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## Cylinder head assembly

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## General description

In a diesel engine there is little carbon deposit and for this reason the number of hours run is no indication of when to overhaul a cylinder head assembly. The factors which indicate when an overhaul is necessary are how easily the engine starts and its general performance.

The cylinder head assembly has two valves fitted for each cylinder, each fitted with double or single valve springs, according to the engine application. The double springs have damper coils which are fitted towards the top face of the cylinder head.

The valves move in phosphated guides which can be renewed. The exhaust valve guide has a counter bore at the bottom and is a little longer than the inlet valve guide.

Both valve stems are fitted with oil seals which fit over the top of the valve guides.

Engine types AB, AD, YB and YD have valve seat inserts fitted in the cylinder head for both inlet and exhaust valves. Engine types AA, AC, YA and YC do not have valve seat inserts, but they can be fitted in service.

## Rocker cover

To remove and to fit

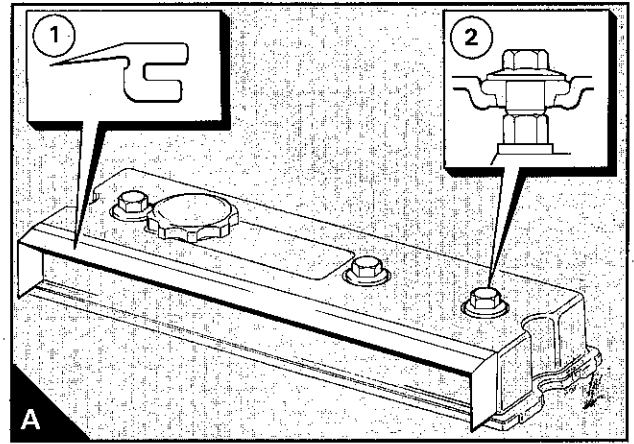
12A-01

### To remove

- 1 Disconnect the breather pipe.
- 2 Remove the cap nuts and the sealing washers from the top of the rocker cover.
- 3 Lift off the rocker cover and the joint together with the rocker cover seal, which is fitted between the rocker cover and the induction manifold.
- 4 When the rocker cover is fitted, the cap nuts are tightened onto the nuts of the rocker brackets. During removal of the cap nuts, it is possible to loosen the nuts of the rocker brackets and these nuts should be checked for tightness every time the cover is removed.

### To fit

- 1 Check the condition of the rocker cover joint and the sealing washers and clean the joint face of the cylinder head. If necessary, the joint can be removed and a new joint fitted with a suitable adhesive.
- 2 Fit the rocker cover together with the seal (A1) which is fitted between the rocker cover and the induction manifold. Fit the seals and the cap nuts (A2). Tighten the cap nuts to 20 Nm (15 lbf ft) 2,1 kgf m. If the cap nuts are tightened too much the cap nuts can fasten on the nuts for the rocker shaft brackets.



## Rocker assembly

### To remove and to fit

12A-02

#### To remove

- 1 Remove the rocker cover, operation 12A-01.
- 2 Release evenly and gradually the fasteners of the rocker shaft brackets; begin with the end brackets and move toward the centre. Remove the fasteners and the washers and lift off the rocker assembly.
- 3 Remove the rubber oil seal (B) from the oil supply connection or the oil supply hole in the cylinder head.

#### To fit

- 1 Fit a new rubber oil seal in the oil supply hole in the cylinder head.
- 2 Check that the push rods fit correctly in the sockets of the tappets. Fit the rocker assembly; ensure that the oil supply connection is fitted correctly into the oil seal. Check that the ends of the adjustment screws fit correctly in the sockets of the push rods.
- 3 Fit the washers and fasteners of the rocker shaft brackets and tighten the fasteners evenly and gradually; begin with the inner fasteners and work towards the end fasteners. Ensure that all the fasteners are tightened evenly to the correct torque, see section 11B.

### To dismantle and to assemble

12A-03

#### To dismantle

- 1 Remove the clips from both ends of the rocker shaft. Ensure that the ends of the rocker shaft are not damaged. Release the location screw for the oil supply connection.
- 2 Dismantle the assembly and make a note of the position of each component to ensure that they can be assembled more easily.

#### To assemble

- 1 Ensure that the oil holes in the rocker shaft and in the rocker levers are not restricted.
- 2 Lubricate the components with clean engine lubricating oil before assembly. Assemble the components in the correct order (A) and ensure that the location screw for the oil supply connection is fitted correctly in the rocker shaft. Fit the clips to the ends of the rocker shaft.

### To inspect and to correct

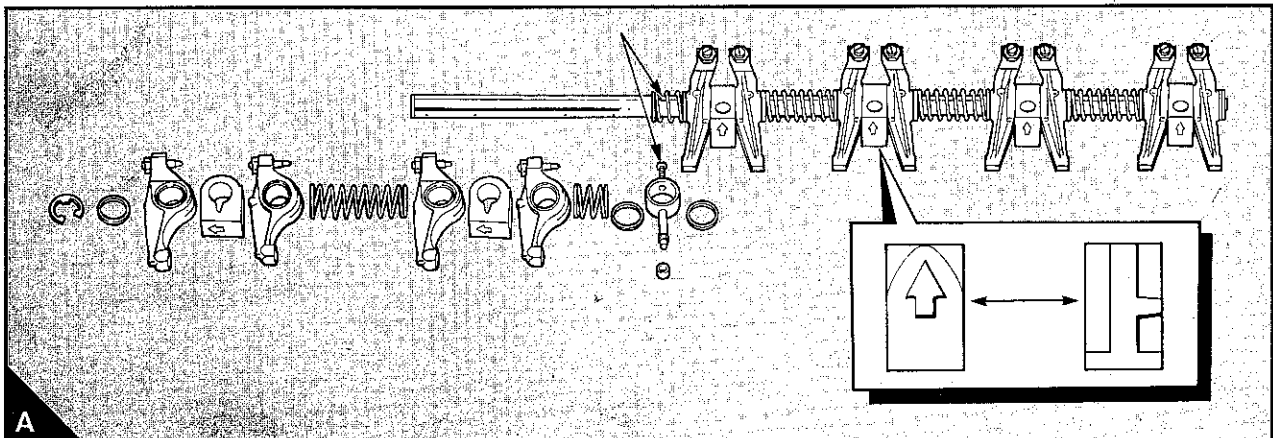
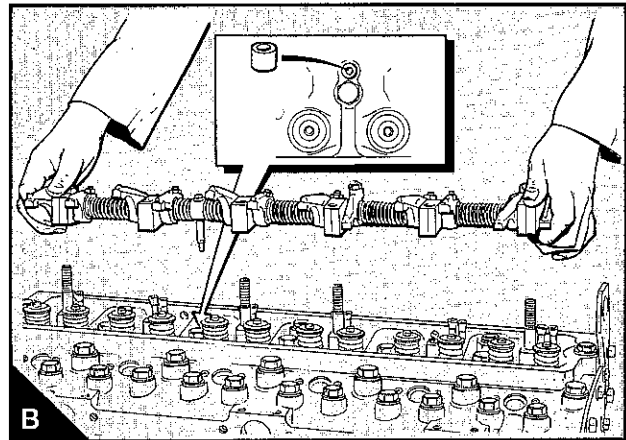
12A-04

