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SERVICE MANUAL

1800 ES

VOLVO

This Manual contains servicing instructions for the Volvo 1800 ES from chassis No. 3070, and year model letter Y. The book is divided up into 9 parts as indicated by the register opposite. The pages and figure illustrations in each part are numbered in such a way that the first figure shows the number of the part concerned while the second one shows the number of the page or figure illustration in that particular part, for example, under the heading "Electrical system"; 3—1, 3—2, etc. A convenient way of finding the particular section you are looking for is to bend the right side of the Manual back so that the arrows in the register point to the index marks on the first page of each section.

The various parts are divided up as follows
- Tools
- Description
- Repair Instructions

The specifications can be found in Part 0, General. The instructions given in this book generally assume that special tools are used and are based on experience gained from method studies.
Similar results may be obtained with other working methods, but we are convinced that by following the instructions given in this Manual you will always achieve the best results in the shortest possible time.

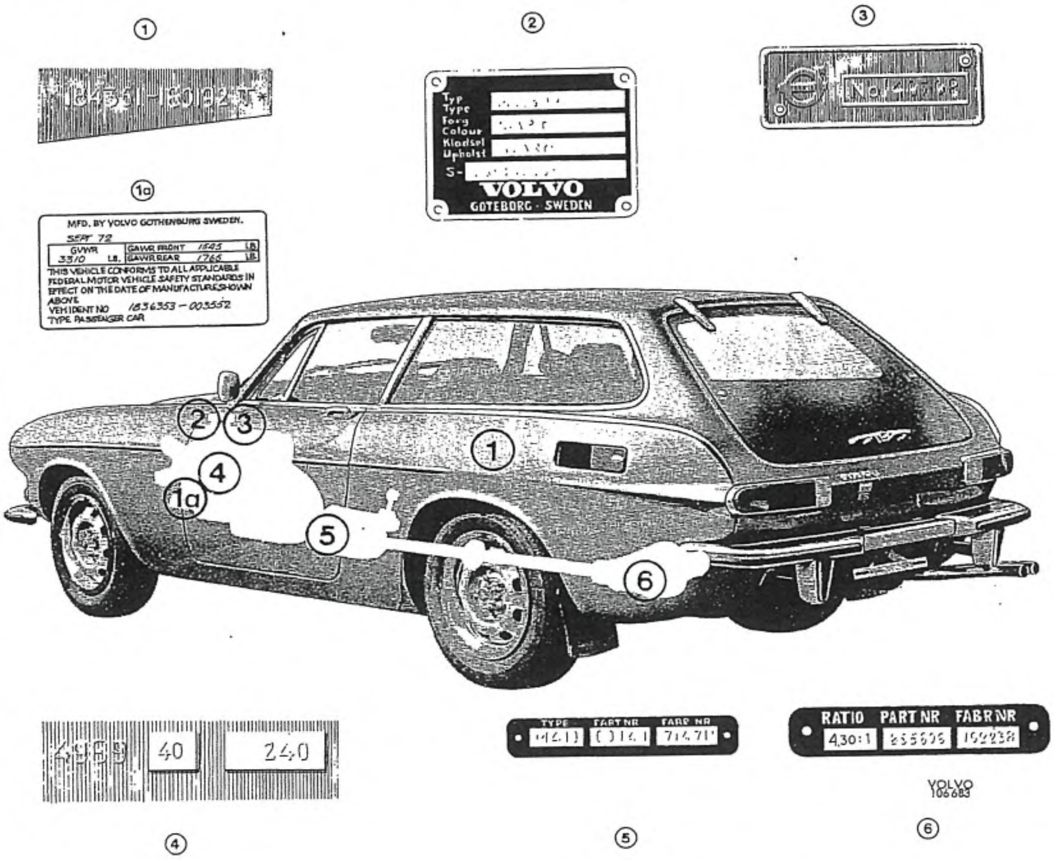
AB VOLVO
Göteborg — Sweden

Part 0

GENERAL

TYPE DESIGNATIONS

TYPE PLATES



1. Type, model designation and chassis number stamped on the front right-hand door pillar.

1a USA only. V.I.N. (Vehicle Identification Number) plate located at the front, left door post.

2. Vehicle type designation, code number for colour and upholstery.
3. Body number.
4. Engine type designation, part number and manufacturing serial number (on left hand side of engine).
5. Gearbox type designation, part number and serial number (underneath gearbox).
6. Plate on left hand side of final drive casing showing reduction ratio, number and serial number for final drive.

SPECIFICATIONS

MEASUREMENTS AND WEIGHTS

	USA/Canada	Other markets
Length	4485 mm (176.6″)	4385 mm (172.6″)
Width	1700 mm (67.0″)	1700 mm (67.0″)
Height	1280 mm (50.4″)	1280 mm (50.4″)
Wheelbase	2450 mm (96.5″)	2450 mm (96.5″)
Track, front	1315 mm (51.8″)	1315 mm (51.8″)
rear	1315 mm (51.8″)	1315 mm (51.8″)
Clearance	155 mm (6″)	155 mm (6″)
Turning circle	9.1 m (30 ft.)	9.1 m (30 ft.)
Curb weight	1200 kg (2640 lb)	1190 kg (2620 lb)

LUBRICATION

ENGINE

Lubricant, type	Engine oil
grade	Service SD, SE and CC (MS)
viscosity, summer (above $-12^{o}C = +10^{o}F$)	Multigrade oil SAE 20 W-40 or 20 W-50
winter (below $-12^{o}C = +10^{o}F$)	Multigrade oil SAE 10 W-30
at continuous temp. below $-18^{o}C$ ($0^{o}F$)	Multigrade oil SAE 5 W-20
Oil change quantity, without oil filter	3.25 dm^3 (5.7 Imp. pints = 6.9 US pints)
with oil filter	3.75 dm^3 (6.6 Imp. pints = 7.9 US pints)

GEARBOX WITH OVERDRIVE

Lubricant, type	Engine oil
viscosity, all year round	SAE 30
alternative	Multigrade oil SAE 20 W-40
Oil change quantity, gearbox and overdrive	1.6 dm^3 (2.8 Imp. pints = 3.4 US pints)

AUTOMATIC TRANSMISSION

Lubricant	Automatic Transmission Fluid, Type F
Oil capacity	6.4 dm^3 (11.3 Imp. pints = 13.5 US pints)

FINAL DRIVE

Lubricant, type, without limited slip differential	Oil acc. to MIL-L-2105 B
with limited slip differential	Oil acc. to MIL-L-2105 B provided with additive for limited slip differential
viscosity, above $-10^{o}C$ ($14^{o}F$)	SAE 90
below $-10^{o}C$ ($14^{o}F$)	SAE 80
Oil change quantity	1.3 dm^3 (2.3 Imp. pints = 2.7 US pints)

STEERING BOX

Lubricant, type	Hypoid oil
viscosity, all year round	SAE 80
oil capacity	0.25 dm^3 (0.4 Imp. pint = 0.5 US pint)

ENGINE

GENERAL

Type, designation		B20E		B20F
Output h.p. at r/m	SAE	135/6000	(SAE J 245)	112/6000
	DIN	124/6000		
Output kW at r/s	SAE	99/100	(SAE J 245)	82/100
	DIN	91/100		
Max. torque $\frac{\text{kpm}}{\text{lb.ft}}$ at r/m	SAE	$\frac{18.0}{130}$/3500	(SAE J 245)	$\frac{16.0}{115}$/3500
	DIN	$\frac{17.0}{123}$/3500		
Max. torque Nm at r/s	SAE	177/58	(SAE J 245)	156/58
	DIN	167/58		

Compression pressure (hot engine) with starter motor at 4.2–5.0 r/s (250–300 r/m)	12–14 kp/cm² (170–200 p.s.i.)	9–11 kp/cm² (129–156 p.s.i.)
Compression ratio	10.5:1	8.7:1
Number of cylinders	4	4
Bore	88.9 mm (3.50″)	88.9 mm (3.50″)
Stroke	80 mm (3.15″)	80 mm (3.15″)
	1.99 dm³	1.99 dm³
Weight incl. electrical equipment	approx. 155 kg (341 lb)	approx. 155 kg (341 lb.)

CYLINDER BLOCK

Material	Special alloy cast iron
Bore, standard	88.92 mm (3.508″)
oversize 0.030″	89.68 mm (3.531″)

PISTONS

Material	Light alloy
Weight	507±5 grammes (18±0.18 oz.)
Permissible weight deviation between pistons in same engine	10 grammes (0.35 oz.)
Height, total	71 mm (2.79″)
Height from piston pin centre to piston crown	46 mm (1.81″)
Piston clearance	0.04–0.06 mm (0.0016″–0.0024″)

PISTON RINGS

Piston ring gap, measured in ring opening	0.40–0.55 mm (0.015–0.022″)
Oversize on piston rings	0.030″

Compression rings

Upper ring chromed.

Number on each piston	2
Height	1.98 mm (0.078″)
Piston ring clearance in groove	0.040–0.072 mm (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″)

GUDGEON PINS

Floating fit. Circlips at both ends in piston.

Fit:

In connecting rod	Close running fit
In piston	Push fit

Diameter, standard	22.00 mm (0.866")
oversize 0.05"	22.05 mm (0.868")

CYLINDER HEAD

Height, measured from cylinder head contact face to bolt head face, B 20 E	85.5 mm (3.394")
B 20 F	87.0 mm (3.425")
Distance from cylinder head top face to upper end of overflow pipe (located under the thermostat)	35 mm (1.38")
Cylinder head gasket, thickness (off-load), B 20 E	0.8 mm = 0.032" (loaded 0.7 mm = 0.028")
B 20 F	1.2 mm = 0.047" (loaded 1.0 mm = 0.039")

CRANKSHAFT

Crankshaft, end float	0.047–0.138 mm (0.0019–0.0054")
Big-end bearings, radial clearance	0.029–0.071 mm (0.0012–0.0028")
Main bearings, radial clearance	0.028–0.083 mm (0.0011–0.0032")

MAIN BEARINGS

Main bearing journals

Diameter, standard	63.451–63.464 mm (2.4980–2.4985")
undersize 0.010"	63.197–63.210 mm (2.4880–2.4886")
0.020"	62.943–62.956 mm (2.4781–2.4786")
Width on crankshaft for pilot bearing shell	
Standard	38.960–39.000 mm (1.5339–1.5354")
Oversize 1 (undersize shell 0.010")	39.061–39.101 mm (1.5378–1.5394")
2 (undersize shell 0.020")	39.163–39.203 mm (1.5419–1.5434")

Main bearing shells

Thickness, standard	1.979–1.985 mm (0.0779–0.0781")
undersize 0.010"	2.106–2.112 mm (0.0829–0.0831")
0.020"	2.233–2.239 mm (0.0879–0.0881")

BIG-END BEARINGS

Big-end bearing journals

Width of bearings recess	31.950–32.050 mm (1.2579–1.2618")
Diameter, standard	54.099–54.112 mm (2.1299–2.1304")
undersize 0.010"	53.845–53.858 mm (2.1199–2.1204")
0.020"	53.591–53.604 mm (2.1099–2.1104")

Big-end bearing shells

Thickness, standard	1.833–1.841 mm (0.0722–0.0725")
undersize 0.010"	1.960–1.968 mm (0.0772–0.0775")
0.020"	2.087–2.095 mm (0.0822–0.0825")

CONNECTING RODS

End float on crankshaft	0.15–0.35 mm (0.006–0.014")
Length, centre–centre	145±0.1 mm (5.71±0.004")
Max. permissible weight deviation between connecting rods in same engine	6 grammes (0.21 oz.)

FLYWHEEL

Permissible axial throw, max.	0.05 mm (0.002")/150 mm (5.9") diam.
Ring gear (chamfer forwards)	142 teeth

FLYWHEEL CASING

Max. aixial throw for rear face	0.05 mm (0.002")/100 mm (3.9") diam.
Max. radial throw for rear guide	0.15 mm (0.006")

CAMSHAFT

Marking	D
Max. lift height	7.2 mm (0.28")
Number of bearings	3
Front bearing journal, diameter	46.975–47.000 mm (1.8494–1.8504")
Intermediate bearing journal, diameter	42.975–43.000 mm (1.6919–1.6929")
Rear bearing journal, diameter	36.975–37.000 mm (1.4557–1.4567")
Radial clearance	0.020–0.075 mm (0.0008–0.0030")
End float	0.020–0.060 mm (0.0008–0.0024")
Valve clearance for control of camshaft setting (cold engine)	1.40 mm (0.055")
Inlet valve should then open at	5.5° B.T.D.C.

Camshaft bearings

Front bearing, diameter	47.020–47.050 mm (1.8512–1.8524")
Intermediate bearing, diameter	43.025–43.050 mm (1.6939–1.6949")
Rear bearing, diameter	37.020–37.045 mm (1.4575–1.4585")

TIMING GEARS

Chrankshaft drive, number of teeth	21
Camshaft gear (fibre), number of teeth	42
Backlash	0.04–0.08 mm (0.0016–0.0032")
End float, camshaft	0.02–0.06 mm (0.008–0.0024")

VALVE SYSTEM

Valves

Inlet

Disc diameter	44 mm (1.732")
Stem diameter	7.955–7.970 mm (0.3132–0.3138")
Valve face angle	44.5°
Valve seat angle	45°
Seat width in cylinder head	2 mm (0.080")
Clearance, both warm and cold engine	0.40–0.45 mm (0.016–0.018")

Exhaust

Disc diameter	35 mm (1.378")
Stem diameter	7.925–7.940 mm (0.3120–0.3126")
Valve face angle	44.5°
Valve seat angle	45°
Seat width in cylinder head	2 mm (0.080")
Clearance, both warm and cold engine	0.40–0.45 mm (0.016–0.018")

Valve guides

Length, inlet valve	52 mm (2.047")
exhaust valve	59 mm (2.323")
Inner diameter	8.000–8.022 mm (0.315–0.316")
Height above upper face of cylinder head	17.9 mm (0.705")
Clearance, valve stem — valve guide, inlet valve	0.030–0.067 mm (0.0013–0.0026")
exhaust valve	0.060–0.097 mm (0.0024–0.0038")

Valve springs

Length, unloaded, approx.	46 mm (1.81")
with a loading of 295 ± 23 N (65 ± 5.0 lb.)	40 mm (1.57")
with a loading of 825 ± 43 N (182 ± 9.5 lb.)	30 mm (1.18")

LUBRICATING SYSTEM

Oil capacity, incl. oil filter	3.75 dm^3 (6.6 Imp. pints = 7.9 US pints)
excl. oil filter	3.25 dm^3 (5.7 Imp. pints = 6.9 US pints)

Oil pressure at 33.3 r/s (2000 r/m) (with warm engine and new oil filter)	2.5–6.0 kp/cm^2 (36–85 psi)
Lubricant, type	Engine oil
grade	Service SD, SE and CC (MS)
viscosity, summer (above –12°C = +10°F)	Multigrade oil SAE 20 W-40 or 20 W-50
winter (below –12°C = +10°F)	Multigrade oil SAE 10 W-30
at continuous temp. below –18°C (0°F)	Multigrade oil SAE 5 W-20

Oil filter

Type	Full-flow type

Oil pump

Oil pump, type	Gear
number of teeth on each gear wheel	9
end float	0.02–0.10 mm (0.0008–0.0040")
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, off-load	39 mm (1.54")
load with 50±4 N (11±0.9 lb.)	26.25 mm (1.03")
70± 8 N (15.4±1.8 lb.)	21.0 mm (0.83")

FUEL SYSTEM

Fuel filter

Type	Paper filter
Changing intervals	20 000 km (12 000 miles)

Fuel pump

Type	Rotor pump
Capacity	100 dm^3/h at 2 kp/cm^2 (22 Imp. galls = 26 US galls/h at 28 psi)
Current consumption	5.0 amps
Relief valve opens	approx. 4.5 kp/cm^2 (64 psi)

Pressure regulator

Setting value	2.1 kp/cm^2 (30 psi)

Injectors

Resistance in magnetic winding	2.4 ohms at +20°C (68°F)

Cold-start valve

Resistance in magnetic winding	4.2 ohms at +20°C (68°F)

Auxiliary air regulator

Fully open at	–25°C (–13°F)
Fully closed at	+60°C (140°F)

Temperature sensor I (intake air)

Resistance	approx. 300 ohms at +20°C (68°F)

Temperature sensor II (coolant)

Resistance	approx. 2500 ohms at +20°C (68°F)

Pressure sensor

Resistance in primary winding (stops 7 and 15)	approx. 90 ohms
Resistance in secondary winding (stops 8 and 10)	approx. 350 ohms

Air cleaner

Type	Paper insert
Changing intervals	40 000 km (24 000 miles)

CO-Test

Hot engine, idling speed	1.0–1.5% (Automatic trans. 0.5–1.0%)

Venting filter (only cars with gas evaporite control system)

Type	Foam plastic filter
Changing intervals	40 000 km (24 000 miles)

COOLING SYSTEM

Type	Sealed system
Radiator cap valve opens at	0.7 kp/cm^2 (10 psi)
Capacity	approx. 8.5 dm^3 (1.87 Imp. galls = 2.24 US galls)
Fan belt, designation	HC–38x888
right-steered vehicle	HC–38x988
Fan-belt tensioning: For a force of 70–100 N (16–22 lb.) right-steered vehicle 55–70 N (12–16 lb.), on the belts between the pulleys, there should be a deflection of	10 mm (0.39")

Thermostat

Type	Wax
Marking	82°C (179°F)
Starts opening at	81–83°C (177–181°F)
Fully open at	90°C (195°F)

TIGHTENING TORQUES

	Nm	Lb ft
Cylinder head (oiled screws) 1 st stage	40	29
2 nd stage	80	58
3 rd stage (after driving the car for 10 minutes)	90	65
Main bearings	120–130	87–94
Big-end bearings	52–58	38–42
Flywheel	50–55	36–40
Spark plugs	35–40	25–29
Camshaft nut	130–150	94–108
Bolt for crankshaft belt pulley	70–80	50–58
Bolt for alternator (1/2")	71–86	50–60
Nipple for oil filter	45–55	32–40
Nut for oil cooler	30–35	21–25
Bolt for oil sump	8–11	6–8

WEAR TOLERANCES

Cylinder:

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

Crankshaft:

Permissible out-of-round on main bearing journals, max.	0.05 mm (0.002")
Permissible out-of-round on big-end bearing journals, max.	0.07 mm (0.0028")
Crankshaft end float, max.	0.15 mm (0.006")

Valves:

Permissible clearance between valve stems and valve guides, max.	0.15 mm (0.006")
Valve spindle, 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")

ELECTRICAL SYSTEM

BATTERY

Type	Tudor 6 EX 4 E
Voltage	12 volts
Grounded	Negative terminal
Battery, capacity, standard	60 Ah
Specific gravity of electrolyte:	
Fully charged battery	1.28
When recharging is necessary	1.21
Recommended charging current	5.5 A

ALTERNATOR

S.E.V. MOTOROLA 14 V–34833 (14 V 55 A)

Output	770 W
Max. amperage	55 A
Max. speed	250 r/s (15000 r/m)
Direction of rotation	Optional
Ratio: engine – alternator	1:2
Min. length, brushes	5 mm (0.2")
Tightening torque: Attaching screws	2.8–3.0 Nm (2.0–2.2 lbft)
Nut for pulley	40 Nm (29 lbft)

Test values

Field winding resistance	3.7 ohms
Voltage drop across isolating diode	0.8–0.9 V
Output test	48 A (min. at 50 r/s = 3000 and approx 13 V)

BOSCH K 1–14 V 55 A 20

Output	770 W
Max. amperage	55 A
Max. speed	200 r/s (12000 r/m)
Direction of rotation	Clockwise
Ratio, engine – alternator	1:2
Min. diameter of slip rings	31.5 mm (1.24")
Max. permissible radial throw on, slip rings	0.03 mm (0.0012")
rotor body	0.05 mm (0.0020")
Min. length of brushes	14 mm (0.53")
Brush pressure	3–4 N (6.6–8.8 lb.)
Tightening torque for pulley	35–40 Nm (25–29 lbft)

Test values

Resistance in, stator	0.14+0.014 ohm
rotor	4.0+0.4 ohm
Output test	55 A (min. at 100 r/s = 6000 r/m and 14 V)

VOLTAGE REGULATOR

S.E.V. Motorola 14 V–33525

Control voltage, cold regulator	13.1–14.4 V
after driving 45 minutes	13.85–14.25 V

BOSCH AD–14 V

Control voltage at 67 alternator r/s, (4000 r/m cold regulator, read off within 30 seconds (lower two contacts)	13.9–14.8
Load current, lower two contacts	28–30 A
Control range (between two upper and lower contacts)	0–0.3 V
Load current, upper two contacts	3–8 A

STARTER MOTOR

Type	Bosch GF 12 V 1 PS
Voltage	12 V
Grounded	Negative terminal
Direction of rotation	Clockwise
Output	approx 736 W (1 hp)
Number of teeth on pinion	9
Brushes, number	4

Test values

Mechanical:

Rotor end float	0.05–0.30 mm (0.002–0.012")
Brush spring tension	11.5–13.0 Nm (2.53–2.86 lb.)
Distance from pinion to ring gear	1.2–4.4 mm (0.047–0.173")
Frictional torque of rotor brake	0.25–0.40 Nm (2.17–3.81 lbin)
Pinion idling torque	0.13–0.18 Nm (1.13–1.56 lbin)
Backlash	0.35–0.60 mm (0.014–0.0018")
Pinion modules	2.11
Minimum diameter of commutator	33 mm (1.3")
Minimum length of elec. brushes	14 mm (0.6")

Electrical:

Unloaded starter motor: 12.0 V and 40–50 A	115–135 r/s (6900–8100 r/m)
Loaded starter motor: 9 V and 185–220 A	17.5–22.5 r/s (1050–1350 r/m)
Locked starter motor: 6 V and 300–350 A	0 r/s

Control solenoid

Cut-in voltage	Min. 8 V

IGNITION SYSTEM

Firing order	1-3-4-2

B 20 E:

Ignition timing, 97 octane (RON) at 10–13 engine r/s (600–800 r/m) (vacuum governor disconnected)	10° B T D C
Spark plugs	Bosch W 240 T 35 or corresponding
Tightening torque	35–40 Nm (25.3–29.0 lbft)

B 20 F

Ignition timing, 94 octane (RON) at 10–13 engine r/s (600–800 r/m) (vacuum governor disconnected)	10° B T D C
Spark plugs	Bosch W 200 T 35
Tightening torque	35–40 Nm (25.3–29.0 lbft)

DISTRIBUTOR

B 20 E

Type	Bosch JFURX 4
Direction of rotation	Anti-clockwise
Breaker point, gap	0.35 mm (0.014")
dwell angle (at 8.3 r/s = 500 r/m)	59–65°
contact force	5.0–6.3 N (1.10–1.40 lb)
Centrifugal governor:	
Advance, total	11.0±1 degrees (distributor)
Advance begins at	6.3–9.2 r/s (375–550 distr. r/m)
Values 5°	13.3–16.2 r/s (800–970 distr. r/m)
7°	16.2–19.0 r/s (970–1140 distr. r/m)
9°	20.0–23.0 r/s (1200–1375 distr. r/m)
Advance finishes at	23 r/s (1380 distr. r/m)
Vacuum governor: (negative control)	
Retard, total	5±1 degrees (distributor)
Retard, begins at	30–110 mm (1.18–4.33") Hg
Values 3°	80–125 mm (3.15–4.92") Hg
Retard finishes at	130 mm (5.12") Hg

B 20 F

Type	Bosch JFUX 4
Direction of rotation	Anti-clockwise
Breaker point, gap	0.35 mm (0.014")
dwell angle at 8.3 r/s (500 r/m)	59–65°
contact force	5.0–6.3 N (1.10–1.40 lb)
Centrifugal governor:	
Advance, total	12±1 degrees (distributor)
Advance begins at	7.0–8.8 distr. r/s (420–530 r/m)
Valves 5°	13.8–16.4 distr. r/s (830–980 r/m)
7°	16.6–19.2 distr. r/s (1000–1150 r/m)
10°	24.2–33.0 distr. r/s 1450–1980 r/m)
Advance finishes at	41.7 distr. r/s (2500 r/m)
Vacuum governor: (negative control)	
Retard, total	5±1 degrees (distributor)
Retard, begins at	30–110 mm (1.18–4.33") Hg
Values 3°	80–125 mm (3.15–4.92") Hg
Retard finishes at	130 mm (5.12") Hg

LAMP BULBS

	Watts	Socket	Number
Headlights	60/55	P 43 t–38	2
Parking lights, front*	4 cp	Ba 9 s	2
Brake and rear lights	32/4 cp	BAY 15 d	2
Turn indicators*	32 cp	Ba 15 s	4
Reversing lights	32 cp	Ba 15 s	1
License plate light	4 cp	Ba 9 s	2
Interior lighting	10 W	SW 8.5	2
Glove locker light	2 W	Ba 9 s	1
Instrument panel lighting, without clock	3 W	W 2.1 d	8
clock	2 W	Ba 7 s	1
Lighting, heater controls	3 W	W 2.1 d	1
Lighting seat belt	2 W	Ba 7 s	1
Lighting for switches	1.2 W	W 1.8 d	1
Lighting, gear selector (BW 35)	1.2 W	W 1.8 d	1
Decal lighting	2 W	Ba 9 s	1
Warning lamps:			
full beam	3 W	W 2.1 d	1
charging	3 W	W 2.1 d	1
* For USA: Turn indicators and parking lights, front	32/4 cp	BAY 15 d	2

	Watts	Socket	Number
turn indicators	3 W	W 2.1 d	1
oil pressure	2 W	Ba 7 s	1
overdrive	1.2 W	Ba 9 s	1
brakes	1.2 W	Ba 9 s	1
elec. heated tailgate window	1.2 W	W 1.8 d	1
emergency warning flashers	1.2 W	W 1.8 d	1
Seat belt	1.2 W	Ba 9 s	1
Side marker lights (only USA)	5 W	Ba 15 S	4

FUSES

Number (5 A)	4
(8 A)	6
(16 A)	2

ELECTRICALLY HEATED REAR WINDOW

Output	approx. 150 W

POWER TRANSMISSION, REAR AXLE

CLUTCH

Clutch, type	Single, dry-plate
Size	8 1/2" (215.9 mm)
Clutch friction area, total	440 cm^2 (68.2 sqin)
Clutch fork free travel	3–4 mm (0.12–0.15")
Clutch pedal travel	140 mm (5.5")
Clutch spring, type	Diaphragm-plate

The clutch levers are not adjustable

GEARBOX

Type designation	M 41
Reduction ratios:	
1st speed	3.41:1
2nd speed	1.99:1
3rd speed	1.36:1
4th speed	1:1
Overdrive	0.797:1
Reverse	3.25:1
Oil pressure, direct drive	approx. 1.5 kp/cm^2 (21 psi)
overdrive	32–35 kp/cm^2 (455–498 psi)
Tightening torque, nut for flange	11.0–14.0 kpm (80–101 lb ft)
Lubricant	Engine oil
viscosity	SAE 30 or SAE 20 W-40
Oil capacity, gearbox and overdrive	approx. 1.6 dm^3 (2.8 Imp. pints = 3.4 US pints)

AUTOMATIC TRANSMISSION

Make and type	Borg-Warner, type 35	
Type designation, B 20 E	321	
B 20 F	351	
Colour of type plate, B 20 E	Grey	
B 20 F	Light orange	
Reduction ratios:		
1st gear	2.31:1	X Converter ratios
2nd gear	1.45:1	X Converter ratios
3rd gear	1:1	X Converter ratios
Reverse	2.09:1	X Converter ratios

Number of teeth, front sun gear	32
rear sun gear	28
planet gear, short	16
planet gear, long	17
ring gear	67
Size of converter	9 1/2" (24 cm)
Torque ratio in coverter	2:1–1:1
Normal stall speed, B 20 E	42.5 r/s (2550 r/m)
B 20 F	40.8 r/s (2450 r/m)
Weights, total with fluid	53.1 kg (117 lb)
Fluid, type	Automatic Transmission Fluid, Type F
Fluid capacity	6.4 dm^3 (11.4 Imp. pints = 13.5 US pints)
Normal operating temperature of fluid	approx. 110–115°C (212–240°F)

APPROXIMATE SHIFT SPEEDS

Throttle position	1–2 shift		2–3 shift		3–2 shift		3–1 shift	
	kmph	mph	kmph	mph	kmph	mph	kmph	mph
Full throttle	45	28	80	49				
Kick-down	63	39	112	70	102	64	Max 49	30

SPRINGS FOR CONTROL SYSTEM

SPRING	Approximate length		Effective number of turns	Wire diameter	
1–2 shift valve	27.8 mm	1.049"	13.5	0.61 mm	0.024"
Primary regulator valve	74.7 mm	2.940"	14	1.42 mm	0.056"
Servo orifice control valve	27.6 mm	1.086"	24	0.64 mm	0.025"
*Servo orifice control valve	30.8 mm	1.213"	25	0.61 mm	0.024"
Modulator valve	27.2 mm	1.069"	19	0.71 mm	0.028"
*Modulator valve	27.2 mm	1.069"		0.71 mm	0.028"
Secondary regulator valve	65.9 mm	2.593"	18	1.42 mm	0.056"
2–3 shift valve (inner spring)	40.4 mm	1.59"	22.5	0.91 mm	0.026"
Throttle valve (inner spring)	20.5 mm	0.807"	28	0.46 mm	0.018"
*Throttle valve (inner spring)	20.5 mm	0.807"	25	0.46 mm	0.018"
Throttle valve (outer spring)	29.8 –	1.107–	19.5	0.81 mm	0.032"
*Throttle valve (outer spring)	30.1 mm	1.185"			
Governor valve	28.8 –	1.107–	18	0.81 mm	0.032"
*Alternative springs	30.1 mm	1.185"			

TIGHTENING TORQUES

APPLICATION	Nm	Lb ft
Torque converter – drive plate	35–41	25–30
Transmission case – converter housing	11–18	8–13
Extension housing – transmission case	41–76	30–55
Oil pan – transmission case	11–18	8–13
Front servo – transmission case	11–18	8–13
Rear servo – transmission case	18–37	13–27
Pump adaptor – front pump body	24–30	17–22
Slotted screws	3–4	2–3
Pump adaptor – transmission case	11–26	8–18.5
Oil deflector flange – transmission case	6–10	4–7

	Nm	Lb ft
Centre support — transmission case	14–25	10–18
Outer lever — manual valve shaft	10–12	7–9
Pressure point	6–7	4–5
Oil pan drain plug	12–17	9–12
Oil tube collector — lower body	25–35	1.7–2.5
Governor line plate — lower body	25–35	1.7–2.5
Lower body end plate — lower body	25–35	1.7–2.5
Upper body end plate front or rear — upper body	25–35	1.7–2.5
Upper body — lower body	25–35	1.7–2.5
Valve bodies assembly — transmission case	6–12	4.5–9
Front pump strainer — lower body	25–35	1.7–2.5
Downshift valve cam bracket — valve body	25–55	1.7–3.5

Governor

Governor body—counterweight	6–7	4–5
Cover plate — governor body	2.5–5.5	1.7–4.0

Brake band adjustment

Adjusting screw locking nut, rear servo — case	41–55	30–40

Special threaded parts

Starter inhibitor switch locknut	6–8	4–6
Downshift valve cable adaptor — transmission case	11–12	8–9
Coupling flange — driven shaft	48–69	35–50
Nipple for oil cooler connection	7–10	5–7
Nut for nipple	14–17	10–12

PROPELLER SHAFT

Type	Tubular, divided, three universal joints, support bearings
Universal joints	Fitted with needle bearings
Lubricant, sliding joint (when assembling)	Molybdenum disulphide chassis grease
universal joints	Chassis grease. Further addition not required

REAR AXLE

Rear axle, type	Semi-floating
Track	1350 mm (53.15")

Final drive

Type	Spiral bevel (hypoid)
Reduction ratio	3.91:1 or 4.30:1
Backlash	0.13–0.20 mm (0.005–0.008")
Pre-loading on pinion bearings, new bearings	1.1–2.3 Nm (9.55–20.0 lbin)
run-in bearings	0.6–1.1 Nm (5.21–9.55 lbin)
Pre-loading on differential bearings	0.13–0.20 mm (0.005–0.008")
Lubricant, type, without limited slip differential	Oil acc. to MIL-L-2105 B
with limited slip differential	Oil acc. to Mil-L-2105 B provided with additive for limited slip differential
viscosity, above –10°C (14°F)	SAE 90
below –10°C (14°F)	SAE 80
Oil change quantity	1.3 dm^3 (2.3 Imp. pints = 2.7 US pints)

Tightening torques

	Nm	Lb ft
Flange	280–300	200–220
Caps	50–70	35–50
Crown wheel	65–90	45–65

BRAKES

FRONT WHEEL BRAKES

Type	Disc brakes
Brake disc:	
Outside diameter	268.5 mm (10.6")
Thickness, new, nominal measurement	14.3 mm (0.6")
reconditioned, min.	13.1 mm (0.52")
Warp	Max. 0.10 mm (0.004")
Brake linings:	
Number per wheel	2
Thickness, new	10 mm (0.394")
Effective area	150 cm^2 (23 sqin)
Code designation	DB 818 FG
Wheel unit cylinders:	
Number per wheel	4
Diameter	36.12 (1.442")

REAR WHEEL BRAKES

Type	Disc brakes
Brake disc:	
Outside diameter	295.5 mm (11.63")
Thickness, new, nominal measurement	9.6 mm (0.378")
reconditioned, min.	Min. 8.4 mm (0.33")
Warp	Max. 0.15 mm (0.006")
Brake lings:	
Number per wheel	2
Thickness, new	10 mm (0.394")
Effective area	100 cm^2 (15.5 sqin)
Code designation	DB 818 FG
Wheel unit cylinders:	
Number per wheel	2
Diameter	36.12 mm (1.422")

MASTER CYLINDER

Type	Tandem cylinder
Nominal diameter	22.2 mm (0.87")
Bore	Max. 22.40 mm (0.882")
Piston diameter	Min. 22.05 mm (0.868")

BRAKE LINE

Outer diameter	3/16"

BRAKE VALVE

Make	A t e
Operating pressure	34±2 kp/cm^2 (484±28 psi)
Outgoing pressure at an input pressure of:	
30 kp/cm^2 (427 psi)	30 kp/cm^2 (427 psi)
50 kp/cm^2 (711 psi)	36–42 kp/cm^2 (512–597 psi)
100 kp/cm^2 (1422 psi)	50–59 kp/cm^2 (711–839 psi)

POWER CYLINDER

Type	Direct operating
Make	A t e
Designation	Bremsgerät T 51
Ratio	1:2.7

PARKING BRAKE

Brake drum:	
Diameter	Max. 179.33 mm (7.0")
Radial throw	Max. 0.15 mm (0.006")
Out-of-round	Max. 0.2 mm (0.008")
Brake linings, effective area	175 cm² (27 sqin)

TIGHTENING TORQUES	Nm	Lbft
Attaching bolts, front brake caliper	90–100	65–70
Attaching bolts, rear brake caliper	60–70	45–50
Attaching nuts, rear guard plate	37–44	27–32
Wheel nuts	100–140	70–100
Stop bolt, master cylinder	5–8	3.5–6
Attaching nuts, master cylinder	24	17
Bleeder nipples	4–6	3–4.5
Brake pipes	11–15	8–11
Brake hoses	16–20	12–15
Plug, brake valve	100–120	70–85
Locknut, brake valve	25–35	18–25
Warning valve, switch	14–20	10–15

FRONT END AND STEERING GEAR

WHEEL ALIGNMENT (unloaded vehicle)

Caster	+2 to +2 1/2°
Camber	0 to +1/2°
King pin inclination at camber of 0°	8°
Toe-in	0 to 3 mm (0–0.12")
Toe-out	
At a 20° turn of the outer wheel the inner wheel should be turned	21.5 to 23.5°

STEERING GEAR

Steering wheel diameter	406.4 mm (16")
Number of turns from stop to stop	3 1/4 turns
Steering housing, make and type	Gemmer, "cam and ball"
reduction ratio	15.5:1
Lubricant for steering housing	Hypoid oil SAE 80
Capacity	0.25 dm³ (0.44 Imp. pint = 0.53 US pint)

Tightening torques	Nm	Lbft
Nut for spindle bearing	70	50
Clamp nut, upper control arm	19–25	14–18
Nut for rubber bush, upper control arm shaft	55–62	40–45
Bolt, upper control arm shaft	55–70	40–50
Nut for lower ball joint	48–55	35–40
Nut for rubber buffer, lower control arm	21–35	15–25
Steering wheel nut	28–40	20–30
Nut for pitman arm	140–170	100–120
Locknut for tie rod	75–90	55–65
Nut for steering rods and tie rods (ball joints)	32–37	23–27
Nut for safety device	30–50	22–36

SUSPENSIONS, WHEELS

SPRINGS

Front springs

Type	Helical spring
Wire thickness	14.1–14.3 mm (0.55–0.56")
External diameter	121.0–122.5 mm (4.77–4.87")
Number of turns, total	8.7
Test values:	
Loading for compression of 1 cm (25/64") (measured within a spring length of 175–215 mm = 6.89–8.46")	478–518 N (105–114 lb)
Length, turn for turn	max. 120 mm (4.72")
Loading for a spring length of 195 mm (7.68")	4810–5110 N (1058–1124 lb)

Rear springs

Type	Helical spring
Wire thickness	11.7–11.9 mm (0.46–0.47")
External diameter	114.5–116.0 mm (4.5–4.6")
Number of turns, total	10.7
Test values:	
Loading for a compression of 1 cm (25/64") (measured within a spring length of 225–265 mm = 8.85–10.43")	194–214 N (43–47 lb)
Length turn for turn	max. 123 mm (4.84")
Loading for a spring length of 245 mm (9.65")	2760–2940 N (607–647 lb)

SHOCK ABSORBERS

Type	Telescopic
Total length:	
Front shock absorbers, compressed	approx. 323 mm (12.72")
unloaded	approx. 444 mm (17.48")
Rear shock absorbers, compressed	approx. 368 mm (14.49")
unloaded	approx. 546 mm (21.50")

WHEELS

Wheel rims

Designation	5.5" J x 15"
Number of wheel nuts	5
Radial throw	max. 1.6 mm (0.063")
Warp	max. 1.6 mm (0.063")
Tightening torque for wheel nuts	100–140 Nm (72–101 lbft)

Tyres

Type	Radial with tube
Size	185/70 HR 15
Pressure (cold tyres), front	1.7 kp/cm² (25 psi)
rear	1.9 kp/cm² (27 psi)

Part 1

SERVICING AND MAINTENANCE

CONTENTS

LUBRICATION

OIL LEVEL CHECKING AND CHANGING

ENGINE

The oil level is checked with the dipstick, see Fig. 1—15.

With a new or reconditioned engine, the oil should be changed after the first 2 500 km (1 500 miles). Thereafter the oil should be changed every 10 000 km (6 000 miles), or at least twice a year, whichever comes first.

The oil should be drained immediately after the car has been driven and while the engine is still warm. To drain the oil, remove the oil drain plug, see Fig. 1—1. When the engine has been emptied of oil, check the washer and screw the plug tightly into position again. Oil is added through the rocker arm casing after removing the filler cap.

Oil with grade designation API "For Service SD, SE and CC" is used for the engine. The previous designation "For Service MS" can also be used. Concerning viscosity, select a multigrade oil according to the following table:

Temperature range	Viscosity
SUMMER (above $-12^oC = +10^oF$)	20 W - 40 or 20 W - 50
WINTER (below $-12^oC = +10^oC$)	10 W - 30

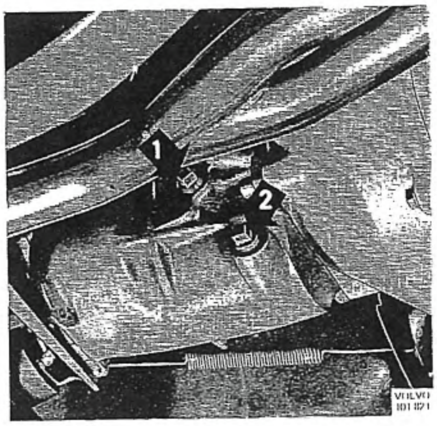


Fig. 1—2. Gearbox
1. Filler plug 2. Drain plug

At very low temperatures (below $-18^oC=0^oF$) or when cold-starting difficulties are anticipated, multigrade oil SAE 5 W-20 is recommended. This oil should not be used when the temperature is continuously above 0^oC (32^oF).

The quantity of oil changed is 3.25 dm^3 (5.7 imp. pints=6.9 US pints). With the oil filter included, the corresponding quantity is 3.75 dm^3 (6.6 imp. pints=7.9 US pints).

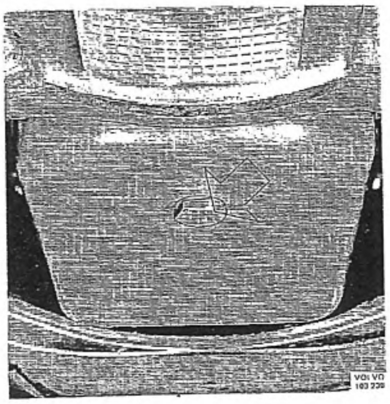


Fig. 1—1. Drain plug on sump

MECHANICAL GEARBOX

To check the oil level, remove the filler plug (1, Fig. 1—2) and then check to see that the oil reaches up to the hole for the plug.

In the case of a new or reconditioned gearbox, the oil should be changed after the first 2 500 km (1 500 miles). The oil should subsequently be changed after every 40 000 km (25 000 miles).

Drain off the old oil after the car has been driven and while the oil is still warm. Observe due care that the oil does not come into contact with your skin. To empty the oil, remove the plugs (1 and 2, Fig. 1—2) and the cover (Fig. 1—3). Also clean the oil filters, see Group 43 B.

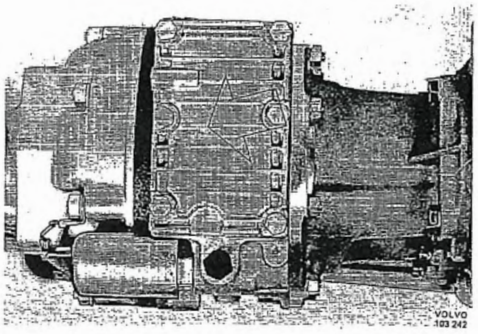


Fig. 1—3. Overdrive

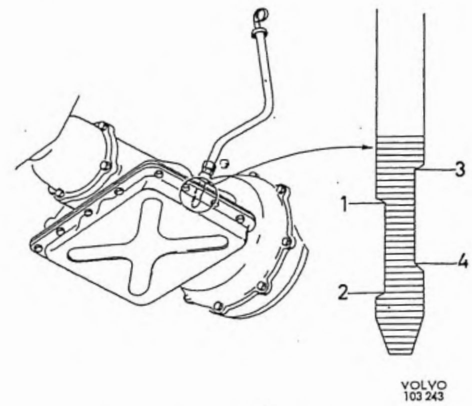


Fig. 1—4. Checking oil level
1. Max. oil level, cold transmission
2. Min. oil level, cold transmission
3. Max. oil level, warm transmission
4. Min. oil level, warm transmission

Re-fit the drain plugs and bolt on the cover securely. Fill with new oil. Fill slowly to enable the oil to run over into the overdrive. The oil should reach up to the filler hole (1, Fig. 1—2). Screw tight the filler plug. For a gearbox with overdrive, engine oil with viscosity SAE 30 is used all the year round. As an alternative, multigrade oil SAE 20 W-40 can be used. The oil changing quantity is 1.6 dm^3 (2.8 Imp. pints=3.4 US pints).

AUTOMATIC TRANSMISSION

Normally oil changing only needs to be carried out when the transmission is reconditioned. The oil level, on the other hand, should be checked after every 10 000 km (6 000 miles).

The vehicle should then stand level. Move the selector lever to position "P" and let the engine run at idling speed. Wipe off the dipstick with a clean rag, paper, etc. Do not use waste or fluffy rags. Insert the dipstick, pull it up and check the oil level. See Fig. 1—4. **Note that there are different levels for a warm or cold transmission.** For a warm transmission, which is the case after driving 8—10 km (5—7 miles), the upper section applies (3 and 4, Fig. 1—4). The lower section (1 and 2, Fig. 1—4) applies to a cold transmission. The text on the dipstick will also remind you of this. If necessary, fill up with oil until the level reaches the "Max" mark. Do not fill above this mark, as this can cause the transmission to become overheated. The difference between the "Min and Max" marks is about 0.5 dm^3 (1 pint). For topping-up, use oil ATF, Type F, that is, a fluid meeting Ford specification M2C 33F.

If frequent filling up is found to be necessary, this indicates leakage which must be put right immediately.

FINAL DRIVE

To check the oil level, remove the filler plug (1, Fig. 1—5) and then check to ensure that oil reaches up to the hole for the plug.

With a new or reconditioned final drive, the oil should be changed after the first 2 500 km (1 500 miles). Oil changing should therefore be carried out only when overhauling is being done.

Oil changing should preferably be done immediately after the vehicle has been driven and while the oil is still warm. When draining the oil remove the plugs marked 1 and 2 in Fig. 1—5.

Clean the magnetic plug (2) well. It is of great importance for the lifetime of the final drive that particles and other impurities accumulated during the running-in are removed.

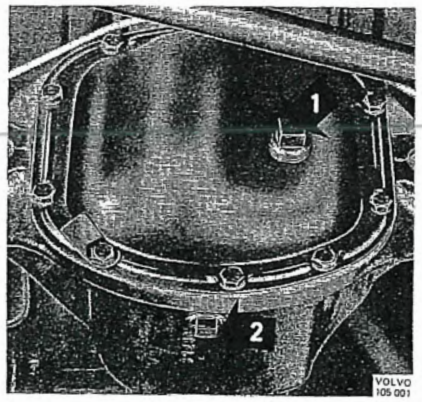


Fig. 1—5. Final drive
1. Filler plug 2. Drain plug

After the drain plug has been re-fitted, fill with new oil. The oil should reach up to the filler hole and the oil capacity is about 1.3 dm^3 (2.3 Imp. pints=2.7 US pints). For changing the oil in the final drive, oil which meets the requirements of the American Military Standard MIL-L-2105 B, SAE 90, is normally used.
A final drive fitted with a limited slip differential is filled at the factory with a transmission oil which meets the requirements of the American Military Standard MIL-L 2105 B provided with an additive for final drives with limited slip differential. For subsequent topping-up and when changing, use oil according to MIL-L-2105 B having the above-mentioned additive. The oil level should be checked and the oil changed at the same intervals and in the same way as for a final drive without a limited slip differential.

STEERING BOX

To check the oil level in the steering box, remove the filler plug (Fig. 1–6) and then check to ensure that the oil reaches up to the hole for the plug.
Normally it is not necessary to change the oil in the steering box except after reconditioning has been carried out. However, should the oil have to be changed for any reason, the old oil can be sucked out by using a suitable device, for example, an oil syringe, which is inserted through the filler hole, or the steering box can also be removed and emptied. Hypoid oil SAE 80 is used for the steering box all the year round.
The oil capacity of the steering box is 0.25 dm^3 (0.4 Imp. pint=0.5 US pint).

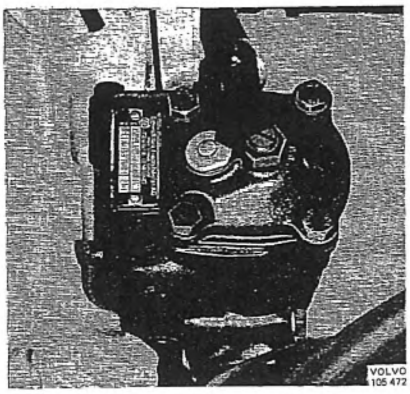


Fig. 1–6. Steering box filler plug

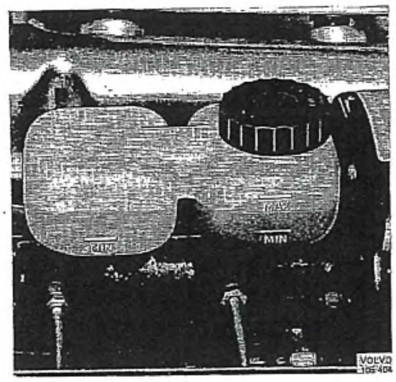


Fig. 1–7. Brake fluid container

CHECKING BRAKE FLUID LEVEL

This check can be made without taking off the cap. (Fig. 1–7). If the check is carried out in connection with a visit to a workshop, the level should be attended to if it is lower than the "Max" mark. Under no circumstances may the level be below the "Min" mark.
If necessary, top up with first-class brake fluid which meets the requirements according to SAE J 1703. Brake fluid with designation DOT 3 or DOT 4 can also be used.
Clean the brake fluid container cap before removal and observe maximum cleanliness when filling with brake fluid. Avoid spilling any fluid onto the paintwork since this will damage it. Check to make sure that the vent hole in the cap is not blocked.

LUBRICATION

DISTRIBUTOR

After every 10 000 km (6 000 miles) the distributor shaft, cam and ignition advance mechanism should be lubricated. The distributor shaft is lubricated by filling the oil cup (3, Fig. 1–8) with engine oil. After filling, close the cup. The contact surface of the cam disc (2) should be lubricated with a thin coating of grease, Bosch Ft 1 v 4, or corresponding grease. The ignition advance mechanism should be lubricated by pouring 2–3 drops of light engine oil (SAE 10 W) on the wick (1) in the distributor shaft.

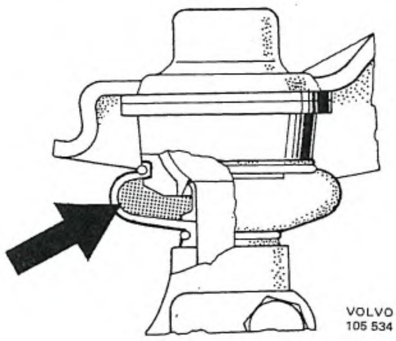


Fig. 1–9. Ball joint

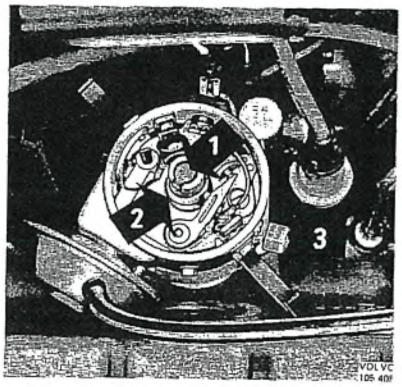


Fig. 1–8. Distributor
1. Lubricating wick 2. Cam disc 3. Oil cup

BODY

To avoid squeaking and unnecessary wear, the body should be lubricated as described below. Nos. 7, and 9 of the lubricating schedule should be lubricated approx. every 10 000 km (6 000 miles) and other parts of the body about once a year. Moreover, during the winter months the locks on the doors and the luggage compartment lid should be given some anti-freeze to prevent them from freezing up.

BALL JOINTS

The upper and lower ball joints of the front end together with the ball joints of the tie rod and steering rod are plastic-lined. Therefore, they do not require lubricating and thus have no grease nipples. As the sealing is extremely important with regard to the serivce life of these ball joints, the rubber seals should be checked every 20 000 km (12 000 miles) to ensure that they are not damaged. If cracked or damaged, the ball joint should be replaced, see Part 6.

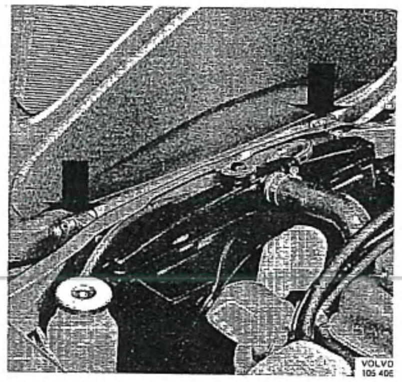


Fig. 1–10. Hood hinges

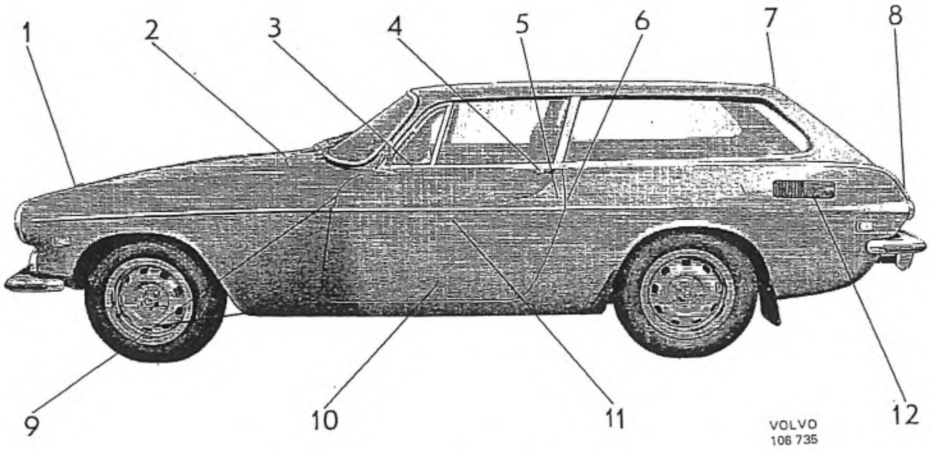


Fig. 1—11. Lubricating points on body

No.	Lubricating point	Lubricant
1.	Hood hinges	Oil
2.	Hood catch	Paraffin wax
3.	Ventilator window catches and hinges	Oil
4.	Door handle lock buttons,	Paraffin wax
	key holes	Lock oil
5.	Door lock lubricating hole	Oil
	Door check	Paraffin wax
6.	Striker plate	Paraffin wax
7.	Tailgate hinges	Oil

No.	Lubricant point	Lubricant
8.	Tailgate lock	Paraffin wax
	Key hole	Lock oil
9.	Door hinges	Oil
	Door stops	Paraffin wax
10.	Front seat slide rails	Paraffin wax
	Seat catches	Oil
11.	Window lifts	Oil and grease
	Locks	Silicon grease
	(Accessible after door upholstery panels have been removed)	
12.	Fuel filler cap hinges	Oil
	Lock	Lock oil

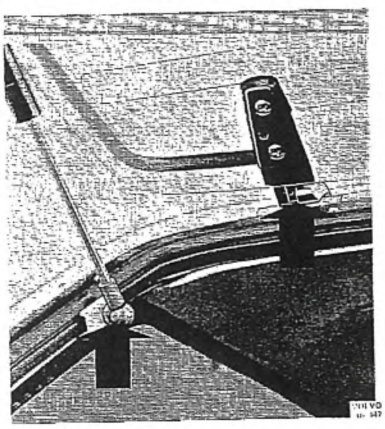


Fig. 1—12. Tailgate hinges

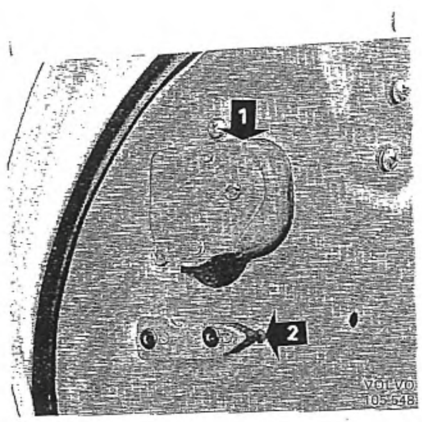


Fig. 1—13. Door hinges
1. and 2. Hinges (light oil)
3. Door stop (paraffin wax)

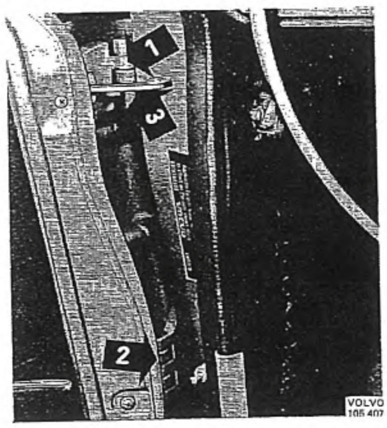


Fig. 1—14. Door lock
1. Lubricating hole (light oil)
2. Striker plate (paraffin wax)

CHECKS WHEN FILLING TANK

Make following checks when filling tank:

1. Check that oil level in engine is between "Max" and "MIN" marks on dipstick (see Fig. 1—15).
2. Without removing the cap, check that level in brake fluid container is above "Min" mark (see Fig. 1—16).
3. Check that coolant level is between "Max" and "Min" marks on expansion tank (see Fig. 1—17).
4. Check that fluid container for windshield washer is filled (see Fig. 1—18).

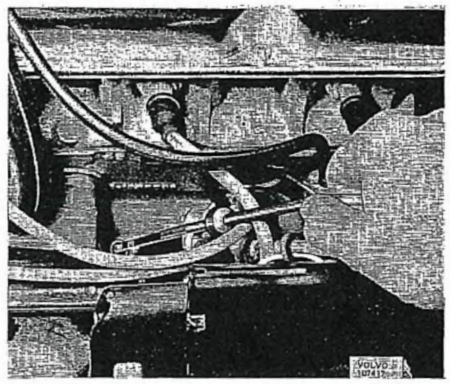


Fig. 1—15. Oil dipstick

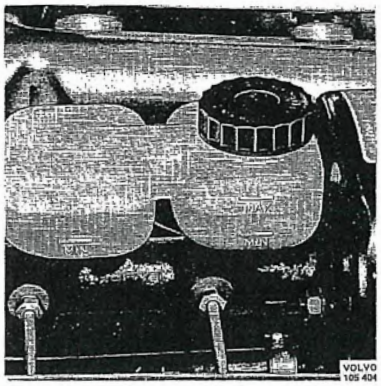


Fig. 1—16. Brake fluid container

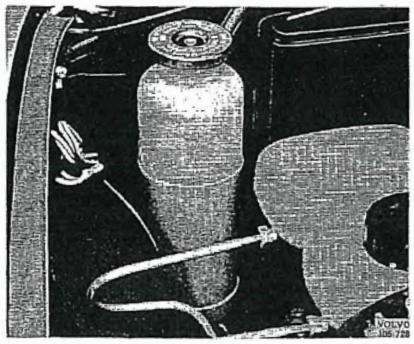


Fig. 1—17. Expansion tank

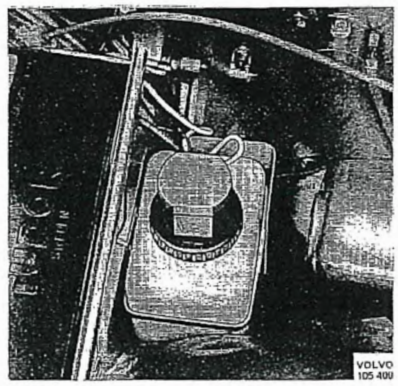


Fig. 1—18. Fluid container

The following checks should be made every other week:

1. Check that electrolyte level in battery is about 5 mm (3/16") above plates (Fig. 1—19). If necessary fill with **distilled** water. Also check that battery and battery terminals are secure.
2. Check to make sure that pressure in tyres correspond to following values (cold tyres):
   Front . . . . 1.7 kp/cm^2 (25 psi)
   Rear . . . . 1.9 kp/cm^2 (27 psi)
   The pressure should also be increased by 0.3 kp/cm^2 (4 psi) for long-distance driving at a speed over 120 kmph (75mph).

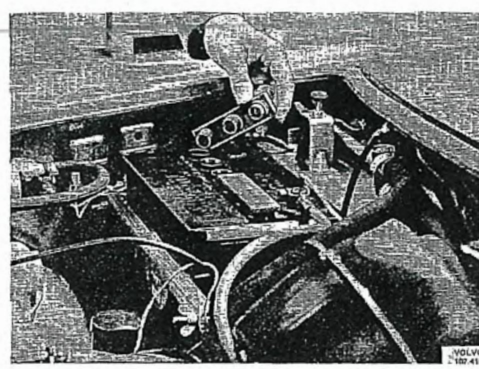


Fig. 1—19. Battery

INSTRUCTIONS FOR LUBRICATING CHART

SYMBOLS

Engine oil
Grade: "For Service SD, SE and CC (MS)"
Viscosity: See page 1:1

Final drive oil
Grade: MIL-L-2105 B
Viscosity: SAE 90
Concerning lubricant for final drive with limited slip differential, see page 3.

Lubricant, see respective note

Light engine oil

Brake fluid
Grade: SAE J 1703

OIL CHANGING QUANTITIES

Engine,	
oil changing quantity	approx. 3.25 dm^3 (5.7 Imp.pints=6.9 US pints)
including oil filter	approx. 3.75 dm^3 (6.6 Imp.pints=7.9 US pints)
Gearbox,	
mechanical	approx. 1.6 dm^3 (2.8 Imp.pints=3.4 US pints)
automatic transmission	approx. 6.4 dm^3 (11.3 Imp.pints=13.5 US pints)
Final drive	approx. 1.3 dm^3 (2.3 Imp.pints=2.7 US pints)
Steering gear	approx. 0.25 dm^3 (0.4 Imp.pint=0.5 US pint)

OTHER LUBRICATING POINTS

In addition to the points indicated in the lubricating chart, the chassis should be greased about once a year at all the joints for the throttle control linkage, parking brake, pedal linkages etc. Certain checks should also be carried out when filling the tank, see page 1:6.

NOTES

Note 1. In connection with any workshop operations which result in the wheel bearings being exposed, the bearings should be removed, cleaned and greased with a high-class, durable grease according to the instructions in Groups 46 and 77. Subsequent adding or replacement of grease should not be carried out.

Note 2. Check that oil reaches up to filling plug (Fig. 1–6).

Note 3. Check there is sufficient brake fluid in container, see page 1:3.

Note 4. Lubricate the distributor according to instructions on page 1:4.

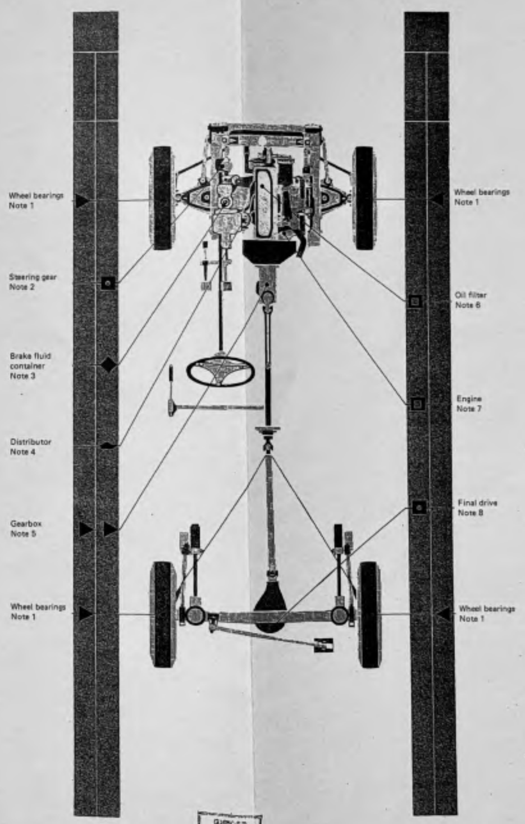
Note 5. Every 10 000 km (6 000 miles) check the oil level, see pages 1:1 and 1:2. Change oil after every 40 000 km (24 000 miles).
NOTE. The type of gearbox will decide the kind of lubricant to be used, see pages 1:1 and 1:2.

Note 6. Replace filter complete according to instructions in Part 2.

Note 7. Check oil level when filling gasoline tank. Change oil according to instructions on page 1:1.

Note 8. Every 10 000 km (6 000 miles) check that oil reaches up to filling plug.
Concerning lubricant for final drive with limited slip differential, see page 1:2.

LUBRICATING CHART



Part 2

ENGINE

CONTENTS

TOOLS

The special tools are preceded by 999 or SVO, e.g., 999 2837 or SVO 2837.

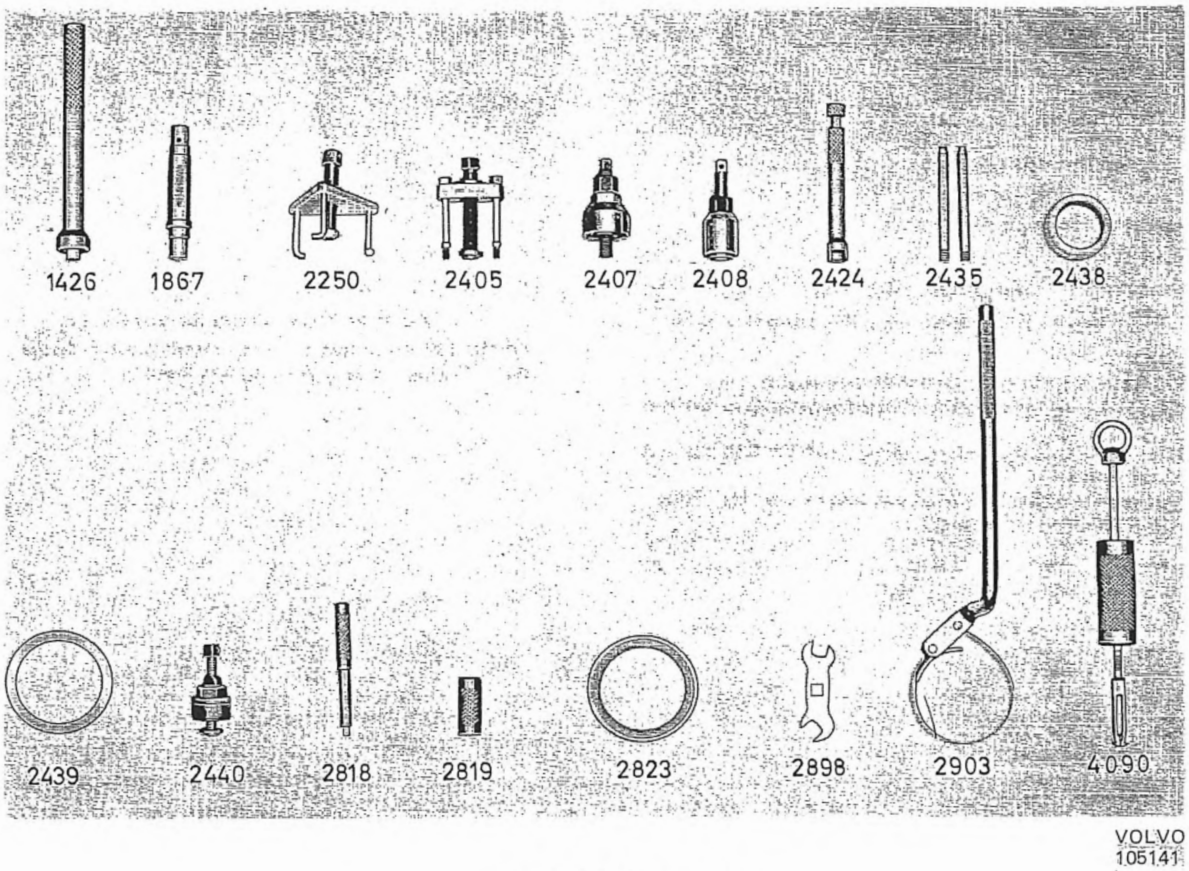


Fig. 2–1. Tools for engine

999 (SVO)
1426 Drift for fitting pilot bearing
1867 Drift for removing and fitting bush in rocker arm and connecting rod
2550 Puller for camshaft gear
2405 Puller for crankshaft gear (2822 can be used as alternative)
2407 Press tool for fitting crankshaft gear
2408 Press for fitting camshaft gear
2424 Grip tool for removing and fitting valve tappets
2435 Dowels (2) for fitting cylinder head
2438 Centering sleeve for timing gear casing and fitting ring circlip

999 (SVO)
2439 Centering sleeve for rear sealing flange and fitting felt ring circlip
2440 Puller for crankshaft hub
2818 Drift for removing valve guide
2819 Drift for fitting guide
2823 Ring for fitting standard piston
2898 Spanner 11/16" for final-tightening of cylinder head bolts
2903 Spanner for removing oil filter
4090 Puller for crankshaft pilot bearing

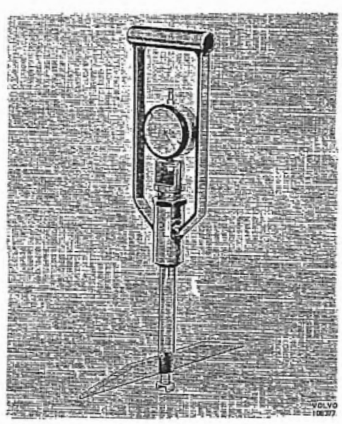


Fig. 2–2. 2906, fan belt tensioner

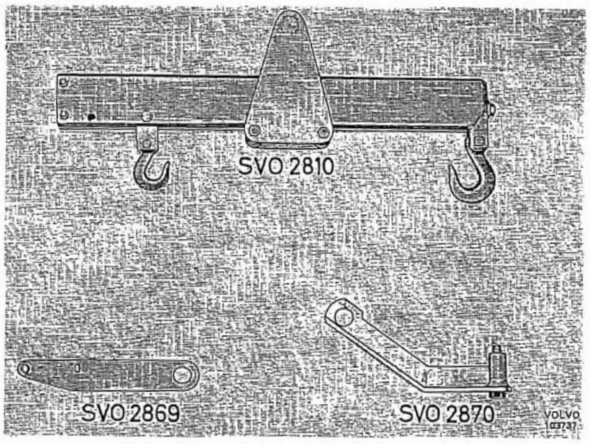


Fig. 2–3. Tools for removing engine

999 (SVO)
2810 Beam for lifting out and installing engine
2869 Lifting lug for attaching lifting beam 2810 in rear 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.)

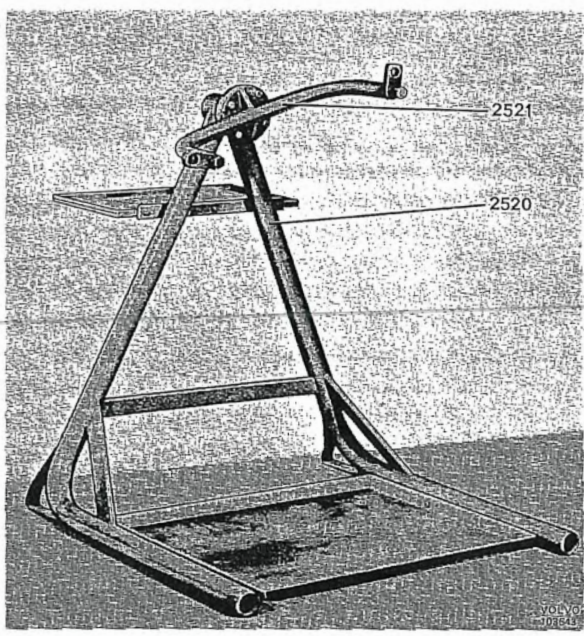


Fig. 2–4. Stand 2520 and fixture 2521 for engine

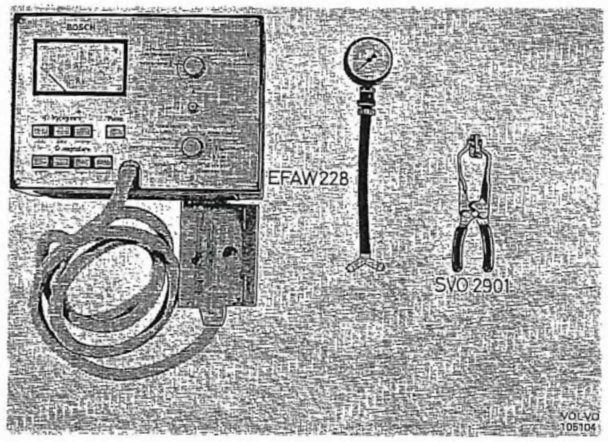


Fig. 2–5. Special tools for fuel system

EFAW 228 Bosch test instrument with pressure gauge
2901 Pinchers, 4 (for pinching fuel lines)

GENERAL
DESCRIPTION

The B 20 E and the B 20 F engines are four cylinder, water-cooled, overhead-valve units with positive crankcase ventilation. The crankcase is journalled in five bearings.
The engines are equipped with electronically controlled fuel-injection.

B 20 F has lower compression and output than B 20 E. It is intended for 91 (RON)* octane fuel.
Engine output is shown in Fig. 2–8.
* RON = Research Method.

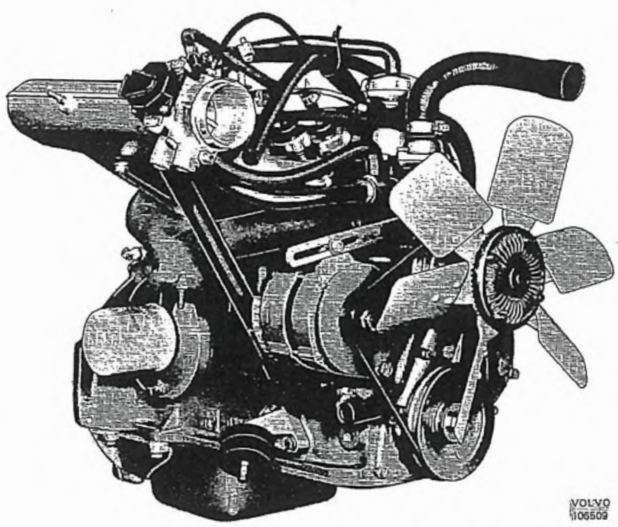


Fig. 2–6. Engine B 20 E viewed from right

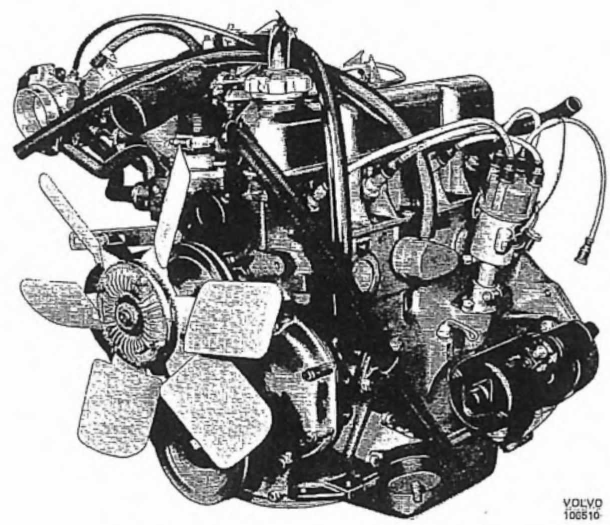
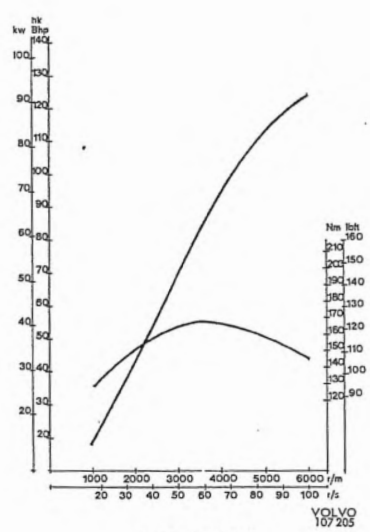
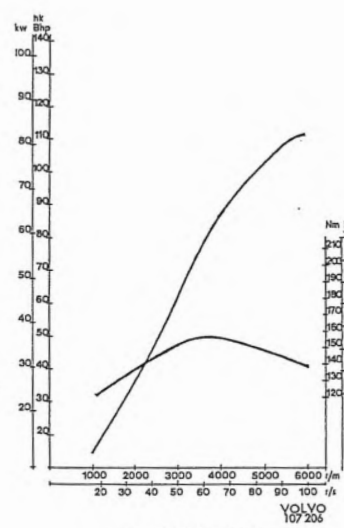


Fig. 2–7. Engine B 20 E viewed from left



B 20 E (DIN)



B 20 F (SAE J 245)

Fig. 2–8. Output and torque curves

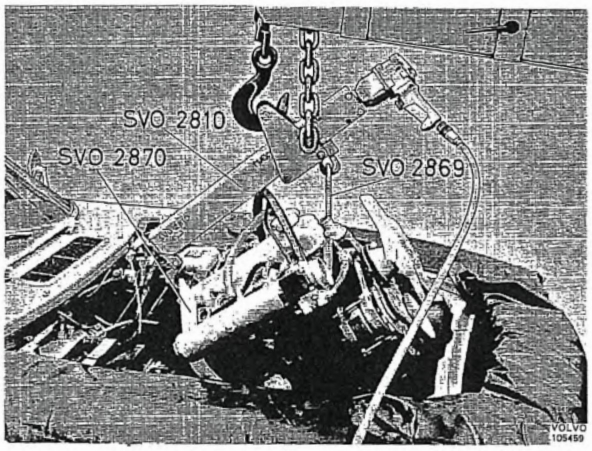


Fig. 2–9. Lifting out engine

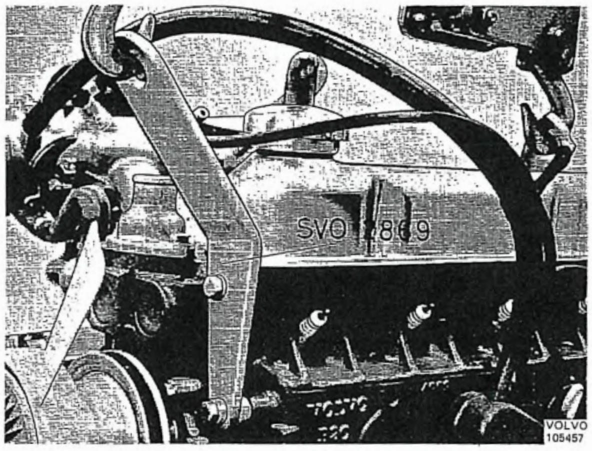


Fig. 2–11. Lifting lug on engine front end

REMOVING ENGINE

1. Remove the gear lever.
2. Place a container under the engine. Remove the lower radiator hose, the plug on the engine block and empty the coolant. Take off the filler cap on the expansion tank.
3. Disconnect the positive lead from the battery.
4. Remove the hose for the pressure sensor and the brake from the inlet duct. Remove the clamp for the hose from the cylinder head.

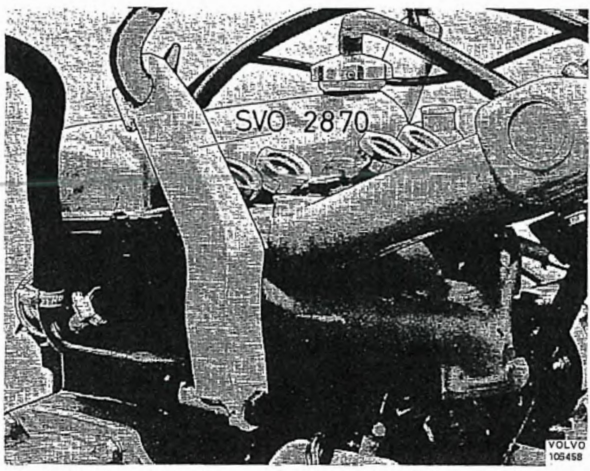


Fig. 2–10. Lifting lug on engine rear end

5. Remove the lock and bracket for the throttle cable.
6. Remove the plug contacts for the temperature sensor, the cold start valve and the throttle valve switch.
   Remove the electric lead from oil temperature and oil pressure sensors in the rapid contact.
7. Remove the oil pressure hose for the oil pressure gauge at the pipe connection.
8. Remove the hose for the induction air.
9. Remove the ground lead from the inlet duct and the electric lead from the temperature sensor.
10. Remove the return line from the pressure regulator and the line from the distributing pipe.
11. Remove the hose for the cold start valve from the distributing pipe.
12. Remove the injectors and fit them with masking caps and plug the holes. Place the injectors, the distributing pipe and pressure regulator on the heater element.
13. Remove the water hoses for the heater element from the engine.
14. Remove the upper radiator hose. Fit the drain plug on the engine block.
15. Remove the radiator and hsoe for the expansion tank.
16. Remove the engine hood.
17. Remove the electric leads from the alternator.
18. Remove the ignition leads from the spark plugs and the distributor cap from the distributor. Remove the plug contact and the electric lead from the distributor. Remove the electric lead from the starter motor.

19. Fit lifting lug 2870 in the rear end of the engine (Fig. 2–10) and lifting lug 2869 in the front end (Fig. 2–11).
20. Prop up the vehicle with four props. Drain the engine oil.
21. Remove nuts and washers for the front engine mounting.
    Remove the nuts for the exhaust manifold flange.
22. Remove the ground lead from the engine.
23. Hook lifting beam 2810 onto the lifting lugs and adjust the block and tackle unit at the rear end. Hoist so that the rear end lifts (see Fig. 2–9).
24. Remove the front universal joint.
25. Remove the return spring for the clutch and the clutch cable and sleeve.
26. Take off the clamp for the exhaust pipe.
27. Remove the speedometer gear at the gearbox and the electric cable from the solenoid.
28. Remove the gearbox member.
29. Hoist the engine with the lifting unit and lower the rear end with the block and tackle.
    Remove the electric cable from the gearbox electric contact and install the cables through the clamp.
    Pull the engine forwards over the front member and raise it. Level up the engine and gearbox and take out the complete unit.

INSTALLING ENGINE

1. Fit the lifting lugs and lifting beam. Hoist the engine into position and fit the electric cables on the gearbox. Lower the engine into position.
2. Fit the speedometer gear and the electric cable on the solenoid.
3. Fit the gearbox member and the universal joint.
4. Fit the clutch cable, sleeve and return spring. Adjust the clutch play according to Part 4 (41).
5. Remove the engine hoist unit. Fit the exhaust manifold flange with a new gasket. (Do not tighten the nuts.)
6. Fit washers and nuts for the front engine mounting.
7. Tighten the nuts for the exhaust manifold flange. Connect the ground lead. Fit the clamp for the exhaust pipe.
8. Lower the vehicle. Remove the lifting lugs.
9. Connect the electric leads for the starter motor and the plug contact and electric lead to the distributor.
   Fit the distributor cap and leads.
10. Connect the electric leads for the alternator.
11. Fit the engine hood.
12. Fit the radiator, the hose to the expansion tank and upper and lower radiator hoses.
13. Connect the hoses for the heater element.
14. Remove the protective plugs and masking caps. Place new rubber seals on the injectors. Fit the injectors and distributing pipe.
15. Fit the hoses to the distributing pipe and pressure regulator.
16. Connect the electric lead for the temperature sensor and the ground lead to the inlet duct. Connect the electric lead from the oil temperature and oil pressure in the rapid contact.
17. Fit the oil hose and hose for the induction air.
18. Fit the plug contacts for the temperature sensor, cold start valve and throttle valve switch.
19. Fit the lock pin and bracket for the throttle cable.
20. Connect the vacuum hose from the brake servo and fit the clamp.
    Connect the hose for the pressure sensor.
21. Connect the battery lead. Fill with engine oil and coolant.
22. Fit the gear lever.
    Check function and for leakage.

GROUP 21

ENGINE

DESCRIPTION

CYLINDER BLOCK

The cylinder block (Illustration A) is made of special cast iron and is cast in a single unit. The cylinder bores, which are surrounded by cooling jackets, are machined directly in the block. The oilways in the block are arranged so that the oil filter, which is of the full-flow type, is directly attached to the right-hand side of the block. A reinforcing bracket is mounted to the cylinder block and flywheel housing for taking up vibrations, see Fig. 2—12.

CYLINDER HEAD AND VALVES

The cylinder head is secured to the block by means of bolts. All the combustion chambers are machined throughout and have separate inlet and exhaust ports, one for each valve.

The valves, which are fitted suspended in the cylinder head, are made of special steel and are carried in replaceable guides. The valve stems are chromed. The valve collet is provided with three lands and the valve with corresponding grooves, which hold the valve but also make suitable rotation possible. (Compare with Fig. 2—24.) The valves are provided with valve guide rubber seals, which are mounted on the guides.

The cooling jackets are designed so that the air around the spark plugs is also cooled. Water distribution is by means of a pipe, the water being directed towards the warmest parts of the engine.

The compression for the B 20 E differs from B 20 F compression due to a cylinder head gasket of different thickness and cylinder lock with different height.

CRANKSHAFT AND BEARINGS

The crankshaft is made of steel and has ground, case-hardened bearing journals. It is carried in five main bearings, the rear flange bearing of which also functions as a pilot bearing axially. There are drilled oilways in the crankshaft for the lubricating oil.

The bearing shells, which are replaceable, consist of a steel backing with indium-plate lead-bronze bearing metal.

CAMSHAFT AND VALVE TAPPETS

The camshaft is made of special-alloy cast iron and has case-hardened cams. It is driven from the crankshaft through a gear train which has a ratio of 1:2. Camshaft axial location is maintained by means of 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 means of 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 are provided with a precision-machined bush which acts as a bearing for the gudgeon pin. The big-end bearing shells are precision-manufactured and are 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 gudgeon pin has a floating fit in both the piston and connecting rod. The axial movement of the gudgeon pin is limited by circlips in the gudgeon pin hole.

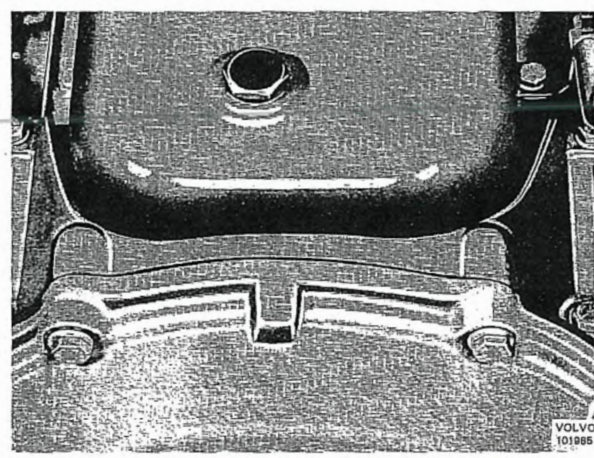


Fig. 2—12. Reinforcing bracket, cylinder block—flywheel housing

INLET DUCT AND EXHAUST MANIFOLD

The exhaust manifold is made of cast-iron and differs from the inlet duct, which is of light-alloy.The inlet duct is intended for electronically controlled fuel injection and is designed as a chamber with four pipes which connect to the inlet ports of the cylinder head.

POSITIVE CRANKCASE VENTILATION

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

Between the rocker arm casing and the inlet duct there is a hose (2, Fig. 2—13). It is connected to the intake manifold by means of a calibrated nipple (3). (This nipple should be cleaned every 40 000 km = 24 000 miles.) Between the oil trap, which is connected to the crankcase, and the air cleaner there is a hose (1) connected for the fresh-air supply. At the connection to the oil trap there is a flame guard (5), which consists of a metal filter. The partial vacuum which arises in the inlet duct when the engine is running, brings about a partial vacuum in the rocker arm casing and crankcase through the hose (2). Fresh air is supplied to the crankcase through the air cleaner via the hose (1).

As the fresh air supply passes through the air cleaner,

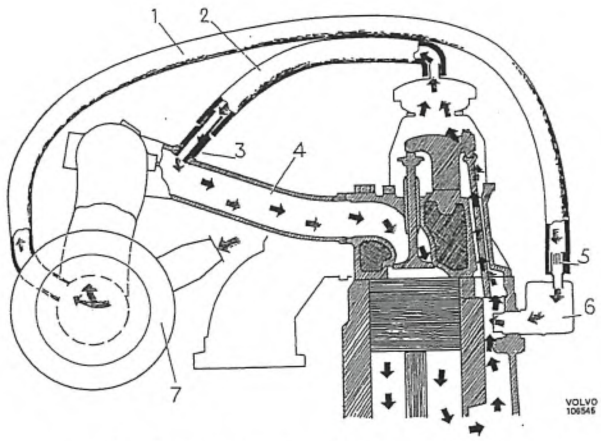


Fig. 2—13. Positive crankcase ventilation

1. Hose for fresh air supply
2. Hose for crankcase gases
3. Nipple
4. Inlet duct
5. Flame guard
6. Oil trap
7. Air cleaner

impurities are prevented from getting into the engine. Where there is a high or medium degree of partial vacuum in the crankcase (inlet duct), which happens during idling and when operating under a light load, the system functions as described above. When the partial vacuum in the crankcase is less than that in the air cleaner, which occurs at full load and/or with large flow quantities, no fresh air is supplied. Instead the flow in the hose (1) reverses and the crankcase gases go both ways. In this way, the crankcase ventilation system can deal with relatively large quantities of crankcase gases without any escaping into the atmosphere.

REPAIR INSTRUCTIONS

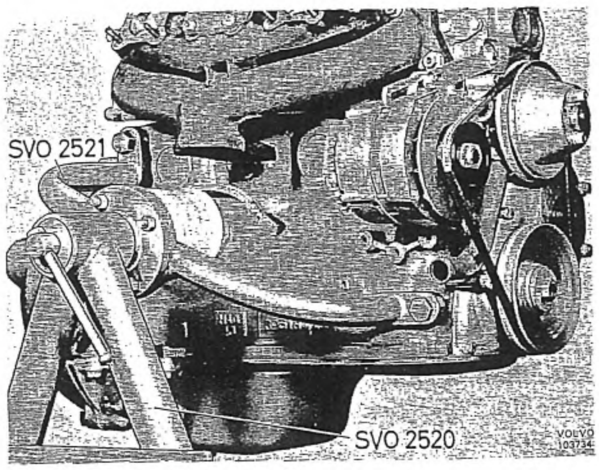


Fig. 2—14. Engine on stand

DISASSEMBLING ENGINE

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

1. Place the engine on stand 2520 with fixture 2521 (see Fig. 2—14). Check that the oil has been drained off.
2. Remove the starter motor and reinforcing plate on the lower front edge of the flywheel housing. Remove the flywheel housing together with the gearbox and then remove the clutch and flywheel.

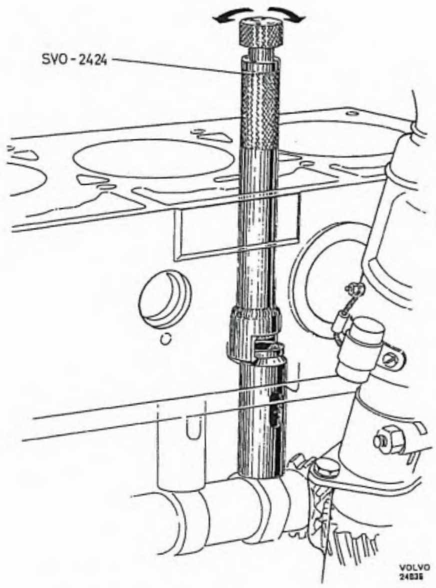


Fig. 2—15. Removing valve tappets

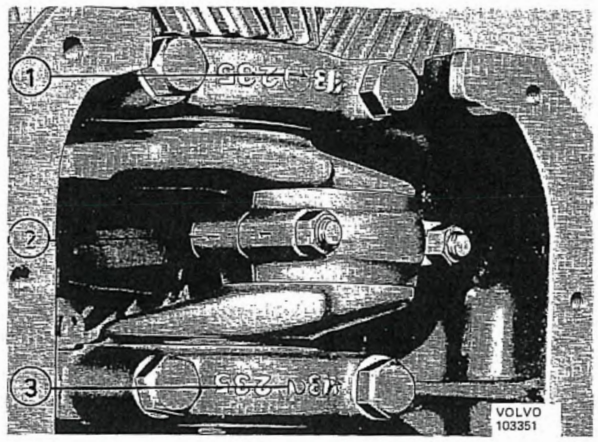


Fig. 2—16. Marking main and big-end bearings
1. Main bearing No. 1 2. Big-end bearing No. 1
3. Main bearing No. 2

3. Remove the rear flange, taking care not to damage the contact surfaces, the alternator, water pump and distributor, the rocker casing, rocker arms, the manifold, holders for injectors, cylinder head and oil filter.
   Remove the valve tappets with tool 2424, see Fig. 2—15.
4. Remove the timing gear casing and the timing gears. Concerning tools, see under the heading "Replacing timing gears". Remove the camshaft.
5. Remove the carbon ridge from the cylinder bores. Remove the sump, 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. Parts made of steel or cast iron can be washed in a degreasing tank with a caustic soda solution. Light-alloy parts can, however, be destroyed by caustic soda so that they should preferably be cleaned with white spirit.
Pistons and bearing shells must never be washed in caustic soda. Rinse the parts with warm water and blow them dry with compressed air after washing. Clean the oilways with particular thoroughness. 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. 2—16. The main bearings are marked 1—5, and the big-end bearings 1—4, Check that all parts are clean and lubricate sliding surfaces with oil before assembling. Always use new gaskets, split pins and lock washers.
No adhesive should be used on the gaskets.
The seals on the ends of both the oil pump delivery pipe and the water pump pipes are in the form of rubber rings. These rings, which seal radially, are made of special rubber with very close tolerances. Only genuine Volve parts should be used. Fitting is facilitated by coating the rings with soap solution. The rings are fitted 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. The timing gear casing and rear sealing flange must be accurately centered when fitting. See under the headings "Replacing timing gear casing" and "Installing rear sealing flange".
The big-end bearing bolts and nuts should be replaced with new ones when reconditioning.
Place the reinforcing bracket in position and tighten all the bolts by hand. Screw firmly the bolts in the flywheel housing and then the bolts in the cylinder block.

The cylinder head is fitted with the help of guide pins 2435. The bolts must be tightened in the sequence shown in Fig. 2–17, in order to avoid unnecessary stresses. Check that the oil hole (Fig. 2–18) for lubricating the rocker arms is clear. The pilot bearing (5, Fig. 2–19) should be lubricated before fitting 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 head gasket of the right thickness, see "Specifications".

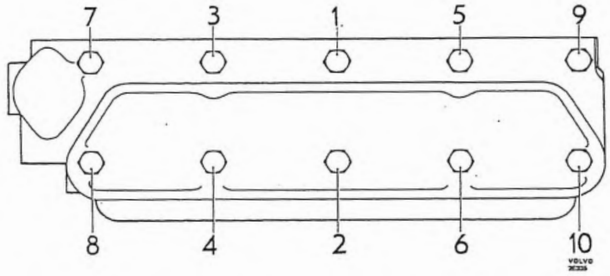


Fig. 2–17. Tightening sequence for cylinder head bolts

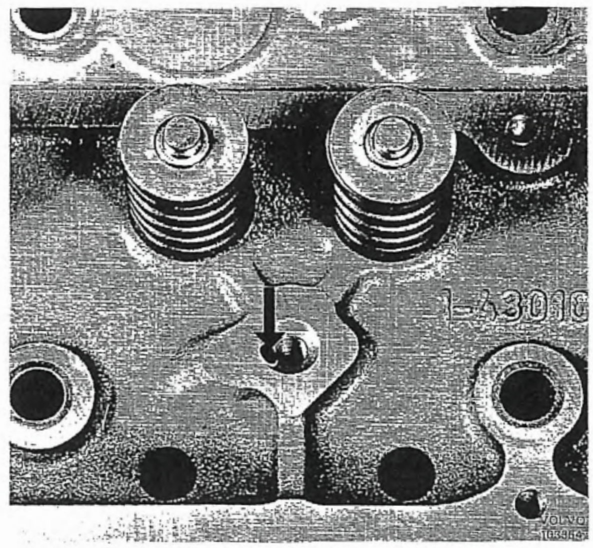


Fig. 2–18. Oil hole in cylinder head

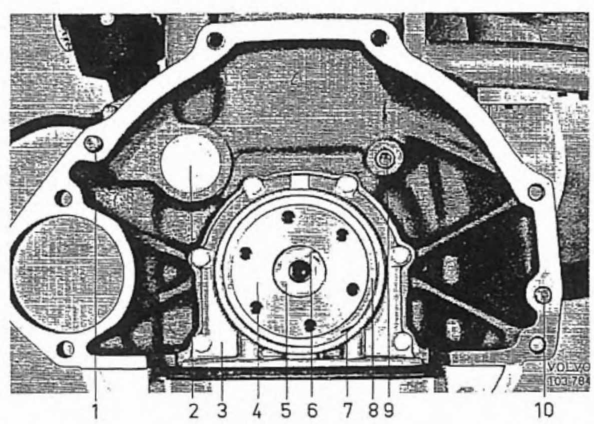


Fig. 2–19. Rear end of engine

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

VALVE GRINDING AND DECARBONIZING

1. Drain off the coolant from the radiator and cylinder block. To do this remove the plug on the right-hand side of the engine and, if necessary, disconnect the lower radiator hose.
2. Remove the positive lead from the battery.
3. Remove the hoses for the pressure sensor, brake servo, crankcase ventilation and ignition distributor.
4. Remove the electric cables from the throttle valve, cold start valve, temperature sensors for coolant and from the injectors.
5. Remove the hose for the induction air.
6. Remove the lock pin and bracket for the throttle cable.
7. Remove the ground cable from the inlet duct and the electric cable from the temperature sensor for the coolant thermometer.
8. Pinch the hose from the fuel tank to the distributing pipe and the return line from the pressure regulator.
9. Remove both the pressure hoses and the hose for the cold start valve from the distributing pipe.
10. Turn the lock rings for the injectors and lift up the injectors together with the distributing pipe.
11. Remove the heating hose and the upper radiator hose.
12. Remove the alternator tensioning bar from the cylinder head.
13. Unscrew the bolts for the inlet duct stay.
14. Remove the inlet duct nuts and bolts.
15. Remove the clamp for the water pipe and the clamp for the brake servo hose.
16. Remove the ignition leads and spark plugs.
17. Remove the rocker arm cover, the rocker arm shaft and the push rods.
18. Remove the injector holders from the cylinder head.
19. Remove the cylinder head bolts and lift off the head. Take off the cylinder head gasket, the flange gasket and the rubber rings for the water pump.

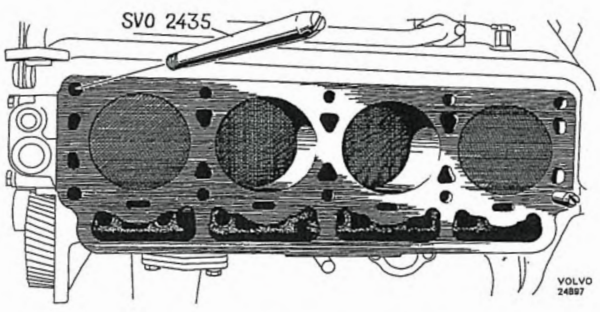


Fig. 2—20. Guide pins for fitting cylinder head

20. Clean the piston crown, combustion chambers, inlet ports and exhaust ports very thoroughly. Do not use emery cloth since small grinding particles can get in between the piston and cylinder walls and consequently cause scoring. Recondition the valve system as described under the heading "Cylinder head and 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 into the shaft.

INSTALLING

21. Screw the guide pins 2435 into the block, one in the front right-hand hole and the other in the left-hand rear hole, see Fig. 2—20. Install a new cylinder head gasket with the "TOP" upwards (wide edge). Install a new inlet duct gasket and new sealing rings for the water pump. Fit the cylinder head. Screw out the guide pins and fit the bolts in these holes as well. For tightening sequences, see Fig. 2—17. Tightening should be in two stages: 1st stage 40 Nm (29 lbft); 2nd stage 80 Nm (58 lbft); 3rd stage: after running the engine, see point 34.
22. Fit the injector holders with new rubber rings on the cylinder head.
23. Fit push rods and rocker arm shaft. Adjust the valves to 0.45—0.50 mm (0.018—0.020"). This is not the final clearance.
24. Fit the rocker arm cover, the spark plugs and the ignition leads.
25. Fit the clamp for the brake servo hose and also the clamp for the water pipe.
    Fit and tighten the inlet duct nuts and bolts.
26. Fit the bolts for the inlet duct stay. Fit the alternator tension bar and adjust the fan belt.
27. Connect the upper radiator hose and the hose for the heating system.
28. Change the rubber seals on the injectors for new ones. Fit the injectors with the distributing pipe. Connect the fuel hoses.
29. Connect the electric cable to the sensor for the temperature gauge and the ground cable to the inlet duct.
30. Fit the bracket and lock pin for the throttle cable.
    Fit the hose for the inductor air.
31. Fit the electric cables for the throttle switch, cold start valve, injectors and temperature sensor for coolant.
32. Connect the hoses for the pressure sensor, brake servo, crankcase ventilation and ignition distributor. Re-fit the battery lead.
33. Fill with coolant and check function and for leakage.
34. Drive the car for about 10 minutes. Final-tighten the cylinder head bolts to 90 Nm (65 lbft) with 2898. Final-adjust valve clearance to 0.40—0.45 mm (0.016—0.018").

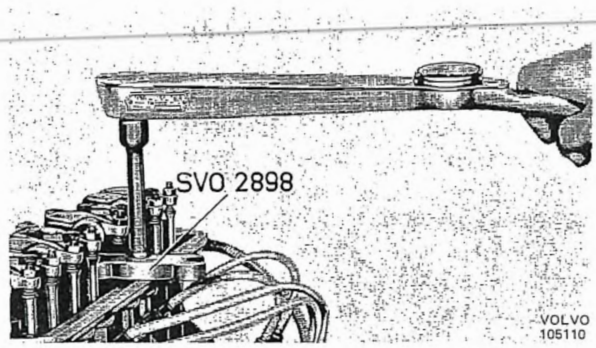


Fig. 2—21. Re-tightening cylinder head bolts

CYLINDER HEAD AND VALVES

DISASSEMBLING

1. Remove the valve springs by first compressing them with valve pliers and removing the valve collets, after which the pliers are released. Place the valves in order in a valve rack. Remove the valve guide seals.
2. Measure the clearance between the stem and guide. With a new valve the clearance should not exceed 0.15 mm (0.006"). Also check that the

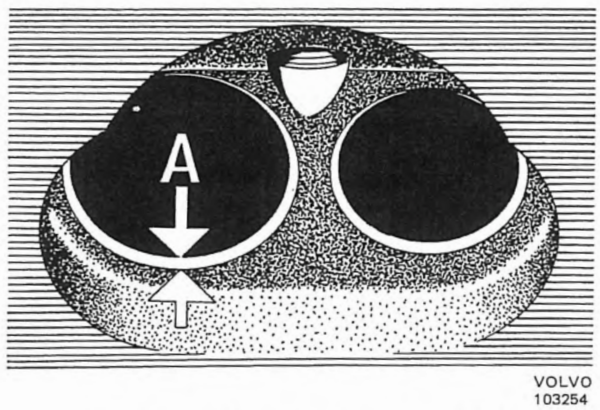


Fig. 2–22. Valve seat width A=2 mm (0.08")

valves are not excessively worn. See the "Specifications" under the headings "Valve system" and "Wear tolerances".

CLEANING

Remove carbon and combustion deposits from the valves, combustion chambers and ports with rotating brushes.

GRINDING VALVES AND VALVES SEATS

1. Grind the valves in a machine after they have been cleaned. If they are excessively worn, fit new valves.
2. Grind the valve seals. Use an electrically driven grinder or a hand milling cutter. A pilot spindle must be carefully fitted before work is started and any worn guides must be replaced with new ones.
   The seat should be ground until a good sealing surface is obtained. The angle is 45° and the width of the sealing surface should be approx 2.0 mm (0.08"), see "A" Fig. 2–22. If the sealing surface is too wide after grinding, it can be reduced by using a 70° grinding stone from the inside and a 20° grinding stone from the outside.
3. Coat the valve sealing surfaces with a thin layer of fine grinding paste and lap in the valves against their seats.
   Then clean the valves and seats and check that good sealing is obtained.

REPLACING VALVE GUIDES

1. Press out the old guides with tool 2818.
2. Press in the new guides using drift 2819 and a 0.4 mm (0.016") thick washer placed between the tool and cylinder head, see Fig. 2–23.
3. Check that the guides are free from burr and that the valves move easily in them.

ASSEMBLING

1. Check that the parts are in good condition and clean. Test the springs to ensure that they maintain the values given in the "Specifications".
2. Place the valves in position. Fit the valve guide seal, valve spring, upper washer and collet.

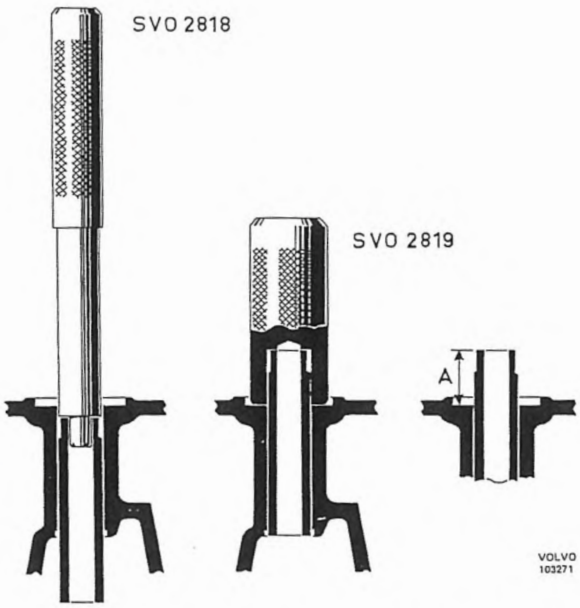


Fig. 2–23. Replacing valve guides
A=17.9 mm (0.705")

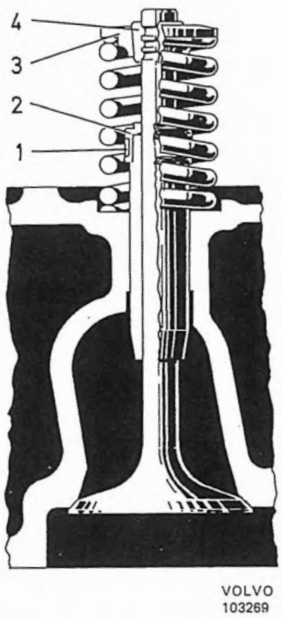


Fig. 2–24. Valve collet and valve guide seal
1. Metal ring
2. Rubber seal
3. Washer
4. Valve collet

REPLACING ROCKER ARM BUSHES AND GRINDING ROCKER ARMS

1. If wear amounts to 0.1 mm (0.004"), replace the rocker arm bush. Use tool 1867 for pressing the bush out and in, see Fig. 2–25. Then ream the bush to an accurate fit on the shaft using a suitable reamer. The hole in the bush should coincide with the hole in the rocker arm.
2. If necessary grind the pressure surface against the valve in a special machine.

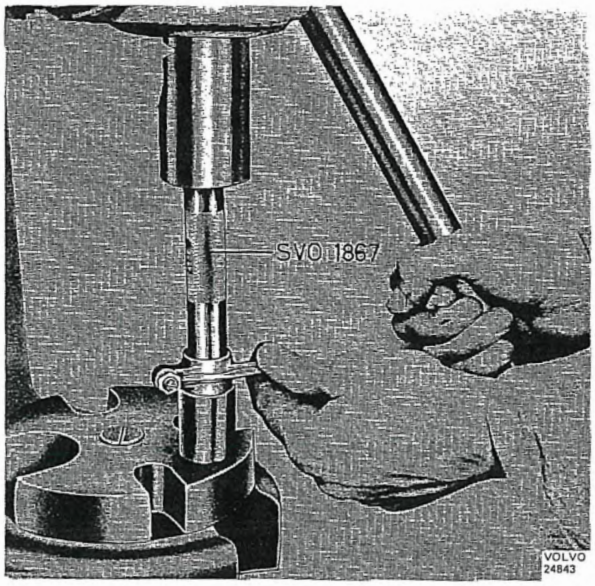


Fig. 2–25. Replacing bush in rocker arm

ADJUSTING VALVE CLEARANCE

The valve clearance can be adjusted satisfactorily with the engine stopped, irrespective of whether it is cold or warm. The clearance is the same for both the inlet and exhaust valve. When adjusting, use two feeler gauges, one "Go" 0.40 mm (0.016") thick and the other "No-Go" 0.45 mm (0.018") thick. The clearance is adjusted so that the thinnest gauge can be inserted easily while the thicker one must not enter. When the piston in No. 1 cylinder is at top dead centre (the compression stroke), adjust valves Nos. 1, 2, 3 and 5 (counted from the front), and with the piston in No. 4 cylinder at top dead centre, valves Nos. 4, 6, 7 and 8.

CYLINDER BLOCK

MEASURING CYLINDER BORES

The cylinder bores are measured with a special dial indicator as shown in Fig. 2–26. Measuring should be

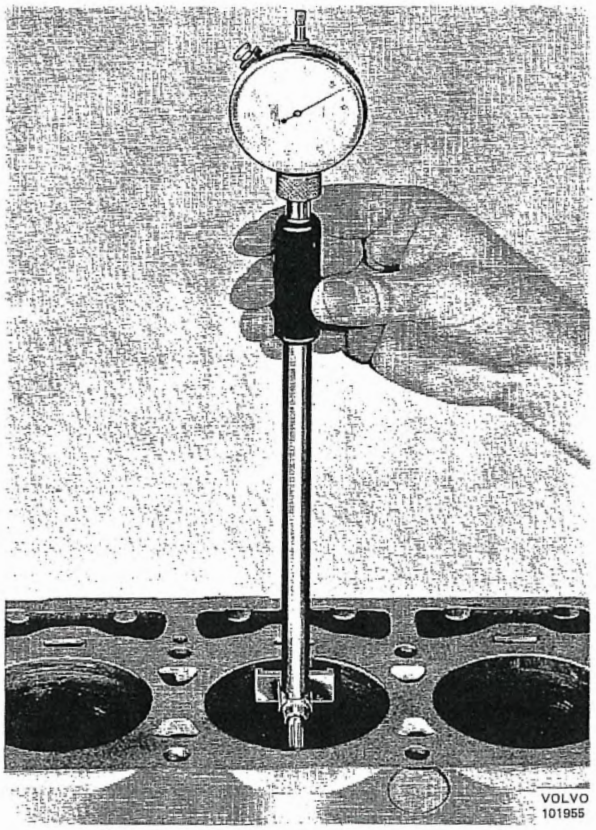


Fig. 2–26. Measuring cylinder bore

carried out just below the top edge of the bore and only in the transverse direction of the engine. A letter is stamped on each cylinder bore indicating the classification of the bore and piston (only on standard models).

PISTONS, PISTON RINGS AND GUDGEON PINS

MEASURING PISTONS

The pistons are measured with a micrometer at right angles to the gudgeon pin hole 12 mm (0.47") from the lower edge on the piston.

FIT OF PISTONS IN CYLINDERS

The fit of the pistons in their respective cylinders is tested with the piston rings not fitted. The clearance at right angles to the gudgeon pin hole is measured with a feeler gauge 1/2" wide and 0.05 mm (0.0020") thick attached to a spring balance. The force applied should be 10 n (2.2 lb.). This gives the average value for piston clearance. When this force is applied, the

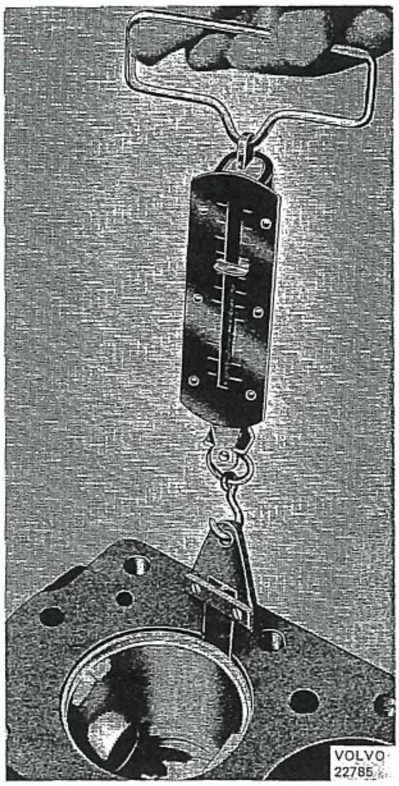


Fig. 2–27. Measuring piston clearance

piston clearance obtained is equal to the thickness of the feeler gauge used. The test is carried out at several different depths. See Fig. 2–27. Standard bore cylinders have a letter stamped on which shows the dimensions, and the pistons concerned should be marked with the same letter.

PISTON RING FIT IN A NEW OR RE-BORED CYLINDER

1. Push down the piston rings one after another in the cylinder bore. Use a reversed piston to ensure that the rings come into the correct position.

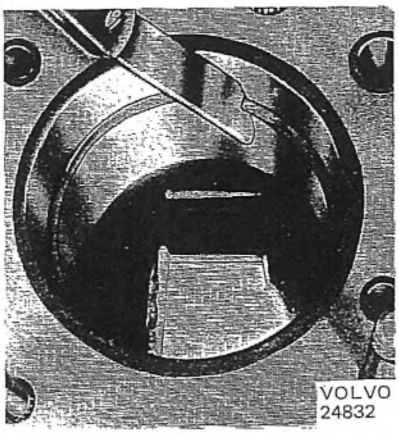


Fig. 2–28. Measuring piston ring gap

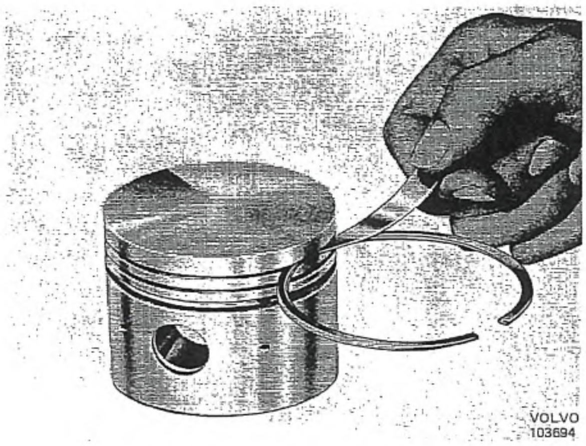


Fig. 2–29. Piston clearance in groove

2. Measure the ring gap with a feeler gauge, see Fig. 2–28. The gap should be 0.40–0.55 mm (0.016–0.022"). If necessary the gap can be increased with the help of a special file.
3. Check the piston rings by rolling them in their respective grooves. Also measure the clearance at a few points. See "Specifications" for measurements.

IN A WORN CYLINDER BORE

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

GUDGEON PINS

The gudgeon pins are available in oversize 0.05 mm (0.002") larger than the standard diameter 22.00 mm (0.866"). If the gudgeon pin hole in the piston is worn so much that an oversize is necessary, the hole

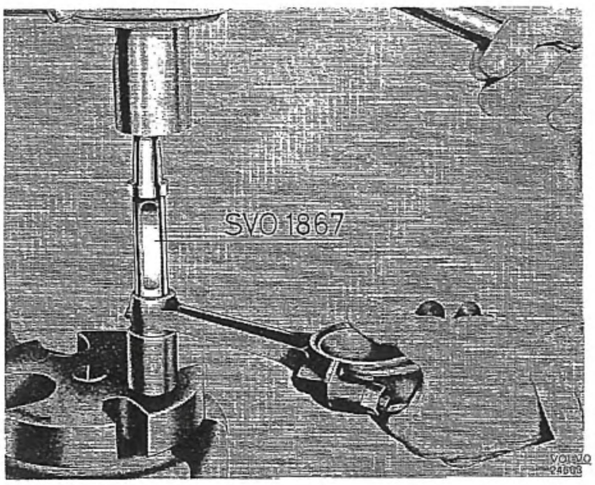


Fig. 2–30. Replacing bush in connecting rod

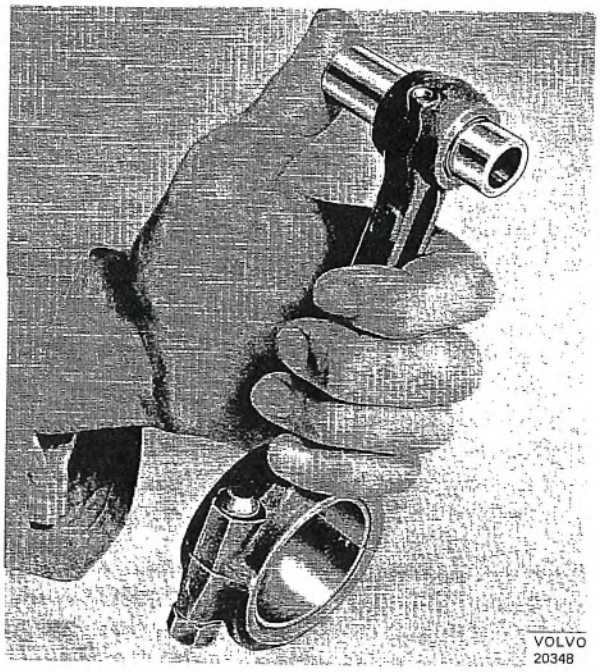


Fig. 2–31. Gudgeon pin fit

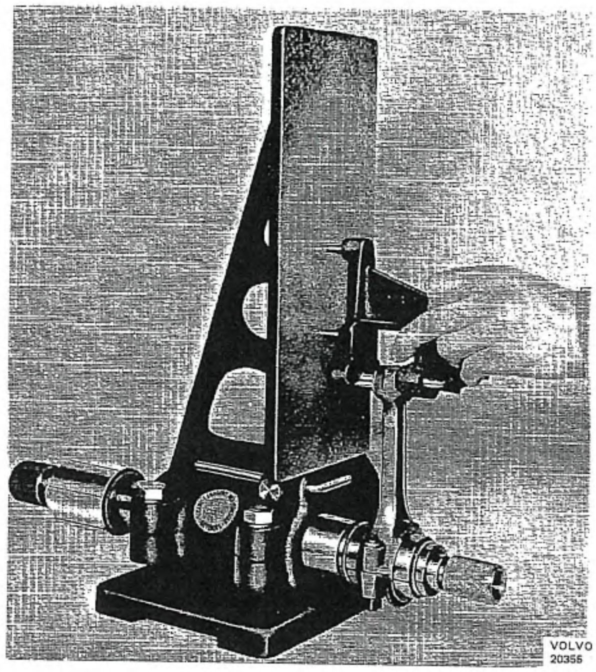


Fig. 2–32. Checking connecting rod

should first be reamed out to the correct measurement. Use a reamer fitted with a pilot guide and only take small cuts at a time.
The fit is correct when the gudgeon pin can be pushed through the hole by hand with light resistance.

CONNECTING RODS

REPLACING BUSHES

If the old bush in a connecting rod is worn, press it out by using drift 1867 and press in a new bush with the same tool, see Fig. 2–30. Make sure that the lubricating holes index with the holes in the connecting rod. Then ream the bush to the correct fit. The gudgeon pin should slide through the hole under light thumb pressure but without any noticeable looseness, see Fig. 2–31.

STRAIGHTENING

Before being fitted, the connecting rod should be checked for straightness, twist and any S-distortion. Straighten if necessary, see Fig. 2–32. Nuts and bolts should be replaced with new ones when reconditioning is being carried out.

ASSEMBLING AND FITTING PISTON AND CONNECTING ROD

When assembling make sure that the piston is facing correctly so that the slot on the piston crown points forwards, see Fig. 2–33. There will be a loud noise if the piston is turned the wrong way. The connecting rod marking should face away from the camshaft side. The gudgeon pins are then fitted, the circlips placed in position and the piston rings installed.
Use piston ring pliers for fitting the rings. The upper compression ring is chromed. Place the bearing shells in their seats. Turn the rings so that their gaps are not opposite one another. Lubricate the piston and bearing surfaces.
Use installation ring 2823, see Fig. 2–34, when fitting the piston and a torque wrench, see "Specifications" for the correct tightening torque.

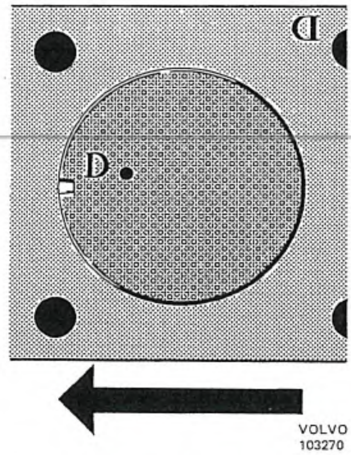


Fig. 2–33. Marking on piston and block

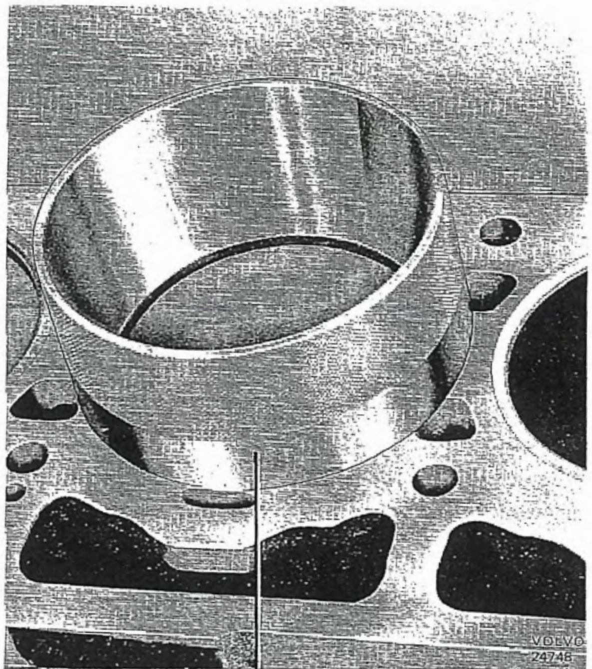


Fig. 2–34. Fitting piston
Installation ring 2823

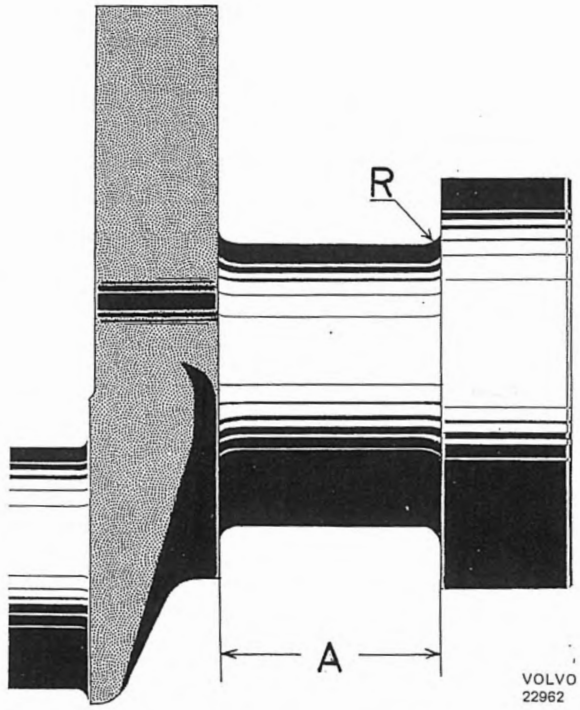


Fig. 2–35. Bearing journal

CRANKSHAFT

After the crankshaft has been cleaned, its journals must be measured with a micrometer. Measuring should be carried out at several points round the circumference and along the longitudinal axis of each journal. Out-of-roundness on the main bearing journal should not exceed 0.05 mm (0.002"), and 0.07 mm (0.003") on the big-end bearing journals. Taper should not exceed 0.05 mm (0.002") on any of the journals.

If the values obtained are close to or exceed the wear limit mentioned above, the crankshaft should be ground to undersize. Suitable bearing shells are available in 2 undersizes. The measurements concerned are to be found in the "Specifications".

Check that the crankshaft is straight to within 0.05 mm (0.002") by using a dial gauge. The crankshaft is fitted on two V-blocks and a dial gauge placed against the center bearing journal after which the crankshaft is rotated. If necessary, straighten the crankshaft in a press.

GRINDING CRANKSHAFT

Before the crankshaft is ground, a check should be made to ensure that it is straight, this being done as described previously. Grinding is carried out in a special machine whereby the main bearing journals and the big-end bearing journals are ground to identical measurements. These measurements, which are given in "Specifications", must be carefully followed in order to ensure correct clearance with ready-machined bearing shells.

On no account must the bearing shells be shaved or the bearing caps filed.

The fillets at the ends of the journals should have a radius of 2.0–2.5 mm (0.080–0.100") on all journals, see Fig. 2–35. The width measurement (A) for the pilot bearing depends on the size of the journal and should be ground in order to obtain the correct measurement.

After grinding has been completed, all the burr should be carefully removed from the oilway openings and all the journals lapped with a fine grinding paste to the finest possible surface finish. The crankshaft should then be washed. All the oilways should be cleaned with particular thoroughness in order to remove any metal chippings and grinding residue.

MAIN AND BIG-END BEARINGS

In addition to standard sizes, bearings shells are available in undersizes of 0.010" and 0.020". The rear main bearing shells are provided with flanges and have a larger width relative to their size. If the crankshaft has been ground to the correct measurement, the right bearing clearance is automatically obtained when the bearing shell concerned is fitted. The bearing shells must not be shaved and the caps must never be filed in order to obtain closer bearing fit.

The bolts should be tightened with a torque wrench, see "Specifications" for the tightening torque.

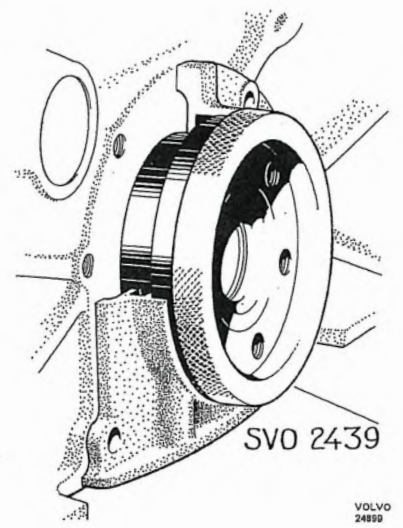


Fig. 2–36. Centering rear sealing flange

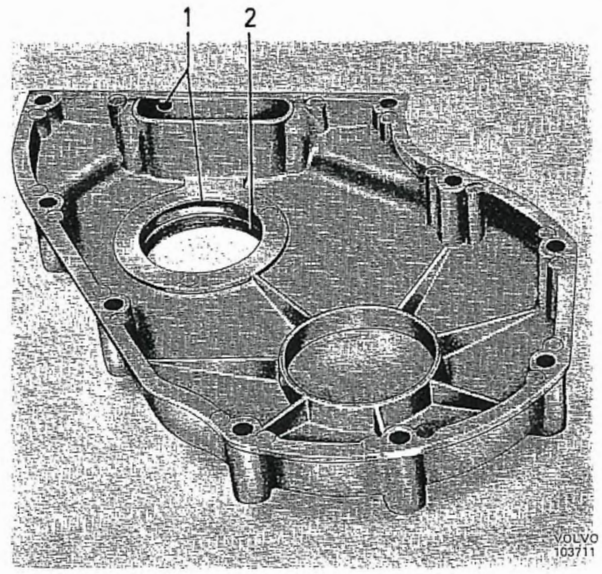


Fig. 2–37. Timing gear casing
1. Drain holes 2. Sealing ring

INSTALLING REAR SEALING FLANGE

1. Make sure that the seal is in good condition and that the flange is clean. The drain hole must not be blocked by incorrect fitting of the sump gasket. The sealing ring must not be fitted in the flange.
2. Fit on the sealing flange but do not tighten the bolts.
3. Center the flange with sleeve 2439, Fig. 2–36. Turn the sleeve round while tightening the bolts and adjust the position of the flange if the sleeve jams. Check that the flange comes flush against the underside of the block.
4. Fit a new felt ring and place on the washer and circlip. Press the circlip into position with the centering sleeve. Check that the circlip engages in its groove.

GRINDING FLYWHEEL

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

PILOT BEARING FOR INPUT SHAFT

The pilot bearing circlip and protecting washer are removed, the pilot bearing pulled out with tool 4090 and checked after having been washed in white spirit.

If the bearing is worn, it should be replaced with a new one. Before fitting, pack the bearing with heat-resistant ball bearing grease. The bearing is fitted with drift 1426, after which the protecting washer and circlip are fitted.

REPLACING OIL SEAL IN TIMING GEAR CASING

1. Release the fan belt. Loosen the attachment of the stabilizer at the frame.
2. Screw out the bolt in the crankshaft. Remove the belt pulley.
3. Remove the circlip for the washer which retains the felt ring. Remove the washer and felt ring. Check that the casing is correctly fitted by inserting a 0.10 mm (0.004") feeler gauge in the gap between the casing and hub on the crankshaft and moving it all round. If the feeler gauge jams at any point, the casing should be centered, see under "Replacing timing gear casing".
4. Fit a new felt ring. Place the washer in position and fit the circlip. Check that the circlip fits properly in position.
5. Fit the remaining parts and tension the fan belt.

REPLACING TIMING GEAR CASING

1. Loosen the fan belt. Remove the fan and pulley on the water pump. Disconnect the stabilizer attachment from the frame.
2. Remove the bolt for the crankshaft belt pulley and remove the pulley.

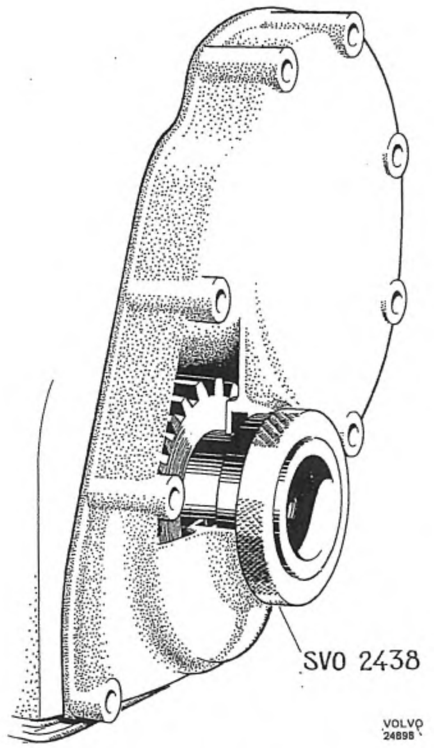


Fig. 2—38. Centering timing gear casing

3. Remove the timing gear casing. Slacken a couple of extra bolts for the sump and be careful not to damage the gasket. Remove the circlip, washer and felt ring from the casing.
4. Make sure that the gaskets are in good condition and that the drain hole is open and clean inside the timing gear casing which is to be fitted, see Fig. 2—37.
5. Place the casing in position and fit the bolts without tightening them.
6. Center the casing with sleeve 2438, see Fig. 2—38. Turn the sleeve while tightening and adjust the position of the casing so that the

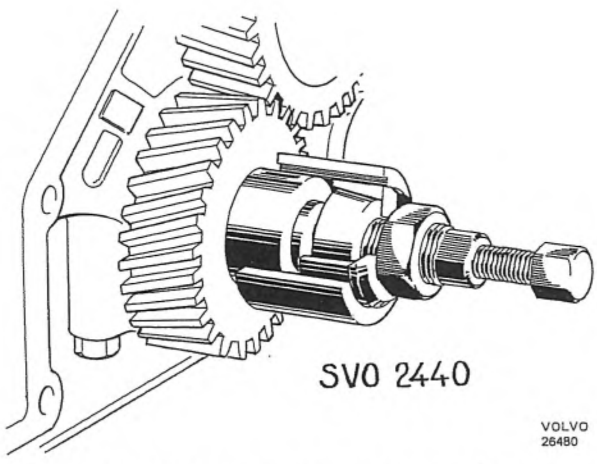


Fig. 2—39. Removing hub on crankshaft

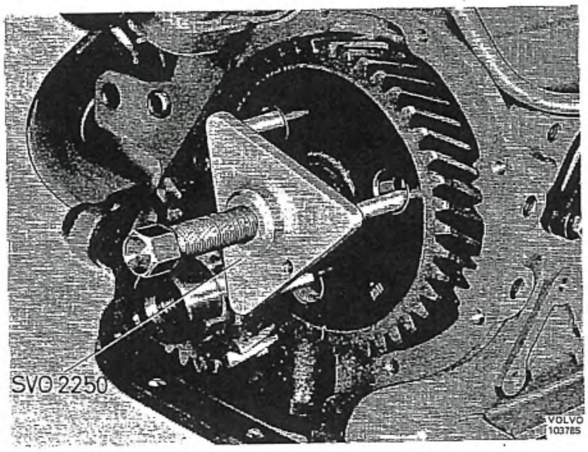


Fig. 2—40. Removing camshaft gear

sleeve is not jammed. Check after final tightening of the casing that the sleeve can be easily rotated without jamming.

7. Fit a new felt ring, washer and circlip. Push them into their position with the centering sleeve 2438. Check that the circlip has engaged in its groove.
8. Fit the other parts and tension the fan belt. See "Specifications" for the tightening torque. Fix the stabilizer attachments firmly to the frame.

REPLACING TIMING GEARS

1. Drain off the coolant and remove the cover plate and radiator.
2. Carry out operations 1—3 in previous section.
3. Remove the hub from the crankshaft with puller 2440. See Fig. 2—39.
   Before applying the tool, its large nut must be screwed backwards so that the cone is not tensioned. The center bolt should also be screwed back.
   Then fit the tool, screw in the large nut so that the hub is firmly held and pull it off by screwing in the center bolt.
4. Remove the camshaft nut and pull off the gear by using puller 2250, see Fig. 2—40.
5. Pull off the crankshaft gear by using puller 2405, Fig. 2—41. Screw out the oil nozzle, blow it clean and then re-fit it as shown in Fig. 2—44. The gears are lubricated by oil fed through this nozzle.
6. Fit the crankshaft gear by using tool 2407 and the camshaft gear by using 2408, see Figs. 2—42 and 2—43. Fit the hub on the crankshaft. Do not push the camshaft backwards so that the seal washer on the rear end loosens.

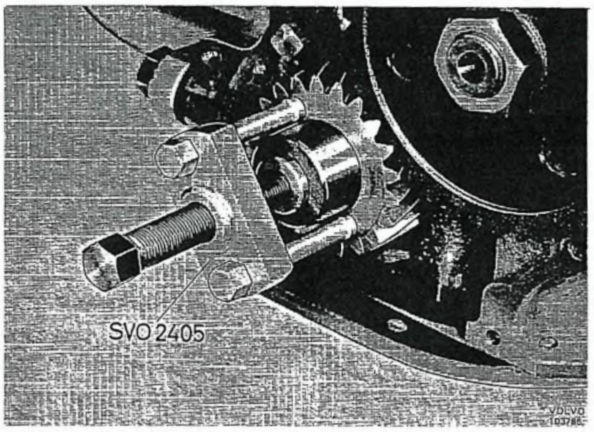


Fig. 2–41. Removing crankshaft gear

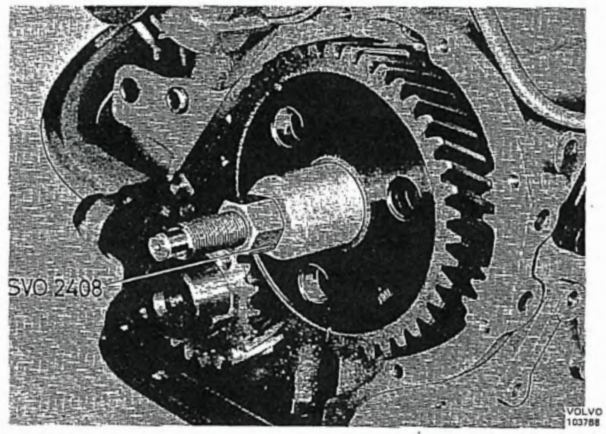


Fig. 2–43. Fitting crankshaft gear

Check that the gears are correctly located relative to each other, see Fig. 2–44. Tool 2407 has a socket intended for turning the crankshaft.
The tooth flank clearance and camshaft axial clearance, determined by the spacer ring behind the camshaft gear, are given in the "Specifications".
Center and fit the timing gear casing as well as the other parts according to operations 4–8 in the previous section.

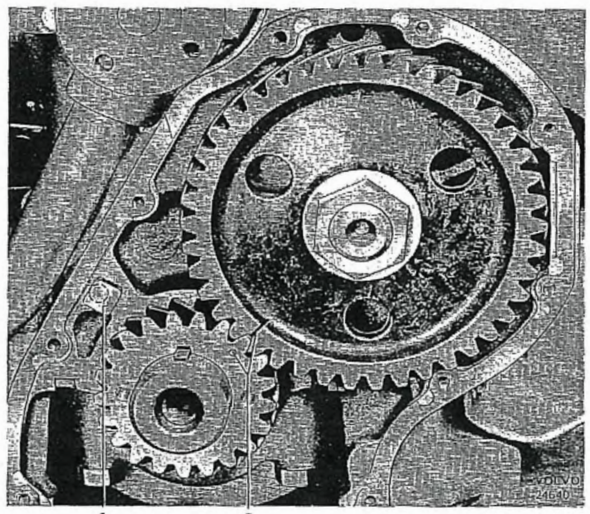


Fig. 2–44. Markings on timing gears
1. Oil nozzle 2. Markings

POSITIVE CRANKCASE VENTILATION

OVERHAUL

At intervals of 40 000 km (24 000 miles) unscrew and clean the nipple (3, Fig. 2–13) and flame guard (5). Check the hoses at the same time. Replace any that are in a poor condition.
For U.S.A. vehicles the overhaul is done every 20 000 km (12 000 miles).

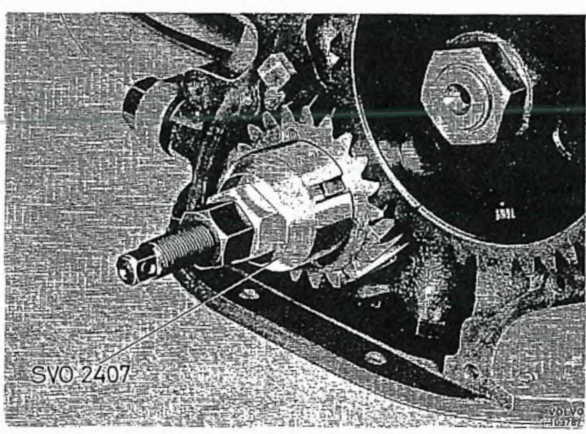


Fig. 2–42. Installing crankshaft gear

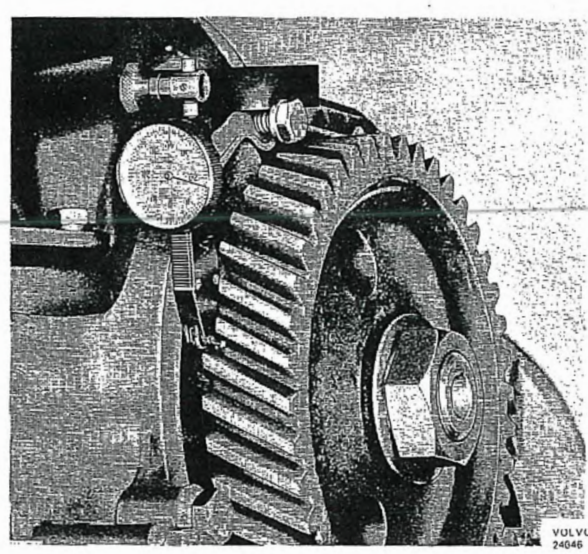


Fig. 2–45. Measuring tooth flank clearance

LUBRICATING SYSTEM

DESCRIPTION

The engine has a force feed lubricating system, see Fig. 2—46. Pressure is provided by a gear pump driven from the camshaft and fitted under the crankshaft in the sump. The gear pump forces the oil past the relief valve, which is also fitted on the pump, through the oil filter and then through oilways out to the various lubricating points. All the oil supplied to the lubricating points, therefore, first passes through the oil filter.

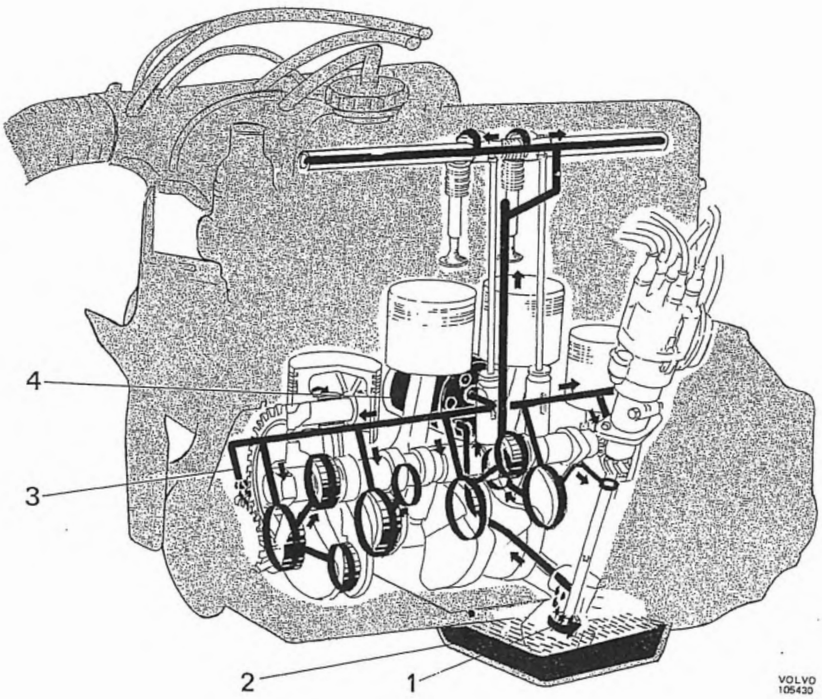


Fig. 2—46. Lubricating system
1. Oil pump
2. Sump
3. Nozzle
4. Oil filter

OIL PUMP, RELIEF VALVE

The oil pump, see Fig. 2—47, is of the gear type and is driven through a gear train from the camshaft. The delivery pipe from the pump to the cylinder block does not have screw unions and is, therefore, automatically tightened in position when the attaching bolts for the pump are tightened. At each end of the pipe there are sealing rings made of special rubber. The relief valve is fitted directly on the pump and consists of a spring-loaded ball. The ball has a cylindrical guide with a stop at the end position and, therefore, operates flexibly. Even at idling speed there is a certain amount of overflow, so that the oil pressure is then relatively low.

OIL FILTER

The oil filter (see Fig. 2—48), which is manufactured as a single unit complete with element, is of the full-flow type and is 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 there is 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 completely and a new one fitted.

