Service Manual
Buses

Section 2 (20–27)
Engine DH10A,
245, 285, 345, 350, 360

TP 16031/1

VOLVO

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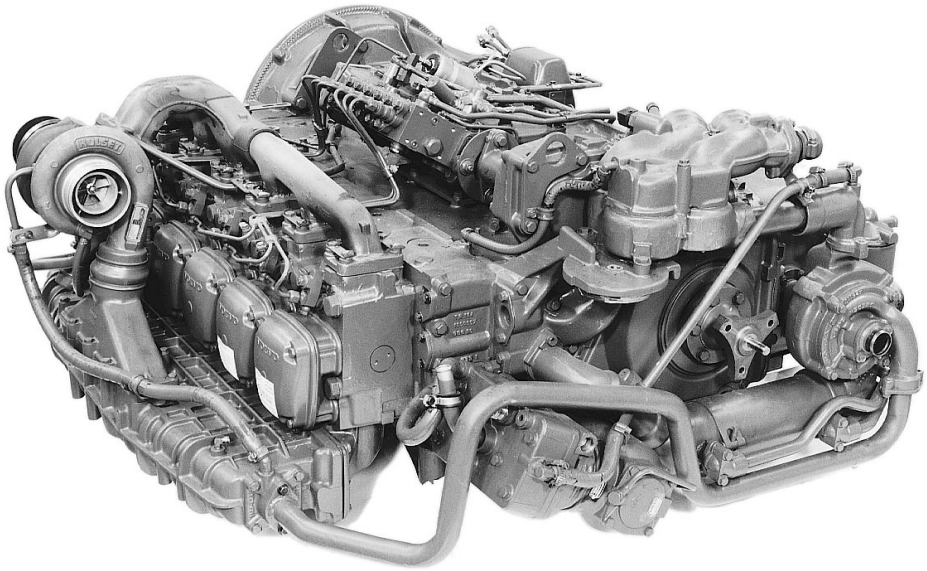
Order number: TP 16031/1

Engine DH10A

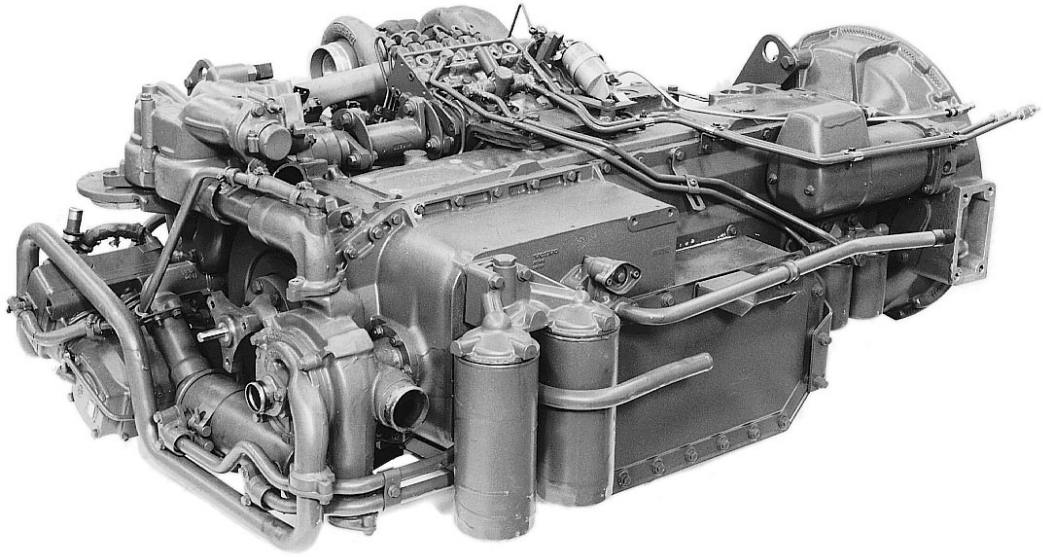


Variants

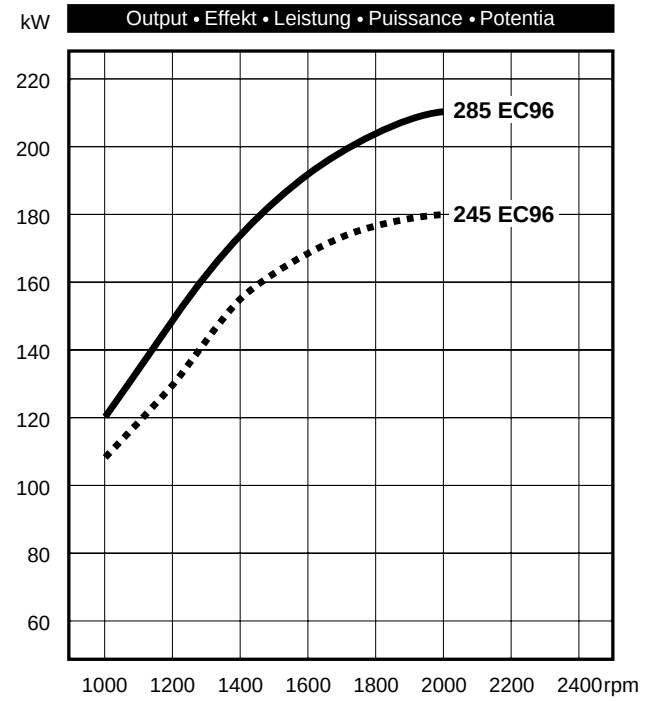
Common characteristics: The DH10A-series is largely based on the earlier THD104 engine. Characteristics: Horizontal design, turbocompressor feed, 9.6 liter displacement. Single circuit coolant-intercooler, separated from the ordinary coolant system. Lube system with two full-flow filters and piston cooling from oil sprayed onto the pistons from underneath. Piston peaks have been changed but still build on the re-entry model, that is, a more favourable air rotation and thereby a more complete combustion. The injection system is electronically controlled (EDC). Injection pressure has been raised as a result of changes in the injection pump. Other nozzles also contribute to better combustion, resulting in lower emissions and lower fuel consumption.

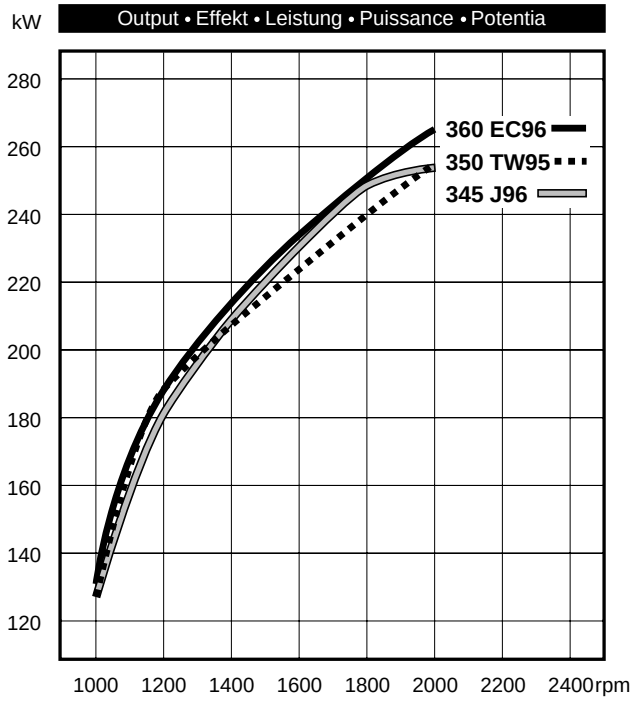
Basic engine	Type	Specific characteristics and areas of use	Bus type
DH10A	**245**	180 kW. Low emissions for city buses. Wastegate and water-cooled turbo for flatter torque curve.	B10B, L, B10M 1996–
DH10A	**285**	210 kW. Low emissions engine for city buses, e.g., articulated buses, bogie buses. Wastegate and water-cooled turbo for flatter torque curve.	B10B, L, B10M 1996–
DH10A	**345**	250 kW. Engine for Japan. Low Nox-value as per Japanese requirements. Altered α. Otherwise similar to 360.	B10M 1996–
DH10A	**350**	260 kW. Engine for Taiwan and other countries. Altered a and no injection timer. Otherwise similar to 360.	B10M 1996–
DH10A	**360**	265 kW. High-output engine for tourist coaches and long-distance buses. Large number produced. Injection pump has a timer that is electronically controlled. Saves fuel at high power output.	B10M, B10B 1996–

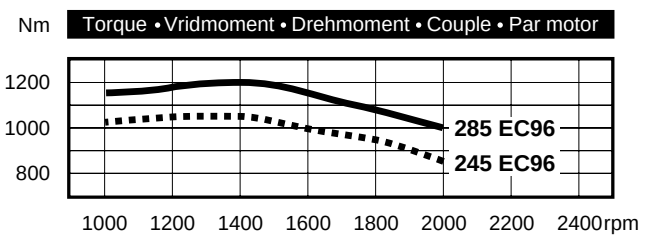
Net output has been measured in accordance with ISO 1585 and SAE J 1349. Smoke requirements met according to ECE/EEC and the Swedish regulations. DH10A fulfils smoke requirements as per 91/542/EEC, Level B (Euro 2) (EC96).

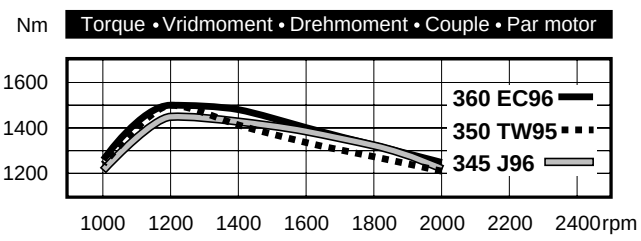


Performance









DH10A 245, 285

DH10A 345, 350, 360

Specifications

General

ENGINE DH10A

Type designation	**245**	**285**	**345**	**350**	**360**
Net output* kW/hp	180/245	210/285	254/345	255/350	265/360
at speed r/s / r/min	33/2000	33/2000	33/2000	33/2000	34.2/2050
Max. torque Nm/kpm at 20 r/s (1200 r/min)	1050/107	1200/122	1440/146	1500/153	1500/153

*** Net as per ISO 1585.**

Number of cylinders	6	
Bore	120.65 mm	
Stroke	140 mm	
Displacement	9.6 dm^3 (9.6 liter)	
	DH10A 245, 285	**DH10A 345, 350, 360**
Compression ratio	20:1	18:1
Firing sequence	1-5-3-6-2-4	
Direction of rotation (B10M frontal view, B10B rear view, engine installed in bus)	Clockwise	
Low idle	8.8±0.8 r/s (530±50 r/min)	8.8±0.8 r/s (530±50 r/min)
High idle	36.6±0.8 r/s (2200±50 r/min)	36.6±0.8 r/s (2200±50 r/min)
De-regulating speed begins at	34.8 r/s (2085 r/min)	38.8±0.8 r/s (2330±50 r/min)
Weight, engine with flywheel, flywheel housing and starter motor, approx	960–980 kg	
Maximum length x width x height	1460 x 1375 x 590 mm	

Engine block

Cylinder head

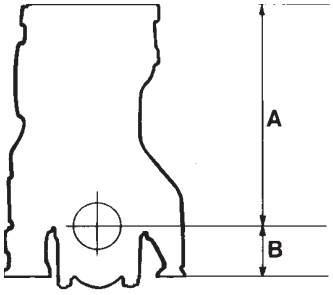
Type	1 per cylinder
Height, new	114.85–115.15 mm
after machining min.	114.65 mm
Groove for cylinder liner,	
width	3.4±0.05 mm
depth	3.0±0.3 mm

Cylinder head bolts

Number/cylinder head	4
Dimension thread	3/4"–10 UNC
Length	200 mm

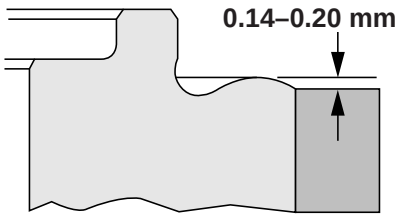
Cylinder block

Height, upper block face – crankshaft centre **(A)** min.	438.8 mm
Height, lower block face – crankshaft centre **(B)**	120 mm
Length	990 mm



Cylinder liners

Type	Wet, replaceable
Height, total	287 mm
Step edge height above block face	0.14–0.20 mm



Cylinder liner (pistons and piston rings) should be replaced with 0.40–0.45 mm wear or if oil consumption is abnormally high.

Pistons

Height, above block face	max. 0.70 mm
No. of ring grooves	3
Piston clearance, fully cast piston	0.12–0.15 mm
Front marking	arrow faces forwards

Piston rings

Compression rings

Number	2
Piston-ring clearance in groove,	
upper compression ring	0.13 mm
lower compression ring	0.09 mm
Piston-ring gap in ring opening 1st ring	0.50 mm
2nd ring	0.70 mm

Oil scraper ring

Number	1
Piston-ring clearance in ring opening	0.4 mm
Piston-ring clearance in groove	0.05 mm

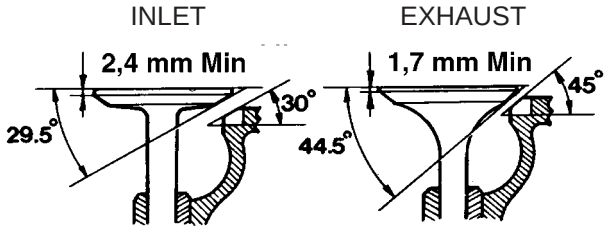
Gudgeon pins

Clearance, gudgeon pin – connecting-rod bushing	0.03 mm
Gudgeon pin diameter stnd.	51.998–52.000 mm
Gudgeon pin hole diameter in piston	52.005–52.013 mm

Valve Mechanism

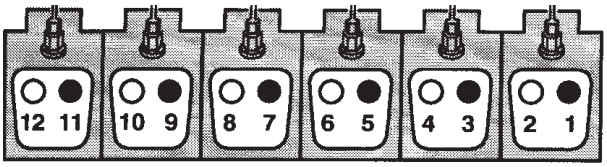
Valves

Disc diameter	
Inlet	50 mm
Exhaust	46 mm
Stem diameter	
Inlet	min. 10.91 mm
Exhaust	min. 10.90 mm
Max. permitted wear	0.07 mm
Valve seat angle/valve edge	
Inlet	29.5°/min. 2.4 mm
Exhaust	44.5°/min. 1.7 mm
Seat angle in cylinder head	
Inlet	30°
Exhaust	45°



Valve clearance, cold engine

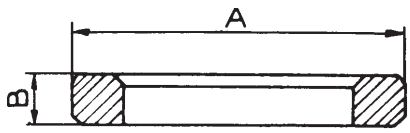
Inlet	0.40 mm
Exhaust	0.70 mm



○ INLET
● EXHAUST

Adjust the valves as follows:

When no. 1 cyl. piston is at T.D.C. after compression, adjust valves 1, 2, 4, 5, 8 and 9.
When no. 6 cyl. piston is at T.D.C. after compression, adjust valves 3, 6, 7, 10, 11 and 12.



Valve seat inserts

Outer diameter (**meas. A**) standard

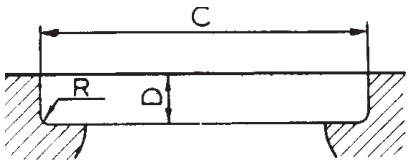
Inlet	54 mm
Exhaust	49 mm

Oversize

Inlet	54.2 mm
Exhaust	49.2 mm

Height (**meas. B**)

Inlet	6.8 mm
Exhaust	9.5 mm



Recess for valve seat inserts

Diameter (**meas. C**), standard

Inlet	54.00–54.03 mm
Exhaust	49.00–49.025 mm

Diameter (**meas. C**), oversize

Inlet	54.20–54.23 mm
Exhaust	49.20–49.225 mm

Depth (**meas. D**)

Inlet	8.8–8.9 mm
Exhaust	11.8–11.9 mm

Recess bottom radius (**meas. R**)

Inlet	0.5–0.8 mm
Exhaust	0.5–0.8 mm

Meas. between valve disc and cylinder head face should be min.

Inlet	0.05–0.50 mm
Exhaust	1.2–1.7 mm

The valve seat may be ground so far that the distance from the valve disc (new valve) to the cylinder head face is max.:

Inlet	1.5 mm
Exhaust	2.5 mm

If the distance is greater, replace the seats.

