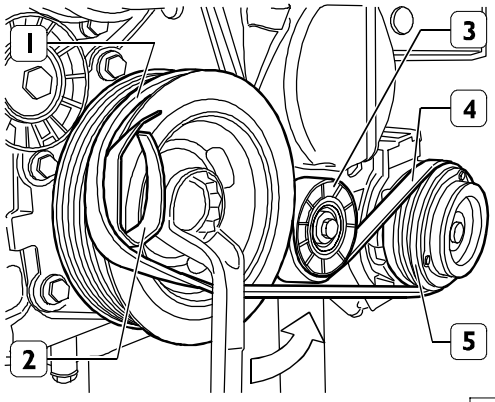
SECTION 6
Removal - refitting of main components

AIR CONDITIONING COMPRESSOR DRIVE BELT REPLACEMENT

For motor F1CE3481C*C124

Removal

Figure 1



102201

Position the vehicle over the service pit or on the lift. Remove the middle soundproofing guard from under the vehicle.
Remove the flexible belt (4) from the pulleys (1 and 5).

Refitting

Fit the 99360186 drift (2) to pulley (1) with the elastic belt (4), and position the belt on roller (3) and pulley (5), making sure to fit the ribs of the belt in the grooves in the pulleys (1 and 5).

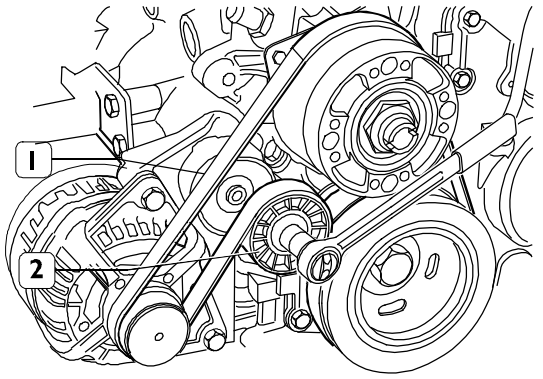
Turn the crankshaft anticlockwise (→) until the belt (4) is completely fitted onto the pulley (1).

WATER PUMP-ALTERNATOR DRIVE BELT REPLACEMENT

For motor F1CE3481C*C124

Removal

Figure 2



88330

Disassemble the compressor drive belt, as described in the relevant chapter.
Using the specific wrench on the automatic belt tensioner (2), reduce the tension of the belt (1) and remove it.

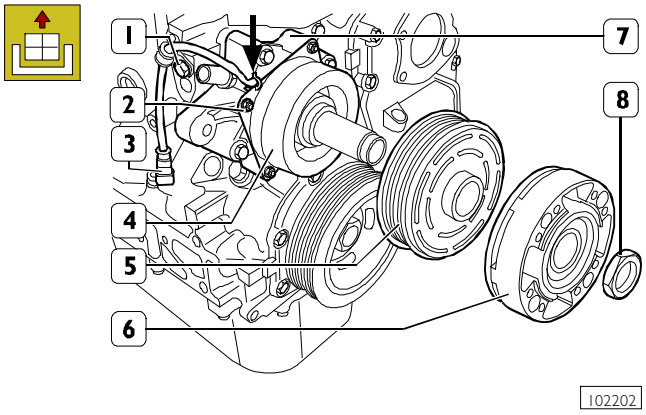
Refitting

Mount the drive belt (1) taking care to position its ribs correctly in the respective races of the pulleys. Release the automatic tightener (2). Rotate crankshaft by one revolution to settle the belt.

Mount the compressor drive belt, if there is one, and adjust the tension as described in the relevant chapter.
Fit the middle soundproofing guard back on.

Removal

Figure 3



Drain off the coolant.
Remove the fan from the electromagnetic coupling.
Remove the water pump/alternator drive belt, as described in the relevant chapter.
Disconnect electrical connection (3) from the engine cable.
Lock the rotation of the electromagnetic coupling (6) and remove nut (8).

NOTE Unscrew nut (8) in a clockwise direction to undo it as it is left-handed.

Remove the hub (6) and pulley (5).
Cut the clamp (→), remove the bolt (1) securing the cabling clamp (3), remove the nuts (2) and detach the electromagnet (4) from the water pump (7).
Remove the bolts and take off the water pump (7).

Refitting

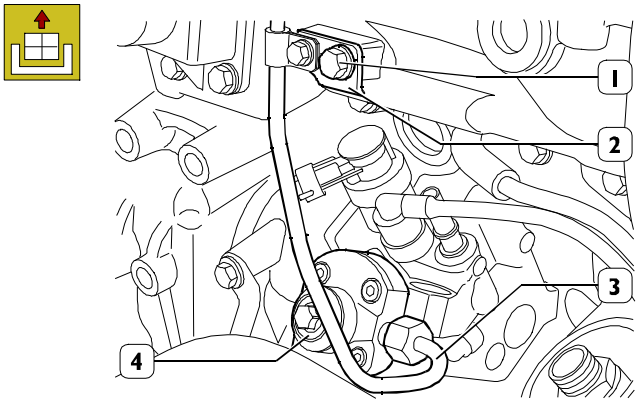
To install, carry out the operations described in the removal process in reverse order, tightening the screws and nuts to the specified torque.

Once installed, fill the engine coolant circuit, start the engine and check for coolant leaks.

HIGH PRESSURE PUMP REPLACEMENT

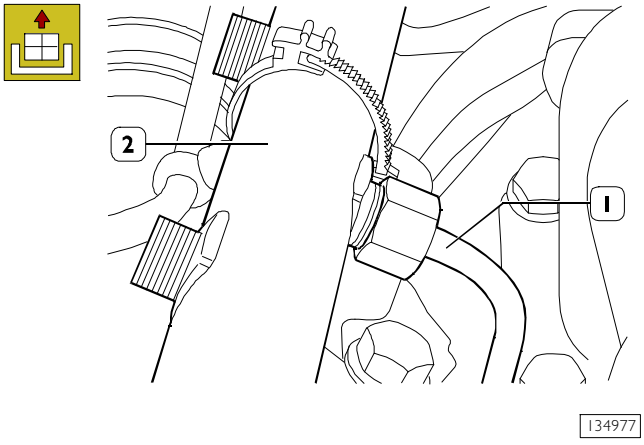
Removal

Figure 4



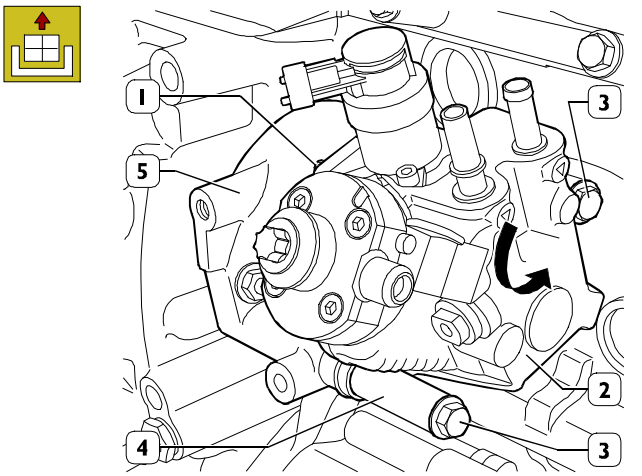
Remove the bolt (1) securing the bracket (2) for the high pressure pipe.
Connect the oil drain pipe (3) to the high pressure turbine (4).

Figure 5



Disconnect the high pressure fuel pipe (1) from the hydraulic accumulator (2).

Figure 6

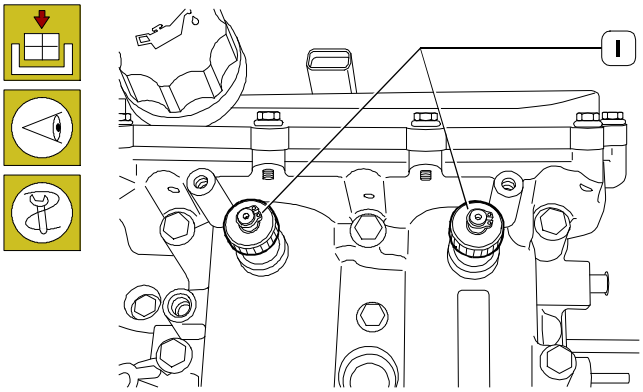


135001

Unscrew and remove the screw (1). Unscrew and remove screws (3) with their washers (4). Remove the high-pressure pump (2) from its support (5).

Refitting

Figure 7



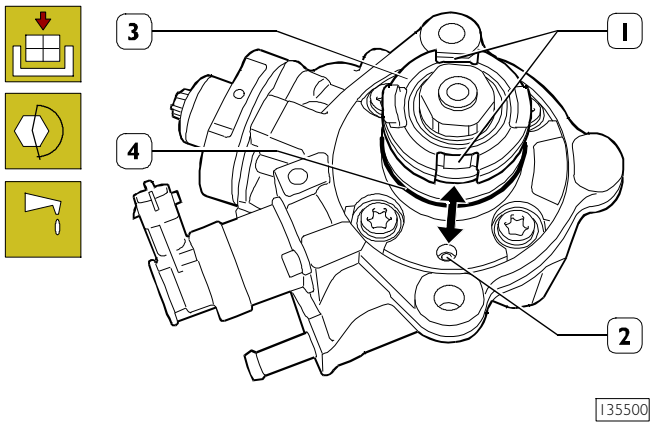
134999

NOTE To reinstall the high pressure pump, the camshafts and crankshaft must be in phase.

Remove the inspection caps from the overhead and turn the crankshaft with a suitable wrench until you can see the cam shaft timing hole, and fit 99360614 tool (1).

NOTE Two revolutions of the crankshaft correspond to one revolution of the camshafts.

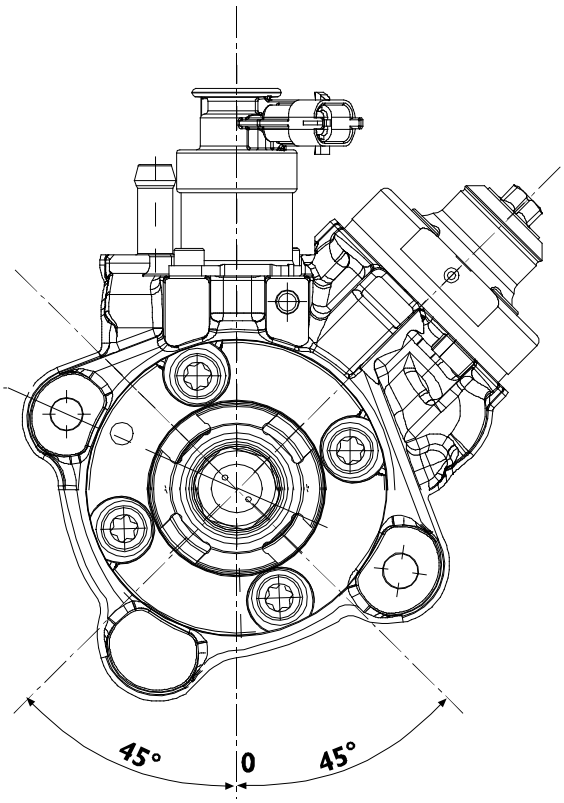
Figure 8



135500

Lubricate a new seal ring (4) and fit it to the high pressure pump.
Make sure the flange (3) is fitted to the high pressure pump.
Make sure the high pressure pump is in a stable position, with the one of the two recesses (1) on the flange (3) in line with the reference on the pump itself (2).

Figure 9



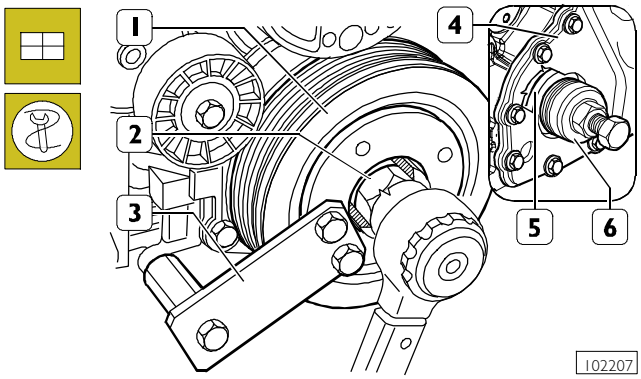
135043

Vertical mounting position

CRANKSHAFT FRONT SEALING RING REPLACEMENT

Removal

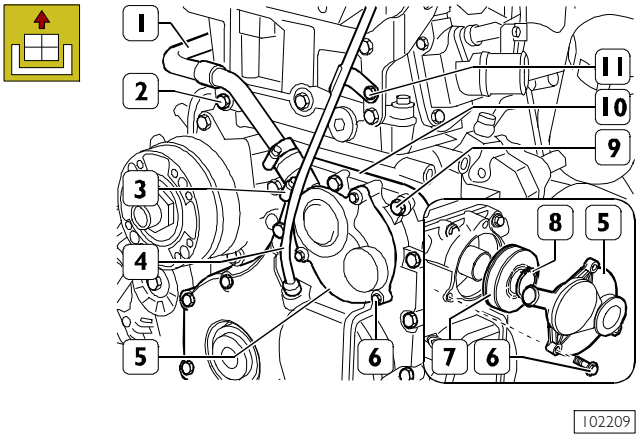
Figure 10



Lock crankshaft rotation with a suitable tool (3), remove the screw (2) and detach the damper pulley (1).
Use 99340059 tool (6), as shown, to remove the seal ring (5) from the cover (4).

NOTE To replace the seal ring only (5) (operation 540442), insert the seal ring into the cover (4), as described in Figure 12.

Figure 11



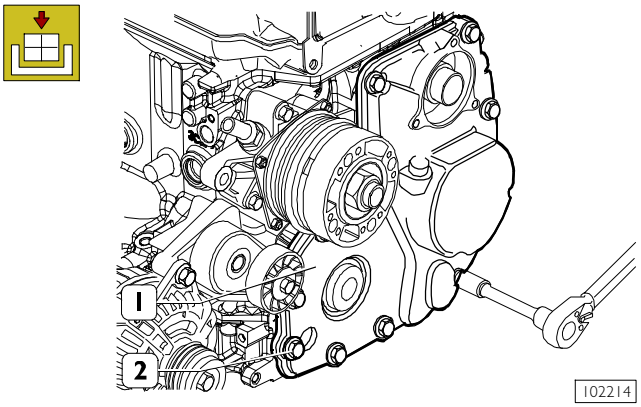
Remove the screw (11) and remove the oil dipstick pipe (4).
Loosen clamp (3), remove screw (2) and remove the pipe (1) from the cover (5).
Remove the screws (6) and the cover (5). Remove the circlip (8). Pull out the centrifugal filter (7).

NOTE The centrifugal filter (7) and cover seal ring (5) must be replaced each time the cover is removed.

Remove the screws (9) and remove the front cover (10).

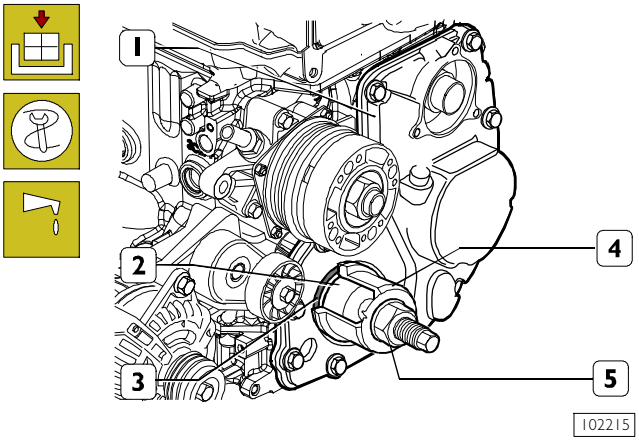
Refitting

Figure 12



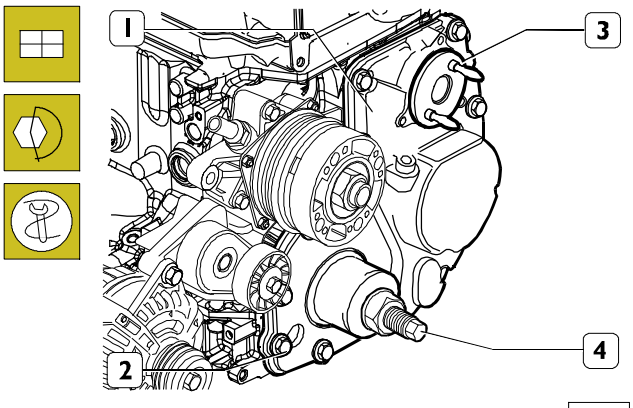
Fit the cover (1) with a new gasket. Screw down screws (2) without tightening fully.

Figure 13



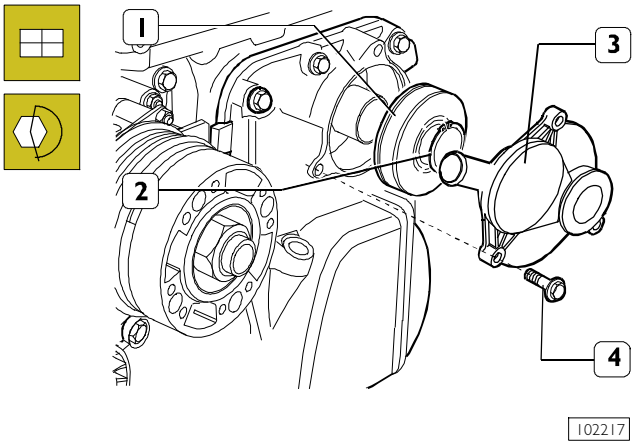
Thoroughly clean the seat of the cover seal ring (1).
Screw part (2) of 99346258 tool into the crankshaft.
Lubricate the shank of the crankshaft and the outer surface of part (2) and fit the new seal ring (3).
Position part (4) on part (2); screw down the nut (5) to fit the seal ring (3) fully inside the cover (1).

Figure 14



Fit 99396039 tool (3) for centring the cover (1) into the set of the centrifugal filter and tighten the screws (2) to the specified torque. Remove 99346258 (4) and 99396039 (3) tools.

Figure 15



Fit a new centrifugal filter (1).
Install a new circlip (2).
Fit the cover (3), and tighten the screws (4) to the specified torque.

NOTE The centrifugal filter (1) and cover seal ring (2) must be replaced each time the cover is removed.

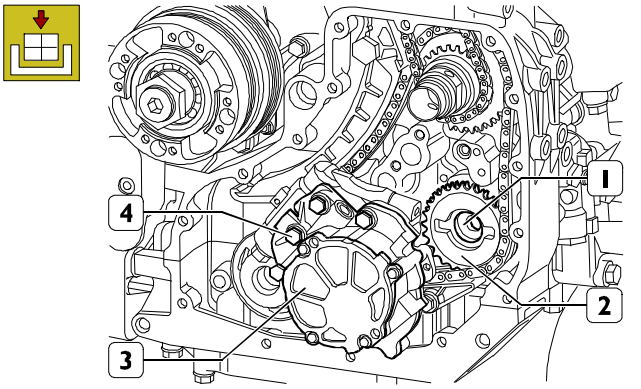
To install the part, repeat the operations described in the removal process in reverse order, tightening the screws and nuts to the specified torques.
Once installed, top up the engine cooling system, and check the oil level of the engine, topping up if necessary. Start the engine and check for coolant leaks.

VACUUM OIL PUMP UNIT (GPOD) REPLACEMENT

Removal

Remove the front cover as described in the relevant chapter.

Figure 16



Remove the screws (3) and remove the oil pump - vacuum pump assembly (2).
Remove the coupling (1) from the gear (4).

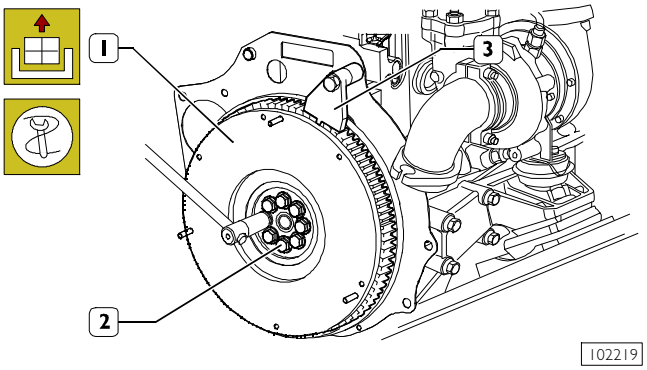
Refitting

Position the coupling (1) on the gear (4).
Fit the vacuum-oil pump assembly (2) inserting a new gasket.
Fasten the screws (3) and tighten to the specified torque.
To install the part, repeat the operations described in the removal process in reverse order, tightening the screws and nuts to the specified torques.
Once installed, top up the engine cooling system, and check the oil level of the engine, topping up if necessary. Start the engine and check for coolant leaks.

CRANKSHAFT REAR SEAL RING REPLACEMENT

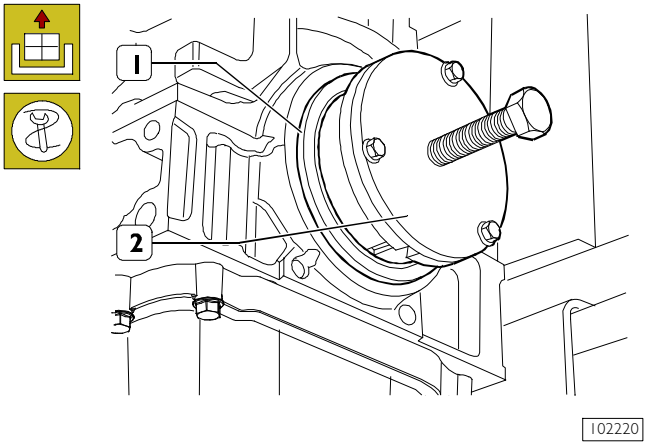
Removal

Figure 17



Lock rotation of the flywheel (1) with 99360306 tool (3).
Take out the screws (2) and remove the flywheel (1).

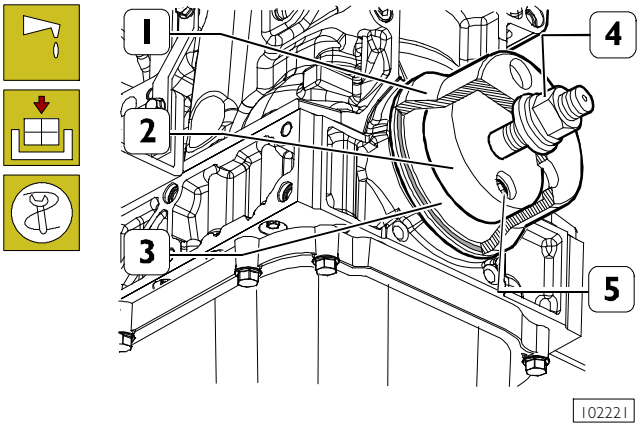
Figure 18



Apply 99340060 tool (2) to the rear seal ring (1) and extract it from the crankcase.

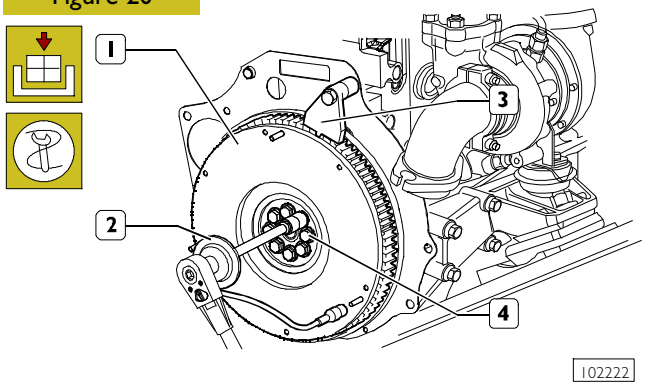
Refitting

Figure 19



Thoroughly clean the seal ring seat.
Lubricate the rear end of the crankshaft with engine oil.
Fit part (2) of tool 99346259 onto the rear end of the crankshaft; secure it with the screws (5) and key the fresh seal (3) onto it.
Position part (1) over part (2); tighten the nut (4) to fit the seal ring (3) fully inside the crankcase.

Figure 20



Mount the flywheel (1) and screw down the screws (4).
Fit 99360306 tool (3) onto the crankcase to lock rotation of flywheel (1).
Tighten the screws (4) securing the flywheel (1) in two steps:

- ❑ Stage 1: with a torque wrench, to a torque of 30 Nm;
- ❑ Stage 2: tightening to 90°angle.

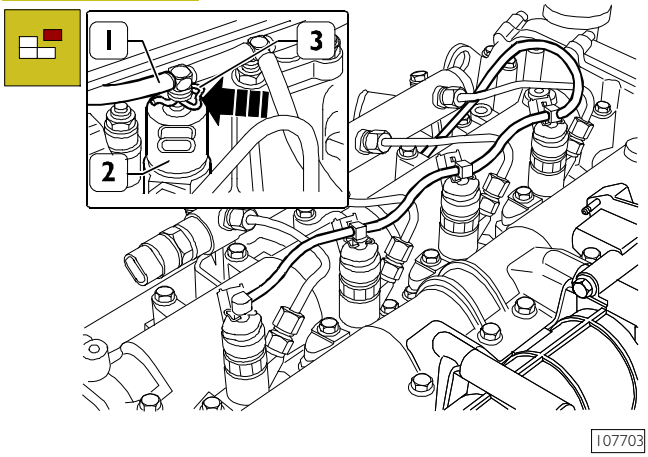
NOTE Use 99395216 tool (2) for angle tightening.

Remove 99360306 tool (3).
Now install the clutch, gearbox and drive shaft, as described in the relevant sections of this manual.

REPLACEMENT OF INJECTORS

Injector recovery pipe removal

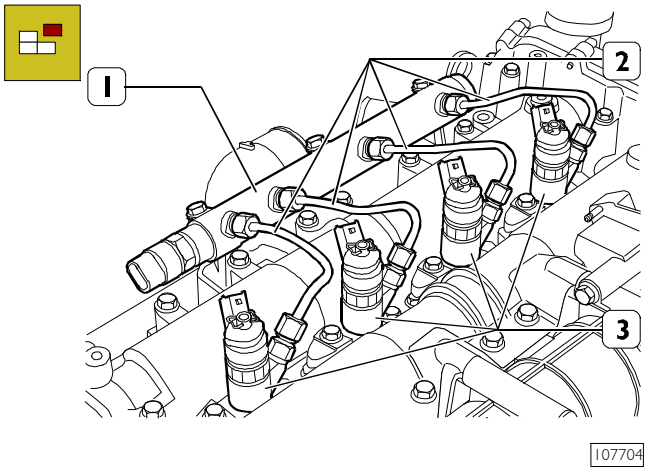
Figure 21



Press the springs (3) in the direction indicated by the arrow and disconnect the pipe unions (1) recovering fuel from the electro-injectors (2).

Injector delivery fuel pipe removal

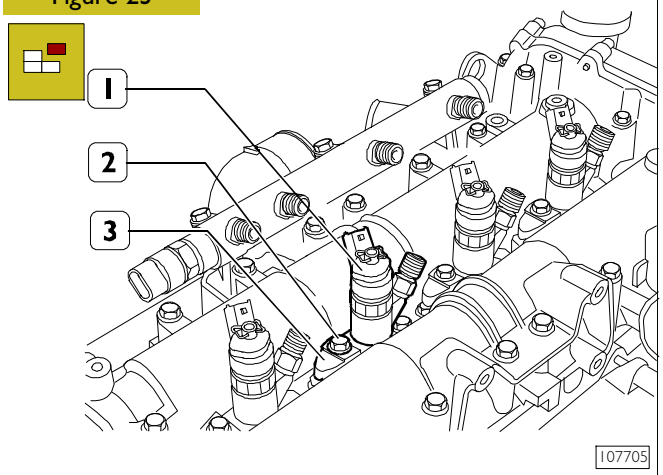
Figure 22



Disconnect the fuel pipes (2) from the electro-injectors (3) and from the hydraulic accumulator (1) (rail).

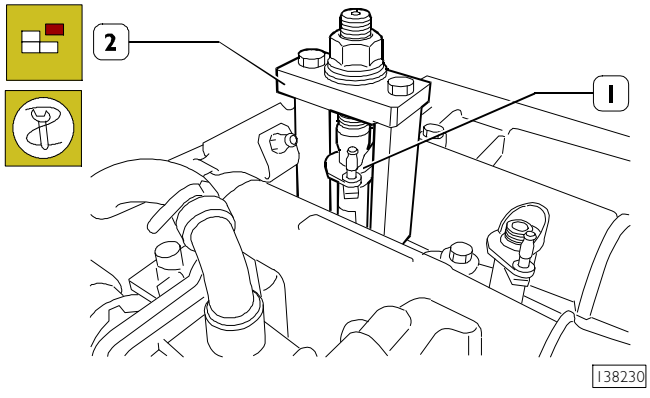
Injector removal

Figure 23



Remove the screws (2) and the brackets (3) fixing the electro-injectors (1) to the cylinder overhead.

Figure 24

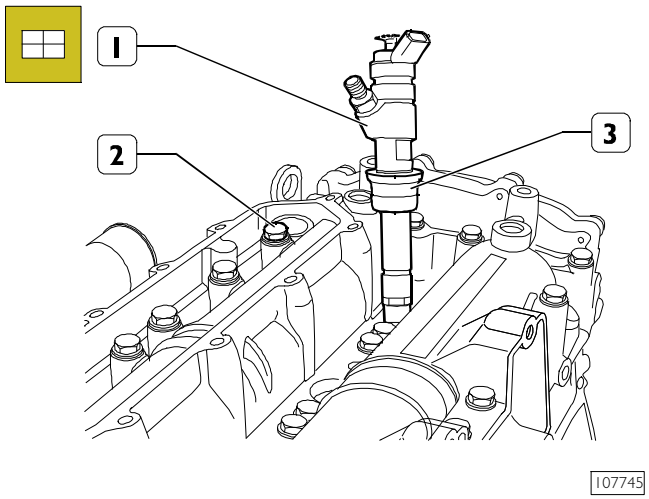


Remove the screws (2) and the brackets (3) fixing the electro-injectors (1) to the cylinder overhead.

Refitting

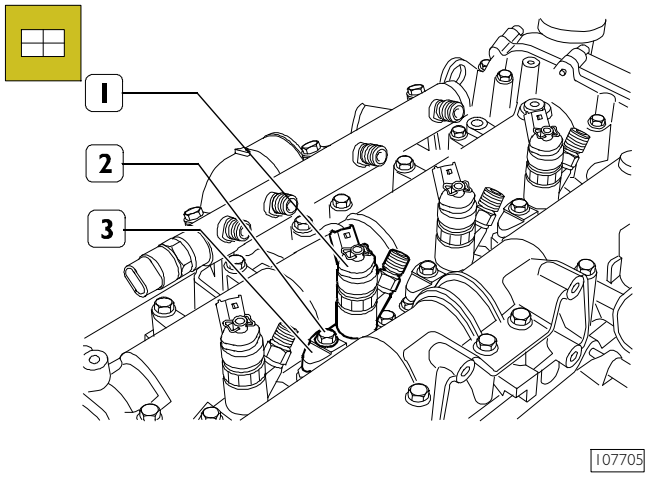
Injector assembly

Figure 25



Fit a new seal (3) on the electro-injector (1) and install the component in the cylinder overhead (2).

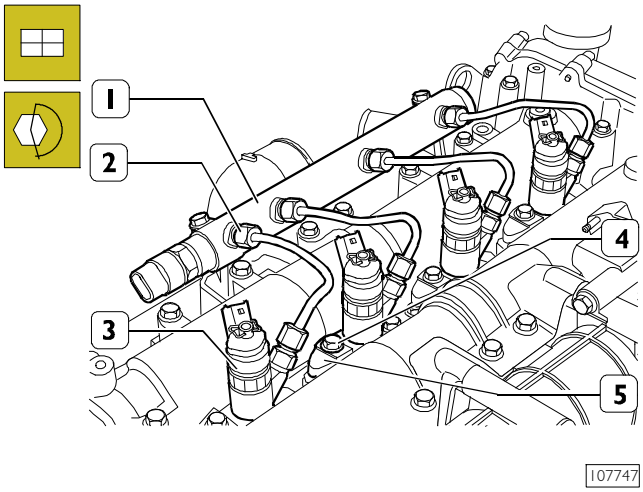
Figure 26



Mount the brackets (3) securing the electro-injectors (1) and tighten the screws (2) without locking them.

Injector delivery fuel pipe assembly

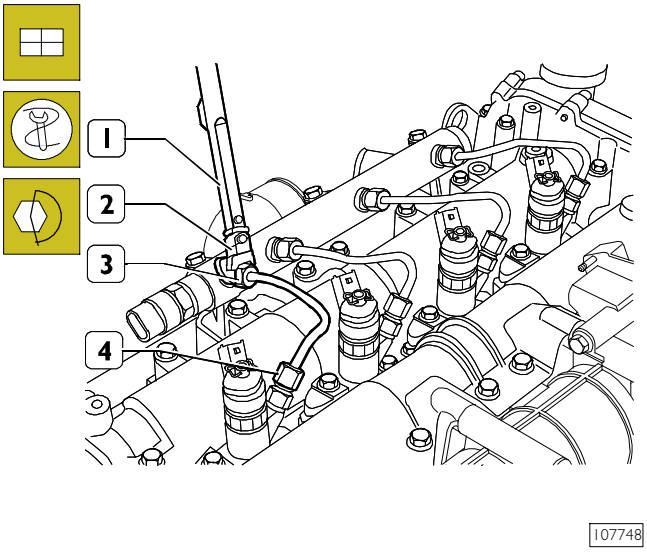
Figure 27



Connect the fuel pipes (2) to the electro-injectors (3) and to the rail (1).
Tighten the screws (4) fixing the electro-injector brackets (5) to the specified torque.

NOTE Whenever removed, the fuel pipes must be replaced with new ones.

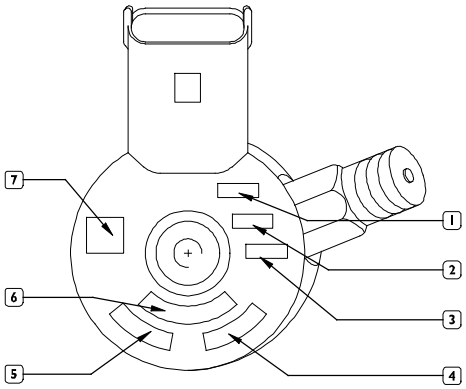
Figure 28



Using the wrench (2) from the 99317915 series and 99389829 torque wrench (1), tighten the fuel pipe fittings (3) and (4) to the specified torque.

Electro-injector reprogramming

Figure 29



1. Production plant code - 2. IMA Matrix code - 3. Uncoded IMA code - 4. Bosch spare part No. - 5. Date of production - 6. Serial No. - 7. Production line code - 8. Iveco spare part No.

The electro-injectors are no longer divided into classes: Min (01) - Med (02) - Max (03), so that deviations from the design flow rates are measured, at the final testing phase, by the manufacturer for each injector and stamped with the IMA code (Injector Menge Abgleichung) on the injector magnet.
At the engine production facility, the I.M.A. code is read in line by an automated reading station, converted into bar code, printed on the engine identification label and applied to the engine.
In the vehicle factory, the EDC 17 ECU is programmed at the end of the line by automatically reading the engine label.

Figure 30

numero	codice OCR iniettore
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

numero	codice OCR iniettore
A	A
B	B
C	C
D	D
E	E
F	F
G	G
H	H
I	I
J	J
K	K
L	L
M	M
N	N
O	O

numero	codice OCR iniettore
P	P
Q	Q
R	R
S	S
T	T
U	U
V	V
W	W
Y	Y
Z	Z

Conversion table of OCR characters into ARIAL font

105067

At the assistance centre the uncoded IMA code is required (3, Figure 29) for the ECU replacement and reprogramming procedure.
The table shows the conversion of OCR characters into Arial fonts.
When electro-injectors on engine mounted on vehicle require replacing, follow the instructions provided below:

- in cases where electro-injectors are removed and do not need to be replaced, their individual positions need to be noted in order to later re-install them in their original positions; this is done to avoid having to reprogram the ECU;
- after replacing one or more injectors, the ECU requires reprogramming;
- before installing a new electro-injector, note the IMA code stamped on the injector, as it becomes difficult to read the code once the injector is in position;
- in the event the ECU is replaced, program the new ECU with the IMA codes of the electro-injectors installed on the engine and copy the correction coefficients (ZFC) of the replaced ECU; if this is not possible, they must be reset and auto-configuration process must be restarted.

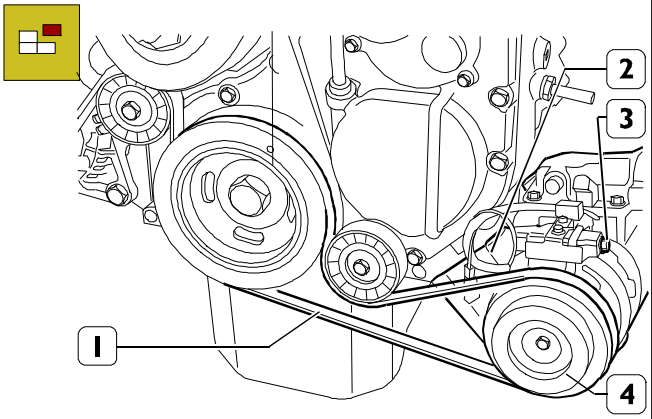
Whilst the engine is running, the EDC 17 ECU performs a number of tests on the electro-injectors' minimum flow rate. In certain conditions (overrun: vehicle deceleration with pedal released) an increasing (very small) quantity of fuel starting from zero is injected and its effect on engine rotation smoothness is observed. Injection start threshold is detected and stored by the ECU.
This auto-configuration process is carried out on each single cylinder.
Therefore, replacing an electro-injector requires that the ECU be reprogrammed, entering the IMA codes of the new electro-injectors and resetting the correction factors (ZFC) of the cylinder concerned.
Replacing all electro-injectors makes it necessary to reset all the correction coefficients (ZFC) of each single electro-injector.
The correction coefficients (ZCF) can be zeroed using the FPT. diagnostic tool, by reprogramming the ECU and performing the sensor replacement procedure provided by the diagnostic tool.

SECTION 7
General mechanical overhauling

ENGINES OVERHAUL

For motor F1CE3481C*C124

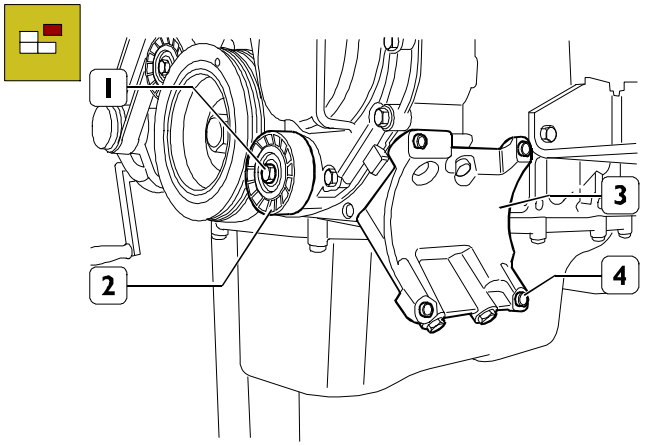
Figure 1



107713

Cut the rubber belt (1), as it cannot be reused.
Remove the screws (3) and remove the climate control system compressor (4) from its mount (2).

Figure 2

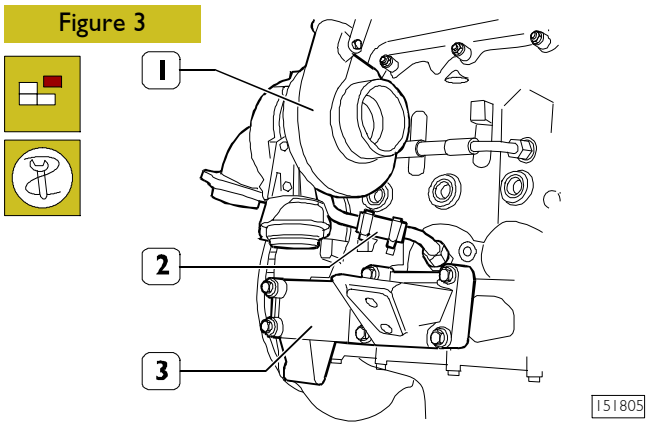


88252

Remove the screws (4) and remove the mount (3).
Take out the screw (1) and remove the fixed belt tensioner (2).

For all motors

Figure 3



If the following parts have not already been removed, do so now:

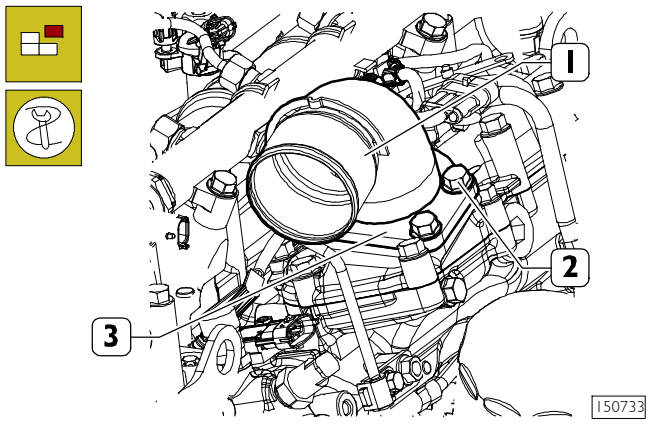
- Dip-stick for oil level check;
- rail guard;
- engine wire, by disconnecting its electrical connections from: thermostat temperature sensor, phase sensor, engine rev sensor, rail pressure sensor, air pressure/ temperature sensor of suction manifold;
- connector which connects the glow plugs to the electronic control unit

To be able to fit the brackets onto the crankcase to secure the engine to the stand for overhauling, it is necessary to remove the left and right engine mounts (3) and disconnect the oil pipe (2) from the turbocharger (1) and from the crankcase.

NOTE Block the turbocharger air/exhaust gas inlets and outlets to prevent foreign bodies getting inside.

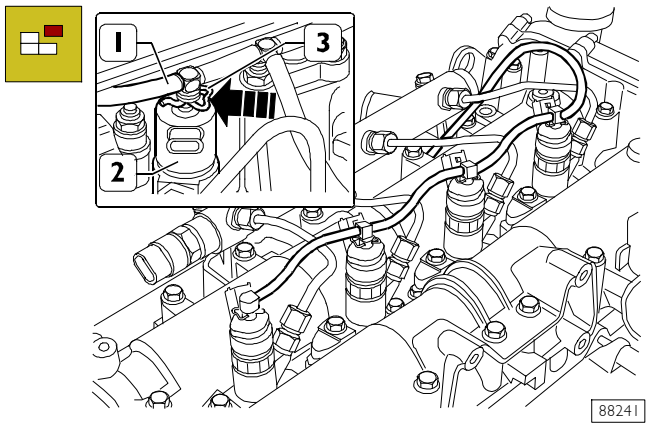
Fit the brackets 99361041 to the crankcase and use these to secure the engine to the rotary stand 99322205. Drain the oil from the engine by removing the plug from the oil sump.

Figure 4



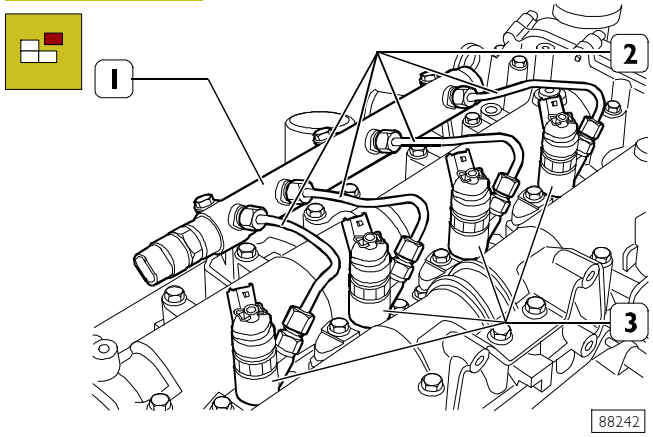
Unscrew the screws (2) and remove the air tube (1) and the end-plate (3).

Figure 5



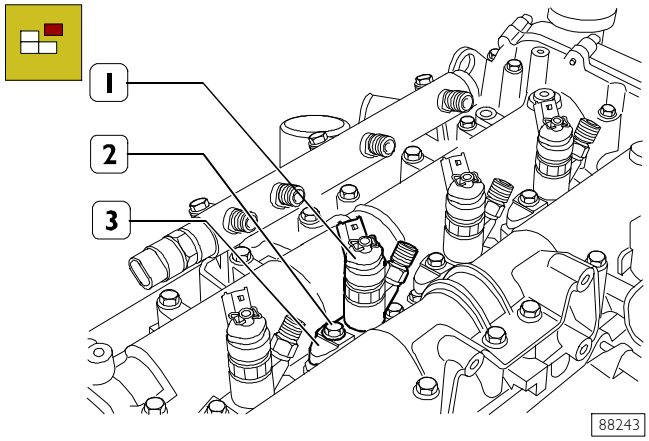
Press the springs (3) in the direction shown by the arrow and disconnect the fittings of the pipe (1) recovering fuel from the electro-injectors (2).

Figure 6



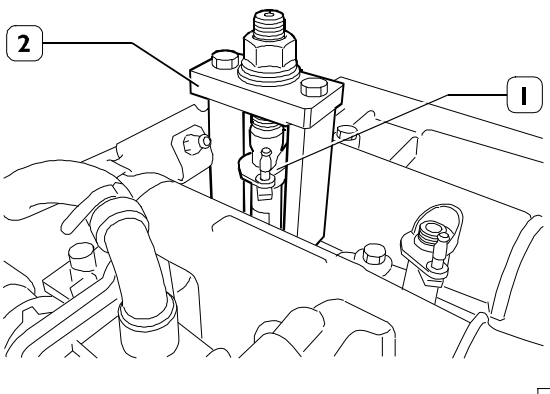
Disconnect the fuel pipes (2) from the electro-injectors (3) and from the hydraulic accumulator (1) (rail).

Figure 7



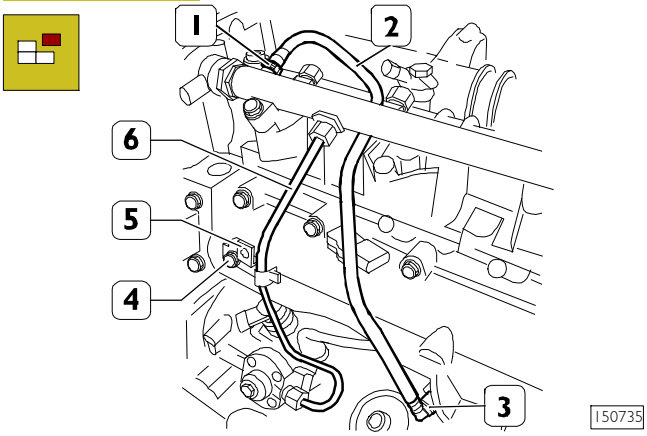
Take out the screws (2) and the brackets (3) fixing the electro-injectors (1) to the cylinder overhead.