#### To inspect

- 1 Clean and inspect all the components for wear and any other damage. Check the clearance of the rocker levers on the rocker shaft. If the clearance is larger than 0,13 mm (0.005 in), renew the rocker lever bush and/or the rocker shaft.

#### To correct

- 1 To renew the rocker lever bush, press out the old bush with a suitable mandrel.
- 2 Press in the new bush with the lubrication hole in the bush on the same side as that in the rocker lever and aligned with it.
- 3 Ream the bush in the rocker lever to give a clearance on the rocker shaft of 0,03/0,09 mm (0.001/0.004 in).



## Valve tip clearances

To check and to adjust

12A-05

The valve tip clearance is measured between the top of the valve stem and the rocker lever (A). With the engine cold, the correct clearances are 0,20 mm (0.008 in) for the inlet valves and 0,45 mm (0.018 in) for the exhaust valves. See B for the position of the valves.

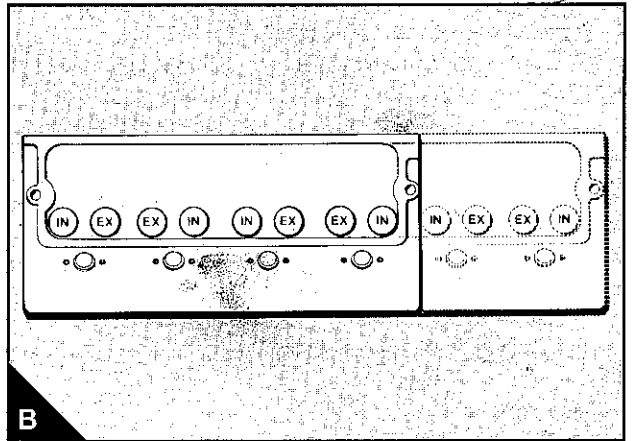
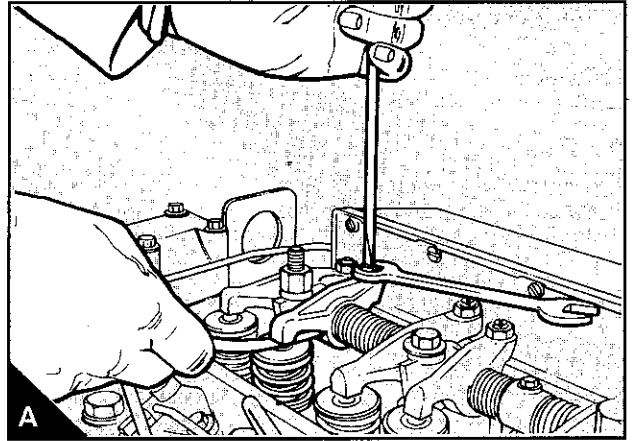
**Attention:** Number 1 cylinder is at the front of the engine.

### Four cylinder engines

- 1 Turn the crankshaft in the normal direction of rotation until the inlet valve of number 4 cylinder has just opened and the exhaust valve of the same cylinder has not fully closed. Check the clearances of the valves of number 1 cylinder and adjust them, if necessary.
- 2 With the valves of number 2 cylinder set as indicated above for number 4 cylinder, check/adjust the clearances of the valves of number 3 cylinder.
- 3 With the valves of number 1 cylinder set, check/adjust the clearance of the valves of number 4 cylinder.
- 4 With the valves of number 3 cylinder set, check/adjust the clearances of the valves of number 2 cylinder.

### Six cylinder engines

- 1 Turn the crankshaft in the normal direction of rotation until the inlet valve of number 6 cylinder has just opened and the exhaust valve of the same cylinder has not fully closed. Check the clearances of the valves of number 1 cylinder and adjust them, if necessary.
- 2 With the valves of number 2 cylinder set as indicated above for number 6 cylinder, check/adjust the clearances of the valves of number 5 cylinder.
- 3 With the valves of number 4 cylinder set, check/adjust the clearances of the valves of number 3 cylinder.
- 4 With the valves of number 1 cylinder set, check/adjust the clearances of the valves of number 6 cylinder.
- 5 With the valves of number 5 cylinder set, check/adjust the clearances of the valves of number 2 cylinder.
- 6 With the valves of number 3 cylinder set, check/adjust the clearances of the valves of number 4 cylinder.



