industrial engines

section 3.1

new 8361 series

workshop manual

Publication No L32023007
Date 02 - 1995

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

INDEX 8361SRI12

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ENGINE SPECIFICATIONS

Engine type. 8361SRI12
4 - stroke Diesel with direct injection
Cylinders,number and arrangement..... ...6, in line
Bore x stroke..... .....112 X 130 mm
Displacement..... .....7,7 l
Compression ratio.....17,6:1
Maximum rating(*)..... ..198 kW(270 CV)
At..... .....2200 rpm
Intermittent rating.....184 kW(250 CV)
At..... .....2200 rpm
Continuous rating (10% overload capacity)... 165 kW(225 CV)
At..... ....2100 rpm
Engine rotation:
(see from flywheel) ....CCW

(*) ISO Fuel Stop Power
- Ambient reference conditions:
ISO 3046/1; 25°C; 100 kPa; 30% relative humidity

TIMING

Valve Timing:

- Intake
  opens: before T.D.C .....17° 32'
  closes: after B.D.C .....38° 44'
- Exhaust
  opens. before B.D.C ....53° 08'
  closes: after T.D.C ....13° 37'

Clearance between valves and
rockers for timing checks.....0,40 mm

Operating clearance between valves and rockers,cold engine;
- intake and exhaust..... .....0,40 ± 0,05 mm

FUEL SYSTEM

In line injection pump type PES

Fixed injection pump delivery start advance.....15°± 30'
Fuel injectors setting .....240 + 8 bar
Firing order.....1-5-3-6-2-4

TURBOCHARGING

The engine is supercharged by a turbocharger driven by the exhaust gases.

Cooling intake air with air-water heat exchanger

The turbocharger is lubricated with the engine oil under pressure.

LUBRICATION

Minimum oil pressure:
- at full throttle.. ....3,5 kg/cm²
- when idling..... ....1 kg/cm²

COOLING SYSTEM

Forced water circulation controlled by centrifugal pump.
Water temperature controlled by thermostat.
Water filtering with multiple recycle filter.
Radiator cooling fan driven by V-belt.

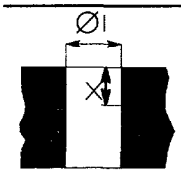
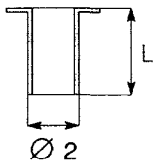
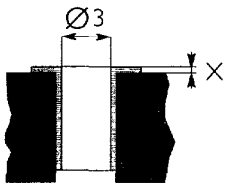
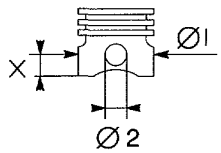
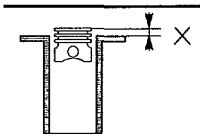
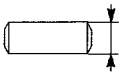
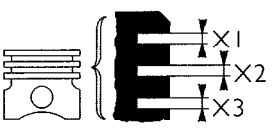
STARTING

By starter motor.

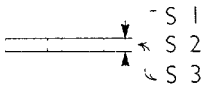
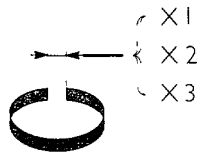
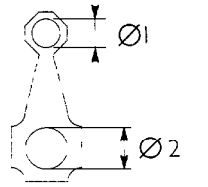
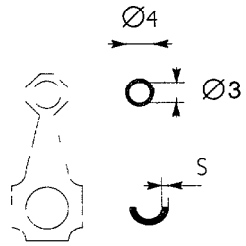
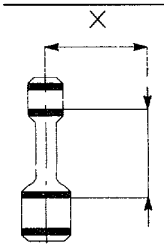
ELECTRIC SYSTEM

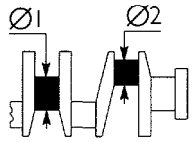
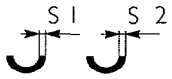
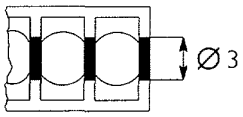
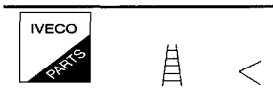
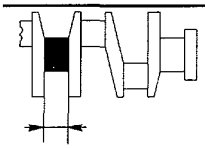
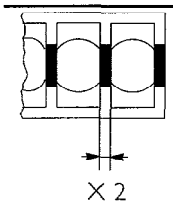
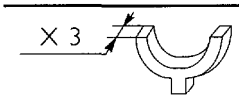
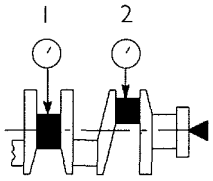
- Voltage.....24 V
- Self-regulated alternator.....30 A
- Starting motor power..... .....4 kW
- Battery (optional).....2, each 110 Ah

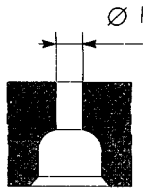
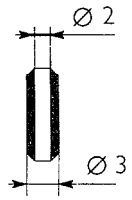
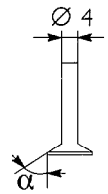
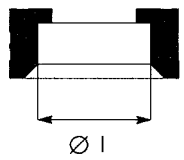
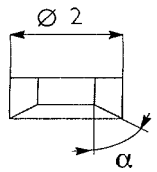
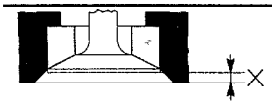
DATA ON ASSEMBLY CLEARANCES

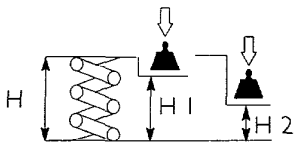
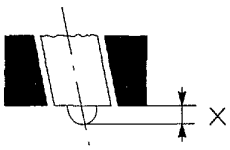
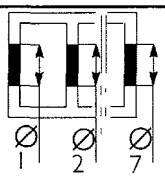
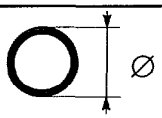
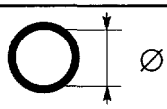
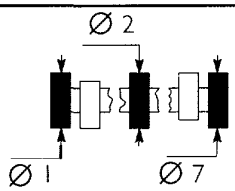
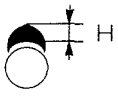
CYLINDER BLOCK AND CRANK MECHANISM COMPONENTS		mm
	Measurement dimension X	165 – 170
	Bores for cylinder liners Ø 1	120,470 ÷ 120,500
	Cylinder liners	
	outside diameter Ø 2	120,470 – 120,490
	length L	--
	Cylinder liners – crankcase housing	– 0,02 – + 0,03
	Outside diameter Ø 2	–
	Cylinder liners	
	Inside diameter Ø 3	112,000 – 112,022
	protrusion X (measured under a load of 4000 kg)	0,16 – 0,25
	Pistons	
	measurement height X	22
	outside diameter Ø 1	111,853 – 111,867
	housing for gudgeon pin Ø 2	42,013 – 42,019
	Piston – cylinder liner	0,133 – 0,169
	Piston diameter Ø 1	–
	Piston protrusion X	0,1 – 0,25
	Gudgeon pin Ø 3	42,000 – 42,006
	Gudgeon pin – pin housing	0,070 ÷ 0,019
	X 1*	3,200 ÷ 3,230
	Piston ring grooves X 2	2,540 – 2,560
	X 3	4,030 ÷ 4,050
	*measured on the Ø of 1175 mm	

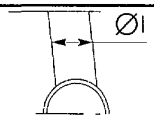
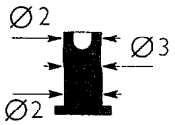
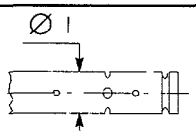
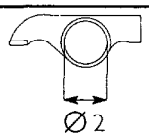
mm

	Piston rings	S 1*	3,075 – 3,095
		S 2	2,480 – 2,490
		S 3	3,975 – 3,990
	*measured on the Ø of 1175 mm		
	Piston ring – grooves	1	0,155 – 0,205
		2	0,050 – 0,080
		3	0,040 – 0,075
IVECO PARTS	Piston rings		–
	Piston ring end gap in cylinder liner		
		X 1	0,15 – 0,30
		X 2	0,20 ÷ 0,45
		X 3	0,30 – 0,60
	Small end bush housing	Ø 1	45,946 – 45,971
	Big end bearing housing	Ø 2	76,698 – 76,718
	Small end bush diameter		
	outside	Ø 4	46,076 ÷ 46,114
	inside	Ø 3	42,020 ÷ 42,035
	Big end bearing shell (S=thickness)	S	2,070 – 2,080
	Small end bush – housing		0,068 ÷ 0,105
	Gudgeon pin – bush		0,014 ÷ 0,035
IVECO PARTS	Big end bearing shells		0,127 – 0,254 – 0,508
	Measurement dimension	X	125
	Maximum out-of-parallel error on connecting rod axes	=	0,08

			mm
	Main journals	Ø 1	79,777 ÷ 79,800
	Crankpins	Ø 2	72,477 – 72,500
	Main bearing shells	S 1	2,174 – 2,184
	Big end bearing shells (S=thickness)	S 2	2,070 – 2,080
	Main bearing housings	Ø 3	84,206 ÷ 84,226
	Bearing shells – main journals Bearing shells – crankpins		0,038 – 0,101
	Main bearing shells		0,254 – 0,508 – 0,762 – 1,016
	Main journal, thrust bearing	X 1	50,000 ÷ 50,050
	Main bearing housing for thrust bearing	X 2	43,000 ÷ 43,074
	Thrust washer halves	X 3	3,378 – 3,429
	Crankshaft end float		0,068 – 0,294
	Thrust washer halves		0,127 – 0,254 – 0,508
	Alignment	1	≥ 0,10
	Ovality	2 1 – 2	± 0,25 0,008
	Taper	1 – 2	0,012

CYLINDER HEAD, VALVE GEAR		mm
	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
IVECO PARTS	Valve guides	0,2
	Valves Ø 4 α Ø 4 α	 8,980 – 8,995 65° 15' ± 5' 8,980 ÷ 8,995 45° 15' ± 5'
	Valve stem and its guide	0,030 – 0,065
	Housing in head for valve seat Ø1 Ø1	 47,980 ÷ 48,020 42,980 ÷ 43,020
	Outside diameter of valve seat, angle of valve seat in cylinder head Ø 2 α Ø 2 α	 48,100 – 48,120 65° ± 15' 43,100 ÷ 43,120 45° ± 15'
	Recessing of valves X	0 – 0,3
	Between valve seat and head	0,04 – 0,08

			mm
	Valve spring height Free spring Under a load of N 618 N 912 N	H H1 H2	 84,9 52 39,5
	Injector protrusion	X	1 ± 0,4
	Camshaft bearing housings in crankcase Ø 1 ⇒ Ø 7		58,000 ÷ 58,025
	Outside diameter of camshaft bushes		58,141 – 58,191
	Inside diameter of bushes		55,050 ÷ 55,085
	Bushes and housings in crankcase		0,116 ÷ 0,191
	Camshaft bearing journals Ø 1 ⇒ Ø 7		54,940 – 54,970
	Bushes and bearing journals		0,080 – 0,145
	Effective cam lift	 H  H	7,077 7,373

		mm
	Tappet cup housing in crankcase Ø 1	18,000 – 18,027
	Outside diameter of tappet cup Ø 2 Ø 3* * Ø for checking clearance	 17,860 – 17,892 17,938 – 17,970
	Between tappets and housings	0,030 – 0,089
	Tappets	0,5 – 1,0
	Rocker shaft Ø 1	24,015 ÷ 24,036
	Rockers Ø 2	24,060 – 24,080
	Between rockers and shaft	0,024 – 0,065

TOOLS

TOOL NUMBER	DESCRIPTION
99305049	Equipment for checking spring loading
99322230	Swivelling telescopic stand
99340205	Impact extractor
99341003	Single action bridge
99341009	Pair of brackets
99341015	Clamp
99342145	Extractor for injector holder case
99348004	Universal extractor, internal, 5 to 70 mm
99350108	Wrench for valve gear clearance adjustment screw
99360183	Tongs for fitting engine piston rings
99360292	Installing tool for fitting seal to valve guide
99360314	Tool for removing cartridge filters
99360321	Tool for rotating engine flywheel
99360351	Tool for locking engine flywheel
99360357	Tool for removing and refitting engine valves
99360419	Box with set of tools for recutting valve seatings
99360445	Tool for compression and measurement of cylinder liner protrusion
99360467	Adaptor for checking cylinder compression (to be used with 99395682)
99360481	Drift for removing valve guide
99360495	Drift for fitting inlet valve guide (use with 99360481)
99360496	Drift for fitting exhaust valve guide (use with 99360481)
99360500	Crankshaft lifting tool
99360503	Rings for lifting cylinder block
99360595	Hoisting beam for removing and refitting engine
99360605	Ring clamp for inserting standard and oversize pistons into the cylinders
99360722	Tool for retaining cylinder liners
99360723	Tool for extracting cylinder liners
99361034	Brackets for securing engine to swivelling stand 99322230
99365063	Tool for refitting injector holder cases
99370005	Handle for drifts (interchangeable)
99370454	Installing tool for fitting crankshaft front seal (use with 99370005)
99374195	Installing tool for fitting crankshaft rear seal (use with 99370005)
99390311	Reaming tool for valve guide
99390425	Tap for threading injector holder cases to be extracted
99394017	Reamer for reconditioning lower part of injector holder case (use with 99394019)
99394018	Cutter for reconditioning injector seating housing (use with 99394019)
99394019	Pilot bush
99395216	Pair of gauges
99395363	Tee square assembly for checking connecting rod distortion
99395682	Diesel engine cylinder compression tester
99395687	Bore micrometer (50 – 175 mm)
99395850	Torque wrench for checking belt tension

TIGHTENING TORQUES

PART		TORQUE Nm	TORQUE Kgm
Cylinder head attachment bolt	♦ 1st stage preliminary torque	118	(12)
	♦ 2nd stage preliminary torque	118	(12)
	3rd stage angle	90° ± 3°	
	4th stage angle	90° ± 3°	
	5th stage angle	45° ± 3°	
Main bearing cap attachment bolts	♦ preliminary torque	60	(6)
	angle	120°	
Big end cap attachment bolts	♦ preliminary torque	40	(4)
	angle	35°	
Flywheel attachment bolts	♦ preliminary torque	100	(10)
	angle	60°	
Rocker shaft pedestal securing nut	♦ preliminary torque	50	(5)
	angle	90°	
Damper hub attachment screw	♦ preliminary torque	450	(45)
	angle	120°	

Screw attaching the sump and shroud support bracket to the front cover	13	(1,5)
Screw attaching the sump to the crankcase, front cover and rear cover	13	(1,5)
Screw attaching the sump and bracket for heat exchanger water inlet pipe to crankcase	13	(1,5)
Screw attaching the sump and bracket for engine breather pipe to crankcase	13	(1,5)
Screw attaching the oil filter body mounting to the crankcase	130	(13)

♦ Lubricate the thread with engine oil

FAULT DIAGNOSIS

Main engine operating faults .

1 – Engine will not start
2 – Engine overheats
3 – Engine lacks power
4 – Engine emits black or dark grey smoke
5 – Engine emits grey (whitish) smoke
6 – Engine emits blue smoke
7 – Abnormal knocking from the engine
8 – Engine stops
9 – Engine exceeds maximum rpm
10 – Oil pressure too high or too low
11 – Excessive fuel consumption

1 ENGINE WILL NOT START

Battery terminal connections serviceable — NO → Clean, check, tighten clamp nuts or replace

YES

Battery serviceable — NO → Carry out the checks described in the "Electrical components" repair manual

YES

Starter motor serviceable — NO → Carry out the checks described in the "Electrical components" repair manual

YES

Starter heater serviceable — NO → Replace

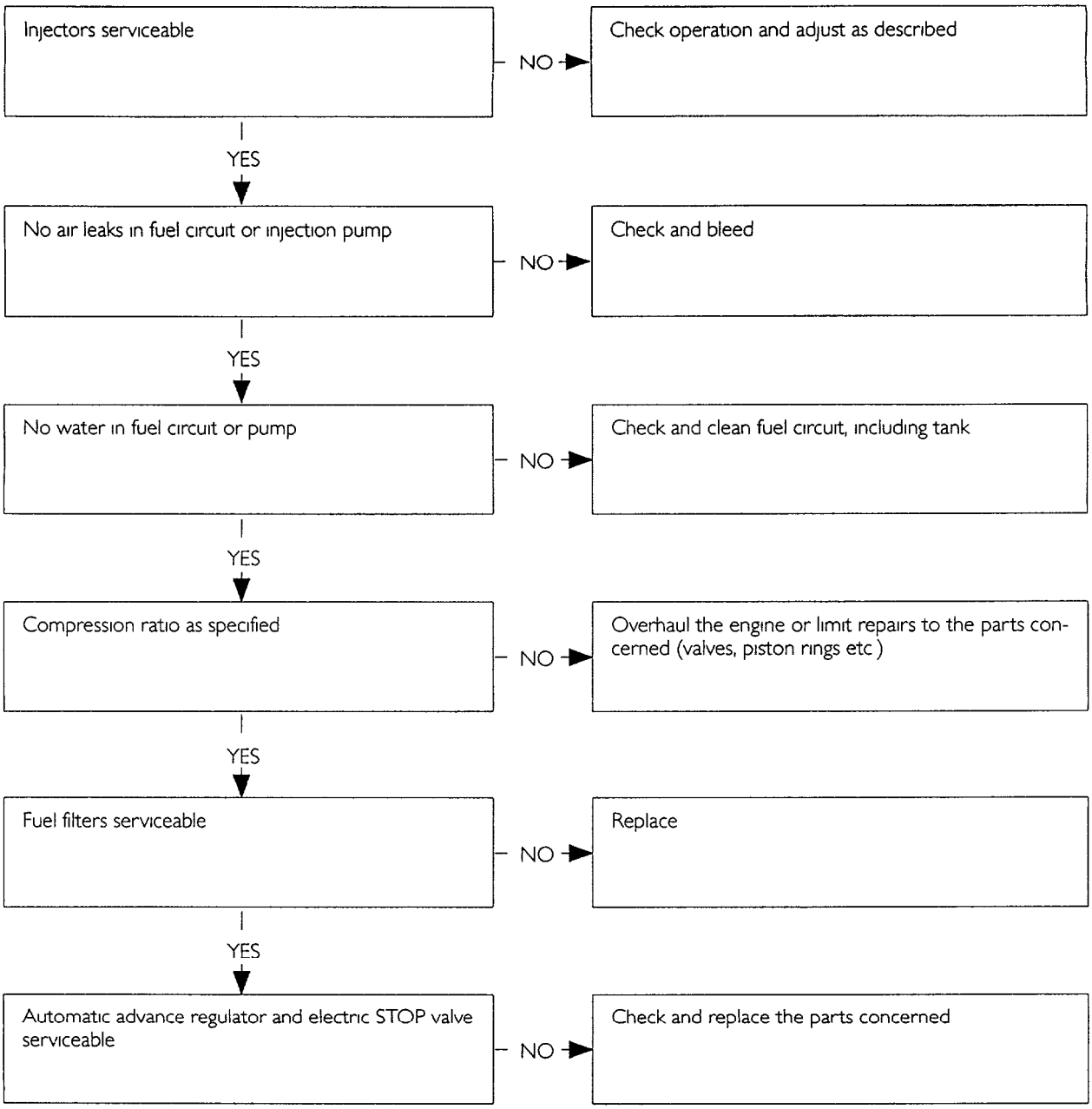
YES

Injection pump timing correct — NO → Check correct timing as described in the relevant chapter

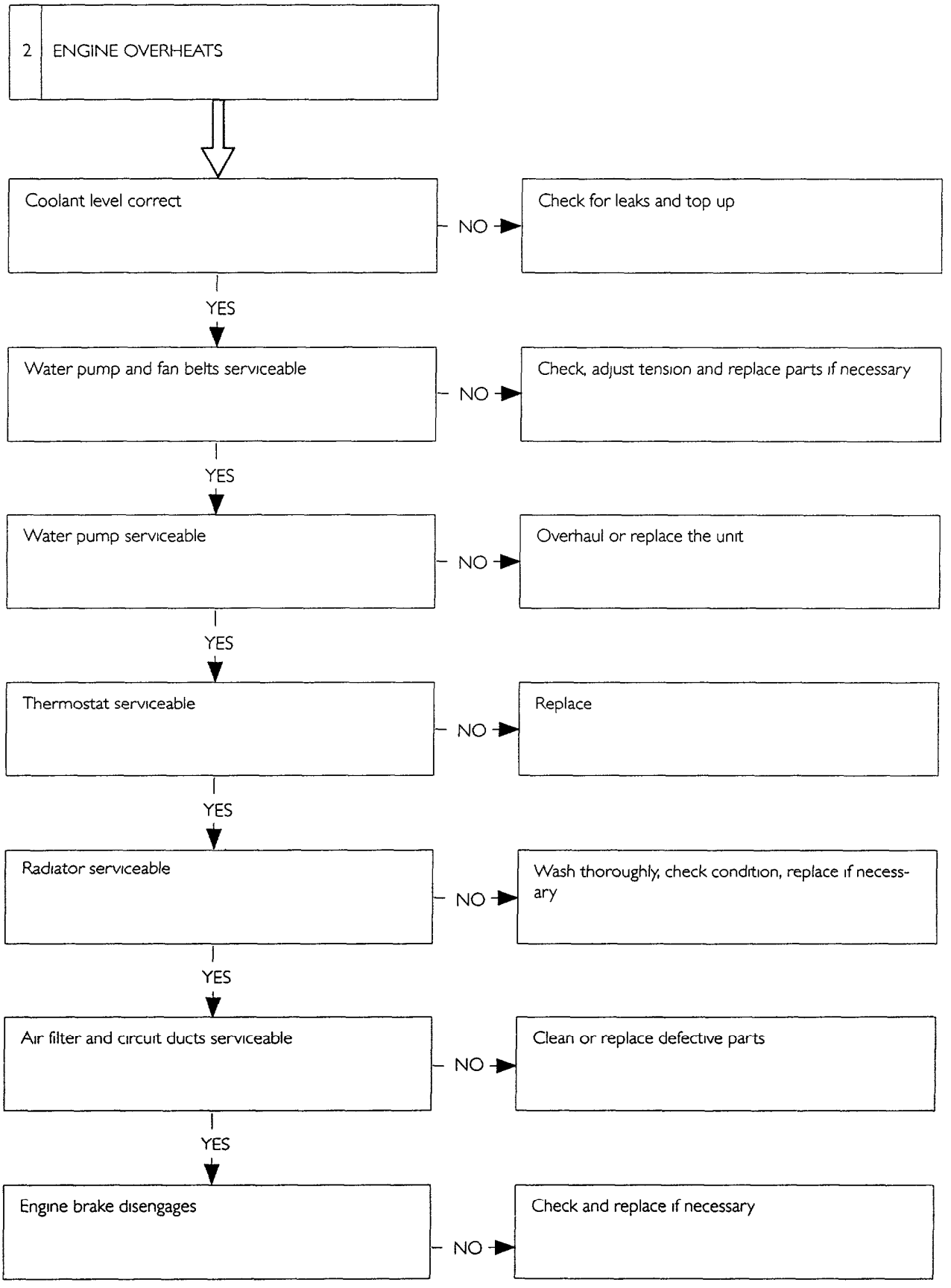
YES

Fuel pump operating correctly — NO → Check and replace if necessary

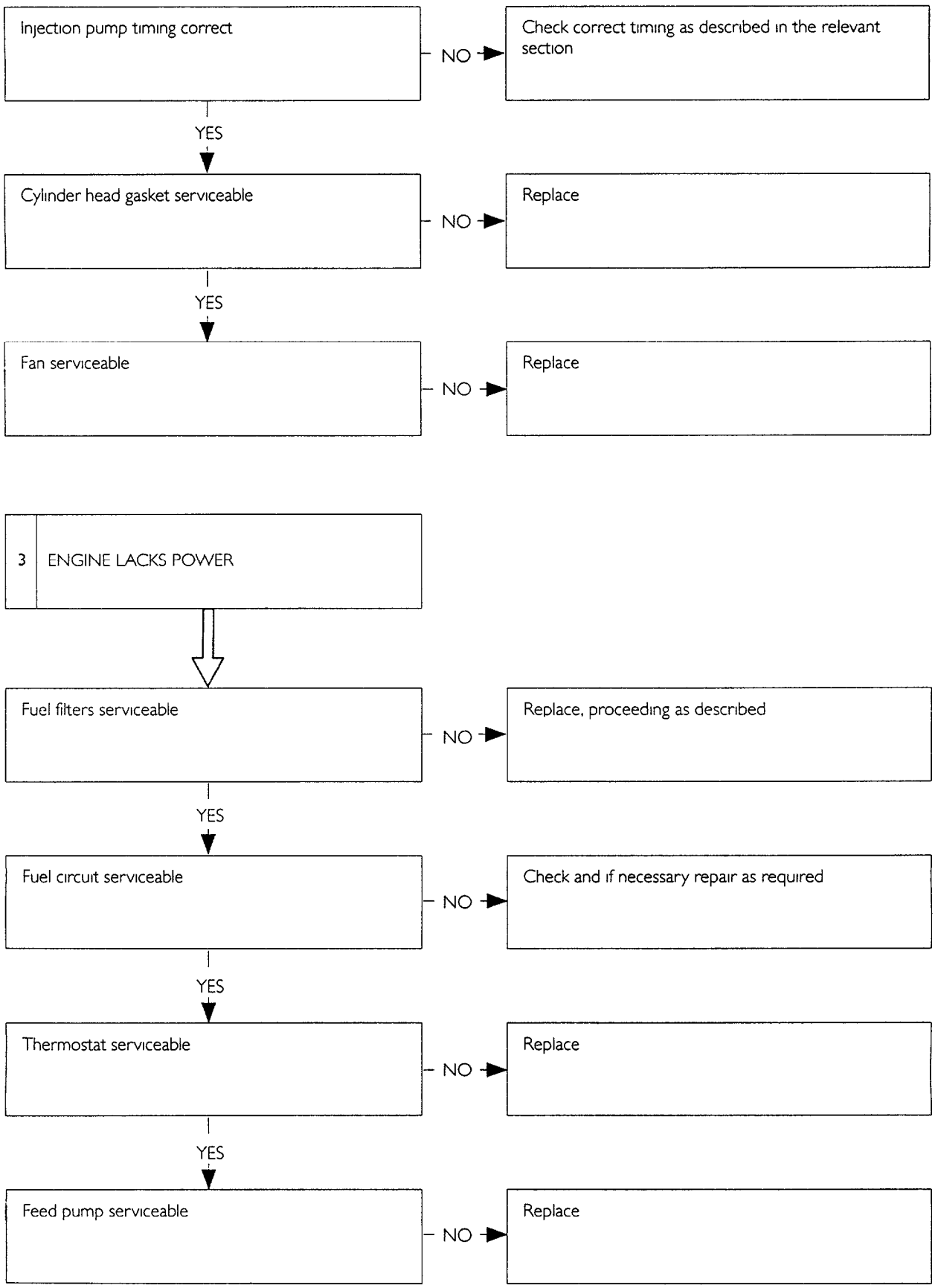
(continued)


Injectors serviceable
NO
Check operation and adjust as described
YES
No air leaks in fuel circuit or injection pump
NO
Check and bleed
YES
No water in fuel circuit or pump
NO
Check and clean fuel circuit, including tank
YES
Compression ratio as specified
NO
Overhaul the engine or limit repairs to the parts concerned (valves, piston rings etc)
YES
Fuel filters serviceable
NO
Replace
YES
Automatic advance regulator and electric STOP valve serviceable
NO
Check and replace the parts concerned

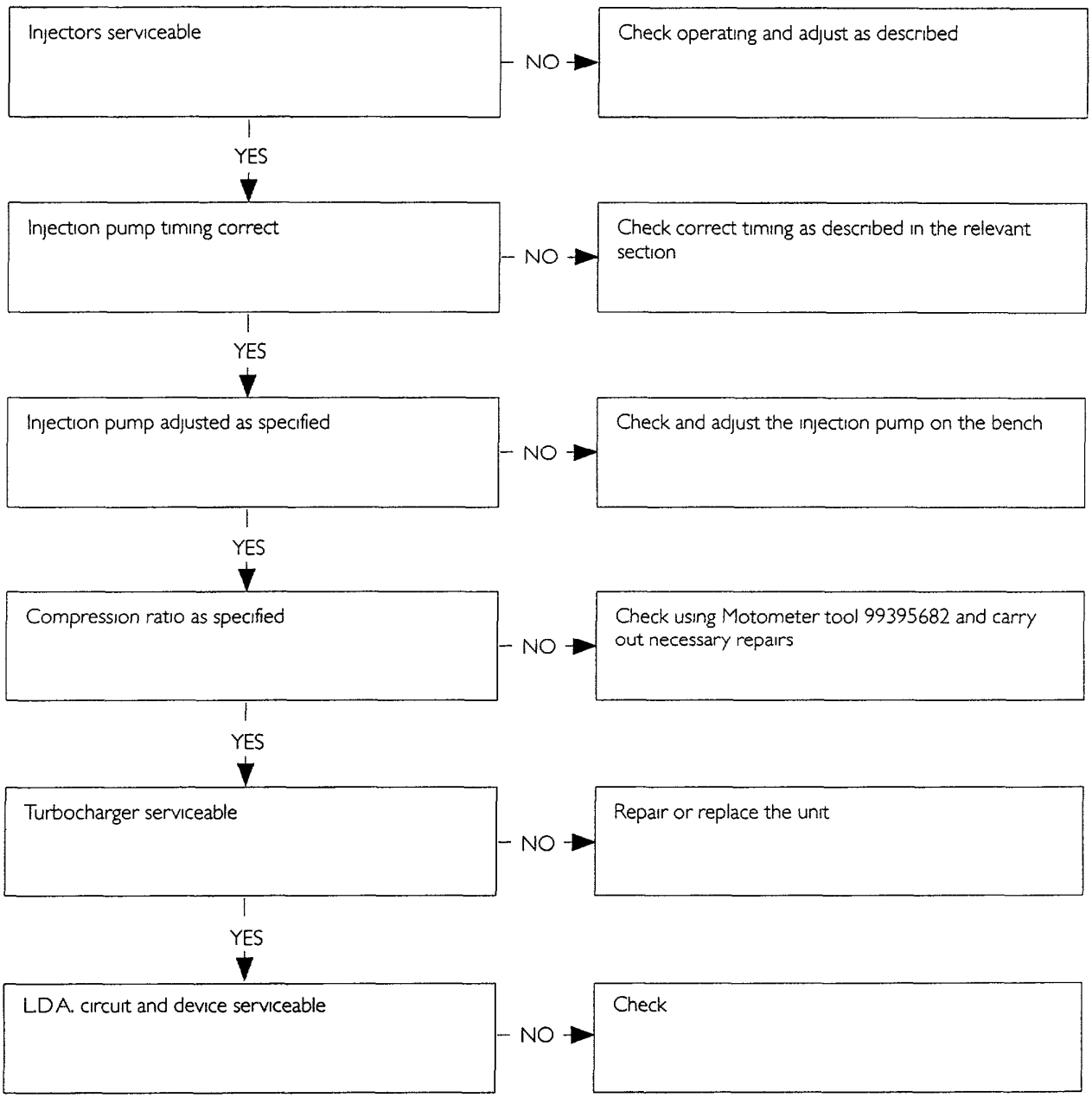
(continued)


