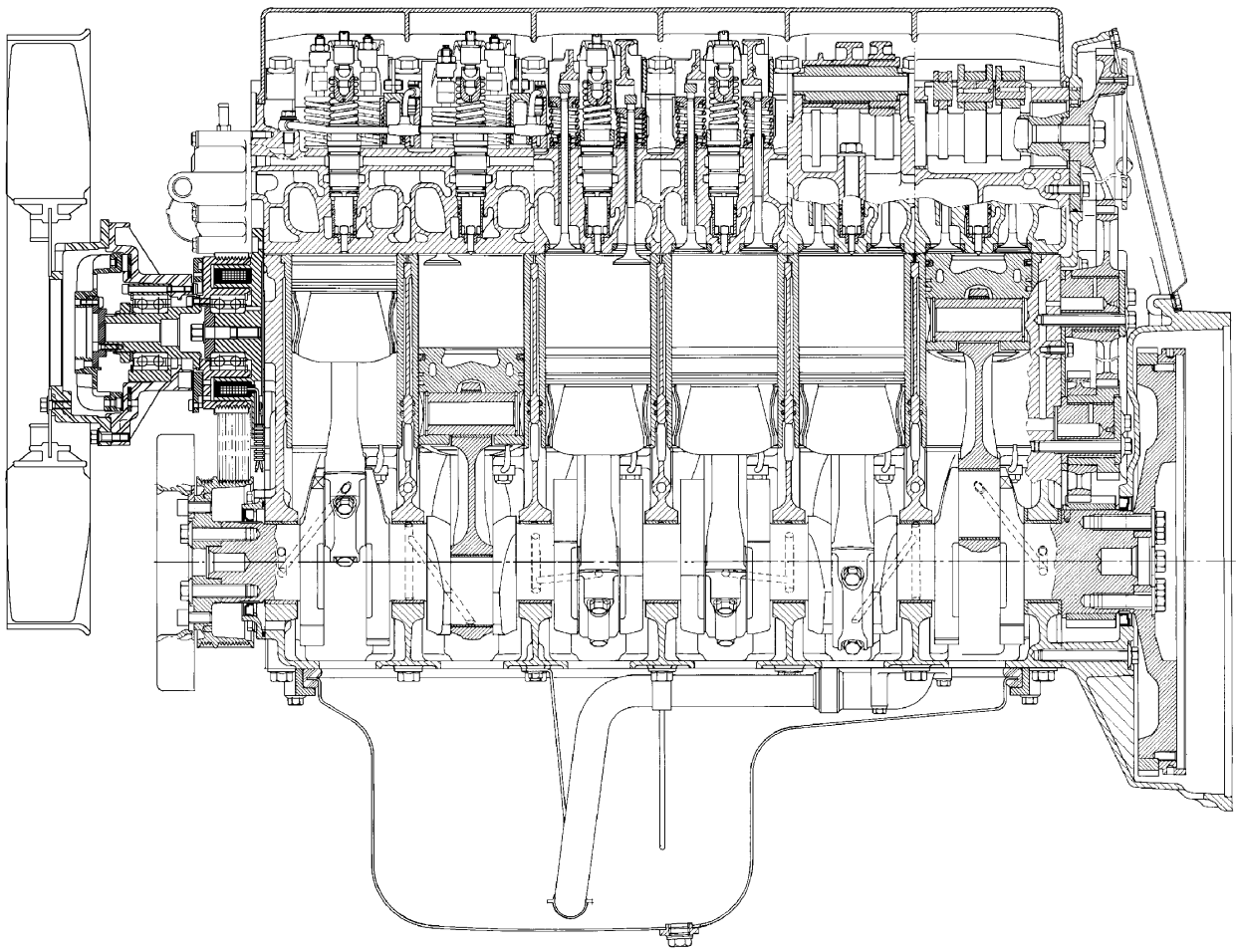
Graph and symbols

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

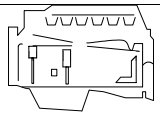
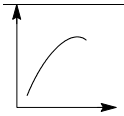
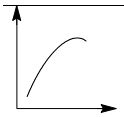
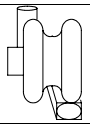
	Intake
	Exhaust
	Operation
	Compression ratio
	Tolerance Weight difference
	Rolling torque
	Replacement Original spare parts
	Rotation
	Angle Angular value
	Preload
	Number of revolutions
	Temperature
	Pressure
	Oversized Higher than…. Maximum, peak
	Undersized Less than…. Minimum
	Selection Classes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

Figure 2



ENGINE - LONGITUDINAL SECTION

GENERAL FEATURES

	Type		F2BE3681C	F2BE3681B	F2BE3681A
ϱ	Compression ratio		16 : 1		
 	Max. output	kW (HP) rpm	230 (310) 2400	245 (330) 2400	265 (360) 2400
 	Max. torque	Nm (kgm) rpm	1300 (132) 1200 ÷ 1675	1400 (143) 1080 ÷ 1655	1500 (153) 1200 ÷ 1685
	Loadless engine idling	rpm	600 ± 50		
	Loadless engine peak	rpm	2660 ± 50		
	Bore x stroke Displacement	mm cm^3	115 x 125 7790		
	SUPERCHARGING Turbocharger type		HOLSET with fixed geometry HX40	HOLSET with variable geometry HE 431 V	
 	LUBRICATION Oil pressure (warm engine) (100 °C ± 5 °C) - idling - peak rpm	 bar bar	Forced by gear pump, relief valve single action oil filter 1.5 5		
COOLING			By centrifugal pump, regulating thermostat, viscostatic fan, radiator and heat exchanger		
	Water pump control		By belt		
	Thermostat: starts to open: fully open:		N. 1 ~85 °C -		
	OIL FILLING Total capacity at 1st filling	liters kg	28 25.2		
	Capacity: - engine sump min level	liters kg	12.5 11.2		
	- engine sump max level	liters kg	23 21		
	- quantity in circulation that does not flow back to the engine sump	liters kg	5 4.5		
	- quantity contained in the cartridge filter (which has to be added to the cartridge filter refill)	liters kg	2.5 2.3		

