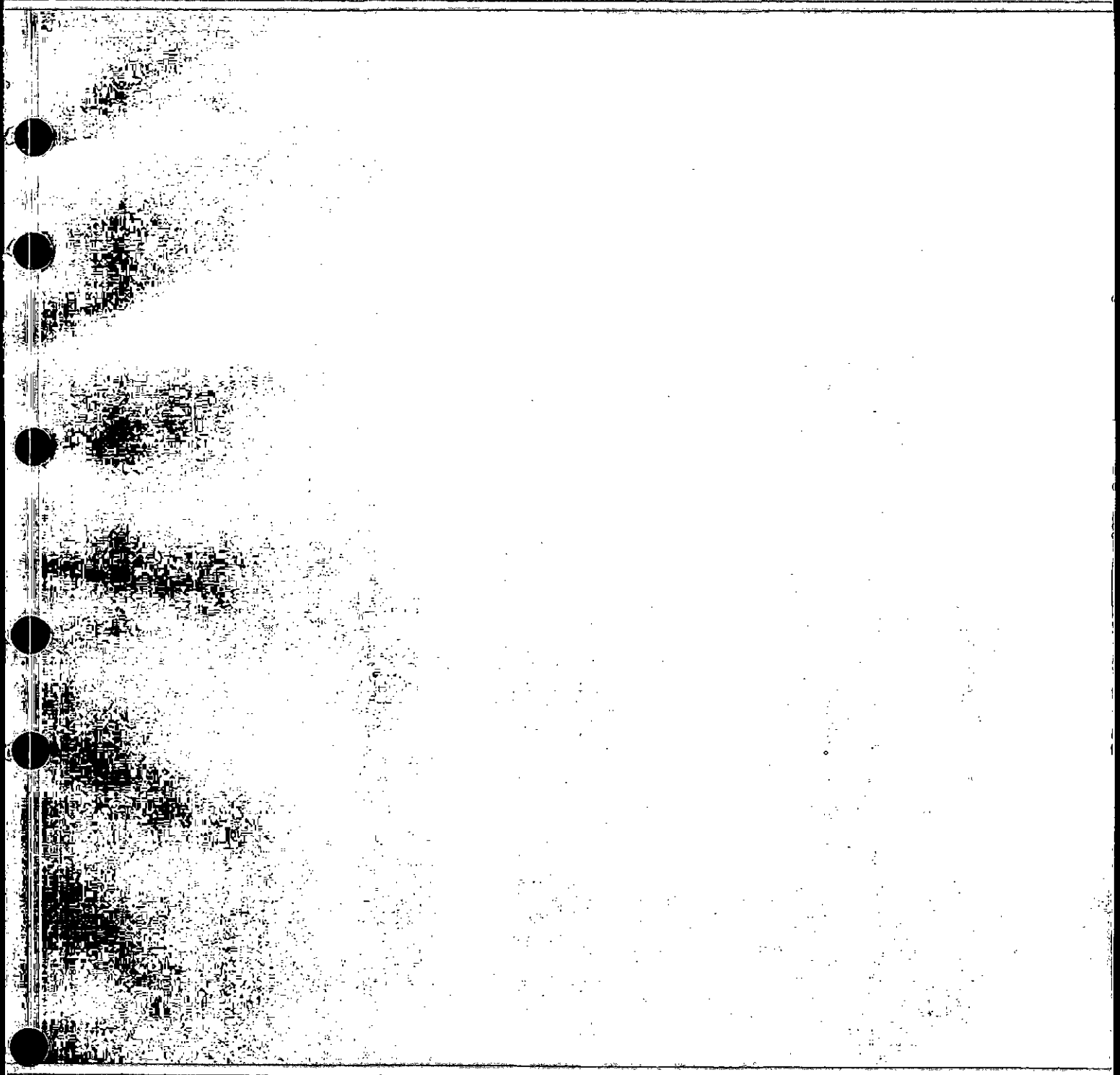
Publ. No. 7738038-4
10-1996
(Replaces 7736967-6)

Workshop Manual

TWD610G/P, TD630ME, TWD630ME

TWD710G/P, TD730ME,TWD730ME, TWD731ME, TAD730G/P



VOLVO

Foreword

This workshop manual contains descriptions and repair instructions for standard versions of industrial diesel engines in the 6 and 7 litres series.
This manual should be used together with the workshop manual "Technical Data" for each engine concerned.
The instructions in this manual describe the most suiteable working methods using the special tools which are shown under the heading "Special tools".
Volvo Penta reserves the right to carry out design modifications without previous notice and disclaims any obligation to carry out corresponding modifications to products already sold or manufactured.

AB VOLVO PENTA

Each engine is supplied with two identical signs, of which one is mounted on the engine block. The other sign should be mounted in a suitable location adjacent to the engine.

VOLVO PENTA	
ENGINE MODEL	XXXXXXXX
SPEC. NO.	XXXXXX
SERIAL NO.	XXXXXXXXXX
RATED NET POWER without fan kW/hp	XXX/XXX
with fan kW/hp	XXX/XXX
SPEED AT RATED POWER rpm	XXXX
PRELIFT mm/INJ. TIMING	X,X+X,X/XX±X,X°
MADE IN SWEDEN	3826077

951211-2

T	–	Turbo charged
A	–	Air-to-air charge air cooler
W	–	Water-to-air charge air cooler
D	–	Diesel engine
7	–	Displacement, litres
3	–	Generation
0	–	Version
P	–	Stationary engine (Power Pac)
G	–	Gen Set engine
M	–	Mobile engine
E	–	Emission controlled engine
C	–	Certified emission engine

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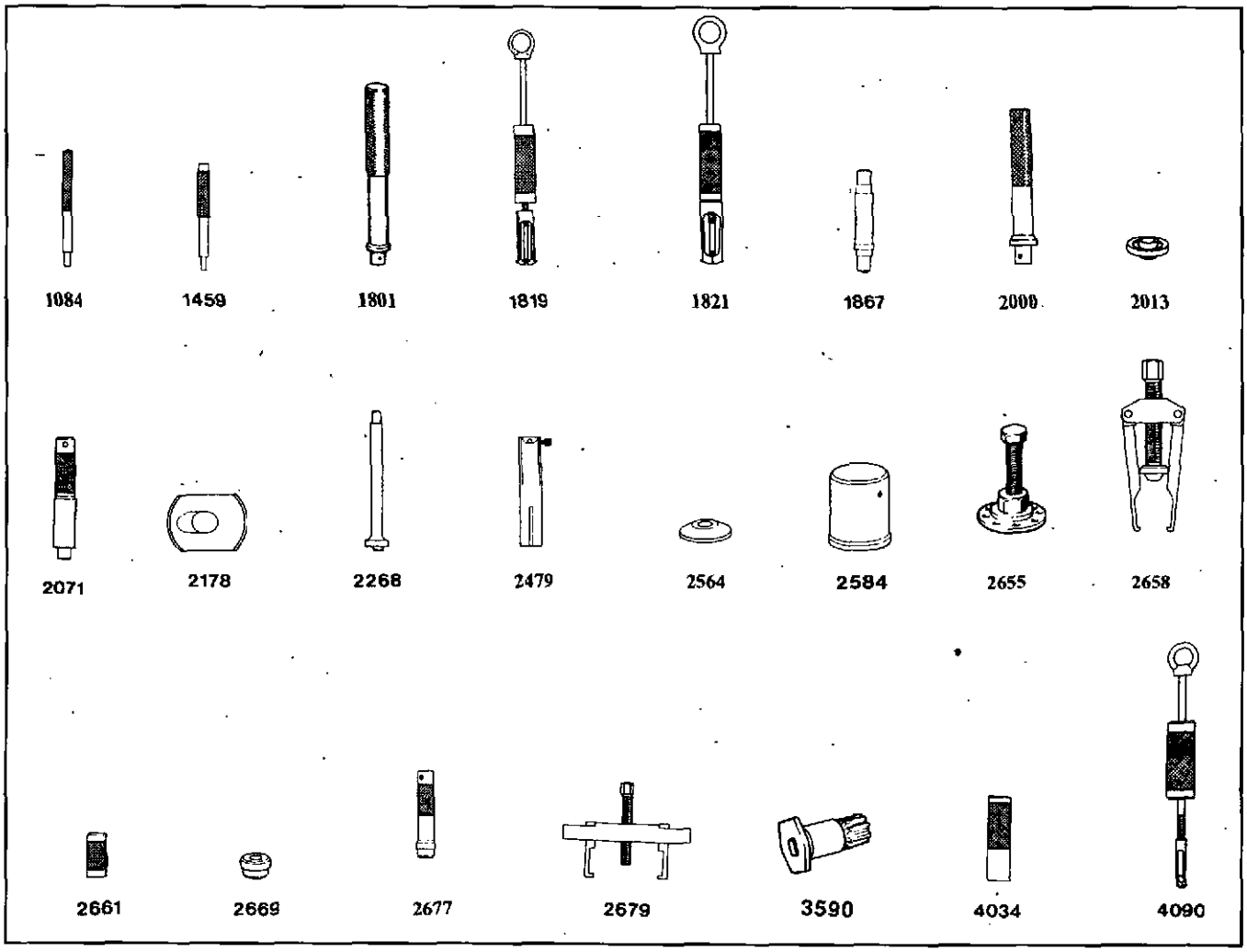
Contents

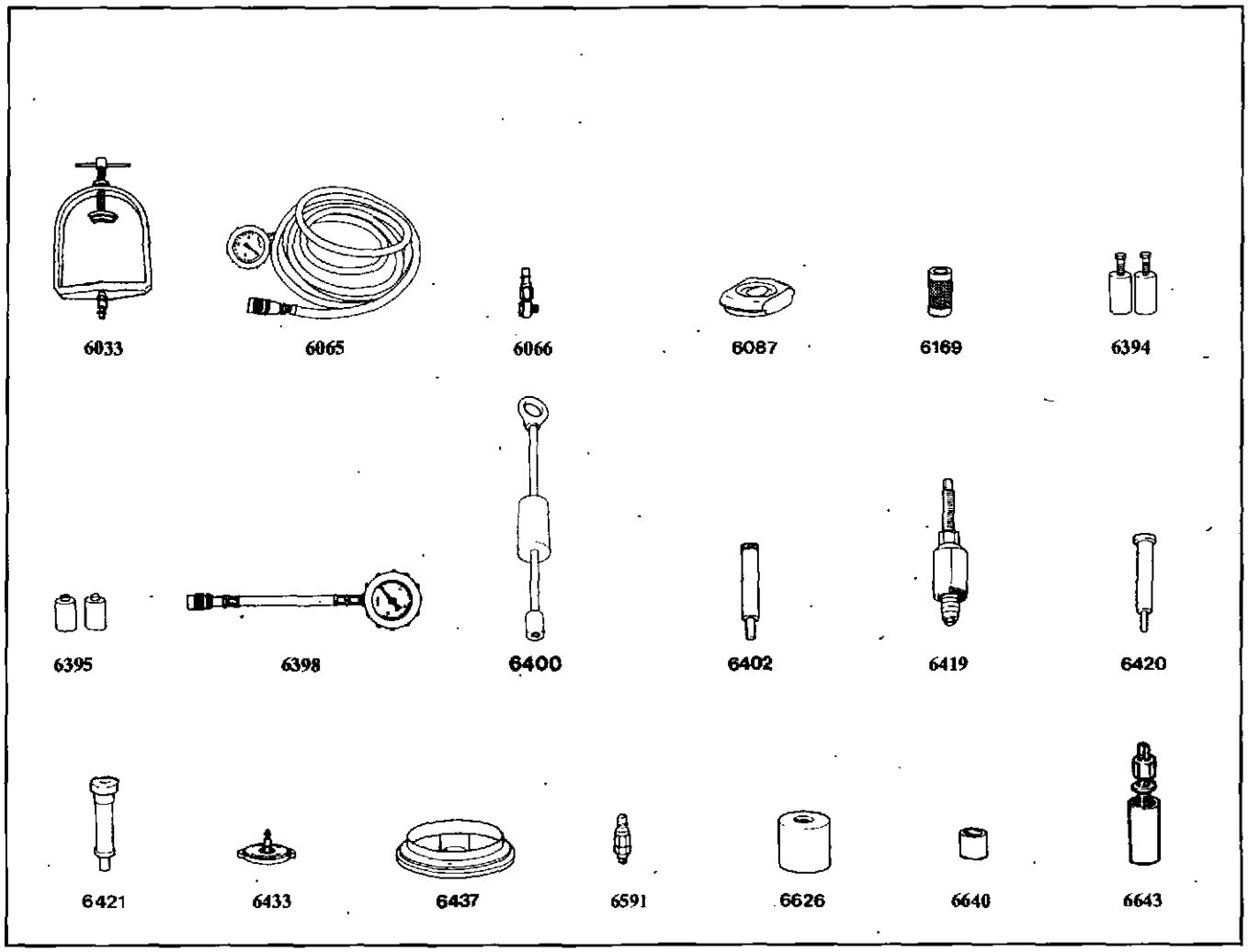
Tools

Special tools

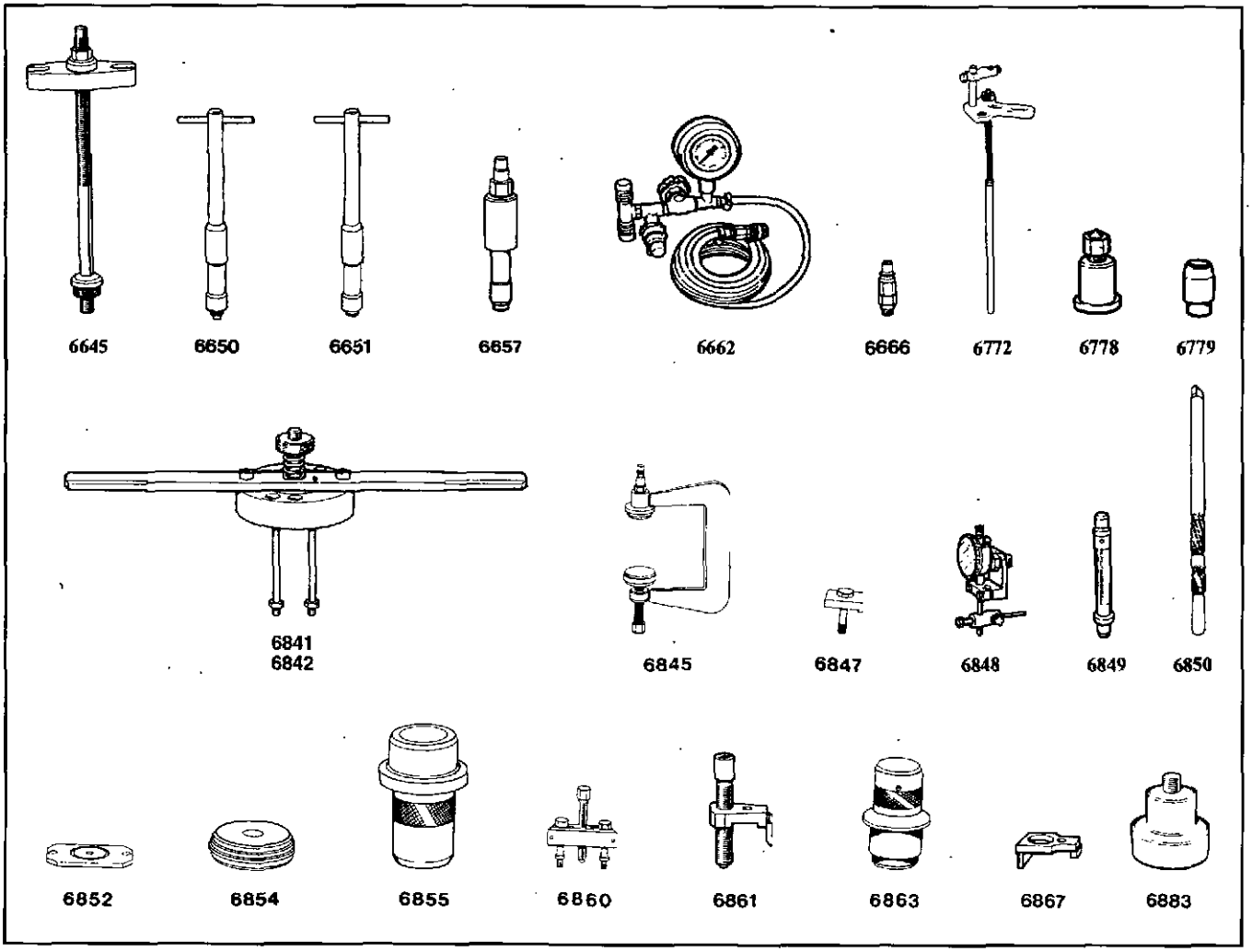
The following special tools are required for work on the engine. The tools are available to order from AB Volvo Penta quoting the appropriate number preceded by 999, e.g. 9991459-0.



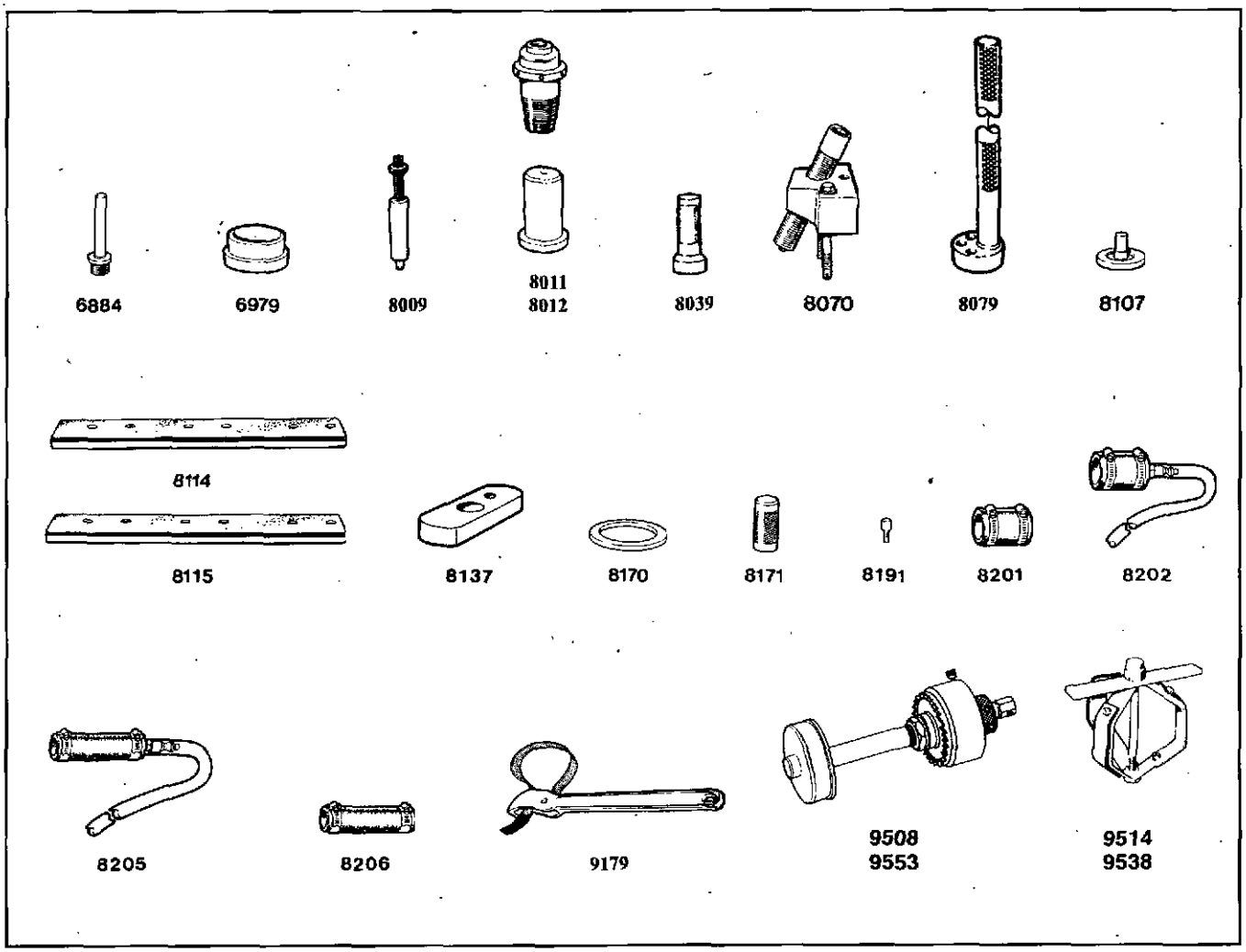
1084-6 Drift for removal of valve guides (71 730,731)
1459-0 Drift for removal of valve guides (610, 630)
1801-3 Standard handle for drifts
1819-5 Extractor for flywheel bearing (610, 630)
1821-1 Puller for flywheel bearing (710,730,731)
1867-4 Drift for changing rocker arm bushing (61 630)
2000-1 Standard handle for drifts
2013-4 Drift for fitting flywheel bearing (Mobile)
2071-2 Drift for gudgeon pin and coolant pump
2178-5 Plate for removal of cylinder liners (71 730,731)
2268-4 Drift for overhauling coolant pump
2479-7 Holder for dial indicator
2564-6 Drift for fitting flywheel bearing (Stationary)
2584-4 Drift for overhauling coolant pump
2655-2 Puller for polygon hub
2658-6 Puller for crankshaft gear wheel
2661-0 Drift for fitting valve guides (710,730,731)
2669-3 Drift for changing gudgeon pin bushing
2677-6 Drift for changing rocker arm bushing (710,730,731)
2679-2 Puller for timing gears (710,730,731)
3590-0 Cranking tool for flywheel
4034-8 Drift for overhauling coolant pump
4090-0 Extractor for overhauling coolant pump



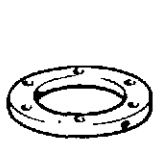
6033-8 Pressure tester for oil cooler (610, 630)
6065-0 Pressure gauge for checking pressure
6066-8 Nipple for checking pressure
6087-4 Plate for removal of cylinder liners (610, 630)
6169-0 Drift for fitting valve guides (630, 730,731)
6394-4 Spacer for removing cylinder liners
6395-1 Spacer for removing cylinder liners
6398-5 Pressure gauge for checking lubricating oil pressure
6400-9 Slide hammer. Can be used together with 6410 and 6657
6402-5 Drift for changing copper sleeves, injectors
6419-9 Extractor for changing copper sleeves, injectors
6420-7 Drift for changing copper sleeves (710, 730,731)
6421-5 Drift for changing copper sleeves (610, 630)
6433-0 Adapter (cap). Used together with 6662
6437-1 Drift for changing rear crankshaft seal
6591-5 Nipple for checking lubricating oil pressure
6626-9 Hollow drift for overrhauling coolant pump
6640-0 Drift, used together with puller 8011 (730,731)
6643-4 Extractor for injectors



6645-9 Extractor for cylinder liners
6650-9 Cleaning tool for copper sleeve seat
6651-7 Cleaning tool for copper sleeve seat
6657-4 Extractor for copper sleeves, injectors
6662-4 Pressure testing equipment, cooling system
6666-5 Nipple for checking boost pressure
6772-1 Measuring tool for checking camshaft wear
6778-8 Pressing tool for fitting sealing ring, output shaft of pump drive (710)
6779-6 Puller for sealing ring, output shaft of pump drive (710)
6841-4 Milling tool (610, 630)
6842-2 Milling tool (710, 730,731)
6845-5 Leakage testing equipment for flat type oil-cooler
6847-1 Pressing tool for cylinder liners
6848-9 Tool for setting injection pump
6849-7 Drift for changing bushings in lube oil pump
6850-5 Reamer for lube oil pump
6852-1 Connecting plate for leakage check, cylinder-heads
6854-7 Pressing plate for cylinder liners
6855-4 Hollow drift for sealing ring, polygon hub
6860-4 Puller for lube oil pump drive
6861-2 Pressing tool for steel ring and copper sleeve (710, 730,731)
6863-8 Drift for changing sleeve thermostat seal
6867-9 Backing piece, used together with extractor 6419
6883-6 Adapater for overhauling coolant pump



6884-4 Drift for overhauling coolant pump
6979-2 Ring for overhauling coolant pump
8009-6 Adapter for compression test
8011-2 Puller for sealing ring, output shaft of pump drive (730)
8012-0 Pressing tool for fitting sealing ring, output shaft of pump drive (730,731)
8039-3 Drift for overhauling coolant pump
8070-8 Pressing tool for copper sleeves, injectors (610, 630)
8079-9 Lifting equipment for changing camshaft
8107-8 Drift for overhauling coolant pump
8114-4 Sealing plate for leakage check, cylinder heads (610,630)
8115-1 Sealing plate for leakage check, cylinder heads (710,730,731)
8137-5 Drift for overhauling coolant pump
8170-6 Spacer ring used together with hollow drift 6855 for changing front crankshaft seal (630, 730,731)
8171-4 Drift for fitting valve guides (730,731)
8191-2 Locking bolt for injection pump adjustment (TWD730ME)
8201-9 Sealing plug for oil cooler leakage test (710, 730,731)
8202-7 Hose union for oil cooler leakage test (710,730,731)
8205-0 Hose union for oil cooler leakage test (610, 630)
8206-8 Sealing plug for oil cooler leakage test (610, 630)
9179-6 Tool for removing oil and fuel filter
9508-6 Milling tool for cylinder liner seat (710, 730,731)
9514-4 Expander for rotating cylinder liner (710, 730,731)
9538-3 Expander for rotating cylinder liner (610, 630)
9553-2 Milling tool for cylinder liner seat (610, 630)



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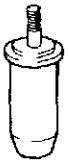

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884 972

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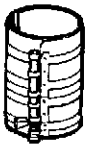

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885 230

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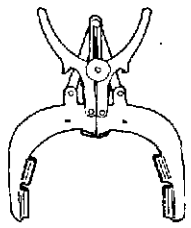
884 872-3 Flange kit, complete for measuring exhaust counter pressure (610, 630)
884 948-1 Pressing tool for fitting crankshaft gear
884 949-9 Fitting tool for polygon hub on crankshaft
884 972-1 Flange kit, complete for measuring exhaust counter pressure (710, 730,731)
884 985-3 Drift for removing impeller with shaft for coolant pump
885 126-3 Piston ring compression tool
885 230-3 Connection nipple for boost pressure checking
885 231-1 Connection washer for leakage check, charge air cooler (TAD-engines)
885 232-9 Sealing washer for leakage check, charge air cooler (TAD-engines)
981 2546-1 Brusch for cleaning bottom of copper sleeve
998 8539-4 Compression gauge

Other special equipment

Like the preceding special tools the following are available to order from AB Volvo Penta specifying the appropriate Part number.



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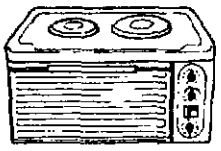

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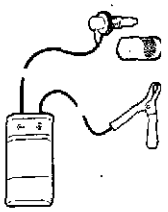

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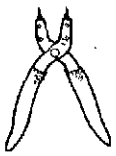

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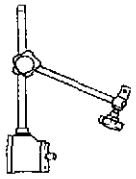
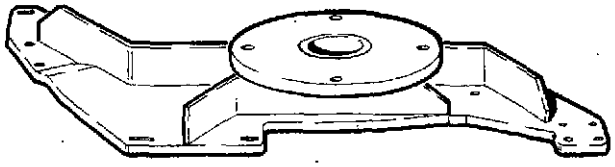
999 9683



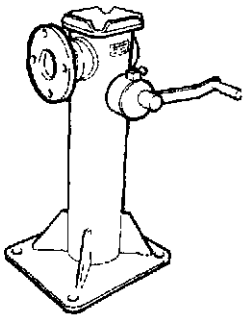
999 9696

998 5423-4 Piston ring tool
998 6981-0 Oven 220 V
998 6982-8 Oven 380 V
998 7057-8 Measuring instrument
998 8183-1 Circlip pliers

998 8460-3 Tachometer
998 9876-9 Dial indicator
999 9683-7 Dial indicator
999 9696-9 Magnetic stand



999 6878

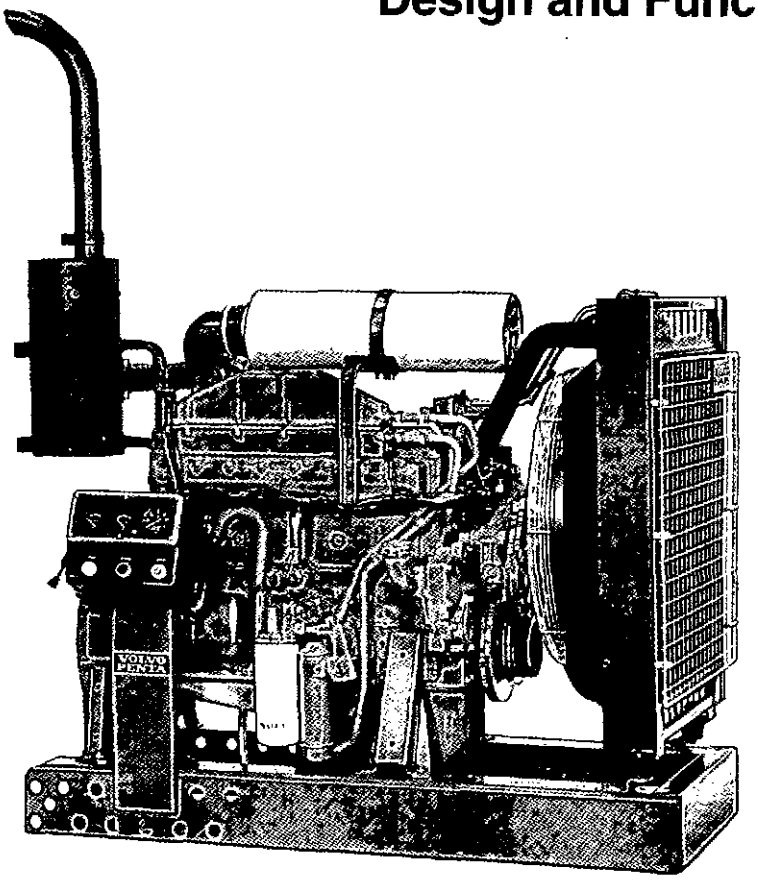


998 6485

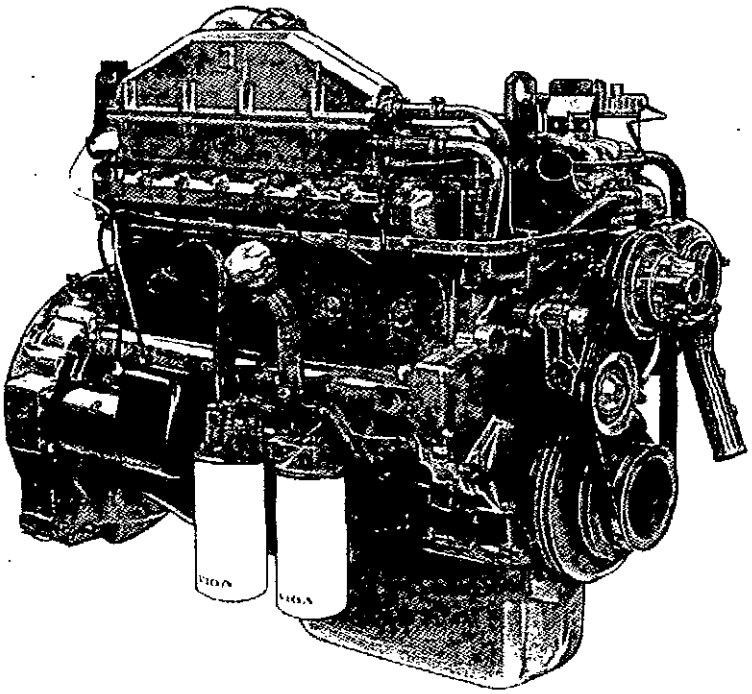
999 6878-6 Engine fixture

998 6485-2 Overhaul stand

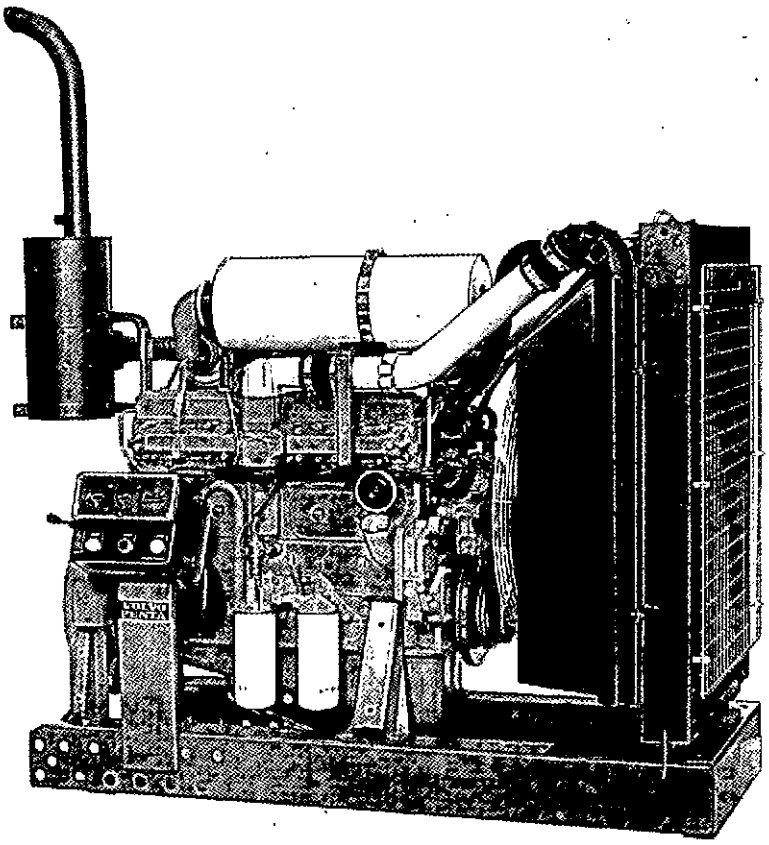
Engine
Design and Function



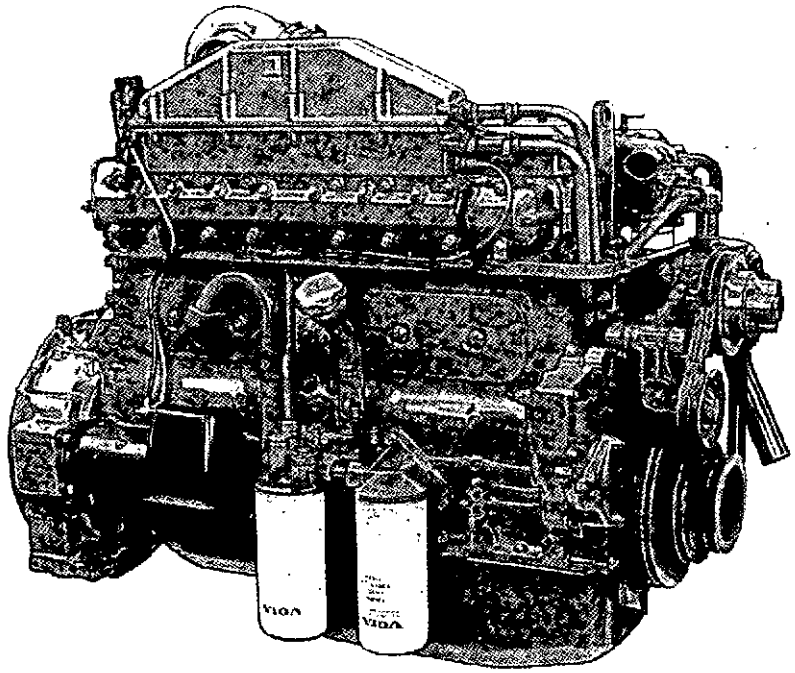
TWD 610 P



TWD 630 ME



TAD 730 P



TWD 730 ME

6- and 7-litre engines

All variants of the engines, except TD630ME and TD730ME, are charge-air cooled intercooler engines.

The TWD variants have a water-to-air charge air cooler, and the TAD variant has an air-to-air charge air cooler.

TWD630ME and TWD730ME have an injection timing adjuster.

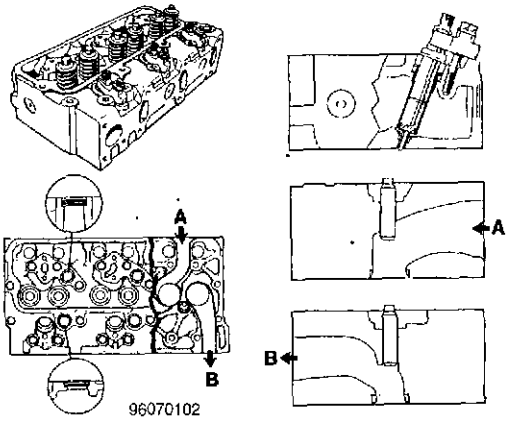
Cylinder heads

The engines have two cylinder heads, each covering three cylinders.

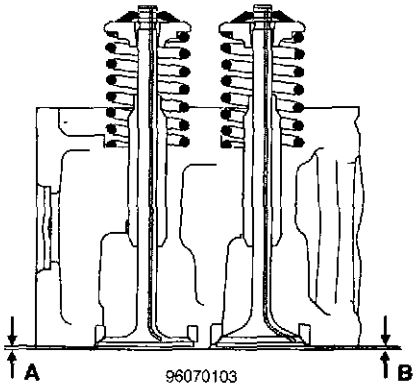
Each cylinder head is held by 20 bolts evenly distributed around the cylinders.

Each cylinder has separate inlet port **(A)** and exhaust port **(B)**.

To meet legislated exhaust emission requirements, the position of the injectors relative to the pistons of the 630, 730 and 731 engines is extremely exact. For this reason, the copper sleeve seats must not be milled nor the cylinder head face ground.



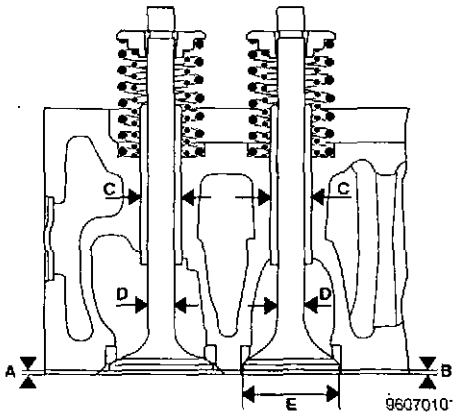
610- 630 engines



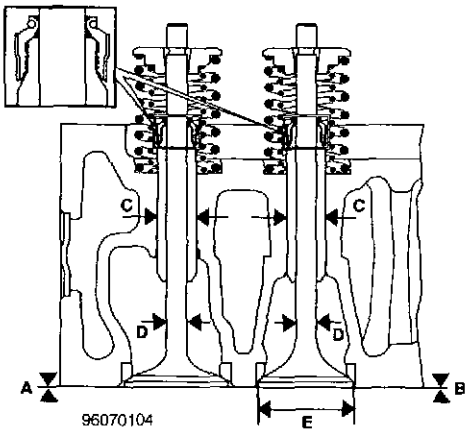
Valves

The illustrations and tables show the differences between the engines when it concerns the valves.

710-engines



T(W)D730- 731 engines



	A	B	C	D	E
610	0.7-1.1	0.7-1.1	-	-	-
630	0.0-0.4	0.0-0.4	-	-	-
710	2,0-2,4	1,0-1,4	18	11	37
TAD730	0±0.2	0±0.2	18	11	37
T(W)D730,731	0-0.4	0-0.4	16	8	39

Cylinder block/cylinder liners

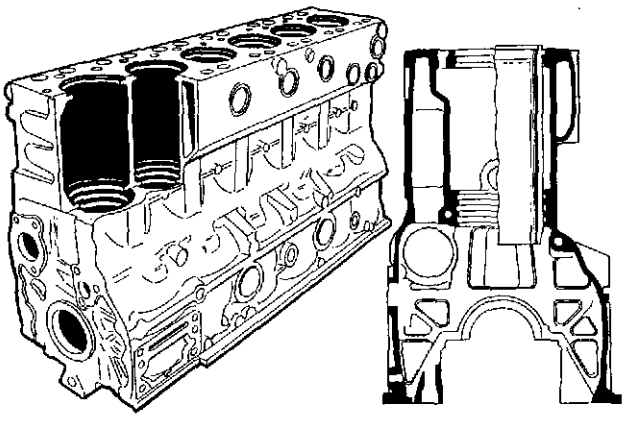
The engines have cylinder blocks with wet, replacable cylinder liners.

The sides of the blocks are bulged round each cylinder and incorporate reinforcing ribs to give a very stiff cylinder block.

The three sealing rings around the bottom of each cylinder liner seal it against the block.

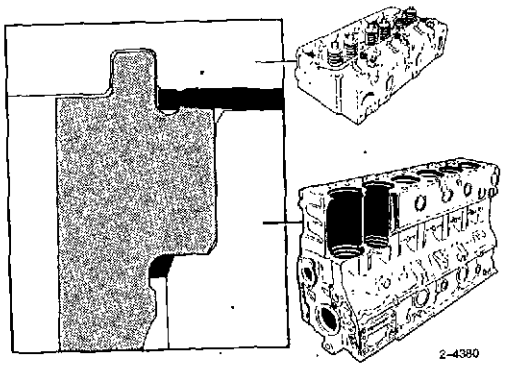
The cylinder liners are plateau honed, which results in lower oil consumption during the running-in period.

The top face of the 630-, 730- and 731-engines must not be ground since this would reduce the distance between piston crowns and valve heads, the ends of the injectors would also come too close to the piston crowns, and effect the emission levels.



Seal arrangements

The seal between the cylinder block, cylinder liners and cylinder heads consists of a steel gasket and grooves combined with a flame barrier.



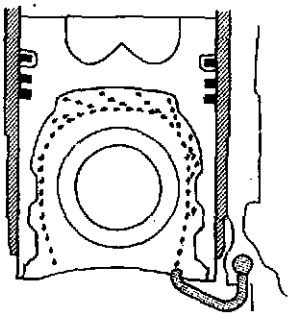
Pistons

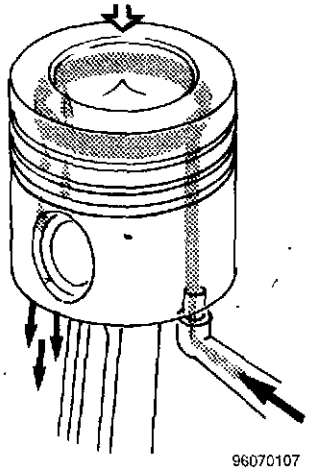
The pistons are made of aluminium alloy and are fitted with two compression rings and one oil ring.

The upper compression ring is located in a special-alloy cast-iron ring carrier integrally cast into the piston. This gives the piston ring groove a long life, despite the heat stresses.

630-, 730- and 731-engines have a upper ring of type "Keystone" which gives an improved sealing to the liner.

All engines, except 610 and TD630 are fitted with piston cooling. The 710-engine has a circular space inside the upper section of the piston in which oil flows to cool the piston. On 730-, 731-engines and TWD630 oil is sprayed on the inside of the upper section of the piston.





Fuel delivery pipes 630,730 and 731

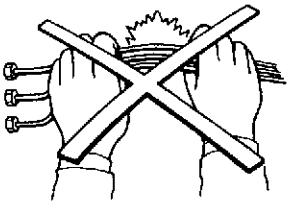
The new pipes are prestressed (except on TD630) which means that they should not be bent or deformed under any circumstances.

Should a delivery pipe become bent or deformed, there is a considerable risk of the pipe fracturing.

A damaged delivery pipe must be replaced.

When changing an injector or the injection pump, the entire pipe assembly must be removed.

Fuel delivery pipes from other engine versions must not be used on 630-, 730- or 731-engines.



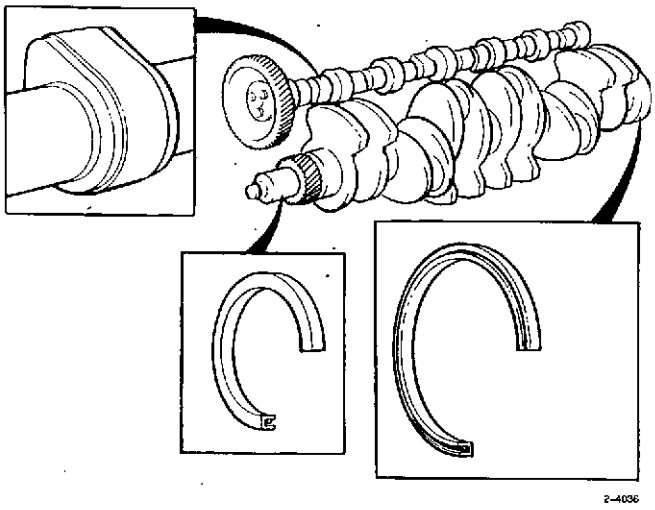
Crankshaft/camshaft

The 7-bearing crankshaft is drop-forged and hardened by nitro-carburization.

The front and rear crankshaft seals consist of rubber sealing rings.

The little-end of the connecting rods is trapezoidal.

The camshaft is drop-forged and induction hardened. The cams are profile ground.



2-4036

Timing gears 610, 710

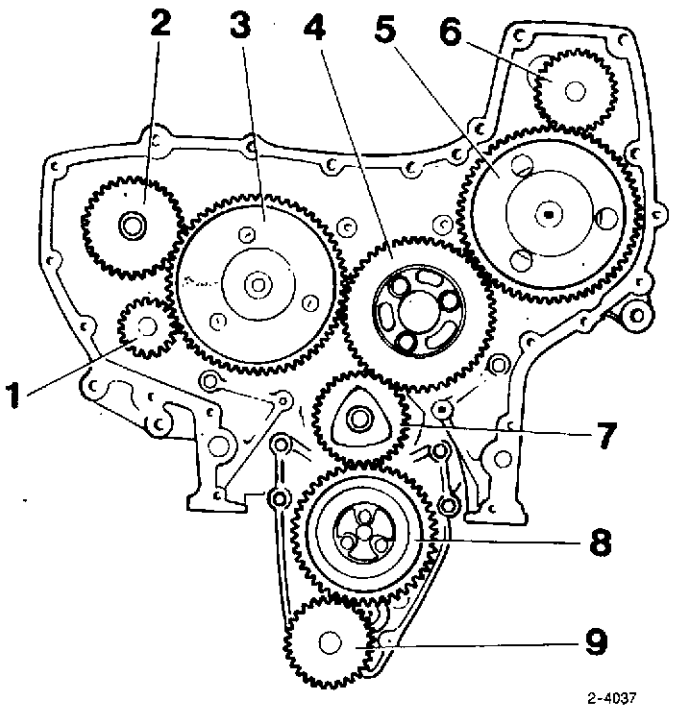
Three different types of surface treatment methods are used for timing gears: case hardening, hardening and tempering and nitro-carburization.

See instructions concerning "nitro-carburized timing gears" before changing any gear wheels.

Timing gears 630, 730 and 731

Two different types of surface treatment methods are used for timing gears: case hardening and nitro-carburization.

The injection pump drive gear does not have any markings to line up with the idler gear (TD630 has markings).



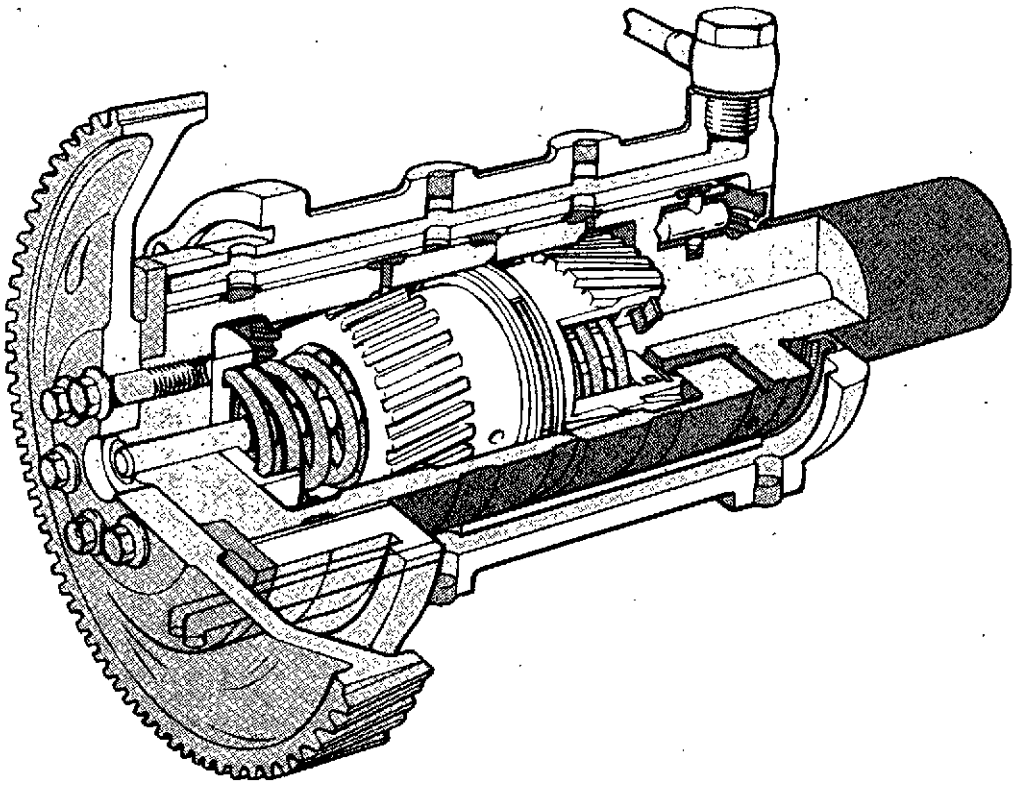
2-4037

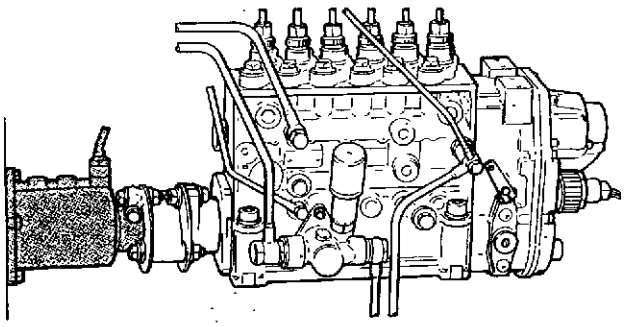
1. Servo pump drive (option)
2. Compressor drive (option)
3. Camshaft drive
4. Idler gear
5. Injection pump drive
6. Coolant pump drive
7. Crankshaft drive
8. Idler gear
9. Engine oil pump drive

Injection timing adjuster

(TWD630ME, TWD730ME)

The injection timing adjuster is fitted to the timing gear casing and its purpose is to vary the injection angle, depending on engine speed.
The injection pump timing gear is fitted to the front flange of the adjuster and the rear flange is connected via a coupling to the injection pump drive shaft.





Service Procedures

Always wash the engine before commencing repairs.

Engine fixture, attachment

Fixture 6878 is used to attach the engine to the overhaul stand.
The fixture is bolted to the right-hand side of the engine according to the sketch below.

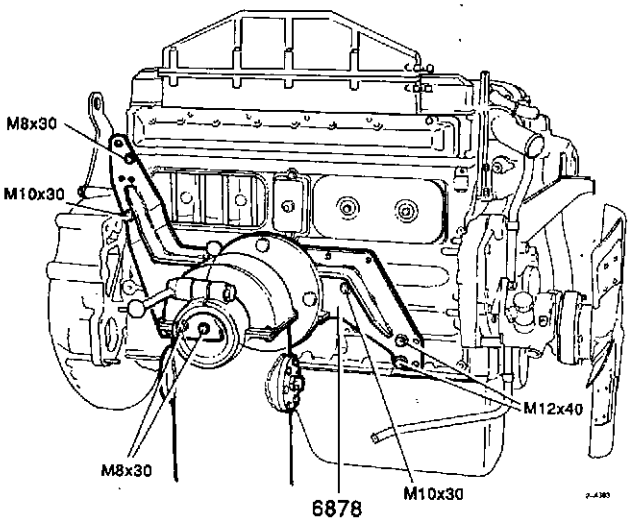
NOTE! It is important that the directions for fitting the fixture to the engine are followed, both where it concerns the number of bolts and bolt dimensions.
Bolts required for 610- and 630-engines:

Three M8x30 mm
Two M10x30 mm
Two M12x40 mm

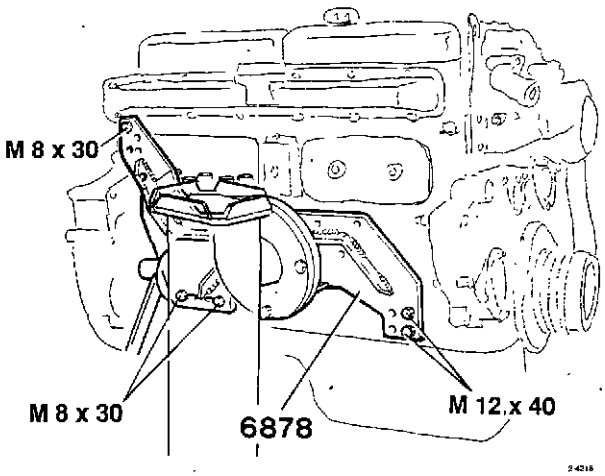
Bolts required for 710-, 730- and 731-engines:

Three M8x30 mm
Two M12x40 mm

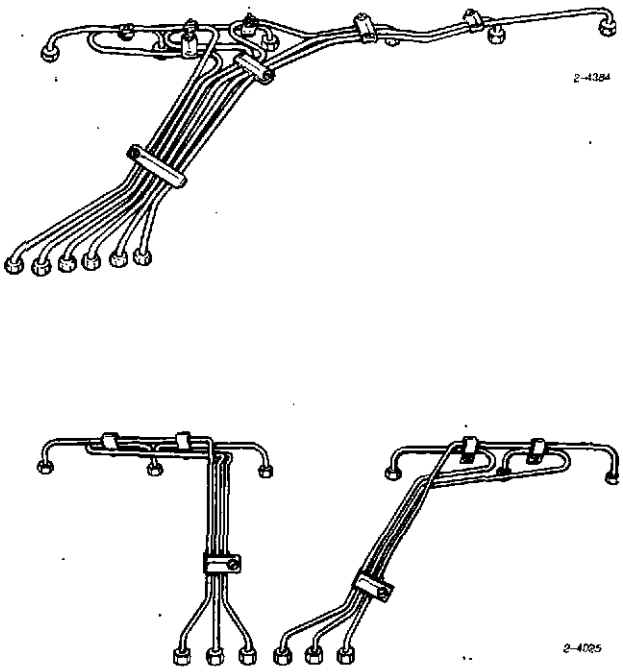
610- and 630-engines



710-, 730- and 731-engines



Fuel delivery pipes



The 630-, 730- and 731-engines (except TD630) are fitted with prestressed fuel delivery pipes. They must not under any circumstances be bent or deformed.

Should a prestressed delivery pipe be bent or deformed, there is a consederable risk of the pipe fracturing.

A damaged delivery pipe must always be replaced.

When removing an injector or the injection pump, the entire pipe assembly must be removed.

Do not remove the pipe assembly clamps, remove the pipes three and three if they are clamped together.

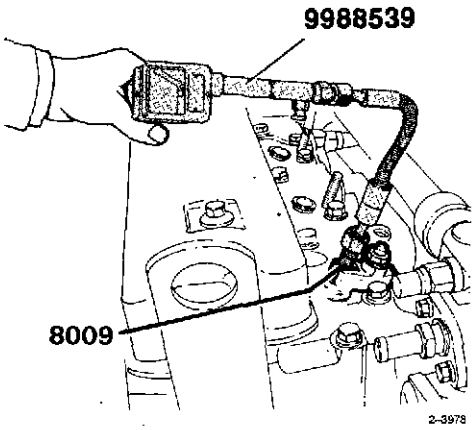
If the complete pipe assembly is clamped together, do not remove the clamps but instead remove the complete pipe assembly.

Compression test

(Injectors removed)

Special tools: 8009, 9988539

1



Fit adapter 8009, attaching it with the injector retainer and nut.

2

Connect the compression gauge and carry out a compression test.

Cylinder head, removing

Special tools: 6643, 6847 (two)

Note! When removing the turbo-compressor the hose at the inlet side should be loosened at the hose-clamp, **not at the V-clamp!**

1
Remove the battery's earth connection.

2
Drain the coolant.

3
Close the fuel cock/cocks.

4
Remove air filter, fuel filter, thermostate housing and required tubes, hoses and cables.

5
Remove exhaust pipe and silencer (if fitted).

6
Remove the turbo-compressor together with the exhaust manifold.

7
Remove the inlet manifold.

Note! TWD-engines: Let the charge air cooler remain mounted on the inlet manifold and remove them as a unit.
Note! TD/TAD-engines: Let the pre-heater remain mounted on the inlet manifold.

8
Dismantle the injectors. (If great care is taken not to damage the injector nozzles, the cylinder heads can be removed with the injectors in place.) Remove the yoke and rotate the injector using a wrench (PU-15) pulling it upwards at the same time. If the injector will not come out, use puller 6643. This prevents the copper sleeve from coming up.

9
Remove the valve covers. Unscrew the bolts attaching the rocker arm bearing brackets and remove the rocker arm mechanism and the push-rods.

10
Remove the cylinder head bolts and lift off the cylinder heads. Remove the cylinder gaskets, rubber seals and their guides from the block.

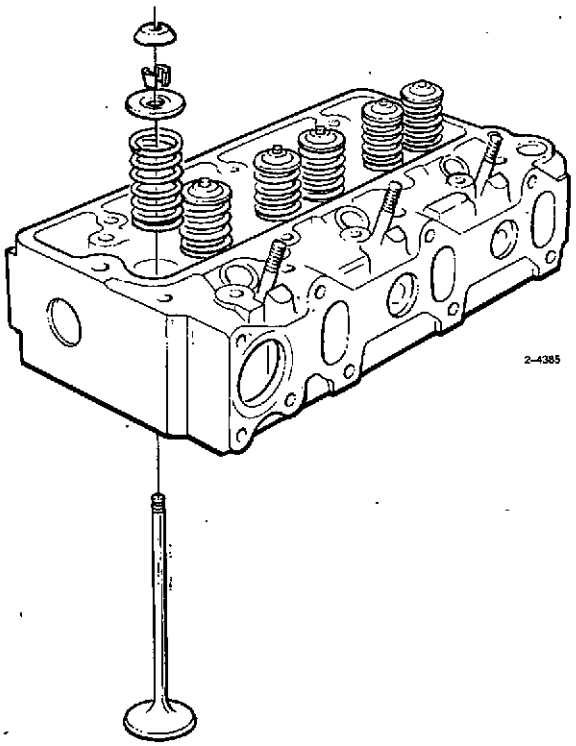
Note! For work where the crankshaft must be rotated in the engine with the cylinder head removed, hold the cylinder lines in place by using press tool 6847. One tool per cylinder liner is sufficient. When measuring the liner height, however, two tools must be used.

Cylinder head, disassembling/assembling

Disassembling

1
Remove the valve caps (710,730, 731), oil seals, valve collets, washers, springs and valves.
Note! Use a valve spring tool to compress the springs when removing the valve collets. Place the valves on a valve rack in the order they were fitted in the engine.

2
Clean all parts, taking particular care with the oil and coolant drillings.



Assembling

1
Oil the valve stems and fit the valves. Make sure that the valves are refitted in the order which they were removed.

2
Fit the valve springs and spring washers. Compress the springs with a valve spring tool and fit the collets.

TWD730ME: Fit the oil seals on the valve guides before fitting the springs.

3 (610, 630, 710)
Fit new oil seals

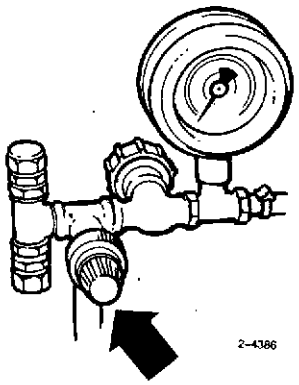
3 (710, 730, 731)
Fit the valve caps.

Cylinder head, leakage check
(Cylinder head removed)

Special tools: 6662, 6852, 8114 (two) (610, 630), 8115 (two) (710, 730, 731)

Before using the pressure tester, it should be checked.

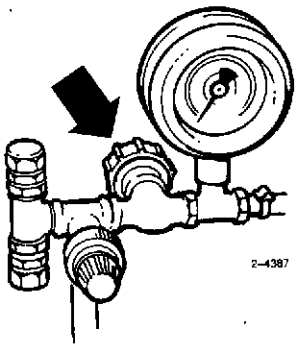
1



Connect the pressure tester to the workshop air supply and set the pressure gauge to **100 kPa (14.50 psi)** with the help of the reduction valve.