2 ENGINE OVERHEATS
Coolant level correct
NO
Check for leaks and top up
YES
Water pump and fan belts serviceable
NO
Check, adjust tension and replace parts if necessary
YES
Water pump serviceable
NO
Overhaul or replace the unit
YES
Thermostat serviceable
NO
Replace
YES
Radiator serviceable
NO
Wash thoroughly, check condition, replace if necessary
YES
Air filter and circuit ducts serviceable
NO
Clean or replace defective parts
YES
Engine brake disengages
NO
Check and replace if necessary

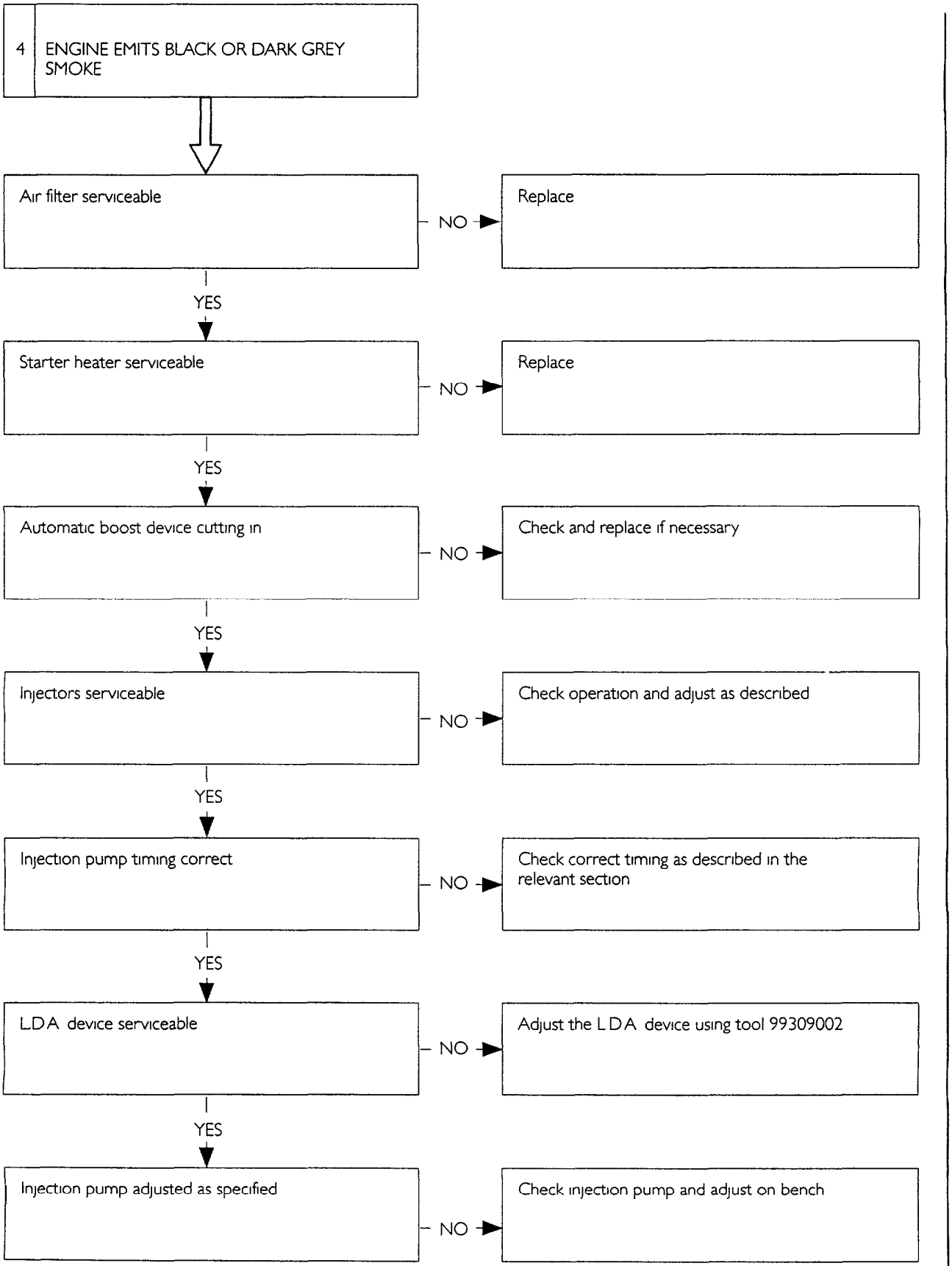
(continued)


Injection pump timing correct
NO
Check correct timing as described in the relevant section
YES
Cylinder head gasket serviceable
NO
Replace
YES
Fan serviceable
NO
Replace
3 ENGINE LACKS POWER
Fuel filters serviceable
NO
Replace, proceeding as described
YES
Fuel circuit serviceable
NO
Check and if necessary repair as required
YES
Thermostat serviceable
NO
Replace
YES
Feed pump serviceable
NO
Replace

(continued)


Injectors serviceable
NO
Check operating and adjust as described
YES
Injection pump timing correct
NO
Check correct timing as described in the relevant section
YES
Injection pump adjusted as specified
NO
Check and adjust the injection pump on the bench
YES
Compression ratio as specified
NO
Check using Motometer tool 99395682 and carry out necessary repairs
YES
Turbocharger serviceable
NO
Repair or replace the unit
YES
L.D.A. circuit and device serviceable
NO
Check

(continued)


4 ENGINE EMITS BLACK OR DARK GREY SMOKE
Air filter serviceable
NO
Replace
YES
Starter heater serviceable
NO
Replace
YES
Automatic boost device cutting in
NO
Check and replace if necessary
YES
Injectors serviceable
NO
Check operation and adjust as described
YES
Injection pump timing correct
NO
Check correct timing as described in the relevant section
YES
LDA device serviceable
NO
Adjust the LDA device using tool 99309002
YES
Injection pump adjusted as specified
NO
Check injection pump and adjust on bench

(continued)

Compression ratio as specified — NO → Check using Motometer tool 99395682 and repair as necessary

YES ↓

Good quality diesel fuel — NO → Clean the tank and replace the diesel filters

5 ENGINE EMITS GREY (WHITISH) SMOKE

Thermostat operating correctly — NO → Replace

YES ↓

Injectors serviceable — NO → Check operation and adjust as described

YES ↓

Injection pump timing correct — NO → Check correct timing as described in the relevant section

YES ↓

Coolant level correct — NO → Coolant probably entering combustion chamber, replace cylinder head gasket or overhaul the engine

YES ↓

Good quality diesel fuel — NO → Clean the tank and replace the diesel filters

(continued)

6 ENGINE EMITS BLUE SMOKE

Excessive oil consumption — YES → Check oil breather, cylinder compressions
If necessary, overhaul the cylinder head or engine

7 ABNORMAL KNOCKING FROM THE ENGINE

Knocking coming from crankshaft — YES → Check main journals for clearance and ovality, tightness of main bearing cap bolts and flywheel bolts, oil pressure Replace parts or overhaul the engine

NO ↓

Knocking coming from connecting rods — YES → Check crankpins for clearance and ovality, tightness of connecting rod cap bolts, connecting rods for distortion Replace parts or overhaul the engine

NO ↓

Knocking coming from pistons — YES → Check clearance between pistons and cylinder liners, piston rings for breaks, gudgeon pin to piston boss clearances Replace parts or overhaul the engine

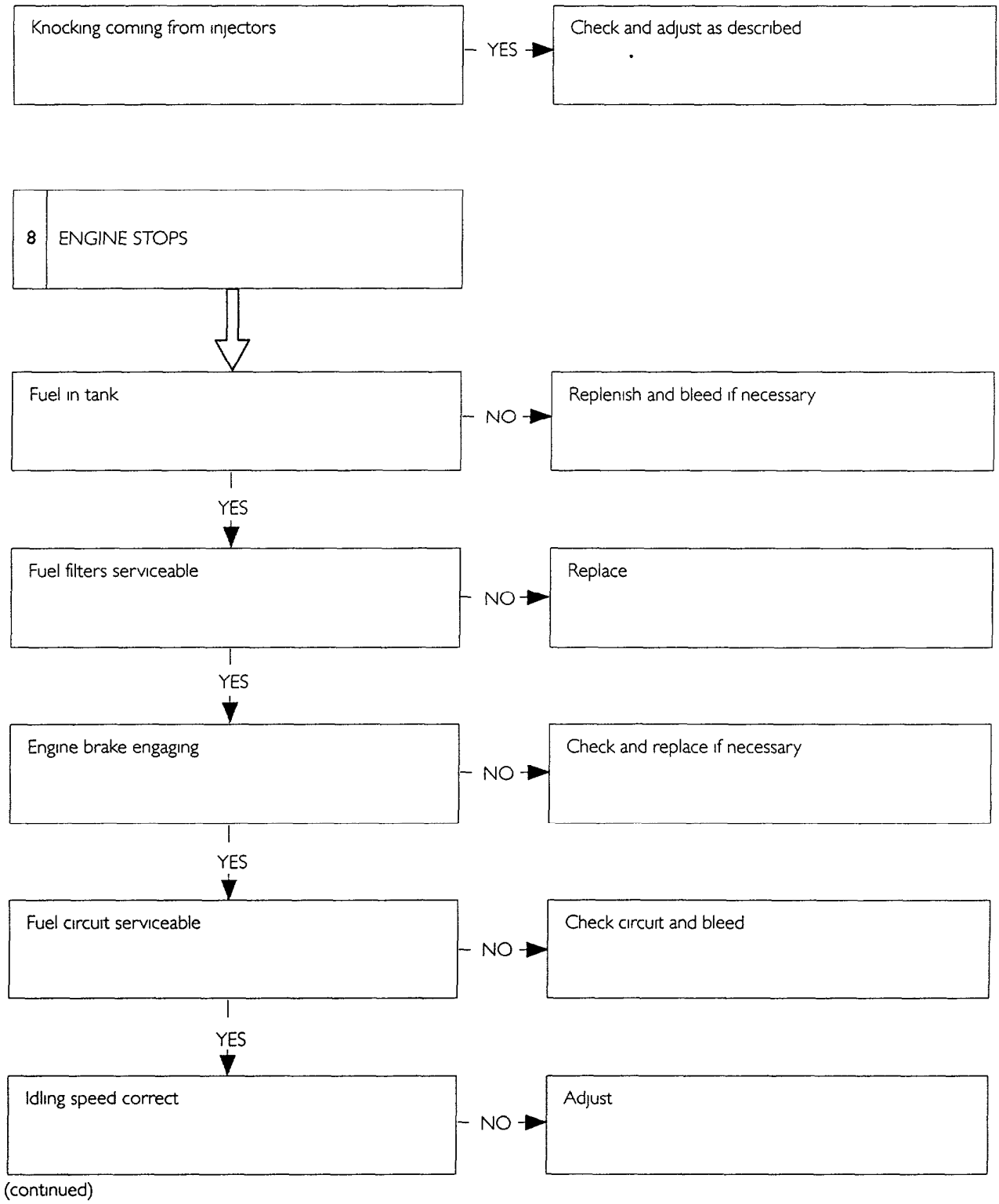
NO ↓

Knocking coming from cylinder head — YES → Check operating clearance between rocker arms and valves, injection pump timing, valve timing Adjust.

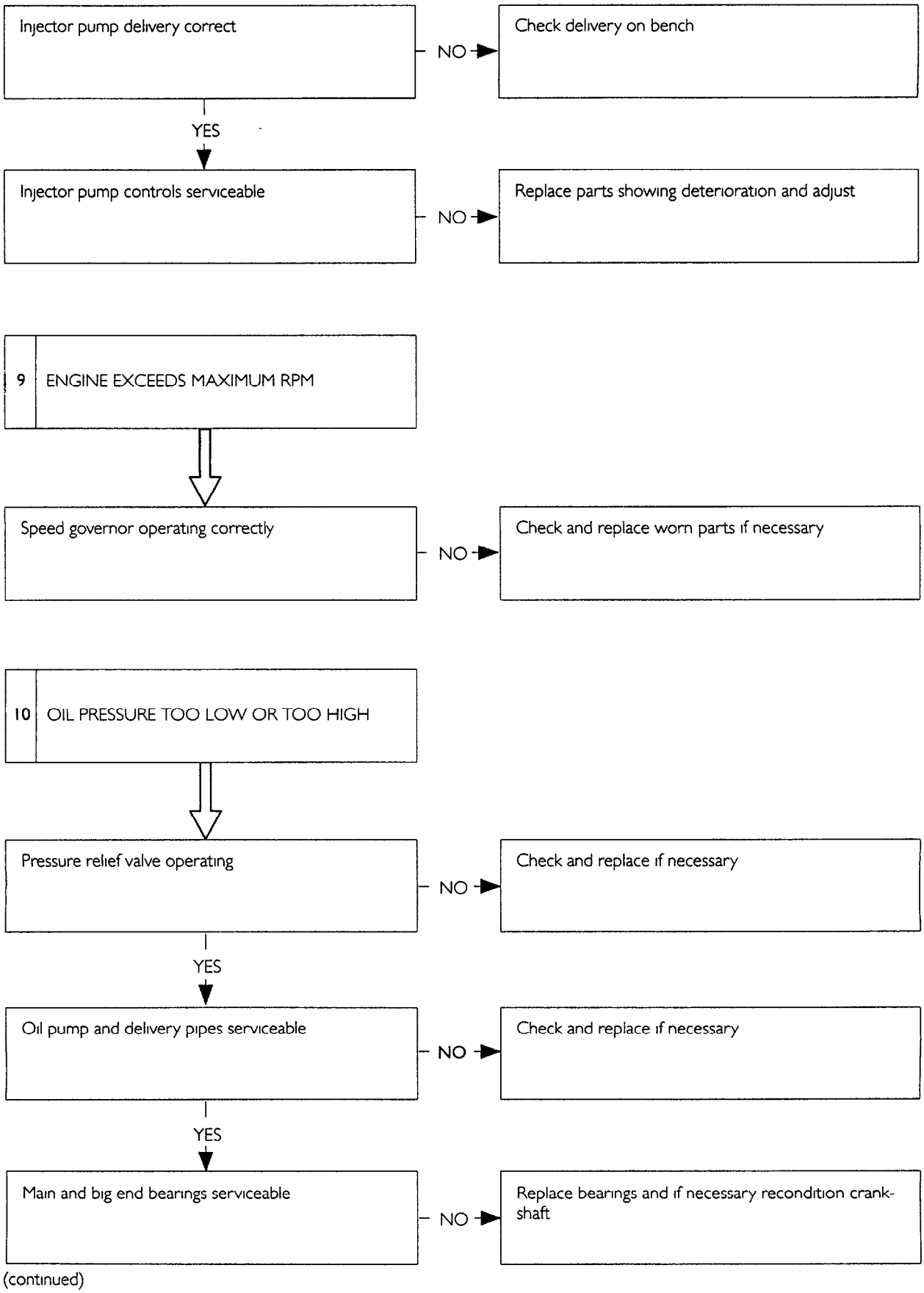
NO ↓

Knocking coming from timing gears — YES → Check gears and replace if necessary

(continued)


Knocking coming from injectors
YES
Check and adjust as described
8 ENGINE STOPS
Fuel in tank
NO
Replenish and bleed if necessary
YES
Fuel filters serviceable
NO
Replace
YES
Engine brake engaging
NO
Check and replace if necessary
YES
Fuel circuit serviceable
NO
Check circuit and bleed
YES
Idling speed correct
NO
Adjust

(continued)


Injector pump delivery correct
NO
Check delivery on bench
YES
Injector pump controls serviceable
NO
Replace parts showing deterioration and adjust
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 crank-shaft

(continued)

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

YES

Air filter serviceable — NO → Replace

YES

Injector adjustment correct — NO → Check operation and adjust as described in

YES

Injector pump adjustment correct — NO → Check and adjust on test bench

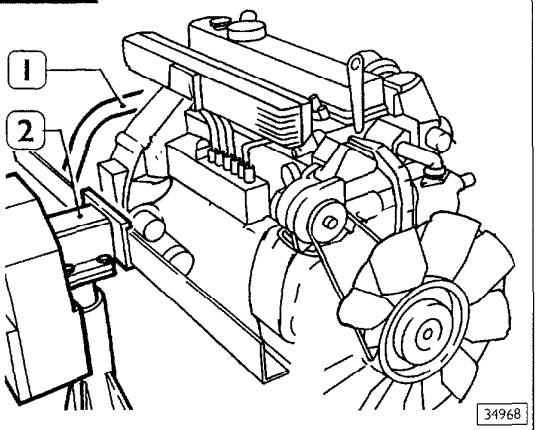
YES

L.D.A. device serviceable — NO → Adjust the L.D.A device using tool 99309002

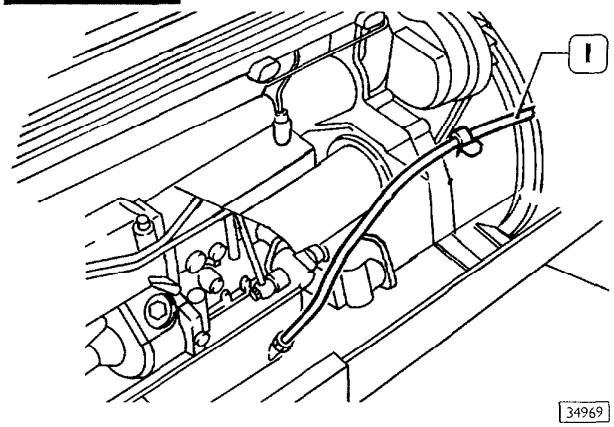
YES

Injection pump timing correct — NO → Check static setting of injection pump

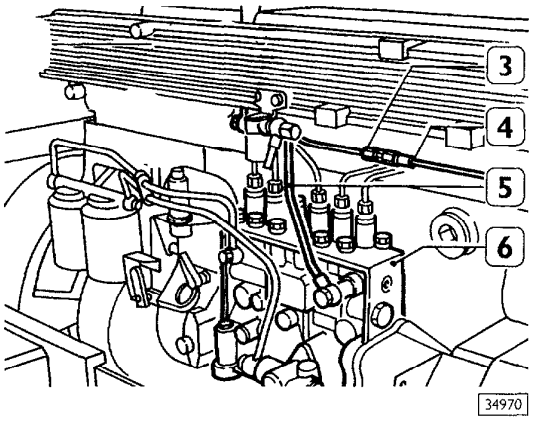
DISMANTLING THE ENGINE ON THE BENCH



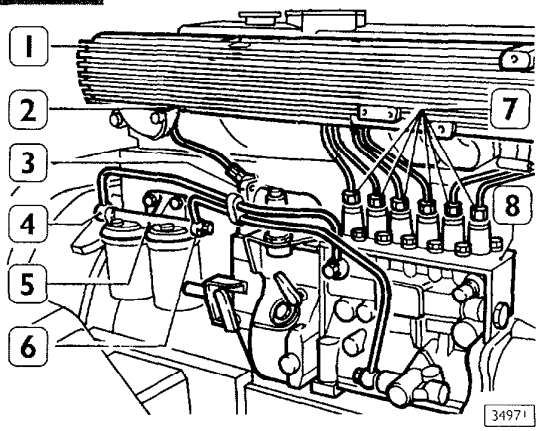
Secure the engine to the swivelling stand 99322230 (2) by means of brackets 99361034 (1) Drain the lubricating oil from the sump



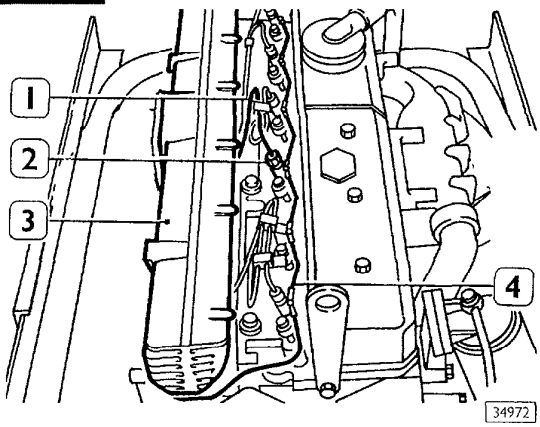
Detach the oil level dipstick sleeve (1)



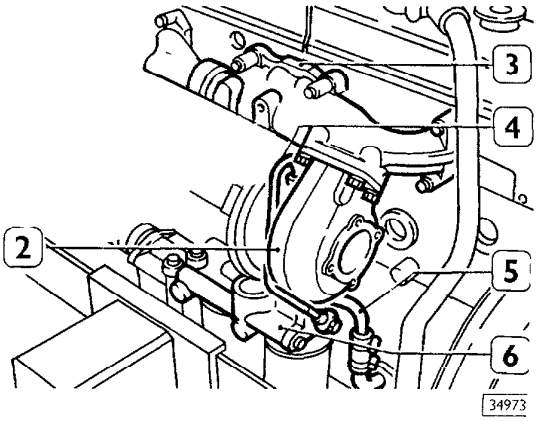
Detach the pipe from the starter heater the pipe (5) from the injection pump (6), the pipe (3) from the fuel return pipe (4) from the injectors



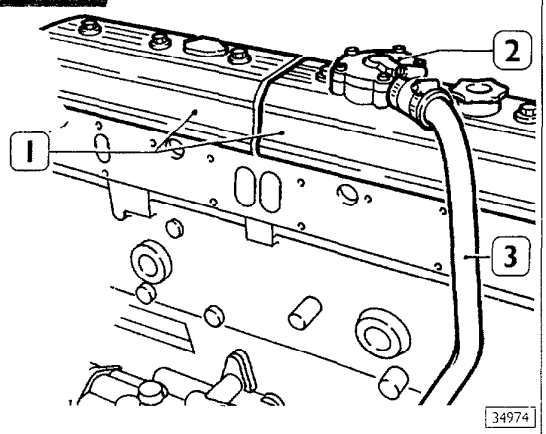
Detach the pipe (2) from the inlet manifold (1) and from the L D A (3), pipes (4, 6) from the fuel filter support (5) and from the injection pump (8), pipe (7) from the injection pump For removing the fuel filters, use tool 99360314



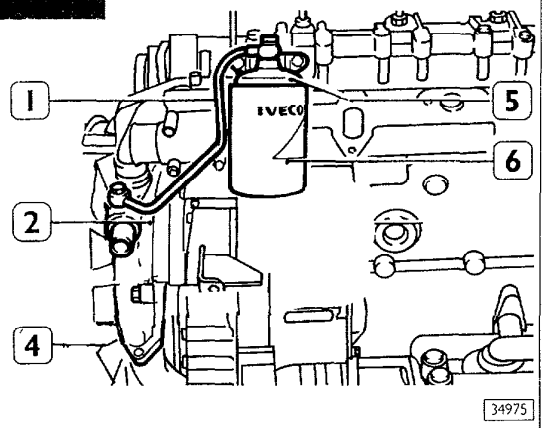
From the injectors (2), detach the fuel return pipe (4) and the delivery pipes (1) Remove the injectors (2) Remove the inlet manifold (3)



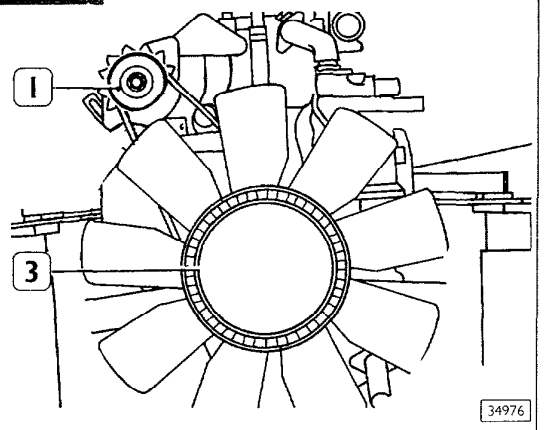
From the turbocharger (2), remove the air duct Remove the oil pipe (4) from the support (6) and pipe (5) from the con nection on the crankcase Remove the exhaust manifold (3) complete with turbocharger



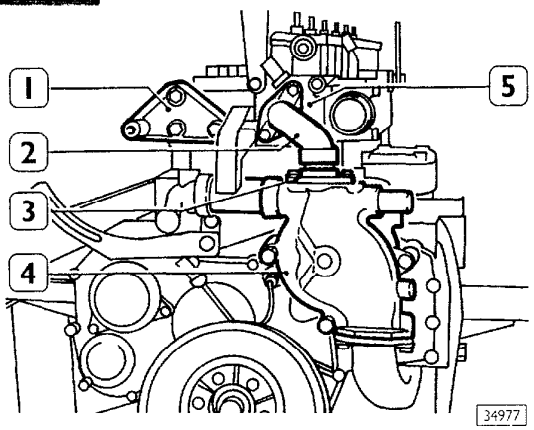
Remove the pipe (3) from the oil breather (2) and from the crankcase
Remove the valve gear covers (1)



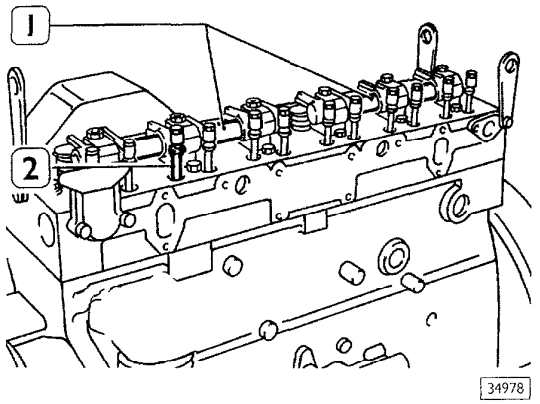
Remove the inhibitor filter (6) using tool 99360314 Detach the coolant pipes (1) from the filter mounting (5) and from the water pump (2) and from the water pump (2) Take off the filter mounting



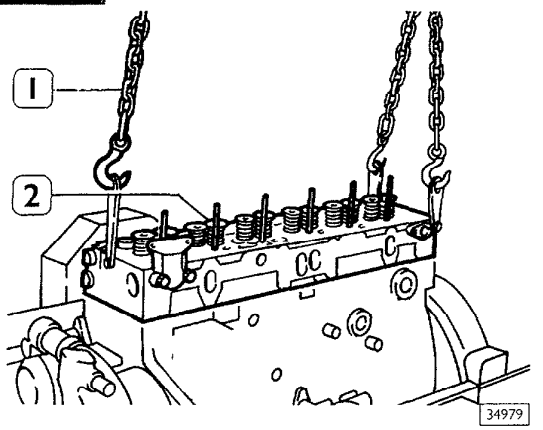
Remove the fan shroud (2), the viscostatic fan (3), the alternator (1) and its drive belt



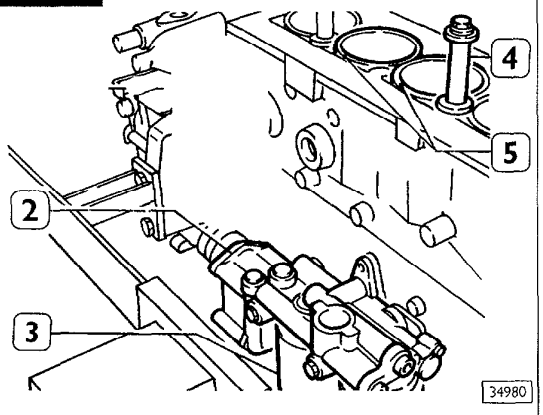
Remove the alternator bracket (1) Remove the flange (3) from the water pump (4), detach the pipe (2) from the thermostat housing (5) and remove the housing