Figure 8



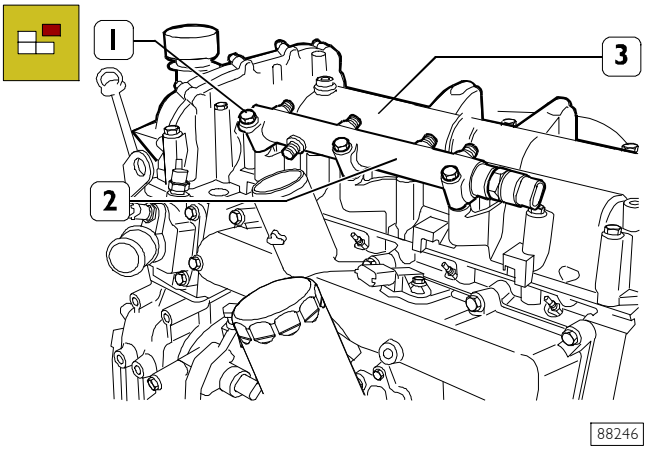
Remove the injector (1) from the head using extractor 99342156 (2) and mark it with the cylinder it belongs to.

Figure 9



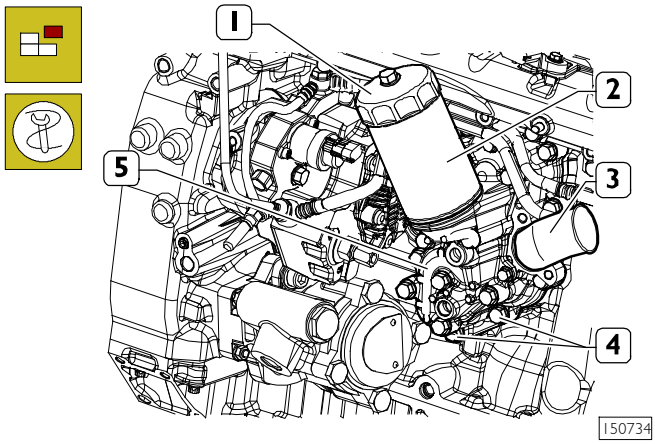
Unscrew the connector (1) on the common rail. Unscrew the connector (5) on the high pressure pump. Undo and remove the fixing screw (3) of the pipe (2) retaining bracket (4). Remove the high pressure fuel pipe (2)

Figure 10



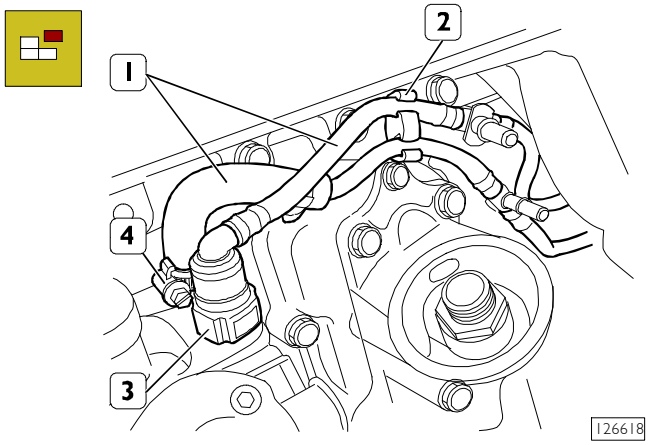
Remove the screws (1) and the hydraulic accumulator (2) from the overhead device (3).

Figure 11



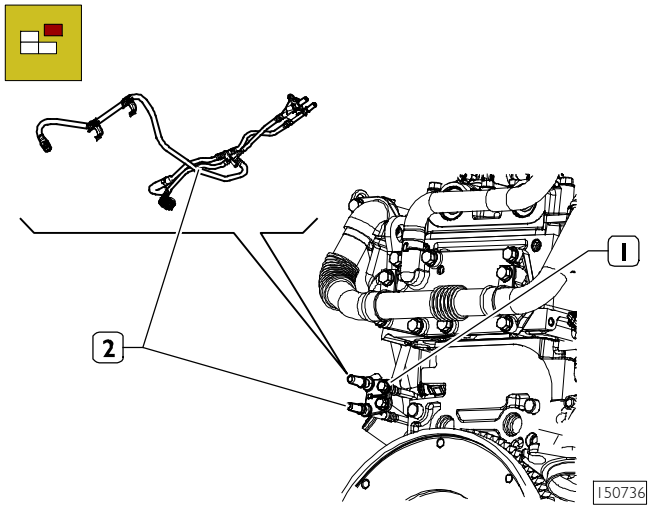
Use tool 99360076 (1) to remove the oil filter (2) from the heat exchanger (5).
Remove the screws (4 and 3) and the heat exchanger (5) with the relevant gasket and pipe (3).

Figure 12



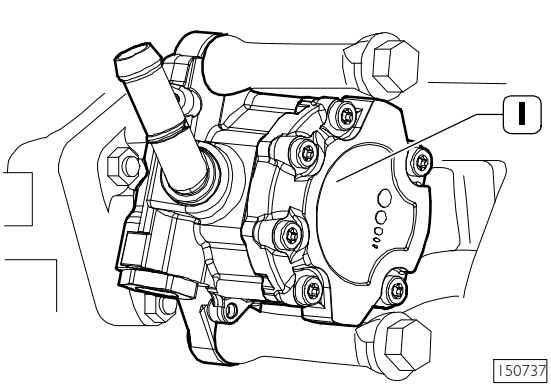
To remove the low pressure pipes (1) from the high pressure pump it is necessary to loosen the band (4), adjust the rapid connector (3) and detach the pipes (1) from the clip (2).

Figure 13



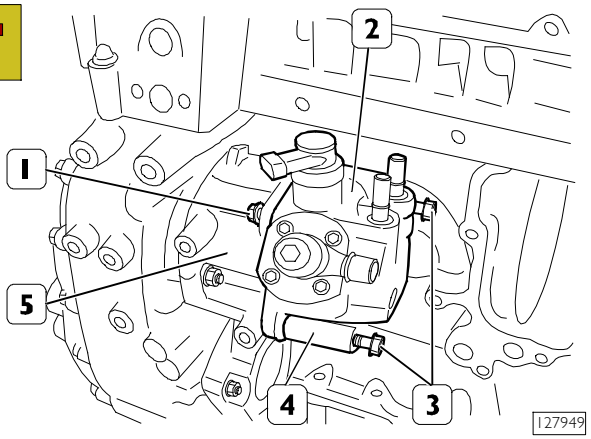
Unscrew the screws (1) and remove the low-pressure fuel hose assembly (2).

Figure 14



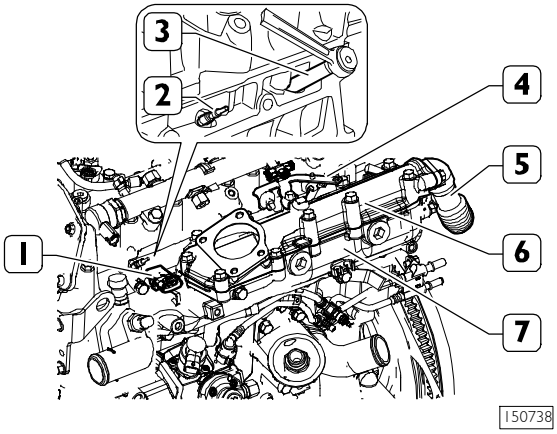
Remove the fixing screws and detach the power-steering pump (1).

Figure 15



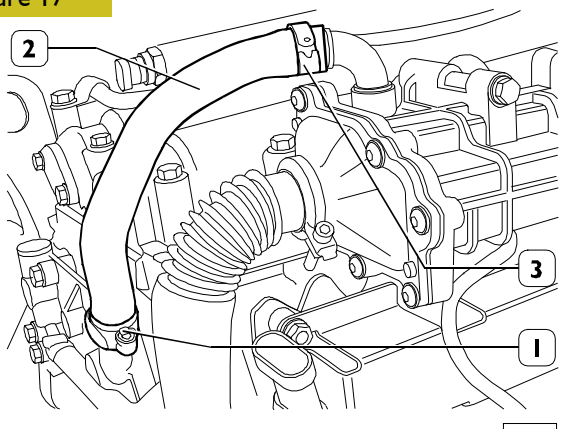
Unscrew and remove the screw (1).
Unscrew and remove the screws (3) with their spacers (4).
Detach the high-pressure pump (2) from the support (5).

Figure 16



Remove the fixing screws and detach the temperature and air-pressure sensor (1), the clamp (4), the EGR tube (6) with its seal, the mixer (7) with its cover (5) and seals, and finally the temperature regulator assembly (8).
Using wrench SP.2275 (3), remove the glow plugs (2).

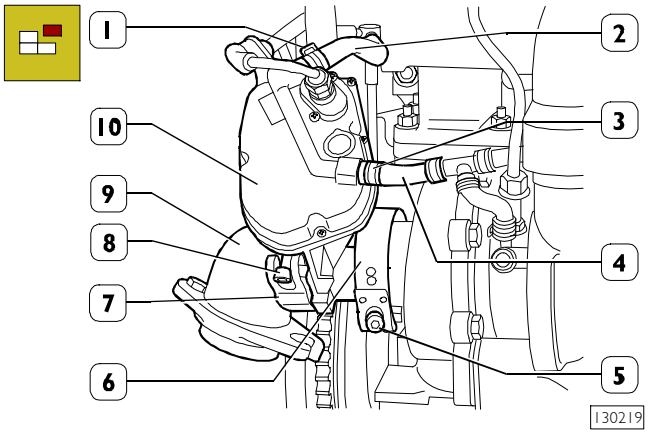
Figure 17



Remove the retaining clamps (1) and (3).
Remove the pipe (2) from the cooler and from the cover.

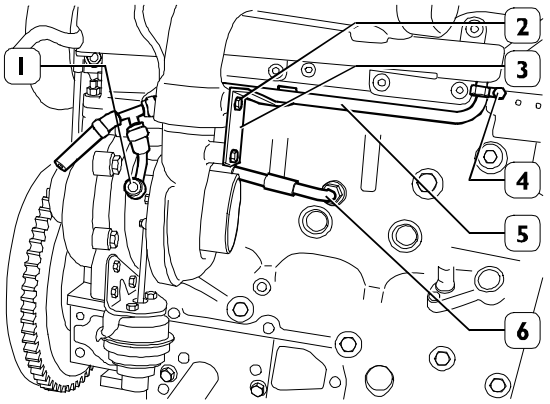
For motors F1CE3481A/R

Figure 18



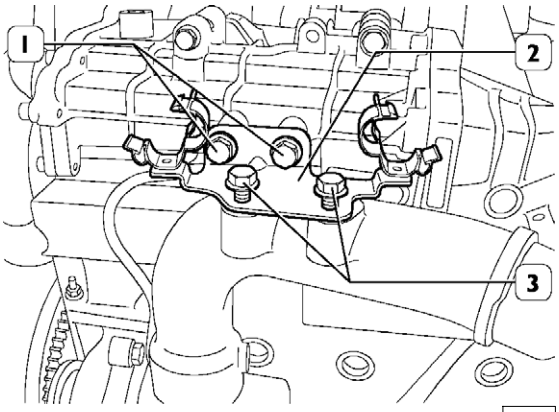
Remove the clamp (1) and detach the pipe (2) from the EBS (10). Remove the clamp (3) and detach the pipe (4) from the EBS (10). Operating on the screw (8), loosen the clamp (7) and detach the pipe (9) from the EBS unit (10). Operating on the screw (5), loosen the clamp (6) and remove the EBS unit (10) from the turboblower.

Figure 19



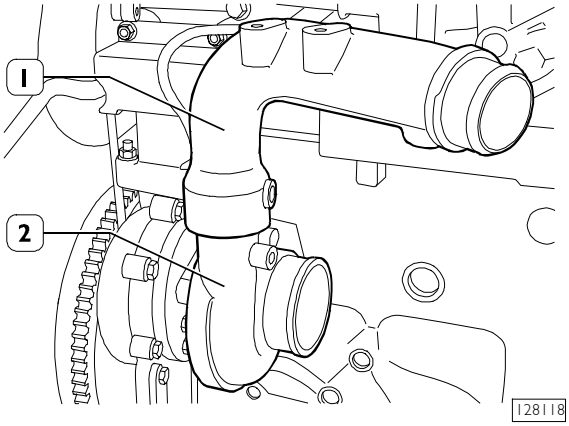
Unscrew and remove the union (1). Unscrew and remove the two screws (2) fastening the bracket (3) to the turbo-blower. Unscrew and remove the fixing screw (4).
Remove tubes (5) and (6).

Figure 20



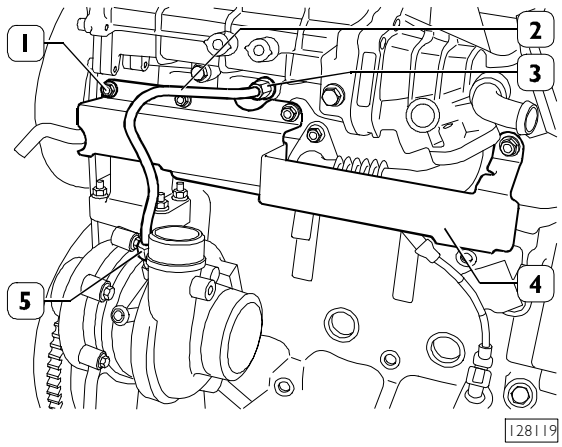
Unscrew and remove the fixing screws (1) and (3).
Remove the bracket (2).

Figure 21



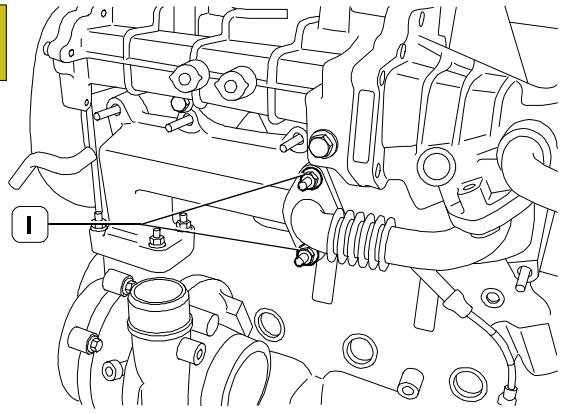
Remove the manifold (1) from the turbocharger (2).

Figure 22



Unscrew the unions (3) and (5), then remove the pipe (2).
Unscrew and remove the fixing nuts (1) and detach the guard (4) taking care to retrieve all the spacers.

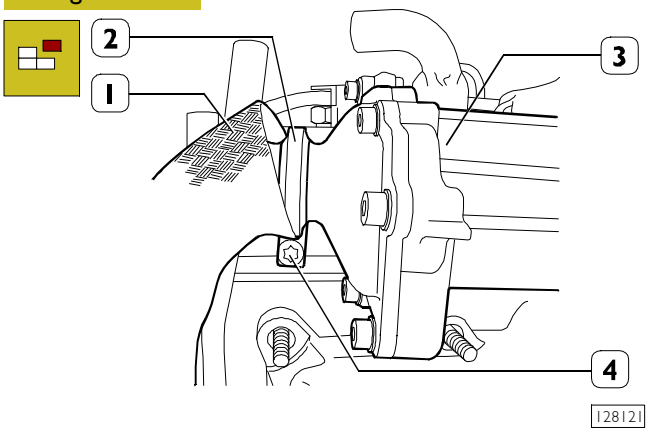
Figure 23



Unscrew and remove the two fixing nuts (1).

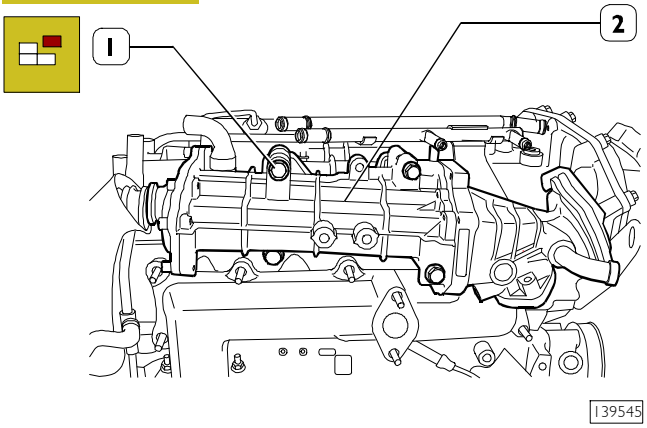
For all motors

Figure 24



Unscrew the screw (4) and remove the clamp (2).
Detach the pipe (1) from the EGR unit (3).

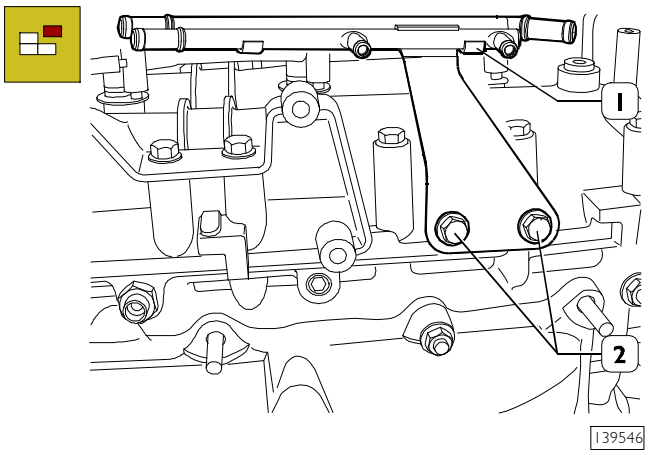
Figure 25



Unscrew and remove the fixing screws (1).
Remove the EGR unit (2)

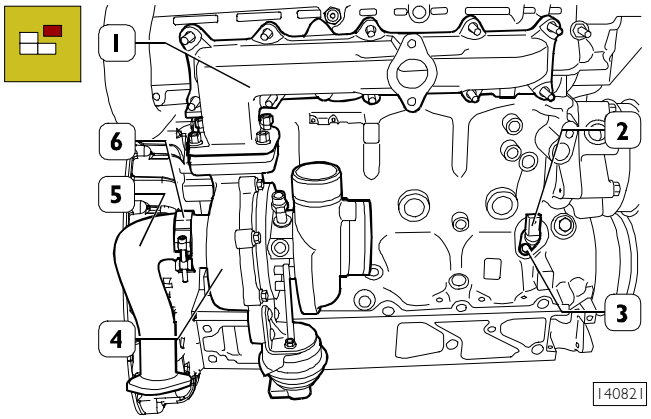
For motors F1CE3481A/R

Figure 26



Unscrew and remove the screws (2).
Remove the pipe (1) together with the supporting bracket.

Figure 27

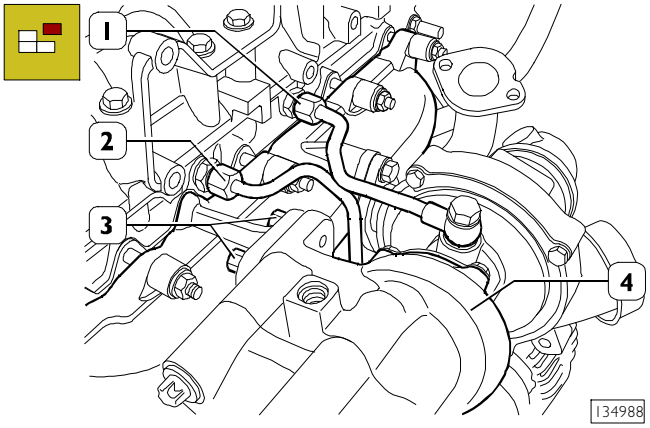


Remove the clamp (6). Remove the pipe (5). Remove the exhaust manifold (1) complete with turbo-blower (4). Remove the metal gasket between the exhaust manifold and the cylinder head. Take out the fixing screw (3) and remove the rev sensor (2).

NOTE The centrifugal filter (1) and the seal ring of the cover (4) must be changed at every removal.

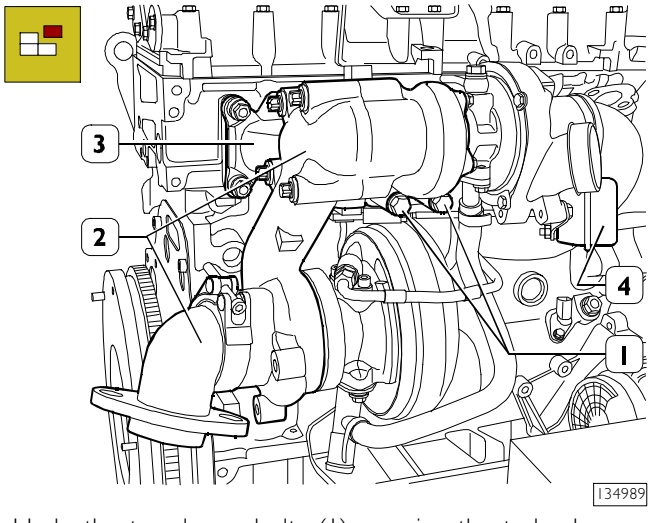
For motor F1CE3481C*C124

Figure 28



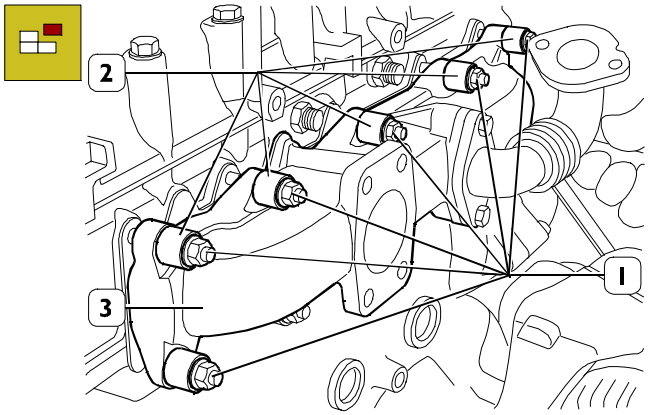
Remove the turbocharger lubrication pipe fittings (1) and (2) from the overhead.
Unscrew the two upper mounting screws (3) securing the two-stage turbocharger to the exhaust manifold (4).

Figure 29



Undo the two lower bolts (1) securing the turbocharger assembly to the exhaust manifold.
Remove the two-stage turbocharger (2) with its gaskets, pipes and Waste-Gate valve (4).

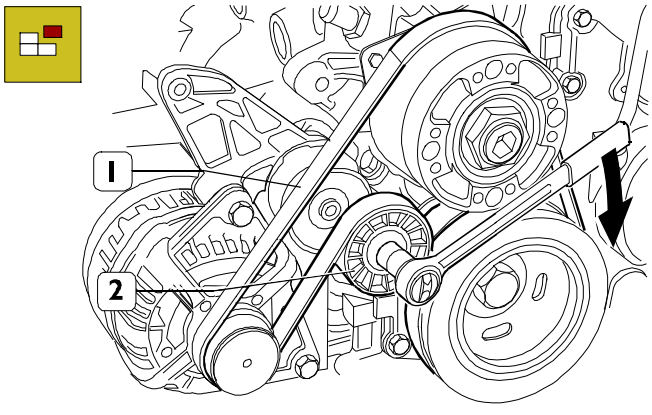
Figure 30



134990

Remove the nuts (1), washers (2) and remove the exhaust manifold (3) with gasket and complete with the exhaust gas recirculation pipe from the cylinder head.

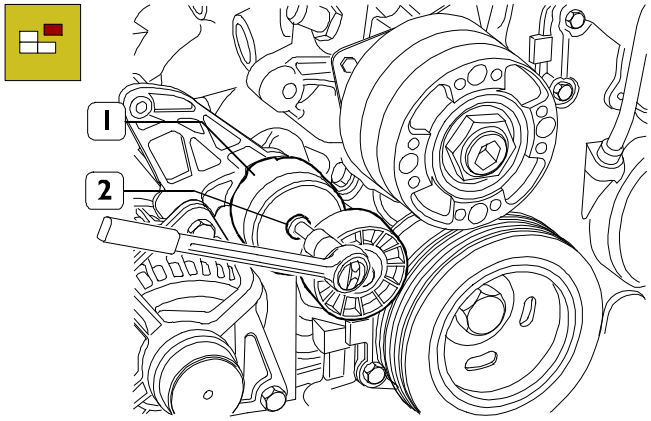
Figure 31



135029

Using (→) the specific wrench on the automatic belt tensioner (2), slacken the tension of the belt (1) and remove it.

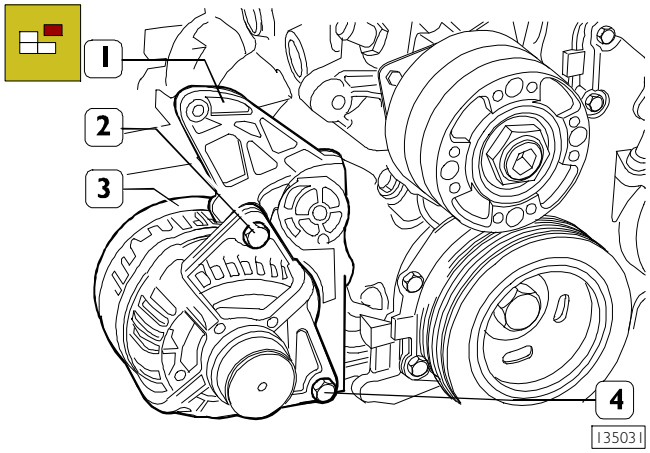
Figure 32



135030

Remove the screw (2) and remove the automatic belt tensioner (1).

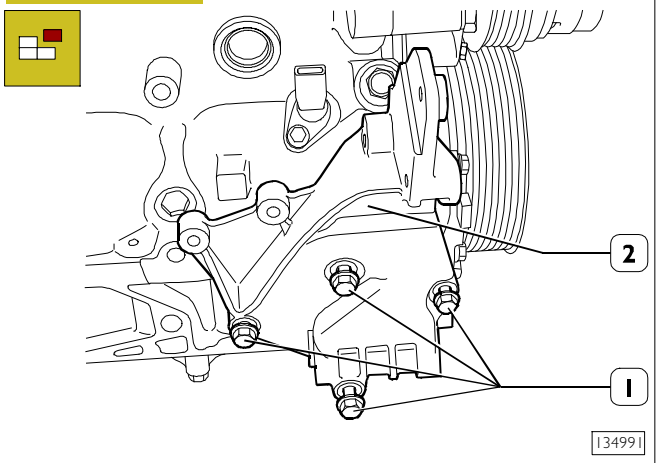
Figure 33



135031

Remove screw (2) and bolt (4), then remove the alternator (3) from its support (1).

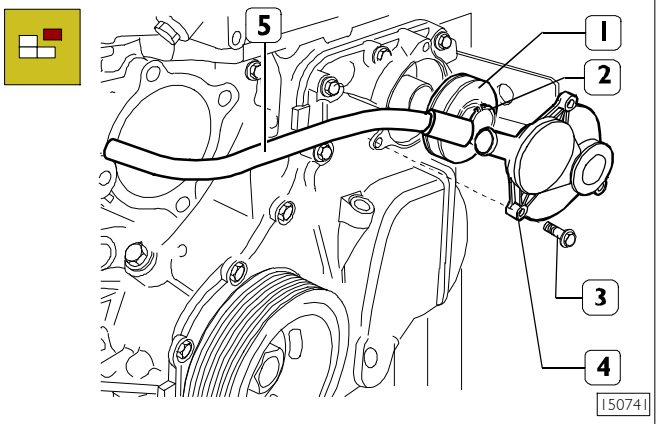
Figure 34



Remove the bolts (1) and remove the support (2) from the crankcase.

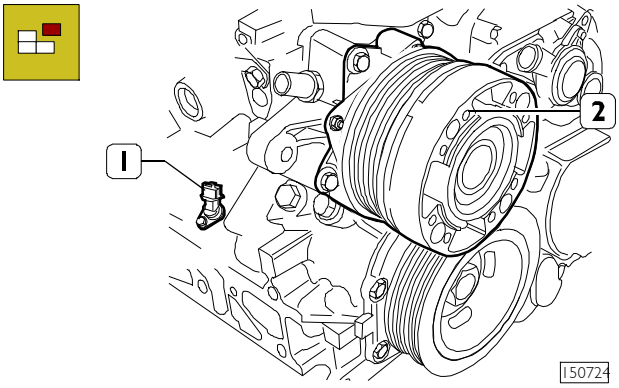
For all motors

Figure 35



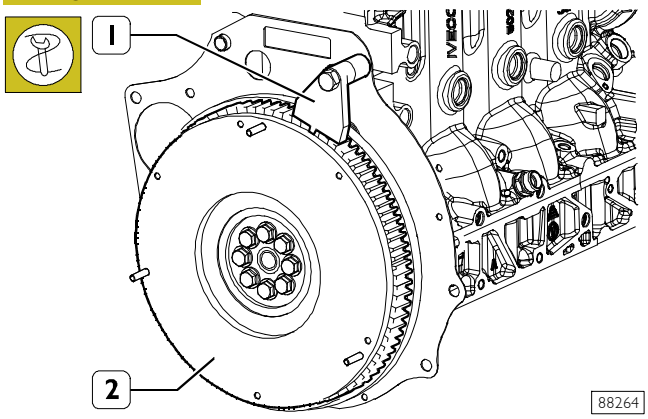
Remove tube (5). Remove the screws (3) and the cover (4). Take off the snap ring (2). Pull out the centrifugal filter (1).

Figure 36



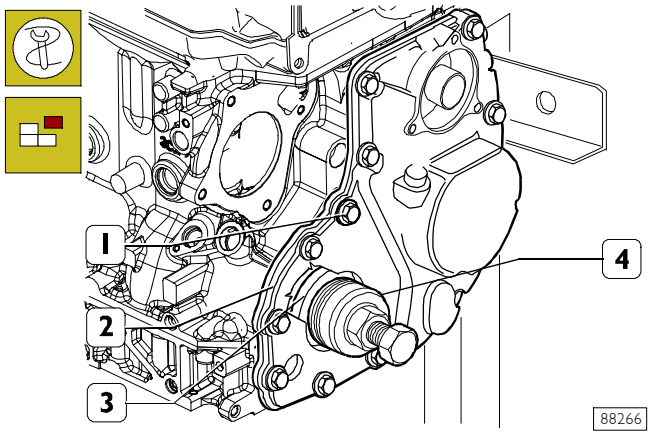
Remove the fastening screw and the rev sensor (1). Remove the water pump (2) by removing the fixing screws.

Figure 37



Stop the rotation of the engine flywheel (2) by means of tool 99360306 (1).

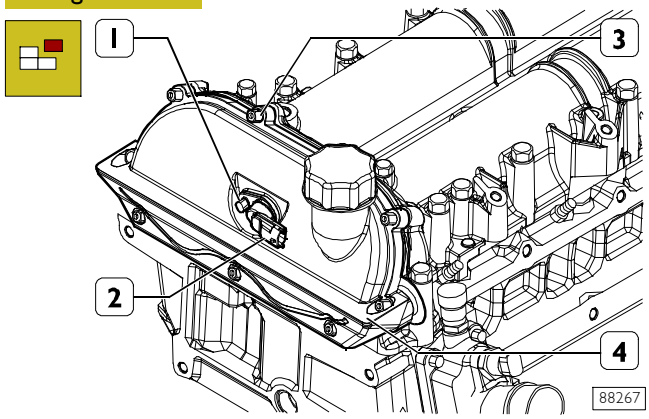
Figure 38



Remove the screws (1) and the distribution cover (2).

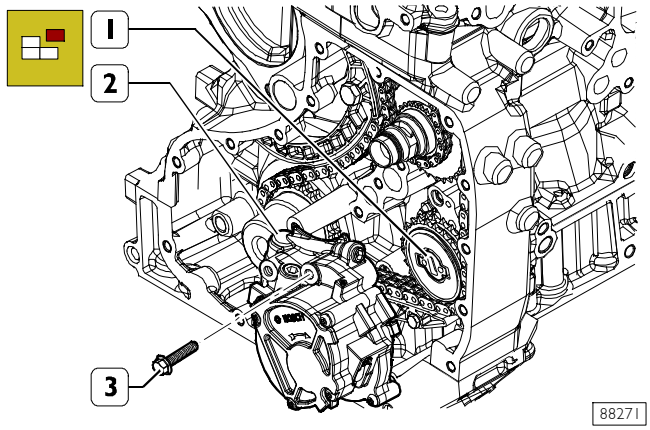
NOTE Tool 99340059 (4) is used to remove the seal ring (3) from the cover (2) when the engine is installed on the vehicle.

Figure 39



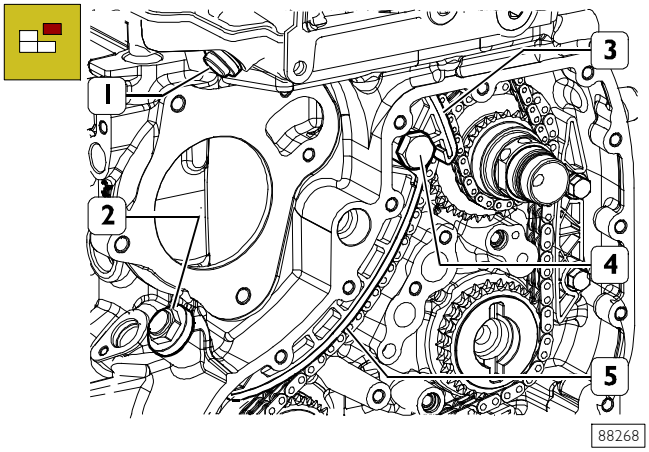
Remove the nut (1) and the phase sensor (2).
Remove the nuts (3) and the cover (4).

Figure 40



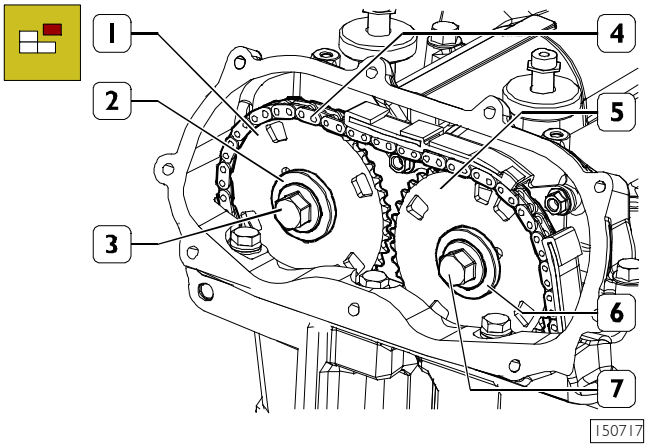
Remove the screws (3) and disassemble the depressor/oil pump unit (2).
Remove the connection key (1).

Figure 41



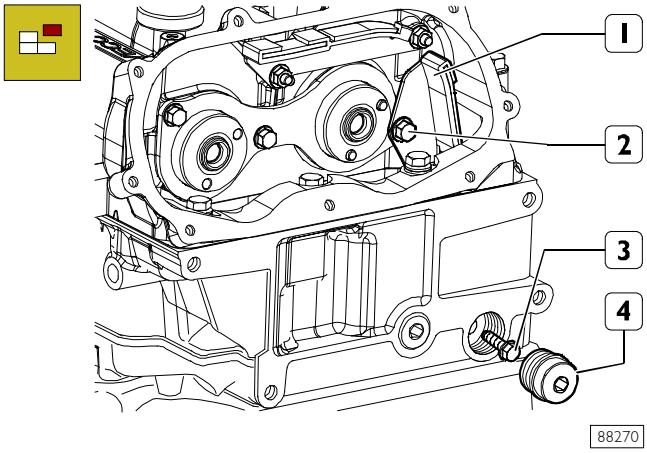
Remove the hydraulic chain tightener: top (1) and lower (2). Remove the pin (4) and disassemble the mobile skid: lower (5) and top (3).

Figure 42



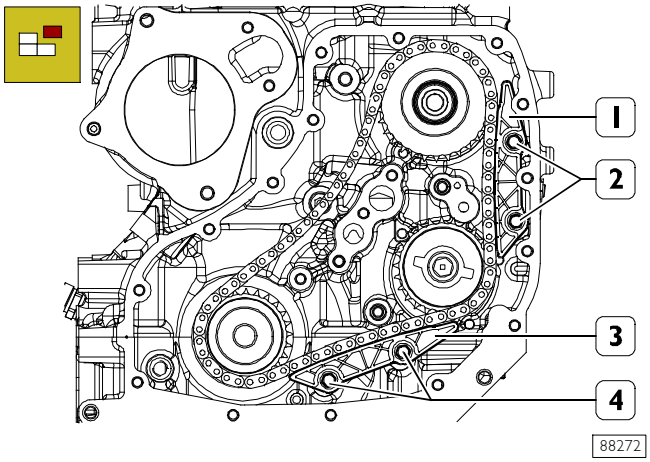
Remove the screw (3), the washer (2) and the gear (1). Remove the screw (7), the washer (6), the gear (5) and the chain (4).

Figure 43



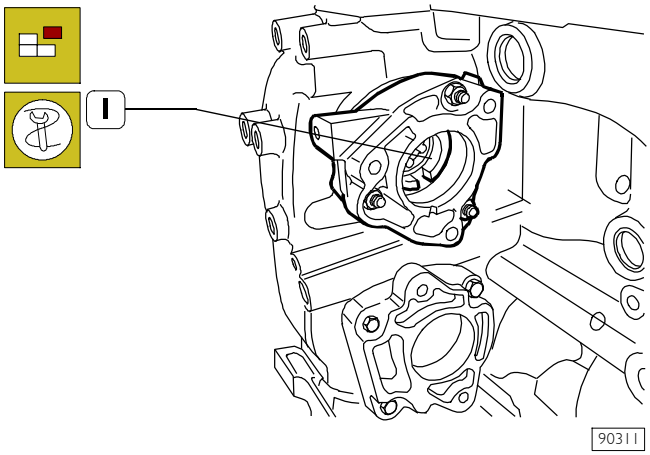
Remove the cap (4), the screws (2 and 3) and the top fixed skid (1).

Figure 44



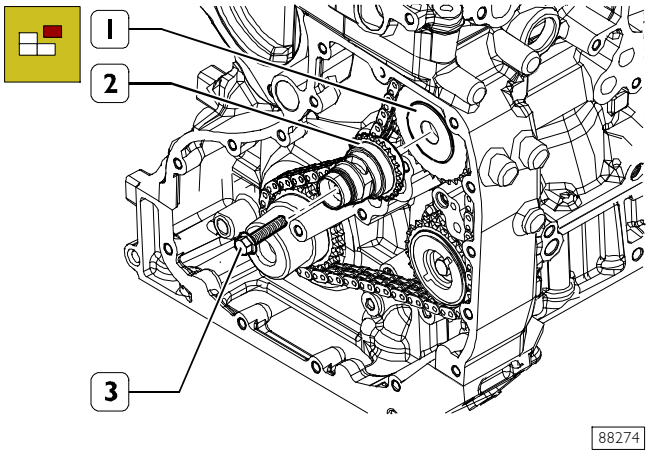
Remove the screws (2) and the side fixed skid (1).
Remove the screws (4) and the lower fixed skid (3).

Figure 45



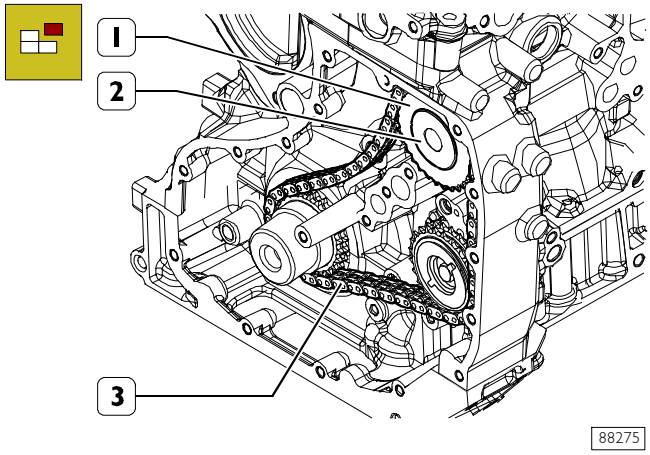
Stop the rotation of the high pressure pump control shaft (1) by inserting the suitable wrench inside it.

Figure 46



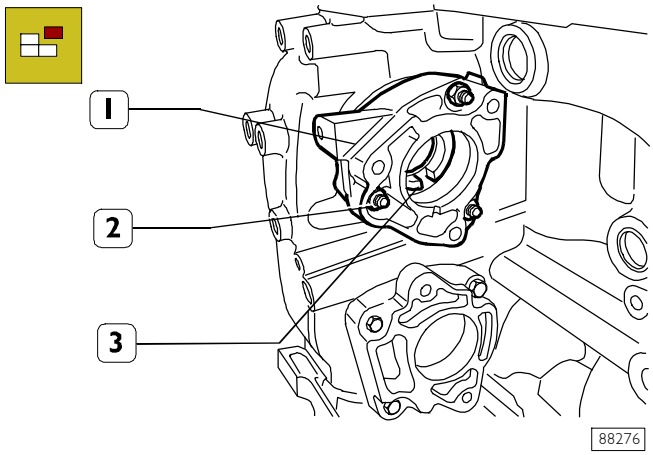
Remove the screw (3) and the stem with the drive gear (2) from the high pressure pump control shaft (1).

Figure 47



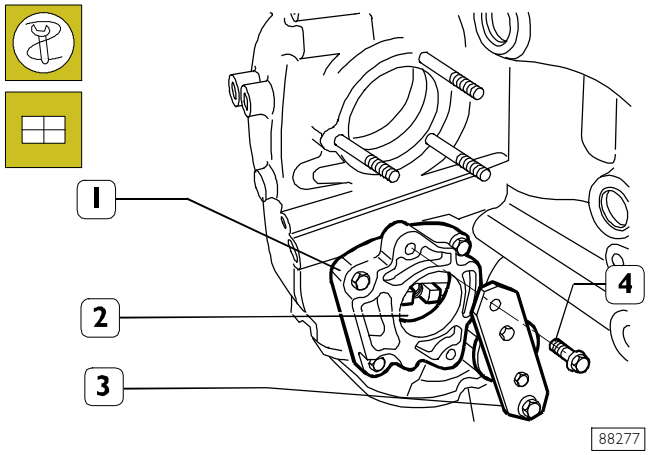
Remove the gear (1) and the chain (3) from the high pressure pump control shaft (2).

Figure 48



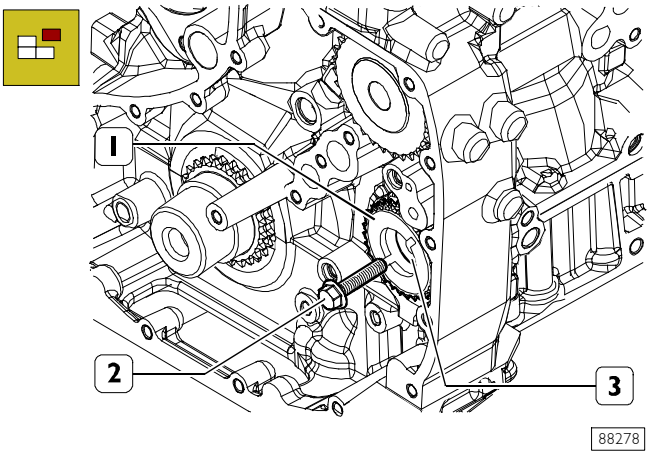
Remove the high pressure pump control shaft (3).
Remove the nuts (2) and the support (1).

Figure 49



Stop the rotation of the hydraulic power steering pump control shaft (2) by inserting tool 99360187 (3) in the shaft and fastening the tool on the support (1) by means of the screws (4).

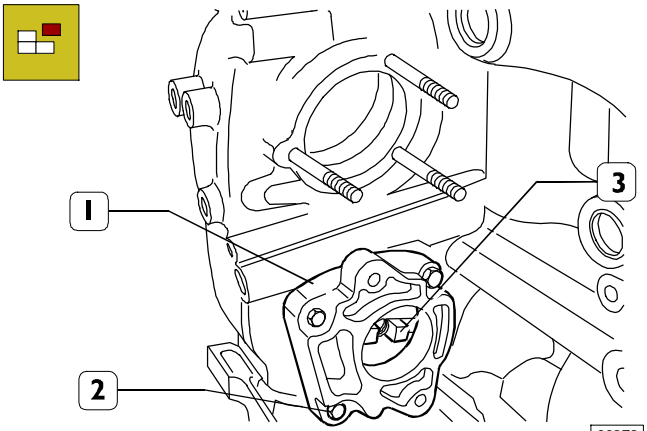
Figure 50



88278

Remove the screw (2) and the gear (1) from the hydraulic power steering control shaft (3).

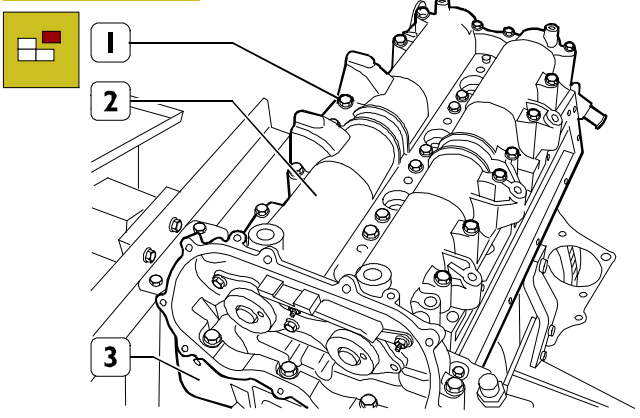
Figure 51



88279

Remove the hydraulic power steering control shaft (3). Remove the nuts (2) and the support (1).

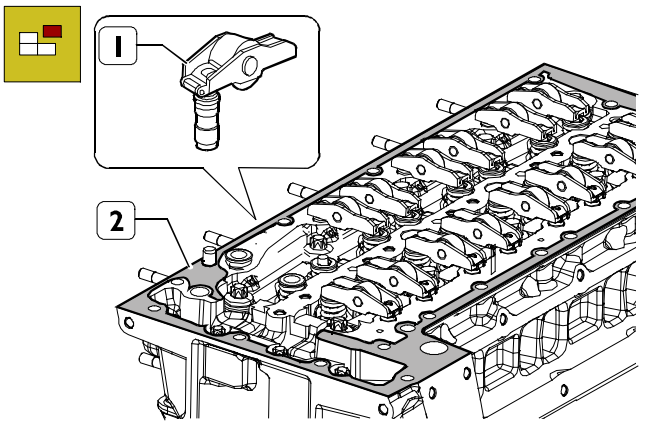
Figure 52



88280

Remove the screws (1) and take off the over-head (2) from the cylinder head (3).