Flywheel pulse transmitter (48035)

Features

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

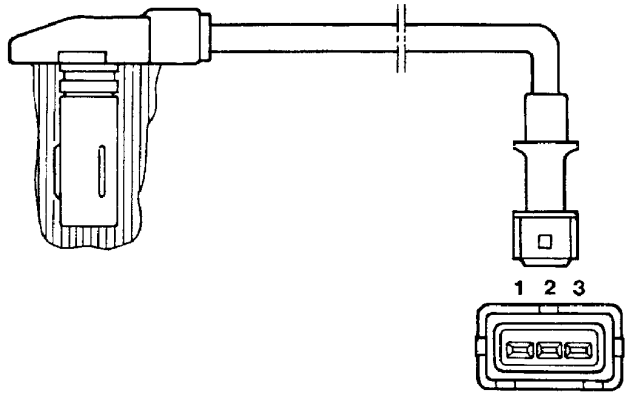
This induction type sensor located on the flywheel generates signals obtained from the magnetic flow lines that close through 54 holes in three series of 18 in the flywheel.

The electronic center uses this signal to detect the various engine ratings and pilot the electronic rev counter.

The rev counter does not operate in the absence of this signal.

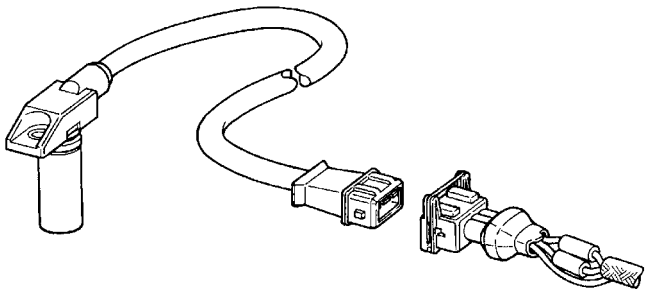
This sensor's air gap is NOT ADJUSTABLE.

Figure 17



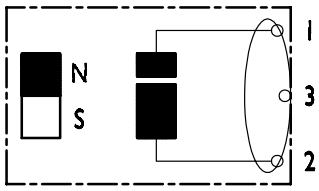
TECHNICAL VIEW 106984

Figure 18



PERSPECTIVE VIEW 106985

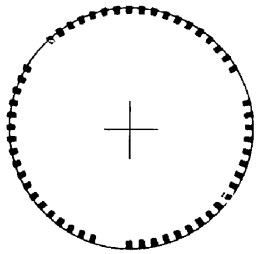
Figure 19



106986

WIRING DIAGRAM

Figure 20



3 x 18

8520

HOLES ON FLYWHEEL

Connector	Function	Cable colour
1	To EDC center pin C 23	—
2	To EDC center pin C 19	—
3	Shields	—

MAINTENANCE

Maintenance services scheme

Programmed maintenance is made up of "Standard" services, plus a set of operations called "Extra Plan" operations, as well as further operations called "Temporal" operations.

Normally, no differentiated plans are prescribed in connection with vehicle use. Where a differentiation in terms of "mission" exists, as many plants are forwarded as many are the "missions".

Using recommended lubricants systematically allows for long replacement intervals with relatively contained costs. To such purpose, see recommended lubricants summary card.

M = STANDARD SERVICE

"Standard" services are indicated by M = "Maintenance".
They must be performed at regular kilometre intervals that are normally multiple among one another.

EP = EXTRA PLAN OPERATIONS

Extra plan operations are indicated by EP = "Extra Plan".
They are services complementary to "standard" services and are to be performed according to intervals which are not compatible with standard services.

T = TEMPORAL OPERATIONS

They are specific interventions that are exclusively connected to temporal intervals and are to be normally performed in particular season conditions. To minimise the number of stops for maintenance it is recommended to program extra plan stops based on average yearly run matching them as much as possible with predefined kilometre intervals.

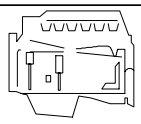
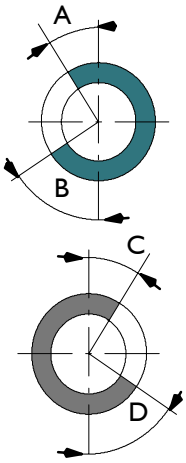
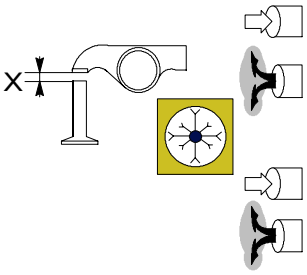
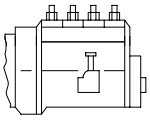
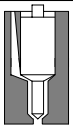
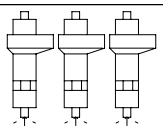
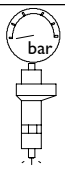
To ensure optimum working conditions, the following pages give the checks, inspections and adjustments that need to be made on the various parts of the vehicle at the required times.

