Marine Diesel Engine

VF4
VF5

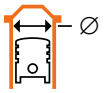
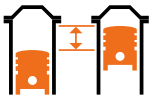
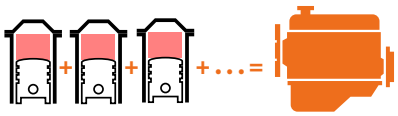
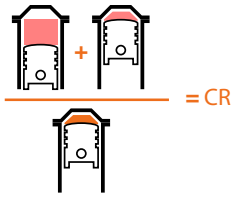
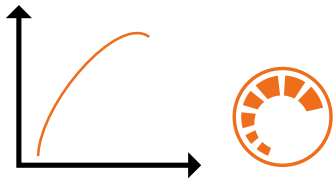
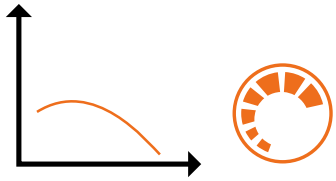
Service Manual

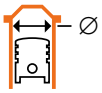
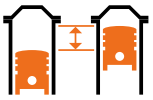
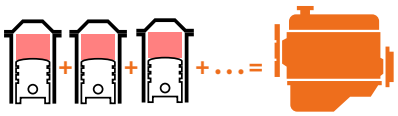
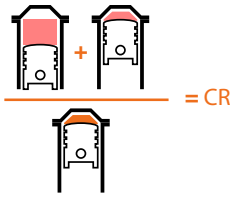
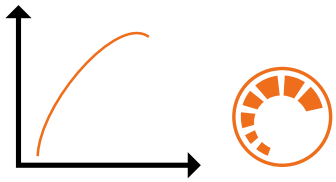
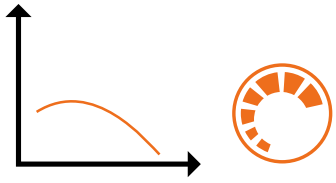
VF4.140E
VF4.170E
VF5.220E
VF5.250E

The information contained in this manual is not binding and providing the basic specification of the model described herein is not affected VETUS reserve the right to introduce any changes in their products without obligation immediately to update this publication .

Contents

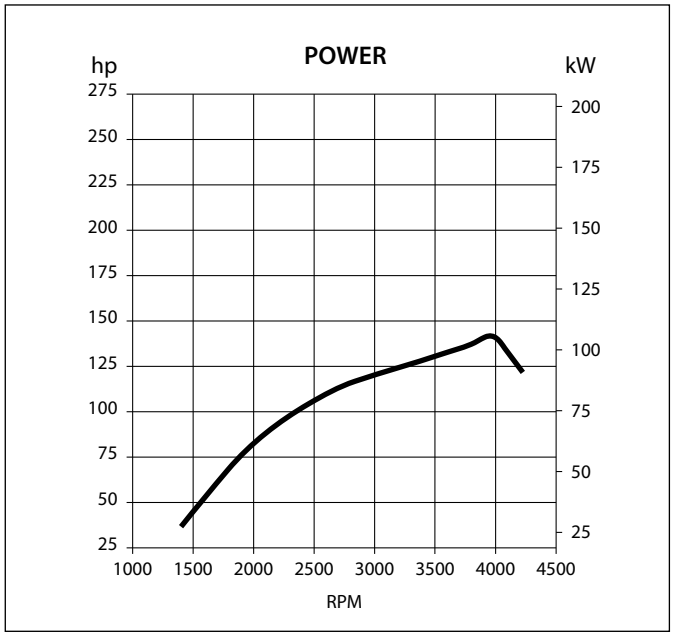
1 Specifications

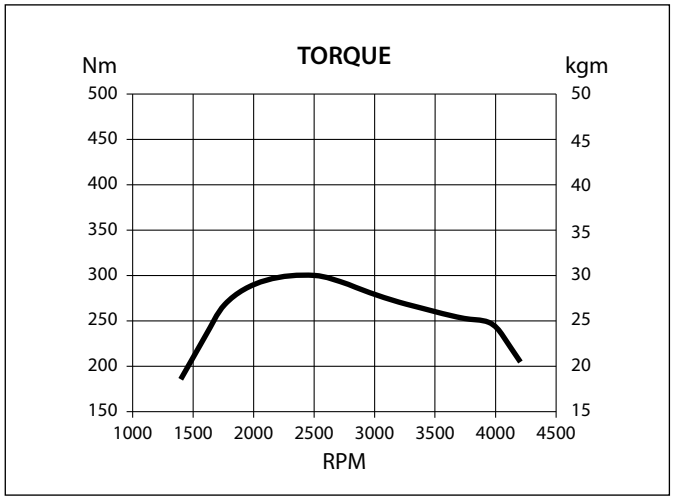
			VF4.140E	VF4.170E
	Cycle		Diesel 4 stroke	
	Valve gear		With 2 camshaft on the cylinder head	
	Fuel system		Direct injection common rail	
	Number of cylinder		4 in line	4 in line
	Bore	mm	82	82
	Stroke	mm	90.4	90.4
	Total displacement	cm^3	1910	1910
	Compression ratio		18 : 1	18 : 1
	Maximum output CEE	kW (CEE)	103	125
		hp (CEE)	140	170
		1/min	4000	4000
	Maximum torque CEE	Nm (CEE)	301	345
		kgm (CEE)	30.1	34.5
		1/min	2400	2400

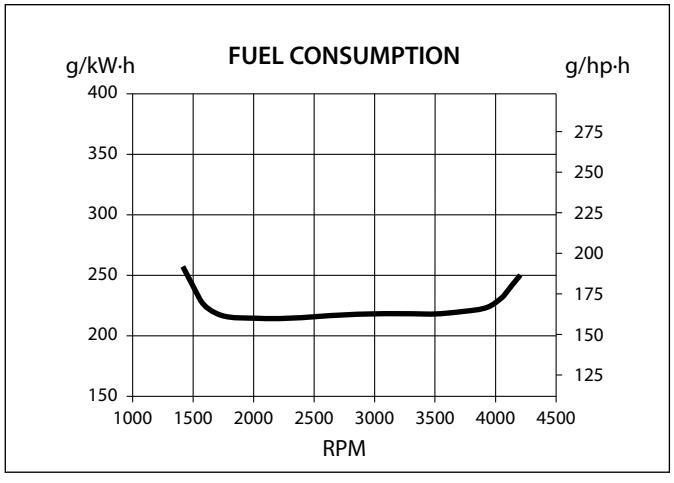
			VF5.220E	VF5.250E
	Cycle		Diesel 4 stroke	
	Valve gear		With 2 camshaft on the cylinder head	
	Fuel system		Direct injection common rail	
	Number of cylinder		5 in line	5 in line
	Bore	mm	82	82
	Stroke	mm	90.4	90.4
	Total displacement	cm^3	2387	2387
	Compression ratio		18 : 1	18 : 1
	Maximum output CEE	kW (CEE)	162	184
		hp (CEE)	220	250
		1/min	4200	4200
	Maximum torque CEE	Nm (CEE)	401	454
		kgm (CEE)	40.1	45.4
		1/min	2400	2600

2 Performance curves

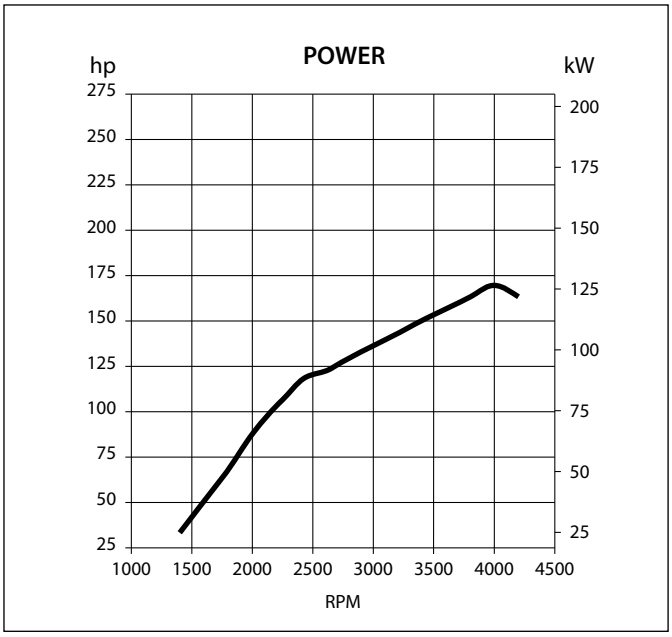
VF4.140E

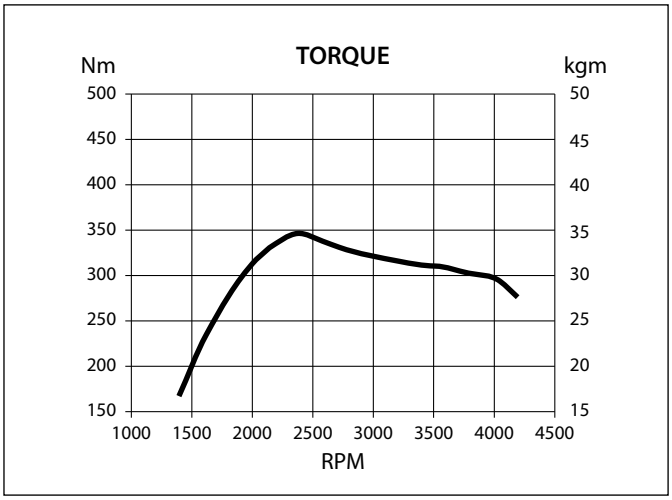


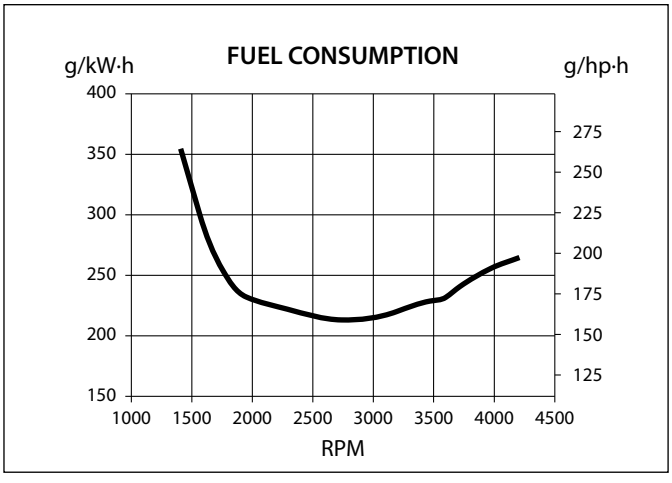




VF4.170E

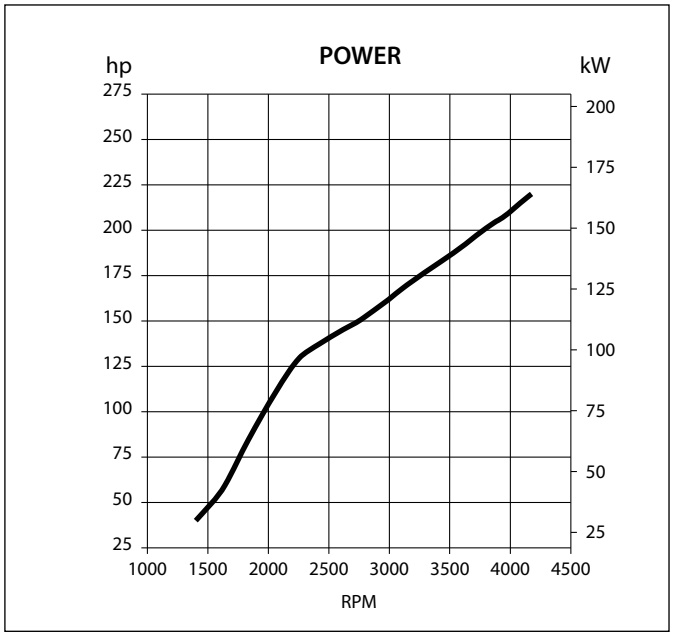


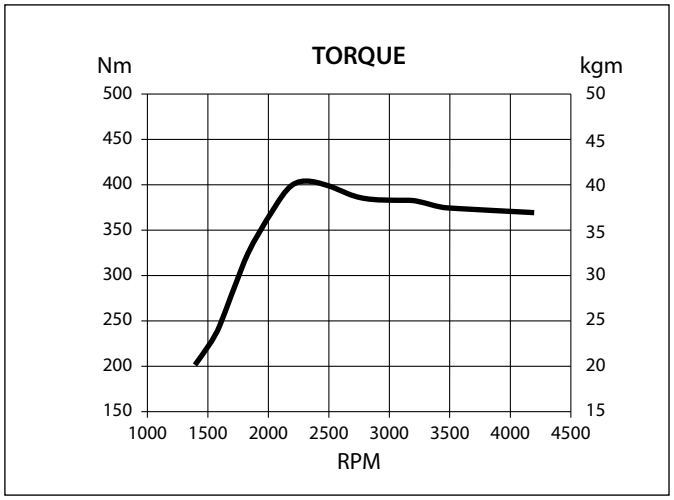


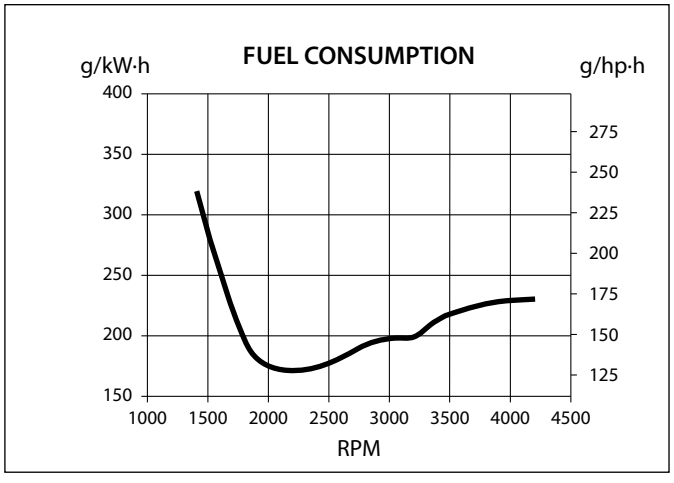


Performance curves according to ISO 8178.

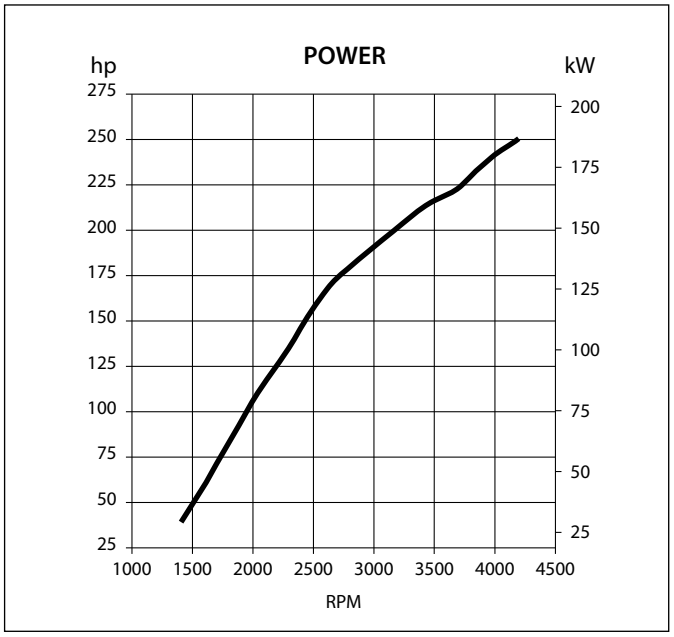
VF5.220E

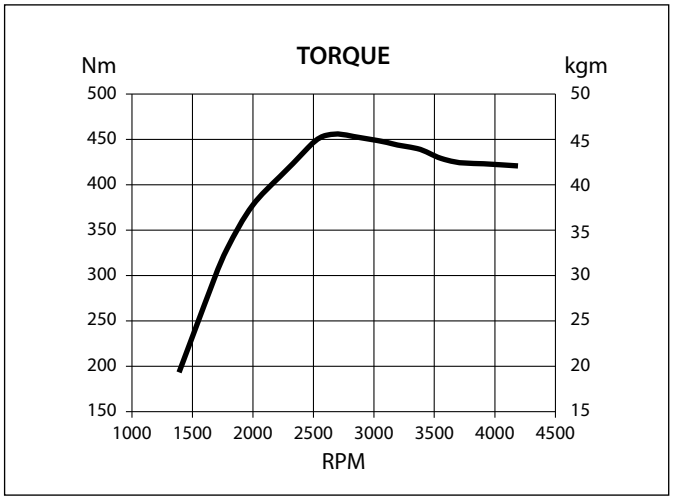


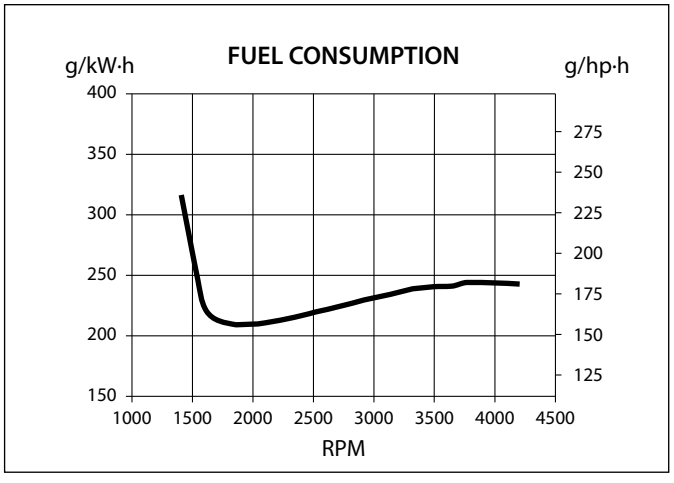




VF5.250E



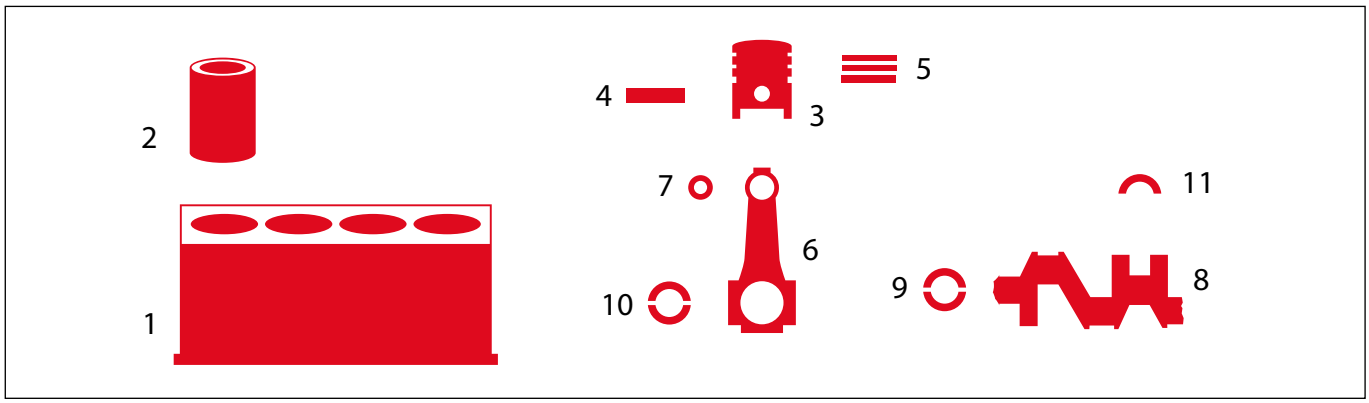


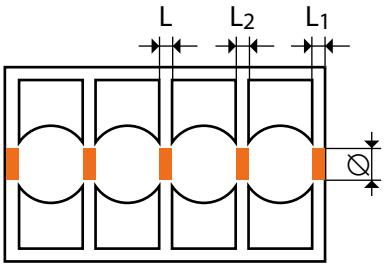
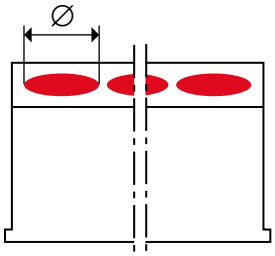
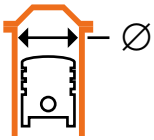
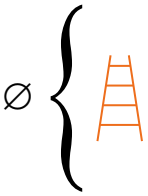


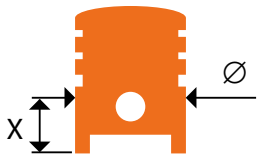
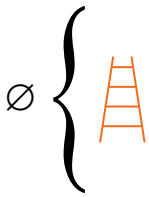
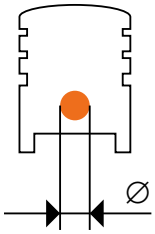
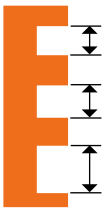
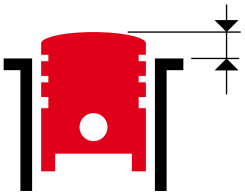
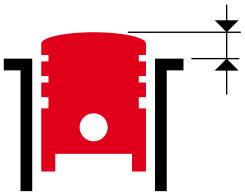
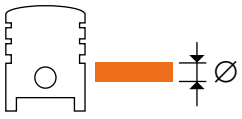
Performance curves according to ISO 8178.

