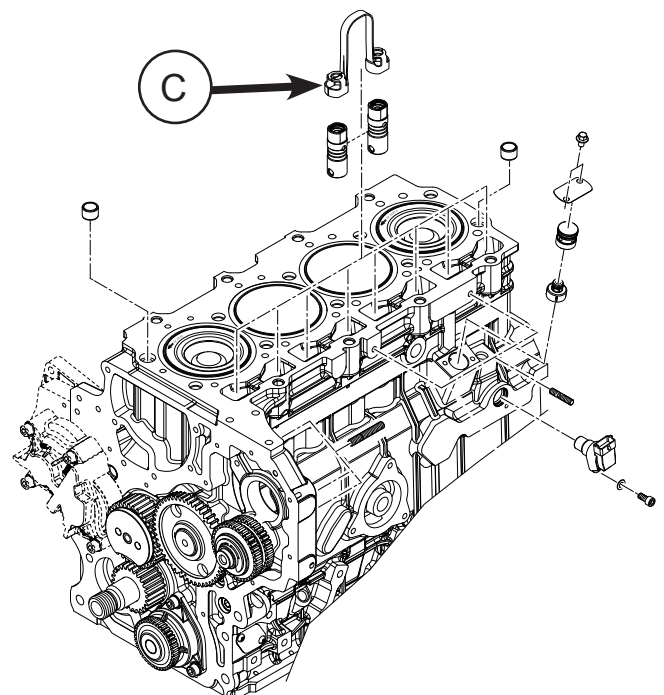
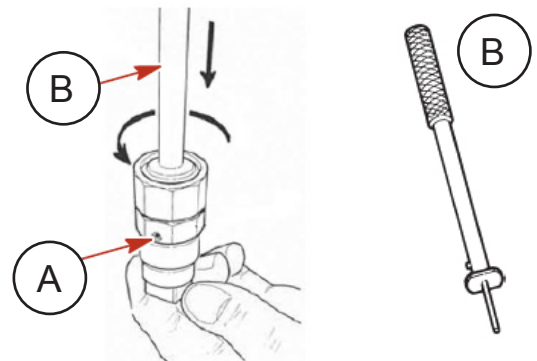
IMPORTANT: Before assembling the tappets, drain the residual oil: use the special tool B, compress the tappet letting the oil come out from the drain hole A.

Smear the tappets and lobes of the camshaft with oil before installing them.

By means of the special tool install the tappets in their seats in the crankcase.

Check that the oil drain hole of the tappet is facing towards the crankshaft.

Install the anti-rotation brackets C and check that they engage correctly preventing tappet rotation.

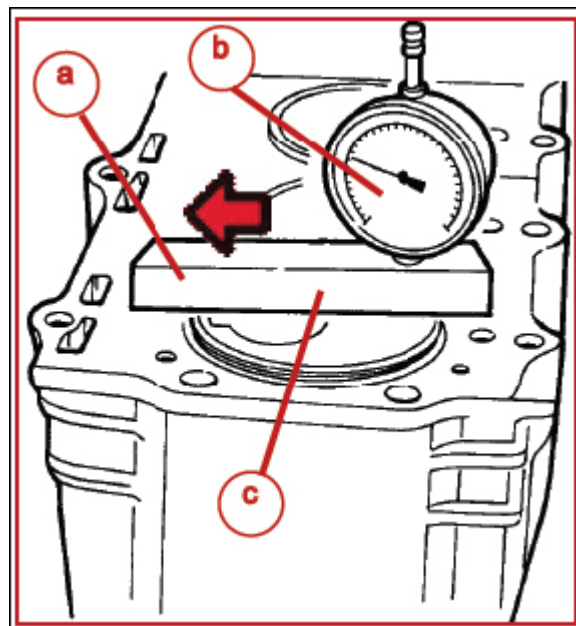


CLEARANCE SPACE

Refer to the following procedure during engine reassembly or when pistons and liners have been removed.

1. Use a dial indicator and a Support Bar (special tool) (refer to Special tools) to measure the projection of the piston at TDC with respect to the crankcase surface.
2. Position the bar with the dial indicator on the surface of the crankcase and set the indicator to zero (0).
3. Move the bar towards the piston that is at TDC, as shown in the figure. Record the measurement.
4. Repeat the same operation to measure the projection of the remaining pistons. Use the average value of the measured values to determine the thickness of the head gasket required for all cylinders.

Piston projection - AVERAGE	Required gasket thickness
0.60 - 0.72 mm	1.42 mm
0.73 - 0.82 mm	1.52 mm
0.83 - 0.95 mm	1.62 mm

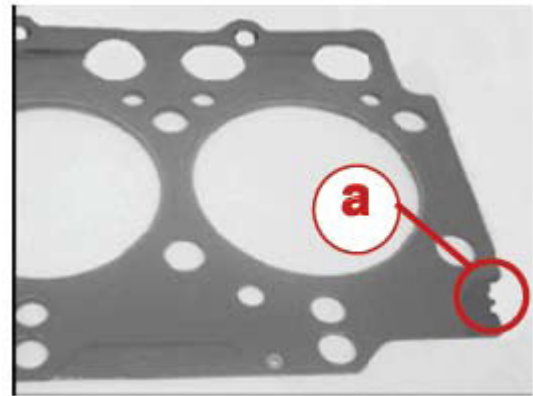


HEAD GASKET

After determining the clearance space, identify and select the specific gasket in terms of thickness.

Note the identification signs (notches or holes) in the gasket angle, as shown in the figure.

No sign indicates a thickness of	1.42 mm
2 signs indicate a thickness of	1.52 mm
1 sign indicates a thickness of	1.62 mm



HEAD

IMPORTANT: Use always new bolts when the existing ones are removed. The new screw must not be lubricated as they already come lubricated with an anti-seize lubricant supplied by the manufacturer.

IMPORTANT: VM Motori does not recommend to reuse the screws: in case of reuse, lubricate the thread and underhead of all M12 screws (12 mm) (side screws) and M14 screws (14 mm) (central screws) with Molykote G Rapid Plus grease.

IMPORTANT: Do not use any type of sealant or adhesive on the head gasket

Place the head gasket on the crankcase.

Install the “centring pin” special tool to be screwed in the holes of the crankcase where the side screws M12 will be screwed.

Fit the side screws M12 and the central screws M14 and tighten them by hand. Tighten the screws as indicated below:

CENTRAL SCREWS M14

a. : Tightening torque 30 Nm

Sequence: 3-2-1-4-5-8-9-10-7-6

b. : Torque angle + 65°

Sequence: 1-2-3-4-5-6-7-8-9-10

c. : Torque angle + 65°

Sequence: 1-2-3-4-5-6-7-8-9-10

- Now tighten the side screws M12.

SIDE SCREWS M12

a. : Tightening torque 30 Nm

Sequence: 11, 12, 13, and 14

b. : Torque angle + 85°

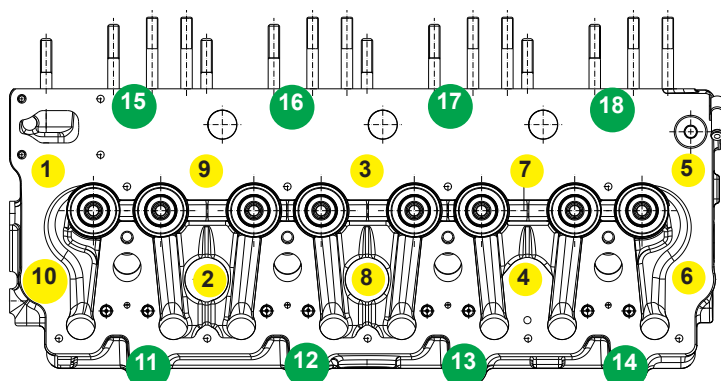
Sequence: 11, 12, 13, and 14

c. : Tightening torque 30 Nm

Sequence: 15, 16, 17, and 18

d. : Torque angle + 85°

Sequence: 15, 16, 17, and 18



HEAD RE-TIGHTENING



IMPORTANT: head re-tightening is an operation to be carried out any time that the head is removed or replaced.

PROCEDURE

1. Let engine run at idle for a few minutes and then let it run at 1/3 of the maximum rpm for approx. 20-30 minutes until the temperature of the coolant reaches the operating temperature of 70-80 °C.
2. Let the engine cool down completely, temperature lower than 40°C, measured on the 1st head.
3. Follow the steps of the procedure described below by fully loosening each central bolt M14 and tightening it as indicated:

CENTRAL SCREWS - M14

Fully loosen one screw at a time and re-tighten it to 30 Nm + 120° (or 60°+60°) following the sequence indicated below.

Loosening sequence: 1-2-3-4-5-6-7-8-9-10

Torque value 30 Nm + Angle value 120° (or 60°+60°)

Tightening sequence: 1-2-3-4-5-6-7-8-9-10

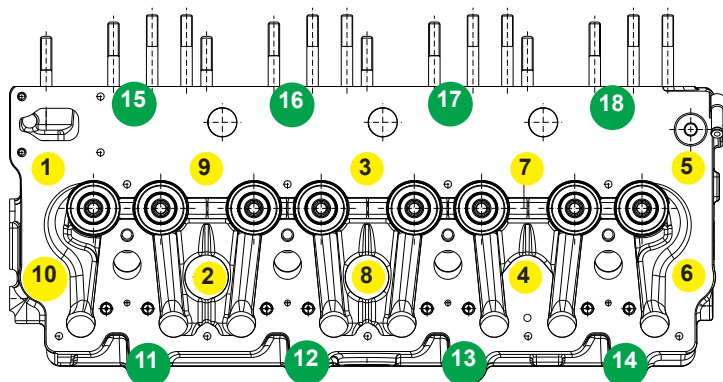
SIDE SCREWS - M12

NOTES: side screws M12 from 11 ÷ 18 (4-cylinder engine) do not require re-tightening.

If necessary, check the side screws M12 with a wrench calibrated to the value indicated.

Check value 90 Nm

Check sequence: 11-12-13-14-15-16-17-18



ROCKER ARMS

Position the crankshaft so that the key **A** is at "2" o'clock (30° before the 1st piston TDC).

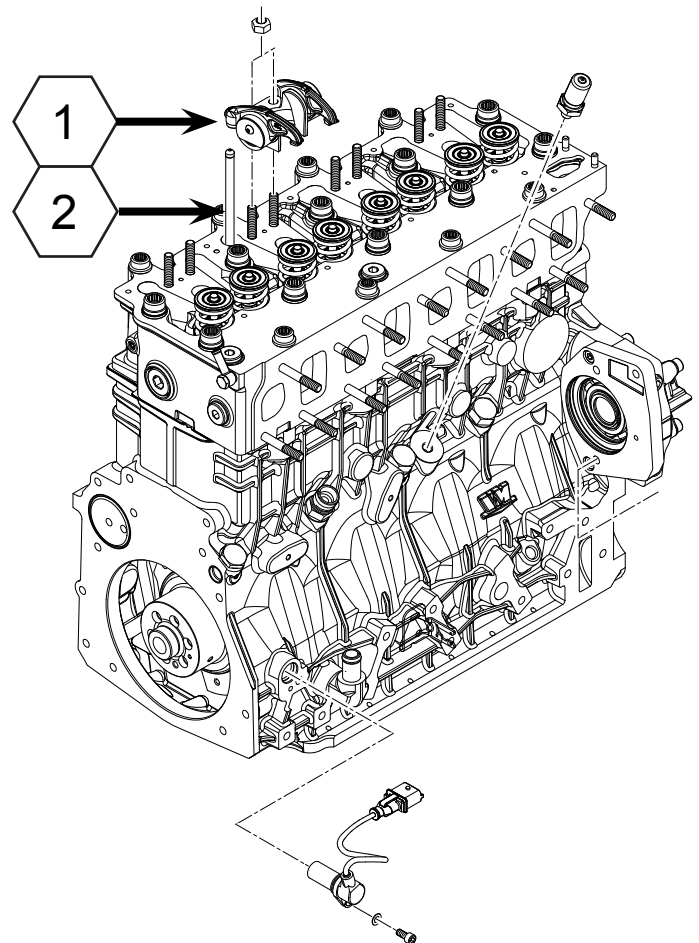
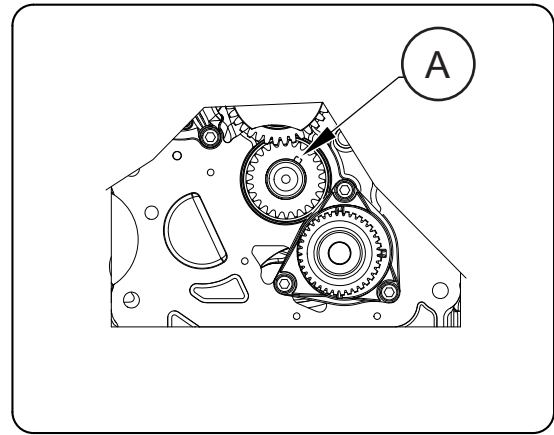
Check that the through-hole of the rods for the lubrication of the rocker arms is not obstructed.

Install the rods **2** in the tappet seats so that they are correctly seated.

Install the rocker arms **1** and tighten the nuts by hand.

Tighten the nuts.

rocker arm support fastening nuts	29 Nm
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REAR SUPPORT

Install the phonic wheel **A** on the crankshaft.

Tighten the screw **1**.

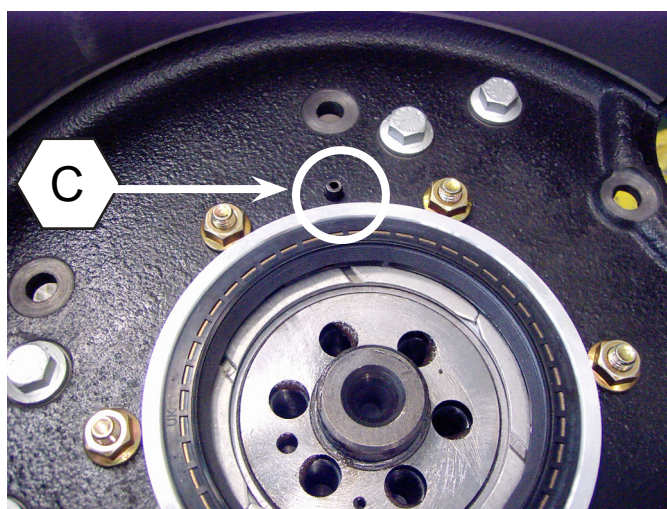
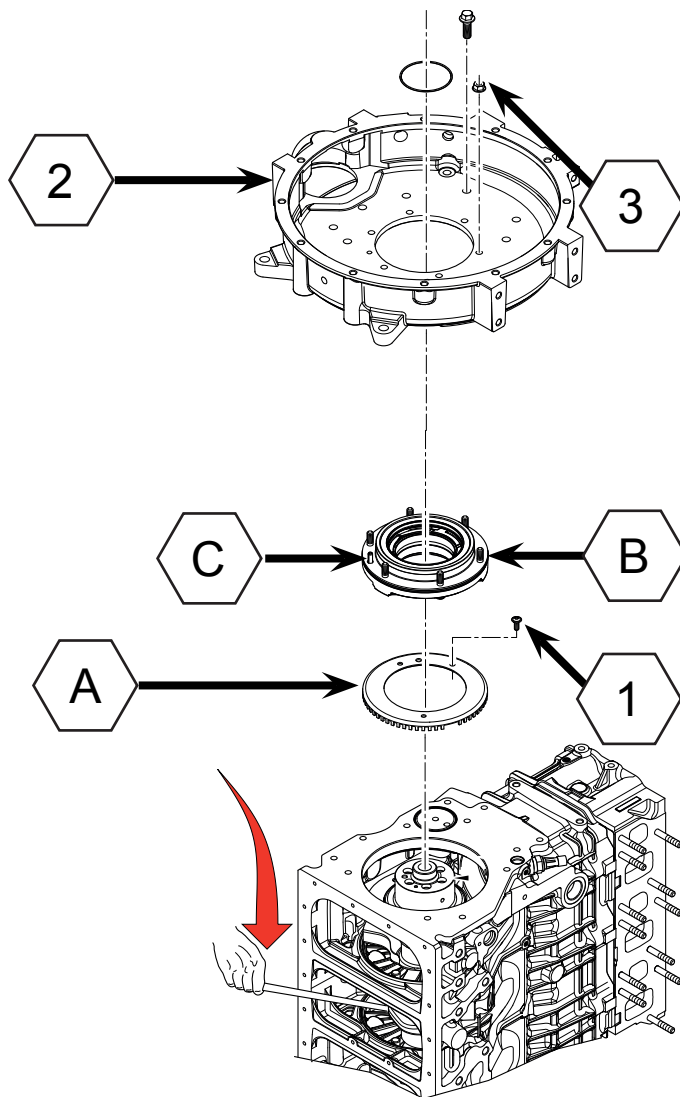
phonic wheel screw	14.6 Nm
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Install the rear support **B** on the flywheel housing **2** aligning pin **C**.

Tighten the nuts **3** retaining the support to the housing, as follows:

1) tighten the nuts to 15 Nm

2) without loosening, repeat the tightening with a torque of 24.5 Nm



FLYWHEEL HOUSING

IMPORTANT: Replace all O-rings any time the flywheel or the housing are removed.

Insert **Dow Corning 7091** type silicon in the groove **B** of the housing **C**, seat of the O-ring **A**.

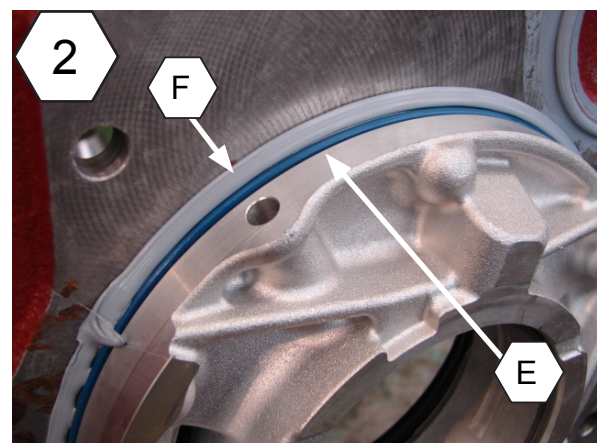
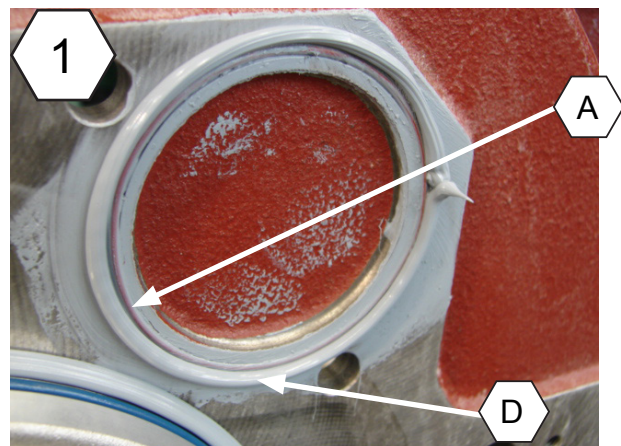
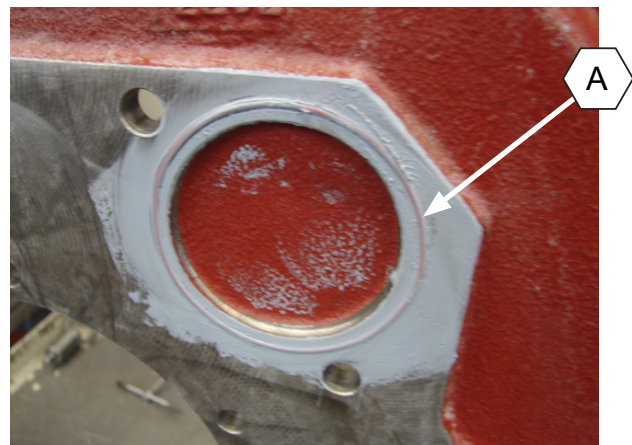
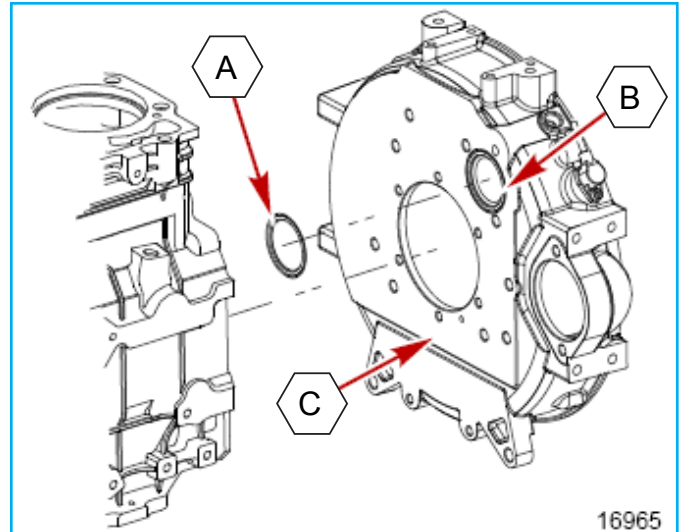
Fit a new O-ring in the groove of the housing. Apply a 2 mm thick silicon bead **D** around the O-ring, as shown in the figure (**PICTURE 1**).