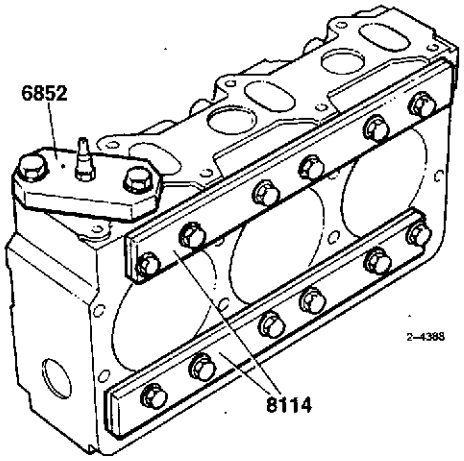
Note! To lock the reduction valve knob, move the lock ring axially.

2



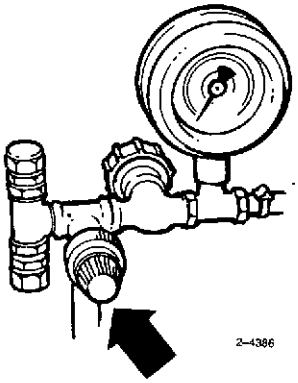
Shut off the valve. The pressure must not drop during two minutes otherwise the gauge cannot be relied upon.

3



Attach the air connection plate 6852 using two M10 bolts and sealing plates 8114 (610, 630) or 8115 (710, 730, 731) using 12 M10x120 mm bolts and nuts.

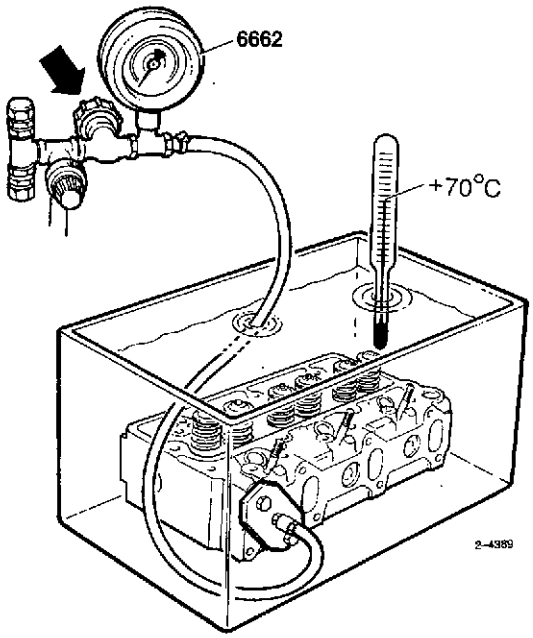
4



Make sure that the reduction valve knob on the testing equipment is unscrewed.

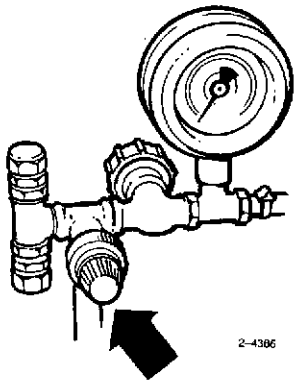
5
Connect the hose from the pressure testing equipment to the air connection plate.

6



Submerse the cylinder head in a container holding 70°C (158°F) warm water and open the knob.

7

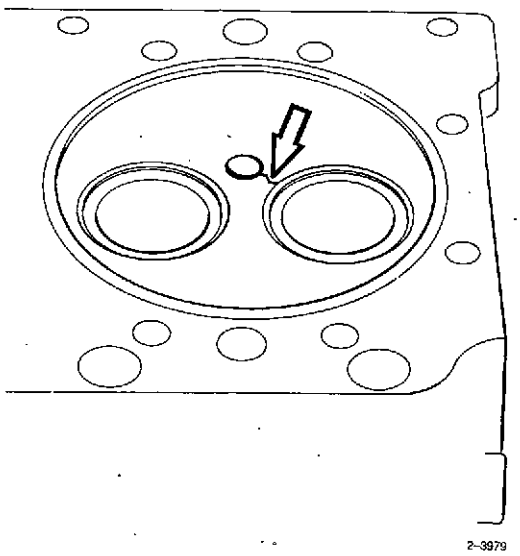


Screw in the reduction valve knob until the gauge shows a reading of **50 kPa (7.25 psi)**. Maintain this pressure for 1 minute.

8

Now increase pressure to **150 kPa (21.75 psi)**. Secure the reduction valve knob with the lock ring and close the shut off valve knob. After one or two minutes, check if the pressure has dropped or if there are bubbles of air in the water container.

Cylinder head, inspection



When overhauling engines with high mileage or long running time, an inspection of the cylinder head might disclose thermal stress cracks between the valve seats and the injector holes.

The cylinder head does not need to be replaced or scrapped because of these heat cracks, if there is no leakage found after pressure testing.

Heat cracks stop after a certain amount of time and experience shows that they have no significance to engine performance.

The cracks initiate at the injector cooper sleeves and extend toward the valve seats.

The reason for this type of crack could be that the injector retainers were overtightened, i.e. wrongly torqued.

Tests have shown that cracks of this type never cause gas or coolant leakage since the cracks do not extend down through to the bottom of the cylinder head.

When leakage has been found, this has been traced to impurities or damage on the seat of the copper sleeve. Therefore, overhauling work must include milling of the seat of the copper sleeve using a special tool, see instructions "Copper sleeves for injectors, changing".

Note! The copper sleeve seats on the 630-, 730- and 731-engines must never be milled.

Concerning cylinder heads received through the Volvo Exchange System, these may have thermal stress cracks. The cracks are always checked during remanufacture and if the heads are released they are considered to be of no importance, that is to say the cylinder head is guaranteed fully usable.

Remanufactured cylinder heads showing this type of crack must, therefore, not be returned.

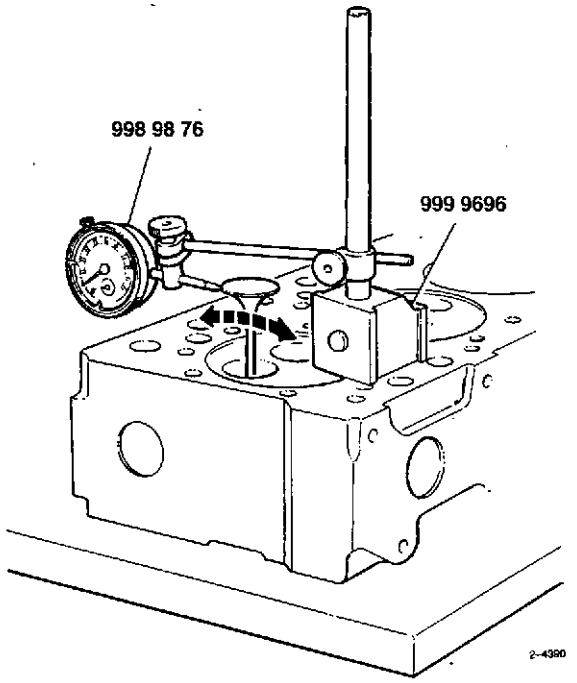
Valve guides, inspection

Special tools: 9696, 9989876

1
Place the cylinder head on a flat surface and fit the new valves into the guides.

The valve stems should rest against the flat surface. If necessary, remove the injector retainer studs in order to obtain good contact.

2



Attach a dial indicator with a magnetic stand so that the dial indicator tip is against the edge of the valve.

Rock the valve in the exhaust and inlet directions. Make a note of the dial indicator reading.

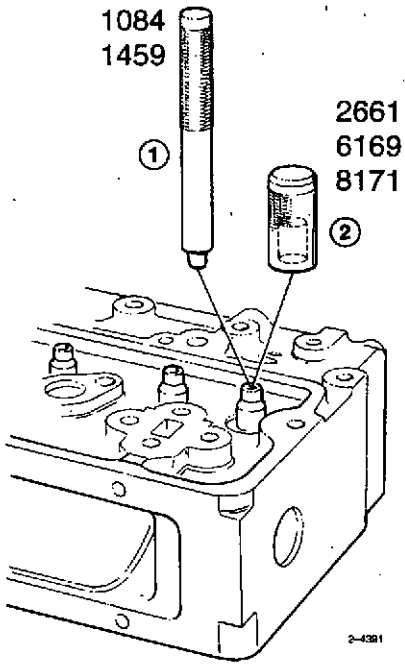
Wear tolerances:
Inlet valve, max clearance **0.33 mm (0.0130")**.
Outlet valve, max clearance **0.38 mm (0.0150")**.

If this values are exceeded the valve guides shall be changed.

Valve guides, changing

Special tools: (610, 630): 1459, 6169
" (710, TAD730): 1084, 2661
" (T(W)D730, 731): 1459, 8171

1



Press out the valve guides using a drift. See "Special Tools".

2
Smear the new guides with oil and press them into place with a drift. See "Special Tools".

The drift automatically gives the correct height of the guide above the cylinder head spring face.

3
Ream the valve guides if necessary.

Cylinder head, face grinding, 610-, 710-engines

(Cylinder heads on 630-, 730- and 731-engines must not be ground)

Special tool: 2479, 998 9876

Cylinder head face unevenness **must not exceed 0.03 mm (0.0012").**

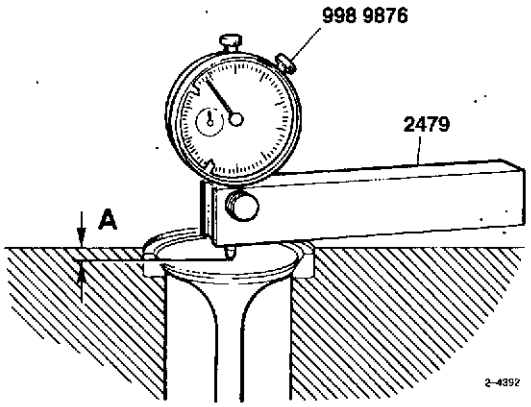
If unevenness exceeds this value, or if blow marks occur, the cylinder head must be face ground (all traces of original grooves must be removed) or changed.

After face grinding, new sealing grooves and flame barrier groove must be machined.

Concerning the cylinder head min. height, see "Workshop Manual, Technical Data".

Surface finish after face grinding must be max. **1.6 RA.**

1



Permissible distance **(A)** between cylinder head face and valve head:

610-engines: Inlet valve **0.7–1.1 mm (0.0276-0.0433")**
Exhaust valve **0.7–1.1 mm (0.0276-0.0433")**

710-engines: Inlet valve **2.0–2.4 mm (0.0788-0.0946")**
Exhaust valve **1.0–1.4 mm (0.0394-0.0552")**

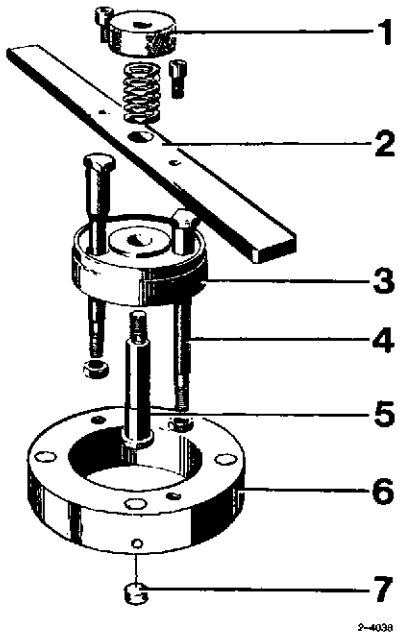
2

If further machining of the cylinder head is required, the valve seats must be milled down.

Cylinder head, milling of sealing grooves, 610- and 710-engines

(Cylinder heads on 630-, 730- and 731-engines must not be milled)

Special tools (610): 2479, 6841
" (710): 2479, 6842



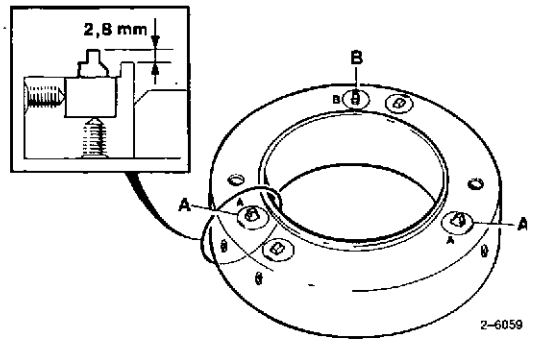
1	Nut	5	Spindle
2	Handle	6	Milling head
3	Guide plate	7	Tool holder
4	Attaching bolt		

Before milling new grooves, the cylinder head must be face ground to remove all traces of original grooves.

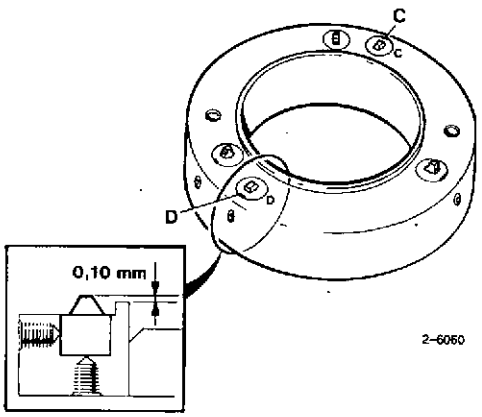
The cylinder head height, and the distance between the face of the valve head and the face of the cylinder head must not be less than that quoted in the specifications.

The groove milling tool is centred by means of the flame barrier groove cutting tool and not by using the guide plate as with other milling tools.

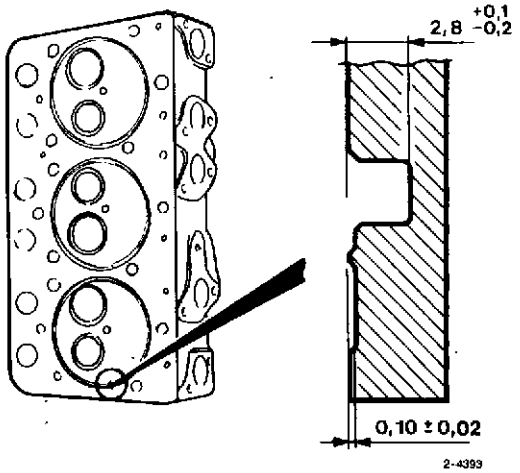
This is the reason why the guide plate attaching bolts have a large clearance relative to the valve guides.



The milling tool has five cutters.
Three of them (marked **A-A-B**) are intended for cutting the flame barrier groove and should be adjusted to **2.8**(+0,1 to -0,2) **mm (0.1103"**(+0,0039 to -0,0079)**).**



The remaining cutters (marked **C-D**) are intended to cut the sealing groove and must be adjusted to **0.10 ± 0.02 mm (0.0039"±0.0008)**.

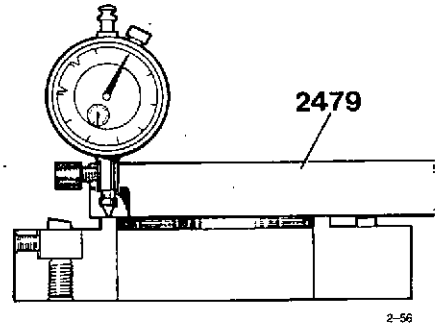


Adjustment of cutter working depth

1
Attach the tool with the cutters facing upwards.
Note! Never place the tool with the cutters facing downwards on a hard surface.

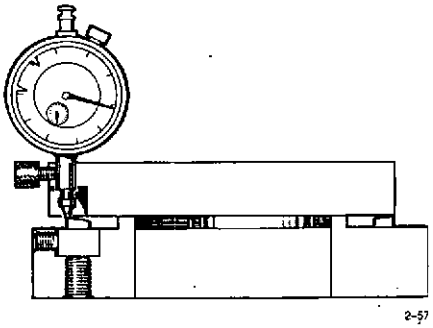
2
Fit the dial indicator to holder 2479 and place the holder over the annular section of the tool.

3



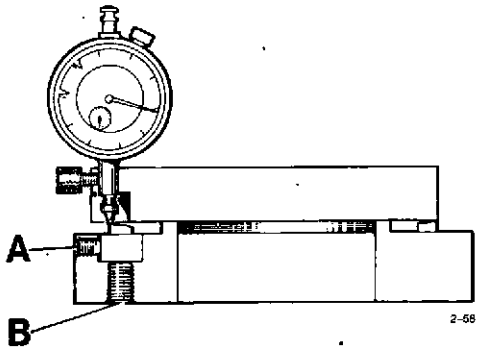
Zero the dial indicator against the annular part of the tool.

4



Push the holder and the dial indicator sideways until the indicator probe is against the highest point of one of the cutters.

5



A. Grub screw
B. Adjusting screw

Slacken grub screw **"A"** using a 4 mm Allen key and also slacken the adjusting screw **"B"** a few turns using a 5 mm Allen key.

6
Push the cutter holder down and turn the grub screw in until it presses against the holder.

7
Put the dial indicator probe against the highest point of the cutter and thread in the adjusting screw until the correct cutter height is reached.

8
Tighten the grub screw.

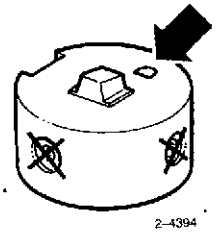
Note! Make sure that the upper face of the cutter holder is level with the milling head. Should this not be the case, the dial indicator must have been spun a complete turn too many.

9
Continue with the other cutters, adjusting to the specified cutting depth as per points 3–8.

Changing cutters

1
Slacken the grub screw a few turns and turn the adjusting screw upwards until the cutter holder can be removed from the head.

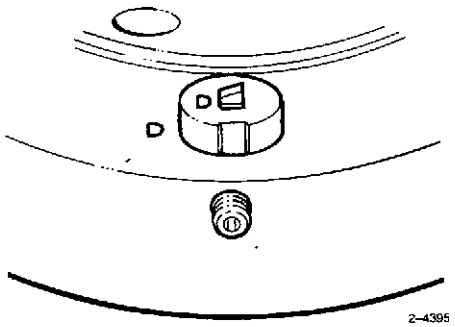
2



The cutter holders are marked with a letter (**A, B, C** or **D**) and the equivalent letter is punched into the cutter head where the cutter holder should be mounted.

Note! The two Allen screws in the steel holder must not be touched.

3



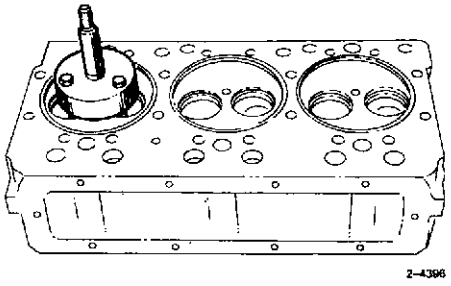
Put the cutter holder into the milling head in accordance with the letter markings and with the groove facing the grub screws. Adjust the cutter height as described previously.

Milling of grooves

1
Secure the cylinder head in a vice.

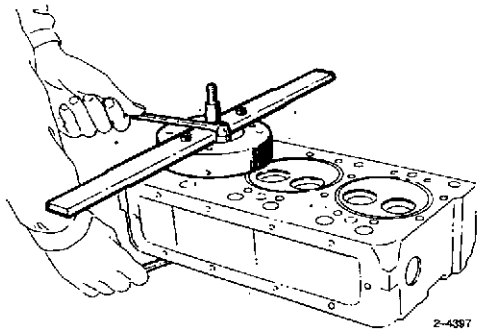
2
Make sure that the cylinder head face is absolutely clean.

3



Fit the tool guide plate to the cylinder head but do not tighten the attaching nuts.

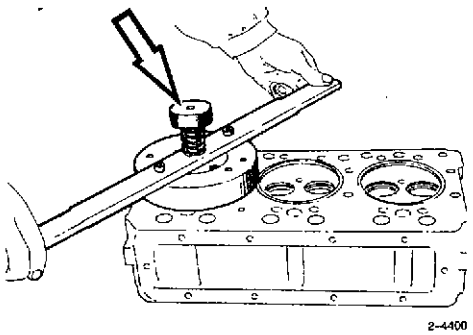
4



Carefully place the milling head on the guide plate, twisting it at the same time so that the tool is centred by the flame barrier groove.

Note! Do not tighten the attaching nuts too much since this could push the valve guides down into the cylinder head.

5



Fit the spring and nut. Loosely tighten the nut.

6
Turn the tool clockwise smoothly and without applying pressure. The cutters will be fed down automatically since the nut moves round, gradually compressing the spring.

7
Turn the tool until the cutter ceases to bite. Then remove the nut and lift off the milling head.

8
Clean the cylinder head thoroughly. Now check the depth of the grooves by putting the milling head back, without spring and nut, and turning it round a few times while pressing with the hand. If the tool does not bite, the grooves are of the correct depth. This check must always be carried out since metal swarf can jam under the milling heads. The edges on the sides of the grooves should be left as they are. Attempts to remove these edges could result in damage to the groove sides and deteriorate the sealing function of the grooves.

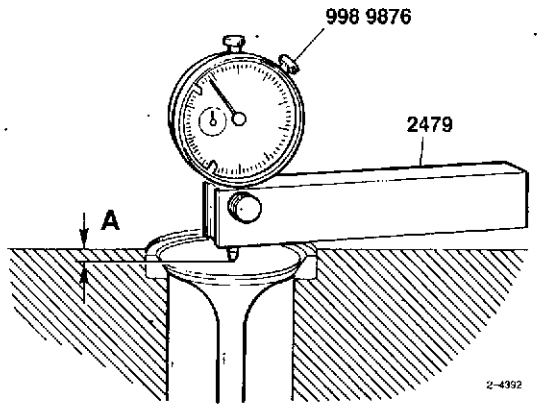
Note! When using a milling tool for the first time after having adjusted the cutters, the finished groove must be check measured using a dial indicator.

To carry out this check, the edges along the sides of the grooves must be carefully removed to ensure that the dial indicator holder is in proper contact with the cylinder head.

Valve seats, changing

Special tool: 2479

1



Valve seats should be changed when the distance **(A)**, measured with a new valve, exceeds the distance specified in "Valve seats, grinding" below or in "Workshop Manual Technical Data".

2
Remove the old valve seat by grinding two diametrical notches in the seat and cracking it with a chisel.

Note! Observe due care so as not to damage the cylinder head.

3
Thoroughly clean the seat location and check the cylinder head for cracks.

4
Measure the diameter of the valve seat location. Check whether a standard size seat or an oversize seat is required. Machine the valve seat location if necessary.

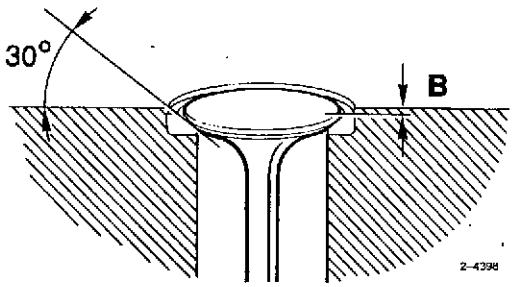
5
Cool the seat in carbon dioxide snow to between **–60°C** and **–70°C (–76°F** and **–94°F)** and warm the cylinder head by hosing it with hot water or in some other equivalent, suitable manner. Press in the seat using a drift. Machine the seat to the specified angle and width.

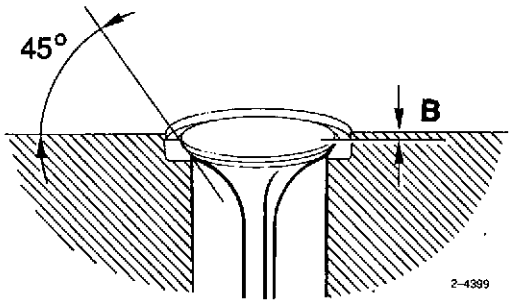
Valve seats, grinding

1
Prior to grinding, check the valve guides and replace them if the wear limits have been exceeded.

Grind the valve seat just enough to give it its correct shape and to ensure good contact.

2





New seats must be ground down until the distance between the cylinder head face and the upper surface of the valve **(B)** measured with a new valve is:

	Inlet valve	Exhaust valve
610	0,7-1,1mm (0,0276-0,0433")	0,7-1,1mm (0,0276-0,0433")
630	0,0-0,4mm 0-0,0158")	0,0-0,04mm (0-0,0158")
710	2,0-2,4mm (0,0788-0,0946")	1,0-1,4mm (0,0394-0,0552")
T(W)D730, 731	0,0-0,4mm (0-0,0158")	0,0-0,4mm (0-0,0158")
TAD731	0,0±0,2mm (0±0,0079")	0,0±0,2mm 0±0,0079")

3
Check the angle with a valve seat gauge after smearing the seat contact surface with a light coating of marking ink.

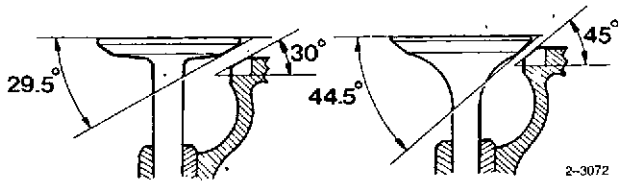
Valves, grinding

Valve sealing surface angles:

Inlet: 29.5°

Exhaust: 44.5°

1



Inlet **Exhaust**

Rub down the sealing surface as little as possible, just enough to remove any damage.

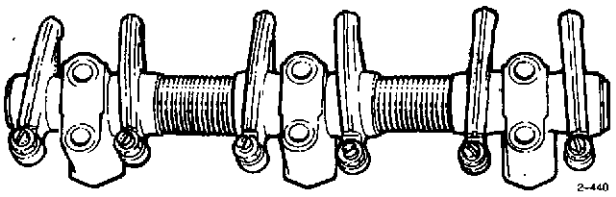
2
If the edge of the valve disc is **less than specified minimum** (see "Workshop Manual Technical Data"), the valve must be changed. Also, valves must be changed if the stems are bent.

3
Check for good sealing by using marking ink.
If leakage is found, re-grind the valve seat, not the valve, and check again.

Rocker arm assembly, overhauling

Special tool: 1867 (610,630), 2677 (710,730,731)

1



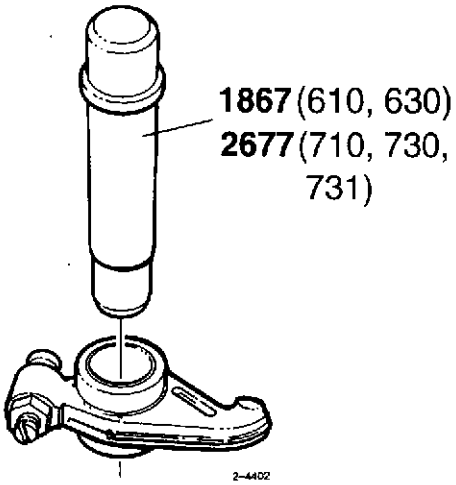
Remove the circlips, the rocker arms, bearing brackets and springs from the rocker arm shaft.

2
Clean all parts, paying particular attention to the oil drilling in the bearing bracket as well as the rocker arm shaft and rocker arm oil holes.

3
Check for wear on the rocker arm shaft and ball pins. The threads on the pins and lock nut must be in good condition. The surface of the rocker arm which is in contact with the valve must not be worn or pitted.

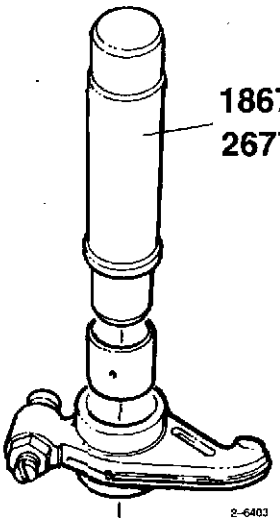
Out-of-round rocker arm bushings must be changed.

4



Press out the bushings using drift 1867 (610, 630), 2677 (710, 730, 731).

5

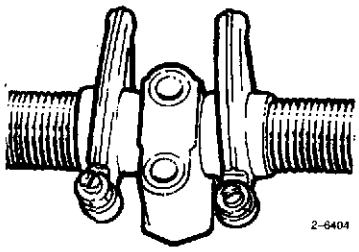


Turn the drift* and press in a new bushing.
Note! Make sure that the oil hole in the bushing coincides with the oil drilling in the rocker arm.

*only 1867

6
Machine ream the bushing.

7



Smear the rocker arm shaft with oil and fit the baring brackets, rocker arms, springs and circlips.
Note that pairs of rocker arms are turned towards each other.

Cylinder head, fitting

(Moments about charged air cooler do not concern TD-engines)

Special tools: 2479, 6847

For tighening torques refer to "Workshop Manual Technical Data".

Fuel and pressure pipes must not be bent or deformed as this can cause cracks and subsequent breakage.

1
Clean the face of the cylinder block. Remove any rust and carbon from the bolt holes using a 9 mm drill (turn it by hand). Clean the threads using a tap, M11x1.5. Remove all loose particles. Measure the height of the cyliner liners above the block face
See "Workshop Manual Technical Data".

2
Smear the faces of the cylinder block and cylinder head with a thin layer of rustproofing fluid (Part No. 282036-3). Fit a new gasket and new sealing rings.

3
If the rear cylinder head has been removed, fit the coolant distribution pipe and the bracket together with new sealing rings.

4
If the front cylinder head has been removed, fit a new sealing ring in the thermostat housing.

5
Lift the cylinder head into position.

6
Check the cylinder head bolts.

Note! The bolts are phosphated and must not be cleaned with wire brush. If there are cut marks under the screw heads or in the threads they shall be replaced with new.

Dip the cylinder head bolts into rustproofing fluid. Then place the bolts on a piece of wire mesh to drain off.

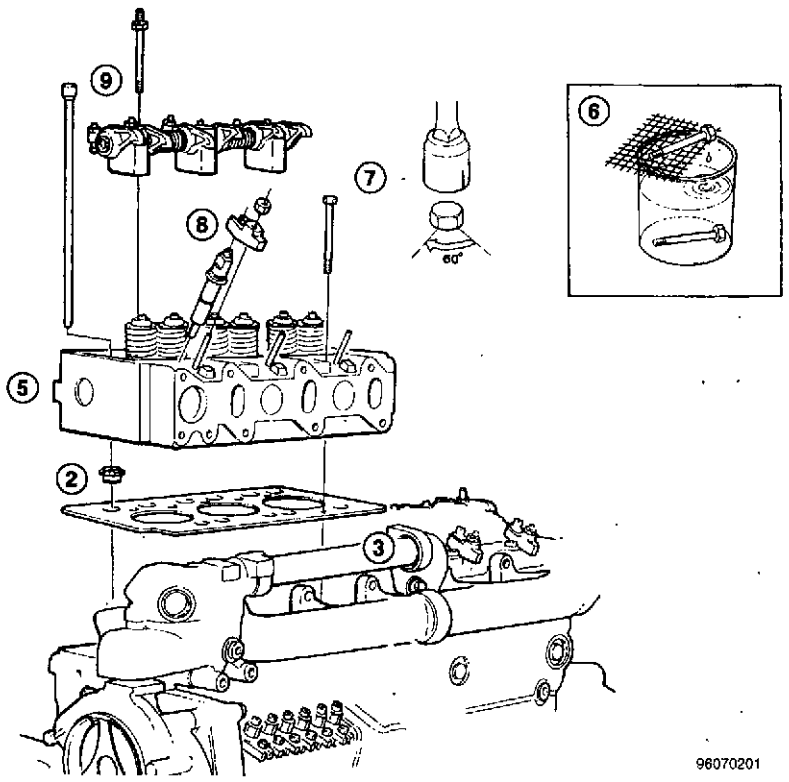
7
Fit the bolts to the cylinder head and tighten them in the specified order and in four stages. See "Workshop Manual, Technical Data.

8
Fit the injectors and torque-tighten the injector retainers.

9
Fit the push rods in the correct order and fit the rocker arm assembly.

Torque-tighten the bolts and adjust the valves.

Figures in the illustration are referred to in the following.



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10
Fit the valve cover (covers).

11
Tighten down the thermostat housing.

12
Fit the exhaust manifold together with new gaskets.

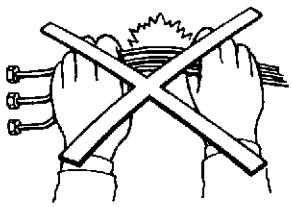
Note! The gaskets should be fitted with the clean metal surface facing the exhaust manifold.

13
Tighten down the turbo with oil delivery and oil return pipes using new gaskets.

14
Fit the temperature sensor.

15
Fit the fuel return pipe. Use new copper washers.

16



Fit the fuel delivery pipes.

Note! The fuel delivery pipes must never under any circumstances be bent or deformed. A damaged fuel delivery pipe must be replaced.
Fuel delivery pipes for 610- or 710-engines must never be used on 630-, 730- or 731-engines.

17
TD and TAD-engines

Apply **approx. 2 mm (1/16")** wide bead of sealant to the inlet manifold. Fit the inlet manifold complete with pre-heater and relay.

TWD-engines

Fit a new gasket. Fit the inlet manifold complete with charge air cooler, pre-heater and relay.

18
Fit the connection pipe between the housing over the charge air cooler and the turbo charger.

Use new seals.

19
Disconnect the oil return pipe from the turbo.

Crank the engine over with the starter motor and with the injection pump at its stop position until a consistent flow of oil comes out of the return oil opening.

20
Re-attach the oil return pipe and check for leaks.

21
Check engine oil level and top up with oil if needed.

Copper sleeves for injectors, changing

Special tools: (610,630): 6421, 8070
(710, 730, 731): 6420, 6821
(all): 6402, 6419, 6643, 6650, 6651, 6657, 6867,

Fuel and pressure pipes must not be bent or deformed as this can cause cracks and subsequent breakage.

Note! The copper sleeves that are fitted to the 630, 730 and 731 engines in production are **approx. 1 mm (0.0394") shorter** than those which are supplied as a spare part.
This means that the new steel ring which is pressed in when changing a copper sleeve will be positioned **approx. 1 mm (0.0394") higher up** in the cylinder head than that which was fitted in production.

1
Clean up around the injectors and pipe connections.

2
Remove the valve covers.

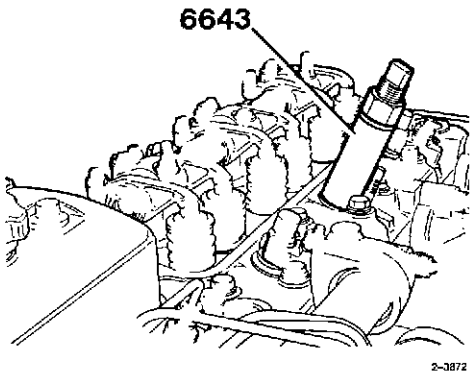
3
Remove the fuel return pipe and plug the ends.

4
Remove the fuel delivery pipes and plug the ends.

Note! Do not remove the pipe assembly clamps, but remove the pipes clamped together.

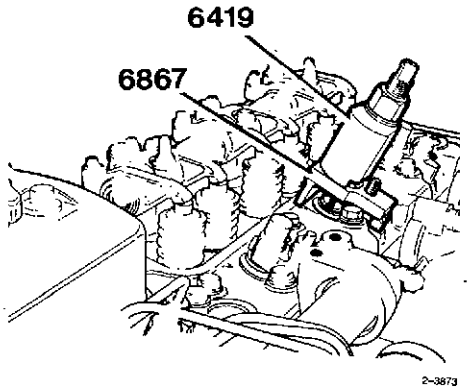
5
Remove the injector retainer and dust cover.

6



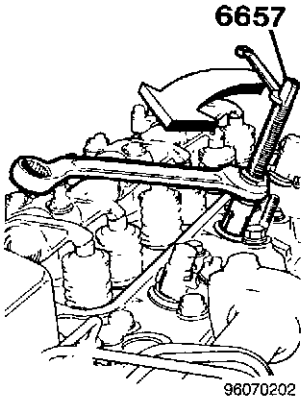
Turn the injector using a 15 mm ring spanner and pulling upwards at the same time.
If required, use extractor 6643.

7



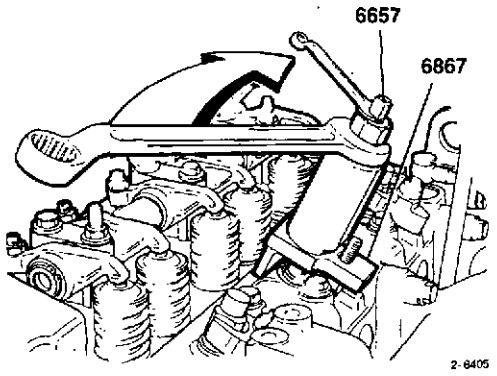
Remove the steel ring with extractor 6419 and backing piece 6867.

8



Extract hte copper sleeve with extractor 6657.
First press the tool spindle to the bottom of the copper sleeve.
Hold the tool in position and turn the spindle anticlockwise until the tool grips the sleeve securely.

9



When the tool has securely gripped the sleeve, fit the backing piece 6867 and fit the tool sleeve on the spindle.

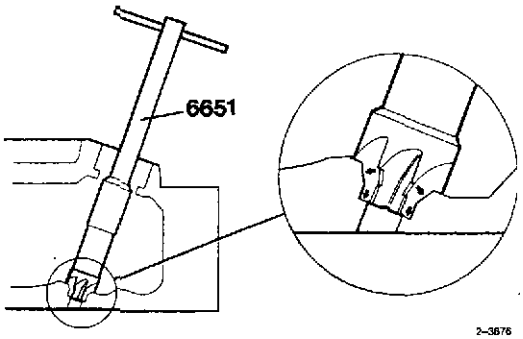
Extract the copper sleeve by turning the nut while counterholding the spindle.

10

Make sure that the lower sealing surface of the copper sleeve in the cylinder head is clean. If it is damaged or coated with deposits, clean it.

Note! The milling tool must not be used on 630, 730 and 731 engines.

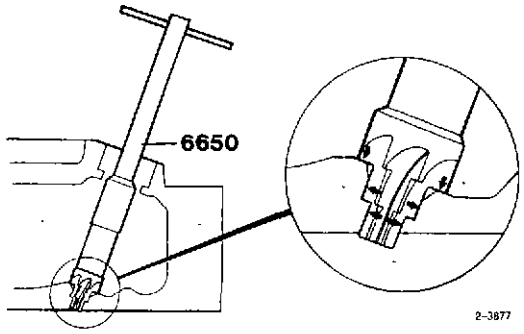
11
Only 610 and 710 engines!



Cleaning is done in two stages. Clean first with milling tool 6651 until it bottoms against the upper face and ceases to cut.

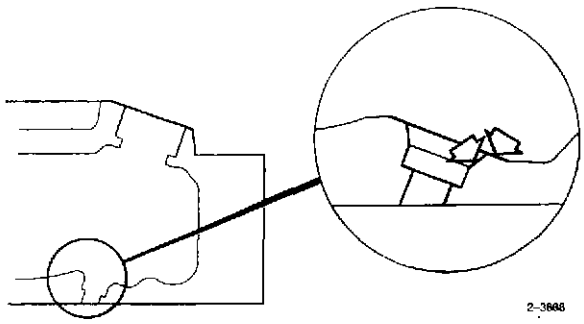
Note! Only clean the sleeve if absolutely necessary since the position of the injector in the cylinder head is altered by each cleaning procedure.

12
Only 610 and 710 engines!



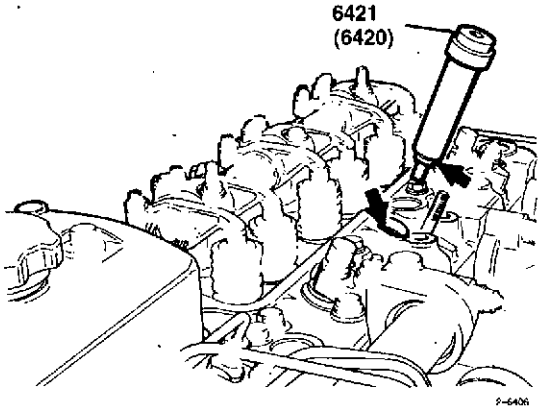
Continue cleaning with milling tool 6650 until it bottoms against the face beneath the cone and ceases to cut.

13
Only 610 and 710 engines!



Check the sealing surfaces.
If necessary, repeat the cleaning operation.
Also check that the location of the upper seal is clean.

14



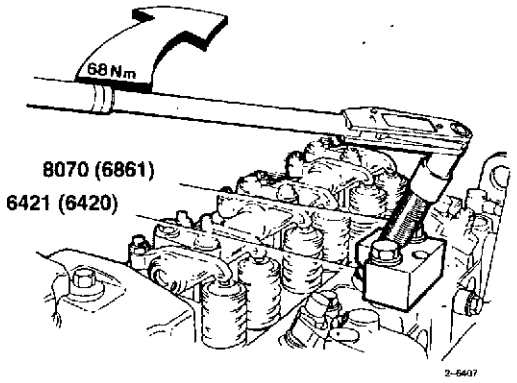
Remove the two cylinder head bolts nearest the copper sleeve.

Smear the upper sealing ring with Vaseline or soapy water and fit it into the cylinder head.

Fit the lower sealing ring to the copper sleeve.

Fit a new steel ring and the copper sleeve to drift 6421 (610, 630) or 6420 (710, 730, 731) and insert the sleeve into the cylinder head.

15

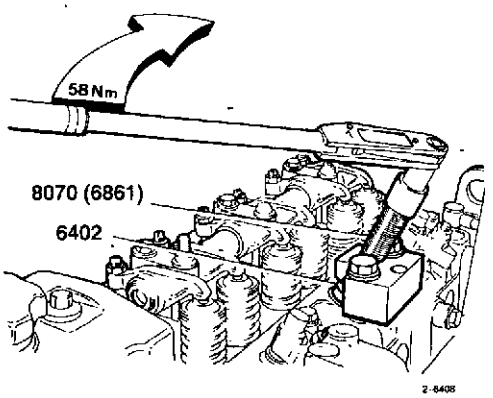


Fit pressing tool 8070 to drift 6421 (610, 630) or 6861 to drift 6420 (710, 730, 731). Press down the steel ring and copper sleeve by turning down the pressing tool at **68 Nm (50.18 lbf.ft)**.

Note! Always change the steel ring and copper sleeve together in order to maintain the correct clearance between ring and sleeve.

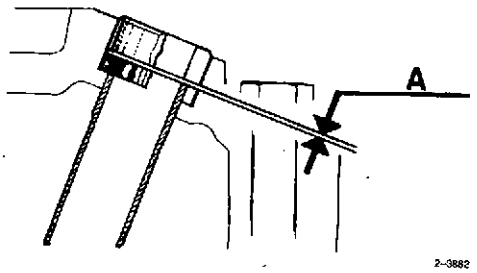
16
Remove the pressing tool and drift.

17



Fit drift 6402 and pressing tool 8070 (610, 630) or 6861 (710, 730, 731) and press down the copper sleeve by turning down the pressing tool at **58 Nm (42.80 lbf.ft)**.

18



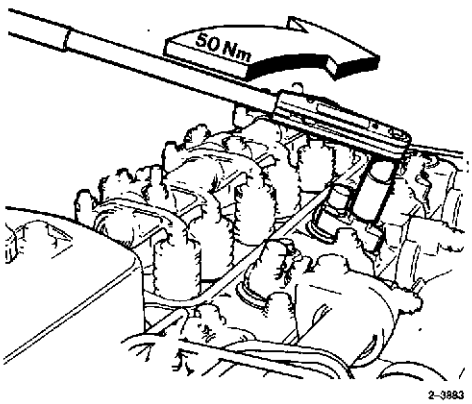
By always using a new steel ring and carrying out the pressing operation in two stages at different pressing forces and using different drifts, the correct clearance is provided between the steel ring and the copper sleeve.

The clearance **(A)** should be **0.10–0.45 mm (0.0039–0.0177")**.

19
Fit the cylinder head bolts and tighten them down alternately in four stages.

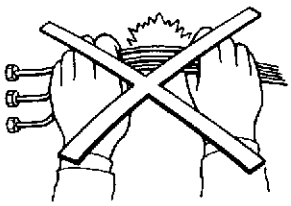
(For tightening torques see "Workshop Manual Technical Data")

20



Fit the injector, dust cover and retainer. Tighten the retainer nut to **50±5 Nm (36.9±3.7 lbf.ft)**.

21



Fit the fuel delivery pipes, the fuel return pipe and valve covers.

Note! The fuel delivery pipes must not under any circumstances be bent or deformed. A damaged fuel delivery pipe must be replaced.

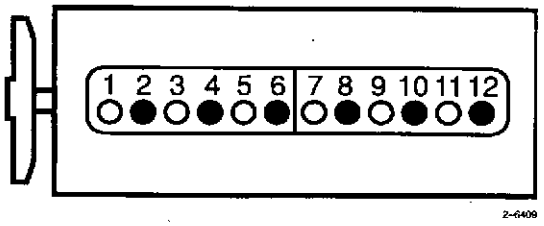
22
Carry out a leakage check.

Valves, adjusting

Special tool: 3590

Position of the valves and valve clearance

- ○ **Inlet 0.40 mm (0.016")**
- ● **Exhaust 0.55 mm (0.022")**



Valve adjustment must only be carried out with the engine cold and switched off.

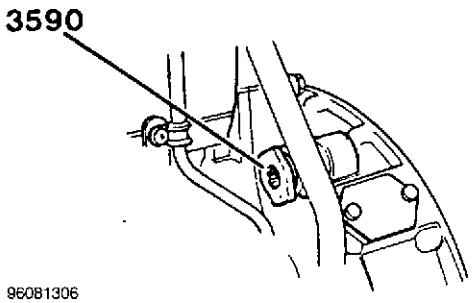
Make sure that any stop control is pulled out and that the starting key is at Off. If the engine has an electromagnetic or air-operated stopping device, make sure that the control on the injection pump is at Stop.

Note! Valve clearance must not be adjusted with the engine running due to the fact that the pistons can hit the valves.

The valves can be adjusted according to the 2-position method.

1
Remove the valve covers.

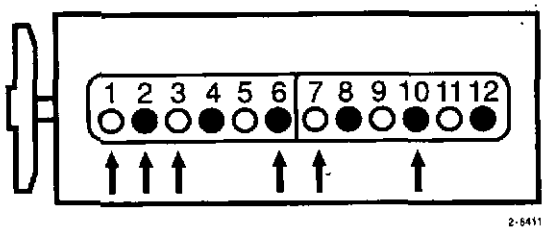
2



Fit cranking tool 3590.

3
Crank the engine round in its direction of rotation until 1st piston is at T.D.C. after compression (0° on flywheel).

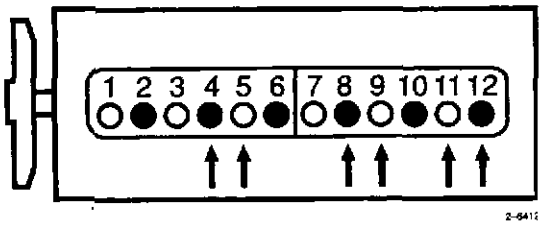
4



Adjust valves: 1, 2, 3, 6, 7, 10.

5
Crank the engine again in the direction of rotation (one complete turn) until 6th piston is at T.D.C. after compression (0° on flywheel).

6



Adjust valves: 4, 5, 8, 9, 11, 12.

7
Change the valve cover gaskets if required and fit the valve covers.

8
Remove the cranking tool.

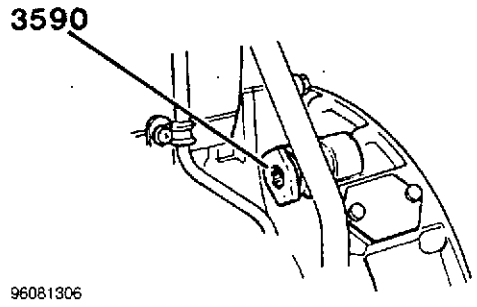
Cylinder liner with piston, removing

(Cylinder head and oil sump removed)

Special tools: 3590, 6087 (610, 630), 2178 (710, 730, 731), 6394 (two), 6395 (two), 6645, 6847 (two)

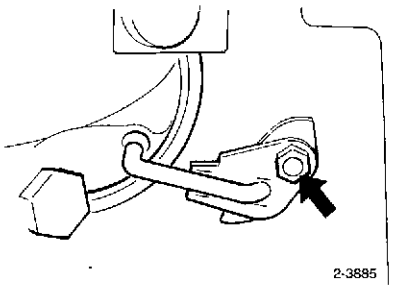
1
Fit the pressing tools on the cylinder liners which are not to be removed.

2



Fit the cranking tool and crank the flywheel until the connecting rod to be removed is in position.

3

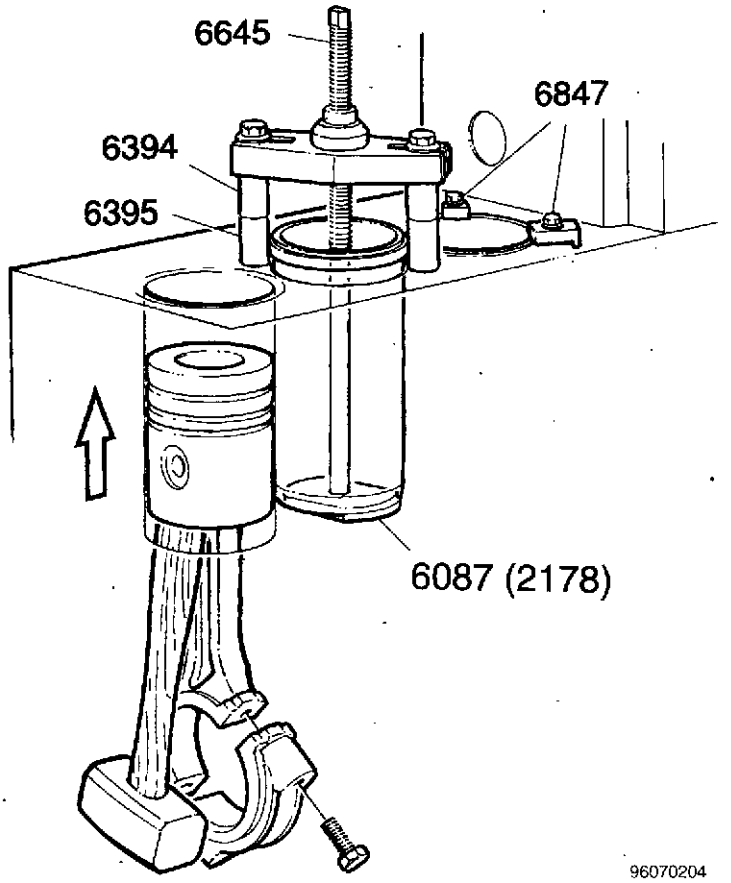


Remove the piston cooling jet, if any.

4
Remove the bearing cap and bearing shells.

5
Tap up the piston with a hammer handle until the piston rings are above the edge of the cylinder liner and lift out the piston and connecting rod.

6
Mark the position of the cylinder liner in the block using a marking pen and pull out the cylinder liner.



Cylinder liner with piston and piston rings, inspection

The cylinder liners and pistons must be carefully cleaned before carrying out inspection and measurement. To be able to carry out a careful check for cracks, the cylinder liner must be removed from the cylinder block.

The position of the cylinder liner must be marked with a marking pen before it is removed.

Cylinder liner

1
Check for cracks, extra care must be taken when checking the liner collar. Checking can be carried out using a magnetic powder test.

2
Wear measuring using a cylinder indicator
In order to measure the wear as accurately as possible, the cylinder indicator should first be set using a gauge ring or micrometer.

Use the original bore size of the cylinder liner as a reference measurement.

Measure the cylinder liner in the upper and lower dead centres and also at different heights. At each measurement point, measuring should be carried out both crosswise and lengthwise in relation to the engine.

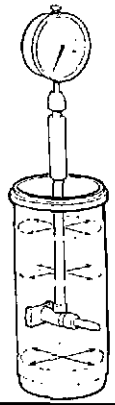
3
Wear measuring using a piston ring (alt.)
Liner wear is easily determined by placing a new piston ring at the upper turning position and measuring the piston ring gap. This is then compared with the piston ring gap below the lower turning point. The wear is determined by dividing the difference by 3.14.

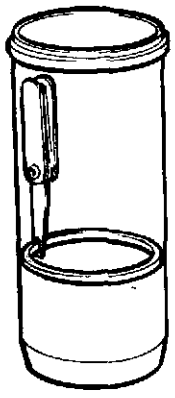
Example:

Piston ring gap in unworn section ..... 0.35mm(0.014")
Piston ring gap at upper turning point ..... 1.30mm(0.051")
Difference:
1.30mm–0.35mm(0.051–0.014") = ... 0.95mm(0.037")

Diameter wear:

$$\frac{0.95\text{mm}(0.037")}{3.14} = 0.30 \text{ mm } (0.012")$$





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4
If wear is greater than **0.35–0.40 mm (0.014-0.016")**, the cylinder liner with piston and piston rings should be changed.

Oil consumption should also be taken into account *when a cylinder liner is to be changed.*

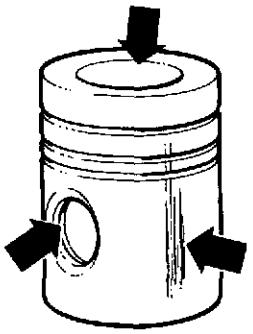
Note! Cylinder liner and piston are classified together. This means that the piston must belong to the same class as the cylinder liner.

Piston and cylinder liner are only available from stock *as a complete unit.*

Pistons

5
Check the pistons for cracks and other damage. If the piston has score marks around the sleeve surface it (liner unit) must be scrapped. Similarly, if the piston has one or several cracks in the gudgeon pin hole or in the bottom of the combustion chamber it shall also be scrapped. Cracks in the edge of the piston top around the combustion chamber are not serious as a rule. The crack test is carried out as per the powdered lime method.

NOTE! If cracks are found in the pistons the fuel injection volume should also be checked.



2-6417

Piston rings

6
Check the wear faces and sides. Black patches on the surface indicate poor contact which means the ring should be replaced. Oil consumption is also of decisive importance for the time when the piston rings should be replaced.

Check the piston ring gap. When measuring, push the ring down below the lower turning point using a piston. Replace the piston rings if the gap is **1.5 mm (0.059")** or more.

The piston rings should otherwise be replaced if there is noticeable wear or ovality in the cylinders as the rings do not usually return to the same position they had before being removed.

Check the piston ring gap also on new rings. For measurements, see "Workshop Manual, Technical Data".

Cylinder block

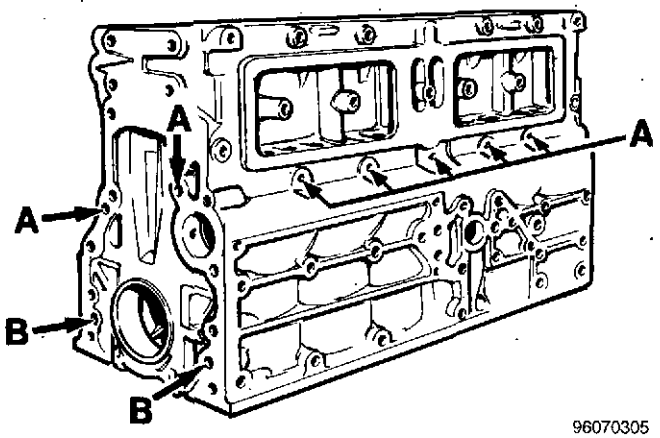
Inspection

Clean the cylinder block thoroughly. Check that all channels are free from deposits and that the block has no cracks anywhere. Slight cracks can be repaired by hot welding. If welding is carried out on the upper face, the cylinder block must be ground flat. (See "Surface grinding", below).

In the event of major defects, fit a new cylinder block. Cylinder blocks supplied as parts should be thoroughly cleaned. To make it possible to clean the longitudinal oil channels effectively, the cylinder blocks are delivered with some plugs unfitted. After cleaning, fit plugs and pins as per the figs below.

A. Plugs to be fitted.
B. Pins to be fitted.
C. Plugs, not to be fitted if a flat type oil cooler is used.
D. Plug to be fitted if the engine is equipped with piston cooling.

The figs below show a cylinder block for the 610, 630-engines.



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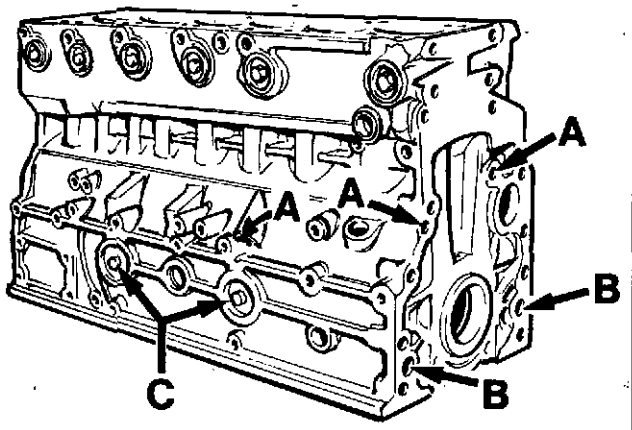

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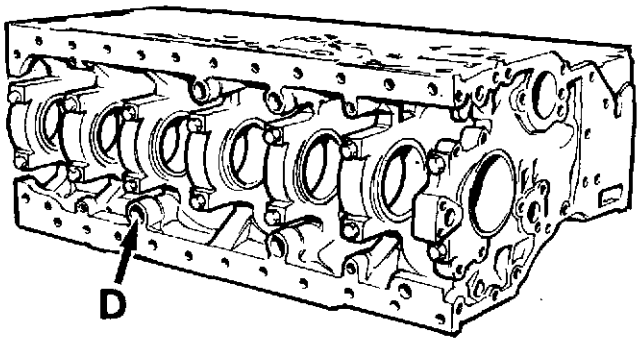

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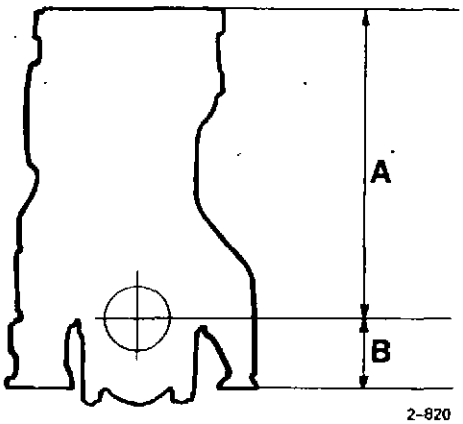
Surface grinding (610, 710 only)

When surface grinding the cylinder block do not go below the minimum dimensions. Measure "A" and "B", see "Workshop Manual, Technical Data".



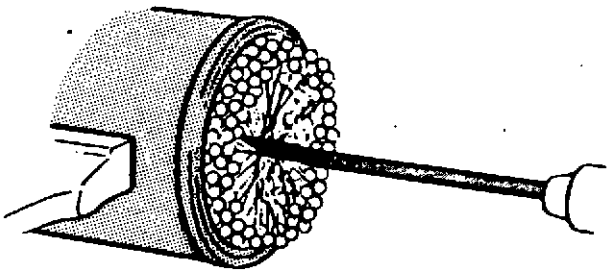
2-820

Note! After grinding of the upper block plane the piston heigt above block face must be measured, see "Workshop Manual, Technical Data".

Cylinder liners, honing

For good lubrication and sealing it is important that the liner walls retain the original honing patter, see fig. Honing, to restore the pattern, is therefore to be carried out when:

- the cylinder liner has scratches (ring seizure, dirt)
- the cylinder liner has bright spots (polishing)



96070303

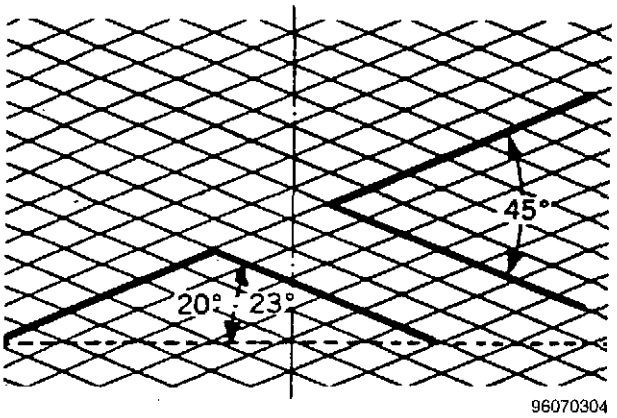
1
Mark the piston and liner before removing to make sure that the same piston and liner are refitted in the same place as before

2
Place the cylinder liner in a vice, see fig. Honing of the cylinder liner when installed in the block is not recommended due to the risk of oil channels becoming clogged and the difficulties to feed correctly.

3
Remove the carbon edge at the top of the liner. Also clean under the liner collar and the recess in the block.

4
Use a low speed electric drill with a speed of 200–400 rpm and "Flex-Hone" tool type GBD 102 mm (610-, 630-engines), or GBD 108 mm (710-, 730-engines). Grade size 80.

Lubricate the cylinder liner with light engine oil before and during honing. Move the honing tool in and out of the cylinder liner at 60 strokes/min. (One inward and outward stroke per second).



96070304

5
The cylinder liners have a honing pattern where the angles are carefully calculated to give optimal life span, see fig.

