



industrial engines

section 5

**8460 INDUSTRIAL**

**TURBOCHARGED INTERCOOLED**

**8460SRi10.00**

**8460SRi11.00**

**WORKSHOP MANUAL**

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**IVECO *aifo***

The data contained in this publication may not have been updated following modifications carried out by the manufacturer, at any time, for technical or commercial reasons and also to conform to the requirements of the law in the various countries.

This publication supplies features and data together with the suitable methods for repair operations to be carried out on each single component of the engine.  
Following the supplied instructions and using the inherent specific fixtures, a correct repair procedure will be obtained in due time, protecting the operators from all possible accidents. Before starting any repair, be sure that all accident prevention devices are available and efficient. Therefore check and wear what indicated by the safety provision: protective glasses, helmet, gloves, safety shoes.  
Before use, check all work, lifting and transport equipment.

## 8460 INDUSTRIAL - TURBOCHARGED INTERCOOLED

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**TIMING**

## Valve Timing :

## - Intake

opens : before T D.C . . . . . 31° 8'

closes : after B D C... . . . . . 38° 2'

## - Exhaust

opens before B.D C . . . . . 54°

closes : after T D C... . . . . . 18° 24'

Operating clearance between valves and rockers,  
cold engine.

intake .... . . . . . 0,25 mm

exhaust.. . . . . . 0,50 mm

**FUEL SYSTEM**

In line-injection pump type Bosch PE

Fixed injection pump delivery start advance. . 11° 30'

Fuel injectors setting. . . . . 260 + 8 bar

Firing order . . . . . 1 - 5 - 3 - 6 - 2 - 4

**LUBRICATION**

## Minimum oil pressure:

- at full throttle . . . . . 3 kg/cm<sup>2</sup>- when idling. . . . . 1,5 kg/cm<sup>2</sup>**STARTING**

By starter motor

**ELECTRIC SYSTEM**

- Voltage. . . . . 24 V

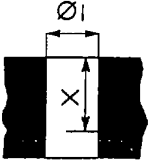
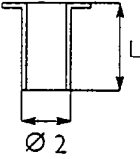


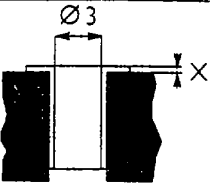
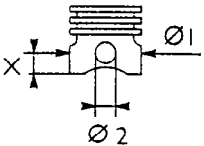


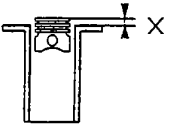
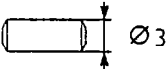


- Self - regulated alternator ..... 24 V, 55 A

- Starting motor power. . . . . 5,4 KW

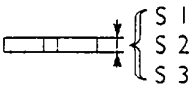


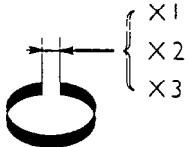
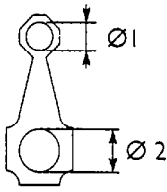
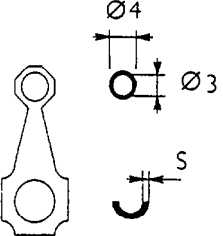


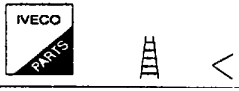
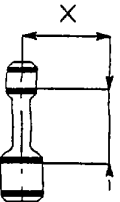
- Battery (optional )... . . . . 2 x 143 Ah

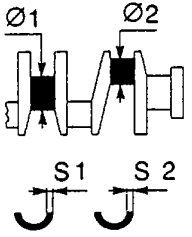
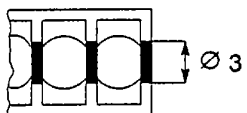


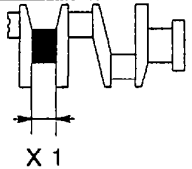
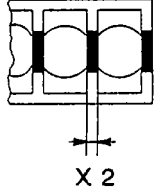
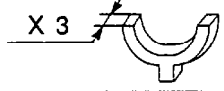


ASSEMBLY CLEARANCE DATA

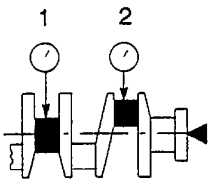
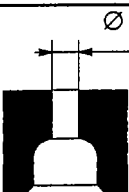
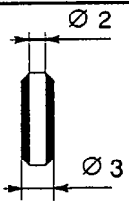


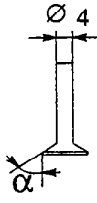


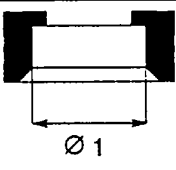
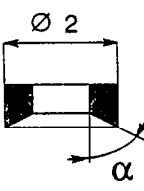
CYLINDER HEAD AND CRANKSHAFTS COMPONENTS

		mm	
	Cylinder barrel housing Ø1	upper lower	137 010 - 137 035 134 000 - 134 025
	Cylinder barrels external diameter Ø2	upper lower	136 975 - 137 000 133 972 - 133 990
	Length	L	-
	Cylinder barrel housings diameter on engine block	upper lower	0010 - 0060 0010 - 0053
	External diameter	Ø2	-
	Cylinder barrel Internal diameter Ø3 Protrusion X		119 990 - 120 015 004 - 007
	Pistons		
	Sizes	X	20
	External diameter	Ø1	119 863 - 119 877
	Pin housing	Ø2	48 008 - 48 012
	Piston - barrel		0 113 - 0 152
	Diameter piston	Ø1	-
	Protrusion pistons	X	max 0,75
	Piston pins	Ø3	47 985 - 47 993
	Pistons pin - pin housing		0015 - 0027
	Split ring slots	X1* X2 X3	320 - 323 306 - 308 503 - 505






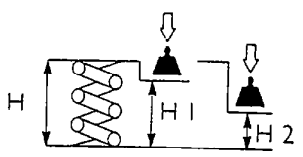
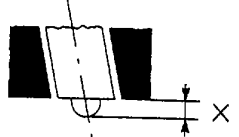
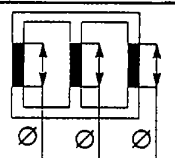
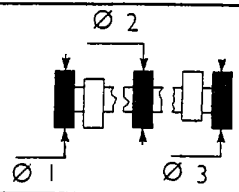
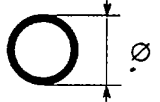




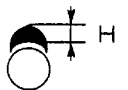

\* The dimension is measured on a diameter of 117 mm

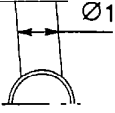
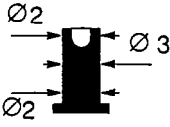


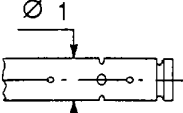
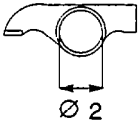


CYLINDER AND CONNECTING ROD UNIT				mm
	Split rings	S 1 *		3 075 - 3 095
		S 2		2 975 - 2 990
		S 3		4 975 - 4 990
*The standard is based on a diameter of 117mm				
	Split ring - slots	1		0 105 - 0 155
		2		0 070 - 0 105
		3		0 040 - 0 075
	Split rings			-
	Opening between the end split ring in cylinder barrel.	X 1		0 40 ÷ 0 65
		X 2		0 25 ÷ 0 50
		X 3		0 30 ÷ 0 45
	Housing diameter for small end bush Housing big end bearing	∅ 1		52 000 - 52 025
		∅ 2		86 213 ÷ 86 235
	Diameter big end journal	external	∅ 4	52 110 ÷ 52 160
		internal	∅ 3	48 023 ÷ 48 033
		Connecting rod half bearing	S	2 079 - 2 089
	Small end journal - housing			0 085 ÷ 0 160
	Piston pin - journal			0 030 ÷ 0 048
	Connecting rod half - bearings			0 254 - 0 508
	Standards	X		125
	Max tolerance on journal alignment	=		0 07

		mm	
	Main journals	Ø 1	
	Crankpins	Ø 2	89,958 – 89,980
	Main bearing shells [S1 = thickness]	S 1	81,978 ÷ 82,000 2,981 ÷ 2,991
	Big end bearing shells [S2 = thickness]	S 2	2,079 ÷ 2,089
	Main bearing housings	Ø 3	96 000 – 96 022
	Bearing shells – main journals – big ends		0,038 ÷ 0,102 0,035 ÷ 0,099
	Main bearing shells		0 254 – 0 508
	Main journal, thrust bearing	X 1	55 94 – 56,00
	Main bearing housing, thrust bearing	X 2	48 00 – 48 05
	Thrust washer halves	X 3	3 870 – 3 920
	Crankshaft end float		0 05 – 0 26
	Thrust washer halves		0 127 – 0 254 – 0 508

		mm	
	Alignment } = 1 Ovalization } ○ 2 Taper } / \ 1-2	≤ 0.05 - 0.010 0.010	
<b>CYLINDER HEAD VALVE GEAR</b>			
	Valve guide housings in the cylinder head	Ø 1	16 000 - 16 018
	Valve guide	Ø 2 Ø 3	9 025 - 9 045 16 028 - 16 039
	Valve guides and seatings in the head		0.010 - 0.039
	Valve guides		-
	Valves	Ø 4 α	8 980 - 8 995 60° 15' ± 5'
		Ø 4 α	8 980 - 8 995 45° 15' ± 5'
	Valve stem and its guide		0.030 - 0.065
	Housing in head for valve seat	Ø 1 Ø 1	50 995 - 51 020 43 985 - 44 015
	Outside diameter of valve seat, angle of valve seat in cylinder head	Ø 2 α Ø 2 α	51 070 - 51 085 60° 44 060 - 44 075 45°



		mm	
	Valve protrusion X 		0.35 ÷ 0.60
	Valve sinking X 		0.8 - 1.05
	Mating between valve and head 		0.050 ÷ 0.090
			0.045 - 0.090
	Spring height		
	Free spring H		83.3
	Spring height under a load of 52 kg ± 2 kg H1 78.75 kg ± 3 kg H2		53 40
	Camshaft support pins X		1.2 ± 0.4
<b>CYLINDER BLOCK AND CRANK MECHANISM COMPONENTS</b>			
	Camshaft bearing housings in crankcase $\emptyset$		65.000 ÷ 65.030
	Camshaft bearing journals		
	front $\emptyset 1$		61.910 - 61.940
	intermediate and rear $\emptyset 2-3$		61.870 ÷ 61.900
	Outside diameter of camshaft bushes $\emptyset$		65.110 ÷ 65.160
	Inside diameter of bushes  $\emptyset$		62.000 ÷ 62.030
	Bushes and housings in crankcase		0.08 - 0.16
	Bushes and bearing journals		
	front		0.06 ÷ 0.12
	intermediate and rear		0.10 ÷ 0.16
	Cam lift		
		H H	8 8

		mm
	Tappet cup housing in crankcase Ø 1	18 000 – 18 027
	Outside diameter of tappet cup Ø 2	17 860 – 17 892
	Ø 3	17 938 – 17 970
	Between tappets and housings	0 030 – 0 089
	Tappets	05 – 1
	Rocker shaft Ø 1	24 015 – 24 036
	Rockers Ø 2	24,06 – 24,08
	Between rockers and shaft	0,024 ÷ 0,065
	Pressure at TDC *bar	≥ 27
	Minimum permissible pressure at TDC * bar	≤ 19
	Engine turnover speed, rpm	200 – 250

(\* ) The value for the pressures is recorded by turning the engine over with the electric starter motor, with oil temperature at 40 – 50° C and the injection pump in the stop condition

**TIGHTENING TORQUE**

DESCRIPTION	TORQUE	
	Nm	Kgm
Cylinder head attachment bolt ◆		
1st stage preliminary torque	100	(10.2)
2nd stage preliminary torque	100	(10.2)
3rd stage angle	180° ± 5°	
Main bearing cap attachment bolts ◆		
Preliminary torque	117.5	(11.9)
Angle	90° ± 5°	
Big end cap attachment bolts ◆		
Preliminary torque	45	(4.6)
Angle	90° ± 5°	
Flywheel attachment bolts ◆		
Preliminary torque	100	(10.2)
Angle	60° ± 5°	
Flywheel cover attachment bolt	150	(15.5)
Bolt retaining pulley to crankshaft ◆		
Preliminary torque	200	(20.4)
Angle	90° ± 5°	
Inlet manifold attachment bolt	32.5	(3.3)
Exhaust manifold attachment bolt	40	(4)
Compressor gear attachment nut	140	(14.2)
Rocker shaft mounting attachment bolt		
Preliminary tightening	17	(1.7)
Angle	180° ± 5°	
◆ Lubricate with UTDM oil before tightening		

**TOOLS**

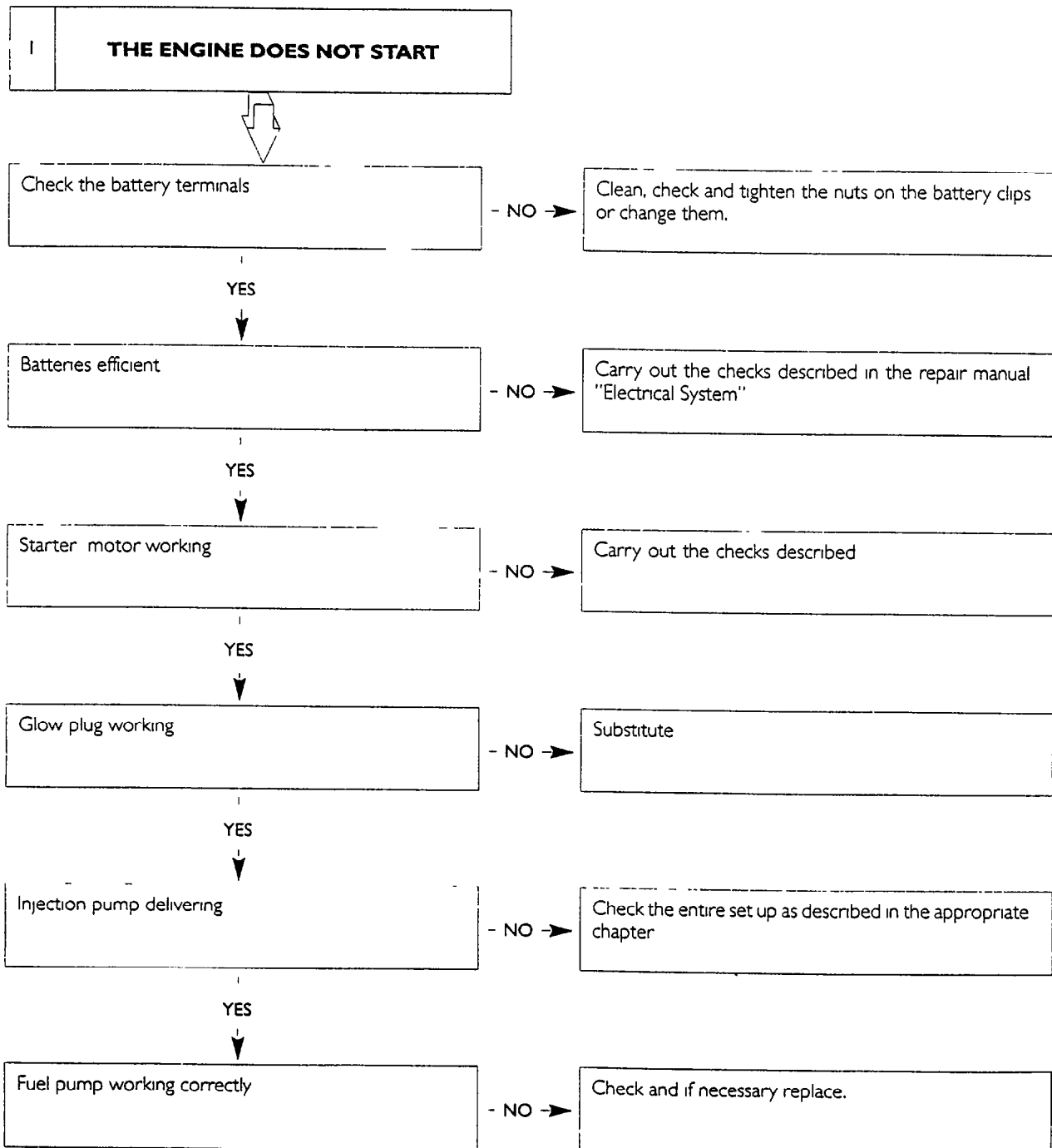
TOOL NUMBER	DESCRIPTION
99342145	Extractor for injector holder case
99350071	Socket wrench (19 mm) with 3/4" square attachment for tightening cylinder head bolts
99350108	Wrench for valve gear clearance adjustment screw
99360184	Pliers for fitting rings to engine pistons
99360268	Tool for removing and refitting engine valves
99360314	Tool for removing cartridge filters
99360320	Tool for turning flywheel
99360351	Tool for retaining flywheel
99360423	Tool for fitting front crankshaft seal (use with 99370006)
99360471	Adaptor for checking cylinder compression (use with 99395682)
99360475	Drift for removing and fitting bushing on injection pump shaft mounting (use with 99370000)
99360481	Drift for removing valve guide
99360494	Drift for fitting valve guide (use with 99360481)
99360500	Crankshaft lifting tool
99360504	Ring for lifting cylinder block
99360585	Hoisting beam for removing and refitting engine
99360603	Ring clamp for inserting standard and oversize pistons into the cylinders
99360772	Threaded plate
99360776	Set of studs
99360778	Extraction bolt
99360782	Ring
99360790	Set of parts
99361032	Brackets for securing engine to swivelling stand 99322230
99365063	Tool for refitting injector holder cases
99370006	Handle for interchangeable drifts
99370415	Tool for measuring cylinder liner protrusion
99370454	Installing tool for fitting crankshaft rear seal (use with 99380006)
99390311	Reaming tool for valve guide
99390789	Set of taps for threading injector holder cases to be extracted
99394017	Reamer for reconditioning lower part of injector holder case (use with 99394019)
99394019	Pilot bush
99394020	Milling wheel for facing injector support housing (use with 99394019)

DIAGNOSTICS

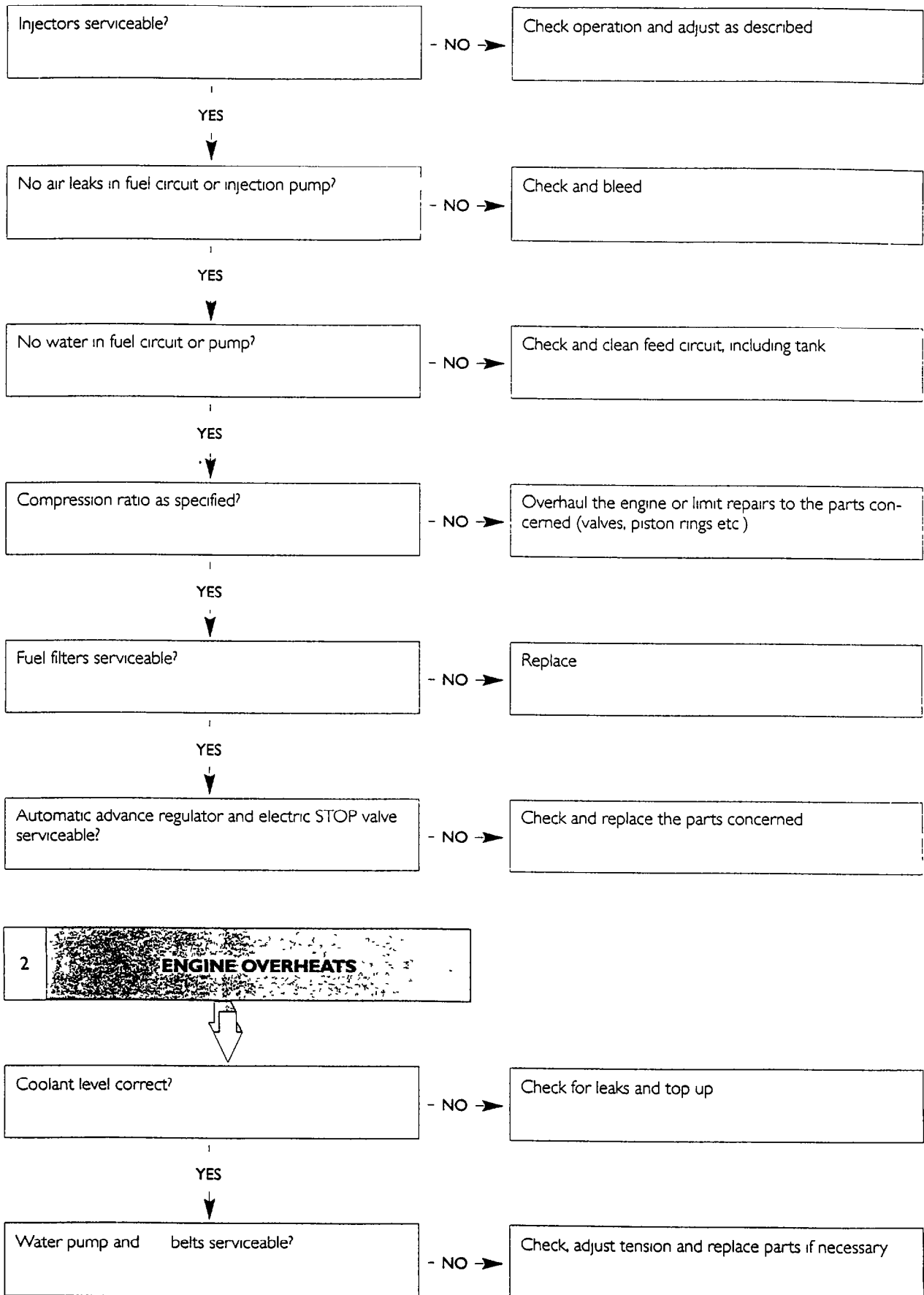
Main engine troubles

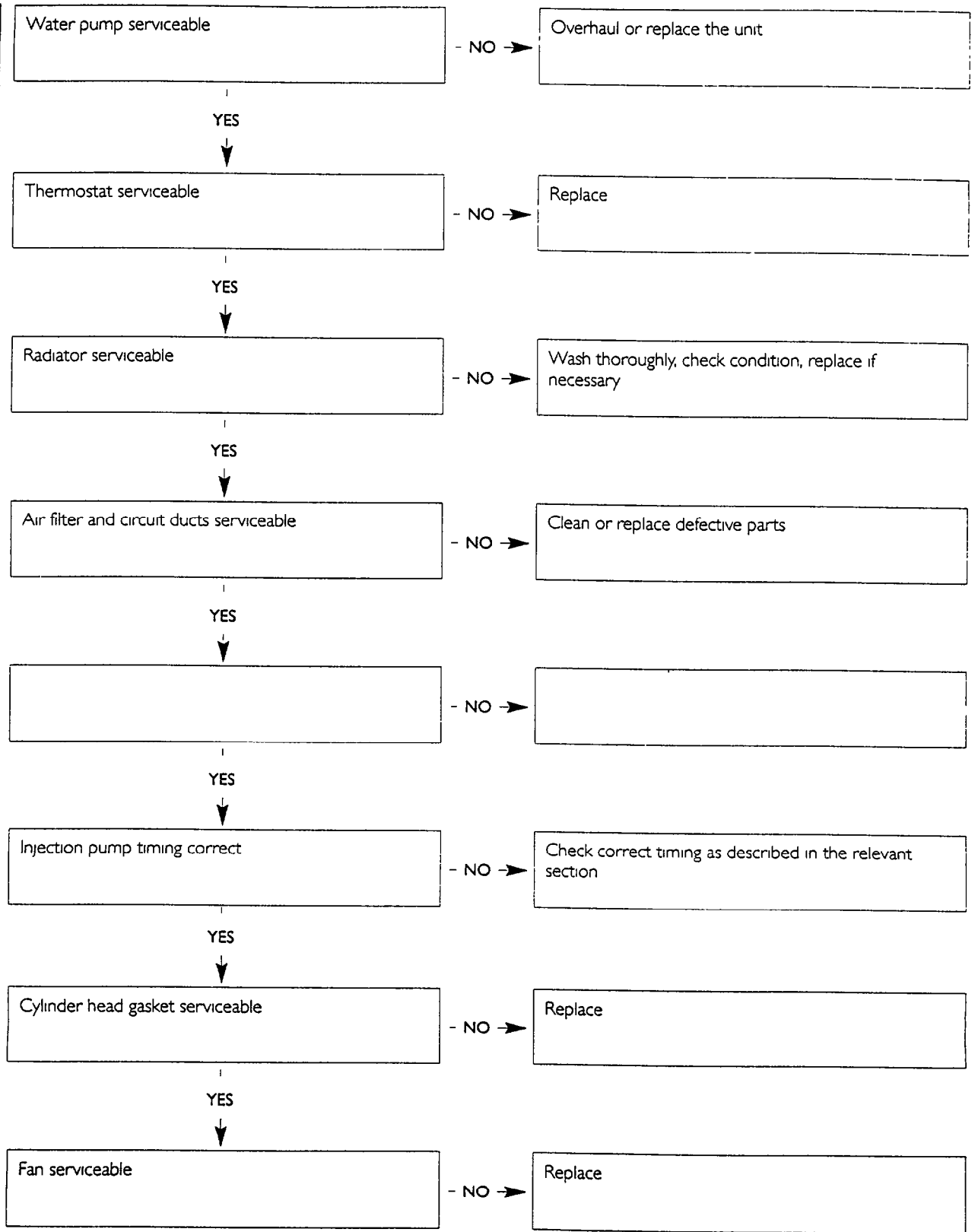
- 1 - The engine does not start.
- 2 - The engine overheats
- 3 - The engine lacks power.
- 4 - Exhaust fumes are black or dark grey
- 5 - Exhaust fumes are grey