Valve guides

Inside diameter

Inlet	11.02–11.04 mm
Exhaust	11.02–11.04 mm

Height above cylinder head spring face

Inlet	20 mm
Exhaust	21 mm

Max. permitted clearance between valve stem and valve guide

Inlet	0.15 mm
Exhaust	0.25 mm

Valve springs

Outer valve spring

Length, off-load	61 mm
With 300–390 N (30–39 kp) load	49.6 mm

Inner valve spring

Length, off-load	53 mm
With 80–170 N (8–17 kp) load	42.6 mm

Camshaft

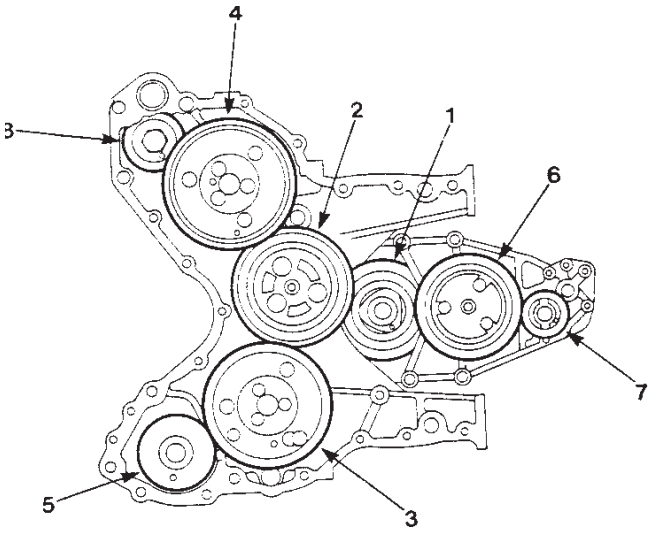
Drive	Gear
No. of bearings	7
Bearing journal diameters, min.	
Front bearing journal	68.94 mm
2nd	66.56 mm
3rd	64.17 mm
4th	63.39 mm
5th	60.99 mm
6th	60.21 mm
7th	56.24 mm
End float, max.	0.18 mm
Radial clearance (same for all bearings) max.	0.079 mm
Max. permitted out-of-round (new bearings)	0.05 mm
Bearings, max. permitted wear	0.05 mm
Lift height min., Camshaft	
Inlet	8.4 mm
Exhaust	9.0 mm
Valve tappets, max. permitted radial clearance	0.08 mm
Checking camshaft setting (cold engine and valve clearance = 0) At 10° flywheel A.T.D.C. no. 1 cyl. inlet valve should open	4.2–4.8 mm
Max. valve lift:	
inlet	13.3 mm
exhaust	14.3 mm
Min. valve lift:	
inlet	13.0 mm
exhaust	14.0 mm

Camshaft bearings

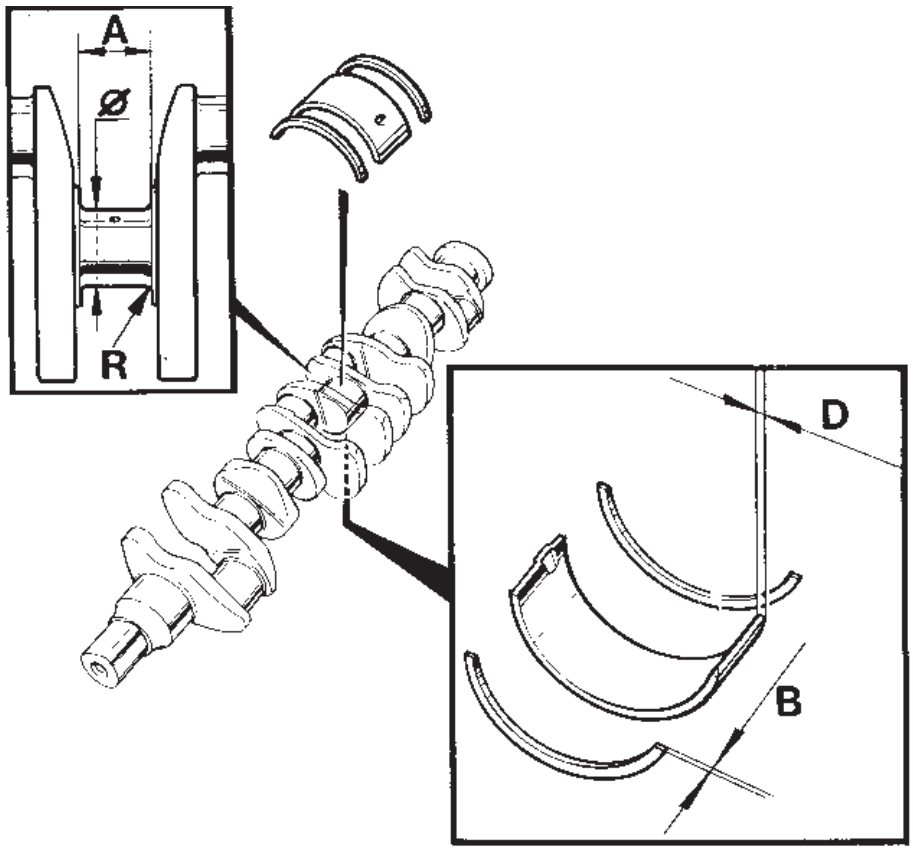
Bearing bores	
Front bearing	69.050–69.075 mm
2nd	66.675–66.700 mm
3rd	64.287–64.312 mm
4th	63.500–63.525 mm
5th	61.112–61.137 mm
6th	60.325–60.350 mm
7th	56.350–56.375 mm
Wear max.	0.050 mm

Timing gears

Number of teeth:	
crankshaft gear (1)	30
intermediate gear (2)	53
injection pump drive gear (4)	60
servo pump drive gear (8)	19
camshaft gear (3)	60
compressor drive gear (5)	26
intermediate gear for oil pump and coolant pump (6)	48
drive gear for oil pump and coolant pump (7)	21
Backlash, max.	0.17 mm
Bearing sleeve, intermediate gear, diam., max.	92.106 mm
Bushing, intermediate gear, diam., max.	92.158 mm
Radial clearance for intermediate gear max.	0.082 mm
Axial clearance for intermediate gear max.	0.15 mm



1. **Crankshaft gear**
2. **Intermediate gear**
3. **Camshaft gear**
4. **Injection pump drive gear**
5. **Compressor drive gear**
6. **Intermediate gear for oil pump/coolant pump**
7. **Drive gear for oil pump/coolant pump**
8. **Servo pump drive gear**



Crank Mechanism

Crankshaft

Length ..... 1154 mm
Crankshaft, end float, max. ..... 0.4 mm
Main bearings, radial
clearance, max. ..... 0.14 mm

The crankshaft is nitrocarburised or induction-hardened. **NOTE**: A nitrocaburised crankshaft may be ground max. to 2nd undersize. With deeper grinding the crankshaft must be re-nitrocarburised.

Main bearing journals

Diameter **(Ø)** for machining
- standard ..... 99.978–100.000 mm
- undersize 0.25 mm ..... 99.724–99.746 mm
- 0.50 mm ..... 99.470–99.494 mm
- 0.75 mm ..... 99.216–99.238 mm
- 1.00 mm ..... 98.962–98.984 mm
- 1.25 mm ..... 98.708–98.730 mm

Main bearing journals
- out-of-round (new) ..... max. 0.006 mm
- wear out-of-round ..... max. 0.08 mm
- taper ..... max. 0.05 mm

Width axial journal pin **(A)**
- standard ..... 45.975–46.025 mm

Oversizes
- 0.2 mm
  - (axial bearing 0.1 mm) .. 46.175–46.225 mm
- 0.4 mm
  - (axial bearing 0.2 mm) .. 46.375–46.425 mm
- 0.6 mm
  - (axial bearing 0.3 mm) .. 46.575–46.625 mm

Fillet radius **(R)** ..... 3.75–4.00 mm

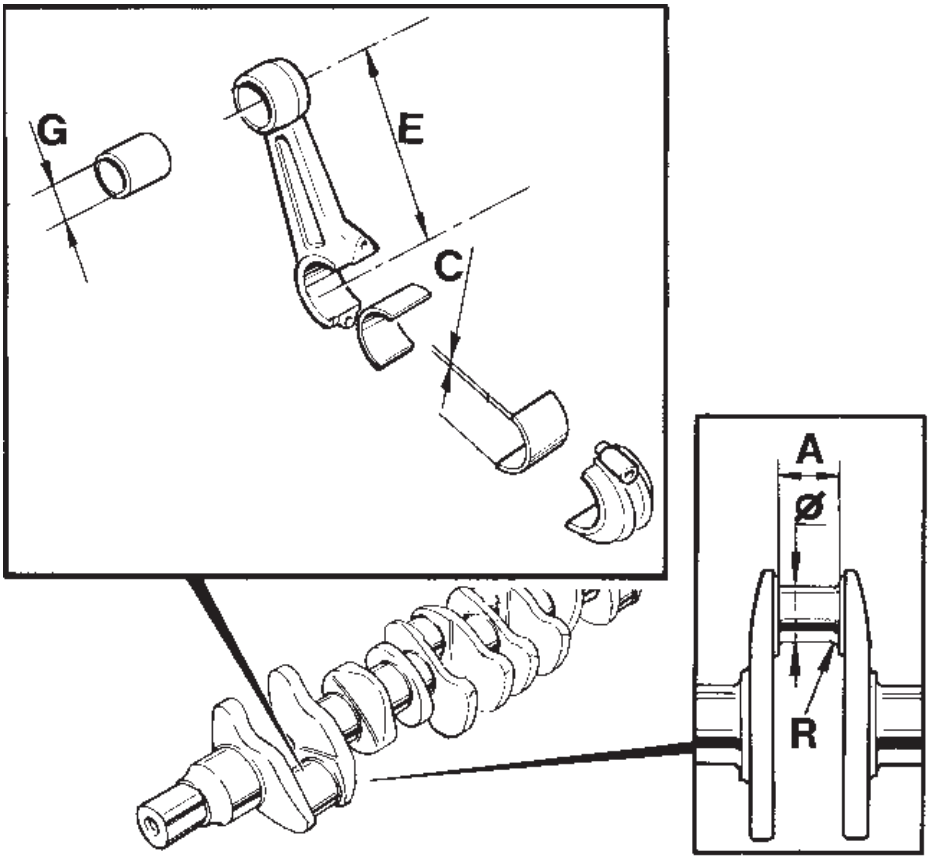
Thrust washers (axial bearing)

Thickness **(B)**, standard ..... 2.312–2.362 mm
oversize 0.1 mm ..... 2.412–2.462 mm
0.2 mm ..... 2.512–2.562 mm
0.3 mm ..... 2.612–2.662 mm
0.4 mm ..... 2.712–2.762 mm

Main bearing shells

Diameter, bearing shell seat
in block ..... 104.978–105.003 mm

Thickness **(D)**,
- standard ..... 2.447 mm
- undersize 0.25 mm ..... 2.574 mm
- 0.50 mm ..... 2.701 mm
- 0.75 mm ..... 2.828 mm
- 1.00 mm ..... 2.955 mm
- 1.25 mm ..... 3.082 mm



Big-end bearing journals

Diameter **(Ø)** for machining		
standard	.....	86.003–86.025 mm
undersize 0.25 mm	.....	85.753–85.775 mm
0.50 mm	.....	85.503–85.525 mm
0.75 mm	.....	85.253–85.275 mm
1.00 mm	.....	85.003–85.025 mm
1.25 mm	.....	84.753–84.775 mm
Axial bearing surface width **(A)**		53.90–54.00 mm
Fillet radius **(R)**	.....	3.75–4.00 mm
Big-end bearing journals		
out-of-round (new)	.....	max. 0.004 mm
slitage orundhet	.....	max. 0.08 mm
konicitet	.....	max. 0.05 mm

Connecting-rod bearing shells

Thickness **(C)**,		
standard	.....	2.413 mm
undersize 0.25 mm	.....	2.540 mm
0.50 mm	.....	2.667 mm
0.75 mm	.....	2.794 mm
1.00 mm	.....	2.921 mm
1.25 mm	.....	3.048 mm

Connecting rods

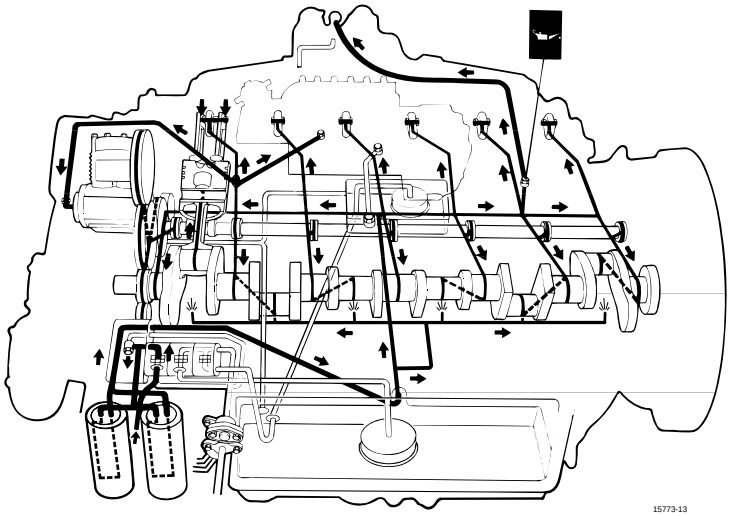
Length, centre crankpin seat – centre gudgeon pin seat:	.....	277 mm
Diameter:		
connecting-rod bushing	.....	57.300–57.346 mm
connecting-rod bushing internal diameter **(G)**	.....	52.022–52.028 mm
Axial clearance, crankshaft – connecting rod, max.	.....	0.35 mm
Connecting-rod bearings, radial clearance, max.	.....	0.12 mm
Max. weight deviation for connecting rods within same engine	.....	50 g
Straightness max. deviation on 100 mm measuring length	...	0.05 mm
Torsion, max. deviation on 100 mm measuring length	...	0.1 mm

Flywheel, installed

Max. permitted axial throw (manual gearbox) measuring radius 150 mm	.....	0.16 mm
Ring gear on flywheel	.....	156 teeth

Flywheel casing, installed

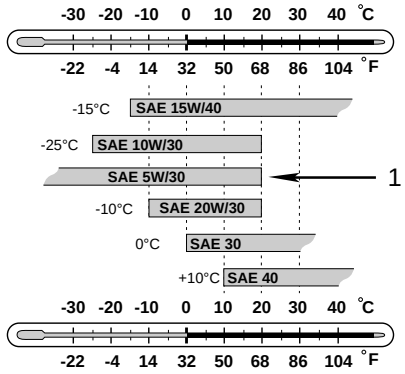
Max. permitted axial throw for contact surface against clutch casing	.....	0.13 mm
Max. permitted radial throw for guide diameter towards clutch casing	.....	0.19 mm



Lubricating system

Oil change quantity, with oil filter	approx. 40 litres
Oil pressure, operating speed	300–500 kPa (3–5 bar)
Oil pressure, idling (low idle)	min. 60 kPa (0.6 bar)
Oil quality	Volvo Drain Specification alt. API Service CD, CE or CCMC -D4, D5

Viscosity acc. to diagram below.



The temperatures refer to stable ambient temperatures.
1) Refers to synthetic or semi-synthetic oil.
NOTE! Only SAE 5W/30 may be used.

Lube oil pump

Type	Gear-driven
Number of teeth	11
Axial play, gear wheel	0.02–0.08 mm
Backlash	0.15–0.35 mm
Diameter,	
bushing for pump shaft	18.050–18.068 mm
bearing sleeve intermediate gear	92.084–92.106 mm
bushing for intermediate gear	92.141–92.176 mm
Drive gear-bracket, distance	1–1.5 mm

Reducer valve

Spring length	
Off-loaded	61 mm
Loaded with 83–86 N (8.3–8.6 kp)	33 mm
Loaded with 64–67 N (6.4–6.7 kp)	39 mm

By-pass valve (oil cooler)

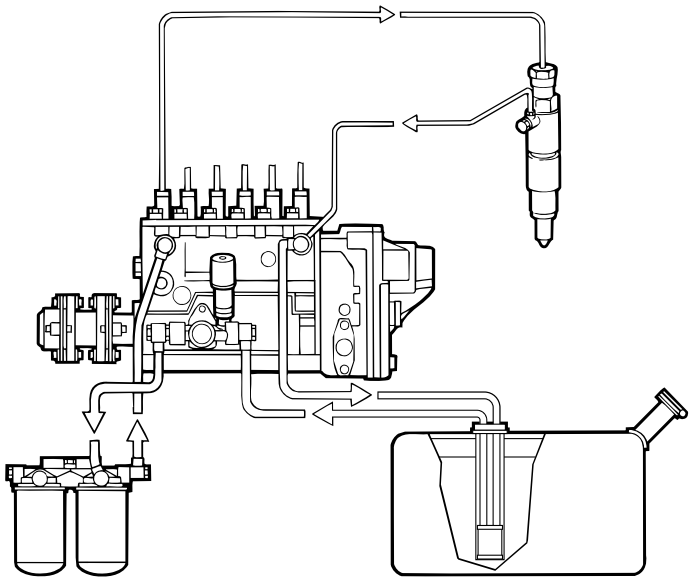
Spring length	
Off-loaded	69 mm
Loaded with 17.9 N (1.79 kp)	32 mm
Loaded with 14.0 N (1.4 kp)	40 mm

Relief valve (direct oil filter)

Spring length	
Off-loaded	69 mm
Loaded with 16.9–18.9 N (1.69–1.89 kp)	32 mm
Loaded with 13–14 N (1.3–1.4 kp)	40 mm

Oil filters

Direct oil filters	
Number	2
Volvo P/N	466634-3
Tightening torque (oiled sealing ring)	25 Nm



Fuel system

Type	EDC (Electronic Diesel Control)
Injection pump direction of rotation, seen from clutch side	Clockwise
Injection sequence	1-5-3-6-2-4

Fuel

Quality must fulfil minimum current legislation as well as national and international standards EN 590, SS-EN 590, DIN EN 590, ASTMD 975 No. 1-D, No. 2-D, JIS KK 2204.

Injection pump

Volvo P/N	425 758
Pump type	PE 6 P 120 A320 RS 8033
Governor type	RE 30
Injection pump direction of rotation	Clockwise
Injection sequence	1-5-3-6-2-4
Injection pump basic setting on engine:	
DH10A 345	5.5±0.5° B.T.D.C.
DH10A 245, 285, 360	7.0±0.5° B.T.D.C.
DH10A 350	9.0±0.5° B.T.D.C.

Performance check

Bus stationary

- Engine switched off
- Start key (feed selector switch) in drive position

Accelerator pedal in idle position:	
Reference voltage (U ref)	4.5–5.0 V
Control rod travel	0.27–0.60 V (6.0–1.2% of U ref)
Accelertor pedal in full throttle position (incl. kickdown):	
Accelrator pedal sensor	62–70% of U ref
Turbo pressure (voltage)	1.30–1.50 V

Speed		1200 r/min		2000 r/min		
	over-press. kPa	**over-press. volt**	**control rod travel volt**	**over-press. kPa**	**over-press. volt**	**control rod travel volt**
DH245	125	3.60	2.40	135	3.76	2.74
DH285	135	3.76	2.55	150	3.99	3.05
DH360	115	3.44	2.87	195	4.71	3.18
D 245	125	3.60	2.36	135	3.76	2.71
DH350	106	3.31	2.87	196	4.75	3.18

DH345 – Values not known when manual went to print.

Measuring during driving
- Fully loaded bus
- Accelerator pedal in full throttle position

Injection timer, only DH10A 345 and 360

Drive ..... Gear
No. of bearings 2
Bore, bearings ..... 67.05–67.08 mm

The injection timer alters the pump basic timing (μ) with engine at operating temp. (above 55°C), see page 97.