Fit a new O-ring **E** in the rear support. Apply a 2 mm thick silicon bead **D** around the O-ring, as shown in the figure (**PICTURE 2**).

Lubricate the crankshaft rear tail and the plain bearing of the rear support.

Install the housing.
Install the housing and tighten the screws retaining it following a cross pattern.

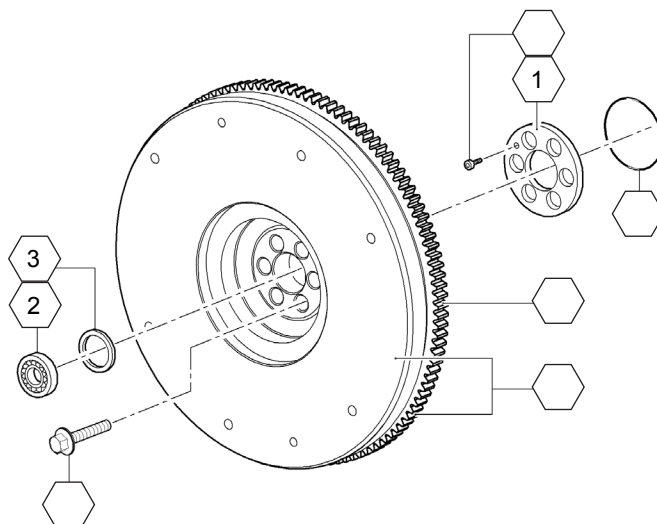
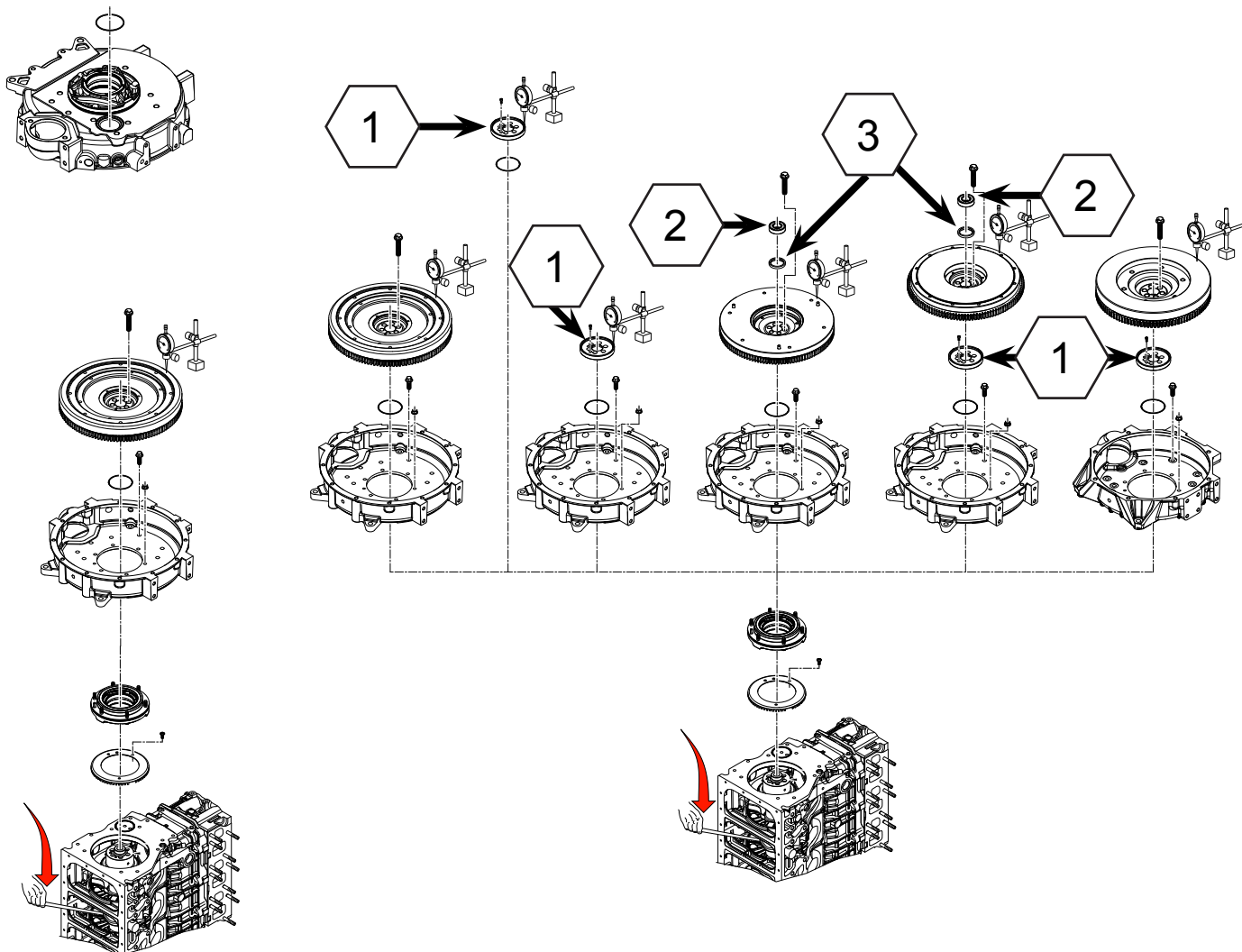
housing fastening screws	68.6 Nm
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FLYWHEEL



IMPORTANT: in some engine versions bearings 2, spacers 3 or shim application ring 1 can be installed.



Fit a new O-ring in the flywheel or in the spacer. Some grease may be used to keep the O-ring in place during the installation. Replace the O-ring any time the flywheel is removed.

When the flywheel is installed, do not touch or handle the rear oil seal lip. Check that the oil seal is in good working conditions. Replace in case of doubt.

Install the guide pins in the rear tail of the crankshaft for flywheel timing.

Install the centring pins as special tool in the rear tail of the crankshaft.

Install the flywheel.

Fit and tighten 4 of the 6 screws by hand.

Remove the flywheel assembling pins and fit the remaining screws.

Remove the starter motor and fit the special tool that prevents crankshaft rotation.

Tighten the screws following a cross pattern, at **50 Nm**.

Fully loosen one screw at a time and tighten following a cross pattern at **20 Nm + 75°**.



IMPORTANT: It is recommended to replace the screws once removed.

If they are reused lubricate the threading and underhead of the screws with engine oil.

The new screws must NOT be lubricated as they already come lubricated with an anti-seize treatment.



NOTES: Check crankshaft axial clearance.

Remove the special tool that prevents crankshaft rotation and install the starter motor.

FLYWHEEL RING

Heat the flywheel ring with a blowtorch on the engine side of the flywheel ring.

Once heated, hit the ring until it comes out of the flywheel. Do not hit the flywheel during this operation.



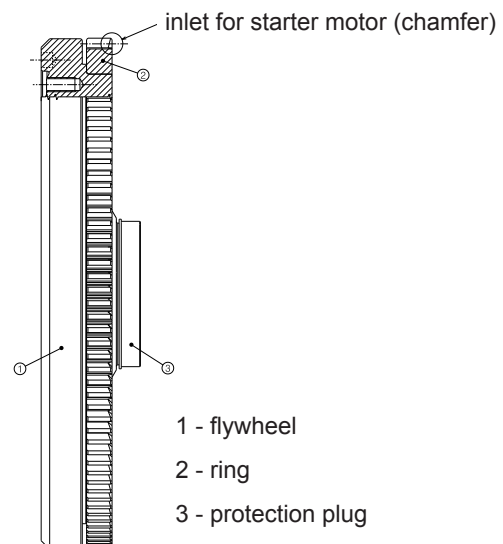
IMPORTANT: If the treated steel is excessively heated its hardness will be altered and it will become weaker. Do not heat any section of these treated steel components, such as the flywheel ring, at temperatures higher than 210 °C.

Heat the new ring for 20 minutes in a pre-heated oven at 190 - 210° C, or heat evenly until the ring expands just enough to slide in the flywheel. Do not overheat the ring.



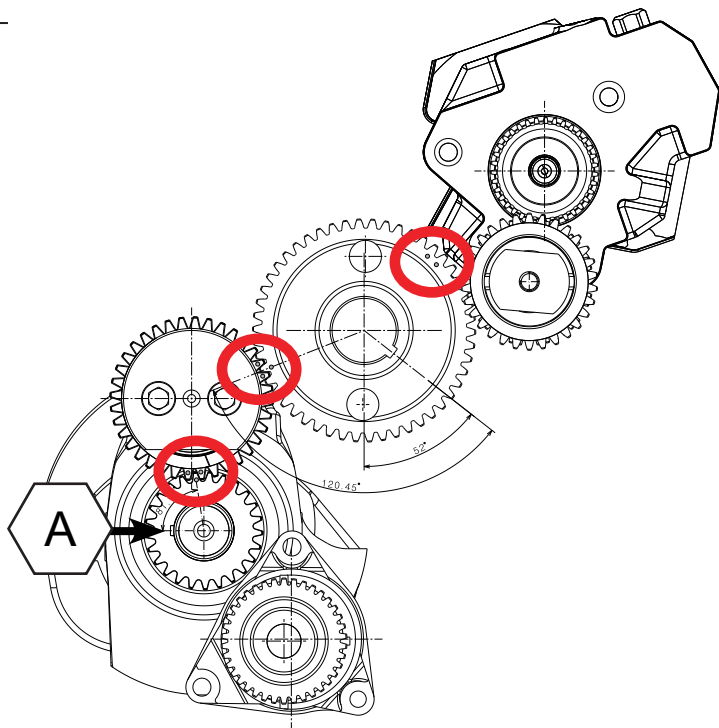
IMPORTANT: The ring must be installed so that the chamfer on the teeth is facing the engine side of the flywheel.

Install the ring. Check that the ring is correctly positioned against the flywheel shoulder. The ring can move away from the flywheel shoulder no more than 0.50 mm.



HIGH PRESSURE INJECTION PUMP

Bring the key **A** of the crankshaft at " 9 " o'clock as shown in the figure, so that the timing engravings are aligned.



Position the pump with shaft in vertical position.

Degrease the cone and threading.

Cut the tab and keep its seat **X** aligned with the fastening hole as shown in **PICTURE 1**. Fit the aluminium spacer **B** with the chamfer facing the gear.

Colour two teeth on the pump gear following the tab axis **X**. Colour the end of the shaft in correspondence of the tab axis **X**, as shown in **PICTURE 2**. Position the gear on the shaft so that the tab seat **X** is aligned with the first compartment on the right of the coloured teeth, as shown in **PICTURE 2**.

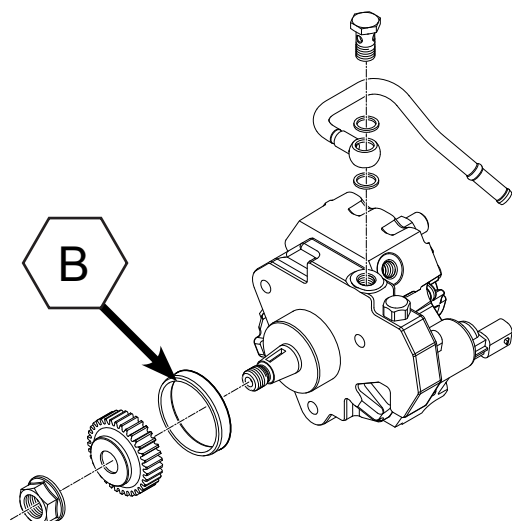
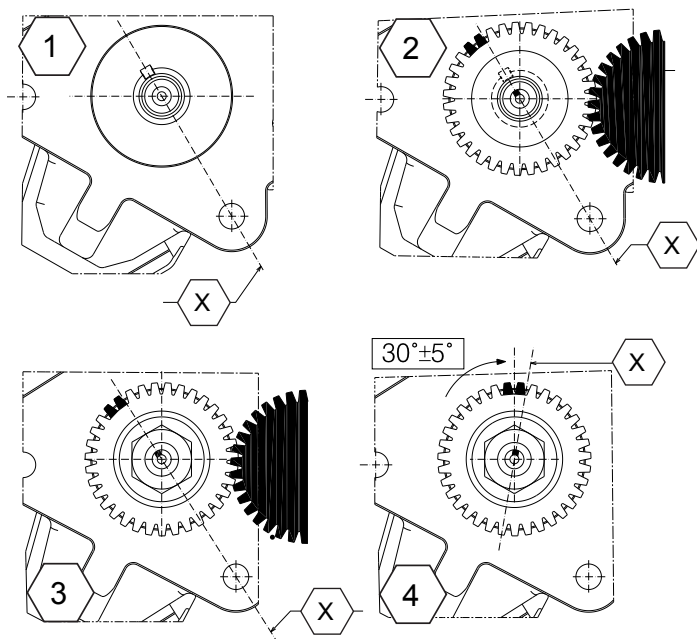
Fit the nut and tighten it to a torque of 10 Nm. Tighten the nut again to 86.3 Nm, see **PICTURE 3**.

Rotate the gear clockwise by $30^\circ \pm 5^\circ$: The **Y** axis will be at " 12 " o'clock, vertical to the two coloured teeth, as shown in **PICTURE 4**.

Install the pump complete with gear in the crankcase, paying attention that the **Y** axis stays vertical at " 12 " o'clock.

Tighten the fastening nuts of the pump to 5 Nm.

Tighten the nuts again to 27.5 Nm



TIMING SYSTEM COVER

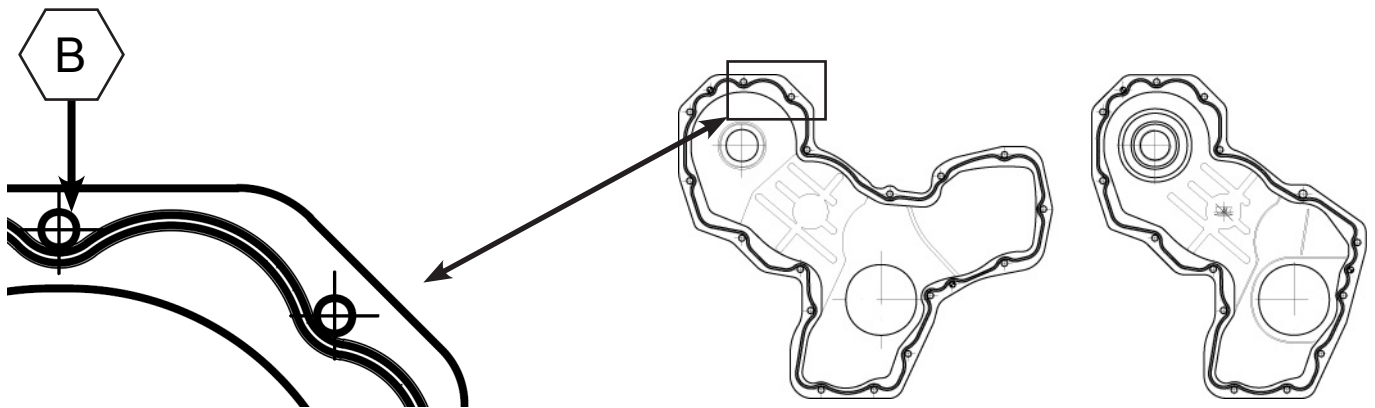
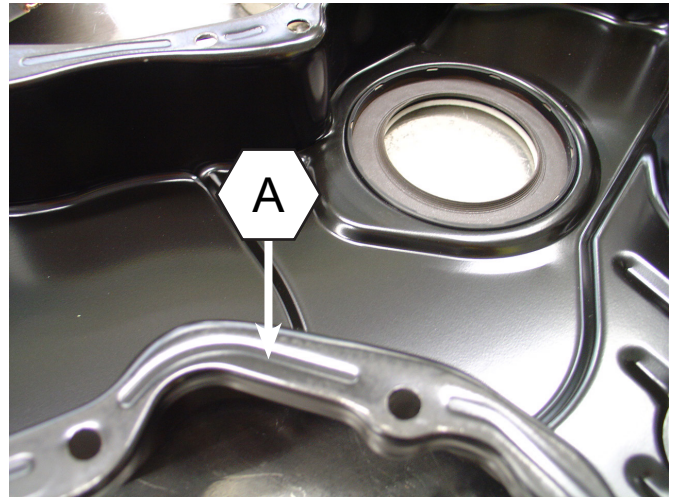
Smear an even bead of sealant (**Dow Corning 7091 silicon**) (as shown in the picture) along the perimeter of the cover, on the tracks **A** and in the inner side of the holes **B** of the cover fastening screws.

Align the cover with the pins installed in the crankcase. Tighten the screws following a cross pattern to:

Timing system cover screws	12.7 Nm
----------------------------	---------



IMPORTANT: wait for at least 20 minutes before starting the engine to allow the silicon to dry



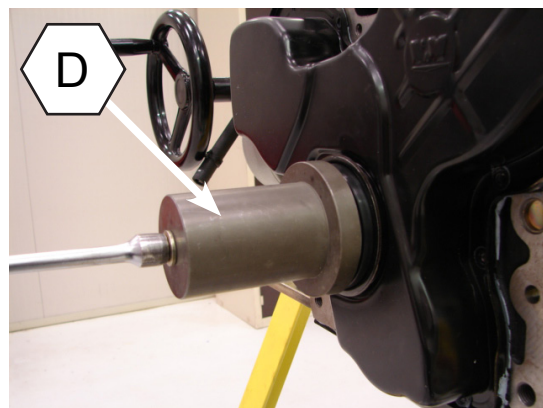
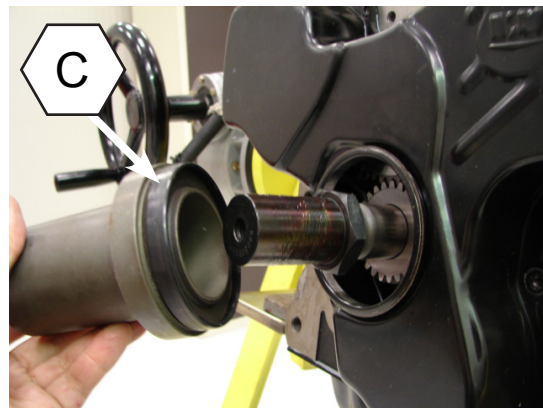
FRONT OIL SEAL

Lubricate the outer perimeter of the oil seal **C**. Do not touch or handle the oil seal lip.

Fit a new oil seal in the special tool **D**.

Tighten the screw of the special tool.

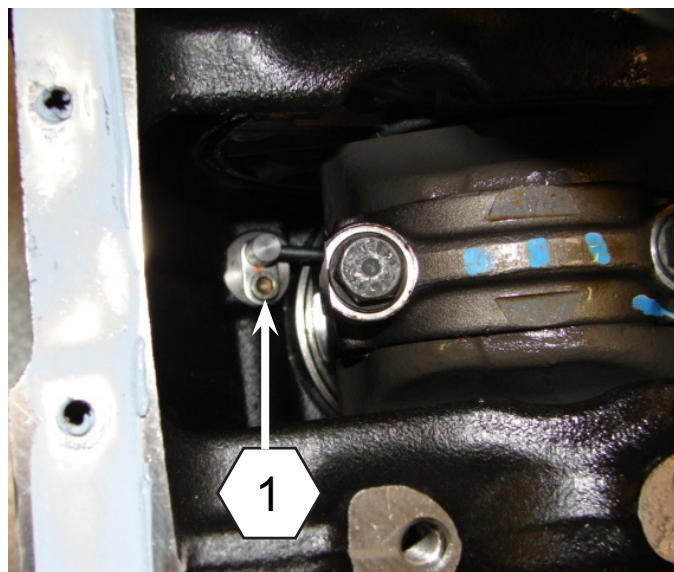
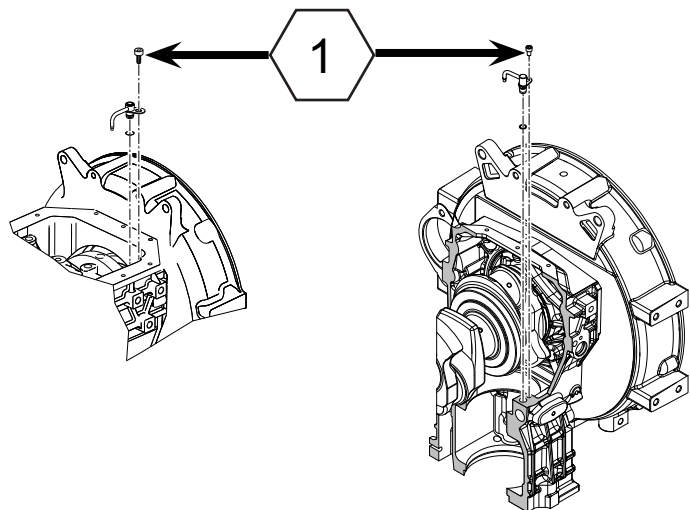
The oil seal will stop when it is correctly installed in its seat.