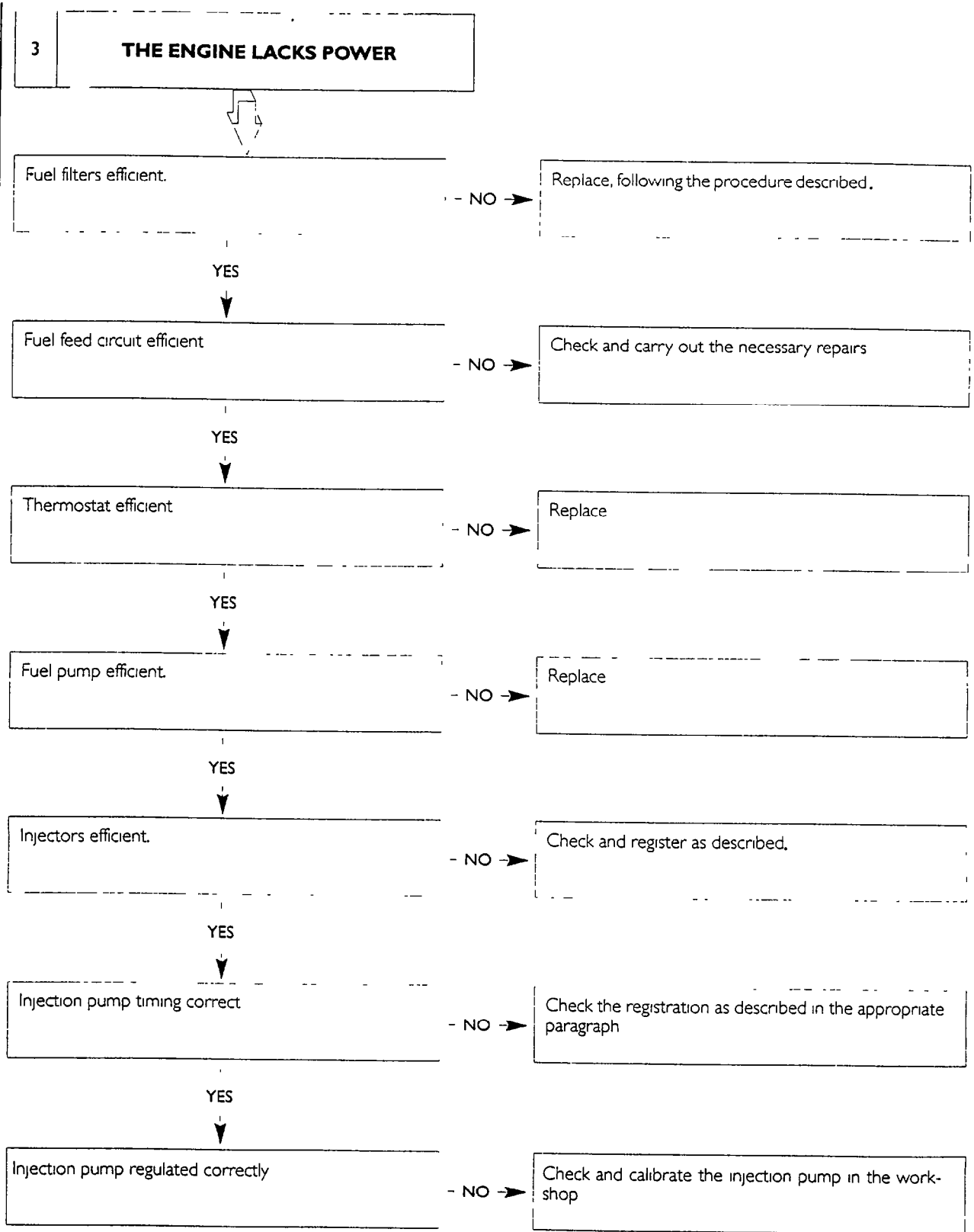
- 6 - Exhaust fumes are blue
- 7 - The engine functions irregularly
- 8 - The engine stops
- 9 - The engine exceeds the maximum rpm
- 10 - Oil pressure is too high or too low
- 11 - Fuel consumption is too high



(continued)

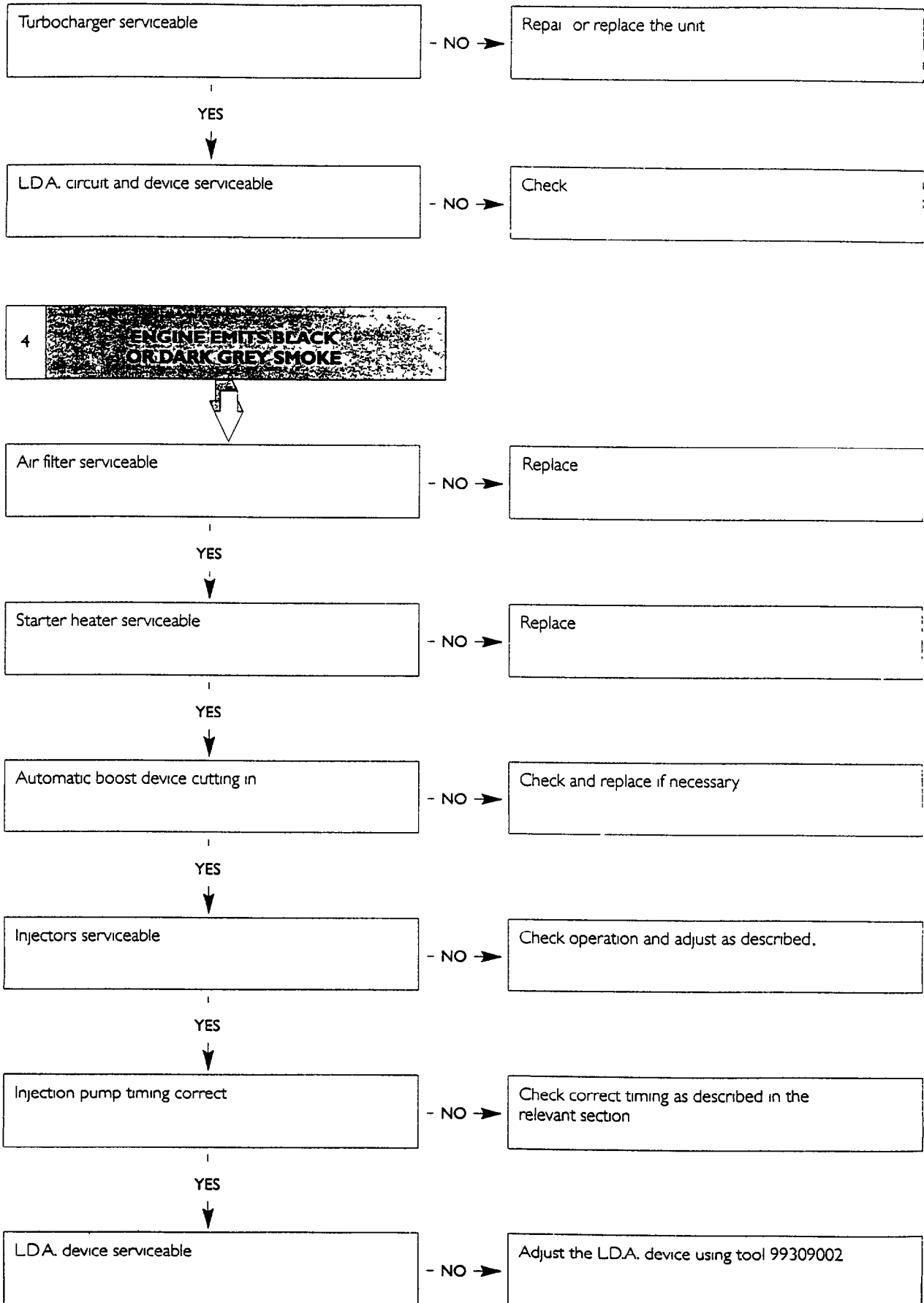






(continued)





LDA device efficient

- NO →

Check the setting of the LDA device using tool 99309002

YES



Injection pump settings correct

- NO →

Check and calibrate the injection pump in the workshop

YES



Compression ratio correct

- NO →

Check using tool 99395682 and carry out necessary repairs

YES



Fuel of good quality

- NO →

Clean the tank and replace the fuel filters

5

**THE EXHAUST FUMES ARE GREYISH/WHITE**



Thermostat working properly

- NO →

Replace

YES



Injectors working properly

NO →

Check and calibrate according.

YES



Injection pump adjusted correctly

- NO →

Check the settings as described in the relative paragraph

YES



Coolant level correct

NO →

Probable leakage of the coolant into the combustion chamber, replace the cylinder head gasket or overhaul the engine

(continued)

6 **ENGINE EMITS BLUE SMOKE**



Excessive oil consumption

- NO →

Check oil breather, cylinder compressions  
If necessary, overhaul the cylinder head or engine

7 **ABNORMAL KNOCKING FROM THE ENGINE**



Knocking coming from crankshaft

- NO →

Check main journals for clearance and ovality, tightness of main bearing cap bolts and flywheel bolts, oil pressure  
Replace parts or overhaul the engine

YES



Knocking coming from connecting rods

- NO →

Check crankpins for clearance and ovality, tightness of connecting rod cap bolts, connecting rods for distortion  
Replace parts or overhaul the engine

YES



Knocking coming from pistons

- NO →

Check clearance between pistons and cylinder liners, piston rings for breaks, gudgeon pin to piston boss clearances  
Replace parts or overhaul the engine

YES



Knocking coming from cylinder head

- NO →

Check operating clearance between rocker arms and valves, injection pump timing, valve timing  
Adjust.

YES



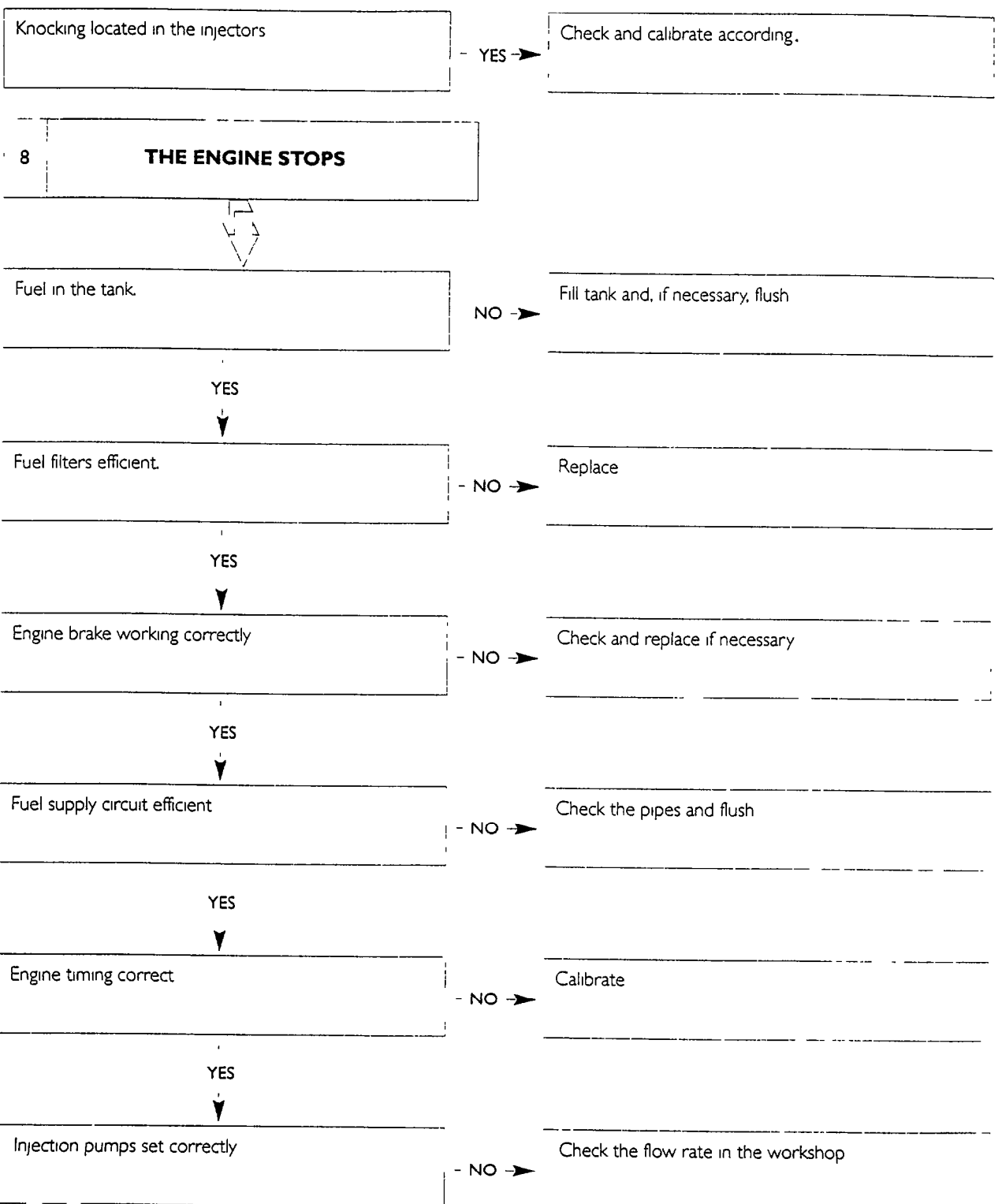
Knocking coming from timing gears

- NO →

Check gears and replace if necessary

YES





(continued)

9 **ENGINE EXCEEDS MAXIMUM RPM**



Speed governor operating correctly

- NO ->

Check and replace worn parts if necessary

10 **OIL PRESSURE TOO LOW OR TOO HIGH**



Pressure relief valve operating

- NO ->

Check and replace if necessary

YES



Oil pump and delivery pipes serviceable

- NO ->

Check and replace if necessary

YES



Main and big end bearings serviceable

- NO ->

Replace bearings and if necessary recondition crankshaft

YES



Engine oil viscosity correct

- NO ->

Replace engine oil with one of suitable viscosity

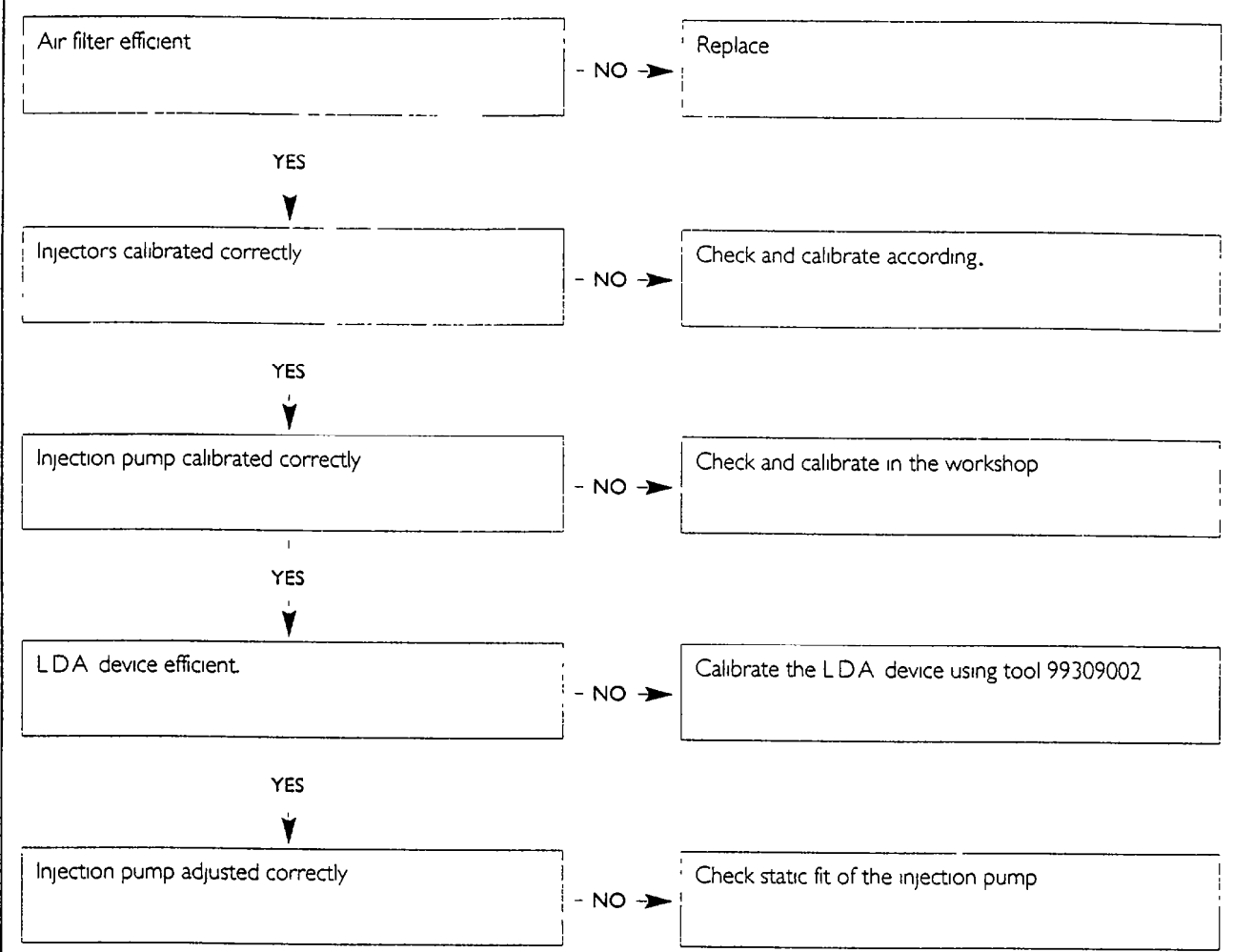
11 **EXCESSIVE FUEL CONSUMPTION**



Fuel tank and pipes serviceable

- NO ->

Eliminate any leaks and replace parts showing deterioration

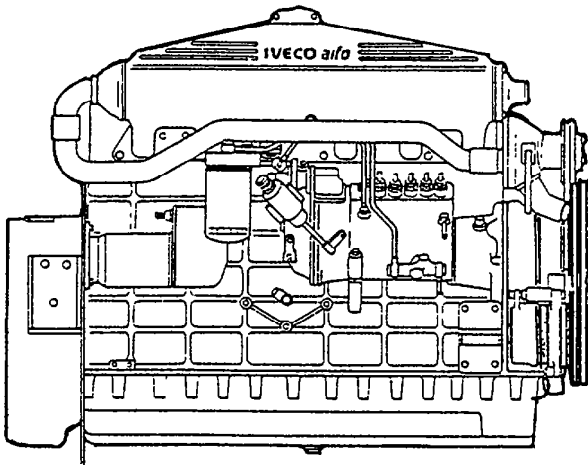


**DISMANTLING THE ENGINE ON THE BENCH**

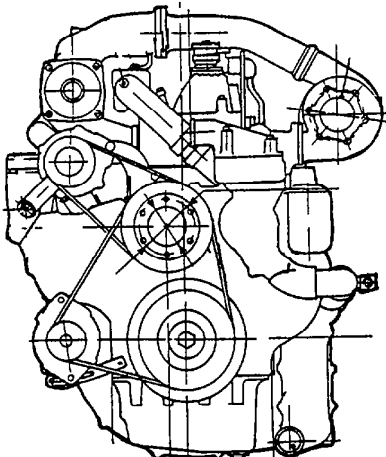
Secure the engine to swivelling stand 99322230 by means of brackets 99361032, drain the lubrication oil from the engine oil sump  
 Remove the oil level dipstick sleeve  
 Disconnect the viscocstatic fan assembly