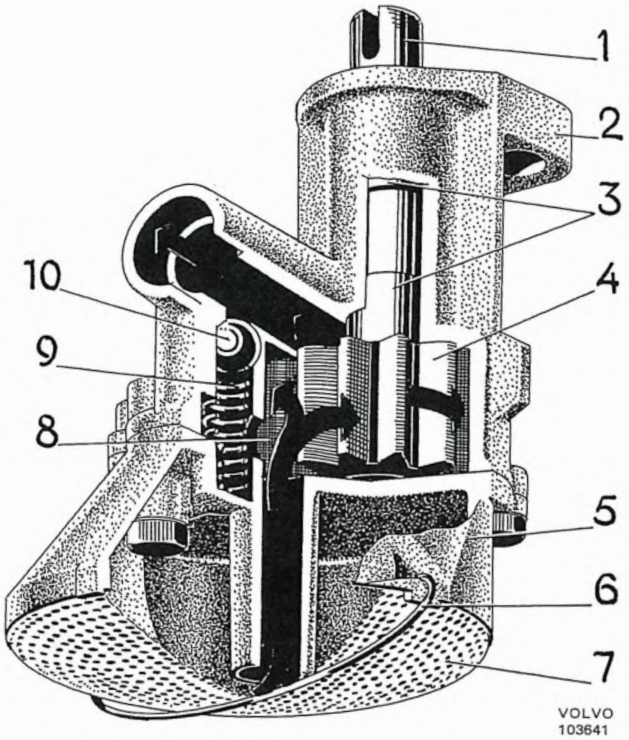


Fig. 2–47. Oil pump

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

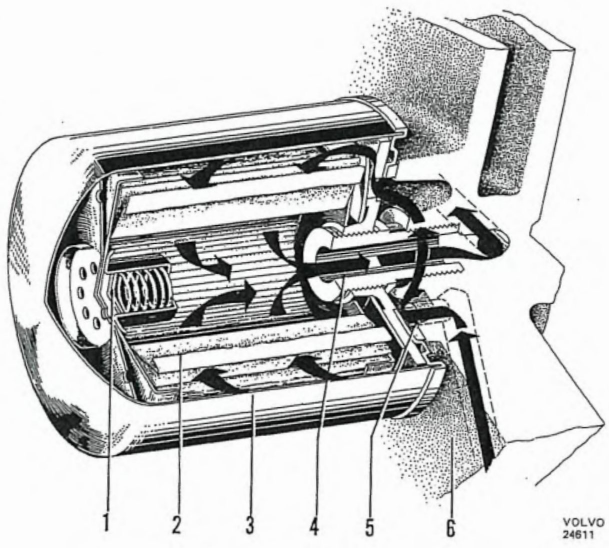


Fig. 2–48. Oil filter

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

OIL COOLER

The B 20 E engine is fitted with an oil cooler.
The oil cooler (Fig. 2–49) is fitted between the oil filter and the cylinder block and consists of an inner section for the oil which is surrounded by a cooling jacket. The engine coolant is led through the cooling jacket. On its way to the oil filter, the oil passes through the cooler and some of the heat in the oil is conducted away by the coolant. The coolant cannot take the shortest path from the inlet (1) to the outlet (3), but is forced by rubber seals (4) to take a zig-zag course and round the cooler, as indicated in Fig. 2–49 by the blue arrows. The discs (2) are cooled by the coolant and are divided by a plate into two compartments, which are linked at the disc periphery. Oil enters the first compartment, nearest the engine block (see red arrows), and is forced the length of the discs (2) into the other compartment and then along its discs, and thereafter into the oil filter.

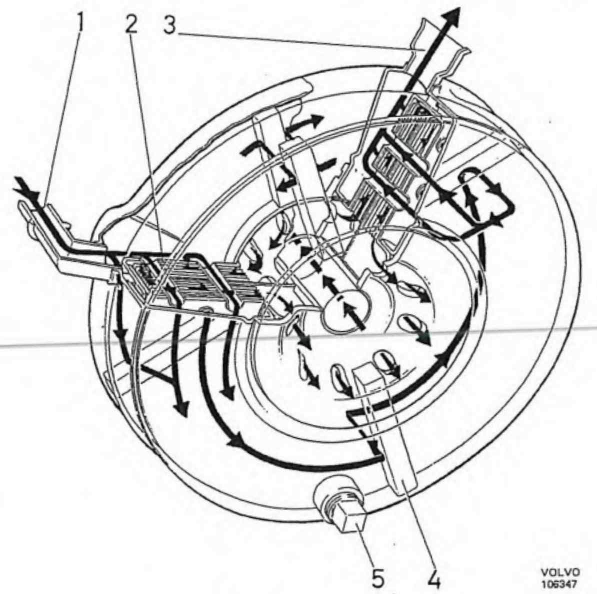


Fig. 2–49. Oil cooler

1. Coolant inlet
2. Discs
3. Cooling outlet
4. Rubber seal
5. Coolant drain plug

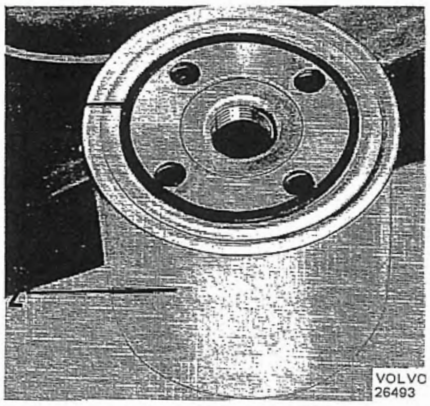


Fig. 2–50. Oil filter ready for fitting
1. Gasket (oiled) 2. Filter

REPLACING OIL FILTER

Together with the element and relief valve, the oil filter (see Fig. 2–48) is screwed as a complete unit on to a nipple fitted in the cylinder block.
The filter should be replaced every 10 000 km (6 000 miles), when the old filter is discarded. With a new or reconditioned engine, the filter should also be changed the first time after 5 000 km (3 000 miles).

1. Remove the old filter with the help of chain tongs, see Fig. 2–51.
2. Coat the rubber gasket (1, Fig. 2–50) of the new filter with oil and make sure that the contact surface for the oil filter is free from dirt. By smearing it with oil, the gasket slides into better contact with the sealing surface. Screw on the filter by hand until it just touches the cylinder block.

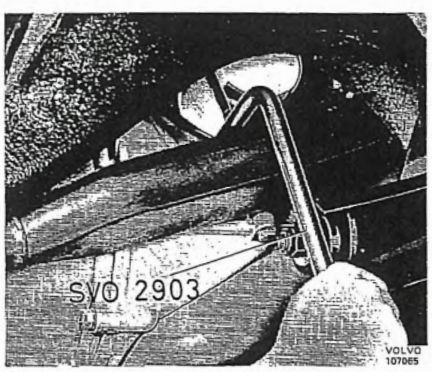


Fig. 2–51. Removing oil filter

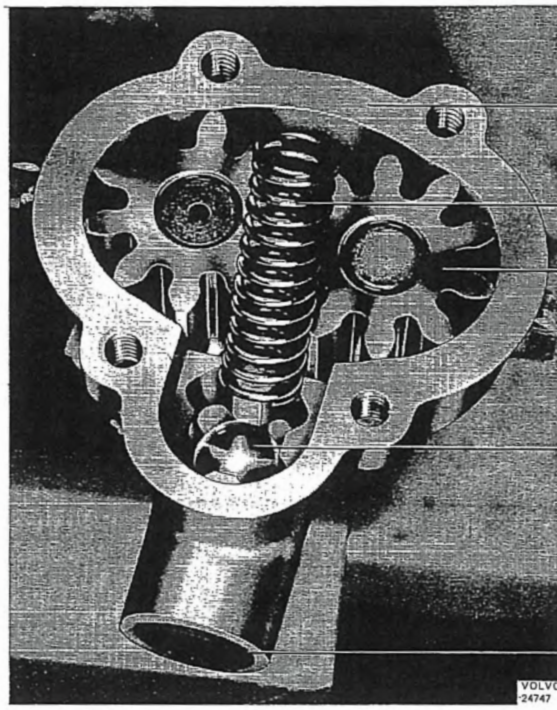


Fig. 2–52. Oil pump

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

3. Screw on the filter a further half turn by hand. **Chain tongs must not be used when fitting.** Start the engine and check that there is no leakage at the joint. Fill up with oil if necessary.

OIL PUMP AND RELIEF VALVE

After the pump has been dismantled and cleaned, check that all the parts are in good condition. Test the relief valve spring (2, Fig. 2–52), see "Specifications" for the values concerned.
Check that the tooth flank clearance is 0.15–0.35 mm (0.006–0.014"), see Fig. 2–53.
Measure the end float, 0.02–0.10 mm (0.0008–0.0040"), with a feeler gauge and a new cover or the old one if not noticeably worn. If the bushes or shaft are worn, replace them with new ones. Note that the driving shaft with gear is replaced as a single unit. The new bushes should be reamed after pressing in with a reamer provided with a pilot guide.
The sealing rings at the ends of the delivery pipe are made of special rubber and are manufactured to very

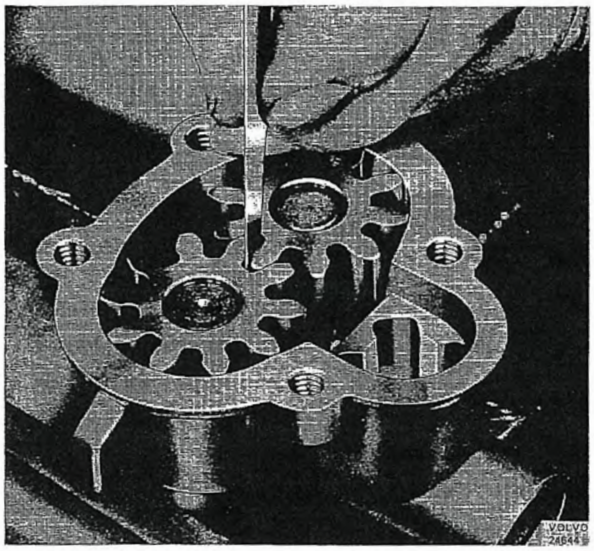


Fig. 2–53. Measuring tooth flank clearance

close tolerances, see Fig. 2–55. Use only genuine Volvo parts. The delivery pipe must be clamped in its correct position first in the oil pump and then the oil pump and pipe together clamped against the block. The pump connecting flange should lie flush against the block before being tightened. Before being fitted, the rubber rings on the pipe can be coated with soapy water since this enables the pipe to take up its position more easily. Tap lightly on the pipe with a soft mallet if necessary.

REPLACING OIL COOLER

1. Drain off the engine coolant by removing the plug in the oil cooler.
2. Disconnect the coolant connection on the oil cooler. Remove the oil filter.
3. Unscrew the nut on the nipple for the oil cooler, and pull off the cooler.
4. Fit the oil cooler with a new rubber ring to the connection against the engine block. The O-ring against the cylinder block should be replaced. The new O-ring should be inserted into the groove on the oil cooler before re-fitting. Coat the groove with a thin layer of adhesive, for example, Pliobond 20 which is resistant to oil up to temperatures of 140°C (280° F). With the nut tightened to a torque 10 Nm (7 lbft), check that the cooler is in good contact with the cylinder block all round. The nut is finally tightened to a torque of 30–35 Nm (23–25 lbft).
5. Fit the oil filter and connect the coolant pipe.
6. Fill up with coolant and, if necessary, also engine oil.
7. Start the engine and check for leakage.

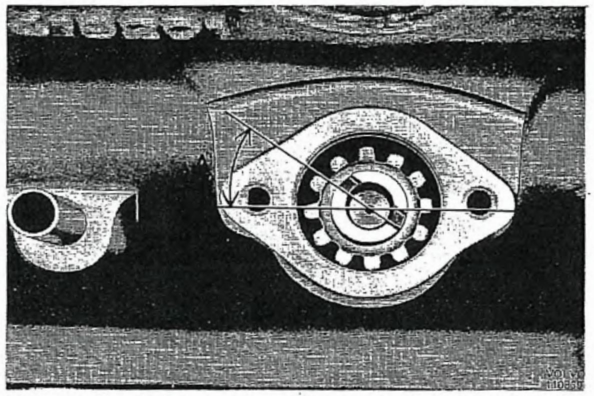


Fig. 2–54. Distributor drive position
A=approx. 5°

If the nipple for the cooler has been replaced, the new ones should be tightened to a torque of 45–55 Nm (33–40 lbft).

OILWAYS

Before being fitted, all the oilways must be cleaned very thoroughly to avoid damage to the bearings, bearing journals and other components.
To clean the cylinder block oilways, remove the sealing plugs. After cleaning and drying with compressed air, fit new plugs.

INSTALLING OIL PUMP

When No. 1 cylinder is at top dead center, fit the oil pump drive and distributor. The small part at the groove is turned obliquely upwards-backwards and the groove set at an angle of 5° to the longitudinal axis of the engine, see Fig. 2–54 (A). Make sure that the shaft goes down into its groove in the pump shaft. (NOTE. When the timing gear marks are opposite each other, then the piston for No. 4 cylinder is in the top dead center position, firing position.)

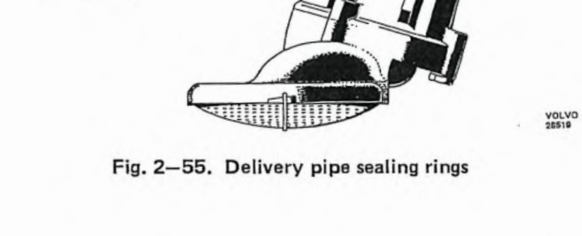


Fig. 2–55. Delivery pipe sealing rings

GROUP 24

FUEL INJECTION ENGINE

DESCRIPTION

The B 20 E/F engines are fitted with an electronically controlled fuel injection system. The system is made up of the following units:
Control unit, electric fuel pump, fuel filter, pressure regulator, injectors, cold start valve, inlet duct, throttle valve switch, auxiliary air regulator, temperature sensors (induction air and coolant), pressure sensor (for pressure in inlet duct), triggering contacts in ignition distributor thermal timer and electronic control unit, see Figs. 2–56 and 2–57.

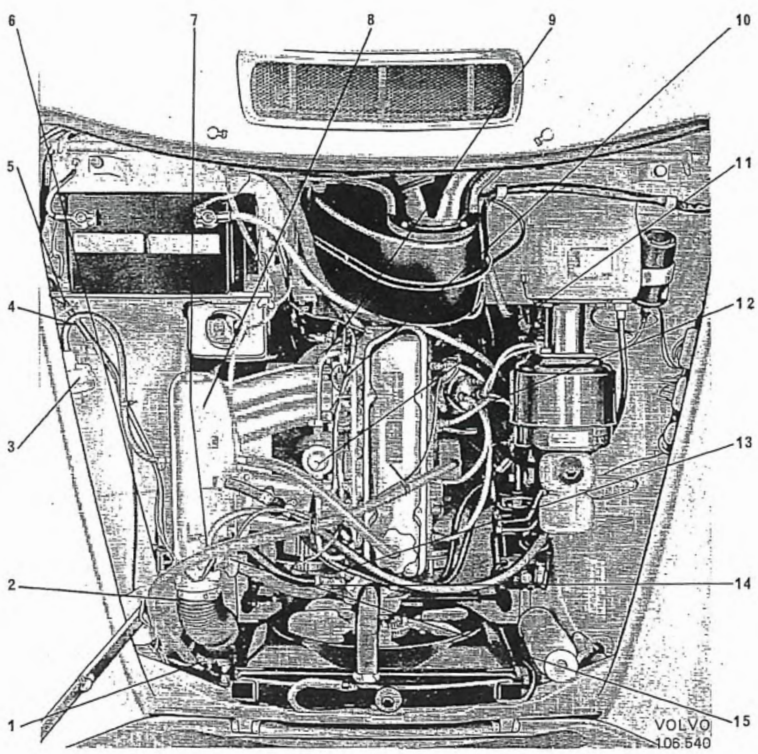


Fig. 2–56. Electronically controlled fuel injection (B 20 E and F)

1. Temperature sensor for induction air
2. Idling adjustment screw
3. Pressure sensor
4. Pump relay
5. Main relay
6. Throttle switch
7. Cold start valve
8. Inlet duct
9. Thermal timer
10. Injectors
11. Pressure regulator
12. Triggering contacts
13. Temperature sensor for coolant
14. Auxiliary air regulator
15. Stop screw for throttle valve

FUNCTION

Fuel is drawn by the electric pump from the tank via the fuel line and through the filter from where it is conveyed under pressure into the fuel line to the injectors.

The pressure regulator, which is connected to the end of the pressure line, limits the fuel pressure to 2.1 kp/cm^2 (30 psi). Excess fuel from the pressure regulator flows back to the tank through the return line. The electro-magnetic fuel injectors which are mounted in the intake ports in the cylinder head, are connected to the fuel line.

The duration of injection for the injectors is governed basically by engine load and speed.

The pressure sensor senses the absolute pressure in the inlet duct and converts it to electrical impulses which are processed by the control unit. Since the pressure in the inlet duct is proportional to engine load the control unit receives information concerning the engine load in this way.

The triggering contacts in the distributor provide the control unit with information about the engine speed. The control unit processes this information and, by means of signals to the injectors, determines how long the injectors will be open in order to provide the right amount of fuel.

The opening time for the cold start valve, which reduces with increased engine temperature, is regulated by the thermal timer relay.

Over and above the basic fuel, extra fuel must be supplied to the engine for starting, running warm and acceleration. During cold starting, the engine is given extra fuel through the cold start valve on the inlet duct.

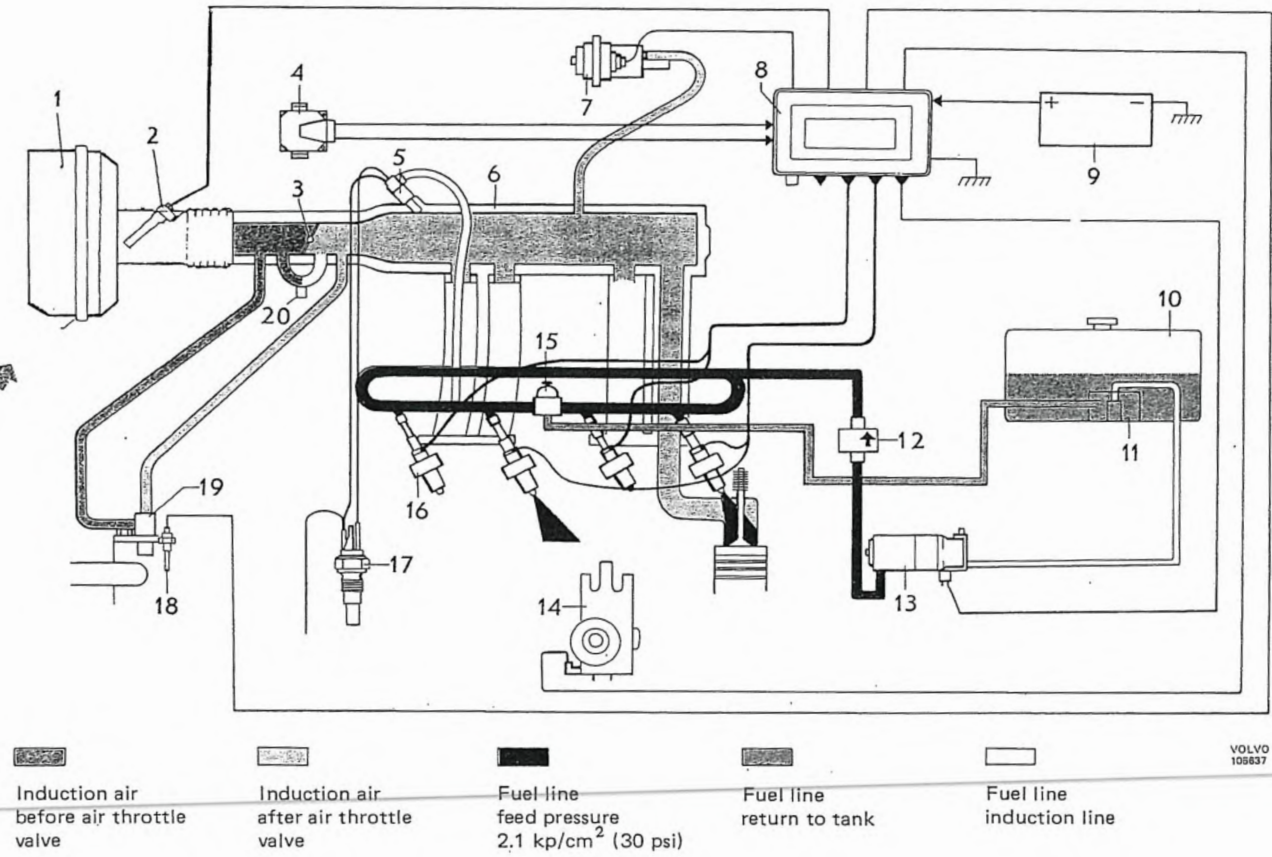


Fig. 2—57. Fuel injection system, principle of operation

1. Air cleaner
2. Temperature sensor for induction air
3. Throttle valve
4. Throttle valve switch
5. Cold start valve
6. Inlet duct
7. Pressure sensor
8. Control unit
9. Battery
10. Fuel tank
11. Fuel filter, suction line
12. Fuel filter, discharge line
13. Fuel pump
14. Distributor with triggering contacts
15. Pressure regulator
16. Injectors
17. Thermal timer
18. Temperature sensor for coolant
19. Auxiliary air regulator
20. Idling adjustment screw

During warming-up the control unit receives information from the temperature sensor in the cooling water circuit and as a result permits the injectors to remain open for a little longer time. If the engine is to function as it should with the increased flow of fuel, more air is required. Extra air is obtained through the auxiliary air regulator which gradually closes as the engine temperature rises.
The electronic control unit receives impulses for additional fuel during acceleration from the throttle valve switch. When the acceleration pedal is depressed, impulses are released from the throttle switch to the control unit which issues orders to the injectors to inject a number of times between the ordinary injections. Depressing the accelerator pedal quickly would cause the duration of the injection to be longer than the ordinary injection time.

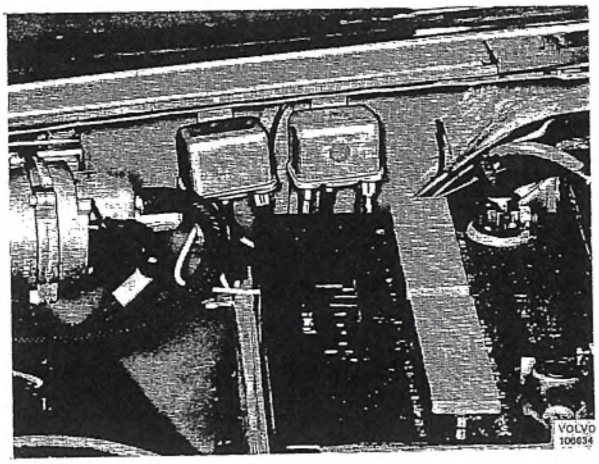


Fig. 2—59. Control relays

CONTROL UNIT

The control unit is located as shown in Fig. 2—58. Its function is to process the information from the various sensors and determine the opening interval for the injectors and when the fuel pump should start operating. The fuel pump is operated via a control relay located on the right wheel arch, see Fig. 2—59. Here in the same place, the main relay feeding the control unit is also placed.
The main relay is provided with a diode in the control circuit to prevent the injection system from being engaged and consequently damaged, if the battery is reversed.

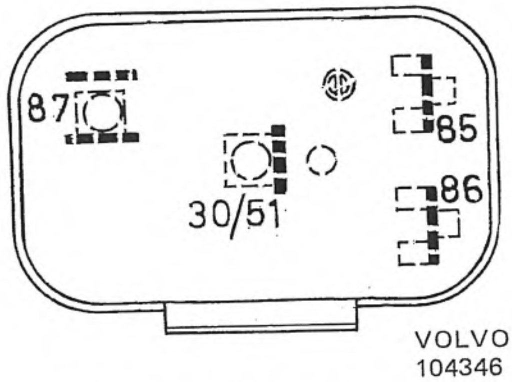


Fig. 2—60. Control relay's connections

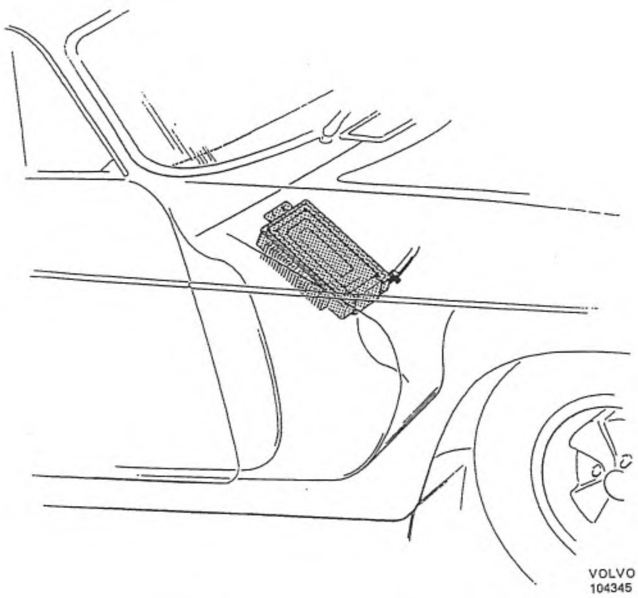


Fig. 2—58. Control unit installed

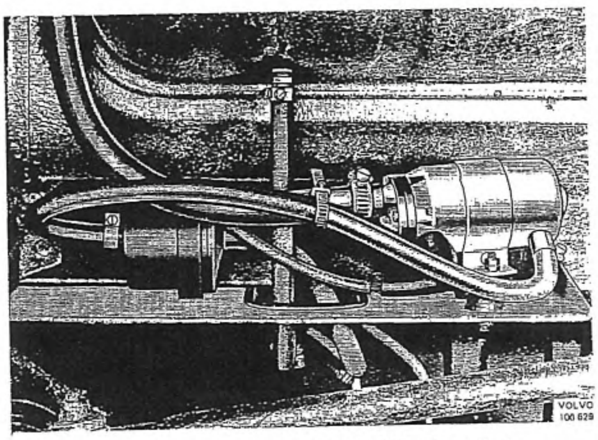


Fig. 2—61. Fuel pump with filter installed

ELECTRIC FUEL PUMP

The electric fuel pump is mounted under the vehicle in front of the fuel tank. Pump and motor are enclosed and cannot be disassembled for repairs. Fuel is drawn in at the front of the pump and discharged at its rear so that the fuel circulating in the pump causes the rotor and brushes to operate in the fuel. The pump is provided with a built-in overflow valve which opens should the pressure for one reason or another exceed 4.5 kp/cm^2 (64 psi), due to, for example, fault in the pressure regulator, fuel line blockage, etc. Fuel is circulated in the pump without pressure being further increased. The pump runs only 1–2 seconds when the ignition is switched on. This is to prevent the engine from being filled with petrol by a leaking cold start valve or injector. The pump then only works when the starter motor engages or when the engine is running.

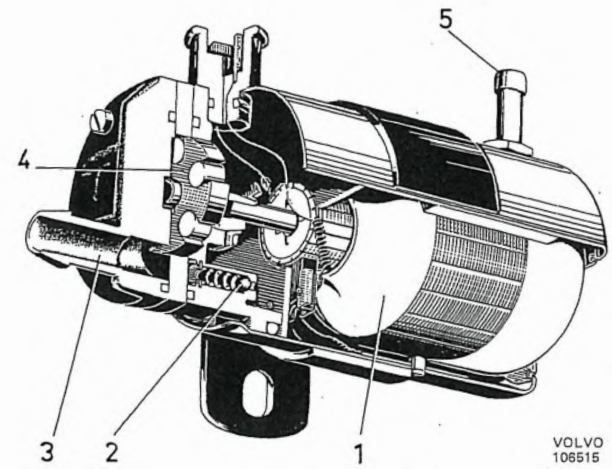


Fig. 2–62. Fuel pump

1. Rotor for elec. motor
2. Overflow valve
3. Inlet
4. Pump rotor
5. Outlet

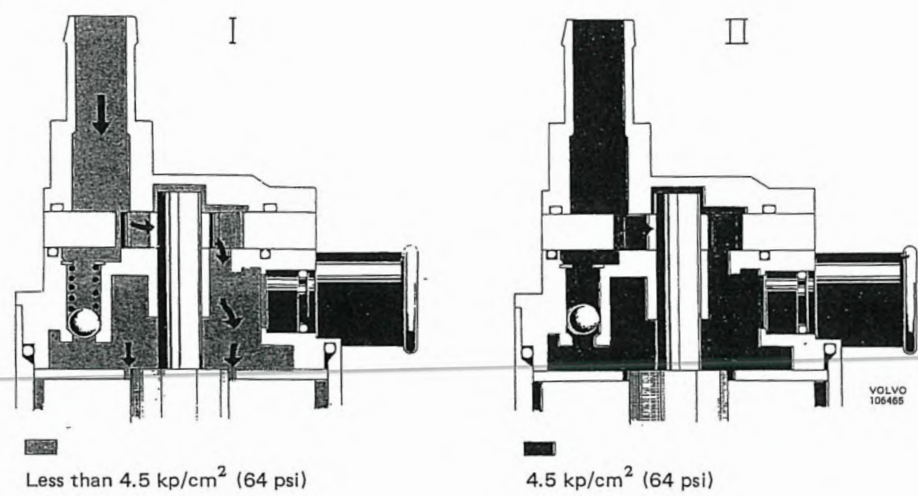


Fig. 2–63. Overflow valve function

I Overflow valve closed
II Overflow valve open

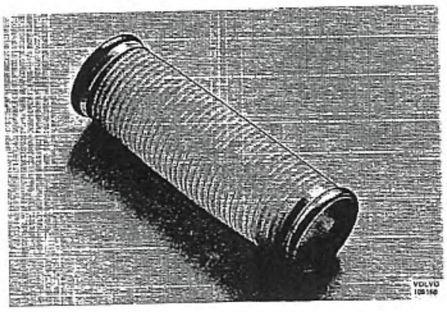


Fig. 2–64. Fuel filter, tank

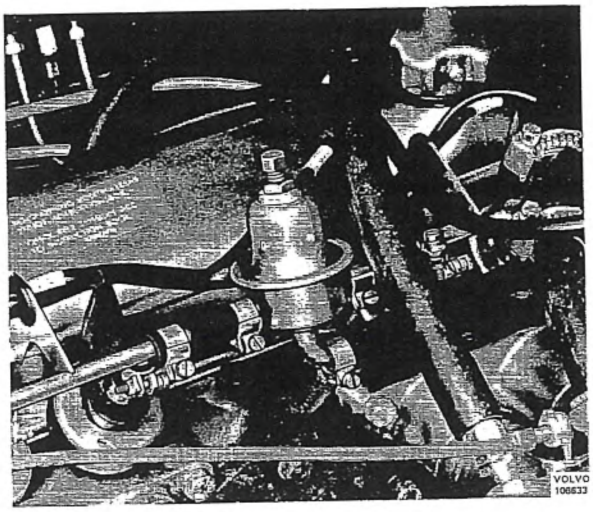


Fig. 2–65 Pressure regulator, installed

FUEL FILTERS

The fuel system is provided with two filters, one in the tank (suction line) and one after the fuel pump (discharge line).

PRESSURE REGULATOR

The pressure regulator is located as shown in Fig. 2–65. It is connected to the distributing pipe, between the 2nd and 3rd injector. The pressure regulator is a fully mechanical regulator which controls the pressure in the fuel lines to 2.1 kp/cm^2 (30 psi). The pressure is adjusted with the help of the adjusting screw.
When the pressure drops below 2.1 kp/cm^2 (30 psi), the valve (1, Fig. 2–66) closes. Once the pressure has exceeded 2.1 kp/cm^2 (30 psi) the valve opens and releases excess fuel into the return line to the tank.

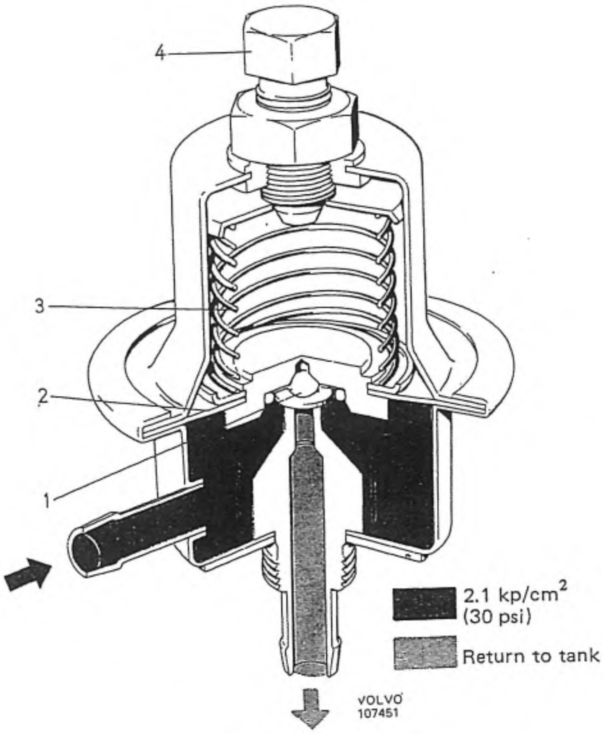


Fig. 2–66. Pressure regulator
1. Valve
2. Diaphragm
3. Spring
4. Adjusting screw

INJECTORS

Fuel is injected into the intake ports in the cylinder head by four injectors, one for each port. The injectors are mounted in holders fitted on the cylinder head.
The injectors operate in two groups, that is, two and two. Injectors 1 and 3 inject simultaneously and 2 and 4 simultaneously.
The fuel is injected while the intake valves are still closed. This means that fuel is collected in the inlet duct until the intake valve opens.
The injector consists of a housing containing a sealing

needle, magnetic winding and return spring, see Fig. 2–68. When the magnetic winding (2) is not in circuit, the return spring (3) presses the sealing needle (5) against a seat and this shuts off the supply of fuel. As the magnetic winding receives current from the control unit, it attracts the rear section of the sealing needle (5), shaped as a magnetic armature, and this lifts the needle about 0.5 mm (0.002") from the seat and permits fuel to pass. Since the needle and opening in the valve are accurately calibrated and the fuel pressure is constant, only the valve opening interval (2–10 milliseconds = 0.002–0.01 seconds) will determine the amount of fuel injected.

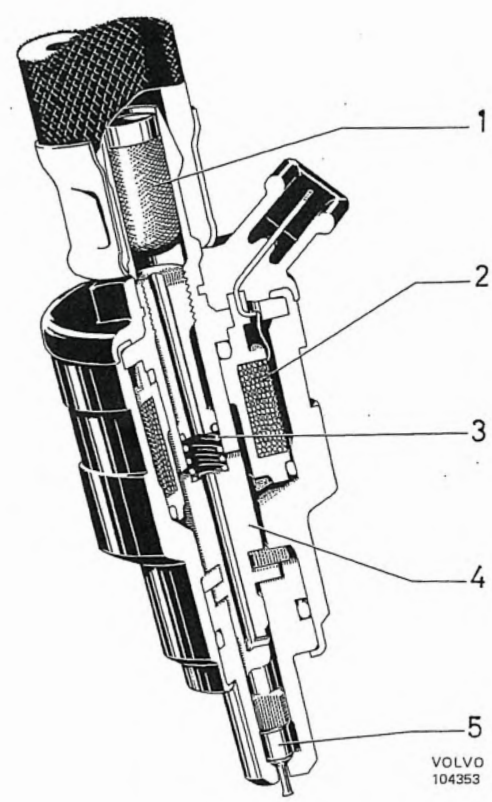


Fig. 2–68. Injector
1. Filter
2. Magnetic winding
3. Return spring
4. Magnetic armature
5. Sealing needle

COLD START VALVE

The cold start valve, which is mounted in the inlet duct after the air throttle, provides the engine with extra fuel during cold starting. The injection time is governed by the thermal timer, which registers the coolant temperature and cuts in current to the cold start valve. At –20°C (–4°F) and colder, the cold start valve provides extra fuel for 12 seconds, and at +35°C (95°F) the valve stops providing the engine with extra fuel at starting. The cold start valve will only inject when the starter motor is running. When the engine is running and the starter has been shut off before the injection interval governed by the thermal timer is completed, the cold start valve also ceases injecting fuel.

The cold start valve consists of a housing containing a magnetic winding and an armature together with return spring and packing. Its location can be seen from Fig. 2–69.

When the magnetic winding (1, Fig. 2–70) is not in circuit, the packing (4) presses against the inlet of the armature (3), which in its turn is actuated by the return spring (2). This keeps the cold start valve closed. When the magnetic winding is fed from the thermal timer, the armature is drawn down and fuel is forced past the packing, through the cold start valve and into the inlet duct.

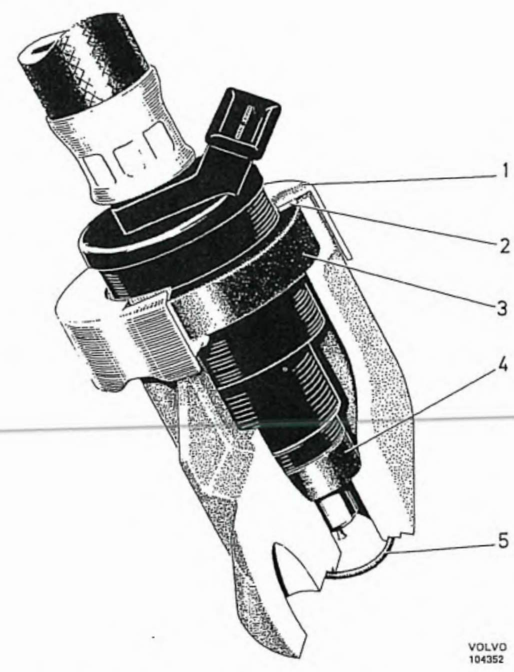


Fig. 2–67. Injector with holder
1. Circlip
2. Steel washer
3. Rubber seal
4. Rubber seal
5. O-ring

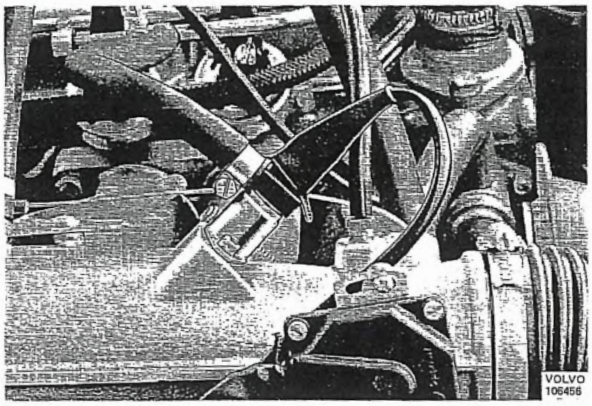


Fig. 2–69. Cold start valve, installed

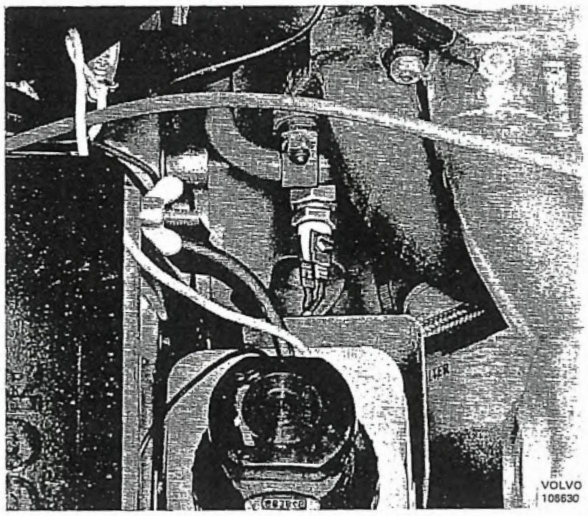


Fig. 2–71. Thermal timer, installed

THERMAL TIMER

When the engine is cold (below +35°C = 95°F) the contacts (1, Fig. 2–72) are closed. When the starter motor is operating, current flows from it to the cold start valve and via cable (3) and contacts (1) to ground. Current at the same time flows from the starter motor via cable (4) and contacts (1) to ground. As long as the contacts (1) are closed and the starter motor engaged, the cold start valve will inject. Cable (4), however, heats up the bi-metal spring (2) which bends so that the contacts (1) open and current to the cold start valve is broken. The warming-up time will depend on engine temperature.

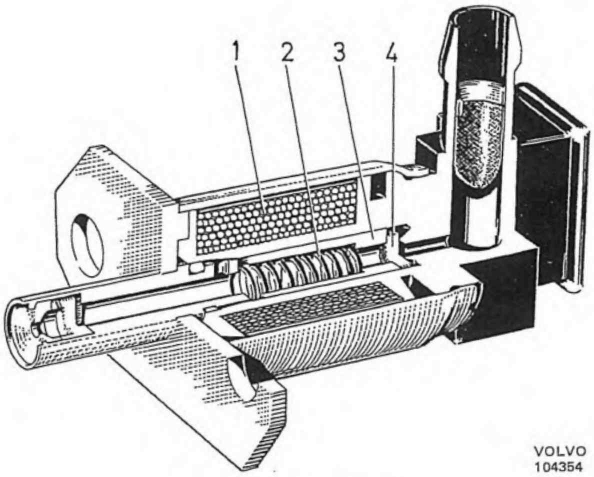


Fig. 2–70. Cold start valve
1. Magnetic winding
2. Return spring
3. Magnetic armature
4. Packing

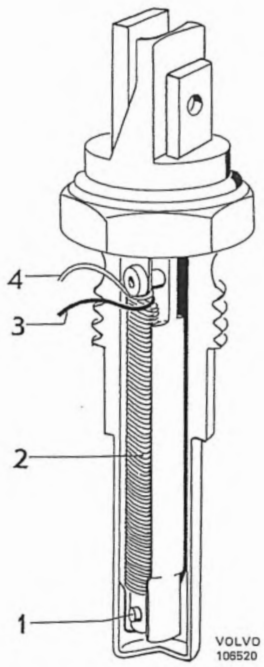


Fig. 2–72. Thermal timer
1. Contacts
2. Bi-metal spring
3. Cable
4. Cable

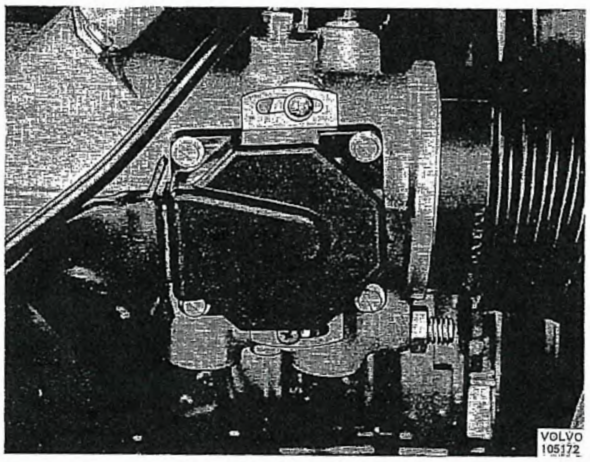


Fig. 2–73. Throttle valve switch

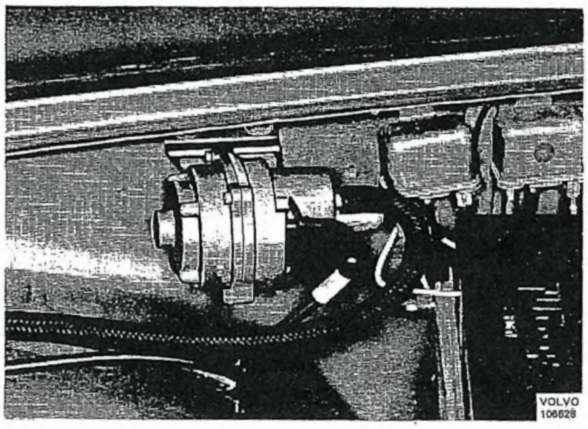


Fig. 2–75. Pressure sensor, installed

THROTTLE VALVE SWITCH

The throttle valve switch is mounted on the inlet duct and is connected to the throttle shaft. It has two functions, to emit impulses to the control unit to increase the fuel supply during acceleration and, during idling or retardation, to engage the control unit's CO-potentiometer by which the CO-content can be regulated.

During acceleration, the switches, 2, Fig. 2–74, are pressed together. This cuts in the circuit so that current flows from one switch to the other. As the switch contacts move across the zig-zag, the control unit receives impulses, their number and rapidity informing the control unit how much additional fuel is to be injected (that is, how many additional injections will take place and how much the injection interval has to be extended). Throttle reduction opens the switches (2, Fig. 2–74) to prevent the control unit from receiving impulses for "extra fuel" when the air throttle valve is closed. At idling or retardation, the switches (4, Fig. 2–74) close and the CO-potentiometer of the control unit is engaged and this regulates the CO-content.

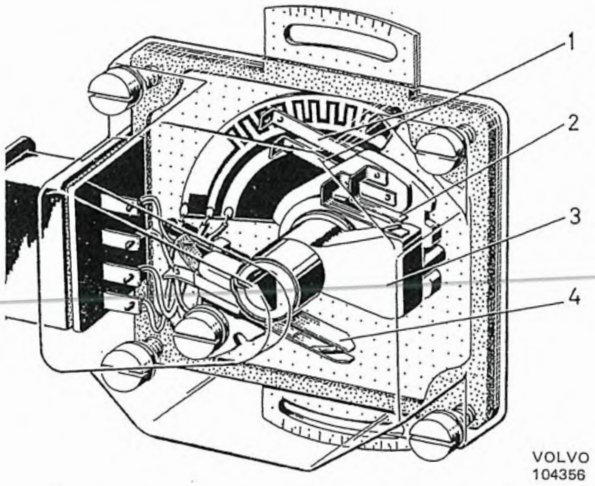


Fig. 2–74. Throttle valve switch
1. Slip switches
2. Switch pair for accelerator function
3. Connection with throttle spindle
4. Switch pair for CO-potentiometer

PRESSURE SENSOR

The pressure sensor senses the pressure in the inlet duct. By permitting pressure variations to influence the armature in the transformer and so alter the transformer inductance, the pressure sensor informs the control unit about the load on the engine. The pressure sensor is located on the right wheel housing and is connected to the inlet duct by means of a hose, see Figs. 2–75 and 2–76.

The pressure sensor, Fig. 2–76, is built into a light-alloy housing.

When the engine is switched off, atmospheric pressure exists on both sides of the diaphragm (8, Fig. 2–76) and the movable armature (11), which is suspended friction-free in both leaf springs (3 and 6) is pressed against the full-load stop (9) by the spring (2). Moreover, both the deflated diaphragm bellows (7) are pressed together, since they are influenced by atmospheric pressure. This permits the armature (11) to move further to the right. In this position with the armature at extreme right, the pressure sensor informs the control unit that maximum possible fuel can now be injected.

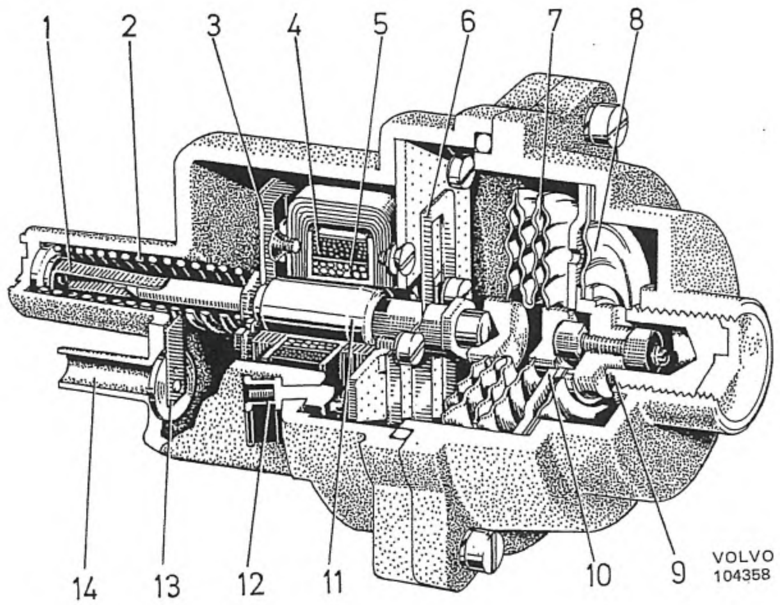


Fig. 2–76. Pressure sensor

1. Damping spring
2. Coil spring
3. Leaf spring (suspension)
4. Secondary winding
5. Primary winding
6. Leaf spring (suspension)
7. Diaphragm bellows
8. Diaphragm
9. Full-load stop
10. Part-load stop
11. Armature
12. Electrical connection
13. Valve
14. Hose connection

When the engine starts and the underpressure from the engine inlet duct influences the left-hand side of the diaphragm (8), atmospheric pressure forces the diaphragm over to the part-load stop (10). At the same time, the diaphragm bellows (7) expand since they are influenced by the under pressure inside the pressure sensor and they move the armature a bit to the left. Depending upon the pressure in the inlet duct (engine load) the armature adjusts itself to different positions during driving.
At full-throttle driving, the pressure in the inlet duct will be almost equal to the atmospheric pressure, at which point the armature takes up the same position as when the engine starts.
The function of the valve (13) is to prevent pressure impulses in the inlet duct (from the piston movement) from being conveyed into the pressure sensor. This valve has a small hole which constricts the impulses. During sudden acceleration, when air will rush into the pressure sensor, the hole in the valve is insufficient to cope with this so that the entire valve is moved by spring pressure away from the opening and air is allowed to enter.

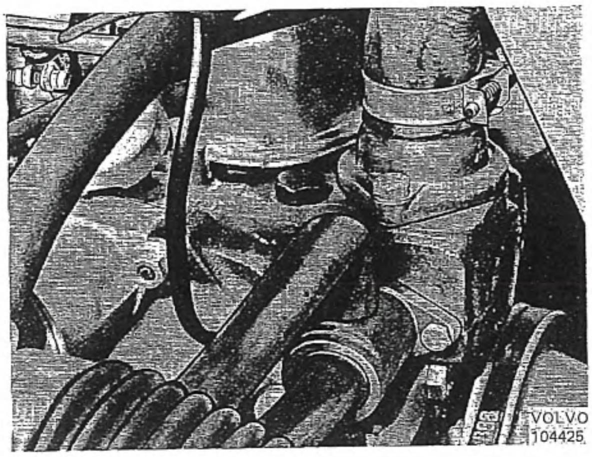


Fig. 2–77. Auxiliary air regulator, installed

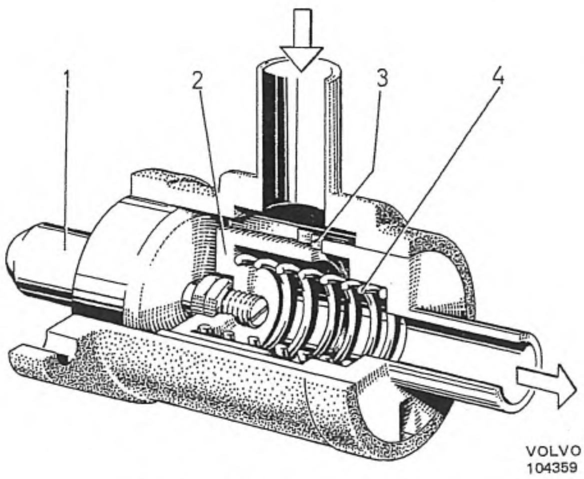


Fig. 2–78. Auxiliary air regulator

1. Capillary tube
2. Regulator slide
3. Auxiliary air pipe
4. Return spring

AUXILIARY AIR REGULATOR

The auxiliary air regulator is placed at the front end of the cylinder head and has its capillary tube projecting into the coolant system, see Fig. 2–77. The regulator operating range is from $-25^{o}C$ ($-13^{o}F$), fully open, to $+60^{o}C$ ($140^{o}F$), fully closed.

At cold start, the auxiliary air regulator opens (how much will depend on the temperature) and admits additional air into the inlet duct. Gradually, as the engine heats up, the capillary tube (1, Fig. 2–78) expands and presses back the regulator slide (2) which, at $+60^{o}C$ ($140^{o}F$), completely shuts off the through-flow area.

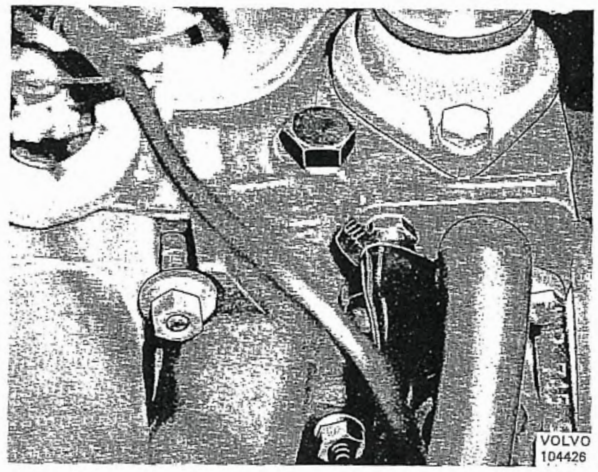


Fig. 2–80. Temperature sensor for coolant

TEMPERATURE SENSORS

The system is fitted with two temperature sensors, one for coolant and one for intake air.

The intake air temperature provides the control unit with information about the temperature of the intake air. At temperatures lower than $+30^{o}C$ ($86^{o}F$) the injection interval increases slightly.

On the basis of the information supplied by the temperature sensor for the coolant, the control unit adapts the injection interval according to the temperature of the coolant.

The coolant temperature sensor is located at the front end of the cylinder head, see Fig. 2–80, and the temperature sensor for the intake air behind the air cleaner, see Fig. 2–79.

The part of the temperature sensor sensitive to temperature variation is a semi-conductor with negative temperature coefficient, that is, the resistance drops with increasing temperature. The resistance alters considerably between different temperatures. For example, at $-20^{o}C$ ($-4^{o}F$) the temperature sensor has a resistance of 15 000 ohms, but at $+60^{o}C$ ($140^{o}F$) only 600 ohms.

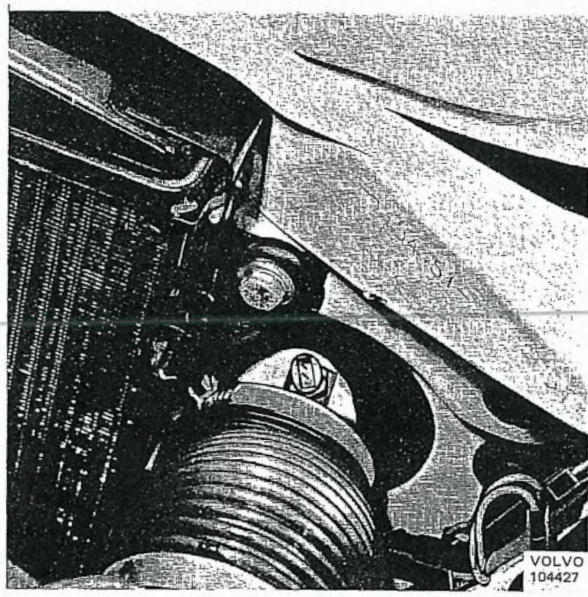


Fig. 2–79. Intake air temperature sensor (connection removed)

INLET DUCT

The inlet duct is of aluminium, and is cast in one piece. It consists of a common inlet duct from the individual induction lead to each induction port in the cylinder head.

A throttle valve is mounted at the mouth of the common inlet duct. During idling, the throttle valve is completely closed. Air then flows in through a "by-pass" pipe under the throttle valve. Idling speed is adjusted by altering the cross-sectional area of the auxiliary air pipe by means of the idle adjustment screw, Fig. 2–81.

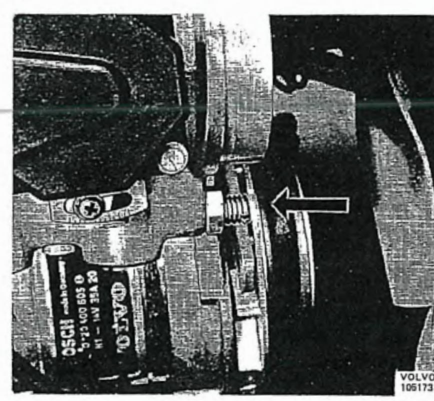


Fig. 2–81. Screw for adjusting idling

TRIGGERING CONTACTS

Below the centrifugal governor in the distributor there is a contact device with two triggering contacts, see Fig. 2—82.

The contacts are actuated by a cam on the distributor shaft.

The function of these contacts is to supply information to the control unit about engine speed to enable the control unit to determine partly when the injection should begin and partly the duration of the injection with the help of information from the pressure sensor.

CABLE HARNESS

All electrical components in the electronic injection system are mounted in a special cable harness with numbered cables. The connections between the cable harness and components are of the so-called "Amp" plug type, which makes for good electrical contact as well as rapid removal and fitting of the various cables. The plugs are provided with grommets to ensure proper installation in the various components. Check that the grommet enters the cut-out on the control unit before pushing in the harness plug firmly. The connections are covered by rubber protectors which also serve for locking purposes. These protectors are removed by pulling the "tongues".

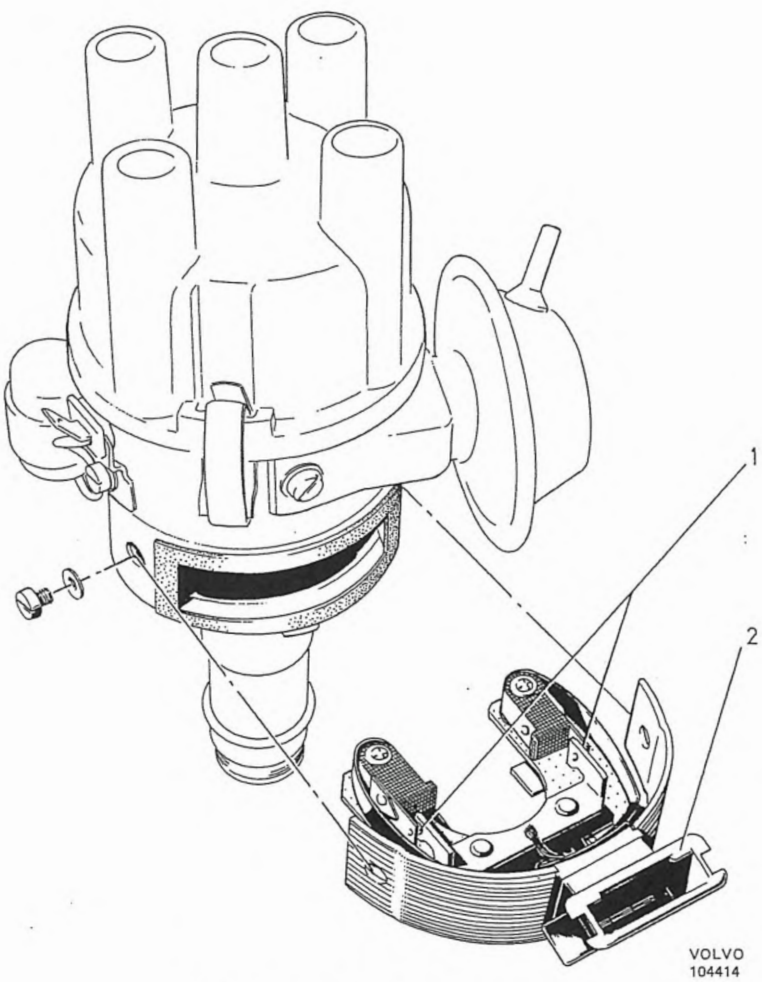


Fig. 2—82. Distributor with contact device
1. Triggering contacts
2. Electrical connection

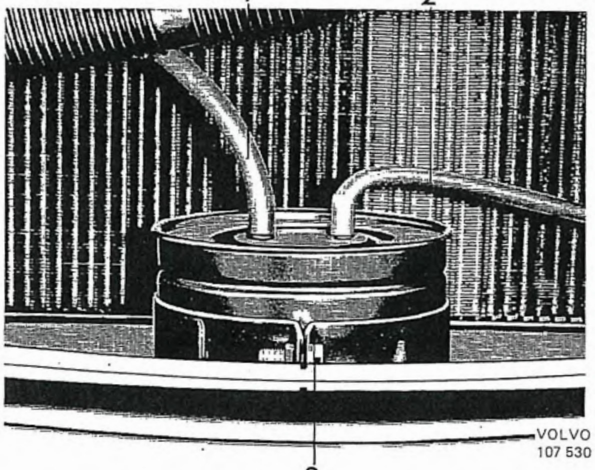


Fig. 2–83. Venting filter
1. Connection to inlet duct
2. Connection from expansion container
3. Attaching screw

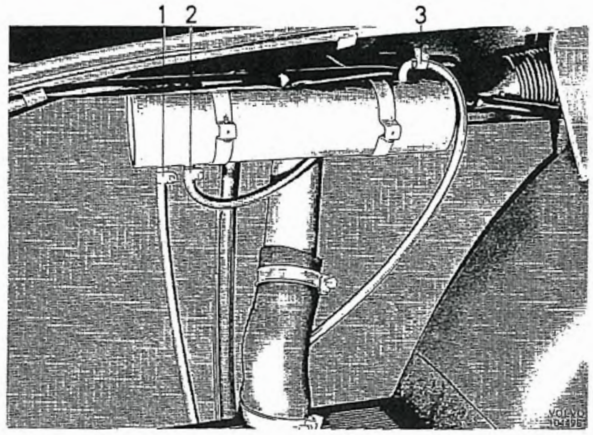


Fig. 2–85. Expansion container
1. Connection from tank
2. Connection from filler tube
3. Connection to venting filter

GAS EVAPORATIVE CONTROL SYSTEM

Vehicles intended for the U.S.A. market are fitted with a gas evaporative control system, which prevents gas fumes from being released into the atmosphere. The system consists of an expansion container and a venting filter, which is filled with active carbon. Also included are the connection hoses between the various components. The venting filter is located behind the radiator grille, see Figs. 2–83 and 2–84. The expansion container is placed to the left in the luggage boot, next to the filler pipe, see Fig. 2–85.
Gas fumes forming in the hermetically sealed tank, particularly during warm weather, are conveyed to the expansion container (2, Fig. 2–86) and from there to the venting filter (4) where they are mixed with the active carbon.
When the engine starts, air is drawn through the venting filter and into the engine via the inlet duct. Gas fumes stored in the active carbon are drawn by the air flow into the engine where they take part in the combustion.
The foam plastic filter at the bottom of the venting filter should be replaced after every 40 000 km (24 000 miles). To replace, slacken the screw (3, Fig. 2–83) and lift up the venting filter whereby the plastic filter can be changed.

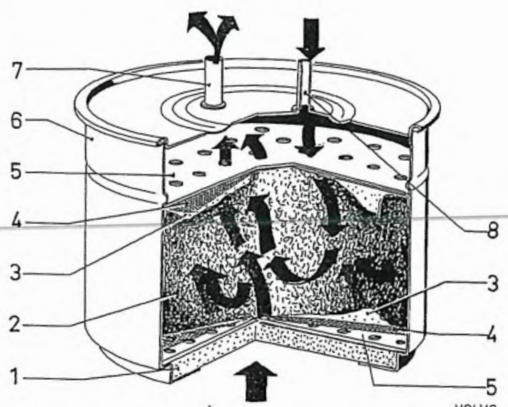


Fig. 2–84. Venting filter
1. Foam plastic filter
2. Active carbon
3. Felt
4. Wire gauze
5. Perforated plate
6. Cannister
7. Connection to inlet duct
8. Connection from expansion cannister

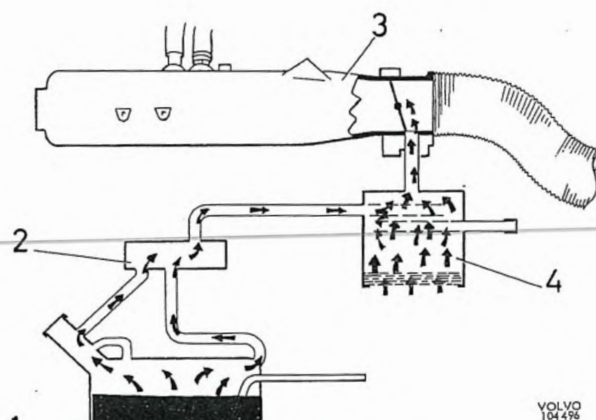


Fig. 2–86. Gas evaporative control system, principle
1. Fuel tank
2. Expansion container
3. Inlet duct
4. Venting filter

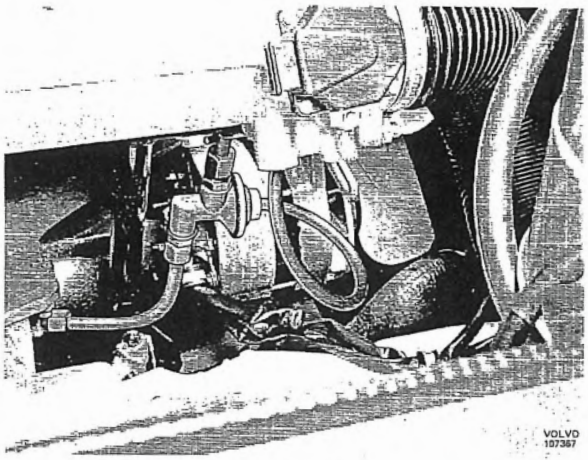


Fig. 2–87. EGR valve, installed

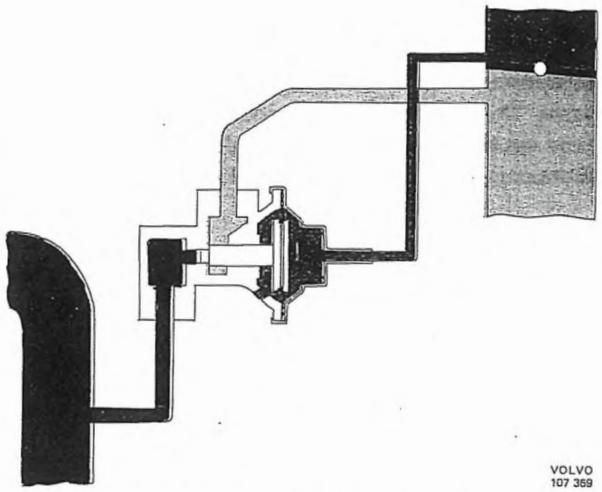


Fig. 2–89 a. Air shutter closed, no exhaust gas recirculation

EXHAUST GAS RECIRCULATION (EGR)

Vehicles with a B 20 F-engine in combination with automatic transmission are equipped with exhaust gas recirculation. This makes for cleaner exhaust gases when driving on half throttle. The system consists of a recirculation channel and an EGR valve operated under a vacuum.

Exhaust gas recirculation takes place when the air shutter is **between** the closed position (idle) and the half-open position (full throttle).

When the air shutter is closed, Fig. 2–89 a, the opening for the EGR line on the EGR valve is in front of the air shutter. The pressure in the EGR line and also in the EGR valve vacuum chamber is then equal to atmospheric pressure. Since the pressure in the EGR valve reference chamber is always equal to atmospheric pressure, the same pressure exists on both sides of the diaphragm and this keeps the valve in a closed position under the force of the spring. In other words, there is no exhaust gas recirculation.

When the air shutter is partly open, Fig. 2–89 b, the opening for the EGR line "moves" behind the air shutter. Behind the air shutter there is partial vacuum which is transmitted to the vacuum chamber of the EGR valve. The atmospheric pressure in the EGR valve reference chamber now presses the diaphragm backwards so that the valve opens. Exhaust gas recirculation now takes place to the intake manifold and back into the cylinders.

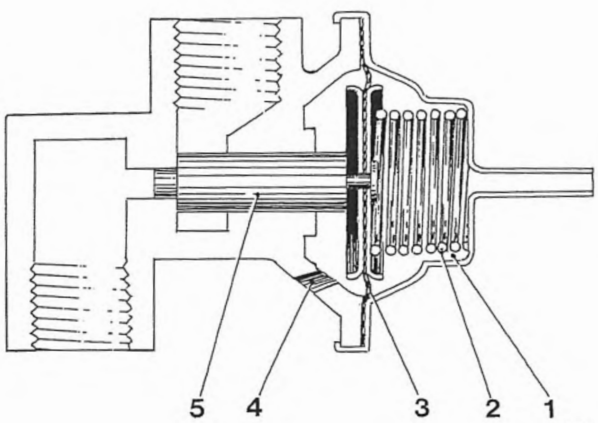


Fig. 2–88. EGR valve
1. Vacuum chamber
2. Return spring
3. Diaphragm
4. Reference chamber
5. Piston

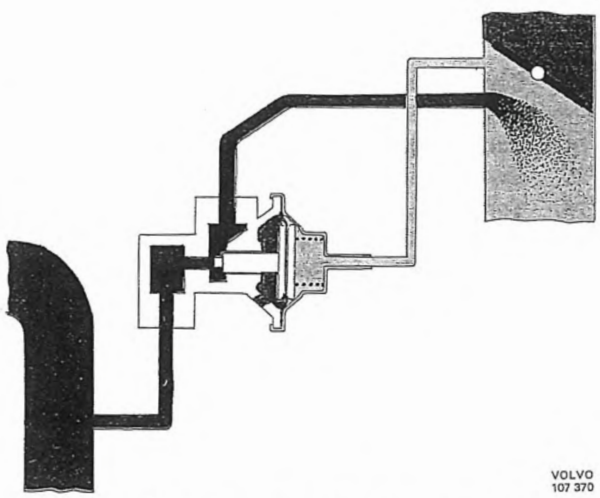


Fig. 2–89 b. Air shutter partly open, exhaust gas recirculation

With fully open air shutter, Fig. 2–89 c, there is atmospheric pressure in the intake manifold and this is transmitted to the vacuum chamber of the EGR valve. The pressure on both sides of the diaphragm is now equal so that the valve is closed by the spring. Exhaust gas recirculation has now stopped.

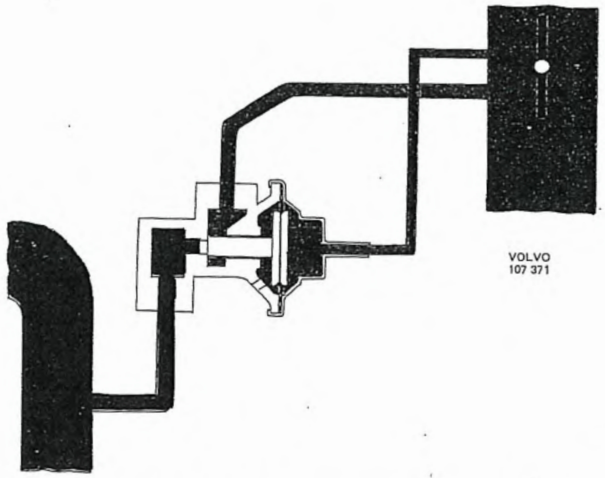


Fig. 2–89 c. Air shutter fully open, no exhaust gas recirculation

CABLE HARNESS NUMBERING

Cable No.	From	To
1	Control unit	Temperature sensor I (intake air)
2	Control unit	Cold start relay, terminal 85
3	Control unit	Injector, cyl. 1
4	Control unit	Injector, cyl. 3
5	Control unit	Injector, cyl. 4
6	Control unit	Injector, cyl. 2
7	Control unit	Pressure sensor
8	Control unit	Pressure sensor
9	Control unit	Throttle valve switch
10	Control unit	Pressure sensor
11	Control unit	Ground
12	Control unit	Distributor (triggering contacts)
13	Control unit	Temperature sensor I (Intake air)
14	Control unit	Throttle valve switch
15	Control unit	Pressure sensor
16	Control unit	Main relay, terminal 87
17	Control unit	Throttle valve switch
18	Control unit	Starter motor, terminal 50
19	Control unit	Pump relay, terminal 85
20	Control unit	Throttle valve switch
21	Control unit	Ignition distributor (triggering contacts)
22	Control unit	Ignition distributor (triggering contacts)
23	Control unit	Temperature sensor II (coolant)
24	Control unit	Main relay, terminal 87
26	Fuel injector, cyl. 1	Ground
27	Fuel injector, cyl. 2	Ground
29	Thermal timer, 6 terminal	Starter motor, terminal 50
30	Fuel injector, cyl. 3	Ground
31	Fuel injector, cyl. 4	Ground
32	Temperature sensor II (coolant)	Ground
33	Cold start valve	Thermal timer, terminal W
34	Cold start valve	Thermal timer, terminal G
35	Fuel pump (–)	Ground
36	Fuel pump (+)	Connector
37	Connector	Pump relay, terminal 87
38	Main relay, terminal 86	Ignition coil, terminal 15

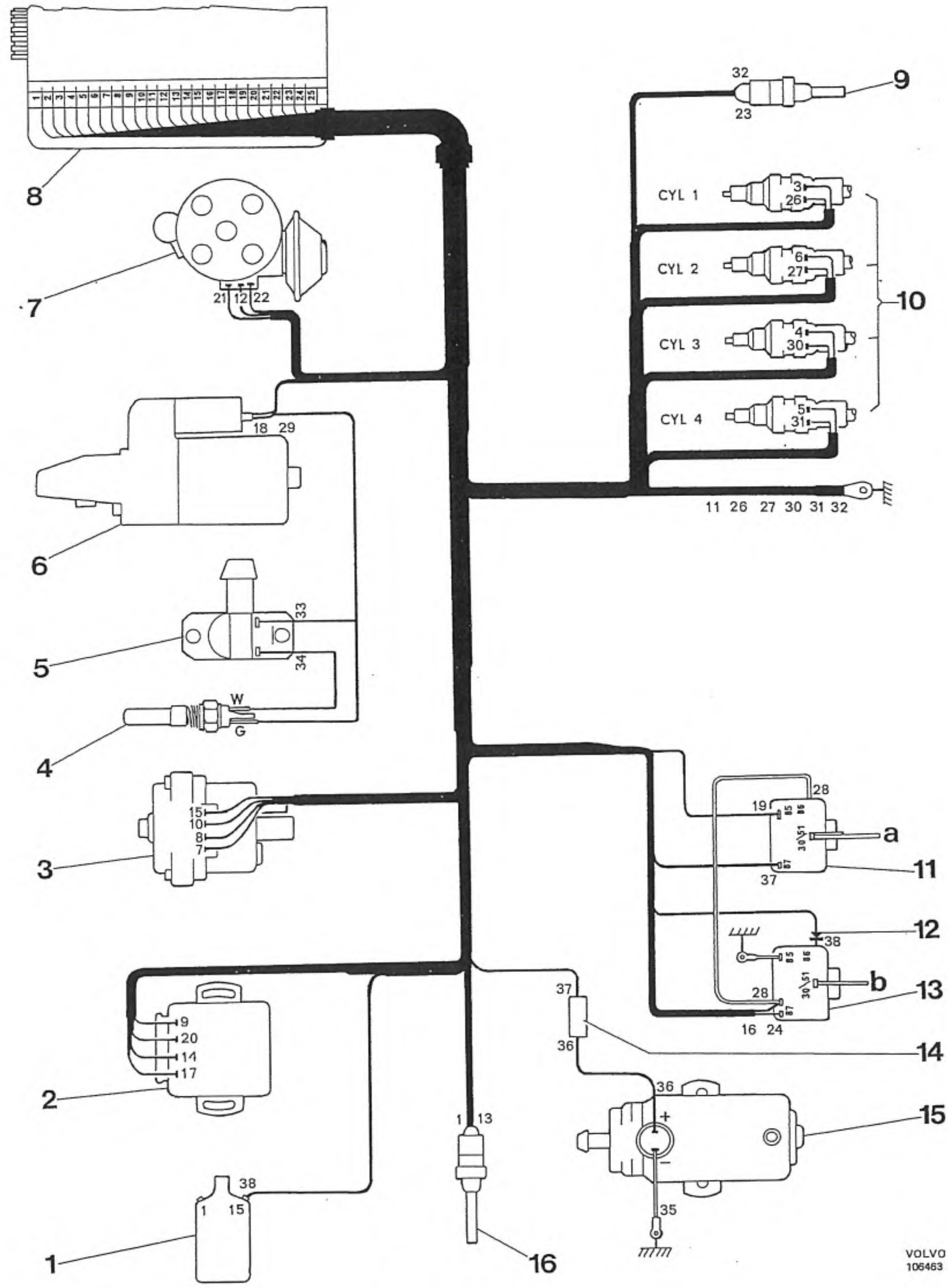


Fig. 2–90. Cable harness

1. Ignition coil
2. Throttle valve switch
3. Pressure sensor
4. Thermal timer
5. Cold start valve
6. Starter motor (terminal 50)
7. Distributor (triggering contacts)
8. Control unit
9. Coolant temperature sensor
10. Injectors
11. Pump relay
12. Diode (located in relay)
13. Main relay
14. Connector
15. Fuel pump
16. Temperature sensor for intake air

a. To fuse 1 (small fusebox)
b. To battery, B+

SPECIAL INSTRUCTIONS FOR WORK ON VEHICLES WITH ELECTRONIC FUEL INJECTION

1. **Never** let the engine run without the battery being connected.
2. **Never** use a high speed battery charger as an aid in starting.
3. At least one battery lead should be disconnected when about to use a high speed charger to charge the battery in the vehicle.
4. On no account may the control unit overheat above 185°F. The control unit must not be connected up (the engine started) when the ambient temperature exceeds 158°F. (With paintwork, etc., when the vehicle is being stove-heated, it must not be driven out of the oven, but conveyed out. If there is risk of temperatures exceeding 185°F, the control unit must first be removed.)
5. The ignition must be switched off before connecting up or disconnecting the control unit.
6. For all work with fuel lines, **great** care must be taken to make sure that no dirt enters the system. Even small dust particles can jam injectors.

TESTING INJECTION EQUIPMENT WITH BOSCH TEST INSTRUMENT EFAW 228

1. Switch off the ignition.
2. Remove the control unit (see page 2—44). Connect the cable from test instrument to the cable harness in the vehicle, see Fig. 2—91.
3. Switch "A" on the instrument to position "Measuring circuit B".
4. Test as follows: (Note. When testing with the test instrument, the entire program should be carried out. Any faulty component should be replaced or adjusted before continuing the test. Extra starting button for operating the starter motor may not be connected until the test "Voltage III starter motor" has been carried out.)

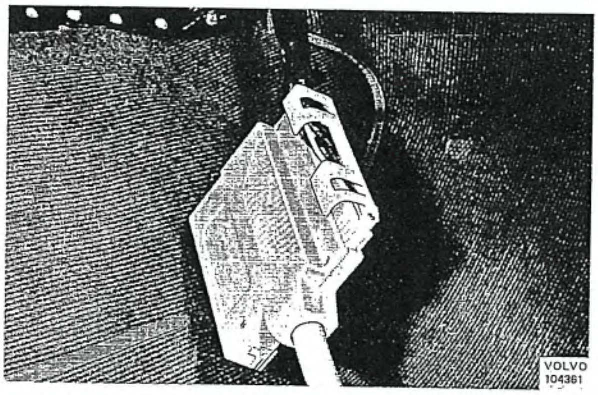


Fig. 2—91. Test instrument connected to cable harness

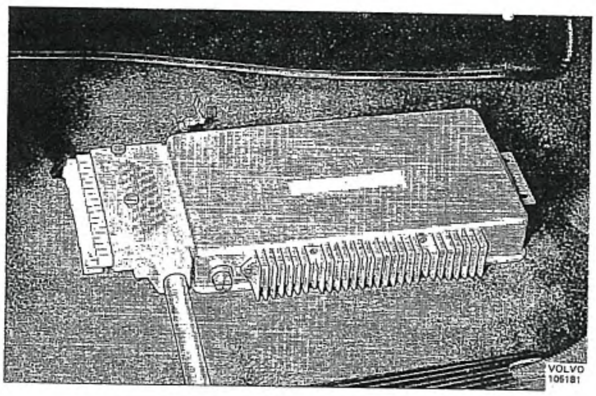
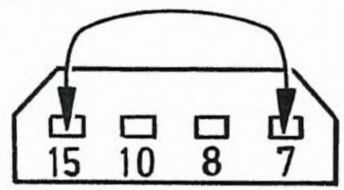
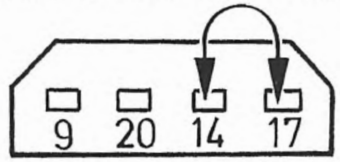


Fig. 2—92. Test instrument connected to cable harness and control unit

Position of switch "B"	Operate	To measure	Indication (nominal value)	Deviation from nominal value. Possible faults and elimination
Voltage I	Switch on ignition	Voltage supply for the control unit	11.0–12.5 (11.0–12.5 volt)	**No reading:** 1. Open circuit in cable 16, from terminal 87 on main relay to control unit. 2. Main relay inoperative. (Check for voltage at terminal 86. If none there, check cable 38 between terminals 86 and 15 on ignition coil. Check grounding from relay terminal 85 and cable 11 from control unit to ground. Check voltage at terminals 30/51. If there is no fault, change relay.) **Voltage below 11 volt:** 1. Flat battery. (Check the battery voltage.) 2. Voltage drop in cables 16 or 11. Voltage drop in relay
Voltage II			11.0–12.5 (11.0–12.5 volt)	As for "Voltage I". Also check cable 24.
Starting voltage	Operate starter for a short time	Voltage at terminal 50 of starter solenoid	9.0–12.0 (9.0–12.0 volt)	**No voltage, starter operates:** Open circuit in cable 18 from terminal 50 on starter motor to conttrol unit. **No voltage as above, starter does not operate:** 1. Ignition/starter switch defective. 2. Open circuit in cable between ignition and terminal 50 on starter. **Voltage below 9.0 volt:** 1. Battery flat. 2. Voltage drop in cable from ignition/starter switch to terminal 50 on the starter solenoid too high. 3. Voltage drop in cable 18.
Adjustment "Ω", pressure sensor				When full deflection on the instrument is not obtained the voltage of the vehicle battery is too low. (See also test stage "Voltage I".)
	Push "ground" button	Resistance between pressure sensor windings and ground (short-circuit ground	"∞" ("∞" Ω)	**Resistance "O":** Short circuit to ground in cable or at pressure sensor. (Pull plug out of pressure sensor, alter reading "∞", replace sensor. If the reading remains an unchanged 0, there is fault in cable 7, 8 or –5.) **Resistance between "O" and "∞":** Damage to insulation. (Proceed as described above.)

Position of switch "B"	Operate	To measure	Indication (nominal value)	Deviation from nominal value. Possible faults and elimination
	Push "Primary" button	Resistance of primary windings of pressure sensor	0.8–1.0 on the Ω scale (approx. 90 Ω)	**Resistance considerably smaller than nominal value:** Damage to insulation. (Pull plug out of pressure sensor and if test instrument shows "∞" replace pressure sensor, otherwise cables 7 and 15.) **Resistance considerably larger than nominal value:** Voltage drop in cables or contacts. (Check cables and contacts.) **Resistance "0":** Short circuit to ground, short circuit in secondary windings. (Pull plug out of pressure sensor and if test instrument shows "∞" replace pressure sensor, otherwise check cables 7 and 15.) **Resistance "∞":** Open circuit in sensor or cables. (Pull plug out of sensor. Bridge plug as shown in illustration. If test instrument indicates 0, replace pressure sensor. If "∞" indicated, check cables 7 and 15.)  VOLVO 104369
	Push in "Secondary" button		3–4 on Ω scale (approx. 350 Ω)	See under "Primary". If needle of the test instrument shows "∞", connect terminals 8 and 10 in the plug instead of 7 and 15.)
Distributor contact I Distributor contact II	Read off test instrument with switch in position I. Switch to position II. If the test instrument swings to 0 in the first position, it should now indicate ∞ and if the instrument shows ∞ in the first position, it should now indicate 0. Switch to position I. Run the engine with short strokes on the starter motor until the instrument shows a reading opposite to the first reading. Switch to position II again and check to make sure that the reading changes.	Functioning of the triggering contacts in the distributor	0 and "∞" (0 and "∞" Ω)	**Resistance between 0 and "∞":** Check terminal on distributor. Check cables 12, 21 and 22. (If there is no fault in the terminal or cables change the contact insert in distributor.)

Position of switch "B"	Operate	To measure	Indication (nominal value)	Deviation from nominal value. Possible faults and elimination
Throttle valve switch I	Open and close throttle valve slowly	Impulses for extra fuel during acceleration	Instrument needle swings approx. 10 times between "0" and "∞" when the throttle valve opens. (0 and "∞" Ω) the instrument needle should indicate "∞" when the throttle valve closes	**Instrument needle shows "0" or swings when throttle valve closes:** Faulty throttle valve switch, replace.
Throttle valve switch II				
Throttle valve switch III	Check that throttle valve is closed	Functioning of the contacts in the throttle	0 (0 Ω) valve switch	**Resistance "∞":** Throttle valve switch incorrectly adjusted or damaged. Open circuit in cable to switch. (Pull out plug and bridge as shown in Illustration. If the pointer swings to "0", there is no damage in the cables. Reconnect the switch. Check setting of throttle valve switch acc. to page 2–47. Change switch if unable to be adjusted.) 
	Open throttle valve approx. 1°. (Place a 0.50 mm=0.02" feeler gauge between stop screw and stop on throttle spindle.)		"∞" ("∞" Ω)	**Reading "0":** Throttle valve switch incorrectly adjusted or damaged. Open circuit in cables. (Pull out plug. If reading swings to "∞", the cables are not damaged. Re-connect switch and check setting acc. to page 2–47. Replace throttle valve switch if unable to be adjusted.)
Temperature sensor I (intake air)		Resistance in temperature sensor for intake air	2–5 (300 Ω at +20°C= 68°F considerably dependent on temperature. Small reading at higher temperature).	**Resistance "∞":** Open circuit. (Pull out plug and connect terminals. If reading swings to "0", change sensor, otherwise check cables 1 and 13.) **Reading "0":** Short circuit. Pull out plug. If reading is the same, check cables 1 and 13. If reading swings to "∞", change sensor.)
Temperature sensor II (coolant)		Resistance in temperature sensor for coolant	0.5–3.5 (approx. 2.5 K Ω at +20°C=68°F. Considerably dependent on temperature. Lower reading at higher temperature.)	See "Temperature sensor I". Check cables 23 and 32.

Valves	Adjust instrument to "∞" again (with switch "B" in position "valves") Push buttons; 1 = injector for cyl. 1 2 = injector for cyl. 4 3 = injector for cyl. 2 4 = injector for cyl. 3	Resistance of the windings in the injector with cable	2–3 (2.4 Ω at $20^oC=68^oF$)	**Resistance "0":** Short circuit in cables or injectors. (Pull plug out of injector concerned and if test instrument shows "∞", exchange injector, otherwise replace cable harness.) **Resistance "∞":** Open circuit in cable or injector windings. (Remove plug from injector concerned, connect terminals in plug. If test instrument shows "0", the injector is defective; otherwise check the cables for the injector.) **Resistance over "3":** Ground cable from the injectors has a bad connection on the engine. (Check ground cables for respective valves, 26, 27, 30 and 31.)

Turn switch "A" to "Valve check". (Switch "B" position is of no importance here.)

Position of switch "B"	Operate	To measure	Indication (nominal value)	Deviation from nominal value. Possible faults and elimination
Valve check	Connect pressure gauge to pressure regulator, see page 2:45 Press "Pump" button on the instrument	Pressure in fuel system	Nominal value 2.1 kp/cm^2 (30 psi)	**No pressure build-up (pump does not start):** Check if pump relay cuts in when "Pump" button is depressed. Relay does not cut-in: Open circuit in cable 28, from main relay terminal 87 to pump relay terminal 86, resp. cable 19 from pump relay terminal 85 to control unit. (If the cables are not damaged, change the relay.) Relay cuts-in: Open circuit in cables 27 and 36, from terminal 87 on pump relay to contact on pump or in cable 35, from contact to ground. Faulty pump. (Check cables, measure voltage at plug contact for pump. If voltage is 12 volts, change pump.) **Pressure above or below 2.1 kp/cm^2 (30 psi):** Pressure regulator incorrectly adjusted or damaged. (Adjust or change regulator.)
Press in "Pump" button briefly	For leakage in fuel system (pressure side)		Pressure may drop to approx. 1.2 kp/cm^2 (16 psi) when "pump" button is released. Pressure may then drop very slowly.	**Pressure drops rapidly below 1.2 kp/cm^2 (16 psi) when "Pump" button is released:** Leakage in fuel system pressure side, pump-pressure regulator. Run up pressure again. Place pinchers (2901) on fuel hose between distributor pipe and fuel pipe from pump. If pressure ceases to drop, fault is in pump or fuel line. If pressure drops in spite of this, remove pinchers from hose, run up pressure again and place pinchers on hose between pressure gauge and pressure regulator (after having released "Pump" button). If pressure does not drop more, then pressure regulator is faulty. If pressure continues to drop, remove pinchers from hose. Run up pressure again and place pinchers on hose between distributing pipe and cold start valve. If pressure ceases to drop, fault is in cold start valve. If pressure continues to drop, fault is in one of injectors, see below.

Position of switch "B"	Operate	To measure	Indication (nominal value)	Deviation from nominal value. Possible faults and elimination
	NOTE. The following control should only be made when it is ascertained that there is a fault in one of the injectors. Remove the injectors, see page 2–46 Press in "Pump" button on the instrument and check the injectors for leakage. Then press in buttons 1, 2, 3 and 4, one after the other with the "Pump" button and check that the injectors open. Take care not to damage the injector needles. Collect the injected fuel to prevent it from making contact with a possibly hot exhaust manifold.	Function and leakage of the injectors		The valve opening may be wet, but the injector must not leak more than 5 drops per minute at 2.1 kp/cm^2 (30 psi).

Position of switch "B"	Operate	To measure	Indication (nominal value)	Deviation from nominal value. Possible faults and elimination

Switch off ignition. Connect control unit to other side of connection from instrument acc. to Fig. 2–92. Remove the pressure gauge. Fit the plug contacts on the distributor and coolant temperature sensor.

Distr. contact I Distr. contact II	Start engine and let it run at about 31.5 r/s (2000 r/m) Switch over instrument to between Z-V contacts I and II	Functioning of the triggering contacts	Instrument pointer should swing to full reading and then to average value. On switching between ZV-contacts I and II, pointer may not move more than 2 fraction marks on voltage scale	**Feed reading deviates more than 2 fraction marks:** (Replace contact kit in distributor.)

Remove instrument and fit control unit.

If the engine does not function properly or not at all in spite of the fact that the above tests did not reveal fault, test with a new pressure sensor. If the engine still does not function, test with a new control unit.

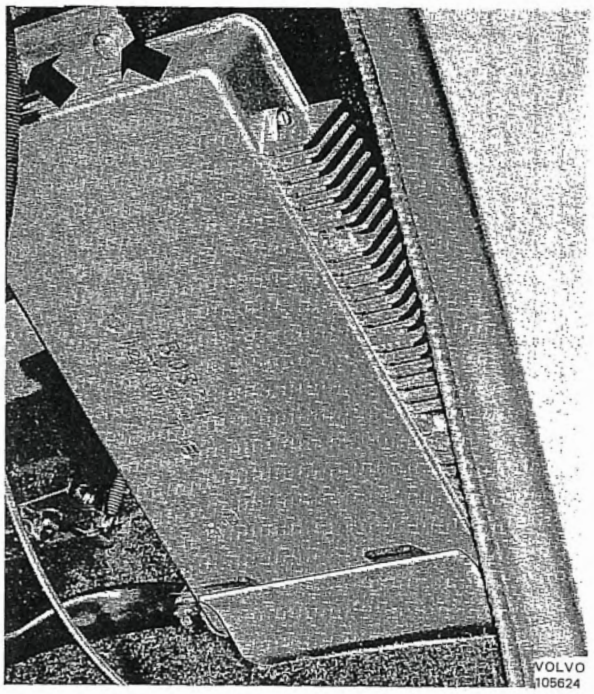


Fig. 2–93. Removing control unit

CONTROL UNIT

REMOVING

1. Disconnect the defroster hose.
2. Remove the two screws, see Fig. 2–93, which secure the control unit. Take down the control unit.
3. Remove the screw (1, Fig. 2–94) for the cap holding the cable harness to the control unit.
4. Pull out the plastic cover strip (2, Fig. 2–94).
5. Make a puller like the one shown in Fig. 2–95. Hook in the puller, see Fig. 2–96, and pull out the plug contact carefully.

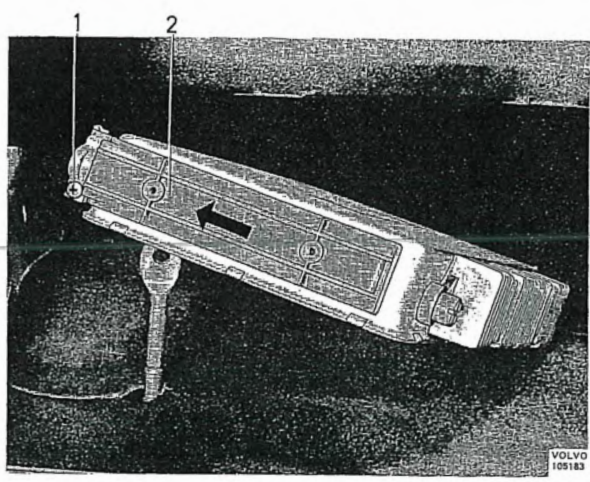


Fig. 2–94. Removing control unit
1. Screw for cap
2. Plastic cover strip

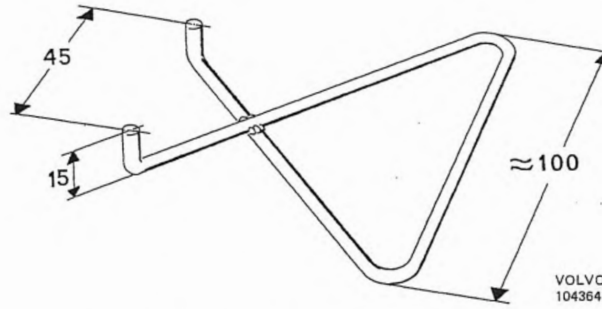


Fig. 2–95. Puller for plug contact
Material: 2 mm (5/64") welding wire

INSTALLING

1. Press the plug contact firmly into the control unit. Fit the plastic cover strip and cap.
   Check that the cable is mounted correctly.
2. Mount the control unit and fit the screws. Make sure that the control cable for the fresh-air intake is not pinched.
3. Fit the defroster hose.

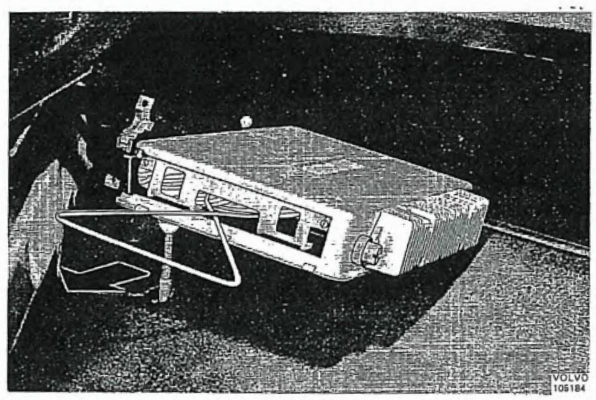


Fig. 2–96. Removing plug contact

FUEL PUMP

REPLACING

1. Remove the plug contact as well as the retainer on which the pump and filter are fitted.
2. Remove the plastic clamp holding the hoses together and clean round the pump hose connections.
3. Fit pinchers (2902) on the hose from the tank to the pump. Slacken the hose clips and remove the hoses.
4. Remove the screws holding the pump and take down the pump.
5. Fit the new pump.

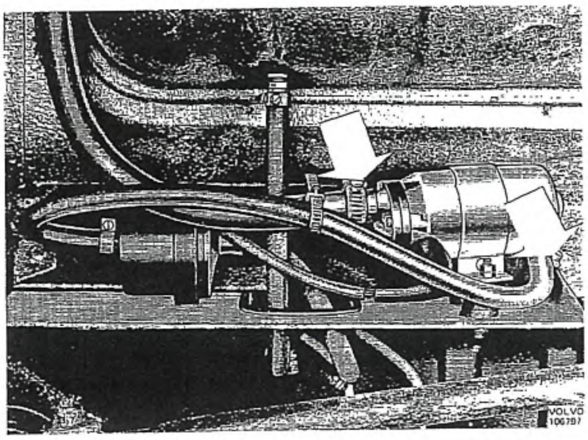


Fig. 2–97. Changing fuel pump

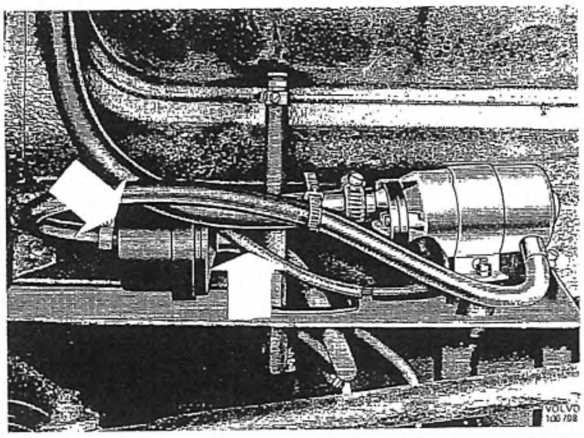


Fig. 2–98. Changing fuel filter

6. Connect the hoses to the pump and remove the pinchers.
7. Place the plastic clamp round the hoses. Fit washer and tighten screw.
8. Connect plug contact and check that pump is functioning and that the hose connections are not leaking.

CHECKING

The pump should be capable of delivering 100 litres/h (22 Imp.galls. = 26.5 US galls./h) at a pressure of 2.1 kp/cm^2 (30 psi). At this load, current consumption should be 5.0 amps.

Note. The pump is pole-sensitive. Observe due care when testing a disconnected pump.

FUEL FILTER

REPLACING (Every 20 000 km = 12 000 miles)

1. Remove the plug contact for the fuel pump and release and remove the retainer on which the pump and filter are mounted.
2. Remove the plastic clamp holding the hoses together and clean round the filter hose connections.
3. Pinch the fuel hoses to the filter with pinchers 2901. Slacken the hose clamps and remove filter.
4. Fit the new filter. Tighten the hose clamps and remove the pinchers.
   Note. Make sure that the new filter is fitted with the arrow pointing in the flow direction. Also make sure that no dirt gets in the connections for the new filter.
5. Check to make sure there is no leakage at the hose connections.
6. Place the plastic clamp round the hoses and fit the retainer.
7. Connect the plug contact to the fuel pump.

PRESSURE REGULATOR

REPLACING

1. Release the clamps at the hose connections for the pressure regulator.
2. Remove the pressure regulator by disconnecting the hoses.
3. Fit the new pressure regulator and tighten the clamps.

ADJUSTING

1. Remove the hose from the fuel pump at the distributor pipe and connect up the pressure gauge, see Fig. 2–99.
2. Run the fuel pump either by starting the engine or by connecting up test instrument Bosch EFAW 228.
3. Slacken the locknut and adjust the pressure to 2.1 kp/cm^2 (30 psi). (Replace regulator if pressure is incorrect.)

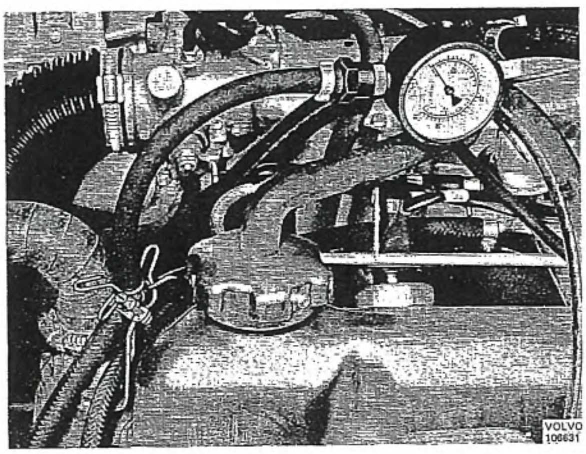


Fig. 2–99. Connecting pressure gauge

4. Disconnect the pressure gauge and connect the fuel hose to the distributor pipe.
   Check to make sure there is no leakage.

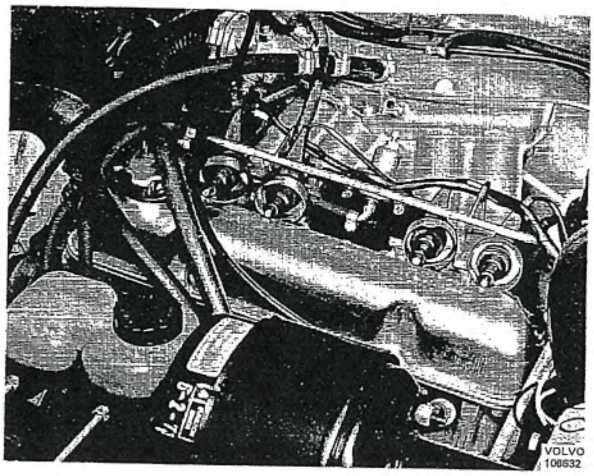


Fig. 2—101. Injectors removed for checking

INJECTORS
REPLACING

1. Disconnect the hose clips for all injectors. Remove the hoses from the retainer at the thermostat housing. Disconnect the cable harness from the distributor pipe.
2. Remove the plug contact from the injector.
   Remove the distributor pipe.
3. Turn the lock ring, Fig. 2—100, anti-clockwise so that it loosens from the bayonet fitting.
   Pull out the injector.
4. Fit the new injector and lock it securely with the lock ring.
   Fit the distributor pipe.
   Fit the cable harness to the distributor pipe and secure the plug contact to the injector.
5. Fit the hoses to the thermostat housing.
   When removing all the injectors, for example, for the purpose of checking, the hose clips need not be removed since all the injectors and distributor pipe can be lifted up at the same time, see Fig. 2—101.
   Note. The rubber ring on the injector should be replaced each time the injector is removed.

CGECKING

Measure the resistance between the terminal pins. It should be 2.40 ohms at +20°C (68°F).
NOTE. Never test an injector by connecting up 12 volts to the terminal. This would ruin the injector immediately since it only caters for a max. operating voltage of 3 volts.
Maximum leakage for the injectors is five drops per minute at 2.1 kp/cm^2 (30 psi).

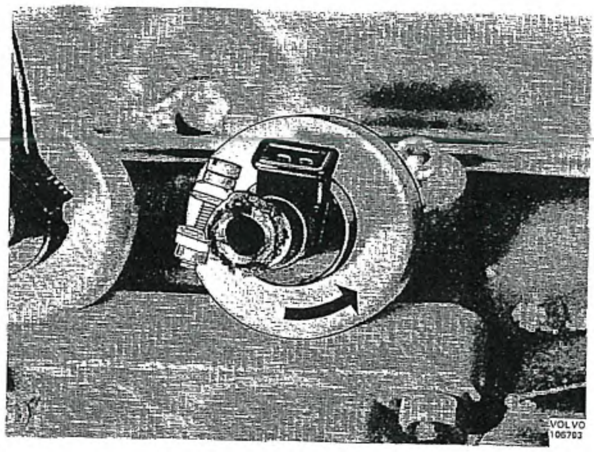


Fig. 2—100. Removing injector

COLD START VALVE
REPLACING

1. Remove the plug contact and the fuel hose from the valve.
2. Remove both the screws and lift off the valve. Fitting is in reverse order.

THROTTLE VALVE
ADJUSTING

1. Slacken the locknut (1, Fig. 2—102) for the stop screw in the throttle valve and unscrew the screw a couple of turns so that it does not lie against the stop on the throttle valve spindle. Check to make sure that the valve is completely closed.
2. Screw the screw in until it touches the stop on the throttle valve spindle. Then screw it 1/2 turn more and secure the locknut. Check to make sure that the throttle valve does not jam or stick in the closed position.
3. Adjust the throttle valve switch, see column opposite.
   NOTE. Idling must **not** be adjusted with the stop screw.

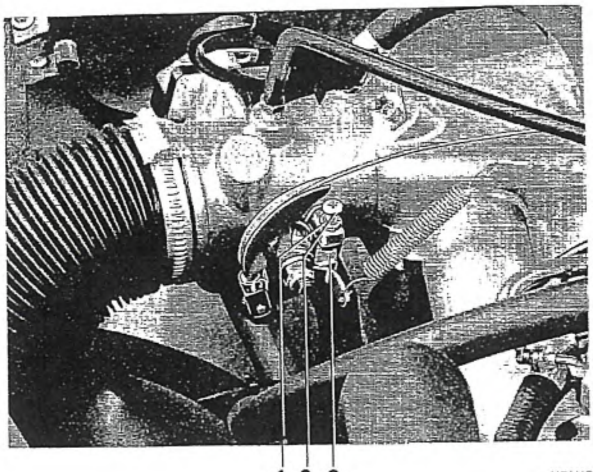


Fig. 2—102. Stop screw for throttle valve

1. Locknut
2. Stop screw
3. Stop on throttle valve spindle

THROTTLE VALVE SWITCH

REPLACING

1. Pull out the plug contact from the throttle valve switch. Remove the two screws holding the throttle valve switch to the intake duct. Pull the throttle valve switch straight out.
2. Press on the new throttle valve switch carefully. Fit the screw loosely. Connect the plug contact. Adjust the throttle valve switch according to below.

ADJUSTING

1. Connect Bosch test instrument EFAW 228, see page 2:38.
2. Set switch "A" to position "Measuring" and switch "B" to position "Throttle valve switch III".
3. Slacken the screw in order to turn the throttle valve switch. Mark the inlet duct at the upper screw if there is not one there already.
4. Turn the throttle valve switch clockwise as far as it can go. Then turn it slowly anti-clockwise until the pointer on the instrument goes over from "∞" to "0".
   Then turn a further 1° (1/2 graduation mark on scale at upper attaching screw) and secure the throttle valve switch.
5. Check to make sure that the instrument pointer goes over to "∞" when the throttle valve opens about 1°. Place a 0.50 mm=0.02" feeler gauge between the stop screw and stop the throttle valve spindle. Change to a 0.30 mm (0.014") feeler gauge, but the pointer should **not** swing to "∞".)

CHECKING

Several components are connected up for the following checks, so that it is not possible to determine with certainty whether the fault is in the throttle switch if the checks are unsatisfactory.

1. Switch on the ignition. Open and close the throttle valve slowly. Clicking sounds should come from a group of injectors to indicate that extra fuel for acceleration has been injected.

THERMAL TIMER

REPLACING

1. Drain the coolant.
2. Disconnect the electric cables.
3. Unscrew and replace the thermal timer.
4. Re-connect the electric cables.
5. Fill with coolant.

AIR CLEANER

REPLACING (every 40 000 km = 24 000 miles)

1. Remove the grille.
2. Slacken the hose clamp for the air intake.
3. Remove the wing nut and lift off the top part of the cleaner housing.
4. Take out the cleaner.
5. Clean the cleaner housing.
6. Place the new cleaner in position and screw on the top part of the cleaner housing.
7. Connect up the air intake and tighten the hose clamp.
8. Re-fit the grille.

TEMPERATURE SENSOR I (INDUCTION AIR)

REPLACING

1. Pull out the four-way plug from the sensor.
2. Change the sensor. Do not tighten the new sensor too hard.
3. Re-fit the four-way plug.

CHECKING

Measure the resistance between the terminal pins and compare with the table next page, in Fig. 2—103.

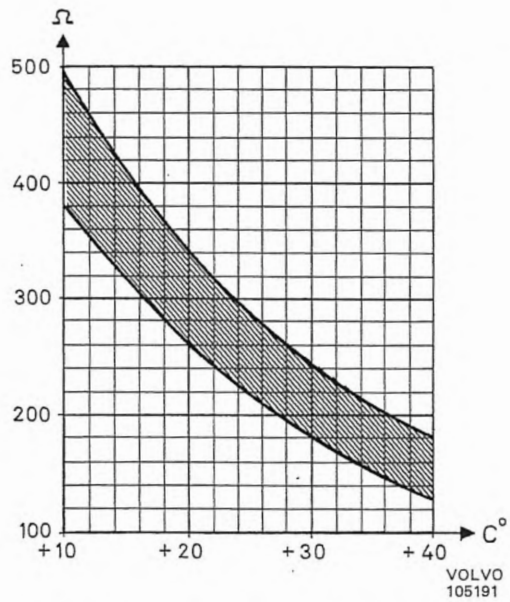


Fig. 2—103. Resistance in temperature sensor for induction air

TEMPERATURE SENSOR II (COOLANT)

REPLACING

1. Drain off the coolant.
2. Pull out the plug contact from the sensor. Screw out and replace the sensor. Do not forget the sealing ring.
3. Re-fit the plug contact and fill with coolant.

CHECKING

1. Measure the resistance between the terminal pins and compare with the table, see Fig. 2—104.

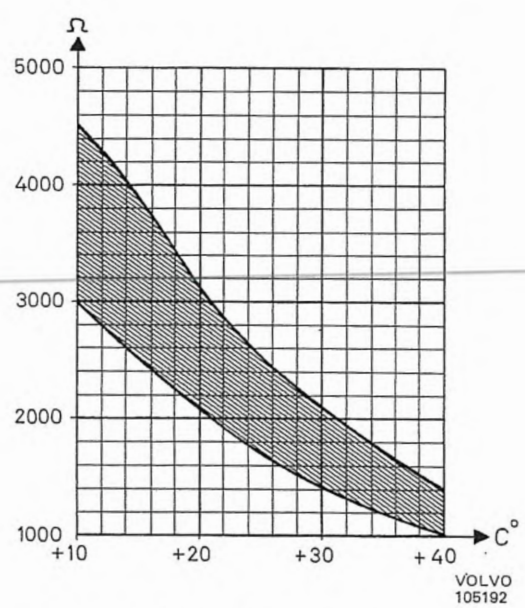


Fig. 2—104. Resistance in temperature sensor for coolant

AUXILIARY AIR REGULATOR

REPLACING

1. Drain off the coolant.
2. Remove the air hoses from the auxiliary air regulator. Unscrew the fixing screws and draw out the regulator.
3. Fit a new sealing ring and screw on the new regulator.
4. Re-fit the air hoses and fill with coolant.

CHECKING

1. Run the engine warm (approx. 86°C = 176°F). Read off the idling speed. After that pull off the hose between the inlet duct and the auxiliary air regulator. Cover the hose opening with the hand.
2. Check that the speed does not drop noticeably in relation to the first reading.
3. If it does drop noticeably, there must be a leak in the auxiliary air regulator, which should be replaced.

PRESSURE SENSOR

1. Pull out the four-way plug. Remove the hose from the pressure sensor.
2. Undo the three fixing screws holding the pressure sensor to the wheel housing.
3. Fit the new sensor on the wheel housing. Connect up the hose and re-fit the four-way plug. Note. Do not take off the protection over the hose connection until the hose has been re-fitted.

CHECKING

Measure the resistance between the terminal points. The resistance should be approx. 90 ohms between 7 and 15 (primary winding).
Approx. 350 ohms between 8 and 10 (secondary winding).
All other combinations should give "∞" resistance.

IGNITION DISTRIBUTOR TRIGGERING CONTACTS

REPLACING

1. Remove the ignition distributor.
2. Undo the two screws securing the holder and pull out the holder.
3. Apply a little grease (Bosch Ft 1 v 4 or corresponding) to the fibre deflecting pieces of the ignition breaker lever on the new holder.
4. Check to make sure the rubber rings are not damaged, replace if necessary.
5. Fit the new holder in the distributor and secure it. (It is not possible to adjust the contacts.)
6. Fit the distributor and adjust the ignition.

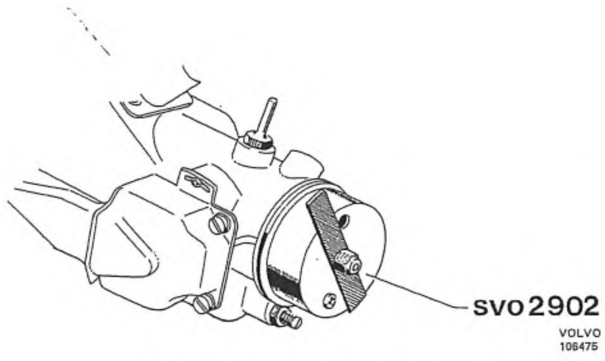


Fig. 2—105. Cover for ignition setting

ADJUSTING IGNITION

1. Connect a rev. counter and stroboscope.
2. Remove the hose for the air cleaner at the inlet duct. Disconnect the hose for the distributor vacuum control from the inlet duct.
3. Start the engine. Fit the plastic cover 2902, as shown in Fig. 2—105, and adjust down the speed to 10—13.3 r/s (600—800 r/m) by moving the bar across the hole in the plastic cover.
4. Adjust the ignition to 10° B.T.D.C. (For the adjustment, slacken the distributor housing and turn in the desired direction.)
5. Remove the plastic cover. Re-fit the hose on the vacuum governor. Re-fit the air cleaner hose.

ADJUSTING IDLING

1. Run the engine until it is warm (approx. 80°C = 176°F). Connect a rev. counter.
2. Remove the hose from the air cleaner at the inlet duct.
3. Check to ensure that the auxiliary air regulator is completely closed by pulling off the hose between the inlet duct and the regulator and by covering the opening with the hand. The speed must not differ much from the previous speed. (Engine insufficiently warm or auxiliry air regulator faulty.) Re-fit the hose.
4. Adjust the idling speed to 15 r/s (900 r/m) by means of the idle adjustment screw. (If the speed cannot be lowered sufficiently, check the basic setting of the throttle valve, see page 2—46.)
5. Re-fit the air cleaner hose.

ADJUSTING CO-VALUE

This adjustment is done at idling speed and with warm engine (80°C = 176°F).

1. Connect up a CO-meter.
2. Adjust the CO-value to 1—1.5% (Automatic 0.5—1.0%) with the adjusting screw on the control unit.
   Turning the adjusting screw clockwise increases the CO-content.

GROUP 25

COOLING SYSTEM

DESCRIPTION

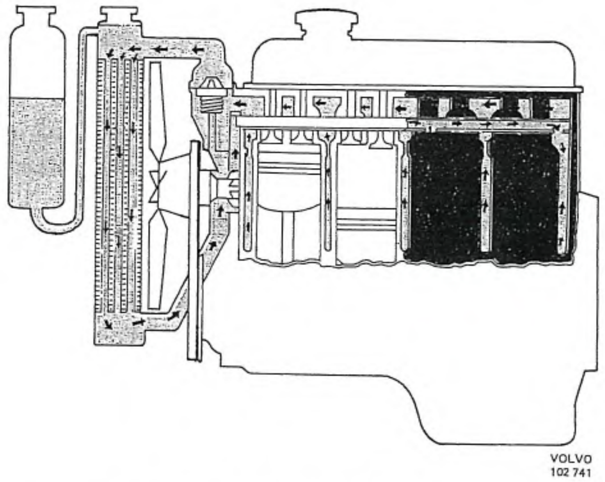


Fig. 2—106. Sealed type cooling system

GENERAL

The engine is water-cooled and the cooling system is of the sealed type, see Fig. 2—106.

The fan is a speed-regulated fan, a so-called viscous type (see Fig. 2—107).

The function is to ensure that the fan blades do not exceed a certain speed even if the engine speed is exceeded. See Fig. 2—115. The six fan blades are mounted asymmetrically to keep down the noise level. The fan coupling consists of the shroud (11, Fig. 2—107) in which the fan blades (1) are secured with the bolt (2). The shroud (11) has two halves which, however, cannot be separated for repairs, the fan coupling then being replaced complete. The hub (8) has a light fit on the water pump flange (6) and is locked by means of the center bolt (7). The hub is provided with a slip disc of friction material (9) surrounded by oil. During idling and at low speeds, the slipping is insignificant, so that the fan provides an air current for good cooling. When the ingoing speed (that of the water pump) exceeds the fan speed, the slipping increases (see Fig. 2—115). With this arrangement the fan speed should never exceed about 41.7 r/s (2500 r/m). The fan noise output would then be low compared with a fan which runs at

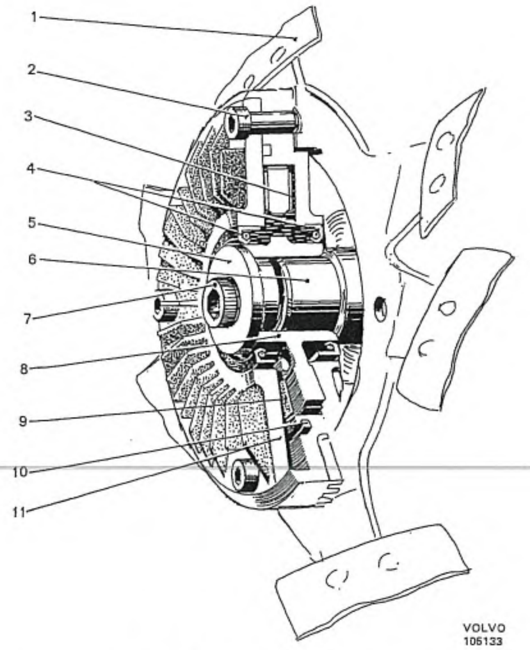


Fig. 2—107. Viscous fan

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. Shroud

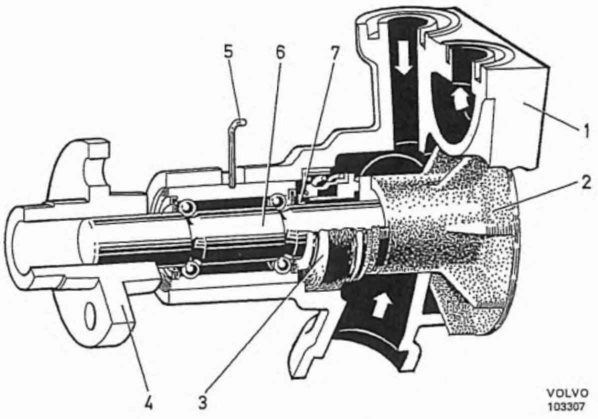


Fig. 2—108. Water pump

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

the same high speeds as the water pump. Compared with this later type of fan, the output loss will be less for the viscous type fan.

A centrifugal pump, Fig. 2—108, takes care of the coolant circulation and a twin thermostat provides rapid warming up of the engine and contributes to the engine maintaining the most suitable temperature under all operating conditions.

The cooling system has a capacity of 8.6 dm^3 (18 pints). Of this quantity, 0.6 dm^3 (1 1/4 pints) fills the expansion tank at maximum level.

In order to achieve the desired effect with the sealed cooling system, it must be well filled and not leak. As coolant, a mixture consisting of 50 % ethylene glycol and 50 % water is used all year round. This mixture provides protection against frost down to minus 35°C (minus 32°F) and should be changed every other year, on which occasion the engine, radiator and expansion tank should be flushed with clean water.

If Volvo anti-freeze for cars is used (it has a red colour), it should not be mixed with other types of anti-freeze.

COOLING SYSTEM INNER CIRCUIT (BY-PASS)

The cooling system consists of two circuits, an inner and an outer one. When the engine is warming up and in very cold weather when large quantities of heat are required for warming up the inside of the car, the coolant circulates almost exclusively through the inner circuit (the by-pass). This circuit covers the engine and car heater. The thermostat is closed, that

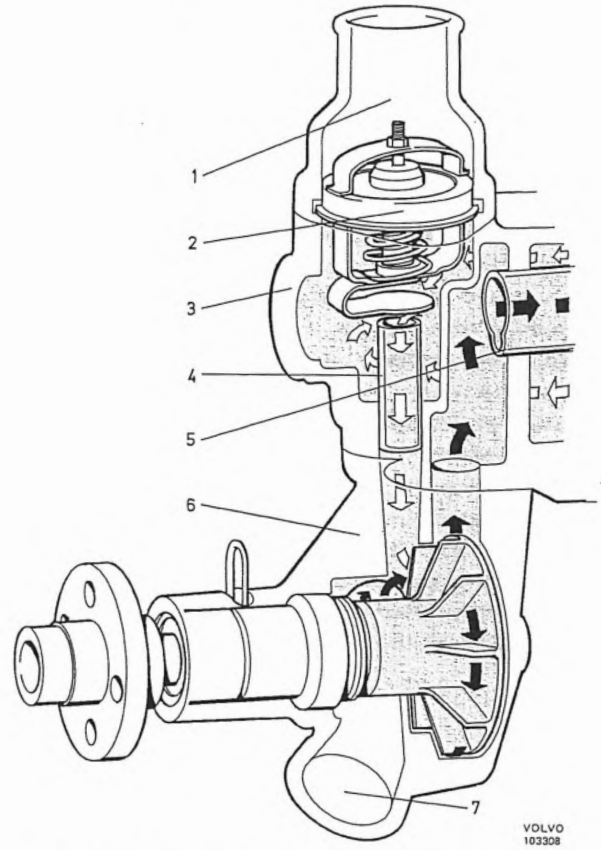


Fig. 2—109. Coolant flow, thermostat closed

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

is, the outlet to the radiator is shut off. The coolant passes through the thermostat by-pass to the distributor pipe (5, Fig. 2—109) in the cylinder head. This results in a uniform cooling of the warmest parts in the cylinder head. Even the parts around the spark plugs are also cold and thereby maintained at a constant temperature. The coolant surrounding the cylinder walls is circulated by means of thermo-syphon action.

COOLANT SYSTEM OUTER CIRCUIT

When the coolant in the inner circuit reaches a suitable temperature for the engine, the thermostat begins to open, during which time by-pass between the thermostat housing and the pump gradually closes, see Fig. 2—110.

Coolant flows from the engine into the upper part of the radiator, is cooled and then sucked by the pump out from the lower part of the radiator from where it

is conveyed into the engine through the distributing pipe.
An air cushion forms in the upper part of the expansion tank and permits the coolant to expand without involving any loss of coolant so that there is air suction at reduced temperature and volume. This arrangement ensures that the cooling system is always filled with coolant, thus minimizing the risk of corrosion. When the cooling system is being topped up, it will probably be difficult to prevent air from entering this system. The air, however, is subsequently separated and forced out into the expansion tank where it is replaced by coolant from this tank. It is, therefore, important to check the coolant level after the system has been emptied and filled with new coolant.
The expansion tank cap is provided with a valve which opens when the pressure in the system goes up to 0.7 atmospheric gauge. There is also a valve which opens when there is a partial vacuum in the system and admits air into the expansion tank.

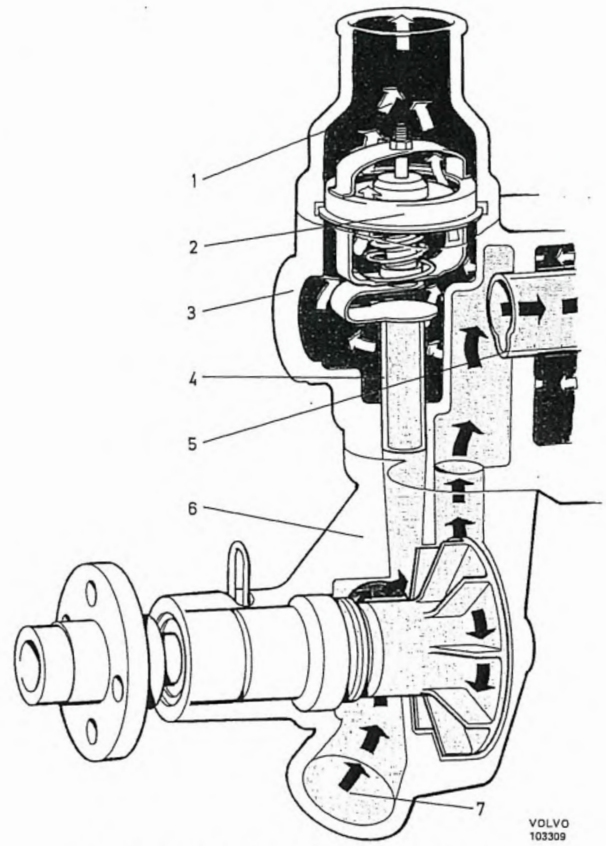


Fig. 2–110. Coolant flow, thermostat open
Concerning numbers above, see previous figure

REPAIR INSTRUCTIONS

RADIATOR
TOPPING UP WITH COOLANT

Topping up with coolant, consisting of 50 % ethylene glycol and 50 % water (all year round) is done in the expansion tank, when the level has fallen to the "Min" mark.
NOTE. Never top up with water only.

DRAINING COOLING SYSTEM

To drain the cooling system, remove the plug on the engine or oil cooler and remove the lower radiator hose. The expansion tank is emptied by first taking it off its mounting and holding it at a sufficient height so that the coolant runs into the radiator. Another way to empty the tank is by turning it upside down.

FILLING EMPTY SYSTEM WITH COOLANT

Before filling, flush the cooling system with clean water. When filling with coolant, through the filler opening on top of the radiator, the heater control should be set at max. heat. Fill the radiator to the top and fit the cap. Fill also the expansion tank to the "Max" mark or to max. 30 mm (1/8") above this mark. Run the engine for several minutes at different speeds. If necessary, top up with more coolant and then fit the expansion tank cap. After driving for a short time, check the coolant level and top up with more coolant since it takes some time before the system is completely devoid of air.

COOLING SYSTEM LEAKAGE CHECK

The cooling system is checked for leakage as follows: Connect a cooling system pressure tester to the hose for the expansion tank. Use a T-nipple and two hose pieces for this.

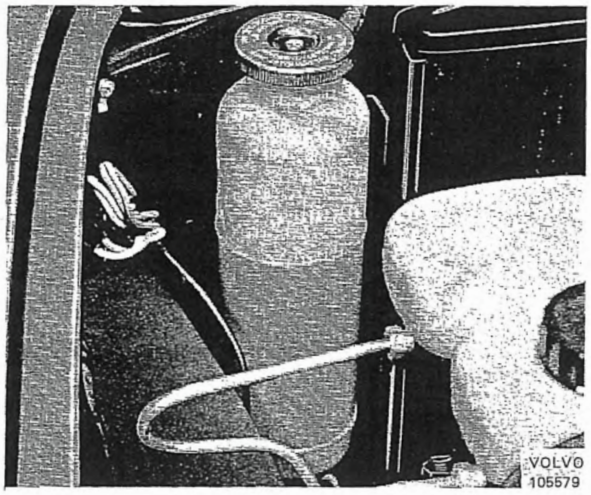


Fig. 2–111. Expansion tank

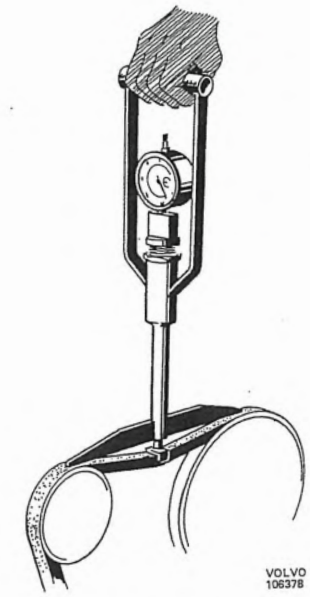


Fig. 2–112. Belt tensioner 2906

Carefully pump the pressure up to almost 0.7 kp/cm^2 (10 psi). Observe the pressure tester gauge. The pressure must not drop noticeably during 30 seconds. If it does, examine and remedy the leakage.

REPLACING RADIATOR

1. Remove the radiator cap and drain the system of coolant by disconnecting the lower radiator hose.
2. Remove the expansion tank with hose and empty out the coolant. Remove the upper radiator hose.
3. Remove the bolts for the radiator (and fan casing). Lift off the radiator.
4. Place the radiator in position and tighten the bolts for the radiator.
5. Fit the radiator hoses as well as the expansion tank with hose.
6. Fill with coolant, see under "Filling empty system with coolant". Start the engine and check for leakage.

REPLACING WATER PUMP

Remove the radiator according to the instructions given under "Replacing radiator" and screw off the water pump. Clean the sealing surfaces and re-fit the pump with new gasket. Make sure when fitting that the sealing rings on the upper side of the pump locate correctly. Also press the pump upwards against the cylinder head extension under the bolting, so that the sealing between the pump and cylinder head will be satisfactory. Make sure that the sealing rings at the water pipes are not damaged and press in the pipes thoroughly when attaching.

THERMOSTAT

After being removed, the thermostat can be tested in a vessel containing heated water. The thermostat should open and close according to the values given in "Specifications". A faulty thermostat should be discarded. Use a new gasket when fitting the thermostat.

TENSIONING PULLEY BELT

Belt tensioner 2906 can be suitably used for checking and adjustung the belt tension.

The gauge is placed on the belt as shown in Fig. 2–112. The belt must lie in the fork on the thrust rod. Push the gauge down until both ends on the stop rule lie against the belt. In this position, read off the gauge. Fig. 2–113 shows the correct values. When

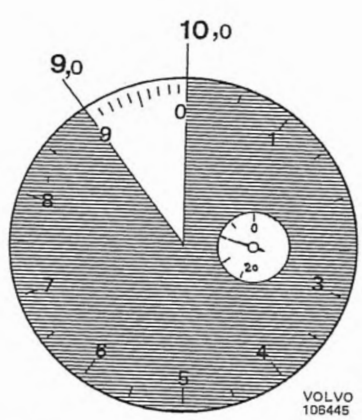


Fig. 2–113. Belt tensioning gauge values
See also table next page

adjusting the belt, use the upper max. limiting value indicated, since the tensioning slackens off somewhat after the engine has been turned over several times.
NOTE. The alternator must not be obliquely loaded. If an iron lever is used for adjusting, it should be placed between the engine and the **front end of the alternator.**
Note that if the lower alternator bolt is not slackened during adjustment, there will be heavy stresses on the drive end bearing shield.
On fitting a new belt, final tensioning should be carried out after driving for about 10 minutes. This will ensure a longer lifetime for the pulley belt.

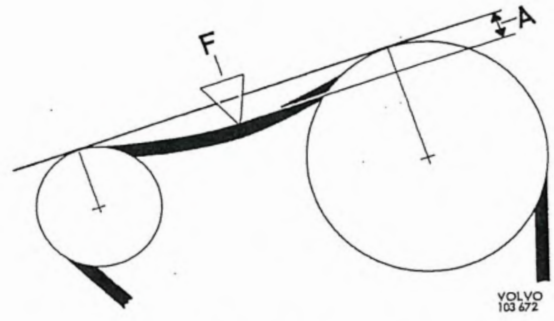


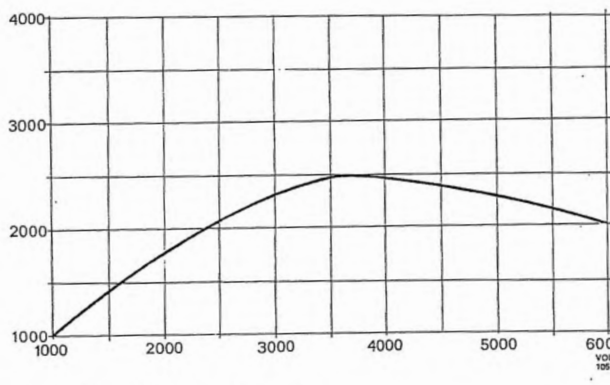
Fig. 2–114. Fan belt tension
F = See table   A = 10 mm (approx. 3/8")

Without 2906

The pulley belt is tensioned so that it can be deflected 10 mm (approx. 3/8") with a force acc. to table applied to the belt midway between the water pump pulley and alternator pulley, see Fig. 2–114. The amount of force applied will depend on the location of the bolt in the oblong slot in the tensioner. With the bolt at the end of the slot (long belt), the force applied should be the lower value; and with the bolt at the beginning of the slot (short belt), a force of the higher value should be applied. If the bolt is located anywhere between these extremes, the force applied should be proportionally within the two limits given.

FAN COUPLING

The fan coupling function can be checked with a stroboscope with variable blinking frequency. Make a mark on the fan and one on the water pump pulley. Find out the speed relationship between fan and pulley by means of the stroboscope. The fan speed should follow the speed of the water pump according to the curve given in Fig. 2–115.



Input speed, rpm (water pump)
Fig. 2–115. Curve for fan coupling slip

Fan belt tensioning

	with 2906			F
	A	B	C	N (lb)
Vehicle with l-h drive	9.0–10.0	7.5–8.0	11.0	70–100 (15.5–22)
Vehicle with r-h drive	7.2– 8.3	6.5–7.1	9.5	55– 70 (12–15.5)
Vehicle with r-h drive and air conditioning	9.0–10.0	8.8–9.3	11.0	85–100 (19–22)

A=Check value with belt tensioner gauge, 2906, new belt
B=With belt in outer position (stretched belt)
C=Value when fitting new belt
F=Depression force in N(lb) when depressing 10 mm (3/8") midway between pulleys.
(The lower value with belt in outer position, stretched.)

1. Inlet duct
2. Coolant outlet
3. Thermostat
4. Valve tappet
5. Valve spring
6. Washer
7. Valve collet
8. Exhaust valve
9. Valve tappet seal
10. Intake valve
11. Oil filler cap
12. Rocker arm
13. Rocker arm shaft
14. Spring
15. Push rod
16. Bearing bracket
17. Rocker arm casing
18. Rubber seal
19. Rubber terminal
20. Rubber seal
21. Cylinder head
22. Distributor
23. Vacuum governor
24. Condenser
25. Electrical connection
26. Flywheel casing
27. Cylinder block
28. Retainer
29. Gear wheel
30. Pilot bearing
31. Flywheel
32. Flange bearing shell
33. Sealing flange
34. Reinforcing bracket
35. Bush
36. Seal
37. Oil pump
38. Main bearing cap
39. Delivery pipe
40. Main bearing shell
41. Crankshaft
42. Piston rings
43. Connecting rod cap
44. Connecting rod
45. Camshaft
46. Connecting shell
47. Piston
48. Washer
49. Spacing ring
50. Camshaft gear
51. Crankshaft gear
52. Nut
53. Hub
54. Washer
55. Bolt
56. Pulley
57. Seal
58. Timing gear cover
59. Oil nozzle
60. Gudgeon pin
61. Fan
62. Bush
63. Coolant inlet
64. Flange
65. Intermediate piece
66. Screw
67. Washer
68. Fan coupling
69. Water pump
70. Sealing ring
71. Pulley
72. Alternator
73. Tensioner
74. Water distributing pipe

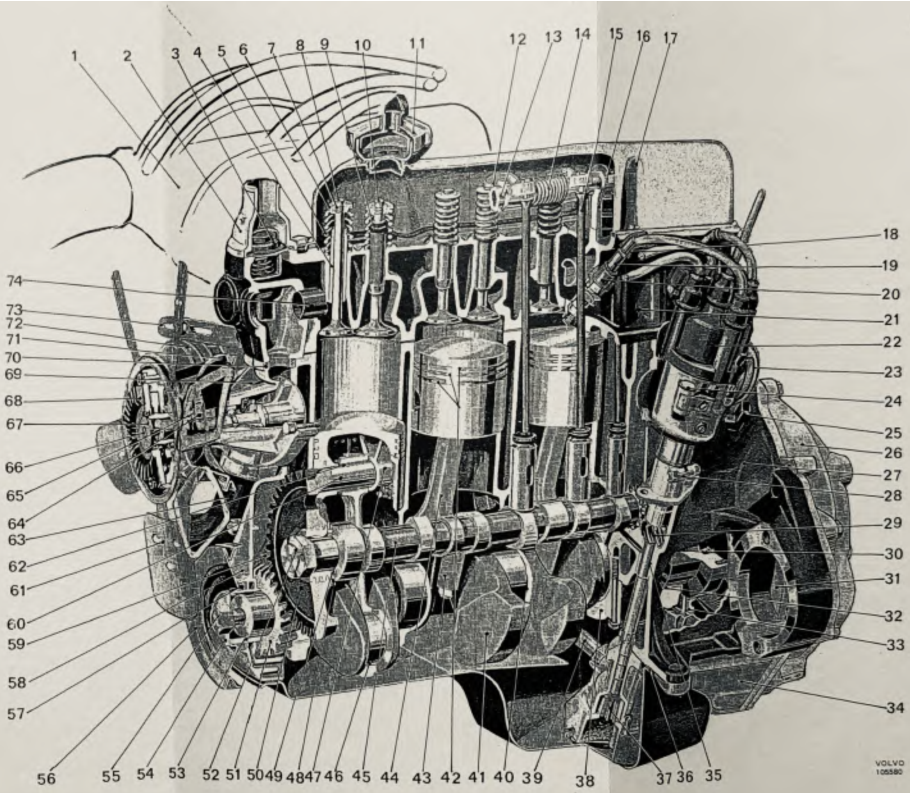


Illustration 2-A. B 20 E/F engine

Part 3

ELECTRICAL SYSTEM AND INSTRUMENTS

CONTENTS

GROUP 30

GENERAL

The electrical system is designed for a voltage of 12 V. The equipment is made up of the following main parts: Battery, alternator and voltage regulator, starter motor, ignition system, lighting, other electrical standard equipment and instruments.

GROUP 31

BATTERY

The battery, Fig. 3–1, is placed on a shelf on the firewall to the right of the engine. It is a 12 V lead battery with a capacity of 60 ampèrehours and with the negative pole stud grounded.

REPAIR INSTRUCTIONS

REMOVING

1. Remove the cable terminals on the battery terminal studs. Use a puller if the cable terminals are stuck to the terminal studs.
2. Remove the holding bar and lift out the battery.
3. Clean the battery with a brush and rinse it down with clean, lukewarm water.
4. Clean the battery shelf and the cable terminals. Use a special steel brush or pliers for the cable terminals.

INSTALLING

1. Place the battery in position.
2. Refit the holding bar and secure the battery.
3. Tighten the cable terminals to the battery terminal studs. Coat the cable terminals and battery studs with vaseline.

SERVICING

If the battery is to function satisfactorily, the acid must be maintained at the specified level above the plates. Ensure that the acid level is about 5 mm (3/16") above the plates. If the level is too low, fill with distilled water to the extent necessary. Also make sure that the battery is securely fixed and that the cable terminals are well-tightened.

The cable terminals and battery terminal studs should be coated with a light coat of vaseline to prevent exidation.

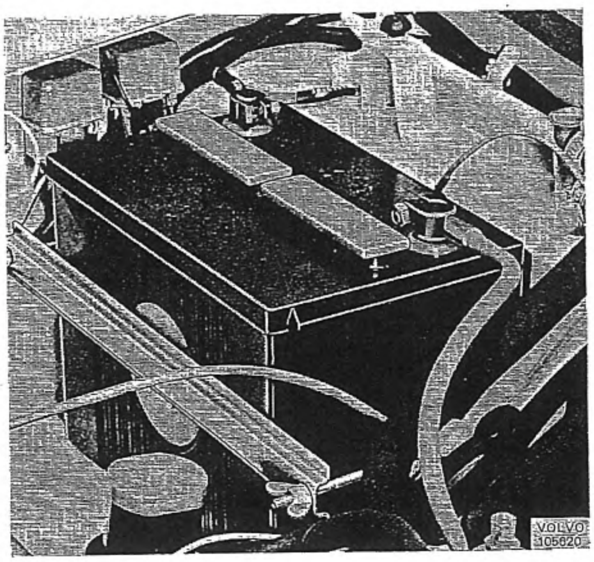


Fig. 3–1. Battery

ALTERNATOR

SEV-MOTOROLA

DESCRIPTION

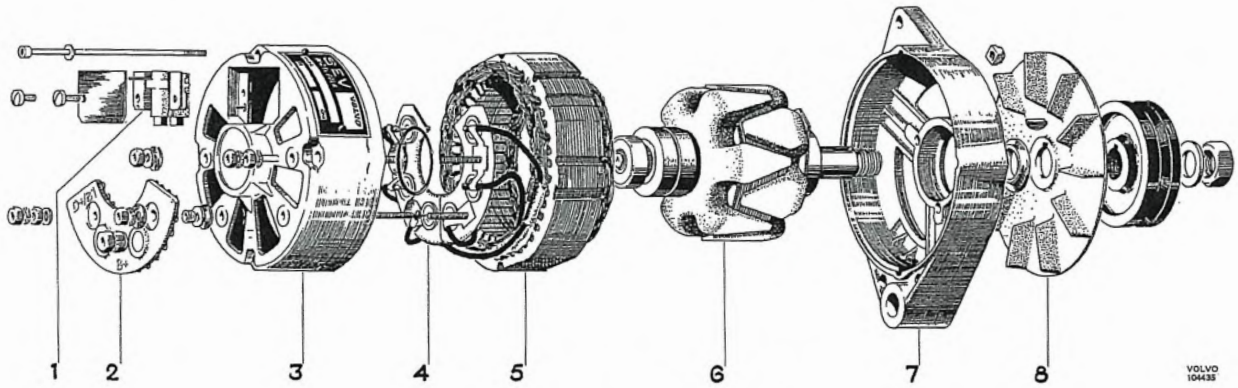


Fig. 3–2. Exploded view of alternator

1. Brush holder
2. Isolation diodes with holder
3. Slip ring end shield
4. Rectifier (silicon diodes)
5. Stator
6. Rotor
7. Drive end shield
8. Fan

The alternator is a three-phase, star-connected alternator unit which is located on the right-hand side of the engine and is driven by a V-belt from a pulley on the crankshaft.

The alternator has a rectifier built into the slip ring end shield. This rectifier consists of six silicon diodes. The alternator has a rotating field (rotor) and stationary generating windings (stator).

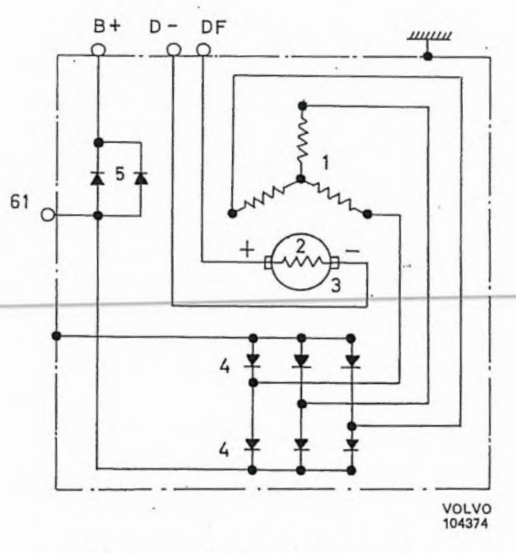


Fig. 3–3. Alternator inner circuit

1. Stator
2. Rotor (field winding)
3. Slip ring and brush holder
4. Rectifier diodes
5. Isolation diodes

The rotor is of the claw-pole type with the field windings fed over the slip rings. The construction of the rotor has made it possible for the alternator to have a max. speed of 250 r/s (15 000 rpm).

The isolation diodes (2, Fig. 3–2), which are placed on the outside of the alternator, have two functions: They prevent the battery from discharging through the regulator and alternator field, and they provide a simple menas of operating the charging warning lamp.

The alternator is self-limiting (max. 55 amps) and for this reason a simple voltage regulator can be used with only voltage control.

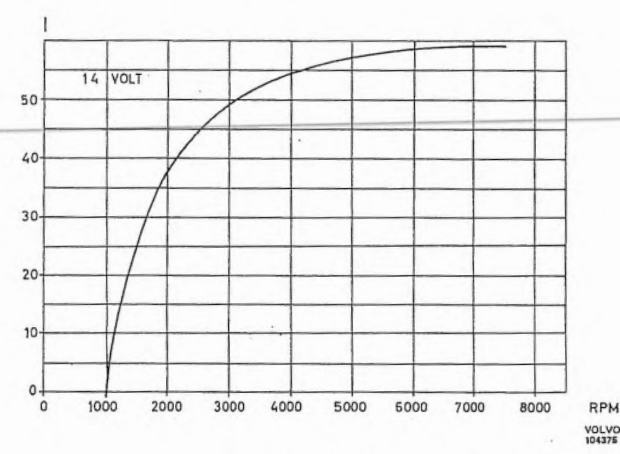


Fig. 3–4. Alternator output curve

SPECIAL INSTRUCTIONS FOR WORK ON ALTERNATOR EQUIPMENT

1. When replacing or installing the battery, make sure that the new battery is connected with the correct polarity.
2. Never run the alternator with the main circuit broken. The battery and/or alternator and regulator leads must never be disconnected while the engine is running.
3. No attempt should be made to polarize the alternator since this is not necessary.
4. When charging the battery while installed in the vehicle the negative battery lead should be disconnected.
5. A rapid charger should not be used as a help in starting.
6. When using an extra battery as an aid in starting, always connect it in parallel.
7. When carrying out any electric welding on the vehicle disconnect the negative battery lead as well as all the alternator leads. The welding unit should always be connected as near as possible to where the welding is to be carried out.