OIL JETS

Tighten the screws 1.

Oil jet screws	12.7 Nm
-----------------------	----------------



THERMOSTATIC VALVE

Smear grease P80 on the O-ring and on the edge of its seat.

Tighten the screws 1.

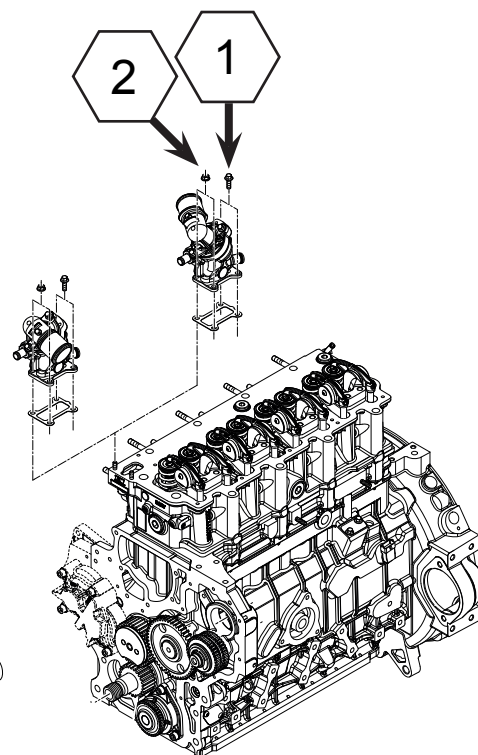
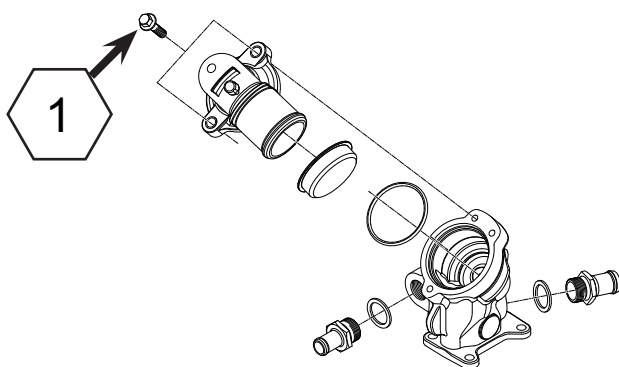
Screws	12.7 Nm
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Tighten the unions 3.

Unions	36 Nm
---------------	--------------

Tighten the nuts 2.

Nuts	11.8 Nm
-------------	----------------

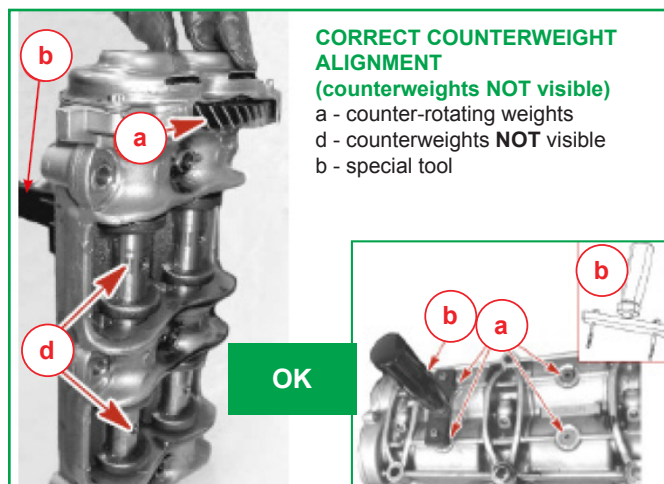


BALANCING WEIGHTS

Bring the 1st piston to TDC (crankshaft tab at " 9 " o'clock).

Align the counterweights **(d)** as indicated in the figure and insert the special tool pins **(b)** in the holes of the counterweights **(d)**: the counterweights should **NOT** be visible.

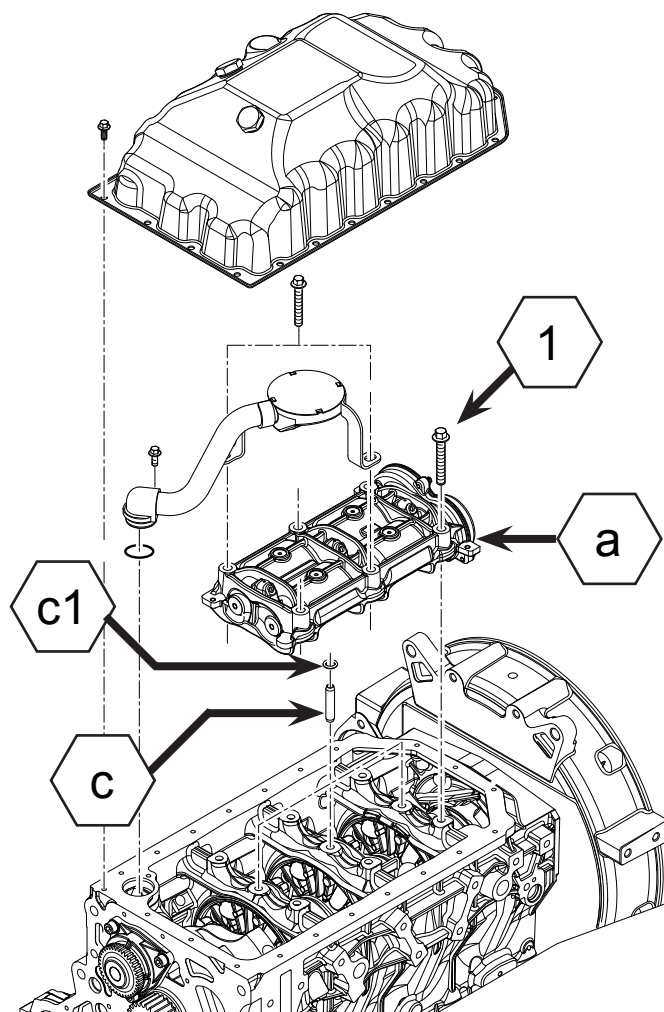
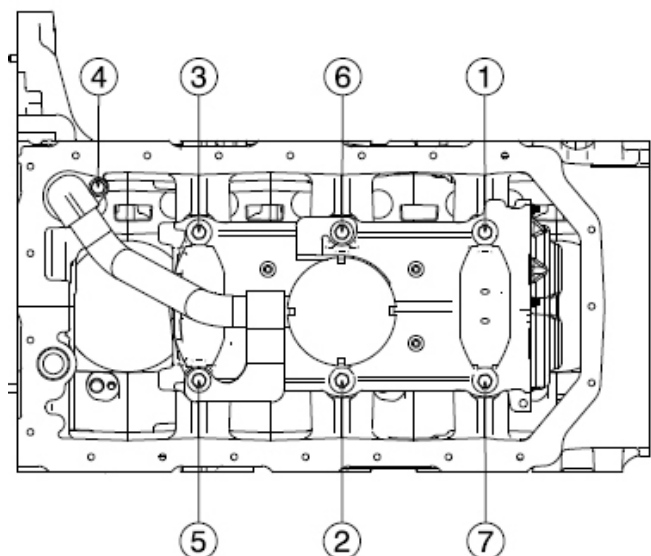
The insertion of the pins stops the rotation of the shafts with the counterweights.



Hold the special tool in position, install the balancing weights **(a)** on the engine block paying attention not to damage the O-rings **(c1)** present on the guides **(c)** that bring the lubrication to the weights.

Remove the special tool and tighten the bolts **1** of the weights, as per the sequence 1-2-3-5-6-7.

Balancing weight bolts	32.4 Nm
Screw 4 (oil intake pipe)	12.7 Nm



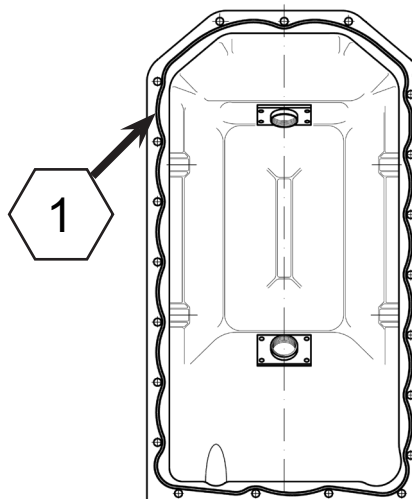
OIL SUMP

Apply an even bead of Dow Corning 7091 silicon 1 around the perimeter of the oil sump flange in the inner part of the holes as shown in the figure.

Install the sump.

Fit the screws and tighten them following a cross pattern.

Oil sump screws	12.7 Nm
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WATER PUMP

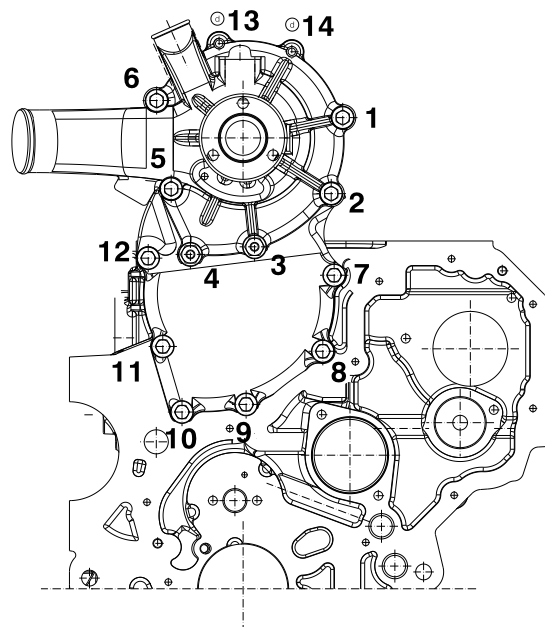
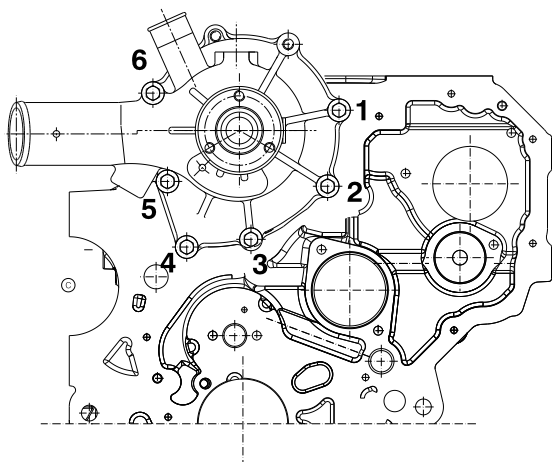
Smear Loctite on both sides of the new pump.

Fit a new gasket.

Tighten the fastening screws following the procedure.

Tighten the screws of the water pump pulley.

Screw pre-tightening 1-3-6-4-2-5 (1-3-6-4-2-5-14-13 for overhang water pump)	6 Nm
screw final tightening 1-3-6-4-2-5 (1-3-6-4-2-5-14-13 for overhang water pump)	32.4 Nm
Screw pre-tightening 7-9-12-10-8-11	6 Nm
screw final tightening 7-9-12-10-8-11	32.4 Nm
water pump pulley fastening screw	27.5 Nm



IDLE PULLEYS - IDLE PULLEY BRACKET

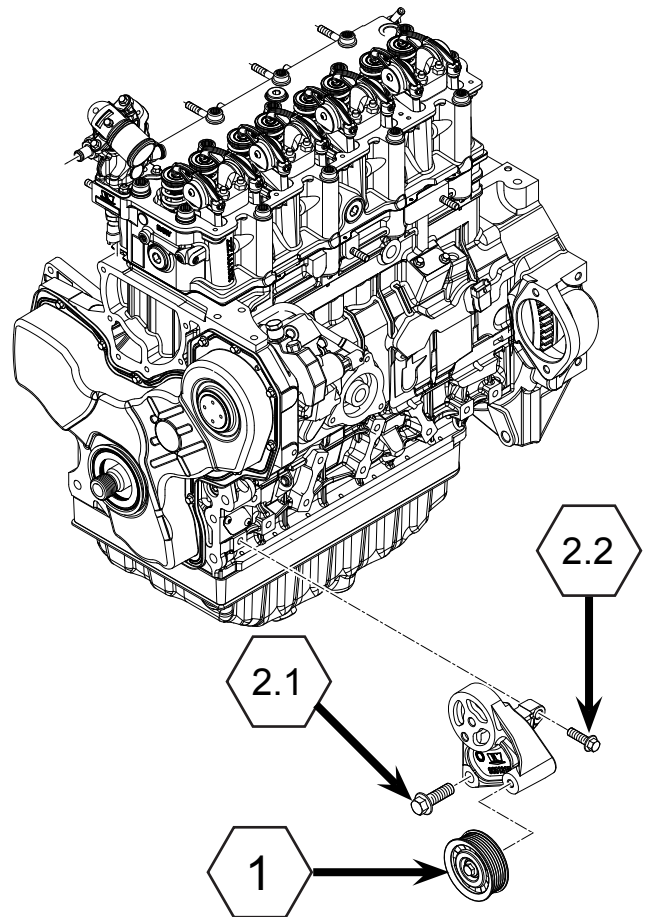
Fit the bracket and tighten the screws **2.1** and **2.2**.

Screw 2.1	78.5 Nm
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Screw 2.2	44.1 Nm
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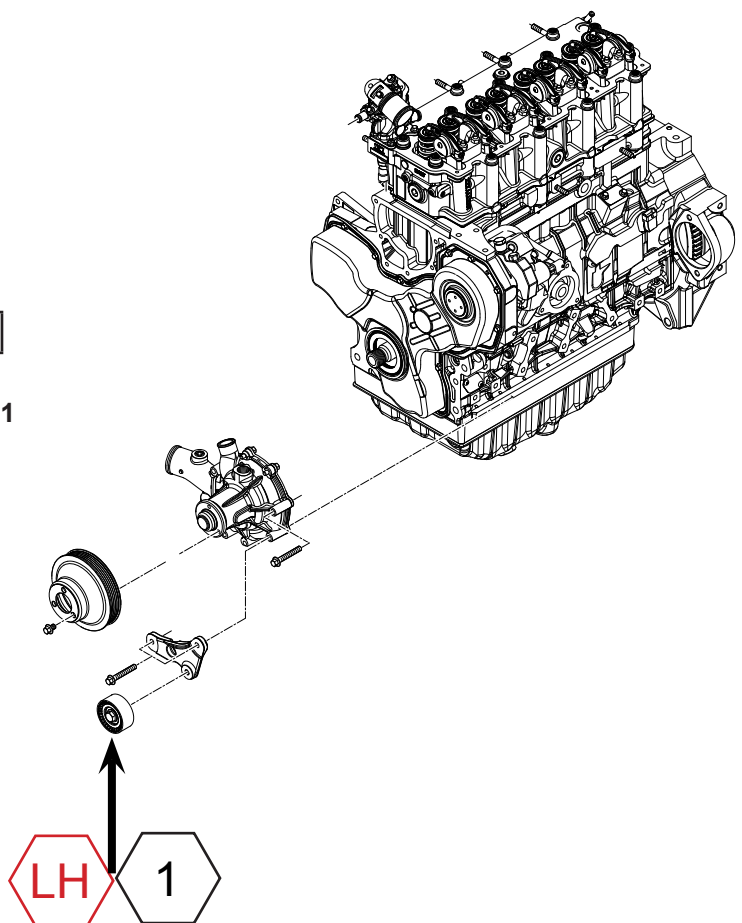
Install the pulley **1**.

Pulley screw	53 Nm
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Pulley screw 1	53 Nm
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 **IMPORTANT:** the screw threading of the pulley **1** installed on the bracket is of the left-hand type.

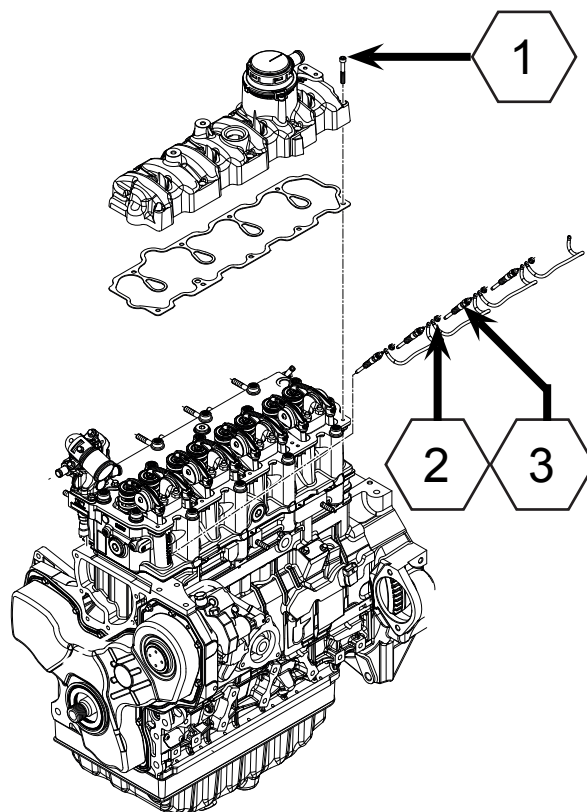
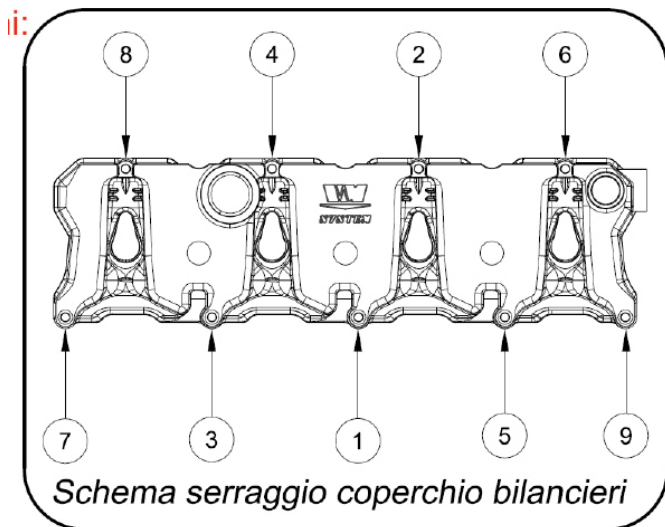


ROCKER ARM COVER

Install the gasket and fit the cover.

Tighten the screws **1** following the sequence shown in the figure.

screws	14.2 Nm
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SPARK PLUGS

Smear the threads of the spark plugs **3** with oil and install them in the head. Tighten the spark plugs.

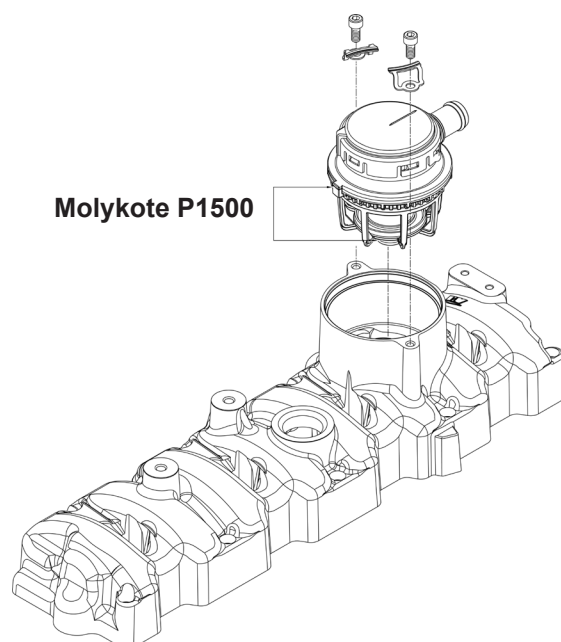
Install the electrical connections and tighten the nuts **2**.

spark plugs	14.2 Nm
-------------	---------

nuts	5 Nm
------	------

ENGINE OIL VAPOUR SEPARATOR

Distribute Molykote P1500 in the area indicated by the arrows in the figure.



