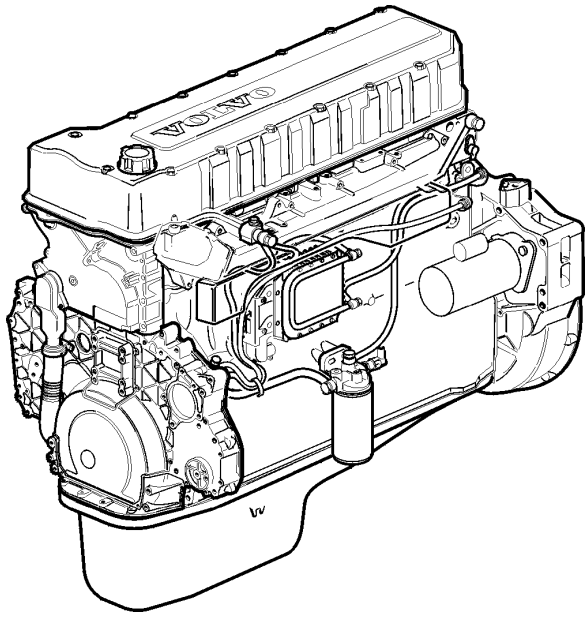
This TSI Service Bulletin and others in Groups 21 and 33 replace TSI Service Manual 210–600, “Basic Engine, D12, D12A, D12B, D12C” (8.2000), publication no. PV776–TSP142853.

Cylinder Compression



W2003244

Fig. 1: VOLVO D12C Engine

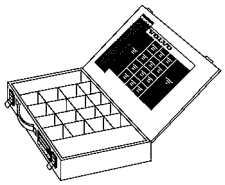
This information covers the procedure for checking cylinder compression on VOLVO D12 engines.

Contents

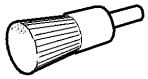
Tools

Special Tools

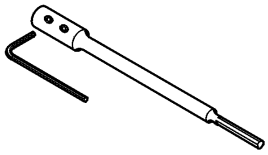
The following special tools are used to replace or repair components. The tools can be ordered from Volvo; please use the specified part number when ordering.



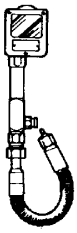
3949521
VEB Shim Kit



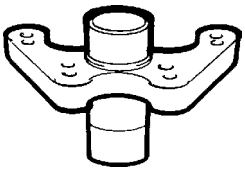
9808570
Brush



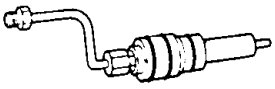
9808616
Handle



9988539
Compression gauge



9996956
Cranking tool

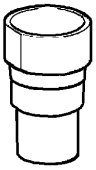


9998248
Adapter

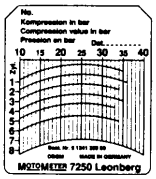
9998249
Protection cap

9998255
Elevation tool

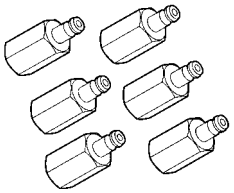
9998511
Lever



9998580
Seal tool



9999693
Graphic Card (used with 9988539)



J-44621
Compression Gauge Adapter Set

2103-06-02-01 Cylinder Compression, Checking

(With EPG or VEB)

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

Note: A diagnostic test can identify possible variations between cylinders; refer to VCADS Pro tool.

Note: When performing a compression test on the D12 engine, install all six adapters (9998248) at the same time. This eliminates the need to remove and reinstall the rocker arm bridge between each cylinder test. It is also unnecessary to remove and adjust the unit injector between each cylinder test.

Note: Before removing the unit injectors, make sure that their surrounding areas are clean.

Special tools: 9808570, 9808616, 9988539, 9996956, 9998248, 9998249, 9998255, 9998511, 9998580, 9998583, 9999696

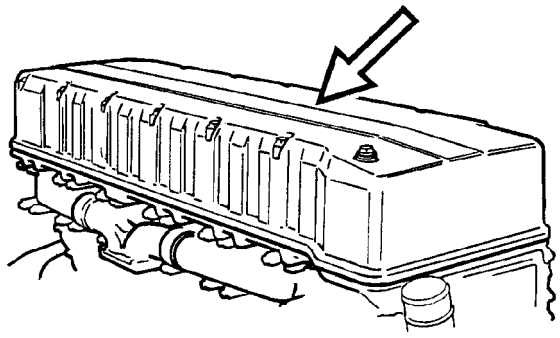
1

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. Clean up fuel spills immediately.

Clean around the drain plug in the fuel filter bracket. Connect a pipe to the plug and direct the other end of the pipe to a suitable container. Open the plug and let the fuel in the cylinder head drain into the container.

2



C2001719

Remove the valve cover.

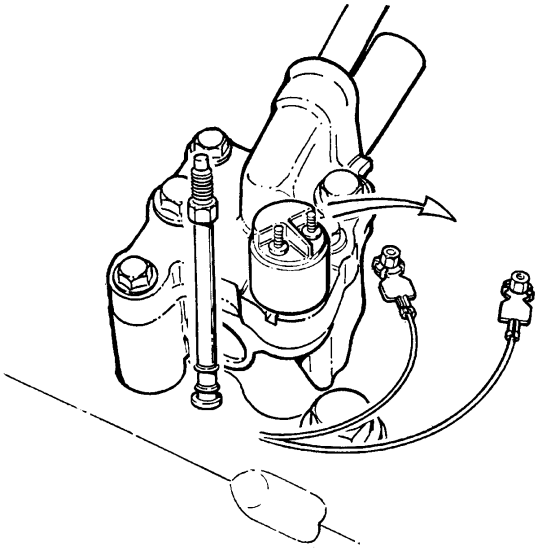
Note: Do not use an impact wrench, or the studs may loosen from the cylinder head and damage the electrical installation and the valve cover.

3

T2008818

Disconnect the electrical connections from the unit injectors.

