

This TSI Service Bulletin replaces TSI Service Bulletin 211-007, "Cylinder Head, D12, D12A, D12B" (11.2001), publication no. PV776-TSP159904.

Date
9.2003

Group
211

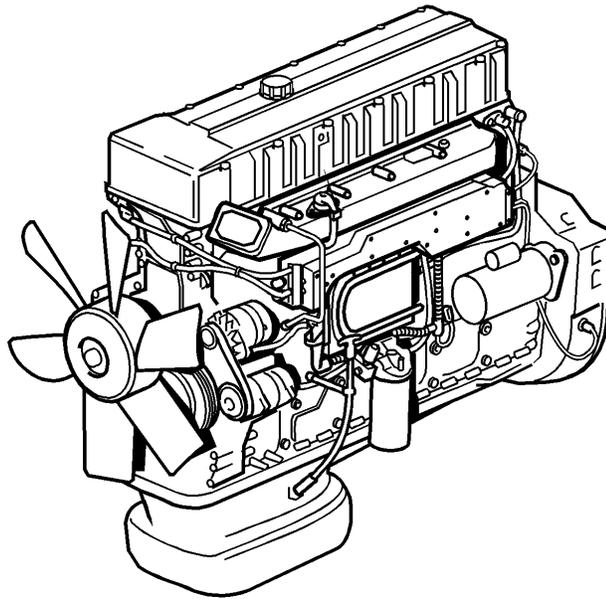
No.
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Cylinder Head D12, D12A, D12B

Cylinder Head



W2002653

Fig. 1: VOLVO D12B Engine

This information covers procedures for repairing the cylinder head of VOLVO D12, D12A, and D12B engines.

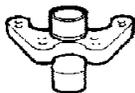
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Tools

Special Tools

The following special tools are used to replace or repair components. The tools can be ordered from Volvo; please use the specified part number when ordering.



9996956
Flywheel Turning Tool



9996966
Cylinder Liner Press Tool



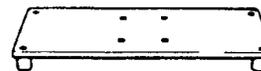
9998249
Protective Sleeve for Unit Injector



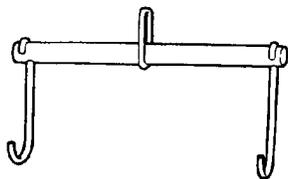
9998251
Cylinder Head Sealing Plug



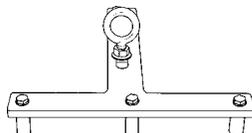
9998255
Rocker Arm Bridge Lifting Tool



9998258
Cylinder Head Adapter (use with Stand)



9998264
Camshaft Removal Tool



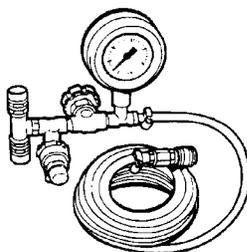
J-41503
Cylinder Head Lifting Fixture



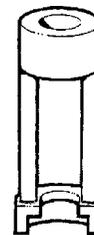
9996159
Tap (for 9996161)



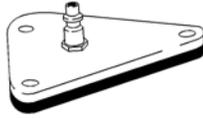
9996161
Hydraulic Cylinder



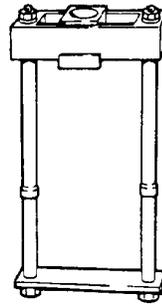
9996662
Pressure Tester



9998246
Valve Spring Removal/Install Tool



9998256
Connection Washer



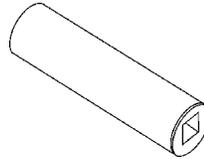
9998260
Press Tool



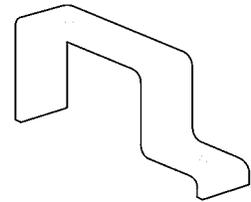
9998266
Sealing Washer



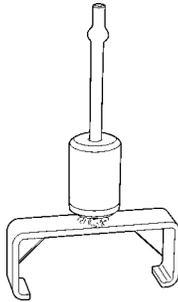
9998335
Valve Stem Seal Guide Sleeve



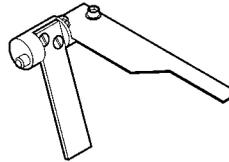
J-41203
Stud Removal and Installation Socket



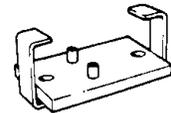
J-41272
Front Cover Alignment Tool



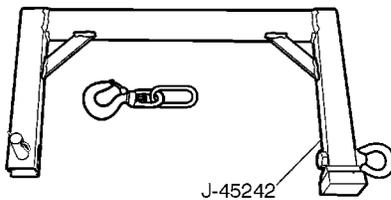
J-44457
Cam Shaft Bearing Cap Remover



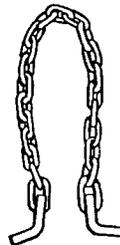
J-42773
Cam Gear Timing Tool



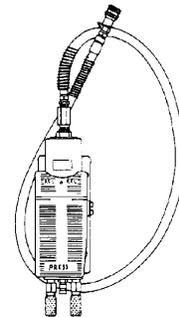
9998270
Camshaft Locking Tool



J-45242
Lifting Bracket



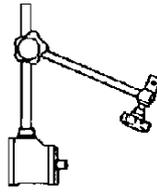
9996239
Cylinder Head Lifting Chain



9996222
Foot Pump (for 9996161)



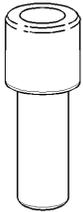
9998259
Sealing Washer



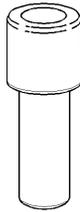
9999696
Magnetic Stand



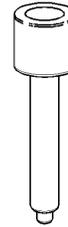
998 9876
9999876
Dial Indicator



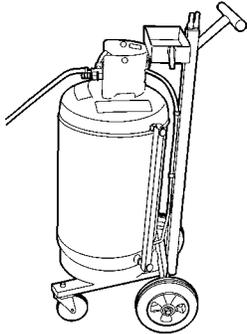
9998261
Drift for Valve Guide



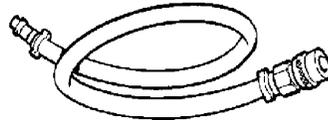
9998262
Drift for Valve Guide



9998263
Drift for Valve Guide



DB72V700
Coolant Extractor



9996049
Coolant Drain Hose



9992479
Holder for Dial Test Indicator

Service Procedures

2111-01-01-01

Cylinder Head, Removal

(With VEB or EPG; also with coolant drained off)

(See also "Cylinder Head, Overhaul" page 27.)

You must read and understand the precautions and guidelines in Service Information, group 21, "General Safety Practices" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.



CAUTION

Observe the greatest possible cleanliness when working on the cylinder head. Dirt particles in the fuel and oil channels can cause the unit injectors to malfunction, and can cause the VEB (if equipped) to fail or cause engine damage.

Note: The exhaust manifold can remain in place when removing the cylinder head. Remove the three bolts holding the thermostat housing. Then, turn the housing back out of the way to allow enough clearance to remove the head.

Note: Do not leave the unit injector tubes open with the injectors removed. Install protective plugs 9998251 to protect tubes from contaminants.

Special tools: 9996966, 9998249, 9998251, 9998255, 9998258, 9998264
Other special equipment: J-41203, J-44457, J-41503

1

Remove the electrical wires from the preheater (if equipped) and the intake manifold sensor and harness from the intake manifold. If the engine is equipped with VEB, remove the oil supply pipe. Plug both of the oil holes in the cylinder head and block.

2

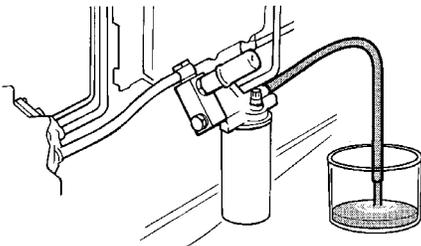
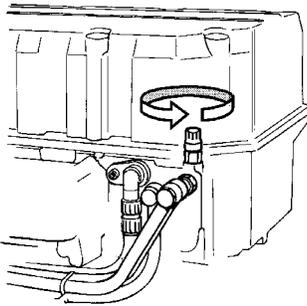
 **WARNING**

Use a hoist or get assistance when lifting components that weight 23 kg (50 lb) or more. Make sure all lifting devices such as chains, hooks, or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. Always use a spreader bar when necessary. The lifting hooks **MUST NOT** be side loaded. Failure to follow these warnings may result in personal injury.

Remove the oil supply line and oil return. Remove exhaust clamp from turbocharger and shutter housing. Remove turbo nuts and lift off turbo.

3
Carefully clean around the cylinder head bleed nipple and the fuel filter bracket drain union located on the right side of the filter housing.

4
Connect a 5/16" drain hose and open the fuel filter bracket drain union. Remove the bleed nipple on the cylinder head.



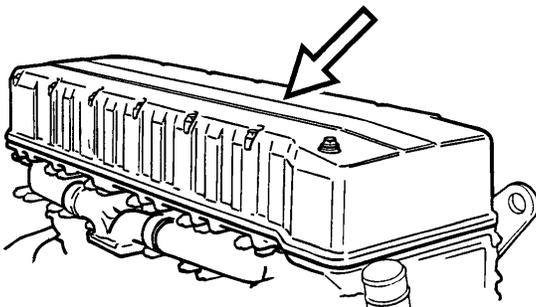
T2006719

5

Remove the valve cover. The valve cover should be removed from the exhaust side of the engine.