Feed pump

Designation ..... FP/KG 24 P 307
Feed pressure (depending on speed and load) ..... 100–400 kPa (1–4 bar)

Injectors DH10A 245, 285

Nozzle stand ..... KBEL 117 P 73
Nozzle (Volvo P/N) ..... DLLA 150 P555 (425694)
Number marking (complete injector) 555
Opening pressure ..... $25\ ^{+0.8}_{-0}$ MPa
Adjusting pressure (new spring) ..... $26\ ^{+0.8}_{-0}$ MPa
No. of holes x bore. ..... 6 x 0.236 mm

Injectors DH10A 345, 350, 360

Nozzle stand ..... KBEL 117 P 73
Nozzle (Volvo P/N) ..... DLLA 152 P571 (8194095)
Number marking (complete injector) 571
Opening pressure ..... $25\ ^{+0.8}_{-0}$
Adjusting pressure (new spring) ..... $26\ ^{+0.8}_{-0}$
No. of holes x bore. ..... 6 x 0.236 mm

Fuel filters

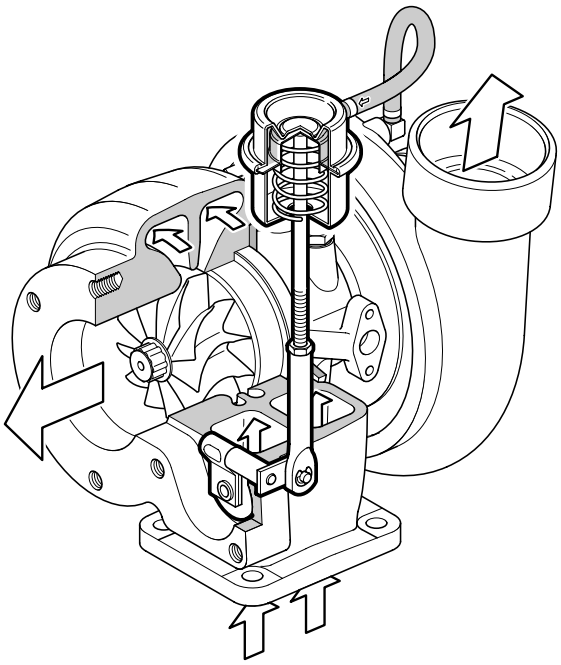
Number 2
Volvo P/N 466 987

Inlet and exhaust systems

Turbocompressor

For engine DH10 245, 285

Designation	HX 40 W – 8594 Z
Cooling	Water-cooled
Lubricating system	Pressure-lubrication
Wastegate opening pressure	155 kPa engine speed 4.04 volts at 2000 r/min
With control rod travel on wastegate	1±0.3 mm (setting)
Check value	0.4–1.5 mm
Axial clearance, rotor	0.04–0.09 mm



Radial clearance at compressor wheel	0.33–0.50 mm

For engine DH10A 345, 350, 360

Designation	GT 4288 N
Lubricating system	Pressure-lubrication
Maximum speed (all)	approx. 1400–1800 r/s (81 000–108 000 r/min)

Measuring with bus stationary

Accelerator pedal in idle position:

Reference voltage	4.5–5.0 V
Control rod travel	0.3–0.6 V
Turbo pressure (voltage)	1.30–1.50 V

Accelerator pedal in full throttle position:

Reference value	62–70% of U ref

Measuring during driving

Accelerator pedal in full throttle position and engine at max. load: See Performance Check

Starter pre-heater

Output	3500 W

Pressure-drop indicator

Red indication at mm VP	580–720

Exhaust-pressure governor

Control pressure with warm-up and exhaust pressure braking	750 kPa

Cooling system

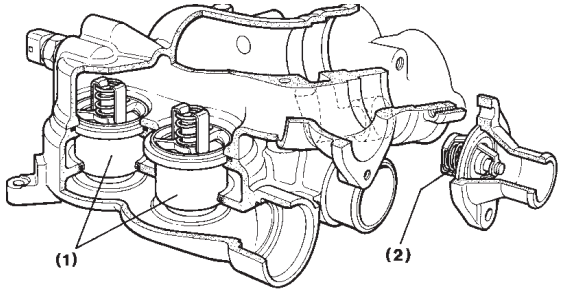
Type	Overpressure closed
Pressure valve opens at	approx. 50 kPa (0.5 kp/cm^2)

Coolant

Anti-freeze

Type	C
Consists of	Glycol with rustproofing
Colour	Blue-green
Volvo art no. 1 kg	1128700-9
5 kg	1129701-7
235 kg	1129702-5

Thermostats



Engine circuit (1)

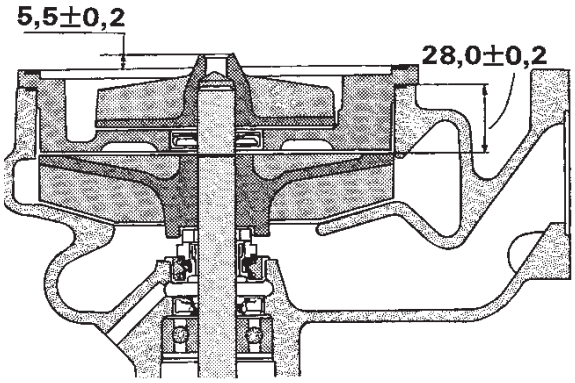
Type	Piston thermostat
Number	2
Marking	82
Opening temperature	82±2°C
Fully open at	95±2°C

Heating distributor thermostat (2)

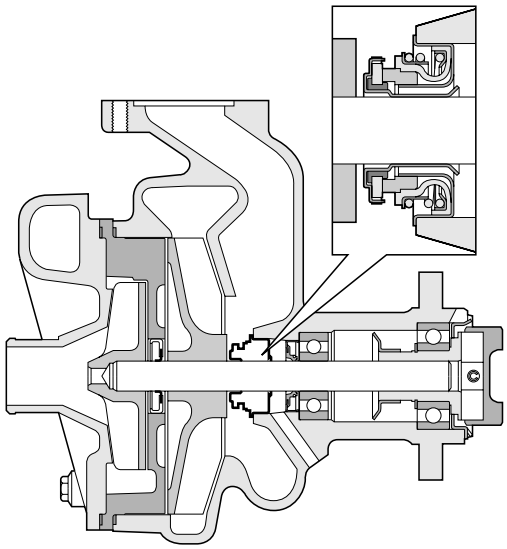
Marking	60
Opening temperature	58–62°C
Fully open at	approx. 77°C

Coolant pump

Impeller press-in depth



Type	Gear-driven pump with two pump gears



Fans B10M

Hydraulic-driven cooling fan

Pump, type/designation	Vickers PVE 19 R
Fan motor, type/designation	Volvo Flygmotor F11-19
Fan speed	
at engine speed 1000 r/min and coolant temperature	
under 90°C	approx. 700 r/min
above 94°C	approx. 2000 r/min
Filter, part no.	4823936
Drive belts	HC 50 1150 Lw x 2 P/N 966846

Fans B10B

Temperature-controlled cooling fan

Type	Bimetal plate/ coolant coupling
Fan speed at engine speed 38.3 r/s (2300 r/min),	
under +37°C	min. 7 r/s (420 r/min)
above +63°C	min. 35.7 r/s (2100 r/min)

Temperatures refer to temp. round bimetal plate.

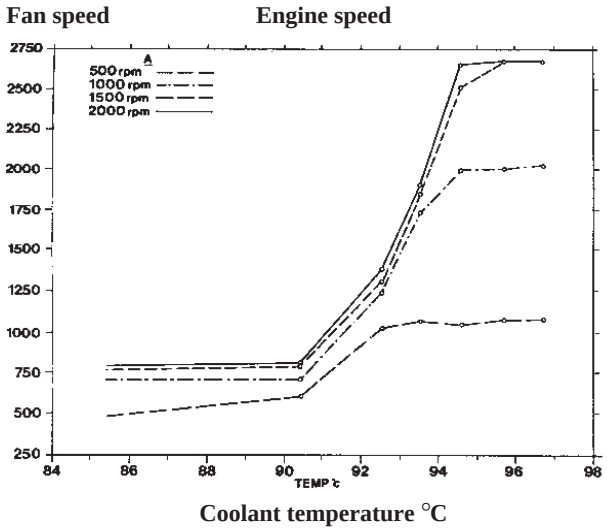
Drive-belt driven cooling fan

Fan drive reduction	1:1.22
Belt type/size (4 belts included in this drive)	HC 12.5 x 1550 P/N 9515805

Hydraulic-driven cooling fan

(rear-mounted)

Pump, type/designation	Vickers PVE 19 R
Fan motor, type/designation	Volvo Flygmotor F11-19
Fan speed	
at engine speed 1000 r/min and coolant temperature	
under 90°C	approx. 700 r/min
above 94°C	approx. 2000 r/min
Filter, P/N	4823936
Drive belts	
late prod.	SPB 2380 Lw P/N 9518424



Coolant temperature °C

Fan B10L

Fan drive, hydraulic	
Pump type/designation	AFGP 31.5 L
Volvo P/N	3118711
Fan motor/designation	Sauer Sundstrand 551/1/00888/ETC
Volvo P/N	9519828
Thermostat valve	Sauer Sundstrand 553/1/09648/093
Volvo P/N	9519829
Closes at	93°C

Fan speed

Engine speed 1000 r/min. and coolant temperature:

Under 80°C	approx. 300 r/min
Above 93°C	approx. 1500 r/min

Wear tolerances

Cylinder head

Height, min.	114.65 mm
Max. pressure at leakage check	150 kPa (1.5 kp/cm^2)

Cylinder liners

A cylinder liner (pistons and piston rings) should be renewed at 0.40–0.45 mm wear or if oil consumption is abnormally high.

Crankshaft

Max. permitted out-of-round on main bearing and big-end bearing journals	0.08 mm
Max. permitted taper on main bearing and big-end bearing journals	0.05 mm
Max. crankshaft end float	0.40 mm
Max. radial clearance	0.14 mm

Connecting rods

Straightness, max. deviation on 100 mm length measured	0.05 mm
Torsion, max. deviation on 100 mm length measured	0.1 mm
End float, max.	0.35 mm
Radial clearance, max.	0.12 mm

Valves

Max. permitted clearance between valve stem and valve guide	
Inlet	0.15 mm
Exhaust	0.25 mm
Valve disc edge should be min.	
Inlet	1.9 mm
Exhaust	1.4 mm

The valve stem insert may be ground down so that distance from the valve disc (new valve) to cylinder head face is max.

Inlet	2.5 mm*
Utlopp	1.5 mm

* With greater distance than above, renew inserts.

Camshaft

End play, max.	0.18 mm
Radial clearance, max.	0.08 mm
Max. permitted out-of-round (with new bearings)	0.05 mm
Bearings, max. permitted wear .	0.05 mm
Valve tappets, max. permitted radial clearance	0.08 mm

Flywheel, installed

Max. permitted axial throw (manual gearbox) measuring radius 150 mm	0.16 mm

Tightening torques

Groups 20–21	Nm	kpm
Cylinder heads (see note 1)		
Main bearings	340±25	34.0±2.5
Big-end bearings	(see note 2)	
Intermediate gear bearings	60 $^{+10}_{-5}$	6.0 $^{+1.0}_{-0.5}$
Flywheel	185 $^{+5}_{-10}$	18.5 $^{+0.5}_{-0.1}$
Pulley, crankshaft	60±6	6.0±0.6
Flywheel casing	140±15	14.0±1.5
Drive gear, injection pump drive with 6 bolts	33±4	3.3±0.4
Drive gear, camshaft	60±5	6.0±0.5
Cleansing plugs, cylinder block	60±10	6.0±1
cylinder head	20±5	2.0±0.5
Centre bolt, crankshaft	560±30	56.0±3
Centre bolt, with torque converter	140 $^{+50}_{-20}$	14.0 $^{+5.0}_{-2.0}$
Vibration damper flange	60±6	6.0±0.6
Front sealing ring	60±6	6.0±0.6
Timing gear casing	40±4	4.0±0.4
Timing gear cover	50±5	5.0±0.5
Engine mounts	80	8.0
Bearing brackets, rocker arm shaft	40±4	4.0±0.4
Thrust washer, camshaft	40±4	4.0±0.4
Axial journalling,camshaft	40±4	4.0±0.4

Group 22	Nm	kpm
Bracket, oil pump	40±4	4.0±0.4
Intermediate gear, oil pump	17±2	1.7±0.2
Sump	18±2	1.8±0.2
Sump cover	24±2	2.4±0.2
Drain plug, sump	60±15	6.0±1.5

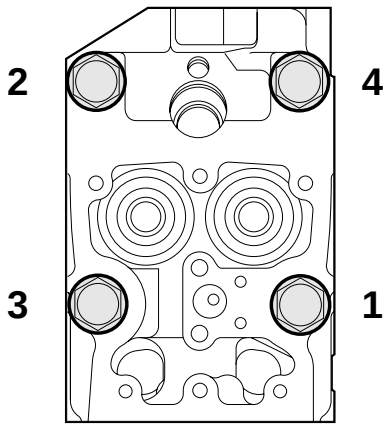
Groups 23–25		
Pressure valve stand, injection pump	85±5	8.5±0.5
Nut for retainer, injectors	45±5	4.5±0.5
Clamp bolt, injection pump		
M11	90±5	9.0±0.5
M12	114±10	11.4±1.0
Laminate screw, injection pump M10	62±5	6.2±0.5
Retaining bolt, injection pump	40±4	4.0±0.4
Drive, injeciton timer	33±4	3.3±0.4
Turbocompressor thrust bearings	4.5	0.45
Turbocompressor wheel	17.0	1.7
Turbocompressor turbine housing	13.6	1.4
Turbocompressor housing	5.7	0.6
Exhaust-pressure governor	10–11	1.0–1.1
Intercooler bearers	20±2	2.0±0.2

Notes:

1 Tightening sequence for cylinder head bolts

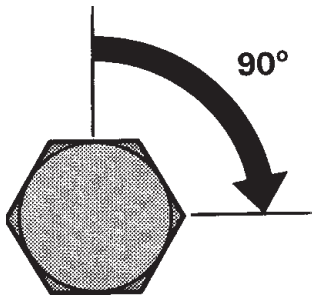
Clean the contact face for the cylinder head bolts prior to fitting the bolts. Dip the bolts entirely (incl. bolt heads) in rustproofing art. no. 1161346-0. The bolts should be drip-free before fitting. Tighten the cylinder head bolts evenly and unhurriedly according to the following stages and torques:

4-stage tightening and torques.
1st stage 50 Nm (5 kpm).
2nd stage 200 Nm (20 kpm).
3rd stage 370 Nm (37 kpm).
Final stage (angle tightening) 90°.

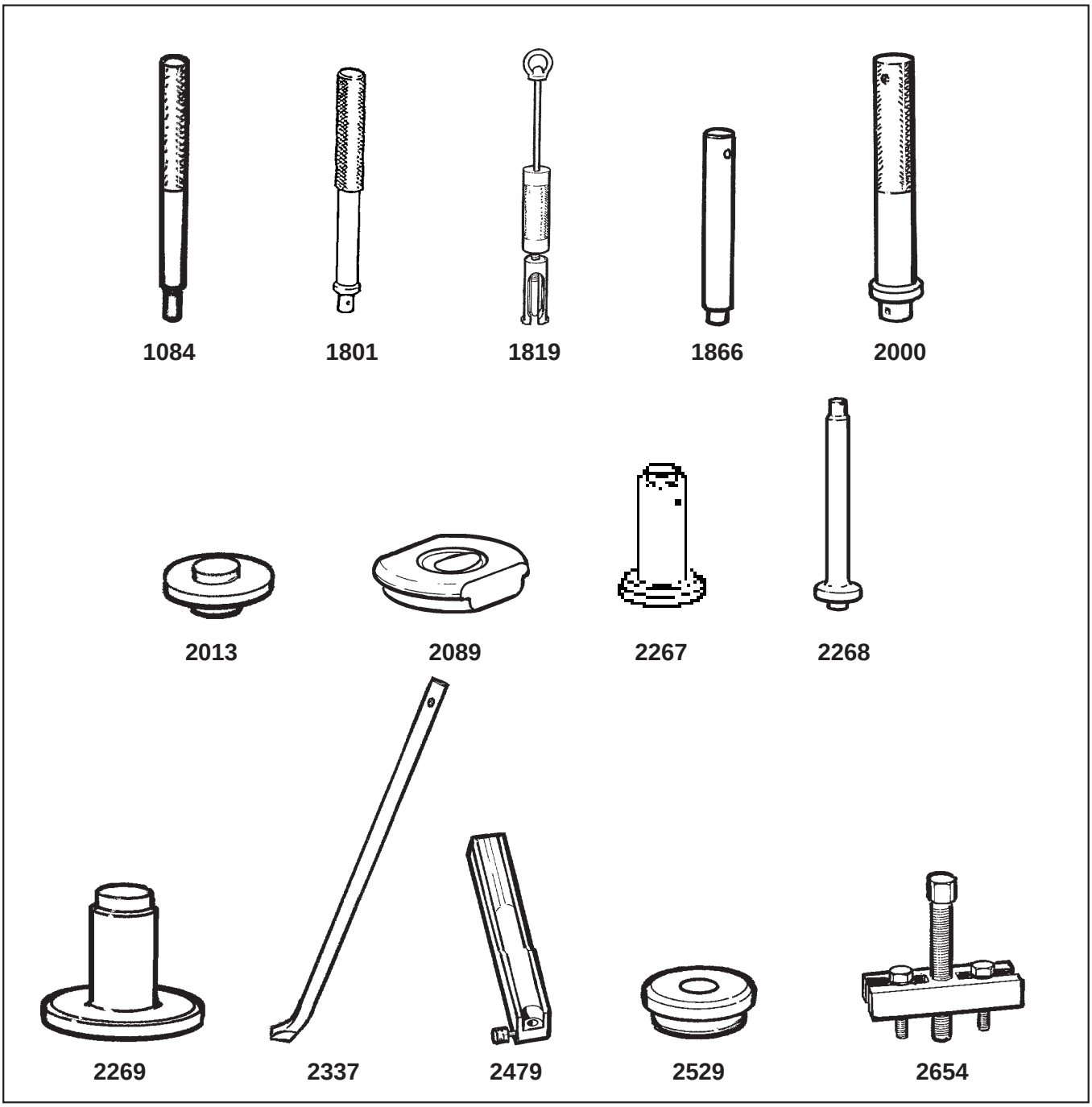


2 Tightening sequence for connecting-rod bearings

Tighten the connecting-rod bearings in 3 stages.
1st stage 40 Nm (4 kpm).
2nd stage 75 Nm (7.5 kpm).
Final stage (angle tightening) 90°.