4



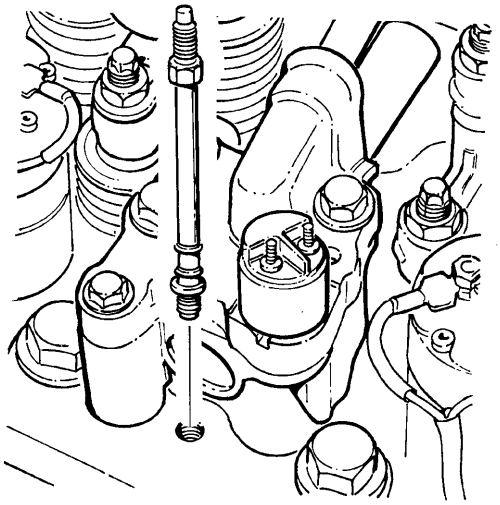
T2008812

Disconnect the electrical connections from the unit injectors and from the VEB control valve. Carefully pull the electrical installation out of the cylinder head.

5

Clean around the VEB control valve.

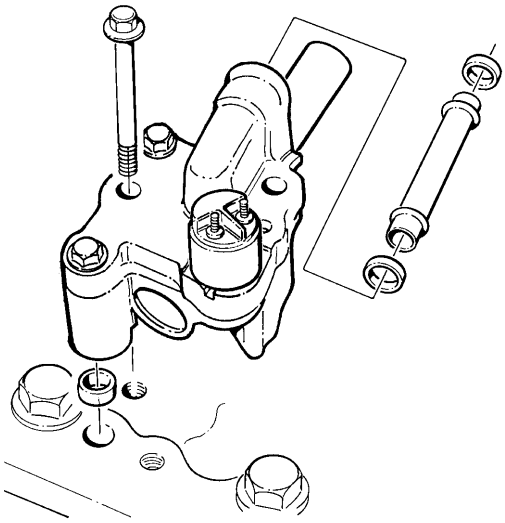
6



T2008813

Remove the valve cover stud located in front of the VEB control valve.

7

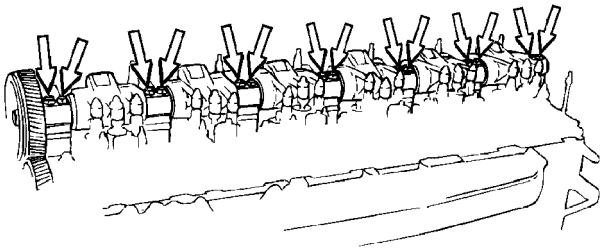


T2008814

Remove the bolts from the VEB control valve and then remove the valve. Also remove the pipe between the control valve and the rocker arm shaft.

Note: Save the valve in a place free from dust. Place a cover over the cylinder head oil hole.

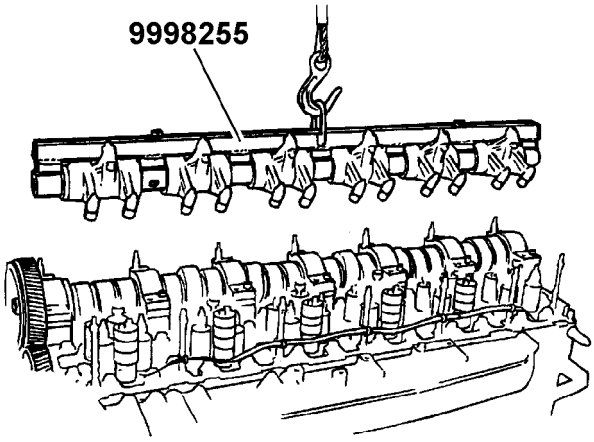
8



C2001720

Loosen the bolts in the rocker arm shaft support uniformly along the entire shaft, so that it is not strained and risk being warped.

9



C2001721

Remove the bolts, attach lifting tool 9998255 9998255, and raise the entire rocker arm assembly.

Note: In engines equipped with the VEB engine brake, fasten the rocker pistons with a rubber band or another suitable device to prevent the pistons from dropping when the rocker arm assembly is lifted.
Rocker pistons are classified in packages (2, 3, or 4 points are stamped on the rocker arms and pistons) and should be kept as an assembly.

10
Remove the bolts fastening the levers of all unit injectors.

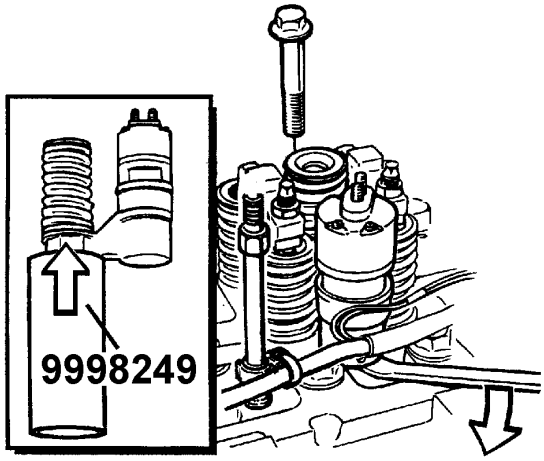
11
Clean around the unit injectors.

12

T2012932

Remove the unit injector with lever 9998511 9998511.

13



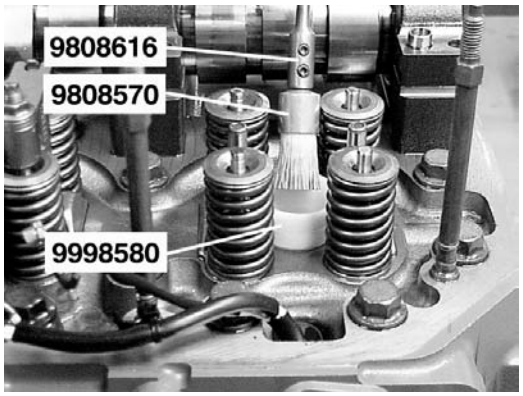
C2000425

Install dust covers 9998249 on the unit injector to protect them from dirt or possible damage. 9998249

14
Use the same procedure to remove the other unit injectors, one at a time.

Note: Arrange the unit injectors on a support so they can easily be reinstalled in their original cylinders.

15



T2014131

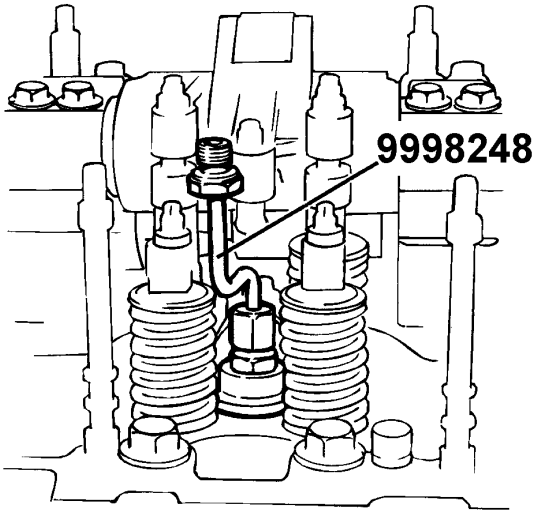
Clean the copper sleeves in the unit injectors using tools 9808616, 9808570, and 9998580.