HEAT EXCHANGER UNIT - EGR VALVE

Install the EGR valve and tighten the screws **3**.

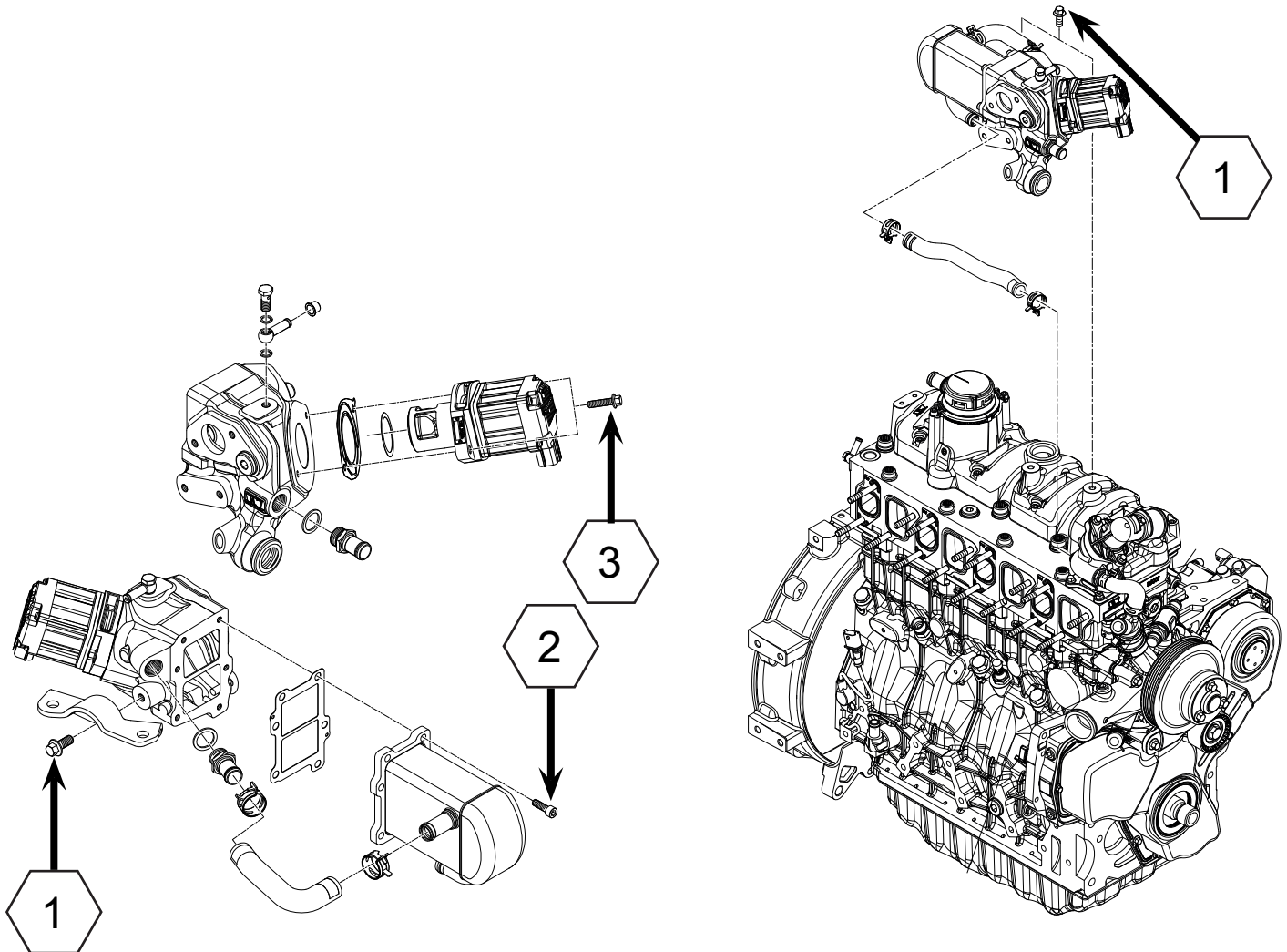
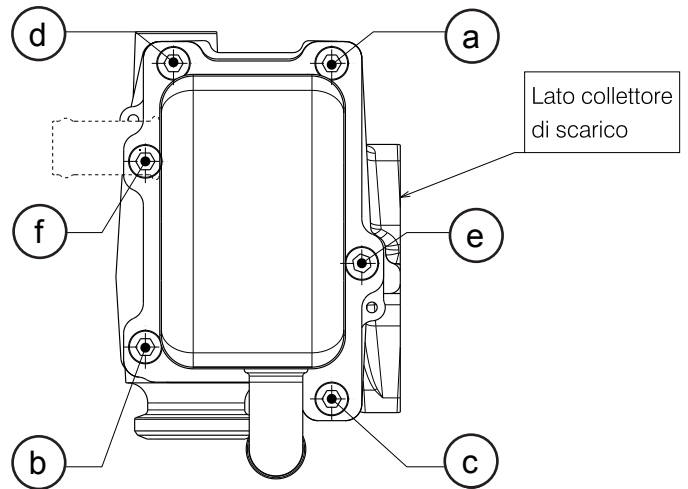
EGR valve screws	13.7 Nm
-------------------------	----------------

Install the EGR heat exchanger and tighten the screws **2** following the sequence:

pre-tightening (sequence a,b,c,d,e,f)	5 Nm
final tightening (sequence a,b,c,d,e,f)	14.7 Nm

Install the bracket and tighten the screw **1**.

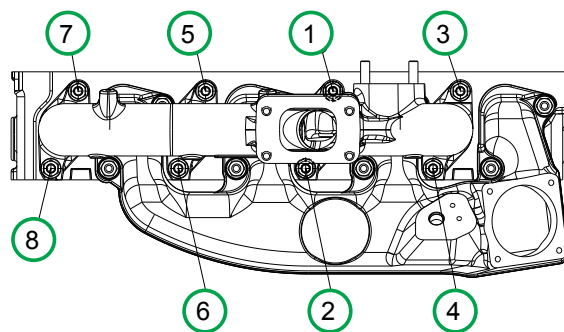
screw	32.4 Nm
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EXHAUST AND INTAKE MANIFOLDS

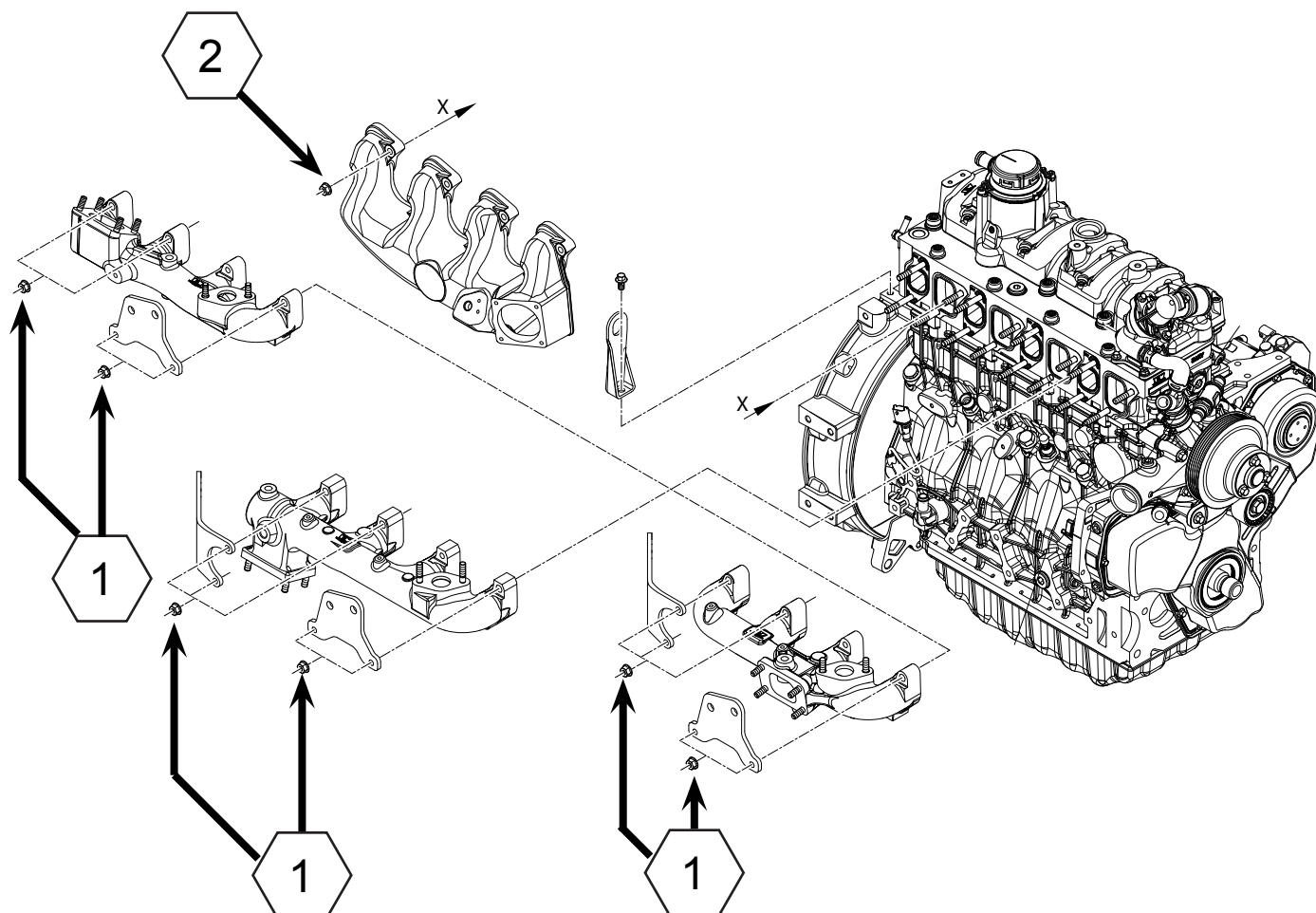
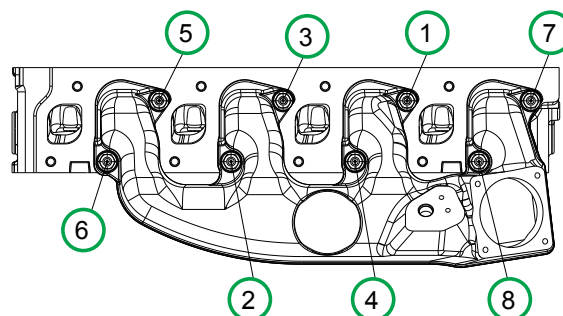
Tighten the nuts 1 of the exhaust manifold following the procedure.

sequence 1,2,3,4,5,6,7,8 - pre-tightening	32.4 Nm
sequence 1,2,3,4,5,6,7,8 - final tightening	32.4 Nm





Tighten the nuts 2 of the intake manifold following the procedure.


sequence 1,2,3,4,5,6,7,8 - pre-tightening	27.5 Nm
sequence 1,2,3,4,5,6,7,8 - final tightening	27.5 Nm



INJECTORS - HYDRAULIC ACCUMULATOR (RAIL)

 **ATTENTION:** When the injector(s) or the rail are removed, it is necessary to follow a specific procedure to correctly install the high pressure fuel pipes.

 **NOTE:** Any time the components of the high pressure system (injection pump, electro-injectors, rail, pipe from rail pump and pipes from rail to injectors) are removed, it is necessary to reinstall new pipes in order to avoid fuel leaks.

 **IMPORTANT:** Any time that one or all the injectors are replaced, the new IMA code must be written again inside the control unit through the diagnosis tool.

Check the cleanliness of the injector seat in the head.

Install a new O-ring in the injector groove and smear it with Molykote P 1500 grease as in the figure.

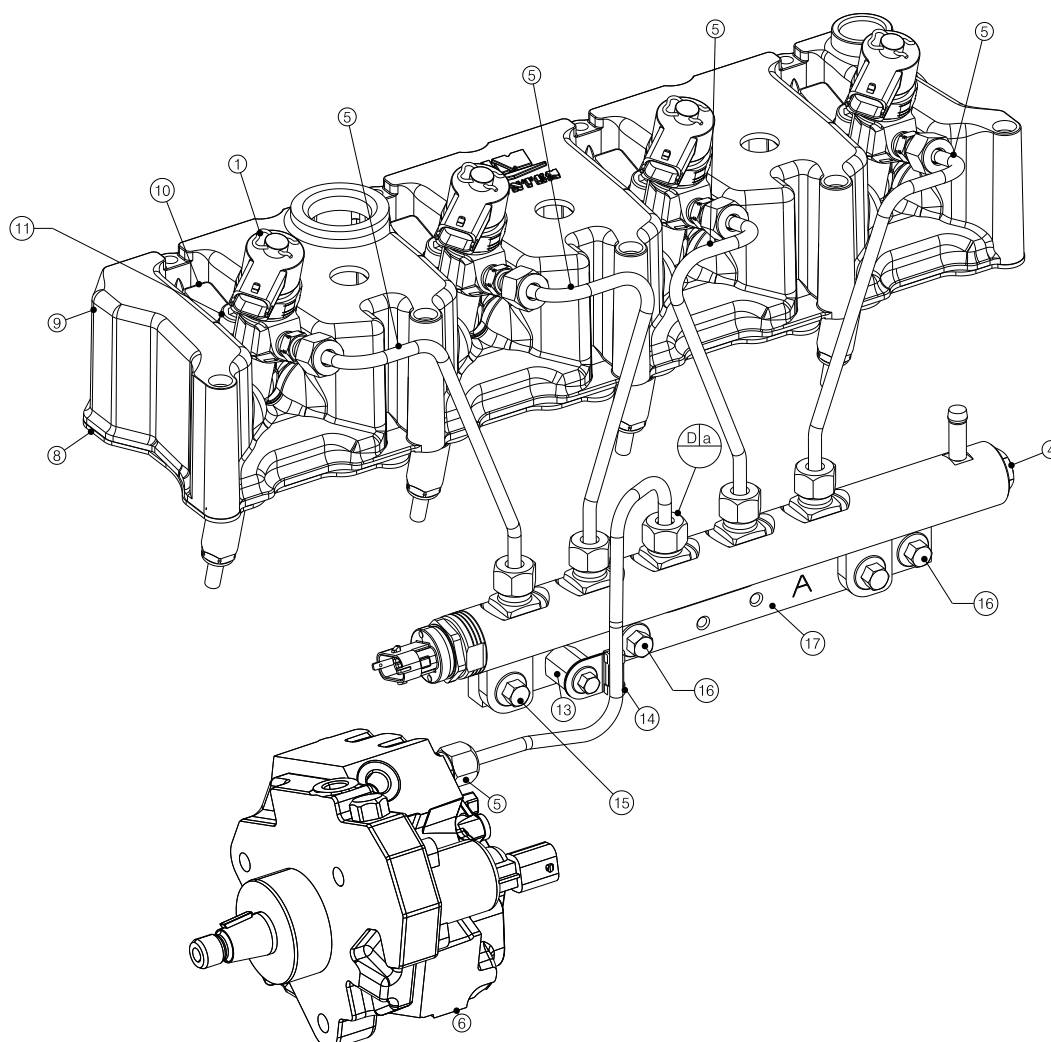
Check that the shim under the injector is correctly placed.

Install the injector in the head.



Tighten the high pressure system components following the procedure.

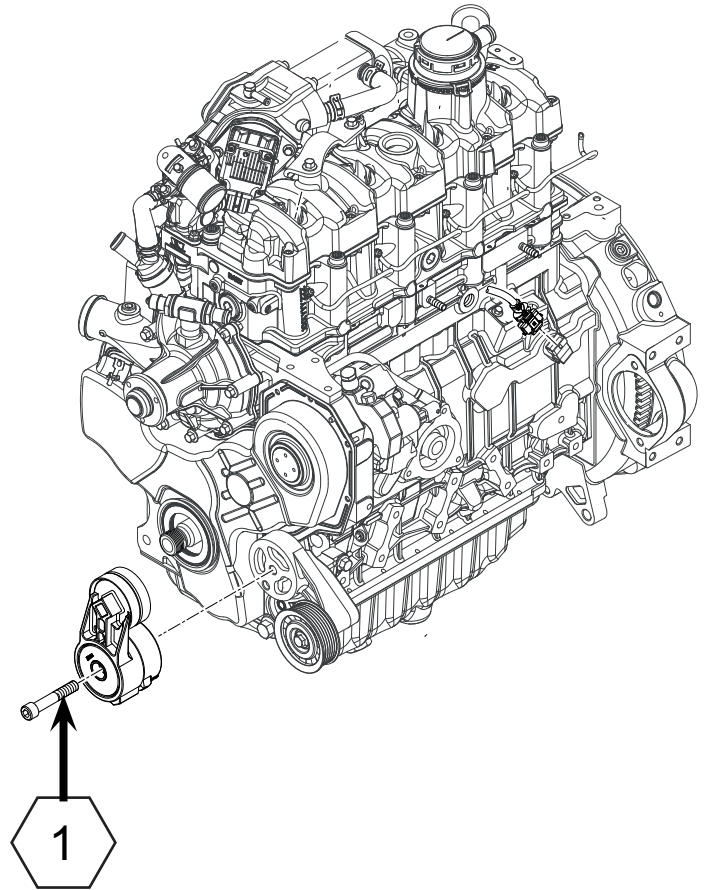
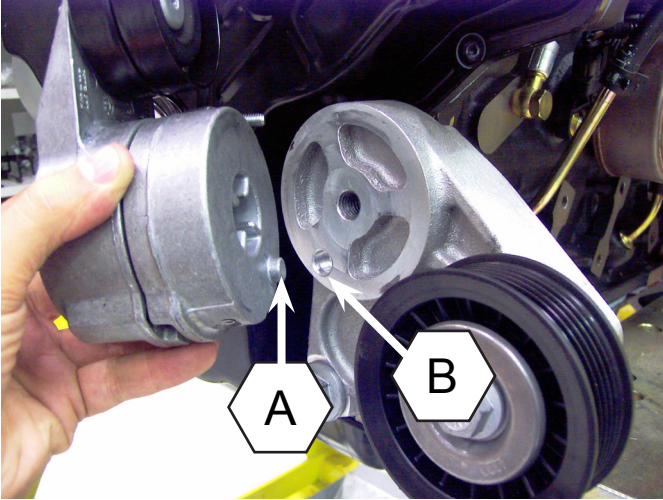
- 1 - Tighten the screws (10) of the injector clamps (1) to 10 Nm.
- 2 - Loosen the screws (10) of the injector clamps (1) by 150°.
- 3 - Start the screws (15) fastening the rail to the bracket (17) and the screws (16) fastening the bracket to the crankcase by hand until fully home
- 4 - Fit and start the pipes from the rail (4) to the injectors by hand
- 5 - Tighten the screws (10) of the injector clamps to the specified torque (23 ± 2 Nm)
- 6 - Tighten the screws (16) fastening the bracket to the crankcase and the screws (15) fastening the rail to the bracket to the specified torque (33 ± 2 Nm)
- 7 - Tighten the nuts of the INJECTOR SIDE pipes (27 ± 2 Nm)
- 8 - Tighten the nuts of the RAIL SIDE pipes (19 ± 2 Nm)
- 9 - Fit the pipe from the pump to the rail and tighten the nuts on the PUMP SIDE to (20.5 ± 2.5 Nm) and on the RAIL SIDE to (19 ± 2 Nm)
- 10 - Tighten the clamp (13) to (14 ± 2 Nm)



ALTERNATOR BELT TENSIONER (AUTOMATIC TYPE)

Align the stud **A** with the hole **B** in the bracket and install the automatic tensioner. Tighten the screw **1** fastening the tensioner.