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

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

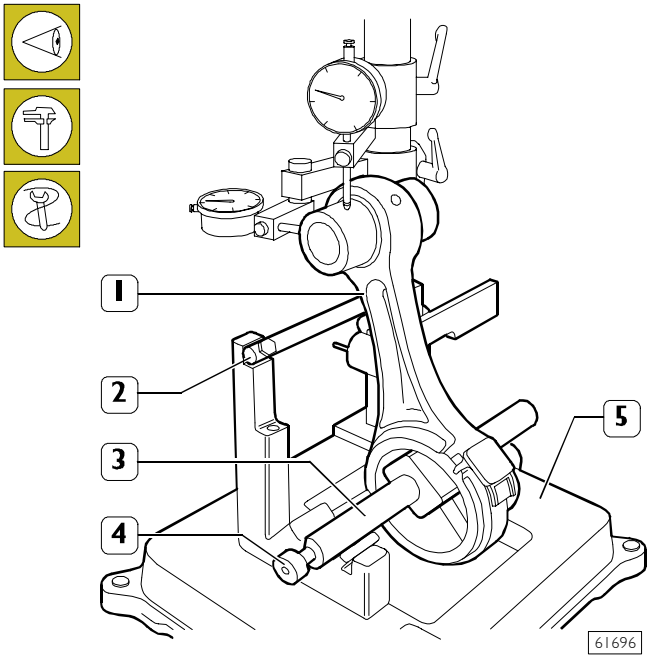
Use engine oil: ACEA E4 (URANIA FE 5W30)
ACEA E7 (URANIA LD7)

- ❑ If the vehicle is used very little or anyhow for less than 1000 hours/100,000 km a year, the engine oil and filter need to be replaced every 12 months.
- ❑ ACEA E4 lubricants classified as ACEA E6 cannot be used according to the change intervals established for class ACEA E4. They shall be changed according to the time intervals established for lubricants ACEA E2, i.e. every 400 hours/40,000 km.
- ❑ If class ACEA E7 engine oil is used, the engine oil and filters must be changed every 800 hours/80,000 km.
- ❑ If class ACEA E2 engine oil is used, the engine oil and filters must be changed every 400 hours/40,000 km.

	Type	**F2BE3681**
	VALVE TIMING	
	opens before T.D.C. A	17°
	closes after B.D.C. B	31°
	opens before B.D.C. D	48°
	closes after T.D.C. C	9°
	For timing check	
	X mm	–
	mm	–
	Running	
	X mm	0.35 to 0.45
	mm	0.35 to 0.45
	FEED	Through fuel pump - Filters
	Injection type Bosch	With electronically regulated injectors UIN2 pump injectors controlled by overhead camshaft
	Nozzle type	-
	Injection order	1 - 4 - 2 - 6 - 3 - 5
	Injection pressure bar	1600

Checking connecting rod alignment

Figure 50 (Demonstration)



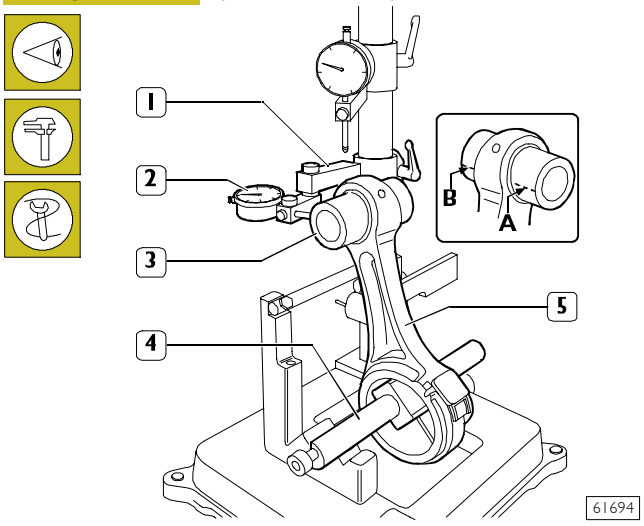
Checking axis alignment

Check the toe-setting for the connecting rods (1) axles using the proper devices (5), according to this procedure:

- ❑ Fit the connecting rod (1) on the spindle of the tool (5) and lock it with the screw (4).
- ❑ Set the spindle (3) on the V-prisms, resting the connecting rod (1) on the stop bar (2).

Checking torsion

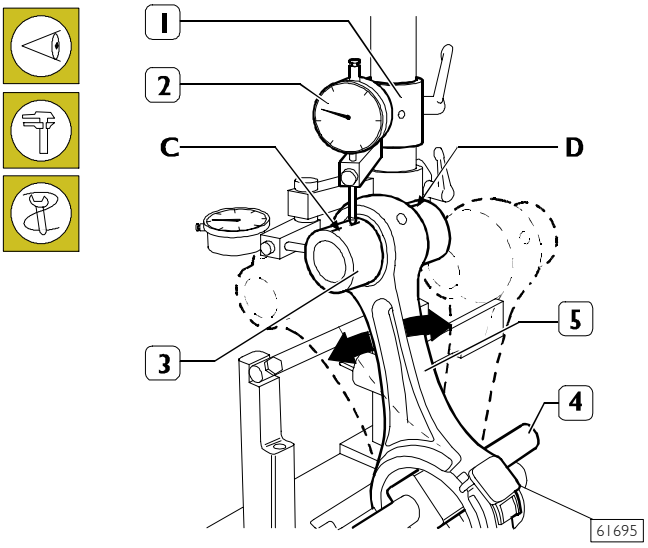
Figure 51 (Demonstration)



Check the torsion of the connecting rod (5) by comparing two points (**A** and **B**) of the pin (3) on the horizontal plane of the axis of the connecting rod.
Position the mount (1) of the dial gauge (2) so that this pre-loads by approx. 0.5 mm on the pin (3) at point **A** and zero the dial gauge (2). Shift the spindle (4) with the connecting rod (5) and compare any deviation on the opposite side **B** of the pin (3): the difference between **A** and **B** must be no greater than 0.08 mm.