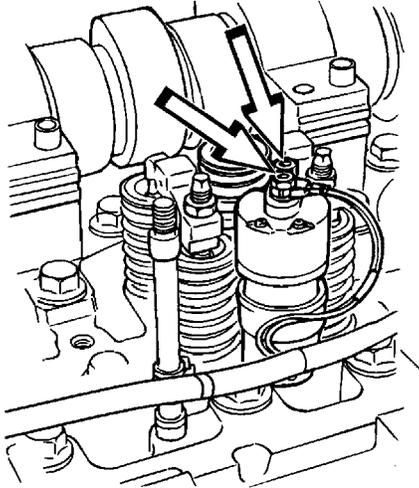
Note: On WIA, bring the valve cover towards the radiator to remove. On WG, it is necessary to remove the engine cover (doghouse).

Note: Be careful to avoid loosening the stud bolts. Otherwise, the unit injector cable harness and/or the valve cover can be damaged.



T2006731

Fig. 2: Valve cover



W2000690

Fig. 3: Electrical cable connections

6

Remove small injector wire from injector and move aside to prevent damage.

7

Remove the fuel lines from the cylinder head and plug the connections. Remove the electrical wires for both the engine coolant temperature sensor and the unit injector.

Note: Pay close attention to the plastic cable ties/straps and remove any broken pieces to prevent clogging or damage to any components.

8

Disconnect the connector for the electrical wires on the upper timing gear cover. Remove the clamp holding the electrical wires to the cover.

9

Remove the upper part of the timing gear cover.

10

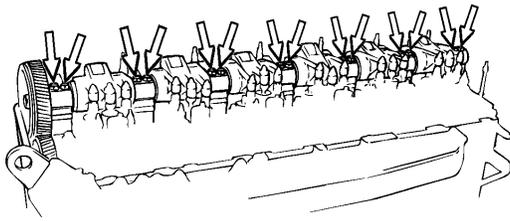
Remove the cam sensor wheel which is mounted on the outside of the camshaft gear.

11

If the engine is equipped with a VEB, remove the control valve and pipe. Plug ports and place assembly in a plastic bag to prevent contamination. To facilitate removal of the VEB control valve, remove the valve cover stud bolt. Use Kent-Moore socket J-41203 to remove early style stud bolts (oval flange). Use a 14 mm deepwell socket for new style studs (hexagonal flange).

Note: On engines equipped with a VEB, use rubber bands to hold the VEB slave pistons in place during rocker arm assembly removal.

J-41203



T2006777

Fig. 4: Rocker arm shaft bolts

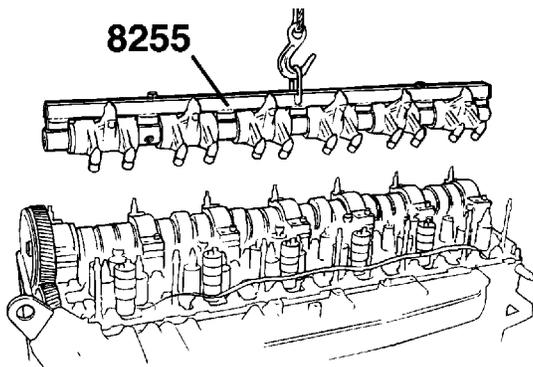
12

Loosen all adjustment lock nuts and screws.

13

Gradually loosen the rocker arm bolts to avoid distorting the rocker arm shaft. Remove the bolts. Install tool 9998255 and lift off the rocker arm assembly.

9998255



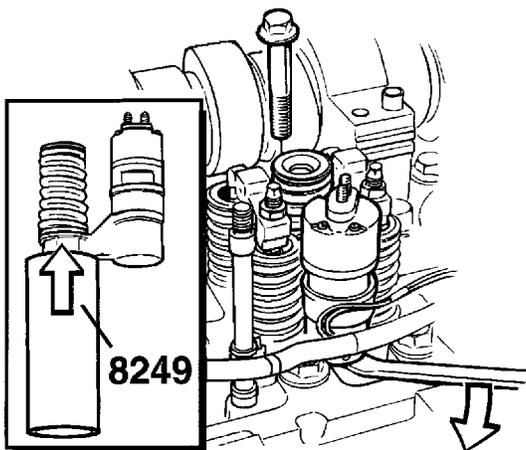
W2002159

Fig. 5: Removing the rocker arm shaft

14

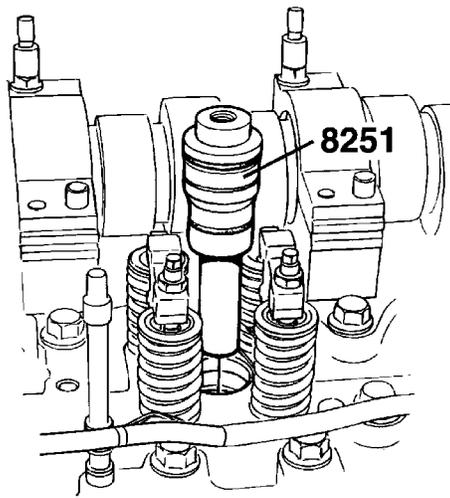
Carefully clean around the unit injectors and remove them. Make sure that no dirt drops into the unit injector space in the cylinder head. Install dust cover 9998249 on the unit injectors.

9998249



W2000716

Fig. 6: Unit injector protector sleeve



W2000689

Fig. 7: Injector bore protector plug

15

Install protective plugs 9998251 in the unit injector bore in the cylinder head.

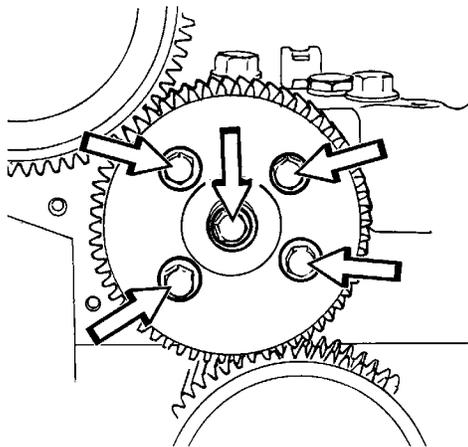
9998251

16

Carefully pull the unit injector wiring harness out of the cylinder head.

17

Remove the adjustable idler gear.



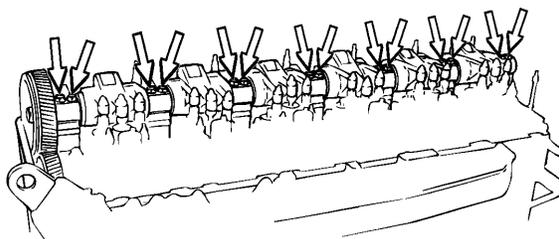
T2007095

Fig. 8: Idler gear bolts

18

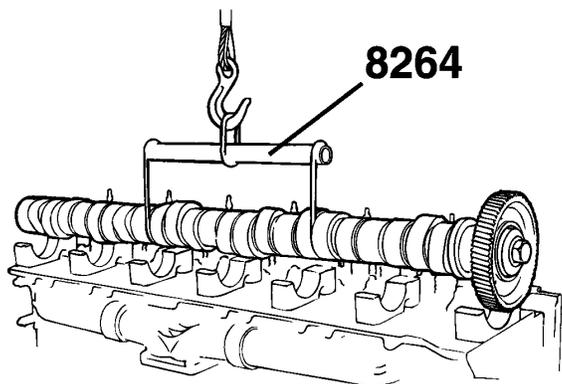
Remove the camshaft cap bolts. Number the caps (1-7) for the respective bearing housings and remove using puller J-44457.

J-44457



T2006777

Fig. 9: Camshaft cap bolts



T2006783

Fig. 10: Removing the camshaft

19

Carefully lift off the camshaft, using tool 9998264.

9998264

20

Remove the cylinder head mounting bolts.

21

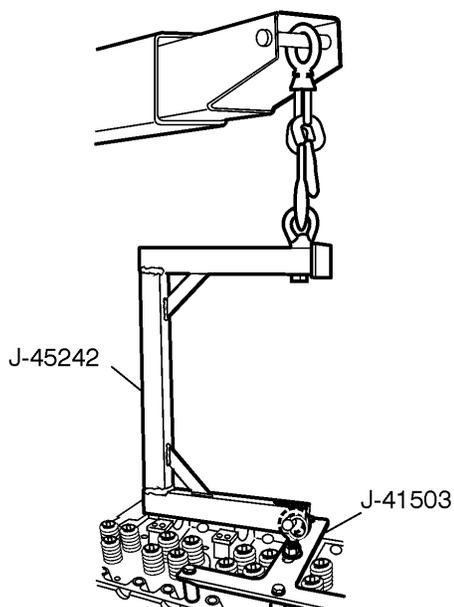
Remove the #4 lower bearing housing for the camshaft. Remove the stud bolt for the valve cover. Use Kent-Moore socket J-41203 to remove early style stud bolts (oval flange). Use a 14 mm deepwell socket for new style studs (hexagonal flange). Install tool 9996239 in the bearing housing and stud bolt holes.