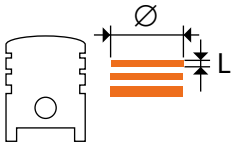
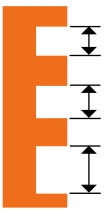
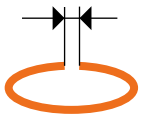
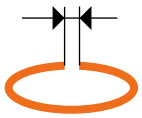
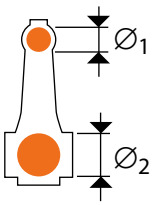
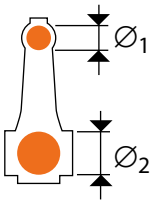
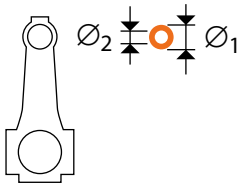
3 Values and fits

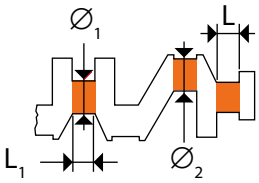
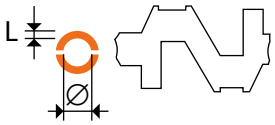
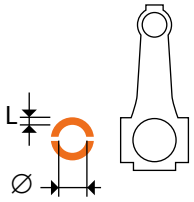
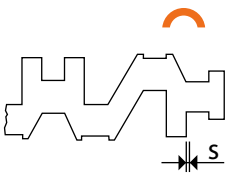
3.1 Crankcase



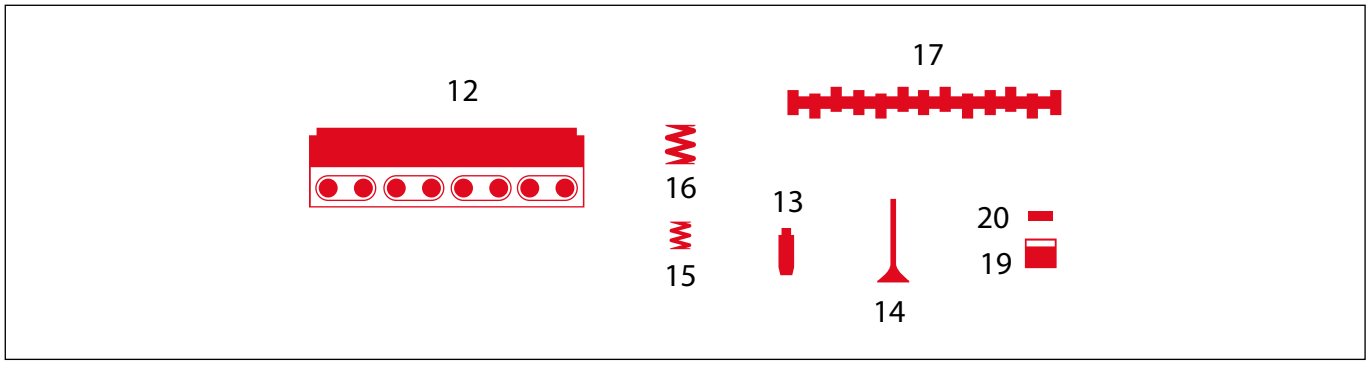
Crankcase					Values [mm]
1			Main bearing housing	**L**	21.720 ÷ 21.800
				L1	-
				L2	-
				Ø	63.705 ÷ 63.718
			Cylinder liner seat	**Ø**	-
		Cylinder liner		**A**	82.000 ÷ 82.010
				B	82.010 ÷ 82.020
				C	82.020 ÷ 82.030
2		Cylinder liner		**Ø1**	-
				Ø2	-
					-
2 - 1		Cylinder liner - Crankcase			-

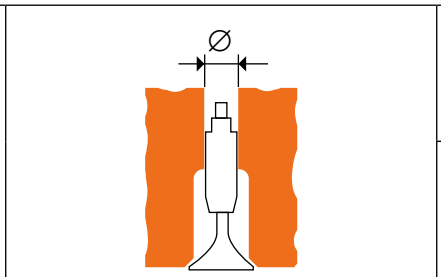
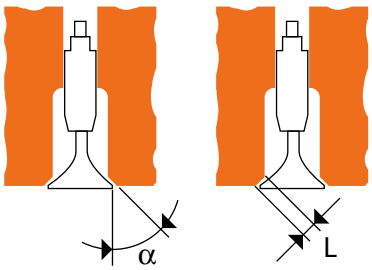
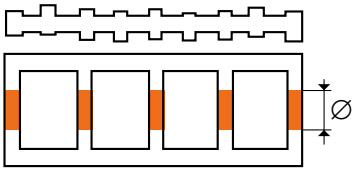
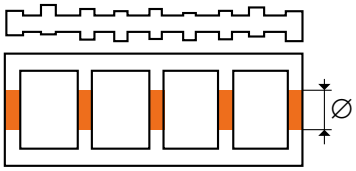
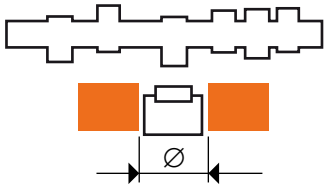
Crankcase					Values [mm]
3		Piston		X	8
				A	81.920 ÷ 81.930
				B	81.930 ÷ 81.940
				C	81.940 ÷ 81.950
					0.4
		Piston pin bore dia		Ø	26.006 ÷ 26.014
		Ring groove width		1	2.080 ÷ 2.100
				2	2.020 ÷ 2.040
				3	2.020 ÷ 2.040
		Piston weight difference			± 5 gr
3 - 1		Piston protrusion - Crankcase			0.014 ÷ 0.294
3 - 2		Piston protrusion - Liner			-
3 - 1		Piston – Cylinder liner			0.070 ÷ 0.090
3 - 2		Piston – Cylinder liner			-
4		Piston pin		Ø	25.982 ÷ 25.987
					0.4
4 - 3		Piston pin - Seat pin			0.012 ÷ 0.022

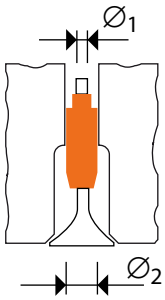
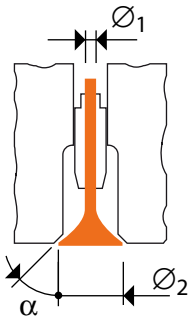
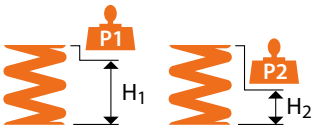
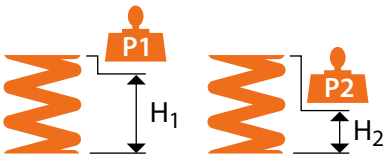
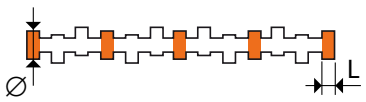
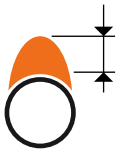
Crankcase					Values [mm]
5		Piston ring		1	1.970 ÷ 1.995
				2	1.970 ÷ 1.995
				3	1.970 ÷ 1.990
					0.4
5 - 3		Piston ring - Ring clearance in piston		1	0.105 ÷ 0.150
				2	0.050 ÷ 0.090
				3	0.030 ÷ 0.070
5 - 1		Piston ring gap		1	0.20÷ 0.35
				2	0.60 ÷ 0.80
				3	0.25 ÷ 0.50
5 - 2		Piston ring gap		1	-
				2	-
				3	-
6		Small end bore diameter		Ø1	-
		Big end bore diameter	$\varnothing_2$	1	-
				2	-
				3	-
		Connecting rod weight difference			± 2.5 g
6		Small end bush I.D.		Ø1	26.006÷ 26.014
		Big end I.D.		Ø2	53.897 ÷ 53.909
		Connecting rod weight difference			± 2.5 g
7		Small end bush		Ø1	29.018 ÷ 29.038
					25.279 ÷ 25.512

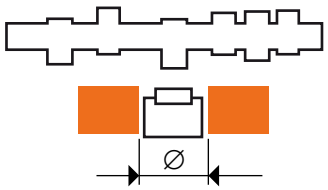
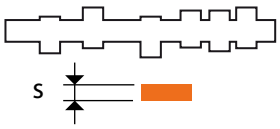
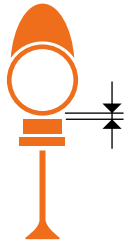
Crankcase					Values [mm]
4 - 7		Piston pin - Small end bush			0.018 ÷ 0.030
7 - 6		Small end bush - Bush seat			0.046 ÷ 0.099
8		Main journal	∅1	**1**	59.994 ÷ 60.000
				2	59.988 ÷ 59.994
				3	59.982 ÷ 59.988
		Crankpin		**A**	50.799 ÷ 50.805
				B	50.793 ÷ 50.799
				C	50.787 ÷ 50.793
				L	-
				L1	26.829 ÷ 26.879
9		Main bearing		**1**	1.831 ÷ 1.837
				2	1.836 ÷ 1.844
				3	1.843 ÷ 1.849
					0.127
9 - 8		Main bearing - Journal			0.031 ÷ 0.051
10		Connecting rod bearing	L	**A**	1.527 ÷ 1.531
				B	1.530 ÷ 1.534
				C	1.533 ÷ 1.537
					0.127
10 - 8		Connecting rod bearing - Pin			0.030 ÷ 0.056
11		Thrust washer		**S**	2.469 ÷ 2.485
					0.127
11 - 8		Thrust crankshaft			0.059 ÷ 0.221

3.2 Cylinder head and valve gear

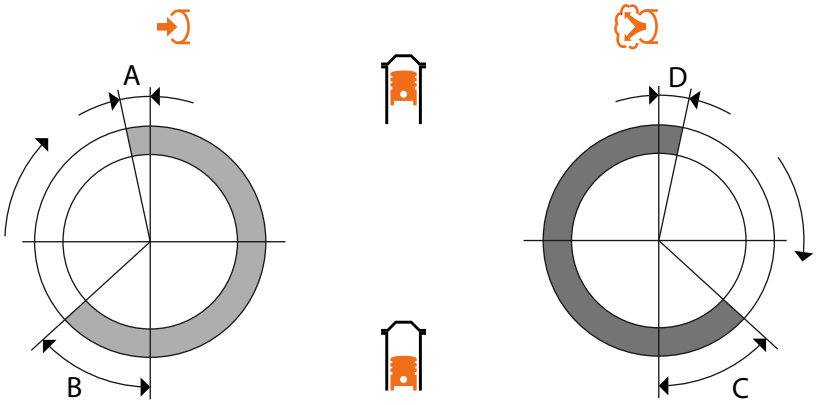


Cylinder head and valve gear					Values [mm]
12		Intake valve guide housing		Ø	29.600 ÷ 29.611
		Exhaust valve guide housing		Ø	27.600 ÷ 27.611
		Valve housing	α		45° ±1′
					45° ± 1′
				L	Circa 2.7
		Camshaft support end exhaust dia. **VF4**		I	43.646 ÷ 43.671
				II	43.446 ÷ 43.471
				III	43.246 ÷ 43.271
				IV	43.046 ÷ 43.071
				V	30.045 ÷ 30.070
		Camshaft support end exhaust dia. **VF5**		I	43.846 ÷ 43.871
				II	43.646 ÷ 43.671
				III	43.446 ÷ 43.471
				IV	43.246 ÷ 43.271
				V	43.046 ÷ 43.071
				VI	30.045 ÷ 30.070
		Tappet housing bore dia.		Ø	37.010 ÷ 37.030

Cylinder head and valve gear						Values [mm]
13		Valve guide	**Ø1**			8.022 ÷ 8.040
						14.010 ÷ 14.030
						14.010 ÷ 14.030
						0.05 - 0.10 - 0.25
13 - 12		Valve guide				0.033 ÷ 0.080
		Seat in cylinder head				0.033 ÷ 0.080
14		Valve			**Ø1**	5.982 ÷ 6.000
					Ø2	27.40 ÷ 27.60
					α	45° 30′ ± 5′
					**Ø1**	5.972 ÷ 5.990
					Ø2	25.40 ÷ 25.60
					α	45° 30′ ± 5′
14 - 13		Valve – Valve guide				0.030 ÷ 0.066
15		Internal valve spring			**P1** daN	-
					H1	-
					P2 daN	-
					H2	-
16		External valve spring			**P1** daN	20.47 ÷ 21.84
					H1	34.0
					P2 daN	44.81 ÷ 47.59
					H2	24.5
17		Journal camshaft and exhaust			**Ø**	26.000 ÷ 26.015
					L	19.250 ÷ 19.330
		Cam lift intake / exhaust				8
						8

Cylinder head and valve gear					Values [mm]
17 - 12		Journal camshaft - Seat in cylinder head **VF4**		**I**	43.600 ÷ 43.615
				II	43.400 ÷ 43.415
				III	43.200 ÷ 43.215
				IV	43.000 ÷ 43.015
				V	30.000 ÷ 30.015
		Journal camshaft - Seat in cylinder head **VF5**		**I**	43.800 ÷ 43.815
				II	43.600 ÷ 43.615
				III	43.400 ÷ 43.415
				IV	43.200 ÷ 43.215
				V	43.000 ÷ 43.015
				VI	30.000 ÷ 30.015
17-12		Journal camshaft - Cylinder head support		**radial**	0.030 ÷ 0.070
				axial	0.100 ÷ 0.230
19		Tappet		**Ø**	36.975 ÷ 36.991
19 - 12		Tappet - Cylinder head			0.019 ÷ 0.065
20		Shim	**S** 		3.25 ÷ 4.90
17 - 20		For timing check			0.50
					0.50
		Normal cold			0.30 ± 0.05
					0.35 ± 0.05

3.3 Valve timing diagram



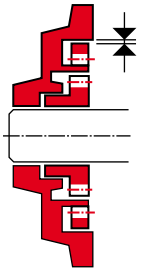
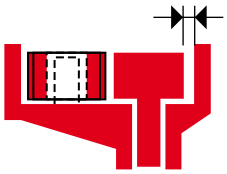
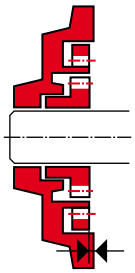
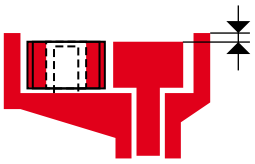
A	Intake	Opens B.T.D.T.	10°
B		Closes A.B.D.C.	18.5°
C	Exhaust	Opens B.B.D.C.	40°
D		Closes A.T.D.C.	9°

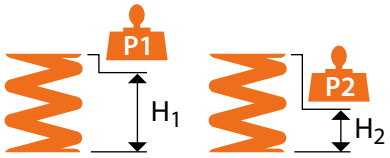
3.4 Cylinder head gasket

Fit the cylinder head, the gasket should have the thickness indicated below in order to maintain compression ratio within the prescribed limits:

Piston protrusion (mm)	Gasket thickness (mm)	Identification notches
-0.020 ÷ +0.100	0.82 ± 0.05	0
+0.101 ÷ +0.200	0.92 ± 0.05	1
+0.201 ÷ +0.295	1.02 ± 0.05	2

3.5 Lubrication

Lubrication		Values [mm]
Lubrication circuit engine		with forced circulation, by means of pump to gears with cartridge filter in series.
Oil pump:	type	With gears, located the front cover crankshaft
Driving pump		With a chain command from the crankshaft
Oil pressure regulation valve		Incorporated in the crank-shaft front cover
Oil filter full flow		With cartridges
Insufficient oil pressure sender		Electrical
	Between the body pump and the gear	-
	Between the gears periphery and the body pump	0.110 ÷ 0.180
	Between the superior side of the gears and the pump cover	-
	Between the superior side of the gears and the cover pump	0.016 ÷ 0.086
	Between the gear and the conductor	0.30
	Operation pressure temperature of 100°C	@ minimal rpm: > 1 bar @ 4000 / min: > 4 ÷ 4.5 bar @ maximum rpm: -

Lubrication			Values [mm]
	Valve spring oil pressure regulation	**P1** daN	12.19 ÷ 13.00
		H1	35
		P2 daN	-
		H2	-

3.6 Cooling system

Cooling system		
Cooling system circuit		To circulation of coolant by means of pump command from thermostatic switch.
Command coolant pump		By means of timing belt
Engine coolant thermostat	Opening temperature	74° ÷ 83°C
	Fully open at	101° ÷ 105°C
	Valve stroke	12 mm
Pressure for held control system		1.08 bar
Exhaust valve control on the cap of the additional expansion tank		1.08 bar

3.7 Fuel system

Fuel system	VF4	VF5
Firing order	1 - 3 - 4 - 2	1 - 2 - 4 - 5 - 3
Distributor type injection pump	Bosch EDC 16 C39	
Calibration pressure injectors	1800 bar	
Rpm minimal engine	800 ± 20 1/min	
Rpm maximal engine to empty	5000 ± 20 1/min	

3.8 Supercharging

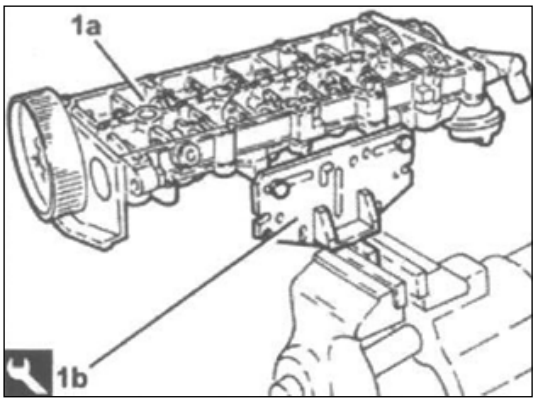
Supercharging (Gas exhaust turbocharger)	VF4	VF5
Turbocharger to variable geometry	Garret GT 17 59V	Garret GT 22 56 V
Pressure of the maximum supercharging to 2400/min	1.05 bar	

4 Repair data

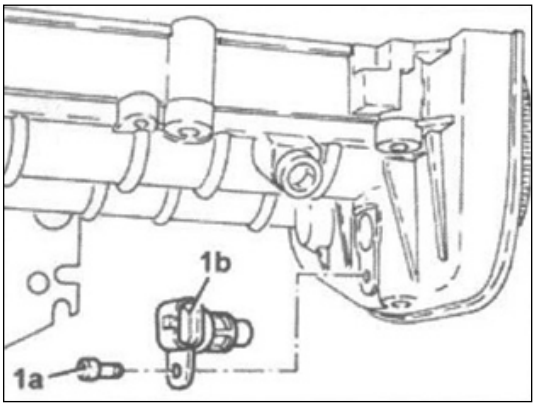
4.1 Cylinder head

4.1.1 Camshaft housing

Position the camshaft housing (1 a) in a vice using the tool (1b)

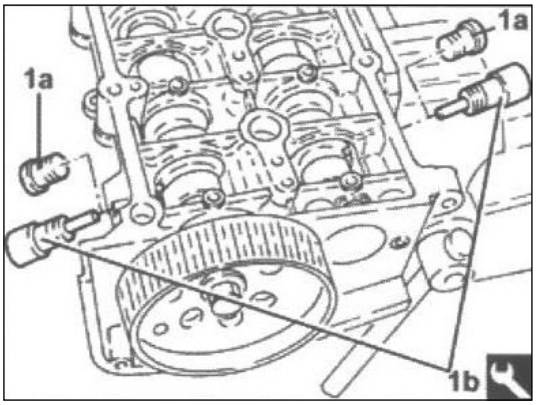


Undo the bolt (1 a) and remove the cam angle sensor (1b).