The viscocstatic fan must be replaced in upright position

Continue dismantling the engine by removing

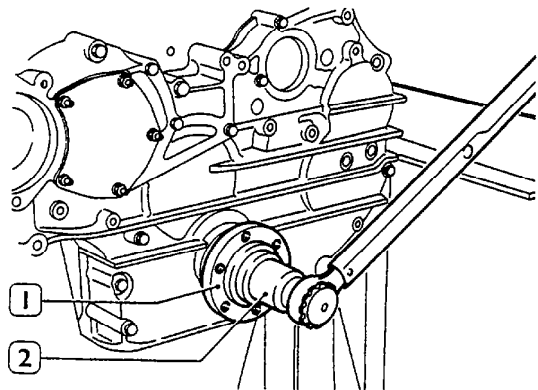


- starter motor
- fuel hoses from injection pump,
- fuel filters with mounts,
- fuel recovery line
- air line for LDA device,
- inlet manifold
- fuel delivery line
- injection pump
- injectors, removing retaining brackets,
- cylinder head coolant manifold
- rocker cover



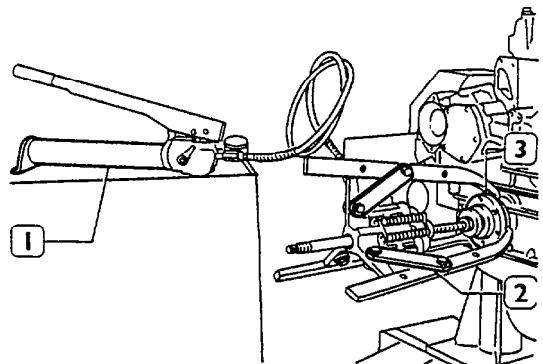
- belts driving alternator
- alternator
- return pulley and mount,
- water filter
- pipe from coolant pump to heat exchanger, water pump with thermostat,
- belt drive pulley and damping flywheel

**Removing damping flywheel hub**



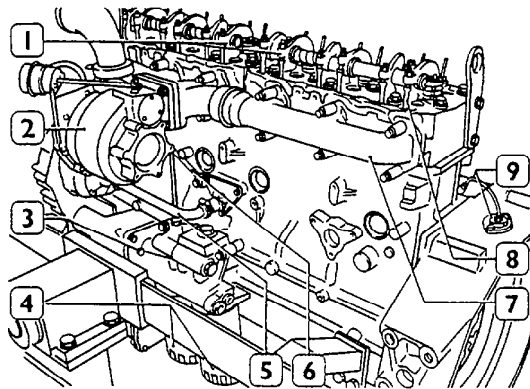
36085

Prevent crankshaft from rotating using tool 99360351  
 Using suitable socket wrench (2), unscrew bolt retaining hub (1), screw reaction block 99340029 in place of the bolt. This precaution protects the operator against the possibility of the hub suddenly coming loose during removal



36086

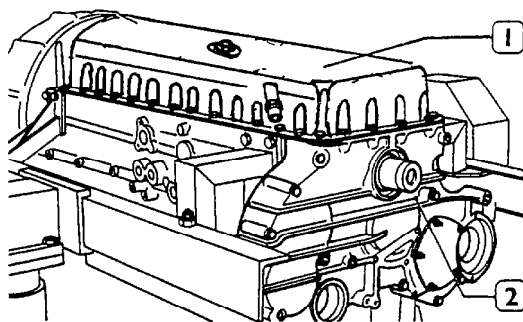
Apply extractor 99340030 (2) to hub (3) complete with hydraulic unit 99341033 Remove the damping flywheel hub with the aid of hydraulic pump 99341034 (1).



36087

Continue by disconnecting

- The lines for oil delivery to (5) and return from (6) the supercharger
- the supercharger (2)
- oil filters (4) and bracket (3) complete with the heat exchanger
- air compressor and water pipes
- exhaust manifold (7)
- equaliser shaft (1)
- equaliser control rods (8)
- valve stem caps
- cylinder head using appropriate eyebolt
- two impulse transmitters (9) on the rear bracket and on the injection pump bracket

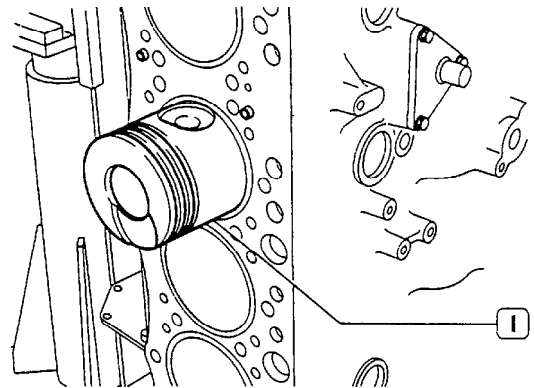


36088

Rotate the engine and remove

- the oil sump (1)
- timing gear cover (2)
- oil pump complete with engine oil suction rose

Only for the engine models with two oil pumps the two oil delivery and return pumps complete with engine oil suction rose

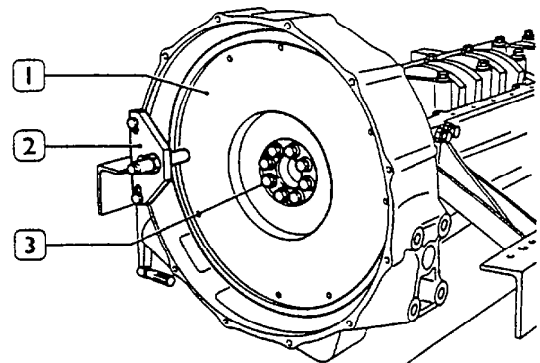


36181

- big end caps with half bearings
- connecting rod – piston unit (1) withdrawing them from the upper part of the piston barrels

When removing the connecting rod – piston unit check whether the connecting rods and relative caps are numbered. If they are not mark them with appropriate numbers according to the barrels they belong to.

### Stripping the Engine Flywheel

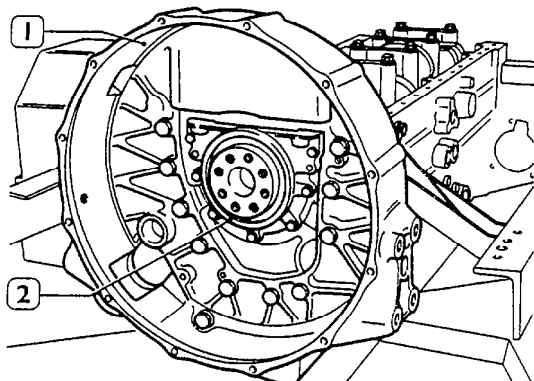


36089

Using tool 99360351 (2) block the rotation of the flywheel (1), loosen the screws (3), remove the tool (2) and remove the engine flywheel

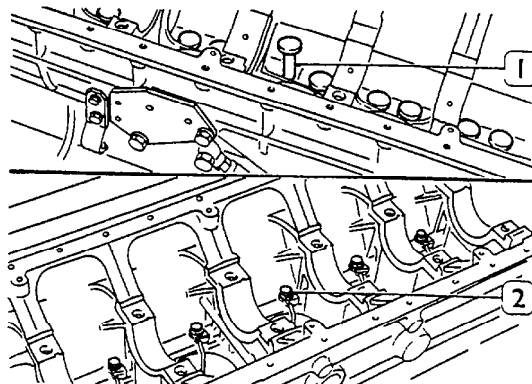
Continue by removing:





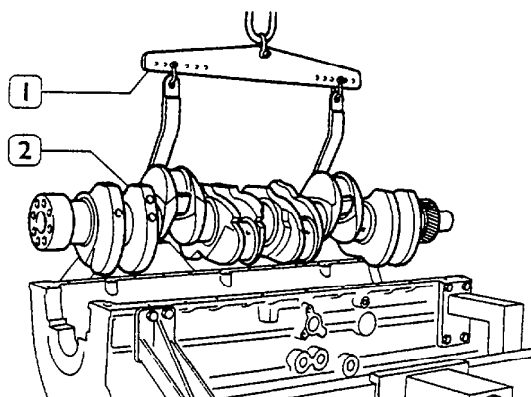
36090

rear mounting (1),  
cover (2) with sealing ring.



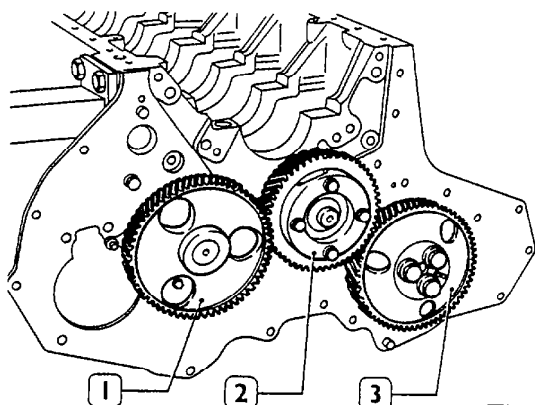
136093

tappets (1),  
oil spray jets (2),  
cylinder liners as described on page 24



36091

main bearing caps with bearing shells,  
crankshaft (2) by means of tool 99360500 (1),  
main bearing shells and half-rings.



36092

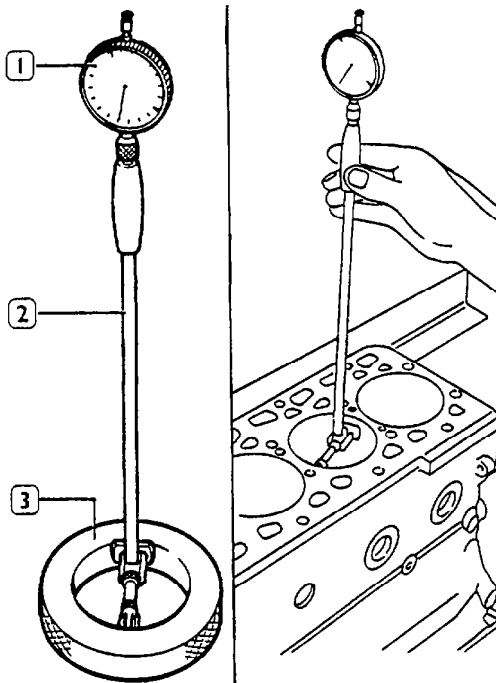
idler gear (2) and mounting;  
injection pump drive gear (3),  
mounting with injection pump toothed coupling,  
camshaft (1),

Once the engine is dismantled, clean the parts  
thoroughly and check for damage

The following pages give instructions for the main checks and  
measurements to be carried out in order to determine whether  
parts are fit for re-use on reassembly

**SERVICING**  
**CYLINDER UNIT**  
**Checks and measurements**

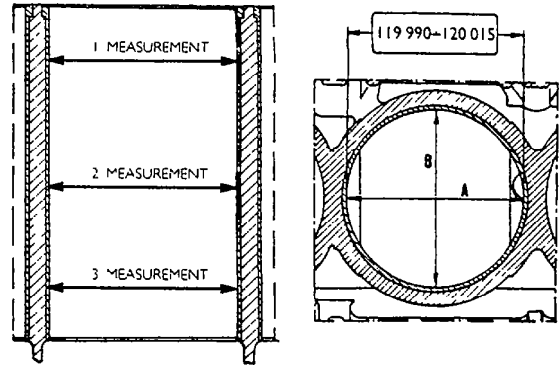
Examine the surfaces of the piston barrels, they must not show any signs of seizing, scoring, ovalization or excessive taper



32579

Internal diameter of the piston barrels is checked for ovalization, excessive taper or wear using a 1/100 bore dial gauge 99395687 (2) previously reset to ring gauge diameter 120 mm.

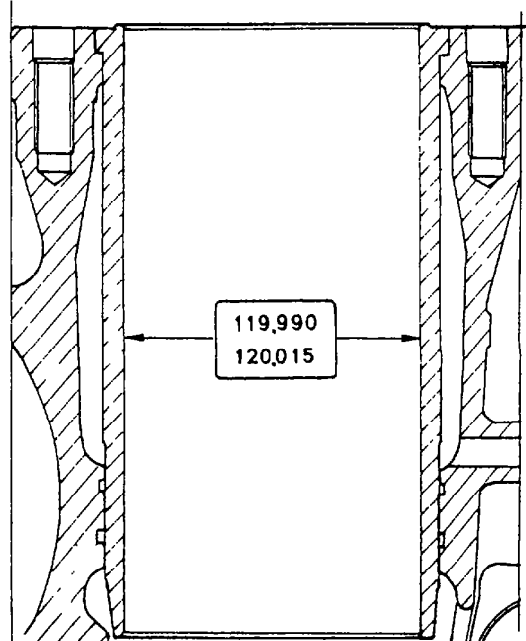
If a 120 mm ring gauge is not available use a micrometer calliper



32332

DIAGRAM FOR PISTON BARREL DIAMETER CHECK

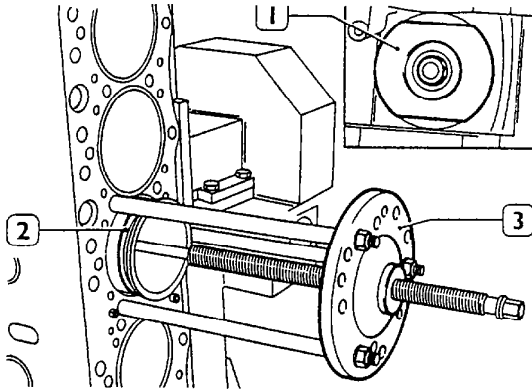
The measurements must be taken for each cylinder at three different heights in the cylinder and on two planes one parallel to the longitudinal axis of the engine (A) and the other perpendicular (B). Maximum wear is usually found in plane (B) in correspondence with the first measurement



22333

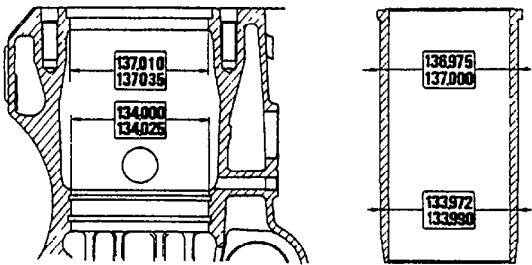
In the case of maximum wear (0.150 mm) or maximum ovalization (0.100 mm) in comparison with the values indicated in figure 23 the barrels must be replaced. The barrels have been subjected to "soft nitriding" treatment and cannot be ground, lapped or trued

REPLACING CYLINDER LINERS



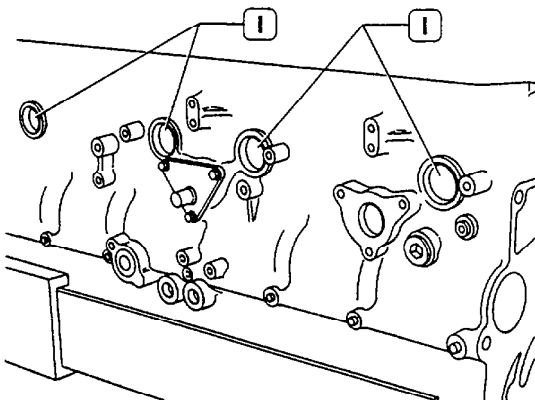
36094

Remove cylinder liners (2) using plate 99360782 (1) and tool 99360711 (3) applied as shown in the diagram



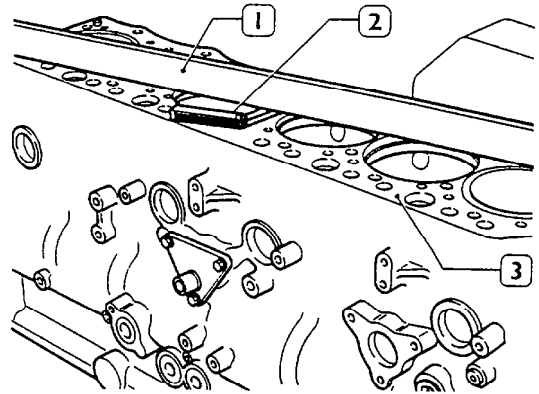
22334

Carefully check cylinder liner seats, the diagram shows the diameters of cylinder liners and seats  
Cylinder liners may be removed and refitted in different seats several times if necessary



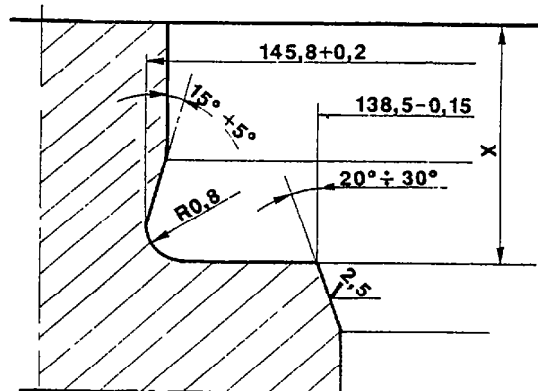
36095

Check the conditions of plugs (1) fitted in machining holes and associated with cylinder unit. Replace if found to be rusty or if the seal appears to be poor



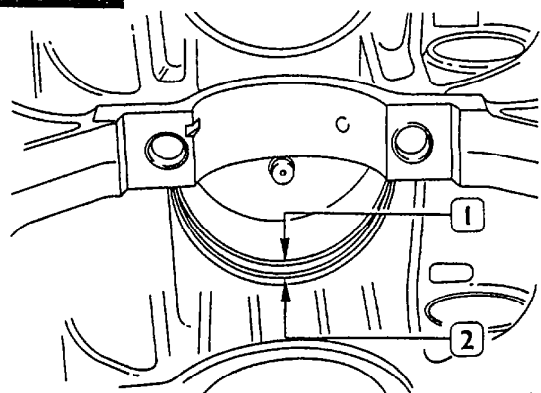
36096

Check cylinder head mating surfaces (3) are flat using a calibrated rule (2) and feeler gauge  
Grind any rough spots removing as little material as possible after removing the locating dowels



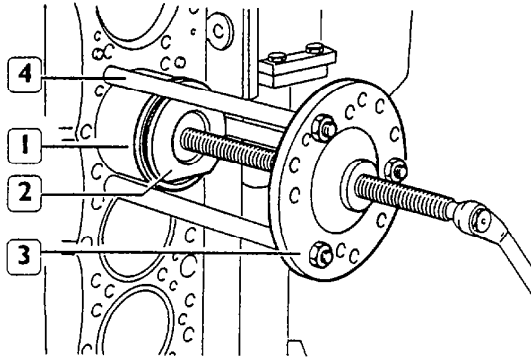
36060

After grinding the cylinder head surface, restore the depth of the cylinder liner border support base X to 10 09 – 10 05 mm

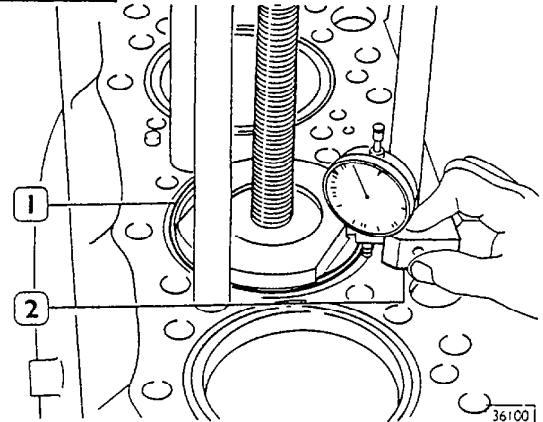


36097

Always replace water seals (1 and 2) each time the cylinder liners are fitted.



