Section 2

Engine

Service Procedures

Index

Specifications

General

		Federal	California
Output bhp at rpm	SAE J 245	98/6000	94/6000
Output kW at r/s	SAE J 245	73/100	70/100
Max torque lb.ft at rpm	SAE J 245	110/3500	105/3500
Max torque Nm at r/s	SAE J 245	149/58	142/58

	Metric	US
Compression pressure, hot engine, cranking with starter motor 250–300 rpm	9–11 kp/cm^2	128–156 psi
Compression ratio	8.7	
Number of cylinders	4	
Bore	88.9 mm	3.500"
Stroke	80 mm	3.150"
Displacement	1.99 liters	
Weight, including electrical equipment and carburetor, approx.	155 kg	341 lbs

Cylinder block

Material	Special alloy cast iron	
Bore, standard (D-marked)	88.91–88.92	3.5004–3.5008
oversize .015"	89.295	3.5155
.030"	89.675	3.5305

Pistons

Material	Light alloy	
Weight, standard	507±5 grams	17.90±0.18 oz
Permissible weight deviation between pistons in same engine	10 grams	0.35 oz
Height, total	71	2.79
Height from piston pin center piston crown	46	1.81
Piston clearance	0.01–0.03	0.0004–0.0012

Piston rings

Piston ring gap, measured in ring opening	0.40–0.55	0.016–0.022

Compression rings

Upper ring chromed		
Number on each piston	2	
Height	1.98	0.078
Compression ring clearance in groove	0.040–0.072	0.0016–0.0028

Oil scraper rings

Number on each piston	1	
Height	4.74 mm	0.186"
Scraper ring clearance in groove	0.040–0.072 mm	0.0016–0.0028"

Piston pins

Floating fit. Circlips at both ends in piston

Fit:		
In connecting rod		Close running fit
In piston		Push fit
Diameter, standard	24.00 mm	0.945"
oversize	24.05 mm	0.947"

Cylinder head

	Metric	US
Height, measured from cylinder contact face to face for bolt heads	87.0 mm	3.42"
Cylinder head gasket, thickness, standard, unloaded	1.2 mm	0.047"
loaded	1.0 mm	0.039"
Distance from top side of head to overflow pipe upper end (pipe placed under thermostat)	35 mm	1.38"

Crankshaft

Crankshaft, end float	0.047–0.137 mm	0.0018–0.0054"
Main bearings, radial clearance	0.028–0.083 mm	0.0011–0.0033"
Big-end bearings, radial clearance	0.029–0.071 mm	0.0012–0.0028"

Main bearings

Main bearing journals

Diameter standard	63.451–63.464 mm	2.4981–2.4986"
Undersize 0.010"	63.197–63.210 mm	2.4881–2.4886"
0.020"	62.943–62.956 mm	2.4781–2.4786"
Width on crankshaft for pilot bearing shell		
Standard	38.960–39.000 mm	1.5338–1.5351"
Oversize 1 (undersize bearing shell .010")	39.061–39.101 mm	1.5438–1.5451"
2 (undersize bearing shell .020")	39.163–39.203 mm	1.5538–1.5551"

Big-end bearings

Big-end bearing journals

Width of bearing recess	29.95–30.05 mm	1.179–1.183"
Diameter, standard	53.987–54.000 mm	2.1255–2.1260"
Undersize 0.010"	53.733–53.746 mm	2.1155–2.1160"
0.020"	53.479–53.492 mm	2.1055–2.1060"

Connecting rods

End float on crankshaft	0.15–0.35 mm	0.006–0.014"
Max. permissible weight deviation between connecting rods in same engine	10 grams	0.35 oz

Flywheel

Permissible axial throw, max., at diameter 150 mm = 6"	0.05 mm	0.002"

Flywheel housing

Max. axial throw for rear face, at diameter 100 mm = 4"	0.05 mm	0.002"
Max. radial throw for rear guide	0.15 mm	0.006"

Camshaft

Max. lifting height:		
Camshaft marked K (manual transmission)	7.2 mm	0.028"
Camshaft marked D (automatic transmission)		
Number of bearings	3	
Radial clearance	0.020–0.075	0.0008–0.0030
End float	0.020–0.060	0.0008–0.0024
Valve clearance for control of camshaft setting (cold engine),		
Camshaft marked D	1.40 mm	0.055"
Camshaft marked K	1.00 mm	0.039"
Inlet valve should then open at:		
Camshaft marked D	5.5° BTDC	
Camshaft marked K	3.5° BTDC	

Timing gears

	Metric	US
Backlash	0.04–0.08 mm	0.0016–0.0032"
End float, camshaft	0.02–0.06 mm	0.0008–0.0024"

Valve system

Valves

Inlet

Disc diameter	44 mm	1.732"
Stem diameter	7.955–7.970 mm	0.3132–0.3138"
Valve seat angle	44.5°	
Seat angle in cylinder head	45°	
Seat width in cylinder head	2 mm	0.08
Clearance, both hot and cold engine	0.40–0.45 mm	0.016–0.018"

Exhaust

Disc diameter	35	0.378
Stem diameter	7.925–7.940	3.3120–.3126
Valve seat angle	44.5°	
Seat angle in cylinder head	45°	
Seat width in cylinder head	2	0.080
Clearance, both hot and cold engine	0.40–0.45 mm	0.16–0.18"

Valve guides

Length, inlet valve	52	2.047
exhaust valve	59	2.323
Inner diameter	8.000–8.022	0.320–0.321
Height above upper face of cylinder head	17.9 mm	0.705"
Clearance, valve stem-valve guide, inlet valve	0.030–.068	0.0012–0.0026
exhaust valve	0.060–.097	0.0024–0.0038

Valve springs

Length unloaded, approx	46 mm	1.81"
with a loading of 295±23 N = 65±5 lbs	40 mm	1.57"
with a loading of 825±43 N = 181 5±9.5 lbs	30 mm	1.18"

Lubricating system

Oil capacity, including oil filter	3.75 dm^3	3.9 US Qts
excluding oil filter	3.25 dm^3	3.4 US Qts
Oil pressure at 33 3 r/s 2000 rpm (with hot engine and new oil filter)	2.5–6.0 kp/cm^2	36–85 psi

Oil pump

Oil pump, type	Gear	
number of teeth on each gear wheel	9	
end float	0.20–0.10 mm	0.0080–0.0040
radial clearance	0.08–0.14 mm	0.0032–0.0055
backlash	0.15–0.35 mm	0.0060–0.0140

Relief valve spring (in oil pump)

Length, unloaded approx.	39.0 mm	1.54
loaded with 50±4 N = 11.0±0.88 lbs	26.25 mm	1.03
70±8 N = 15.4±1.7 lbs	21.0 mm	0.83

Fuel injection system

	Metric	US

Fuel filter

Type	Paper	
Change interval	80 000 km	50 000 miles

Fuel pump

Type	Electric, roller type
Capacity	100 dm^3/h at 5 kp/cm^2 26.5 gals/hour at 71 psi
Current draw	Max. 8.5 Amps

Auxiliary air valve

Completely open	at −30°C	−22°F
Completely closed	at + 70°C	+ 158°F
Line pressure	4.5–5.2 kp/cm^2	64–74 psi
Rest pressure	1.7–2.4 kp/cm^2	24–34 psi
Control pressure, hot engine	3.7±0.2 kp/cm^2	50–55 psi

Air filter

Type	Paper	
Change interval	40 000 km	25 000 miles

CO

Warm engine and idle	0.5–3.5 %
USA	1.5 %

Cooling system

Type	Sealed system	
Radiator cap valve opens at	0.7 kp/cm^2	10 psi
Capacity	Approx. 9.4 dm^3	10 US Qts
Fan belt, designation	HC- 38X888	

Thermostat, Type 1

Type	Wax	
Marking	170	
Starts to open at	75–78°C	168–172°F
Fully open at	89°C	192°F

Thermostat Type 2

Type	Wax	
Marking	82°	
Starts to open at	81–83°C	177–181°F
Fully open at	90°C	195°F

Wear tolerances

Cylinders:

To be rebored when wear amounts to (if engine has abnormal oil consumption)	0.25 mm	0.010"

Crankshaft

Permissible out-round on main bearing journals, max.	0.05 mm	0.0020"
Permissible out-of-round on big-end journals, max.	0.07 mm	0.0028"
Crankshaft end float, max.	0.15 mm	0.0060"

Valves

Permissible clearance between valve stems and valve guides max.	0.15 mm	0.0060"
Valve stems, permissible wear, max.	0.02 mm	0.0008"

Camshaft

Permissible out-of-round (with new bearings) max.	0.07 mm	0.0028"
Bearings, permissible wear, max.	0.02 mm	0.0008"

Timing gears

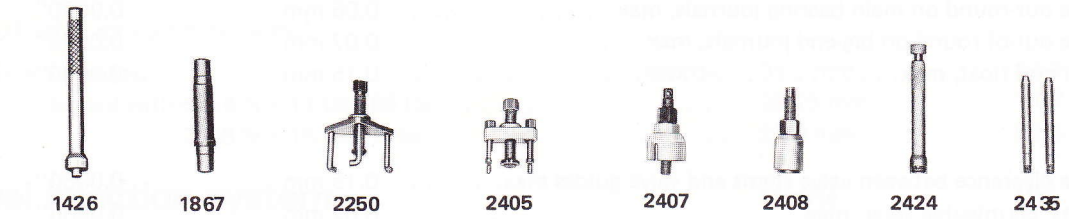
Permissible backlash, max.	0.12 mm	0.0048"

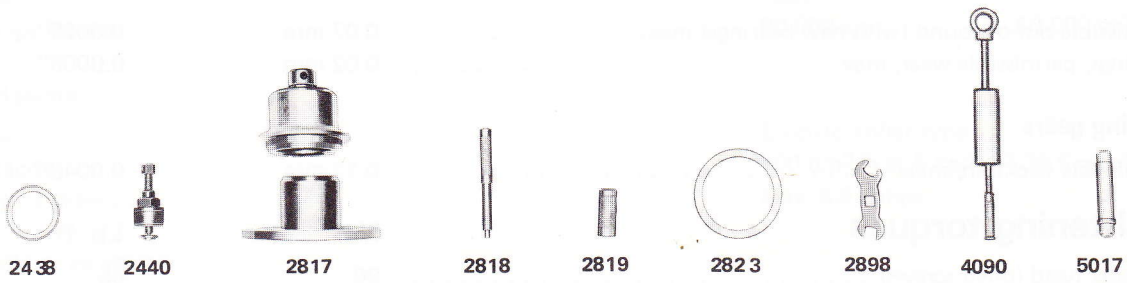
Tightening torques

	Nm	Lb. ft
Cylinder head (oiled screws)	90	65
Main bearings	120–130	87–94
Big-end bearings	70–78	51–57
Flywheel	65–70	47–51
Spark plugs	35–40	25–29
Camshaft nut	130–150	94–108
Bolt for crankshaft pulley:		
Alternator bolt (1/2")	70–85	50–60
Nipple for oil filter	45–55	32–40
Oil pan bolts	8–11	6–8

Tools

Special tools are preceded by 999 or SVO (e.g. 999 2837 or SVO 2837).

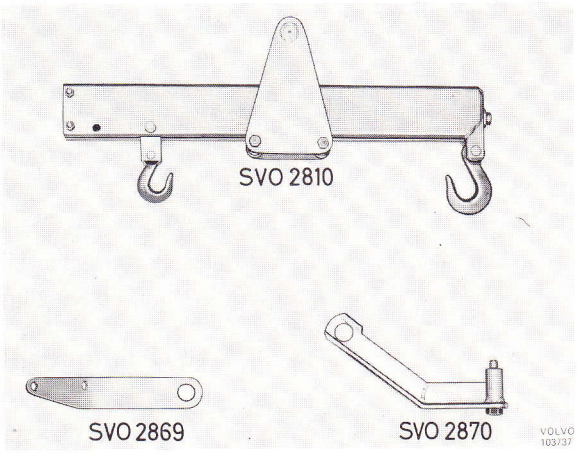




Engine tools

999 (SVO)
1426 Drift for installing pilot bearing
1867 Drift for removing and installing bushing in rocker arm
2250 Puller for camshaft gear
2405 Puller for crankshaft gear (SVO 2822 can be used as alternative)
2407 Press tool for installing crankshaft gear
2408 Press tool for installing camshaft gear
2424 Grip tool for removing and installing valve tappets
2435 Guide pins (2) for installing cylinder head
2438 Centering sleeve for timing gear cover and installing ring circlip

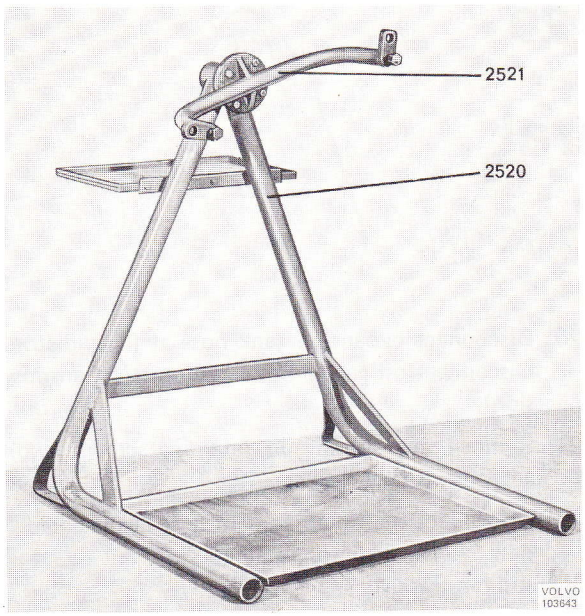
999 (SVO)
2440 Puller for crankshaft hub
2817 Drift for installing crankshaft oil seal on engine rear end (rubber lips seal)
2818 Drift for removing valve guide
2819 Drift for installing valve guide
2823 Ring for installing standard piston
2898 Wrench 11/16" for final-tightening of cylinder head bolts
4090 Drift for removing and installing connection rod bushing
5017 Drift for removing and installing connecting rod bushing



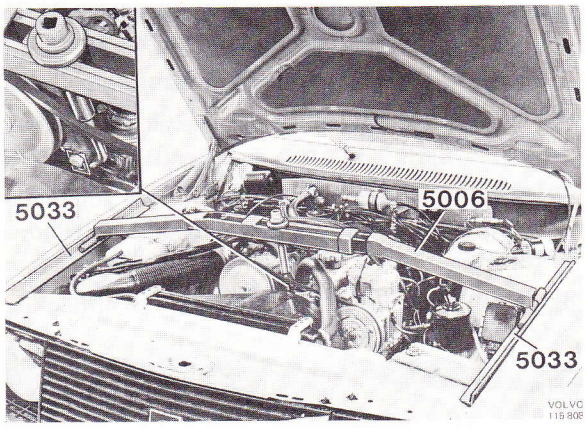
Tools for removing engine

999 (SVO)
2810 Beam for lifting out and installing engine
2869 Lifting lug for attaching lifting beam 2810 in front end of engine
2870 Lifting lug for attaching lifting beam 2810 in rear end of engine

(The previous lifting tool 2425 can also be used for lifting out and installing the engine)

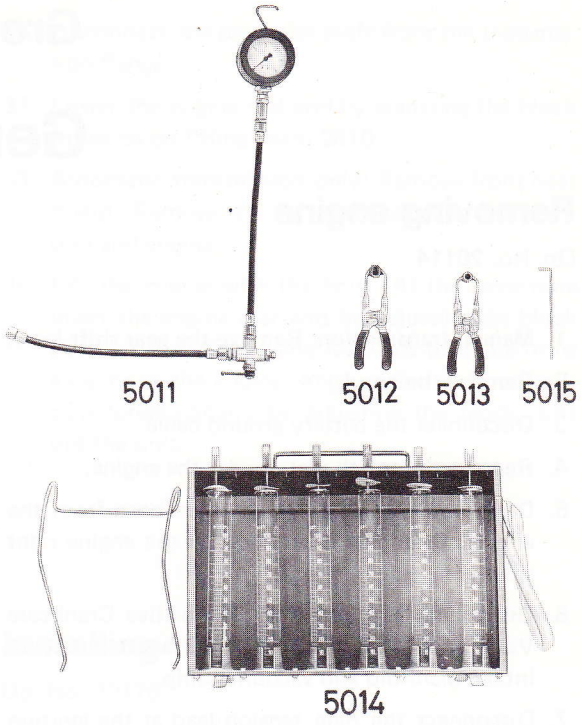


Stand 2520 and fixture 2521 for engine



Lifting tool, used when replacing front engine mount

999 5006 Lifting beam
999 5033 Support



Special tools for B 20 E/F

999 (SVO)
5011 Pressure gauge, for testing line pressure and control pressure
5012 Tool, for installation of nylon hoses 5 and 8 mm diam.
5013 Same, but for 10 mm diam. hose
5014 Gauge, for checking injected fuel quantity for each injector
5015 Wrench 3 mm, for CO adjustment

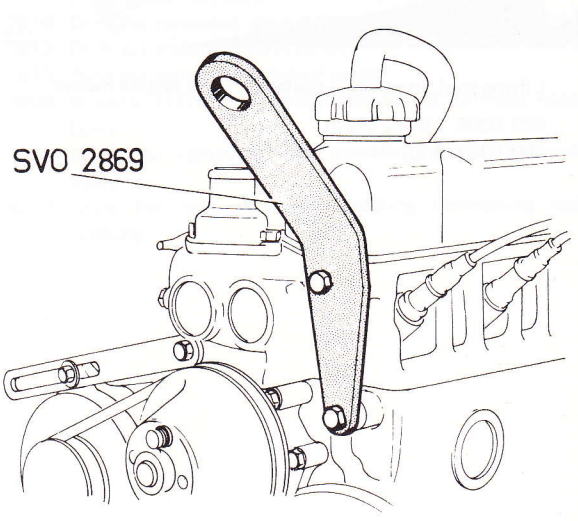
Group 20

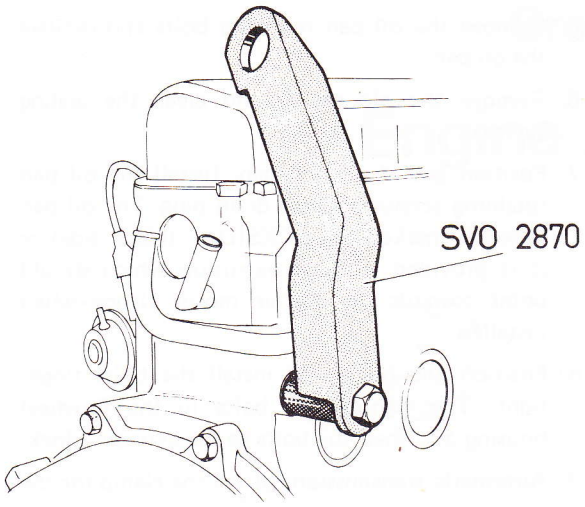
General

Removing engine

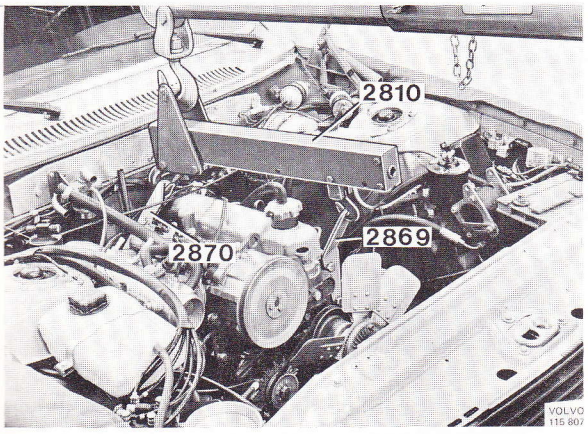
Op. No. 20114

1. **Manual transmission:** Remove the gear shift lever.
2. Remove the hood.
3. Disconnect the battery ground cable.
4. Remove the splash plate under the engine.
5. Drain coolant. Disconnect lower hose from the engine. Open the drain cock on the engine right side.
6. Disconnect the hose for the Positive Crankcase Ventilation. Disconnect brake assist hoses at intake manifold and vacuum pump.
7. Disconnect the high tension lead at the ignition coil. Unplug the distributor wires.
8. Disconnect cable and wire at the starter. Disconnect the ground cable at the engine block.
9. Disconnect the air bellow connecting CI unit and intake manifold.
10. Disconnect fuel hoses: front fuel filter to engine (two hoses), from distributor pipe to engine (two hoses), one hose at control pressure regulator, one hose at cold start injector and four hoses at injectors.
    Put the hoses aside. Be careful not to splash gasoline on the paintwork.
11. Disconnect the fuel filter from the firewall and put it aside.
12. Disconnect wires: at the control pressure regulator (including ground wire), at the cold start injector, at the auxiliary air valve, at the thermal time switch, at the oil pressure switch and at the temperature sender.
13. Disconnect the hoses at the diverter valve on the firewall.
14. Remove the Air Injection Reactor pipe.
15. Disconnect two vacuum hoses for the charcoal canister at the intake manifold.
16. Disconnect the throttle cable at the throttle housing and from the intake manifold bracket.
17. Disconnect the alternator wire connector.
18. Remove the EGR valve from the intake manifold.
19. Remove the thermal time switch complete with extension.
20. Disconnect expansion tank hose at the radiator. Disconnect oil cooler hoses (automatic transmission).
21. Remove the fan shroud retaining screws (two) and push it to the rear.
22. Disconnect the upper coolant hose at the engine. Remove the radiator retainers. Lift out radiator and fan shroud.
23. Disconnect the water hoses at the firewall.
24. Remove the washer container.
25. Slacken the power pump drive belt and remove the pump pulley. Disconnect the power pump from the engine bracket and put it aside.
26. Remove the idler roller for the air pump drive belt.
27. Disconnect the oil filler pipe for the automatic transmission from the flywheel housing. Remove the rear eye bolt from the manifold.
28. Install front lifting lug 2869 and rear lifting lug 2870, see Figs.





29. Jack up the vehicle and put it on stands.
30. Remove the exhaust pipe flange nuts at the manifold. Remove the EGR valve with pipe.
31. Remove the retaining nuts for front and rear engine mounts.
32. Install lifting beam 2810 and attach an engine hoist, see Fig. Adjust the block to the beam rear end.
    Lift the engine so much that the rear engine mount is off-loaded.



33. Disconnect the transmission ground cable. Disconnect clutch wire from clutch fork and housing (manual transmission) and the gear shift control from the transmission (automatic).
34. Remove front exhaust pipe clamp and transmission support member.
35. Disconnect speedometer cable and electrical wires from the transmission.
36. Disconnect the propeller shaft from the transmission flange.
37. Lower the engine rear end by adjusting the block forwards on lifting beam 2810.
38. **Automatic transmission only:** Remove front heat shield. Remove the oil pipes between transmission and engine.
39. Lift the engine with the hoist. At the same time lower the engine rear end by adjusting the block position. Pull the engine forwards over the front axle, hoist the engine. Align engine and transmission longitudinally by adjusting the block. Lift out the unit.

Installing engine

Op. No. 20176

1. Attaching lifting lugs and lifting beam to the engine. Install the engine in position.
2. **Automatic transmission:** Connect the oil pipes to the transmission. Install the heat shield.
3. Reconnect propeller shaft, speedometer wire and electrical connections to the transmission.
4. Install the transmission support member. Install the front exhaust pipe clamp.
5. **Manual transmission:** Install clutch wire and check that the play is 1/8" (=3–4 mm).

   Automatic transmission: Reconnect the gear shift control.
   Reconnect the transmission ground cable.
6. Install retaining nuts for front and rear engine mounts.
7. Install the exhaust pipe flange nuts. Install EGR valve with pipe.
8. Remove engine hoist and lifting beam.
9. Jack up the vehicle, remove the stands, and place the vehicle on the floor.
10. Remove lifting lugs 2869 and 2870.
11. Attach the oil filler pipe for the automatic transmission to the flywheel housing. Reinstall the rear lifting eyelet to the manifold.
12. Reinstall the power pump on the engine bracket. Reinstall pump pulley.
    Install and tighten power pump drive belt.
13. Install idler roller for the air pump drive belt. Install and tighten the air pump drive belt.
14. Attach the heater hoses to the firewall connections.

15. Position the fan shroud over the fan. Position the radiator and install the retainers. Install fan shroud, upper and lower coolant hoses, hose from expansion tank. Install oil cooler pipes (automatic transmission).
16. Install the washer container. Close the engine block drain cock.
17. Install thermal time switch and extension.
18. Reconnect the alternator wires. Reconnect vacuum hoses from charcoal canister to intake manifold.
19. Install throttle wire.
20. Install air injection pipe. Reconnect hoses to the diverter valve.
21. Reconnect electrical wires to: temperature sender, oil pressure switch, thermal time switch, auxiliary air valve, cold start injector and control pressure regulator.

    NOTE: Do not forget the control pressure regulator ground cable.
22. Install fuel filter.
23. Install the fuel pipes with copper washers on both sides of the banjo nipples: to the injectors (four), cold start injector (one), control pressure regulator (one), distributor pipe (2) and fuel filter (two).
24. Install the rubber bellow between the air cleaner and CI unit.
25. Reconnect starter cable and wire. Reconnect the battery ground cable.
26. Reconnect distributor wires and ignition coil high tension lead.
27. Reconnect brake booster hoses and hoses for Positive Crankcase Ventilation.
28. Install the hood.
29. **Manual transmission:** Install the gear shift lever.
30. Fill coolant and check engine oil.
31. Check function and leak test.

Replacing oil pan gasket

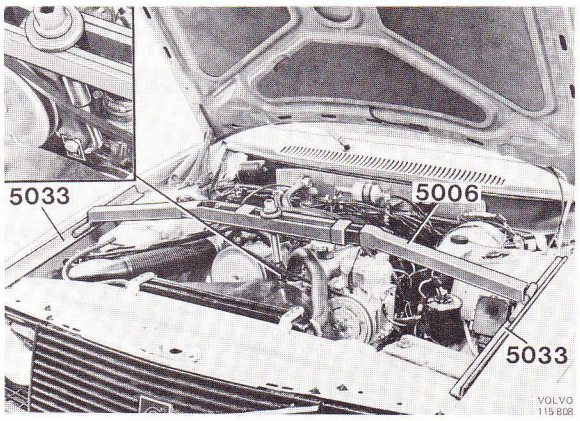
Op. No. 21702

1. Jack up the vehicle and put it on stands.
2. Remove the splash guard under the engine and drain the oil.
3. **Automatic transmission:** Remove the clamp for the oil pipes at the brace.
4. Remove the brace.
5. Remove the oil pan retaining bolts and remove the oil pan.
6. Remove the old gasket and clean the sealing surfaces.
7. Position gasket and oil pan. Install the oil pan retaining screws and the drain plug. The oil pan gasket is marked "BLOCKSIDA" (block side) or it is provided with an extrusion which should point towards the starter motor flange when installed.
8. Position the brace and install the bolts finger tight. The tighten the bolts to the flywheel housing and then the bolts to the cylinder block.
9. **Automatic transmission:** Install the clamp for the oil pipes.
10. Install the splash guard and lower the vehicle.
11. Fill oil.

Replacing front engine mount

Op. No. 20122 = right side
Op. No. 20124 = left side
Op. No. 20126 = both

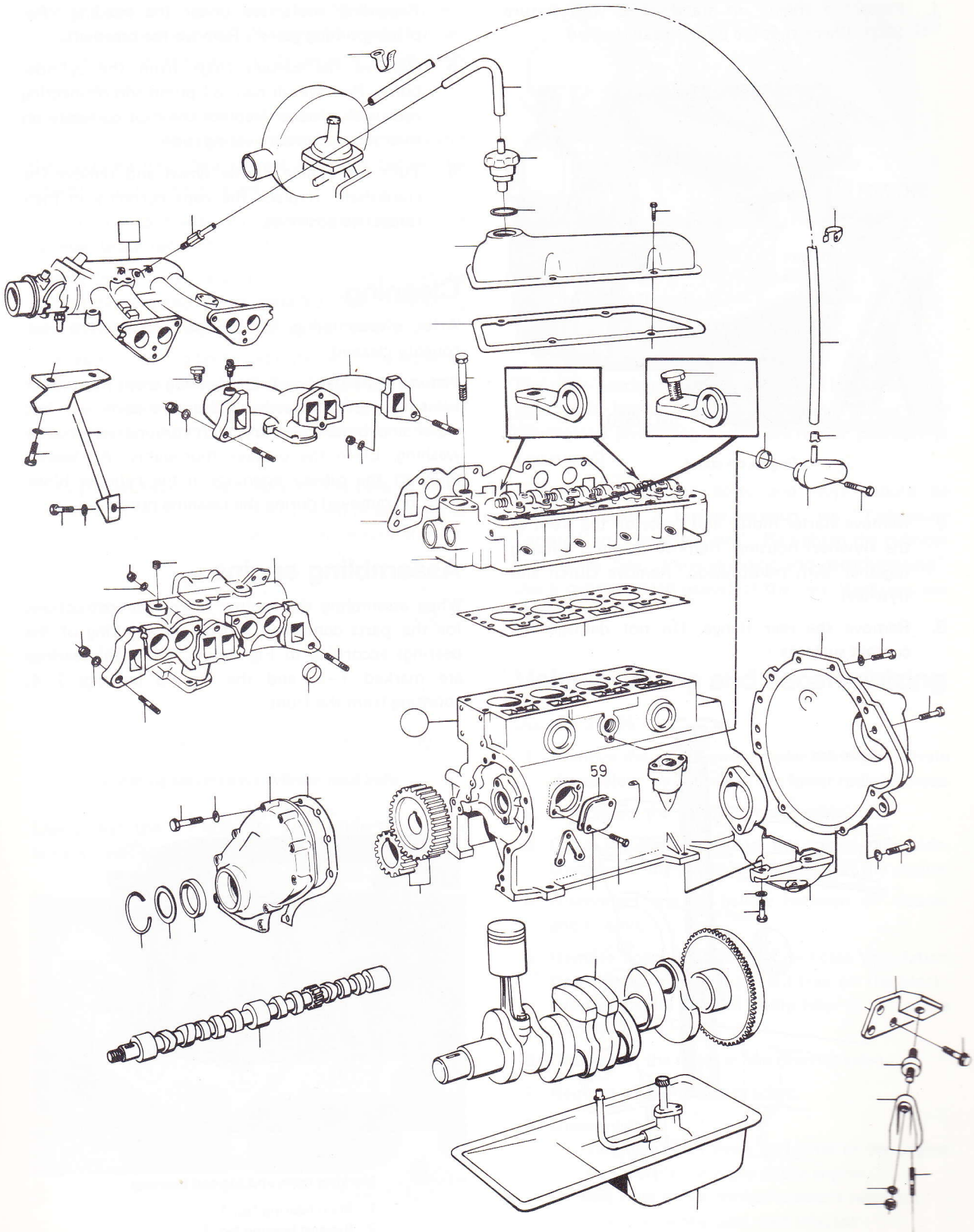
1. Disconnect the battery ground cable.



2. Install lift bar 5006 and supports 5033 as shown. Position a washer on the retaining bolt for the air pump bracket which will prevent the hook from sliding forwards.
3. Jack up and off-load the engine mounts.
4. Jack up the vehicle and put it on stands.
5. Remove the splash guard under the engine.
6. Remove the lower retaining nuts and disconnect the engine mounts from the engine.
7. Replace parts as necessary.
8. Installation is in opposite order.

Group 21

Engine Assembly



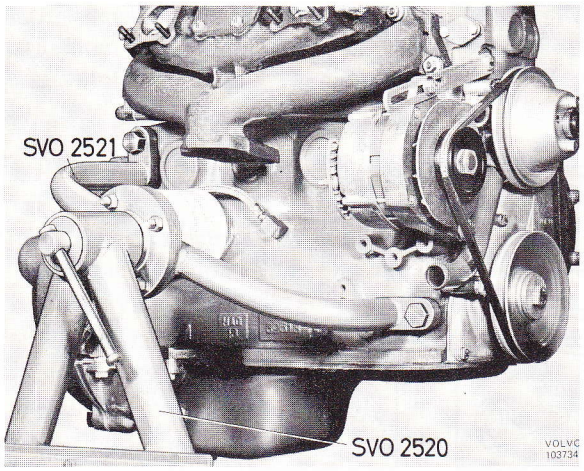
Spare Parts Illustration

+ VOLVO PARTS
1 021 13659

Disassembling engine

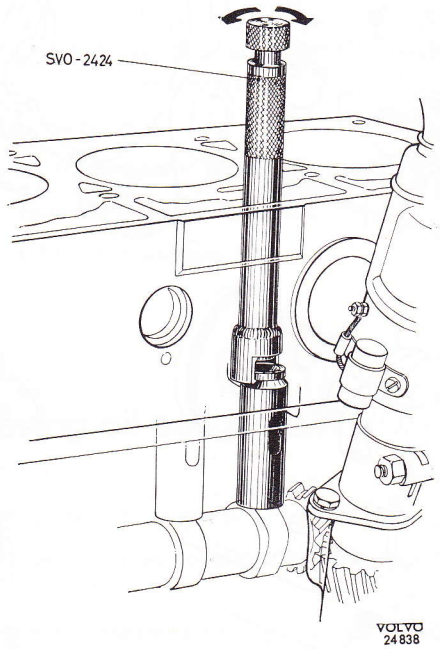
After the engine has been lifted out of the vehicle, disassembling is as follows. (Instructions for the individual parts are under the separate headings concerned.)

1. Place the engine on stand 2520 with fixture 2521. Check that the oil has been drained.



Engine on stand

2. Remove starter motor and brace on the front of the flywheel housing. Remove flywheel housing together with transmission. Remove clutch and flywheel.
3. Remove the rear flange. Do not damage the contact surfaces.



Removing valve tappets

Remove alternator, water pump and distributor, valve cover, rocker arms, manifold, cylinder head and oil filter.

Remove valve tappets with tool 2424, see Fig.

4. Remove timing gear cover and timing gears. Regarding tools, see under the heading "Replacing timing gears". Remove the camshaft.
5. Remove the carbon ridge from the cylinder bores. Remove oil pan, oil pump and connecting rods with pistons. Replace the caps correctly on their respective connecting rods.
6. Turn the engine upside down and remove the crankshaft. Replace the caps correctly in their respective positions.

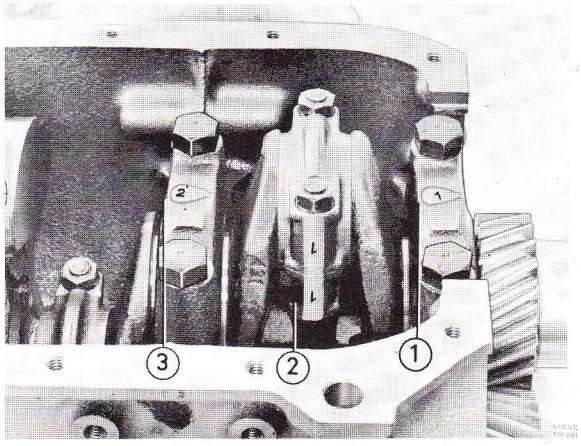
Cleaning

After disassembling, all the parts should be thoroughly cleaned.

Pistons, light alloy parts and bearing shells must never be washed in caustic soda. Clean the parts with hot water and blow them dry with compressed air after washing. Clean the oilways thoroughly. All sealing plugs at the oilway openings in the cylinder block must be removed during the cleaning process.

Assembling engine

When assembling the engine, follow the instructions for the parts concerned. Check the marking of the bearings according to Fig. below. The main bearings are marked 1–5, and the big-end bearings 1–4, counting from the front.



Marking main and big-end bearings

1. Main bearing No. 1
2. Big-end bearing No. 1
3. Main bearing No. 2

Check that all parts are clean and lubricate sliding surfaces with oil before assembling. Always use new gaskets, cotter pins and lock washers.

Do not apply any sealing compound on the gaskets.

The seals on the ends of both the oil pump delivery pipe and the water pump pipes are "O-rings". These rings, which seal radially, are made of special rubber with very close tolerances. Only genuine Volvo parts should be used.

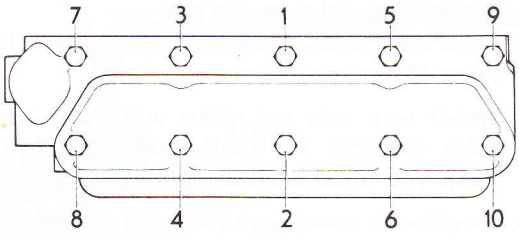
Installation is facilitated by coating the rings with soap solution. The rings are installed on the pipes and then pressed into their correct positions before the attaching bolts are tightened.

The oil pump flange should lie flush against the cylinder block before tightening.

Timing gear cover and rear seal flange must be accurately centered when installed. See "Replacing timing gear cover" and "Installing rear seal flange".

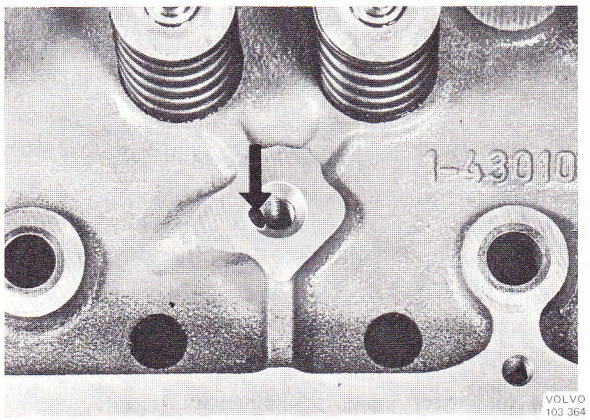
The big-end bearing bolts and nuts should be replaced with new ones whenever disconnected. The reinforcing bracket on the flywheel housing is installed according to point 8 under "Replacing oil pan gasket".

The cylinder head is installed with the help of guide pins 2435. The bolts must be tightened in sequence as shown below in order to avoid unnecessary stresses.

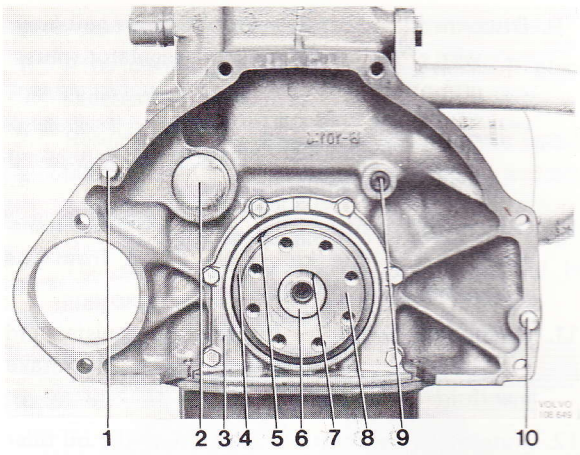


Tightening sequence for cylinder head bolts

Check that the oil hole for lubricating the rocker arms is clear, see below.



Oil hole in cylinder head



Rear end of engine

1. Guide pin
2. Core plug
3. Sealing flange
4. Sealing washer
5. Circlip
6. Pilot bearing
7. Circlip
8. Crankshaft
9. Lug
10. Guide pin

The pilot bearing should be lubricated before installation with heat-resistant ball bearing grease. The bearing and protecting washer are held in position by a circlip (6).

The most important bolts and nuts should be tightened with a torque wrench, see "Tightening Torques" in "Specifications". Re-tighten the cylinder head bolts. See "Valve grinding and decarbonizing". Use a cylinder head gasket of the right thickness, see "Specifications".