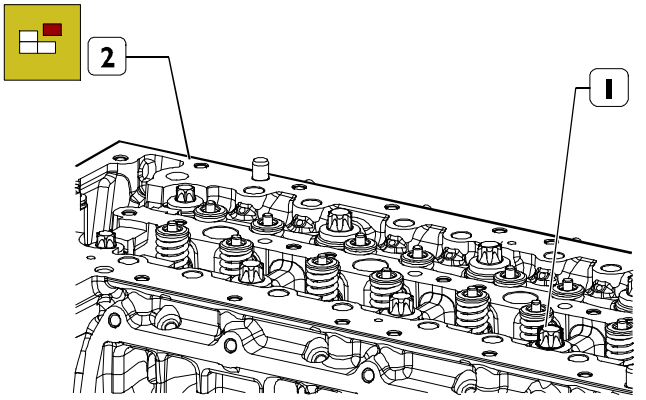
Figure 53



88281

Remove the hydraulic tappets (1) with the rocker arms. Remove the gasket (2).

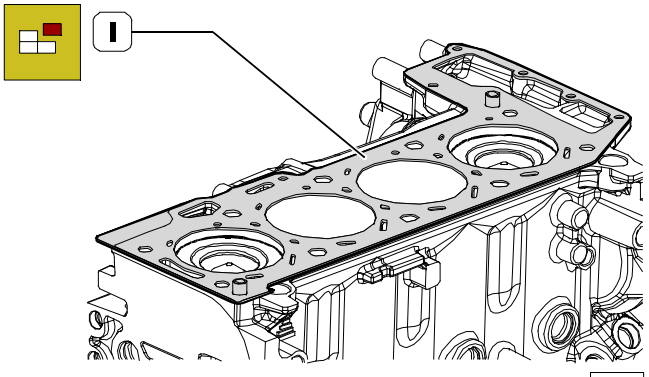
Figure 54



88282

Take out the screws (1) and remove the cylinder head (2).

Figure 55

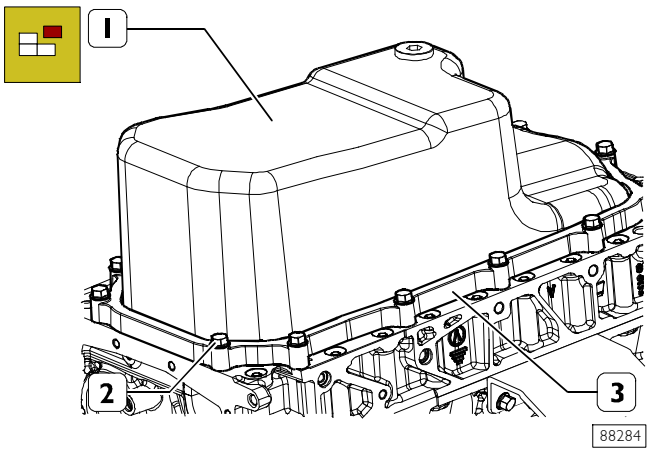


150710

Remove the cylinder head gasket (1).

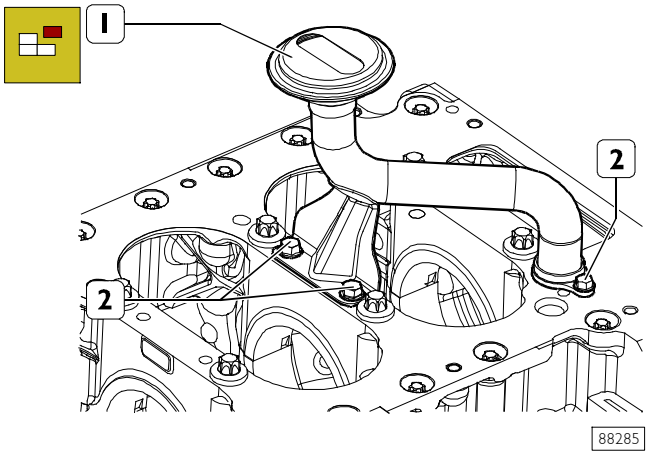
NOTE Check the protrusion of the pistons (2) as described under the relevant heading to check the possibility of facing the crankcase if it has deformed.

Figure 56



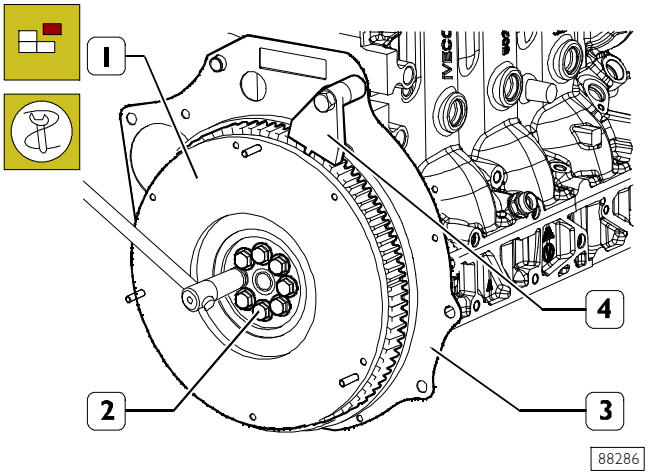
Remove the screws (2) and take off the oil sump (1) with its gasket and frame (3).

Figure 57



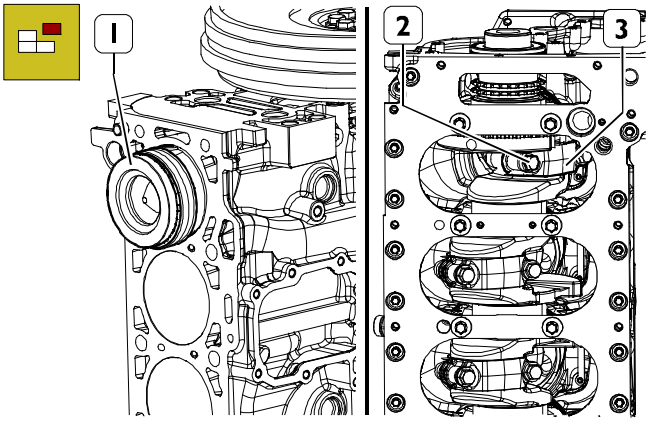
Remove the screws (2) and the suction rose (1).

Figure 58



Block rotation of the flywheel (1) with tool 99360306 (4). Take out the screws (2) and remove the engine flywheel (1). Take out the guard (3), if present.

Figure 59

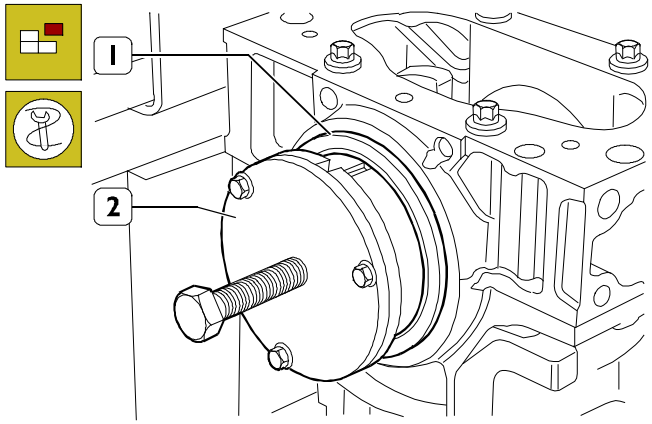


88738

Take out the screws (2) and remove the connecting rod caps (3).
Extract the pistons (1) from the top of the crankcase.

NOTE On the same side of the connecting rod and its associated cap, indicate the number of the cylinder from which the connecting rod has been removed. Keep the bearing shells in their respective housings since, if they are used, they will need to be fitted in the position found during removal.

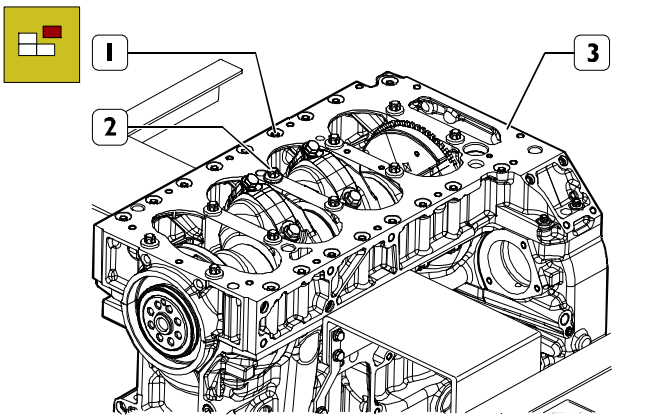
Figure 60



88287

Apply tool 99340060 (2) to the rear O-ring (1) and extract it from the crankcase.

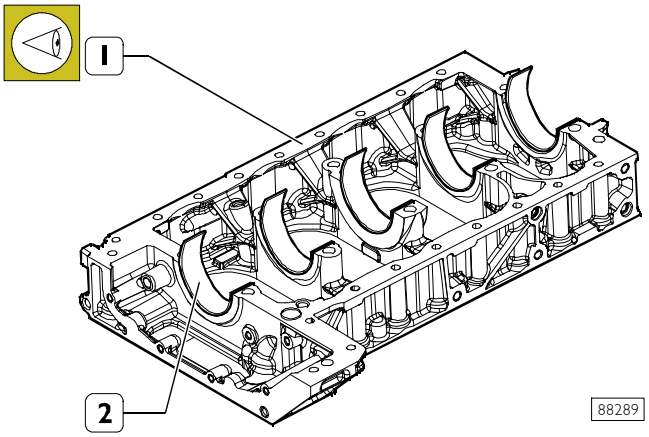
Figure 61



88288

Remove the screws (2) and take off the oil sump (1) with its gasket and frame (3).

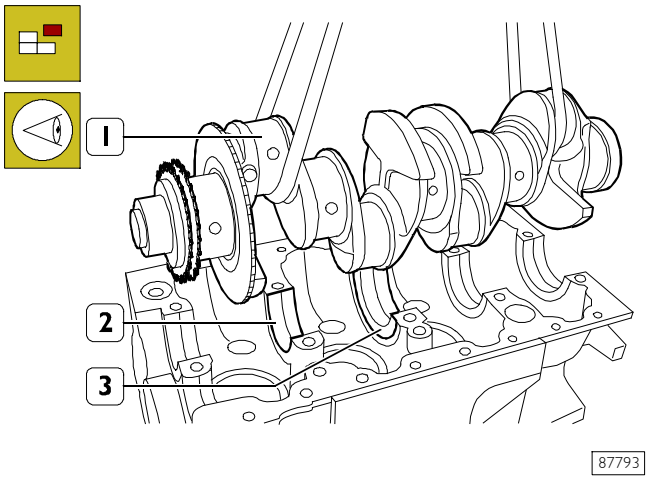
Figure 62



88289

NOTE Note the assembly position of the top main bearing shells (2) since, if they are reused, they will need to be fitted in the position found during removal.

Figure 63

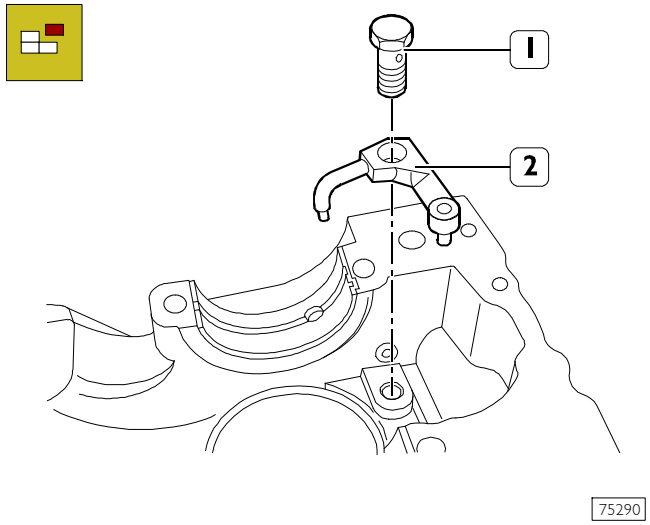


With the aid of a hoist and a rope, remove the crankshaft (1).

NOTE Note the assembly position of the top main bearing shells (2) since, if they are reused, they will need to be fitted in the position found during removal.

The central half-bearing (3) is fitted with shoulder half-rings.

Figure 64

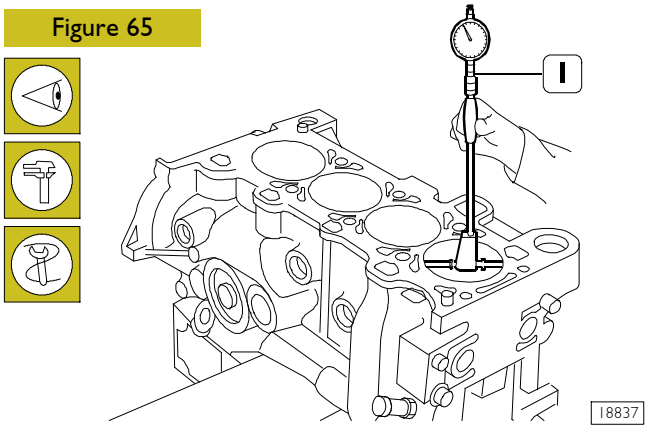


Take out the couplings (1) and remove the oil jets (2).

NOTE On completing engine removal, it is necessary to clean the removed parts thoroughly and check their integrity.
The following pages give the instructions for the main checks and measurements to make in order to determine whether the parts can be reused.

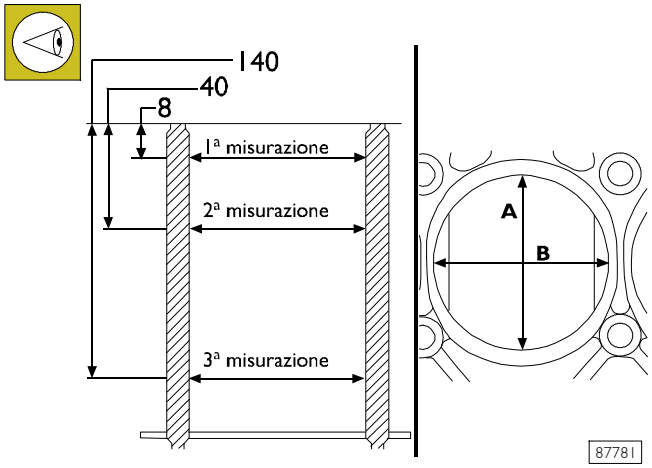
REPAIRS
CYLINDER BLOCK
Checks and measurements

Figure 65



Once the engine removal is complete, carefully clean the cylinder block. For the cylinder block transportation use the suitable rings.
Carefully check that the crankcase has no cracks in it.
Check the state of the plugs. If they are rusty or there is any doubt about their seal, replace them. Examine the surfaces of the cylinder liners; they must show no sign of meshing, scoring, ovalization, taper or excessive wear. The inside diameter of the cylinder liners is checked, to ascertain the extent of ovalization, taper and wear, using the bore meter 99395687 (1) fitted with a dial gauge previously reset on the ring gauge of the diameter of the cylinder liner or on a micrometer.

Figure 66



The measurements must be made for each single cylinder at three different heights up the liner and on two planes at right angles to each other: one parallel to the longitudinal axis of the engine (B) and the perpendicular (A); the greatest wear is generally found on this last plane with the first measurement.
On finding ovalization, taper or wear, go ahead and bore/grind and finish the face of the cylinder liners. The refacing of the cylinder liners should be done in relation to the diameter of the pistons supplied as spare parts oversized by 0.4 mm of the nominal value and to the prescribed assembly clearance.

Figure 67

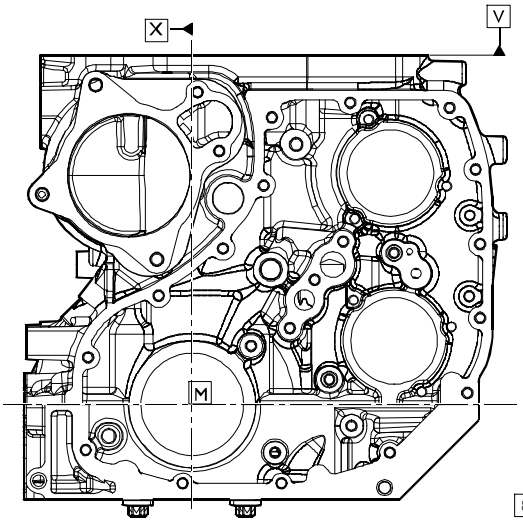
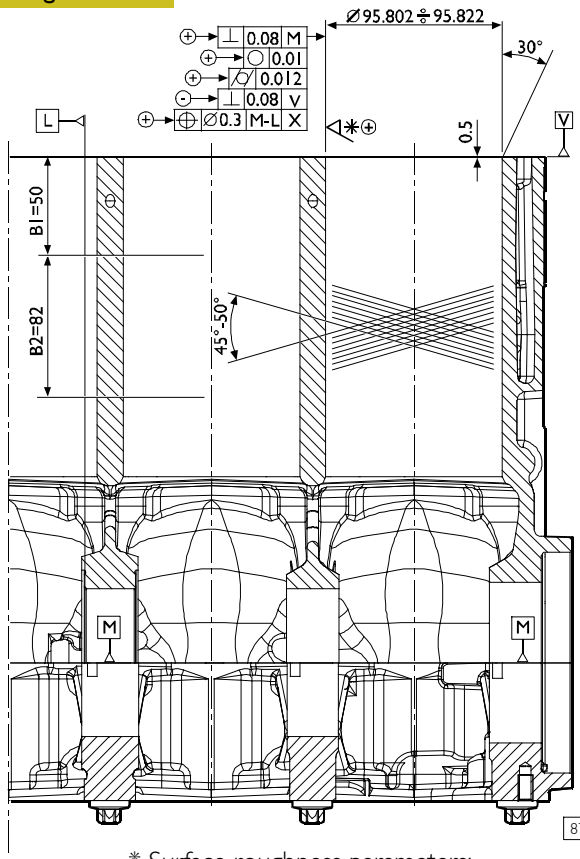


Figure 68



* Surface roughness parameters:

R1 = 4 ÷ 10 µm
Rz = 3 ÷ 8 µm
Ra = 0,3 ÷ 0,6 µm
W1 < 2 µm

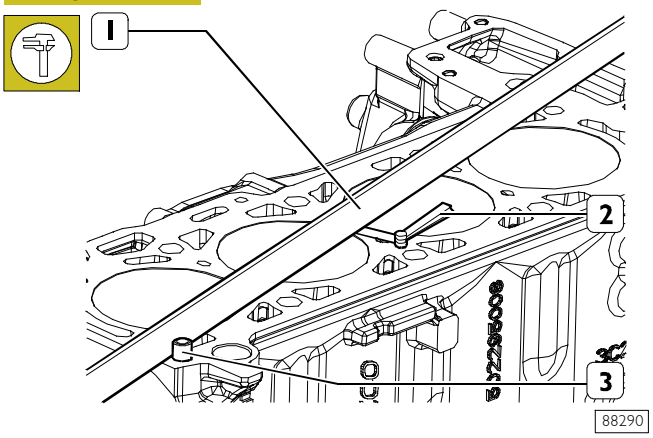
Permissible surface porosity for machined cylinder (see Figure 68)

ZONE B1 = Area of greatest mechanical stress, segment/liner contact: No.2 non-continuous porosities are permissible max. 0.5x0.5. — C — 100%

ZONE B2 = Surface involved in segment rubbing: No.2 non-contiguous porosities are permissible max. 1x0.8. — C — 100%

Checking head mating surface on cylinder block

Figure 69

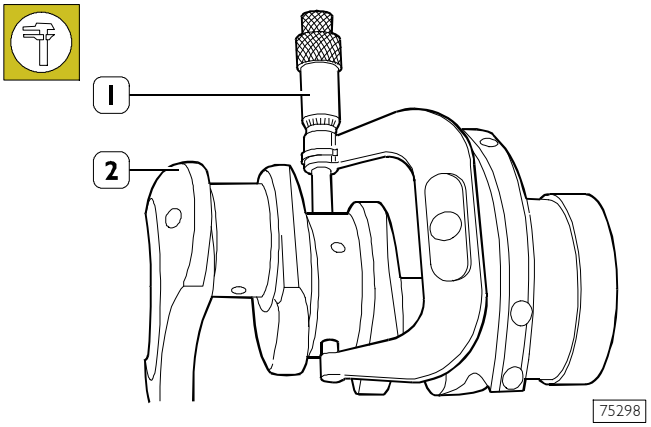


See that the head mating surface, on the cylinder block, has no deformation.
This check can be made, after taking out the grub screws (3), with a surface plate spread with carbon black or with a calibrated rule (1) and a feeler gauge (2). After ascertaining the areas of deformation, level the bearing surface with a grinding machine.

NOTE The crankcase can only be surfaced after making sure that, on completing the work, the piston protrudes from the cylinder liner by no more than the prescribed value.

CRANKSHAFT
Measuring main journals and crank pins

Figure 70



On finding signs of seizure, scoring or excessive ovalization on main journals and crankpins, it is necessary to regrind the pins. Before grinding the pins (2), measure the shaft pins with a micrometer (1) to establish to what diameter it is necessary to decrease the pins.

NOTE It is advisable to enter the measurements in a table. See Figure 71.

Figure 71

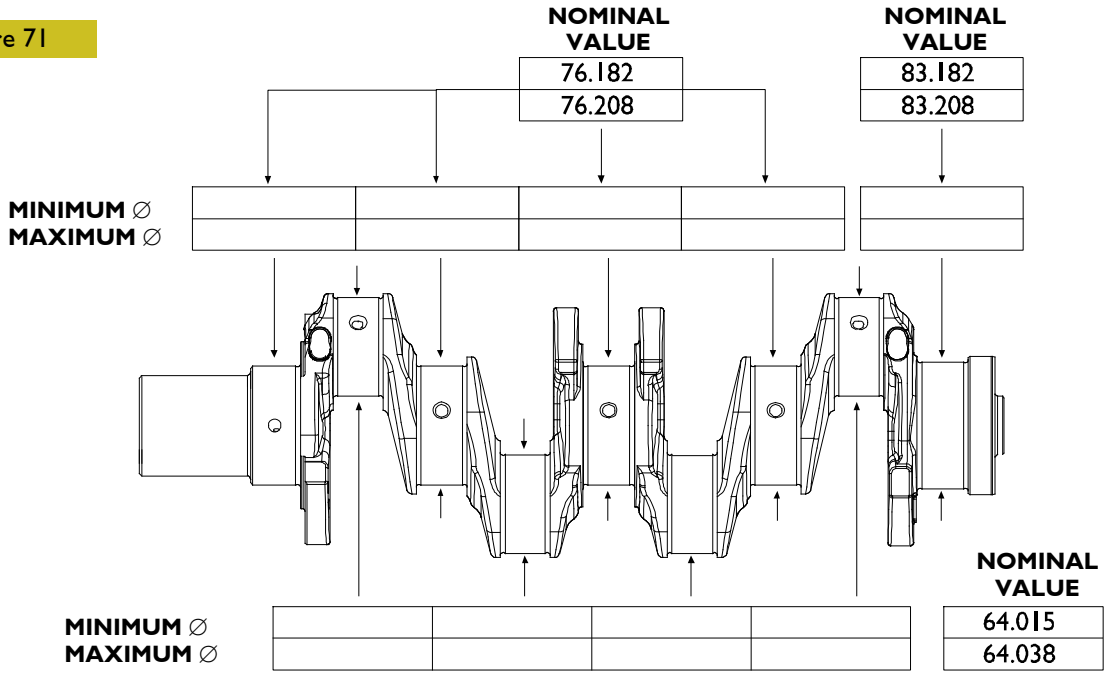


TABLE IN WHICH TO ENTER THE MEASUREMENTS OF THE CRANKSHAFT MAIN JOURNALS AND CRANKPINS

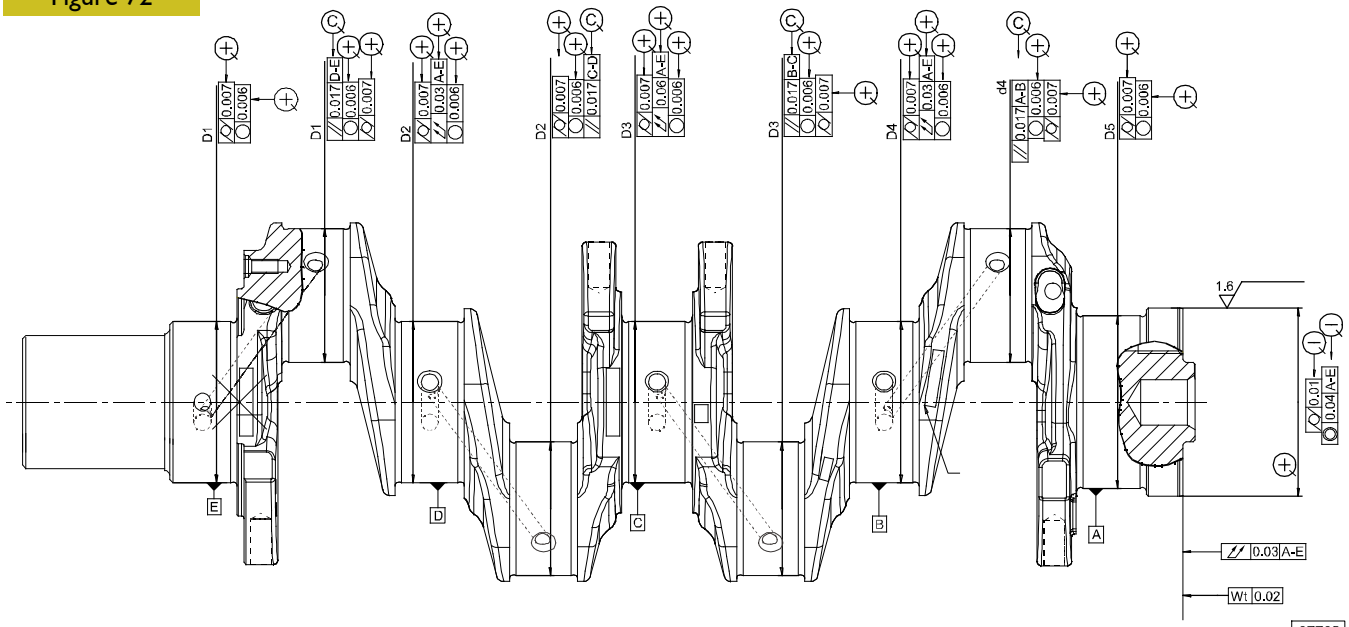
NOTE The main journals and crankpins must always be ground to the same undersize class.
The undersizing performed, on the main journals or crankpins, must be marked by punching on the side of crank arm no. 1.

For undersized crankpins, letter M.
For undersized main journals, letter B.
For undersized crankpins and main journals, letter MB.

The undersize classes are:
0.254 – 0.508 mm.

Checking crankshaft

Figure 72

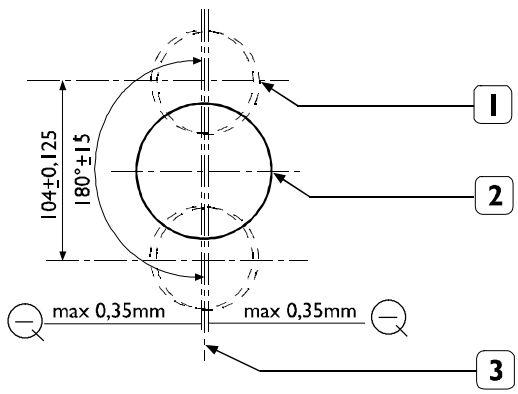


MAIN CRANKSHAFT TOLERANCES

TOLERANCES	TOLERANCE CHARACTERISTIC	GRAPHIC SYMBOL
SHAPE	Circularity	○
	Cylindricality	⌭
ORIENTATION	Parallelism	//
	Perpendicularity	⊥
POSITION	Concentricity or coaxiality	◎
OSCILLATION	Circular oscillation	↗
	Total oscillation	⌰

CLASS OF IMPORTANCE ASCRIBED TO THE PRODUCT CHARACTERISTICS	GRAPHIC SYMBOL
CRITICAL	©
IMPORTANT	⊕
SECONDARY	⊖

Figure 73



NOTE The checks on the tolerances indicated in the figures must be made after grinding the crankshaft pins.

SYMMETRY BETWEEN MAIN JOURNALS AND CRANKPINS

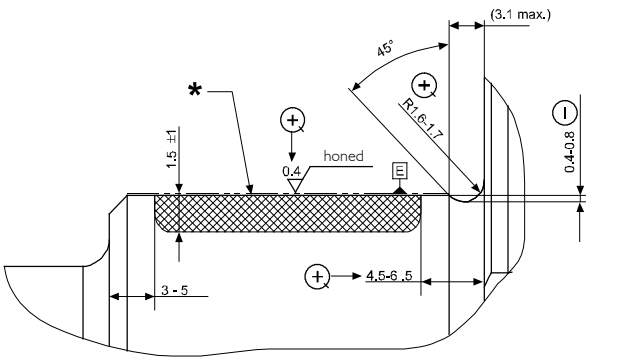
1. Crankpins
2. Main journals
3. Normal position

After grinding, keep to the following:

- ❑ Round off the edges of deburring the holes for lubrication of the main journals and crankpins.

Journal on timing system side

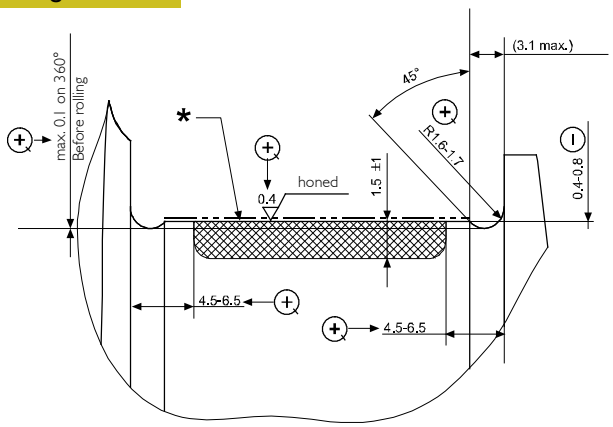
Figure 74



87787

Intermediate journals no. 2-4

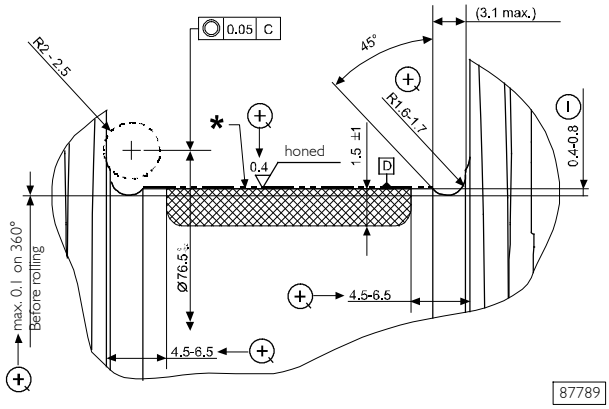
Figure 75



87788

Intermediate journal no. 3

Figure 76

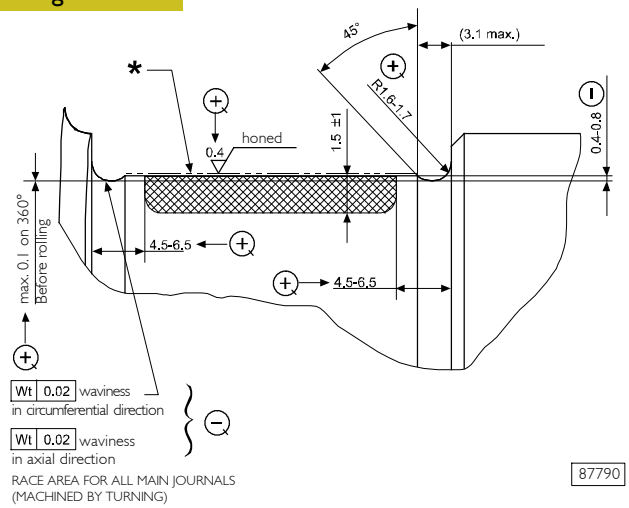


87789

MAIN DATA OF MAIN JOURNALS AND CRANKPINS

Journal on flywheel side

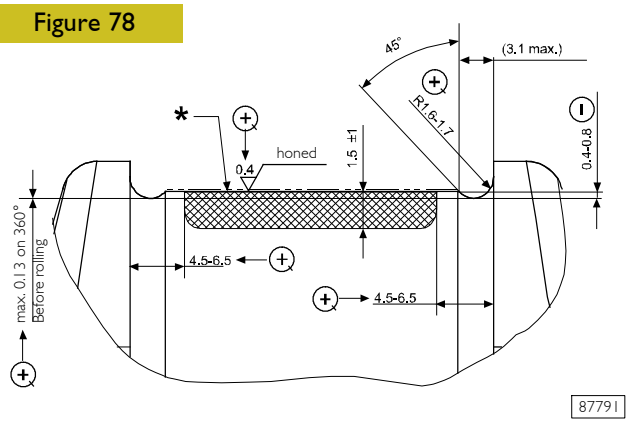
Figure 77



87790

Crankpins

Figure 78



87791

* As far as both values are concerned, for the whole 360°.

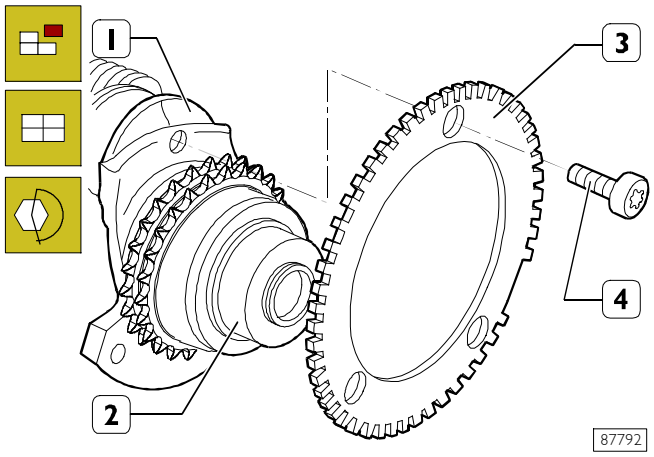
NOTE Since, during the 0.254 and 0.508 mm undersizing on the diameter of the crankpins and main journals, the rolled portion of the side races of the pins may get involved, it is necessary to turn the races keeping to the data given in the figure and to do the rolling keeping to the following instructions.
Rolling force:

- ❑ 1st main journal 925 ±25 daN.
- ❑ 2nd – 3rd – 4th – 5th main journal 1850 ±50 daN.
- ❑ crankpin 1850 ±50 daN.

- ❑ Rolling turns: 3 approach, 12 effective, 3 out.
- ❑ Rolling speed: 56 rpm.
- ❑ Reduction of the connecting rod pin slot diameter after rolling: 0.15 ÷ 0.30 mm*.
- ❑ Reduction of the journal slots after rolling: 0.15 ÷ 0.30 mm.

* Measured with calibrated rollers Ø 2.5 mm.

Figure 79



Take out the screws (4) and replace the phonic wheel (3).
The screws (4) are coated with LOCTITE 218 and must be replaced with fresh ones after each disassembly.
They must be tightened to a torque of 10 ± 1 Nm.

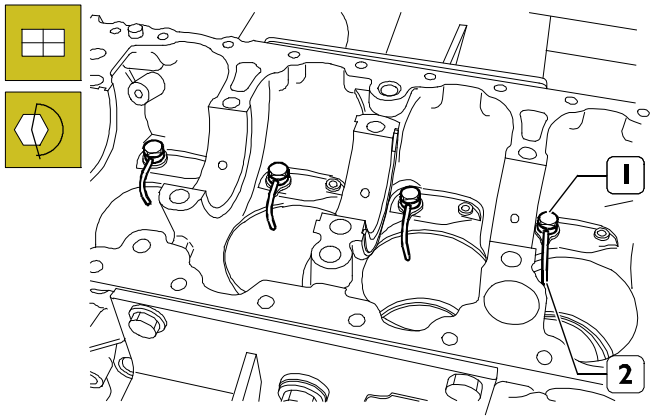
Replacing timing control gear

On finding the timing control gear teeth (1) damaged or worn, remove them from the crankshaft (2) using a suitable extractor.
The new gear is fitted onto the crankshaft by heating it to a temperature of 180°C for no longer than 15 minutes.
On completing assembly and after the gear has cooled, it must withstand a torque of 150 Nm without slipping.

ENGINE ASSEMBLY

The following parts must be replaced with new ones at the time of assembly: retaining rings, seals and gaskets, screws whose thread is coated with sealant.

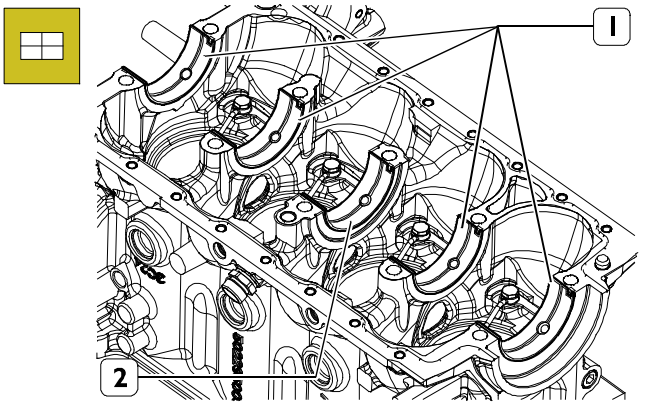
Figure 80



Fit on the oil spray nozzles (2) and tighten the couplings (1) to the prescribed torque.

Assembling main bearings

Figure 81



NOTE Not having found it necessary to replace the main bearings, they need to be fitted back on in the same sequence and position found upon disassembly.

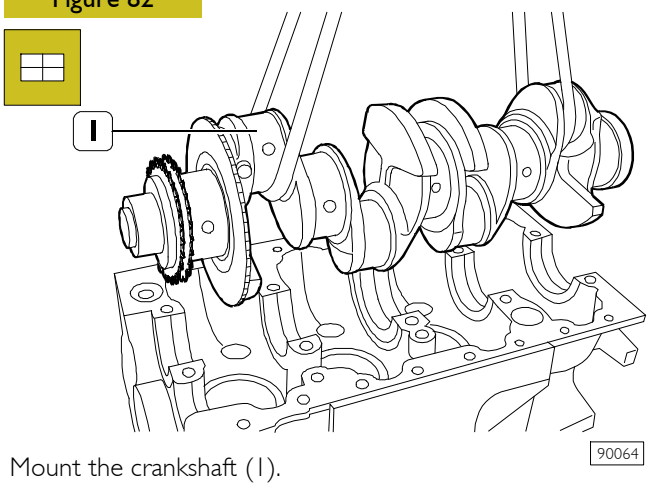
The main bearings (1) are supplied as spare parts undersized on the inside diameter by 0.254 ÷ 0.508 mm.

NOTE Do not do any accommodating on the bearings.

Thoroughly clean the top main bearing shells (1) and position them in the crankcase.

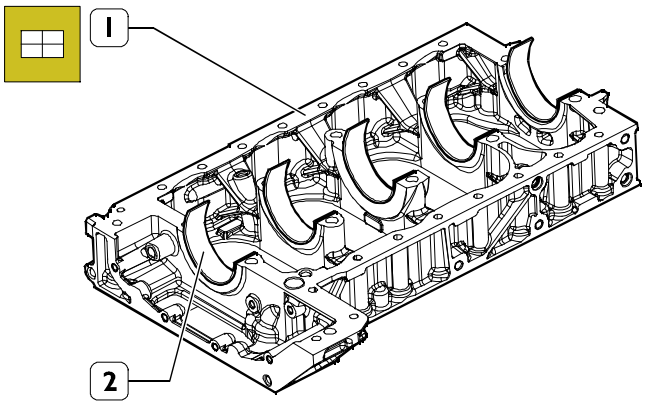
NOTE The middle half ring (2) is fitted with thrust washers.

Figure 82



Mount the crankshaft (1).

Figure 83

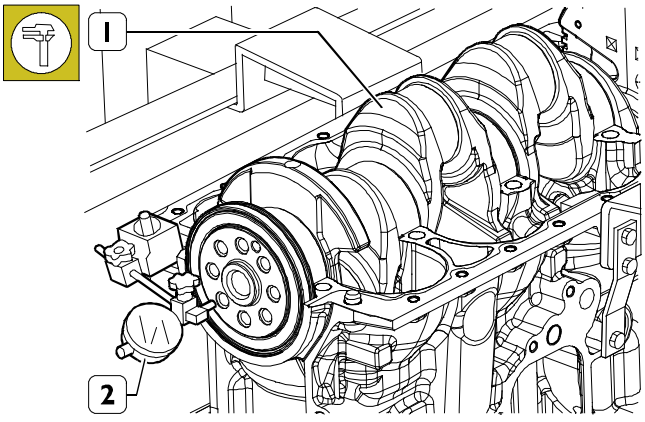


88289

Thoroughly clean the bottom main bearing shells (2) and mount them in the crankcase base (1).

Checking crankshaft end float

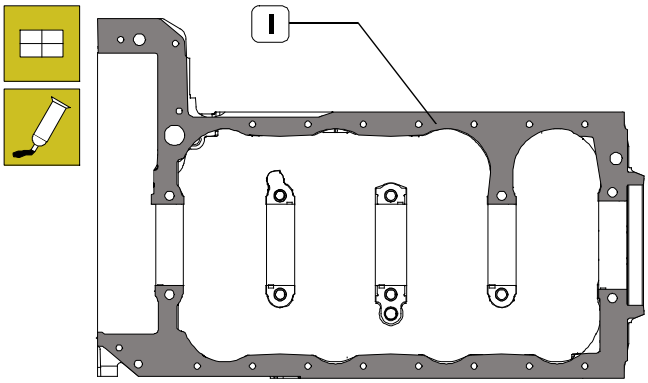
Figure 84



88293

The end float is checked by setting a dial gauge (2) with a magnetic base on the crankshaft (1) as shown in the figure.
The normal assembly clearance is 0.060 – 0.310 mm.
If you find the clearance to be greater than as required, replace the rear main bearing shells carrying the thrust bearings and repeat the clearance check between the crankshaft pins and the main bearing shells.
If the end float of the crankshaft does not come within the prescribed values, it is necessary to grind the crankshaft and accordingly change the main bearing shells.
NOTE: The middle main bearing has half thrust washers integrated in it, so it performs the function of a thrust bearing. It is supplied as a spare part only with the normal shoulder thickness.

Figure 85

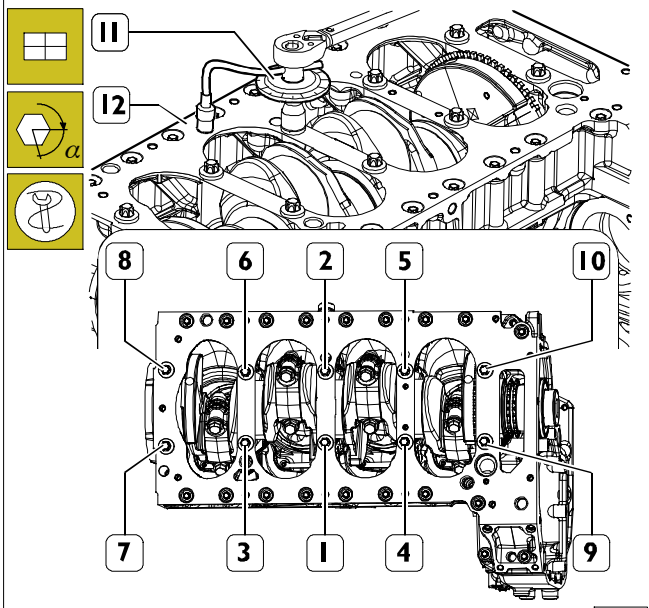


88294

Thoroughly clean the crankcase / crankcase base mating surface.
Apply, on base, sealant LOCTITE 510, as indicated in the scheme. The sealant must result to be even, not patchy.

NOTE Mount the crankcase base within 10 minutes of applying the sealant.

Figure 86



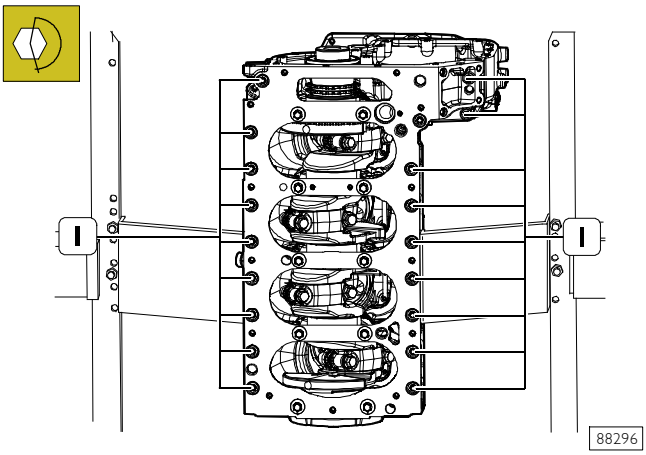
88292

Mount the crankcase base (12) and tighten the fixing screws in three stages, following the sequence shown in the figure:

- ❑ Step 1: with a torque wrench, to a torque of 50 Nm.
- ❑ Step 2: closing to an angle of 60°.
- ❑ Step 3: closing to an angle of 60°.

NOTE Use tool 99395216 (11) for the angle closing.

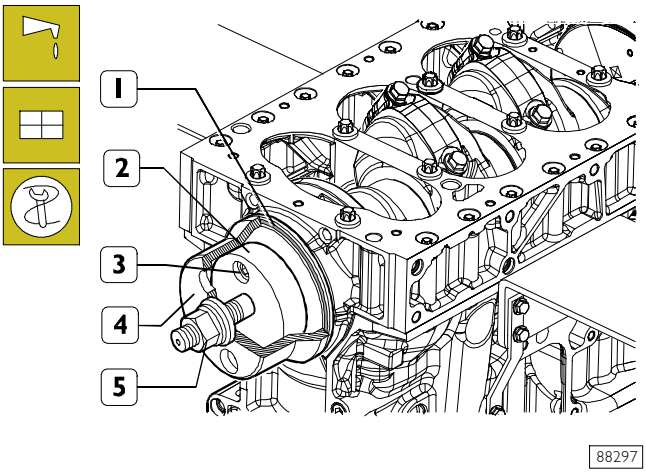
Figure 87



Then tighten the outer screws (1) to a torque of 26 - 30 Nm.