REMOVING ALTERNATOR

1. Disconnect the negative lead to the battery.
2. Disconnect the leads to the alternator.
3. Remove the bolt for the adjusting bar.
4. Remove the bolt holding the alternator to the engine block.
5. Remove the fan belt and lift the alternator forwards.

DISASSEMBLING ALTERNATOR

1. Release the two screws holding the brush holder and remove the isolation plate. Pull out the brush holder.
2. Remove the nut and washer. Lift off the pulley, fan, key and spacer washer.
3. Remove the nuts and washers on terminal 61 and the corresponding on the other side of the isolation diode. Lift off the isolation diode holder, see Fig. 3–6.
4. Mark the drive end shield, stator and slip ring end shield to avoid confusion when assembling. Remove the four attaching screws.
5. Remove the stator and slip ring end shield with the help of two screwdrivers, which are inserted in two of the sockets between the stator and drive end shield, see Fig. 3–7.

   NOTE. The screwdrivers may not be inserted deeper than 2 mm (just over 1/16"), otherwise the stator may be damaged.
6. Release the three screws holding the support plate of the drive end bearing. Release the bearing by knocking the end of the shaft against a piece of wood, see Fig. 3–8.
7. Remove the nuts and washers for the diode holders.
8. Remove the stator and diode holders for the slip ring end shield.

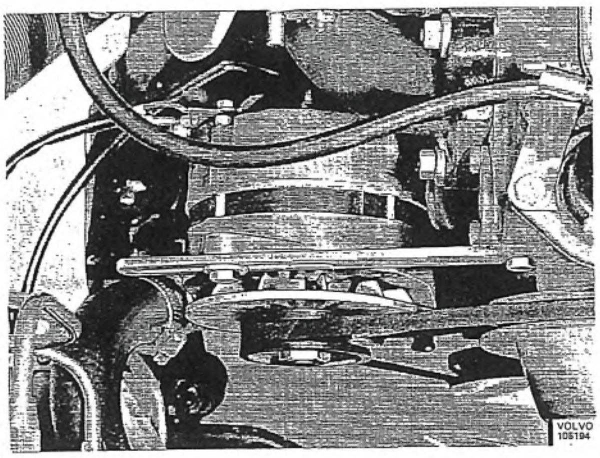


Fig. 3–5. Alternator fitted

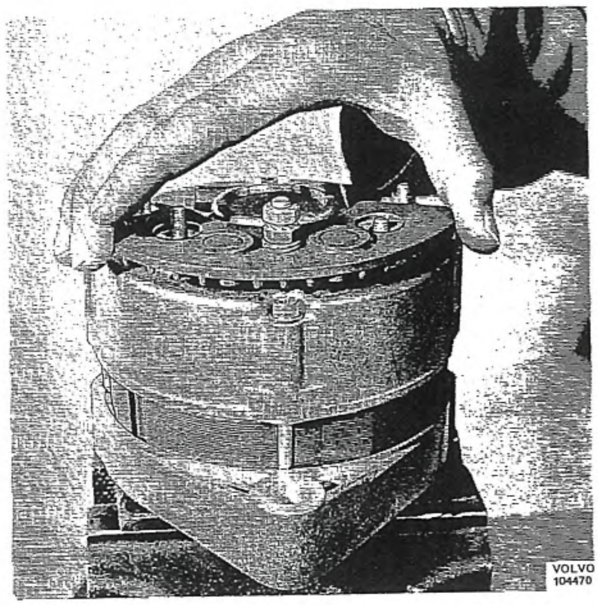


Fig. 3–6. Removing isolation diodes

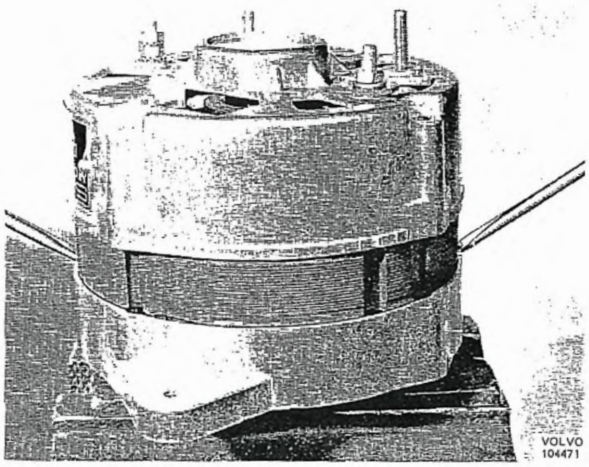


Fig. 3—7. Disassembling alternator

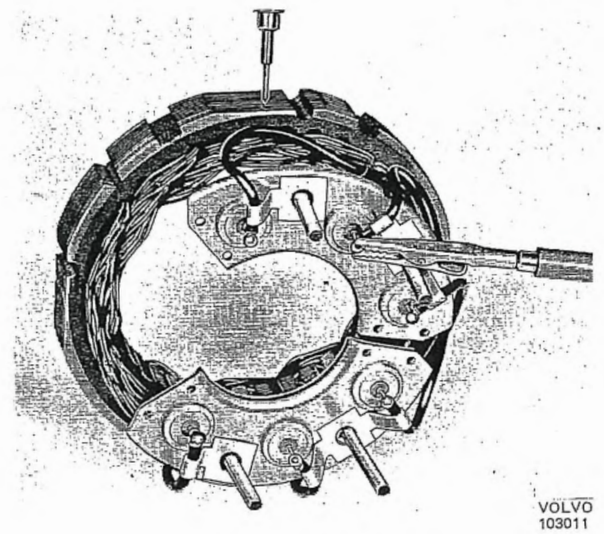


Fig. 3—9. Checking stator

CHECKING DISASSEMBLED ALTERNATOR

STATOR

Check the stator for any short-circuiting. If one or several of the coils are burnt, there must be a short-circuit in the stator. Connect a test lamp (12 V, 2—5 W) between the stator plates and a terminal on the stator, see Fig. 3—9.

If the lamp lights, the isolation between the stator winding and the stator plates must be burnt out, in which case the stator should be replaced.

NOTE: Only a 12 V, 2—5 W test lamp may be used: 110 or 220 V, D.C. or A.C. lamps may NOT be used. This applies to all the alternator components.

Check the diodes with a diode tester, see Fig. 3—10. If any of the rectifier diodes is faulty, the entire diode holder (with three diodes) must be replaced. If any of the isolation diodes is faulty, replace the holder, complete with siolation diodes.

If a diode tester is not available, the diodes should be soldered loose (see page 3—5) and tested with an ohmmeter. The diodes should have high resistance in reverse direction and low resistance in the flow direction.

ROTOR

Check to make sure that the slip rings are not dirty or burnt.

Check the winding for breakage or damaged isolation. Measure the resistance between the slip rings, see Fig. 3—12. At 25° C (77° F) the resistance should be 3.7 ohms.

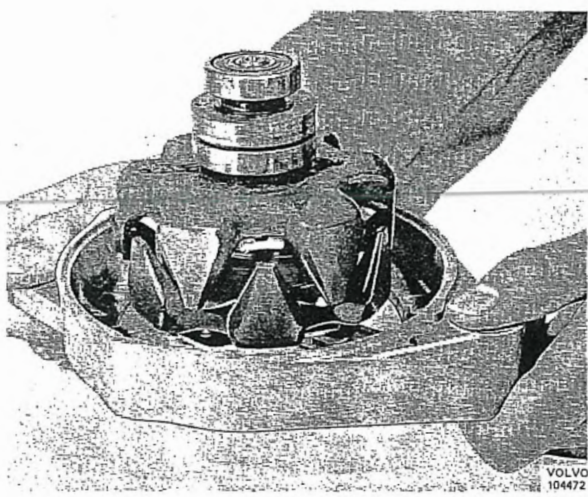


Fig. 3—8. Removing drive end shield

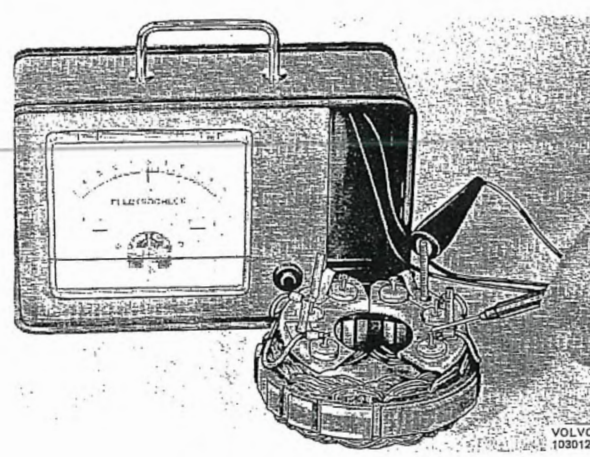


Fig. 3—10. Checking diodes

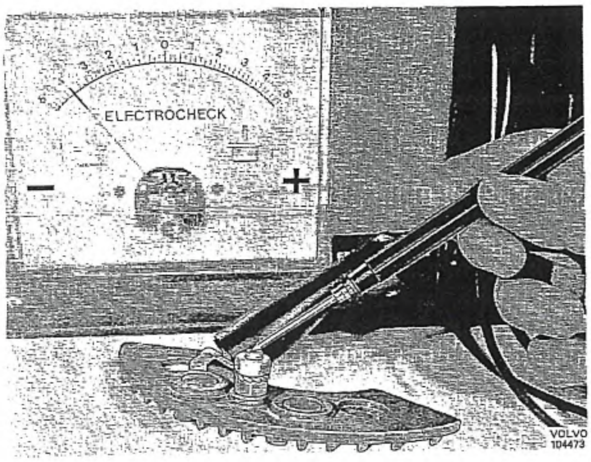


Fig. 3–11. Checking isolation diodes

If the slip rings are dirty, clean them carefully with a cloth moistened in trichlorethylene. The slip rings can also be polished with fine sand paper.
If the winding is faulty, the entire rotor must be replaced.
Check the bearings. (The bearings should always be replaced when the alternator has been disassembled.)

BRUSH HOLDER

Connect a test lamp between the brushes. The lamp must not light.
Connect the test lamp between the DF-terminal and "+" brush. The lamp should give a steady light even if the brush or the terminal cable is moved see Fig. 3–13. Connect the test lamp between the brush holder frame "–" brush. The lamp should give a

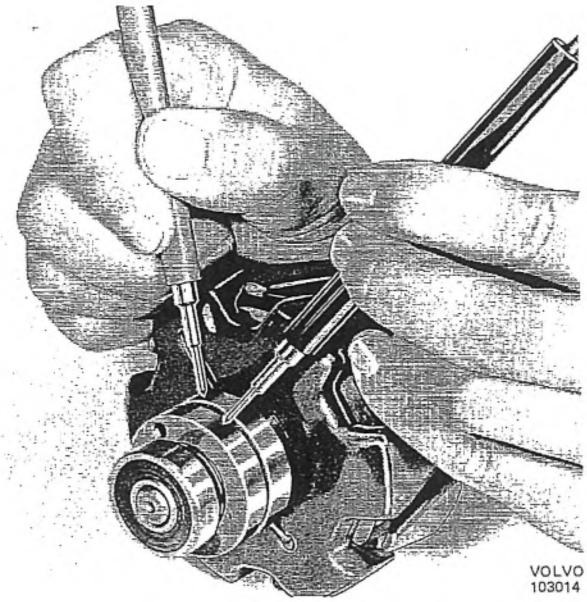


Fig. 3–12. Check-measuring rotor

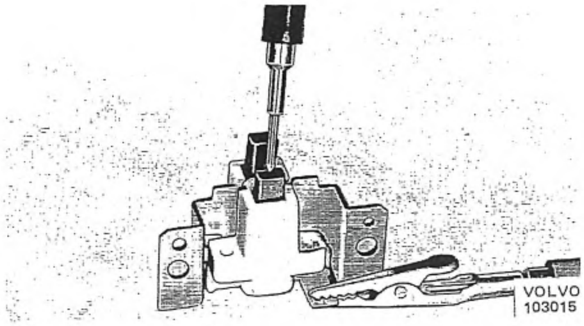


Fig. 3–13. Checking brush holder

steady light even if the brush or the terminal lead is moved.
If the brush holder does not meet the above requirements or if the brush length is less than 5 mm (approx. 3/16"), then replace the brush holder.
The brush length is measured between the brush contact surface and holder, with the brush resting against the spring, see Fig. 3–14.

REPLACING RECTIFIER DIODES

1. Mark the leads connecting the stator to the diodes. Solder loose the leads.
2. Place the new diode holder in exactly the same position occupied by the old one. Hold the outgoing diode lead with a pair of flat pliers. (This is to conduct the heat from the soldering point so as not to damage the new diode.)
3. Solder on the diodes, see Fig. 3–15.
   NOTE. The complete "+" or "–" diode holder must be replaced even if only one diode is faulty.

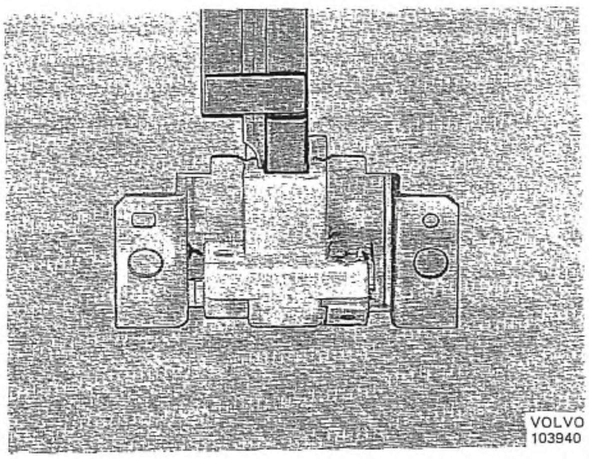


Fig. 3–14. Measuring brush length

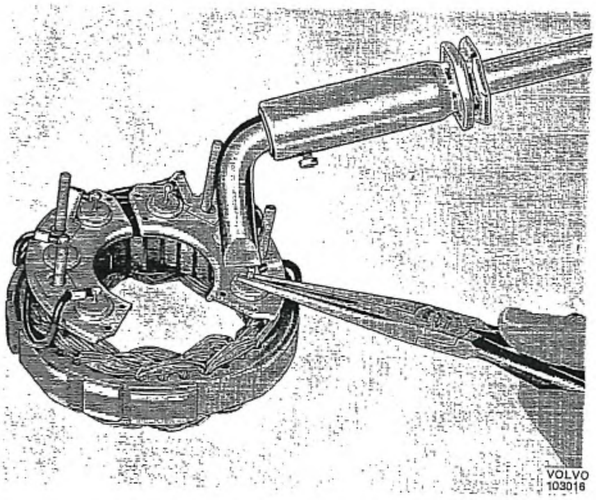


Fig. 3–15. Soldering on diodes

Use a well-heated soldering iron, minimum 100 W for the soldering.

Never change places for the two diode holders. The **positive diode holder** is isolated from the frame by means of isolation washers and sleeves and its diodes are marked in **red.**

The **negative diode holder** is not isolated and its diodes are marked in **black.**

REPLACING BEARINGS

DRIVE END SHIELD BEARING

Removing

1. Place the rotor in a vice with soft jaws.
2. Pull the bearing off with a claw puller, see Fig. 3–16.

Installing

1. Place the support plate on the rotor shaft with the three elevations facing the rotor winding.
2. Press the bearing in with the help of a tubular sleeve which presses on the bearing inner ring, see Fig. 3–17.

SLIP RING END BEARING

Removing

1. Place the rotor in a vice with soft jaws.
2. Pull the bearing off with a claw puller.

Installing

1. Press the bearing on with a tubular sleeve which presses on the bearing inner ring.

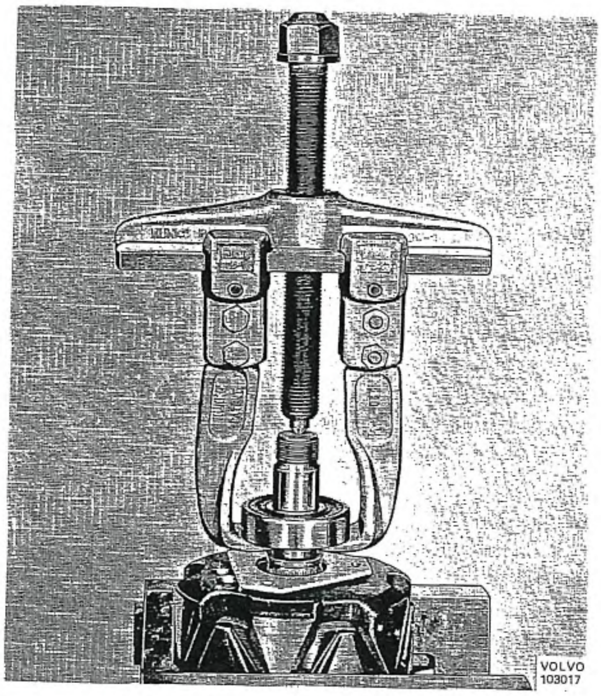


Fig. 3–16. Removing bearing

REPLACING SLIP RING END SHIELD O-RING

1. Remove the O-ring with a steel blade with rounded edges (for example, a feeler gauge), see Fig. 3–18.
2. Wash the groove clean.
   Check that the hole in the bearing shield is not blocked.

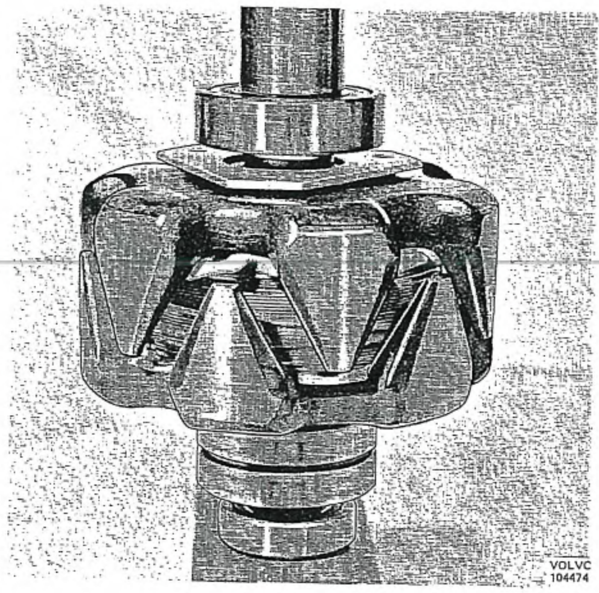


Fig. 3–17. Installing bearing

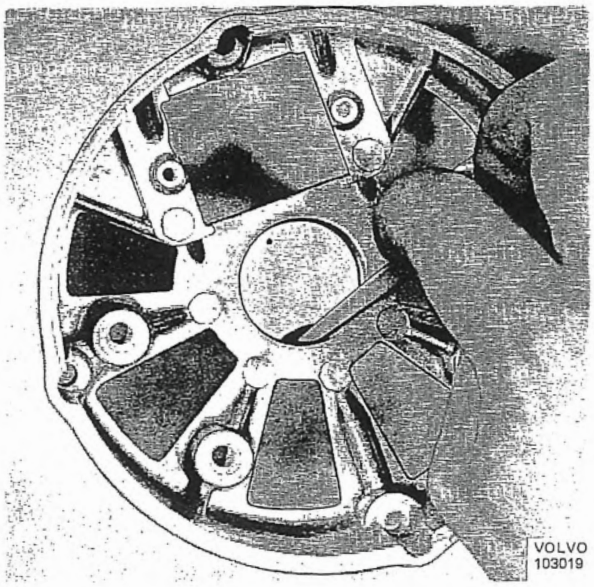


Fig. 3—18. Removing O-ring

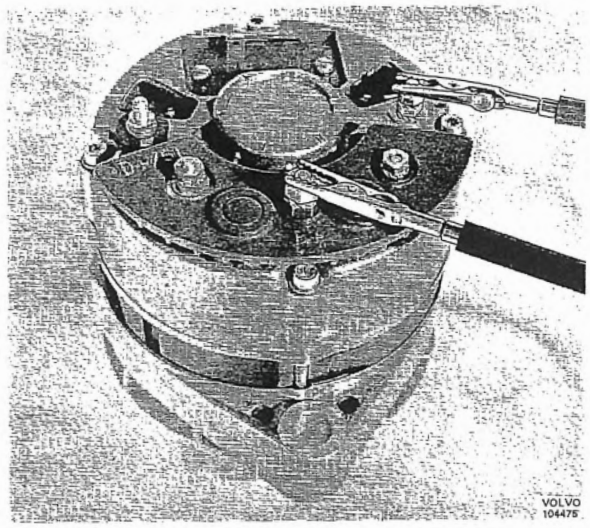


Fig. 3—19. Checking alternator

3. Fit a new O-ring.
   Lubricate the O-ring and the hole with mineral oil or similar.
   The O-ring should be replaced each time the alternator has been dismantled.

ASSEMBLING ALTERNATOR

1. Fit the stator and the diode holders in the slip ring end shield. (Do not forget the isolation washers for the positive diode holder.) Fit the nuts and washers on the negative diode holder screws.
2. Press the rotor into the drive end shield. Fit the three screws for the drive bearing support plate.
3. Fit together the rotor and stator sections.
4. Fit the attaching screws. Tightening torque 2.8—3.0 Nm (2.0—2.2 lbft).
5. Fit the plastic tube and isolation washers on the screws on which the isolation diode is to be mounted.
   Fit the isolation diode, put on the nuts and washers. Fit the brush holder.
6. Fit the spacer washer, key, fan pulley, washer and nut. Tightening torque 40 Nm (29.0 lbft).
7. Connect a test lamp between B+ and the alternator frame. Switch the terminals. The lamp should light only in one direction, see Fig. 3—9. After any repairs, the alternator should be test-run in a test bench.

INSTALLING ALTERNATOR

1. Place the alternator in position while fitting on the fan belt at the same time.
2. Fit the attaching bolts and tensioning iron without tightening up the bolts. Adjust the belt tension (see Part 2, Engine, Group 26) and secure the alternator.
   NOTE. Force may only be applied to the front end of the alternator when adjusting the belt tension. Fit the leads to the alternator.
4. Fit the battery lead.

VOLTAGE REGULATOR
DESCRIPTION

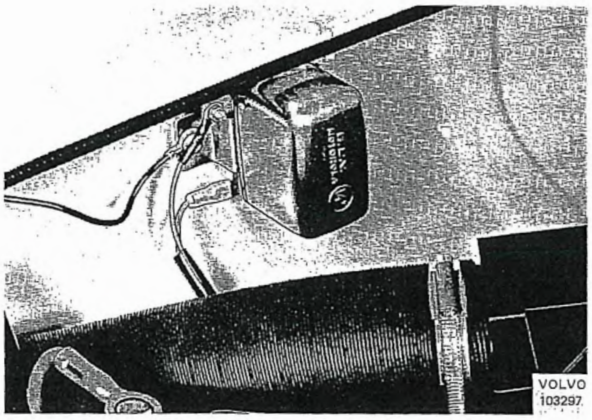


Fig. 3–20. Voltage regulator installed

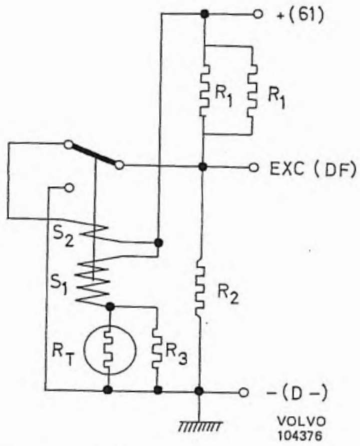


Fig. 3–21. Inner wiring of regulator

	Voltage winding
S2	Acceleration winding
R1	Regulator resistances (2) 10 Ω ± 10%
R2	Damping resistance 30 Ω ± 10%
R3	Compensation resistance (adapted to RT during manufacture)
RT	Compensation thermistor approx. 4 Ω at 25°C (17°F)

The regulator, Fig. 3–20, is a twin contact type with a fixed upper contact, a movable contact and a fixed lower one. The movable contact is attached to an armature which is actuated by a voltage coil. The regulator also houses four resistors and one thermistor.

FUNCTION

When the ignition key is switched on, current flows through the charging warning lamp to + (61) on the regulator. It is then conducted via the regulator through the field winding to earth.

When the alternator starts rotating, alternating current is formed in the stator. This alternating current is rectified by the silicon diodes and the direct current produced is re-fed via the regulator to the field winding until the regulating voltage has been reached.

When the regulating voltage has been reached the armature is attracted by the coil. This causes the contacts to open and the field current must pass the resistances R1, Fig. 3–21.

If in spite of this, the voltage rises, the armature is drawn further down and the movable contact meets the lower contact so that the field winding is earthed at both ends, this causing the voltage to drop rapidly. The cycle is repeated continuously so that the voltage im maintained constant.

TESTING ALTERNATOR AND VOLTAGE REGULATOR

GENERAL

Fixed clamps should be used for all testing of the alternator equipment. So-called crocodile clamps should not be used as they have a certain tendency to loosen. A loose lead can result in the alternator and regulator being damaged. When about to connect up instruments, disconnect the battery first.

CHECKING ALTERNATOR CIRCUIT

Before carrying out any tests on the alternator or regulator in the vehicle check the battery and vehicle wiring system for damaged leads or insulation, loose or corroded lead terminals and poor earthing. **Check the fan belt** (see Part 2, Engine, Group 26). Any of the above faults must be remedied before the electrical checks can be started.

TESTING BATTERY

Test the battery with a hydrometer and battery tester. If the battery is not fully charged, remove it from the car and charge it or replace it with a new one if necessary. A fully charged battery which is otherwise in good condition should always be used when testing.

CHECKING VOLTAGE DROP

This test is made to check the leads between the alternator and the battery and also the battery earth lead. The test should be carried out with a fully charged battery in good condition. The battery terminals should be well cleaned and tightened. Load the alternator with about 10 amps. Suitable load: Mainbeam lights switched on. With the engine running and the alternator supplying 10 amps, measure with a suitable voltmeter the voltage between the positive pole of the battery and B+ on the alternator. If the voltage at this this test exceeds 0.3 volt, there is a fault in the lead or contact, which must be remedied immediately. After repairing the leads or contacts, measure once again. With the same load as above, measure the voltage drop between the negative pole of the battery and the alternator terminal D–. Here the voltage drop must not exceed 0.2 volt. If the voltage drop exceeds 0.2 volt, check the battery earth lead, the alternator contact with the engine and the engine contact with the chassis. After making the necessary repairs measure again.

CHECKING ALTERNATOR

(In a test bench or in the vehicle)

Connect up the alternator as shown in Fig. 3–22. Check that the current through the field winding (ammeter C) is 3–3.5 amps. (If the current is not the correct one, then check the brush holder and field winding.) Run the alternator to a speed of 50 r/s (3000 r/m) (engine speed 25 r/s = 1500 r/m).

The alternator should then produce at least 48 amps at 14 volts. (A further load may be connected up in order to maintain the voltage at 14 volts.) This applies to a warm alternator and an ambient temperature of 25° C (77°F).

Measure the voltage at B+ and 61 when the alternator charges.

The voltage should be 0.8–0.9 volt more than at terminal 61, otherwise the isolation diodes are faulty and should be replaced.

CHECKING VOLTAGE REGULATOR

(In a test bench or in the vehicle)

Connect up the alternator and regulator as shown in Fig. 3–23. Run the alternator at about a speed of 83.2 r/s (5000 r/m) (engine speed 41.6 r/s = 2500 r/m) for 15 seconds. Then read off the voltage on the voltmeter. With no load on the alternator, the voltmeter should read 13.1–14.4 volts with the regulator ambient temperature at 25°C (77°F).

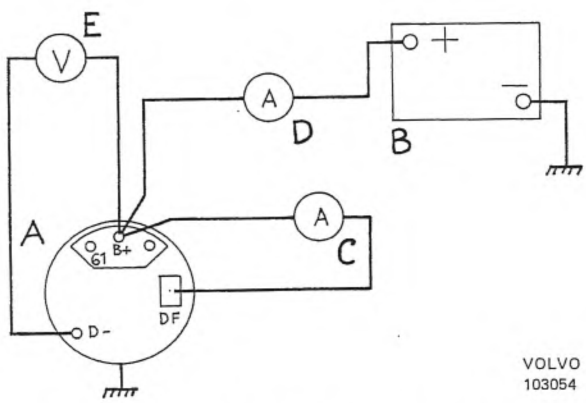


Fig. 3–22. Wiring diagram for testing alternator

A Alternator
B Battery 60 Ah
C Ammeter 0–10 amps
D Ammeter 0–50 amps.
E Voltmeter 0–20 volts

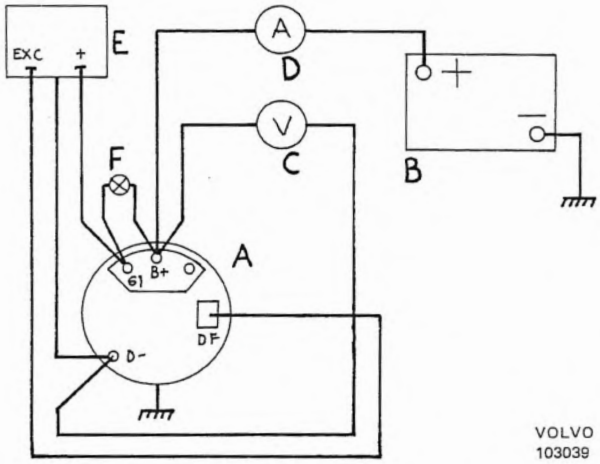


Fig. 3—23. Wiring diagram for testing voltage regulator

A Alternator
B Battery 60 Ah
C Voltmeter 0—20 amps.
D Ammeter 0—50 amps.
E Voltage regulator
F Warning lamp 12 volts. 2 watts

Load the alternator with 10—15 amps. for example, full-beam headlights, and read off the voltage. The voltage should also lie on this occasion between 13.1—14.4 volts. For ambient temperatures other than 25°C (77°F), see the diagram in Fig. 3—24.

If the voltage is outside the tolerance limits, the regulator should be replaced.

If the voltage regulator is to be tested more accurately, install it in the vehicle which should then be driven for about 45 minutes at a speed above 50 kmph (30 mph).

The reason for the driving is to enable the regulator to obtain the correct working temperature.

NOTE. The vehicle must be driven. It is not sufficient just to have the engine idling.

Immediately after, or preferably during driving, measure the voltage between B+ and D— on the alternator. The engine should be turning over at about 25 r/s (1500 r/m) (50 r/s = 3000 alternator r/m) when the measuring is being carried out. When the regulator ambient temperature is about 25°C (77°F), the voltage should be 13.85—14.25 volts. For other ambient temperatures, see Fig. 3—25.

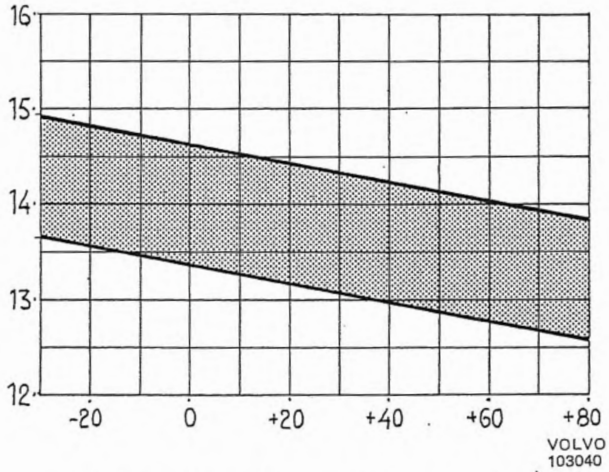


Fig. 3—24. Voltage-temperature diagram for cold voltage regulator

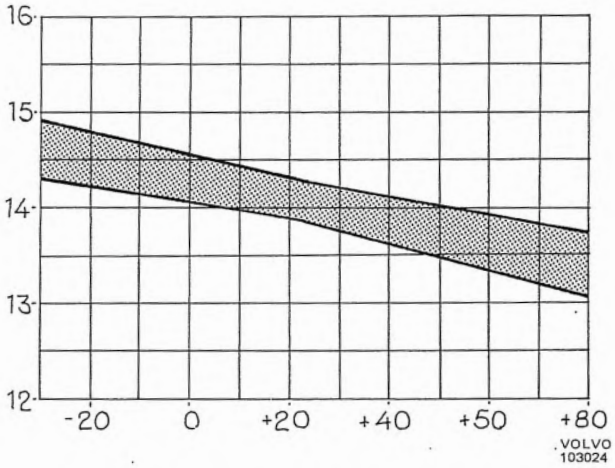


Fig. 3—25. Voltage-temperature diagram for warm voltage regulator

FAULT TRACING

FAULT	REASON
Alternator does not charge	Worn or insufficiently tensioned fan belt. Breakage in charging circuit. Worn brushes. Breakage in rotor winding. Breakage in isolation diodes. Faulty regulator.
Charging weak or irregular.	Worn or insufficiently tensioned fan belt. Intermittent breakage in charging circuit. Worn brushes. Breakage or short-circuiting in one or several rectifier diodes. (Breakage in a diode reduces the charging current about 5 amps. Short-circuiting in a diode limits the alternator charging current to 7–8 amps and causes a rumbling sound in the alternator.) Partial short-circuiting in the rotor. Breakage or short-circuiting in the stator. Faulty regulator.
Too high charging.	Faulty regulator. Faulty terminals on regulator or alternator. Short-circuiting in isolation diodes.
Noise in alternator.	Worn fan belt. Loose pulley. Worn bearings. Short-circuiting in one or several rectifier diodes. Alternator pulley incorrectly aligned in relation to the crankshaft pulley.
Charging warning lamp glows	Voltage drop in fusebox.

ALTERNATOR

BOSCH

DESCRIPTION

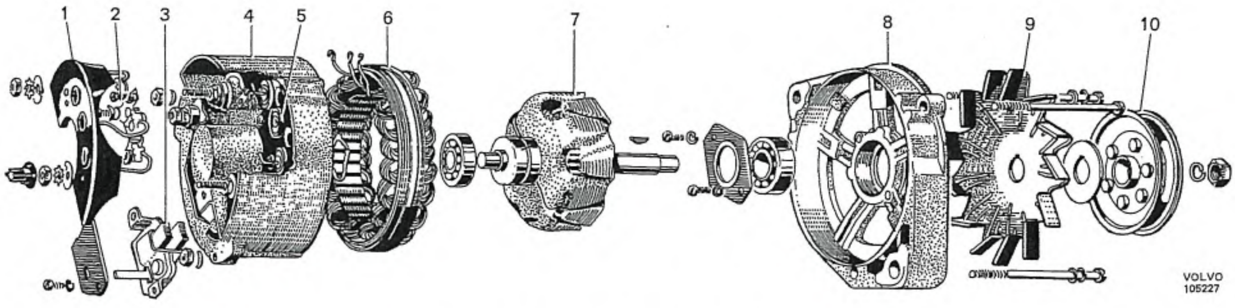


Fig. 3–26. Alternator dissassembled

The alternator is a three-phase, star-connected alternator unit. It has a rectifier built into the slip ring end shield and is made of six silicon diodes. The drive end shield houses three magnetizing diodes which feed the field winding via the charging regulator. The alternator differs from a dynamo in that it has a rotating field winding (rotor) and a stationary main winding (stator).

The rotor is of the claw-pole (12-pole) type with the field winding fed across two slip rings.

The alternator is self-limiting (max. 55 amps) and for this reason a simple voltage regulator can be used with only voltage control.

FUNCTION ALTERNATOR–VOLTAGE REGULATOR

When the ignition is switched on, current flows through the warning lamp to D+ on the voltage regulator. The current is in circuit via the governor to the field winding and then to ground.

When the rotor rotates, alternating current forms in the stator. The main part of the current is rectified by plus and minus diodes and is conducted via B+ on the alternator to the battery. A small part of the current is rectified by the magnetizing diodes and is conducted via 61/D+ to the charging regulator and then to the field winding. This cycle is repeated until a control voltage has been reached, at which point the

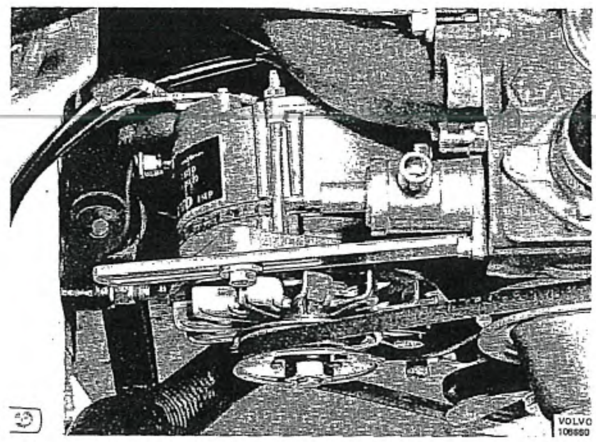


Fig. 3–27. Alternator installed

lower contacts on the charging regulator open (see 1, Fig. 3—50), and the field current is forced to pass the control resistance. If the voltage rises further, the armature on the voltage pole is drawn further down and this closes the upper contacts (see 2, Fig. 3—50), so that the field winding is grounded at both ends and the voltage drops. This cycle is repeated continuously so that voltage is maintained constant.

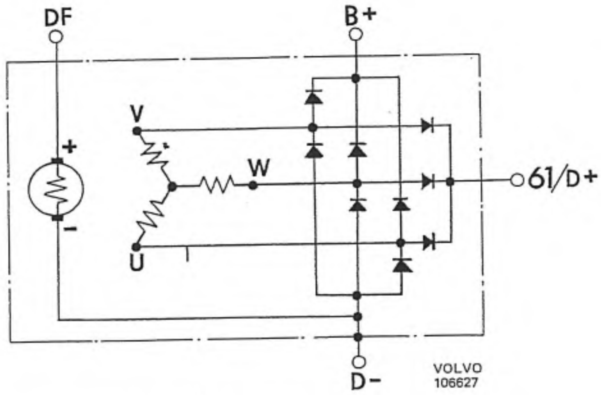


Fig. 3—28. Alternator inner circuit

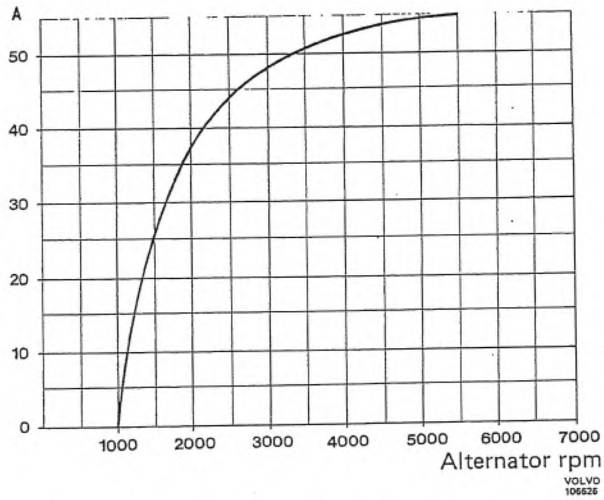


Fig. 3—29. Alternator output curve

REPAIR INSTRUCTIONS

SPECIAL INSTRUCTIONS FOR WORK ON ALTERNATOR EQUIPMENT

1. When replacing or installing the battery, make sure that the new battery is connected with the correct polarity.
2. Never run the alternator with the main circuit broken. The battery and/or alternator and regulator leads must never be disconnected while the engine is running.
3. No attempt should be made to polarize the alternator since this is not necessary.
4. When charging the battery while installed in the vehicle, the negative battery lead must be disconnected.
5. When using an assist battery as in aid in starting, always connect it in parallel.
6. When about to carry out any electric welding work on the vehicle, disconnect the negative battery cable and B+ on the alternator, also pull the plug out of the charging regulator. The welding unit should always be connected as near as possible to where the welding is to be carried out.

REMOVING ALTERNATOR

1. Disconnect the negative lead to the battery.
2. Disconnect the leads to the alternator.
3. Remove the bolts for the adjusting bar.
4. Remove the bolt holding the alternator to the engine block.
5. Remove the fan belt and lift the alternator forwards.

DISASSEMBLING ALTERNATOR

1. Remove the nut and washer for the pulley and pull off the pulley and fan impeller. Remove the key.

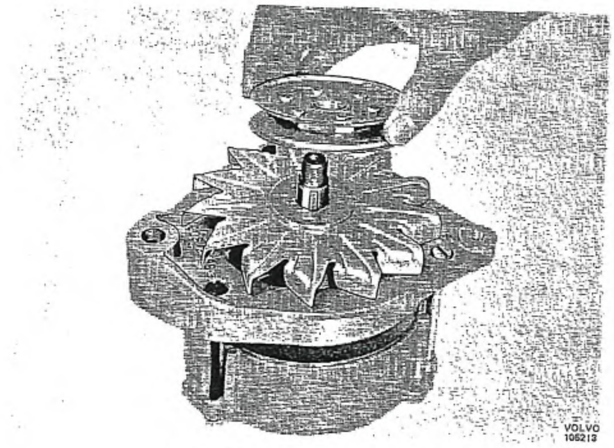


Fig. 3–30. Removing pulley

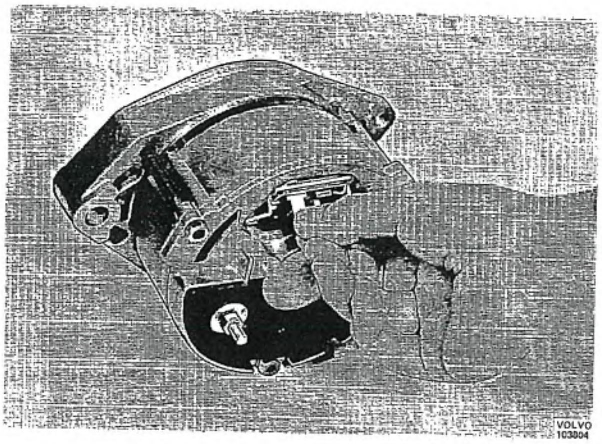


Fig. 3–31. Removing brush holder

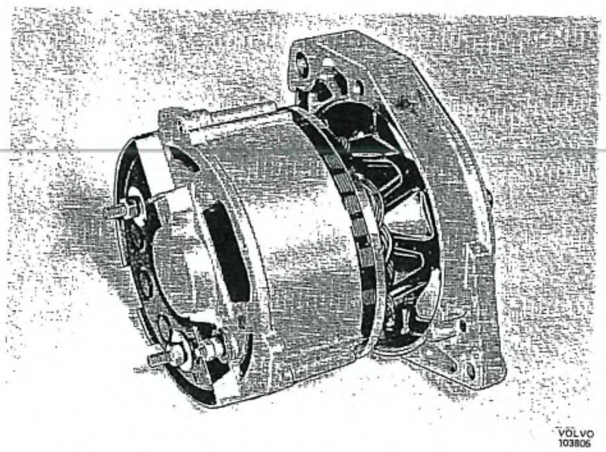


Fig. 3–32. Removing rotor and slip ring end shield

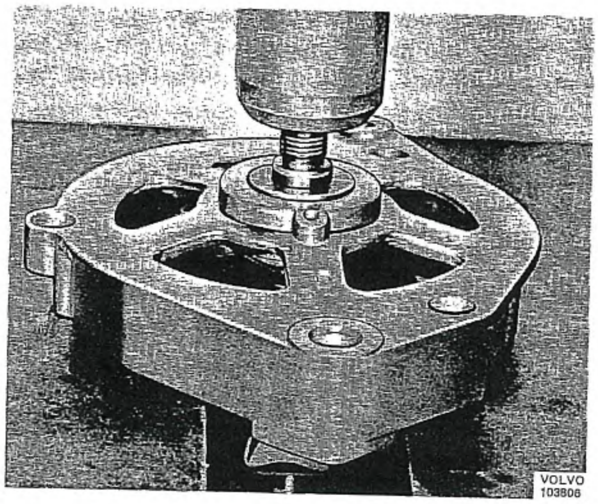


Fig. 3–33. Removing rotor

2. Remove the screws for the brush holder and take off the holder, see Fig. 3–31.
3. Remove nuts, washers and screws holding the alternator together and remove the slip ring end shield and rotor from the stator and drive end shield.
4. Press the rotor out of the slip ring end shield, see Fig. 3–33.
5. Remove the screws for the washer holding the slip ring end shield bearing and press out the bearing.
6. Remove the nuts for the plus diode plate and lift up and bend to the side the plate.
7. Solder loose the stator connections from the connection points and lift off the stator.

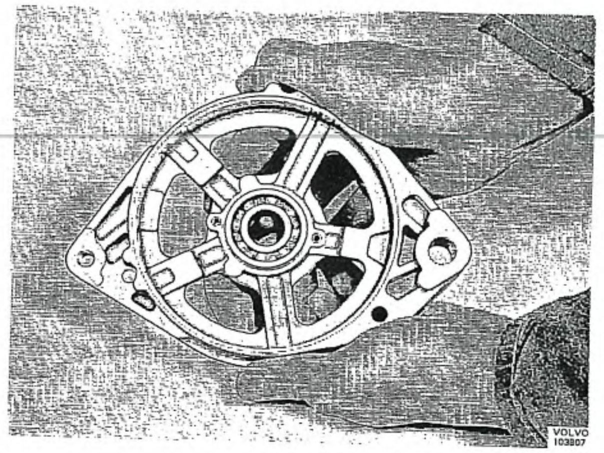


Fig. 3–34. Removing slip ring end shield bearing

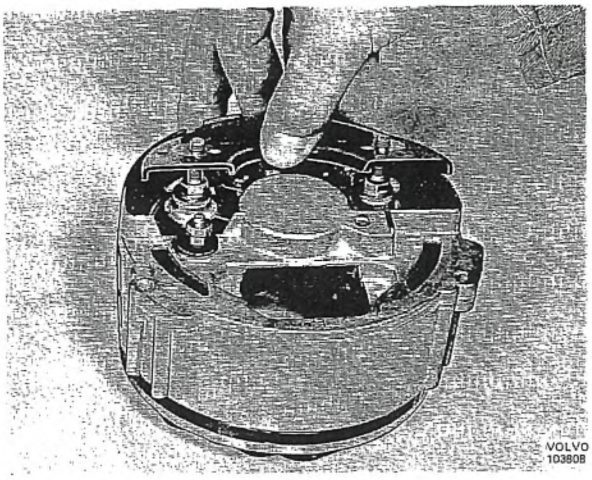


Fig. 3–35. Removing positive diode plate

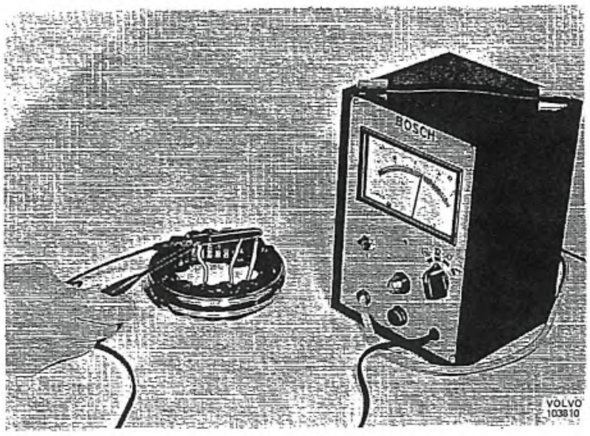


Fig. 3–37. Checking stator resistance

CHECKING DISASSEMBLED ALTERNATOR

Stator

Check the stator insulation by connecting 40 volts alternating current between frame and a phase lead. Check the stator for damage by measuring the resistance between the phase leads, see Fig. 3–37. The resistance should be 0.14 ohm + 10%.

Rotor

Check the rotor insulation by connecting 40 volts alternating current between rotor frame and a slip ring, see Fig. 3–38.

Measure the resistance between the slip rings.

The resistance should be 4.0 ohms + 10%.

If the slip rings are burnt or damaged they can be turned. At tailstock chuck should be used when turning.

The minimum diameter for the slip rings is 31.5 mm (1 1/4").

After turning, check the slip rings with a dial indicator for out-of-roundness. Max. permissible out-of-roundness is 0.03 mm (0.0012").

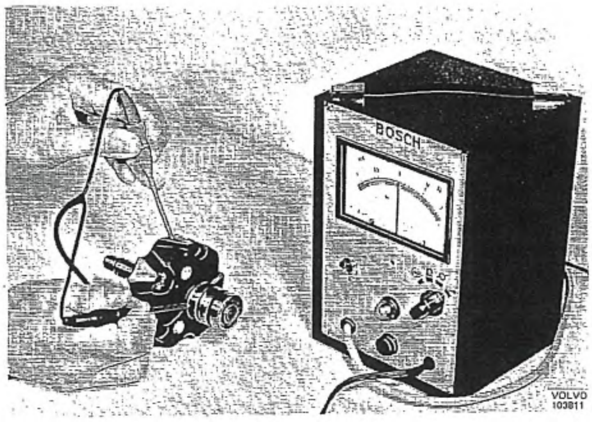


Fig. 3–38. Checking rotor insulation

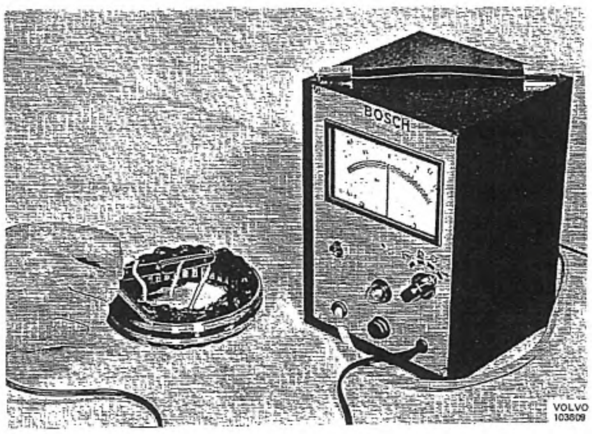


Fig. 3–36. Checking stator insulation

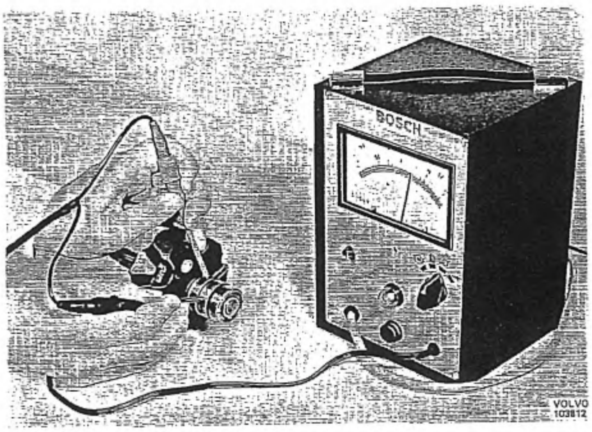


Fig. 3–39. Checking rotor resistance

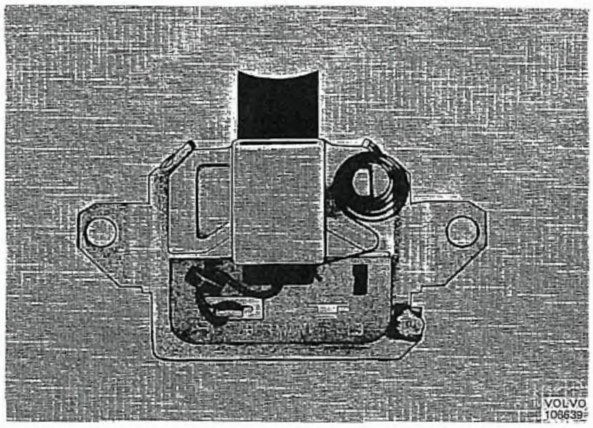


Fig. 3–40. Checking brush length.

Brush holder

Check the brush holder insulation with 40 volts alternating current. Measure the brush length with brush removed from the retainer. Minimum length 14 mm (9/16").

Diodes

Check the diodes with a diode tester. Faulty diodes should be replaced as follows:

REPLACING DIODES

Positive diodes

1. Solder loose the positive diode plate from the connection points. Press out the faulty diode with a suitable drift.

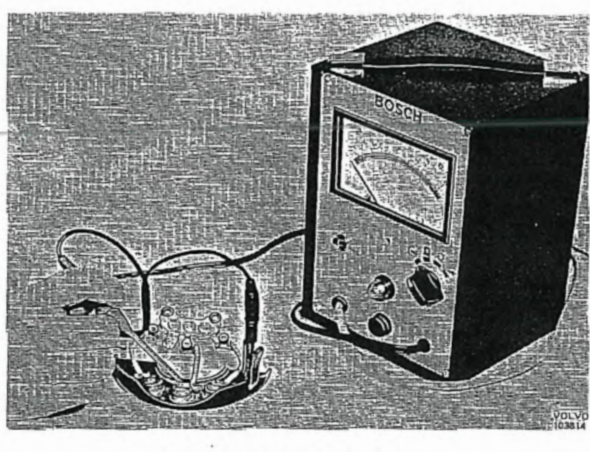


Fig. 3–41. Checking diodes

2. Calibrate the hole in the positive diode plate with a suitable tool (e.g. Bosch EFLJ 57/0/3 and 57/0/5).
3. Oil the new diode with silicon oil (e.g. Bosch 0163V2) and press it in with a suitable tool.
4. Paint the new diode and any spots on the outside of the positive diode plate with black chlorinated rubber enamel (Bosch F 1 87 V 1 or corresponding) in order to prevent corrosion.
5. Solder on the positive diode plate to the connection points. Check with the diode tester.

Negative diodes

1. Solder loose the negative diodes from the connection points. Screw loose the plate with the magnetizing diodes and lift off the plate together with the positive diode plate.
2. Press out the faulty diode with a suitable tool.
3. Oil the new diode with silicon oil (e.g. Bosch OI 63 V 2) and fit it in the end shield.
4. Solder on the negative diodes to the connection points and check with the diode tester.

Magnetizing diodes

1. If any of the magnetizing diodes is faulty, replace the entire plate with all three diodes.

ASSEMBLING ALTERNATOR

1. Fit the stator in the drive end shield and solder on the stator leads to the connection points. Fit the positive diode plate.
2. Grease the slip ring end shield bearing (Bosch Ft 1 V 34 or corresponding) and fit the bearing and washer in the slip ring end shield.
3. Press the end shield and spacer ring onto the rotor as shown in Fig. 3–44.
4. Grease the drive end shield bearing (Bosch Ft 1 V 34 or corresponding). Apply a thin layer of Molycote paste to the drive end shield bearing seat and assemble the alternator. (Do not forget the spring ring in the drive end shield bearing seat.) Assemble the alternator parts together by means of the bolts and nuts. Tighten the bolts to a torque of 5.0–6.0 Nm (3.5–4.3 lbft) and the nuts to 4.5–6.0 Nm (3.3–4.3 lbft).
5. Fit the brush holder.

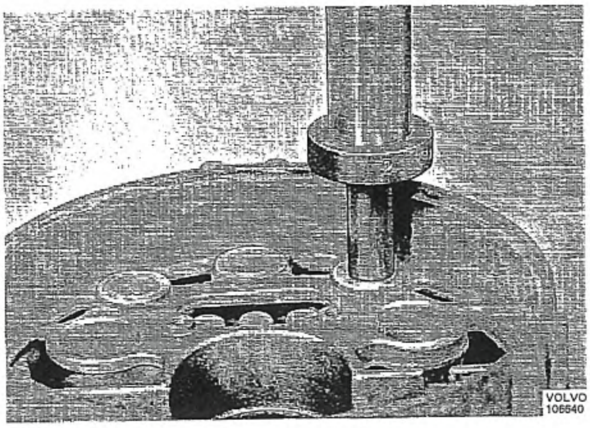


Fig. 3–42. Pressing out diode

6. Fit the key, fan impeller, pulley, washer and nut.
7. Tighten the nut to a torque of 40 Nm (29 lbft). After assembling, the alternator should be test-run on a test bench before being installed in the vehicle.

INSTALLING ALTERNATOR

1. Lift the alternator in position while putting on the fan belt at the same time.

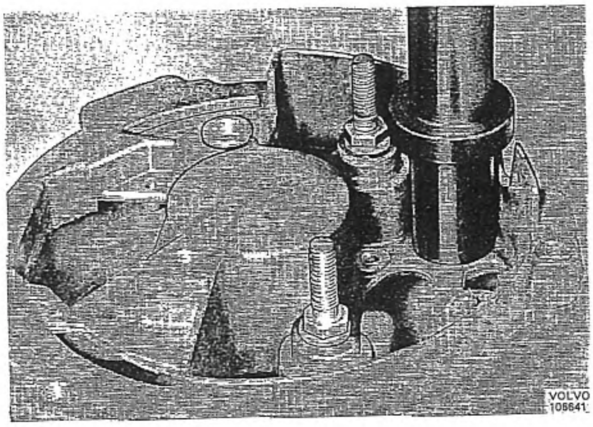


Fig. 3–43. Pressing in diode

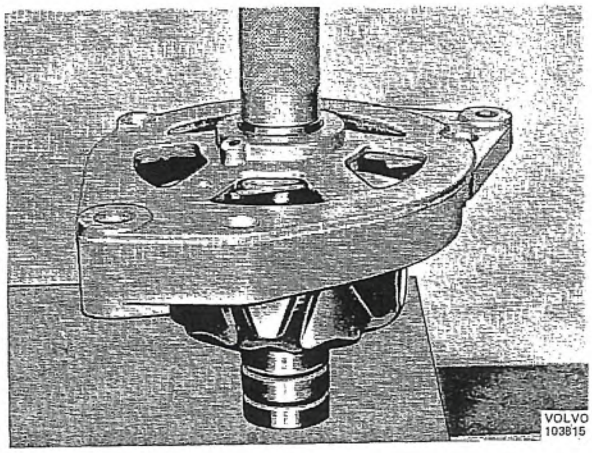


Fig. 3–44. Assembling rotor and slip ring end shield

2. Fit the attaching bolts and adjusting bar but do not tighten.
3. Adjust the belt tension and secure the alternator. (The belt is tensioned properly when it can be deflected 10 mm (3/8") halfway between the alternator pulley and water pump pulley with a force of 56–76 N = 12–17 lb.)
   NOTE. When adjusting the belt tension, force may only be applied at the front of the alternator.
4. Fit the electric leads to the alternator.
5. Fit the negative lead to the battery.

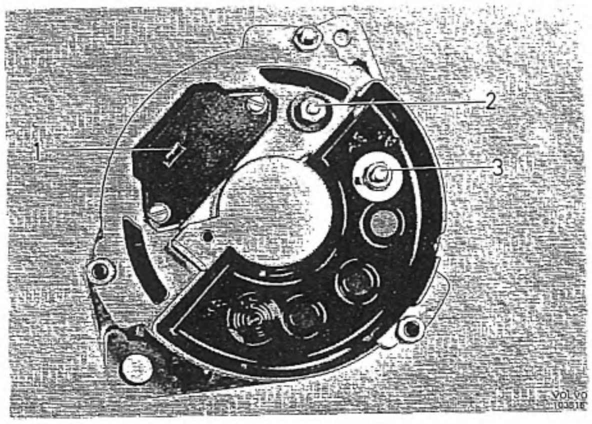


Fig. 3–45. Alternator terminals
1. DF To field winding
2. 61/D+ From magnetizing rectifer
3. B+ To battery

VOLTAGE REGULATOR

BOSCH

DESCRIPTION

The voltage regulator is fitted by two screws to the rear section of the left wheel plate, see Fig. 3–46. It is a mechanical, single-pole voltage regulator with a lower contact, a movable contact and an upper contact, see Fig. 3–50. The regulator resistor is placed under a plate underneath the regulator. Temperature compensation is operated by a bimetal spring which influences the spring tension so that the regulator receives lower regulating voltage at higher temperatures.

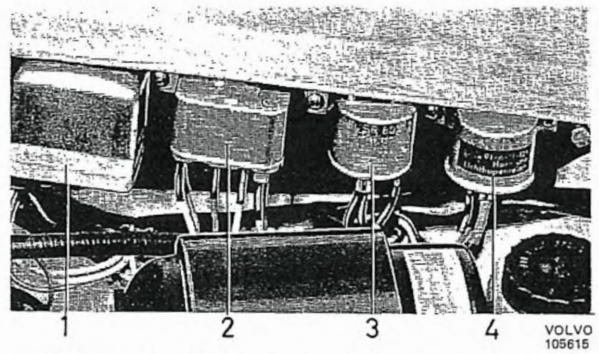


Fig. 3–46. Voltage regulator fitted

1. Voltage regulator
2. Step relay for fullbeam and dipped switching
3. Relay for reversing lights
4. Horn relay

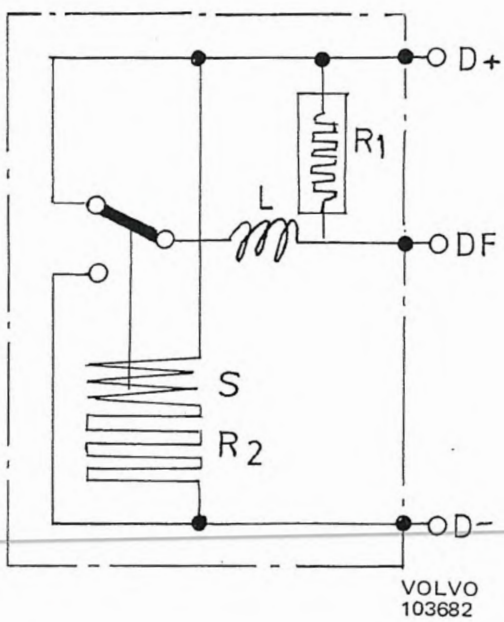


Fig. 3–47. Inner wiring of voltage regulator

S Voltage winding 35Ω
R_1 Regulator resistor 2.45
R_2 Compensation resistor 50Ω
L Contact impedance coil

TESTING ALTERNATOR AND VOLTAGE REGULATOR

For all testing of the alternator equipment, fixed clamps should be used. So-called crocodile clamps should not be used as they have certain tendency to loosen. A loose lead can result in the altérnator and regulator being damaged. Disconnect the battery before connecting up any instruments.

TESTING ALTERNATOR CIRCUIT

Before carrying out any tests on the alternator or regulator in the vehicle, check the battery and the vehicle wiring for faults in the leads or isolation, loose or corroded lead terminals and poor earthing. **Check the fan belt.** Any of these faults must be repaired before the electrical checks are started.

TESTING BATTERY

Test the battery with a hydrometer and battery tester. If the battery is not fully charged, remove it from the car and charge it or replace it with a new one if necessary. A fully charged battery which is otherwise in good condition should always be used when testing.

CHECKING VOLTAGE DROP

This test is made to check the leads between the alternator and the battery and also the battery ground lead. The test should be carried out with a fully charged battery in good condition. The battery connections should be well cleaned and tightened. Loads the alternator with about 10 amps. Suitable load: Mainbeam lights switched on. With the engine running and the alternator supplying 10 amps, measure with a suitable voltmeter the voltage between the positive pole of the battery and B+ on the alternator. If the voltage at this test exceeds 0.3 volt, there is a fault in the cable or contact, which must be remedied immediately. After repairing the faulty leads or contacts, measure once again. With the same load as above, measure the voltage drop between the negative pole of the battery and the alternator terminal D–. Here the voltage drop must not exceed 0.2 volt. If the voltage drop exceeds 0.2 volt, check the battery ground lead, the alternator contact with the engine and the engine contact with the chassis. After making the necessary repairs, measure again.

TESTING ALTERNATOR

(In a test bench or in the vehicle)

Connect up the alternator as shown in Fig. 3–48. Run it to a speed of 100 r/s (6000 r/m). (Regulate the voltage to about 14 volts by means of the load resistor F.) The alternator should produce 55 amps at 100 r/s (6000 r/m) and a voltage of 14 volts.

At the same time check to make sure that the charging warning lamp does not light or glow.

If the alternator does not meet the above requirements first check the brushes and diodes.

TESTING AND ADJUSTING VOLTAGE REGULATOR

(In a test bench or in the vehicle)

Connect up the regulator to an alternator in good condition as shown in Fig. 3–49.

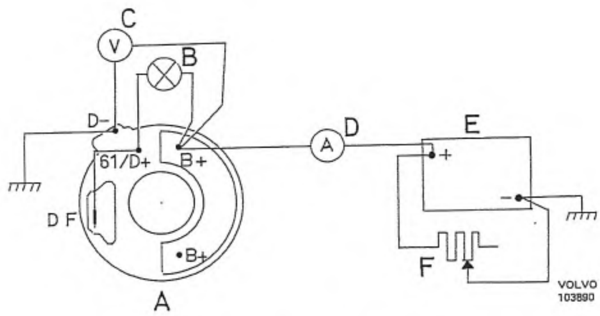


Fig. 3–48. Wiring diagram for testing alternator

A. Alternator
B. Control lamp 12 volts, 2 watts
C. Voltmeter 0–20 volts
D. Ammeter 0–50 amps.
E. Battery 60 ampèrehours
F. Load resistor

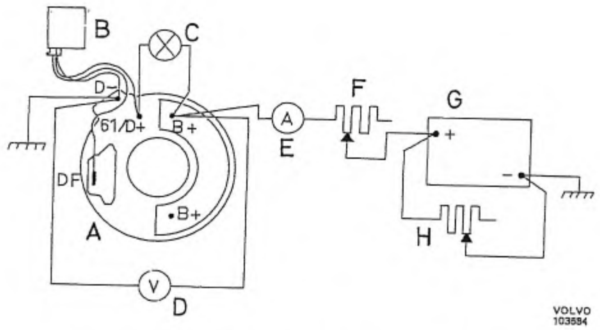


Fig. 3–49. Wiring diagram for testing voltage regulator

A. Alternator
B. Voltage regulator
C. Control lamp 12 volts 2 watts
D. Voltmeter 0–20 volts
E. Armature 0–50 amps.
F. Regulator resistor
G. Battery 60 ampèrehours
H. Load resistor

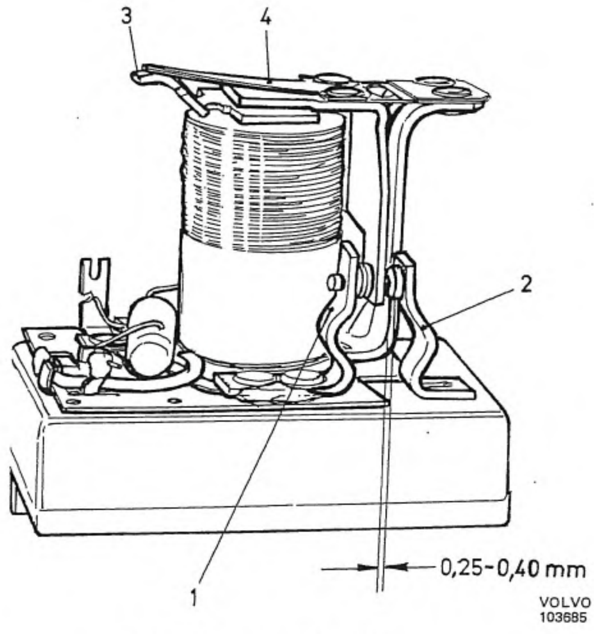


Fig. 3–50. Voltage regulator

1. Regulator contact for lower control range (lower contact)
2. Regulator contact for upper control range (upper contact)
3. Stop bracket
   Spring upper section: Steel spring
   Lower section: Bimetal spring

Run the alternator to a speed of 66.8 r/s (4000 r/m) (engine speed 33.4 r/s = 2000 r/m). Load the alternator with about 44–46 amps.

Rapidly lower the alternator speed to about 16.7 r/s (1000 r/m) (in vehicle, idling speed), raise the speed again to 66.8 r/s (4000 r/m) (engine speed 33.4 r/s = 2000 r/m) and adjust the load to about 44–46 amps. Read off the voltmeter. The voltage should be 13.9–14.8 volts and the regulator should be regulated on the left (lower) contact (1, Fig. 3–50). The reading should be made within 30 seconds after the test has begun. Reduce the load on the alternator to 3–8 amps and read off the regulating voltage. This voltage should now lie within the tolerance 0 volt to minus 0.4 volt in relation to the first reading. The regulator should now be regulated on the right (upper) contact (2, Fig. 3–50).

The regulating voltage in the lower regulating range is adjusted by bending the stop bracket for the bimetal spring, see Fig. 3–51.

If the stop bracket is bent downwards, the regulating voltage should drop, if bent upwards the opposite should be the effect. If the regulating voltage in the upper regulating range is too high or too low in relation to the lower regulating range (0 volt to minus 0.4 volt) this is adjusted by bending the holder for the left (lower) contact and correcting at the same time the gap between the right (upper) contact and the movable contact according to Fig. 3–50.

If the holder is bent towards the right (upper) contact, the regulating voltage in the upper regulating range will drop. To avoid faulty adjustments due to residual magnetism in the regulator core, it is necessary to reduce the alternator speed down towards 0 after each adjustment and then increase the speed and make a new reading.

(If the adjusting is comprehensive and the regulator is warm, it can be suitably cooled to ambient temperature by means of compressed air before the final reading is made.)

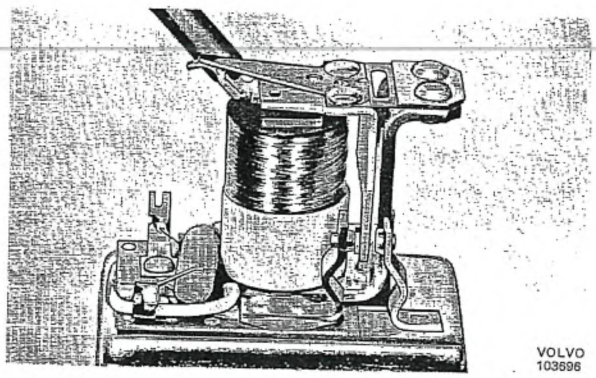


Fig. 3–51. Adjusting control voltage

FAULT TRACING

SYMPTOM

FAULT TRACING METHOD	FAULT
Warning lamp does not light with engine off.	
Test lamp (12 volts 2 watts) between B+ and 61/D+ on alternator lights.	Warning lamp burnt out or break in its circuit to D+ on regulator.
Test lamp between B+ and 61/D+ does not light. Test lamp between 61/D+ and ground lights.	Short-circuiting in a positive diode.
Test lamp between 61/D+ and ground gives a weak light. Remove the plug at the regulator and connect an ammeter between B+ and DF on the alternator. The ammeter shows: 0 amp.	Worn brushes, oxide on slip rings or breakage in rotor winding.
2.0–2.5 amps.	Breakage in regulator or in lead DF from regulator to DF on alternator.
Warning lamp lights with engine off or running.	
Disconnect the plug at the regulator: Warning lamp still lights.	Short-circuiting in the circuit between D+ on regulator and 61/D+ on alternator.
Warning lamp goes out. Re-fit the plug in the regulator and connect an ammeter between B+ and D+ on the alternator. Read off the ammeter: Less than 2.0–2.5 amps.	Defective regulator (breakage).
Greater than 2.0–2.5 amps.	Short-circuiting in the circuit between DF on the regulator and DF on the alternator. Short-circuiting in the rotor winding.
Warning lamp lights with engine off but starts to give a weak light when engine is running.	
Test lamp between B+ and 61/D+ on the alternator with the engine running: Does not light.	Transition resistance in the charging circuit or in the lead to the warning lamp.
Gives a weak light.	Defective regulator (overcharging of the battery) or defective alternator (insufficient charging of the battery).
Fit new regulator. Test lamp between B+ and 61/D+: Does not light.	Removed regulator defective.
Gives a weak light.	Defective alternator.

GROUP 33

STARTER MOTOR

TOOLS

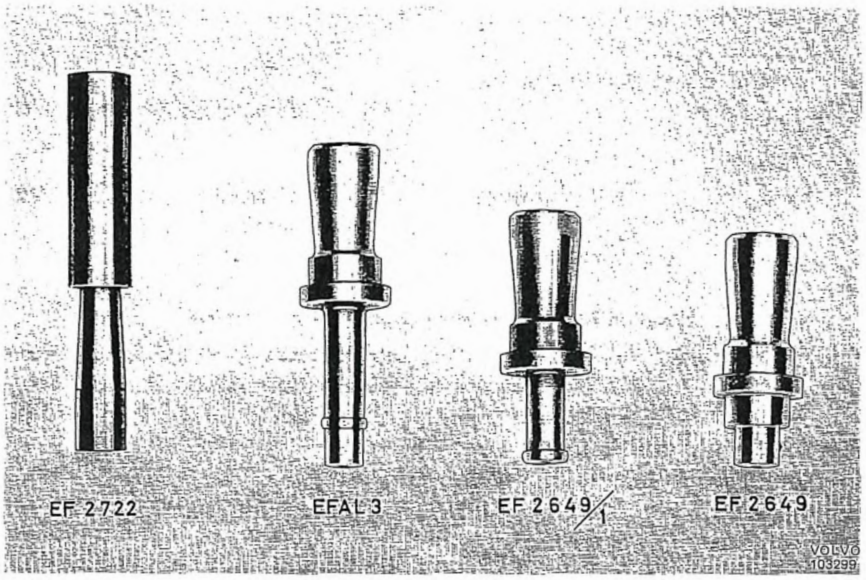


Fig. 3–52. Bosch special tools

EF 2722	Sleeve and drift for fitting circlip
EFAL 3	Smoothing drift
EF 2649/1	Smoothing drift
EF 2649	Drift for fitting bush

DESCRIPTION

The starter motor, Fig. 3–53, is mounted on the flywheel housing on the left-hand side of the engine. It consists of a 4-pole series-wound motor. The pinion on the starter motor rotor shaft moves axially to engage with the flywheel ring gear. The pinion is controlled by a solenoid.

Turning the ignition key to the starting position cuts in the solenoid causing the armature in the solenoid to be drawn in and the starter motor pinion to engage the ring gear on the engine flywheel.
When the armature has moved a certain distance, the contacts for the main current close and the starter motor starts running.

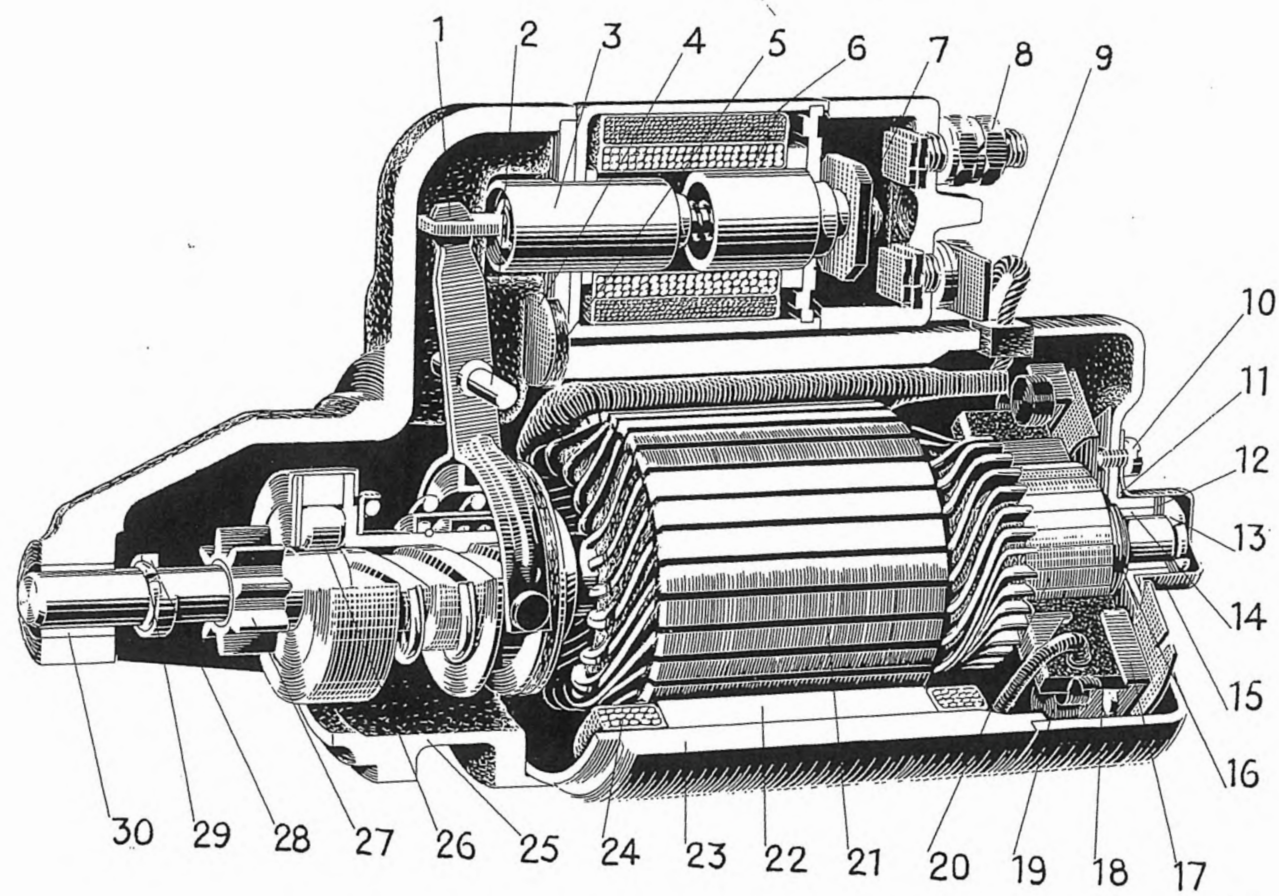


Fig. 3—53. Starter motor

1. Shift lever
2. Pivot pin (bearing screw)
3. Plunger
4. Steel washer
5. Rubber washer
6. Winding
7. Contact plate
8. Terminal for battery lead
9. Connection lead to field
10. Screw
11. Rubber gasket
12. Shims
13. Snap ring
14. Bush
15. Commutator end frame
16. Adjusting washers
17. Brush holder
18. Brush
19. Brush spring
20. Commutator
21. Armature
22. Pole shoe
23. Stator
24. Field winding
25. Drive end frame
26. Roller bearing
27. Pinion
28. Stop ring
29. Snap ring
30. Bush

REPAIR INSTRUCTIONS

REMOVING

1. Remove the cable terminal from the battery negative terminal stud.
2. Disconnect the leads from the starter motor.
3. Unscrew the bolts which hold the starter motor to the flywheel housing and lift it off.

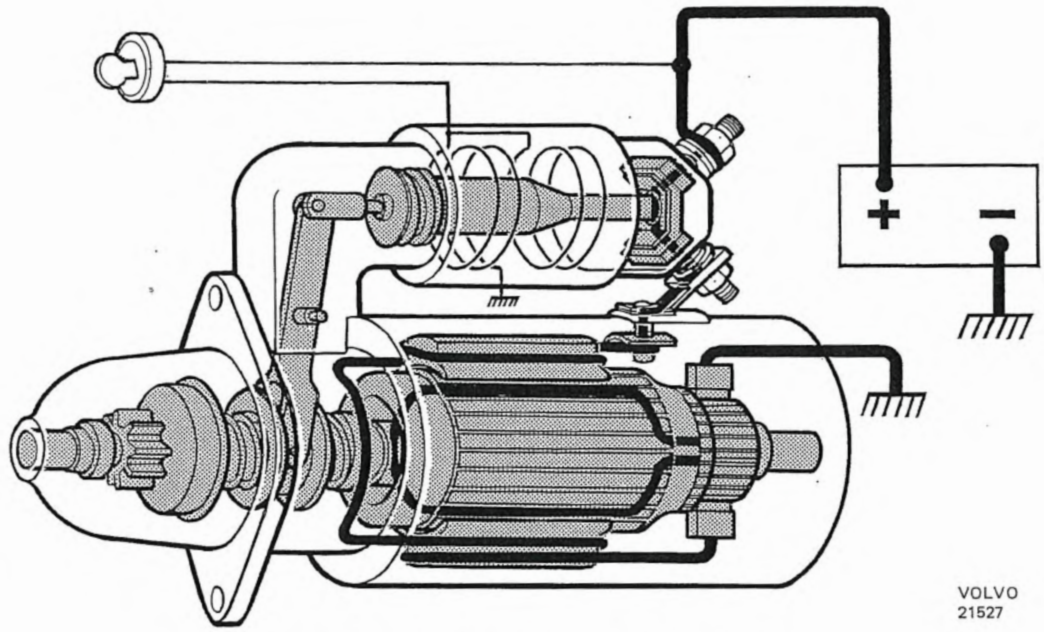


Fig. 3–54. Starter motor, general arrangement

DISASSEMBLING STARTER MOTOR

1. Remove the small cover on the front end of the shaft.
2. Lift off the lock washer and adjusting washers as shown in Figs. 3–57 and 3–58.
3. Remove the two bolts holding the commutator end frame and remove the frame.
4. Lift up the brushes and holders.
5. Remove the brush bridge from the rotor shaft. NOTE. The washers are as shown in Fig. 3–60. When the bridge is removed, the negative brushes follow also, but the positive brushes will remain in the field winding.
6. Unscrew the nut which holds the field terminal connection to the control solenoid.
7. Unscrew the attaching screws for the control solenoid. Remove the solenoid.

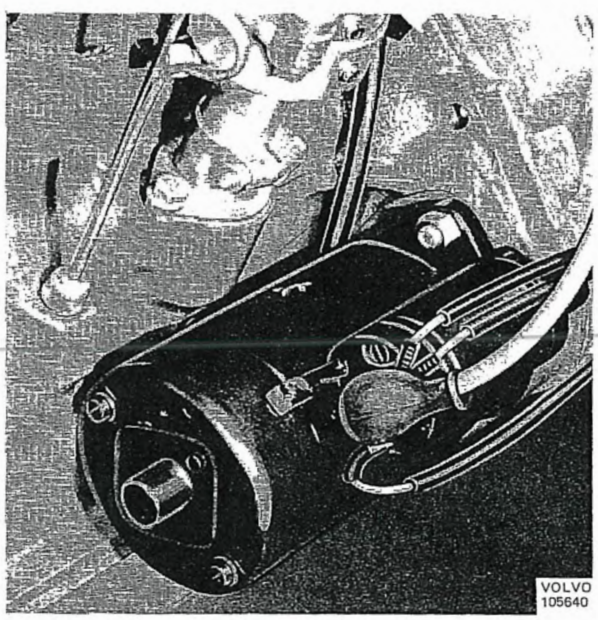


Fig. 3–55. Starter motor installed

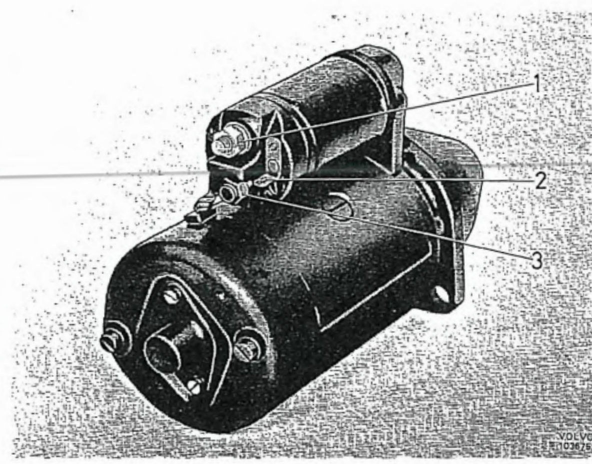


Fig. 3–56. Starter motor terminals
1. From battery 2. From ignition switch 3. To field winding

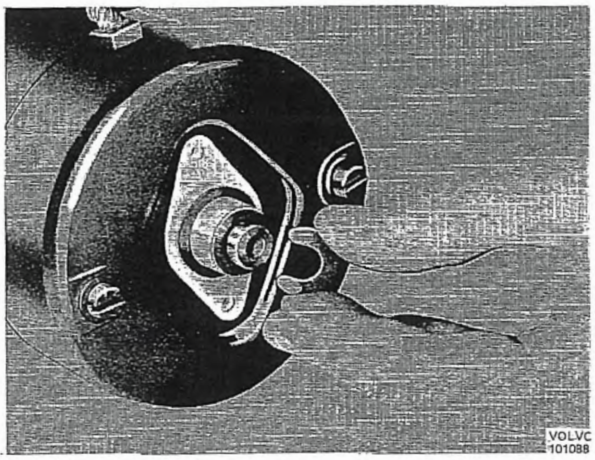


Fig. 3–57. Removing lock washer

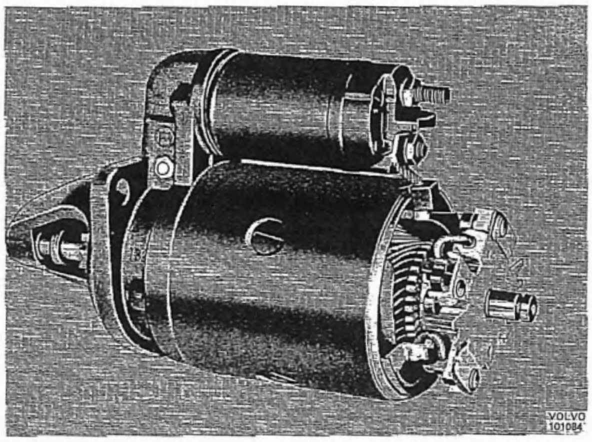


Fig. 3–59. Starter motor with bearing shield removed

8. Remove the drive end frame and armature from the stator.
9. Remove the rubber washer and metal washer, see Fig. 3–62.
10. Remove the screw on which the shift lever is carried.
11. Lift the armature with pinion and lever out of the drive end frame.
12. Knock back the stop washer and remove the snap ring on the armature shaft.
13. Remove the stop washer and pull off the starter pinion.

INSPECTING

Examine the armature for mechanical damage such as a bent or worn shaft, scored commutator and damaged windings.

If the armature shaft is bent or worn, the armature should be replaced.

If the commutator is scored or unevenly worn, it should be turned. The commutator diameter must not be less than 33 mm (1.3'').

The commutator should be checked with a micrometer after turning. A radial throw of 0.08 mm (0.003'') may be considered permissible. The isolation between the laminations should be milled down to 0.4 mm (0.016'') below the surface of the laminations, see Figs. 3–64 and 3–65. This work is carried out in a special apparatus, or if such is not available, with a ground-off hacksaw blade.

Examine the armature for shorting by placing it in a growler machine. Switch on and hold a hacksaw blade a few mm from the armature, see Fig. 3–66. If the blade vibrates in any position when the armatures is rotated, one of the following faults can be the reason:

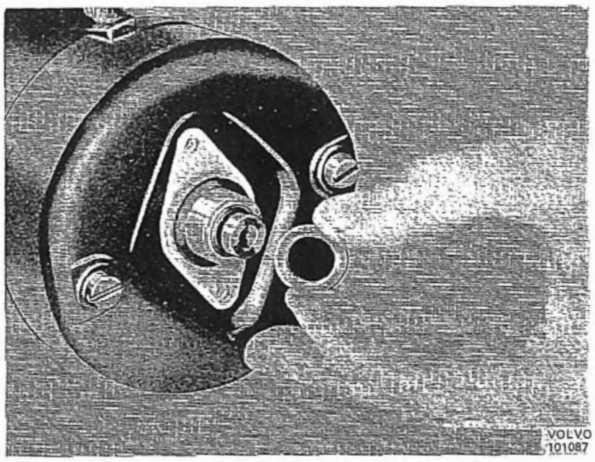


Fig. 3–58. Removing adjusting washers

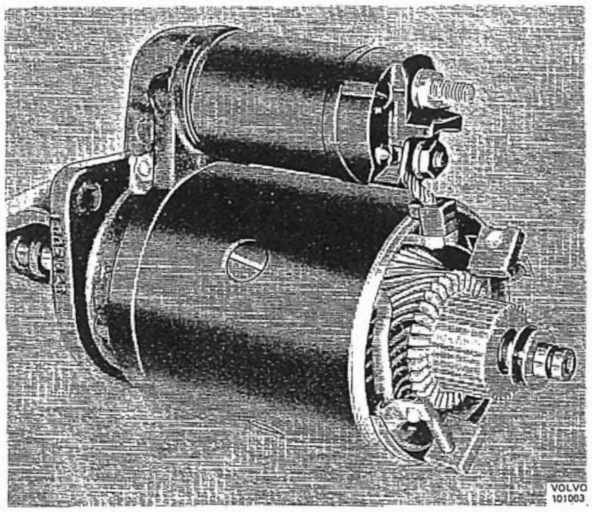


Fig. 3–60. Starter motor with brush bridge removed

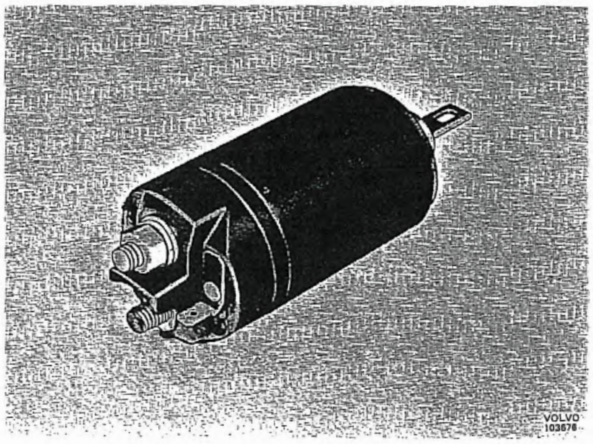


Fig. 3–61. Control solenoid

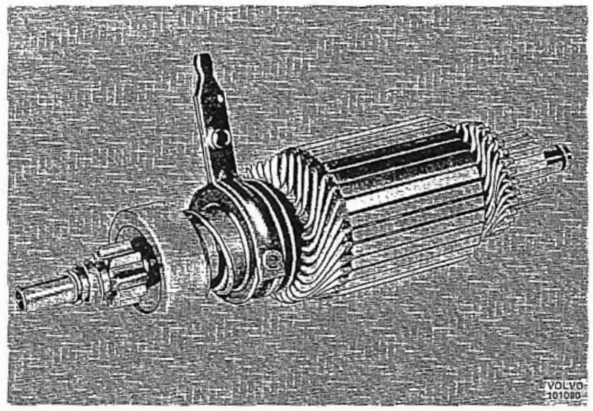


Fig. 3–63. Armature with pinion

shorting through the armature frame, shorting in the commutator or between the windings. Check the stator with 40 volts A.C., see Fig. 3–67.
Examine the drive end frame and brush holders. If any of these parts are damaged or excessively worn, they must be replaced. A bearing clearance of up to 0.12 mm (0.005") may be considered permissible.
Inspect the other parts and replace any that are damaged or worn. The snap ring should always be replaced with a new one, since when being removed it may have been damaged or lost its tension.

CHECKING CONTROL SOLENOID

If the control solenoid does not function, first check that the battery is in good condition. If there is no fault in the battery, connect a lead between the battery positive terminal and the control solenoid contact screw for the control lead. If the control solenoid still does not engage the starter pinion and main current, it should be removed from the starter motor. If, on the other hand, it engages satisfactorily, examine the starter switch and leads.
When the control solenoid has been removed, it should be wiped clean. Then press the armature in several times and test again by connecting it to a battery. If the control solenoid does not function after the above measures, replace it with a new one.

REPLACING BRUSHES

When replacing the brushes, remove and disassemble the starter motor. Solder brushes loose from their attachments in the brush holder and field winding

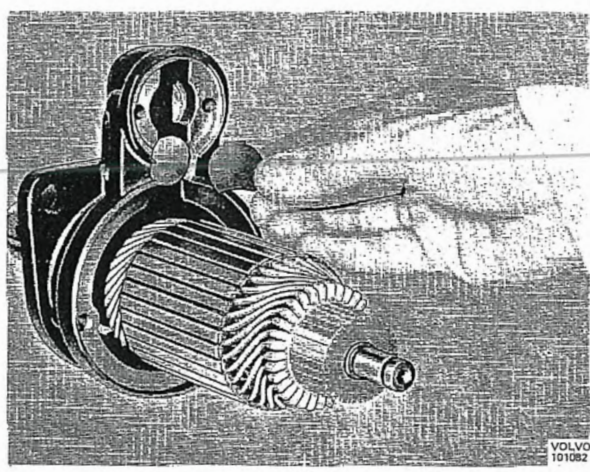


Fig. 3–62. Removing sealing washer

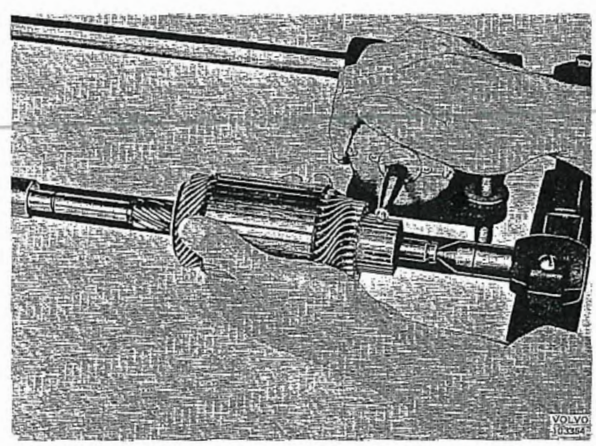


Fig. 3–64. Milling commutator

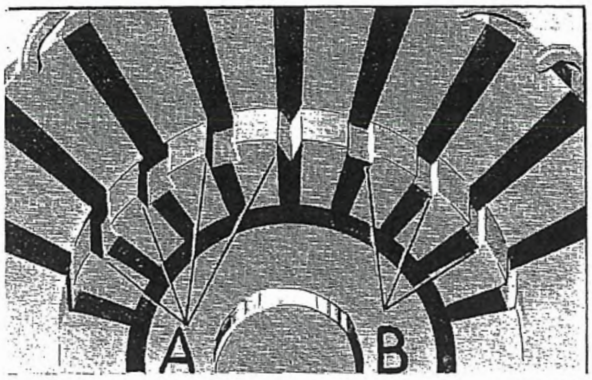


Fig. 3–65. Commutator milling
A. Incorrect mlling
B. Correct milling

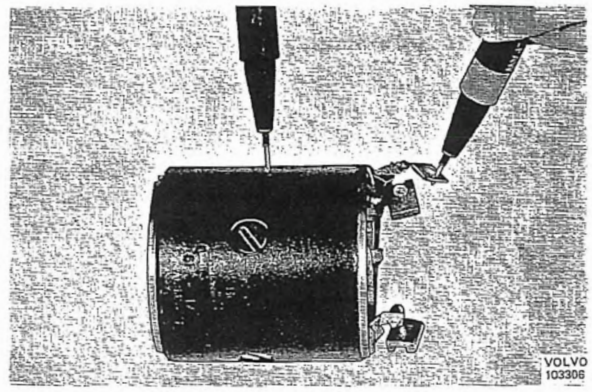


Fig. 3–67. Checking stator

respectively. The new brushes should be soldered on quickly and with sufficient heat. Solder must not be allowed to run down into the brush leads as this will prevent the movement of the brushes in the brush holders and may reduce the brush spring pressure. Brushes which have worn down less than 14 mm (approx. 1/2") should be replaced with new ones.

INSTALLING SELF-LUBRICATING BUSHES

The self-lubricating bushes are only worn insignificantly during operation if they are lubricated in the correct manner. If lubricating is neglected, the bushes dry out, with the result that they wear quickly. For replacement purposes, bushes are supplied ready-machined to suitable dimensions. When being fitted, the bushes should not be machined internally or externally since the pores can then be partially blocked up, resulting in reduced lubricating capacity.

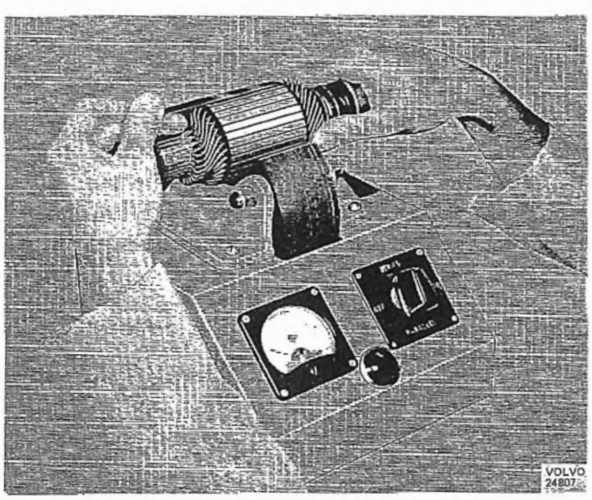


Fig. 3–66. Testing armature

Replace the bushes as follows:

1. Drive out the worn bushes with the help of a sutitable tool.
2. Clean the hole for the bushes and cut away any burr.
3. Press in the new bushes with the help of a suitable drift.
   NOTE. Before a self-lubricating bush is fitted, it should lie in light oil for at last a 1/2 hour.

REPLACING FIELD WINDINGS

1. If the starter motor has not been disassembled, this must be done. Follow the instructions under the heading "Disassembling".

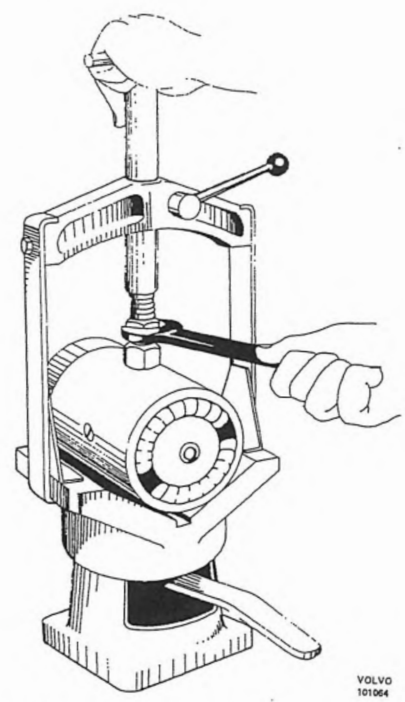


Fig. 3–68. Rotating clamping block for removing field windings

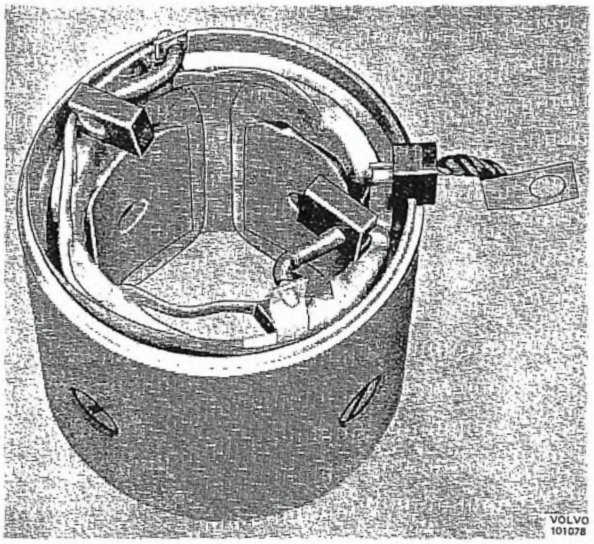


Fig. 3–69. Stator with soldered brushes

2. Mark the pole shoes and pole housing in a suitable manner so that they come in the same position when assembling.
3. Then place the stator in the rotating clamping block as shown in Fig. 3–68 (Bosch EF AW 9) or similar and unscrew the pole screws.
4. Before fitting new field coils, warm them slightly. Then place the pole shoes in position in the field coils and slide them into the stator. Tighten the pole screws lightly. Press in a suitable drift. Set up the stator in the rotating clamping block and tighten the pole shoes firmly.
5. Force out the press drift with a drift press. Check the fitted field windings for breakage and short-circuiting.

ASSEMBLING STARTER MOTOR

1. Lubricate the parts of the starter motor according to Fig. 3–71.

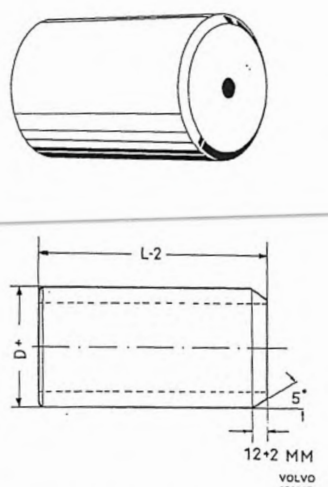


Fig. 3–70. Press drift for fitting field windings
D=66.4–66.09 mm (2.599–2.602") L=85 mm (3.346")

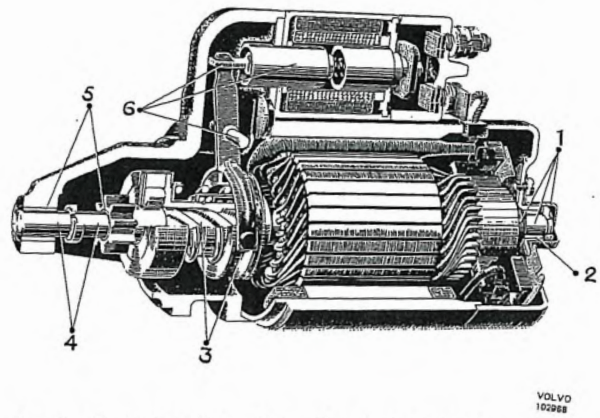


Fig. 3–71. Lubricating scheme for starter motor

Use Bosch lubricant (or equivalent) in accordance with the following directions:

1. Ft 2 V 3. Place a thin layer of grease on the isolation washers, the shaft end, the adjusting washers and lock washer.
2. Ol 1 V 13. Place the bush in oil for 1 hour before fitting.
3. Ft 2 V 3. Apply plenty of grease in the armature thread and the engaging lever groove.
4. Ft 2 V 3. Place the bushes in oil for a 1/2 hour before fitting.
5. Ol 1 V 13. Place a thin layer of grease on the armature shaft.
6. Ft 2 V 3. Lubricate the engaging lever joints and the iron core of the solenoid with a thin layer of grease.

2. Fit the starter pinion on the armature shaft, and the wear washer as well as the snap ring. Secure the wear washer in position.
3. Fit the engaging arm on the pinion. Fit the armature in the drive end frame.
4. Fit the screw for the shift lever.
5. Fit the metal washer and rubber washer in the drive end frame.
6. Fit the stator on the armature and the drive end frame.
7. Secure the solenoid in the shift lever. Screw tight the solenoid.
8. Fit the washers on the armature shaft as shown in Fig. 3–60.
9. Place the brush bridge in position. Fit the brushes.
10. Fit the commutator bearing frame. Screw the starter motor together with the two through bolts.
11. Fit the adjusting washers and the snap ring on the shaft end. Check the axial clearance of the armature. If necessary, adjust with the washers until the play agrees with the values in the "Specifications".
12. Screw on securely the small casting over the shaft end.

INSTALLING

1. Place the starter motor in position and secure it.
2. Connect the elctric cables.
3. Fit the lead terminal on the negative pole stud of the battery.

IGNITION SYSTEM

DESCRIPTION

The ignition system is of the battery ignition type. It consists of the following main parts: Ignition coil, distributor, ignition leads and spark plugs.

IGNITION COIL

The ignition coil is fitted on the firewall, see Fig.3–72.

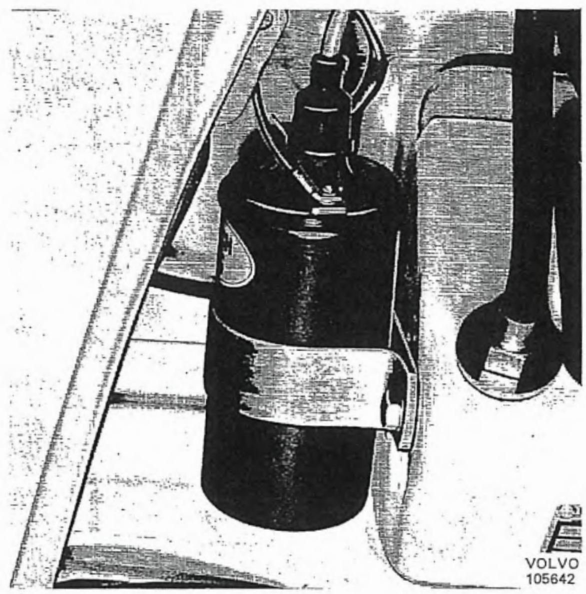


Fig. 3–72. Ignition coil fitted

DISTRIBUTOR

The distributor, Fig. 3–73, is fitted on the left-hand side of the engine and is driven from the camshaft. A centrifugal governer fitted under the ignition plate regulates the distributor in relation to engine speed. The adjustment in relation to loading is controlled by a vacuum regulator.

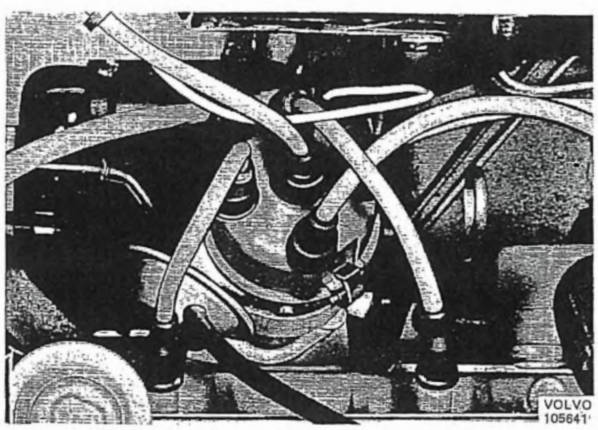


Fig. 3–73. Distributor fitted

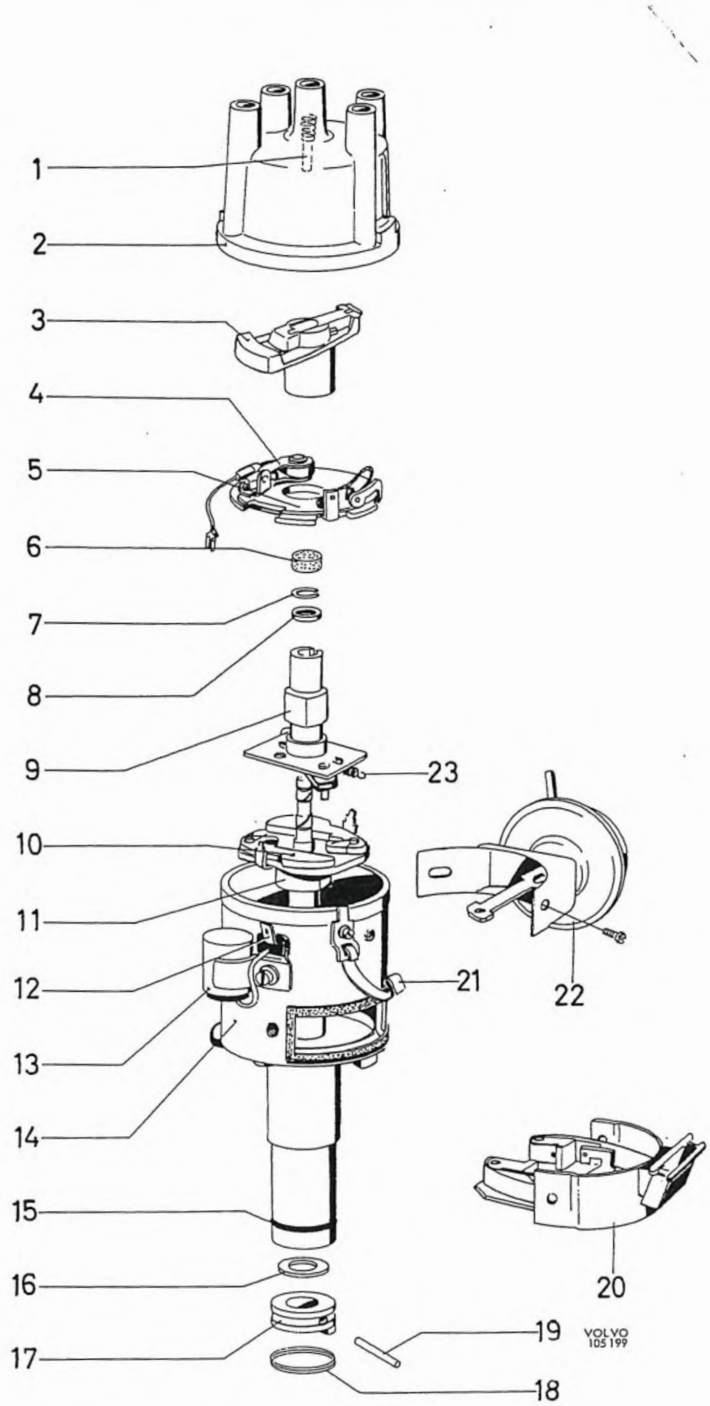


Fig. 3–74. Distributor

1. Rod brush (carbon)
2. Distributor cap
3. Distributor rotor arm
4. Ignition breakers
5. Ignition plate
6. Lubricating felt
7. Snap ring
8. Washer
9. Breaker cam
10. Centrifugal weight
11. Cam for triggering contacts
12. Primary terminal
13. Capacitor
14. Distributor body
15. Rubber seal
16. Washers
17. Flange
18. Resilient ring
19. Lock pin
20. Contact device
21. Lock clasp for distr. cap
22. Vacuum regulator
23. Centrifugal governor spring

DISTRIBUTOR

REMOVING

1. Release the lock clasps for the distributor cap and lift off the cap.
2. Remove the primary lead from the primary connection.
3. Remove the vacuum hose from the vacuum regulator. (When removing the hose from the bakelite connection, observe great care not to break the connection.)
4. Pull out the plug contact for the triggering contacts.
5. Slacken the screw and pull up the distributor.

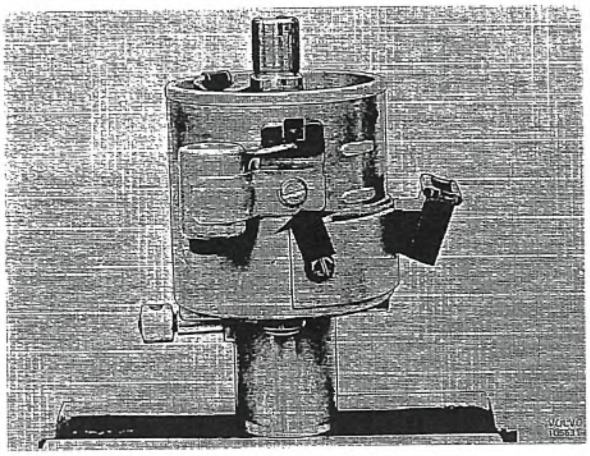


Fig. 3–76. Removing primary connection

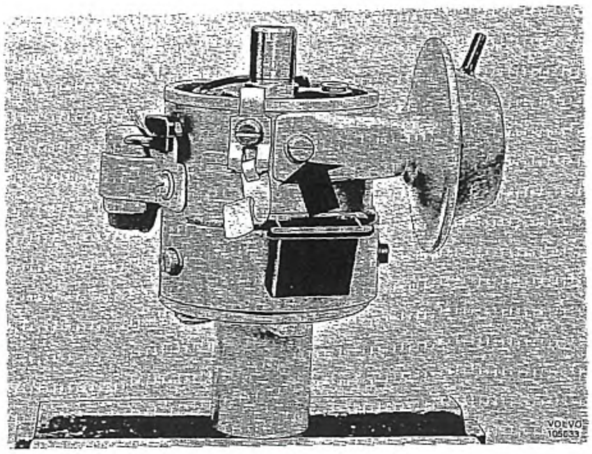


Fig. 3–75. Removing vacuum regulator

DISASSEMBLING

1. Pull off the distributor arm.
   Remove the circlip for the pull rod from the vacuum regulator.
   Remove the vacuum regulator.
2. Remove the triggering contacts.
3. Mark up how the lock clasps for the cap are located and remove them.
   Disconnect the lead from the ignition contacts and remove the primary connection.
   Lift up the ignition plate.
4. Disconnect the springs for the centrifugal governor and mark up how the ignition cam is located in relation to the distributor shaft. Secure the breaker cam in a vice with soft jaws. Carefully knock on the distributor housing with a plastic mallet (Fig. 3–77) until the snap ring (7, Fig. 3–74) has released and lift off the ignition cam.
5. Remove the resilient ring and mark up how the driving collar is located in relation to the distributor shaft.

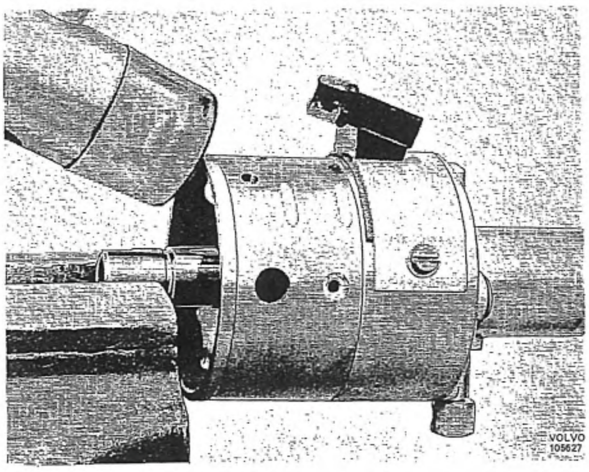


Fig. 3–77. Removing circlip

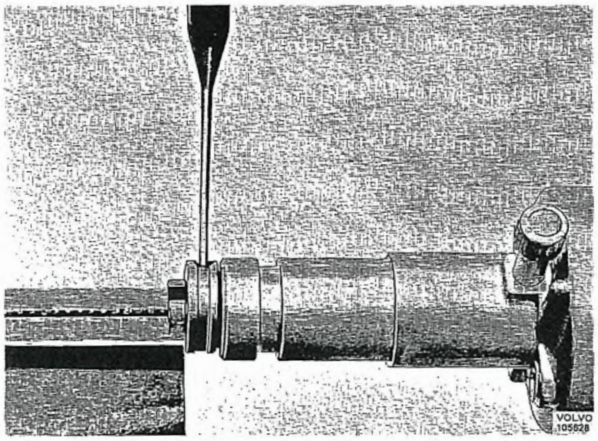


Fig. 3–78. Removing driving collar

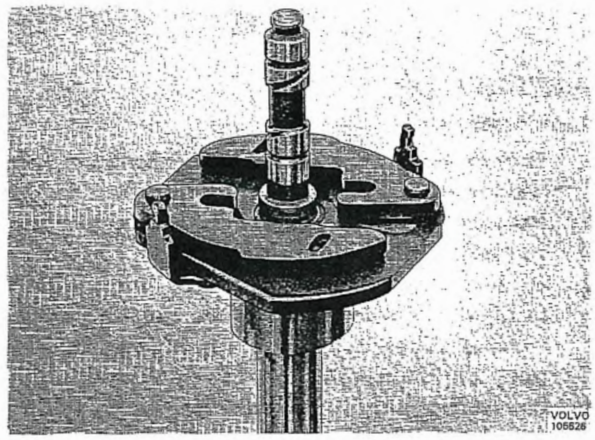


Fig. 3–79. Distributor shaft with centrifugal weights

Tap out the pin (Fig. 3–78), lift off the driving collar and pull up the distributor shaft.
Check that no washers have been lost.

6. Remove the lock spring for the centrifugal weights and lift up the weights.

Distributor housing

The play between the distributor housing and the shaft should not exceed 0.2 mm (0.008"). If the play is excessive, replace the bushes and, if this is insufficient, also the shaft.

INSPECTING

Ignition plate

The surface of the ignition contact points should be flat and smooth. The colour of the contacts should be grey. Oxidized or burnt contacts must be replaced. After a long period of use, the contact lip can be worn and the spring fatigued, so that the contacts should be replaced if the distributor for any reason is disassembled.
The ignition plate must not be loose, worn or have burr on.

Distributor shaft

The play between the distributor shaft and the breaker camshaft must not exceed 0.1 mm (0.004"). The cams on the breaker camshaft must not be scored or worn down so that the dwell angle is altered.
The holes in the centrifugal weights must not be oval or deformed in any other way.
The centrifugal weight springs must not be deformed or damaged.

ASSEMBLING

1. Lubricate the distributor parts according to the instructions given in Fig. 3–80.
2. Fit the centrifugal weights and also the lock springs on to the weights. Fit the ignition camshaft on to the distributor shaft. Hook in the springs for the centrifugal governor. Fit the easher and circlip for the ignition camshaft. The circlip is placed into position by means of a suitable sleeve. Fit the lubricating felt.
3. Fit the distributor shaft in the distributor housing and install the driving collar on the distributor shaft. Make sure that the fiber washers come against the distributor housing. Fit the pin in the collar and check the axial clearance on the distributor shaft. The clearance should be 0.1–0.25 mm (0.004–0.010"). Any adjustment can be done by altering the number of adjusting washers on the distributor shaft.
Fit the resilient ring on the driving collar.
4. Fit the ignition plate. Fit the lock clasps for the cap. Fit the primary connection and connect the lead from the ingnition contacts.
5. Fit the triggering contacts.
6. Fit the vacuum regulator and connect the pull rod to the ignition plate.

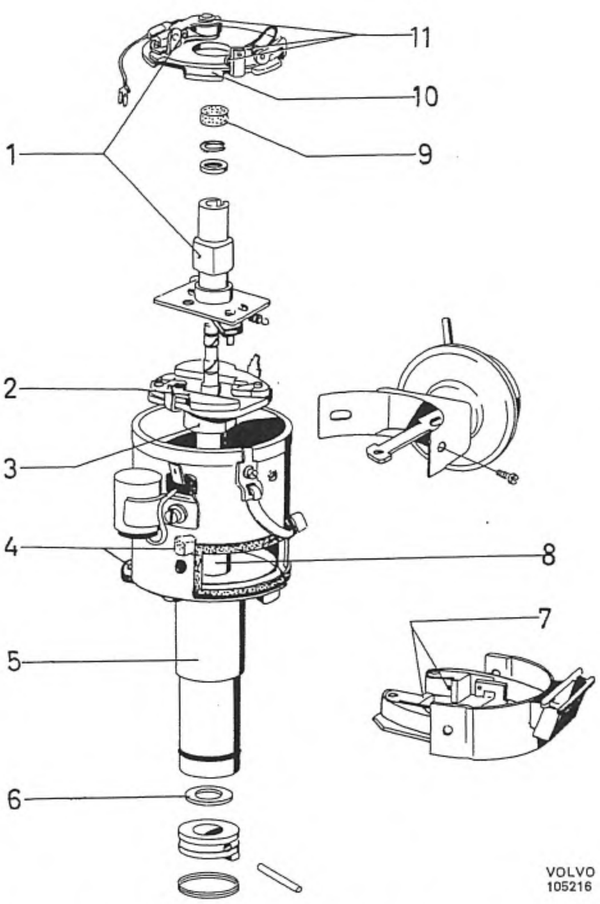


Fig. 3–80. Lubricating scheme for distributor

Use Bosch lubricant (or equivalent) according to below.

1. Ft 1 v 4. Place a little grease on the fiber tab and a light layer on the ignition cam.
2. Ft 2 v 3. Grease the weights.
3. Ft 1 v 4. Place a light layer on the ignition cam.
4. Ol 1 v 13. Fill the lubricator with oil and soak the felts in oil.
5. Ol 1 v 13. Place the brushes in oil for at least 1/2 hour before fitting. Soak the lubr. felt in oil.
6. Ft 2 v 3. Grease the washers.
6. Ft 1 v 4. Place a little grease on the fiber tabs.
8. Ol 1 v 13. Oil the shaft before fitting.
9. Ol 1 v 13. Soak the lubr. felt in oil.
10. Ol 1 v 2. Oil the ignition plate.
11. Fit 1 v 26. Grease the bush for the movable contacts, the pin for the vacuum regulator and the ball.

7. Check that the ignition contacts are mounted correctly both horizontally and vertically. Adjustment should be made with a suitable tool (for example, Bosch EFAW 57 A), but only the fixed contact may be bent. Wash the contacts with trichlorethylene or chemically pure gasoline.

Run the distributor on a test bench and check according to the "Specifications".

Fit the distributor rotor arm.

REPLACING IGNITION CONTACTS

The ignition contacts can be replaced with the distributor fitted, but **should** be done with the distributor dismantled.

1. Remove the distributor rotor arm.
2. Disconnect the electric lead at the primary connection.
3. Remove the screw for the ignition contacts and lift up the old contacts.
4. Lubricate the distributor according to the instructions given in Fig. 3–80.
5. Fit the new ignition contacts.
6. Connect the electric cable at the primary connection.
7. Check that the ignition contacts are located correctly both vertically and horizontally.
   Adjustment should be made with a suitable tool, (for example, Bosch EFAW 57 A), but only the fixed contact may be bent. Wash the ignition contacts with trichlorethylene or chemically pure gasoline.

Run the distributor on a test bench and check according to the "Specifications".

TESTING DISTRIBUTOR IN TEST BENCH

1. Run the distributor at 8.32 r/s (500 r/m) in its ordinary direction of rotation (anti-clockwise) and adjust the breaker contact dwell angle according to the "Specifications".
2. Adjustment is made by slackening a little the screw for the ignition contacts and then inserting a screwdriver in the recess, Fig. 3–81, and turning the screwdriver until the dwell angle is the correct one.
   Then tighten the screw for the ignition contacts.

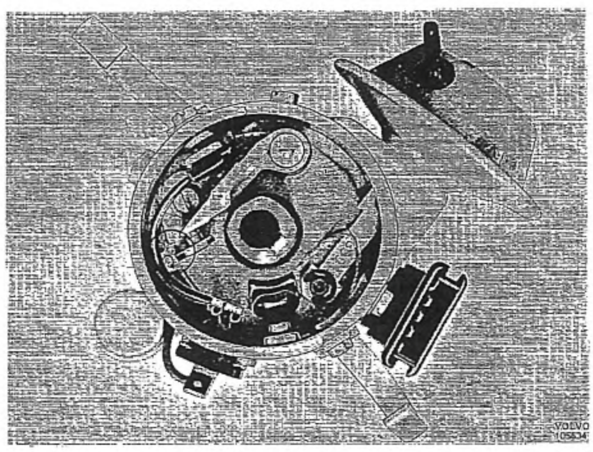


Fig. 3–81. Recess for adjusting ignition contacts

3. Run the distributor and set the protractor on the test bench so that a marking comes opposite 0° at such a low speed (below 3.34 r/s = 200 distributor r/m) that the centrifugal governor does not function. Increase the speed slowly and read off the values at the prescribed graduations. A newly lubricated distributor should first be run up to maximum speed several times. Permissible tolerance for the centrifugal governor is ±1°.
4. Run the distributor at low speed and adjust the protractor so that a marking is obtained at 0°. Connect the vacuum hose from the test bench to the vacuum regulator. Increase the vacuum gradually and read off the values at the prescribed graduations.

INSTALLING

1. Place the distributor in position.
2. Press the distributor downwards while turning the distributor arm at the same time. When the distributor goes down about 5 mm (3/16") and it is no longer possible to turn the distributor arm, the driving collar of the distributor is then in the slot on the distributor drive.
3. Turn the distributor housing so that it takes up the same position it had before removal.
4. Connect the primary lead. Fit on the distributor cap.
5. Install the electric cable for the triggering contacts.
6. Start the engine and set the ignition. (If the engine does not start, turn the distributor housing until it does.)

IGNITION SETTING

Ignition setting should be carried out according to the instructions in Part 2, Group 24.

GROUP 35

LIGHTING

DESCRIPTION

The lighting consists of two full- and dipped-beam headlights, parking lamps, rear lamps, license plate light and side marker lights (only U.S.A.).

The headlights are switched on and off by the lighting switch on the instrument panel. Switching between full- and dipped-beam positions is done by moving the directional indicator lever switch towards the steering wheel. The relay (3, Fig. 3–99) then connects up the lighting.

The rear lights have separate bulbs for rear lights, stop lights, reversing lights and directional indicators. The license plate lighting has three bulbs, two for the license plate and one for reversing.

REPAIR INSTRUCTIONS

HEADLIGHTS

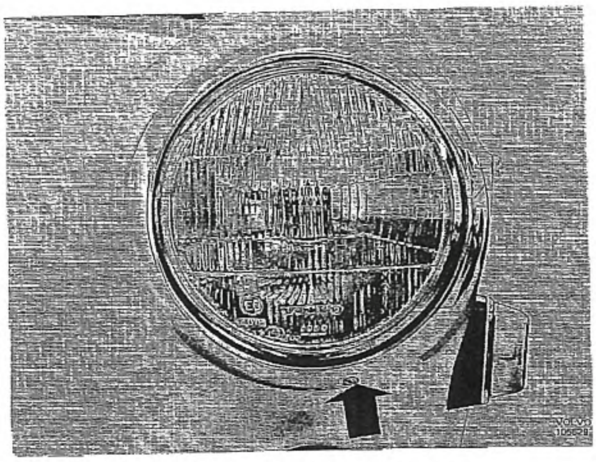


Fig. 3–82. Removing headlight rim

REMOVING

1. Remove the screw for the headlight rim (Fig. 3–82). Lift off the rim by moving its lower section outwards and upwards.
2. Remove the screws indicated in Fig. 3–83 with arrows and lift off the inner ring.
3. Disconnect the connection contact from the bulb socket and pull it straight out as shown in Fig. 3–84.
4. Unhook the spring (4, Fig. 3–85) from the slide casing. If necessary, slacken the screws (1 and 2, Fig. 3–85).
5. Remove the spring and adjusting screws from the protection cover.
6. Disconnect the protection cover from the fender and pull out the cable and rubber bush.
7. Fitting is in reverse order to removal. Make sure that the cables are properly fitted. Tighten the screws carefully.

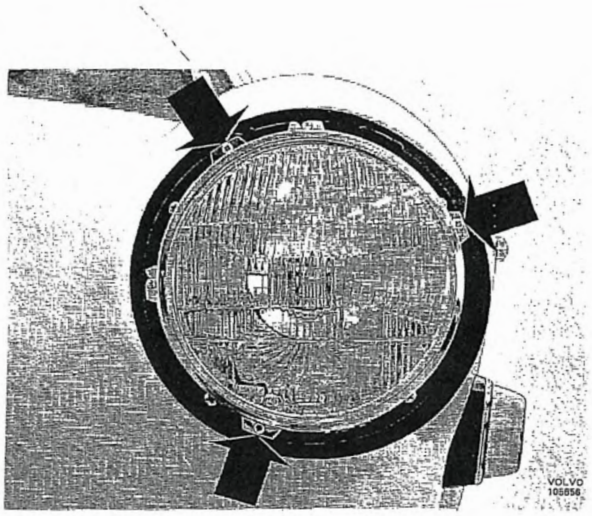


Fig. 3—83. Removing headlight inner ring

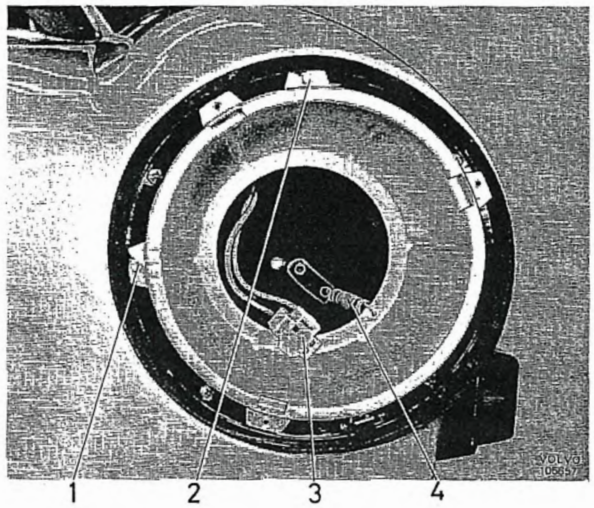


Fig. 3—85. Headlight casing
1. Adjusting screw, horizontal
2. Adjusting screw, vertical
3. Connection contact
4. Spring

REPLACING HEADLIGHT BULB

1. Carry out operations 1—3 under the heading "Removing".
2. Lift off the spring holding the bulb holder at the insert and lift out the holder, Fig. 3—86. Then remove the old bulb.
3. Fit the new bulb, see Fig. 3—87. Do not touch the bulb glass with your fingers. Make sure that the bulb is fitted properly in the insert. The small nibs on the bulb collar should fit in the insert jacket.
4. Fitting is in reverse order to removal.

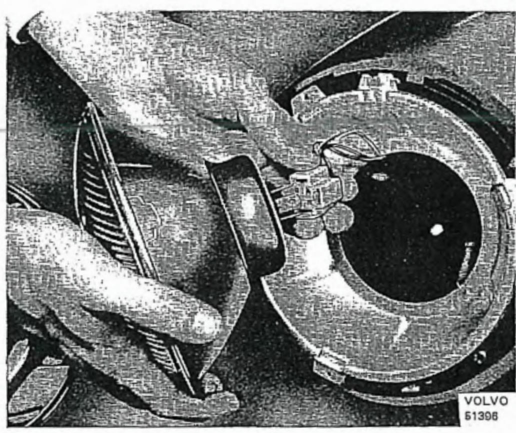


Fig. 3—84. Removing connection contact

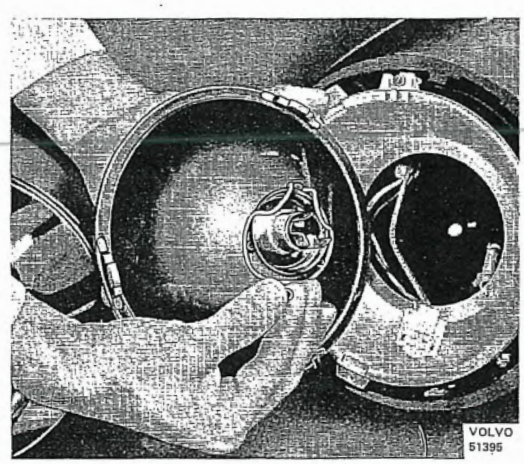


Fig. 3—86. Removing bulb holder

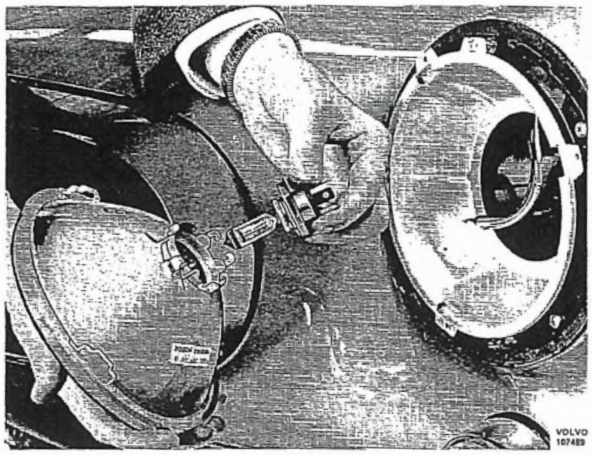


Fig. 3—87. Fitting bulb

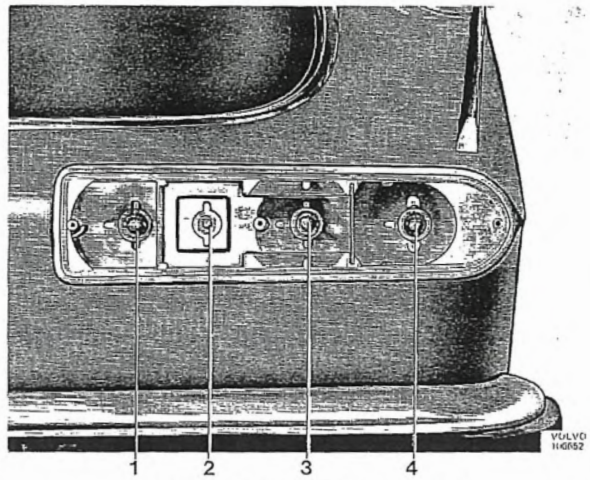


Fig. 3—89. Rear light glass removed

1. Reverse light
2. Tail light
3. Brake stoplight
4. Dir. ind. flasher

ADJUSTING HEADLIGHTS

From the viewpoint of traffic safety, it is of the utmost importance that the headlights are adjusted in accordance with current regulations.

Adjustment is done by means of the two screws (1 and 2, Fig. 3—85).

The adjusting should be carried out with the help of an approved light-adjusting unit.

REAR LIGHTS

Replacing rear light

1. Unscrew the screws holding the glass, see Figs. 3—88.
2. Unscrew the two screws holding the rear light housing to the body. The nuts are accessible from inside the luggage compartment.
3. Disconnect the cables at the connectors.

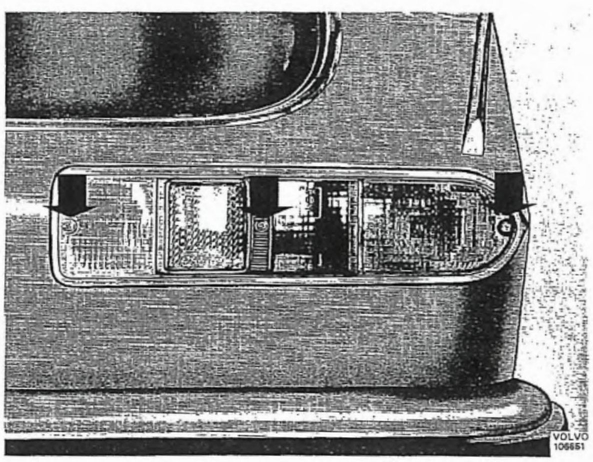


Fig. 3—88. Removing rear light

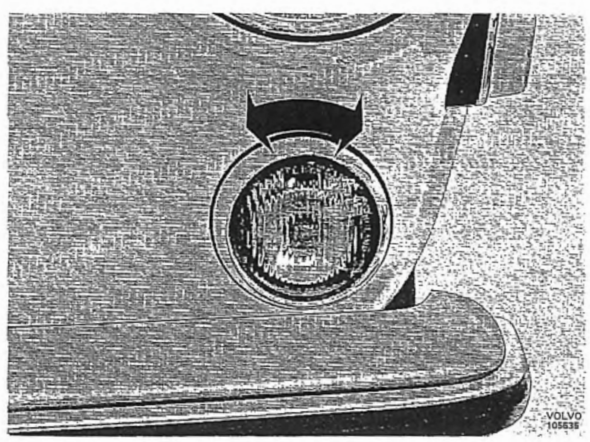


Fig. 3—90. Removing directional indicator and parking light glass

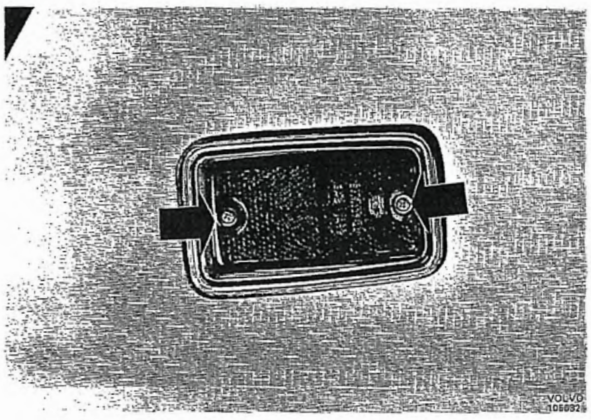


Fig. 3–91. Side marker light

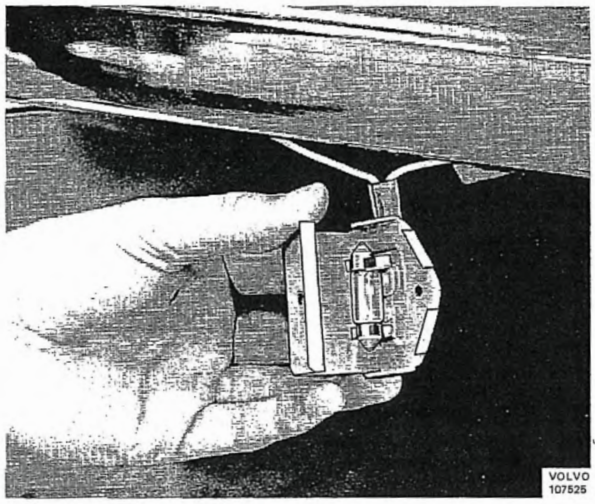


Fig. 3–93. License plate light, removing bulb

DIRECTIONAL INDICATOR FLASHER AND PARKING LIGHT

To remove the glass for this light, turn it to the left, see Fig. 3–90.

SIDE MARKER LIGHTS

Two flasher marking lights are placed on each side of the car.
To replace the bulb, take off the glass. The glass is fitted on the body by means of two screws.

LICENSE PLATE LIGHT

The license plate light is illuminated by two lamps fitted on the bumper. To replace the bulb, remove the screw securing the glass, then take off the glass and the bulb is accessible for removal.

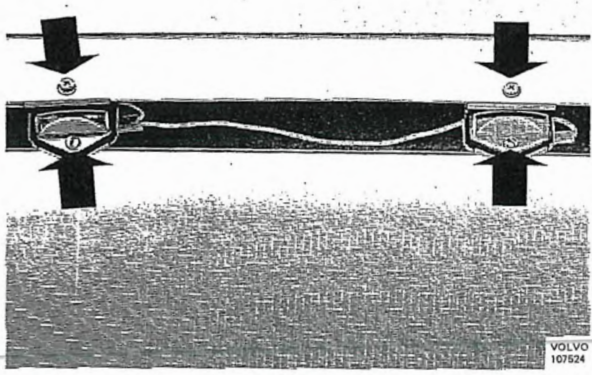


Fig. 3–92. License plate light, removing light housing

OTHER ELECTRICAL STANDARD EQUIPMENT

DESCRIPTION

DIRECTIONAL INDICATOR SYSTEM

The directional indicator system consists of a thermal-type flasher relay, directional indicator switch, flash lamps on the front fenders and bulbs in the rear lights.

The directional indicators can also be used as simultaneous emergency warning flasher lights, when the special switch for this function on the instrument panel is switched on.

The flasher relay is mounted under the instrument panel.

The directional indicator lever switch, see Fig. 3–101, which has automatic parking, is placed under the plastic cover on the steering column.

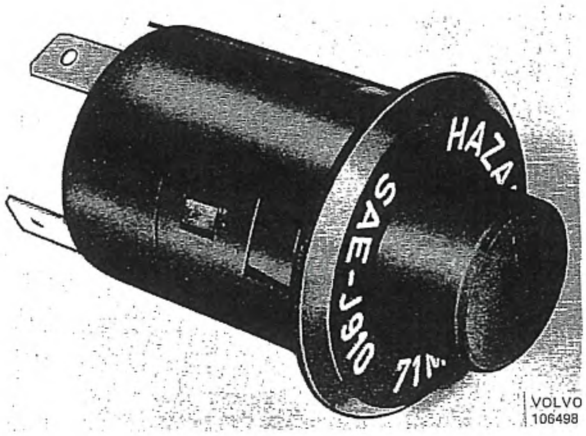


Fig. 3–95. Switch for flasher relay

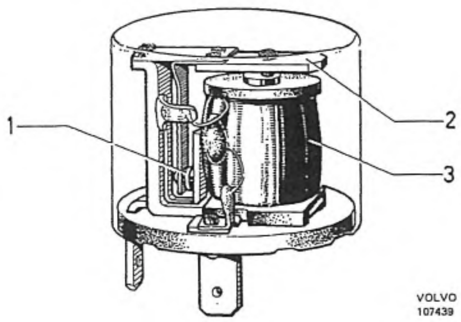


Fig. 3–94. Buzzer

1. Contacts
2. Armature
3. Coil

IGNITION SWITCH

The ignition switch is integrally built with the steering wheel lock. The switch has four positions:

0. Complete electrical system disconnected and steering wheel locked.
1. Current to fusebox (Intermediate position).
2. Same as position 1 but also current to ignition coil (Driving position).
3. Same as position 2 but also current to starter motor solenoid (Starting position). When ignition key is released in position 3, it returns automatically to position 2.

Vehicles intended for U.S.A. are fitted with a special steering wheel lock with warning buzzer which buzzes

when the driver's door is opened and the ignition key is in the ignition switch, in other words, if the steering wheel is not locked.
The buzzer is placed under the dashboard on the left-hand side and is connected between the fusebox (via the ignition) and the door switch on the driver's side.
The buzzer consists of a pair of contacts and a coil. When current passes across the contacts and through the coil, the armature is drawn down towards the core of the coil. While the armature is being drawn down towards the core, the contacts cut out the current and the armature springs back, etc. This cycle is repeated continuously as long as current is switched on, that is, as long as the driver's door is open and the ignition key is in the ignition.

HORNS

The horns are mounted to the left of the radiator behind the grille.
One of the horns has a low frequency and the other a high frequency.
The horn ring mounted inside the steering wheel operates the horns.

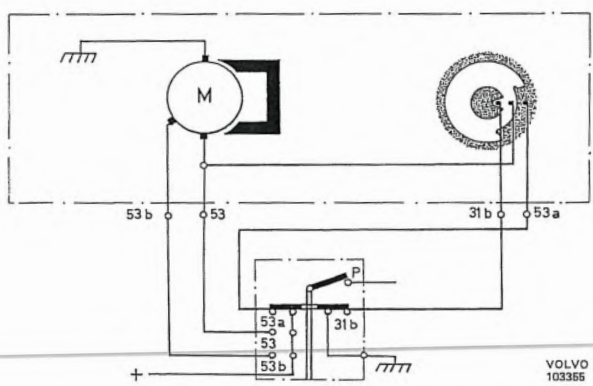


Fig. 3—96. Wiring diagram for windshield wiper motor

WINDSHIELD WIPERS

The windshield wipers are driven by an electric motor. The motor is connected to the wiper blades by means of link arms. It has a permanently magnetized field and two speeds which are selected by means of the switch mounted on the dashboard. The motor is fitted with 3 brushes, one negative brush and two positive brushes. The positive brushes are connected up one at a time for full and half speed respectively. The gear housing for the wiper unit contains an integrally built parking switch. The purpose of this switch is to return the blades to a suitable, previously determined, parking position irrespective of where the blades are when switched off.