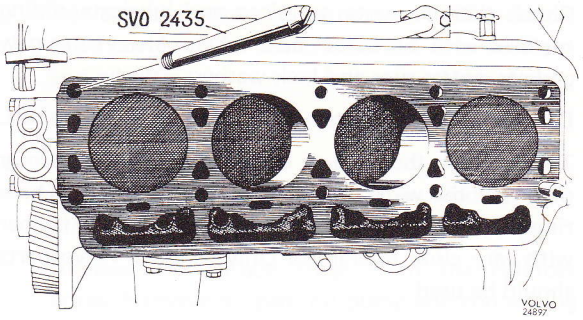
Valve grinding and decarbonizing

Op. No. 21404

1. Remove the splash guard under the engine. Drain the coolant by removing the lower radiator hose.
2. Disconnect the battery ground cable.
3. Open the drain cock on the engine right side. Disconnect the upper radiator hose at the engine.
4. Disconnect the air bellow between air cleaner and CI unit.
5. Remove hoses for Positive Crankcase Ventilation from intake manifold and oil trap on the block. Disconnect the vacuum pump hose at the intake manifold.
6. Disconnect the hoses at the diverter valve.
7. Remove air pump and bracket.
8. Disconnect:
   two fuel hoses from fuel filter at the engine
   two distributor pipes at the engine
   one hose at the control pressure regulator
   one hose at the cold start injector
   four hoses at the injectors

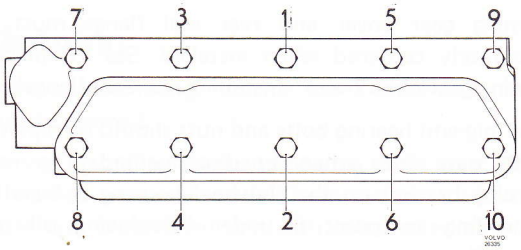
9. Disconnect:
   wire at the control pressure regulator (plus ground wire)
   wire at the cold start injector
   wire at the auxiliary air valve
   wire at the temperature sender
10. Disconnect throttle cable (for automatic transmissions also the kick-down cable) from the intake manifold.
11. Disconnect two hoses for charcoal canister and one hose for the EGR valve from the intake manifold.
12. Automatic transmission: Disconnect the oil filler pipe from the flywheel housing.
13. Remove the water pipe rear clamp from the manifold.
14. Remove retaining screws for the intake manifold brace.
15. Remove the nuts at the flange between exhaust manifold and exhaust pipe.
16. Disconnect the high tension leads at the spark plugs.
17. Disconnect the upper water hose at the firewall.
18. Remove valve cover, rocker arm shaft and push rods.
19. Remove the cylinder head bolts. Remove the cylinder head. Remove cylinder head gasket, flange gasket and rubber rings for the water pump.
20. Remove intake manifold and exhaust manifold.
21. Clean piston head and combustion chambers, intake ports and exhaust ports very thoroughly. Do not use emery cloth since small grinding particles may enter the space between piston and cylinder walls and cause damage.
    Re-condition the valve system according to instructions under "Cylinder head valves". Check that the oilway to the rocker arm mechanism on the valve tappet side in the middle of the head is clean. In the cylinder head oil goes up through the bolt hole, between the bolt and hollow partition, through a diagonal oilway to the attaching bolt for the rocker arm shaft and then up to the shaft.
22. Position a new gasket on the cylinder head and install exhaust manifold and intake manifold.
23. Install the guide pins 2435 in the block. One in the front right hole and the other in the left rear hole.

    Install a new cylinder head gasket with the TOP marking upwards (wide edge). Install new seals for the water pump. Install the cylinder head.



Guide pins for cylinder head installation

Remove the guide pins and install the bolts instead. Tightening sequence, see below.

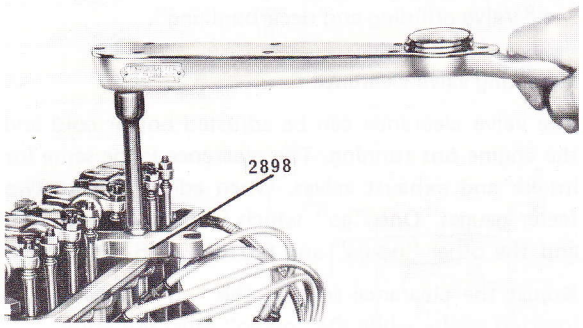


Tightening sequence for cylinder head bolts

Tighten in three stages:
First stage: 30 lb. ft. (40 Nm)
Second stage: 60 lb. ft. (80 Nm)
Third stage: after the engine has been driven hot, see p. 43.

24. Install push rods and rocker arm shaft. Adjust valve clearance to 0.018–0.020" (0.45–0.50 mm). This is not the final valve clearance setting.
25. Install valve cover, spark plugs and ignition leads.
26. Reconnect the water hose to the connection at the firewall.
27. Use a new gasket and reconnect the exhaust pipe to the exhaust manifold flange.
28. Install the retaining nuts for the intake manifold brace.
29. Attach the water pipe rear clamp to the manifold.
30. Automatic transmission: Reconnect the oil filler pipe.
31. Install the EGR valve hose. Reconnect the two hoses from the charcoal canister to the intake manifold.
32. Reconnect the throttle cable (automatic transmission: kick-down cable).
33. Reconnect wires at: temperature sender, auxiliary air valve, cold start injector and control pressure regulator (plus ground wire).

34. Reconnect fuel hoses:
    at the injectors (four)
    cold start injector (one)
    control pressure regulator (one)
    distributor pipe (two)
    fuel filter (two)
35. Install air pump and bracket.
36. Reconnect the hoses at the diverter valve.
37. Reconnect the positive crankcase ventilation hoses and the vacuum pump hose at the intake manifold.
38. Close the drain cock at the engine right side. Install upper and lower radiator hoses.
39. Install the air bellow connecting intake manifold and CI unit.
40. Install the splash plate under the engine.
41. Reconnect the battery ground cable.
42. Fill coolant.
43. Run the engine hot for ten minutes. Switch off and let it cool.
    Re-tighten cylinder head bolts to 65 lb.ft. (90 Nm), using tool 2898.
    Adjust valve clearance to 0.016–0.018" (0.40–0.45 mm), final adjustment



VOLVO 105110

Re-tightening cylinder head bolts

Cylinder head and valves

Disassembly

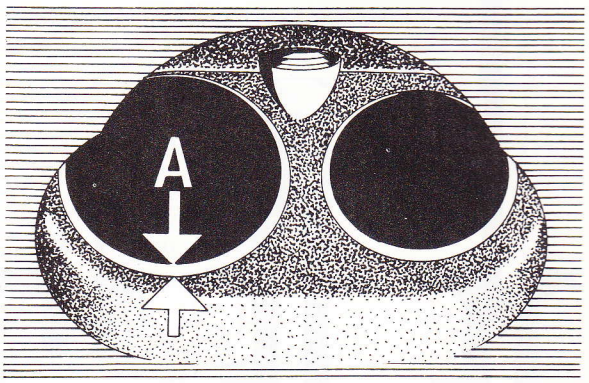
1. Remove the valve springs. Use a spring compressor and remove the valve retainer locks.
   Place the valves in order in a valve rack.
   Remove the valve guide seals.
2. Measure clearance between stem and guide. For a new valve the clearance should not exceed 0.006" (0.15 mm). Also check that the valves are not excessively worn. See specifications in front of section.

Cleaning

Use steel wire brushe to remove carbon and deposits from valves, combustion chambers and ports.

Grinding valves and valve seats

1. After cleaning, machine grind the valves. Replace excessively worn valves.
2. Reseat the valves. Before cutting the valve seats a pilot spindle must be carefully installed and any worn guides replaced. Cut the seat until a good sealing surface is obtained. The seat angle is 45°. The width of the sealing surface should be approx. 0.08" (2.0 mm), as shown in the Fig.



VOLVO 103 254

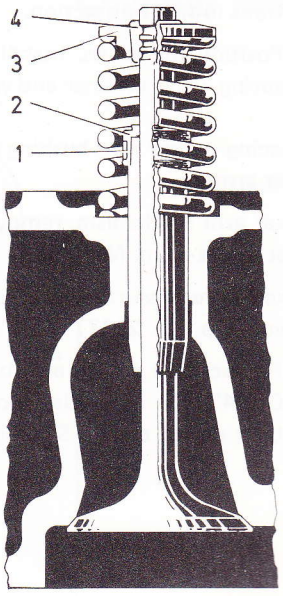
Valve seat width A = 0.08" (2 mm)

If the sealing surface is too wide after grinding, it can be reduced by using a 20° cutter from the outside and a 70° cutter from the inside.

3. Apply valve grinding compound on the valve sealing surfaces and lap the valves against the seats.
   Then clean valves and seats and check that good sealing is obtained.

Replacing valve guides

Op. No. 21415



1. Metal ring
2. Rubber seal
3. Washer
4. Valve collet

VOLVO 103 259

1. Use tool 2818 to press out the guides.

2. Use drift 2819 to press in the new guides.

   NOTE: to obtain correct depth: a 0.016" (0.4 mm) washer should be positioned between the cylinder head and the tool.

Replacing valve guides A = 0.705" (17.9 mm)

3. Check that the guides are free from filings and that the valves move easily in them.

Assembling

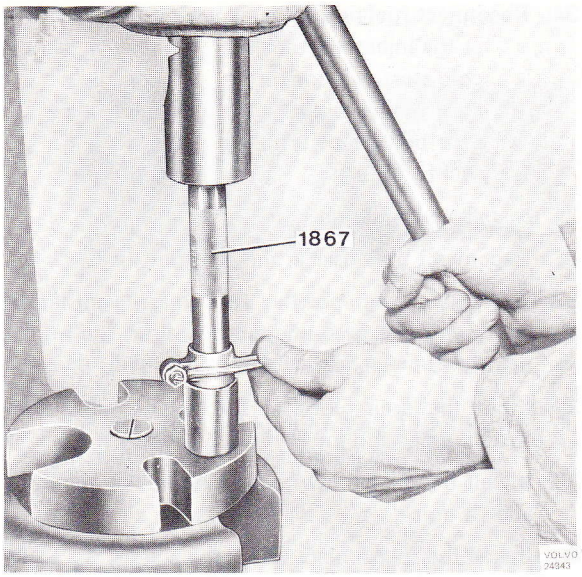
1. Check that the parts are in good condition and clean. Test the springs according to the specifications in front of section.
2. Position the valves. Install valve guide seal, valve spring, valve retainer and valve retainer locks.

Replacing rocker arm bushing and resurfacing rocker arms

Rocker arm mechanism, remove and install, including adjust valves = Op. No. 21439

Rocker arms, resurface, rocker arm mechanism removed = Op. No. 21477

1. Replace the rocker arm bushing if wear exceeds 0.004" (0.1 mm). Use tool 1867 for pressing the bushing out and in. See Fig.



Replacing rocker arm bushing

   Then ream the bushing to an accurate fit. The hole in the bushing should coincide with the hole in the rocker arm.

2. If necessary, resurface the rocker arm in a special machine.

Installing cylinder head

See "Valve grinding and decarbonizing".

Adjusting valve clearance

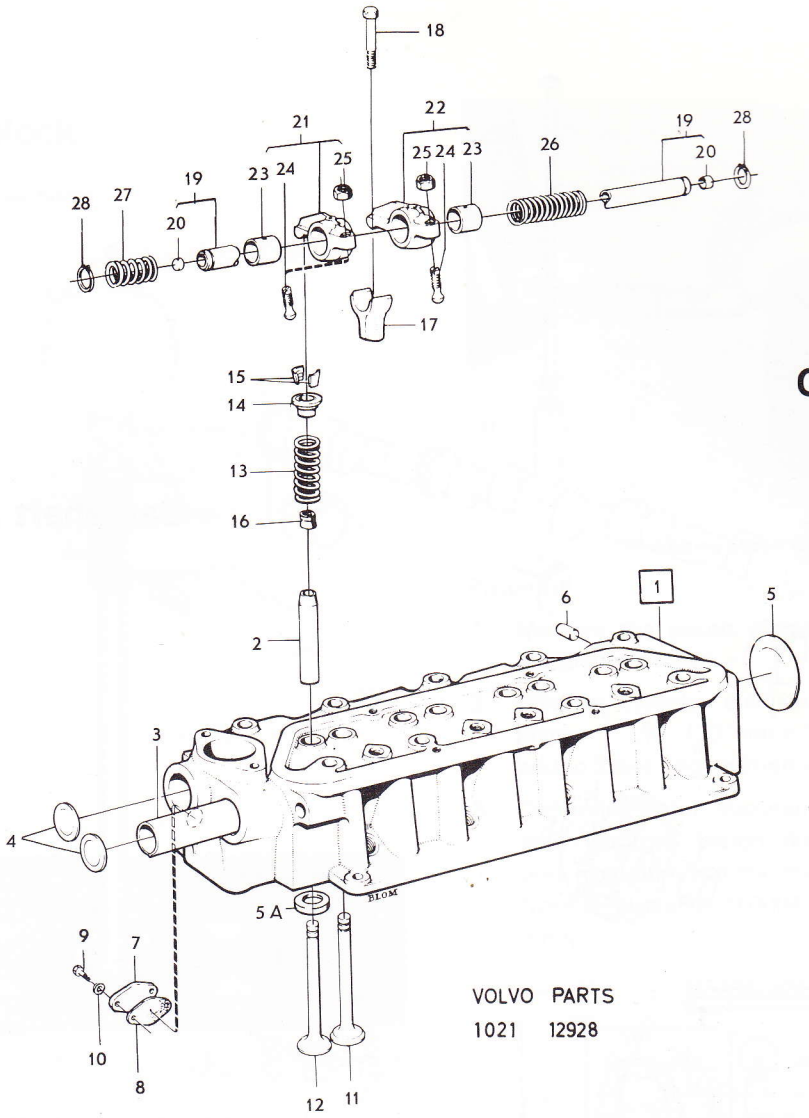
The valve clearance can be adjusted hot or cold and the engine not running. The clearance is the same for intake and exhaust valves. When adjusting, use two feeler gauges. One "go" which is 0.016" (0.40 mm) and the other "no-go" and 0.018" (0.45 mm) thick.

Adjust the clearance so that the "go" gauge can be inserted easily, while the "no-go" must not enter.

Valve adjustment procedure

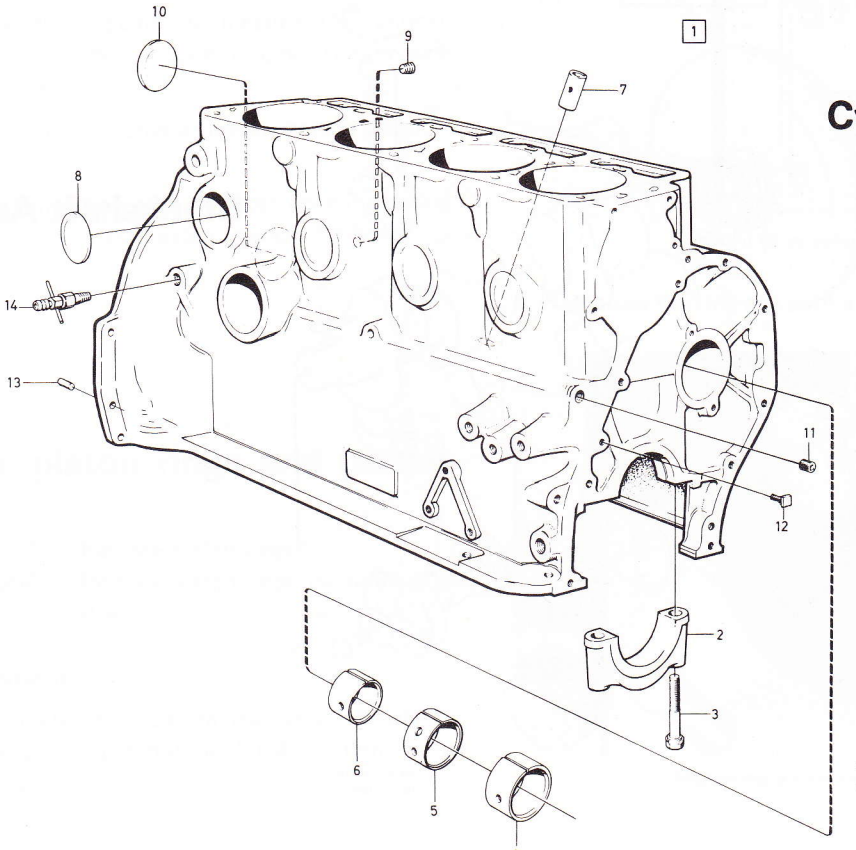
Turn the crankshaft until number 4 cylinder rocker arms "rock" and adjust number 1 cylinder valve clearance.
Turn the crankshaft until number 2 cylinder rocker arms "rock" and adjust number 3 cylinder valve clearance.
Turn the crankshaft until number 1 cylinder rocker arms "rock" and adjust number 4 cylinder valve clearance.
Turn the crankshaft until number 3 cylinder rocker arms "rock" and adjust number 2 cylinder valve clearance.

Cylinder Head

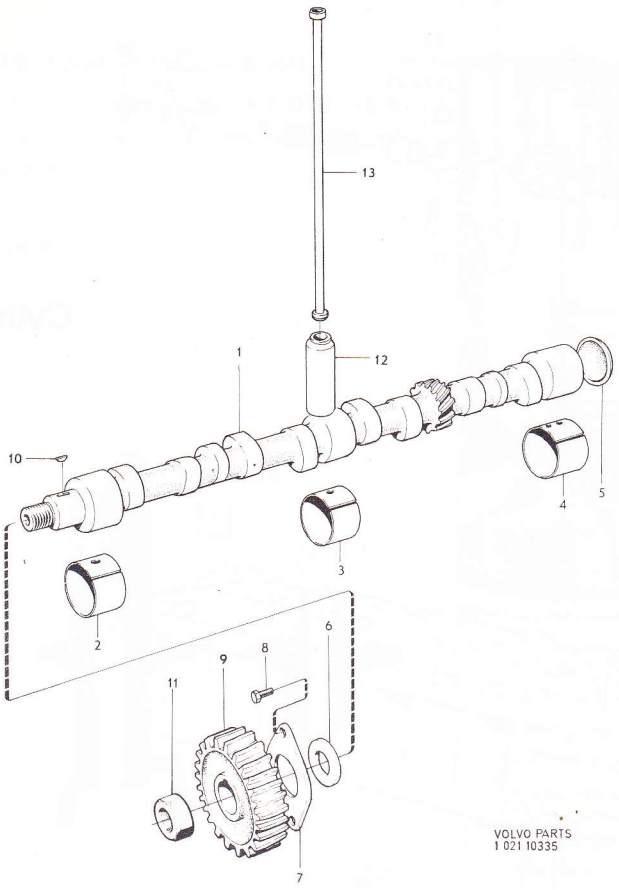


VOLVO PARTS
1021 12928

Cylinder Block

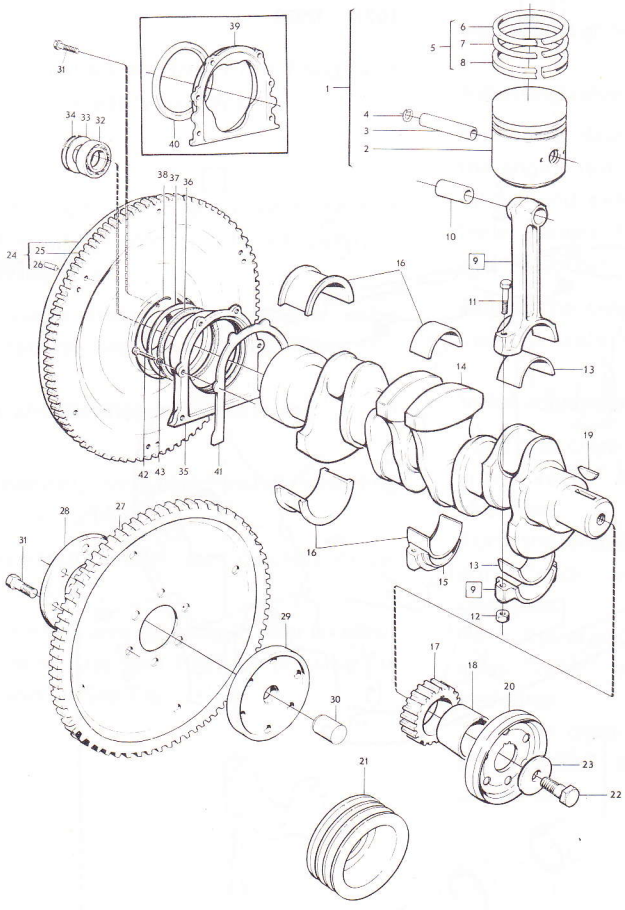


VOLVO PARTS
1021 12926



VOLVO PARTS
1 021 10335

Camshaft Assembly

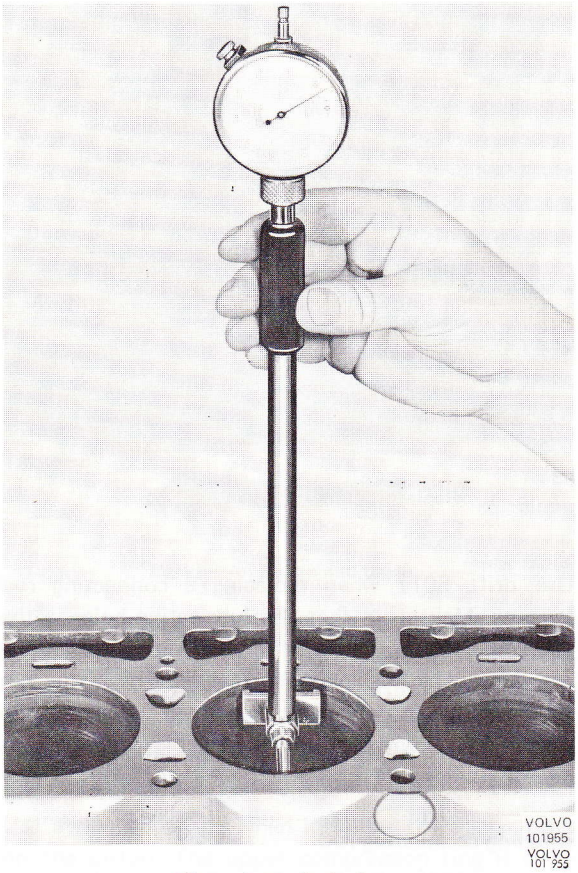


VOLVO PARTS
1021 12927

Crankshaft Assembly

Cylinder block

Measuring cylinder bores



Measuring cylinder bore

Use a special dial indicator to measure the cylinder bores. Measure just below upper ring position in bore and cross engine.

Minimum wear is measured at the lower ring position in bore.

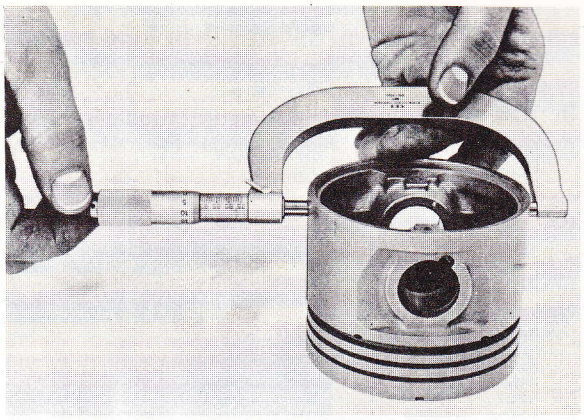
A letter is stamped on each cylinder bore indicating classification of bore and piston (standard models).

Pistons, piston rings and piston pins

Op. No. 21210 = "Replace piston rings".
Op. No. 21250 = "Replace piston rings, including grind valves".

Measuring pistons

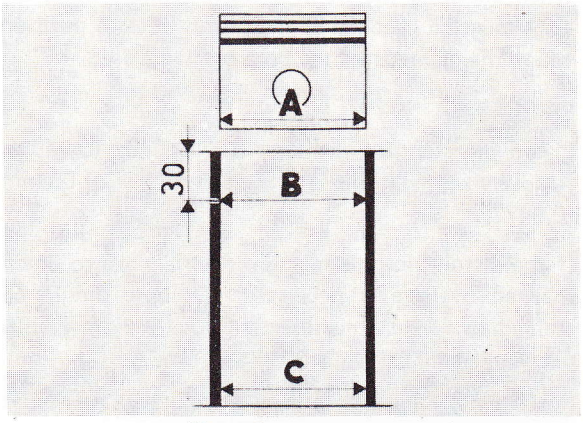
Use a micrometer to measure the piston perpendicular to the piston pin hole and 1/4" (7 mm) from the lower edge.



Measuring piston diameter

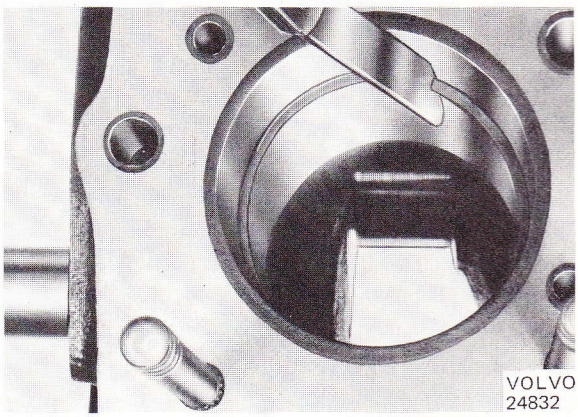
Piston fit

1. Measure the piston diameter (A) according to instructions above.
2. Measure cylinder diameter several places cross engine 1 1/4" (30 mm = B) from block surface and to lower ring position in bore (C).
3. Determine piston maximum and minimum clearance (subtract piston diameter from cylinder bore maximum and minimum diameters).
   Normal clearance 0.0004–0.0012" (0.01–0.03 mm).



Piston fit in cylinder

4. Measure the ring gap with a feeler gauge.



Measuring piston ring gap

Gap should be 0.016–0.022" (0.40–0.55 mm). Increase the gap with a file if necessary.

3. Check the piston rings by rolling them in their grooves. Use a feeler gauge to measure the clearance at several points.

Piston ring side clearance

Clearance in groove for compression ring and scraper ring. 0.0016–0.0028" (0.040–0.072 mm).

A worn cylinder bore

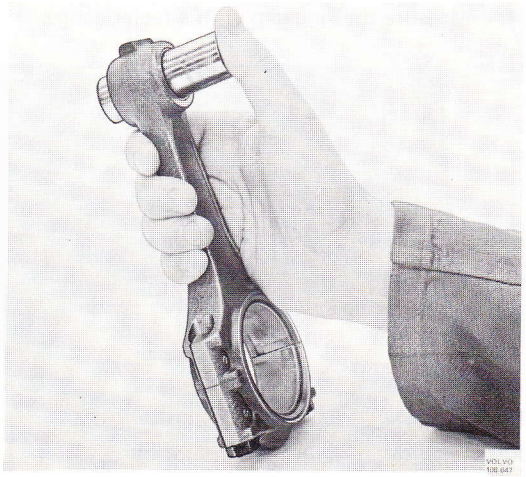
When checking the fit in a worn cylinder bore, the rings must be checked at the piston bottom position where the diameter of the bore is smallest.

Piston pins

Piston pin standard diameter is 24.00 mm (0.945"). An oversize piston pin is available which is 24.05 mm (0.947").

If the piston pin hole in the piston is worn so much that an oversize is necessary, the hole should be reamed to correct measurement. Use a reamer with pilot guide and take small cuts at a time.

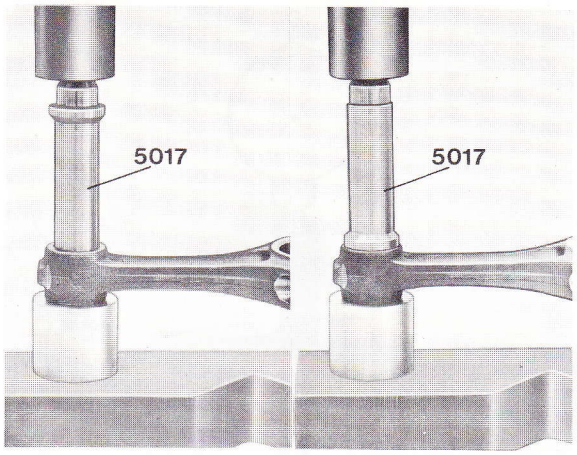
Check piston pin fit in piston and connecting rod. It should be a sliding fit.



Piston pin fit

Connecting rods

Replacing bushing

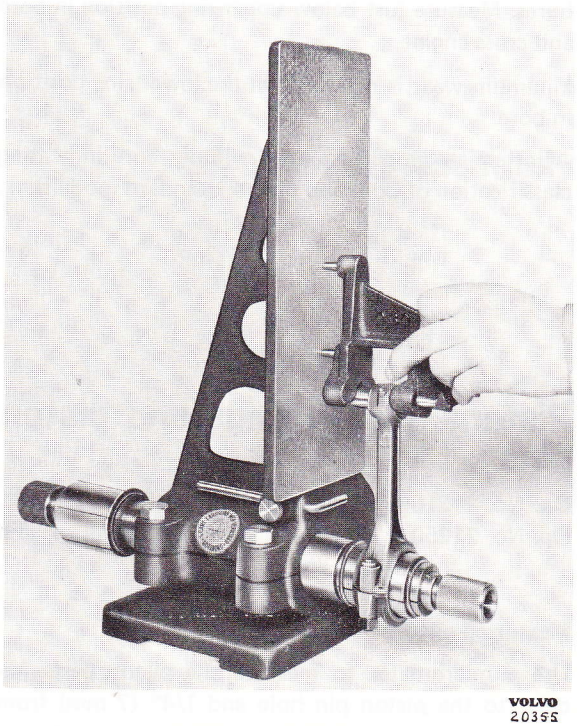


Replacing connecting rod bushing

Use drift 5017 when replacing a connecting rod bushing. Make sure that the lubricating holes in the bushing coincide with the holes in the connecting rod. Ream the bushing to correct fit. The piston pin should slide through the hole under light thumb pressure but without any noticeable looseness, as described under "Piston pins".

Aligning connecting rod

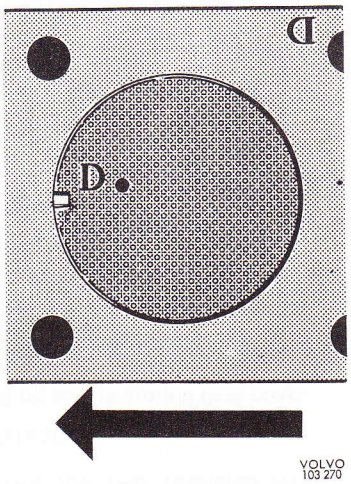
Op. No. 21279 = Replace piston, including align connecting rod, one (each additional = Op. No. 21281)



Checking connecting rod

Check connecting rod for bend, torsion or S-distorsion. Align if necessary. Connecting rod bolts and nuts should be replaced whenever disassembled.

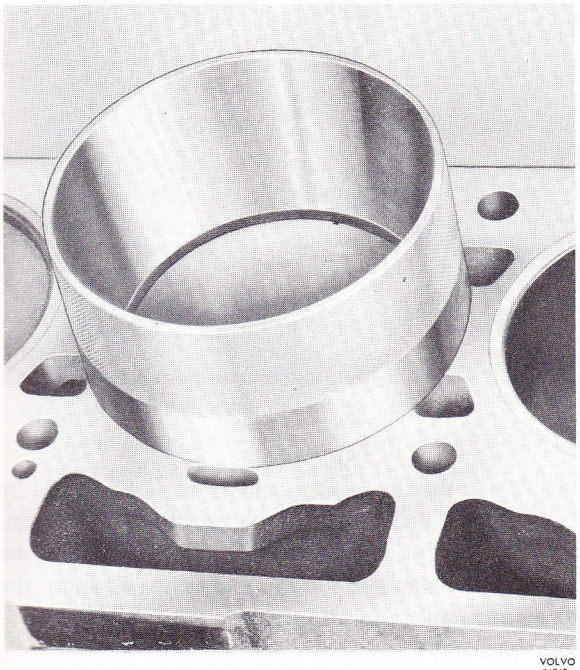
Assembling and installing piston and connecting rod



Marking on piston and block

When assembling, it is important to observe that the slot on the piston head should face forwards. The engine will be very noisy if the piston is turned the wrong way. Also observe that the connecting rod marking should face away from the camshaft side. Install piston pins and snap rings.

Use a ring expander when installing the piston rings on the piston. The upper compression ring is chromed. Space the ring gaps evenly around the periphery. Place the bearing shells in their seats. Lubricate piston and bearing surfaces.



Piston installation

Installation ring 2823

Use tool 2823 when installing the pistons. Torque the connecting rod bolts to 50–55 lb.ft. (70–78 Nm).

Crankshaft

Replace crankshaft = Op. No. 21693.

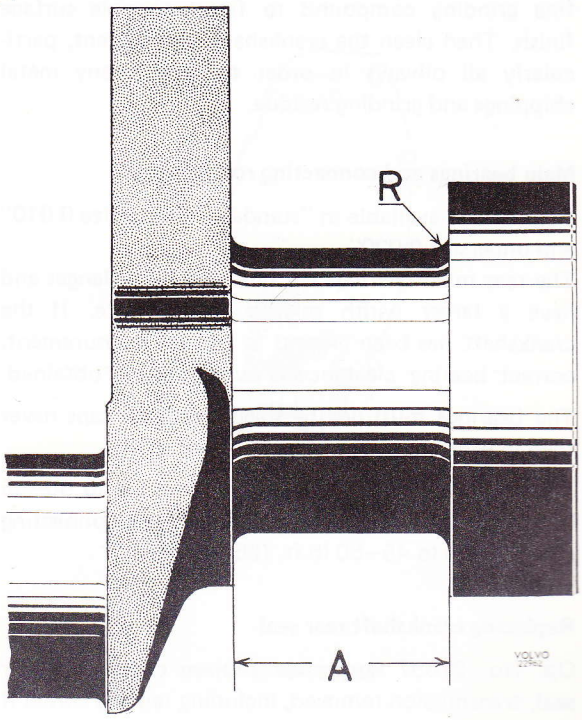
Cleaning

Handle the crankshaft with care to avoid damage to the finished surfaces. Clean with solvent and blow out oil passages with compressed air.

Inspection

Check for cracks, scratches, grooves or scores. Check the crankshaft oil seal surface for nicks, sharp edges or burrs that might damage oil seals during installation or cause premature seal wear.

Measure the diameter of each journal in several places to determine out-of-round, taper or undersize condition.



Bearing journal

Crankshaft journal out-of-round should not exceed 0.002" (0.05 mm). Connecting rod bearing journal out-of-round should not exceed 0.003" (0.07 mm). Taper should in both cases not exceed 0.002" (0.05 mm) on any journal.

If the limits are exceeded, the crankshaft should be reconditioned. Bearings are available in two undersizes. Find dimensions in "Specifications".

Use a dial gauge to check that the crankshaft is straight within 0.002" (0.05 mm). Place the crankshaft on two V-blocks and place a dial gauge against the center bearing journal and rotate the crankshaft. If necessary, align the crankshaft in a press.

Grinding crankshaft

Before grinding, check for straightness as previously described. Grinding is performed in a special machine. Main bearing journals and connecting rod bearing journals are ground to identical measurements according to "Specifications". These measurements must be carefully followed in order to ensure correct clearance with the stock bearings.

The bearings must under no circumstances be shaved or the caps filed.
The radius of the fillets at the end of the journals should be 0.080–0.100" (2.0–2.5 mm) on all journals. The width (A) for the pilot bearing (thrust bearing) should be ground according to the size of the journal. There are two oversizes, see "Specifications".

After grinding, all burr should be carefully removed from the oilway openings and all journals lapped with fine grinding compound to finest possible surface finish. Then clean the crankshaft with solvent, particularly all oilways in order to remove any metal chippings and grinding residue.

Main bearings and connecting rod bearings

Bearings are available in "standard", undersize 0.010" and undersize 0.020".
The rear main bearings are provided with flanges and have a larger width relative to the size. If the crankshaft has been ground to correct measurement, correct bearing clearance is automatically obtained.

The bearings must not be shaved and the caps never filed in order to obtain closer bearing fit.

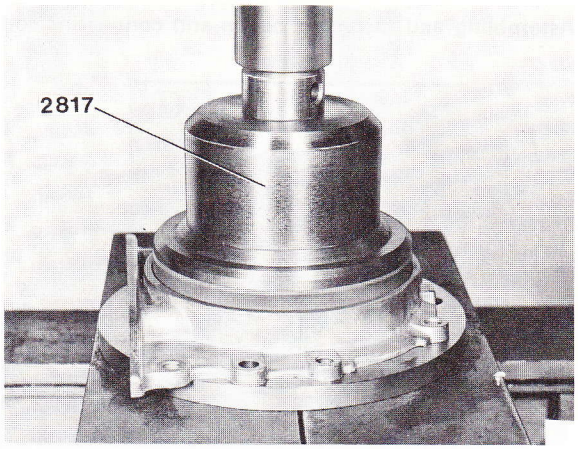
The main bearing bolts should be torqued to 50–55 lb.ft. (70–78 Nm) and the bolts for the connecting rod bearings to 45–50 lb.ft. (65–70 Nm).

Replacing crankshaft rear seal

Op. No. 21667 comprises: replace crankshaft rear seal, transmission removed, including replace clutch if necessary.

1. (Transmission removed). Remove clutch and flywheel from the engine. Remove the two oil pan bolts in the flange. Slacken one of the two bolts on each side so that the oil pan pressure on the flange will be reduced. Remove the flange.
2. Use the drift for tool 2817 to press out the seal. Use a suitable adapter for the flange to prevent it from damages.
3. Use tool 2817 to press in the seal.

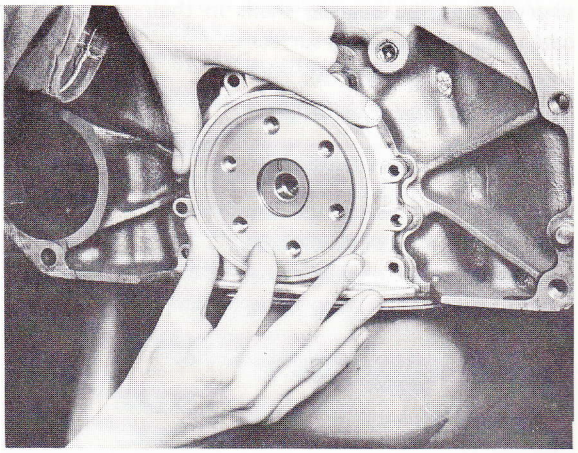
NOTE: first inspect the seals mating surface on the crankshaft.



VOLVO 103 367

Seal installation

With tool 2817 the seal can be installed at various depths. With a new crankshaft or a crankshaft with approved sealing surface, install the seal in its outer position (the center bolt screwed in fully). With the sealing mark on the crankshaft, install the crankshaft seal with the center bolt screwed out a couple of turns or so.



VOLVO 103 366

Flange installation

4. Clean the flange, especially its sealing surface. Oil the seal and install the flange with a new gasket. Be careful when installing the flange on the crankshaft. Use your fingers to position the sealing lip.

   The seal retainer is provided with bosses which guide the retainer when installing on the crankshaft journal.

Grinding flywheel

If the wear surface on the flywheel is uneven or burnt, the surface can be ground in a saddle-mounted grinding machine. Do not grind off more than 0.03" (0.75 mm) of the original thickness.

Pilot bearing for input shaft

Op. No. 21607 = flywheel bearing, replace, pressure plate removed.

Remove snap ring and protecting washer. Use tool 4090 to pull out the pilot bearing.
Clean and check the bearing and replace it if necessary.
Pack the bearing with heat-resistant ball bearing grease. Use drift 1426 to install the bearing. Install protecting washer and snap ring.

Replacing oil seal in timing gear cover

Op. No. 21520

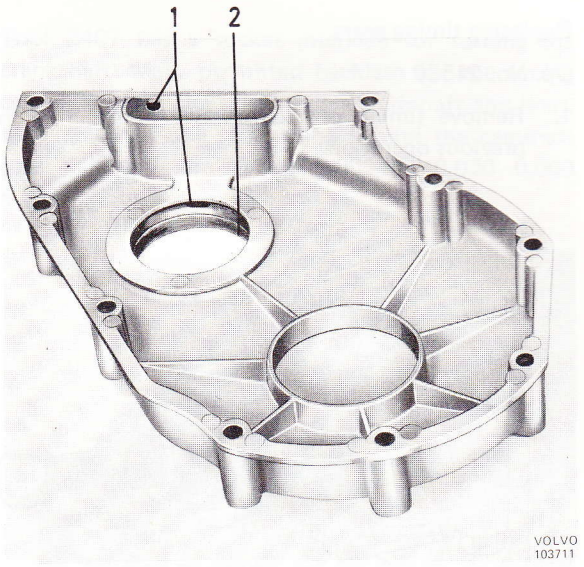
1. Remove the two retaining screws for the fan shroud and pull the shroud to the rear.
   Remove the fan center bolt. Remove fan and fan shroud.
2. Slacken the drive belts. Remove the bolt in the crankshaft and the pulley.
3. Remove the snap ring for the washer which retains the felt ring. Remove washer and felt ring.