Fit the ring gauge (1) on the piston barrel, lubricate the lower part of the barrel and fit it using plate 99360782 (2), tool 99360799 (3) and rods 99360776 (4)  
Repeat the checks on the protrusion of the piston barrels as described below

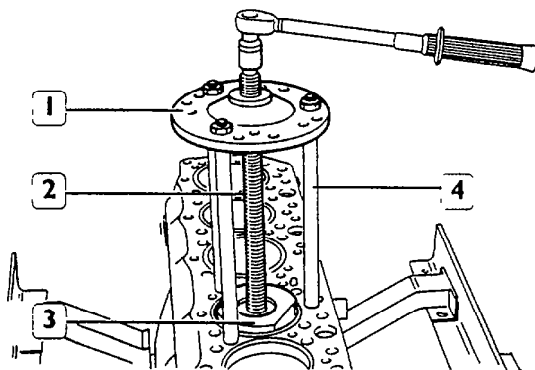


Using tool 99370415 (2), fitted with a dial gauge, check that the protrusion of the piston barrels (1) is 0.040 - 0.07 mm  
If the values registered are not within these limits proceed as follows

- extract the piston barrel, remove the water seals (1 and 2, Figure 29)  
remove the ring gauge (1, Figure 30)
- replace the barrel and set up the tool (1 and 3, Figure 31)
- tighten the screws to torque 140 Nm to ensure that the edge of the barrel is sitting correctly in the housing
- using tool 99370415 (2, Figure 32) fitted with a dial gauge, measure the cavity in two places (at 180°) and find the average depth

Then on the basis of the average depth use the table below to find the correct ring gauge to fit

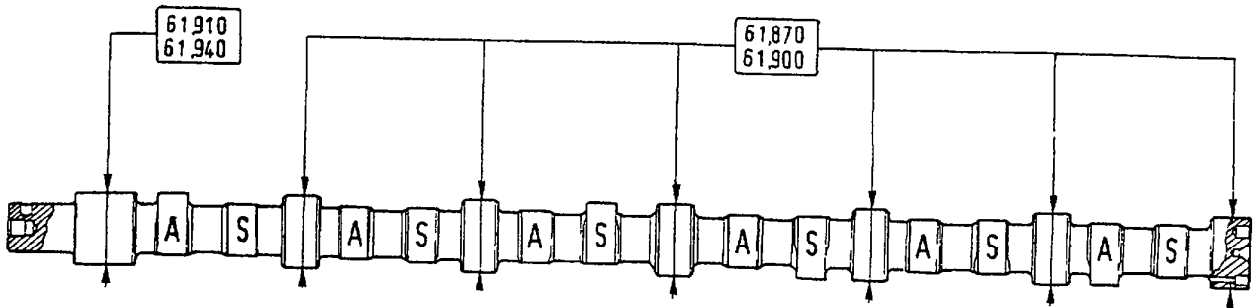
### Checking and Calibrating Protrusion of Piston Barrels



The check on the protrusion of the piston barrels is carried out using plate 99360782 (3) and tool 99360799 tightening the screw to torque 140 Nm

Depression within range (mm)	Thickness of shim to be fitted (mm)
0.015 - 0.034	0.08
0.035 - 0.054	0.10
0.055 - 0.074	0.12
0.075 - 0.095	0.14

**VALVE GEAR  
CAMSHAFT**



**MAIN CAMSHAFT DATA**

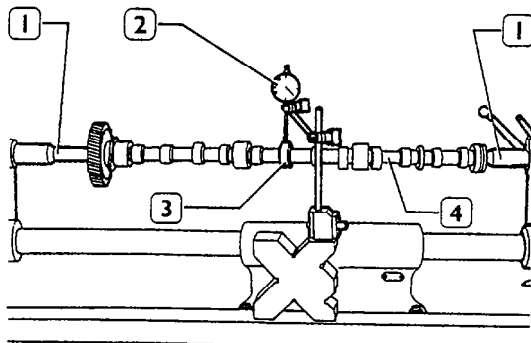
The data given refer to normal journal diameter

18083

The surfaces of shaft bearing journals and cam journals should be perfectly smooth, it is advisable to replace the shaft and

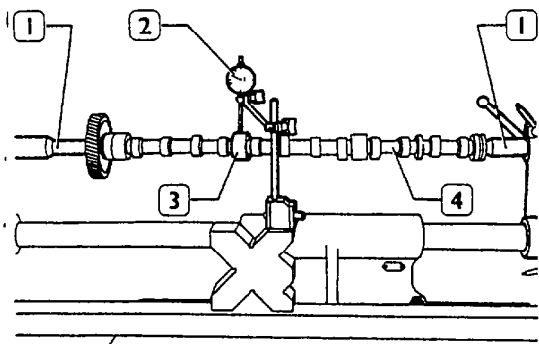
bushes if the journals show signs of binding and scoring

**CHECKING CAM LIFT AND JOURNAL ALIGNMENT**



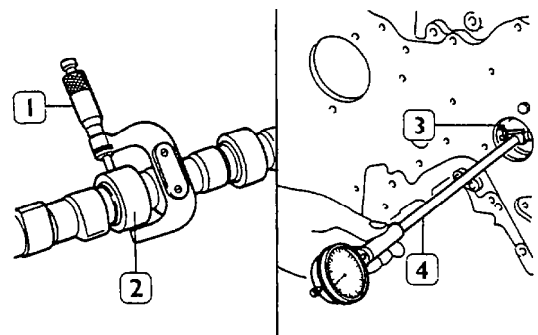
32716

Arrange the camshaft (4) between the centres (1) and use dial gauge (2) check the lift of cams (3) which should be  
8 mm for the inlet cam  
8 mm for the exhaust cam



32717

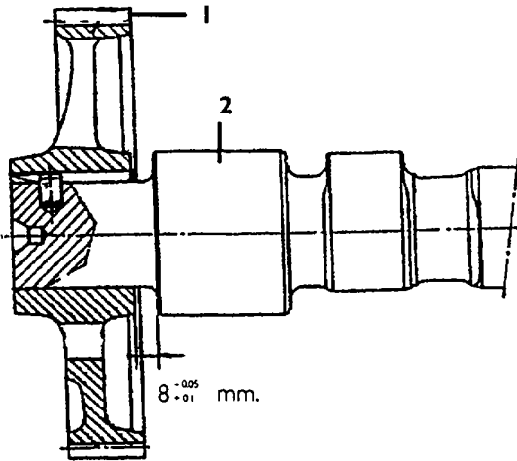
Still with camshaft (4) arranged between centres (1), check misalignment of bearing journals (3) for misalignment using dial gauge (2), this should not exceed 0.020 mm  
Replace the shaft if misalignment is found to be greater



36101

To check the installation fit, measure the diameter of camshaft journals (2) using micrometer (1) and the inside diameters of bushes (3) using bore micrometer (4). The actual installation fit is calculated as the difference between the two values. This should be 0.60 – 0.120 mm for the front bearing and 0.100 – 0.160 mm for intermediate and rear bearings  
If higher clearances are found, replace the bushes and also the camshaft, if necessary

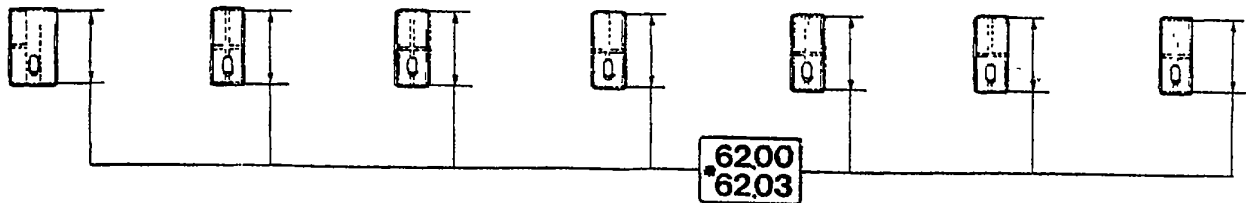
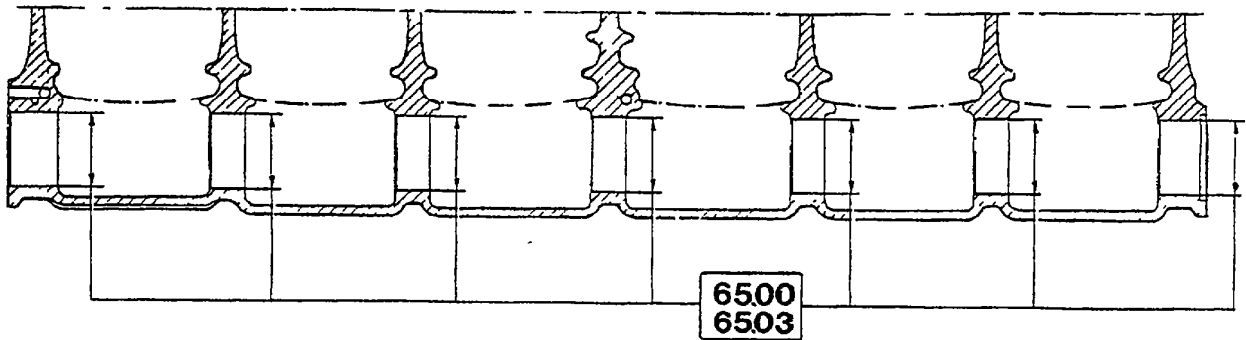
Replacing Camshaft Gears



36102

Check that the teeth of the control gear (1) are not broken or worn. If the gear (1) is to be replaced it must be welded at 200°C and fitted so that the distance between the shoulder of the camshaft (2) and the shoulder of the gear is  $8.005^{+0.005}_{-0.01}$  mm.

BUSHINGS



36132

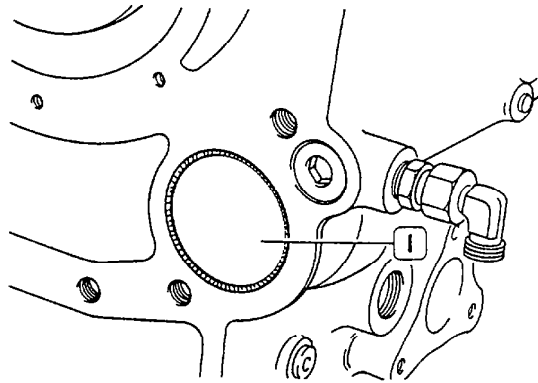
MAIN DATA FOR THE BUSHING OF THE CAMSHAFT AND RELATIVE HOUSING

\* Value to be taken after fitting the bushings

The camshaft bushings must fit very tightly in their housings. The internal surfaces must not show any traces of drag or wear. Before replacing the bushings measure their diameter

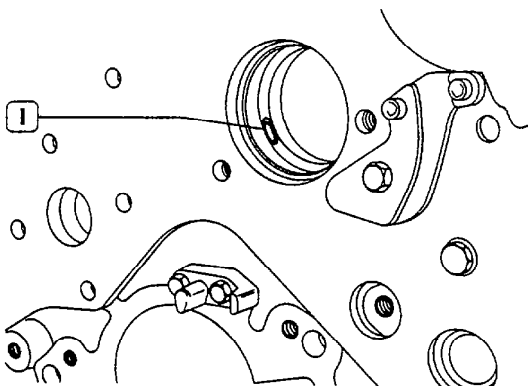
with the bore dial gauge (figure 31). For the stripping and refitting of the bushings use an appropriate beater.

**REPLACING BUSHES**



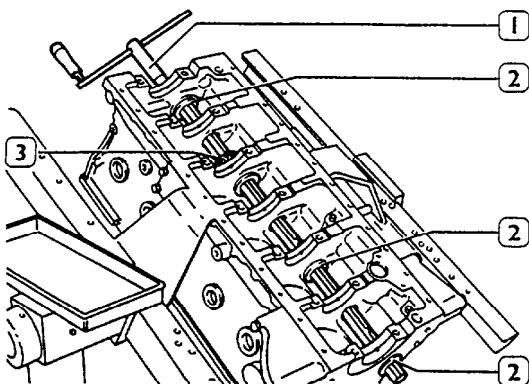
36103

In order to replace the rear bush, first remove sealing plug (1) on crankcase, Spread LOCTITE 275 over the surfaces of plug (1) when fitting



36104

Fit the bushes so that oil feed holes (1) are aligned with crankcase holes



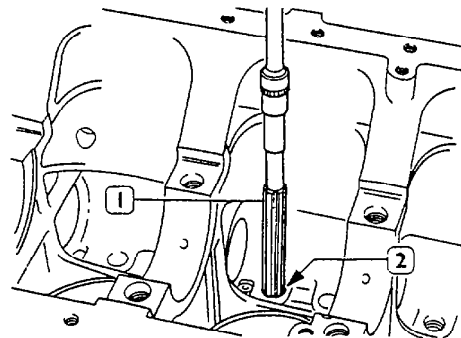
32721

After fitting, ream the camshaft bushes to specified values using chuck (1) fitted with guide bush (2) and cutter (3)

**TAPPETS**

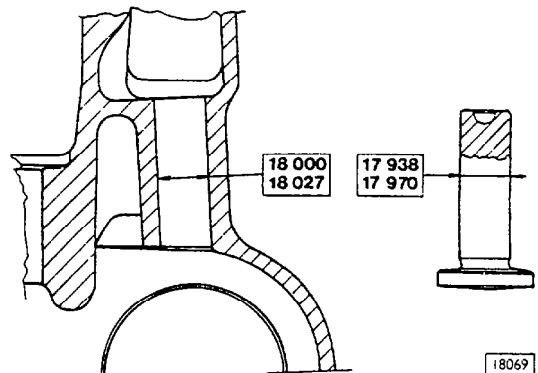
Replacement tappets are supplied in standard sizes and 0.5 – 1 mm oversize

**Replacing tappets**



36105

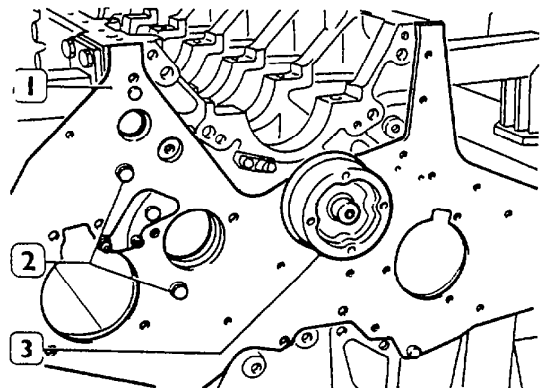
When replacing loose tappets, fit oversize tappets and ream out housings (2) using a suitable reamer (1)



18069

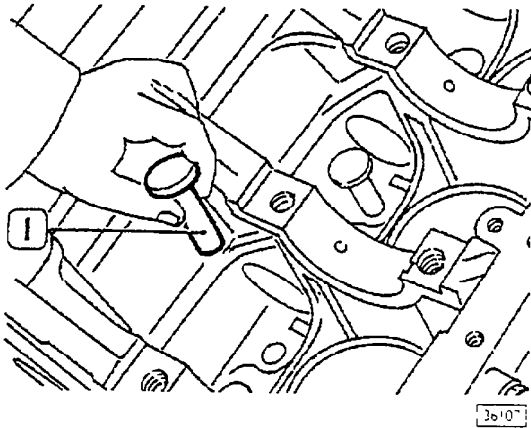
MAIN DATA FOR TAPPETS AND HOUSINGS IN THE CRANKCASE

**Fitting tappets - Camshaft**



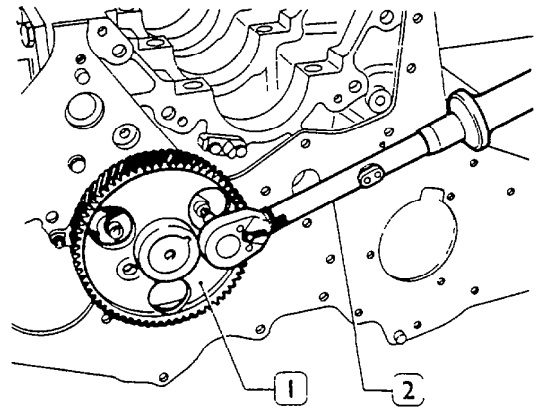
36106

In order to position front plate (1) perfectly, fit intermediate gear mounting (3) in its seat and tighten screws (2) to specified torque



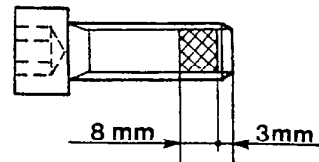
Lubricate the tappets (1) and fit them in the engine block

3b107



Lubricate the bushes supporting the camshaft, making care not to damage the support bushes when assembling the shaft, secure the camshaft to the front plate with the special plate and screws, and tighten with a torque wrench (2)

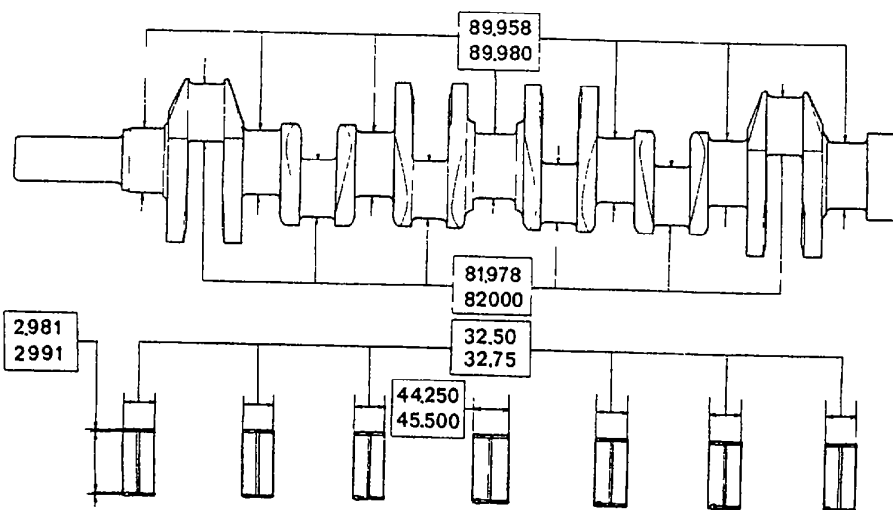
3b108



3b109

The thread of the securing screws is treated with a thread locking product, "Eslok", in the area indicated

**DRIVE SHAFT**



22344

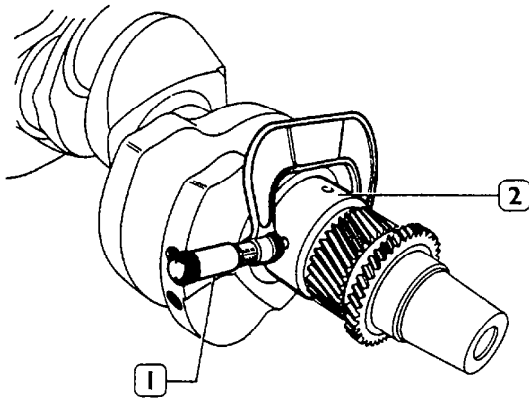
MAIN DATA FOR THE DRIVE SHAFT PINS AND THE HALF BEARINGS

Check the condition of the journals and the big end pins, there must be no signs of scoring, ovalization or excessive wear  
The data given refers to the normal diameter of the pins



**MEASURING MAIN BEARING JOURNALS AND CRANKPINS**

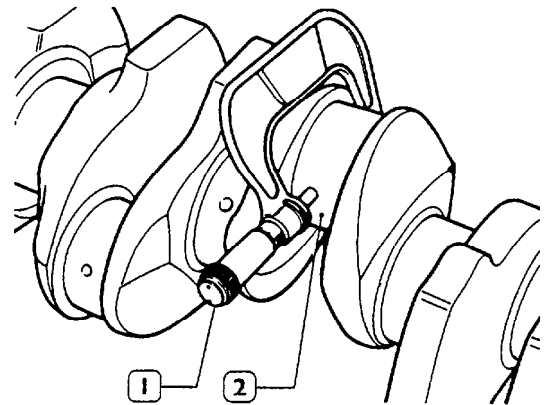
Before regrinding the journals, measure main journals and crankpins (2) with micrometer gauge (1) and establish the diameter to which the journals must be reground on the basis of the scale of bearing undersizes



MEASURING MAIN JOURNALS

36110

Undersize categories are 0.254 – 0.508mm



MEASUREMENT OF CONNECTING ROD BEARING JOURNALS

36111

It is advisable to enter the measurements recorded in a table (Figure 45)

**MAIN JOURNALS**

	1	2	3	4	5	6	7
MINIMUM Ø							
MAXIMUM Ø							

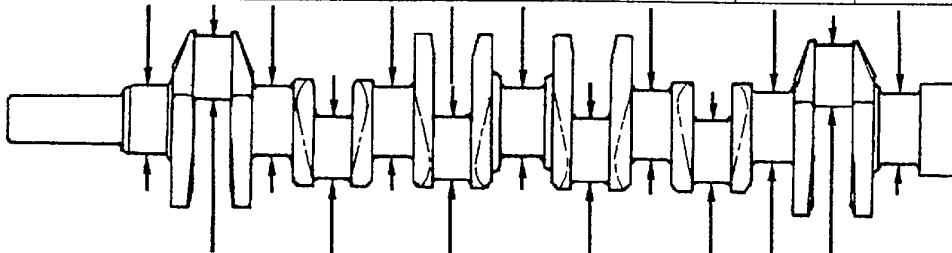


Table for entering main journal and crankpin measurements

	1	2	3	4	5	6
MINIMUM Ø						
MAXIMUM Ø						

**CRANKPINS**

36061

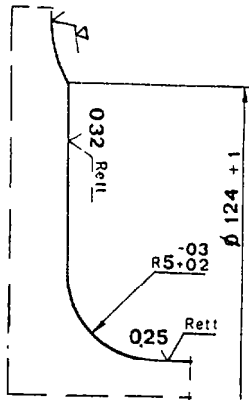
Main journals and crankpins are always all reground to the same undersize category in order not to impair crankshaft balance.

Regrinding carried out on main journals or crankpins must be indicated by appropriate markings stamped on the side of crank web no 1

- For undersize crankpins the letter M
- For undersize main journals the letter B
- For undersize crankpins and main journals the letters MB

When grinding the journals and big end pins it is essential to maintain the values shown in figures 52, 53 and 54

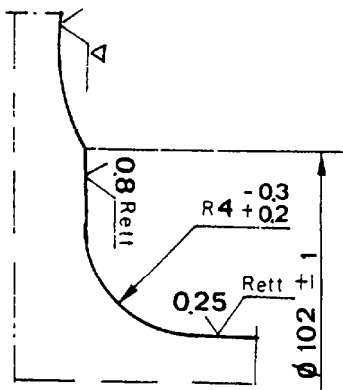
Figure 52



22346

Detail of the union of the central journal  
Rett = grind

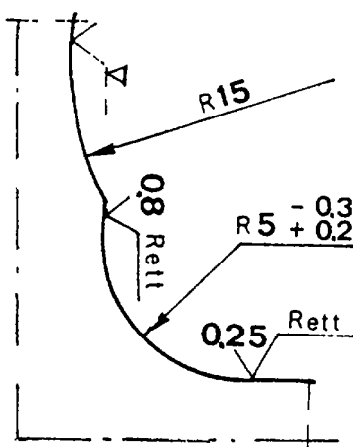
Figure 53



22347

Detail of the union of the big end pins  
Rett = grind

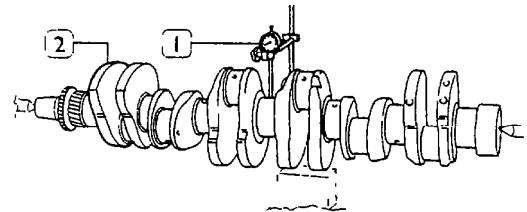
Figure 54



22348

Detail of the union of the front, intermediate and rear journals.  
Rett. = grind

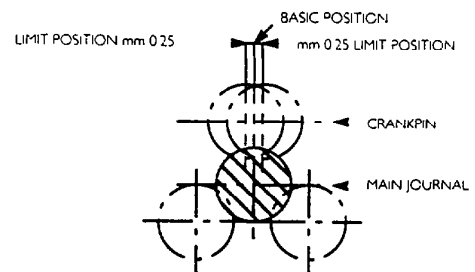
### Checking Alignment of Journals and Big End Pins



361

This check must be carried out after grinding the drive shaft pins. Place the drive shaft (2) on the tailstock and use a 1/100 dial gauge (1)

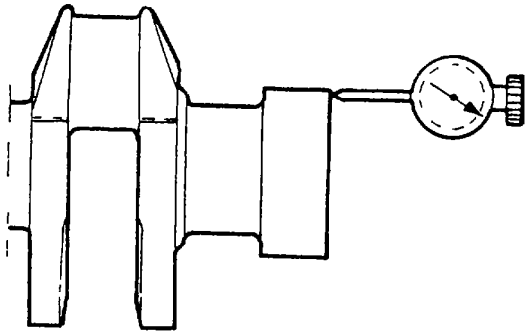
- Alignment of journals maximum tolerance 0.10 mm between two successive pins and 0.20 mm overall reading



2219

- Alignment of the big end pins with respect to the journals. the axis of each pair must be on the same plane maximum tolerance perpendicular to that plane is  $\pm 0.25$  mm

The tolerance for the distance between the axis of the drive shaft and the external surface of each big end pin is  $\pm 0.10$  mm.