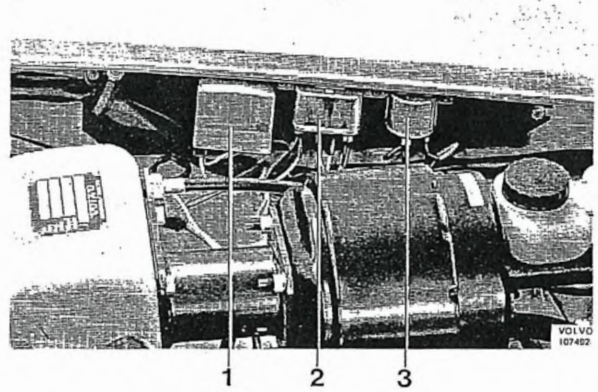


Fig. 3—97. Control relays

1. Voltage regulator
2. Step relay for full beam and dipped switching
3. Horn relay

WINDSHIELD WASHER

The windshield washer, which is placed in the right-hand wheel housing is driven by an electric motor, see Fig. 3—98. The pump, located at the bottom of the water container, is connected to the motor by means of a shaft. The pump is of the centrifugal type.
Turning the windshield washer switch mounted on the dashboard engages the windshield washer.

SWITCHES

All switches are of the pull-push type. The switches for lighting and ventilation have three positions. The switch for the windshield wiper has also three positions but the washer is also engaged by turning the knob on this switch.

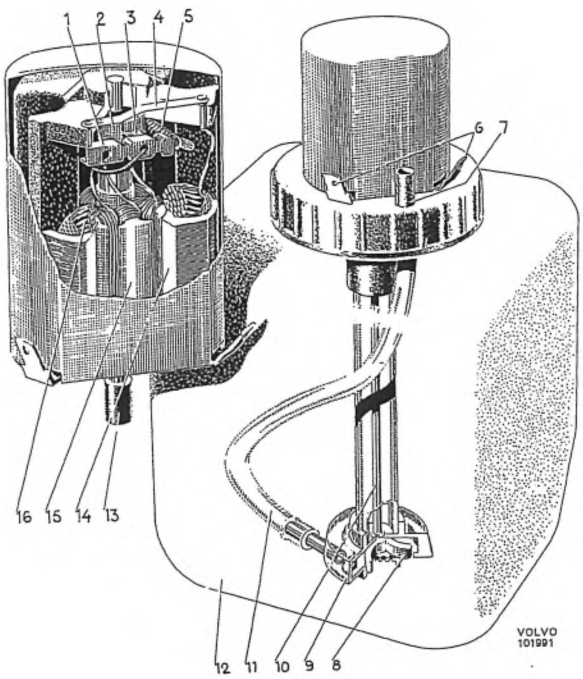


Fig. 3–98. Windshield washer
1. Brush holder
2. Commutator
3. Brush
4. Thermal fusing
5. Spring
6. Terminal pin
7. Water outlet
8. Pump impeller
9. Pump housing
10. Shaft
11. Hose
12. Container
13. Flange
14. Stator
15. Rotor
16. Field winding

INSTRUMENT AND INTERIOR LIGHTING

The instrument lighting consists of 9 bulbs mounted to the various instruments and is accessible from the rear side of the dashboard.

Mounted in the instrument panel are the warning lamps. All warning lamps are accessible for replacement from the rear side of the instrument panel. The interior lighting consists of two courtesy lights located at the rear next to the rear window. The bulbs for these lights are accessible after the glass cover has been removed.

FUSES

The fuses are mounted in a fusebox located under the dashboard to the left of the driver.

BRAKE LIGHT SWITCH

The brake light switch is placed on the pedal carrier beneath the dashboard. It is operated mechanically by the brake pedal.

CONTROL RELAYS

As standard the 1800 ES cars are fitted with two control relays, a step relay for the fullbeam and cipped lights and a control relay for the horn.

All control relays are placed on a bracket at the front on the left wheel housing, see Fig. 3–97.

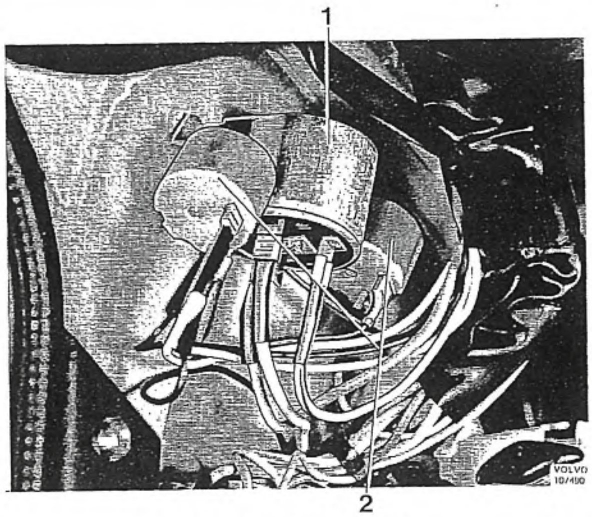


Fig. 3–99. Relay and buzzer
1. Relay for elec. heated rear window
2. Buzzers (USA)

REPLACING DIRECTIONAL INDICATOR LEVER SWITCH

1. Remove the steering wheel according to the instructions given in Part 6.
2. Unscrew the screws securing the casing over the switch, see Fig. 3–100.
3. Unscrew the two screws holding the switch in position, see Fig. 3–101.

REPLACING IGNITION SWITCH

Disconnect the battery ground lead. Remove the ignition switch from the steering wheel lock by unscrewing both the bolts holding the switch to the lock. Replace the ignition switch and fit a new one on the steering wheel lock.

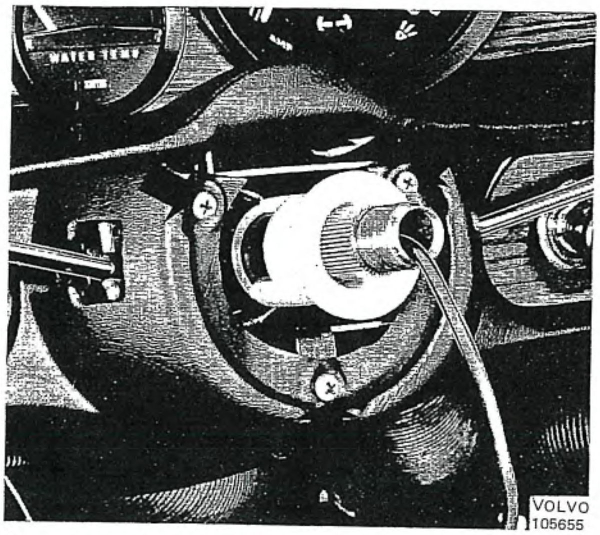


Fig. 3–100. Removing directional indicator lever switch casing

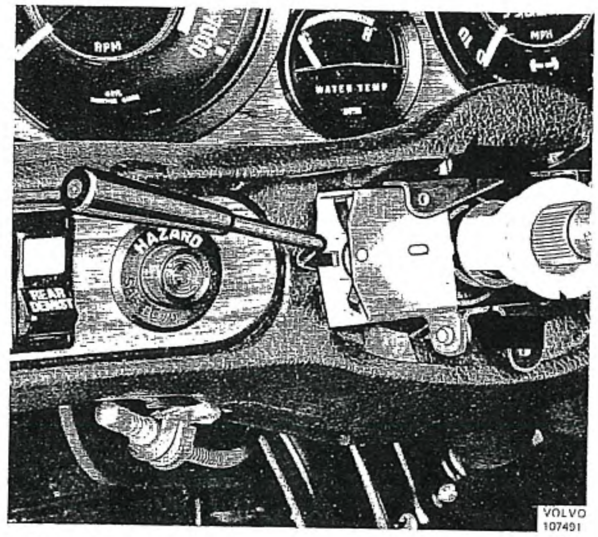


Fig. 3–101. Removing directional indicator lever switch

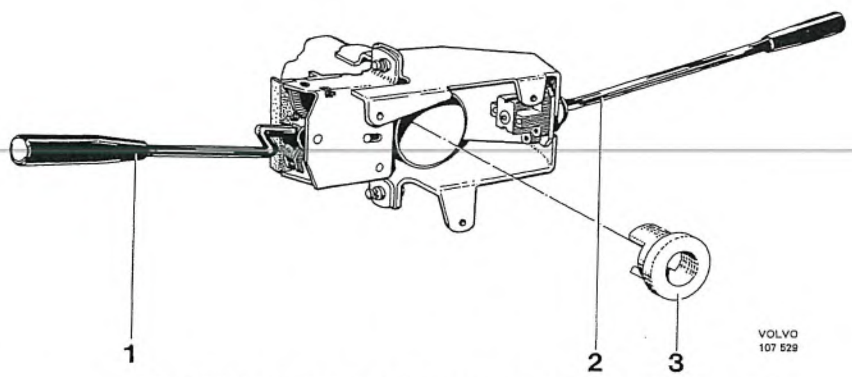


Fig. 3–102. Directional indicator lever switch and overdrive switch

1. Directional indicator lever switch
2. Overdrive switch
3. Flange

REMOVING AND ADJUSTING HORN RING

Carefully lever loose the impact pad. Disconnect the electric cable. Remove the horn ring by unscrewing the three spring-loaded screws holding the ring to the steering wheel. Fitting is in reverse order to removal. The horn ring can be adjusted by means of the spring-loaded screws.

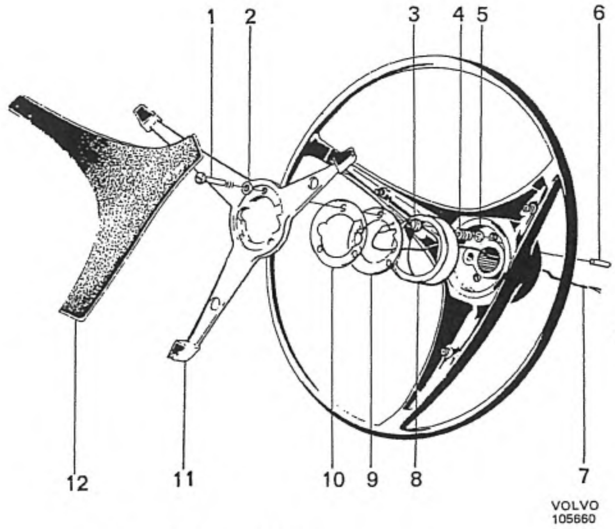


Fig. 3—103. Horn ring

1. Stop screw
2. Washer
3. Isolating bush
4. Thrust spring
5. Tab washer
6. Grooved straight pin
7. Horn cable
8. Contact ring
9. Contact washer
10. Isolating washer
11. Horn ring
12. Impact pad

REPLACING INTERIOR LIGHT BULB

Remove the bulb glass by pulling its lower section straight out. Replace the bulb. Refit the glass.

REPLACING MAP-READING LIGHT BULB

To remove the bulb, first press it in slightly and then turn it anti-clockwise.

REMOVING SWITCHES

To remove a switch, first unscrew the knob and then slacken the nut for the switch with a suitable screwdriver, see Fig. 3—104.
The rocker type switches are removed by compressing the snap-ons on the reverse side of the switch, after the switch can be pushed out.

REPLACING BRAKE LIGHT SWITCH

When replacing the brake light, make sure that the new switch is adjusted correctly so that it functions satisfactorily. The distance between the brake pedal released and the threaded bronze hub on the switch should be 4 ±2 mm (0.16 ± 0.008") (A, Fig. 3—105). If the distance must be adjusted, release the attaching screw for the bracket and move the bracket until the correct distance is obtained.

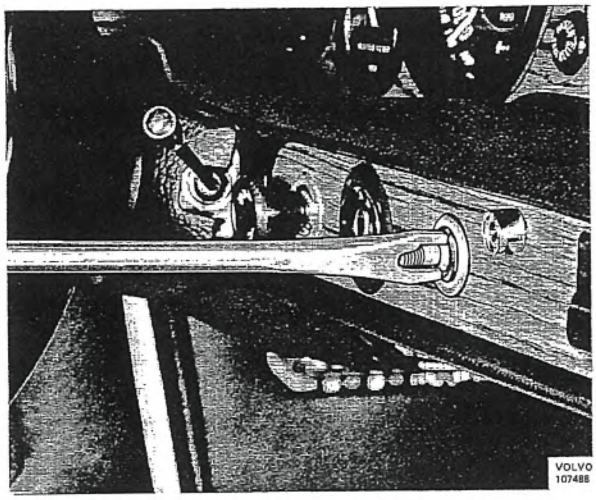


Fig. 3—104. Removing nut for switch

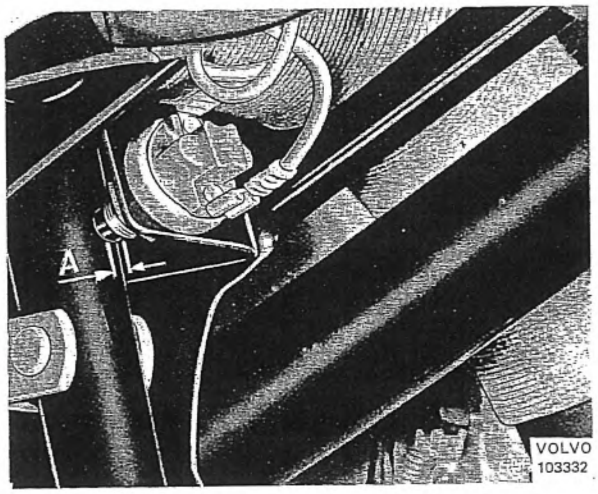


Fig. 3—105. Brake light switch

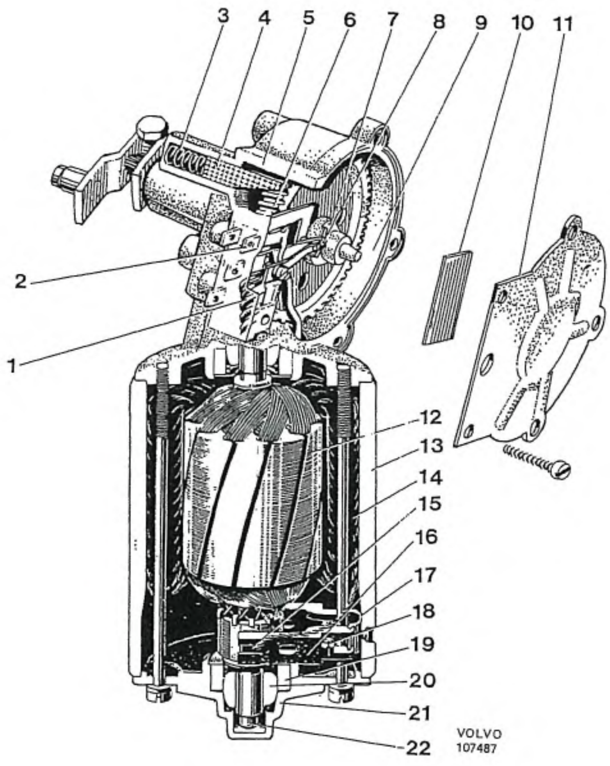


Fig. 3–106. Windshield wiper motor

1. Gear
2. Elec. connection switch
3. Spring
4. Key
5. Gear housing
6. Gear
7. Cut-out cam
8. Switch
9. Groove for packing
10. Space spring
11. Cover
12. Rotor
13. Stator
14. Field coil
15. Brush
16. Brush holder
17. Holder
18. Spring
19. Lubricating felt
20. Bearing bush
21. Cover
22. Shaft end

REMOVING WINDSHIELD WIPER UNIT COMPLETE

Disconnect the battery ground lead. Remove the wiper arms, both the nuts, washers and seals. Disconnect the electric cables to the wiper motor and remove both the bolts holding the wiper to the body.

INSTALLING WINDSHIELD WIPERS

The wipers are fitted in reverse order to removal.

DISASSEMBLING WINDSHIELD WIPER MOTOR

Remove the nut for the crank arm on the output shaft and tap loose the arm.
Remove the screws for the gear housing cover.
Lift off the cover.
Remove the gear wheel with output shaft and key with spring.
Remove the screws for the switch cover and lift off the cover and disconnect the electric cables to the wiper motor.
Remove both the screws holding together the gear housing, stator and cover.
Remove the cover and carefully separate stator and gear housing.
Lift off the rotor.
Assembling is in reverse order to disassembling.

GROUP 38

INSTRUMENTS

DESCRIPTION

Instrumentation consists of seven instruments:
Rev. counter, coolant temperature gauge, engine oil temperature gauge, speedometer, fuel gauge, oil pressure gauge and clock.

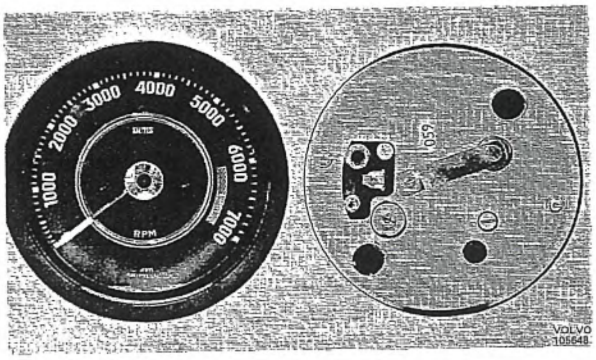


Fig. 3—107. Revolution counter, front and reverse

REVOLUTION COUNTER

The revolution counter is connected in series by means of a white and a red cable to the low-tension cable of the ignition system and is connected between ignition coil and distributor. The white cable is connected to the distributor and the red one to the ignition coil.
Firing impulses from the ignition coil are reinforced in the revolution counter with help of an inductance oil. A moving coil, linked with the revolution counter needle, turns in proportion to the frequency of the impulses from the ignition coil, so that the needle points to the speed of the engine.

TEMPERATURE GAUGE FOR COOLANT

The temperature is measured electrically, the temperature gauge being of the so-called bimetal type. The unit consists of a pickup mounted on the engine, and a gauge fitted in the combined instrument which is fed over a so-called voltage stabilizer. The pickup is of the semi-conductor type, that is, it contains a semi-conductor the electrical resistance of which alters with the temperature. Current through the pickup is proportional to the temperature indicated by the gauge.
The amount of current passing through the instrument and pickup determines how much the bimetal spring in the instrument is heated and thus how much temperature the needle indicates. A warmer engine permits more current to pass through the pickup and results in a higher gauge reading.

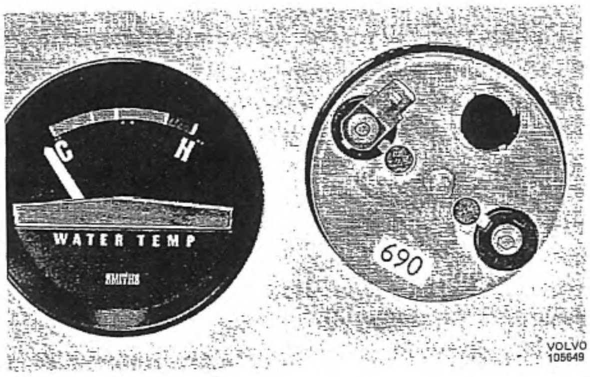


Fig. 3—108. Temperature gauge, coolant, front and reverse

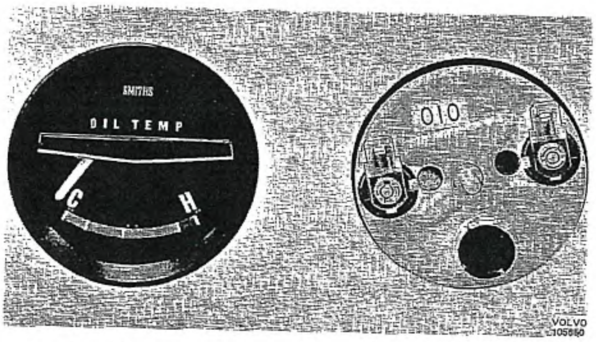


Fig. 3—109. Oil gauge, engine oil, front and reverse

TEMPERATURE GAUGE FOR ENGINE OIL

The unit consists of a pickup and gauge and its function is the same as the coolant temperature gauge. The pickup is located on the left-hand side of the engine.

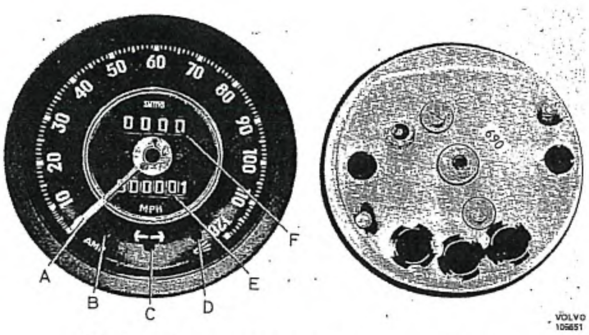


Fig. 3—110. Speedometer, front and reverse

SPEEDOMETER (Combined instrument)

In addition to the speedometer, the combined instrument also consists of a mileometer, trip meter and warning lamps for charging, directional indicators and fullbeam headlights. The speedometer is of the eddy current type. It houses a permanent magnet which is mechanically connected with a speedometer cable driven from a worm gear in the gearbox. On top of the magnet there is a drum which is linked via a separately journalled shaft to the speedometer gauge needle. Rotation of the magnet generates eddy currents which produce a turning torque on the drum. This rotation is proportional to the speed of the vehicle. The coil spring limits the degree of torque when the speed of the magnet increases. The effect of magnet and coil spring is balanced so that the rotation speed of the roller gives a speedometer gauge proportional to the speed of the car. The mileometer and trip meter are driven by a worm gear in the combined instrument.

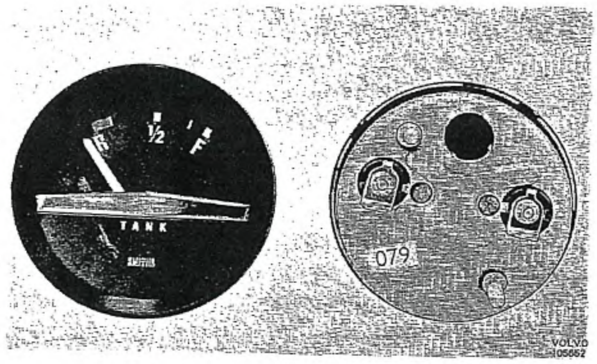


Fig. 3—111. Fuel gauge, front and reverse

FUEL GAUGE

The amount of fuel in the tank is measured electrically. This is achieved by means of a bimetal type indicating instrument and a pickup mounted in the fuel tank. Current is fed through the same voltage stabilizer as for the temperature gauge. The pickup consists of a variable resistor, a lever and a float. Depending upon the amount of fuel in the tank and, correspondingly, the position of the float, a larger or lesser part of the pickup resistor is in circuit. The bimetal instrument used here is of the same type as that for the temperature gauge.

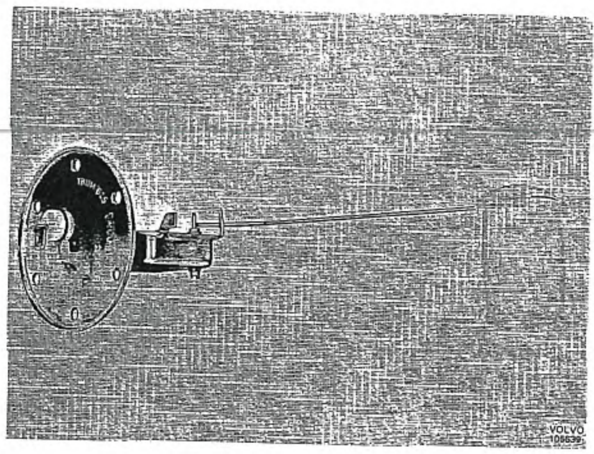


Fig. 3—112. Fuel gauge pickup in tank

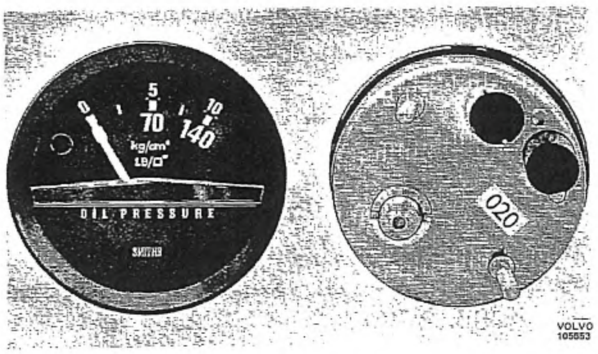


Fig. 3–113. Oil pressure gauge, front and reverse

OIL PRESSURE GAUGE

The oil pressure gauge, which is mechanical, is connected to the pressure lubricating system of the engine by means of a delivery pipe.

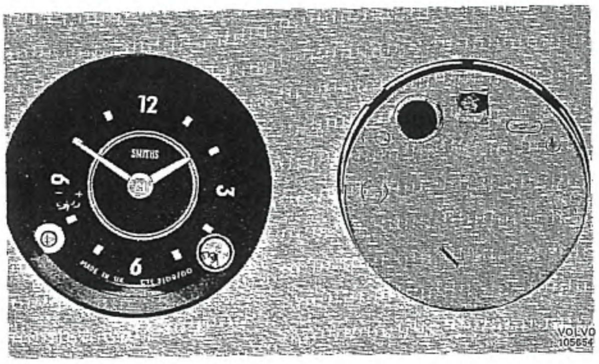


Fig. 3–114. Clock, front and reverse

CLOCK

The clock is electrically operated and receives current via the oil pressure sensor.

VOLTAGE STABILIZER

The temperature and fuel gauges are powered by a voltage of approx. 10±0.2 volts and are fed through a voltage stabilizer. The stabilizer contains a bimetal spring and a contact breaker. When the ignition is switched on, current flows through the stabilizer and out to the instruments. This heats the bimetal spring of the stabilizer which bends and thus breaks the circuit. As the spring cools, it returns to its original position and the circuit is closed again. This cycle is repeated continuously. A constant voltage of 10 ± 0.2 volts is mantained. The breaking and making of the circuit is not visible on the instruments due to their inertia. The stabilizer is mounted on the reverse side of the combined instrument.

WARNING LAMPS

CHARGING

The charging warning lamp is connected to the alternator. It lights up when the alternator voltage is lower than the battery voltage. As the battery voltage rises and commences to charge the battery, the warning lamp goes out. This is an indication that the alternator is charging.

DIRECTIONAL INDICATORS

The warning lamp for the directional indicators flashes when the indicators are engaged. It is connected across the switch for the indicators.

BRAKES

The brake warning lamp receives current via the ignition switch and can be grounded at two points: when the parking brake is applied, the warning lamp is grounded by the switch so that the warning lamp lights and remains lighted as long as the parking brake is applied.

Should a fault occur in one of the circuits of the hydraulic brake system so that the difference in pressure between the circuit, on application of the brakes, is more than 8–10 kp/cm^2 (114–142 psi), a warning valve (Fig. 3–116) closes and the warning lamp lights. The warning lamp blinks until the fault in the brake system is repaired and the warning valve re-set. Concerning re-setting the warning valve, see Part 5, Brakes, Group 52.

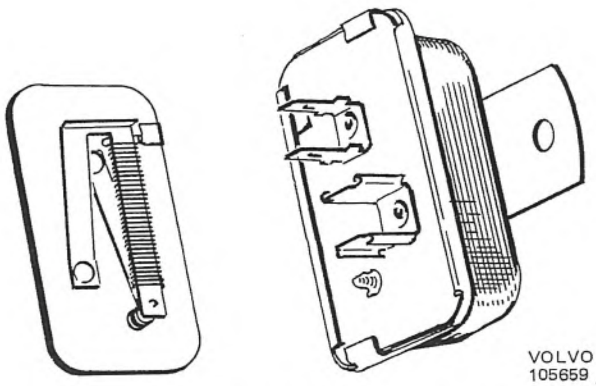


Fig. 3–115. Voltage stabilizer

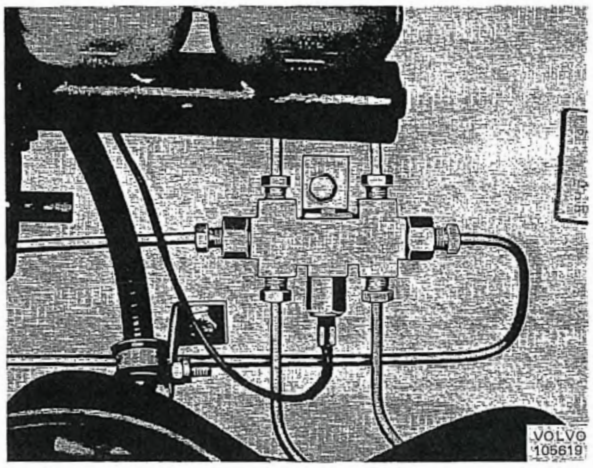


Fig. 3—116. Warning valve

FULL-BEAM HEADLIGHTS

A warning lamp for the full-beam headlights flashes simultaneously with the headlights. The lamp is connected in parallel with the full-beam headlights at the step relay.

OIL PRESSURE

The warning lamp for oil pressure receives current via the ignition switch and is grounded through a pressure sensitive valve on the engine. When the engine is running and the oil pressure normal, the connection between lamp and ground is open. When the oil pressure sinks below a pre-determined value, the pressure sensitive valve closes the circuit and the warning lamp lights.

REPAIR INSTRUCTIONS

During all work under the dashboard and instrument panel, disconnect the battery ground lead to avoid possible short-circuiting.
When replacing an instrument, first disconnect the connections on the reverse side, then remove the nuts and attaching iron and pull the instrument straight out.

When replacing the voltage stabilizer, make sure that the new stabilizer fits in the same position as the old one, otherwise the voltage from the stabilizer will be altered.
NOTE. Never connect a 12 volt source to the instruments which are normally fed by the voltage stabilizer. Check breakages, etc., with an ohmmeter.

gauge. A functional test on the stabilizer can be carried out with a temperature gauge or a fuel gauge in series with a resistance of about 12 ohms and a constant D.C. voltage of 10±0.2 volts. Note the reading. Then replace the D.C. voltage with a 12 volt battery and the voltage stabilizer. Do not forget to ground the stabilizer sleeve. The same reading should be obtained. During testing, the stabilizer must lie in the same position as it does in the car. Replace a damaged stabilizer with a new one since it cannot be repaired.

REMOVING OIL PRESSURE GAUGE

Disconnect the delivery pipe from the gauge, otherwise see above.

CHECKING VOLTAGE STABILIZER

The voltage stabilizer, see Fig. 3—115, is mounted with a screw to the reverse side of the oil temperature

CHECKING SPEEDOMETER CABLE

It is most important that the speedometer cable is correctly fitted if the speedometer is to function properly. It is vitally important that the cable is not bent too sharply. At no point must the radius of a bend be less than 100 mm (4"). If it is less than this, vibration and noise can occur in the instrument. The drive couplings must run true in the outer casing of the cable. This is checked with the cable rotating.

CHECKING COOLANT TEMPERATURE GAUGE

The sender and gauge are not repairable and the entire unit must be replaced if damaged. The gauge can be tested with an ohmmeter. The resistance should be about 58 ohms. This can be suitably measured between the nuts on the reverse side of the instrument plate. The sender should also be checked with an ohmmeter. Its resistance should be about 31.4–47.6 ohms at 100° C (212° F). The gauge can also be checked by connecting to a 12 volt battery across a voltage stabilizer and with a correct sender in series. During warming up, the instrument should show the corresponding temperature. A check can suitably be made with a thermometer (sender and thermometer lowered in heated water).

The checking value for the gauge are:	°C	°F
Beginning of green area	45	113
At first dividing line between green areas	70	158
At second dividing line between green areas	80	176
At dividing line between green and red areas	100	212

CHECKING ENGINE OIL TEMPERATURE GAUGE

The pickup and indicating instrument are not repairable and must be exchanged if faulty or damaged. The resistance of the indicating instrument should be about 58 ohms. This can suitably by measured between the nuts on the reverse side of the instrument. The pickup resistance should be between 140–160 ohms at 100° C(212° F).

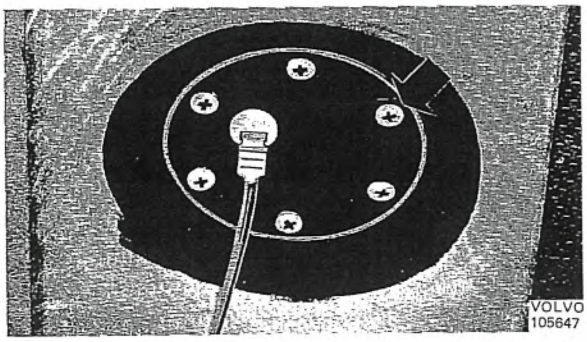


Fig. 3–117. Pickup for fuel gauge

REMOVING AND CHECKING FUEL GAUGE

The pickup and gauge cannot be repaired but must be replaced as a complete unit. The instrument can be tested with an ohmmeter. Its resistance should be about 58 ohms. This can be measured between both the contact washers on the reverse side of the instrument. To remove the pickup, Fig. 3–117, open the cover in the luggage compartment, remove the spare wheel and lift aside the mat. The pickup is fixed by means of six crosshead screws. Use a crosshead screwdriver to remove these screws. The pickup is checked with an ohmmeter. At the upper stop, full tank, the pickup should have a resistance of 16–22 ohms. At the lower stop, empty tank, the resistance should be 240–260 ohms. Moving the float arm backwards and forwards should not cause a break in the circuit (gauge reading). It is not permitted to check the instrument by connecting the pickup line to the body of the vehicle, as this would ruin the instrument.

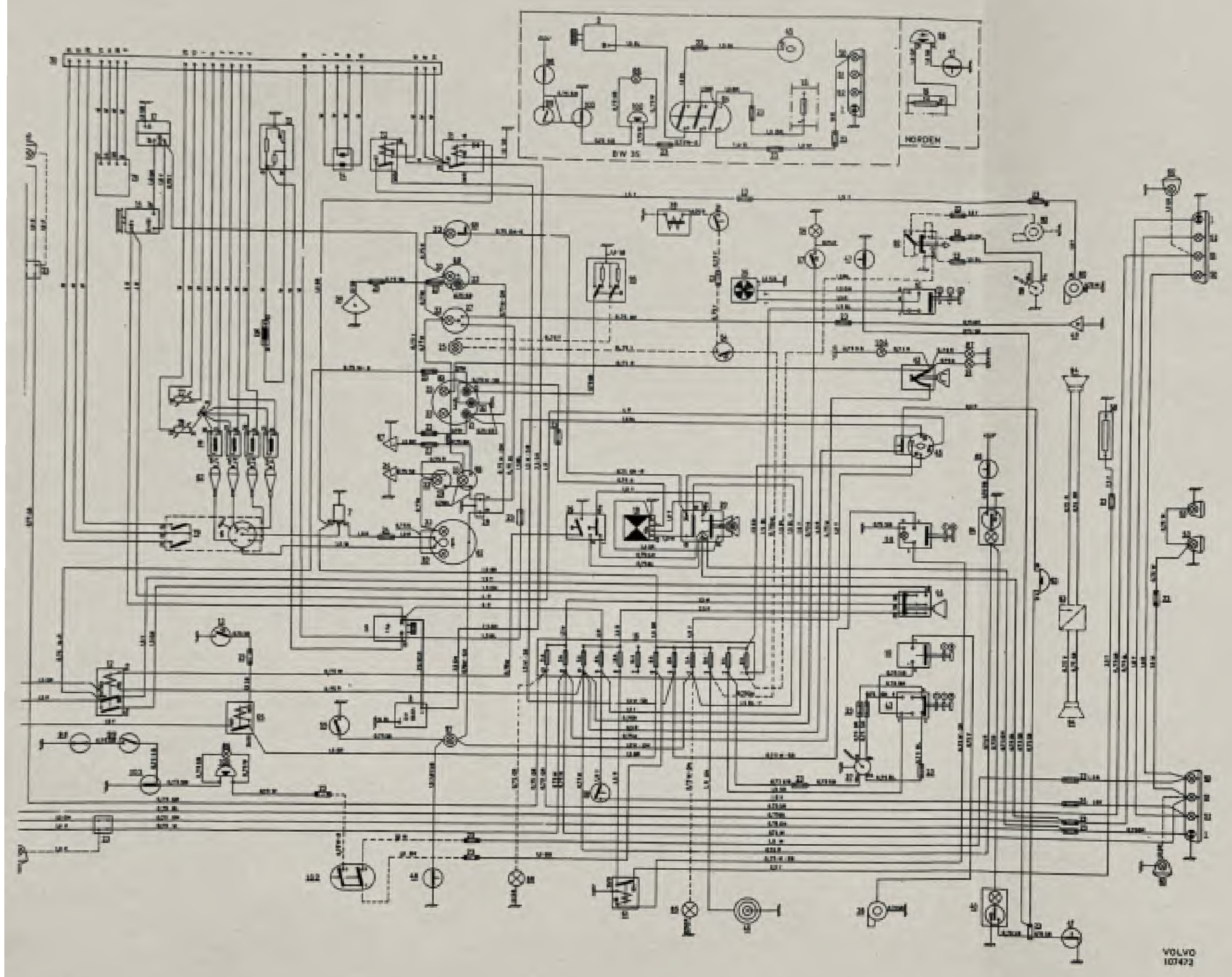


Illustration 3—A. Wiring diagram

1	Dir. ind. flashers	32 CP
2	Parking lights	4 CP
3	Headlight dipped beams	40 W
4	Headlight main beams	45 W
5	Horn	
6	Distributor firing order	1-3-4-2
7	Ignition coil	
8	Battery	12 V 60 Ah
9	Starter motor	1.0 hp
10	Switch for windshield washer	
11	Main beams warning lamp	
12	Dipper relay for main and dipped beams and headlight flashers	
13	Horn ring	
14	Alternator	35 A
16	Fusebox	
17	Charging regulator	
18	Brake contact	
19	Flasher unit	
20	Switch for emergency warning flashers	
21	Battery charging warning lamp	3 W
22	Oil pressure warning lamp	2 W
23	Connector	
24	Connector (R-H drive only)	
25	Overdrive warning lamp M41	1.2 W
26	Switch for dir. ind. and headlight flashers	
27	Fuel gauge	
28	Voltage stabilizer	
29	Temperature gauge	
30	Oil pressure sender	
31	Contact for overdrive on gearbox M41	
32	Flashers warning lamp	3 W
33	Instrument panel light	
34	Coolant temperature sensor	
35	Heater control light	3 W
36	Heater	
37	Windshield wipers	
38	Windshield washer	
39	Solenoid for overdrive on gearbox M41	
40	Interior lamp	10 W
41	Switch for heater	
42	Switch for windshield wipers and washer	
43	Instrument panel light rheostat	
44	Light switch	
45	Starter switch	
46	Cigarette lighter	
47	Door switch	
48	Switch for parking brake control	
49	Fuel gauge tank unit	
50	Reversing light	32 CP
51	Rear lights	4 CP
52	Brake stoplights	32 CP
53	License plate light	2x4 CP
54	Switch for overdrive M41	
55	Brake warning contact	
56	Map light	
57	Switch for map light	
58	Elec. heated rear window	
59	Switch, elec. heated rear window	
60	Side marker lights (USA only)	5 W
61	Relay for elec. heated rear window	
62	Spark plugs	
63	Warning buzzer	
64	Contact on gearbox BW 35	
65	Horn relay	
66	Oil temperature gauge	
67	Oil temperature sensor	
68	Oil pressure gauge	
69	Clock	
70	Electronic unit	
71	Main relay for fuel injection	
72	Relay for fuel pump	
73	Thermal timer contact	
74	Pressure sensor	
75	Throttle valve switch	
76	Start valve	
77	Temperature sensor I	
78	Temperature sensor II	
79	Triggering contact	
80	Fuel pump	
81	Injection valves	
82	Rev. counter	
83	Speedometer	
84	Interior light, rear	10 W
85	Seat belts light	2 W
86	Seat belt warning lamp	
87	Lighting for switch	
88	Shift positions light (BW 35 only)	
89	Door switch, rear	
90	Tailgate washer	
91	Tailgate wiper	
92	Switch for tailgate wiper and washer	
93	Radio	
94	Loudspeaker	
95	Dimmer switch for overdrive warning lamp M41	
96	Warning buzzer light	
97	Brake warning lamp	
98	Contact, seat buckle, passenger	
99	Contact, passenger seat	
100	Warning buzzer, safety belts	
102	Contact, gearbox M41	
103	Contact, seat buckle, driver	
104	Decal lighting (only USA)	

Colour	code:
SB	Black
W	White
Y	Yellow
GN	Green
GR	Grey
BL	Blue
R	Red
BR	Brown
W-SB	White-black
W-GN	White-green
BL-R	Blue-red
BL-W	Blue-white
BL-Y	Blue-yellow
GN-R	Green-red

Part 4

POWER TRANSMISSION, REAR AXLE

CONTENTS

GROUP 41

CLUTCH

TOOLS

The following special tools are used for work on the clutch.

The special tools are preceded either by 999 or SVO (e.g. 999 1801 or SVO 1801).

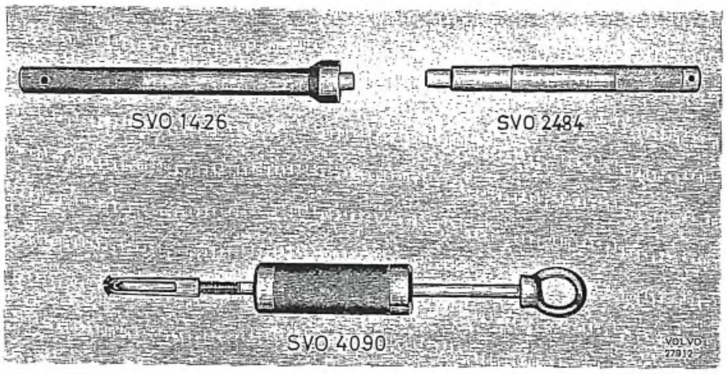


Fig. 4—1. Special tools
999 (SVO) 1426 Drift for pilot bearing in flywheel.
999 (SVO) 2484 Mandrel for centering clutch plate.
999 (SVO) 4090 Puller for ball bearing in flywheel.

DESCRIPTION

The clutch (Illustration 4-A) is of the diaphragm spring type. It mainly consists of a pressure plate, a diaphragm spring and clutch casing. The diaphragm spring has a double function, that of a clutch lever when declutching and a pressure spring when engaging.

The clutch is operated by the clutch pedal, the movements of which are transferred to the clutch via a wire, a lever and a release bearing.

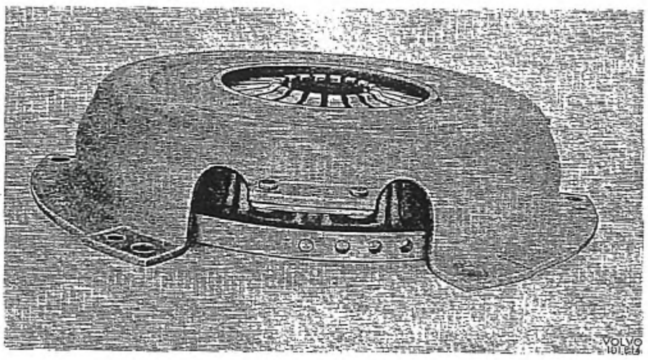


Fig. 4—2. Clutch

WORK ON CLUTCH IN VEHICLE

REPLACING CLUTCH WIRE

1. Unhook the return spring for the release fork. Slacken the rear nut and possibly the front nut a couple of turns. Disconnect the wire from the release fork.
2. Loosen the clamp holding the wire to the reinforcing member of the wheel housing.
3. Take off the bearing bolt for the pedal. Disconnect the wire from the pedal. Slacken the nut for the wire sleeve. Remove the wire.
4. Fit the new wire in the reverse order to removal.

REPLACING CLUTCH PEDAL OR BUSHES

The description given below is applicable if it concerns either the replacement of the pedal or of the bushes.

1. Unhook the return spring for the pedal. Slacken the nut and remove the bolt. Disconnect the pedal from the wire and remove the pedal.
2. Take out the tubular shaft. Drive out the bushes with a suitable drift.
3. Fit the new bushes. Lubricate them with grease. Fit the tubular shaft.
4. Place the return spring on the bearing sleeve of the pedal. Move the pedal into position and attach it to the wire. Fit the bolt which holds the pedal.
5. Hook on the return spring. Check and if necessary adjust the clutch fork free travel.

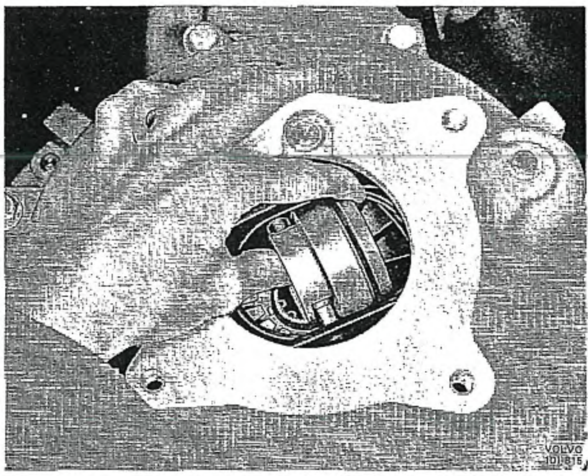


Fig. 4–3. Removing release bearing

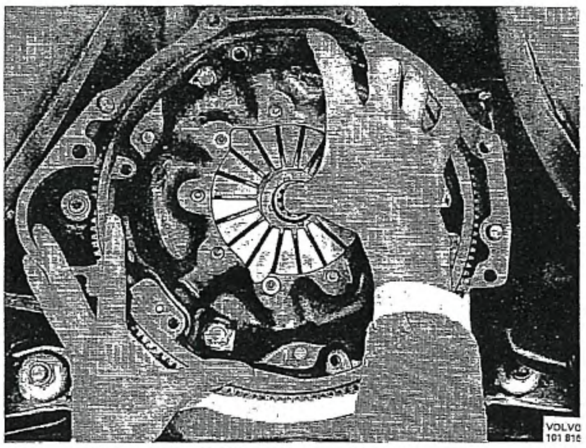


Fig. 4–4. Removing clutch

REMOVING CLUTCH

1. Remove the gearbox according to the instructions given in Group 43.
2. Remove the upper bolt for the starter motor.
3. Remove the release bearing. See Fig. 4–3. Disconnect the wire from the release fork. Slacken the wire sleeve from the bracket.
4. Slacken the bolts and remove the flywheel housing.

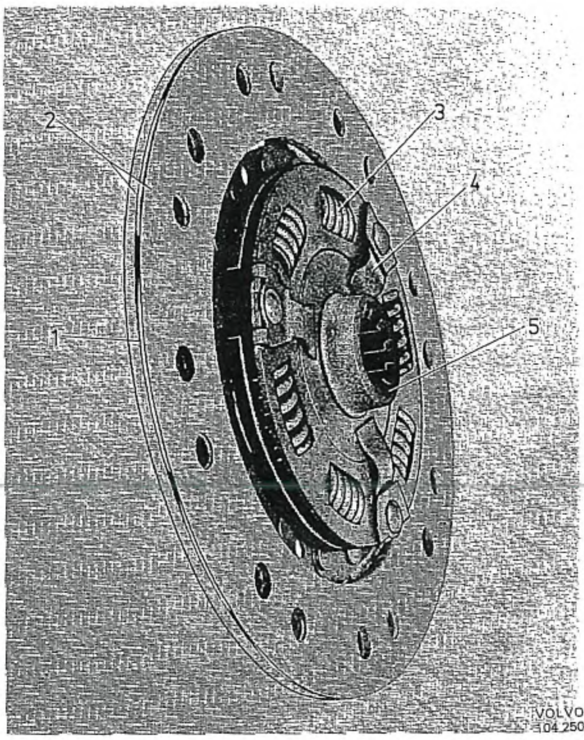


Fig. 4–5. Clutch disc

1. Disc
2. Facings
3. Spring
4. Damping spring
5. Hub

5. Slacken the bolt for the release fork ball joint. Remove the ball and the release fork.
6. Slacken the bolts holding the clutch to the flywheel by loosening them crosswise a couple of turns at a time to prevent warping. Remove the clutch and clutch plate. See Fig. 4—4.

REPLACING CLUTCH FACINGS

1. Drill out the old rivets with a drill having the same diameter as the rivets, 3.5 mm (0,14"), and remove the old facings.
2. Check the clutch plate. The indentations on the tongues should be even. The clutch plate must not be warped. The clutch springs and rivets in the hub should fit securely and not show any signs of looseness. Check to make sure that there are no cracks.
   If the clutch plate has any of the above defects, it should be replaced with a new one.
3. Rivet on the new facings (preferably in a rivet press). NOTE. The rivets should be inserted from the side on which the facing lies and riveted up from the opposite direction against the disc. Use every other hole in the facing. After riveting, the facings should be spaced from each other as determined by the indentations on the clutch disc. See Fig. 4—5. This is most important in order to achieve a smooth engagement when starting and driving.
   The clutch facings must be absolutely free from oil. Oil on the facings can cause clutch grabbing.

INPUT SHAFT BEARING IN FLYWHEEL

1. The bearing is pulled out with puller 4090, see Fig. 4—6. The bearing is cleaned in gasoline (petrol). If the bearing, upon inspection, runs smoothly and evenly and has no noticeable play, it should be packed with ball bearing grease and re-fitted. NOTE. Heat-resistant grease should be used.
   The bearing should be pressed in by drift 1426.

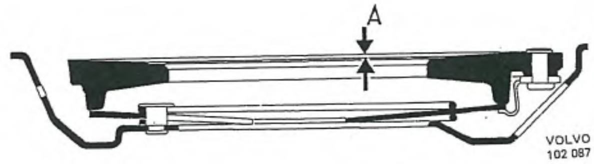


Fig. 4—7. Checking curvature of pressure plate

INSPECTING

As the clutch cannot be disassembled, it must be replaced complete if faulty. Check the clutch carefully. Check the pressure plate for damage by heat, cracks, scoring or other damage on the friction surface. Check the curvature of the pressure plate with a 240 mm (9 1/2") long steel ruler, which is placed diagonally across the friction surface of the pressure plate. Then measure the distance between the straight edge of the ruler and the inner diameter of the pressure plate. This measurement must not exceed a maximum 0.03 mm (0.0012"), see Fig. 4—7. There must be no "crowning", i.e. clearance between the straight edge of the ruler and the outer diameter of the pressure plate. Carry out the check at several points. Check the pressure spring carefully; if it is cracked or damaged in any other way, the clutch should be replaced.

Check the release bearing by turning it round a few times under light pressure so that the balls rotate against the races. The bearing should turn easily without binding at any point. The release bearing

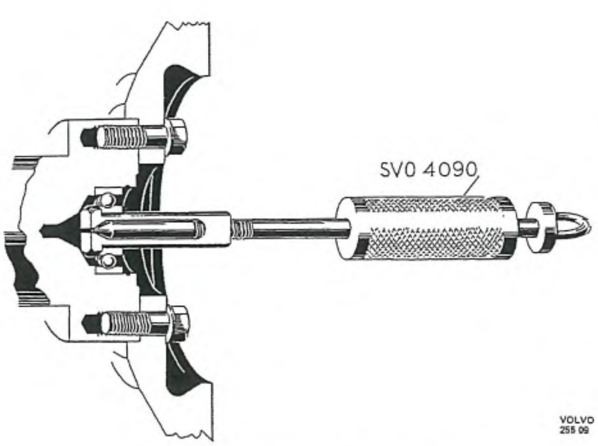


Fig. 4—6. Removing pilot bearing

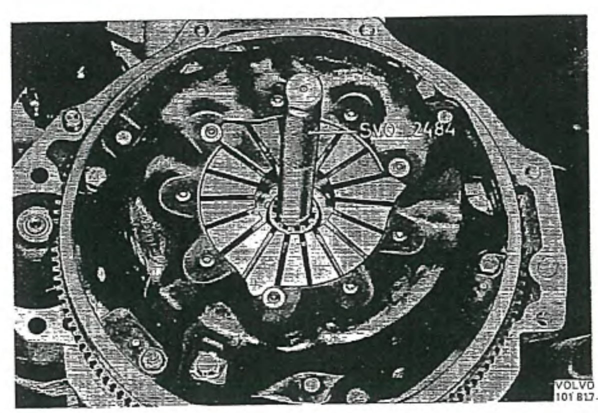


Fig. 4—8. Installing clutch

should also slide easily on the guide sleeve from the gearbox.

INSTALLING

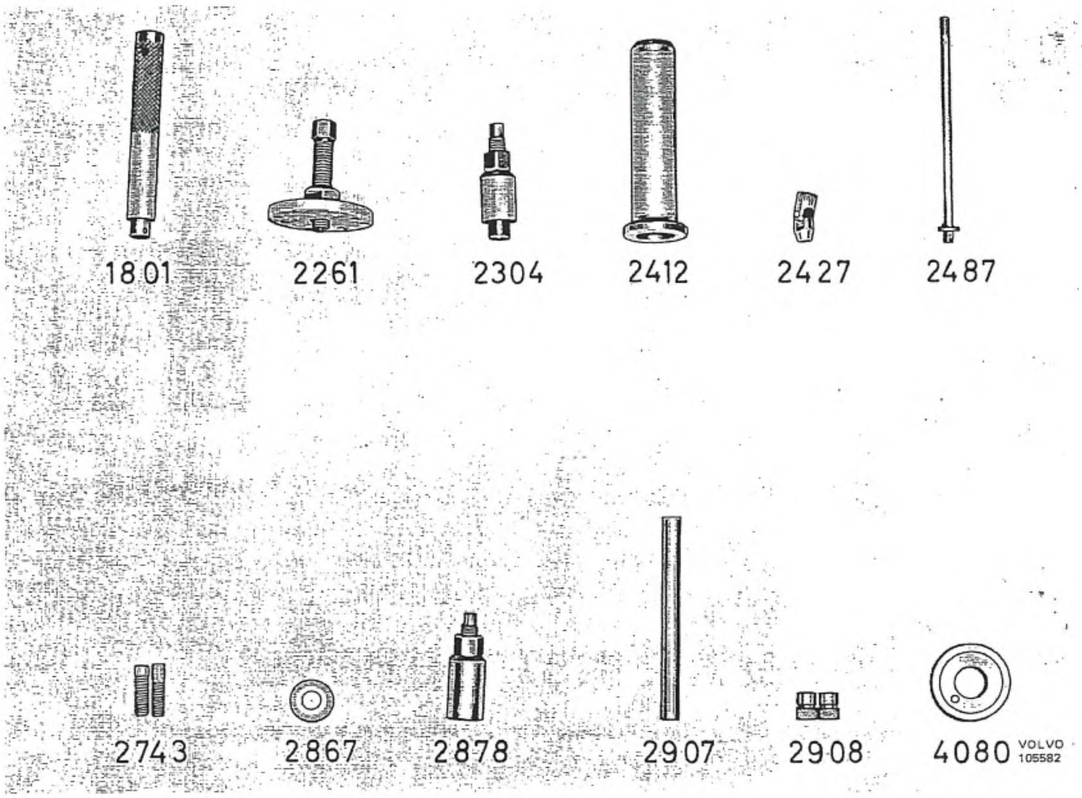
Before installing, check that the clutch facings, flywheel and pressure plate are completely free from oil. Wash them with clean gasoline (petrol) and wipe off well with a clean piece of cloth.

1. Set up the clutch plate (the longest side of the hub facing backwards) together with the clutch and insert the centering mandrel 2484 so that the guide journal on this centers the pilot bearing in the flywheel, see Fig. 4—8.
2. Fit the six bolts which hold the clutch and tighten them crosswise a couple of turns at a time. Remove the centering mandrel.
3. Fit the release yoke in the flywheel housing.
4. Place the upper bolt for the starter motor in the housing. Then install the housing. Fit the bolts in the following order: First the four upper (7/16"), and then the lower bolts for the starter motor, and finally the two lower (3/8"). The nut for the starter motor upper bolt is fitted after the clutch wire has been fitted.
5. Insert the wire sleeve in the bracket and put on the rear nut. Securely fix the wire in the release fork. Fit the release bearing.
6. Fit and tighten the nut for the upper starter motor bolt.
7. Install the gearbox according to the instructions given in Group 43.
8. Adjust the clutch fork free travel.

GEARBOX

TOOLS

The following special tools are required for carrying out gearbox repairs.
The special tools are preceded either by 999 or SVO (e.g. 999 1801 or SVO 2261).



999
(SVO) **Fig. 4—9. Special tools**

1801 Standard handle 18x200 mm
2261 Puller for flange
2304 Press tool for fitting flange
2412 Drift for fitting bearing on input shaft and for fitting input shaft in housing
2427 Universal joint for 2487
2487 3/8" hexagon socket spanner for upper gearbox bolts
2743 Guide pins for gearbox
2867 Drift for fitting oil seal in cover for input shaft
2878 Puller for removing reverse shaft
2907 Mandrel for fitting idler gear
2908 Centering plug for thrust washer, used (two) together with 2907 when fitting idler gear
4080 Drift for fitting bearing in rear cover
The following tools are also used:
2520 Stand for fixture 2922
2922 Fixture for gearbox when disassembling and assembling (used together with 2520, see Fig. 4—13)

DESCRIPTION

M 41 is a four-speed fully synchronized gearbox supplemented with an overdrive. Concerning overdrive, see Group 43 B. The fact that the gearbox is fully synchronized means that there is synchronization on all the forward gears. The construction of the gearbox is shown in Fig. 4—10 and Illustration 4—B. All gears with the exception of reverse are in constant mesh with one another. In the neutral position the gears on the mainshaft rotate freely. For this reason they are provided with bronze bushes. When a gear is engaged, the corresponding gear wheel is connected to the mainshaft by means of an engaging sleeve.
The gear lever positions are shown in Fig. 4—11.

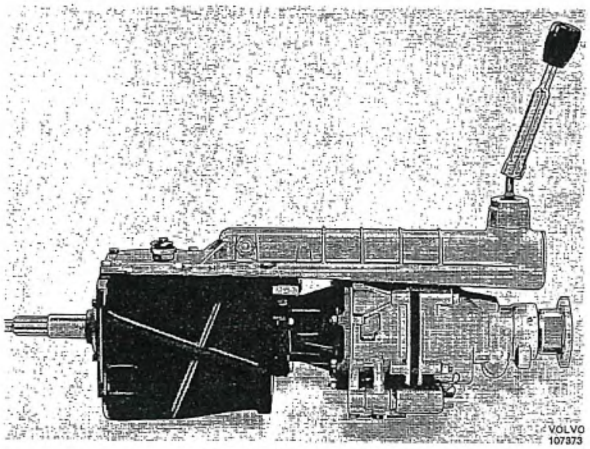


Fig. 4—10. Gearbox

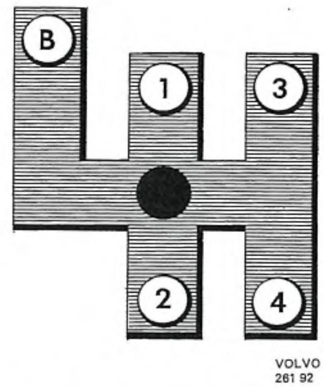


Fig. 4—11. Gear lever positions

REPAIR INSTRUCTIONS

Concerning repair instructions for overdrive, see Part 4 (43 b), "Overdrive".

REMOVING

1. Remove the oddments console on the tunnel and the gear lever.
2. Disconnect the ground battery lead. Remove the attaching bolts for the radiator.
3. Hoist the vehicle and place four axle props underneath.
4. Unscrew the bolts holding the propeller shaft to the flanges and also the attaching bolts for the support bearings. Pull the propeller shaft about 10 cm (0,4") to the rear.
5. Support under the oil sump with a jack. Insert a wooden block in between sump and jack.
6. Remove the screw for the exhaust pipe front clamp, the speedometer hose from the gearbox and the cross-member and rear engine mounting.
7. Lower the engine about 20 mm (0,8"). Disconnect the electric cables from contacts and attachment to gearbox.
8. Slacken the right upper and left lower gearbox bolts with spanner 2487, flexible joint 2427, extension piece with 3/8" square end and ratchet handle, see Fig. 4—12. Fit two guide pins 2743, see Fig. 4—25. Slacken the other two bolts. Pull out the gearbox backwards and lower it.

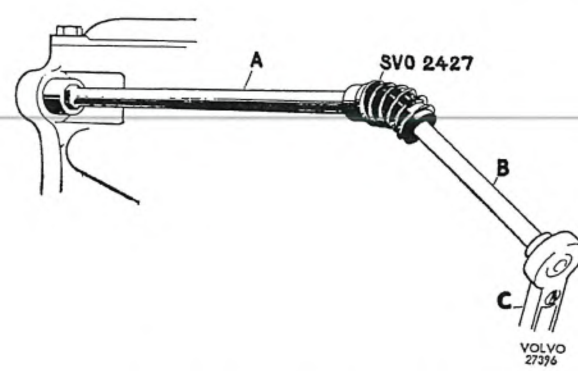


Fig. 4—12. Removing gearbox bolts

A=2487
B=Extension with 3/8" square
C=Ratchet handle

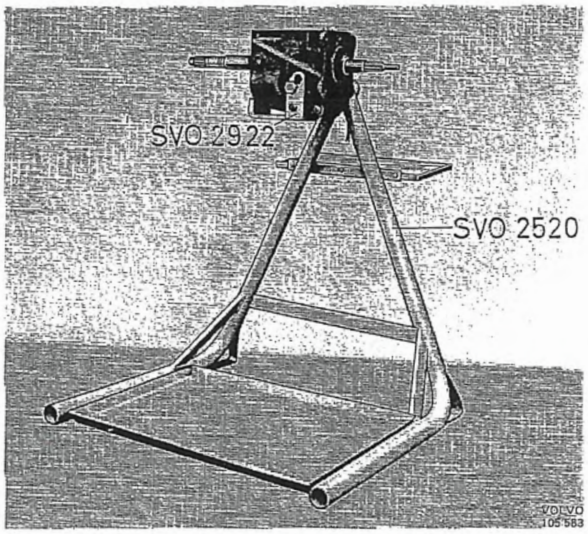


Fig. 4—13. Gearbox in fixture

DISASSEMBLING

1. Fit fixture 2922 in stand 2520. Place the gearbox in the fixture, see Fig. 4—13.
2. Unscrew the bolts for the gearbox cover. Lift off the cover. Remove the springs and interlock balls for the selector rails.
3. Unscrew the nuts securing the overdrive to the intermediate flange. Remove the overdrive.
4. Remove the cover over the selector rails. Unscrew the selector fork bolts.
5. Slide the selector fork backwards to 1st speed position. Drive out the pin slightly (it must not foul the 1st speed gear wheel). Then move the selector fork forwards sufficiently to allow the pin to pass in front of the gear wheel. Drive out the pin.
6. Slide out the selector rails. When doing this, hold the selector forks so that they do not come askew and jam on the rails. Remove the selector forks.
7. Unscrew the bolts for the rear cover. Turn the cover so that it does not lock the shaft for the idler and reverse gears. Drive out the shaft for the idler gear. **NOTE. The shaft must be driven out backwards.** Let the idler gear fall into the bottom of the gearbox.
8. Pull out the mainshaft.
9. Unscrew the bolts and remove the cover over the input shaft. Lever out the oil seal from the cover with a screwdriver or similar.
10. Drive out the input shaft. If necessary, remove the circlip and press the ball bearing off the shaft.
11. Take out the idler gear. Pull out the shaft for the reverse gear with puller 2878, see Fig. 4—14. Take out the reverse gear and other parts.

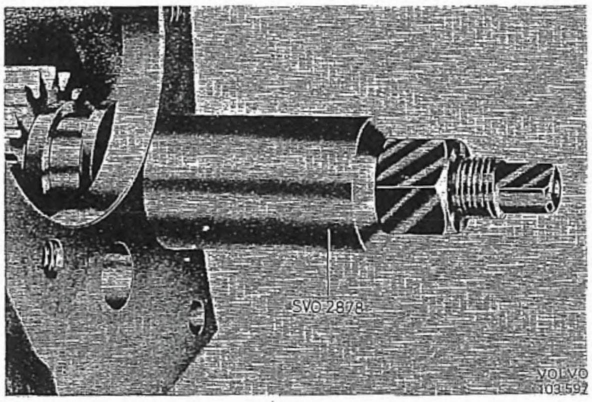


Fig. 4—14. Removing reverse gear

DISASSEMBLING MAINSHAFT

1. Remove the circlip and press off the rotor for the overdrive oil pump. Remove the circlip for the mainshaft rear bearing. Slide the engaging sleeve for 1st speed and 2nd speed forwards. Place the shaft in a press and a support under the 1st speed gear wheel. Press out the shaft as shown in Fig. 4—15.
2. Remove the synchronizing cone, thrust washer, engaging sleeves, engaging springs, and snap rings from the shaft.

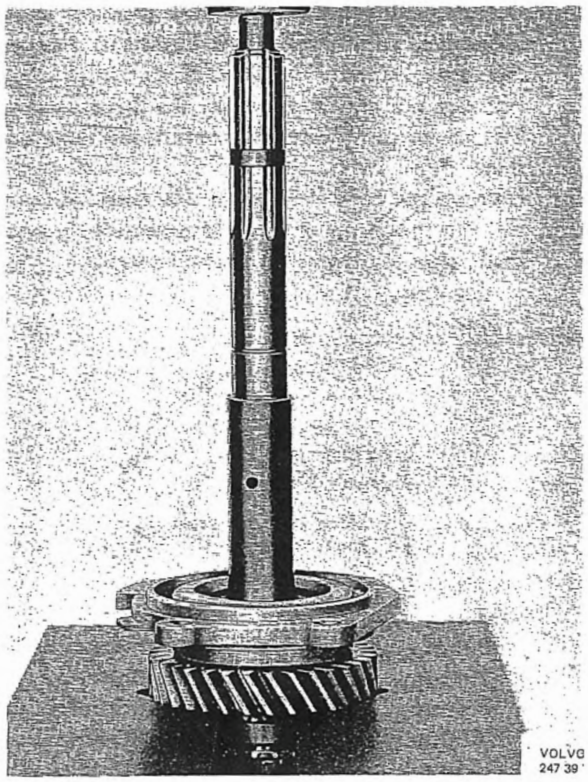


Fig. 4—15. Disassembling mainshaft

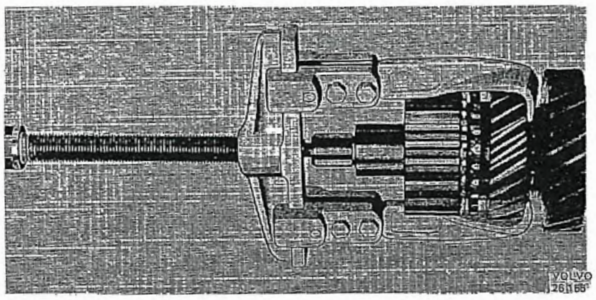


Fig. 4–16. Removing front synchronizer

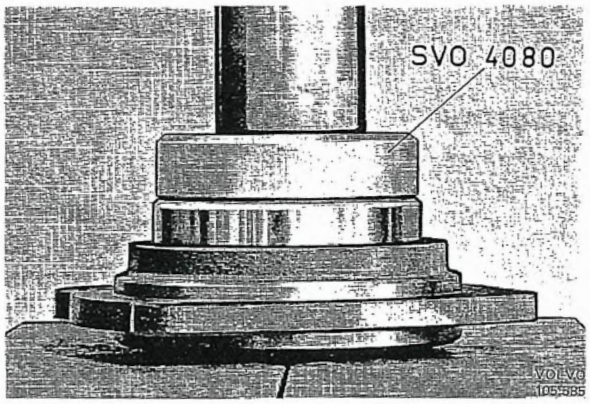


Fig. 4–17. Installing ball bearing in rear cover

3. Remove the circlip on the front end of the shaft. Pull off the synchronizing hub and 3rd speed gear wheel with a puller, see Fig. 4–16. Remove the thrust washer.
4. Remove the circlip and then the thrust washer, 2nd speed gear wheel, synchronizing cone and spring.
5. Remove the oil seal from the rear cover and take out the speedometer gear. If necessary, remove the circlips and press out the ball bearing.

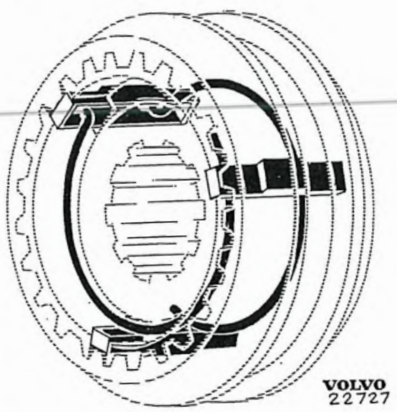


Fig. 4–18. Assembling synchronizer

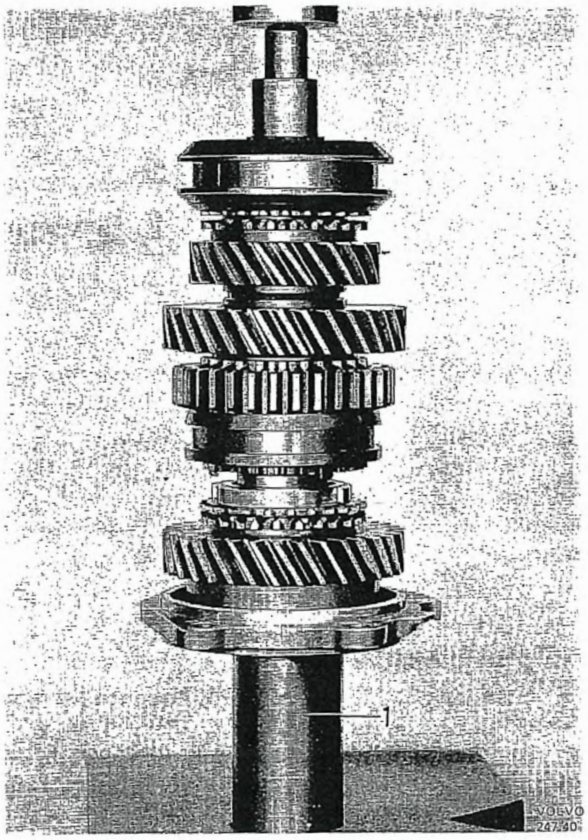


Fig. 4–19. Installing rear cover
1. Sleeve

INSPECTING

Check the gear wheels, particularly for cracks or chips on the tooth surfaces. Damaged or worn gears must be replaced.
Check the ball bearings, particularly for scoring or cracks on the races or balls.

ASSEMBLING

ASSEMBLING MAINSHAFT

1. Press the ball bearing into the rear cover, see Fig. 4–17, and fit the circlip. There are different thicknesses of circlips, so select one which fits snugly into the groove.
2. Install the parts for the 1st and 2nd synchronizer on the mainshaft. Fit the snap rings correctly, see Fig. 4–18.
3. Place the rear cover and ball bearing on a cushioning ring or sleeve as shown in Fig. 4–19. Fit the thrust washer, 1st speed gear wheel and synchronizing cone. Press in the shaft. Select a circlip of suitable thickness and fit it. Fit the key, the rotor for the oil pump and circlip.
4. Install the synchronizing cone, 2nd speed gear

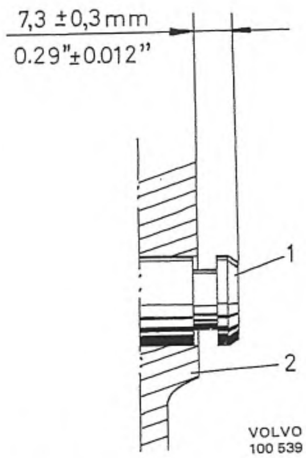


Fig. 4–20. Installing reverse shaft

wheel and thrust washer on the shaft. Select a circlip which fits snugly into the groove on the shaft and fit it.

5. Install the thrust washer, 3rd speed gear wheel and synchronizing cone on the shaft. Assemble the 3rd and 4th speed synchronizing parts. Fit the snap rings correctly, see Fig. 4–18. Then install the synchronizer on the mainshaft. Select a locking ring of the correct thickness and fit it.

ASSEMBLING GEARBOX

1. Fit the striker lever and striker. Fit the reverse gear and reverse shaft. The reverse shaft is fitted so that it projects 7.0–7.6 mm (0.276–0.300") outside the gearbox housing, see Fig. 4–20.
2. Place mandrel 2907 in the idler gear. Fit the spacing washers and needles (24 in each bearing). Use grease to hold the needles and washers in position.
3. Fix the washers to the housing with grease and guide them up into position with the centering

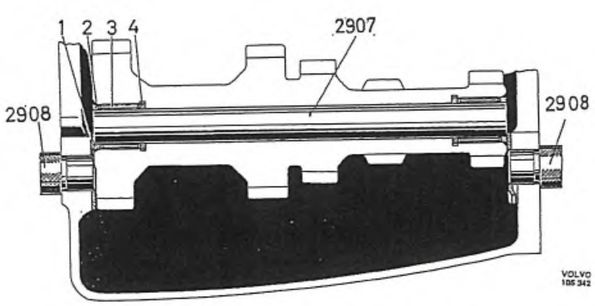


Fig. 4–21. Installing idler gear

1. Thrust washer
2. Spacing washer
3. Needle bearing
4. Spacing washer

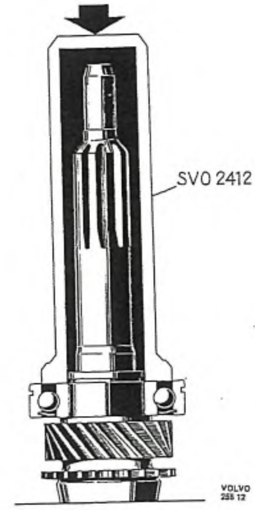


Fig. 4–22. Installing ball bearing on input shaft

plugs 2908, see Fig. 4–21. Lay the idler gear in the bottom of the housing.

4. Press the bearing onto the input shaft with the help of drift 2412, see Fig. 4–22. Select a circlip of suitable thickness and fit it. Place the 14 bearing rollers for the mainshaft in position in the input shaft. Use grease to hold the rollers in place. Press the input shaft into position in the housing. Press the oil seal into the cover with drift 2867.
Then fit the cover over the input shaft. Do not forget the O-rings for the bolts.
5. Place the mainshaft in the housing. Turn the rear cover so that the countershaft can be fitted.
6. Turn the gearbox upside down. Fit the countershaft from the rear. Hold against 2907 with the hand. Ensure that the thrust washers do not loosen and fall down.
7. Install the overdrive. Use new locking for the intermediate flange.

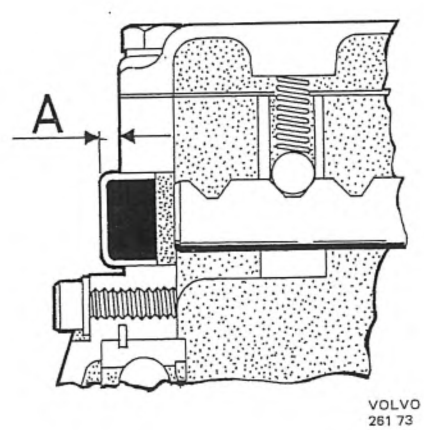


Fig. 4–23. Installing end cap over selector rail
A=approx. 4 mm (0.16")

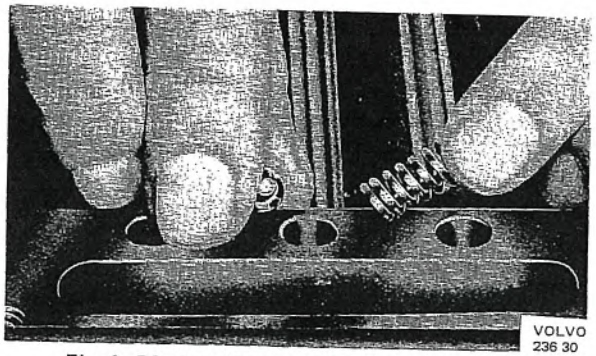


Fig. 4–24. Installing interlock balls and springs

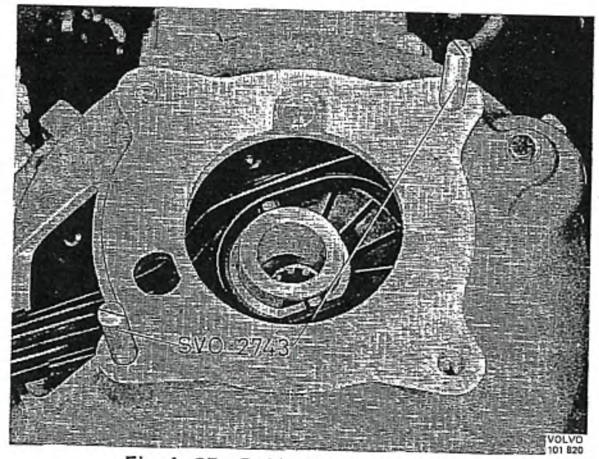


Fig. 4–25. Guide pins for gearbox

8. Install the selector rails and forks. Move over the selector fork to the rear position when fitting the pin. Use a new pin. Fit the cover over the selector rails.
   NOTE. If the end caps at the front end of the housing have been removed, these should be fitted in the same way as previously, i.e. the center end cap should project about 4 mm (0.16") outside the face of the housing, see Fig. 4–23.

9. Place the interlock balls and springs in position, see Fig. 4–24. Fit on the gearbox cover. Check that all the gears engage and disengage freely.

INSTALLING

Make sure that guide pins 2743 are fitted acc. to Fig. 4–25. Installing is done in the reverse order to removal. Fill up the gearbox with oil.

GROUP 43 B

OVERDRIVE

TOOLS

The following special tools are required for work on the overdrive unit.

The special tools are preceded either by 999 or SVO (e.g. 999 1801 or SVO 1801).

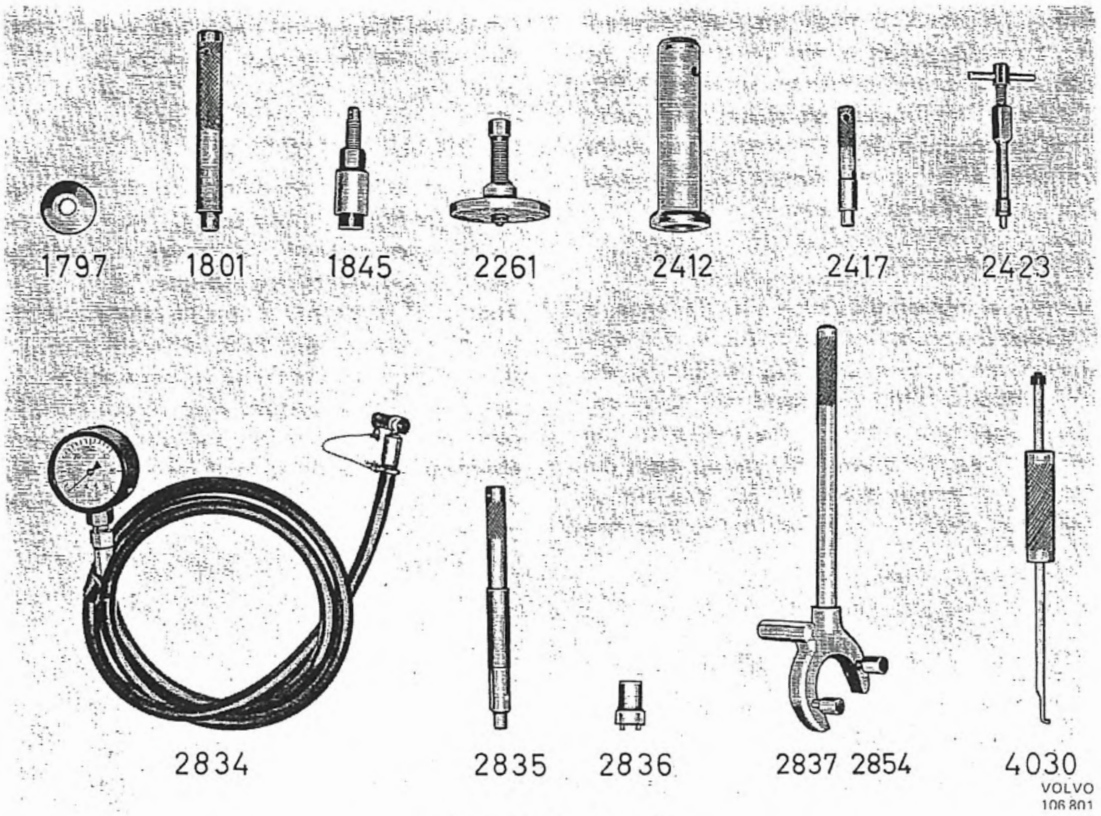


Fig. 4–26. Special tools

999
(SVO)

1797 Drift for removing rear bearing, output shaft
1801 Standard handle
1845 Press tool for fitting flange
2261 Puller for flange
2412 Sleeve drift for fitting front rear bearing on output shaft and oil seal at flange
2417 Drift for fitting bush in output shaft
2423 Puller for bush in output shaft

999
(SVO)

2834 Pressure gauge for checking oil pressure
2835 Centering mandrel for splines in planet carrier and uni-directional clutch
2836 Socket for removing and fitting plugs for fine filter oil pump and relief valve
2837 Counterhold for flange (cars fitted with B 20 E)
2854 Counterhold for flange (cars fitted with B 20 F)
4030 Puller for oil seal at flange

DESCRIPTION

The overdrive unit is of the epicyclic type and is attached to the rear end of the gearbox. Its design and construction are shown in Fig. 4–34 and Illustration 4–C. The working principle of the overdrive is as follows:

DIRECT DRIVE POSITION

When travelling forwards, power is transmitted from the gearbox mainshaft through the uni-directional clutch to the output shaft of the overdrive. At the same time the clutch sliding member (position 1, Fig. 4–27) is pressed by four springs against the tapered part of the output shaft. When reversing or when the engine acts as a brake, the torque is transmitted through the clutch sliding member.

OVERDRIVE POSITION

In the overdrive position the clutch sliding member is pressed against the brake ring (see II, Fig. 4–27) with the help of the pistons (27, Fig. 4–34) in the hydraulic cylinders. This also locks the sunwheel. Since the planet gear retainers are linked to the mainshaft through the splines, the planet gears are forced to rotate around the sunwheel. The output shaft will thus rotate at a higher speed than the mainshaft.

ELECTRICAL SYSTEM

The overdrive is engaged by electro-hydraulic means. On the gearbox cover there is a contact which cuts in when 4th speed is engaged. Thus the overdrive can only be engaged when this speed is engaged. It is switched on by means of a switch placed underneath the steering wheel. This switch closes the circuit via the switch on the gearbox to a solenoid on the overdrive. The solenoid armature is thus moved and this operates the control valve to the position for overdrive.

HYDRAULIC SYSTEM

The hydraulic system consists of the following main parts: Pre-filter, plunger pump, fine filter, hydraulic cylinders and plungers, relief valve and a control valve which is operated by the solenoid.

The relief valve has a special construction with a hydraulic piston and three different springs. It has three different functions: It must maintain a low pressure in the system with direct drive, a high pressure with overdrive, and also provide smooth changing when shifting from overdrive to direct drive and vice versa. Its function is described in more detail below.

The oil flow with direct drive is shown in Fig. 4–31.

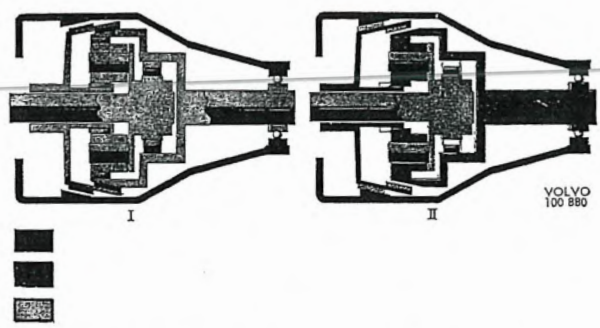


Fig. 4–27. Working principle of overdrive

I. Direct drive position

II. Overdrive position

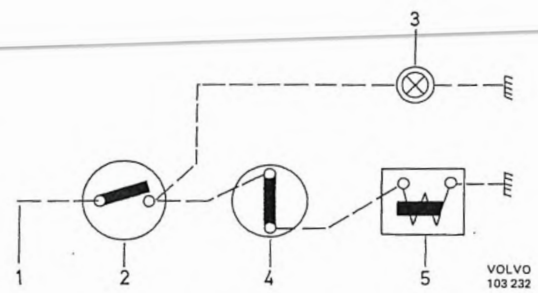


Fig. 4–28. Electrical circuit diagram

1. Lead from fusebox
2. Switch for overdrive
3. Warning lamp for overdrive
4. Switch on gearbox
5. Solenoid on overdrive

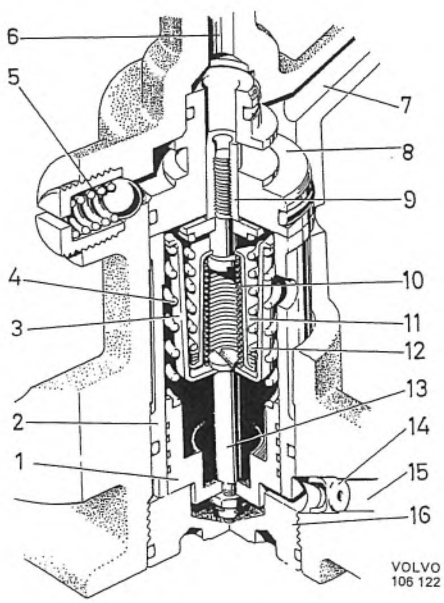


Fig. 4—29. Relief valve

1. Dashpot piston
2. Dashpot sleeve
3. Dashpot spring cup
4. Dashpot spring
5. Relief valve for lubricating oil pressure
6. Drilling from oil pump
7. Drilling to mainshaft
8. Relief valve body
9. Relief valve spindle
10. Residual spring
11. Relief valve spring cup
12. Relief valve spring
13. Dashpot spindle
14. Restrictor plug
15. Drilling from operating valve
16. Dashpot plug

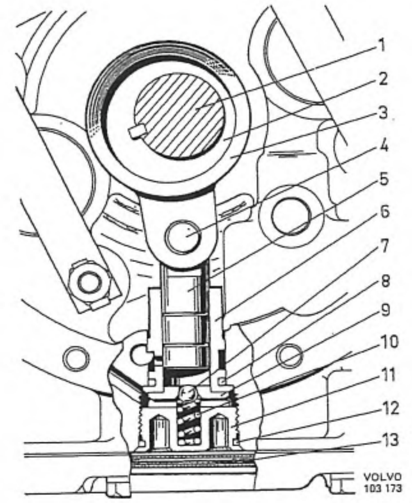


Fig. 4—30. Oil pump

1. Mainshaft
2. Eccentric
3. Connecting rod
4. Gudgeon pin
5. Piston
6. Cylinder
7. Ball
8. O-ring
9. Valve seat
10. Spring
11. Plug
12. O-ring
13. Pre-filter

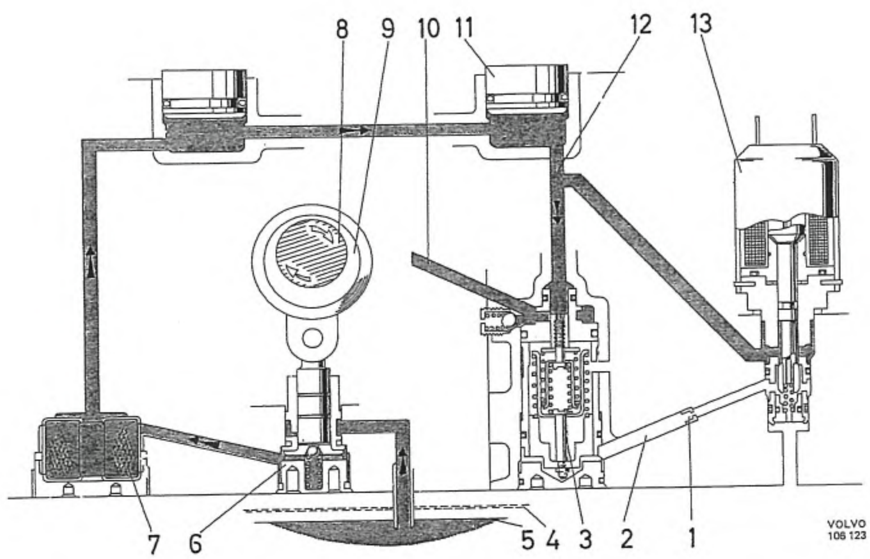


Fig. 4—31. Function with direct drive

1. Nozzle
2. Channel, control valve — relief valve
3. Relief valve
4. Pre-filter
5. Oil sump
6. Oil pump
7. Fine filter
8. Gearbox mainshaft
9. Eccentric
10. Channel, relief valve — mainshaft
11. Piston
12. Channel, oil pump — hydraulic cylinder — control and relief valves
13. Control valve and solenoid

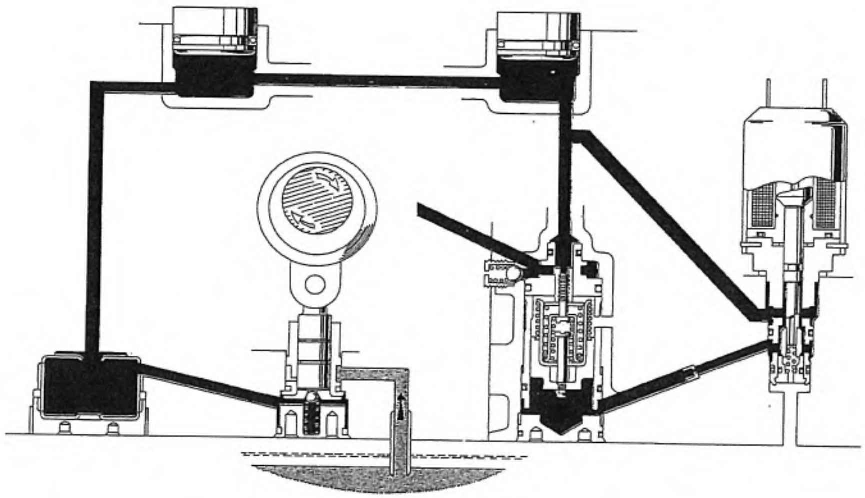


Fig. 4—32. Overdrive in function

The oil is drawn through the pre-filter by the plunger pump and is conveyed under pressure through the fine filter. From here the oil flows further through the hydraulic cylinders to the relief and control valves. The control valve closes and the large piston of the relief valve is in its lower position. This off-loads the springs so that only a low pressure is required to press down the small piston of the relief valve. Oil then flows past the small piston out into the channel to the mainshaft. When the overdrive is engaged, Fig. 4—32, the control valve is displaced and oil flows through the oilway and operates the large piston of the relief valve. This is then moved upwards and causes the springs to tension. The more the springs tension the greater the force is required to press down the small piston, this causing the hydraulic pressure to rise. The pistons are thereby displaced in the hydraulic cylinders, the clutch sliding member is pulled forwards and contact made with the brake ring. With disengagement of the overdrive, the connection between channels 12 and 2 closes. Instead, the connection between channel 2 and the sump opens. This permits oil under the large piston of the relief valve to flow out into the sump, the pressure in the system drops and direct drive is engaged. Because of the orifice nozzle in the channel and owing to a suitable balancing of the spring force, a certain time passes for the piston of the relief valve to move from one outer position to the other. This interval is so adapted that a smooth engagement occurs without any slipping of gears.

Oil passing the small piston of the relief valve is conveyed through the channel and a drilling in the mainshaft to the uni-directional clutch and the needle bearing shaft. Thereafter the oil is caught up by a plate and led via the planet gear back to the gearbox housing, see Fig. 4—33.

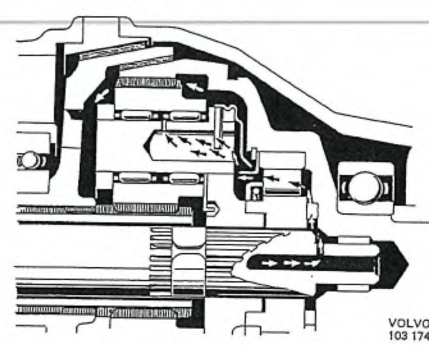


Fig. 4—33. Lubricating system

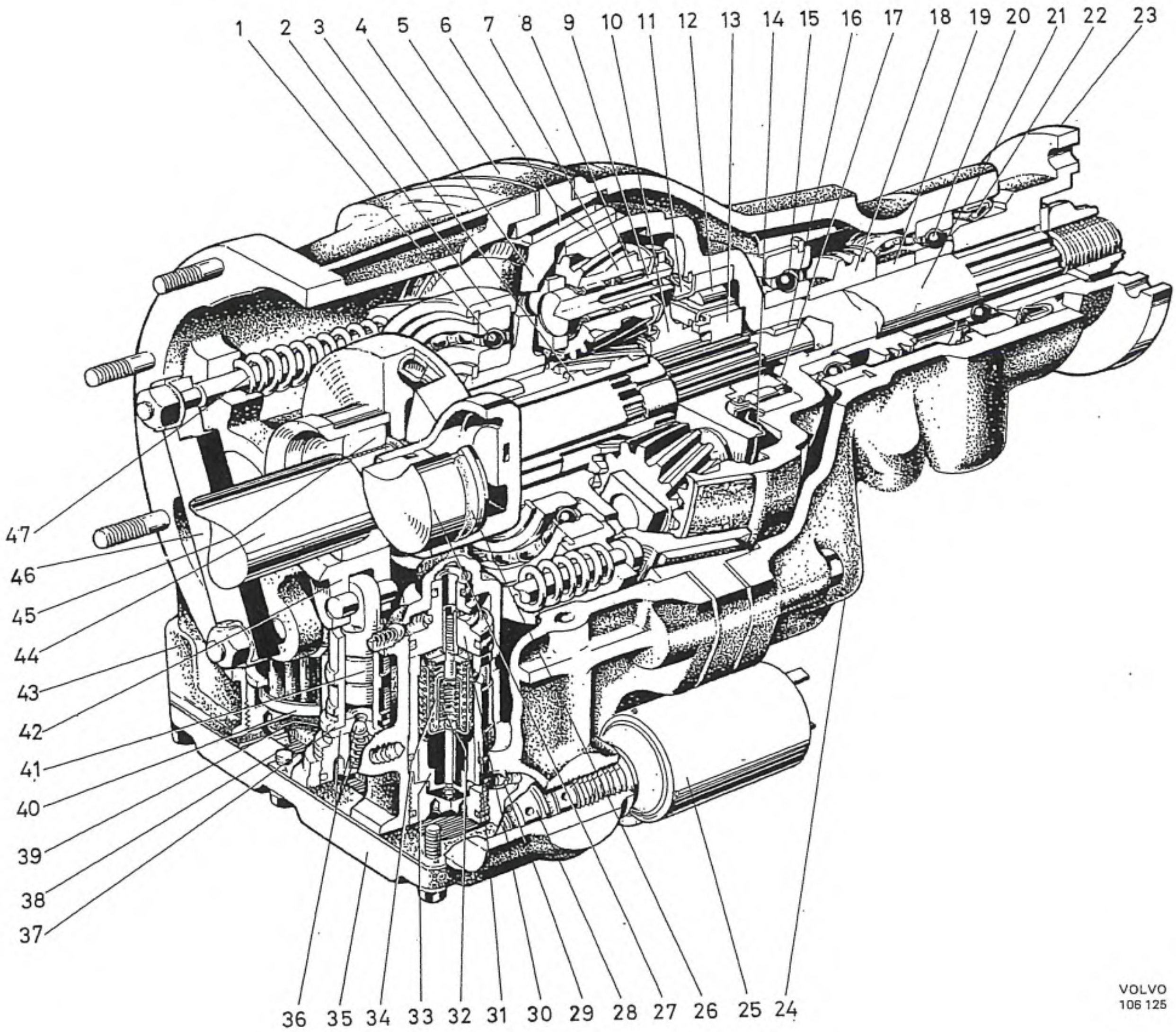


Fig. 4–34. Overdrive.

1. Output shaft support bearing
2. Thrust bearing retainer
3. Sunwheel
4. Clutch sliding member
5. Brake ring
6. Clutch member linings
7. Planet gear
8. Needle bearing
9. Shaft
10. Planet carrier
11. Oil thrower
12. Uni-directional clutch rollers
13. Uni-directional clutch
14. Oil trap
15. Ball bearing
16. Bush
17. Thrust washer
18. Speedometer driving gear
19. Spacer
20. Ball bearing
21. Output shaft
22. Oil seal
23. Coupling flange
24. Rear casing
25. Solenoid
26. Piston seal
27. Piston
28. Operating valve
29. Orifice nozzle
30. Cylinder top
31. Cylinder
32. Spring
33. Large piston
34. Small piston
35. Base plate
36. Check valve for oil pump
37. Pump cylinder
38. Magnet
39. Pre-filter
40. Fine filter
41. Pump plunger
42. Connecting rod
43. Front casing
44. Input shaft (gearbox mainshaft)
45. Eccentric
46. Bridge piece
47. Spring

WORK ON OVERDRIVE IN VEHICLE

CHECKING OIL PRESSURE

The oil pressure can be suitably checked when driving on test rollers or on a motorway. The check can also be made with the vehicle jacked up but this should be avoided for reasons of safety.

Checking is as follows:

1. Remove the plug under the operating valve and connect the pressure gauge 2834, see Fig. 4–35.
2. Read off the pressure when driving on direct drive at about 40 kmph (25 mph). The pressure should then be about 1.5 kp/cm^2 (21 psi).
3. Engage the overdrive and check that the pressure rises to 32–35 kp/cm^2 (455–498 psi).
4. Disengage the overdrive and check the time for the pressure to drop to 1.5 kp/cm^2 (21 psi). **The time must not exceed 3 seconds.**

REPLACING SOLENOID AND OPERATING VALVE

The solenoid and operating valve are integrally built as one unit, which is replaced complete. For removing and fitting, use a 25 mm (1") fixed spanner. Use a new seal and O-rings when fitting. The tightening torque should be 42–55 Nm (30–40 lbft).

CHECKING AND REPLACING RELIEF VALVE

1. Remove the base plate and the pre-filter. Collect the oil in an oil container. Warning. If the vehicle has been driven recently, the oil may be hot and scald if it comes into contact with your skin.
2. Remove the plug under the relief valve with tool 2836, see Fig. 4–36. Pull out the large piston of the relief valve, then the spring and spring retainer. Even the low-pressure spring will also be included in the removal. Then pull out the small piston with its spring and spring retainer, also the cylinder and end washer. Use a pair of pliers with narrow jaws for the piston unit and a loop, see Fig. 4–37, for the cylinder and washer.
3. Wash all the parts in white spirit and blow them dry with compressed air. Check them carefully for wear and damage. The pistons should run easily in their cylinders. Faulty parts must be replaced. NOTE. The following units are available as spare parts: End washer, cylinder, the small piston, adjuster washer, low-pressure spring, large piston, plug and the O-rings.

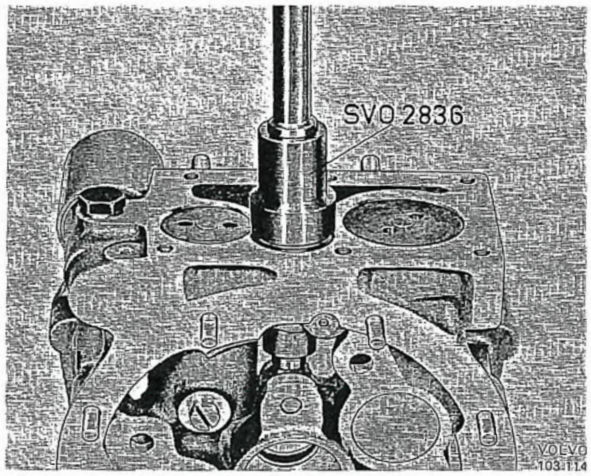


Fig. 4–36. Removing plug

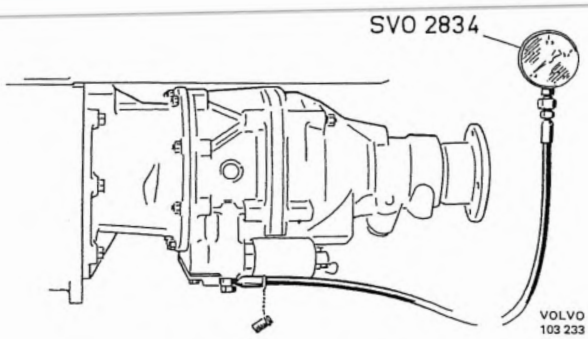


Fig. 4–35. Checking oil pressure

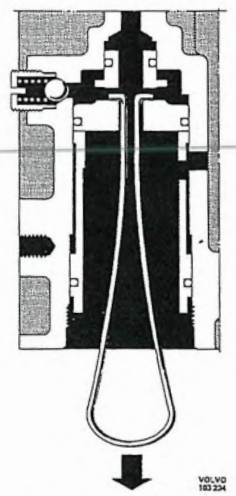


Fig. 4–37. Removing relief valve

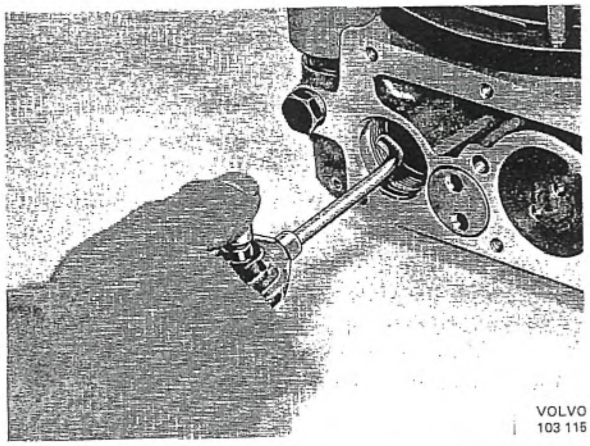


Fig. 4–38. **Blowing orifice nozzle clean**

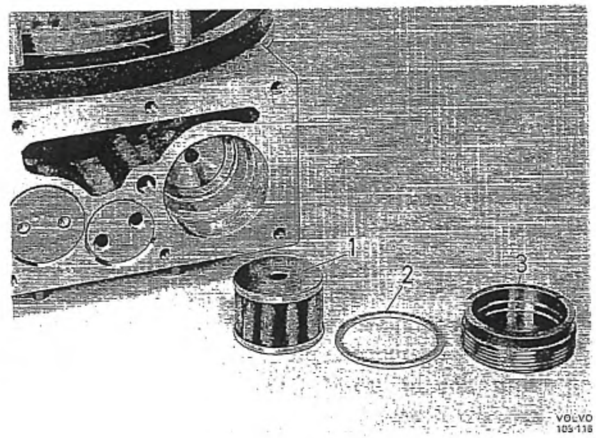


Fig. 4–39. Fine filter
1. Filter 2. Seal 3. Plug

4. Before fitting the parts of the relief valve, it may be suitable to blow the orifice nozzle clean with compressed air, see Fig. 4–38.
5. Fit the new O-rings on the end washer, cylinder and plug. Lubricate the parts with oil. Then install them in the following order: End washer, cylinder, small piston, low-pressure spring, large piston and plug. Tighten the plug to a torque of 22 Nm (16 lbft).
6. Fit the pre-filter and base plate with a new gasket. Make sure that the magnet is in position on the base plate. Fill with oil.

CLEANING ORIFICE NOZZLE

The orifice nozzle is accessible after the cylinder of the relief valve has been removed according to above. Blow the orifice nozzle clean with compressed air, see Fig. 4–38.

CHECKING AND REPLACING CHECK VALVE

1. Remove the base plate and pre-filter. Collect the oil in an oil container. Warning. If the vehicle has been recently driven, the oil may be hot and cause damage if contact is made with your skin.
2. Remove the plug with tool 2836. Take out the non-return valve spring, non-return ball and non-return body.
3. Clean all the parts in white spirit and blow them dry with compressed air. Check the parts for damage and wear. Replace faulty parts.
4. Fit a new O-ring on to the plug and then re-fit the non-return body, ball, spring and plug. Tighten the plug to a torque of 22 Nm (16 lbft).
5. Re-fit the pre-filter and base plate together with a new gasket. Do not forget the magnet on the bottom plate. Fill with oil.

CLEANING FILTER

1. Remove the base plate and the pre-filter. Collect the oil in an oil container. Warning. If the vehicle has been recently driven, the oil may be hot and scald if contact is made with the skin.
2. Remove the plug and take out the seal and fine filter, see Fig. 4–39.
3. Clean all the parts in white spirit. Then blow them dry with compressed air.
4. Fit the fine filter, a new seal and the plug. Tighten the plug to a torque of 22 Nm (16 lbft).
5. Re-fit the pre-filter and the base plate with a new gasket. Make sure the magnet is in position on the base plate. Fill with oil.

REMOVING OVERDRIVE

To facilitate removal, the vehicle should first be driven with the overdrive engaged and then disengaged **with the clutch pedal depressed.** The last-mentioned is important in order to avoid torsional tensions in the shaft between the planet carrier and uni-directional clutch. Any stresses will disappear even if oil with pressure of 20–25 kp/cm^2 (284–355 psi) is connected to the output at the operating valve. The overdrive is engaged and disengaged with this pressure.

Removal is as follows:

1. Carry out operations 1–7 under "Removing" in Group 43a.
2. Disconnect the cables to the solenoid.

3. Unscrew the bolts holding the overdrive unit to the intermediate flange. Pull the overdrive straight out backwards until it goes free from the gearbox mainshaft.

DISASSEMBLING OVERDRIVE

Maximum cleanliness must be observed when working with the overdrive unit. Before disassembling, clean the outside of the unit thoroughly. Then first dismantle the main parts as follows:

1. Place the overdrive vertically in a vice provided with copper jaws. Remove the solenoid and operating valve.
2. Bend down the locking tab, unscrew and remove the nuts for the piston bridge pieces. Remove the bridge pieces.
3. Unscrew the nuts holding the brake ring, front and rear casing. Loosen the nuts gradually all round in order to avoid any disorted tension from the springs. Lift off the front casing and brake ring, see Fig. 4—40.
4. Tap loose the brake ring from the front casing with the help of a copper drift and hammer.
5. Remove the springs for the clutch sliding member. Lift out the clutch sliding member complete with thrust bearing and sunwheel.
6. Lift out the planet carrier complete.

REMOVING FRONT CASING

1. Place the casing with the front side downwards on a bench. Connect compressed air to the hole for the operating valve and blow out the pistons.
2. Disconnect the base plate and remove the pre-filter. Then remove the plugs and take out the parts for the respective fine filter, relief valve and pump check valve. See also under the heading "Work on overdrive in vehicle", page 4:16.
3. Press down and pull out the pump cylinder.

Then take out the connecting rod and pump plunger.

DISASSEMBLING CLUTCH UNIT

1. Remove the circlip for the sunwheel. Pull out the sunwheel backwards.
2. Remove the inner circlip for the bearing. Hold the bearing body and tap loose the clutch sliding member with a rubber mallet.
3. Remove the outer circlip and press the bearing out of the bearing housing.

DISASSEMBLING REAR CASING

1. Remove the bolt and pull out the retainer, the bush and the speedometer pinion.
2. Remove the nut. Use 2837 as a counterhold for cars fitted with B 20 E and 2854 for cars fitted with B 20 F. Pull off the flange with puller 2261. Place the housing in a press and press out the output shaft.
3. Remove the spacer, the speedometer driving gear. Pull out the bearing on the output shaft suitably with a so-called knife extractor. The rear bearing and oil seal are pressed out of the housing with drift 1797 and handle 1801.
4. Remove the circlip and the oil thrower, which hold the uni-directional clutch on the output shaft. Lift out the uni-directional clutch components. Remove the thrust washer. If necessary pull the bush on the output shaft out with puller 2423, see Fig. 4—41.

INSPECTING OVERDRIVE

Before inspecting, clean all the parts in white spirit and then blow thew dry with compressed air. Pay

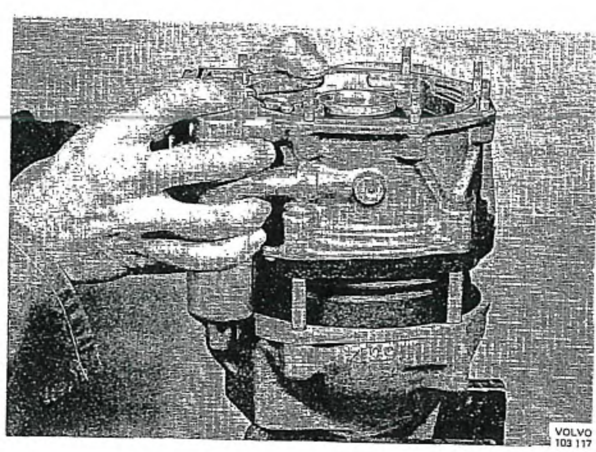


Fig. 4—40. Disassembling overdrive

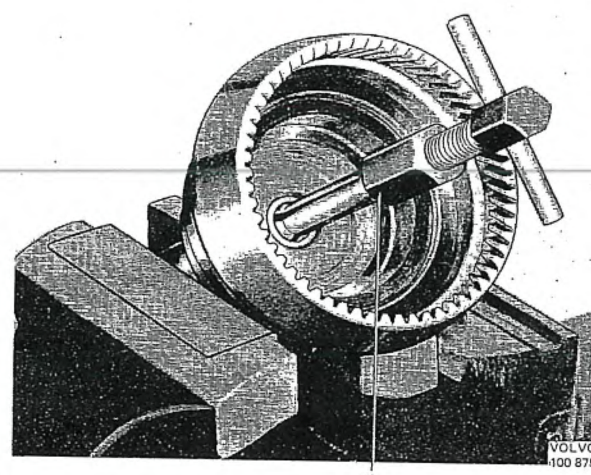


Fig. 4—41. Removing bush, output shaft
1. Puller 2423

particular attention to the cleaning of the filters and all the oilways. Check that the orifice nozzle in the channel between the relief and operating valves is clean. If it is not possible to blow the nozzle clean, it can be cleaned with a pointed wooden stick or suchlike. Hard objects must not be used since this can alter the graduation.
Check also that the groove inside the ring gear on the output shaft is properly cleaned. Dirt collects here due to centrifugal force. After cleaning, check all the parts carefully for wear, cracks or other damage.
Pay particular attention to the following:
Check the solenoid with the help of a 12 volt battery and an ammeter. Current consumption should be about 2 ampères. Check the movement of the valve during engagement and disengagement.
Check to make sure that the filters are not damaged. Also check the pistons of the hydraulic system for abrasion and wear. Check the valves for wear. Make sure that all the springs are not damaged. Check all the gears and ball bearings for cracks and wear. Make sure that the bush on the sunwheel it not worn. With replacement, change the sunwheel complete with bush. The bush must be concentric with the gear wheel, and this is difficult to bring about outside a workshop.
Check the brake ring for abrasion, cracks or wear. Check to make sure that the linings on the clutch sliding member are not burnt or worn.

ASSEMBLING OVERDRIVE

Use new gaskets. O-rings, lock washer and seals when assembling. Observe maximum cleanliness since the hydraulic system is sensitive to impurities.

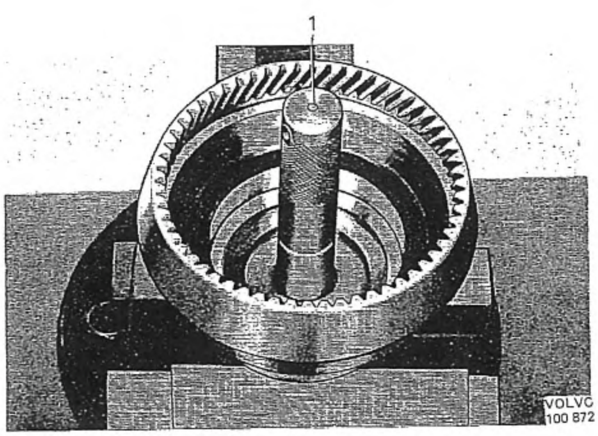


Fig. 4—42. Installing bush, output shaft
1. Drift 2417

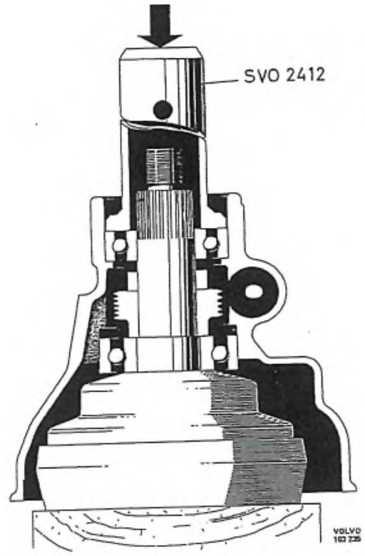


Fig. 4—43. Installing output shaft

ASSEMBLING REAR CASING

1. Push the bush on to the output shaft with drift 2417, see Fig. 4—42. Press the front bearing to the output shaft with drift 2412.
2. Press the rear bearing on to the rear casing section with drift 2412.
3. Place a wooden block under the output shaft as support. Fit the speedometer driving gear and spacer. Press on the rear casing with drift 2412, see Fig. 4—43.
4. Press in the oil seal with drift 2412. Fit the coupling flange, the washer and nut. Tighten the nut to a torque of 110—140 Nm (80—100 lbft). Use 2837 or 2854 as a counterhold.

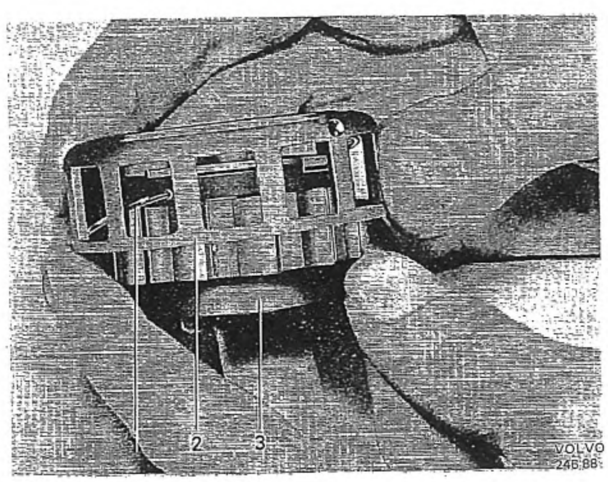


Fig. 4—44. Assembling uni-directional clutch, I
1. Spring 2. Cage 3. Uni-directional clutch hub

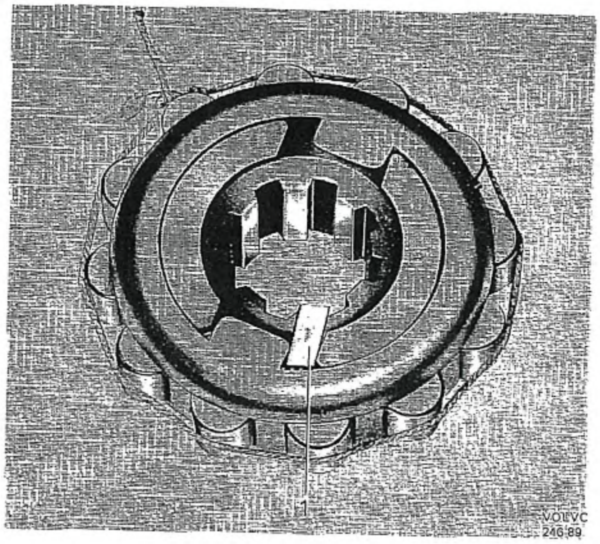


Fig. 4—45. Assembling uni-directional clutch, II
1. Key

5. Assemble the uni-directional clutch, spring and roller cage, see Fig. 4—44. Turn the roller cage clockwise as far as it will go and lock it in this position with a key as shown in Fig. 4—45. Place in the rollers. Tie a piece of rubber band or string round the rollers.
6. Fit the thrust washer and then the uni-directional clutch in position on the output shaft, see Fig. 4—46. Fit the oil thrower and install the circlip, see Fig. 4—47.
7. Fit the speedometer pinion and bush. Fit the retainer and bolt.
8. Place the planet carrier complete with planet gear in position on the output shaft. Guide up the splines into the planet carrier and uni-directional clutch with drift 2835, Fig. 4—48.

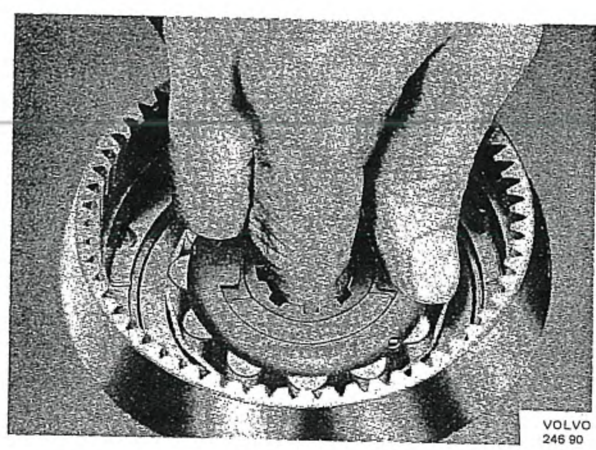


Fig. 4—46. Installing uni-directional clutch

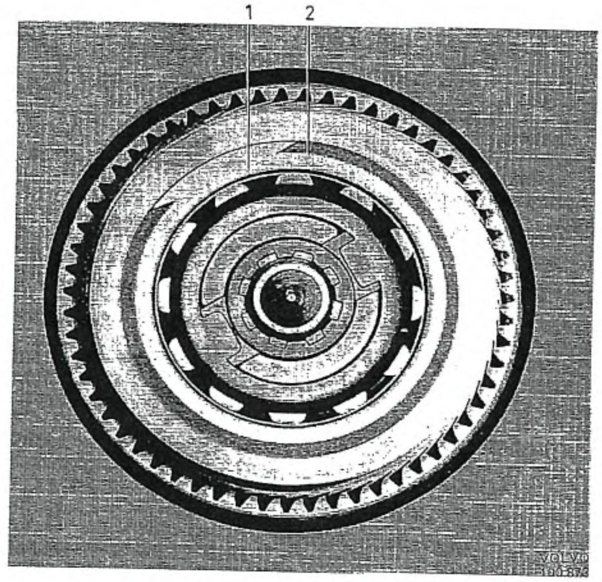


Fig. 4—47. Installing oil thrower
1. Oil thrower plate 2. Circlip

ASSEMBLING CLUTCH UNIT

1. Press the ball bearing into the retainer and fit the circlip.
2. Fit the bolts on the bearing retainer. Then press the bearing with retainer on to the clutch sliding member. Fit the circlip.
3. Fit the sunwheel on to the clutch sliding member. Fit the circlip.
4. Install the clutch unit in position on the output shaft. Fit the four thrust springs on to the bolts.

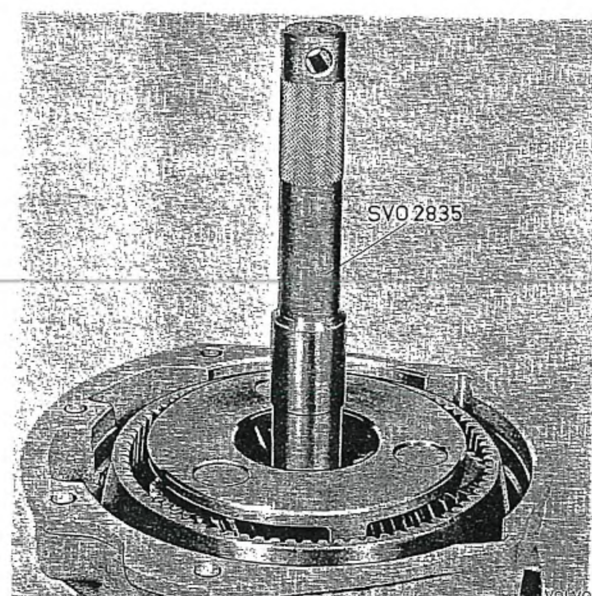


Fig. 4-48. Installing planet gear

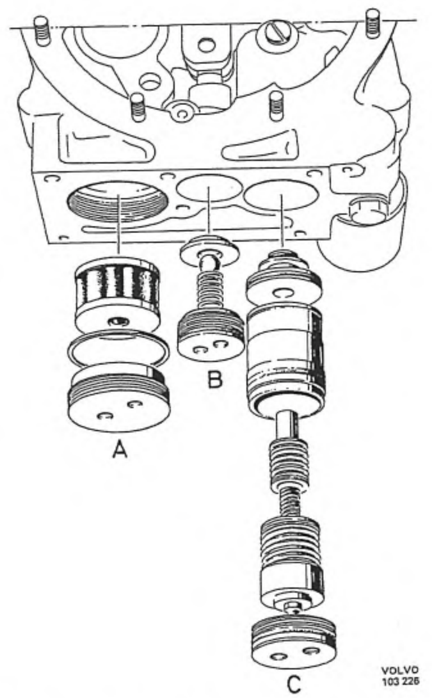


Fig. 4-49. **Installing fine filter, oil pump check valve and relief valve**

A. Fine filter
B. Check valve for oil pump
C. Relief valve

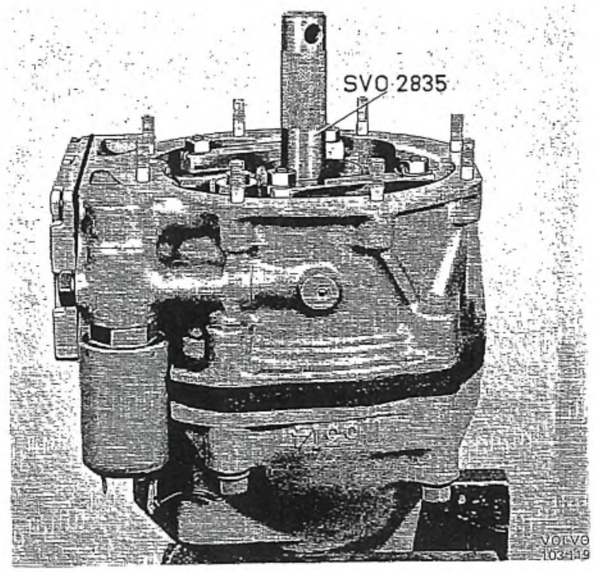


Fig. 4—50. **Installing front casing**

ASSEMBLING AND INSTALLING FRONT CASING

1. Fit the fine filter. Also fit the relief valve parts in the following order: End washer, cylinder, small piston, low-pressure spring, large piston and plug, see Fig. 4—49.
2. Place the connecting rod and pump plunger in position in the casing. Then push in the cylinder. After that fit the non-return body, non-return ball, spring and plug.
3. Tighten the plugs for the fine filter, relief valve and pump check valve with torque wrench and tool 2836. The tightening torque is 22 Nm (16 lbft). Fit the pre-filter, magnet, gasket and base plate.
4. Fit the operating pistons in their cylinders.
5. Install the brake ring on the front casing. Place the front casing on the rear one. Fit washers and nuts, see Fig. 4—50. Note that both the copper washers should be fitted on the upper bolts. Tighten the bolts a little at a time until they are tightened evenly all round.
6. Fit both the thrust washers. Tighten and lock the nuts. Fit the operating valve and solenoid.

INSTALLING OVERDRIVE

Installing the overdrive is in reverse order to removal. Fill with oil. Check the oil in the gearbox after the vehicle has been driven 10—15 km (6—9 miles).

AUTOMATIC TRANSMISSION

TOOLS

The following special tools are required for repairing the transmission.

The special tools are preceded either by 999 or SVO (e.g. 999 1801 or SVO 2261).

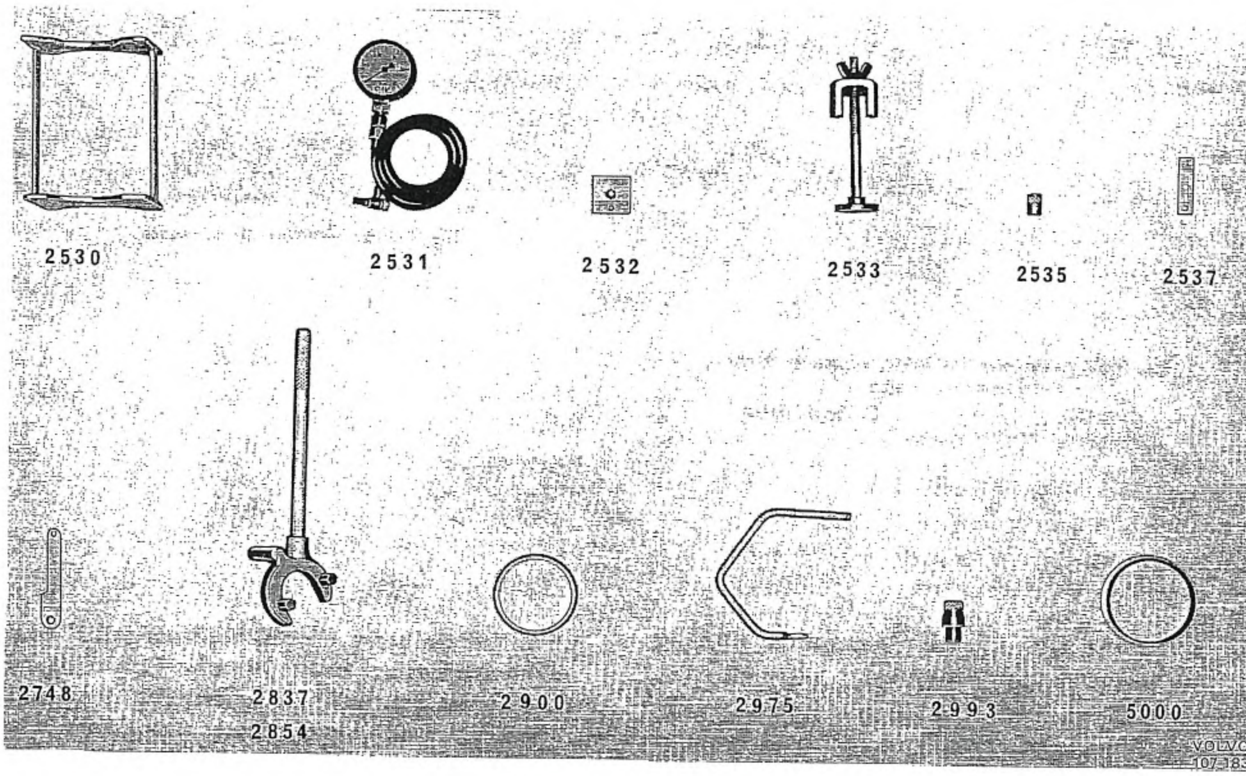


Fig. 4—51. Special tools

999
(SVO)

2530 Fixture for disassembling and assembling the transmission.
2531 Manometer complete with hose and connection for checking the oil pressure.
2532 Attaching plate for magnetic holder when measuring end float of input shaft.
2533 Press tool for compressing clutch when removing and fitting the snap ring.
2535 5/16" square socket for adjusting rear brake band.
2537 Spacer for adjusting front brake band.
2746 Transmission fixture when removing and fitting, see Fig. 4—69.

999
(SVO)

2748 Dynamometric wrench for adjusting front brake band.
2837 Counterhold for flange (cars fitted with B 20 E)
2854 Counterhold for flange (cars fitted with B 20 F).
2900 Ring for fitting piston in front clutch (used together with 2993).
2975 Spanner for locknut on contact for starter inhibitor and reversing light.
2993 Guide for fitting piston in front clutch
5000 Ring for fitting piston in rear clutch.

Instead of bench rack 2530 the following can be used for disassembling and assembling, see Fig. 4—70.

2520 Stand
2934 Fixture

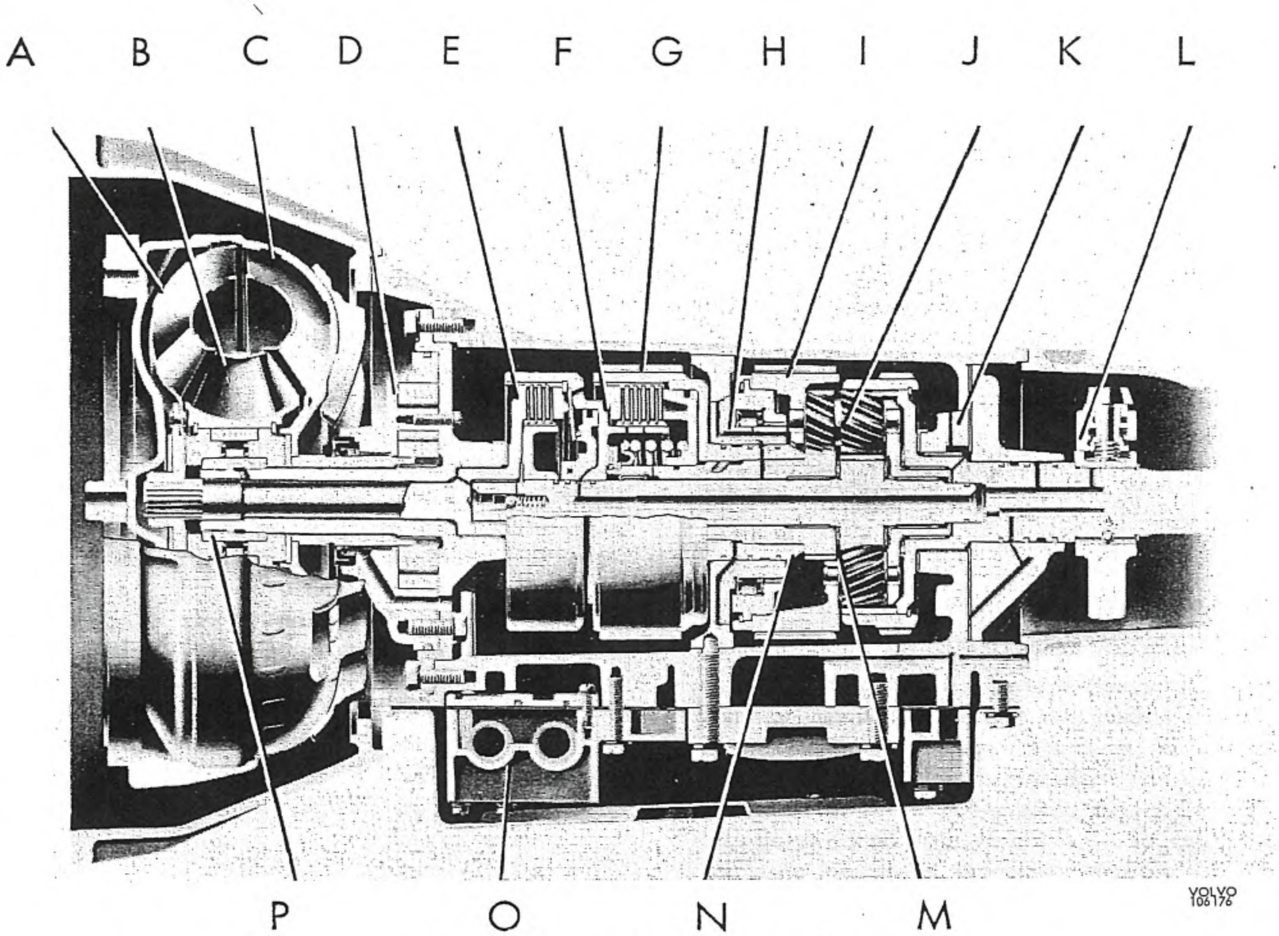


Fig. 4—52. Sectioned view of the transmission

A. Turbine
B. Stator
C. Impeller and cover
D. Front pump
E. Front clutch
F. Rear clutch
G. Front brake band
H. One-way clutch in transmission
I. Rear brake band
J. Planetary gear set
K. Oil deflector flange
L. Governor
M. Reverse sun gear
N. Forward sun gear
O. Control system
P. One-way clutch in converter

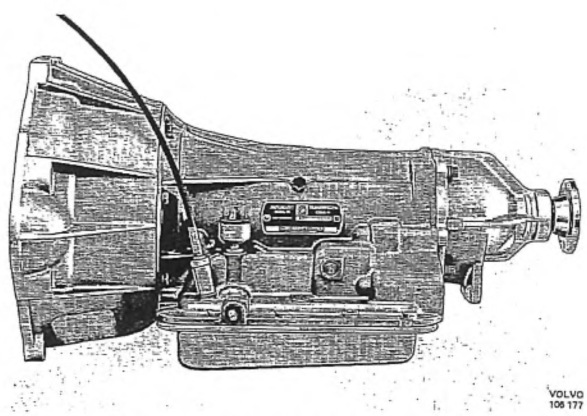


Fig. 4—53. Borg-Warner Automatic Transmission, type 35

DESCRIPTION

The Volvo automatic transmission for cars is of Borg-Warner manufacture, type 35. It consists of two main components:

1. A three-element hydrokinetic torque converter coupling capable of torque multiplication at an infinitely variable rate between 2:1 and 1:1.
2. A hydraulically operated transmission comprising a planetary gear set with a valve system which automatically selects a suitable gear in relation to the speed of the car and position of the accelerator pedal.
   There is also a selector control with positions "P", "R", "N", "D", "2" and "1", see Fig. 4–54.

THE TORQUE CONVERTER

The torque converter serves both as a clutch and as an extra (hydraulic) gear between the engine and transmission. It provides a means of obtaining smooth application of engine power to the driving wheels and additional engine torque multiplication to the 1st and 2nd gears of the transmission. The converter also provides extreme low-speed flexibility when the transmission is in 3rd gear and, due to the ability of multiplying engine torque, it gives good acceleration from very low road speed without having to resort to a downshift in the transmission.

The converter consists of three main components — an impeller connected to the engine crankshaft, a turbine connected to the input shaft of the transmission and a stator mounted on a sprag-type one-way clutch supported on a fixed hub projecting from the transmission case.

The converter functions as follows:

The impeller is rotated by the engine and converts the engine power into hydrokinetic energy. The fluid flows from the impeller vanes to the turbine vanes and returns to the impeller through the stator vanes. The curvature of the various vanes is so designed that when a speed differential exists between the impeller and the turbine, the angle of the fluid flow from the turbine is changed by the stator vanes in such a way that the discharge of fluid from the stator assists in driving the impeller. Under such conditions, torque multiplication occurs and varies from 2:1 when the turbine is stalled (i.e. when, with any of the driving ranges selected, the vehicle is held stationary and the engine is operating at maximum throttle opening) to 1:1 when the turbine reaches a speed approximately 90 % of that of the impeller. When this speed differential between the impeller and turbine is achieved, the fluid flow angle from the turbine is such that the stator is driven in the same direction as the turbine and the impeller. Under these circumstances, the converter becomes a fluid flywheel or coupling and there is no torque multiplication.

TRANSMISSION

The transmission consists of a mechanical power transmission system — planetary gear, two clutches, two brake bands and a one-way clutch — and a hydraulic system — front and rear pump, centrifugal governor and a control valve system which regulates the fluid pressure and directs the fluid to the various transmission components.

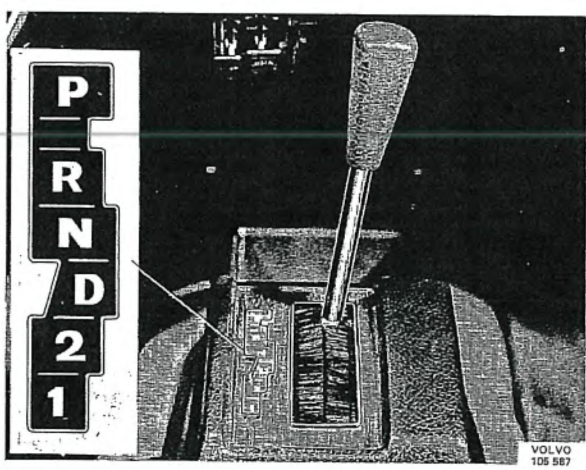


Fig. 4–54. Selector lever positions

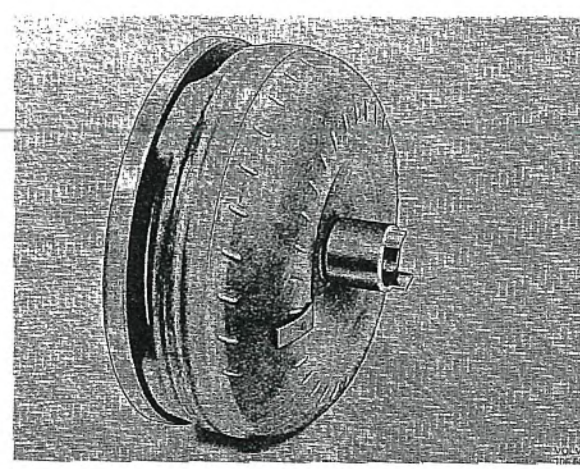


Fig. 4–55. Converter

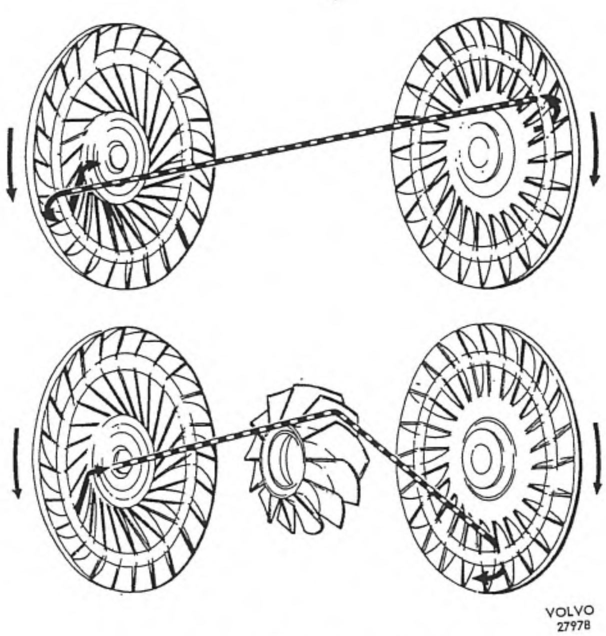


Fig. 4—56. Function of converter

Mechanical power transmission

PANETARY GEAR

The planetary gear assembly consists of two sun gears, two sets of pinions, a pinion carrier and a ring gear, see Fig. 4—57. Helical involute tooth forms are used throughout. In all forwards gears, power enters through the forward sun gear; in reverse, power enters through the reverse sun gear. Power leaves the gear assembly by the ring gear. The pinions are used to transmit power from the sun gears to the ring gear. In reverse, a single set of pinions is used which causes the ring gear to rotate in the opposite direction to the sun gear. In forward gears, a double set of pinions is used to cause the ring gear to rotate in the same direction as the sun gear. The carrier locates the pinions in their correct positions relative to the two sun gears and the ring gear (and also forms a reaction member in certain conditions). The various mechanical ratios of the gear set are obtained by the engagement of hydraulically operated multi-disc clutches and brake bands.

CLUTCHES

The clutches, see Fig. 4—58, consist of multi-disc units operated by hydraulic pistons. In all forward gears the front clutch connects the converter to the forward sun gear; for reverse, the rear clutch connects the converter to the reverse sun gear.

BRAKE BANDS

Brake bands, operated by hydraulic servos, hold elements of the gear set stationary to effect an output speed reduction and a torque increase. In "lockup", the rear band holds the pinion carrier stationary and provides the 1st gear ratio of 2.39:1 and, in reverse, a ratio of 2.09:1. The front band holds the reverse sun gear stationary to provide the 2nd gear ratio of 1.45:1.

ONE-WAY CLUTCH

In the drive position "D", a one-way clutch is used in place of the rear band to prevent the pinion carrier from turning opposite to engine rotation, thus also providing a 1st gear ratio of 2.39:1. This one-way clutch, allowing the transmission to freewheel in 1st gear, provides smooth ratio changes from 1st to 2nd and vice versa.

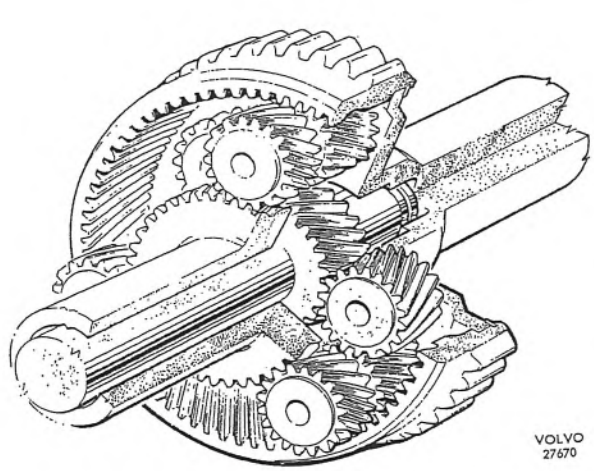


Fig. 4—57. Planetary gear

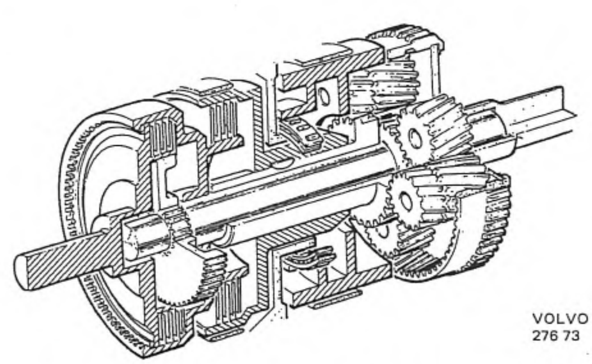


Fig. 4—58. Planetary gear, clutches and brake bands

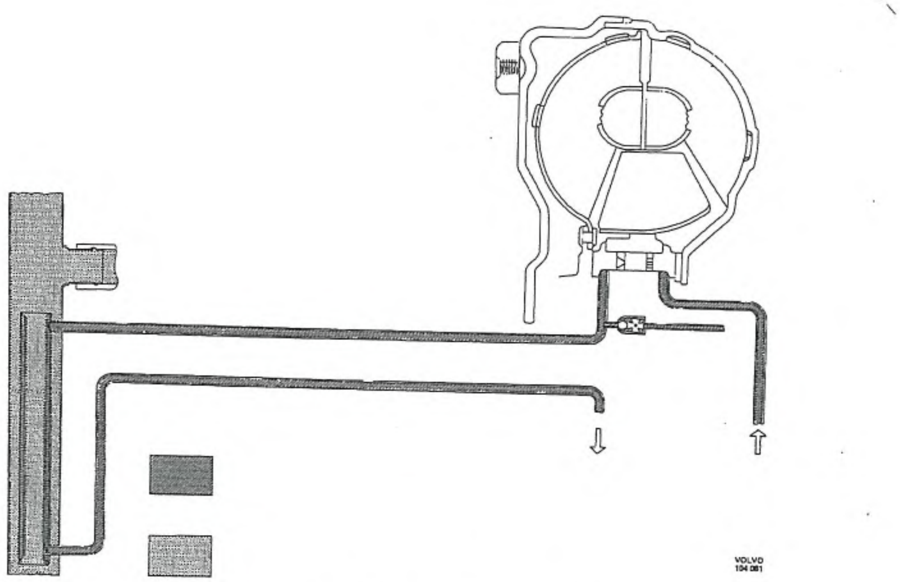


Fig. 4—59. Principle of operation for oil cooler

OIL COOLER

The automatic transmission is connected to an oil cooler. This is housed in the bottom tank of the engine radiator and is connected as shown in Fig. 4—59. The oil cooler is connected to the nipples (1, 2, Fig. 4—60) on the right-hand side of the transmission.