Checking bending

Figure 52 (Demonstration)



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

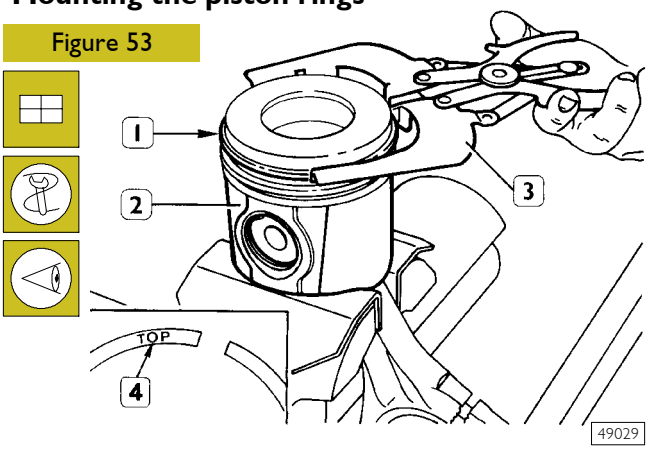
Mounting the connecting rod - piston assembly

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

The connecting rod screws can be reused as long as the diameter of the thread is not less than 13.4 mm.

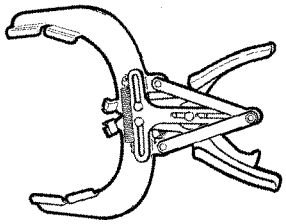
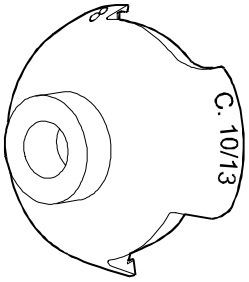
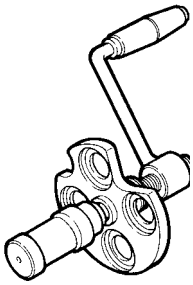
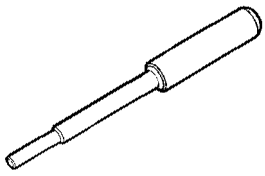
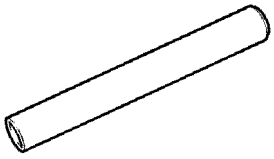
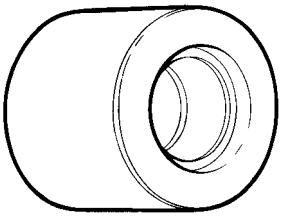
Mounting the piston rings

Figure 53

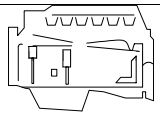
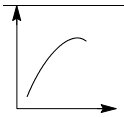
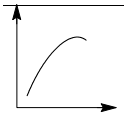
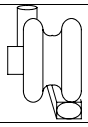


To fit the piston rings (1) on the piston (2) use the pliers 99360184 (3).
The rings need to be mounted with the word "TOP" (4) facing upwards. Direct the ring openings so they are staggered 120° apart.

TOOLS

TOOL NO.		DESCRIPTION
99360184		Pincers for removing and refitting circlips and pistons (105-160 mm)
99360192		Guide for flexible belt
99360264		Tool to take down-fit engine valves
99360288		Tool to remove valve guide
99360292		Tool to install gasket on valve guide
99360294		Tool to drive valve guide (to be used with 99360288)

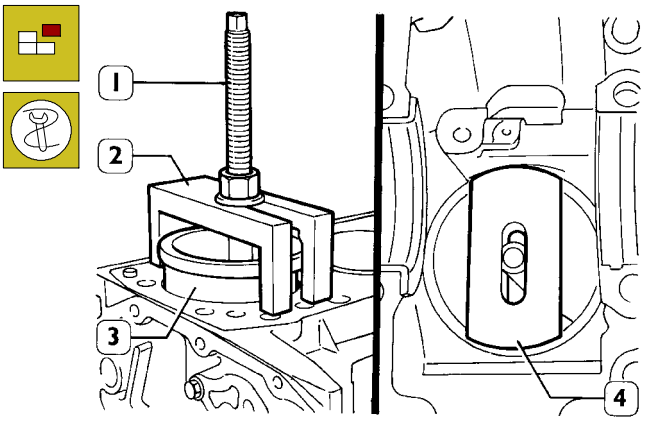
GENERAL FEATURES

			F3AE3681D	F3AE3681B	F3AE3681A
	Type				
Q	Compression ratio		16.5 : 1		
 	Max. output	kW (HP) rpm	310 (420) 2100	310 (420) 2100	332 (450) 2100
 	Max. torque	Nm (kgm) rpm	1900 (194) 1050 ÷ 1550	1900 (194) 1200 ÷ 1550	2100 (214) 1050 ÷ 1550
	Loadless engine idling	rpm	550 ± 50		
	Loadless engine peak	rpm	2420 ± 50		
	Bore x stroke Displacement	mm cm^3	125x140 10300		
	SUPERCHARGING Turbocharger type		HOLSET HE531V with variable geometry		
	LUBRICATION Oil pressure (warm engine) (100 °C ± 5 °C) - idling - peak rpm	 bar bar	Forced by gear pump, relief valve single action oil filter 1.5 5		
	COOLING		By centrifugal pump, regulating thermostat, viscostatic fan, radiator and heat exchanger		
	Water pump control		By belt		
	Thermostat: starts to open: fully open:		N. 1 ~84 °C ± 2 °C 94 °C ± 2 °C		
 **Urania FE 5W30** **Urania LD 5** **Urania Turbo LD**	OIL FILLING Total capacity at 1st filling Capacity: - engine sump min level - engine sump max level - quantity in circulation that does not flow back to the engine sump - quantity contained in the cartridge filter (which has to be added to the cartridge filter refill)	 liters kg liters kg liters kg liters kg liters kg	 32 28.8 17 15.3 25 22.5 7 6.3 2.5 2.3		