9808616
9808570
9998580

CAUTION

While cleaning the copper sleeves for the unit injectors, never use spatulas, steel brushes, or any other steel objects. Do not clean the injector nozzles, as this can damage them or obstruct the nozzle holes, which can reduce engine power or bind piston rings.

16



C2000411

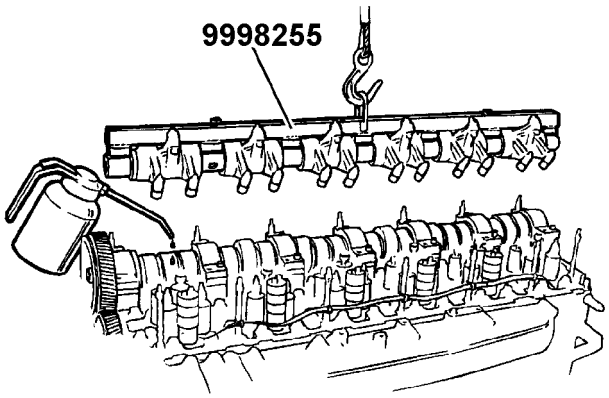
Install the 6 compression test adapters 9998248 in the cylinder head.

9998248

CAUTION

DO NOT leave unit injector tubes opened. If not installing 9998248 adapters, install 9998251 protective plugs to protect tubes from contaminants.

17

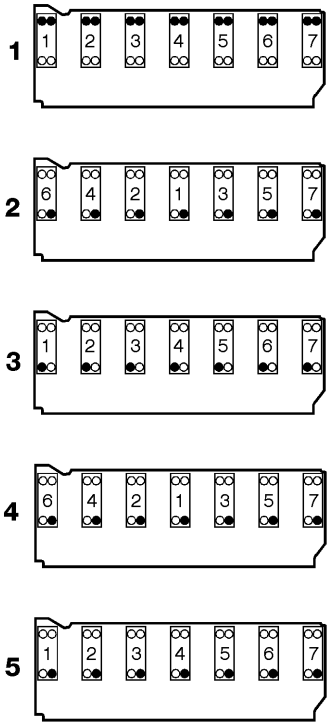


C2001726

Lubricate the valve bridges and camshaft lobes with engine oil. Using lifting tool 9998255, install the rocker arm bridge.

9998255

18



W2003520

Fig. 2: Bearing caps and camshaft/rocker shaft, tightening sequence

Gradually tighten the bolts so that the rocker arm shaft does not bend or warp (also check that the guide pins fit correctly in the camshaft supports). Tighten the shaft until it lies against the camshaft lobes, then torque-tighten using the proper bolt sequence (see Fig. 2: Bearing caps and camshaft/rocker shaft, tightening sequence, page 7) and the following 5-step process:

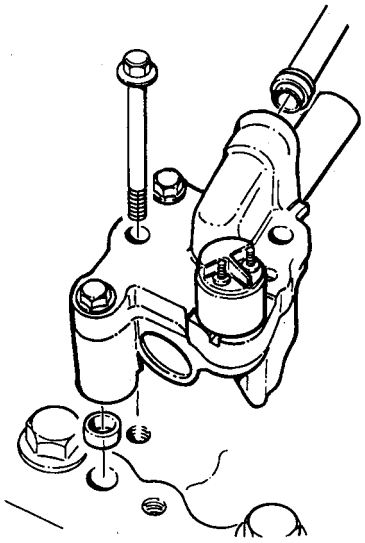
D12C:

1. 15 ± 5 Nm (11 ± 4 ft-lb); +90 ± 5°
2. 60 ± 5 Nm (44 ± 4 ft-lb)
3. 15 ± 5 Nm (11 ± 4 ft-lb); +120 ± 5°
4. 60 ± 5 Nm (44 ± 4 ft-lb); loosen to 0 Nm (0 ft-lb)
5. 15 ± 5 Nm (11 ± 4 ft-lb); +120 ± 5°

D12, D12A, D12B:

1. 15 ± 5 Nm (11 ± 4 ft-lb); +90 ± 5°
2. 45 Nm (33 ft-lb)
3. 15 ± 5 Nm (11 ± 4 ft-lb); +90 ± 5°
4. 45 Nm (33 ft-lb); loosen to 0 Nm (0 ft-lb)
5. 15 ± 5 Nm (11 ± 4 ft-lb); +90 ± 5°

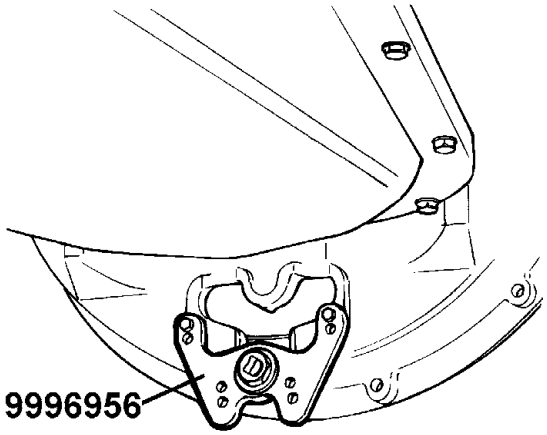
19



T2008958

In VEB engines, install the control valve.

20



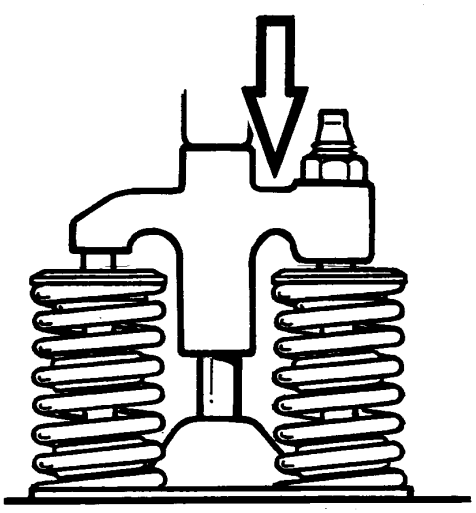
C2000183

Install flywheel turning tool 9996956. 9996956

21

Turn the engine to the next marking on the camshaft for the valve adjustment.