## Valve springs

To change the valve springs  
(with cylinder head fitted)

12A-06

Special tools:

Valve spring compressor, PD.6118B

Stud adaptor for use with PD.6118B, PD.6118-7

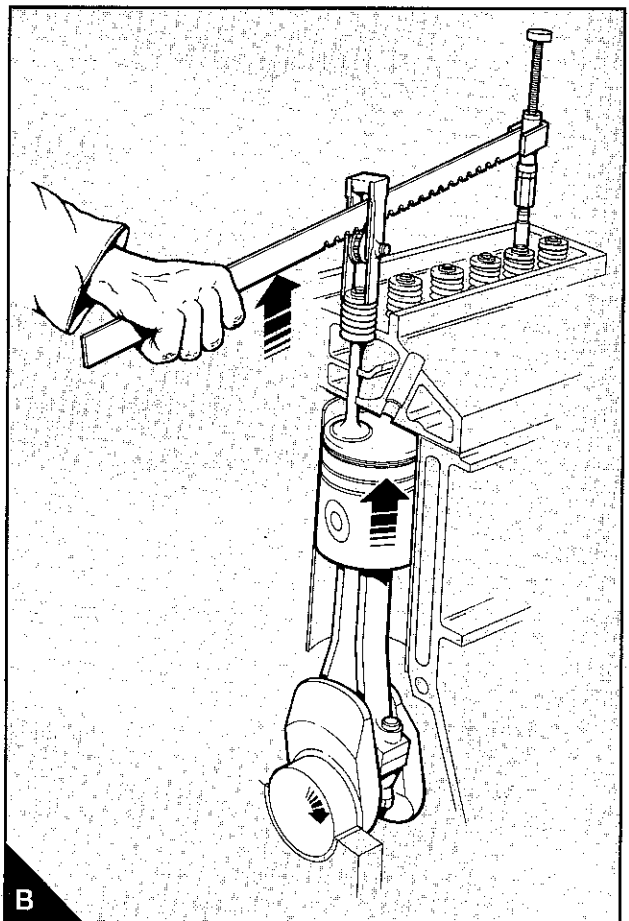
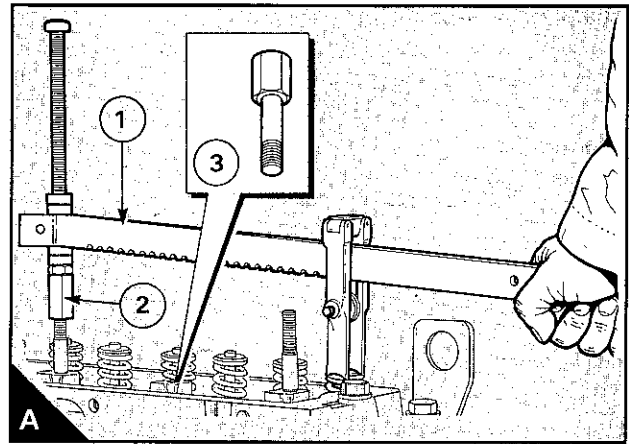
Setscrew adaptor for use with PD.6118B, PD.6118-8

Paragraphs 1 to 12 refer to a change of valve springs for a single cylinder.

- 1 Remove the rocker cover, operation 12A-01.
  - 2 Turn the crankshaft in the normal direction of rotation until the inlet valve of the relevant cylinder has just opened and the exhaust valve has not fully closed. In this position the piston will be at approximately top dead centre (TDC).
  - 3 Remove the rocker assembly, operation 12A-02.
  - 4 Fit the valve spring compressor (A1) and the relevant adaptor (A2 or A3).
  - 5 Compress the valve spring(s) and remove the collets. Ensure that the valve springs are compressed squarely or damage to the valve stem can occur.
  - 6 Release the valve spring compressor and remove the valve spring caps and valve spring(s).
- Attention:** Do not turn the crankshaft while the valve springs are removed.
- 7 Put the new valve springs in position. If double valve springs are fitted, ensure that the closed damper coils are towards the cylinder head (12A.10/A).
  - 8 Fit the valve spring caps.
  - 9 Fit the valve spring compressor, compress the valve springs and fit the collets. Ensure that the valve springs are compressed squarely or damage can occur to the valve stem. Remove the valve spring compressor.
  - 10 Fit the rocker assembly, operation 12A-02.
  - 11 Check the valve tip clearances, operation 12A-05.
  - 12 Fit the rocker cover, operation 12A-01.

If other or all of the valve springs are to be changed, they can be changed two cylinders at a time. The pairs of cylinders are: engine types AA, AB, AC and AD - 1 and 4, 2 and 3; engine types YA, YB, YC and YD - 1 and 6, 2 and 5, 3 and 4.

If the rocker assembly has been removed, piston TDC can be found as follows: Fit the valve spring compressor and compress the valve springs to open the valve. Turn the crankshaft, by hand, in the normal direction of rotation until the piston touches the valve. Continue to turn the crankshaft, and at the same time, release pressure on the valve spring compressor until the piston is at TDC (B).



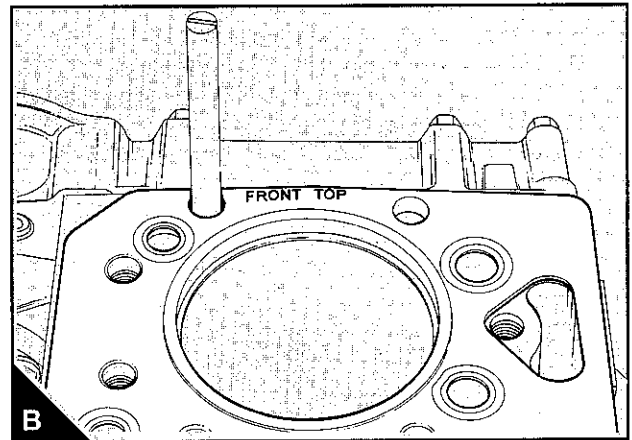
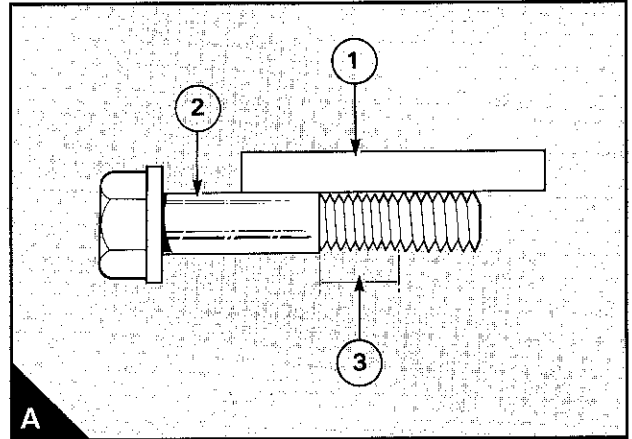
## Cylinder head assembly