   Check that the cover is correctly installed by inserting a 0.004" (0.10 mm) feeler gauge in the gap between cover and hub on the crankshaft and move it all round. If the feeler gauge jams at any point, center the cover as described under "Replacing timing gear cover".
4. Install a new felt ring. Position the washer and install the snap ring. Check that the snap ring fits properly in position.
5. Re-install the crankshaft pulley. Install and tighten drive belts. Place the fan shroud on the engine. Install the fan and then the fan shroud.

Replacing timing gear cover

Op. No. 21502

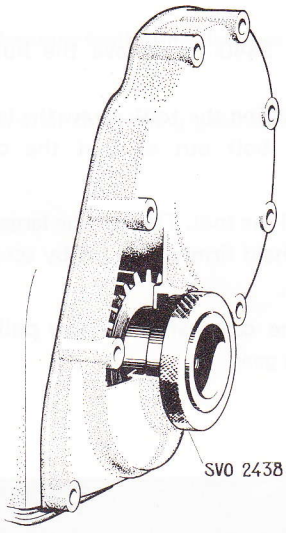
1. Remove the two retaining screws for the fan shroud and pull it to the rear. Remove the fan center bolt. Remove fan and fan shroud.
2. Slacken the drive belts. Remove water pump pulley and crankshaft pulley.
3. Remove timing gear cover. Slacken a couple of the oil pan bolts. Be careful not to damage the gasket. Remove snap ring, washer and felt ring.
4. Check that the drain hole is open and clean inside the timing gear cover.



Timing gear cover

1. Drain holes 2. Seal

5. Check that the gaskets are in good condition, replace if necessary.
   Position cover and install the bolts finger tight.



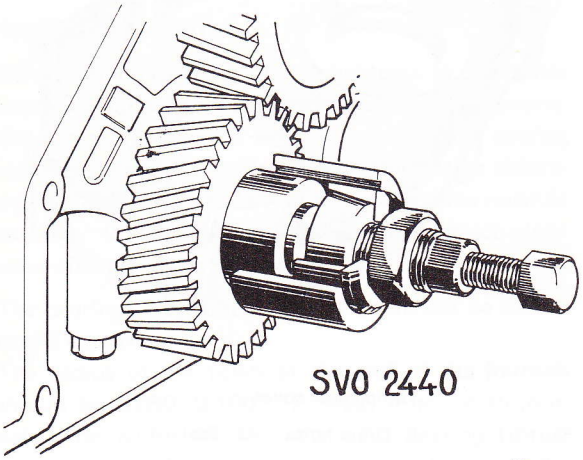
Centering timing gear

6. Use sleeve 2438 to center the cover. Turn the sleeve while tightening. Adjust the position of the cover so that the sleeve does not jam. After final tightening of the cover, check that the sleeve can be easily rotated without jamming.
7. Install a new felt ring washer and snap ring. Use centering sleeve 2438 to push them in position. Check that the snap ring is engaged in the groove.
8. Install remaining parts and tension the drive belts.

Replacing timing gears

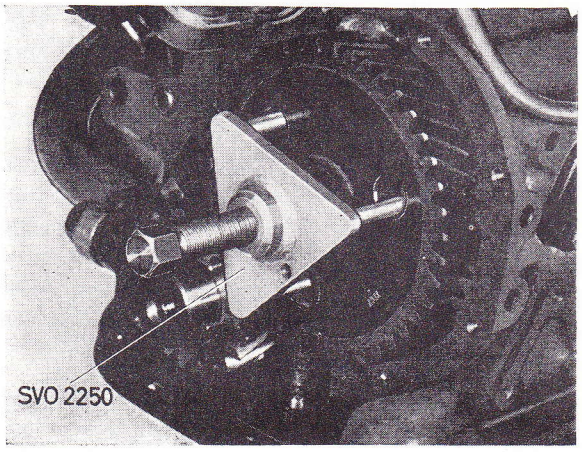
Op. No. 21530

1. Remove timing gear cover. See points 1–3 in previous operation.



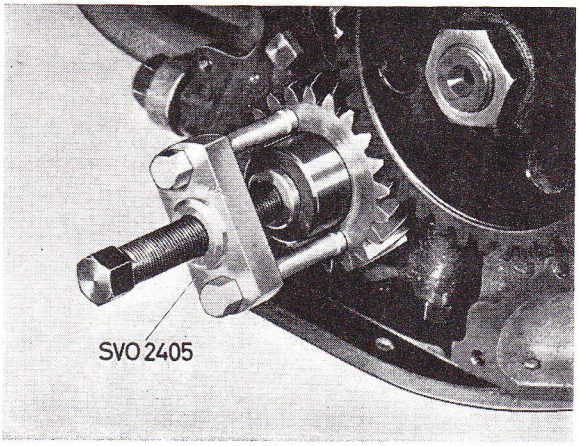
Removing hub on crankshaft

2. Use puller 2440 to remove the hub from the crankshaft.
   Before applying the tool, screw the large nut and the center bolt out so that the cone is not tensioned.
   Then install the tool. Tighten the large nut so that the hub is held firmly. Pull off by screwing in the center bolt.
3. Remove the camshaft nut. Use puller 2250 to pull off the gear.



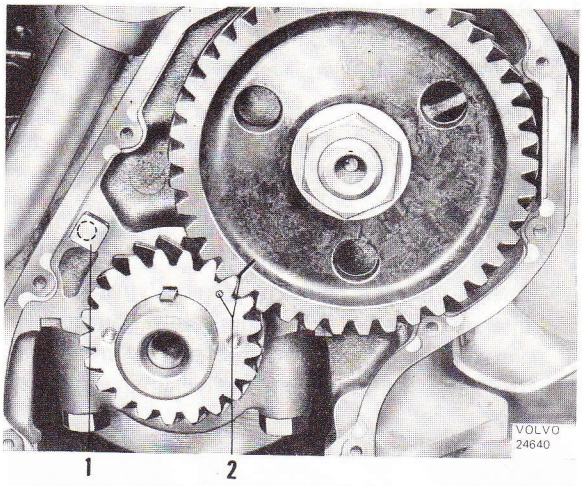
Removing camshaft gear

5. Use puller 2405 to pull off the crankshaft gear.



Removing crankshaft gear

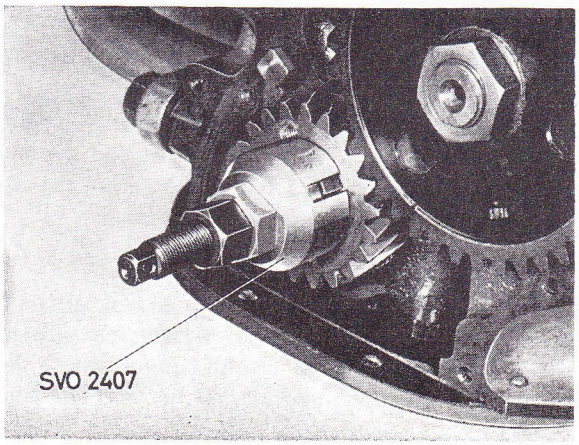
Remove the oil jet and blow it clean. Re-install it as shown below. (The gears are lubricated by oil fed through this jet.)



Marking on timing gears

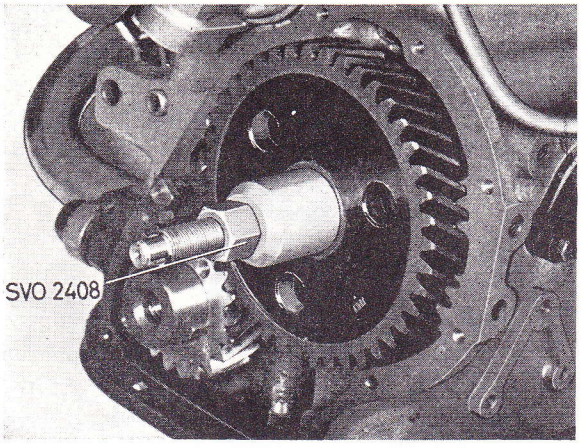
1. Oil nozzle 2. Markings

6. Use tool 2407 to install the crankshaft gear.



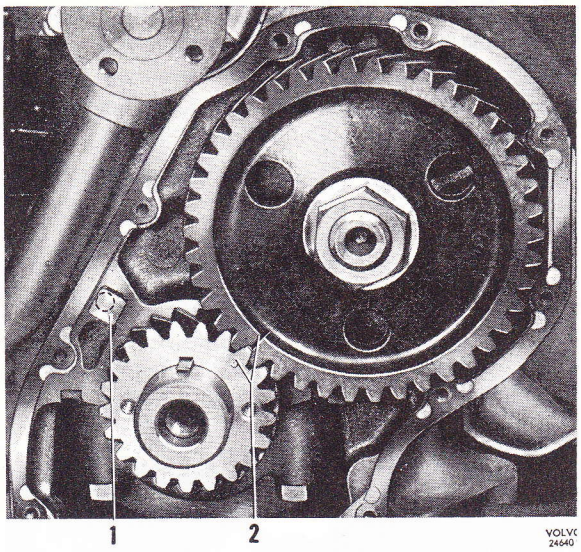
Installing crankshaft gear

Use tool 2408 to install the camshaft gear.



Installing camshaft gear

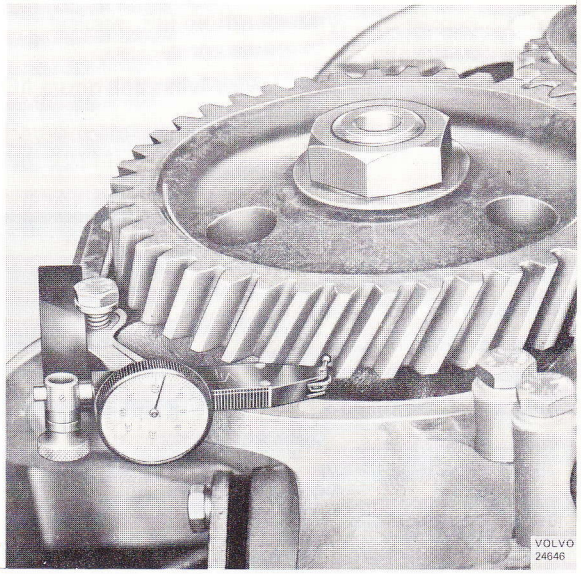
Install the hub on the crankshaft. Do not push the camshaft backwards so that the seal washer on the rear end comes loose. Check that the gears are in the correct position relative to each other, see below.



Marking on timing gears

1. Oil nozzle 2. Markings

Tool 2407 has a socket intended for turning the crankshaft. Max. permitted backlash for the timing gears is 0.0048" (0.12 mm). The camshaft and float, determined by the spacer ring behind the camshaft gear, is maximum 0.008–0.0024" (0.020–0.060 mm).

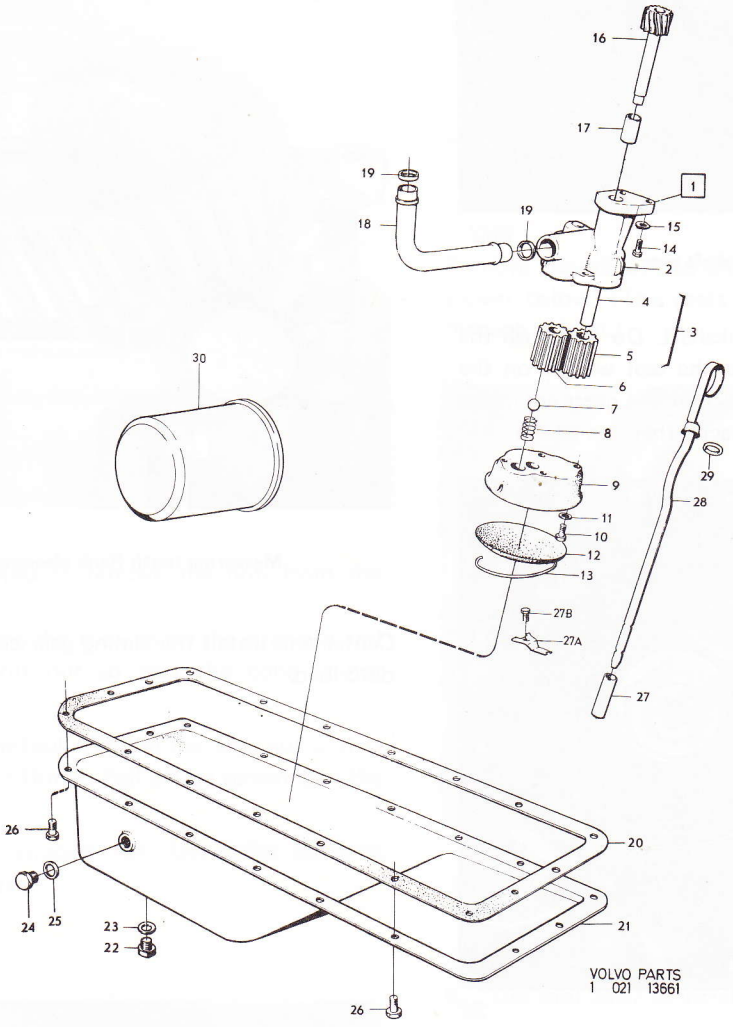


Measuring tooth flank clearance

Center and install the timing gear cover as previously described.

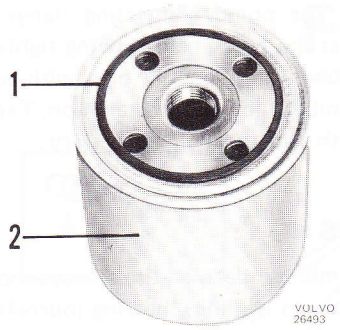
Group 22

Engine Oiling System



Replacing oil filter

Op. No. 22207



Oil filter

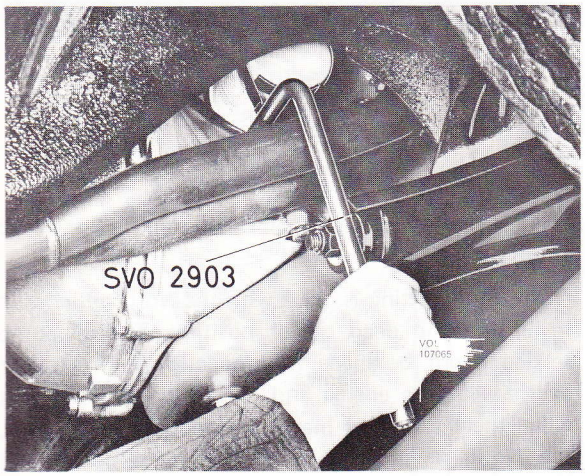
1. Gasket
2. Filter cartridge

The oil filter cartridge is screwed onto a nipple in the cylinder block.

Replace the oil filter at each oil change. If the oil filter for any reason is changed separately, 1/2 qt. of oil should be added.

Oil and oil filter cartridge are replaced the first time at the 1500 mile service inspection. Subsequent oil changes are made with 7500 mile intervals or **at least twice a year.** However, under adverse conditions, such as
hot ambient temperatures
trailer pulling
hill climbing
driving long distances at high speeds
extended periods of idling or low speed operation
short trip operation at freezing temperatures
require oil changes more frequently.

1. Remove the old filter with an oil filter wrench.

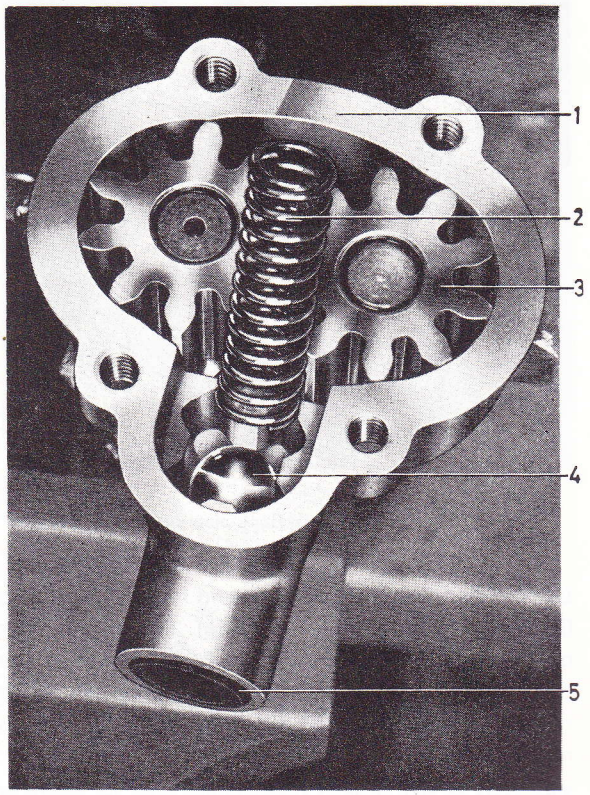


Removing oil filter

2. Coat the rubber gasket "1" of the new filter with oil. Make sure that the contact surface for the oil filter is free from dirt. Coating the rubber gasket with oil makes it slide into better contact with the sealing surface.
   Screw on the filter by hand until it just touches the cylinder block.
3. Screw on the oil filter a further half turn by hand. **Do not use tools.**
   Start the engine and check that there is no oil leakage. Fill oil if necessary.

Oil pump and relief valve

Remove and install oil pump, oil pan removed = Op. No. 22111



Oil pump

1. Pump body
2. Spring for relief valve
3. Gear
4. Valve ball
5. Hole for oil pipe

Disassemble and clean the pump. Check the condition of all parts. Test the relief valve spring, see "Oil pump specifications" below.

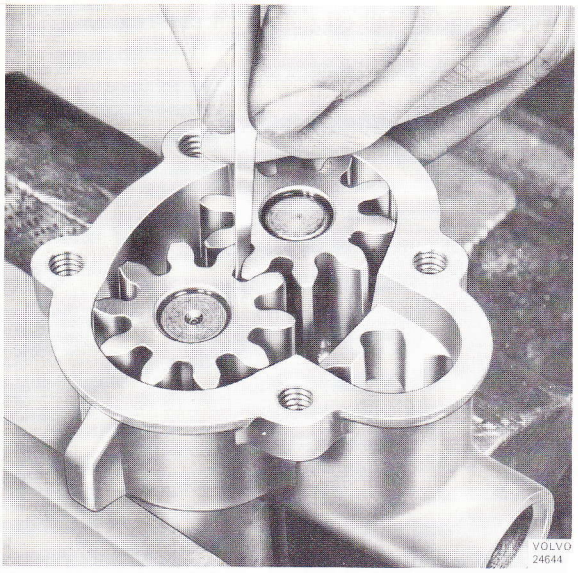
Oil pump specifications

Type	Gear
Number of teeth on each gear wheel	9
End float	0.0040–0.0080" (0.10–0.20 mm)
Radial clearance	0.0032–0.0055" (0.08–0.14 mm)
Backlash	0.0060–0.0140" (0.15–0.35 mm)

Relief valve spring

Length, unloaded	approx. 1.54"	(39 mm)
Loaded with 11.0±0.88 lbs. (50±4 N)	1.03"	(26.25 mm)
Loaded with 15.4±1.7 lbs. (70±8 N)	0.83"	(21.0 mm

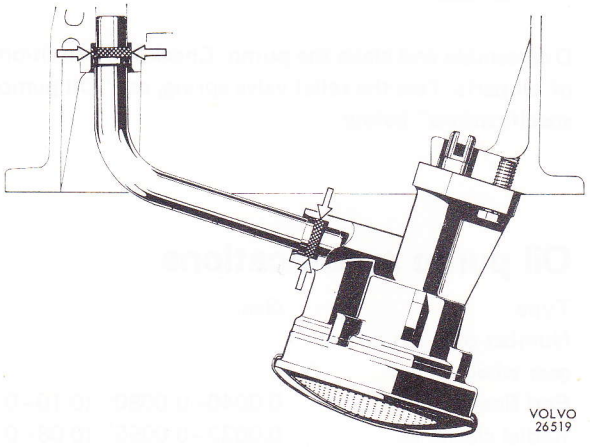
Check that the backlash (tooth flank clearance) is 0.006–0.014" (0.015–0.035 mm) see below.



Measuring tooth flank clearance

Use a feeler gauge to check the end float. It should be 0.0008–0.0040" (0.02–0.10 mm). Use a new cover or the old one if it is not noticeably worn. If the driving shaft or the house is worn, they should be replaced. Note that the driving shaft with gear is replaced as a unit.

The seals at the ends of the delivery pipe are made of special rubber and manufactured to very close tolerances, see Fig. below.



Delivery pipe seals

Use only genuine Volvo parts. The delivery pipe is first clamped in its correct position in the oil pump. Then the oil pump and pipe together are clamped against the block. The pump connecting flange should lie flush against the block before being tightened. Coating the rubber rings on the pipe with soapy water before assembly facilitates installation. Tap lightly on the pipe with a soft mallet if necessary.

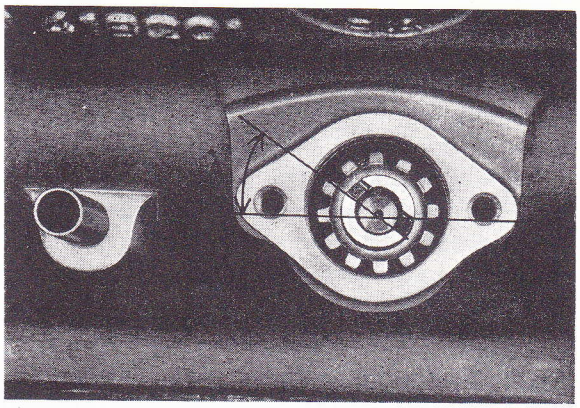
Oilways

Before assembling, clean all the oilways thoroughly to avoid damage to bearings, bearing journals and other components.

Remove the sealing plugs to clean the cylinder block oilways. Install new plugs after cleaning and drying with compressed air.

Aligning oil pump gear

Crank the engine to compression and top dead center for the No. 1 cylinder. Install oil pump and distributor drive. The short part of the slot should point upwards – backwards. The slot angle "A' should be 5°, see Fig. below.



Distributor drive position

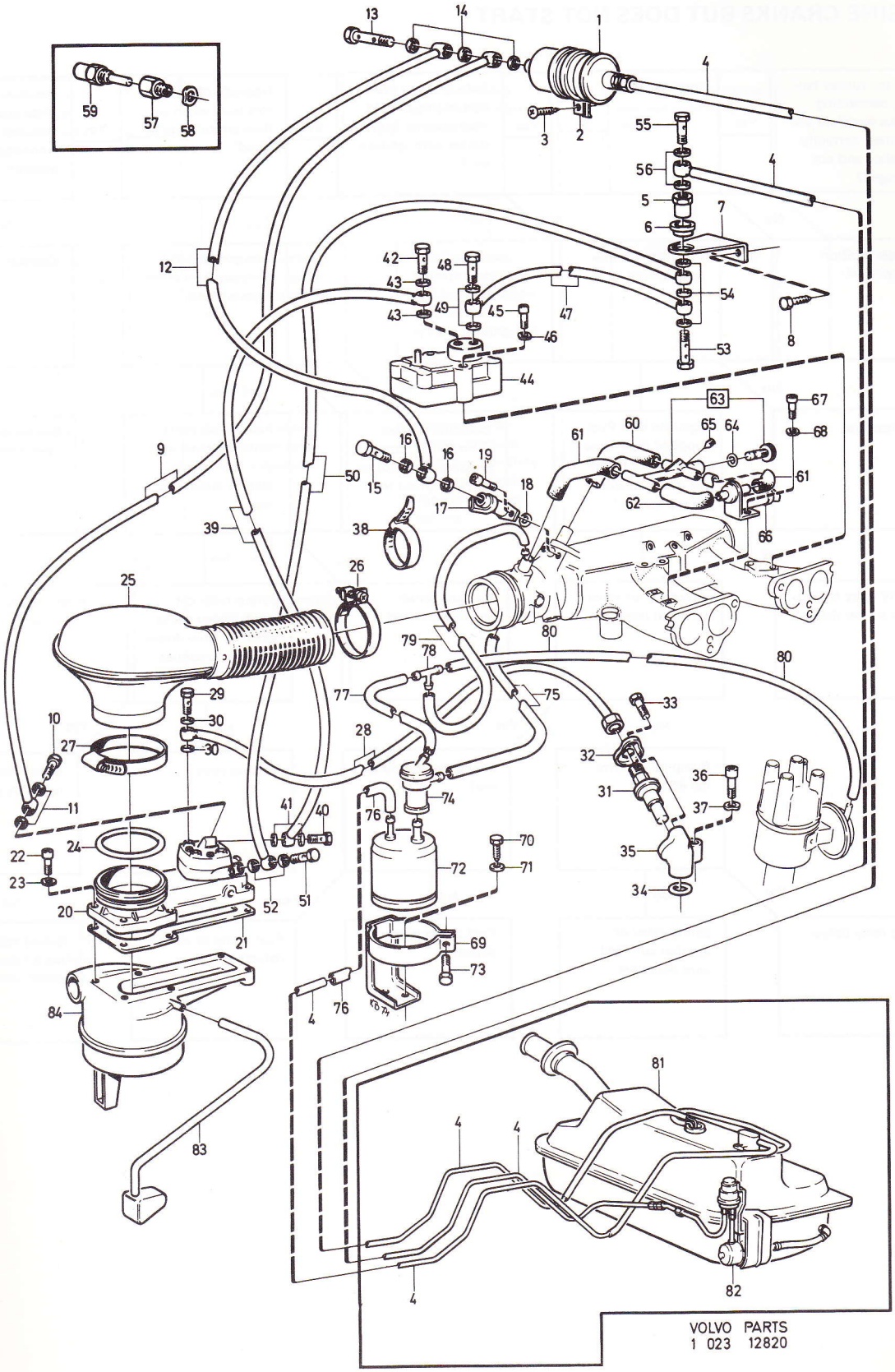
A = approx. 5°

Make sure that the shaft goes down into its slot in the pump shaft.

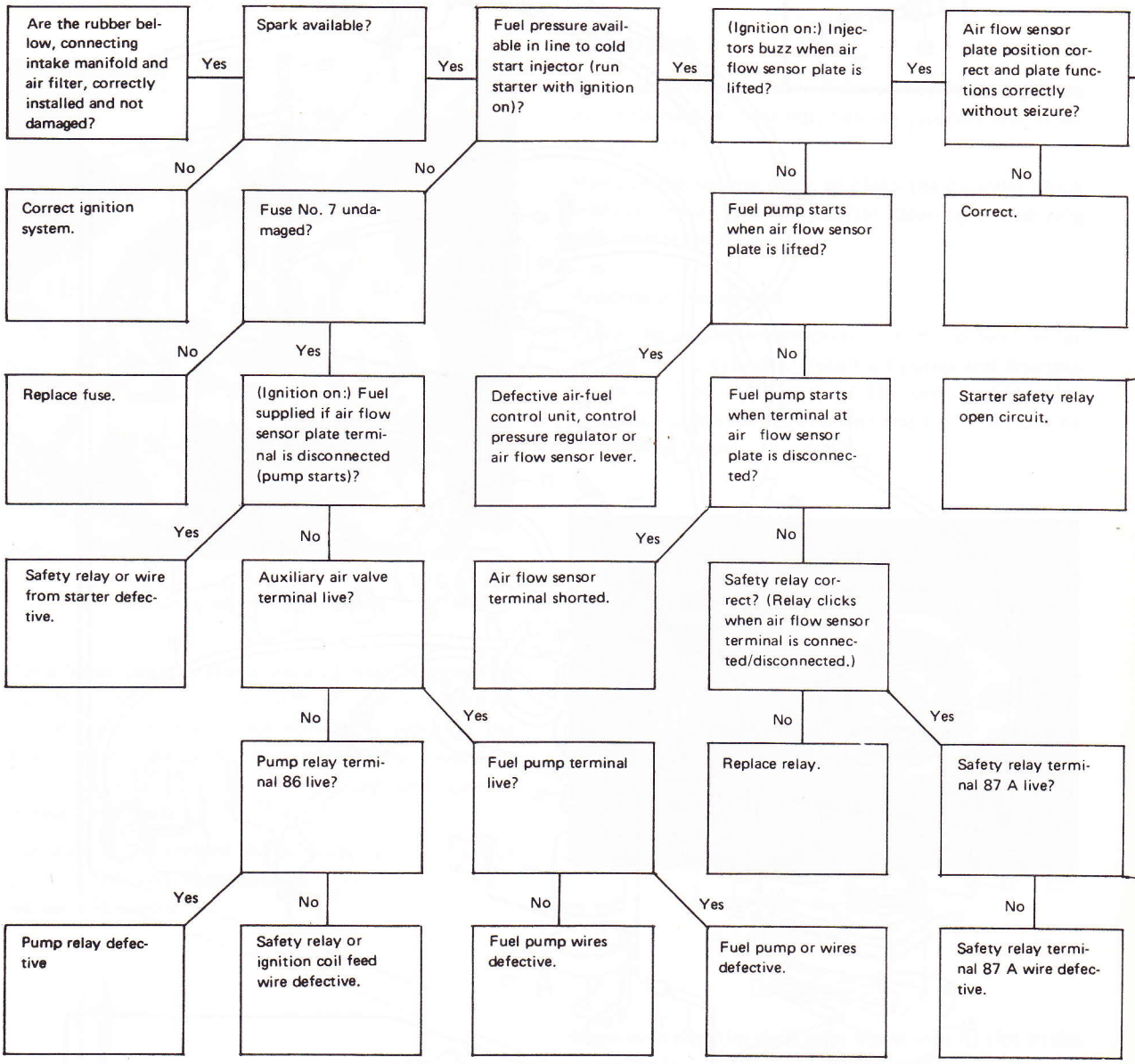
NOTE: this setting is made with the No. 1 cylinder in firing and top dead center position. The oil pump setting might be made in connection with a major overhaul of the engine and it should be noted that when the **timing gear marks** are opposite each other, the No. 4 cylinder is in the top dead center and compression position.

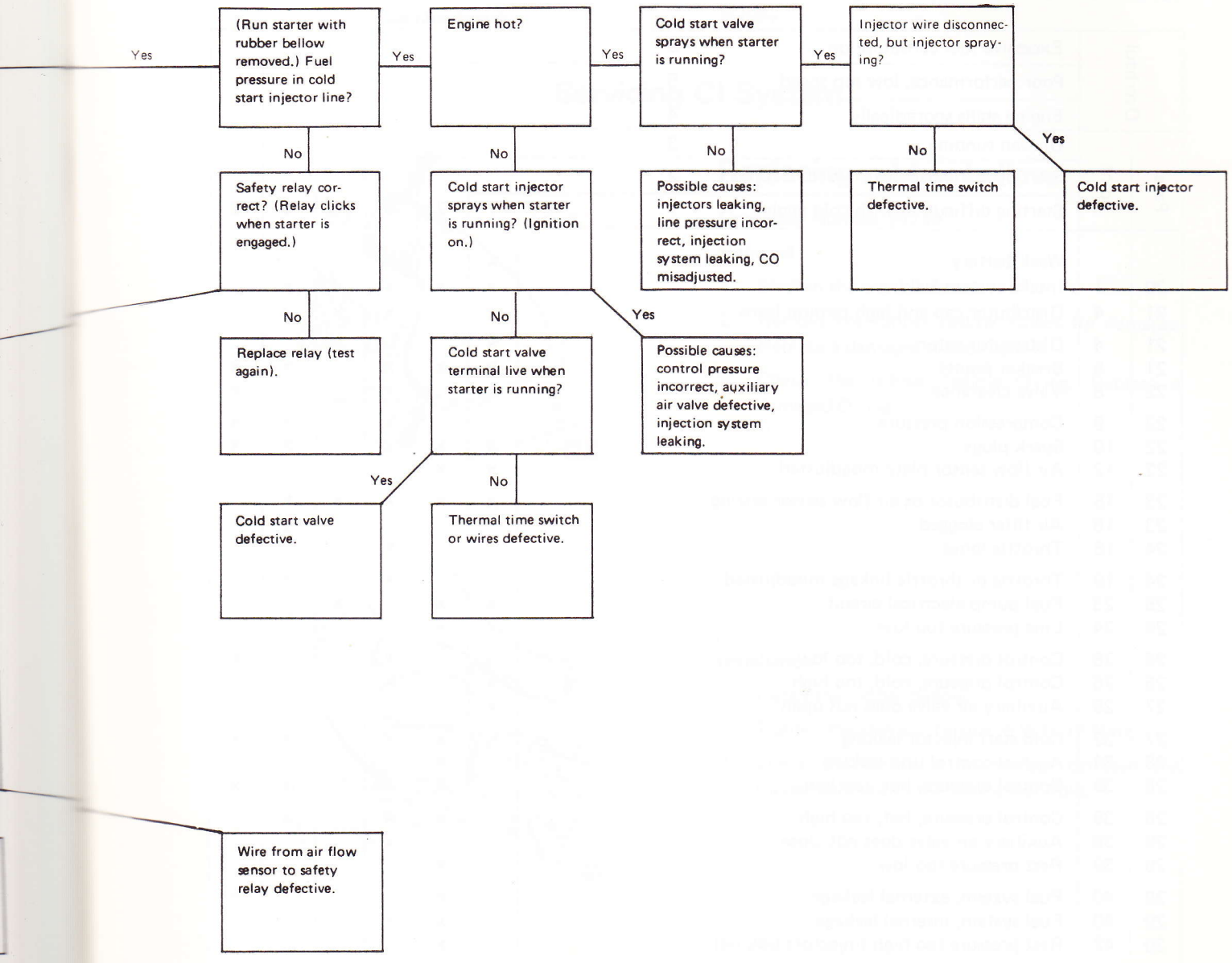
Group 24

Fuel System



ENGINE CRANKS BUT DOES NOT START

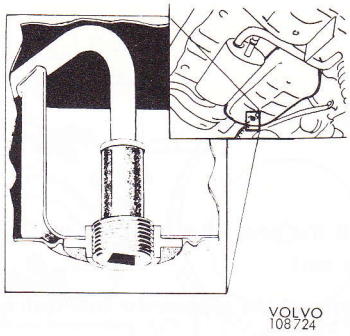



Yes
(Run starter with rubber bellow removed.) Fuel pressure in cold start injector line?
Yes
Engine hot?
Yes
Cold start valve sprays when starter is running?
Yes
Injector wire disconnected, but injector spraying?
Yes
Cold start injector defective.
No
Thermal time switch defective.
No
Possible causes: injectors leaking, line pressure incorrect, injection system leaking, CO misadjusted.
No
Cold start injector sprays when starter is running? (Ignition on.)
No
Safety relay correct? (Relay clicks when starter is engaged.)
No
Replace relay (test again).
Wire from air flow sensor to safety relay defective.
Yes
Possible causes: control pressure incorrect, auxiliary air valve defective, injection system leaking.
No
Cold start valve terminal live when starter is running?
Yes
Cold start valve defective.
No
Thermal time switch or wires defective.

CI fuel injection service diagnosis

Possible faults and causes

Page	Point	Overhaul	Excessive fuel consumption	6						
			Poor performance, low top speed	5						
			Engine stalls sporadically	4						
			Uneven running	3						
			Starting difficulties with warm engine	2						
			Starting difficulties with cold engine	1	1	2	3	4	5	6
			Weak battery		x					
20	1		Intake system leaking		x	x	x	x	x	
21	4		Distributor cap and high tension leads		x		x	x	x	
21	4		Distributor rotor		x					
21	5		Breaker points		x	x	x		x	x
22	8		Valve clearance				x			x
22	9		Compression pressure				x		x	x
22	10		Spark plugs		x	x	x		x	x
22	12		Air flow sensor plate misadjusted		x	x				
23	15		Fuel distributor or air flow sensor seizing		x	x	x	x	x	
23	16		Air filter clogged						x	
24	18		Throttle loose				x			
24	19		Throttle or throttle linkage misadjusted				x		x	
25	23		Fuel pump electrical circuit		x	x		x		
25	24		Line pressure too low		x	x				
26	26		Control pressure, cold, too low				x			x
26	26		Control pressure, cold, too high		x		x			
27	29		Auxiliary air valve does not open		x					
27	32		Cold start injector leaking		x	x	x		x	x
28	34		Air-fuel control unit leaking			x				
28	35		Control pressure, hot, too low			x	x		x	x
28	35		Control pressure, hot, too high			x	x		x	
28	36		Auxiliary air valve does not close				x			
29	39		Rest pressure too low			x				
29	40		Fuel system, external leakage			x				x
29	40		Fuel system, internal leakage			x	x			
30	42		Rest pressure too high (injectors leaking)			x				
30	42		Injectors leaking			x	x			
30	44		Cold start injector does not spray		x					
30	44		Thermal time switch, open electrical circuit		x					
31	47		Fuel lines (filters) clogged		x			x	x	
31	48		Injectors defective (clogged)				x		x	
32	48		Fuel distributor clogged				x		x	
33	53		Distributor incl. advance mechanism		x	x	x	x	x	x
33	53		Ignition timing						x	x
33	54		Thermal time switch, shorted			x				
34	55		Injector retainer (O-ring) leaking				x			
34	56		CO misadjusted			x	x	x	x	x



Fuel filter in tank

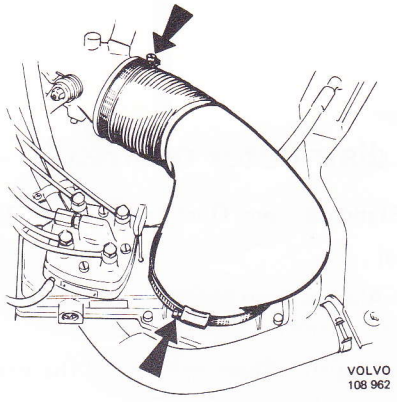
Fuel Tank Filter

The filter should be cleaned at intervals of 15000 miles (25000 km).

The filter is accessible after that the bottom plug has been removed.

When installing, make sure that the suction pipe is centered with the flange hole. Otherwise the filter can be pressed down cocked when installing the pipe or the bottom plug. At worse this could shut off the fuel supply.

Servicing CI System

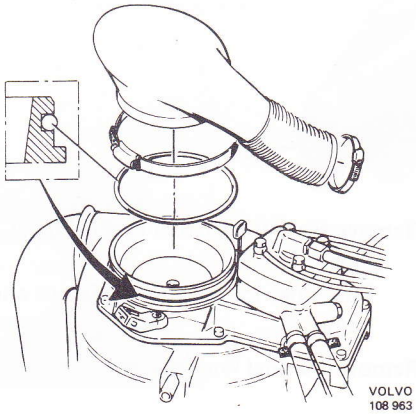


Replacing rubber bellow

Operation Number 24749

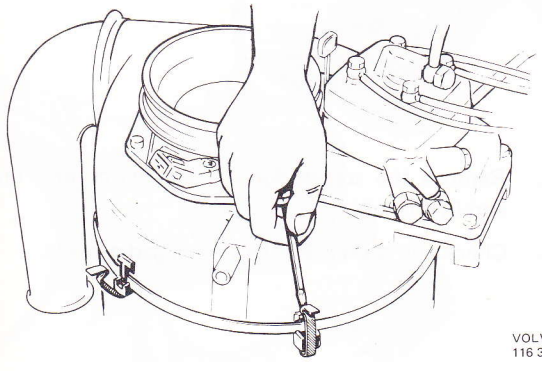
Removal

1. Slacken the two clamps.
2. Remove the rubber bellow. Check for damages. Replace a damaged rubber bellow.
3. Check the rubber bellow O-ring. Replace a damaged O-ring.