DTC	Failing component	Visible failures	Possible causes	Repair actions	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1E6	SENSOR POWER SUPPLY 1	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E7	SENSOR POWER SUPPLY 2	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E8	SENSOR POWER SUPPLY 3	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1E9	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1EA	ECU OVERRUN MONITORING ERROR	No effect perceived by the driver.	Excessive/insufficient battery voltage or possible internal control unit problem.	Check battery voltage or connections with the ECM. Replace the control unit if necessary.				
1EB	ATMOSPHERIC PRESSURE SENSOR	No effect perceived by the driver. Environmental pressure recovery value: 700 mbar.	Fault in sensor inside control unit.	Change ECU.				

Removing cylinder liners

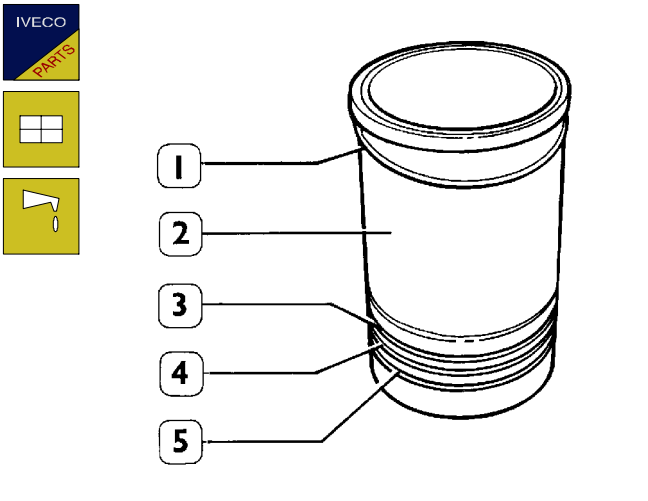
Figure 8



Place details 99360706 (2) and plate 99360726 (4) as shown in the figure, by making sure that the plate (4) is properly placed on the cylinder liners.
Tighten the screw nut (1) and remove the cylinder liner (3) from the block.

Fitting and checking protrusion

Figure 9

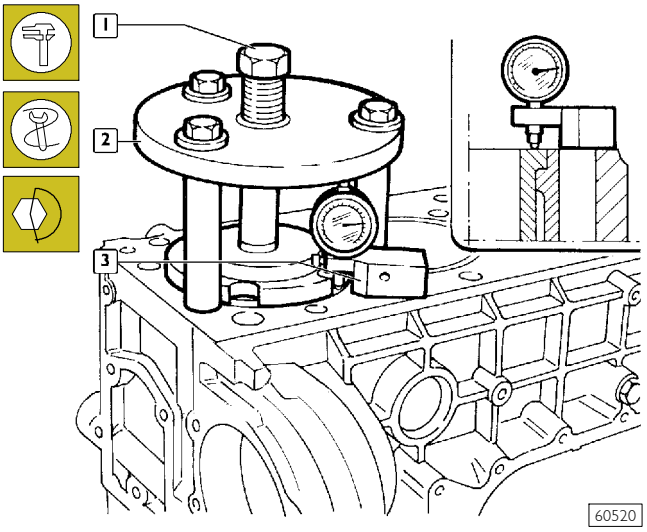


Always replace water sealing rings (3, 4 and 5).
Install the adjustment ring (1) on the cylinder liner (2); lubricate lower part of liner and install it in the cylinder unit using the proper tool.

NOTE

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

Figure 10 (Demonstration)



Check the protrusion of the cylinder liners, using tool 99360334 (2) and tightening screw (1) to 225 Nm torque.
Using a dial gauge (3), measure the cylinder liner protrusion, from the cylinder head supporting surface, it must be 0.045 to 0.075 (Figure 11); otherwise, replace the adjustment ring (1, Figure 9) supplied as spare parts having different thicknesses.