Assembling rear seal

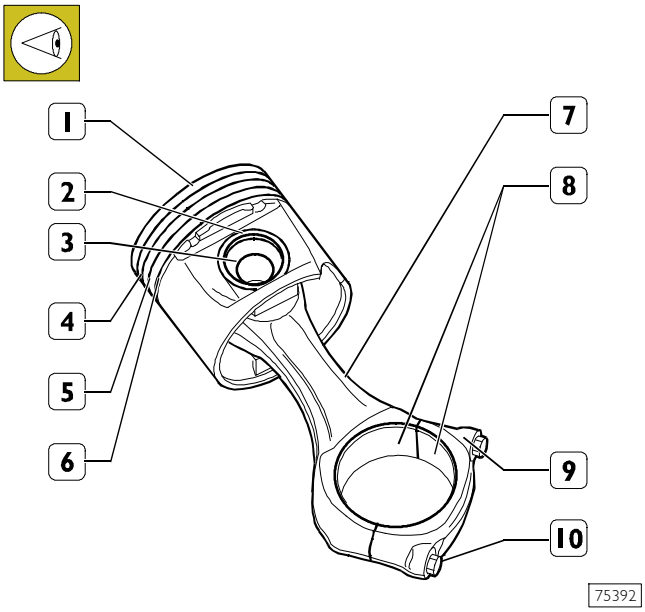
Figure 88



Carefully clean the seal seat.
Lubricate the rear shank of the crankshaft with engine oil.
Fit part (2) of tool 99346259 onto the rear shank of the crankshaft; secure it with the screws (3) and key the fresh seal (1) onto it.
Position part (4) on part (2); screw down the nut (5) to fit the seal (1) fully inside the crankcase.

CONNECTING ROD - PISTON ASSEMBLY

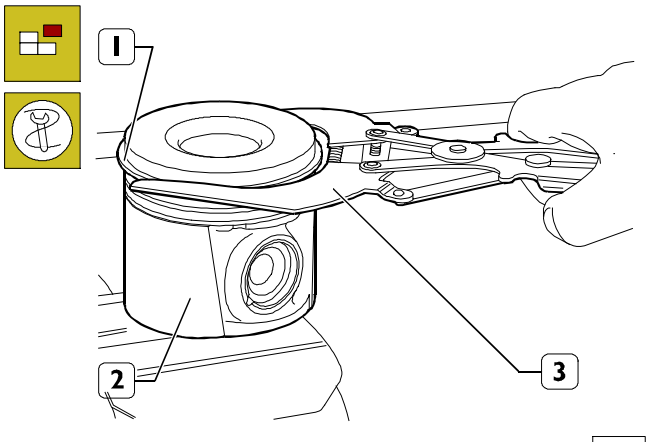
Figure 89



PISTON – CONNECTING ROD ASSEMBLY
1. Piston - 2. Piston ring - 3. Pin - 4. Trapezoidal ring - 5. Oil scraper ring - 6. Slotted oil scraper ring with spiral spring - 7. Connecting rod body - 8. Bearing shells - 9. Connecting rod cap - 10. Cap fixing screws.

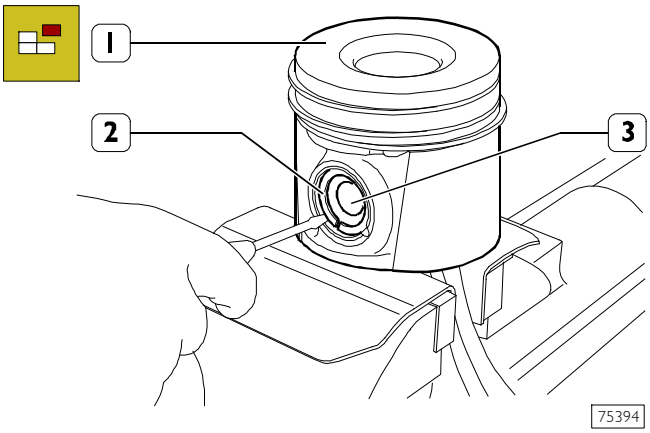
Check the pistons. They must show no signs of seizure, scoring, cracking or excessive wear; replace them if they do.

Figure 90



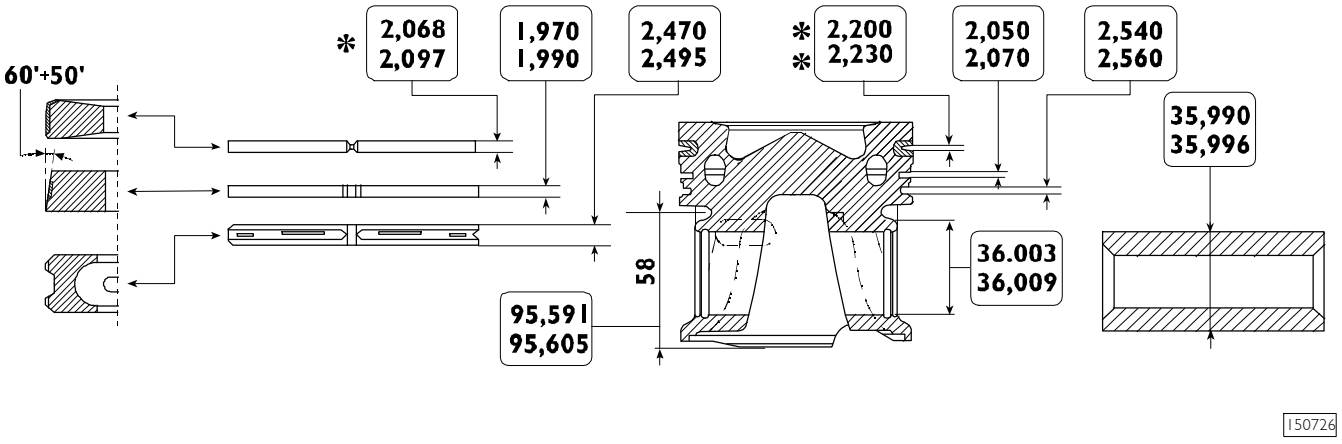
Remove the piston rings (1) from the piston (2) using pliers 99360183 (3).

Figure 91



Remove the piston (1) from the connecting rod, taking out the piston ring (2) and extracting the pin (3).

Figure 92



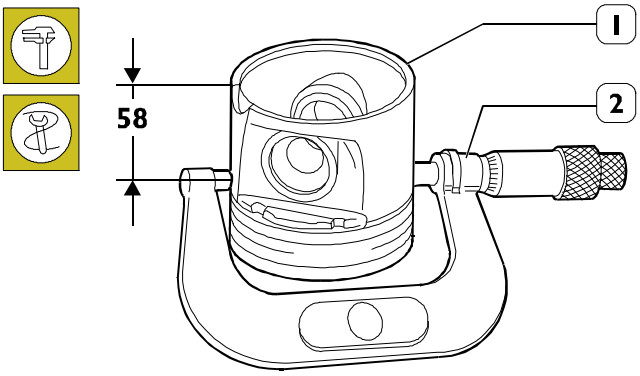
MAIN DATA FOR MAHLE, PINS AND PISTON RINGS

* The value is measured at 1.5 mm from the outer diameter

** The value of the diameter measured is 91.4 mm

Pistons
Measuring piston diameter

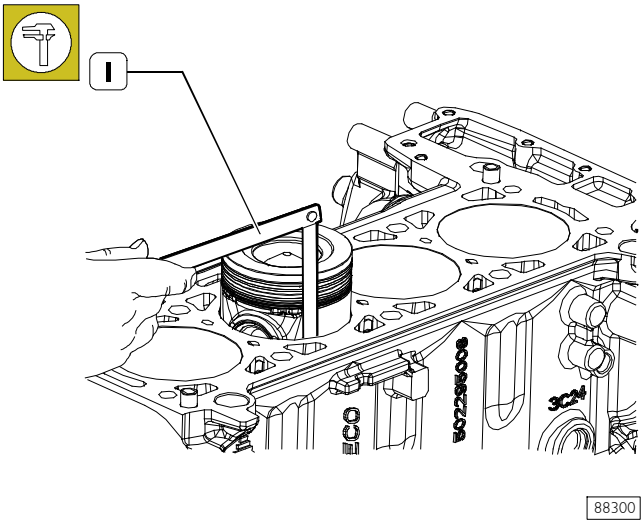
Figure 93



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

NOTE The pistons are supplied as spare parts with the standard, normal and 0.4mm oversize diameters together with rings, pin and retaining rings.

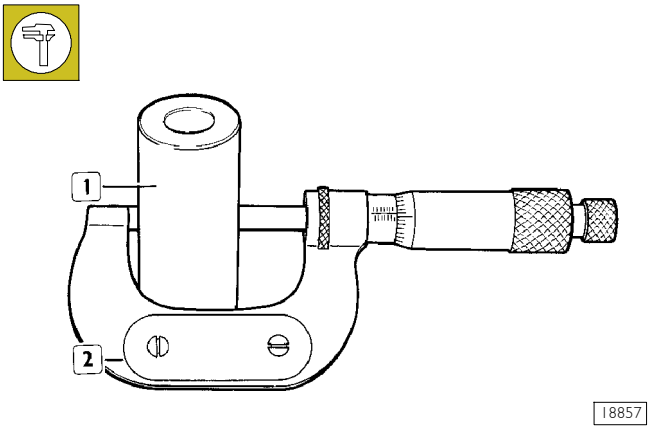
Figure 94



The clearance between the piston and cylinder liner can also be checked using a feeler gauge (1) as illustrated in the figure.

Piston pins

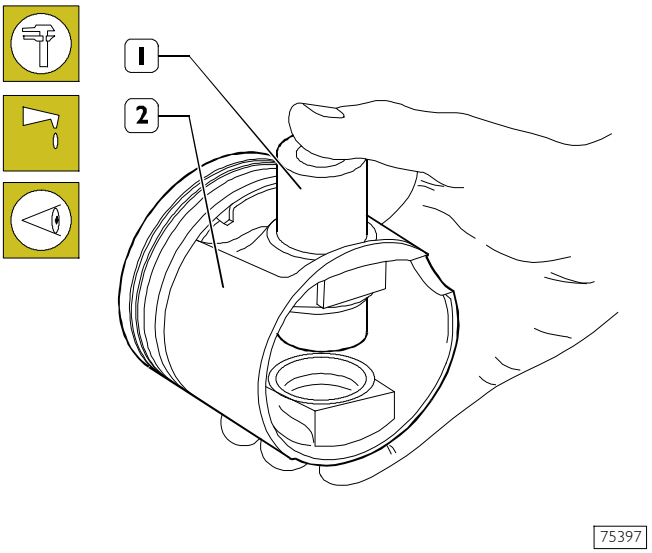
Figure 95



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

Conditions for correct pin-piston coupling

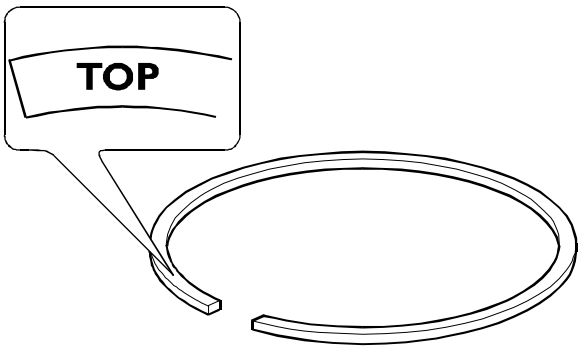
Figure 96



Lubricate the pin (1) and its seat on the hubs of the piston (2) with engine oil. The pin must go into the piston by lightly pressing with the fingers and must not drop out by gravity.

Piston rings

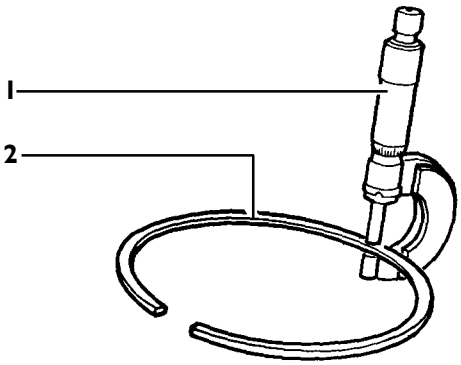
Figure 97



74947

The trapezoidal split rings (1st slot) and the oil scraper rings (2nd slot) have the word TOP etched in them; when fitting them on the piston, the word TOP must be facing upwards.

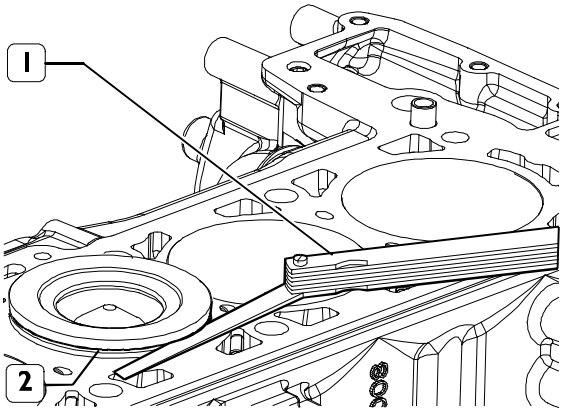
Figure 98



16552

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

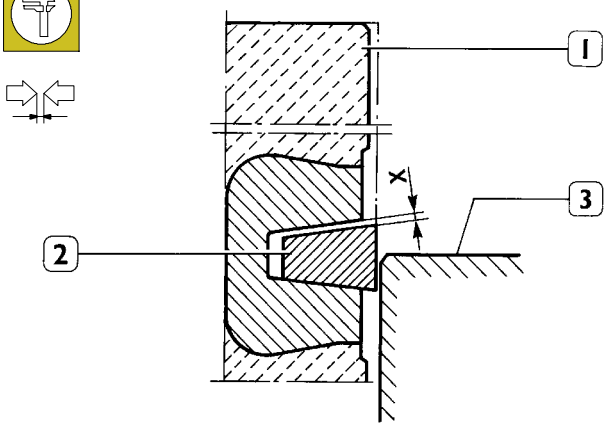
Figure 99



88301

Check the clearance between the trapezoidal ring (2) (1st slot) and the associated slot on the piston with a feeler gauge (1), proceeding as follows: insert the piston into the cylinder liner so that the ring (2) comes approximately half way out of it.

Figure 100

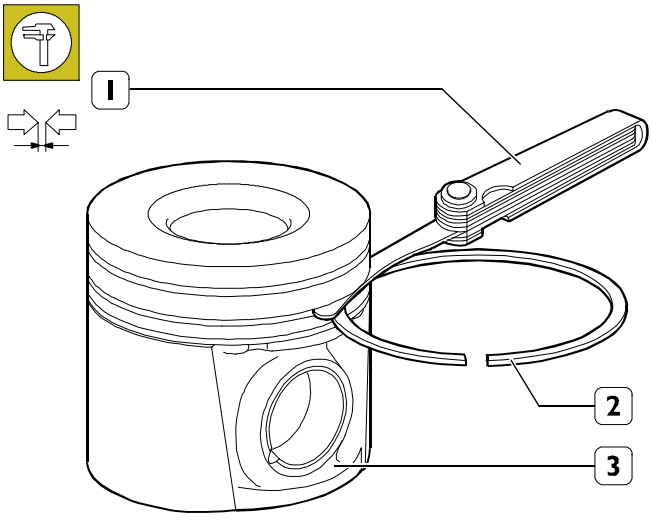


41104

DIAGRAM FOR MEASURING THE CLEARANCE X BETWEEN THE FIRST PISTON SLOT AND THE TRAPEZOIDAL RING
1. Piston slot - 2. Trapezoidal piston ring - 3. Cylinder liner

Using a feeler gauge (1, Figure 99), check the clearance (X) between the ring (2) and the slot (1); this clearance must have the prescribed value.

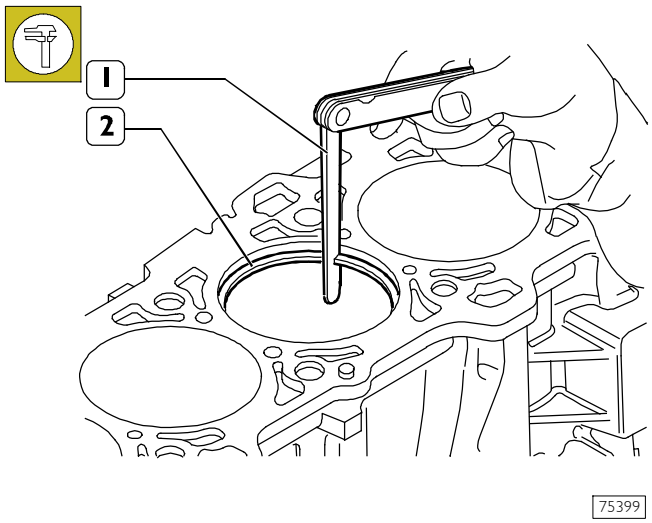
Figure 101



75398

Check the clearance between the piston rings (2) of the 2nd and 3rd slot and the associated seats on the piston (3) with a feeler gauge (1).

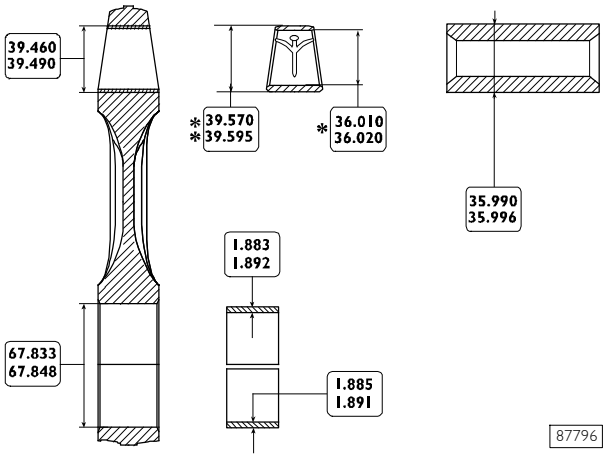
Figure 102



Check the opening between the ends of the piston rings (2) inserted in the cylinder liner using a feeler gauge (1).

Connecting rods

Figure 103



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

* Internal diameter to obtain after driving into the small end and grinding with a reamer.
** Dimension cannot be measured in the free state.
*** Thickness of the bearing shell supplied as a spare part.

NOTE Each connecting rod has its cap marked:

- with a letter: O or X indicating the diameter class of the big end mounted in production;
- with a number indicating the weight class of the connecting rod mounted in production.

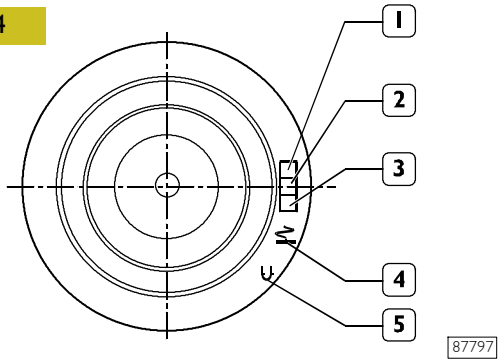
In addition, it could be stamped with the number of the cylinder in which it is fitted.
In the event of replacement it is therefore necessary to number the new connecting rod with the same number as the one replaced.
The numbering must be done on the opposite side to the bearing shell retaining slots.
The connecting rods are supplied as spare parts with the diameter of the big end 67.833 - 67.848 mm marked with the letter O and the weight class marked with the number 33.
It is not permissible to remove material.

Bushing

Check that the bush in the small end has not come loose and shows no sign of seizure or scoring. If it does, replace the complete connecting rod.

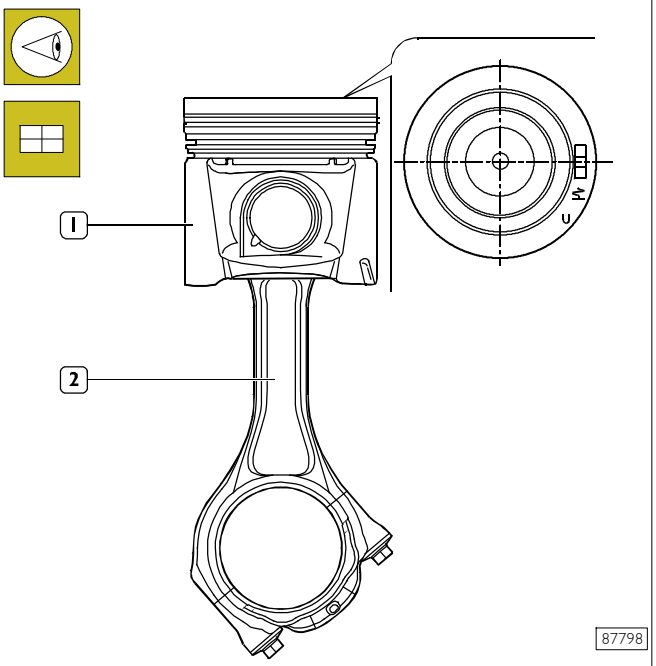
Assembling connecting rod-piston assembly

Figure 104



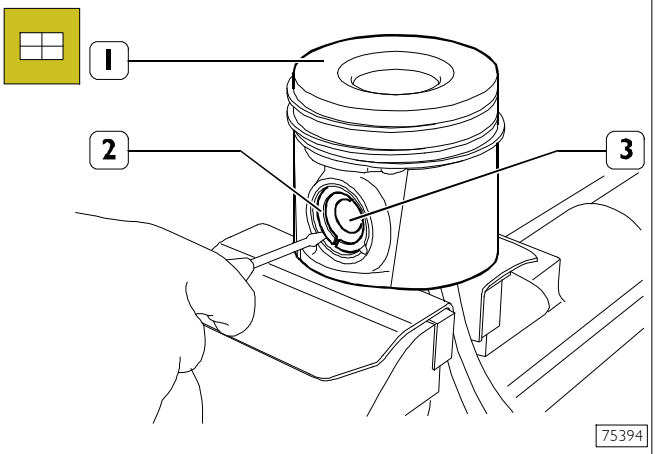
Etched on the top of the piston are: the type of engine (1), class selection (2) and supplier (3) as well as the direction of fitting the piston in the cylinder liner (4). The mark (5) is for passing the 1st slot insert adhesion test.

Figure 105



Connect the piston (1) to the connecting rod (2) together with its cap so that the piston assembly reference, position of the connecting rod and of the cap are observed as shown in the figure.

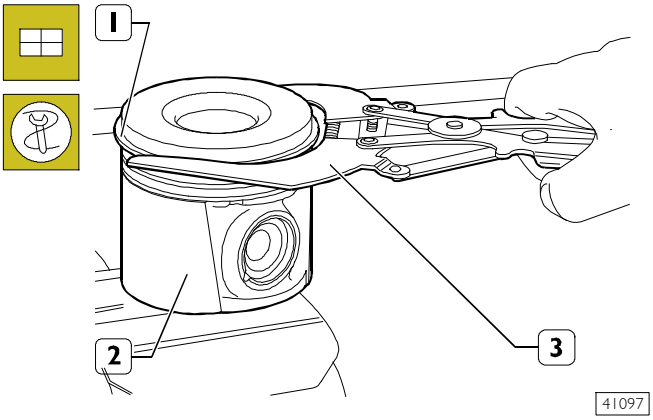
Figure 106



Position the piston (1) on the connecting rod, insert the pin (3) and secure it with the split rings (2).

Assembling piston rings

Figure 107

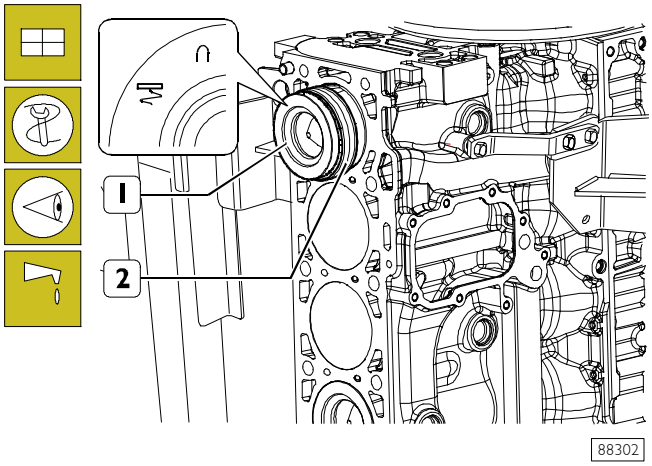


Fit the piston rings (1) on the piston (2) using the pliers 99360183 (3).

NOTE The 1st and 2nd slot rings need to be mounted with the word "TOP" facing upwards.

Assembling connecting rod – piston assemblies in cylinder barrels

Figure 108



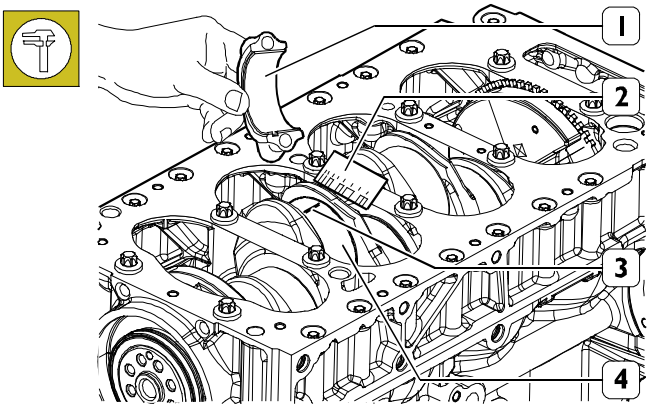
Lubricate the pistons well, including the piston rings and the inside of the cylinder liners.
With the aid of the clamp 99360605 (2), fit the connecting rod – piston assembly (1) in the cylinder liners, checking that:

- ❑ The number of each connecting rod corresponds to the cap mating number.
- ❑ The openings of the piston rings are staggered 120° apart.
- ❑ The pistons are all of the same weight.
- ❑ The symbol punched on the top of the pistons faces the engine flywheel, or the recess in the skirt of the pistons tallies with the oil spray nozzles.

NOTE Not finding it necessary to replace the connecting rod bearings, you need to fit them back in exactly the same sequence and position found on disassembly.

Measuring crankpin assembly clearance

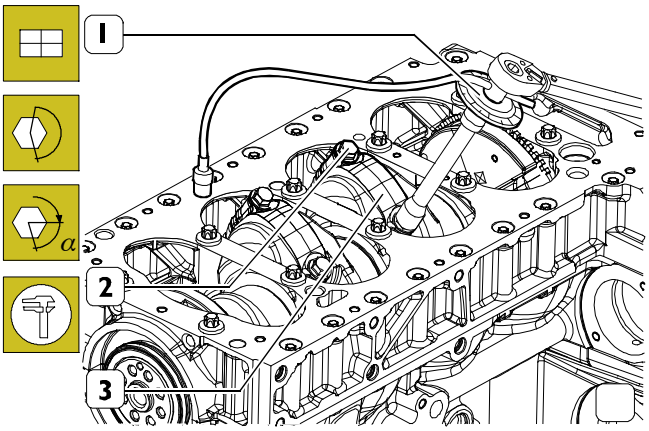
Figure 109



To measure the clearance, carry out the following steps:

- ❑ Thoroughly clean parts (1) and (4) and eliminate all traces of oil.
- ❑ Place a length of calibrated wire (3) on the crankshaft pins (4).

Figure 110



- ❑ Fit the connecting rod caps (3) with the associated bearing shells.
- ❑ Tighten the screws (2) in two steps:
  - Step 1: with a torque wrench, to a torque of 50 Nm.
  - Step 2: closing to an angle of 70°.

NOTE Use tool 99395216 (1) for the angle closing.

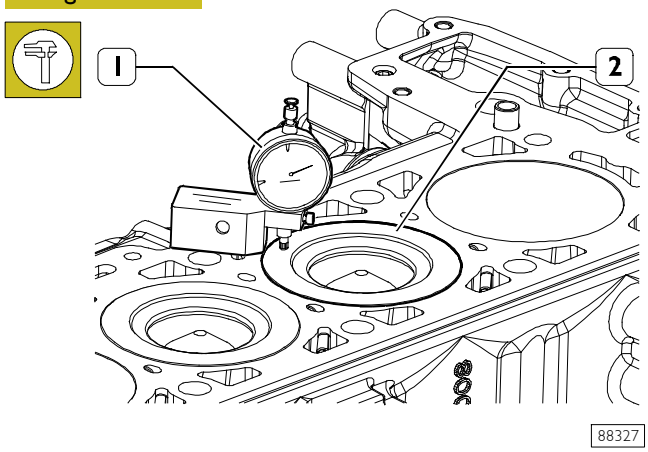
- ❑ Remove the cap (3) and determine the existing clearance by comparing the width of the calibrated wire (3, Figure 109) with the graduated scale on the case (2, Figure 109) that contained the calibrated wire. On finding a clearance other than as prescribed, replace the bearing shells and repeat the check.
  On obtaining the prescribed clearance, lubricate the connecting rod bearing shells and fit them permanently by tightening the connecting rod cap fixing screws as described.

NOTE The connecting rod cap fixing screws must always be replaced for permanent assembly.

Manually check that the connecting rods slide axially on the pins of the crankshaft.

Checking piston protrusion

Figure 111



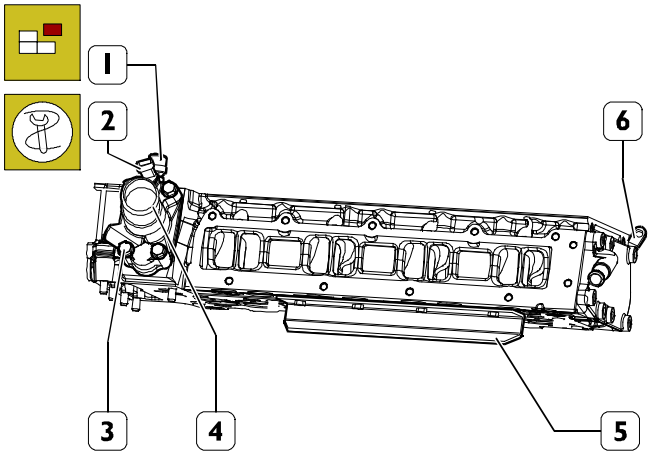
At the end of the connecting rod-piston assembly refitting, check the piston protrusion (2) at the T.D.C. compared to the top level of the cylinder block by means of a dial gauge (1) and relevant base 99370415.

NOTE The difference between the minimum and maximum protrusions of the four pistons must be = 0.15 mm.
The cylinder head gasket in the set of spare gaskets needed for complete engine overhaul is supplied with a single thickness. Clearly, it is supplied separately too.

CYLINDER HEAD

Disassembly

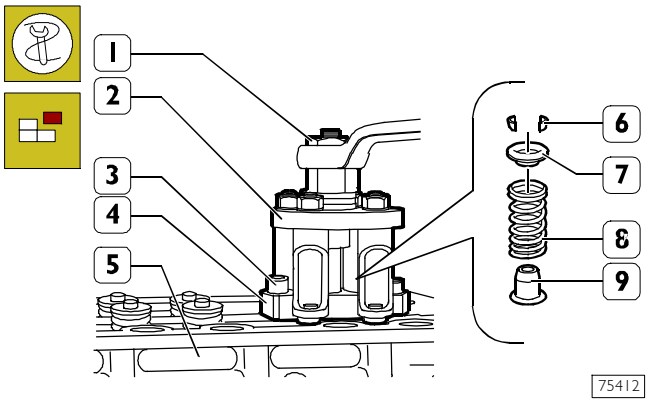
Figure 112



Apply the support SP. 2271 (5) on the cylinder head and tighten the support in a vice.
Remove the brackets (6) for lifting the engine.
Remove the sensors (1 and 2), if needed.
Take out the screws (3) and remove the thermostat casing (4).

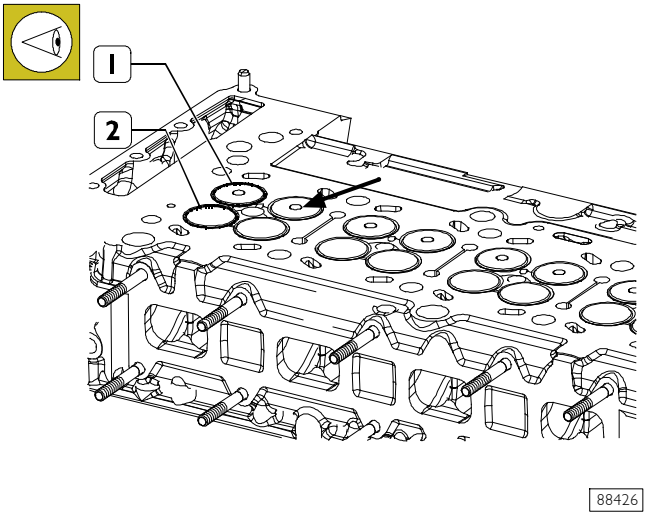
Disassembling valves

Figure 113



Fit part (4) of tool 99360260 onto the cylinder head (5) and secure it with the screws (3).
Fit part (2) of tool 99360260 onto part (4), screw down the nut (1) so that on compressing the springs (8) it is possible to remove the cotters (6). Then take out the plates (7) and the springs (8).
Using suitable pliers, remove the oil seal (9).
Repeat these operations on the remaining valves.
Turn the cylinder head over.

Figure 114



The intake (1) and exhaust (2) valves have the same diameter mushroom.
The central cavity (→) of the mushroom of the intake valve (1) is distinguished from that of the exhaust valve (2).

NOTE Before removing the valves from the cylinder heads, number the valves in order to refit them correctly if they are not changed.
A = intake side - S = exhaust side

Remove the intake (1) and exhaust (2) valves.

Checking cylinder head seal

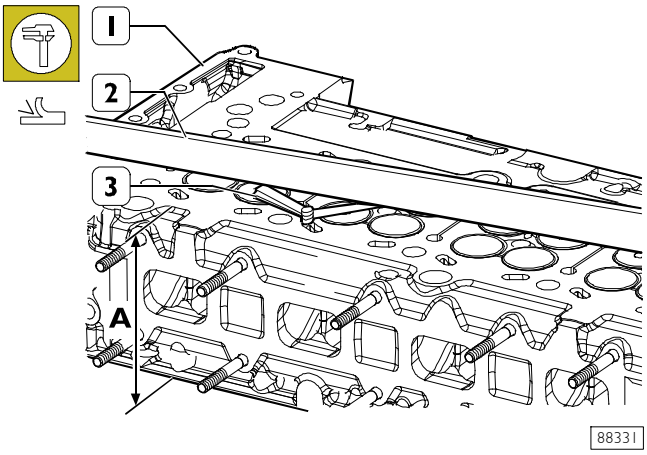
Check the hydraulic seal using a suitable tool.
Pump in water heated to approx. 90°C at a pressure of 2 ÷ 3 bars.
Replace the cup plugs if they are found to leak at oil, using a suitable drift for their removal - assembly.

NOTE Before mounting the plugs, apply LOCTITE 270 water-reacting sealant on their sealing surfaces.

If there is any leakage from the cylinder head, it must be replaced.

Checking cylinder head mating surface

Figure 115

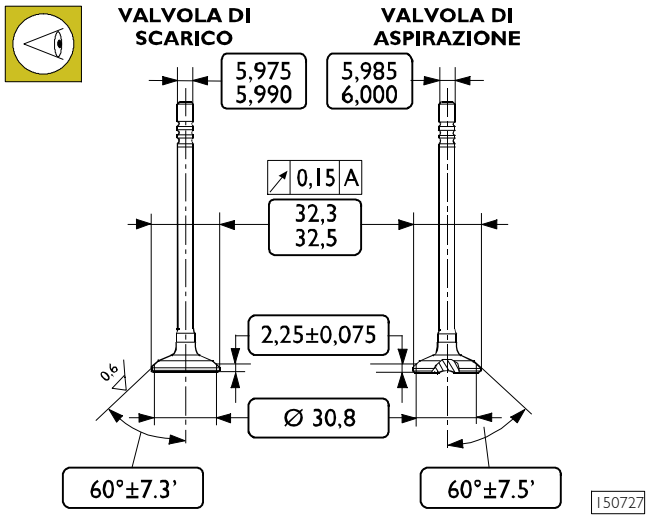


The mating surface of the head (1) with the cylinder block is checked using a rule (2) and a feeler gauge (3).
The deformation found on the entire length of the cylinder head must be no greater than 0.20 mm.
For greater values, regrind the cylinder head according to the values and instructions given in the following figure.
The nominal thickness A of the cylinder head is 112 ±0.1 mm; the maximum permissible removal of metal must not exceed a thickness of 0.2 mm.

NOTE After regrinding, check the valve recessing and if necessary regrind the valve seats to make the prescribed valve recessing.

VALVES

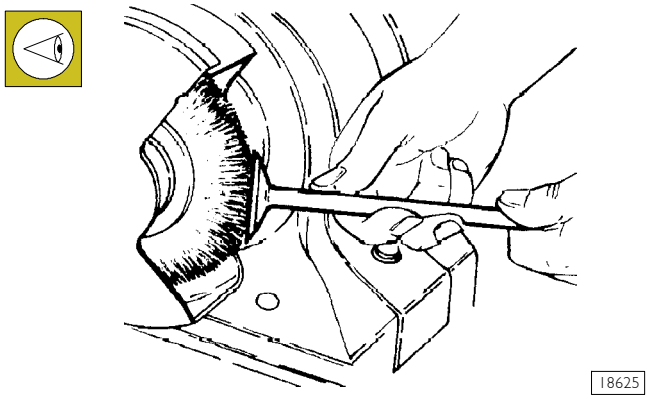
Figure 116



MAIN DATA OF INTAKE AND EXHAUST VALVES

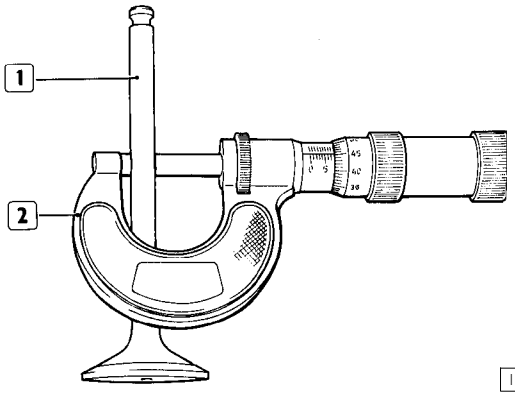
Removing deposits, refacing and checking valves

Figure 117



Remove the carbon deposits on the valves with a wire brush. Check that the valves show no signs of seizure, cracking or burning.

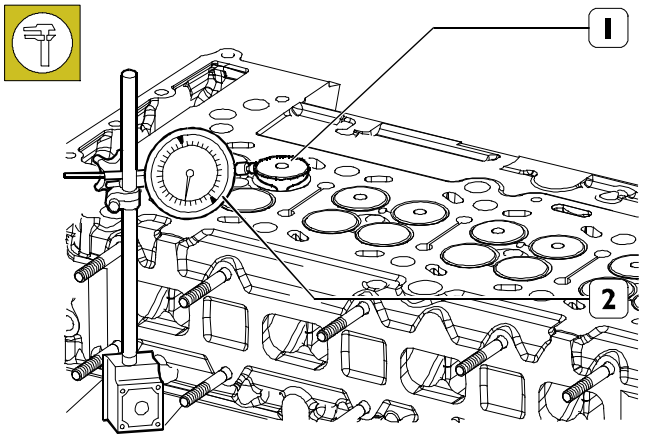
Figure 118



Use a micrometer (2) to measure the valve stem (1): it must have the value shown in Figure 132. If necessary, grind the valve seats by means of the grinding machine, and remove as little material as possible.

Checking clearance between valve stem and valve guide and centring valves

Figure 119

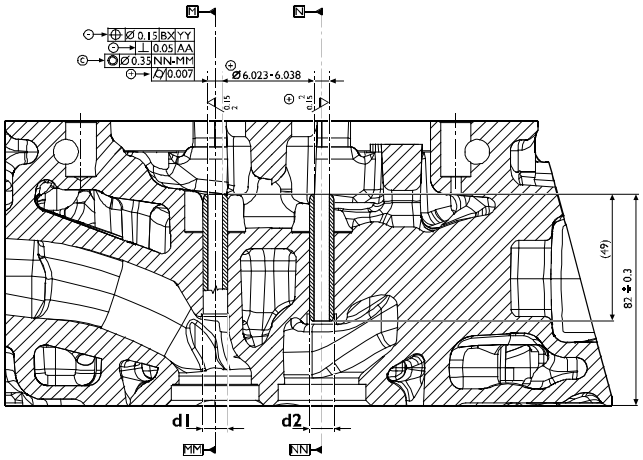


88332

The checks are made using a dial gauge (2) with a magnetic base, positioned as illustrated. The assembly clearance is 0.033 - 0.063 mm.
Making the valve (1) turn, check that the centring error is no greater than 0.03 mm.

VALVE GUIDES
Replacing valve guide

Figure 120



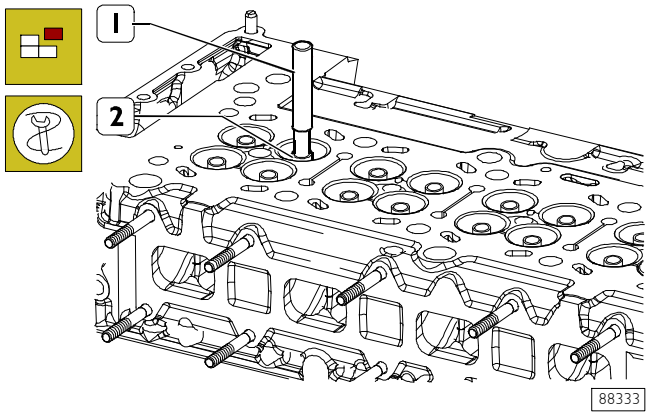
87800

MAIN DATA OF VALVE GUIDES - SEATS

Valve guide seat inside Ø	9.980 ÷ 10.000 mm
Valve guide outside Ø	10.028 ÷ 10.039 mm

* Measurement to be made after driving in the valve guides.

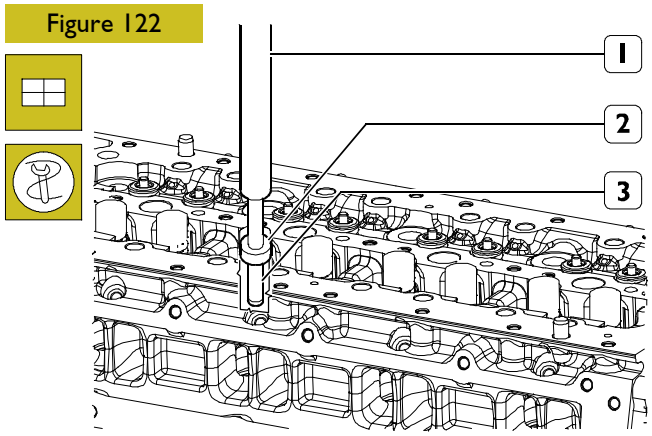
Figure 121



88333

Remove the valve guides (2) with the drift.

Figure 122

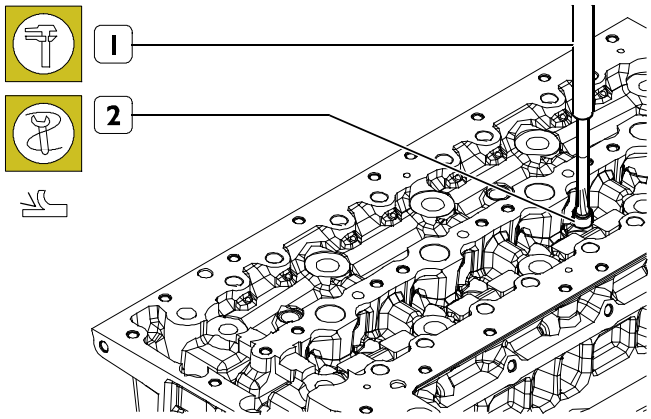


88334

Warm up the cylinder head to 80° ÷ 100°C and, by means of beater SP.2312 (1) fitted with element SP.2311 (2), fit the new valve guides (3) previously lubricated with engine oil. Driving force 10 ÷ 25 KN.
If the above mentioned tools are not available, fit the valve guides by positioning them in the cylinder head according to the value shown in Figure 120.

Boring valve guides

Figure 123



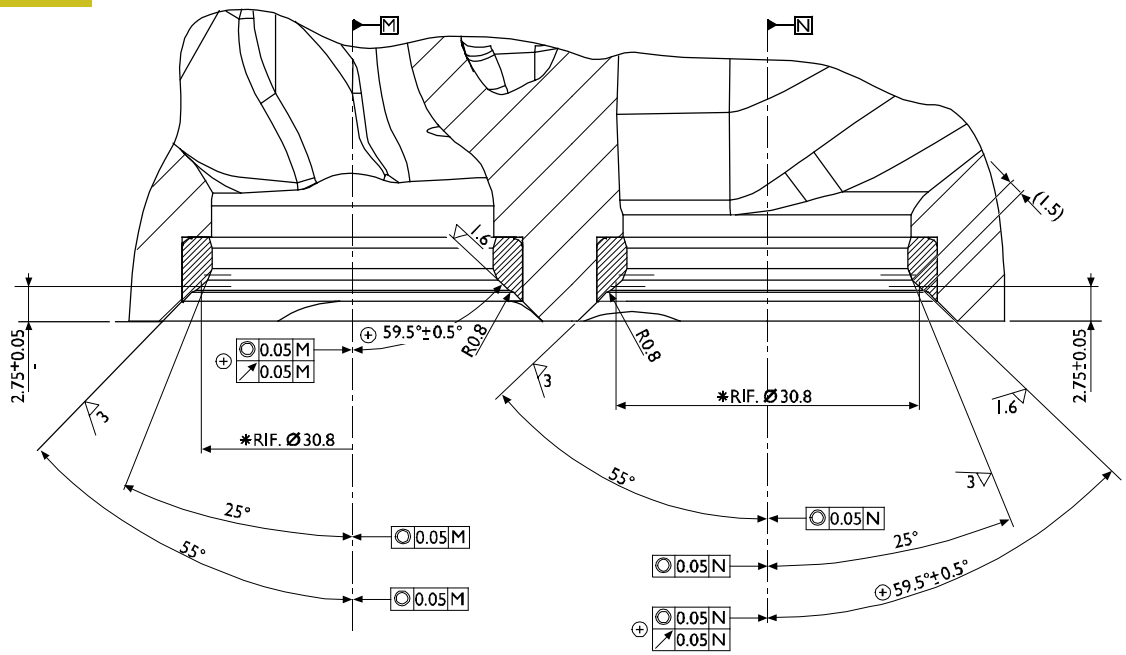
88335

After driving in the valve guides (2), regrind them with the smoother.

VALVE SEATS

Regrinding - replacing valve seats

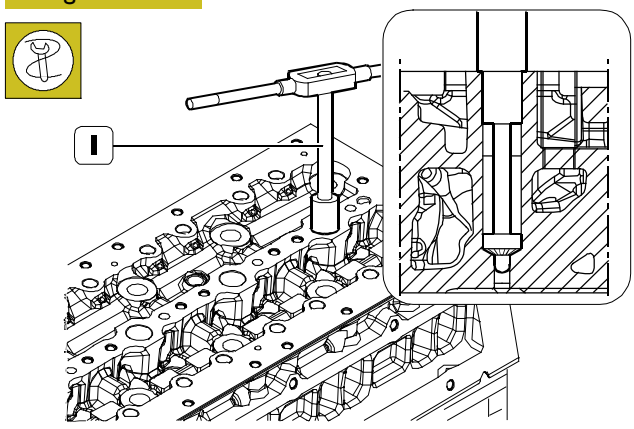
Figure 124



87801

Check the valve seats. On finding any slight scoring or burns, regrind them with an appropriate tool according to the angles given in Figure 124.
Having to replace them, with the same tool and taking care not to affect the cylinder head, remove as much material from the valve seats as possible until, with a punch, it is possible to extract them from the cylinder head.
Heat the cylinder head to 80 ÷ 100°C and, using a suitable drift, fit in it the new valve seats, previously chilled in liquid nitrogen.
Using a specific tool, regrind the valve seats according to the angles given in Figure 124.