When honing after a piston ring change the original honing pattern must be followed to keep the lubrication properties.

The honing marks must be formed uniformly and cut evenly in both directions over all the cylinder surface.

Note! The correct speed must be maintained to obtain the correct pattern.

6
Clean the liner thoroughly after honing. Use warm water, a brush and detergent (never use thinners, paraffin or diesel oil). Dry the liner using paper or a cloth which does not leave any fluff. After drying, lubricate the liner with light engine oil.

Cylinder liner seats, overhauling

Special tools: 9989876, 2479, 6847, 9538 (610, 630), 9514 (710, 730, 731), 9553 (610, 630), 9508 (710, 730, 731)

A damaged cylinder liner seat is rectified by milling the liner shelf. The material which is removed by milling is compensated by shims which are available in different thicknesses.

1
Clean the liner seat and calculate the extent of the damage.

2
Fit the cylinder liner without sealing rings into the cylinder block and attach it with two pressing tools.

3
Measure the height of the liner at four different places and calculate the thickness of the shims. The smallest possible number of shims should be used.

Correct height should be **0.38–0.43 mm (0.0150–0.0169")**.

4
Remove the cylinder liner and roughen up the lining seat with emery cloth.

5
Bolt the milling tool 9553 (610, 630) or 9508 (710, 730, 731) to the cylinder block and make sure that the feed sleeve does not exert pressure on the tool.

6
When the milling tool has been bolted down, screw down the feed bolt so that it presses lightly against the milling tool.

Fit and zero-set the dial indicator.

7
Turn the milling tool steadily while turning the feed sleeve at the same time.

Note! Use a T-bar to turn the milling tool.

8
When **0.02 mm (0.0008")** remains to the correct height, stop the feed and rotate the tool several turns.

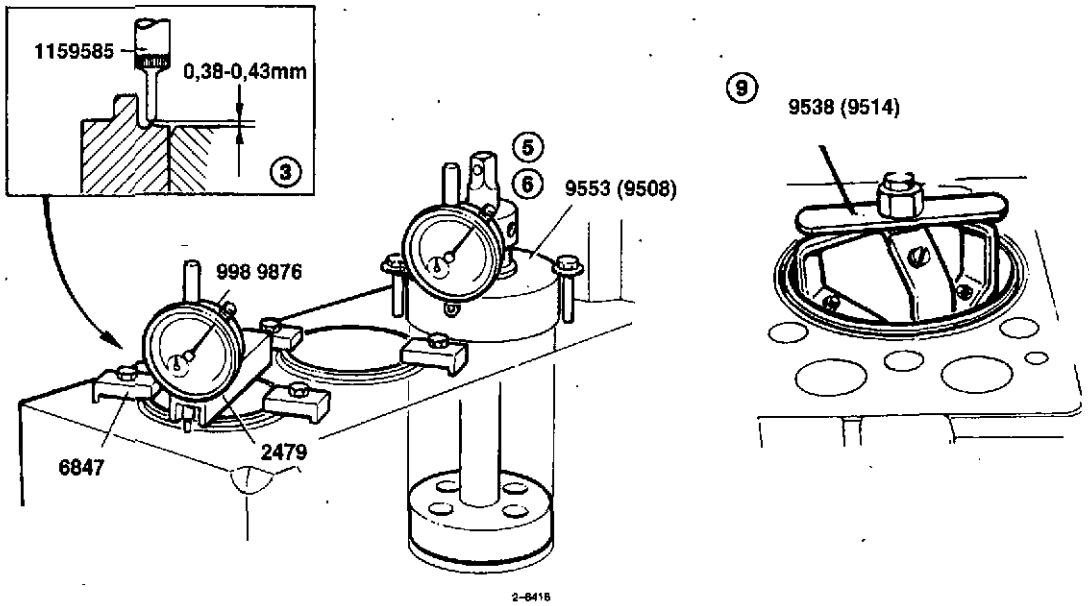
9
Remove the O-rings and reply grinding compound to the underside of the liner collar if there is so little damage on the liner recess that it is not necessary to use the milling cutter.

Insert the liner into the block and turn it backwards and forwards until the compound is used up. Remove the liner and wipe off the grinding compound. Repeat the grinding operation until good contact is obtained.

To turn the liner use expander 9538 (610, 630) or 9514 (710, 730).

10
Check the contact with marking dye and mark the liner so that it comes into the same position when fitted as it had when the contact was checked.

Figures in the illustration are referred to in the following.



Cylinder liner, fitting

Special tools: 998 9876, 2000, 2479, 6847 (two), 6854

1
Remove the old sealing rings in the cylinder block and make sure that the sealing surfaces are well cleaned. Use a cleaning fluid and a brass wire brush.

Note! No scraping tools to be used.

2
If the cylinder liner seat has not been renovated, fit the cylinder liner, without sealing rings, into the cylinder block and secure it using two pressing tools.

3
Measure the height of the liner in four different places and calculate the thickness of the shims. Use as few shims as possible.

The correct height should be **0.38–0.43 mm (0.0150–0.0169")**.

Mark the liner against the cylinder block so that it is correctly fitted when reassembling. Take out the liner.

4
Smear the sealing rings which are to be fitted in the cylinder block with the lubricant provided in the sealing ring carton.

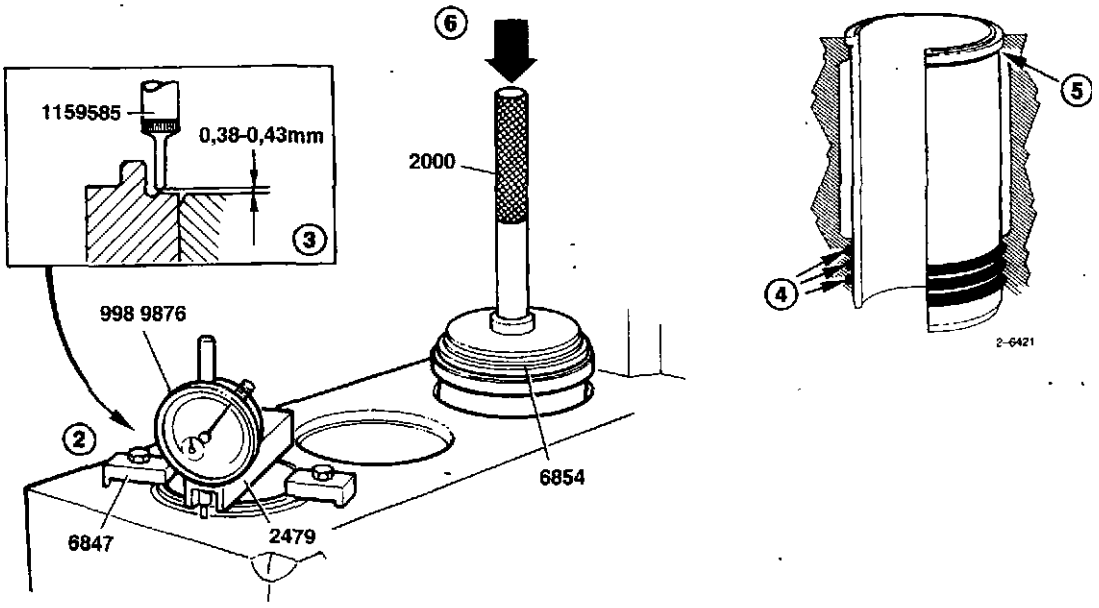
Place the rings in the grooves following Volvo Penta Parts installation instructions.

5
If shims are required, these should be placed on the cylinder liner. Lubricate the new sealing ring and fit it beneath the liner collar.

6
Carefully press in the cylinder liner. Use drift 6854 together with standard handle 2000.

7
Fit pressing tools 6847 (two) to hold the cylinder liner in position.

Figures in the illustration are referred to in the following.



Gudgeon pin bushing, changing

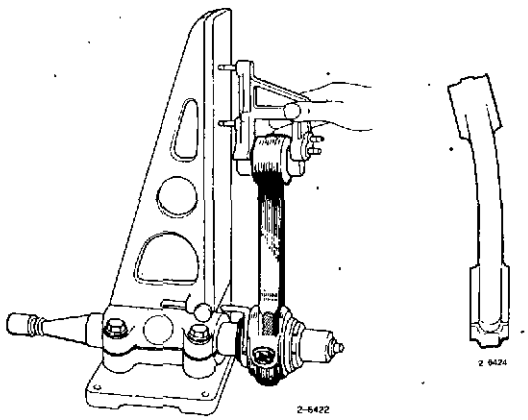
Special tools: (610, 630): 1801, 2669
(710, 730, 731): 1801, 2497

On 710, 730, 731 the little end of the connecting rods is trapetzoidal. The bushing must be line-bored after changing.

Before changing the gudgeon pin bushing, the connecting rod should be checked with regard to cracks, straightness and for warp.

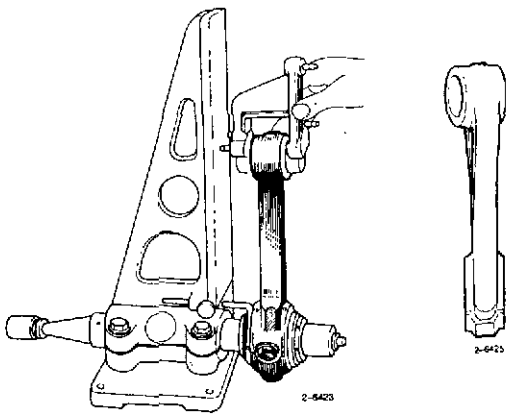
A cracked, bent or warped connecting rod should be scrapped.

1



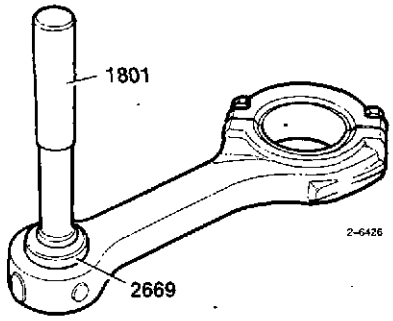
Use a new gudgeon pin and measure the connecting rod in a fixture.
Straightness, max. deviation 0.05 mm (0.002") on a length of 100 mm (3.94").

2



Warp, max. deviation 0.1 mm (0.0039") on a length of 100 mm (3.94").

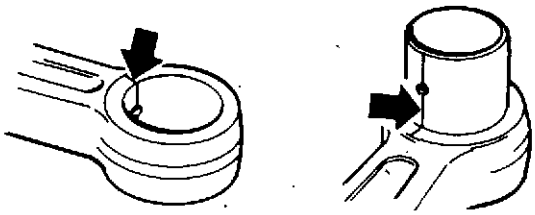
3



Press out the old bushing using drift and handle.

4
Heat up the connecting rod to approx. 100°C.

5



Press in the new bushing using the same tools as when pressing out the old bushing. Make sure that the oil hole in the bushing is opposite the oil drilling in the connecting rod.

6
610-, 630-engines
Ream the bushing.

710-, 730- and 731-engines
Line bore the bushing.

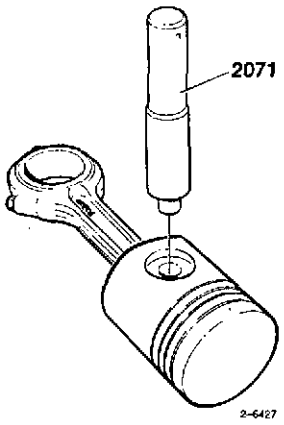
Fit is correct when an oiled gudgeon pin is able to slide slowly through the bushing under its own weight.

7
After reaming, the connecting rod must be checked in a fixture to ensure that the hole in the bushing is correctly positioned.

Piston, changing

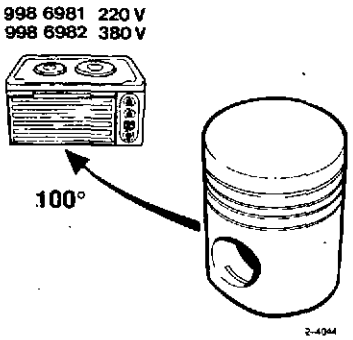
Special tool: 2071

1



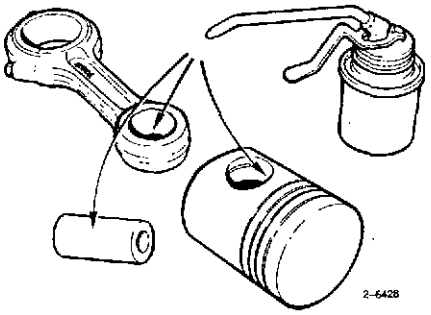
Remove the circlips and press out the gudgeon pin with drift 2071.

2



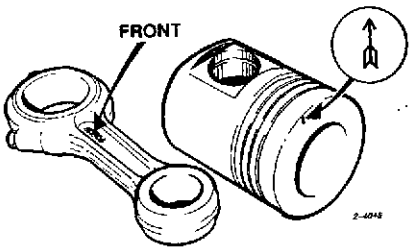
Fit one circlip to the piston. Heat up the piston to about **100°C (212°F)**.

3



Oil the piston, gudgeon pin and the gudgeon pin bushing with engine oil.

4



Position the piston and the connecting rod so that both front markings are facing the same way.
Carefully press in the gudgeon pin using drift 2071 and fit the other circlip.

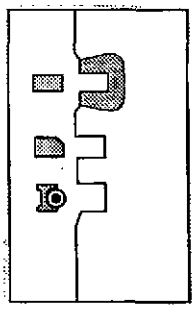
Note! The gudgeon pin should enter easily, it must not be knocked in.

5

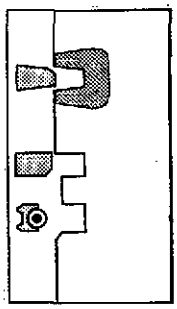
Check that the piston and connecting rod can move easily relative to each other and that the gudgeon pin is not sticking in the gudgeon pin bushing.

6

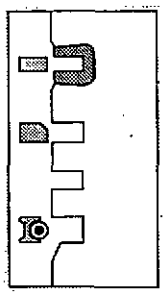
610-engines



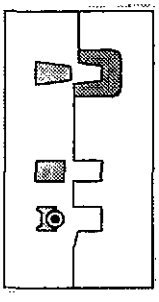
630-engines



710-engines



730-, 731-engines



If the piston rings are to be removed and refitted, use a piston ring tool.Refer to sketch concerning the positioning of the piston rings. (No third compression ring on 710-engines after engine serial no. 17834).

Note! New cylinder liners are delivered complete with pistons and piston rings.

Pistons, fitting

Special tools: 3590, 6847, 9696, 998 9876, 885126

1
Oil the piston and piston rings with engine oil.

2
Make sure that the ring gaps are staggered around the pistons.

3
Fit the piston and connecting rod with the arrow and "Front" marking facing forward.

Use tool 885126 to guide the piston rings into the cylinder line.

4
Smear the bearing shells and crank pin with engine oil. Fit the shells, making sure that they are correctly positioned on the crankshaft and in the cap.

5
Fit the cap according to the marking and fit the bolts.

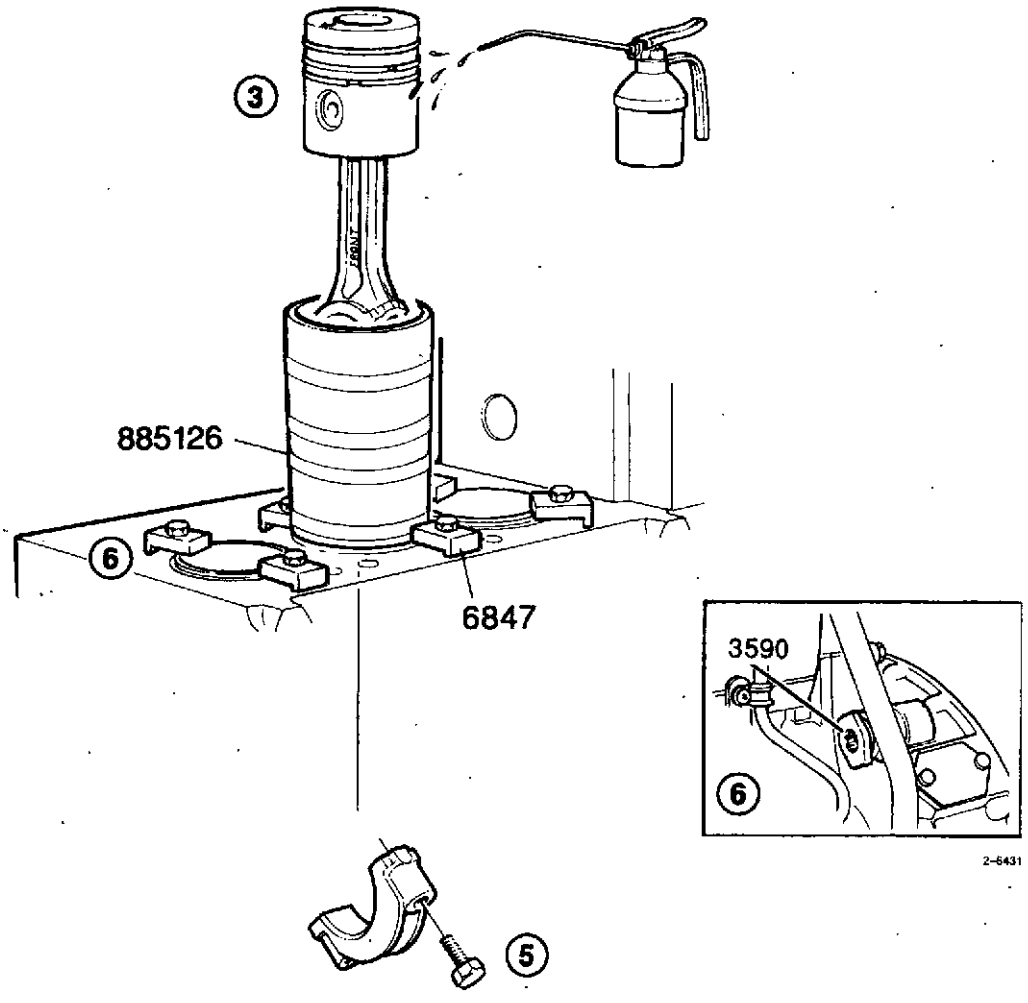
6
Make sure that the pressing tools are in position and crank the flywheel until the piston reaches its bottom position.

Torque-tighten the bolts.

7
Remove the cranking tool.

8
Check the piston height above the block surface, see "Workkshop Manual, Technical Data".

Figures in the illustration are referred to in the following.



Polygon hub, changing

Special tools: 2655, 884949

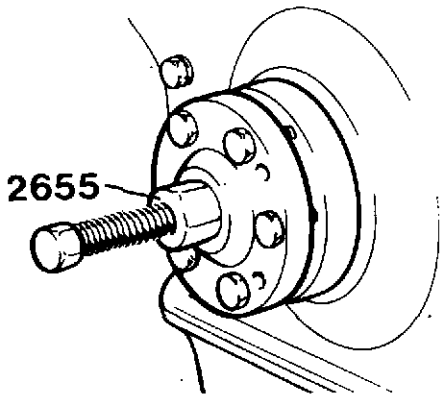
Removing

1
Remove the fan and the fan belts. Remove the generator belt, the generator and the bracket.

Note! The fan must always be stored vertically.

2
Remove the polygon hub bolt and centre washer.

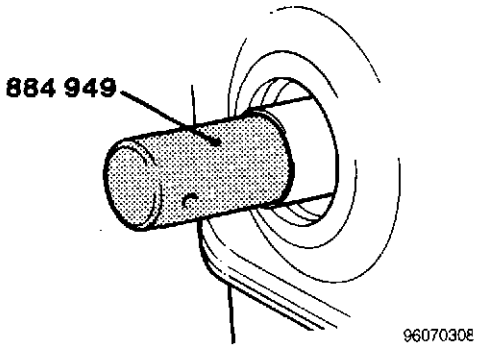
3

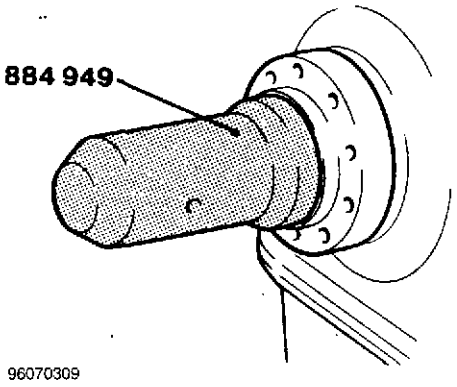


Pull off the polygon hub using puller 2655.

Fitting

4





Check the polygon hub and its contact face on the crankshaft. Any cutting marks are to be removed with fine emery cloth.

Grease the crankshaft journal with molybdenum disulphide. Fit the centering section of drift 884949 on the crankshaft journal. Heat the polygon hub to approx. **100°C (212°F).** Place the hub quickly onto the journal with tool 884949. This gives you a clearence of approx. **5 mm (0.20")** of the gear surface.

5
Fit the washer and centre bolt and tighten the bolt to **200 Nm (150 lbf.ft).** Let the hub cool and tighten the bolt to **260 Nm (192 lbf.ft)**

6
Assemble the vibration damper and fan pulley, if fitted. Tighten the bolts to **90 Nm (66 lbf.ft).**

7
Fit the fan and the generator with belts.

Sealing ring for polygon hub, changing

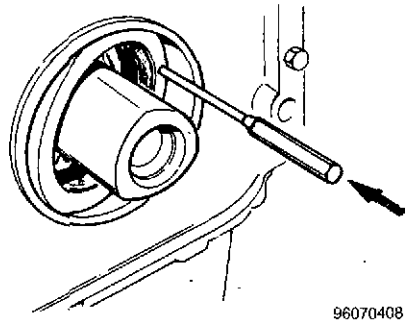
(Polygon hub removed)

Special tool: 6855, 8170 (630, 730, 731)

1

Only 630-, 730- and 731-engines.
Remove the noise shield from the timing gear cover.

2



Remove the sealing ring using a drift.

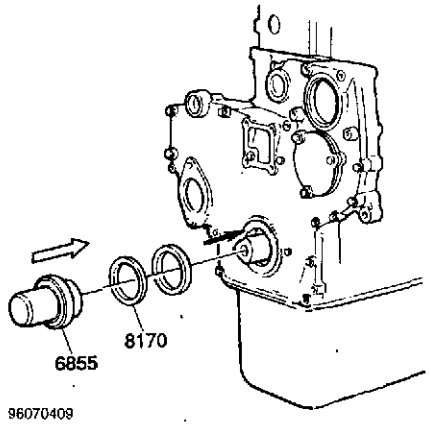
3

Clean the sealing ring seating area.

4

Mobile engines
Clean the noise shield and the contact surface on the timing gear cover.

5



Fit a new sealing ring on drift 6855 and tap it in until the drift bottoms.

Note! On engines with noise shield, fit spacer ring 8170 to the drift before fitting the sealing ring.

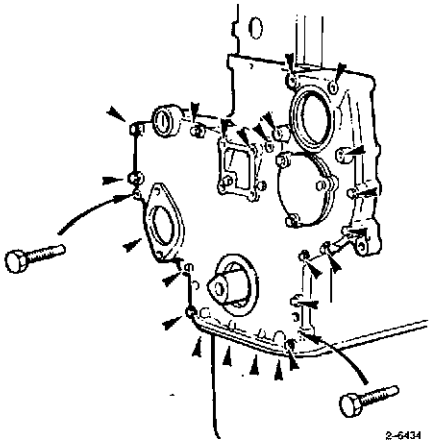
6

Mobile engines
Apply an approx, **2 mm (1/16")** wide bead of sealant (Part no. 116 1231) to the timing gear cover and fit the noise shield.

Sealant on timing gear cover, changing

(Polygon hub and noise shield (if fitted) removed)

1



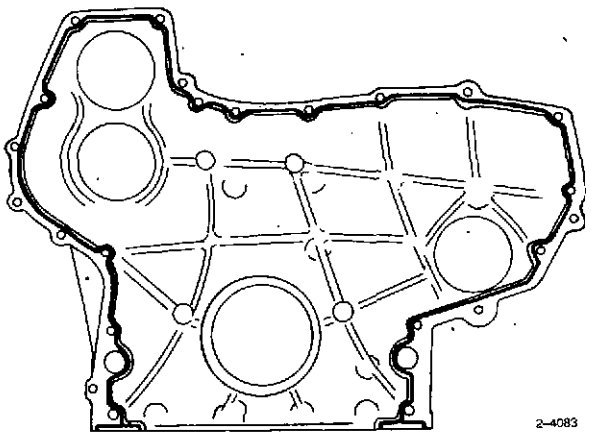
Expose the timing gear cover and remove all the bolts.

Note! To facilitate removal of the timing gear cover, two M8x30 mm bolts can be used. Grind off the end of the threads (about 10 mm) and thread the bolts into the holes. **See figure**.

2

Clean the contact surface of the timing gear casing against the timing gear cover.

3



Apply an even **approx. 2 mm (1/16")** wide bead of sealant (Part no. 1161231) to the timing gear cover, see illustration.
Note! The timing gear cover must be fitted and bolted down within **20 minutes.**

Timing gears, changing

(Timing gear cover removed)

Special tools: 2658, 2679, 3590, 884948

Note! Certain timing gears are nitro-carburated (marked "N" or "NITRO"). They can also be recognized by their flat grey to grey-yellow colour. These gears must not be installed together with earlier, induction hardened gears (marked HT).

Case hardened gears (marked CH) are permitted in all gear combinations.

See also "Service Bulletin" 21–5 no. 5.

Note! Never turn the crankshaft or camshaft when the timing gears have been removed. Pistons and valves can strike each other and be damaged.

Removing

1
Remove the front valve cover.

2
Crank the flywheel round until 1st piston is at T.D.C. after compression, 0° on flywheel.

3
Slacken the bolts for the camshaft drive, idler gear and injection pump drive.

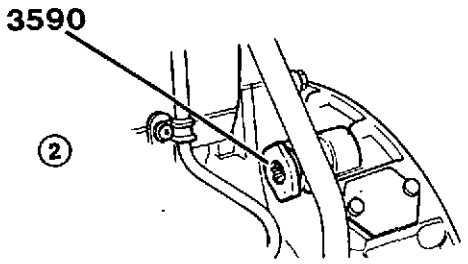
4
Remove the idler gear and the axial bearing.

5
Remove the injection pump drive and camshaft drive. *If necessary, use the puller 2679.*

Note! When using the puller on engines fitted with injection timing adjuster, place a socket head plug, Part no. 952076-8, with the hexagon hole against the flange to prevent the puller centre bolt pressing against the timing adjuster connecting rod.

6
Remove the crankshaft drive using puller 2658.

Figures in the illustration are referred to in the following.



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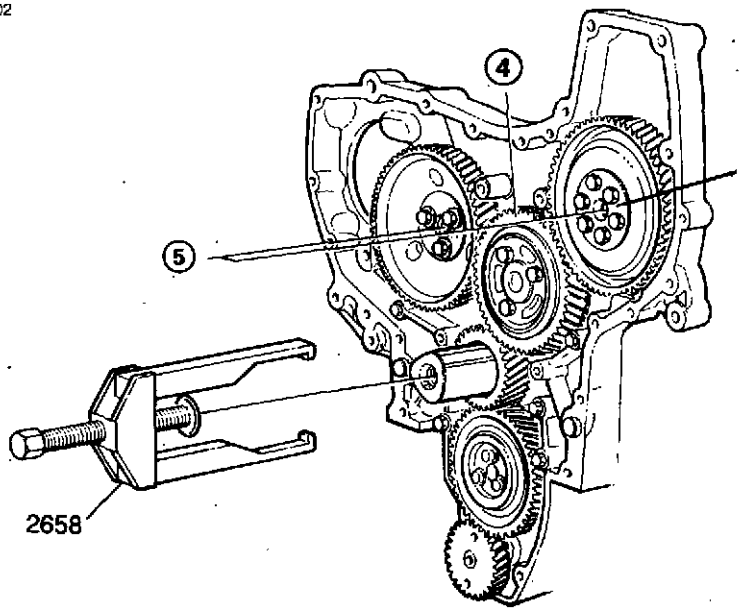

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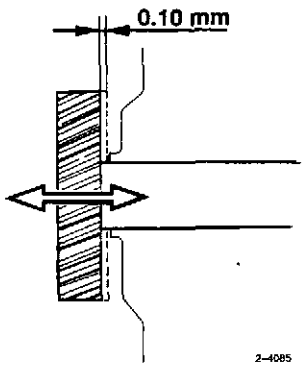
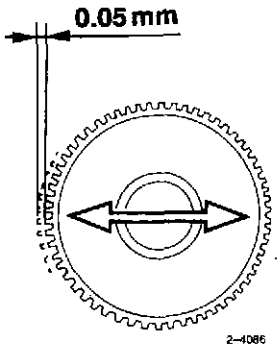
Fitting

When fitting timing gear drive wheels, all clearances must be checked.

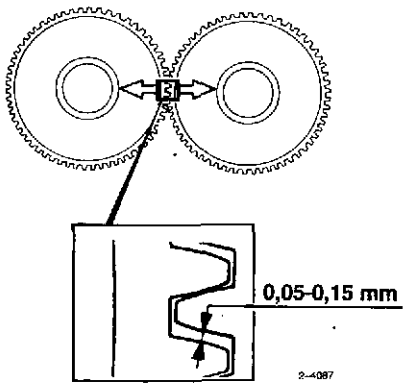
8



Axial play for idler gear: max. 0.10 mm (0.004").



Radial play for idler gear: max. 0.05 mm (0.002").



Backlash: 0,05-0,15 mm (0,002-0,006")

9

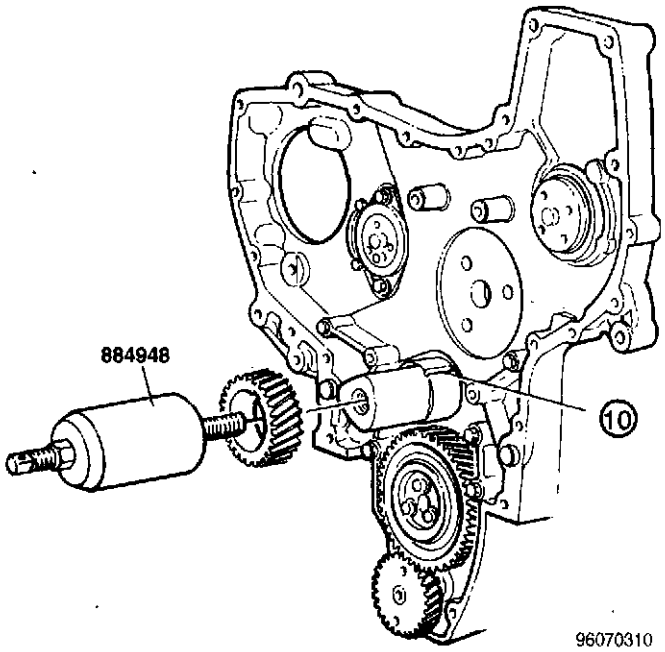
Check that the keyway in the crankshaft is in good condition and that the key is correctly positioned in the slot.

10

Press on the crankshaft drive gear using tool 884948.

Note! Make sure that the cogs mesh properly with the oil pump idler gear.

Figures in the illustration are referred to in the following.



11
Fit the camshaft drive gear, idler gear and axial bearing. Make sure that the markings on the crankshaft drive gear, idler gear and camshaft drive gear match up.

12
Tighten the bolts by hand until the drive gear wheels bottom in their positions.

13
Fit the injection pump drive gear and make sure that the marking against the idler gear matches up.

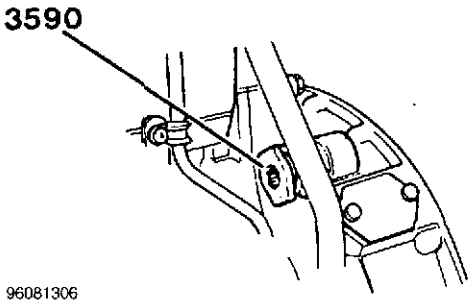
Note! There are no marking on the injection pump drive gear on 730- and TWD630-engines.

14
Torque-tighten the timing gear drive wheels.

15
Set the injection pump, see "Fuel system".

16
Remove the cranking tool and refit the inspection cover to the flywheel casing.

17
Fit the front valve cover.



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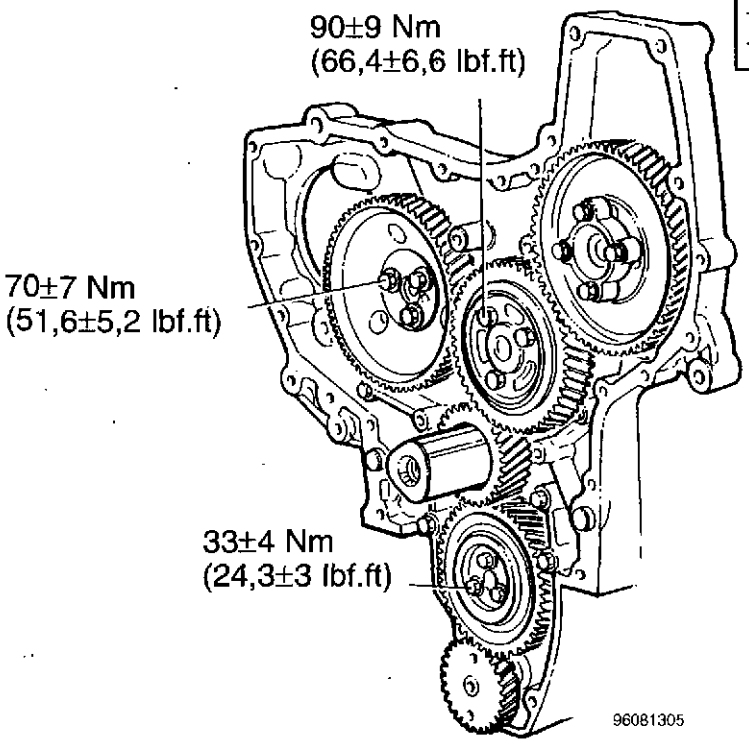
Injection pump drive gear

Engine	Screw, pcs	Torque
710, TD730,TWD731	3	60±6 Nm
610, TD630ME	4	35±4 Nm
TWD630/730ME	6	33±4 Nm
TAD730G/P	6	33±4 Nm



96081305

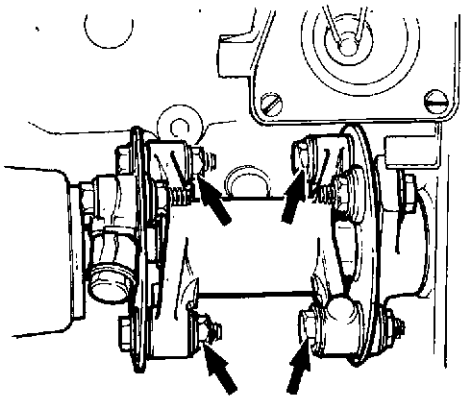
Seal on output shaft between timing gears and injection pump, changing (TD730ME, TWD731ME and 710-engines)

Special tools: 3590, 6778, 6779

1
Remove the front valve cover.

2
Crank the flywheel round in the direction of rotation with tool 3590, until 1st cylinder is on compression (0° on flywheel and both valves of 1st cylinder closed).

3

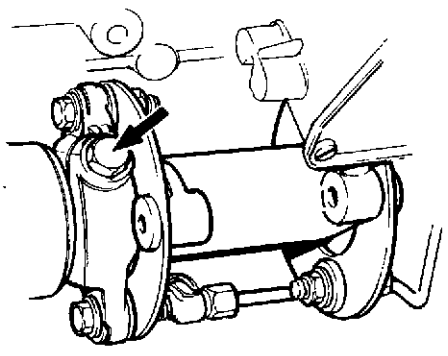


96081401

Remove the bolts from the pump coupling (four).

Note! Do not remove the bolts holding the flange discs to the flanges.

4

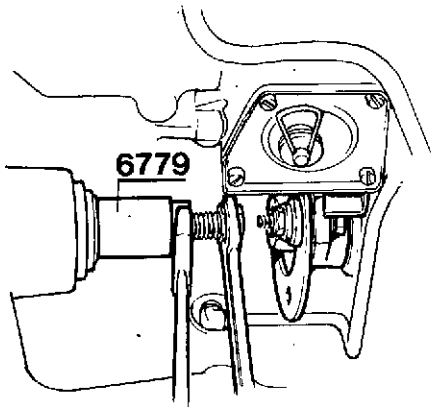


96081308

Loosen the clamping bolt whick holds the flange to the drive shaft.

5
Remove the pump coupling and flange.

6

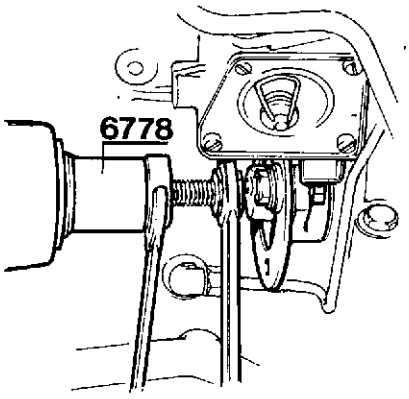


96081309

Pull out the old seal by screwing puller 6779 into the seal. At the same time, apply pressure to the puller so that the puller threads cut into the steel ring of the seal. Pull out the seal by screwing in the puller bolt.

7
Smear the new seal and drive shaft with oil.

8

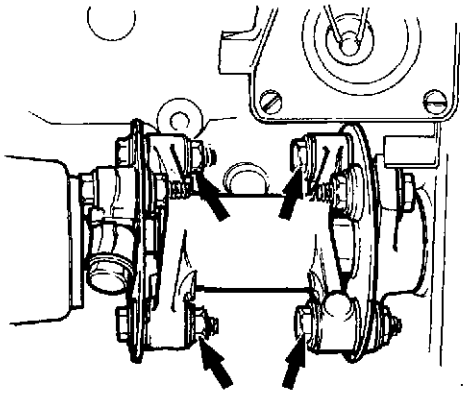


96081310

Press in the seal using tool 6778 until it is flush with the shaft lousing.

9
Fit the flange to the drive shaft.

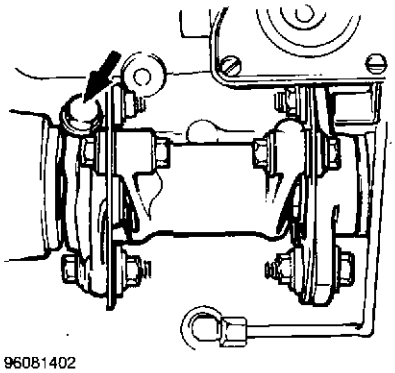
10



Fit the pump coupling and torque-tighten the bolts.

11
Check the setting of the injection pump.

12



Torque-tighten the clamping bolt of the pump coupling.

13
Remove the cranking tool from the flywheel casing and fit the inspection cover.

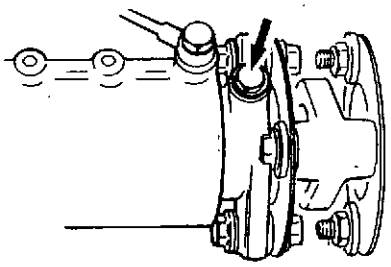
14
Fit the valve cover.

Seal on output shaft between timing gears and injection pump, changing (TWD630, TAD-TWD730)

(Injection pump removed)

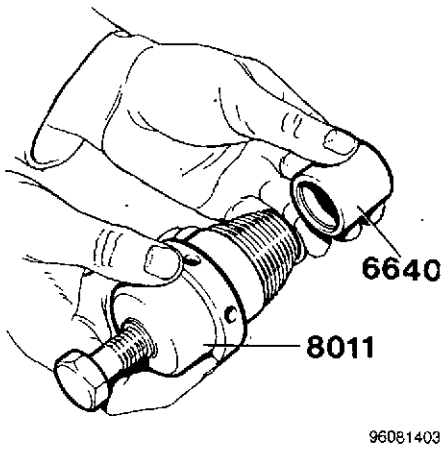
Special tools: 6640, 8011, 8012

1



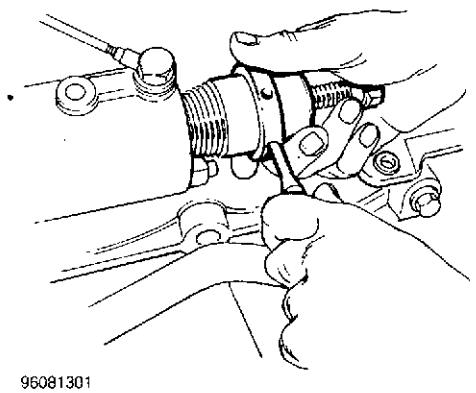
Slacken the clamping bolt which holds the flange to the shaft and remove the flange.

2



Fit drift 6640 into puller 8011. Turn the drift so that the shallow hole faces the puller bolt.

3

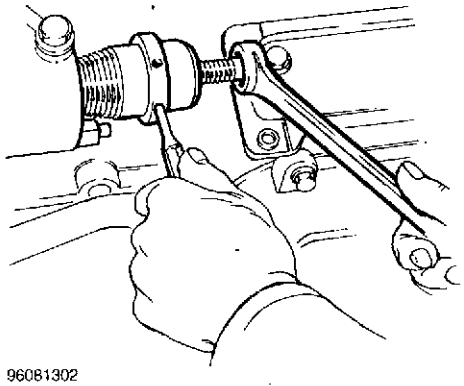


96081301

Screw the puller into the old seal with the help of a drift.

At the same time, apply pressure to the puller so that the puller threads cut into the steel ring of the seal.

4

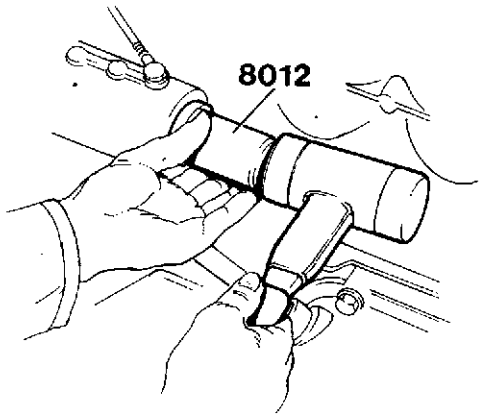


96081302

Pull out the old seal by screwing in the puller bolt and counterholding the puller at the same time with the drift.

5
Smear the new seal and drive shaft with oil.

6



96081303

Fit the seal on the shaft and tap it in with drift 8012 until it is flush with the shaft housing.

7
Fit the flange, the pump coupling and the injection pump. (See "Fuel System").

8
Check the setting of the injection pump.

Camshaft, changing

(Camshaft drive gear removed)

Special tools: 3590, 8079

1
Remove the valve covers.

2
Remove the rocker arm assemblies and push rods.

Note! Mark the push rods or place them in a rack to make sure they are refitted in the same order.

3
Remove the air compressor if fitted.

4
Remove hoses, piping and lines so that the tappet inspection covers be exposed.

5
Remove the tappet inspection covers.

Note! It is not necessary to remove the middle cover.

6
Remove the tappets and mark them so that they can be fitted in the same position when reassembling.

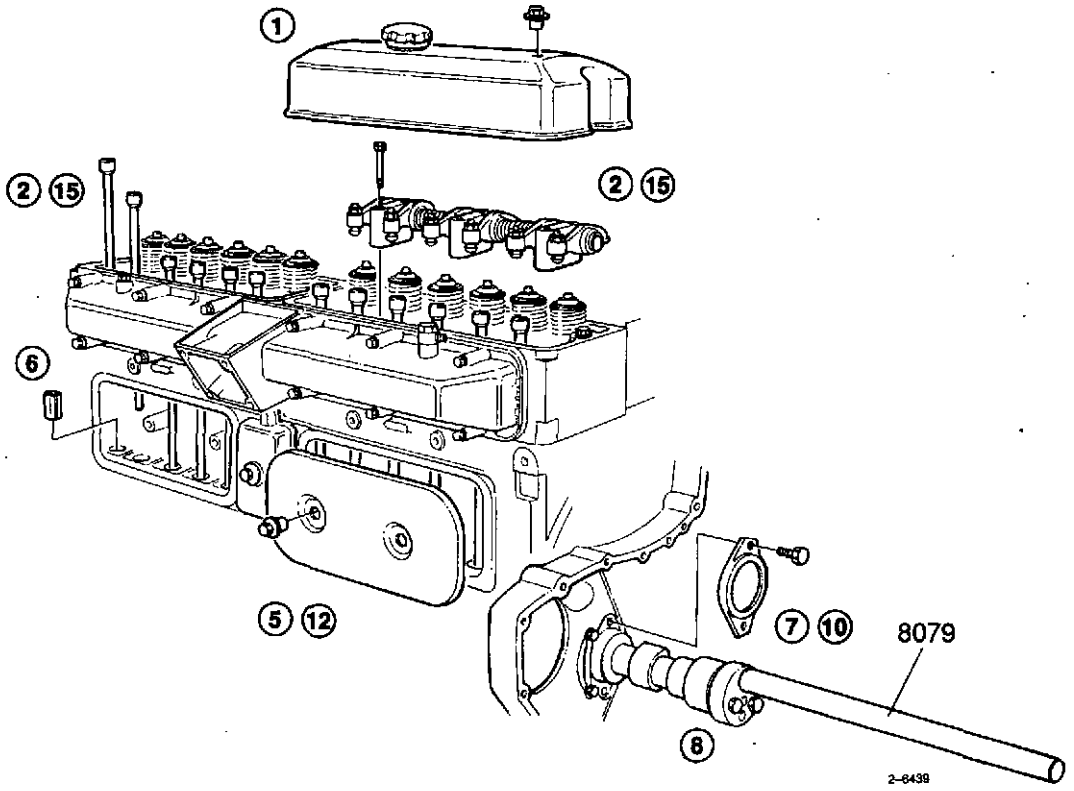
7
Remove the camshaft flange.

8
Attach tool 8079 to the camshaft. Carefully withdraw the camshaft.

9
Smear all the bearing surfaces of the new camshaft with engine oil.

Transfer tool 8079 to the new camshaft and carefully lift the camshaft in position.

Figures in the illustration are referred to in the following.



10
Fit the camshaft flange and torque-tighten the bolts.
See "Workshop Manual, Technical Data".

11
Smear the tappets with engine oil and put them back in the same order they were taken out.

Note! Replace the tappets if they are worn or damaged.

12
Fit the tappet inspection covers.

If required, fit new gaskets.

13
Fit the air compressor. If required, fit a new O-ring.

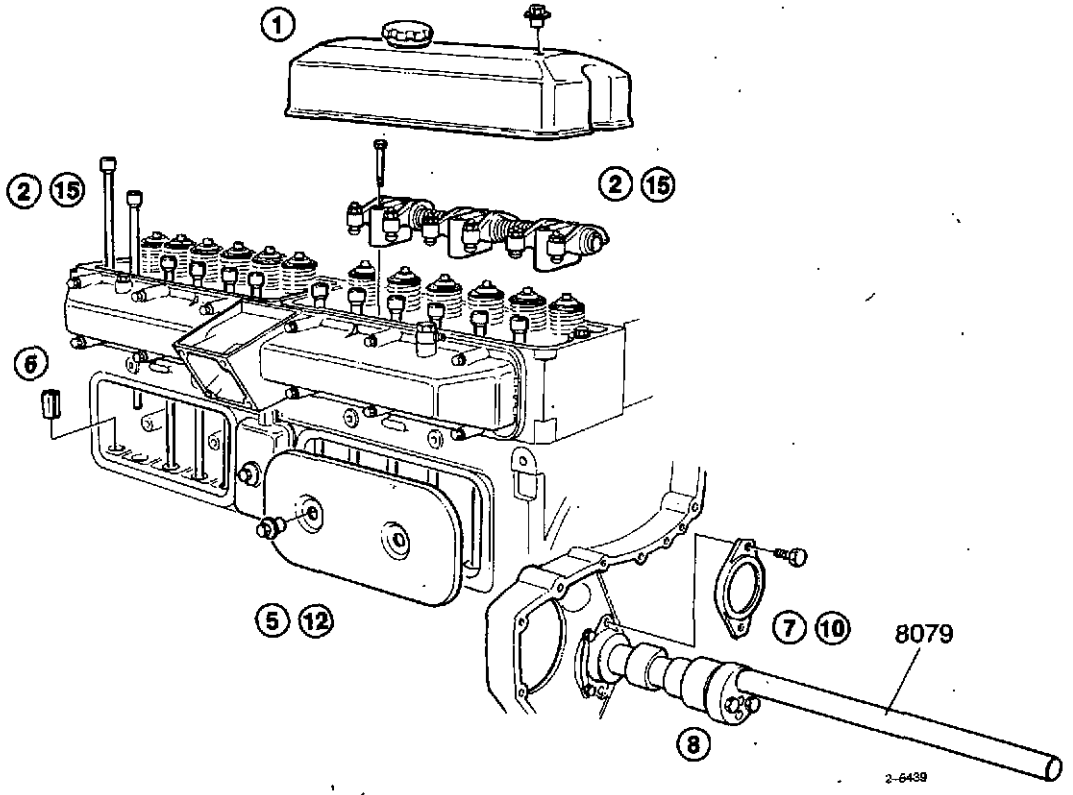
14
Fit and connect up the lines, pipes and hoses previously removed.

Note! Steps 15 and 16 must not be carried out before the camshaft drive gear, idler gear and crankshaft drive gear have been fitted according to their markings.

15
Fit the push rods in the order they were removed, fit the rocker arm assemblies and torque-tighten the bolts.
See "Workshop Manual, Technical Data".

16
Adjust the valve clearances and fit the valve covers.

Figures in the illustration are referred to in the following.



Sealant on timing gear casing, changing

(Coolant pump, air compressor, servo pump (if fitted) and timing gears removed)

1
Remove the clamping bolt from the injection pump drive coupling.

Engines with injection timing adjuster
Remove the oil-pipe between the engine and the timing adjuster.

610-, TD630-engines
Remove the injection pump.

2
Remove the timing gear casing bolts. Remove the casing.

3
Clean the contact surfaces of the cylinder block and the timing gear casing.

Note! The surfaces must be dry befor applying the sealant.

4
Apply an even **approx. 2 mm (1/16")** wide bead of sealant (Part no. 1161231) to the timing gear casing, see fig.

Note! The timing gear casing must be fitted and bolted down **within 20 minutes.**

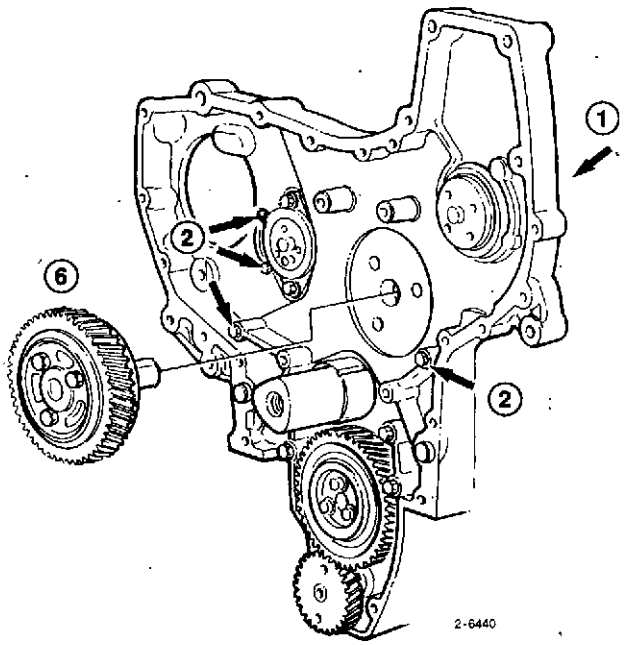
5
Lift the timing gear casing into position. Fit but do not tighten the timing gear casing bolts yet.

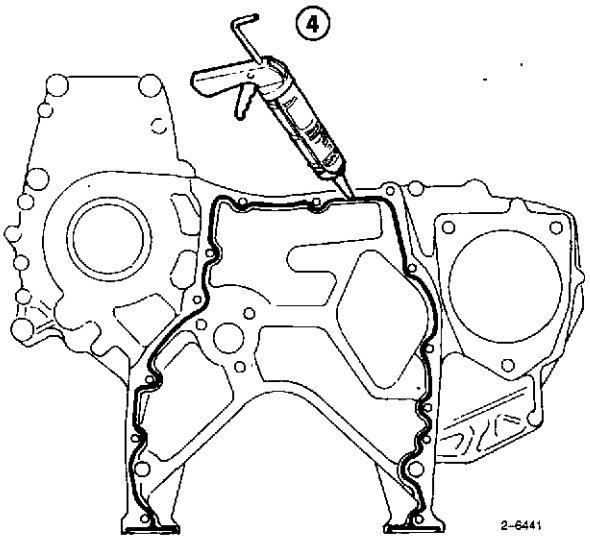
6
Fit the idler gear and tighten the bolts to centre the *timing gear casing.*

7
Torque-tighten the timing gear casing bolts.
See "Workshop Manual, Technical Data".

8
Remove the idler gear.

Figures in the illustration are referred to in the following.





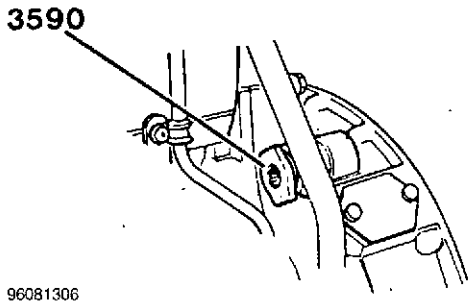
Camshaft, checking for wear

(Cylinder heads fitted)

Special tools: 3590, 6772, 998 9876

1
Remove the valve covers.

2

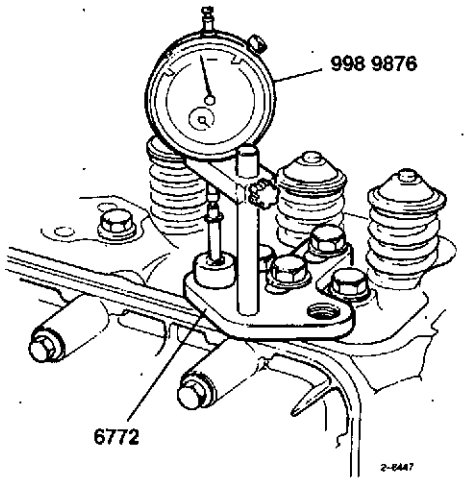


Fit cranking tool 3590.

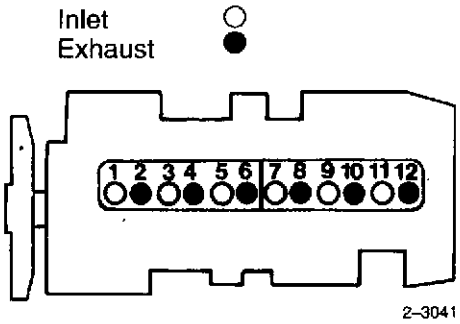
3
Crank the flywheel round until the rocker arms of 1st cylinder are rocking.

4
Remove the rocker arm assemblies and all push rods. Mark the push rods or place them in a rack to make sure they are refitted in the same order.

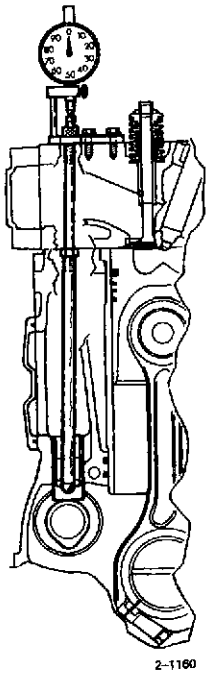
5



Attach tool 6772 to the cylinder head beside 1st cylinder exhaust valve. (Use two M10x20 mm bolts.) Attach a dial indicator to the tool.

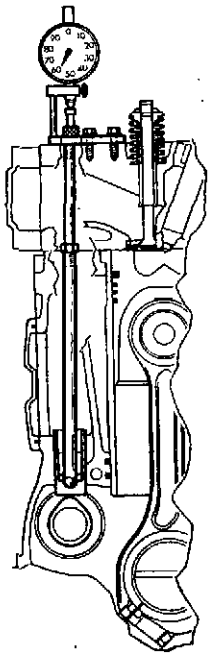


6



Adjust the length of the tool push rod under preload against the exhaust valve tappet.
Crank the flywheel round until the push rod of tool 6772 is in its bottom position. Check that the push rod is under preload and zero-set the dial indicator.

7



Crank the flywheel round until the push rod of tool 6772 is in its top position. Make a note of the dial indicator reading.

8
Transfer the push rod of tool 6772 to the inlet valve tappet and repeat the procedure.

The readings must not be less than specified.
See "Workshop Manual, Technical Data".

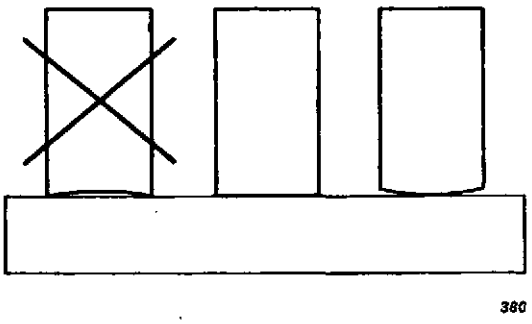
9
Transfer the tool and measure the lifting height for each of the remaining cylinders.

10
Fit the push rods in the same order they were taken out, fit the rocker arm assemblies and torque-tighten the bolts.
See "Workshop Manual, Technical Data".

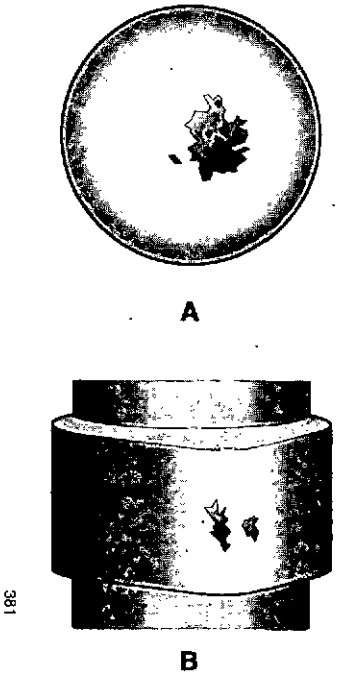
11
Adjust the valves, fit the valve covers and remove the cranking tool.

Camshaft and tappets, inspection

Check with a steel ruler that the contact surface of the tappets to the camshaft is spherical (convex). It may also be completely flat, but absolutely not concave, see fig. If there is a visible light aperture in the middle of the lift surface between ruler and tappet the tappet shall be replaced.



Checking the tappets



Slight pitting damage on tappet (A) and camshaft (B).

Note! If the tappet is worn across the lifting surface the tappet shall be scrapped. The "dike" shows that the tappet has not rotated. A dark edge on the tappet shows that the surface is not worn down.

It is the condition of the tappets that determines if checking of camshaft wear is necessary.

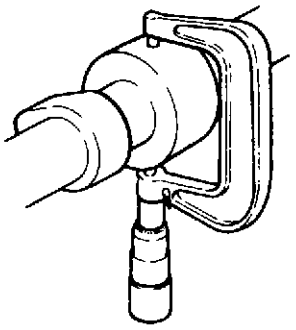
Check the tappets with respect to pitting damage. Pitting damage can occur for many reasons. The damage consists of small metal particles which loosen from the hardened surface. Tappets and camshafts with slight pitting damage, see fig, can be re-fitted. It has been proved that such damage seldom becomes worse.

Check the bearing races and cam curves of the camshaft for wear. The cams may, for example, be angularly worn in an axial direction. This can in less serious cases be adjusted by grinding the cams. Replace the camshaft in the event of further damage or wear. When replacing the camshaft all the taqppets must be replaced.

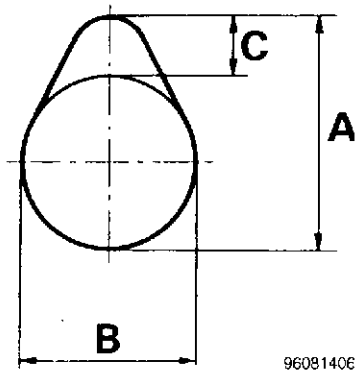
Camshaft, measurement

Measure the camshaft's bearing races with a micrometer. Max. wear and ovality: **0.07 mm (0.0028").** The straightness of the shaft is checked via indicating. Max. radial throw relative to the end bearings: **0.04 mm (0.0016").** Lift height (nock height) is measured with sliding calipers.

Masurements for camshaft and camshaft bearings are to be found in " Workshop Manual, Technical Data".