Installation

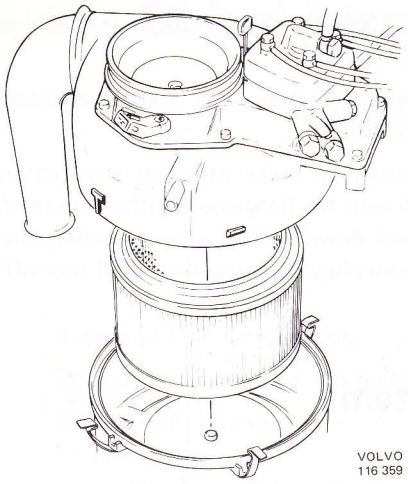
1. Install the rubber bellow.
2. Tighten the clamps. Torque: 5 lb.ft. (7 Nm).
3. Check that there is no leakage between the rubber bellow and the intake manifold.



Replacing air filter cartridge

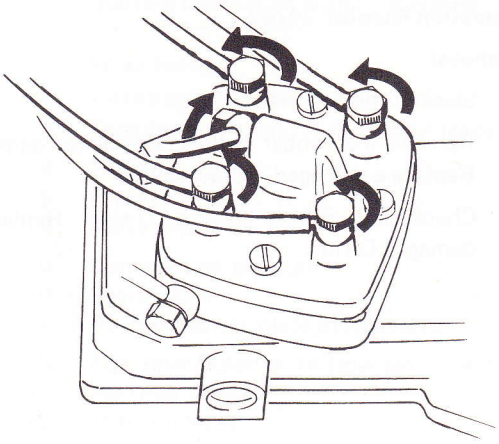
Operation Number 23209

1. Remove the rubber bellow.
2. Disconnect the plug at the fuel distributor.
3. Unsnap the latches, remove the air cleaner upper part including the fuel distributor.
4. Remove the air cleaner cartridge.



VOLVO
116 359

5. Install the new filter cartridge and the air cleaner upper part.
6. Re-connect the plug at the fuel distributor.
7. Install the rubber bellow.



VOLVO
116 381

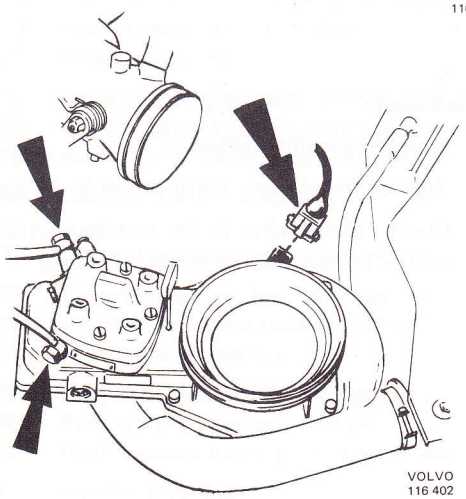
Fuel distributor overhaul

Volvo Standard Times Operation Number 24739

Removal

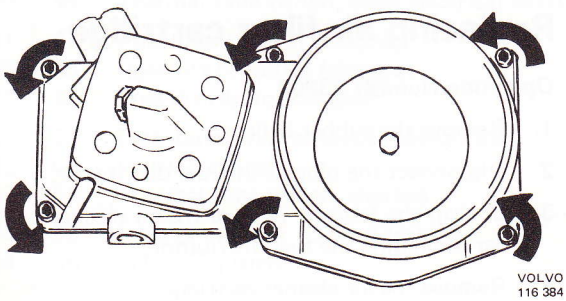
NOTE: Always clean the fuel line connections carefully before the lines are removed.

1. Remove the rubber bellow and the strap for the injector lines.
2. Remove the injector lines and the control pressure line from the fuel distributor.



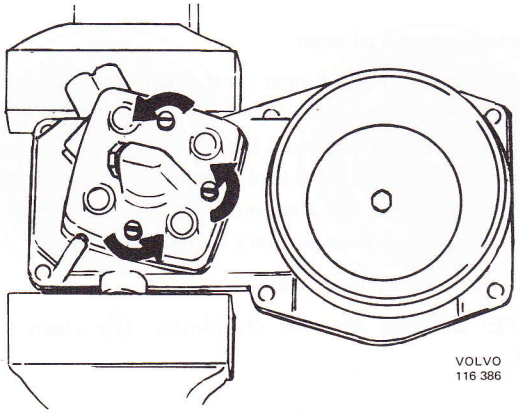
VOLVO
116 402

3. Remove from the air-fuel control unit:
   Plug
   Fuel lines for cold start injector and re-circulation.
4. Remove the fuel lines at the fuel filter.



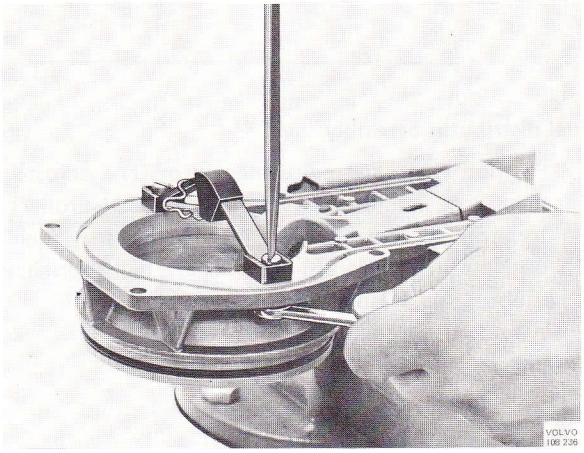
VOLVO
116 384

5. Remove the screws for the air-fuel control unit and lift it out.
6. Check the gasket. Replace damaged gaskets.

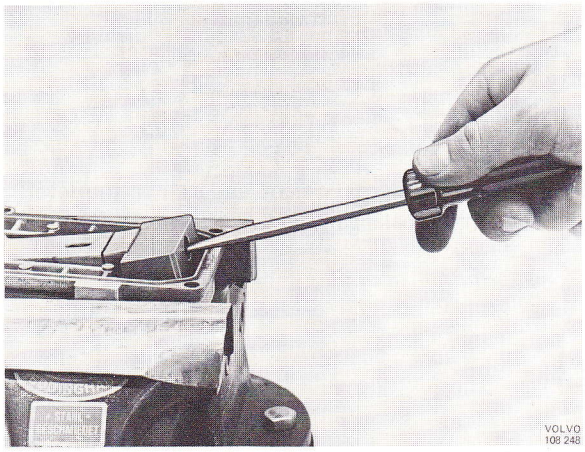


Fuel distributor disassembly

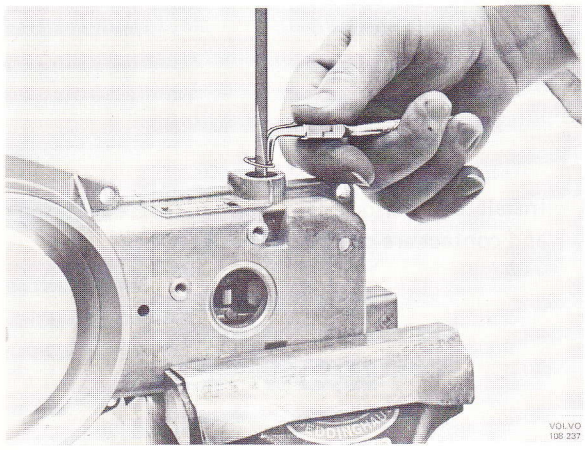
1. Put the fuel distributor in a vise, but lightly as forces may damage it.
2. Remove the three screws and carefully lift off the fuel distributor, watch that the control plunger does not fall out and get damaged. NOTE: the fuel distributor should under no circumstances be disassembled.
3. Check the gasket. Replace a damaged gasket.



4. Remove the two retaining screws for the bridge piece. Remove the bridge piece.

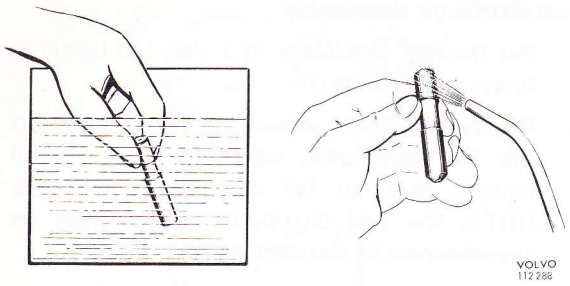


5. Remove the screws for the balance weight. Remove the balance weight.



6. Remove the lever with the adjustment arm by removing lock ring, washer, rubber seal, springs and balls as well as shaft.

Worn or damaged parts should be replaced.

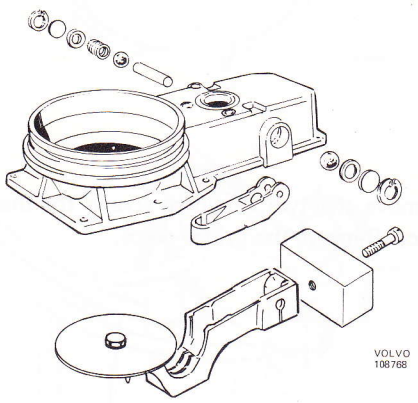


Cleaning control plunger

Wash the control plunger and clean it with compressed air. Check the plunger for damage. If the plunger is worn or damaged, the fuel distributor should be replaced. NOTE: the fuel distributor should under no circumstances be disassembled. Any attempt to clean the slots will cause more harm than good.

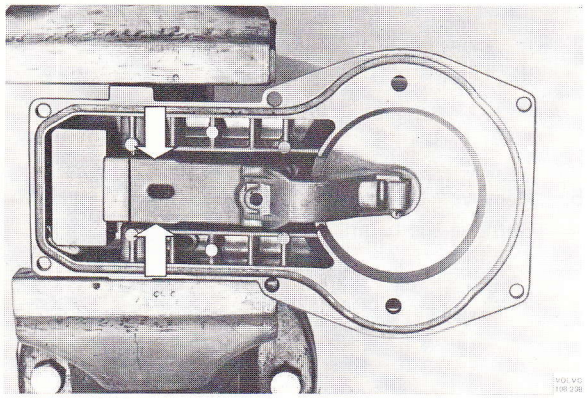
Also clean the cylinder slots.

NOTE: Exercise extreme cleanliness. Use clean solvent.

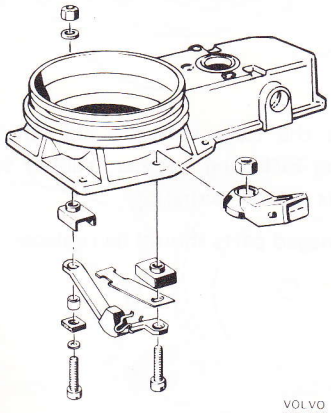


Fuel distributor assembly

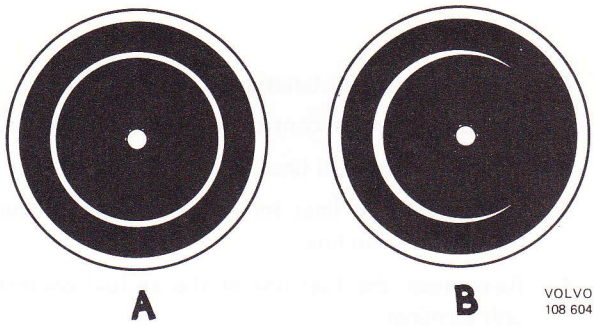
1. Position lever and adjustment arm. The adjustment arm should be positioned so that the roller for the control plunger is towards the fuel distributor. Position in order: shaft, balls, spring, rubber seals, washers and lock rings.



2. Install the balance weight and center the lever. Tighten the balance weight.

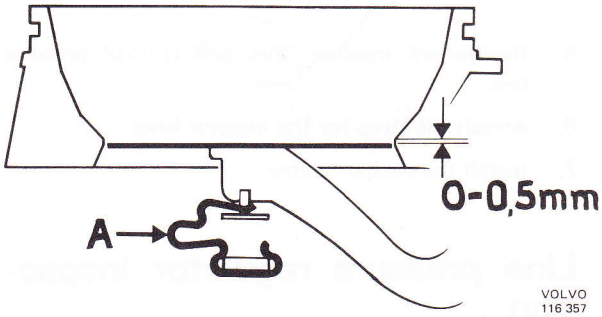


3. Install the sensor plate stop so that the spring and contact are on the right side.



4. Center the air flow sensor plate. (The sensor plate may not touch the air venturi at any point.)

   If adjustment is needed: Loosen the plate screw, move the plate to the right position and tighten the screw again.

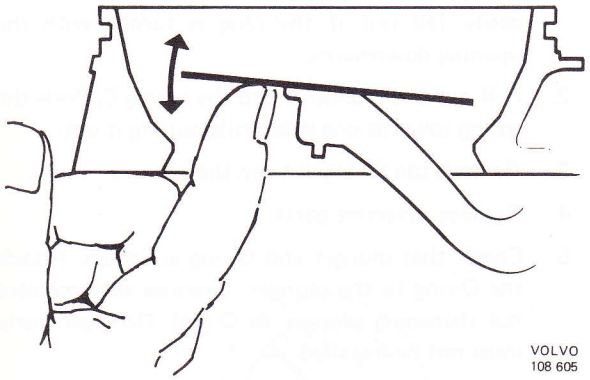


5. Check the air flow sensor plate rest position.

   The upper part of the air flow sensor plate should be in level with or no more than 1 mm below the air venturi edge.

   If needed:

   Adjust at A with needle nose pliers.

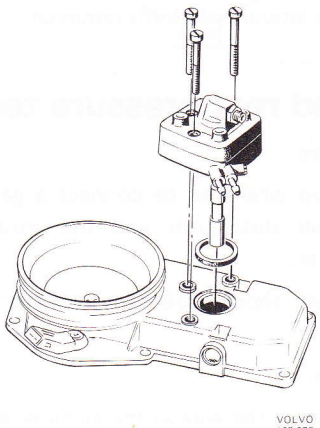


6. Check that the lever does not seize by lifting the air flow sensor plate from low to high position.

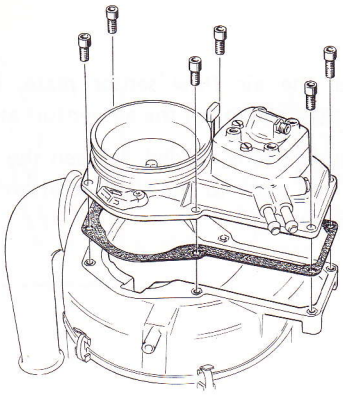
   If the lever seizes, the reason might be:

   A. The lever seizes in the housing, repeat point 2.

   B. The lever pivot seizes in the housing, repeat point 1.

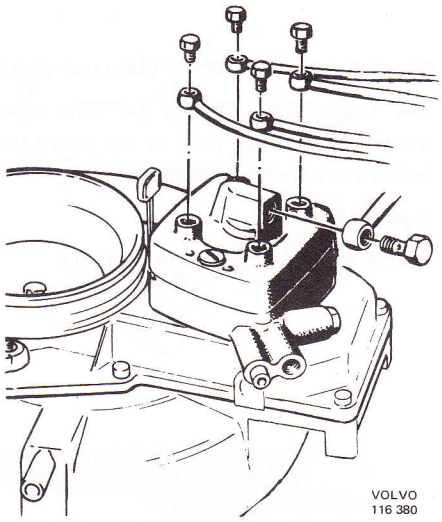


7. Install the fuel distributor carefully, avoid damaging control plunger and O-ring.
   Torque: 2.3–2.7 lb.ft. (3.2–3.8 Nm).


VOLVO
108 971

Air-fuel control unit installation

1. Attach the air-fuel control unit to the air cleaner.
2. Re-connect the fuel lines to the filter.
3. Re-connect fuel lines for cold start injector and the recirculation line.
4. Re-connect the fuel line at the air-fuel control unit terminal.
   Torque: 2.3–2.7 lb.ft. (3.2–3.8 Nm).


VOLVO
116 380

5. Re-connect injector lines and control pressure line.
6. Attach the strap for the injector lines.
7. Install the rubber bellow.

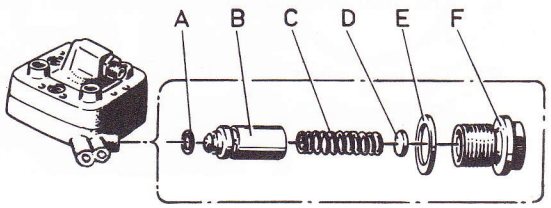
Line pressure regulator inspection

Volvo Standard Times Operation Number 24741

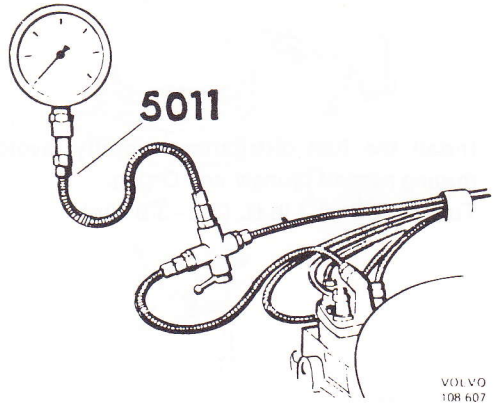
1. Screw out the plug F.

   NOTE: In the plug are several shims D, which easily fall out if the plug is turned with the opening downwards.
2. Pull out the plunger B and the spring C. Press the spring towards one side while pulling it out.
3. Remove the O-ring A from the plunger.
4. Replace defective parts.
5. Check that plunger and O-ring are clean. Attach the O-ring to the plunger. Exercise extreme care not damaging plunger or O-ring. Damaged parts must not be installed.

   The plunger may not be swapped, as plungers and fuel distributors are paired.
6. Install plunger, spring, plug with copper washer E and the amount of shims removed.



VOLVO
116 389



VOLVO
108 607

Line and rest pressure test

Line pressure

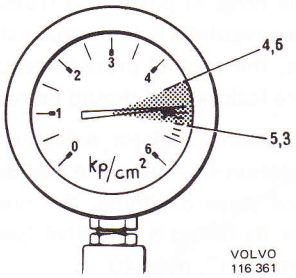
1. Use two wrenches to connect a gauge 5011 to the fuel distributor and the control pressure regulator.
2. The lever should point towards the fuel distributor.
3. Ignition on.
4. Disconnect the wire at the air flow sensor.

5. Read line pressure. It should be 4.6–5.3 kp/cm2 = 65.3–75.3 psi.

Reasons for low line pressure:

A. Fuel line leakage. Check and remedy.

B. The line pressure regulator incorrectly adjusted. Adjust according to instructions.



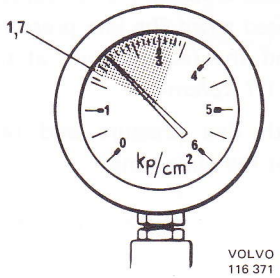
C. If there is no line pressure at all, but the pump operating, the reason might be clogged fuel lines, filters or fuel distributor.

D. Fuel pump pressure too low or fuel tank filter clogged.

Causes for too high line pressure:

A. Recirculation line clogged.

B. Line pressure regulator incorrectly adjusted. Adjustments, see page 42.



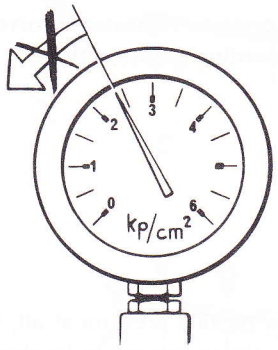
Rest pressure

1. Perform steps 1–4 under "Line pressure" above.
2. Re-connect the electrical wire at the air flow sensor.
3. Read after a few seconds the rest pressure which should be min. 24 psi (1.7 kp/cm2) and max. 51 psi (= max. injector opening pressure).

   The pressure may not noticeably decline within one minute.

   Incorrect rest pressure, see adjustment of line pressure regulator, page 42.

   Rest pressure declining too fast, see tightness check below.



VOLVO
108 977

Tightness check

Perform points 1–3 under "Rest pressure" above.

1. Check the tightness of the system by observing the pressure. The pressure may not decline noticeably within one minute.
   Faults:

   Rest pressure declines too fast, causes:

A. Control pressure regulator defective.

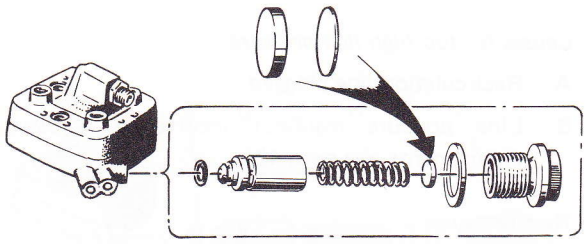
   Put the lever in position 3 (towards the control pressure regulator). If pressure still drops in one minute, the control pressure regulator or its fuel lines are leaking and should be replaced.

B. Line pressure regulator defective. Block the fuel recirculation line after the fuel distributor. If the pressure stops declining, the line pressure regulator or its O-ring is defective. See "Line pressure regulator test", page 40.

C. Fuel pump check valve leaking. Put the gauge lever in position 2. Remove air flow sensor wire for a few seconds to bring up line pressure. Reconnect the wire. Pinch the fuel feed hose from the tank to the pump. The check valve is defective if the fuel pressure stops declining.

D. Fuel lines leaking.

Line and rest pressure adjustment


VOLVO
116 385

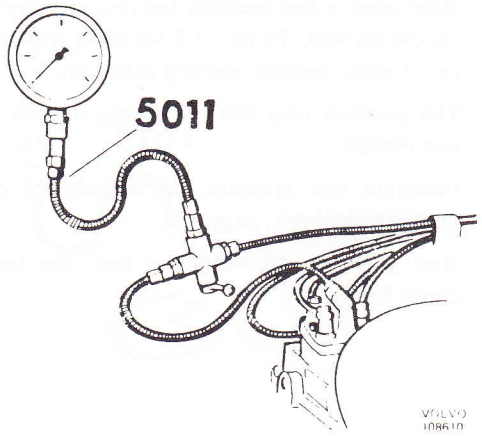
Remove or add shims in the line pressure regulator. There are two shim thicknesses:

0.1 mm gives 0.06 kp/cm² = 0.8 psi pressure difference

0.5 mm gives 0.3 kp/cm² = 4.3 psi pressure difference

Use mainly the thick shims for adjustment. The thin shims are used when the line pressure is 4.9 kp/cm² or more and the rest pressure at the same time is higher than 1.7 kp/cm².

NOTE: Both line pressure and rest pressure are influenced at the same time.

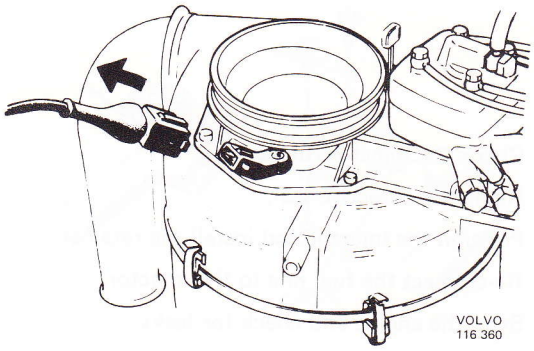


VOLVO
108610

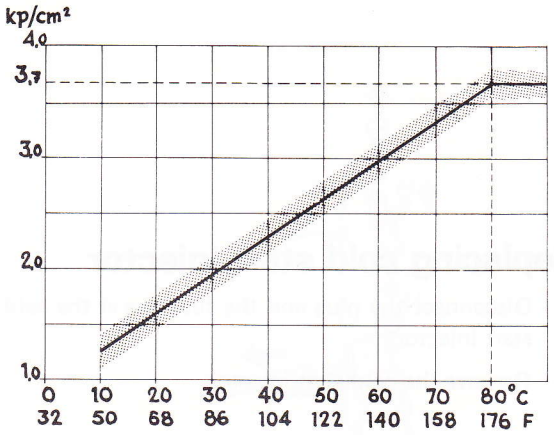
Control pressure test

NOTE: The engine should be cold (at ambient temperature) before the control pressure is checked.

1. Connect pressure gauge 5011 to the fuel distributor and the control pressure regulator.
2. Turn the gauge lever so it points in a right angle to the connection from the fuel distributor.


VOLVO
116 360

3. Ignition on
4. Start the fuel pump by disconnecting the wire at the air flow sensor.



VOLVO
108749

5. Read the control pressure and compare with the chart.

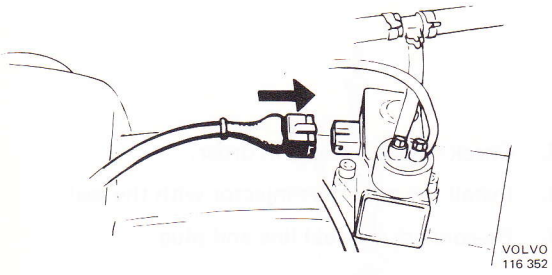
   As you see in the chart, the control pressure at +20°C = 70°F should be 1.6±0.15 kp/cm² = 20.6–24.8 psi

Control pressure too low:

Try a new control pressure regulator.

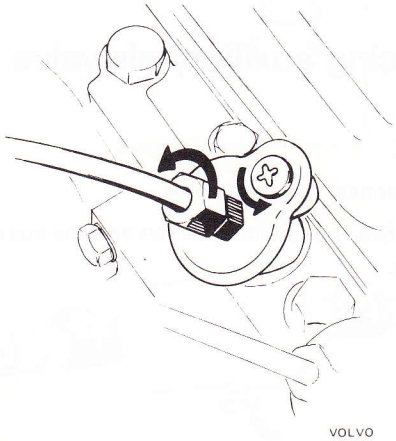
Control pressure too high:

The control pressure may be clogged. If it is in order, replace the control pressure regulator.


VOLVO
116 352

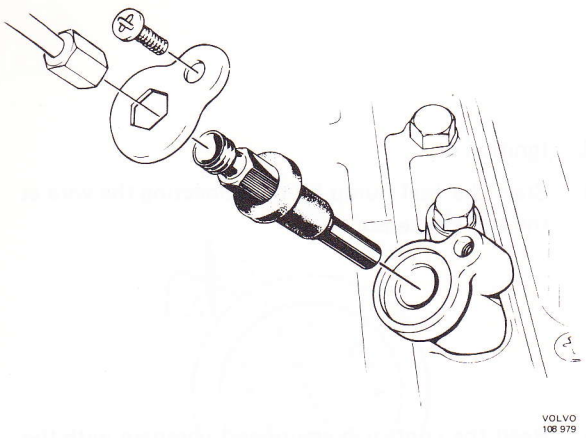
6. Re-connect the plug at the control pressure regulator.

   The control pressure should in 3 minutes rise to 3.7±0.2 kp/cm² = 50–55 psi.

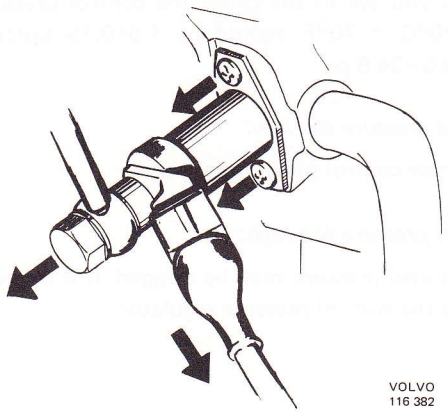

VOLVO
108 998

Replacing injector

1. Clean round fuel injector and fuel pipe.
2. Disconnect the fuel line at the injector.
3. Remove the injector retainer.

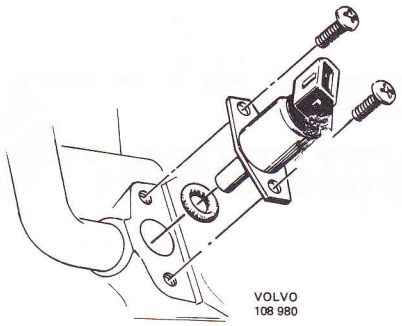


4. Check the injector rubber seal.
   Replace a defective seal.
5. Position the injector and install the retainer.
6. Re-connect the fuel line to the injector.
7. Start the engine and check for leaks.



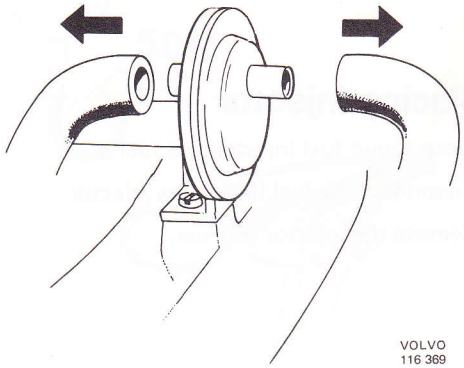
Replacing cold start injector

1. Disconnect the plug and the fuel line at the cold start injector.
2. Remove the cold start injector.

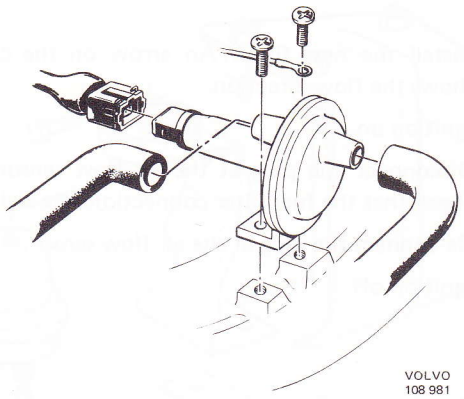


3. Check that the seal is in order.
4. Install the cold start injector with the seal.
5. Re-connect the fuel line and plug.

Replacing auxiliary air valve



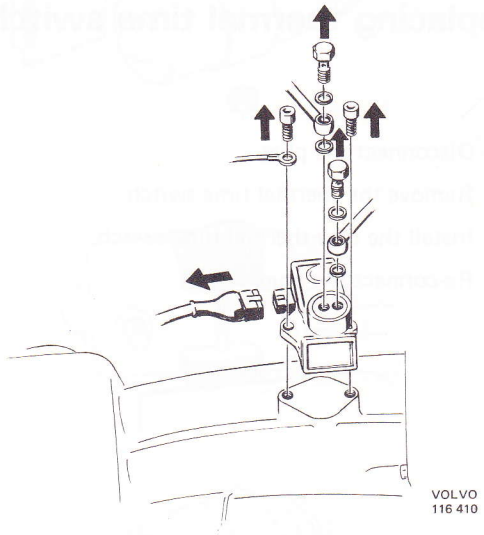
1. Disconnect plug and hoses.
2. Remove the retaining screws and the auxiliary air valve.


VOLVO
108 981

3. Install the auxiliary air valve.

   NOTE: The ground wire which should be connected to one of the retaining screws.

4. Re-connect hose and plug.


VOLVO
116 410

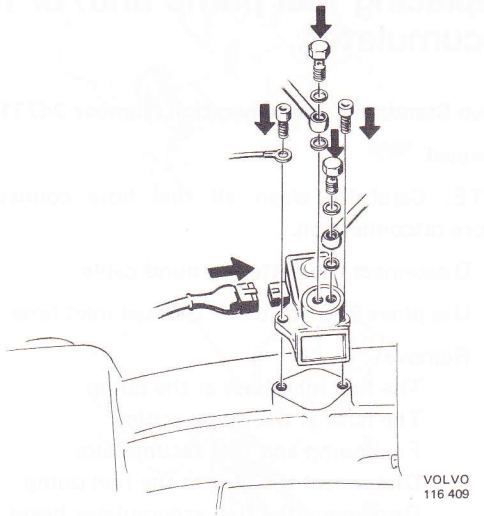
Replacing control pressure regulator

Volvo Standard Times Operation Number 24751

Removal

NOTE: Always carefully clean around the fuel hose connections before the hoses are disconnected.

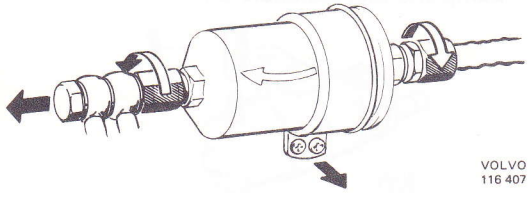
1. Remove the straps for the fuel lines.
2. Remove the hose from the fuel distributor at the control pressure regulator.
3. Remove the plug and the return hose at the control pressure regulator.
4. Remove the control pressure regulator.
5. Disconnect the fuel hose at the control pressure regulator.


VOLVO
116 409

6. Install the control pressure regulator and connect hoses and plug. Re-attach the strap for the fuel lines.

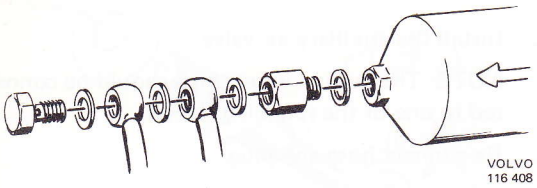
   NOTE: The ground cable which should be connected to one of the retaining screws.

7. Check the control pressure.

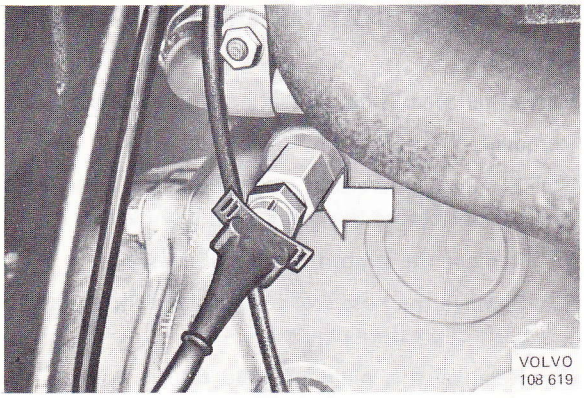

VOLVO
116 407

Replacing fuel filter

1. Clean hose connections.
2. Remove the fuel filter.
3. Remove both nipples with washers.



4. Install the new filter. An arrow on the casing shows the flow direction.
5. Ignition on.
6. Disconnect the plug at the air flow sensor and check that the fuel filter connections are tight.
7. Re-connect the plug at the air flow sensor.
8. Ignition off.



Replacing thermal time switch

1. Disconnect the plug.
2. Remove the thermal time switch.
3. Install the new thermal time switch.
4. Re-connect the plug.

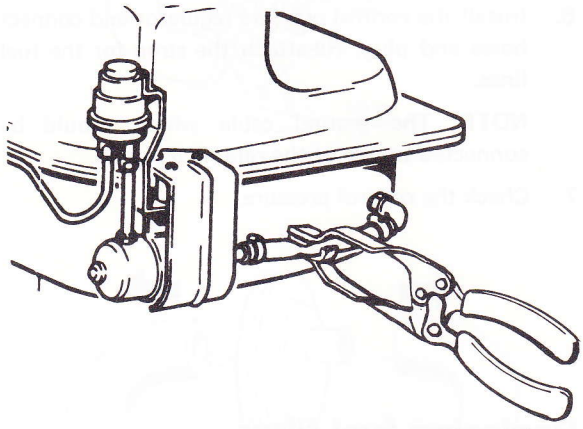
Replacing fuel pump and/or fuel accumulator

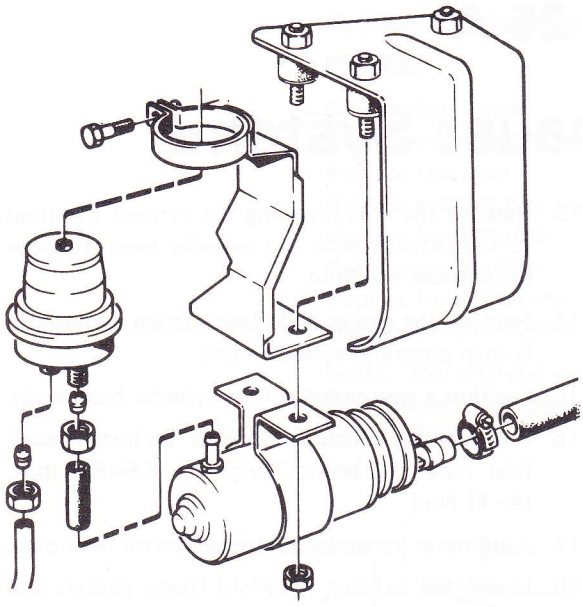
Volvo Standard Times Operation Number 24711

Removal

NOTE: Carefully clean all fuel hose connections before disconnection.

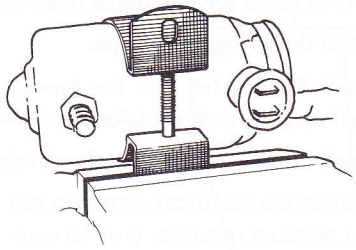
1. Disconnect the battery ground cable.
2. Use pliers 2901 to block the fuel inlet hose.
3. Remove:
   The fuel inlet hose at the pump
   The hose at the pump outlet
   Fuel pump and fuel accumulator
   Disconnect the plug at the fuel pump
   Disconnect the fuel accumulator hoses.
4. Separate bracket and rubber cushion from fuel pump and fuel accumulator.





Installation

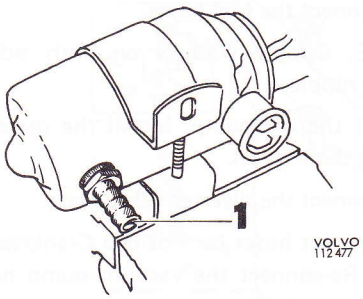
1. Attach bracket and rubber cushion to the pump.
2. Install:
   Fuel accumulator
   Fuel accumulator hoses. The fuel hose between the fuel accumulator and the fuel pump should be replaced whenever disconnected.
3. Connect the plug to the fuel pump and install the fuel pump.
4. Attach the outlet hose at the pump.
5. Attach the inlet hose at the pump and remove the pliers.
6. Re-connect the battery ground cable.



Replacing fuel pump check valve

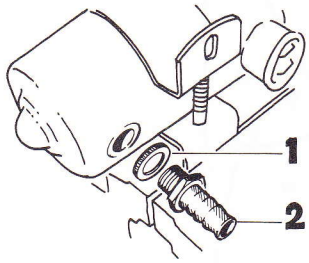
Remove the pump, install it in a vise.

NOTE: Never use anything but the bracket to hold the pump



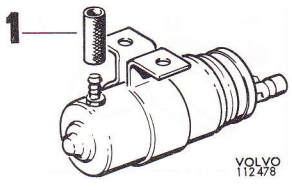
Remove the check valve "1".

NOTE: Do not allow any dirt to enter the pump



Install a new check valve "1" with a new gasket "2". Be sure to use the **correct gasket.**

Torque to 12–16 lb.ft. (16–20 Nm).
Do not overtighten. It will cause deformation of threads and fuel pump housing.



Install a new hose "3" on the check valve.
Install the valve.