Special Tools



(999)- ***Description,*** use

1084 ***Drift,*** pressing out valve guide

1801 ***Standard handle***

1819 ***Extractor,*** support bearings flywheel

1866 ***Drift,*** pressing out bushing exhaust brake

2000 ***Standard handle***

2013 ***Drift,*** pressing out/in gudgeon pin

2089 ***Puller plate,*** cylinder liner

2267 ***Drift,*** pressing in bearings, injection pump drive

2268 ***Drift,*** pressing out/in bearing coolant pump

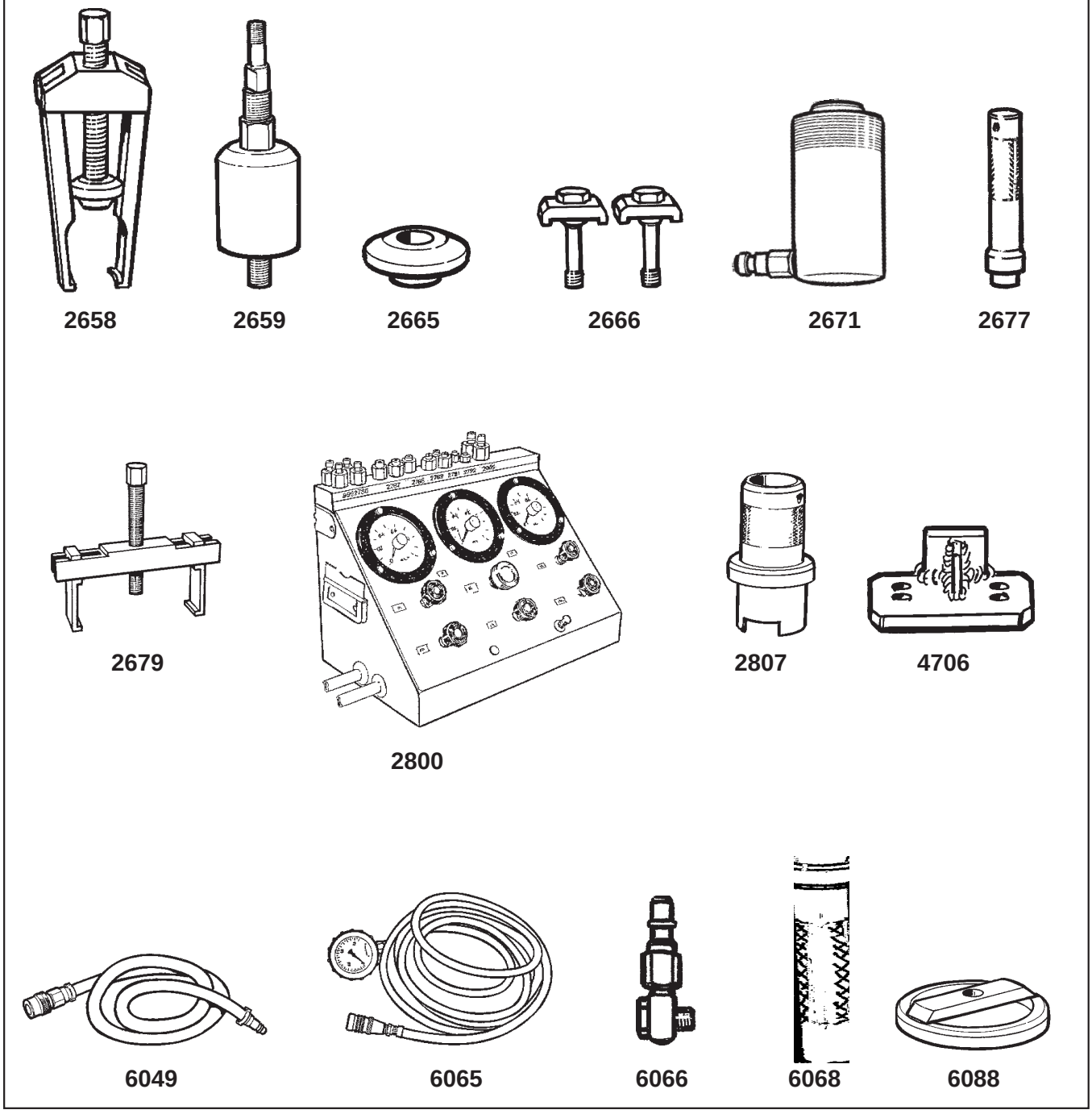
2269 ***Counterhold,*** fitting bearings coolant pump and fan motor

2337 ***Lever***

2479 ***Holder,*** dial indicator

2529 ***Socket,*** pressing out/in connecting rod

2654 ***Puller,*** oil pump drive gear



(999)- ***Description,*** use

2658 ***Puller,*** crankshaft drive gear

2659 ***Press tool,*** pressing in crankshaft drive gear

2665 ***Press tool,*** bearings flywheel

2666 ***Press tool*** (holders), measuring cylinder liner height

2671 ***Hydraulic cylinder*** 18 tonnes

2677 ***Drift,*** pressing out/in bushing, rocker arm

2679 ***Puller,*** camshaft and injection pump drive gear

2800 ***Test bench*** (pressure tester gauge)

2807 ***Centering tool,*** coolant pump

4706 ***Stop tool,*** flywheel

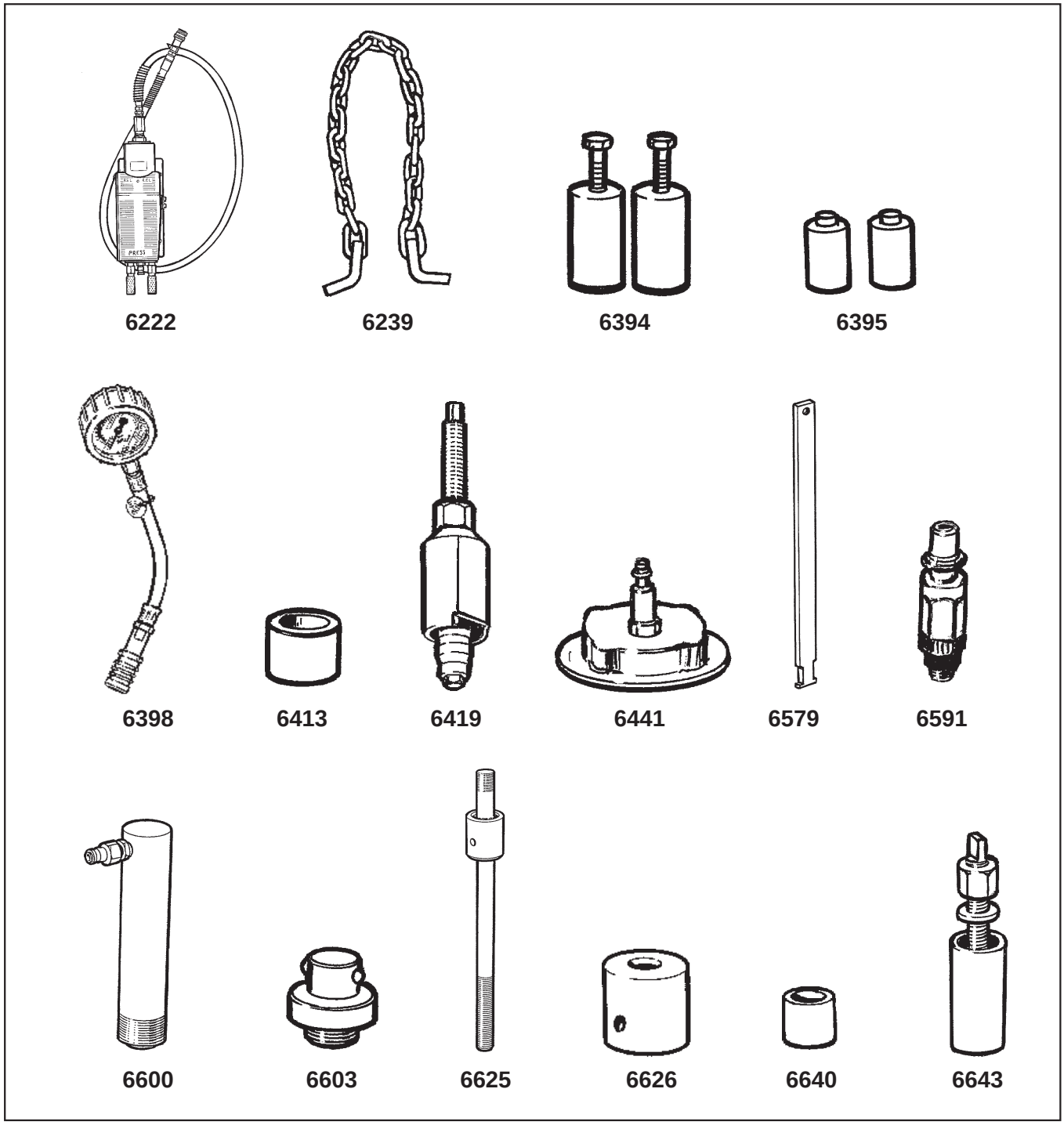
6049 ***Hose,*** draining coolant, pressure-testing system

6065 ***Pressure gauge 2.5 bar,*** fuel feed pressure, charge pressure

6066 ***Connection nipple*** (used together with 6065)

6068 ***Drift,*** exhaust-pressure governor

6088 ***Drift,*** crankshaft rear seal



(999)- ***Description,*** use

6222 ***Hydraulic pump,*** air-driven for hydraulic cylinder

6239 ***Lift chain***

6394 ***Spacer,*** pressing out cylinder liners

6395 ***Spacer,*** pressing out cylinder liners

6398 ***Pressure gauge 16 bar,*** checking oil pressure

6413 ***Extension,*** puller, polygon hub

6419 ***Extractor,*** steel ring, injectors

6441 ***Test cap,*** with nipple, pressure-testing cooling system

6579 ***Lever***

6591 ***Connection nipple,*** checking charge pressure

6600 ***Hydraulic cylinder 10 tonnes***

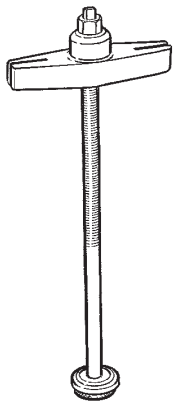
6603 ***Adapter,*** used with 6600

6625 ***Spindle,*** pressing on polygon hub

6626 ***Hollow drift,*** fitting polygon hub

6640 ***Hollow drift,*** used with 8011

6643 ***Extractor,*** injectors



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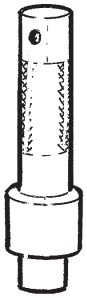

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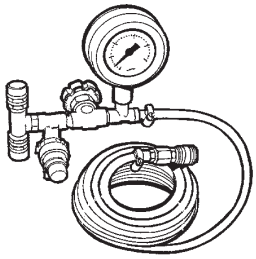

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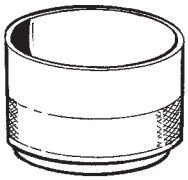

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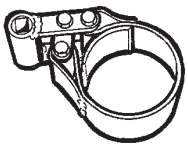

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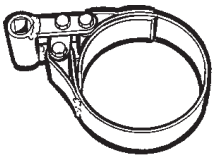

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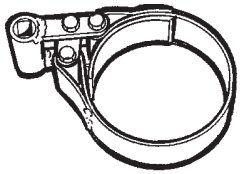

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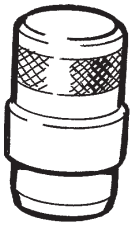

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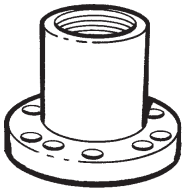

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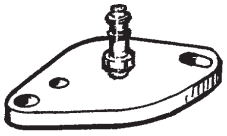

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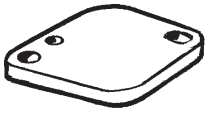


6816

(999)- ***Description,*** use

6645 ***Puller yoke,*** cylinder liners

6647 ***Reaming tool,*** copper sleeves

6656 ***Centering tool,*** oil pump

6662 ***Pressure gauge,*** cylinder head, cooling system

6664 ***Piston-ring compressor,*** fitting pistons

6666 ***Union,*** checking oil pressure

6669 ***Drift,*** pressing in valve guide, inlet valve

6670 ***Filter tool 80 mm,*** fuel filter

6671 ***Oil filter tool***

6672 ***Filter tool 108 mm,*** oil filter

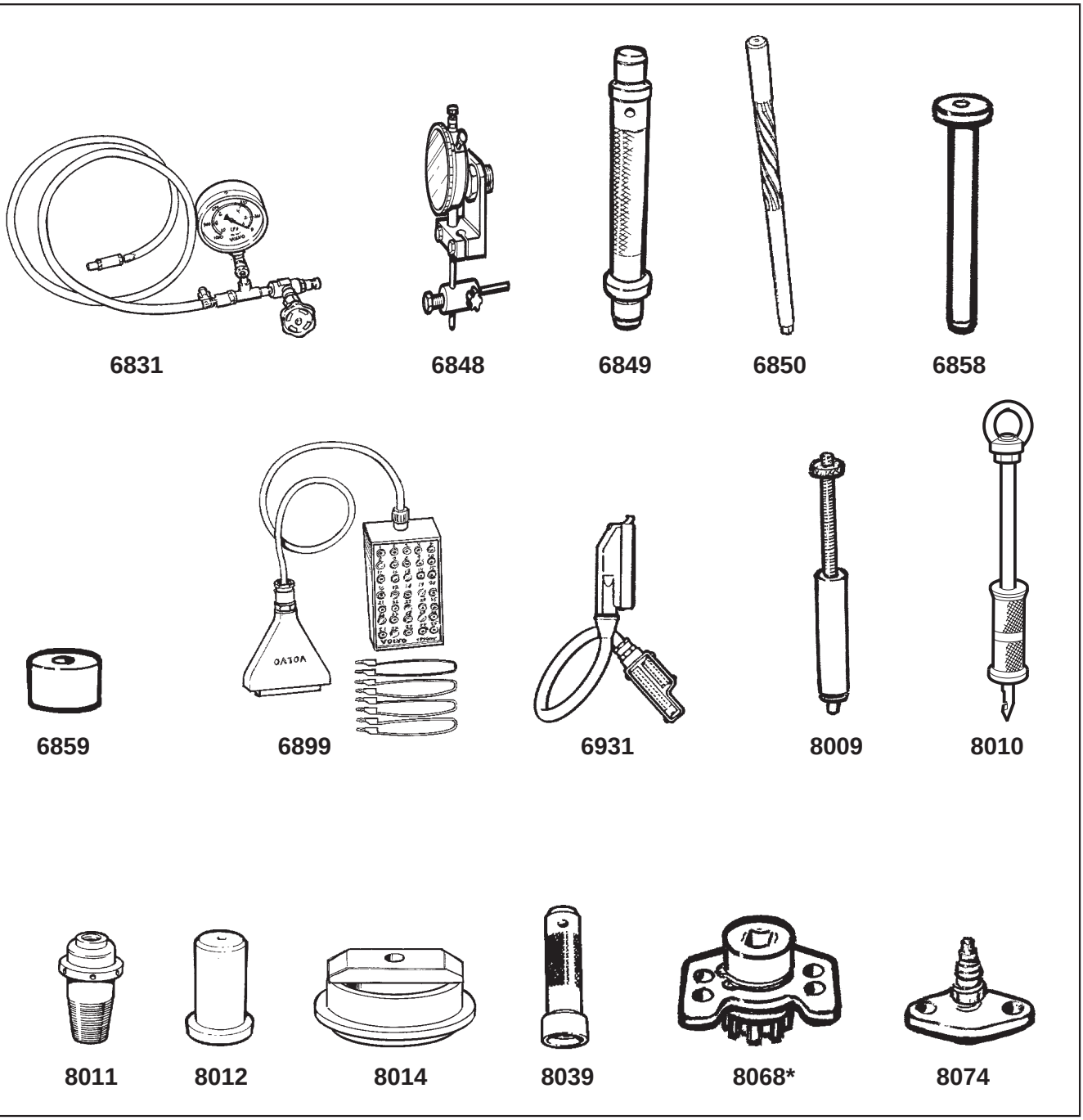
6685 ***Clamp,*** pressure testing cylinder head

6781 ***Hollow drift,*** fitting seal thermostat housing

6796 ***Hollow drift,*** pulling off polygon hub

6815 ***Connection washer,*** pressure testing intercooler

6816 ***Sealing washer,*** pressure testing intercooler



(999)- Description, use

6831 Pressure-drop gauge, low-pressure indicator

6848 Measuring tool, setting injection angle

6849 Drift, pressing out/in bushing, oil pump

6850 Reamer, oil pump

6858 Drift, pressing out shaft, coolant pump

6859 Counterhold, coolant pump bearings

6899 Test box, for troubleshooting

6931 Adapter, for Troubleshooting (EDC)

8009 Adapter, compression test

8010 Extractor, crankshaft rear seal

8011 Extractor, seal injection pump drive

8012 Press tool, fitting seal injection pump

8014 Hollow drift, fitting seal polygon hub

8039 Drift, seal coolant pump

8068* Crank tool, flywheel (formerly 6220)

8074 Nipple, pressure-testing oil cooler

* Fit 2 bolts, P/N 955514.