J-41203, 9996239

22

Install lifting bracket J-41503 on to the cylinder head. Carefully lift off the cylinder head from the engine. Then, remove the head gasket from the cylinder block.

J-41503



W0002015

23

Install adapter 9998258 on the cylinder head. (Applies if work is to be performed on the head. The purpose of the tool is to attach the cylinder head to the overhaul stand.)

9998258

24

Install 9996966 to liners to prevent the liner from loosening the seal when rotating the engine.

9996966

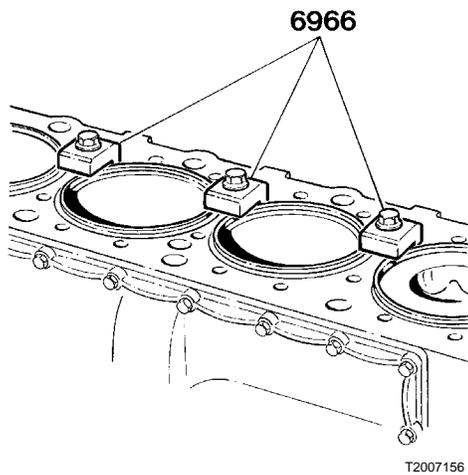


Fig. 11: Locking the cylinder liners in place

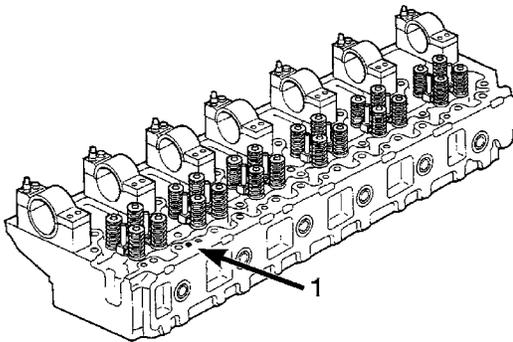
2111-02-01-01 Cylinder Head, Installation

(See also "Cylinder Head, Overhaul" page 27.)

You must read and understand the precautions and guidelines in Service Information, group 21, "General Safety Practices" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

CAUTION

Observe the greatest possible cleanliness when working on the cylinder head. Dirt particles in the fuel and oil channels can cause the unit injectors to malfunction, and cause the VEB (if equipped) to fail or cause engine damage.



W2003459

Fig. 12: 1) Remove plug only for engines with Volvo Engine Brake (VEB)

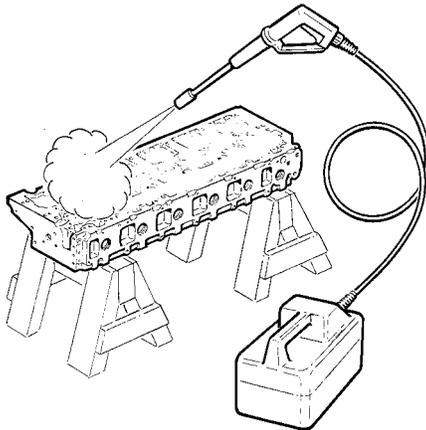
Note: When installing an exchange cylinder head on a D12 engine with a Volvo Engine Brake (VEB), the oil supply plug (shown in illustration) must be removed prior to installation of the VEB solenoid. In engines with exhaust pressure governor (EPG), only the plug must remain in place.

CAUTION

Failure to remove the oil supply plug on a D12 with Volvo Engine Brake (VEB) exchange cylinder head will cause camshaft seizure. Severe engine damage will result.

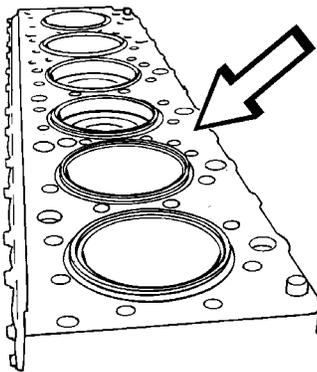
Special tools: 9996956, 9998251, 9998255, 9998258, 9998264
Other special equipment: 9999708, J-41203, J-41272, J-42773, J-41503

1



T2007163

Fig. 13: Cleaning the cylinder head



T2007087

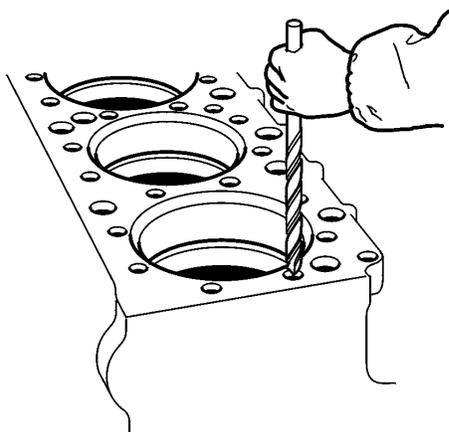
Fig. 14: Cylinder block sealing surface

Clean all gasket and O-ring surfaces of the cylinder head and block. Make sure all bolt holes in the cylinder head and block are free of oil and debris.

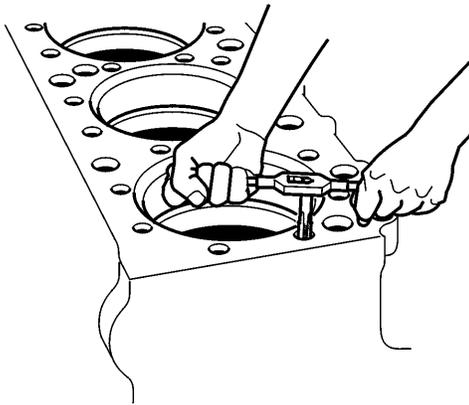
2

If debris or carbon is in the cylinder head bolt holes, clean the top of the hole before the threads by using a 17 mm drill. Turn it manually into the hole.

17 mm drill



C2001734



C2002611

3
Clean the threads with a M16x2 thread tap.

Note: To remove residue from bolt holes, use chip vacuum tool PT-2900

M16x2 tap,
PT-2900

4
Remove the tools used to hold down the liner.

 **WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

5
Clean the cylinder block surface and around the cylinder liner.

6
Install the new cylinder head gasket to the engine block and the new rubber seal to the timing gear plate.

Note: Make sure that the seal is correctly positioned against the timing gear plate.

7
Carefully lift the cylinder head onto the cylinder block. Remove the lifting tool J-41503.

J-41503

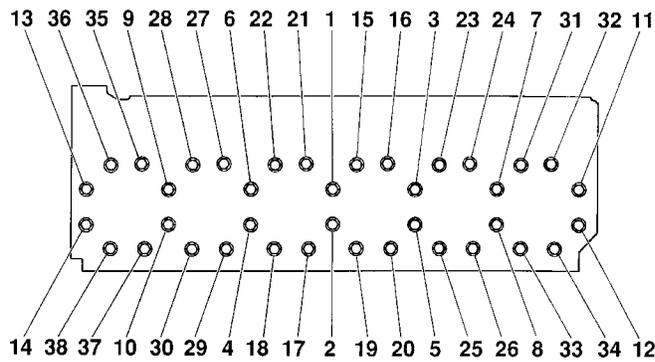


Fig. 15: Cylinder head bolt torque sequence T2007004

8
Install the cylinder head bolts and torque-tighten using proper sequence (see Fig. 15: Cylinder head bolt torque sequence, page 15) and the following steps:

- 1 Tighten bolts to a torque of 60 ± 10 Nm (44 ± 7 ft-lb).
- 2 Check tighten to same torque.
- 3 Turn bolt $90 \pm 5^\circ$. Make diagonal mark across bolt head with a felt-tip pen after turning or use angle gauge.
- 4 Turn bolt an additional $90 \pm 5^\circ$. Make another diagonal mark across bolt head with felt-tip pen after turning.

Note: Marking diagonal lines across the bolt heads will help to identify which bolts have been torqued.

Note: O-rings are no longer recommended for use when installing cylinder head bolts shanks.

9
Cut off the protruding ends of the rubber seal on the timing gear plate.

10
Position the bearing housings for the camshaft on the cylinder head.



CAUTION

Make sure that the mating surface under the bearing housings is clean and the guide pins are not damaged. If installing a new cylinder head, you must install the bearing housings supplied with the cylinder head.