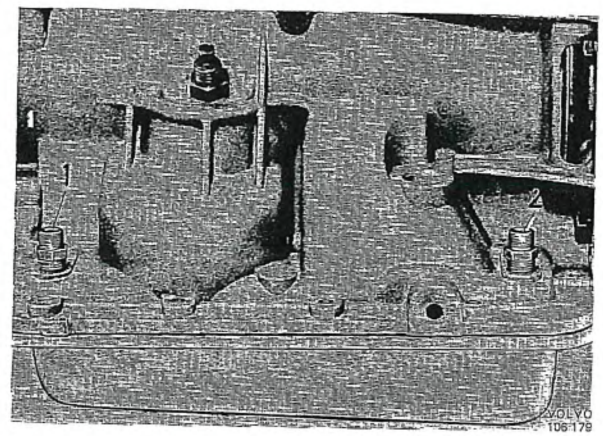


Fig. 4—60. Oil cooler connection

1. Connection nipple for oil cooler
2. Connection nipple for oil cooler

REPAIR INSTRUCTIONS

When carrying out any work on the vehicle, the selector lever should be in position "P".

Provided the transmission is operating satisfactorily, the car may be towed in position "N", on condition that the transmission is properly adjusted and the fluid level is correct. **If the transmission is inoperative, the propeller shaft should be disconnected before starting towing.**

The control system of the automatic transmission is manufactured with the same degree of precision and accurate fits as the injection equipment of a diesel engine. Fluid circulates through the converter, transmission and control system. **It is therefore necessary to observe the utmost cleanliness when working on the transmission.**

WORK ON TRANSMISSION IN VEHICLE

CHECKING FLUID LEVEL

Normally oil changing is only required when the transmission has been reconditioned. However, the oil level should be checked every 10 000 km (6 000 miles).

When checking the oil level, the car should be on a level surface. Move the selector to position "P" and let the engine idle. The filling pipe with dipstick is located in front of the bulkhead on the righthand side of the engine. Pull up the dipstick, and wipe it with nylon cloth, paper or chamois leather. Fluffy rags must not be used. Insert the dipstick, then pull it up and note the oil level, see Fig. 4—61.

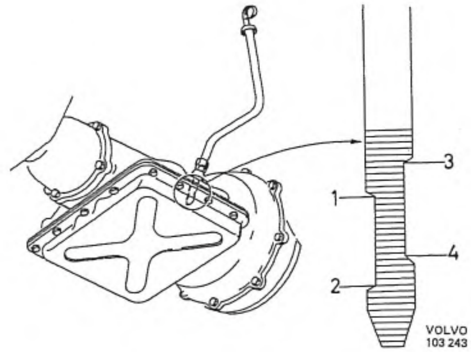


Fig. 4–61. Checking oil level

1. Max. oil level, cold transmission
2. Min. oil level, cold transmission
3. Max. oil level, transmission run warm
4. Min. oil level, transmission run warm

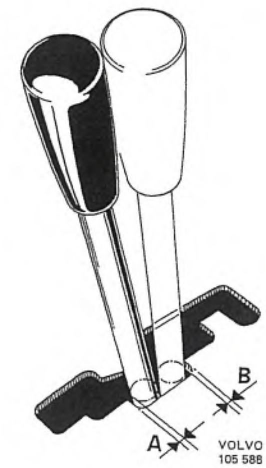


Fig. 4–62. Adjusting selector controls
A=B

NOTE. There are different oil level marks for a warm or cold transmission. When the transmission is warm, after the car has been driven about 8–10 km (5–7 miles), the upper area (3 and 4, Fig. 4–61) applies. The lower area (1 and 2) applies when the transmission is cold. The text on the dipstick also mentions this difference.

If necessary, top up with oil to the "Max" mark. Do not exceed this mark, otherwise the transmission can become overheated. The difference between the "Min" and "Max" mark is about 1 pint (0.5 litre). Use an oil which is approved as "Automatic Transmission Fluid, type F".

If topping up with oil is required often, there must be leakage, which should be attended to immediately.

REMOVING AND INSTALLING VALVE BODIES ASSEMBLY

1. Jack up and place props under the vehicle. Drain off the oil into a vessel which is absolutely clean. See Fig. 4–68.
   NOTE. The oil may be very hot and scald if contact is made with the skin.
2. Release the bolts for the oil sump and remove the sump. Carefully remove the oil tubes (Fig. 4–71).
3. Release the throttle cable from the cam. Remove the three bolts, see Fig. 4–72, which secure the valve bodies assembly to the transmission casing. Remove the valve bodies assembly straight downwards so that it releases from the oil tubes at the front end.
4. Make sure that the oil tubes are in position on the front pump body. Place the valve bodies assembly in position and secure it with the three bolts, see Fig. 4–72.
5. Fit the throttle cable to the cam. Mount the oil tubes as shown in Fig. 4–71. Check that the magnetic element lies in the oil sump and fit the sump. Use a new gasket. Coat the threads on the oil drain plug with sealing fluid 277961 and then fit the plug.
6. Lower the vehicle, fill with oil.

ADJUSTING SELECTOR CONTROLS

1. Check that the lever on the transmission and the lever at the intermediate journalling are parallel. If they are not, adjust the lenght of the lower control rod.
2. Disconnect the upper control rod from the intermediate lever. Set the selector to "N".
3. Set the lever on the transmission to third position ("N"). Adjust the length of the control rod so that the ball shell is opposite the ball bolt. Connect the control rod to the lever.
4. Check the adjustment. This is done by checking the distances to the inhibitor plate in "N" and "D" position (A and B, Fig. 4–62). The clearance should be the same for both positions. If necessary, alter the length of the control rod.
5. Check that the output shaft is locked with the selector lever in position "P".

ADJUSTING THROTTLE CABLE

Correct adjustment of this cable is most important for satisfactory operation of the transmission. There are three different methods. **Adjust first in accordance with A, see Fig. 4–63. Method B is to be applied if the transmission is not functioning satisfactorily and method C when replacing the cable.**

A. 1. Check that engine idling speed is correctly adjusted and that the inner cable and outer cable are correctly attached.
   2. Screw up the threaded sleeve until it almost

A. Adjusting cable stop
B. Adjusting with tachometer and manometer
1. Chock the wheels and apply the brakes
2. Select position "D"
3. Connect a revolution counter (a)
4. Connect a pressure gauge (b)
c. Measure pressure (P) at 8.3 r/s (500 r/m)
d. Measure pressure (P+R) at 16.6 r/s (1000 r/m)
R. Should be 1.1—1.4 kp/cm^2 (15—20 psi)
C. Adjust the cam in transmission
c. Accelerator pedal in idling position
e. Accelerator pedal fully depressed

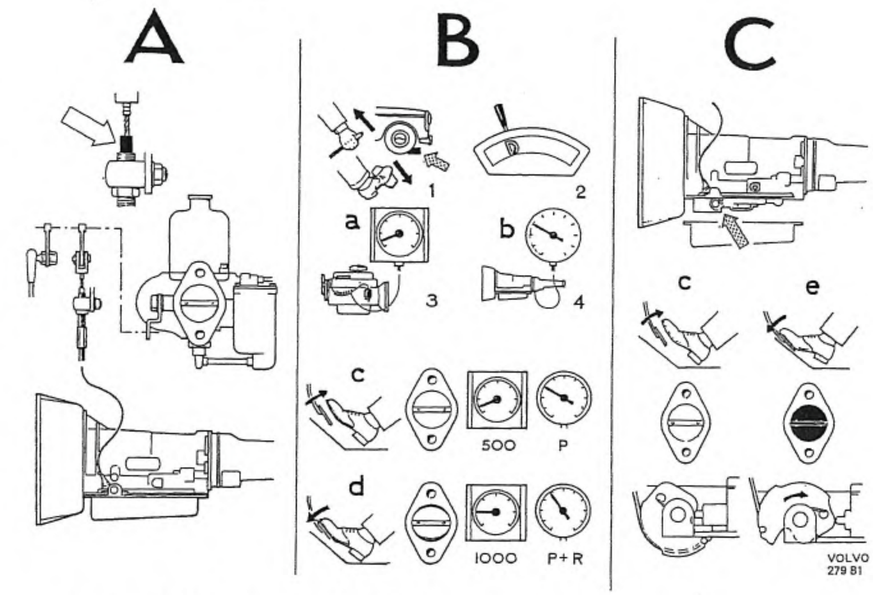


Fig. 4—63. Adjusting throttle cable

lies against the stop (for vehicles with single carburettor), and 1 mm (1/32") from the stop for vehicles with twin carburettors, the stop being crimped on the cable.

3. With the accelerator pedal fully depressed, check that:
   a. the carburettor lever is at the full open stop.
   b. the line pressure at converter stall speed amounts to at least 11 kp/cm^2 (160 psi).

B. If the cable stop has been damaged or moved the cable must be adjusted as follows:
1. Connect a tachometer to the engine and manometer to the transmission as shown in Fig. 4—64.
2. Chock the wheels and apply the brakes. Start the engine and move the lever to "D". Read of the pressure at 8.3 and 16.6 r/s (500 and 1 000 r/m). At 16.6 r/s (1 000 r/m) the pressure should be 1.1—1.4 kp/cm^2 (15—20 psi) higher than at 8.3 r/s (500 r/m). If the pressure rise is less than 1.1 kp/cm^2 (15 psi), the effective length of the outer cable should be increased by means of the adjuster. Conversely, if the rise is more than 1.4 kp/cm^2 (20 psi) the effective length of the outer cable should be decreased.

NOTE. On vehicles which an exhaust emission control system, it may be more suitable to measure the pressure at 11.6 and 20 r/s (700 and 1 200 r/m). The pressure increase also in this case should be 1.1—1.4 kp/cm^2 (15—20 psi).

C. If a new cable has to be fitted, the transmission oil pan must be removed. In this event it is often simpler to adjust the cable by observing the movement of the cam in relation to accelerator pedal movement as follows:
1. With the accelerator pedal fully released and the carburettor lever at the idling stop, the heel of the cam should contact the full diameter of the downshift valve, with all the slack of the inner cable taken up.
2. With the accelerator pedal fully depressed and the carburettor lever at the full open stop, the constant radius area of the cam should be the point of contact with the downshift valve.

Note:
1. The cable is pre-lubricated with silicon or molybdenum disulphide lubricant and must not be oiled.
2. Ensure that at all times the outer cable is correctly located in the adjuster.

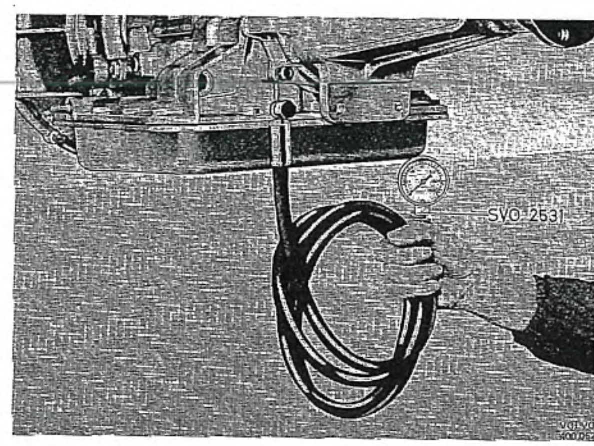


Fig. 4—64. Connecting manometer

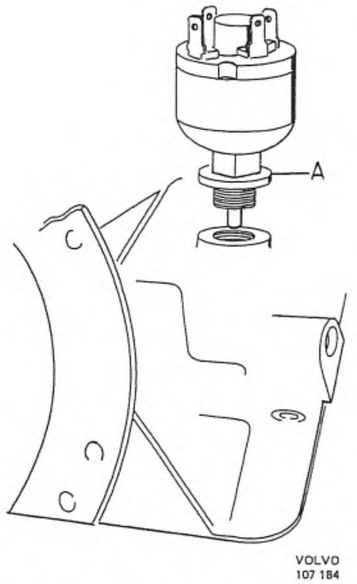


Fig. 4—65. Fitting starter inhibitor contact

A. Packing

ADJUSTING STARTER INHIBITOR CONTACT

1. Disconnect the electric cables from the contact. Unscrew the contact with spanner 2975.
2. Fit a new packing (A, Fig. 4—65) on the contact. Screw in the contact and tighten it with the spanner 2975. Hook up the electric cables.
3. Check that the engine can only be started with the shift selector in positions "P" and "N", that the back-up lights go on with the selector in position "R" and that the seat reminder functions in "D", "2" and "1",

ADJUSTING REAR BRAKE BAND

When adjusting this band in the car, a hole has been introduced in the body tunnel, which is accessible after the mats have been moved to one side and the

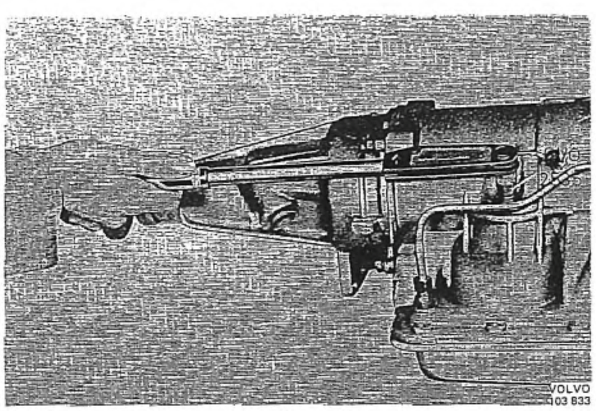


Fig. 4—66. Adjusting rear brake band

rubber removed. Otherwise adjusting is carried out as follows:

1. Slacken the locknut for the adjusting screw.
2. Use the special socket 2535 and connect the torque wrench to the adjusting screw, see Fig. 4—66. Tighten the screw to 14 Nm (10 lbft). Back off the adjusting screw one turn.
3. Tighten the locknut and fit any parts which have been removed.

AIR PRESSURE CHECKS

Air pressure checks can be made on the transmission assembly to determine whether the clutches and brake bands are operating. These checks can be made with the transmission in the car or on the bench. In either event, drain the fluid from the transmission and remove the oil pan as well as the valve bodies assembly with oil tubes. The air used must be clean and dry.

If the clutch and bands operate satisfactorily with air pressure, faulty operation of the transmission must be due to malfunction of the hydraulic control system. The valve bodies assembly must then be disassembled, cleaned, inspected and re-assembled.

Front clutch and governor feed "A"

Apply air pressure to the passage (5) of the transmission case rear wall, see Fig. 4—67. Listen for a thump, indicating that the clutch is functioning. On the bench, also verify by rotating the input shaft with air pressure applied.

If the extension housing has been removed, rotate the output shaft so that the governor weight will be at the bottom of the assembly. Verify that the weight moves inwards with air pressure applied.

Rear clutch "B"

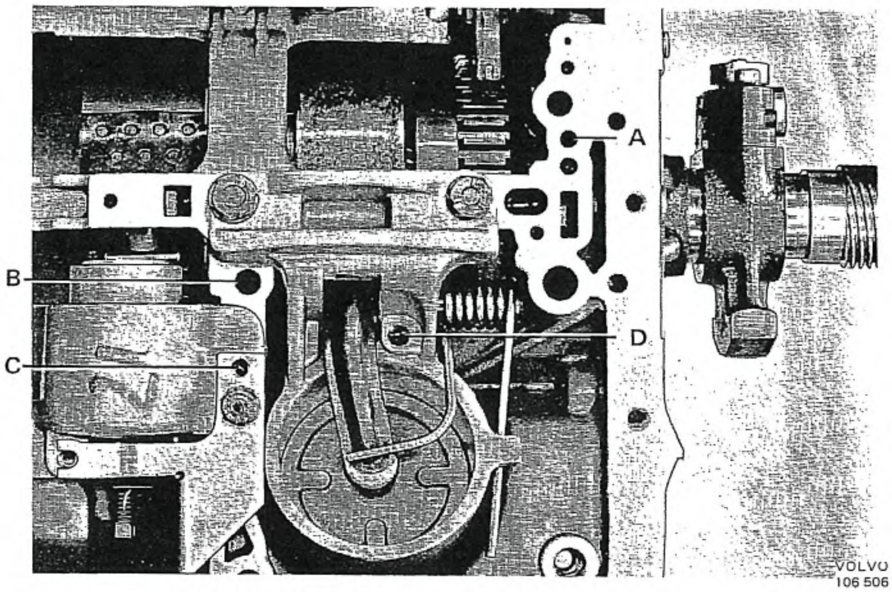
Apply air pressure to the passage (15) of the transmission case web. On the bench, verify by turning the input shaft that the clutch is functioning. Keep air pressure applied for several seconds to check for leaks. Then listen for a thump indicating that the clutch is releasing when the air pressure is removed.

Front servo "C"

Apply air pressure to the hole immediately adjacent to the rear retaining bolt. Observe the movement of the piston pin.

Rear servo "D"

Apply air pressure to the hole on the servo body. Observe the movement of the servo lever.



A. Front clutch (5)
B. Rear clutch (15)
C. Front servo application
D. Rear servo

Fig. 4—67. Functioning test with compressed air

REMOVING

1. Disconnect the battery ground lead and lift off the container for the windshield washer unit. Disconnect the throttle cable from lever and bracket. Remove the attaching bolts for the radiator. Hoist the vehicle and prop supports under the front and rear axles.
2. Drain the oil into a completely clean vessel, see Fig. 4—68. NOTE. The oil may be very hot and can scald if contact is made with the skin.
3. Disconnect the propeller shaft from the transmission flange. Disconnect the oil pipes to the oil cooler. Remove the reinforcing bracket under the oil sump.
4. Unscrew the attaching bolts for the converter. The crankshaft is turned forwards with a wrench on the pulley bolt. The wrench can also be used as a counterhold.
5. Place a jack with fixture 2746 under the transmission. Remove the shift control rods, the bracket for the shift lever and the cross-member for the rear engine mounting.
6. Remove the screw for the front silencer clamp. Disconnect the speedometer cable from the transmission. Lower the jack until the oil filler pipe touches the firewall.
7. Disconnect the electric cables from the starter inhibitor and reversing lights, the two upper bolts for the converter casing, the oil filler pipe and finally the other bolts on the converter casing.
8. Lower the jack and pull the transmission to the rear so that the guide pins on the converter are released from the flange. Lower the jack fully and pull forward the transmission. NOTE. The transmission must not be tilted forwards otherwise the converter can glide off the input shaft.

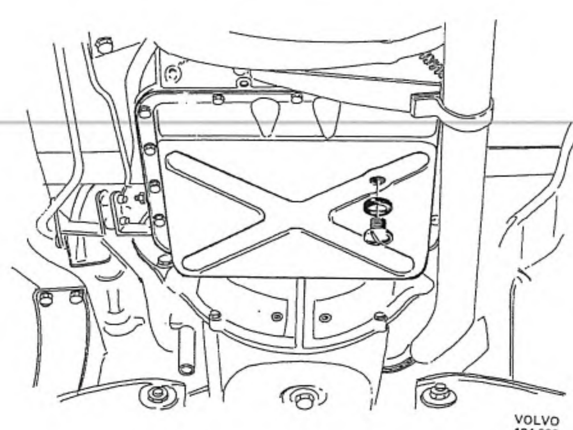


Fig. 4—68. Oil drain plug

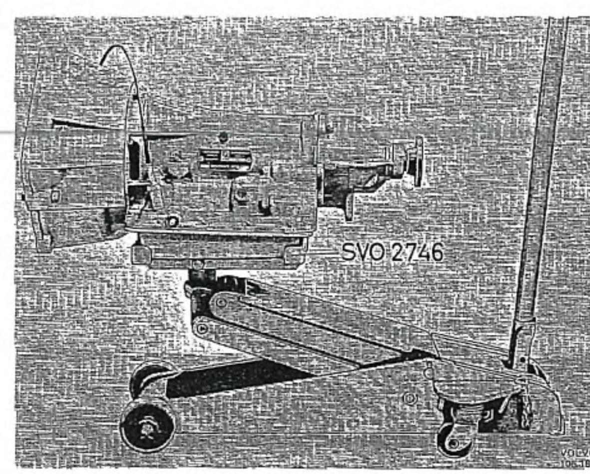


Fig. 4—69. Fixture for transmission

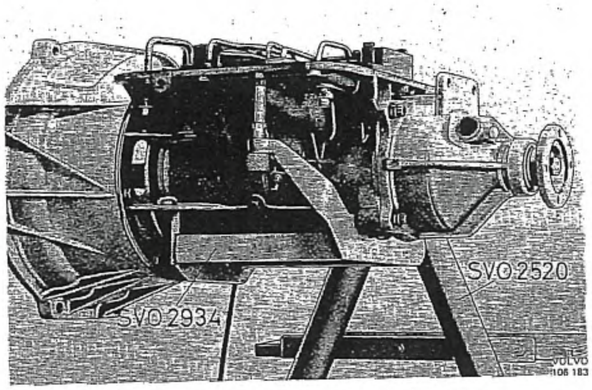


Fig. 4–70. Transmission in fixture 2934

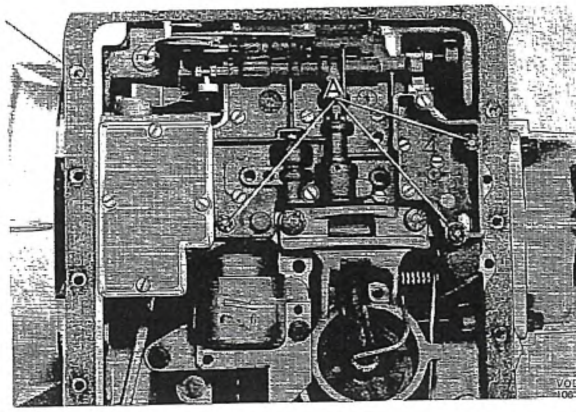


Fig. 4–72. Valve bodies assembly
A. Attaching bolts

DISASSEMBLING

As a general rule it is advisable only to disassemble those components requiring attention as indicated by road-testing or fault-tracing procedure.

Prior to the removal of any components, the outside of the transmission must be thoroughly washed down with white spirit. A high standard of cleanliness is required when handling or storing components.

When disassembling, the transmission should be inverted and placed on the bench cradle or in fixture 2934 as shown in Fig. 4–70, and special tools used as shown in the service tool list. Treat the various components with great care, particularly light-alloy parts. When the transmission is to be completely disassembled, follow the procedure below.

1. Remove the six bolts and withdraw the converter housing.
2. Unscrew the "Wedglok" screw for the drive flange on the output shaft. Pull out the drive flange and catch the 3/8" plain washer. Loosen and withdraw the rear housing. Remove the speedometer gear.
3. Unscrew the bolts for the oil pan and remove this. Lever out the oil tubes B-E carefully as shown in Fig. 4–71.

THE VALVE BODIES ASSEMBLY

Work on the whole assembly should preferably be carried out in a diesel test-room or in a room with similar standards of cleanliness.

4. Disconnect the downshift valve cable from the downshift valve cam. Unscrew the three screws which retain the valve bodies assembly to the transmission housing, see Fig. 4–72. Lift the

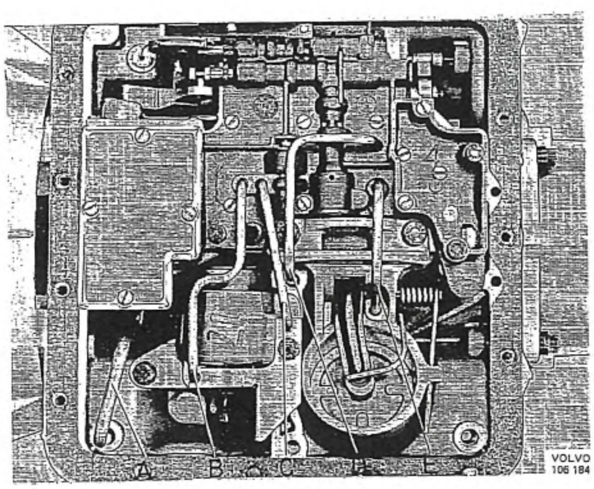


Fig. 4–71. Oil tubes

A. Converter outlet
B. Front servo release
C. Front servo application
D. Rear clutch
E. Rear servo

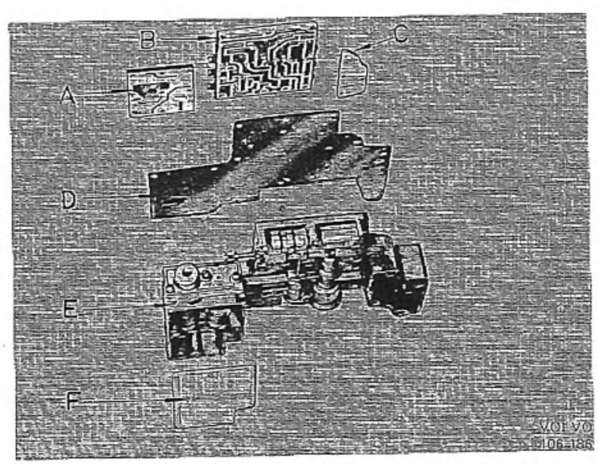


Fig. 4–73. Main components of valve bodies assembly

A. Oil tube collector
B. Upper valve body
C. Governor line plate
D. Separating plate
E. Lower valve body
F. Pump strainer

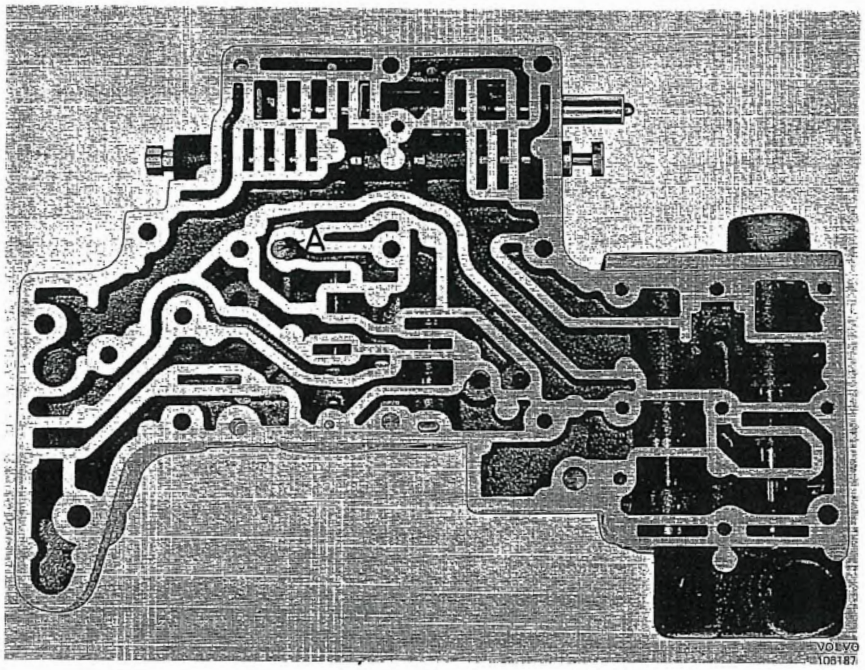


Fig. 4–74. Check valve in lower valve body

A. Check valve for fast 3–2.

valve bodies assembly straight up so that it releases from the oil tubes at the front end.

5. Unscrew the two screws for the bracket of the downshift valve cam.
6. Remove the strainer for the oil pump respectively.
7. Unscrew from above the screws which retain the upper valve body. Turn the valve bodies assembly round and unscrew the other six screws from underneath.
8. Unscrew the eight screws which retain the oil tube collector.
9. Unscrew the four screws which retain the governor line plate. Note that two screws are under one of the strainers.
10. Remove the separating plate and then the check

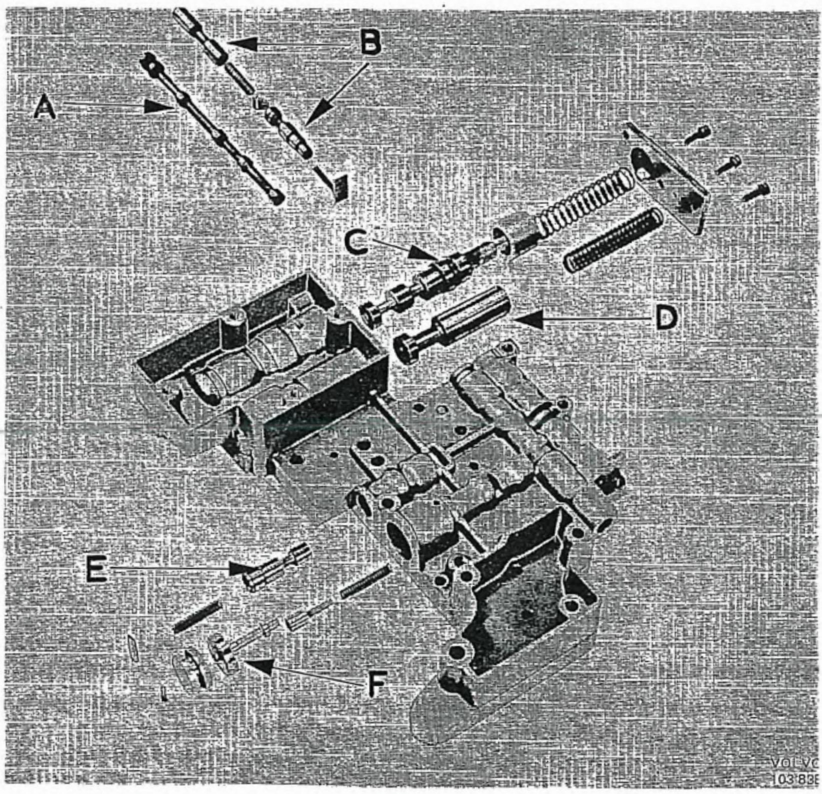


Fig. 4–75. Lower valve body

A. Manual control valve
B. Downshift and throttle valve
C. Primary regulator valve
D. Secondary regulator valve
E. Servo orifice control valve
F. Modulator valve

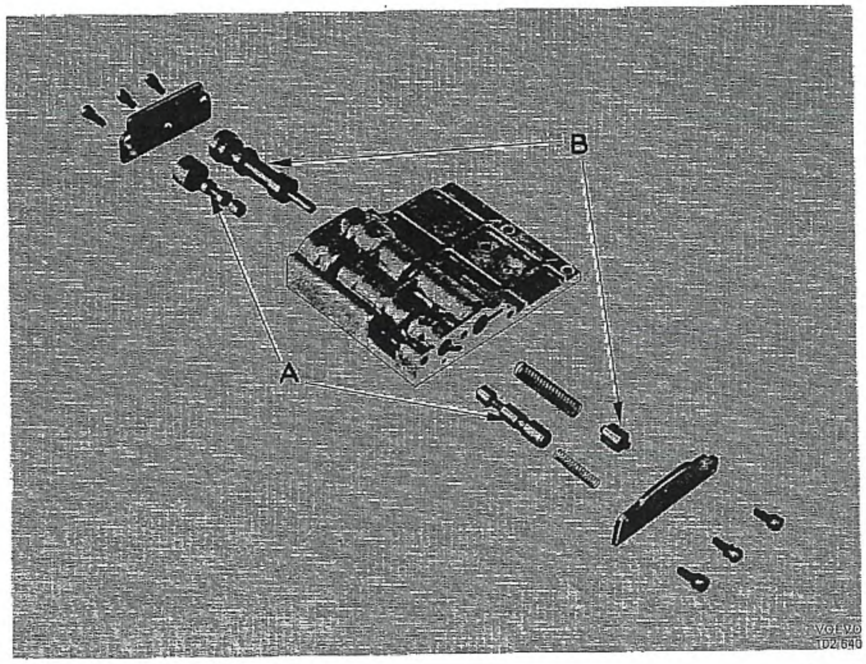


Fig. 4–76. Upper valve body
A. 1–2 shift valve and plunger
B. 2–3 shift valve and plunger

valve for fast 3–2, see Fig. 4–74. Withdraw the manual control valve, see "A", Fig. 4–75.

11. Remove the stops for the throttle valve and the return spring. Then withdraw the downshift valve, spring and throttle valve, see "B", Fig. 4–75.
12. Remove the dowel pin which retains the plug for the modulator valve. Then remove the plug, valve, plunger and spring.
13. Remove the stop for the servo orifice control valve and then the spring and valve.
14. From the manual valve side of the lower valve body, remove the following components: three screws, lower body end plate, primary regulator spring, primary regulator valve sleeve, primary regulator valve, secondary regulator valve spring and secondary regulator valve.
15. Remove the six screws and end plate from the upper valve body, see Fig. 4–76. Remove the following parts from the rear end of the body: shift valve 2–3, inner spring and plunger together with shift valve 1–2. The spring and plunger for shift valve 1–2 are removed in the other direction.

FRONT AND REAR SERVOS

16. Remove the two screws which retain the front servo to the body, withdraw the servo and the strut for the band.
17. Remove the snap ring in the servo with a small screwdriver. Take out the piston and separate the various parts. Drive out the slotted spring pin and lever pivot pin if necessary.
18. Unscrew the two screws retaining the rear servo and withdraw this and the strut.
19. Unhook the spring. Drive out the pivot pin and the lever. Pull out the piston.

PUMP ASSEMBLY

20. Remove the oil tubes in the housing. In case of difficulty pull them out with needle-nose pliers as shown in Fig. 4–77.
21. Set up the dial indicator gauge as shown in Fig. 4–78 with plate 2532 and magnetic attachment. Place the point of the gauge against the shaft end, move the shafts and gears backwards and forwards and read off the end-float. This should

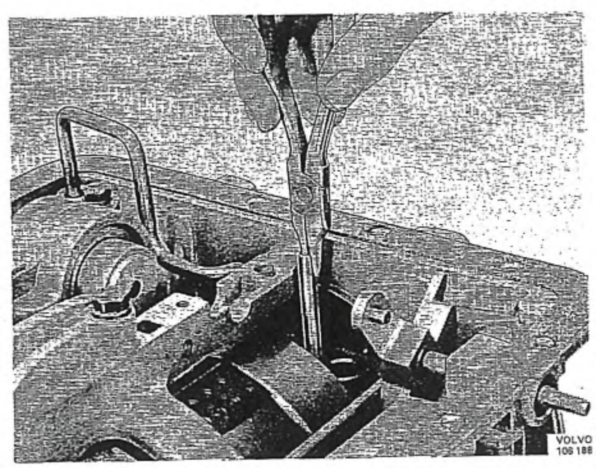


Fig. 4–77. Removing converter inlet and outlet tubes using needle-nose pliers

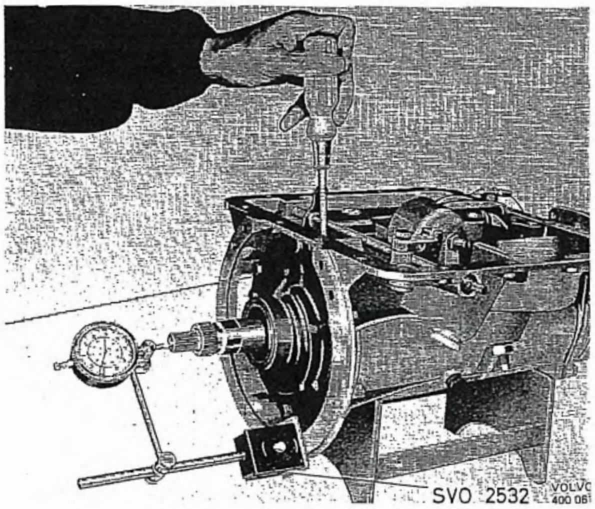


Fig. 4—78. Checking end float

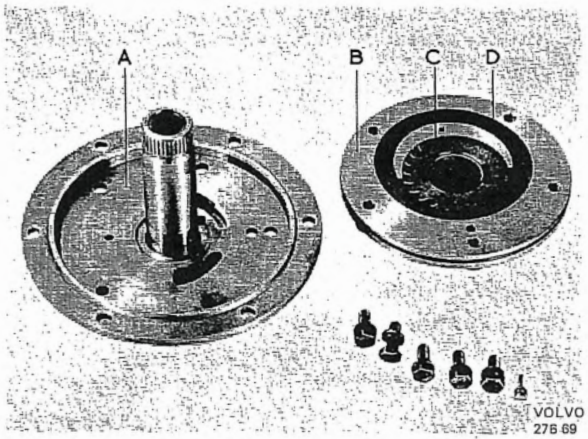


Fig. 4—80. Converter support separated from front pump

A. Pump adaptor and converter support assembly
B. Body and bush assembly
C. Driving gear
D. Driven gear

be 0.25—0.75 mm (0.010—0.030"). Note the amount of play.

22. Unscrew the six bolts which retain the pump to the body. Withdraw the pump and remove the gasket. Push the shaft inwards when withdrawing the pump, see Fig. 4—79.
23. Unscrew the five hexagon bolts and the slotted screw. Separate the pump body, gears and other parts, see Fig. 4—80.

FRONT CLUTCH ASSEMBLY

24. Withdraw the front clutch assembly and input shaft complete, see Fig. 4—81. Take care of the thrust washers. Take out the front brake band.
25. Remove the snap ring with a screwdriver. Withdraw the input shaft. Take out the inner and outer plates and the clutch hub.
26. Remove the snap ring, spring, and piston. If the piston is tight, lay the clutch body with the opening downwards on a bench and blow out the piston with compressed air.

REAR CLUTCH ASSEBMLY

27. Withdraw the rear clutch assembly together with the forward sun gear shaft, see Fig. 4—82.
28. Remove the two oil rings at the front of the shaft. Then withdraw the shaft. Take care of the two needle thrust bearings.
29. Remove the three oil rings from the clutch body hub.
30. Remove the snap ring and take out the pressure plate, inner and outer plates.
31. Place special tool 2533 on the clutch as shown in Fig. 4—83. Tighten the wing nut until the snap

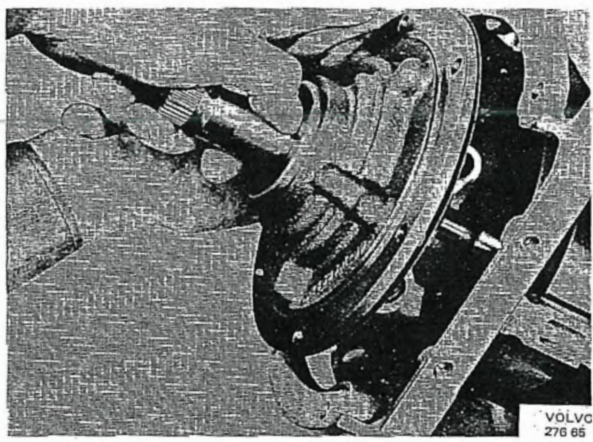


Fig. 4—79. Removing front pump

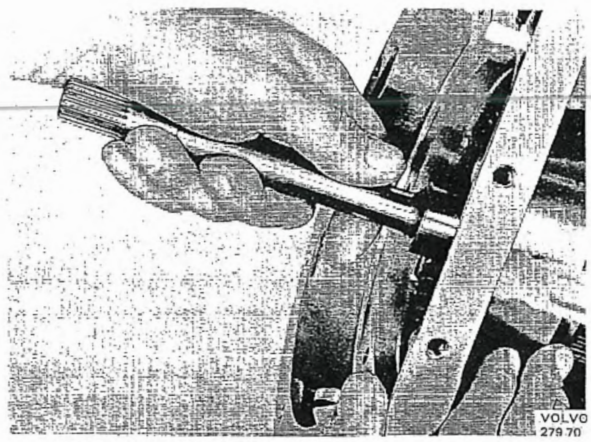


Fig. 4—81. Withdrawing front clutch assembly

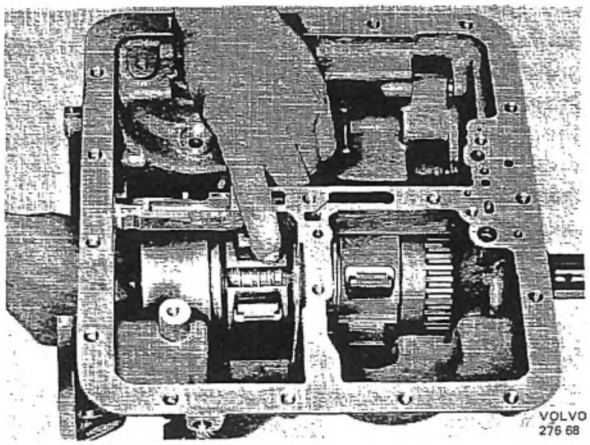


Fig. 4—82. Withdrawing rear clutch and forward sun gear group

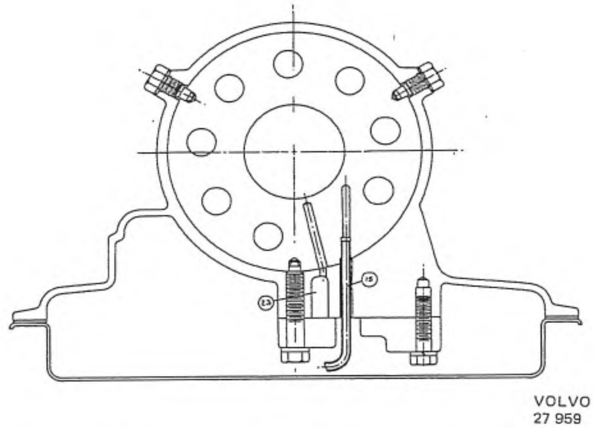


Fig. 4—84. Center support, retention and passages

ring releases. Remove the snap ring and screw back the wing nut. Remove the special tool, then the retainer and spring. Withdraw the piston. If necessary blow out the piston with compressed air.

CENTER SUPPORT AND PLANET GEARS

32. From the outside of the transmission case remove the two center support screws, see Fig. 4—84. Withdraw the center support and planet gears, see Fig. 4—85. Take out the rear brake band. Separate the center support, one-way clutch and planet gears. Remove the snap ring and the outer race of the one-way clutch.

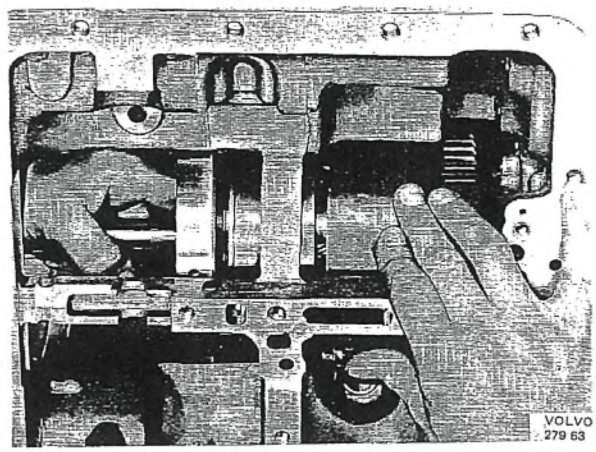


Fig. 4—85. Withdrawing center support and planet gears

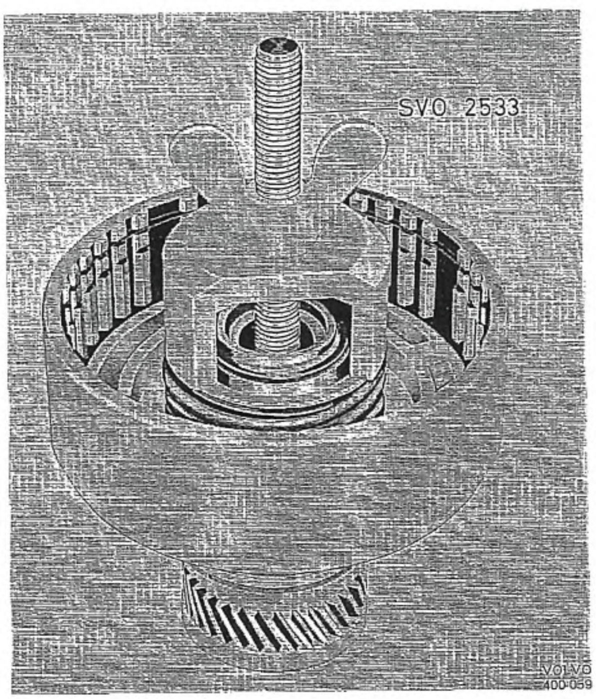


Fig. 4—83. Disassembling rear clutch

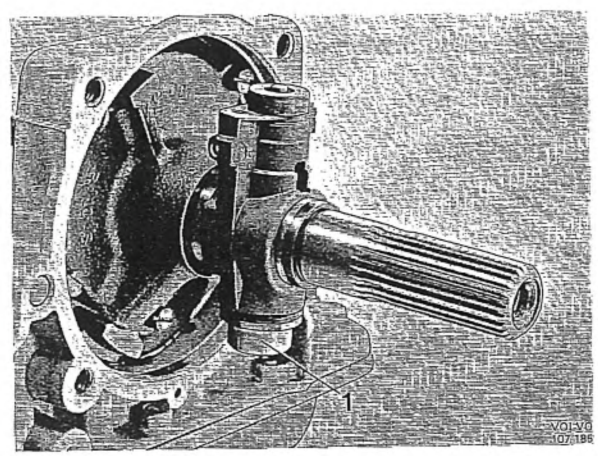


Fig. 4—86. Removing governor

1. Bolt

GOVERNOR

33. Release the bolt and pull the governor off the shaft, see Fig. 4–86.
34. Press the valve unit together and remove the clip. Remove the various parts.

OIL DEFLECTOR FLANGE

35. Unscrew the five slotted screws. Withdraw the oil deflector flange.
36. Remove the three oil sealing rings from the driven shaft.

DRIVEN SHAFT

37. Withdraw the driven shaft. Remove the thrust washer. If necessary remove the snap ring and separate the ring gear from the driven shaft.

SHAFT, PARKING PAWL AND LEVERS

38. Remove all locking clips. Push the manual valve lever in on the shaft and remove the lock pin. Separate the parts. The anchor pin for the parking pawl can be withdrawn with a magnet or shaken out. If the control shaft is to be removed, drive out the lock pin in the housing.
39. The throttle cable and other parts in the body are removed as necessary.

INSPECTING

After cleaning, all parts should be thoroughly checked for wear or other damage.

Check that the white metal bush for the driven shaft and the pins for the parking pawl linkage are firmly secured in the case. If they are loose, the case must be replaced.

Check the thrust washers and needle bearings for wear and any seizing. If the end-float is within the permissible limits, it can be taken for granted that the thrust washers are not worn.

Check the gears for wear, seizing or tooth fractures. Also check that the pinions in the planet gear pinion carrier run easily on the needle bearings.

Check the brake bands and discs for wear, overheating or other damage.

ASSEMBLING

The utmost cleanliness must be observed when assembling the transmission.

Before assembling, all parts must be carefully washed in white spirit.

Use new gaskets when assembling. Lubricate the parts with "Automatic Transmission Fluid, type F". Tighten all bolts with a torque wrench in accordance with the torque chart in the "Specifications". Use sealing compound 277961 on the threads of the inhibitor switch, the pressure point plug and the oil drain. Locking fluid Loctite CV or corresponding is used for the flange bolt, and Loctite AV for the nipples for the oil cooler connections. Note that items not described in this section are assembled in the reverse order to dismantling.

TRANSMISSION CASE, SHAFT, PARKING PAWL AND LEVERS

1. The transmission case is inverted on the bench cradle or in the fixture.
2. Assemble the shaft, parking pawl and levers in the reverse order to dismantling. Make sure that the springs for the levers are correctly fitted, see Fig. 4–88. Fitting the detent ball is facilitated by pressing down the ball using a short length of tubing as shown in Fig. 4–87.

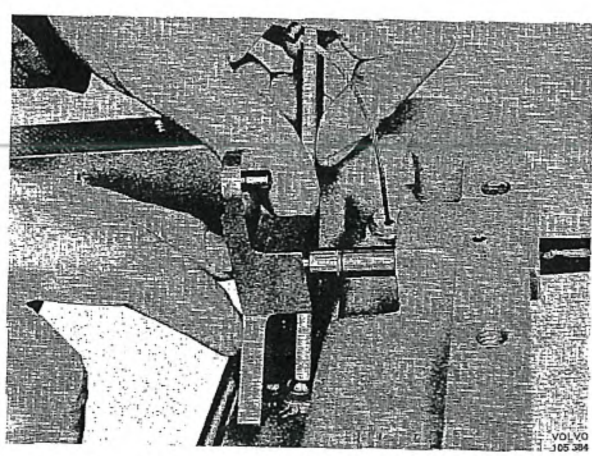


Fig. 4–87. Locating manual valve lever on detent ball spring

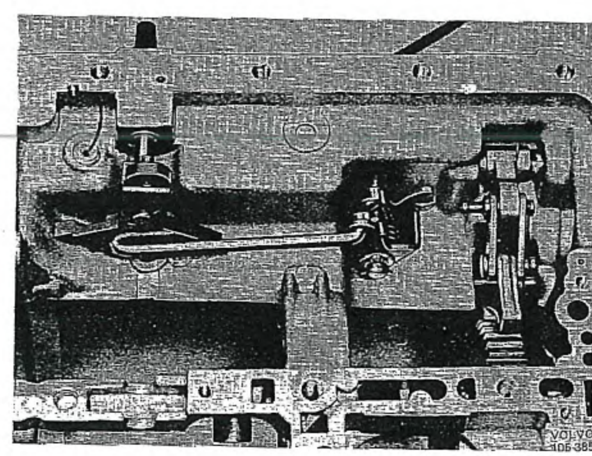


Fig. 4–88. Parking pawl and linkage installed

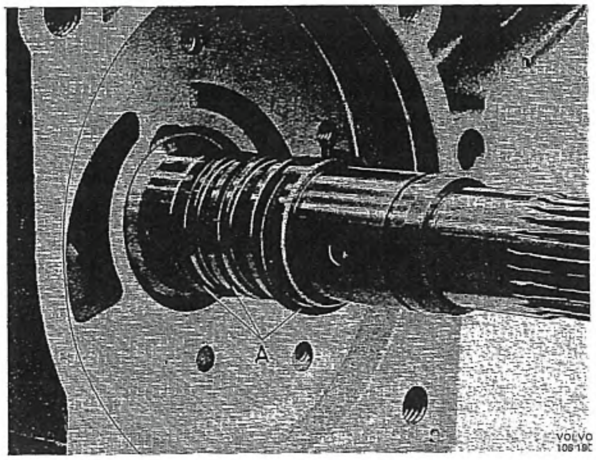


Fig. 4–89. Installing driven shaft oil rings
A. Sealing rings

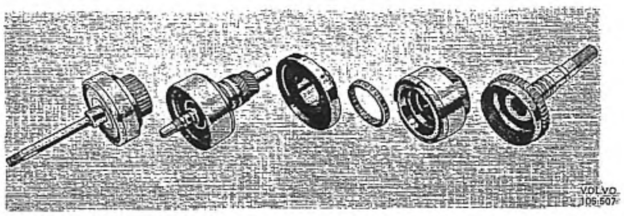


Fig. 4–90. Gear train components

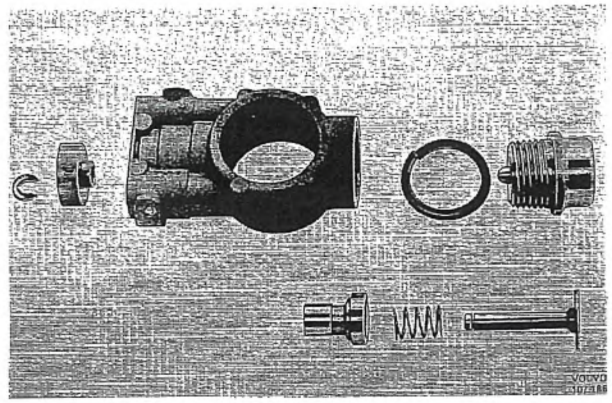


Fig. 4–92. Governor assembly disassembled

DRIVEN SHAFT

3. The thrust washer for the driven shaft, see Fig. 4–91, is stuck onto the transmission case with vaseline. The driven shaft complete with ring gear is then installed into the transmission case.

REAR PUMP

4. Fit the three oil sealing rings on the shaft, see Fig. 4–89. Exercise care when doing this as the oil sealing rings are very fragile. Stand the box on its front end and support under the shaft. Center the oil rings. The oil deflector flange is then fitted.

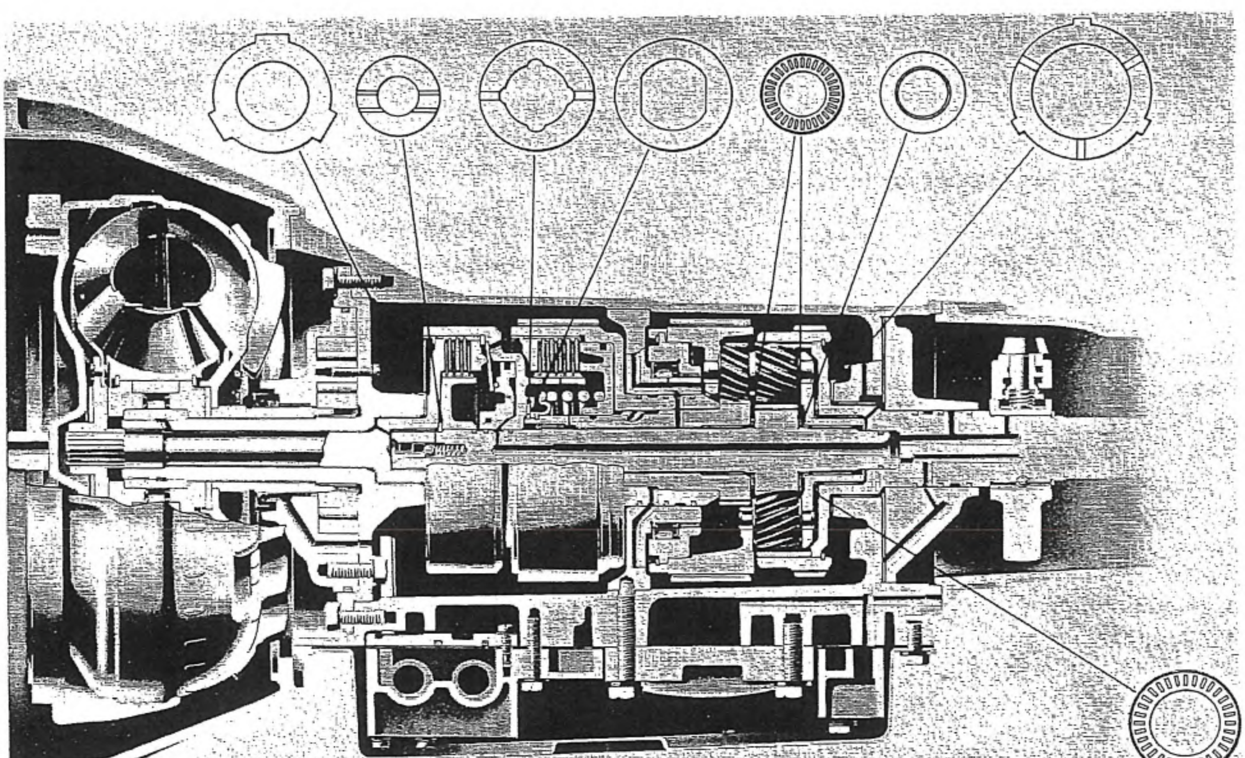


Fig. 4–91. Location of thrust washers

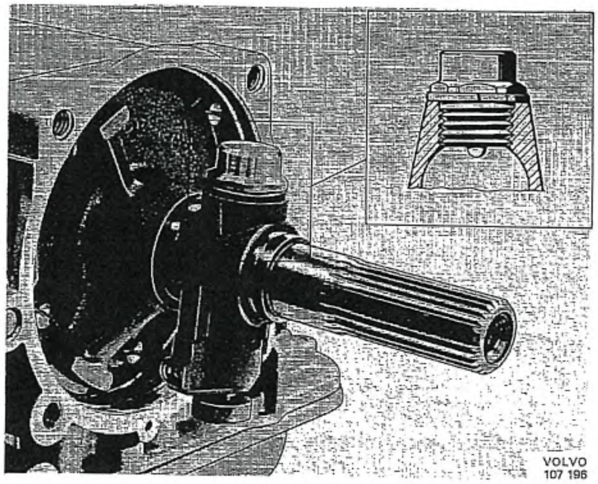


Fig. 4–93. Governor and driven shaft

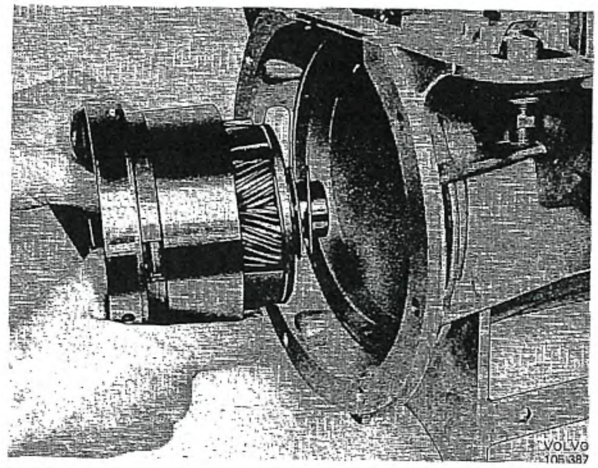


Fig. 4–96. Installing center support and planet gears with needle thrust bearing and plate washer

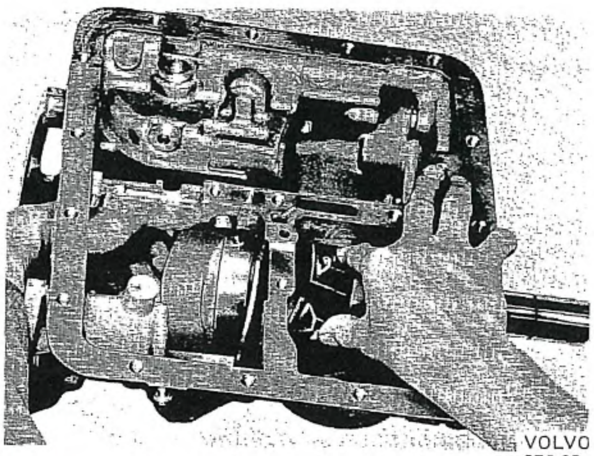


Fig. 4–94. Installing rear brake band

GOVERNOR

5. Push the governor onto the shaft as shown in Fig. 4–93. Make sure that the bolt enters the recess in the shaft. Tighten the bolt to a torque of 20–25 Nm (15–18 lbft). This torque must not be exceeded.
   NOTE. It is not certain that the spring washer will be fully compressed when tightening the bolt.

REAR BRAKE BAND AND SERVO

6. Place the rear brake band in position in the case, see Fig. 4–94. Then fit the rear servo assembly. Tighten only the rear (short) servo screw since the long one also locates the center support.

PLANET GEAR AND CENTER SUPPORT

7. Assemble the planet gear, one-way clutch and center support, see Fig. 4–96. Stick the thrust plate and needle thrust bearing to the planet cover with vaseline.
8. Turn the fluid passage holes in the centre support upwards and fit the assembled unit into the

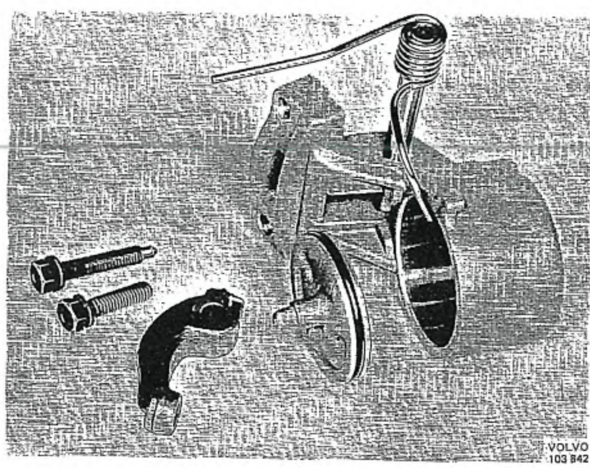


Fig. 4–95. Rear servo assembly disassembled

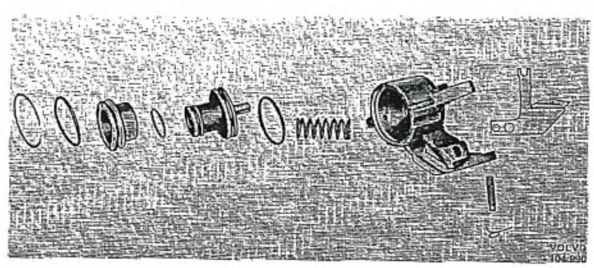


Fig. 4–97. Front servo assembly disassembled

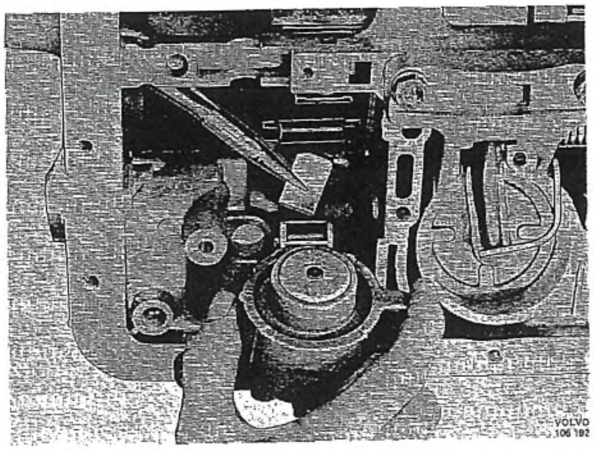


Fig. 4–98. Installing front servo and strut

transmission case. (Note that the holes point downwards when the transmission is turned the right way up, see Fig. 4–84.)

9. Fit the two center support screws from outside. Remember that the lock washers also serve as sealing washers so that the flat surface should face inwards. Then tighten the servo screw locating the support.

FRONT BRAKE BAND AND SERVO

10. Place the front brake band in position, see Fig. 4–98. Stick the strut to the servo lever with vaseline.
    Fit the servo. The shorter bolt is fitted at the front. Make sure that the servo strut is correctly engaged with the slot in the brake band. The cam for self-adjusting is fitted later.

REAR CLUTCH

11. Fit the sealing rings for the piston. Use fitting ring 5000 and fit the piston in the clutch case, see Fig. 4–100.
12. Fit the spring, spring seat and snap spring using special tool 2533, which is used when disassembling, see Fig. 4–83.
13. Install the clutch plates. Note that the outer plates are coned and that all the plates should be fitted with the cone facing in the same direction. Begin with an outer plate and then fit inner and outer plate alternately. Fit the pressure plate and snap ring.
14. Place the front needle thrust bearing on the rear sun gear shaft. Fit the shaft in the rear clutch assembly. Install the oil sealing rings, see Fig. 4–101.
15. Install the rear needle thrust bearing and fit the clutch in the transmission as shown in Fig. 4–102.

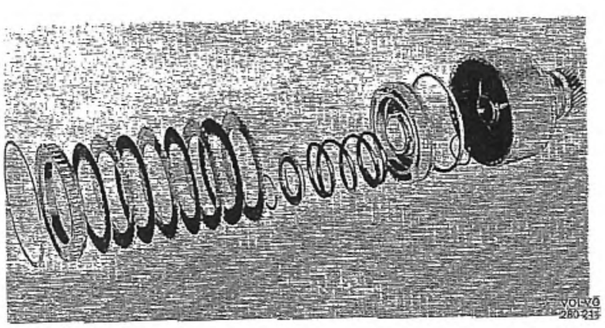


Fig. 4-99. Rear clutch disassembled.

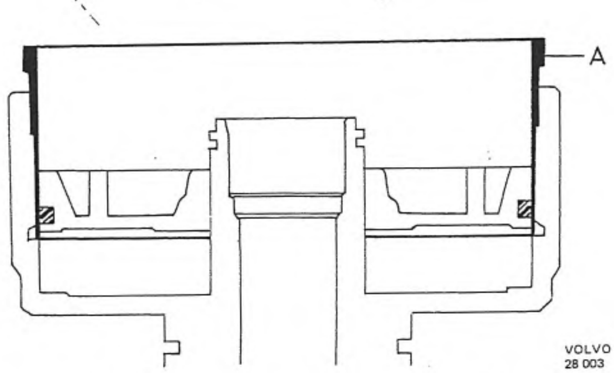


Fig. 4–100. Installing piston for rear clutch
A. Fitting ring 5000

FRONT CLUTCH

16. Place the guide 2993 in the clutch housing (drum). Fit the sealing ring on the piston and a new O-ring

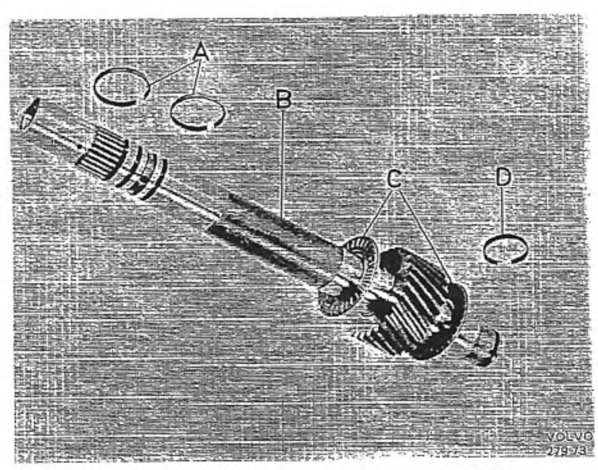


Fig. 4–101. Forward sun gear components
A. Oil sealing rings, front clutch
B. Forward sun gear assembly
C. Needle thrust washers
D. Oil sealing ring, governor feed

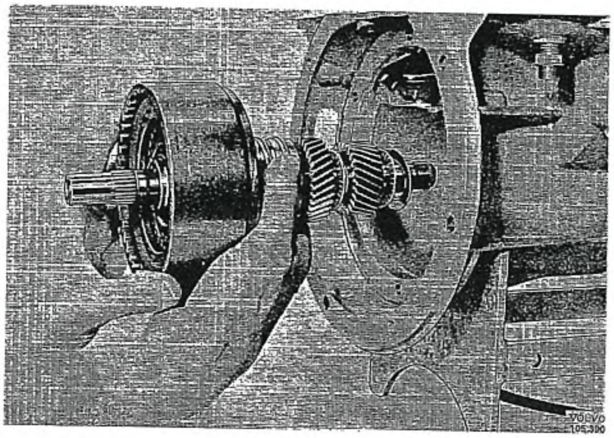


Fig. 4—102. Installing rear clutch and forward sun gear group

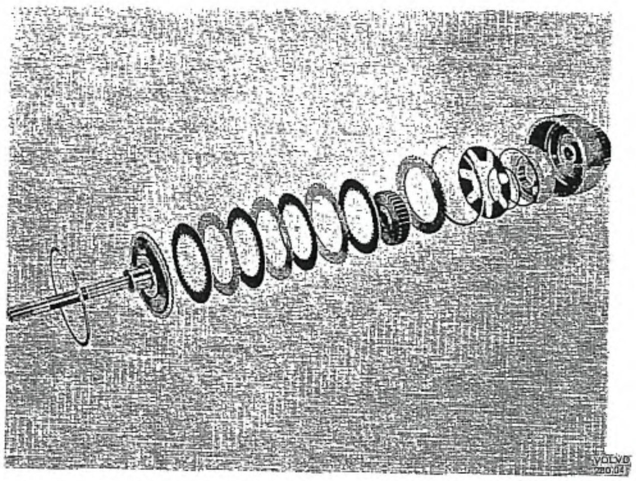


Fig. 4—103. Front clutch disassembled

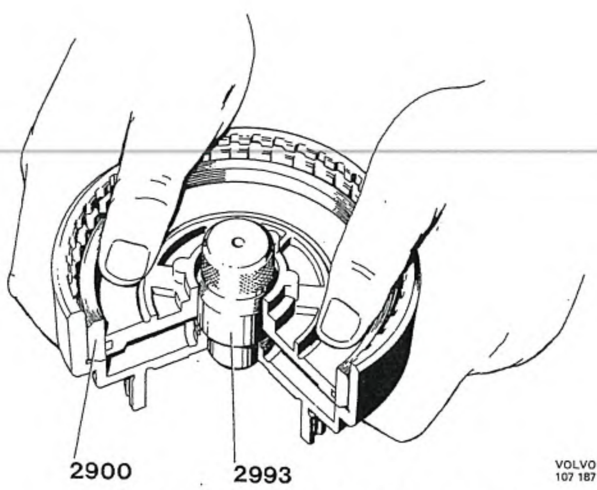


Fig. 4—104. Fitting piston for front clutch

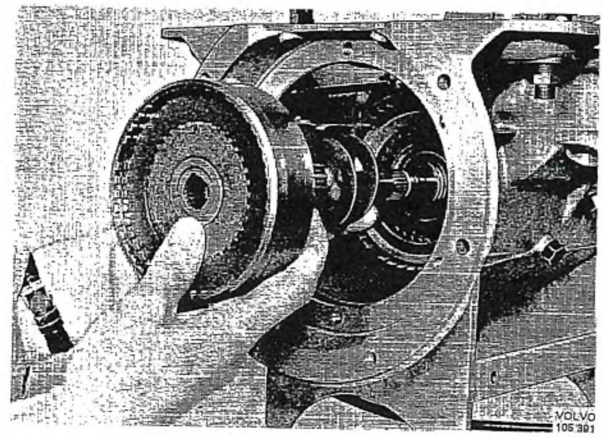


Fig. 4—105. Installation sequence, front clutch cylinder thrust and backing washers

in the drum. Place the piston in the fitting ring 2900. Press it down until it is level with the lower edge of the ring. Place the piston over the guide in the clutch housing according to Fig. 4—104. Hold the housing in your hands and push down the piston with the thumbs. Remove the tool. Fit the spring with the dished side facing rear. Fit the snap ring.

17. Install the clutch assembly with its two different thrust washers in the transmission, see Fig. 4—105. Be careful not to damage the oil sealing rings. For indentification of the thrust washers, see Fig. 4—91.
18. Fit the pressure plate, inner and outer plates, and hub. Fit the thrust washer for the clutch hub and input shaft into the front clutch, see Fig. 4—106. Fit the snap ring.
19. Fit the O-ring on the pump body, then assemble the pump in the reverse order to disassembling.
20. Stick on the thrust washer with vaseline and then fit the pump with a new gasket on the trans-

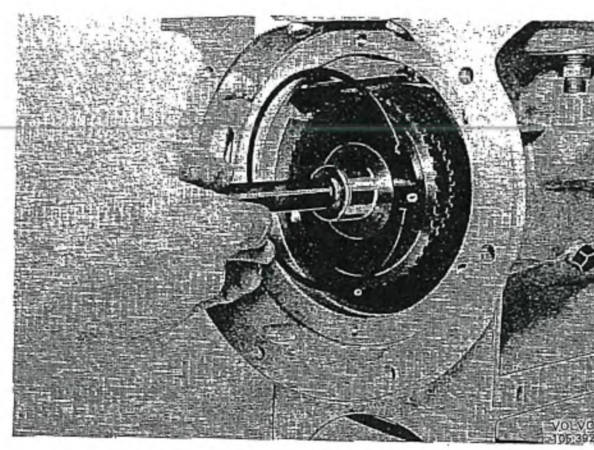


Fig. 4—106. Installation sequence, front clutch snap ring, input shaft and thrust washer

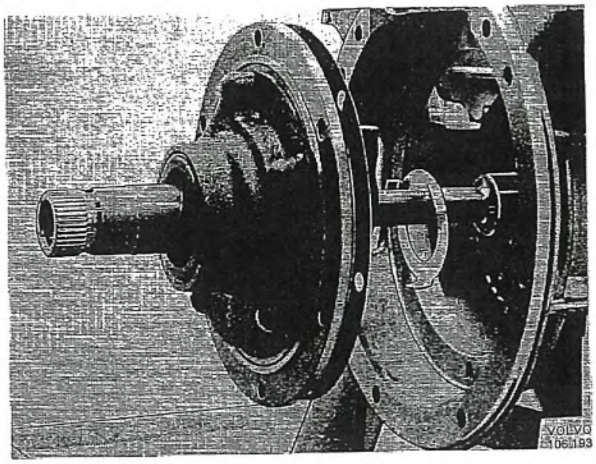


Fig. 4—107. Installation sequence, front pump assembly thrust washer and gasket

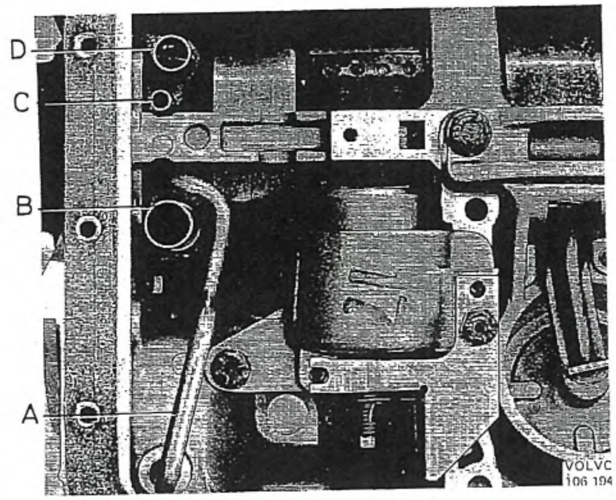


Fig. 4—109. Location of oil tubes, front of gearbox
A. Converter outlet
B. Pump inlet
C. Converter inlet
D. Pump outlet

mission case, see Fig. 4—107. Re-check the axial play in accordance with point 21, page 4:33.

EXTENSION HOUSING

21. Place the speedometer gear correctly on the driven shaft as shown in Fig. 4—108. Fit the extension housing with a new gasket and fit the drive flange with washer and nut.

VALVE BODIES ASSEMBLY

22. When assembling, all the component parts which have been disassembled should be thoroughly cleaned and lubricated with oil approved as "Automatic Transmission Fluid, type F" prior to reassembling in the reverse order to disassembling. Line up the component parts of the valve bodies assembly by using two of the retaining bolts. Check the free movement of all valves in their bores. Check that the strainer is flat so that it makes a complete seal when screwed down. Tighten the screws to the specified torque.
23. Fit the oil tubes for the pump and converter on the pump, see Fig. 4—109. Do not forget the O-ring for the pump inlet tube.
24. Fit the valve bodies assembly onto the transmission. Connect the throttle cable.

MISCELLANEOUS

25. Place the spacer block 2537 between the bolt and cylinder, see Fig. 4—110. Tighten the bolt with torque wrench 2748 until the ratchet handle

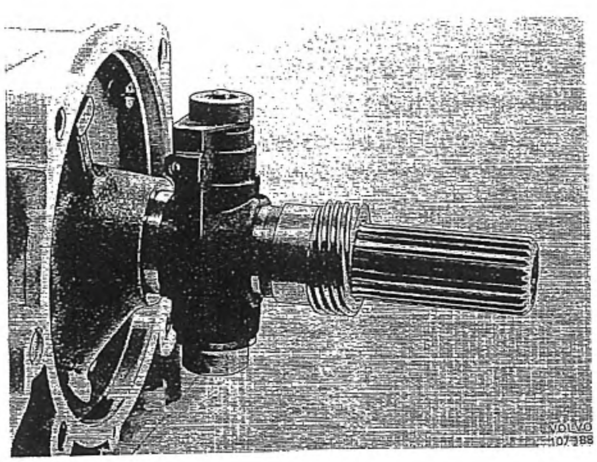


Fig. 4—108. Installing speedometer gear

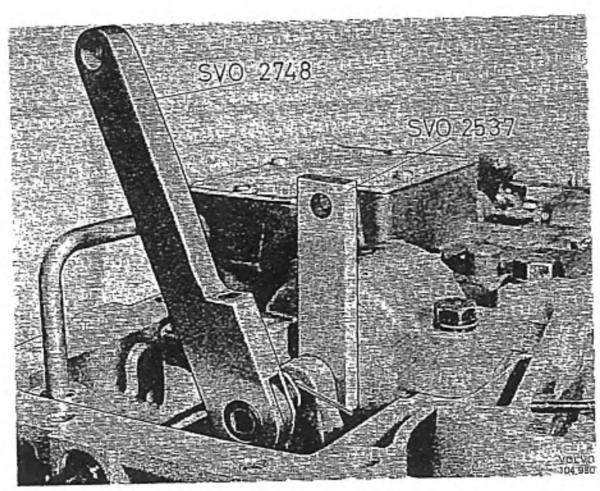


Fig. 4—110. Adjusting front brake band

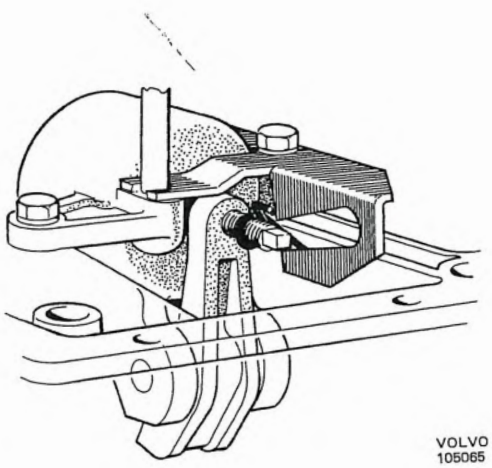


Fig. 4—111. Self-adjusting

clicks out. This corresponds to a torque of 1.15 Nm (10 lb.in.).

26. Adjust the position of the spring on the adjusting screw. It should be 1—2 threads from the lever. Remove the torque wrench and spacer block and then fit the cam. Insert the longer end of the spring in the cam, see Fig. 4—111.
27. Fit the four oil tubes according to Fig. 4—112. NOTE. The oil tube for releasing the front control cylinder is provided with a constriction (A, Fig. 4—113). This end is fitted in the control system.

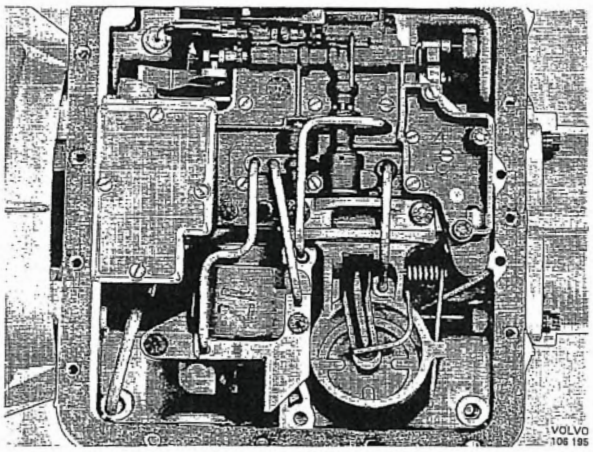


Fig. 4—112. Pump strainer attachment and oil tubes installed

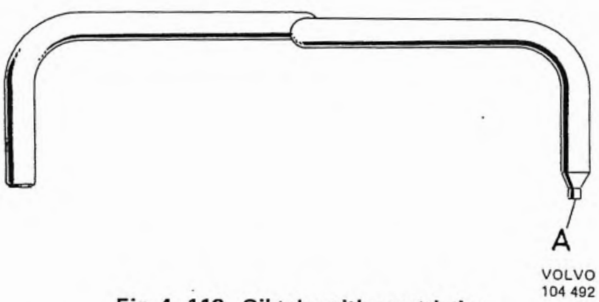


Fig. 4—113. Oil tube with constriction

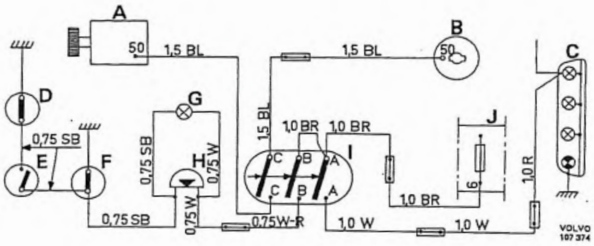


Fig. 4—114. Wiring diagram

A. Starter motor
B. Ignition
C. Reversing lights
D. Contact for seat belt, passenger
E. Contact in passenger seat
F. Contact for seat belt, driver
G. Reminder lamp for seat belt
H. Warning buzzer for seat belt (certain markets)
I. Contact on gearbox
J. Fusebox

Colour code:

BL	= blue
BR	= brown
R	= red
SB	= black
W	= white

28. Adjust the rear brake band, see "Adjusting rear brake band" on page 4:29. Fit the starter inhibitor contact, see "Replacing starter inhibitor contact" on page 4:29.
29. Place the magnetic piece in the oil pan. Fit the oil pan with a new gasket.

INSTALLING

The converter, converter housing and transmission are installed in the reverse order to removal. Connect the leads for the starter inhibitor contact and reversing light correctly, see Fig. 4—114.

SELECTOR CONTROLS

DISASSEMBLING

1. Jack up the car. Disconnect the control rods from the transmission lever (9, Fig. 4—115) and the lever arm (5).
2. Unscrew the bolts and remove the bracket (6) from the lever arm. Remove the nut and separate the various parts.
3. Remove the shift lever knob. Unscrew both the front bolts for the casing (16) over the selector control. Remove the tunnel console.
4. Disconnect the cable for the quadrant lighting (2). Unscrew the bolts and remove the selector lever (1) and the inhibitor plate (15).

5. Remove the bolts holding the inhibitor plate (15), rubber bellows (14) and bearing housing (12) together. Unscrew the nut and remove the lever (3).
6. Remove the circlip and drive out the lock pin (11) for the selector lever. Separate the other parts.

INSPECTING

Check shafts and bushes for wear. Check ball caps and ball bolts. The ball caps must not run so easily on the bolts that there is risk that they fall off. Worn or damaged parts should be replaced.

ASSEMBLING

1. Fit the bushes in the bearing house and on the levers. Grease the bushes and ball caps. Then assemble the control in reverse order to disassembling.
2. Adjust the length of the lower control rod (8) so that the levers (9 and 7) on the transmission and intermediate journalling are parallel.
3. Check to make sure the control is properly adjusted. This is done by checking the distance to the gating in position "N" and "D" (A and B, Fig. 4—62). The clearance for both positions should be the same. If necessary, adjust the length of the upper control rod (4).
4. Check to make sure that the output shaft is locked with the selector lever in "P" position.

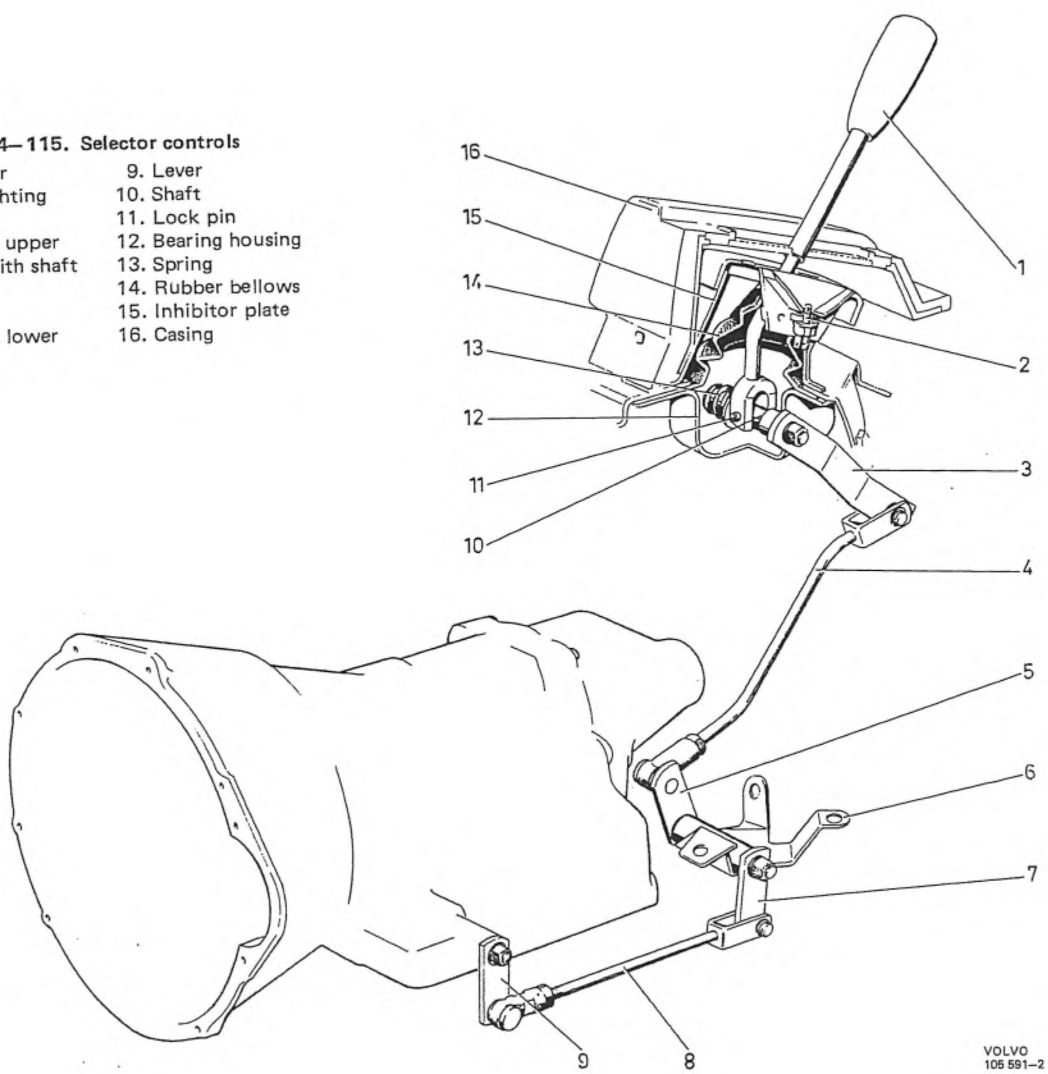


Fig. 4—115. Selector controls

1. Selector lever
2. Quadrant lighting
3. Lever
4. Control rod, upper
5. Lever arm with shaft
6. Bracket
7. Lever
8. Control rod, lower
9. Lever
10. Shaft
11. Lock pin
12. Bearing housing
13. Spring
14. Rubber bellows
15. Inhibitor plate
16. Casing

FAULT TRACING

ROAD-TESTING

(Used together with the fault-tracing scheme.)

It is important to gain as much information as possible as to the precise nature of any fault. If possible, go out in the car with the customer and get him to demonstrate the fault. In all cases, the following road-test procedure should be carried out completely as there may be more than one fault.

TEST NO.

1. Check that the starter only operates with the selector in "P" and "N" and that the reversing light operates only in "R".
2. Apply the brakes and, with the engine running at normal idling speed, select "N–D", "N–2", "N–1" and "N–R". Transmission engagement should be felt in each position selected.
3. Check the converter stall speed with the transmission in "1" and "R". Check for slip or clutch squawk.
   Note. Do not stall for longer than 10 seconds or the transmission will overheat.
4. With the transmission at normal running temperature, select "D". Release the brakes and accelerate with minimum throttle opening. Check for 1–2 and 2–3 shifts. Note. At minimum throttle openings, the shifts may be difficult to detect. Confirmation that the transmission is in 3rd gear may be obtained by selecting "2" or "1", when a 3–2 downshift should be felt.

6a. Stop and restart using full throttle acceleration. Check for 1–2 and 2–3 shifts according to the shift speed table in the "Specifications".

b. At 40 kmph (24 mph) in 3rd gear, depress the acceleration to full throttle position. The car should downshift to 2nd gear. Repeat at 65 kmph (40 mph). The car should accelerate in 3rd gear and should not downshift to 2nd.

c. At 50 kmph (30 mph) in 3rd gear, depress the accelerator to the kick-down position. The transmission should downshift to 2nd gear.

d. At 25 kmph (15 mph) in 3rd gear, depress the accelerator to the kick-down position. The transmission should downshift to 1st gear.

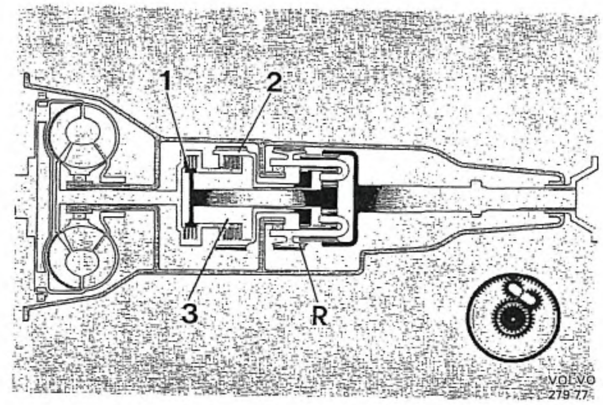


Fig. 4–116. Principle diagram for fault tracing

1. Front clutch gives 1st gear
2. Front brake band gives 2nd gear
3. Rear clutch gives 3rd gear

R. Rear brake band gives reverse and engine braking "1".

7a. Stop and restart using forced-throttle acceleration. Check for 1–2 and 2–3 shifts according to the shift speed table in the "Specifications".

b. At 65 kmph (40 mph) in 3rd gear, release the accelerator and select "1". Check for 3–2 downshift and engine braking. Check for rollout 2–1 downshift at about 8 kmph (5 mph) and engine braking.

8. Stop, and with "1" still engaged, release brakes and, using full throttle, accelerate to 30 kmph (20 mph). Check for no slip or clutch squawk and no upshifts.
9. Stop and select "R". Release brakes and reverse using full throttle if possible. Check for no slip or clutch squawk.
10. Stop on the brakes facing downshift on a gradient and select "P". Release the brakes and check that the parking pawl will hold the car. Re-apply the brakes before disengaging the parking pawl. Repeat with the car facing uphill. Check that the selector is trapped by the inhibitor in "P".

FAULT-TRACING SCHEME

(To be used in conjunction with the road-test procedure.)

TEST	FAULT	ACTION
1.	Starter will operate in "P" or "N"	19
2.	Starter operates in all selector positions	20
	Excessive bump on engagement of "D", "2", "1" or "R"	4, 3
3.	If stall speed higher than specified:	
	a. with slip and squawk in "1"	1, 2, 3, 13, 11
	b. with slip and squawk in "R"	1, 2, 3, 13, 12
	If stall speed lower than specified, check engine performance	
	If stall speed more than 10 r/s (600 r/m) lower than specified	21
4.	No drive in "D" (if normal in "11, omit 11 and 13; if no drive in "D", "2", "1" or "R", and 17)	1, 2, 3, 13, 11, 16
	Delayed or no 1–2 shift	3, 14, 13, 5, 6
	Slip on 1–2 shift	2, 3, 5, 6, 7, 13
	Delayed or no 2–3 shift. (If normal in "R", omit 12.)	3, 14, 13, 5, 6, 12
	Slip or engine run-up on 2–3 shift	2, 3, 5, 13, 12
	Bumpy gear shifts	3
	Drag in "D2" and "3	8
	Drag on 2–3 shift	5, 6
5a.	Slip and squawk or judder on full throttle take-off in "D"	1, 2, 3, 13, 11
	Loss of performance and overheating in "D 3" (seized stator)	21
	Continue as for test 4 above	
b.	Transmission downshifts too easily	3
c, d.	Transmission will not downshift	
6a.	As test 6a above	3, 13, 14
b.	No 3–2 downshift or engine braking	1, 5, 6, 7, 12
	No 2–1 downshift or engine braking	8, 9, 10
7.	Slip and squawk or judder on take-off in "1"	1, 2, 3, 13, 11
8.	Transmission upshifts	1
	Slip and squawk or judder on take-off in "R"	1, 2, 3, 13, 12
	Slip but no judder on take-off in "R" (if engine braking available in "1", 1st gear omit 8, 9, 10)	1, 2, 3, 8, 9, 10
	Drag in "R"	5
	No drive in "R" (if engine braking available in "1", 1st gear omit 8, 9, 10)	1, 2, 3, 8, 13, 9, 10, 12
9.	No park	1, 15
Mis-cell-aneous	Screech or whine, increasing with engine speed	17
	Grinding or grating noise from transmission	18
	Knocking noise from torque converter area	22
	At high speeds in "D 3", transmission downshifts to "D 2" and immediately back to "D 3"	12

ACTION

1. Check manual linkage adjustment.
2. Check fluid level.
3. Check adjustment of downshift valve cable using line pressure gauge and tachometer.
4. Reduce engine idling speed.
5. Check front band adjustment.
6. Check front servo seals and tubes for leakage.
7. Check front band for wear.
8. Check rear band adjustment.
9. Check rear servo seal and fit of tubes.
10. Check rear band for wear.
11. Examine front clutch and seals, also front sun gear shaft rings. Verify that cup plug in driven shaft is not leaking or dislodged.
12. Examine rear clutch, check valve, and seals. Check fit of tubes.
13. Strip valve bodies and clean.

14. Strip governor valve and clean.
15. Examine parking pawl, gear and internal linkage.
16. Examine one-way clutch.
17. Strip and examine front pump and drive fingers.
18. Strip and examine gear train.
19. Adjust starter inhibitor contact outwards.
20. Adjust starter inhibitor contact inwards.
21. Replace torque converter.
22. Examine torque converter drive plate for cracks or fracture.

FAULT TRACING ON CONVERTER

The converter housing is welded together and can therefore not be repaired but must be replaced in the event of defects. There is no drain plug since fluid changes do not occur and fluid filling is done through the transmission.

The stall speed means the speed obtained at full throttle on the engine with the lock-up engaged but with the car stationary. Check that the transmission has the correct running temperature and that the fluid level is correct before the stall speed test. The test must not take place longer than ten seconds, otherwise the transmission will overheat.

Fault-tracing on the converter is carried out as follows:

1. If the general performance of the vehicle is below standard, check the converter stall speed with an accurate tachometer by applying maximum pressure on the footbrake pedal, selecting "Lock-up" and fully depressing the accelerator. If the stall speed is up to 5 r/s (300 r/m) below that specified, the engine is not developing its full power.
2. Inability to start on steep gradients combined with poor acceleration from rest indicates that the converter stator one-way clutch is slipping or that the stator support is fractured. This condition permits the stator to rotate in an opposite direction to the turbine and torque multiplication cannot occur. Check the stall speed and, if it is more than 10 r/s (600 r/m) below that specified, the converter assembly must be replaced.
3. Below standard acceleration in 3rd gear above 50 kmph (30 mph) combined with a substantially reduced maximum speed, indicates that the stator one-way clutch has locked in the engaged condition. The stator will then not rotate with the turbine and impeller, therefore the fluid flywheel phase of the converter performance cannot occur. This condition will also be indicated by excessive overheating of the transmission, although the stall speed will remain as specified. In this case the converter assembly must be replaced.
4. Stall speed which is higher than specified, indicates that the converter is not receiving its required fluid supply or that the clutches of the automatic transmission are slipping.

PROPELLER SHAFT

DESCRIPTION

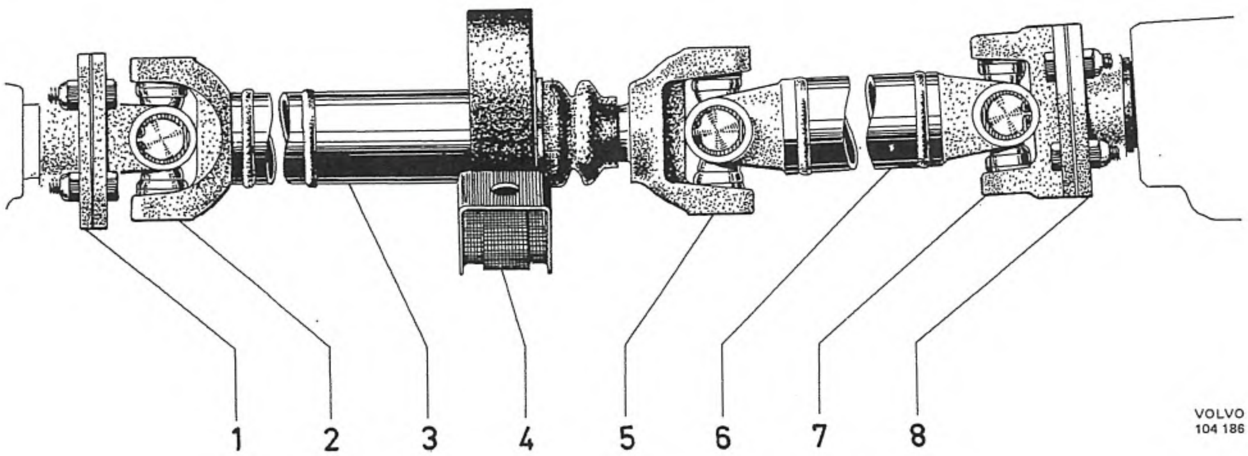


Fig. 4–117. Propeller shaft with support bearing

1. Flange on transmission
2. Front universal joint
3. Front section of propeller shaft
4. Support bearing
5. Intermediate universal joint
6. Rear propeller shaft
7. Rear universal joint
8. Flange on rear axle

The propeller shaft is of the divided, tubular type, see Fig. 4–117. The rear end of the front section of the propeller shaft is in the form of a splined sleeve. In this there is a splined shaft which also forms one of the yokes on the intermediate universal joint. The rear end of the front section of the propeller shaft is carried in a ball bearing. The ball bearing is fitted in a rubber bearing housing, which is attached to the propeller shaft tunnel with a cover, see Fig. 4–118. The propeller shaft is fitted with three universal joints. Each joint consists of a spider with four ground trunnions which are carried in flange yokes by means of needle bearings.

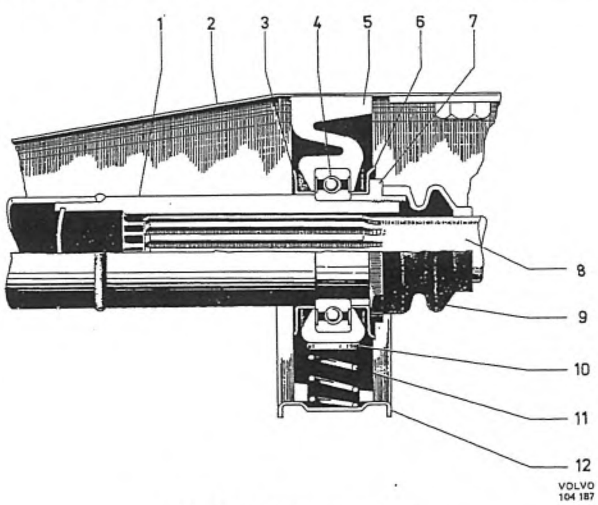


Fig. 4–118. Support bearing

1. Front section of propeller shaft
2. Floor tunnel
3. Dust cover
4. Ball bearing
5. Rubber housing
6. Dust cover
7. Nut
8. Rear section of propeller shaft
9. Rubber cover
10. Washer
11. Suspension spring
12. Cover

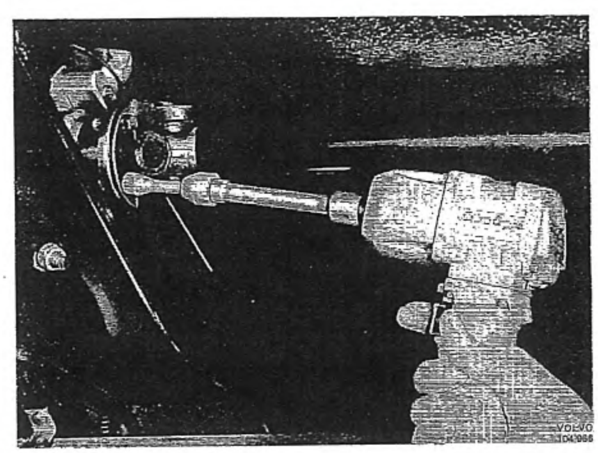


Fig. 4–119. Removing bolts

REPLACING SUPPORT BEARING

1. Jack up the vehicle. Slacken the propeller shaft from the rear axle flange. Bend back the lock washer and unscrew the nut at the sliding joint. Pull out the propeller shaft to the rear.
2. Loosen the cover for the support bearing. Pull off the complete support bearing.
3. Press the old bearing out of the rubber housing. Fit in the new bearing.
4. Fit the support bearing and the other parts in the reverse order to removing. If the splined joint appears dry, lubricate it with grease mixed with molybdenum disulphide.

REMOVING

Jack up the car. Slacken the propeller shaft from the gearbox and rear axle flanges. The bolts can be loosened by an air impact wrench and special socket 2846 for cars fitted with B 20 E and 2779 for cars fitted with B 20 F, see fig. 4–119. Loosen the cover for the support bearing and take down the complete propeller shaft.

DISASSEMBLING

DISASSEMBLING THE PROPELLER SHAFT

1. Bend back the lock washer and unscrew the nut for the support bearing. Remove the rear section of the propeller shaft. Pull off the support bearing.
2. Take the support bearing out of the housing.

DISASSEMBLING UNIVERSAL JOINTS

1. Remove the snap rings which secure the needle bearings in the yokes, see Fig. 4–120.
2. Secure the shaft in a vice so that the universal joint comes as near as possible to the vice jaws. Remember that the propeller shaft is tubular and can easily be deformed.

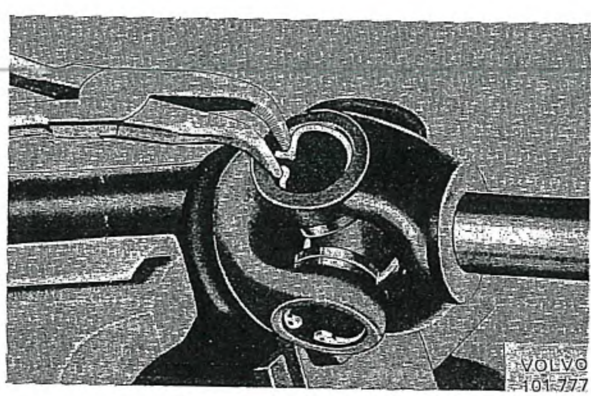


Fig. 4–120. Removing snap ring

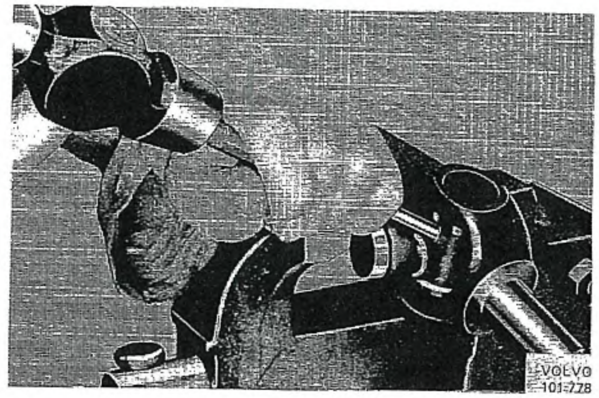


Fig. 4–121. Removing spider, I

3. With a hammer and metal punch drive the spider as far as it will go in one direction. The needle bearing will then come about half way out.
4. Then drive the spider as far as it will go in the opposite direction, see Fig. 4–121.
5. Drive out one of the needle bearings with a thin metal punch. Remove the spider, see Fig. 4–122. Drive out the other needle bearing.

INSPECTING

It is extremely important to ensure that the propeller shaft is straight. Since even minor damage on a propeller shaft can cause vibration, inspection must be carried out very carefully. The shaft should be set up between centers and checked along its entire length with an indicator gauge while it is rotating. If it is out-of-true more than 0.25 mm (0.010"), the shaft must be replaced.

Note. No attempt should be made to straighten a damaged propeller shaft — it should be replaced with a new one.

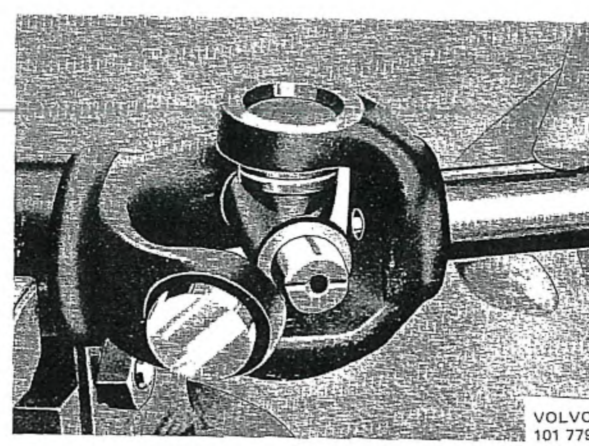


Fig. 4–122. Removing spider, II

Examine the support bearing by pressing the bearing races against each other by hand and turning them in opposite directions. The bearing should run easily without binding at any point. If it does not, scrap the bearing and replace it with a new one.
Check needle bearings and spiders. Worn or damaged parts should be replaced.

ASSEMBLING

ASSEMBLING UNIVERSAL JOINTS

1. During possible fitting of the old needle bearings, check that they are filled with grease and that the rubber seals are not damaged. New bearings should be half-filled with grease.
2. Insert the spider in the flange yoke. Push over the spider in one direction so far that the needle bearing can be fitted onto the trunnion, see Fig. 4—123. Then press in the needle bearing so far that the snap ring can be fitted. Use a drift with a diameter slightly less than that of the needle bearing sleeve.

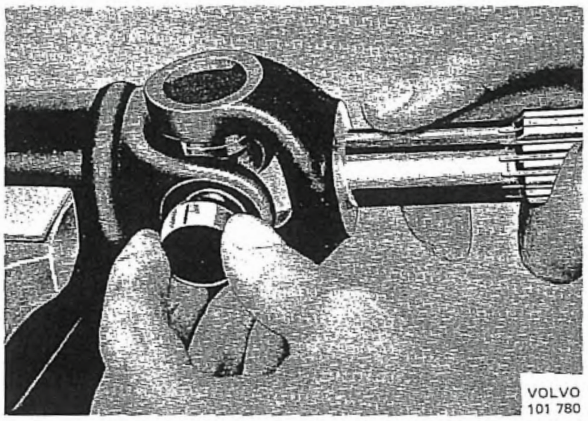


Fig. 4-123. Installing spider

3. Fit the other needle bearing and snap ring in the same way. Also the fitting of the spider in the other yoke should be carried out in the same way as described in the previous paragraph.

INSTALLING

Installing is in reverse order to removing.

GROUP 46

REAR AXLE

TOOLS

The tools are preceded either by 999 or SVO (e.g. 999 1801 or SVO 2261).

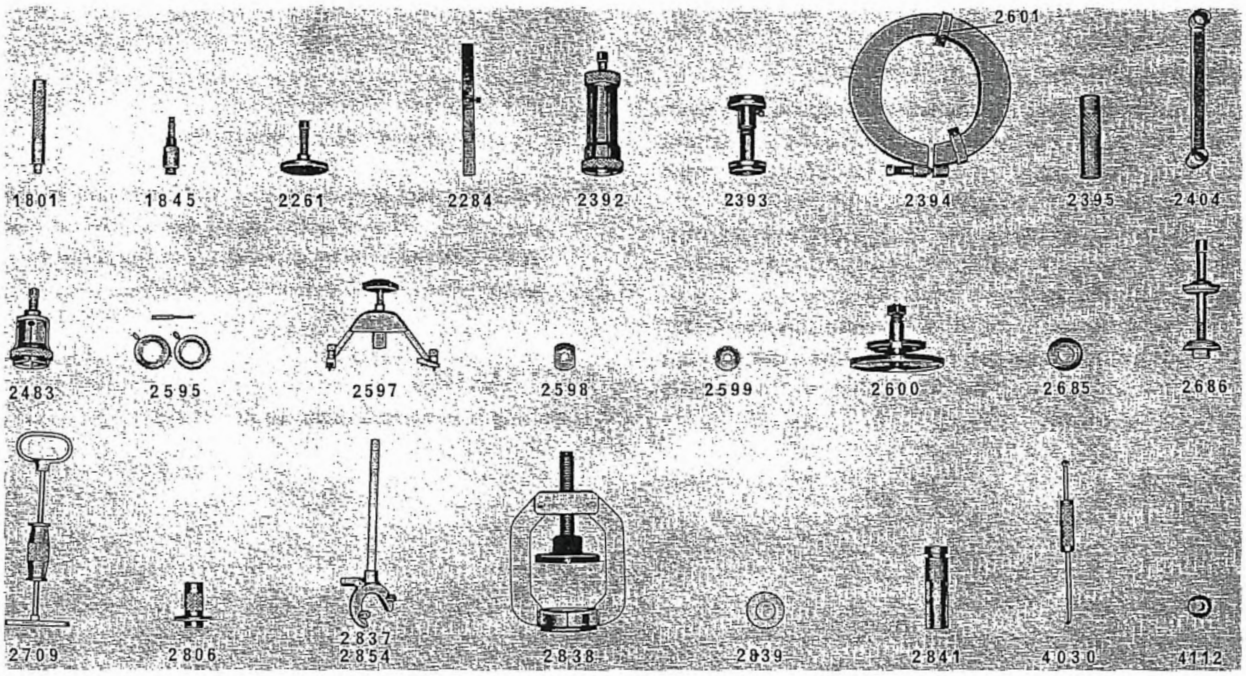


Fig. 4–124. Special tools for rear axle

VOLVO 107391

999
(SVO)
1801 Standard handle 18x200 mm
1845 Press tool for fitting flange
2261 Puller for flange
2284 Retainer for dial indicator for final drive adjustment
2392 Puller for rear pinion bearing
2393 Measuring tool for adjustment of pinion
2394 Expander tool used for removing and fitting differential
2395 Sleeve for fitting inner ring rear pinion bearing
2404 Tool for fitting front pinion bearing
2483 Puller for differential carrier bearings
2520 Stand (Fig. 4–125).
2522 Fixture for rear axle (used together with stand 2520 for work on the final drive) (Fig. 4–125)
2595 Adjusting rings for differential
2597 Brake for crown wheel, used when checking tooth contact
2598 Drift for removing outer ring, rear pinion bearing
2599 Drift for removing outer ring, front pinion bearing

999
(SVO)
2600 Measuring fixture for adjusting rings
2601 Holder for expander tool 2394 (fitted on tool)
2685 Adjusting ring for pinion
2686 Press tool for fitting outer rings, pinion bearing
2709 Puller for drive shaft
2714 Fixture for rear axle, used on garage jack for removing and fitting rear axle, see Fig. 4–162
2806 Tool for fitting oil seal at flange
2837 Counterhold for flange (cars fitted with B 20 E)
2838 Press tool for removing and fitting bearing and ring on drive shaft lock
2839 Ring for fitting bearing and lock ring on drive shaft Used together with 2838
2841 Spanner for adjusting ring 2685
2854 Counterhold for flange (cars fitted with B 20 F)
4030 Puller for oil seal at flange
4112 Drift for fitting differential carrier bearings

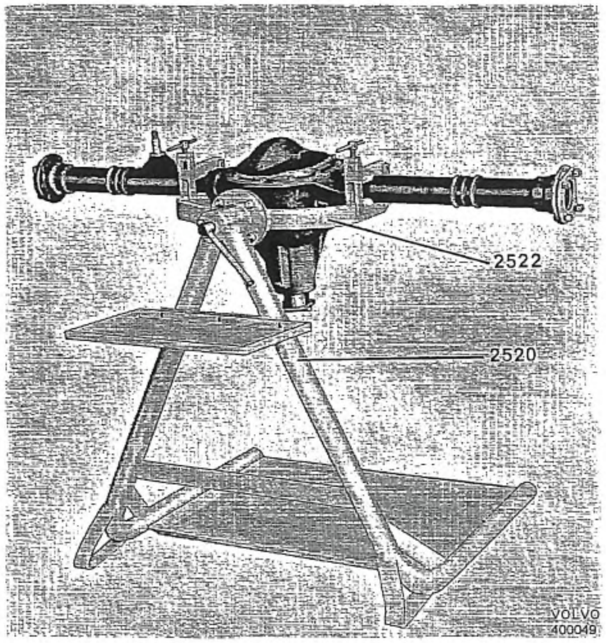


Fig. 4—125. Stand and fixture for rear axle

DESCRIPTION

The rear axle is carried in two support arms. The support arms are provided with a couple of robust bushes and are attached to the body. The rear axle housing is attached to the support arms with levers. In order to take up the rear axle torque, there are two torque rods attached to the drive shaft tubular covers and to the body. A track bar prevents the body and rear axle from moving sideways in relation to each other. The design of the rear axle is shown in Illustration 4-E.

The final drive is of the hypoid type, that is to say, the drive pinion lies below the center of the crown wheel. It consists of the drive pinion, crown wheel and differential gears. The gear backlash and differential carrier bearing tension are adjusted by means of shims inside the differential carrier bearings.

The differential carrier and the crown wheel are journalled in the final drive housing by means of two taper roller bearings. The crown wheel is attached to the differential carrier by means of bolts. The differential gears themselves in the differential carrier consist of two bevel pinions on a trunnion and two side gears in which drive shafts are carried by means of internal splines. The differential gears are journalled so that they can rotate and permit the drive shafts to rotate at different speeds when the car is being driven round bends. A thrust washer is fitted under each of the differential gears. The drive pinion is carried in taper roller bearings. The axial location of the drive pinion relative to the crown wheel is adjusted by means of shims under the outer race of the rear pinion bearing.

The outer end of each drive shaft is journalled in a tape roller bearing. Bearing clearance is not adjustable but is determined by the construction of the bearing, see Fig. 4—126. There is an oil seal on the outside of the drive shaft bearings.

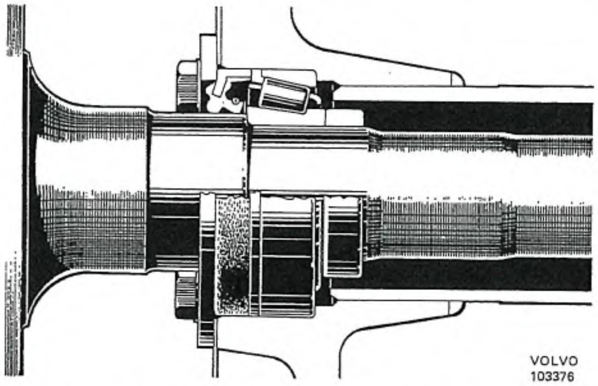


Fig. 4—126. Drive shaft journalling

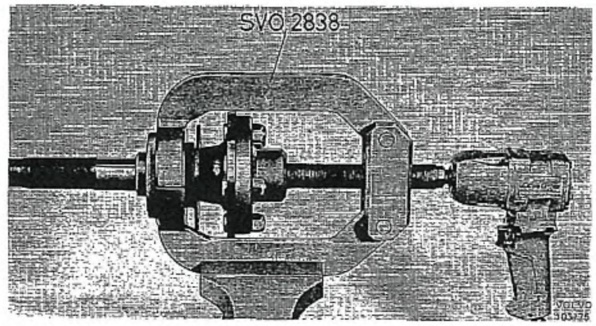


Fig. 4—128. Removing drive shaft bearing

REPLACING BEARINGS AND DRIVE SHAFT OIL SEALS

1. Jack up the vehicle and place props under the rear axle. Remove the wheels.
2. Disconnect the brake pipe from the brake caliper. Slacken the bolts for the brake disc and remove the disc.
3. Slacken the bolts for the thrust washer. These are slackened through the holes in the drive shaft flange. Pull out the drive shaft with puller 2709, see Fig. 4—127.
4. Secure press tool 2838 in a vice. Secure the drive shaft to the spindle plate. Screw in the spindle so that the tool arms can be placed against the bearing, see Fig. 4—128. Screw out the spindle and press off the bearing and lock ring. Remove the oil seal.
5. Fill the space between the lips on the new seal with grease. Then place the seal on the drive shaft. Fit the bearing and lock ring. Turn the bearing correctly, see Fig. 4—126.
   NOTE. Always use a new lock ring.
   Place fitting ring 2839 against the bearing and the lock ring. Close the tool arms and lock them round the fitting ring, see Fig. 4—129. Press on the bearing and lock ring by screwing in the spindle.
6. Grease the bearing. Then fit the drive shaft. Tighten the bolts for the thrust washer to a torque of 50 Nm (36 lbft). Fit the brake disc and brake caliper. Connect the brake line. Bleed and adjust the brakes, see Part 5.
7. Fit on the wheels and wheel nuts. Lower the vehicle. Tighten the wheel nuts.

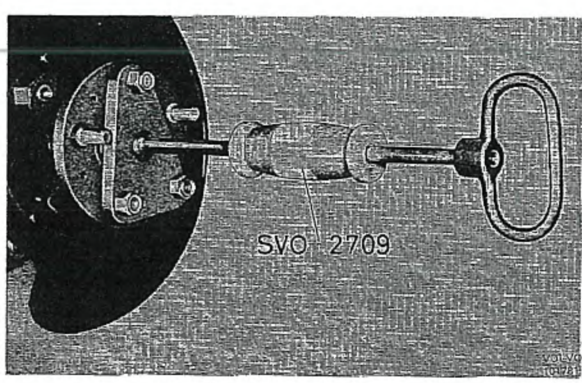


Fig. 4—127. Removing drive shaft

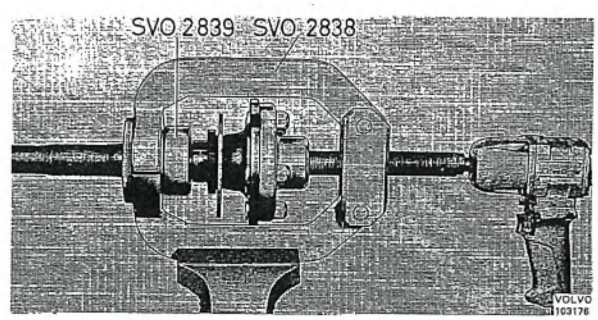


Fig. 4—129. Installing drive shaft bearing

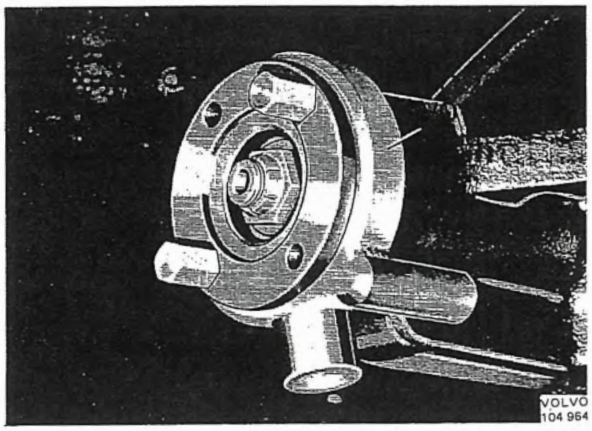


Fig. 4—130. Counterhold for flange

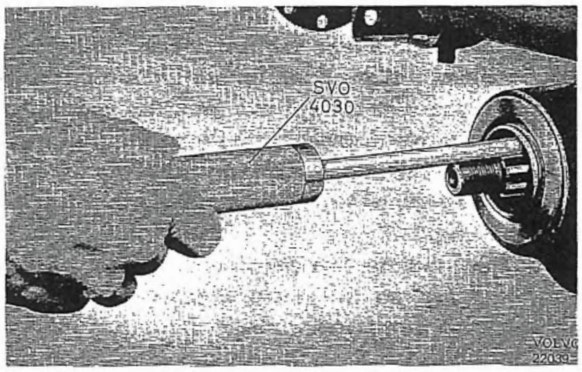


Fig. 4—132. Removing oil seal

REPLACING PINION OIL SEAL

1. Disconnect the rear section of the propeller shaft from the flange on the pinion. Check for looseness of the pinion in its bearing. If it is loose, this must be remedied before a new oil seal is fitted. See the instructions under the heading "Assembling".
2. Remove the nut for the flange. For this purpose, use tool 2837 as a counterhold for cars fitted with B 20 E and 2854 for cars fitted with B 20 F, see Fig. 4-130. Pull off the flange with puller 2261, see Fig. 4-131. Pull out the old oil seal with puller 4030, see Fig. 4-132.
3. Coat the seal lips of the new ring with grease. Lubricate also the spring coil so that it does not jump off during fitting. Then fit the oil seal with 2806, see Fig. 4-133.
4. Press on the flange with the help of press tool 1845, see Fig. 4-134. Fit the washer and nut. Tighten the nut to a tightening torque of 280-300 Nm (200-220 lbft).

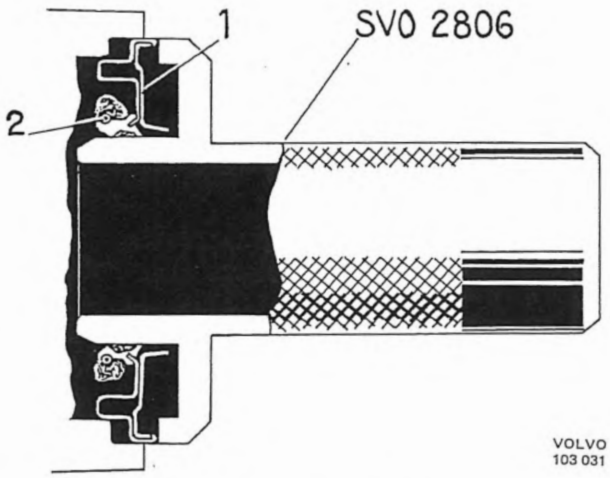


Fig. 4—133. Installing oil seal
1. Pinion oil seal
2. Spring coil with grease

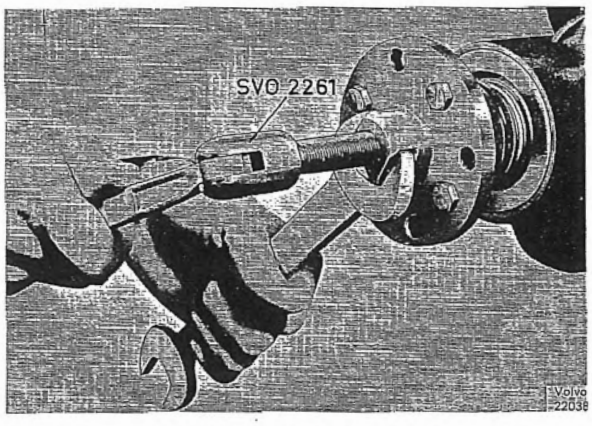


Fig. 4—131. Removing flange

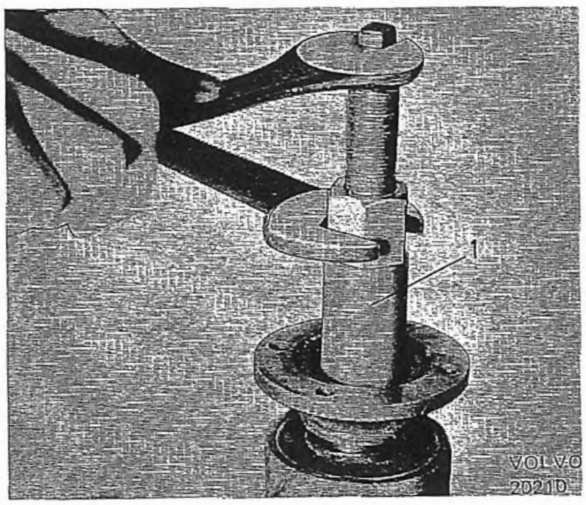


Fig. 4—134. Installing flange
1. Press tool 1845

REMOVING

1. Place chocks before the front wheels. Slacken the rear wheel nuts. Place fixture 2714 on a garage jack and jack up the rear end. See Fig. 4-162. Place props in front of the support stay attachment to the body. Lower the jack until the body rests on the props. Remove the nuts and lift off the wheels.
2. Disconnect the rear propeller shaft section from the flange on the pinion. Disconnect the brake lines to the rear axle casing.
3. Disconnect the track rod, shock absorbers and shock absorber bands from the rear axle and the brake cables from the brackets and levers on the brake backing plate. Use tool 2742, see Part 5.
4. Slacken the bolts a couple of turns for the torque and support stay attachments to the body. Lower the rear axle and remove the springs. Remove the bolts for the torque rods and support arms and pull out the rear axle.

DISASSEMBLING

1. Place the rear axle in fixture 2522. The rear axle is placed with the underside of the final drive facing inwards to the fixture support, when the pinion is pointing downwards. Remove the brake pipes.
2. Slacken the bolts for the brake backing plates and brake shoe retainer. They are slackened through the holes in the drive shaft flanges. Pull out the drive shafts with puller 2709, see Fig. 4-127.
3. Remove the inspection cover.
4. If the final drive is being reconditioned because of noise, the contact pattern should be checked before disassembling takes place, as this might assist in locating the fault. Before doing this, clean the teeth so that no misleading contact pattern is obtained.
5. Check the alignment markings on the cap and carrier, see Fig. 4-135. If there are no markings, or if they are difficult to see, mark one side with a punch. Remove the cap.
6. Fit tool 2394 in the holes in the drive pinion carrier as shown in Fig. 4-136. Fit the tool with retainers 2601. Tension the tool until it fits exactly in the holes in the carrier. Then tension the bolt a further 3—3 1/2 turns. Lift out the differential carrier with crown wheel. Tool 2337 can be used for this purpose.
7. Turn the final drive and let the oil run out into a container. Remove the nut for the flange. Use for this purpose tool 2837 as a counterhold for cars fitted with B 20 E and 2854 for cars fitted with

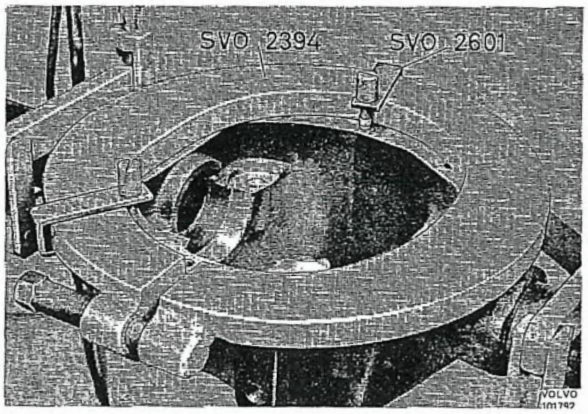


Fig. 4—136. Expanding drive pinion carrier

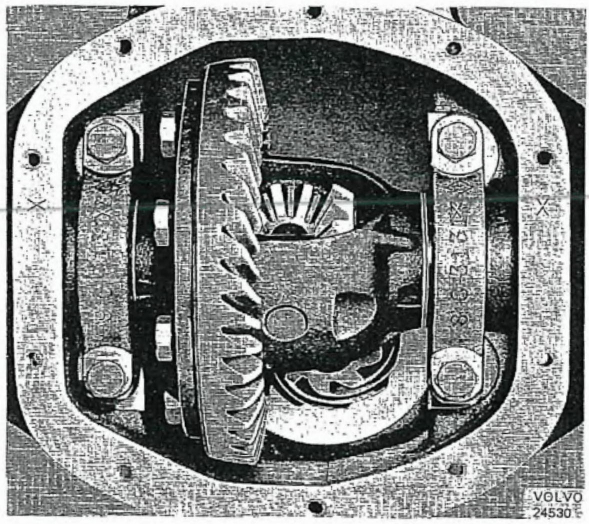


Fig. 4—135. Alignment markings on cap and carrier

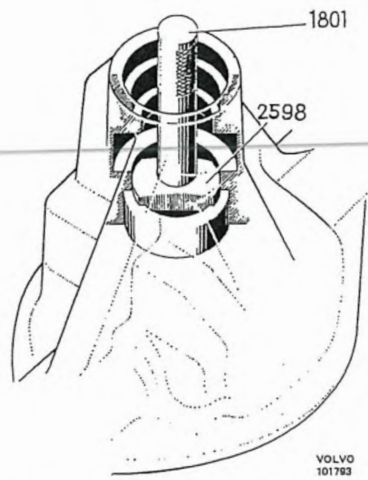


Fig. 4—137. Removing rear pinion bearing race

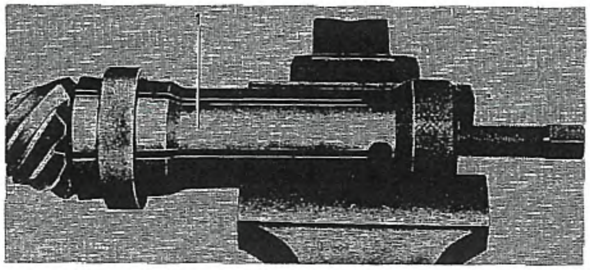


Fig. 4–138. Removing rear pinion bearing
1. Puller 2392

B 20 F, see fig. 4-130. Pull off the flange with puller 2261, see Fig. 4-131. Press out the pinion.

8. Drive out the front pinion bearing, the washer and the oil seal with standard handle 1801 and drift 2599.
9. If necessary, drive the rear bearing out of position, see Fig. 4-137. Use standard handle 1801 and drift 2598.
10. Clean the gasket surface. File off all burr on the surface on which the indicator retainer 2284 will slide.
11. If necessary, pull off the rear bearing from the pinion with puller 2392, see Fig. 4-138. The puller is fitted in the following way: Move the puller down over the rollers and press down the lock ring. Then pull up the puller with the bolt until the rollers lie flush with the edge of the inner race and the edge on the puller. Knock out the lock ring with a hammer. See also Fig. 4-139.

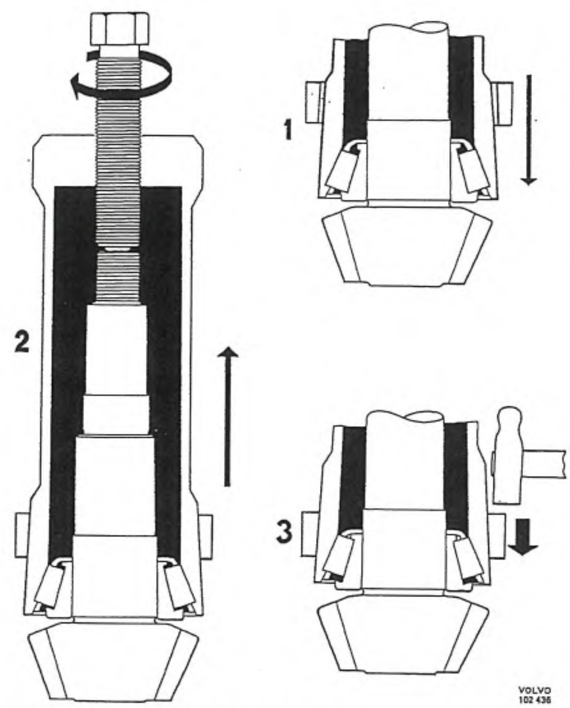


Fig. 4–139. Installing puller
1. The puller is pressed down over the rollers
2. The rollers are pulled up
3. The lock ring is secured with a hammer

DISASSEMBLING DIFFERENTIAL

1. Loosen the ring gear bolts and remove the crown wheel.
2. Drive out the lock pin, see Fig. 4-140, and then the shaft for the differential gears. Take out the block, the differential gears and the thrust washers.
3. Pull off the differential carrier bearings with puller 2483, see Fig. 4-141. Do not loosen the shims. Concerning the fitting of the puller, see also Fig. 4-139.

INSPECTING

First clean all the parts thoroughly. Check all the bearing races and bearings. The races, rollers or roller retainers must not be scratched or damaged. All damaged bearings and bearing races must be replaced. Check both the pinion drive and crown wheel carefully for damage to the teeth. The most common damage is from seizing gear teeth, see Figs. 4-142 and 4-143. This is caused by incorrect running-in, wrong oil, insufficient tooth flank clearance or faulty tooth contact. If the cause of the seizing is not remedied at

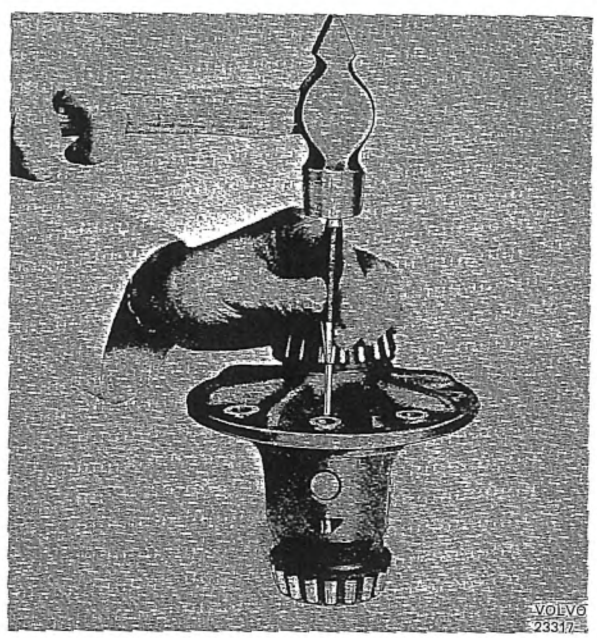


Fig. 4–140. Removing lock pin

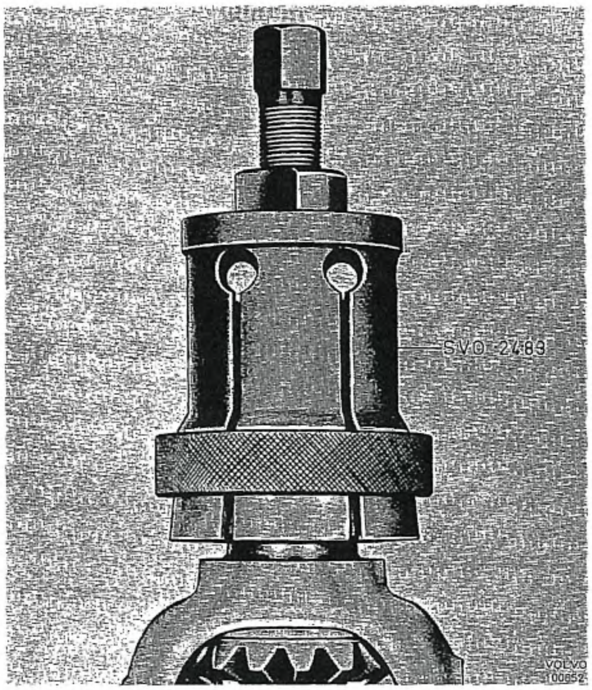


Fig. 4–141. Removing differential carrier bearings

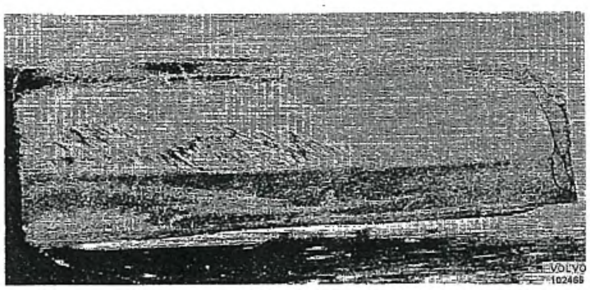


Fig. 4–142. Gear seizing

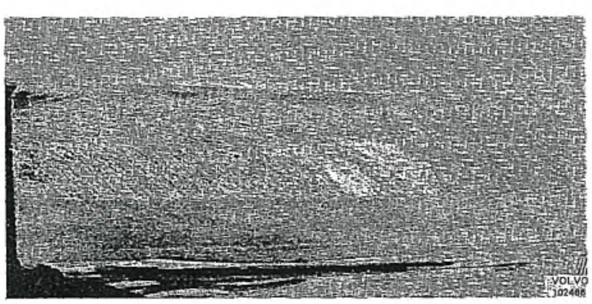


Fig. 4–143. Gear seizing

an early stage, the whole gear wheel can be damaged. The differential gears should also be examined for damaged to the teeth. They should be fitted in a clean and dry condition in the differential carrier together with the shaft and thrust washers. Play should then be checked by means of marking blue behind both the differential side gears. If the play exceeds 0.06 mm (0.0024"), when the gears have been rotated to maximum play, replace with thicker washers. These are available in sizes 0.74, 0.78, 0.82, 0.86, 0.90, 0.94 and 0.98 mm (0.029, 0.031, 0.032, 0.033, 0.035, 0.037 and 0.039"). Also check to see whether the cylindrical part of the flange which goes into the oil seal is worn or scratched. If so, replace the flange together with the oil seal. The pinion nut is provided with a slit for locking. In time this slit loses its locking effectiveness. For this reason, the nut should be replaced if it has been removed a couple of times. The washer under the nut should also be replaced if deformed.
Check the oil seals and replace them if damaged or worn.
Make sure that there are no cracks in the rear axle casing. Check that the brackets for the support arms and track rod are intact.

ASSEMBLING

The greatest cleanliness should be observed when assembling and adjusting final drives. Dirt in a tapered roller bearing can result in completely inaccurate measurement values.
On measuring the bearing clearance or pre-loading, the bearing should be oiled and rotated several turns loaded.

ASSEMBLING DIFFERENTIAL

1. Place the differential side gears and the thrust washers in the differential carrier. Then "roll" in the differential pinions both simultaneously with the dished thrust washers, see Fig. 4-144.
2. Insert the thrust block and drive in the shaft.
3. Check the differential unit. If the gear play has not been measured, check it according to the instructions given under the heading "Inspecting". If oversize washers are fitted, this can be checked by turning the gears one turn. The requisite torque should not exceed 10 Nm (7.0 lb ft). The tool for marking this check can be easily made from a shortened drive shaft which is adapted to a suitable torque wrench. After the checking and any replacement of the thrust washers, fit the lock pin.
4. Fit the crown wheel. Make sure that the contact surface are clean and without burr. Tighten the bolts. The tightening torque is 65–85 Nm (47–72 lbft).

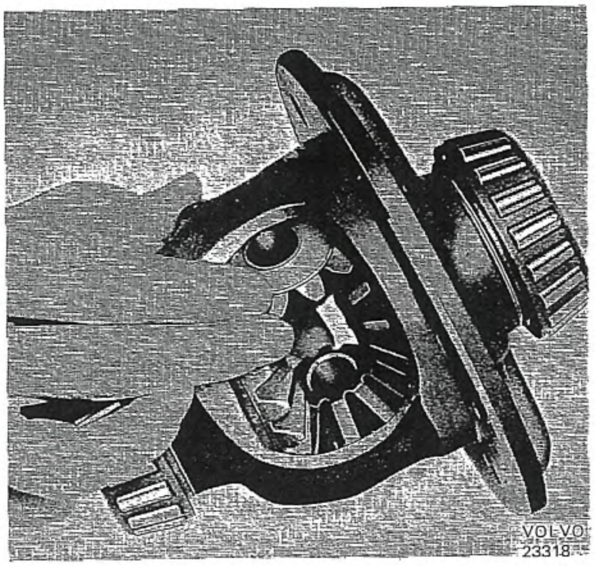


Fig. 4—144. Fitting differential gear

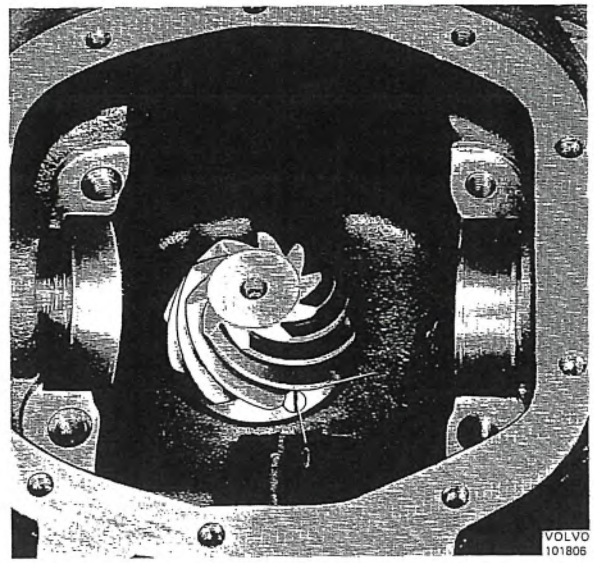


Fig. 4—146. Locating pinion with adjusting tool
1. Lock screw

NOTE. Always use new bolts for those gears where the bolts are locked only by means of friction in the thread and the contact surface of the screw head. To achieve the effect intended, the bolts are tightened to their limit. A certain permanent flexibility is thereby obtained in the bolt which becomes distorted if further tightening is attempted.

INSTALLING PINION

1. Clean the marking surface on the pinion with extremely fine emery cloth. Fit the adjusting ring 2685 and tool 2841 (or 2684) on the pinion, see Fig. 4-145. Place the pinion in the carrier so that the bolt on the adjusting ring faces the bearing side of the carrier, see Fig. 4-146.
2. The pinion should have a certain nominal measurement (A, Fig. 4-147) to the center line of the crown wheel. Due to tolerances in the manufacturing, there are deviations from the nominal measurement.
This is indicated in the ground surfaces on the pinion with a figure.
The surface is generally ground down 0.30 mm (0.012") so that the deviation is always indicated by plus tolerance and in hundredths of a millimetre. The plus sign is excluded.
To check the location of the pinion, use a dial indicator, indicator retainer 2284 and a measuring tool 2393, which consists of two parts: a pinion gauge and an adjuster fixture.
The check is carried out in the following way: Place the pinion on the ground surface of the pinion and the adjusting jig in the differential

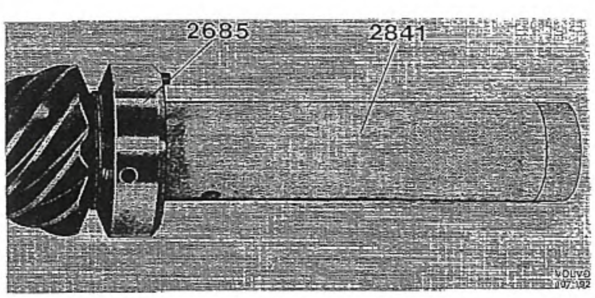


Fig. 4—145. Adjusting ring and tool for pinion location

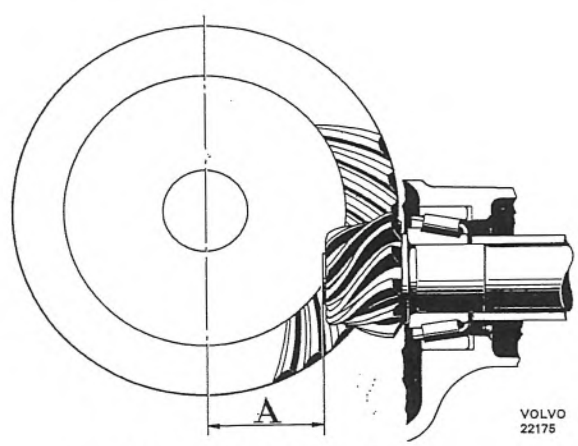


Fig. 4—147. Pinion location
A Nominal measurement=2.55"

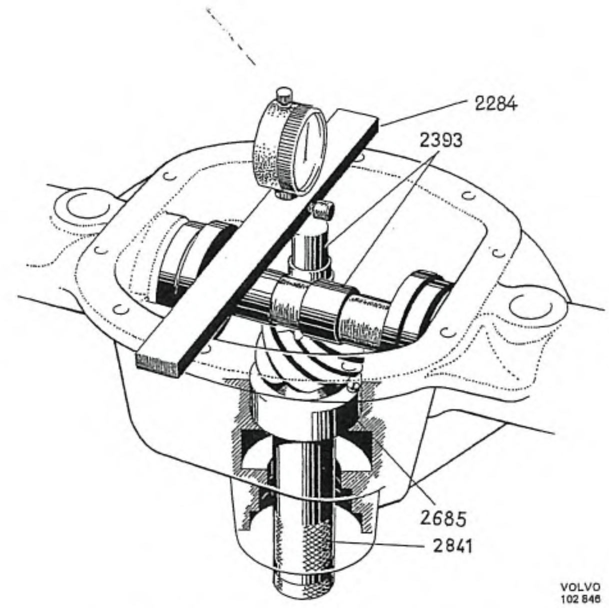


Fig. 4—148. Locating measuring tools

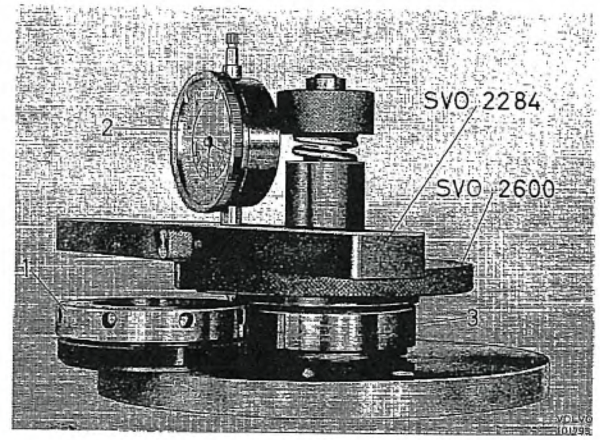


Fig. 4—151. Determining shim thickness
1. Adjusting ring 2. Dial indicator 3. Bearing, complete

bearing position as shown in Fig. 4-148. Place the indicator retainer on the drive pinion carrier and zero-set the gauge against the adjusting jig, see Fig. 4-149. Then move the indicator retainer over so that the indicator comes against the pinion gauges, see Fig. 4-150.