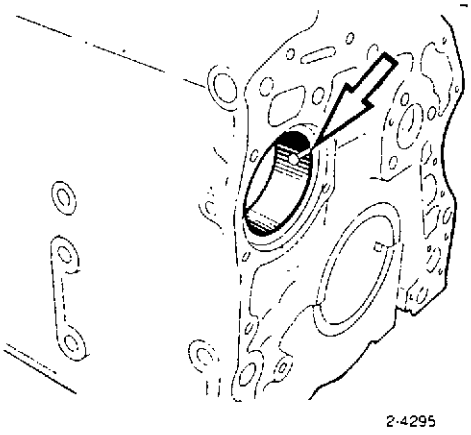
Measurement of bearing races



Measurement of camshaft lift C (nock height)
C = A–B

Camshaft bearing, changing

The camshaft bearings are pressed into position and must be line bored afterwards. This means that camshaft bearings can only be changed in conjunction with a complete overhaul of the engine.



When pressing in the bearings, special care must be taken to ensure that the oil holes in the bearings line up with the oil drillings in the engine block. The front camshaft bearing should be turned with the groove facing forwards.

Crankshaft

The crankshaft is nitro-carburized.

A nitro-carburized crankshaft has a greater resistance to fatigue and wear than an induction-hardened crankshaft.

Inspection

The inspection of the crankshaft must be extremely thorough to avod unnecessary overhauling. To determine overhauling requirements, the following applies:

A. Measure the bearing journals and pins for out-of-roundness, wear and taper. See "Workshop Manual, Technical Data".

B. Assess the surface damage.

For nitro-carburized shafts, the following applies:

What on an induction-hardened crankshaft may be regarded as scoring due to dirt can in the case of a nitro-carburized shaft be the normal surface finish as on a new crankshaft. The markings show up very clearly on a shaft that has been in use because of the shiny bearing surfaces. Very small particles can loosen from the thin surface layer after the shaft has been in use for some time.

This phenomenon is easily confused with scoring caused by dirt, but close inspection will show that the marks do not go entirely round the bearing journal and have uneven edges. These slight defects do not necessarily require the regrinding of the crankshaft.

As a rule, it is sufficient to polish the bearing journal and fit a new bearing shell.

C. Measure crankshaft alignment (throw).

The crankshaft should be placed on either a pair of V-blocks, under 1st and 7th main bearing journals, or fixed between stocks. Measurements should be made on the 4th main bearing.

The following applies with regard to the values measured:

1
Less than **0.2 mm (0.0079")** – no alignment necessary if wear and surface damage do not necessitate regrinding.

2
Between **0.2–0.7 mm (0.0079–0.0276")** – can be aligned, but care must be taken to avoid over-alignment.

Note! Do not align more than absolutely necessary.

3
More than **0.7 mm (0.0276")** – the shaft must be scrapped due to risk of cracking during alignment.

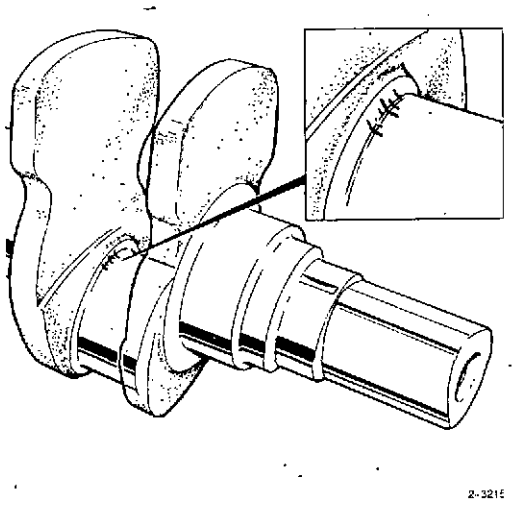
D. Checking for cracks.

Checking must be carried out after alignment and before and after grinding.

To check, use a magnetic powder test of type Magnaglo, i.e. fluorescent powder which can be seen under ultraviolet light.

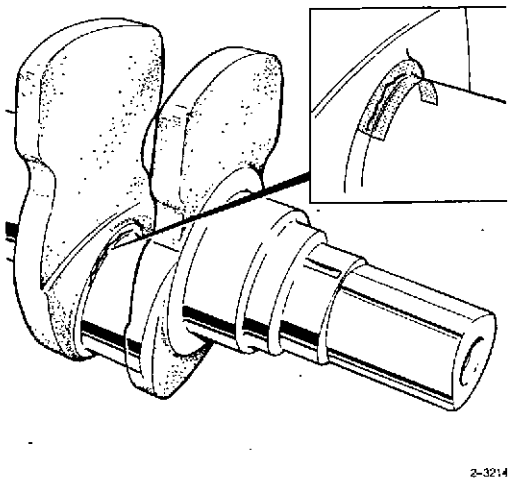
Refer to manufacturer's instructions on the method to be adopted. When assessing the cracks, the following applies:

1



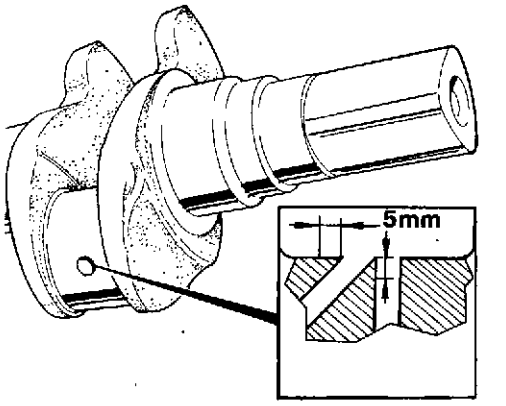
The shaft must be scrapped if there are longitudinal cracks on the journals and in the fillets.

2



The shaft must be scrapped if there are crosswise cracks within the marked zone. This applies to both crank pins and main bearing journals.

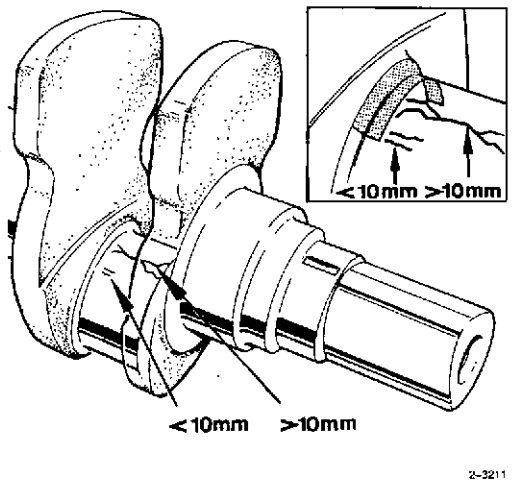
3



2 3212

The shaft must be scrapped when cracks longer than **5 mm (0.2")** are adjacent to the area around the oil holes. Cracks shorter than **5 mm (0.2")** can be removed by grinding.

4



2-3211

The shaft must be scrapped when cracks are longer than **10 mm (0.4")** outside the marked area. Isolated cracks less than **10 mm (0.4")** are acceptable.

Grinding

When overhauling, keep to the following routines:

1
Alignment (only as required).

2
Check for cracks.

3
Measure the bearing journals, see "Workshop Manual, Technical Data".

4
Grind to undersize as specified in "Workshop Manual, Technical Data".

5
Check for cracks.

6
Re-nitro-carburize after grinding to undersize more than **0.50 mm (0.02").** Nitro-carburizing can be done using the gas or salt method according to the experience of the operator carrying out the treatment.

7
Check for throw after nitro-carburizing.

8
Align if necessary (throw between **0.2–0.7 mm (0.0079–0.0276")**).

9
Carry out a magnetic powder test.

10
The crankshaft must be carefully lapped and cleaned after nitro-carburizing. The crankshaft must always be thoroughly cleaned after overhauling.

In order that all oil drillings are cleaned efficiently, late production crankshafts are fitted with threaded plugs in each crank web. These plugs should be removed during the cleaning procedure.

Big-end bearings, changing, all

(Sump removed)

Special tool: 3590

1
Fit cranking tool 3590 and crank the flywheel round until the caps on connecting rods 1 and 6 are in position for removing the bolts.

2
Remove the caps from connecting rods 1 and 6. Remove the bearing shells and clean the bearing seats in the connecting rods and caps.

Note! Do not mix up the caps.

3
Check the bearing pins and bearing shells.

Should any bearing have seized, the cause must be determined before new shells are fitted.

4
Check-measure the bearing pins. Max permissible **out-of-round 0.08 mm (0.0032").**

Max. permissible **taper 0.05 mm (0.02").** Should any of the max. measurement values be exceeded, the crankshaft must be removed and put right.

Note! Should any uncertainty arise, check the specifications to see whether the shaft is of standard size or undersize.

5
Fit the new bearing shells and check that the correct size of bearing is fitted. Make sure that the bearing shell locating tag correctly enters the locating groove in the connecting rod and that the oil hole in the connecting rod and shell line up.

6
Smear the bearing shells and crankshaft bearing pins with oil. Fit the caps according to the markings and torque-tighten the bolts.
See "Workshop Manual, Technical Data"

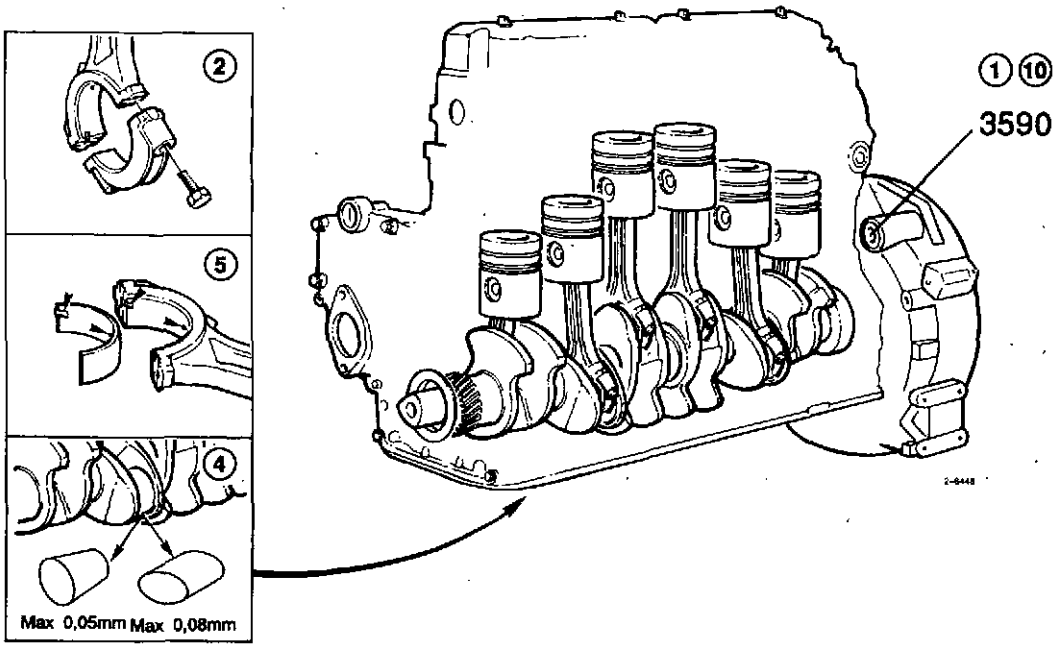
7
Crank the flywheel until connecting rods 5 and 2 are in position and repeat 2–6 above.

8
Crank the flywheel until connecting rods 3 and 4 are in position and repeat 2–6 above.

9
Make sure that none of the bearings are seizing.

10
Remove the cranking tool.

Figures in the illustration are referred to in the following.

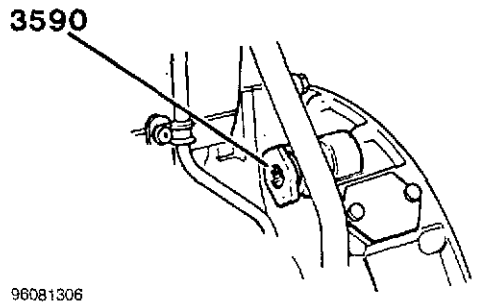


Main bearings, changing, all

(Sump removed)

Special tool: 3590

1

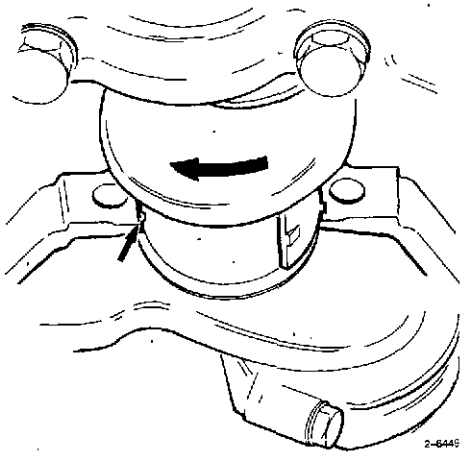


Fit cranking tool 3590.

2
Remove the oil pipes from the cylinder block and oil pump.

3
Remove the bolts holding the front main bearing cap. Remove the oil pump together with the main bearing cap.

4



Remove the upper bearing shell by inserting a pin into the crankshaft oil hole and rolling the bearing shell out by turning the crankshaft round.

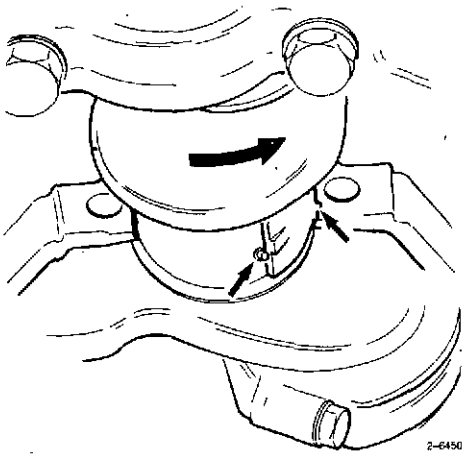
5
Clean and check the bearing seats, caps, crank journals and bearing shells. If a bearing has seized, the cause must be determined before new bearing shells are fitted.

6
Make sure that the correct size of bearing is fitted when changing.

Note! Should uncertainty arise, check in the specifications to see which oversize is fitted.

7
Smear the crank journals and the new bearing shells with oil.

8



The top bearing shell is fitted by turning the crankshaft against the direction of rotation with the pin in the oil hole.

Check that the locating tag of the bearing shell fits correctly into the recess in the bearing locating groove.

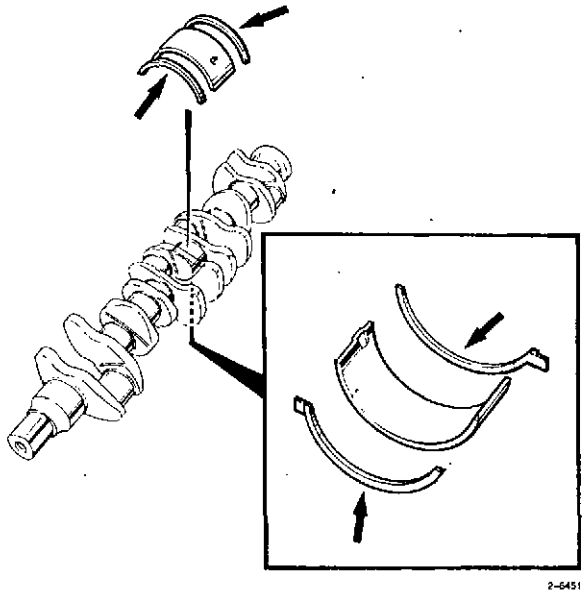
9
Fit the bearing cap with a new shell and torque-tighten the bolts.
See "Workshop Manual, Technical Data"

10
Change the other main bearings, one at a time, and in the same manner as the first one. Check after changing each main bearing that the shaft does not seize, by cranking round the shaft using the cranking tool.

11
Check the crankshaft axial play and change the axial bearing washers if there is too much play or if the washers are damaged.

The axial play should be **0.07–0.27mm, max. 0.40 mm (0.0028–0.0106", max. 0.0158")**. Measure using a dial indicator.

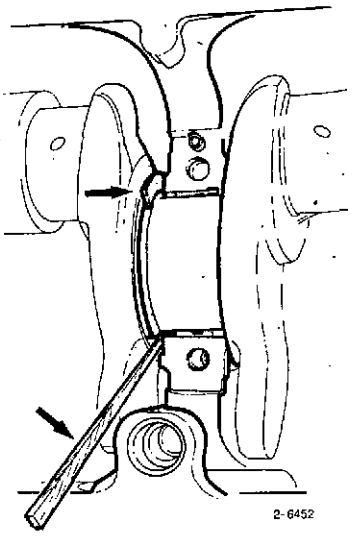
12

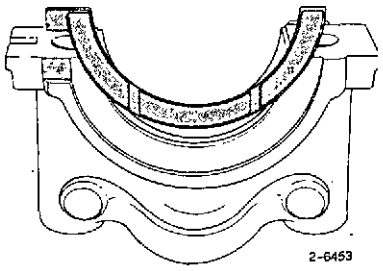


The crankshaft axial bearing is placed in the middle main bearing position.

The axial bearing washers are available in a number of oversize dimensions, see "Workshop Manual, Technical Data".

13





To remove the axial bearing washers in the cylinder block bearing position, use a narrow piece of plastic or wood.

In the main bearing cap, the axial bearing washers are placed in the countersunk grooves.

14
When all the main bearing caps have been torque-tightened, again check the crankshaft axial play.

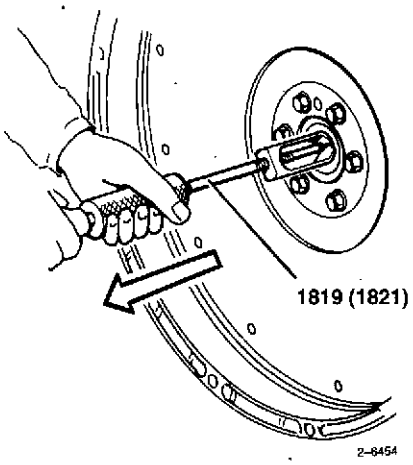
15
Fit the oil pipes.

16
Remove the cranking tool.

Flywheel bearing, changing

Special tools (Mobile): 1801, 1819, 2013
Special tools (Stationary): 1801, 1821, 2564

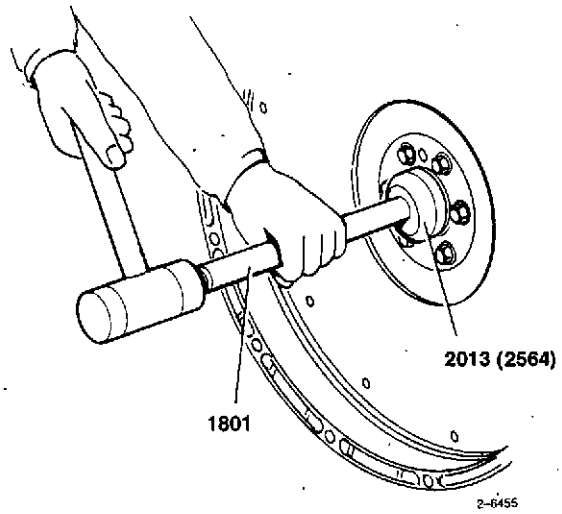
1



Remove the flywheel bearing using tool 1819 (Mobile) or 1821 (Stationary).

2
Clean the flywheel and check it for damage.

3

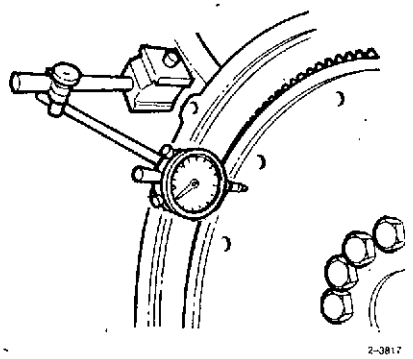


Fit the new flywheel bearing using drift 2013 (Mobile) or 2564 (Stationary) and handle 1801.

Flywheel, checking for warp

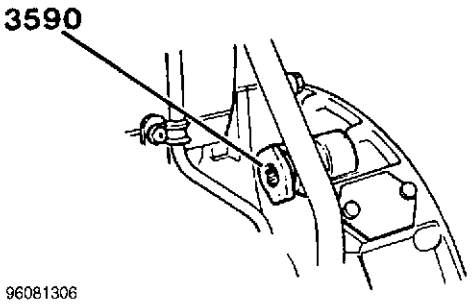
Special tool: 998 9876, 9696, 3590

1



Mount the dial indicator in a magnetic stand and zero-set the dial indicator with the probe against the flywheel.

2



Crank the flywheel round with tool 3590, noting the max. and min. values.

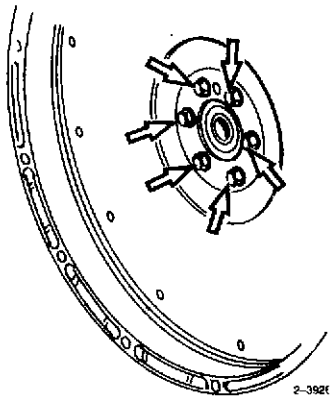
3
The difference must not exceed **0.15 mm (0.0060")** on a measuring radius of 150 mm (6").

In the case of excessive warp, remove the flywheel and check for dirt or unevenness between the flywheel and the crankshaft contact face.

4
Remove the cranking tool.

Flywheel, changing

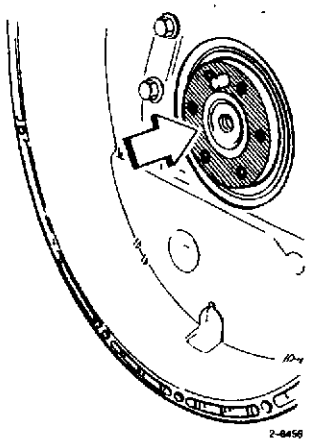
1



Remove the bolts and lift off the flywheel.

2
Check the flywheel bearing. Change a damaged bearing.

3



Clean the crankshaft flange contact surface against the flywheel.

4
Clean the flywheel contact surface against the crankshaft flange.

5
Check that the flywheel guide stud on the crankshaft is in position and is undamaged.

6
Lift up the flywheel and fit the bolts.

7
Lock the flywheel.

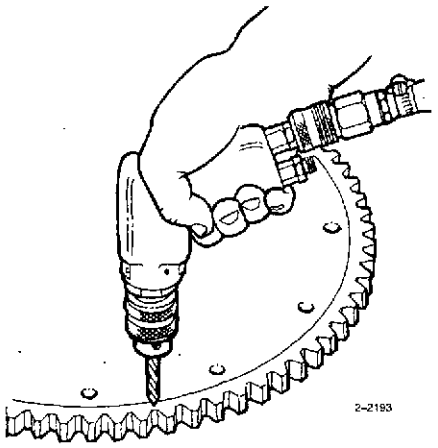
8
Torque-tighten the flywheel bolts.
See "Workshop Manual Technical Data"

9
Remove the blocking tool if fitted.

Ring gear, changing

(Flywheel removed)

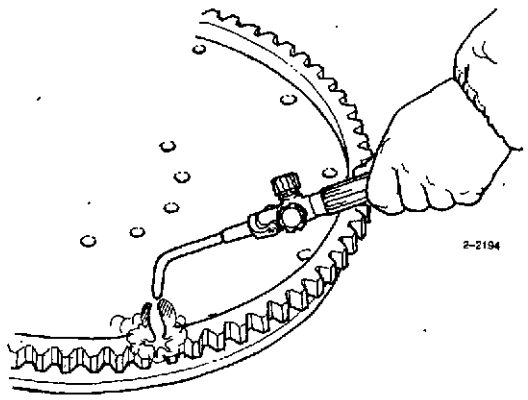
1



Drill 1–2 holes in the ring gear between teeth. Crack the ring gear at these holes with a chisel and lift off the ring gear.

2
Clean the ring gear contact surface with a wire brush.

3

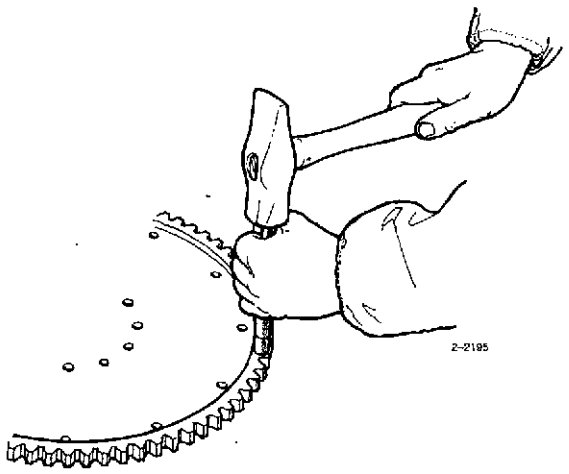


Heat up the new ring gear with a blow torch or in an oven.

Apply the heat carefully and evenly. Make sure the ring gear does not become too hot and lose its tempering.

To check the heating process, polish the ring gear to a shine at several places and stop the heating process when the surfaces become blued **(180–200°C) (356–392°F)**.

4



Fit the heated ring gear onto the flywheel and tap it into position using a soft drift and a hammer.

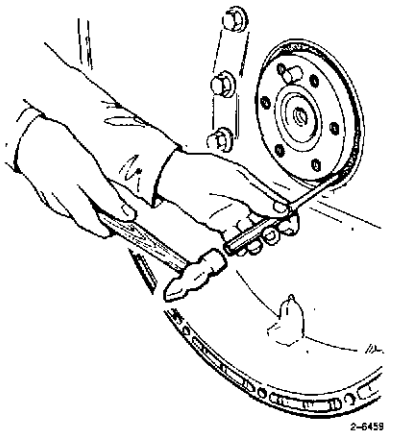
5
Allow the ring gear to cool down in air.

Crankshaft seal, rear, changing

(Flywheel removed)

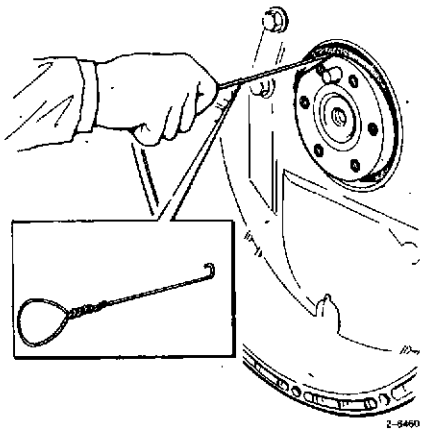
Special tools: 2000, 6437

1



Keel over the sealing ring with a drift.

2

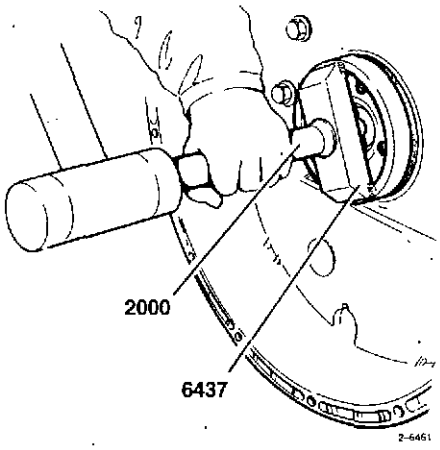


Bend a piece of steel wire as illustrated, hook the steel wire behind the sealing ring and pull it out.

3

Clean the sealing surfaces inside the flywheel casing and on the crankshaft.
Smear the new sealing ring with engine oil.

4



Tap the sealing ring carefully into position using drift 6437 and handle 2000.

Note! If there are wear grooves in the crankshaft, observe that the new sealing ring must not be fitted in these grooves.

Flywheel casing, sealant, changing

(Flywheel removed)

1
Remove the rear bolts (four) of the oil sump.

2
Remove the flywheel casing bolts.

3
Remove the flywheel casing from the cylinder block. Carefully use a plastic mallet.

4
Wipe clean the contact surfaces of the flywheel casing and cylinder block.

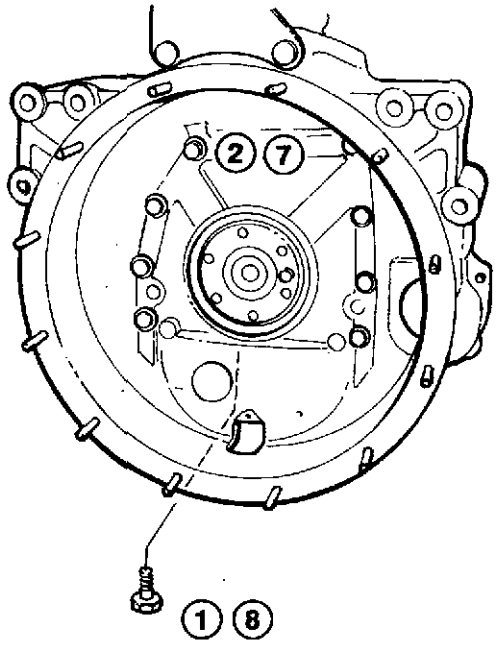
5
Apply an even **2 mm (1/16")** wide bead of sealant (Part no. 1161231) to the contact surface of the flywheel casing.

6
Fit the flywheel casing **within 20 minutes** of application of the sealant.

7
Torque-tighten the casing bolts.
See "Workshop Manual, Technical Data".

8
Fit the oil sump bolts (four) and torque-tighten them.

Figures in the illustration are referred to in the following.



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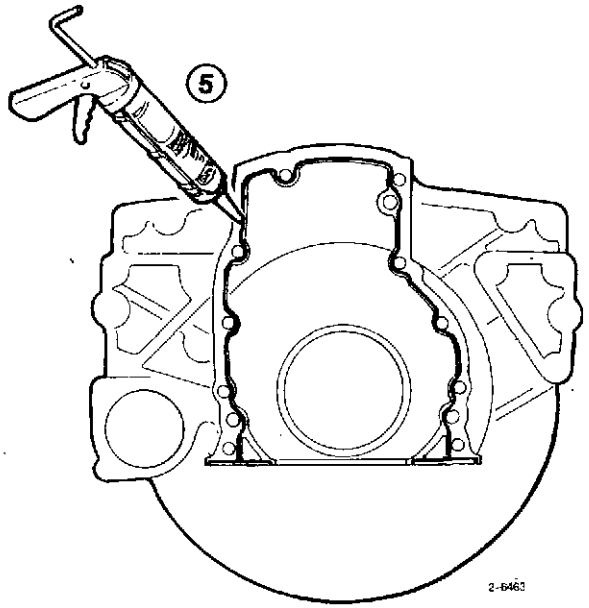


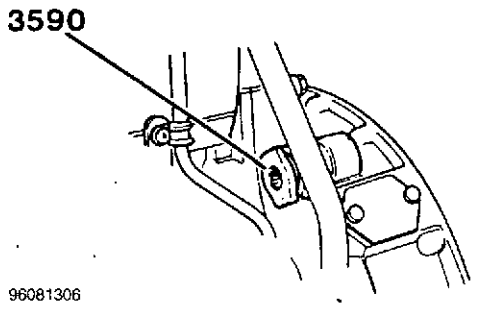
2-6463

Flywheel casing, checking for warp

Special tool: 998 9876, 9683, 9696, 3590

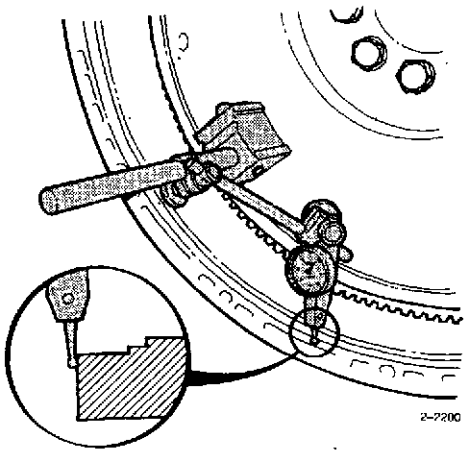
1
Clean the flywheel and flywheel casing.

2



Fit cranking tool 3590.

3



Fit a dial indicator to a magnetic stand.

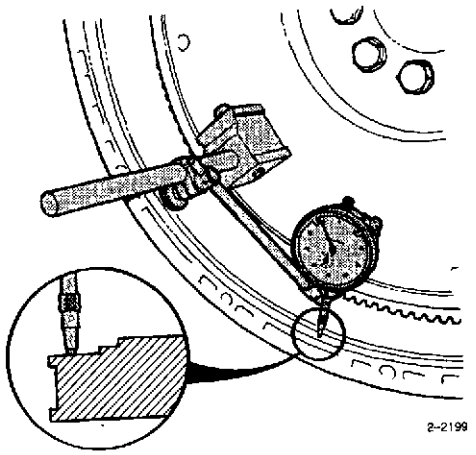
Mount the magnetic stand on the flywheel with the probe of the dial indicator against the outer edge of the flywheel casing.

Crank the flywheel round and calculate the difference between the max. and min. values.

Transfer the magnetic stand and dial indicator to the opposite side of the flywheel and carry out the same measurement procedure.

The difference between these two results must not exceed **0.15 mm (0.0060").**

4



Mount the magnetic stand on the flywheel with the proble of the dial indicator against the inner edge of the flywheel casing.

Crank the flywheel round noting the max. and min. values.

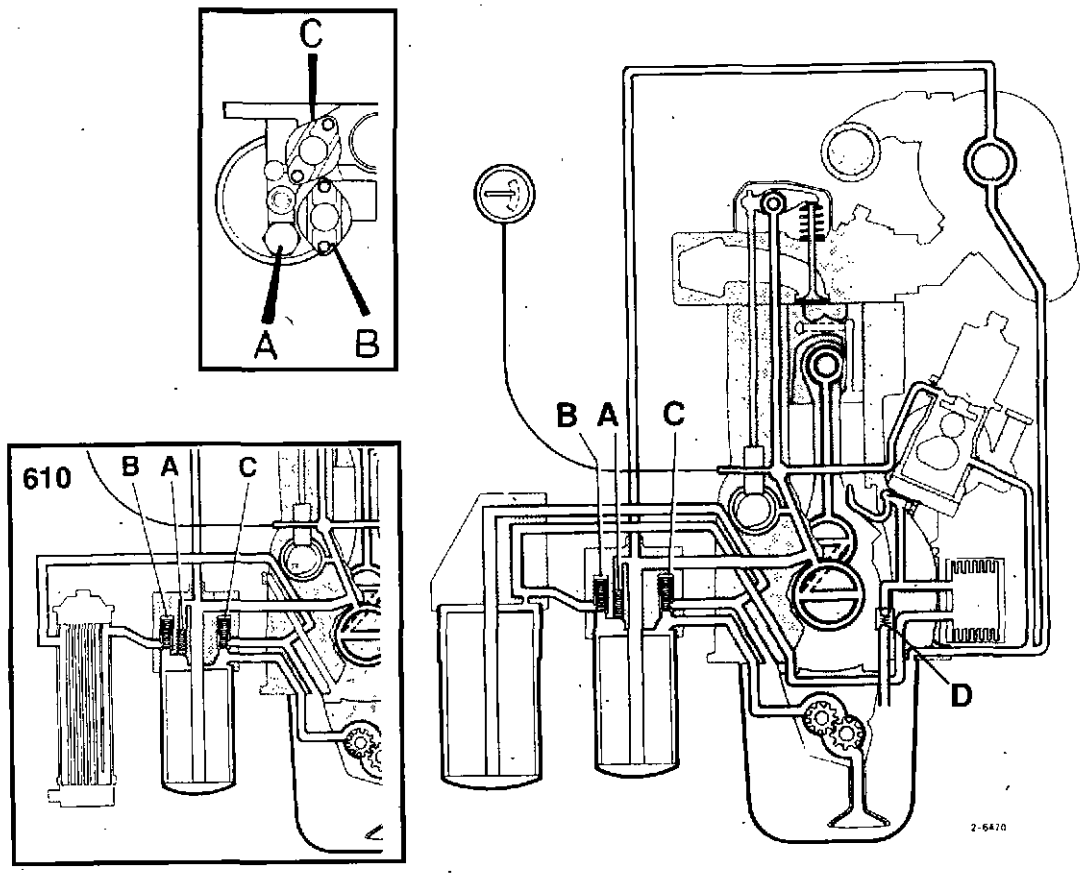
The inner edge of the casing must be concentrical with the flywheel within **0.25 mm (0.0099").**

5
Should any of the readings in points 3 and 4 be exceeded, check the contact of the flywheel casing against the cylinder block.

6
Remove the cranking tool.

Lubricating system

Design and Function



Oil valves

A
Overflow valve for oil filter

The overflow valve opens to safeguard lubrication should the filter become blocked.

B
Oil cooling valve (610, TD630)

(Oil cooler on TD630 is optional)
At engine revs approx. 1000 r/min, the oil cooling valve opens to allow some of the oil to flow to the oil cooler, and from there it flows back to the oil sump.

Piston cooling valve (TWD630, 710, 730, 731)

The piston cooling valve opens when engine revs reach slightly above idling speed and oil pressure has picked up.

Oil is led via a drilling to the piston cooling duct in the engine block.

Six jets are connected to the piston cooling duct; one for each piston, and these spray oil into the bottom of the piston skirts (TWD630/730) or into the oil cooling duct of the pistons (710, TAD730).

C
Reduction valve

The reduction valve opens should oil pressure become excessive, allowing surplus oil to flow back to the sump.

D
By-pass valve, oil cooler (TAD730)

The valve opens, allowing surplus oil, not required for piston cooling to flow back to the sump.

TWD630ME-engines

The lube system om the TWD630ME-engine differs from the other 610/630-engines as follows:

- Larger lube oil pump (same as on 710, 730)
- Flat type oil cooler (same as on 710, 730)

Service Procedures

The engine must always be washed before repairs are commended.

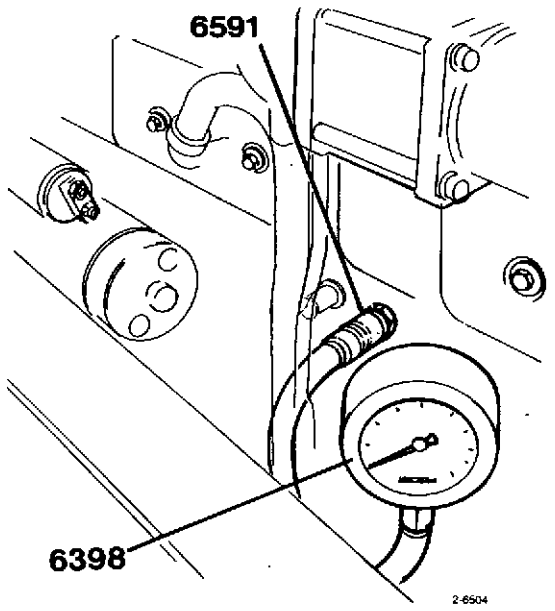
Lubricating oil pressure, checking

Special tools: 6398, 6591

1
Remove the oil pressure sensor on the rear end of the cylinder block, on the right-hand side.

Note! If required, clean up the shreads in the cylinder block using a screw tap (1/8"–27 NPSF). Smear some grease onto the tap to hold any cuttings.

2



Fit nipple 6591 and connet pressure gauge 6398 to the nipple.

3
Check oil pressure at idling and operating speed with the engine at operating temperature. See "Workshop Manual Technical Data" for correct value.

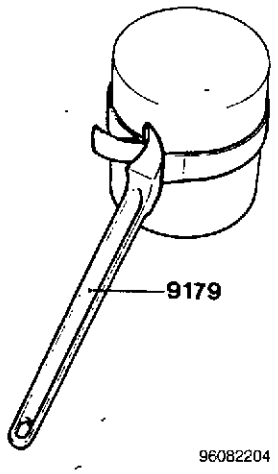
4
Remove the measuring equipment and fit the oil pressure sensor.

Oil filters, changing

Special tool: 9179

1
Place a container under the filters.

2



Clean the filter bracket and remove the filters using tool 9179.

3
Moisten the seals of the new filters with oil and screw the filters on by hand until the seals are in contact with the filter bracket. Then tighten the filters by hand a further **half turn.**

4
Fill up with engine oil and crank the engine with the starter motor until oil pressure is recorded by the pressure gauge.

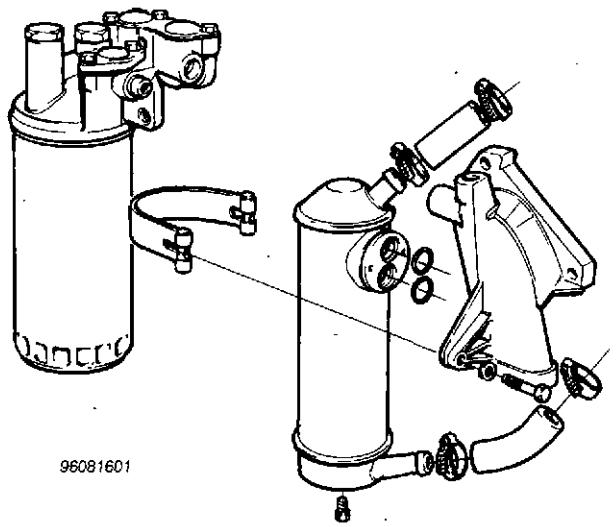
Note! Cranking the engine with the starter motor applies when changing filters and oil cooler or other components of the lubricating oil system.

5
Start the engine and check for leakage round the oil filters.

Oil cooler, changing

Tube type oil cooler

1
Drain the coolant from the engine.



2
Remove the oil cooler bottom plug and drain off the coolant.

3
Remove the lower coolant hose from the oil cooler and the upper coolant hose from the pipe.

4
Loosen the retaining clamp and lift off the oil cooler.

5
Clean the sealing ring surfaces on the oil cooler bracket.

6
Fit the upper coolant hose on the new oil cooler.

7
Fit new sealing rings and lift the oil cooler into position, at the same time fitting the lower coolant hose.

8
Fit the retaining clamp and tighten the two nuts and equal amount.

9
Connect the upper coolant hose to the pipe.
Tighten all hose clamps.

10
Top up with coolant and engine oil.

11
Crank the engine round with the starter motor until oil pressure is recorded by the pressure gauge.

12
Check for leakage.

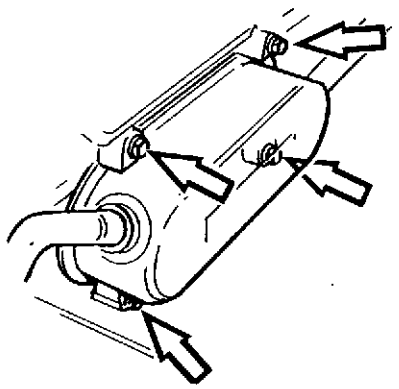
Flat type oil cooler

1
Drain off the coolant.

2
Remove the bracket holding the rear coolant pipe to the cylinder block.

3
Pull the coolant pipe out of the cylinder block and oil cooler.

4



Remove the oil cooler attaching bolts.

5
Pull the oil cooler off the front coolant pipe and remove the cooler from the cylinder block.

6
Clean the sealing surfaces and fit new sealing rings to the cylinder block.

7
Fit new sealing rings to the coolant pipes.
Note! Smear the sealing surfaces with petroleum jelly or soap solution.

8
Push the oil cooler onto the front coolant pipe and bolt the cooler to the cylinder block.

9
Fit the rear coolant pipe.
Note! Push the coolant pipe into the oil cooler first and then into the cylinder block.

10
Re-fit the holding bracket for the rear coolant pipe to the cylinder block.

11
Fill up with coolant and lubricating oil.

12
Crank the engine with the starter motor until oil pressure is recorded by the pressure gauge.

13
Start the engine and check for leakage round the oil cooler and connections.

Oil cooler, leakage test.
(Oil cooler removed)

Tube type oil cooler

Special tools: 6033, 6662, 8205, 8206

1
Flush the coolant side of the oil cooler with water-soluble degreasing fluid. Wash the oil side of the cooler with degreasing solvent.

2
In order to discover any small leakages, the oil cooler must be the same temperature as ambient room temperature.

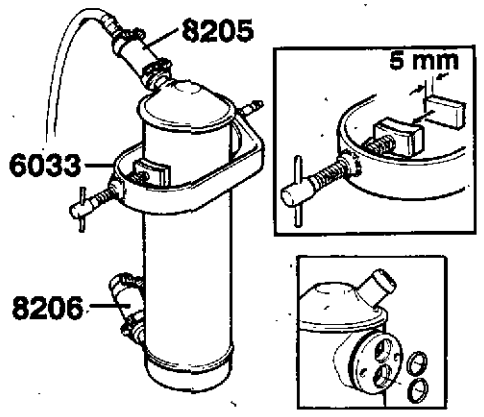
Flush the oil cooler with water at room temperature until it reaches ambient temperature. Drain off all water.

3
Fit the O-rings on the flange which connects the cooler to the oil system.

4
Fit leak detection equipment 6033 and check that it is properly sealed against the O-rings.

Fit seal 8206 on one of the coolant connections and hose connection 8205 (alt. 8200) on the other.

Make sure that the seals function properly.



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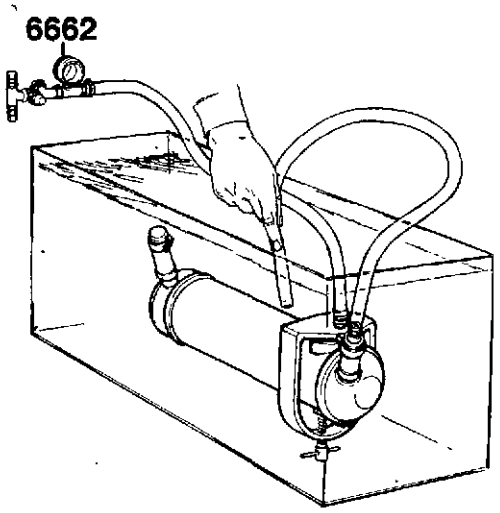
5



96081605

Connect leak detection equipment 6662 to 6033.

Lower the oil cooler into a bath containing water at ambient temperature.

Position the measurement hose approx. **2 cm (0.8")** under the surface of the water.

Note! Water must not enter the measurement hose.

The leakage check is to be carried out at three different pressures: **15 kPa, 100 kPa and 250 kPa (2.2, 14.5 and 36 psi).**

The test period for each test pressure should last for **at least one minute.**

Air bubbles emerging from the measurement hose indicate internal leakage in the oil cooler.

Air bubbles around the oil cooler indicate external leakage.

During the test, the extractor fans and ventilation system of the workshop must not be started or stopped and sudden inrushes or releases of air should be avoided. This is because changes of pressure in the workshop could be misinterpreted as leakage.

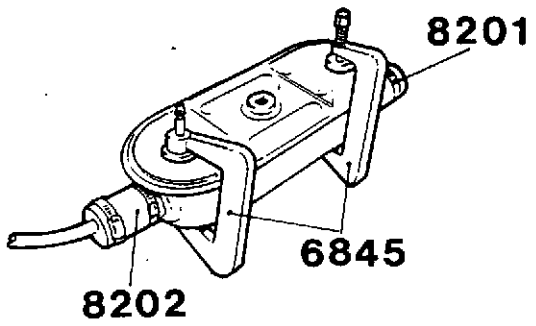
Flat type oil cooler

Special tools: 6662, 6845, 8201, 8202

1
Clean the coolant side of the oil cooler with water-soluble degreasing fluid.
Clean the oil side of the cooler with degreasing solvent.

2
To discover any small leakages, the oil cooler must be the same temperature as ambient room temperature.
Flush the oil cooler with water at room temperature until it reaches ambient temperature.
Drain off all water.

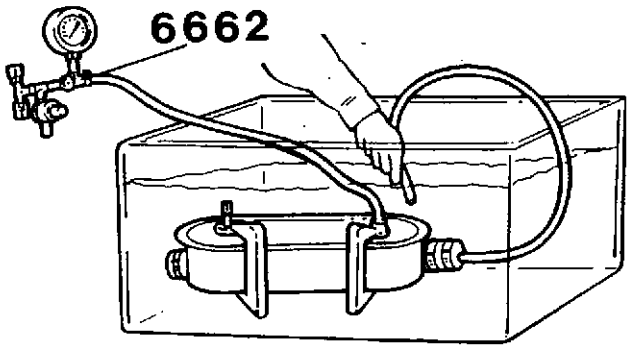
3



200-6433

Fit leak detection equipment 6845 making sure that it seals properly.
Fit seal 8201 to one of the coolant connections and hose connection 8202 to the other.
Make sure that the seals function properly.

4



200-6434

Connect leak detection equipment 6662 to 6845.

Lower the oil cooler into a bath containing water at ambient temperature.

Position the measurement hose approx. **2 cm (0.8")** under the surface of the water.

Note! Water must not enter the measurement hose.

The leakage check is to be carried out at three different pressures: **15 kPa, 100 kPa and 250 kPa (2.2, 14.5 and 36 psi).**

The test period for each test pressure should last for **at least one minute.**

Air bubbles emerging from the measurement hose indicate internal leakage in the oil cooler.

Air bubbles around the oil cooler indicate external leakage.

During the test, the extractor fans and ventilation system of the workshop must not be started or stopped and sudden inrushes or releases of air should be avoided. This is because changes of pressure in the workshop could be misinterpreted as leakage.

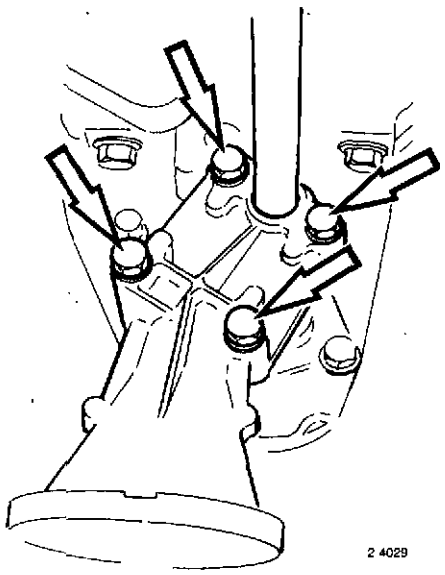
5

Remove the cooler from the bath and disconnect the leakage testing equipment.

Lubricating oil pump, changing
(Sump removed)

Removing

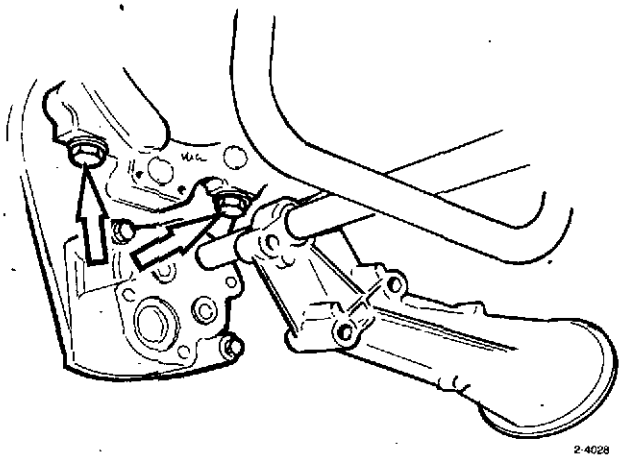
1



Remove the bolts holding the oil feed pipe and oil suction pipe.

2
Remove the oil suction pipe bracket from the oil pump.

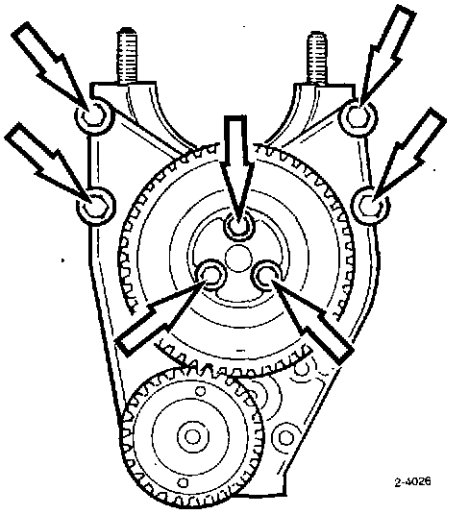
3



Remove the bolts from the front main bearing cap and lift off the oil pump together with the cap.

4
Remove the bearing shell from the cap.

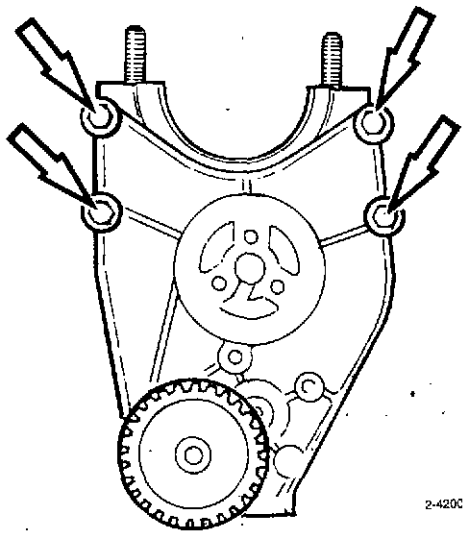
5



Remove the intermediate drive gear and the main bearing cap from the oil pump bracket.

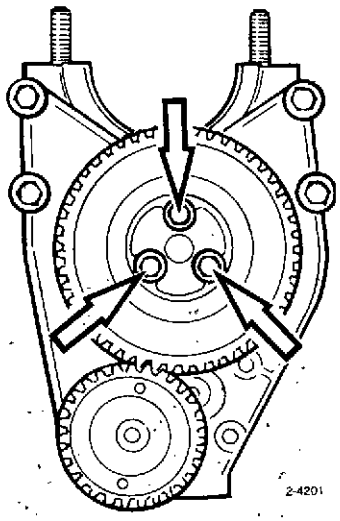
Fitting

6



Screw the main bearing cap to the oil pump bracket. Torque-tighten the bolts and lock with the lock tabs. See "Workshop Manual Technical Data" for correct tightening torque!

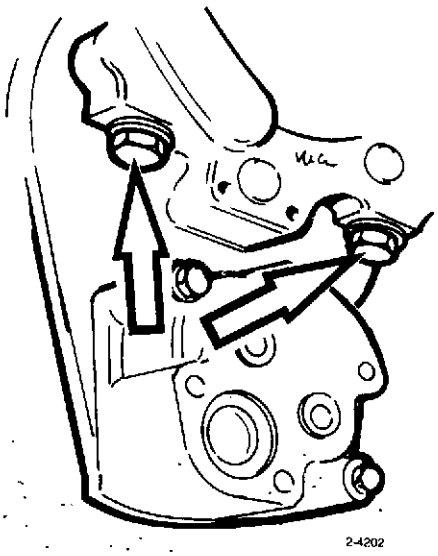
7



Fit the intermediate drive gear and torque-tighten the bolts.
See "Workshop Manual Technical Data" for correct tightening torque!

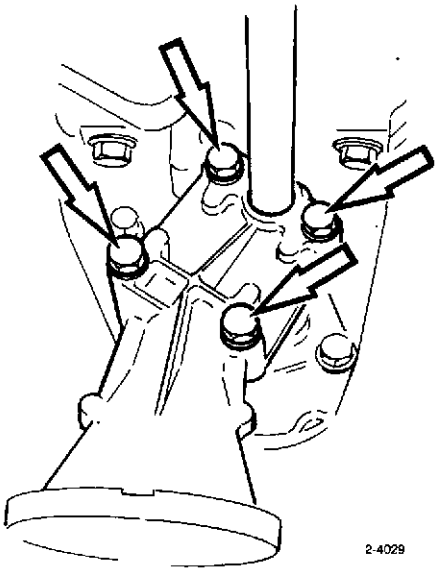
8
Smear with oil and fit the main bearing shell in the cap.

9



Fit the oil pump in position, fit the bearing cap bolts and tighten to the specified torque.

10



Fit new O-rings and bolt the oil suction pipe bracket to the oil pump.

Lubricating oil pump, overhauling

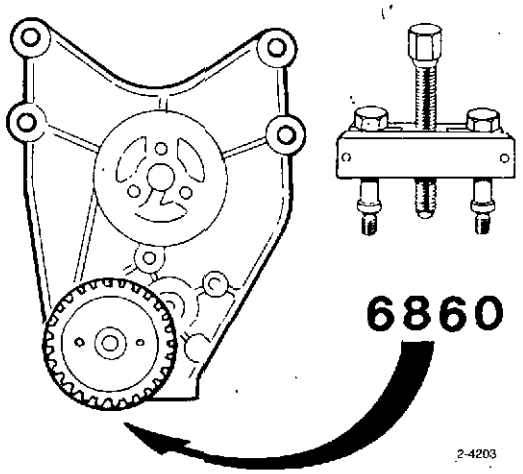
(Lubricating oil pump removed)

Special tools: 6849, 6850, 6860

1
Remove the main bearing cap from the oil pump bracket.

2
Remove the intermediate drive gear.

3



Pull the oil pump drive gear from the shaft using puller 6860.

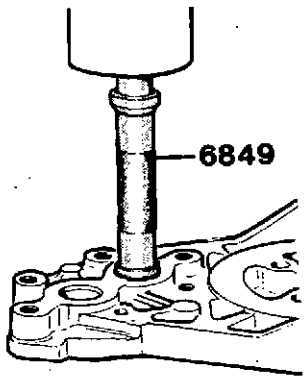
4
Mark the pump housing in relation to the bracket. Remove the bolts and the pump housing from the bracket.

5
Remove the pump gears from the housing.

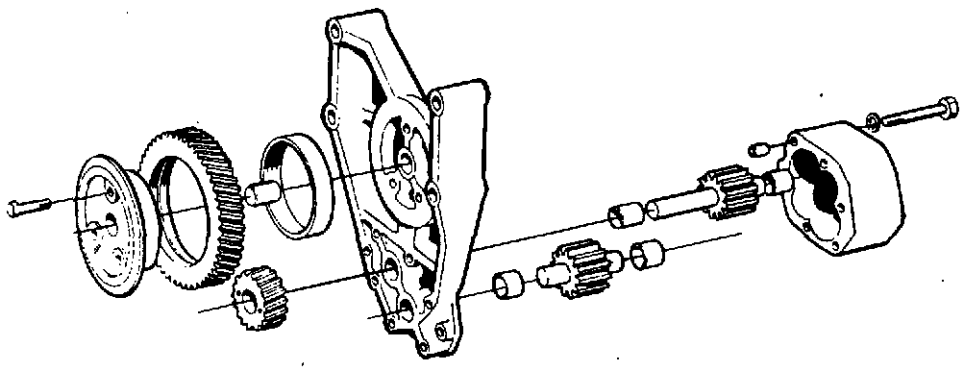
6
Check the housing for scoring and wear and also check for leakage between the bracket and pump housing. If there has been a leakage, the contact surfaces will be black.

Check the pump gears for wear on flanks, outer diameter and end faces.

7



Press the bushings out of the bracket and pump housing using tool 6849.



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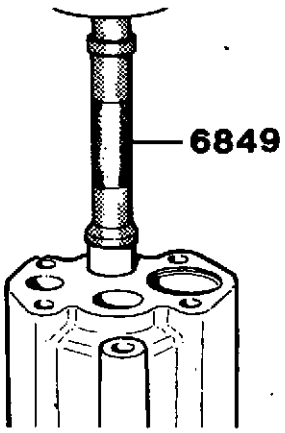
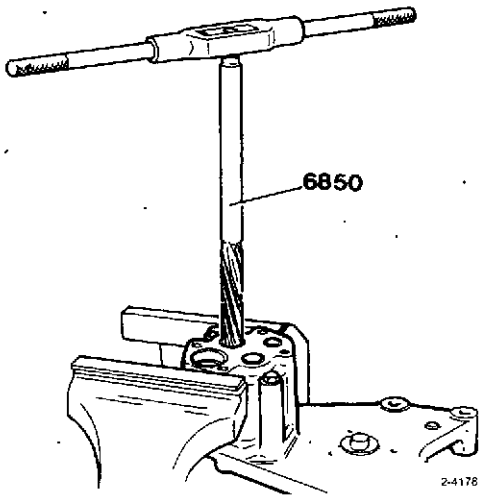


Press the new bushings into the pump housing and bracket using tool 6849.

9
Bolt the pump housing to the bracket considering earlier markings, to provide a guide when reaming the bushings.

10



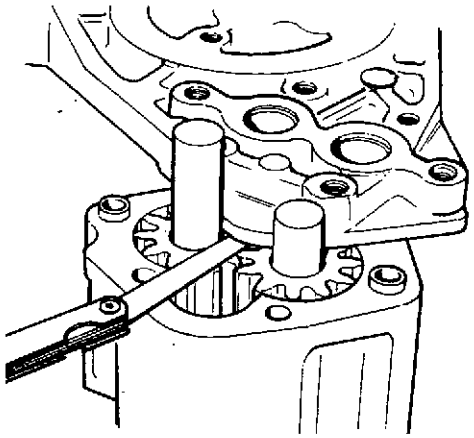
Ream the bushings in the pump housing and bracket using tool 6850.