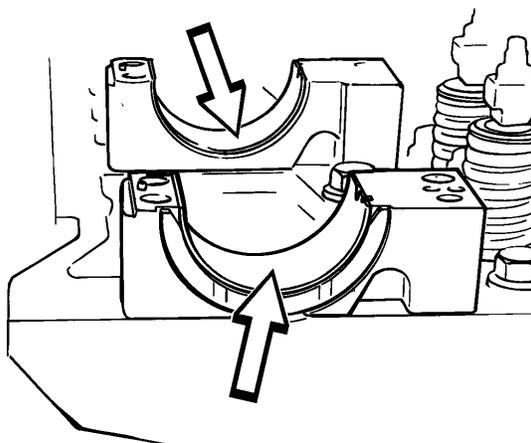
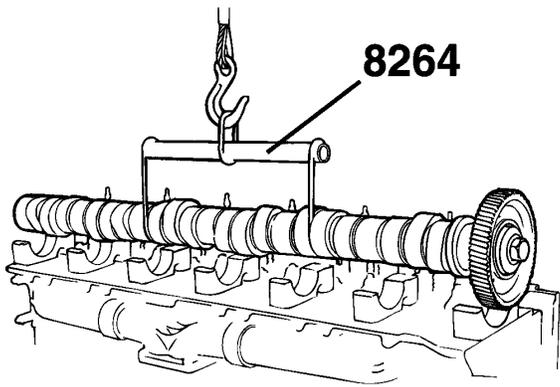


Fig. 16: Bearing shell halves T2007126

11
Coat the bearing shell halves with clean engine oil and install them in the bearing housings.

12
Remove the 5 bolts fastening the adjustable idler gear and remove the adjustable idler gear assembly (if it has not already been removed).



T2006783

Fig. 17: Installing the camshaft

13

Carefully hoist the camshaft into place using camshaft lifting tool 9998264.

9998264

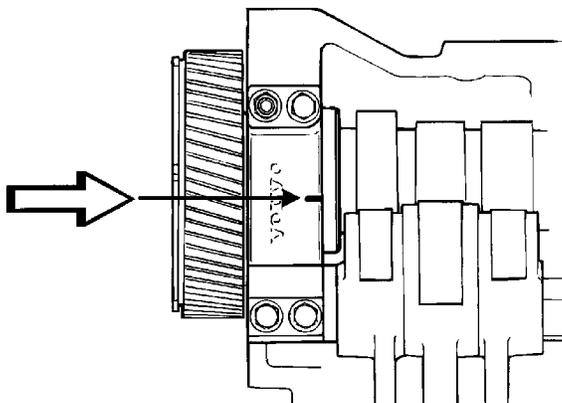
14

Coat the bearing shell halves with clean engine oil and install them in the camshaft caps. Install the caps on their respective bearing housings. Install and **hand-tighten** the bolts.

Note: Do NOT install the bolts for the rocker arm shaft.

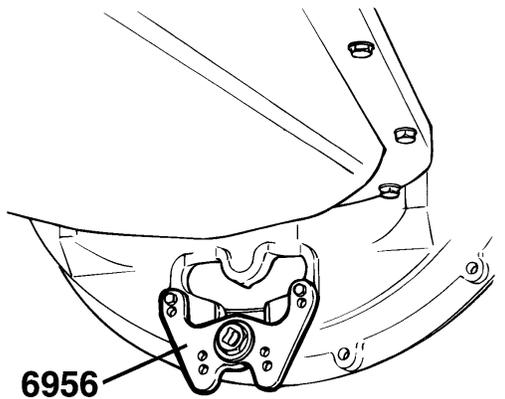
15

Set the camshaft to Top Dead Center (TDC), according to the marking on the camshaft, at the front bearing housing.



W2000936

Fig. 18: Positioning camshaft (rocker arms not installed)



T2006672

Fig. 19: Cranking tool installed

16

Remove the inspection cover from underneath the flywheel housing and install cranking tool 9996956.

9996956

17

Rotate the flywheel until it is at 0°.

Install idler gear and adjust gear lash and timing. Refer to "Camshaft Timing, Check and Adjust" page 21.

18

Carefully route the wiring harness for the unit injectors into the cylinder head and place on the outside of the rocker cover studs.

19

Remove protective plug 9998251 from the injector bore.

9998251

20

Remove each injector from the protector and install new O-rings. Coat the sealing rings with clean engine oil.

Note: Remove the bore protector and clean the bore before installing the injector into the bore (9998251)

9998251

21

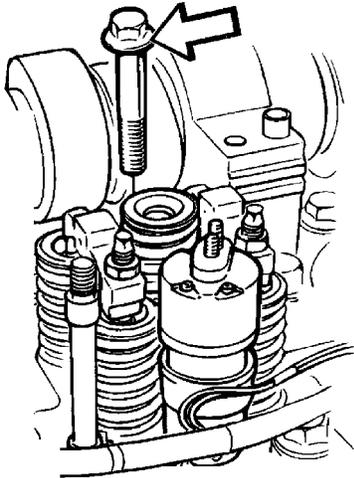
Install the unit injectors and center them between the valve springs. Torque-tighten unit injector hold down bolt as follows:

• **If using new copper sleeve:**

- 1 Tighten to 20 ± 5 Nm (15 ± 4 ft-lb).
- 2 Turn bolt $180 \pm 5^\circ$.
- 3 Loosen to "0" Nm
- 4 Tighten 20 ± 5 Nm (15 ± 4 ft-lb).
- 5 Turn bolt $60 \pm 5^\circ$.

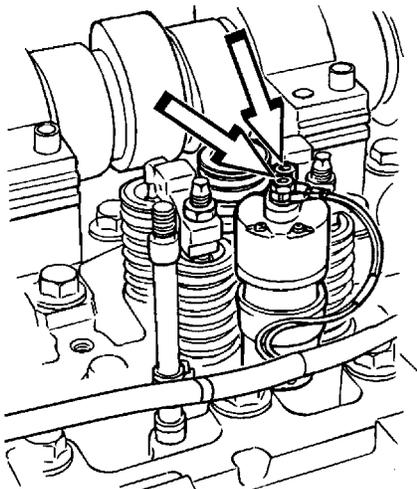
• **If using old copper sleeve:**

- 1 Tighten to 20 ± 5 Nm (15 ± 4 ft-lb).
- 2 Turn bolt $60 \pm 5^\circ$.



W2000718

Fig. 20: Unit injector retaining bolt



W2000690

Fig. 21: Unit injector cable connections

22

Connect the unit injector electrical wires and torque the nut to 1 ft-lb (1.36 Nm).

CAUTION

DO NOT OVERTIGHTEN. Hold wires while tightening. If the screws break, the unit injector must be replaced.

Note: Using torque wrench 9999708, torque-tighten the nut to 1.4 Nm (12 in-lb). Route the unit injector electrical wires to the outside of the valve cover bolts.

- 1 ft-lb (1.36 Nm)
- 1.4 Nm (12 in-lb)

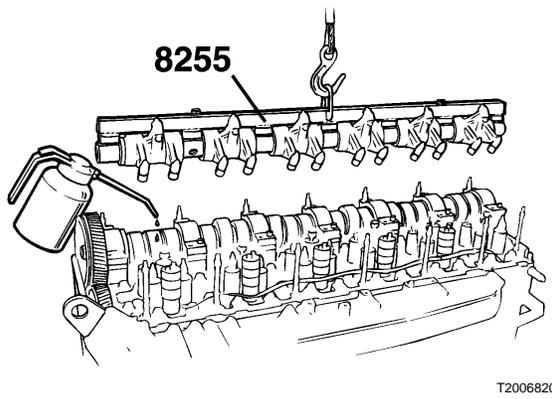


Fig. 22: Installing the rocker arm bridge

23

Apply clean engine oil to the valve bridges and camshaft lobes. Using tool 9998255, hoist the rocker arm assembly into place. Make sure that the valve bridges and the rocker arms are correctly positioned in relation to each other.

9998255

24

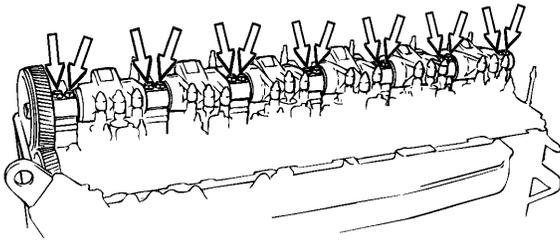
Using the crossover pattern, tighten the rocker arm shaft bolts until the rocker arm shaft bottoms out against the bearing housings.



CAUTION

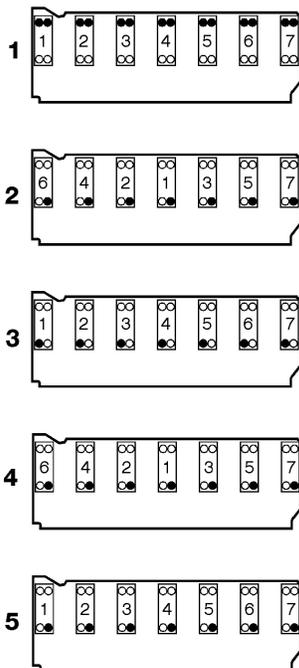
Gradually tighten the rocker arm shaft to avoid distorting the shaft.