Group 25 A

Intake and Exhaust Systems

Replacing manifold gaskets

Op. No. 25124

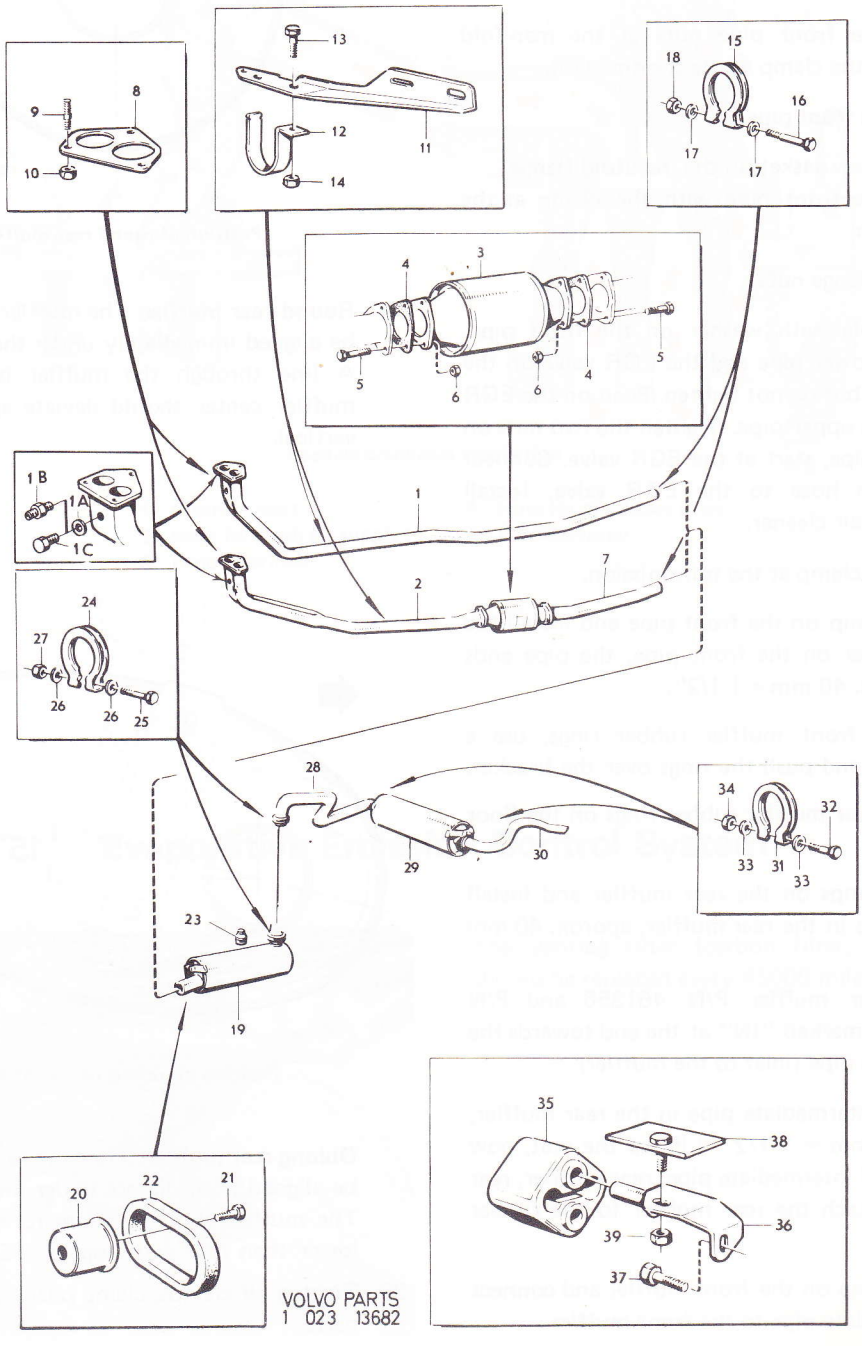
1. Disconnect the battery ground cable.
2. Remove the air bellow connecting intake manifold and CI unit.
3. Disconnect the hoses for Positive Crankcase Ventilation at the intake manifold and flame arrester. Disconnect the vacuum pump hose at the intake manifold.
4. Disconnect the hoses at the diverter valve.
5. Disconnect the air pump with tensioner. Let the bracket remain on engine.
6. Disconnect:
   two fuel hoses from fuel filter at the engine
   two distributor pipes at the engine
   one hose at the control pressure regulator
   one hose at the cold start injector
   four hoses at the injectors
7. Disconnect:
   wire at the control pressure regulator (plus ground wire)
   wire at the cold start injector
   wire at the auxiliary air valve
8. Remove the air injection pipe.
9. Disconnect throttle cable (for automatic transmissions also the kick-down cable) from the intake manifold.
10. Disconnect two hoses for charcoal canister and one hose for the EGR valve from the intake manifold.
11. Remove the brace from the intake manifold. Remove retaining nuts and the intake manifold.
12. Automatic transmission: Disconnect the oil filler pipe from the flywheel housing.
13. Remove the nuts retaining the exhaust manifold to the exhaust pipe and cylinder head. Remove the exhaust manifold.
14. Remove the gasket and clean mating surfaces on branch pipes and cylinder head.
15. Position a new gasket on the cylinder head studs.
16. Position the exhaust manifold. Re-install manifold nuts and bolts. Torque to 6.5–8.0 lb.ft. (9–11 Nm).
17. Automatic transmission: Install the oil filler pipe.
18. Install the exhaust manifold flange gaskets and flange nuts.
19. Attach the intake manifold to the cylinder head. Attach the brace for the intake manifold.
20. Re-install the air injection pipe.
21. Re-install EGR valve and the hoses connecting charcoal canister to the intake manifold.
22. Re-install throttle cable (kick-down cable).
23. Re-connect the electrical wires. Do not forget the control pressure regulator ground wire.
24. Re-connect the fuel hoses.

    NOTE: Copper washers on both sides of the banjo nipples.
25. Install the air pump. Install the drive belt and adjust the tension.
26. Re-connect the diverter valve hoses.
27. Re-connect hoses for Positive Crankcase Ventilation. Re-connect the vacuum pump hose at the intake manifold.
28. Install the air bellow. Reconnect the battery ground cable.

Replacing complete exhaust system

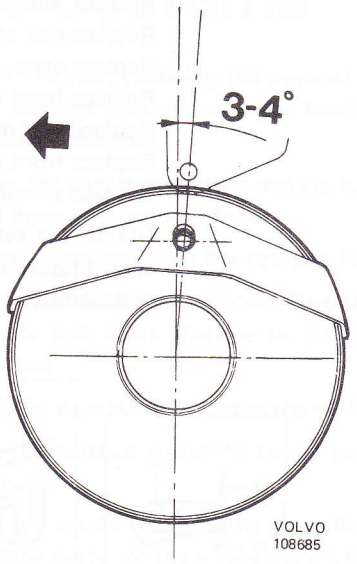
Operation	Op.No.
Replace front pipe	25216
Replace intermediate pipe	25206
Replace rear pipe	25218
Replace exhaust pipe support on transmission	25224
Replace front muffler	25212
Replace rear muffler	25210
Replace front pipe and muffler	25232
Replace exhaust system suspension O-rings	25234

NOTE: the catalytic converter must be handled with care. Shocks may crack the ceramic insert and cause replacement.



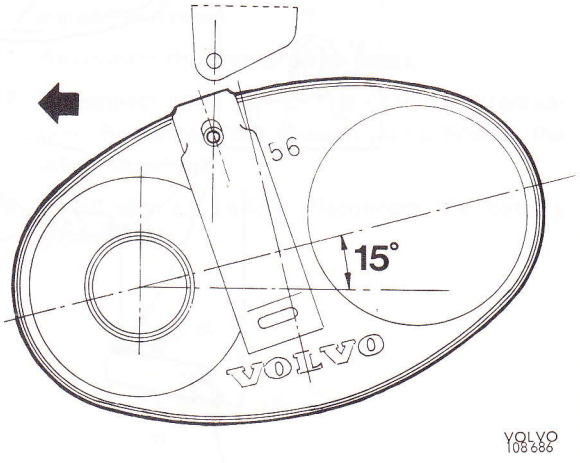
1. Loosen the clamps for the front muffler.
2. Remove the intermediate pipe from the front muffler.
3. Remove the front muffler suspension rings. Use a screwdriver to pull the rubber rings off the brackets.
4. Pull the front muffler loose from the front pipe.
5. Remove the rear muffler suspension rings and remove intermediate pipe, rear muffler and rear pipe as a unit.
6. Remove air cleaner and battery. Disconnect the vacuum hose at the EGR valve and remove the EGR valve. Remove lower pipe and nipple with washer from the front pipe.
7. Remove the front pipe nuts at the manifold flange, and the clamp at the transmission.
8. Remove the front pipe.
9. Position a new gasket on the manifold flange. Position the front pipe with the clamp at the transmission.
10. Install the flange nuts.
11. Install nipple with washer on the front pipe. Install the lower pipe and the EGR valve on the lower pipe, but do not tighten. Position the EGR valve to the upper pipe. Tighten the two nuts on the lower pipe, start at the EGR valve. Connect the vacuum hose to the EGR valve. Install battery and air cleaner.
12. Tighten the clamp at the transmission.
13. Position clamp on the front pipe and install the front muffler on the front pipe, the pipe ends joint approx. 40 mm = 1 1/2".
14. Install the front muffler rubber rings, use a screwdriver and push the rings over the bracket.
15. Install the rear muffler rubber rings on the floor brackets.
16. Position clamps on the rear muffler and install the rear pipe in the rear muffler, approx. 40 mm = 1 1/2".

    NOTE: Rear muffler P/N 461356 and P/N 460981 are marked "IN" at the end towards the intermediate pipe (inlet to the muffler).
17. Install the intermediate pipe in the rear muffler, approx 40 mm = 1 1/2". Lift up the unit, now consisting of intermediate pipe, rear muffler, rear pipe and attach the rear muffler to the rubber rings.
18. Position clamp on the front muffler and connect the intermediate pipe to the front muffler.
19. Adjust the position of the rear muffler. Adjust by turning the rear muffler, also by changing position of the front muffler on the front pipe.



Position of round rear muffler

Round rear muffler: The muffler brackets should be aligned immediately under the body brackets. A line through the muffler bracket and the muffler center should deviate approx. 4° from vertical.



Position of oblong rear muffler

Oblong rear muffler: The muffler brackets should be aligned immediately under the body brackets. The muffler should deviate forwards (front end lower than rear end) approx. 15° from vertical.

20. Tighten all clamps, clamp positioned over slotted parts.

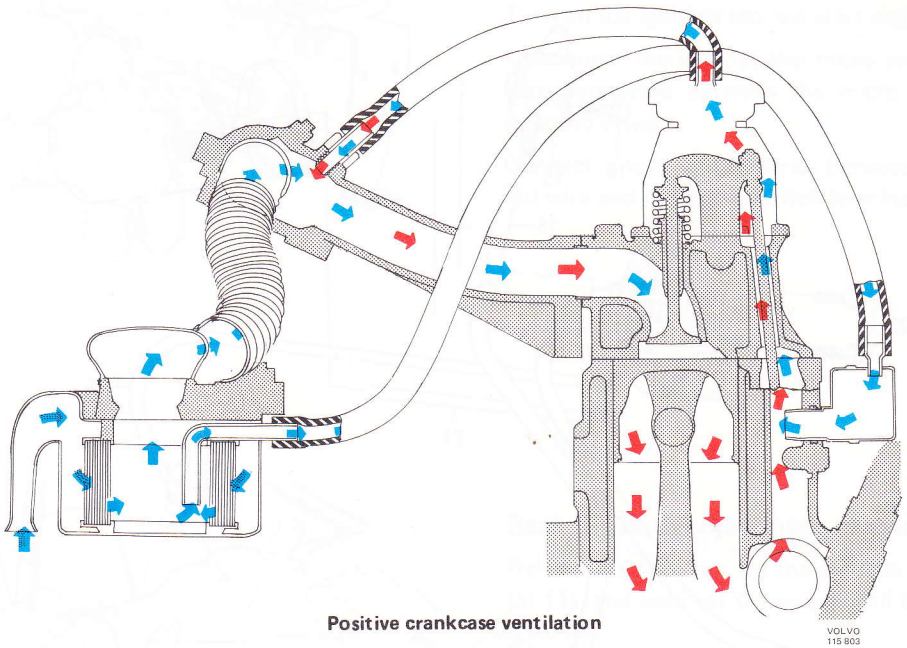
Group 25 B

Emissions Control Systems

Positive crankcase ventilation

Overhaul

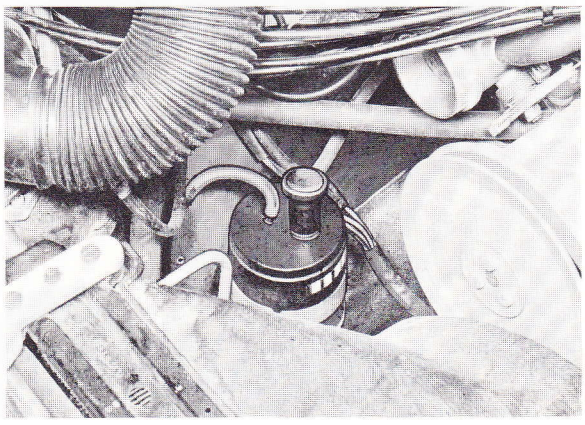
Nipple "3" and Flame Arrester "5" should be removed and cleaned every 15000 miles. Check the hoses at the same time and replace whatever necessary.



Positive crankcase ventilation

1. Cleaner insert
2. Hose for fresh air supply
3. Nipple (orifice)
4. Hose for crankcase gases
5. Flame arrester

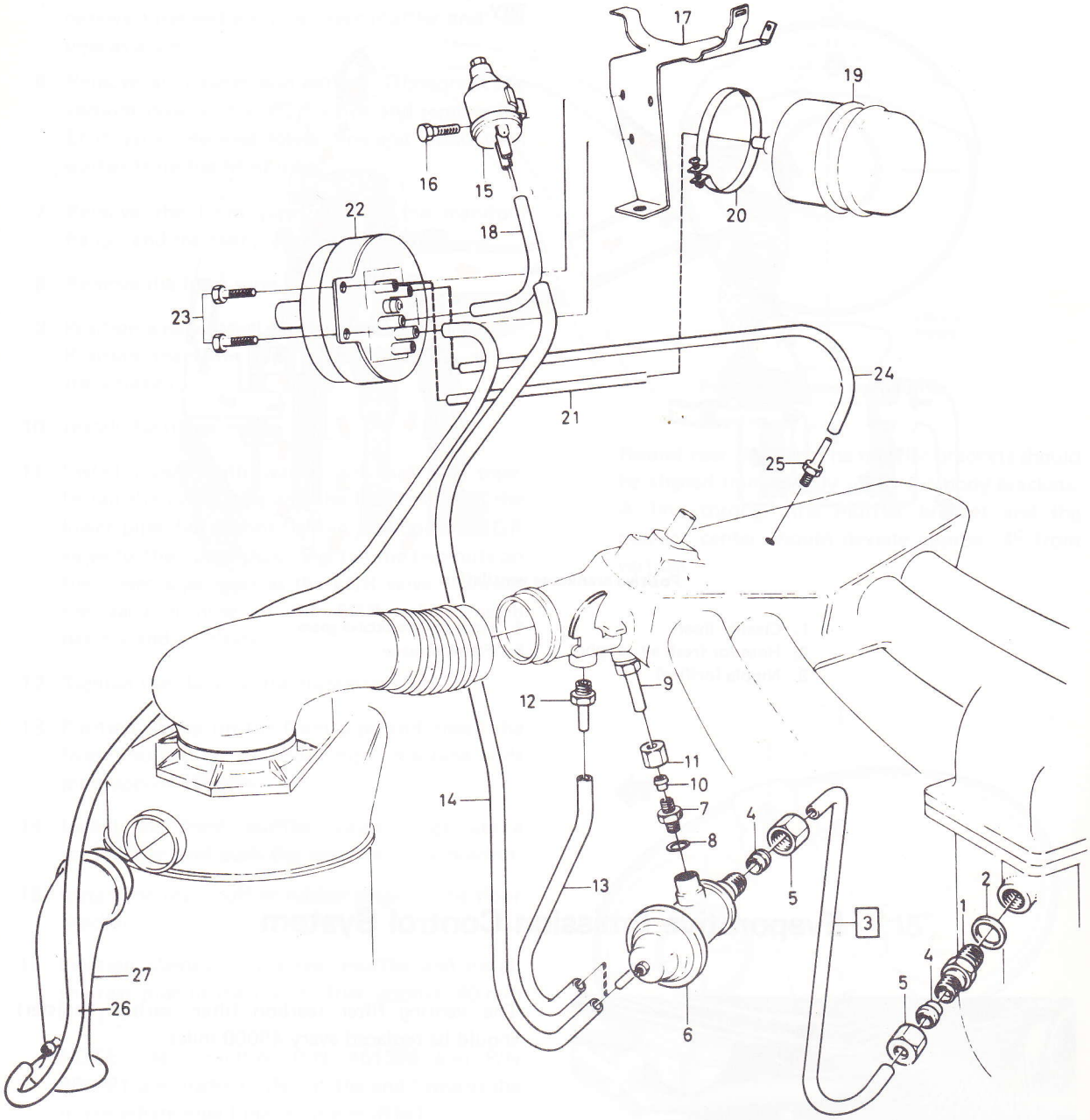
Evaporative Emission Control System



The venting filter (carbon filter, carbon canister) should be replaced every 45000 miles.

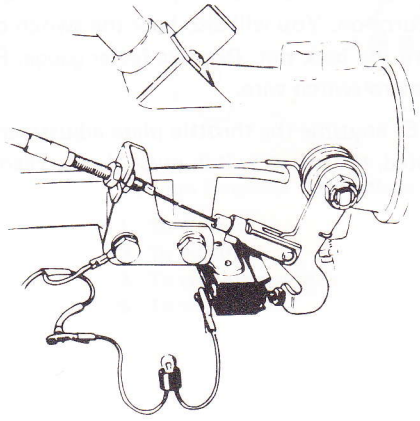
Exhaust Gas Recirculation System

"EGR"



VOLVO PARTS
1 023 13078

Adjustment of throttle and micro switch

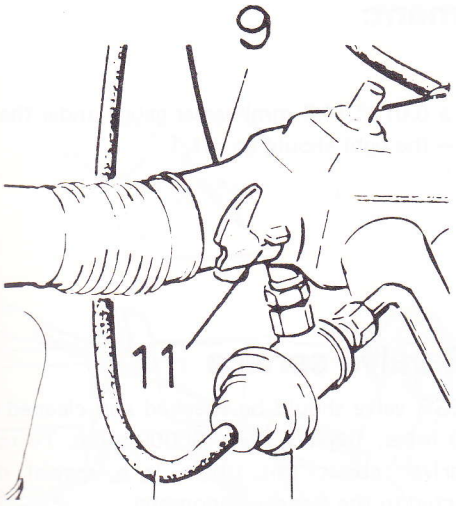


Ignition on.
Connect test light.

Turn on the ignition (do not start engine).

Disconnect the wire at the micro switch (this is the wire connected between the micro switch and the solenoid valve).

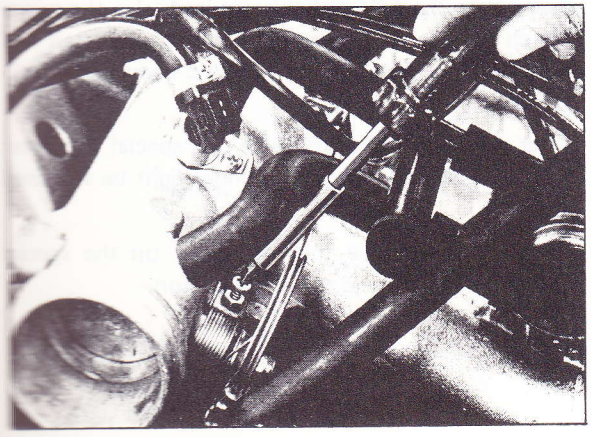
Connect a test light in series between the disconnected wire and the micro switch terminal.



Back off both adjustment screws.

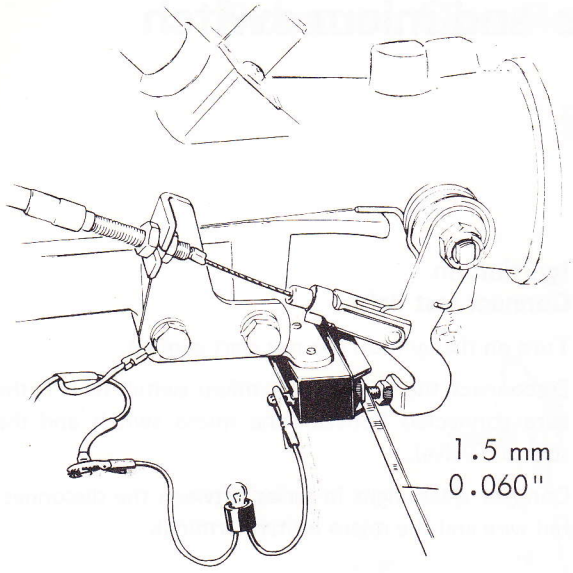
Release the lock nut on the throttle plate stop screw (at 11), and back off the screw until the throttle plate is closed.

Also, release the lock nut on the micro switch (at 9) and back off its screw so it does not interfere with setting the throttle adjustment. The test light should go out, and stay out for now.



Adjust throttle screw.

Turn the Throttle plate stop screw until it touches the stop, and add 1/2 turn. Secure the lock nut. Check that the throttle plate is free, and not binding, in closed position.



0.056" – light on
0.072" – light out

Adjust micro-switch screw.

Insert a 0.060" feeler gauge under the throttle stop screw. Test light should still be out at the micro switch.

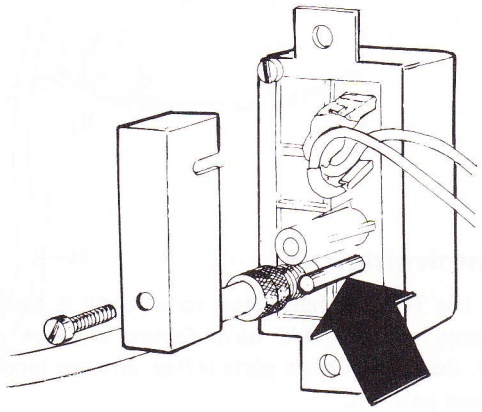
Then turn in the micro switch screw until the light just turns on. You will also hear the switch click. Secure the lock nut. Remove feeler gauge. Reconnect the micro switch wire.

NOTE: anytime the throttle plate adjustment screw is adjusted, the micro switch must also be readjusted.

Check of adjustment:

Insert a 0.056" (1.4 mm) feeler gauge under the throttle plate stop screw – the test light should stay on.

Insert a 0.072" (1.8 mm) feeler gauge under the stop screw – the light should go off.



EGR valve service

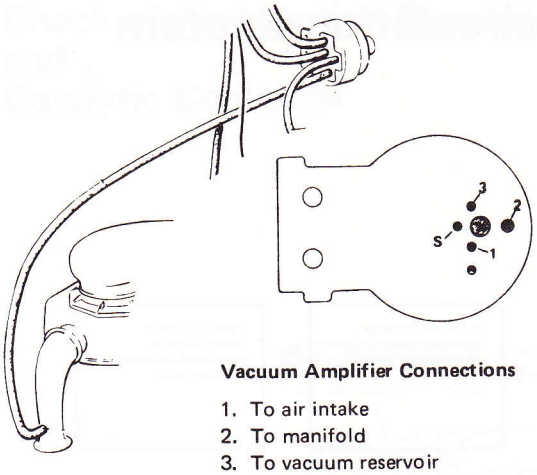
The EGR valve should be checked and cleaned every 15000 miles. Replace every 30000 miles. To remind the driver about this, there is a special device connected to the standard odometer.

It is located under the dash board and after 15000 miles of driving it switches on a reminder light on the dash board (in the combined instrument).

Every time the EGR valve is serviced, also the micro switch for the EGR system should be adjusted and the retaining bolts for the catalytic converter check-torqued.

After servicing the EGR valve, the special odometer should be zeroed and the reminder light be switched off.

To do this, remove the rear cover on the special odometer and depress the white button.



Vacuum Amplifier Connections

1. To air intake
2. To manifold
3. To vacuum reservoir
S. To solenoid

Test the EGR valve

Start engine – connect vacuum pump.

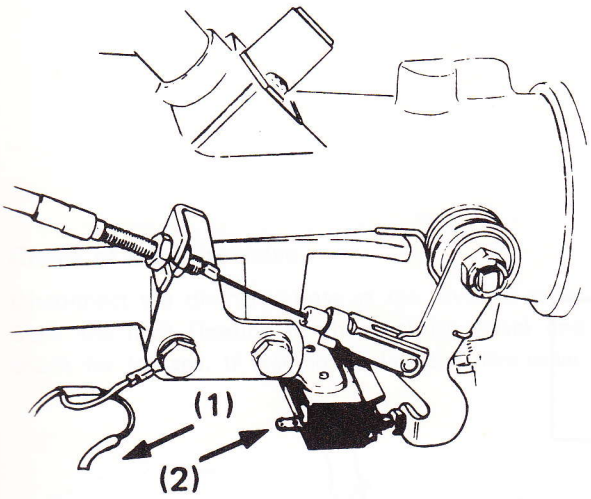
Start engine. Let idle.
Remove the air intake hose from the vacuum amplifier, at connection number 1.

Connect the vacuum pump or any other suction device to the outlet number 1 on the vacuum amplifier.

Apply vacuum

The EGR valve should not open, i.e. the idling should not change.

Check that the system holds a vacuum for approximately 10 seconds.



Check EGR function electrically

With vacuum still applied on outlet number 1, disconnect the wire from the micro switch.

The EGR valve should open. That is, the engine should idle poorly or it will stop.

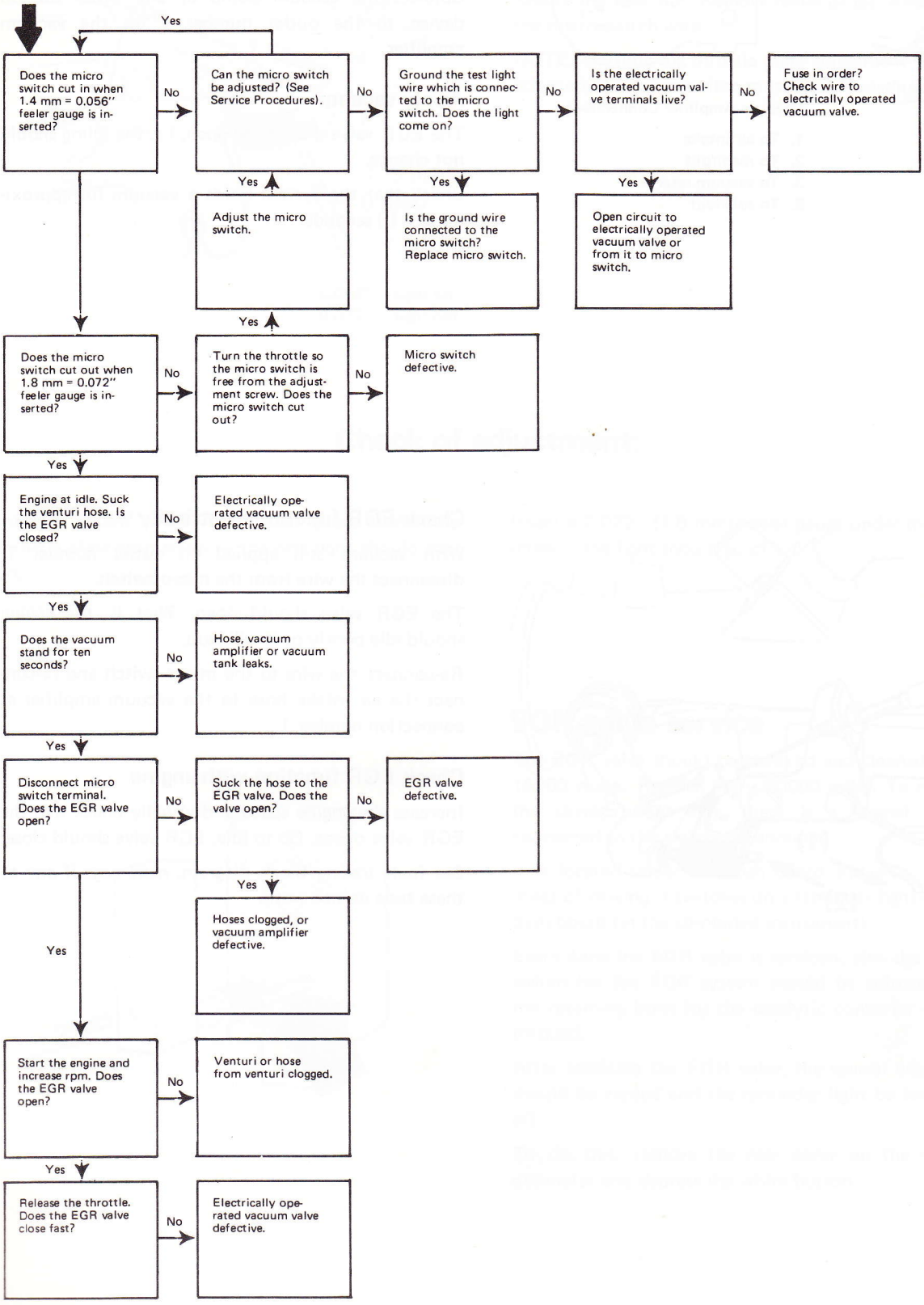
Re-connect the wire to the micro switch and re-connect the air intake hose to the vacuum amplifier at connection number 1.

Check EGR function with engine

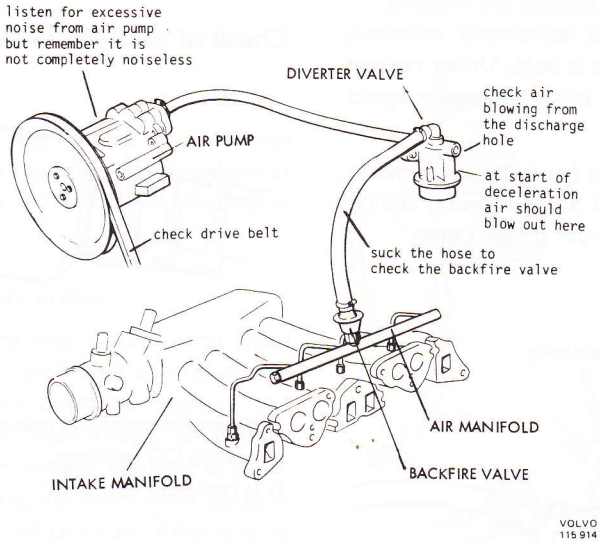
Increase the engine speed and visually check that the EGR valve opens. Go to idle, EGR valve should close.

See fault tracing block diagram, next page if any of these tests do not work.

Check of Exhaust Gas Recirculation System

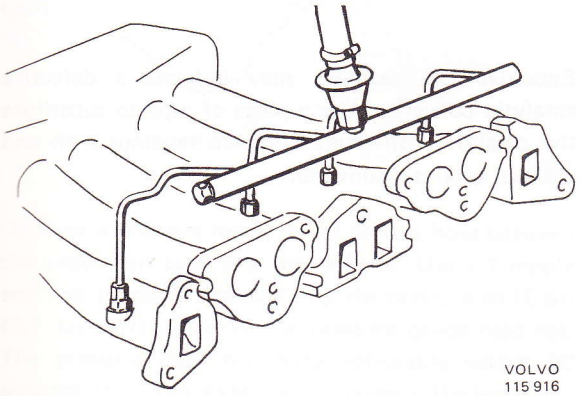


Check of Air Injection Reactor System and Catalytic Converter



Check of backfire valve

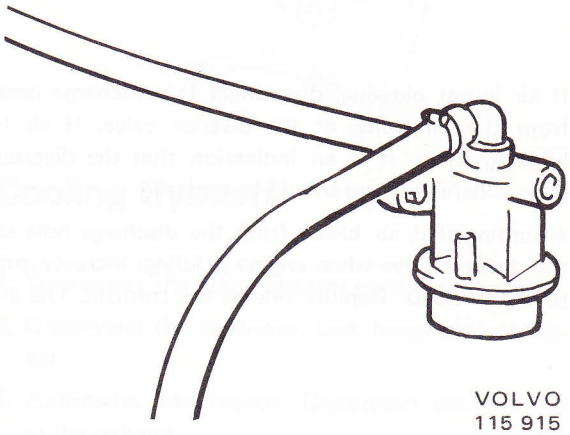
Disconnect the discharge hose at the diverter valve. Suck the hose (leading to the backfire valve) and check for leakage. If leaking, replace backfire valve.



Reconnect the hose and start engine. Rapidly increase rpm. If backfiring occurs, the valve is defective and should be replaced.

Check of diverter valve

Disconnect the discharge hose at the diverter valve and block it with plug or tongs (preventive measure).



Check that air is blowing from the discharge hole when engine is idling. (Do not attempt to block the outlet, especially not a higher speeds, as this could ruin the air pump if the diverter valve is defective.)

Check of drive belt

Check condition and tension. If the drive belt is broken, the backfiring valve must be checked.

NOTE: If V-belt for the pump breaks, the backfire valve must be replaced.

Check of air pump

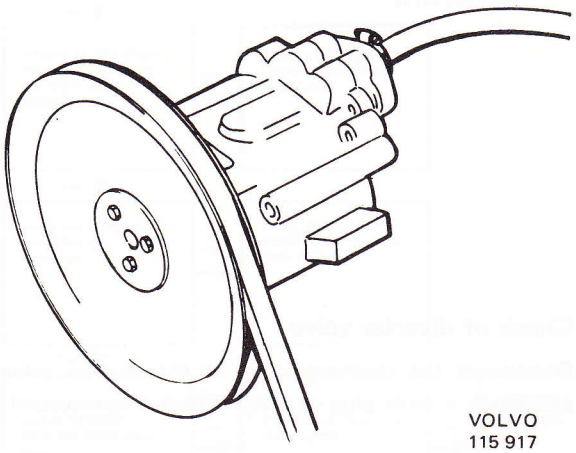
(Do not lubricate or repair)

Start engine and listen for excessive noise from pump.

NOTE: the Air system is not completely noiseless, especially not when the pump is cold. Under normal circumstances noise rises in pitch as engine speed increases.

Disconnect the discharge hose from the air pump at the diverter valve. Check that air is blowing but do not block the hose as it could ruin the air pump.

Possible air pump faults:
- air leak
- pump touching other components
- pump loose
- pump out of order



VOLVO
115 917

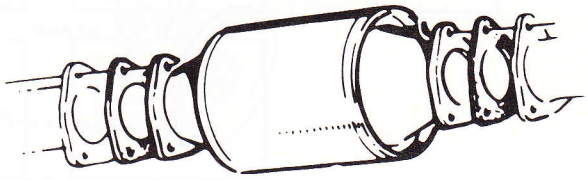
If air is not blowing, disconnect the discharge hose from the air pump at the diverter valve. If air is blowing there, it is an indication that the diverter valve is defective and should be replaced.

Assuming that air blows from the discharge hole of the diverter valve when engine is idling: increase rpm to 3500–4000. Rapidly release the throttle. The air stream from the discharge hole should cease for a couple of seconds. Instead it should blow from the five holes in the side of the valve.

If air does not blow through the holes, it is an indication that the vacuum signal function is inoperative.

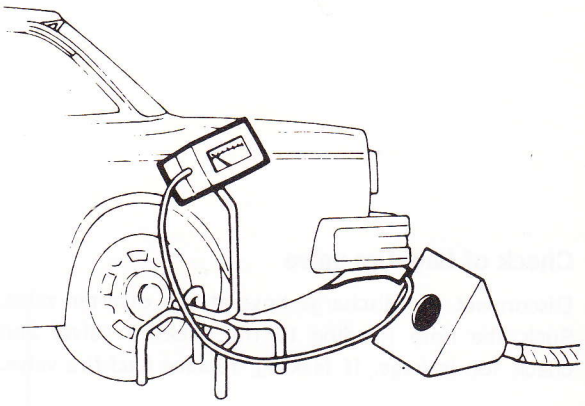
It could be a defective diverter valve or blocked vacuum lines.

Check of catalytic converter



VOLVO
115 913

A defective catalytic converter would be indicated by excessive CO readings.
It is replaced as a unit.



VOLVO
115 912

Excessive CO readings may indicate a defective catalytic converter. Use a piece of pipe to substitute the catalytic converter. Compare readings with and without catalytic converter.

Group 26

Cooling System

Topping up with coolant

Top up with coolant when the level in the expansion tank is at the "Min" mark. Use a mixture consisting of 50 % ethylene glycol and 50 % water.

NOTE: Never top up with water only.

Draining cooling system

When draining the coolant first remove the expansion tank cap. Then disconnect the lower radiator hose at the radiator and open the drain cock at the engine right side.

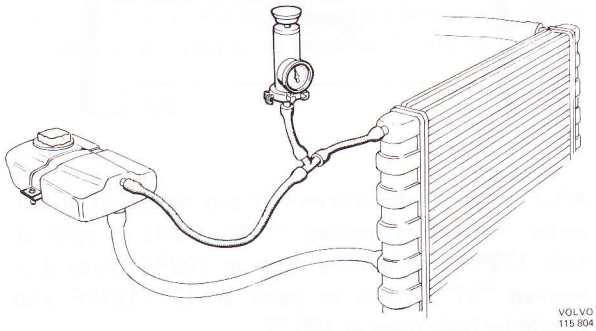
Filling coolant into an empty system

Before filling, flush the cooling system with clean water. When filling coolant, the heater control should be set at max. heat. Fill until the level in the expansion tank is at the "Max" mark or slightly higher. Run the engine for several minutes at different speeds. If necessary top up with more coolant and then install the expansion tank cap. After driving for a while check the coolant level again and top up with more coolant. It will take some time before the system is completely emptied of air.

Cooling system leak test

Op. No. 26006

Check the cooling system for leaks as follows:

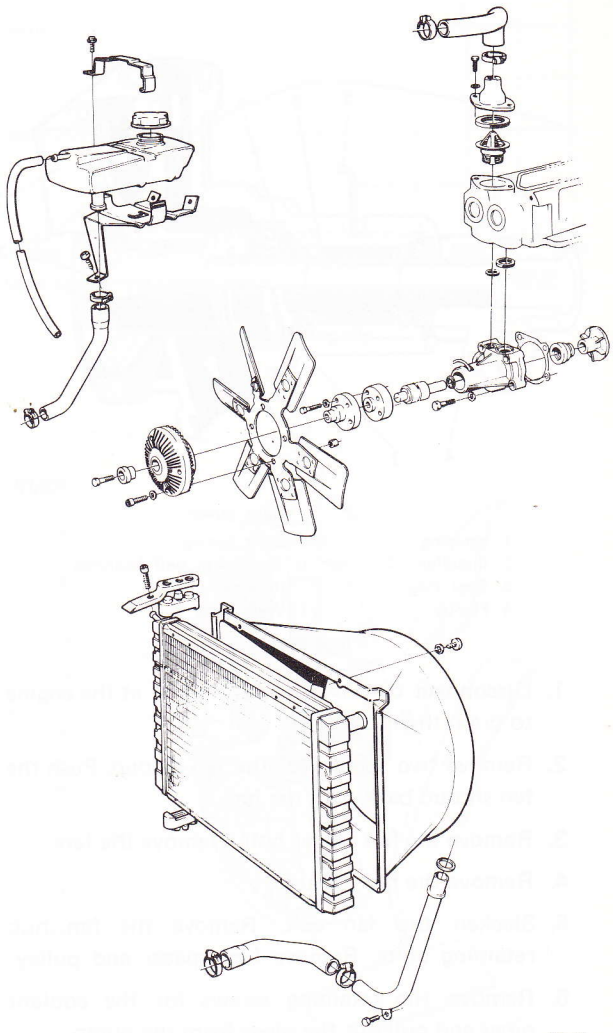


Connect a pressure tester to the narrow hose between the expansion tank and the radiator. Use a T-nipple and two pieces of hoses. Pump the pressure to 10 psi (0.7 kp/cm2). Observe the pressure gauge readings. The pressure must not drop noticeably within 30 seconds. If it does, examine and remedy the leak.

Replacing radiator

Op. No. 26108

1. Disconnect the lower radiator hose at the radiator to drain the coolant.



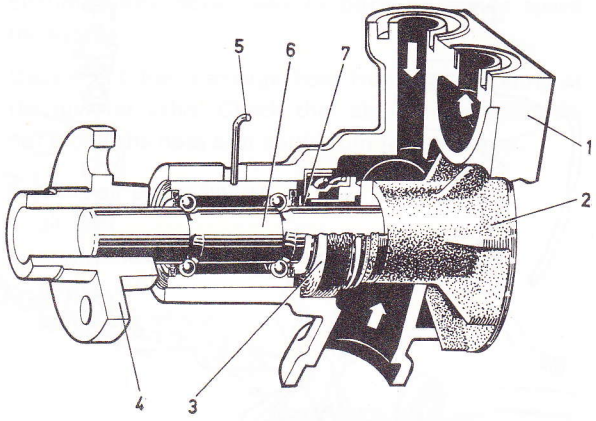
Cooling System

2. Disconnect the upper radiator hose at the radiator.
3. Disconnect the expansion tank hoses at the radiator.
4. Automatic transmission: Disconnect the oil pipes at the radiator.
5. Remove two screws for the fan shroud and move the fan shroud rearwards.
6. Remove the radiator retainers. Lift up the radiator.

7. Position the new radiator and install the retainers. The fan shroud should be positioned over the fan.
8. Install the fan shroud.
9. Re-connect the hoses at the radiator. Automatic transmission: re-connect oil pipes.