Figure 125

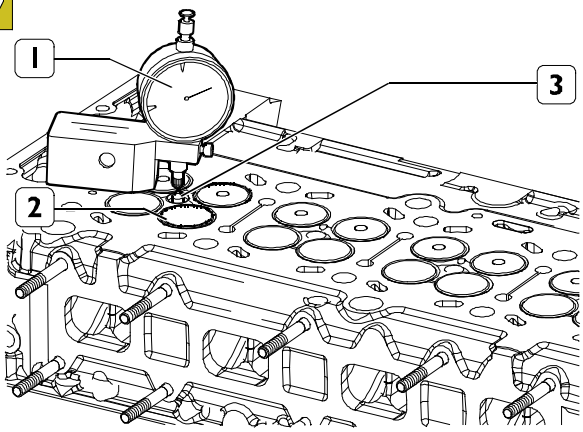


88336

Using the milling cutter 99394038 (1), clean the injector seat of any deposits.

Mount the valves, block the seat of the electro-injectors and glow plugs; using a suitable tool, check the seal of the valves/seats.

Figure 126

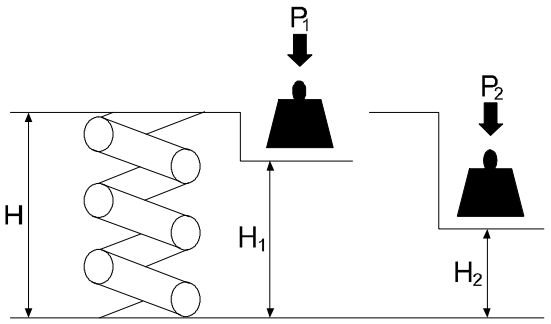


88337

Using a dial gauge (1), check that, from the plane of the cylinder head, the valve recessing (2) and the protrusion of the injector (3) and of the glow plug have the prescribed value:
- Valve recessing: 0.375 ÷ 0.525 mm.
- Injector protrusion: 2.77 ÷ 3.23 mm.
- Glow plug protrusion: 3.78 mm.

VALVE SPRINGS

Figure 127



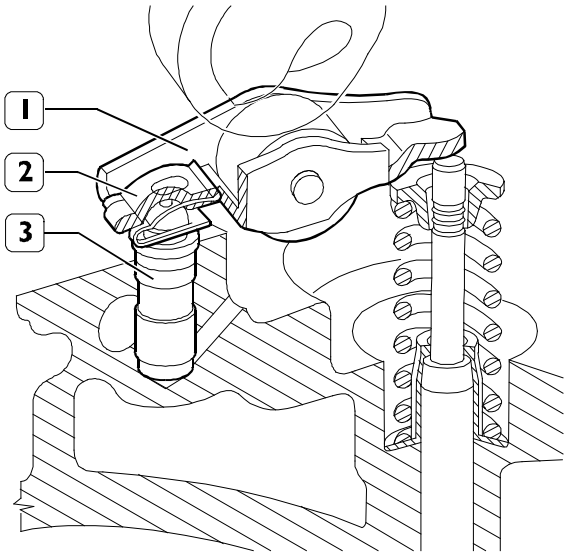
50676

MAIN DATA TO CHECK INTAKE AND EXHAUST VALVE SPRINGS

Height	Under a load of
mm	N
H 55.05	Free
H1 45	P 320 ±12
H2 35	P1 657 ±24

ROCKER ARMS - TAPPETS

Figure 128

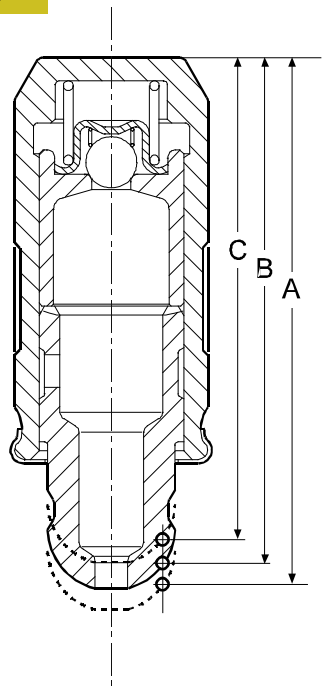


75461

COMPLETE ROCKER ARM ASSEMBLY

The rocker arm assembly is composed of the rocker arm (1), hydraulic tappet (3), made integral with each other by the clip (2).

Figure 129

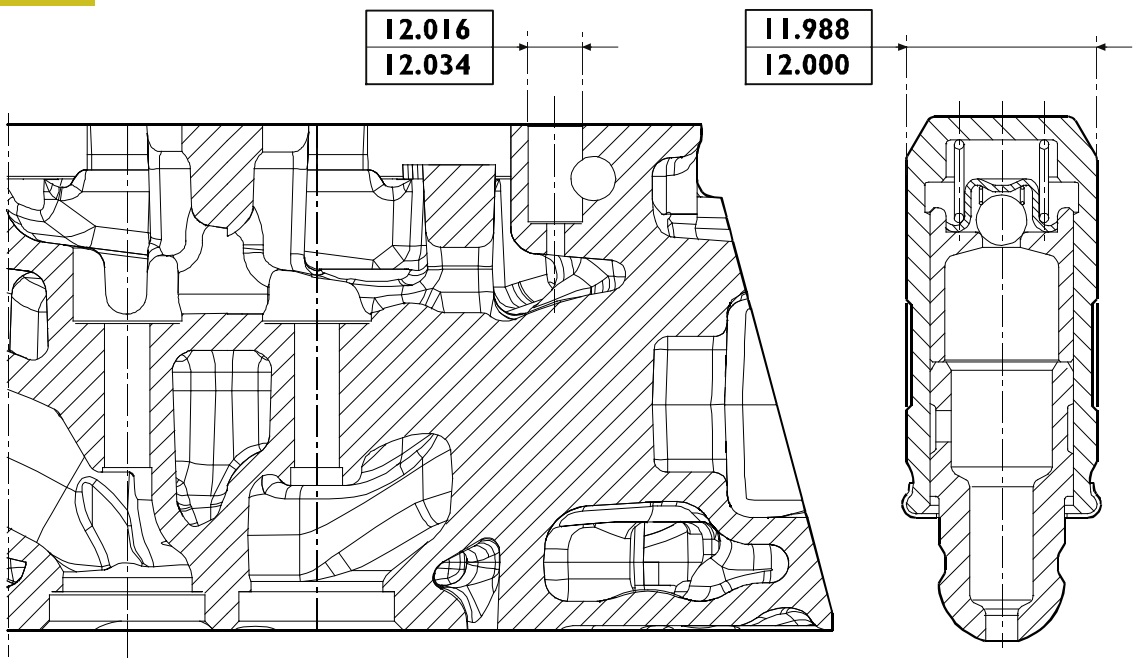


75942

CROSS-SECTION OF THE HYDRAULIC TAPPET

A = 32.44 ±0.3, end of stroke
B = 31.30, working position
C = 29.75 ±0.25, start of stroke

Figure 130



MAIN DATA HYDRAULIC TAPPETS - SEATS

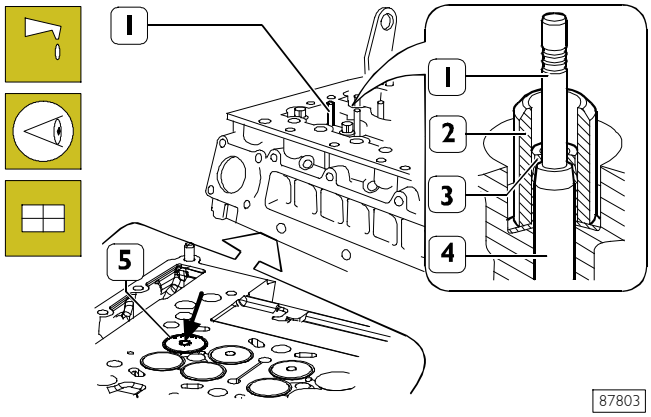
Checks

The sliding surface of the tappets must have no scoring/dents; replace them if they do.

Using a micrometer, measure the diameter of the tappets and, using a bore meter, measure the diameter of the seats in the cylinder head; the difference in the measurements will give the assembly clearance.

ASSEMBLING CYLINDER HEADS

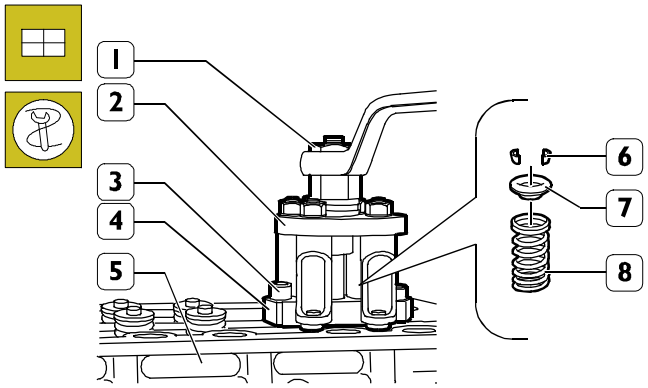
Figure 131



Lubricate the stem of the valves (1) and insert them into the associated valve guides (4) according to the position marked during removal. Using tool SP.2264 (2), mount the oil seals (3) on the valve guides (4).

NOTE The suction valves (5) are different from the exhaust ones for a slot (→) in the centre of the valve head.

Figure 132



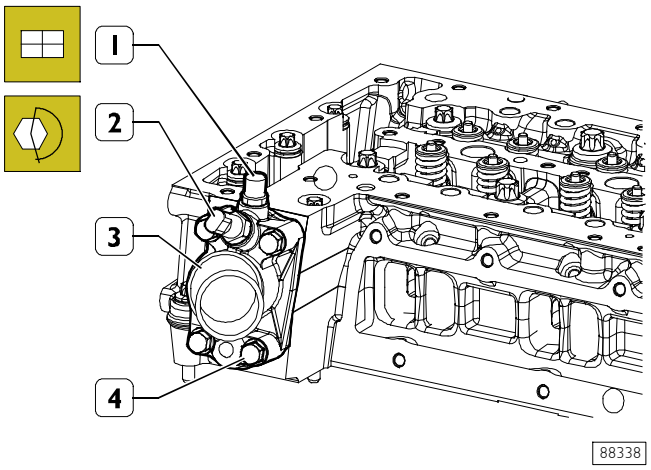
Position the springs (8) and plates (7) on the cylinder head (5).

Fit the part (4) of tool 99360260 onto the cylinder head (5) and secure it with the screws (3).

Fit the part (2) of tool 99360260 onto part (4), screw down the nut (1) so that by compressing the springs (8) it is possible to insert the retaining cotters (6); then unscrew the nut (1) checking that the cotters (6) have settled in correctly.

Repeat these operations on the remaining valves.

Figure 133

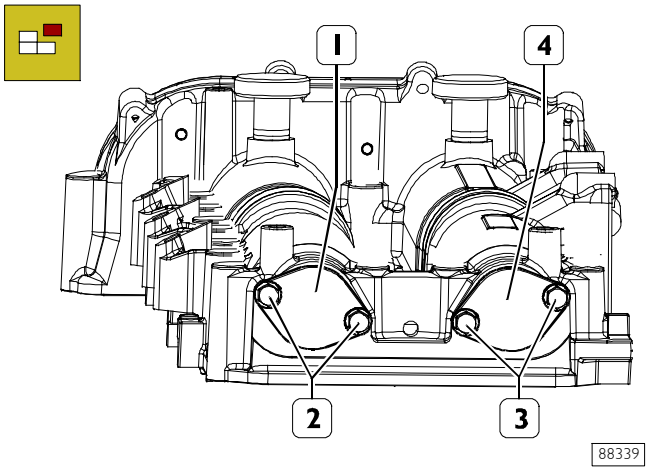


Fit the thermostat casing (3) with a new seal and tighten the fixing screws (4) to the prescribed torque.
Fit the temperature sensors (1 and 2) and tighten them to the prescribed torque.
Fit the brackets for lifting the engine and tighten the fixing screws to the prescribed torque.

Overhead

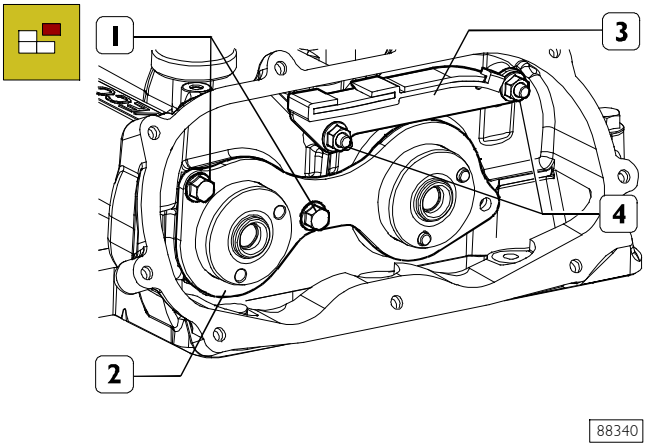
Overhead removal

Figure 134



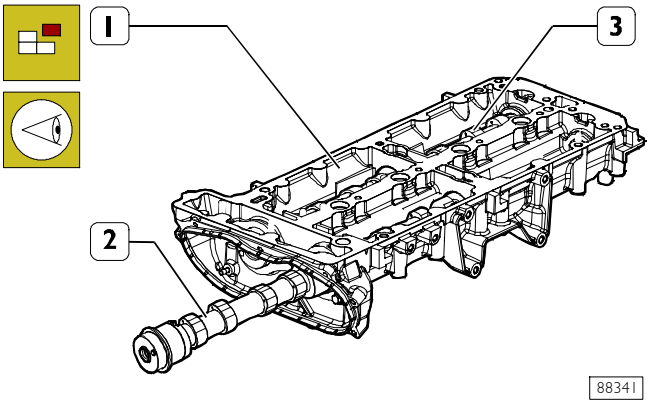
Remove the screws (2 and 3) and the covers (1 and 4) together with the over-head seal rings.

Figure 135



Remove the nuts (4) and the top skid (3).
Remove the screws (1) and the shoulder plate (2).

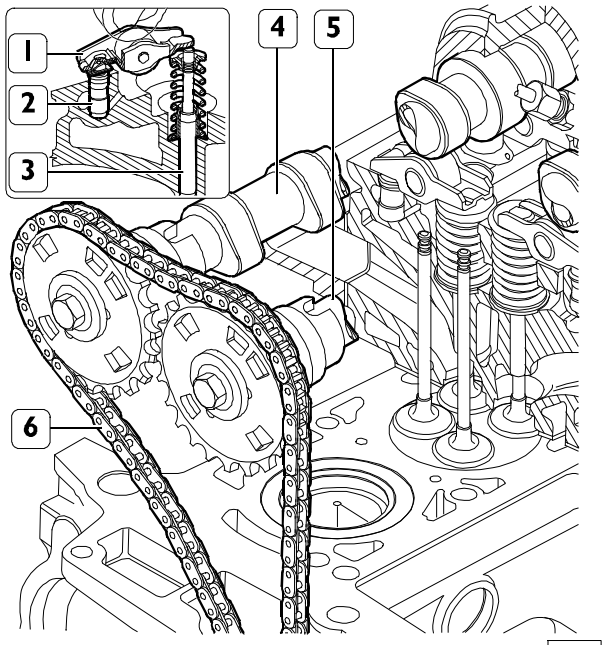
Figure 136



Tilt the over-head (1) and take care not to damage the seats, then take off the camshafts (2 and 3) from the overhead.

TIMING SYSTEM

Figure 137



1. Rocker arm - 2. Reaction hydraulic tappet - 3. Valve assembly - 4. Camshaft on exhaust side - 5. Camshaft on suction side - 6. Camshaft control chain.

Description

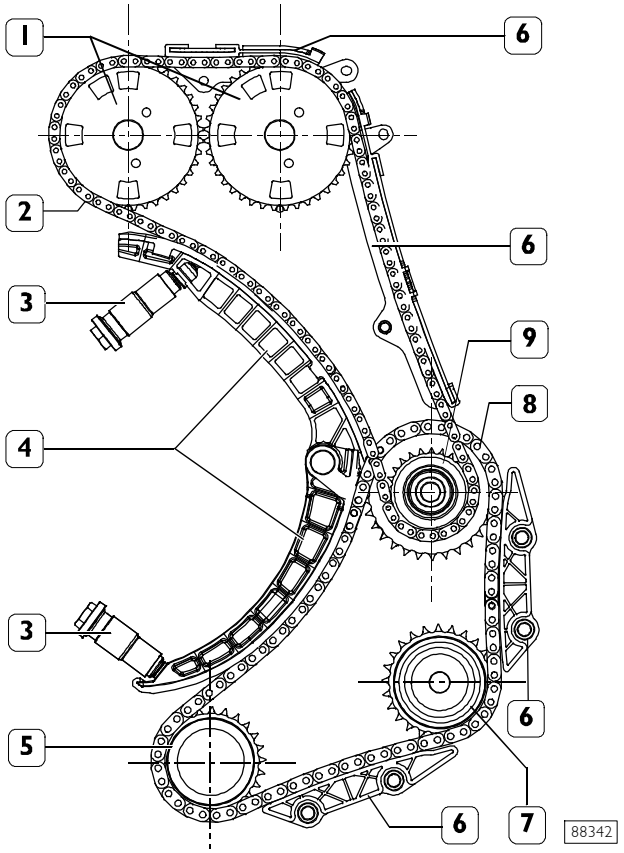
The timing system is the type with a twin camshaft in the head and four valves per cylinder with hydraulic tappets.
The control is transmitted by two chains:

- a double chain by 3/8" is set in motion by the driving shaft and sets the control shafts in motion: oil pump/depressor - high pressure pump;
- a single chain is set in motion by the high pressure control shaft gear and sets the camshafts in motion.

The camshaft gears are mutually interchangeable and are fitted with slots to make it possible for the phase sensor to detect the phase.
The rocker arms, one for the valve, are kept in contact with the corresponding cam by an hydraulic tappet, thus eliminating the need for regular adjustments.

NOTE Change both chains, even if only one of them is faulty.

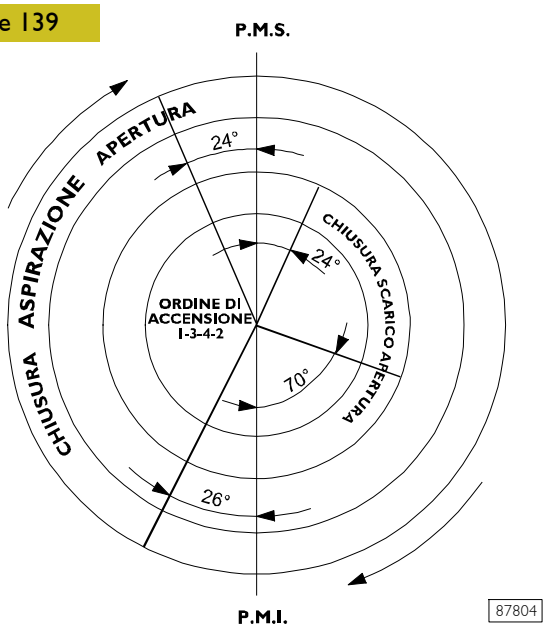
Figure 138



TIMING SYSTEM AND AUXILIARY SYSTEM DIAGRAM

1. Camshaft control gear - 2. Single chain - 3. Hydraulic chain tightener - 4. Chain - 5. Drive gear on driving shaft - 6. Fixed skid - 7. Oil pump/depressor control shaft gear - Hydraulic power steering pump - 8. Double chain - 9. High pressure pump control shaft gear.

Figure 139

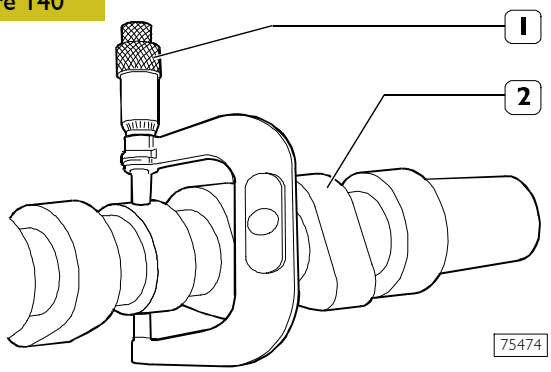


TIMING SYSTEM DIAGRAM

Camshaft Checks

The surfaces of the shaft supporting pins and of the cams must be finely honed; if there is any sign of meshing or scoring, replace the shaft.

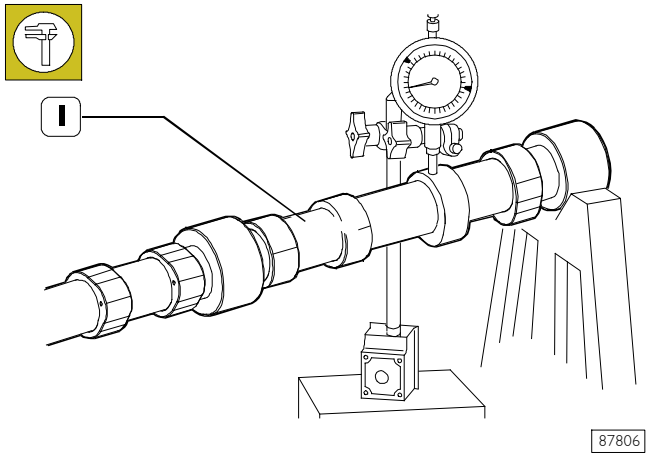
Figure 140



Using a micrometer (1), measure the diameter of the pins (2) of the camshaft and, using a bore meter, measure the diameter of the supporting seats in the overhead.
The difference between these two measurements gives the existing clearance.
The nominal assembly clearance is 0.037 ÷ 0.088 mm.

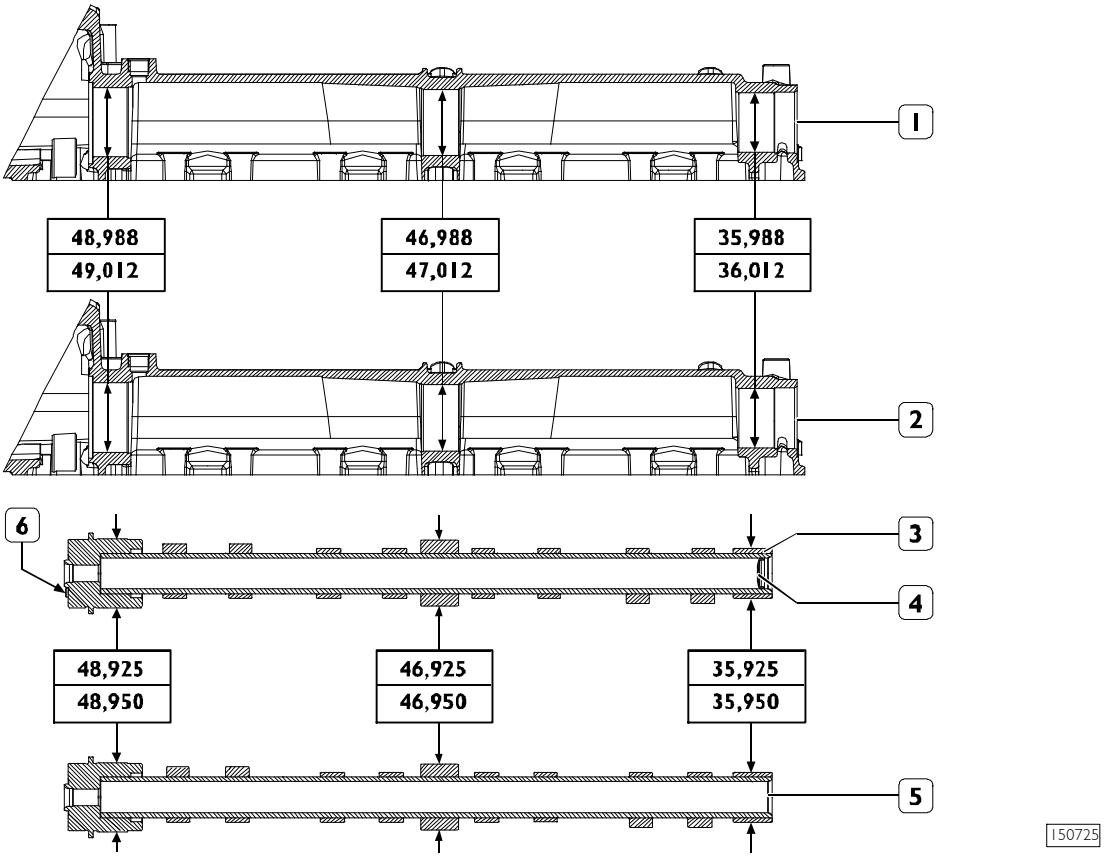
Checking cam lift and pin alignment

Figure 141



Place the shaft (1) on the parallels and use a centesimal dial gauge fitted on the central support to check that the alignment error does not exceed 0.04 mm; otherwise, change the shaft. Check also the cam lift: it must correspond to the prescribed value; if different values are detected, change the shaft.

Figure 142



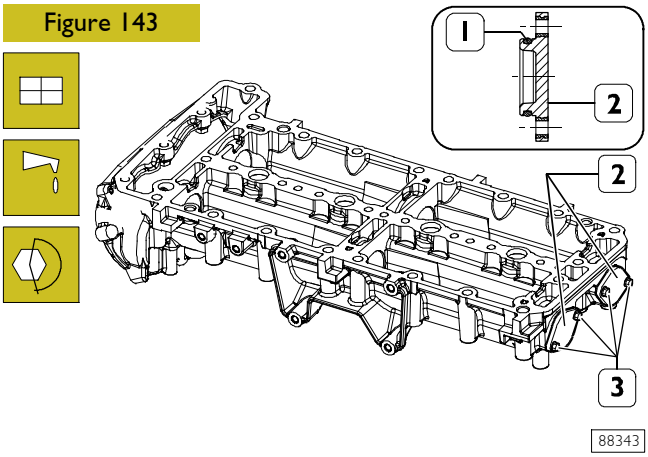
MAIN DATA, CAMSHAFT PINS AND SEATS

1. Intake valve camshaft seats - 2. Exhaust valve camshaft seats - 3. Intake valve camshaft - 4. Exhaust valve camshaft.

The camshaft (3) of the suction valves can be recognised through the spring cup (4) and the dowel (6).

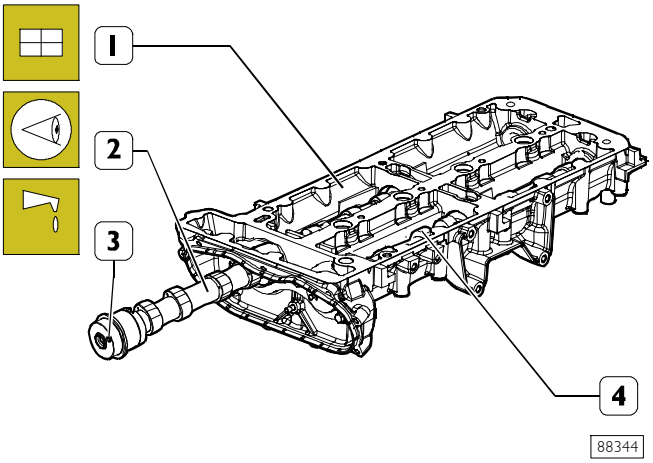
Assembling overhead

Figure 143



Lubricate the new seal rings (1) with engine oil and fit them on the covers (2).
Fit the covers (2) on the overhead, drive in the fastening screws (3) and tighten them to the prescribed torque.

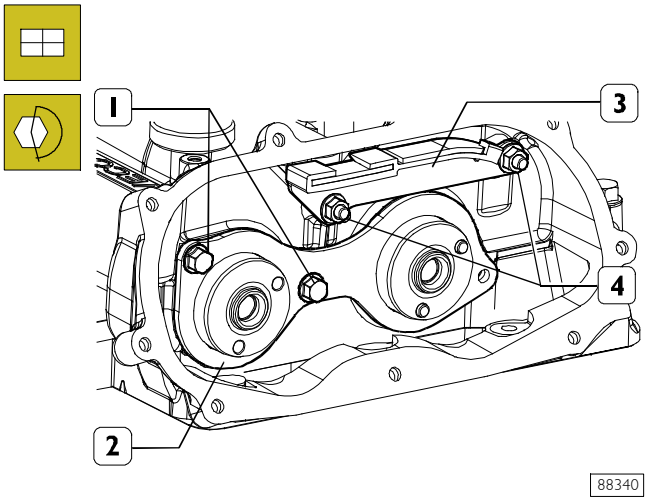
Figure 144



Lubricate the support pins of the suction camshafts (2) and exhaust camshafts (4) and fit them on the overhead (1).

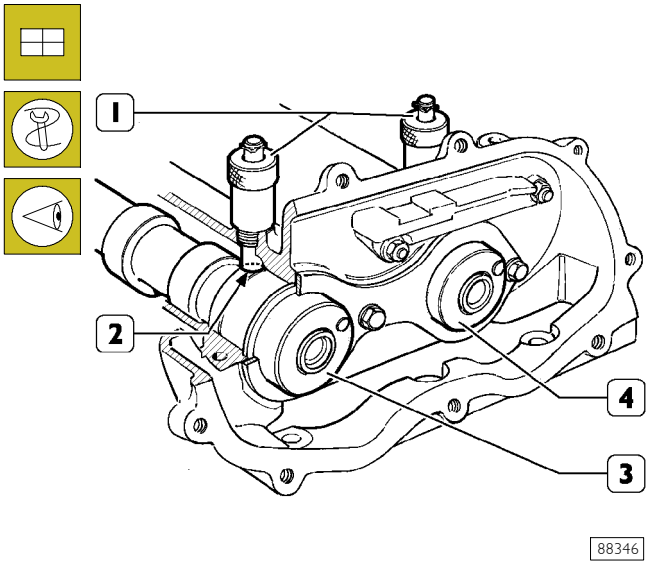
NOTE During this operation do not exchange the assembly position of the shafts.
The suction camshaft can be recognised (2) through the dowel (3) on the front side and the retainer on the rear side.
In addition, take care not to damage the support seats of the over-head shafts.

Figure 145



Fit the top skid (3) and drive in the nuts (4), then tighten them to the prescribed torque.
Fit the shoulder plate (2) and drive in the screws (1), then tighten them to the prescribed torque.

Figure 146

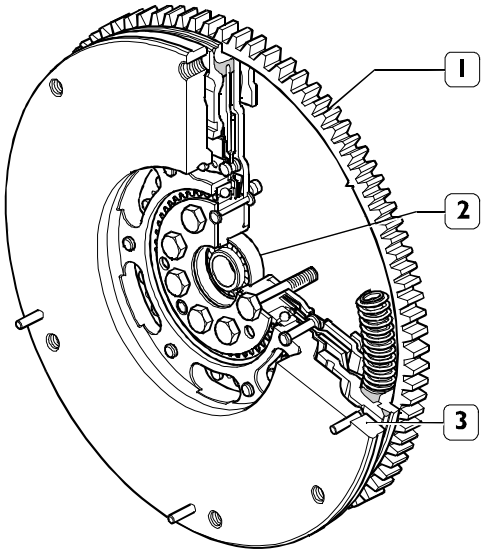


Position the camshafts (3 and 4) so that the pins 99360614 (1) can be inserted in the camshaft slots (2) through the over-head threaded holes.

DOUBLE COUNTERWEIGHT ENGINE FLYWHEEL

For motor F1CE3481C*C124

Figure 147

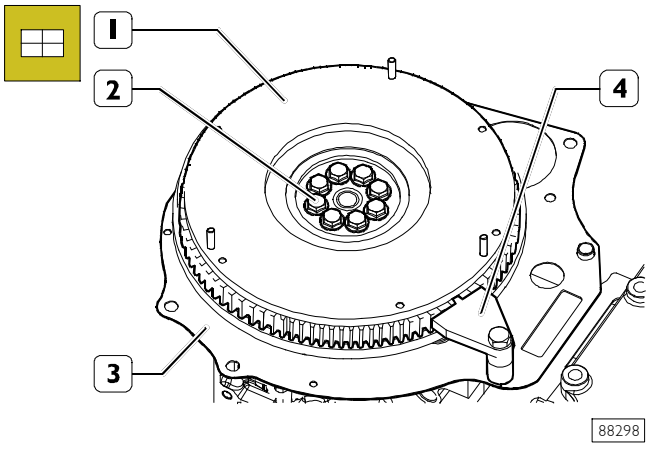


Double-mass engine flywheel, one integral with the drive shaft and one with the input shaft of the gearbox and in between a torsion elastic dampening system.
The advantages of this type of flywheel compared to the normal one are:

- ❑ Dampening of engine irregularities transmitted to the gearbox and resulting drive noise reduction;
- ❑ Noise reduction in the cabin as a result of the overall noise reduction.

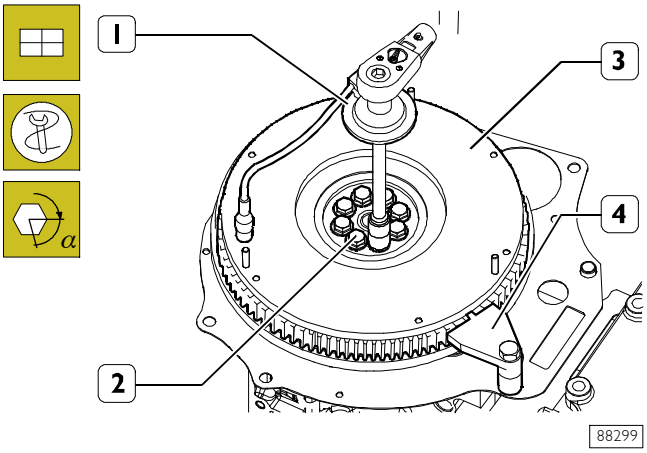
Check the clutch disc mating surface, if there are too many scratches, change the engine flywheel (3).
Check the conditions of the bearing (2) and the crown gear (1), if they are worn out or damaged change the engine flywheel (3).

Figure 148



Position the metal sheet guard (3) on the cylinder block, if present.
Mount the engine flywheel (1) and screw down the screws (2).
Fit tool 99360306 (4) onto the crankcase to block rotation of the engine flywheel (1).

Figure 149



Tighten the screws (2) fixing the engine flywheel (3) in two steps:

- ❑ Step 1: with a torque wrench, to a torque of 30 Nm.
- ❑ Step 2: closing to an angle of 90°.

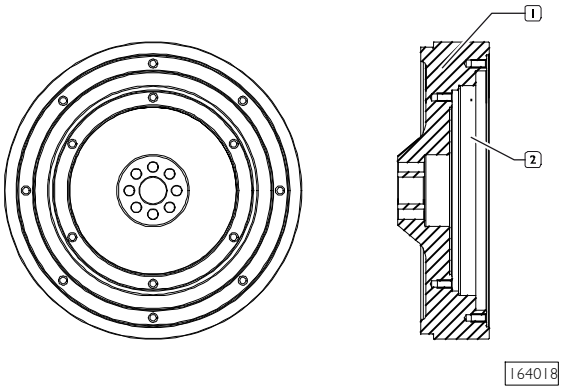
NOTE Use tool 99395216 (1) for the angle closing.

For motors F1CE3481A/R

SINGLE MASS

The single mass flywheel consists of a single integral steel disc with driving shaft. Compared to the double mass flywheel configuration, there are no advantages relating to damping motor irregularities transmitted to the gearbox and noise reduction in the cab, however it has advantages in terms of reducing production costs. It does not require fixed positioning on the driving shaft since it is not fitted with a reference pin. The fasteningholes are equidistant.

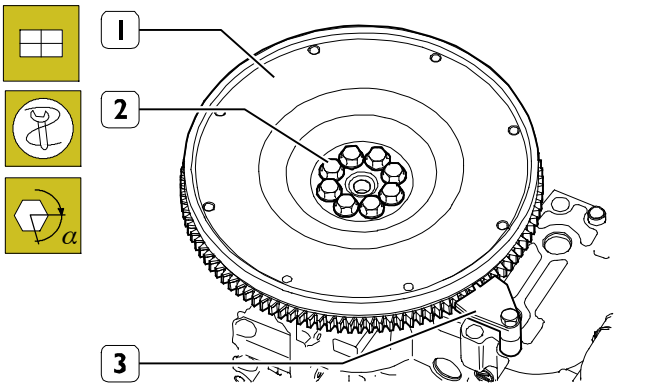
Figure 150



1. Motor side - 2. Transmission side

NOTE The assembly and disassembly procedure is the same for both the single mass and double mass flywheel configuration.

Figure 74



166740

Mount the engine flywheel (1) and screw down the screws (2). Fit tool 99360306 (4) onto the crankcase to block rotation of the engine flywheel (1).

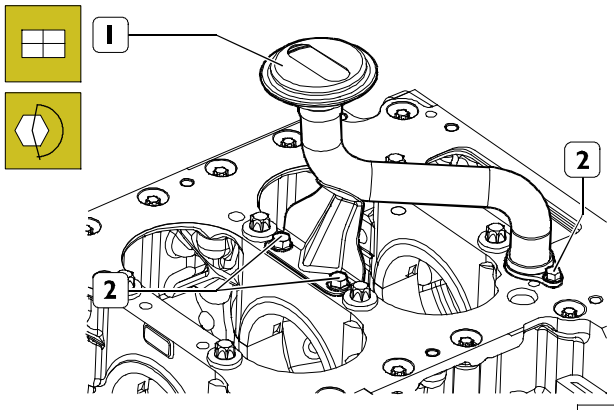
Tighten the screws (2) fixing the engine flywheel in two steps:

- ❑ Step 1: with a torque wrench, to a torque of 30 Nm.
- ❑ Step 2: closing to an angle of 90°.

NOTE Use tool 99395216 (1) for the angle closing.

For all motors

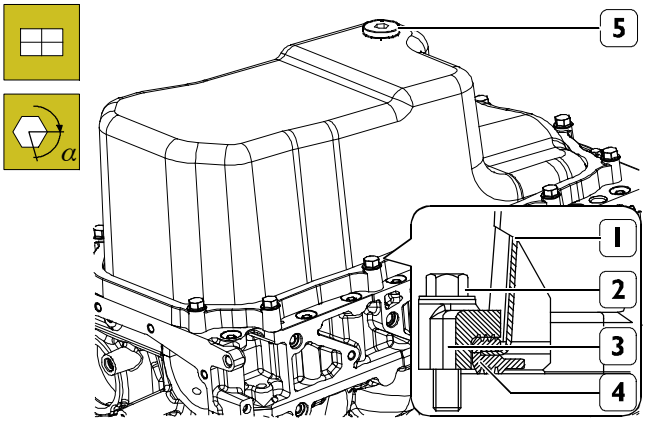
Figure 75



88285

Mount the suction strainer (1) together with the pipe. Screw down the fixing screws (2) and tighten them to the prescribed torque.

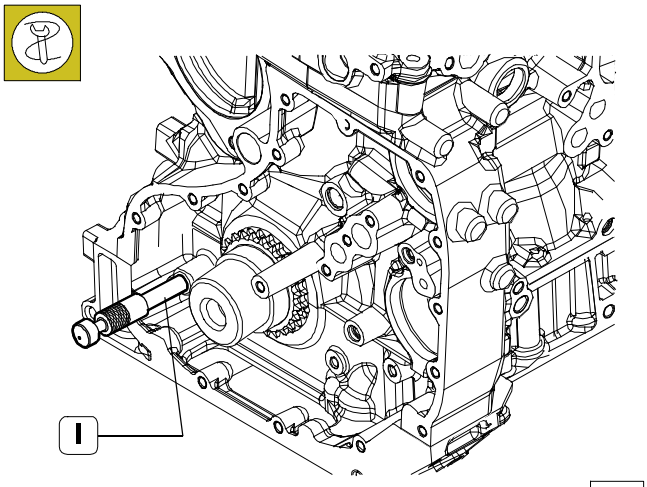
Figure 76



88329

Fit the gasket (4) and the frame (3) onto the oil sump (1). Screw down the fixing screws (2) and tighten them to the prescribed torque.
Screw down the oil drain plug (5) and tighten it to the prescribed torque.

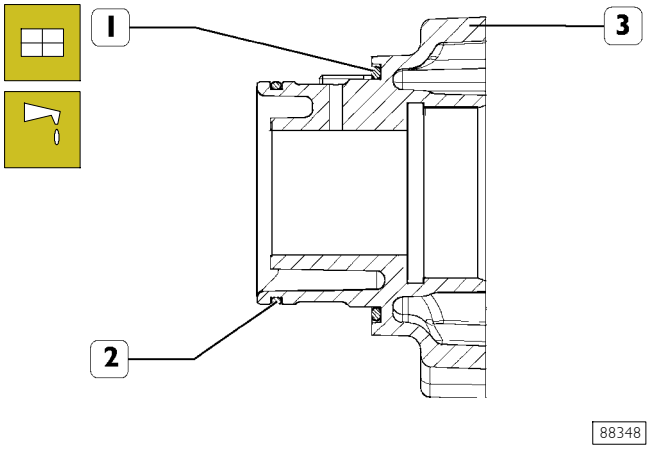
Figure 77



88347

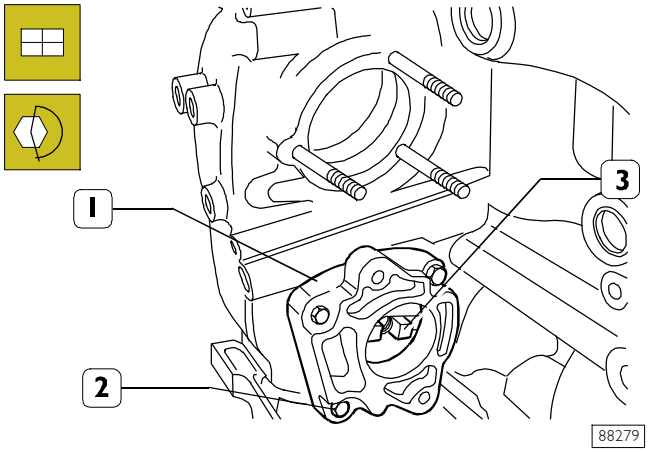
Rotate the driving shaft so that the tool 99360615 (1) can be inserted in the shaft crank hole through the cylinder block hole, in order to stop the engine in the timing system setting condition.

Figure 155



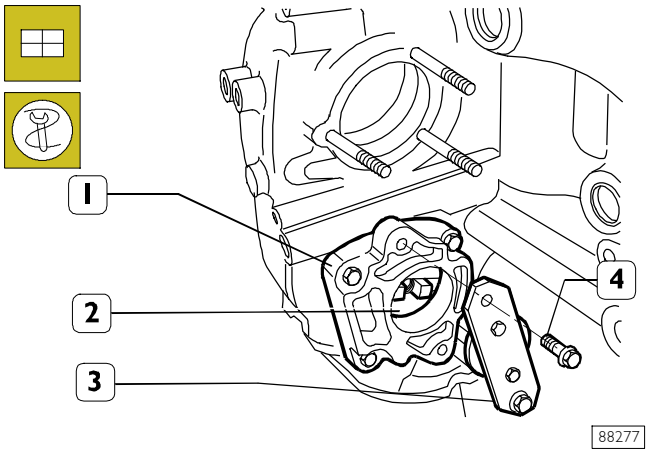
Lubricate the seal rings (1 and 2) with engine oil and fit them on the support (3).

Figure 156



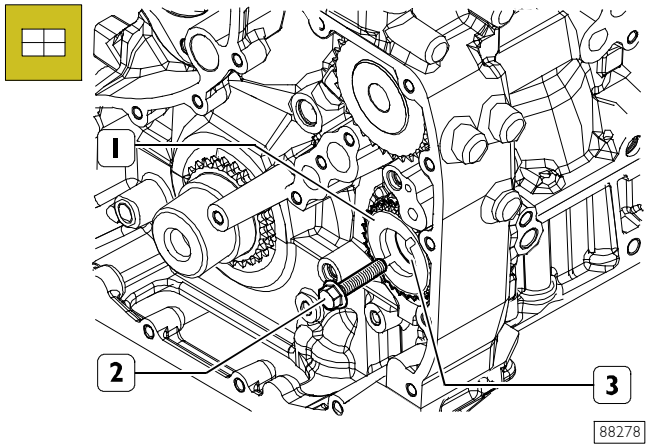
Fit the support (1) and drive in the nuts (2), then tighten them to the prescribed torque.
Fit the stem (3).

Figure 157



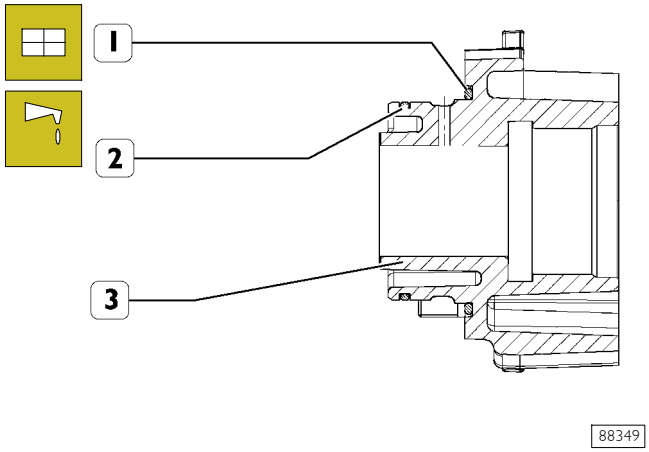
Stop the stem rotation (2) of the hydraulic power steering pump by inserting in the latter the tool (3) and fastening the tool on the support (1) by means of the screws (4).

Figure 158



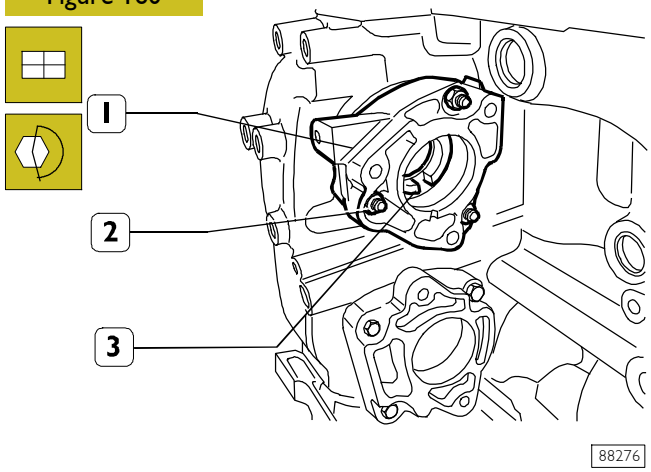
Fit the gear (1) on the stem (3) of the hydraulic power steering pump.
Drive in the screw (2) without locking it.