25



T2006777

Fig. 23: Tightening rocker arm shaft and camshaft together



W2003520

Fig. 24: Bearing caps and camshaft/rocker shaft, tightening sequence, D12, D12A, D12B

On engines equipped with VOLVO Engine Brake, reinstall the VEB control valve at this time. Slide the valve and pipe into the rocker arm shaft as a unit. Apply Loctite to the mounting bolt threads and torque the bolts to $33 \pm 4 \text{ Nm}$ ($24 \pm 3 \text{ ft-lb}$).

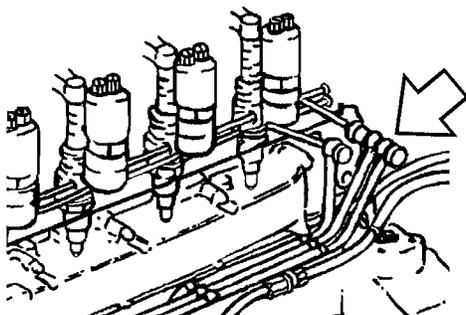
Note: Make sure that the flywheel is at 0° and the camshaft is at TDC according to the marking. Tighten the rocker arm shaft **together** with the camshaft, using the 5-step torque sequence shown below. When reinstalling a rocker arm shaft that has been loosened or removed, torque-tighten only the bolts that hold the rocker arm shaft.

- 1 $15 \pm 5 \text{ Nm}$ ($11 \pm 4 \text{ ft-lb}$); $+90 \pm 5^\circ$
- 2 45 Nm (33 ft-lb)
- 3 $15 \pm 5 \text{ Nm}$ ($11 \pm 4 \text{ ft-lb}$); $+90 \pm 5^\circ$
- 4 45 Nm (33 ft-lb); loosen to 0 Nm (0 ft-lb)
- 5 $15 \pm 5 \text{ Nm}$ ($11 \pm 4 \text{ ft-lb}$); $+90 \pm 5^\circ$

26

Install fuel lines to the rear of the cylinder head.

Note: Use new copper washers.



W2000720

Fig. 25: Fuel lines installed

2154-06-03-02 Camshaft Timing, Check and Adjust

You must read and understand the precautions and guidelines in Service Information, group 21, "General Safety Practices" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

Special tools: 9996956, J-41272, J-42773

1

Note: Special tools with part numbers that begin with "J" are available from Kent-Moore.

Remove the cam sensor wheel.

2

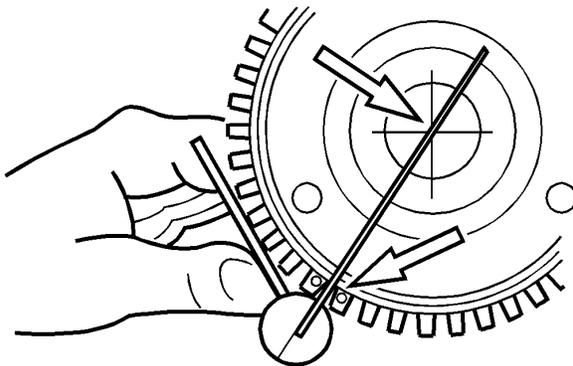
Install the camshaft alignment tool J-42773 by inserting the guide pin into the hole under the camshaft drive gear. Rotate the tool to position the lever against the drive gear teeth to ensure correct positioning of the camshaft alignment tool.

3

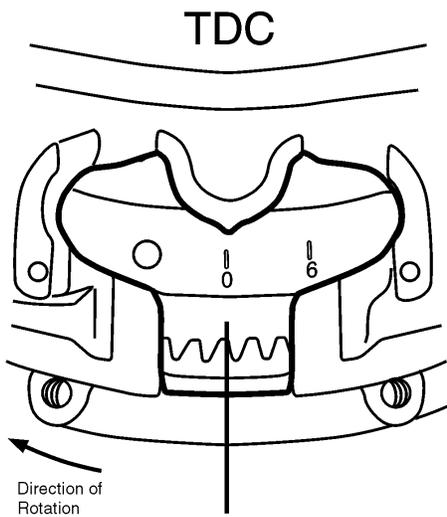
With J-42773 held in position, set the camshaft as shown.

Note: The camshaft setting must be exactly as illustrated in the illustration. It is important that the camshaft gear marking is positioned precisely on both sides of the tool in a line extending from the center of the camshaft.

J-42773



T2012262



W2004266

- 4**
Rotate the flywheel in the opposite direction of rotation approximately 20° , and then in the direction of rotation 20° to the 0° mark exactly. If you pass the mark, repeat this entire step.



CAUTION

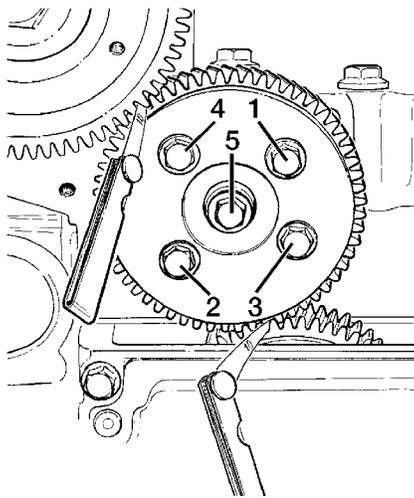
Final rotation of the flywheel in the opposite direction of normal rotation will result in an incorrect setting due to the gear train lash.

- 5**
Clean all sealant from front of the head.

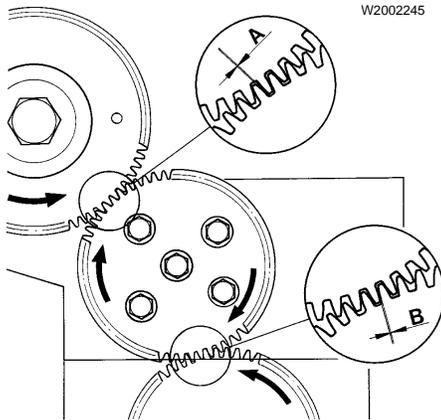
- 6**
Install the adjustable idler gear assembly.

Note: The bolts are the single-use "stretch" type and should not be reused. Pipe sealant should be used on the center bolt.

7



W2002245



T2008255

Insert the 0.10 mm (0.004 in.) feeler gauge on the load sides of the (A and B) gear teeth.

8

Torque the bolts to an initial torque of only 15 ± 3 Nm (11 ± 2 ft-lb).

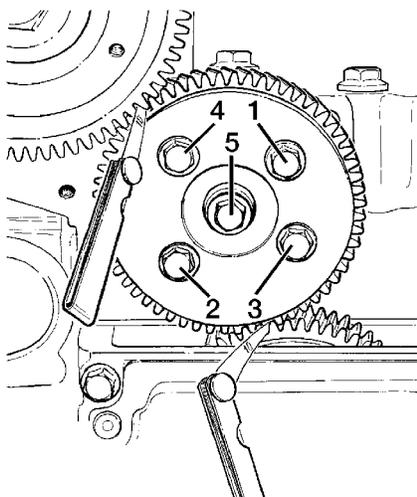
Note: An additional $120 \pm 5^\circ$ is required after the correct backlash is confirmed.

15 ± 3 Nm
(11 ± 2 ft-lb)

9

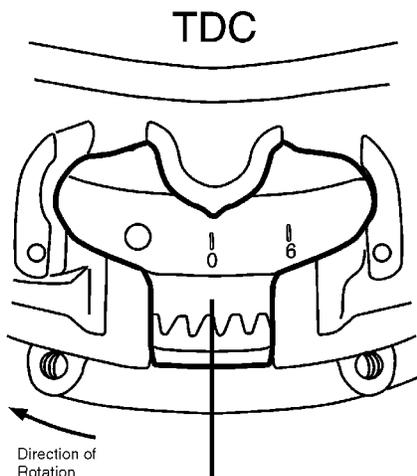
Check that both feeler gauges have the same resistance when inserting them and pulling them out. The correct backlash is 0.05-0.17 mm (0.002-0.007 in.).

0.05-0.17 mm
(0.002-0.007 in.)



W2002245

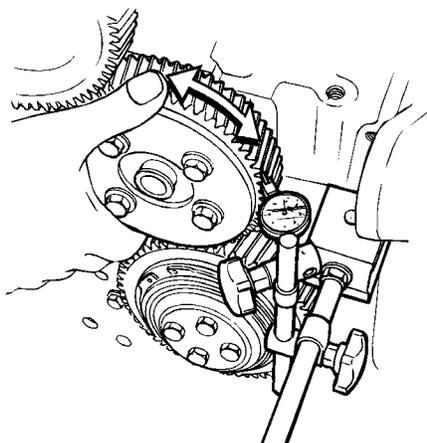
10
Tighten the bolts an additional $120 \pm 5^\circ$ per the torque sequence shown.



W2004266

11
Re-check camshaft timing. Rotate the engine opposite the direction of rotation approximately 20° . Continue in the direction of rotation until the two dots on the cam gear are equally spaced on both sides of the camshaft alignment tool, J-42773. Verify that the pointer on the flywheel is within specifications (2 mm BTDC to 2 mm ATDC).