If the pinion is, for example, marked 33, the pinion gauge should lie 0.33 mm (0.013"), see table below) under the adjuster fixture. The setting is adjusted by turning the cam on the pinion until the gauge dial shows the correct value. Then lock the adjusting ring with the lock screw. Remove the measuring tool and pinion.

3. Place the complete rear pinion bearing with the outer ring in measuring fixture 2600. Put on the plate, spring and nut. Turn the nut with the flat side facing upwards. The plate, and thereby the bearing, is turned forwards and backwards several times so that the rollers take up the correct position. Place the adjusting ring in the measuring fixture as shown in Fig. 4-151. Use

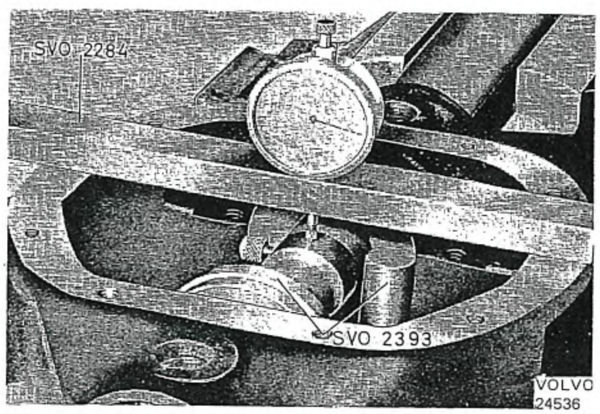


Fig. 4—149. Zero-setting indicator

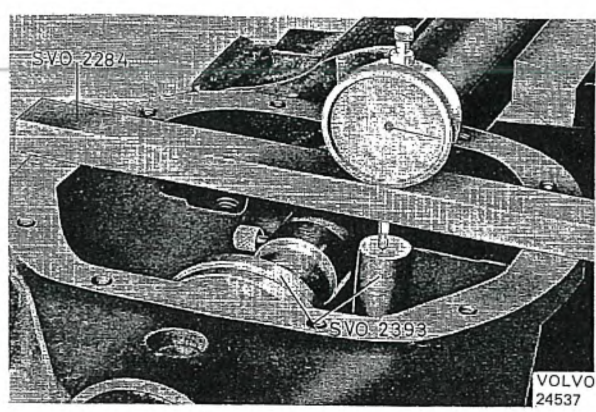


Fig. 4—150. Measuring pinion location

Conversion table, mm to inches

mm	inches	mm	inches
0.20	0.0079	0.31	0.0122
0.21	0.0083	0.32	0.0126
0.22	0.0087	0.33	0.0130
0.23	0.0091	0.34	0.0134
0.24	0.0094	0.35	0.0138
0.25	0.0098	0.36	0.0142
0.26	0.0102	0.37	0.0146
0.27	0.0106	0.38	0.0150
0.28	0.0110	0.39	0.0154
0.29	0.0114	0.40	0.0157
0.30	0.0118		

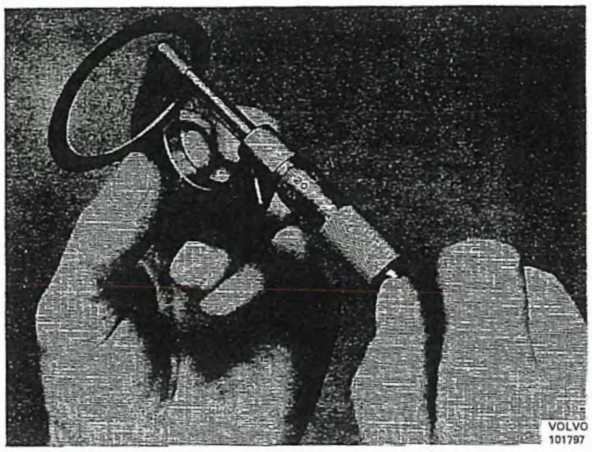


Fig. 4–152. Measuring shims

retainer 2284 and dial indicator and place the measuring point of the indicator opposite the adjusting ring and zero-set the indicator. Then set the pointer of the indicator to the outer ring of the bearing. The dial indicator now shows at once the thickness the shims should have. Measure shims for the correct thickness with a micrometer, see Fig. 4-152. NOTE. It is almost impossible to obtain a shim with exactly the correct thickness. However, they must not be 0.03 mm (0.0012") thicker than the measured value, but up to 0.05 mm (0.002") thinner.

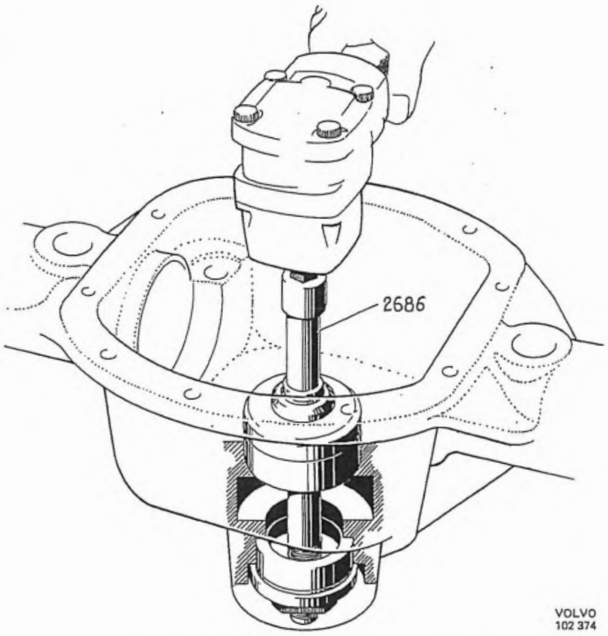


Fig. 4–154. Installing bearing races

4. Press the rear bearing on the pinion with sleeve 2395, see Fig. 4-153. NOTE. The washer under the rear bearing inner ring must **not** be fitted when reconditioning. Place on the measured shims and press in both the outer rings of the bearings with tool 2686, see Fig. 4-154.

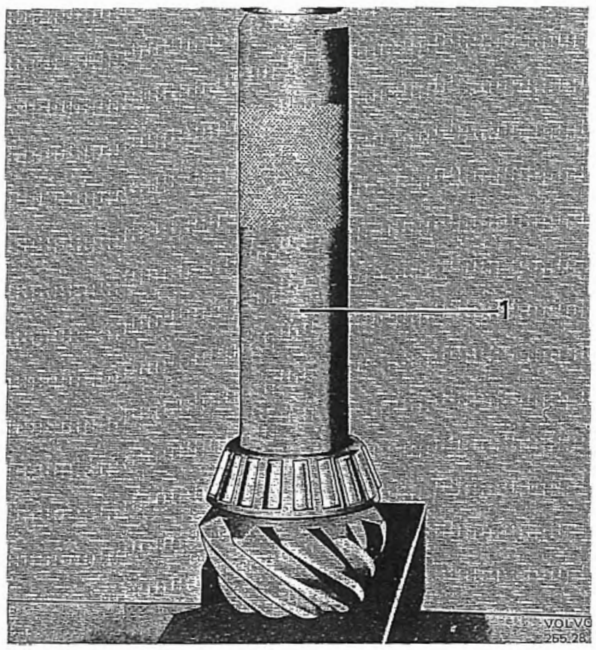


Fig. 4–153. Fitting rear pinion bearing
1. Sleeve 2395

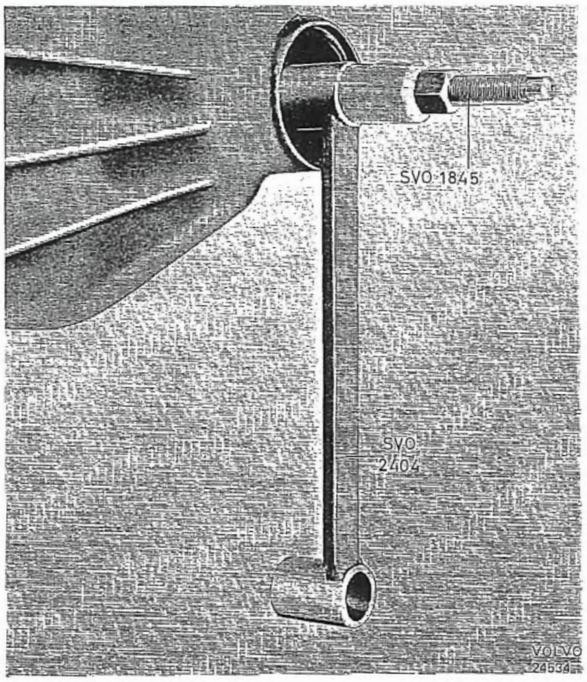


Fig. 4–155. Installing pinion

5. Insert the pinion in the casing and fit on three 0.75 mm (0.03") thick shims and the front pinion bearing. Fit tool 2404 and press tool 1845 on the front end of the pinion and pull in. If a nut tightener is used for fitting the pinion, the pinion must be pressed forwards so that it does not strike the bearing positions.
6. Replace press tool 1845 with washer and nut. Tighten the nut to a tightening torque of 280–300 Nm (200–220 lbft). Fit on the pinion gauge and the dial indicator retainer. Pull down the pinion while turning it forwards and backwards at the same time. Zero-set the indicator. Then press the pinion upwards, turning it at the same time forwards and backwards. Read off the clearance.
7. Remove the pinion. Remove the shims corresponding to the measured clearance + 0.07 mm (0.003"). Fit on the pinion.

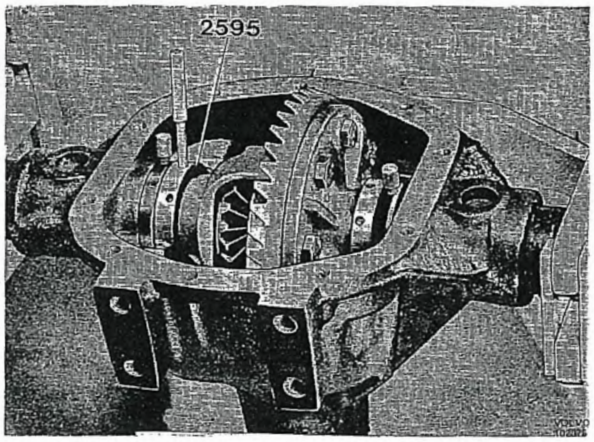


Fig. 4–156. Adjusting rings for differential

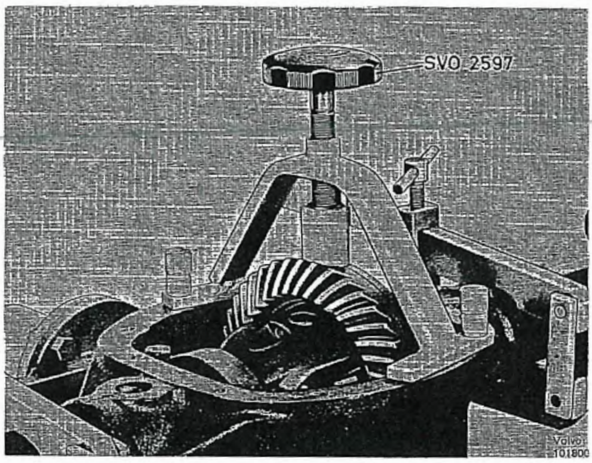


Fig. 4–157. Brake tool for differential

8. Then check the pinion bearing fit with the torque gauge. The torque gauge should show 0.6–1.1 Nm (5.20–9.55 lbin) for used bearings, and 1.1–2.3 Nm (9.55–20 lbin) for new bearings when the pinion rotates. On new final drive units, stresses can be higher due to another type of installation method. In other words, there is no fault.
   Often an alternation in the thickness of the shims is required because of the tolerances which must be present.
9. Check the location of the pinion with the dial indicator, retainer 2284 and measuring tool 2393, see also point 2.

INSTALLING DIFFERENTIAL

1. Lubricate the inside of the adjusting rings 2595 and put them on the differential carrier. The ring with the black-oxidized adjusting ring should be placed on the crown wheel side. Also lubricate the bearing location in the carrier. Place the differential carrier and the adjusting rings in the final drive housing, see Fig. 4-156. Use the dial indicator and adjust in the rings so that the correct backlash 0.15 mm (0.006") is obtained. The tooth flank clearance may vary between 0.13 mm (0.005") and 0.20 (0.008"), but should be kept as near 0.15 mm (0.006") as possible. Tighten the lock screws in the adjusting rings.
2. Fit on brake tool 2597 as shown in Fig. 4-157. Mark with colour several teeth at three points on the crown wheel. This can act as a check for possible crown wheel warping. Rotate the pinion 10–12 turns in both directions and check the contact marking pattern. At the correct tooth contact, the contact pattern should be horizontal

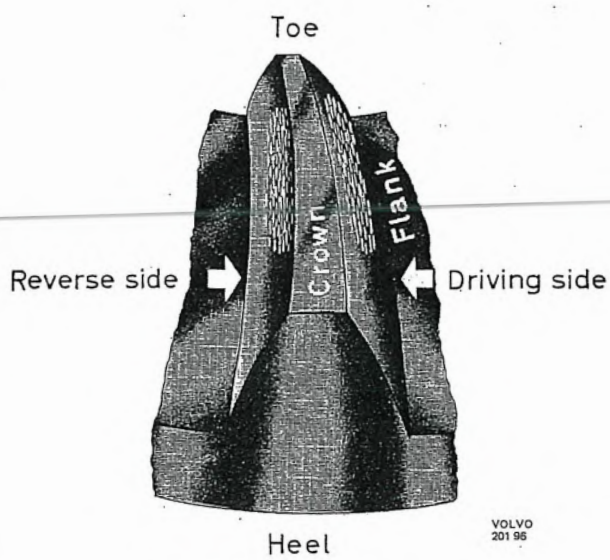


Fig. 4–158. Correct tooth contact

in the middle of the tooth but somewhat nearer to the toe than the heel. The pattern on the coast side and drive side should coincide with each other. See Fig. 4-158. If the patterns do not coincide, the location of the pinion must be adjusted before assembling is continued. If the patterns lie too far towards the heel on the drive side and too far towards the toe on the coast side, see Fig. 4-159, the pinion should be moved inwards.

If the contact patterns lie too far towards the toe on the drive side and too far towards the heel on the coast side, see Fig. 4-160, the pinion should be moved outwards. Note that the patterns will lie somewhat nearer the toe when the adjusting rings are fitted than when the bearings are fitted.

3. When correct backlash and contact pattern are obtained, remove the differential and adjusting ring. Then place the center washer on the measuring fixture. Fit a bearing into the measuring fixture, likewise the plate, spring and nut. Fit the nut with the flat side facing downwards. Rotate the plate forwards and backwards several times. Put on the dial indicator and retainer 2284. Zero-set the indicator to the adjusting ring and then place the measuring point facing the bearing, see Fig. 4-151. Read off the indicator. With a micrometer measure the shims, the total thickness of which corresponds to the read-off value + 0.07 mm (0.003"). Place the shims together with the measured bearing to the one side. Repeat the above procedure with the other bearing.
   NOTE. Make sure on which side the respective bearing and shims are to be fitted.
4. Fit the shims on the differential carrier and press on the bearings. For this purpose use drift 4112, see Fig. 4-161. When fitting the second bearing, use drift 2599 as a cushioning ring so as not to damage the first bearing already pressed on.
5. Fit tool 2394 on the drive pinion carrier, see Fig. 4-136. Expand the tool until the pins are exactly flush against the hole edges in the carrier and then tighten the screws a further 3–3 1/2 turns. Fit the differential and outer rings. Remove tool 2394. Fit the cap and tighten the bolts to a torque 50–70 Nm (36–50 lbft).
6. Check the backlash and the contact marking patterns.

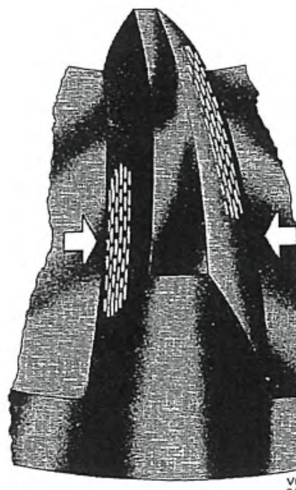


Fig. 4–160. Faulty tooth contact

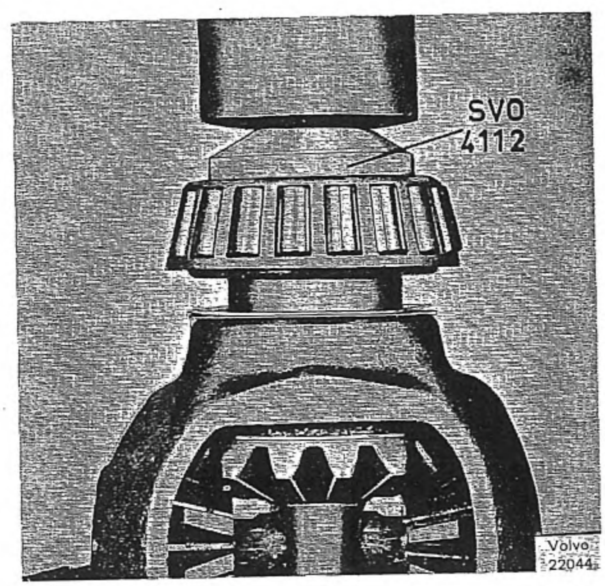


Fig. 4–161. Installing differential bearings

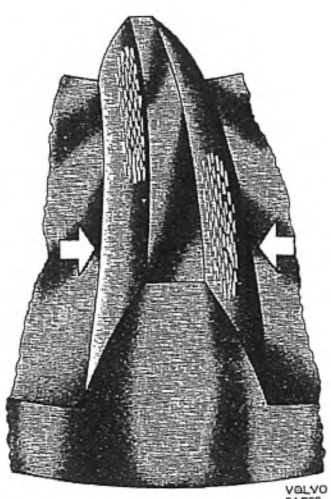


Fig. 4–159. Faulty tooth contact

ASSEMBLING REAR AXLE

1. Remove tool 2404. Fit the oil slinger. Smear the oil seal lips with grease. Lubricate the spring coil also with grease to prevent it from jumping out during fitting. Then fit the oil seal with drift 2806. Press on the flange with the help of tool 1845, see Fig. 4-134. Fit the washer and nut. Tighten the nut to a tightening torque of 280—300 Nm (200—220 lbft).
2. Fit the inspection cover and gasket.
3. Fit the drive shaft. Tighten the bolts for the thrust washers to a torque of 50 Nm (36 lbft).
4. Then fit the brake discs and brake caliper. Grease the bearings.
   Finally fit the brake pipes.

INSTALLING

1. Place the rear axle in fixture 2714 on a jack, see Fig. 4-162. Move the rear axle under the vehicle and fit on the bolts for the torque and support stays.
2. Fit the springs in position and raise the rear axle. Fix the track rod, shock absorbers and shock absorber bands and connect up the brake cables.
3. Fit the rear section of the propeller shaft to the rear axle flange. Connect the brake lines and bleed the brakes. Adjust the parking brake.
4. Fit the wheels. Remove the props and lower the vehicle. Tighten the wheel nuts to a torque of 100—140 Nm (70—10 lbft). Fill the rear axle with oil.

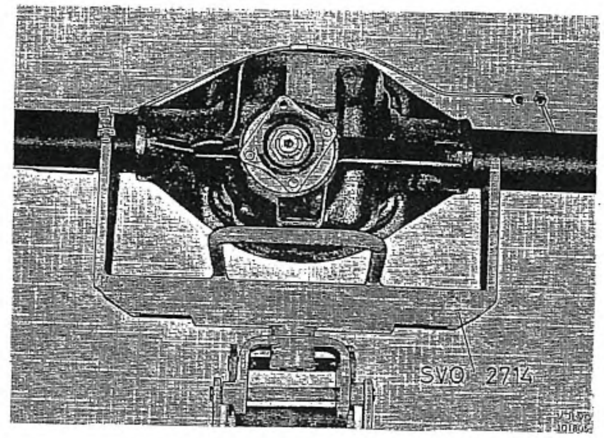


Fig. 4—162. Fixture for rear axle

1. Clutch pedal
2. Return spring
3. Screw for pedal shaft
4. Bracket
5. Pedal stop
6. Rubber sleeve
7. Nut
8. Rubber bush
9. Washer
10. Clutch wire
11. Clutch cover
12. Clutch plate
13. Flywheel casing
14. Crankshaft
15. Support bearing in crankshaft
16. Circlip
17. Flywheel
18. Adjusting nuts
19. Holding plate
20. Release fork
21. Return spring
22. Dust cover
23. Release bearing
24. Thrust spring
25. Clutch plate shaft (input shaft, gearbox)
26. Cover, gearbox
27. Support rings
28. Pressure plate
29. Retainer

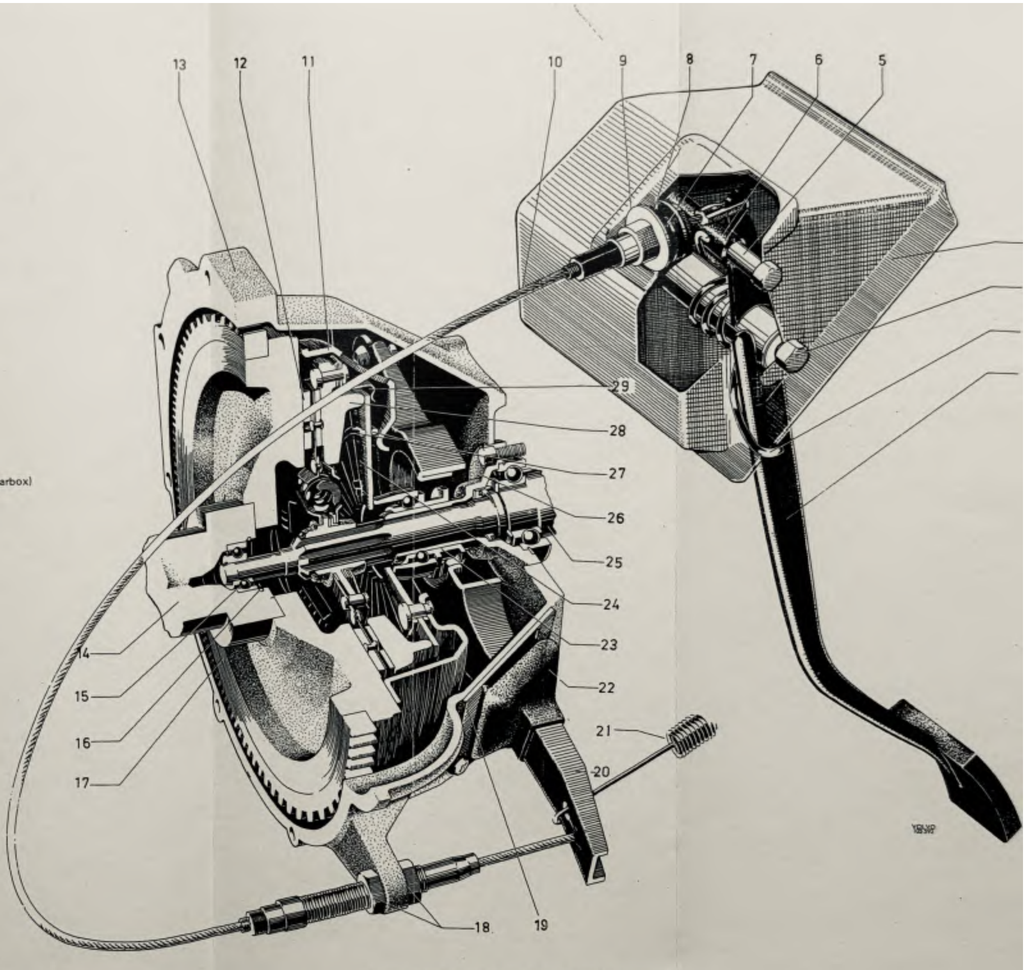


Illustration 4—A. Clutch and clutch controls

1. Gear lever, upper section with knob
2. Rubber bushes
3. Gear lever, lower section
4. Washer
5. Spring
6. Cover
7. Bush
8. Protective cover
9. Gearbox cover
10. End casing
11. Circlip
12. Ball bearing
13. Striker (x-ray)
14. Bush
15. Gear shifter rod
16. Contact for reversing lights and belt reminder
17. Selector fork, 1st and 2nd speeds
18. Gate
19. Sliding plate
20. Sleeve (reverse catch)
21. Spring
22. Sleeve
23. Spring
24. Insert
25. Engaging sleeve and gear wheel for reverse
26. Syncronizing cone
27. Overdrive switch
28. Push plate for overdrive switch
29. Thrust washer
30. Circlip
31. Thrust washer
32. Gear wheel for 3rd speed
33. Needle bearings
34. Selector fork, 3rd and 4th speeds
35. Spring
36. Interlock ball
37. Synchronizing hub
38. Insert
39. Selector rail for 3rd and 4th speeds
40. Selector rail for 1st and 2nd speeds
41. Selector rail for reverse
42. Engaging sleeve
43. Spring
44. Synchronizing cone
45. Ball bearing
46. Roller bearing
47. Sealing ring
48. Cover
49. Input shaft
50. Spacer washer
51. Thrust washer
52. Housing
53. Needle bearing
54. Spacer washer
55. Countershaft
56. Idler gear
57. Mainshaft
58. Gear wheel for 2nd speed
59. Needle bearings
60. Reverse shaft
61. Reverse gear
62. Bush
63. Striker lever (x-ray)
64. Needle bearings
65. Gear wheel for 1st speed
66. Thrust washer
67. Rear cover
68. Intermediate flange

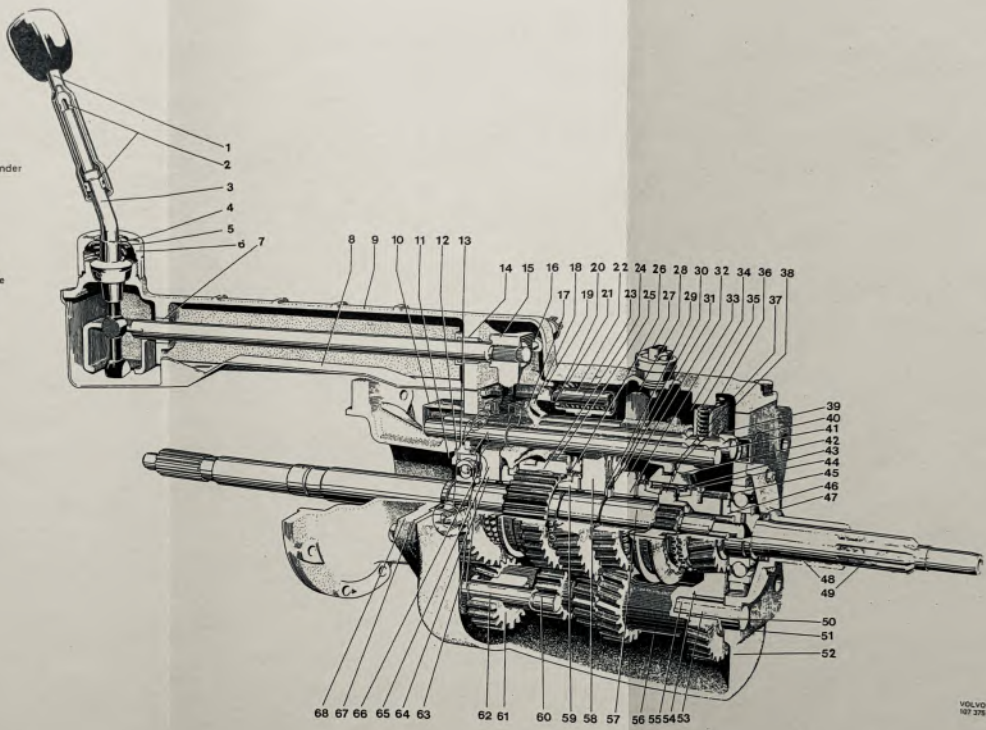


Illustration 4—B. Gearbox M 41 (without overdrive)

1. Nut
2. Lock washer
3. Bridge piece
5. Breather
6. Front casing
7. Gasket
8. Brake ring
9. O-ring
10. O-ring
11. Seal
12. Gasket
13. Solenoid
14. Bolt
15. Thrust bearing retainer
16. Spring
17. Ball bearing
18. Circlip
19. Circlip
20. Circlip
21. Stud
22. Piston seal
23. Piston
24. Connecting rod
25. Non-return ball
26. Non-return valve spring
27. Plug
28. Key
29. Resilient ring
30. Circlip
31. Eccentric
32. Piston pin
33. Gasket
36. Stud
37. Orifice nozzle
38. Seal
39. Plug
40. O-ring
41. End piece
42. Piston
43. Washer
44. Spring
45. Retainer
46. Spring
47. Screw
48. Screw
49. Holder
50. Spring
51. O-ring
52. Plug
53. Nut
54. Piston
57. O-ring
58. Cylinder
59. O-ring
60. Plug
61. Spring
62. Ball
63. Non-return body
64. O-ring
65. Pump body
66. Pump plunger
67. Washer
68. Fine filter
69. Seal
70. Plug
71. Data plate
72. Screw
73. Planet gear and carrier
74. Sunwheel
75. Clutch sliding member
76. Pre-filter
77. Gasket
78. Magnet
79. Base plate
80. Bolt
81. Resilient washer
84. Bush
85. Thrust washer
86. Oil thrower
87. Circlip
88. Uni-directional clutch
89. Stud
90. Resilient washer
91. Nut
95. Speedometer pinion
96. O-ring
97. Bush
99. Bolt
100. Retainer
101. Oil seal
102. Stud
106. Speedometer driving gear
110. Output shaft
111. Ball bearing
112. Spacer
113. Rear casing
114. Ball bearing
115. Oil seal
116. Flange
117. Washer
118. Nut

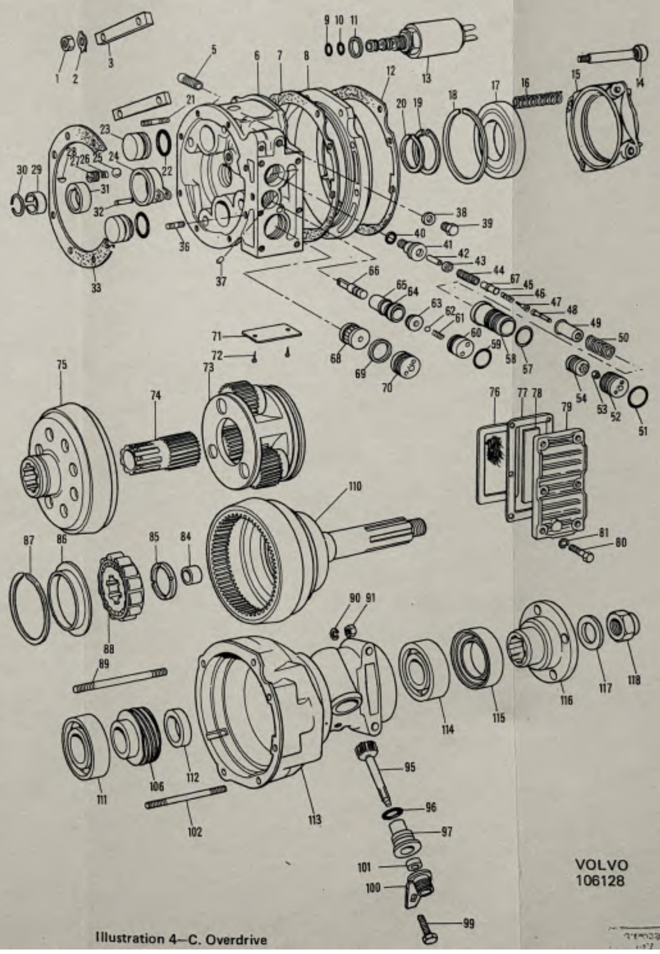


Illustration 4—C. Overdrive

1. Oil seal
2. Front pump
3. O-ring
4. Pump body
5. Gasket
6. Thrust washer
7. Snap ring
8. Input shaft
9. Thrust washer
10. Hub
11. Disc kit
12. Snap ring
13. Spring
14. Ring
15. Piston ring (rubber)
16. Piston and reed
17. Rubber ring
18. Front clutch cylinder
19. Front servo
20. Servo strut
21. Contact pin
22. Brake band
23. Thrust washer
24. Thrust washer
25. Snap ring
26. Spring seat
27. Spring
28. Snap ring
29. Disc kit
30. Piston ring (rubber)
31. Piston
32. Front drum
33. Oil ring
34. Rubber ring
35. Needle bearing
36. Key
37. Reverse sun gear
38. Needle thrust plate
39. Oil rings
40. Forward sun gear
41. Oil ring
42. Centre bearing
43. Servo strut
44. Brake band
45. Needle thrust bearing
46. Thrust plate
47. Snap ring
48. Free wheel
49. Brace
50. Planetary gear
51. Thrust plate and bearing
52. Gear
53. Snap ring
54. Driven shaft
55. Washer
56. Oil ring
57. Seal ring
58. Transmission housing
59. Rear servo
60. Stop shaft
61. Nipple
62. Plate
63. Oil deflector plate
64. Lock bolt
65. Spindle
66. Spring
67. Valve
68. Centrifugal governor
69. Counterweight
70. Speedometer gear
71. Flange

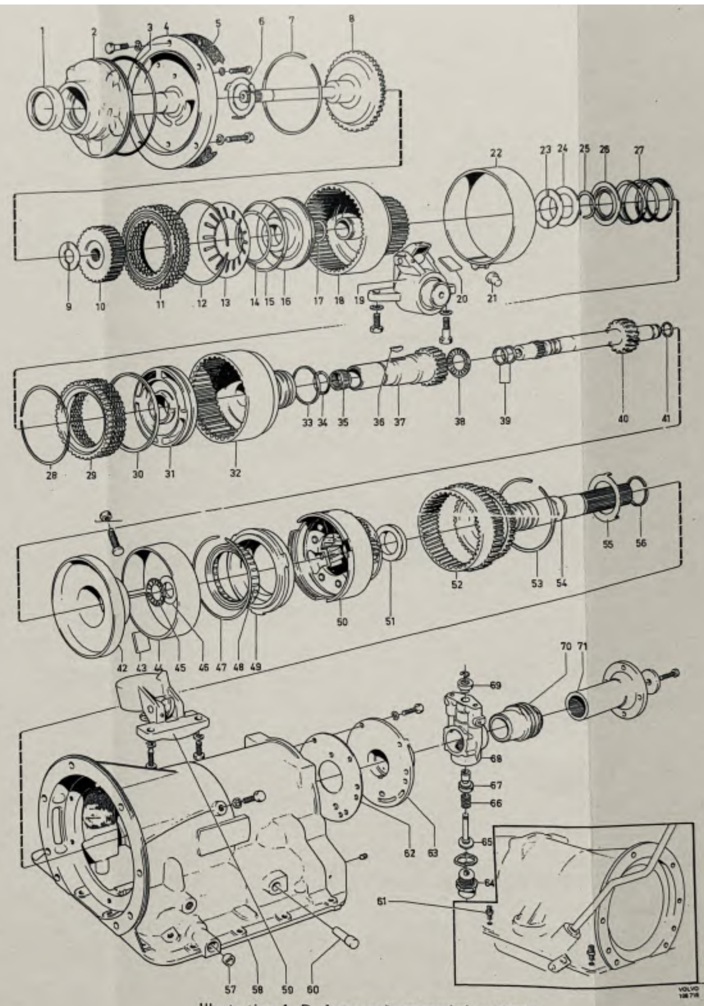


Illustration 4—D. Automatic transmission BW 35

	A	B	C	D	E	F	a	b	c	d	e	f	g	h	l	m	n	p	s	N	O	P	Q	R	S	T	U	V	W	X	Z
Engagement of "R", "D", "2" or "1"																															
Bumpy	–	2	–	1	–	–	–	–	5	3	–	4	–	–	–	–	–	–	–	–	6	–	7	–	–	–	–	–	–	–	–
Delayed	1	–	2	3	–	–	4	7	6	5	–	–	–	–	–	–	–	–	8	9	–	10	–	–	11	–	–	–	–	12	–
None	1	–	3	–	–	–	3	4	5	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7	8	9	10
Starting from rest																															
None forward	–	–	1	–	–	–	–	3	2	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–	5	–	–	–	–	–
None reverse	–	–	1	–	–	2	7	6	5	–	–	–	–	6	–	4	4	–	–	–	–	9	–	–	8	–	–	–	–	–	–
Seizure reverse	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–
No neutral	–	–	1	–	2	–	8	9	3	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–
Upshifts																															
No 1–2	–	–	1	–	–	–	8	9	10	–	–	6	7	3	–	4	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–
No 2–3	–	–	1	–	–	–	8	9	10	–	–	6	7	2	–	–	3	4	–	–	–	5	–	–	–	–	–	–	–	–	–
Above normal shift speeds	–	1	–	–	–	–	–	8	9	10	–	2	7	3	–	4	5	6	–	–	–	–	–	–	–	–	–	–	–	–	–
Below normal shift speeds	–	1	–	–	–	–	–	5	6	–	–	2	–	3	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–
Upshifts quality																															
Slip on 1–2	1	2	3	–	4	–	8	9	10	6	–	7	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–
Slip on 2–3	1	2	3	–	4	–	9	10	11	7	–	8	–	–	–	–	–	–	–	–	–	5	–	6	–	–	–	–	–	–	–
Rough on 1–2	–	1	–	–	2	–	–	–	10	3	–	4	5	6	–	–	–	–	–	9	–	–	–	–	–	–	7	8	–	–	–
Rough on 2–3	–	1	–	–	2	–	–	–	6	3	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–	–
Seizure on 1–2	–	–	–	–	–	1	–	5	6	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	3	4	–	–	–	–
Seizure on 2–3	–	–	–	–	1	–	2	3	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Downshifts																															
No 2–3	–	1	–	–	–	–	–	–	–	–	–	–	–	3	–	2	–	–	–	–	–	–	–	–	4	–	–	–	–	–	–
No 3–2	–	1	–	–	–	–	–	–	–	–	–	–	–	3	–	2	–	–	–	–	–	–	4	5	–	–	–	–	–	–	–
Involuntary high speed 3–2	1	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–
Above normal shift speeds	–	1	–	–	–	–	–	5	6	–	–	4	–	2	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–
Below normal shift speeds	–	1	–	–	–	–	–	5	6	–	–	4	–	2	–	7	8	3	–	–	–	–	–	–	–	–	–	–	–	–	–
Downshifts quality																															
Slip on 2–1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Slip on 3–2	–	–	–	–	1	–	6	7	8	4	–	5	–	–	3	–	–	–	–	–	–	9	–	2	–	–	–	–	–	–	–
Rough on 2–1	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	1	–	–	–	–	–
Rough on 3–2	–	–	–	–	1	–	–	–	5	3	–	5	–	2	–	–	–	–	–	–	–	6	7	8	–	–	–	–	–	–	–
Line pressure																															
Low, idling	1	–	2	3	–	–	6	8	5	4	–	–	–	–	–	–	–	–	7	–	–	–	–	–	–	–	–	–	9	–	–
High, idling	–	1	–	2	–	–	–	–	–	3	5	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Low at stall	1	2	–	–	–	–	6	8	7	3	–	5	4	9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10	–
High at stall	–	–	–	–	–	–	–	–	4	1	–	2	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stall speed																															
More than 10 r/s (600 r/m) below nominal speed	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Over 43.4 r/s (2600 r/m)	1	–	2	–	–	3	4	5	6	7	–	–	–	–	–	–	–	–	–	8	–	9	–	–	10	11	–	12	–	–	13
Overheating	1	–	–	–	2	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4

FAULT INVESTIGATION KEY

Preliminary adjustment faults

A. Incorrect front brake band adjustment.
B. Incorrect rear brake band adjustment.
C. Fluid level incorrect.
D. Downshift valve cable incorrectly assembled or adjusted.
E. Manual linkage incorrectly assembled or adjusted.
F. Incorrect engine idling speed.

Hydraulic control faults

a. Oil tubes missing or not installed correctly.
b. Sealing rings missing or broken.
c. Valve bodies assembly screws missing or incorrectly tightened.
d. Primary regulator valve sticking.
e. Secondary regulator valve sticking.
f. Throttle valve sticking.
g. Modulator valve sticking.
h. Governor valve sticking, leaking or incorrectly fitted.
l. Orifice control valve sticking.
m. 1–2 shift valve sticking.
n. 1–2 shift valve sticking.
p. 2–3 shift valve plunger sticking.
s. Pump check valve missing or sticking.

Mechanical faults

N. Front clutch slipping due to worn plate or faulty parts.
O. Front clutch seized or plates distorted.
P. Rear clutch slipping due to worn plates or faulty check valve in piston.
Q. Rear clutch seized or plates distorted.
R. Front band slipping due to faulty servo, broken or worn brake band.
S. Rear brake band slipping due to faulty servo, broken or worn brake band.
T. One-way clutch slipping or incorrectly fitted.
U. One-way clutch seized.
V. Input shaft broken.
W. Pump drive fingers on converter hub broken.
X. Pump worn.
Z. Converter blading and/or one-way clutch fails.

QUICK-REFERENCE FAULT-TRACING CHART FOR AUTOMATIC TRANSMISSION

1. Tubular shaft
2. Differential carrier bearing
3. Bearing cap
4. Shims
5. Differential carrier
6. Thrust washer
7. Differential side gear
8. Lock pin
9. Differential pinion
10. Crown wheel
11. Shaft
12. Thrust washer
13. Rear axle casing
14. Flange
15. Dust cover plate
16. Oil slinger
17. Oil seal
18. Shims
19. Front pinion bearing
20. Pinion
21. Rear pinion bearing
22. Shims

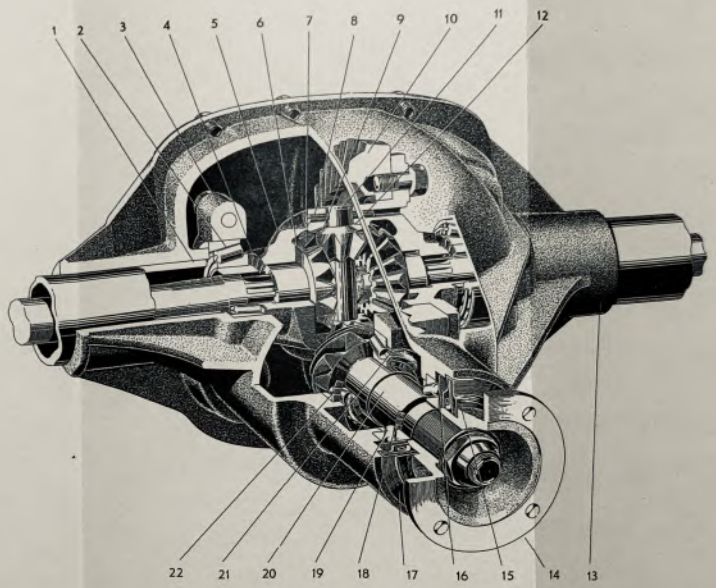


Illustration 4—E. Final drive

Part 5

BRAKES

CONTENTS

GENERAL

TOOLS

The designation SVO before the tool number is to be replaced by the number 999.

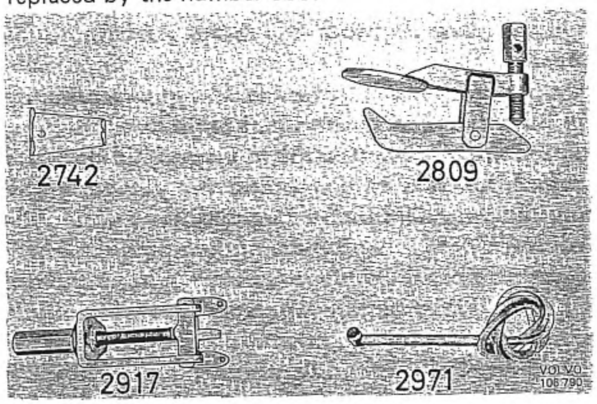


Fig. 5–1. Special tools

2742 Holder for cable spring
2809 Tool for pressing in piston
2917 Extractor for brake pads
2971 Bleeder tool

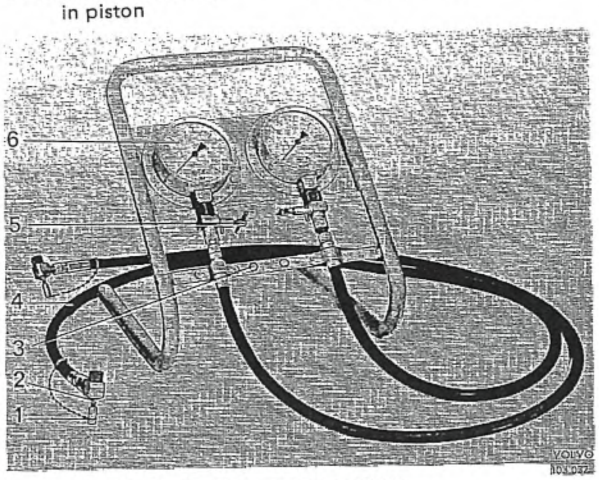


Fig. 5–2. Testing device 2741.

1. Nipple plug
2. Connection nipple
3. Enlarging nipple
4. Hose
5. Bleeder tap
6. Pressure gauge

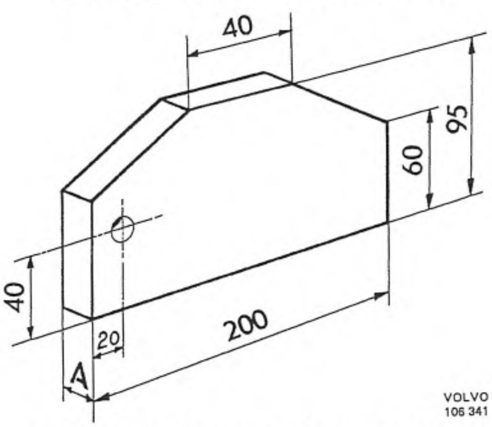


Fig. 5–3. Wooden insert for barke calipers

A = 15.5 mm (0.61") for front brake calipers
13 mm (0.51") for rear brake calipers

This applies also to new production of older tools.

The following special tools are used for repair work on the brake system.
The testing device (Fig. 5–2) is used, for example, to trace faults in the brake system.
Removal of the pistons in the front brake caliper is made easier with the help of wooden inserts according to Fig. 5–3.
A hose connector (see 2, Fig. 5–4) is required for removing the pistons in the rear brake calipers.
For bleeding the system a bleeder unit, of the type shown in Fig. 5–5, is used. A connector cover (see 1, Fig. 5–4) is also required for connecting the unit to the brake fluid container.

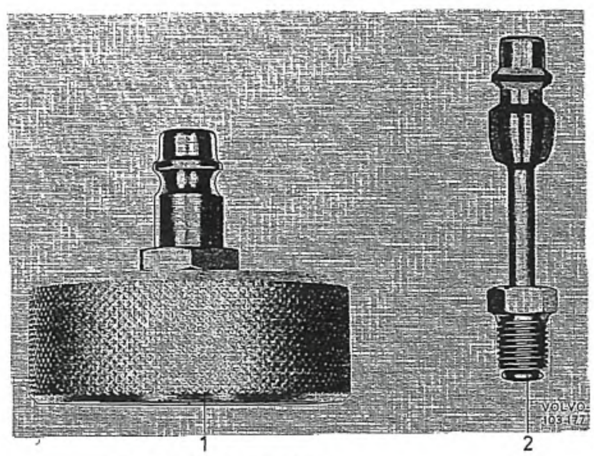


Fig. 5–4. Connectors

1. Connector
   (Can be obtained from Volvo Service)
2. Connector for brake caliper

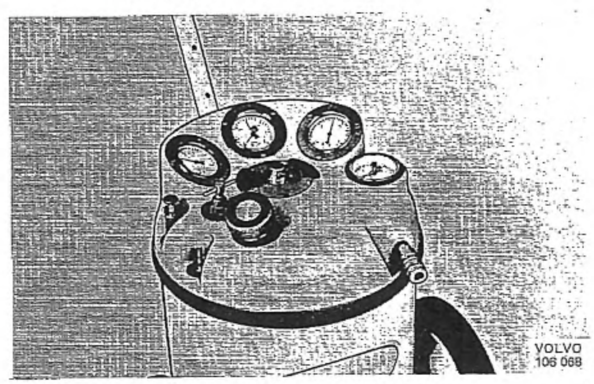


Fig. 5–5. Type of bleeder unit

DESCRIPTION

The footbrake system has disc brakes on all four wheels. Its layout can be seen on Fig. 5–6.
It is a two-circuit system due to the fact that it has a tandem-type master cylinder (3) and the front wheel brake calipers (16) have two pairs of cylinders completely separated from each other. One of the circuits serves the lower cylinders for the front wheel brakes and the left wheel, the other taking care of the upper cylinders of the front wheel brake units and the right rear wheel. With this arrangement, braking effekt is ensured, even if there is a breakdown in one of the brake lines.

The servo cylinder (4) is directly influenced by the brake pedal and, with the help of vacuum from the engine inlet duct, It ensures that less pedal pressure is required for braking. The purpose of the brake valves (9 and 12) is to assist with a suitable distribution of braking power between the front and rear wheel brakes.
The warning valve (2) warns the driver when there is an abnormal pressure difference between the circuits. Concerning a more detailed description of the units making up the footbrake and the parking brake systems, see the respective Groups in question.

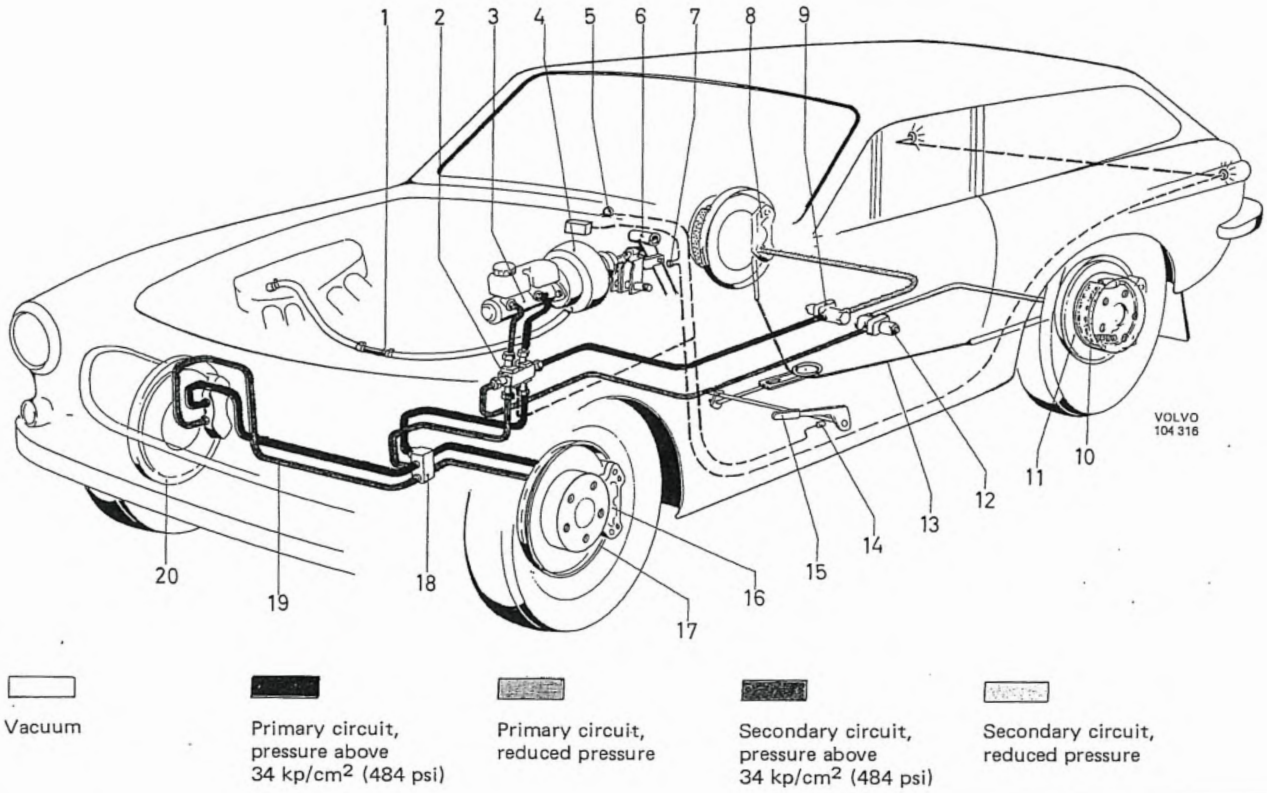


Fig. 5–6. Brake system

1. Check valve
2. Warning valve
3. Master cylinder with brake fluid container
4. Power cylinder
5. Warning lamp
6. Brake pedal
7. Brake switch
8. Rear brake caliper
9. Brake valve, primary circuit
10. Brake shoes, parking brake
11. Brake disc with brake drum
12. Brake valve, secondary circuit
13. Cable, parking brake
14. Parking brake warning switch
15. Parking brake
16. Front brake caliper
17. Brake disc
18. 6-way union (double 3-way union)
19. Brake line
20. Guard plate

REPAIR INSTRUCTIONS

CLEANING

The components of the hydraulic brake system should be cleaned in clean brake fluid or denatured alcohol, which does not contain benzene (benzol). Of the existing kinds of denatured alcohol being sold generally only methylated spirit is free from benzene. Brake fluid is an excellent but expensive cleaning agent. From most viewpoints. **methylated spirit** is therefore the most suitable.

Petrol, white spirit, trichlorethylene or alcohol with benzene must not be used for cleaning since, like the slightest trace of mineral oil, they attack the rubber seals and cause them to swell out. For this reason, hands should be washed with soap and water before the internal parts are touched. The mechanic working with the hydraulic components should preferably be provided with rubber gloves.

Final rinsing should take place in a cleaning agent free from impurities after which the parts can be dried in the open air. To precipitate the drying and complete the cleaning process, filtered, compressed air free from moisture can be used. It is of the utmost importance that no alcoholic residue is left in the system when filled with brake fluid. Traces of alcohol in the brake fluid reduces its boiling point and can result in the formation of vapour which can affect brake functioning.

After being cleaned and dried, the parts should be moistened with brake fluid, assembled and then the complete unit filled with brake fluid as soon as possible in order to prevent corrosion attacks from the moisture in the air. This applies to parts which should be fitted immediately in the vehicle. To counteract corrosion on brake parts which are stored, or for any other reason are not corered by brake fluid, the plungers, cylinders and seals should be coated with a thin layer of lubricant called brake paste intended for this purpose. Under no conditions whatoever must other types of grease or rustproofing oil be used.

BRAKE FLUID

Only first-class brake fluid, which is guaranteed by a well-known manufacturer to fulfil the requirements according to the standard SAE J 1703, should be used for the brake system. Brake fluid with designation DOT 3 or DOT 4 can also be used. Mixing of brake fluids produced by different firms should be avoided.

When the container of the master cylinder is being filled, likewise with all work concerning connections, etc. the greatest cleanliness should be observed in order to prevent dirt from getting into the system. Only clean, unused brake fluid should be filled. **Brake fluid which is expelled during, for example, bleeding, may not be put back into the system.**

After use over a long period, it it normal that even first-class brake fluid gradually deteriorates through the absorption of moisture and small impurities. Deteriorated brake fluid can be recognized by the fact that, compared with new brake fluid, it is darker or has changed its colour, is relatively odourless and watery, i.e. when felt between the fingers it lacks the normal feeling of a light lubricating film. Such brake fluid should be replaced by new fluid, and this should also be done when the master cylinder and wheel brake units are being overhauled.

FAULT TRACING

The following fault tracing procedure can be used, for example, after the discovery, following upon some kind of brake testing, that the capacity of the footbrake system is not what it should be. Fault tracing can also be carried out with a view to preventing faults arising.

1. Check that the level of the brake fluid reaches up to the "Max" mark on the container. Top up, if necessary. See under the heading "Brake Fluid".
2. Remove both the inside bleeder nipples at one of the front brake calipers and connect up the testing device 2741 shown in Fig. 5—2.
3. Depress the brake pedal several times to even out any partial vacuum in the power brake cylinder and in this way disconnect it. Check that when free the brake pedal is about level with the clutch pedal.
4. Apply and release the footbrake while reading off the pressure gauges of the testing device. The pressure in both the circuits should be observed. At 100 kp/cm^2 (1422 psi), there must not be a difference in pressure of more than 3 kp/cm^2 (42.7 psi).
5. With the help of a pedal jack apply the footbrake to a hydraulic brake pressure of about 100 kp/cm^2 (1422 psi). Check the lines and parts for damage and leakage. The pressure should remain unchanged for at least 15 seconds.
6. Remove the pedal jack. Depress the brake pedal and maintain this pressure. Start the engine. Here a noticeable lowering of the pedal should be felt when the servo cylinder starts to operate.
7. Stop the engine after it has run at least 1 minute. With the help of the pedal jack apply a hydraulic pressure of 25 kp/cm^2 (356 psi). Wait a couple of minutes. The hydraulic pressure should not drop more than 5 kp/cm^2 (71 psi).

8. Check the warning valve. Connect a hose to one of the bleeder nipples of the testing device and open the device. Switch on the ignition switch and check that the warning lamp lights when the parking brake is applied.
Release the parking brake. With a pedal jack apply the footbrake slowly. When the warning lamp lights, check the pressure on the pressure gauge. The lamp should light at a pressure difference of 5–15 kp/cm^2 (71–213 psi) be tween the circuits.
After the test, shut off the bleeder nipple and remove the pedal jack. Disconnect the electric cable and unscrew the warning valve switch so that the warning valve returns to its normal position. Screw in the electric switch to a tight tening torque of 14–20 Nm (10–15 lbft). Connect the electric cable.
9. Check the brake valve of the secondary circuit by connecting the testing devices to the bleeder nipple on the left rear wheel brake unit and to the upper nipple on one of the front wheel brake units. Apply the footbrake with the pedal jack on the incoming pressure according to the table below. Read off the outgoing pressure on the gauge which is connected to the rear wheel brake unit. From the point of view of leakage, the brake valve is not defective if the pressure remains unaltered for at least 15 seconds.

Incoming pressure kp/cm^2 (psi)	30 (427)	50 (711)	100 (1422)
Outgoing pressure kp/cm^2 (psi)	30 (427)	36–42 (512–597)	50–59 (711–839)

10. Check the other brake valve in the same way by connecting it to right rear wheel brake unit and the inner, lower nipple of the front wheel brake unit.
11. Jack up the vehicle so that the wheels rotate freely. Apply and release the brake during which a check is made to see if the wheels can be rotated. The wheels should be free for half a second after the pedal has been released. The test should be carried out with and without a partial vacuum in the servo brake cylinder.

FAULT TRACING SCHEME

Test operation	Fault	Cause	Remedy
3	Pedal too low or too high	Faulty brake pedal or carpet	Adjust
4	Fading pressure	Damaged brake line Blocked hose	Replace damaged lin Replace hose
	Difference between circuits greater than 3 kp/cm^2 (42.7 psi)	Leakage in a circuit Faulty master cylinder	See point 5 Recondition master cylinder
5	The pressure drops	External leakage	Tighten connectors and replace line or recondition leaking part
		Leaking brake valve	Recondition or replace brake valve
		Leaking seal in wheel unit cylinder	Recondition wheel unit cylinder
		Leaking seal in master cylinder	Recondition master cylinder

Test operation	Fault	Cause	Remedy
6	The pedal does not go down	Leaking vacuum line Blocked air filter or leaking seal for front pressure plunger in power cylinder Leaking check valve Faulty power cylinder	Replace vacuum line Replace filter or seal Replace power cylinder completely
7	The pressure drops more than 5 kp/cm^2 (71 psi)	Leaking check valve Leaking seal for front pressure plunger in power cylinder Internal fault in power cylinder	Remove and blow clean the valve and replace the seal ring. If insufficient, replace check valve Remove master cylinder and replace seal Replace power cylinder complete
8	The parking brake warning lamp does not light Footbrake warning lamp does not light Warning lamp does not go out when pistons have returned to normal position Warning when pressure difference is other than 5–15 kp/cm^2 (71–213 psi)	Wrongly adjusted switch Faulty electrical parts Faulty switch Pistons seize Faulty warning valve	Adjust switch Replace faulty parts Replace switch Replace warning valve Replace valve
9–10	Faulty outgoing pressure	Leaking valve Faultily set valve	Recondition or replace brake valve Adjust if reconditioned valve tested, see page 5:19
11	A circuit fades The rear wheel brakes fade A wheel brake fades	Blocked equalizing hole in master cylinder Parking brake cable chafes Faultily adjusted parking brake Faulty brake valve Worn sealing ring Damaged brake line Blocked hose	Recondition master cylinder Replace cable Adjust parking brake Recondition or replace brake valve Replace line Replace hose Recondition wheel brake unit

SERVICING

From the point of view of traffic safety, the condition of the brakes is an extremely important factor. It is essential, therefore, that any work carried out on the system should be done by qualified mechanics with the greatest care, likewise that a regular check is made according to the instructions given below.

CHECKING BRAKE FLUID LEVEL

When filling the tank with fuel, check to make sure that the fuel level in the master cylinder container is not below the "Min" mark. This can be done without removing the cap. Every 10 000 km (6 000 miles) top up, if necessary, to the "Max" container mark.
A first-class brake fluid which meets the requirements according to SAE J 1703 should be used for topping-up. Brake fluid with the designation DOT 3 or DOT 4 can also be used. Before removal, clean the cap of the container and observe maximum cleanliness when filling with fluid. Avoid spilling the brake fluid onto the paintwork as this can damage it. Check to make sure that the vent-hole in the cap is not blocked.

CHECKING BRAKE PADS

Every 10 000 km (6 000 miles) check the wear on the linings. The brake pads should be replaced when the linings are worn down to a thickness of about 3 mm (1/8"). Under no circumstances must the linings be worn down below 1.5 mm (1/6"). For replacement of the pads, see pages 5:10 and 5:11.

FUNCTION CHECK

In addition to the regular check on the brakes carried out by the driver as result of the driving done, the brakes should be checked every 10 000 km (6 000 miles) by a workshop mechanic. The footbrake should also be checked then to make sure that it functions satisfactorily; if necessary, check with the help of proper testing equipment (see "Fault Tracing"). A check should also be made that there is no leakage and that the brake lines are not exposed to such damage that leakage can be expected. The parking brake should provide full braking power at the 3rd—4th ratchet segment. If it does not do so, adjust the parking brake according to the instructions given on page 5:34.

OVERHAUL

Every third year or 60 000 km (36 000 miles) the brake system seals and air filter for the servo brake cylinder should be replaced. Where driving conditions are for the most part dusty, the air filter should be replaced more often.

WHEEL BRAKE UNITS

DESCRIPTION

FRONT WHEEL BRAKE UNITS

Fig. 5–7 shows how the brake components are located at the front wheels. The disc (1) is of cast iron and is attached to the wheel hub with which it rotates. The cover plate (2) protects the disc from dirt.

Mounted on the stub axle is the front wheel brake caliper (3) which houses the wheel unit cylinders and brake pads. The front wheel brake caliper consists of a housing in two halves (6 and 14, Fig. 5–8) bolted together and located on either side of the brake disc. Each half contains two cylinders and pistons. The upper cylinder is completely separated from the lower one, but both upper and lower cylinder are each connected through channels to the corresponding cylinder in the other half. The function of the sealing rings (1) is partly to prevent brake fluid from oozing out and partly to return the pistons to the rest position after braking. Rubber dust covers (3) prevent dirt from entering. Each sealing ring has a square section and presses against the piston from the slightly oblique groove in the housing. The brake pads (10) are provided with bonded facings and are held in position by means of retaining pins (13).

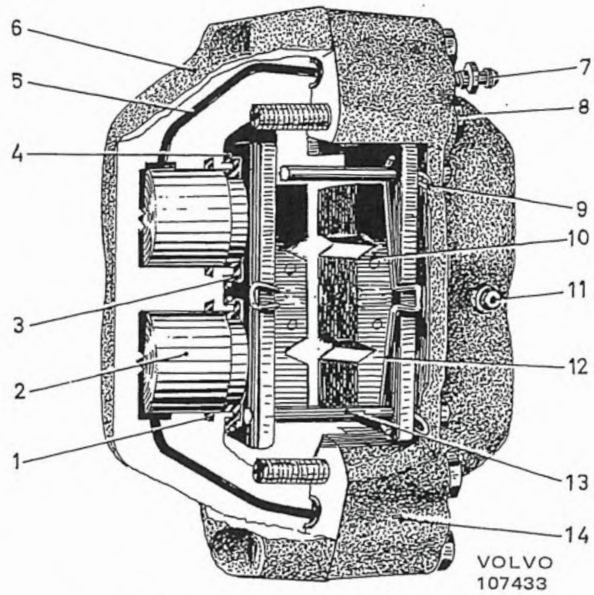


Fig. 5–8. Front wheel brake caliper

1. Sealing ring
2. Piston
3. Rubber dust cover
4. Retaining ring
5. Channel
6. Outer half
7. Upper bleeder nipple
8. Bolt
9. Retaining clip
10. Brake pad
11. Lower bleeder nipple
12. Damping spring
13. Retaining pin
14. Inner half

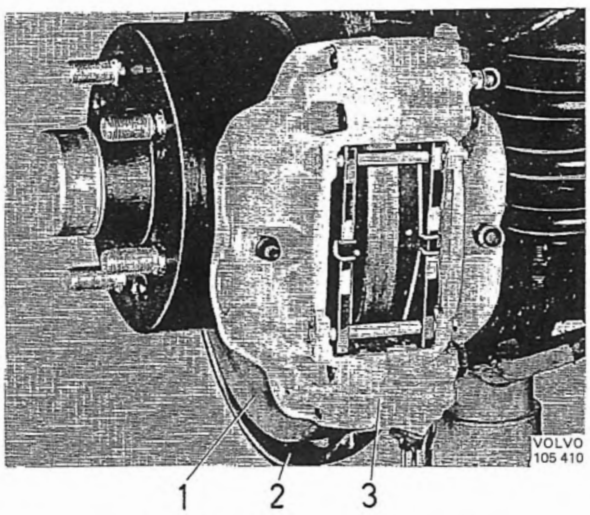


Fig. 5–7. Brake components, front wheel

1. Brake disc
2. Cover plate
3. Front brake caliper

REAR WHEEL BRAKE UNITS

(Footbrake component)

Fig. 5–9 shows the location of the brake components on the rear wheels. The brake disc (2) is of cast iron and is fixed to the drive shaft with which it rotates. The cover plate (3) prevents dirt from reaching the disc.

The rear wheel brake caliper is mounted to the rear axle casing with the help of a retainer. It houses the wheel unit cylinders and brake pads. It consists of a housing divided in two halves (6 and 11, Fig. 5–10) bolted together and located on either side of the brake disc. Each half contains a piston and a cylinder linked by means of a channel in the housing.

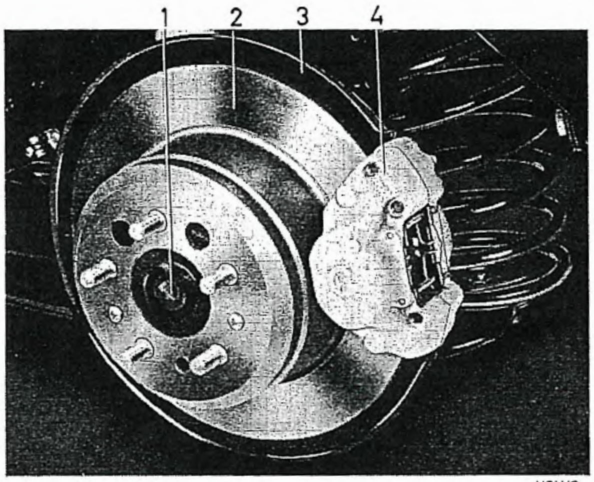


Fig. 5–9. Brake components, rear wheel

1. Drive shaft
2. Brake disc
3. Cover plate
4. Rear brake caliper

The sealing rings (1) have a square section and press against the piston from the slightly oblique groove in the housing. The function of the sealing rings is partly to prevent brake fluid from oozing out and partly to return the pistons to the rest position efter braking.

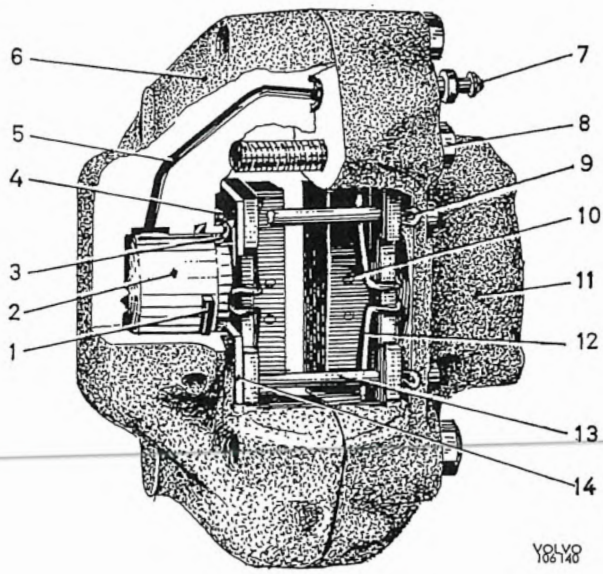


Fig. 5–10. Rear brake caliper

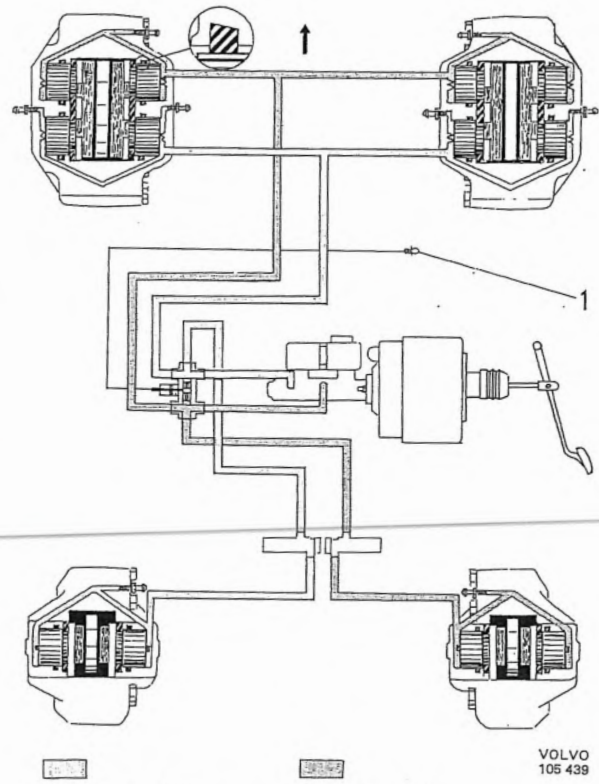
1. Sealing ring
2. Piston
3. Rubber dust cover
4. Retaining ring
5. Channel
6. Outer half
7. Bleeder nipple
8. Bolt
9. Retaining clip
10. Brake pad
11. Inner half
12. Damping spring (alt. 1)
13. Retaining pin
14. Washer

The rubber dust covers (3) prevent dirt from entering. The brake pads (10) are provided with bonded facings and are held in position by means of retaining pins (13).

FUNCTION

HYDRAULIC

The upper cylinders of the front wheel brake units and the right rear wheel brake unit are connected through brake lines to the primary chamber of the master cylinder, see Fig. 5–11. In the same way the lower cylinders of the front wheel brake units and the left rear wheel brake unit are connected to the master cylinder through the secondary chamber.



Secondary circuit, pressureless

Primary circuit, pressureless

VOLVO
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Fig. 5–11. Rest position

1. Warning lamp

A warning valve is located between the master cylinder and the brake lines for both the circuits. The valve is connected to the same warning lamp which indicates when the parking brake is applied. The lamp will light during brake application if there is too large a pressure difference (about 10 kp/cm^2 = 142 psi) between the two brake circuits.
When the pressure in the master cylinder rises as a result of brake application, the pistons are displaced and press the lining pads against the rotating friction surface of the brake disc, see Fig. 5–12. The pressure applied, and thus the brake effect, varies in proportion to the foot effort applied to the pedal. When the pistons are displaced, the sealing rings are tensioned laterally. They remain in this state as long as the footbrake is applied. When the brake pedal is released, the pistons are relieved of hydraulic pressure. Since there is no residual hydraulic pressure in the system line, the tension in the sealing rings is sufficient to move the pistons back to a certain extent, see Fig. 5–11. The return movement forms the clearance between the brake linings and the brake disc. This means that, in the rest position, the brake linings are always at a certain distance from the brake disc regardless of wear, so that the wheel brakes are self-adjusting.
Should leakage occur in one of the circuits, full braking effect is still obtained on both the front wheels and one rear wheel if pedal pressure is increased. Fig. 5–13 shows how this operates when leakage occurs in the secondary circuit. When there is a pressure difference in the brake circuits of about 10 kp/cm^2 (142 psi), the warning valve piston is pressed over to the side with less pressure and the warning lamp lights. The warning lamp will remain lighted until the leakage in the circuit concerned is repaired.

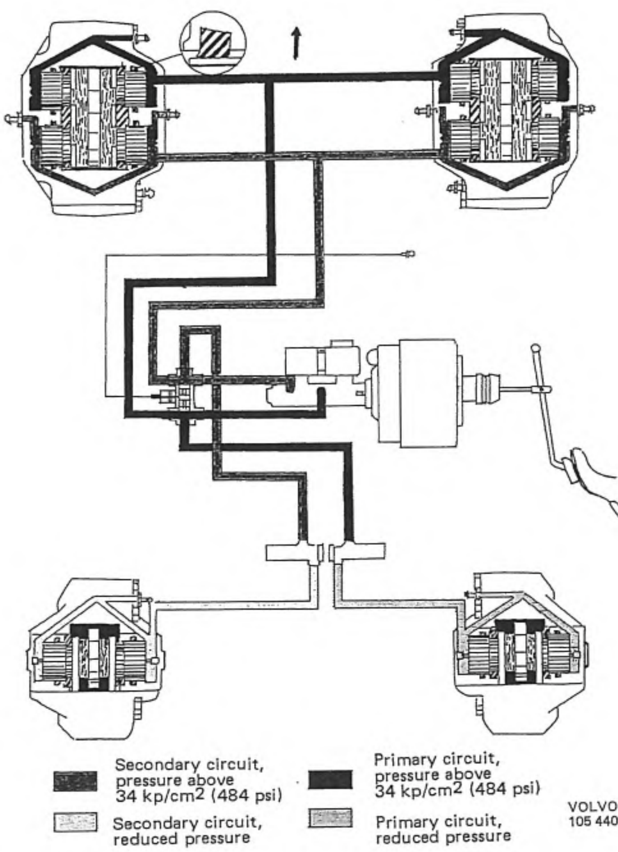


Fig. 5–12. Brake application

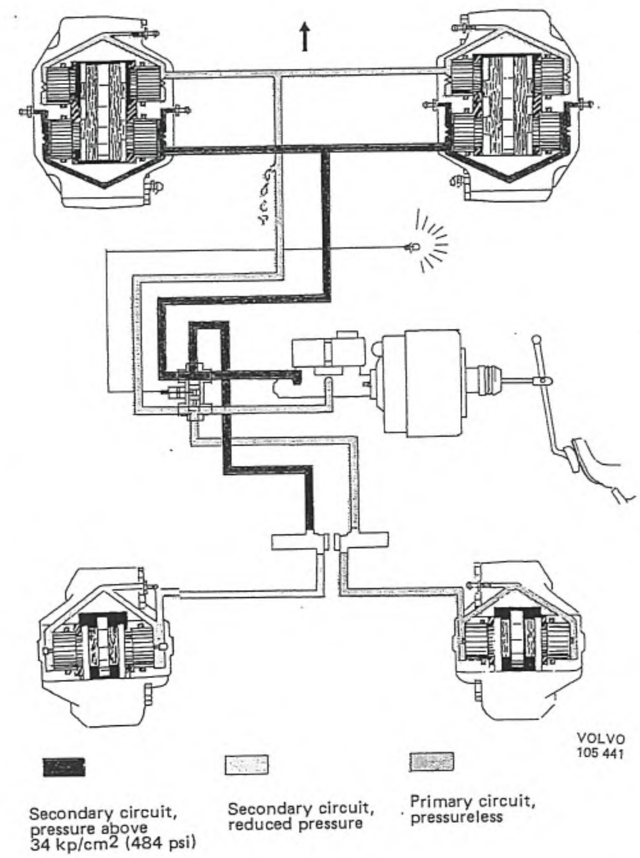


Fig. 5–13. Brake application, leakage in primary circuit

REPLACING BRAKE PADS

The brake pads should be replaced when about 3 mm (1/8") of the lining thickness remains. On no account must the linings be worn down to below 1.5 mm (1/16").

To avoid uneven braking effect, all the vehicle's brake linings should have the same designation.

The function and lifetime of the linings will benefit if lengthy and hefty braking is avoided in the beginning.

1. Slacken the wheel nuts slightly.
2. Jack up the vehicle and place props under the rear axle and under the front jack attachments. Unscrew the wheel nuts and lift off the wheels.
3. Remove the hairpin-shaped locking clips for the guide pins. Pull out one of the lock pins while holding the damper springs in place. Remove the springs and the other lock pin.
4. Pull out the pads with tool 2917, see Fig. 5–14. If the used pads are to be re-fitted, mark them to ensure they are restored to their original position.
5. Carefully clean out the cavity in which the pads are located. Replace any dust covers that are damaged. If dirt has penetrated into the cylinder due to a damaged cover, recondition the brake unit. Check the friction area of the brake disc.
6. To provide room for the new brake pads, press the pistons into the cylinders. The pistons can be pressed in evenly and without risk with tool 2809 according to Fig. 5–15. If done properly, the pistons can be pressed in perhaps more rapidly with another tool in the same way but, for example, if a screwdriver is used and wrongly applied, the pad, rubber seal and piston may be damaged. Note that when pressing in the pistons, the fluid brake level in the container rises so that the brake fluid can spurt out.
7. Fit the new pads, see Figs. 5–17 and 5–18. Place one of the lock pins in position and fit the damper springs and the other lock pin. Fix the pins with new locking clips (alt. 1). Check that the pads are movable.
8. After replacing the necessary brake pads, depress the brake pedal several times to check that the movement is normal. Generally the system does not require bleeding after replacing the brake pads.

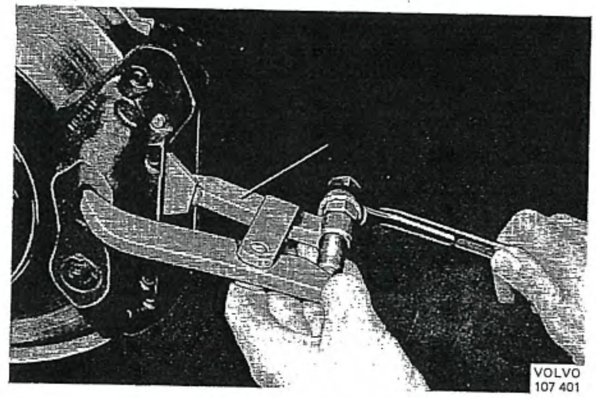


Fig. 5–15. Pressing in piston

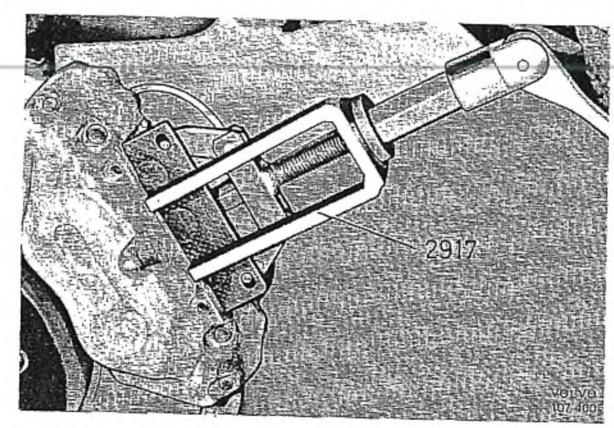
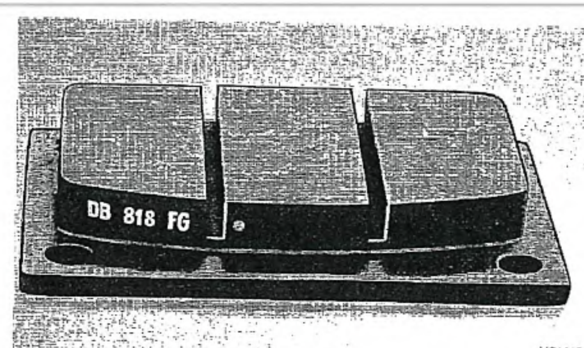


Fig. 5–14. Removing brake pads



VOLVO
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Fig. 5–16. Marking

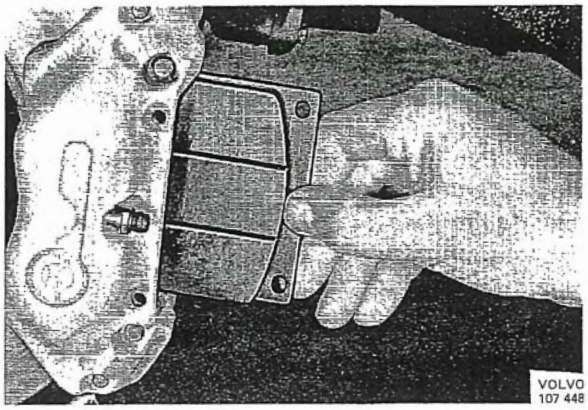


Fig. 5–17. Fitting brake pads, front brake caliper

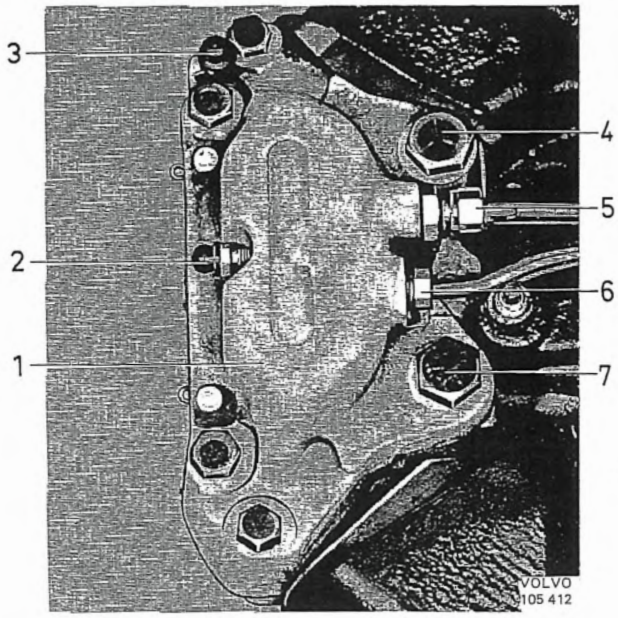


Fig. 5–19. Front wheel brake unit fitted

1. Front wheel brake caliper
2. Lower bleeder nipple
3. Upper bleeder nipple
4. Attaching bolt
5. Connection for primary circuit
6. Connection for secondary circuit
7. Attaching bolt

9. Re-fit the wheels after cleaning the contact surfaces and brake disc of sand, dirt, etc. Tighten the nuts sufficiently so that the wheels are securely held. Lower the vehicle and tighten finally the wheel nuts. Tighten each other nut a little at a time until all are finally tightened to a torque of 100–140 Nm (70–100 lb ft). Fit the hub caps.

NOTE. The function and lifetime of the linings will benefit if lengthy and hefty braking is avoided in the beginning.

RECONDITIONING WHEEL BRAKE UNITS

When working with the hydraulic system, observe the instructions under "Cleaning" and "Brake fluid", Group 50.

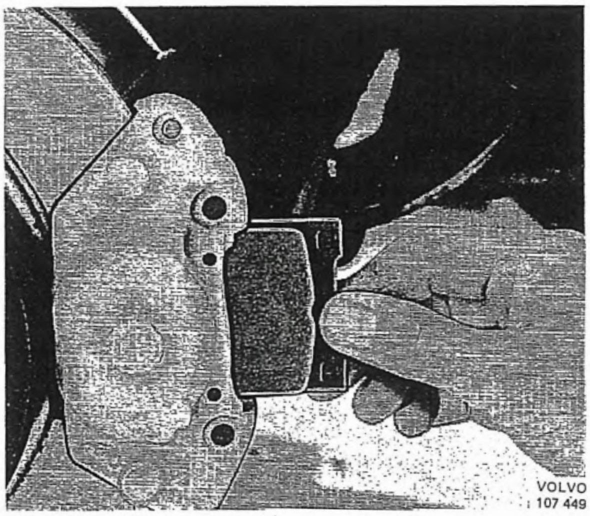


Fig. 5–18. Fitting brake pads, rear brake caliper

Front brake calipers

REMOVING

1. Slacken the wheel nuts slightly. Temporarily plug the vent-hole in the brake fluid container cap to reduce leakage.
2. Jack up the front end and place props under the front jack attachments. Unscrew the wheel nuts and lift off the wheels.
3. Disconnect the connections 5 and 6, Fig. 5–19 from the brake.
4. Unscrew the attaching bolts (4 and 7) and remove the brake caliper, see Fig. 5–20. Place the protective cover on the brake lines to prevent unnecessary leakage.

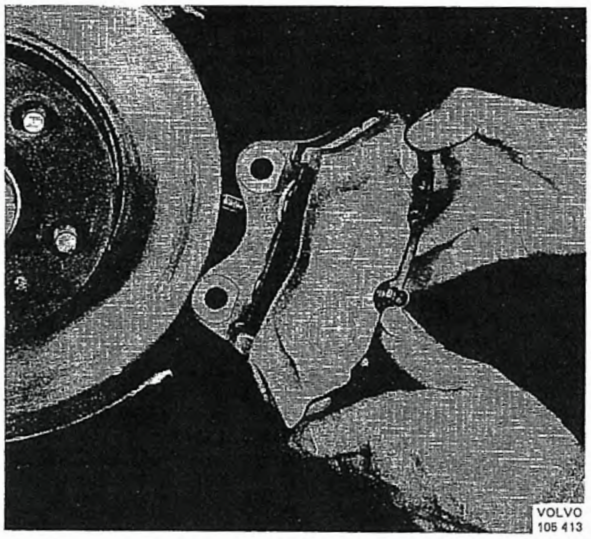


Fig. 5–20. Removing front wheel brake caliper

DISASSEMBLING

1. Remove the hairpin-shaped retaining clips for the retaining pins. Pull out one of the retaining pins while holding the damping springs in position. Remove the springs and the other retaining pin. Pull out the pads.
2. Remove the retaining rings for the rubber dust covers. Place a piece of wood, similar in shape to that shown in Fig. 5–3, between the pistons and press them out against the wood with the help of compressed air, see Fig. 5–21. The pistons con then be easily removed. Lever off the rubber dust covers.
3. Remove the sealing rings with the help of a blunt tool. Be careful not to damage the edge of the groovers. Unscrew the bleeder nipples and also the brake lines.

NOTE Both halves of the brake caliper should not be separated. The reason for this is that the assembling requires test pressure equipment and special fluid for the bolts.

INSPECTING

Before inspecting clean all the parts according to the instructions given under "Cleaning", Group 50. Make sure that the channels are clean.
The sealing rings and rubber dust covers should be replaced whenever reconditioning takes place. If any of the cylinders are scored or scratched, or damaged in any way, the complete cylinder housing should be replaced. Inspect the other parts and replace any that are damaged or worn.
Check also the brake disc, see under "Brake Disc".

ASSEMBLING

1. Coat the working surfaces of the pistons and cylinders with brake fluid.
2. Fit new sealing ring in the cylinders, see Fig. 5–22.
3. Fit the plungers with the large end diameter facing inwards. Make sure that the plungers are fitted in straight and are not scratched.

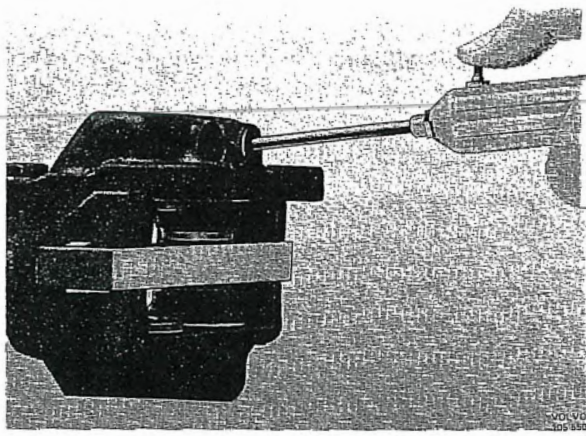


Fig. 5–21. Removing pistons

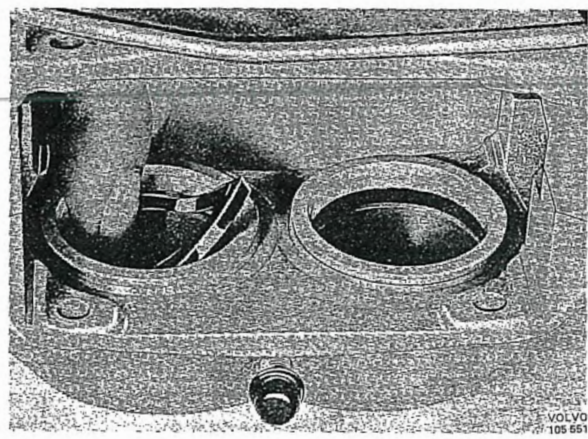


Fig. 5–22. Fitting sealing ring

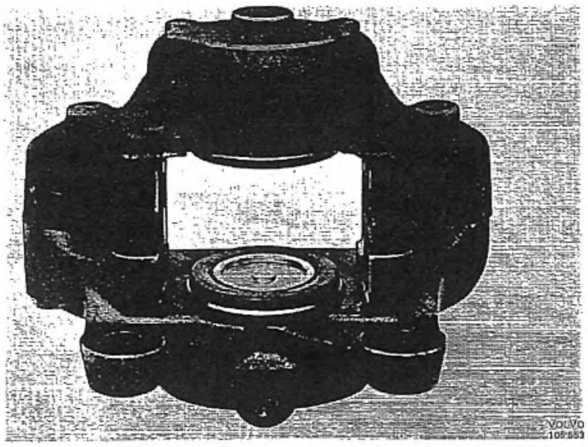


Fig. 5–23. Front brake caliper assembled

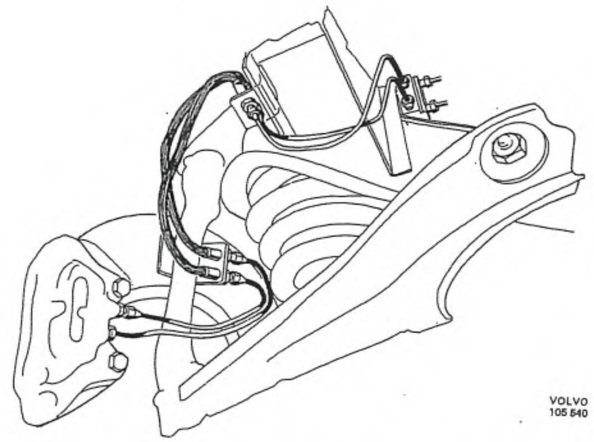


Fig. 5–24. Fitting front brake hoses

4. Fit the rubber covers on the plunger and housing. Fit the lock rings.
5. Fit the brake pads. Place one of the retaining pins in position and fit the damping springs and then the other retaining pin. Secure the pins with the hairpin-shaped retaining clips. Check that the pads are movable.
6. Fit the bleeder nipples and also the brake lines.

INSTALLING

1. Place the caliper in position. Check that the contact surfaces of the retainer are clean and not damaged. Check the location of the brake caliper in relation to the brake disc. Axial deviation is checked by measuring with a feeler guage on both sides of the disc the distance between disc and caliper support nib. The difference in measurement is max. 0.25 mm (0.010"). The caliper should be parallel with the disc. This is checked by measuring the distance to the upper and lower support nibs on the caliper. The location of the brake caliper can be adjusted with shims, which are available in thicknesses of 0.2 and 0.4 mm (0.008 and 0.016"). Coat the attaching bolts with a couple of drops of Locktite, type AV, and then fit them. Check that the brake disc rotates easily in the brake pads.
2. Fit the connectors as shown in Figs. 5–19 and 5–24. Remove the plug for the vent-hole in the brake fluid container cover.
3. Fit on the wheel after the contact surfaces have been cleaned of dirt, and then tighten the nuts sufficiently so that the wheel cannot be displaced on the hub. Remove the props. Lower the vehicle and tighten the wheel nuts Tighten every other nut a little at a time, until all are finally tightened to a torque of 100–140 Nm (70–100 lb.ft).
4. Bleed the fitted brake caliper, see Group 52.

Rear wheel brake shoes

REMOVING

1. Slacken the wheel nuts sligthly. Temporarily plug the vent-hole in the brake fluid container cap to reduce leakage.

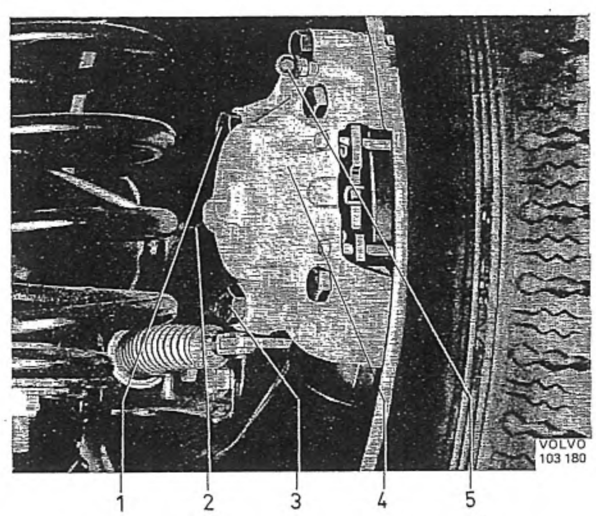


Fig. 5–25. Rear wheel brake unit fitted

1. Attaching bolt
2. Brake line
3. Attaching bolt
4. Rear wheel brake caliper
5. Bleeder nipple

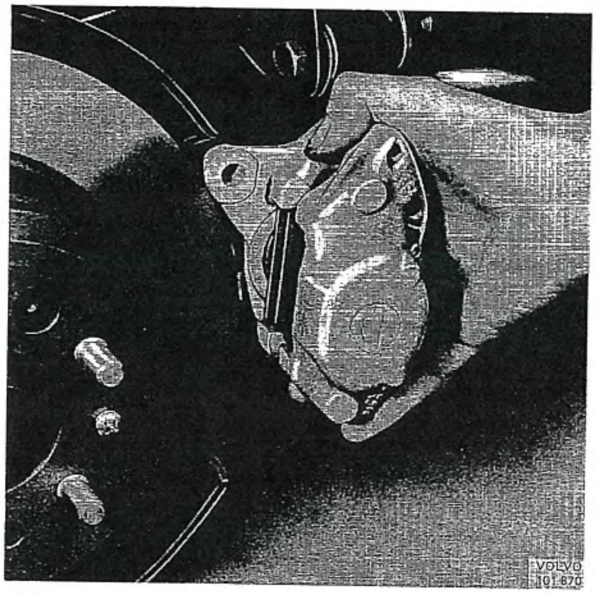


Fig. 5—26. Removing rear wheel brake caliper

2. Jack up the front end and place props under the rear axle. Remove the wheels. Release the parking brake.
3. Disconnect the brake line (2, Fig. 2—25) from the caliper and fit a protective cover on the brake line. Remove the attaching bolts (1 and 3, Fig. 5—25). Remove the brake caliper, see Fig. 5—26.

DISASSEMBLING

1. Remove the hairpin-shaped retaining clips for the retaining pins. Pull out one of the retaining pins while keeping the damping springs in position. Remove the springs and then the other retaining pin. Pull out the pads and the spacers.
2. Remove the retaining ring and the rubber dust covers. Place a wooden disc, see Fig. 5—3, between the pistons and press them out towards the disc with the help of an air line, see Fig. 5—27. The pistons can then be easily removed. Lever off the rubber covers.
3. If a piston feels stiff to remove, connect up an airline, see Fig. 5—28. If one of the pistons is removed, the cylinder can be sealed by means of a rubber washer and 2809 (see Fig. 5—28).
4. Remove the sealing rings with the help of a blunt tool. Take care not to damage the edges of the grooves. Screw out the bleeder nipple.

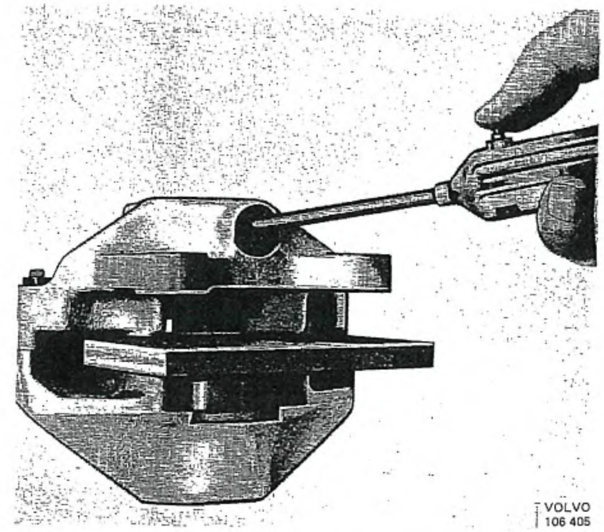


Fig. 5—27. Removing pistons

NOTE. The brake caliper halves should not be separated. Then reason for this is that subsequent assembling would require test pressure equipment and special fluid for the bolts.

INSPECTING

Before inspecting clean all the parts according to the instructions given under "Cleaning", Group 50. Make sure that the channels are clean.

Sealing rings and rubber dust covers are replaced after each reconditioning. If any of the cylinders are scored, scratched, etc., the entire cylinder housing

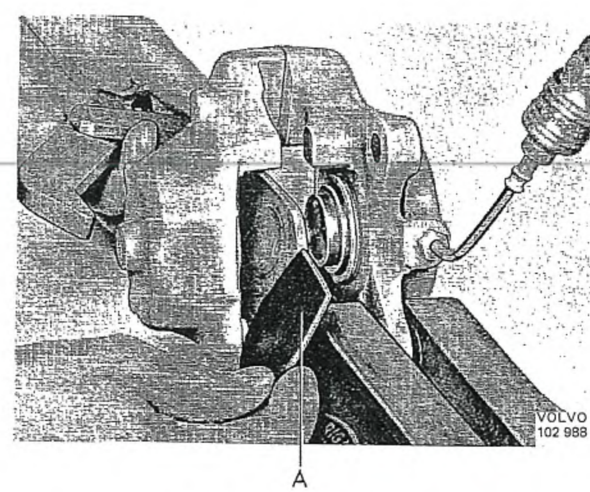


Fig. 5—28. Removing piston
A=rubber dust cover

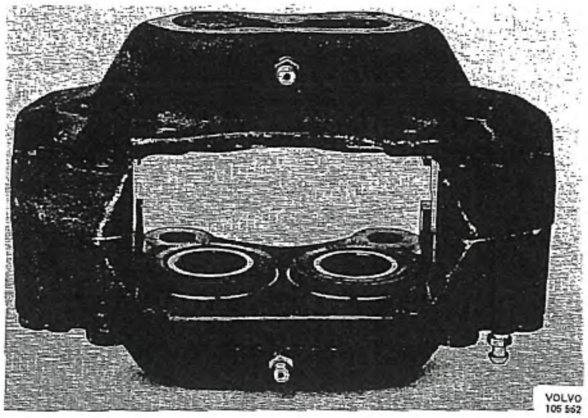


Fig. 5–29. Rear wheel brake caliper assembled

must be replaced complete. Inspect the other parts and replace any that are damaged or worn.
Check also the brake disc, see under "Brake Disc".

ASSEMBLING

1. Coat the working surfaces of the pistons and cylinders with brake fluid.
2. Fit new seals in the cylinders.
3. Fit one of the pistons into the caliper. Make sure that the piston is fitted in straight and is not scored.
4. Fit and test the other piston in the same way as above. Place the rubber dust covers on the piston and housing. Fit the retaining pins.
5. Fit the brake pads and the spacers. Place one of the retaining pins in position and fit the damping springs and then the other retaining pin. Fit the hairpin-shaped retaining clips. Check that the pads are movable.
6. Fit the bleeder nipple.

INSTALLING

1. Place the caliper in position. Check that the contact surfaces of the retainer are clean and not damaged. Check the location of the brake caliper in relation to the brake disc. Axial deviation is checked by measuring with a feeler guage on both sides of the disc the distance between disc and caliper support nib. The difference in measurement is max. 0.25 mm (0.010"). The caliper should be parallel with the disc. This is checked by measuring the distance to the upper and lower support nibs on the caliper. The location of the brake caliper can be adjusted with shims which are available in thicknesses of 0.6–1.8 mm (0.024–0.071"). Fit the attaching bolts after they have been coated with a couple of drops of Lock tite, type AV. Check that the brake disc rotates easily in the brake pads.
2. Connect the brake line, see Fig. 5–25. Remove the plug for the vent-hole in the brake fluid container cover.
3. Fit on the wheel after the contact surfaces have been cleaned of dirt, and then tighten the nuts sufficiently so that the wheel cannot be displaced on the hub. Remove the props. Lower the vehicle and tighten the wheel nuts. Tighten every other nut a little at a time, until all are finally tightened to a torque of 100–140 Nm (70–100 lbft).
4. Bleed the fitted brake caliper, see Group 52.

BRAKE DISC

The brake disc should be examined with regard to the friction surface, run-out and thickness.
Small marks on the friction surface or linings are of minor importance, but radial scoring reduces the braking effect and increases wear on the linings. The run-out must not exceed 0.1 mm (0.004") for the front wheel brakes and 0.15 mm (0.006") for the rear wheel brakes at the outer edge of the disc and is measured, for example, according to Fig. 5–30. Check first that the wheel bearings are correctly adjusted and that the disc fits securely on the hub.

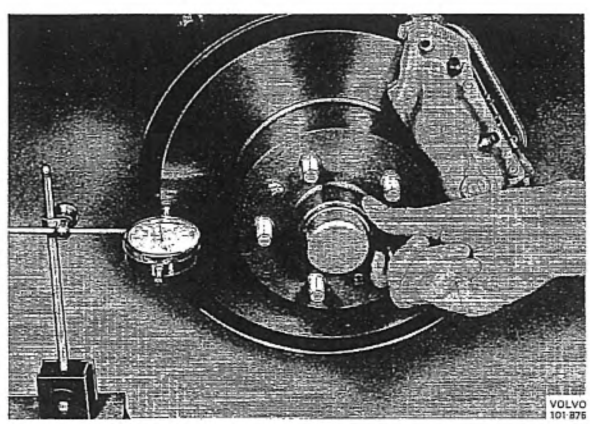


Fig. 5–30. Checking run-out

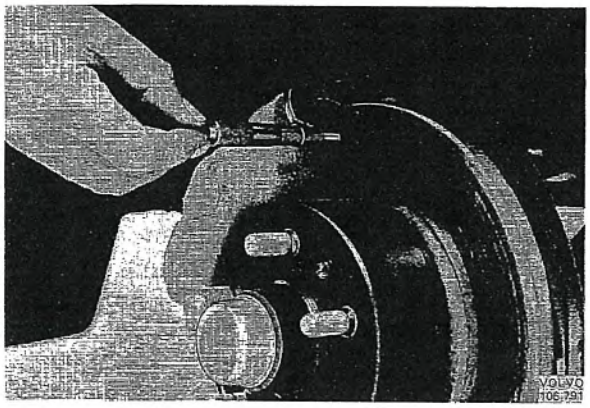


Fig. 5–31. Checking thickness

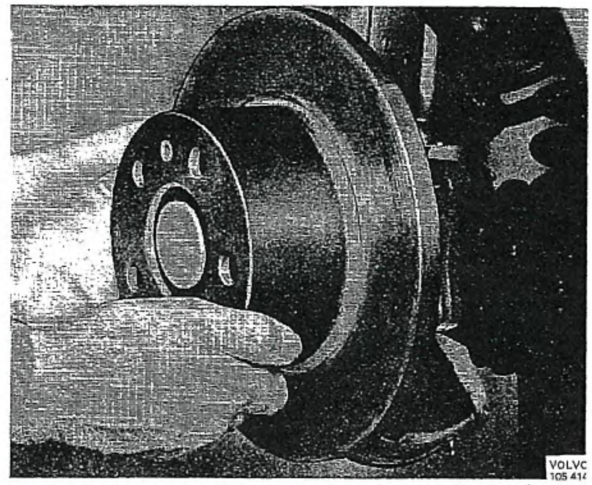


Fig. 5–32. Removing brake disc

The thickness is measured with, for example, a micrometer. It should not vary more than 0.03 mm (0.0012") when the disc is rotated one turn, since this can cause a vibrating brake pedal.
If a fault is discovered during the above-mentioned inspection, the brake disc should be replaced. When doing this, the brake caliper should first be removed. Then unscrew the lock bolts and lift off the brake disc, see Figs. 5–32 and 5–85. Tap on the inside of the disc with several light blows from a plastic hammer or similar tool. When fitting, check that the contact surface is clean.

If for any reason, a new brake disc is not available, the old one can be reconditioned by fine turning. Here accurate aligning of the disc is required and machining the thickness of the disc must not be less than 13.14 mm (0.17") for the front wheel brakes. The surface irregularity should be max. 3 μ measured on an arbitary diameter and max. 5 μ measured radially. After the reconditioning, the disc must not have a run-out of more than 0.1 mm (0.004") and its thickness must not vary more than 30 μm (0.0012").

HYDRAULIC FOOTBRAKE SYSTEM

DESCRIPTION

MASTER CYLINDER

The master cylinder is of the tandem type. Its construction is shown in Fig. 5—33 and its function is as follows:

When the system is at rest (Fig. 5—34), the pistons are kept pressed back by the force of the springs. When the pistons are in this position, the connections between the brake fluid container and wheel brake units are open. At the moment braking takes place, the primary piston (to the right) is pressed in by the piston rod. This closes the connection between the container and the wheel brake unit und the pressure in front of the piston rises. This pressure influences the secondary pistion so that it also is moved to the left. The same over-pressure arises in front of both pistons (Fig. 5—35), the brake fluid is forced out into the respective brake line and all the wheel brakes are applied, providing the system is functioning properly. If a leakage has occurred in the secondary circuit, no hydraulic counterpressure builds up in front of the secondary piston. Instead, this piston is moved inwards when the brakes are applied until it is stopped by the end of the cylinder (Fig. 5—36).

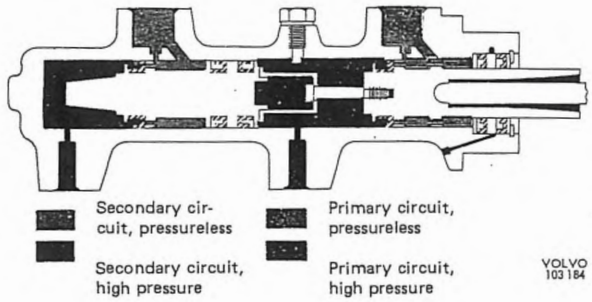


Fig. 5—35. Normal brake application

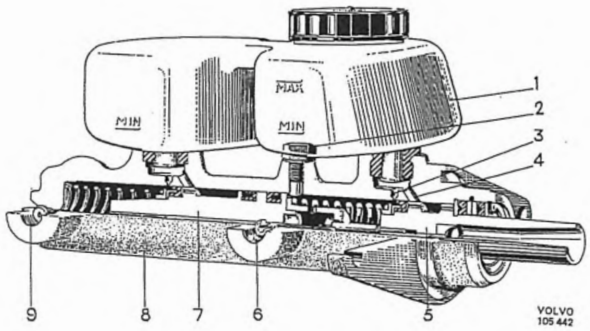


Fig. 5—33. Master cylinder

1. Container
2. Stop screw
3. Equalizing hole
4. Overflow hole
5. Connection for primary circuit
7. Secondary piston
8. Cylinder
9. Connection for secondary circuit

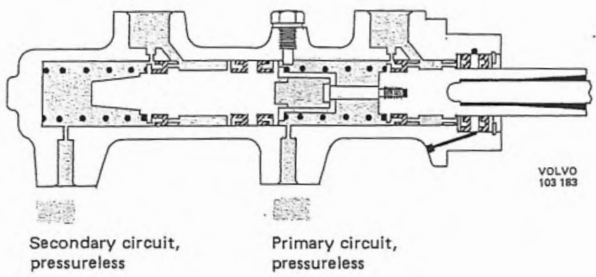


Fig. 5—34. Rest position

1and 2. Connection for brake fluid container

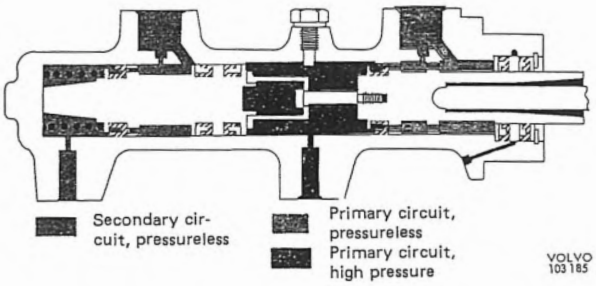


Fig. 5—36. Brake application with leakage in secondary circuit

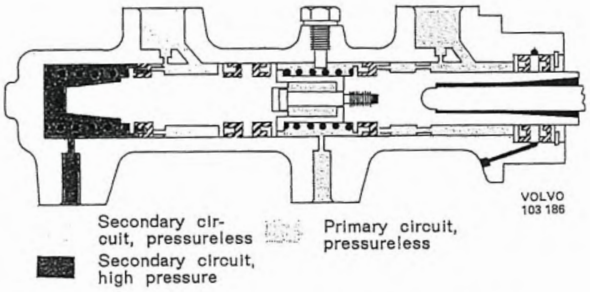


Fig. 5—37. Brake application with leakage in primary circuit

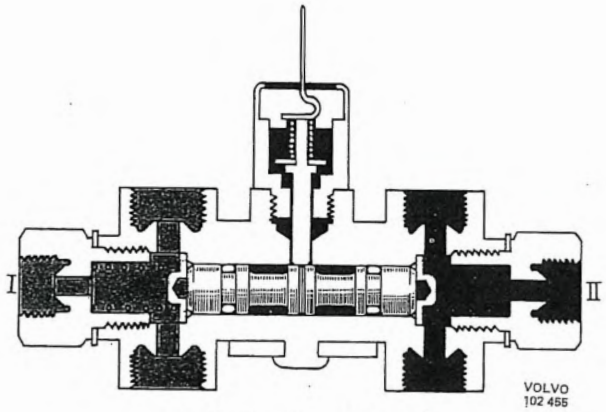


Fig. 5—39. Normal position

The hydraulic pressure between the pistons can then rise and apply the brakes in the primary circuit. If leakage occurs in the primary circuit, the primary piston is moved and the brakes are applied until the primary piston makes contact with the secondary piston. Both pistons are then pressed inwards, the pressure in front of the secondary plunger rises and the brakes in the secondary circuit are applied (Fig. 5—37).

WARNING VALVE

A warning valve is connected between the brake lines from the master cylinder and the six-branch union. Its function is to warn the driver when the pressure difference between the two brake circuits exceeds about 10 kp/cm^2 (142 psi). The valve construction is shown in Fig. 5—38 and it operates as follows:

If there is no fault in the circuits and the brakes are applied, the hydraulic pressure on the pistons is largely the same on both sides (Fig. 5—39). But should, for example, the pressure in the secondary circuit be somewhat higher than in the primary circuit, this will try to displace the pistons to the right in the figure. This lifts the thrust washer (11) and the pressure of the spring (9) counteracts the displacement.

It is only when the pressure in the secondary circuit first exceeds that in the primary circuit by about 10 kp/cm^2 (142 psi) that the pistons are pushed so far to the right that the guide pin (4) can be pressed downwards. When this happens, the switch washer (2) reaches the housing (3) and current is cut in (Fig. 5—40). The guide pin is prevented from returning to its normal position until the fault has been rectified and the warning switch removed.

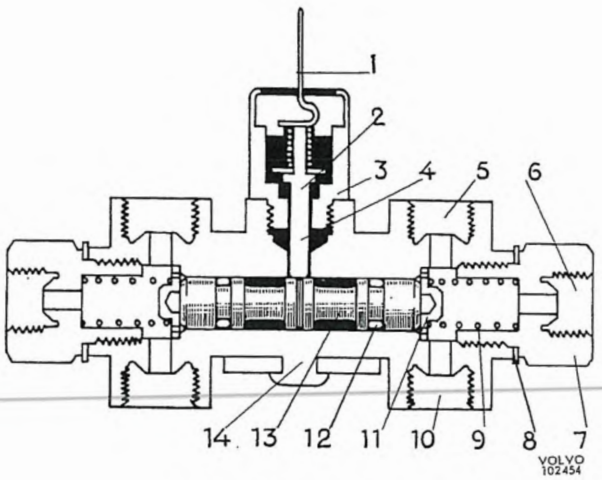


Fig. 5—38. Warning valve

1. Electrical connection
2. Switch washer
3. Switch housing
4. Guide pin
5. Connection, rear wheel brakes
6. Connection, master cylinder
7. End piece
8. Sealing washer
9. Spring
10. Connection, front wheel brakes
11. Thrust washer
12. O-ring
13. Piston
14. Housing

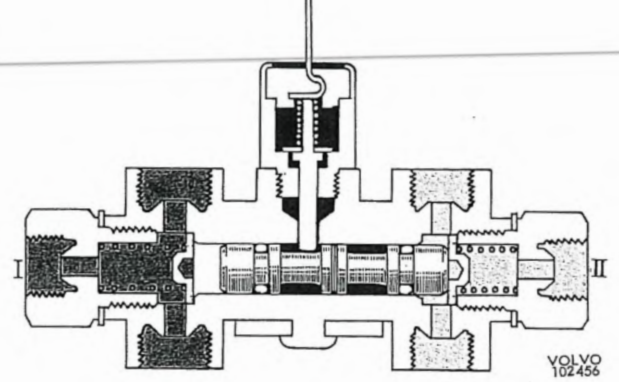


Fig. 5—40. Warning position

BRAKE VALVE

A brake valve is connected to each of the rear wheel brake lines, see Fig. 5–6. When the ingoing brake pressure exceeds 34 kp/cm^2 (484 psi) a reduction takes place in the valve. The more powerful the pedal pressure, the greater will be the reduction and thereby the larger the difference between the hydraulic pressure in the front wheel and rear wheel cylinders. This results in a suitable distribution of braking force between both pairs of wheels. The construction of the brake valve is shown in Fig. 5–41 and its function is the following.

When the footbrakes are applied, the pressure from the master cylinder is transmitted via the connection (7, Fig. 5–41). The pressure then proceeds through the cylinder (6), the counterbore, past the valves (17) and (4) to cylinder (3) and then on through connection (19) to the rear wheel brake cylinders, see Fig. 5–42. The hydraulic pressure per unit surface is equal on the different parts of the piston (21), but since the pressure surface is larger in cylinder (3) than in cylinder (6), the force developed will move the piston to the right of the figure. However, this is counteracted by the pressure from the spring (10).

When the hydraulic pressure approaches 34 kp/cm^2 (484 psi) the spring pressure is overcome and the piston (21) is moved to the right. By means of pressure from the valve spring (5), the valve (4) shuts off the connection between the two cylinders and forms two separate systems, one for the front wheels and one for the rear wheels.

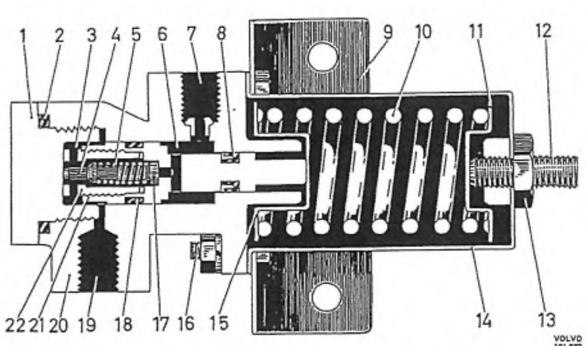
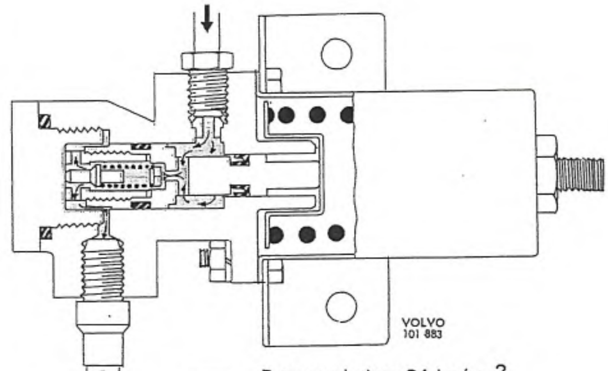


Fig. 5–41. Brake valve, construction

1. Plug.
2. O-ring
3. Cylinder
4. Valve
5. Valve spring
6. Cylinder
7. Connection to master cylinder
8. Piston gasket
9. Bracket
10. Spring
11. Retainer
12. Adjusting screw
13. Locknut
14. Spring housing
15. Retainer
16. Bolt
17. Equalizing valve
18. O-ring
19. Connection to rear wheel brake cylinders
20. Housing
21. Piston
22. Valve housing

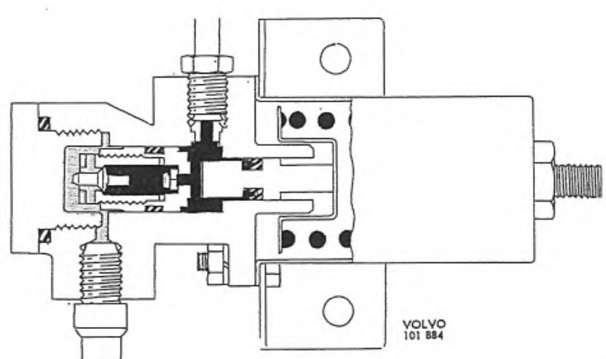


Pressure below 34 kp/cm^2 (484 psi)

Fig. 5–42. Brake application

With continued increase in pressure in the master cylinder and front wheel cylinders, the hydraulic force in cylinder (6) moves the piston to the left so that the valve rod comes up against its stop and opens the valve, this causing the pressure in cylinder (3) to increase. Due to the larger pressure surface in this cylinder, the piston is moved to the right again and the valve closes. In this way, the piston assumes a position of balance and the outgoing pressure from the brake valve will be lower than the ingoing pressure, see Fig. 5–42. The difference in these pressures is determined by the different areas and spring tension.

When the brake pedal is released, the pressure in the cylinder (6) falls. The piston (21) is moved to the right by spring (10). When the pressure on the right-hand side of the valve (4) falls so much that the hydraulic pressure on the left-hand side enables the valves to be actuated, the connection between both the cylinders is opened again. As the pressure falls, spring (10) presses the left piston back to its original position where the valve is held in the open position by mechanical means, see Fig. 5–41. The equalizing valve (17) is fitted with control channels which ensure an even flow of pressure through the valve.



Reduced pressure

Pressure above 34 kp/cm^2 (484 psi)

Fig. 5–43. Reducing action

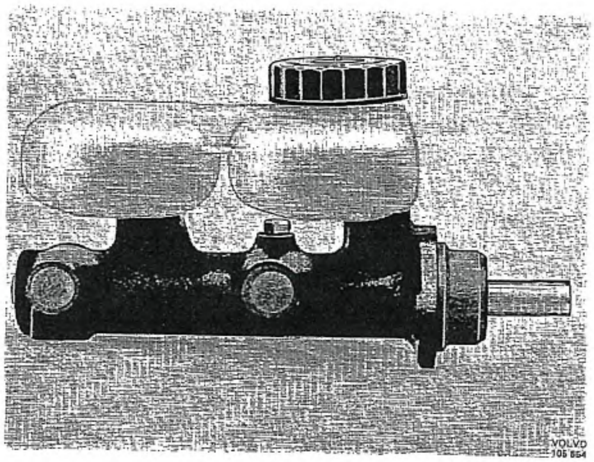


Fig. 5—44. Master cylinder removed

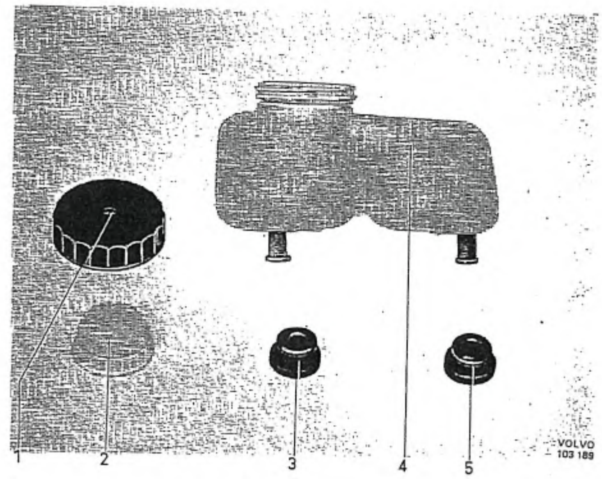


Fig. 5—46. Container parts

1. Filler cap
2. Strainer
3. Rubber seal
4. Container
5. Rubber seal

MASTER CYLINDER

With regard to repair work on the hydraulic system, the instructions given under "Cleaning" and "Brake Fluid", Group 50, should be observed. When the master cylinder is removed, the brake pedal should not be depressed because this would displace the parts of the servo cylinder and might cause damage.

REMOVING

1. Place a cover over the mudguard and rags under the master cylinder in order to avoid possible damage to the paintwork should the brake fluid spill over.
2. Remove the lines from the master cylinder and fit plastic plugs as the lines are disconnected.
3. Remove the two attaching nuts for the master cylinder and lift the cylinder forwards, see Fig. 5—44. Empty out the brake fluid.

DISMANTLING

1. Fix the flange of the master cylinder firmly in a vice, see Fig. 5—45.
2. Place both hands under the container and pull it up from the rubber seals. Remove the filler cap and strainer from the container and also the rubber seals from the cylinder, see Fig. 5—46.
3. Unscrew the stop screw (Fig. 5—47). Remove the circlip from the primary piston with the help of circlip pliers. Remove the pistons.

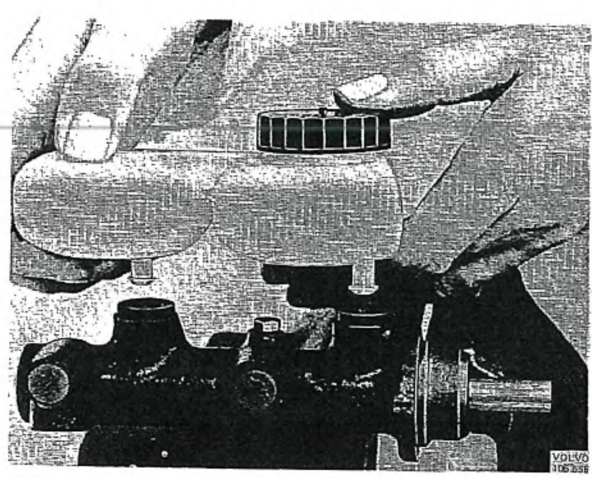


Fig. 5—45. Removing container

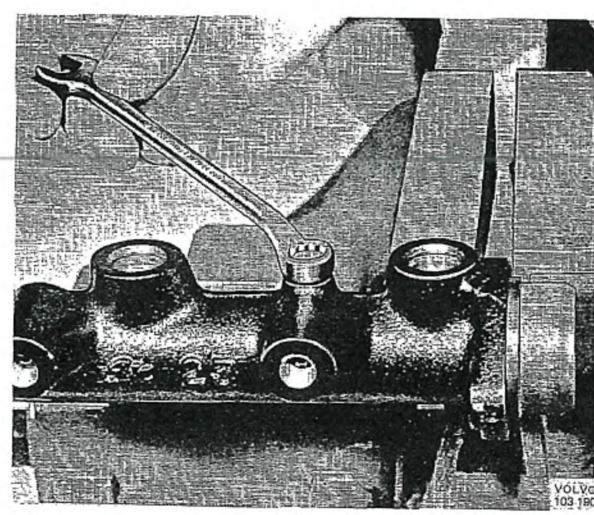


Fig. 5—47. Removing stop screw

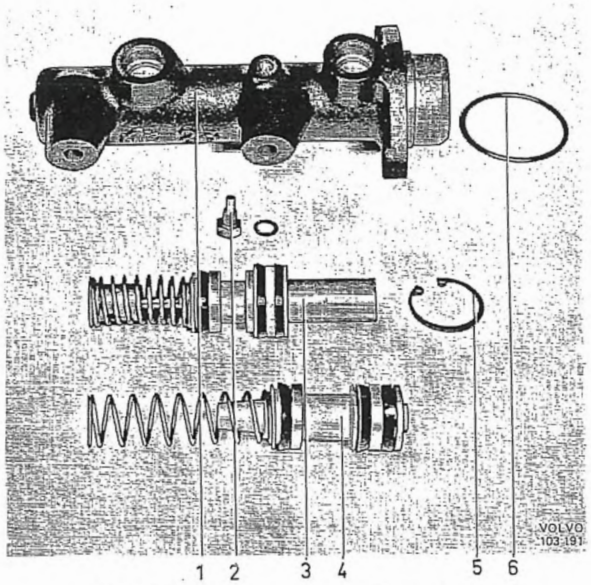


Fig. 5–48. Master cylinder disassembled

1. Cylinder housing	4. Secondary piston
2. Stop screw	5. Circlip
3. Primary piston	6. Sealing ring

INSPECTING

Before inspecting, clean all the parts according to the instructions given under "Cleaning", Group 50. Examine the inside of the cylinder carefully. If there are any scores or scratches, the cylinder should be replaced. Rust and similar damage can as a rule be eliminated by honing the cylinder. The procedure for this varies with different makes of tools so that no general description can be given. Follow, therefore, the instructions of the manufacturer. Clean the cylinder carefully after honing and check that the holes are clear.

If wear on the cylinder or secondary piston is suspected, the diameter should be measured with a micrometer or indicator. The cylinder bore must not exceed 22.40 mm (0.881") and the diameter of the piston may not be less than 22.05 mm (0.870"). Each time reconditioning is carried out, replace the primary piston (3, Fig. 5–48) and the secondary piston (4, Fig. 5–48) complete as well as the stop screw (2) with washer and circlip (5), also the sealing ring (6). Moreover, the rubber seals (Fig. 5–46) for the container should be replaced.

ASSEMBLING

1. Fit the thin washer (5, Fig. 5–49), the seal (4) and the back-up ring (3) on the secondary piston. Fig. 5–49 shows how the parts are located.

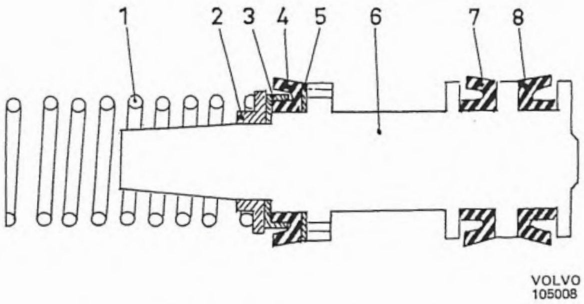


Fig. 5–49. Secondary piston

1. Spring	5. Washer
2. Thrust washer	6. Piston
3. Back-up ring	7. Piston seal
4. Piston seal	8. Piston seal

2. Coat brake fluid on the cylinder and dip the piston and seals in brake fluid before fitting. Fit the spring (1) and thrust washer (2) on the secondary piston and fit the piston, see Fig. 5–50. Observe care when inserting the seals in the cylinder.
3. Fit the thin washer (7, Fig. 5–51), seal (6) and back-up ring (5) on the primary piston. Fig. 5–51 shows how the parts should be located. Fit the spring (2) with spring plate (4) and sleeve (1) on the primary piston. Compress the spring and tighten the screw (3) to the bottom. The tightening torque is 2–3 Nm (1.5–2.2 lbft).
4. Fit the washer (9), seal (10), plastic washer (11), seal (12) and washer (13) on the primary piston.
5. Dip piston and seals in brake fluid and observe care when fitting the parts in the cylinder, see Fig. 5–52. Fit the circlip (14, Fig. 5–51) in position. Fitting of the parts is made easier if the primary piston is held pressed in with the help of a 3 mm (1/8") drift through the overflow hole or with the help of a clamp.

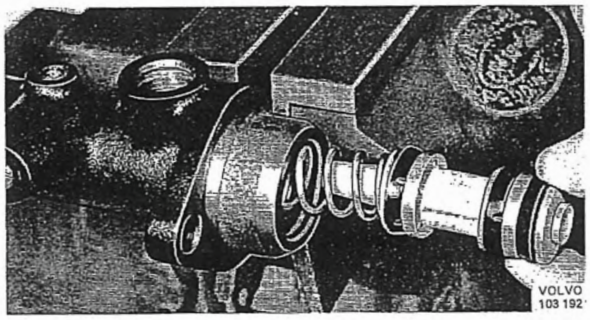


Fig. 5–50. Fitting secondary piston

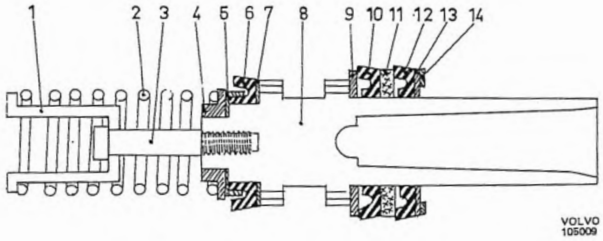


Fig. 5–51. Primary piston

1. Sleeve
2. Spring
3. Screw
4. Spring plate
5. Back-up ring
6. Piston seal
7. Washer
8. Piston
9. Washer
10. Piston seal
11. Plastic washer
12. Piston seal
13. Washer
14. Circlip

6. Check that the hole for the stop screw is not blocked and fit the screw with a new sealing washer. The tightening torque is 5–8 Nm (3.5–6.0 lbft).
7. Check the movement of the pistons and that the through-flow holes are not blocked. The equalizing holes are checked by inserting a soft copper wire, diameter 0.5 mm (25 s.w.g.), see Fig. 5–53. If an equalizing hole is not clear, this means that the master cylinder is generally wrongly assembled.
8. Fit the brake fluid container parts with new seals. Check to make sure that the vent-hole in the cap is open and fit the strainer and cap in position.

FITTING

1. Place the sealing ring (6, Fig. 5–48) on the master cylinder. Fit the cylinder in position and then the washers together with the attaching nuts. The tightening torque for the nuts is 12–15 Nm (8.7–10.8 lbft).

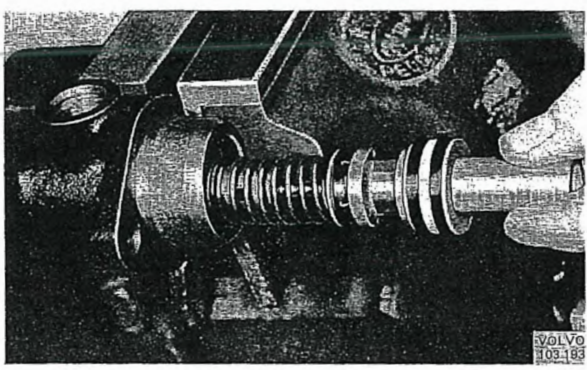


Fig. 5–52. Fitting primary piston

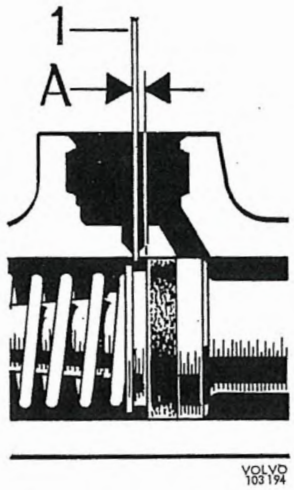


Fig. 5–53. Checking equalizing hole

1. 0.5 mm (25 s.w.g.) soft wire
A = Clearance between washer and seal (Approx. 0.5 mm = 0.02")

2. Connect up the lines, see Fig. 5–54. Depress the pedal and tighten the nuts for the lines when fluid free from air bubbles forces its way out.
3. Bleed the entire brake system.

WARNING VALVE

NORMALIZING PISTONS

1. Disconnect the electric cable and screw out the warning switch (Fig. 5–55) so that the pistons return to normal position.

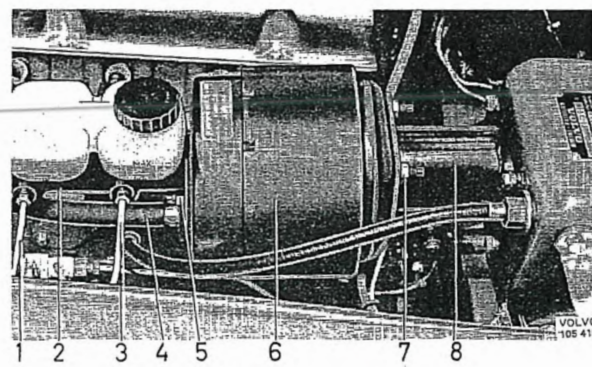


Fig. 5–54. Brake parts

1. Brake line, secondary circuit
2. Master cylinder
3. Brake line, primary circuit
4. Vacuum hose
5. Attaching nut, master cylinder
6. Power cylinder
7. Attaching nut, power cylinder
8. Bracket

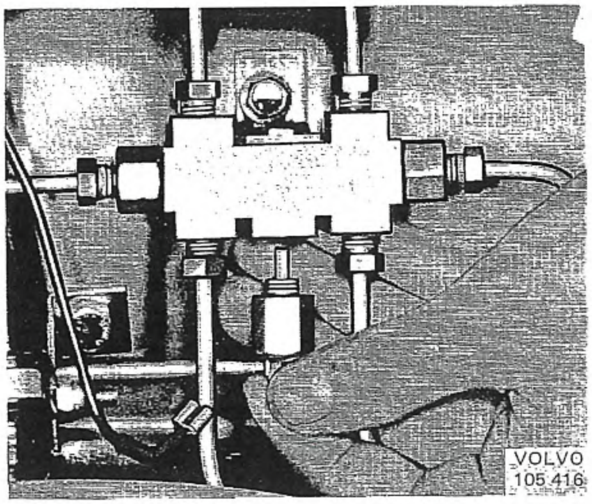


Fig. 5–55. Removing warning switch

2. Repair and bleed the faulty hydraulic circuit.
3. Screw in the warning switch and tighten it to a torque of 14–20 Nm (10–14 lbft). Connect the electric cable.

REPLACING WARNING VALVE

1. Disconnect all connections. Remove the attaching nut and then the valve.
2. Install the new valve in reverse order to removal. Fig. 5–56 shows the various connections.
3. Bleed the brake system.

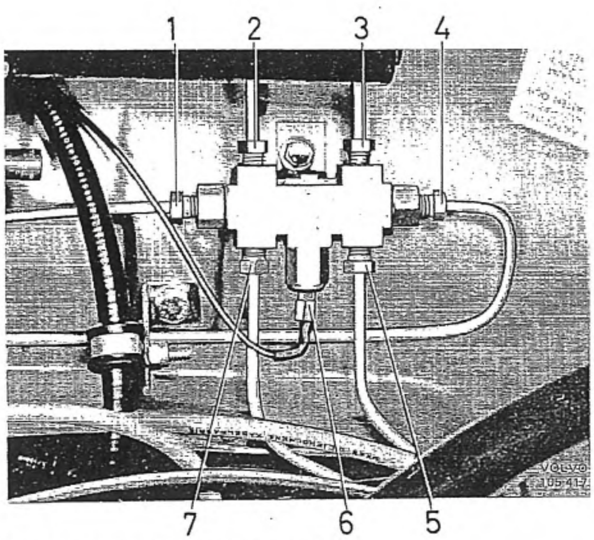


Fig. 5–56. Warning valve fitted

1. Primary line, rear wheels
2. Primary line, master cylinder
3. Secondary line, master cylinder
4. Primary line, rear wheels
5. Secondary line, front wheels
6. Electric cable
7. Primary line, front wheels

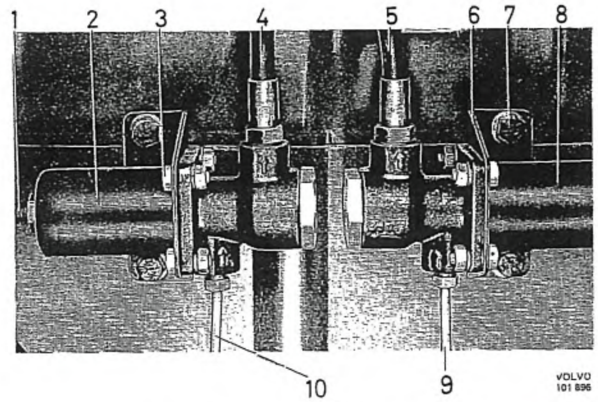


Fig. 5–57. Brake valves fitted

1. Adjusting screw
2. Left brake valve (secondary circuit)
3. Bolt (assembling)
4. Brake hose to left rear wheel
5. Brake hose to right rear wheel
6. Bracket
7. Attaching screw
8. Right brake valve
9. From the master cylinder primary circuit
10. From the master cylinder secondary circuit

BRAKE VALVES

REMOVING

Unscrew and plug the connection of the brake pipe (10, Fig. 5–57). Slacken the brake hose (4) a max. 1/4 turn at the valve. Remove the attaching screw and unscrew the valve from the brake hose, see Fig. 5–58.

RECONDITIONING

1. Separate the spring housing from the hydraulic part by removing the four bolts (16, Fig. 5–41). Shake out the springs and container. **The adjusting screw must not be removed.**

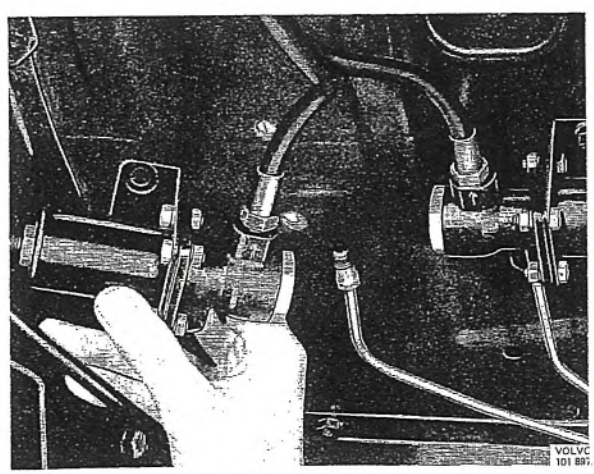


Fig. 5–58. Removing brake valve

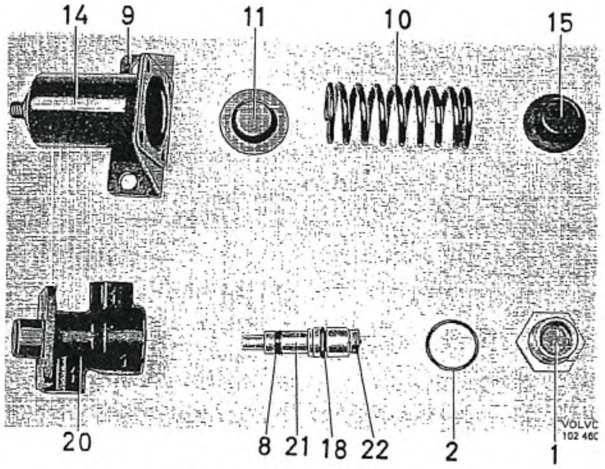


Fig. 5—59. Brake valve disassembled

1. Plug
2. O-ring
8. Piston seal
9. Bracket
10. Spring
11. Retainer
14. Spring housing
15. Retainer
18. O-ring
20. Housing
21. Piston
22. Valve housing

2. Screw out the plug (1) and press out the piston complete, see Fig. 5—59.
3. Clean the hydraulic part, see under the heading "Cleaning", Group 50.
4. Inspect the parts. If the cylinder surfaces are scratched or damaged by rust, the valve should be replaced complete. However, if the cylinder surfaces are not damaged, replace only the piston complete. When doing so, check that the seal is facing in the direction shown in the Fig. 5—60.
5. Fit the piston (21) complete after having coated it with a brake fluid or a light layer of brake paste. Screw in the plug (1) together with the O-ring (2). The tightening torque is 100—120 Nm (70—85 lbft).
6. Place the retainer (11) in the housing (14) and turn it according to Fig. 5—41. Place the retainer (15) in the spring (10) and insert it in position in the housing. Now fit the housing to the hydraulic part with the help of bolts, washers and nuts.

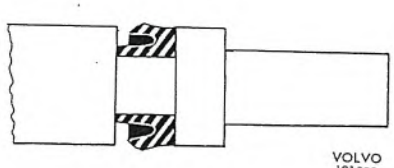


Fig. 5—60. Piston seal

INSTALLING

Screw the brake valve on to the brake hose, see Fig. 5—58. Place the valve in position and check that there is no tension in the hose. Fit the attaching bolts and connect up the brake pipe. Tighten the connections. Bleed the brake system.