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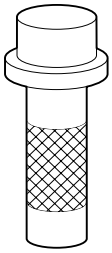

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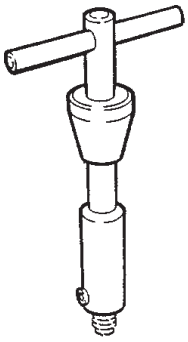

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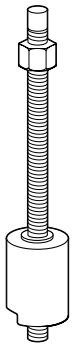

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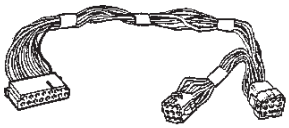

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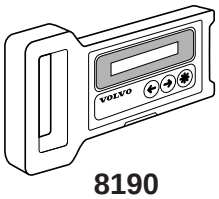

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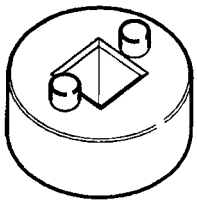

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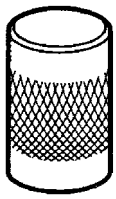

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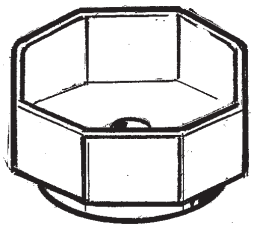

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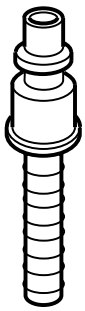

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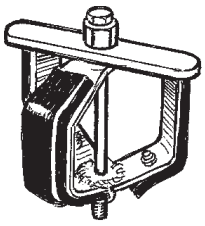

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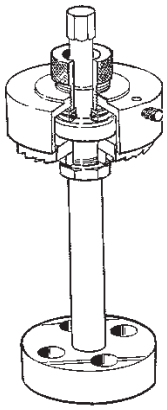

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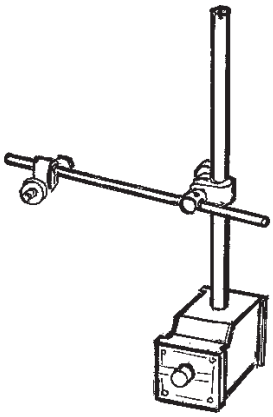
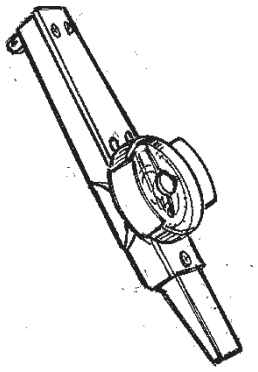


9696



9708

(999)- ***Description,*** use

8075 ***Cover washer,*** pressure-testing oil cooler, used with 2800

8079 ***Extractor,*** for camshaft

8113 ***Drift,*** bearing, coolant pump

8134 ***Threading tool,*** copper sleeves, injectors

8140 ***Extractor,*** copper sleeves, injectors

8180 ***Adapter,*** checking charge pressure (EDC)

8190 ***Measuring instrument,*** for injection timing

8419 ***Pin spanner,*** for cleansing plugs

8449 ***Drift,*** pressing in valve guides

8487 ***Tool,*** for oil filter

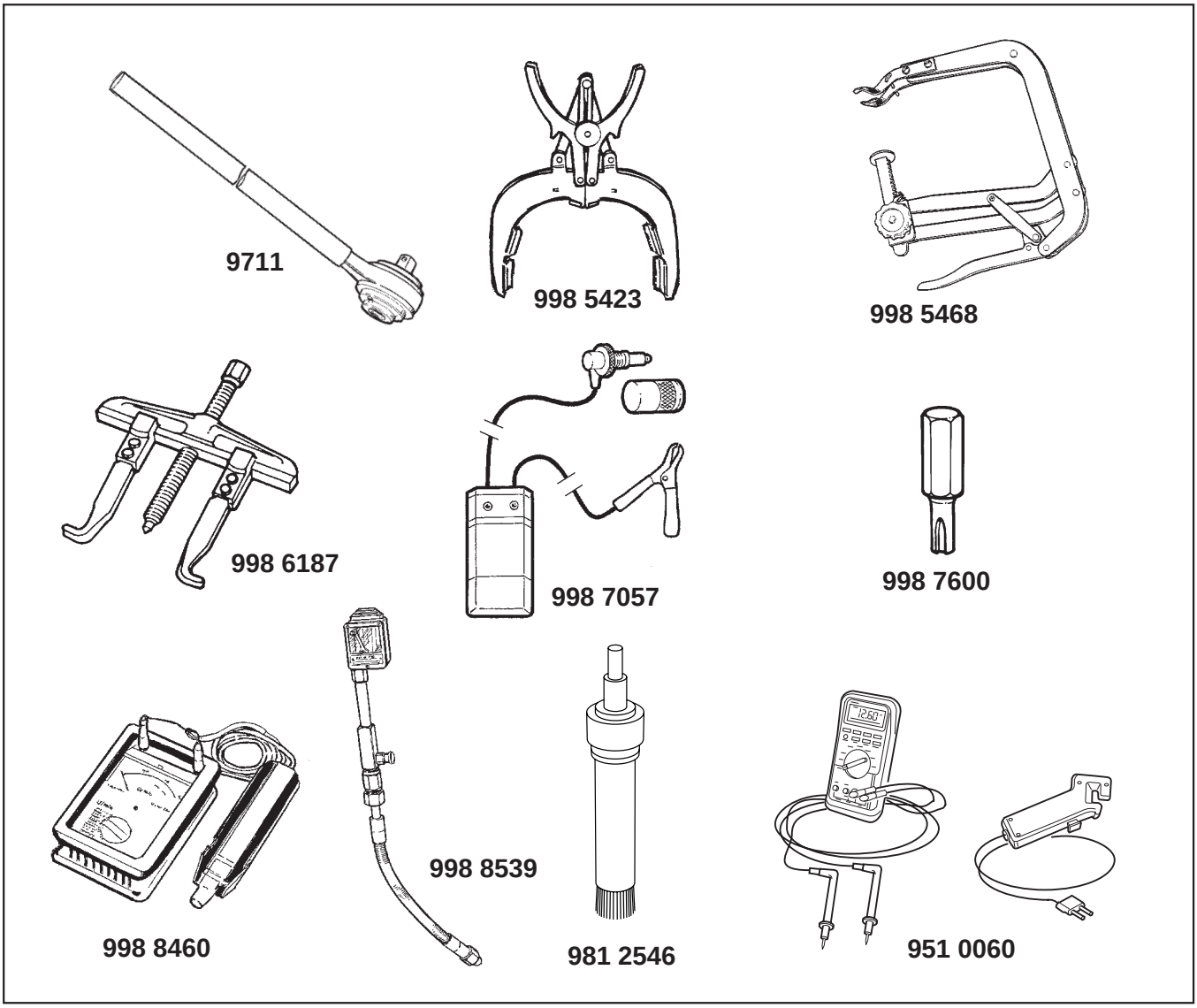
9314 ***Nipple,*** checking wastegate

9511 ***Expander,*** turning cylinder liners when milling liner seat

9551 ***Milling tool,*** cylinder liner seat

9696 ***Magnetic stand,*** for dial indicator

9708 ***Torque gauge***



(999)- ***Description,*** use

9711 ***Torque multiplier,*** 4x

(998)-

5423 ***Piston ring rod***

5468 ***Valve spring tester***

6187 ***Puller,*** fan motor electric-driven cooling fan

7057 ***Tool,*** for basic setting injection pump

7600 ***Adapter,*** assembling turbocompressor

8460 ***Speed gauge,*** for measuring fan speed

8539 ***Compression guage***

(981)- ***Description,*** use

2546 ***Cleansing tool,*** cleaning copper sleeve seats

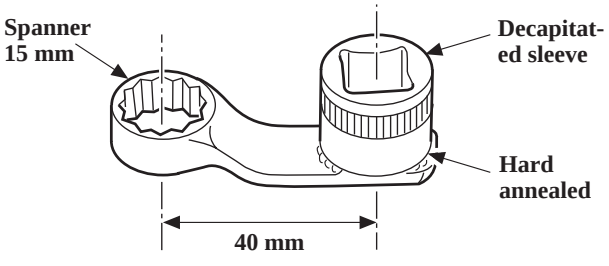
(951)- ***Description,*** use

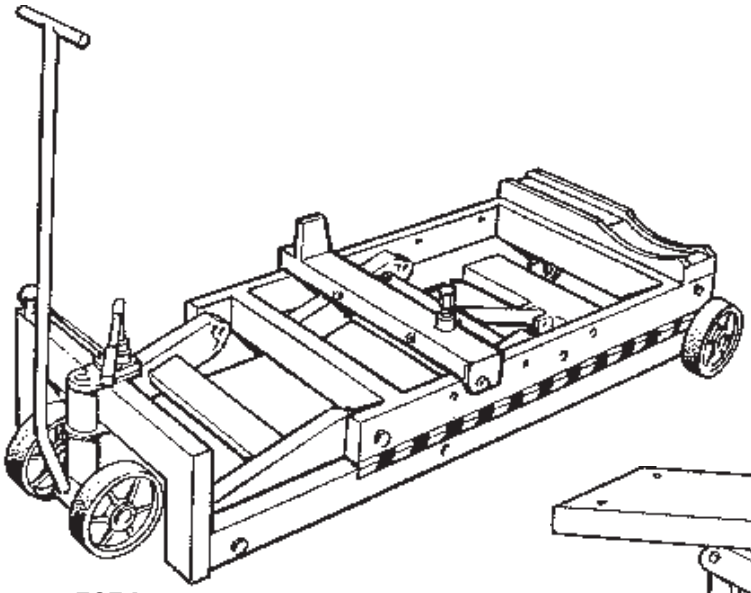
0060 ***Multimeter***

Special tool, EDC, for testing injection pump on test bench, refer to Testing, injection pump, on page 102.

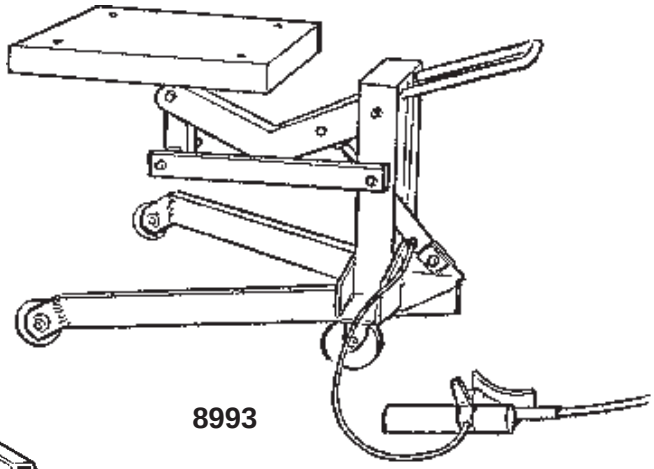
Tool for flange discs

pump coupling (made by own workshop)

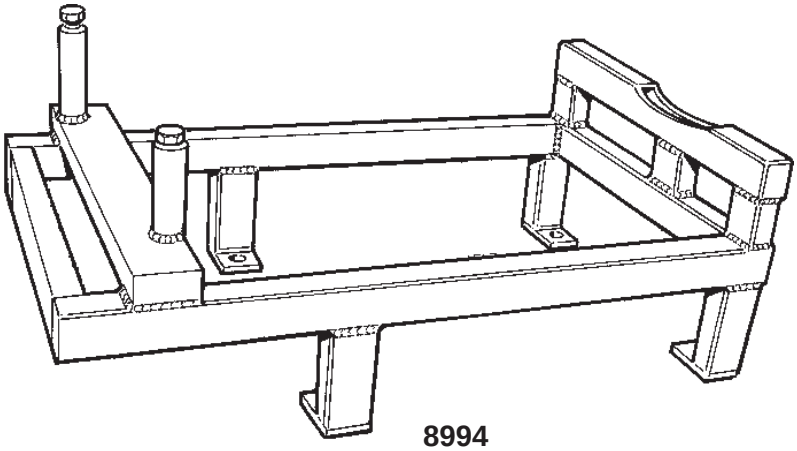




5654



8993



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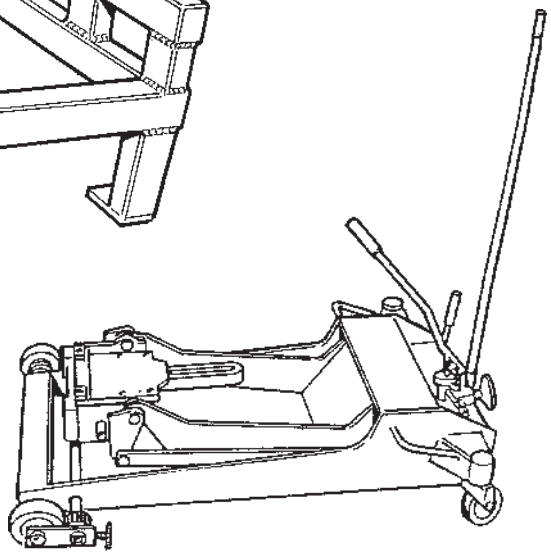


999 9954

(998)- Description, use

5654 Engine carrier trolley

8993 Lift table

8994 Engine fixture

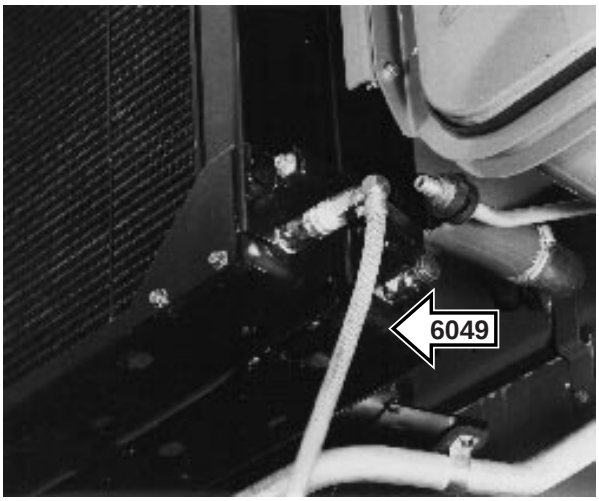
(999)-

9954 Component jack, for radiator assembly

Removing and installing engine

Draining coolant

Special tool:
(999) 6049 Drain hose



Weight, engine with gearbox approx. 1300 kg

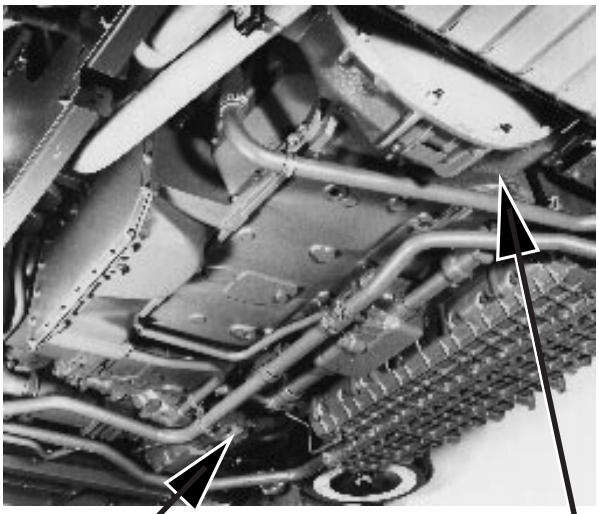
Warning!

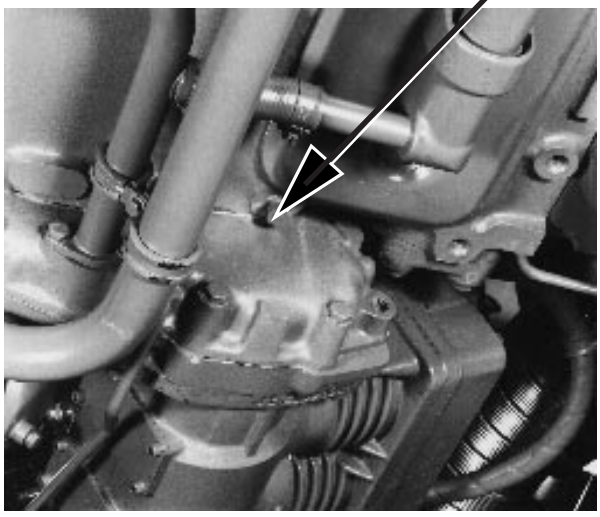
Handling heavy components as those mentioned above, requires experience in stacking and lifting. Work involving this must never be done by inexperienced personnel. Always make sure the lift tools can cope with the work in hand and are in good condition.

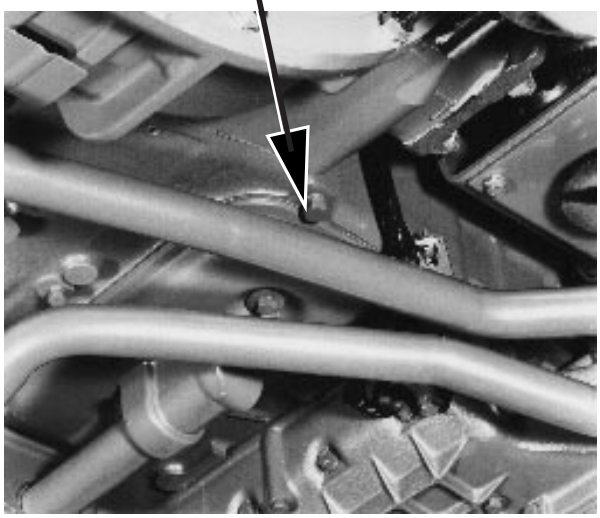
Make sure the lift fixture slots securely into the engine lift points and that the guide edges fix against the lift forks or lift table.

Always switch off the main switch and disconnect the battery cables before removing electrical connections.

The number and location of the drain points vary with bus type. Drain points common to all types are the radiator and two drain points on the engine. **Coolant must be handled with the same care and caution as for other fluids dangerous to health.**







Topping-up coolant

Recommended for the cooling system (and heating system) is a mixture of 50% anti-freeze and 50% water.

Never use coolant with less than 40% anti-freeze. This also applies to topping-up. The anti-freeze protects the cooling system from corrosion and damage from freezing.

Volvo coolant is recommended even when the coolant does not require anti-freeze. It provides very good protection against corossion.

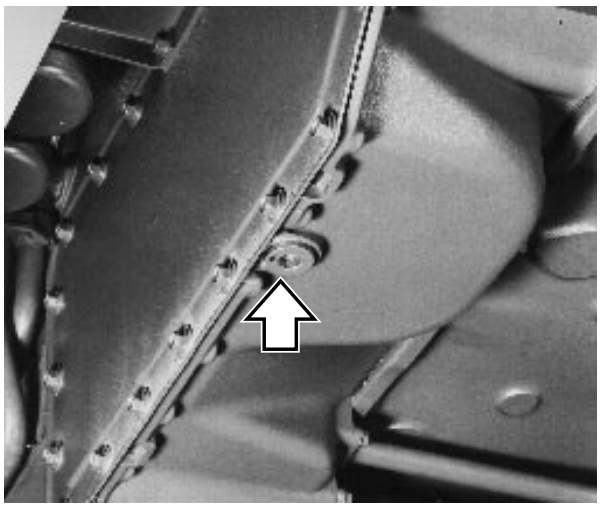
On buses with roof-mounted air conditioning system, where the coolant is above the level of the expansion tank, the coolant has to be pumped up by starting the circulation pump.

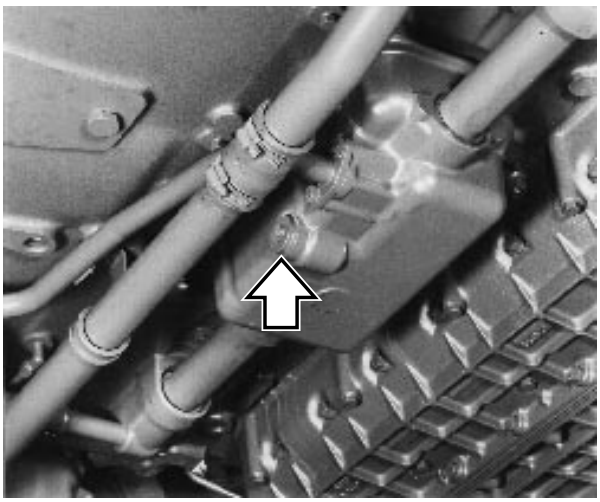
Top-up gradually via the expansion tank until the system is full. Check the coolant level after having run the engine warm.