11
Remove the bolts and remove the pump housing from the bracket.

12
Carefully clean the pump housing and bracket to remove all swarf.

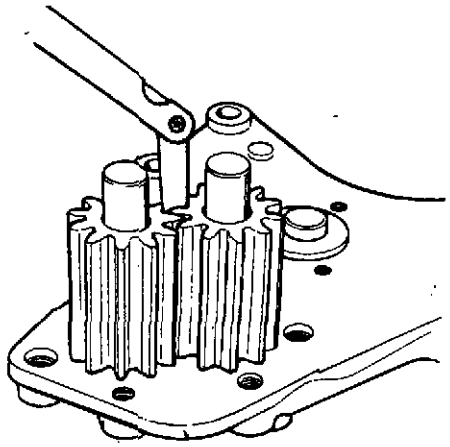
13
Smear the new pump gears and bushings with engine oil, fit the gears into the housing.
Note! Make sure that the shortest idler gear journal is facing the oil pump bracket

14



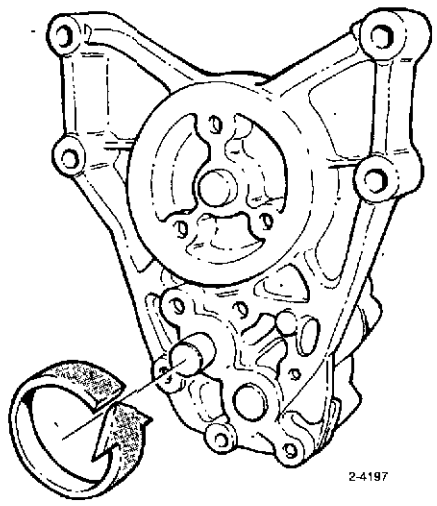
Check the axial clearance of the pump gears with a feeler gauge.
Correct clearance is **0.07–0.15 mm (0.003 – 0.006")**.

15



Check the pump gear backlash using a feeler gauge. Correct backlash is **0.15 – 0.30 mm (0.006 – 0.012")**.

16

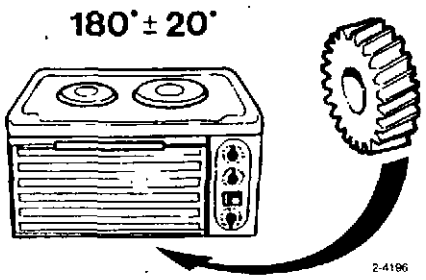


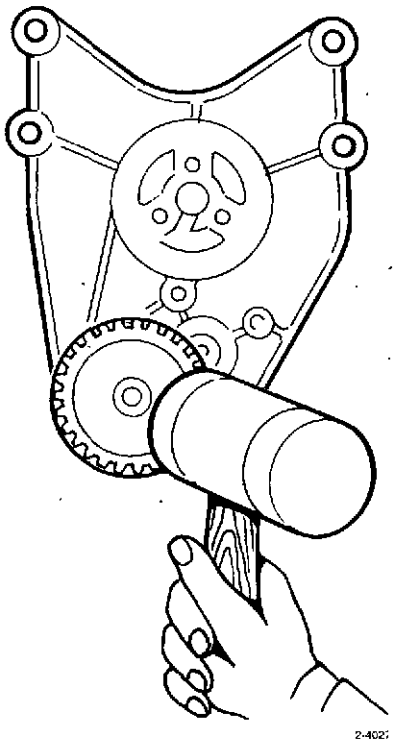
After checking axial clearance and backlash, transfer the pump gears to the bracket. Then fit and tighten the pump housing to the bracket, considering earlier markings. Check by turning the pump shaft **one full turn** that the pump gears turn and mesh easily and do not baulk.

17

When overhauling an early design pump where pump shaft and drive gear had a key and keyway, the drive gear should also be changed.

18

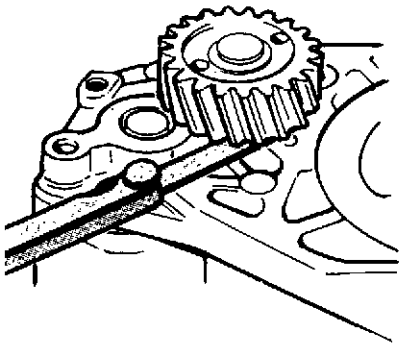




Heat up the oil pump drive gear to **180±20°C (356±68°F)** and tap the gear onto the shaft using a plastic mallet.

Note! On early design pumps, an axial washer was originally fitted between the drive gear and bracket. This washer should not be re-fitted when overhauling the pump.

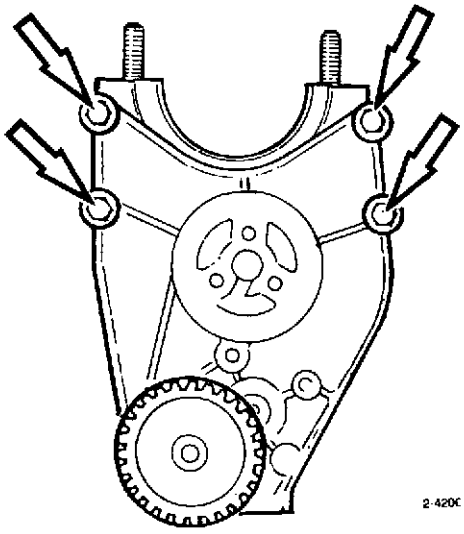
19



Check the clearance between the pump gear and bracket using a feeler gauge.

The correct clearance should be **1.0–1.5 mm (0.04 – 0.06")**.

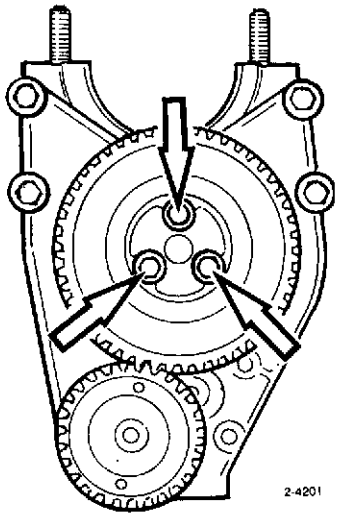
20



Bolt the main bearing cap to the oil pump bracket. Fit and torque-tighten the bolts.

See "Workshop Manual Technical Data" for correct tightening torque!

21



Fit the intermediate gear and torque-tighten the bolts.

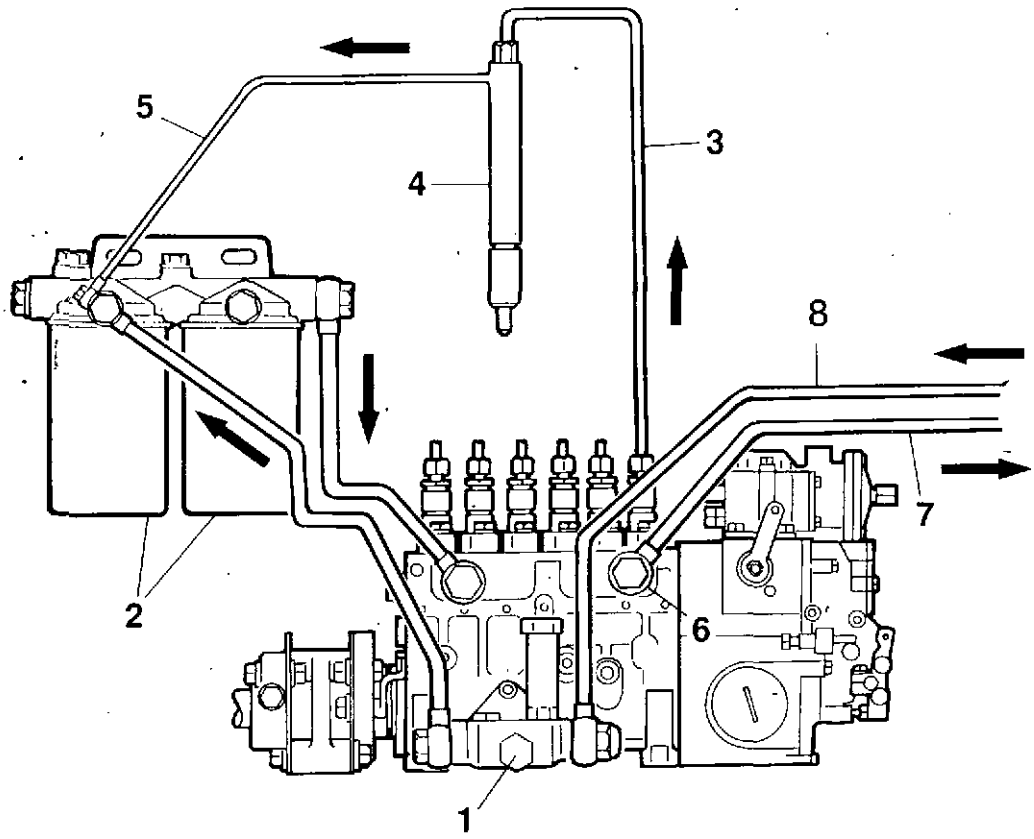
See "Workshop Manual Technical Data" for correct tightening torque!

Fuel system

Design and function

General

The main components of the fuel system are: fuel tank with level sensor, feed pump, two fuel filters, injection pump, injectors and piping.



TWD730ME

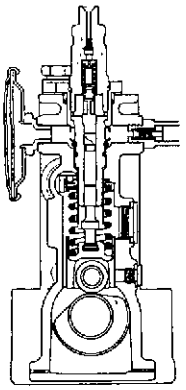
Fuel system

1 Feed pump
2 Fuel filter
3 Fuel delivery pipe
4 Injector
5 Leak-off pipe
6 Overflow valve
7 Fuel return pipe
8 Fuel feed pipe

Injection pump

The injection pump is driven from the engine timing gears. The pump stands on a shelf on the left-hand side of the engine and is driven of the engine timing gears via a pump coupling. (On 610, and TD630 it is flange-mounted on the timing gear casing). Lubrication is by means of a connection to the engine lubricating system.

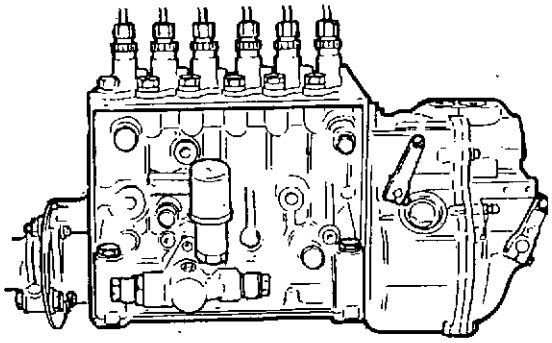
The pump setting is measured with a dial indicator, as a lift from the basic circle at a specified crankshaft angle.



2-4216

The TWD730ME engines have a bracket with a threaded hole, fitted on the front end of the pump. A corresponding hole is provided in the carrier flange of the pump shaft.

This is intended for use with a special tool which allows the pump to be locked in position at the start of injection on 1st cylinder.



2-6474

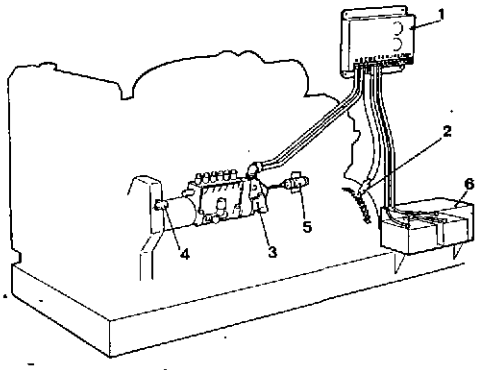
Governor

The injection pumps are fitted with centrifugal governors.

The governors work by means of speed-sensitive flyweights. The speed is regulated throughout the entire speed range of the engine, from low idling to high idling (variable speed type).

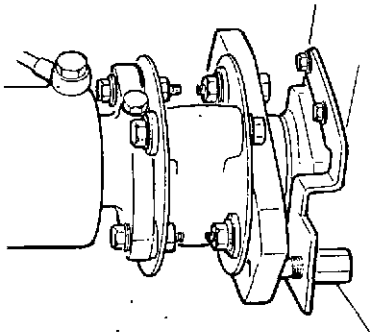
Some engines are fitted with electronic speed governors. The electronic governor system is a control unit which controls the engine speed. Its task is to:

- maintain the idling speed at the set value
- maintain the enginer's operating speed at the preset value despite varying loads.



Electronic governor system

1 Control Unit
2 Engine speed pickup
3 Actuator
4 Engine speed pickup for overspeed protection
5 Stop solenoid / fuel shut-off valve
6 Batteries



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Injection timing adjuster

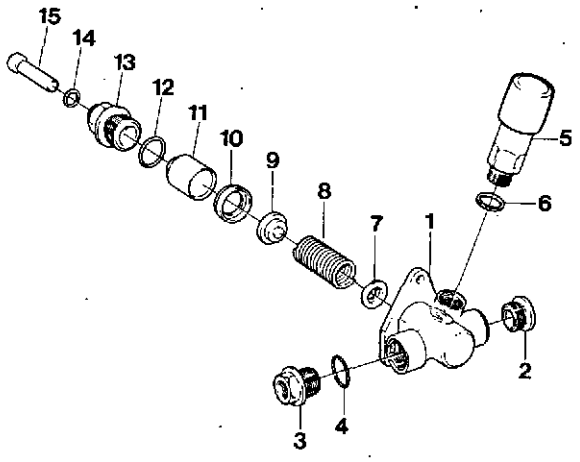
TWD630ME and TWD730ME is fitted with an injection timing adjuster, the purpose of which is to provide a variable injection point to match engine speed. See Page 14.

Feed pump

The feed pump is mounted on the injection pump and is driven from the injection pump camshaft.

The feed pump pressure is determined by the overflow valve of the fuel system.

1. Housing
2. Union
3. Union
4. O-ring
5. Hand primer
6. Gasket
7. Spring disc
8. Spring
9. Valve
10. Spacer
11. Pump plunger
12. O-ring
13. Union
14. O-ring
15. Push rod



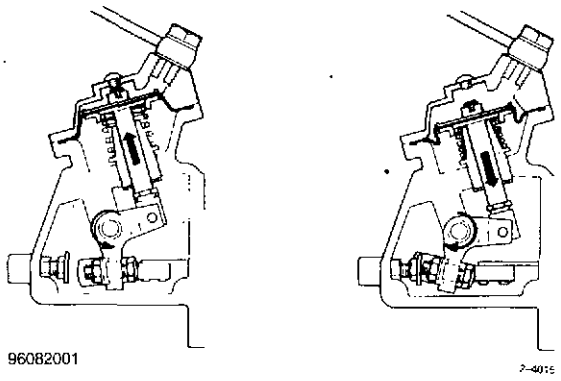
Smoke limiter (some engines)

The location and type of smoke limiter is dependent on the make and type of pump but its purpose of limiting the quantity of fuel supplied by the injection pump at low boost pressure from the turbo-compressor is common to all smoke limiting devices.

The diaphragm in the smoke limiter is acted on, via a pipe, by pressure in the inlet manifold. Movement of the diaphragm is carried to a linkage which acts on the travel of the injection pump control rod.

In conditions of low boost pressure, control rod travel is shortened by the smoke limiter causing the injection pump to lower the maximuim fuel quantity delivered.

In cases of high boost pressure, the smoke limiter allows the control rod to move to a position giving a higher maximum fuel quantity.



Low boost pressure

High boost pressure

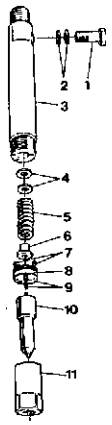
Injectors

The purpose of the injectors is:

- To atomize the fuel in order to provide reliable ignition and combustion.
- *Together with the air swirl, to distribute the jets of* fuel in the combustion chambers so as to give an optimum mixture of fuel and air.

The injector opening pressure is determined by the tension of the delivery spring.

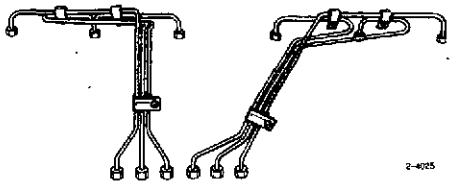
1. Banjo bolt
2. Gaskets
3. Injector holder
4. Adjusting washers
5. Spring
6. Pressure pin
7. Guide pins
8. Guide
9. Guide pins
10. Injector
11. Injector nut

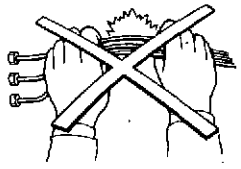


Fuel delivery pipes

Some of the engines is fitted with pre-tensioned fuel delivery pipes. Under no condition should the pipes be bent or reshaped. Should a pre-tensioned pipe be bent or deformed, there is a considerable risk of it snapping. A damaged pipe should always be replaced with a new one.

When removing injectors or the injection pump, the entire pipe assembly must be removed as one. Do not remove the pipe clamps. Remove the pipes in threes. If the entire pipe assembly is clamped togheter, then remove all pipes as one.





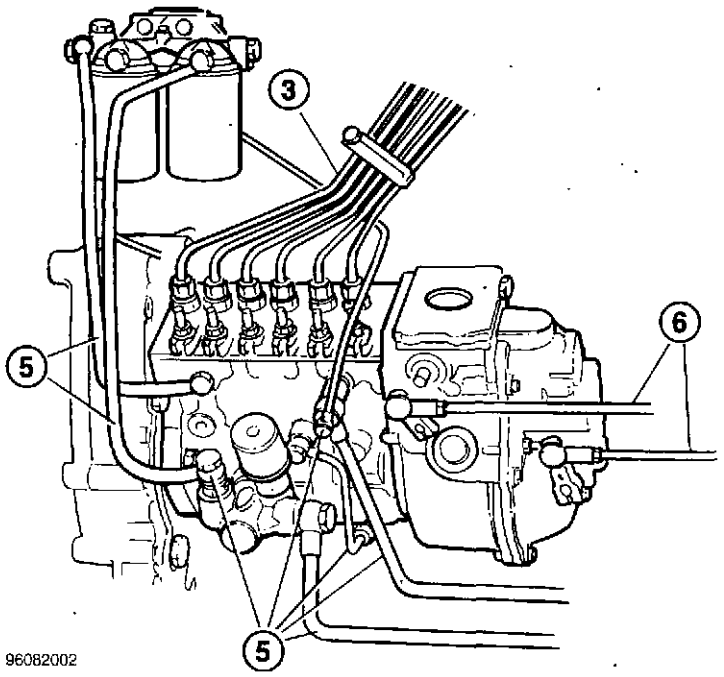
Service Procedures

The engine must always be cleaned before commencing repairs.

Injection pump, removing

610, 630 with flange mounted pump

Special tool: 3590



Figures in the illustration are referred to in the following.

Note! Protective plugs must always be fitted to all fuel and oil pipes and connections when disconnecting the pump.

1
Clean the injection pump, pipes and the part of the engine nearest the pump.

2
Remove the valve cover on 1st cylinder.

3
Remove the fuel delivery pipes.

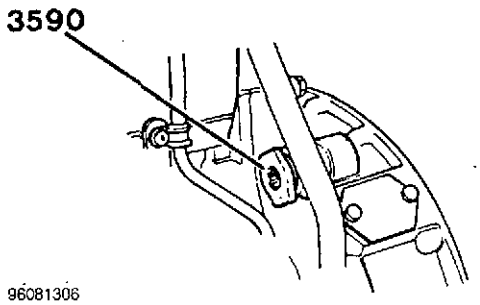
Note! The pipes are clamped together. Do not remove the clamps, remove all pipes as one.

4
Remove the pipe from the smoke limiter (if fitted).

5
Remove the oil and fuel pipes from the injection pump.

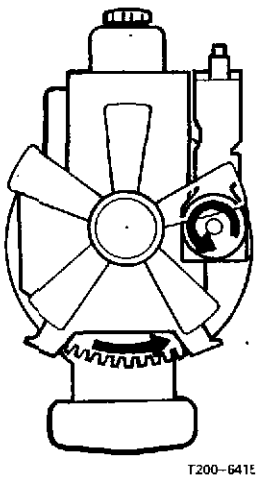
6
Remove the accelerator and stopping linkages.

8



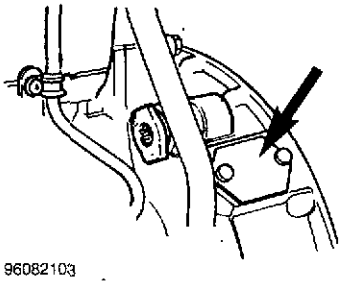
Crank the flywheel until 1st cylinder is on compression (0° on the flywheel and both valves on 1st cylinder closed).

9



Crank the flywheel **against the direction of rotation** approx. 1/4 turn.

10



Remove the inspection cover in the flywheel casing.

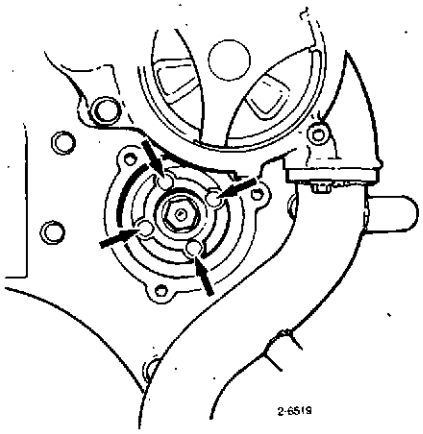
11

Crank the flywheel round **in the engine's direction of rotation** until the markings for correct setting degree , see "Workshop Manual Technical Data", coincides with the indicator on the flywheel casing.

Note! This setting should be carried out to ensure the injection pump drive gear is in the correct position when refitting the pump.

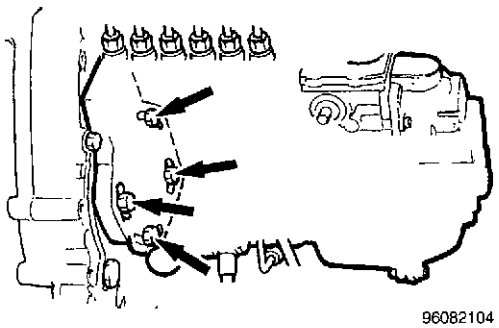
Do not crank the flywheel round when the pump drive gear has been removed.

12



Remove the cover in front of the pump drive gear and remove the drive gear bolts and flange.

13



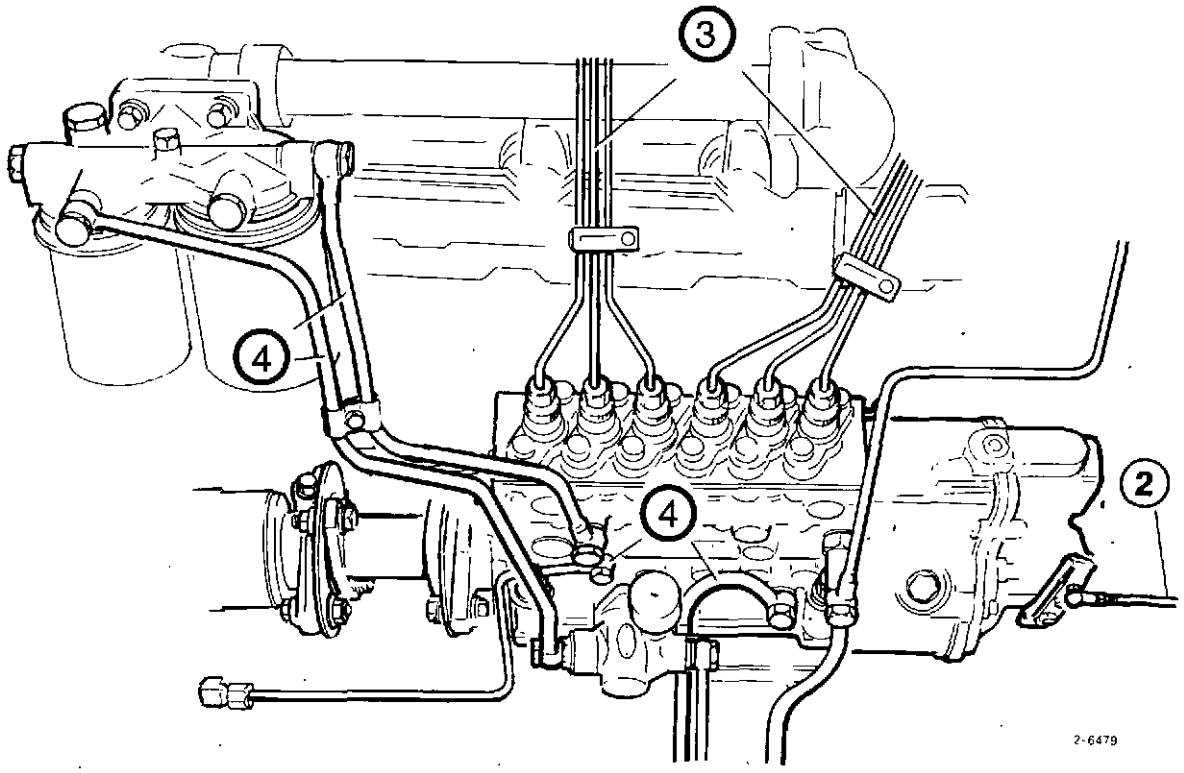
Remove the retaining nuts and carefully lift off the injection pump.

14

Fit the valve cover, if necessary change the gasket.

TWD630ME, TWD710G/P, TAD730G/P, TD730ME, TWD730ME, TWD731ME

Special tool: 3590



Figures in the illustration are referred to in the following.

Note! Protective plugs must always be fitted to all fuel and oil pipes and unions when disconnecting the pump.

1
Clean the injection pump, pipes and the part of the engine nearest the pump.

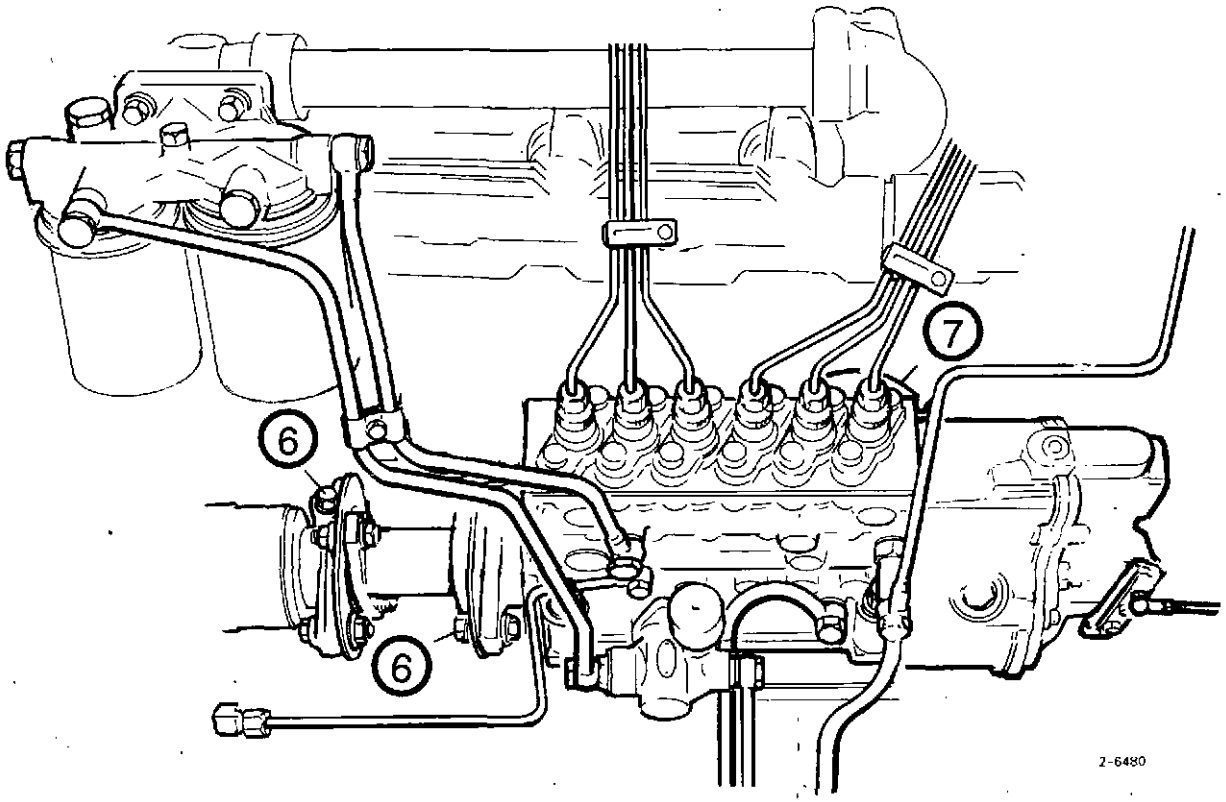
2
Remove the accelerator and stopping linkages.

3
Remove the delivery pipes and plug the connections.

Note! Fuel delivery pipes are clamped together in threes. Do not remove the clamps, remove all three pipes as one.

4
Remove all fuel and oil pipes from the injection pump.

5
Remove the pipe from the smoke limiter (if fitted).



Figures in the illustration are referred to in the following.

6
Slacken the pump coupling clamping screw and remove the bolts connecting the pump coupling to the injection pump carrier flange.

7
Remove the pressure equaliser from the injection pump (if fitted).

8
Remove the injection pump mounting bolts and carefully lift off the pump.

Injection pump, fitting

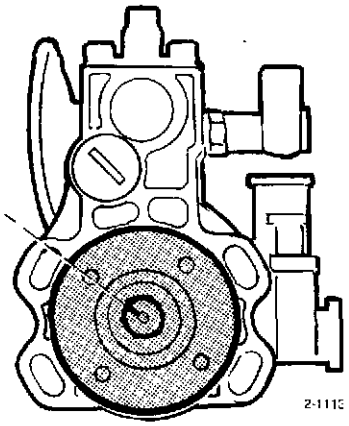
610, 630 with flangemounted pump

Special tools: 3590, 6848, 998 9876

Note! Do not remove the protective plugs from the injection pump before fitting the pipes. Check that the pump and governor are filled with oil to the correct level.

Use new copper washers.

1

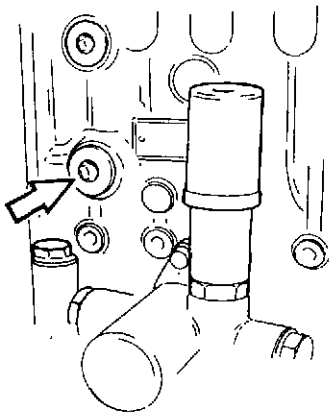


Set the injection pump camshaft so that the broken line on the end of the shaft is directed towards the upper edge of the oval hole in the pump end wall upper inner flange anchorage.

2
Fit a new sealing ring on the injection pump guide flange against the timing gear casing.

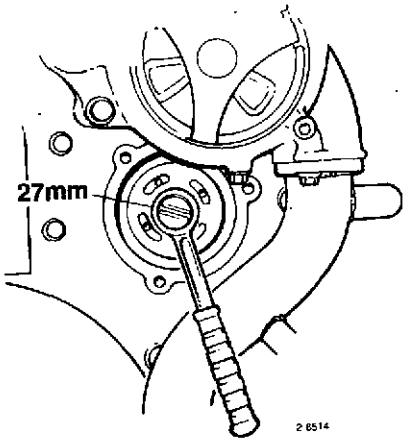
3
Fit and bolt down the injection pump. Position the pump so that the studs are in the middle of the oval holes in the pump attachment flange.

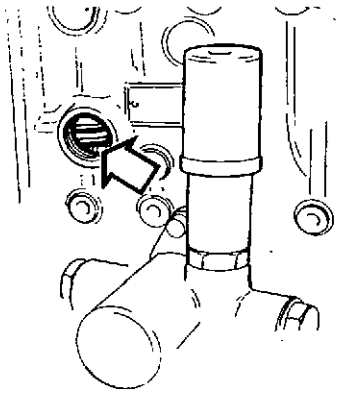
4



Remove the hex socket plug together with washer to reveal the 1st tappet on the injection pump.

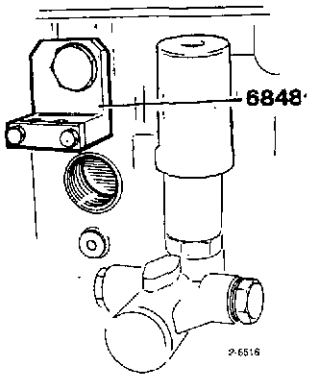
5





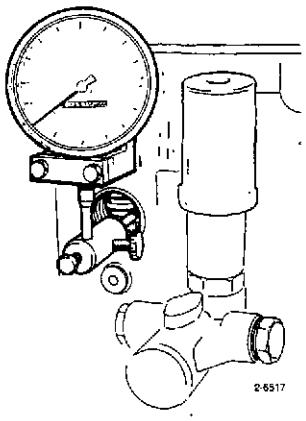
Using a 27 mm socket and extension, turn the pump camshaft until the 1st tappet is in its bottom position.

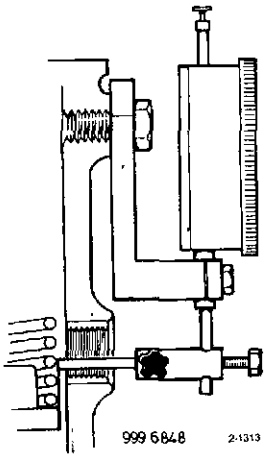
6



Fit tool 6848 to the injection pump.

7

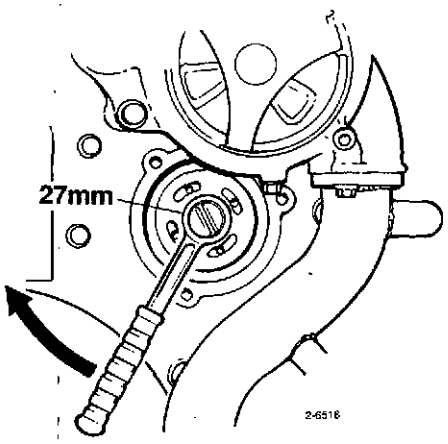




Fit a dial indicator to 6848. Adjust the probe so that it is in contact with the tappet.

8
Zero-set the dial indicator.

9

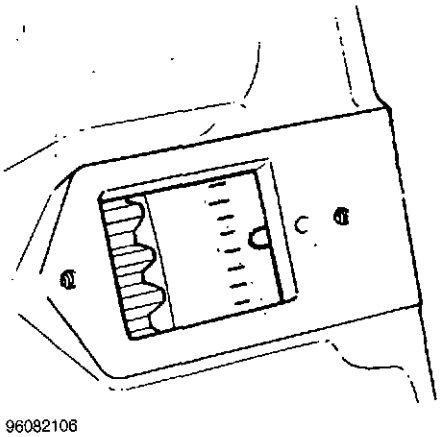


Turn the pump camshaft **in the pump's direction of *rotation.***

Check that the zero-setting of the dial indicator is still correct when turning is commenced.

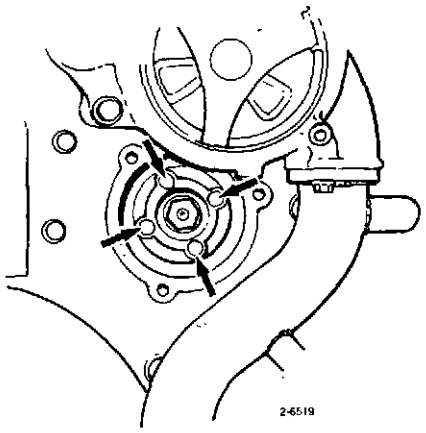
10
Continue to turn the pump camshaft **in the pump's direction of rotation** until the value for the lift from basic circle specified by the specifications is shown on the dial indicator.

11

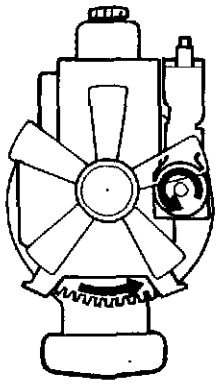


Check that the flywheel has not been moved from its set position and that the markings for correct setting degree , see "Workshop Manual, Technical Data", co-incides with the indicator on the flywheel casing.

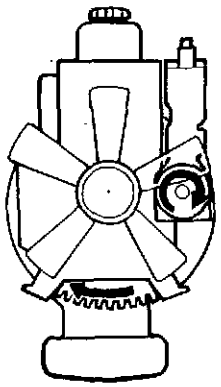
12



Fit the pump gear flange and torque-tighten the bolts according to the specifications.

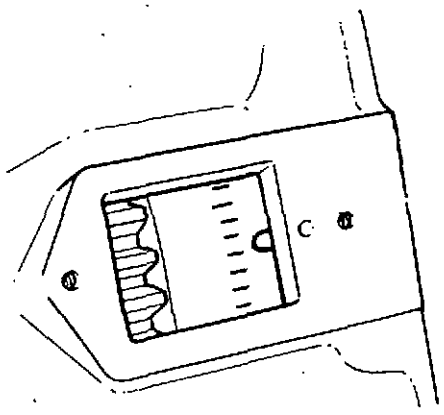


Against the direction of rotation



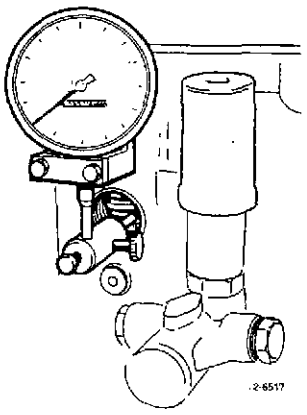
In the direction of rotation

13



Check the setting by first cranking the flywheel **against the engine's direction of rotation** approx. 1/4 turn and then in the **in the engine's direction of rotation** until the markings for correct setting degree, see "Workshop Manual, Technical Data", coincides with the indicator.

14



Check that the dial indicator shows the correct value for lift from basic circle, see "Workshop Manual, Technical Data",

15

Should any readjustment be necessary, the injection pump can be turned within the limits of the oval holes in the attachment flange against the timing gear casing.

Note! After the attachment nuts have been loosened, the injection pump should first be turned in the pump camshaft direction of rotation and then against the shaft direction of rotation until the correct value has been obtained on the dial indicator. The attachment nuts should then be tightened and a new check carried out.

16

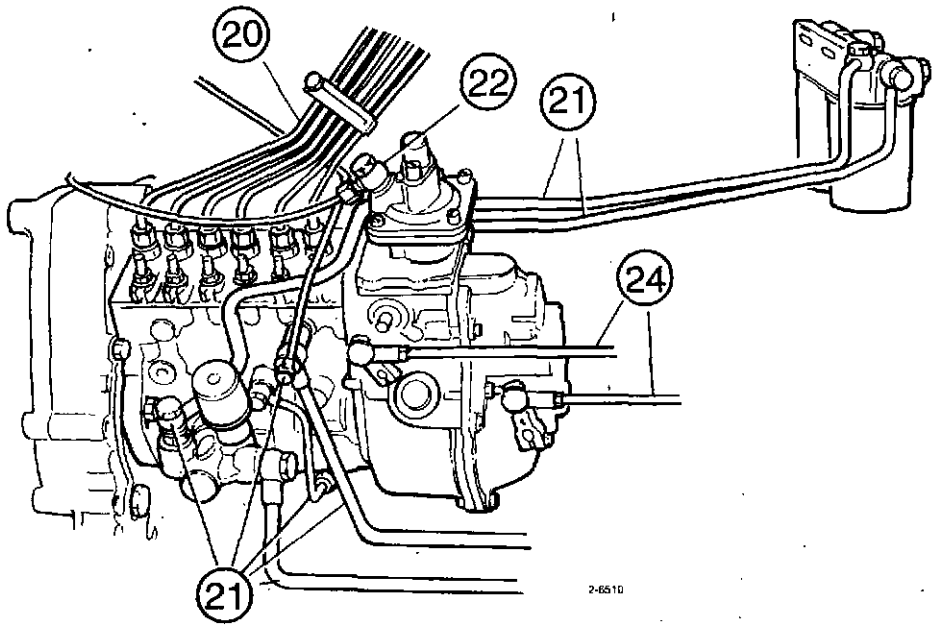
Remove the setting tool, fit new sealing washers and re-fit the plugs on the injection pump.

17

Remove the cranking tool from the flywheel casing.

18

Re-fit the inspection cover on the flywheel casing.



The figures in the illustration are referred to in the following.

19
Fit the cover in front of the pump drive gear.

20
Fit the fuel delivery pipes.

21
Fit all fuel and oil pipes.

22
Fit the pipe to the smoke limiter (if fitted).

23
Fit the pressure equaliser (if any).

24
Fit the accelerator and stopping linkages.

25
Bleed the fuel system.

26
Start the engine and check for leakage.

TWD630ME, TWD710G/P, TAD730G/P, TD730ME, TWD730ME, TWD731ME

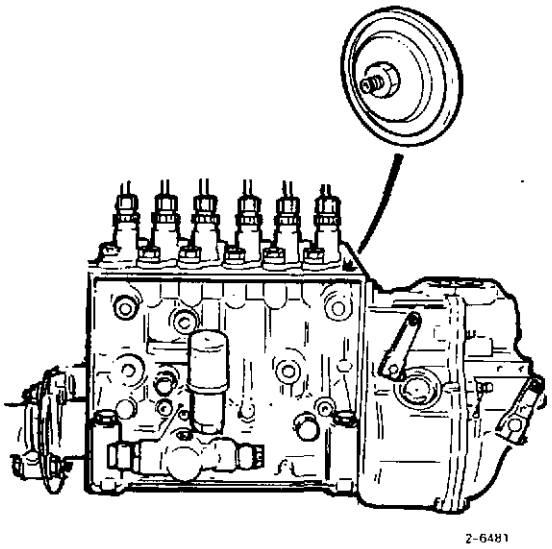
Special tools: 3590, 6848, 998 9876,
3590, 8191(TWD730ME)

Note! Do not remove the protective plugs from the injection pump before fitting the pipes. Check that the pump and governor are filled with oil to the correct level.

Use new copper washers.

1
Check that the pump coupling is in good condition and clean. There must be no traces of oil or other impurities.

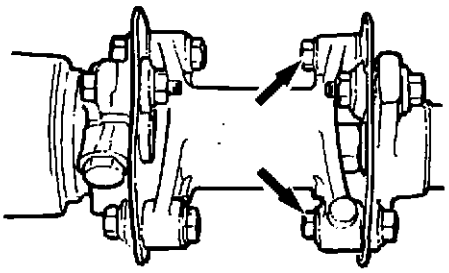
2



Fit the pressure equalizer (some engines) to the injection pump.

3
Fit the injection pump into position, fit and tighten the bolts.

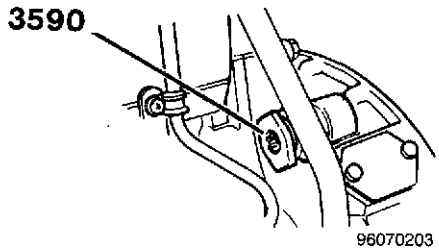
4



Fit together the pump coupling and the injection pump carrier flange, tightening the nuts to the specified torque.
Note! Do not tighten the clamping bolt.

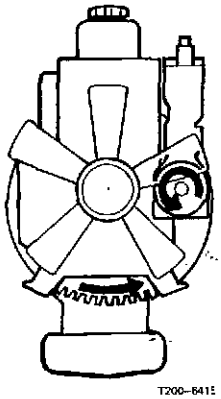
5
Remove the valve cover from 1st cylinder.

6



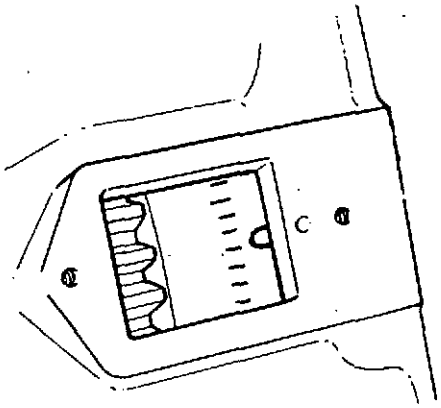
Remove the inspection cover on the flywheel casing. Fit cranking tool 3590 and turn the flywheel until 1st cylinder is on compression (0° on flywheel and both valves of 1st cylinder closed).

7



Turn the flywheel approx 1/4 turn **against** the engine's direction of rotation.

8



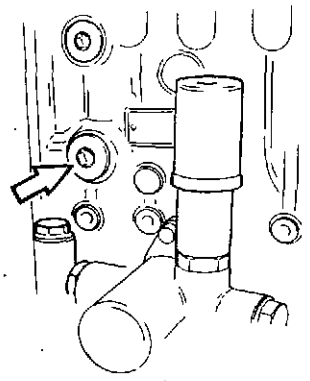
Turn the flywheel back **in the engine's direction of rotation** until the correct numbers of degrees coincides with the marking on the flywheel. See "Workshop Manual, Technical Data".

9

Note! This adjustment must be done accurately and the flywheel must never be cranked against the direction of rotation to provide fine adjuistment. If the flywheel has been turned too far, the adjustment must be done from the beginning again.

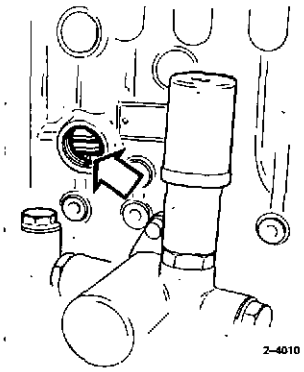
TWD630ME, TWD710G/P, TAD730G/P, TD730ME, TWD731ME

10



Remove the hex-socket plug and washer to reveal 1st tappet of the injection pump.

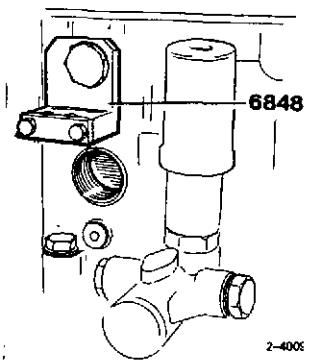
11



Using a polygrip, turn the pump coupling until the tappet moves to its bottom position.

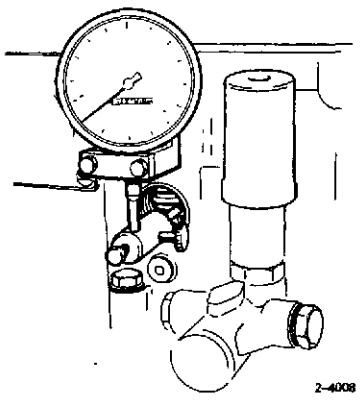
Note! Take care so as not to damage the pump coupling.

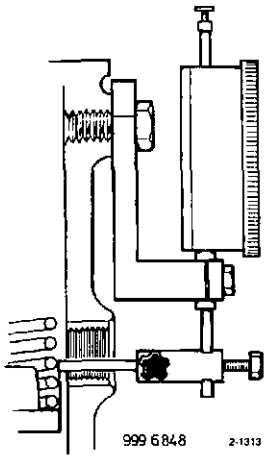
12



Fit tool 6848 to the injection pump.

13



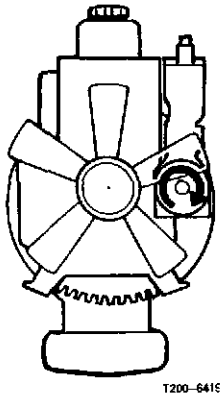


Fit the dial indicator to 6848. Adjust the reach of the probe so that it is just in contact with the tappet.

14

Zero-set the dial indicator.

15



Using a polygrip, turn the pump coupling **in the pump's direction of rotation.**

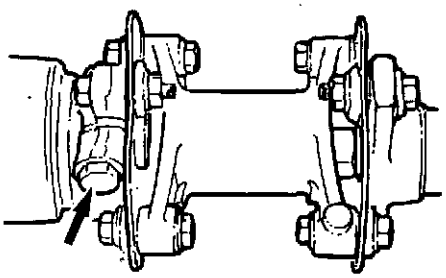
Check that the zero reading of the dial indicator is still correct when turning is commenced.

16

Continue to turn the pump coupling **in the pump's direction of rotation** until the correct amount of lift from basic circle according to Specifications is shown by the dial indicator.

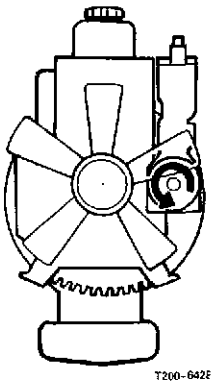
Now turn the pump coupling until the dial indicator reading is **approx. 1-2 mm (0.04-0.08")** more than the lift from basic circle specified.

17



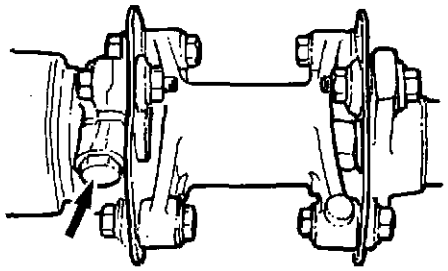
Tighten the clamping screw sufficiently tight so that the pump coupling can be turned with powerful resistance. This must be done to eliminate gear-tooth flank play in the timing gear and play in the injection timing device (if fitted).

18



Turn the pump coupling back **against the pump's direction of rotation** until the specified lift from basic circle is shown by the dial indicator.

19

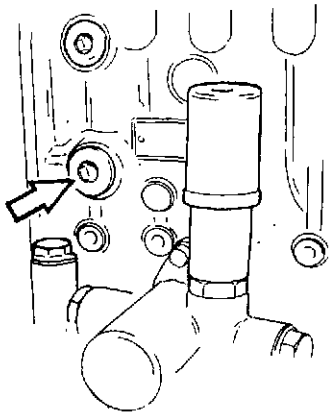


Now tighten the clamping bolt of the pump coupling to the specified torque.
See "Workshop Manual Technical Data"

20

Check the setting by cranking the flywheel **1/4 turn against the engine's direction of rotation** as described in step 7. Then crank **the flywheel in the engine's direction of rotation** until the correct amount of lift from basic circle is shown by the dial indicator. Note the degree marking on the flywheel and check that it is the same as the specified value.

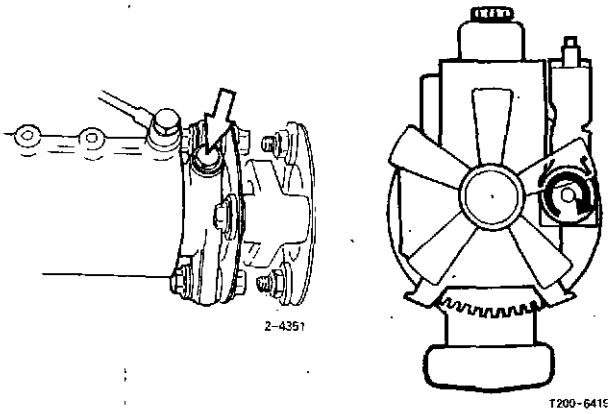
21



Remove the adjusting tools and replace the hex-socket plug fitting a new copper washer.

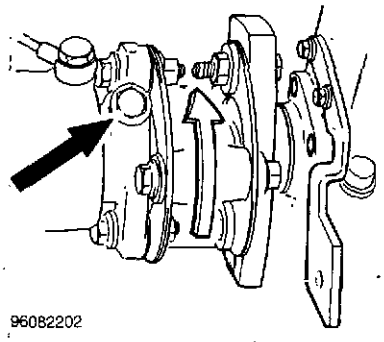
TWD730ME

22



Slacken the pump coupling clamping bolt and turn the pump coupling about 1/4 turn in the pump's direction of rotation.

23



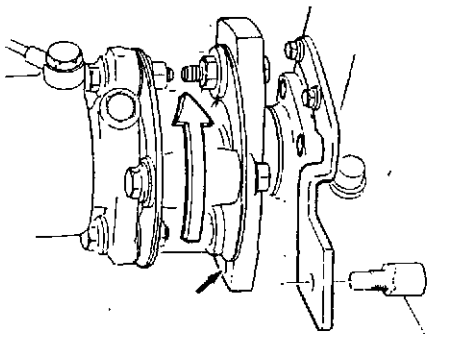
Tighten the pump coupling clamping bolt but only sufficiently to allow the coupling to be turned against the direction of rotation with considerable effort.

Note! The pump coupling should always be turned **against the direction of rotation** when setting the injection angle. This is in order to eliminate as much as possible any play between the timing gears and in the injection timing adjuster.

If the clamping bolt of the pump coupling is not tightened down sufficiently when the pump coupling is being turned, against the direction of rotation, there will be insufficient pretension and the setting will not remain accurate.

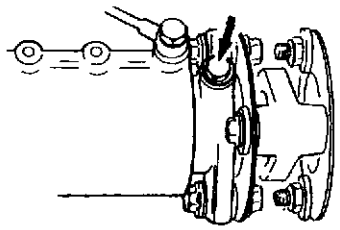
Take care so as not to damage the pump coupling.

24



Turn the pump coupling **against the direction of rotation** until locking bolt 8191 can be easily screwed into the injection pump carrier flange.
Note! If the pump coupling is turned too far, the adjustment must be started from the beginning.

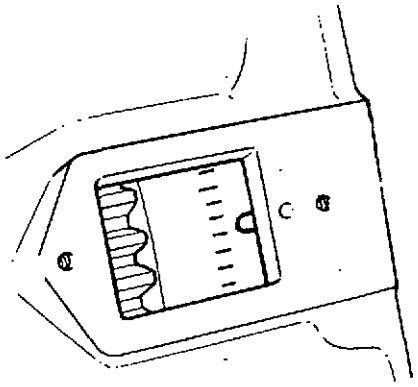
25



Tighten the clamping bolt to the specified torque.

26
Remove locking bolt 8191 from the injection pump.

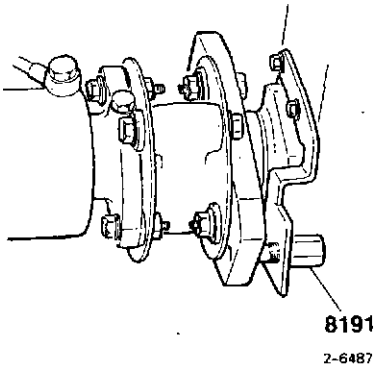
27



Check the adjustment by first turning the flywheel approx. 1/4 turn **against the engine's direction of rotation** and then back **in the engine's direction of rotation** until the correct number of degrees coincides with the marking on the flywheel.

Note! Set the number of degrees within the upper half of the tolerance range. If the flywheel is cranked too far, it must once again be turned back against the direction of rotation approx. 1/4 turn.

28



Check that locking bolt 8191 can be easily screwed into the injection pump carrier flange. If this is not the case, the adjustment must be started from the beginning again.

29
Remove the locking bolt from the injection pump.

Points common for all engines

30
Remove the cranking tool from the flywheel casing and fit the inspection cover.

31
Fit the valve cover, if necessary change the gasket.

32
Fit the fuel delivery pipes. Fuel delivery pipes must never be bent or altered. A damaged fuel delivery pipe should be replaced with a new one.

33
Fit all fuel and oil pipes.

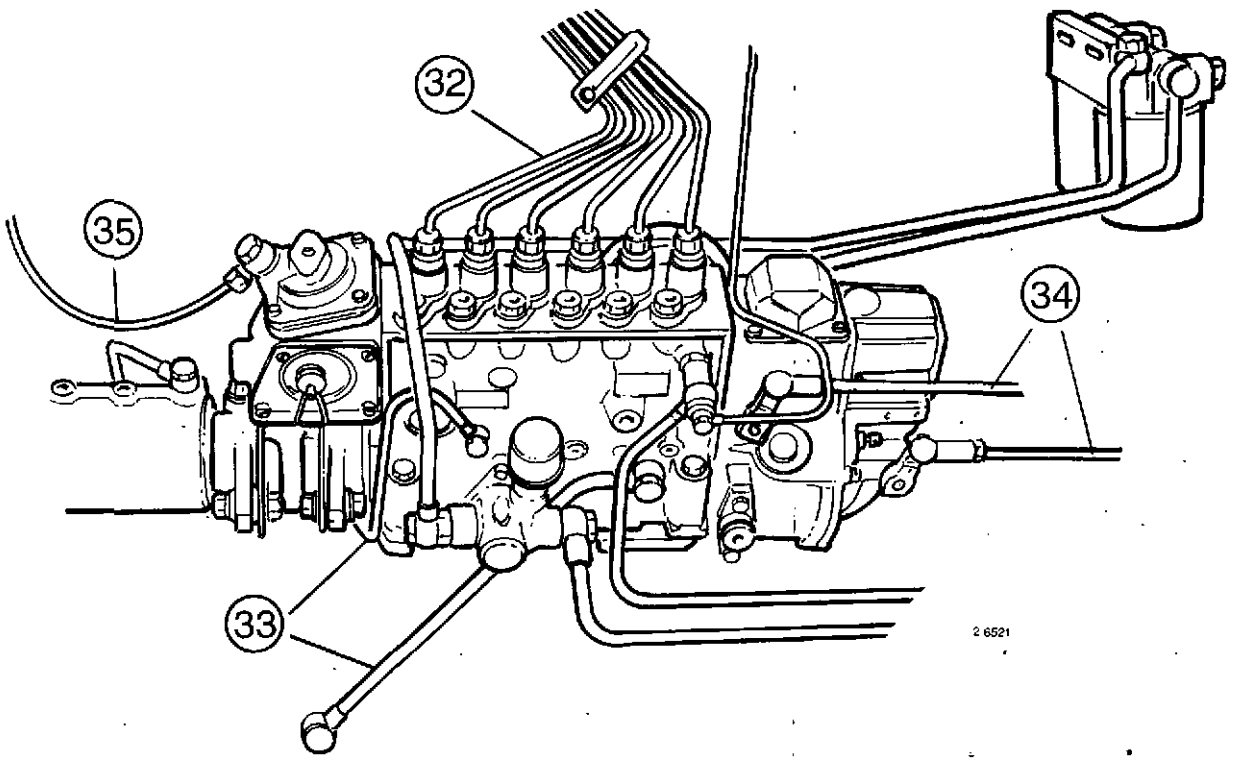
34
Fit the accelerator and stopping linkages.

35
Fit the pipe to the smoke-limiter (if fitted).

36
Bleed the system.

37
Start the engine and check for leakage.

Figures in the illustration are referred to in the following.



Injection pump, setting on the engine with measuring tool 998 7057

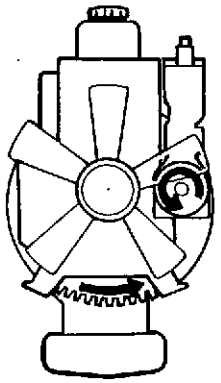
(Basic setting angle)

Special tools: 998 7057

1
Remove the valve cover on no.1 cylinder.

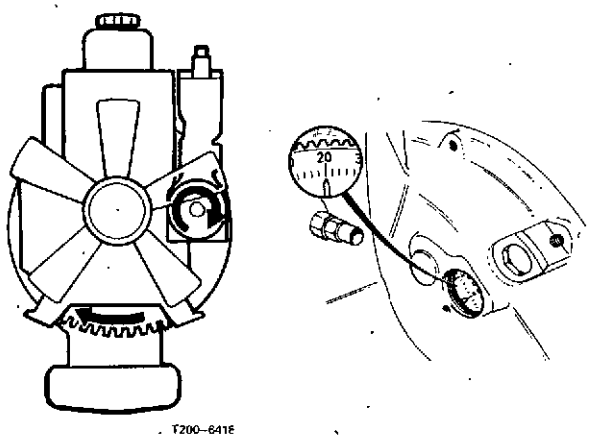
2
Crank the flywheel round in the direction of rotation until 1st cylinder is on compression (0° on flywheel and both valves of 1st cylinder closed.

3



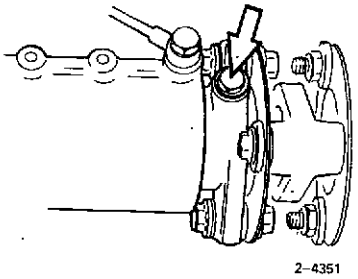
Crank the flywheel **back against the engine direction of rotation** approx. 1/4 turn.

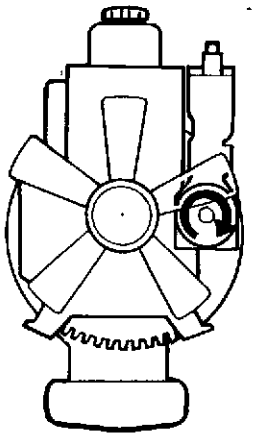
4



Crank the flywheel round in the direction of rotation until the correct degree markings according to "Workshop Manual, Technical Data" is immediately behind the needle on the flywheel housing.
Note! Set the degree marking within the upper half of the tolerance area which is stated in the specifications. The setting must be accurately carried out, and do not crank the flywheel back against the direction of rotation to finely adjust the setting. If the flywheel has been cranked too far, the setting procedure must be carried out again.