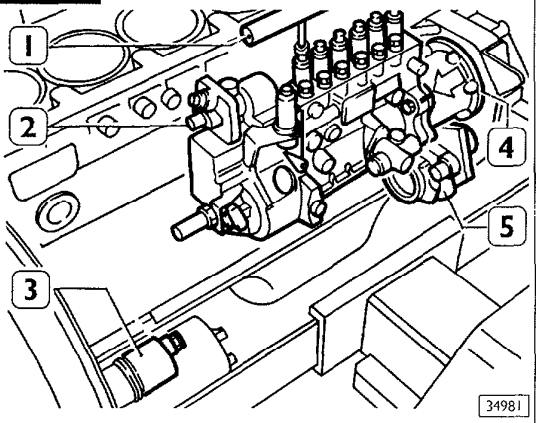
Remove the rocker shaft (1)
Remove the caps from the ends of the valves and withdraw the push rods (2)



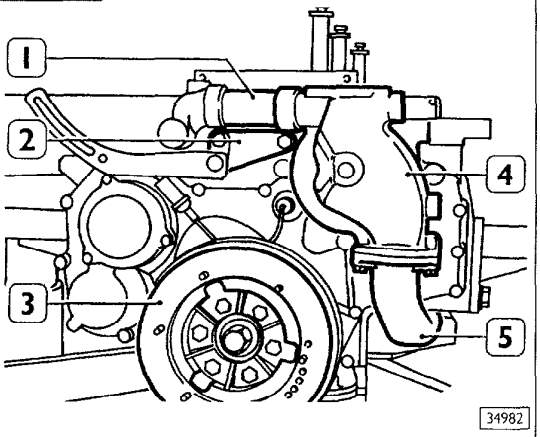
Remove the cylinder head bolts (2) and, using tool 99360595 (1), lift off the cylinder head and remove the gasket



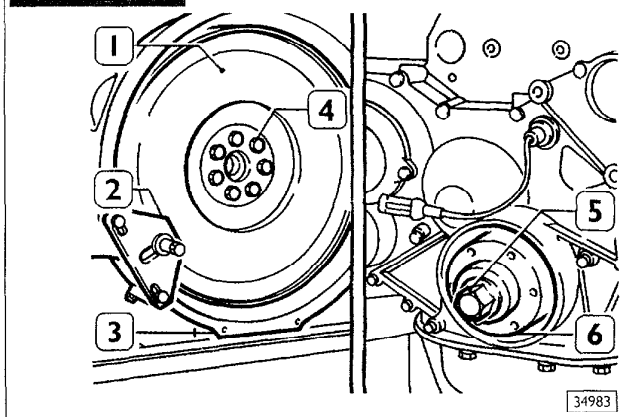
Fit the pillars 99360722 (4) for retaining the cylinder liners (5) to the crankcase Using tool 99360314, remove the oil filters (3) from the heat exchanger (2) and remove the heat exchanger



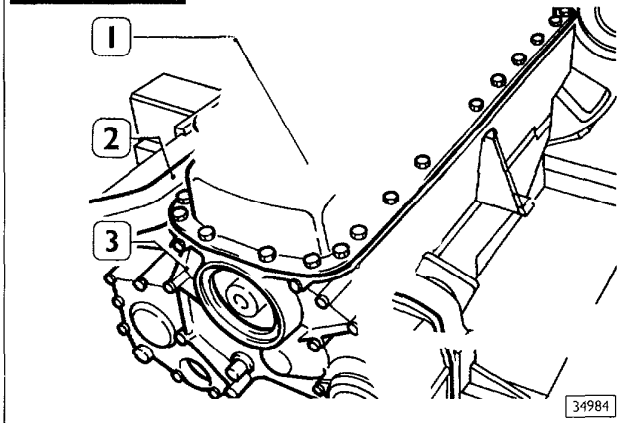
Mark the position (arrow) in which the injection pump (2) is fitted to the support (4) Fit tool 99365136 (1) to the unions of the injection pump (2) and remove the pump and starter motor (3)



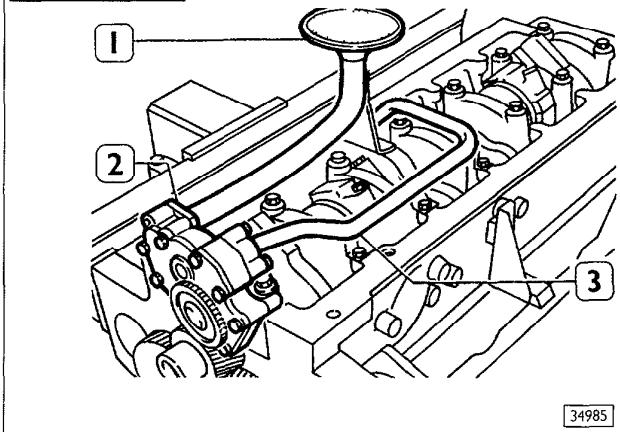
Remove the pipes (1 and 5) and take off the water pump (4) Remove the alternator bracket (2) and the damper flywheel (3) with the front and rear pulleys



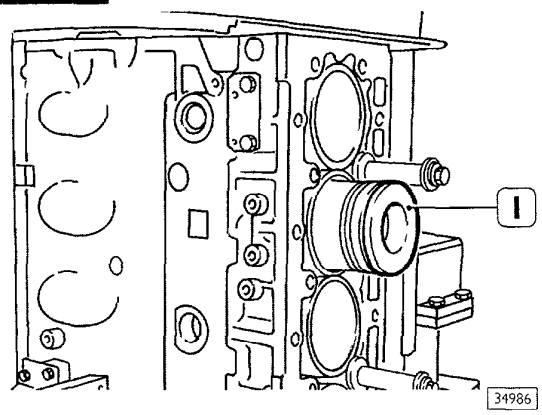
Prevent the flywheel (1) from rotating by fitting tool 99360351 (2) to the flywheel and casing (3) Unscrew the screw (5) and take off the hub (6) Unlock the screws attaching the flywheel and remove the tool



Remove the sump (1), brackets (2 and 4) and the timing gear cover (3)

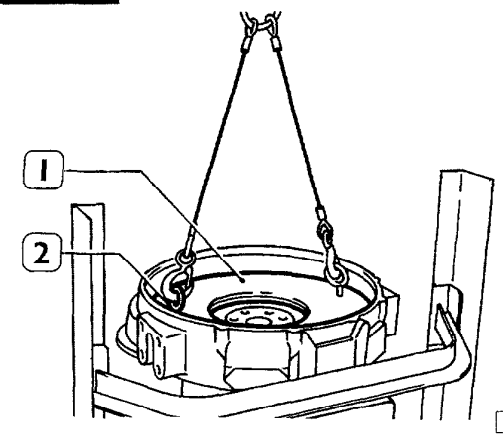


Remove the pipe (3) and the oil strainer (1) from the crankcase and from the oil pump (2), then remove the oil pump

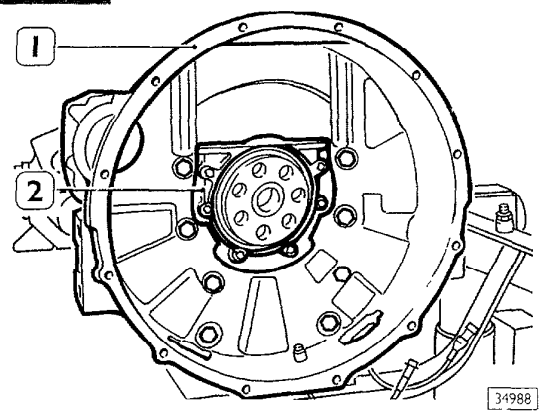


Fit suitable handles to the flywheel so that it can be rotated
Position the engine vertically
Remove the big end caps and their bearing shells and then take the connecting rod/piston assemblies (1) out of the cylinder liners

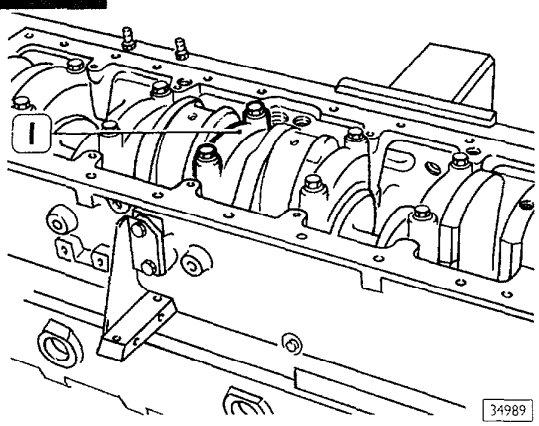
If on dismantling the connecting rod/piston assemblies it is found that the connecting rods and their caps are not numbered, the numbers should be stamped on them according to the numbering of the cylinders to which they belong



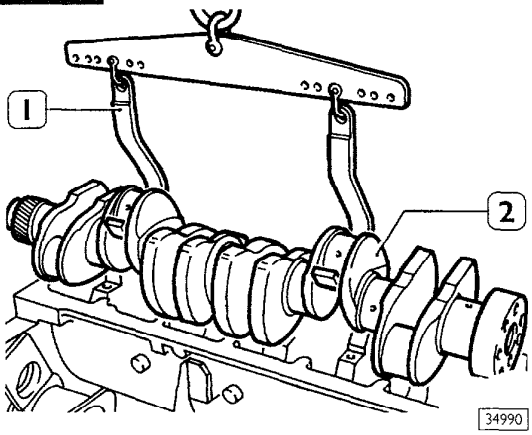
Remove the attachment bolts of the flywheel (1), fit suitable hooks (2) to it and remove the flywheel (1) from the crankshaft using a cable and lifting tackle



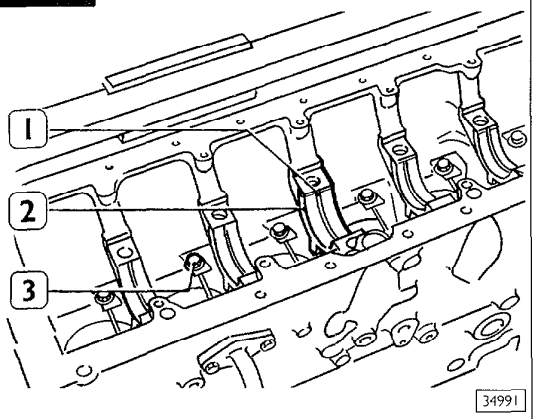
Unscrew the screws and remove the rear support (1) and the cover (2) with seal for the crankshaft



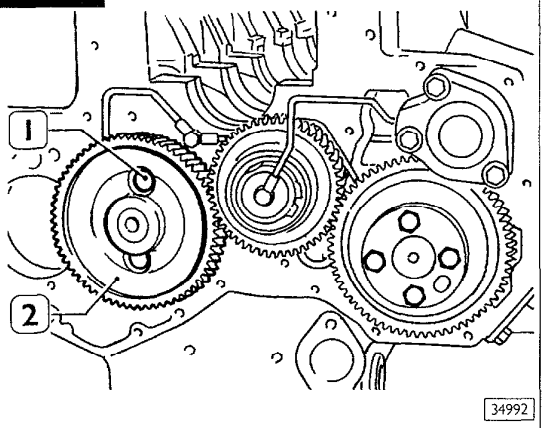
Using a suitable wrench, unscrew the main bearing bolts and remove the caps (1) with their bearing shells and the thrust washer halves



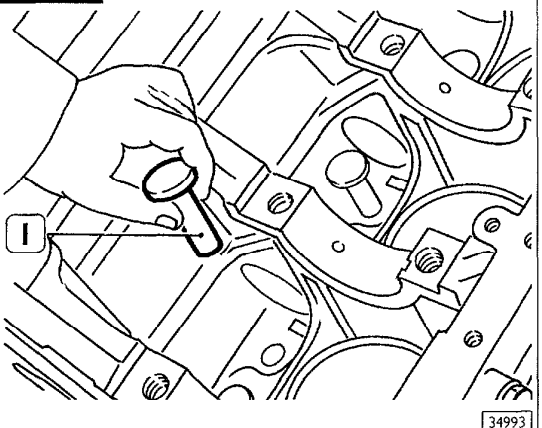
With the help of lifting tackle and tool 99360500 (1), raise the crankshaft (2) and remove it



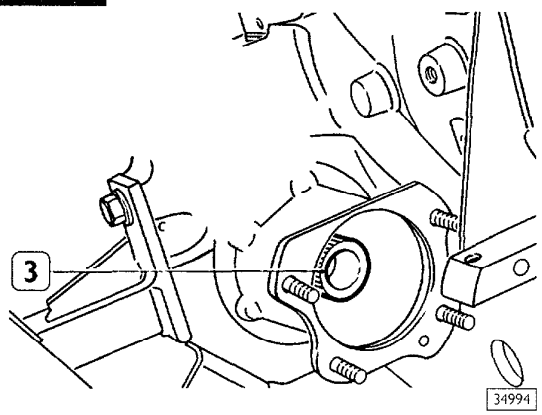
Remove the main bearing shells (1) and the thrust washer halves (2)
Remove the jets (3)



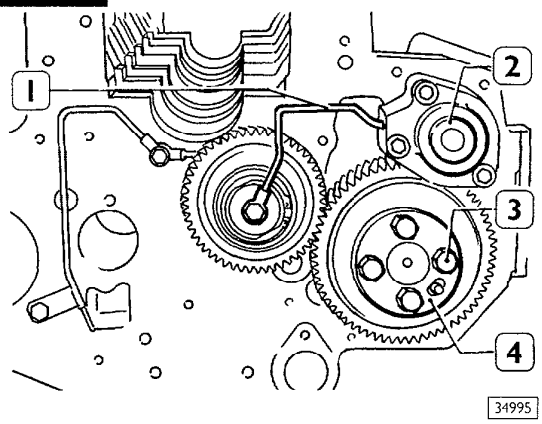
Using an Allen key, unscrew the screws (1) securing the thrust plate of the camshaft (2) and remove the shaft from the cylinder block, taking care that the bearing bushes are not damaged during the operation



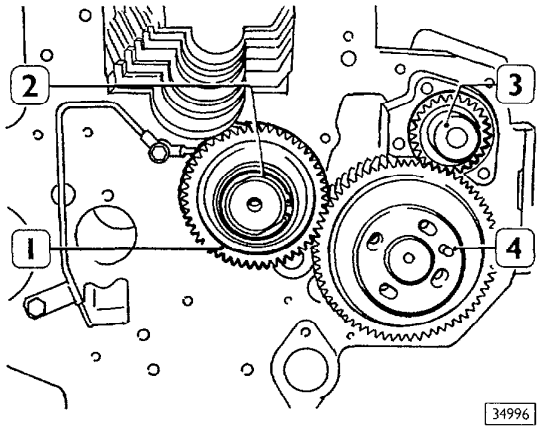
Extract the tappets (1) from their housings



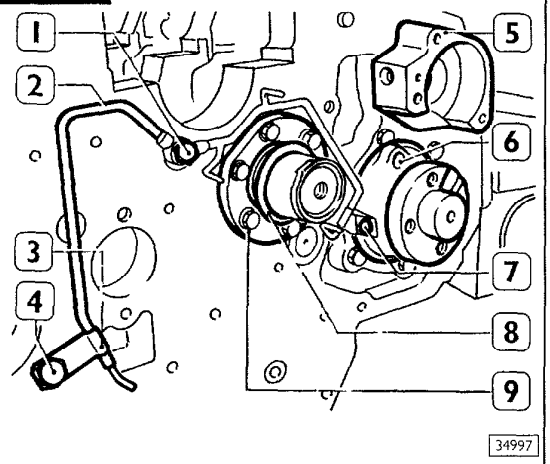
Withdraw the splined bush (3)



Remove the cover (2) and oil pipe (1) Take off the screws (3) and the ring underneath them (4)



Remove the shaft with gear (2) and gear (4) Take off the circlip (2) and remove the gear (1)



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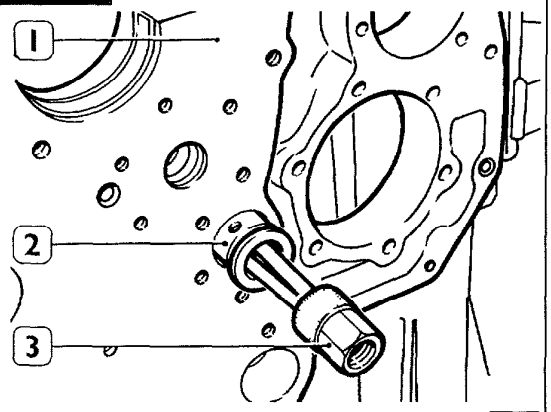
Take off the adjustment shim (8)
Remove the locking tab of the strip (3) from nut (4) and take off the nut
Remove the screw (7), the union (1) and detach the pipe (2)
Remove the intermediate gear shaft (9), the support (6) for the injection pump drive shaft and the support (5) for the power steering pump drive shaft



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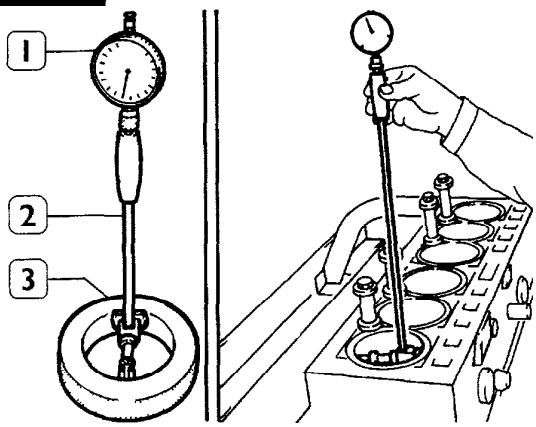
Using an appropriate extraction tool (3), extract the valve (2) for piston cooling jets from the crankcase (1)

When dismantling of the engine is complete, the parts dismantled must be thoroughly cleaned and checked for soundness
The following pages give instructions for the main checks and measurements to be carried out in order to determine whether the parts are fit for re-use on reassembly

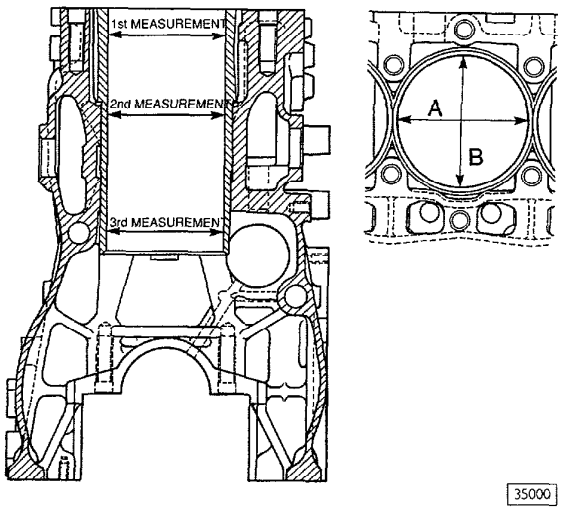
REPAIR OPERATIONS
CYLINDER BLOCK
Checks and measurements



34994

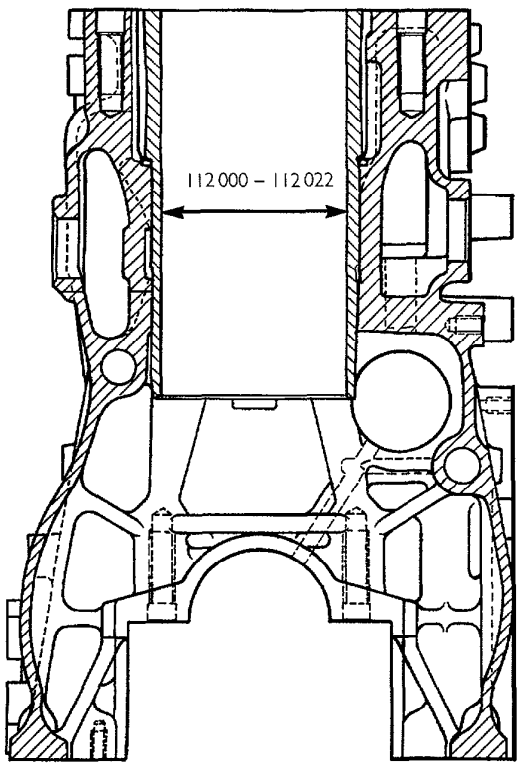
The inside diameter of the cylinder liners is checked to ascertain the amount of ovality, taper and wear by means of gauge 99395687 (2) fitted with a hundredths dial gauge (1), previously zeroed on the ring gauge (3) 112 mm in diameter

Where the 112 mm diameter ring gauge is not available, use a micrometer for this purpose



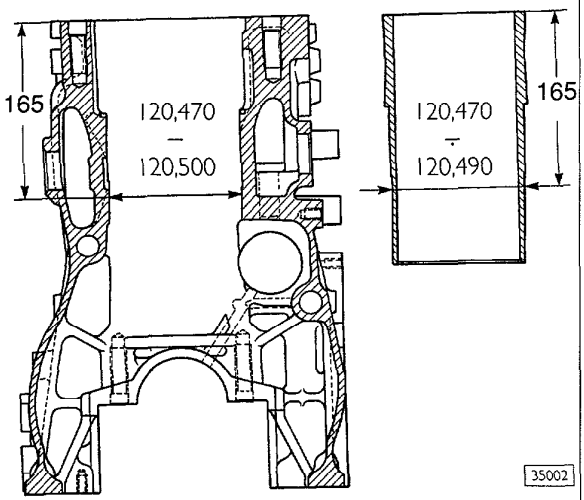
35000

The measurements must be carried out on each individual cylinder at three different levels and in two planes at right angles to each other, as shown in the figure
Maximum wear is found in line with the 1st measurement on axis B



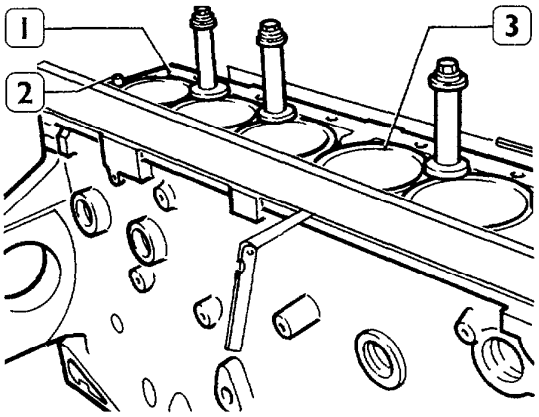
35001

If maximum wear of more than 0 150 mm is found or maximum ovality of 0 100 mm compared with the values shown in the figure, the cylinder liner must be replaced since the internal surface of the liner has been given soft nitriding treatment, for which the operations of grinding, lapping or truing up are not permitted



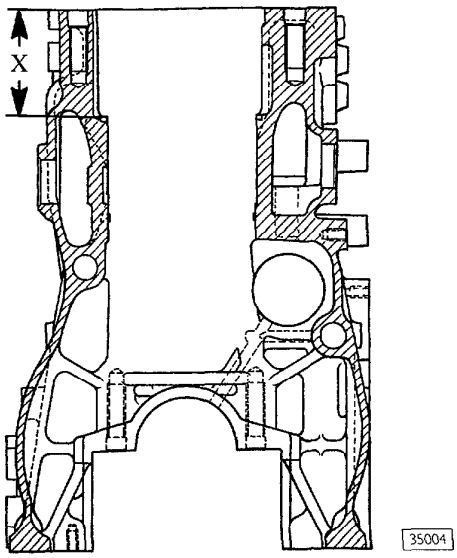
35002

The plan shown in the figure gives the outside diameters of the cylinder liner and the internal diameters of its housing as well as the point at which these are to be measured
The cylinder liners may if necessary be extracted and fitted several times in different housings



35003

Check that the mating surface (1) for the cylinder head is flat using a straight edge and a feeler gauge
After ascertaining the areas of distortion, true up the mating surface, having first extracted the locating dowels (2) and cylinder liners (3), in accordance with the procedures indicated in section "540420 REPLACING CYLINDER LINERS", removing as little material as possible and bearing in mind that, after skimming, the protrusion of the piston from the cylinder liners must be 0 1 – 0 25 mm

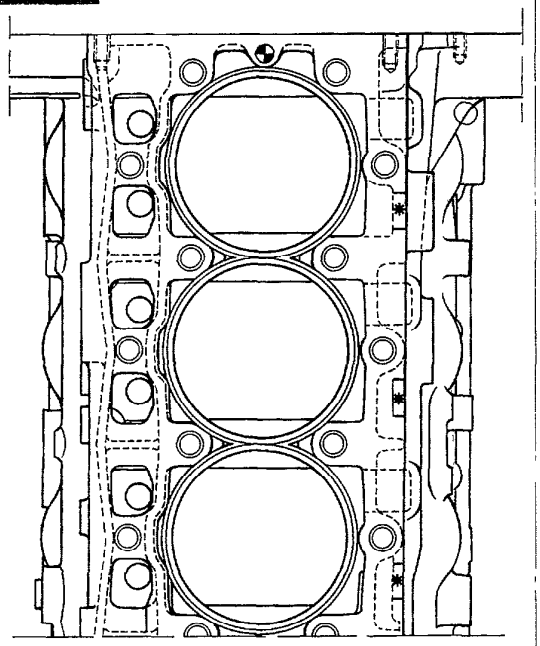


35004

When the crankcase has been skimmed, restore the depth of the cylinder liner seating base so that the distance X is within the ranges of the subdivisions of the following classes

I 90 000 – 90 010
II 90 011 – 90 020
III 90 021 – 90 030
IV 90 031 – 90 040
V 90 041 – 90 050

The dimension X is the average of three measurements carried out at three points 120° apart

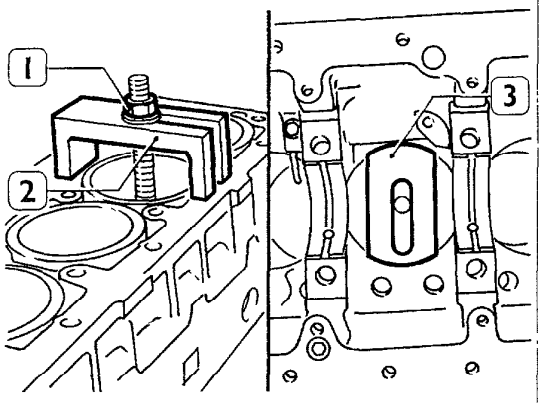


35006

Stamp the class of measurement recorded on the crankcase at the points shown by the asterisks

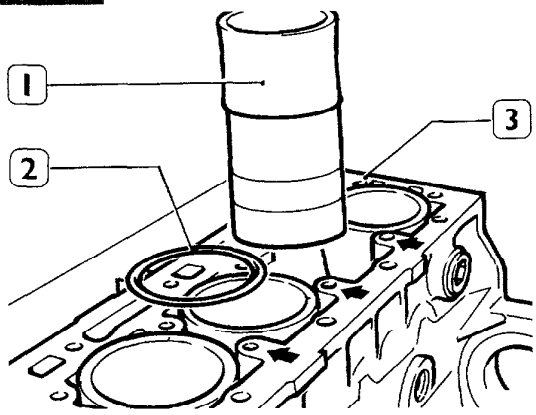
Check the condition of the machining plugs in the cylinder block, if they are rusted or there is the least suspicion of leakage, replace them

Replacing cylinder liners



35007

Position the parts (2 and 3) of tool 99360723 on the crankcase as shown in the figure, checking that the plate (3) of the tool is resting correctly on the cylinder liner
Screw up the nut (1) and withdraw the cylinder liner from the crankcase

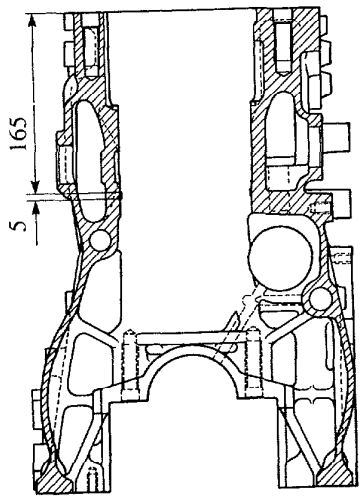


35008

Fit the cylinder liners, proceeding as described below

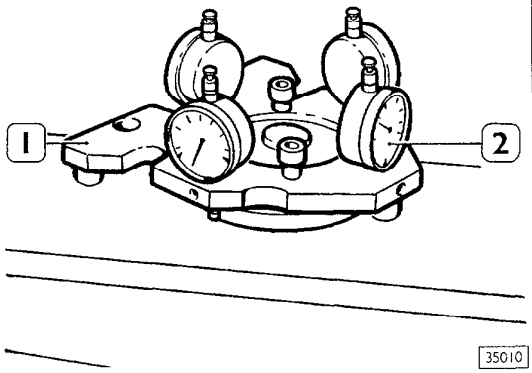
Thoroughly clean the cylinder liners and crankcase (3) with chlorothene so that there is no residue of the old adhesive,
Degrease the parts to which adhesive is to be applied both on the crankcase and on the cylinder liners (see fig 45), on the basis of the classes stamped on the crankcase at the points shown by the arrows, fit the shim (2) of the thickness shown in the following table