Figure 159



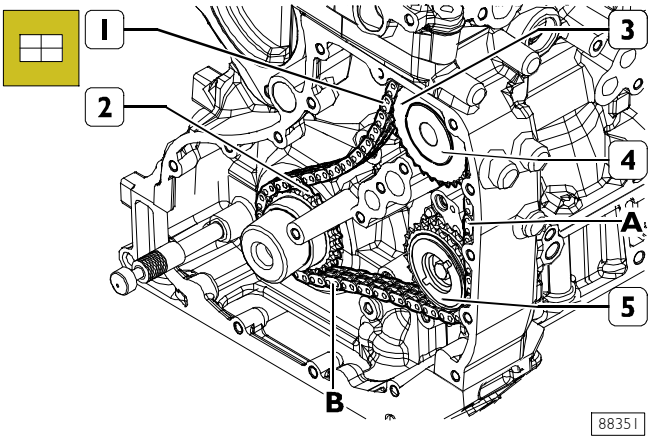
Lubricate the new seal rings (1 and 2) with engine oil and fit them on the support (3).

Figure 160



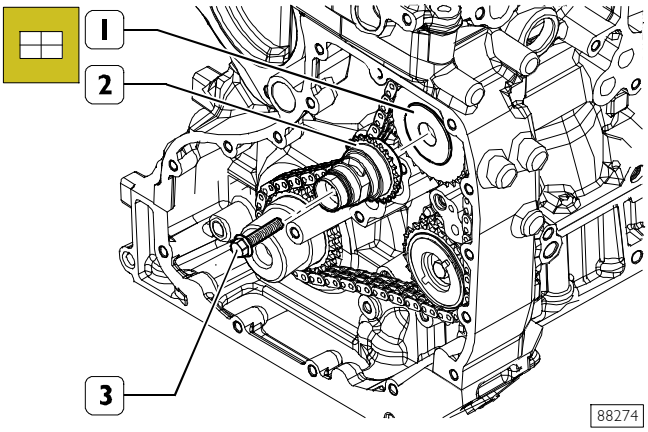
Fit the support (1), drive in the nuts (2) and tighten them to the prescribed torque.
Fit the control stem (3) of the high pressure pump.

Figure 161



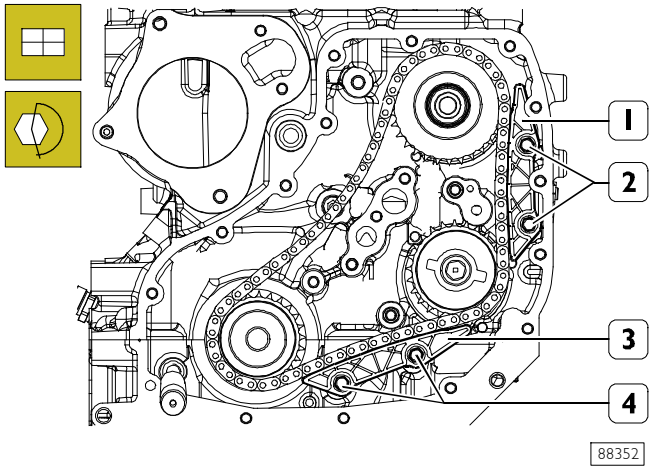
Position the chain (1) on the gears (2, 3 and 5) and fit the gear (3) on the stem (4) so that the chain (1) in tracts A and B is tensioned.

Figure 162



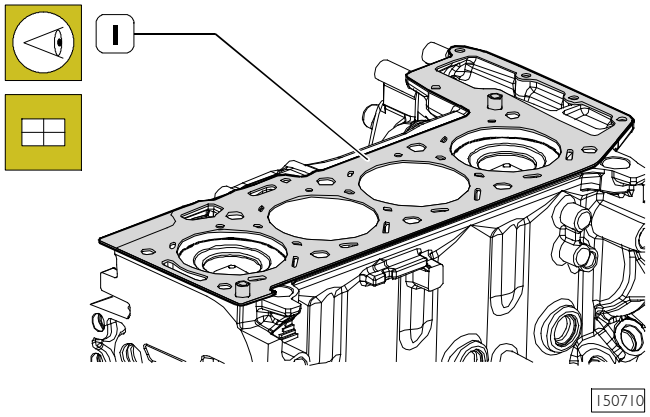
Fit the stem with the drive gear (2) on the high pressure pump control stem (1).
Drive in the fastening screw (3).

Figure 163



Check the conditions of the fixed skids (1 and 3) and change them if worn out.
Fit the skid (1) and drive in the fastening screws (2), then tighten them to the prescribed torque.
Fit the skid (3) and drive in the fastening screws (4), then tighten them to the prescribed torque.

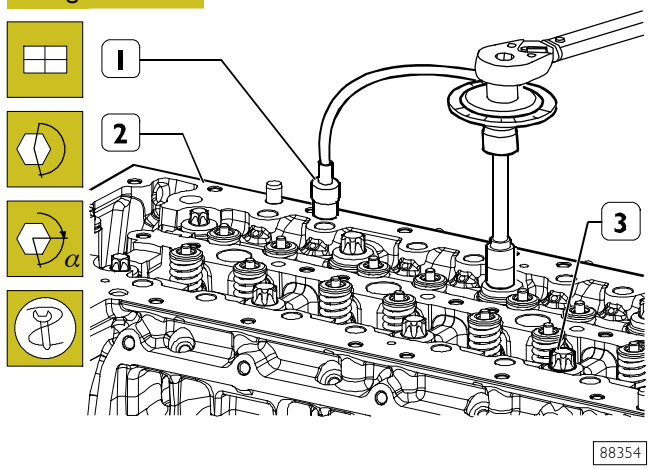
Figure 164



Check that the mating surfaces of the cylinder head and crankcase are clean.
Keep the cylinder head gasket clean.
Place the gasket (1) of the cylinder head with the thickness given in section "Check piston protrusion", with the "TOP" sign facing the head.

NOTE It is essential to keep the gasket sealed in its package until just before assembly.

Figure 165



Mount the cylinder head (2).
Screw down the fixing screws (3) and tighten them, in three successive stages, following the order and methods shown in the following figure.

NOTE The angle closure is done with tool 99395216 (1).

Figure 166

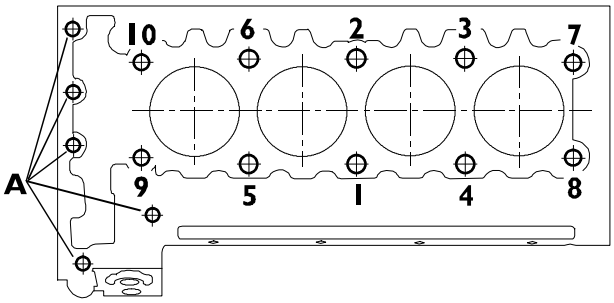
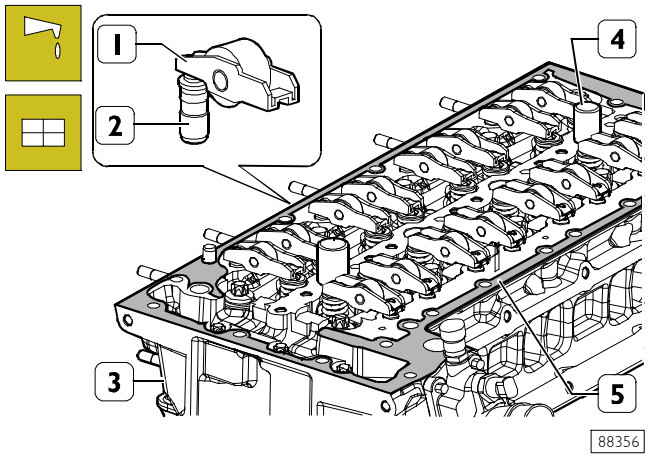


Diagram of the tightening sequence for the cylinder head fixing screws:

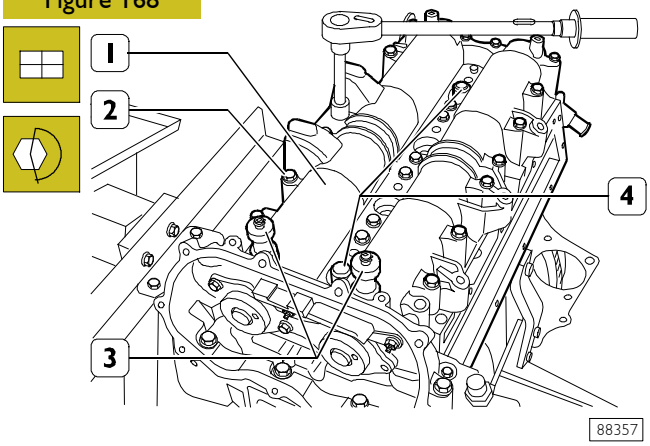
- ❑ 1st phase: pre-tightening with torque wrench
  - screws 1-2-3-4-5-6 to a torque of 130 Nm;
  - screws 7-8-9-10 to a torque of 65 Nm.
- ❑ 2nd phase: angle closing
  - screws 1-2-3-4-5-6 90°;
  - screws 7-8-9-10 90°.
- ❑ 3rd phase: angle closing
  - screws 1-2-3-4-5-6 90°;
  - screws 7-8-9-10 60°.
- ❑ Screws A, to a torque of 25 Nm.

Figure 167



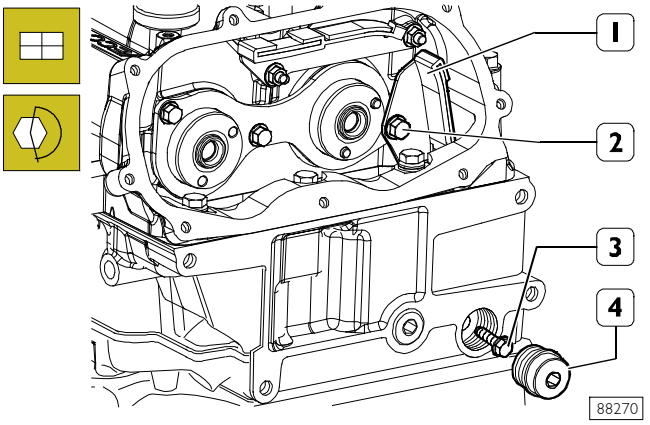
Thoroughly clean the hydraulic tappets (2), lubricate them and fit them in the cylinder head (3), positioning the rocker arms (1) on the valves correctly.
Fit on the gasket (5).
Insert the two tools SP. 2264 (4) into the electro-injector seats for subsequent centring of the overhead on the cylinder head.

Figure 168



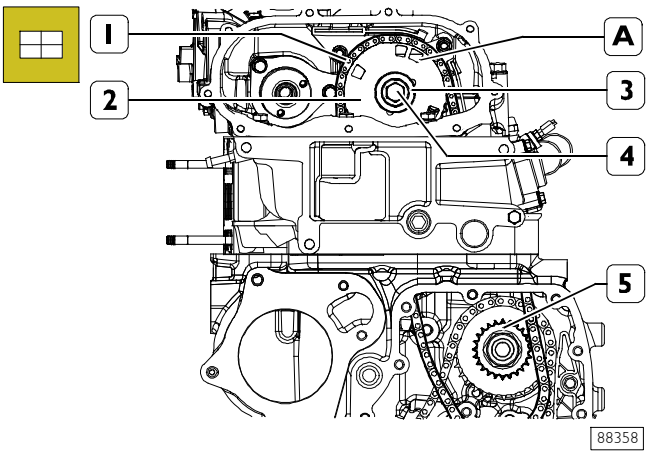
Mount the overhead (1) together with the tools 99360614 (3) for the timing and tighten the fixing screws (2) to the prescribed torque.
Take out the tools SP. 2264 (4).

Figure 169



Fit the top fixed skid (1). Drive in the screws (2 and 3) and tighten them to the prescribed torque.
Fit the rubber cap (4) of the new gasket and tighten it to the prescribed torque.

Figure 170

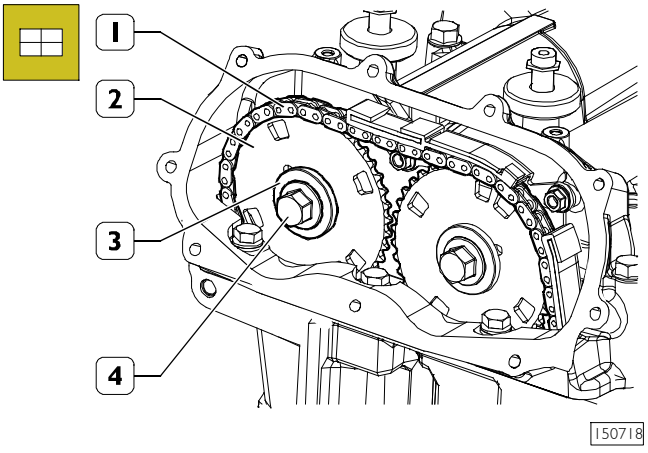


Position the chain (1) on the gear (5) and gear (2).
Mount the gear in such a way that fitting on aspiration valve timing system shaft dowel makes slots A to result to be positioned as in figure.

NOTE The chain arm (1) between the two gears must be tensioned.

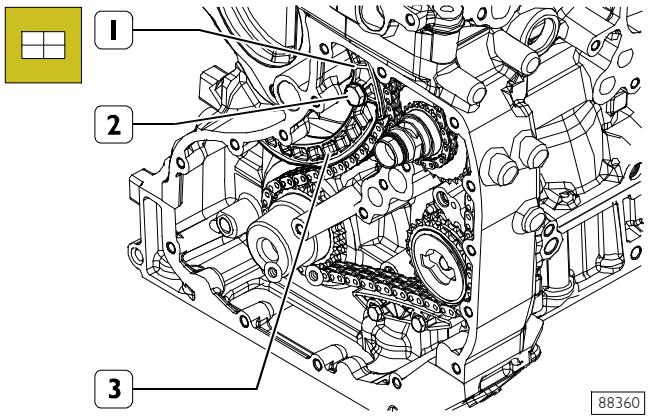
Drive in the fastening screw (4) with the washer (3) without tightening it completely.

Figure 171



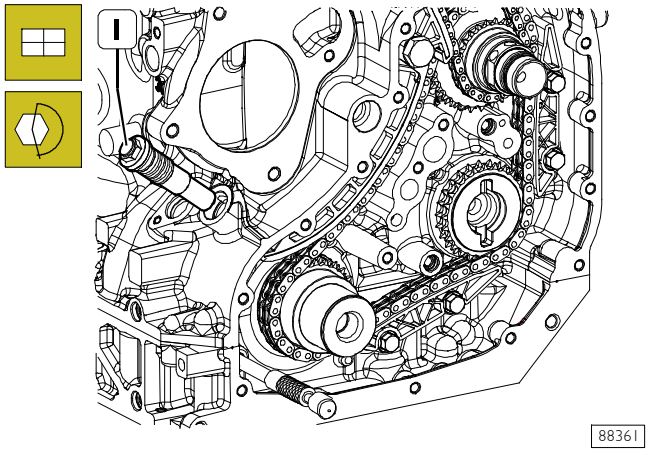
Position the chain (1) on the gear (2) and fit the latter on the camshaft of the exhaust valves.
Drive in the fastening screw (4) with the washer (3) without tightening it completely.

Figure 172



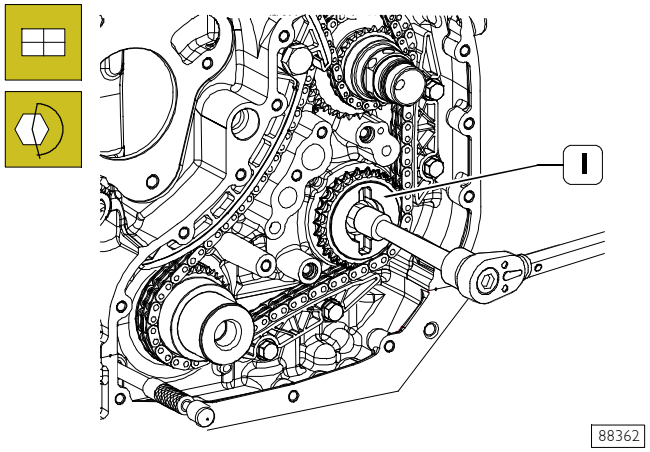
Check the conditions of the mobile skids (1 and 3), if worn out change them.
Position the mobile skids (1 and 3) and clamp them on the cylinder block by the pin (2) and tighten it to the prescribed torque.

Figure 173



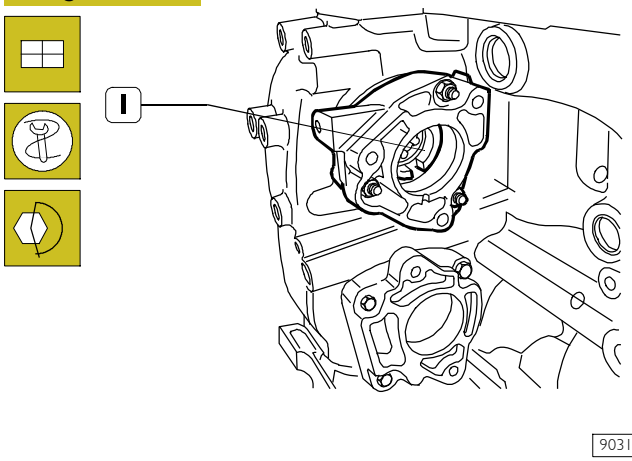
Drive in the chain hydraulic tightener (1) and lock it to the prescribed torque.

Figure 174



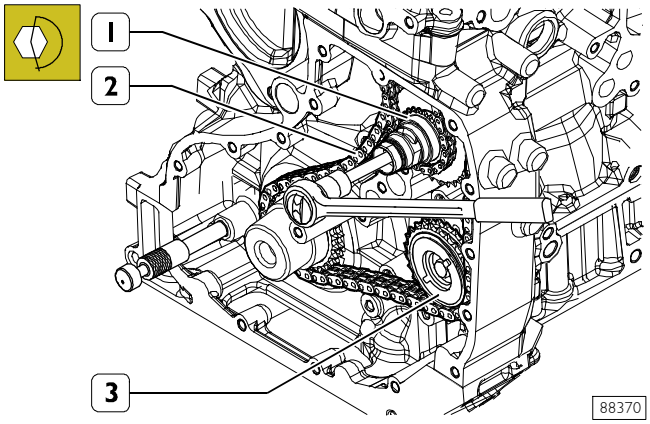
Tighten the fastening screw of the gear (1) on the hydraulic power steering control stem to the prescribed torque.

Figure 175



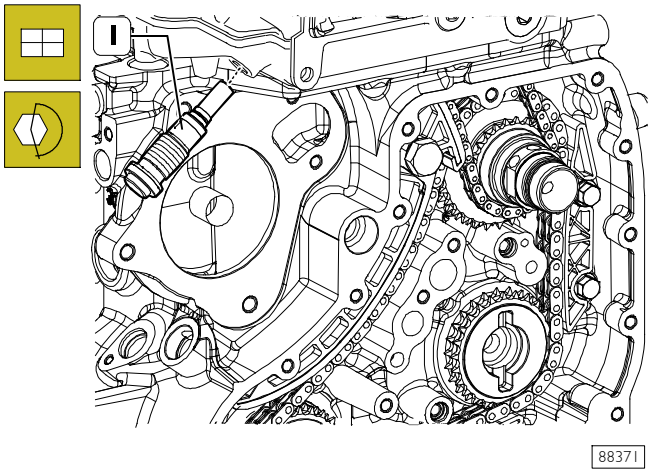
Stop the rotation of the high pressure pump control shaft (1) by inserting the suitable wrench inside it.

Figure 176



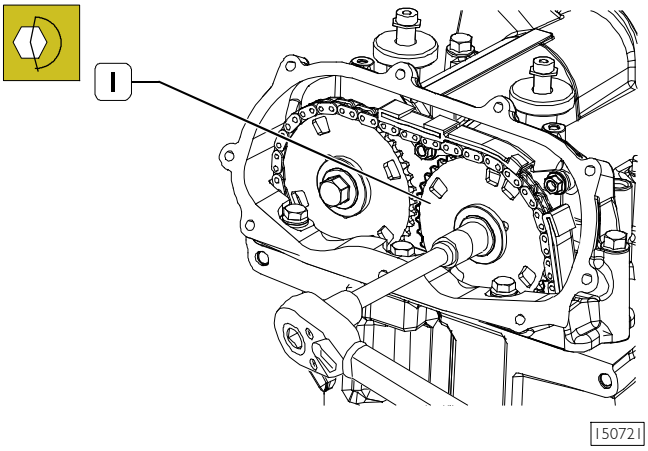
Make sure that the chain (2) and the tract between the gear (1) and gear (3) is tensioned.
Tighten the fastening screw of the stem with the drive gear (1) on the high pressure pump control stem to the prescribed torque.

Figure 177



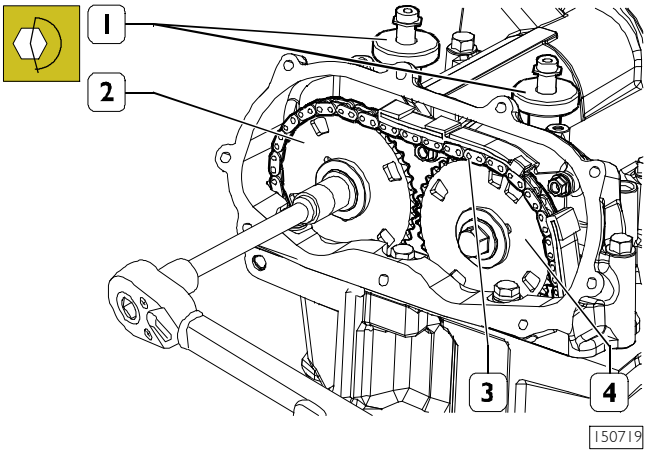
Drive the in the chain hydraulic tightener (1) and lock it to the prescribed torque.

Figure 178



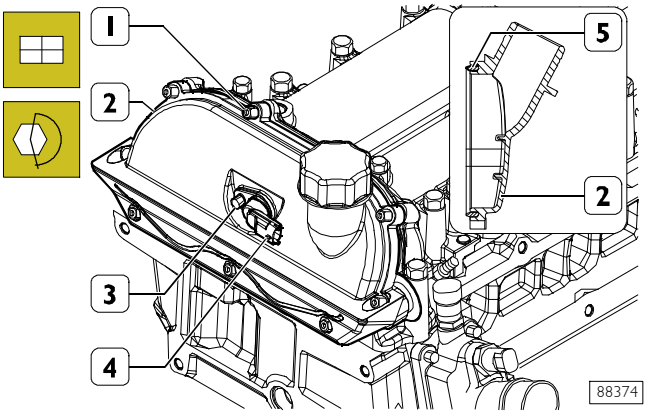
Tighten the fastening screw of the gear (1) on the suction valve camshaft to the prescribed torque.

Figure 179



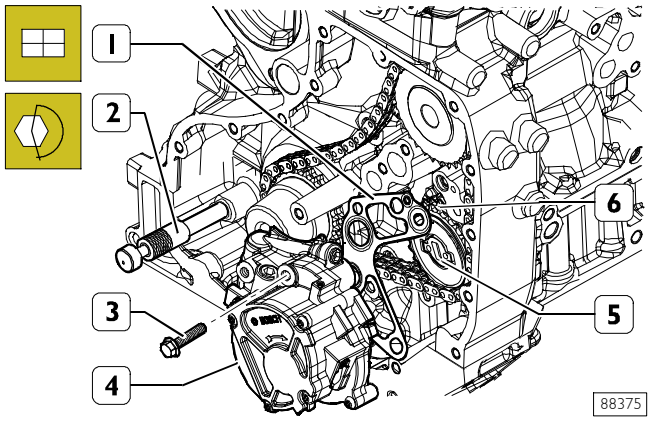
Make sure that the chain (3) in the tract between the gear (2) and gear (4) is tensioned.
Tighten the fastening screw of the gear (2) on the exhaust valve camshaft to the prescribed torque.
Remove tools 99360614 (1).

Figure 180



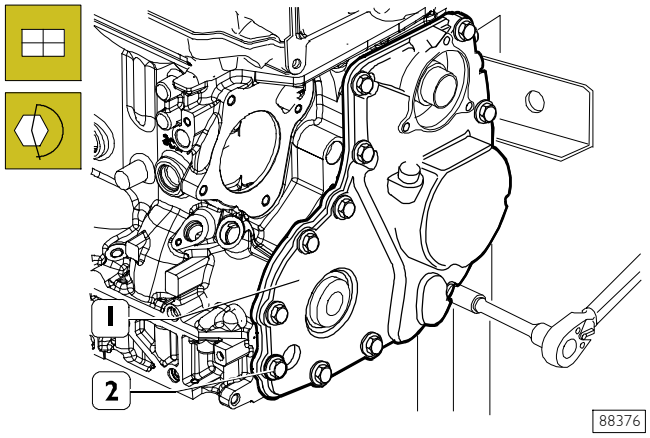
Fit a new gasket (5) in the cover (2).
Fit the cover (2), drive in the screws (1) and tighten them to the prescribed torque.
Fit the phase sensor (4).
Drive in the fastening nut (3) and tighten it to the prescribed torque.

Figure 181



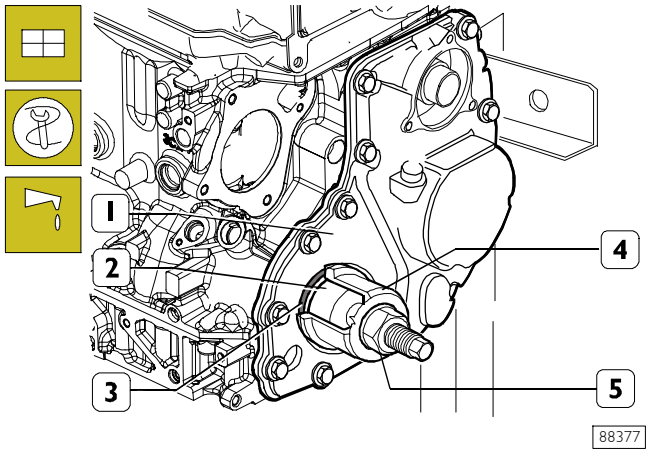
Position the joint (5) in the gear (6).
Fit the oil pump/depressor unit (4) by inserting a new gasket (1). Drive in the screws (2) and tighten them to the prescribed torque.
Remove tool 99360615 (2).

Figure 182



Fit the cover (1) with a new gasket. Drive in the screws (2) without tightening them completely.

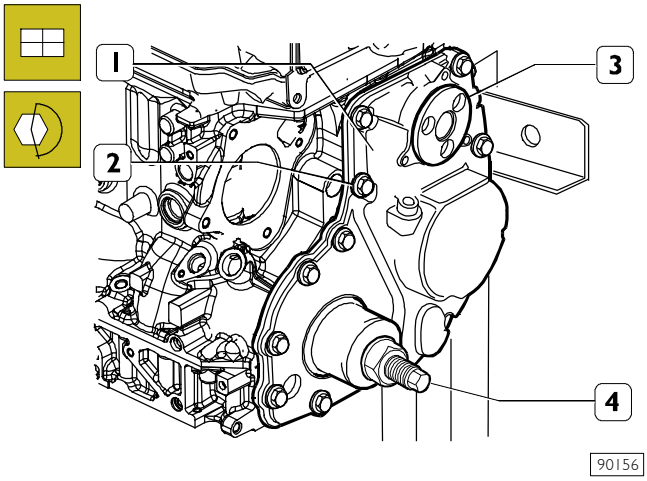
Figure 183



Clean accurately the seat of the cover seal ring (1).
Drive in the element (2) of tool 99346258 in the driving shaft tang.

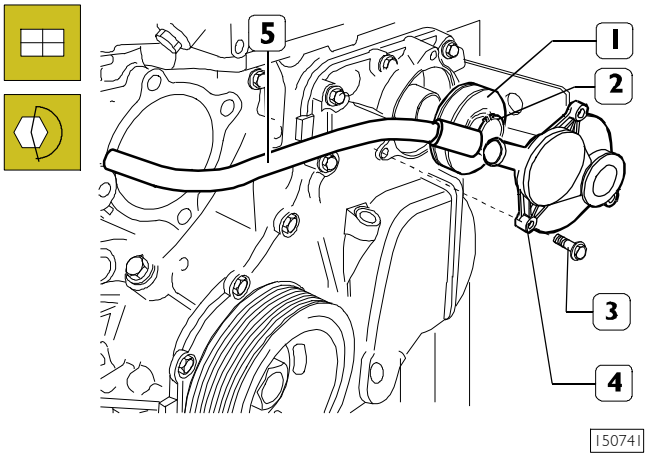
Lubricate the tang of the driving shaft and the element outside (2) and fit flush the new seal ring on this element (3). Position the element (4) on element (2), lock the nut (5) until fitting the seal ring (3) completely in the cover (1).

Figure 184



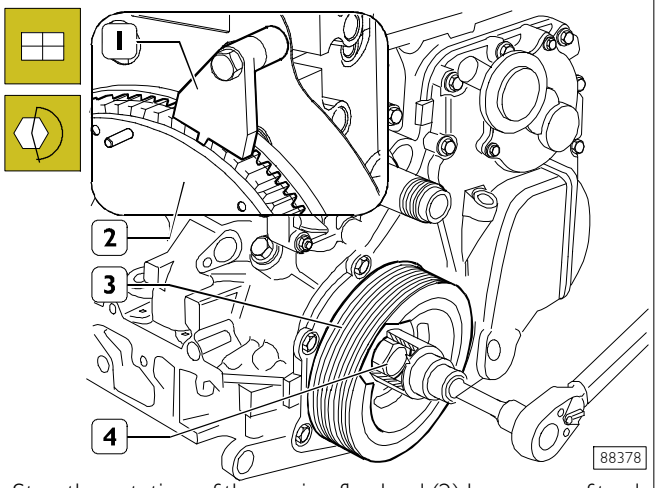
Mount tool 99396037 (3), for centering cover (1), into centrifugal filter seat and tighten screws (2) at prescribed torque. Remove: 99346258 (4) and 99396039 (3) tools.

Figure 185



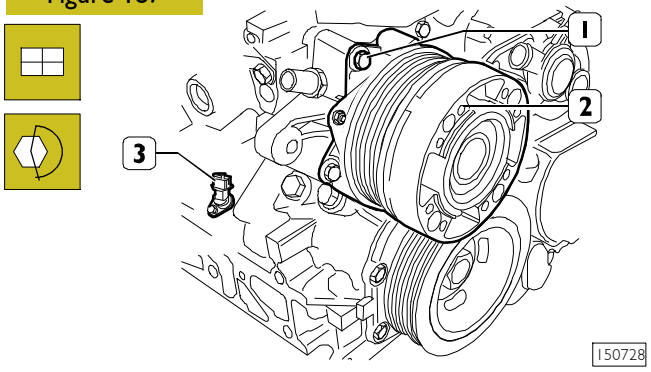
Fit a new centrifugal filter (1).
Fit a new snap ring (2).
Fit the cover (3), drive in the screws (4) and tighten them to the prescribed torque.

Figure 186



Stop the rotation of the engine flywheel (2) by means of tool 99360306 (1).
Fit the damper pulley (3). Drive in the screw (4) and tighten it to the prescribed torque.

Figure 187

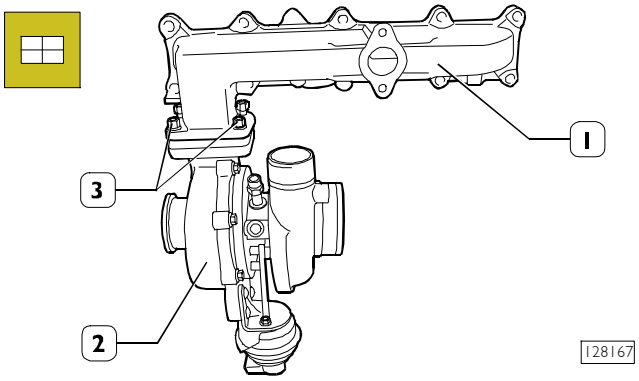


Fit the water pump (2) with a new gasket. Drive in the screws (1) and tighten them to the prescribed torque.

Fit the rev sensor (3), drive in the fastening screw and tighten it to the prescribed torque.

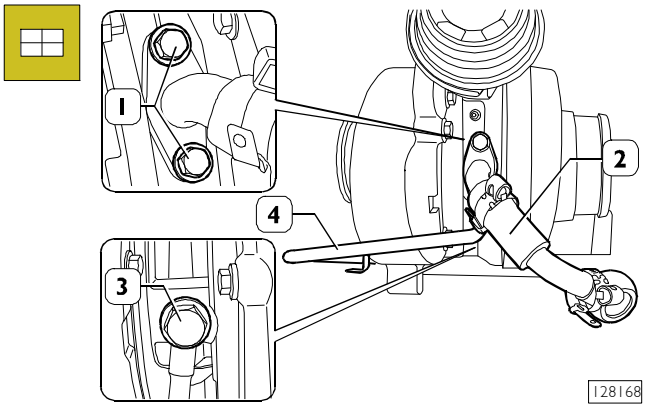
For motors F1CE3481A/R

Figure 188



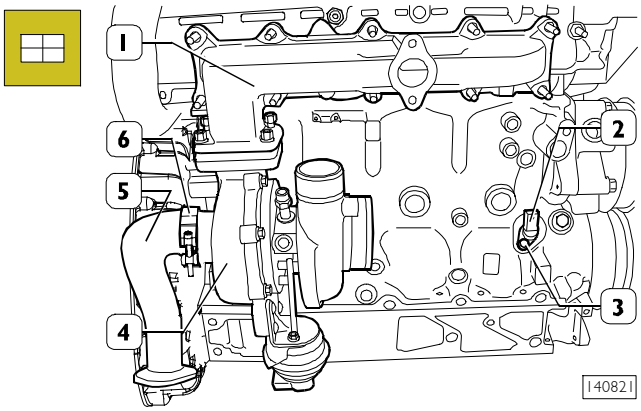
Fit the turbocharger (2) with relative gasket on the exhaust manifold (1).
Screw on without tightening the fixing nuts (3) leaving some clearance between turbocharger and exhaust manifold.

Figure 189



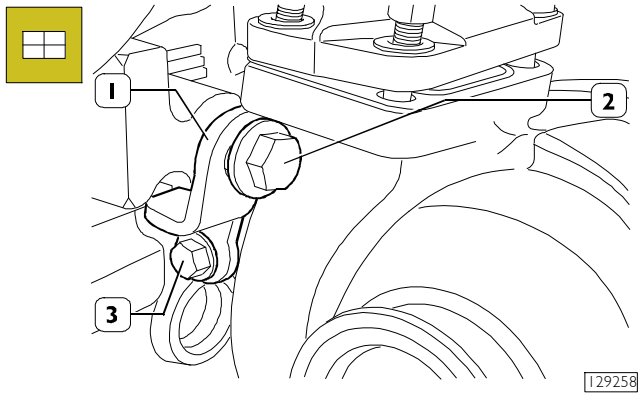
Refit the oil return pipe (2) on the turbocharger.
Screw on the fixing bolts (1) and tighten it to a torque of 10 Nm.
Install the cooling pipe (4) on the turbocharger
Screw on without torque tightening the fixing nuts (3) in order to allow the pipe (4) positioning while assembling the turbocharger, exhaust manifold assembly on the crankcase

Figure 190



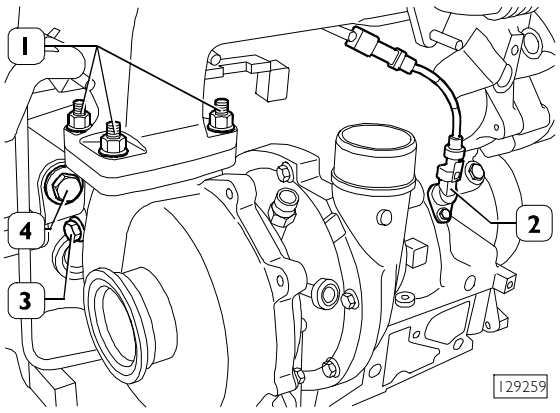
Place a new metallic gasket on the crankcase, then fit up the exhaust manifold (1) complete with the turbocharger (4).
Fit the revolutions sensor (2) in its seat, forcing it manually up to the position reached clic.
Screw on the fixing screw (3) and tighten it to a torque of 10 Nm.
Fit the pipe (5) and tighten the clamp (6)

Figure 191



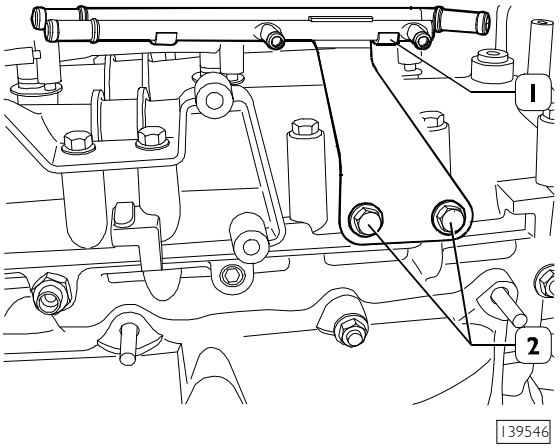
Place the support bracket (1) between the crankcase and the turbine. Drive in the screw (2) up to its halt.
Drive in the screw (3) without tightening it to a torque.

Figure 192



Tighten the fixing nuts (1) between turbocharger and exhaust manifold to a torque of 25 Nm.
Tighten the fixing screw (3) to a torque of 25 Nm.
Tighten the fixing screw (4) to a torque of 50 Nm.
Put the cable extension (2) on the revolutions sensor

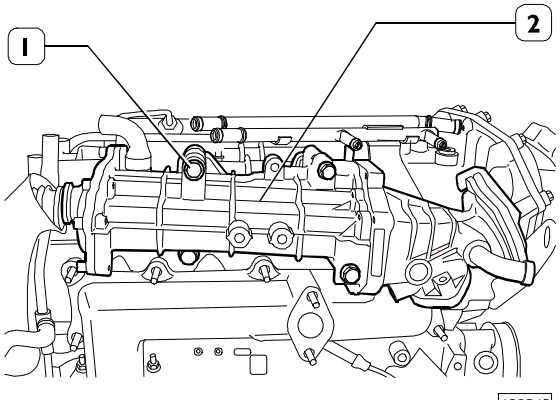
Figure 193



Install the degasser (1).
Screw on the fixing screws (2) and tighten it to a torque of 25 Nm.

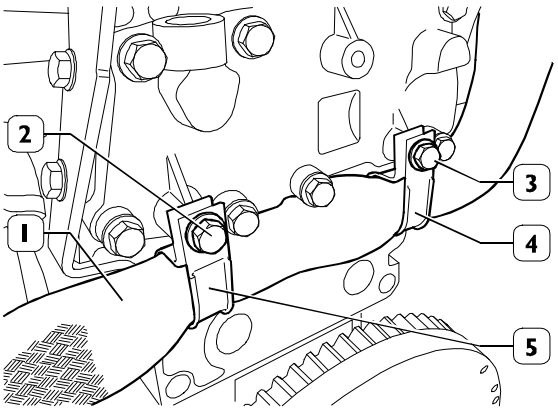
For all motors

Figure 194



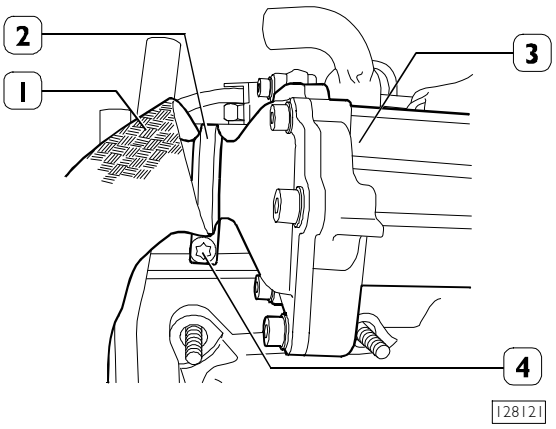
Fit the EGR assembly (2) on the overhead and tighten the fixing screws (1) to a tightening torque of 25 Nm.

Figure 195



Assemble the piping (1) on the cylinder head retaining it by means of the collars (4) and (5).
Put the screws (2) and (3) and tighten it to a torque of 25 Nm.

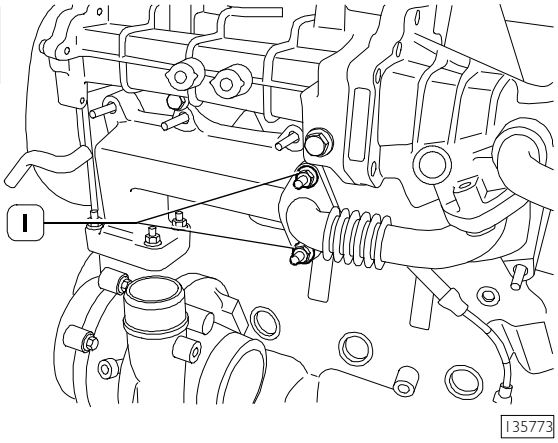
Figure 196



Fit the pipe (1) on the EGR unit (3).
Put the collar (2) positioning the screw (4) as shown in figure; tighten the screw (4).

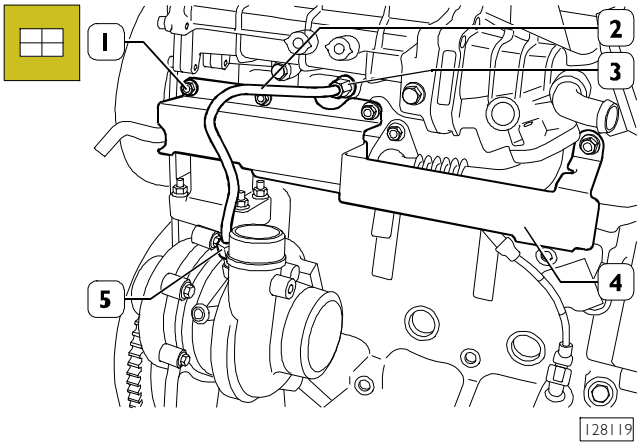
For motor F1CE3481C*C124

Figure 197



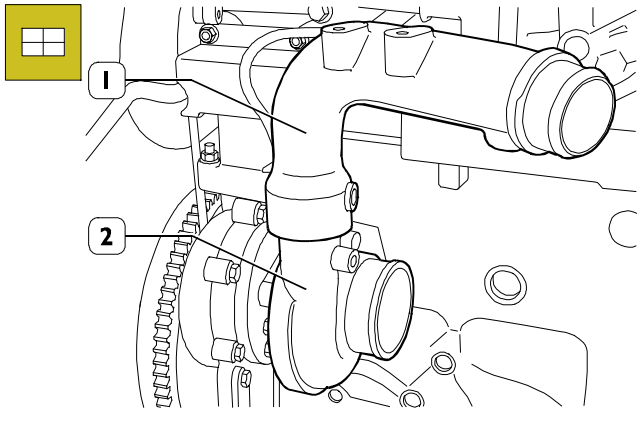
Tighten the two nuts (1) to a torque of 30 Nm

Figure 198



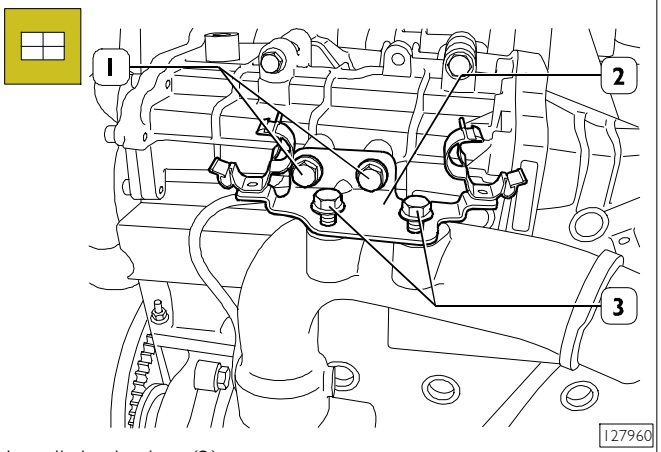
Refit the protection (4).
Position the spacers and the nuts (1); tighten the nuts (1) to a torque of 25 Nm.
Connect the oil pipe (2) to the turbocharger and the cylinder head, and tighten the pipe unions (3) and (5) to the prescribed torque: 30 Nm

Figure 199



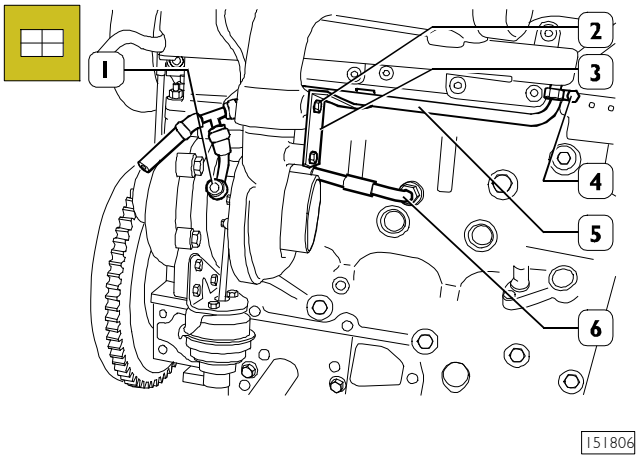
Refit the manifold (1) on the turbocharger

Figure 200



Install the braket (2).
Drive in the screws (1) and (3) and tighten it to a torque of 25 Nm

Figure 201

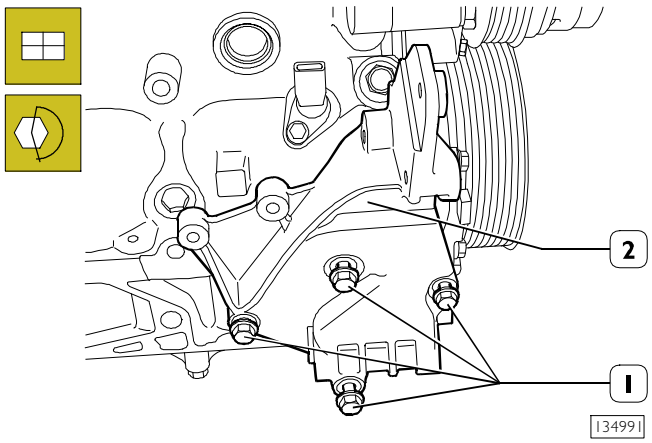


Fit the cooling pipe (5) on the turbocharger.
Install the braket (3) on the manifold; tighten the screws (2) to a torque of 10 Nm.
Screw in the union (1) on the turbocharger; tighten it to a torque of 25 Nm.
Tighten the screw (4) on the crankcase.