Figure 11

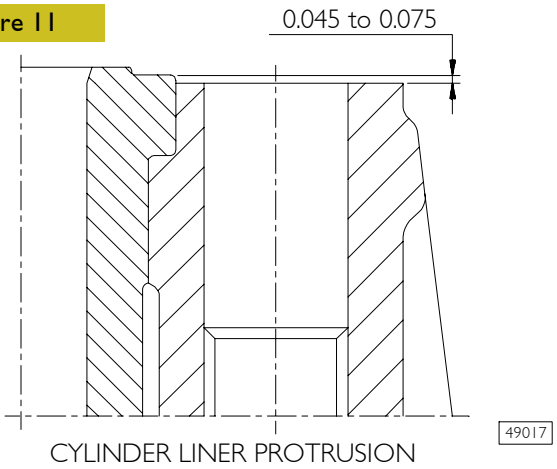
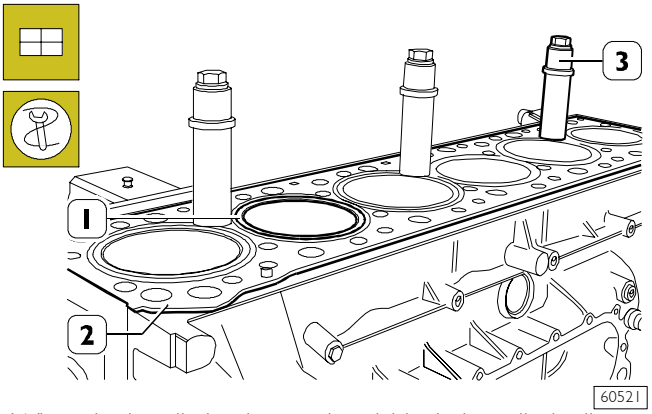
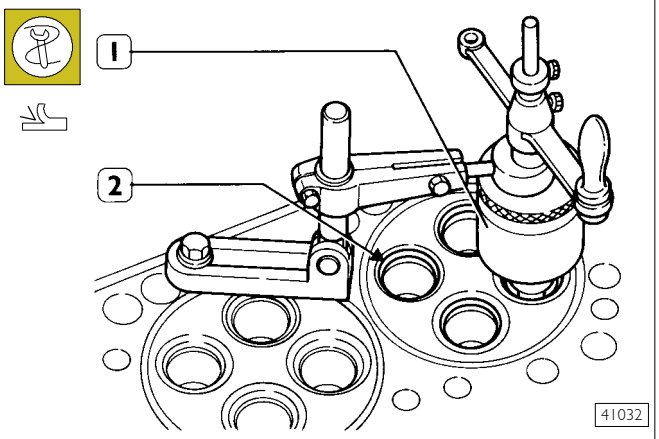


Figure 12 (Demonstration)



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

Figure 66 (Demonstration)



Check the valve seats (2). If you find any slight scoring or burns, regrind them with tool 99305019 (1) according to the angles shown in Figure 64 and Figure 65. If it is necessary to replace them, using the same tool and taking care not to affect the cylinder head, remove as much material as possible from the valve seats so that, with a punch, it is possible to extract them from the cylinder head.
Heat the cylinder head to 80 – 100°C and, using a drift, fit in the new valve seats (2), chilled beforehand in liquid nitrogen.
Using tool 99305019 (1), regrind the valve seats according to the angles shown in Figure 65.
After regrinding the valve seats, using tool 99370415 and dial gauge 99395603, check that the position of the valves in relation to the plane of the cylinder head is:
- -0.65 to -0.95 mm (recessing) intake valves;
- -1.8 to -2.1 mm (recessing) exhaust valves.

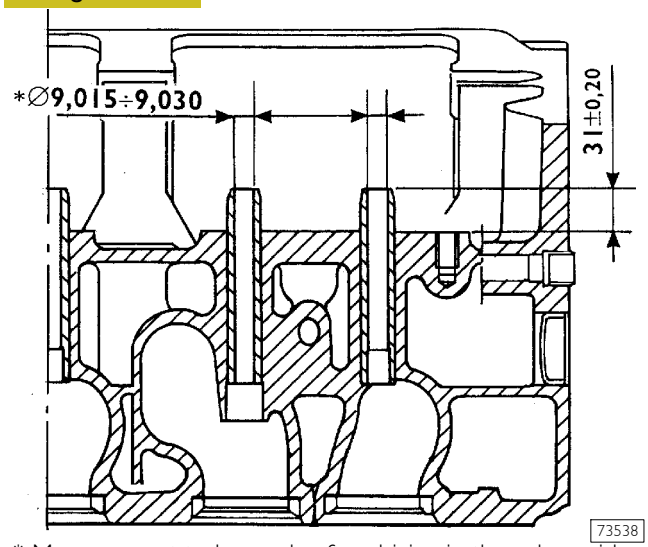
Checking clearance between valve-stem and associated valve guide

Using a dial gauge with a magnetic base, check the clearance between the valve stem and the associated guide. If the clearance is too great, change the valve and, if necessary, the valve guide.

Valve guides

Replacing valve guides

Figure 67



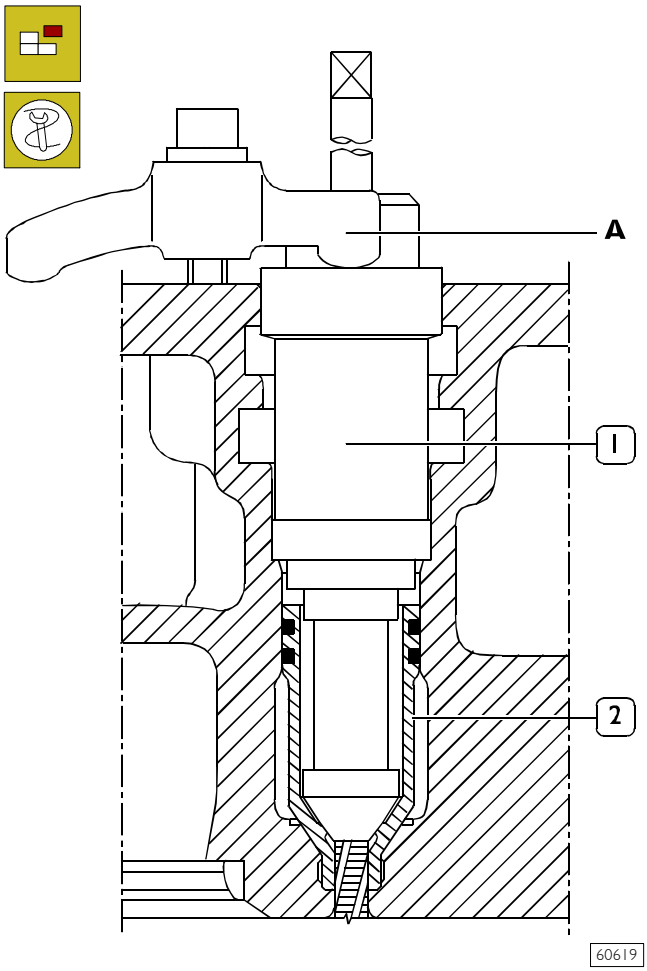
* Measurement to be made after driving in the valve guides

The valve guides are removed with the drift 99360481.
They are fitted with the drift 99360481 equipped with part 99360295.
Part 99360295 determines the exact position of assembly of the valve guides in the cylinder head. If they are not available, you need to drive the valve guides into the cylinder head so they protrude by 30.8-31.2 mm.
After driving in the valve guides, rebore their holes with the smoother 99390311.