ADJUSTING

The adjusting screw (12, Fig. 5—41) is not intended for adjusting in the normal meaning of the word. Its function is to balance the variations in the manufacturing. The carefully checked adjustment made at the initial assembling is generally sufficient for the entire lifetime of the valve. **For this reason, the adjusting screw must not be touched.**

If, after reconditioning, it has been established with the help of testing according to "Fault Tracing", paragraph 9, Group 50, that the outgoing pressure lies outside the limit values, an adjustment can be made with the adjusting screw. Turning the screw clockwise increases the outgoing pressure. Lock the screw finally after turning. The tightening torque for the locknut is 25—35 Nm (18—25 lbft). The adjustment may only be carried out after reconditioning.

BRAKE LINES

CLEANING

The brake lines can be cleaned by flushing them with brake fluid or spirit and then by blowing them clean with moisture-free filtered compressed air. The purpose of this is to remove all brake fluid and dirt particles and should be carried out in connection with the complete reconditioning of the hydraulic system and a new fitting.

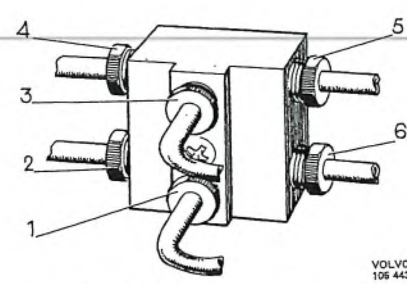


Fig. 5—61. 6-branch union

1. Secondary circuit from warning valve
2. Secondary circuit, left front wheel
3. Primary circuit from warning valve
4. Primary circuit, left front wheel
6. Secondary circuit, right front wheel

When complete reconditioning is being carried out, the brake service unit (see Group 50) can suitably be connected to the master cylinder and then the system emtied through the bleeder nipples. The system should therefore be flushed with spirit, after which it should be blown clean with compressed air. When such a reconditioning has been carried out, the components of the hydraulic system should be taken out and checked to ensure that any diret and flushing fluid have been effectively removed.

NOTE. With regard to requirements concerning the cleaning agent, see the general instructions, Group 50. Do not top up with brake fluid which has been drained from the system.

REPLACING BRAKE LINES

If leakage occurs, or if the brake lines have been exposed to such external damage that leakage or blockage can result, the damaged lines should be replaced according to the instructions given below.

1. To prevent unnecessary spilling of brake fluid, the existing filler cap on the master cylinder container should be temporarily replaced with one without a vent-hole.
2. Clean round the connections and remove the damaged brake line.
3. Take a completely new brake line, blow it clean internally with moisture-free filtered compressed air and fit it. Make sure that the brake line lies in such a position that it does not chafe while driving. Particularly important points are where the pipes pass the steering rod, where they must not come nearer than 10 mm (3/8"). If a pipe is not bent correctly, it should be adjusted manually before being fitted.
   Bending a pipe already connected often results in deformation at the connections. Do not forget the clips.
4. Bleed the brake system according to the instructions given below. Fit the filler cap with vent-hole on the container.

BLEEDING HYDRAULIC SYSTEM

An indication that there is air in the system is that the brake pedal can be depressed without any appreciable resistance, or if it feels spongy.

As soon as any part of the system has been removed, bleeding must be carried out. Air can also enter the system if there is too small a quantity of brake fluid in the container. If, for example, only a wheel brake unit has been removed, it is usually sufficient just to bleed this. If on the other hand, the master cylinder or its lines have been removed, the entire brake system must be bled.

When bleeding or other similar work is being carried out, no brake fluid must be permitted to get on to friction surfaces or linings. Do not spill any fluid on the paintwork as this may damage it. If the vehicle is to be placed on props during the bleeding, the rear end should be somewhat higher than the front end.

When filling with oil observe the following: The brake fluid must meet the requirements according to SAE J 1703. Brake fluid with the designation DOT 3 or DOT 4 can also be used. **Brake oil which has been bled out of the system must under no circumstances be put back into the bleeder unit or the container.**

BLEEDING WITH BLEEDER UNIT

1. Check to make sure there is full return on the brake pedal and that neither mats nor suchlike prevent full travel (about 150 mm = 6") from being utilized during the bleeding. Depress the brake pedal several times to even out any partial vacuum in the power cylinder and in this way disconnect it.

Fig. 5–62. Pedal travel
A = approx. 150 mm (6")

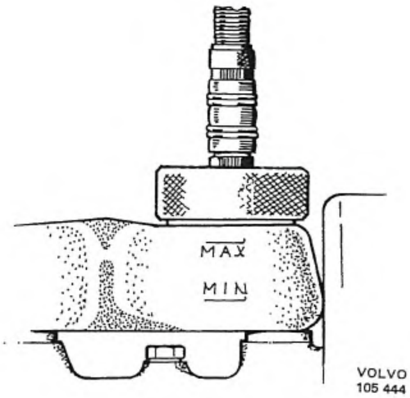


Fig. 5–63. Connecting unit

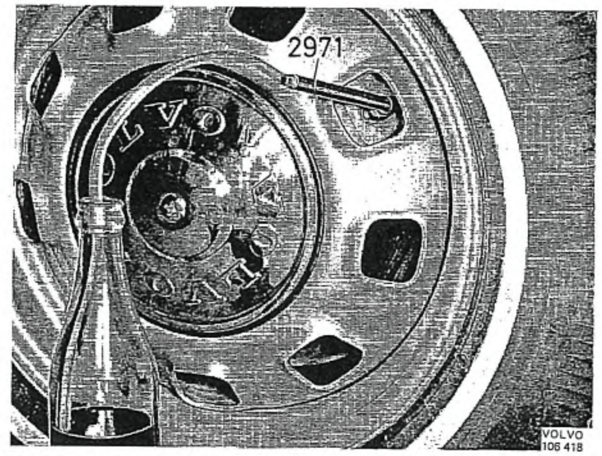


Fig. 5–65. Bleeding front wheel brake unit

2. Remove the electric switch from the warning valve.
3. Clean round the cap on the brake fluid container. If necessary fill the container with brake fluid up to the "Max." mark.
4. Fit on the container a cap specially used when bleeding, see Fig. 5–63. Connect the bleeder unit according to the instructions of the manufacturer. The working pressure is 2 kp/cm² (28.4 psi). The type of bleeder unit which may be used is shown in Fig. 5–5.
5. Bleeding should take place in the order shown in fig. 5–64. Note that the bleeder nipple should be opened max. half a turn in order to prevent air from sneaking in via the threads of the nipple. When bleeding, remove the protective cap and fit the bleeder tool 2971. See Figs. 5–65 and 5–66. Let the other end of the hose hang down into a collecting vessel. Open the bleeder nipple and have someone carefully depress the brake pedal. Close the nipple when brake fluid free from air dubbles flows out. Make sure there is no leakage between the nipple and the tool, as this can give rise to misleading results.
6. Repeat the bleeding so that both circuits are bled at least twice. Refit the protective caps on the nipples.
7. Remove the hose to the brake fluid container and release air to the unit. Remove the cap on the container. Blow clean the vent-hole on the standard cap and refit this on the container.

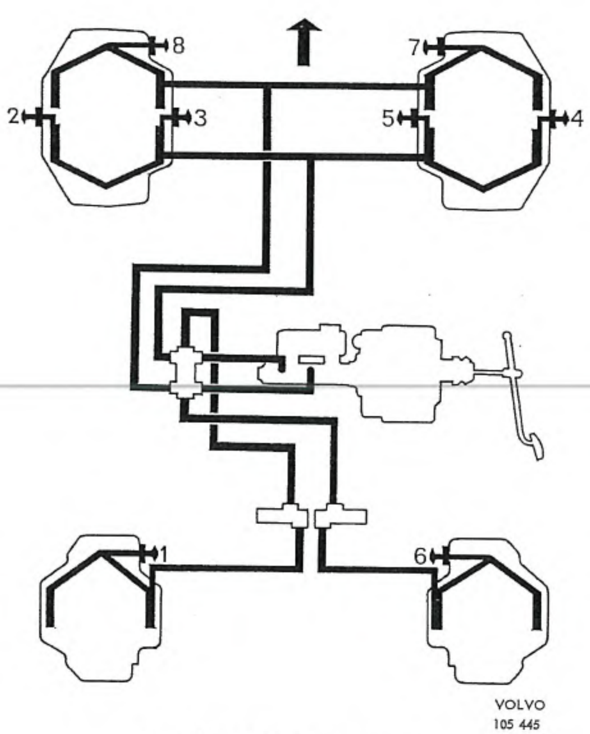


Fig. 5–64. Bleeding diagram

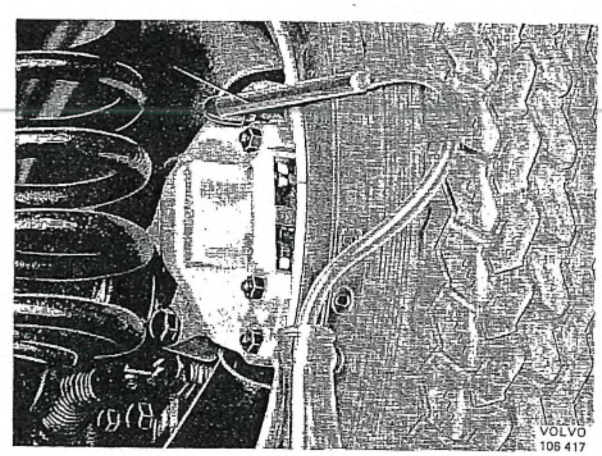


Fig. 5–66. Bleeding rear wheel brake unit

8. Fit the warning switch and tighten it to a torque of 14–20 Nm (10–15 lbft). Connect the electric cable. Check that the warning lamp lights only when the parking brake is applied.

MECHANICAL BLEEDING

1. Check that there is full travel on the brake pedal (about 150 mm = 6", measurement A, Fig. 5–62).
2. Remove the electric switch from the warning valve.
3. Clean round the cap on the brake fluid container. Blow clean the vent-hole in the cap. If necessary, fill the container with brake fluid up to the "Max." mark. To prevent air forcing its way in through the brake fluid container, the oil level in the container must not go below the "Min." mark.
4. Required for the bleeding is a plastic hose which can be pressed on to and sealed round the bleeder nipple. The lower end of the hose should be extended by means of a glass or plastic tube. Also required is a glass bottle filled with so much brake fluid that the opening of the pipe can be kept under the surface in order to prevent air from being sucked into the system. To turn the nipple use a 5/16" ring spanner. New brake fluid must be available so that the container can be gradually filled. The level must not go below the "Min." mark since this would allow air to penetrate into the system via the container.
5. Bleeding should be carried out in the order shown in Fig. 5–64 and as follows:
   Remove the protective cap and fit the ring spanner and plastic hose on to the bleeder nipple. Allow the opening of the pipe to hang bottle, see Fig. 5–67. Open the bleeder nipple at the most half a turn. Slowly press the brake pedal down to the bottom. When the pedal reaches the bottom, pause a little and then quickly release the pedal. Repeat this procedure until brake fluid free from air bubbles flows out. Then press the pedal to the bottom and close the bleeder nipple.
6. Repeat the bleeding so that both the circuits are bled at least twice. Refit the protective caps on the nipples.
7. Fill the container with brake fluid up to the "Max." mark.
8. Fit the warning switch and tighten it to a torque of 14–20 Nm (10–15 lbft). Connect the electric cable. Check that the warning lamp lights only when the parking brake is applied.

ADJUSTING BRAKE LIGHT SWITCH

Check the distance from the brass hub on the brake light switch to the brake pedal, see Fig. 5–68, when the brake pedal is released. The distance should be 4±2 mm (0.16±0.08"). To adjust, slacken the screw for the bracket. Remember to tighten the screw after adjusting.

REPLACING BUSHES IN BRAKE PEDAL AND LEVER

1. Remove the brake light switch in order not to damage it.
2. Remove the split pin bolt (14, Fig. 5–69) and unhook the return spring (11).
3. Remove the bolt (9) and pull forward the pedal.
4. Remove the bolts (1 and 5) and pull forward the link system.

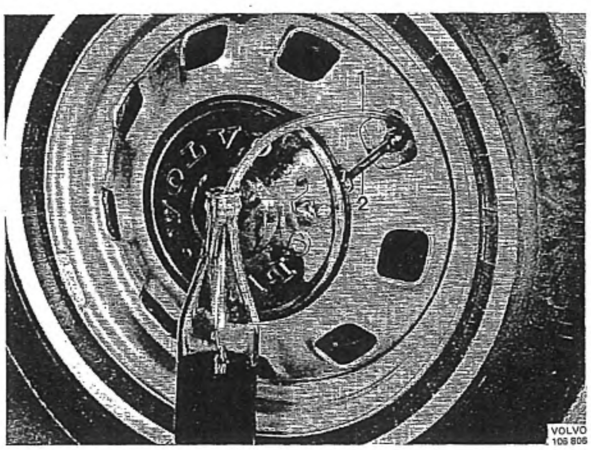


Fig. 5–67. Mechanical bleeding
1. Plastic hose   2. Bleeder tool 2971

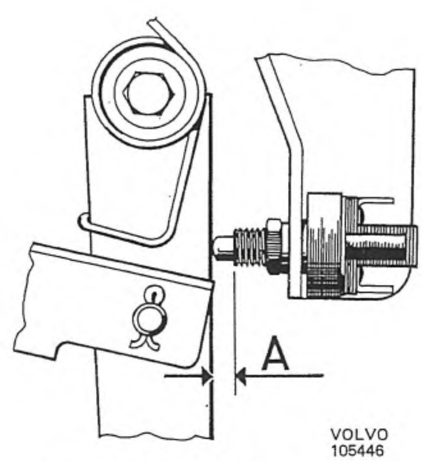


Fig. 5–68. Adjusting brake light switch
A = 2–6 mm (0.08–0.24")

5. Press out the bearing sleeves (3 and 12) and the bushes (2 and 10).
6. Clean the parts and replace those that are worn.
7. Press in the new bushes and lubricate them with universal grease. Fit the bearing sleeves.
8. Fit the double lever (17) and thrust link (15) in position in the vehicle. Fit the bolts (1 and 5) and nuts.
9. Place the pedal with return spring in position and fit the bolt (9) and nut. Hook on the return spring and fit the split pin bolt (14).
10. Fit the brake light switch and adjust its location if necessary, see under "Adjusting brake light switch".

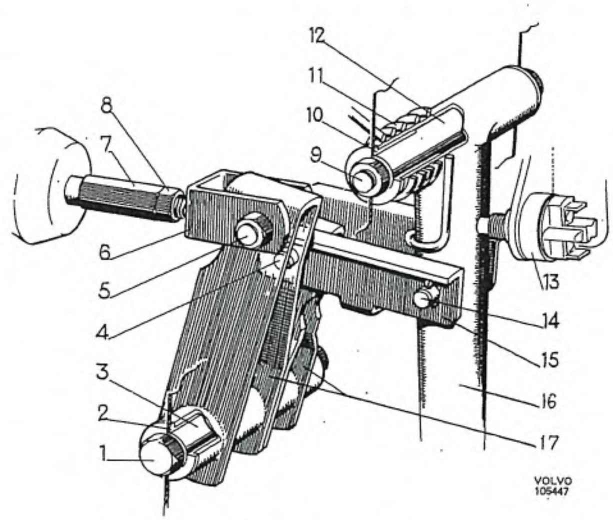


Fig. 5–69. Brake pedal suspension

1. Bolt
2. Bush
3. Bearing sleeve
4. Split pin bolt
5. Bolt
6. Yoke
7. Thrust rod
8. Locknut
9. Bolt
10. Bush
11. Spring
12. Bearing sleeve
13. Brake light switch
14. Split pin bolt
15. Thrust link
16. Brake pedal
17. Double lever

AUXILIARY BRAKE SYSTEM

DESCRIPTION

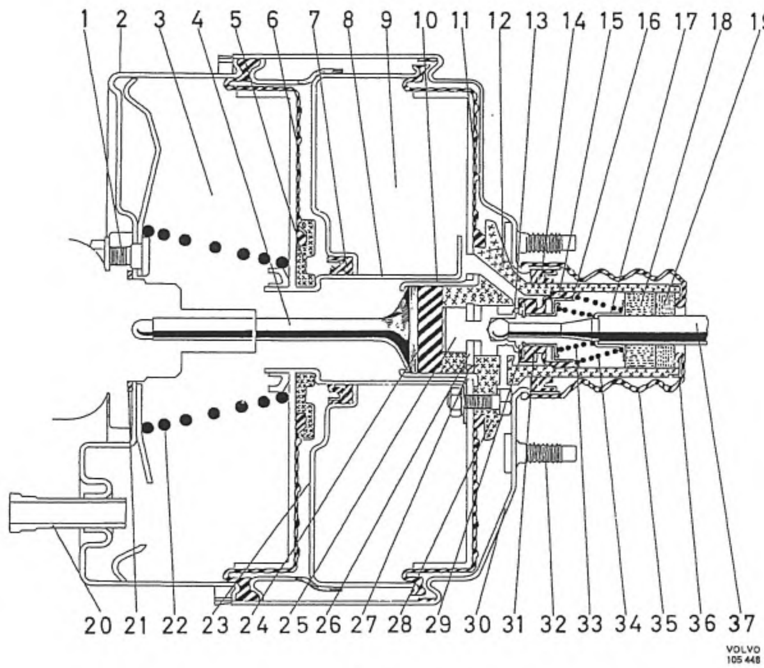


Fig. 5–70. Power cylinder

1. Attaching bolt for master cylinder
2. Cylinder
3. Front vacuum chamber
4. Front thrust rod
5. Retainer
6. Diaphragm
7. Sealing ring
8. Guide sleeve
9. Rear vacuum chamber
10. Retainer
11. Diaphragm
12. Guide housing
13. Valve piston seal
14. Sealing ring
15. Seal
16. Guide
17. Retainer
18. Filter
19. Silencer
20. Vacuum inlet
21. Sealing ring
22. Return spring
23. End
24. Reaction disc
25. Valve piston
26. Stop washer
27. Washer
28. Guide housing
29. Valve guide
30. End
31. Valve plate
32. Attaching screw
33. Valve spring
34. Return spring
35. Rubber spring
36. Washer
37. Rear thrust rod

POWER CYLINDER

This is a mechanical tandem-type power device located between the brake pedal and the master cylinder, see Fig. 5–6. Due to the power cylinder, which is assisted by vacuum from the engine inlet duct, less pedal pressure is required when braking. The construction as well as the designation and location of the parts are shown in Fig. 5–70. The power cylinder functions as follows.

When the system is at rest, the parts of the power cylinder are in the position shown in Fig. 5–71. The thrust rod spring holds the thrust rod and the valve piston flexibly connected to it pressed to the right. Movement is limited by the stop plate. In this position, the valve plunger keeps the valve lifted from the seat in the guide housing, and this closes the air channel and opens the vacuum channel. Thus an equivalent vacuum exists on both sides of the

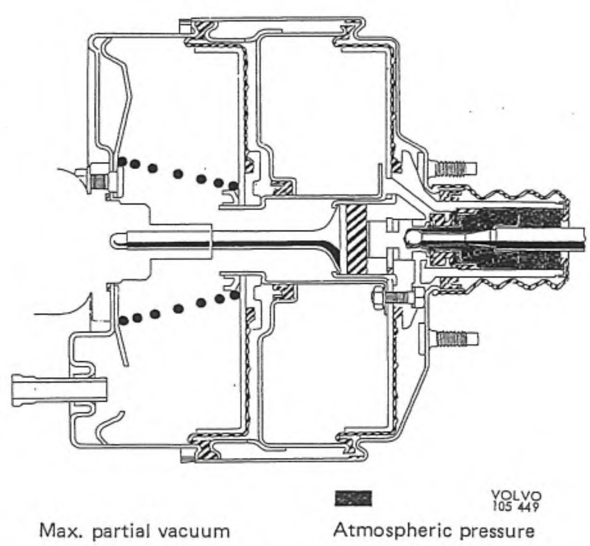
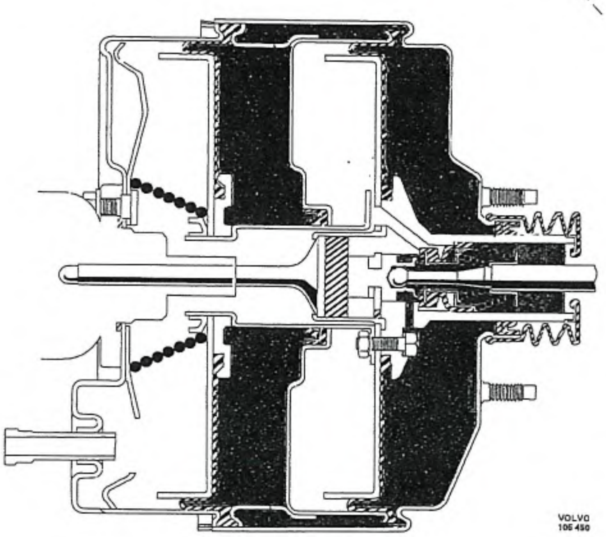


Fig. 5–71. Rest position



Max. partial vacuum

Atmospheric pressure

Fig. 5–72. Full brake application

diaphragm which, together with the guide housing, is held pressed to the right end position of the diaphragm spring.

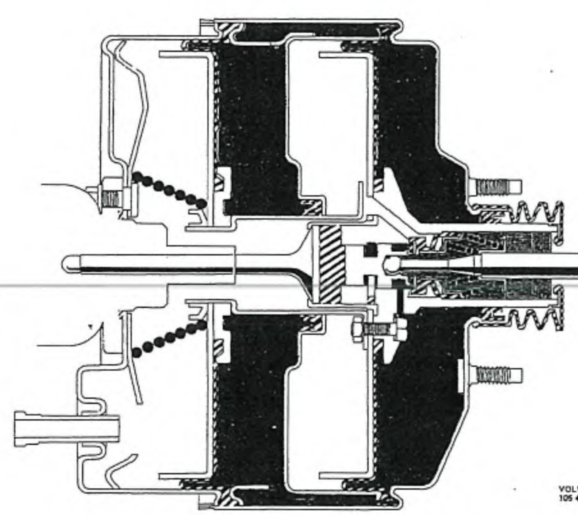
When the brake pedal is depressed, the rear thrust rod and valve piston are moved to the left (forwards). The valve spring causes the valve plate to move also until it reaches the seal in the guide housing. This closes the connection between the front and rear side of the diaphragm. When the piston continues moving, its movements are transferred via the reaction disc and front thrust rod to the master cylinder. When the seat of the valve pistion leaves the plate, the connection between the rear side and the centre of the valve section is opened. Air from atmospheric pressure can then flow in behind the diaphragm. When there is partial vacuum on the front side of the diaphragm, it is moved, and also the guide housing, forwards. In this way, the force applied to the front thrust rod is increased. The parts of the power cylinder are in the position shown in Fig. 5–72 when the pedal pressure provides maximum servo effect.

If the pedal pressure is less than that mentioned above, the same procedure takes place in the beginning. During brake application, the hydraulic pressure in the master cylinder increases and also the counter-pressure on the front thrust rod. The pressure of the guide housing is transmitted to the thrust rod through the outer part of the reaction disc. Because the disc is made of rubber, its periphery contracts while its centre tends to expand, see Fig. 5–73. This causes the guide housing to be moved further forwards than the valve piston and results in the seat of the piston reaching the valve shutting off the air supply. The pressure behind the diaphragm remains constant and is thus unable to overcome the hydraulic counter-pressure in the master cylinder. The movable parts of the power cylinder, therefore, remain in this position, and constant braking is obtained as long as the same pressure is maintained on the brake pedal.

If pressure on the pedal is increased, the pressure of the valve piston on the reaction disc centre will be greater, this causing a certain displacement forwards of the piston. When this happens, the valve leaves the seat of the piston, more air can flow in and greater brake application is obtained until the new equalizing position is attained.

If the pressure on the pedal is reduced, the reaction disc centre can be thrust out still further, and this causes the valve piston to lift the valve from the seat in the guide housing. The spaces on both sides of the diaphragm are thereby connected with each other, equal pressure arises, the guide housing is moved backwards by the spring pressure and there is a reduction in the brake application. This procedure also reduces the contraction of the reaction disc periphery, so that the valve piston can return to the position shown in Fig. 5–73 and the new equalizing position is reached. If the brake pedal is released fully, all the parts of the servo cylinder are returned to the rest position and the brakes are released.

Should any fault occur with the vacuum supply, brake application can still take place due to the fact that the power cylinder functions as an extended thrust rod. As no power effect is then obtained, greater pressure on the pedal is of course required.



Max. partial vacuum

Partial vacuum

Atmospheric pressure

Fig. 5–73. Partial brake application

CHECK VALVE

The check valve (Fig. 5–74) is placed on the line between the engine intake manifold and the power brake cylinder, its purpose is to prevent air from flowing back to the power brake cylinder. The valve only opens when there is more vacuum at connection 1 than a connection 2.

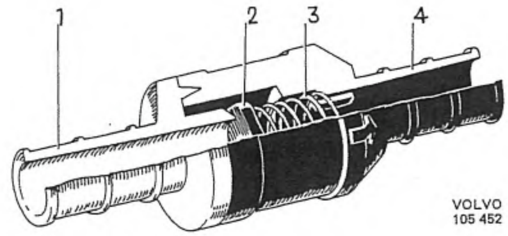


Fig. 5–74. Check valve

1. Connection for power cylinder
2. Valve
3. Return spring
4. Connection to engine

REPAIR INSTRUCTIONS

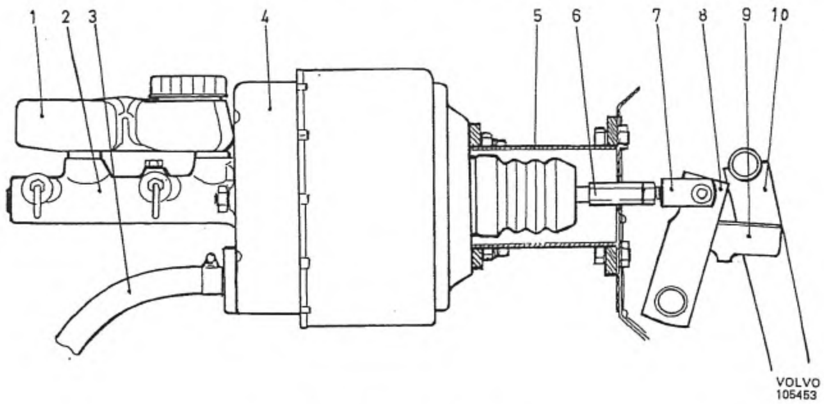


Fig. 5–75. Brake parts

1. Brake fluid container
2. Master cylinder
3. Vacuum hose
4. Power cylinder
5. Bracket
6. Thrust rod
7. Yoke
8. Double lever
9. Thrust link
10. Brake pedal

POWER CYLINDER

The power cylinder cannot be repaired. The filter, however, can be changed. If the power cylinder is faulty in any way, it must be replaced complete.

REMOVING

1. Remove the master cylinder. Disconnect the vacuum hose and the support clamp on the power cylinder.
2. Unscrew the attaching nuts for the power cylinder.
3. Unscrew the locknut and screw out the yoke (7, Fig. 5–75).
4. Lift forward the power cylinder.

INSTALLING

1. Place the power cylinder in position and screw the yoke (7) to the bottom on the thrust rod (6). Tighten the locknut. Fit the attaching nuts for the power cylinder.
2. Install the master cylinder, vacuum hose and other parts on the power cylinder.
3. Check and if necessary adjust the pedal location and brake light switch.
4. Bleed the entire brake system.

REPLACING FILTER

The filter can be replaced with the power cylinder fitted, but this concerns vehicles with right-hand drive. For vehicles with left-hand drive, the power cylinder must first be removed.

1. Lever off the rubber cover. Remove the washer

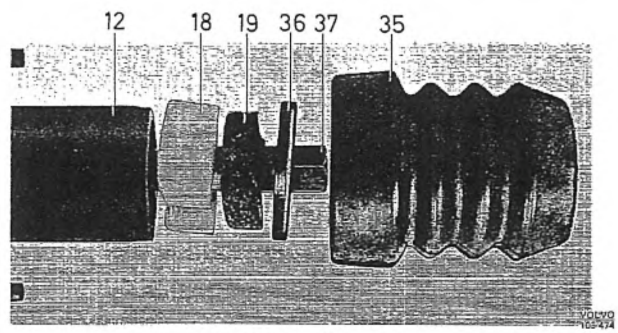


Fig. 5–76. Filter parts

12. Guide housing
18. Filter
19. Damper
35. Rubber cover
36. Washer
37. Rear thrust rod

with screwdriver. Pull out the silencer and filter, see Fig. 5–76.

2. Fit the new filter and damper on the thrust rod. The slots should face 180° from each other, see Fig. 5–76.
3. Fit the parts in position. Make sure that the rubber cover is fitted properly on the cylinder and washer.

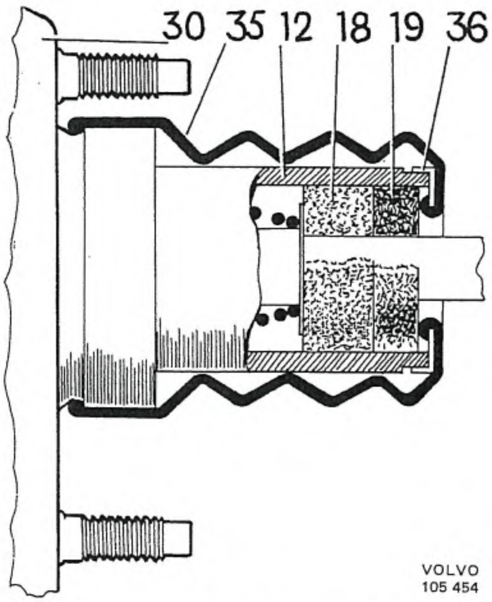


Fig. 5–77. **Filter parts**

12. Guide housing
18. Filter
19. Silencer
30. End
35. Rubber cover
36. Washer

REPLACING CHECK VALVE

Remove the check valve (2, Fig. 5–78) from the vacuum hose. Ensure that the new check valve functions properly. Fit the valve so that the arrows on the valve housing point away from the servo cylinder. The vacuum hose connection should face downwards.

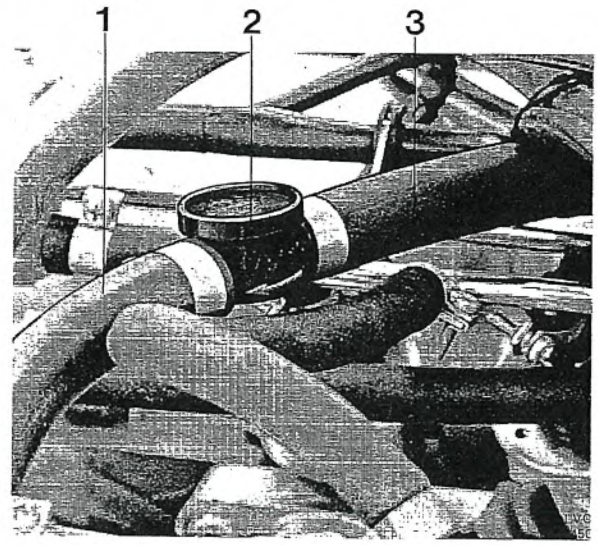


Fig. 5–78. **Check valve fitted**

1. Connection for engine
2. Check valve
3. Connection for power cylinder

GROUP 55

PARKING BRAKE

DESCRIPTION

The construction of the parking brake is shown in Fig. 5—79. The parking brake lever is mounted on the floor on the outside of the driving seat. The movement of the lever is transmitted via the shaft (20), pull rod (19), lever and pull rod (2) to the pulley. From here the movement is transmitted through the cable (9) to the rear wheel brake units. At each rear wheel, the movements of the cable influence the lever (16), which is carried in a movable rod on the brake shoes. The lower ends of the brake shoes are held pressed against the anchor bolt (15) by the lower spring. The upper ends are jointed through the adjusting mechanism (13) to which they are held pressed by the spring (12), which also locks the small serrated wheel of the adjusting screw. Due to this type of suspension. the brake shoes are self-centering and both the shoes are partly self-applying (Duo-Servo). The brake drum is fitted on the drive shaft and so designed that it also serves as a brake disc for the footbrake.

When the parking brake is applied, the lever and rod press the shoes against the brake drum. When the wheels or drive shaft attempt to turn the drum, the shoes accompany the rotation because of the friction between lining and drum. Due to the "floating" suspension of the shoes, the primary shoe is thus

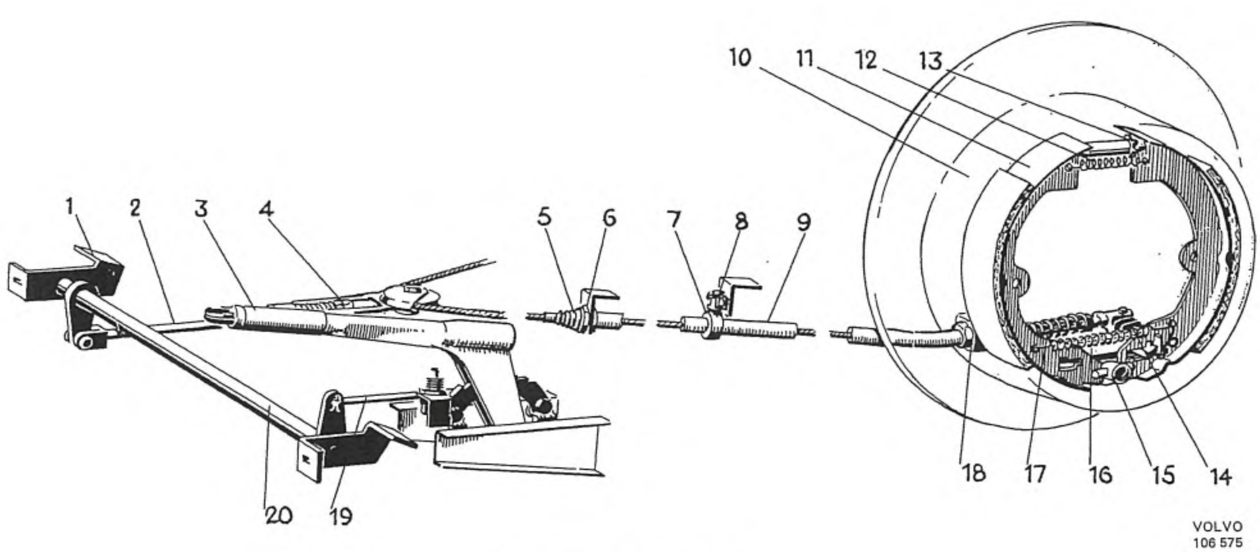


Fig. 5—79. Parking brake

1. Bearing bracket
2. Pull rod
3. Brake lever
4. Adjuster
5. Rubber cover
6. Front attachment
7. Rubber eyelet
8. Attachment
9. Cable with sleeve
10. Brake drum
11. Brake shoe
12. Return spring
13. Adjusting mechanism
14. Rubber cover
15. Anchor bolt
16. Lever
17. Return spring
18. Rear attachment
19. Pull rod
20. Shaft

pressed upwards and the secondary shoe downwards until the lower end moves towards the anchor bolt, see Fig. 5—80.

Due to the fact that the turning centre of the secondary shoe lies in the anchor bolt and that of the primary shoe in the adjusting device, the friction between the drum and the linings will assist in brake application. Also contributing to this is the retarding effect on the secondary shoe because of the primary shoe's endeavour to accompany the direction of rotation of the drum.

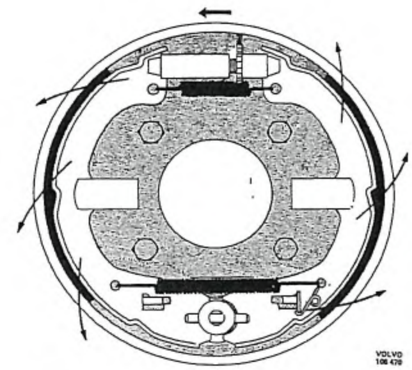


Fig. 5—80. Duo-servo principle

REPAIR INSTRUCTIONS

ADJUSTING PARKING BRAKE

The parking brake should give full effect at the third-fourth notch. It it does not do so, adjustment should be carried out. Here the wheel brake units are first adjusted and, if necessary, the cable.

1. Apply the parking brake and loosen the wheel nuts.
2. Jack up the rear end, place props under the rear axle, remove the nuts and take off the wheels. Release the parking brake.
3. Check that the brake pads are not stuck to the brake disc. To prevent the lever when adjusting from influencing the shoes and thus give misleading results, the spring tension acting on the lever should be reduced. This can be done by fitting holder 2742 (Fig. 5—83) or by disconnecting the cable from the lever.
4. Set the drum so that its hole coincides with the serrations on the adjusting screw and apply the shoes by moving the screwdriver handle upwards, see Fig. 5—81. When the drum can be rotated easily, discontinue applying the shoes. Then turn the adjusting screw back 4—5 serrations. Check that the shoes do not "drag" by rotating the drum in its normal direction of rotation. Very little dragging may be permitted. If, however, the dragging is more pronounced, the adjusting screw should be released a further 2—3 serrations. Connect the cable to the lever and remove the holder 2742.
5. Repeat the adjusting procedure with the other rear wheel.
6. Apply the parking brake lever and check that full braking effect is obtained on the 3rd—4th notch. If the parking brake can be applied still further,

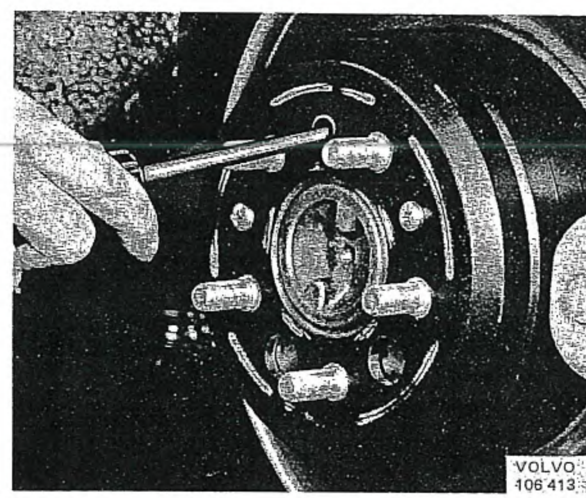


Fig. 5—81. Adjusting parking brake, rear wheel

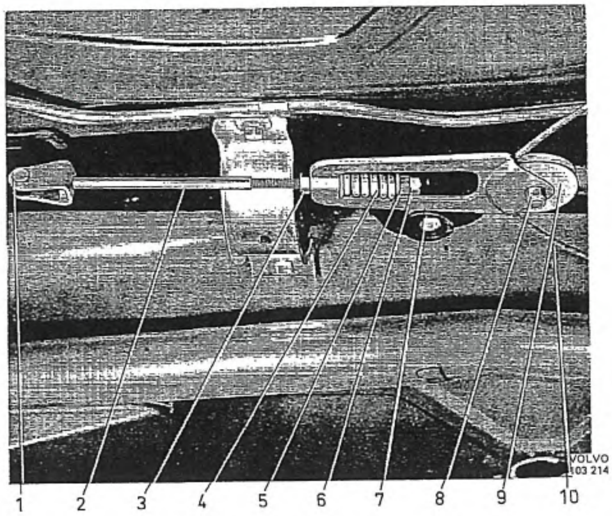


Fig. 5–82. Adjusting device cable

1. Bolt
2. Pull rod
3. Locknut
4. Spring
5. Nut
6. Locknut
7. Pulley
8. Bolt
9. Wheel
10. Cable

the cable should be tensioned. This is done by loosening the locknuts and screwing in the pulley on the pull rod, see Fig. 5–82. After adjusting, tighten the locknuts. Check that there is approximately the same braking effect on both rear wheels.

7. Mount the wheels after having cleaned any dirt from the contact surfaces, and tighten the wheel nuts sifficinetly so that the wheel cannot move. Remove the props. Lower the vehicle and tighten the nuts. Tighten every other nut a little at a time until all are tightened to a torque of 100–140 Nm (70–100 lbft).

REPLACING PARKING BRAKE CABLE

REMOVING

1. Apply the parking brake and loosen the wheel nuts.
2. Jack up the rear end, place props under the rear axle, remove the nuts and take off the wheels. Release the parking brake.
3. Remove the bolt (8, Fig. 5–82) and then the wheel (9) from the pulley (7).
4. Remove the rubber cover (5, Fig. 5–79) for the front attachment of the cable sleeve and the nut as well as the attachment for the rubber suspension ring on the frame member. Remove the cable from the other side of the attachment in the same way.

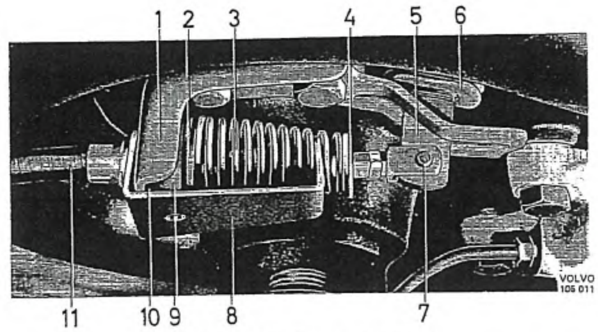


Fig. 5–83. Fitting spring tool

1. Cable attachment
2. Washer
3. Return spring
4. Washer
5. Lever
6. Rubber
7. Lock pin
8. Holder 2742
9. Nut
10. Lock washer
11. Cable

5. Place holder 2742 so that the return spring is held in position according to fig. 5–83. Bend up the lock and remove the lock pin so that the cable releases from the lever.
6. Remove the return spring with washers. Loosen the nut for the rear attachment of the cable sleeve. Lift the cable forwards after having loosened both sides of the attachments.

INSTALLING

1. Adjust the brake shoes of the rear wheels. Check that the brake pads do not stick to the brake disc and adjust the drum so that its hole coincides with the serrations of the adjusting screw. Place a screwdriver between the serrations of the adjusting screw and apply the shoes by moving the screwdriver handle upwards, see Fig. 5–81. When the drum can be turned easily, discontinue applying the shoes. Then turn the adjusting screw 4–5 serrations back.
2. Fit on new rubber cable guides for the cable suspension. Place the cable in position in the rear attachment and tighten the nut. Fit the washers and return spring. Compress the spring with the help of the holder tool, see Fig. 5–83. Oil the lock pin and fit it together with the cable on the lever. Fit the attachment and rubber cable guide on the frame member.
3. Fit the cable in the same way as above on the other side of the vehicle.
4. Place the cable sleeve in position in the front attachments and fit rubber covers.
5. Lubricate and fit the pulley on the pull rod. Adjust the pulley so that the parking brake gives full effect at the 3rd–4th notch.
6. Fit the wheels, see operation under "Adjusting parking brake".

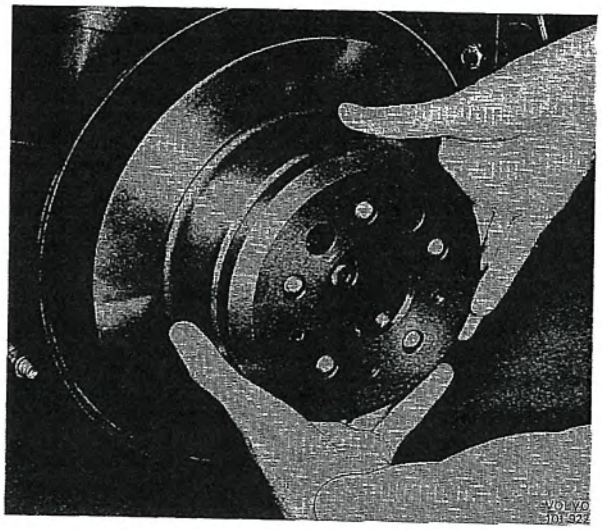


Fig. 5–84. Removing brake drum

REAR WHEEL BRAKE UNIT (PARKING BRAKE COMPONENT)

DISASSEMBLING

1. Apply the parking brake, and loosen the wheel nuts.
2. Jack up the rear end, place props under the rear axle, remove the nuts and take off the wheels. Release the parking brake.
3. Screw loose the brake line (2, Fig. 5–25) from the rear brake caliper and plug the connection. Brake fluid must not spill onto the disc or brake pads. Remove the attaching bolts (1 and 3). Lift out the caliper, see Fig. 5–26.
4. Remove the attaching bolts for the brake drum and lift off the drum, see Fig. 5–84.
5. Remove both the return springs and the adjusting device. Lift forward the shoes, see Fig. 5–86. Manipulating the links will facilitate removal.

INSPECTING

First check that there is no oil leakage. If there is oil leakage, replace the sealing ring, see Group 46. Clean all the parts except the brake linings. Check that the lever joint does not chafe and replace parts which are damaged or worn.

If the brake linings are oily or worn down to the rivets, replace the shoes completely. The brake drum should be replaced it its friction surface is concave, or if its out-round exceeds 0.2 mm (0.008"). Rust spots can, however, be polished off. Wipe the contact surfaces on the backing plate.

ASSEMBLING

1. If new linings or drums are to be fitted, slacken the adjuster (4, Fig. 5–79) to remove tension in the cable.
2. Coat the 6 guide lips on the backing plate as well as the lever joint and adjusting screw with heat-resistant graphite grease intended for this purpose. Check that the lever and anchor bolt parts are correctly fitted, see Fig. 5–86. Check that the washer (8, Fig. 5–87) and the spring (9) are in position on the primary shoes.
3. Fit the brake shoes, see Fig. 5–85. The shorter sleeve on the adjusting device should be turned forwards on the right-hand side and backwards on the left-hand side, see Fig. 5–87.

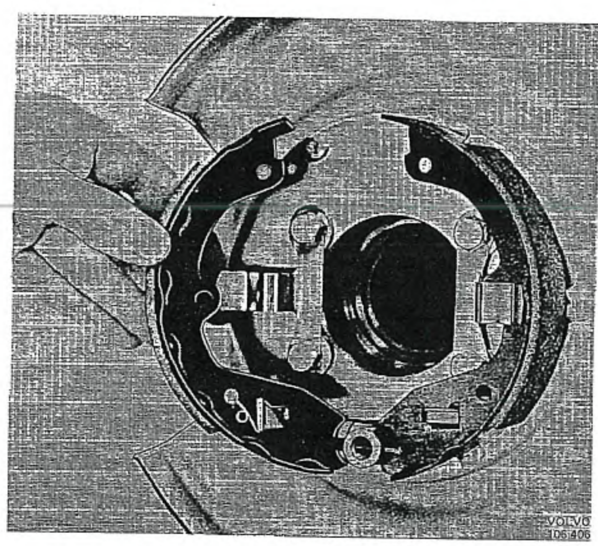


Fig. 5–85. Fitting brake shoes

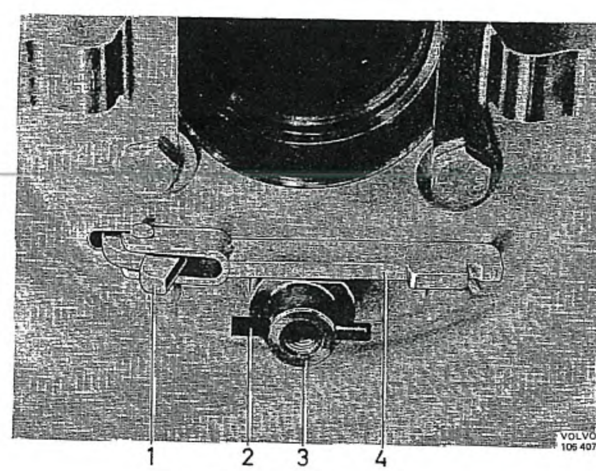


Fig. 5–86. Brake parts

1. Lever
2. Guide pin
3. Anchor bolt
4. Link

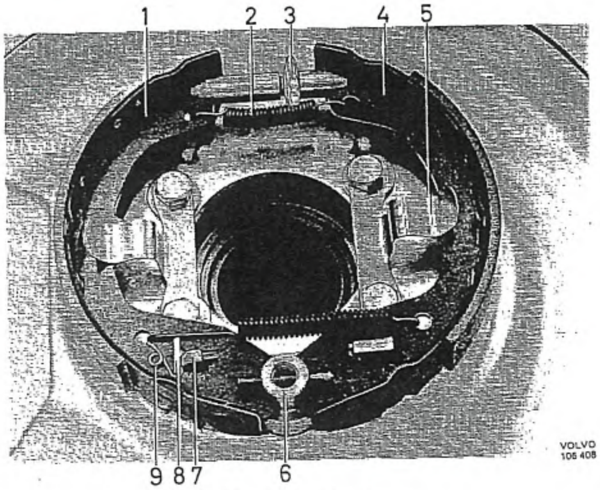


Fig. 5–87. Parking brake

1. Rear brake shoe (primary shoe)
2. Upper return spring
3. Adjusting mechanism
4. Front brake shoe (secondary shoe)
5. Retainer for brake shoe
6. Anchor bolt
7. Lever
8. Washer
9. Spring

4. Hook on the return spring
5. Fit the brake drum with attaching bolts.
6. Place the brake caliper in position. Fit any shims and the attaching bolts (1 and 3, Fig. 5–25) after smearing the bolts with a couple of drops of Locktite, type AV.
7. Check that the brake pads move freely from the brake disc and adjust the parking brake, see operations 4–6 under "Adjusting parking brake".
8. Bleed the fitted brake caliper, see Group 52.
9. Fit the wheel, see operation 7 under "Adjusting parking brake".

REPLACING PARKING BRAKE LEVER OR RATCHET PARTS

1. Release the parking brake. Remove the seat and uncover the mat at the lever.
2. Remove the split pin and washer at the shaft lever. Turn the pull rod so that it can release from the lever. Remove the ratchet segment (12, Fig. 5–88).
3. Unscrew the bolts for the bearing attachment and drive out the pin (14) and attachment. Lift forward the lever (9).
4. Unscrew the lock bolt and remove the bracket (1) and push button (2). Remove the spring from the lever. Remove the rivet (11) and take out the thrust rod (8) and pawl (10).
5. Fit the new parts in reverse order to removal. Make sure that the rivet is properly fastened without impeding the movement of the pawl. Lubricate the bushes with a light layer of ball bearing grease. Do not forget to lock the pull rod.

REPLACING SHAFT

1. Jack up the rear end and place props under the rear axle.
2. Release the praking brake and isconnect the pull rod (19, Fig. 5–79) from the shaft lever.
3. Remove the split pin and stretch the cables so that the pull rod can be released from the shaft lever. Remove the bearing attachments and lift forward the shaft (20).
4. Lubricate the bushes in the new shaft with a light layer of ball bearing grease. Check that the bearing attachment pins are not damaged. Install the shaft in reverse order to removal.

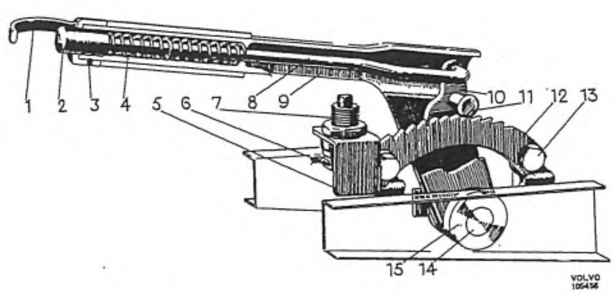


Fig. 5–88. Parking brake components

1. Bracket
2. Push button
3. Lock bolt for bracket
4. Spring
5. Bracket
6. Electrical connection
7. Contact for brake warning lamp
8. Thrust rod
9. Brake lever
10. Pawl
11. Rivet
12. Ratchet segment
13. Bolt
14. Pin
15. Bush

Part 6

FRONT END AND STEERING GEAR

CONTENTS

GROUP 60

GENERAL

TOOLS

The special tools are marked 999 or SVO before the tool number (e.g. 999 1794 or SVO 1794).

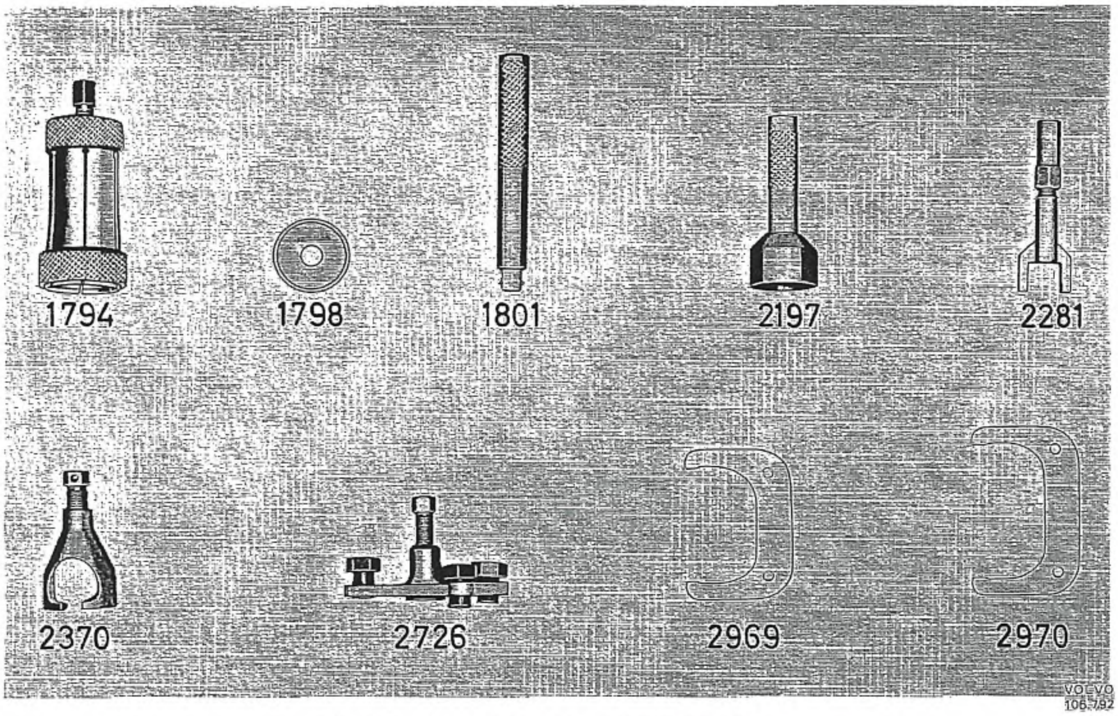


Fig. 6–1. Special tools for work on front axle

999
(SVO)
1794 Puller for inner wheel bearings
1798 Drift for fitting sealing ring in hub
1801 Standard handle 18x200
2197 Drift for removing and fitting grease cap in hub
2281 Press tool for lower ball joint

999
(SVO)
2370 Puller for pitman arm
2726 Puller for front wheel hub
2969 Gauge for ball joint type 1
2970 Gauge for ball joint type 2

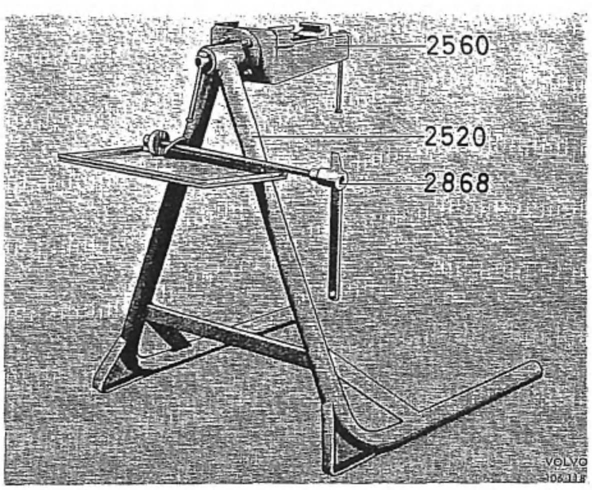


Fig. 6–2. Special tools for work on front axle removed

999
(SVO)
2520 Stand for fixture
2560 Fixture
2868 Press tool for spring

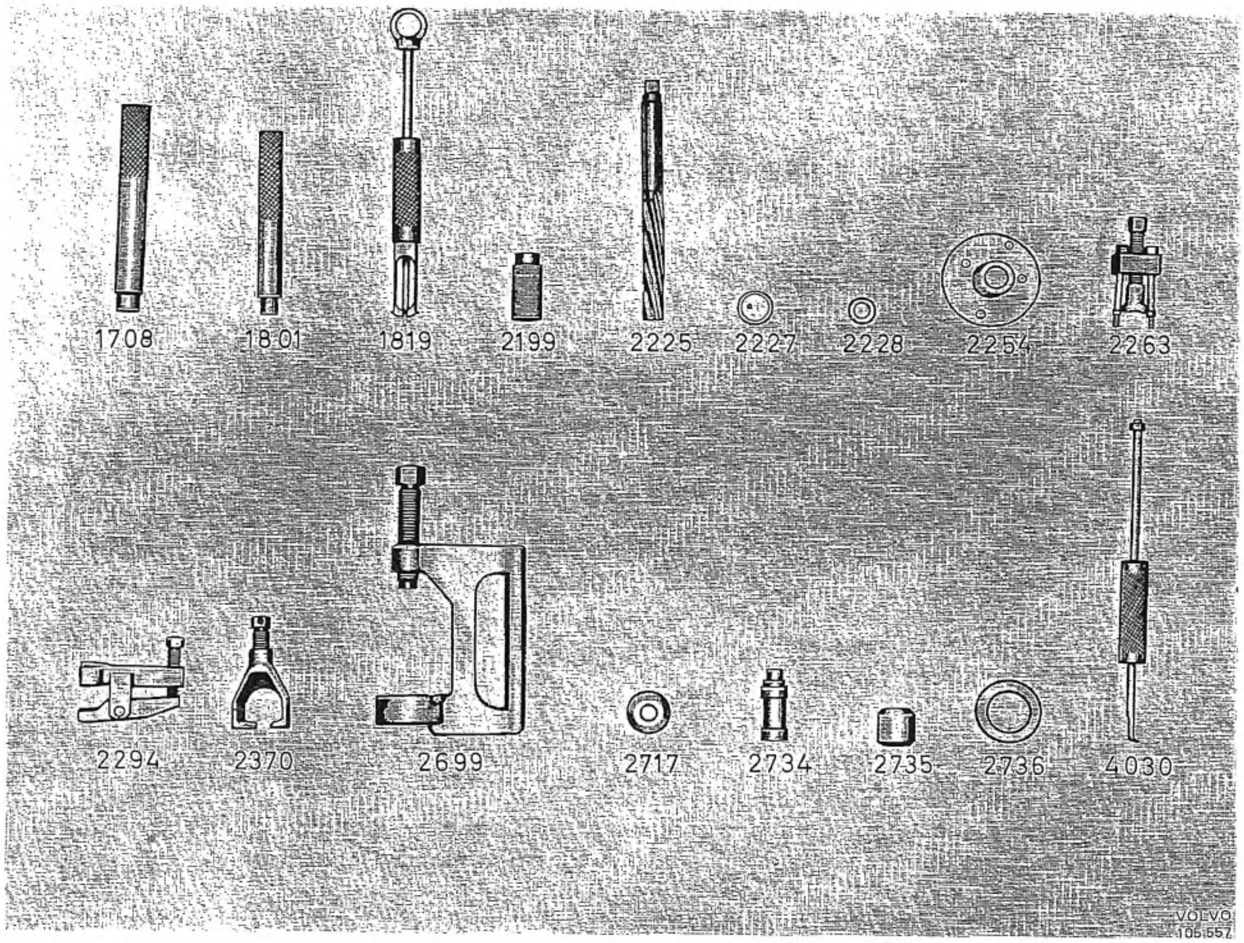


Fig. 6—3. Special tools for work on steering gear

999
(SVO)
1708 Drift for removing upper bearing ring
1801 Standard handle 18x200
1819 Puller for bearing ring and pitman arm shaft bushes
2199 Protecting sleeve for sealing ring
2225 Reamer for pitman arm shaft bushes
2227 Drift for fitting sealing ring
2228 Drift for fitting pitman arm shaft bushes
2254 Guide for reamer
2263 Puller for steering wheel
2294 Press tool, ball joints for steering rod
2370 Puller for pitman arm
2699 Press tool for relay arm
2717 Drift for fitting outer bearing ring
2734 Drift for removing bush, relay arm
2735 Drift for fitting bush, relay arm
2736 Counterhold for removing bush, relay arm
4030 Extractor for sealing ring

WHEEL ALIGNMENT

WHEEL ANGLES

For the vehicle to have good steering properties and a minimum of tyre wear, the front wheels must have certain pre-determined settings, generally known as the wheel angles. The wheel angles refer to the caster, camber, king pin inclination, toe-out and toe-in.

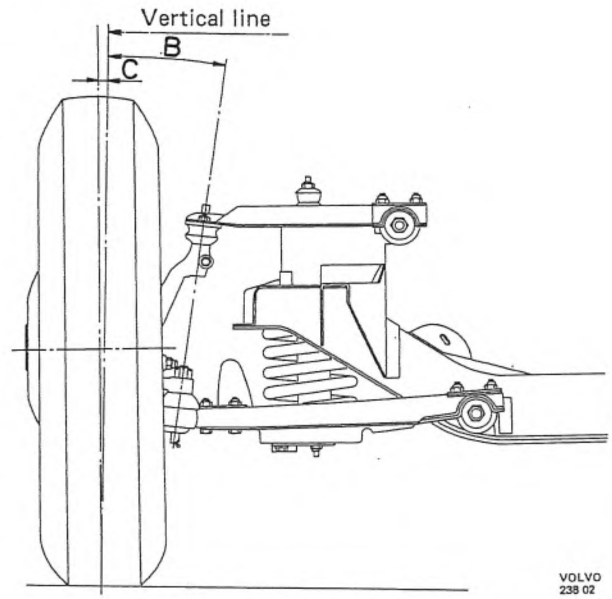


Fig. 6–5. Camber and king pin inclination
B=King pin inclination C=Camber

CASTER

Caster generally refers to the longitudinal inclination (forwards or backwards) of the king pin. As this vehicle does not have a king pin, the caster consists of the angle between a vertical line and a line through the centre of the ball joints (Fig. 6–4).

CAMBER

Camber is the inclination of the wheel itself outwards or inwards. It is positive if the wheel is inclined outwards (see C, Fig. 6–5) and negative if the wheel inclines inwards. Faulty camber causes uneven tyre wear.

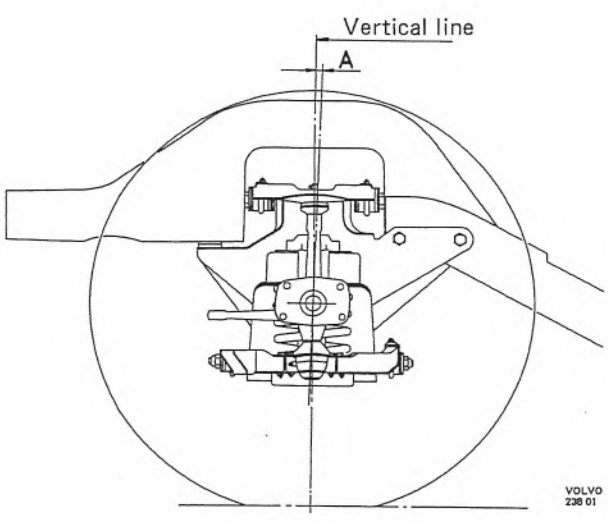


Fig. 6–4. Caster
A=Caster

KING PIN INCLINATION

King pin inclination means the inclination of the king pin inwards. Since this car does not have a king pin, the inclination is represented by an angle made between a vertical line and a line through the centre of the ball joints (B, Fig. 6–5).

King pin inclination causes the centre lines of the ball joints and the wheel to approach each other towards the road surface. This makes the wheel easier to turn. The inclination also assists the tendency of the wheel to run straight forwards since the car is lifted very slightly when the wheels are turned.

TOE-OUT

When driving round a bend, the wheels roll at different radii. For them to have the same pivoting centre, and consequently minimum tyre wear, the front wheels must be turned to different extents. This relationship is determined by the shape of the steering rod and steering arms, see Fig. 6–6.

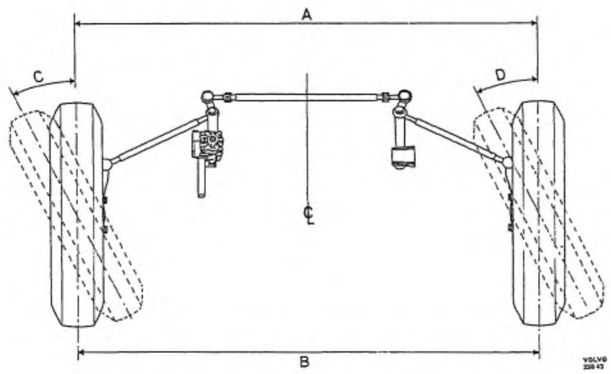


Fig. 6–6. Toe-out and toe-in

TOE-IN

The difference in the distances (A and B, Fig. 6–6) between the wheels measured at hub height at the front and rear of the tyres is known as toe-in. The purpose of toe-in is to reduce tyre wear.

PROCEDURE BEFORE WHEEL ADJUSTING

The factors listed below can influence the wheel angles. Therefore, any faults should be remedied before measuring and adjusting.

1. Difference in tyre pressure and wear.
2. Looseness in front wheel bearings.
3. Looseness in ball joints or control arm attachments.
4. Broken springs.
5. Abnormal (temporary) equipment or loading.

Other factors which can influence the steering during operation without making themselves directly known during the measuring of the wheel angles are:

1. Wheel throw greater than 2.5 mm (0.1").
2. Poor shock absorbers.
3. Steering gear incorrectly adjusted.
4. Looseness in relay arm journalling or steering rod parts.

MEASURING WHEEL ANGLES

The wheel angles are measured with special measuring instruments of which there are many different types. No general description can, therefore, be given as to how measuring should be carried out except in the case of the steering geometry. The measuring principle is that camber is measured directly with the wheels pointing straight forwards. Caster and king pin inclination cannot be measured directly. Instead, the angular alteration which occurs when the wheel is turned from 20° outward to 20° inwards is measured on the instrument.

Most types of modern wheel alignment measuring instruments require that the wheels are locked with, for example, the help of a pedal jack.

When measuring the wheel angles, follow the instructions for the measuring instruments concerned.

CHECKING WITH WHEEL ALIGNMENT INDICATOR

The wheel alignment indicator should be calibrated between –2 to +5 m/km and is used as follows:

Straighten the car so that left wheels are in a straight line with the indicator when the car is about 2 metres (6 1/2 ft.) from the indicator. Let go the steering wheel and slowly drive over the indicator plate (2–4 km.p.h. = 2 1/2 miles). NOTE. The steering wheel must **not** be touched until the front wheels have come on the other side of the indicator.

If the green lamp on the indicator board remains lighted, then the front end is properly adjusted and the wheels are properly aligned.

If one of the red lamps light, and a buzzer starts buzzing, then there is something wrong with the front wheel alignment and it should be adjusted.

CHECKING KING PIN INCLINATION

The king pin inclination, which on this vehicle is represented by the inclination of the centre line of the ball joint, should be 8° at a camber of 0°. This cannot be adjusted and is difficult to measure exactly due to the tension and resilience in the parts, so that the angle read off on the instruments will not be the exact king pin inclination but can serve as a guide.

CHECKING TOE-OUT

1. Place the vehicle front wheels on turntables and make sure that the wheels point straight forwards. Before the car is placed on them, the turntables must be set to zero and locked.
2. Turn the wheels to the left until the right wheel has turned 20° inwards. The scale on the left turntable should then read 22.5±1°.
3. Check the position of the right wheel in the same manner by turning the wheels to the right until the left wheel has turned 20° inwards, when the right turntable scale should give the same reading as previously indicated on the left. Both measurements should thus lie within the above-mentioned tolerances, otherwise it means that the steering gear or front end is distorted.
4. There are no adjusting possibilities, but if the toe-out is incorrect, the steering arms and steering rods should be checked. Replace any parts that are damaged.

ADJUSTING WHEEL ANGLES

NOTE. The front wheel angles must always be adjusted in the following order:

1. Caster
2. Camber
3. Toe-in

From a labour-saving point of view, it may be suitable, however, to adjust the caster and camber at the same time, see under "Camber".

CASTER

The caster for each wheel should be within the tolerance range $+2^\circ$ to $+2\ 1/2^\circ$, that is, it should be min. $+2^\circ$ and max. $+2\ 1/2^\circ$ positive.

The caster can be adjusted either with shims (1, Fig. 6–7) at the control arm shaft or with shims (1, Fig. 6–8) at the side-member. The first alternative is selected when the camber is also to be adjusted, and the second when only the caster is to be seen to.

Method 1 (at control arm shaft)

Bend up the lock plate (3, Fig. 6–7) and slacken the attaching bolts (2) so much that the shims (1) can be lifted up. The caster is adjusted, for example, to **positive** either by **adding** shims to the **rear** bolt or by **removing** shims at the **front** bolt. The shim thicknesses required to alter the angle to a certain extent can be seen from the diagram in Fig. 6–9. Shims are stocked in thicknesses of 0.15–0.5–1.0–3.0 and 6.0 mm (0.006–0.020–0.039–0.120 and 0.240"). The caster angle is altered to the same extent either by

a. removing a shim at one the bolts
b. adding a shim to the other bolt
c. moving over half of the required shim thickness from one bolt to the other.

Adjustment should be in accordance with alternative c for the right caster.

After adjusting, tighten the bolts to a torque of 55–70 Nm (40–50 lbft).

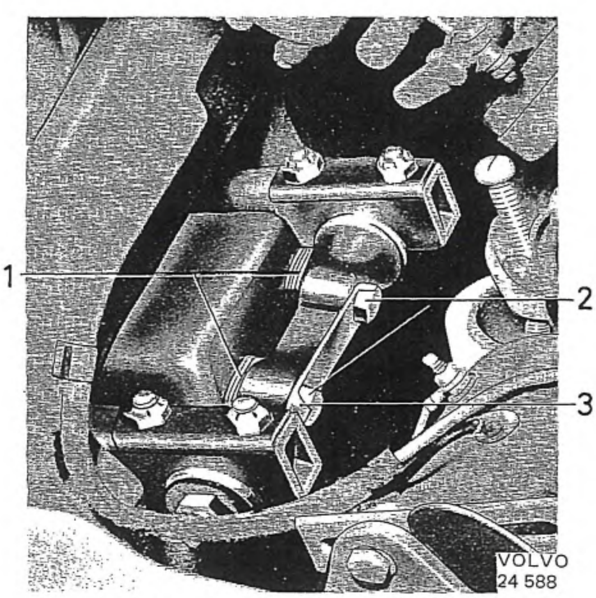


Fig. 6–7. Adjustment parts at control arm shaft
1. Shims 2. Bolts 3. Lock plate

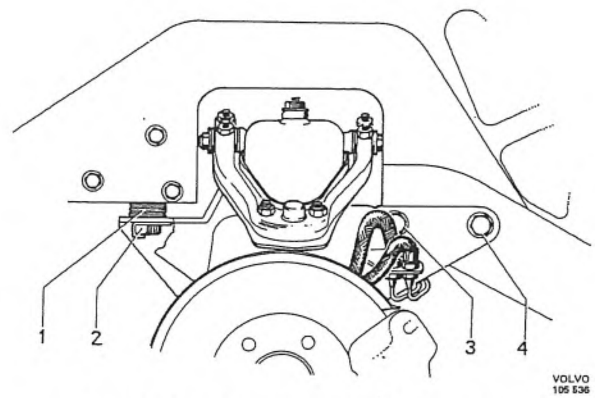


Fig. 6–8. Adjustment parts at side-member
1. Shims 2. Bolt 3. Bolt 4. Bolt

Method 2 (at side-member)

Raise the front end and place props under the body at the jack attachments. Release the attaching bolts (2, 3 and 4, Fig. 6–8). Add or deduct the number of shims required in order to get the proper caster. Shims for this purpose are available in thicknesses of 2 and 3 mm (0.08 and 0.12"). The diagram in Fig. 6–9 shows how much the caster is to be altered. The same alteration should be made on both sides to avoid extra tension in the front axle member. Tighten the bolts before a new measurement.

CAMBER

The camber for each wheel should be within a tolerance range of 0° to $+1/2^\circ$, that is, it should be min. 0° and max. $1/2^\circ$ positive.

When adjusting bend the lock plate (3, Fig. 6–7) up and slacken the attaching bolts (2) so much that the shims (1) can be lifted up. Thereafter either increase

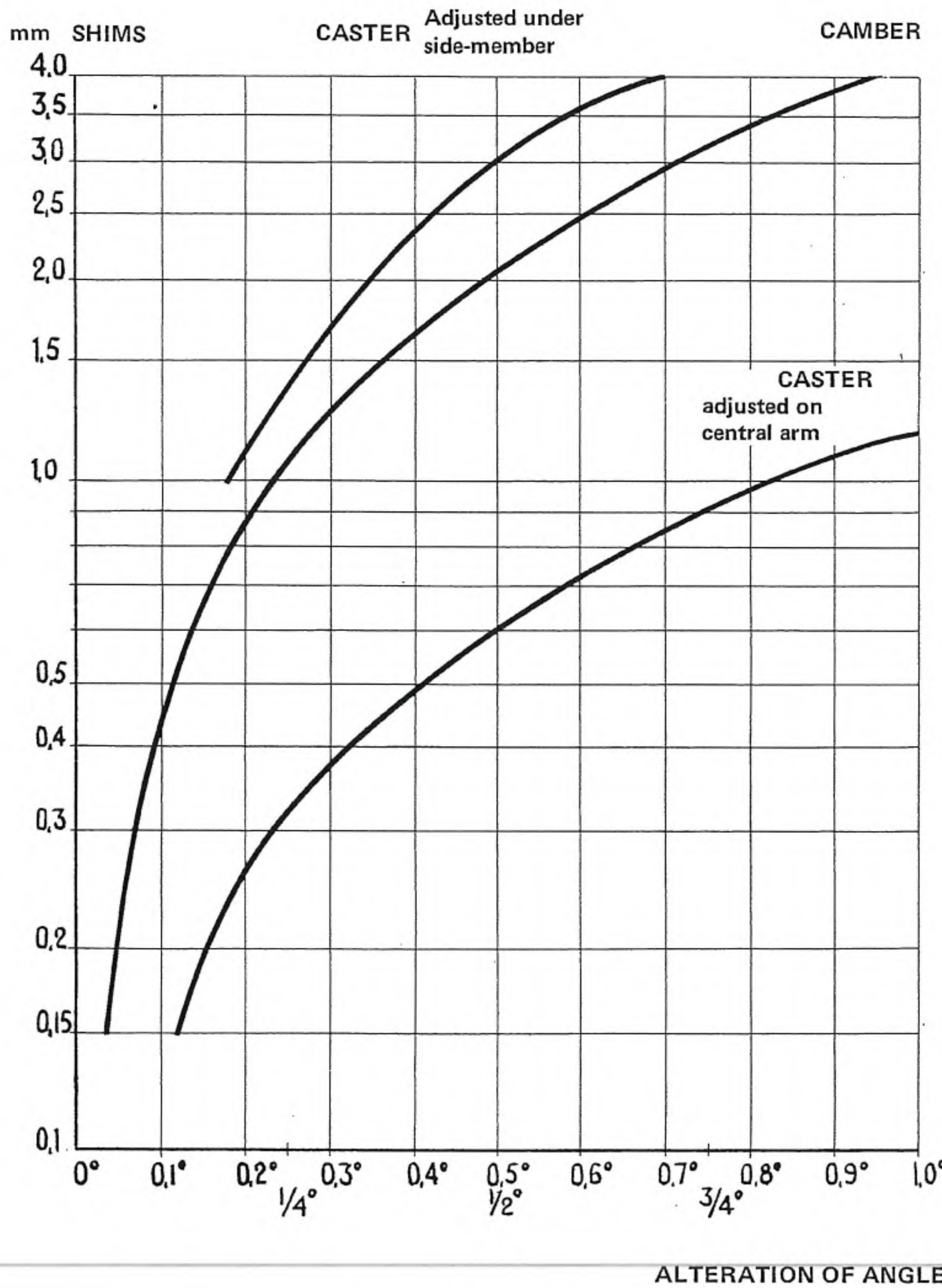


Fig. 6—9. Diagram for alteration of caster and camber

or reduce the number of shims equally for both bolts. More positive camber is obtained by removing shims and negative camber by increasing the number of shims.

The shim thickness required to alter the angle to a certain extent is shown in the diagram in Fig. 6–9. Shims are stocked in thicknesses of 0.15–0.5–1.0–3.0 and 6.0 mm (0.006–0.020–0.039–0.120 and 0.240"). The total thickness of shims at each bolt may not exceed 12 mm (0.48"). The difference in thickness between the shims at the front and rear bolts may be max. 2.5 mm (0.1"). Note that an equal number of shims must be removed or added at both the bolts if the camber is not to be altered.

After adjusting tighten the bolts to a torque of 55–70 Nm (40–50 lbft) and lock them.

In order to save time and labour adjust the caster and camber at the same time by removing or adding shims for the camber and altering the number of shims for the caster. For example, if the camber is increased 0.6° and the caster 1/4°, first remove 2.5 mm (0.1") in shims at both the bolts and move 0.15 mm (0.006") in shim thickness from the front to the rear bolt.

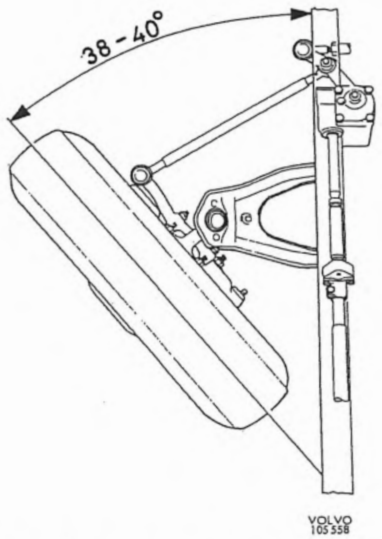


Fig. 6–10. Adjusting max. wheel lock

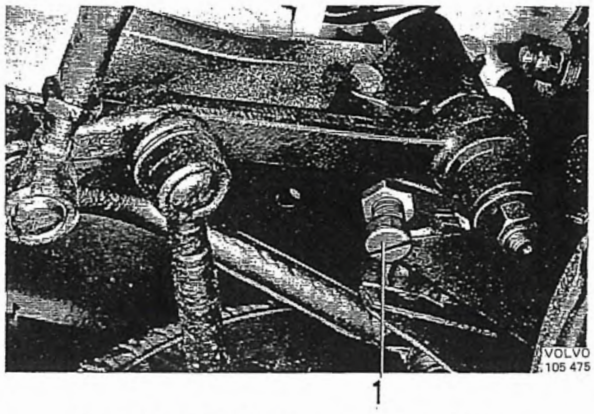


Fig. 6–11. Adjusting screw, max. wheel lock
1. Adjusting screw

ADJUSTING TOE-IN

The toe-in should be 0–3 mm (0–1/8") with the wheel spreader. Incorrect toe-in is adjusted by slackening the locknuts on the tie rod, after which the rod is turned in the required direction. The distance between the tyres at the front is reduced, that is to say, toe-in is increased by turning the tie-rod in the normal direction of rotation of the wheel. Tighten the locknut after adjustment to a torque of 75–90 Nm (55–65 lbft).

ADJUSTING STEERING LIMITS

Turning of the wheels is limited by stop screws at the pitman arm for left-hand driving and at the relay arm for right-hand driving, see Fig. 6–11.

Checking is done as follows:

1. Turn the left wheel for a left-hand turn as far as it goes. Check that the lock angle of the wheels is 38–40°. If it is not, then adjust to this value with the stop screw (Fig. 6–11) at the pitman arm.
2. Repeat this procedure with the right wheel and the stop screw on the relay arm.
   NOTE. Check that the brake hoses are clear at full wheel lock.

FRONT AXLE

DESCRIPTION

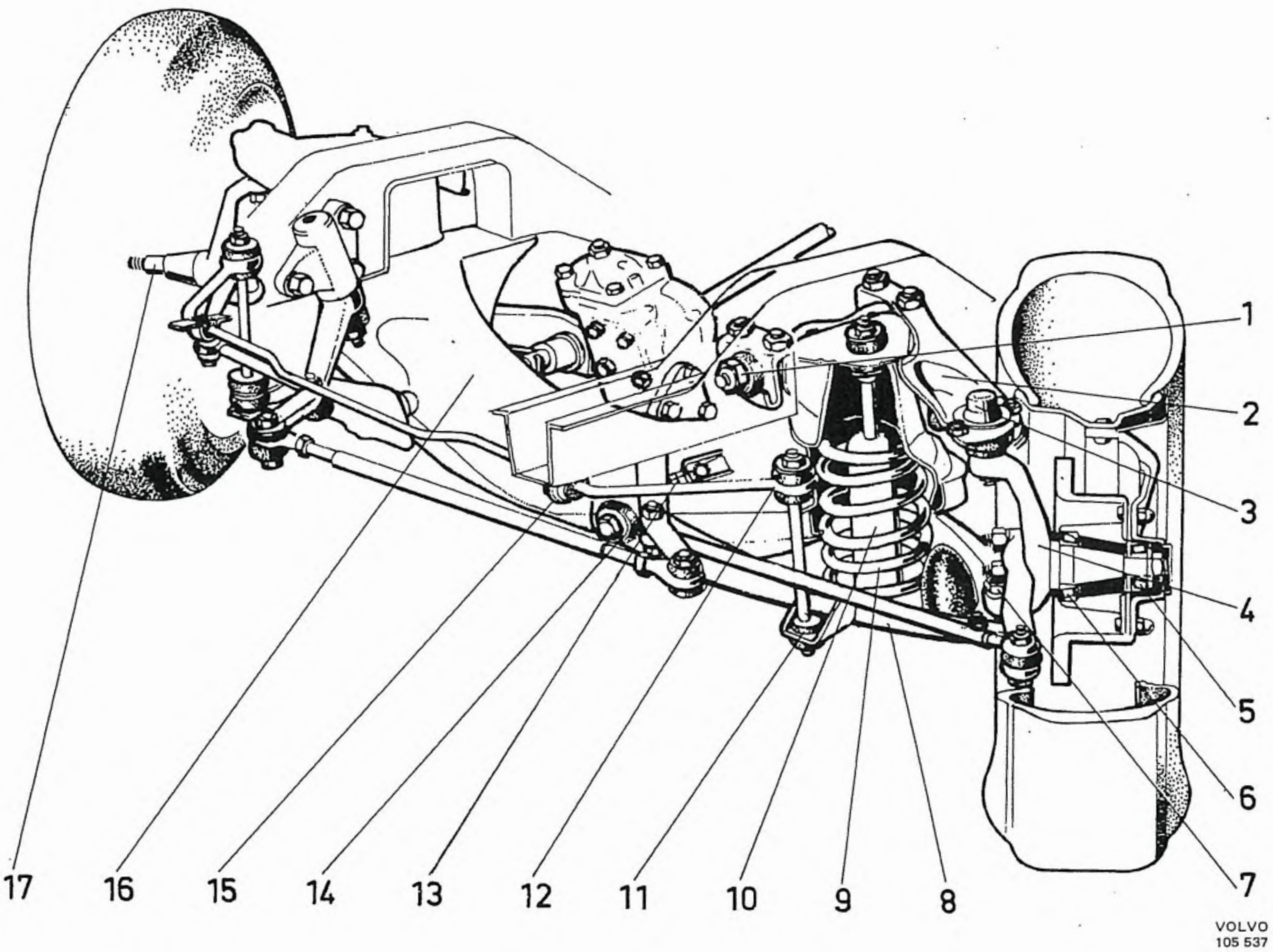


Fig. 6–12. Front axle

1. Upper control arm bush
2. Upper control arm
3. Upper ball joint
4. Steering knuckle
5. Outer wheel bearing
6. Inner wheel bearing
7. Lower ball joint
8. Lower control arm
9. Coil spring
10. Shock absorber
11. Stabilizer attachment
12. Stabilizer
13. Stop bolt, max. wheel lock
14. Lower control arm bush
15. Frame attachment for stabilizer
16. Front axle member
17. Stub axle

The vehicle has independent front wheel suspension. This means that there is no actual front axle, this being replaced by a robust box-section front axle member. This member is bolted to the self-supporting body and the front wheel suspension and springs are fitted at the ends of the member. The construction is illustrated in Fig. 6—12.

The steering knuckle is pivoted on the upper and lower control arms by means of ball joints (3 and 7) which are screwed into the control arms. The control arm shafts are carried in rubber bushes (1 and 14, Fig. 6—12) which are journalled in the control arms.

Camber and caster are adjusted by means of shims between the upper control arm shaft and its attachment in the front axle member (see Fig. 6—7).

The front wheels are carried in taper roller bearings (5 and 6, Fig. 6—12). The front spring assembly consists of coil springs (9) inside which telescopic shock absorbers (10) are fitted. In order to increase its anti-rolling properties, the car is equipped with a stabilizer (12) which is attached partly to the lower control arms (11) and partly to the frame (15).

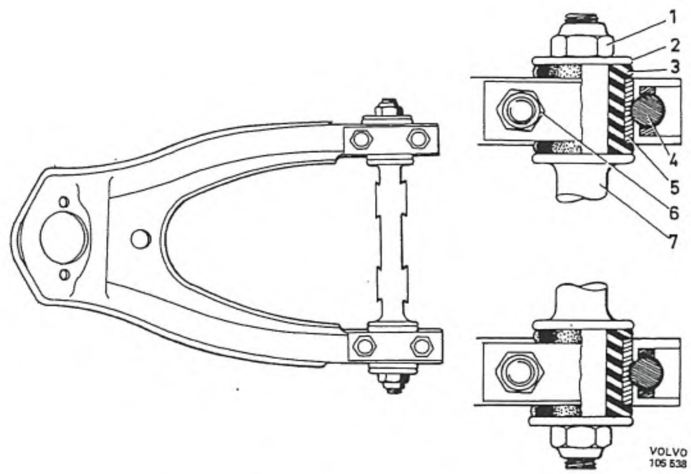


Fig. 6—13. Upper control arm

1. Nut
2. Flat washer
3. Bush
4. Clamp
5. Sleeve
6. Nut
7. Control arm shaft

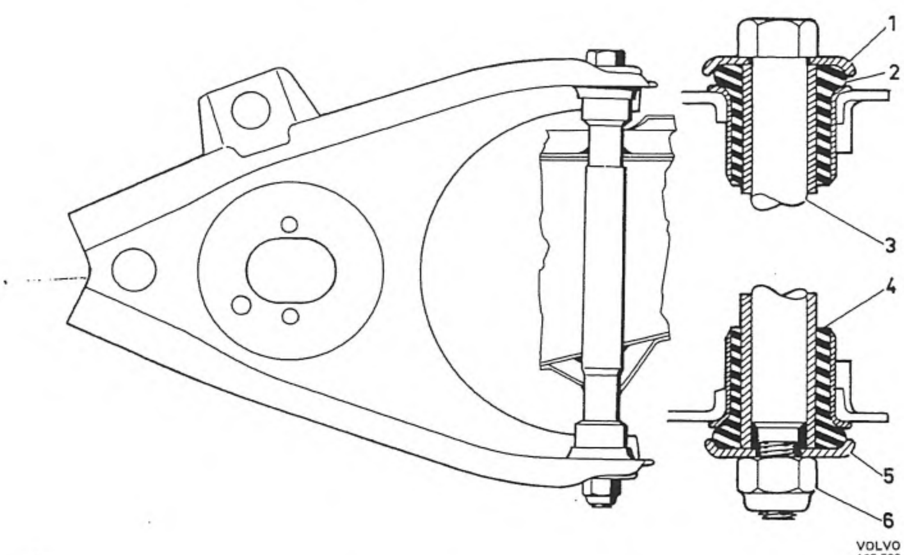


Fig. 6—14. Lower control arm

1. Washer
2. Bush
3. Bolt (shaft)
4. Bush
5. Washer
6. Nut

GENERAL

The upper and lower ball joints in the front end also the ball joints for the tie rod and steering rods are plastic-lined. For this reason, they require no maintenance lubrication and are therefore not fitted with lubricating nipples. Since the sealing is extremely important concerning the lifetime of these ball joints, the rubber seals should be checked every 10 000 km (6 000 miles) to make sure they are not damaged. Cracked or damaged seals should be replaced by new ones. When fitting, fill the rubber seals with universal grease.

The control arms may only be straightened to a minor extent and then only in cold condition. If the old control arm deviates considerably compared to a new one, it should be replaced.

No straightening whatsoever is permitted for the stub axles and steering knuckles.

FRONT END COMPLETE

REMOVING

1. Temporarily plug the vent-hole in the brake fluid container cap to reduce leakage. Slacken the nuts for the front wheels a couple of turns.
2. Jack up the front end sufficiently that the wheels are off the ground. Prop up under the body at the front jack attachments.
3. Remove the wheel nuts and take down the wheels.
4. Prop some kind of support under the front end of the engine.
5. Place a wooden block under the brake pedal. Disconnect the brake hoses from the body and mask the connections to make sure no dirt gets in.
6. Remove the pitman arm with the help of puller 2370, see Fig. 6—40.
7. Disconnect the front engine mountings. Remove the relay arm and stabilizer from the body.
8. Place a jack under the front axle member. Unscrew the front axle member attaching bolts (2, 3 and 4, Fig. 6—8). Take care of the shims (1).
9. Lower the front axle member and pull it forwards.

DISASSEMBLING AND ASSEMBLING

Fixture 2560 and stand 2520 can suitably be used for work on a removed front end.

After the shock absorber has been removed, place tool 2868 as shown in Fig. 6—15. Compress the spring by screwing the spindle in until there is clearance at the rubber buffer of the upper control arm.

Concerning other instructions, see under "Removing" and "Installing" for the various components.

INSTALLING

1. Place the front axle member on a jack and move it under the vehicle.
2. Raise the jack so that the member comes into proper position. Fit the shims and tighten the bolts (2, 3 and 4, Fig. 6—8) properly.
3. Remove the support from under the engine and secure the engine at the front engine mountings.
4. Fit the relay arm and the stabilizer to the body.
5. Fit the pitman arm, making sure that the scribed mark on the pitman arm shaft and the pitman arm coincide. Fit the spring washer and nut. Tighten the nut to a torque of 135—165 Nm (100—120 lbft).
6. Fit the attaching bolts for the stabilizer. Connect the brake hoses.
7. Bleed the brakes in accordance with the instructions given in Part 5. When about to do this remove the temporary plug from the brake fluid container cap.
8. Mount the wheels and lower the vehicle.
9. Check wheel alignment. See under "Wheel alignment", page 6:3.

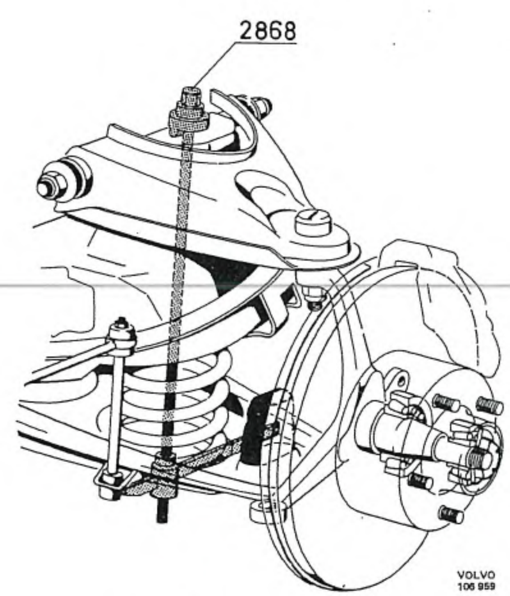


Fig. 6—15. Compressing spring

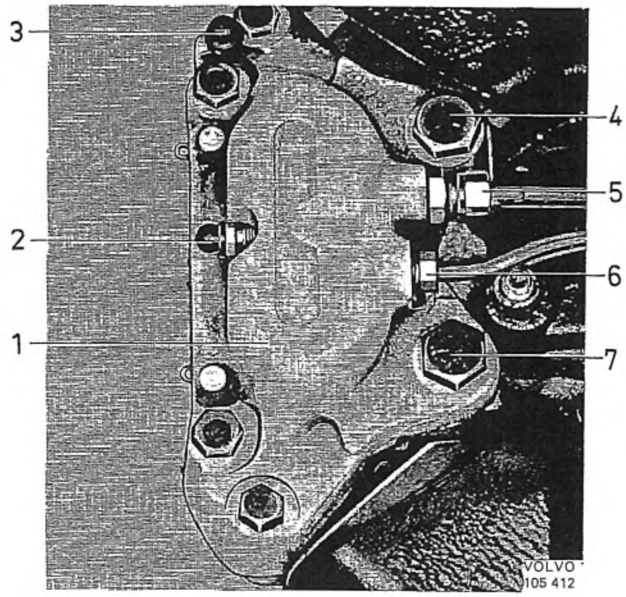


Fig. 6–16. Front wheel brake unit fitted

1. Front brake caliper
2. Lower bleeder nipple
3. Upper bleeder nipple
4. Attaching bolt
5. Connection for upper wheel cylinder
6. Connection for lower wheel cylinder
7. Attaching bolt

STUB AXLE

REMOVING

1. Slacken the wheel nuts slightly. For the moment plug the vent-hole in the brake fluid container cap in order to reduce leakage.

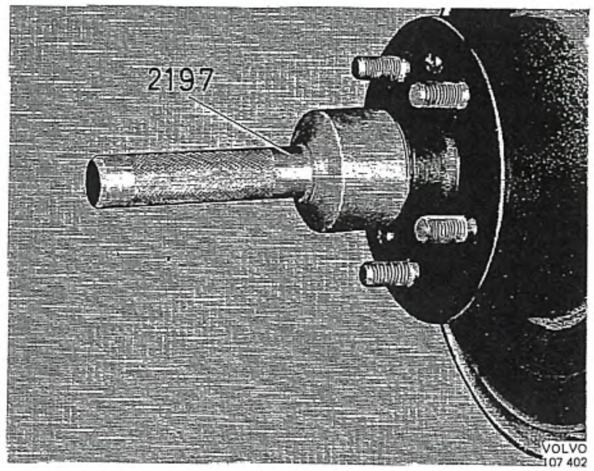


Fig. 6–18. Removing grease cap

2. Raise the front end and prop blocks under the lower control arms. Unscrew the wheel nuts and lift off the wheels.
3. Unscrew the nipples of the brake pipes from the hose nipples. Slacken the pipes slightly at the brake caliper.
4. Unscrew the attaching bolts (4 and 7, Fig. 6–16) and remove the brake caliper, see Fig. 6–17. Remove any shims if fitted.
5. Remove the grease cap with 2197 according to Fig. 6–18. Remove the split pin and castle nut. Pull off the hub with puller 2726, see Fig. 6–19. If necessary, pull off the inner bearing from the steering knuckle with 1794 according to Fig. 6–20.

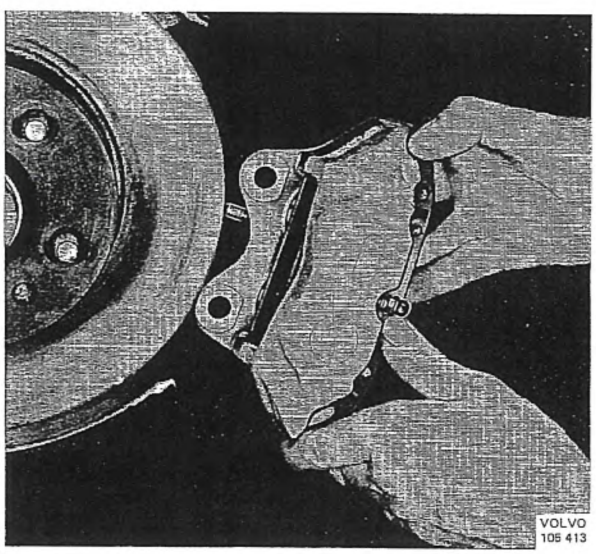


Fig. 6–17. Removing brake caliper

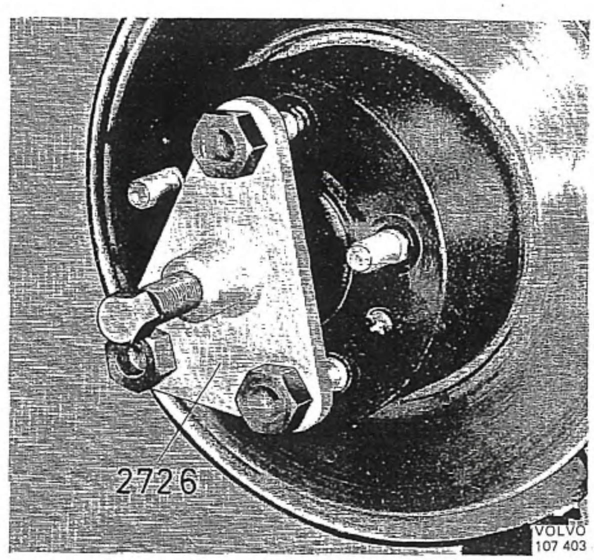


Fig. 6–19. Removing hub

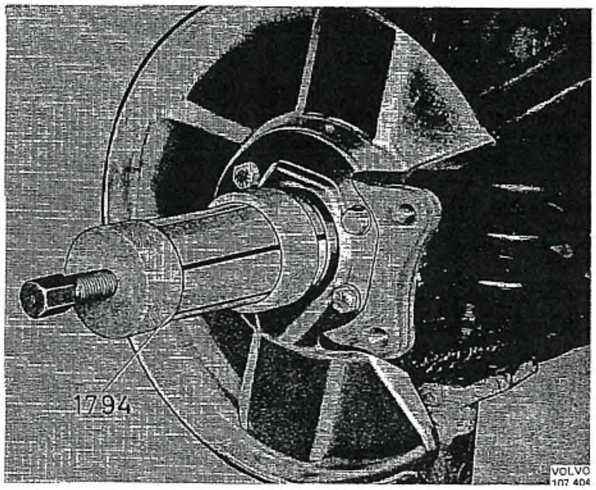


Fig. 6–20. Removing inner bearing

6. Remove the four bolts and separate the protective cover, retainer and steering arm from the knuckle.
7. Remove the ball joints, see operations 3–4 under "Removing" for the upper and lower ball joints respectively.
8. Lift out the stub axle steering knuckle.

CLEANING AND LUBRICATING WHEEL BEARINGS

Since the wheel bearings are exposed, they must be cleaned and lubricated before being re-fitted. The following recommendations are therefore to be followed.

After the bearing and bearing ring have been removed, clean the hub and grease cap thoroughly. Make sure that all the old grease even inside the hub is removed. Compressed air can suitably be used for rough cleaning of the bearings. Thereafter wash the bearing components in white spirit and allow them to dry. Avoid drying with compressed air since it often contains water and dust particles. Accessible bearing parts should be dried with a cloth or cotton rag (no waste). A new bearing taken straight out of its packing does not have to be cleaned.

After cleaning, inspect the parts. If damage, rust or bluing is discovered on the bearing races or rollers, change the bearings. If the outer or inner ring is loose in its position, try remedying this by fitting a new ring. The sealing rings are to be replaced if they are worn or damaged.

When lubricating the wheel bearings, use only a first-class durable grease for wheel bearings. Pack as much grease as possible by hand between the roller retainers and inner race. Also grease the outside of the rollers and retainer. Fill the spaces in the hub between the outer and inner bearing with grease according to Fig. 6–21.

Soak the felt rings of the wheel hubs in oil, for example, light engine oil, before fitting.

Clean bearings is of great importance to their lifetime. Therefore, do not let ungreased bearings remain unprotected. Observe the utmost cleanliness when fitting them.

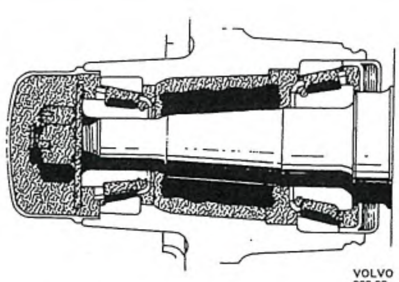


Fig. 6–21. Front wheel bearings

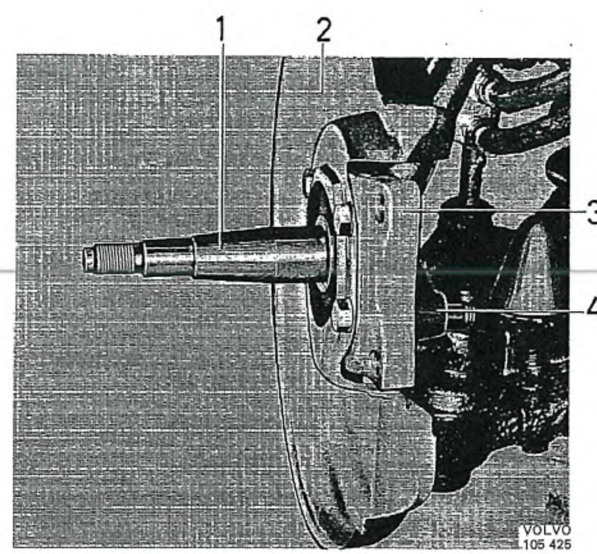


Fig. 6–22. Front end components

1. Stub axle
2. Protective plate
3. Retainer
4. Steering arm

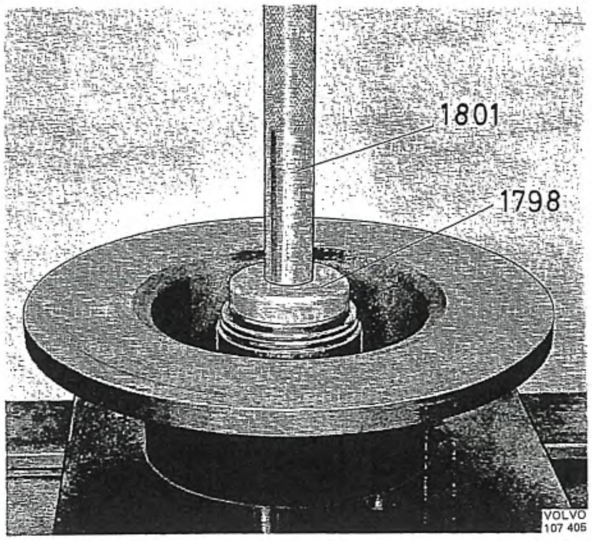


Fig. 6–23. Installing sealing ring

INSTALLING

1. Fit the stub axle (steering knuckle) in position and then the ball joints, see operation 2 under "Fitting" for the upper and lower ball joints respectively.
2. Fit together the steering knuckle, retainer, steering arm and protective plate with the four bolts, see Fig. 6–22.
3. Place the inner bearing in position in the hub. Press the sealing ring in with drift 1798 and standard handle 1801, see Fig. 6–23.
4. Place the hub on the stub axle. Fit the outer bearing, washer and castle nut.
5. Fit the front wheel bearings by tightening the nut with a torque wrench to a torque of 70 Nm (50 lbft) while rotating the hub. Then slacken the nut two hex flats. If the nut recess does not coincide with the split pin hole in the stub axle, slacken the nut some more to enable the split pin to be fitted. Check to make sure that the hub can be rotated easily without looseness.
6. Fill the grease cap halfway with grease and fit it with tool 2197.
7. Fit the brake caliper in position. Check to make sure that it takes up the proper position in relation to the brake disc. Check for axial deviation by measuring on both sides of the disc with a feeler gauge the distance between disc and support lug of the caliper. Maximum difference in measurement allowed is 0.25 mm (0.01"). The caliper should be parallel with the disc. This is checked by measuring the distance to the upper or lower support lug on the caliper. The location of the brake caliper can be adjusted by means of shims. Fit the attaching bolts after having given them a couple of drops of Locktite, type AV.
8. Connect the brake lines as shown in Fig. 6–15.
9. Bleed the fitted brake caliper, see Part 5.
10. Fit the wheel after having first cleaned the contact surfaces from dirt, etc., and tighten the wheel nuts so much that the wheel cannot be moved. Lower the vehicle and final-tighten the wheel nuts.

UPPER BALL JOINT

CHECKING WEAR

In principle this check can be made with the front end either jacked up or lowered. However, the upper control arm should not be against the rubber stop.

Check to see whether the ball joint has any **radial** clearance by bending up the wheel. If there is radial clearance, the upper ball joint should be replaced. Note: Do not mix up possible play in the wheel bearings with clearance in the ball joint.

Axial clearance should not be measured for the upper ball joint.

REMOVING

1. Slacken the wheel nuts several turns.
2. Raise the front end and place a trestle under the lower control arm. Unscrew the wheel nuts and take down the wheel.
3. Unscrew the nuts (5, Fig. 6–24) and remove the bolts (8). Lift off the upper control arm (7).
4. Unscrew the nut (10) and remove the bolt (9). Remove the upper ball joint (6) together with sealing washer and rubber cover from the steering knuckle.

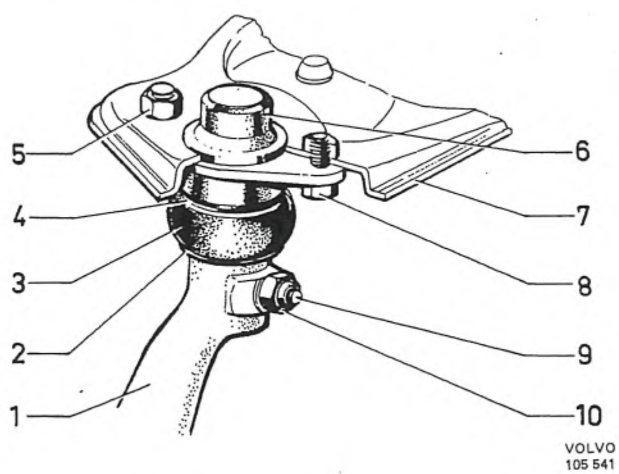


Fig. 6–24. Upper ball joint attachment

1. Spindle	6. Upper ball joint
2. Circlip	7. Upper control arm
3. Rubber cover	8. Bolt
4. Circlip	9. Clamp bolt
5. Nut	10. Nut

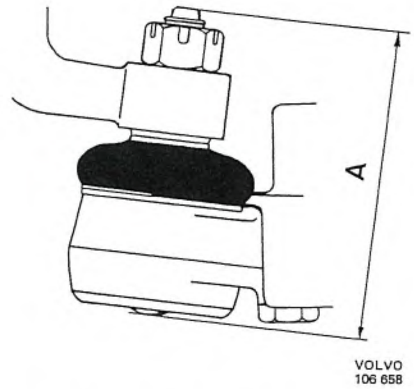


Fig. 6—25. Lower ball joint, type 1 (without spring)
A=Max. 94 mm (3.76")

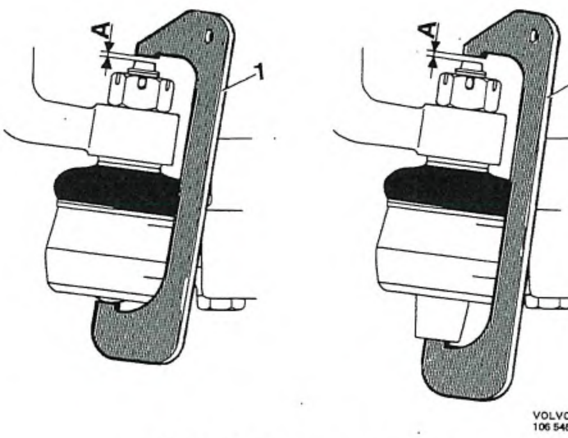


Fig. 6—27. Approved ball joints
1. 2969 for ball joint type 1
   2970 for ball joint type 2
A = Clearance

INSTALLING

1. Check to make sure that the rubber seal is not damaged and is filled with grease. If necessary, top up with universal grease. Make sure that the sleeve and circlips are properly located, see Fig. 6—24.
2. Place the ball joint in position on the steering knuckle and fit the clamping bolt.
3. Connect the upper control arm to the ball joint and fit the attaching bolts.
4. Fit the wheel and screw on the wheel nuts. Lower the vehicle and final-tighten the wheel nuts.

LOWER BALL JOINT

CHECKING WEAR

There are two types of lower ball joints. Type 2 (Fig. 6—26) has a built-in spring, while type 1 (Fig. 6—25) does not have such a spring.

This gauge is available for making a quick check on the lower ball joint in its operating position. The check should be made with normal load on the wheels, that is, with the vehicle standing on the ground, or a platform or similar. The wheels should point straight forwards. The tool cannot be used when jacking with a jack or hoist, which off-loads the ball joint. The check is carried out as follows: Place the gauge over the ball joint. If the gauge (see Fig. 6—27) can be fitted over the ball joint, then the joint can be approved. If the length of the ball joints is greater than the tool span (see Fig. 6—28), the ball joint should be replaced.

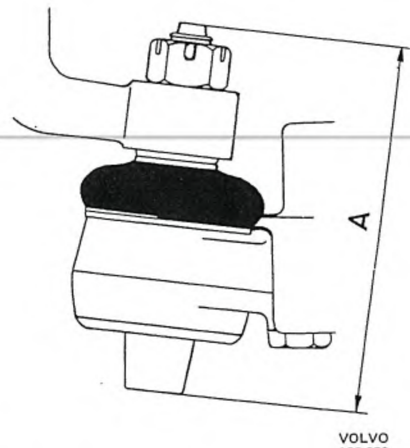


Fig. 6—26. Lower ball joint, type 2 (with spring)
A=Max. 111 mm (4.4")

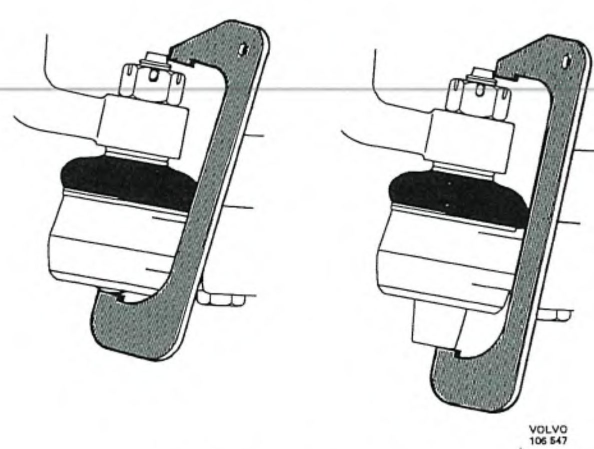


Fig. 6—28. Worn ball joints

REMOVING

1. Slacken the wheel nuts several turns.
2. Raise the front end and place a trestle under the lower control arm. Unscrew the wheel nuts and take down the wheel.
3. Unscrew the nuts (6, Fig. 6–30) and remove the four bolts (8). Remove the nut (3).
4. Disconnect the brake hoses from the retainer. Fit tool 2281 to the steering knuckle, see Fig. 6–29. Probably the retainer for the brake lines may have to be bent slightly to the one side. Turn the tool nut until the tool starts to tension. Then turn the nut until the ball joint releases, but max. 1 1/2 turns. If the ball joint is so securely fitted that it cannot be slackened with this turning, try tapping light taps with a hammer and counterhold on the steering knuckle's ball joint attachment.

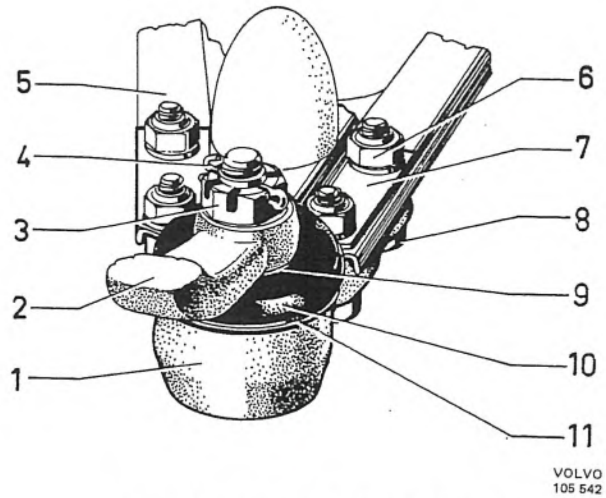


Fig. 6–30. Lower ball joint attachment

1. Lower ball joint
2. Spindle
3. Castle nut
4. Split pin
5. Lower control arm
6. Nut
7. Bracket
8. Bolt
9. Circlip
10. Rubber cover
11. Circlip

INSTALLING

1. Check to make sure the rubber seal is not damaged and fill with grease. If necessary, fill with universal grease. Make sure that the sleeve and circlips take up their proper position, see Fig. 6–30.
2. Fit the ball joint in position on the steering knuckle and fit the nut. Tighten the nut to a torque of 48–55 Nm (35–40 lbft).
3. Connect the lower ball joint to the control arm and fit the four attaching bolts.
4. Fit the brake hoses and bleed the brake caliper.
5. Fit the wheel and wheel nuts. Lower the vehicle and final-tighten the wheel nuts. Fit the hub cap.

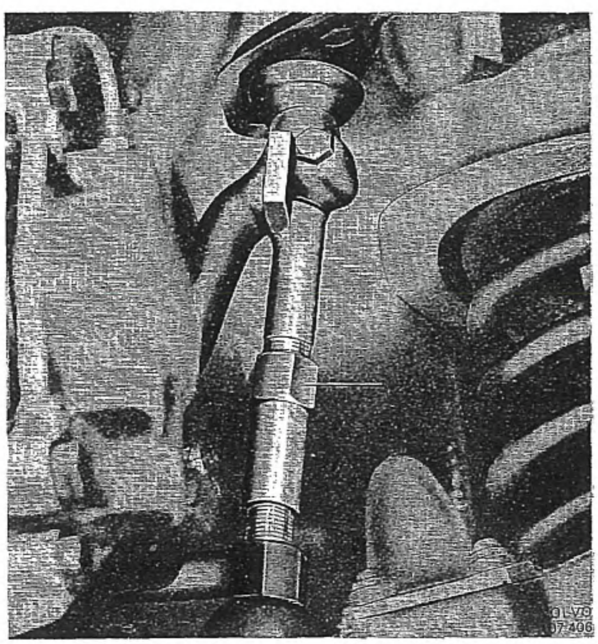


Fig. 6–29. Removing lower ball joint

UPPER CONTROL ARM

REPLACING BUSHES

1. Slacken the wheel nuts several turns.
2. Raise the front end and place a trestle under the lower control arm. Unscrew the wheel nuts and lift off the wheel.
3. Unscrew the nuts (6, Fig. 6–13) and remove the clamps (4).
4. Bend up the lock plate (3, Fig. 6–7), unscrew the attaching bolts (2) and remove the shaft. Take care of the shims (1).
5. Remove the nuts (Fig. 6–13), the washers (2), the bushes (3) and the sleeves (5).

6. Fit the new rubber bushes and sleeves on the control arm shaft.
To facilitate fitting, soap solution can suitably be used as a lubricant. Fit the washers (2) and tighten the nuts (1) see Fig. 6–13. Then fix the control arm with its clamp loose on both the bushes.
7. Fit the shims and fix the shaft (9) and wishbone. see Fig. 6–7. Tighten the attaching bolts (1) to a torque of 48–55 Nm (35–40 lbft) and lock them with the tab washer (3).
8. Tighten the attaching nuts. (6, Fig. 6–13) for the clamps to a torque of 20–25 Nm (14–18 lbft). Mount the other components in reverse order to removal.
9. Check the wheel angles, see under "Wheel alignment".

REPLACING UPPER CONTROL ARM

1. Remove the hub cap and slacken the wheel nuts slightly.
2. Raise the front end and place a trestle under the lower control arm. Unscrew the wheels nuts and take down the wheel.
3. Unscrew the nuts (6, Fig. 6–13) and remove the clamps (4).
4. Remove the nuts (5, Fig. 6–24) and the attaching bolts (8) for the upper ball joint and lift off the upper control arm.
5. Fit the new control arm in position and also the attaching bolts for the upper ball joint. Fit the clamps and tighten the nuts to a torque of 20–25 Nm (14–18 lbft).
6. Re-fit the other components. Check the wheel alignment.

LOWER CONTROL ARM

REPLACING LOWER CONTROL ARM BUSHES

1. Raise the front end and place props under the front axle member.
2. Unscrew the nut (6, Fig. 6–14). Use a spanner on the bolt head as a counterhold if the bolt (3) follows the nut. Remove the washer (5).
3. Place a jack under the lower control arm inside the spring and jack up so far that the bolt (3) can be easily removed.
4. Then replace the old bushes (2 and 4) with new ones and make sure they face in the proper direction as shown in Fig. 6–14.
5. Fit the bolt (3). Make sure that the smallest washer (1) is placed nearest the bolt head.
6. Fit the large washer (5) and the nut (6), which must not be tightened.

7. Lower the jack and place it under the control arm at the outer edge of the spring. Carefully jack up until the distance (D, Fig. 6–31) between the top of the rubber buffer and the front axle member is approx. 40 mm (1 1/2"). Tighten the nut (6) in this position.
8. Lower the vehicle. Check the wheel angles, see under "Wheel alignment".

REPLACING LOWER CONTROL ARM

1. Remove the hub cap and slacken the wheel nuts slightly.
2. Raise the front end and place props under the front axle member. Unscrew the wheel nuts and take down the wheel.
3. Remove the upper nut for the shock absorber, the washers and rubber bushes. Take off the lower attaching washer and remove the shock absorber downwards.
4. Place a jack under the lower control arm in the middle under the spring. Raise the jack until the upper control arm's rubber buffer lifts.
5. Disconnect the stabilizer from the lower control arm. Remove the four attaching bolts (8, Fig. 6–30) and disconnect the lower ball joint from the control arm.
6. Lower the jack slowly and remove the spring when the control arm has been lowered sufficiently.
7. Unscrew the nut (6, Fig. 6–14) and remove the washer (5). Pull out the bolt (3) and lift off the control arm. Take care of the bushes and washers.
8. Installing is in reverse order to removal.
The distance (D, Fig. 6–31) between the top of the rubber buffer and the front axle member should be approx. 40 mm (1 1/2") when tightening the nut (6). After fitting, check and if necessary adjust the wheel angles, see under "Wheel alignment".

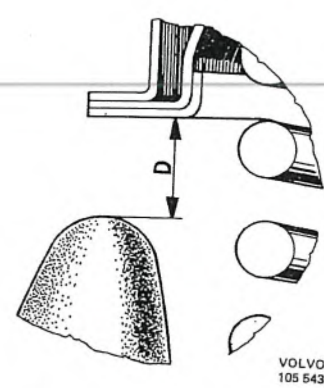


Fig. 6–31. Installing position
D=40 mm (1 1/2")

STEERING GEAR

DESCRIPTION

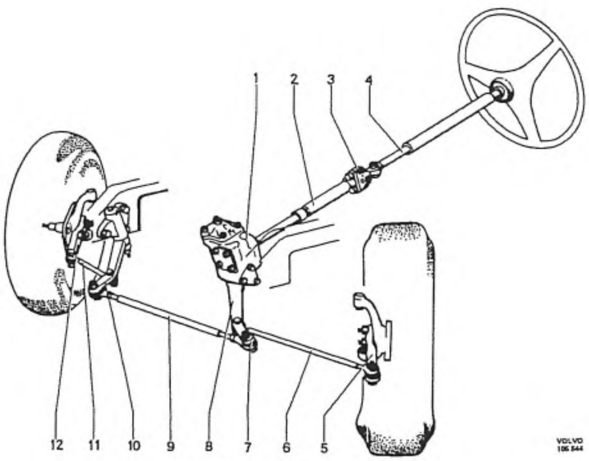


Fig. 6–32. Steering gear

1. Steering housing
2. Safety device
3. Rubber flange
4. Steering column
5. Left steering arm
6. Left steering rod
7. Ball joint
8. Pitman arm
9. Tie rod
10. Relay arm
11. Right steering rod
12. Right steering arm

The construction of the steering gear is shown in Fig. 6–32. Steering wheel movement is transmitted to the wheels through the steering column (4), steering housing (1), pitman arm (8), tie rod (9), steering rods (6 and 11) and steering knuckles. The gear in the steering housing (Fig. 6–34) is of the "worm and roller" type. The steering cam is carried in two ball bearings and the pitman arm shaft in three bushes.

The safety device (2) consists of a splined union with clamping sleeve, which permits axial compression during hefty impact. Together with the rubber flange (3), this device eliminates the risk of the steering wheel being pushed backwards–upwards should a frontal collision occud.

The relay arm (1, Fig. 6–33) is supported on a pin in the bracket by means of a bush. The bush consists of three parts, a rubber bush with an outer sleeve of sheet-metal and an inside one consisting of a spacing sleeve. The outer sleeve has a press fit in the hole of the relay arm. When the relay arm is turned, movement takes place between the outer sleeve and the rubber bush, the intervening space of which has been lubricated for life. In other words, the journalling requires no lubrication.

The steering column is journalled in the jacket tube (Fig. 6–38). The coupling (26) consists of a rubber disc which joins the flanges to the steering column and sleeve. Linkage with the steering housing is by means of bolting with clamping sleeve (3) which permits axial compression with powerful impact (frontal collision).

The ball joints on the rods are plastic-lined and therefore do not require any lubrication.

The car has a turning cicle of about 9.5 m (31 ft).

The number of steering wheel turns from lock to lock is 3 1/4.

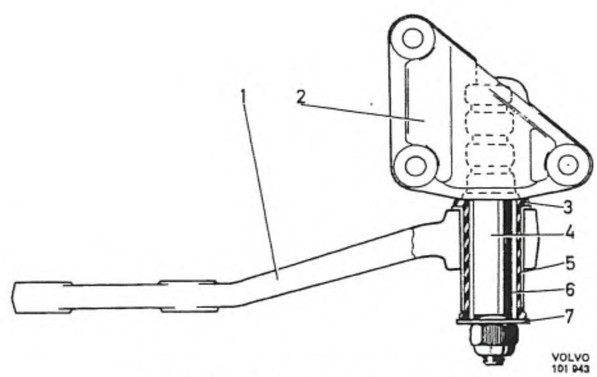


Fig. 6–33. Relay arm journalling

1. Relay arm
2. Bracket
3. Rubber bush
4. Bearing pin
5. Sleeve
6. Sleeve
7. Washer

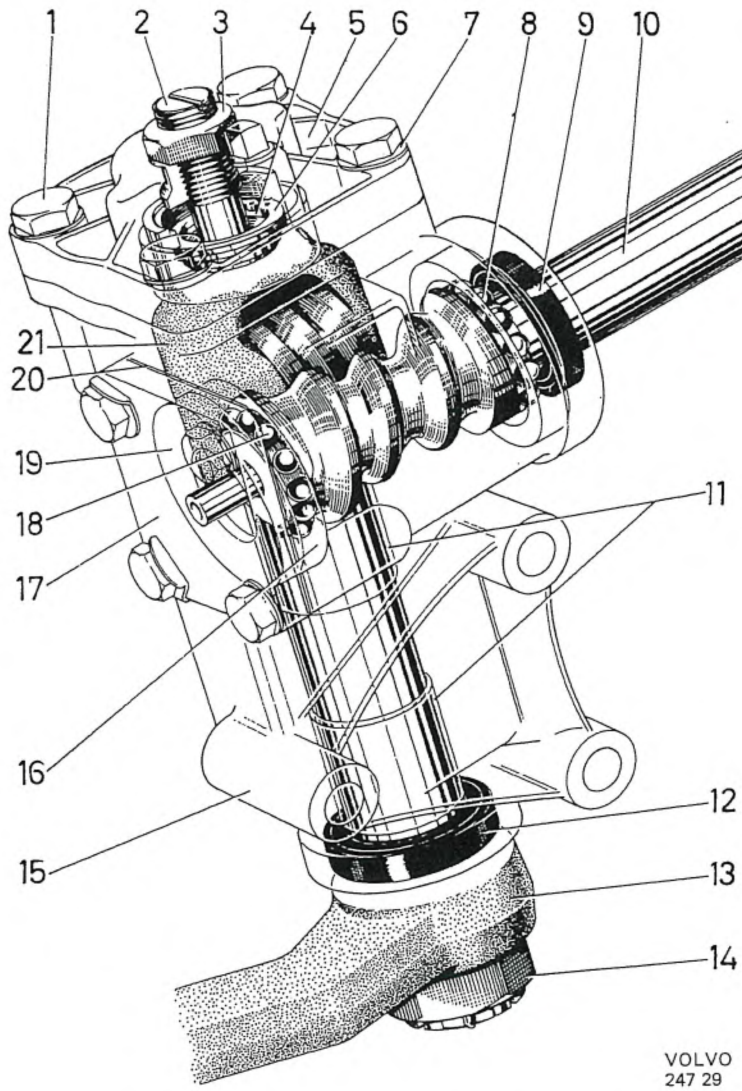


Fig. 6–34. Steering housing

1. Bolt
2. Adjusting screw
3. Locknut
4. Pitman arm shaft bush
5. Cover
6. Lock ring
7. Tab washer
8. Upper steering worm bearing
9. Oil seal, steering column
10. Steering worm shaft
11. Pitman arm shaft bush
12. Pitman arm shaft seal
13. Pitman arm
14. Nut
15. Housing
16. Lower bearing cap
17. Steering column cover
18. Lower steering worm bearing
19. Washer
20. Shims
21. Pitman arm shaft with roller

STEERING WHEEL LOCK

The vehicle has been made tamper-proof by means of a steering wheel lock integrally built with the ignition switch. The ignition switch has four positions, 0-I-II-III. When the steering wheel is turned, so that a slot on the lock lug (3, Fig. 6–35) comes opposite the lock pin, the pin enters the slot and locks the steering wheel column so that the front wheels cannot be turned. When the ignition key is inserted and switched to position "I", the lock pin is pulled back and this releases the steering column which is secured in a withdrawn position. At position "I", the vehicle can be moved with the ignition switched off.
At position "II", the ignition is switched on and in position "III" the starter motor can be engaged.
The steering wheel lock is mounted to the column by means of two shear-off bolts.

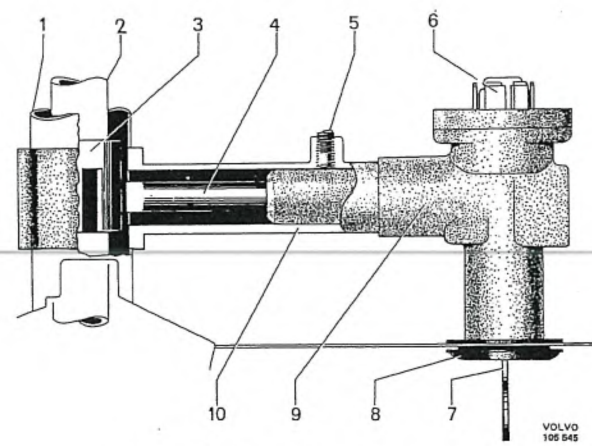


Fig. 6–35. Steering wheel lock parts

1. Steering column jacket
2. Steering column
3. Lock lug
4. Lock plunger
5. Lock bolt (sheared)
6. Electrical connection
7. Key
8. Rubber bush
9. Steering wheel lock
10. Attachment

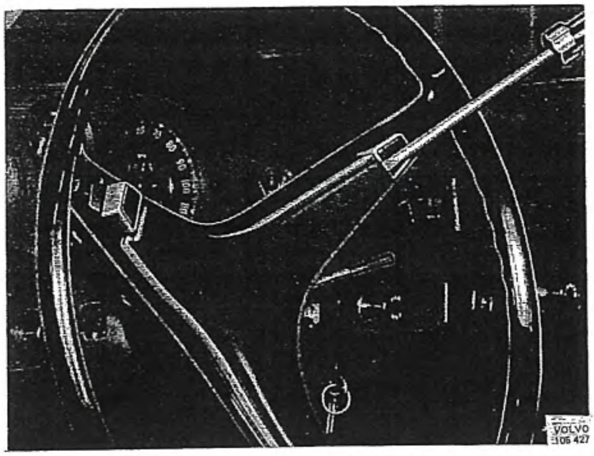


Fig. 6–36. Removing impact pad

Replacing steering wheel

1. Carefully lever loose the impact pad, see Fig. 6–36.
2. Disconnect the horn cable from the terminal. Unscrew the three screws and lift out the horn ring with screws, springs and washers.
3. Push down the horn cable so that it projects only a couple of mm outside the steering column. Unscrew the steering wheel nut. Mark up the location of the steering wheel.
4. Pull the steering wheel off with puller 2263, see Fig. 6–37.

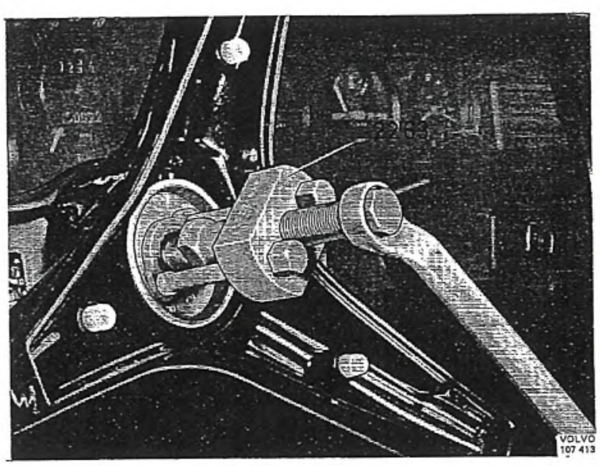


Fig. 6–37. Removing steering wheel

5. Fit the new steering wheel and the other parts. Tighten the steering wheel nut to a torque of 28–40 Nm (20–30 lbft). Tighten the horn ring bolts to the bottom.

Replacing steering wheel lock

1. Disconnect one of the battery leads.
2. Disconnect the connections from the ignition lock after line-up marks have been made if necessary.
3. Take off the sheared lock bolt (5, Fig. 6–35). Use an angle driller and bolt extractor. Bolt diameter 8 mm (5/16").
4. Press in the rubber bush (8) and lift forward the steering wheel lock.
5. Fit the new steering wheel lock and the rubber bush. Fit the lock bolt so far that it just bottoms. Check the function of the steering wheel lock. If necessary adjust the lock to the right position.
6. Connect all the electric cables and test to make sure the various components function properly.
7. Tighten the lock bolt until the hex head shears off.

Replacing steering column and bearing in steering column jacket

1. Remove the clamping bolt (5, Fig. 6–38) and disconnect one of the battery leads.
2. Remove the steering wheel, see under "Replacing steering wheel". Remove the flange, turn indicator lever switch, spring and bearing seat.
3. Disconnect the lock ring (23) and pull down the spring (6) and seat (7) for the bearing.
4. Pull out the steering column with the help of the steering wheel.
5. If the bearings (13 and 22) in the steering column jacket are to be replaced, remove the old ones with a suitable tool such as an extractor.
6. Insert the steering column in the steering column jacket and fit the parts of the lower bearing. Fit the horn cable with the help of wire. Push the steering column into the flange and fit the clamping bolt (5) and lock ring (23).
7. Fit the upper bearing parts and the turn indicator lever switch as well as the flange. Fit the steering wheel and check the function of the steering wheel lock.
8. Tighten the steering wheel nut to a torque of 28–40 Nm (20–30 lbft) and fit the horn ring and the remaining parts.

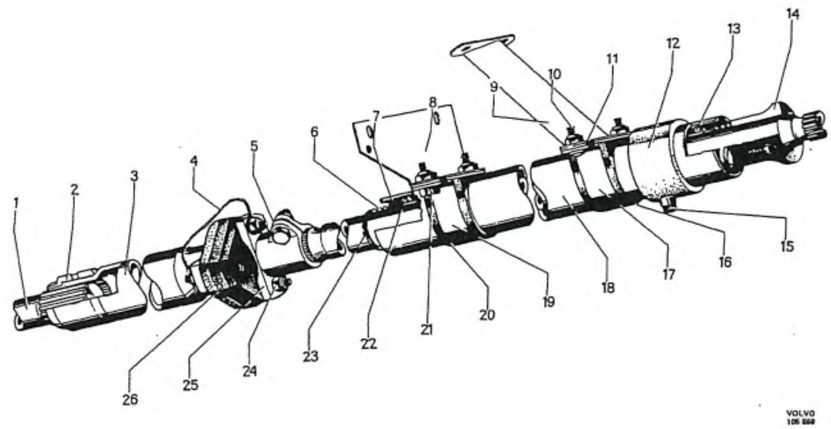


Fig. 6–38. Steering column

1. Steering worm shaft
2. Nut
3. Sleeve
4. Ground lead
5. Clamping bolt
6. Spring
7. Seat
8. Lower attachment
9. Upper attachment
10. Shear bolt
11. Spacer
12. Steering lock attachment
13. Upper bearing
14. Flange
15. Bolt
16. Rubber bush
17. Clamp
18. Steering column jacket
19. Clamp
20. Rubber bush
21. Bolt
22. Lower bearing
23. Lock ring
24. Nut
25. Flange
26. Coupling disc (rubber)

STEERING HOUSING

REMOVING

1. Pull the horn cable out from the connector at the steering housing.
2. Unscrew the nut (4, Fig. 6–39) from the sleeve (5). Use a hock spanner in the nut hole.
3. Remove the pitman arm with puller 2370 (Fig. 6–40).
4. Unscrew the three attaching bolts (3, Fig. 6–41). Lift forward the steering housing. If the cable terminal gets in the way, cut the cable at the terminal and fit a new terminal when re-fitting.

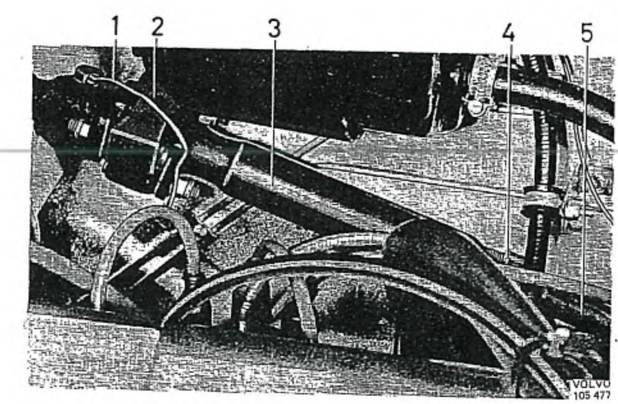


Fig. 6–39. Coupling parts

1. Electric cable
2. Coupling disc (rubber)
3. Sleeve
4. Nut
5. Steering worm shaft

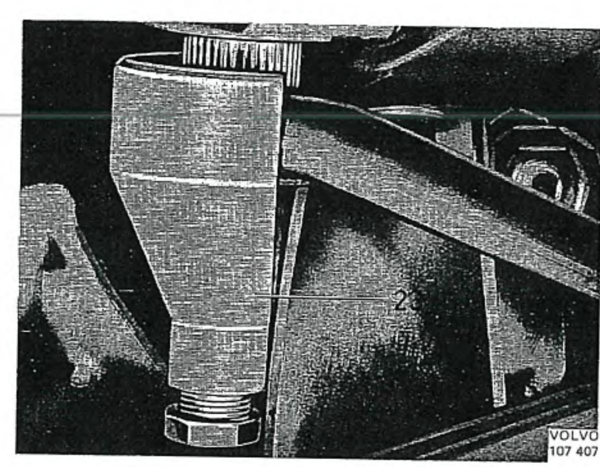


Fig. 6–40. Removing pitman arm

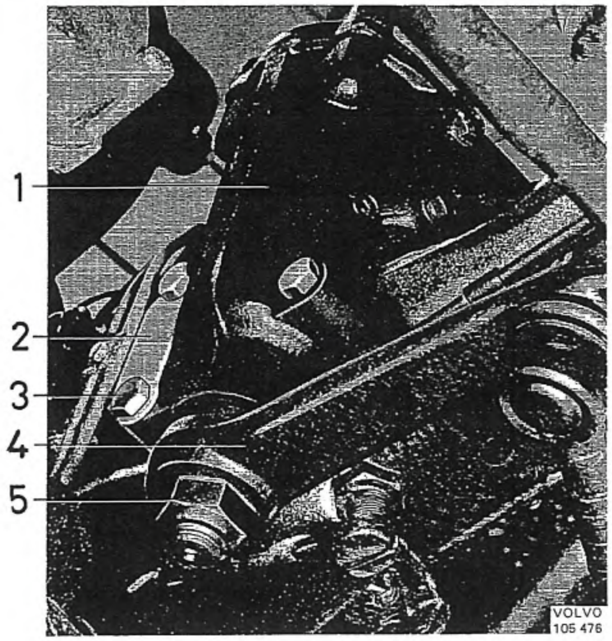


Fig. 6–41. Steering housing fitted

1. Steering housing
2. Bracket
3. Attaching bolt
4. Pitman arm
5. Nut

DISASSEMBLING

1. Clean the outside of the steering housing.
2. Set the steering housing in the middle position. Remove the four bolts (1, Fig. 6–34) for the upper cover (5), pull up the cover and pitman arm shaft a bit and drain the oil. Pull out the cover and pitman arm shaft.
3. Remove the bolts and lower cover (17). Take care of the shims (20).

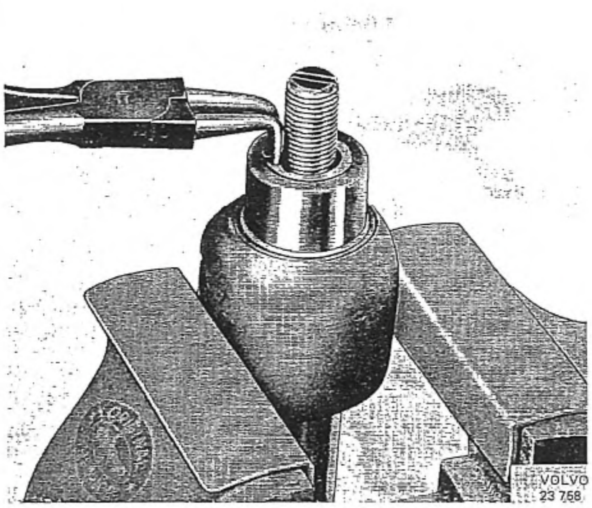


Fig. 6–42. Removing adjusting screw

4. Carefully tap on the steering worm shaft (10) so that the lower bearing outer race releases from the housing. Take out the shaft (10) with bolt and bearing.
5. Release the locknut (3) and unscrew the adjusting screw (2) from the cover. The adjusting bolt can be removed from the pitman arm shaft after the lock ring has been taken off, see Fig. 6–42.

INSPECTING

Clean all the parts in white spirit. The sealing plug must not come in contact with acetone-hardened cleaning agent. Check the sealing rings. If they show the slightest indication of wear or damage, replace them. They are replaced with the help of puller 4030 or with a screwdriver. Check the pitman arm shaft. The roller must not be scored, scratched or heavily worn on the contact surfaces or be loose in the pitman arm shaft. If this is the case or if the shaft has other damage, replace the shaft.

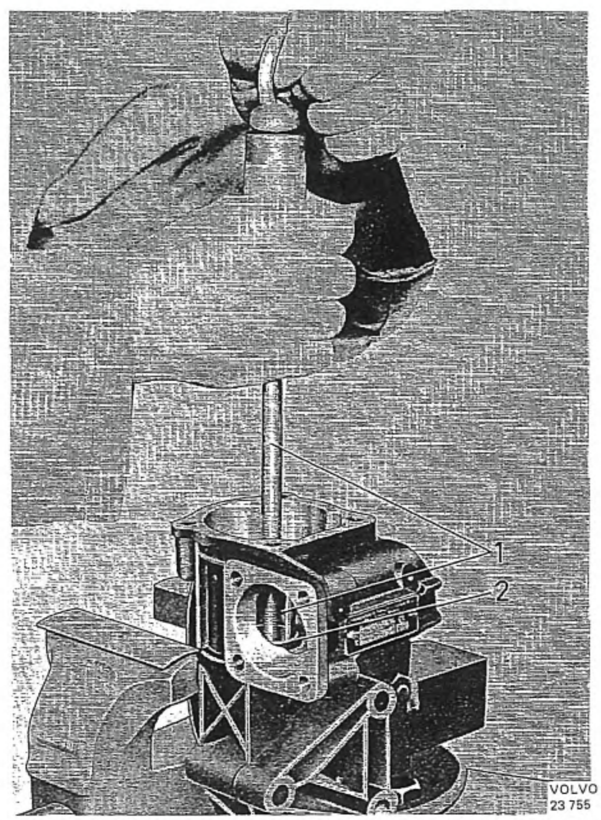


Fig. 6–43. Removing pitman arm shaft bush
1. 1819 2. Pitman arm shaft bush

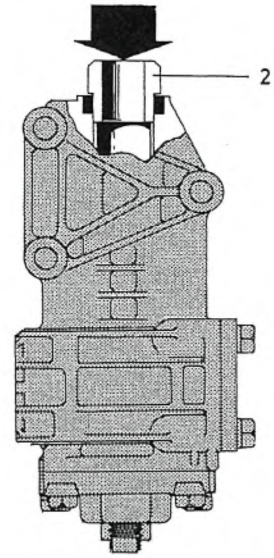


Fig. 6–44. Fitting pitman arm shaft bush

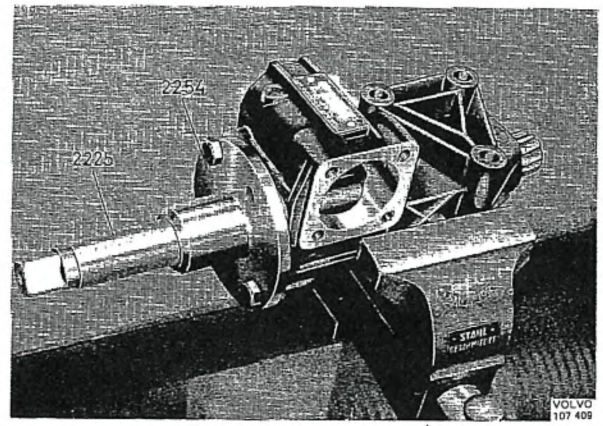


Fig. 6–45. Reaming pitman arm shaft bushed

Check the contact surfaces of the steering worm shaft against the roller as well as the inner races of the ball bearings. If there is evidence of scratches, scoring or heavy wear, replace the steering worm shaft with steering column. Examine the outer rings and balls of the bearings. Replace bearing parts that are scored or damaged in any other way. The upper bearing outer ring is removed with the help of puller 1819 or, if the sealing ring is removed, with drift 1708.
Check to see if the pitman arm shaft is loose in the housing by removing them each in their own direction with puller 1819 (Fig. 6–43). The bush in the pitman arm shaft cover cannot be removed so that the cover must be replaced complete.