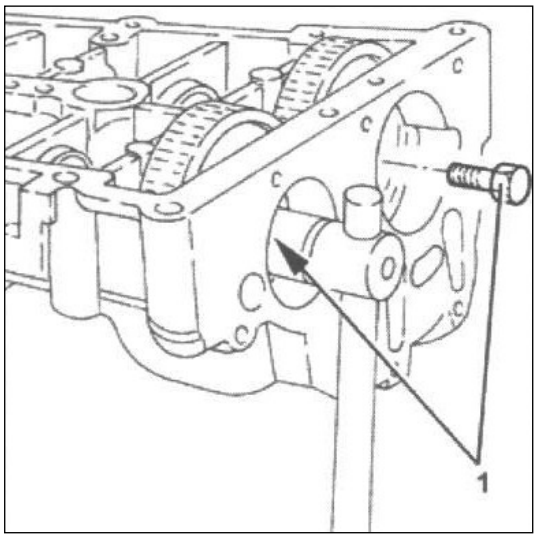


Remove plugs (1 a) and fit camshaft timing tools (1b) on the camshaft housing.

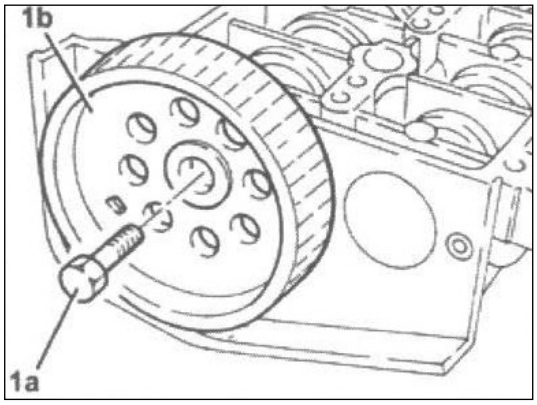
☛ Check that the tools are correctly fitted in the housings in the camshaft.



Undo the bolts fixing the camshaft gears (1)

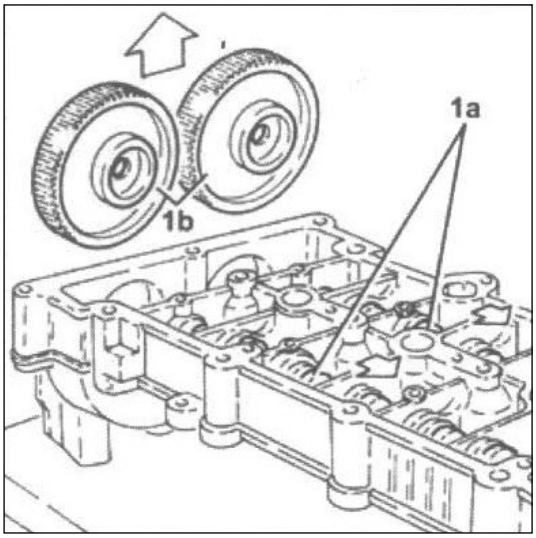


Undo the bolt (1 a) and remove the exhaust side camshaft toothed drive pulley (1b).



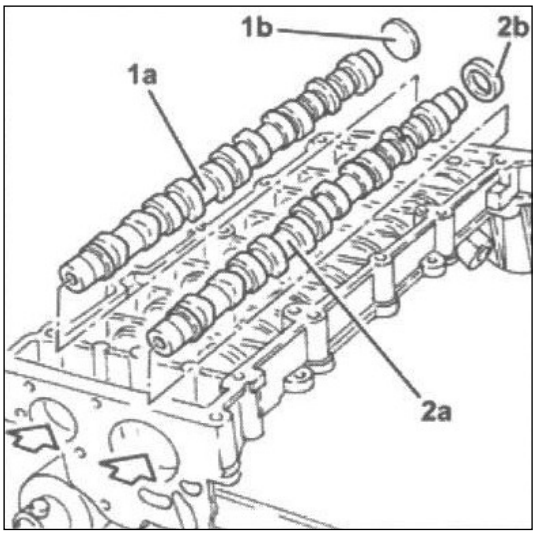
Remove the camshaft timing tools from the cylinder head extension.

Withdraw the camshaft (1 a), as far as necessary and remove the camshaft gears (1b)

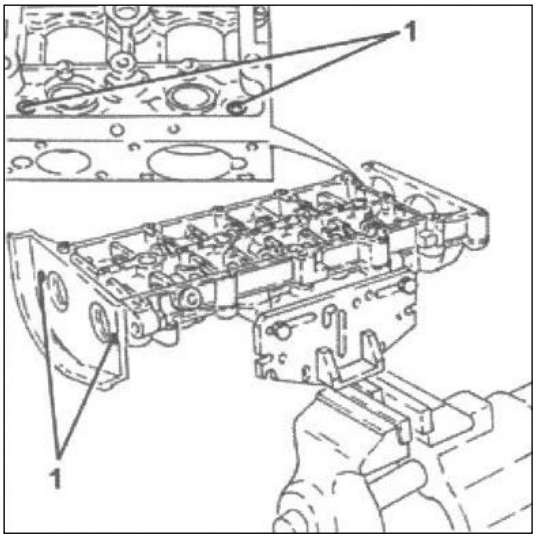


Using a suitable drift, extract the inlet side camshaft (1 a) and plug (1b).

Using suitable drift, extract the exhaust side camshaft (2 a) and oil seal (2b).

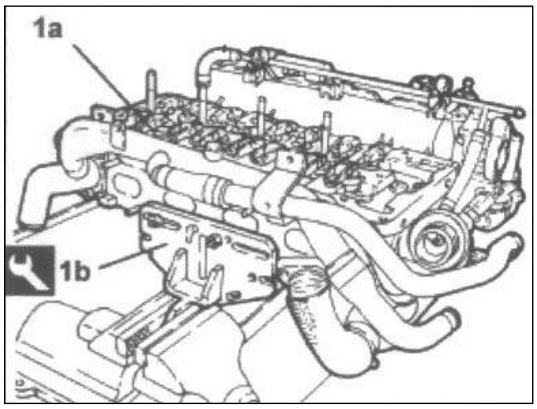


Undo and remove the engine oil lubrication duct plugs (1).



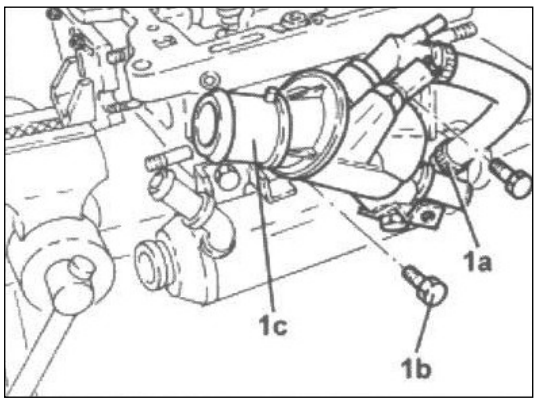
4.1.2 Lower cylinder head

Position the cylinder head (1 a) in a vice using the tool (1b).



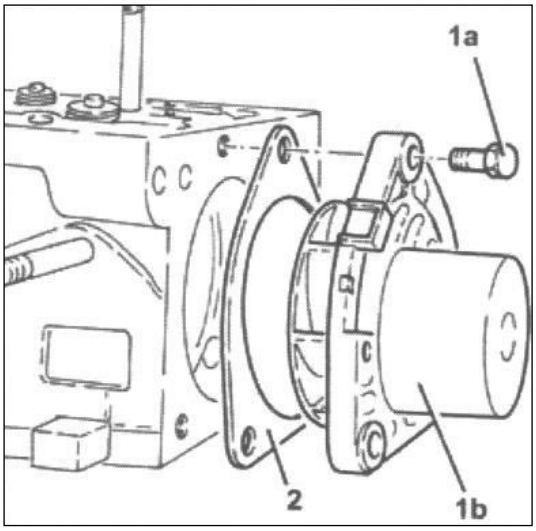
Remove the hydraulic tappets.

Loosen the band (1 a), undo the bolts (1b) and remove the thermostat (1c) complete with O-ring.

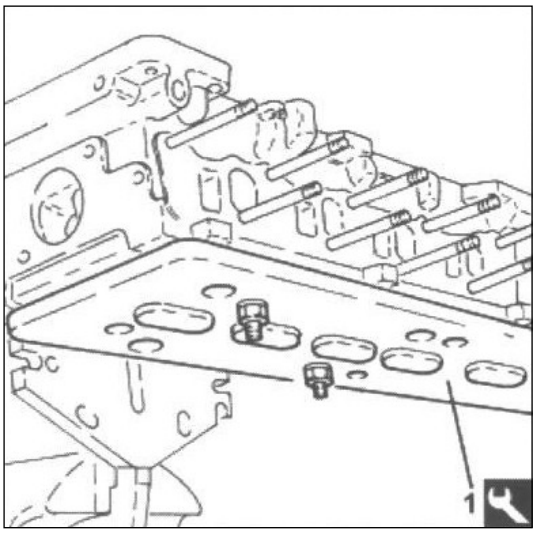


Undo the bolts (1 a) and remove the water pump (1b).

Remove the gasket.



Fit a wooden stand on the cylinder head plane to support the valves and secure it using bolts.



Fit the cotters (1 a) using the tools (1b lever) and (1c chamber)

Remove the valve upper shim.

Remove the valve spring.

Remove the shim (for exhaust valves only)

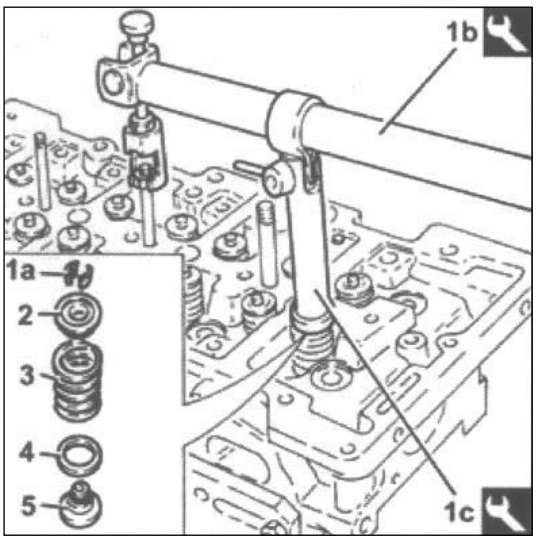
Remove the valve guide oil seal with integrated lower valve shim.

Carry out the same operations on the other valves.

Remove the wooden stand and recover the valves.

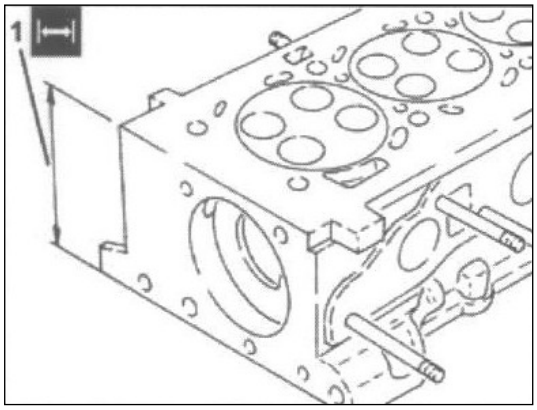
Remove the lower cylinder head from the support tool.

Replace the valve guide.



Clean any residues of the old basket from the lower cylinder head plane.

Check that the flatness of the lower cylinder head plane corresponds to the recommended.



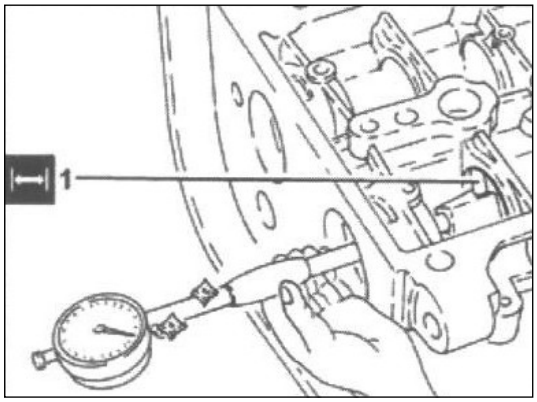
Cylinder head		
Lower surface flatness	=	0.1 ± 0,05

If the planarity of the lower cylinder head plane does not correspond to the recommended figures, regrind it without exceeding the minimum permitted height.

Cylinder head		
Lower plane minimum permitted height	=	107.0 ± 0.05

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

Check that the diameter of the valve stems corresponds to the recommended figures; if not, replace the worn valves.



Inlet valve stem diameter	=	5.982 ÷ 6.000
Exhaust valve stem diameter	=	5.972 ÷ 5.990

Check that the length of the valve springs when released is within the recommended values.

Valve spring free length	=	43.1 mm

Using a torque wrench, check that the valve spring specifications correspond to the recommended figures; if not, replace the worn components.

Length of valve springs under a load of 20.47 ÷ 21.84 daN	=	34.0 mm
Length of valve springs under a load of 44.81 ÷ 47.59 daN	=	24.5 mm

Check that the diameter of the camshaft bearings corresponds to the recommended figure; if not, replace the worn camshaft/s.

Diameter of inlet and exhaust shaft bearings VF4		
• Diameter I bearing	=	43.600 ÷ 43.615
• Diameter II bearing	=	43.400 ÷ 43.415
• Diameter III bearing	=	43.200 ÷ 43.215
• Diameter VI bearing	=	43.000 ÷ 43.015
• Diameter V bearing	=	30.000 ÷ 30.015

Diameter of inlet and exhaust shaft bearings VF5		
• Diameter I bearing	=	43.800 ÷ 43.815
• Diameter II bearing	=	43.600 ÷ 43.615
• Diameter III bearing	=	43.400 ÷ 43.415
• Diameter IV bearing	=	43.200 ÷ 43.215
• Diameter V bearing	=	43.000 ÷ 43.015
• Diameter VI bearing	=	30.000 ÷ 30.015

Check that the nominal camshaft cam lift corresponds to the recommended figures; if not, replace the worn camshaft/s.

Nominal inlet/exhaust cam lift	=	8.00 mm

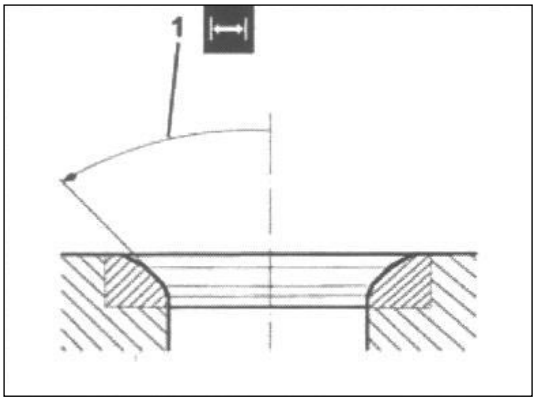
Check that the diameter of the camshaft supports corresponds to the recommended figures; if not, replace the cylinder head.

Diameter of inlet and exhaust shaft supports VF4		
• Diameter I support	=	43.646 ÷ 43.671
• Diameter II support	=	43.446 ÷ 43.471
• Diameter III support	=	43.246 ÷ 43.271
• Diameter VI support	=	43.046 ÷ 43.071
• Diameter V support	=	30.045 ÷ 30.070

Diameter of inlet and exhaust shaft supports VF5		
• Diameter I support	=	43.846 ÷ 43.871
• Diameter II support	=	43.646 ÷ 43.671
• Diameter III support	=	43.446 ÷ 43.471
• Diameter IV support	=	43.246 ÷ 43.271
• Diameter V support	=	43.046 ÷ 43.071
• Diameter VI support	=	30.045 ÷ 30.070

The outer diameter of the valve seats is as follows.

Inlet valve seat outer diameter	=	29.600 ÷ 29.611
Exhaust valve seat outer diameter	=	27.600 ÷ 27.611



Grind the valve seats to the recommended size.

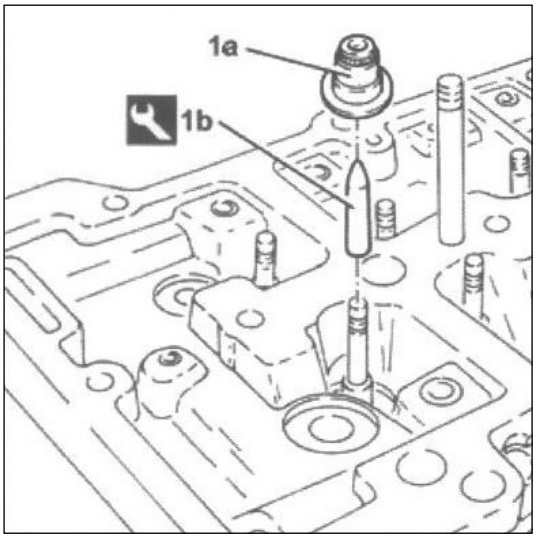
Valve seat band		
Angle in contact with valve	=	45° +/- 1’

Grind the valve seats using a suitable tool.

Position the lower cylinder head in the vice using the tool (support).

Fit the valves in the seats, then support them using the wooden stand and secure it using suitable bolts.

Place the valve guide oil seal (1 a) in position using the tool (1b extractor/fitting tool).