J-42773

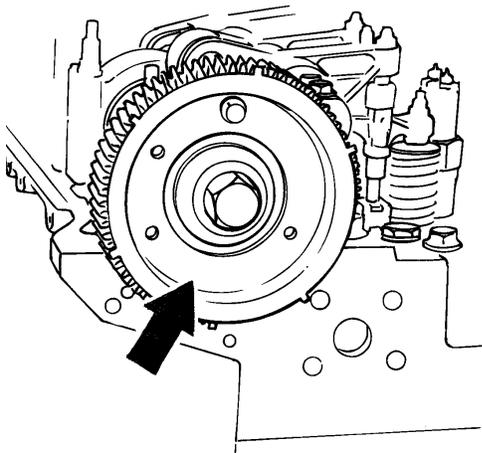


T2007084

12
After the rocker assembly has been torqued in place, use a dial indicator to perform a final check of the adjustable idler gear backlash. Correct backlash is 0.05 – 0.17 mm (0.002 – 0.007 in.).

0.05 – 0.17 mm
(0.002 – 0.007 in.)

Fig. 26: Checking backlash



T2007096

13

Install the cam sensor wheel on the camshaft drive gear. Install and torque/tighten the three bolts to 25 Nm (19 ft-lb).

25 Nm
(19 ft-lb)

14

Clean the contact surfaces for the upper timing gear cover. Replace with a new seal.

15

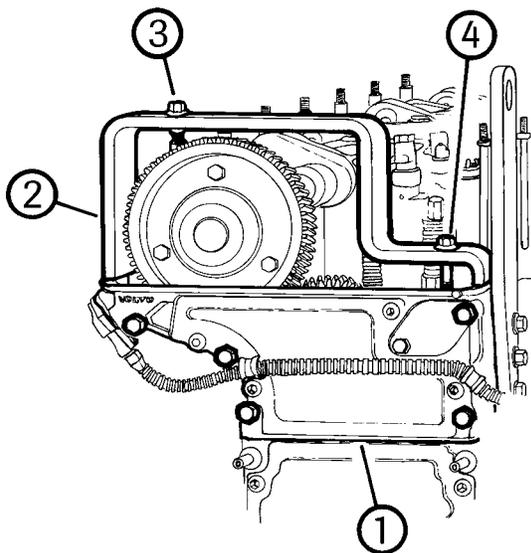
Apply an even bead of sealant around the timing gear cover. Install the cover.

Note: Do not allow sealant to harden before installing the cover.

16

Install the alignment tool J-41272 on the forward right-hand valve cover stud using an existing valve cover nut. To attach the left-hand side, thread the bolt (supplied with the tool) into the hole in the cylinder head. The top of the cover must be flush with the top of the cylinder head. Otherwise, oil leaks may result.

J-41272



W2002163

Fig. 27: Installing alignment tool J-41272

- 1 Upper gear cover
- 2 Alignment tool
- 3 Valve cover nut
- 4 Bolt supplied with J-41272

17

Draw the cover down evenly until the cylinder head and cover are aligned. Tighten bolts in the proper sequence and torque to 33 ± 3 Nm (24 ± 3 ft-lb).

33 ± 3 Nm
(24 ± 3 ft-lb)

18

Measure the cam sensor-to-pole wheel air gap.

Note: Make sure the air gap is between 0.3 – 0.7 mm (0.011 – 0.028 in.).

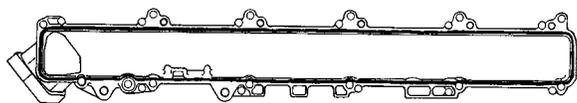
0.3 – 0.7 mm
(0.011 – 0.028 in.)

19

Connect the electrical cable to the cam sensor on the cover.

20

Apply an even 2 mm (0.08 in.) bead of sealant around the intake manifold. Install the intake manifold and connect the electrical wires.



T2007149

Fig. 28: Intake manifold



CAUTION

The sealant must not harden before installing the intake manifold. If the engine is equipped with a VEB, make sure that sealant does not enter the oil channel as this can negatively affect brake operation.

21

Install the turbocharger; refer to Service Information, Group 25.

22

Adjust the valves and unit injectors. For the adjustment procedure, refer to Service Information, Group 23.

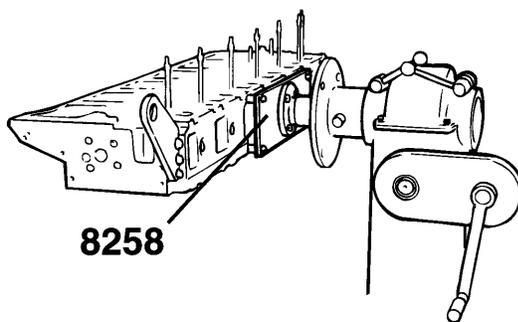
2111-04-04-01 Cylinder Head, Overhaul

 **CAUTION**

Observe the greatest possible cleanliness when working on the cylinder head. Dirt particles in the fuel and oil channels can cause the unit injectors to malfunction, and can cause the VEB (if equipped) to fail.

One or more of the following procedures also may be used as reference or included as part of this procedure; for information, see Service Information, Group 2:

- Cylinder Compression, Checking
- Valve Guide Wear, Checking
- Valve Guide, Replacement
- Valve Seat, Replacement (One)
- Valve, Adjustment
- Valve, Grinding
- Valve Seat, Grinding



T2006781

Fig. 29: Attaching the cylinder head to the overhaul stand.

Special tools: 9996159, 9996161, 9996222, 9998246, 9998260, 9998355, 9998258, 9998335

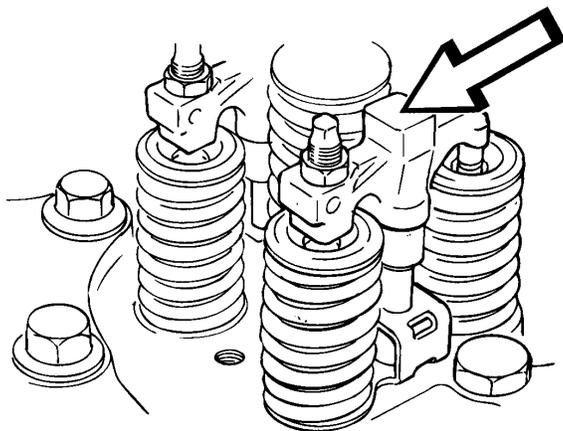
Disassembly

1

Attach the cylinder head firmly to the overhaul stand so that it can be turned if necessary.

Note: It is important that extreme cleanliness be observed when working on the cylinder head. Dirt and particles can cause the unit injector to fail. If the engine is equipped with a VEB, both the brake and engine functions may be affected.

9998258



T2007050

Fig. 30: Valve bridges (non-VEB shown)

2

Remove the valve bridges.

Note: Mark the bridges and place them in order so that they can be reinstalled in their original positions on the cylinder head.

3

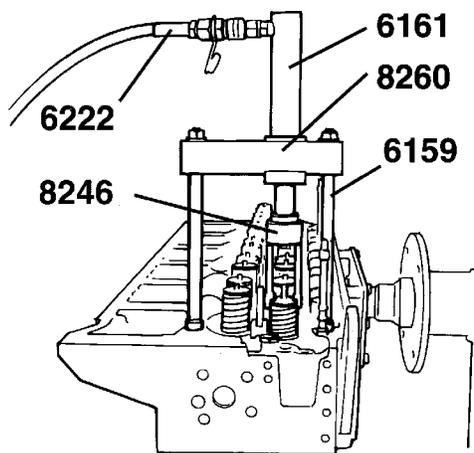
Install pressing tool 9998260 together with the counter hold which holds the valves.

9998260

4

Install hydraulic cylinder 9996161, with studs 9996159 and drift 9998246, in pressing tool 9998260 using 9996222 hydraulic pump. Press down the valve rotator and remove the valve locks.

9996159, 9996161, 9996222, 9998246, 9998260

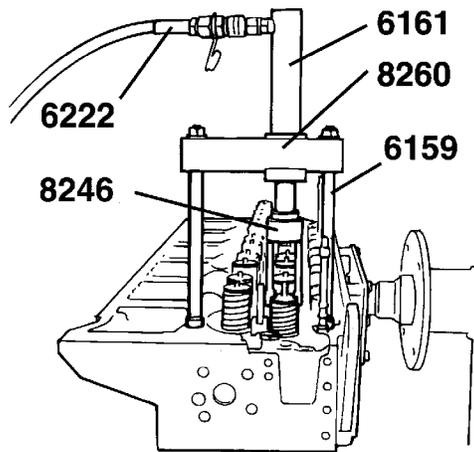


T2006782

Fig. 31: Removing the valve locks

5

Remove the remaining valves in a similar manner. Place the valves and springs on a rack so that after testing, they are reinstalled in their original positions in the cylinder head.



T2006782

Fig. 32: Installing the valve locks

Assembly

6

Coat the valve stems with clean engine oil. Place the valves in the valve guides. Position tool 9998335 on the valve stem and push the seal over the tool until the seal bottoms out against the valve guide. Install the springs with regard to whether they are intake or exhaust valve springs. Carefully press down the springs and install the valve locks.

Note: Exhaust valves have double springs.