CLASS	THICKNESS (mm)
I	3 18 ÷ 3 19
II	3 19 ÷ 3 20
III	3 21 ÷ 3 30
IV	3 31 ÷ 3 40
V	3 41 – 3 50

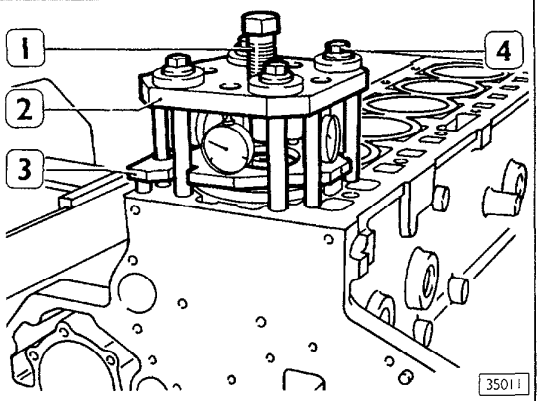


35009

Using a suitable tool, apply LOCTITE 576 evenly to the crankcase at the point indicated to form a ring 5 mm high, position the shim (2, fig 44) of the thickness shown in the table and insert the cylinder liner into the crankcase



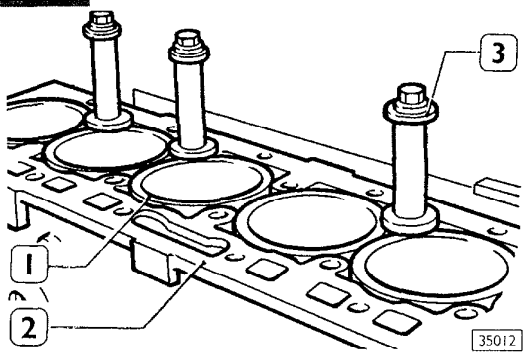
– place the component of tool 99360445 (1) on a surface plate and zero the dial gauges



– position the component of tool 99360445 (3) on the cylinder liner, fit the compression fixture (2) to the tool and secure it to the crankcase by means of the four bolts (4)
□ tighten the screw (1) to a torque of 110 Nm (11 kgm)

This torque corresponds to a load of about 4000 kg In these conditions read off from the dial gauge the protrusion of the cylinder liner which should be, as an average value, 0 16 – 0 25

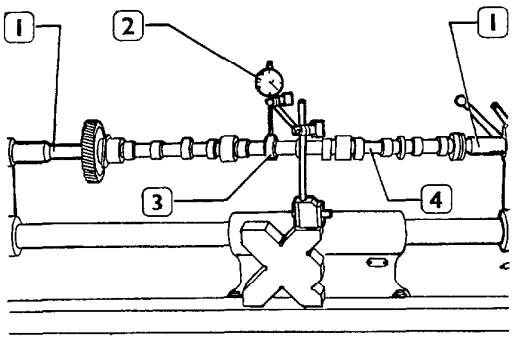
The maximum deviation of the average value recorded between each individual cylinder liner must be not more than 0 03 mm
If different values are found, replace the adjustment shim according to the procedures already described



When fitting is completed, lock the cylinder liners (1) to the crankcase (2) by means of the pillars 99360722 (3)

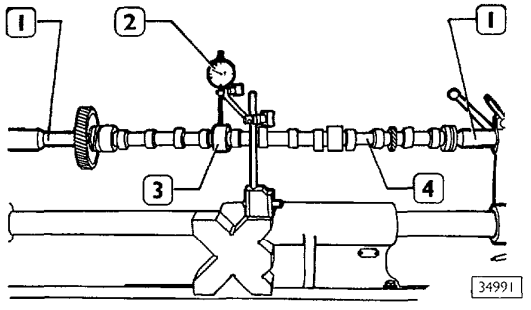
Assembly of the engine must be finished within 10 hours of the application of LOCTITE 576 to the crankcase

VALVE GEAR
Camshaft
Checking cam lift and journal alignment

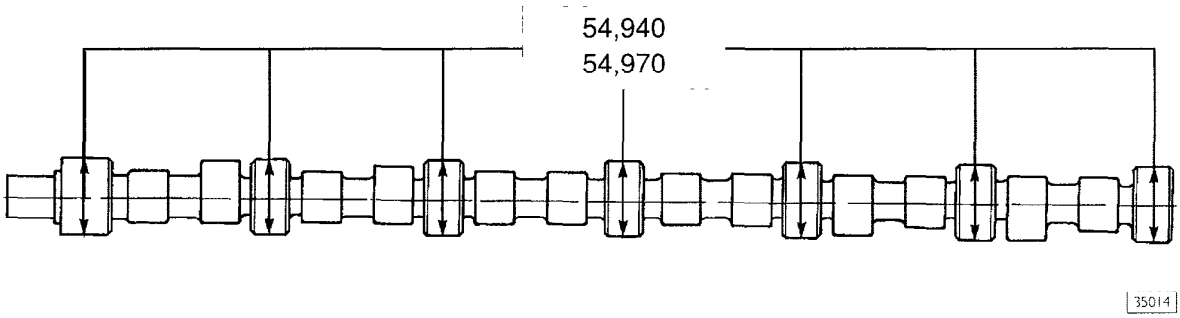


Arrange the camshaft (4) between the centres (1) and using the hundredths dial gauge (2) check the lift of the cams (3) which should be

– 7 077 mm for the inlet cam
□ 7 373 mm for the exhaust cam

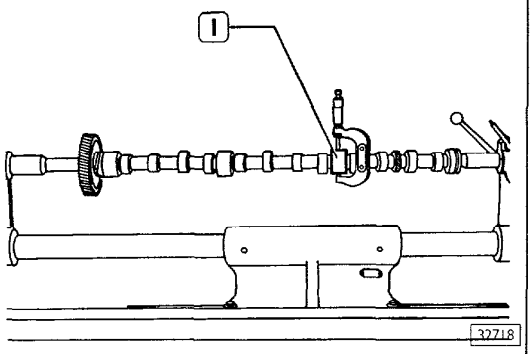


Still with the camshaft (4) arranged between centres (1), check the bearing journals (3) for misalignment using the hundredths dial gauge (2), this must not be more than 0 020 mm If a larger misalignment is found, replace the shaft



MAIN DATA FOR THE CAMSHAFT

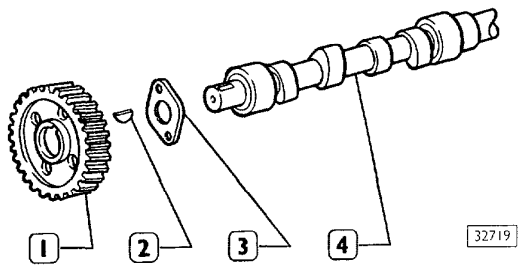
The surfaces of the bearing journals on the shaft and those of the cams must be perfectly smooth,



To check the assembly clearance, measure the inside diameters of the bushes (fig 54) and the diameter of the camshaft journals (1, fig 51), the difference will give the actual clearance present If clearances of more than 0 160 mm are found, replace the bushes and the camshaft too, if necessary

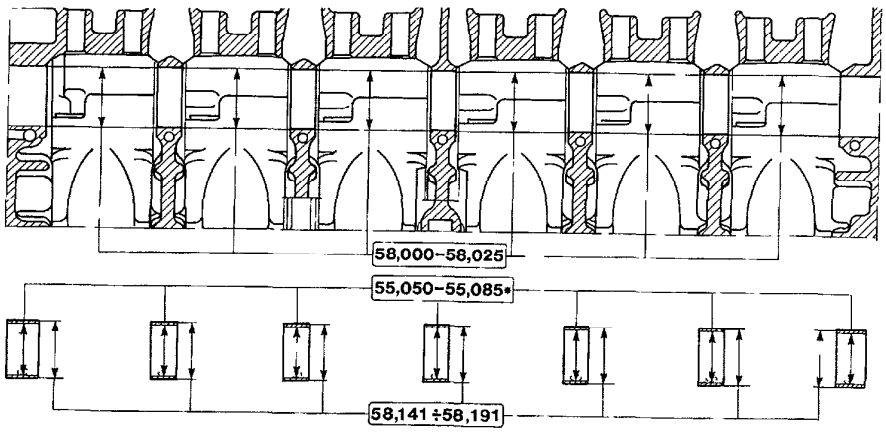
if instead there are signs of seizing or scoring, the shaft and its bushes should be replaced

REPLACING THE CAMSHAFT GEAR



Check that the teeth of the camshaft gear (1) are not excessively damaged or worn, if they are, replace it When fitting the new gear, it should be heated in an oven for 10' at a temperature of 180° and then shrunk onto the shaft (4), having first fitted the plate (3) and key (2) to the shaft

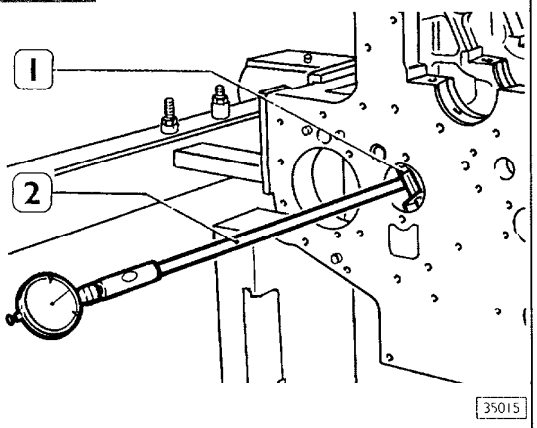
BUSHES



MAIN DATA FOR CAMSHAFT BUSHES AND THEIR HOUSINGS IN THE CRANKCASE

* Dimension to be obtained after the bushes have been installed

Replacing the bushes

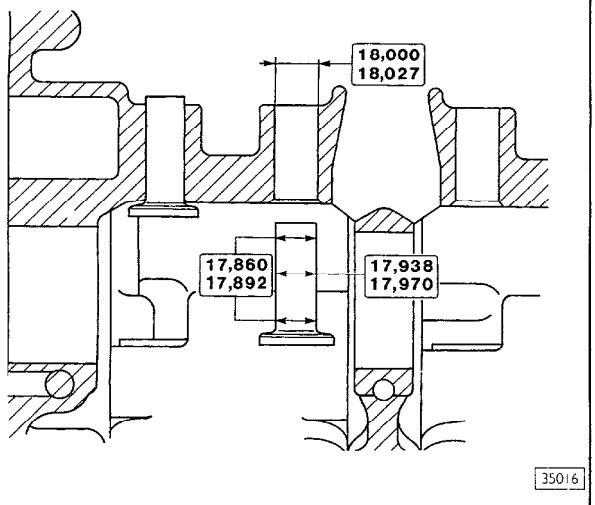


The surfaces of the bushes must not show any signs of seizing or scoring, if they do, replace them
Measure the bush (1) inside diameters using a bore micrometer (2), if values greater than the tolerances are found, replace them Use an appropriate tool to dismantle and assemble the bushes

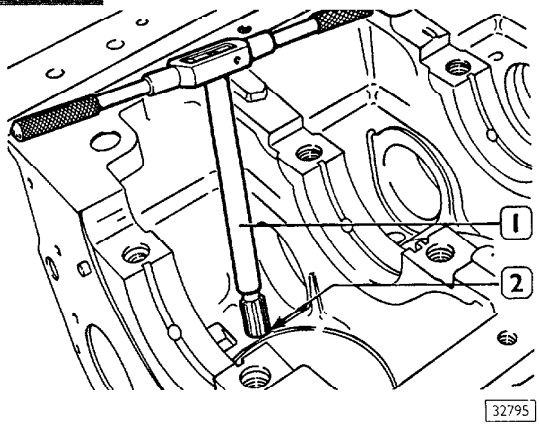
Fit the bushes so that the oil feed holes are lined up with those in the crankcase

After fitting, ream the camshaft bushes using the appropriate tools to bring the internal diameter of the bushes to the nominal value indicated in figure 54

Replacing tappets



MAIN DATA FOR TAPPETS AND THEIR HOUSINGS IN THE CRANKCASE

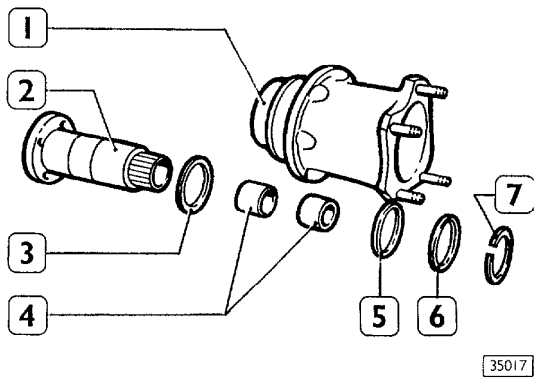


Replacement of the tappets due to excessive clearance in the housings involves fitting oversize tappets and reaming out the housings (2) using a suitable reamer (1)

Replacement tappets are supplied in standard size and 0 10, 0 20, 0 30 mm oversize

INJECTION PUMP DRIVE

Replacing bushes

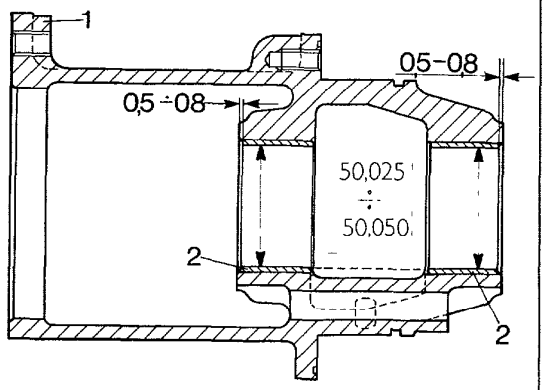


COMPONENT PARTS OF THE INJECTION PUMP SUPPORT

1 Injection pump support – 2 Shaft – 3 Adjustment shim – 4 Bush – 5 Adjustment shim – 6 Washer – 7 Circlip

Remove the retaining circlip (7) and remove the shaft (2), washer (6) and adjustment shims (4 and 5) from the support (1) Check the mating surfaces of the shaft (1) and of the bushes (4), these must not show any deterioration and the fit clearance must not be excessive
The nominal diameter of the shaft is 49 984 – 50 000 mm

POWER STEERING PUMP DRIVE
Replacing the bushes

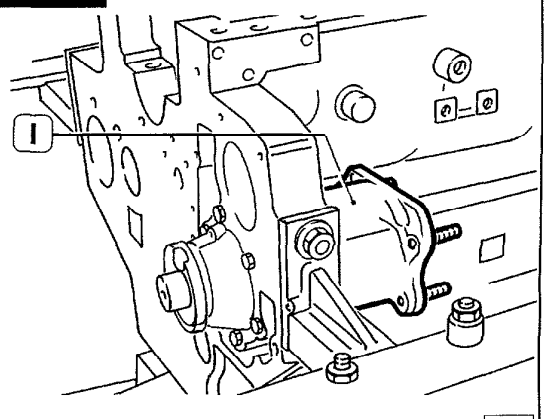


35018

If excessive fit clearance not attributable to the shaft is found, replace the bushes (2), using a suitable drift to remove and fit them

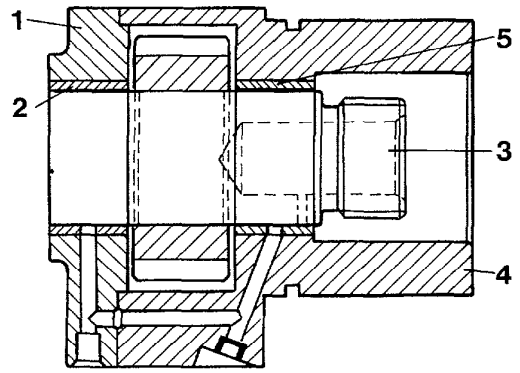
The bushes must be fitted with the joint facing the notch in the support for lubrication of the adjustment shim, and they must be recessed by 0 5 – 0 8 mm with respect to the faces of the support, as shown by the arrows

When the bushes (2) have been fitted, ream them out so that their nominal diameter is 50 025 – 50 050 mm
Assemble the support components by reversing the dismantling operations



35019

Position a new seal on the injection pump support (1) and fit the support to the crankcase



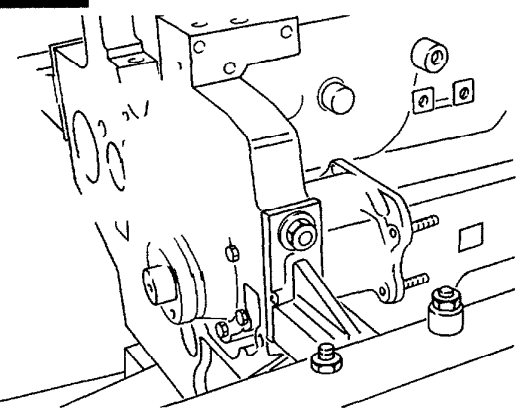
35020

SECTIONAL VIEW OF THE POWER STEERING DRIVE SHAFT SUPPORT
1 Support, timing gear cover side – 2 Bush – 3 Shaft – 4 Support, crankcase side – 5 Bush

Check the mating surfaces of the shaft (3) and bushes (2 and 5), these must not show any deterioration and the fit clearance must not be excessive
The nominal diameter of the shaft is 36 984 – 37 000 mm
If excessive fit clearance not attributable to the shaft (3) is found, replace the bushes (2 and 5), using a suitable drift to remove and fit them

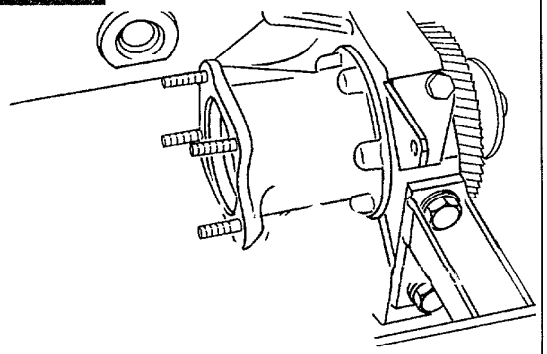
To fit the bushes (2 and 5), it is necessary to chill them in liquid nitrogen or heat the supports (1 and 4) so that there is a temperature difference of 270° C between the components Maximum temperature permitted for the supports 350° C

When the bushes (2 and 5) have been fitted, ream them out with a reamer so that their nominal diameter is 37 050 – 37 073 mm



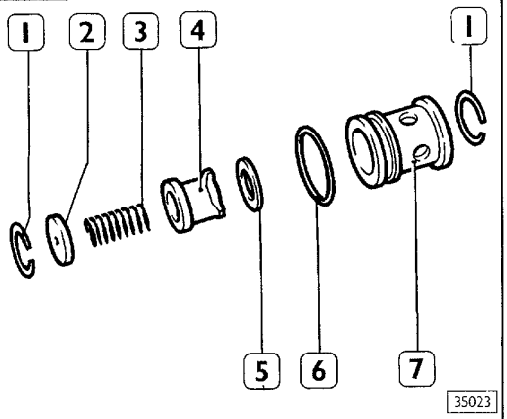
35021

Position a new seal (1) in the support (2) and fit the support to the crankcase



35022

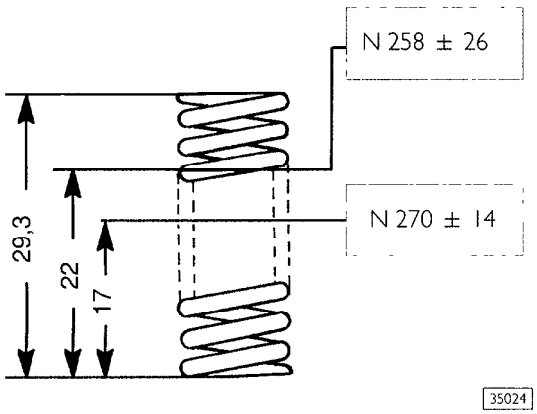
On the opposite side, fit the power steering pump attachment flange



35023

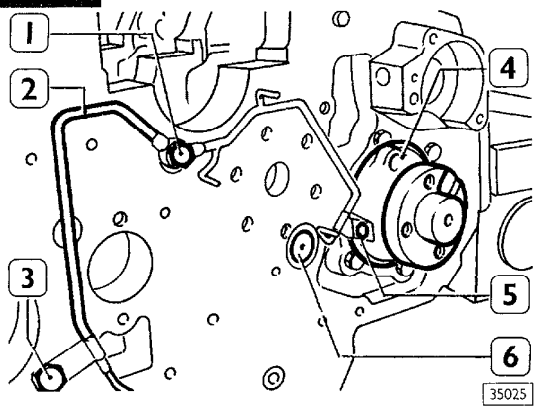
COMPONENT PARTS OF THE PISTON COOLING JET VALVE

1 Circlip – 2 Dish – 3 Spring – 4 Valve – 5 Washer – 6 Seal – 7 Valve body



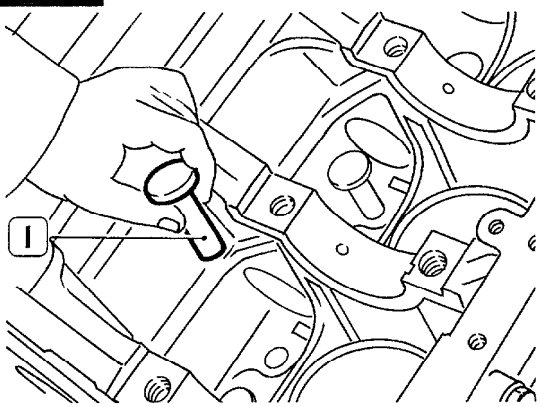
35024

MAIN DATA FOR CHECKING THE SPRING FOR THE PISTON COOLING JET VALVE



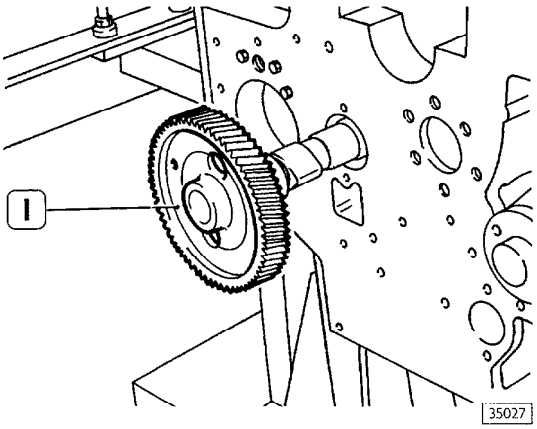
35025

Fit a new seal to the valve body (6) and fit it to the crankcase Secure the oil pipe (2) to the crankcase by means of the screw (5) Bend over the locking tabs onto the screws (3 and 5)



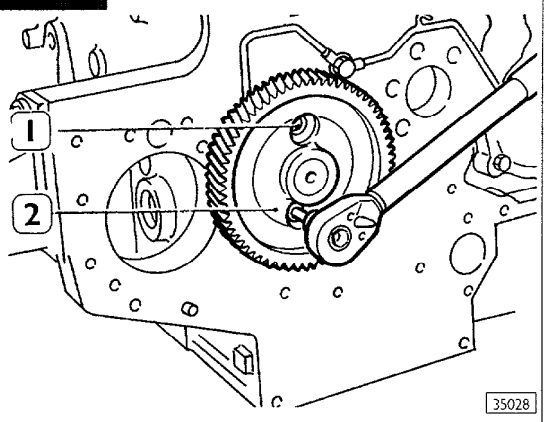
34993

Fit the tappets (1) into their housings



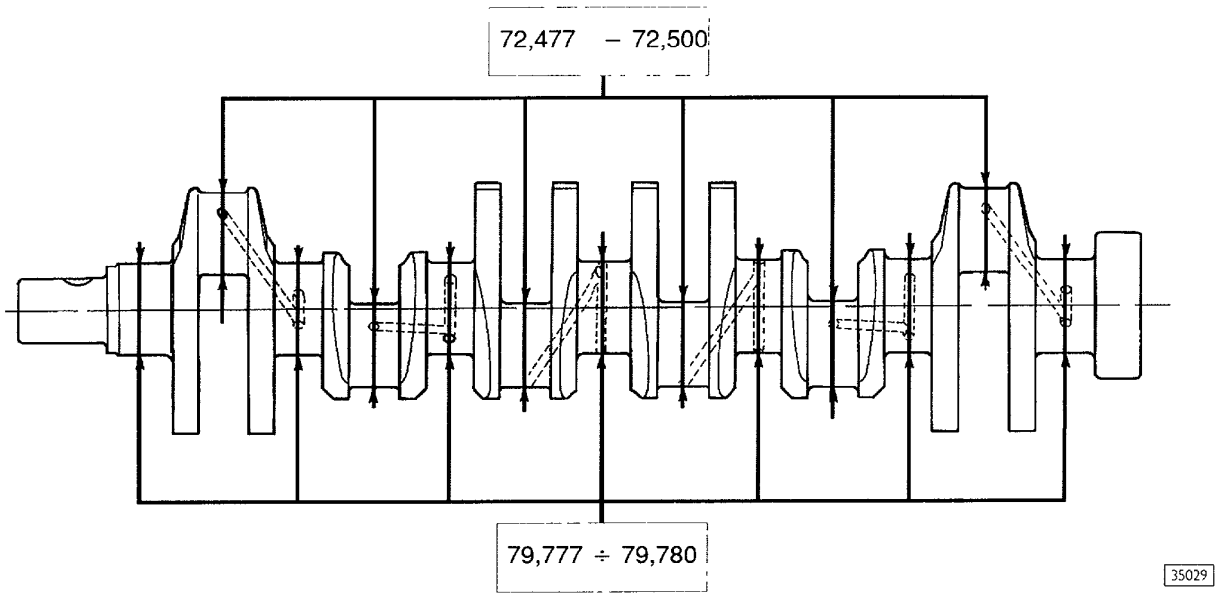
35027

Lubricate the bearings of the camshaft (1) and insert the shaft into the crankcase



Tighten the screws (1) securing the camshaft retaining plate (2)

CRANKSHAFT

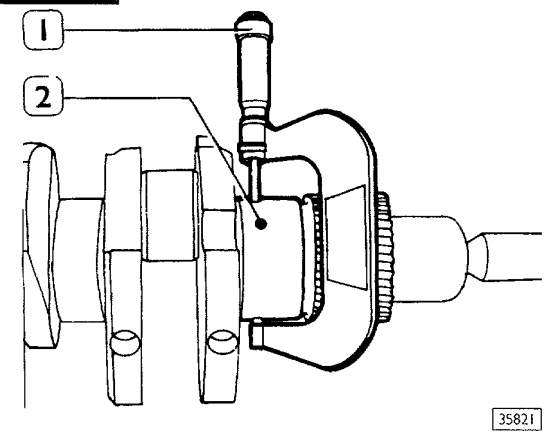


MAIN DATA FOR THE CRANKSHAFT MAIN JOURNALS AND CRANKPINS

Measuring the main bearing journals and crankpins

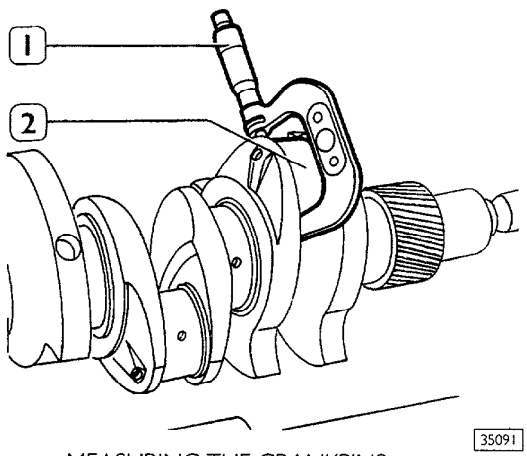
Before regrinding the journals, measure the main journals (2) with a micrometer (1) and establish on the basis of the scale of bearing undersizes (7) the diameter to which the journals must be reground

The classes of undersize are 0 254, 0 508, 0 762, 1 016 mm for the main bearing shells and 0 127, 0 254, 0 508 mm for the big end shells



MEASURING THE MAIN BEARING JOURNALS

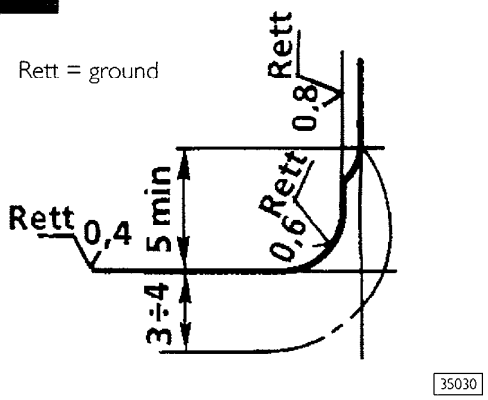
Main bearing journals and crankpins are always all reground to the same undersize class so as not to impair crankshaft balance



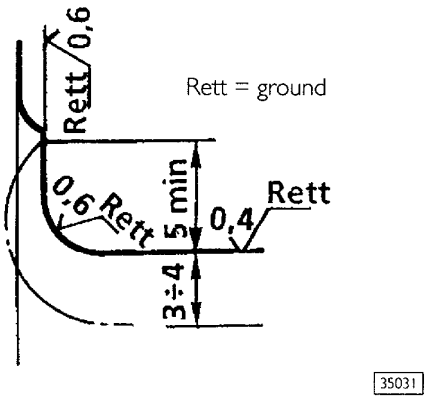
MEASURING THE CRANKPINS

During the grinding operation, take great care to comply with the values for the main journal and crankpin blend radiuses given in the following figures

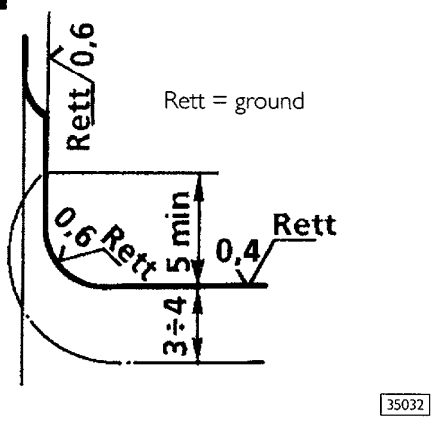
Regrinding carried out on main journals or crankpins must be indicated by appropriate markings stamped on the side of crank
web no 1
For undersize crankpins the letter M
For undersize main journals the letter B
For undersize crankpins and main journals the letters MB