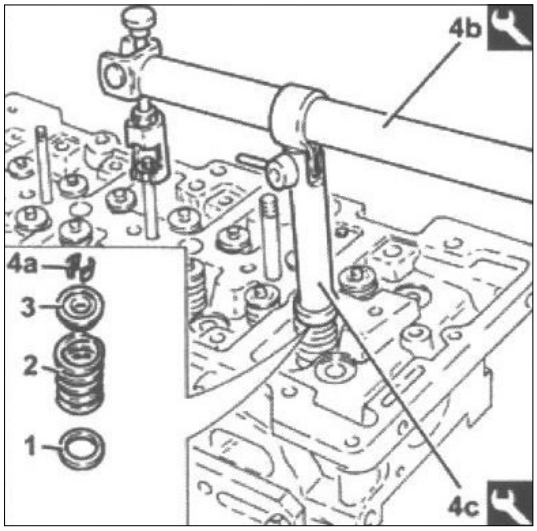


Place the shim in position (for exhaust valves only).

Fit the valve spring in its seat.

Refit the upper valve shim.

Place the cotters (4 a) in their housings using the tools (4b lever) and (4c chamber).



Carry out the same operations on the other valves.

Remove the wooden stand for supporting the valves from the cylinder head plane.

Refit the water pump, complete with basket, in its housing and secure it tightening the bolts to the recommended torque.

Water pump	
Bolt M8	value (da Nm) cylinder head side 2.3 ÷ 2.8

Place the thermostat in its housing with the new O-ring and secure it to the cylinder head by tightening the bolts to the recommended torque.

Thermostat	
Bolt M8	value (da Nm) cylinder head side 2.5

Place the hydraulic tappets in their housings.

Remove the lower cylinder head from the support tool.

4.1.3 Camshaft housing.

Position the camshaft housing in the vice using the tool (support).

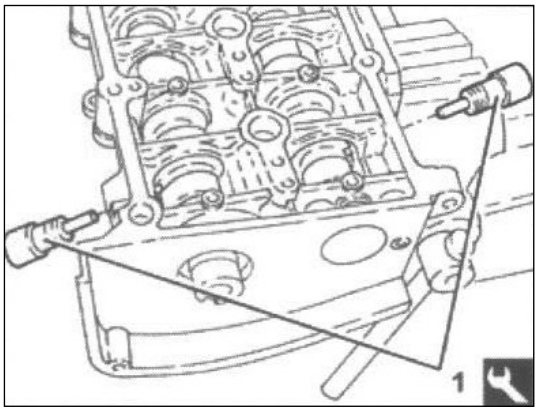
Tighten the engine oil lubrication duct plugs.

Place the camshaft gears in their housings.

Place the camshaft gears in their housings and secure them without tightening the bolts.

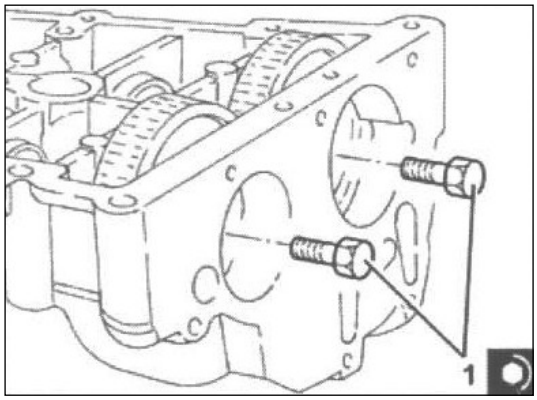
Fit the camshaft timing tools (template)

☛ Check that the tools are correctly fitted in the housings in the camshaft.

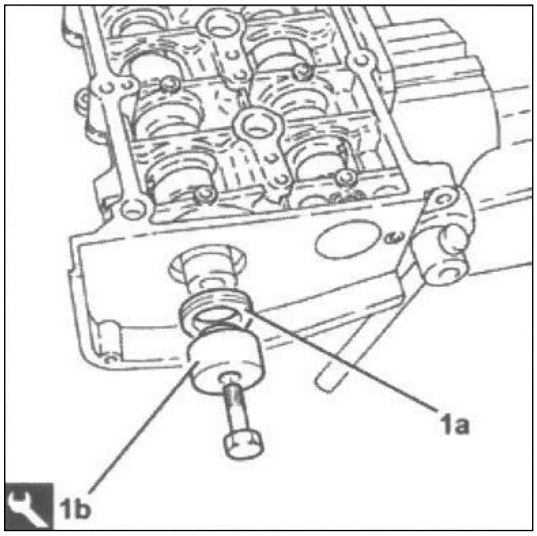


Tighten the camshaft gear fixing bolts to the recommended torque.

Camshaft gears	
Bolt M12	(da Nm) camshaft side 2.9 ÷ 3.2 + 40°



Fit the exhaust side camshaft front oil seal (1 a) using the tool (1b fitting tool).

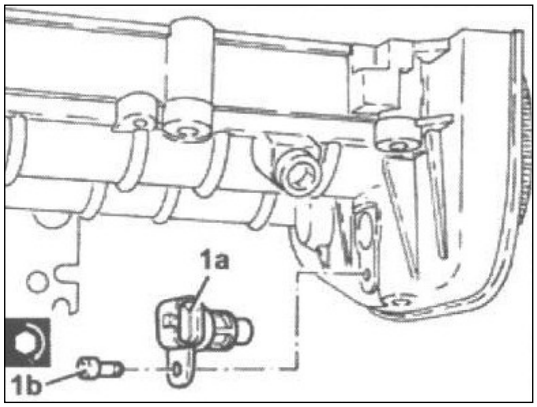


Fit the intake side camshaft plug.

Refit the exhaust side camshaft toothed pulley and secure by screwing in the bolt without tightening.

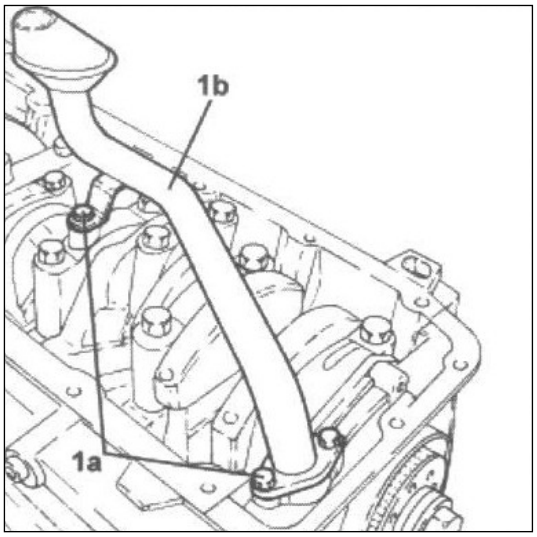
Position the cam angle sensor (1 a) in its housing and secure it tightening the bolt (1b) to the recommended torque .

Cam angle sensor	
Bolt M6	(da Nm) 0,8 ÷ 1,0



4.2 Crankshaft

Undo bolts (1 a) and remove oil intake duct (1b).



Fit the tool for rotating the crankshaft (flange)

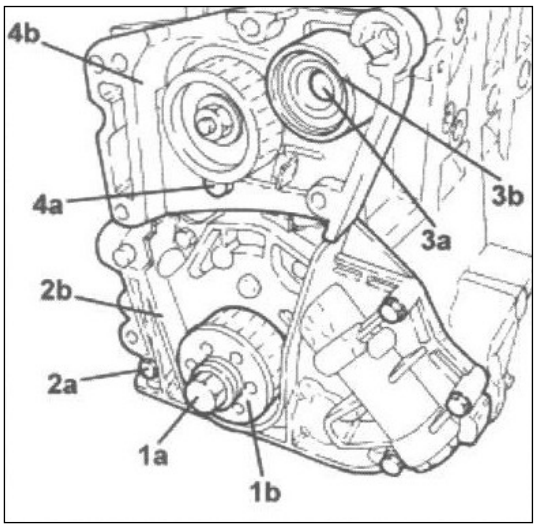
Undo bolt (anti-clockwise) (1 a) and remove toothed drive pulley (1b).

Undo bolts (2 a) and remove crankshaft front oil seal cover with built-in oil pump (2b).

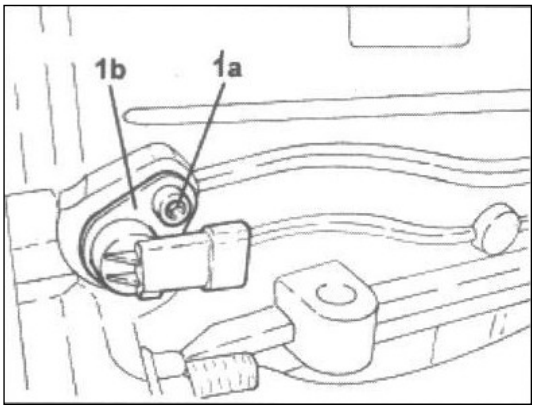
Remove the gasket.

Undo bolt (3 a) and remove timing belt fixed tensioner (3b).

Undo bolt (4 a) and remove timing belt tensioners mounting (4b)



Undo bolt (1 a) and remove rpm sensor (1b).



Rotate the camshaft using the tool fitted previously until the cylinder concerned is at B.D.C.

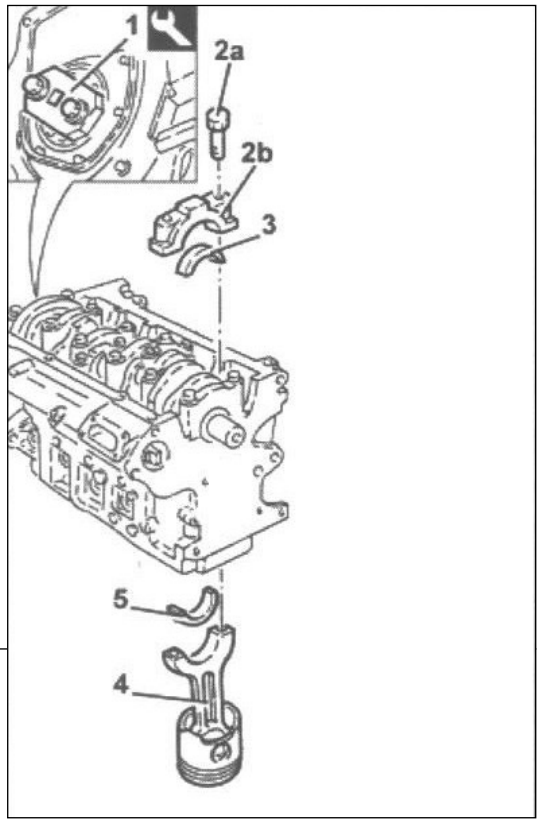
Undo bolts (2 a) and remove connecting rod cap (2b).

Remove the lower connecting rod half-bearing.

Remove the connecting rod-piston assembly.

Remove the upper connecting rod half-bearing.

Carry out the same operations for removing the remaining pistons.

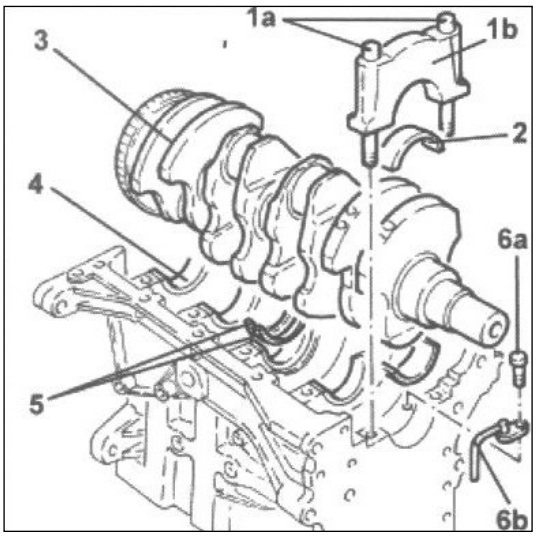


Check that the crankshaft end play corresponds to the recommended figures using a magnetic base and dial gauge.

Crankshaft end play
0.049 ÷ 0.211 mm

If the value for the crankshaft end play does not correspond with the recommended figures, when refitting, regrind the crankcase seat and use suitable oversize thrust washer.

VF4



Undo bolts (1 a) and remove crankcase rear cover (1b) with built-in oil seal.

Remove the lower main journal half-bearings.

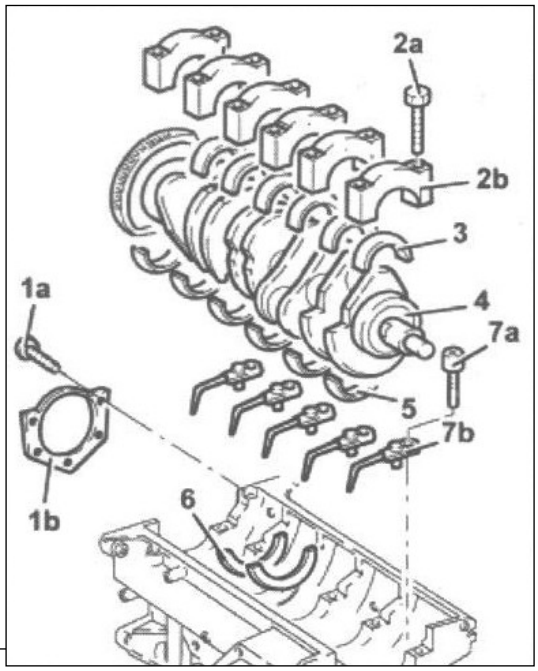
Remove the crankshaft.

Remove the upper main journal half-bearings.

Remove the thrust washers.

Undo bolts (6 a) and remove jets (6b) from the crankcase.

VF5



Undo bolts (1 a) and remove crankcase rear cover (1b) with built-in oil seal.

Undo bolts (2 a) and remove bearing caps (2b).

Remove the lower main journal half-bearings.

Remove the crankshaft.

Remove the upper main journal half-bearings.

Remove the thrust washers.

Undo bolts (7 a) and remove jets (7b) from the crankcase.

Drill and remove the water/oil sealing plugs from the crankcase to allow for washing.

Remove the engine block from the overhaul stand and place on a suitable work bench.

Wash the dismantled components.

Fit the water/oil sealing plugs in the crankcase using suitable fitting, tools.

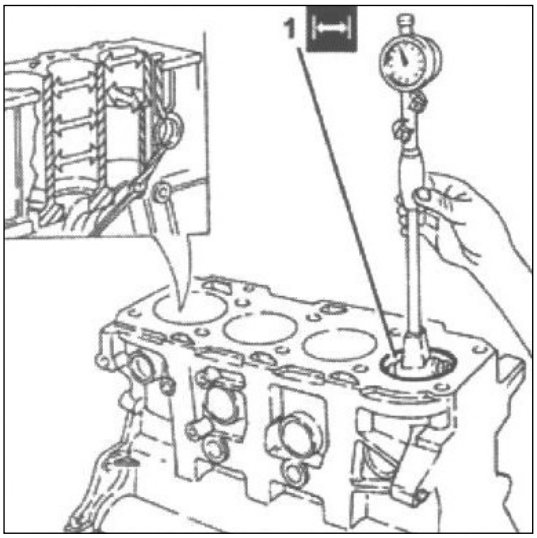
Lubricate all the mechanical components with engine oil.

Check that the cylinder head support surface does not have cracks or surface grooves.

Check that the planarity of the cylinder head support surface corresponds to the recommended figure; if this is not the case, regrind the cylinder head support surface.

Cylinder head lower surface flatness
0,1 mm

Measure the cylinder bore diameter using the diagram illustrated.



Cylinder liner inner diameter	
Grade A	82.000 ÷ 82.010
Grade B	82.010 ÷ 82.020
Grade C	82.020 ÷ 82.030

Check that the taper and ovality of the cylinder liners/bores is within the recommended limits.

Cylinder liner taper	< 0.005 mm
Cylinder liner ovality	< 0.05 mm

If the cylinder bore measurements are not within the recommended limits, ream the cylinder bores following the recommended oversize.

☛ If reaming, ensure all the bores have the same oversize.

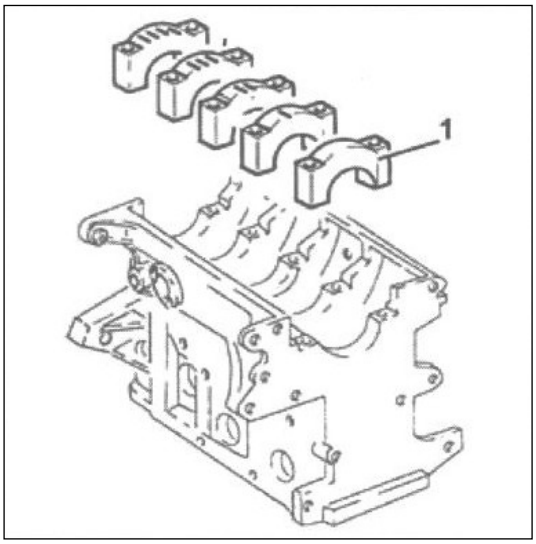
Cylinder liner bore diameter oversize
0.1 mm

Fit the bearing caps.

☛ The bearing caps have progressive references (from zero to five VF4, or zero to six VF5, starting from the timing system side) which define the fitting position.

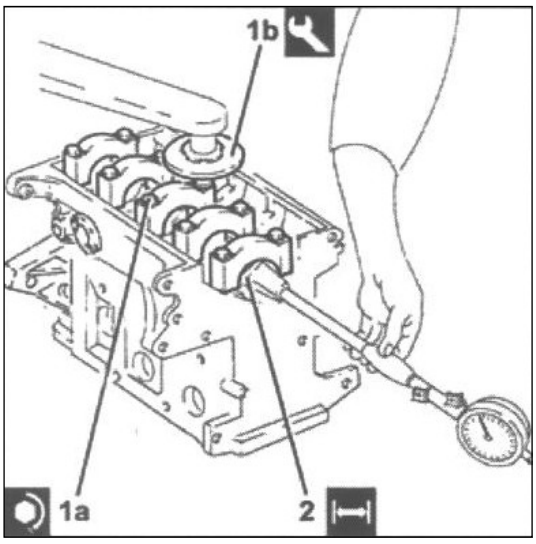
Tighten bearing cap bolts (1 a) to the recommended torque, use torque wrench (1b).

Bearing caps	
Bolt M12	(da Nm) 2.4 ÷ 2.6 + 100°



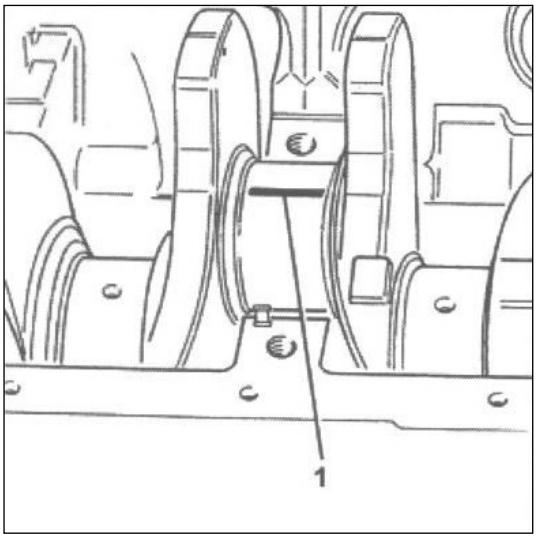
Check that the diameter of the main journal seats is within specified limits.

Main journal seat diameter
63.705 ÷ 63.718 mm



Check that there are no deposits or blockages in the crankshaft lubrication ducts.

Check that the diameter of the main journals corresponds to the recommended figures.



Main journal diameter	
Category A	59.994 ÷ 60.000 mm
Category B	59.988 ÷ 59.994 mm
Category C	59.982 ÷ 59.988 mm

If the diameter of the main journals is not correct, they should be reground to the recommended undersize.