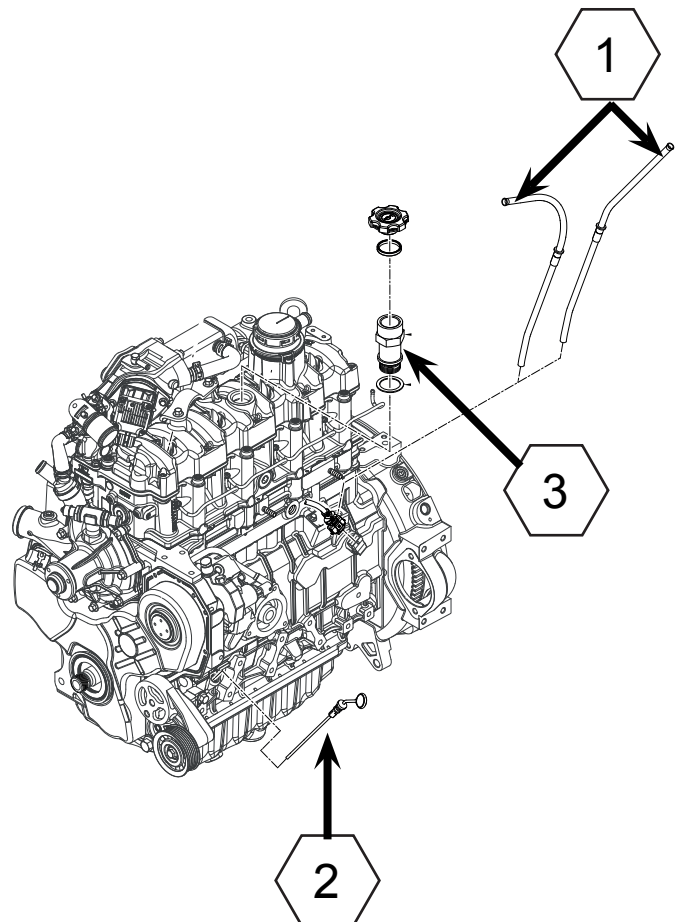
Automatic tensioner - fastening bolt	78.5 Nm
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ENGINE OIL DIP STICK - ENGINE OIL FILLING PLUG ADAPTER

Install the rod holder pipe **1** using Loctite 638 in the surface to be inserted in the crankcase.

Fit the rod **2** manually.

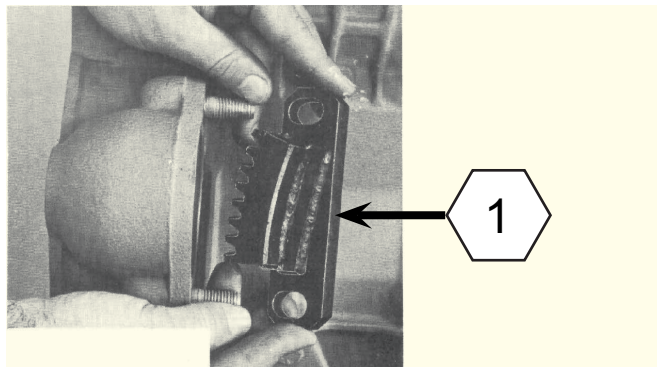
Tighten the engine oil filling plug adapter **3** to **80 Nm**.



CRANKSHAFT FRONT PULLEY

Clean the contact surfaces between hub and nut with solvent and dry using compressed air.
Clean the crankshaft thread with solvent and dry.
Clean the surface of the hub in contact with the oil pump transmission gear.

Fit the tool **1** that prevents crankshaft rotation, to be installed instead of the starter motor.



Smear “**Molykote G Rapid Plus Paste**” grease on the LH thread of the hub nut **5** and on the surface of the crankshaft pulley/hub **6**, when the nut narrows.

Align the key seat on the crankshaft pulley/hub **6** with the key present on the crankshaft. Screw the nut manually.



ATTENTION: The nut must be screwed with the flanged part towards the crankshaft gear (towards the inside of the engine).

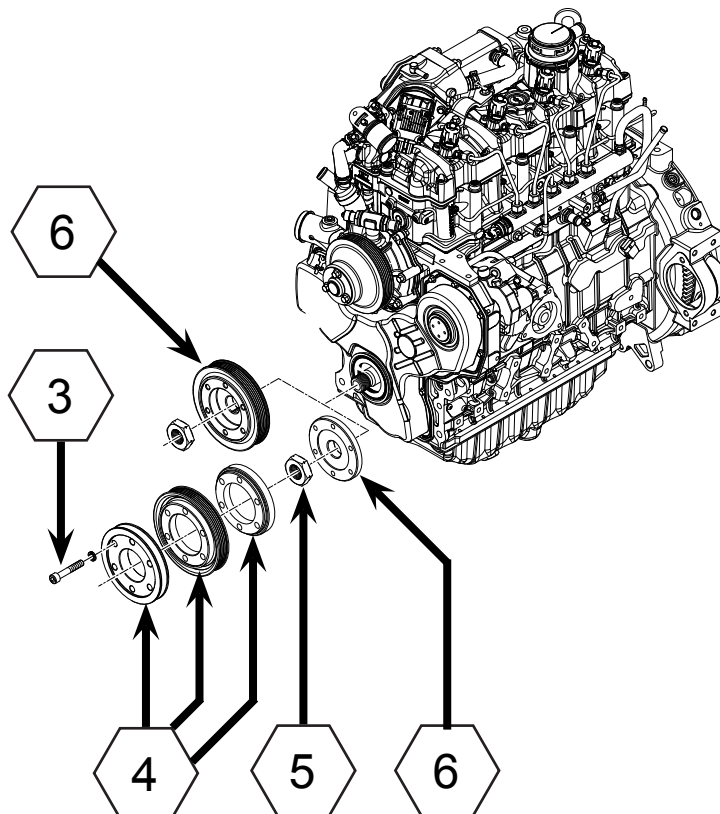
TIGHTENING PROCEDURE

Tighten the nut to 400 Nm.
Loosen the nut and tighten it again to 600 Nm

Fit the screws **3** with the relevant washers and tighten the pulley **4**.

Screw 3	45.1 Nm
---------	---------

Remove the tool that prevented crankshaft rotation, installed instead of the starter motor.



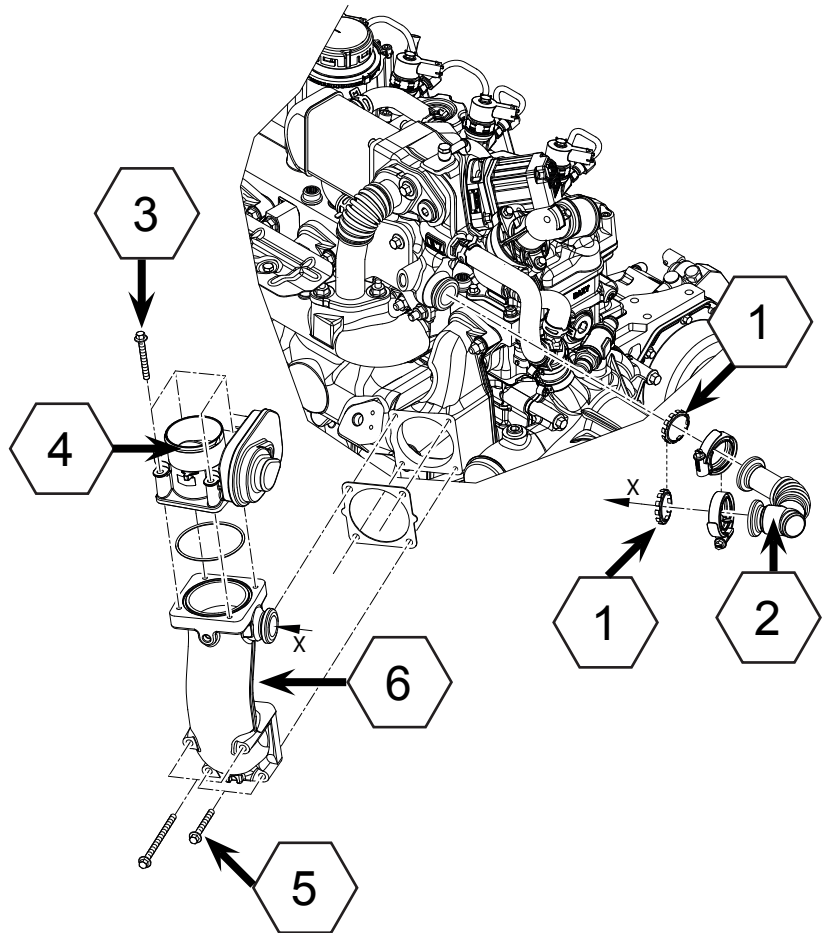
EGR VALVE PIPE AND SLEEVE - TVA THROTTLE INTAKE VALVE

Install the TVA valve **4** on the intake sleeve **6**.
Tighten the screw **3**.

Screw 3	10.8 Nm
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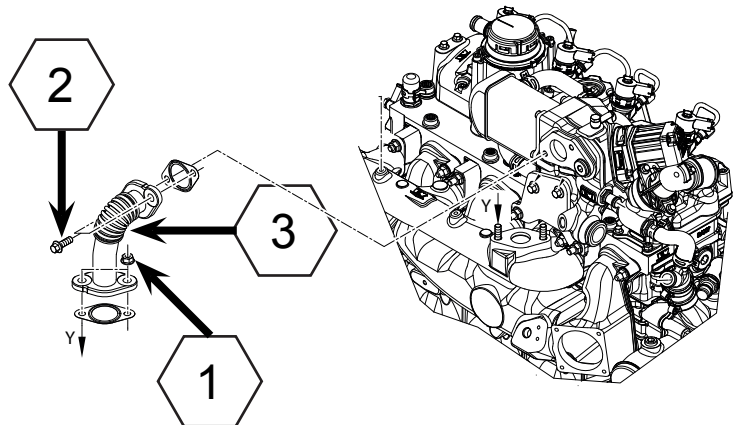
Install the intake sleeve **6** and tighten the screws **5**.

Screw 5	10.8 Nm
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Install the sleeve **3** and tighten the nuts **1** and the screws **2**.

Screw 2 and nut 1	32.4 Nm
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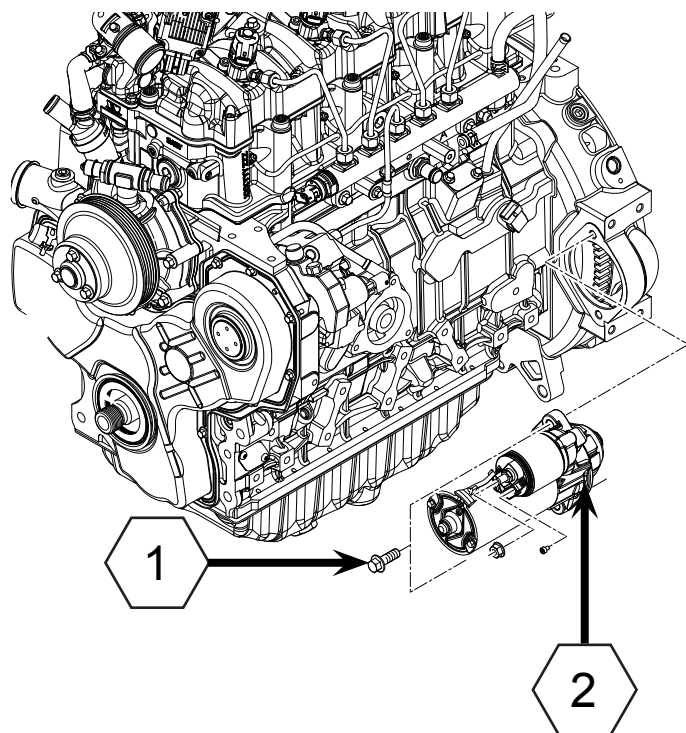


STARTER MOTOR

Install the starter motor 2.

Tighten the screw 1.

Screw 1	83.4 Nm
---------	---------



ALTERNATOR BRACKET - IDLE PULLEYS

- Tighten the screws 1 to the crankcase
- Tighten the screws 1.

Screw 1	68.6 Nm
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- Tighten the screw 3 of the eyebolt

Screw 3	32.4 Nm
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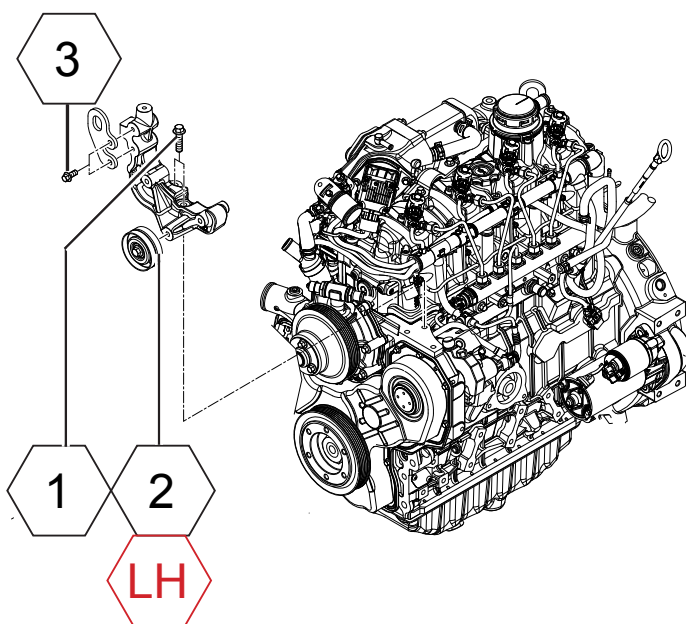
- Tighten the pulley 2 to the alternator bracket.



IMPORTANT: the screw threading of the pulley 2 installed on the alternator bracket is of the left-hand type.

Tighten the screw 2.

Pulley screw 2	53 Nm
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ALTERNATOR

Install the alternator to the bracket and tighten the screws **2** with the relevant nuts.

Tighten the screws **2**.

Screw 2	45.1 Nm
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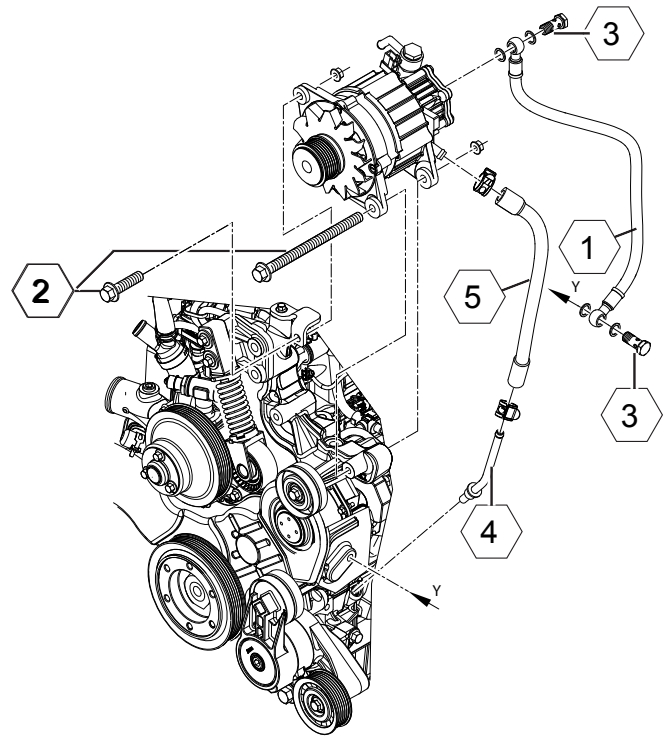
Install the oil delivery pipe **1** to the vacuum pump.

Tighten the unions **3**.

Unions 3	27.5 Nm
-----------------	----------------

Install the pipe **4** applying Loctite 638 to the surface of the pipe to be installed in the crankcase.

Install the oil drain pipe **5** from the vacuum pump.



OIL/WATER HEAT EXCHANGER

Lubricate the O-rings of the exchanger **A** with Molycote 111 grease.

Screw the fitting **B** and tighten it.

Fitting B	60 Nm
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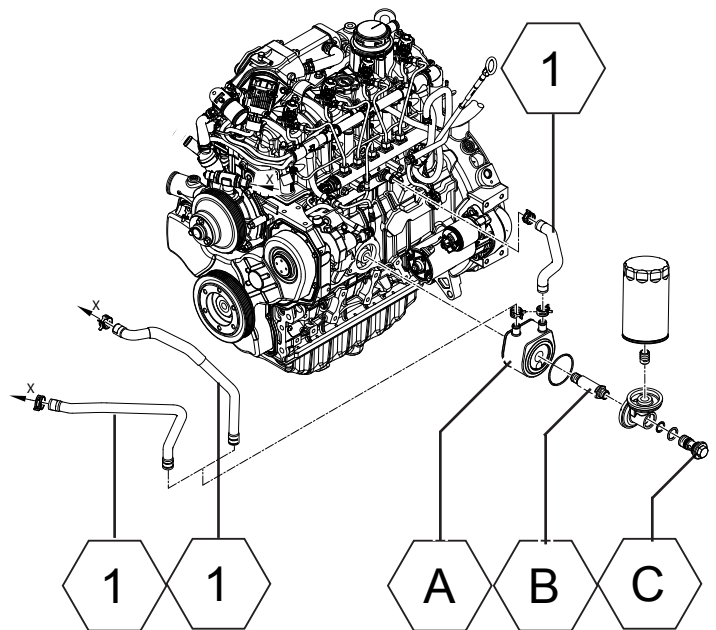
Lubricate with Molycote 111 grease the O-ring of the screw **C** fastening the exchanger oil filter support.

Screw the screw **C** and tighten it.

Screw C	39.2 Nm
----------------	----------------

Install the water pipes **1** connected to the crankcase and the exchanger.

Install the fitting in the oil filter support using Loctite 630. Remove any excess of Loctite, lubricate with oil the filter gasket and install it.



OIL FILTER

Lubricate with oil the filter gasket and install it.

Tighten the cartridge

Cartridge	12.7 Nm
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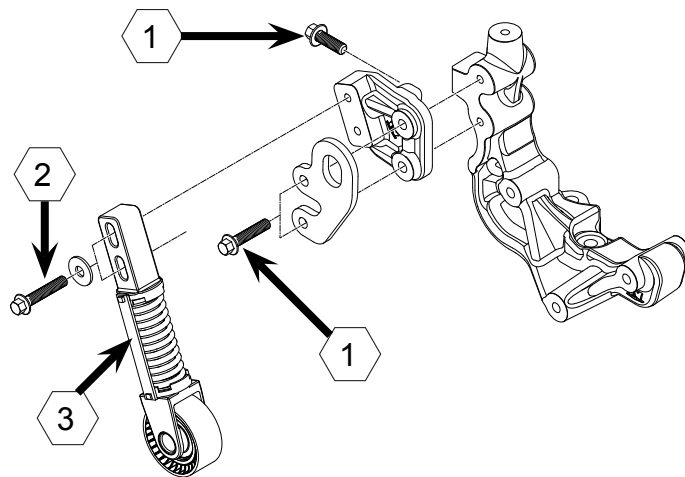
LINEAR TENSIONER - ALTERNATOR BELT

Fit the screws 1.

Tighten the screws 1.

Screw 1	32.4 Nm
----------------	----------------

Start the screws 2 without tightening them.



Make sure the tensioner is locked with the bracket 3.

Drive the screws 2 fully home by hand.


Position the belt.

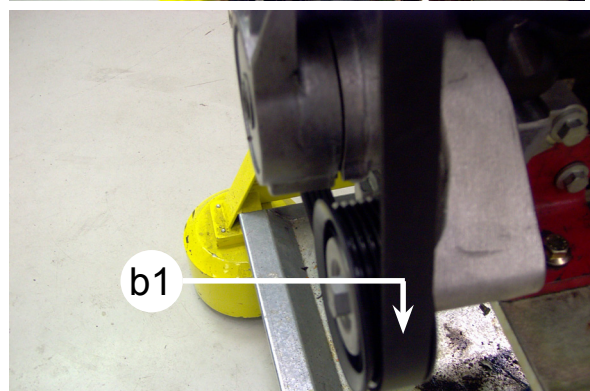
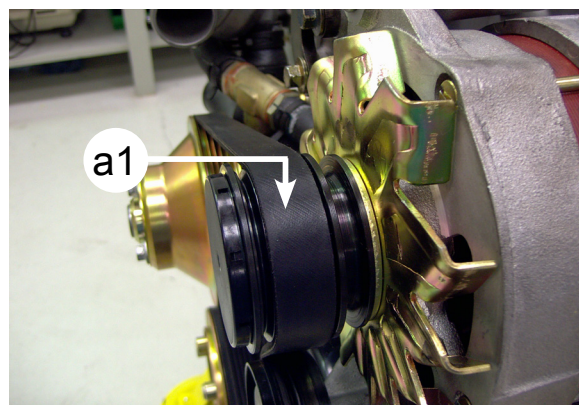
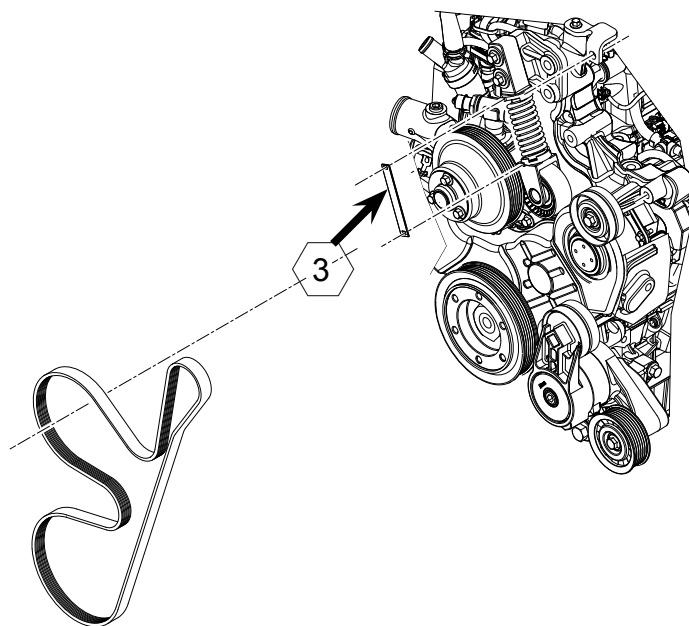
Move the tensioner with care to bring the tensioner pulleys against the belt.