22

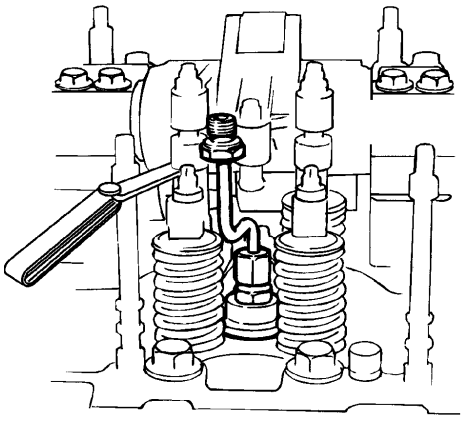


T2009075

Loosen the screw in the valve bridge until the bridge stops contacting the valve stems. Put pressure on the valve bridge and hand-tighten the screw to 0 lash. Turn an additional 60° and torque-tighten the retaining nut to 38 ± 4 Nm (28 ± 3 ft-lb).

38 ± 4 Nm
(28 ± 3 ft-lb)

23



W2003733

Checking intake valve play with tool 9998248 installed

Check the intake valve play and adjust if the play is not within specifications:

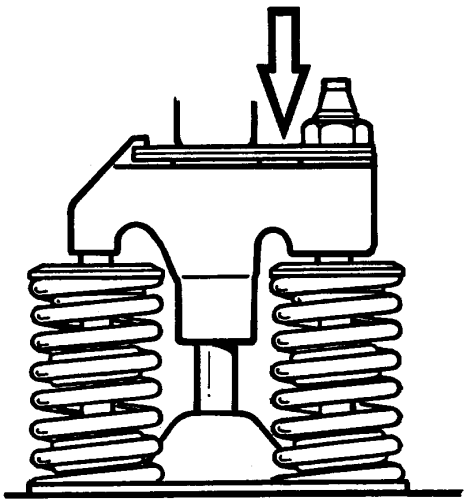
- Intake valves: 0.20 ± 0.05 mm (0.008 ± 0.002 in.)

Note: Mark each valve with a felt marker pen as you adjust them so as to know which valves are already adjusted.

24

Turn the engine to the next marking on the camshaft for the exhaust valve adjustment.

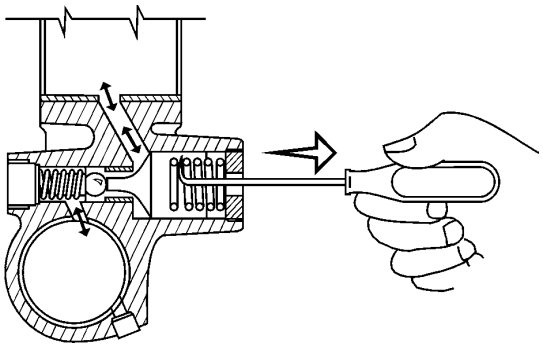
25



T2009073

To adjust the valve bridge, use the same procedure described for the intake valve, but do not tighten the nut.

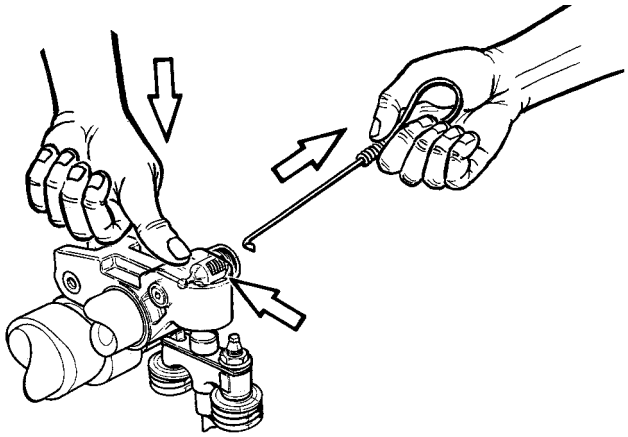
26



W2002165

Using a cotter pin removal tool or similar instrument, compress the coil spring of the rocker piston.

27

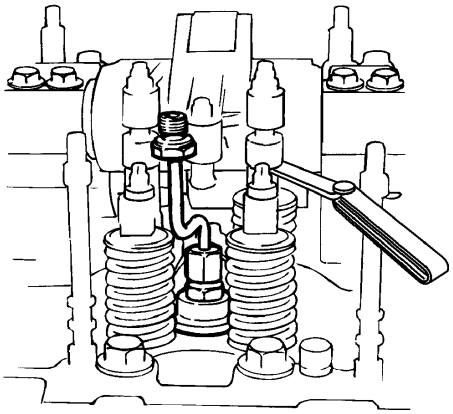


T2009009

While compressing the coil spring, press down firmly on the exhaust rocker arm. This will force out any oil and properly seat the power piston to its innermost position in the rocker arm.

Note: Be sure there is no oil on the rocker arm preventing the piston from reaching the end of its stroke. This can act as a hydraulic wedge and prevent correct adjustment.

28



W2003734

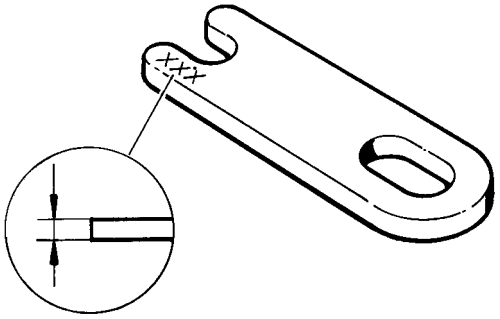
Checking exhaust valve play with tool 9998248 installed

Insert a feeler gauge, with the specified measure, between the valve bridge and the rocker piston end. Turn the piston to prevent it from tilting.

Acceptable valve clearance (play)	
Exhaust	0.50 ± 0.05 mm (0.0196 ± 0.0019 in.)
Exhaust with VEB	1.60± 0.05 mm (0.063 ± 0.002 in.)

Note: If there is play: try with different feeler gauges until the play disappears. That makes it possible to find out which shim measure will be used in step **29**. If unable to insert the feeler gauge, try a thinner gauge until one fits or until there is no longer any play.