Main journal diameter undersize
0.127 mm

☛ Crankpin undersizes higher than the value mentioned will adversely affect the structural resistance of the crankshaft (following contact between the tool and rolled connectors). As far as the above is concerned, if the regrinding requires under sizes greater than 0.127 mm, then the crankshaft must be replaced and a new one ordered from the parts dept.

Check that the diameter of the crank pins corresponds to the recommended figures.

Crankpin diameter	
Category A	50.779 ÷ 50.805 mm
Category B	50.793 ÷ 50.799 mm
Category C	50.787 ÷ 50.793 mm

If the diameter of the crank pins is not correct, they should be reground to the recommended undersize.

Crankpin diameter undersize
0.127 mm

☛ Crankpin undersizes higher than the value mentioned will adversely affect the structural resistance of the crankshaft (following contact between the tool and rolled connectors). As far as the above is concerned, if the regrinding requires under sizes greater than 0.127 mm, then the crankshaft must be replaced and a new one ordered from the parts dept.

Check the main bearings, noting that the half-bearings should not be adapted. Replace them if scoring or signs of binding are noted.

Fit the half-bearings, making sure they are scrupulously clean.

☛ If the crankshaft has been round, fit new oversize half- bearings to restore the initial tolerance conditions.

Fit the crankshaft into its seat on the crankcase.

Fit the calibrated wire (plastigage) for measuring the bearing clearance.

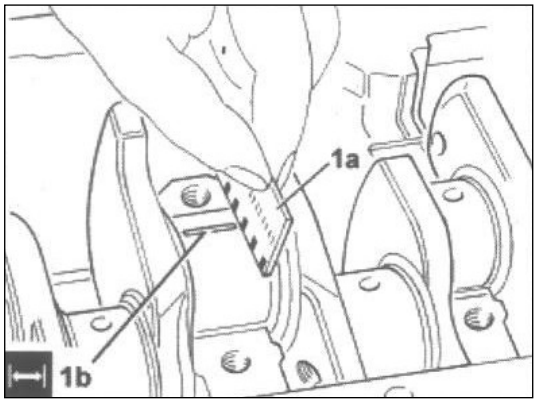
☛ Check one journal at the time, without rotating the crankshaft.

Fit the bearing caps complete with half-bearings and tighten the bolts to the recommended torque.

Bearing caps	
Bolt M12 (da Nm)	2.4 ÷ 2.6 + 100°

The bearing caps have progressive references (from zero to five starting from the timing system side) which define the fitting position.

Remove the bearing caps fitted previously and, using a suitable graduated measuring instrument (1 a), measure the clearance shown by calibrate



Clearance between main bearings- crankshaft main journals
0.011 ÷ 0.071 mm

☛ If the figure measured is outside of the tolerance, replace the half-bearings with ones of the correct size and category.

Measure the clearance for all the bearings, being careful to take the measurements one at a time without moving the crankshaft at all.

Check that the small end bush diameter is within the recommended limits; if not, replace the worn small end bush, refer to:

Small end bush inner diameter
26.006 ÷ 26.014 mm

Check that the outer diameter of the gudgeon pins is within the recommended limits; if not, replace the worn gudgeon pins.

Gudgeon pin outer diameter
25.982 ÷ 25.987 mm

Fit the piston rings in the cylinder bore and check that the opening between the ends is within the recommended values; if this is not the case, replace the cir-clips.

Cylinder compression piston ring gap	
I piston ring gap	0.20 ÷ 0.35 mm
II piston ring gap	0.60 ÷ 0.80 mm
Scraper ring gap	0.25 ÷ 0.50 mm

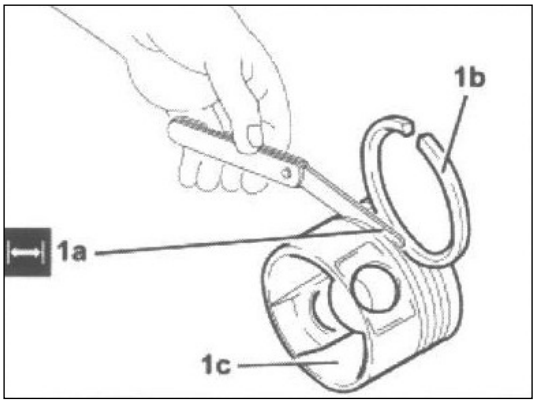
Check that the outer diameter of the pistons corresponds to the recommended figures; if not, replace the piston complete with piston rings and gudgeon pin.

Piston outer diameter	
Grade A	81.920 ÷ 81.930 mm
Grade B	81.930 ÷ 81.940 mm
Grade C	81.940 ÷ 81.950 mm

☛ Measure perpendicular to the gudgeon pin axis, 9 mm from the lower edge of the skirt.

Check that backlash (1 a) between rings (1b) and the seats in pistons(1c) corresponds to the recommended figures.

Cylinder compression piston ring	
I piston ring	0.105 ÷ 0.150 mm
II piston ring	0.050 ÷ 0.090 mm
Scraper ring	0.030 ÷ 0.070 mm

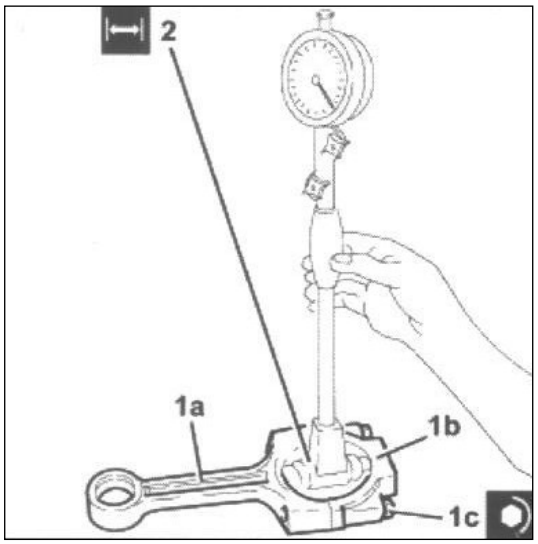


Fit caps (1b) on connecting rods (1 a) and secure them by tightening bolts (1c) to the recommended torque.

Connecting rod big end bearing caps	
Bolt M9 (da Nm)	2.4 ÷ 2.6 + 60°

Check that the diameter of the big end corresponds to the recommended figures; if not, replace the connecting rods.

Big end inner diameter
53.897 ÷ 53.909 mm



Check that there are no signs of seizing on the flywheel ring gear teeth; if this is not the case, replace it.

Fit the crankcase on the overhaul stand and secure it using the bolts.

Fit the thrust washers on the fourth bearing support.

☛ The crankshaft supplied by the parts dept, comes without half-bearings and the main journals and crankpins are the "normal" size; the half-bearings to be fitted must therefore be selected identifying the class of each main journal crankpin for the new crankshaft.

The following must be determined for the selection of main journal half-bearings:

- the numerical code stamped on the flywheel;
- the paint mark, if present, next to the main journals.

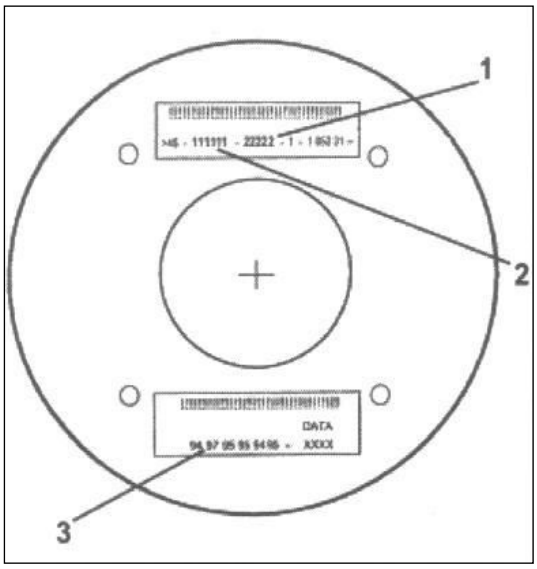
Below is an example of the identification of main journal grades.

1 Crankpin identification numerical code: the number on the left refers to the first timing-side bearing,

2 Main journal identification numerical code: the first number on the left refers to the first timing-side bearing.

3 Series of numbers (if present), in groups of two digits, which indicate the dimensions (thousandth part) of the main journals: the first two numbers on the left refer to the first timing-side main journal.

☛ Only use the codes that relate to the key, all other codes on the flywheel should not be used.



For the identification of the main journal category, refer to the numerical code for reference 2.

In the case of the example, the numbers 111111 indicate that all six bearings are grade A (red) as indicated in the table.

A further method for identifying the grade of the bearings is to read reference 3 (if present) in the diagram.

In the case of the example, the number 94 (first on the left) corresponds to the dimensions 59.994 for the first timing-side bearing which, as indicated in the table, identifies Grade A (red); the same method should be applied for other groups of two digits for the same reference 3 (97 – 95 – 94 – 95).

4.2.1 Main journal identification

Bearing grade A	Normal, diameter 59.994 ÷ 60.000 paint mark –, numerical code 1 (94 00)°
Bearing grade B	Normal, diameter 59.988 ÷ 59.994 paint mark –, numerical code 2 (88 94)°
Bearing grade C	Normal, diameter 59.982 ÷ 59.988 paint mark – numerical code 3 (82 88)°
Bearing grade D	Normal, diameter 59.867 ÷ 59.873 (*) paint mark – numerical code 6 (67 73)°
Bearing grade E	Normal, diameter 59.861 ÷ 59.867 (*) paint mark – numerical code 7 (61 67)°
Bearing grade F	Normal, diameter 59.855 ÷ 59.861 (*) paint mark – numerical code 8 (55 61)°

(*) 0.127 mm undersize

(°) Last two numbers (thousandth part) of the main journal dimension.

In the case of using a crank shaft where the maximum undersize for the bearings is 0.127 mm through grindings, the grade should be selected through the measurement of the diameter of the bearing using table as a reference.

Having defined the grade and the colour of each new or reground crankshaft bearing, it is necessary to select the pair or thickness of the bearings that should be the same colour as the corresponding bearing; the pair of half-bearings required can be ordered from the parts dept. By quoting the order no.

The above is designed to guarantee the optimum operational clearances.

Lastly, we wish to point out that the clearance between the main journal and the half-bearing, obtained through the selection method indicated above, should generally be within the following values:

Minimum: 0.025 mm – Maximum: 0,052 mm; this value can be measured, as a final check, using the calibrated wire (plastigage).

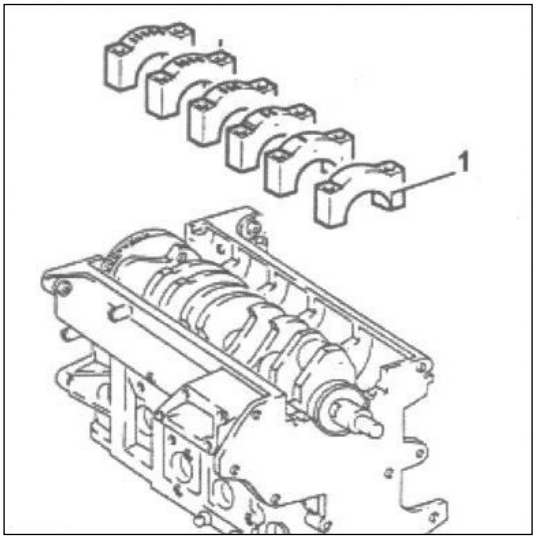
Place the lubrication jets back in their housings and secure them to the crankcase using the bolts.

Fit the crankshaft in the crankcase.

Fit the bearing caps complete with half-bearings and tighten the bolts to the recommended torque.

Bearing caps		
VF4	Bolt M12 (da Nm)	1.9 ÷ 2.1 + 100°
VF5	Bolt M12 (da Nm)	2.4 ÷ 2.6 + 100°

☛ The bearing caps have progressive references (from zero to five starting from the timing system side) which define the fitting position.



Fit the tool for rotating the crankshaft.

Rotate the crankshaft using the tool fitted previously until the cylinder concerned is at B.D.C.

Fit piston-connecting rod assembly (1 a) complete with half-bearing using tool (1b).

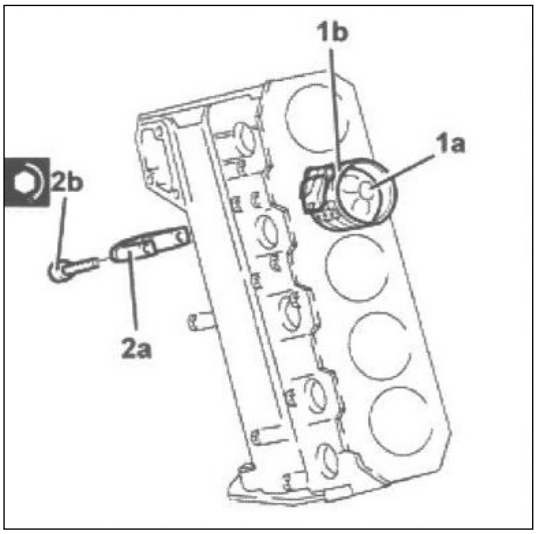
- ☛ The piston-connecting rod assemblies are fitted in the cylinder block/crankcase so that the combustion chamber in the piston is facing the intake side.
- ☛ For the selection of the connecting rod half-bearings, follow the procedure described previously for the main journal half-bearings.

Fit connecting rod cap (2 a) complete with half-bearing and secure it without tightening bolts (2b).

- ☛ Fit the connecting rods so that the number stamped on each rod faces toward the same side as the number stamped on the big end (inlet side).

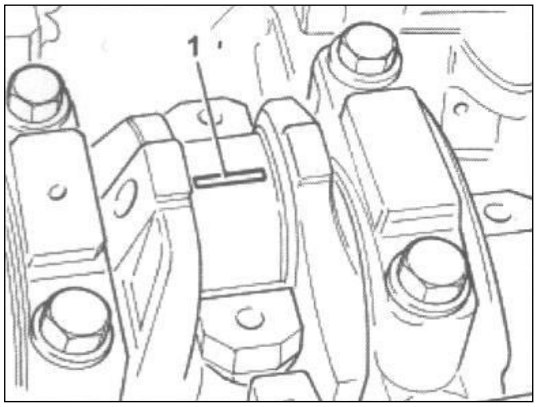
For the remaining cylinders, carry out the same operations to refit the pistons and connecting rods.

Test the crankpin clearance by applying plastigage to measure crankpin installation clearance.



Tighten connecting rod cap bolts to the recommended torque.

Connecting rod big end bearing caps	
Bolt M9 (da Nm)	2.4 ÷ 2.6 + 60°



Undo the bolts and remove the connecting rod caps complete with half-bearings.

Using an appropriate graduated measuring tool (1 a),measure the clearance indicated by plastigage (1b).

Clearance between crankpins crankshaft bearings	
VF4	0.030 ÷ 0.056 mm
VF5	0.016 ÷ 0.070 mm

If the value measured is not within the recommended figures, replace the connecting rod bearings.

Carry out this test on all the crankpins, one at a time, without ever turning the crankshaft.

Fit the connecting rod caps complete with half bearings and tighten the bolts.

Tighten connecting rod cap bolts to the recommended torque.

Connecting rod big end bearing caps	
Bolt M9 (da Nm)	2.4 ÷ 2.6 +60°

Remove the flange for rotating the crankshaft.

Place the crankcase rear cover with integrated oil seal in position and secure it by tightening the bolts to the recommended torque.

Flywheel side oil seal cover		
Bolt (pre-treated to be replaced.) (engine block side)	M6 (daNm)	0.8 ÷1.0

Place the crankcase front cover complete with oil pump and gasket in its seat and tighten the bolts to the recommended torque.

Crankshaft oil seal front cover		
Bolt (pre-treated to be replaced) (engine block side)	M6 (daNm)	0.8 ÷1.0

Refit the engine oil intake duct complete with O-ring in its housing and secure it by tightening the bolts to the specified torque.

Engine oil intake		
VF4	Bolt M6 (daNm)	0.8 (oil pump side)
VF5	Bolt M6 (daNm)	0.9 (oil pump side)

Apply silicon sealant to the entire perimeter of the oil sump.

Place the oil sump back in its housing.

Tighten the bolts securing the oil sump to the crankcase to the recommended torque using the tool (spanner).

Engine oil sump	
Bolts front and rear M8 (daNm)	2.5

Tighten the bolts securing the oil sump to the crankcase front and rear covers to the recommended torque using the tool.

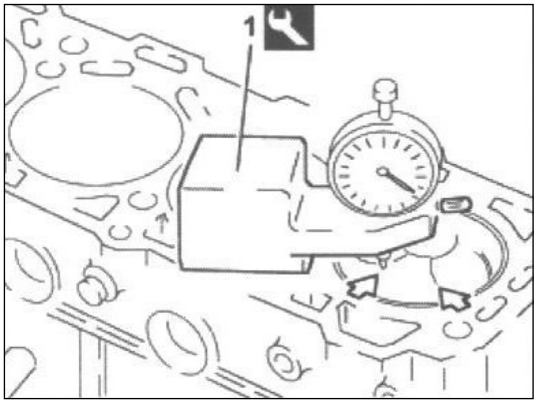
Engine oil sump	
Side bolts M6 (daNm)	0.9

Fit the tool for rotating the crankshaft (flange).

Position the timing belt toothed drive pulley in its housing and tighten the bolt (anti-clockwise thread) to the recommended torque.

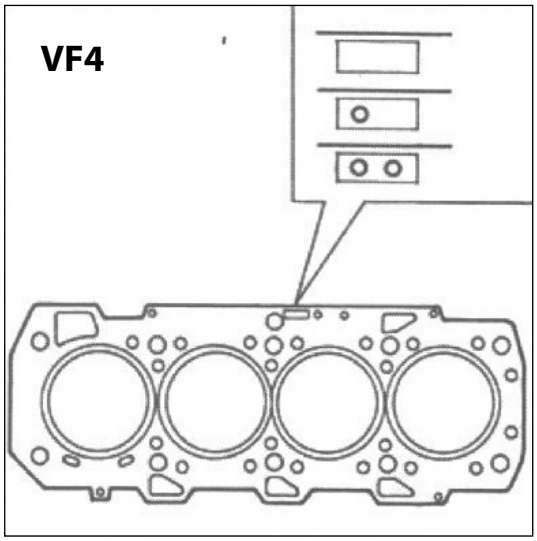
Toothed drive pulley	
Left hand bolt M16 (daNm)	32.3 ÷ 35.7 (crankshaft side)

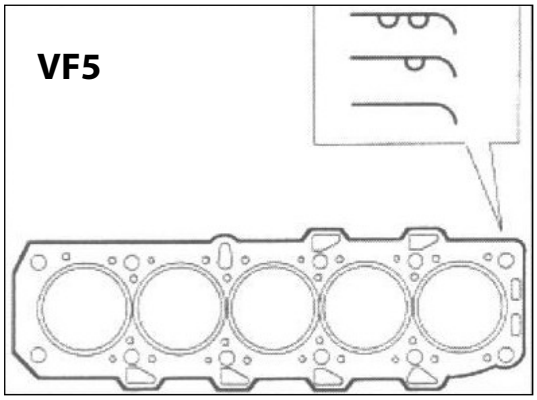
Measure the piston projection in two places at 180° on the gudgeon pin axis using the tool and take the average of the two values measured for each piston. (dial gauge support).



Select the correct size cylinder head gasket depending on the maximum value out of the averages of the projection for each individual piston.