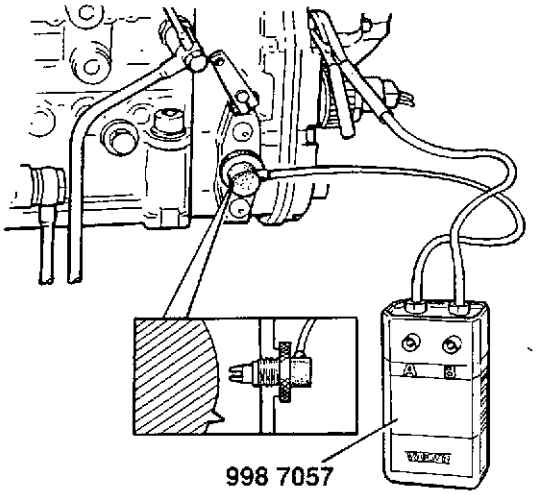
5





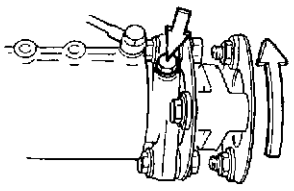
Slacken the pump coupling clamping bolt and turn the pump coupling approx. 1/4 turn **in the pump direction of rotation.**

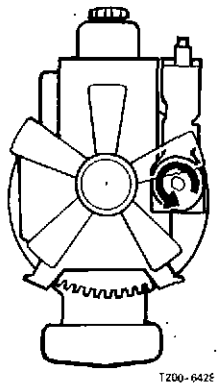
6



Remove the plug in the the governor housing and fit the measuring instrument sender, alternatively, fit the sensor in the bracket on the front pump wall. Earth the measuring instrument earth cable to a suitable place on the injection pump.

7





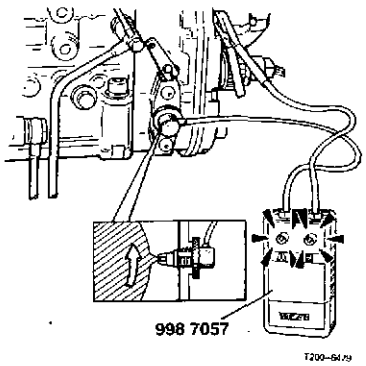
Tighten down the pump coupling clamping bolt so much that the coupling, with considerable resistance, can be turned against the direction of rotation.

Note! The pump coupling should always be turned **against the direction of rotation** when setting the injection angle. This is in order to eliminate as much as possible any play between the timing gears and in the injection timing adjuster.

If the pump coupling clamping bolt is not tightened down sufficiently when the pump coupling is turned against the direction of rotation, there will be insufficient preloading and the setting will not be exact.

Care must be taken not to damage the pump coupling.

8

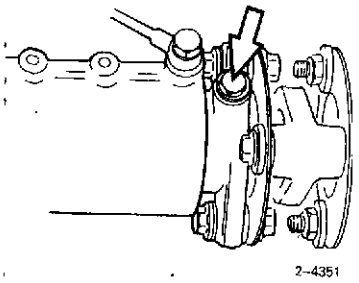


Carefully turn the pump coupling ***against the direction of rotation*** until both light emitting diodes on the instrument light up.
The injection pump is now in position for the injection cycle to commence on no.1 cylinder.

Note! The measuring instrument is very sensitive, which ensures that the setting will be exact.
Make sure that the pump coupling is not turned too far, but **precisely** to the point where both the light emitting diodes light up.

If the pump coupling is turned to far, the setting procedure must be carried out again.

9



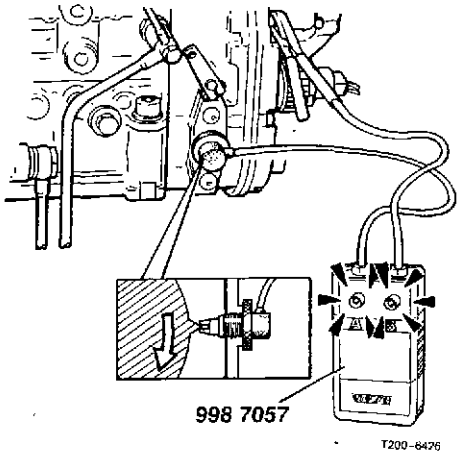
Torque-tighten the pump coupling clamping bolt according to the specifications in the "Workshop Manual, Technical Data".

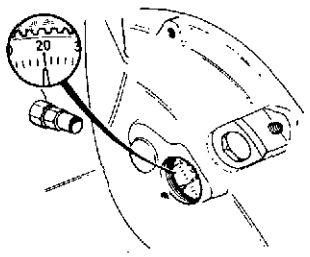
After-checking

10

Crank the flywheel back **against the engine direction of rotation** approx. 1/4 turn.

11

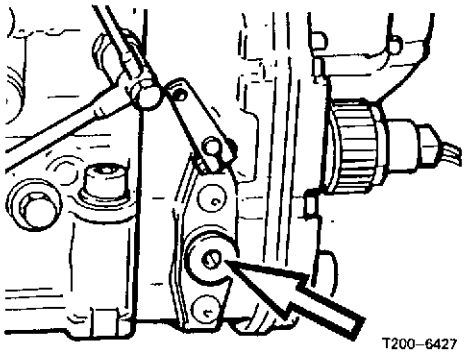




Crank the flywheel **in the direction of rotation** until both the light emitting diodes on the instrument light up.

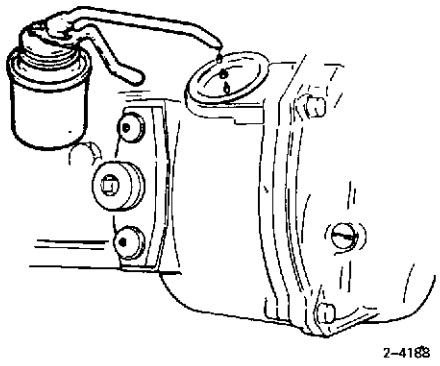
Read off the degree marking on the flywheel and check *that the setting lies within the upper area according to* the specifications given the "Workshop Manual, Technical Data".

12



Remove the measuring instrument sensor and refit the plug in the governor housing.

13



Top up with equivalent amount of engine oil that ran out when the plug for the measuring instrument sensor was removed.

14

Fit the inspection plug on the flywheel casing.

15

Fit the valve cover.

Injectors, changing

Special tool: 6643

1

Clean around the injectors and pipe connections.

2

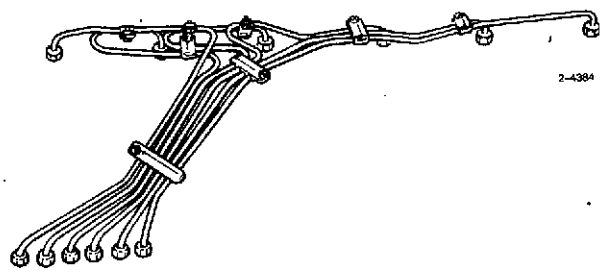
710- and 730-engines

Remove the exhaust temperature sensor from the exhaust manifold.

3

Remove the leak-off pipe between the injectors and plug the connections.

4



Remove the fuel delivery pipes and plug the connections.

Note! Fuel delivery pipes are clamped together. Do not take off the clamps but remove the pipes as one. Fuel delivery pipes must never be bent or altered.

A damaged fuel delivery pipe should always be replaced with a new one.

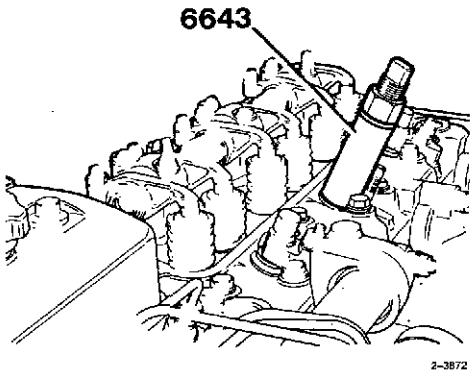
5

Remove the nuts from the injector holders and remove the holders.

6

Remove the rubber seals from the injectors.

7

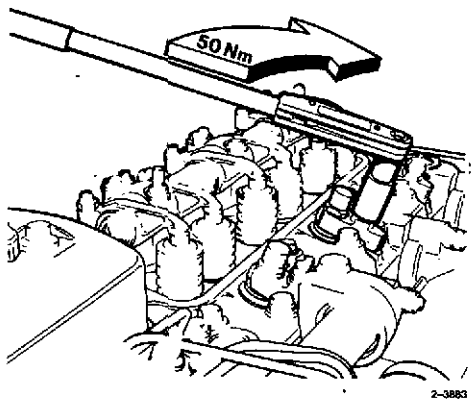


Turn the injectors with a ring spanner (RSp-15) pulling simultaneously upwards. If necessary, use puller 6643.

8
Clean the faces of the copper sleeves against which the injectors are seated. See "Copper sleeves for injectors, cleaning", next page.

9
Fit the new injectors.

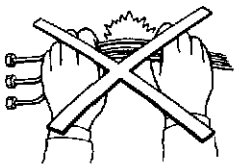
10



Fit new rubber seals around the injectors.
Fit the holders and torque-tighten the nuts.
See "Workshop Manual Technical Data"

11
Fit the leak-off pipe using new copper washers.

12



Fit the fuel delivery pipes.

Note! Fuel delivery pipes must never be bent or altered. A damaged fuel delivery pipe must always be replaced with a new one.

13
710- and 730-engines
Fit the exhaust temperature sensor.

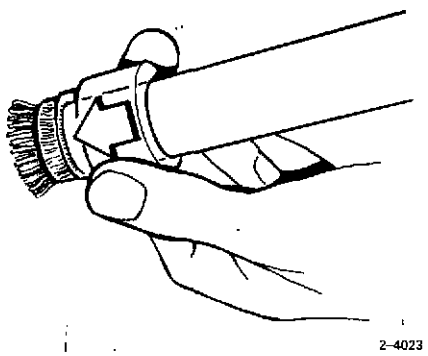
14
Start the engine and check for leakage.

Copper sleeves for injectors, cleaning

A special brush, Part no. 9812546, is used to clean the bottom of the copper sleeve.

The brush can be ordered from AB Volvo Penta.

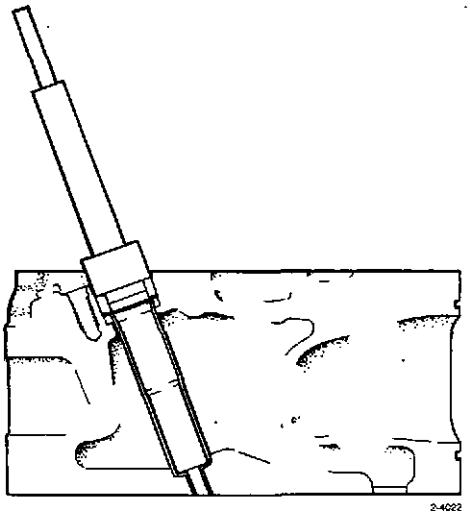
1



The cleaning brush is supplied complete with an assembly sleeve.

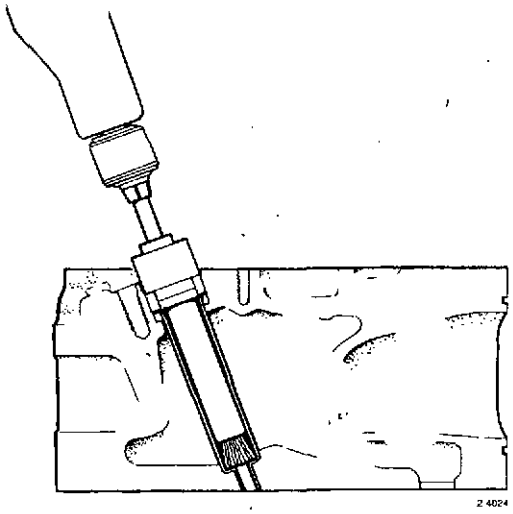
Before mounting the brush in a drilling machine, push the sleeve down over the brush head.

2



Fit the assembly sleeve over the copper sleeve.

3



Push the brush down into the sleeve. Attach a drilling machine and clean the sleeve.

4
After brushing clean, use compressed air to blow out any residue.

Injectors, overhauling

1
Clean the outside of the injector.

2
Disassemble the injector. Pull the injector needle out of the sleeve and place the parts in an injector cleaning fluid. If several injectors are cleaned at the same time, make sure that the prematched needles and sleeves are not mixed up with others. To avoid this, the injectors should be placed in order on an injector rack or in different compartments.

3
Wash the parts in an Ultrasonic washer. Blow them dry.

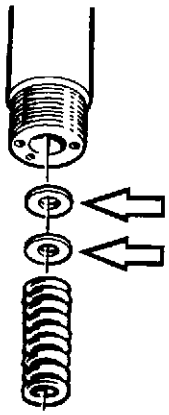
4
Check the injector thoroughly.

The injector should be examined through an illuminated magnifying glass or in an injector microscope. The injector sleeve can also be examined under the microscope. If the seat is dented, the injector needle must be replaced together with the sleeve or, in cases of only slight damage, it can be lapped in a lapping or injector grinding machine.

5
Check all other parts.

6
Dip the injector parts in clean diesel fuel or calibration oil.

7



Assemble the injector making sure that the thickness of the adjusting washers for opening pressure is the same as those originally fitted.

Check opening pressure and spray pattern in an injection tester, see page 105.

Recommendations for adjusting opening pressure, setting pressure and changing injectors

The injection process is carried out under very high pressure so that the dispersal of fuel is as effective as possible. As the injectors become older, opening pressure drops below the given pressure of new injectors.

This pressure drop is completely normal and does not affect the function of the injectors or the engine performance to any great degree. Adjusting the injectors can mean that the service life of the nozzle assembly is shortened.

If the following we give some general recommendations on how to check the injectors and so avoid unnecessary replacing and adjusting of same.

The injectors should not be checked unless there are clear indications that they are not operating normally, for example, a considerable increase in exhaust smoke has been noted.

Most important in this test are the opening/adjusting pressures and leakage.

Spray pattern are more difficult to assess and do not give any clear indication of the condition of the nozzle.

In addition to the opening pressure the "Technical Data" also state the setting pressure. This value refer to new injector or injector with new thrust spring.

Since the setting pressure for a new spring is somewhat higher than the opening pressure, this gives one a certain margin to allow for fatigue of the thrust spring. When a thrust spring has become fatigued, the opening pressure drops about **5 per cent.**

Opening pressure will in time drop even more, but the injector will still function satisfactorily.

Investigations have shown that for a used spring the pressure drop evens out at about **15 per cent** below opening pressure. However this pressure drop is no reason to adjust or replace the injector. The pressure drop lies within the specified working area.

Leakage test

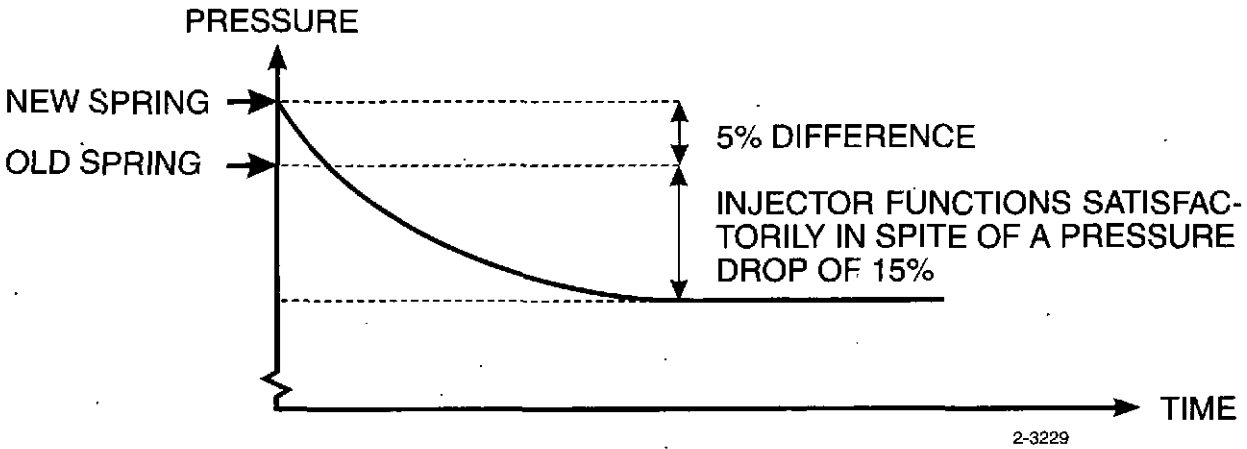
The test is to check if there is any leakage from the nozzle. If leakage is present it occurs between the tip of the nozzle needle and the tapered sealing area of the nozzle sleeve.

Wipe the nozzle tip dry. Connect a pressure gauge and pump up pressure to **2 MPa (290lbf/in²)** below the opening pressure of the injector. Keep the pressure constant for **10 seconds.** No fuel should drip from the nozzle tip, but a moist nozzle is acceptable.

Spray pattern

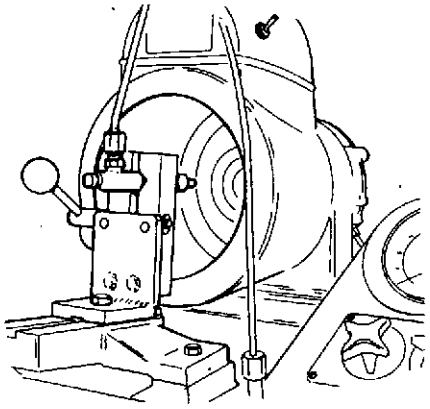
The condition of the nozzle is difficult to assess concerning spray pattern.

Many times the nozzle can function satisfactorily in the engine, even though some doubts may exist concerning spray pattern.



Opening pressure, adjusting

1

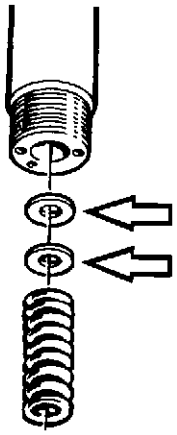


Connect the injector to an injection tester.

2
Slowly press down the tester lever until the injector opens and releases fuel.

3
Read off the opening pressure on the tester pressure gauge.

4



If the reading does not agreee with the pressure stipulated by the "Specifications", the setting must be altered. This is done by fitting adjusting washers.

Note! No more than two washers may be used. If sufficient pressure cannot be obtained using the two thickest washers, the spring must be replaced.

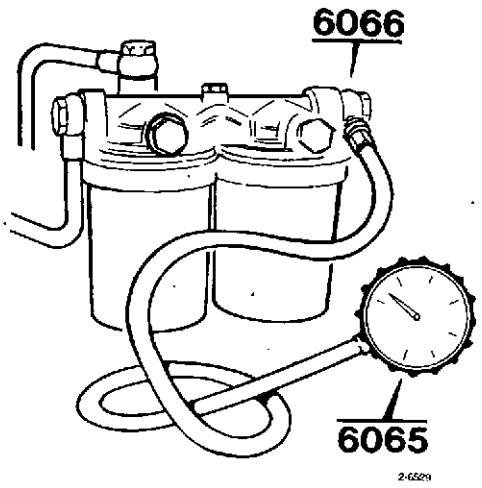
Opening pressure/setting pressure
See engine "Specifications" concerning opening pressure and setting pressure (new spring).

Spray pattern
At a pump speed of 4–6 strokes per second, the spray pattern should be uniform and the fuel finely atomised. On completion of testing, plug the pipe connections and protect the injector tips with caps.

Fuel feed pressure, checking

Special tools: 6065, 6066

1



Nipple 6066 and pressure gauge 6065 are connected to the outlet on the discharge side of the fuel filter. Pressure is measured when the fuel has passed through the filter insert. To do this check, first increase engine speed and then lower it to enable the pressure to be read-off at low idle.

The feed pressure must not drop below **100 kPa (14.5psi)**.

Feed pump, changing

1
Clean round the feed pump.

2
Close the fuel cocks.

3
Disconnect both the fuel pipes.

4
Remove the feed pump from the injection pump.

5
Clean up and fit a new gasket to the injection pump.

6
Fit and bolt down the feed pump.

7
If lubricating oil has run out of the injection pump, it must be topped up with an equivalent amount of engine oil.

8
Connect the fuel pipes.

9
Bleed the fuel system.

10
Start the engine and check for leakage.

Feed pump, overhauling

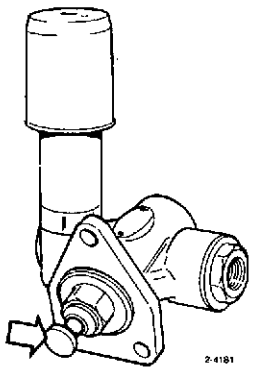
(Pump removed)

All engines except TWD730ME

1
Clean the outside of the pump.

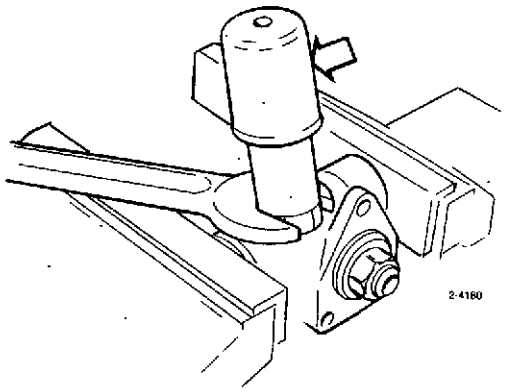
Disassembling

2



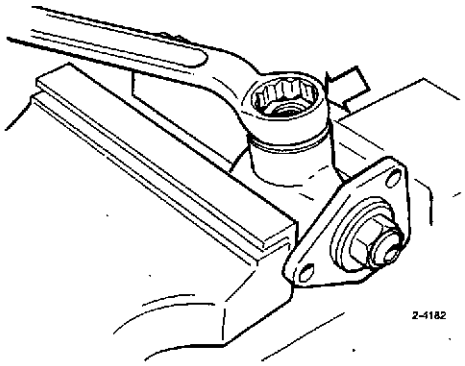
Disconnect the push rod.

3



Remove the hand primer.

4



Remove the union.

5
Remove the valve housing and the plunger.

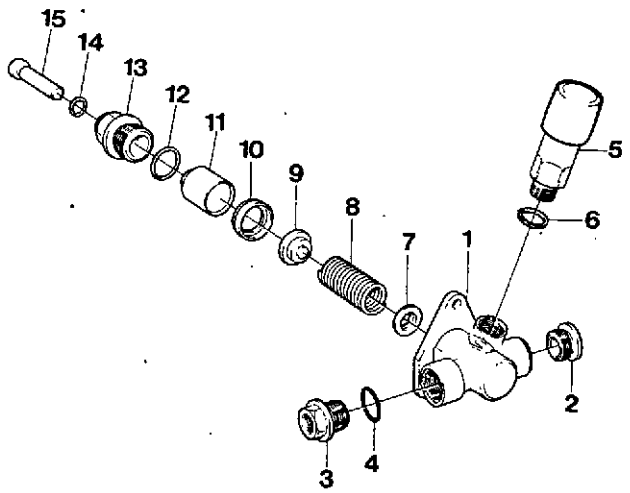
6
Remove the valve, discs (two) and spring.

Inspection

Examine all parts, replacing any which are damaged or worn.

Assembling

Observe maximum cleanliness and rinse the parts in clean diesel fuel before fitting together.



1. Housing
2. Union
3. Union
4. O-ring
5. Hand primer
6. Gasket
7. Spring disc
8. Spring
9. Valve
10. Spacer
11. Pump plunger
12. O-ring
13. Union
14. O-ring
15. Push rod

7
Fit the spacer (10) into the pump plunger (11).

8
Fit the valve (9), the spring disc (7) and the spring (8) to the pump plunger (11).

Insert the pump plunger (11) into the pump housing.

9
Fit the O-ring (12) to the union (13) for the valve.

10
Fit the union (13) to the pump housing.

11
Fit the union (3) and the O-ring (4) to the pump housing.

12
Fit the hand primer (5) and the gasket (6).

13
Fit the O-ring (14) to the push rod (15).

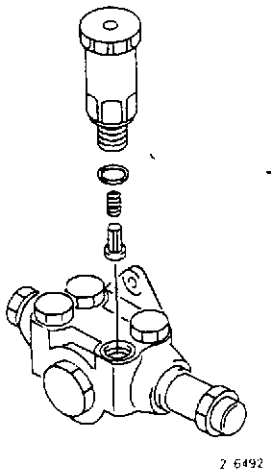
Note! If the pump is not going to be refitted immediately, fit protective plugs to both connections.

TWD730ME

1
Clean the outside of the pump

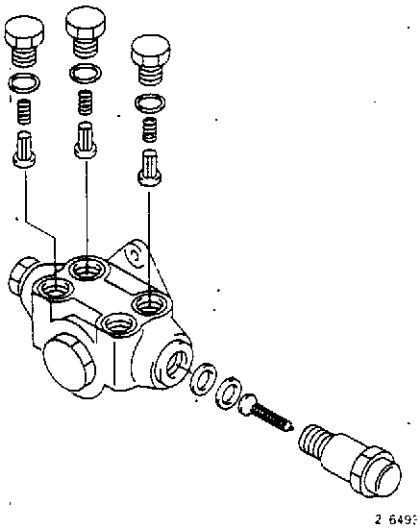
Disassembling

2



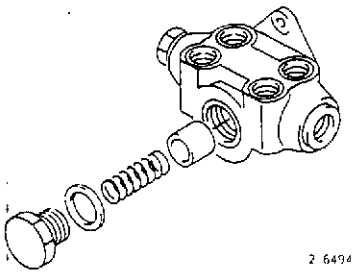
Remove the hand primer, washer, spring and valve.

3



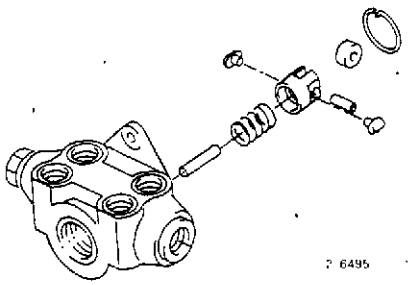
Remove the unions and from them remove the springs and valves. Remove the strainer from the inlet union.

4



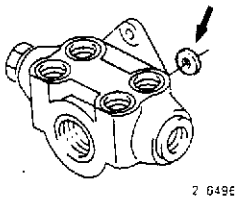
Remove the plug, removing the spring and pump plunger.

5



Remove the circlip and then the roller cage, spring and thrust rod.

6



Remove the sealing ring.

Inspection

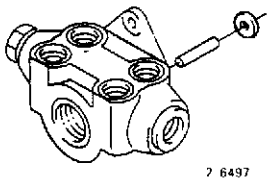
7
Examine all parts and replace any which are damaged or worn.

Washers and seals must always be replaced with new ones.

Assembly

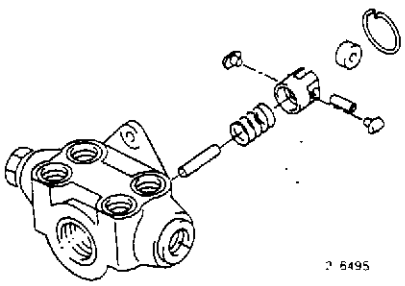
8
Observe maximum cleanliness and rinse the parts in clean diesel fuel before fitting together.

9



Smear the seals and thrust rod with oil. Insert the thrust rod into the pump housing and fit the seal. Carefully tap the seal into position with a socket or equivalent.

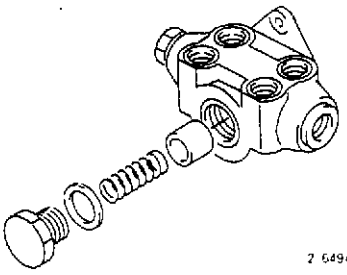
10



Smear with oil and assemble the roller cage, rollers, pin and guide studs.

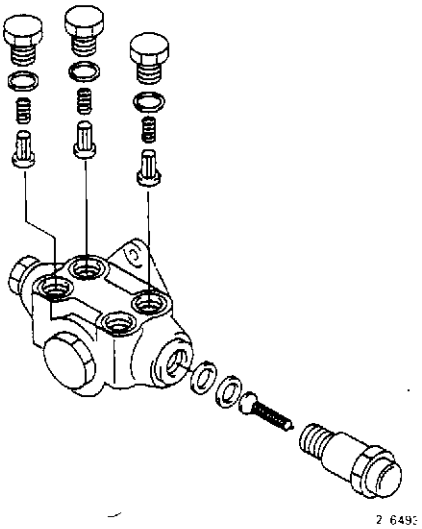
Put the spring and roller cage into the pump housing and fit the circlip.

11



Dip the pump plunger into clean diesel fuel and re-fit it into the pump housing. Fit the spring, a new copper washer and screw in the plug.

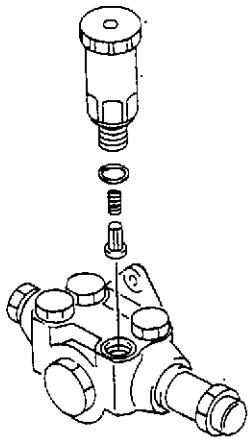
12



Fit the valves and springs. Screw in the plugs using new copper washers.

Fit the strainer and union using new copper washers.

13



Fit the valve and spring and screw on the hand primer using a new copper washer.

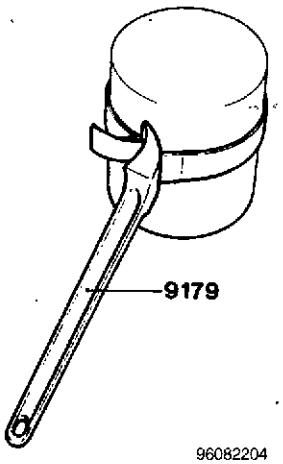
Note! If the pump is not going to be re-fitted immediately, fit protective plugs to all connections.

Fuel filter, changing

Special tool: 9179

1
Carefully clean the filter bracket.

2



96082204

Remove the fuel filters with tool 9179.

3
Moisten the seals of the new filters with oil and screw them on finger-tight until the seals are in contact with the bracket. Now turn the filters a further **half turn.**

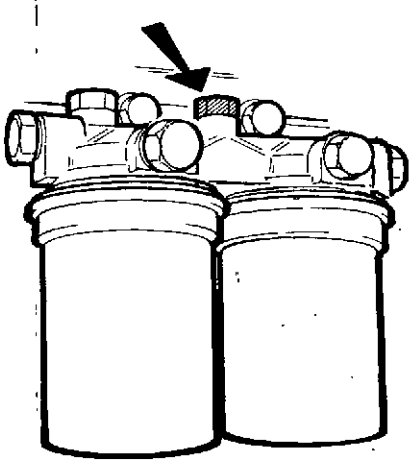
4
Bleed the fuel system.

5
Start the engine and check around the filters for leakage.

Fuel system, bleeding

(engines equipped with fuel shut-off valve, energized to run, see also page 114.)

1



2-6531

Open the bleed nipple on the fuel filter holder.

2
Charge the fuel system by using the feed primer pump. When fuel which is free from air bubbles starts to flow out of the bleed nipple, close the bleed nipple as the flow of fuel continues. Normally, no further bleeding is needed.

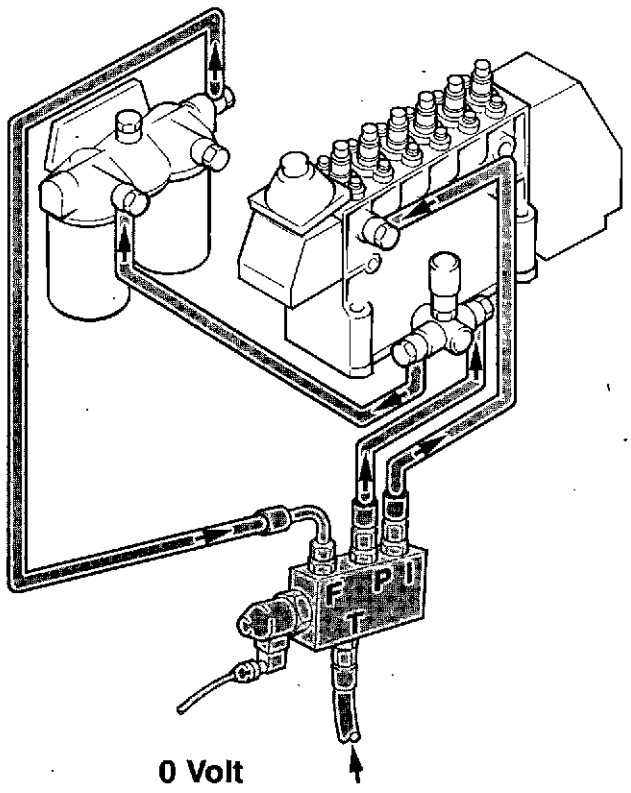
3
Should it prove necessary to bleed the injection pump, slacken the connection for the overflow valve. Continue hand priming until fuel free from bubbles of air also flows out here, at which point the connection is re-tightened while fuel cintinues to flow.

Note! Do not bleed via the pressure equalizer.

Fuel shut-off valve for stopping the engine

Version 1

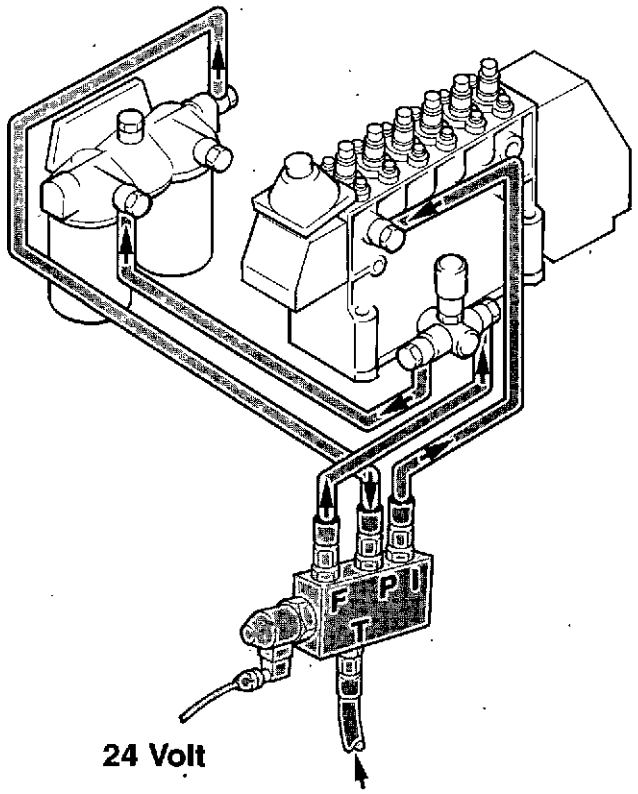
Fuel shut-off valve supplied with voltage during stop



The diagram shows the fuel flow during operation.

Version 2

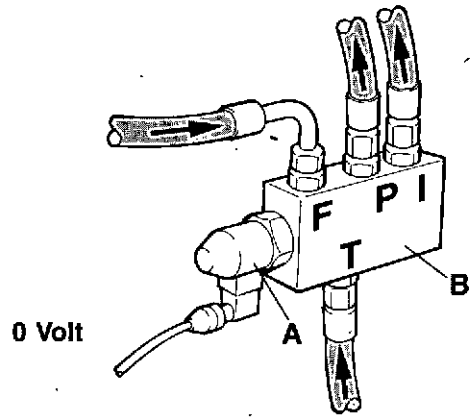
Fuel shut-off valve supplied with voltage during operation



The diagram shows the fuel flow during operation.

Fuel shut-off valve supplied with voltage during stopping

General



The diagram shows the fuel flow during operation.

Fuel shut-off valve for stopping the engine. The valve changes the direction of flow in the fuel system during the stop procedure.

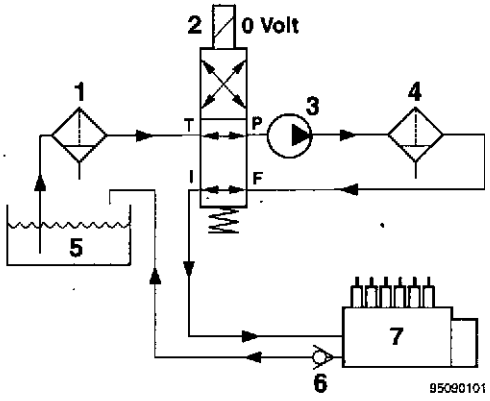
A. Solenoid valve
B. Valve housing

Connections in valve housing, markings:
T. Inlet from fuel tank
F. Outlet to feed pump
P. Inlet from fuel filter
I. Outlet to injection pump

Tightening torque for pipe connections: 22 Nm.

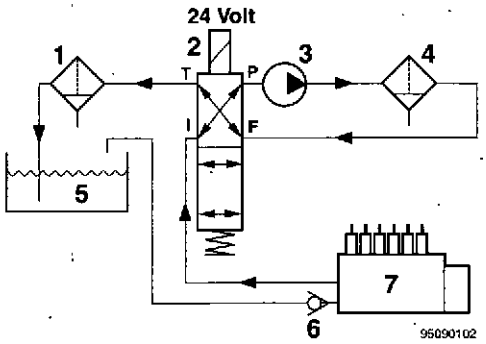
Function

During operation
The valve is not connected and the fuel has the normal direction of flow. The fuel pump (3) induces fuel from the tank (5) via the pre-filter (1) after which the fuel is pressed through the fine filter (4) and on to the injection pump (7).



Flow diagram, fuel shut-off valve
Engine in operation (the solenoid valve is not activated).

During the stop procedure
When the key switch is moved to the stop position ("S") the solenoid valve (2) is activated. The valve therefore changes the direction of the fuel flow to and from the feed pump, whereby an underpressure of 0.3 - 0.4 bar is built up in the injection pump's fuel chamber. This prevents filling of the pump element and the engine stops (the pump element requires overpressure for filling). The overflow valve (6) prevents fuel flowing into the injection pump via the return pipe.



Flow diagram, fuel shut-off valve
The stop function is activated (the solenoid valve is connected)

Venting the fuel system

Venting the fuel system is carried out in the same way as for engines without shut-off valve, see page 69

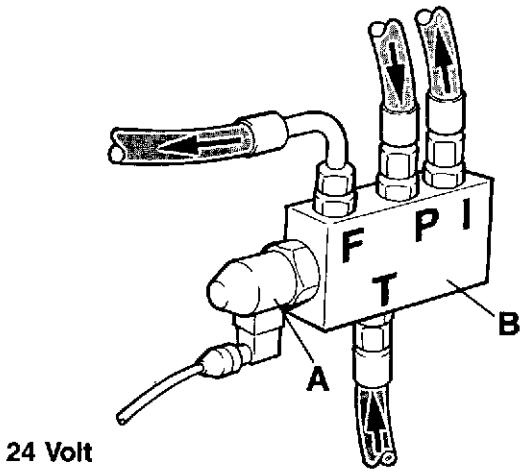
Trouble shooting

The engine does not stop / does not start:

1. Let an assistant turn the key switch to the stop position ("S") or press in the stop button, and listen to the function noise. Does the valve click when the stop is activated? Check if necessary the plunge function.
2. Check that there is voltage to the solenoid valve's contact unit when the key switch is in the stop position (S).

Fuel shut-off valve supplied with voltage during operation

General



The diagram shows the fuel flow during operation.

Fuel shut-off valve for stopping the engine. The valve changes the direction of flow in the fuel system during the stop procedure.

A. Solenoid valve
B. Valve housing

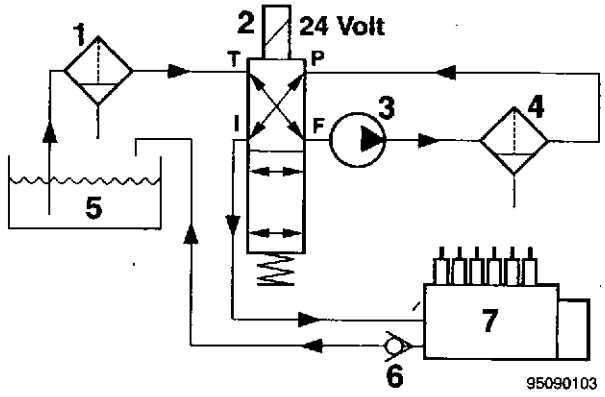
Connections in valve housing, markings:
T. Inlet from fuel tank
F. Outlet to feed pump
P. Inlet from fuel filter
I. Outlet to injection pump

Tightening torque for pipe connections: 22 Nm.

When the engine is switched off the valve is in the stop position. It is not supplied with voltage. With the valve in this position the engine will not start.

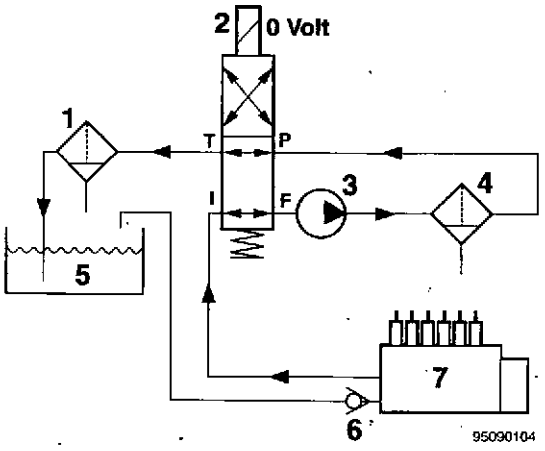
Function

During operation
The valve is connected and the fuel has the normal direction of flow. The fuel pump (3) induces fuel from the tank (5) via the pre-filter (1) after which the fuel is pressed through the fine filter (4) and on to the injection pump (7).



Flow diagram, fuel shut-off valve
Engine in operation (the solenoid valve is activated).

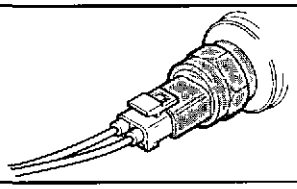
During the stop procedure
When the key switch is moved to the 0 position or the stop button is pressed, the solenoid valve (2) releases. The valve therefore changes the direction of the fuel flow to and from the feed pump, whereby an underpressure of 0.3 - 0.4 bar is built up in the injection pump's fuel chamber. This prevents filling of the pump element and the engine stops (the pump element requires overpressure for filling).
The overflow valve (6) prevents fuel flowing into the injection pump via the return pipe.



Flow diagram, fuel shut-off valve
The stop function is activated (the solenoid valve is not activated)

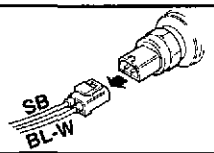
Venting the fuel system
Fuel shut-off valve supplied with voltage during operation

Is there "automatic stop in case of too low oil pressure" with Volvo Penta's type of oil pressure switch mounted? When the engine is stopped this switch is closed ("Nc" = Normally closed).The switch is placed on the right-hand side of the cylinder block. It is used on Genset and Stationary engines.



Yes

Release the contact unit at the oil pressure switch.
SB = black
BL-W = blue-white



Is the engine fitted with Volvo Penta's instrument box (Genset or Stationary engine series)?

Yes

Genset and Stationary engines with Volvo Penta's instrument box

1. If there is a coolant level alarm - check the level. When the level is too low the level alarm stops the engine.
2. Press the start button (green) briefly. The instrument is now activated and the charging lamp lights. If there is a coolant level alarm: Press the interlock button (black) for approx. 4 seconds.
3. Vent the fuel system as per standard procedure.
4. Press the stop button (red).
5. Reset the contact device.
6. The engine is now in operational condition.

No

Is there "automatic stop in case of too low oil pressure " with foreign oil pressure switch which is open when the engine is stopped? ("No" = Normally open)

Yes

Short-circuit the oil pressue switch's contact device with a jumper.

No

Volvo Penta's key switch or foreign key switch

1. Turn the key switch to operating position/ignition. On Volvo Penta's key switch position 1 (15+).
2. The solenoid valve is now activated for operation (not stop position).
3. Vent the fuel system as per standard procedure.
4. The engine is now is operational condition.

Trouble shooting
Fuel shut-off valve supplied with voltage during operation

The engine does not stop / does not start:

1. Check that there is voltage to the solenoid valve's contact unit when the key switch is in the operating position. The violet cable should be supplied with voltage during operation. The solenoid valve has a 21W coil. Power consumption approx. 1A (24V) and approx. 2A (12V). Black cable minus.

2a. Let an assistant turn the key switch to the operating position and then to the 0 position and listen to the function noise. Does the valve click? Check if necessary the plunge function.

2b. Engines with Volvo Penta's instrument box (Genset/Stationary engines).
Press the start button briefly first and then the stop button (if necessary press repeatedly). A clicking noise should be heard from the valve.
Note: The interlock button must be held pressed.

3. Check that the overflow valve (6) on the injection pump seals in reverse direction so that the fuel cannot reach the pump via the return pipe.

Intake and exhaust systems

Design and function

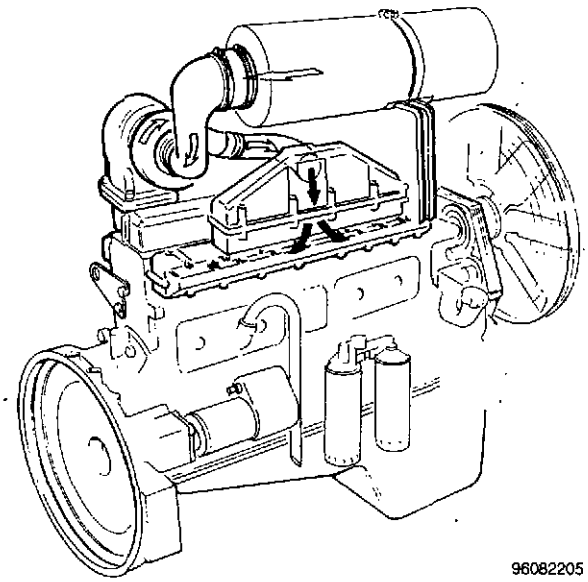
Charge air cooler

The purpose of the charge air cooler is to lower the temperature of the inducted air before it is forced into the cylinders of the engine.

Turbo-charging the engine, which means that the turbo-compressor forces air into the cylinders, increases the temperature of the air. If the air is cooled, downstream of the turbo, it reduces in volume and more air (oxygen) can reach the cylinders. This form of cooling is known as charge air cooling. With charge air cooling, more fuel can be metered into the engine providing a higher engine output. The charge air cooler (intercooler) lowers induction air temperature by approx. 100°C and boosts engine output by approx. 10%. Engine torque is also higher and fuel consumption is lower. A turbo-charged diesel engine with charge air cooling has the best coefficient of efficiency of all combustion engines.

TWD-engines

The charge air cooler is of water to air type and mounted on top of the engine. The air cooler is connected to the engine's cooling system.



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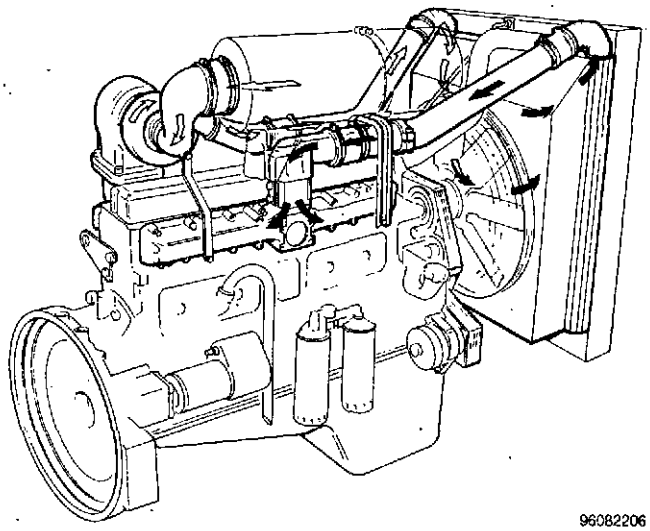
TAD-engines

The charge air cooler is of air to air type and is mounted behind the engine's radiator.



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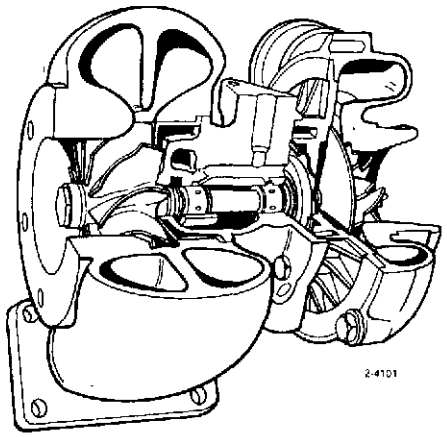
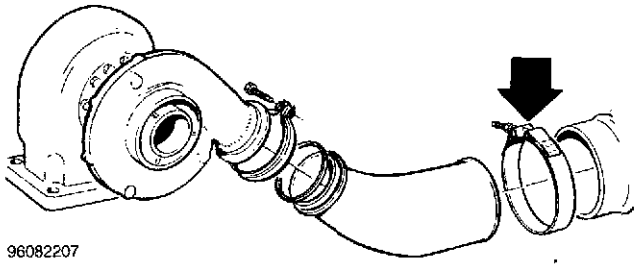
Turbo-compressor

The turbo-compressor is powered by the exhaust gases which pass through the turbine housing to reach the exhaust system. The passage of the exhaust gases causes the turbine wheel to spin inside the turbine housing. On the same shaft as the turbine wheel is a compressor wheel. The compressor wheel is placed in a housing which is connected in-line between the air cleaner and the inlet manifold of the engine.

As the compressor wheel rotates, air is sucked in through the air cleaner. The air is compressed and forced into the cylinder of the engine.

Note! When removing the turbo do not loosen the "V"-clamp between the compressor and the pipe. Loosen the hoseclamp.





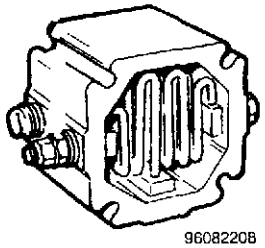
Starting heater

The purpose of the starting heater is to warm up the air in the inlet manifold when the engine is being started. The heated air facilitates starting the engine and reduces the development of smoke in a cold start.

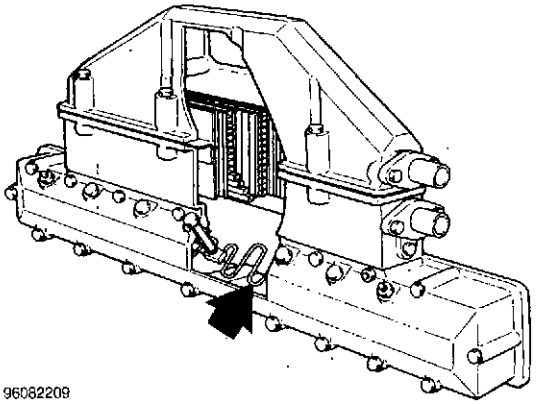
The starting system has manual pre-heating. On certain engine variants, the engagement time for the starting heater is controlled by a stepless, temperature-related time relay.

The time relay regulates both the pre-heating and postheating times, depending on the temperature of the engine.

TD- and TAD-engines



TWD-engines



Service Procedures

Always wash the engine before commencing repairs.

Turbo-compressor, changing

Removing

1
Remove the exhaust pipe from the turbo compressor.

2
Remove the bolts from the turbo oil delivery and oil return pipes.

3
Remove the nuts and lift off the turbo from the exhaust manifold.

4
Clean the contact surfaces of the exhaust manifold, oil delivery and oil return pipes.

Fitting

5
Check that there are no broken parts on the turbo, gasket remains or carbon deposits in the exhaust manifold, air hose or charge air pipe.

6
Fit a new gasket, fit the turbo in position, fit and tighten the bolts.

7
Fit the turbo oil delivery pipe using a new gasket.

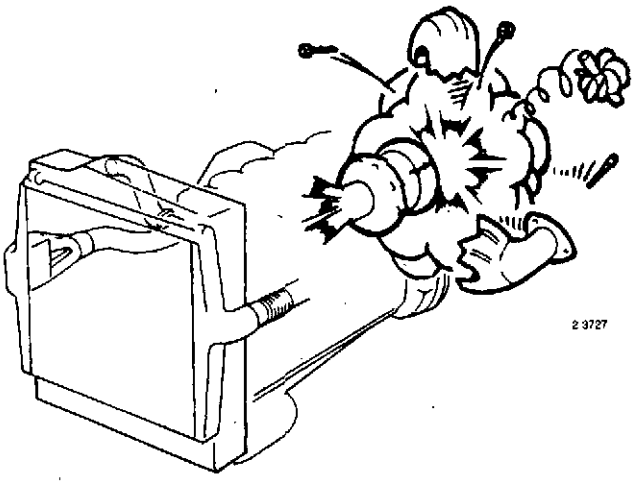
8
Fit the turbo exhaust pipe, fit new tab washers, tighten down and lock the nuts.

9
Crank the engine around with the starter motor until oil runs out through the turbo oil return opening.

10
Fit the turbo oil return pipe using a new gasket.

11
Check for leakage, check the engine oil level, top up if necessary.

Procedures in case of turbo failure on charge air cooled engines



Should the turbo unit fail on a charge air cooled engine, it is essential to check the charge air cooler.

Should extensive oil leakage be suspected or that foreign objects, such as parts from a fractured compressor wheel, have been forced into the charge air cooler, the following procedures must be followed:

1
Check the charge air hoses leading to the charge air cooler. If traces of oil are found at the charge air cooler, the cooler must be removed and cleaned internally with a low aromatic solvent of the paraffin type.

The cooler must be wiped and blown clean after treatment with the above solvent. The charge air pipes and charge air hoses must also be checked.

If the charge air hoses are contaminated with oil, they must be replaced since the oil will negatively affect the rubber.

2
Should the failure of the turbo have resulted in a fracture of the compressor wheel, the charge air cooler must be leakage-checked to establish whether or not it has been damaged by bits of the compressor wheel.

Turbo-compressor, changing/fitting to engine

NOTE! Prior to changing a turbo, always find out the cause of failure. Put right any faults before the new turbo unit is fitted.

When changing/fitting a turbo-compressor, it is very important that the instructions provided with the compressor are carefully followed.

1
For a turbo unit to operate satisfactorily, one condition is that the engine oil system and intake system are kept in good working order, that is to say that the oil is changed at the recommended times, that the correct type of oil is used, and that the oil cleaner and air cleaner are also changed as appropriate.

The initial measure is therefore to check the engine oil, and if so required to replace the oil cleaner before the new turbo unit is fitted. Preferably, the engine should be run a few minutes before the new turbo is fitted.

2
Before starting the new turbo, use an oil can to pump oil into the turbo bearing system thereby providing initial lubrication during starting. Before staring the engine, crank it around with the starter motor until oil comes out of the turbo oil return opening.

3
When changing a turbo, care must be taken so that flakes of rust or carbon deposits do not drop into the exhaust manifold. These flakes could damage the turbine of the new unit.

It is also important to clean the induction line from the air cleaner, since any bits lying there from, for example, a fractured compressor wheel, would cause an immediate breakdown of the new turbo.

4
Always check that the injection equipment is in good condition and that all of the restricted components are fitted with authorized, unbroken seals.

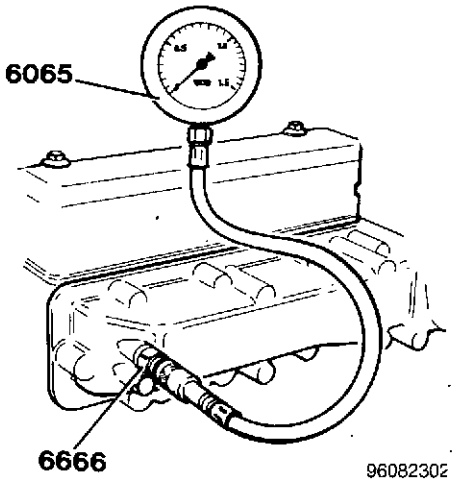
5
Check that the oil is circulating properly after starting the engine by loosening the oil return pipe union on the turbo.

Boost pressure, checking

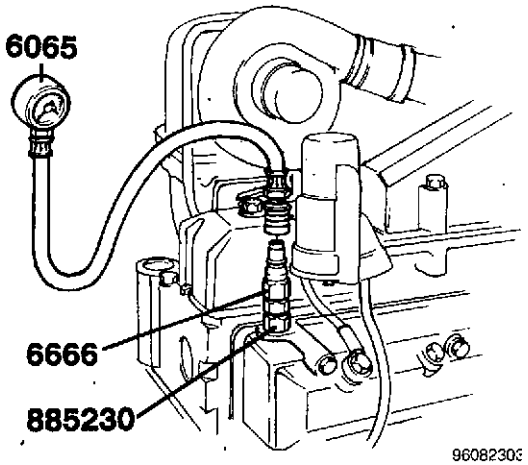
Special tools: 6065, 6666 , 885230 (TWD)

1

TD/TAD



TWD



Fit the connecting nipple and gauge to the inlet manifold.

Mobile engines: The gauge should have a hose which is sufficiently long to allow the gauge to be observed from the driving seat.

2

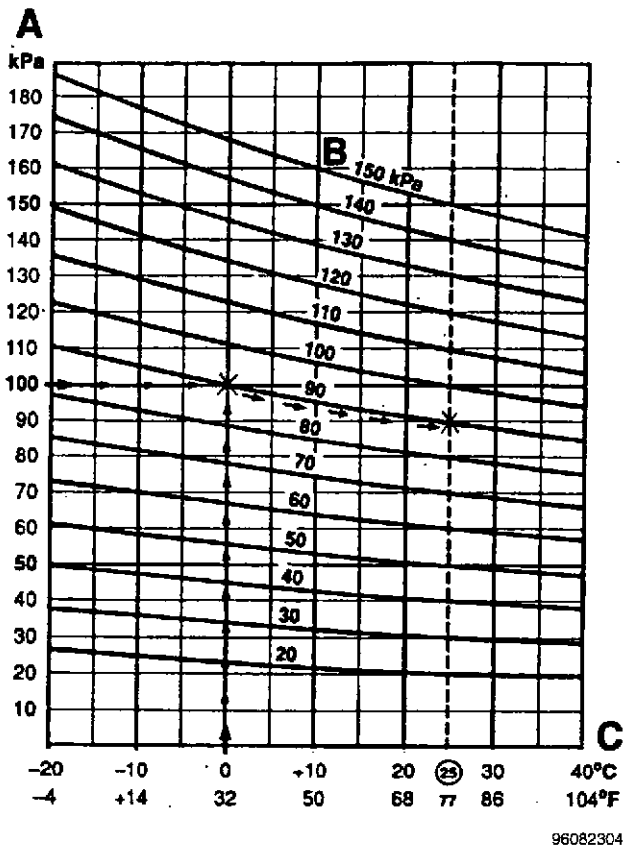
Measurements are carried out with the engine fully loaded and with the throttle fully open (full engine load) and engine speed slowly passing the revs given in the specifications for boost pressure.

Note! For this test to give a true picture of the situation, it is essential that the full load condition is maintained sufficiently long for the pressure to stabilize. It should also be remembered that boost pressure varies with the temperature of the inlet air (ambient air).

If boost pressure is measured at any other temperature than **+25°C (+77°F)**, the boost pressure reading must be adjusted by means of the diagram below.

Example:

A pressure of 100 kPa measured at 0°C (32°F) is equivalent of 92 kPa at +25°C (+77°F).



Boost pressure at different temperatures

A Measured boost pressure
B Correction curves
C Temperature of inlet air

Rectifying low boost pressure

1
Tightness of seals, inlet and exhaust manifolds
It is important that connections between the turbocompressor and inlet manifold do not have inadequately tightened clamps.

The charge air pipe seals must not be damaged and the charge air hoses must not be cracked or damaged.

In addition to a lower boost pressure, leakage will also cause a higher exhaust gas temperature which will result in higher stresses on the exhaust pipe, turbo, valves and piston rings.

In some cases, superstructure work on the vehicle will have called for the rerouting of the exhaust pipe or it being extended. An exhaust pipe operating with too large a back pressure reduces boost pressure, gives a lower engine output and increases exhaust temperature with the related risk of burnt valves and turbo failure.

After any conversion of the exhaust system, the back pressure must always be checked in accordance with the instructions given on page 115.

The following demands must be met when converting an exhaust system:

a)
The diameter of the jointing pipe must be 1/2-1" larger than the pipe to which it is to be connected

b)
The transition between the existing pipe to which the connection is being made, and the jointing pipe, must not be abrupt. It should be tapered, the taper being about 180 mm long.

c)
The pipe elbows should have as large a radius as possible. Pleating should be avoided.

2
Air cleaner
Check that the air cleaner is not clogged.

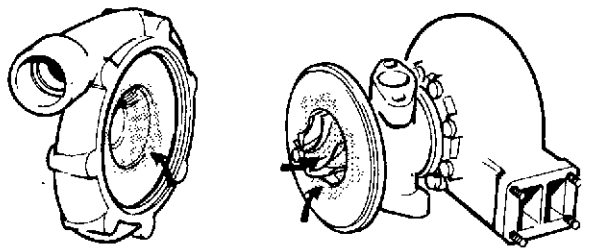
3
Accelerator linkage
Check that the accelerator linkage provides for full travel of the injection pump arm.

4
Turbocharger
Check if the rotor shaft is sluggish or if the turbine wheel and compressor wheel chafe against their housings. Turn the wheel at first with a slight pressure, and then with a slight axial pull. If the wheel is sluggish the turbocharger must be immediately replaced or reconditioned. Check the wheel for damage.

In the event of daily operation in dusty or oily air, regular cleaning of the compressor housing and compressor wheel is recommended. Fouled compressor parts can result in low boost pressure.

The compressor parts can be cleaned with the unit fitted as follows:

Remove the compressor housing. Clean the compressor housing, compressor wheel and the endhead in parrafin or the like. Fit the compressor housing and measure the boost pressure again.