Replacing injector cases

Removal

Figure 68



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

❑ Thread the case (2) with tool 99390804 (1).

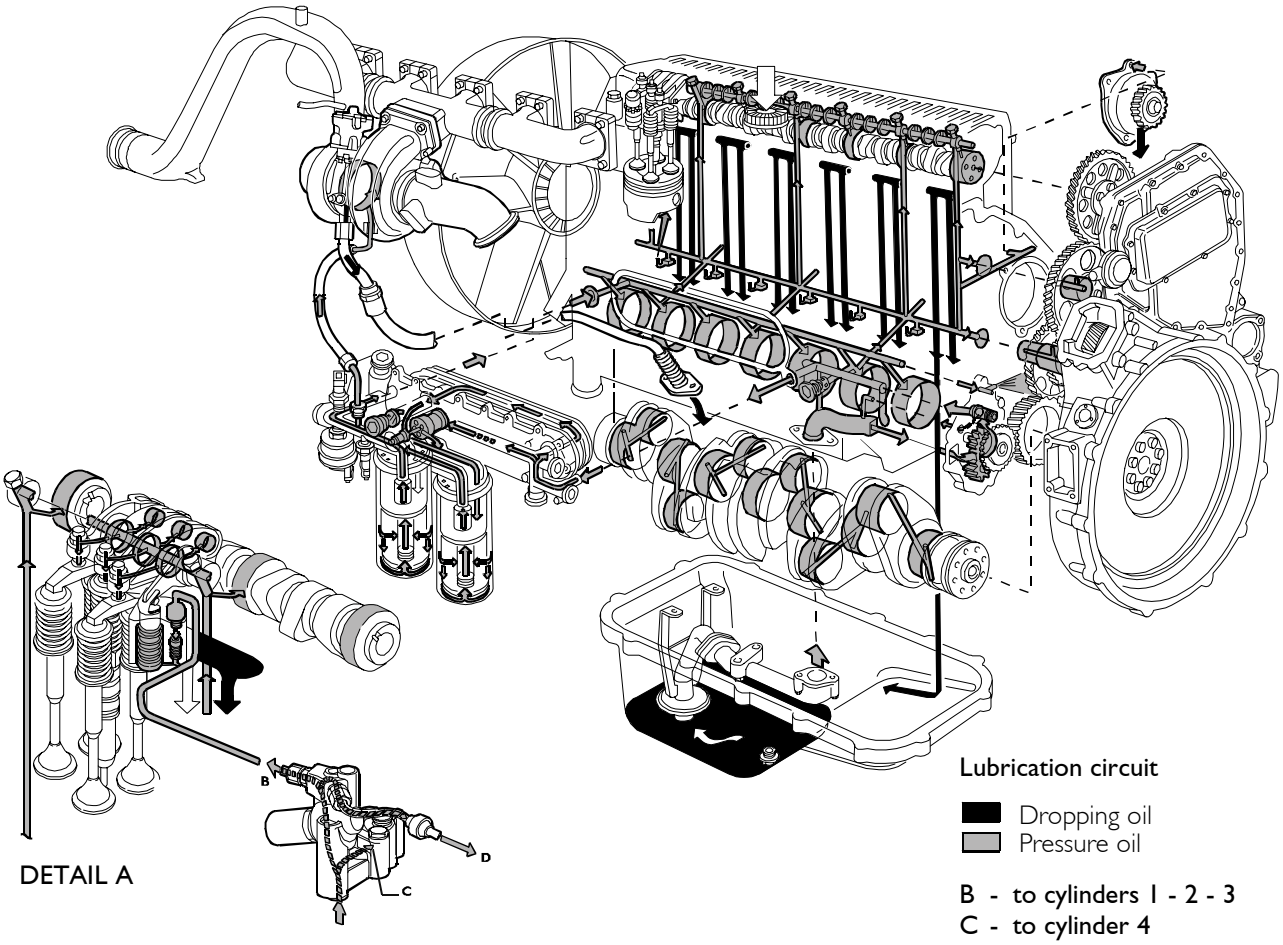
The steps described in Figs. 68 – 71 – 72 – 73 need to be carried out by fixing the tools, with the bracket A, to the cylinder head.

LUBRICATION

Engine lubrication is obtained with a gear pump driven by the crankshaft via gears.

A heat exchanger governs the temperature of the lubricating oil. It houses two oil filters, indicator sensors and safety valves.