Tighten the screws 2 of the tensioner

Screw 2	32.4 Nm
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Remove the bracket 3.

 **IMPORTANT:** To correctly align the belt, it must be positioned in the most inner grooves of the alternator pulley (a1) and transmission pulley (b1).



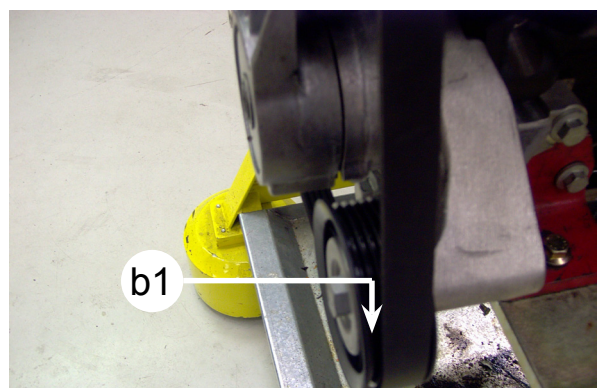
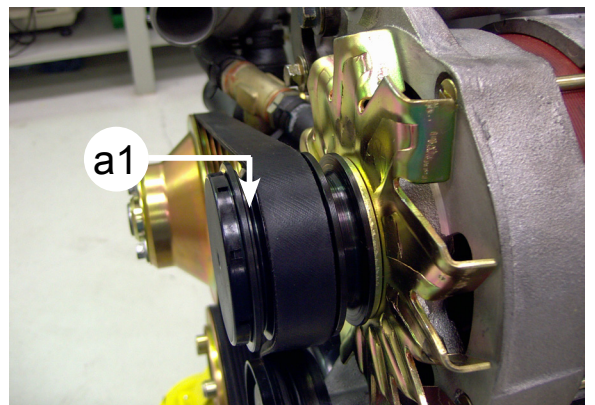
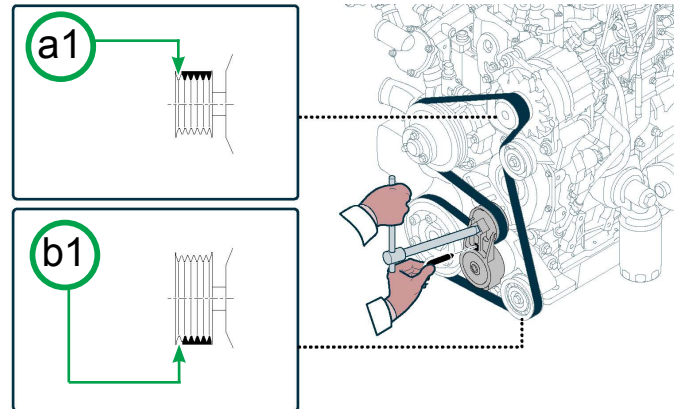
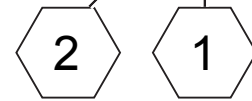
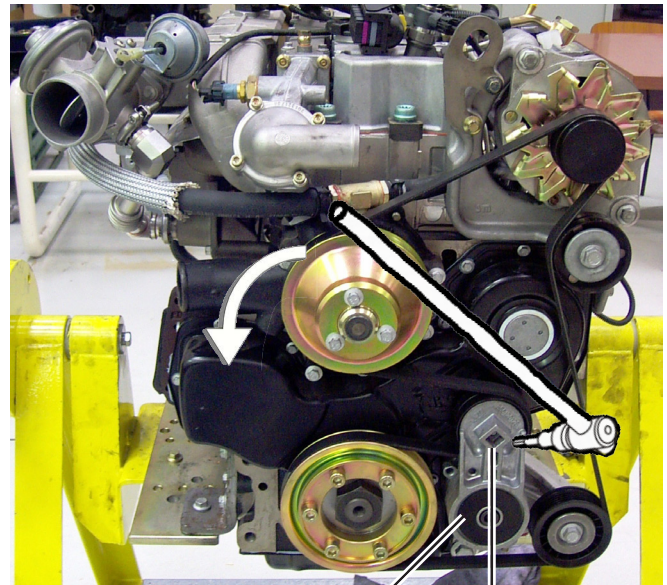
AUTOMATIC TENSIONER - ALTERNATOR BELT

With tensioner installed insert a key commonly available on the market in the seat **1** and rotate the tensioner **2** following the direction of the arrow.

Install the belt and release the tensioner.



IMPORTANT: To correctly align the belt, it must be positioned in the most inner grooves of the alternator pulley (**a1**) and transmission pulley (**b1**).



TURBOCHARGER

Install the turbo and tighten the nuts **7**.

nut 7	32.4 Nm
--------------	----------------

Install the oil delivery pipe to the turbo **1**.

Tighten the nut to the crankcase **5**.

nut 5	32.4 Nm
--------------	----------------

Tighten the union **4**.

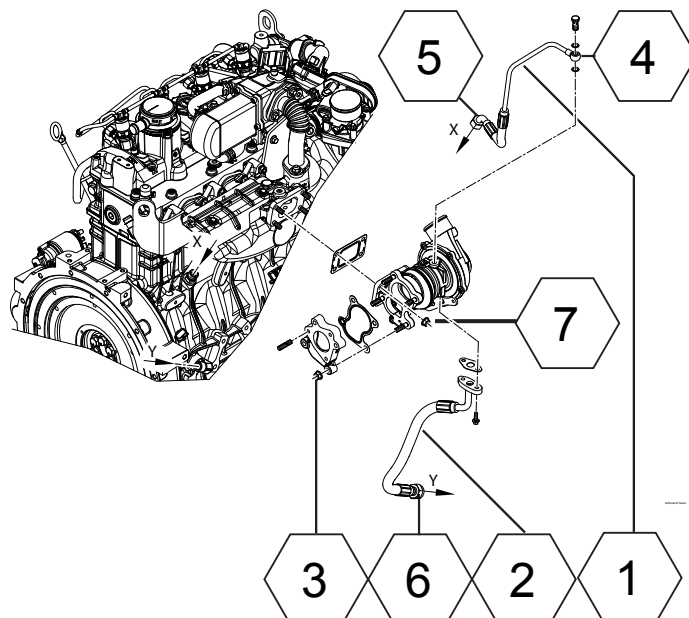
union 4	24.5 Nm
----------------	----------------

Install the oil drain pipe from the turbo **2** and tighten the nut **6**.

nut 6	49 Nm
--------------	--------------

Install the drain flange and tighten the nuts **3**.



nut 3	32.4 Nm
--------------	----------------



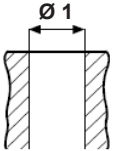
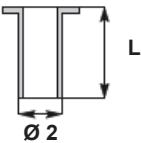

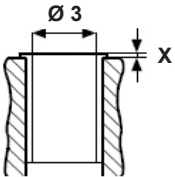
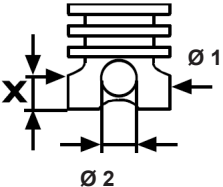

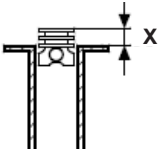
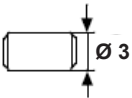

TECHNICAL SPECIFICATIONS	2
Symbols - Service Operations.....	2
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TECHNICAL SPECIFICATIONS

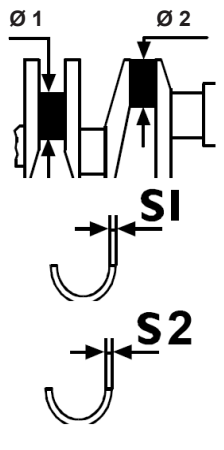

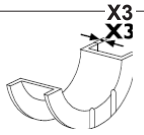
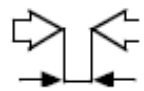
Symbols - Service Operations

 <p>Interference - Forced assembly</p>	 <p>Clearance</p>
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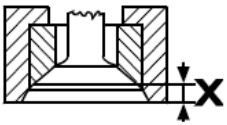





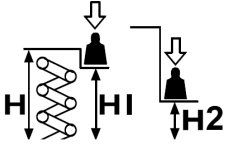
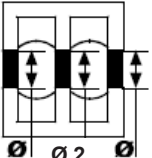
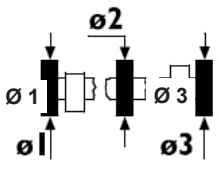
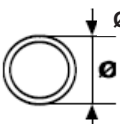
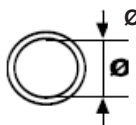


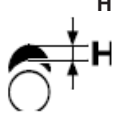


Technical data - dimensional values and tolerances

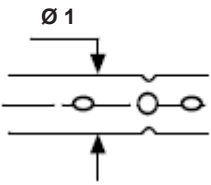
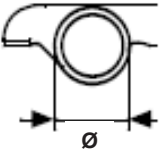
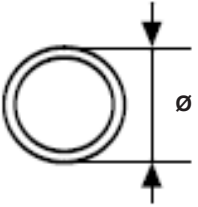
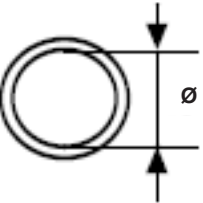


		Type		
PISTON - CYLINDER UNIT				
	Liner seat in the crankcase			
	Ø 1	up	103,020 - 103,080 mm	
		down	101.8 - 102 mm	
	Liner			
	Outer diameter			
	Ø 2	up	109,925 - 109,975 mm	
		down	102.935 - 102.985 mm	
length	L	167.7 - 168 mm		
	Liner clearance - crankcase seat			
	up		-	
	down		-	
	Liner			
	inner Ø	Ø 3	93.995 - 94.015 mm	
	Protrusion/Projection	X	- 0.01 ÷ + 0.07 mm	
	Piston			
	Measurement point	X	18 mm	
	outer Ø (Ø 1)	Ø 1	93,897 - 93.913 mm	
	gudgeon pin seat	Ø 2	32,001 - 32,008 mm	
	Liner - piston clearance		A	0,082 - 0,118 mm
			B	-
	Piston protrusion		X	0.60 - 0.95 mm
	Piston gudgeon pin		Ø 3	31,992 - 31,996 mm
	Gudgeon pin clearance - gudgeon pin seat in piston			0,039 - 0,058 mm

Type			
CONNECTING ROD - PISTON UNIT			
Piston rings			
	Piston ring seat	X1 *	3 mm (nominal)
		X2 *	2.06 - 2.08 mm
		X3 **	3.03 - 3.05 mm
	* measured on 84.9 mm diameter		
** measured on 85 mm diameter			
	trapezoidal - 1st ring	S1 *	2,575 - 2,595 mm
	chamfered - 2nd ring	S2	1,970 - 1,990 mm
	oil scraper - 3rd ring	S3	2.970 - 2.990 mm
	* measured at 1.5 mm from the outer diameter		
	Rings and ring seat clearance	1	/
		2	0.07 - 0.11
		3	0.04 - 0.08 mm
	Ring gap in cylinder seat	X1	0.30 - 0.50 mm
		X2	0.30 - 0.50 mm
		X3	0.30 - 0.60 mm
Connecting rod			
	Gudgeon pin bushing seat con-rod little end	Ø 1	36,000 - 36,025 mm
	Plain bearing seat con-rod big end	Ø 2	57.563 - 57.582 mm
	Classes	A	57.563 ≤ 57.568
		B	57.568 ≤ 57.573
		C	57.573 ≤ 57.578
D		57.578 ≤ 57.583	
	Con-rod little end gudgeon pin bushing diameter		
	installed in little end	Ø 4	32,035 - 32,050 mm
	outer	Ø 3	36,075 - 36,100 mm
	Con-rod plain bearing thickness (S)		
	colour	red	1,790 - 1,795
	colour	blue	1,795 - 1,800
	colour	yellow	1,800 - 1,805
colour	green	1,805 - 1,810	
	Interference between con-rod big end gudgeon pin seat and bushing		0.050 - 0.100 mm
	Weight class	A green	995 - 1009.9 g
		B blue	1009.9 - 1024.9 g
		C white	1024.9 - 1039.9 g
		D yellow	1039.9 - 1055 g
	Measurement point	X	100 mm
	Maximum parallelism error	/	0.08 mm

		Type		
CRANKSHAFT UNIT - MAIN JOURNALS AND CRANK JOURNALS				
	Crankshaft - main journals and crank journals			
	Main journals	Ø 1	front 62.985 - 63.005 mm central 63.005 - 63.020 mm rear 79.985 - 80.000 mm	
	Classes	1	/	
		2	/	
		3	/	
	Crank journals	Ø 2	53,940 - 53,955 mm	
	Classes	1	/	
		2	/	
		3	/	
	Front bushing		1,986 - 1,996 mm	
	Rear bushing		3,150 - 3,300 mm	
	Central bushing	S1		
	Green		1,818 - 1,826 mm	
	Brown		1,812 - 1,820 mm	
	Colour			
	Colour			
	Con-rod plain bearing	S2		
Red		1,790 - 1,795		
Blue		1,795 - 1,800		
Yellow		1,800 - 1,805		
Green		1,805 - 1,810		
*				
	Bushing clearance		front 0.023 - 0.083 mm central 0.008 - 0.051 mm rear 0.045 - 0.085 mm	
	Con-rod plain bearing clearance		0.012 - 0.066 mm	
	Rear shim thickness	X3	Standard 2.310 - 2.360 mm 1st increase (+0.10 mm) 2nd increase (+0.20 mm)	
	Crankshaft axial clearance		0,080 - 0,230 mm	

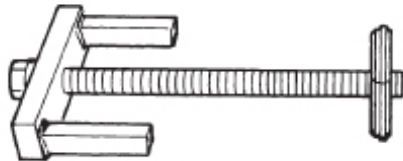
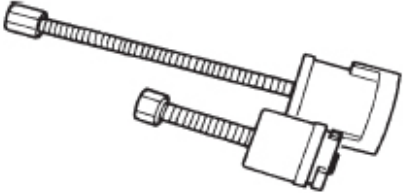
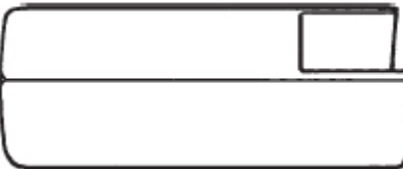

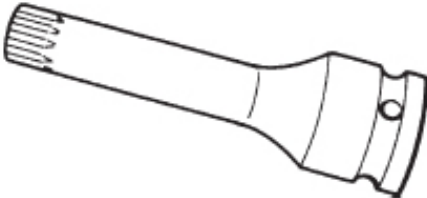
		Type		
HEAD - TIMING SYSTEM UNIT				
	Seat in the head for valve guide	Ø 1	13,992 - 14,008 mm	
	Valve guide (new guides installed in the head)	Ø 2	7.979 - 7.994 mm 7.990 - 8.005 mm	
		Ø 3	14,028 - 14,039 mm	
	Interference between guide and seat in the head			0.02 - 0.047 mm
	Valve			
		Ø 4	7.94 - 7.96 mm	
		Ø 4	7.921 - 7.939 mm	
	Valve stem and relative guide clearance			
				0.03 - 0.065 mm
				0.04 - 0.073 mm
	Valve seat in the head			
		Ø 1	41,962 - 41,985 mm	
		Ø 1	38,964 - 38,988 mm	
	Valve seat outer diameter: valve seat inclination in the head			
		Ø 2	42.070 - 42.086 mm	
		Ø 2	39.050 - 39.066 mm	

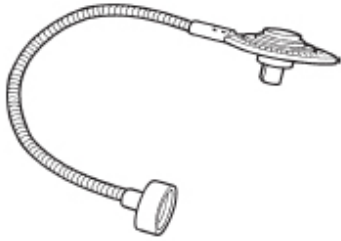
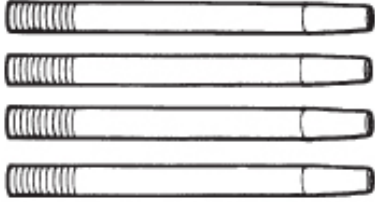

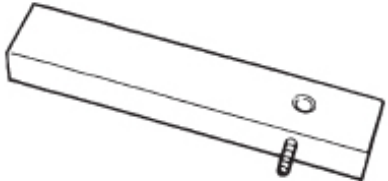
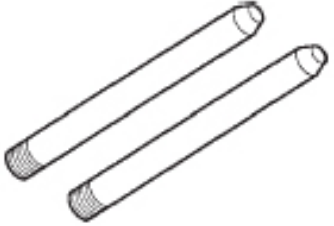

		Type		
HEAD - TIMING SYSTEM UNIT				
	Valve indentation (service limit)		0 - 0.3 mm	
			0 - 0.3 mm	
	Interference between valve housing and housing seat in the head		0,085 - 0,124 mm	
			0,062 - 0,102 mm	
	Valve spring height			
	free height	H	48 mm / 44.65 mm	
	under load of:			
	294 N / 333.5 N (± 6%)	H1	38.5 mm / 38.6 mm	
635 N / 907.4 (± 4%)	H2	28.2 mm		
	Camshaft bushing seat in crankcase	Ø	57.000 - 57.030 mm	
	Camshaft pins	Ø	FRONT 53.495 - 53.510 mm CENTRAL 53.450 - 53.470 mm REAR 53.480 - 53.500 mm	
	Camshaft bushing - outer Ø	Ø	front 57.121 - 57.161 mm central/rear 57,130 - 57,161 mm	
	Camshaft bushing - inner Ø	Ø	FRONT 53.59 - 53.62 mm CENTRAL/REAR 53,550 - 53,600 mm	
	Interference between camshaft bushing and seat in crankcase		FRONT 0,091 - 0,161 mm CENTRAL/REAR 0,100 - 0,156 mm	
	Clearance between bushing and camshaft pins		FRONT 0.08 - 0.125 mm CENTRAL 0.08 - 0.125 mm REAR 0.05 - 0.12 mm	
	Camshaft rise		6,850 mm	
			7,303 mm	

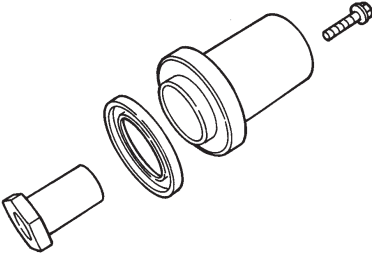
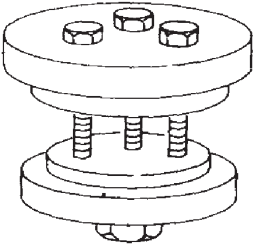
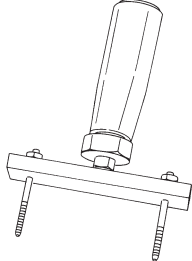

HEAD - TIMING SYSTEM UNIT				
	Rocker arm pin - Ø	Ø 1	21,979 - 22 mm	
	Rocker arm inner Ø	Ø	24,990 - 25,021 mm	
	Rocker arm outer Ø	Ø	25,045 - 25,070 mm	
	Rocker arm bushing inner Ø	Ø	22.03 - 22.05 mm	
	Interference between bushing and rocker arm pin seat		0,024 - 0.08 mm	
	Clearance between rocker arm pin and bushing		0,030 - 0,071 mm	

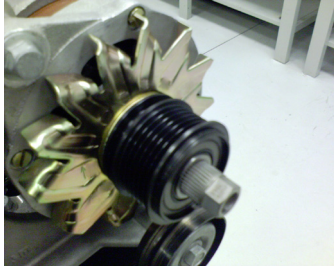


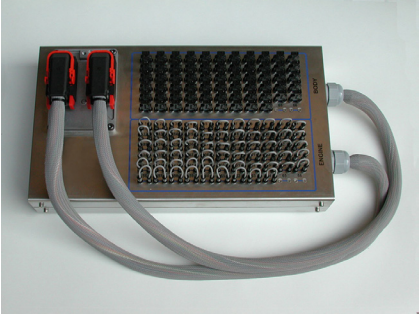
SPECIAL TOOLS..... 2

SPECIAL TOOLS

VM code	Description	Picture
68400012A	Liner puller	
68400015A	Tool for crankshaft and camshaft plain bearing fitting/removal	
68410006A	Tool for crankshaft installation	
68410012F	Tool for hydraulic tappet fitting/removal	
68420016F	XZN wrench for side head screws (12 mm)	
68420015F	XZN wrench for central head screws (14 mm)	