To remove and to fit

12A-07

### To remove

- 1 Drain the cooling system.
- 2 Disconnect the battery terminals.
- 3 Engine types AA and YA: Remove the air filter/cleaner hose at the induction manifold.  
Engine types AB, AC, AD, YB, YC and YD: Remove the air filter/cleaner hose at the compressor inlet of the turbocharger.
- 4 Remove the pipe which is fitted between the cold start device in the induction manifold and the fuel filter. Disconnect the electrical connection.
- 5 Engine types AB, AD, YB and YD: Remove the boost control pipe which is fitted between the front of the induction manifold and the fuel injection pump.
- 6 Remove the induction manifold.
- 7 Engine types AB, AC, AD, YB, YC and YD: Disconnect all connections to the turbocharger and remove the turbocharger, operation 18A-01.
- 8 Remove the exhaust manifold.
- 9 Remove the low pressure fuel pipes which are fitted between the fuel injection pump and the fuel filter. Where a Bosch fuel injection pump is fitted, keep the fuel outlet banjo bolt with the fuel injection pump. Remove the fuel pipe fitted between the fuel lift pump and the fuel filter. Remove the fuel filter bracket together with the fuel filter.
- 10 Remove the high pressure fuel pipes. Where a Bosch fuel injection pump is fitted, ensure that a separate spanner is used to prevent movement of the fuel injection pump outlets when the connections of the high pressure pipes are released. Fit suitable covers to all open connections on the fuel injection pump.
- 11 Remove the atomiser leak-off pipe.
- 12 Remove the atomisers, operation 20A-02. Fit suitable covers to the nozzles and the open connections.
- 13 If a compressor is fitted: Remove the coolant pipe which is fitted between the cylinder head and the compressor. Then remove the coolant pipe which is fitted between the by-pass connection and the compressor.
- 14 Release the clip of the coolant by-pass hose at the cylinder head. Release the setscrews and remove the coolant by-pass connection and the hose.
- 15 Disconnect the coolant temperature sender unit.
- 16 Engine types AB, AD and certain AA: Remove the oil cooler, operation 21A-07A.
- 17 Remove the rocker cover, operation 12A-01.
- 18 Remove the rocker assembly, operation 12A-02.
- 19 Remove the push rods.
- 20 Release the cylinder head setscrews evenly and gradually in the reverse sequence to that shown in 12A.08/A or B. Check the setscrews for distortion with a straight edge (A1) held along the setscrew (A2). If there is a visual reduction in the diameter of the thread that has not been in engagement with the cylinder block (A3), the setscrew must be discarded.
- 21 Remove the cylinder head and put it on a surface that will not damage the face of the cylinder head. Do not use a lever to separate the cylinder head from the cylinder block.

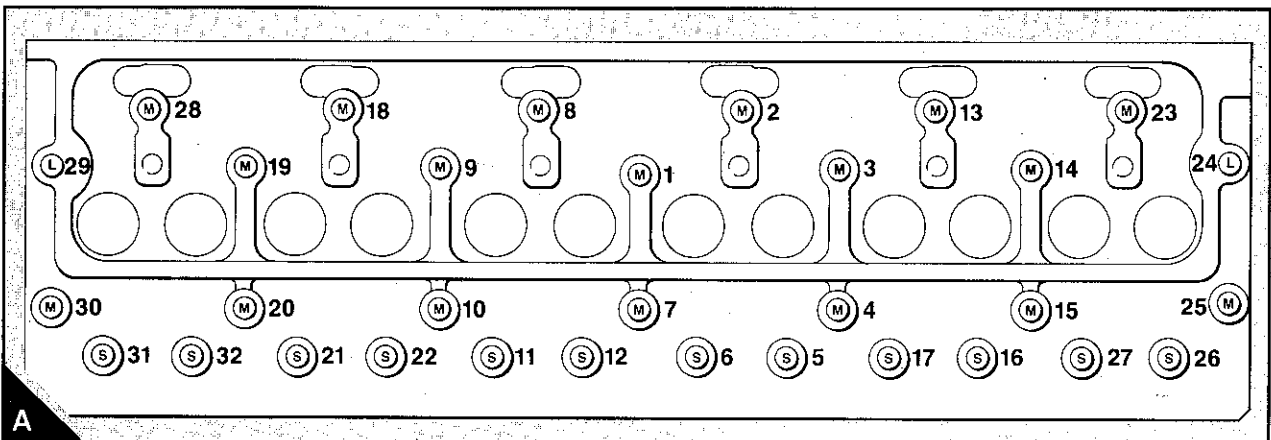
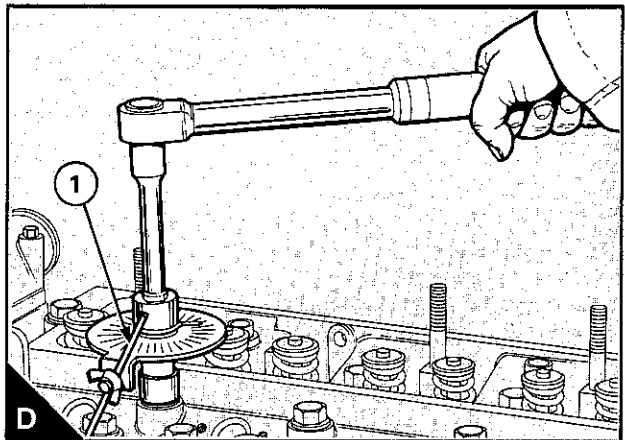
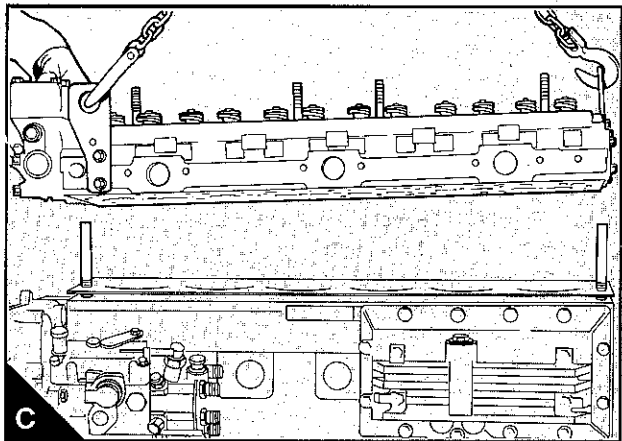
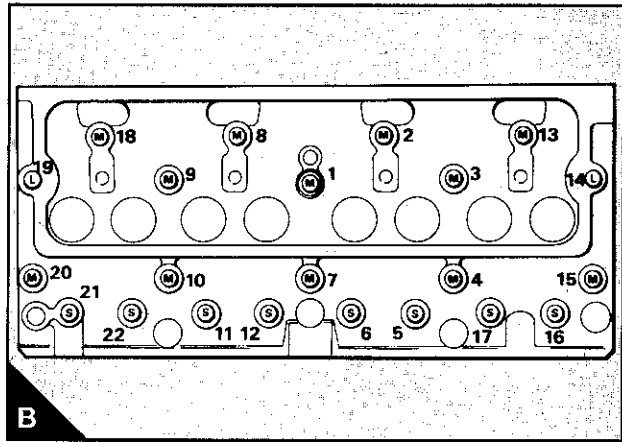