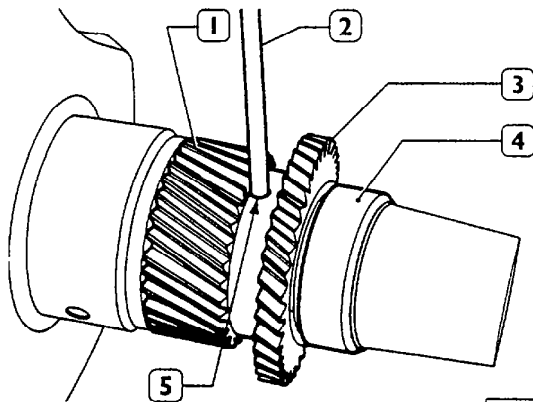


13074

Flywheel attachment flange when the shaft is rotated, with the dial gauge resting as shown, over a diameter 2–4 mm less than the maximum diameter of the support surface, the changes should not exceed 0.02 mm

**REPLACING TIMING GEARS AND OIL PUMP**

Check that the teeth of gears (1–2) are not damaged or worn. Otherwise remove using an appropriate extractor



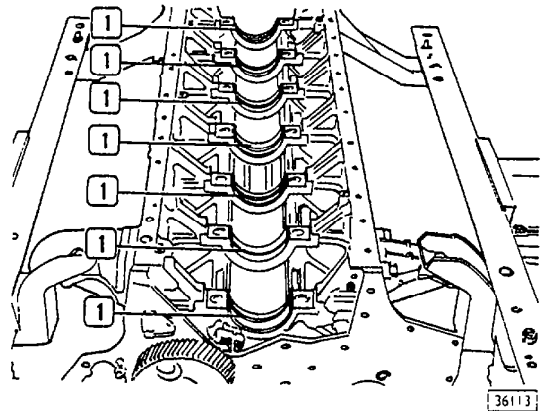
36112

When fitting new gears (1 and 3) and bush (4), heat both for 10 minutes in an oven at 200°C and before fitting to shaft. When fitting gear (1), take particular care to align hole (5) with the hole on the shaft. Use a 6 mm locating pin for the operation.

**FITTING MAIN BEARINGS**

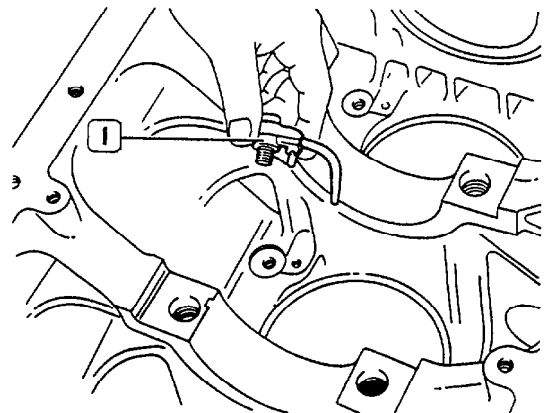
Replacement main bearings are supplied in inside diameter undersizes of 0.254 – 0.508 mm

Do not attempt to adapt bearings



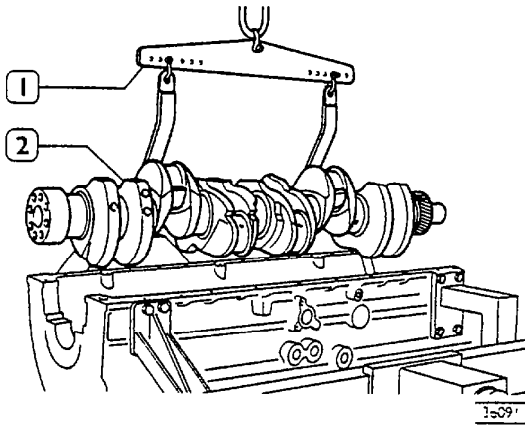
36113

Position bearing shells (1) in main bearing housings



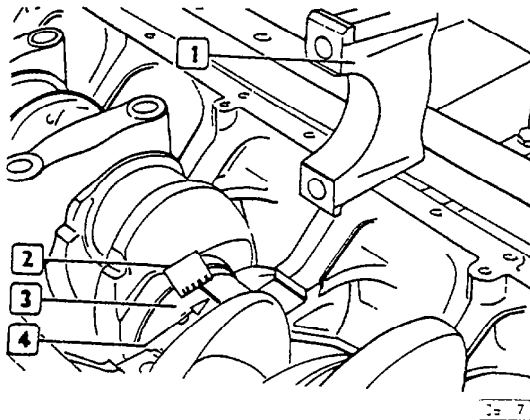
36115

Fit oil spray jets (1)



Lift the drive shaft (2) using tool 99360500 (1) and rest it on the half bearing

### Checking Clearance of Main Bearings

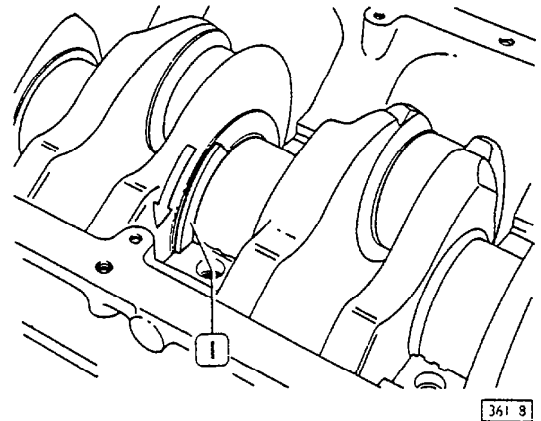


- The check is carried out using calibrated wire, as follows
- clean the parts carefully and in particular eliminate any traces of oil
  - place a piece of calibrated wire (4) on the drive shaft pins (3), parallel to the longitudinal axis
  - fit the caps (1) complete with half-bearings to the relative supports,
  - lubricate and position the fixing screws of the caps and tighten them using a force gauge spanner to the prescribed torque.
  - Remove the lower engine block and calculate the clearance between the main half bearings and the drive shaft big end pins by comparing the width of the calibrated wire at the widest point with the scale on the envelope (2)

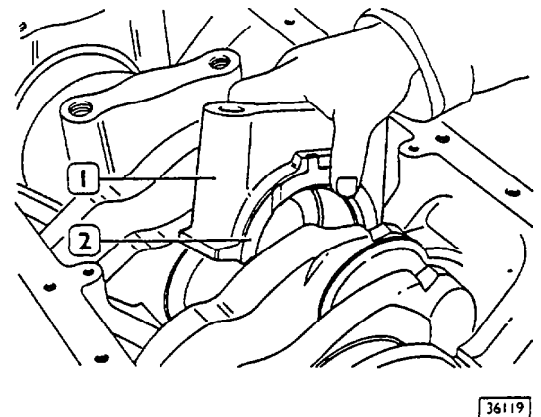
### Checking Driving Shaft Shoulder Clearance

The standard clearance is 0.050 mm  $\pm$  0.260. If clearance exceeds this figure replace the shoulder half rings with new ones of standard or increased thickness.

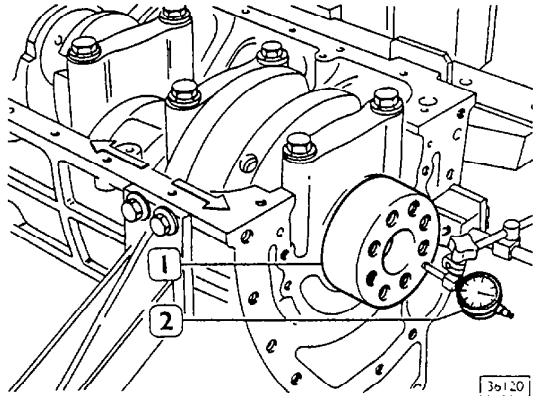
Engine block half rings are not interchangeable



Place the shoulder clearance rings (1) on the central support, with the channels towards the shim of the drive shaft.

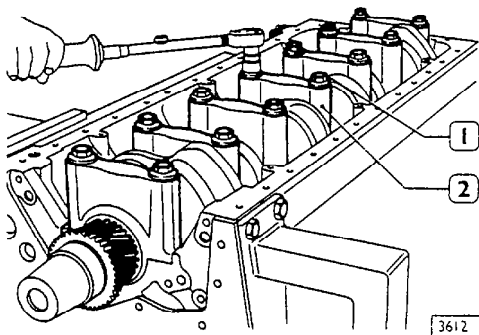


Fit the bearing caps on the half bearings (1) position the shoulder clearance half rings (2) with the anti-friction alloy surface towards the shim of the drive shaft.



Tighten the fixing screws on the bearing caps to the prescribed torque, check the shoulder clearance of the drive shaft (1) using a comparator  
The standard assembly clearance is 0.050 – 0.260 mm

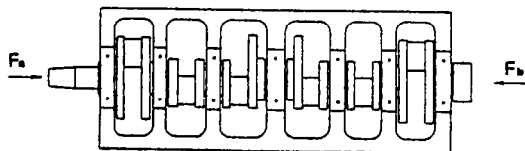
**Instructions for the fitting of the self-centring of the shoulder clearance half rings.**



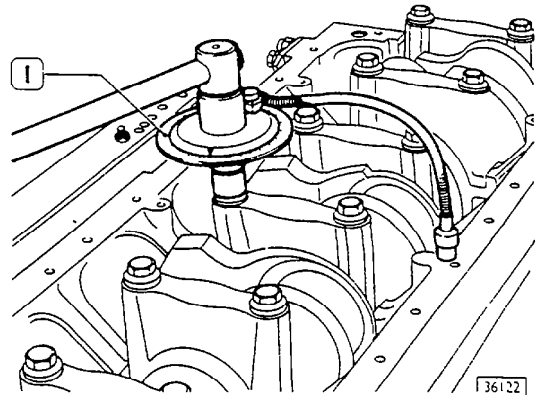
Tighten the screws (1) of the bearing caps to torque 80 Nm, loosen the two screws of the central cap (2) and tighten them to torque 15 Nm

The fixing screws of the bearing caps can be re-used until the of the thread is less than 17.4 mm measured over the length of 50 mm

TIMING SIDE FLYWHEEL SIDE

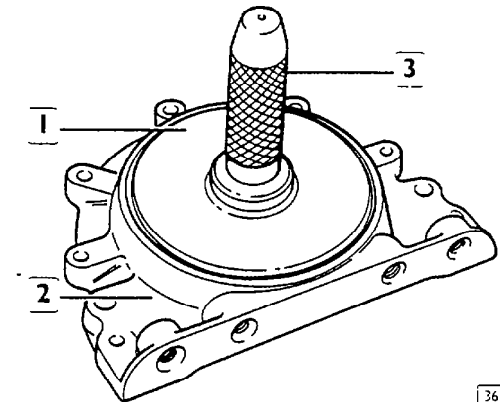


Place an axial force (⇒) of 2500N on the front part of the drive shaft and release; carry out the same procedure on the opposite end of the drive shaft. Tighten the two screws of the central cap to the prescribed torque (117.5 Nm + 90° ± 5°)

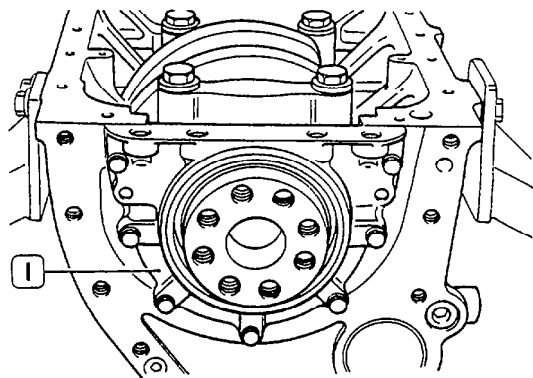


Complete the tightening of the bearing caps using the socket spanner 99395216(1)

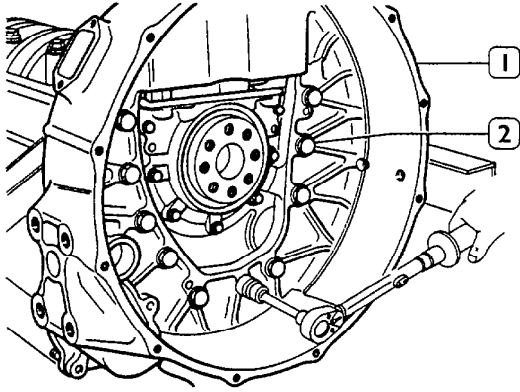
**Rear Cover Drive Shaft**



Fit the choke ring on the rear cover (2) using the wrench 99370454 (1) and grip 9937006 (3)



Fit the rear cover (1) with relative seal on the engine block



36125

Fit rear mounting (1) and tighten bolts (2) to a torque of 142.5 Nm (14.5 kgm) using a torque wrench

**FLYWHEEL**

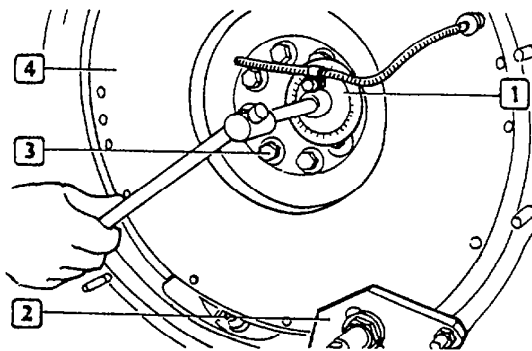
Check the clutch plate mating surface. Skim or replace the flywheel if scoring is present.

**REPLACING THE FLYWHEEL RING GEAR**

If the teeth of the ring gear fitted to the flywheel are badly damaged, replace the ring gear. Before fitting, the ring gear must be heated to a temperature of 80° C

Flywheel attachment bolts may be reused until the diameter is reduced to below 15.5 mm

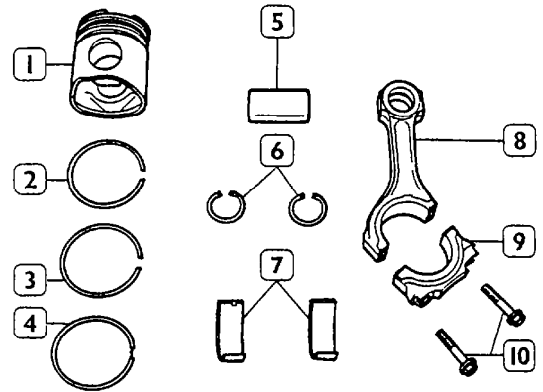
**Installing the flywheel**



36169

Fit flywheel (4); apply retaining tool 99360351 (2) and tighten retaining bolts (3) to a torque of 100 Nm (10.2 kgm) using a torque wrench. Further tighten through 60° ± 5° using graduated device 99395216 (1).

**CONNECTING ROD/PISTON ASSEMBLY**

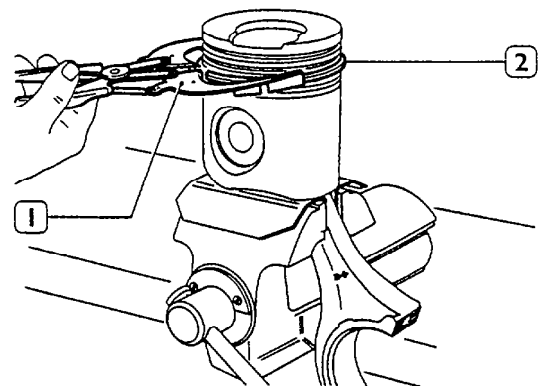


36126

**PISTON - CONNECTING ROD ASSEMBLY**

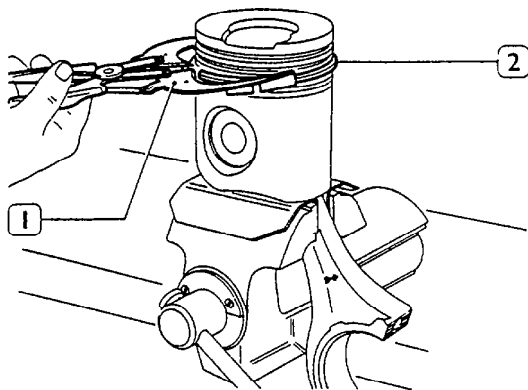
- 1 Piston - 2 Retaining clips - 3 Sealing ring - 4 Oil scraper ring - 5 Gudgeon pin - 6 Circlips - 7 Bearing shells - 8 Connecting rod - 9 Connecting rod cap - 10 Screws

Check the pistons. Replace if they show signs of seizing, scoring, cracking or excessive wear

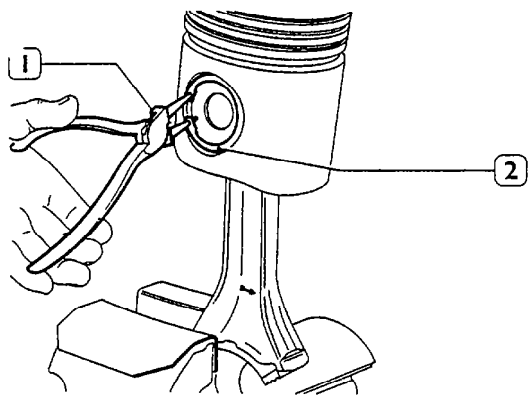


36127

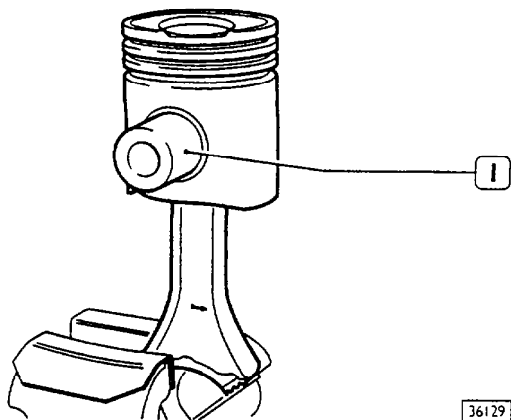
Remove the piston rings from the piston (2) using pliers 99360184 (1)



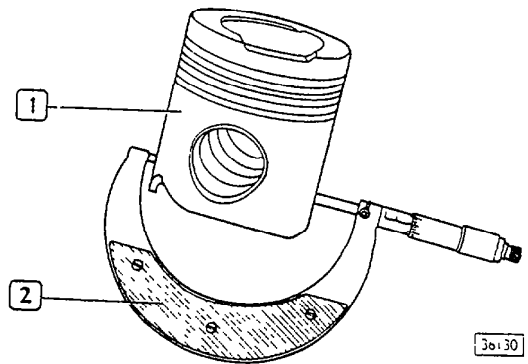
36127  
Removal of the split rings from the piston (2) using pliers 99360184 (1)



36128  
Removing the piston pin split rings (2) using the round tipped pliers (1)

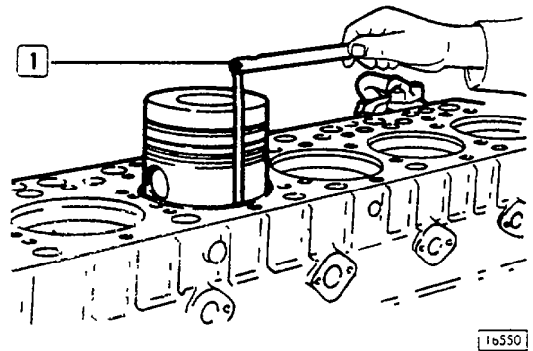


36129  
Removing the piston pin (1)  
If removal is difficult use the appropriate beater



36130  
Using a micrometer (2) measure the diameter of the piston (1) to find the assembly clearance. The diameter should be measured 20 mm from the base

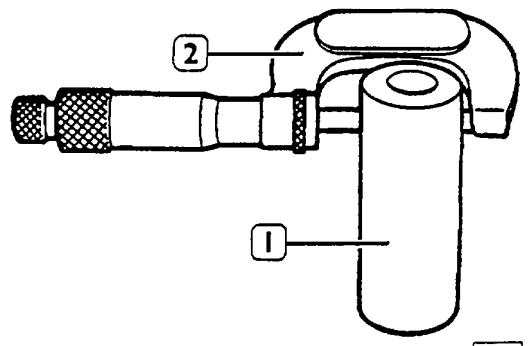
**Piston**  
**Measuring the Diameter of the Pistons**



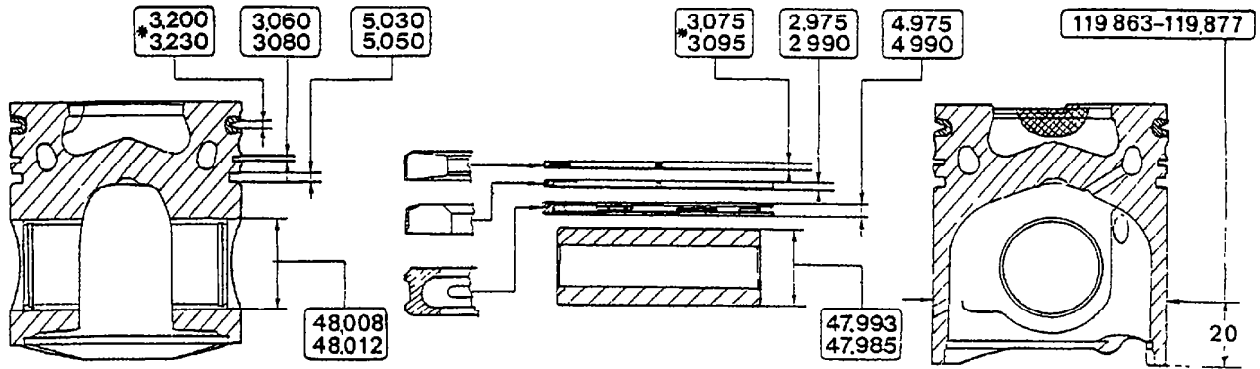
16550  
The clearance between the piston and the piston barrel can be checked either by measuring the diameter of the pistons and of the barrels or using a feeler gauge (1) as illustrated