29



T2009008

Calculate the thickness for the new shims using “A-B” (below). **A maximum of two shims may be used.** (If two shims are needed, select the shims so they are both about the same thickness.)

A - B = shims required
A = Measured play
B = Specified play tolerance

Note: Shims are available in thickness intervals of 0.05 mm (0.002 in). Sizes range from 2.0 – 2.4 mm (0.08 – 0.094 in.), and from 3.2 – 3.95 mm (0.126 – 0.156 in.). The thickness is stamped on the shims.

30

Carefully clean the shims and valve bridge. Install the shims and tighten the adjustment screw lock nut to 38 ± 4 Nm (28 ± 3 ft-lb).

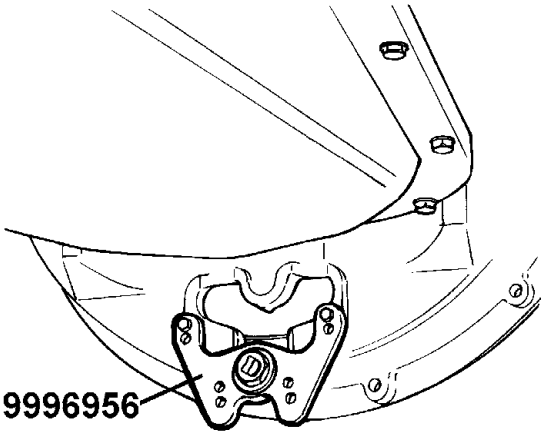
38 ± 4 Nm (28 ± 3 ft-lb)

Note: Make sure that the adjustment screw does not move out of position when tightening the nut.

31

Use the same procedure to check the play of the other valves.

32



C2000183

Remove flywheel turning tool 9996956.

33

⚠ CAUTION

Before running the engine with the starter motor, remove the voltage supply fuse for the engine ECU (fuse 43) to prevent the engine from starting accidentally.

Connect a contact switch to the starter motor or ask another person to help you run the engine with the contact switch.

34

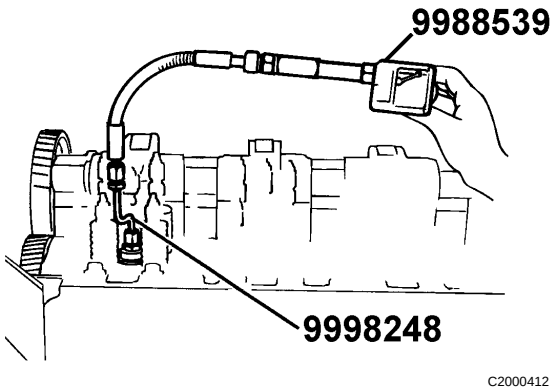


Fig. 3: Connecting the compression tester to adapter

Using adapter 9998248, connect compression tester 9988539 to cylinder number 1 and perform the test. Note that compression gauge adapter J-44621 must be installed on 9998248 before connecting it to the compression tester. 9988539 9998248
Run the engine with the starter motor until the compression gauge needle stops (compression maximum value). Write down the maximum value for the cylinder compression.

Note: Do not run the starter motor for more than 15 seconds in time intervals of 60 seconds.

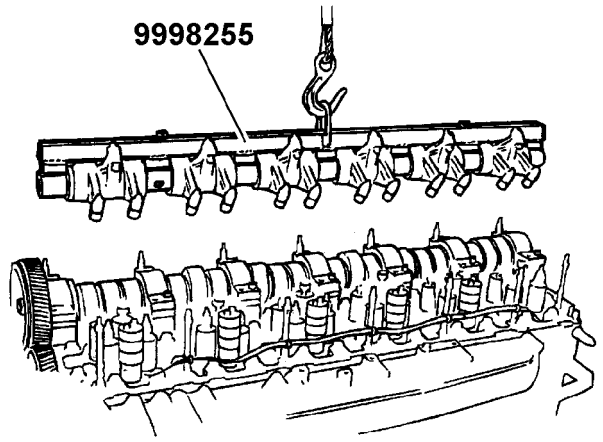
35
Repeat the test for all cylinders.

Note: No cylinder should be more than 20% below the maximum cylinder. Make necessary repairs, if required, before reassembly. Refer to Service Information, Group 21.

Reassembly

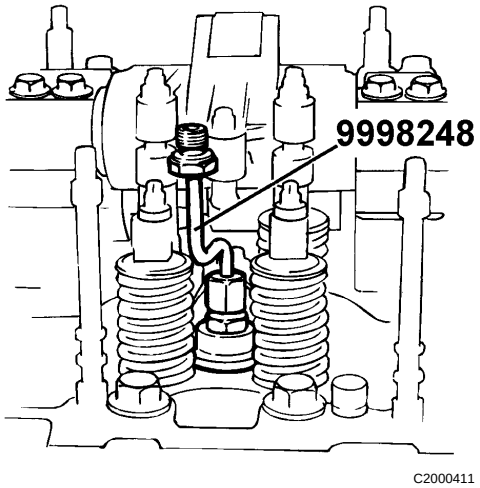
36
Remove the bolts and remove the VEB control valve.

37



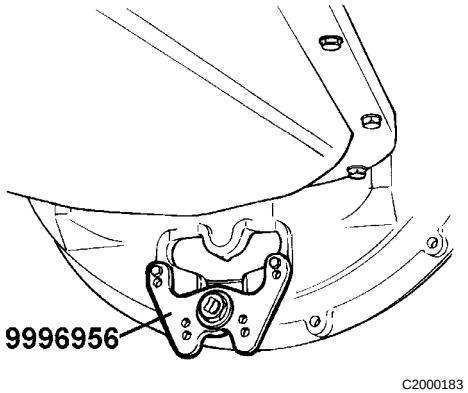
Remove the complete rocker arm shaft using lifting tool 9998255. 9998255

38



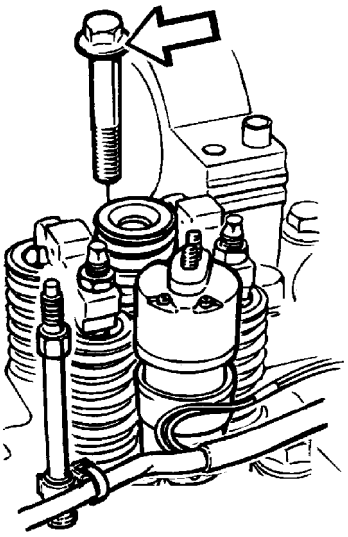
Remove adapters 9998248 from all cylinders.