**To fit**

**Special tools:**

Angle gauge, to tighten cylinder head setscrews, MS.1531

- 1 Clean the bottom face of the cylinder head and top face of the cylinder block. Ensure that there is no debris in the cylinder bores.
  - 2 Put the cylinder head gasket in position; the cylinder head gasket must be fitted without jointing compound. It is stamped "FRONT TOP" for correct assembly (12A.07/B).
  - 3 To hold the gasket in the correct position when the cylinder head is fitted, fit two suitable 1/2 UNF studs (C) in positions 15 and 20 (B) or positions 25 and 30 (A). Put the cylinder head in position.
  - 4 Lightly lubricate the setscrew threads and the thrust faces of the setscrew heads. Engage some of the setscrews in their correct positions (A or B) and remove the guide studs. Engage the remainder of the setscrews in their correct positions.
  - 5 Gradually and evenly tighten the setscrews to 110 Nm (80 lbf ft) 11,1 kgf in the sequence shown in A or B.
  - 6 Repeat paragraph 5 to ensure that all the setscrews are tightened to the correct torque.
  - 7 Tighten the setscrews, in the correct sequence, a further part of a turn according to the length of the setscrews, see A or B. Short setscrews (S) must be turned a further 150° (2.5 flats). Medium length setscrews (M) must be turned a further 180° (3 flats). Long setscrews (L) must be turned a further 210° (3.5 flats). A special tool (D) can be used for this operation. Fit the tool between the socket and the handle. Position the stop (D1) against a suitable protrusion on the cylinder head to prevent movement of the degree dial in a clockwise direction. Turn the pointer to align with the zero mark on the degree dial. Tighten the setscrew until the pointer on the tool is at the correct angle for the length of setscrew.
- If no tool is available, make a suitable mark on the cylinder head in line with a corner of each setscrew, see 12A.09/A. Make another mark, at the correct angle (counter-clockwise), on the edge of the flange of each fastener according to the length of the setscrew.
- Tighten each setscrew in the correct sequence until the marks on the flange are next to, and in line with, the marks on the cylinder head.
- 8 Put the push rods in position. Ensure that the end of each push rod fits correctly in the tappet socket.
  - 9 Fit the rocker assembly, operation 12A-01.
  - 10 Set the valve tip clearances, operation 12A-05.
  - 11 Fit the atomisers, operation 20A-02.





**12** Fit the high-pressure fuel pipes; tighten the connection nuts to 18 Nm (14 lbf ft) 1,9 kgfm. Where a Bosch fuel injection pump is fitted, ensure that a separate spanner is used to prevent movement of the fuel injection pump outlets.

**13** Fit the fuel filter and the bracket. Fit the low-pressure fuel pipes between the fuel injection pump and the fuel filter.

**14** Fit the coolant by-pass connection; tighten the setscrews and hose clip.

**15** If a compressor is fitted: Fit the coolant pipe between the cylinder head and the compressor. Then fit the pipe between the coolant by-pass and compressor.

**16** Engine types AB, AD and certain AA: Fit the oil cooler, operation 21A-07A.

**17** Fit the exhaust manifold. The manifold joints are fitted without jointing compound.

**18** Engine types AB, AC, AD, YB, YC and YD: Fit the turbocharger, operation 18A-01.

**19** Engine types AA, AB, AC and AD: Fit the induction manifold. Ensure that the manifold joints for the front and rear positions are fitted with the notch at the top left when the manifold is fitted to the cylinder head (B). The manifold joint for the centre position can be fitted either way. Fit the joints without jointing compound.

Engine types YA, YB, YC and YD: Fit the induction manifold. Ensure that the joints are fitted with the notch at the top and the straight edge towards the centre (C). Fit the joints without jointing compound.

**20** Fit the fuel pipe between the fuel filter and the fuel lift pump.

**21** Fit the fuel pipe between the fuel filter and the cold start device in the induction manifold. Connect the electrical connection to the cold start device.

**22** Engine types AB, AD, YB and YD: Fit the boost control pipe between the front of the induction manifold and the fuel injection pump.