**Piston Pins**

The pins are fitted with clearance on both the big end and on the piston

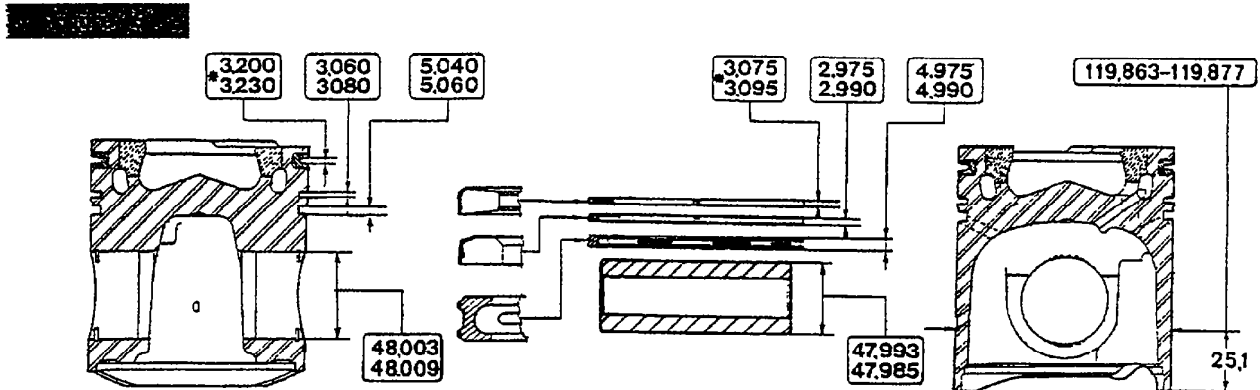


32618  
Measuring the diameter of the pin (1) using a micrometer (2)



MAIN DATA FOR THE PISTON, PISTON RINGS AND GUDGEON PIN ( Engine 8460SRi10.00 )

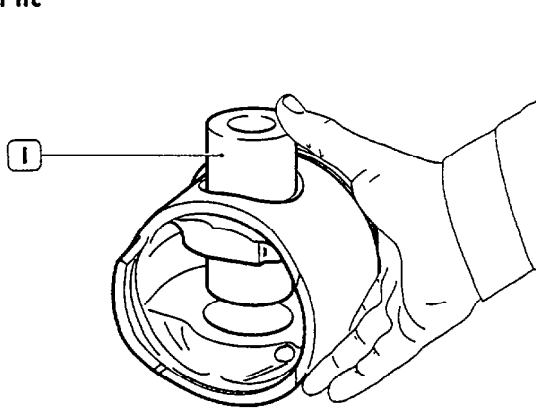
\* The dimension is measured at a diamete. of 117 mm



MAIN DATA FOR THE PISTON, PISTON RINGS AND GUDGEON PIN ( Engine 8460SRi11.00 )

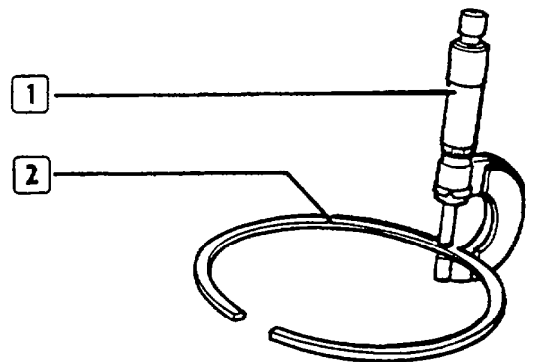
\* The dimension is measured at a diameter of 117 mm

**Conditions for a correct gudgeon pin to piston fit**



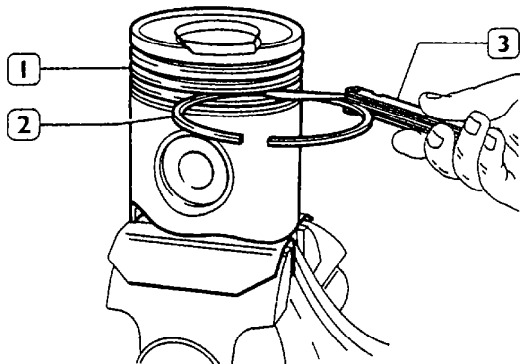
Lubricate pin (1) and its housing in the piston bosses with engine oil. Push the pin into the piston by pressing lightly with a finger. It should not drop out under its own weight.

**PISTON RING**



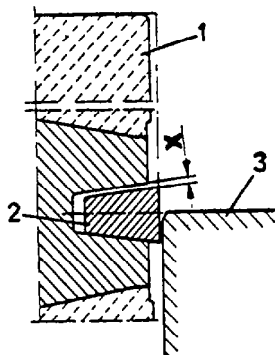
Check the thickness of piston ring (2) using micrometer (1)





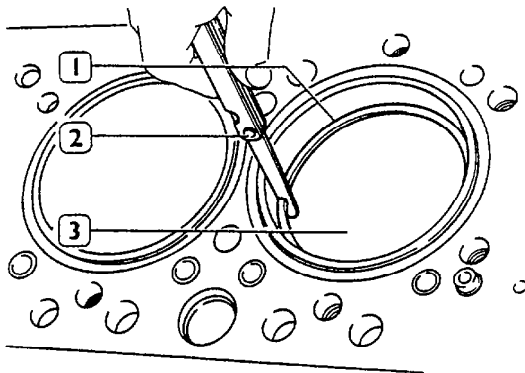
36133

Check the clearance between piston rings (2) and the grooves on piston (1) using feeler gauge (3)



3513

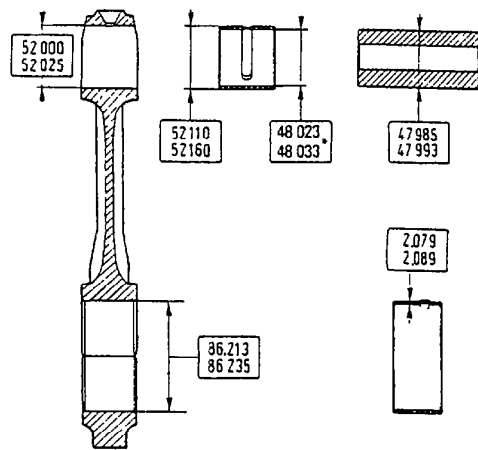
Compression ring (2) in the first groove is wedge shaped. Clearance X between the compression ring and the groove is measured by positioning piston (1) with the relevant ring in cylinder liner (3) in such a way that the compression ring half projects from the cylinder liner.



36134

Measure the clearance between the ends of piston rings (1) inserted into cylinder liner (3) using feeler gauge (2). Replace the piston rings if the gap between the bottom or top ends is greater or lower than specified.

CONNECTING RODS

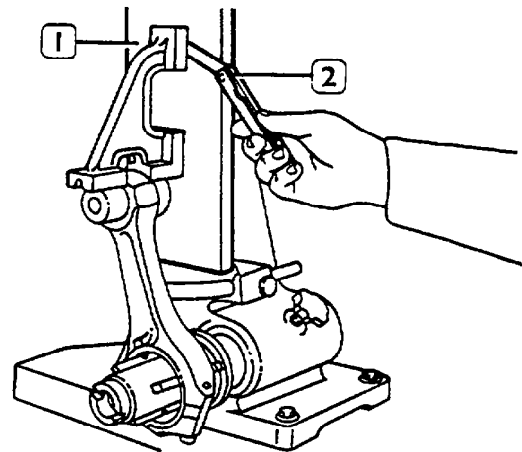


36135

MAIN DATA FOR CONNECTING ROD, BUSH, GUDGEON PIN AND BEARING SHELLS

\* Dimension to be obtained after press-fitting the bush

Checking connecting rod for distortion

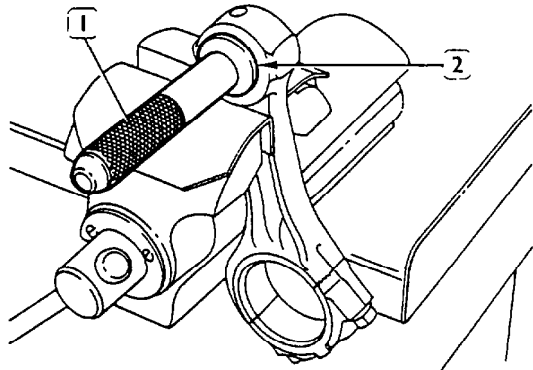


36624

Check that the connecting rod axes are parallel using tool 99395363 (1) and feeler gauge (2). Permitted tolerance is 0.07 mm measured at 125 mm from the rod longitudinal axis.

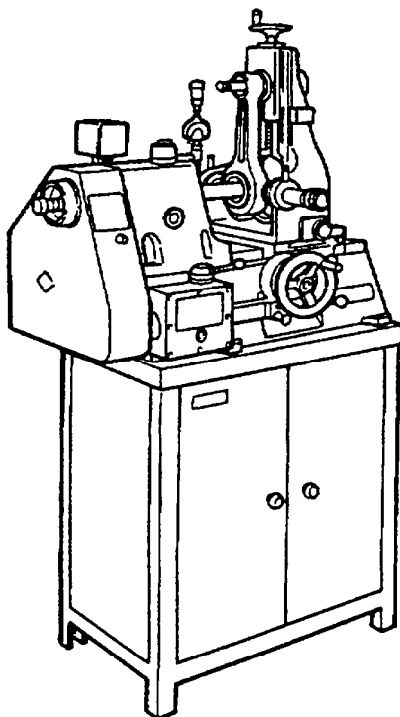
Each connecting rod body and cap are marked with a number indicating that they fit together. The connecting rod may also be stamped with the number of the cylinder in which it is fitted. In case of replacement, therefore, mark the new connecting rod with the same number as the old one.

**Bushings**



Remove and refit the bush (2) using the appropriate beater (1)

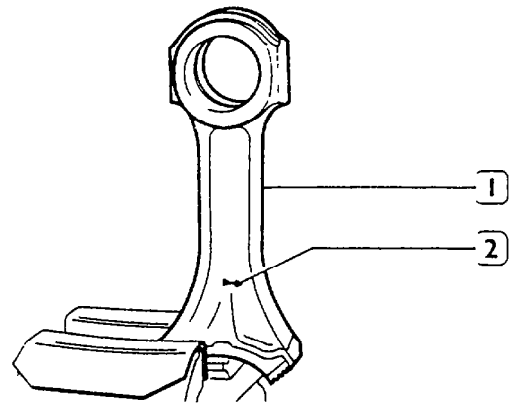
After positioning the bush in the small end of the connecting rod machine the bush to obtain the prescribed diameter



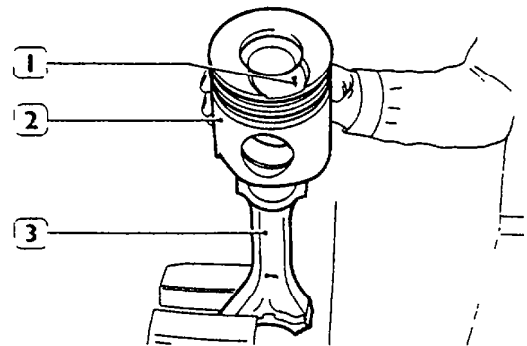
Machine the small end of the connecting rod using grinder 99301044.

**Fitting the Connecting Rod – Piston**  
**Connecting Rod – Piston Mating**

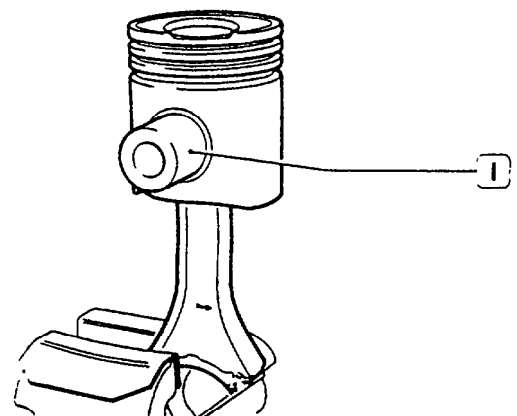
The mating between the connecting rod and the piston must be carried out according to the following values



Position the connecting rod (1) in a clamp with the raised arrow (2) towards the operator

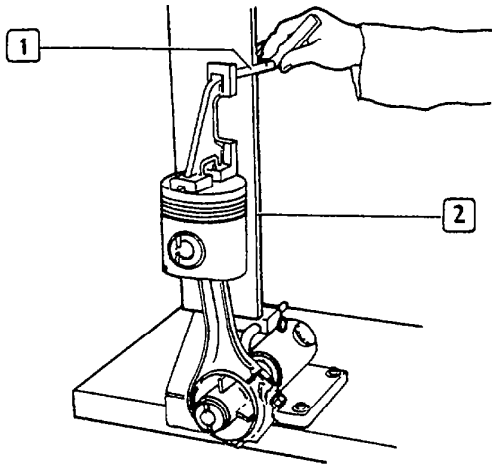


Fit the piston (2) on the connecting rod (3) so that the arrow (1) marked on the top is towards the operator



Fit the pin (1) and the choke rings

**Checking the Connecting Rod – Piston Unit**

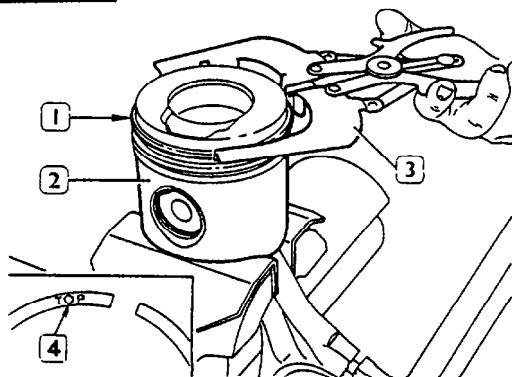


36139

Check the alignment of the connecting rod – piston unit using tool 99395363 (2) and a feeler gauge (1) The surface of the top of the piston must be perfectly perpendicular to the floor of the tool

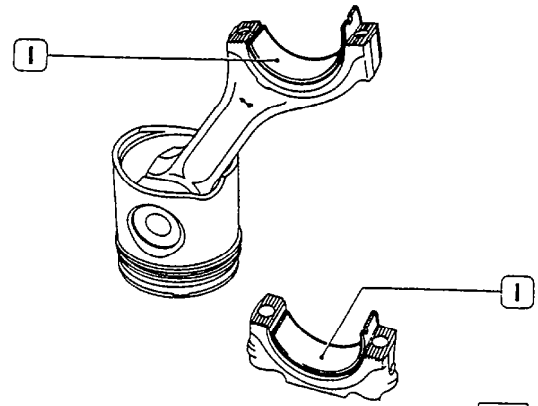
The screws for the connecting rod can be re-used as long as the diameter of the thread is at least 13.4 mm

**Fitting the Split Rings**



36140

To fit the split rings (1) to the piston (2) use the pliers 99360183 (3) The rings must be fitted with the word "TOP" (4) upwards and the gaps must be turned through 120°

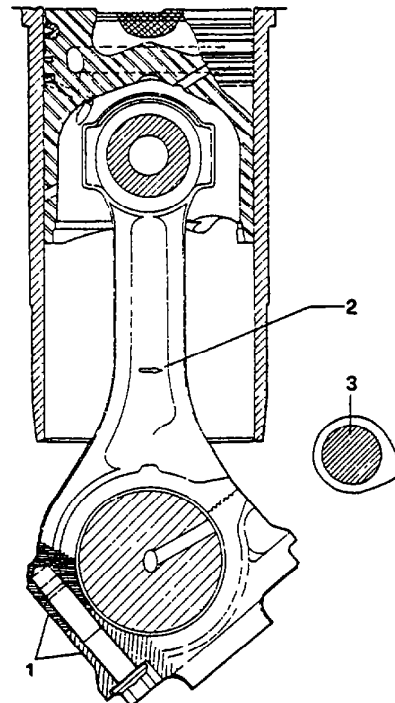


36141

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

Do not try to adapt the half bearings

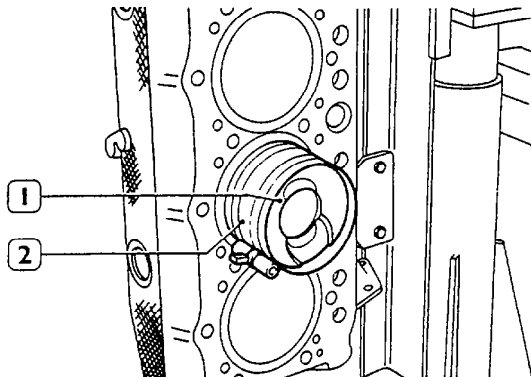
**Fitting the connecting rod – piston into the piston barrel**



22367

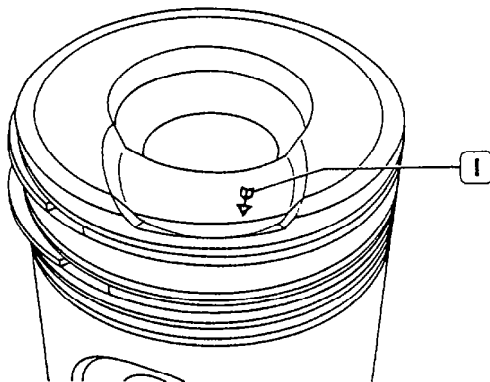
DIAGRAM OF THE MATING OF THE CONNECTING ROD AND THE PISTON READY FOR FITTING INTO THE PISTON BARREL

1 Mating number is printed here 2. Raised arrow showing direction in which engine rotates 3 Drive shaft.



36142

Fitting connecting rod-piston assembly (1) into the cylinder liner using ring clamp 99360605 (2).  
Lubricate the parts concerned before fitting



36143

When fitting the connecting rod/piston assemblies, check the following:

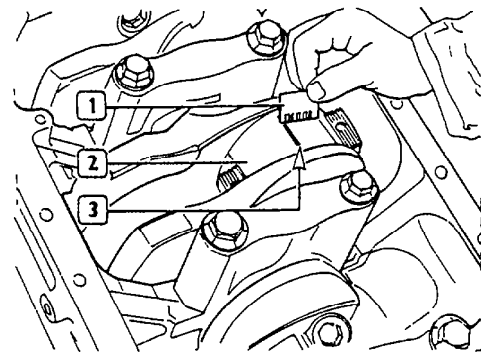
Arrow (1) stamped on the piston crowns faces toward the front of the engine.

Connecting rod numbers (1, Fig 91) face away from the opposite end of camshaft (3).

The piston ring gaps are staggered 120° apart.

### MEASURING CONNECTING ROD

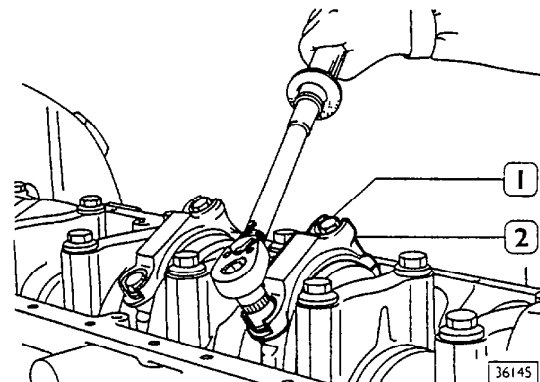
Proceed as follows to measure the clearance:  
clean parts thoroughly and remove all traces of oil,



36144

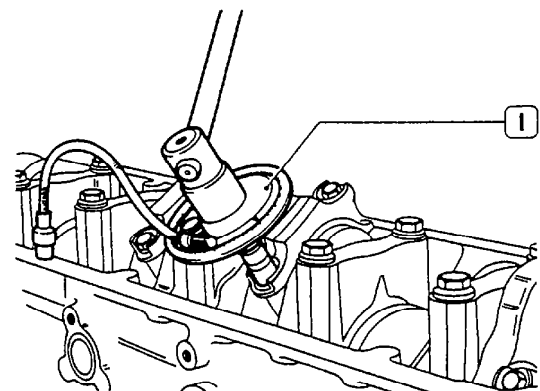
position a strip of plastigage (3) on crankshaft journals (2), fit the connecting rod cap and tighten the bolts to the specified torque. The bolts must be lubricated, remove the connecting rod cap and determine the clearance by comparing the width of plastigage (3) with the scale divisions given on package (1) containing the plastigage

### Fitting big end caps



36145

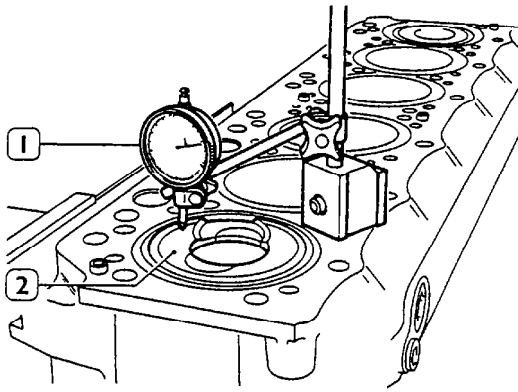
Connect the connecting rods to the crankshaft journals, fit big end caps (2) with bearing shells. Tighten bolts (1) to a torque of 45 Nm (4.6 kgm) using a torque wrench



36146

Apply tool 99395216 (1) and tighten the bolts further through an angle of 90° ± 5°. Check that the connecting rods can be moved from side to side on the crankshaft journals.