5
Injection pump
Check the following:

Governing, advance injection angle, calibration, fast idle, smoke limiter diaphragm and triggering point, curve plate setting, sealing.

If the boost pressure is too low despite the above points having been checked and found to be in good order, the low boost pressure may be the result of contamination. The compressor housing, compressor wheel and compressor housing and wall can be washed with a low aromatic solvent of paraffin type. After washing, the parts must be thoroughly dried off and blown clean.

6
Delivery pressure
Check that fuel leakage does not occur and that the pump provides the correct delivery pressure.

7
Pressure pipes
Check that the pipes are of the correct size and that the holes are not upset

8
Injectors
Check the markings, opening pressure, spray pattern and that the holes are not faulty or clogged.

9
Engine condition
Check the compression and valve clearances.

If the boost pressure remains unsatisfactory once all these points have been checked and approved, the turbocharger should be reconditioned or replaced.

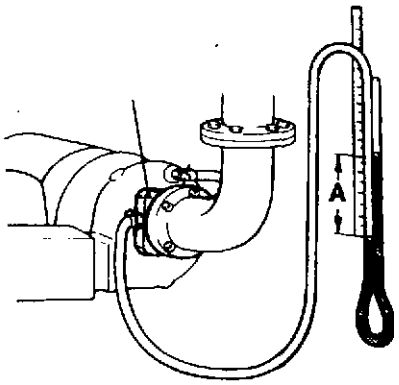
Checking the exhaust back pressure

Special tool: Flange kit 884872 (610, 630)
Flange kit 884972 (710, 730)

1
Remove the exhaust pipe from the turbocharger exhaust outlet. Remove the stud bolts.

2
Clean the contact surfaces. Fit the longer stud bolts included in the flange kit.

3



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Fit the measuring flange to the turbine housing with gaskets on both sides. Fit the exhaust pipe.

4
Connect a transparent plastic hose, partly filled with water, to the measuring flange or alternatively a low-pressure pressure gauge.

The difference between the water columns (A) show the back-pressure of the exhaust system in mm water column.

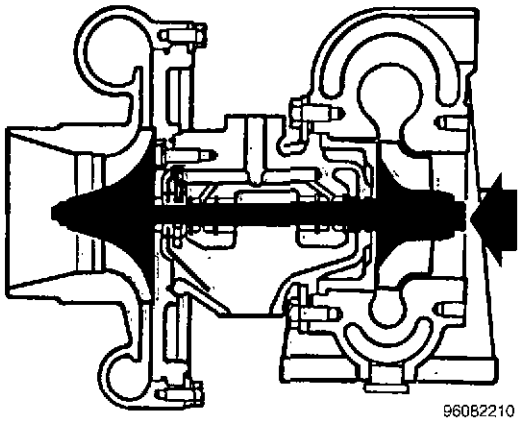
5
Run the engine at **full load and full throttle** for a few minutes and check that the back-pressure does not exceed specified values. Regarding maximum back-pressure, see "Workshop Manual Technical Data".

An exhaust system with excessively high back-pressure decreases the boost pressure, gives reduced engine output and increases exhaust smoke and exhaust gas temperature, which in turn can lead to burnt valves and turbocharger failure.

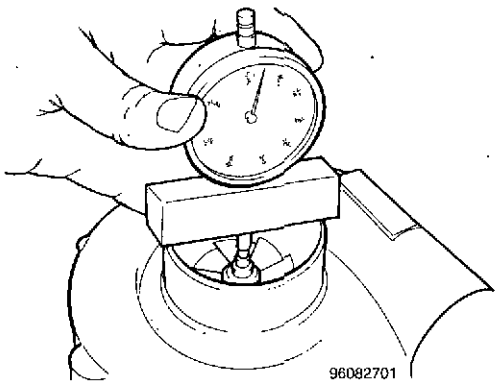
Turbo-compressor, checking the bearing clearance

Checking the axial and radial clearance is normally done only in conjunction with reconditioning when it is required to ascertain the degree of wear in the unit.

Measuring axial clearance



Place a dial indicator with an 8 mm (5/16") shank in the holder as shown. Secure the dial indicator.



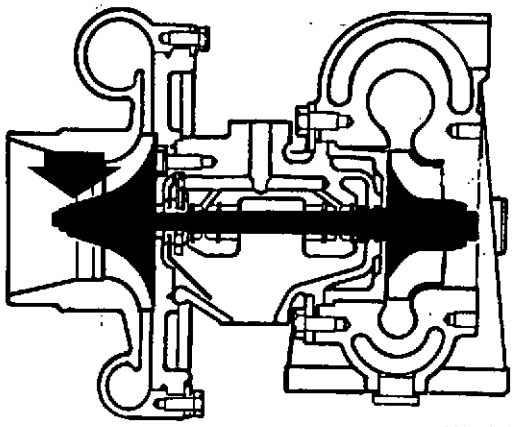
Place the holder on the compressor housing. Make sure that the measuring point rests against the centre of the shaft.

Press down the holder against the compressor intake and at the same time press the turbine rotor up and down by hand. Read off the dial indicator.

Axial clearance:

Schwitzer S2A, S2B: max 0.14 mm (0.0055")
Holset H1E, H2A: 0.10-0.16 mm (0.004-0.006")

Measuring radial clearance



Place a rocking arm dial indicator with its measuring point at the compressor nose.

Press down the rotor, upon which the indicator arm is resting, at the same time as the rotor on the opposite end of the shaft is pushed upwards. Set the indicator to zero.

Move the rotor up, upon which the indicator arm is resting, at the same time as the rotor at the opposite end of the shaft is pushed downwards.

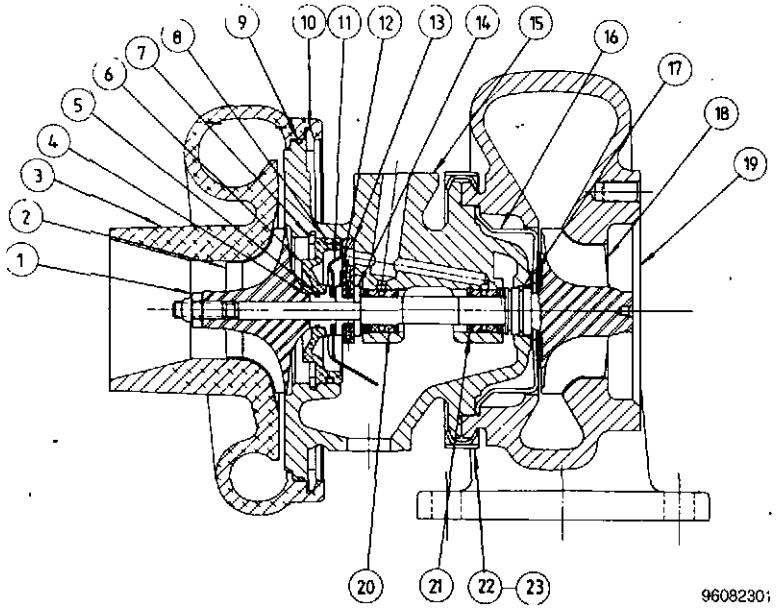
Measuring the radial clearance. Rotate the rotor through 90° and repeat the measuring procedure.

Radial clearance:

Schwitzer S2A: max (compressor side) 0.82 mm (0.032")
Schwitzer S2B: max (compressor side) 0.95 mm (0.037")
Holset H1E, H2A:(compressor side) 0.30-0.46 mm (0.012–0.018")

Turbo-compressor, overhauling

Schwitzer S2A, S2B



1. Locknut
2. Compressor wheel
3. Compressor cover
4. Piston ring holder
5. Piston ring
6. Cover
7. Snap ring
8. O-ring
9. O-ring (optional)
10. Snap ring
11. Oil deflector
12. Thrust collar
13. Thrust Bearing
14. Thrust ring
15. Bearing housing assy.
16. Heat shield
17. Piston ring
18. Shaft and wheel assy.
19. Turbine housing
20. Bearing
21. Circlip
22. Vee clamp
23. Locknut

Dismantling

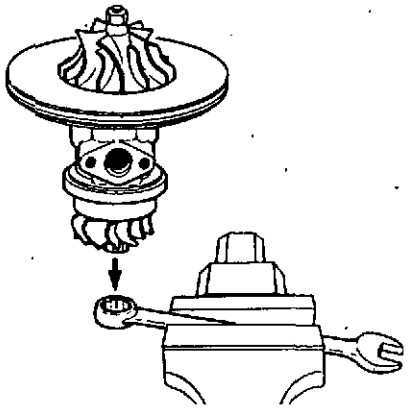
1
Mark the relative positions of the compressor cover (3) and the turbine housing (19) to the bearing housing (15).

2
Fix the turbine housing in the vice using soft jaws with the turbocharger shaft vertical.

3
Remove the large snap ring (10) securing the compressor cover and lift off the compressor cover.

4
Remove the Vee clamp (22) securing the turbine housing.

5
Lift the central core assembly out of the turbine housing. Clamp a suitable 12 point socket wrench in the vice as per the figure.



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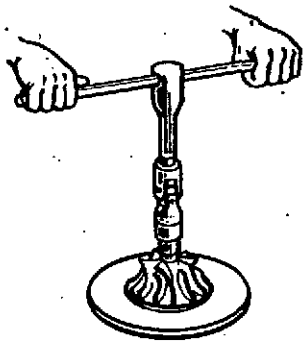
6
Place the 12 point hub of the turbine wheel into the socket. Release the compressor wheel locknut (1).
NOTE! Later version of S2B has left hand threaded nut (4 C 94 stamped on the sign).



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Note! Use a **T-handle wrench** together with a universal joint to avoid side-loading the turbine wheel shaft.

7
Remove the compressor nut (1) and slide the compressor wheel (2) from the turbine shaft.

8
Gently remove the turbine shaft and wheel (18) by tapping with a small soft faced mallet on the compressor end of the shaft. Be careful not to bend or damage the shaft.

9
Remove the insert retaining snap ring (7) from the compressor side of the bearing housing.

10
Carefully bend up the cover (6) using two screwdrivers.

Note! Thread a piece of plastic tubing over the screwdrivers to avoid damaging the bearing housing.

11
Push the piston ring holder (4) out of the cover (6).

12
Remove the oil deflector (11), thrust bearing (13), thrust washer (14), thrust collar (12) from the bearing housing.

13
Using suitable circlip pliers, remove the outer circlips from the both ends of the bearing housing, remove the journal bearings and inner circlips.

Cleaning of Parts

1
Aluminium parts
Soak in commercially available non-caustic solvent until all deposits have been softened. Clean surfaces with bristle brush and soft scraper. Vapour blast may be used providing bearing surfaces are protected.

2
Cast iron parts
Soak in commercially available non-caustic solvent. Alternatively bead blast, taking care with internal profile surfaces.

3
Shaft and wheel assembly
Soak in commercially available solvent to remove oily residue. Mask entire shaft section and vapour blast wheel and hub to total cleanliness. Avoid concentrating on piston ring seal groove.

Inspection of parts

1
Bearing housing
Inspect bearing bore visually for sign of damage or wear.

Check turbine end seal bore for damage.

2
Compressor wheel (2)
Inspect visually for evidence of bent, burred, nicked or eroded blades, and for evidence of scuffing on the back face. Very minor damage is acceptable. Reject and replace if damage appears sufficient to affect wheel balance. Do not attempt to straighten any bent blades.

3
Shaft and wheel assembly
Check journal diameter for wear.

Minimum diameter is **8.99 mm (0.3539")**.

Check seal groove width. Max. **1.58 mm (0.0622")**.

Measure eccentricity between large and small shaft diameter. Max. **0.0076 mm (0.0003")**.

Max. unbalans in both planes **0.36 g mm (0.0005 oz. in)**.

Replace if outside limits.

4
Visually inspect **compressor cover (3).** Reject and replace if damage is excessive.

5
Piston ring holder (4)
Check piston ring groove width max. **1.58 mm (0.0622")** and for signs of taper or damage to groove. Reject if worn.

6
Turbine heat shield (16)
Replace if cracked or warped.

7
Thrust ring (14)
Replace if surface is worn. In most cases these may be reused by reversing the position so that the non worn side is in contact with the thrust bearing.

8
Thrust collar (12)
No sign of surface disturbance or wear on the thrust face.

9
Turbine housing (19)
Inspect visually for evidence of contour damage and evidence of overtemperature damage such as cracking, pitting, warping, erosion. Reject and replace if damage is excessive.

Assembling

Check before reassembling that all parts have been thoroughly cleaned and dried with compressed air. It is very important that no foreign particles enter the turbo during assembly.

Lubricate all moving parts with clean engine oil at assembly

Use only parts complying with the dimensions outlined in the inspection instructions plus an "Overhaul Kit".

1
Fit the inner snap rings (21) for the journal bearings in the bearing housing. Fit the journal bearings and the outer snap rings.

2
Place a new piston ring (17) in the groove in the turbine wheel shaft. Fit the heat shield over the shaft so that it rests against the turbine wheel.

3
Fit the shaft and wheel etc. into the bearing housing assembly. Take care not to damage the piston ring when entering the sealing bore.

4
Place this assembly into the turbine housing with the shaft vertical. Fit the thrust ring (14) onto the shaft. Fit the thrust bearing (13) into the bearing housing.

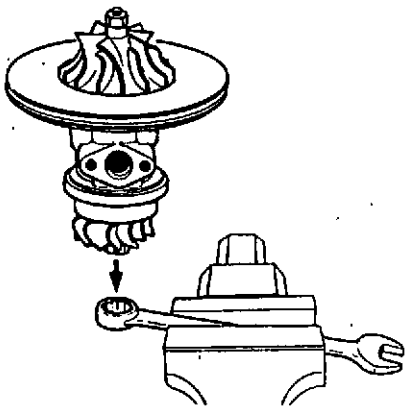
5
Fit the thrust collar (12) and oil deflector (11). Fit a new O-ring (8) to the groove in the cover (6). Fit a new piston ring (5) into the piston ring holder.

6
Fit the piston ring holder into the cover taking care not to damage the piston ring.

7
Lubricate the O ring (8) and assemble the cover into the bearing housing and retain with the snap ring, taking care to ensure the bevelled edge is uppermost.

8
Fit the compressor wheel and lock nut.

9
Clamp the appropriate 12 point cap wrench in a vice. Place the hub of the turbine wheel into the socket.



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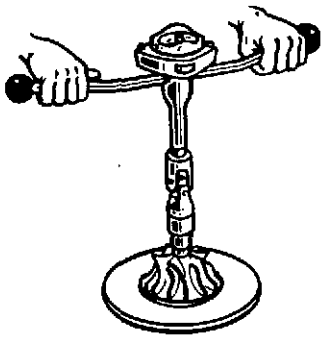
Tighten the compressor locknut to **10.2 Nm (7.5 lbf.ft)** and apply two drops of Locktite to the threads.



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Note! Use a T-handle torque-wrench together with a universal joint to avoid side-loading the turbine wheel shaft.

10
Check the wheel assembly's **radial and axial clearances.**

11
Fit the o-ring in its recess in the end of the bearing housing. Put the bearing housing in the compressor housing (3), align to previous marking. Lock tight the compressor housing with the large snap ring (turn the bevelled side to the turbine side).

12
Fit the core assembly into the turbine housing (19), orientate to the marks, fit the Vee clamp (22) and tighten the locknut to **7 Nm (5 lbf.ft).**

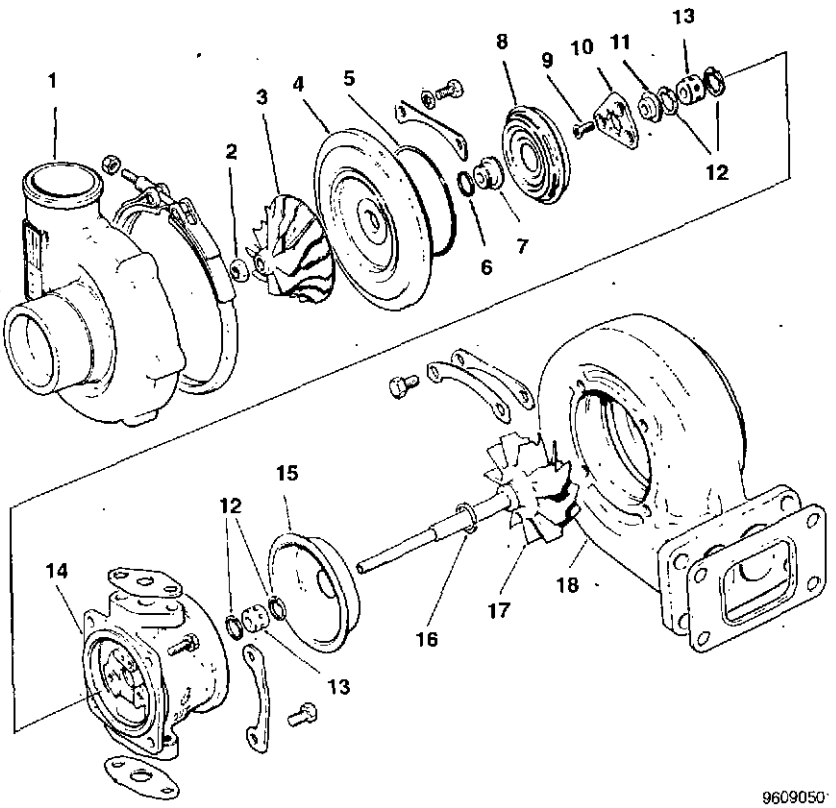
13
Check the rotor's running clearance by spinning the shaft at the same time pressing the turbine rotor inwards. Thereafter press in the comressor rotor and make the same check

14
Spray oil into the bearing housing. Fit protective covers on all openings if the unit is not to be fitted immediately.

For fitting of turbocharger on engine, see instructions.

Holset H1E, H2A

1. Compressor housing
2. Nut
3. Compressor wheel
4. End cover
5. Sealing ring
6. Piston ring seal
7. Piston ring holder (oil thrower)
8. Oil deflector
9. Bolt
10. Axial thrust bearing
11. Thrust ring
12. Lock ring
13. Bearing
14. Bearing housing
15. Heat shield
16. Piston ring seal
17. Turbine wheel and shaft
18. Turbine housing



Dismantling

1
Secure the unit's exhaust flange in a vice.

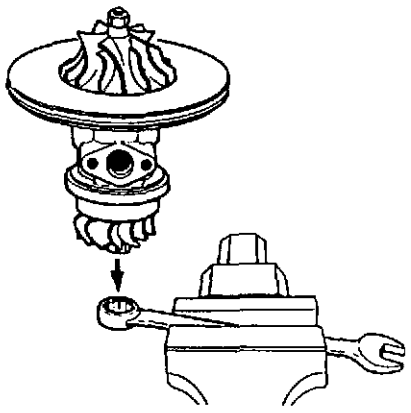
2
Make line-up marks between the turbine housing (18), the bearing housing (14), end cover (4) and compressor housing (1).

3
Loosen the tensioner strap (end cover-compressor housing) and move the tensioner strap onto the bearing housing.

4
Remove the compressor housing. Tap if necessary with a soft hammer to separate the parts.
Note. Be careful when dismantling the housings so as not to damage the compressor or turbine rotors. These components cannot be repaired but must be replaced if damaged.

5
Remove bolts, lock tabs and clamp washers holding the bearing housing against the turbine housing and lift out the bearing housing. Remove the tensioner strap.

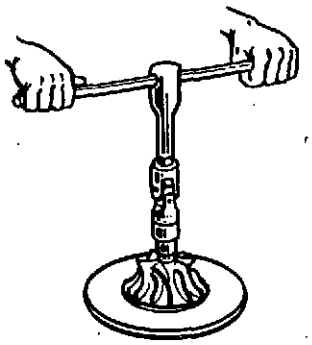
6
Lift the central core assembly out of the turbine housing. Clamp a suitable 12 point cap wrench in the vice as per the figure.



7
Place the 12 point hub of the turbine wheel into the cap wrench. Release the compressor wheel locknut (2).

NOTE! The nut has a left-hand thread.

Use a T-bar together with an universal joint and a socket so as not to apply an oblique load to the turbine rotor shaft. Lift out the compressor wheel.



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8
Remove the end cover (4) and press out the piston ring holder (7) with piston ring seal. Remove the piston ring. Lift out the oil deflector (8).

9
Remove the thrust bearing (10) and remove the thrust ring (11).

Note! The thrust bearing is fixed with three bolts with Torx grooves (internal 12 sided socket): Use a Torx-wrench, size TX20 (3.86 mm/0.1520").

10
Remove the bearing housing from the shaft. Remove the heat shield (15).

11
Remove circlips and bearing bushings from the bearing housing. Remove the piston ring from the turbine rotor shaft.

Cleaning of parts

1
Aluminium parts
Soak in commercially available noncaustic solvent until all deposits have been softened. Clean surfaces with bristle brush and soft scraper. Vapour blast may be used providing bearing surfaces are protected.

2
Cast iron parts
Soak in commercially available noncaustic solvent. Alternatively bead blast, taking care with internal profile surfaces.

3
Shaft and wheel assembly
Soak in commercially available solvent to remove oily residue. Mask entire shaft section and vapour blast wheel and hub to total cleanliness. Avoid concentrating on piston ring seal groove.

Inspection of parts

1
Bearing housing
Inspect bearing bore visually for sign of damage or wear.

Check turbine end seal bore for damage.

2
Compressor wheel (3)
Inspect visually for evidence of bent, burred, nicked or eroded blades, and for evidence of scuffing on the back face. Very minor damage is acceptable. Reject and replace if damage appears sufficient to affect wheel balance. Do not attempt to straighten any bent blades.

3
Visually inspect **end cover (4).** Reject and replace if damage is excessive.

4
Turbine housing (18)
Inspect visually for evidence of contour damage and evidence of overtemperature damage such as cracking, pitting, warping, erosion. Reject and replace if damage is excessive.

5
Piston ring holder (7)
Check piston ring groove for signs of taper or damage to groove. Reject if worn.

6
***Thrust ring* (11)**
Replace if surface is worn.

7
Inspect all other parts systematically after careful cleaning. Always replace bushings and their circlips, piston ring seals, compressor rotor shaft nut, sealing rings, bolts and lock tabs when overhauling.

For more detailed reconditioning information, see manufacturer's instructions.

Assembling

Before assembling, check that all components are properly cleaned. It is very important that no foreign particles enter the turbo during assembly. **Lubricate all moving parts with clean engine oil at assembly.**

1
Fit the inner circlips for the bearing bushings. Locate the bushings and fit the outer circlips.

Note! The lock rings shall be fitted with bevelled edge facing the bearing bushing.

2
Turn the bearing housing so that the turbine rotor side (the end without bolt holes) faces upwards. Place the heat shield (15) on the bearing housing.

3
Fit the piston ring in its groove on the turbine rotor shaft. Centre the ring and carefully guide the shaft down through the heat shield and the bearing housing's bushings.

4
Hold the turbine rotor shaft so that it cannot fall down on the floor and carefully tighten the turbine wheel hub in a vice (use soft jaws). Mind the turbine rotor vanes.

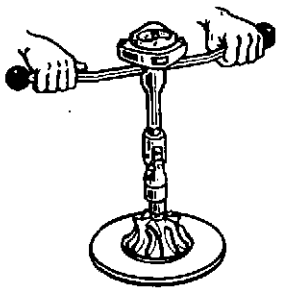
5
Place the thrust ring (11) on the shaft with the flange facing downwards. Fit the thrust bearing (10). **Tightening torque 4.5 Nm (39 lbf.in).** Fit the oil deflector (8).

Note! The three fixing bolts for the thrust bearing are fitted with Torx grooves (internal 12-sided socket). Use a Torx wrench, size TX20 (3.86 mm = 0.1520")

6
Fit the piston ring on the ring holder (7) and fit the ring holder in the end cover (4). Place the sealing ring (5) in the end cover groove.

7
Fit the end cover on to the bearing housing and tighten according to earlier markings. Tightening torque **9 Nm (78 lbf.in).**

8
Clamp a suitable 12 point cap wrench in a vice with the axis vertical.



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Fit the compressor wheel. Tighten the nut to **14 Nm (122 lbf.in).**

NOTE! The nut has a left-hand thread

Use a T-bar together with an universal joint and a socket so as not to apply an oblique load to the turbine rotor shaft.

9
Check the rotor's radial and axial clearances according to instructions.

10
Secure the turbine housing's exhaust flange in a vice.

11
Place the tensioner strap on the bearing housing.

12
Fit the bearing housing on the turbine housing according to earlier marking. Lubricate the attaching bolt's threads with heat resistant lubrication paste/graphite grease (e.g. Never Seez). Fit clamp washers and lock tabs and tighten the bolts to **14 Nm (122 lbf.in).** Lock the bolts with the lock tabs.

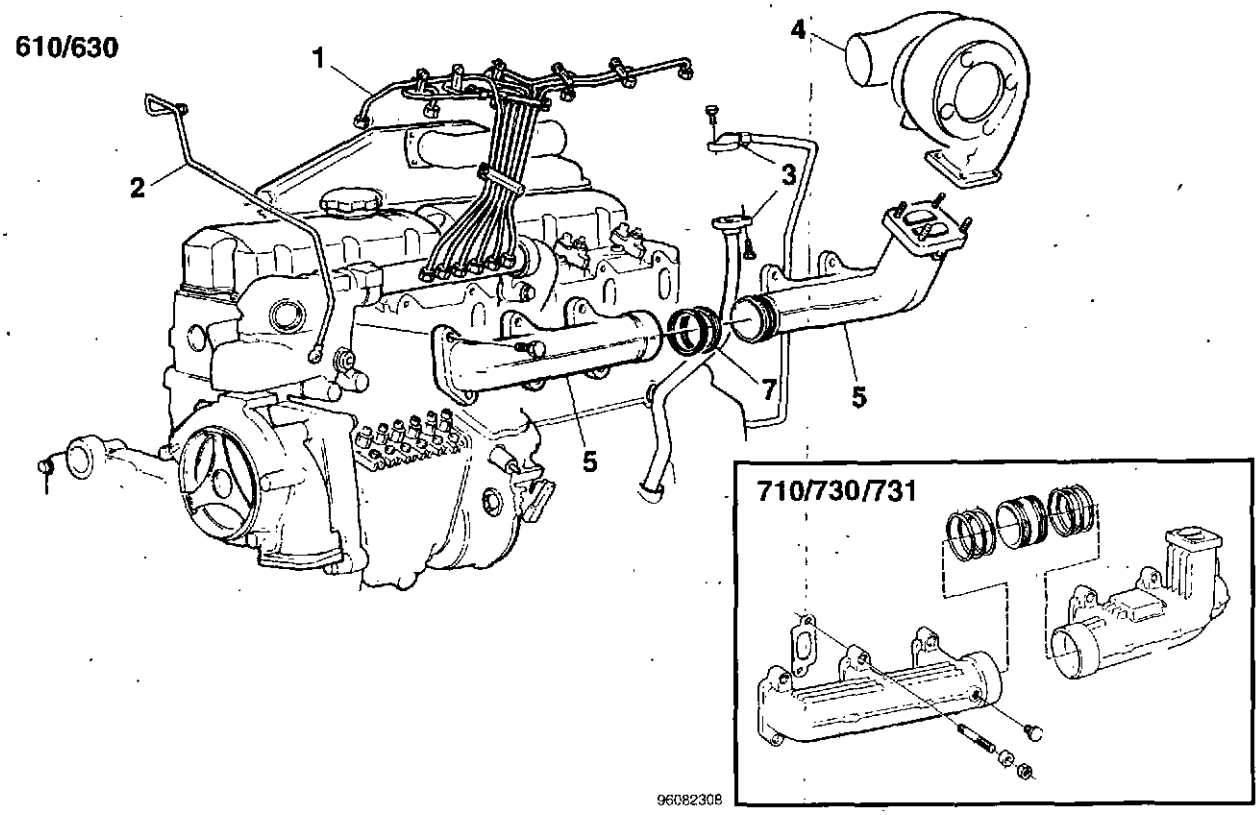
13
Fit the compressor housing according to the earlier markings.

Fit the tensioner strap and tighten the nut to **14.5 Nm (126 lbf.in). (8.5 Nm (75 lbf.in)** for later versions with a silver-plated nut.)

14
Check the rotor's running clearance by spinning the shaft at the same time pressing the turbine rotor inwards. Thereafter press in the compressor rotor and make the same check.

15
Spray oil into the bearing housing. Fit protective covers on all openings if the unit is not to be fitted immediately.

For fitting of turbocharger on engine, see instructions.



The figures in the illustration are referred to in the following.

Gaskets for exhaust manifold, *changing*

Removing

1
Remove the fuel delivery pipes and plug the connections.

Note! The fuel delivery pipes are clamped together. Do not remove the clamps. The pipes should be removed as a unit.

2
Remove the fuel leak-off pipe from the overflow valve. Split the pipe at the 1st or 6th injector junction piece and remove the pipe.

3
Remove the oil delivery and oil return pipes from the turbo.

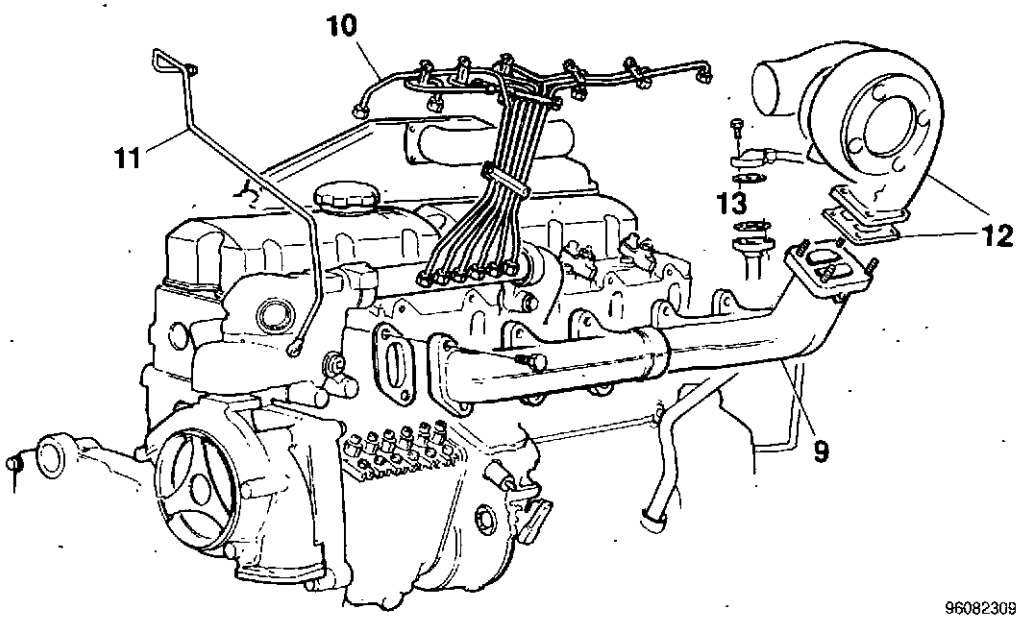
4
Remove the turbo from the exhaust manifold.

5
Remove the exhaust manifold bolts and sleeves. Lift off the manifold.

6
Remove the gaskets and clean all contact surfaces on the exhaust manifold and cylinder heads.

7
Disassemble the exhaust manifold, clean the junction piece and fit new sealing rings as required.

8
Assemble the exhaust manifold, blowing out any flakes of carbon with compressed air.



The figures in the illustration are referred to in the following.

Fitting

9
Fit and bolt tight the exhaust manifold using new gaskets.

Note! Make sure that the graphite part of the gasket faces the cylinder head and the plain metal surface lies against the exhaust manifold.

10
Fit the fuel delivery pipes.

Note! Under no circumstances must the fuel delivery pipes be bent or deformed. A damaged fuel delivery pipe must be changed.

11
Fit the fuel leak-off pipe using new copper washers.

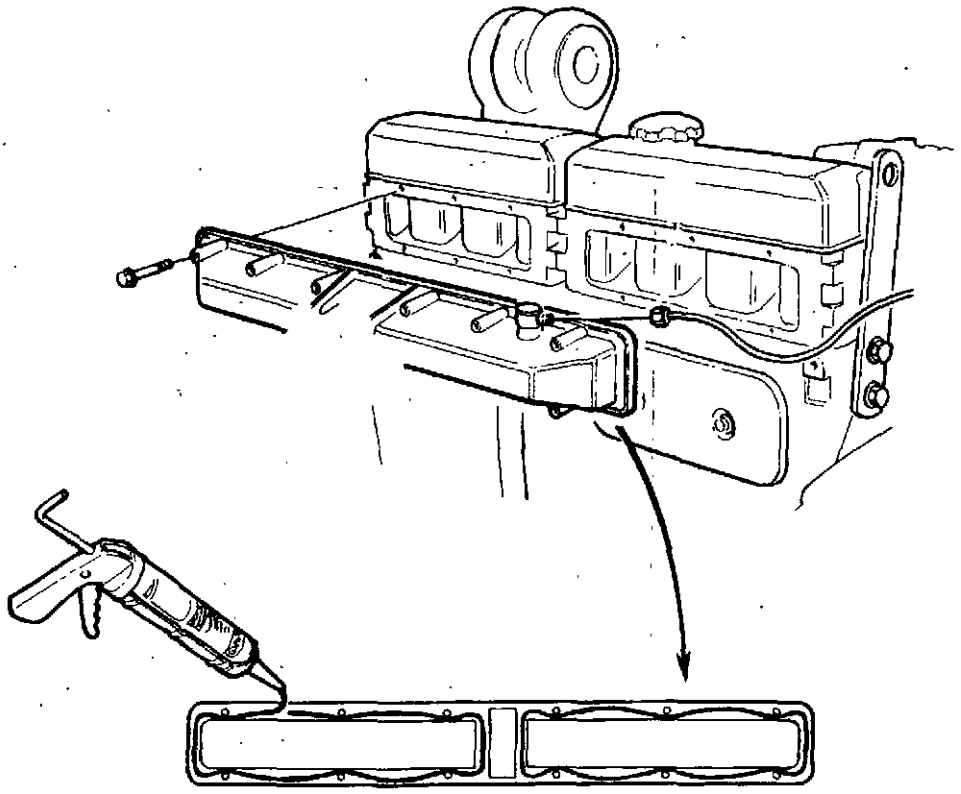
12
Fit a new gasket on the exhaust manifold and attach the turbo.

13
Fit the turbo oil delivery and oil return pipes using new gaskets.

14
Disconnect the turbo oil return pipe and crank the engine around with the starter motor until oil runs out through the turbo oil return opening.

15
Fit and tighten the turbo oil return pipe.

16
Check for leakage. Check the engine oil level, top up if necessary.



The figure shows the TD/TAD-engine

Sealant/gasket, inlet manifold, changing

1
Expose the inlet manifold.

Note! To make it easier to remove the inlet manifold, it may be necessary to remove the compressor cooling loop on certain variants.

2
Remove the bolts. Remove the inlet manifold.

TWD-engines: Remove the inlet manifold together with the charge air cooler.

3
Clean the inlet manifold and cylinder head contact surfaces.

4
All engines except TWD-engines
Apply an approx. **2 mm** (0.0787") wide bead of sealant (Partno.1161277) to the inlet manifold.

TWD-engines
Fit a new gasket.

5
Fit and tighten down the inlet manifold.

6
Connect the hose to the smoke limiter.

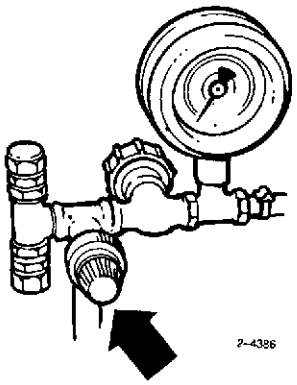
7
Fit and tighten down the components that were loosened or removed when exposing the inlet manifold.

Charge air cooler, checking for leakage (TAD-engines)

Special tools: 6662, 885231, 885232

Before using the pressure tester, it should be checked.

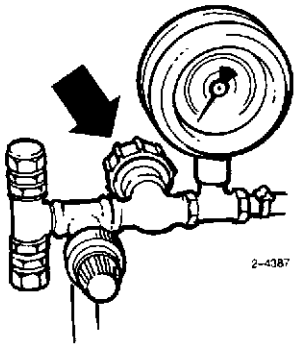
1



Connect the pressure tester to the workshop air supply and set the pressure gauge to 100 kPa (14.5 psi) with the reduction valve.

Note! To lock the reduction valve knob, move the lock ring axially.

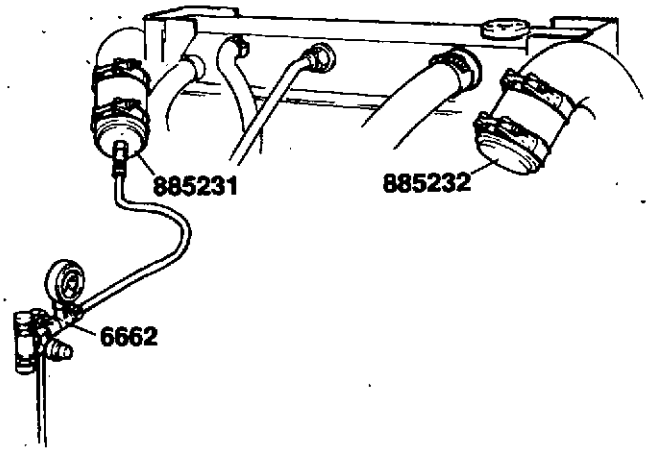
2



Shut off the valve. The pressure must not drop during 2 minutes otherwise the gauge cannot be relied upon.

3
Disconnect the charge air hoses from the charge air cooler.

4



Fit connection tool 885231 and sealing tool 885232 together with new hoses (if needed) on the charge air cooler.

Unscrew the pressure tester reduction valve.

Connect the pressure tester to the charge air cooler.

5
Open the shut-off valve knob and set the gauge to a pressure of 70 kPa (10.2 psi) with the reduction valve.

6
Close the shut-off valve. During one minute pressure may not drop more than 20 kPa (2.9 psi) otherwise the charge air cooler cannot be approved.

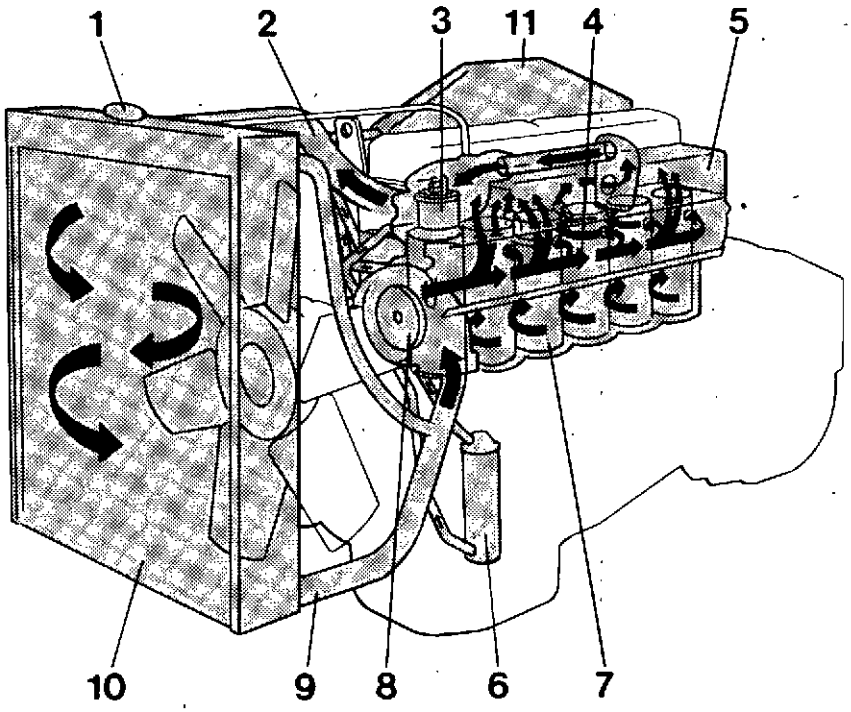
7
In the event of leakage, repeat the check several times. Also check the pressure tester hoses and connections.

8
Remove the pressure tester, connection washer and sealing washer.

9
Connect the charge air hoses.

Cooling system

Design and function



96090502

1. Filler cap
2. Line/thermostat housing- upper radiator tank
3. Piston thermostat
4. Distribution channel
5. Cylinder head
6. Oilcooler (7 lit. engine). (Tube type on 6 lit. engine)
7. Cylinder liner
8. Coolant pump
9. Line to the pump's suction side
10. Radiator
11. Charge air cooler (water to air, TWD-engine))

The coolant is pumped round the system by a gear wheel-driven pump and is led via a distribution gallery into the cylinder block.

From the gallery, the coolant is led via holes to the cylinder liners and to the two cylinder heads.

From the front cylinder head, the coolant is led back directly to the thermostat housing, and from the rear cylinder head the coolant is led through a separate pipe back to the thermostat housing.

On TWD-engines the charge air cooler is connected to the cooling system. The coolant is led through a pipe from the coolant pump. The outlet pipe of the charge air cooler is connected to the oil cooler.

The oil cooler is of the flat type mounted horizontally on the left-hand side of the engine.

Some engines have a tube type oil cooler mounted vertically on the right-hand side of the engine.

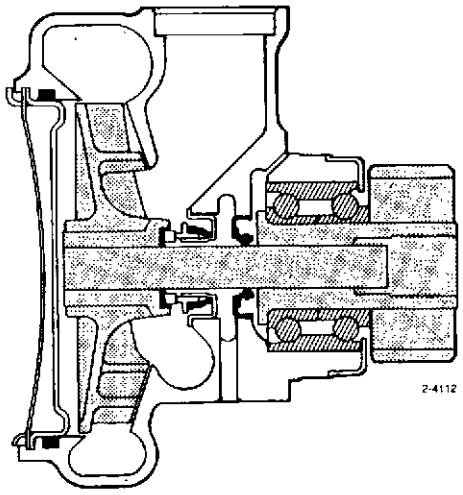
Coolant from the oil cooler is led back to the thermostat housing via a pipe connected to the thermostat housing cover. A pressure valve in the expansion tank cap regulates pressure in the cooling system.

Coolant pump

The coolant pump is mounted on the timing gear cover and is operated via a gear wheel from the engine timing gears.

The pump is fitted with three seals, two coolant seals and one oil seal.

The pump shaft is journalled in a double ball bearing.



Thermostat housing, thermostat

The thermostat housing is made of press-cast aluminium and is attached to the front cylinder head.

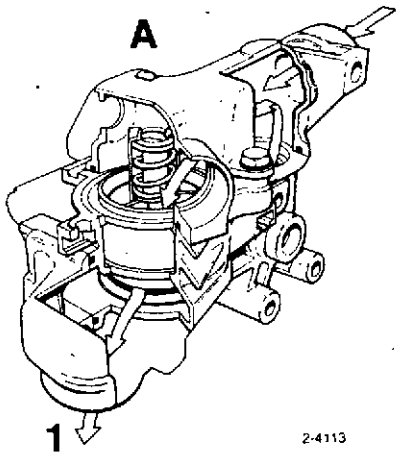
The thermostat is of the sleeve type.

When engine temperature is low, the thermostat closes and the coolant is led through a by-pass channel back to the coolant pump.

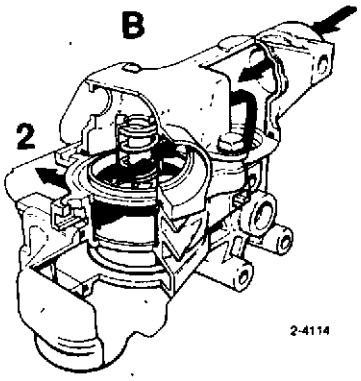
As engine temperature increases, the thermostat gradually opens the passage to the radiator, and at the same time the by-pass channel closes.

Note! The engine must never be runned without thermostat. For test running it is possible to force a thermostat open. The gap should be 12 – 13 mm.

With this test-thermostat installed the function of the cooling system is the same as if the thermostat was taken away.



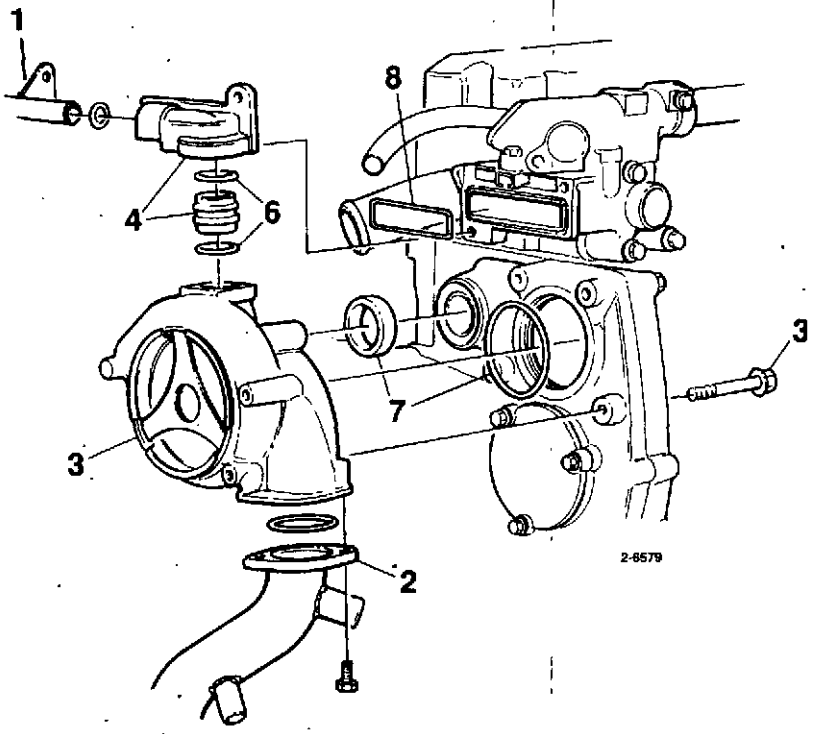
A. Thermostat in closed position
1. To coolant pump



B. Thermostat in open position
2. To radiator

Service procedures

Always wash the engine before commencing repairs.



The figures in the illustration are referred to in the following.

Coolant pump, changing

1
Disconnect the pipe (if fitted) from the thermostat housing front cover and remove the cover retaining bolts.

2
Remove the pipe from the coolant pump.

3
Remove the retaining bolts and lift out the coolant pump.

4
Remove the thermostat housing cover from the coolant pump and remove the pipe between the cover and pump.

5
Clean all sealing surfaces.

6
Fit new sealing rings to the pipe between the thermostat housing cover and coolant pump. Fit the pipe and thermostat housing cover to the coolant pump.

7
Fit new sealing rings for the coolant pump sealing against the timing gear cover and cylinder head.

8
Fit a new sealing ring on the thermostat housing cover, lift the coolant pump into position, fit and tighten the bolts.

9
Fit the thermostat housing cover.

10
Fit the pipe (if any) on the thermostat housing cover and fit the pipe on the coolant pump. Use new sealing rings.

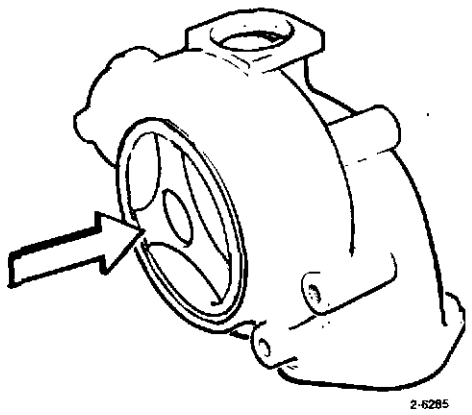
11
Top up with coolant and check for leakage.

Coolant pump, overhauling

Special tools: 2071, 2268, 2584, 4034, 4090, 6626, 6883, 6884, 6979, 8039, 8107, 8137, 884985

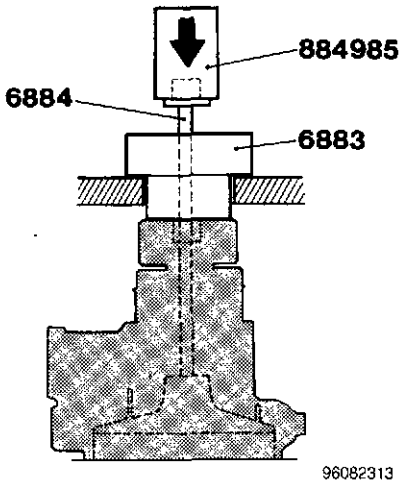
Disassembling

1



Remove the locking tab, cover and O-ring.

2



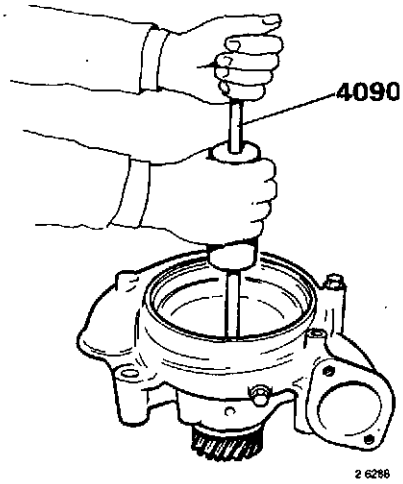
Screw tool 6883 onto the drive shaft.

Fit drift 6884 onto drift 884985. Insert the thin drift (6884) through the tool 6883.

Place the coolant pump in a hydraulic press with counterhold under the tool 6883.

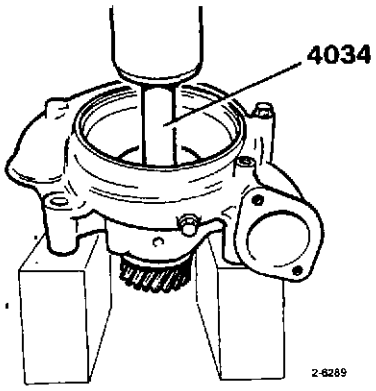
Press out the impeller with shaft.

3



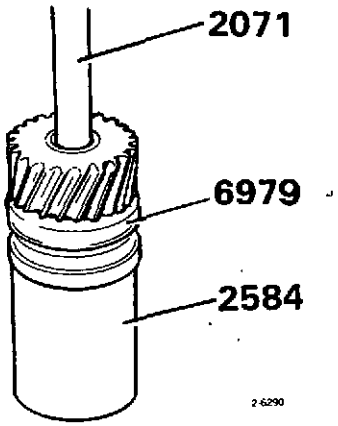
Remove the sealing ring using extractor 4090.

4



Press out the bearing pin together with bearing and gear wheel with tool 4034.

5



Press the gear wheel off the bearing pin.

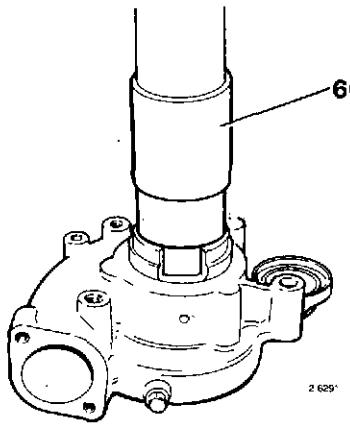
Inspection

Replace all old components with the new ones supplied with the repair kit. Before reassembling, check that the pump housing is not damaged.

Assembling

Note! When assembling the coolant pump, all pressfit surfaces should be lubricated with a mixture of equal amounts of molybdenum disulphide and engine oil.

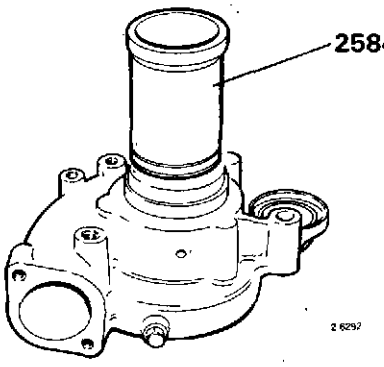
6



Press the bearing pin and bearing into the pump housing with hollow drift 6626.

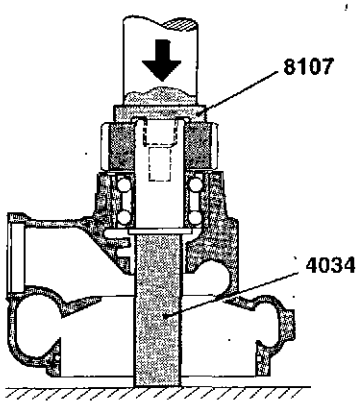
Note! Press on the bearing outer race. Use mounting paste.

7



Press on the locking ring with hollow drift 2584.

8



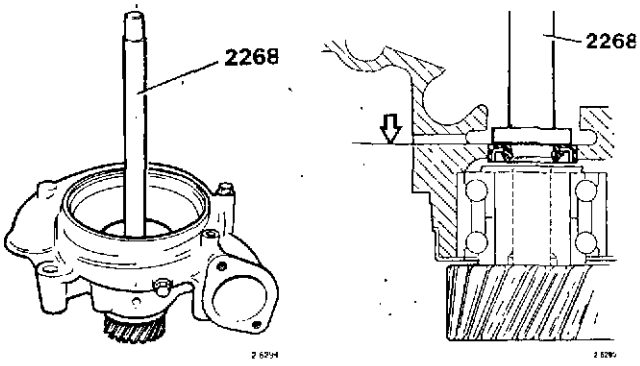
Place the coolant pump in an hydraulic press using drift 4034 as a counterhold under the bearing shaft. Press on the gear until it makes contact against the bearing.

Note! Use mounting paste.

9

Check that the bearing pin and gear wheel rotate easily. Bearing noise and axial play is not permitted.

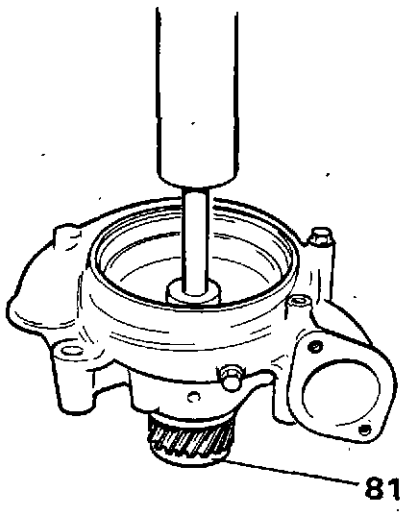
10



Position the sealing ring for the engine oil in the pump housing.

Note! Check that the sealing ring lip faces downwards. Press on the sealing ring carefully until it is flush with the edge of the pump housing, see sketch.

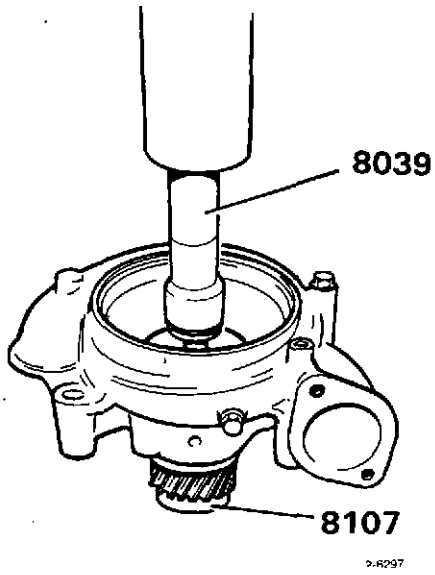
11



Press on the impeller shaft.

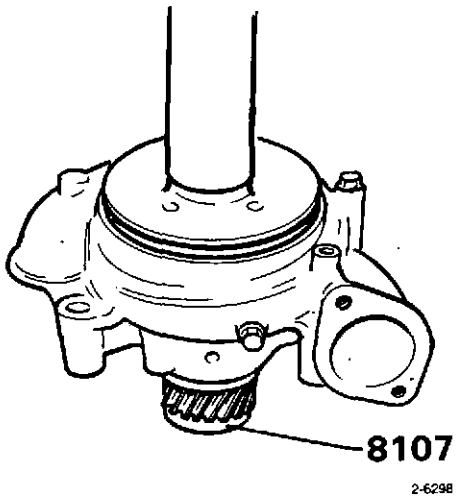
Use 8107 as a counterhold under the gear wheel. Press down the shaft until it bottoms.

12



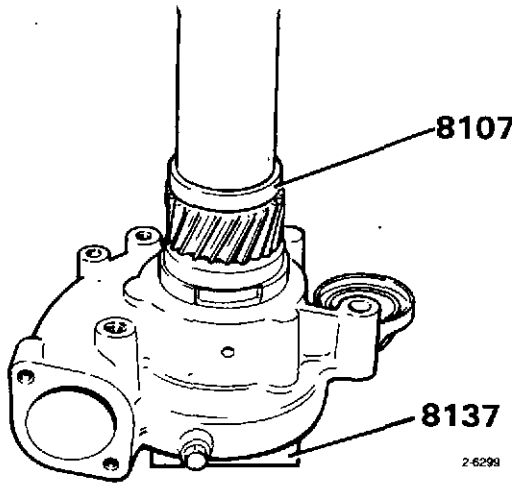
Using tool 8039, press on the sealing ring until it bottoms in the pump housing. Place 8107 as a counterhold under the gear wheel.

13



Press the impeller approx. 15 mm onto the shaft. Place 8107 as a counterhold under the gear wheel.

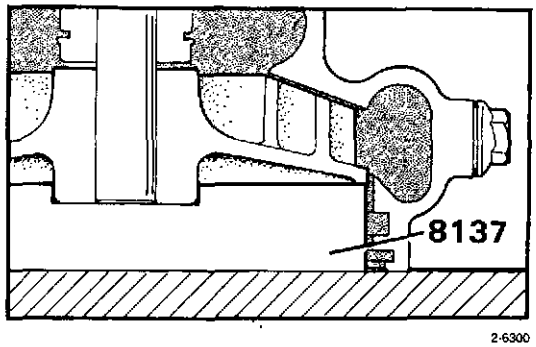
14



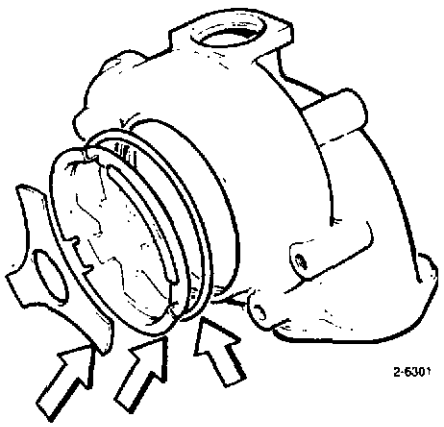
Turn the pump so that the impeller faces downwards and position it so that the impeller rests on tool 8137.

Using tool 8107, press the pump carefully until it bottoms against the pressing table.

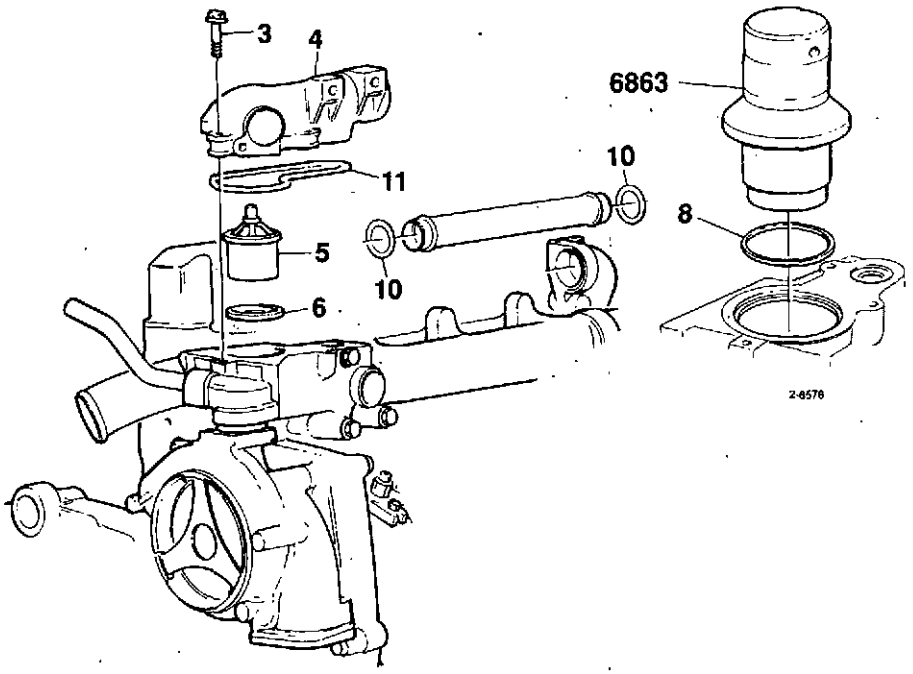
Note! Due to the design of tool 8137 correct measurement is obtained between the impeller and pump housing.



15



Fit new O-ring. Fit the cover and locking tab (bent inwards).
Note! Lubricate the O-ring with soft soap before assembling.



The figures in the illustration are referred to in the following.

Sleeve thermostat, changing

Special tool: 6863

1
Remove the fuel filter bracket from the thermostat housing cover.

Note! Do not loosen the fuel pipes.