39



Reinstall flywheel turning tool 9996956.

40



T2008956

Install new O-rings in the unit injectors. (For D12C, choose the two thickest violet rings in the O-ring set.) Lubricate the O-rings with clean engine oil. Install the unit injector and align it between the valve springs. Torque-tighten the lock nut to 52 ± 4 Nm (38 ± 3 ft-lb).

52 ± 4 Nm (38 ± 3 ft-lb)

41

Use the same procedure to install the other unit injectors.

42

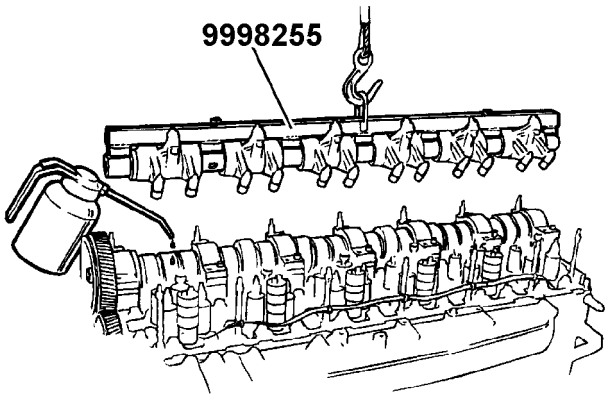
Connect the wire to the unit injector terminal. Torque-tighten the nut to 1.4 Nm (1.0 ft-lb).

1.4 Nm (1.0 ft-lb)

⚠ CAUTION

Do not over-tighten. Over-tightened nuts may permanently damage the unit injector.

43

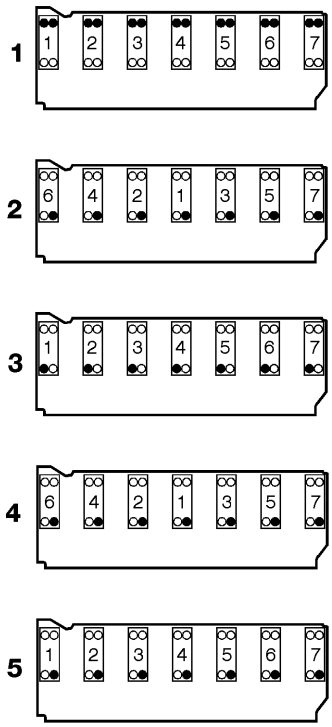


C2001726

Lubricate the valve bridges and camshaft lobes with engine oil. Using lifting tool 9998255, install the rocker arm assembly.

9998255

44



W2003520

Fig. 4: Bearing caps and camshaft/rocker shaft, tightening sequence

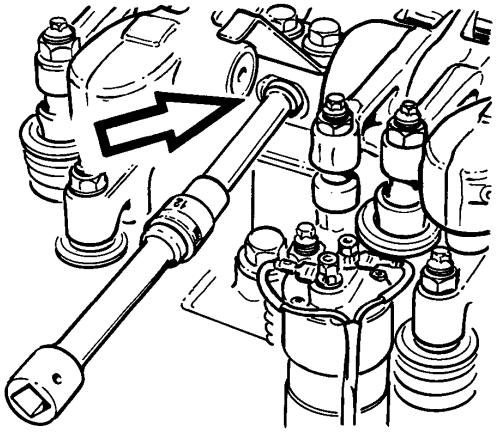
Gradually tighten the bolts so that the rocker arm shaft does not bend or warp (also check that the guide pins fit correctly in the camshaft supports). Tighten the shaft until it lies against the camshaft lobes, then torque-tighten using the following 5-step torque sequence (see also Fig. 4: Bearing caps and camshaft/rocker shaft, tightening sequence, page 13):

D12C:	1	15 ± 5 Nm (11 ± 4 ft-lb); +90 ± 5°
	2	60 ± 5 Nm (44 ± 4 ft-lb)
	3	15 ± 5 Nm (11 ± 4 ft-lb); +120 ± 5°
	4	60 ± 5 Nm (44 ± 4 ft-lb); loosen to 0 Nm (0 ft-lb)
	5	15 ± 5 Nm (11 ± 4 ft-lb); +120 ± 5°
D12, D12A, D12B:	1	15 ± 5 Nm (11 ± 4 ft-lb); +90 ± 5°
	2	45 Nm (33 ft-lb)
	3	15 ± 5 Nm (11 ± 4 ft-lb); +90 ± 5°
	4	45 Nm (33 ft-lb); loosen to 0 Nm (0 ft-lb)
	5	15 ± 5 Nm (11 ± 4 ft-lb); +90 ± 5°

45

Remove the rubber bands holding the VEB rocker pistons.

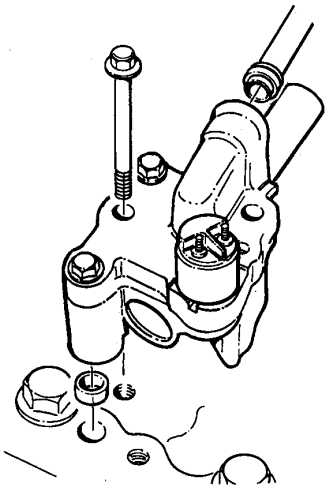
46



T2009070

Thoroughly clean the VEB control valve pipe. Lubricate the rocker arm shaft hole. Using a 1/2–inch extension and a socket, connect the pipe to the socket and install a new sealing ring on the other end of the pipe. Connect the pipe to the rocker shaft and check that the seal ring is properly positioned.

47



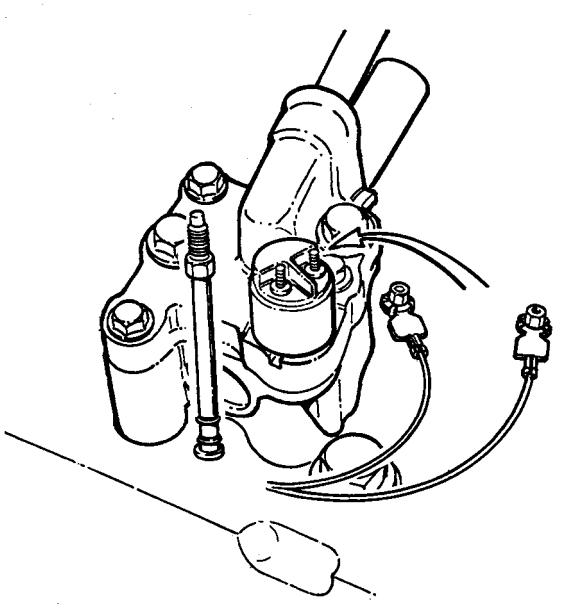
T2008958

Install a sealing ring to the pipe and install the VEB control valve.