Cylinder head gasket size with average maximum piston projection	
0	opening projection -0.020 ÷ +0.100 mm – thickness 0.82 ÷ 0.05 mm
1	opening projection +0.101 ÷ +0.200 mm – thickness 0.92 ÷ 0.05 mm
2	opening projection +0.201 ÷ +0.295 mm – thickness 1.02 ÷ 0.05 mm





Place the cylinder head centring bushes on the cylinder block.

Fit the cylinder head basket selected.

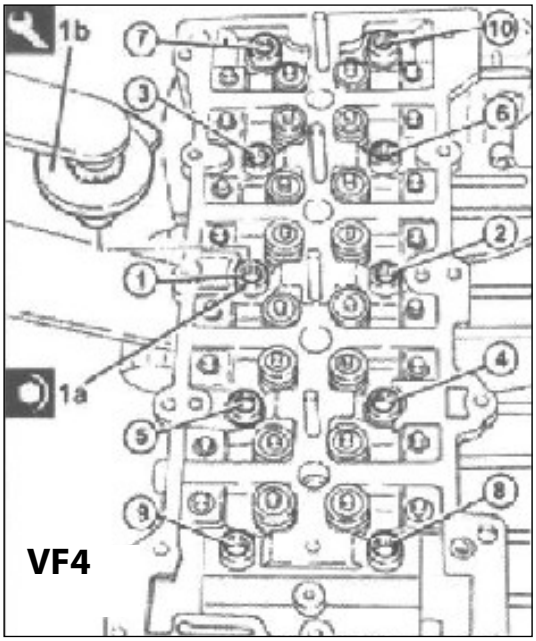
Position the cylinder head on the cylinder block/crankcase.

Tighten the cylinder head bolts to the specified torque.

☛ Follow the order shown in the diagram for each tightening sequence.

Camshaft housing		
VF4	Bolt M12 (daNm)	6.2 ÷ 6.8 + 4.5+90°+90°+90° (Crankcase side)

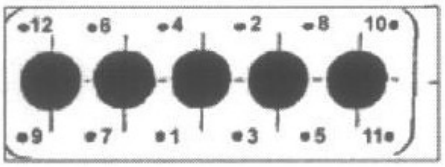
☛ The value of 2 daNm in the table above is a tightening value for all the bolts following the order illustrated in the diagram.



Camshaft housing		
VF5	Bolt M12 (daNm)	2 + 4.5+90°+90°+90° (Crankcase side)

☛ The value of 2 daNm in the table above is a tightening value for all the bolts following the order illustrated in the diagram.

VF5



Position the rpm sensor in its housing and secure it using the bolt.

Place the timing belt tensioner mount in its housing and secure it using the bolt.

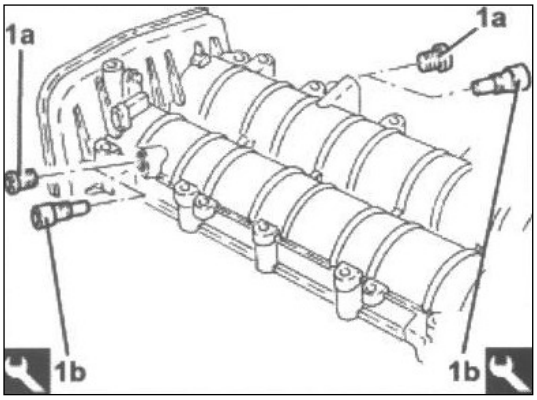
Place the timing belt fixed tensioner in its housing and secure it using the bolt.

Fit the pressure pump mounting complete with pump and secure it using the bolts.

Place the timing belt side guard in its housing and secure it using the bolts.

Remove plugs (1 a) and fit camshaft timing tools (1b) on the camshaft housing.

☛ Check that the tools marked "A" are correctly fitted in the seats on the camshaft.



Remove the timing tool, (templates) camshaft side, and tighten the plug.

Fit a new upper cylinder head basket in position.

Position the camshaft housing and secure it by tightening the bolts to the recommended torque.

Camshaft housing	
Bolt M8 (daNm)	2.3 ÷ 2.8 (cylinder head side

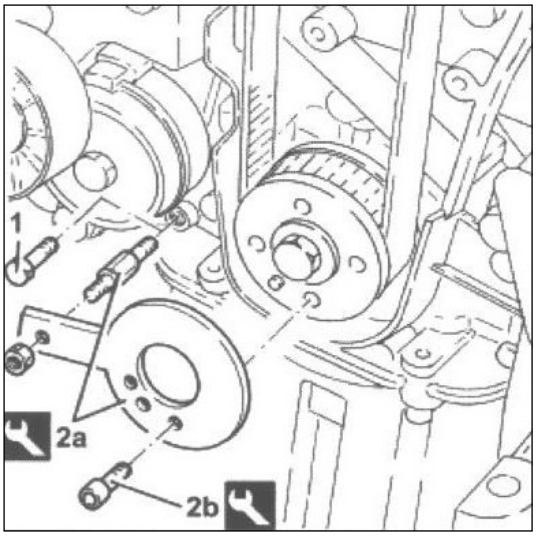
Loosen the bolt fixing the exhaust side timing belt toothed drive pulley.

Undo the bolt fixing the crankcase front cover shown in the diagram.

Temporarily fit the toothed timing drive belt on the toothed drive pulley.

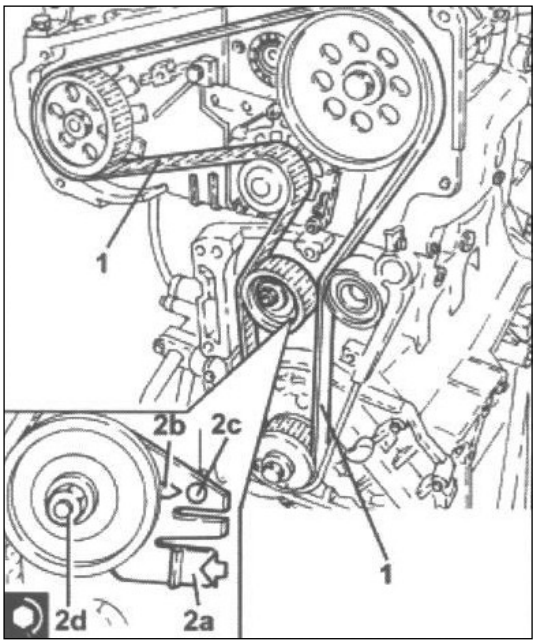
Fit tool (2 a template) and fasten it using calibrated screw (2b).

Fully fit the toothed timing drive belt.



Use a screwdriver for leverage in opening (2 a) until the reference for tensioner (2b) is aligned with reference opening (2c). In this position, tighten nut (2d) for the belt tensioner to the recommended torque.

Timing moving tensioner	
Nut M8 (daNm)	2.3 ÷ 2.8



Tighten the bolt fixing the exhaust side timing belt toothed drive pulley to the specified torque.

Driver toothed pulley	
Bolt M12 (daNm)	2.9 ÷ 3.2 + 40° (camshaft side)

Remove the camshaft timing tools, exhaust and crankshaft side.

Rotate the crankshaft through two turns and check again that the timing is correct by refitting the timing tools removed previously.

Check the collimation of the reference marks for the tensioning of the timing belt tensioner and remove the timing tools.

Tighten the bolt fixing the crankcase front cover removed previously.

Tighten the plug on the upper cylinder head for fitting the exhaust-side timing tool.

Fit the injectors and brackets in their seats and tighten the nuts.

- ☛ VF4: Start the assembly with the injector on the fourth cylinder and follow the sequence until the first cylinder.
- ☛ VF5: Start the assembly with the injector on the fifth cylinder and follow the sequence until the first cylinder.

Place the fuel return pipe back in place and connect it to the injectors and the return manifold pipe.

Place the single fuel manifold in its housing and secure it by tightening the bolts to the recommended torque.

Single fuel manifold pipe (rail)	
Bolt M8 (daNm)	2.3 ÷ 2.8 (cylinder head extension side)

Connect the return pipe to the single fuel manifold and secure it with the band.

Lace new rigid pipes from the fuel manifold to the injectors in their housing and tighten the connectors to the recommended torque.

Pipes from fuel manifold to injectors	
Connector M14 (daNm)	2.2 ÷ 2.4 (rail side)
Connector M12 (daNm)	2.4 ÷ 2.6 (injector side)

Place a new rigid pipe between the pump and the single fuel manifold back in its housing and tighten the connectors to the recommended torque.

Pipes from pressure pump to fuel manifold	
Connector M14 (daNm)	2.2 ÷ 2.4 (fuel manifold side)
Connector M12 (daNm)	2.2 ÷ 2.4 (pressure pump side)

Refit the auxiliary drive belt pulley and secure by tightening the bolts to the recommended torque.

Services pulley on crankshaft	
Bolt M8 (daNm)	2.3 ÷ 2.5 (crankshaft side)

Refit the timing belt guard and secure it using the bolts.

Place the exhaust manifold assembly, complete with new gasket, back in its housing and secure it by tightening the nuts to the recommended torque.

Exhaust manifold	
Nut M8 (daNm)	2.3 ÷ 2.8 (turbocharger side)

Connect the turbocharger lubrication oil delivery pipe to the crankcase and tighten the connector to the recommended torque.

Engine oil supply pipe to turbo - crankcase	
Connector M10 (daNm)	4.5 ÷ 5.5

Connect the turbocharger lubrication oil outlet pipe to the sump and tighten the bolts to the recommended torque.

Engine oil supply pipe from turbo	
Bolt M6 (daNm)	0.8 ÷ 1.0 (engine block side)

Place the alternator in position and secure it by tightening the bolts to the recommended torque.

Alternator	
Bolt M12x1.25x120 (daNm)	6.3 ÷ 7.7
Bolt M10x1,25x100 (daNm)	4.5 ÷ 5.5

Place the auxiliary drive belt automatic tensioner in position and tighten the bolts to the recommended torque.

Engine components single belt moving tensioner	
Bolt M8 (daNm)	2.3 ÷ 2.5

Fit and tension the single auxiliary drive belt by working on the automatic tensioner using the tool (spanner).

Secure the electrical connection for the engine oil pressure switch.

Secure the electrical connection for the rpm sensor

Attach the electrical connection for the coolant temperature sensor.

Secure the electrical connection for the pressure relief sensor.

Secure the electrical connections for the spark plugs.

Secure the electrical connection for the pressure regulator on the single fuel manifold.

Secure the electrical connections for the injectors.

Secure the electrical connection for the timing sensor.

Secure the electrical connection for the alternator.

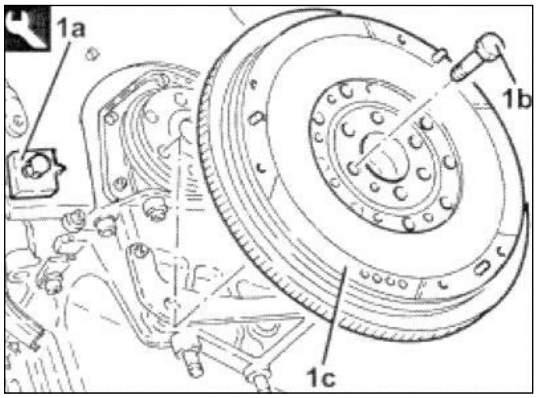
Place the alternator power supply cable back in its housing and secure it using the nut.

Secure the engine wiring using the various retaining clips.

4.3 Engine flywheel

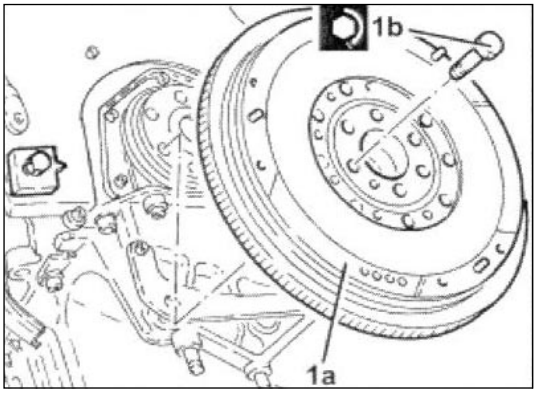
With the flywheel lock (1 a) fitted, undo the bolts (1b) and remove the flywheel (1c).

The bolts fixing, the flywheel have been treated with a special agent; therefore they should be replaced each time they are removed.



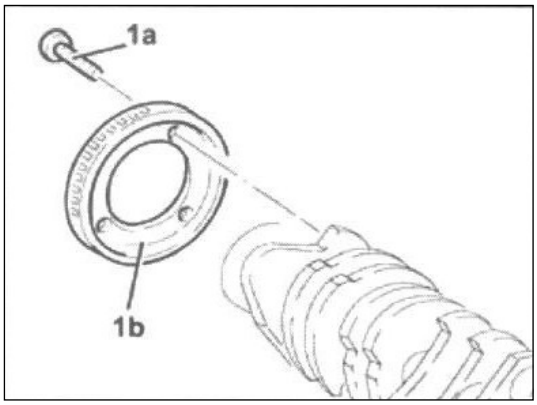
Place the flywheel (1 a) in its housing and secure it tightening the new bolts (1b) to the recommended torque.

Engine flywheel	
Bolt M12 (daNm)	16.0



4.4 Crankshaft phonic wheel for rpm and timing sensor replace with crankshaft removed

Undo the bolts (1 a) and remove the phonic wheel for the rpm and timing sensor (1b) from the crankshaft.

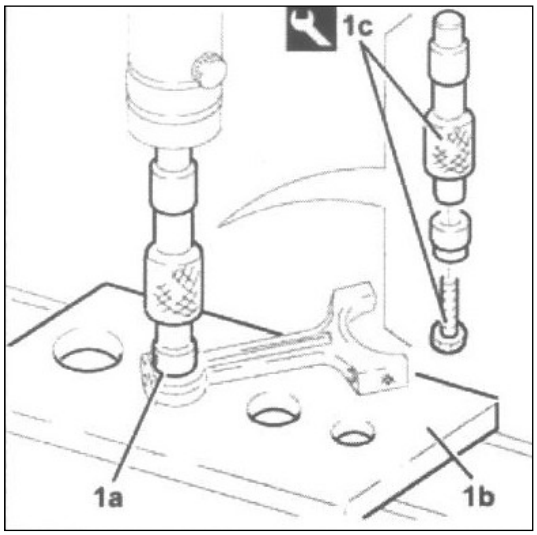


Fit a new rpm and timing sensor flywheel on the crankshaft and secure it tightening the bolts to the recommended torque.

Phonic wheel on crankshaft	
Bolt M5 (daNm)	2.3 ÷ 3.3

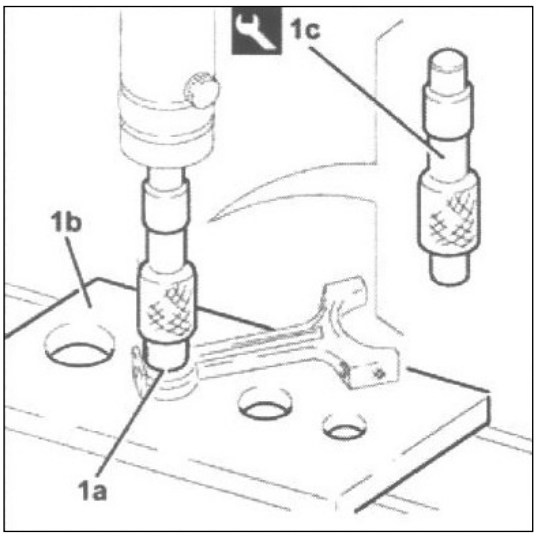
4.5 Connecting rod small end bush (one) replace

Remove the bush (1 a) from the small end using a hydraulic press, a suitable plate (1b) and the tool (1c extractor/fitting tool) constructed as illustrated in the diagram.



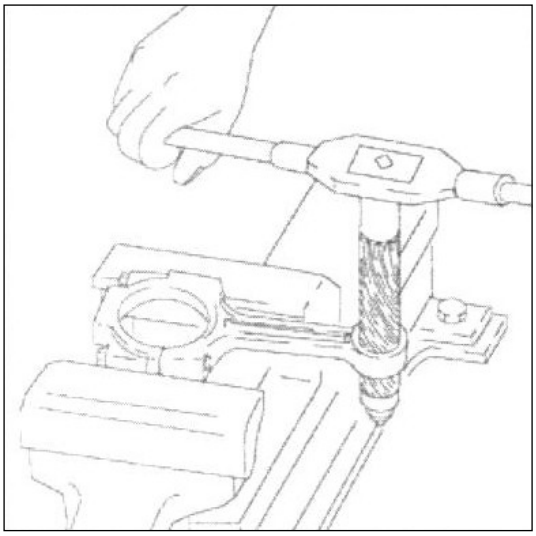
Fit a new bush (1 a) in the small end using a hydraulic press, a suitable plate (1b) and the tool (1c extractor/fitting tool) constructed as illustrated in the diagram.

☛ The bush should be fitted in the small end so that the lubrication port is aligned with the one in the small end.



Ream the inner diameter of the small end bush to the recommended figure.

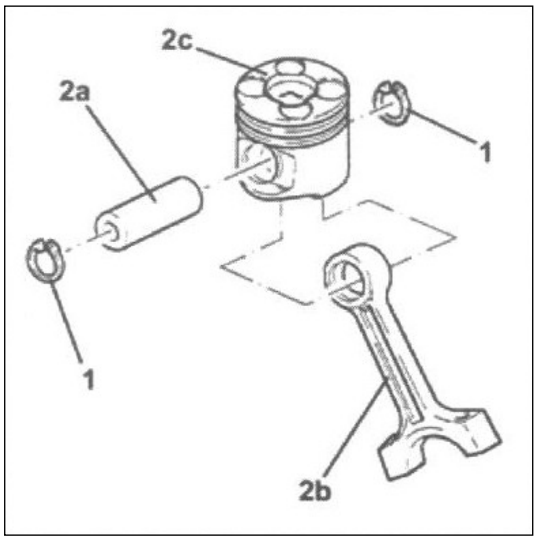
Small end bush	
Inner diameter	26.006 ÷ 26.014 mm



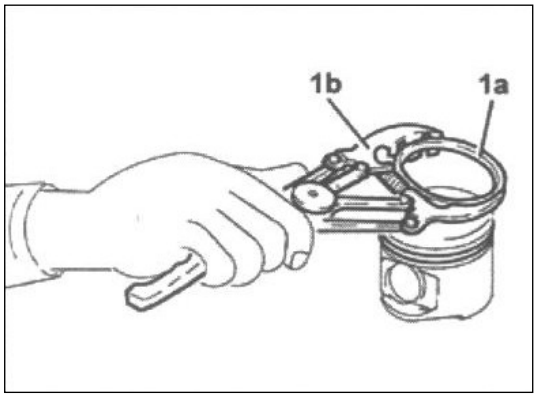
4.6 Set of pistons, gudgeon pins and seals (replace)

Remove the piston rings.

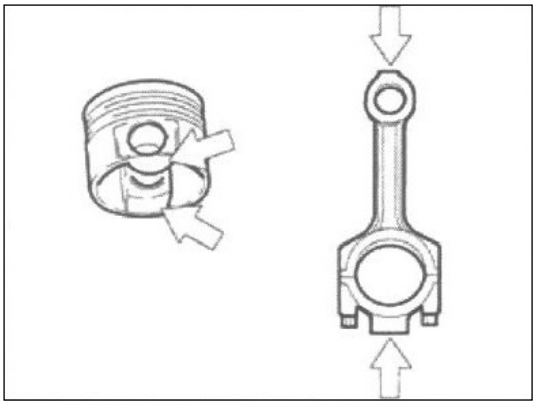
Release the pin (2 a) and separate the connecting rods (2b) from the piston (2c).