68420019F	Tool for angular wrench	
68460003A	Head centring pins	
68480003A	Tool to prevent crankshaft rotation (to be installed instead of the starter motor)	
68490007A	Tool for liner height measurement	
68460005F	Flywheel centring pins	
68400038F	Crankshaft gear puller (for crankshafts with cylindrical front tail)	

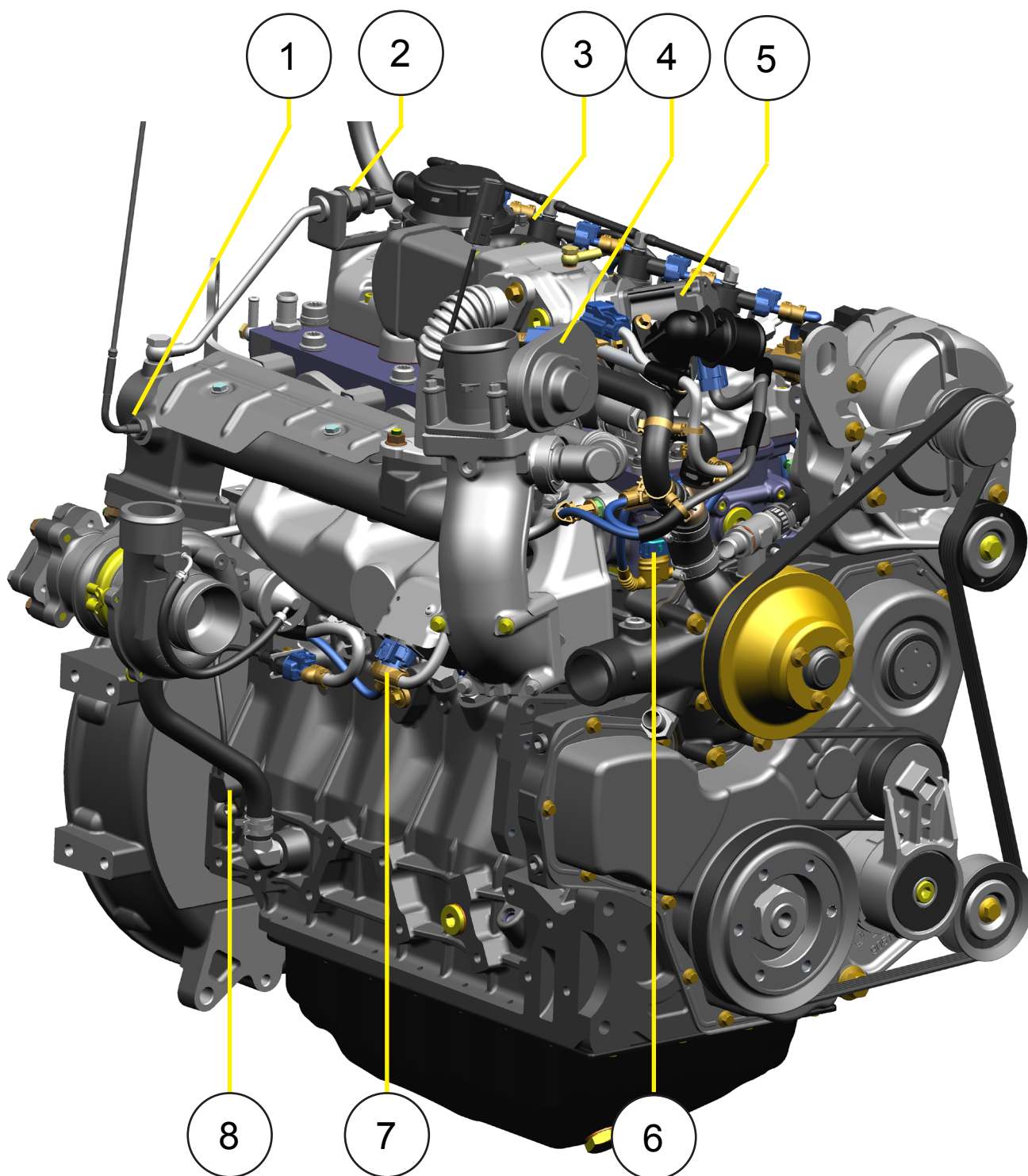
68410013G	Tool for crankshaft front oil seal assembly	
68410010F	Tool for crankshaft rear oil seal assembly	
68480013F	Tool for counter-rotating weight timing (only for engine versions where installed)	
6844009F 68440010F	Plate for head hydraulic leakage test Plate for head hydraulic leakage test with O-rings	

68420022F	Tool for alternator idle pulley removal	
68490040F	Engine test wiring	
68490034F	Adapter for engine compression test	
68500017F 68500016F	Break out box (without jumpers) (with jumpers)	

	<p>Oscilloscope ("PicoScope" type recommended) Tool for the visualisation of the wave shapes of the crankshaft and timing sensor</p>	
<p>68490007F</p>	<p>Tool for belt assembly for linear tensioner (to be applied on the belt)</p> <p>A: belt tensioning B: tensioner spring blockage</p>	
<p>68490039F</p>	<p>Tool for belt assembly for linear tensioner (to be applied on the tensioner)</p>	
<p>68500019F</p>	<p>Diagnosis tool for the R750 engine family</p>	
<p>68480013F</p>	<p>counter-rotating weight timing</p>	

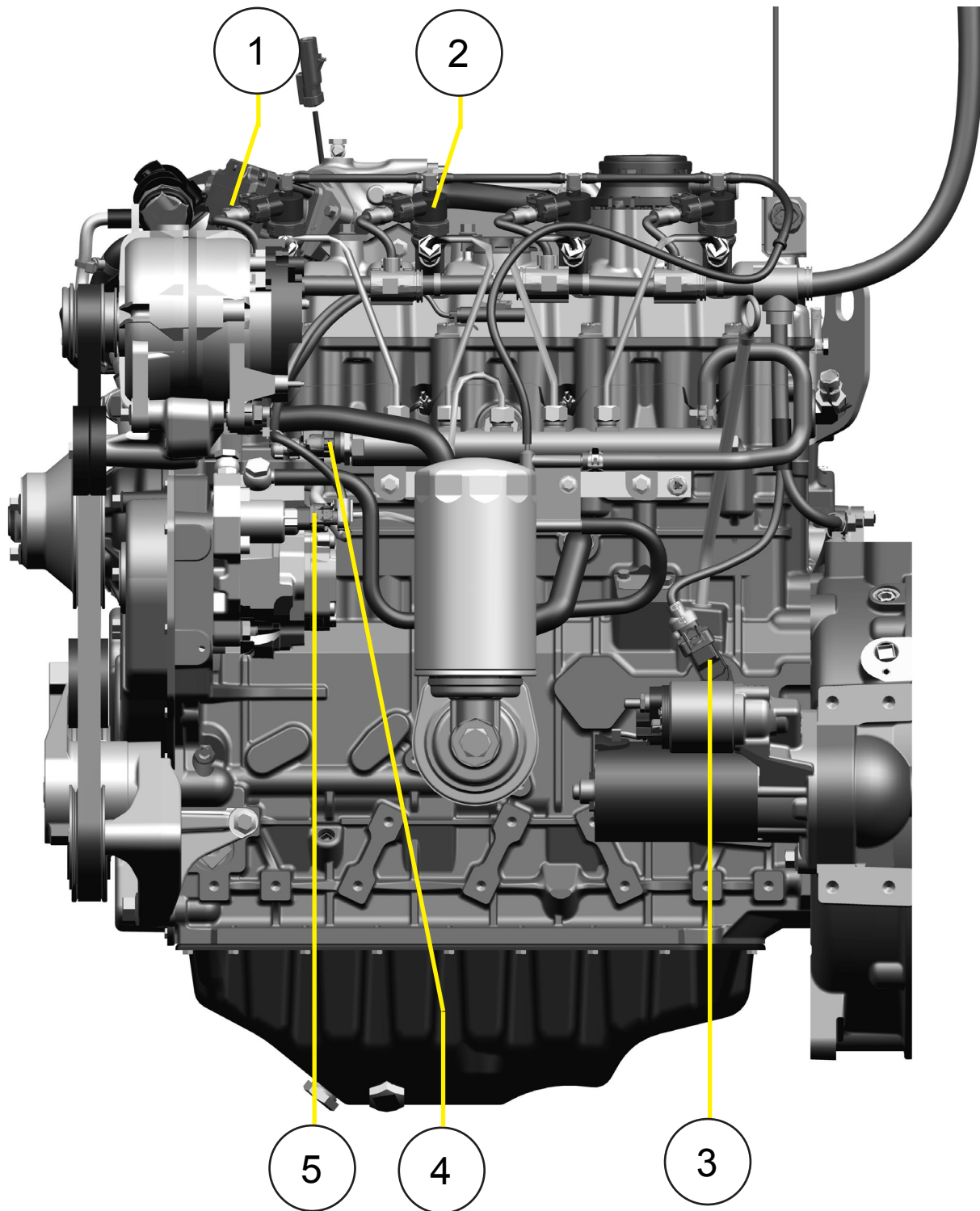
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ELECTRIC / ELECTRONIC SYSTEM

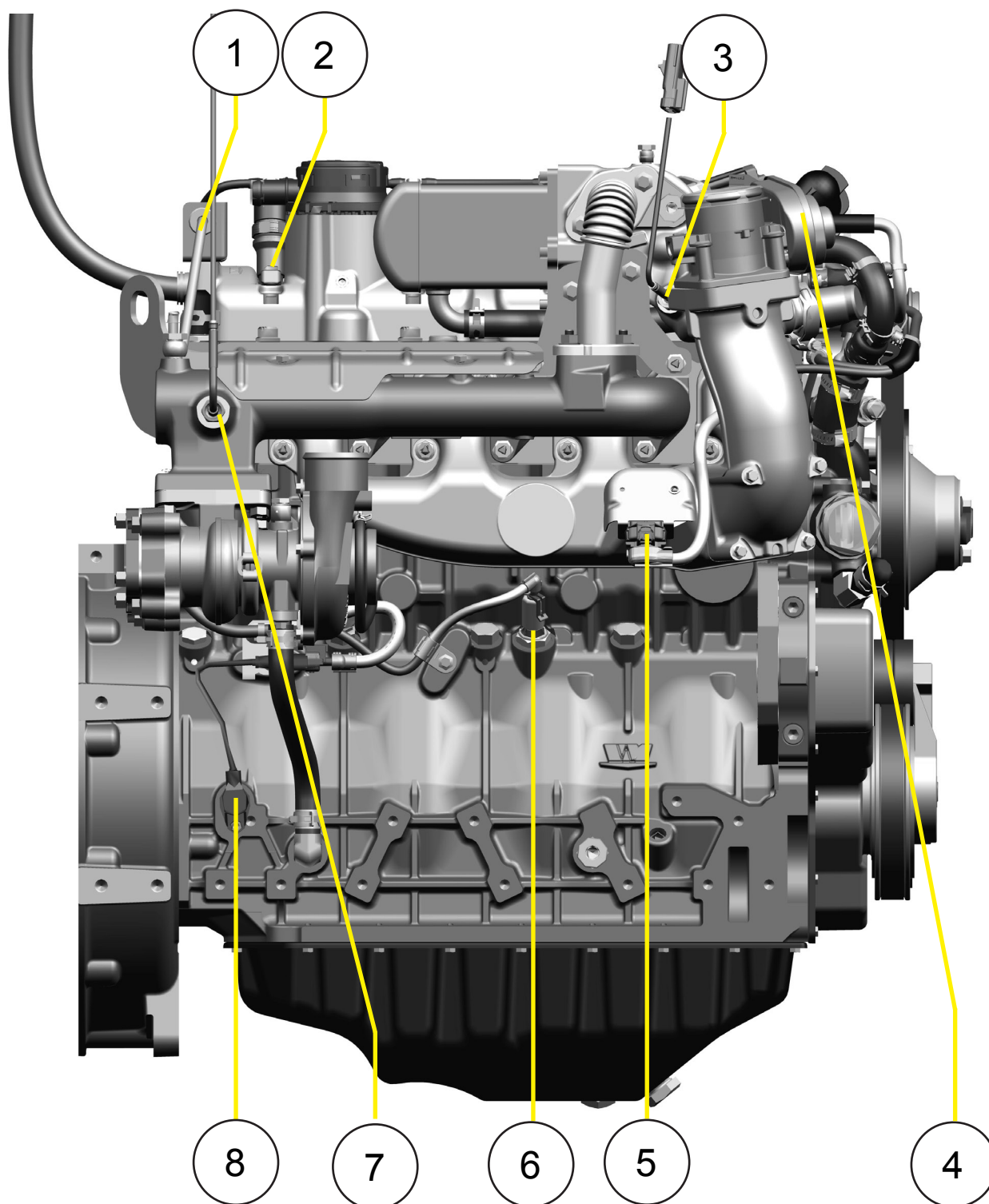


- 1 - exhaust gas T3 temperature sensor
- 2 - exhaust gas P3 pressure sensor
- 3 - injector
- 4 - TVA throttle intake valve

- 5 - EGR exhaust gas recirculation valve
- 6 - coolant temperature sensor
- 7 - air temperature/pressure sensor
- 8 - engine rpm sensor



- 1 - EGR exhaust gas recirculation valve
- 2 - injectors
- 3 - camshaft timing sensor
- 4 - rail pressure sensor
- 5 - MPROP fuel flow rate valve



1 - exhaust gas P3 pressure sensor

2 - injectors

3 - EGR exhaust gas temperature sensor

4 - TVA throttle intake valve

5 - air temperature/pressure sensor

6 - engine oil pressure manostat

7 - exhaust gas T3 temperature sensor

8 - engine rpm sensor

ELECTRIC SENSORS - INSTALLATION

- 1 - exhaust gas P3 pressure sensor
- 2 - EGR temperature sensor
- 3 - exhaust gas T3 temperature sensor

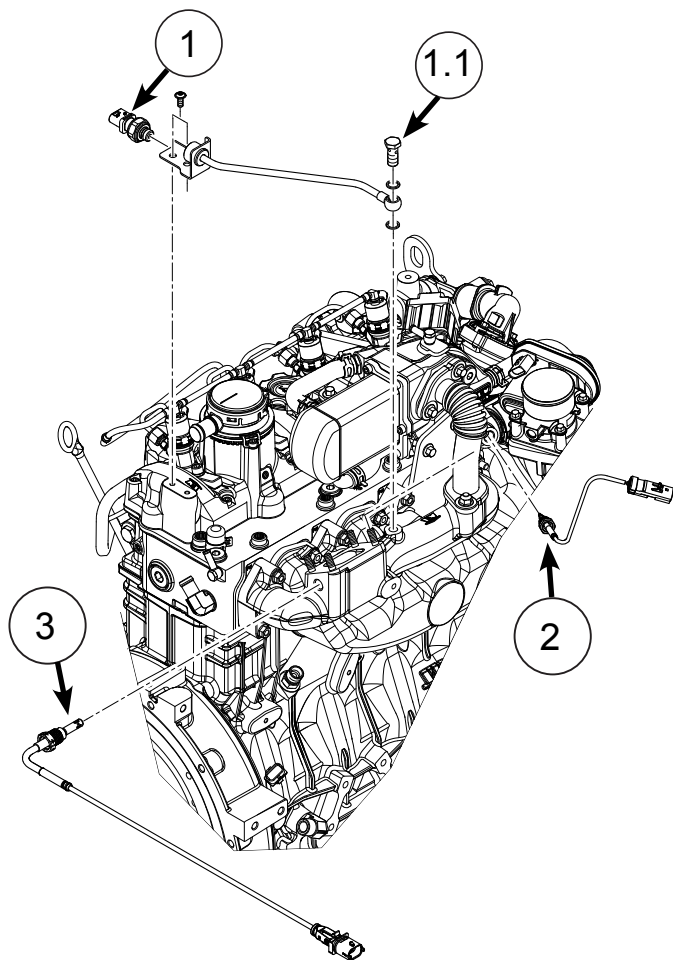


IMPORTANT: correct tightening of exhaust gas 1 pressure sensor:

pre-fit the union and the relevant gaskets on the pipe eyelet: smear ORAPI PATE HT 900 anti-seize paste on the thread of the union and position the pipe moving both the union and the rocker arm cover fastening screws closer to the manifold, without tightening. Calibrate following the sequence below:

- 1) sensor bracket screws (10.8 Nm)
- 2) Union (27.5 Nm)
- 3) Sensor (14 Nm)

1 - exhaust gas P3 pressure sensor	14 Nm
1.1 - exhaust gas pressure sensor pipe union	27.5 Nm
2 - EGR temperature sensor	24.5 Nm
3 - exhaust gas T3 temperature sensor	45.1 Nm

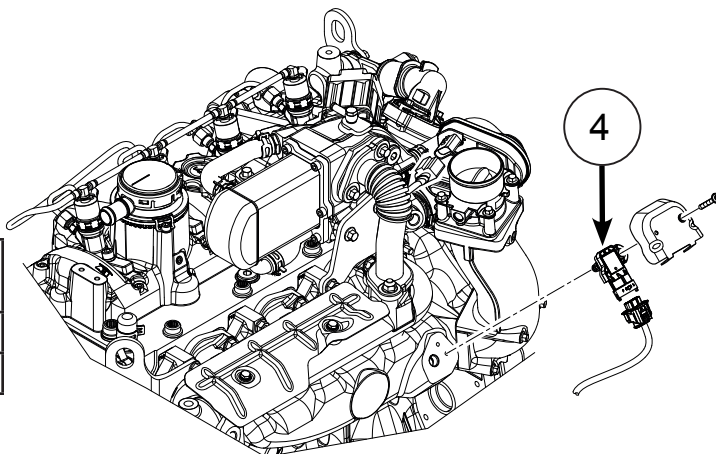


- 4 - air pressure/temperature sensor in the intake manifold



IMPORTANT: lubricate the O-ring with Molykote 111 grease

4 - air pressure/temperature sensor in the intake manifold	0.51 Nm

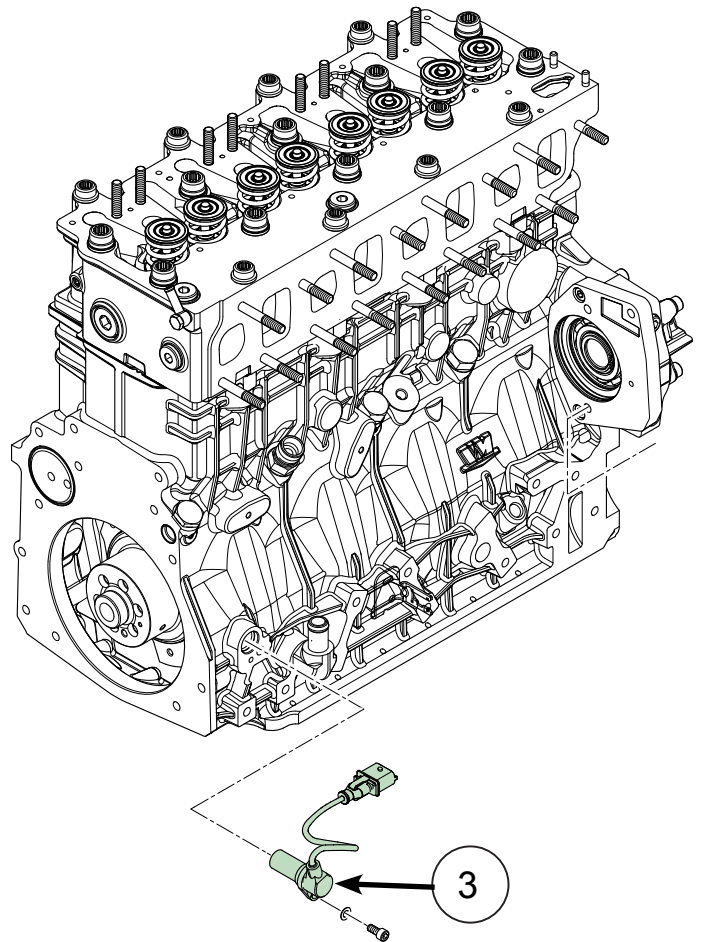
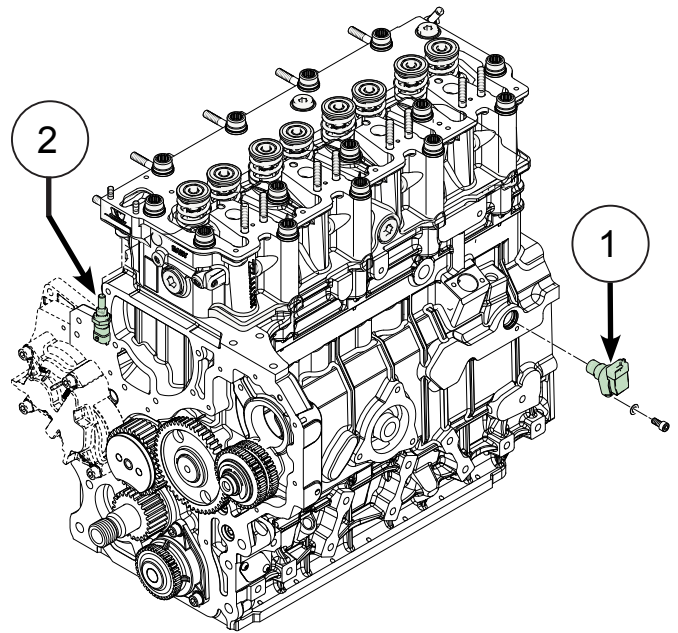