**Checking the Position of the Pistons**



36147

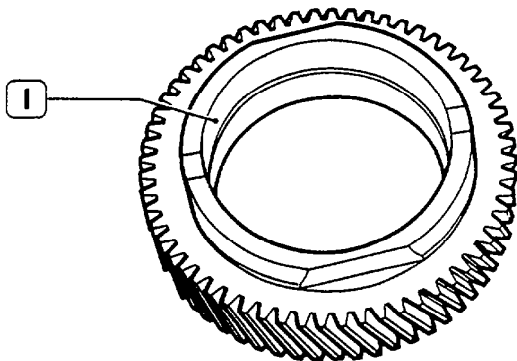
When fitting is completed check the position of the pistons (2) using a magnetic base dial gauge (1), protrusion must not exceeded 0.75 mm

**TIMING GEAR**

**Checking and Replacing the Intermediate Gear**

Check that the teeth of intermediate gear are not damaged or worn, replace if necessary

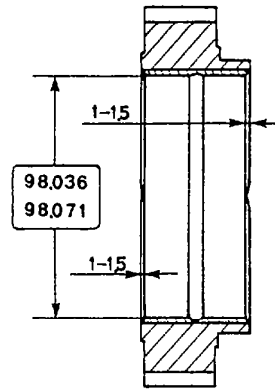
Figure 104



36148

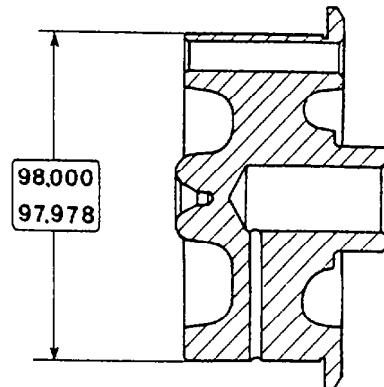
Check the faying surface of the bush (1) if there are any signs of seizing or scoring replace the bush using the appropriate beater

**Replacing the Bush of the Intermediate Gear**



36079

Fit the bush (1, fig 104) so that sits below the plane of the gear by 1 - 1.5 mm, after fitting grind the bush to obtain the correct nominal diameter

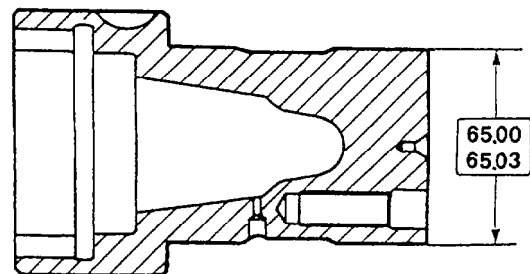


36080

Check that the surface of the intermediate gear support is not damaged or worn  
Check that the oil holes are not clogged

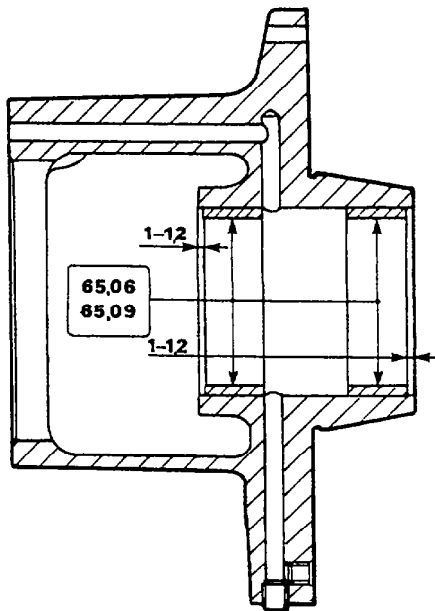
**INJECTION PUMP CONTROL**

**Replacing the Support Bushes**



36081

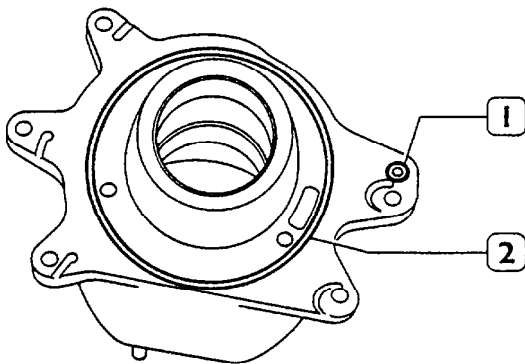
Check that the mating surfaces of the shaft and the bushes are not damaged and that clearance is not excessive  
The nominal diameter of the shaft is 65.00 + 65.03



36082

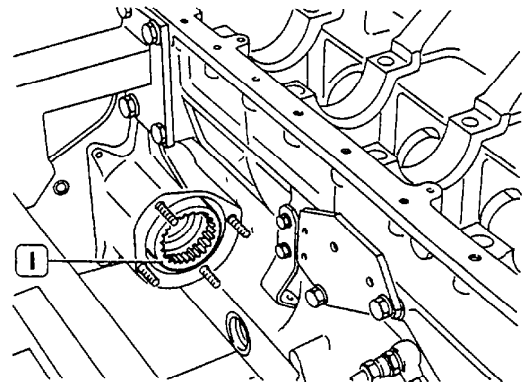
If excessive fit clearance not attributable to the shaft is found, replace the bushes, using a suitable drift for removal and refitting  
 When the bushes have been fitted, ream them out so that their nominal diameter is  
 50 025 – 50 050 mm

Fit the bushes so that they are recessed by 1 – 1,2 mm with regard to the mounting surface.



36149

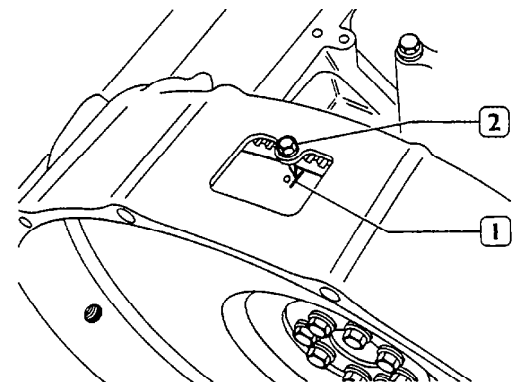
Fit the injection pump control coupling mount on the front plate after interposing sealing rings (1 and 2)



36150

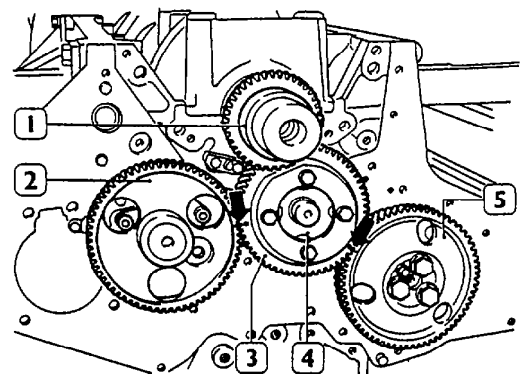
Fit the injection pump shaft into the mount

**Fitting the idler gear and setting the timing**



36151

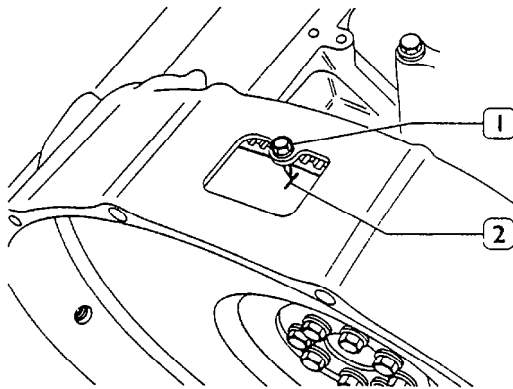
Turn the flywheel until the 0 (1) stamped on it indicating TDC is in line with pointer (2)



36152

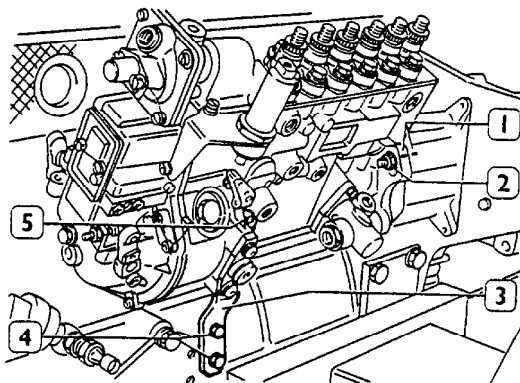
Install intermediate gear (3) with support (4), so that the marks stamped on it line up with the corresponding marks on the gears of camshaft (2) and crankshaft (1) Fit injection pump gear (5), ensuring that reference marks (=>) are aligned as before

### ASSEMBLING AND TIMING THE INJECTION PUMP



36153

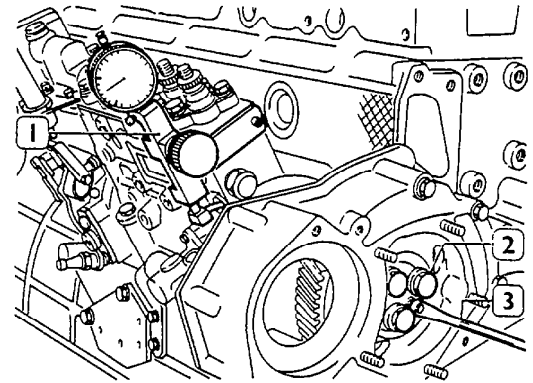
Rotate the engine flywheel until the machined sign **1** (2) which corresponds to the spark lead exactly matches the metal point (1)  
Remove the inspection cap from the injection pump, rotate the shaft to delivery start position.



36154

Fit the injection pump matching the notches marked before stripping, to fix the injection pump in the relative supports proceed as follows

- screw on the nuts – do not tighten to driving torque (2)
- position the rear support (3) on the engine block and position the screws without tightening them (4)
- fit screw (5) without locking it;
- tighten the nuts (2) and the screws (5) to torque
- tighten the screws (4)



36155

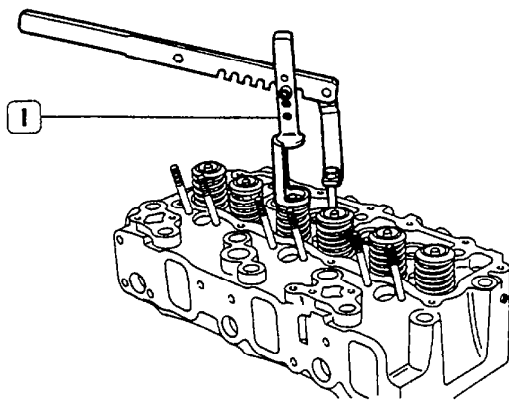
Fit tool 99365183 and dial gauge to the injection pump (1) resting the rod of the tool on timing piston crown  
Set the dial gauge to 0 when the timing piston is at BDC  
Turn the flywheel back by half a turn  
Rotate the engine in the opposite direction and check that when the sign **1** on the flywheel (2, Figure 113) which corresponds to the spark lead exactly matches the metal point (1, Figure 113), the pump has covered the delivery start pre-travel This can be determined using the dial gauge and the table of trial values  
If the values are not correct loosen the screws (2) and move the cams (3) in order to effect the prescribed pre-travel Repeat the check and tighten the screws (2)

**CYLINDER HEADS**

**Hydraulic leak test**

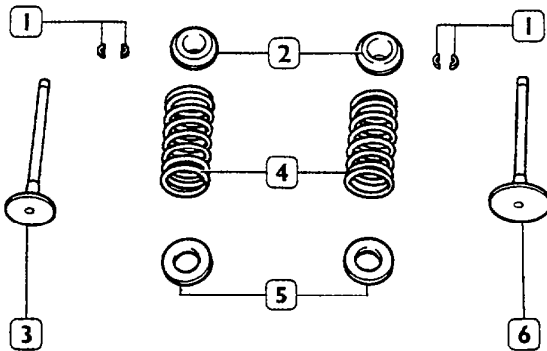
Before dismantling the cylinder head, carry out the hydraulic leak test using the appropriate tool  
 Pump water heated to approx 90° C and at a pressure of 4 – 5 bars into the cylinder head Under these conditions, no leaks should be found; if they are, replace the cylinder head

**DISMANTLING VALVES**



36156

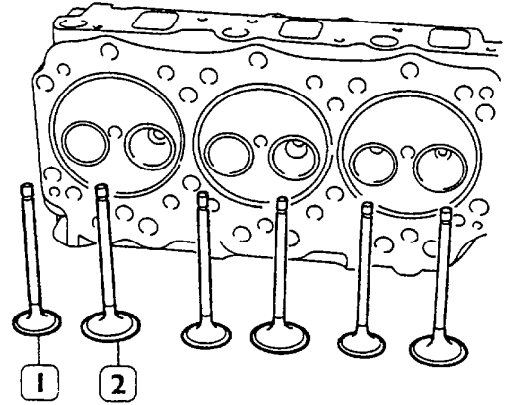
Rest the cylinder head on the workbench and use tool 99360357 (1) to apply pressure to spring cup (2, fig 130) so that by compressing spring (4) valve collets (1) can be removed Then take off upper cup (2), spring (3) and lower cup (5) Repeat the operation on all the valves.  
 Turn the cylinder head upside down and withdraw valves (3-6)



36157

**COMPONENTS OF VALVE ASSEMBLY**

1 Collet – 2. Upper cup – 3 Exhaust valve – 4 Valve springs –  
 5. Lower cups – 6 Inlet valve

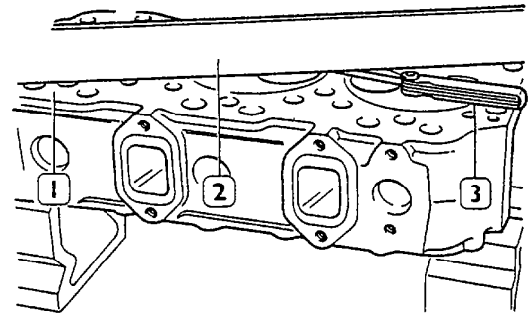


36158

**BOTTOM VIEW OF CYLINDER HEAD**

1 Exhaust valve – 2 Inlet valve

**Checking mating surfaces on cylinder block**



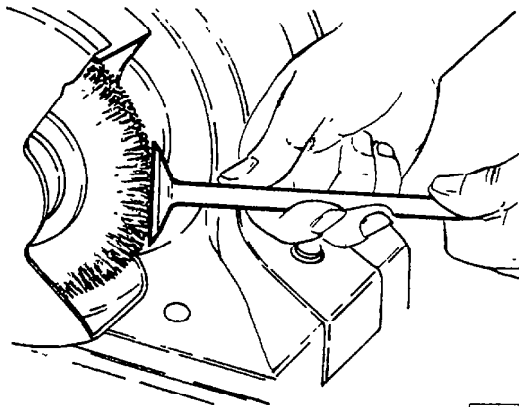
36159

Check mating surface (1) of the head with the cylinder block using straight edge (2) and feeler gauge (3)  
 If values in excess of 0.15 mm are found over the whole length of the surface, true up the head on a suitable surface grinder, removing as little material as possible



**VALVES**

**Removing Carbon Deposits and Checking the Valves**



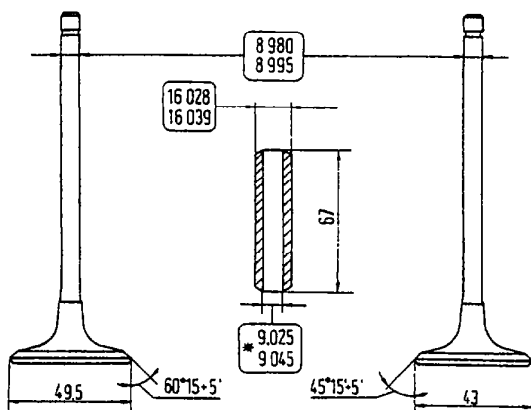
18625

Remove carbon deposits using the metal brush supplied. Check that the valves show no signs of seizing, scoring or cracking. Check the diameter of the valve stem using a micrometer (see figure 121) and replace if necessary.

**Grinding the valves**

If necessary ream the valve guides using tool 99301014 setting the angle at  $45^{\circ} 15' \pm 5'$  for the exhaust valves and  $60^{\circ} 15' \pm 5'$  for the intake valves – removing the least material possible.

Figure 121

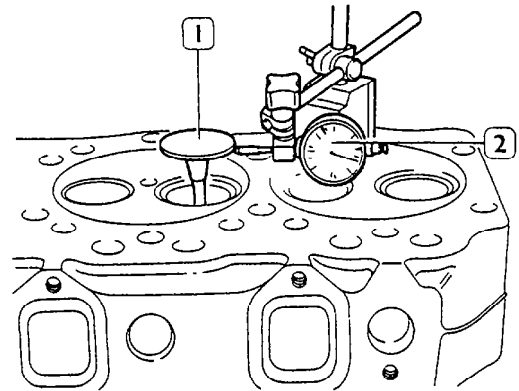


2238\*

MAIN DATA VALVES AND VALVE GUIDES

\* value to be taken after fitting the valve guides

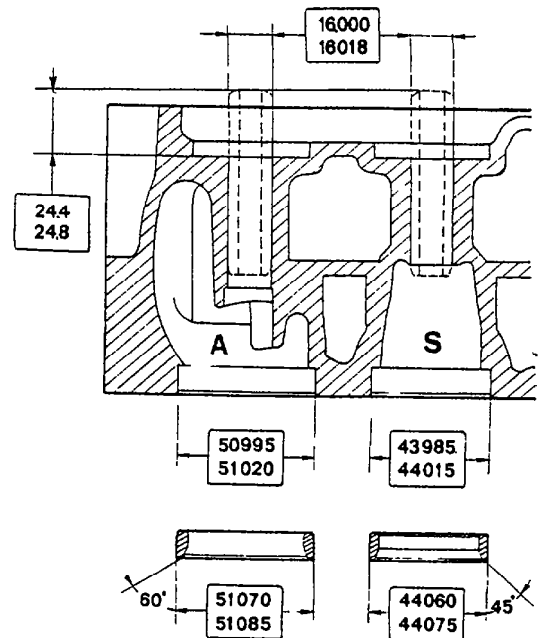
**Checking the clearance between the valve stem and the valve guide**



Using a magnetic base dial gauge (2) check the clearance between the valve stem (1) and relative guides. If clearance is excessive replace the valves and if necessary the valve guides.

**VALVE GUIDES**

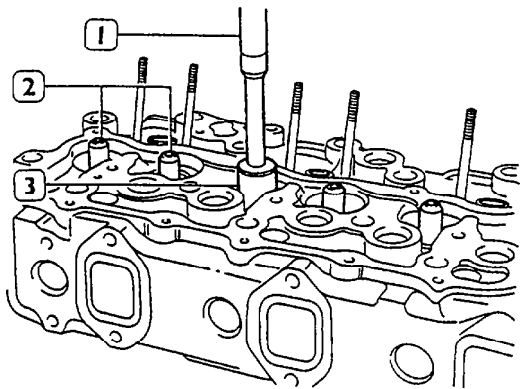
Figure 123



22388

MAIN DATA CYLINDER HEAD AND VALVE GUIDES

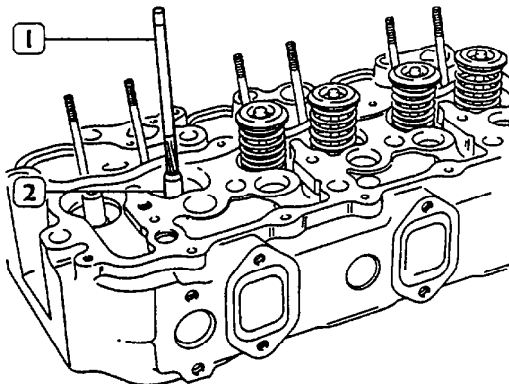
A = INTAKE  
S = EXHAUST



36161

Remove the valve guides using drift 99360481 (1)  
Fit using drift 99360481 (1) equipped with adapter 99360494 (3)  
Adapter 99360494 determines the correct fitting position for the valve guides in the cylinder head. If this part is not available, the guides must be installed in the cylinder head so that they protrude from it by the amounts shown in figure 123

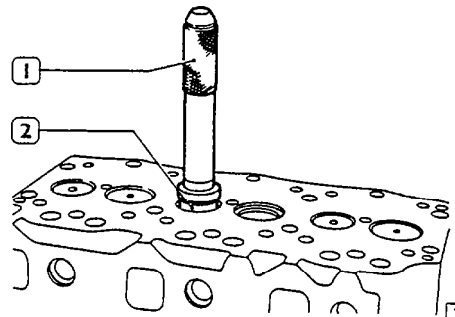
### Reaming the valve guides



36162

After press fitting valve guides (2), ream the holes in valve guides (2) using reaming tool 99390311 (1).

### Replacing – Recutting the valve seats



36163

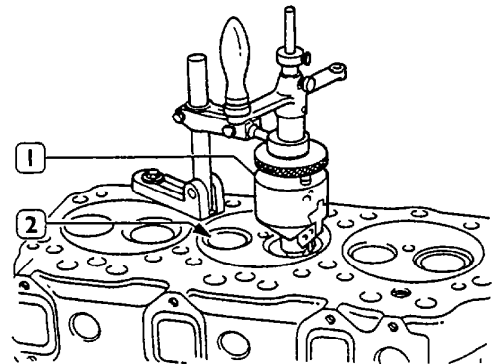
When replacing valve seats, use the appropriate tool to remove

Valve seats (2) are press-fitted by cooling the seats in a tank containing liquid nitrogen ( $-180^{\circ}\text{C}$ ) and press-fitting using drift (1)

Installation clearance.

inlet 0.050 – 0.090

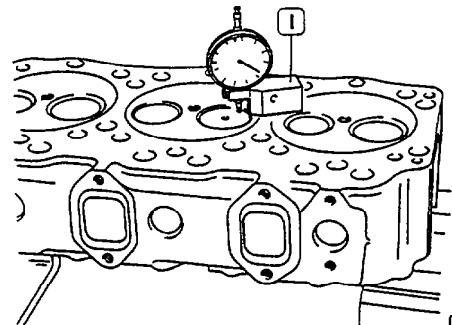
exhaust 0.045 – 0.090



36164

Using Hunger tool 99360419 (1) to recut the valve seats in the cylinder head

Recut the valve seats in the cylinder head whenever the valves or valve guides are reconditioned or replaced



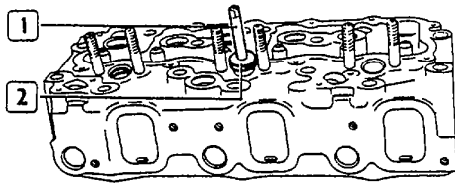
36165

After recutting the valve seats, use tool 99370415 (1) to check that the positions of valves with respect to the cylinder head face is.

inlet valve protrusion 0.35 – 0.60 mm.