DETAIL OF MAIN JOURNAL BLEND RADII

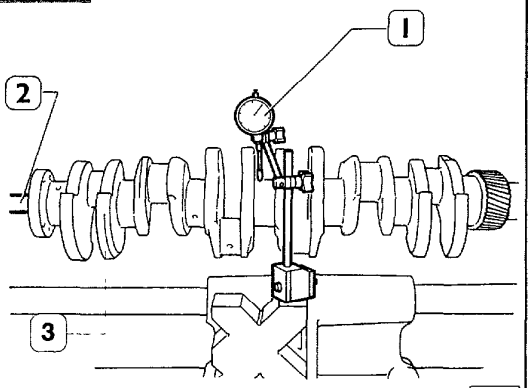


DETAIL OF CRANKPIN BLEND RADII



DETAIL OF CENTRE MAIN JOURNAL BLEND RADII

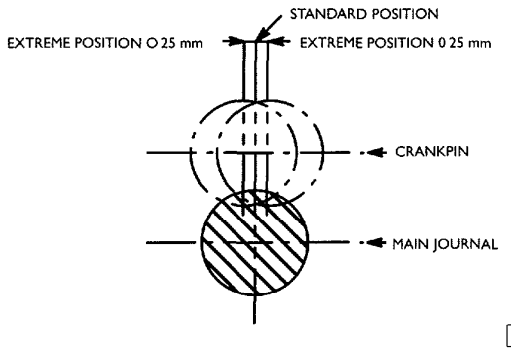
Checking main journal alignment



35033

This check must be carried out after regrinding, if any, of the journals on the crankshaft (3) by positioning the crankshaft between centres (2) and using a hundredths dial gauge (1) for the check

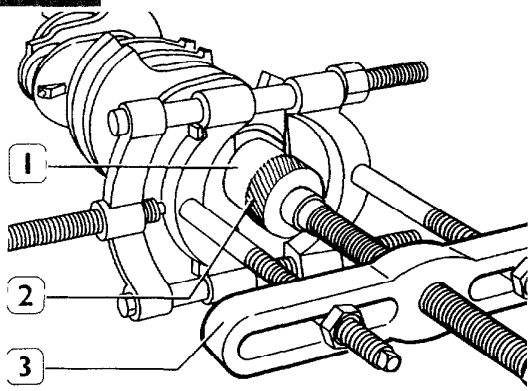
- ☐ Main journal alignment maximum tolerance > 0 10 mm (total reading on the dial gauge)



6236

- ☐ Alignment of the crankpins with the main journals the centreline of each pair of crankpins and the centreline of the main journals must be in the same plane the maximum tolerance permitted at right angles to this plane is ± 0 25 mm
- ☐ For the distance between the axis of rotation of the shaft and the outer surface of the crankpins, the maximum tolerance permitted is ± 0 10 mm

Replacing camshaft and oil pump drive gears



35034

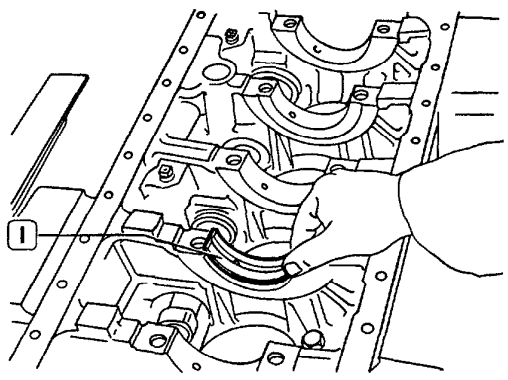
Check that the teeth of the gear (1) are not damaged or worn, if they are, remove them using a suitable extractor (3)

When fitting the gear (1) to the shaft (2), there must be a temperature difference of 120 – 150^0 C between the two parts

Fitting main bearings

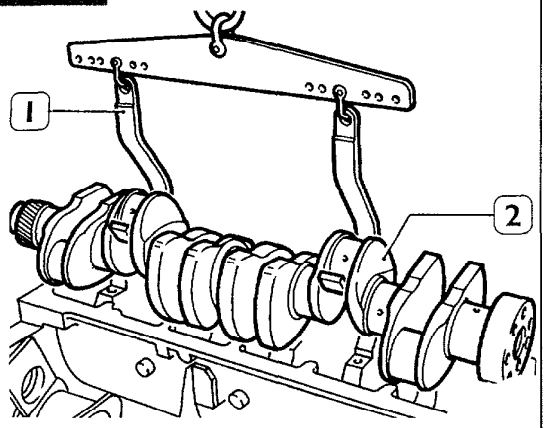
Replacement main bearings are supplied in inside diameter undersizes of 0 254, 0 508, 0 762, 1 016 mm

Do not carry out fitting operations on the bearings



32728

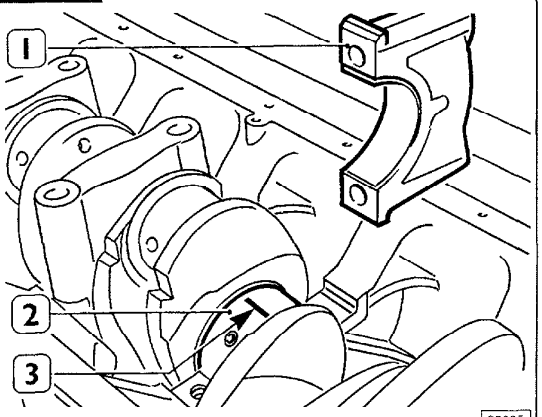
Position the bearing shells (1) in the main bearing housings in the crankcase



34990

Using tool 99360500 (1) fit the crankshaft (2) onto the bearing shells

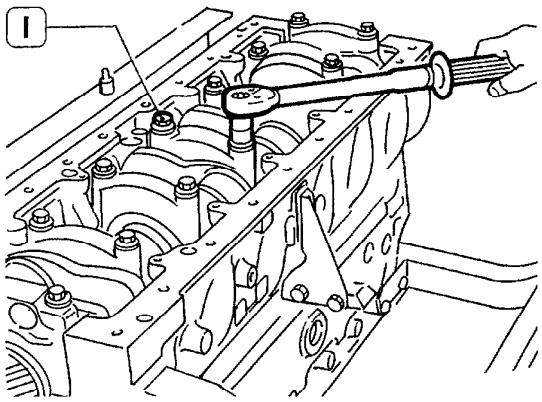
Measuring main bearing assembly clearances



35035

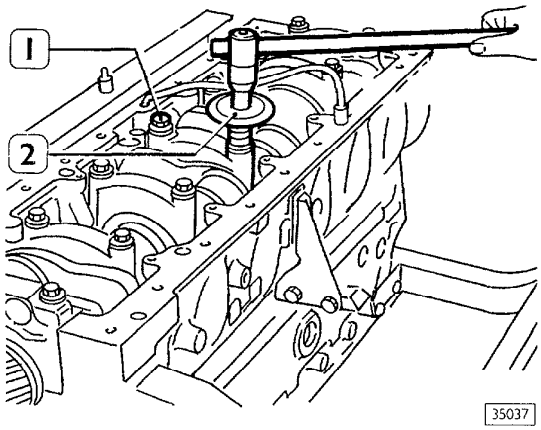
The clearance between the crankshaft journals and the relevant bearings is checked by the plastigage method, proceeding as follows

- ☐ thoroughly clean the parts and remove all traces of oil
- ☐ arrange a strip of plastigage (3) on the main journals (2), parallel with the lengthwise axis
- ☐ fit the caps (1) together with the bearing shells to the relevant housings



35036

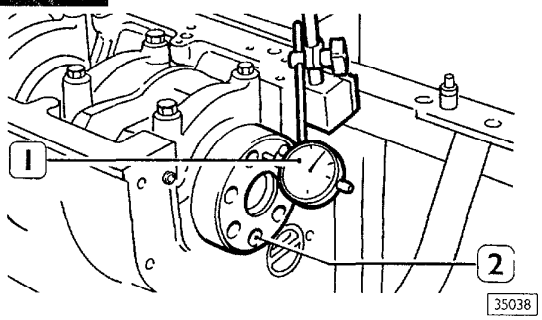
- ☐ tighten the main bearing cap securing bolts (1), having first lubricated them, to the prescribed torque of 60 Nm (6 kgm)



35037

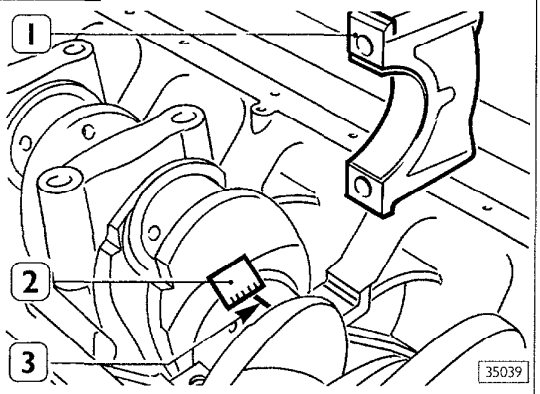
- ☐ fit tool 99395216 (2) to the angle gauge wrench and tighten the bolts (1) a further 120°

Checking crankshaft end float



35038

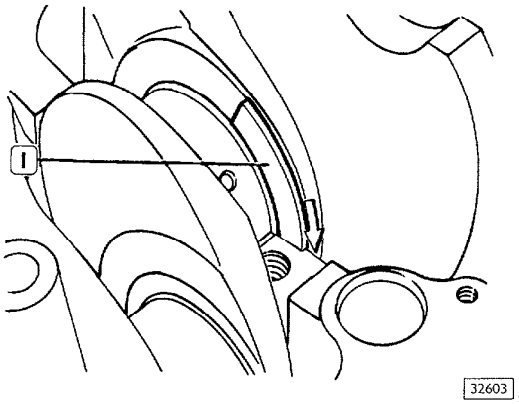
Using a dial gauge with magnetic base (1), check the end float of the crankshaft, this should be 0.068 – 0.294 mm
If a larger end float is found, replace the thrust washer halves with new ones of standard thickness or if necessary 0.127, 0.254 or 0.508 oversize



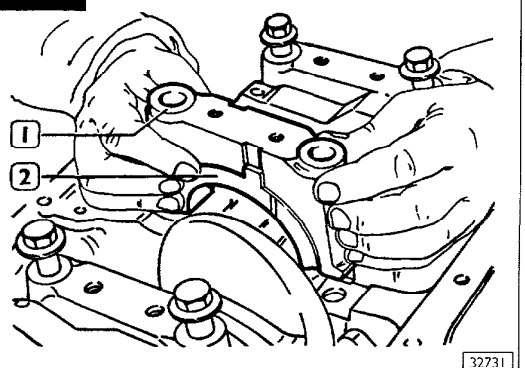
☐ remove the main bearing caps (1)

The clearance between the main bearing shells and their respective journals is measured by comparing the width of the plastigage (3) at the point of greatest flattening with the scale divisions given on the package (2) containing the plastigage

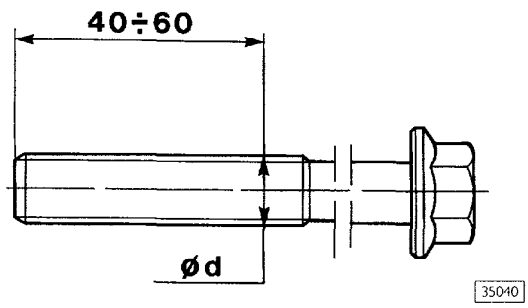
The numbers given on the scale show the fit clearance in mm, which should be 0 068 – 0 794 mm



Position the thrust washer halves (1) on the 6th housing with the surface covered with anti–friction alloy towards the facing on the crankshaft

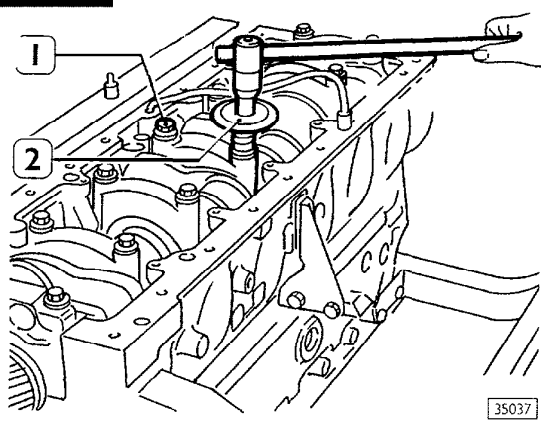


Fit the main bearing caps with bearing shells, before fitting the cap (1), position the halves of the thrust washer (2) with the surface covered with anti–friction alloy towards the facing on the crankshaft



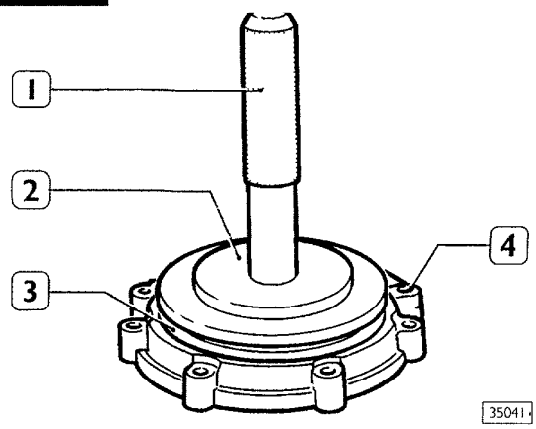
To re–use the main bearing attachment bolts, check that at the point shown, the diameter **d** is 13 5 mm If not, replace

Lubricate the thread and the head underside (→) with engine oil, fit and tighten to a torque of 60 Nm (6 kgm)



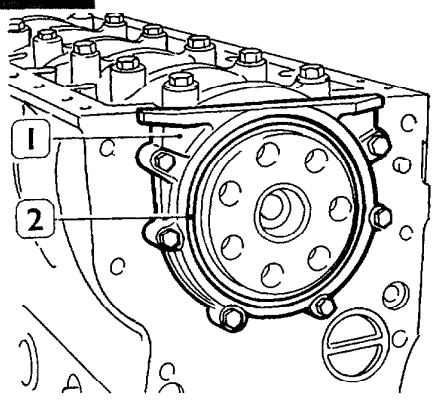
Further tighten the screws (1) by 1205, using tool 99395216 (2)

Crankshaft rear cover

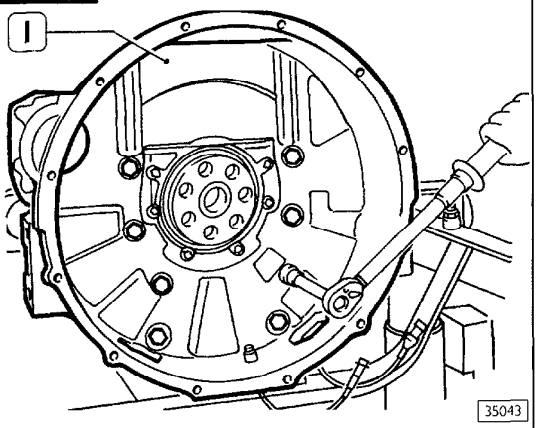


Using installing tool 99374195 (2) and handle 99370005 (1), fit the seal (3) to the rear cover (4)

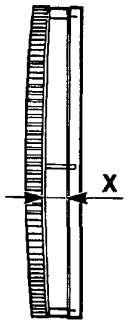
Replace the flywheel ring gear



Lubricate the seal (2) and, having first fitted the gasket, fit the rear cover (1)

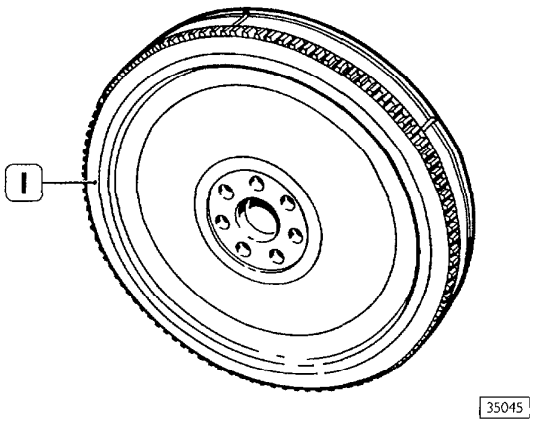


Fit the clutch bell housing (1) and tighten the securing screws to the prescribed torque

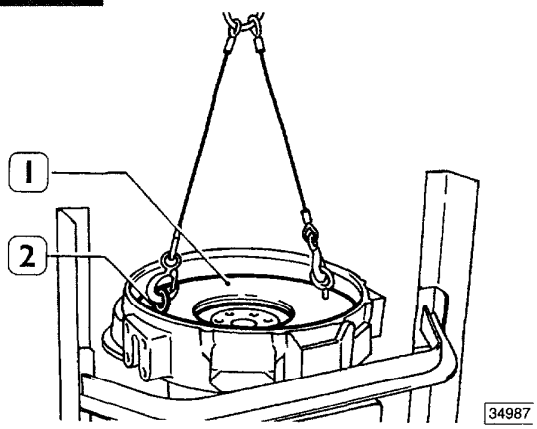


Check the seating surface for the clutch plate If scoring is present, the flywheel must be skimmed

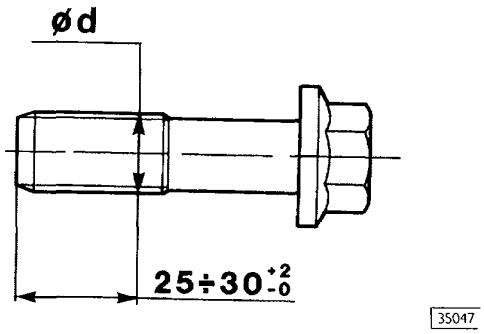
⚠ Check that there are no cuts, swellings or stamping on the circular zone (**X**), if there are, replace the flywheel



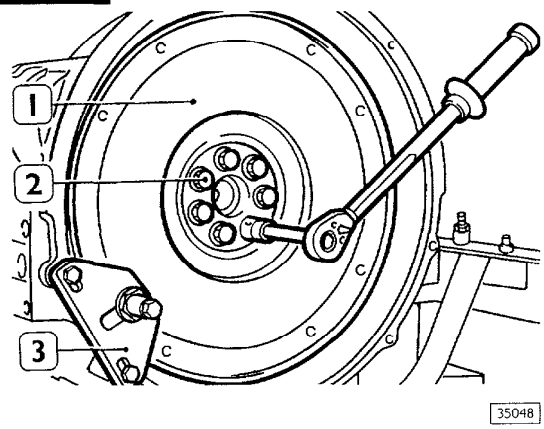
If the teeth of the ring gear (1) fitted to the flywheel are badly damaged, replace the ring gear Before fitting, the ring gear must be heated to a temperature of 80° C



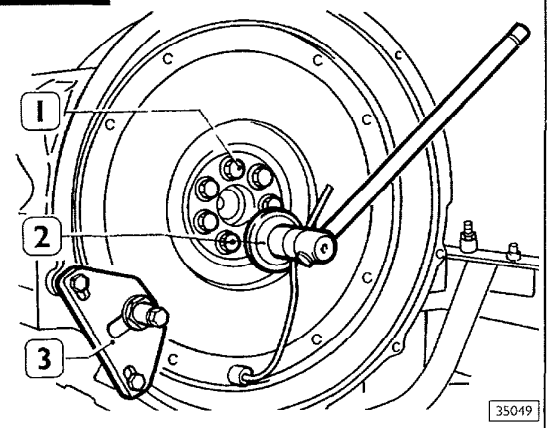
Fit the flywheel (1) to the crankshaft



⚠ To re-use the flywheel attachment bolts, check that at the point shown, the diameter **d** is 15 5 mm If not, replace

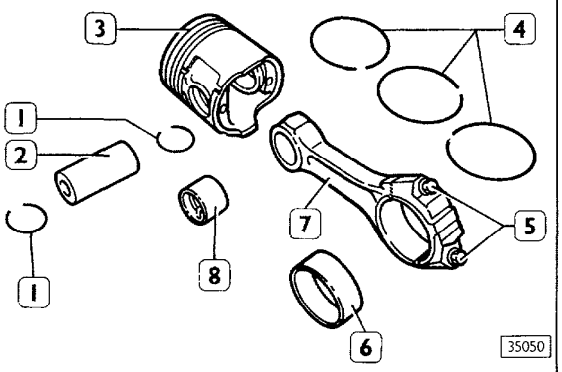


Prevent the flywheel (1) from rotating using tool 99360351 (3) and tighten the bolts (2), having first lubricated them with engine oil, to a torque of 100 Nm (10 kgm)



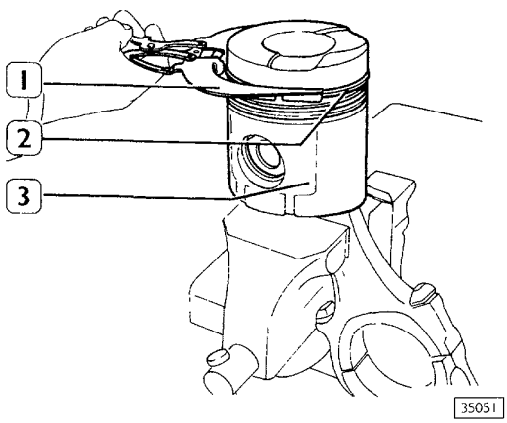
Using tool 99395216 (2), tighten the bolts (1) further for 60°, remove tool 99360351 (3)

CONNECTING ROD/PISTON ASSEMBLY

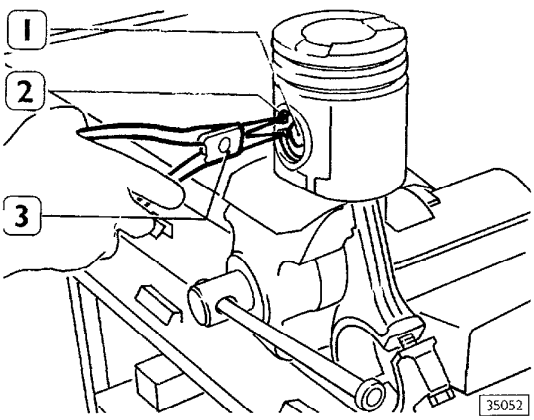


COMPONENT PARTS OF THE PISTON/CONNECTING ROD ASSEMBLY

1 Retaining clips – 2 Gudgeon pin – 3 Piston – 4 Piston rings – 5 Bolt – 6 Bearing shells – 7 Connecting – rod – 8 Bush

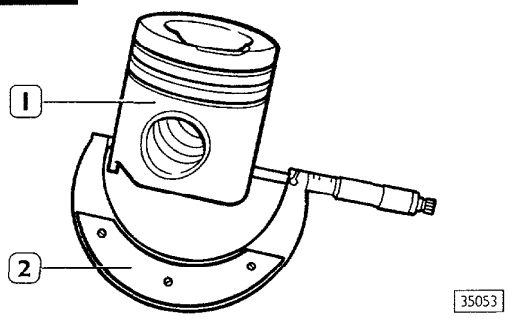


Remove the piston rings (2) from the piston (3) using tongs 99360183 (1)



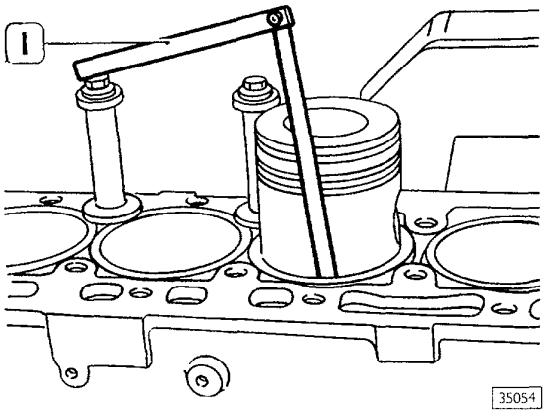
The gudgeon pin (1) retaining clips (2) are removed using pliers (3)

Piston



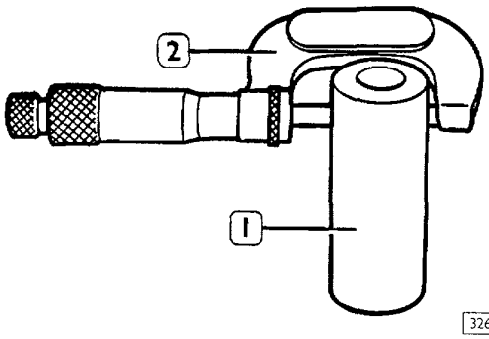
The diameter of the piston (1) is measured using a micrometer (2) to determine the assembly clearance

The diameter must be measured 22 mm from the base of the skirt



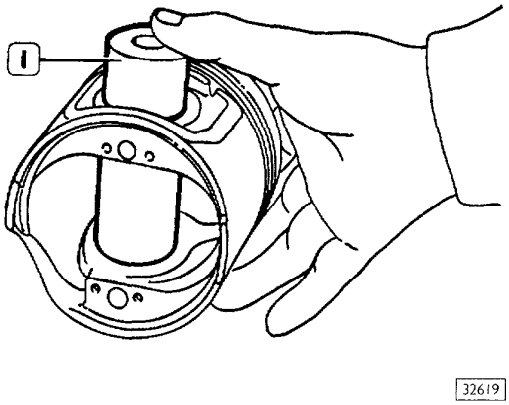
The clearance between the piston and cylinder liner can also be measured using a feeler gauge (1)

Gudgeon pin



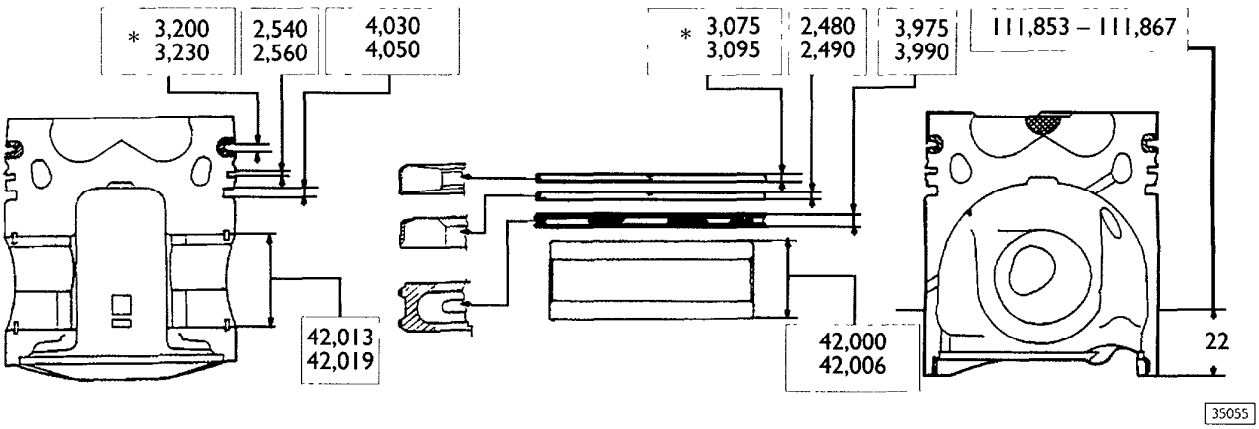
The pins are fitted with clearance both in the small end and in the piston

Conditions for correct gudgeon pin to piston fit



When fitting new pins, check the correct fit with the housing in the piston by carrying out the following check

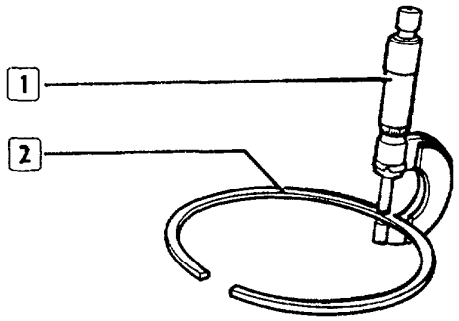
- ☐ lubricate the pin and its housing in the piston bosses with engine oil
- ☐ holding the pin in a vertical position, insert it into the bosses in the piston
- ☐ it should be possible to insert the pin simply by pressing on it
- ☐ the pin should not drop out of the bosses by itself



MAIN DATA FOR THE PISTON, PISTON RINGS AND GUDGEON PIN

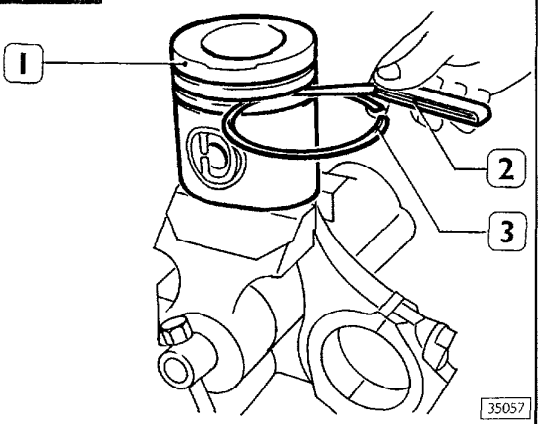
* The dimension is measured on the Ø 117.5 mm