Replacing water pump

Op. No. 26202



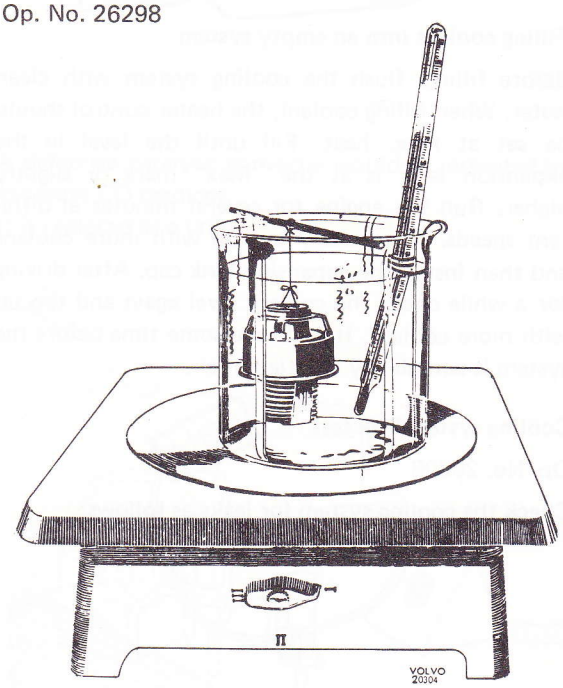
Water pump

1. Housing
2. Impeller
3. Seal ring
4. Flange
5. Lock spring
6. Shaft with ball bearings (integral unit)
7. Wear ring

1. Disconnect the lower radiator hose at the engine to drain the coolant.
2. Remove two screws for the fan shroud. Push the fan shroud back over the fan.
3. Remove the fan center bolt. Remove the fan.
4. Remove the fan shroud.
5. Slacken the fan belt. Remove the fan hub retaining bolts. Remove fan, spacer and pulley.
6. Remove the retaining screws for the coolant pipes and pull out the pipes from the pump.
7. Remove the pump retaining bolts. Remove the pump.
8. Remove gasket residues, etc., on the cylinder block mating surface.
9. Install the seal rings on the pump top side and rings on the pipes.
10. Fit a new gasket on the pump block side.
11. Install the pump. The upper coolant pipe should be positioned in the pump. Press the pump up against the cylinder head extension in order to achieve good sealing between pump and cylinder head.
12. Install the lower coolant pipe. Carefully press the pipe into the pump before the retaining screws are tightened.
13. Install lower radiator hose.
14. Install pulley, spacer and fan hub.
15. Install and tighten the fan belt. It should be possible to depress the pump approx. 3/8" halfway between alternator and water pump pulleys, using a "normal" thumb pressure.
16. Locate the fan shroud over the pulley.
17. Install the fan. Attach the fan shroud.
18. Fill coolant.

Thermostat

Op. No. 26298



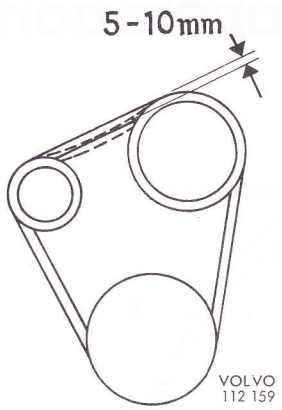
After removal, the thermostat can be tested in hot water. Type 1 is marked "170", starts to open at 168–172°F and is fully open at 192°F. Type 2 is marked "82", starts to open at 177–181°F and should be fully open at 195 °F.

Replace a defective thermostat. Use a new gasket when installing.

Tensioning drive belt

Adjust drive belt = Op. No. 26205
Replace drive belt = Op. No. 26212

Tension the belt so that it can be deflected approx. 3/8" halfway between water pump pulley and alternator pulley.



Fan belt tension

The belt length between the two pulleys may influence the tension. With the tensioner bolt at the end of the slot (long belt) the force applied should be lower. With the bolt at the beginning of the slot (short belt) a higher force should be applied.

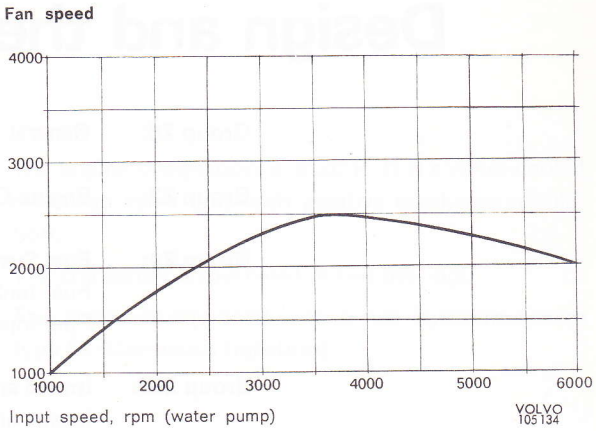
NOTE: The alternator must not be obliquely loaded. If a lever is used to adjust, it should be placed between the engine and the front end of the alternator.

Note that if the lower alternator retaining bolt is not slackened during adjustment, there will be heavy stresses on the drive end bearing shield.

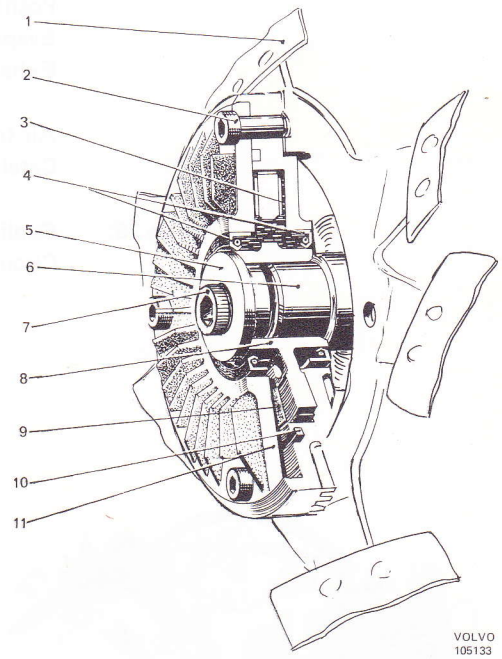
On installing a new belt, a second tensioning should be made after approx. 10 minutes of driving.

Viscous fan drive

This can be checked with a stroboscope. Make one mark on the fan and one on the water pump pulley. Use the stroboscope to find the speed relationship between them. The fan speed should be according to the curve below.



Fan coupling slip



Viscous fan drive

1. Fan blade
2. Bolt
3. Oil
4. Seals
5. Washer
6. Flange, water pump
7. Center bolt
8. Hub
9. Friction material
10. Rubber ring
11. Housing

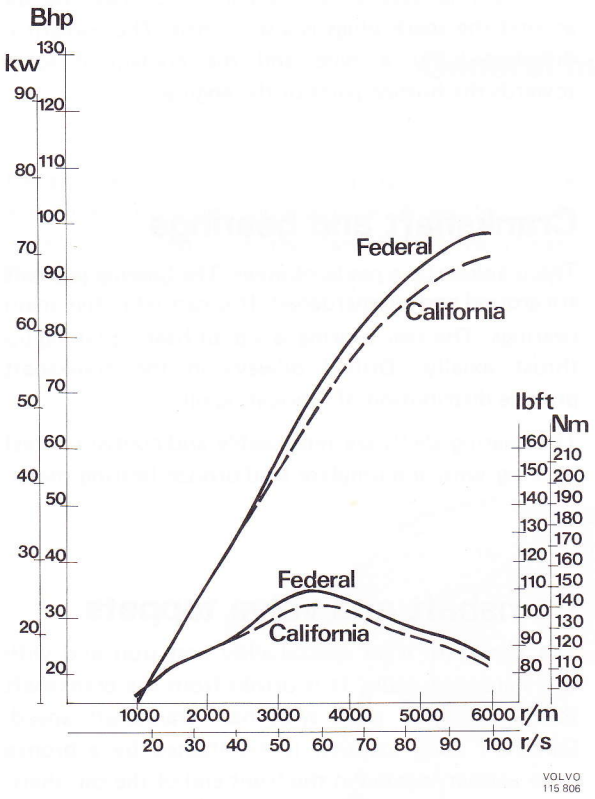
Section 2

Engine

Design and theory of operation

Group 20

General Information

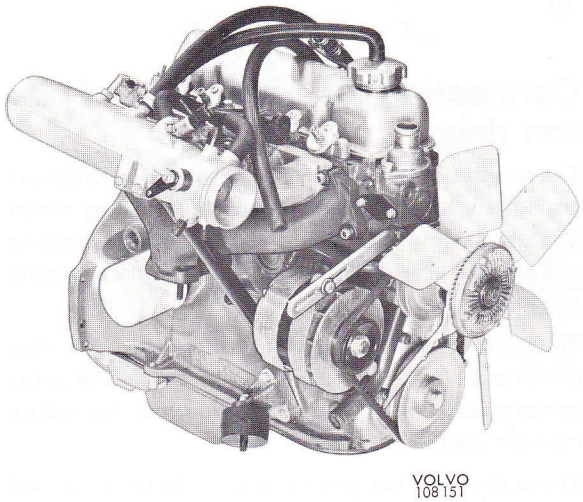


Output and torque

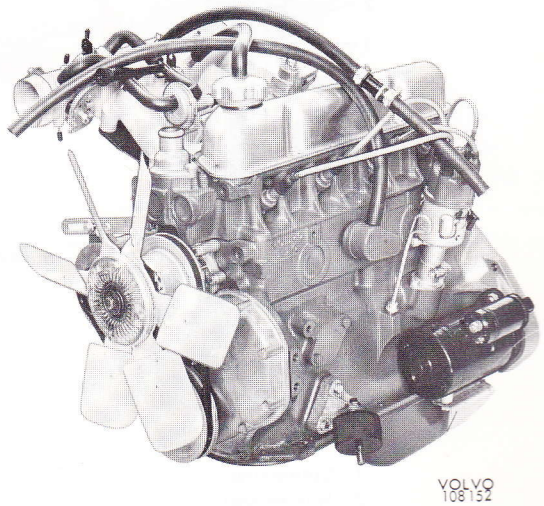
The engine designation is B 20 F. It is a water-cooled over-head valve unit with positive crankcase ventilation.

The crankshaft is journaled in five bearings.

The engine is equipped with a fuel injection system type CI (Continous Injection).



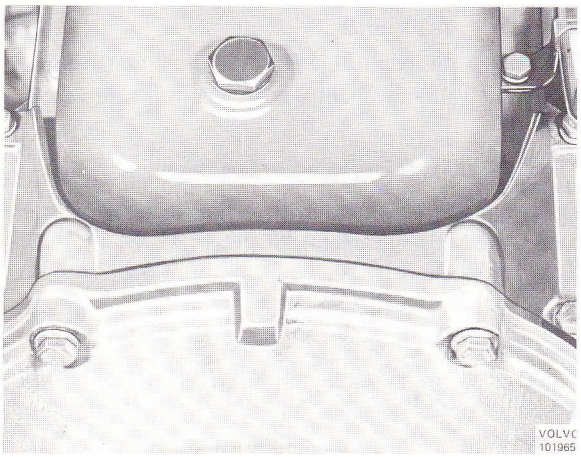
Engine B20F, right view



Engine B20F, left view

Cylinder block

The cylinder block is of special cast iron and made in a single unit. The cylinder bores are surrounded by cooling jackets and machined directly in the block. The oilways in the block are arranged so that the oil filter is directly attached to the right side of the block. The oil filter is of the full-flow type. A brace to take up vibrations is attached to the cylinder block and the flywheel housing.

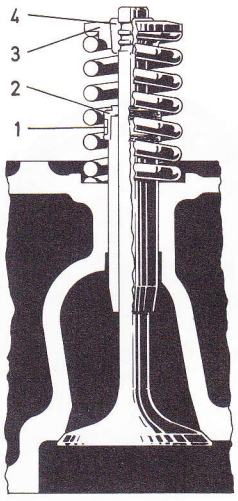


Brace between cylinder block and flywheel housing

Cylinder head and valves

The cylinder head is attached to the block by bolts. All the combustion chambers are machined. There are separate inlet and exhaust ports, one for each valve.

The valves are made of special steel and with the stems chromed. The guides are replaceable.



1. Spring ring
2. Rubber seal
3. Spring retainer
4. Spring retainer locks

The valve spring retainer locks are provided with three lands and the valve stem with corresponding grooves which make suitable rotation possible. The valves are provided with valve guide rubber seals, mounted on the guides.

The cooling jackets are designed so that the air around the spark plugs is also cooled. The coolant is distributed by a pipe and the coolant directed towards the hottest parts of the engine.

Crankshaft and bearings

The crankshaft is made of steel. The bearing journals are ground and casehardened. It is carried in five main bearings. The rear bearing is a pilot bearing taking up thrust axially. Drilled oilways in the crankshaft provide distribution of lubricating oil.

The bearing shells are replaceable and consist of steel backing with indiumplate lead-bronze bearing metal.

Camshaft and valve tappets

The camshaft is of special-alloy cast iron and with case-hardened cams. It is driven from the crankshaft through a gear train with half crankshaft speed. Camshaft axial location is maintained by a bronze axial washer located at the front end of the camshaft. Axial play is determined by a spacer ring behind the camshaft gear which has a steel hub.

The valve tappets are actuated directly by the camshaft. They are located in holes in the block above the camshaft and transfer movement to the valves by push rods and rocker arms. There are no inspection covers for the valve tappets since these are accessible after the cylinder head has been removed.

Connecting rods, pistons and piston rings

The connecting rods are made of drop-forged steel and provided with a precision machined bushing which acts as a bearing for the piston pin. The connecting rod big-end bearing shells are precision-manufactures and replaceable.

The pistons are made of light-alloy and have two compression rings and one oil scraper ring. The upper compression ring is chromed in order to reduce cylinder wear.

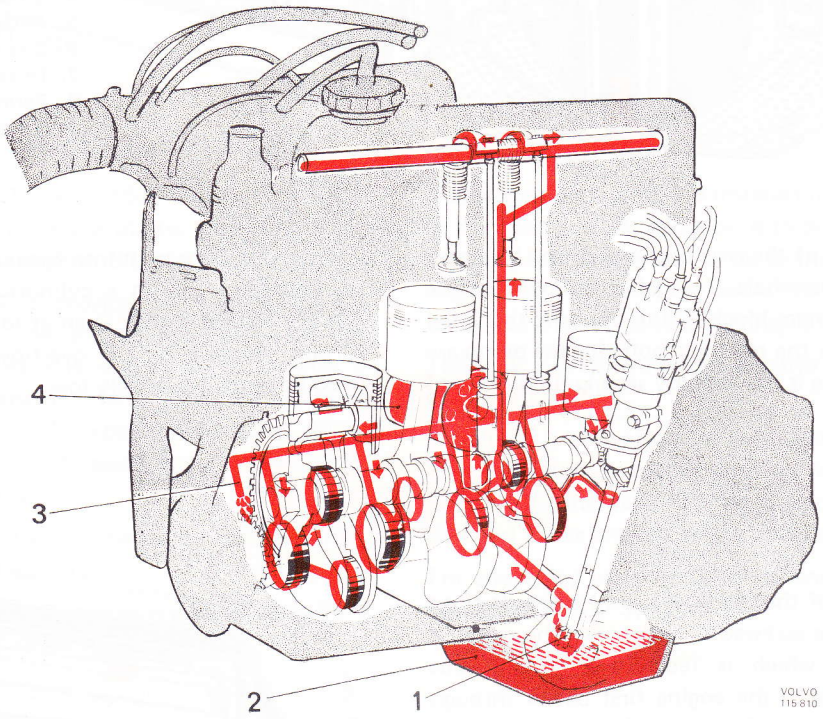
The piston pin has a floating fit in both piston and connecting rod. The axial movements of the piston pins are limited by snap rings in the piston pin hole.

Group 22

Engine oiling system

General information

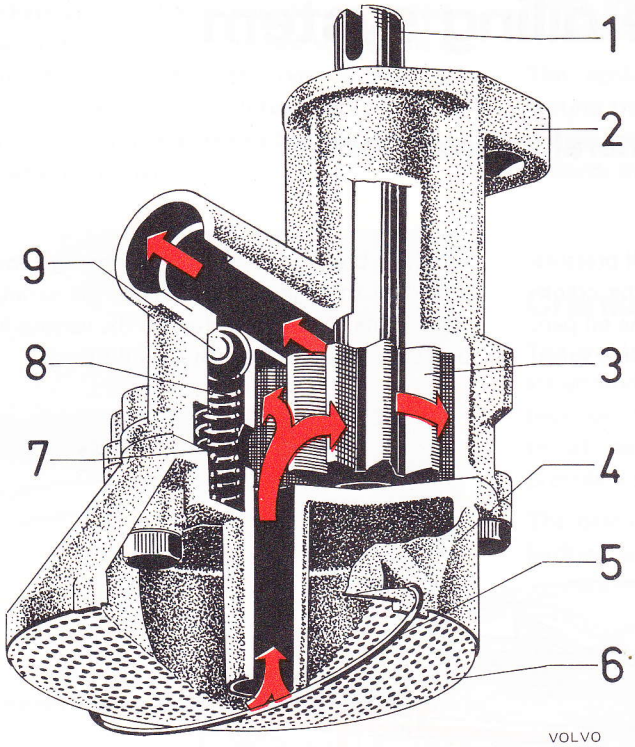
The engine has a force-feed oiling system. Oil pressure is provided by a gear pump driven from the crankshaft. It is located under the crankshaft in the oil pan. The gear pump forces the oil past the relief valve, which is built in to the pump, through the oil filter and then through oilways out to the various lubricating points. All oil supplied to the various lubricating points first passes through the oil filter.



Engine oiling system

1. Oil pump
2. Oil pan
3. Nozzle
4. Oil filter

Oil pump and relief valve



VOLVO
115 809

Oil pump

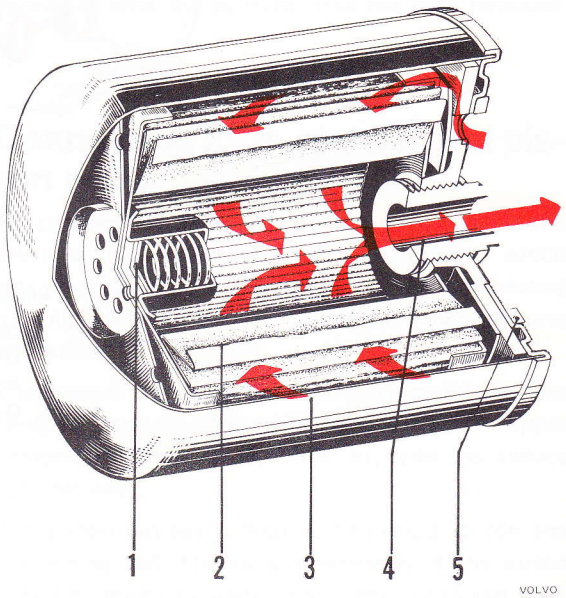
1. Drive shaft
2. Pump body
3. Driving gear
4. Cover
5. Retainer clip
6. Strainer
7. Drive gear
8. Spring for relief valve
9. Valve ball

The oil pump is of the gear type and driven by a gear train from the camshaft. The delivery pipe from the pump to the cylinder block is automatically tightened in position when the retaining bolts for the pump are tightened. Sealing is provided by sealing rings made of special rubber.

The relief valve is built into the pump. It consists of a spring-loaded ball in a cylindrical guide, operating flexibly against a seat. Even at idling speed there is a certain amount of oil overflow, so that the oil pressure is then relatively low.

Oil filter

The oil filter is of the full-flow type. It consists of an oil filter cartridge screwed directly onto the cylinder block. The oil which is fed out to the various lubricating points in the engine first passes through the oil filter element which is made of special paper. In the oil filter cartridge there is also a by-pass valve which allows the oil to by-pass the element if resistance to flow should become excessive. When replacing the filter, the old one is discarded and a new one installed.



VOLVO
109 021

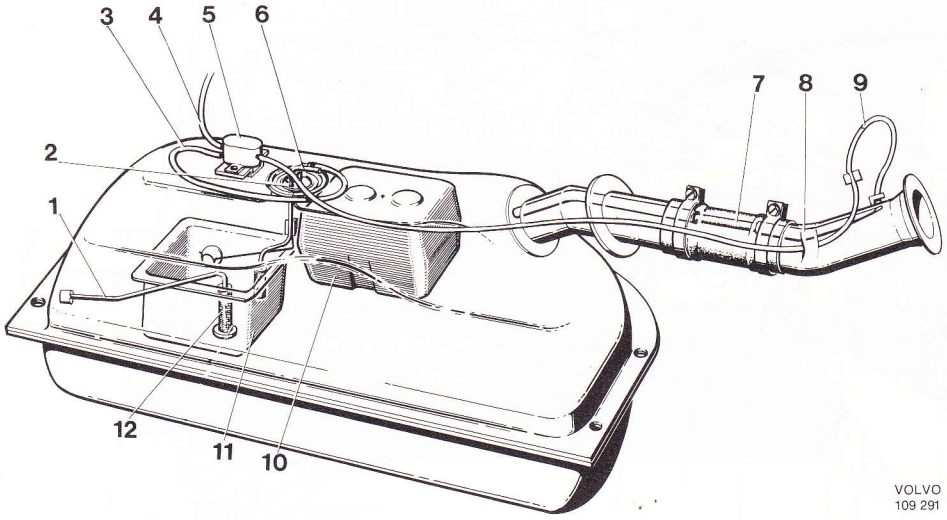
Oil filter

1. Relief valve
2. Element
3. Body
4. Nipple
5. Gasket

Group 24

Fuel system

Fuel tank



Fuel tank

1. Fuel output
2. Level sender unit
3. Hose connecting tank and equalizing valve
4. Venting filter hose
5. Equalizing valve
6. Connection for return line
7. Hose
8. Breather pipe
9. Equalizing hose
10. Expansion tank
11. Baffle can
12. Fuel filter

Tank capacity: 60 liters = 15.8 US gals. = 13.2 Imp.gals. The volume of the plastic expansion tank inside the fuel tank is approx. 5 qts. = liters.

The expansion tank is provided with an equalizing hole on the upper side and an access hole on the underside. The excess hole is sized to accomplish a slow filling of the expansion tank. When the fuel tank is filled to capacity, the expansion tank has still a capacity to absorb the increased fuel volume caused by rising temperatures.

The tank is equipped with a baffle can with the fuel outlet through the filter "12".

The fuel return line from engine is connected to "6".

A fuel (tank) filter "6" is installed in the suction line in the fuel tank. Its function is to prevent any dirt in the tank from being sucked up to the fuel pump. The filter should be cleaned every 15 000 miles. It is accessible after the tank drain plug has been removed.

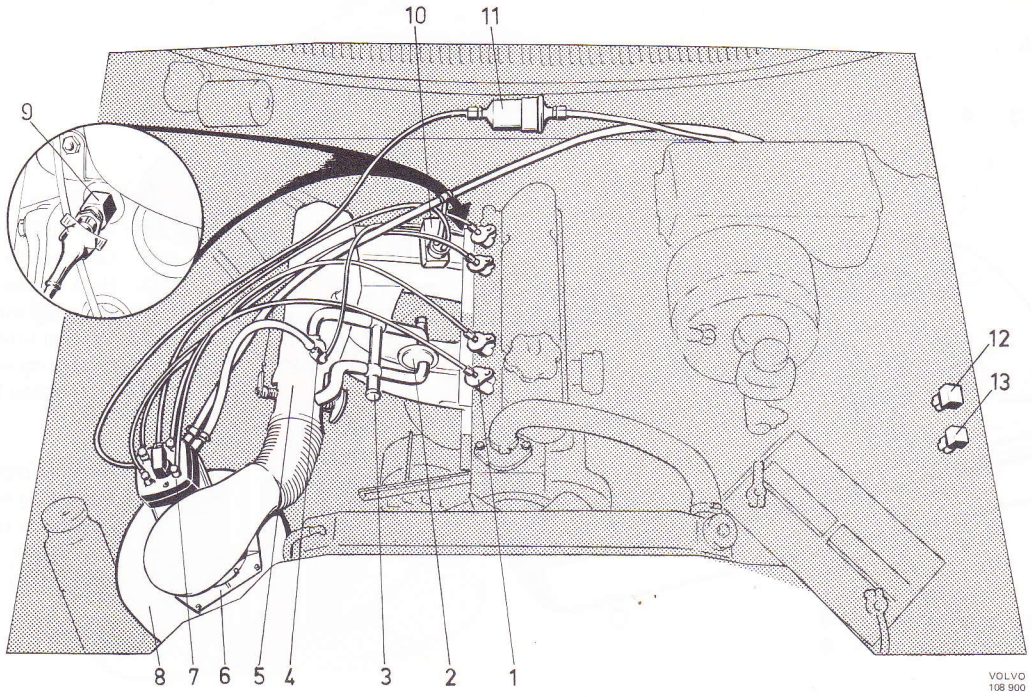
The tank is provided with a breather pipe "8" and an equalizer hose "9".

The hose is connected to the equalizing valve "5". The valve is also connected to the tank via the hose "3" and to the venting filter (carbon filter charcoal canister) in the engine compartment via hose "4".

For equalizing valve function see under "Evaporative Emission Control System".

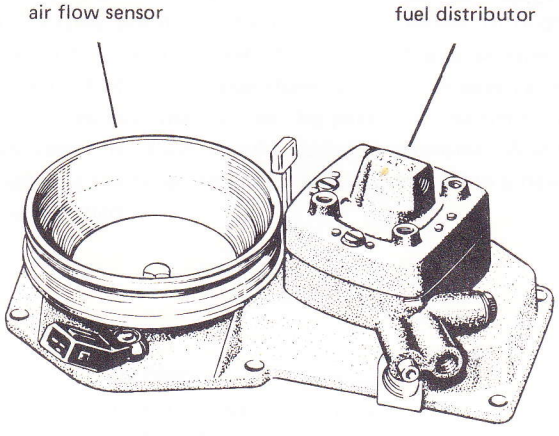
CI System

General



CI Fuel Injection System

1. Injector
2. Auxiliary air valve
3. Idle adjustment screw
4. Cold start injector
5. Intake manifold
6. Air flow sensor
7. Fuel distributor
8. Air cleaner
9. Thermal time switch
10. Control pressure regulator
11. Fuel filter
12. 13. Safety relay and pump relay



Air-Fuel Control Unit

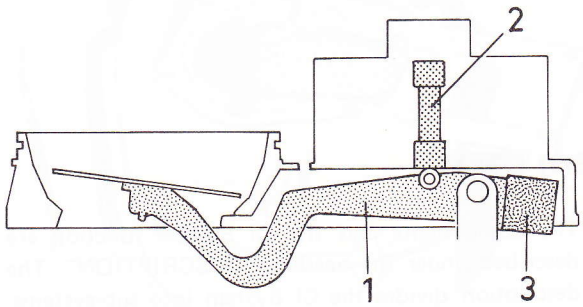
The B 20 E and B 20 F engines are equipped with a fuel injection system, called the CI System. CI stands for Continuous Injection, which means the injection valves of the system are always open, that is, are always injecting fuel when the engine operates. The amount of fuel is not controlled by variation of the injection time but through variation of the fuel flow through the injectors.

The CI-system principle is to measure continuously the air flow into the engine and let this air flow control the amount of fuel fed to the engine. The measuring of the induced air and the control of the fuel flow is provided by an air-fuel control unit which is the "heart" of the CI System. The air-fuel control unit consists of an air flow sensor and a fuel distributor.

The CI system fuel control principle

The air flow sensor consists of an air flow sensor plate in an air venturi.

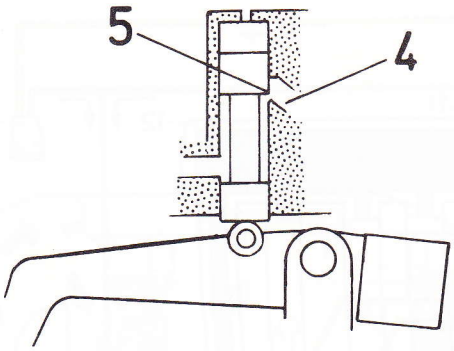
The air flow upwards through the air venturi lifts the air flow sensor plate to a position where the slot A is large enough to let the air pass through. A large air flow lifts the air flow sensor plate to a high position, a small air flow to a low position.



VOLVO
109 000

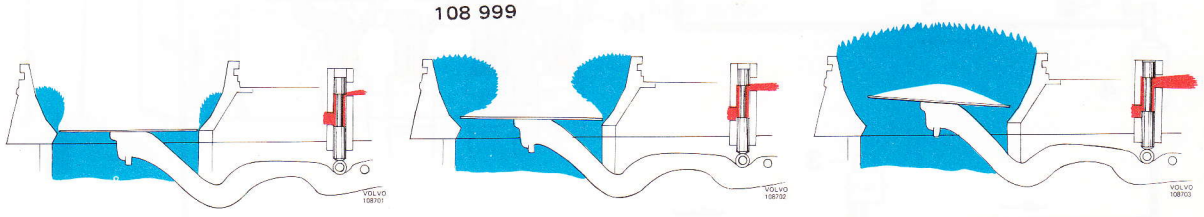
The movement of the air flow sensor plate is transferred by a lever 1 to a control plunger 2 in the fuel distributor.

The lever is provided with a balance weight 3 which equalizes the weights of the plate and the lever.

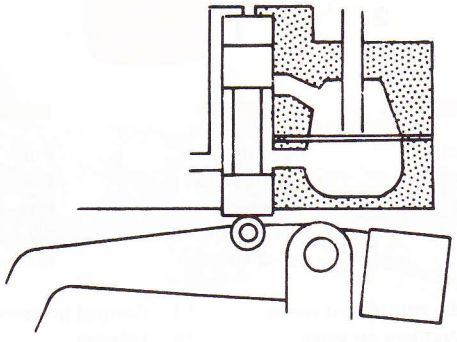


VOLVO
108 999

The control plunger is located in a cylinder (''barrel''), which is provided with four metering slots 4, one for each cylinder. When lifted, the edge 5 of the control plunger uncovers the metering slots. A high air flow sensor plate position (thus also a high control plunger position) corresponds to a large uncovered metering slot area; a low position to a small.

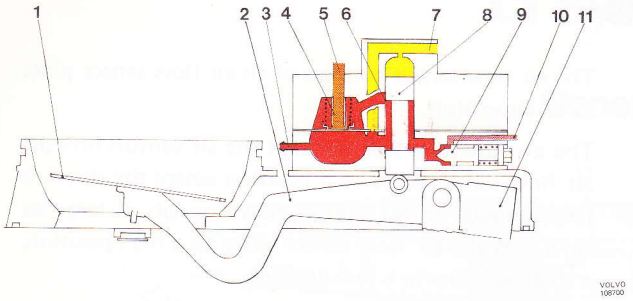


Idle **Part throttle** **Full throttle**



VOLVO
108 995

The difference between the fuel pressure ahead of the slot and after the slot must be constant in order to ensure that the fuel quantity passing through the metering slots is proportional to the uncovered metering slot area. This is ensured by four pressure regulating valves, one for each metering slot, which maintain a constant pressure drop of 0.1 kp/cm^2 = 1.4 psi over the slot.



1. Air flow sensor plate
2. Lever
3. From fuel pump
4. Pressure regulating valve
5. To injector
6. Control plunger head
7. To control pressure regulator
8. Plunger
9. Line pressure regulator
10. To fuel tank
11. Balance weight

The red color shows fuel flowing to and from the slots, the orange color fuel flowing to the injectors while the yellow color shows a control pressure which prevents the control plunger from reacting too heavily at vibrations and rapid increases of the induced air.

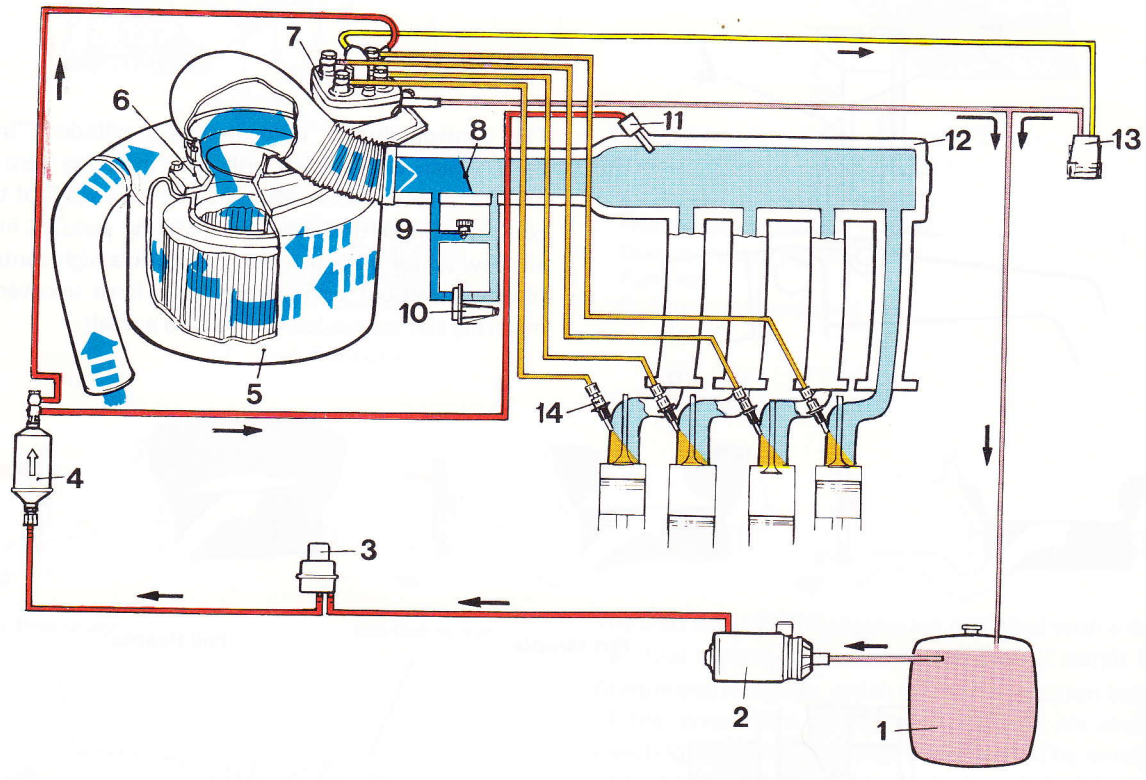
This is the CI System fuel control principle.

The CI system parts

Besides the fuel distributor, the CI System comprises several other components, which in cooperation achieve a good result at every driving condition.

The picture below shows the CI System parts.

The components and the CI System function are described under the heading "DESCRIPTION". The description divides the CI System into sub-systems: air system, fuel system and electrical system.



Air
Atmospheric pressure

Air
Under-pressure

Fuel
Line pressure 4.5 kp/cm^2

Fuel
Pressure-less

Fuel
Injection pressure, approx. 3 kp/cm^2

Fuel
Control pressure, approx 3.7 kp/cm^2 (hot engine)

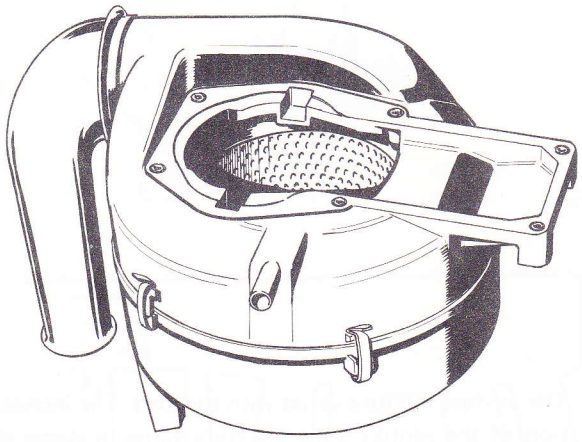
1. Fuel tank
2. Fuel pump
3. Pressure accumulator
4. Fuel filter
5. Air cleaner
6. Air flow sensor
7. Fuel distributor
8. Throttle
9. Idle adjustment screw
10. Auxiliary air valve
11. Cold start injector
12. Intake manifold
13. Control pressure regulator
14. Injector

Description

Air system

The air system comprises components necessary to clean, measure, control and guide the air to the engine cylinders: air cleaner, air flow sensor, throttle, intake manifold, as well as idle adjustment device and auxiliary air valve.

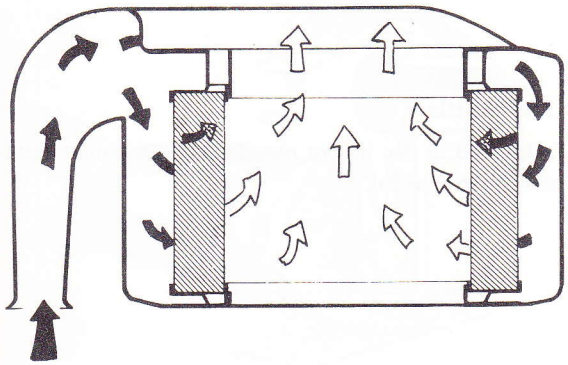
The components will be described in this order, that is, the description follows the air flow through the system.



VOLVO
108 902

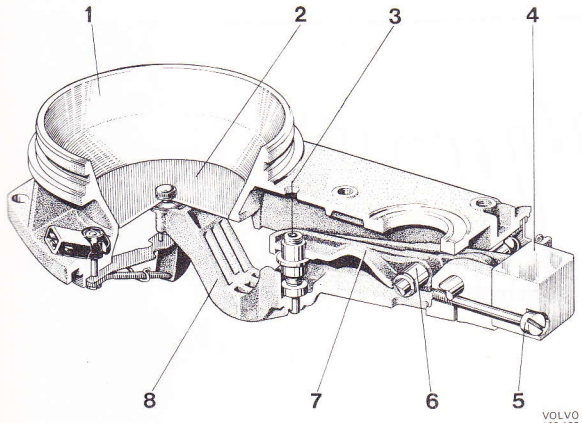
The air cleaner

has a replaceable paper type cartridge, which should be replaced every 40 000 km = 24 000 miles.



When the air passes from the air intake to the center of the air cleaner it passes the air filter which removes dust and dirt which could cause damage to the engine.

The air flows upwards from the air cleaner to the air flow sensor.



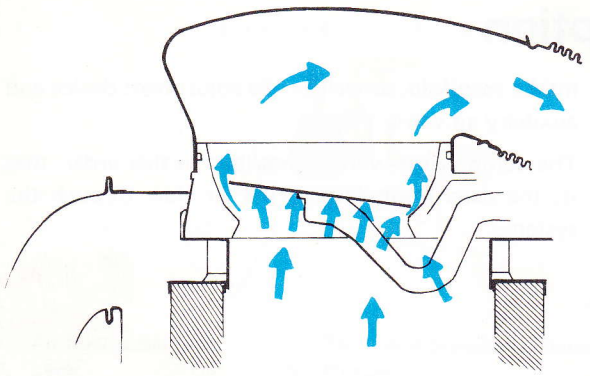
VOLVO
108 195

The air flow sensor

consists of an air venturi 1 and of an air flow sensor plate 2 moving in the air venturi.

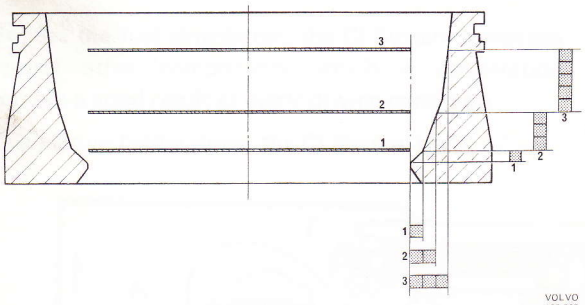
The air flow sensor plate is connected to the lever 8 which via the link 6 transfers the plate movement to the control plunger in the fuel distributor. The balance weight 4 compensates for the weight of lever and sensor plate.

The CO adjustment is achieved by the adjustment screw 3, and the lever 7 which control the basic location of the control plunger.



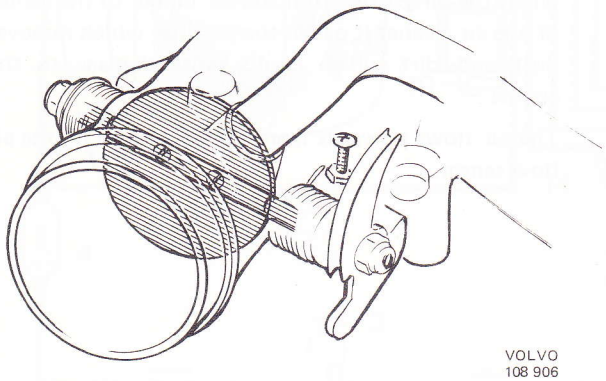
VOLVO
108 904

The air flow coming from the air cleaner lifts the air flow sensor plate a sufficient amount to let the air pass through.