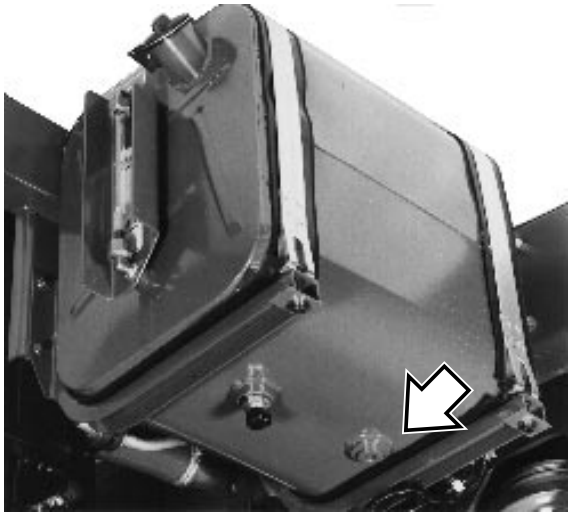
NOTE! For the B10M (late prod. or older that has been altered afterwards) where the vent line from the radiator goes down into the bottom of the expansion tank, we recommend topping-up from the evacuation connection in the bottom of the radiator. This is a good way of getting rid of any air pockets in the cooling system.

Draining oil

There are three plugs for draining the oil: One underneath the sump; one next to the oil pocket on the inspection panel; and one on the underside of the oil tank.







Tightening torque for drain plugs:
60±15 Nm (6.0±1.5 kpm).

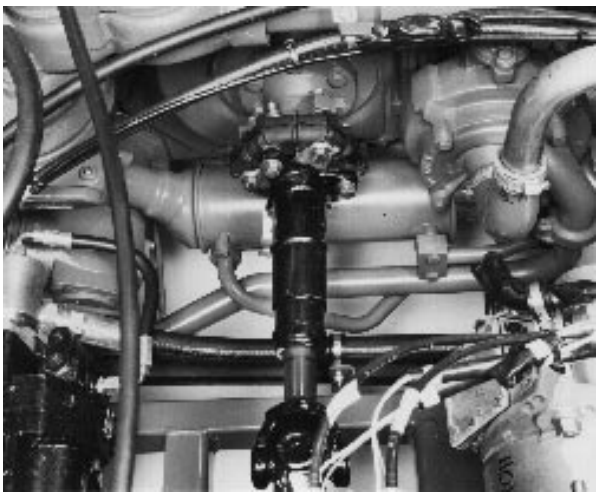
Instructions on topping-up oil, refer to page 32.

Removing and installing engine

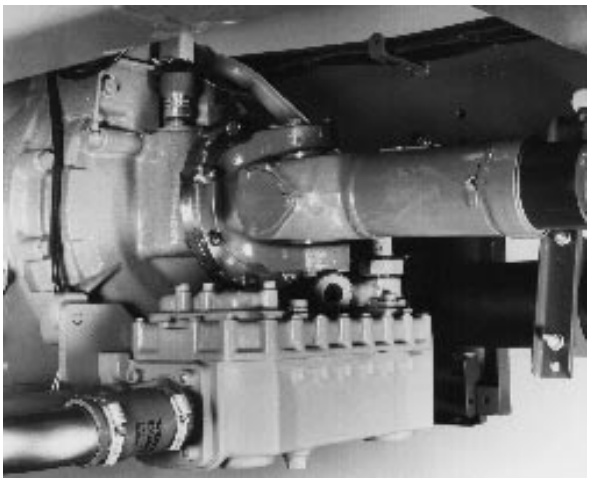
Special tools:
(998) 8993 Lift table
8994 Engine fixture

1. Drain the oil and coolant. Switch off the power with the battery main switch.

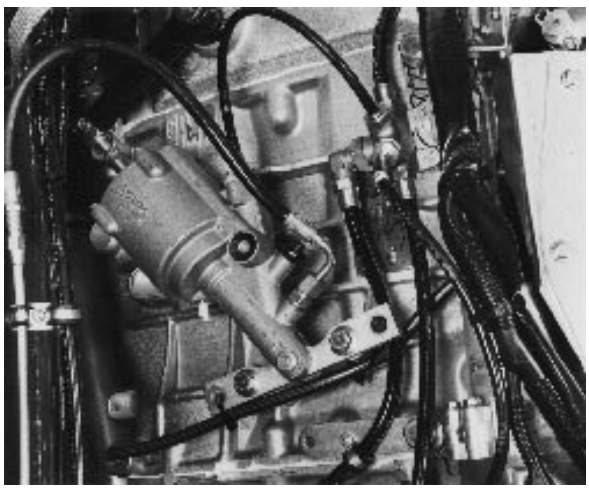
   Release the fan prop shaft.



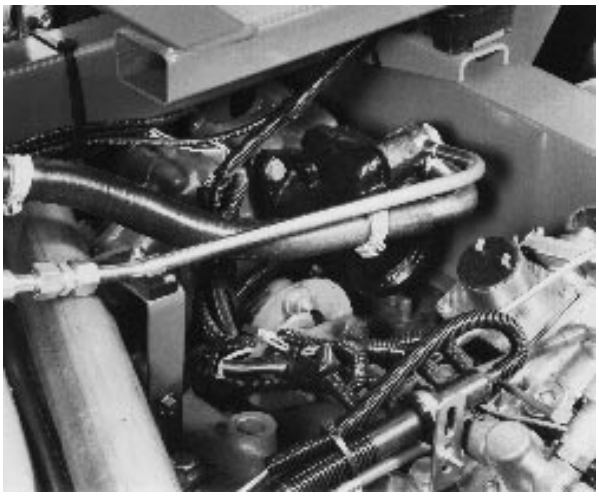
2. Release the propeller shaft.



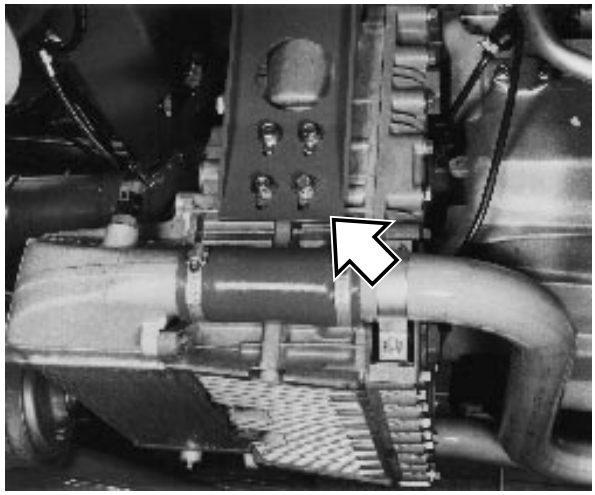
3. Remove the clutch servo.



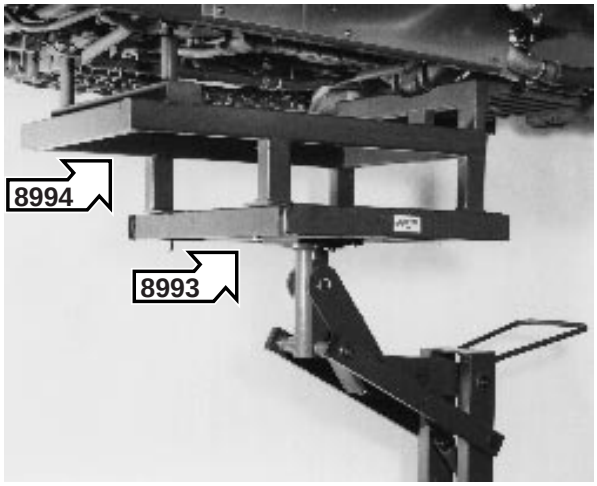
4. Release the steering servo pump.

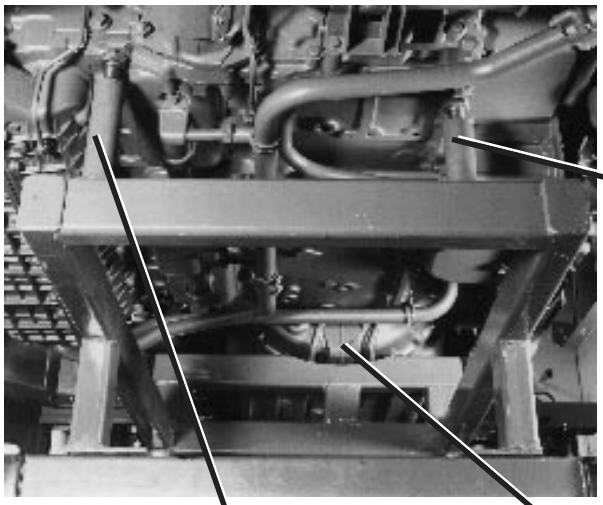


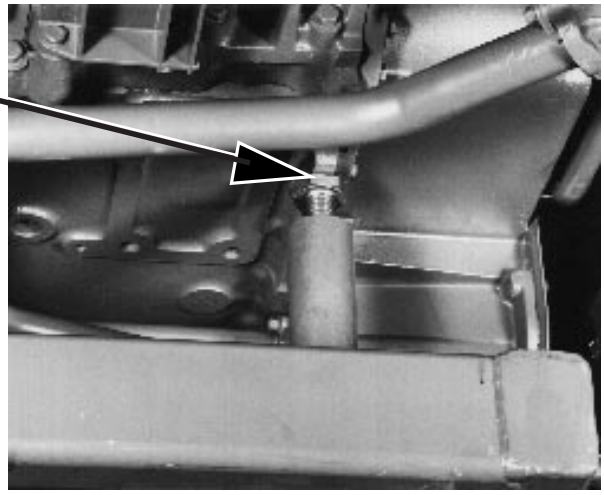
5. Detach/disconnect necessary cables, hoses and pipes. Release gearbox attachments, if any.

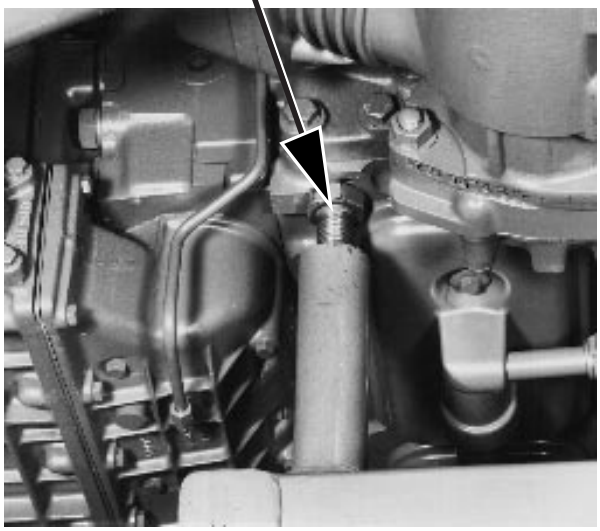


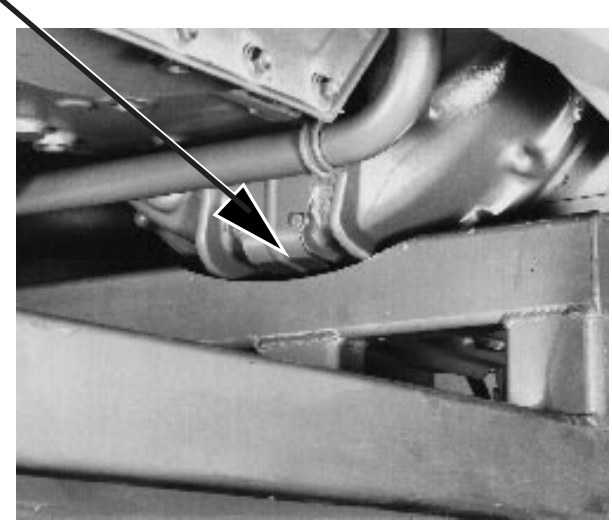
6. Run the engine carrier trolley in underneath. See support points overleaf.

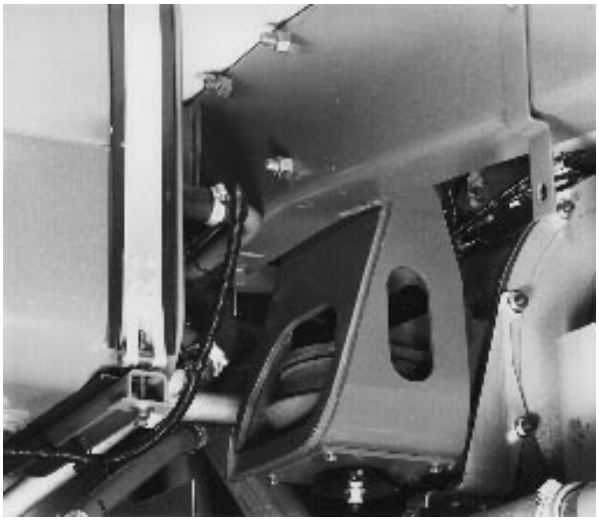












7. Detach the engine mounts from the frame member and lift out the engine together with the gearbox.

Observe due care with regard to the fuel pipes!
The location of the delivery pipes between the injection pump and the injectors require the engine to be angled slightly so that the pipes do not catch on the frame member.

Note in connection with lifting out engine…

Tightening torque for the following bolting:

Fan prop shaft	**48±5 Nm (4.8±0.5 kpm)**
Propeller shaft	**54 Nm (5.4 kpm)**
Engine mounts	**80 Nm (8 kpm)**

Bear in mind that rubber parts age and are affected by climatic conditions. If necessary, replace them. Check the engine mounts and replace if necessary.

Top-up oil and coolant.

Removing and installing rear engine

Special tool:
(998) 5654 Engine carrier trolley

Drain the coolant and engine oil (see pages 25 and 26). The engine is suitably lifted out together with the gearbox. To remove and install, run the engine carrier trolley in underneath the engine and adjust the supports, see next page.

Always turn off the power with the battery main switch.

To observe when removing/installing the engine

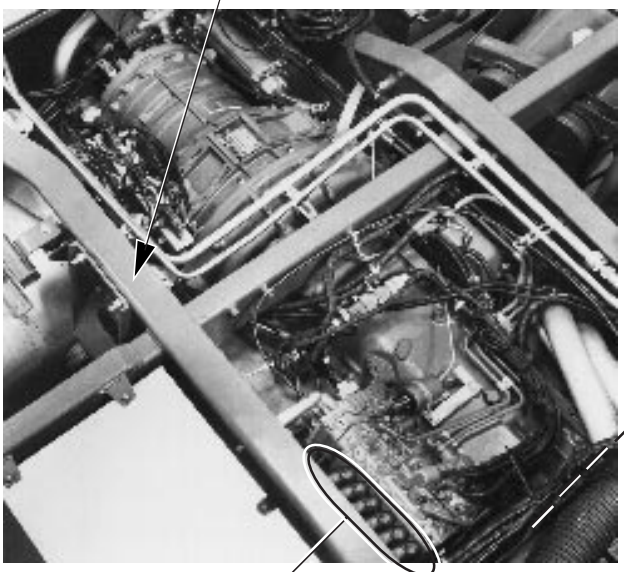
Fuel system
Open the fuel pipe joint at the gearbox.

Bolting

Engine mounts	**80 Nm (8 kpm)**
Propeller shaft	**54 Nm (5.4 kpm)**

Inlet and exhaust systems
Disconnect the inlet hose from the turbocompressor. Disconnect the exhaust at the flex hose between the turbocompressor (exhaust brake/EPG) and the silencer hook.

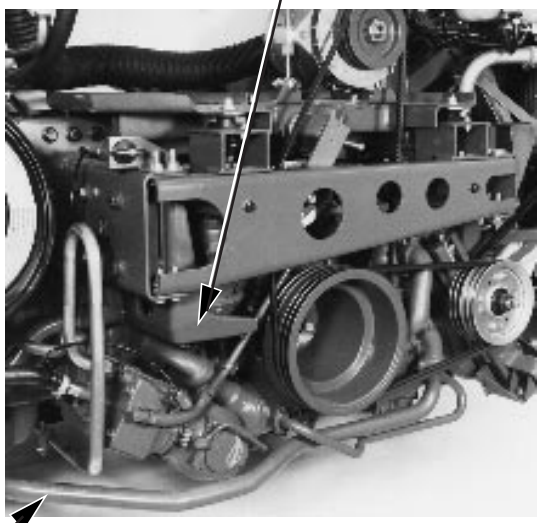
Release the bracket from both the frame member and the engine mount pads.



Observe due care with regard to the fuel system delivery pipes! After the engine has been disconnected from its mounts, pipes, electric cables, etc., draw the engine-gearbox out sideways so that the delivery pipes are free from the frame member.