Piston rings



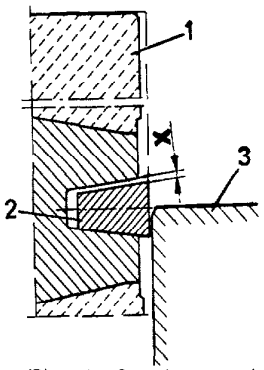
16552

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



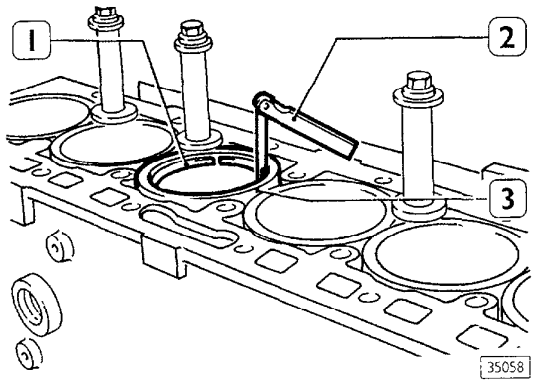
35057

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



3513

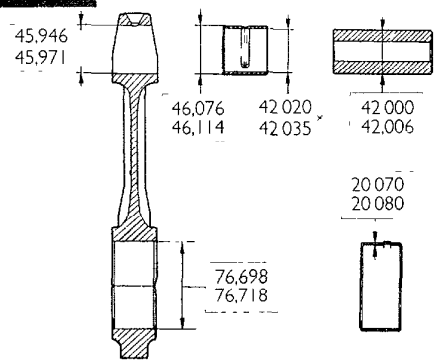
The compression ring (2) in the first slot is wedge shaped The clearance X between the compression ring and the groove is measured by positioning the piston (1) with the relevant ring in the cylinder liner (3) in such a way that the compression ring half projects from the cylinder liner



35058

The clearance between the ends of the piston rings (1) inserted into the cylinder liner (3) is measured using a feeler gauge (2)

Connecting rods

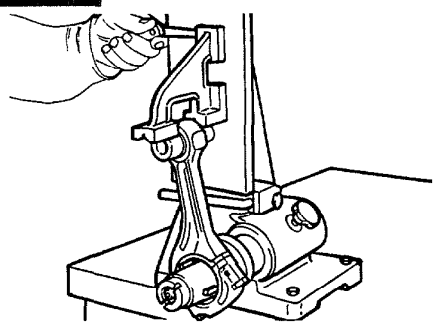


35059

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

* Dimension to be obtained after installing the bush

Checking connecting rod for distortion

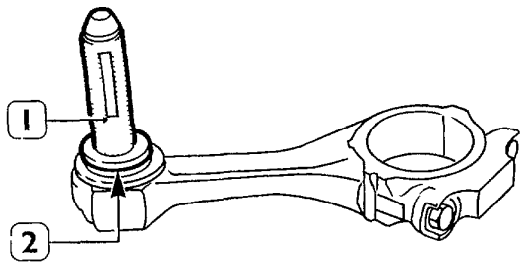


32738

Check that the connecting rod axes are parallel The tolerance permitted is 0 08 mm measured at 125 mm from the lengthwise axis of the rod

Each connecting rod is marked on the body and cap with a number indicating that they fit together Moreover, it may be stamped with the number of the cylinder in which it is fitted In case of replacement, it is therefore necessary to number the new connecting rod with the same number as the one replaced

Bushes



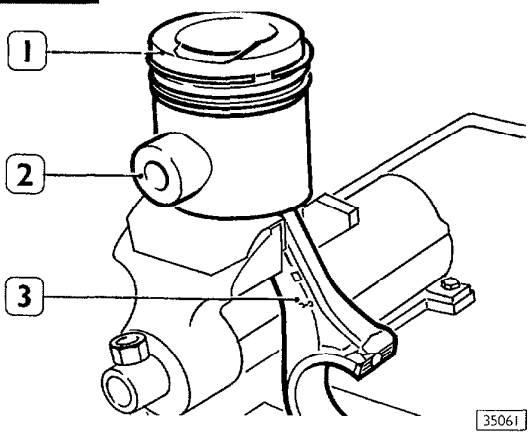
35060

The bush (2) is removed and refitted using the appropriate drift (1)

After installing the bush in the connecting rod small end, remove the part which protrudes at the side and then ream the bush to the specified diameter using reamer 99301044

ASSEMBLING THE CONNECTING ROD/PISTON ASSEMBLY

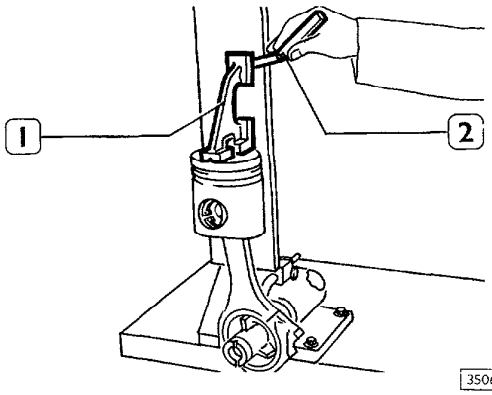
Assembling connecting rod to piston



35061

Position the piston (4) on the connecting rod (3) so that the words "LATO PUNTERIE" (TAPPET SIDE) (1) on the crown are on the opposite side to the number stamped on the connecting rod Insert the gudgeon pin (2) and fit the retainer circlips

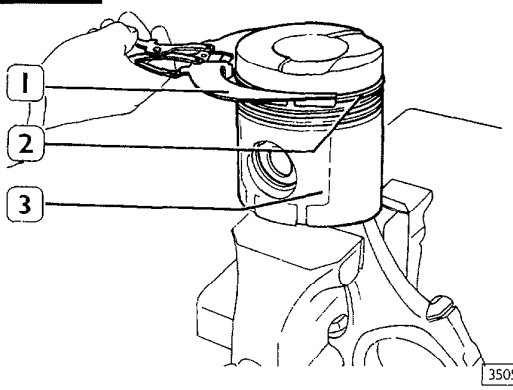
Checking connecting rod/piston for distortion



35062

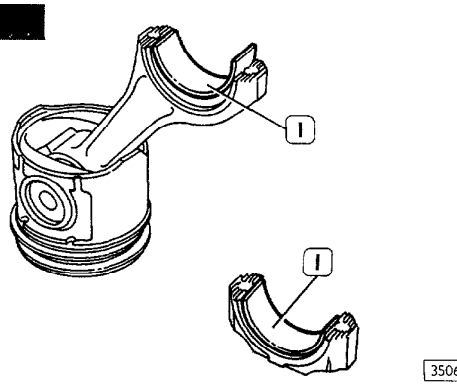
Check the connecting rod–piston assembly for distortion using fixture 99395363 (1) and a feeler gauge (2) The plane of the piston crown must be exactly at right angles to the plane of the fixture 99395363

Fitting piston rings



35051

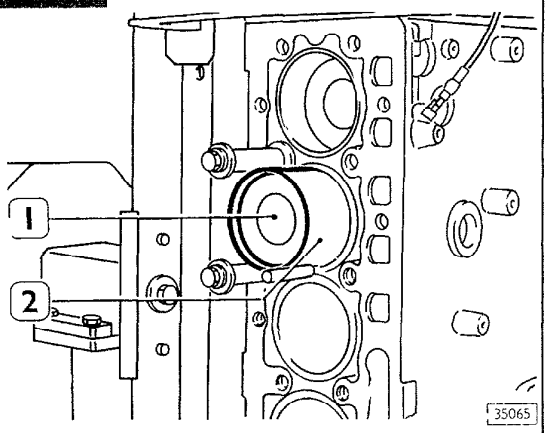
The piston rings (2) are fitted to the pistons (3) using tongs 99360183 (1) The rings must be fitted with the word TOP facing upwards, and also the ring gaps must be located so that they are 120° apart



35064

Fit the bearing shells (1) to the connecting rod and to the cap

Do not carry out any fitting operations on the bearing shells

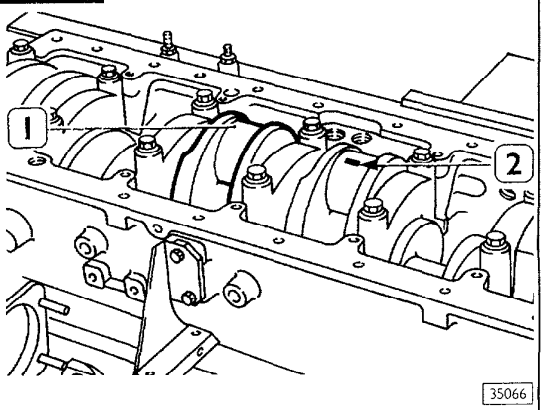


The connecting rod/piston assembly (1) is fitted into the cylinder liner using ring clamp 99360605 (2)
Lubricate the parts concerned before fitting

When fitting the connecting rod/piston assemblies into the liners, check that

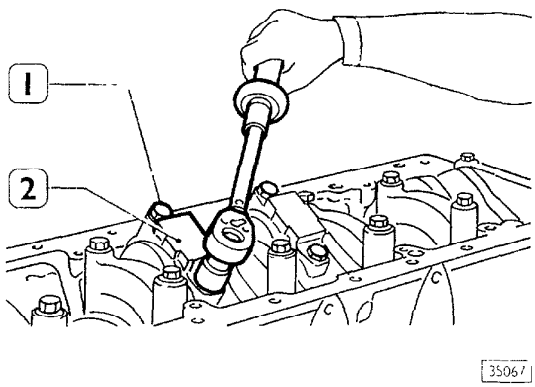
- ☐ the connecting rod number corresponds to the number of its cylinder
- ☐ the words "LATO PUNTERIE" (TAPPET SIDE) stamped on the piston crowns are facing the camshaft
- ☐ the numbers on the connecting rods are facing away from the camshaft side
- ☐ the piston ring gaps are staggered 120^0 apart

Measuring crankpin assembly clearance

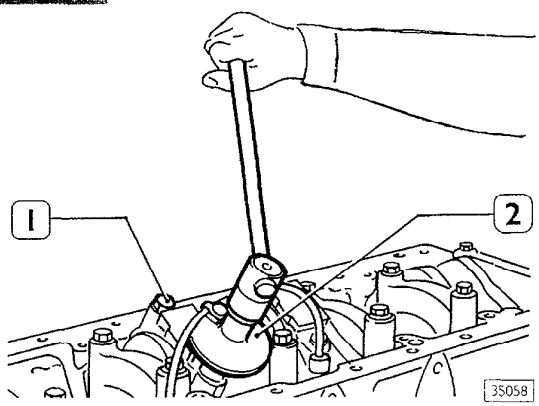


To measure the clearance, carry out the following operations

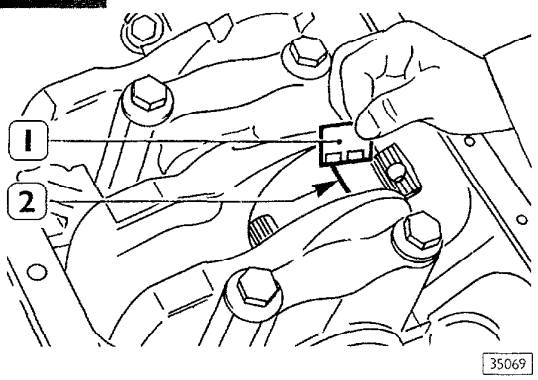
- ☐ thoroughly clean the parts and remove all traces of oil
- ☐ position a strip of plastigage (2) on the crankshaft journals (1)



- ☐ lubricate the threads and undersides of the heads of the big end attachment bolts (1)
- ☐ fit the connecting rod caps (2) and, using a torque wrench, tighten the bolts (1) to a torque of 40 Nm

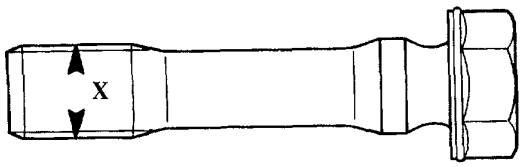


- ☐ using tool 99395216 (2), tighten the bolts (1) a further 35^0



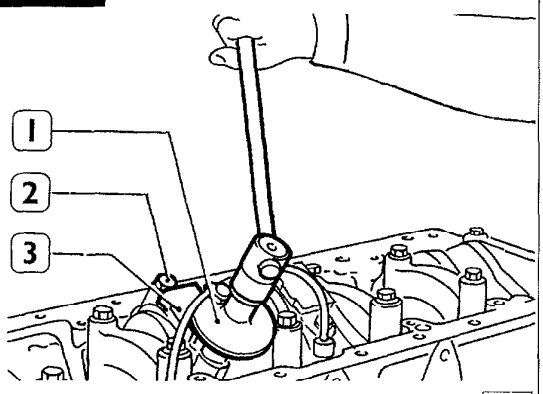
- ☐ remove the connecting rod cap and determine the clearance by comparing the width of the plastigage (2) with the scale divisions given on the package (1) containing the plastigage

Fitting big end caps



35070

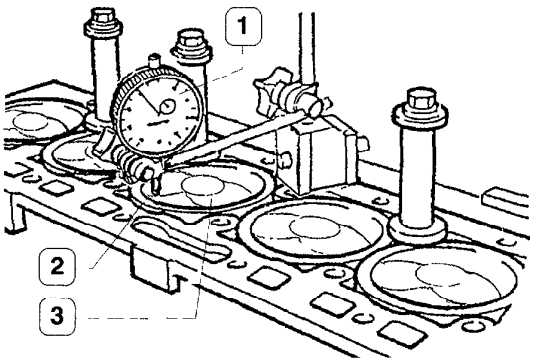
To re–use the big end cap attachment bolts, check that at the point shown, the diameter X is 13 5 mm If not, replace



35071

Lubricate the big end bearing shells, the threads and undersides of the heads of the securing bolts (2)
Fit the big end caps (3) and tighten the bolts (2), having first lubricated them with engine oil, to a torque of 40 Nm, then tighten further, by means of tool 99395216 (1), to an angle of 35°

Checking piston position

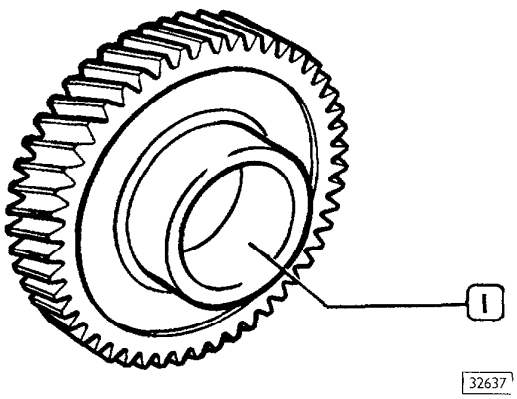


35072

When fitting is complete, check the protrusion of the pistons (3) at TDC with respect to the cylinder liner face using a dial gauge (1) with magnetic base (3)
The top lands of the pistons must project 0 1 – 0 25 mm above the face of the cylinder liners (2)

TIMING GEARS

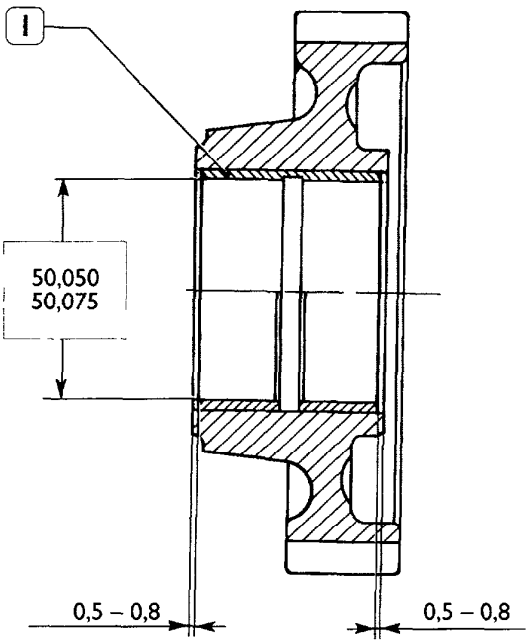
Checking and replacing the idler gear



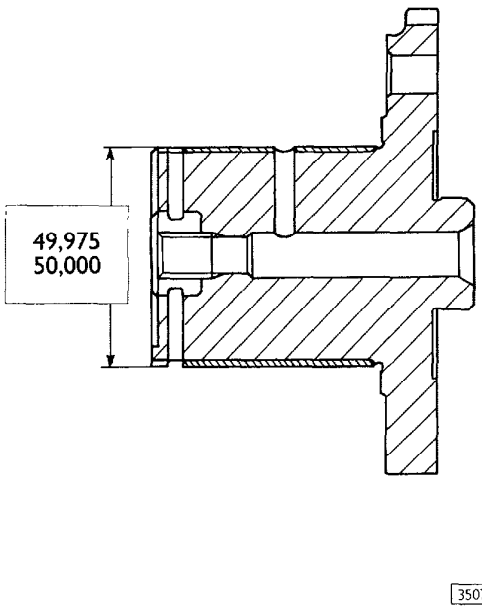
32637

Check the idler gear for damage and excessive tooth wear, replacing it if necessary
Check the contact surfaces of the bush (1) for scoring or signs of seizing, or excessive play on the bearing journal, if these are found, replace the bush (1) using a suitable drift

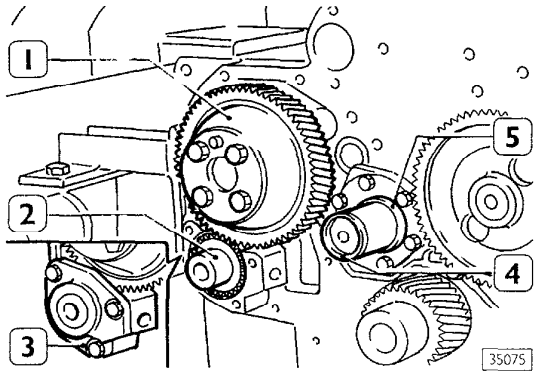
Replacement of idler gear bush



Fit the bush (1) so that it is recessed with respect to the face of the gear by 0 5 – 0 8 mm
After fitting, ream the bush to obtain the nominal diameter shown in the figure

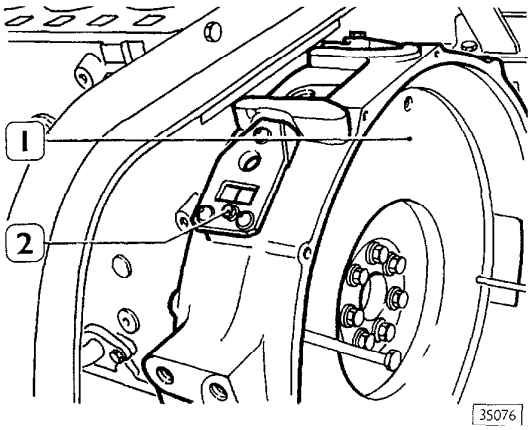


Check the surface of the idler gear pin for damage or excessive wear Check that the oil feed holes are not blocked

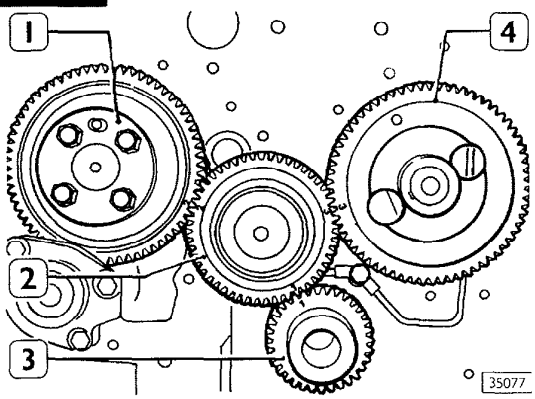


Fit the pin (4) and position the adjustment shim (5) on it Fit the injection pump drive gear (1), the power steering pump drive spindle and the support (3)

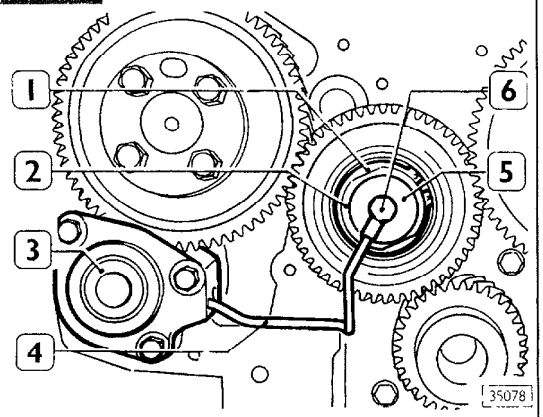
Fitting the idler gear and setting the timing



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

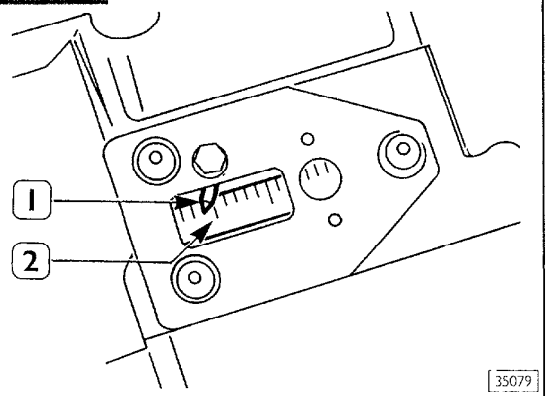


Install the idler gear (2), locating it so that the numbers 1, 2 and 3 stamped on it line up with the same numbers engraved on the crankshaft gear (3), the camshaft gear (4) and the injection pump gear (1)

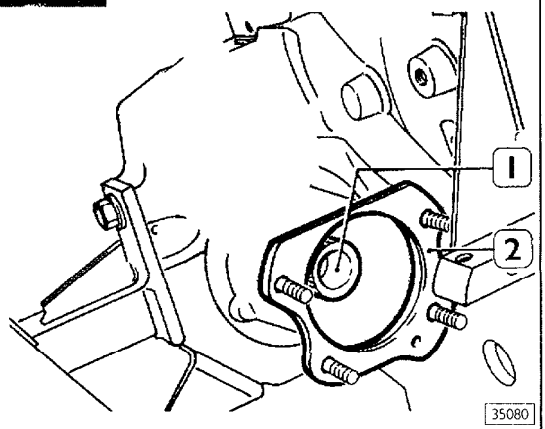


Fit the washer (1) and circlip (2), insert the oil pipe (4) in the support (3) and secure this to the pin (5) by means of the union (6)

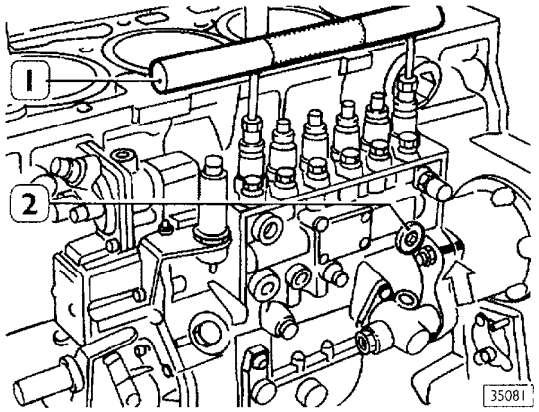
FITTING THE INJECTION PUMP AND SETTING THE TIMING



Turn the flywheel until the mark corresponding to $15° \pm 30'$ of injection advance is exactly lined up with the reference pointer (1)



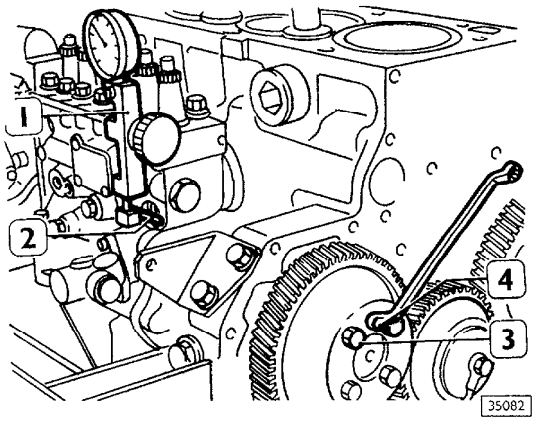
Install the connection coupling (1) on the drive shaft housed in the support (2) remembering that it engages via a double dog and a double recess



Remove the inspection plug (2) from the injection pump, turn the shaft until the tappet relating to the above hole is in the start of delivery position

Using tool 99365136 (1), fit the injection pump, lining up the marks previously made when dismantling, and then secure the injection pump to its support

If the engagement dogs of the coupling joint and the injection pump shaft are found to be 180^0 out of phase, turn the crankshaft one revolution



Fit tool 99365134 (1) fitted with a dial gauge to the injection pump and rest the stylus (2) of the tool on the crown of the tappet

Zero the dial gauge when the tappet is at BDC

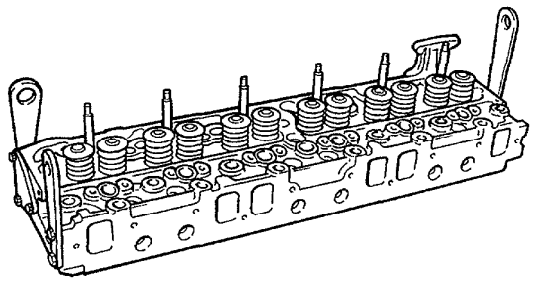
Turn the flywheel backwards about half a turn

Then turn the flywheel in the opposite direction and check that when the mark corresponding to $15° \pm 30'$ of injection advance on the flywheel is lined up with the reference pointer (2, fig 133), the plunger has travelled a start of delivery pre–stroke, read off from the dial gauge, of 3 55 ± 0 05 mm

If a different value is found, loosen the screws (3) and adjust the cam so as to achieve the prescribed pre– stroke Repeat the check and tighten the screws (3)

CYLINDER HEAD

Hydraulic leak test

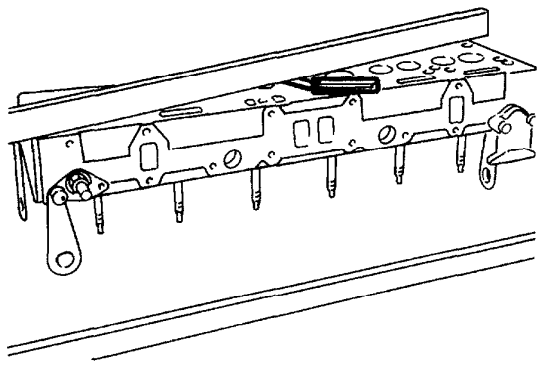


35083

Before dismantling the cylinder head, carry out the hydraulic leak test

Fit the appropriate equipment to the cylinder head 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

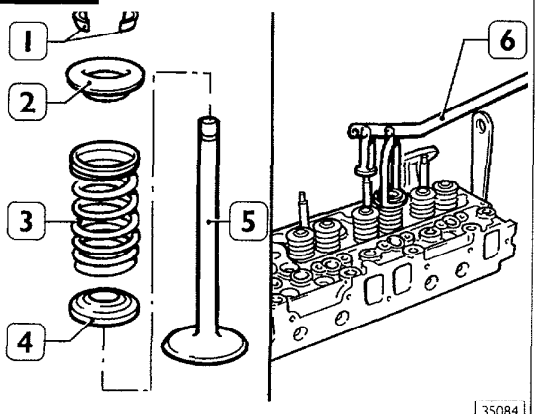
Checking the mating surface of the head with the cylinder block



35086

The mating surface of the head with the cylinder block is checked using a straight edge and a feeler gauge If values of more than 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

DISMANTLING OF VALVES



35084

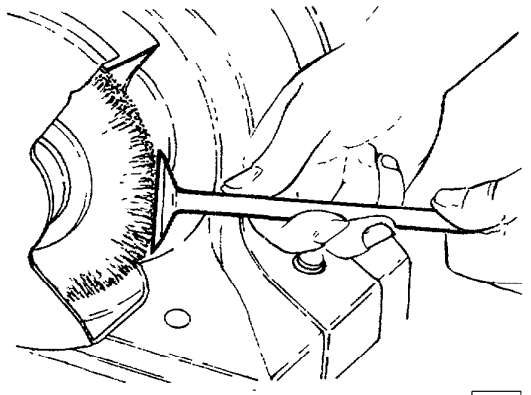
Rest the cylinder head on the workbench and, using tool 99360357 (6), apply pressure to the spring cup (2) so that by compressing the spring (3) the valve collets (1) can be removed. Then take off the upper cup (2), the spring (3) and the lower cup (4)

Repeat the operation on all the valves

Turn the cylinder head upside down and withdraw the valves (5).