VOLVO
108 905

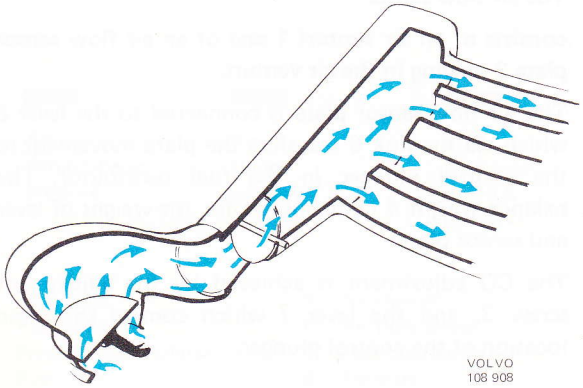
The air-fuel mixture varies with the load. The inclination of the venturi walls therefore varies in stages in order to provide a correct fuel-air mixture at all loads.



VOLVO
108 906

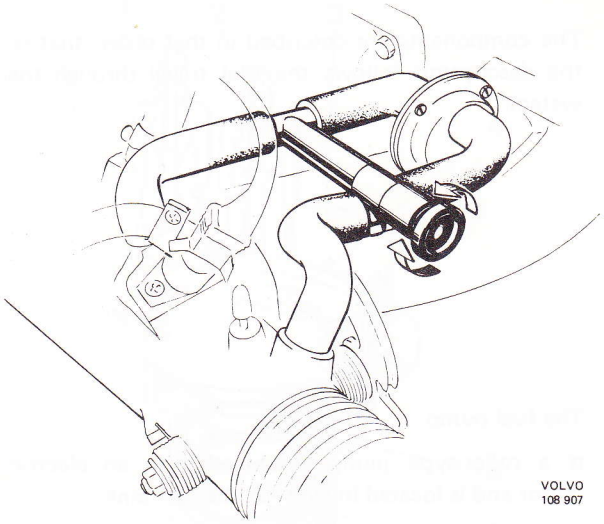
The throttle

is located in the intake manifold and is controlled by the throttle pedal.



VOLVO
108 908

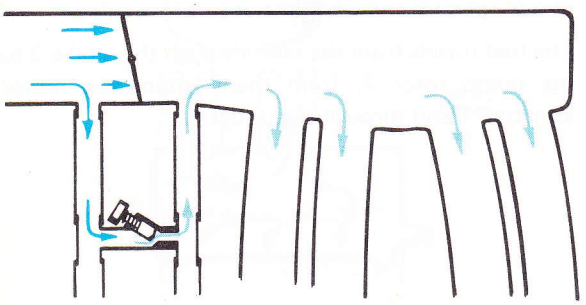
The throttle controls the air flow to the engine and thereby the engine rpm.



VOLVO
108 907

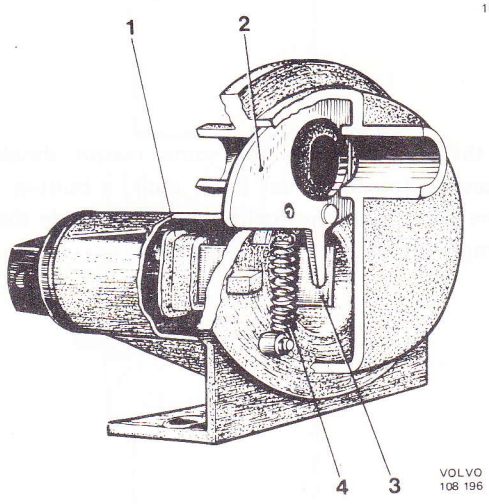
The idle adjustment screw

is located in a channel by-passing throttle.



VOLVO
108 909

The idle adjustment screw increases or decreases the area of the by-pass channel, thereby controlling the induced air and the idle rpm.



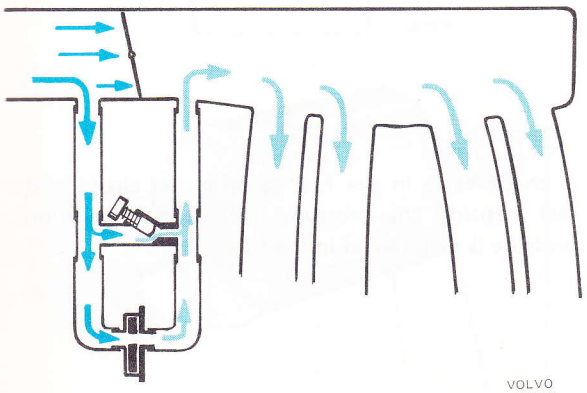
VOLVO
108 196

The auxiliary air valve

is located on the intake manifold and is, like the idle adjustment screw, by-passing the throttle.

The bimetallic spring 3 presses on the valve 2 when the engine is cold and thereby the by-pass air channel is kept open.

Current flows through the coil 1 when the starter motor operates and when the engine is running. The coil heats the bimetallic spring which decreases the pressure on the valve which is gradually closed by the coil spring 4.



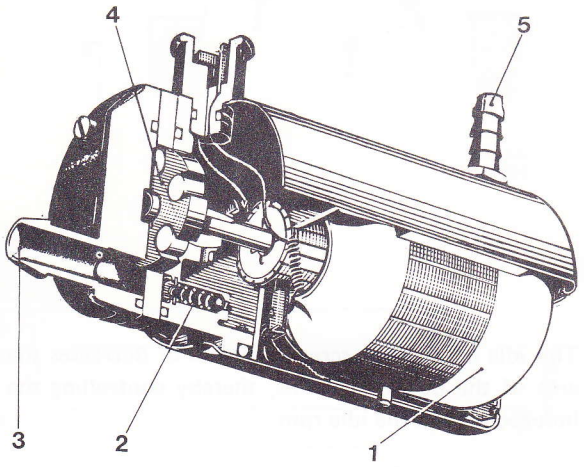
VOLVO
108 910

The auxiliary air valve is open at cold start and during the warm-up period, thereby providing the engine with air and a higher rpm.

Fuel system

The fuel system comprises components needed to feed, clean, control and distribute the fuel to the engine cylinders: fuel pump, fuel accumulator, fuel filter, fuel distributor, injectors as well as control pressure regulator, fuel lines and line pressure regulator.

The components are described in that order, that is, the description follows the fuel travel through the system.



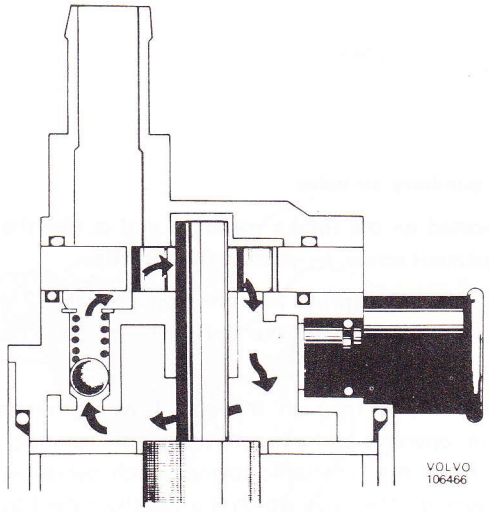
VOLVO
108 197

The fuel pump

is a roller-type pump combined with an electric motor and is located in front of the fuel tank.

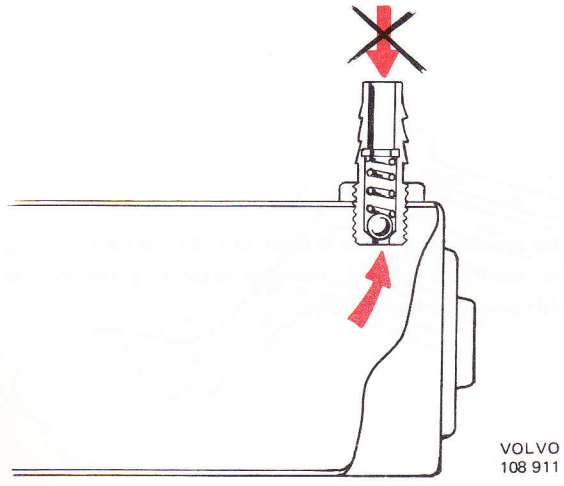
Current is fed to the fuel pump when the starter motor operates and when the engine is running.

The fuel travels from the tank through the intake 3 to the pump rotor 4, from there around the motor armature 1 and through the outlet 5.



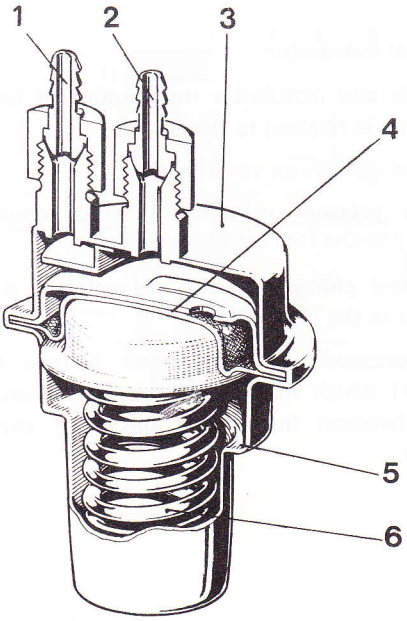
VOLVO
106466

If the fuel pressure for some reason should be excessive (pinched fuel lines, etc.), a built-in relief valve opens and the fuel re-circulates inside the fuel pump without any pressure increase.

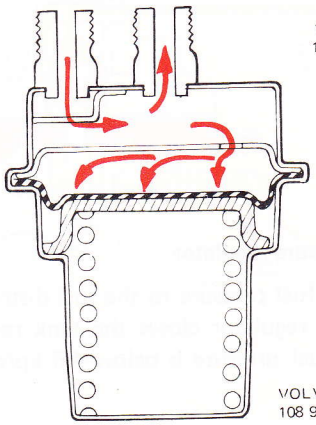


VOLVO
108 911

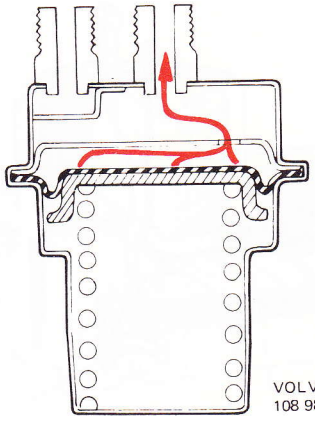
A check valve in the fuel pump outlet closes in the rest position the pressure line so that the supply pressure is maintained in the fuel circuit.



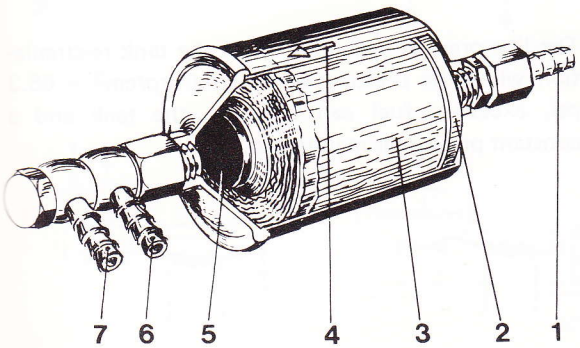
VOLVO
108 198



VOLVO
108 989



VOLVO
108 988



The fuel accumulator

is located close to the fuel pump. It helps accumulate and maintain a certain pressure in the fuel system when the fuel check valve has closed (when the engine and thereby also the fuel pump does not operate).

When the fuel pump starts working, fuel is fed through the inlet 1 to the pressure chamber 3, and the diaphragm 4 and the plunger 5 are pressed against the stop 6, compressing the spring 7.

When the spring is compressed, fuel is fed through the outlet 2 to the fuel filter and the fuel distributor.

When the engine (and thereby also the fuel pump) stops, the declining pressure causes the fuel distributor to stop the re-circulation of the fuel to the tank. The check valve in the fuel pump blocks the fuel passage back to the tank. The result is a pressure: the rest pressure. The rest pressure is maintained at approx. 2 kp/cm^2 = 28 psi for an extended period of time by the diaphragm 4 and the spring 6 which feed stored fuel out in the fuel lines. A remaining fuel pressure, the rest pressure, makes for safer starts and prevents vapor locks at high ambient temperatures.

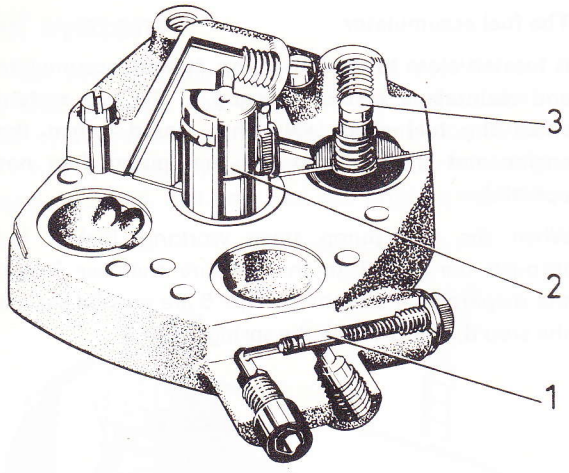
The fuel accumulator pressure chamber also acts as a muffler on fuel pump noise.

The fuel filter

is a fine filter with paper element and nylon mesh. Its location in the circuit is between the fuel accumulator and the fuel distributor.

The fuel filter change interval is 50 000 km = 30 000 miles. The direction of flow is marked by arrows on the housing.

1. Inlet
2. Nylon fine filter
3. Paper filter
4. Direction of flow
5. Rubber cone
6. To cold start injector and fuel distributor



The fuel distributor

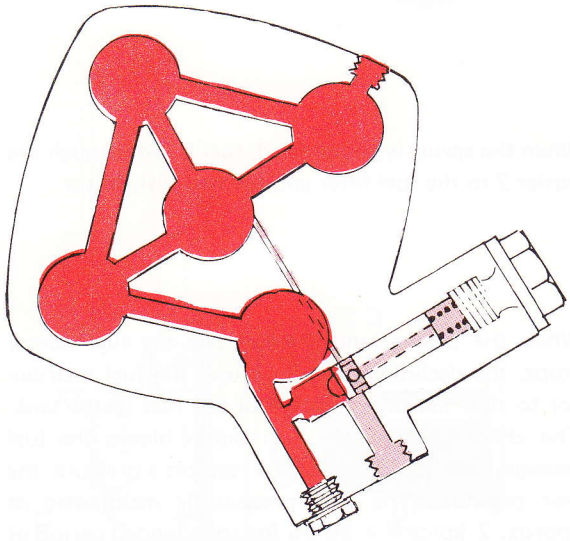
controls and distributes the amount of fuel to the injectors, in relation to the air flow.

The fuel distributor consists of:

A line pressure regulator 1 which controls the pressure to the fuel distributor.

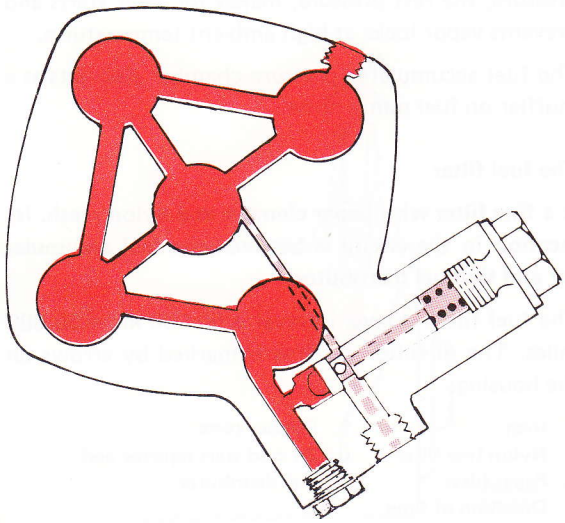
A control plunger 2 which controls and distributes the fuel to the injectors.

Four pressure regulator valves 3 (one for each injector) which maintain a constant pressure difference between intake and outlet of the control plunger.

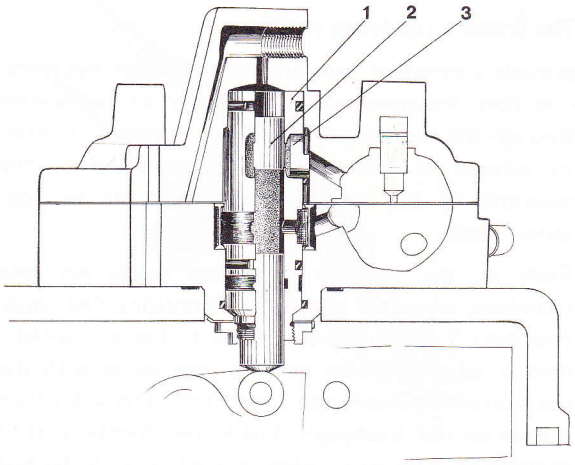


The line pressure regulator

controls the fuel pressure to the fuel distributor. The line pressure regulator closes the tank re-circulation line if the fuel pressure is below 4.6 kp/cm^2 = 65.3 psi.



The line pressure regulator opens the tank re-circulation when the pressure exceeds 4.6 kp/cm^2 = 65.3 psi, excessive fuel can travel to the tank and a constant pressure is maintained.



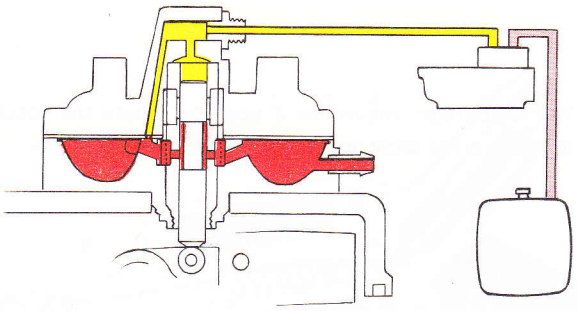
VOLVO
108 202

The fuel control unit

has a cylinder 1 in which the control plunger 2 (governed by the air sensor plate) operates. The cylinder wall has four metering slots 3, feeding the fuel to the four pressure regulating valves, one for each slot.

Depending on the position of the air flow sensor plate in the air venturi, the control plunger opens the metering slots more or less. When the air flow sensor plate is positioned higher, the metering slots are opened further and more fuel is directed through the pressure regulating valves.

As mentioned before, a hydraulic pressure (the control pressure) is counteracting the control plunger's movement upwards.

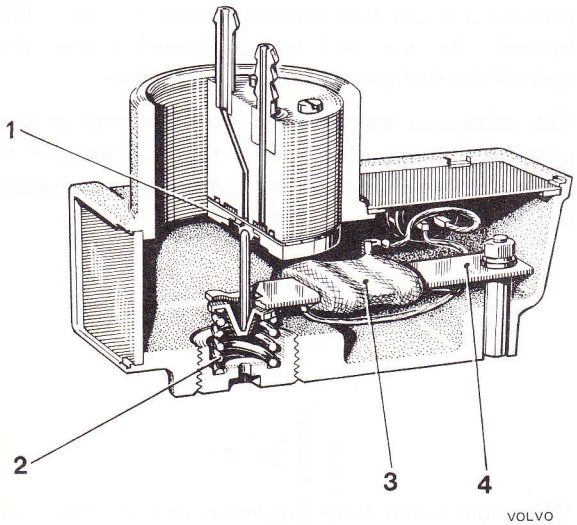

VOLVO
108 913

The control pressure

Some of the fuel from the fuel distributor inlet is diverted to the control plunger top side. From there it travels first to a control pressure regulator and thereafter to the tank.

The control pressure is controlled by the control pressure regulator and is normally 3.7 kp/cm^2 = 52.5 psi.

The control pressure fuel acts on top of the control plunger and passes a restriction. The restriction dampens the movements of the air flow sensor plate and prevents it from getting excessive positions at fast acceleration.



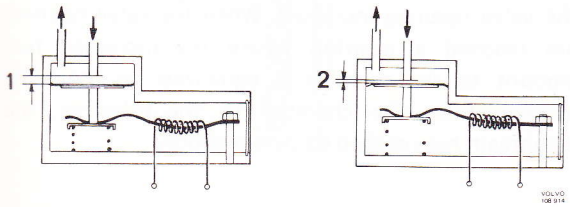
VOLVO
108 210

The control pressure regulator

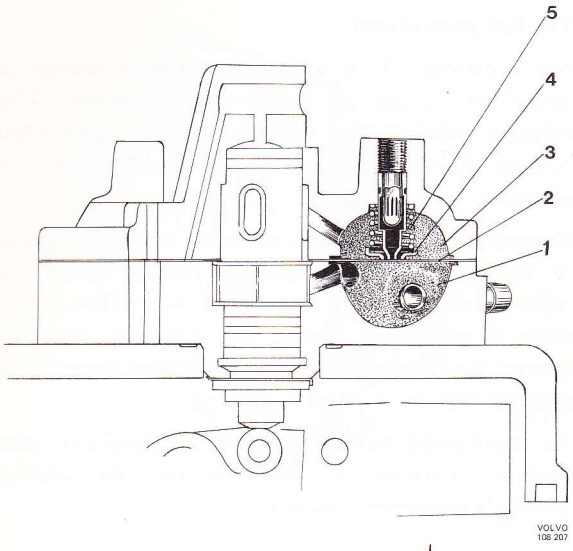
controls, during the warm-up period, the control pressure in relation to the engine temperature so the enigne fuel mixture is enrichened. The control pressure is kept at a constant level of approx. 3.7 kp/cm^2 = 52.5 psi when the engine has reached normal operating temperature.

When cold, the bi-metallic spring 4, compresses the coil spring 2. More with decreasing ambient (engine and bi-metallic spring) temperatures. The compression of the coil spring causes the diaphragm valve 1 to open and more fuel can pass through the tank, lowering the control pressure. Lower control pressure will allow the air flow sensor plate to raise further in the air flow. Consequently also the control plunger rises and a richer air-fuel ratio is provided. When the engine has started, current flows through the coil 3 which heats the bi-metallic spring.

That means that the spring pressure gradually decreases, the diaphragm is pressed upwards, the passage gets smaller and the control pressure increases.



Cold engine:	**Hot engine:**
Large opening area (1)	Small opening area (2)
Low control pressure	High control pressure
Rich mixture	Lean mixture

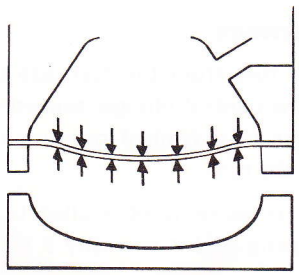


VOLVO
108 207

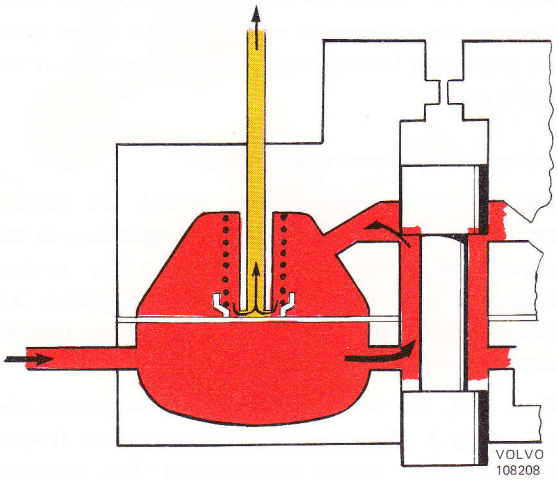
The pressure regulating valves

provide a constant pressure drop through the metering slots, independent of the amount of fuel passing through the metering slots. This is necessary in order to achieve an injection rate proportional to the positions of the control plunger and the air flow sensor plate.

Each of the pressure regulating valves has two chambers, separated by a steel diaphragm. The upper chambers 3, which are connected to the slot outlets, have a valve 4 whose opening area varies with the position of the diaphragm 2, and a coil spring 5 which presses on the diaphragm. The lower chambers are in connection with each other as well as with the slot inlets.


VOLVO
108 915

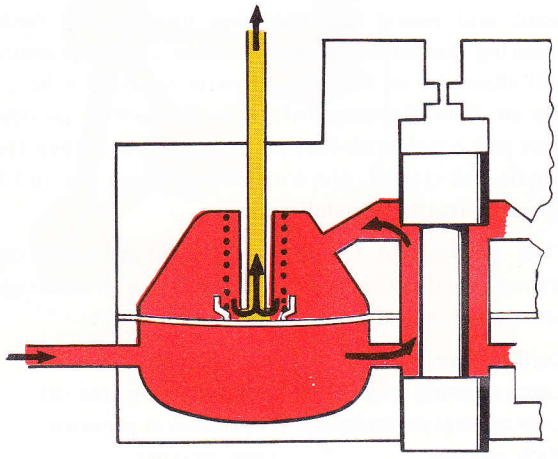
The diaphragm maintains a position where the total pressure is the same on both sides of the diaphragm.


VOLVO
108208

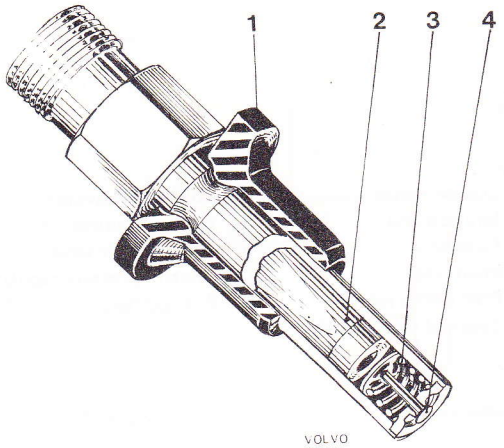
The fuel pressure in the lower chambers is the same as the line pressure, i.e. 4.6 kp/cm^2 = 65.3 psi.

To balance this, in the upper chamber the coil spring pressure and the fuel pressure should sum up to 4.6 kp/cm^2. As the coil spring pressure makes 0.1 kp/cm^2 the fuel pressure will be 4.5 kp/cm^2.

The difference between the fuel pressures in the upper and lower chambers is thus 0.1 kp/cm^2 = 1.4 psi and originated by the coil spring in the upper chamber.



When fuel is fed from one metering slot of the fuel control unit into the upper chamber, the pressure rises and the diaphragm is depressed downwards and the valve opening increased. When the valve opening has reached a position where the increased fuel amount to the chamber is equalized by the same increase from the chamber to the injectors, the diaphragm has reached its new position.

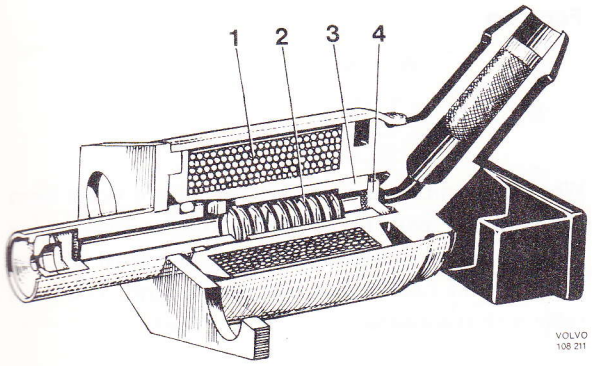


The injectors

have a spring-controlled valve which opens at a fuel pressure of 3.6 kp/cm² = 51 psi. (Valves with serial numbers below "423" have opening pressure 3.3 kp/cm² = 47 psi.). The valves are designed to fully atomize the fuel, also at low fuel flows.

The fuel pressure will open the valve and that will make the injection continuous while the fuel flow, i.e. fuel quantity, varies according to the air quantity inducted.

The injectors are provided with a rubber seal and installed in a bracket on the cylinder head by a retainer.



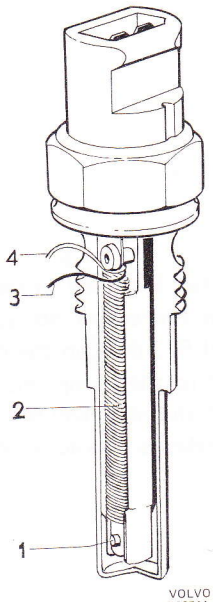
The cold start injector

supplies extra fuel at cold starts.

It consists of a housing containing a solenoid coil, an actuator, a return spring and a seal. When there is no current flow through the solenoid coil 1, the return spring 2 presses the actuator 3 against the gasket 4 and the cold start injector is closed. When there is a current flow from the thermal time switch through the solenoid coil, the actuator is withdrawn and fuel fed through the seal, through the cold start injector and into the intake manifold.

The injection time is controlled by the thermal time switch. The thermal time switch provides extra fuel for 12 seconds at $-20^{o}C = 5^{o}F$. At temperatures higher (warmer) than $-20^{o}C = 5^{o}F$ the cold start injection time decreases gradually and ceases completely at $+35^{o}C = 95^{o}F$.

The cold start injector is injecting fuel only when the starter is operating. The cold start injector stops injecting fuel if the engine starts and the starter stops operating before the time permitted by the thermal time switch is up.

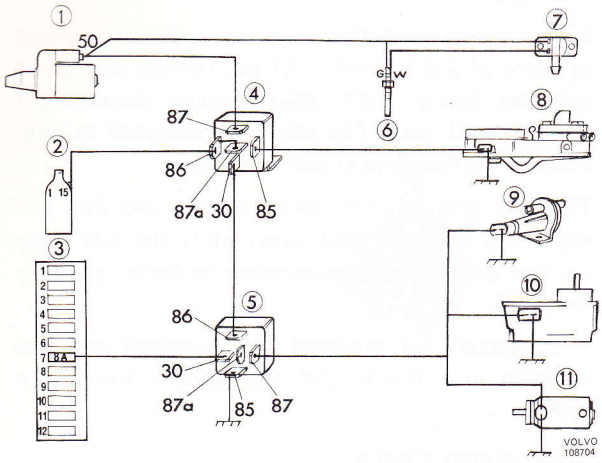


The thermal time switch

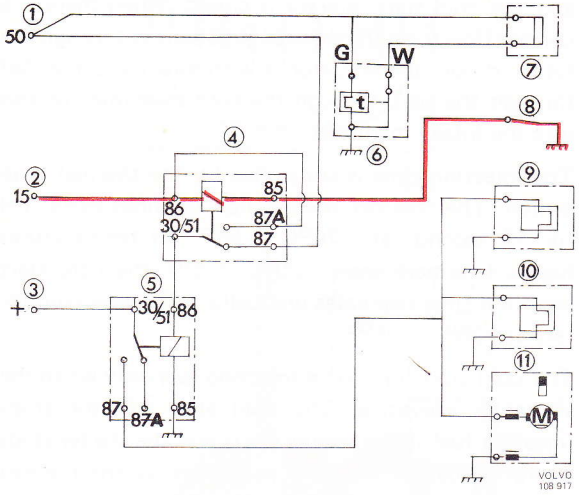
determines the cold start injector operating time.

The thermal time switch is a sealed unit, utilizing contacts controlled by a bi-metallic spring. The bi-metallic spring has two coils, one activated from the cold start injector and one from the starter.

The contacts 1 are closed at cold engine (below $+35^{o}C = 95^{o}F$). When the starter operates there is current flow from the starter to the cold start injector and via the wire 4 and the contacts 1 to ground. At the same time there is current flow from the starter via wire 3 and contacts 1 to ground. The cold start injector operates as long as the contacts 1 are closed and the starter operates. The wire 3 heats the bi-metallic spring 2, which reacts, the contacts 1 open and the cold start valve ceases operating. The heating time varies with the engine temperature; the warmer the engine the shorter the heating time for the bi-metallic spring and consequently also the injection time for the cold start injector.

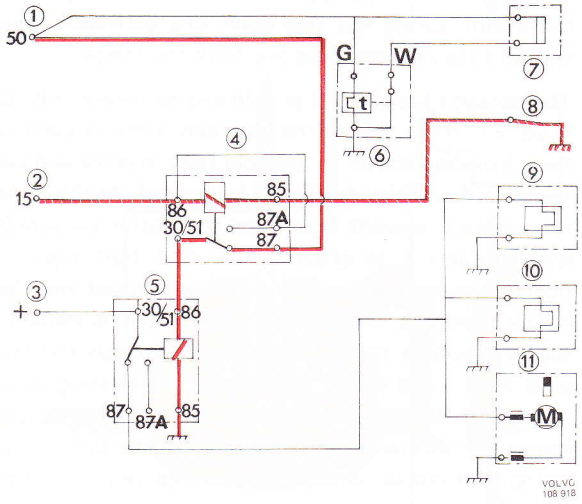


1. Starter motor
2. Ignition coil
3. Fuse box
4. Main relay
5. Fuel pump relay
6. Thermal time switch
7. Cold start injector
8. Air-fuel control unit
9. Auxiliary air valve
10. Control pressure regulator
11. Fuel pump

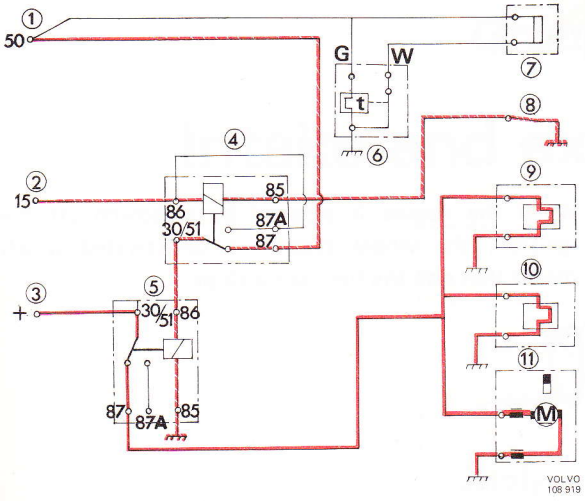


Function

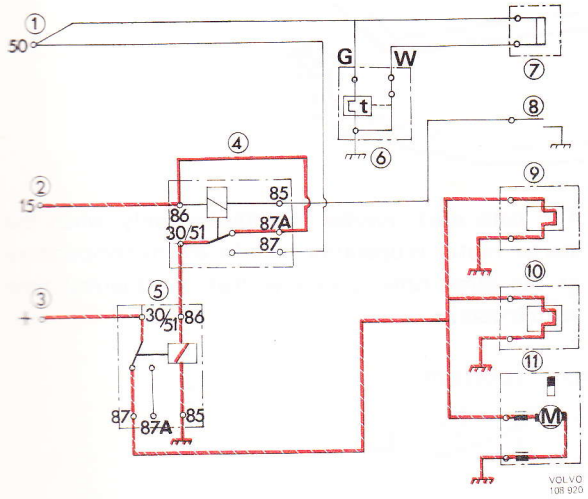
When the ignition is switched on, current flows from the ignition coil terminal 15, to the main relay terminal 86 through realy coil to terminal 85 and finally to air fuel control unit and ground. The main relay is thus activated.



When the ignition key is turned to starting position, current flows from the starter terminal 50 to the main relay terminal 87, through the closed contacts to terminal 30 and to the pump relay terminal 86. From there through the relay coil to terminal 85 and ground. The pump relay is thus activated.

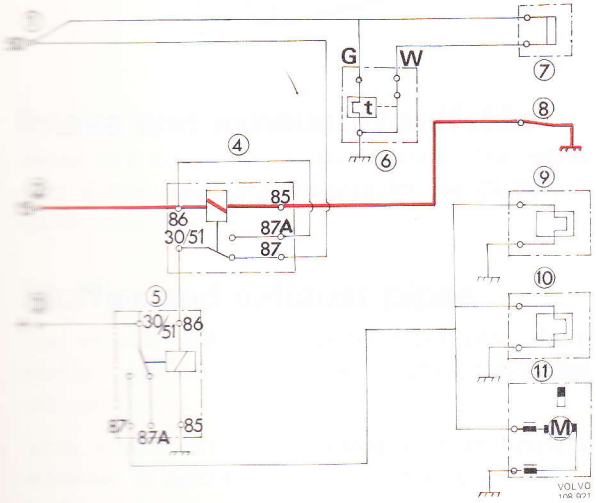


Current flows from fuse No. 7 to the pump relay terminal 30, through the closed contacts to terminal 87, to fuel pump and ground. The fuel pump is thus activated and pumps fuel. The control pressure regulator and the auxiliary air valve are activated at the same time as the fuel pump.

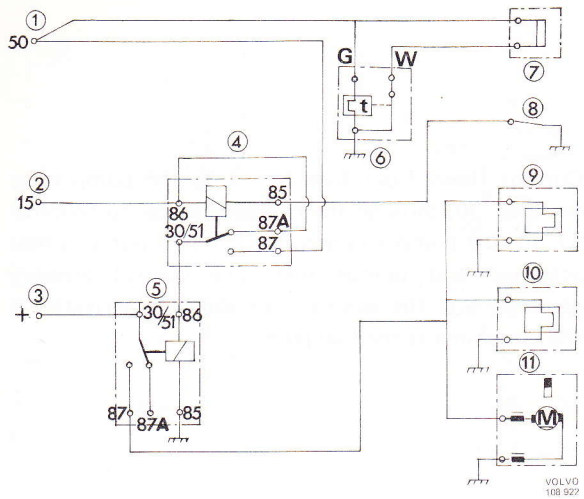


When the starter motor is operating or after the engine has started, the contacts at the air-fuel control unit open, the ground circuit is opened, and the main relay is de-activated. Current now flows from terminal 86 to terminal 87a, through the contacts to terminal 30. The fuel pump relay is thus still activated and the pump pumps fuel.

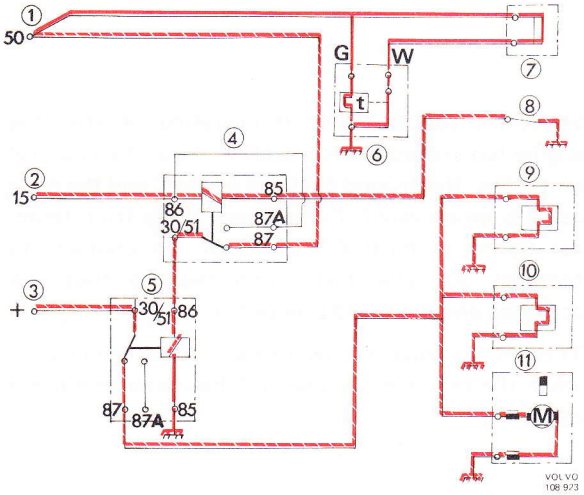
There is no current flow to main relay terminal 87 when the engine is running and the starter motor not operating.



If the engine stops (with the ignition still switched on), the contacts at the air-fuel control unit close. Main relay terminal 85 is grounded, the relay is activated, and terminal 30 is connected to terminal 87. As there is no current flow to terminal 87, the pump relay is de-activated and the fuel pump stops working.