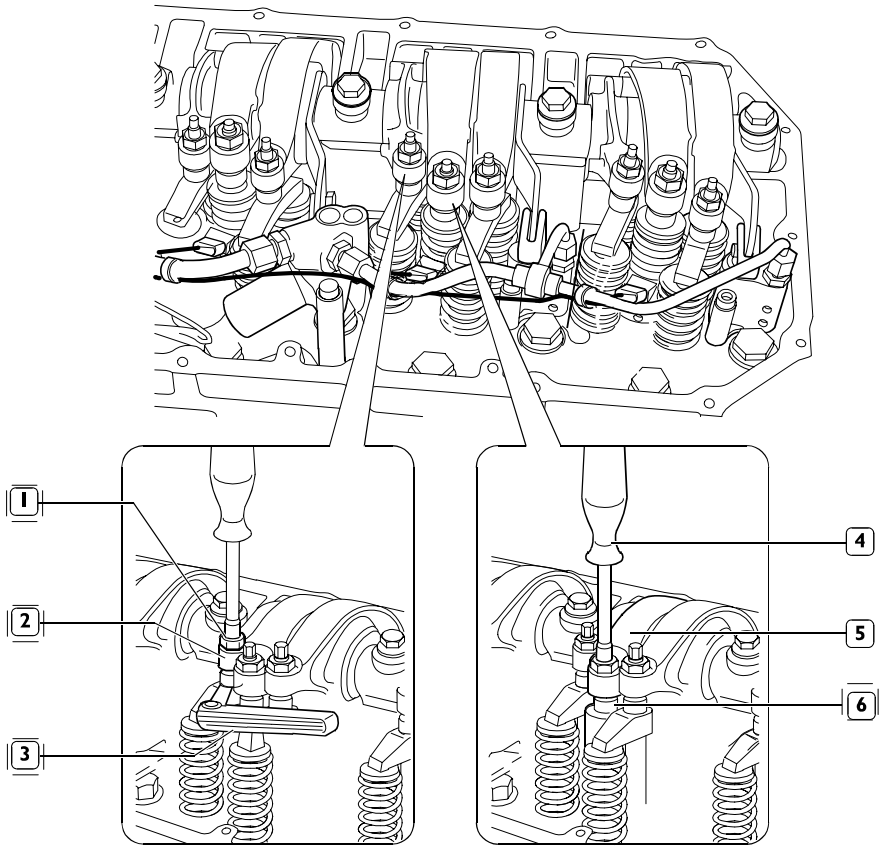
Figure 6



Exhaust brake solenoid valve with piston driving the exhaust brake of the 4th cylinder.

Intake and exhaust rocker play adjustment and pre-loading of rockers controlling pump injectors

Figure 88



ADJUSTING INTAKE/EXHAUST ROCKERS AND INJECTION

Adjustment of clearances between rockers and valve studs and preloading of pump injector rockers should be carried out with extreme care.
Bring the cylinder under examination to the firing stage, the valves of this cylinder remain closed while the valves of the other cylinder in the pair can be adjusted.
The cylinder pairs are 1-6,2-5,3-4.
Strictly adhere to directions and data given on the table below.

Adjusting clearances between rockers and intake/exhaust/valve studs:

- ❑ Use a box wrench to loosen the adjusting screw locking nut (1).
- ❑ Insert the feeler gauge blade (3).
- ❑ By using proper wrench, screw or unscrew rocker arm adjusting screw (2);
- ❑ Ensure the feeler gauge blade (3) can slide between the parts concerned with a slight friction.
- ❑ Hold the screw still while tightening the nut (1).

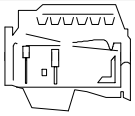
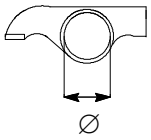
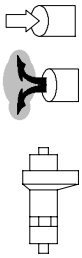
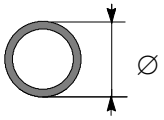
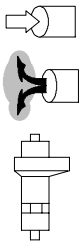
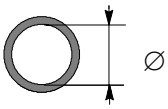
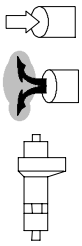
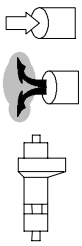
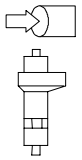
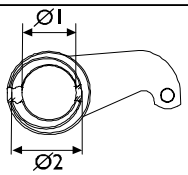
Setting pump-injector rocker preloading:

- ❑ Use a box wrench to loosen the nut fastening the adjusting screw for rocker arm (5) controlling pump-injector (6).
- ❑ With a suitable wrench (4) tighten the adjusting screw until the pumping element reaches its-end-of-stroke point.
- ❑ Lock the adjusting screw to a torque of 5 Nm (0.5 kgm) by means of a torque wrench.
- ❑ Back off the adjusting screw 1/2 to 3/4 turn.
- ❑ Tighten the lock nut.

FIRING ORDER **1-4-2-6-3-5**

Clockwise start-up and rotation	Adjusting cylinder valve no.	Adjusting clearance of cylinder valve no.	Adjusting pre-loading of cylinder injector no.
1 and 6 at TDC	6	1	5
120°	3	4	1
120°	5	2	4
120°	1	6	2
120°	4	3	6
120°	2	5	3

NOTE In order to properly carry out the above-mentioned adjustments, follow the sequence specified in the table, checking the exact position in each rotation phase by means of pin 99360612, to be inserted in the 11th hole in each of the three sectors with 18 holes each.

	Type	F3BE3681
		mm
	Seats for bushings in rocker arms: 	45.000 to 45.016 59.000 to 59.019 46.000 to 46.016
	Outside diameter of bushings for rocker arms: 	45.090 to 45.130 59.100 to 59.140 46.066 to 46.091
	Inside diameter of bushings for rocker arms: 	42.025 to 42.041 56.030 to 56.049 42.015 to 42.071
	Bushings and seats: 	0.074 to 0.130 0.081 to 0.140 0.050 to 0.091
	Rocker arm bushings and shaft: 	0.025 to 0.057 0.015 to 0.087
	Engine brake control lever Eccentric pin outer diameter Ø1 Rocker arms shaft seat Ø2	55.981 to 56.000 42.025 to 42.041