7

Install the valve bridges in their respective positions and adjust. See Service Information, Group 23, Valve and Electronic Unit Injector Adjusting.

2111-06-04-01 Cylinder Head, Pressure Test (First)

(Head removed; thermostat housing and exhaust manifold removed)

You must read and understand the precautions and guidelines in Service Information, group 21, "General Safety Practices" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

CAUTION

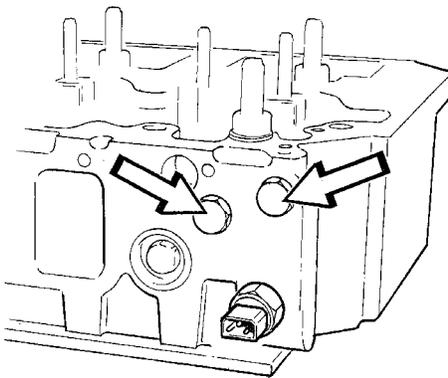
Observe the greatest possible cleanliness when working on the cylinder head. Dirt particles in the fuel and oil channels can cause the unit injectors to malfunction, and can cause the VEB (if equipped) to fail or cause engine damage.

Special tools: 9996662, 9998256, 9998259, 9998266, 960631, 11996, 9998251

1

Install two (2) 960631 plugs and two (2) 11996 copper washers into the fuel pressure and fuel return connections.

960631
11996



T2007142

Fig. 33: Installing the plugs in fuel system ports

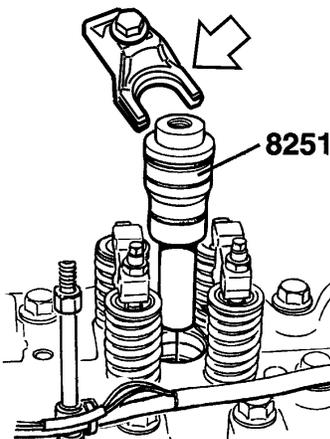
2

Install the injector bore protective plugs 9998251 with O-rings removed and secure with the injector hold down from the engine assembly. Hand tighten the hold down bolt.

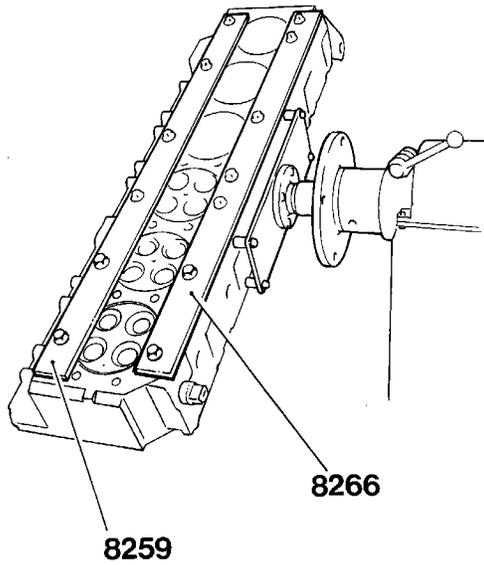
DANGER

The injector hold down prevents the injector tube from being blown from its bore when air pressure is applied.

9998251



W2004233

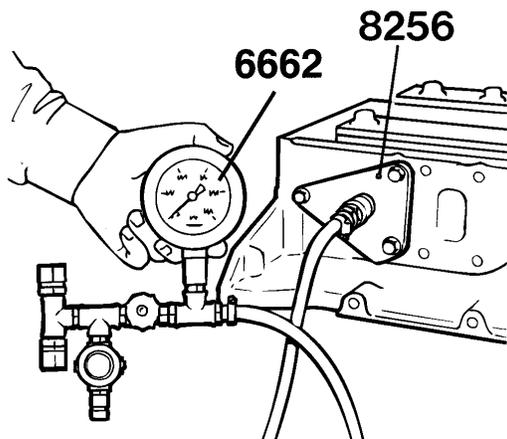


T2007143
Fig. 34: Installing the sealing washers

3

Install sealing washers 9998259 and 9998266, using the cylinder head bolts and M16 nuts.

9998259, 9998266

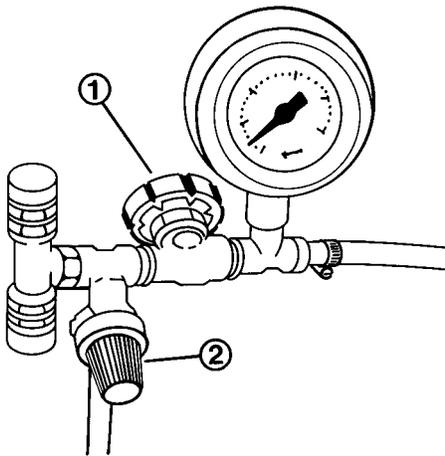


T2007153
Fig. 35: Connection washer installed

4

Clean the contact surface and install the connection washer 9998256 on the thermostat housing position on the cylinder head.

9998256

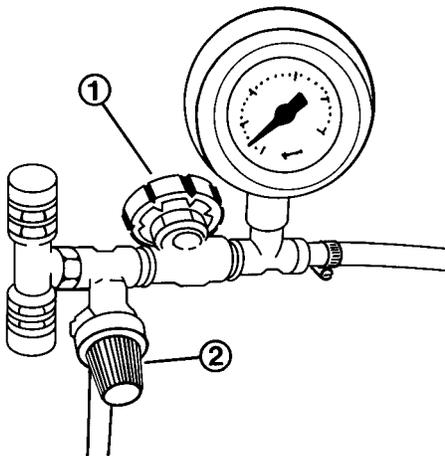


W2000715

Fig. 36: Pressure reduction knob

5
Before using pressure tester 9996662, connect it to the shop air supply and set the pressure gauge to 103 kPa (15 psi) using the reduction valve. Lock the reduction valve knob (2) with the lock ring.

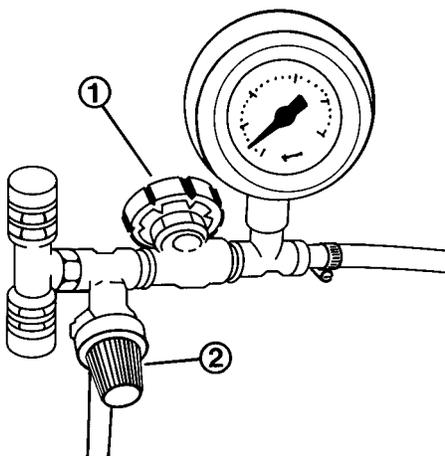
9996662



W2002162

Fig. 37: Shut-off valve knob

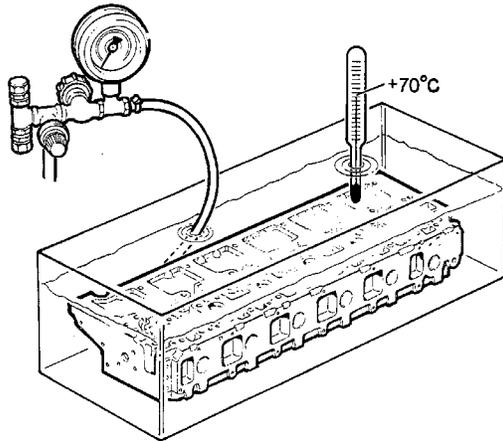
6
Close the shut-off valve (1). Verify that the pressure does not drop for two minutes.



W2000715

Fig. 38: Pressure reduction knob

7
Make sure that the pressure gauge reduction valve knob (2) is open (turn counterclockwise).



T2007167

Fig. 39: Cylinder head in tank of water

8

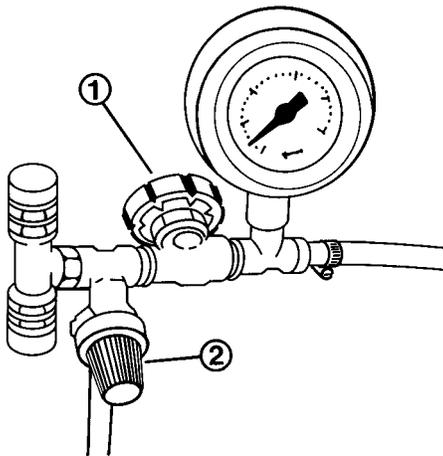
Remove the cylinder head from the overhaul stand and immerse the head in a tank of water heated to 70 °C (160 °F).

9

Open the shut-off valve.

10

Turn the reduction valve knob (2) clockwise until the gauge shows a reading of 50 kPa (7.25 psi). Maintain this pressure for one minute.



W2000715

Fig. 40: Pressure reduction knob

11

Then, increase the pressure to 160 kPa (23 psi). Secure the reduction valve knob with the lock ring and close the shut-off valve. After two minutes, check to see if the pressure has dropped or if there are air bubbles in the water bath.