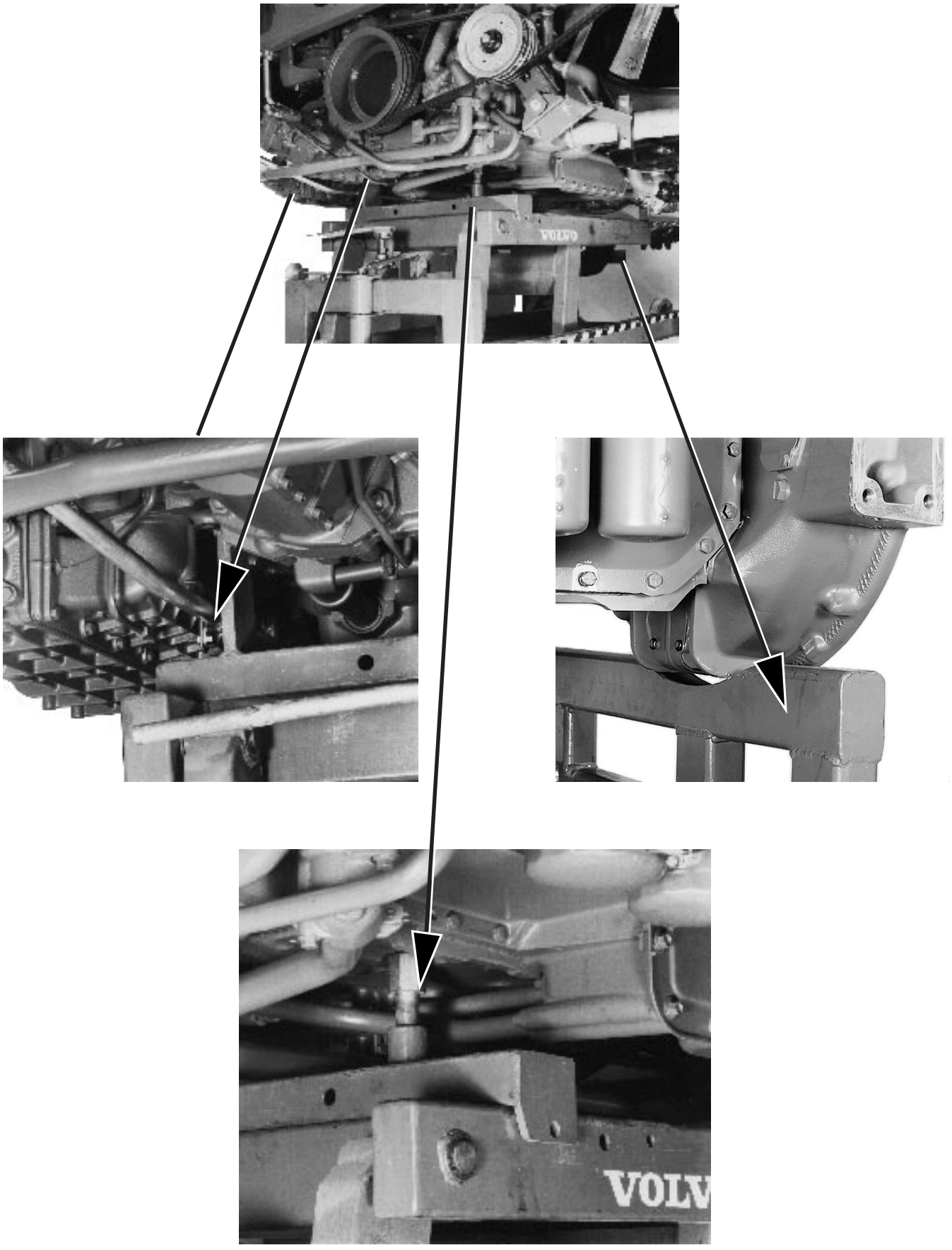
The steering servo pump is detached from the engine and hung up in a suitable place.

Detach the bracket from the frame member. Detach the engine rear mount pad.



Remove the intercooler pipes under the engine to make room for the engine carrier trolley. Disconnect the coolant pipe hose. Otherwise, the coolant pipes can remain in place.

Adjust in the supports on the lift unit as shown in the pictures below.



Servicing the engine

The VOLVO warranty for exchange engines (factory new or overhauled) applies on the following conditions:

1. **Fuel filters, oil filters**
   Both the engine's fuel filters and both the oil filters must be changed at the same time.

2. **Cooling system**
   It must be possible to make use of the cooling system's entire capacity. The radiator must be well-cleaned both inside and outside, or new. Change coolant filters, if such are fitted.

3. **Hoses**
   Use new hoses for both the cooling and heating systems and new hoses for the oil pipes.

4. **Drive belts**
   Use new drive belts for the fan prop shaft, alternator drive, etc.

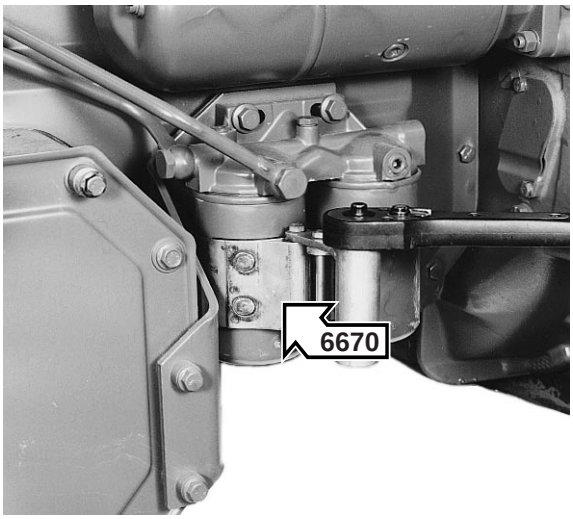
5. **Air cleaner**
   Thoroughly clean the air cleaner housing and connections. Install a new filter and check the filter housing and hose connections for leakage.

6. **Instruments and connections**
   Make sure oil pressure and coolant pressure gauges show correct pressures.

Other measures
Components such as the alternator, starter motor, air compressor and steering servo pump must not be faulty and preferably recently inspected.

Replacing fuel filters

Special tool:
(999) 6670 Filter removal tool



The fuel gauge pressure decides when the filter should be changed, see also under "Service and maintenance". Replace both filters at the same time.

1. Clean the outside of the filter bracket to prevent dirt getting in when fitting the new filter.

2. Unscrew and discard the filters. Use tool 6670 if the filters cannot be unscrewed by hand.

3. Screw on the new fuel filters. First by hand to when the seal makes contact with the filter bracket and then manually tighten a half turn more.

4. If there is a relief valve mounted on the injection pump then normally there is no need to bleed the fuel system. Instead manually pump about 15 strokes with the hand primer and then start the engine.

Topping-up oil

Top-up via the oil tank filler tube.

The oil level is checked with the oil tank level tube. Thisshould be done with the engine idling or immediately after stopping the engine.

The level should be between the Max. and Min. levels on the oil tank level tube.

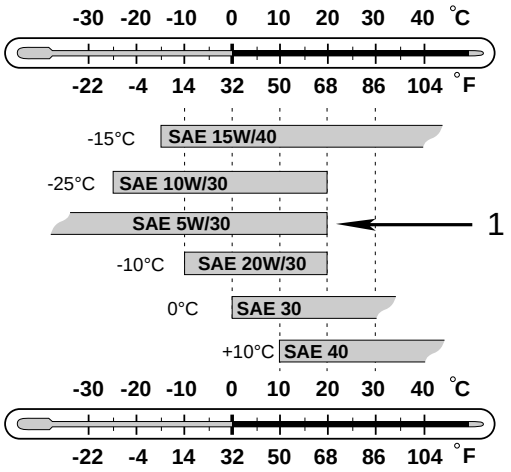
The oil level must never go below the Min. mark!

Oil quality

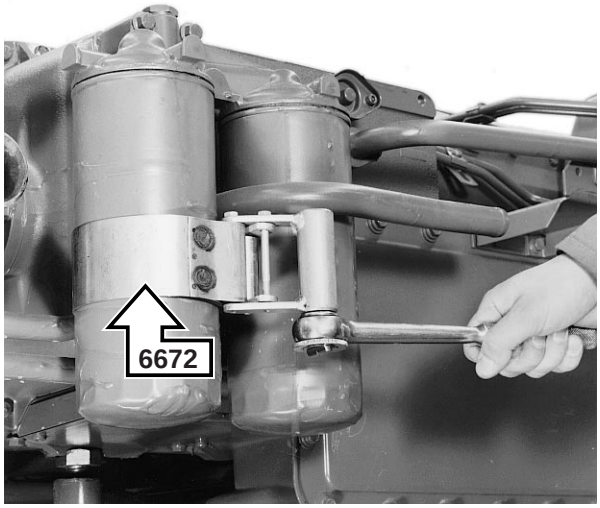
According to **VOLVO DRAIN SPECIFICATION (VDS, VDS2)** or **API CD,** CE OR CCMC -D4, D5.

Viscosity, see graph below.

The temperatures refer to stable air temperatures.



Concerns semi-synthetic or full-synthetic engine oil.
NOTE! Only SAE 5W/30 may be used.



Replacing oil filters

Special tools:
(999) 6672 Filter removal tool
(Alternative tool:
(999) 8487 Filter removal tool)

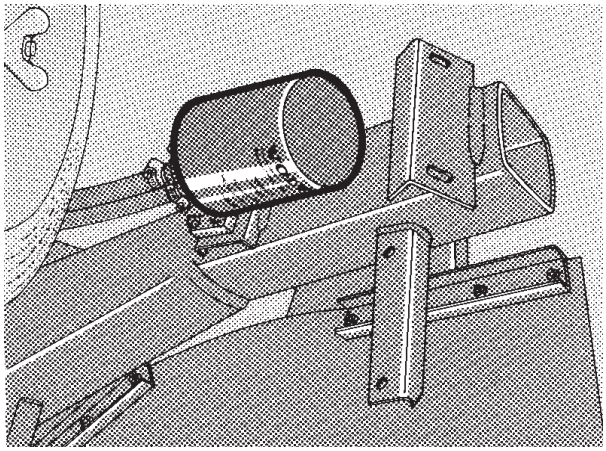
1. Remove the plate underneath the engine

2. Replace both oil filters when changing the engine oil

3. The filters cannot be cleaned – renewal the only service measure permitted.

4. Fit the oil filters according to the instructions on the filter cannister.

(The alternative filter removal tool can be used if working area is confined.)



Replacing coolant filter

Special tool:
(999) 6671 Filter removal tool

1. Remove the plate underneath the engine.
   Remove the filter with tool 6671.

2. Fit the new filter according to the instructions on the filter cannister.
   Refit the plate underneath the engine.

Condition test

A **compression test** is a simple and reliable way of finding out the condition of the engine. The test shows whether or not cylinders and valves are leaking.

Low compression pressure on all cylinders indicate worn cylinder liners and/or piston rings. Should a particular cylinder have a lower pressure, this may be due to leaking valves, broken piston rings or damaged cylinder head gasket.

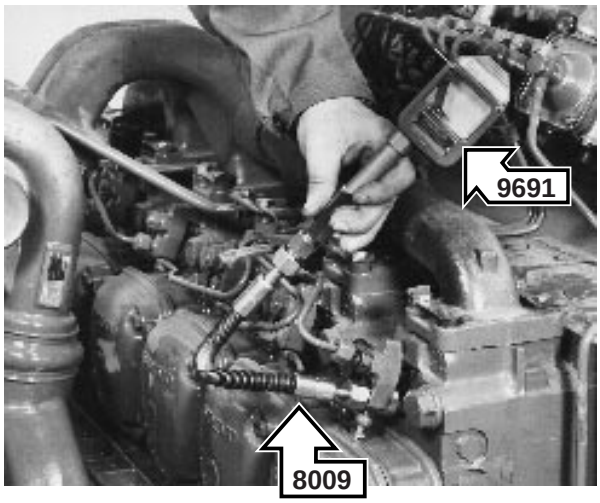
Low **charge pressure** and **fuel system malfunction** can cause the following symptoms: low start torque, and smoky exhaust gases.

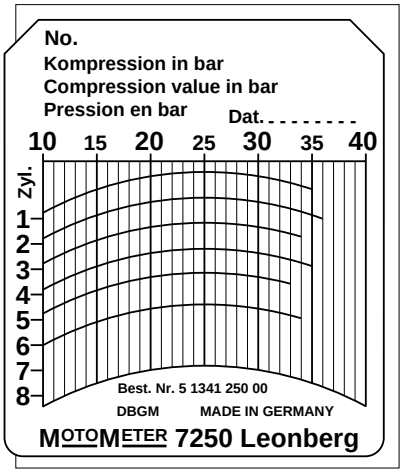
Low oil pressure may indicate worn crankshaft bearings. However, it would be best first to check the lubricating system valves.

The cooling system is checked for leakage by pressure-testing the coolant remaining in the system. This means that all the following components in the system are check for leakage: radiator, connections, hoses, coolant pump, heating system, etc. See chapter Cooling system.

Camshaft wear can be checked by measuring the camshaft lift (valve lift) without having to remove the camshaft from the engine.

The timing gears and **camshaft** can be checked by measuring the valve timing. If the valve stroke deviates from that specified, there is risk of the exhaust valve striking its piston.





Compression test

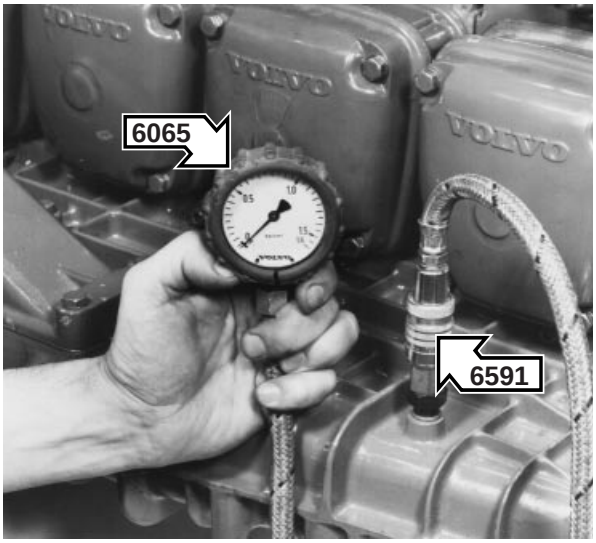
Special tools:
(999) 8009 Adapter
9691 Compression gauge

1. Run the engine warm.
2. Stop the engine and let the mechanical stop control remain pulled out.
3. Remove all the injectors.
4. Fit adaptor 8009. Use the injector retainer to hold the adaptor in position.
5. Connect compression gauge 9691 to the adapter.
6. Read-off the compression gauge at normal starter motor speed (3.7 r/s). Pressure should be:

DH10A 245, 285 ..... 3.6 MPa (36 kp/cm^2)
DH10A 345, 350, 360 ..... 3.2 MPa (32 kp/cm^2)

Charge pressure
Mechanical testing (pressure gauge)

Special tools:
(999) 6065 Pressure gauge
6666 Nipple



The pressure gauge connection hose should be long enough to enable gauge read-off from the driver seat. The measuring socket for the charge pressure is located on the intercooler.

Drive uphill on full engine load and throttle. Read-off the charge pressure when engine speed passes 2200 r/min. Repeat this several times and compare the readings with the specified charge pressure.

It is important for proper results that full load is maintained long enough for the pressure to stabilize itself.

A clogged air filter or blocked air inlet will result in pressure drop at the compressor inlet. This lowers the charge pressure and reduces engine power. Before checking the charge pressure, check the pressure-drop indicator in the inlet hose from the air cleaner. If its window is full red, it is time to replace the air cleaner filter insert.

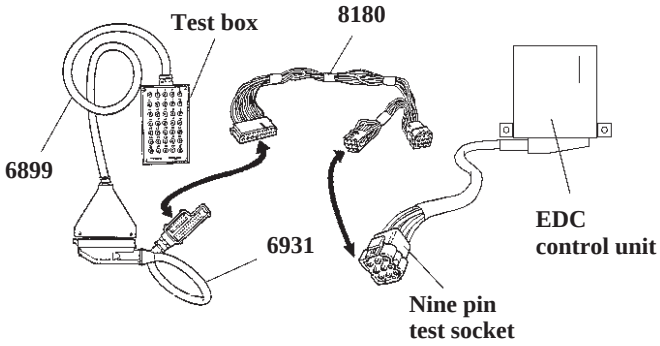
After testing fit and tighten up the screw plug for the measuring socket. Make sure it is properly tightened as there is always a risk that an insufficiently tightened plug slackens during driving. If the plug drops off, the charge pressure will drop and notably lower the power output, Ther is also risk of dirt getting into the engine, particularly in connection with much idling and engine braking.

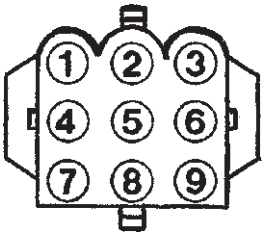
At too low charge pressure:

Check:
- for compressor wheel damage
- that the compressor wheel rotates easily
- that the axial/radial clearance feels normal
- that the compressor wheel does not scrape against the compressor housing when pressed axially
- that the wastegate opens, see Specifications
- Fuel filter, fuel feed pressure
- EDC-sensor, charge pressure
- Control rod travel, injection pump, see Fuel system, testing injection pump.

Charge pressure
Electrical testing (multimeter)

Special tools:
(999) 6899 Test box
6931 Adapter
8180 Adapter
(951) 0060 Multimeter





Nine pin test socket

$$\text{Unorm} = \text{Measured volts, charge pressure} \times \frac{5}{\text{Measured reference voltage}}$$

If the meassuring is done at a temperature other than +20°C, adjust the Unorm according to the table on the following page.

The charge pressure is checked in two stages; on the engine switched off and on it when driving. The voltage measured corresponds to a kPa measuring value.

Connect-up as in figure.

Measure between the measuring points on the test box 6899.

As alternative, measuring can be done directly in the nine-pin test socket.

1. Measuring on engine switched off

Measuring with the engine switched off ensures that the charge pressure sensor gives a measuring value that agrees with the “should” value (see Specifications), providing the charge pressure sensor is functioning properly, and that gives us a reference voltage which corresponds to the voltage measured between the charge pressure sensor and the control unit.

The measuring is done as follows with the engine off and the start key (feed selector switch) in Drive position:

Measuring on text box (6899)
– measuring points 1–4, reference voltage
– measuring points 3–4, charge pressure (voltage)

Compare with the “should” values in the specifications for the respective engine.

Correction of measured values

In order to be able to compare the measured volt value for max. charge pressure with the value given in the specifications for the respective engine, the value may have to be corrected because the reference value can vary. We call the new value the Unorm value (Unorm).

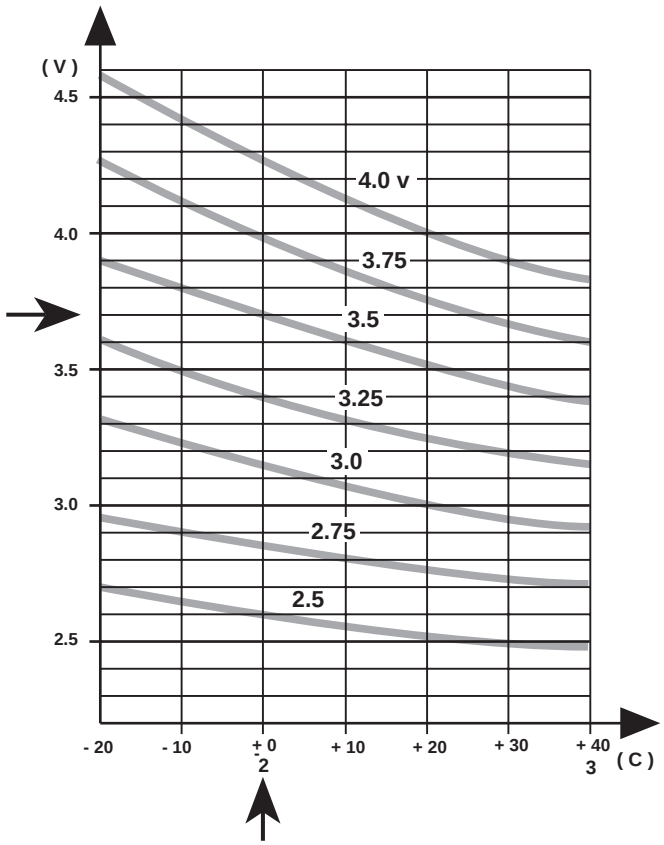
If the measuring is done at an ambient temperature other than +20°C, the measured value must be corrected (see table on next page).