VALVES

Removing deposits and checking valves



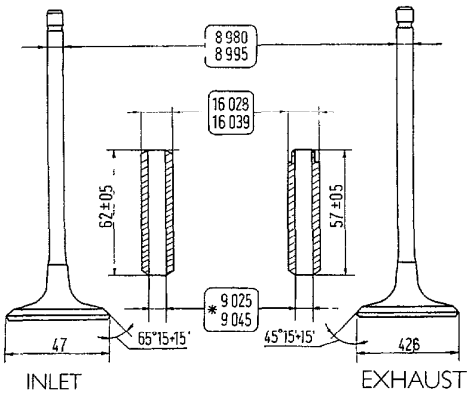
18625

Remove carbon deposits from the valves using a suitable wire brush

Check the valves for signs of seizing or cracking and also, using a micrometer, check that the diameter of the valve stem is within the specified limits (see fig 141) If not, replace the valves

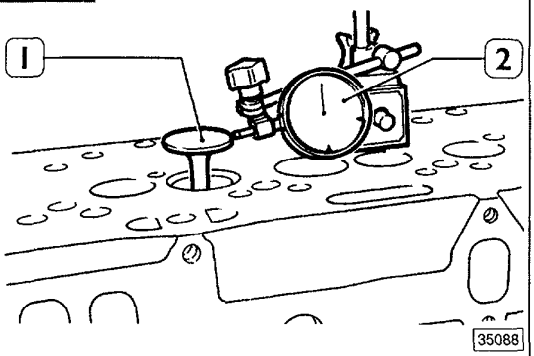
Refacing the valves

If necessary, reface the seatings on the valves using grinding machine 99301014, setting an angle of 45° 15' ± 5' for exhaust valves and 65° 15' ± 5' for inlet valves removing as little material as possible



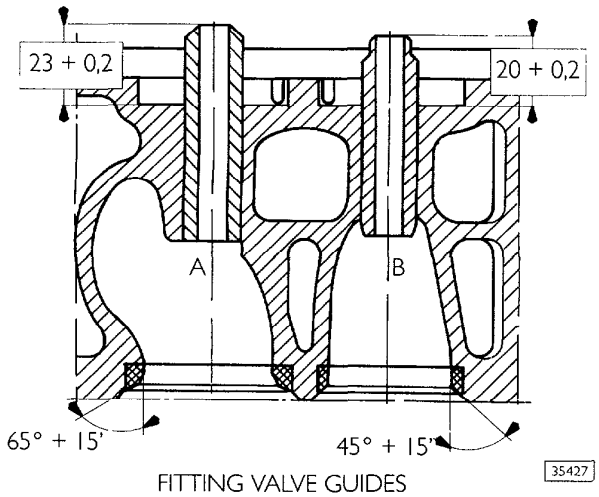
MAIN DATA FOR VALVES AND VALVE GUIDES
* Dimension to be obtained after installing the valve guides

Checking valve stem to valve guide clearance

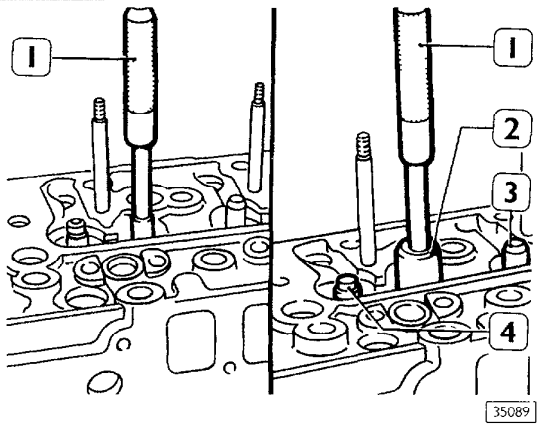


Using a dial gauge (2) with magnetic base (1), check the play between the valve stem (3) and its guide If excessive play is found, replace the valve and if necessary the valve guide

VALVE GUIDE



FITTING VALVE GUIDES
A Inlet valve guide B Exhaust valve guide



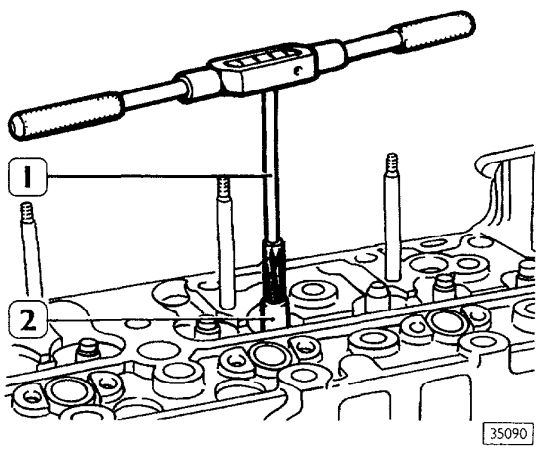
The valve guides are removed using drift 99360481 (1)

They are fitted using drift 99360481 (1) equipped with the adaptor (2)
- 99360495, for inlet valve guides (3)
- 99360496, for exhaust valve guides (4)

Adaptors 99360495 and 99360496 determine the correct fitting position for the valve guides in the cylinder head, if they are not available, the guides must be installed in the cylinder head so that they protrude from it by the amounts shown in figure 143

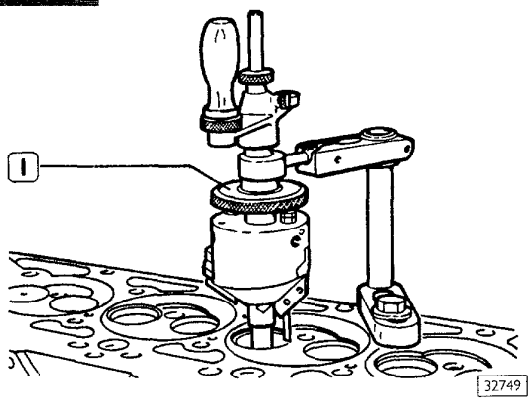
Replacement valve guides are also supplied with the outside diameter 0 2 mm oversize

Reaming the valve guides



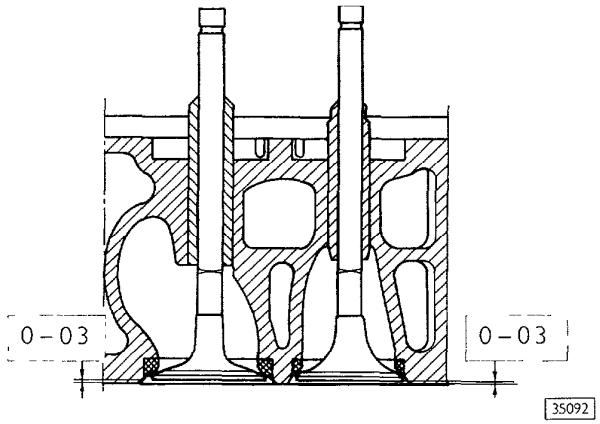
After installing the valve guides, ream the holes in the valve guides (2) using reaming tool 99390311 (1)

Recutting the valve seats

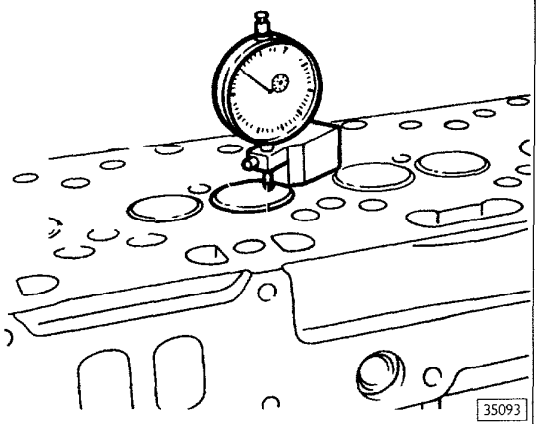


Using the Hunger tool 99360419 (1), recut the valve seats in the cylinder head

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

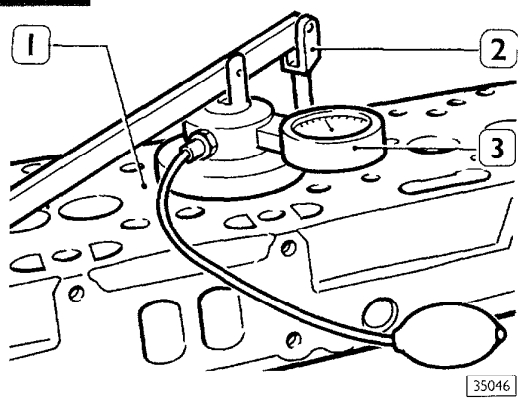


RECESSING OF THE INLET AND EXHAUST VALVES FROM THE CYLINDER HEAD FACE



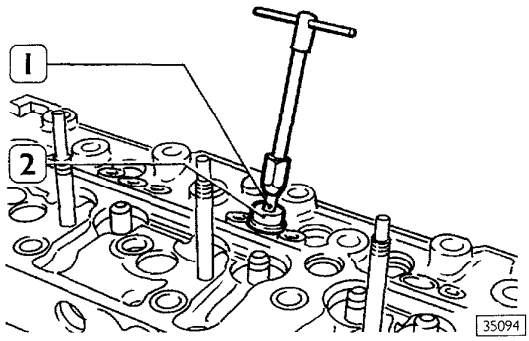
After recutting the valve seats, check that the recessing of the inlet and exhaust valves with respect to the cylinder head face is 0 0 – 0 3 mm

Valve leakage test

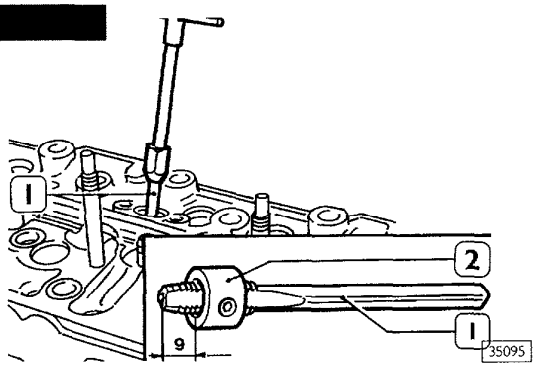


The leakage test on the valves in the cylinder head (1) is carried out using the appropriate equipment (2 and 3)

Replacing injector holder cases



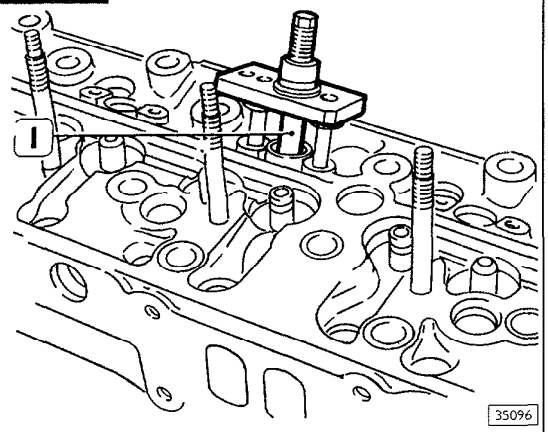
A defective fit between the injector and the case pressed into the cylinder head or between the case and the housing in the cylinder head causes a loss of compression or coolant loss In the first case, the fault can be eliminated by reconditioning the case housing using cutter 99394018 (1) and bush 99394019 (2), remembering that the protrusion of the injector from the face of the cylinder head must be 1 ± 0 4 mm



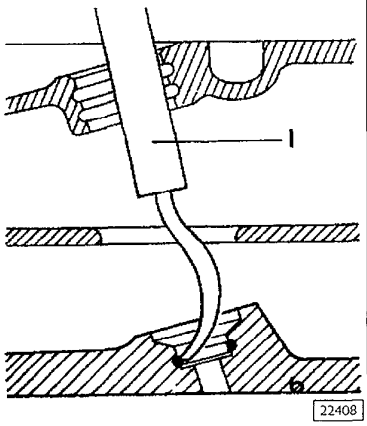
In the second instance, the case must be replaced, proceeding as follows

- ☐ tap a thread in the case using tool 99390425 (1)

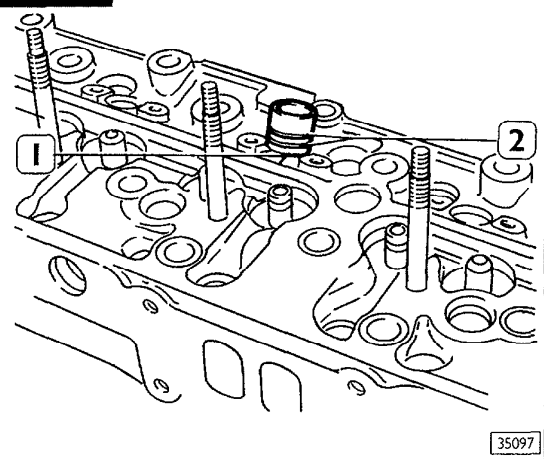
The stop bush (2) must be positioned about 9 mm from the end of the tool (1)



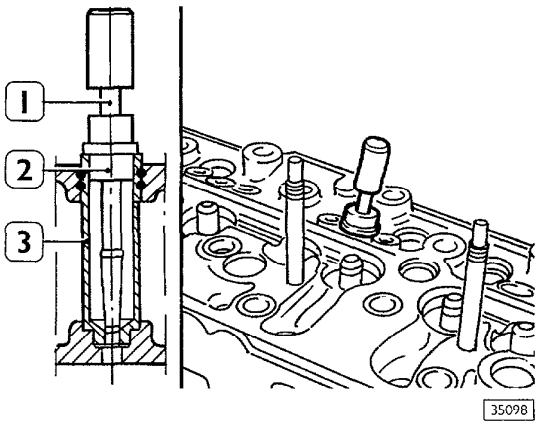
- using extractor 99342145 (1), extract the casing from the cylinder head



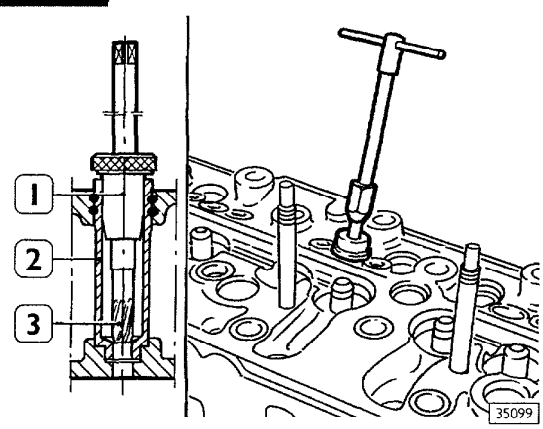
Using a suitable tool (1), remove any copper residue left in the splines in the cylinder head



Lubricate the seals (2), fit them to the case (1) and insert the latter into the housing in the cylinder head

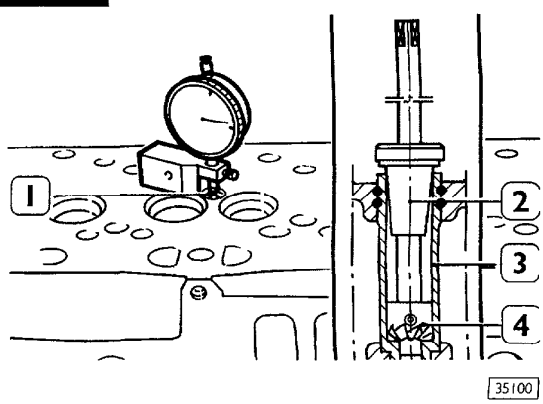


Spread the lower seating of the case (3) in the cylinder head using spreading tool 99365063 (1) and bush 99394019 (2)



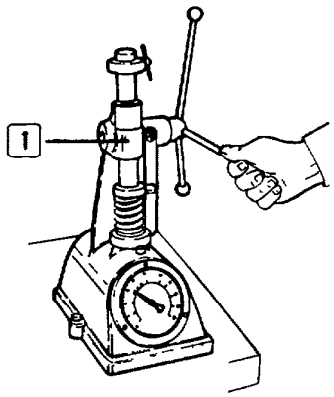
Ream the hole in the case (2) using reamer 99394017 (3) and bushes 99394019 (1)

Checking injector protrusion

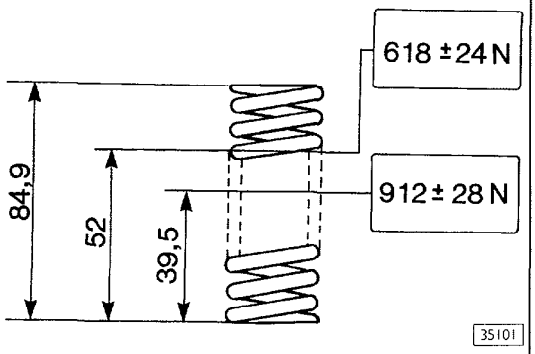


Check the protrusion of the injector (1) from the cylinder head face If necessary, adjust the injector protrusion with respect to the cylinder head face by recutting the seating using cutter 99394018 (4) and bush 99394019 (1), the value should be 1 ± 04 mm

VALVE SPRINGS

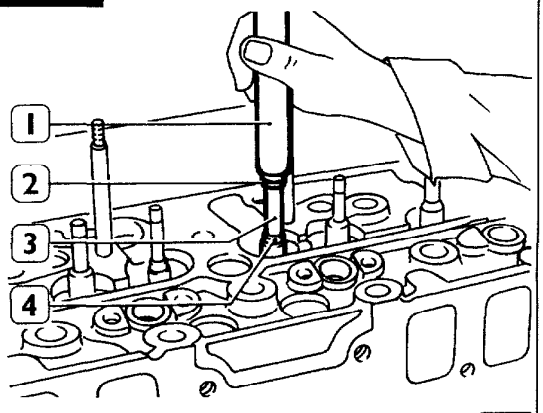


Before fitting, the characteristics of the valve springs must be checked using tool 99305049, and the data on load and elastic deformation compared with those given for new springs in the following figure

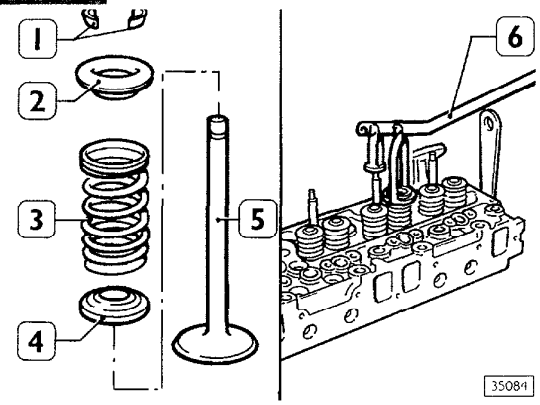


MAIN DATA FOR CHECKING THE VALVE SPRINGS

Fitting the valves



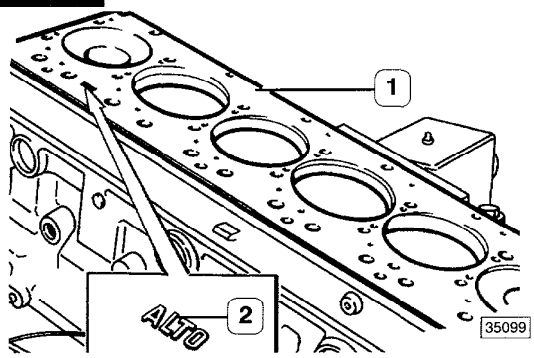
Lubricate the valve stems (3) and insert them into their valve guides, using installing tool 99360292 (1), fit the seals (2) to the exhaust valve guides (4)



On the cylinder head arrange the lower spring cup (4), the spring (3) and the upper spring cup (2), using tool 99360357 (6), compress the spring (3) and secure the parts to the valve with the split collets (1)

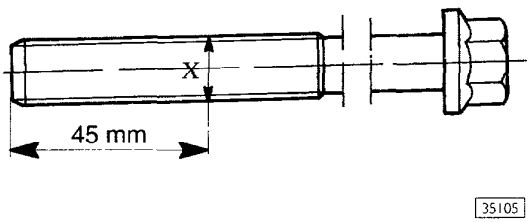
The part of the spring with the more closely spaced coils (marked with paint) must face towards the head

FITTING THE CYLINDER HEAD

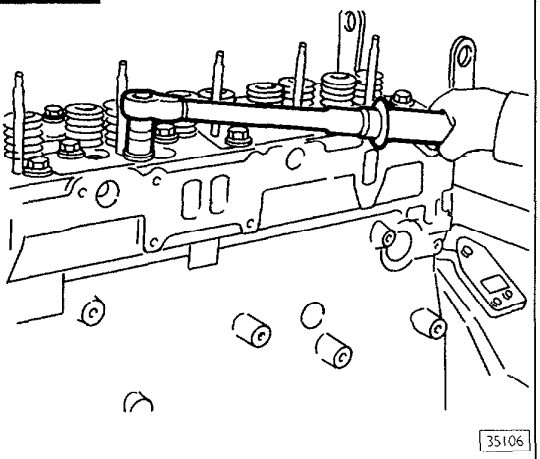


To fit and tighten down the cylinder head, proceed as described below

- ☐ arrange the gasket (1) on the crankcase with the word ALTO (TOP) (2) facing the operator

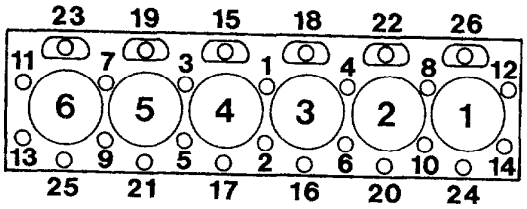


To re-use a cylinder head bolt, check that at the point X shown, the diameter is 15 5 mm If not, replace the bolt



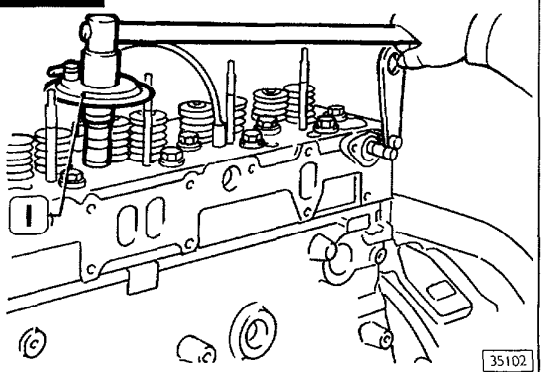
35106

- ☐ position the cylinder head on the crankcase, lubricate the bolts and screw them down



35107

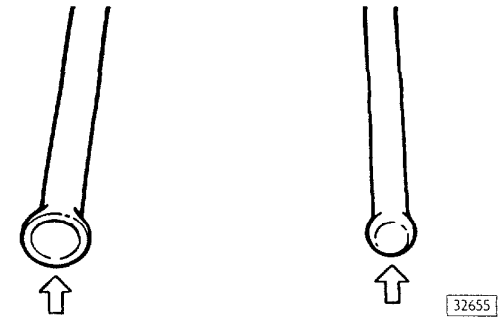
- ☐ tighten the bolts in the order shown in the figure and using the procedure described below
- ☐ stage 1, using a torque wrench (fig 164), carry out initial tightening to a torque of 118 Nm
- ☐ stage 2, retighten to a torque of 118 Nm



35102

- ☐ stage 3, fit tool 99395216 (1) to the angle gauge wrench and tighten by an angle of 90° ± 3°
- ☐ stage 4, tighten by an angle of 90° ± 3°
- ☐ stage 5, for bolts 1 to 14 only, tighten by an angle of 45° ±3°

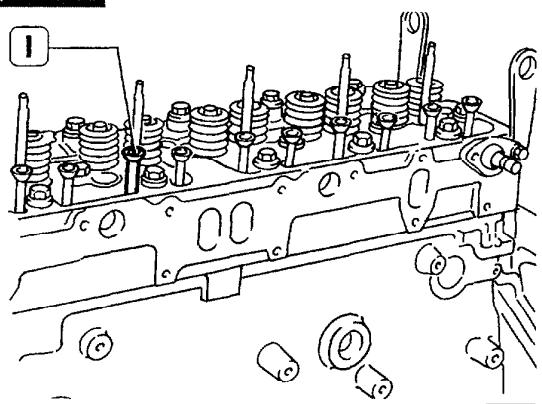
PUSHRODS



32655

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

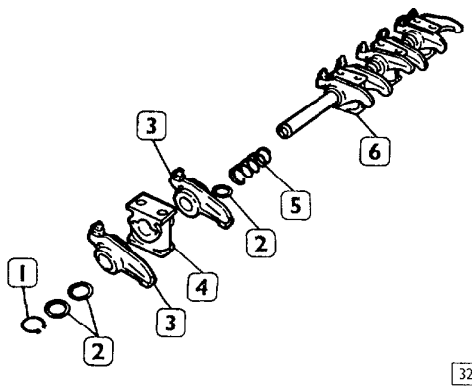
Pushrods for inlet and exhaust valves are identical and therefore interchangeable



35109

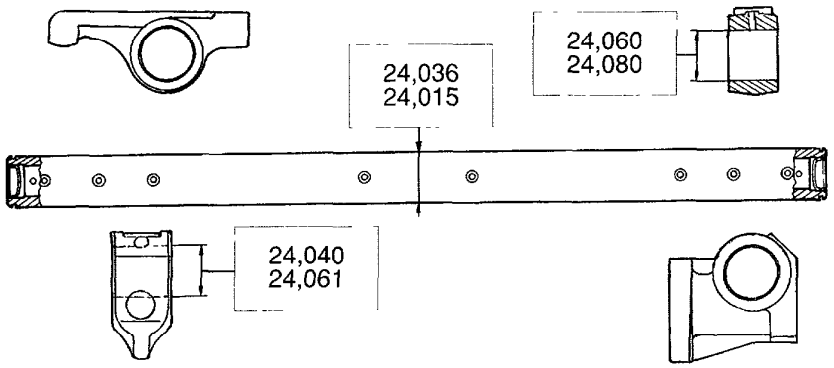
Fit the pushrods (1) into their seatings

ROCKER SHAFT ROCKERS



32658

COMPONENT PARTS OF THE ROCKER SHAFT
1 Circlip – 2 Adjustment shims – 3 Rockers – 4 Pedestal for shaft – 5 Spring – 6 Shaft

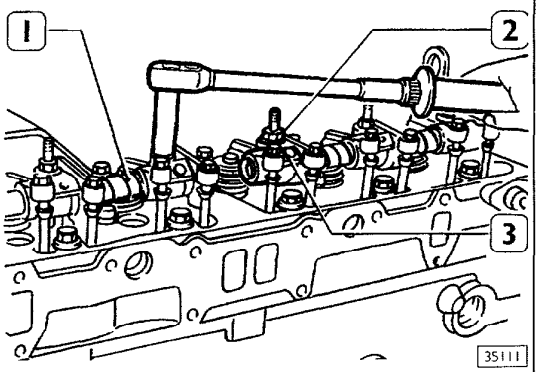


35110

MAIN DATA FOR ROCKER SHAFT PEDESTALS, ROCKER SHAFT AND ROCKERS

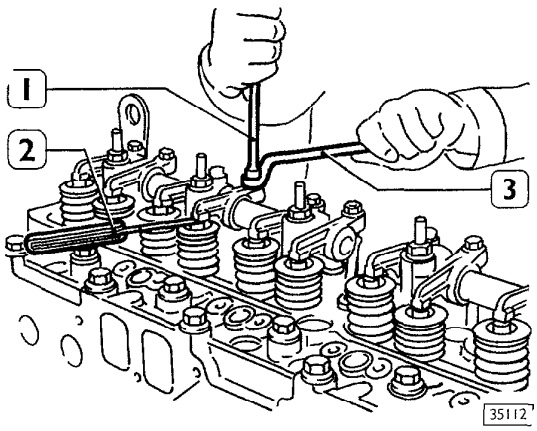
Check that the contact surfaces of the rockers with the shaft and of the shaft with the pedestals are not excessively worn or showing deterioration
Check that the plugs fitted to the ends of the shaft provide a perfect seal

Fitting the rocker shaft and adjusting the operating clearance between the valves and rockers



35111

Fit the caps onto the valve stems
Fit the rocker shaft assembly (1)
Tighten the nuts (2) securing the pedestals (3) to a torque of 50 Nm, then tighten them a further 90°, using tool 99395216 to check this



35112

Using wrench 99350108 (1), a feeler gauge (2) and a bi-hexagon wrench (3), adjust the clearance between the valves and rockers as indicated below

☐ rotate the crankshaft until the valves of no 1 cylinder are rocking and adjust the valves marked with an asterisk as shown in the table

cylinder no	1	2	3	4	5	6
inlet	–	–	*	–	*	*
exhaust	–	*	–	*	–	*

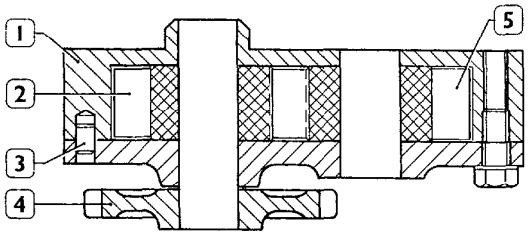
☐ rotate the crankshaft until the valves of no 6 cylinder are rocking and adjust the valves marked with an asterisk as shown in the table

cylinder no	1	2	3	4	5	6
inlet	*	*	–	*	–	–
exhaust	*	–	*	–	*	–

LUBRICATION

Engine lubrication is obtained by means of a gear type pump (fig 173) fitted to the lower part of the crankcase in line with the front main bearing, it is driven by the crankshaft gear

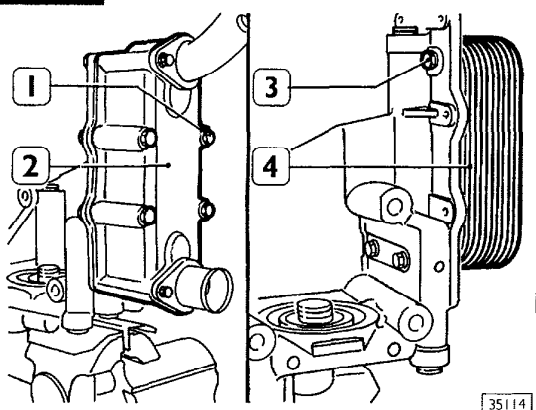
OIL PUMP



SECTIONAL VIEW OF THE OIL PUMP
1 Pump body – 2 Driving gear – 3 Cover – 4 Oil pump drive gear – 5 Driven gear

Check that the gears (2, 4 and 5) are not worn or showing deterioration and that their shafts do not have excessive play in the housings in the body (1) or the cover (3)
If any fault is found, replace the oil pump complete