2143-06-05-01 Valve Guide Wear, Checking

Cylinder head removed and installed in overhaul stand

You must read and understand the precautions and guidelines in Service Information, group 21, "General Safety Practices" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

1

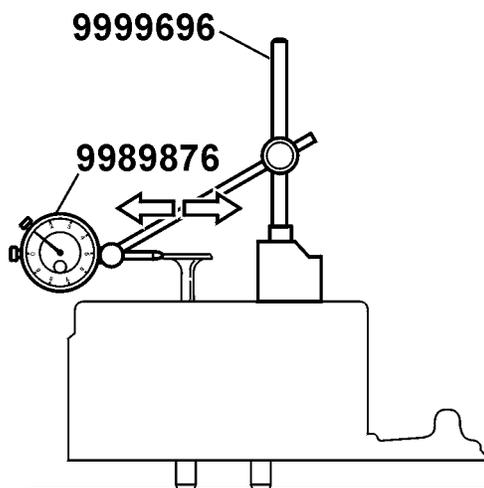
Remove the seal from the valve guide.

2

Rotate the cylinder head so that it is in the vertical position.

3

Insert a new valve guide so that the end of the valve spindle is level with the edge of the guide.



C2002649

Fig. 41: Checking for valve wear

4

Using a dial indicator with a magnetic base, position it so that the dial indicator tip is against the edge of the valve rotator. Rock the valve in the direction of the exhaust and intake ports. Read the value on the dial indicator.

Wear tolerances

- a** Maximum allowable diametrical wear on valve stem
— 0.010 mm (0.00039 in).
- b** Maximum allowable clearance between valve stem and valve guide:
 - Intake valve — 0.025 mm (0.00098 in)
 - Exhaust valve — 0.038 mm (0.00150 in)

2143-03-05-03 Valve Guides, Replacement (One Cylinder Head)

You must read and understand the precautions and guidelines in Service Information, group 21, "General Safety Practices" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

Special tools: 9996159, 9996161, 9998260, 9998261, 9998262, 9998263, 9996222

Removing

1

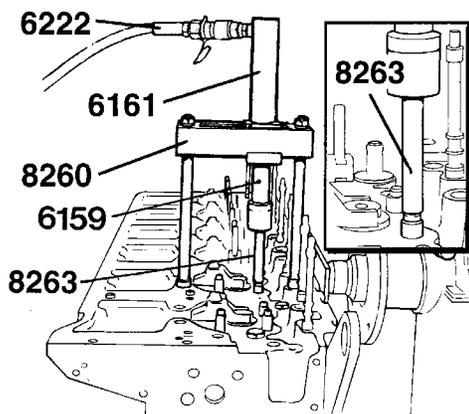
Install pressing tool 9998260 in the holes for the cylinder head attachment bolts.

Note: Place **washers** between the nuts and the bottom surface of the cylinder head.



CAUTION

Wear eye protection whenever using press.



T2007152

Pressing tool 9998260 installed

2

Tighten the tool nuts.

3

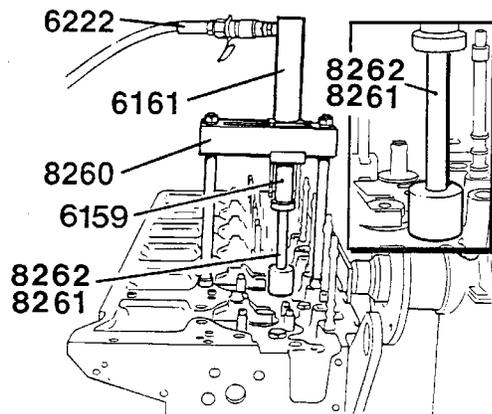
Install hydraulic cylinder 9996159 in tool 9998260. Press out the valve guide. Repeat steps to remove other valve guides.

Note: Tool 9998261 may have to be used between 9998263 and 9996159 if the cylinder stroke is not long enough.

Installing

1

Coat the outside of the valve guides with engine oil before pressing them into place.



T2007165

Installing new valve guides

2

Press the intake valve guide using tool 9998261. The guide for the exhaust valve is pressed in using tool 9998262.

Note: Intake valve tool 9998261 is marked *Int*, and the exhaust valve tool 9998262 is marked *Ex*. Press until the tools bottom against the face of the cylinder head. The other guides are pressed into place in a similar way.

3

Install new seals on the valve guides.



CAUTION

After having changed the valve guides, the cylinder head must be carefully cleaned to ensure that no particles enter the cylinder head fuel gallery.

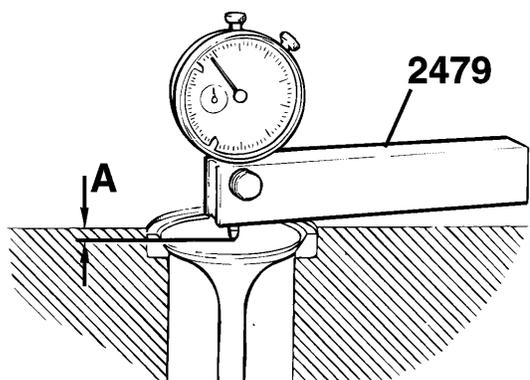


CAUTION

Dirt and particles can cause the electronic unit injectors (EUI) to fail. If the engine is equipped with a VEB (Volvo Engine Brake), both the brake function and engine function may be affected.

2149-03-05-01 Valve Seat, Replacement (One)

You must read and understand the precautions and guidelines in Service Information, group 21, "General Safety Practices" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.



T2007047

Measuring wear of the valve seats

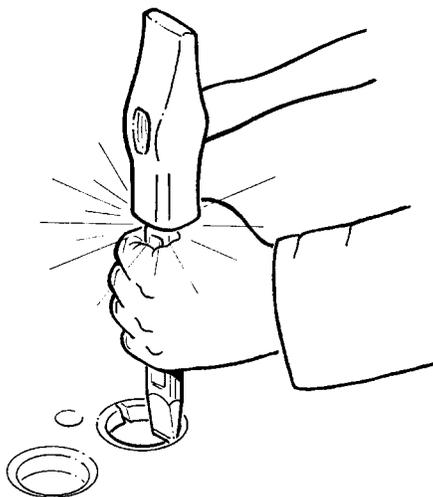
1

The valve seats should be changed when the distance "A", measured with a new valve exceeds:

- a Intake valve— 1.5 mm (0.06 in)
- b Exhaust valve — 1.8 mm (0.07 in)

2

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



W2000717

Fig. 42: Checking valve seat

3

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

4

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

5

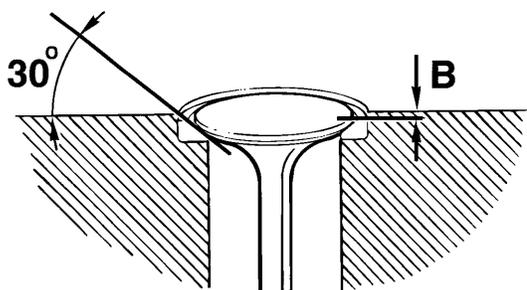
Measure the diameter of the seat location. Check whether a standard size seat or an oversize seat is required. Machine the valve seat location, if necessary.

2149-05-05-01 Valve Seat, Grind (One)

You must read and understand the precautions and guidelines in Service Information, group 21, "General Safety Practices" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

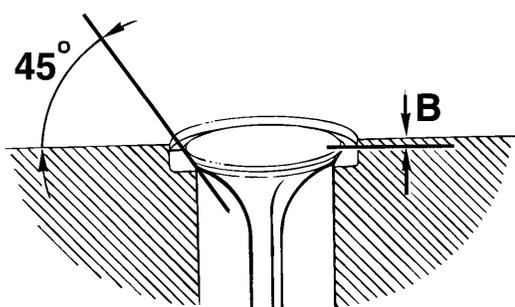
- 1
Prior to grinding, check the valve guides and replace them if the wear limits have been exceeded.
- 2
Grind the valve seat just enough to give it its correct shape and to ensure a good contact surface for the valve rotator.

3



T2007045

Fig. 43: Valve seat angles, Intake Valve



T2007046

Fig. 44: Valve seat angles, Exhaust Valve

Dimension **B** shows the amount of wear or grinding allowed on the valve seat. The distances are measured with a new valve and the wear tolerances are:

- a Intake valve— 1.5 mm (0.06 in)
- b Exhaust valve — 1.8 mm (0.07 in)

2145-03-04-01 Rocker Arms, Replacement (All)

You must read and understand the precautions and guidelines in Service Information, group 21, "General Safety Practices" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

1

Note: To change the rocker arm mechanism on the engine, refer to "Cylinder Head, Removal" page 5 and to "Cylinder Head, Installation" page 12 for removal and installation of the rocker arm shaft assembly.

Note: Where it concerns changing components, it is possible to change the rocker arm shaft, complete rocker arms or bolts with ball socket heads.

2

Remove the rocker arms from the rocker arm shaft.

3

Clean the components, paying special attention to the oil channel in the bearing housing and to the rocker arm shaft and rocker arm oil holes.

4

Check the rocker arm shaft and bolts with ball socket heads for wear. The threads on the bolts and lock nuts should be undamaged. If a bushing on a rocker arm is out-of-round, the complete rocker arm must be changed.

5

Coat the rocker arm shaft with clean engine oil and re-install the rocker arms.