NOTE Connect the oil pipe (6)

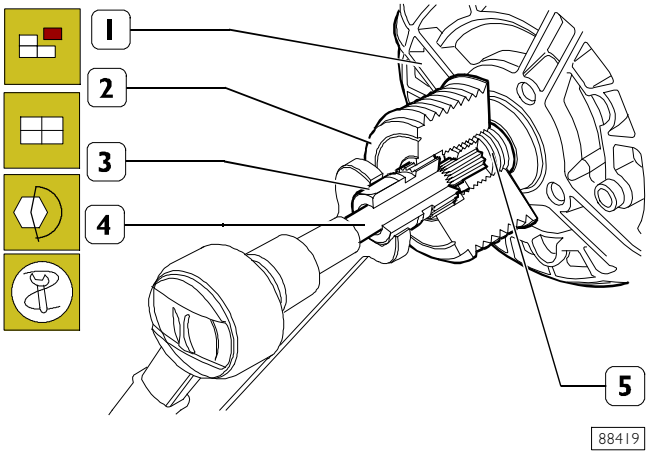
For motor F1CE3481C*C124

Figure 202



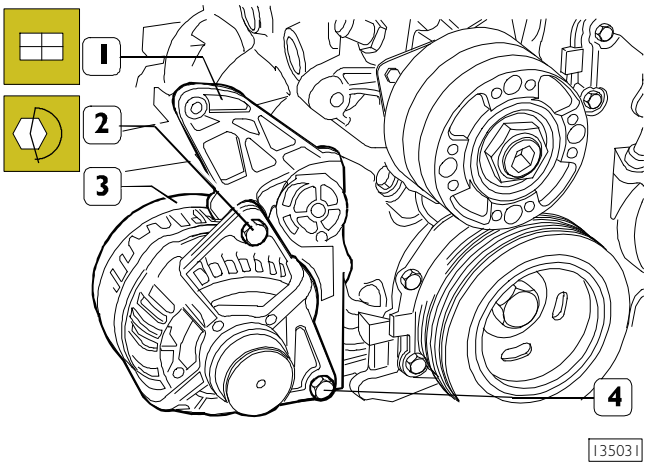
Fit the support (2), and tighten the screws (1) to the specified torque.

Figure 203



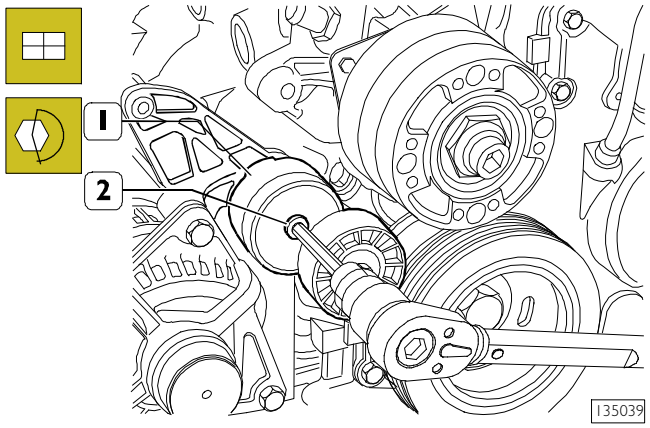
The freewheel (2) prevents the idling oscillations of the engine from affecting the alternator (1) via its drive belt.
If necessary, replace the freewheel as follows (2).
Remove the freewheel cap (2).
Fit 99358026 tool (3 and 4) as shown in the diagram.
Block the rotation of the freewheel (2) with part (3) and unscrew the shaft (5) of the alternator (1) with part (4).
Fit the new freewheel (2) in the reverse order. The freewheel (2) must be secured to the shaft (5), applying a maximum torque to the shaft of 85 Nm.

Figure 204



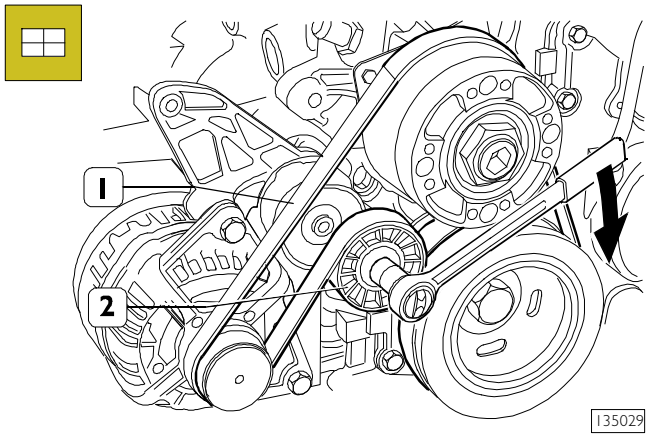
Fit the alternator (3) to the mount (1), secure it with bolt (4) and screw (2), and tighten them to the specified torques.

Figure 205



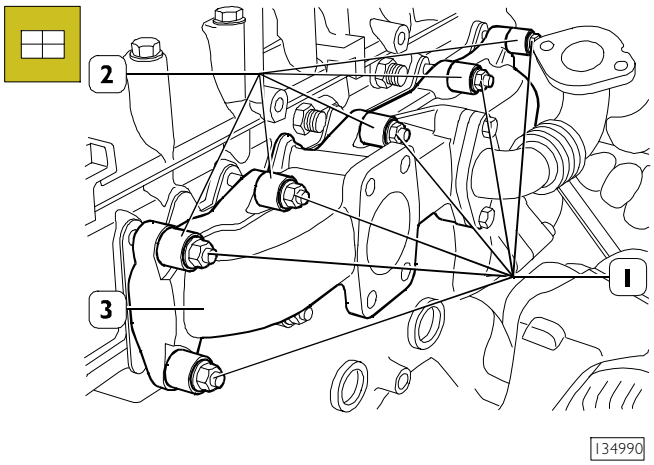
Fit the automatic chain tensioner (1) insert in the screw (2) and tighten to the specified torque.

Figure 206



Using (→) a wrench on the automatic belt tensioner (2), fit the belt (1), making sure that the ribs on the belt fit properly into the grooves on the pulley.

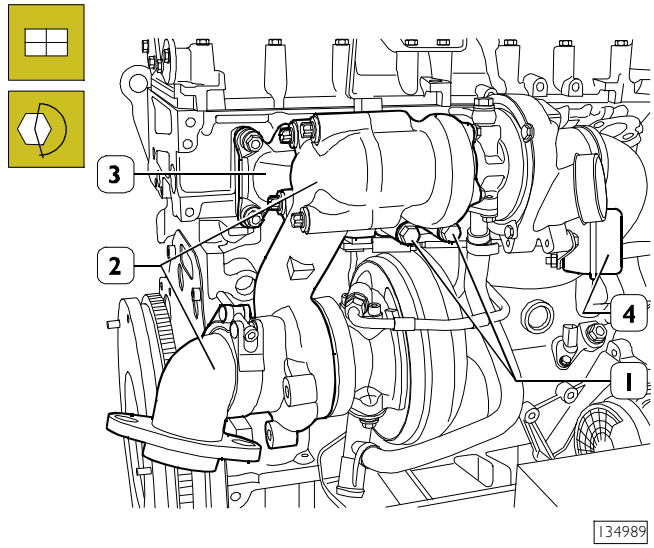
Figure 207



Fit the exhaust manifold (3) with a new gasket.
Insert the spacers (1), screw on the nuts (2), then tighten them to the specified torque.

If the turbocharger is overhauled and/or replaced, make sure all air pipes are whole, clean and free from foreign bodies.
Furthermore, check that the sealing gaskets operate correctly and that the connection sleeves are fastened, checking that the intake ducts, air filter and radiators (intercooler) are not clogged.
Check that the oil circulation pipes are not broken nor clogged: otherwise replace them or fix the problem.

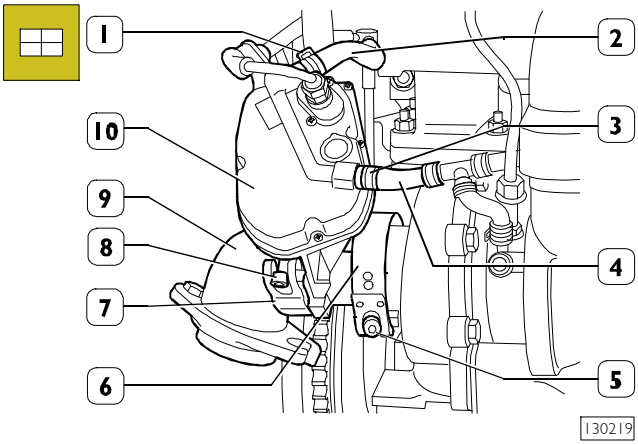
Figure 208



Fit the turbocharger unit (2) with a new gasket onto the exhaust manifold complete with pipes and waste gate (4).
Insert the two lower screws (1) securing the turbocharger assembly to the exhaust manifold and tighten them to the specified torque.

For motors F1CE3481A/R

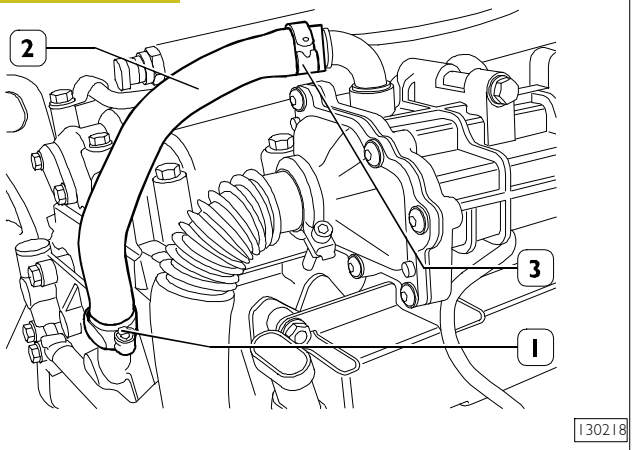
Figure 209



Refit the EBS unit (10) on the turbine outlet; place the collar (6) and tighten the screw (5).
Fit the pipe (9) on the EBS unit (10).
Put on the collar (7) and position it so that the screw (8) doesn't go to interfere with the operation of the valve.
Insert the pipe (2) for EBS coolant (9) in the union. Drive the collar (1) to a stop position.
Insert the pipe (4) for EBS coolant (10) in the union . Drive the collar (3) to a stop position.

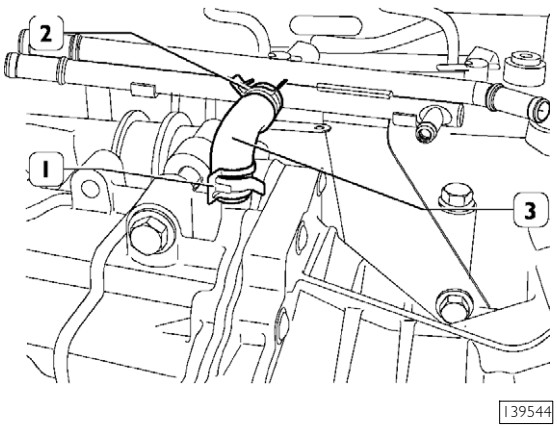
For all motors

Figure 210



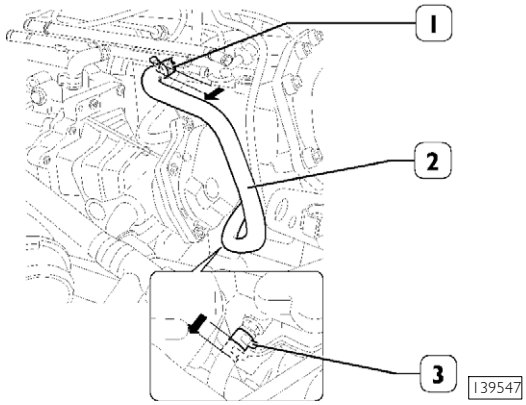
Connect the pipe (2) with the heat exchanger and the cover.
Retain it by means of the collars (1) e (3).

Figure 211



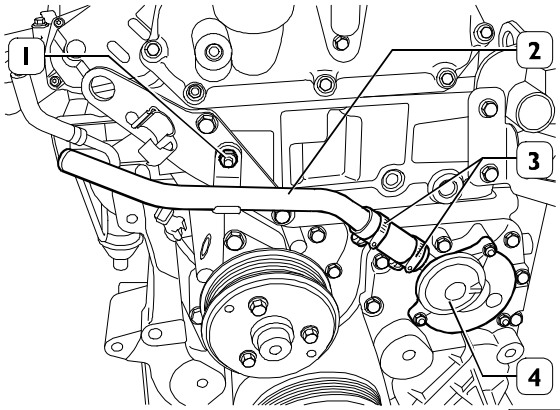
Connent the pipe (3) between the degasser and the heat exchanger.
Fasten the pipe (3) to the adapters by means of the collars (1) and (2).

Figure 212



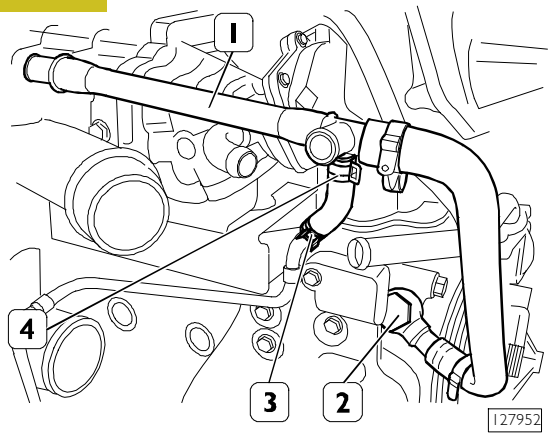
Connect the pipe (2).
Fasten the pipe (2) to the adapters by means of the collars (1) e (2).

Figure 213



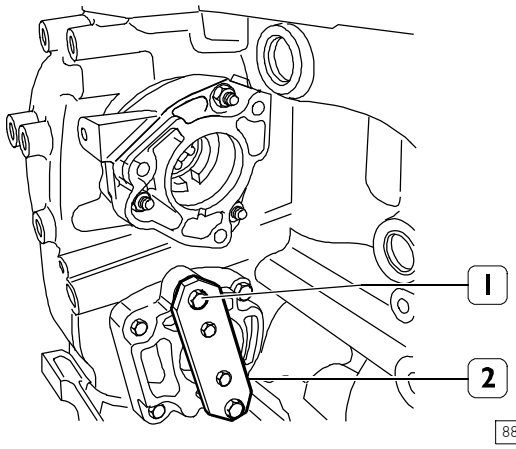
Connect the pipe (2) to the blow-by filter.
Tighten the collars (3).
Tighten the nut (1).
Fit the cover (4)

Figure 214



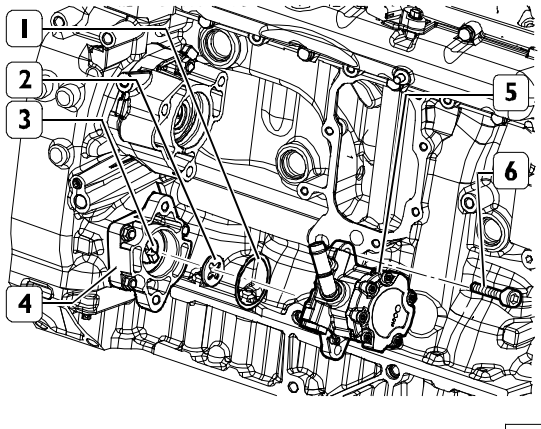
Install the pipe (1).
Screw in the union (2) on the crankcase.

Figure 215



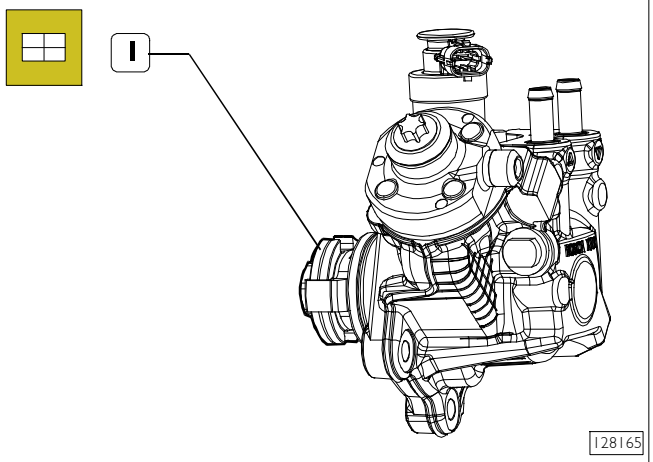
Remove the fastening screws (1) and remove tool 99360187 (2).

Figure 216



Position the joint (2) on the stem (3). Slightly lubricate the seal ring (1) and fit it on the power steering pump (5).
Fit the power steering pump on the support (4).
Drive in the fastening screws (6) and tighten them to the prescribed torque.

Figure 217

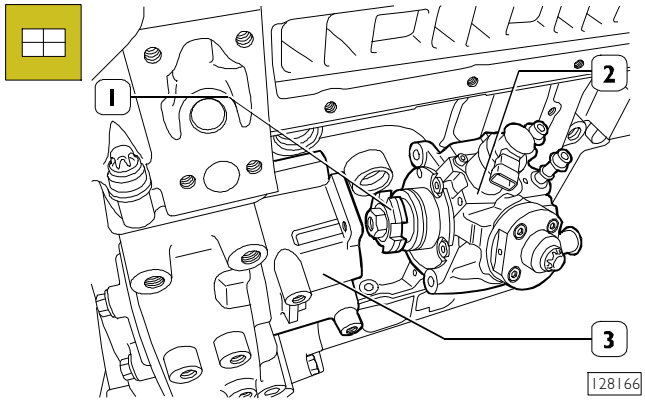


The relative position between the control shaft and the pump axis is determined by the flange fitted on the pump.

NOTE If a new high pressure pump is fitted it comes from Bosch in a stable balanced position (at BDC) with the flange fitted.

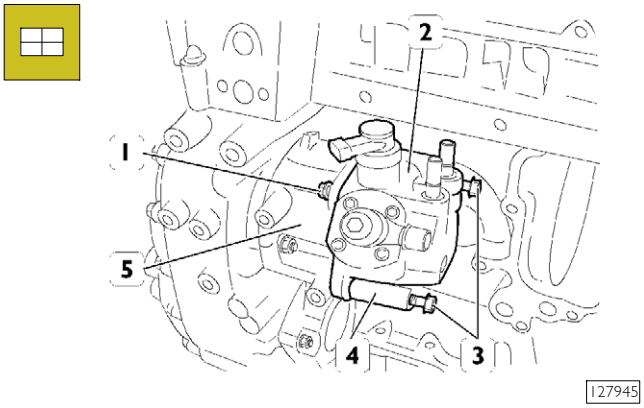
If the high pressure pump is not replaced, it should be placed in the stable balanced position (at BDC) turning the control shaft (1) appropriately.

Figure 218



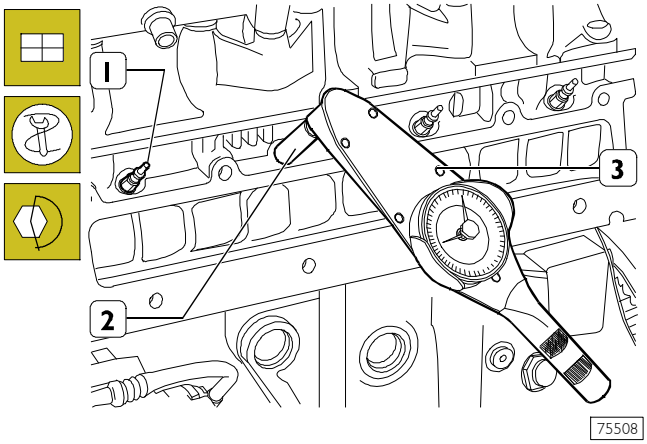
Fit the pump (2) so that the control shaft teeth mesh in the spider (1) seats.
Rotate the pump (keeping the shafts and the gears locked) so that the openings are aligned with the ones for the support (3).

Figure 219



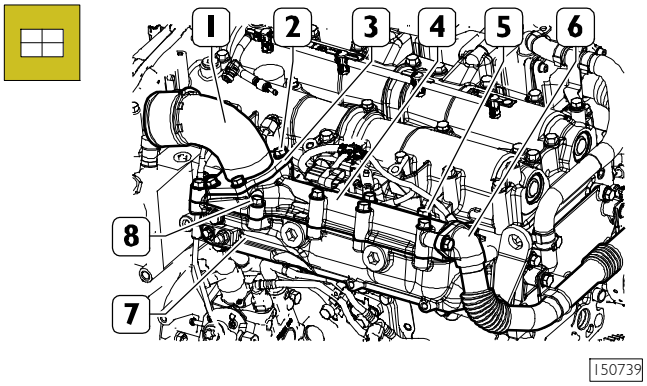
Fully tighten the fixing bolt (1) on the pump support side. Tighten the three fixing bolts (3) complete with spacers (4) in their seats. Tighten the three bolts (3) to a torque of 25 Nm. Tighten the bolt (1) to a torque of 10 Nm.

Figure 220



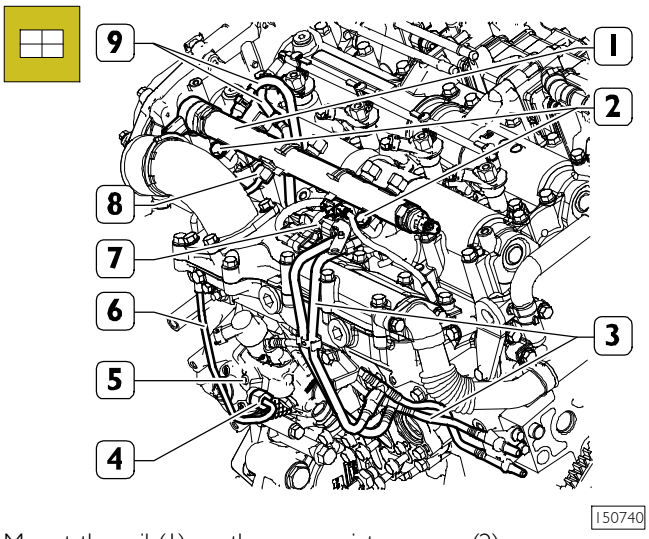
Mount the glow plugs (1) and, using the box-type wrench and torque wrench 99389819 (3), tighten them to a torque of 8 ÷ 10 Nm.

Figure 221



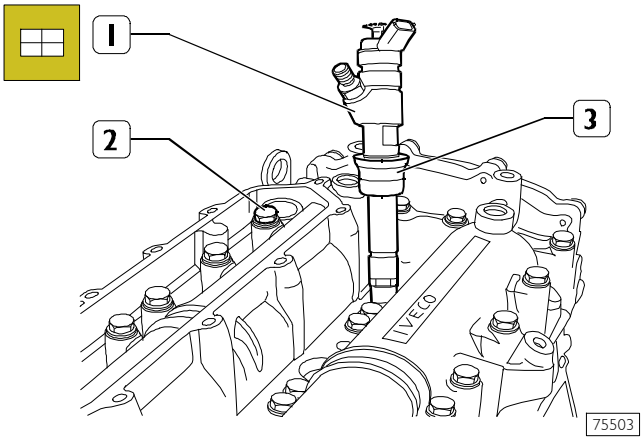
Mount the cover (2) on the mixer (1) using the appropriate screws (3).Mount the plate (4) and the air tube (5) on the cover using the screws (6).The EGR tube (6) must also be fixed to the cover with the correct screws (7) using the appropriate seals.

Figure 222



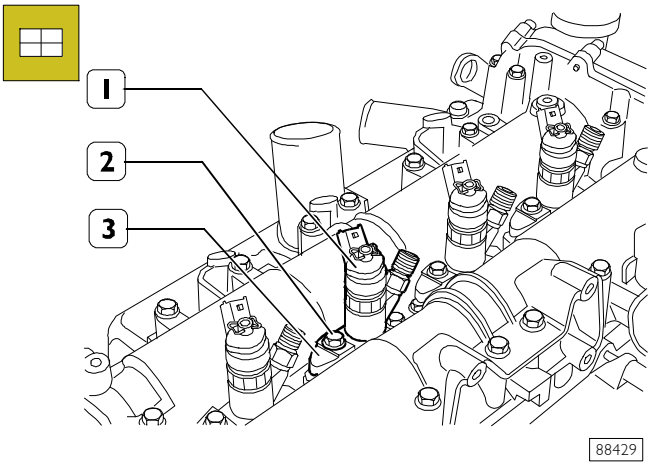
Mount the rail (1) on the appropriate screws (2).
Connect the fuel pipe (6) to the hydraulic accumulator (1) and to the high-pressure pump (5).Proceed with assembly, installing: low-pressure tubes (9)(3) electrical connections (7)

Figure 223



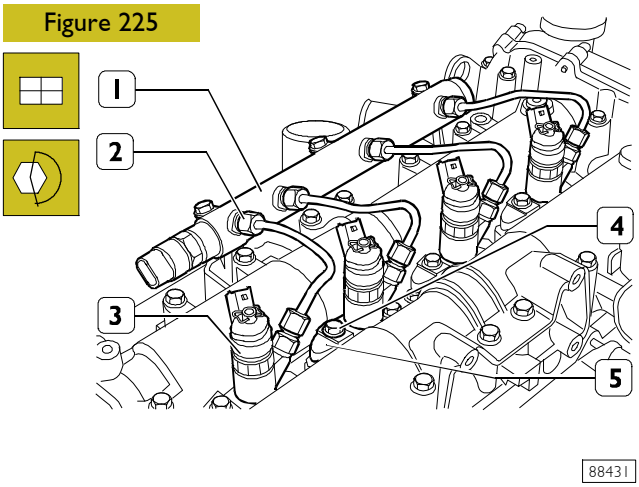
Fit a new seal (3) on the electro-injector (1) and mount this in the overhead (2).

Figure 224



Mount the brackets (3) fastening the electro-injectors (1) and screw down the screws (2) without locking them.

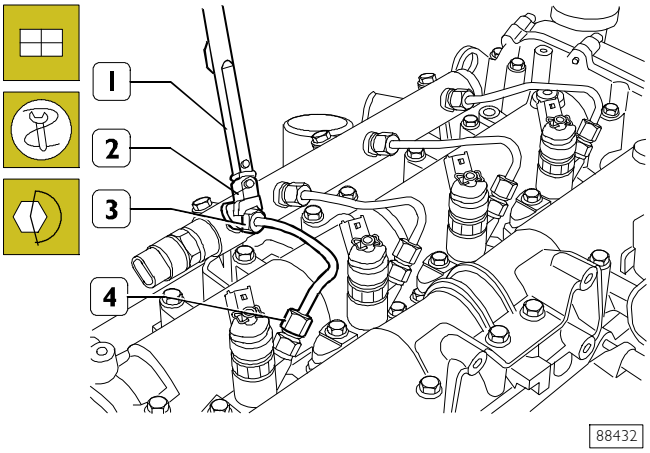
Figure 225



Connect the fuel pipes (2) to the electro-injectors (3) and to the hydraulic accumulator (1).
Tighten the screws (4) fixing the electro-injector brackets (5) to the prescribed torque.

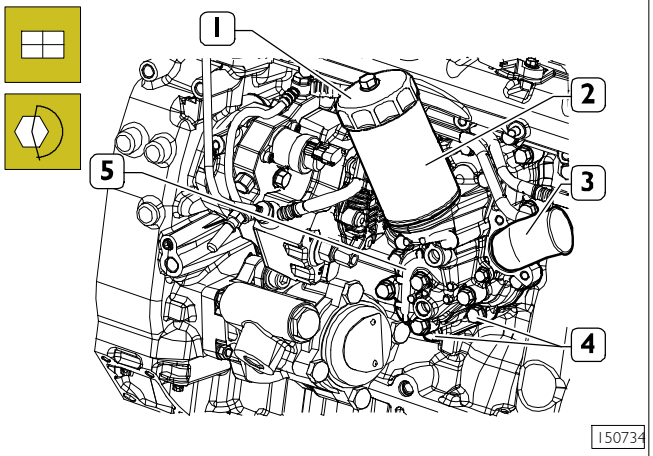
NOTE Whenever they get removed, the fuel pipes must be replaced with new ones.

Figure 226



Using the wrench (2) of the 99317915 series and the torque wrench 99389829 (1), tighten the fuel pipe fittings (3) and (4) to the prescribed torque.

Figure 227

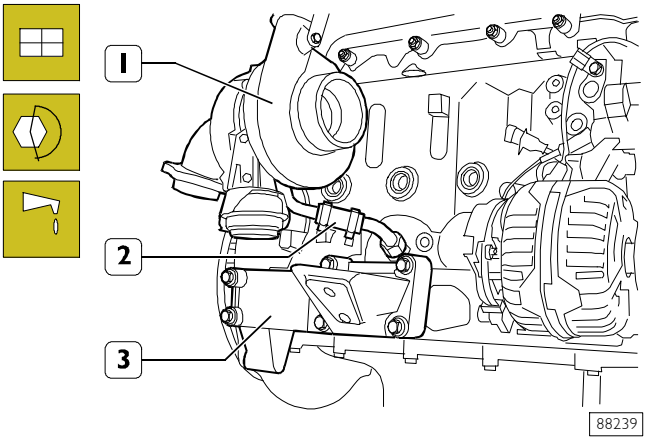


Fit heat exchanger (5), complete with a new gasket, onto the engine base. Drive in the screws (4) and tighten them to the prescribed torque. Lubricate a new seal and fit it on the pipe (3). Fit the pipe (3) onto the heat exchanger (5).
Lubricate the seal ring of the oil filter (2) with engine oil and fasten it on the heat exchanger (5). Use tool 99360076 (1) to tighten the oil filter to the prescribed torque.

NOTE Whenever they get removed, the fuel pipes (3) must be replaced with new ones.

Fasten the pipe (3) on the support bracket with the bolt (4) tightened to the prescribed torque.

Figure 228

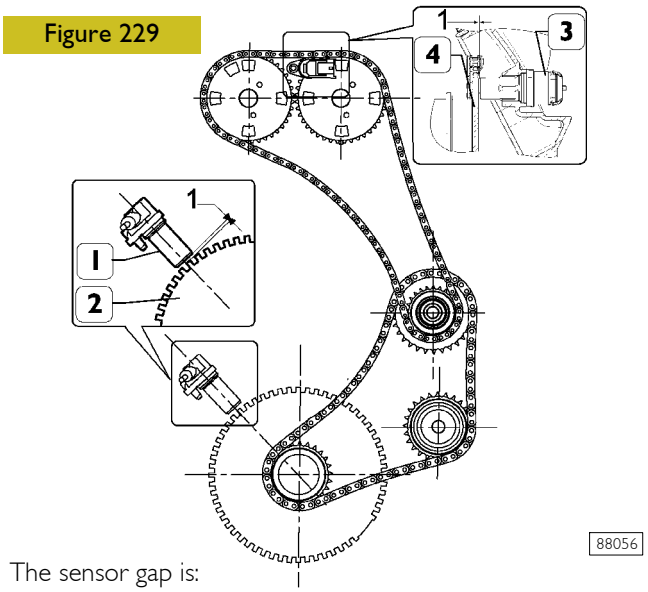


Apply the spring equalizing rocker arm on the engine lifting hooks, fasten the rocker arm to the hoist and remove the engine from the rotating stand (3).
Remove the brackets 99361041(3).

Complete engine assembly.
Fit on the left and right engine mountings (3) and tighten the fixing screws to the prescribed torque.
Connect the oil pipe (2) to the turbocharger (1) and to the crankcase and tighten the fixing screws and the coupling of the oil pipe (2) to the prescribed torque.
If applicable, mount the following parts:

- ❑ Engine cable, connecting its electrical connections to the thermostat temperature sensor, timing sensor, engine speed sensor, pressure regulator, rail pressure sensor and intake manifold air pressure/temperature sensor.
- ❑ Hydraulic accumulator guard.
- ❑ Add the prescribed grade and quantity of lubricating oil to the engine.
- ❑ Dip-stick for oil level check
- ❑ Fuel exhaust pipe from injectors

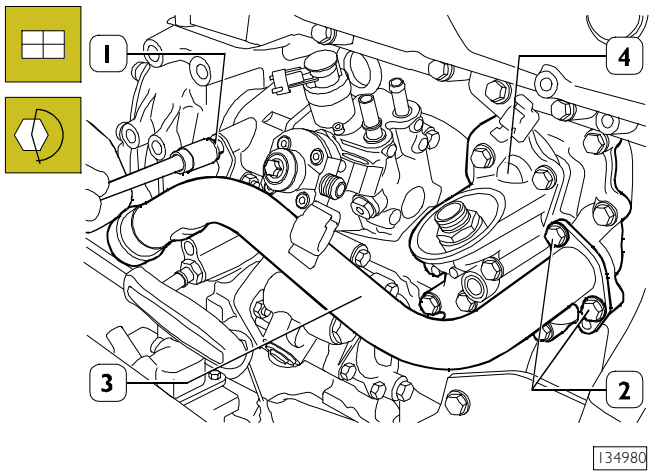
Figure 229



The sensor gap is:

- ❑ 1 mm, between the gear (4) of the camshaft and the phase sensor (1).
- ❑ 1 mm, between the phonic wheel (2) and speed sensor (1).

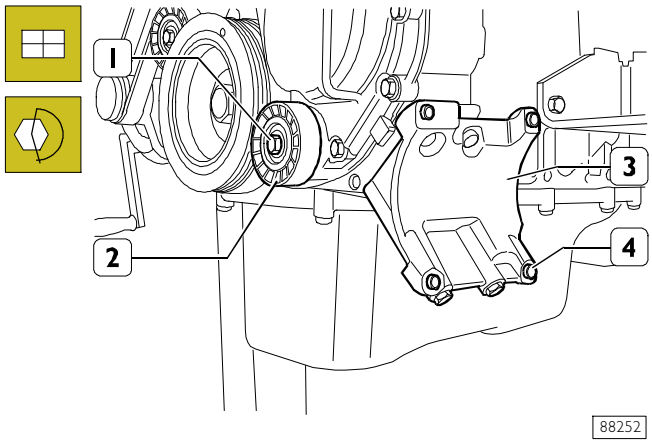
Figure 230



Insert the two upper screws (3) securing the turbocharger assembly to the exhaust manifold (4) and tighten them to the specified torque.
Screw the lubrication pipe fitting (1) and (2) to the turbocharger assembly and tighten to the specified torque.

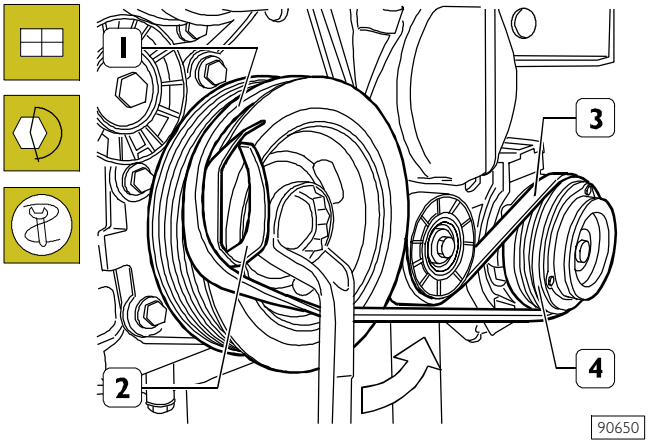
For motor F1CE3481C*C124

Figure 231



If present, fit the mount (3), and tighten the screws (4) to the specified torque.
Fit the fixed belt tensioner (2), insert the screw (1) and tighten to the specified torque.

Figure 232



If present, mount the conditioner compressor (4), tighten the mounting screws to the specified torque and fit the flexible belt (3) as described below.

NOTE The installation of the climate control unit compressor flexible belt requires the use of 99360186 tool (2). Different methods may cause tensions impairing spring belt.

Fit the flexible belt (3) using 99360186 tool (2) onto the pulley (4) and fit the tool on the pulley (1).
Turn the crankshaft in an anticlockwise direction (⇒) until the belt is correctly seated on the pulley (1).

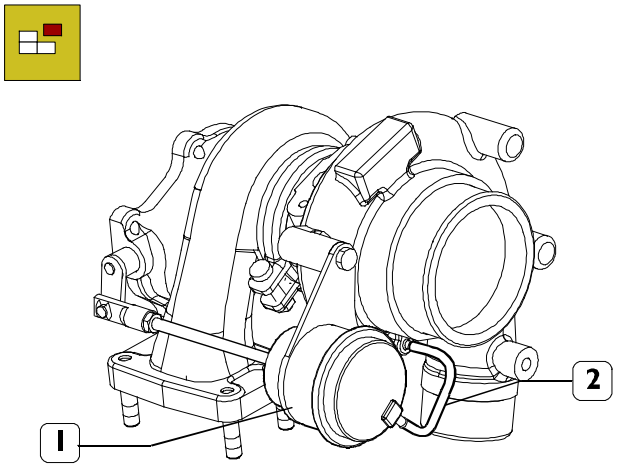
NOTE The flexible belt must be replaced with a new one every time it is removed from the vehicle.

REPAIRS

NOTE On finding irregular engine operation due to the turbocharging system, it is first expedient to perform the checks on the turbocharger, check the efficiency of the seals and the fixing of the couplings, additionally checking there is no clogging in the intake sleeves, air filter or radiators. If the turbocharger damage is due to a lack of lubrication, check that the oil circulation pipes are not burst or clogged, in which case replace them or eliminate the trouble.

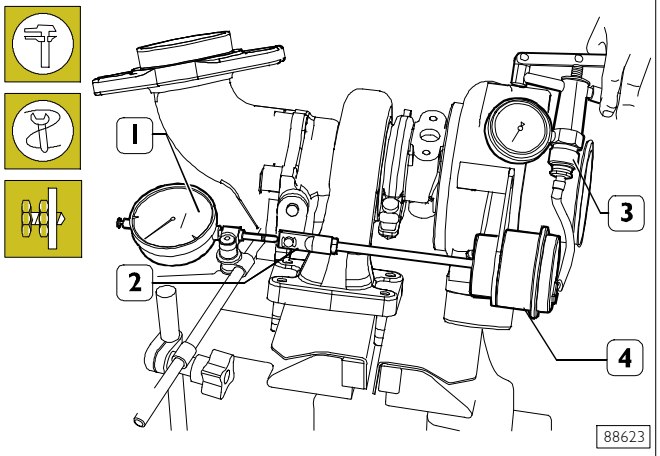
Pressure relief valve
Checking and adjusting pressure relief valve

Figure 233



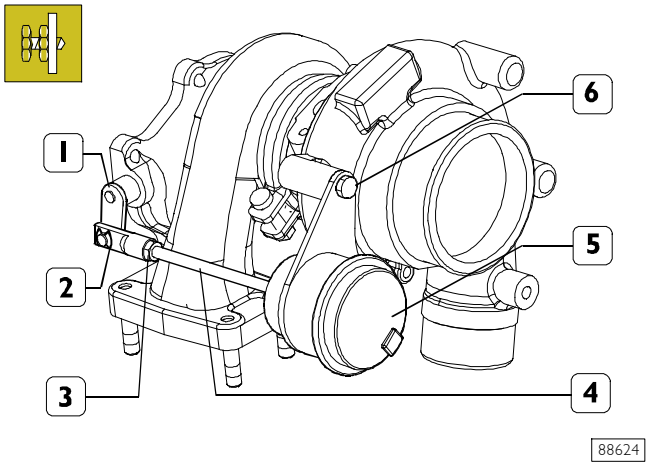
Cover the air, exhaust gas and lubricating oil inlets and outlets. Thoroughly clean the outside of the turbocharger using anticorrosive and antioxidant fluid. Disconnect the pipe (2) from the union of the pressure relief valve (1) and fit on it the pipe of the device 99367121 (3, Figure 234).

Figure 234



Rest the tip of the dial gauge (1) with a magnetic base on the end of the tie rod (2) and zero it. Using the device 99367121 (3), introduce compressed air into the valve casing (4) at the prescribed pressure and make sure this value stays constant throughout the check; replace the valve if it doesn't. In the above conditions, the tie rod must have made the prescribed travel.

Figure 235



If a different value is detected, slacken the nut (3) and rotate the tie rod (4) as required.

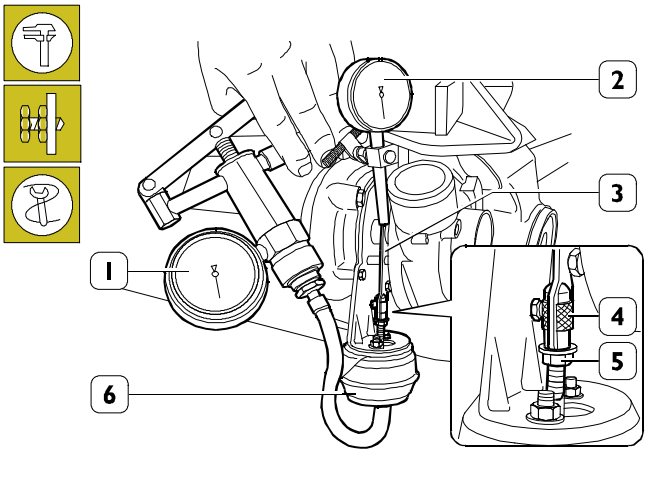
Changing the pressure relief valve

Remove the fastener (2) of the tie rod on the lever (1) and take off the valve (5) from the turbocharger by pulling out the fastening screws (6).
Fit the new valve by carrying out the operations for removal in reverse order and adjust the travel of the tie rod as described under the relevant heading.

NOTE Before fitting the turbocharger on the engine, it is necessary to fill the central body with engine lubricating oil.

Checking and adjusting the actuator

Figure 236



Cover air, exhaust gas and lubricant inlets and outlets.
Clean the turbosupercharger outside accurately using anticorrosive and antioxidant fluid and check the actuator (6).
Clamp the turbosupercharger in a vice.
Apply vacuometer 99367121 (1) pipe to actuator (6) hose.
Apply the magnetic base gauge (2) to exhaust gas inlet flange in the turbine.
Set gauge (2) feeler pin on tie rod (3) end and set gauge (2) to zero.
Operate the vacuum pump and check whether the tie rod (3) stroke values correspond to the vacuum values shown in the following table:

- vacuum 0 mm Hg	Fully open valve
- vacuum 180 mm Hg	Valve stroke 2.5 mm
- vacuum 450 mm Hg	Valve stroke 10.5 mm

If a different value is found, replace the turbocharger..

NOTE During the check the vacuum value shall not fall, otherwise the actuator shall be replaced.

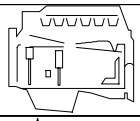
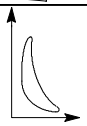
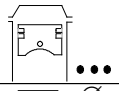
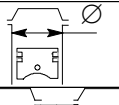
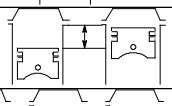
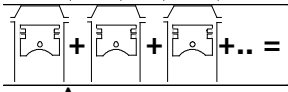
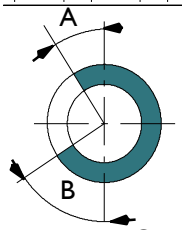
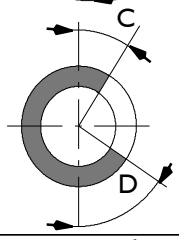
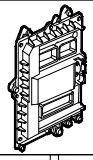
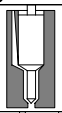
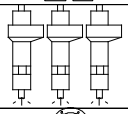
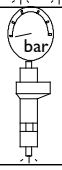
NOTE NOT ALLOWED ARE:

- ❑ **any replacement or regulation of the actuator, since the calibration of such component is made in an optimal way for each turbocharger and is guaranteed for the turbocharger;**
- ❑ **any operation on nut (5) and ring nut (4), since such operation does not change engine supply characteristics but may impair engine reliability and duration.**

Ring nut (4) is sealed with antitempering yellow paint.
In case of engines under guarantee, each above specified intervention and/or alteration to paint applied on ring nut (4) causes the lapse of the guarantee.

SECTION 8
Technical specifications

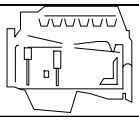
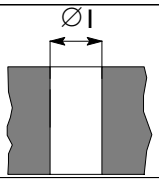
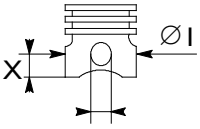
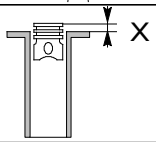
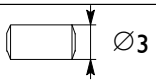
GENERAL SPECIFICATIONS

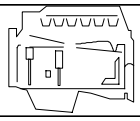
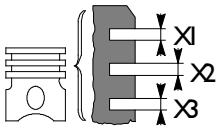
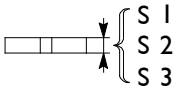
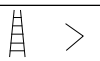
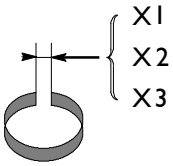
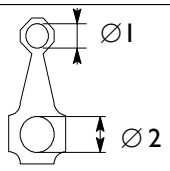
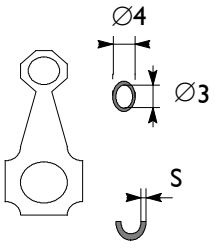
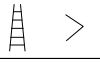
	Type		**F1CE3481**
	Cycle		Diesel 4 strokes
	Supply		Turbocharged with intercooler
	Injection		Direct
	Number of cylinders		4 in line
	Bore	mm	95.8
	Stroke	mm	104
	Total displacement	cm^3	2998
	TIMING SYSTEM		
	Start before T.D.C.	A	24°
	end after B.D.C.	B	26°
	Start before T.D.C.	D	70°
	end after B.D.C.	C	24°
	**FUEL FEED**		
	Injection Type:	Bosch	high pressure common rail EDC17
	Nozzle type		Injectors BOSCH
	Injection sequence		1 - 3 - 4 - 2
	Injection pressure	bar	1800

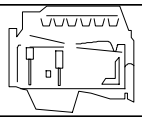
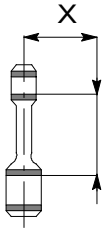
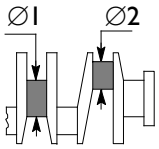
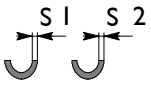
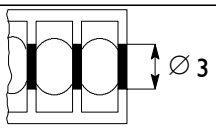
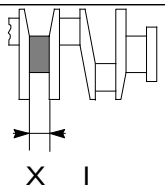
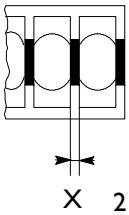
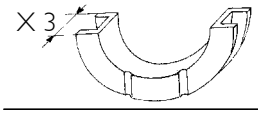
Data, features and performances are valid only if the setter fully complies with all the installation prescriptions providedby FPT.

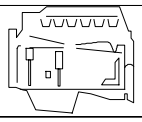
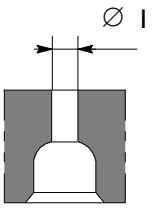
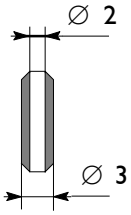
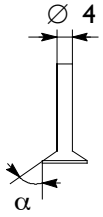
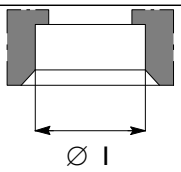
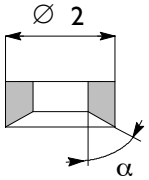
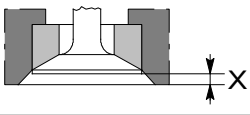
Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turnsbased on which the engine has been designed.