Remove the clamp and the pipe for the oil cooler if fitted.

Remove the sealing ring.

2
Remove the fuel leak-off pipe between if needed.

3
Remove the bolts for the thermostat housing cover.

4
Lift up the thermostat housing cover approx. 20 mm and turn it carefully until it loosens from the coolant distributor pipe.

5
Remove the sleeve thermostat.

6
Remove the thermostat housing sealing ring by tapping it with a drift until it upsets and can be extracted.

7
Clean the thermostat housing and the cover.

8
Fit a new sealing ring on drift 6863 and carefully tap down the ring until the drift bottoms against the housing.

Note! Fit the sealing ring with the sealing lip downwards.

9
Fit a new thermostat.

10
Fit new sealing rings on the coolant distributor pipe.

Note! Apply soapy water to the sealing rings.

11
Fit a new sealing ring in the thermostat housing cover.

12
Press the thermostat housing cover on the coolant distributor pipe and attach the cover to the thermostat housing.

13
Fit a new sealing ring on the oil cooler pipe (some engines). Fit the pipe and attach the clamp.

Note! Apply soapy water to the sealing ring.

14
Fit the fuel leak-off pipe if it has been loosened.

Attach the fuel filter bracket to the thermostat housing cover.

Note! The attachment holes are oval to enable the bracket to be adjusted and to avoid stresses in the fuel pipes.

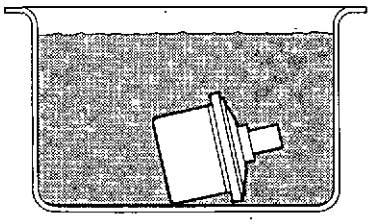
Thermostat, function check

A function check must be carried out before fitting a new thermostat.

1
Check that the thermostat has closed fully. This can be done by holding it up against the light, there must be no visible gap at the opening point.

If the thermostat does not close properly, change it.

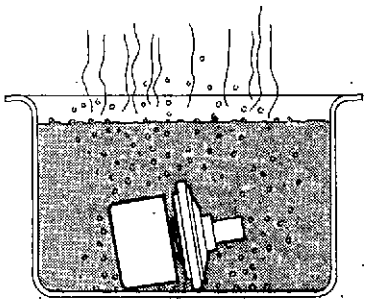
2



Heat up water in a receptacle to **+70°C (158°F)** and immerse the thermostat in the water as illustrated.

3
Check after at least 30 seconds that the thermostat is still closed.

4



Now heat the water to boiling point (100°C/212°F)

Check after at least 30 seconds at boiling point that the thermostat has opened at least 7 mm.

If the thermostat does not open, change it.

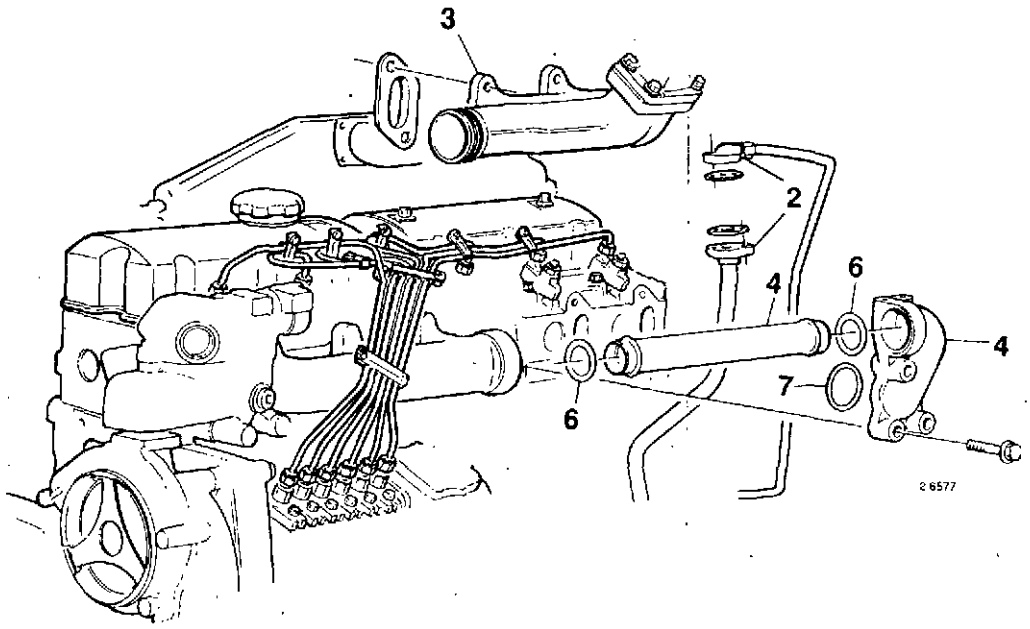


Figure shows 610-, TD630- engine

Seals, coolant distributor pipe bracket, changing

610-, 630-engines

1
Disconnect the oil delivery pipe from the turbo charger.

2
Remove the oil return pipe from the turbo charger.

3
Remove the bolts for the rear section of the exhaust manifold and lift off the manifold together with the turbo.

4
Remove the bracket and the coolant distributor pipe.

5
Clean the bracket, pipe, thermostat housing cover, cylinder head and exhaust manifold contact surfaces.

6
Fit new sealing rings on the coolant distributor pipe and press the bracket on the pipe.
Note! Apply soapy water to the sealing rings.

7
Fit a new sealing ring on the bracket.

8
Press the coolant distributor pipe into the thermostat housing cover and bracket, fit the bracket.

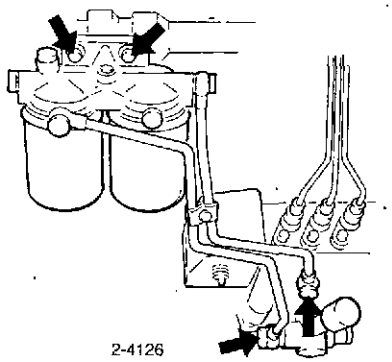
9
Fit and tighten down the exhaust manifold using new gaskets.
Note! Make sure that the graphite part of the gasket faces the cylinder head and the plain metal surface lies against the exhaust manifold.

10
Fit the turbo oil delivery and oil return pipes using new gaskets.

710-, 730-, 731-engines

Fuel and pressure pipes must not be bent or deformed as this can cause cracks and subsequent breakage.

1



Disconnect the fuel pipes from the injection pump and remove the fuel filters together with the bracket. Plug the connections on the injection pump.

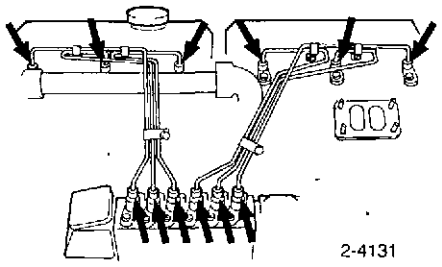
2
Remove the air pipe and exhaust pipe from the turbo.

3
Remove the oil delivery pipe and loosen the oil return pipe from the turbo.

4
Remove the nuts and lift off the turbo.

5
Remove the turbo oil return pipe from the cylinder block.

6

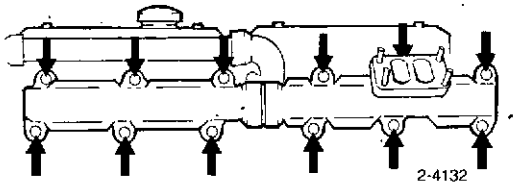


Remove the fuel delivery pipes and plug the connections.

Note! The fuel delivery pipes are clamped three and three. Do not remove the clamp, three pipes should be removed as a unit.

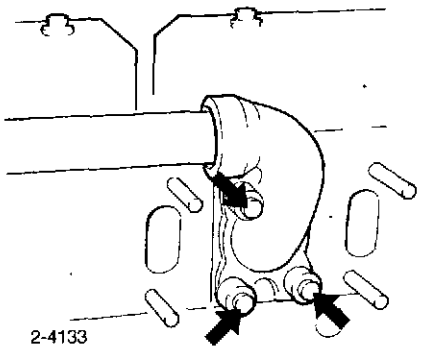
Under no circumstances must the fuel delivery pipes be bent or deformed. A damaged fuel delivery pipe must be replaced.

7



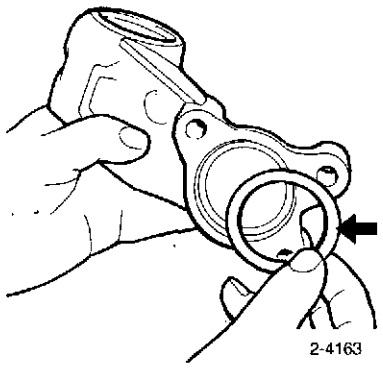
Remove the exhaust manifold nuts and sleeves. Lift off the manifold.

8



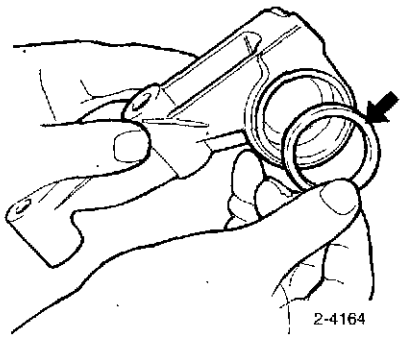
Remove the coolant distributor pipe connection from the rear cylinder head and remove the pipe.

9



Clean the coolant distributor pipe connection and fit a new sealing ring.

10

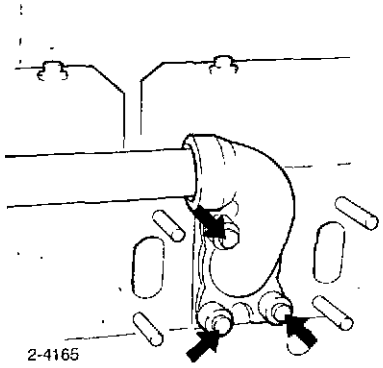


Fit a new sealing ring in the thermostat housing and in the coolant distributor pipe connection.

11

Apply soapy water to the sealing rings and press the pipe into the thermostat housing.

12

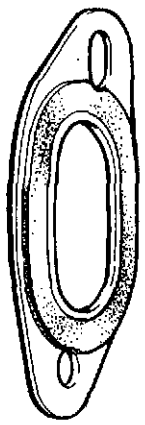


Fit the connection to the pipe and attach the connection to the cylinder head.

13

Clean the exhaust manifold and cylinder head contact surfaces.

14



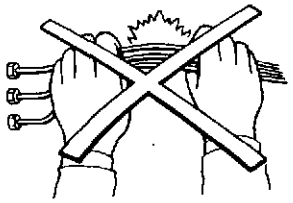
Fit the new gaskets on the cylinder heads.

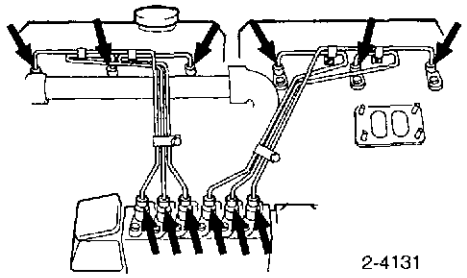
Note! Make sure that the graphite part of the gasket faces the cylinder head and the plain metal surface lies against the exhaust manifold.

15
Lift up the exhaust manifold into position and fit the sleeves and nuts.

Attach the manifold.

16





Fit the fuel delivery pipes.

Note! Under no circumstances must the fuel delivery pipes be bent or deformed. A damaged fuel delivery pipe must be changed.

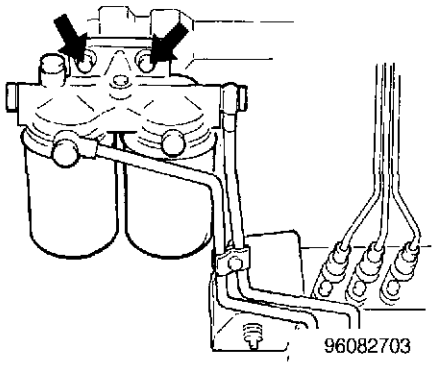
17
Fit the turbo oil return pipe in the cylinder block.

18
Fit a new gasket on the exhaust manifold, lift up and attach the turbo.

Fit the turbo oil delivery and oil return pipes using new gaskets.

19
Fit the air pipe and the exhaust pipe.

20



Fit the fuel filters together with the bracket and connect the pipes to the injection pump.

Note! Do not tighten the fuel filter bracket bolts until the pipes have been connected.

The attachment holes are oval to enable the bracket to be adjusted and to avoid stresses in the fuel pipes.

21
Bleed the fuel system.

Thermostatically controlled fan, function check

Special tool: 9988460

Operational disturbances concerning the fan can be due to, among other things, an incorrect amount of silicone fluid or worn parts in the control device.

Before carrying out a function check, make sure that the radiator is not clogged and that the coolant temperature sensor is working.

If the thermostat in the cooling system is not functioning, this may disturb the function of the fan.

Note that fitting of so-called radiator blinds can mean that the termostatically controlled fan will operate continuously.

The fan can be presumed to not be working properly should any of the following be observed:

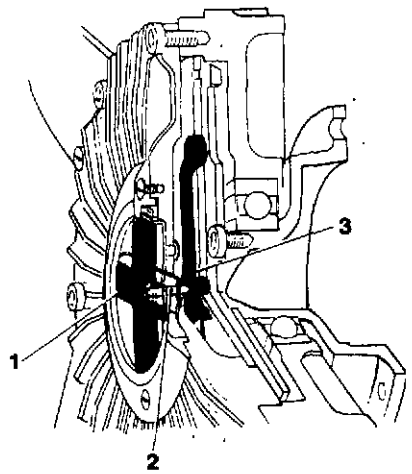
1. The fan does not engage, i.e. low fan speed is maintained despite high engine load. This will imply a high coolant temperature.

2. The fan does not disengage, despite low engine load.

Control device

A.The fan rotates at reduced speed:

The bimetallic spring (1) presses against the control pin (2) moving it towards the valve lever (3).

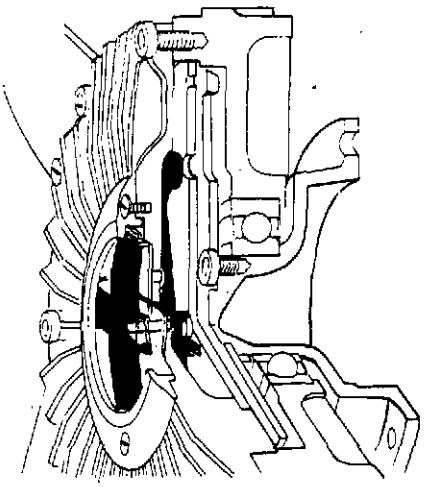


Control device

1 Bimetallic spring
2 Control pin
3 Valve lever

B. The fan is fully engaged

The bimetallic spring flexes outwards due to the temperature increase in the ambient air.



Speed check, fan disengaged

1

Run the engine at idling speed for **5 minutes**. Air temperature in front of the fan must not exceed **+ 30°C (+86°F)**.

The silicone fluid which, when the engine is switched off, ran into the drive chamber, is now pumped back to the storage chamber.

2

Increase engine speed to 43.3 r/s (2600 r/min). Fan speed should now be 8.7-21.7 r/s (520-1300 r/min).

If the fan speed is not as specified above, the fan should be changed.

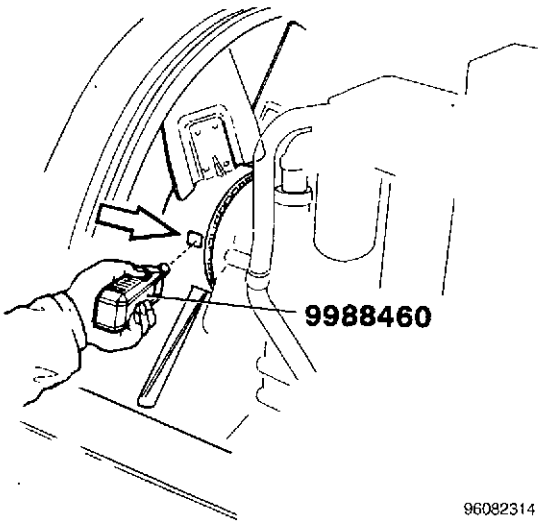
Note! The fan must not be topped up with silicone fluid if the speed is too low.

Checking revs of engaged cooling fan

Special tools: 9795

1
The engine operating temperature should be high enough for the fan to be fully engaged.

2
Increase engine speed to 43.3 r/s (2600 r/min). Fan speed should exceed 36.8 r/s (2200 r/min). If fan speed is lower, the fan should be changed.



Checking revs of thermostatically controlled cooling fan

Warning!
Keep your hand and the measuring instrument at a safe distance from the blades of the fan when checking revs.

Faulty cut-in temperature

If, despite the fact that the fan cut-in speed is correct, high coolant temperatures are suspected when driving, and also the fact that the fan cannot be heard engaging as coolant temperature rises, the fan cut-in temperature is probably incorrect.

Fan cut-in temperature cannot be adjusted or checked in the vehicle since special instruments are required.

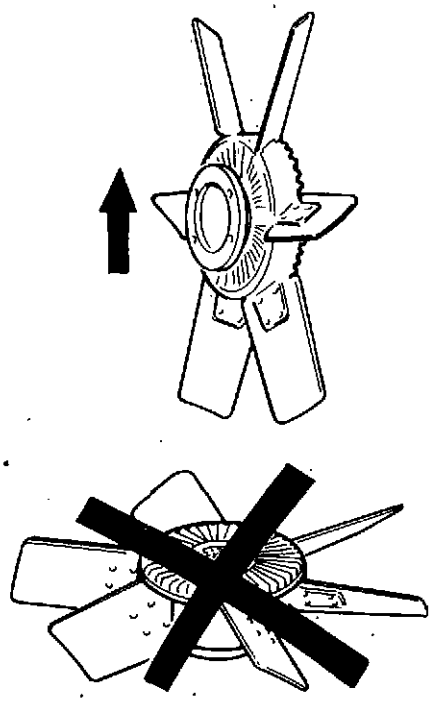
If the cut-in/cut-out temperatures are suspected as being incorrect, the fan must be changed.

Thermostatically controlled cooling fan, changing

A thermostatically controlled fan contains an accurately adapted amount of silicone fluid in order to function reliably.

For this reason, such a fan must always be stood vertically when out of the vehicle.

If positioned horizontally, the silicone fluid may leak out, resulting in the fan losing its properties.



When changing a fan, always check the new fan for leakage. If leakage is suspected, special instruments are required for checking cut-in temperature, speed, etc.

Coolant

The coolant should be a mixture of anti-corrosion additive and water or, where there is a risk of freezing, antifreeze and water, see below.

The coolant should be changed and the system flushed clean once a year. At the same time check all hoses and connections and cure any leakage. Replace all loose, swollen or otherwise damaged hoses.

Antifreeze

The antifreeze prevents corrosion in the cooling system and also freezing during the winter. We recommend the use of **Volvo Penta antifreeze*** (ethylene glycol, gluegreen), which contains correctly balanced corrosion inhibitors. To get full protection against corrosion, always use at least 40% antifreeze. This means that topping-up, whenever necessary, should be done with the corresponding antifreeze mixture.

Note! Volvo Penta antifreeze must not be mixed with any other kind of antifreeze.

*)
Part No. 1141646-8, 5 litres (1,32 US gals).
Part No. 1141647-6, 210 litres (55,48 US gals)

Mixing table, antifreeze/water

Resuisite volume of antifreeze in % of total coolant volume for freeze protection down to approx.		
-28°C(-18°F)	-40°C(-40°F)	-56°C(-69°F)
40%	48%	60%

At the most, the freezing point can be lowered to –56°C (–69°F) (60% antifreeze). **Increasing the mixture of antifreeze past this point reduces the protection from freezing.**

Mix the antifreeze with water in a separate vessel prior to filling the cooling system.

NOTE! Antifreeze is hazardous (poisonous if consumed).

Anti-corrosion additives

To prevent corrosion it is simplest to use a suitable mixture of genuine Volvo Penta antifreeze (glycol) all year round (at least 40%). It should be changed every autumn.

In cases where antifreeze is not used, an anti-corrosion additive should be added to the coolant. Use **Volvo Penta anti-corrosion additive** (part No. 1141526-2) which is available in quantities of 1/2 litre, 3 cans (1,5 litres) are required.

Clean the cooling system thoroughly before filling. Run the engine warm soonest after filling to get the best possible effect from the additive.

To maintain the protection against corrosion, the coolant should thereafter be **supplemented** with further 1/2 litre anti-corrosion additive **every 400th hour of operation.**

NOTE! Other types of anti-corrosion additive, glycol or antifreeze must **absolutely not** be mixed with this anti-corrosion additive. The anti-corrosion additive *does **not** prevent the formation of ice and should only* by used where the temperature is always above 0°C (32°F).

Checking the coolant level

On engines with separate expansion tank (optional equipment) the level, with a cold engine, should be slightly higher than the middle of the tank (never below the MIN mark). On other engines the level should be approx. 4–5 cm (2") below the filler caps sealing edge. There must be an air space to allow for expansion of the coolant.

WARNING! Open the filler cap very carefully when the engine is warm. Hot steam or fluid can spray out.

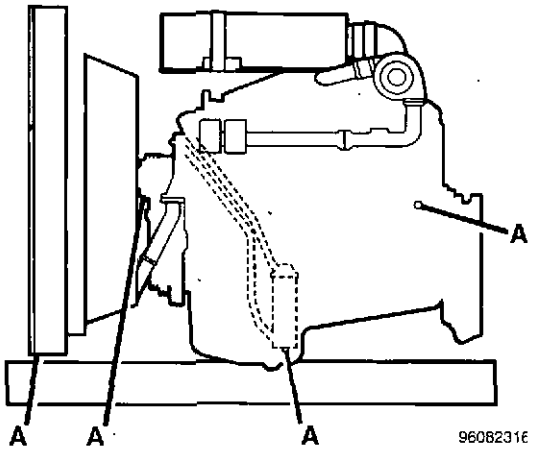
An insufficient quantity of coolant can lead to poor circulation, which increases the risk of overheating, resulting in damage to the engine.

Draining the coolant

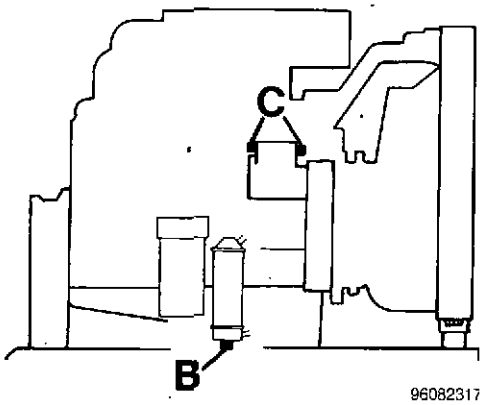
Before draining the coolant, stop the engine, unscrew the filler cap.

See figure for the location of drain cocks and plugs. Unscrew the coolant filter, if fitted.

Check carefully to make sure that all water runs out.



A = Drain cock/plug for coolant.



B = Drain plug, 610-engines

C = Drain plugs on compressor (accessory)

Filling the coolant

Filling must not be done so fast that air locks from in the system. The air must be able to pass out through the filler opening.

Filling should be carried out with the engine stopped. The engine must not be started until the system has been vented and completely filled. If a heater system is connected to the engine's cooling system, the heat control valve should be fully opened and the heater system vented during filling.

Flush clean the cooling system before filling with coolant. Check all hoses and connections and cure any leaks. Close the drain cocks.

Fill with coolant to the correct level (see "Checking the coolant level"). Check that the cooling system is properly vented by **carefully opening the venting cock** after the engine has been started and has reached operating temperature. Any remaining air is thus removed.

WARNING! Open the filler cap (venting cock) very carefully when the engine is hot. Steam or hot coolant can spray out.

Topping-up should be carried out with the same mixture as used in the cooling system.

On engines with a separate plastic expansion tank (optional equipment), the filling of large volumes is done directly through the filler opening on the cooler/engine's expansion tank, until the system is vented and completely filled. Close the venting cock, screw on the filler cap and finally fill the separate expansion tank to between the MIN and MAX marks.

Coolant temperature too high

Too high coolant temperature can be caused by:

- Low coolant level, air in the system
- Reduced air flow through the radiator, dirty radiator (applies to industrial engines)
- Poor drive belt tension (applies to industrial engines)
- Blocked cooling system
- Faulty thermostat
- Faulty temperature gauge
- Faulty setting of injection pump with regard to the preinjection angle.

Coolant temperature too low

Too low coolant temperature can be caused by:

- Faulty thermostat
- Faulty temperature gauge

Checking the temperature gauge

Remove the temperature sender. Connect the cables to the temperature gauge and immerse the sender in hot water. Compare the temperature gauge reading with that of a thermometer.

Coolant loss

Loss of coolant can occur in two ways:

- Loss of coolant during running
- Loss of coolant after stopping a hot engine

Coolant loss during running can be due to leaks in the cooling system or air or combustion gases being pressed into the cooling system causing the coolant to be forced through the pressure valve. The fault can be in the compressed air compressor, it fitted, or leakage at the cylinder head gaskets.

Loss of coolant after stopping a hot engine is generally due to a faulty pressure valve (filler cap).

Checking the radiator

Should higher than normal coolant temperatures be observed, the passage of air through the radiator must always be checked.

Check that the external cooling sections of the radiator are not blocked by insects or other impurities that can restrict the air flow. If obstructions are found use a mild grease-dissolving detergent and water. **Never** use water at high pressure or compressed air.

Straighten out any bent cells in the cell system. Flush the radiator from front. In cases of more serious blockage the radiator must be removed entirely and then cleaned with a mild detergent.

Also check that the fan cover has not come loose or is leaking in any other way.

Adjusting the drive belts

Replace belts which have become oily, worn or damaged in any way.

NOTE! Belts that work in pairs should always be replaced at the same time.

Tension the alternator belts after loosening the alternator. Correct tension is obtained when the belts can be depressed approx. **10 mm (0.400")** midway between the pulleys.

The engine is equipped with an automatic belt tensioner for the fan belts.

Cleaning the cooling system

The cooling system should be cleaned when changing the coolant.

It is generally sufficient to flush through with clean water, but if the cooling system has large rust and mud deposits we recommend the following cleaning method:

1
Empty and flush the system clean. Dissolve 1 kg (2.2 lbs) of oxalic acid* in 5 litres.(4.4 lbs.qts/5.3 US qts) of hot water and pour into the cooling system. Top up with clean water.

WARNING! protect hands and face. Oxalic acid is poisonous and hazardous to the skin.

2
Run the engine until it reaches normal operating temperature and then for **another 2 hours approx.**

NOTE! Any heater controls must be on "hot".

3
Drain the system and **flush out immediately and thoroughly with clean water.** For this purpose the thermostat housing (thermostat), upper and lower radiator hoses, drain cocks and plugs should be removed to give the best possible draining speed. Do not forget the engine heater or heater element, if fitted. Continue flushing until the water running out is clean. It is essential to remove all oxalic acid, otherwise the remains can increase the risk of further corrosion.

4
Dissolve 200 grams (7 ozs.) of bicarbonate* (sodium hydrogen carbonate) in 5 litres (4.4 Imp.qts/5.3 US qts) of water an pour into the cooling system. Top up with clean water.

NOTE! Never use soda (sodium carbonate Na2Co3) as incorrect handling can result in severe corrosion damage.

5
Run the engine at normal operating temperature for approx. 10–15 mins. This point must be done thoroughly in order to neutralize the oxalic acid.

6
Flush the system thoroughly clean according to point 3. Increased flushing effect can be obtained by mixing air with water, in which case flushing must, **without question, be carried out from bottom to top (radiator), or from the drain cock in question on the cylinder block.**

NOTE! Remove the filler cap from the expansion tank/radiator. In the case of separate expansion tank, this should also be flushed from the bottom and up with the filler cap removed for efficient cleaning. Flush the heater, if fitted, with the hoses removed to be sure that remaining deposits are removed.

7
If there are still deposits in the cooling system, repeat the steps under points 1–6.

When cleaning, check that all hoses are free from defects. Replace if necessary.

8
Fill the system with a coolant recommended by Volvo Penta. See section "Coolant".

*) Not marketed by Volvo Penta, can be purchased from chemical stores. Chemical formula for oxalic acid: C2H2O2.

Chemical formula for sodium hydrogen carbonate: Na HC O3.

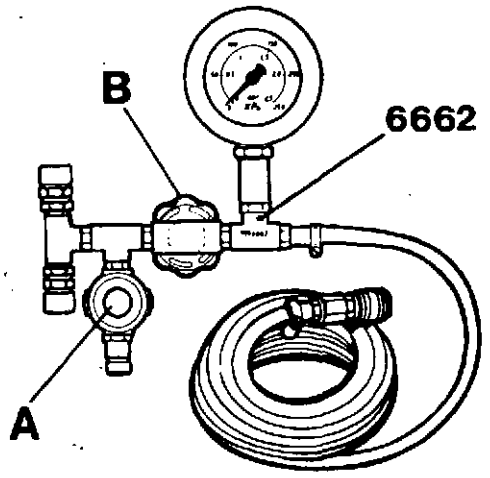
Pressure-testing the cooling system

Special tools: 6662, together with compressed air and 6433. Alternatively a standard type of pressure-testing device can be used.

Checking the pressure-testing device 6662

Before using the pressure-testing device it must be checked as follows:

A. Check that the knob on the relief valve (A) is screwed out and connect the test device to the compressed air system. Open cock (B) and adjust the relief valve until a pressure of **100 kPa (1 kp/cm²/14.5 p.s.i.)** is indicated on the gauge.



NOTE! The relief valve's knob can be locked with a locking ring which is moved axially.

NOTE! Always follow valid safety regulations.

B. Close cock (B). The pressure must not drop during two minutes if the test device is to be considered reliable.

Pressure testing

1
Remove the coolant filler cap and fit instead cap 6433 on the radiator. Plug the connection to an extra plastic expansion tank, if fitted, during the pressure-testing.

2
Ensure that the knob on the relief valve (A) is screwed out and connect the hose from the pressure-testing device to the cap 6433.

3
Seal the drain line from the filler pipe.

4
Connect the pressure-testing device 6662 to the compressed air system and open the cock (B).

5
Pull out the lock ring for the knob on the relief valve. Increase the pressure by screwing in the knob until the pressure gauge reads **70 kPa (0.7 kp/cm² = 10 psi).** Lock the knob by pressing in the lock ring and close the cock (B).

6
Check during one minute that the pressure does not drop. If there is difficulty in locating the leak, drain the coolant, re-pressurize the system and apply soapy water to hose connections, drain cocks etc, until the leak is found.

NOTE! Make sure that the pressure never exceeds **70 kPa (0.7 kp/cm² = 10 psi).** Increased pressure can, among other things, damage the coolant pump seal.

NOTE! Always follow valid safety regulations.

7
Remove the testing device.

Checking the pressure valve

The pressure valve is located in the filler cap. For this test the same pressure-testing device is used as for testing for leakage in the cooling system. See previous section.

1
Drain part of the coolant and connect the pressure-testing device with a nipple to any plugged hole in the cooling system.

2
Extend the draining hose from the filler pipe with a hose which opens out into a vessel containing water.

3
Apply the pressure, see "Pressure testing the cooling system", previous section, and read off the pressure gauge when the valve opens (water will bubble in the vessel with the drain line/filler cap).

See "Workshop Manual, Technical Data" for valve opening pressure.

4
Remove the testing equipment. Fit the plug and fill the engine with coolant.

Electrical system

The engine is equipped with a 2-pole electrical system with alternator. System voltage is 24 volts.

Important

For engines with alternators the following are applicable:

1 **Never break the circuit between alternator and battery when the engine is running. The main switch must therefore not be switched off until the engine has stopped.** Cables shall not be disconnected while the engine is running since this can also damage the voltage regulator.

2 Batteries, battery cables and cable terminals shall be checked regularly. The battery poles shall be well-cleaned and the terminal clamps always tightened and well greased so that no interruption occurs. All cables shall be well tightened, and there shall be no loose connections.

Note! Do not interchange the battery's plus and minus poles when fitting the batteries. Compare with wiring diagram. Check drive belt tension regularly.

3 When starting with auxiliary batteries, see **"Starting with auxiliary battery".**

4 In the event of repairs to alternator equipment both battery cabled shall be removed first. The same applies for quick-charging of batteries.

Note! Follow the relevant safety instructions when charging batteries.

5 Never test with screwdriver or the like to any connection to see if it sparks.

Arc welding

When arc welding electrically on the engine or on the installation components, always prepare as follows:

Remove the 2 battery terminals and then all the alternator leads from the alternator. Attach the welding clamp to the component to be welded and as close to the welding spot as possible. Never attach the welding clamp to the engine or in a way that the current will have to pass through a bearing. After the welding is finished: Install the alternator leads **before** you install the battery terminals.

Starting with auxiliary battery

WARNING! The batteries (especially auxiliary batteries) contain an oxyhydron gas mixture which is very explosive. A spark generated by connecting the jumper leads incorrectly is sufficient to explode a battery and cause personal injury and damage.

If the batteries are frozen they must be thawed out first before attempting to start them with an auxiliary battery.

1 Check that the auxiliary batteries are connected (in series or parallel) so that the rated voltage corresponds with the engines system voltage.

2 Connect the one end of the red jumper cable to the auxiliary battery's plus terminal (marked P or + with red paint). Always check that the clamps are well secured to avoid sparks.

3 Connect the other end of the red cable to the plus terminal on the flat battery where the plus cable to the engine is connected.

4 Connect the end of the black cable to the minus terminal on the auxiliary battery (marked with blue paint N or –).

5 Connect the other end of the black cable to a point some way off from the flat batteries, e.g. at main switch, or minus cable or connection of minus cable to the engine.

6. Start the engine.

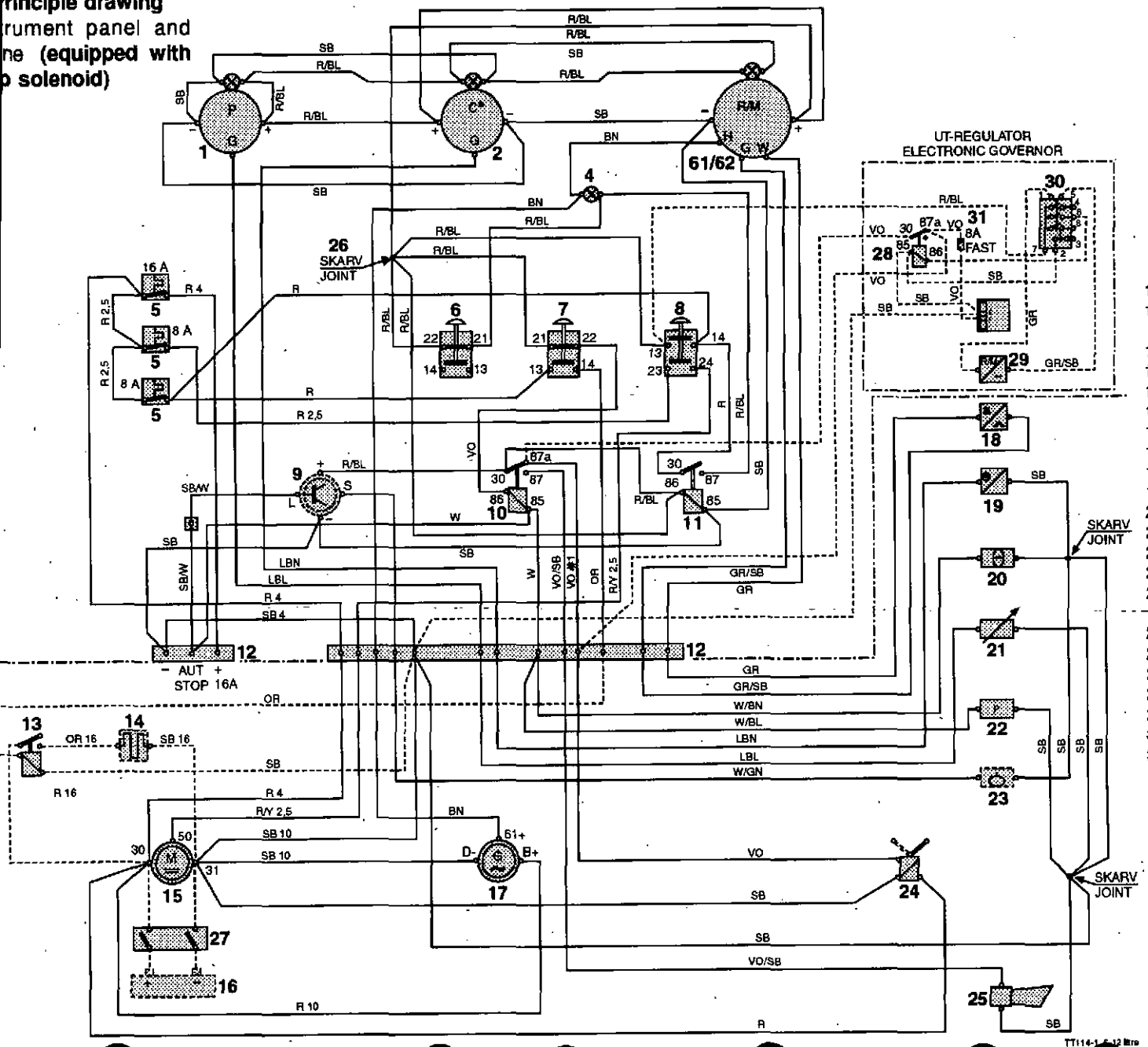
Note! Do not interfere with connections when attempting to start (spark risk) and do not lean over batteries.

7. Remove cables in exactly the reverse order to which they were connected.

Note! The usual cables to the standard batteries must on no account be disconnected.

Wiring diagrams

rinciple drawing
rument panel and
ne **(equipped with**
p solenoid)

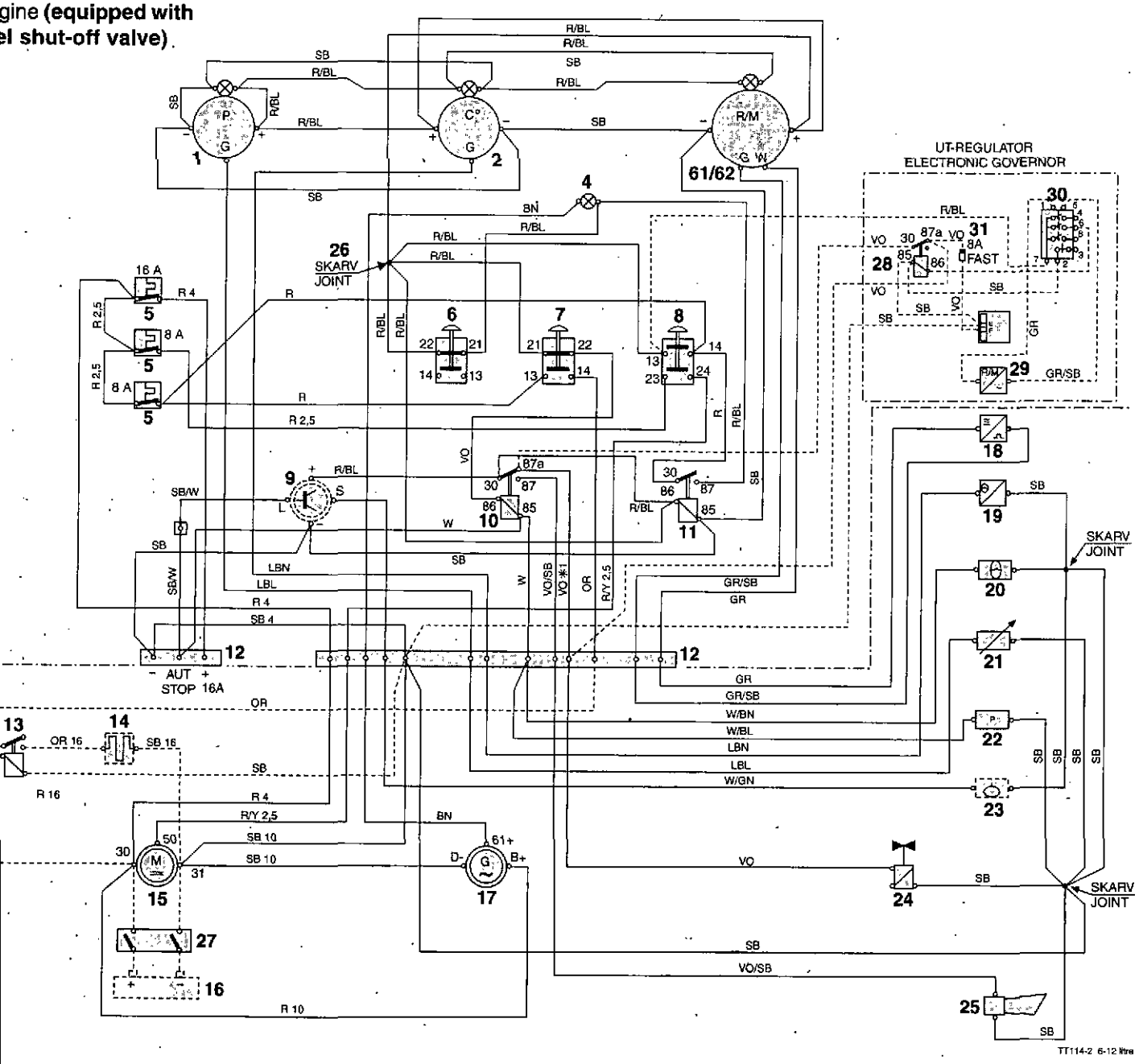


Pos.list to principle drawing 1 and 2

1. Oil pressure gauge
2. Coolant temperature gauge
3. Rev. counter with built-in hour counter
4. Warning lamp, charging
5. Semi-automatic fuses, (manual resetting)
6. Stop button
7. Interlock button
8. Start button
9. Relay for coolant level switch (accessory)
10. Relay for coolant temp. switch, oil pressure switch
11. Holding current relay (operating current and instrument)
12. Terminal bar, 16A fuse for automatic stop
13. Relay for preheater element
14. Preheater element
15. Starter motor
16. Battery
17. Alternator
18. Speed sender
19. Coolant temp sender
20. Coolant temp. switch (normally OFF)
21. Oil pressure sender
22. Oil pressure switch (normally OFF)
23. Coolant level switch (optional)
24. Stop solenoid (principle drawing 1) / Fuel shut-off valve (principle drawing 2) (energized to run)
25. Horn
26. Connection
27. Battery switch
28. Relay
29. Pickup for overspeed protection
30. *Engine overspeed switch*
31. Fuse, 8A

*1 Dismount at inst. of GAC-regulator

Principle drawing
strument panel and
gine **(equipped with**
el shut-off valve).



Cable areas in mm² (given after colour code in wiringdiagram).
1,5mm² when no other area is given.

Colour code

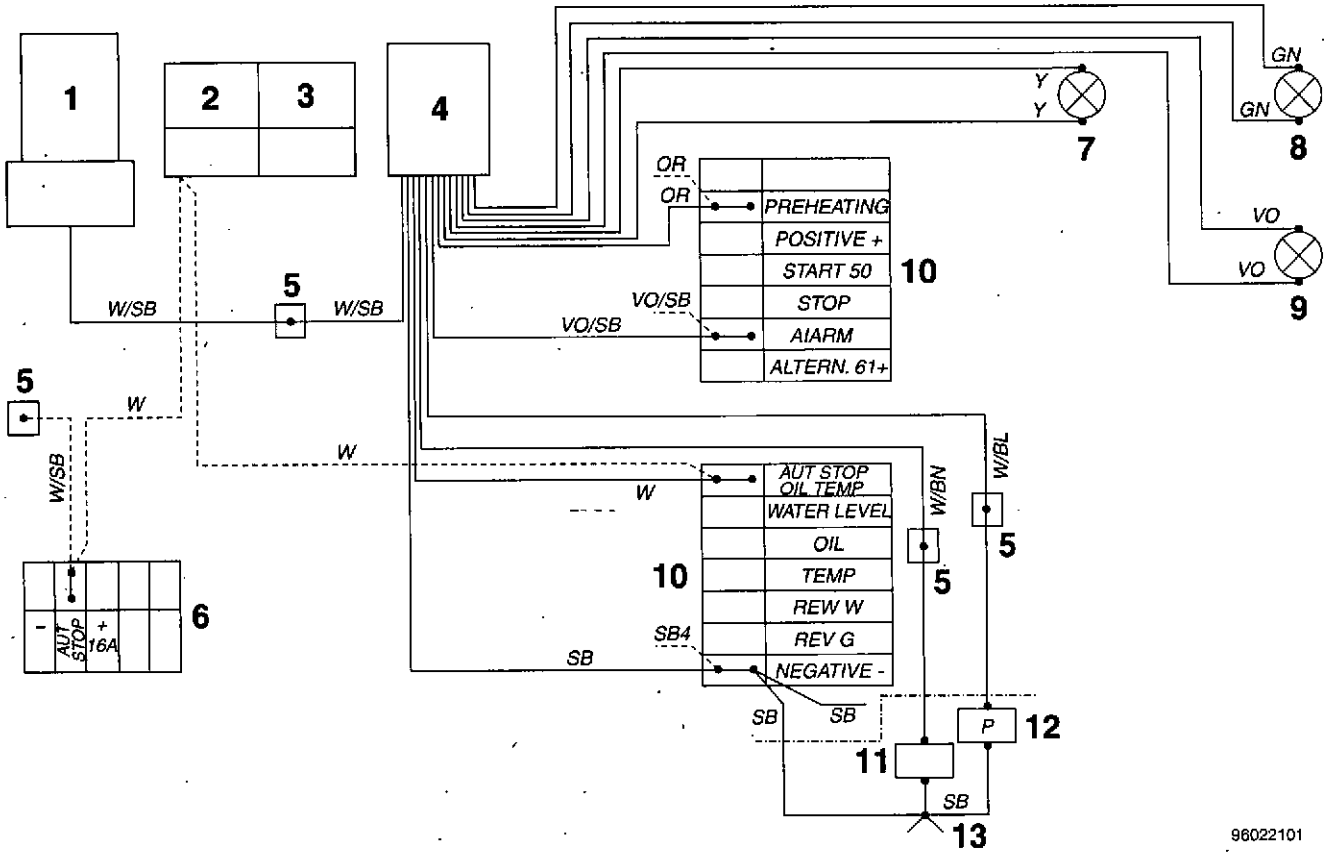
BL	=	Blue
OR	=	Orange
LBL	=	Light blue
VO	=	Violet
BN	=	Brown
R	=	Red
LBN	=	Light brown
SB	=	Black
GN	=	Green
W	=	White
GR	=	Grey
Y	=	Yellow

Battery cable areas are related to battery positioning.
Distance, starter motor- batteries:
max. 2 m, area = 70 mm²
max. 4 m, area = 120 mm²

Relation mm²/AWG*
* American Wiring Gauge

mm²	1,0	1,5	2,5	10	16
AWG	16 (17)	15 (16)	13	7	5

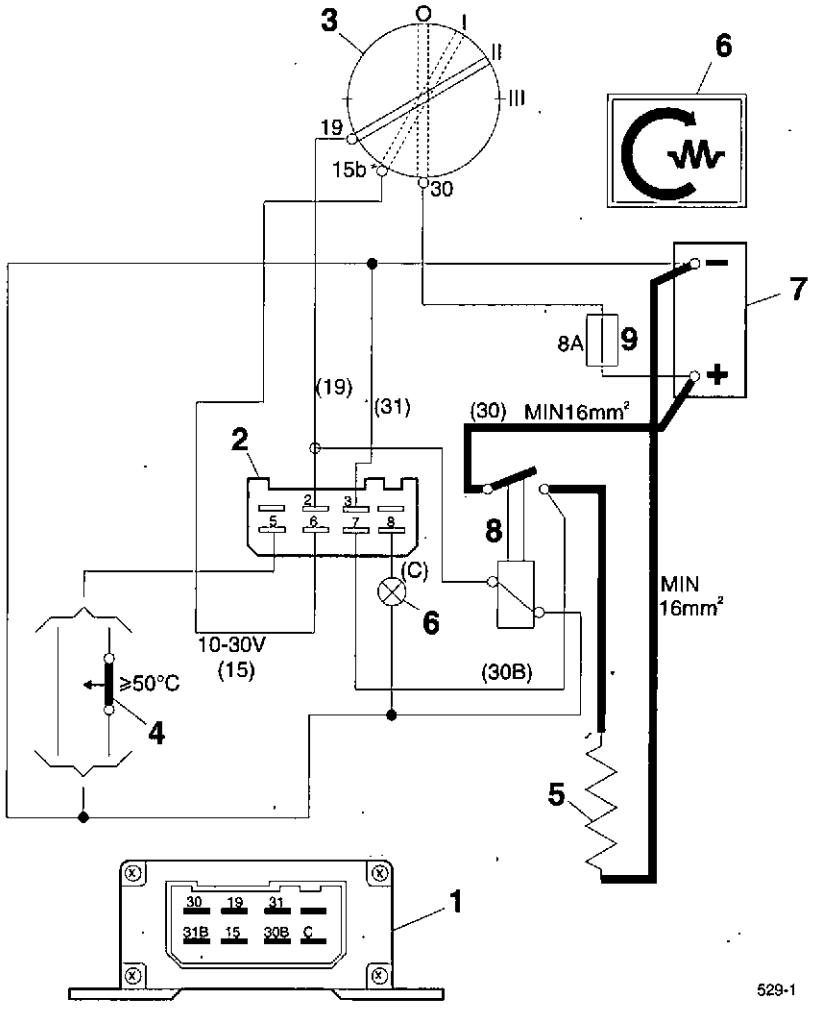
Principle drawing.
nnection of alarm sepa-
or (accessory) to instru-
nt panel.

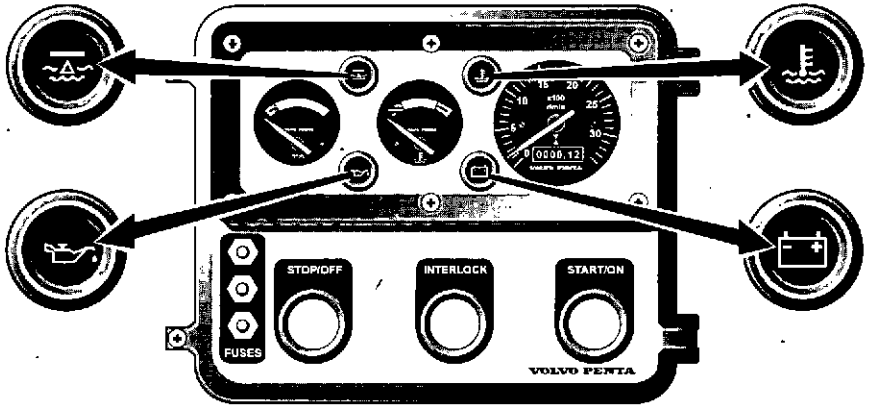


1. Relay for coolant level switch (accessory)
2. Relay for coolant temp. switch, oil pressure switch
3. Holding current relay (operating current and instrument)
4. Alarm separator
5. Connection
6. Terminal bar, 16A fuse for automatic stop
7. Warning lamp, high coolant temp. (optional)
8. Warning lamp, low coolant level (optional)
9. Warning lamp, low oil pressure (optional)
10. Terminal bar for engine cables
11. Coolant temp. switch (normally OFF)
12. Oil pressure switch (normally OFF)
13. Union

- - Dashed line is existing cable

Principle drawing
onnection of time relay kit
ccessory) for connection
starter element.



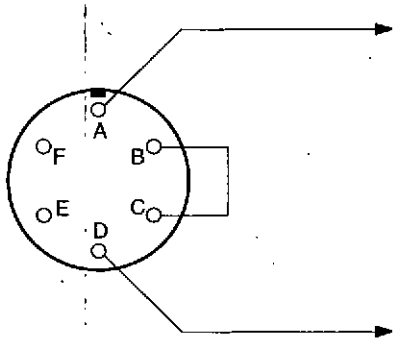


TT179

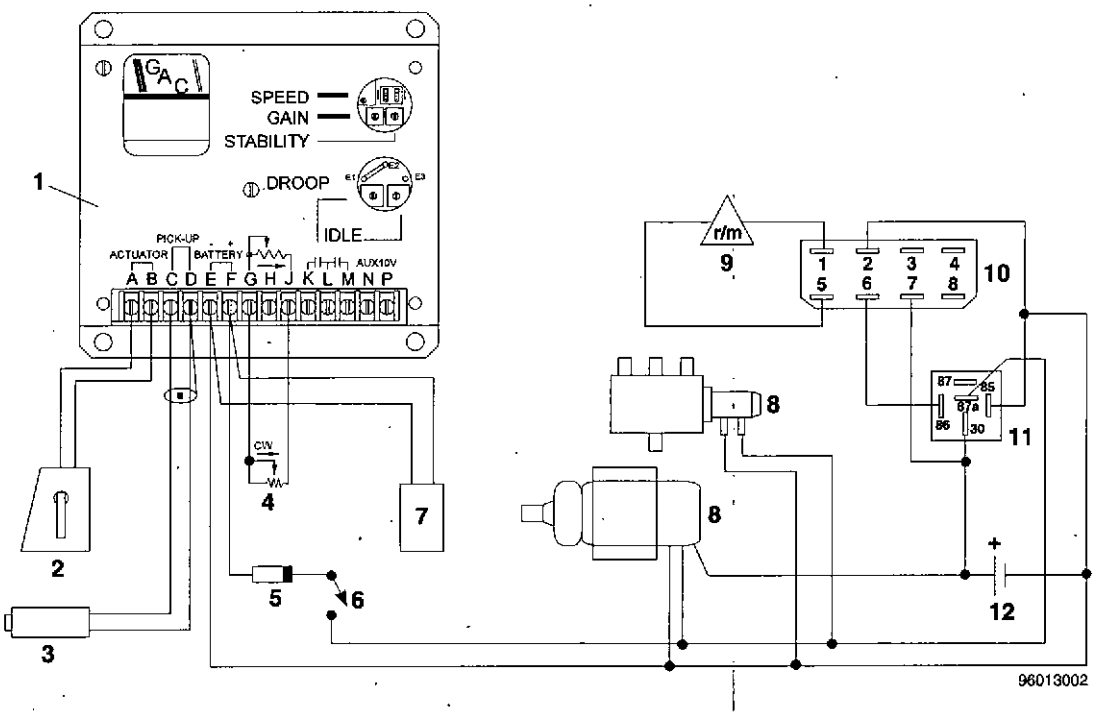
1. Key switch
2. Indicator lamp (connected starter element)
3. Battery
4. Fuse (8A)
5. Contact piece, 8-pole.
6. High output relay for starter element
7. Temperatur gauge (accessory)
8. Starter element
9. Time relay

Electronic speed governor

Wiring



Connecting the actuator for 24V system voltage



The stop solenoid / fuel shut off valve (8) connected live during operation (optional). Engine stops with switch (6).
Note! Later version has a built-in transient protection. Therefore, only a separate transient protection (7) for the Control Unit is required.

1. Control Unit
2. Actuator
3. Pickup
4. Multi-turn potentiometer*
   *Not from Volvo Penta
5. Fuse (fast) 8A
6. Main switch
7. Transient protection
8. Stop solenoid / Fuel shut off valve
9. Engine speed pickup for overspeed protection
10. Engine speed switch (overspeed protection)
11. Relay

Troubleshooting

1. Engine does not start

Starter motor does not turn engine over

CAUSE	REMEDY
• Discharged batteries	Charge / replace the batteries (or connect up auxiliary batteries as described on page 153
• Main switches off	Switch on the main switch
• One of the semi-automatic fuses in the junction box has tripped (pos. 6 in the engine wiring diagram page 154-155)	Reset the fuse by pressing in the button on the fuse
• Poor contact / break, electrical leads	Rectify any open-circuits / loose connections. Check for oxidation on the contacts. If required, clean them and spray with damp-inhibitor spray. See the wiring diagrams on page 154-155
• Faulty key switch / start button	Replace key switch / start button
• Faulty start relay	Replace start relay
• Faulty starter motor / -solenoid	Contact authorized service personnel
• Water on top of piston going into compression stroke	Contact authorized service personnel. Do not try to start the engine if you think there is water in it

Starter motor turns over slowly

CAUSE	REMEDY
• Discharged batteries	Charge / replace the batteries (or connect up auxiliary batteries as shown on page 153
• Poor contact / break, electrical leads	Rectify any open-circuits / loose connections. Check for oxidation on the contacts. If required, clean them and spray with damp-inhibitor spray. See the wiring diagrams on page 154-155

Starter motor turns over as normal but engine does not start

CAUSE	REMEDY
• Air in fuel system	Vent the fuel system as shown on page 110
• No fuel	
- fuel cook closed	Open the fuel cook
- fuel tank empty	Fill with fuel
- fuel filters clogged (due to contaminants / paraffin precipitation in the fuel as a result of low outside temperatur)	Change filters
• Stop solenoid / fuel shut off valve connected / seizing	Check that stop solenoid/fuel shut off valve is in operating position
• Insufficient preheating	
- incorrect starting procedure	Try start again as shown in Instruction Book
- starter element is not engaged	Check that none of the semi-automatic fuses has tripped (pos.6 in wiring diagram on page 154-155) Reset the fuse by pressing the button.
	Check the electrical leads, the interlock button and the relay for the starter element. Contact authorized personnel if the starter element needs to be replaced
• Blocked combustion air intake	Check air intake for blockage

2. Engine starts but stops again/ runs unevenly

CAUSE	REMEDY
• Air in fuel system	Vent the fuel system as shown on page 110
• No fuel	
- fuel cooks closed	Open the fuel cooks
- fuel tank empty	Fill with fuel
- fuel filters clogged (due to contaminants / paraffin precipitation in the fuel as a result of low outside temperatur)	Fit new fuel filters (pre-filters and / or fine filters). Vent the fuel system as shown on page 110
• Stop solenoid / fuel shut off valve connected / seizing	Check the stop solenoid / fuel shut off valve function
• Insufficient preheating	
- incorrect starting procedure	Try start again as shown in Instruction Book
- starter element is not engaged	Check that none of the semi-automatic fuses has tripped (pos. 6 in wiring diagram on page 154-155) Reset the fuse by pressing the button.
	Check the electrical leads, the interlock button and the relay for the starter element. Contact authorized personnel if the starter element needs to be replaced

• Insufficient air flow to engine	
- air filter blocked	Fit new air filter/check ventilation to engine room
• Faulty injector	Check / change injector

3. Coolant temperature too high

CAUSE	REMEDY
• Coolant level in engine too low (air in system)	Fill the engine with coolant and vent the system as described on page 149.
• Faulty thermostat	Install a new thermostat
• Clogged radiator and/or charge air cooler (TAD)	Clean as described on page 150.
• Faulty circulation pump	Contact authorized service personnel
• Faulty temperatur gauge / sender	Check / change temperatur gauge / sender
• Faulty setting of injection angle	Check / adjust the injection angle. Contact authorized service personnel

4. Coolant temperature too low

CAUSE	REMEDY
• Faulty thermostat	Install a new thermostat

5. Engine does not reach correct speed at wide open throttle

CAUSE	REMEDY
• The engine abnormally loaded	If possible reduce the load
• Insufficient fuel flow	
- fuel filters clogged (due to contaminants / paraffin precipitation in the fuel as a result of low outside temperature	Fit new fuel filters (pre-filters and / or fine filters). Vent the system as shown on page 110
• Water in fuel	Clean fuel tank. Drain water from pre-filter
• Insufficient air flow to engine	
- air filter blocked	Fit new air filter/check ventilation to engine room
- air leak between turbo and engine's inlet manifold	Check the rubber hose between the connecting pipe, plus other connections. Tighten the hose clips
- Faulty turbo charger	Contact authorized service personnel
- Poor engine room ventilation	Check that the ventilation ducts to the engine room are not blocked
• Throttle controls incorrectly adjusted	Adjust the throttle controls

• Excessive back pressure in exhaust system	Check that the exhaust pipe is not restricted in any way
• Faulty setting of injection pump	Contact authorized service personnel
• Fault in smoke limiter	
- smoke limiter seizing.	Contact authorized service personnel
- pressure pipe between inlet manifold and smoke limiter leaking.	Fit a new pressure line
- faulty diaphragm in smoke limiter	Contact authorized service personnel
- faulty setting	Contact authorized service personnel
• Stop lever position	Check that the stop lever is in fully operating position

6. Engine runs on

CAUSE	REMEDY
• One of the semi-automatic fuses in the junction box has tripped (pos. 6 in the engine wiring diagram page 154-155	Reset the fuse by pressing in the button on the fuse
• Poor contact / break, electrical leads Check for oxidation on the contacts. If required,	Rectify any open-circuits / loose connections. clean them and spray with damp-inhibitor spray. See the wiring diagrams on page 154-155
• Faulty stop button	Replace stop button
• Faulty stop solenoid/fuel shut off valve	Contact authorized service personnel

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