**23** Fit the electrical connection to the coolant temperature sender unit.

**24** Connect the coolant outlet and the hoses for the cab heater. Tighten the clips.

**25** Fill the cooling system.

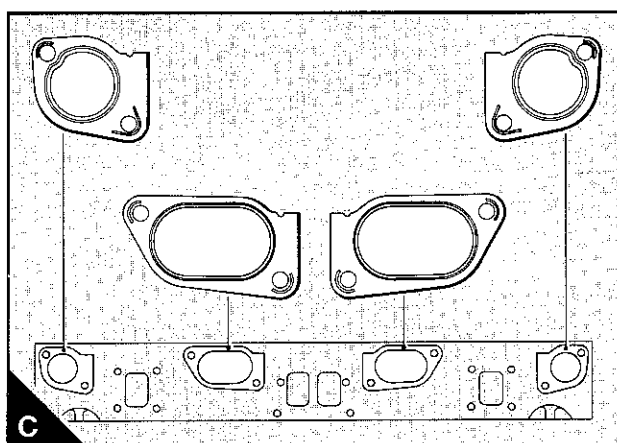
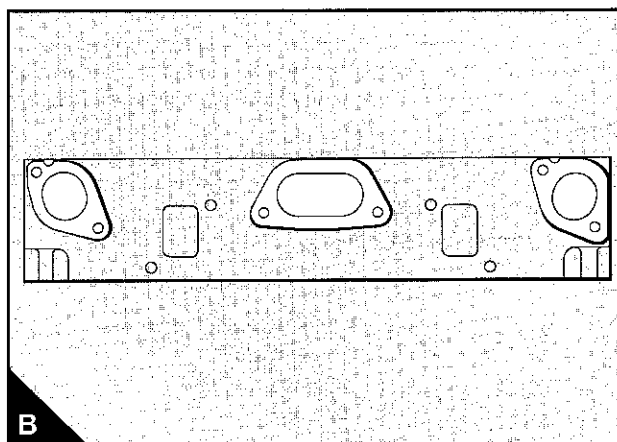
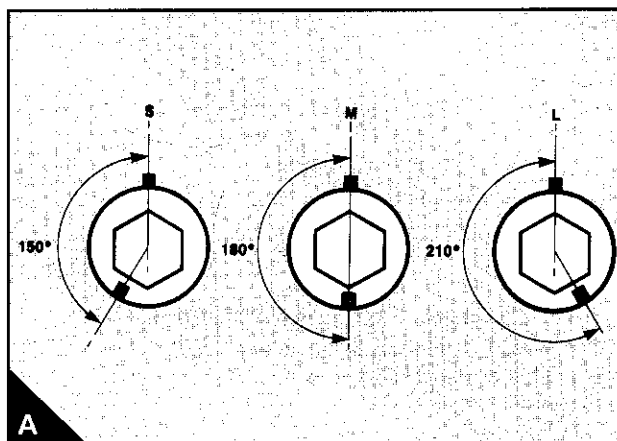
**26** Connect the air filter/cleaner.

**27** Connect the battery.

**28** Eliminate air from the fuel system, operation 20A-08A or 20A-08B.

**29** Start the engine and run it at low speed. Check that oil flows from the holes in the rocker levers. If the oil flow is correct, fit the rocker cover, operation 12A-01.

It is not necessary to tighten the cylinder head setscrews again with the engine hot or after a limited period in service.



## Valves and valve springs

To remove and to fit

12A-08

Special tools:

Valve spring compressor, PD.6118B

Stud adaptor, PD.6118-7

Setscrew adaptor, PD.6118-8

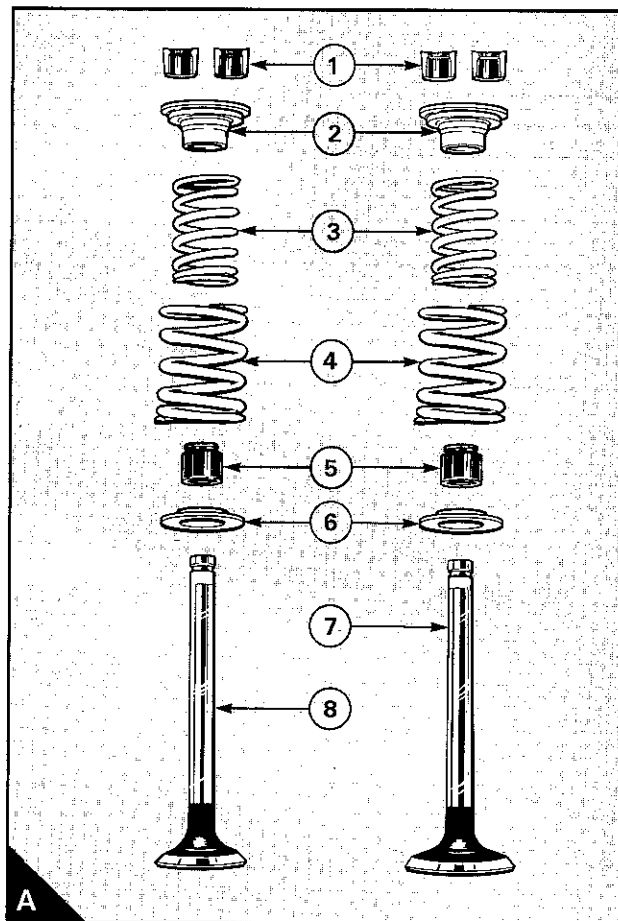
### To remove

- 1 Remove the cylinder head, operation 12A-07.
- 2 Clean the bottom face of the cylinder head and check the depth of the heads of the valves below the face of the cylinder head, see operation 12A-09.
- 3 Make a suitable mark on the heads of the valves to ensure that the valves can be fitted in their original positions, if they are to be used again.
- 4 Use the valve spring compressor and the relevant adaptor to compress the valve spring(s) and remove the collets. Ensure that the valve springs are compressed squarely or damage can occur to the valve stem.
- 5 Release the valve spring compressor and remove the valve spring cap, valve spring(s), valve stem seal and the valve seat washer.
- 6 Repeat items 4 and 5 for the other valves.

### To fit

The components of the valve assembly are shown in A. Certain engines are fitted with single valve springs.

- 1 Lubricate the valve stems (A7 and A8) with clean engine oil and fit the valves in their respective guides.
- 2 Fit the spring seat washers (A6). Fit new valve stem seals (A5) on the valve guides. If double valve springs are used, fit the inner and outer valve springs (A3 and A4) on the spring seat washers with their damper coils toward the cylinder head. If single valve springs are used, the spring does not have a damper coil and it can be fitted with either end to the cylinder head. Fit the valve spring caps (A2).
- 3 Use the valve spring compressor and the relevant adaptor to compress the valve spring(s) and fit the collets (A1). Ensure that the valve springs are compressed squarely or damage can occur to the valve stem.