- 1 - camshaft timing sensor
- 2 - coolant temperature sensor
- 3 - crankshaft position rpm sensor

1 - camshaft timing sensor	10.8 Nm
2 - coolant temperature sensor	14.2 Nm
3 - crankshaft position rpm sensor	10.8 Nm

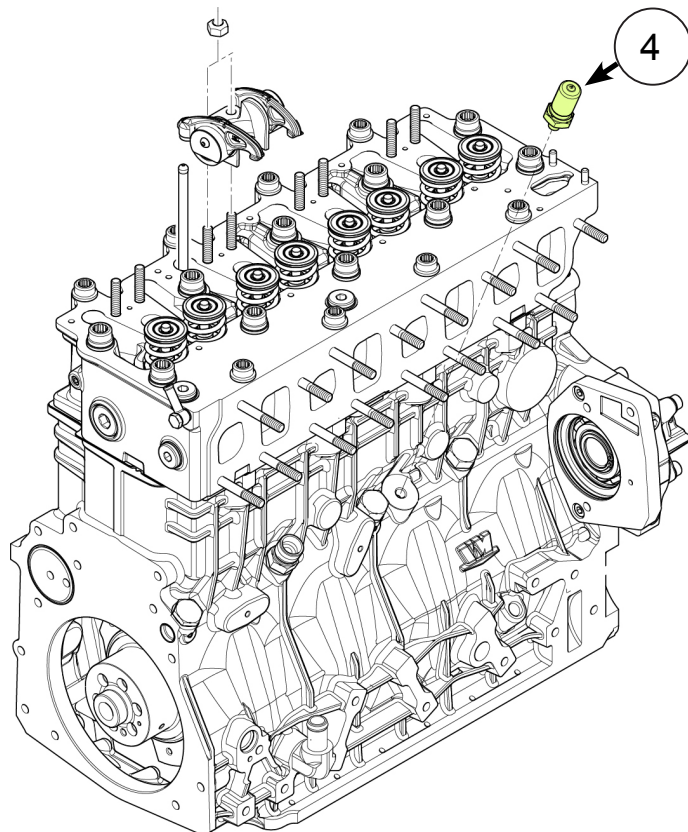


IMPORTANT: smear Loctite 510 on the threading of the coolant temperature sensor



4 - Engine oil pressure manostat

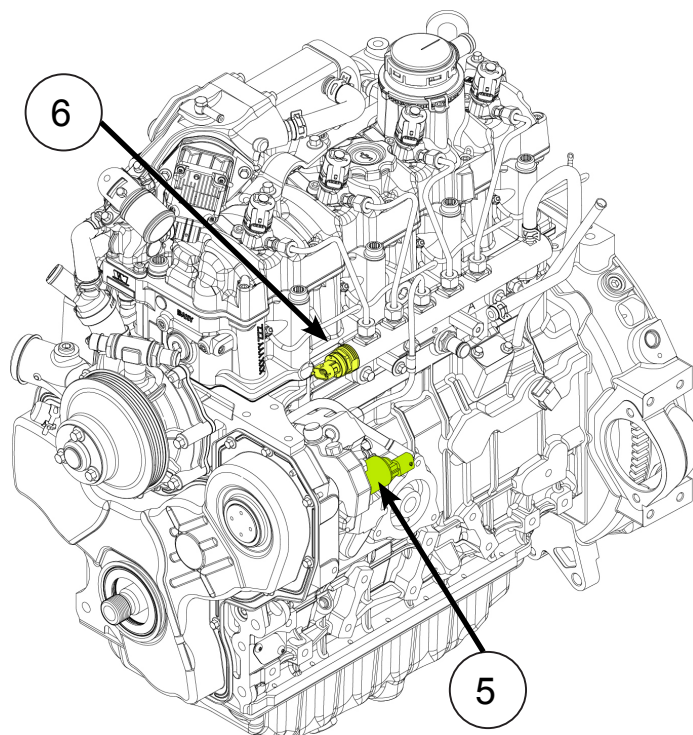
4 - engine oil pressure - switch	34.3 Nm



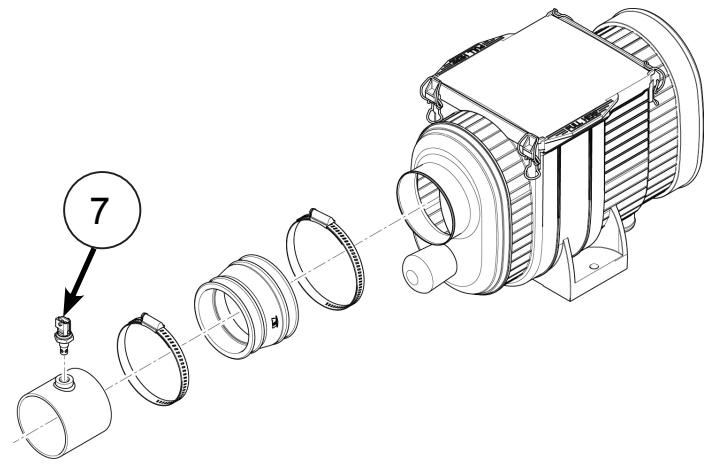
5 - MPROP fuel flow rate valve

6 - Rail pressure sensor

6 - rail pressure sensor	70 Nm



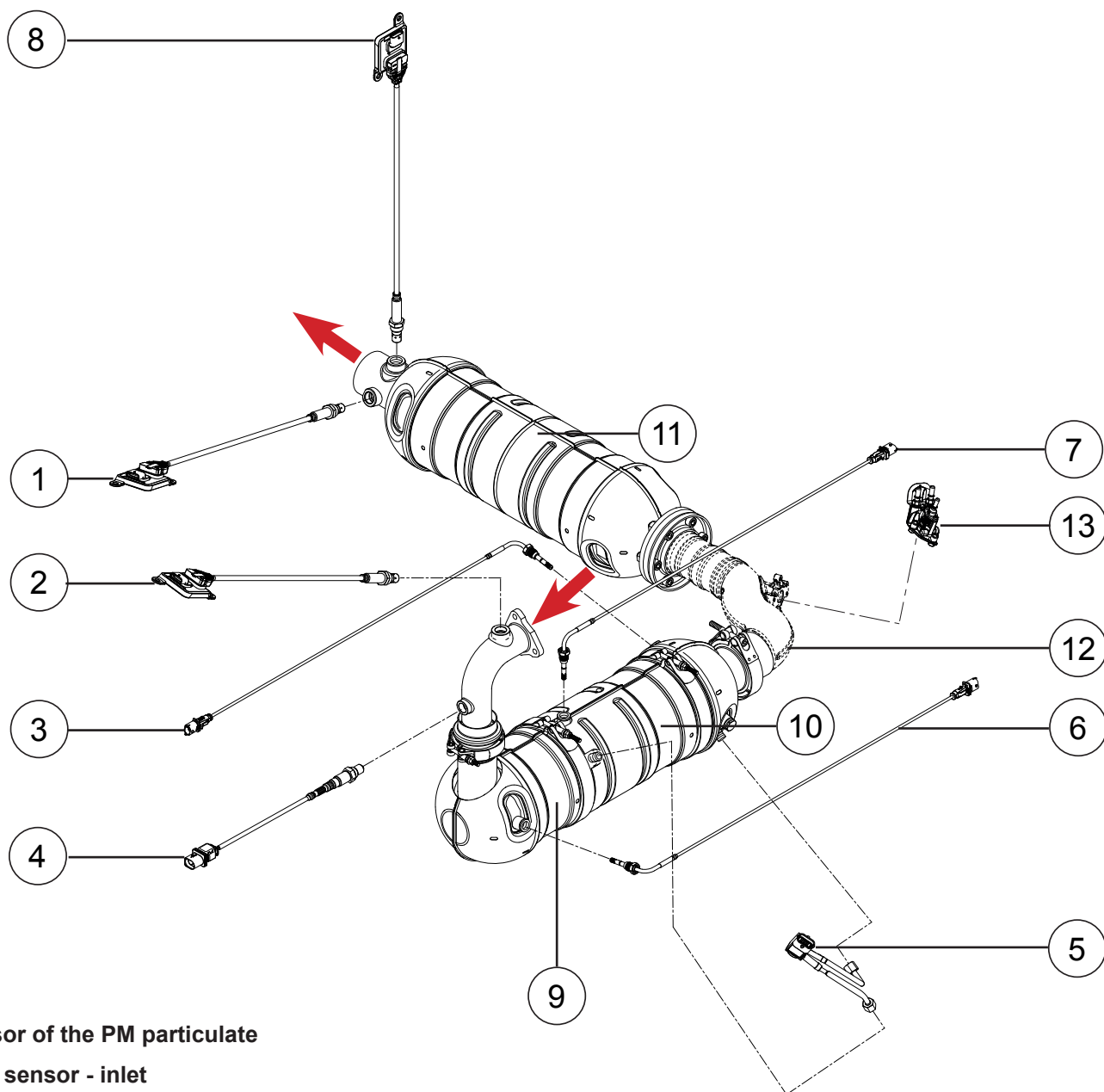
7 - Ambient temperature sensor



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AdBlue pump - Pumping module.....	5
AdBlue pump filter	5
AdBlue tank	6

EXHAUST SYSTEM

EXHAUST SYSTEM LAYOUT



- 1 - sensor of the PM particulate
- 2 - NOx sensor - inlet
- 3 - SCR temperature sensor - inlet / DPF outlet
- 4 - lambda sensor
- 5 - DPF differential pressure sensor
- 6 - DOC temperature sensor - inlet
- 7 - DPF temperature sensor - inlet
- 8 - NOx sensor - outlet
- 9 - DOC catalyst filter
- 10 - DPF particulate filter
- 11 - SCR catalyst
- 12 - AdBlue mixer
- 13 - Injector / AdBlue dosing module

1 - sensor of the PM particulate	14 Nm
2 / 8 - NOx sensor	50 ± 10 Nm
3 / 7 - DPF/SCR temperature sensor	45 ± 4.5 Nm
4 - lambda sensor	45 ± 4.5 Nm
6 - DOC temperature sensor	45 ± 4.5 Nm



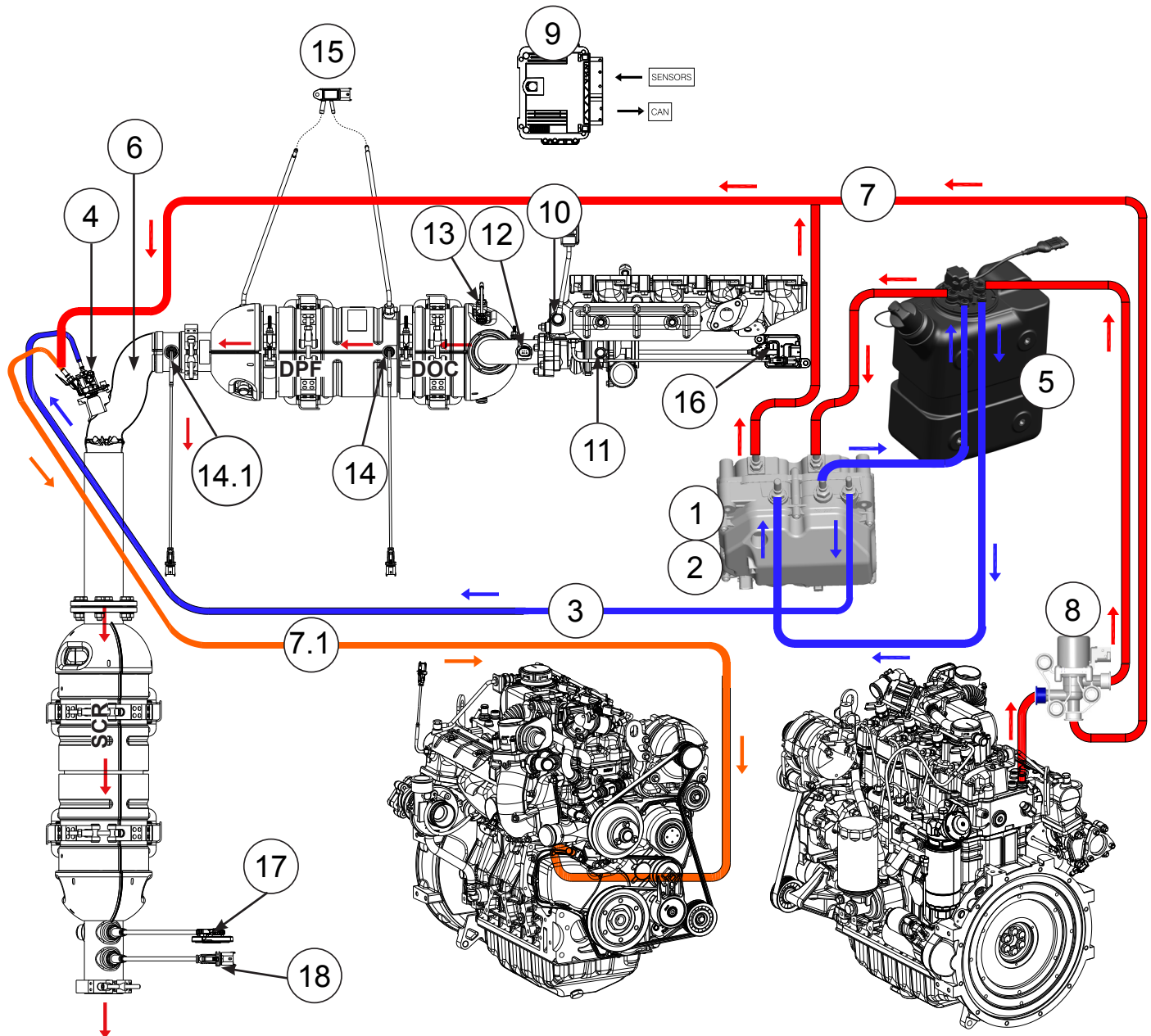
IMPORTANT: the pastes to be applied on the threading of the sensor before installing it are listed below.

For the DPF and DOC sensors (3,7,6) use an anti-seize paste for high temperatures.

For the NOx sensors (2,8) use a Weicon "High Tech" anti-seize paste.

For the lambda sensor (4) and for the PM particulate sensor (1) use an Optimol anti-seize paste.

AdBlue CIRCUIT



- | | |
|---|---------------------------------------|
| 1 - AdBlue pump - Dosing module | 13 - DOC temperature sensor |
| 2 - AdBlue pressure sensor (inside the AdBlue pump) | 14 - DPF temperature sensor |
| 3 - AdBlue line | 14.1 - SCR temperature sensor |
| 4 - AdBlue dosing unit - Injector | 15 - DPF differential pressure sensor |
| 5 - AdBlue tank | 16 - NOx sensor - SCR |
| 6 - AdBlue Mixer | 17 - NOx sensor - SCR |
| 7 - 7.1 Engine coolant line | 18 - sensor of the PM particulate |
| 8 - 3-way valve | |
| 9 - Engine electronic management control unit | |
| 10 - Exhaust gas P3 pressure sensor | |
| 11 - Exhaust gas T3 temperature sensor | |
| 12 - Lambda sensor | |

AdBlue INJECTOR - DOSING UNIT

1 - engine coolant pipe connections

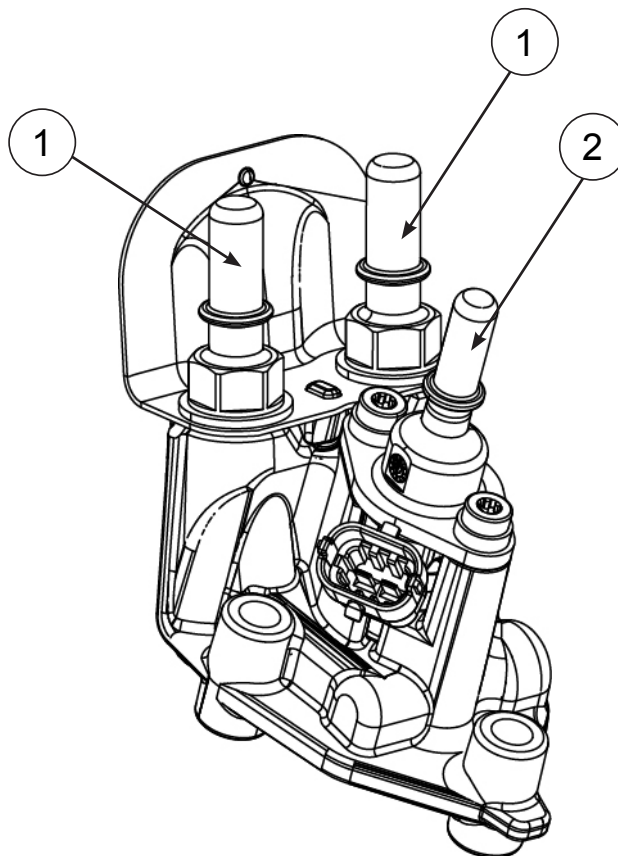
2 - AdBlue pipe connection

Install the injector with its gasket in the AdBlue Mixer.

Lubricate the fastening screws using a Teflon fluid.

Tighten the screws until the gasket is seated correctly on the flange.

Tighten the screws to **8 +/- 2 Nm**.



AdBlue PUMP - PUMPING MODULE

1 - engine coolant pipe connections

2 - AdBlue pipe connection:

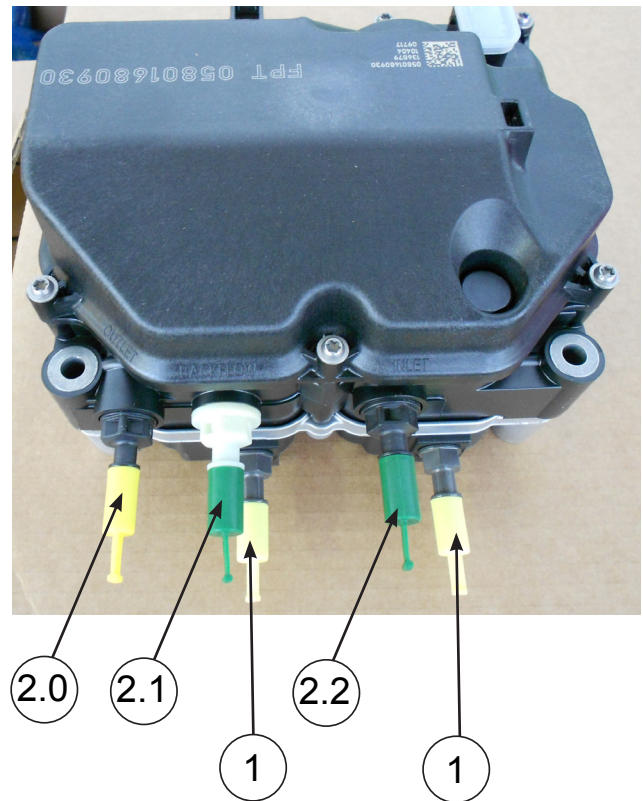
2.0: outlet / 2.1: return / 2.2: inlet

Install the injector with its gasket in the AdBlue Mixer.

Lubricate the fastening screws using a Teflon fluid.

Tighten the screws until the gasket is seated correctly on the flange.

Tighten the screws to **8 +/- 2 Nm**.



AdBlue PUMP FILTER

Unscrew the cover and extract the filter.

Fit a new cartridge and tighten the cover to **20 +/- 5 Nm**.



AdBlue TANK

- 1 - engine coolant pipe connections - outlet
- 2 - engine coolant pipe connections - return
- 3 - AdBlue pipe connections - return
- 4 - AdBlue pipe connections - outlet
- 5 - level, temperature, Adblue quality sensor