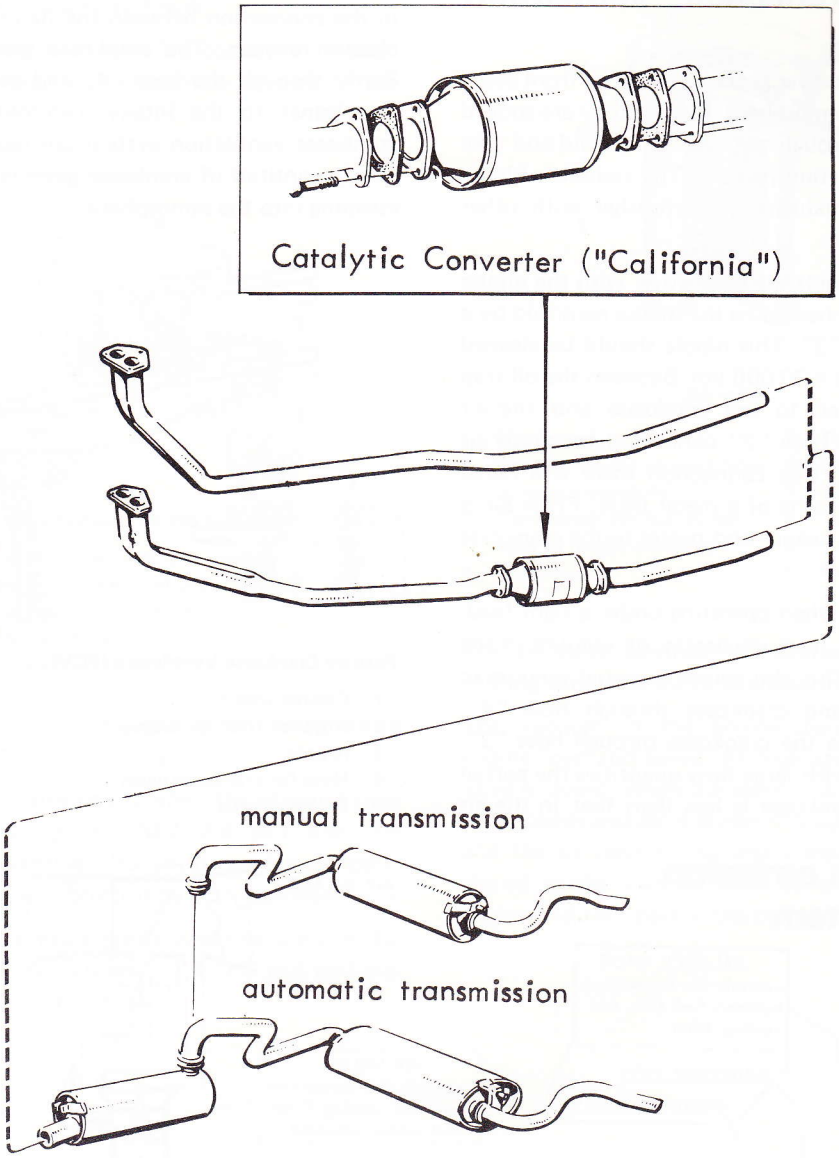
When the engine is stopped by switching off the ignition, the whole system is de-activated which means that also the fuel pump stops.



The cold start injector is activated only when the starter motor is operating and the engine temperature at the same time is so low that the thermal time switch cuts in.

Group 25 A

Intake and exhaust systems



Intake and exhaust manifolds

Intake and exhaust ducts are separate. The intake duct is light alloy and designed for the CI System (Continuous Injection).

Muffler and exhaust pipes

The exhaust system comprises front pipe, front muffler, intermediate pipe, rear muffler (resonator) and rear pipe.

Some vehicles are also equipped with an catalytic converter as described under Emission Control Systems.

The front pipe is attached to the exhaust manifold flange by studs and nuts. There are three heat shields to reduce heat transfer from the exhaust system to the body. The shields are attached at the joint fire wall/front floor and on top of the front and rear muffler.

The front pipe is supported at the transmission in order to reduce exhaust manifold tensions.

The front muffler is at the front end suspended by two rubber rings.

The rear muffler is suspended at both ends by rubber rings.

Group 25 B

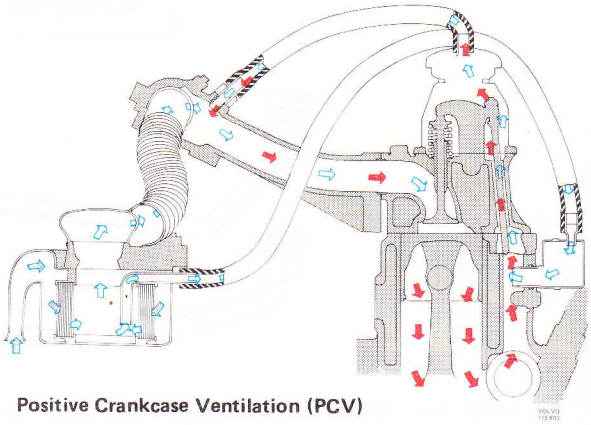
Emission Control Systems

Positive crankcase ventilation (PCV)

This arrangement prevents crankcase gases from being released into the atmosphere. Instead they are sucked into the engine through the intake manifold and take part in the combustion process. The residue is blown out through the exhaust pipe together with other combustion residues.

The hose "4" connects the valve cover with the intake manifold. It is connected to the intake manifold by a calibrated nipple "3". This nipple should be cleaned every 12 000 miles = 20 000 km. Between the oil trap which is connected to the crankcase and the air cleaner there is a hose "2" connected for fresh air supply. At the oil trap connection there is a flame arrester "5". It consists of a metal filter. Fresh air is cleaned in the air cleaner and passes to the crankcase through hose "2".

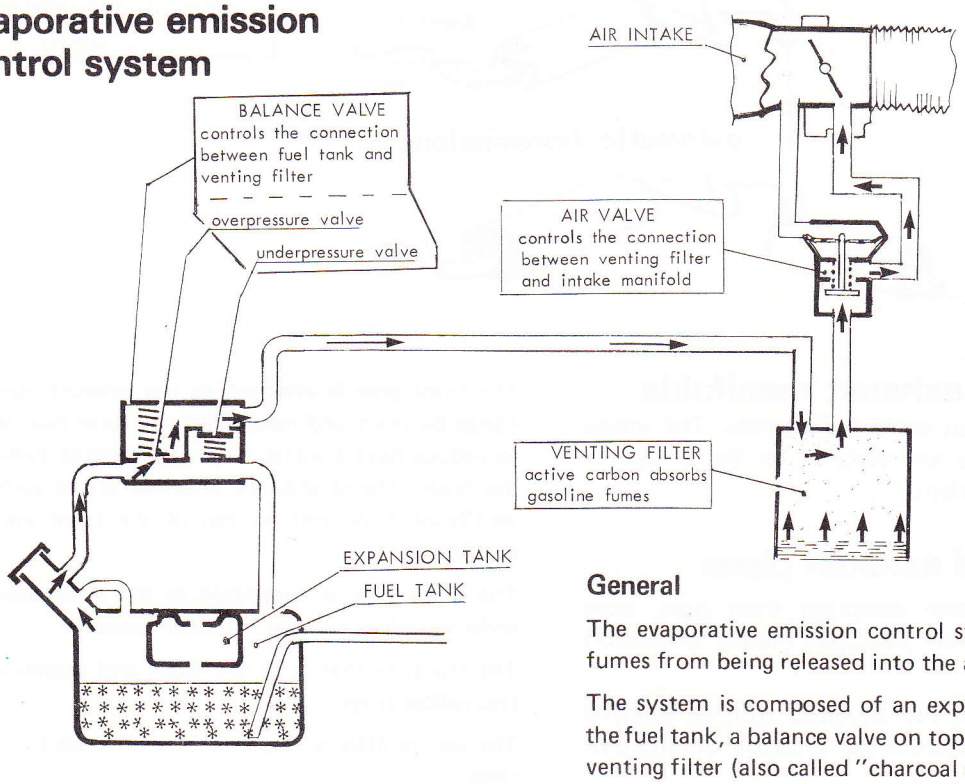
During idling and when operating under a light load, there is a high or medium degree of vacuum in the intake manifold. This also causes a partial vacuum in the valve cover and crankcase through hose "4". Fresh air passes to the crankcase through hose "2". At full load and with large flow quantities the partial vacuum in the crankcase is less than that in the air cleaner and no fresh air is supplied. Instead, the flow in the connection between the flame arrester and air cleaner reverses. The crankcase gases go two ways. Partly through the hose "4" and partly through the air cleaner to the intake manifold. This way the crankcase ventilation system can deal with relatively large quantities of crankcase gases without any gases escaping into the atmosphere.



Positive Crankcase Ventilation (PCV)

1. Cleaner insert
2. Hose for fresh air supply
3. Nipple
4. Hose for crankcase gases
5. Flame arrester

Evaporative emission control system



General

The evaporative emission control system prevents gas fumes from being released into the atmosphere.

The system is composed of an expansion tank inside the fuel tank, a balance valve on top of the fuel tank, a venting filter (also called "charcoal canister", "carbon

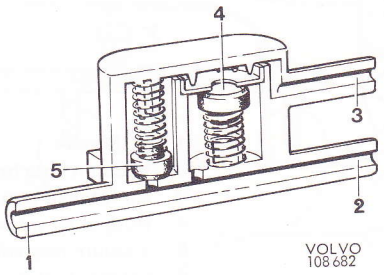
filter", etc) with an air valve and located in the engine compartment, and of hoses connecting the components.

Function

The expansion tank absorbs fuel expansion caused by rising temperature with full tank.

Fuel fumes in the fuel tank are conveyed through hoses to the balance valve assembly on top of the fuel tank.

Balance valve



Balance valve (located on the fuel tank)

1. Hose from the tank filler neck
2. Hose from tank (fuel gauge sender)
3. Hose from venting filter
4. Underpressure valve
5. Overpressure valve

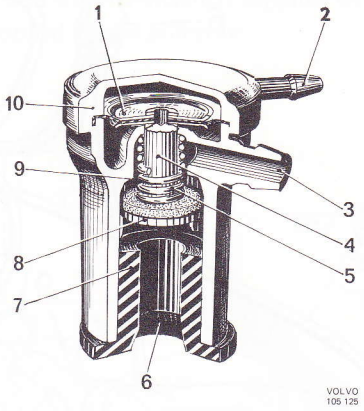
The balance valve is composed of an overpressure valve and an underpressure valve.

The overpressure valve opens when the pressure rises above 0.05–0.20 kp/cm^2 (0.7–2.8 psi) and the fumes go to the venting filter in the engine compartment. There they are absorbed by active carbon.

The underpressure valve opens when vacuum in the tank exceeds 0.1–0.2 kp/cm^2 (1.4–2.8 psi) and lets air in through the venting filter.

The balance valve is designed in such a way that it prevents fuel from running up the hose to the venting filter when taking a sharp turn.

Air valve



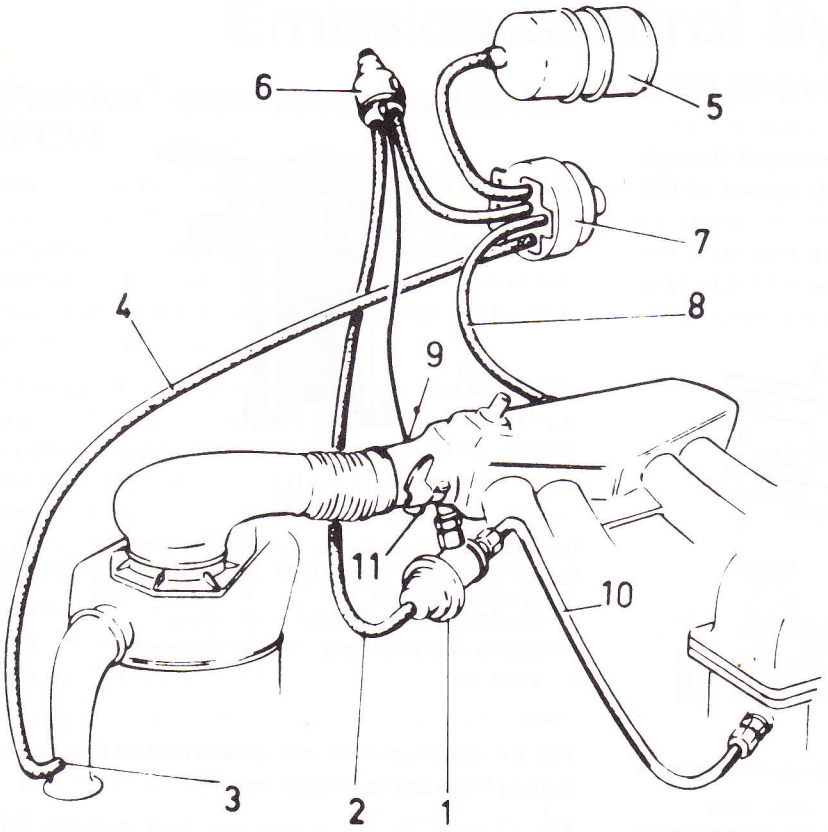
Air valve

1. Diaphragm
2. Connection for vacuum hose to intake manifold
3. Connection for fuel fumer hose to intake manifold
4. Valve rod
5. Thrust spring
6. Connection for venting filter
7. Rubber sleeve
8. Valve
9. Valve seat
10. Housing

The air valve controls the connection between the venting filter and the intake manifold.

The vacuum in the engine manifold depends on engine load and speed. At high vaccum (idle) the air valve is closed. When the vacuum drops (at speed), the valve opens and air is drawn through the venting filter and the air valve to the intake manifold. Fuel fumes stored in the venting filter follow the air into the engine and take part in the combustion.

Exhaust Gas Recirculation (EGR) Valve with Vacuum Amplifier



Parts not interchangeable with 1974 models

1. EGR valve
2. Vacuum hose for EGR valve
3. Air intaken venturi
4. Hose to air intake
5. Vacuum reservoir
6. Solenoid valve
7. Vacuum amplifier
8. Manifold vacuum hose
9. Micro-switch (hidden)
10. Throttle

The purpose of the EGR valve with vacuum amplifier is to control the amount of EGR to meet Nox emission standards with minimal sacrifice in vehicle driveability.

EGR function

The system uses venturi vacuum at the air intake (3, above) as a measure of the total air flow.

This weak venturi vacuum signal controls the vacuum amplifier (at 7) which regulates the EGR valve through a solenoid valve (at 6).

The vacuum amplifier (at 7) receives two inputs:

A. The weak venturi vacuum signal to be amplified.

B. The strong manifold vacuum for its Power source (see hose at 8).

The system has a vacuum reservoir (at 5) and a check valve in the vacuum amplifier (at 7) to maintain adequate vacuum regardless of variations in engine manifold vacuum. The amplifier thus continues to provide needed vaccum at higher speeds and moderate accelerations, when the manifold vacuum generally drops.

The EGR valve is closed at:

1. Engine idling.

The EGR valve is closed at engine idling by a solenoid valve (at 6) in front of the EGR valve. This solenoid valve is controlled electrically by a micro-switch on the throttle (at 9).

2. Full throttle.

Built into the vacuum amplifier (at 7) is a relief valve to "dump" the venturi signal at wide open throttle, closing the EGR valve when full power is required.

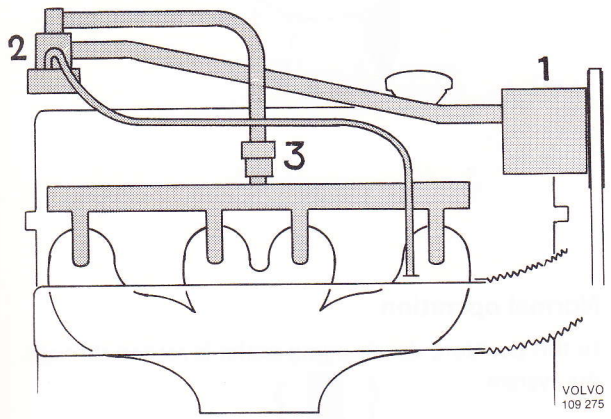
The EGR valve is open in varying degrees depending on driving conditions and engine load, from slight throttle opening until wide open throttle. It takes a vacuum, in hose 2, to open the EGR valve.

Air injection reactor, 240 and 164

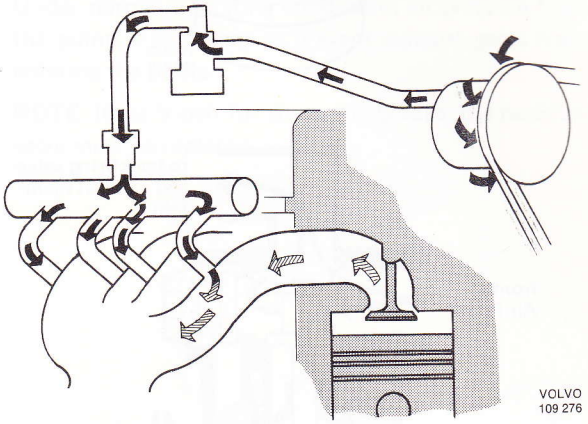
General

This is an exhaust emission system that actually burns the unburned portions of the exhaust gases to reduce the hydrocarbon and carbon monoxide content.

When the gases leave the cylinders, they are extremely hot and still flammable if supplied with oxygen. This is supplied by the pump air.



VOLVO
109 275


VOLVO
109 276

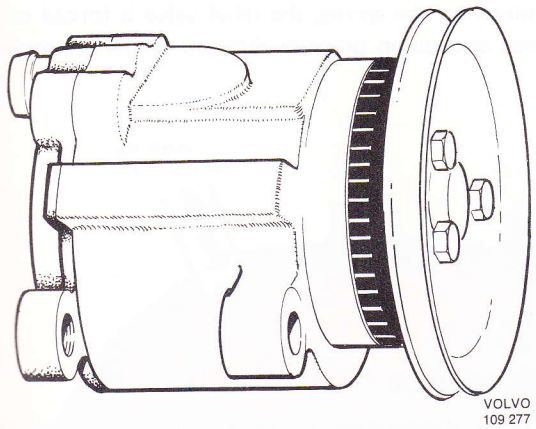
The system is composed of:

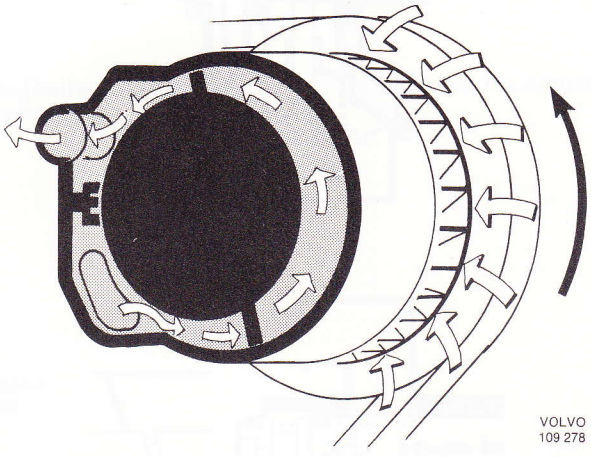
(1) air pump
(2) diverter valve
(3) backfiring valve
(4) air manifold

Under normal operation, air is pumped from the air pump, via the diverter valve, the backfiring valve and the air manifold into the branches of the exhaust manifold.

Air pump

(Do not lubricate or repair)


VOLVO
109 277


VOLVO
109 278

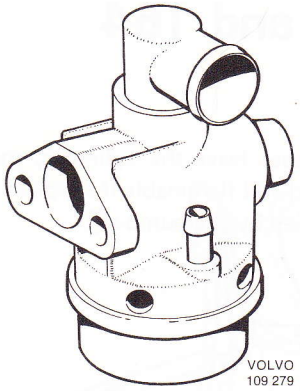
The air pump is a vane type pump and driven by a belt.

The pump is permanently lubricated and MUST NOT be lubricated.

NOTE: If the V-belt for the pump breaks the backfire valve must be replaced.

The pump takes in air via a filter which collects larger impurities. Then the air is compressed by the vane pump and discharged through the outlet in the rear end of the pump housing.

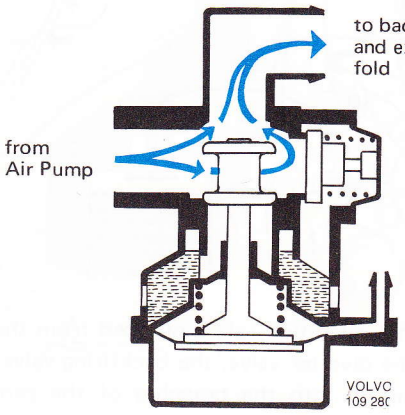
Diverter valve



The diverter valve is located on the firewall.

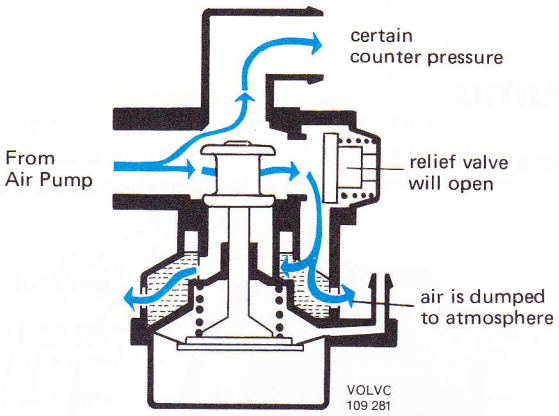
It closes the air discharge to the air manifold at the beginning of a deceleration.

It also limits the maximum air pressure.



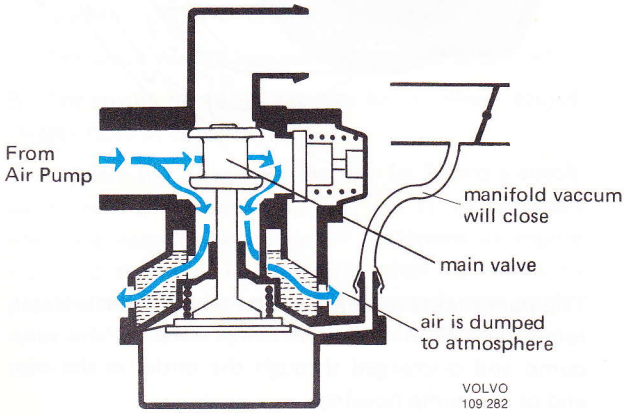
Normal operation

In this position, the air pump outlet is routed through the system.



Excess pressure

When pump pressure reaches a value which is determined by the spring, the relief valve is forced off its seat and pump pressure dumped to the atmosphere.

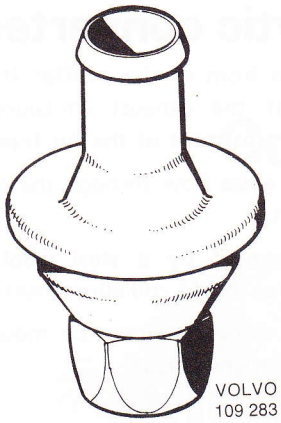


Deceleration

During deceleration, the exhaust gases are overly rich. Air injected at this time would cause backfiring.

When a sharp rise in vaccum is sensed, the diverter valve exhausts the air pump output into the atmosphere for a few seconds.

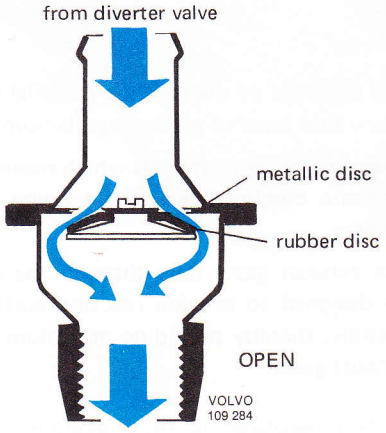
Backfire valve



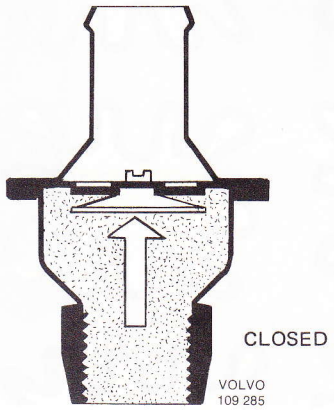
It is mounted on the air manifold and is a check valve preventing exhaust gases from flowing back toward the components of the Air Injection Reactor system, for instance in case of backfiring or if the air pump for any reason should become inoperative.

Under normal operating conditions, air pressure from the pump is sufficient to prevent exhaust gases from entering the pump.

NOTE: If the V-belt for the pump breaks, the backfire valve must be replaced.

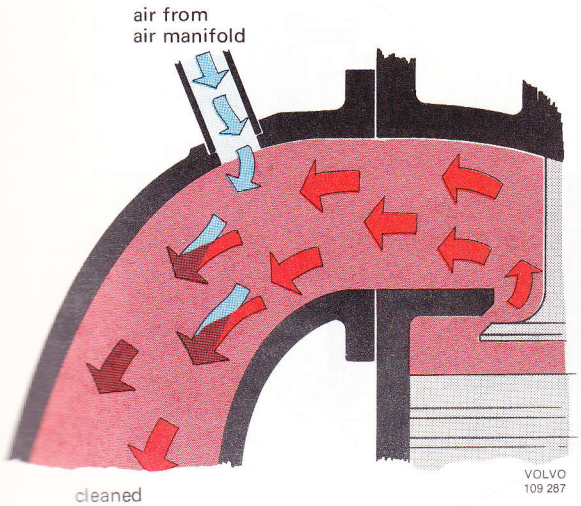


normal flow



backfiring

The holes in the metallic disc are closed by the rubber disc and gases cannot reverse.



cleaned
exhaust
gases

Oxygen from the air injected reacts with unburned hydrocarbons and carbon monoxide. The results are carbon dioxide and water (steam). Some rests of oxygen and exhaust emissions will yet always persist.

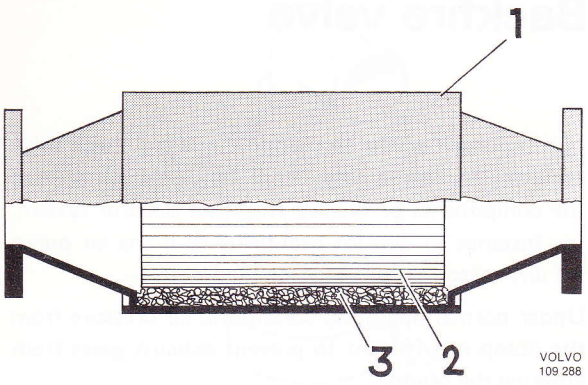
Catalytic converter

It is fitted in front of the muffler. It is designed to take care of the exhaust emissions which have persisted the treatment of the Air Injection Reactor.

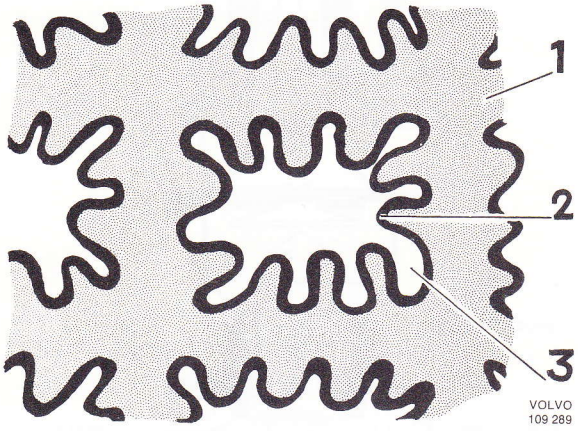
The exhaust gases flow through the channels in the ceramic insert.

This is suspended by a steel wool sleeve which protects against shocks and allows heat expansion.

Caution: the converter must be mounted within 2 inches of its designed place.



1. Stainless steff cover
2. Ceramic material
3. Steel wool

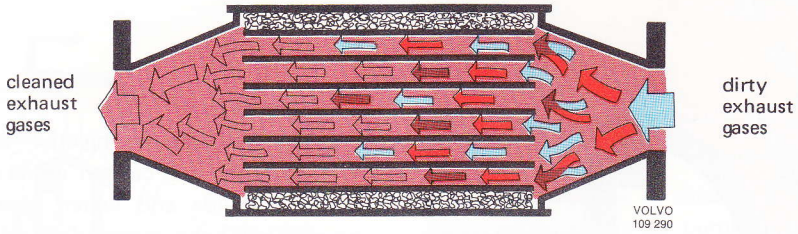


1. Ceramic material
2. Coating
3. Channel

The channels of the ceramic material are coated with a very thin layer of platinumpalladium.

These metals are catalysts which means that they will facilitate combustion without being used up themselves.

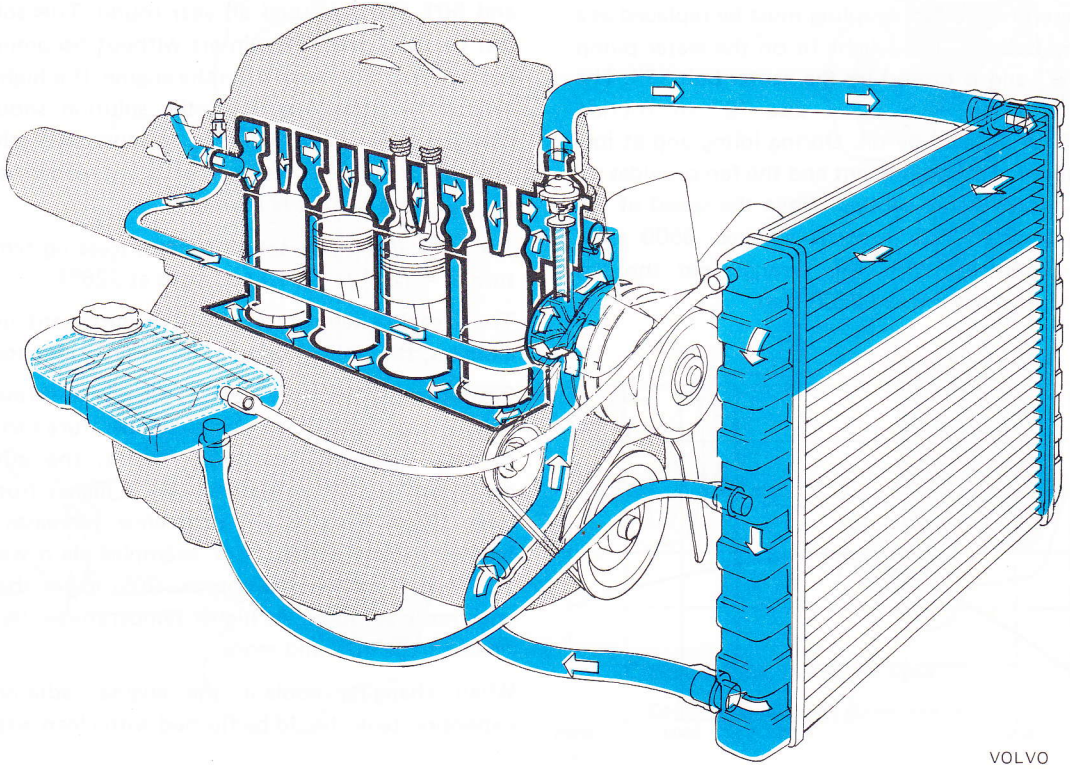
The exhaust gases flow through the channels which are designed to provide reaction surfaces as large as possible, thereby providing maximum cleaning of the exhaust gases.



Under hood the converter will reach 1200° (2280° F)

Group 26

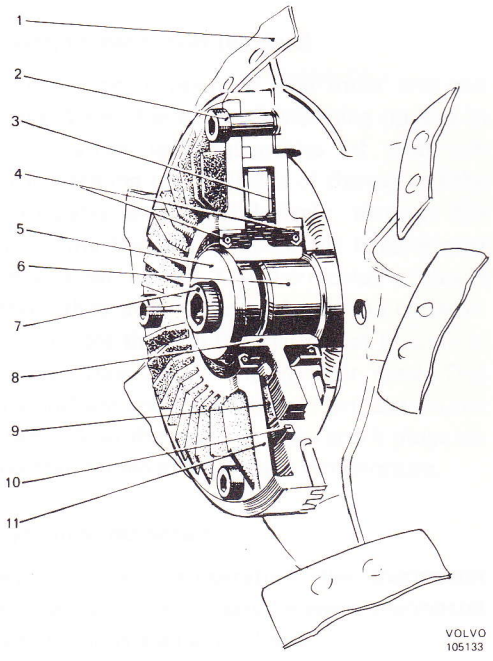
Cooling system



VOLVO
115 805

General

The vehicle is provided with an enclosed cooling system and a viscous drive fan (speedregulated fan).



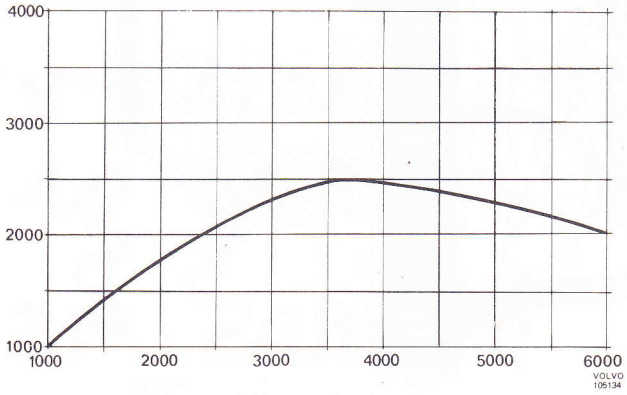
VOLVO
105133

Viscous fan drive

1. Fan blade
2. Bolt
3. Oil
4. Seals
5. Washer
6. Flange, water pump
7. Center bolt
8. Hub
9. Friction material
10. Rubber ring
11. Housing

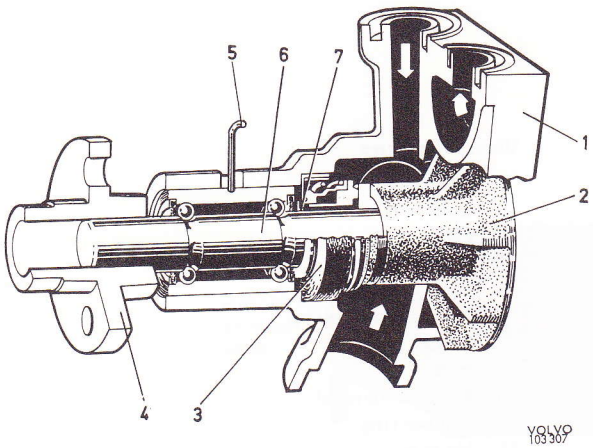
The viscous drive fan reduces at increased speeds the fan speed compared to the fan hub speed.

The six fan blades are assymmetrically installed in order to reduce noise. The coupling for the fan consists of housing "11" in which the fan blades "1" are secured by bolts "2". The housing "11" consists of two halves which cannot be separated for repairs. And therefore the fan coupling must be replaced as a unit. The hub "8" has a light fit on the water pump flange "6" and is locked by the center bolt "7". The hub is provided with a slip disc "9" of friction material surrounded by oil. During idling and at low speeds slipping is insignificant and the fan provides air current for effective cooling. When the speed of the water pump/fan hub exceeds approx. 3500 rpm, slipping increases. With this arrangement the fan speed should never exceed 2500 rpm.



Curve for fan coupling slip

This arrangement reduces fan noise as well as power required to run the fan at high speeds.



Water pump

1. Housing
2. Impeller
3. Seal ring
4. Flange
5. Lock spring
6. Shaft with ball bearings (integral unit)
7. Wear ring

A centrifugal pump provides coolant circulation. A double-acting thermostat provides fast warming up of the engine and keeps the engine operating under the most suitable temperature for all operating conditions.

The enclosed cooling system should be well filled. As coolant a mixture consisting of 50% ethylene glycol and 50% water is used all year round. This solution can be used over two winters without becoming too corrosive to the material in the engine. If a higher per cent of anti-freeze is used, the solution should be changed every year. However, mixture strength with more than 60% ethylene glycol is not recommended. Always use a reputable brand.

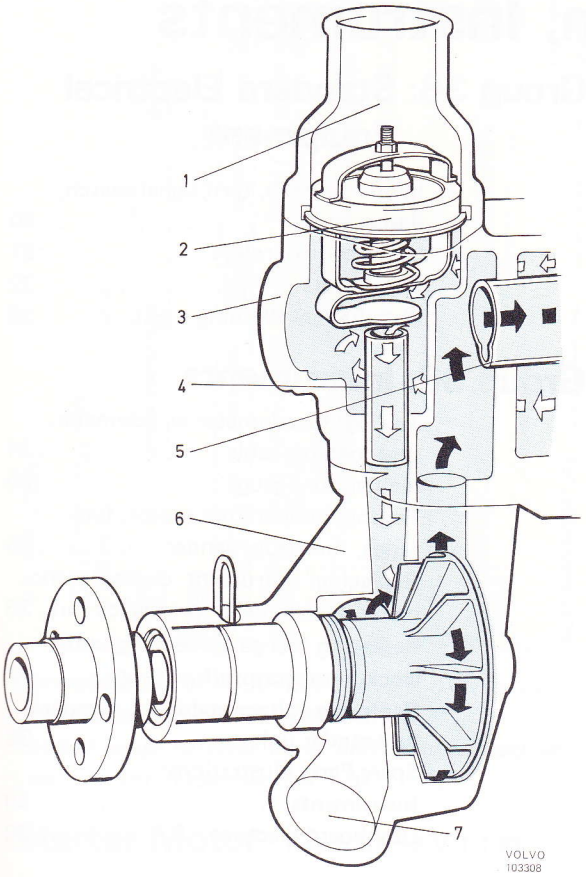
The 50% anti-freeze solution has a freezing temperature of $-32^{\circ}F$ ($-35^{\circ}C$) and boils at $226^{\circ}F$.

The freezing temperature is very important in **cold climates,** the boiling temperature in **hot climates.**

Cavitation reduces the coolant flow rate through an engine water jacket as coolant temperature increases. Because of its higher boiling point, the ethylene glycol and water coolant provide a higher flow rate than plain water. The difference increases with increasing temperature. For example: plain water at $205^{\circ}F$ has a flow rate approx. 20% lower than the anti-freeze solution. At higher temperatures the difference can be 40% and more.

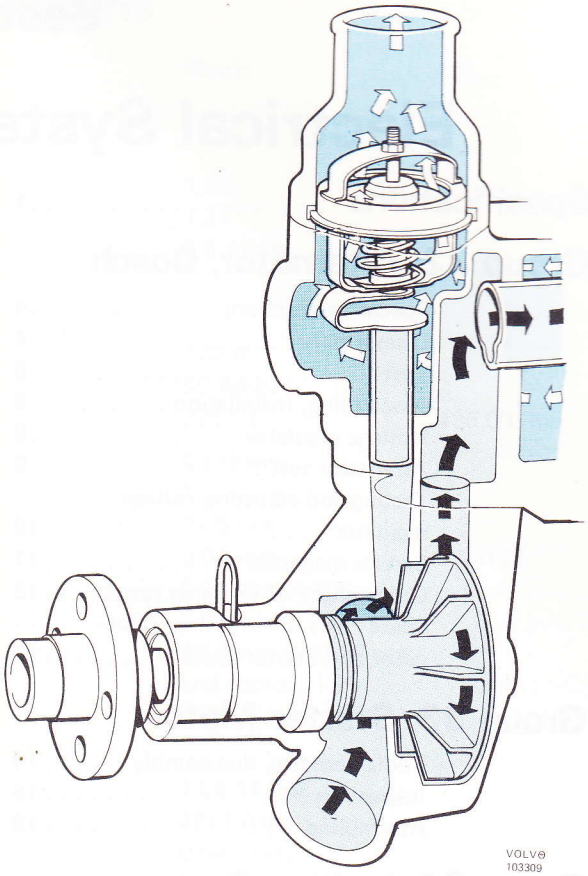
When changing coolant the engine radiator and expansion tank should be flushed with clean water.

Cooling system inner and outer circuits



Coolant flow, thermostat closed

1. To radiator
2. Thermostat
3. Cylinder head
4. By-pass pipe
5. Distributor pipe
6. Water pump
7. From radiator



Coolant flow, thermostat open

Concerning numbers above, see previous figure

Cooling system inner circuit (by-pass)

The cooling system consists of one inner and one outer circuit. When the engine is warming up and in very cold weather large quantities of heat are required for warming up the inside of the car and the coolant circulates almost exclusively through the inner circuit (the by-pass). This circuit is composed by engine and car heater. The thermostat is closed which means that there is no outlet to the radiator. The coolant passes through the thermostat by-pass to the distributor pipe "5" in the cylinder head. This results in a uniform cooling of the hottest parts in the cylinder head. Also the vicinity of the spark plugs are cooled and maintained at a constant temperature.

Cooling system outer circuit

At a certain coolant temperature, the thermostat begins to open and the by-pass between thermostat housing and pump is gradually closed.

Coolant now flows into the upper part of the radiator. The air flow through the radiator reduces the coolant temperature. The pump sucks the coolant out from the lower part of the radiator and conveys it into the engine through the distributor pipe.

An air cushion forms in the upper part of the expansion tank and permits the coolant to expand without any loss of coolant. This arrangement ensures that the cooling system is completely filled and thereby minimizes corrosion. When the cooling system is being topped up or repaired it is not possible to prevent air from entering the system. This air, however, is subsequently separated and forced into the expansion tank where it is replaced by coolant from this tank. It is therefore important to check the coolant level after that the system has been emptied and filled.

The expansion tank is provided with an overpressure valve (part of the "radiator cap") which opens when the pressure in the system exceeds 10 psi (0.7 kp/cm^2). There is also an underpressure valve which opens when there is vacuum in the system and admits air into the expansion tank.