Remove the piston rings (1 a) from the pistons using a suitable tool (1b).



Check the alignment of the connecting rods using suitable equipment; if it is not correct, replace the connecting rod.



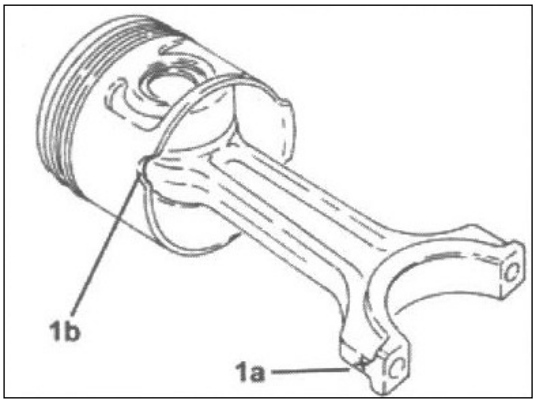
Check that the weight difference between the pistons corresponds to the recommended figures.

☛ The arrows in the diagram illustrate where material can be removed from the to equalize the weight.

Engine piston set	
Weight difference between pistons	± 5g
Weight difference between connecting rods	± 2.5g

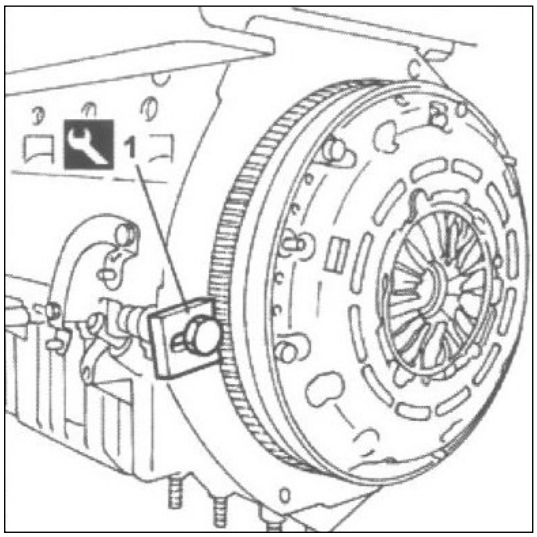
Join the connecting rods to the pistons so that the number printed on the connecting rod head (1 a) is facing notch (1b) on the piston skirt for the oil jet housing.

Fit the pins and secure them using the cir-clips.



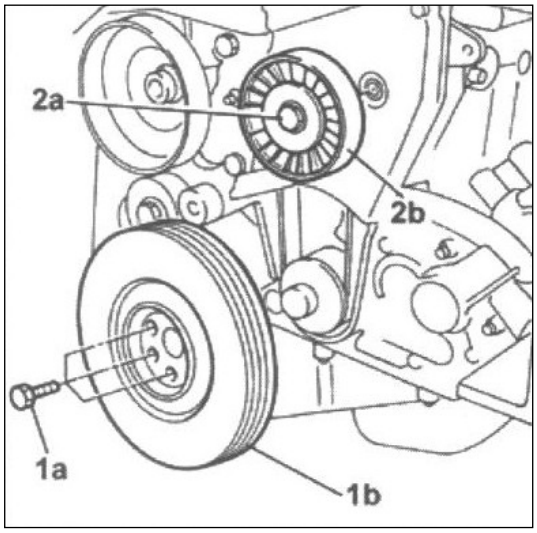
4.7 Toothed timing belt

Position the flywheel retaining tool in its seat (flywheel lock).

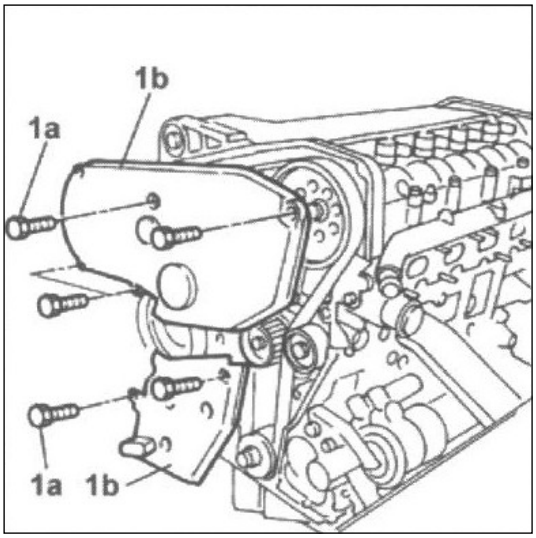


Undo bolts (1 a) securing crankshaft pulley (1b) and remove.

Undo the fixing bolt (2 a) and remove the single drive belt fixed tensioner (2b).

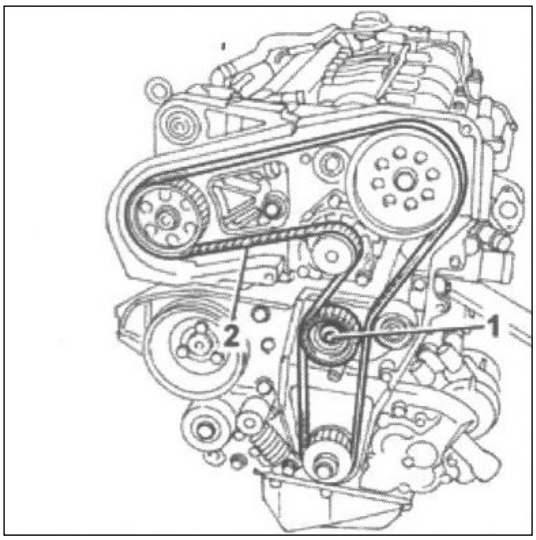


Undo bolts (1 a) and remove the protective timing covers (1b).



Loosen the moving timing tensioner nut.

Remove the toothed timing belt.



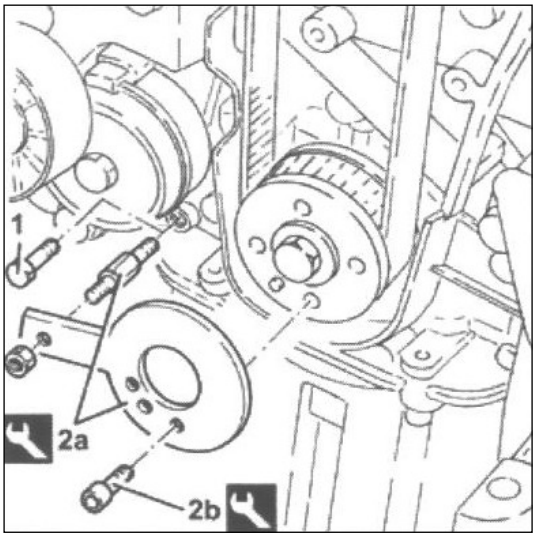
Remove plug (1 a) and fit camshaft timing tool (1b templates) to the cylinder head extension.

☛ Check the tools marked “A” are correctly fitted in the seat on the camshaft.

Undo the bolt fixing the crankcase front cover shown in the diagram.

Temporarily fit the toothed timing drive belt on the drive pulley.

Fit the tool (2 a template) and fasten it using the calibrated screw (2b).



The crankshaft must be rotated, using small movements to allow the locating dowel on the timing drive pulley to be inserted in the opening in the tool.

Fully fit the toothed timing drive belt.

Use a screwdriver on the tensioner (3 a) tab for leverage until the reference (3b) is in the maximum tension position, then lock the nut (3c) fixing the moving tensioner in this position

Remove the tools used to ad just the timing.

Rotate the crankshaft through two revolutions.

Re-check the alignment of the timing references, loosen the nut securing the mobile tensioner and align mobile indicator (4 a) with hole (4b), i.e. ad just to nominal tension position, then tighten nut (4c) securing the belt tensioner to torque.

Mobile timing tensioner	
Nut M8 (daNm)	2.5

Loosen the bolt retaining the timing pulley.

Rotate the crankshaft through two revolutions.

Recheck the timing by refitting the timing tools

Check the timing belt tensioner references are aligned.

Tighten the bolt fixing the crankcase front cover removed previously.

Tighten the plug on the cylinder head extension for fitting the exhaust side timing tool.

Fit the toothed timing belt protective guards and tighten the retaining bolts.

Position the flywheel retaining tool in its seat.

Fit the crankshaft pulley in position and tighten the fixing bolts.

Flywheel lock	
Bolt M8 (daNm)	2.5

Fit the fixed timing belt tensioner for the single engine component drive belt and tighten the retaining bolt to torque.

Remove the flywheel lock.

Tighten the bolt fixing the exhaust side camshaft toothed pulley to the recommended torque.

4.8 Fuel filter assembly

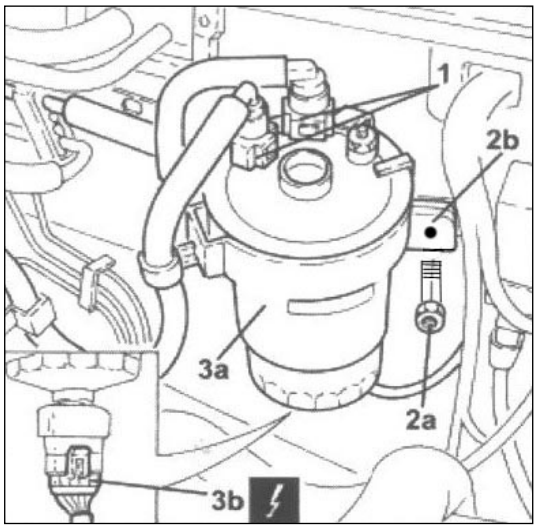
Make sure that the ignition key is in the OFF position then, disconnect the battery terminal (-) .

Disconnect the rapid connectors from the fuel filter, fuel filter side.

Unscrew the fuel filter from the bracket.

Raise the fuel filter assembly (3 a) by the required amount and disconnect the electrical connection (3b) from the water presence sensor, then remove.

Working at the bench, unscrew the water presence sensor in the fuel filter and remove.



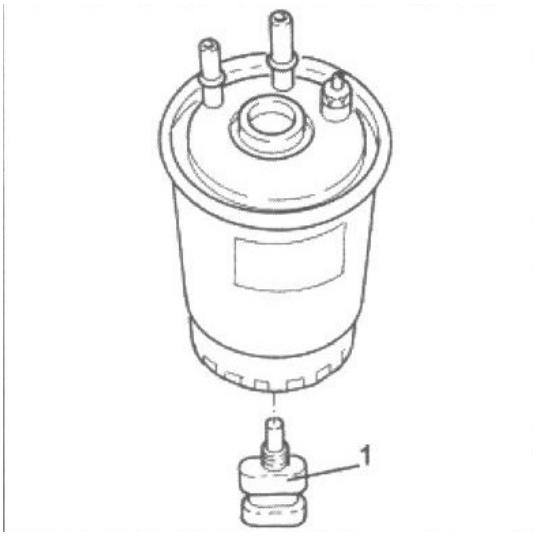
Refit the water sensor in its seat on the fuel filter.

Connect the electrical connection to the water presence sensor, then refit the fuel filter assembly in its seat.

To screw the filter in its seat of the bracket.

Connect the rapid connectors for the fuel pipes, fuel filter side.

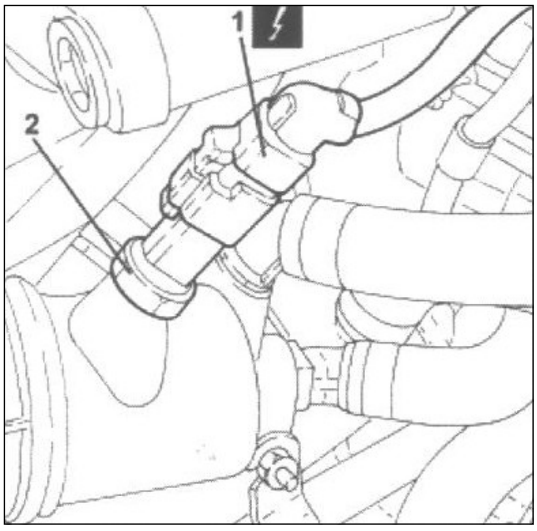
Connect the negative battery terminal (-).



4.9 Engine coolant temperature sensor

Disconnect the electrical connection from the engine coolant temperature sensor (1).

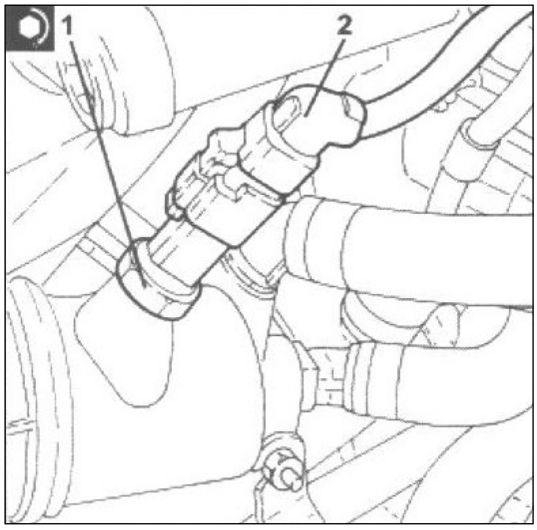
Undo the engine coolant temperature sensor and remove it.



Place the engine coolant temperature sensor in its housing and tighten it to the recommended.

Engine coolant temperature sensor	
M ... (daNm)	0.8 Thermostat side

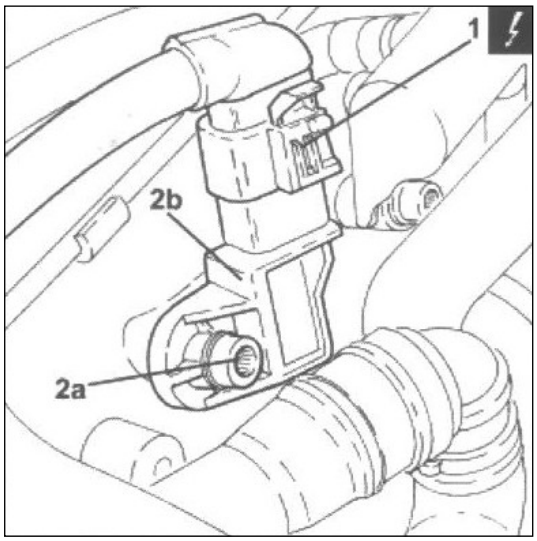
Connect the electrical connection to the engine coolant temperature sensor.



4.10 Pressure relief sensor

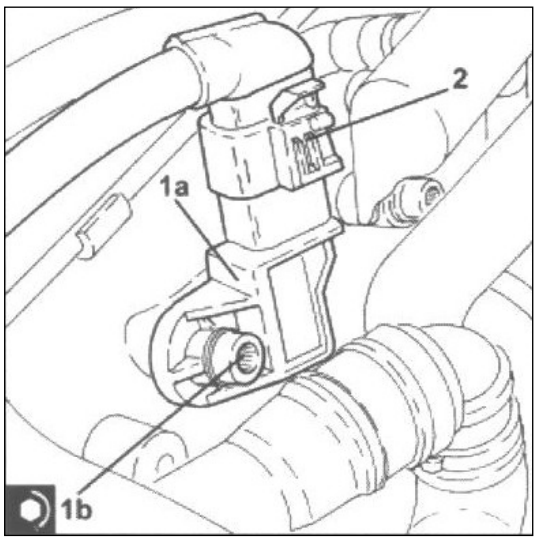
Make sure that the ignition key is it in the OFF position, then disconnect the battery terminal (-).

Undo bolts (2 a) and remove the pressure relief sensor (2b).



Position the excess pressure sensor (1 a) in its housing and secure it tightening the bolt(1b) to the recommended torque.

Excess pressure sensor	
Bolt M ... (daNm)	0.9



Connect the electrical connection for the pressure relief sensor.

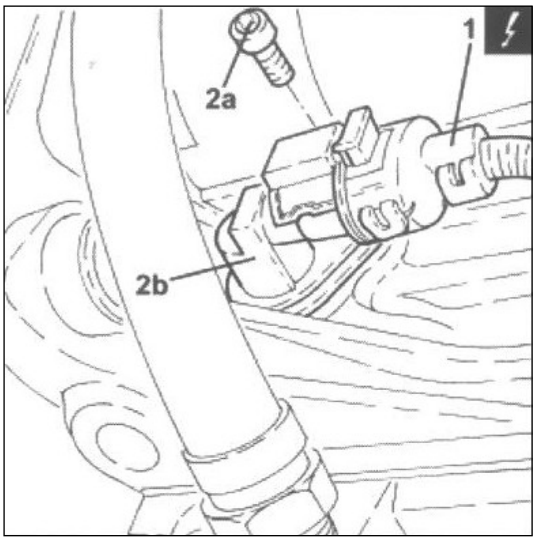
Connect the negative (-) battery terminal.

4.11 Engine rpm sensor

Make sure that the ignition key is in the OFF position, then disconnect the battery terminal (-).

Disconnect the electrical connection from the engine rpm sensor (1).

Undo the bolt (2 a) and remove the rpm sensor (2b).

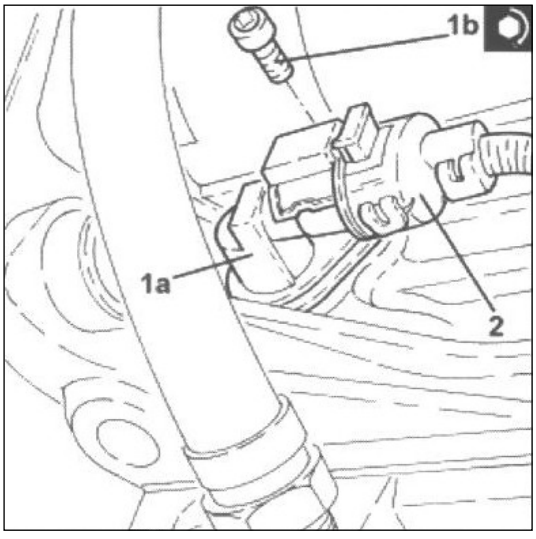


Position the engine rpm sensor (1 a) in its housing and secure it tightening the bolt (1b) to the recommended torque .

Rpm sensor	
Bolt M6 (daNm)	0.6 ÷ 1.0 (engine block side)

Connect the electrical connection for the engine rpm sensor.

Connect the negative battery terminal (-) .

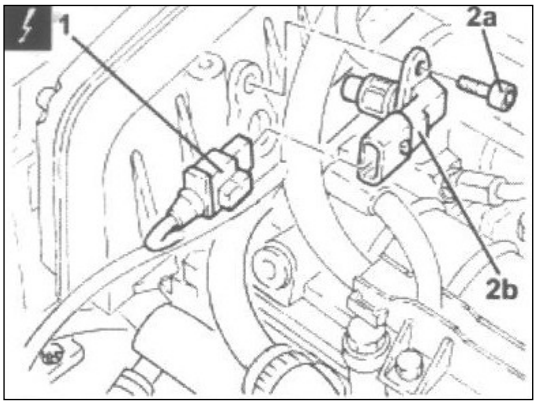


4.12 Cam angle sensor

Make sure that the ignition key is in the OFF position, then disconnect the battery terminal (-).