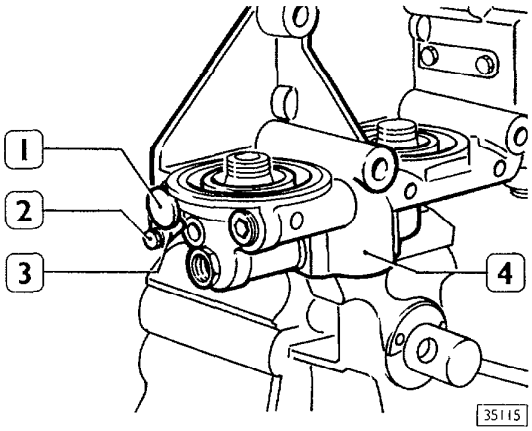
HEAT EXCHANGER



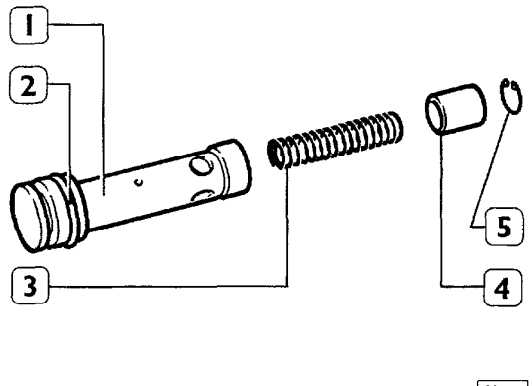
Remove the attachment screws (1) and take off the cover (2)
Remove the attachment screws (3) and take off the heat exchanger (4)

The following components are housed in the heat exchanger mounting the pressure relief valve, setting 7 5 bars, the fine filtered oil delivery regulation valve, setting pressure 4 bars

Pressure relief valve

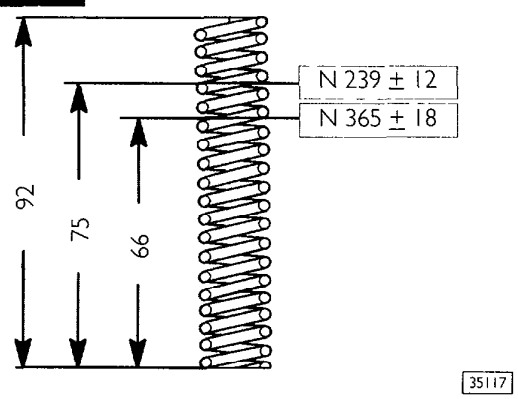


Remove the screw (2) securing the bracket (3) retaining the pressure relief valve (1) and remove the valve from the heat exchanger mounting (4)

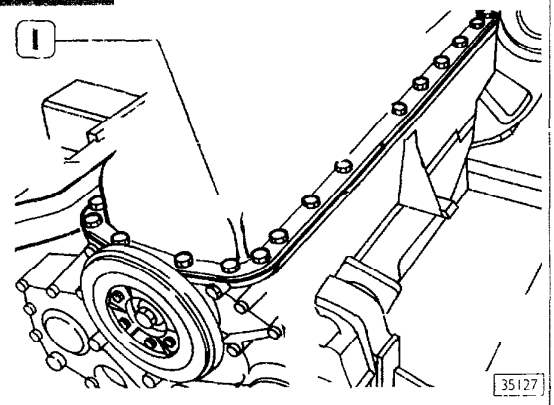


COMPONENT PARTS OF THE PRESSURE RELIEF VALVE
1 Valve body – 2 Seal – 3 Spring – 4 Valve – 5 Circlip

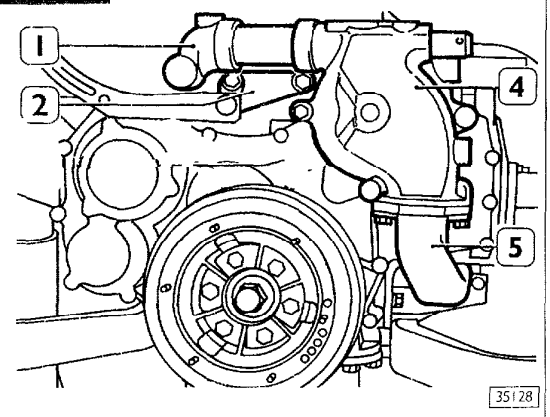
Remove the circlip (5) and withdraw the spring (3) and the valve (4) from the valve body (1)
Check that the valve (4) slides freely in the valve body (1) without excessive play



MAIN DATA FOR CHECKING THE RELIEF VALVE SPRING

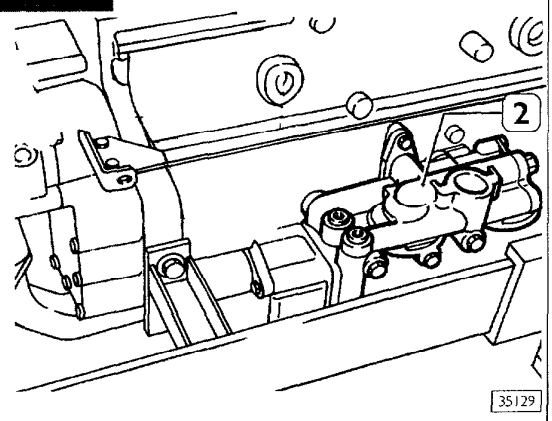


Position the gasket on the crankcase and fit the sump (1)
Fit the brackets

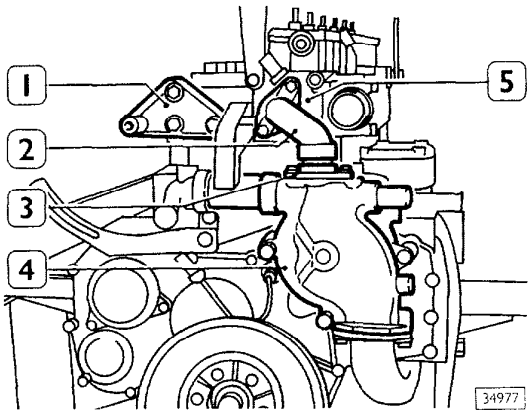


Fit the alternator bracket (2), the water pump (4) and pipes (4 and 5), fit and adjust the pulse transmitter as follows

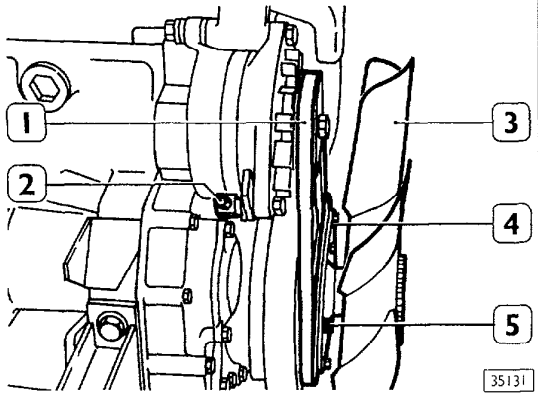
- ☐ screw in the transmitter (3) until contact occurs
- ☐ unscrew one turn, corresponding to a gap of 1 mm
- ☐ tighten the lock nut to a torque of 40 ± 12 Nm



Then fit the heat exchanger (2) and the compressor (1)



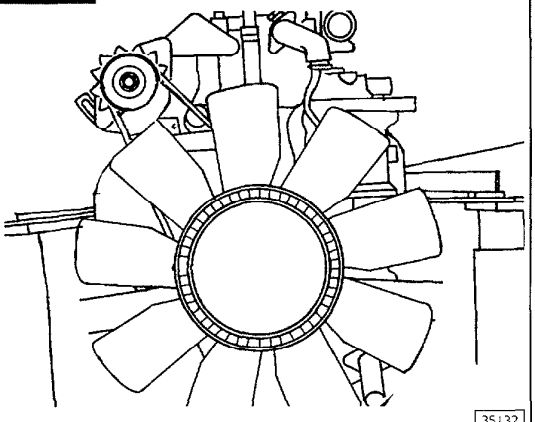
Fit the thermostat housing (5) and attach the pipe (2) to it
Refit the flange (3) to the water pump (4)
Fit the alternator to the alternator bracket (1) with the drive belt



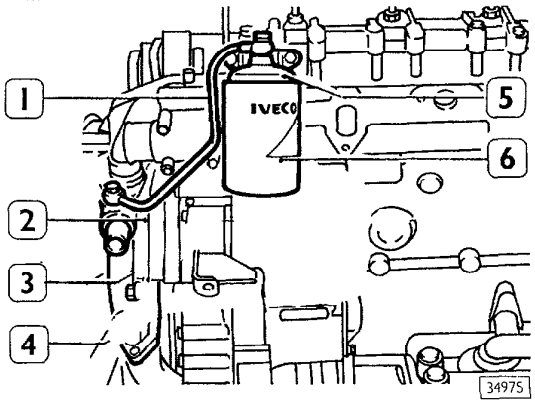
If a different value is found, adjust the tension of the belt (1) by means of the tensioner (2)

After the engine has run for a period of 1 h, again check that the tension is 40 – 50 daN, if not, adjust the belt tension once again

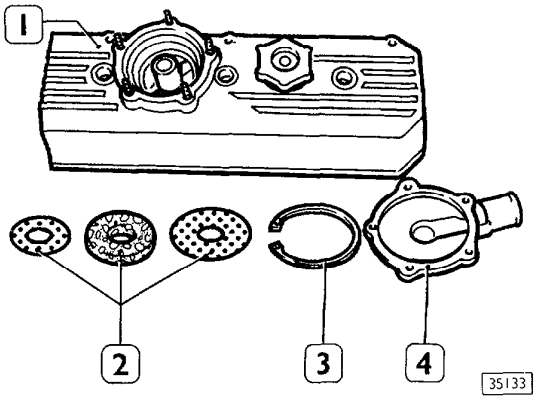
Fit the viscostatic fan (3) and secure it to the pulley (4) by means of the nuts (5)



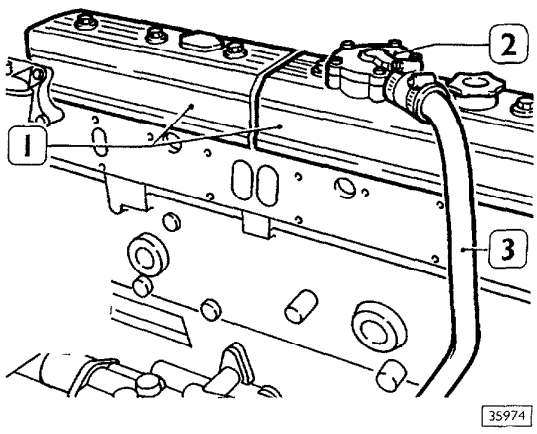
Fit the fan shroud (1)



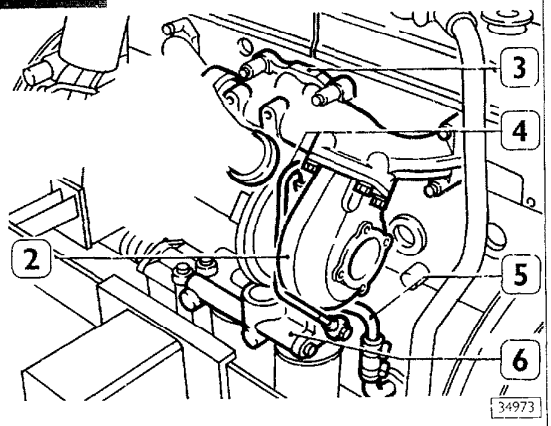
Fit the mounting (5) and screw the inhibitor filter (6) onto it
Connect pipes (3 and 4) to the water pump (2)
and pipe (1) to the mounting (5) and to the water pump (2)



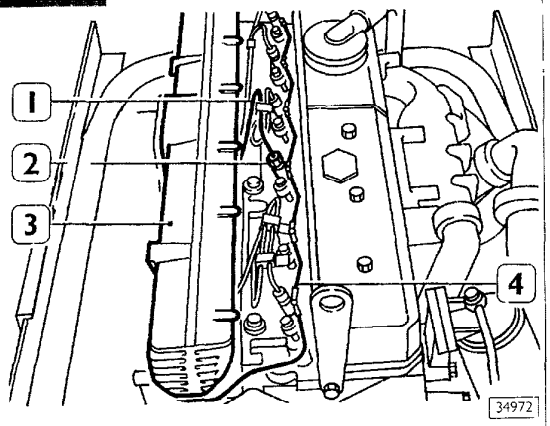
To clean the oil breather filter, mark the position in which the cover (4) is fitted to the rocker cover (1) and remove the filter
Remove the circlip and take out the filter components (2)



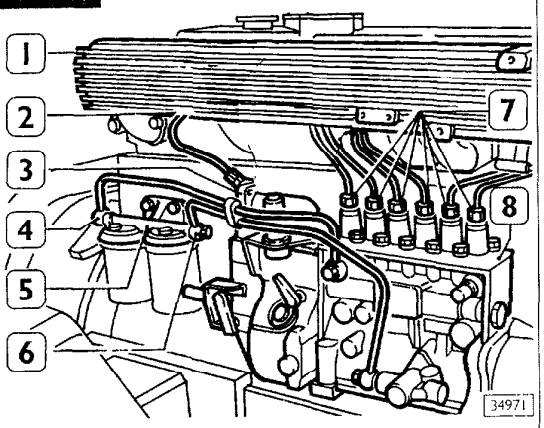
Fit the valve gear covers (1)
Connect the oil breather pipe (3) to the breather (2) and secure it to the crankcase



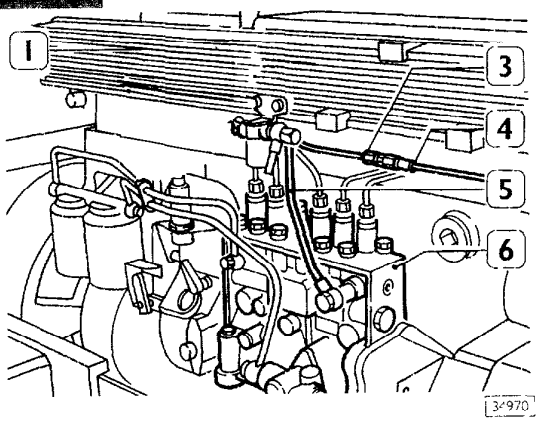
Fit the turbocharger (2) to the exhaust manifold (3) and refit the manifold to the cylinder head
Connect oil pipe (4) to the support (6) and oil pipe (5) to the coupling on the crankcase Fit the air duct (1)



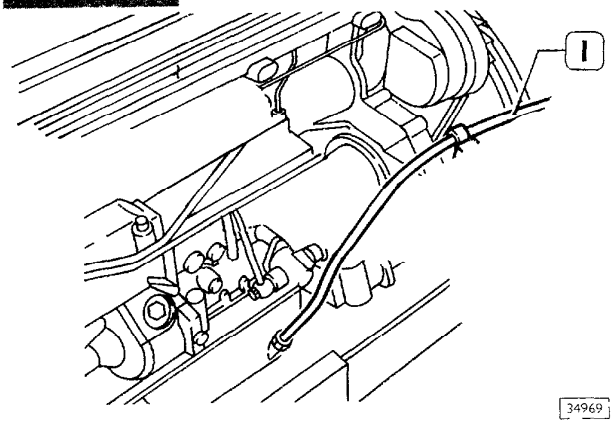
Fit the inlet manifold (3) and the injectors (2)
Connect the fuel delivery (1) and fuel return (4) pipes to the injectors



Fit the fuel filters Connect pipes (4 and 6) to the filter mounting (5) and to the injection pump (8), pipe (2) to the inlet manifold (1) and to the LDA device (3), pipe (7) to the injection pump (8)



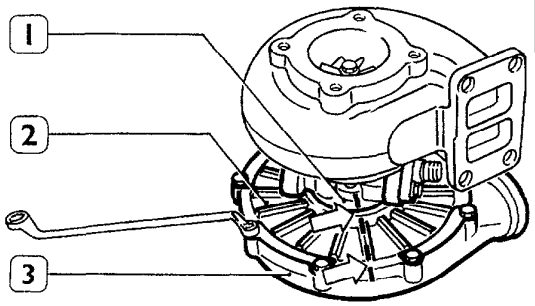
Connect pipe (5) to the injection pump (6), pipe (3) to the fuel recovery pipe (4), pipe (1) to the thermostarter



Fit the air duct (2) and the sleeve (1) for the oil level dipstick

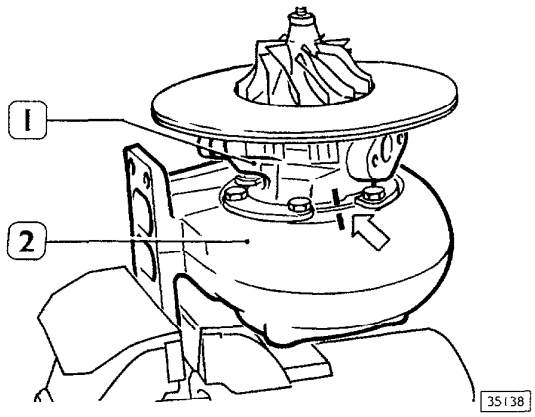
OVERHAULING THE TURBO-CHARGER TYPE KKK,K27.2

Preliminary checks



35137

Thoroughly clean the outside of the turbocharger using anti-corrosion and anti-oxidising liquids
Mark the assembly position of the compressor body (3) to the flange (2) and of the flange to the centre body (1) Separate the compressor body (3) from the flange (2) by removing the retaining screws (4)

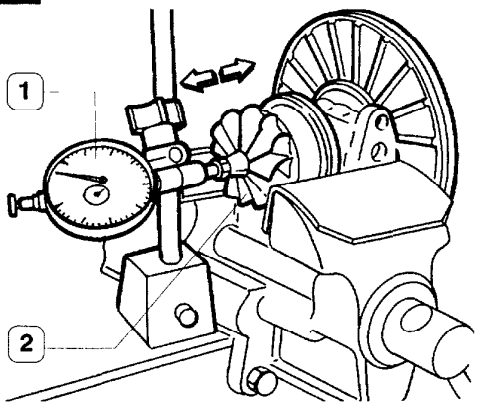


35138

Mark the assembly position of the turbine body (2) on the centre body (1)
Remove the securing screws and separate the centre body (1) from the turbine body (2)

After detaching the turbine and compressor bodies and before proceeding to check the play in the bearings, check that the above components and the centre body are free from wear or erosion or foreign object impacts, also, there should be no carbonised oil present in the oil outlet port
If even one of these points is found, replace the turbocharger complete

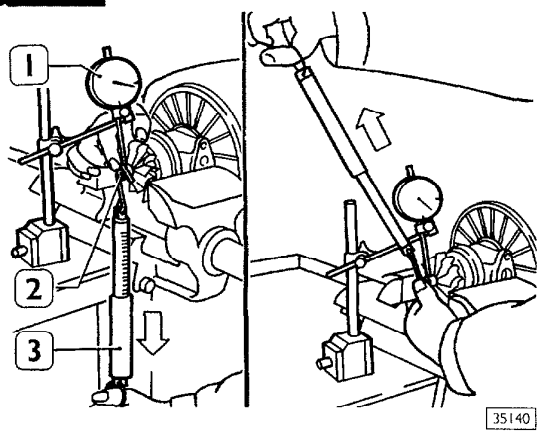
Checking bearing play



35139

The end and radial play in the bearings should be measured on the shaft at the turbine rotor (2) end

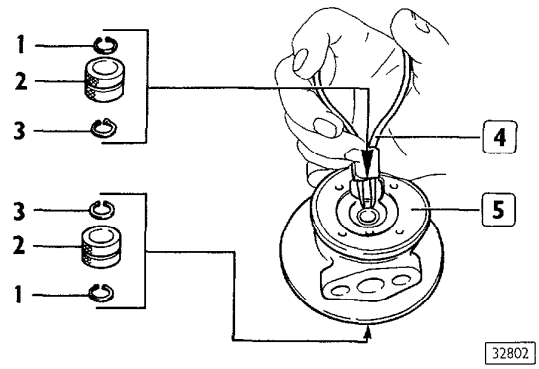
Position the stylus of the dial gauge (1) with magnetic base on the spindle (2) and zero the dial gauge
Press the spindle (2) in the directions shown by the arrows and check that the end play in the bearings is no more than 0 16 mm



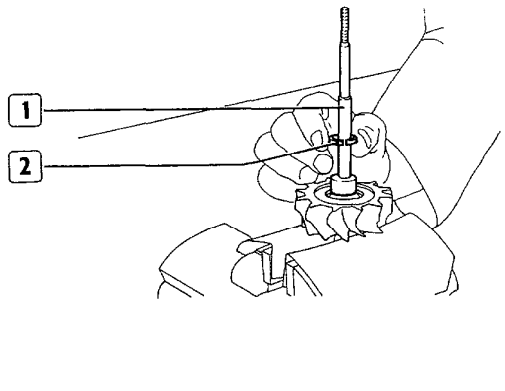
35140

Position the stylus of the dial gauge (1) on the spindle (2) at the point shown in the figure Using a spring balance (3), pull down on the spindle with a force of 50 N and zero the dial gauge in these conditions Still with a force of 50 N, pull up on the spindle and measure the spindle deflection on the dial gauge
This should be not more than 0 42 mm
Repeat the check at one other point at least on the spindle

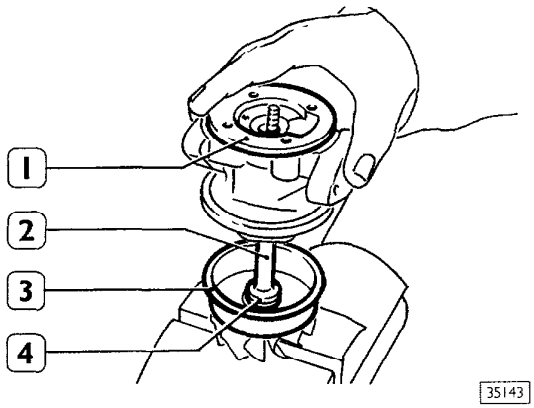
Assembling



Using pliers (4), fit the inner circlips (3) to the centre body (5), insert the bushes (2) lubricated with engine oil and secure them with the outer circlips (1)

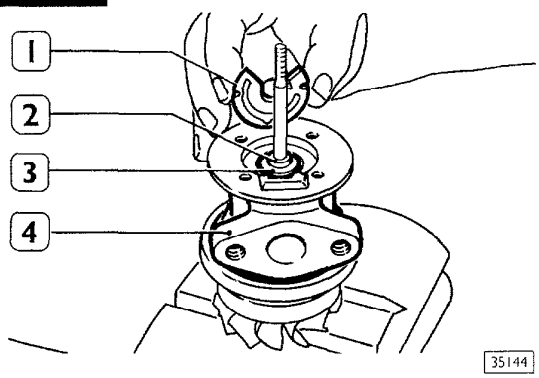


Position the circlip (2) in its housing on the turbine rotor shaft (1)

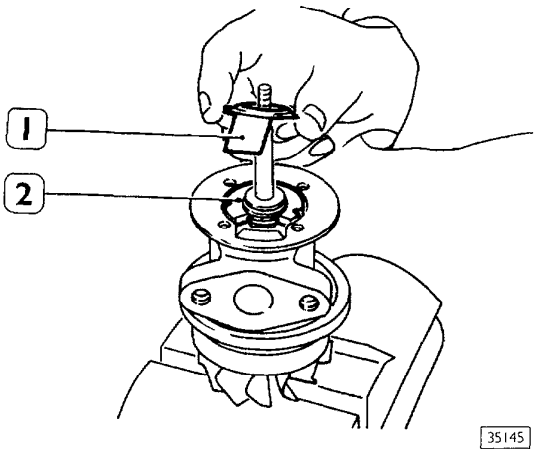


Lubricate the turbine rotor shaft (2), fit the heat shield (3), fit the centre body (1)
When compressing the circlip (4), make sure that the opening is 90^0 away from the oil feed hole

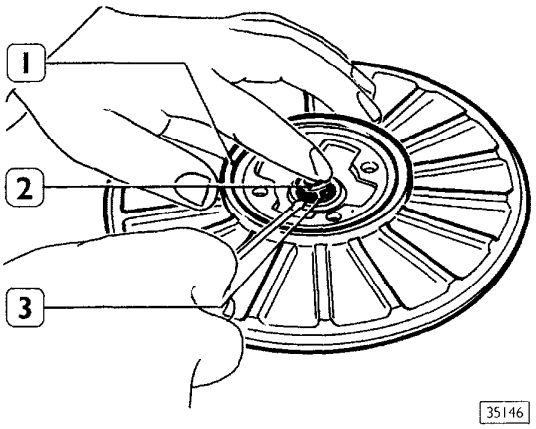
The circlip (4) is correctly positioned in its housing if the heat shield (3) and centre body (1) rotate freely



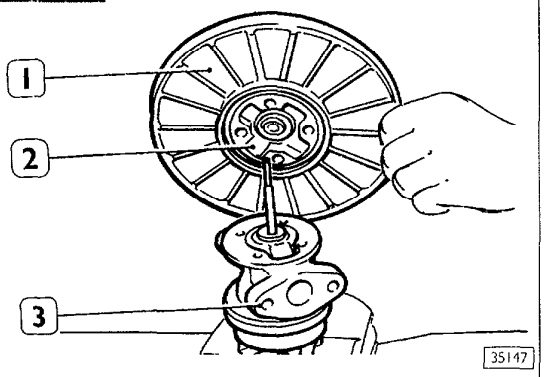
Position the washer (3), spacer (2) and axial bearing (1) in the centre body (4)



Fit the thrust washer (2) and the oil thrower (1)

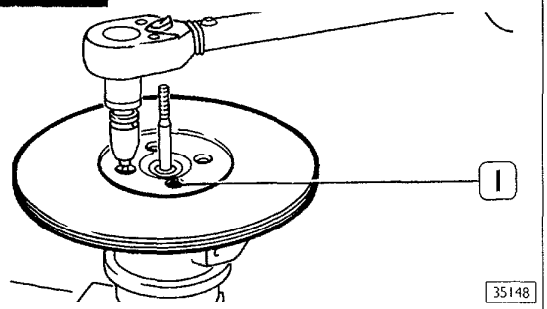


Fit the bush (2) complete with circlip (3) to the flange (1)

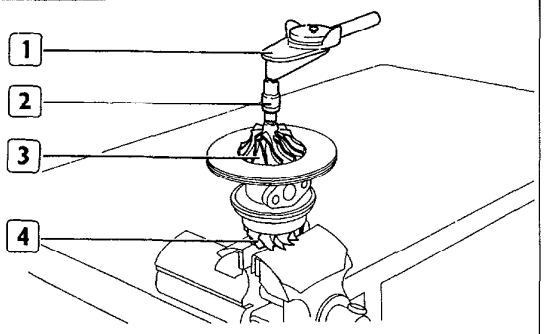


Fit the inner seal (2) to the flange (1) and fit this to the centre body (3), lining up the marks made when dismantling

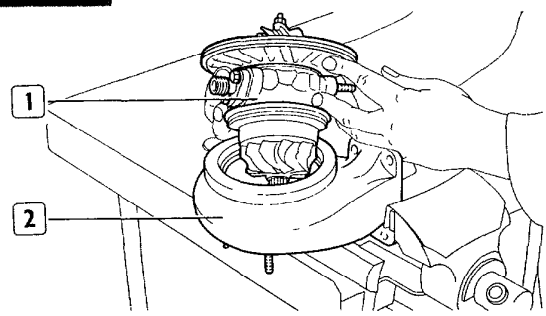
The seal (2) must be coated with NEVER–SEEZ compound



Apply LOCTITE 640 to the threads of the screws (1) and tighten them to a torque of 6 Nm (0 6 kgm)

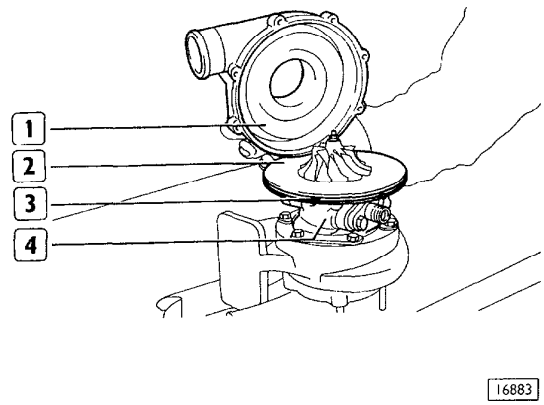


Heat the compressor rotor (1) to 130° C Lubricate the rotor shaft (3) and fit the compressor rotor (1) to this Screw on a new securing nut and tighten it to a torque of 7 + 2 Nm, (0 5 + 0 2 kgm) After about 10' apply LOCTITE 640 to the threads of the shaft, unscrew the nut by 1 – 2 turns and retighten it to a torque of $5^{+60°}_{-5°}$ Nm
($0\,5\ ^{+60°}_{-5°}$ kgm)
To conclude, seal the shaft nut and thread with locking varnish and check the end and radial play in the bearings as described on page 153



Fit the centre body (1) complete into the turbine body (2), taking care to line up the marks made when dismantling Tighten the screws securing the centre body to the turbine body to a torque of 20 Nm (2 kgm)

The threads of the turbine body securing screws must be coated with NEVER–SEEZ compound beforehand



Position a new seal (3) in the housing on the intermediate disc (2) and fit the compressor body (1) to the centre body (4), taking care to line up the marks made when dismantling Tighten the screws securing the compressor body to the centre body to a torque of 7 Nm (0 7 kgm)

Before fitting the turbocharger to the engine, the centre body should be filled with engine lubricating oil