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**To inspect and to correct****12A-09**

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**Special tool:**

Gauge, valve depth, PD.41D

Dial gauge for use with PD.41D, PD.208

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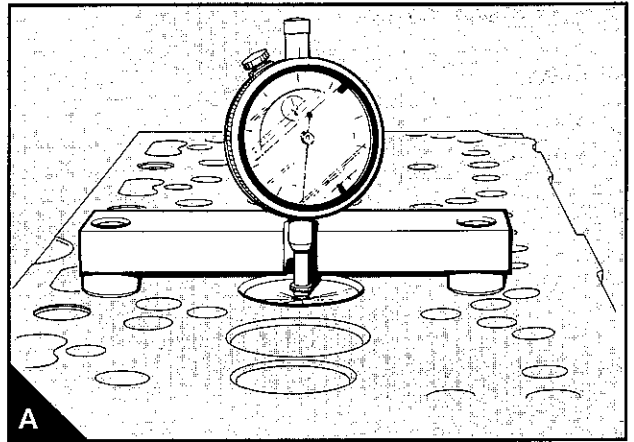
**1** Check the depth of the valves below the face of the cylinder head before the valve springs are removed. Ensure that the heads of the valves and the bottom face of the cylinder head are clean. Put the valve depth tool on the face of the cylinder head and zero the dial gauge. Carefully put the valve depth tool in position over the head of each valve (A) and make a note of the measurement. In service the maximum depth for the inlet valve is 1,85 mm (0.073 in) and for the exhaust valve it is 2,08 mm (0.082 in). If a valve is below the depth limit, check the valve depth with a new valve in position. If the valve depth is still below the limit and a valve seat insert is fitted, the insert must be renewed. Where a valve seat insert is not fitted, the bottom face of the cylinder head can be machined to reduce the valve depth, or an insert can be fitted, operation 12A-14.

**2** Check the valves for cracks. Check the stems of the valves for wear and for correct fit in their valve guides.

**3** Check that the seat faces of the valves are not badly burnt or damaged. Seat faces of valves which are damaged can be ground on a special machine. Valves which have only little damage can be lapped to their valve seats. When new valves are fitted, the valve depths must be checked, see paragraph 1.

**4** Check that the load on the valve springs is correct at their fitted length, see section 11C.

Fit new valve springs at every complete engine overhaul.



# 12

## Valve guides

To inspect

12A-10

Check the valve guides for wear. The maximum clearance between the valve stem and the bore of the guide is 0,13 mm (0.005 in) for inlet valves and 0,15 mm (0.006 in) for exhaust valves. If the clearance with a new valve fitted is more than the limit, then a new valve guide must be fitted.

To remove and to fit

12A-11

Special tools:

Remover/replacer for valve guides (main tool), PD.1D

Adaptor for use with PD.1D, PD.1D-1A

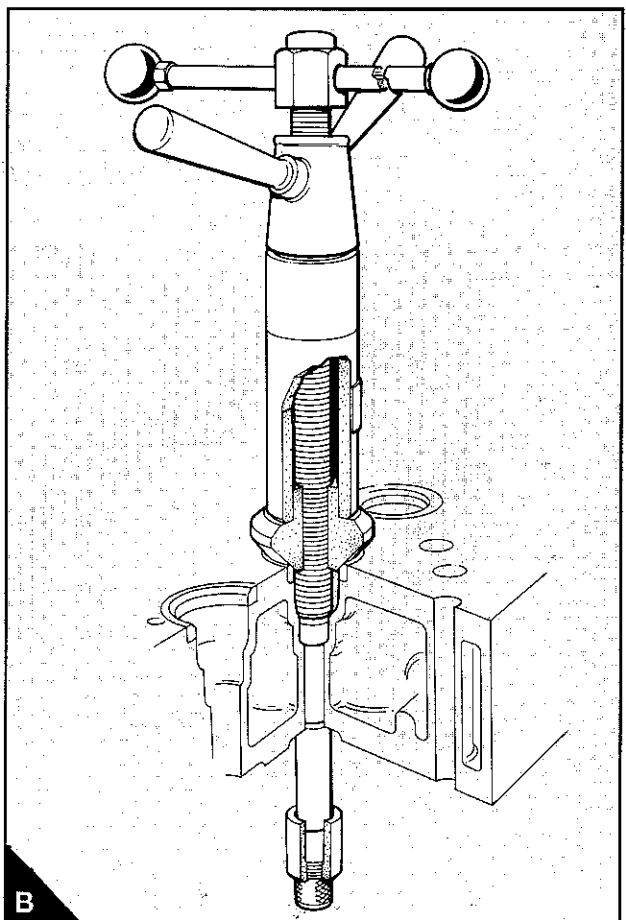
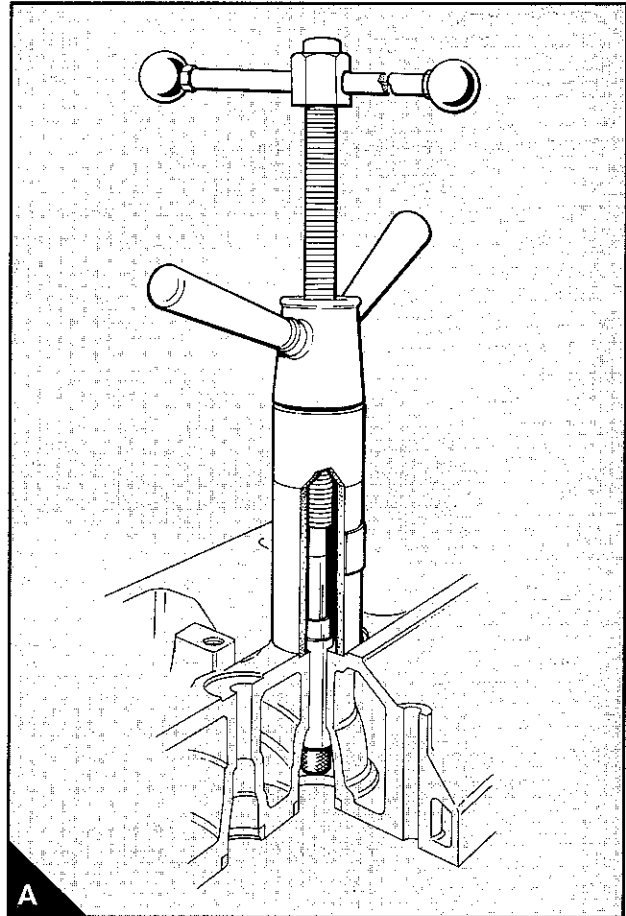
Adaptor for use with PD.1D and PD.1D-1A, PD.1C-6

**To remove**

Fit the removal and replacement tool and the adaptor and pull the valve guide out of the cylinder head (A).