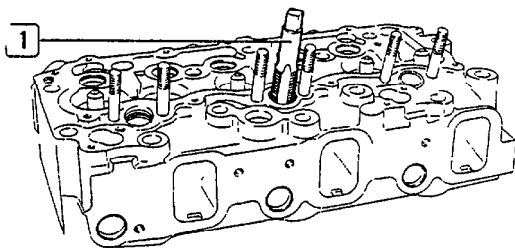
exhaust valve recessing 0.80 – 1.05

Replacing Nozzle Sheaths



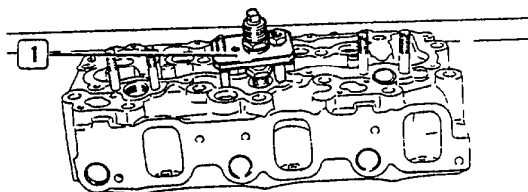
18122

Imperfect mating between the injectors and the sheaths keyed into the cylinder head or between the sheath and its seat will cause either loss of compression or water leaks  
 In the first case the problem can be solved by reaming the seat of the sheath using tool 99394020 (1) and the bush 99394019 (2) – bearing in mind that the injectors must protrude 1.2 – 0.4 mm



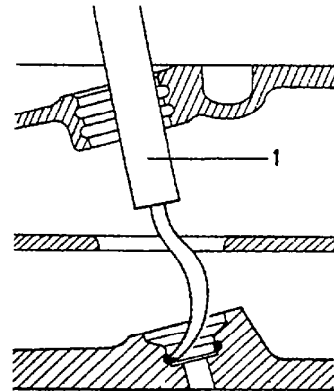
18123

In the second case replace the sheath as follows  
 thread the sheath using the set of taps 99390788 (1)



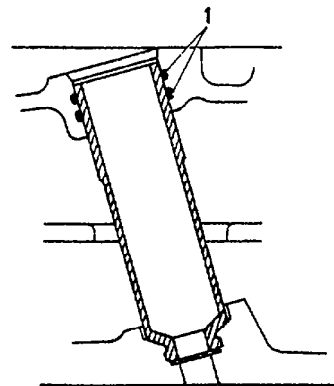
18124

using the extractor 99342145 (1) remove it from the cylinder head



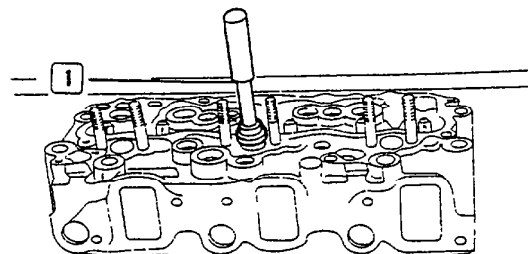
22408

Using the appropriate tool (1) remove any traces of copper in the grooves of the cylinder head  
 Remove the upper choke rings



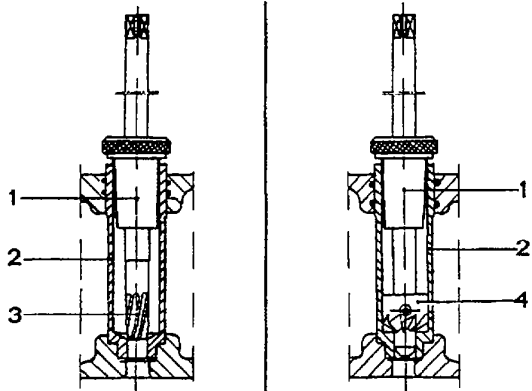
22409

Lubricate the choke rings (1) and position them in the relative seats  
 Fit the sheaths into the seats on the cylinder head



18125

Cold head the lower seat of the sheath on the cylinder head using tool 99365063 (1)

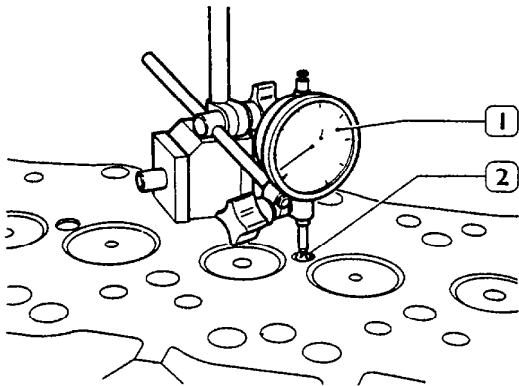


36166

Ream the bore in case (2) using reamer 99394017 (3) and bush 99394019 (1)

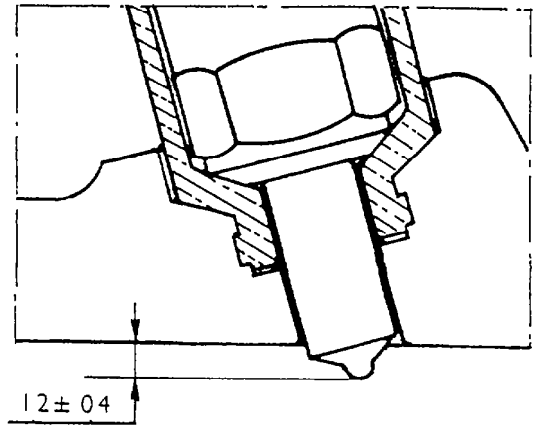
Restore the protrusion of the injection in relation to the cylinder head plane using cutter 99394020 (4) and bush 99394019 (1) This should be  $2.1 - 2.9$  mm

#### Checking injector protrusion



36167

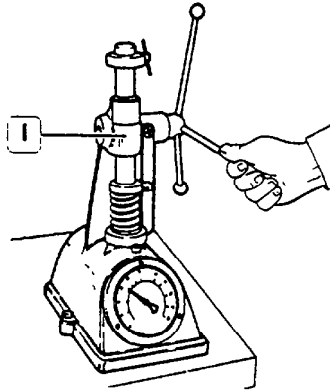
Use dial gauge with magnetic base (1) to check the protrusion of injector (2) from the cylinder head face. If necessary, adjust by recutting the seating using cutter 99394020 and bush 99394019



23163

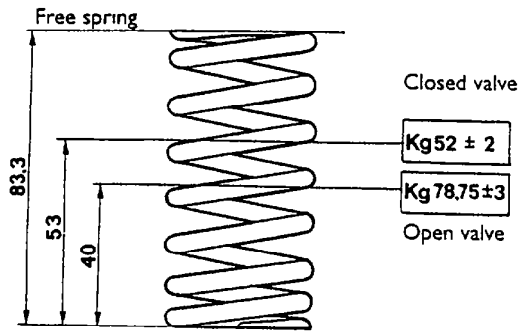
INJECTION PROTRUSION

**VALVE SPRINGS**



10587

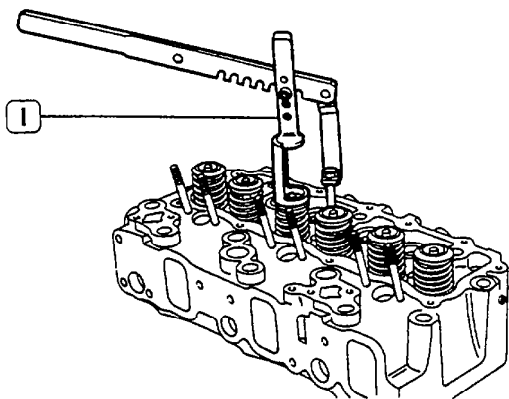
Before fitting check the flexibility of the valve springs using tool 99305049, compare data with standards given in figure 139



22391

MAIN DATA FOR INTAKE AND EXHAUST VALVE SPRING CHECK

**Fitting valves**

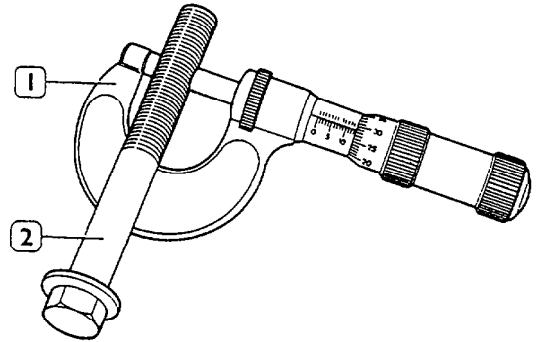


36156

Lubricate the valve stems and introduce them into the respective valve guides. Position the lower and upper spring caps in the cylinder head. Using tool 99360357 (1) press the spring and fit the retaining cotters.

**CYLINDER HEAD ASSEMBLY**

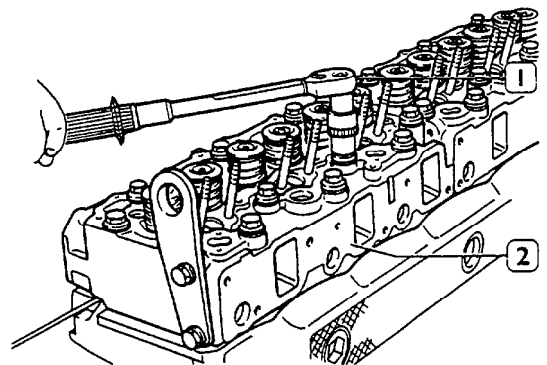
For mounting and tightening the cylinder heads proceed as follows



36168

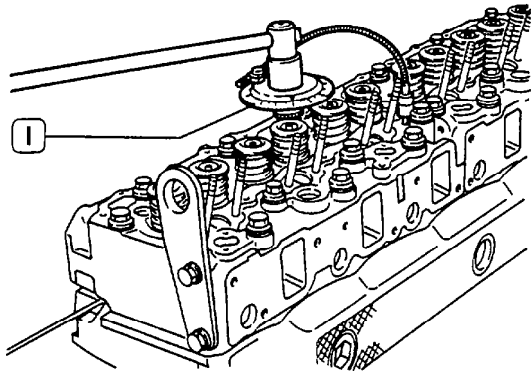
In order to re-use the head fixing screws (2) use a micrometer to check that the diameter of the thread is not less than 15.4 mm (measured between 45 and 70 mm from the beginning of the thread (otherwise replace them))

Position the seals on the block, fit the cylinder head (2), fit the screws after oiling them and tighten them as explained in figure 139



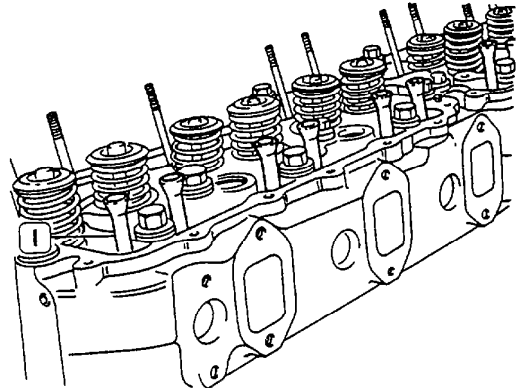
36138

- 1<sup>st</sup> stage pre-torque using a force gauge spanner (1) to torque 100 Nm
- 2<sup>nd</sup> stage tighten to torque 100 Nm



36169

Stage 3, fit tool 99395216 (1) to angle gauge wrench (2) and tighten through an angle of 180°



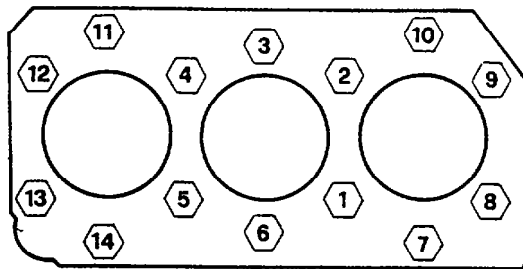
36170

Fit pushrods (1) into their seatings

### ROCKER SHAFT ROCKERS

Check that the rockers, rocker shaft and pedestals do not display signs of wear, scoring or seizing  
Check that the plugs fitted to the ends of the shaft provide a perfect seal

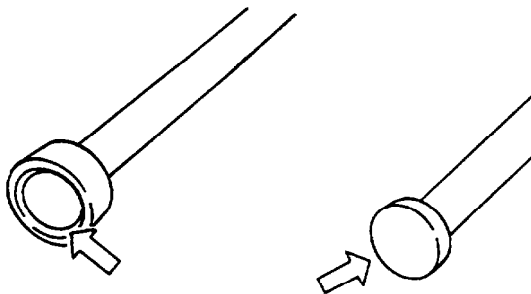
Check that the spacer spring dimensions are as shown in figure 142.



18095

CYLINDER HEAD BOLT TIGHTENING DIAGRAM

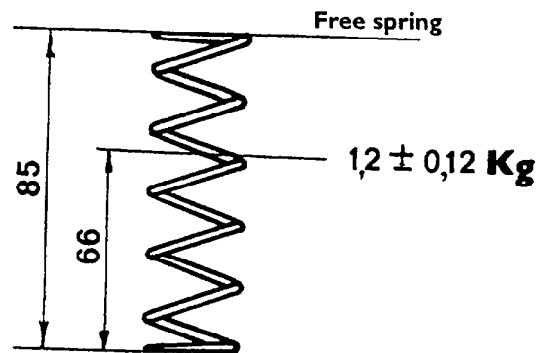
### PUSH RODS



17453

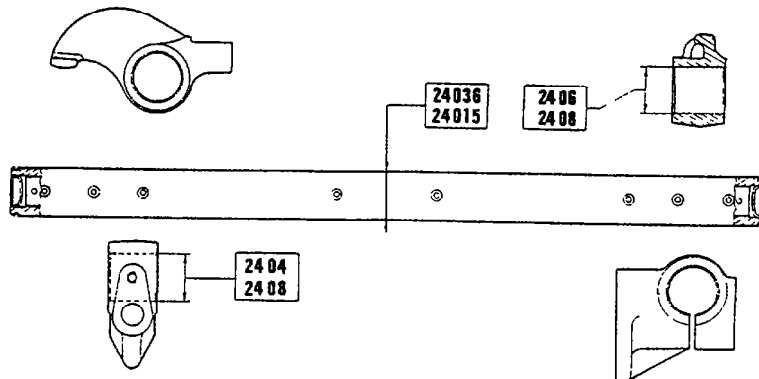
The valve pushrods must be free from distortion, the cup seatings for the adjustment screws and the ball ends locating in the tappets (arrowed) must not show any signs of seizing or wear, if they do, replace the rods.

Pushrods for inlet and exhaust valves are identical and therefore interchangeable



18097

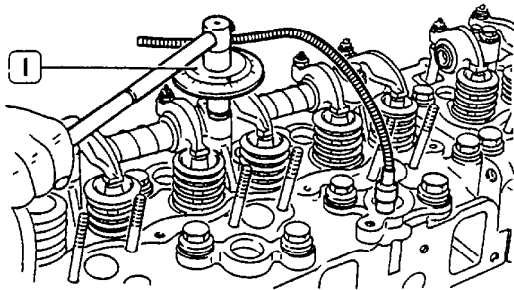
MAIN DATA FOR CHECKING ROCKER SPACER SPRINGS



132395

MAIN DATA – SUPPORTS, EQUALISER SHAFT AND EQUALISERS

**Assembly Equaliser Shafts and Clearance Check**



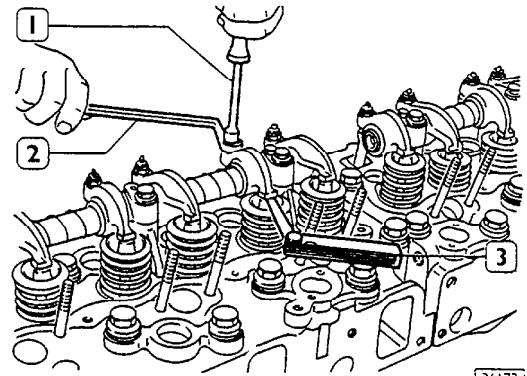
20171

Fit the caps on the valve stems

Fit the equaliser shafts as follows

balance the valves of barrel N°1, fit the equaliser shaft for barrels 1, 2, 3, tighten the screws to pre torque 17 Nm (1.7 kg) fit tool 99395216 (1) and tighten with angle  $180^\circ \pm 5^\circ$

Balance the valves for cylinder N°6 and fit the equaliser shaft for barrels 4, 5, 6, tighten the screws as before



36172

Adjust clearance between equalisers and valves using tool 99350108 (1), spanner (2) and feeler gauge (3)

The working clearance is 0.25 mm for intake and 0.50 mm for the exhaust. Take the barrel to be checked to firing stroke, the valves of this cylinder remain closed while balancing those of the symmetric barrel

Symmetric barrels are 1 – 6, 2 – 5 and 3 – 4

In order to carry out the checks more quickly proceed as follows

- rotate the drive shaft, balance the valves of barrel N°1 and adjust the barrels marked with an asterisk in the table below

barrel no	1	2	3	4	5	6
intake	-	-	*	-	*	*
exhaust	-	*	-	*	-	*

- rotate the drive shaft, balance the valves of barrel N°6 and adjust the valves marked with an asterisk in the table below

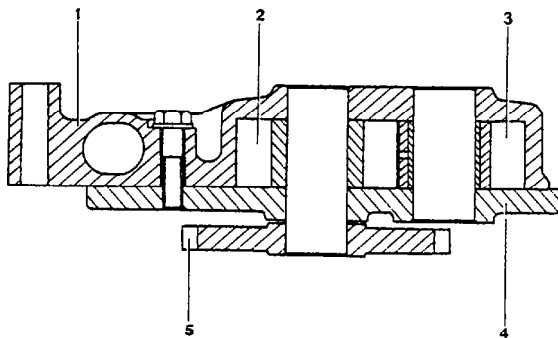
barrel no	1	2	3	4	5	6
intake	*	*	-	*	-	-
exhaust	*	-	*	-	*	-

**LUBRICATION**

The engine is lubricated using a gear pump (fig 146) applied to the lower part of the base with the front support. It is driven from the camshaft using gears.

**OIL PUMP**

Fig. 148



36173

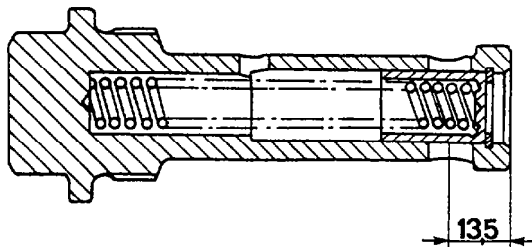
CROSS-SECTION THROUGH OIL PUMP

- 1 Pump case - 2 Driving gear - 3 Driven gear -
- 4 Cover - 5 Oil pump drive gear

Check that the gears (2-3-5) are not worn or showing deterioration and that their shafts do not display excessive play in the housings in case (1) or cover (4)  
Replace oil pump assembly if any fault is found.

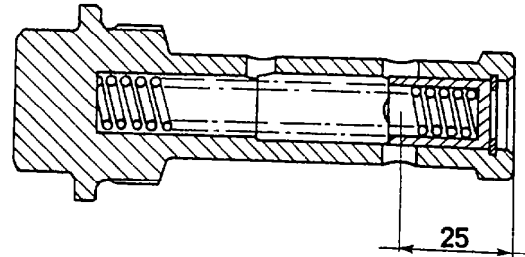
**Regulation valve  
Pressure relief valve**

The regulation valves and pressure relief valves are fitted to the oil filter mounting



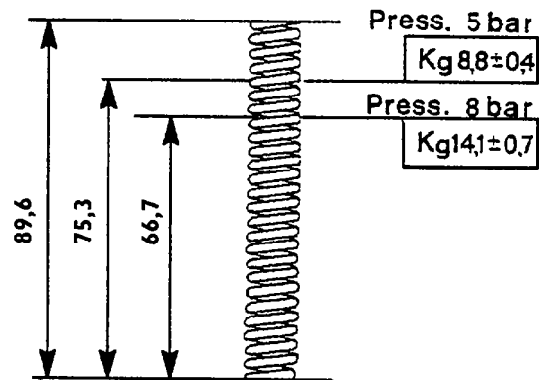
36174

CROSS SECTION THROUGH REGULATION VALVE



36175

CROSS-SECTION THROUGH PRESSURE RELIEF VALVE



36176

MAIN DATA FOR CHECKING REGULATION VALVE AND PRESSURE RELIEF VALVE SPRING

The regulation valve and pressure relief valves differ only in the gap between the four oil ports and the edge of the valve case. This is 135 mm for the regulation valve and 25 mm for the pressure relief valve. They are not therefore interchangeable upon installation

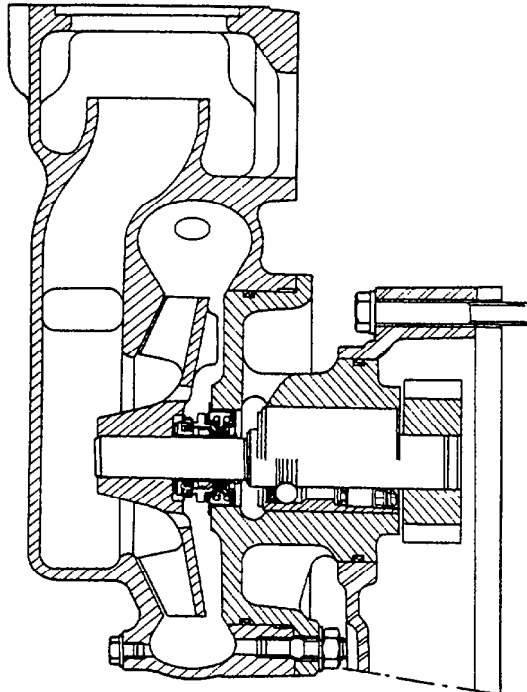
**OIL FILTER**

Two double filtration oil filters are fitted to the engine. Opening pressure for the filter valve 25 ± 0.2 bar

When fitting the filters, observe the following instructions

- oil the seals
- screw filters in until the seals contact the seating bases
- tighten through a further 3/4 turn

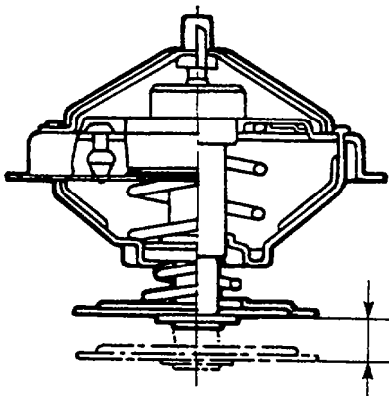


**COOLING SYSTEM****WATER PUMP**

36177

**CROSS-SECTION THROUGH THE WATER PUMP**

Check that there are no cracks or leaks in the pump body, if there are, replace the water pump assembly

**THERMOSTAT**stroke begins  $79^\circ \pm 2^\circ$ stroke 7 mm at  $94^\circ$ 

36178

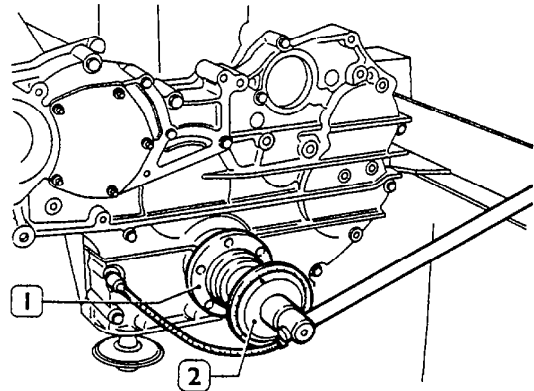
Check thermostat operation and replace in case of doubt

**COMPLETING ASSEMBLY OF THE ENGINE ON THE BENCH**

Complete engine assembly by installing or connecting

- oil pump with strainer,
- sealing ring to timing cover and timing cover to plate

Prevent the flywheel from turning using tool 99360351



36179

Fit damping flywheel hub (1) and tighten bolt

Stage 1 pretorque of 200 Nm (20.5 kgm)

Stage 2 tighten through  $90^\circ \pm 5^\circ$  using tool 99395216 (2).

- damping flywheel and alternator drive pulley
- water pump with thermostats and water pump—crankcase connection manifold,
- pulley return support and pulley,
- water manifold on cylinder head,
- injectors, tighten to specified torque by means of brackets,
- fuel delivery lines from injection pump to injectors,
- mounting with fuel filters and lines,
- starter motor,
- pulse sender unit and adjust position as follows: tighten sender unit into contact, unscrew by one turn corresponding to a 1 mm gap, tighten locknut to specified torque,
- rocker cover,
- exhaust manifold,
- coolant inhibition filter and connecting pipes.