Note: Check that the cylinder head oil channel cover has been removed.

Note: Use a new seal ring between the VEB control valve and the engine cylinder head. Check that the ring is properly positioned before tightening the bolts for the VEB control valve.

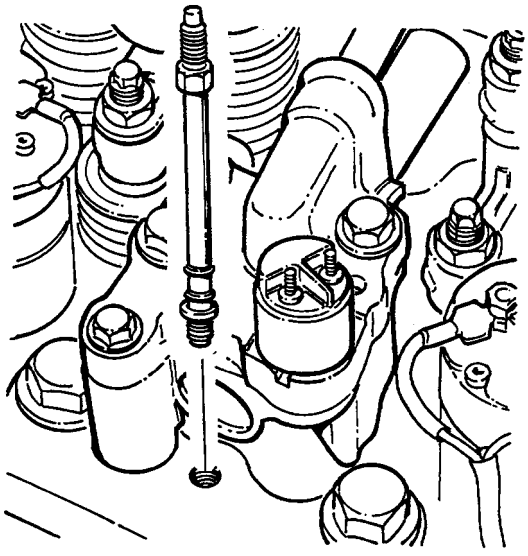
48



T2008960

Connect the electrical installation for the VEB solenoid valve to the control valve and carefully tighten the terminals so that the valve is not damaged.

49



T2008959

Install the stud in front of the VEB control valve.

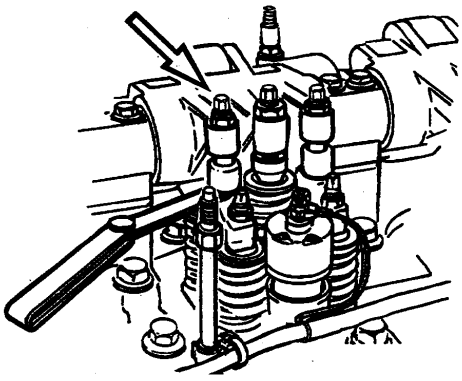
Note: Use loctite to lock the thread.

50
Turn the engine until the next marking on the camshaft for the valve adjustment.

51
To set the play to zero in the valve bridge, loosen the bolt until valve bridge stops contacting the valve stems. Then, hand-tighten the bolt until it contacts the support. Turn the bolt an additional 60° and torque-tighten the bolt nut to 38 ± 4 Nm (28 ± 3 ft-lb).

38 ± 4 Nm
(28 ± 3 ft-lb)

52



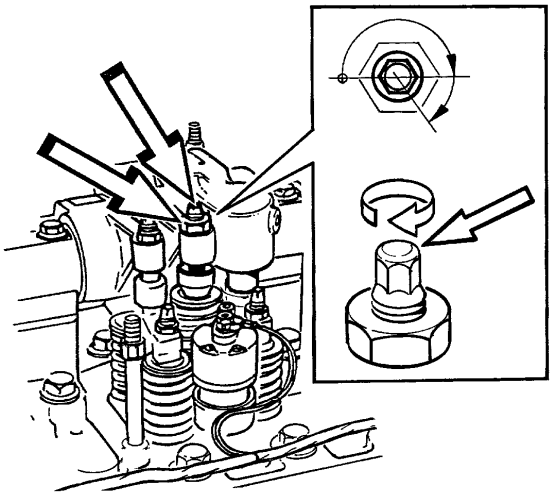
T2008968

Adjust the correct intake valve play:

- Intake valves: 0.15 – 0.25 mm (0.006 – 0.010 in.)

Note: Mark each valve with a felt marker pen as you adjust them so as to know which valves are already adjusted.

53



T2008845

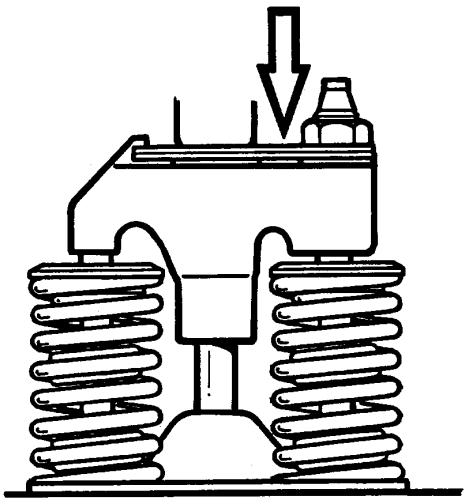
Adjust the rocker arm for the unit injector until the play in the camshaft is zero. Turn the adjusting bolt 3 or 4 flats and then torque-tighten to 52 ± 4 Nm (38 ± 3 ft-lb).

52 ± 4 Nm
(38 ± 3 ft-lb)

54
Use the same procedure to adjust the other unit injectors.

55
Turn the engine until the next marking on the camshaft for the exhaust valve adjustment.

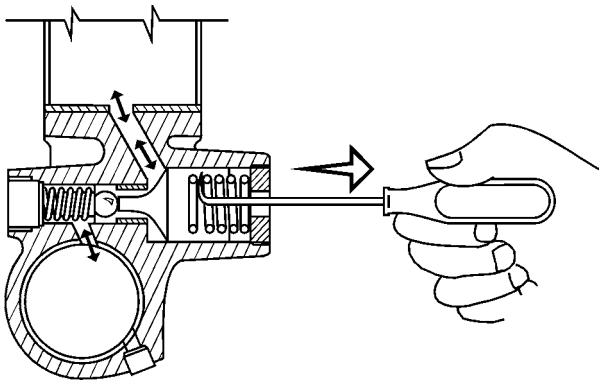
56



T2009073

To adjust the valve bridge, use the same procedure described for the intake valve, but do not tighten the nut.