ASSEMBLING

1. From each direction press in the pitman arm shaft bushes with drift 2228 and standard handle 1801, see Fig. 6–44. Ream the bushes with reamer 2225. Use tool 2254, which is fixed to the housing by means of two bolts, see Fig. 6–45. Clean the housing carefully from metal filings after reaming.
2. Fit the sealing rings for the pitman arm shaft and steering column with the help of drift 2227.
3. If the outer race of the upper bearing has been removed, press it in with 2717. When pressing in, make sure that it fits against the shoulder on the housing.
4. Carefully fit the steering camshaft with bearing in the housing in order not to damage the sealing ring. Fix the steering housing in a vise so that the steering cam shaft is horizontal. Fit the lower cover and washer together with shims of the same thickness as previously. Use sealing agent on the bolts. Tighten the cover while checking at the same time that the shaft rotates easily without looseness. A torque of 10–25 Ncm (6–14 lbin) is required to turn the steering cam to the proper tensioning.
5. Fit the adjusting screw, washer and circlip on the pitman arm shaft, see Fig. 6–46. The axial play for the adjusting screw should be as small as possible and should not exceed 0.05 mm (0.002"). The play can be reduced by replacing the washer (2) with a thicker one. However, the adjusting screw should be easy to turn after fitting.

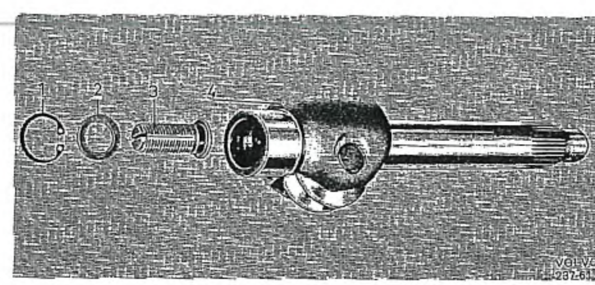


Fig. 6–46. Pitman arm shaft

1. Circlip	3. Adjusting screw
2. Washer	4. Pitman arm shaft with roller

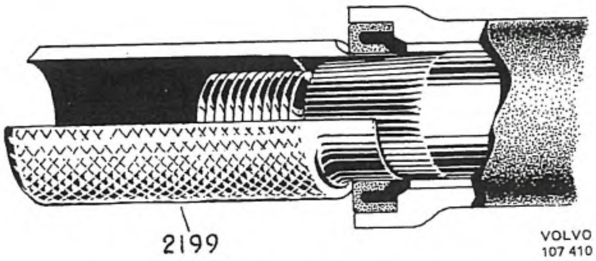


Fig. 6–47. Installing pitman arm shaft

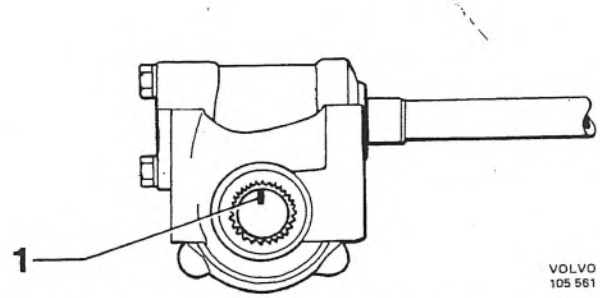


Fig. 6–49. Steering housing in middle position
1. Scribed mark on pitman arm shaft

6. Install the protective sleeve 2199 as shown in Fig. 6–47 and fit the pitman arm shaft in the housing. Apply some drops of oil to the adjusting screw in the pitman arm shaft.
7. Install the cover and gasket over the pitman arm shaft. Screw up the adjusting screw so far that the pitman arm shaft is not jammed when the attaching bolts are tightened. Lock the bolts with sealing agent.
8. Place the steering worm shaft in the middle position. Screw in the adjusting screw so far as to notice resistance when rotating the shaft forwards and backwards over the middle position. Fit a spring balance at a distance of 210 mm (8 1/2") from the shaft centre. The spring balance can suitably be attached to a swing iron mounted on the steering worm shaft, see Fig. 6–48.

Screw back the adjusting screw so far that the spring balance gives a reading of 4–7 N (1–1.5 lb) when it turns the shaft over the middle position. Tightening should take place at right angles to the shaft and the steering housing is mounted so that the shaft is vertical during the measuring. After adjustment to the correct take-up, lock the adjusting screw with the stop nut. Repeat the test after the stop nut has been tightened securely.
Incline the steering housing to the angle it takes up in the vehicle and fill with hypoid oil SAE 80 to the level of the filler hole.

INSTALLING

1. Place the steering housing in the middle position (Fig. 6–49) and turn the steering wheel so that the front wheels point straight forward.
2. Install the horn cable through the steering housing, if necessary, with the help of an iron wire.
3. Install nut (5, Fig. 6–41), the steering housing and its attaching bolts loosely in position.

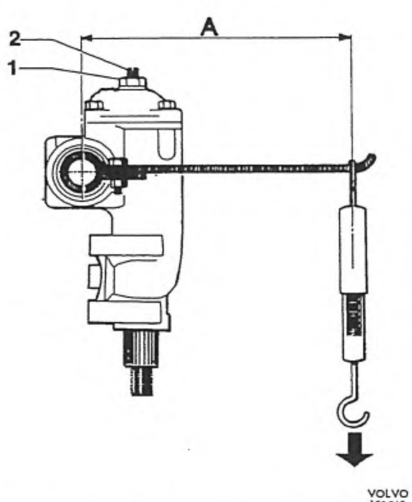


Fig. 6–48. Checking take-up between worm and roller
A=210 mm (8 1/4")
1. Locknut 2. Adjusting screw

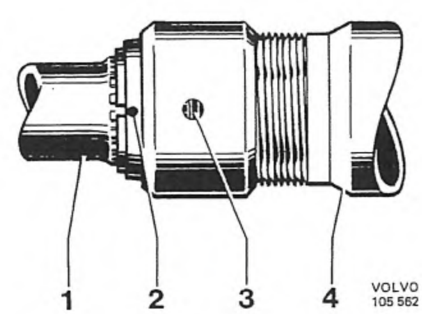


Fig. 6–50. Nut locking
1. Steering worm 3. Hole
2. Punch pop 4. Sleeve

4. Adjust the location of the steering housing so that the least possible tension is obtained in the clutch disc. Tighten the attaching bolts. Tighten the nut on the tensioning sleeve to a torque of 30–50 Nm (22–36 lbft) and lock it with punch pops on the slit of the tensioning sleeve, see Fig. 6–50.
   Connect the horn cable.
5. Fit the pitman arm so that the line-up mark on the pitman arm shaft comes opposite the line-up mark on the pitman arm. Tightening torque is 140–170 Nm (100–120 lbft).

RECONDITIONING STEERING RODS AND TIE RODS

The steering rods and tie rod may not be straightened. If warped or damaged in any other way, they are to be replaced.
The ball joints cannot be dismantled or adjusted, so when worn or damaged they are to be replaced. The ball joints of the steering rods are integrally made with the steering rods so that, when necessary, the steering rod must be replaced complete. When removing, first take off the split pins and castle nuts. Then place tool 2294 on the ball joint as shown in Fig. 6–51. Press in the tool well and make sure that the thread on the ball joint enters the recess in the tool. Screw in the bolt until the ball joint loosens. If the steering rod is to be removed with the wheel still on,

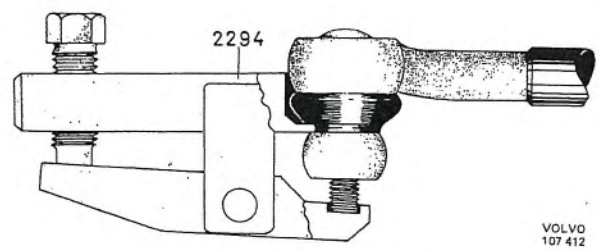


Fig. 6–52. Removing steering rod

first release the ball joint at the pitman arm and relay arm according to above. Then turn the steering rod forwards – upwards and place the tool on the ball joint as shown in Fig. 6–52.
In order to facilitate correct fitting, the left steering rod has been marked with the letter "L" and the right steering rod with the letter "R" at the outer end. The marked end should be fitted to the steering arm (at the wheel).
The ball joints for the tie rod can be replaced individually. When replacing, first release the ball joint from the pitman arm and relay arm according to above (see Fig. 6–51). Then release the locknut and clamp bolt and screw out the ball joint. The new ball joint is screwed in from the beginning with the same number of turns, and this makes the wheel aligning easier. Lock the ball joint to the rod, tightening torque 75–90 Nm (55–65 lbft).
When replacing the rubber covers on the ball joints, fill the new ones with universal grease.
When the ball joint is to be fitted to the arm, turn the ball pin so that the split pin hole is crosswise in the longitudinal direction of the rod. Tighten the castle nut to a torque of 32–37 Nm (23–27 lbft) and lock it with a split pin.
After carrying out the reconditioning of the rods and ball joints, always check the wheel alignment.

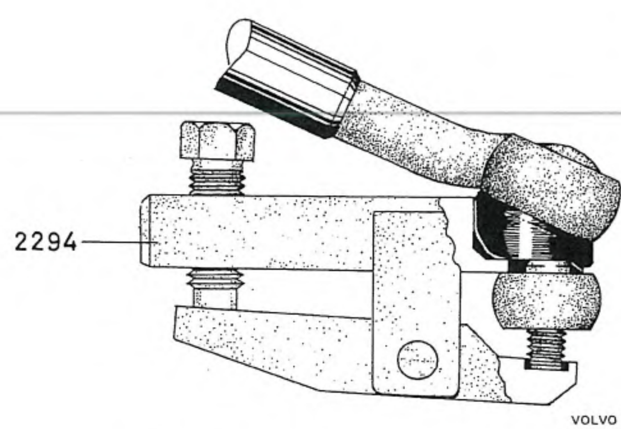


Fig. 6–51. Removing steering rod

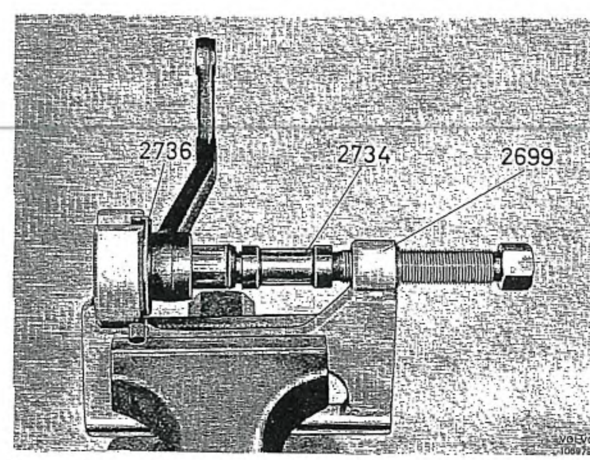


Fig. 6–53. Removing rubber bush, relay arm

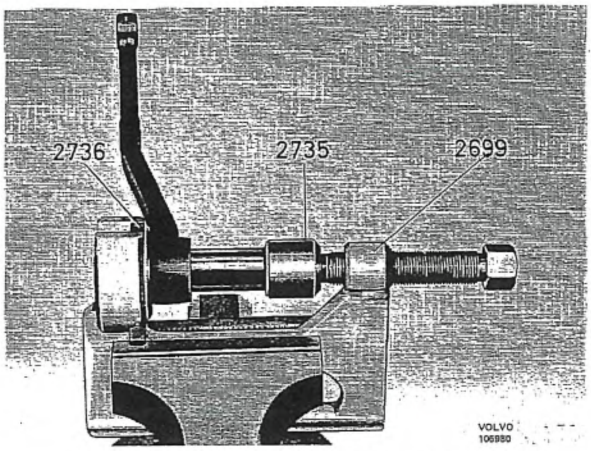


Fig. 6–54. Fitting rubber bush, relay arm

REPLACING RELAY ARM BUSH

1. Jack up the vehicle at the front end.
2. Disconnect the ball joints for the steering rod and tie rod from the relay arm with puller 2294, see Fig. 6–51.
3. Remove the nut and washer (7, Fig. 6–33) and take down the relay arm (1).
4. Place press 2699 in a vise and press out the bush with tool 2736 and drift 2734 (Fig. 6–53).
5. Turn the relay arm and press in the bush with tools 2699 + 2736 and drift 2735 (Fig. 6–54).
6. Place the relay arm in position, fit the washer (7, Fig. 6–33) and the nut.
7. Fit the steering rod (in the inner hole on the relay arm) and the tie rod. Tighten the nuts to a torque of 32–37 Nm (23–27 lbft).
8. Lower the vehicle.

Part 7

SPRINGS, SHOCK ABSORBERS, WHEELS

CONTENTS

GENERAL

TOOLS

The special tools are preceded either by 999 or SVO (e.g. 999 1801 or SVO 2726).

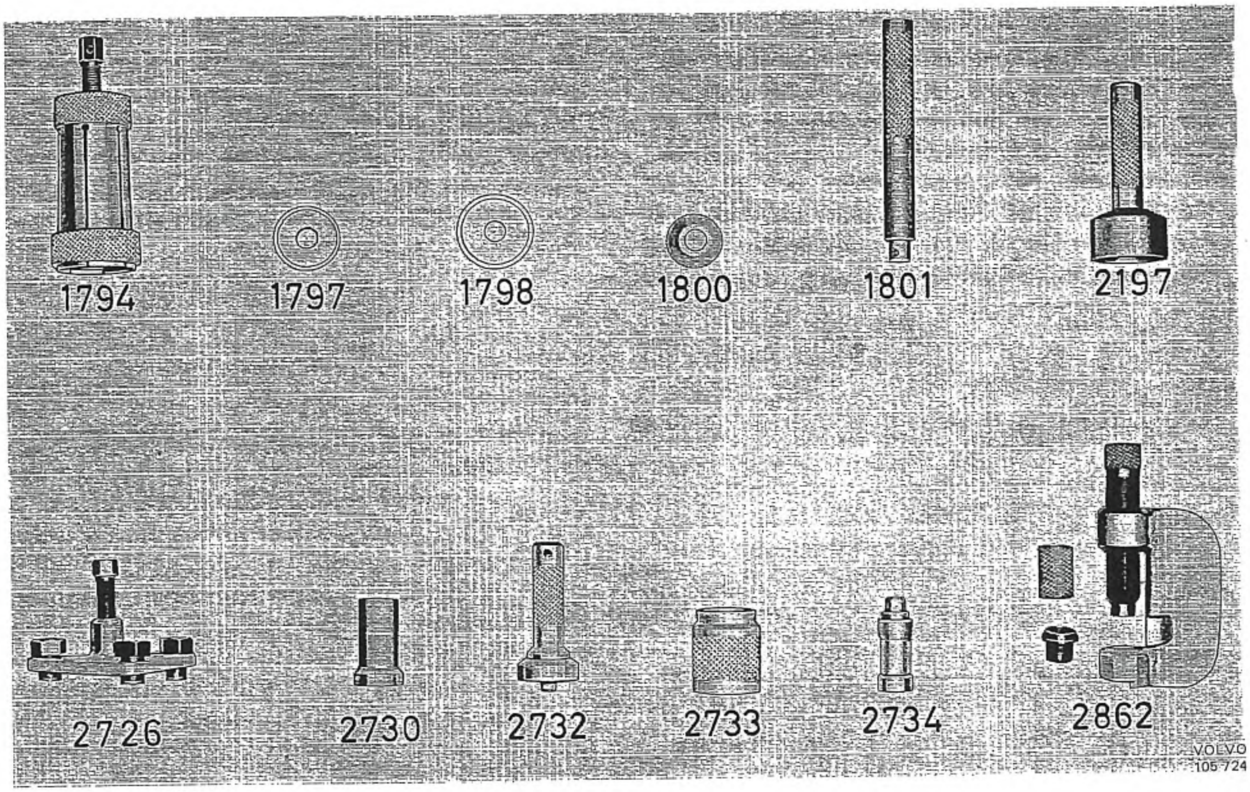


Fig. 7–1. Tools used for work on the rear axle suspension and hub

999
(SVO)

1794 Puller for inner ring, inner front wheel bearings
1797 Drift for fitting outer ring, outer front wheel bearings
1798 Drift for fitting outer ring and sealing ring, inner front wheel bearings
1800 Drift for removing outer ring, outer front wheel bearings
1801 Standard handle 18x200
2197 Drift for removing and fitting grease cap
2726 Puller for front wheel hub
2730 Drift for removing and fitting front bush in torque rod (+ 2733)
2732 Drift for fitting and removing rear bush in torque rod
2733 Counterhold for removing and fitting bushes in torque rod and support stay
2734 Drift for fitting and removing bushes in support stay
2862 Press tool for replacing wheel bolt

GROUP 73

SPRINGS

DESCRIPTION

The 1800 is fitted with coil springs at front and rear. The front wheels have individual suspension. The upper ends of the front springs (3, Fig. 7–2) are seated in housings formed in the front axle member, and the lower ends in the lower control arms. The lower control arms are also provided with rubber buffers (2), for absorbing any impacts arising from loading on the spring. The upper control arms are fitted with rubber buffers (1) which limit the downward movement of the control arms.

The upper ends of the rear springs (5, Fig. 7–4) support against the body and at the lower ends to the support arms behind the rear axle. Rubber buffers (3, Fig. 7–4) fitted on the rear side-members take up impacts from loading on the springs.

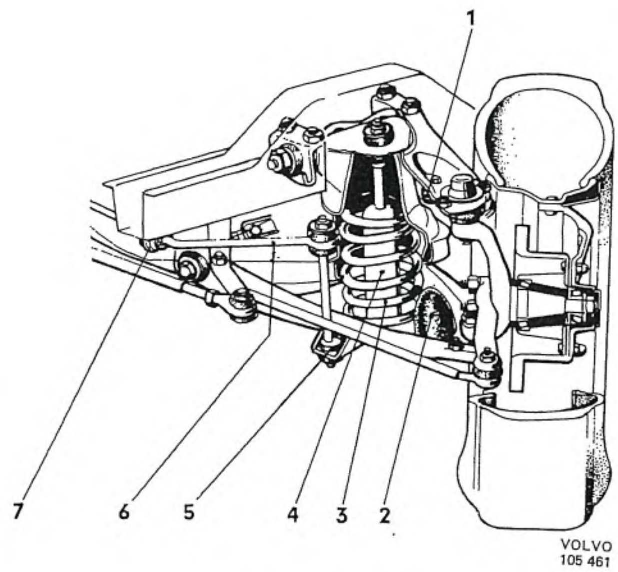


Fig. 7–2. Front spring and shock absorber

1. Rubber buffer
2. Rubber buffer
3. Spring
4. Shock absorber
5. Attachment for stabilizer
6. Stabilizer
7. Attachment for stabilizer

REPAIR INSTRUCTIONS

FRONT SPRINGS

REMOVING

1. Jack up the front end and place props under the front axle member.
2. Unscrew the wheel nuts and remove the wheel.
3. Remove the upper nut on the shock absorber and also the bolts for the lower attaching washer and draw down the shock absorber.
4. Place a jack under the lower control arm in the middle under the spring and jack up until the upper control arm rubber buffer lifts.
5. Unscrew the stabilizer from the lower control arm. Remove the nut for the lower ball joint.
6. Lower the jack slowly and remove the spring when the control arm has come down far enough. If the lower ball joint does not release when the jack is lowered, use removal tool 2281, see Service Manual, Part 6.

CHECK-MEASURING

Before fitting the spring, it should be check-measured. Measure the length of the spring compressed coil by coil, and the length under load in accordance with the "Specifications". Check also the rubber spacer.

INSTALLING

Place the rubber spacer and the washer in position in the spring housing in the member and install the spring in reverse order to removal. (See Fig. 7—3.)

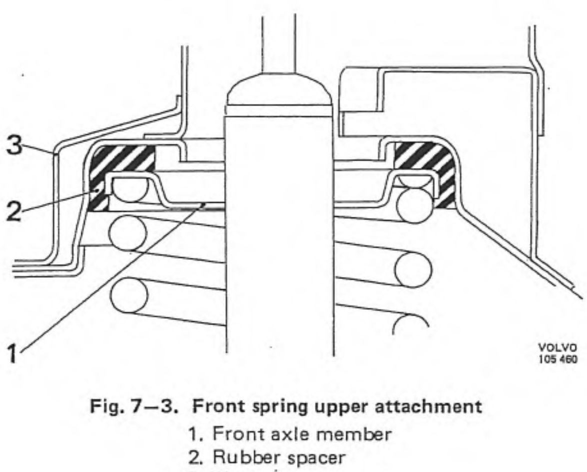


Fig. 7—3. Front spring upper attachment

1. Front axle member
2. Rubber spacer
3. Washer

REAR SPRINGS

REMOVING

1. Raise the rear end and place props under at the rear jack attachments.
2. Remove the wheels and release the parking brake.
3. Place a jack under the rear axle casing and jack up so far as to off-load the shock absorber band.
4. Unscrew the shock absorber at the lower attachment and the shock absorber band at the upper attachment
5. Lower the rear axle until the spring is free and remove the spring and spacer.

CHECK-MEASURING

See under "Front Springs, Check-measuring".

INSTALLING

Installing is in reverse order to removal. Make sure that the rubber cushion (7, Fig. 7—4) and the rubber spacer (4, Fig. 7—4) are fitted properly.

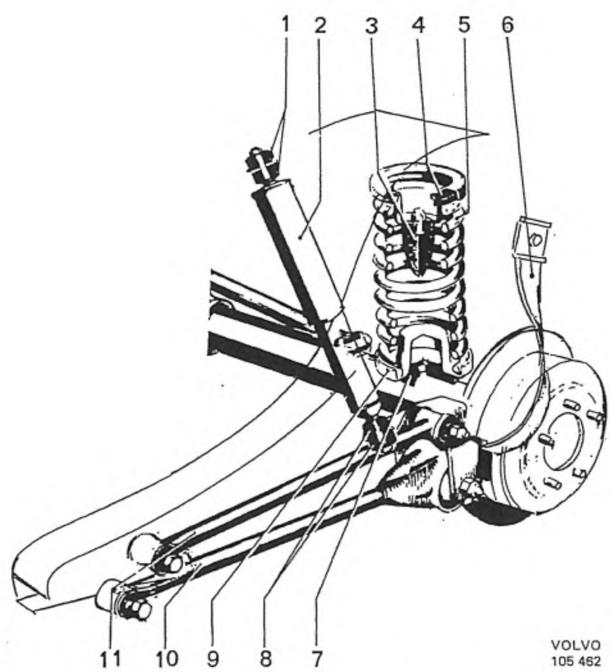


Fig. 7—4. Rear axle suspension

1. Upper shock absorber bushes
2. Shock absorber
3. Rubber buffer
4. Rubber spacer
5. Spring
6. Shock absorber band
7. Rubber cushion
8. Lower shock absorber bushes
9. Spring attachment
10. Torque rod
11. Support stay

SHOCK ABSORBERS AND STABILIZING DEVICES

DESCRIPTION

GENERAL

The 1800 is fitted with hydraulic, double-acting shock absorbers of telescopic type. They require no maintenance and cannot be disassembled.
The shock absorber attachments (Figs. 7—6 and 7—7) comprise threaded pins journalled in rubber bushes and washers. In order to prevent damage to the rear shock absorbers, shock absorber bands are fitted between the body and the rear axle to limit the down travel of the axle on the springs.
The stabilizer (6, Fig. 7—2) which is attached to both the lower control arm and the frame, increases the stability of the vehicle.
The rear axle is attached to the body through two flexibly mounted support stays (11, Fig. 7—4) and two torque rods (10). A track bar takes up lateral forces working on the vehicle. The stays, rods and track bar are provided with replaceable rubber bushes.

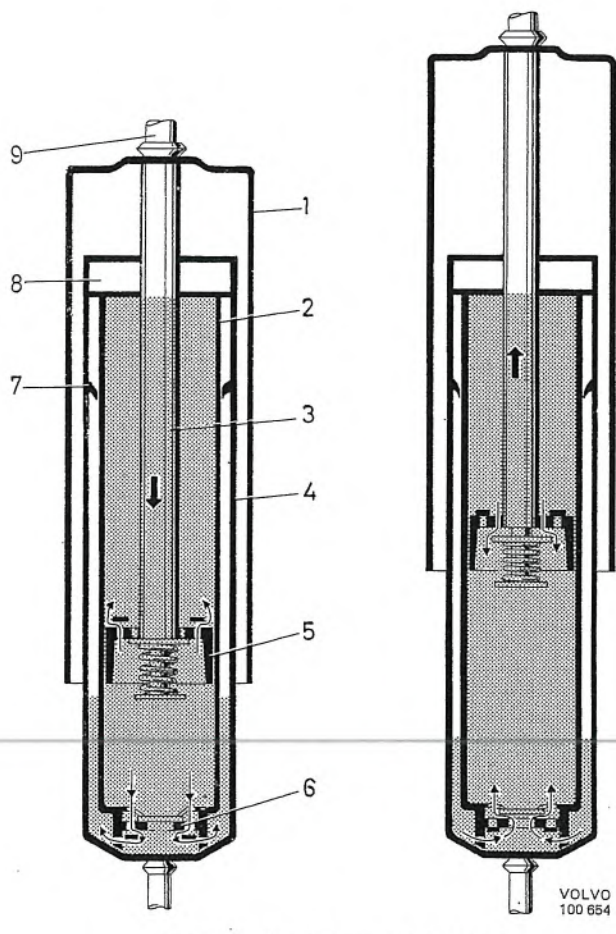


Fig. 7—5. Shock absorber, function

1. Dust cover
2. Working cylinder
3. Piston rod
4. Reservoir cylinder
5. Piston
6. Valve
7. Baffle ring
8. Cover
9. Upper attachment

SHOCK ABSORBERS

CONSTRUCTION

The construction of the shock absorbers is shown in Fig. 7—5. The outer cylinder (1) serves only as a protection against dust and dirt. The other two cylinders (2 and 4) are concentrically arranged, one inside the other. The inner cylinder (2) is the actual working cylinder, the lower end of which is provided with a valve (6). Inside the inner cylinder there is a piston (5) in which holes are drilled, the flow of oil through these holes being controlled by valves.
The piston is attached to a piston rod (3), the upper end of which forms an attachment to the body. At the lower end of the shock absorber, a similar screw attachment is fitted. The space between the cylinders (2 and 4) serves as a reservoir and is only partially filled with fluid. The inner cylinder (2) is completely filled with fluid on both sides of the piston (5). The cover (8) acts as a seal and guide for the piston rod (3). The baffle ring (7) acts as a baffle for the fluid.

FUNCTION

When the shock absorber is compressed or extended through the suspension of the vehicle, the piston (5) is moved in the inner cylinder (2). Fluid then flows through the valve-controlled holes in the piston. The speed at which the piston moves is determined by the rate at which the fluid passes through the holes from one side of the piston to the other. Since the drilled holes are very narrow, the fluid can only pass through slowly, thus braking the movement of the piston. When the shock absorber is suddenly compressed or extended, a further braking effect is caused by turbulence in the fluid passing through the holes in the piston. This dampens any rolling tendency on the part of the vehicle and ensures smoother running.

When the shock absorber is compressed or extended, the volume on each side of the piston is not altered equally since the piston rod occupies a certain space. When the shock absorber is compressed, therefore, some of the fluid passes out through the valve (6) into the reservoir, and when the shock absorber is extended, fluid is again sucked into the cylinder (2) on the underside of the piston.

REPAIR INSTRUCTIONS

CHECKING SHOCK ABSORBERS

An accurate check can only be made on the shock absorbers with special checking devices. A rough check, however, can be made in order to find out whether the shock absorbers are functioning on the whole. This is done by noting the damping effect immediately after rocking the car up and down. The test can also be made by driving the vehicle over a bumpy surface. The removed absorber can be tested by tightly fixing the lower attachment in a position similar to that when fitted in the vehicle. If it is then alternately pulled out and compressed, it is possible to judge whether it is functioning properly or not. Notice on making this check that, when the shock absorber is extended, its resistance is three times as great as when compressed, this due its way of operating.

If the shock absorber does not function satisfactorily in both directions, it should be replaced. Worn or damaged rubber bushes are to be replaced.

REPLACING FRONT SHOCK ABSORBERS

1. Remove the upper nut, washer and rubber bush.
2. Remove the lower attaching nut, washers and rubber bush.
3. Release the bolts (5, Fig. 7–6) for the lower attachment (4) in the lower control arm and pull out the attaching washer and shock absorber.
4. Installing is in reverse order to removal. Place the washers and rubber bushes according to Fig. 7–6.

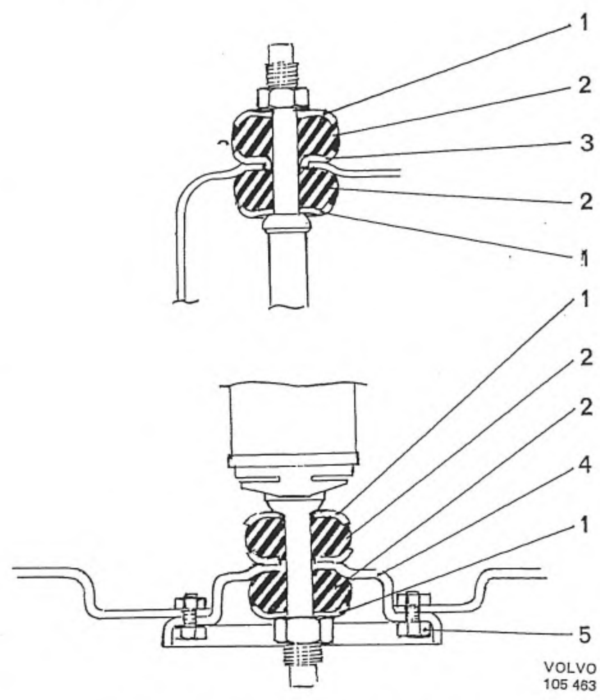


Fig. 7–6. Front shock absorber attachment
1. Shock absorber washer (small hole)
2. Rubber bush
3. Shock absorber washer (large hole)
4. Lower attachment
5. Bolt for lower attachment

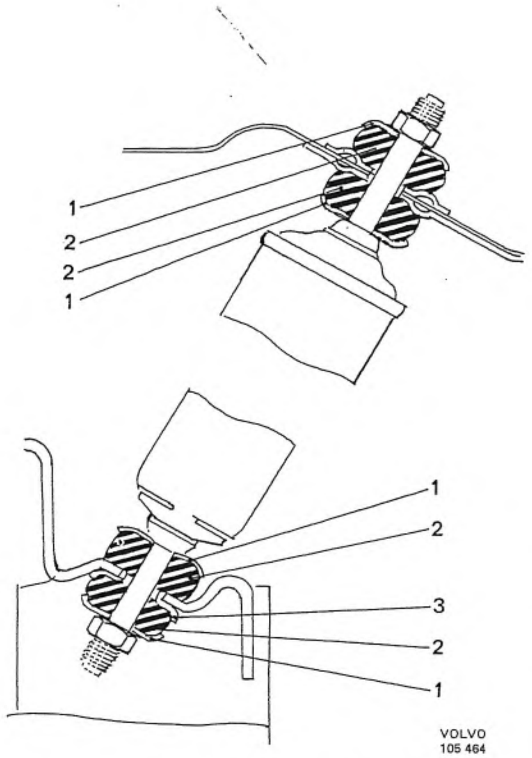


Fig. 7–7. Rear shock absorber attachment
1. Shock absorber washer (small hole)
2. Rubber bush
3. Shock absorber washer (large hole)

REPLACING REAR SHOCK ABSORBERS

1. Fold forward the rear seat backrest and remove the upholstery for the shelf under the rear window.
2. Remove the shock absorber upper nut, washer and rubber bush.
3. Remove the lower nut, washer and bush and take out the shock absorber.
4. When installing, place washers and rubber according to Fig. 7–7.

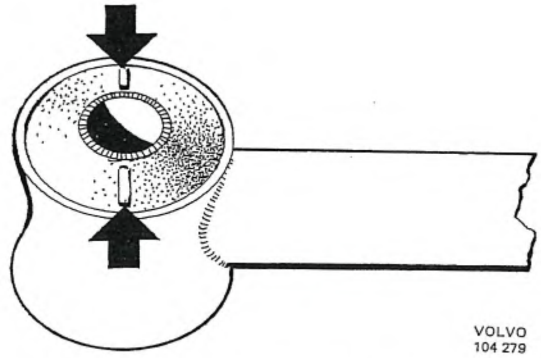


Fig. 7–9. Marking support stay bush

REPLACING SUPPORT STAY BUSHES

1. Raise the vehicle and place props under in front of the rear jack attachment.
2. Remove the through bolts holding the support stay to the front and rear end, and take down the stay.
3. Press out the bushes with 2734, and use 2733 as a counterhold (see Fig. 7–8).
4. Before pressing in the new bushes, smear them with oil so that they slide in easily and do not get damaged.
5. When installing, turn the bush so that the markings on the bush are at right angles to the longitudinal direction of the support stay, as shown by the arrows in Fig. 7–9. The bush can suitably be pressed in with a press drift directly on the bush and with 2733 as a counterhold (see Fig. 7–10).
6. Install the support stay and remove the props.

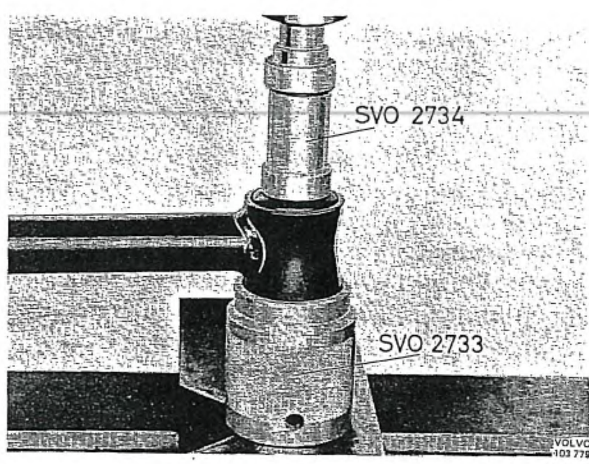


Fig. 7–8. Removing support stay bush

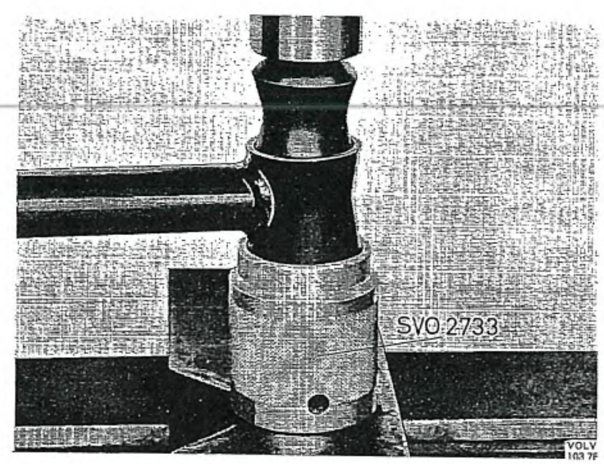


Fig. 7–10. Fitting support stay bush

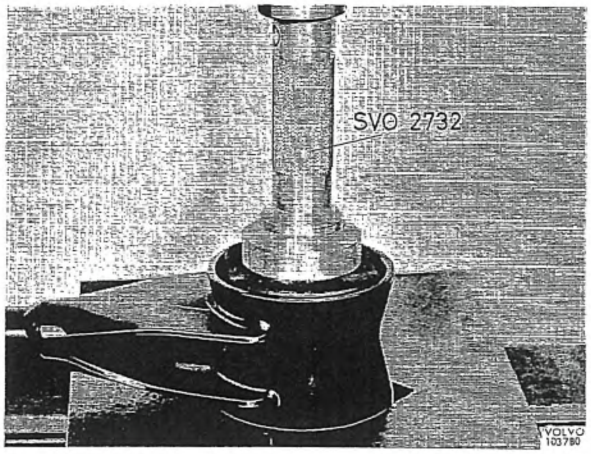


Fig. 7—11. Removing and fitting rear bush on torque rod

REPLACING TORQUE ROD BUSHES

1. Raise the rear end and place props under at the rear jack attachments.
2. Remove the through bolts in the front and rear end of the torque rod and take down the rod.
3. Press out the rear bush with 2732 (see Fig. 7—11).
4. Before fitting the new bush, coat it with oil so that it slides easily and does not get damaged.
5. Press in the rear bush with 2732 (see Fig. 7—11).
6. Press out the front bush with 2730, and with 2733 as a counterhold (see Fig. 7—12).

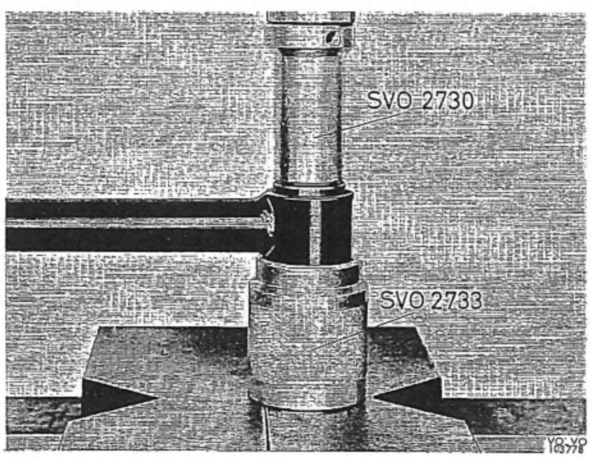


Fig. 7—12. Fitting front bush on torque rod

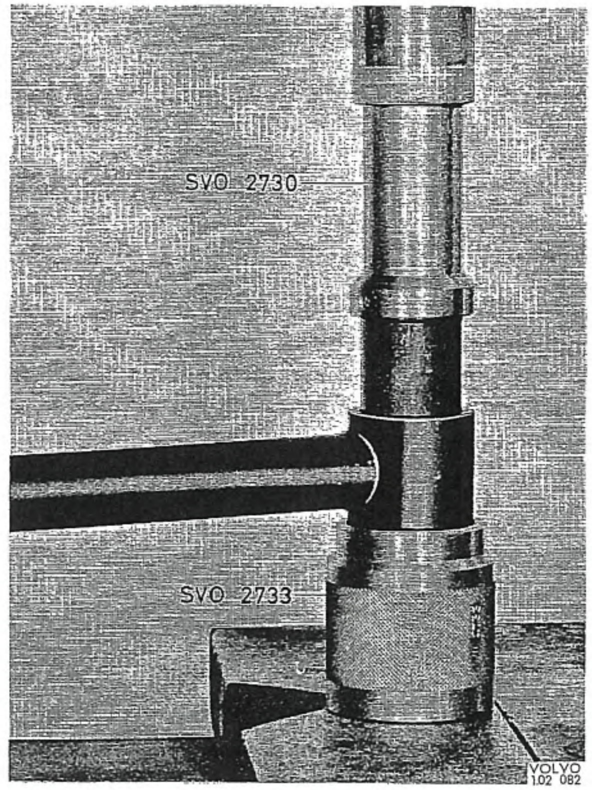


Fig. 7—13. Removing front bush on torque rod

7. When pressing in a new front bush, turn 2730 as shown in Fig. 7—13. Use 2733 as a counterhold.
8. Install the torque rod, remove the props and lower the vehicle.

REPLACING TRACK BAR BUSHES

1. Remove the nuts and the through bolts holding the track bar to the rear axle and the body bracket. Take down the bar.
2. Press out the bushes with a screwdriver or similar.
3. When fitting the new bushes, apply a little oil to them and press them in by hand.
4. When re-fitting, make sure that the spacer sleeve for the track bar is placed in the end of the bar's attachment to the body.

WHEELS

REPAIR INSTRUCTIONS

CHANGING WHEELS

It is important when fitting wheels that all grit and dirt are removed from the contact surfaces between wheel and hub and that surface paint is removed from new parts.

REPLACING WHEEL STUDS

The wheel studs can be replaced without removing the front wheel hubs or drive shafts.

1. Remove the brake caliper and brake disc according to the instructions given in Part 5.
2. Set up tool 2862, without the accessory components, as shown in Fig. 7—14, then operate the nut runner until the stud is fully removed. If the old stud was loose in the hub, the hole must be check-measured. If the hole diameter exceeds 16.27 mm (0.64"), the hub must be replaced.
3. Then insert a new, oversize wheel stud and press it in by hand as far as possible.
4. Place the accessory, the pin, in the press tool.
5. Install the sleeve on the outer end of the wheel stud.
6. Place the tool in position as shown in Fig. 7—15, and operate the nut runner to screw in the stud completely.

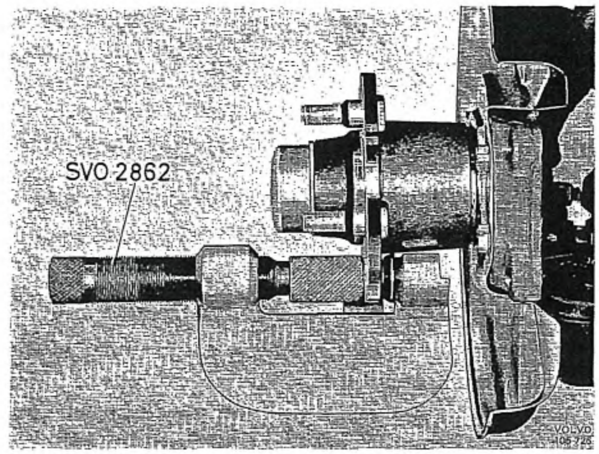


Fig. 7—15. Fitting wheel stud

NOTE. When replacing a wheel stud, always use a new, oversize stud. The oversize stud can be fitted without previously machining the hole.

REPLACING AND ADJUSTING FRONT WHEEL BEARINGS

1. Raise the front end and place props under the lower control arms. Unscrew the wheel nuts and take down the wheel.
2. Remove the front wheel brake unit according to the instructions given in Part 5, "Removing front wheel brake units".

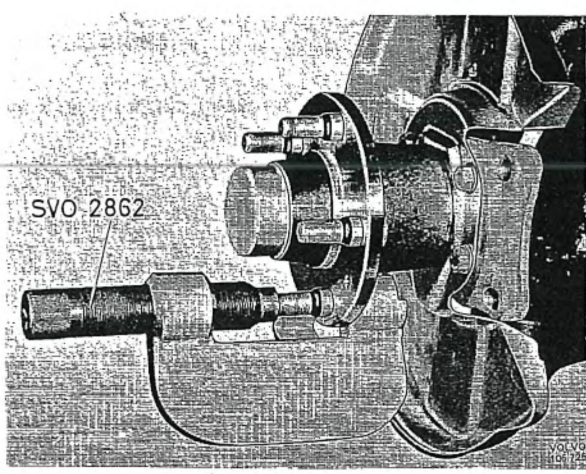


Fig. 7—14. Removing wheel stud

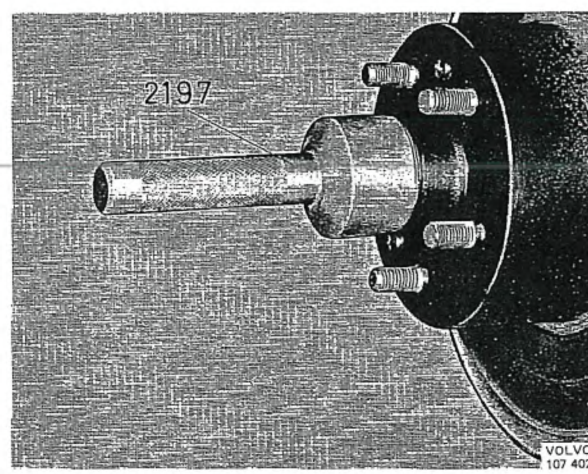


Fig. 7—16. Removing grease cap

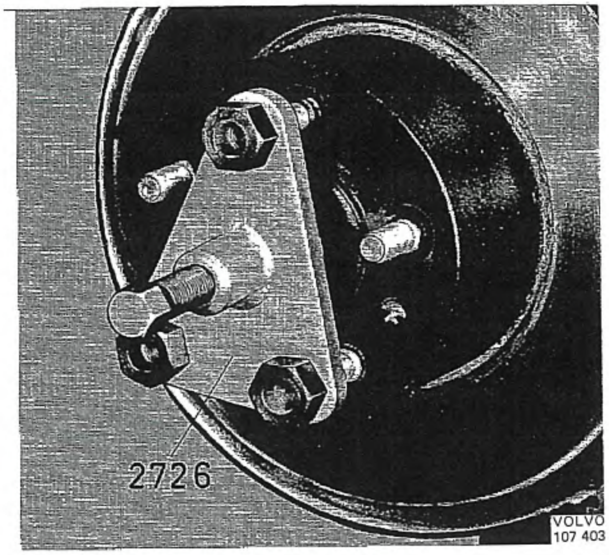


Fig. 7–17. Removing hub

3. Remove the grease cap with tool 2197, see Fig. 7–16. Remove the split pin and castle nut. Pull off the hub with puller 2726 (see Fig. 7–17). Pull off the inner bearing for the stub axle with puller 1794 (Fig. 7–18) if the bearing is still fitted.
4. Remove the bearing rings from the hub. For the outer bearing ring use 1800 and standard handle 1801 (Fig. 7–19). The inner bearing ring is knocked out with a suitable drift.
5. Clean the hub, brake disc and grease cap.
6. Press in the new bearing rings. In addition to standard handle 1801, use drift 1798 (Fig. 7–20) for the inner bearing ring and for the outer bearing ring 1797 (Fig. 7–21).

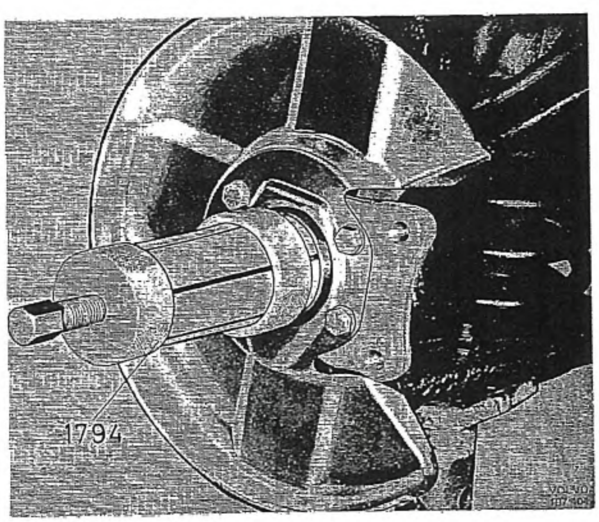


Fig. 7–18. Removing inner ring, inner bearing

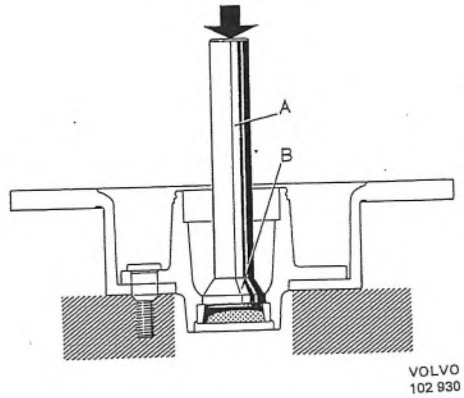


Fig. 7–19. Removing outer ring, outer bearing
A=1801 B=1800

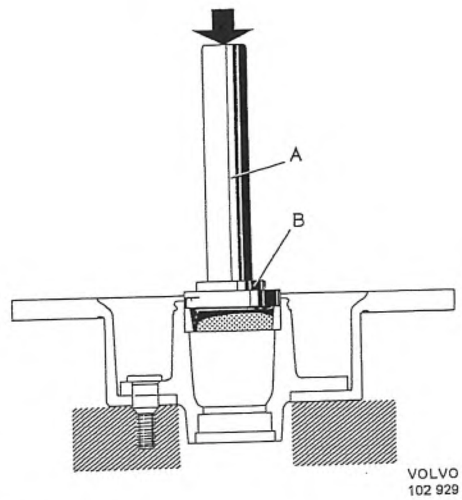


Fig. 7–20. Fitting outer ring, inner bearing
A=1801 B=1798

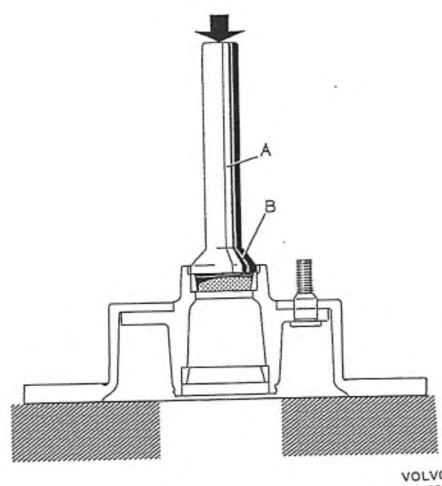


Fig. 7–21. Fitting outer ring, outer bearing
A=1801 B=1797

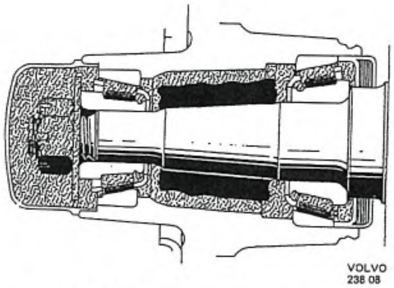


Fig. 7—22. Lubricating front wheel hub

7. Press grease into the bearings with the help of a grease gun. If such is not available, pack the bearings with grease by hand. Pack in as much as possible between the roller retainer and bearing inner ring. Also apply grease to the outer sides of the bearings and on the outer rings pressed into the hub. Fill the recess in the hub with grease all round up to the smallest diameter on the outer ring for the outer bearing, see Fig. 7—22.
   Use a first-class bearing grease for the bearings. Place the inner bearing in position in the hub. Press in the sealing ring with drift 1798 together with standard handle 1801 (Fig. 8—23).
   NOTE. Soak the felt ring of the seal with, for example, light engine oil.
8. Place the hub on the stub axle. Fit the outer bearing, washer and castle nut.
9. The front wheel bearings are adjusted by first tightening the nut with a torque wrench to a torque of 70 Nm (50 lbft). Then slacken the nut two hex flats. If the nut recess does not coincide with the split pin hole in the spindle, slacken the

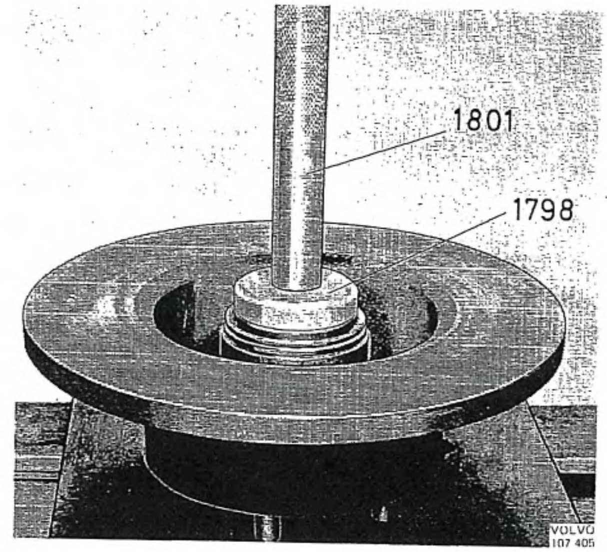


Fig. 7—23. Fitting sealing ring

nut further to enable the split pin to be fitted. Check to make sure that the hub rotates easily without looseness.
10. Fill the grease cap halfway with grease and fit it with tool 2197.
11. Fit the front wheel brake units in accordance with the instructions given in Part 5.
12. Fit the wheel after first having cleaned the contact surfaces between wheel and hub from dirt, etc., and tighten the nuts so much that the wheel cannot be moved on the hub. Remove the props. Lower the vehicle and final-tighten the wheel nuts. Tighten every second nut in sequence until all are finally tightened to a torque of 100—140 Nm (70—100 lbft).

Part 8

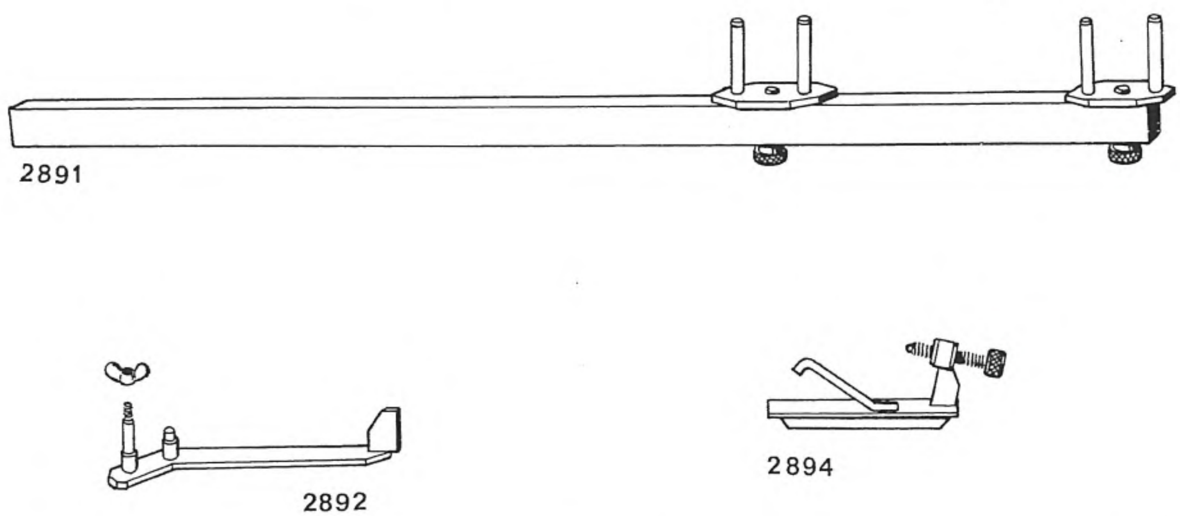
BODY

CONTENTS

GENERAL

TOOLS

The special tools may be preceded by 999 or SVO, e.g. 999 2891 or SVO 2891.



VOLVO
105 691

Fig. 8–1. Tools

999
(SVO)
2891 Rule for measuring height of side-member
2892 Arm for measuring height of side-member
2894 Holder for fixing measuring rule

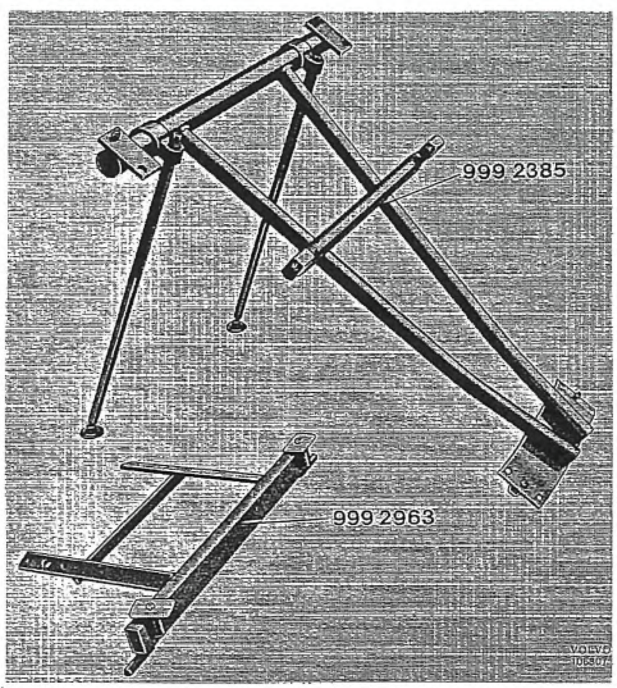


Fig. 8–2. Fixture for replacing side-members

BODY FRAME

DESCRIPTION

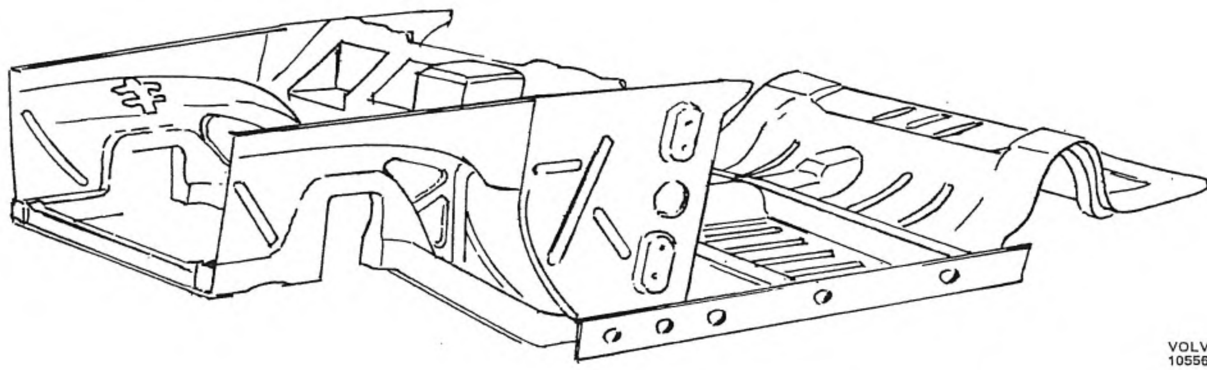


Fig. 8—3. Floor section

The 1800 ES has an integral body so that there is no chassis frame. The body is composed of a number of pressed steel plates, each of which forms part of the supporting construction.
The body can suitably be divided up into the floor, side sections, rear section, scuttle, roof section, front fenders, doors and hood.

The floor and frame section (Fig. 8-3) consist of a front and rear floor plate, inner cantrail, front and rear cross-members, tunnel and scuttle.
The floor plates are welded together at the rear seat support.
On each side at the bottom, the rear floor plate has a longitudinal reinforcing member and between these a

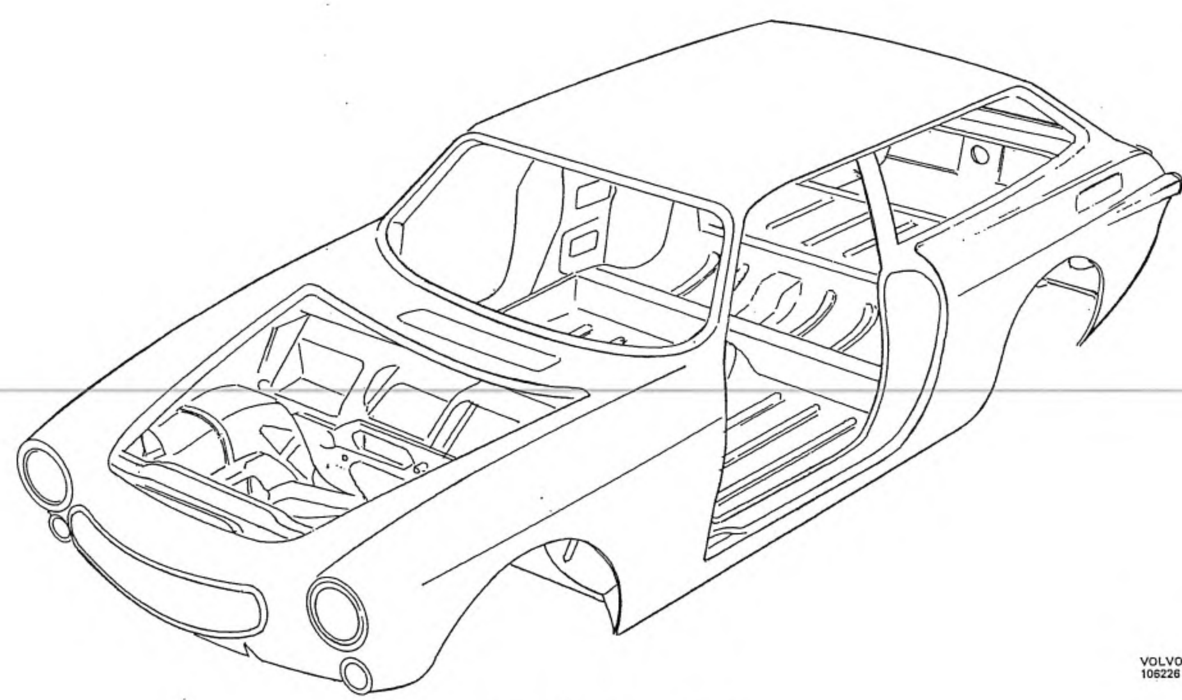


Fig. 8—4. Body, 1800 ES

number of cross-members. One of the cross-members is provided with an attachment for the rear axle track bar. In the rear floor plate for mounting the fuel tank, there is a flanged hole, the upper part of which forms a section of the cargo space floor. The scuttle consists of the firewall, wheel arches, front upper cross-member and lower cross-member. The firewall forms the front transverse wall of the body and has welded end pieces. Projecting from the front floor section are two front side-members. At the front, they are joined together by means of a cross-member and at the rear they are connected to the front cross-member under the front seats. Upper side-members run from the upper corner at the firewall — front post. These are spot-welded to the front post, front side plate and wheel arch plates. Attached to the side-members are the front axle member and the bumper support bars. The roof section consists of a number of plates. The roof plates form the upper section of the cowl, the windshield opening and the roof itself.

The body is sound-isolated. Floor isolation is provided by isolation mats and textile carpets. The walls, doors and the roof are isolated with self-adhesive isolation panels. The firewall is isolated with sound-isolating material and the inside of the hood is lined with self-adhesive foam plastic overlaid with a covering extremely difficult to ignite.

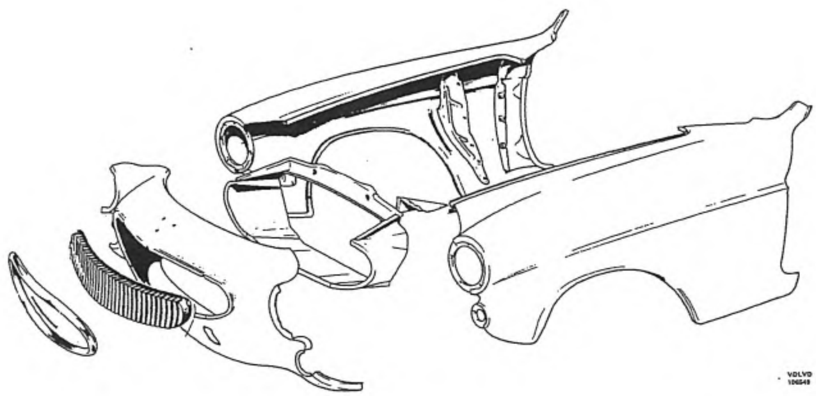


Fig. 8—5. Front fenders and front section

HOOD, GRILLE AND FENDERS

DESCRIPTION

The hood consists of an outer and inner plate spot-welded together. The hood is opened on two hinges at the front. When closed, it is locked by a lever fitted at the firewall. The hood lock lever is released by means of a handle located under the dash inside the vehicle.

The radiator grille is made of plastic and is attached to the front end by means of steel clamps.
The front section and front fenders are welded to the wheel arch plates, upper side-members, front cross-member and front posts. The front section also serves as an air duct for the radiator.

REPAIR INSTRUCTIONS

Removing and fitting hood

1. Unscrew the hood support from the hood and fold down the hood.
2. Remove the radiator grille (see special instructions).
3. Remove the hood by unscrewing the hood hinge bolts (2, Fig. 8–6) from the hood. In order to get at the bolts for the right-hand hinge, the outer part of the air cleaner must be taken off.

When the hood is fitted, line it up in the opening so that there is the same slit all round the hood before tightening the hinge bolts. The holes in the hinges are larger than the diameter of the bolts so that it is possible to adjust the location of the hood both laterally and longitudinally. The hood elevation can be adjusted at the front end by placing shims (1, Fig. 8–6) between hood and hinges, and at the rear end with shims placed between hood and lock brackets. At the rear edge there are also adjustable rubber stops (1, Fig. 8–7).

HOOD LOCK

The hood lock is mounted at the firewall and is operated by means of a handle under the dashboard. The hood tensioning with the hood down is adjusted partly by screwing in or out the rubber stops (1, Fig. 8–7) and partly by placing shims under the lock catches on the hood. The lock brackets are bolted to

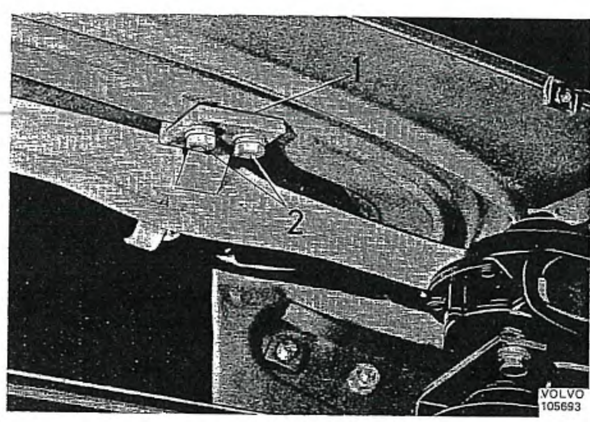


Fig. 8–6. Hood hinges
1. Shims 2. Hood hinge bolts

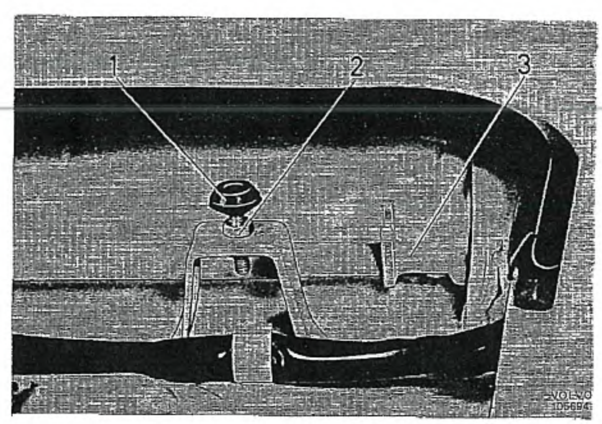


Fig. 8–7. Hood lock and rear adjustment
1. Rubber stop 2. Locknut 3. Hood lock cross shaft

the rear corner of the hood and are lubricated with paraffin wax when adjusting. To adjust the cross shaft for the lock, first release the nut at the handle inside the vehicle. Then undo the two bolts at the cross pin attachment on the right-hand side inside the engine compartment, after which the cross shaft can be pulled to the right.

REPLACING GRILLE

REMOVING

1. Undo the lower clamps with suitable pliers (see Fig. 8–8).
2. Take out the radiator grille with the lower part first.

INSTALLING

1. Install the grille with the upper part first so that the clamps come on the right side of the plate edge on the front section.

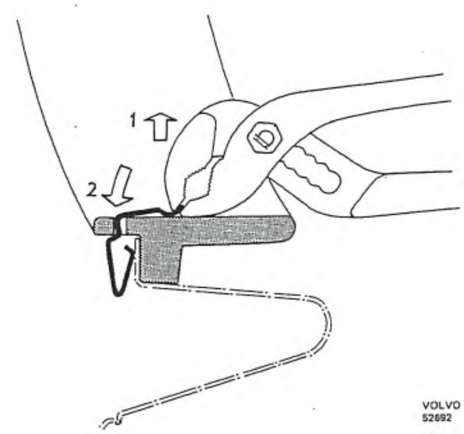


Fig. 8–8. Removing grille

2. Fit the lower clamps with suitable pliers. Place the clamps above the hole and then **press** the clamp into position.

DOORS AND TAILGATE

DESCRIPTION

The doors are constructed of an inner and an outer plate which are flanged and spot-welded together. Hinges are fitted to the inner plate. The doors are adjustable both longitudinally, vertically and laterally.

The door locks are screwed to the doors. The push button for the outer door handle actuates a lever which, in its turn, releases a rotating lock plunger. The inside door handle is mounted at the remote control, which is fixed to the inner door plate by means of a screw. The handle transmits movement to the lock plunger by means of link rods. The lock mechanism is fitted in a cylinder under the door handle.

The window winders consists of lifting arms with toothed segments. Two parallel lifting arms, one of them linked to a toothed segment, move the window to the desired opening when the window winder is turned.

The tailgate is made of hardened glass with bedded electrical wiring for demisting. The hinges are bolted to the top of the tailgate and the body. The handle with lock is fixed to the lower part of the tailgate, which is balanced by two gas springs, one on each side.

REPAIR INSTRUCTIONS

REMOVING DOOR UPHOLSTERY AND INSIDE DOOR OPENER

1. Remove the winder handle by pressing in the trim washer against the upholstery and pushing it towards the winding handle (Fig. 8–9). This releases the spring clip and the winding handle can then be taken off.
2. Remove the inner door opener by knocking in the pin with a suitable drift (see Fig. 8–10).
3. Carefully take out the plugs in the screw holes of the armrest (1, Fig. 8–11) and then undo the

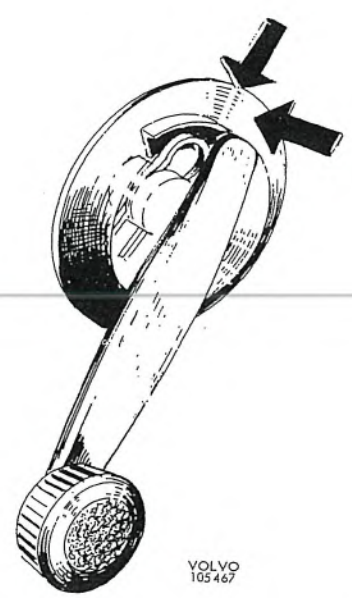


Fig. 8–9. Removing window winder

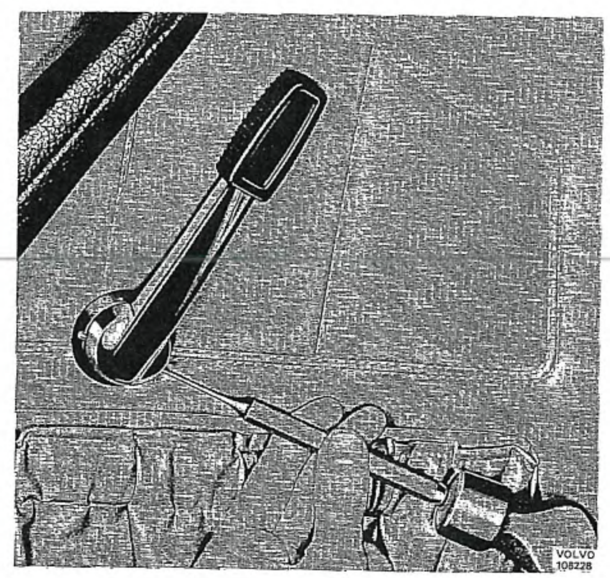


Fig. 8–10. Removing inside lock handle

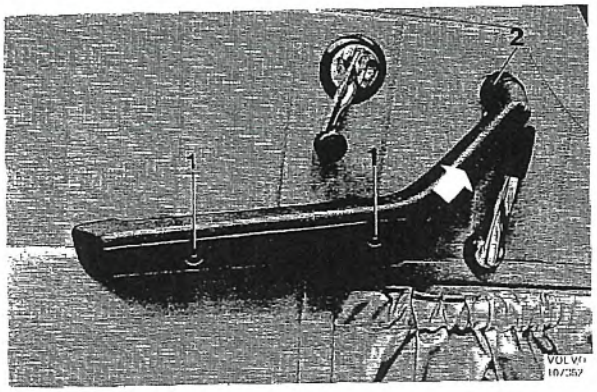


Fig. 8–11. Armrest

1. Plugs for armrest screw holes
2. Plastic ring
3. Arrow shows direction armrest is to be pushed off

screws. Thereafter turn the plastic ring (2, Fig. 8–11) several turns to the left and move the armrest forwards/upwards (3, Fig. 8–11). This releases the armrest from its front attachment, so that the armrest can be pulled straight out.

4. Undo the door upholstery panel by carefully levering with a screwdriver under the edge of the panel (Fig. 8–12). When the clips have loosened, lift the door panel upwards.
5. Remove the protective paper on the door.

REMOVING AND INSTALLING DOOR

The door can be removed with or without the hinges remaining in the door. If the hinges are to remain on the body, first remove the door upholstery according to the instructions in the previous section. Then undo the bolts (1, Fig. 8–13) and the door can be drawn outwards from the hinges.

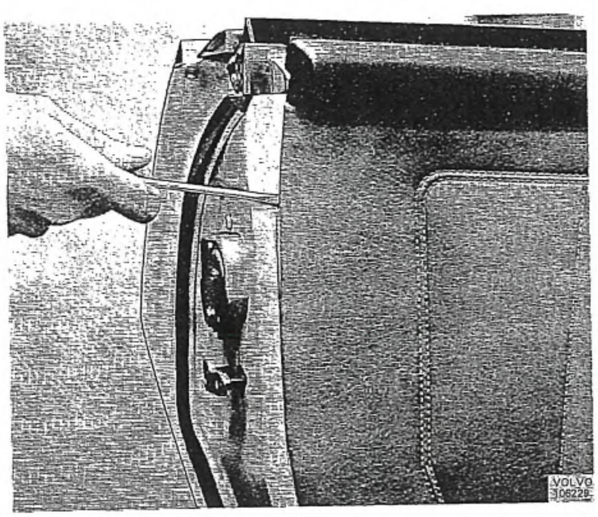


Fig. 8–12. Removing door upholstery

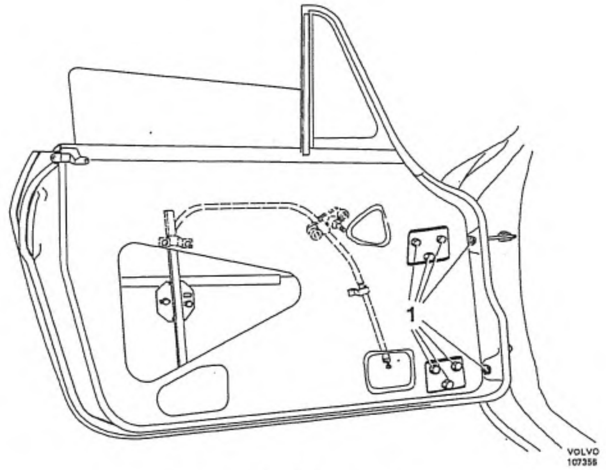


Fig. 8–13. Door inside

1. Bolts for hinge

When the door is to be removed complete with hinges, first take off the front side upholstery. After that drill or knock out the door stop pivot pin (1, Fig. 8 – 14). After the bolts for the hinges have been released (two bolts for each hinge) the door can be lifted off.

When fitting, the door can be adjusted longitudinally and vertically because the bolt holes in the body are larger than the diameter of the bolts. Lateral adjustment of the door is made by means of shims.

DOOR STOP

The door stop (Fig. 8–14), consists of a lock plate and a guide bolted to the upper hinge and a link with rubber buffer. In order to remove the door stop, the door must first be taken off (see previous section). The link is released by drilling out or knocking out the pivot pin.

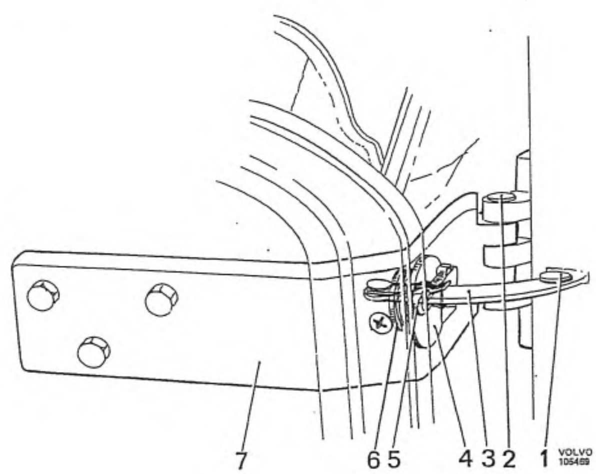


Fig. 8–14. Door stop

1. Pivot pin
2. Hinge pin
3. Link
4. Lock plate
5. Guide
6. Rubber buffer
7. Upper hinge

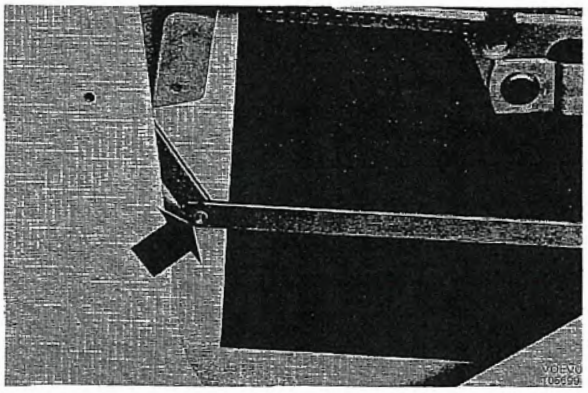


Fig. 8–15. Locking for remote control lever

REMOVING DOOR LOCK AND LOCK HANDLE

1. Carry out points 1–4 under "Removing door upholstery and inside door opener".
2. Remove the locking for the remote control lever (see Fig. 8–15).
3. Unscrew the three bolts for the remote control (see Fig. 8–16) and take out the control from the door.
4. Remove the lock (9, Fig. 8–18) for the lever between the lock and the outer handle.
5. Unscrew the two screws (1, Fig. 8–17) for the link arm for the remote control and the two screws (2, Fig. 8–17) which hold the guide for the lock.
6. Unscrew the remaining two screws (3, Fig. 8–17) and take the lock out through the hole in the inner plate of the door.
7. Remove the lock handle by unscrewing the screw (6) and nuts (7, Fig. 8–18).

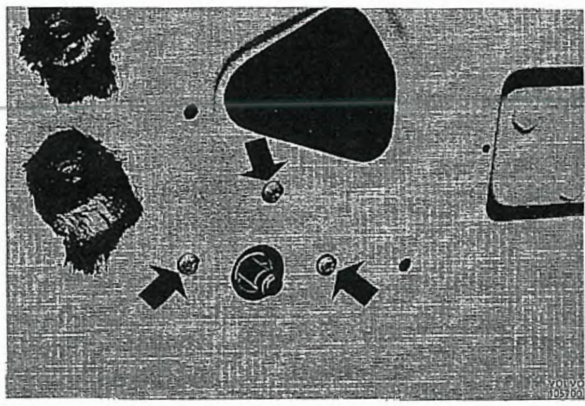


Fig. 8–16. Screws for remote control

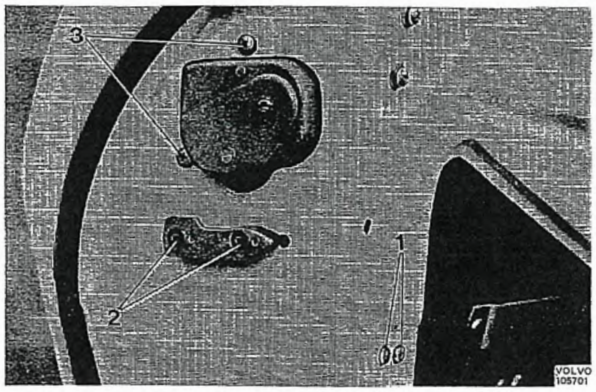


Fig. 8–17. Screws for door lock
1. Screws – remote control link arm
2. Screws – lock guide
3. Screws – lock

DISASSEMBLING LOCK HANDLE

1. Unscrew the bolt (1, Fig. 8–19) for the control lever and the bolt (2) for the sleeve and take off both sleeve and spring.
2. Remove the circlip (5, Fig. 8–20). The lock cylinder can then be taken out of the push button.

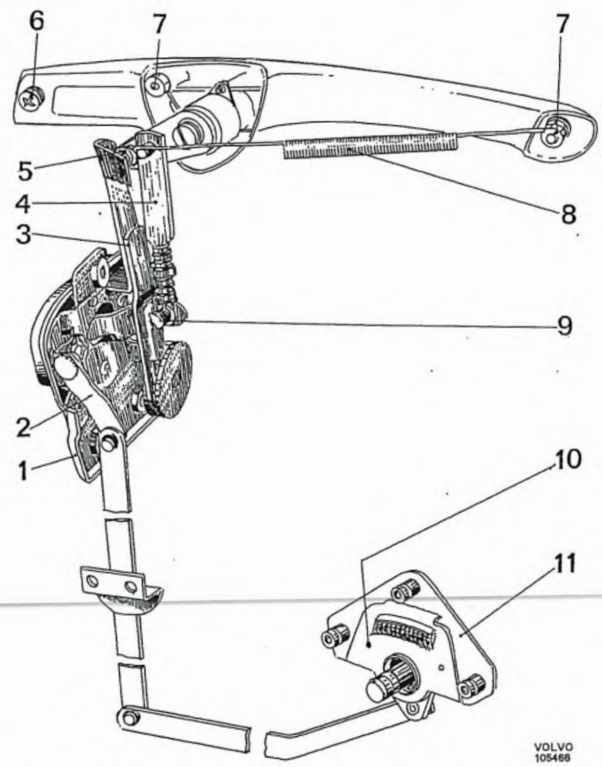


Fig. 8–18. Door lock with remote control

1. Lock
2. Lever
3. Lever
4. Connection link
5. Adjusting screw
6. Screw for lock handle
7. Nuts for lock handle
8. Spring
9. Lock for lever
10. Hole for split pin for fitting remote control
11. Remote control

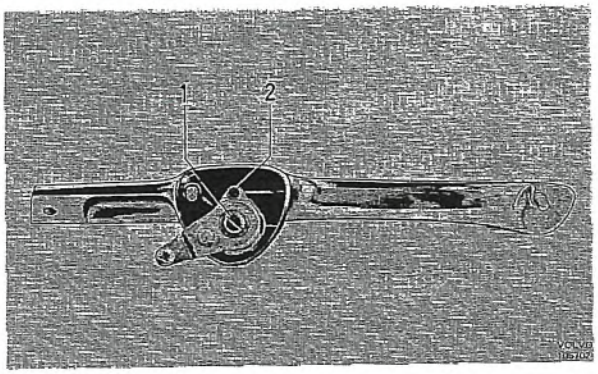


Fig. 8–19. Lock handle
1. Bolt for control lever 2. Bolt for sleeve

INSTALLING AND ADJUSTING DOOR LOCK AND LOCK HANDLE

1. Unscrew the lock handle and make sure that the washers between handle and door plate are located properly.
2. Place the lock in position in the door and fit the screws (1, 2 and 3, Fig. 8–17).
3. Fit the connection link (4, Fig. 8–18) and the spring (8). Adjust the length of the link by screwing on the spring at the lower end of the link so that the lock handle control arm meets the lock lever (3) in the unlocked position.
4. Check or adjust if necessary the clearance between the lock handle control lever and the door lock lever (Fig. 8–21). The clearance should be 1–2 mm (1/16"). Adjust with the screw (5, Fig. 8–18).
5. Tighten the remote control lever so that the spring in the control is compressed, and lock the control in this position by placing a split pin in the hole (10, Fig. 8–18).
6. Fit the remote control in the door without tightening the screws fully.

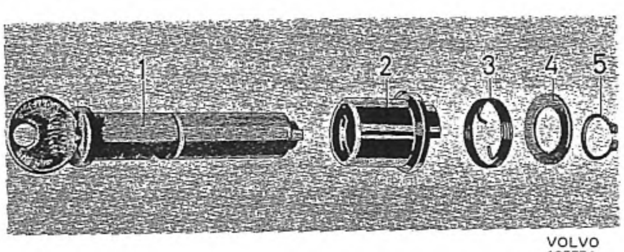


Fig. 8–20. Door lock push button disassembled
1. Lock cylinder
2. Push button
3. Spring
4. Washer
5. Circlip

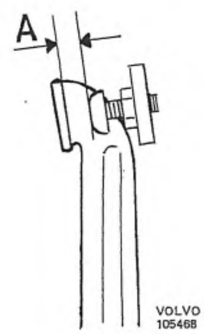


Fig. 8–21. Clearance between lock handle control lever and door lock lever
A=1–2 mm (1/16")

7. Push the remote control backwards until the lever stops against the lock. Hold the control in this position and tighten the screws.
8. Remove the split pin and test the function of the lock.

STRIKER PLATE

The striker plate (Fig. 8–22) is made of steel and is fitted with a nut plate. It is adjustable thanks to the holes in the body being larger than the attaching bolts.
The vertical location of the striker plate is checked by closing the door with the outside door handle push button depressed so that the guide pin glides straight into the striker plate.
NOTE. This should be done immediately after fitting the striker plate.

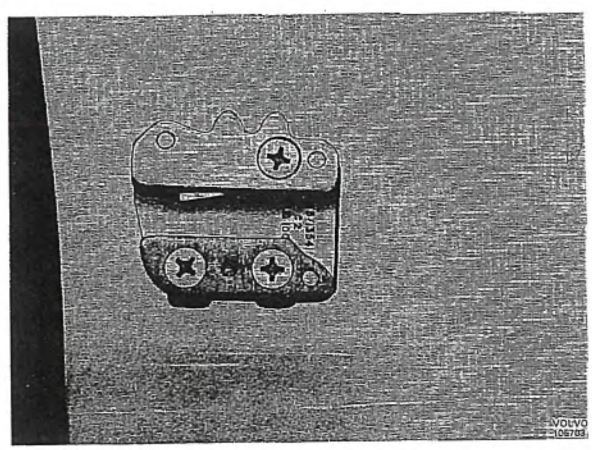


Fig. 8–22. Striker plate

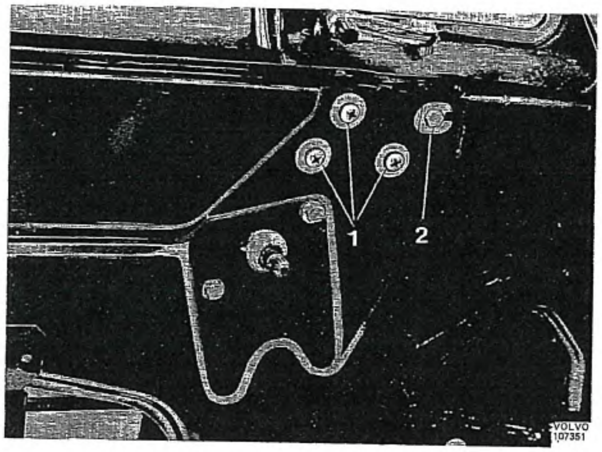


Fig. 8–23. Screws for ventilation window
1. Screws for ventilation window frame
2. Bolt for ventilation window lower pivot pin

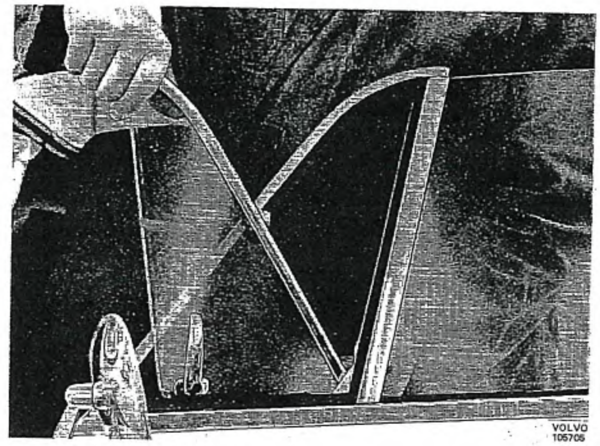


Fig. 8–25. Taking out ventilation window without frame

REMOVING AND INSTALLING VENTILATION WINDOW WITH FRAME

The frame of the ventilation window is integrally built with one of the guide rails for the winding window. The ventilation window with frame can be suitably removed as follows:

1. Carry out points 1–4 under "Removing door upholstery and inside door opener".
2. Unscrew the screws for the chromium plate on the front edge of the door and remove the plate.
3. With the winding window in the closed position, unscrew the two screws holding the guide rail inside the door.
4. Undo the screws holding the frame (1, Fig. 8–23).
5. Wind down the winding window to the bottom position. Then pull the ventilation window straight up and turn it a half turn so that the attachment on the lower part of the guide rail can be taken out of the door (Fig. 8–24).

NOTE. When fitting, check to make sure that the winding window glides easily into the guide rails.

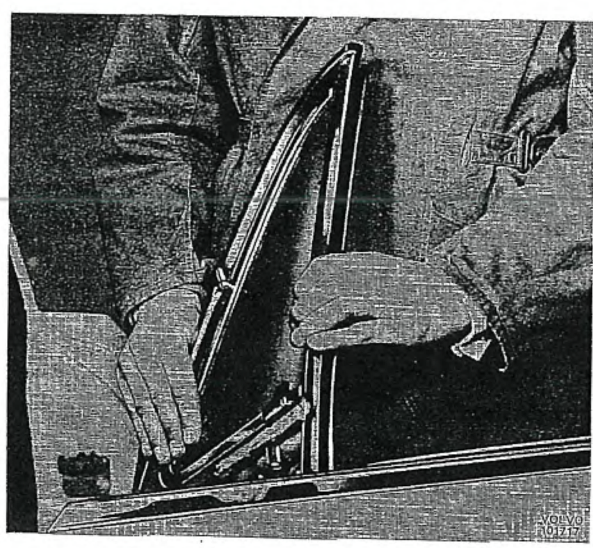


Fig. 8–24. Taking out ventilation window with frame

REMOVING AND INSTALLING VENTILATION WINDOW WITHOUT FRAME

1. Carry out points 1–4 under "Removing door upholstery and inside door opener".
2. Undo the plastic covering over the door and release the bolt (2, Fig. 8–23). Put your hand through the large hole in the inner plate of the door and remove the cover for the ventilation window pivot pin.
3. Open the ventilation window completely and press it downwards so that its upper pivot pin unhooks, after which the window can be removed (Fig. 8–25).
4. When fitting, tighten the bolt (2, Fig. 8–23) until the window is sufficiently stiff to open and close.

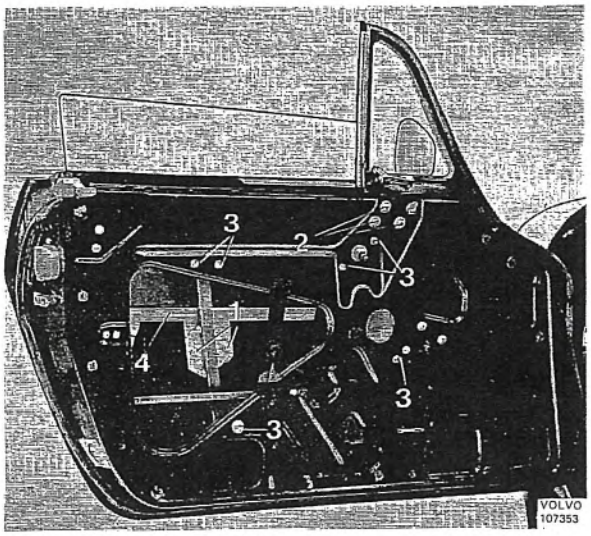


Fig. 8–26. Door inside

1. Screws for attaching regulator channel
2. Screws for ventilation window frame
3. Screws for window regulator
4. Regulator channel

REMOVING WINDING MECHANISM

1. Carry out points 1–4 under "Removing door upholstery and inside door opener".
2. Fit the winding handle and wind the window to such a position that the screws (1, Fig. 8–26) for the winding rail attachment to the winding mechanism is accessible.
3. Release the screws (1) and lift up the winding window (Fig. 8–27).
4. Remove the chromed plate on the front edge of the door.
5. Release the screws securing the frame to the ventilation window in the door, three at the top (2, Fig. 8–26) and one at the bottom of the winding rail. Lift off the ventilation window with frame.

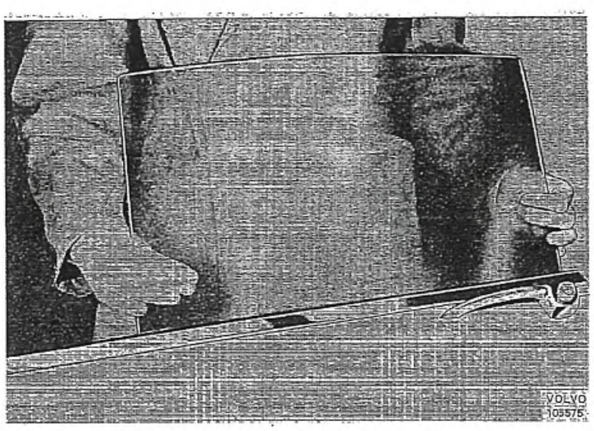


Fig. 8–27. Taking out winding window

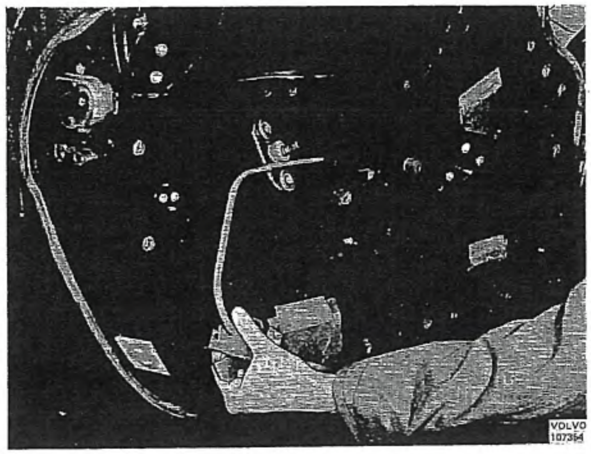


Fig. 8–28. Taking out window winder

6. Remove the lock pin for the remote control lever and separate the levers.
7. Undo the screws (3, Fig. 8–26) securing the window winder and take out the winding mechanism as shown in Fig. 8–28.

INSTALLING WINDOW WINDER

1. Install the winding mechanism in the door and screw it tight with the screws (3, Fig. 8–26).
2. Assemble the levers for the remote control and press on the lock clamp.
3. Fit the ventilation window and fit the chromed plate to the front edge of the door.
4. Place the window in its guides and screw it to the winding mechanism. Check to make sure that the sealing strips in which the window glides are not damaged.
5. Adjust the window so that it fits properly against the sealing strip in the body. Check that the upper location of the window corresponds to the location of the body to the ventilation window. This end position is adjusted by means of the screw (1, Fig. 8–29) which is released by undoing the lock nut (2). The end position of the window is pushed up or down by screwing in or out the screw (1).
6. Replace the protective paper and the door panel as well as the armrest, door handle and window winder.

When changing only the window, fit it so that its rear end is in line with the plastic of the window rail (Fig. 8–30).

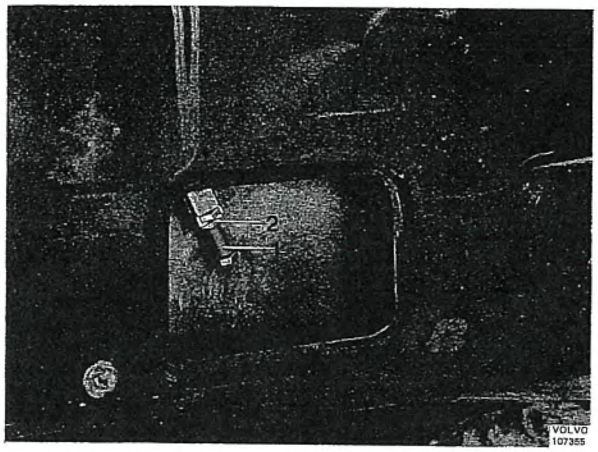


Fig. 8—29. Adjusting mechanism for winding window upper end position

1. Adjustment screw
2. Locknut

TAILGATE

The tailgate is suspended by means of two hinges with rubber seals. The hinges are fixed to the glass by means of two bolts. Since this tailgate glass is hardened, greatest care should be taken when working with it. The hinges and handle may not be tensioned harder than necessary, 4—8 Nm (3—6 lbft), and the rubber seals between the glass and steel must always be installed in such a way that there is no direct contact between the glass and steel.

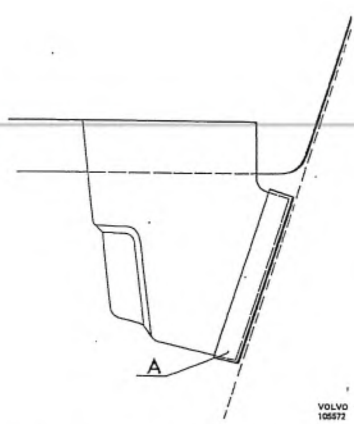


Fig. 8—30. Plastic cover A on winding rail should be in line with rear edge of window

REMOVING

To remove the glass, first take out the gas springs by removing the safety catch and then by pulling the spring straight out from the bolt. Then (with tailgate closed) release the screws (1, Fig. 8—31) and fold up the hinges. After that disconnect the cables from the window by heating the soldering point (2) with a soldering iron.

The rear window can also be removed by loosening the roof lining at the rear edge. The nuts (3) are then released and the cable connections disconnected at the connector, after which the window is lifted off.

INSTALLING

To re-install the tailgate window, first place it in its proper position with the rubber spacers for the hinges. The solder on the cables. Fit the screws (1) and adjust in the window. Make sure that the distance between the moulding strip screws and the tailgate window is minimum 3.5 mm (1.4") all round. Then fit the gas springs.

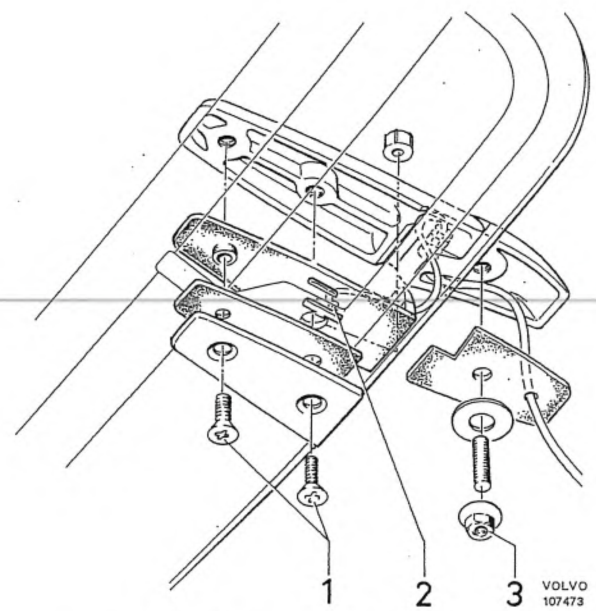


Fig. 8—31. Hinge for tailgate

1. Crosshead screw 2. Soldering point 3. Nut

TAILGATE LOCK

REMOVING

1. Screw out the screws (6, Fig. 8–32) and the center bolt (2).
2. Push up the lock cylinder (1) with the bolt (2). Remove the lock cylinder and the center bolt.
3. Turn the lock tab (8) a quarter turn and remove it (8) and the lock handle (3).
4. Remove the nut (4) entirely with the help of angled snap pliers and lift off the handle (5) and the rear piece (7).

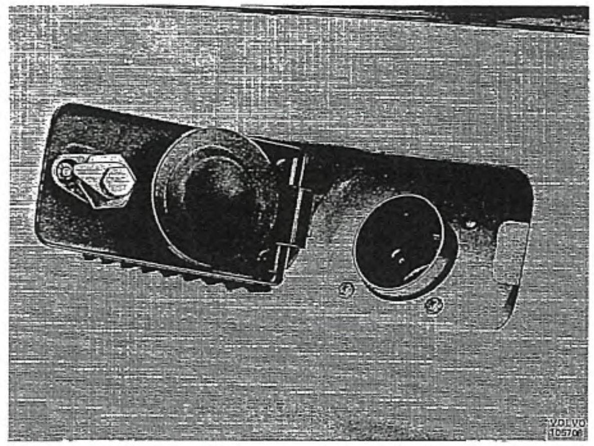


Fig. 8–33. Fuel tank cap with lock

INSTALLING

1. Place a rubber spacer between window and handle (5). Then screw the handle firmly into position by means of the crosshead screws (6).
2. Fit the rear piece (7) with its rubber packing and secure it with the nut (4).
3. Fit the lock handle (3) in the handle (5).
4. Move in the lock tab (8) from underneath and turn it a quarter turn. Push down the lock cylinder (1) and secure it with the center bolt (2).
5. Check lock's function.

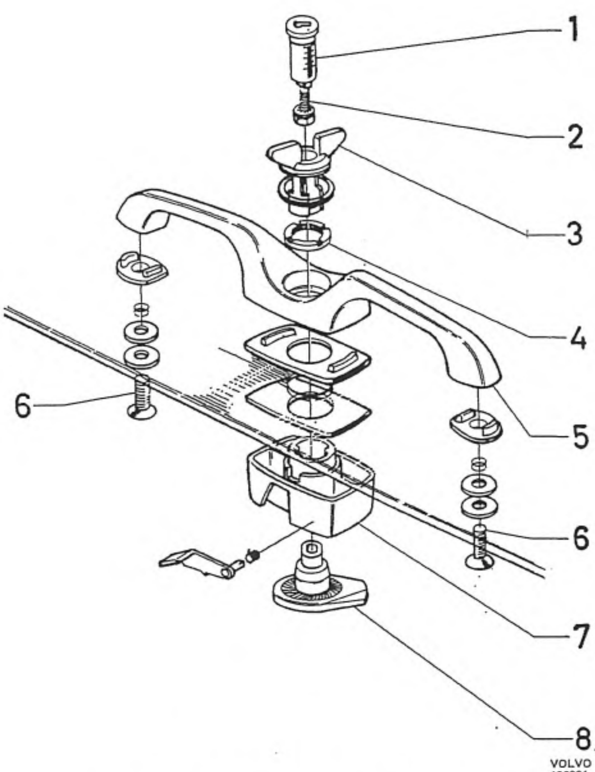


Fig. 8–32. Tailgate handle with lock

1. Lock cylinder	5. Handle
2. Center bolt	6. Crosshead screw
3. Lock handle	7. Rear piece
4. Nut	8. Lock tab

FUEL TANK CAP WITH LOCK

To remove the tank cap, the left air extractor vent outside grille must first be removed. The grille is attached by means of a clip on the inside of the rear fender. The tank cap is bolted on by means of two bolts.

The lock cylinder is removed by taking off the bolt (7) and lock arm (6, Fig. 8–34). If the entire lock is to be removed, the locknut (5, Fig. 8–34) must be removed.

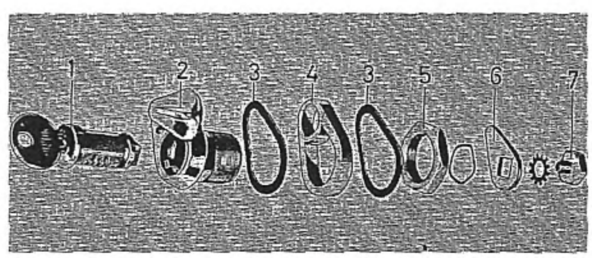


Fig. 8–34. Tank cap lock disassembled

1. Lock cylinder	5. Locknut
2. Housing	6. Lock arm
3. Spacer	7. Bolt
4. Lower section	

TRIM MOULDINGS, GLASS AND SEALING STRIPS

REPAIR INSTRUCTIONS

Trim mouldings

WAIST MOULDING

The waist trim moulding for the front fenders, doors and rear fenders is attached by means of resilient clips. To remove the moulding, insert some suitable wooden tool between the body and the moulding next to the clips and lever outwards (Fig. 8–35). To fit the moulding, first put the clamps on the moulding. Then hold the moulding against the body with the clamps opposite their holes and push the moulding against the body with the hand.

DOOR MOULDING

The door trim moulding is attached by means of clips from the rear edge of the door and up to the ventilation window. At the ventilation window the moulding is attached by the ventilation window frame holding the moulding clamped downwards. To remove the moulding, the plate on the front edge of the door must first be removed. Then plate a suitable wooden lever under the moulding beginning at the rear and lever up the moulding bit by bit up to the ventilation window (Fig. 8–36).

NOTE. Use masking tape or similar under the wooden lever when levering up the moulding in order not to damage the paintwork. When this is done, the moulding can be removed by bending the front edge of the ventilation window inwards, this enabling the moulding to be drawn up.

In order to remove the door moulding under the rear side window, the window must first be taken off. To do this follow the instructions given under "Rear side window". The moulding can then be removed by releasing its plate screws.

REAR FENDER MOULDING

The moulding on the upper edge of the rear fender is attached by means of screw clamps. In order to release the front nut, the rear side panel upholstery inside the vehicle must be removed, while the other nuts are released from the cargo space after the side-board has been taken off.

Removing windshield and tailgate trim moulding

1. The trim moulding is released from the rubber stripping (do not pull off the trim moulding) by inserting a nylon knife (moistened) in between and all round the moulding.
2. Slide over the connectors to one section of the moulding.
3. Remove the trim moulding by pressing the rubber stripping seam out of the way of the moulding with a moistened wooden knife and

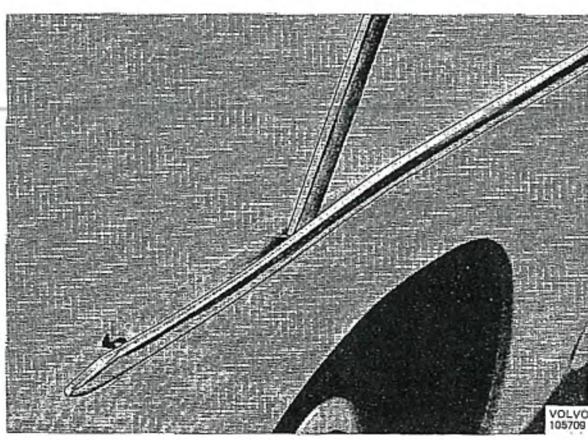


Fig. 8–35. Removing waist trim moulding

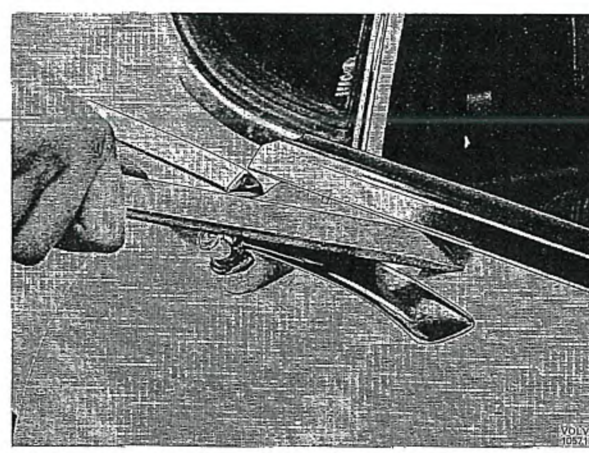


Fig. 8–36. Removing door trim moulding

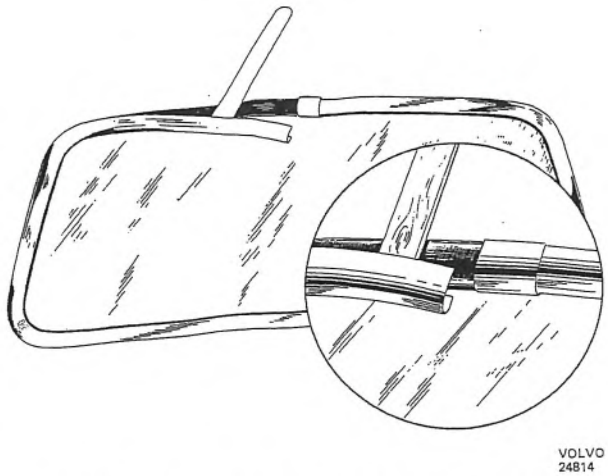


Fig. 8–37. Removing trim moulding for windshield and tailgate

with another such knife releasing the moulding at the middle (Fig. 8–37). Carefully lift the moulding out of the way while using the other wooden knife to move the rubber stripping to the side.

INSTALLING WINDSHIELD AND TAILGATE TRIM MOULDING

Place a leather cord (Ø 4 mm=5/32"), moistened in soap solution or kerosine, in the rubber stripping groove for the moulding.
Place one half of the moulding in position and press it in while drawing the leather cord up over the moulding out of the way, so that the moulding is pressed against the rubber stripping (Fig. 8–38). Slide over the connecting pieces and repeat with the other moulding half. Adjust the position of the joining pieces to make sure that they cover both the halves.

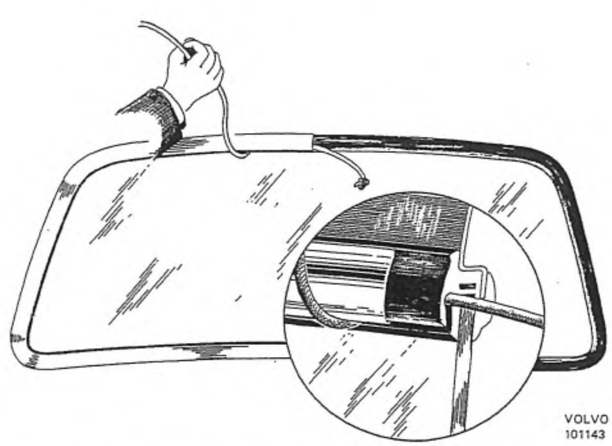


Fig. 8–38. Fitting trim moulding for windshield and tailgate

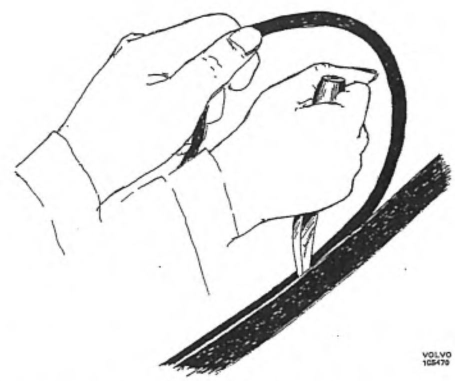


Fig. 8–39. Cutting windshield rubber stripping

Glass

REMOVING WINDSHIELD

1. Place some kind of protective cover over the hood and dashboard.
2. Remove the trim moulding in accordance with the instructions just given and take off the wiper arms.
3. Cut up the rubber stripping along the groove for the trim moulding and remove the cut rubber so that the windshield is uncovered there (Fig. 8–39).
4. Press out the windshield.
5. Pull round the rubber stripping and clean the windshield frame with toluene.

INSTALLING WINDSHIELD

1. Clean the rubber stripping, windshield and windshield frame with toluene.
2. Fit the rubber stripping on the windshield.
3. Fit a cord (suitably of terylene), beginning in the middle of the upper side, in the rubber stripping slot for the plate edge (Fig. 8–40).
4. Set the windshield with rubber stripping in position. Carefully tap several blows with the **palm of the hand** (with glove on) so that the windshield sits well all round. From the inside carefully take off the cord. This causes the rubber stripping to cover the plate edge (Fig. 8–41). Sometimes it may be necessary to adjust the location of the windshield with the palm of the hand. If the cord is too stiff, there is risk of the stripping being damaged. This can be remedied by striking with the palm of the hand from the inside or vice versa if the rubber strip does not cover the edge of the plate properly.
5. Check that the rubber strip seals well all round. If necessary adjust the position of the windshield both vertically and laterally by striking with the palm of the hand.

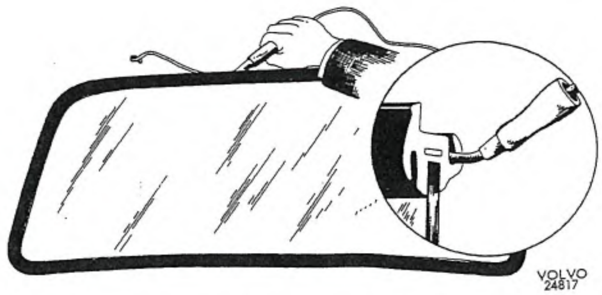


Fig. 8–40. Putting fitting cord in rubber strip

6. With a sealing compound gun fill in between windshield — rubber strip and between rubber strip — body with sealing compound.
7. Clean off surplus sealing compound from the body and windshield with toluene.
8. Fit the trim moulding in accordance with previous instructions and the wiper arms.

NOTE. The sealed joints must not come in contact with water for at least one hour after the sealing has been carried out.

REMOVING REAR QUARTER WINDOW

1. Remove the trim moulding in accordance with previous instructions.
2. Release the rubber strip from the window and from the body by inserting a nylon putty knife moistened in synthetic washing solution (the putty knife should be moistened now and then during the course of the work) all round between rubber strip and window, and rubber strip and body.
3. Start removing the rubber strip in the upper left-hand corner by levering the rubber strip over the edge of the body from the inside and at the same time by carefully pulling out the strip from outside with a pair of grips. Then pull off with care the strip by hand all round and remove the rear quarter window.
4. Clean round the edge of the body and remove all the old sealing compound. If the compound has hardened to the body, carefully scrape it off and then wash clean with naphtha. Check to make sure that the sheet-metal edge is not deformed in any way. If the sealing compound has not dried on the body edge, the rubber strip can also be washed with naphtha. Otherwise fit a new rubber strip.

INSTALLING REAR QUARTER WINDOW

1. Moisten the outer edge of the window and fit on a rubber strip starting at one of the corners. Adjust the strip so that it is fitted properly all round.
2. Fit a cord (preferably terylene Ø 4 mm=5/32") in the groove of the rubber strip for the sheet-metal edge, beginning at the top centre as shown in Fig. 8–40.
3. Place the rear quarter window with rubber strip in position. Wearing working gloves, carefully strike the window a few blows with the palm of the hand to ensure that it makes good contact all round. Carefully pull out the cord from inside. This will cause the rubber strip to "creep" over the sheet-metal edge as shown in Fig. 8–41. It may sometimes be necessary to adjust the position of the window with the palm of the hand. If the cord feels stiff to pull out, there is risk of damage to the strip, and to avoid this, strike the window from inside with the palm of the hand and vice versa if the rubber strip does not "creep" over the edge of the sheet-metal properly.
4. Check that the rubber strip seals well all round. If necessary adjust the position of the rear window both vertically and laterally by striking with the palm of the hand.
5. Seal the joints between the rubber strip and window and rubber strip and sheet metal with sealing compound, using a gun with a flat nylon nozzle. Make sure that the sealing compound fills the joint well. Scrape off surplus compound and wash the window and sheet metal with naphtha. Then clean and polish round the window and sheet metal with some suitable polishing agent.
6. Install the trim moulding in accordance with previous instructions.

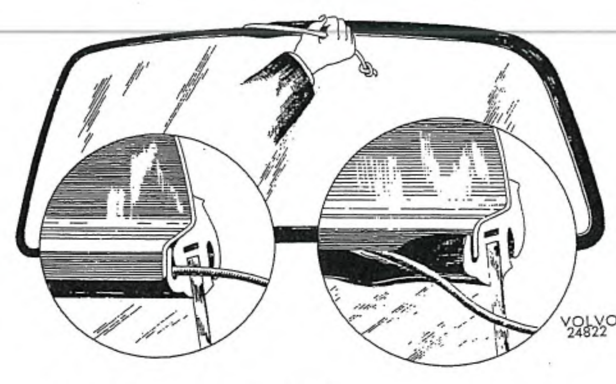


Fig. 8–41. Fitting windshield and rear quarter window

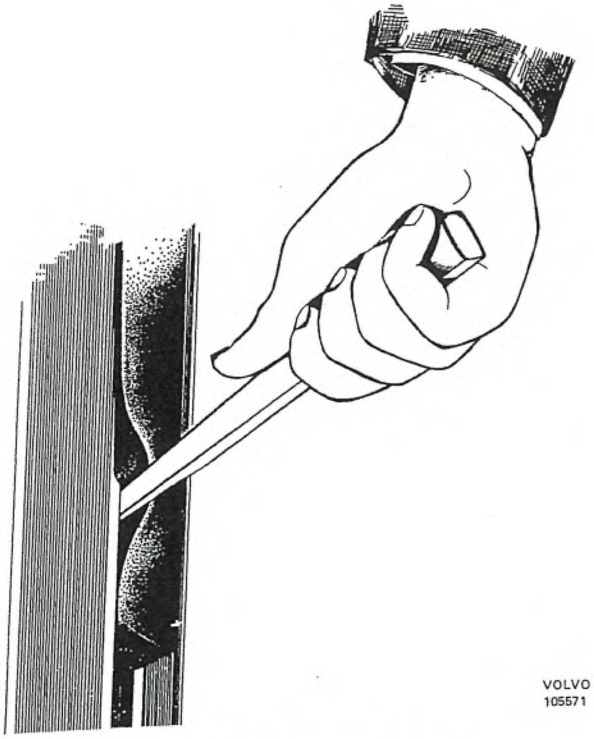


Fig. 8–42. Fitting sealing strip for door

Sealing strips

DOOR STRIP

The sealing strips are secured by means of spot-welded fastening rails.

A sealing strip is removed by pulling it outwards, so that the ridge of the strip releases from the rail. When fitting the sealing strip, place one of the ridges in position in the rail and press down the other ridge into the rail with the help of a wooden putty knife. Move the knife along the rail as shown in Fig. 8–42.

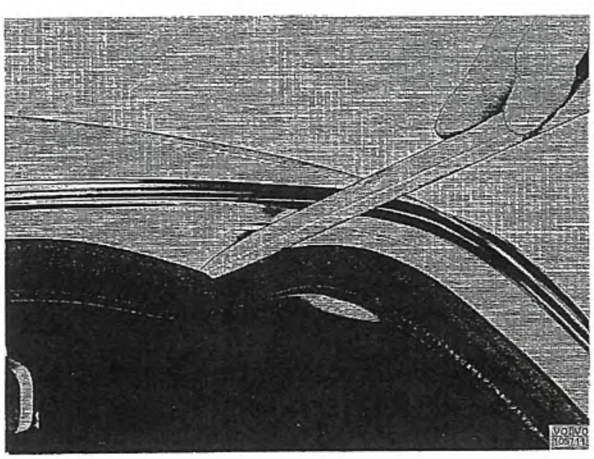


Fig. 8–43. Removing sealing strip for door opening

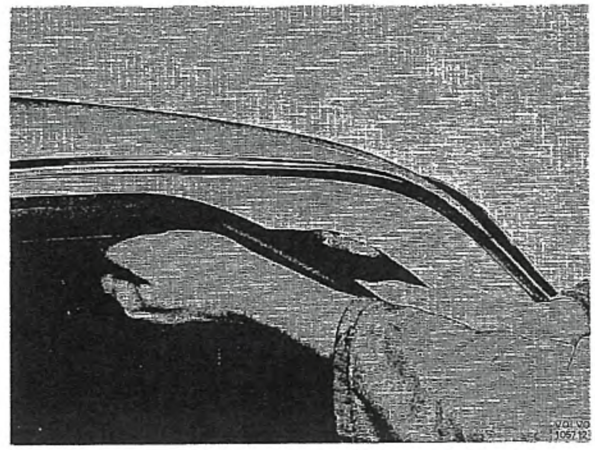


Fig. 8–44. Fitting sealing strip for door opening

SEALING STRIP FOR DOOR OPENING

The strip which seals all round the door opening in the body is fixed to the opening's spot-welded flange. To remove the strip, first release it with a wooden putty knife (see Fig. 8–43) and then pull off the strip from the flange.

The strip is fitted by pressing it firmly against the flange with the hand (see Fig. 8–44).

TAILGATE SEALING STRIP

This strip, which is only pressed firmly into position, is removed by pulling it loose from the projecting edge. To install, press it firmly against the edge.

UPHOLSTERY, INTERIOR EQUIPMENT AND HEATING SYSTEM

DESCRIPTION

UPHOLSTERY AND INTERIOR EQUIPMENT

Headlining

The headlining consists of plastic fabric stretched on roof ribs and secured in retainers fitted on the upper limit of the body sides.

Door upholstery

The door upholstery consists of wood-fibre sheeting lined with non-woven padding and covered with textile-plastic.
It is secured to the door by means of clamps. The front armrests, which are made of moulded plastic, are screwed to the door upholstery.

Covering for firewall and floor

The sides of the firewall are lined with millboard and provided with pockets. The cowl itself is covered with a plastic impregnated felt mat. The floor is covered with textile mats.

Fig. 8–46. Front seat

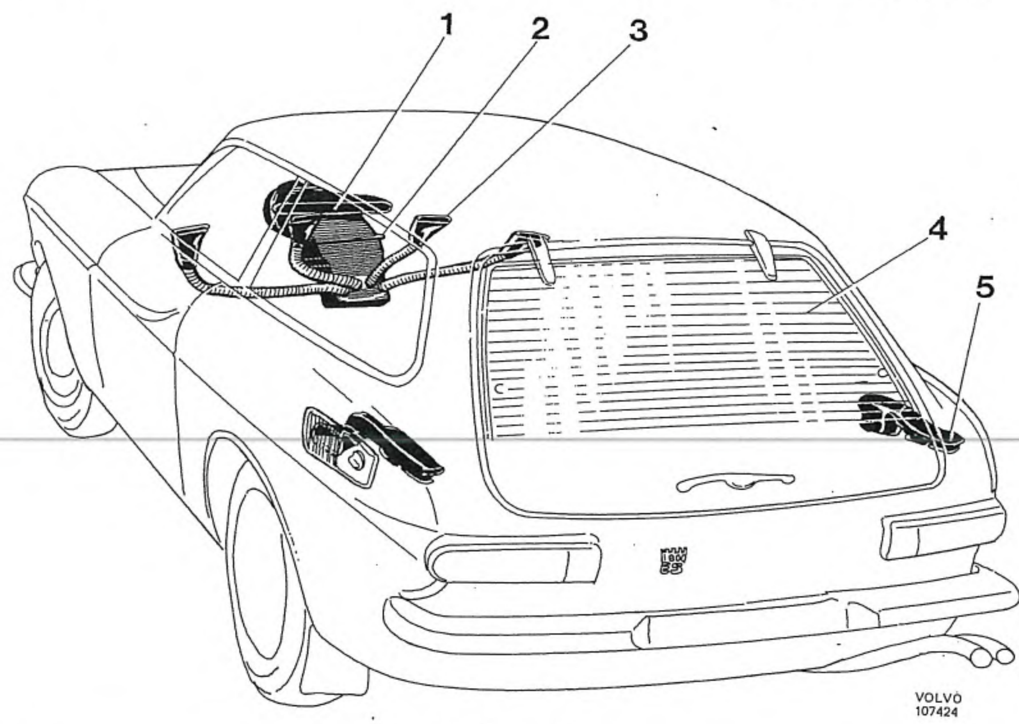


Fig. 8–45. Heating system

1. Air intake for heater and fresh-air intake
2. Heater
3. Defroster for windshield
4. Electrically heated tailgate window
5. Air extractor vent

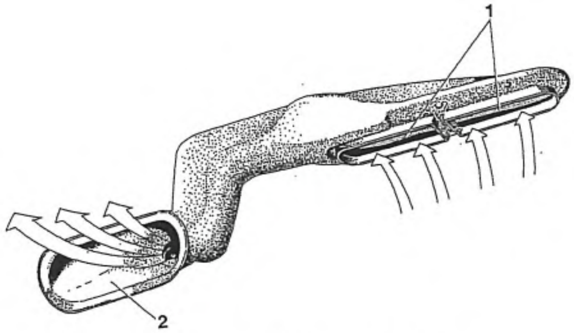


Fig. 8–47. Air extractor vent
1. Non-return valve
2. Place for outer grille

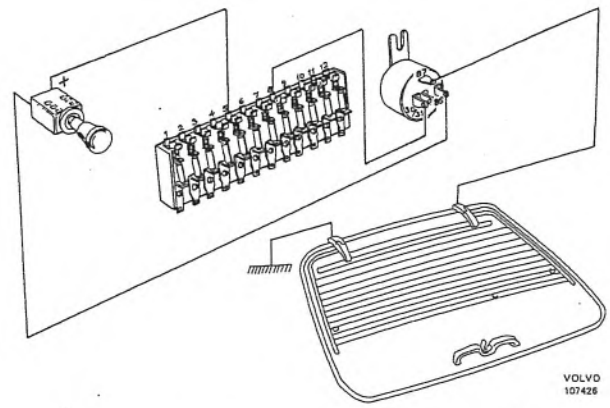


Fig. 8–49. Wiring diagram for electrically heated tailgate window

Front seats

The front seat (Fig. 8–46) is built up on a tubular frame fitted with rubber webbing for the backrest and cushion. The stuffing consists of foam plastic covered with leather and plastic fabric. The rake is regulated by means of a lever on the outside of the seat and the lumbar support adjusted by a knob on the side of the backrest nearest the tunnel. The seat cushion is secured to the seat frame by means of snap buttons.

Rear seat

The rear seat consists of loose foam plastic cushions with textile-plastic covering. The backrest can be folded forwards in order to provide more room for luggage. It latches automatically in the tilted-up position.

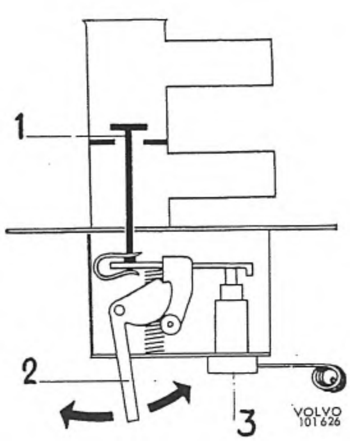


Fig. 8–48. Principle of heat control valve
1. Valve
2. Lever for heating controls
3. Thermostat

HEATING SYSTEM

The heating system is a combined warm air and fresh air system. The incoming air is blown by a fan through the cellular system of the heater unit and out into the car. The fresh air is heated and directed to the required areas inside the car by means of the various controls.

There are two adjustable intakes for only fresh air located in the upper section of the firewall.

Good compartment ventilation is further improved by two air extractor vents fitted with non-return valves and located in the rear fenders (see Fig. 8–47).

The heated air temperature is regulated by means of a heat control valve. How this valve functions in principle can be seen from Fig. 8–48.

The function of the heat control valve is to keep the temperature of the heated air at a pre-set and constant temperature. This is done by means of the thermostat built into the control valve. The temperature control regulates the supply of heated coolant to the cell system. The heat control valve is connected in series with the cell system so that all coolant passing through the cell system also passes through the control valve. The heated coolant in turn heats the air which is fed through the heater unit by the heater fan or the slipstream. If the coolant temperature increases, the thermostat capillary tube expands and acts on the valve in the control system so that there is a smaller flow of coolant. With less coolant flowing through, the air temperature through the unit will be lower and this in turn affects the capillary tube which contracts and permits more fluid to flow through. This cycle is repeated continuously so that a stable air temperature is achieved.

Also included in the heating system of the car is the electrically heated rear window. Output, of approx. 150 Watts, is controlled by a switch on the dashboard. The switch is wired across a control relay (see wiring diagram, Fig. 8–49) which cuts off the current when the ignition is switched off.

Headlining

The headlining (Fig. 8–50) is stretched on a wooden fibre frame and is provided with a number of stretchers which keep the headlining at full stretch. When removing, first release the holder for the sun visor. With a suitable tool bend down the end of the stretchers all round the edge of the roof so that the clips release and the headlining can be taken down.

Removing front seats

Release the snap buttons holding the cushion to the frame and remove the cushion. Hook loose the return spring of the seat and unscrew the four bolts securing the slide rails to the floor.

Instrument panel

The instrument panel is screwed to the body. The screws are accessible from underneath partly at the sides and partly at the edge of the windshield.

HEATING SYSTEM

REMOVING FAN MOTOR

The fan motor and fan gear are replaced as a single unit.

1. Disconnect the battery ground connection and then the fan motor electric cables.
2. Unscrew the two bolts securing the fan motor to its mounting plate.
3. Remove the mounting plate from the heater.
4. Remove the fan motor from the heater (Fig. 8–51). (In certain cases, the rocker arm casing may have to be removed in order to get out the fan motor. In this case cover the rocker arm mechanism with some kind of protection to prevent impurities, etc., from getting in.)

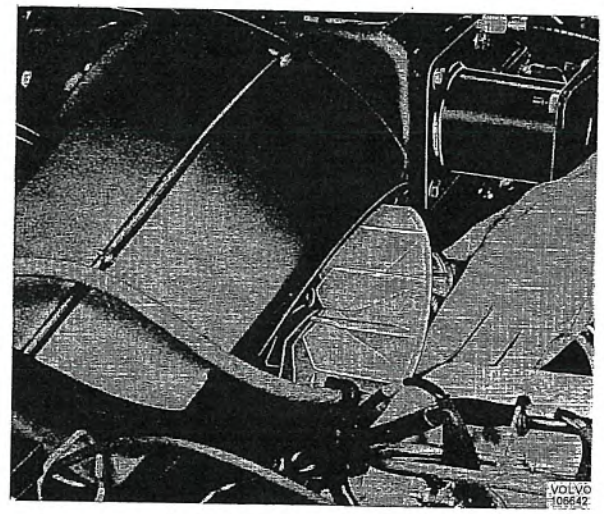


Fig. 8–51. Taking out fan motor

INSTALLING FAN MOTOR

1. Screw the mounting plate to the fan motor.
2. Fit the fan motor with plate to the heater.
3. Connect up the fan motor electric cables and the battery ground cable.
4. (Where applicable.) Re-fit the rocker arm casing.

REPLACING FAN MOTOR BRUSHES

1. Remove the fan motor according to the instructions in previous section.
2. Lift the spring-loaded retainers and unhook the brushes.
3. Disconnect the brushes by heating loose the retainers.
4. Solder on new brushes (see Fig. 8–52).

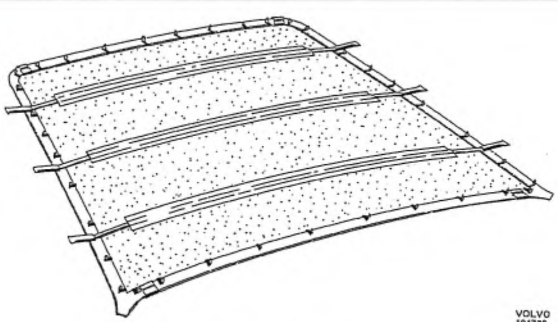


Fig. 8–50. Headlining

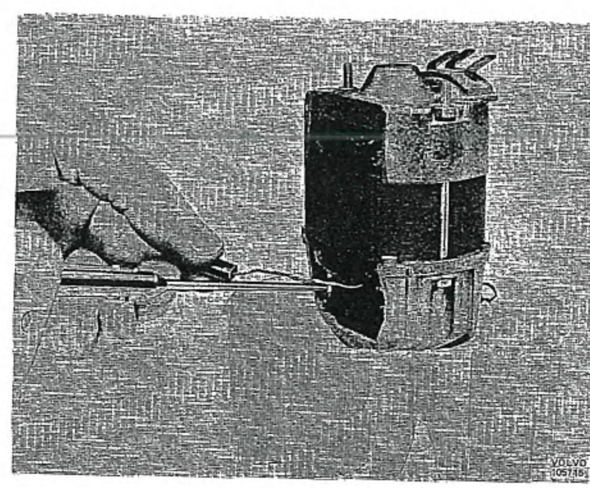


Fig. 8–52. Soldering brushes

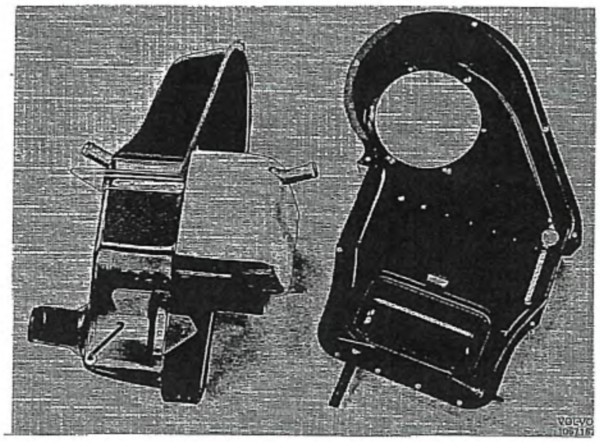


Fig. 8–53. Heater halves separated

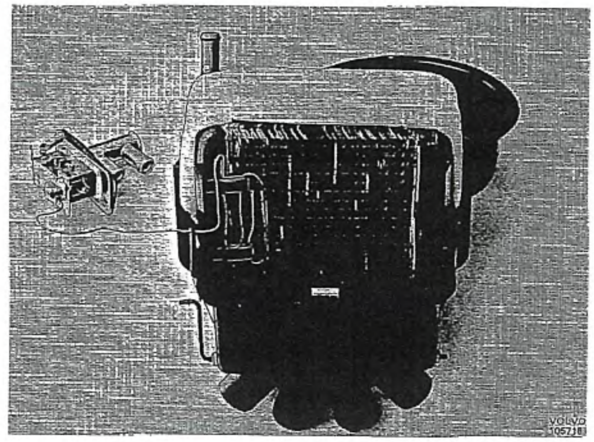


Fig. 8–55. Placing of thermostat capillary tube

REMOVING HEATER

The heater is removed as a complete unit according to the following (applies also to repairs to or replacement of cell system).

1. Drain the coolant.
2. Disconnect the hoses at the cell system and the heater control valve, also the cables from the fan motor.
3. Disconnect the heater fresh-air intake.
4. Unscrew the heater's four attaching nuts.
5. Remove the defroster hoses and disconnect the heater control valve and the wires from the controls.
6. Lift out the heater with the heater control valve.

DISASSEMBLING HEATER

1. Unscrew the fan motor.
2. Unscrew the screws holding together the heater halves and separate them (Fig. 8–53).
3. Lift out the cell system (Fig. 8–54).

CHECKING CELL SYSTEM

Clean the outside of the cell system and lower it under pressure, but max. 1.2 kp/cm^2 (17 psi), into heated water, temperature approx. 70–80°C (158–176°F). The cell system seams are tin-soldered. The connection pipes are hard-soldered. After any leakage point has been discovered, clean the point in question very thoroughly so that the new solder can fill the gap properly.

After completing the sealing, re-check the cell system for leakage in accordance with the above testing procedure.

ASSEMBLING HEATER

1. Check the shutters to make sure they do not jam or are loose.
2. Install the thermostat capillary tube, see Fig. 8–55.
3. Where needed, apply new sealing compound. Place it in the joint between both the halves of the heater before screwing them together (see Fig. 8–56).
4. Screw on the fan motor.

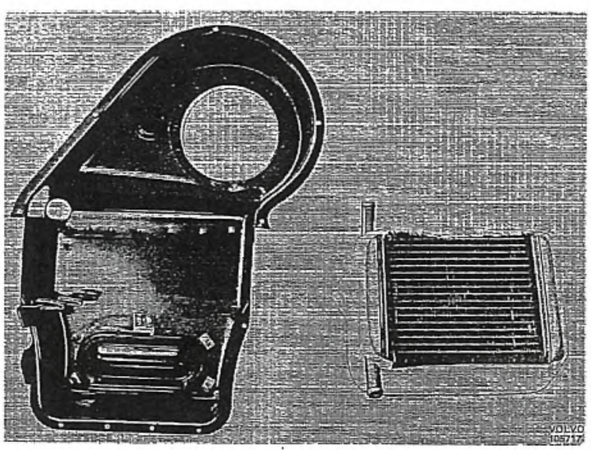


Fig. 8–54. Cell system taken out

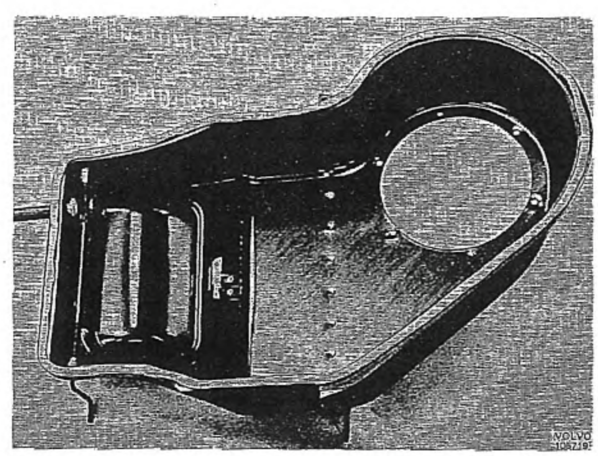


Fig. 8–56. Sealing heater joint

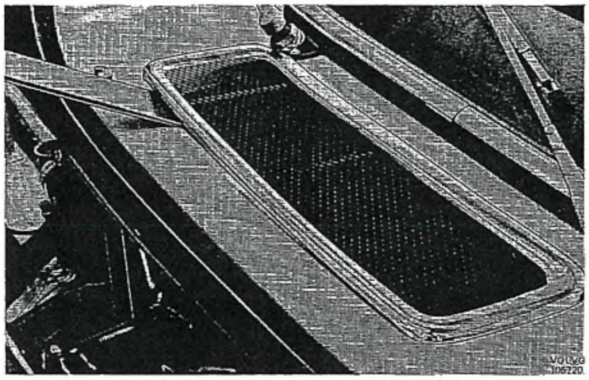


Fig. 8–57. Removing air intake grille

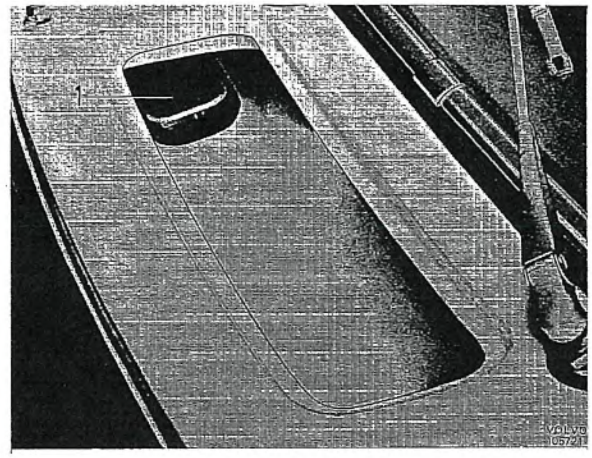


Fig. 8–58. Air intake
1. Opening for fresh-air intake

INSTALLING HEATER

Make sure that all damaged hoses and packings are replaced. Check their locations after installation. Handle the heat control valve and its copper tubing with care.

1. Insert the heater fresh-air duct, and screw it on securely.
2. Screw on the heater.
3. Fit the heat control valve and the hoses to the defroster and cell system.
4. Install the wires from the heater control and fit the cables to the fan motor.

After fitting, check the shutters, controls and the fan motor function. Make sure that the heater drain hose is open and located in the proper position. Top up with coolant if necessary.

Start the engine, increase the speed rapidly a sufficient number of times in order to ensure that the system is bled and top up to the required level with coolant. Repeat this procedure until the cooling system is completely vented.

ADJUSTING HEATING CONTROLS

Move the controls up to the closed position. Then check the location of the shutter and the heat control valve. If these are not in the fully closed position, they should be adjusted. To do this, slacken the wire sleeves at the respective attaching points on the heater or heat control valve. After adjustment has been carried out, move the heating controls up and down several times and check the function.

REPLACING VENTILATION DEVICE AND CONTROLS

1. Remove the fresh-air grille with the help of a wooden putty knife (see Fig. 8–57).
2. Remove the splash guard insert clamps and lift up the insert. Make sure that no clamps fall down into the heater.
3. Unscrew the nut holding the pull control and press out the ventilation device in the direction, underneath – upwards.
4. Check before fitting that the shutter does not stick and that the sealing strip is fully satisfactory and properly installed.
   The shutter should be adjusted so that it fits against the sealing strip with a slight tension when the pull control is pushed in fully.

GROUP 86

BUMPERS

VEHICLES FITTED WITH BUMPER SHOCK ABSORBERS

Both the front and rear bumpers are made up of three aluminium alloy parts and a reinforcing steel member. The outer parts are provided with rubber strips. The various sections are bolted together and the bumper as a whole fixed to the front side members via energy-absorbing, telescopic shock absorbers.

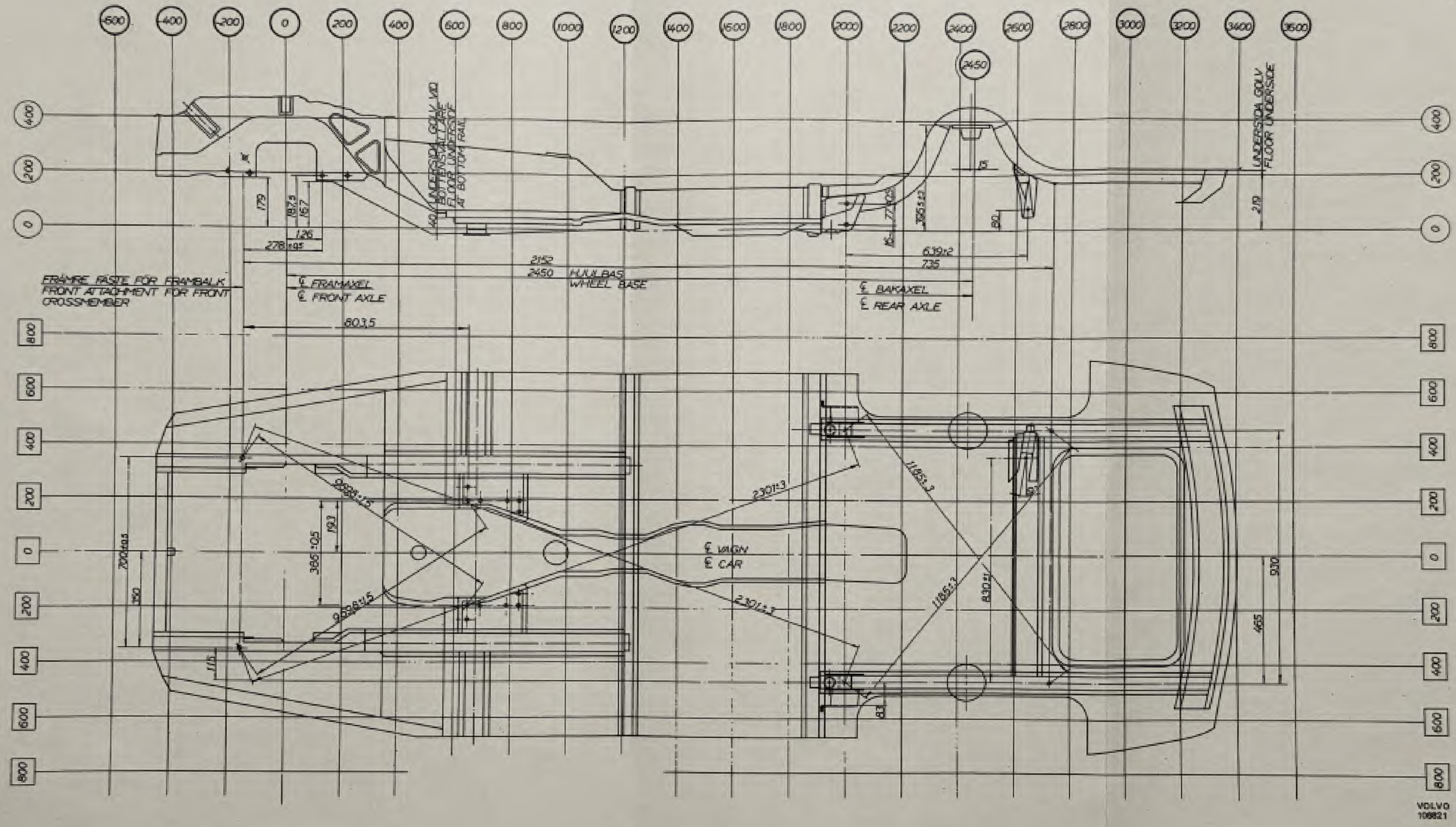
VEHICLES WITHOUT BUMPER SHOCK ABSORBERS

This type of shock absorber is made entirely of aluminium alloy.

The front bumper consists of three sections, the outer ones of which are faced with rubber strips bolted to the bumper.

The rear bumper is made up of five sections. Even the outer parts of this rear bumper are faced with rubber strips.

The various sections of the bumpers are bolted together and attached to the body by means of four support arms. The rear bumper is also attached by two extra support irons.



Control drawing for body floor Volvo 1800 ES