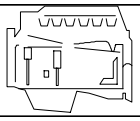
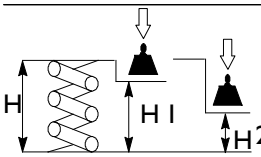
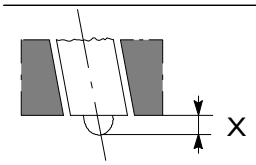
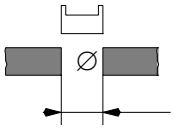
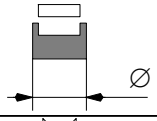
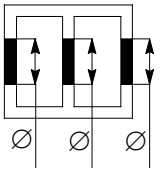
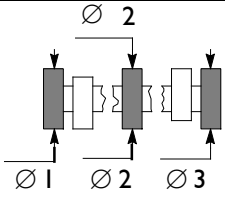
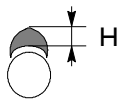
ASSEMBLY DATA – CLEARANCES

	Type		**F1CE3481**
CYLINDER ASSEMBLY AND CRANK MEMBERS			
	Cylinder liners:	Ø 1	95.802 ÷ 95.822
	Pistons: supplied as spares type measurement outside diameter seat for pin	 X Ø 1 Ø 2	MAHLE 58 95.541 ÷ 95.555 36.003 ÷ 36.009
	Piston – cylinder liners		0.197 ÷ 0.231
	Piston diameter	Ø 1	0.4
	Piston protrusion from crankcase	X	0.3 ÷ 0.6
	Piston gudgeon pin	Ø 3	95.541 ÷ 95.555
	Piston gudgeon pin – pin seat		0.07 ÷ 0.019

	Type	F1CE3481
CYLINDER ASSEMBLY AND CRANK MEMBERS		mm
	Type of piston	-
	Piston ring slots X1*	2.200 ÷ 2.230
	Piston ring slots X2	2.050 ÷ 2.070
	Piston ring slots X3	2.540 ÷ 2.560
	* measured on Ø of 92.5 mm	
	Piston rings: S1*	2.068 ÷ 2.097
	Piston rings: S2	1.970 ÷ 1.990
	Piston rings: S3	2.470 ÷ 2.495
	* measured at 1.5 mm from the external Ø.	
	Piston rings – slots 1	0.103 ÷ 0.162
	Piston rings – slots 2	0.060 ÷ 0.100
	Piston rings – slots 3	0.045 ÷ 0.090
	Piston rings	0.4
	Piston ring end opening in cylinder liner:	
	X1	0.20 ÷ 0.35
	X2	0.60 ÷ 0.80
	X3	0.30 ÷ 0.60
	Small end bushing seat Ø 1	39.460 ÷ 39.490
	Connecting rod bearing seat* Ø 2	67.833 ÷ 67.848
	* connecting rod supplied as spare part	
	Small end bushing diameter	
	outside Ø 4	39.570 ÷ 39.595
	inside Ø 3	36.010 ÷ 36.020
	Big end bearing shells supplied as spare part	-
	- top S	1.883 ÷ 1.892
	- bottom S	1.885 ÷ 1.891
	Small end bushing – seat (interference)	0.08 ÷ 0.135
	Piston gudgeon pin – bushing	0.014 ÷ 0.030
	Big end bearing shells	0.254 - 0.508

	Type	F1CE3481
CYLINDER ASSEMBLY AND CRANK MEMBERS		mm
	Measurement X	125
	Maximum error on alignment of connecting rod axes =	0.09
	Main journals Ø 1 No. 1-2-3-4 No. 5	 76.182 ÷ 76.208 83.182 ÷ 83.208
	Crankpins Ø 2	64.015 ÷ 64.038
	Main bearing shells S1*	2.165 ÷ 2.174
	Big end bearing shells S2*	1.883 ÷ 1.892 1.885 ÷ 1.891
	* supplied as spare parts	
	Main bearing housings Ø 3 No. 1-2-3-4 No. 5	 80.588 ÷ 80.614 87.588 ÷ 87.614
	Bearing shells - main journals	0.032 ÷ 0.102
	Bearing shells – crankpins	0.035 ÷ 0.083
	Main bearing shells	0.254 ÷ 0.508
	Big end bearing shells	0.254 ÷ 0.508
	Main journal for shoulder X 1	32.500 ÷ 32.550
	Main bearing housing for shoulder X 2	27.240 ÷ 27.290
	Half thrust washers X 3	32.310 ÷ 32.460
	Crankshaft shoulder	0.040 ÷ 0.240

	Type	**F1CE3481**
CYLINDER HEAD – TIMING SYSTEM		mm
	Guide valve seats on cylinder head Ø1	9.980 ÷ 10.000
	Valve guides Ø 2 Ø 3	6.023 ÷ 6.038 10.028 ÷ 10.039
	Valve guides and seats on head (interference)	0.028 ÷ 0.059
	Valve guides	0.05 - 0.10 - 0.25
	Valves: Ø 4 α Ø 4 α	5.985 ÷ 6.000 60° ±7.5' 5.975 ÷ 5.990 60° ±7.30'
	Valve stem and relevant guide	0.023 ÷ 0.053
	Seat on head for valve seat: Ø1 Ø1	34.490 ÷ 34.415 34.490 ÷ 34.515
	Outside diameter of valve seats; angle of valve seats on cylinder head: Ø 2 α Ø 2 α	34.590 ÷ 34.610 59.5° ±5' 34.590 ÷ 34.610 59.5° ±5'
	Recessing X Recessing X	0.375 ÷ 0.525 0.375 ÷ 0.525
	Between valve seat and head	0.075 - 0.12 0.075 - 0.12
	Valve seats	-

	Type	F1CE3481
CYLINDER HEAD – TIMING SYSTEM		mm
	Valve spring height: free spring H under a load of: N320 ± 16 H1 N657 ± 30 H2	 55.05 45 35
	Injector protrusion X	2.77 ÷ 3.23
	Seats for tappets on cylinder head normal Ø	12.016 ÷ 12.034
	Normal diameter tappets	11.988 ÷ 12.000
	Between tappets and seats	0.016 ÷ 0.046
	Camshaft pin seats in cylinder overhead 1 ⇒ 7 Ø 1 Ø 2 Ø 3	 48.988 ÷ 49.012 46.988 ÷ 47.012 35.988 ÷ 36.012
	Camshaft supporting pins: Ø 1 Ø 2 Ø 3	 48.925 ÷ 48.950 46.925 ÷ 46.950 35.925 ÷ 35.950
	Supporting pins and seats	0.032 ÷ 0.087
	Useful cam height H H	 3.622 4.328

TIGHTENING TORQUES

PART	TORQUE	
	Nm	kgm
M15x1.5 L 193 hex bolt securing inside of cylinder head		
first stage: pre-tightening	130 ± 6.5	13 ± 0.65
second stage: angle	90°	
third phase: angle	90°	
M12x1.5 L 165 hex bolt securing cylinder head laterally		
first stage: pre-tightening	65 ± 3.3	6.5 ± 0.325
second stage: angle	90°	
third phase: angle	60°	
M8x1.25 L 117/58 hex bolt securing cylinder head, chain housing side	25 ± 13.5	2.5 ± 0.13
Tapered threaded hexagon socket plug R 1/2"	40 ± 4	4 ± 0.4
Tapered threaded hexagon socket plug R 3/8"	29 ± 2.9	2.9 ± 0.3
Tapered threaded plug with hexagon socket head R 1/8" on cylinder head	7 ± 0.7	0.7 ± 0.07
Tapered threaded plug with hexagon socket head R 1/4" on cylinder head	9 ± 0.9	0.9 ± 0.09
Threaded male plug M26x1.5	50 ± 5	5 ± 0.5
Flanged screw M6x1 fixing camshaft rear cover	10 ± 1	1 ± 0.1
Flanged screw M6x1 fixing camshaft thrust plate	10 ± 1	1 ± 0.1
Hex screw with flange M8x1.25 L 30/40/77/100 fixing overhead	25 ± 2.5	2.5 ± 0.25
Threaded male plug M14x1.5 L 10 on timing cover	25 ± 2.5	2.5 ± 0.25
M6x1x25 cylindrical head hexagon socket screw securing timing cover	10 ± 1	1 ± 0.1
M6x1 flanged nut securing timing cover	10 ± 1	1 ± 0.1
M12x1.5 L 125 screw securing inside of lower crankcase		
first stage: pre-tightening	50 ± 5	5 ± 0.5
second stage: angle	60°	
third phase: angle	60°	
Bolt M8x1.25 L 77.5/40 securing lower crankcase externally	26 ± 2.6	2.6 ± 0.26
Flanged hex bolt M11x1.25x49 securing con rod caps		
first stage: pre-tightening	50 ± 2.5	5 ± 0.25
second stage: angle	70°	
Flanged hex bolt M12x1.25x52.5 securing engine flywheel		
first stage: pre-tightening	30 ± 1.5	3 ± 0.15
second stage: angle	90°	
M6x1x15 hex socket screw securing pulser ring to crankshaft	15 ± 1.5	1.5 ± 0.15
M10x1 union for piston cooling nozzle	25 ± 2.5	2.5 ± 0.25
Tapered threaded hex socket plug R 3/8"x10	40 ± 4	4 ± 0.4
Hex screw with flange M20x1.5x58 fixing damper pulley on crankshaft	350 ± 17.5	35 ± 0.175
Tapered plug R 1/8 x 8 on crankcase base	7 ± 0.7	0.7 ± 0.07
Water drain plug M14x1.5 L10 on crankcase	25 ± 2.5	2.5 ± 0.25
Crankcase fitting for turbocharger oil return G 3/8" x 12	50 ± 5	5 ± 0.5
Screw M6x1 fixing suction strainer	10 ± 1	1 ± 0.1
Hex screw with flange M8x1.25 fixing oil and vacuum pump assembly	25 ± 2.5	2.5 ± 0.25
M12x1.5x35 drive pin of oil and vacuum pump assembly	130 ± 13	13 ± 0.13
Fitting R 1/4" for oil delivery to turbocharger	40 ± 4	4 ± 0.4
Hex screw with flange M8x1.5 L35 fixing frame retaining oil sump	25 ± 2.5	2.5 ± 0.25
Male threaded plug with O-ring M22x1.5 L10	50 ± 10	5 ± 1
Hex screw with flange M8x1.25 L60 fixing oil and vacuum pump assembly	25 ± 2.5	2.5 ± 0.25
Hex screw with flange M8x1.25 fixing power steering pump mount	25 ± 2.5	2.5 ± 0.25

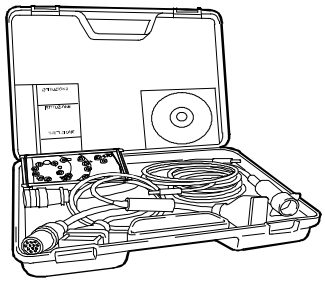
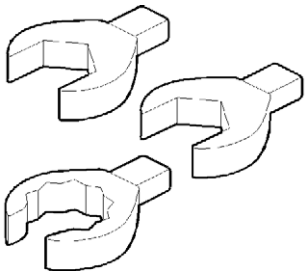
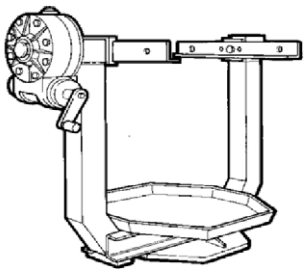
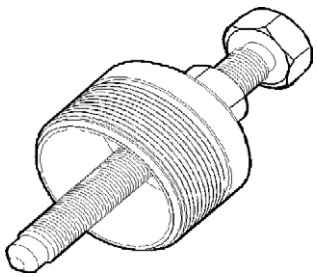
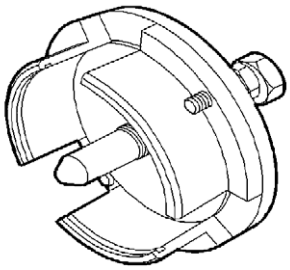
PART	TORQUE	
	Nm	kgm
Flanged screw M8x1.25 L18 fixing timing cover	25 ± 2.5	2.5 ± 0.25
Screw with flange M6x1 L20 fixing Blow-by unit	10 ± 1	1 ± 0.1
Cap M14x1.5 L10	25	2.5
Hex screw with flange M8x1.25 L40 fixing inlet manifold	30	3
Flanged nut M8x1.25 fixing exhaust manifold	25 ± 2.5	2.5 ± 0.25
M10 x 1.25 x 50 Fixed idler	50 ± 5	5 ± 0.5
M8 x 1.25 x 45 Belt tensioner	25 ± 2.5	2.5 ± 0.25
M10 x 1.25 Alternator	50 ± 5	5 ± 0,5
M10 x 1.25 x 30 Alternator	50 ± 5	5 ± 0.5
M10 x 1.25 x 35 Alternator support	50 ± 5	5 ± 0.5
M10 x 1.25 x 100 Alternator support	50 ± 5	5 ± 0.5
M8 x 1.25 x 70 Alternator support	25 ± 2.5	2.5 ± 0.25
M8 x 1.25 x 30 Alternator support	25 ± 2.5	2.5 ± 0.25
Hex socket bolt M8x1.25 L65 for Poli-V automatic belt tensioner	25	2.5
Hex screw with flange M10x1.25 L22 for guide pulley roller for Poli-V belt	40	4
Flanged hex screw M12x1.75 L30 fixing gear to camshaft	110	11
Timing chain tensioner bolt M22x1.5x22	50 ± 2	5 ± 0.2
Bolt M10x1.5x12 for timing chain mobile pads	40 ± 2	4 ± 0.2
Cylindrical head hexagon socket screw M8x1.25x30 securing fixed pads	25 ± 2.5	2.5 ± 0.25
Cylindrical head hexagon socket screw M6x1 L16/20 securing pads	10 ± 1	1 ± 0.1
Bolt M12x1.5 fixing water temperature sensor	30 ± 3	3 ± 0.3
M6x1 cylindrical head hexagon socket screw securing air temperature/pressure sensor	10 ± 1	1 ± 0.1
M6x1 cylindrical head hexagon socket screw securing engine rpm sensor	10 ± 1	1 ± 0.1
M6x1 hexagon socket screw securing timing sensor	10 ± 1	1 ± 0.1
M8 x 1.25 Turbocharger	25 ± 2.5	2,5 ± 0.25
M14 x 1.5 Turbocharger oil delivery pipe	35 ± 3.5	3.5 ± 0.35
M6 x 1 x 20 Turbocharger oil return pipe	10 ± 1	1 ± 0.1
M22 x 1.5 Turbocharger oil return pipe	45 ± 4.5	4.5 ± 0.45
Nut M8x1.25 fixing turbocharger	25 ± 2.5	2.5 ± 0.25
Flanged hex screw M8x1.25 for turbocharger gas outlet pipe	25 ± 2.5	2.5 ± 0.25
Union M14x1.5 for fixing oil delivery pipe to turbocharger	35 ± 3.5	3.5 ± 0.35
Fitting M22x1.5 for oil return pipe from turbocharger	45 ± 4.5	4.5 ± 0.45
Flanged hex screw M6x1 fixing oil return pipe from turbocharger	10 ± 1	1 ± 0.1
M8 x 1.25 x 25 Complete support from valve to throttle body	25 ± 2.5	2.5 ± 0.25
Threaded pipe union R 1/4"	40 ± 4	4 ± 0.4
M10 x 1.25 x 35 Air compressor	50 ± 5	5 ± 0.5
M10 x 1.25 x 110 Air compressor	50 ± 5	5 ± 0.5
M12 x 1.25 x 48 Air compressor support	50 ± 5	5 ± 0.5
M10 x 1.25 x 25 Air compressor support	50 ± 5	5 ± 0.5
M10 x 1.25 x 60 Air compressor support	50 ± 5	5 ± 0.5
M22 x 1.5 Water inlet pipe	50 ± 5	5 ± 0.5
M14 x 1.5 Water delivery pipe	30 ± 3	1 ± 0.1
M16 x 1.5 Water pipe	50 ± 5	5 ± 0.5
M16 x 1.5 Water return pipe	35 ± 3.5	3.5 ± 0.35
M12 x 1.5 Water delivery pipe	40 ± 4	4 ± 0.4

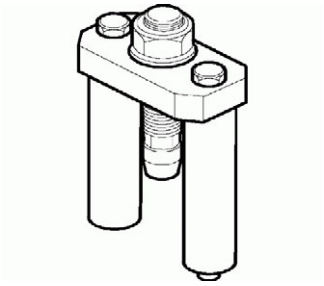
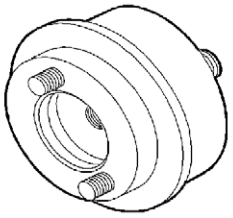
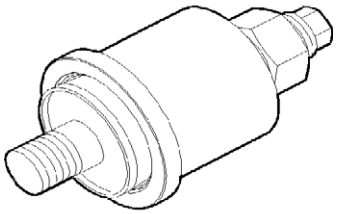
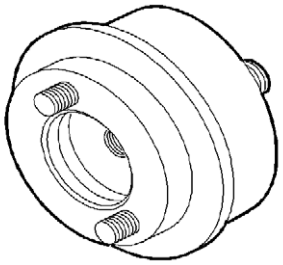
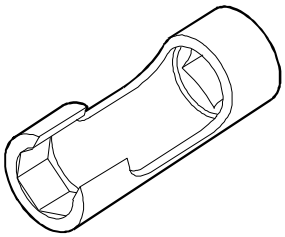
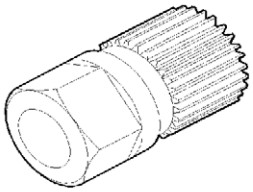
PART	TORQUE	
	Nm	kgm
R1/8" x 12.5 Oil delivery fitting from turbocharger on to the crankcase	35 ± 3.5	3.5 ± 0.35
M18 x 1.5 Air compressor control pulley	120 ± 12	12 ± 0.12
Hex screw with flange M6x1x16 fixing air pipe	10 ± 1	1 ± 0.1
M6x1 flanged hex screw securing oil fill pipe	10 ± 1	1 ± 0.1
Oil filter cartridge M22x1.5	25 ± 2.5	2.5 ± 0.25
Hex bolt M8x1.25x30 securing heat exchanger	25 ± 2.5	2.5 ± 0.25
Oil filter cartridge fitting M24x1.5 *	80 ± 8	8 ± 0.8
M6 x 1 x 12 Oil dipstick	10 ± 1	1 ± 0.1
M8x1.25x30/40 flanged hex screw securing heat exchanger internal element	25 ± 2.5	2.5 ± 0.25
M8x1.25 flanged hex screw securing cylinder head rear cover	25 ± 1.25	2.5 ± 0.125
Hex screw with flange M8x1.25 fixing coolant delivery pipe	25 ± 1.25	2.5 ± 0.125
M12x1.5 pressure switch on coolant tank	25 ± 2.5	2.5 ± 0.25
M6 x 1 x 18 Cooler internal element	10 ± 1	1 ± 0.1
Flanged nut M8x1.25 for coolant delivery pipe support bracket fastening	25 ± 2.5	2.5 ± 0.25
Flanged screw M8x1.25 for thermostat fastening	25 ± 2.5	2,5 ± 0.25
Socket cylinder head screw M10x1.5 for alternator fastening	50 ± 5	5 ± 0.5
Flanged screw M10x1,25x110 for hydraulic power steering pump fastening	40 ± 4	4 ± 0.4
Flanged screw M12x1,25 securing the power steering pump	50	5
Flanged screw M8x1,25 securing the power steering tank support	25 ± 2.5	2.5 ± 0.25
Flanged screws M10x1.25 for power take off cover fastening	50 ± 5	5 ± 0.5
M12 x 1.25 x 12 Plug on the oil sensor base	25 ± 2.5	2.5 ± 0.25
G 3/8" x 12 Oil return fitting from turbocharger on to the crankcase	50 ± 5	5 ± 0.5
G 3/8" x 12 Plug	40 ± 4	4 ± 0.4
Oil pressure switch M14x1.5	25 ± 2.5	2.5 ± 0.25
M8x1.25 socket-head cap screw securing the E.G.R. valve to the exhaust manifold	25 ± 2.5	2.5 ± 0.25
M8x1.25 socket-head cap screw securing the E.G.R. valve to the exchanger	25 ± 2.5	2.5 ± 0.25
M8x1.25 flanged screw securing the heat exchanger	25 ± 2.5	2.5 ± 0.25
M6x1 socket-head cap screw for E.G.R. pipe fastening collar	5 ± 0,25	0.5 ± 0.03
G 1/4" Oil delivery fitting to turbocharger	40 ± 4	4 ± 0.4
M8 x 1.25 x 20 EGR valve to exhaust manifold	25 ± 2.5	2.5 ± 0.25
M6 x 1 EGR pipe (collar)	5 ± 0.5	0.5 ± 0.05
High-pressure injection system		
Flanged nut M8x1.25 for high pressure pump support fastening	25	2.5
Hydraulic accumulator fastening screw M8x1.25 L50	28	2.8
High pressure pump fastening screw M8x1.25 L90	25	2.5
Screw M6x1x16 for fastening of fuel delivery pipe anchoring bracket	10	1
Pipe union for fuel delivery pipes to rail and electric injectors: - M14x1.5 - M12x1.5	 19 ± 2 25 ± 2	 1.9 ± 0.2 2.5 ± 0.2
Socket cylinder head screw M8x1,25 for fastening of electric injector retaining bracket	28 ± 2.8	2.8 ± 0.3
Flanged nut M8x1,25 for anchoring bracket support fastening	25 ± 2,5	2.5 ± 0.25
Pin fastener M12x1.25 for high pressure pump	110 ± 11	11 ± 0.11
Flanged nut (M6x1) for low-pressure fuel pipe fastening	10 ± 1	1 ± 0.1
TE flanged screw (M8x1.25) for pipe supporting bracket fastening	25 ± 2.5	2.5 ± 0.25
Filler neck M12x1.5 for adjustable pipe union	25 ± 2.5	2.5 ± 0.25
M6 x 1 x 10 Diesel fuel LP pipe	10 ± 1	1 ± 0.1

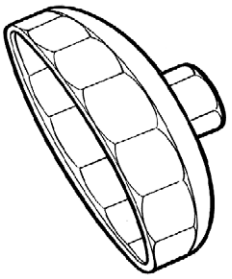
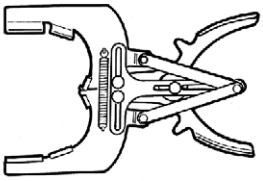
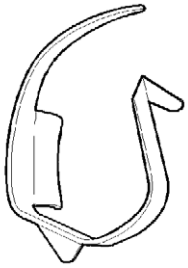
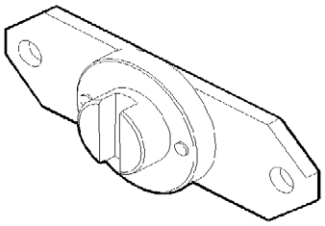
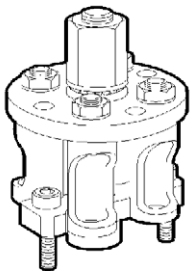
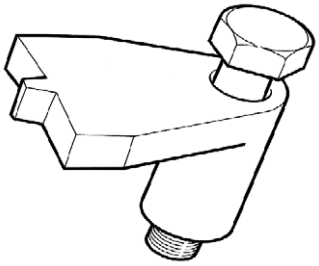
* Apply LOCTITE 577 to the thread

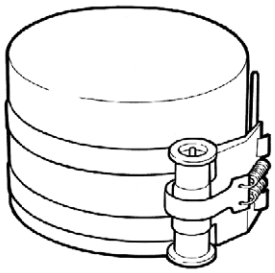
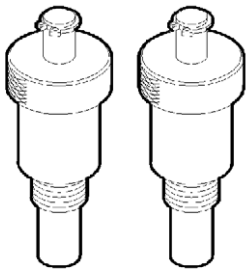
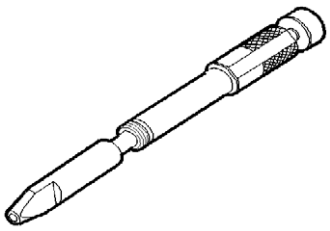
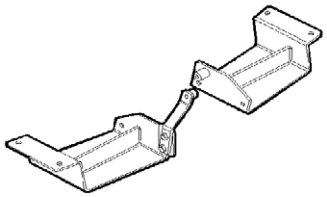
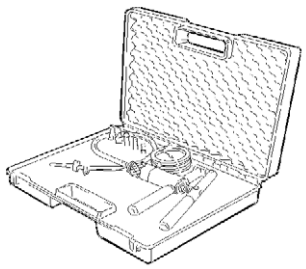
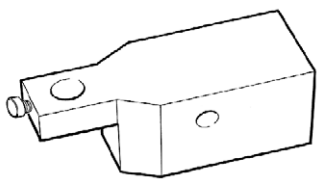
SECTION 9
Tools

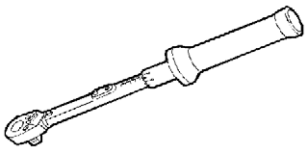
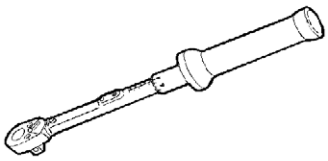
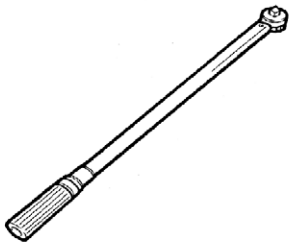
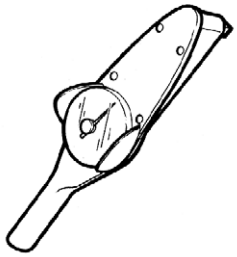
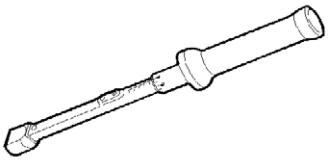
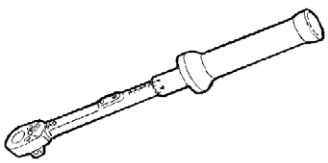
TOOLS

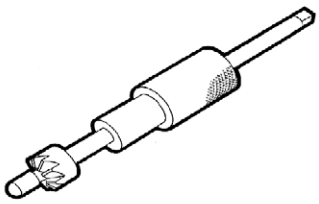
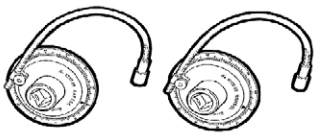
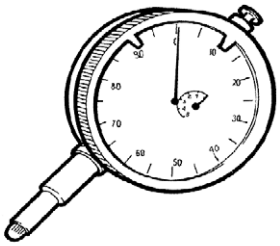
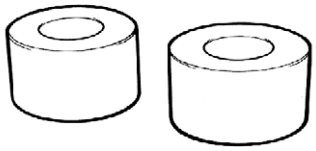
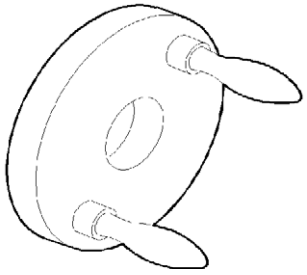
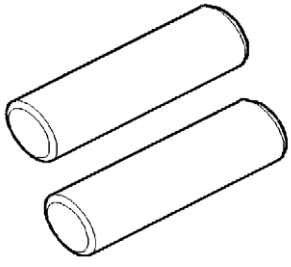
TOOL NO.		DESCRIPTION
99327281		PT-BOX
99305454		Tool used to check the low-/high-pressure system fuel supply circuit
99317915		Set of 5 pin wrenches 9X12 (14-15-17-18-19 mm)
99322205		Revolving stand for overhauling units (1000daN/m capacity, 120daN/m torque)
99340059		Extraction tool for crankshaft front ring seal
99340060		Extraction tool for crankshaft rear gasket

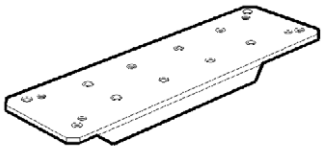
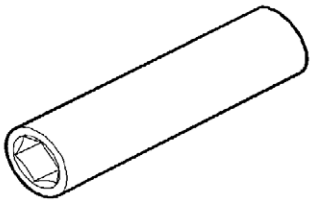
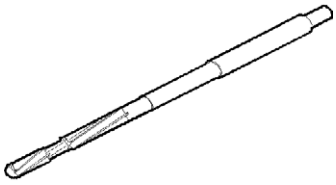
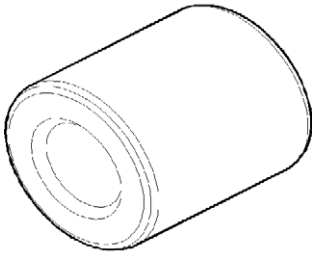
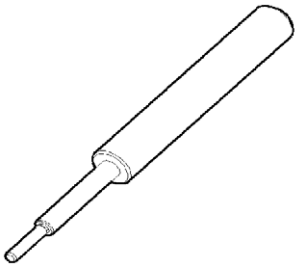
TOOL NO.		DESCRIPTION
99342156		Extractiontool for injectors
99346259		Key to fit crankshaft rear gasket
993462158		Key to fit crankshaft front gasket
993462159		Key to fit crankshaft rear gasket
99352115		Wrench for removing/refitting injector pipes (ch. 17)
99358026		Wrench for removing/refitting the alternator freewheel

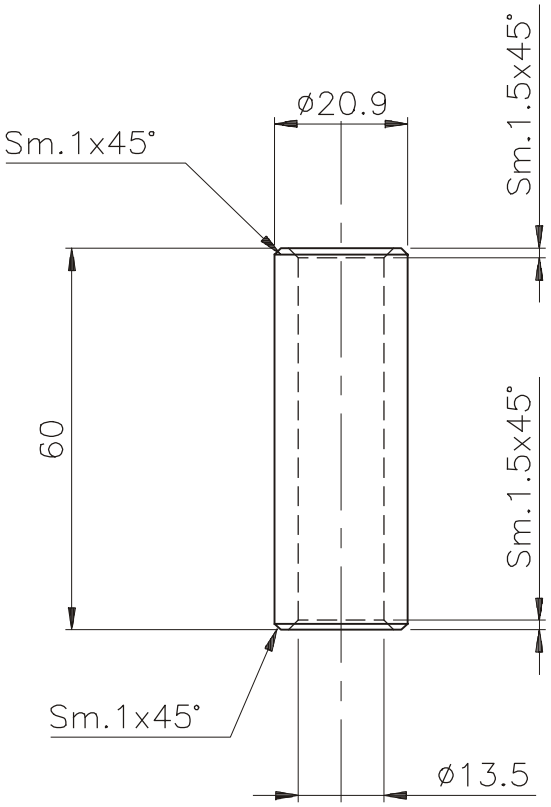
TOOL NO.		DESCRIPTION
99360076		Tool to remove oil filter (engine)
99360183		Key to fit crankshaft rear gasket
99360186		Guide for fitting rubber belt
99360187		Tool for retaining power steering pump drive shaft
99360260		Tool for removing and installing engine valves
99360306		Tool to retain engine flywheel

TOOL NO.		DESCRIPTION
99360605		Band for fitting piston into cylinder barrel (60 - 125 mm)
99360614		Tool (2) for camshaft timing
99360615		Tool for crankshaft timing
99361041		Brackets for fastening engine to 99322205 rotary stand
99367121		Manual pump for pressure and depression measures
99370415		Gauge base for different measurements (to be used with 99395603)

TOOL NO.		DESCRIPTION
99389813		Torque Wrench (20-120 Nm) with square 1/2 "
99389817		Torque wrench (60 ÷ 320 Nm) with 1/2" square head
99389818		Torque wrench (150-800 Nm) with 3/4" square head
99389819		Torque wrench (0-10 Nm) with 1/4" square head
99389829		Dog typedynamometric wrench 9x12 (5-60 Nm)
99389831		Torque wrench (10-60 Nm) with 3/8" square head

TOOL NO.		DESCRIPTION
99394038		Milling cutter for grinding injector seats
99395216		Pair of gauges with ½" and ¾" square head for angle tightening
99395603		Dialgauge (0 - 5 mm)
99396030		Calibrated rings for the lay shaft bearing adjustment (use with 99370466)
99396039		Timer cover centring ring(use with 99346258)
SP2264		Pins for mounting valve guide gaskets

TOOL NO.		DESCRIPTION
SP2271		Cylinder head support
SP2275		Bushing (8 mm) for the removal and remounting of glow plugs
SP2310		Sleeker for valve guide
SP2311		Punch for valve guide refitting (use with SP2312)
SP2312		Punch for valve guide removal



Modification:

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

MAT.	COVER.	DRAWN	N°DRAWING
Pom / Nylon	**/**	**UTS (B)**	**SP. 2264**

ISO ≤ IT8
4 ≤ 30'
Ra ≤ 0.4

Perni

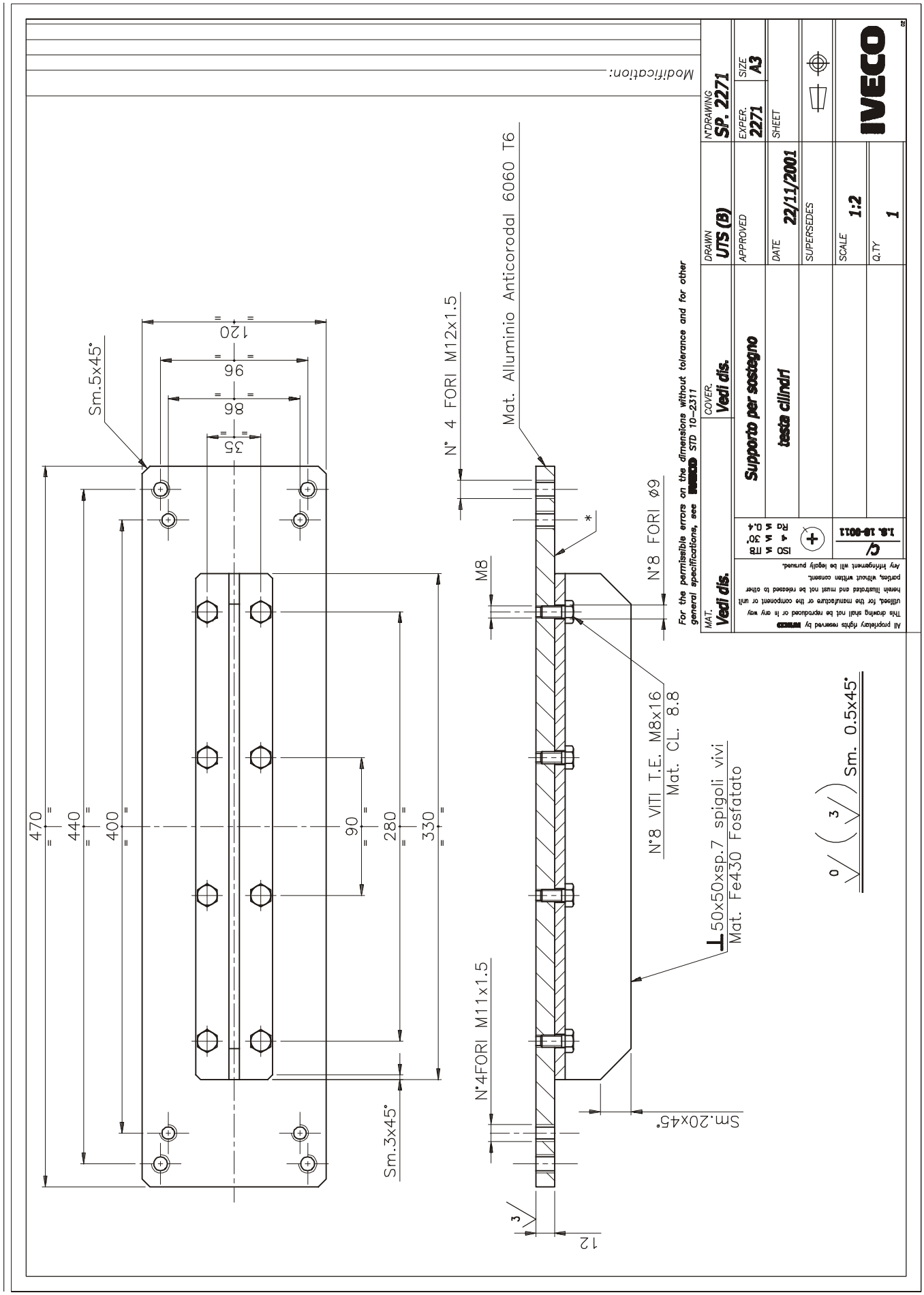
per piantaggio guarnizione

guida valvole

C/
I.S. 18-0011

APPROVED	EXPER.	SIZE
	2264	**A4**
DATE **19/06/2001**	SHEET	
SUPERSEDES		
SCALE **1:1**	IVECO	
Q.TY **2**		

02


Modification:
Sm.5x45°
120
96
86
35
470
440
400
90
280
330
Sm.3x45°
N° 4 FORI M12x1.5
Mat. Alluminio Anticorodal 6060 T6
N°8 FORI ø9
M8
N°8 VITI T.E. M8x16
Mat. CL. 8.8
⊥50x50xsp.7 spigoli vivi
Mat. Fe430 Fosfatato
N°4FORI M11x1.5
Sm.20x45°
12
3
Sm. 0.5x45°
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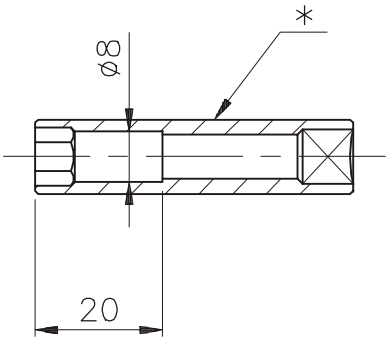
This drawing shall not be reproduced or in any way utilized, for the manufacture or the components or units herein illustrated and must not be released to others parties, without written consent.
Any infringement will be legally pursued.
ISO M 13
Ra 4 M 30° 0,4
MAT. Vedi dis.
For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10-2311
COVER. Vedi dis.
Supporto per sostegno
testa cilindri
DRAWN UTS (B)
APPROVED
DATE 22/11/2001
SUPERSEDES
SCALE 1:2
Q.TY 1
N°DRAWING SP. 2271
EXPER. 2271
SHEET
SIZE A3
I.S. 18-8011
IVECO

VARIA DA ART. COMMERCIALE USAG cod.235EL 1/4" – Ch.8

SOLO PER QUANTO INDICATO



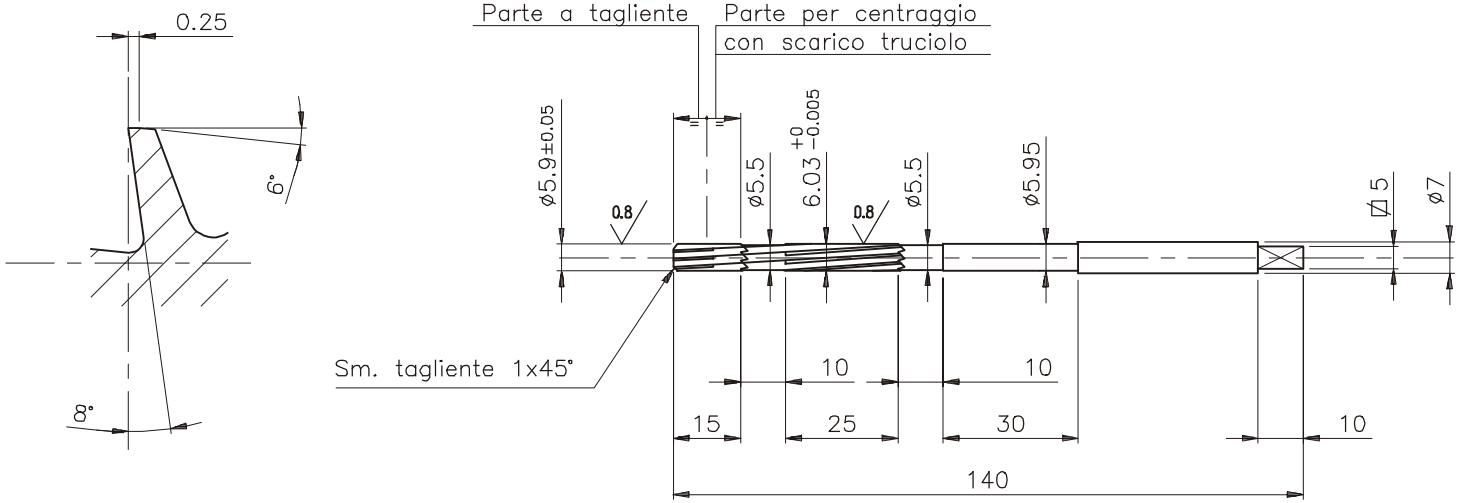
6 Sm. 0.5x45°

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

Modification:

MAT. /	COVER. /	DRAWN UTS (B)	N°DRAWING SP. 2275
Bussola (8 mm) per montaggio/ smontaggio candelette		APPROVED	EXPER. 2275 / SIZE A4
		DATE 25/07/2001	SHEET
		SUPERSEDES	
C/ I.S. 18-0011	ISO ≤ IT8 4 ≤ 30' Ra ≤ 0.4	SCALE 1:1	IVECO
		Q.TY 1	02

PARTIC. DENTE – Scala 10:1



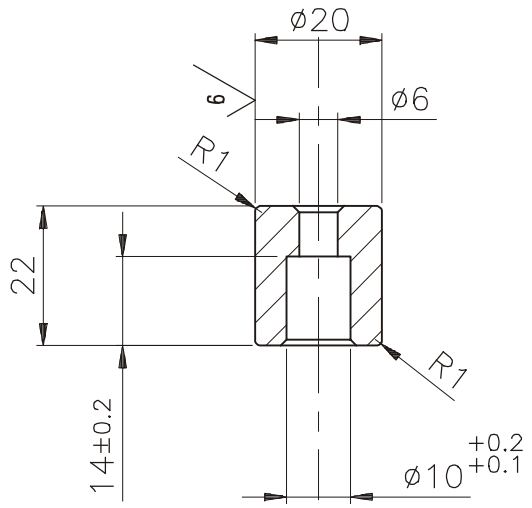
N° 6 DENTI – ELICA SINISTRA – INCLINAZIONE 6°

Modification:

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

MAT. **UNI U100WC HRC 62÷64**	COVER. **/**	DRAWN **UTS (B)**	N°DRAWING **SP. 2310**
Lisciatoio per guida valvole		APPROVED	EXPER. **2310** / SIZE **A3**
		DATE **10/12/2001**	SHEET
		SUPERSEDES	
		SCALE **1:1**	IVECO
		Q.TY **1**	

ISO ≤ IT8 4 ≤ 30' Ra ≤ 0.4



Modification:

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

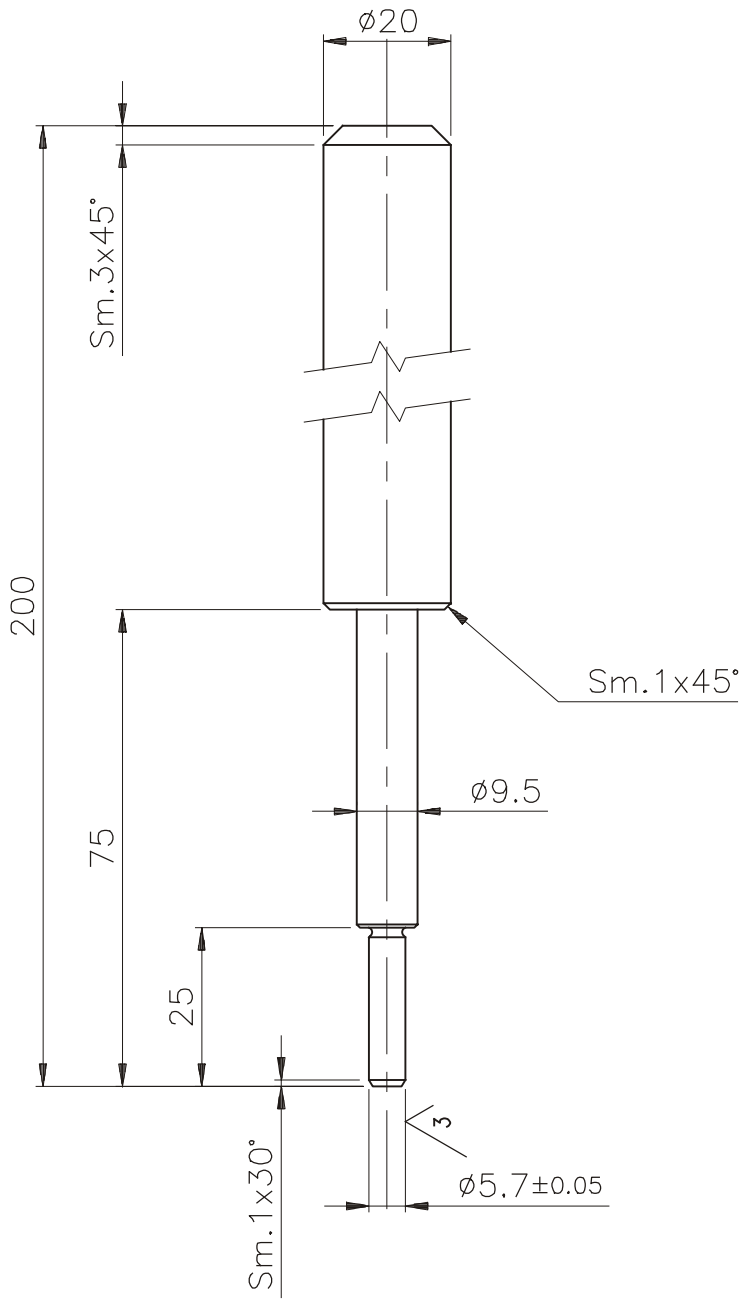
MAT.	COVER.	DRAWN	N°DRAWING
39NiCrMo3 Bon.	Fosfat.	UTS (B)	SP. 2311

ISO ≤ IT8
4 ≤ 30'
Ra ≤ 0.4

C/
I.S. 18-0011

Battitoio per piantaggio	APPROVED	EXPER. 2311	SIZE A4
guida valvole	DATE 10/12/2001	SHEET	
(usare con sp. 2312)	SUPERSEDES		
	SCALE 1:1	IVECO	
	Q.TY 1		

02



Modification:

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

MAT.	COVER.	DRAWN	N°DRAWING
39NiCrMo3 Bon.	**Fosfat.**	**UTS (B)**	**SP. 2312**

Battitoio per spiantaggio	APPROVED	EXPER. **2312**	SIZE **A4**
guida valvole	DATE **10/12/2001**	SHEET	
	SUPERSEDES		
	SCALE **1:1**	IVECO	
	Q.TY **1**		

ISO ≤ IT8 ∢ ≤ 30' Ra ≤ 0.4

C/ I.S. 18-0011

02

Appendix

SAFETY PRESCRIPTIONS
Standard safety prescriptions

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

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

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

Prevention of injury

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

During maintenance

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

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

For engines equipped with electronic gearbox:

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

Respect of the Environment

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