**To fit**

- 1 Clean the parent bore for the valve guide.
- 2 Lubricate the outer surface of the new guide with clean engine lubricating oil.
- 3 Fit the valve guide with the reduced diameter for the valve stem seal at the top. Use the tool, adaptor and distance piece to pull the valve guide into the cylinder head (B). When fitted correctly, the top of the valve guide will have a protrusion of 15,10 mm (0.594 in) above the valve spring seat.

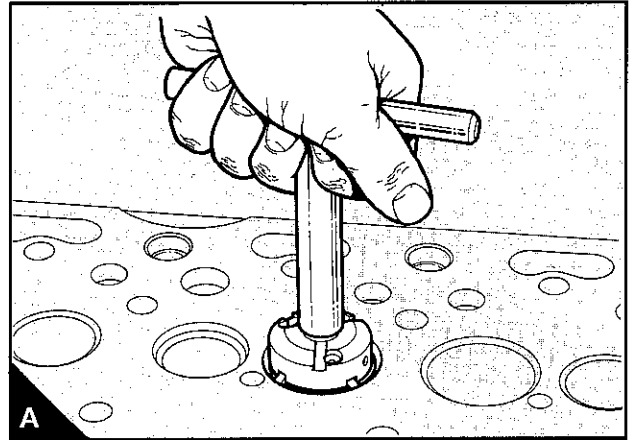


## Cylinder head

To inspect and to correct

12A-12

- 1 Remove the cylinder head assembly, operation 12A-07.
  - 2 Remove the thermostat housing.
  - 3 Inspect the cylinder head for signs of gas or coolant leakage.
  - 4 Remove the valve springs and the valves, operation 12A-08.
  - 5 Clean the face of the cylinder head and the passages for coolant and for lubricating oil. The water jacket can be cleaned with a special solvent which must be used in accordance with the manufacturer's instructions.
  - 6 Test the cylinder head for leaks at the pressure given in section 11C.
  - 7 When the cylinder head is thoroughly clean, check it for cracks. Examine carefully the areas around the valve seats and around the holes for the atomiser nozzles.
  - 8 The bottom face of the cylinder head can be machined if: there is distortion, see paragraph 9; there are deep scratches; or, for engines types AA, AC, YA, and YC, the valve depths are below the service limit.
  - 9 Use a straight edge and feeler gauges to check the cylinder head for distortion across and along its bottom face, see section 11C. If the distortion is more than the limit given in section 11C, the bottom face can be machined. Remove only the minimum material and ensure that the thickness of the cylinder head will not be less than 120,48 mm (4.035 in) after the cylinder head has been machined.
- Attention:** After the cylinder head has been machined the valve seats must be corrected to give the correct valve head depth. It is advisable to work to the minimum limit to allow for later wear.
- 10 Check the valve seats for wear and for damage.
  - 11 Before any work is done on the valve seats, ensure that there is no wear on the valve guides, see section 11C. If the valve guide wear is more than the limit, then the valve guide must be renewed, operation 12A-11.
  - 12 Where there is little damage, the valve and valve seat can be lapped. When the valve seats are lapped keep the seat as narrow as possible and ensure that all the compound used to lap the valve and the seat is removed.
  - 13 More badly damaged valve seats can be corrected by use of the cutter tool, operation 12A-13, or new inserts can be fitted, operation 12A-14.



- 4 Carefully turn the cutter in a clockwise direction. Remove only the minimum material to ensure a good seat. Keep the seat as narrow as possible.
- 5 When the seat is cut, remove the cutter and the pilot. Remove any debris from the area of the valve seat and the port.
- 6 Fit the valve and lightly lap the valve and the seat.
- 7 Check that the valve depth is within limits, see section 11C.

If a valve seat has become too damaged or too worn, a valve seat insert can be fitted to engines types AA, AC, YA and YC. Engines types AB, AD, YB and YD have valve seat inserts fitted as standard and these inserts can be renewed.

To correct a valve seat  
with a valve seat cutter

12A-13

Special tools:

Cutter for inlet valve seats, MS.281\*

Cutter for exhaust valve seats, MS.275\*

Pilot for use with valve seat cutters, MS.150-9.5\*

Handle set for use with valve seat cutters, MS.67B\*

\* Included in set of adjustable cutters for valve seats, MS.73A

- 1 If the valve guide is worn, renew it, operation 12A-11.
- 2 Fit the pilot in the valve guide and tighten the pilot.
- 3 Select the relevant cutter. Set the cutters to the diameter of the valve seat to be cut. Fit the cutter on the pilot and fit the handle (A). Ensure that the cutter is not allowed to fall on to the seat as this can damage the blades.

- 1 Remove the valve guide and clean the bore into which the guide is to be fitted.
- 2 Fit new valve guides, operation 12A-11.
- 3 With the bore of the new valve guide used as a pilot, machine the recess in the cylinder head to the dimensions shown in section 11C, or machine out the old insert. Remove all debris and clean the insert recess.
- 4 If the bottom face of the cylinder head has been machined, the insert will have to be surface ground on the back face to ensure that there is no protrusion of the insert above the bottom face of the cylinder head. After the back of the insert has been ground, ensure that the outer edge of the back face has a 0,9/1,3 mm (0.035/0.051 in) chamfer at 30° to the vertical.
- 5 With the bore of the valve guide used as a pilot, and with the rear face of the insert towards the cylinder head, press in the insert with the tool shown in section 11C. Do not use a hammer on the insert and do not use lubrication. Use a hydraulic press or a hand press in one continuous movement. Ensure that the bottom of the insert is in contact with the bottom of the recess.
- 6 Cut the valve seat at an included angle of 88° operation 12A-09, and lightly lap the valve and the valve seat. Ensure that the depth of the valve head below the face of the cylinder head is within the production limits, see section 11C. Work as near as possible to the minimum figure to allow for future wear on the valve seat.