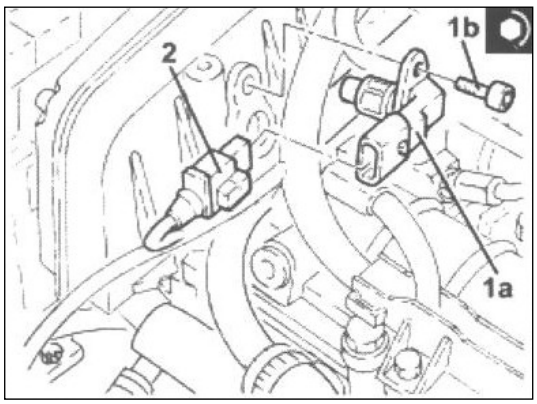
Disconnect the electrical connection from the cam angle sensor.

Undo the bolts (2 a) and remove the cam angle sensor (2b).



Position the cam angle sensor (1 a) in its housing and secure it tightening the bolt (1b) to the recommended torque.

Cam angle sensor	
Bolt M6 (daNm)	0.8 ÷ 1.0 (cylinder head extension side)

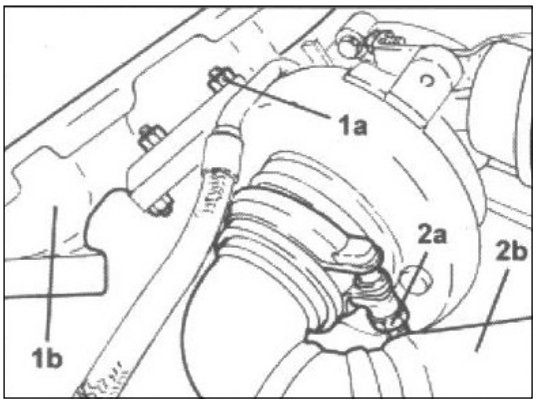


Connect the electrical connection to the cam angle sensor.

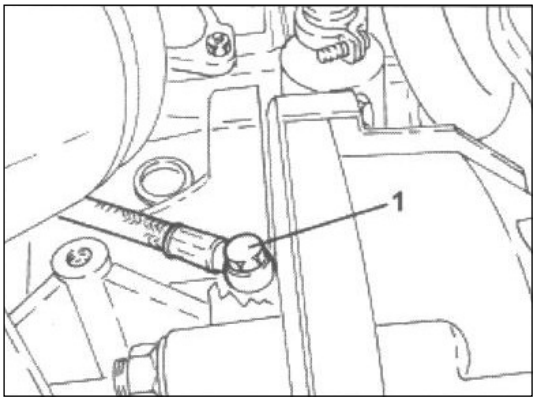
Connect the negative battery terminal (-).

4.13 Variable geometry turbocharger

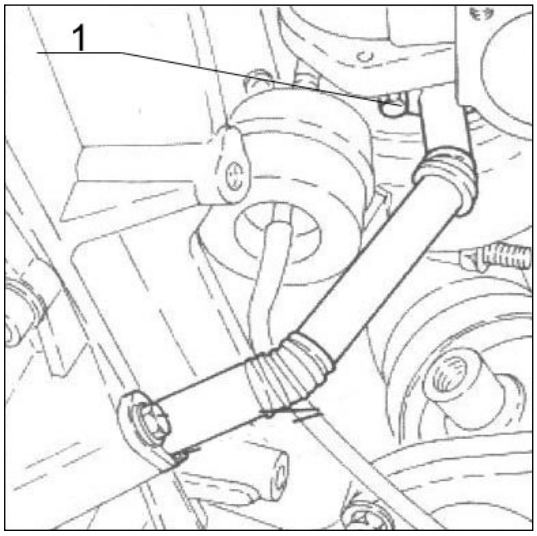
Loosen collar (2 a) and disconnect exhaust pipe (2b) from the turbocharger.



Undo the engine oil delivery pipe connector turbocharger side.

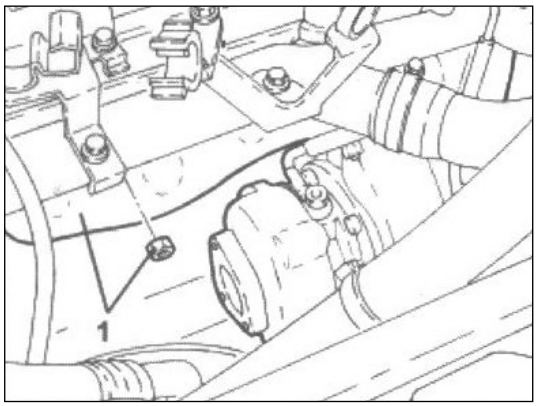


Loosen the collar on the sleeve the engine oil return pipe, turbocharger side.



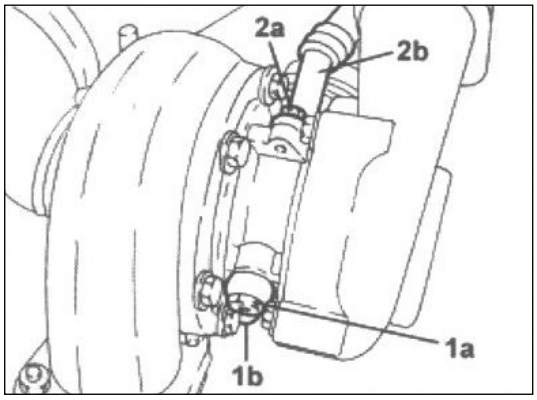
Undo the nuts securing the turbocharger on the exhaust manifold.

Remove the gasket.



Undo connector (1 a) and remove turbocharger engine oil supply pipe (1b).

Undo bolts (2 a) and remove turbocharger oil return pipe (2b).



Place the turbocharger engine oil return pipe back in position and tighten the turbocharger-side bolts to the recommended torque.

Engine oil supply pipe from turbocharger	
Bolt M6 (daNm)	0.8 ÷ 1.0 (turbocharger side)

Place the engine oil supply pipe back in position and tighten the turbocharger-side connector to the recommended torque.

Engine oil supply pipe from turbocharger	
Connector M10 (daNm)	1.5 (turbocharger side)

Tighten the nuts securing the turbocharger to the exhaust manifold to the recommended torque.

Turbocharger fastening	
Nut M8 (daNm)	2.3 ÷ 2.8 (turbocharger side)

Tighten the bolts securing the engine oil return pipe, turbocharger side, to the specified torque.

Engine oil supply pipe from turbocharger	
Bolt M6 (daNm)	0.8 ÷ 1.0 (turbocharger side)

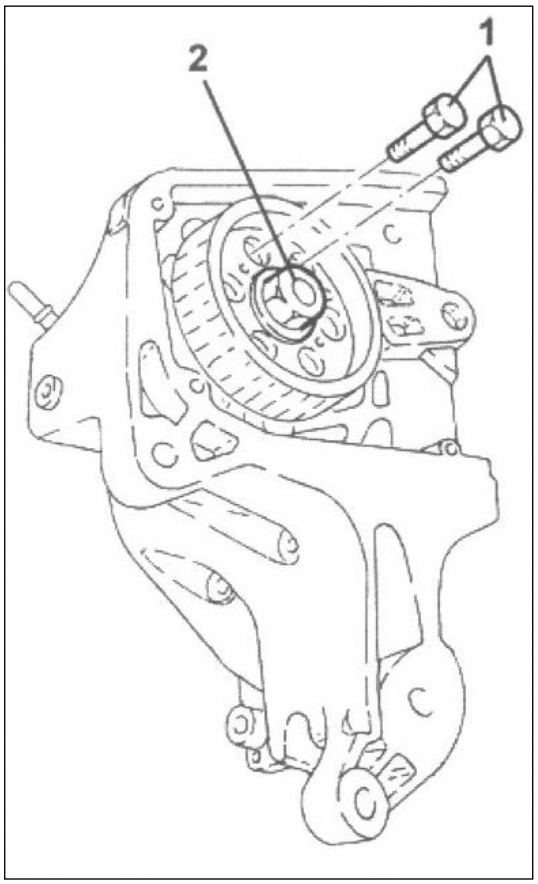
4.14 Pressure pump support VF4

Position the pressure pimp support in a vice fitted with protective jaws.

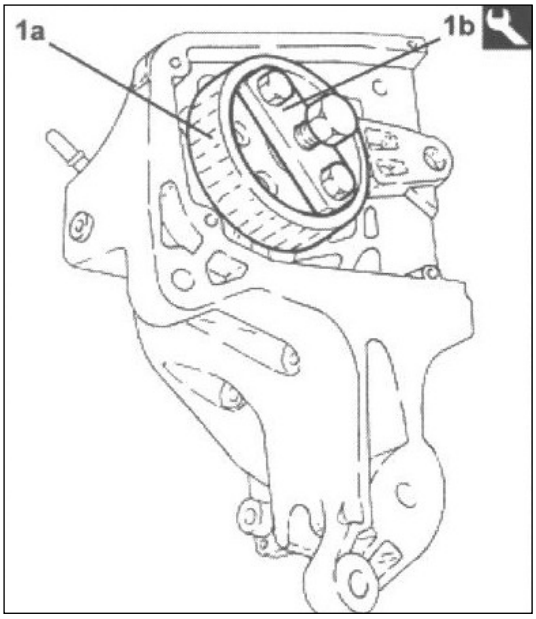
Lock the rotation of the pressure pump drive pulley using two bolts.

Undo the pressure pump drive pulley nut.

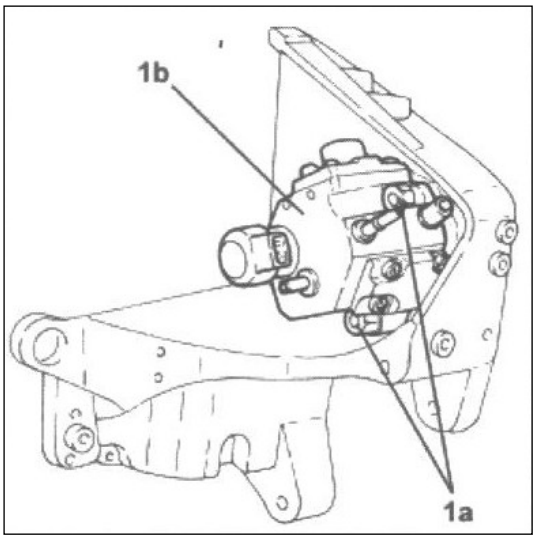
Undo the two bolts for locking the rotation of the pressure pump drive pulley fitted previously.



Remove the pressure pump drive pulley (1 a) using the tools (1b extractor).

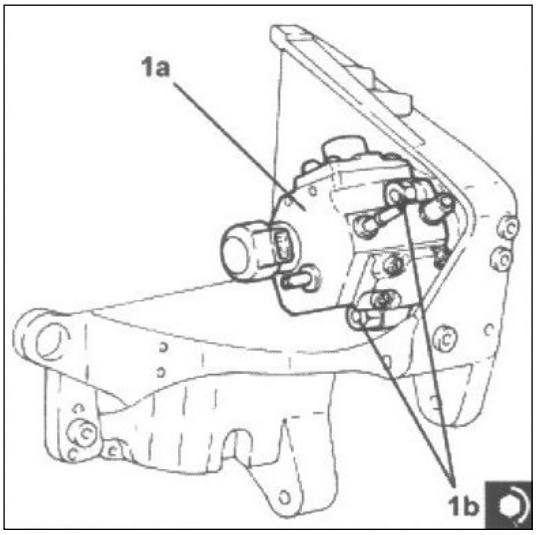


Undo the nuts (1 a) and remove the pressure pump (1b) from the support.



Place the pressure pump (1 a) on the support and secure it tightening the nuts (1b) to the recommended torque .

Injection pressure pump mount	
Nut M8 (daNm)	2.3 ÷ 2.8



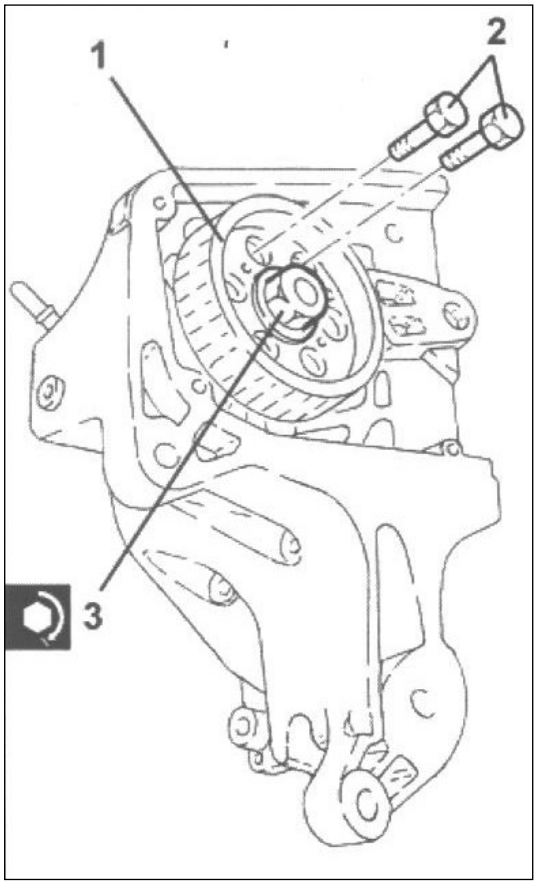
Place the pressure pump drive pulley back in its housing.

Lock the rotation of the pressure pump drive pulley using two bolts.

Tighten the nut fixing the pressure pump drive pulley to the recommended torque.

Pressure pump control pulley	
Nut M14 (daNm)	4.2 ÷ 6.6

Undo the two bolts for locking the rotation of the pressure pump drive pulley fitted previously.



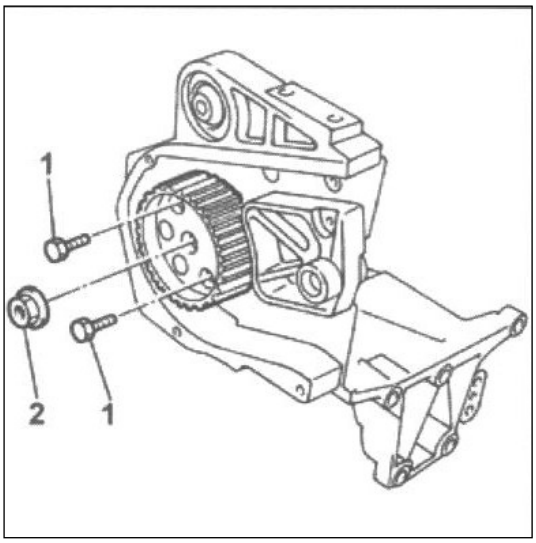
4.15 Pressure pump support VF5

Position the pressure pimp support in a vice fitted with protective jaws.

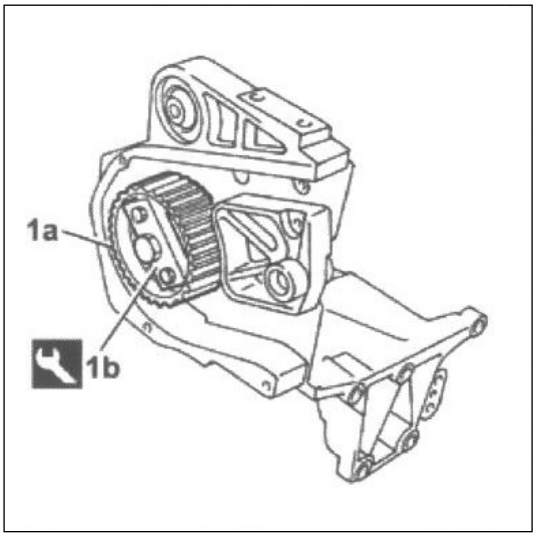
Lock the rotation of the pressure pump drive pulley using two bolts.

Undo the pressure pump drive pulley nut.

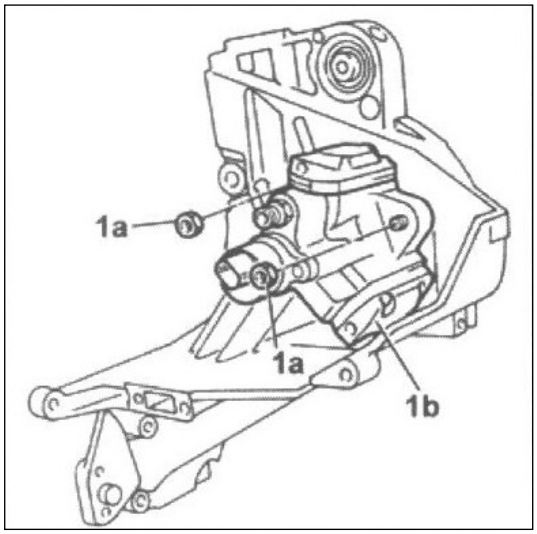
Undo the two bolts for locking the rotation of the pressure pump drive pulley fitted previously.



Remove the pressure pump drive pulley (1 a) using the tools (1b extractor).

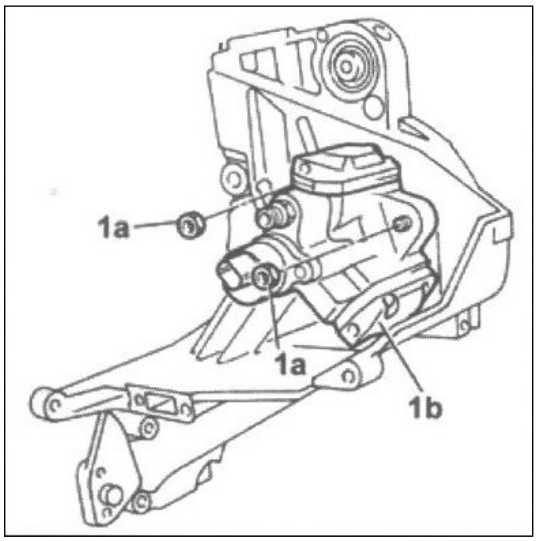


Undo the nuts (1 a) and remove the pressure pump (1b) from the support.



Place the pressure pump (1 a) on the support and secure it tightening the nuts (1b) to the recommended torque.

Injection pressure pump mount	
Nut M8	(daNm) 2.3 ÷ 3.3

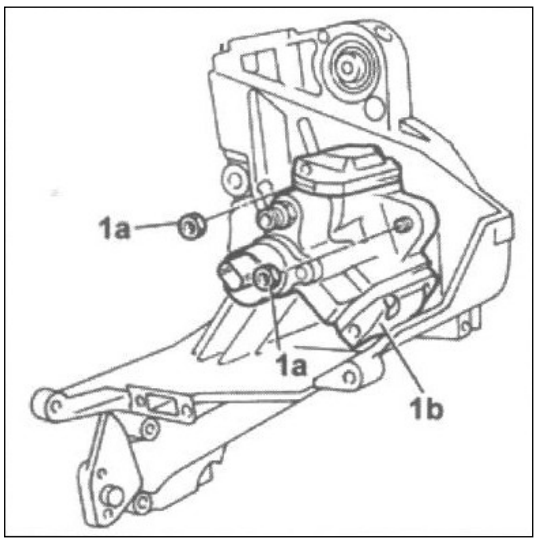


Place the pressure pump drive pulley back in its housing.

Lock the rotation of the pressure pump drive pulley using two bolts.

Tighten the nut fixing the pressure pump drive pulley to the recommended torque.

Pressure pump control pulley	
Nut M14 (daNm)	4.2 ÷ 6.6



Undo the two bolts for locking the rotation of the pressure pump drive pulley fitted previously.

VF4 VF5

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