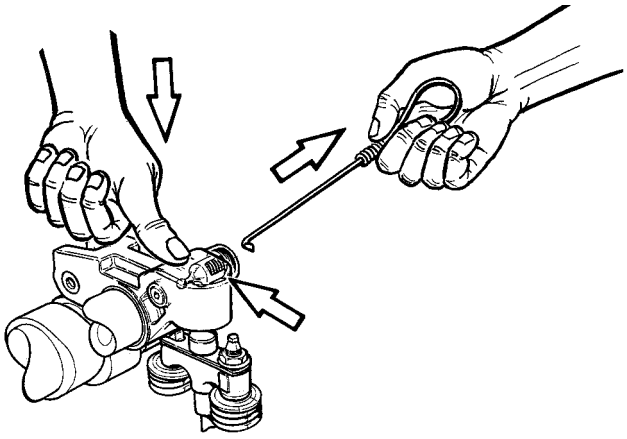
57



W2002165

Using a cotter pin removal tool or similar instrument, compress the coil spring of the rocker piston.

58

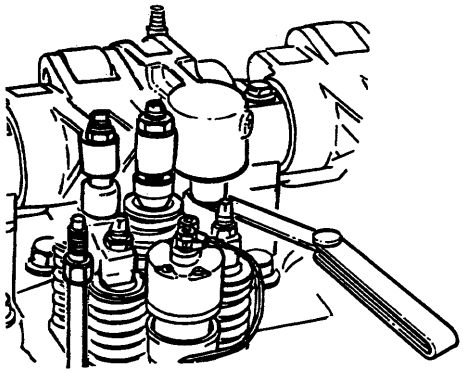


T2009009

While compressing the coil spring, press down firmly on the exhaust rocker arm. This will force out any oil and properly seat the power piston to its innermost position in the rocker arm.

Note: Be sure there is no oil on the rocker arm preventing the piston from reaching the end of its stroke. This can act as a hydraulic wedge and prevent correct adjustment.

59



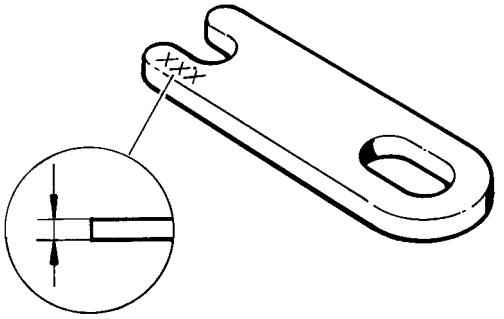
T2008966

Insert a feeler gauge, with the specified measure, between the valve bridge and the rocker piston end. Turn the piston to prevent it from tilting.

Acceptable valve clearance (play)	
Exhaust	0.50 ± 0.05 mm (0.0196 ± 0.0019 in.)
Exhaust with VEB	1.60± 0.05 mm (0.063 ± 0.002 in.)

Note: If there is play: try with different feeler gauges until the play disappears. That makes it possible to find out which shim measure will be used in step **60**. If unable to insert the feeler gauge, try a thinner gauge until one fits or until there is no longer any play.

60



T2009008

Calculate the thickness for the new shims using “A-B” (below). **A maximum of two shims may be used.** (If two shims are needed, select the shims so they are both about the same thickness.)

A - B = shims required
A = Measured play
B = Specified play tolerance

Note: Shims are available in thickness intervals of 0.05 mm (0.002 in). Sizes range from 2.0 – 2.4 mm (0.08 – 0.094 in.), and from 3.2 – 3.95 mm (0.126 – 0.156 in.). The thickness is stamped on the shims.

61

Carefully clean the shims and valve bridge. Install the shims and tighten the adjustment screw lock nut to 38 ± 4 Nm (28 ± 3 ft-lb).

38 ± 4 Nm (28 ± 3 ft-lb)

Note: Make sure that the adjustment screw does not move out of position when tightening the nut.

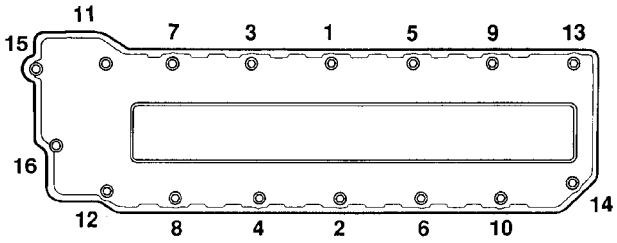
62

Use the same procedure to check the play of the other valves and unit injectors.

63

Install the engine ECU fuse.

64



T2012845

Install the valve cover and torque-tighten the bolts to 20 ± 2 Nm (15 ± 1 ft-lb) following the sequence shown.

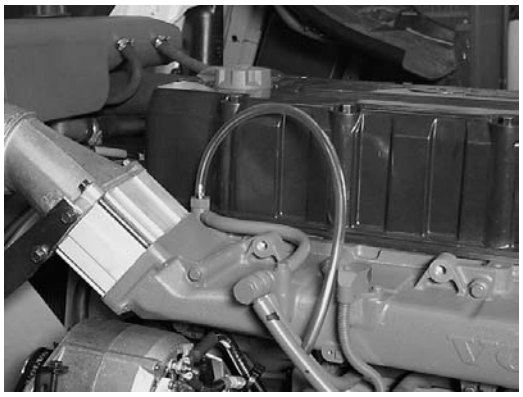
Note: Check that the nut flanges and rubber rings properly fit the valve cover holes to avoid damage to the valve cover.

65

T2012934

Connect a hose to the air bleed nipple in the fuel filter bracket. Open the drain plug and pump fuel with the manual pump until the fuel comes out with no air bubbles through the hose. Tighten the drain plug in the fuel filter bracket, remove the hose, and place the protection cap on the drain plug.

66



T2012797

Connect the hose to the air drain nipple on the cylinder head front and drain the air by pumping fuel with the manual pump until the fuel comes out with no air bubbles through the hose. Tighten the air drain nipple, remove the hose, and place the protection cap on the nipple.

67
Start the engine and keep it running at idling speed for approximately 10 minutes to purge any air remaining in the fuel system. Check the seals in all fuel pipe connections.

68
Check that the engine reaches the normal operating temperature and let it run for another 5 minutes at idling speed. When the idle speed stabilizes, the cylinder balancing is finished and the correct amount of fuel the unit injector should inject in each cylinder is defined.

Note: Disconnect all power-consumption components, such as power take-off, air conditioning, etc., to allow the cylinder balancing to occur.