The corrected voltage is then compared to the charge pressure voltage given in the Specifications.

2. Measuring on engine during driving

The engine should be max. loaded during driving in order to come up to max. turbo pressure (see instructions, page 35).

Measuring is done in the same way and between the same pins as above.



With low charge pressure, check:

– for any damage to the turbocompressor

– fuel filters, fuel feed pressure

– charge pressure sensor

– control rod travel, injection pump (see Testing injection pump).

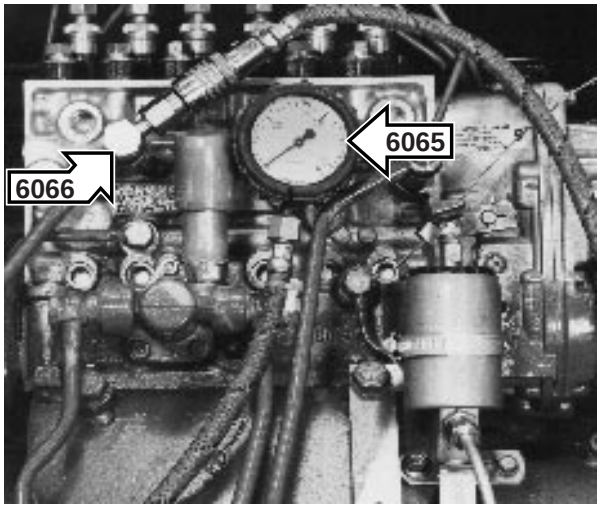
Example

At 0°C ambient temperature, the turbo pressure voltage should be 3.7 V.

– Go to 3.7 V on the vertical axis on the diagram.

– Follow it horizontally to where it intersects the vertical line for the ambient temperature (0°C).

– The corrected voltage is read-off on the respective curve in the diagram. In our example 3.5 V, which corresponds to the voltage at 20°C.



Fuel feed pressure

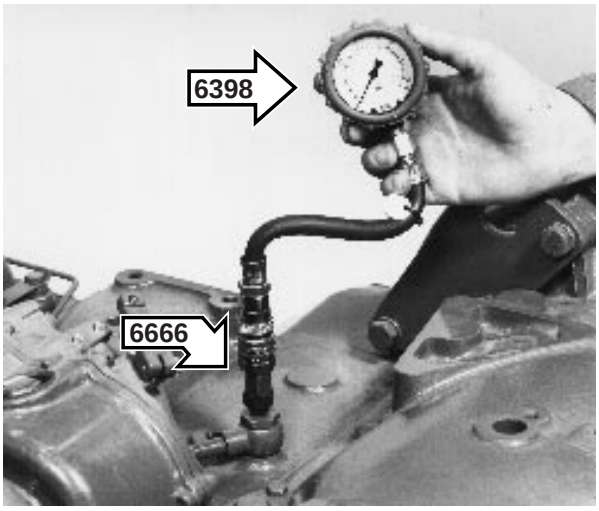
Special tools:
(999) 6065 Pressure gauge
6066 Nipple
968179 Banjo screw

Note: Before using the banjo screw, make sure it has been decapitated to a length of 26 mm, otherwise it will break the end of the thread insert in the pump connection.

Before measuring the feed pressure, run the engine at high idle and then drop it to low idle when reading-off. Read-off the pressure within one minute.

The fuel feed pressure must be min. **100 kPa** (1.0 kp/cm^2).

A low feed pressure will have a negative effect on the engine's top output. In the event of complaints about poor output, it would be well to check the feed pressure under load (the same procedure as when checking the charge pressure). Low fuel feed pressure can be caused by a contaminated fuel filter, a faulty relief valve or feed pump failure.



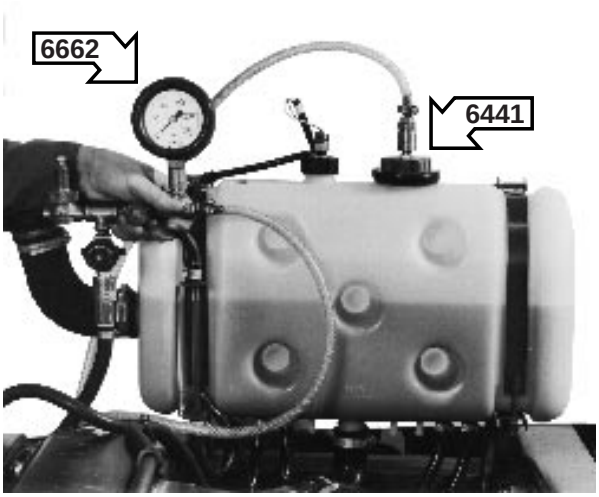
Oil pressure

Special tools:
(999) 6398 Pressure gauge
6666 Nipple

At normal engine operating speed and temperature, the oil pressure should be **300–50 kPa** (3.0–5.0 kp/cm^2).

If the oil pressure is below 60 kPa (0.6 kp/cm^2) with a warm engine and at low idle, this does not mean anything is amiss as long as the pressure does not go below approx. 300 kPa (3.0 kp/cm^2) at operating speed.

If the oil pressure is low and a faulty reducer valve is suspected, it should be removed and checked.



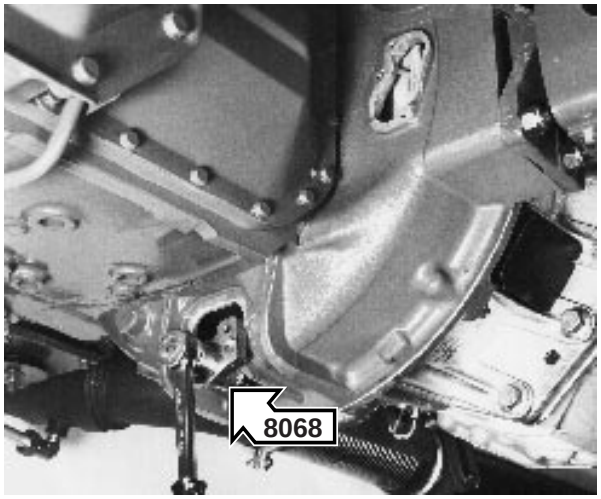
Pressure-testing cooling system

Special tools:
(999) 6441 Test cap with nipple
6662 Pressure tester

Check the coolant hoses for ageing (hardness), cracks, separation, blisters, scuffing, etc. Replace a damaged or badly worn hose before checking for leakage. If necessary, top-up with coolant before pressure testing.

Connect the pressure tester together with test cap and fit the cap temporarily in position. Pressure test at **70 kPa** (0.7 kp/cm^2).

When the pressure stabilizes, check all the components in the system – radiator, connections, hoses, coolant pump, heating system, etc. If the pressure gauge shows a drop in pressure, this indicates leakage, which must be remedied!



Valve tappets, valve timing

Special tool:
(999) 8068 Crank tool

1. Fit crank tool 8068.

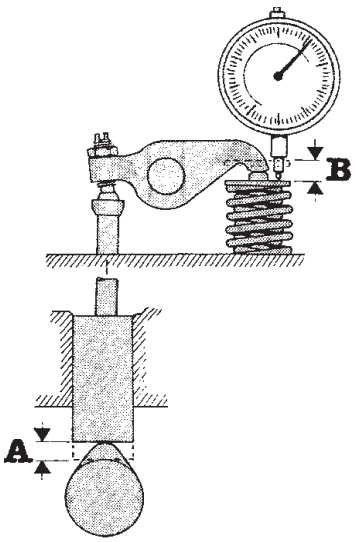
2. Let an assistant rotate the flywheel.

3. Set valve clearance to 0 mm before measuring + a half turn more on the adjuster screw. Pre-set the dial indicator to 15 mm.

4. Measure valve lift as follows:

When the valves "change" direction (open/close) on cylinder no.	Measure valve lift on cylinder no.
1	6
5	2
3	4
6	1
2	5
4	3

5. Check the valve time for no. 1 cylinder (see table below).
6. Adjust the valves to correct clearance, see below.



Camshaft lift A **Valve lift B**

Min. camshaft lift in mm (A) (new camshaft)		Min. valve lift in mm 0 mm valve clearance (B)	
inlet	exhaust	inlet	exhaust
8.4	9.0	13.0	14.0

Checking camshaft adjustment

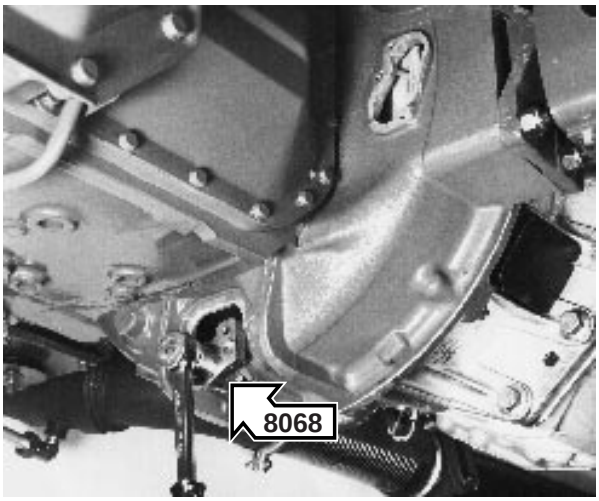
Valve lift must be within the stated tolerance in order to be able to check the camshaft adjustment.

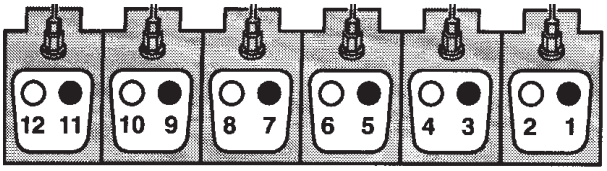
Checking camshaft adjustment (cold engine and valve clearance = 0).

With flywheel position at 10° A.T.D.C. the no. 1 cylinder inlet valve should open 4. 2 – 4.8 mm.

Adjusting valves

Special tool: (999) 8068 Crank tool





Valve clearance should be adjusted with a cold engine.

Pull out the manual stop control!

Adjusting

1. Fit crank tool 8068.
2. Crank the flywheel in its direction of rotation until no.1 cyl. piston is at top dead centre position after the compression stroke (0° on the flywheel).

   Adjust valves: 1, 2, 4, 5, 8, 9

   Again crank the flywheel in its direction of rotation (one turn) until no. 6 cyl. piston is at top dead centre position after the compression stroke (0– on the flywheel).

   Adjust valves: 3, 6, 7, 10, 11, 12

   Replace valve cover gaskets if necessary.

Valve clearance: ❍ Inlet: 0.40 mm
● Exhaust: 0.70 mm

Group 21

Engine

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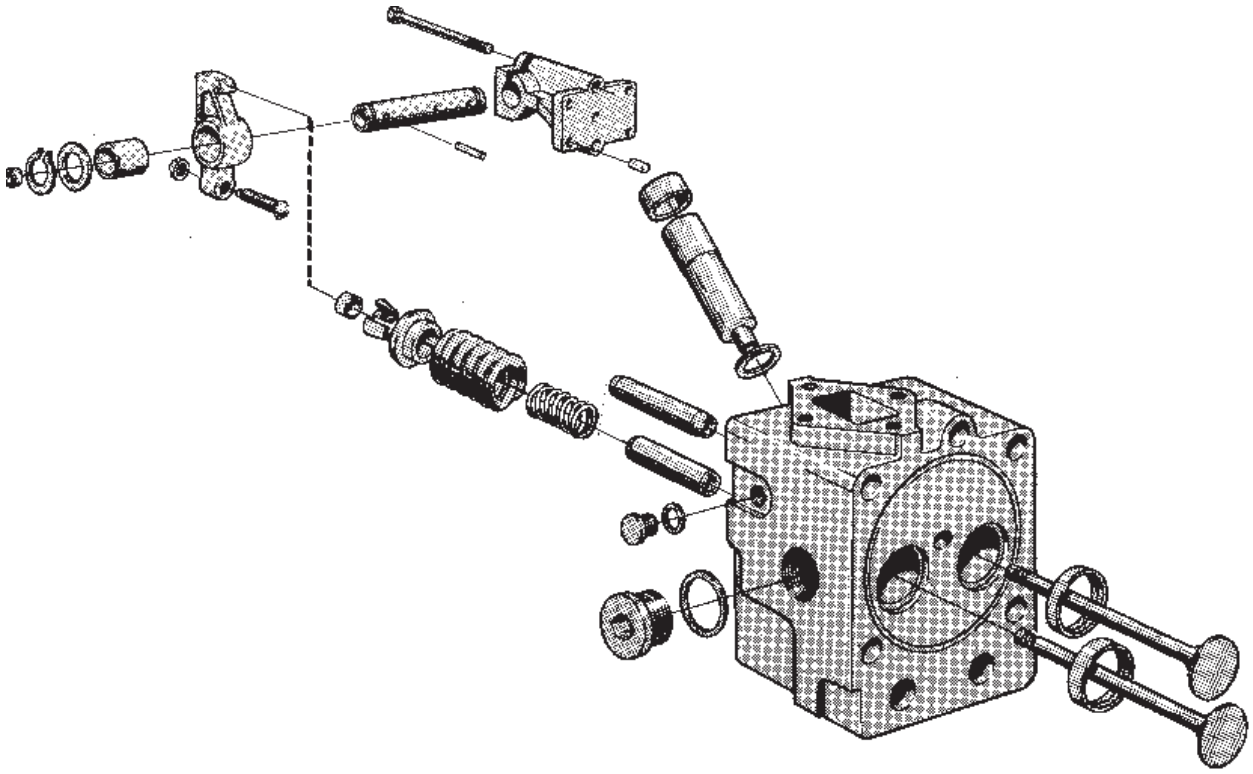
Cylinder head



The cylinders have separate cylinder heads, which are interchangeable and bolted to the cylinder block by four 3/4" bolts per cylinder head.

Having separate cylinder heads is not only technically advantageous with regard to sealing between cylinder head and cylinder block, it also makes servicing easier.

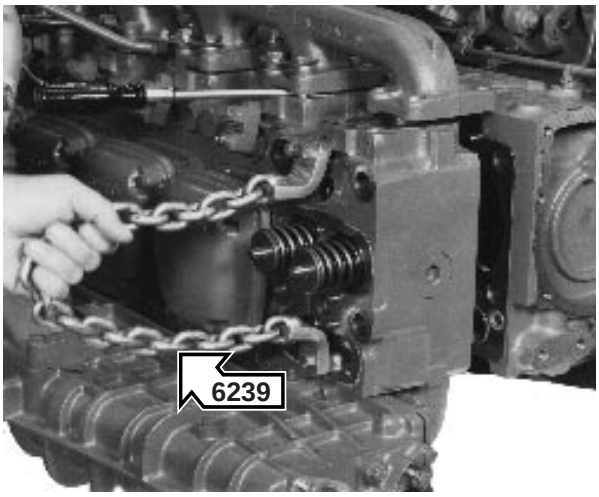
Sealing against the cylinder block consists of a special groove in the cylinder head face, a steel gasket and a stepped edge on the cylinder liner collar. Sealing on the coolant side is provided by O-rings.

The inlet duct in the cylinder head has a defined and accurately calculated shape that results in “whirled” air in the piston combustion chamber. Far out on the inlet valve the cylinder head has a notch that lowers the rotation speed at the beginning of the valve opening movement.

The valve mechanism for each cylinder head consists of:

– an inlet valve and an outlet valve
– valve guides
– double valve springs with washers and valve locks
– rocker arms with adjusting screws
– rocker arm shaft with bearing brackets
– push rods and valve tappets

The material in the outlet valves is **nimonic**.The inlet valves contain nickel and chromium. Valve guides and valve seats are replaceable.



Cylinder head, removing/cleaning

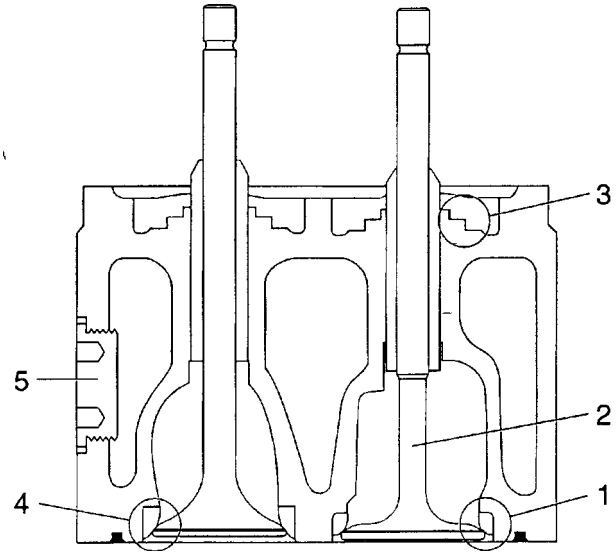
Special tools:
(998) 5468 Valve spring clamp
(999) 6239 Lift chain
6643 Extractor

1. Drain the coolant.

2. Remove…

– rocker arm cover
– delivery pipes
– injectors, rocker arm bracket and push rods.

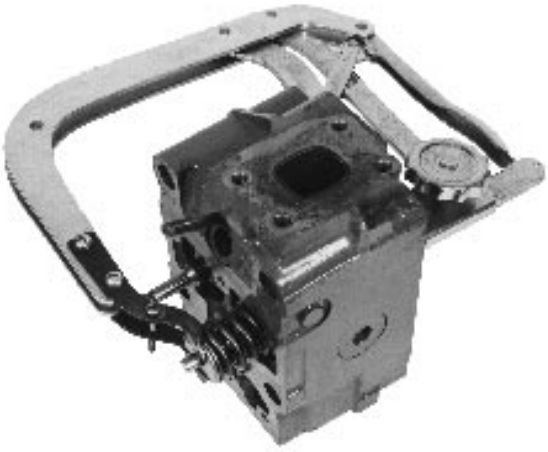
If necessary, use extractor 6643 to remove the injectors.



Some alterations have been made to the cylinder head, compare with the THD 104-engine, particularly with regard to optimating inlet air flow.

New features

1. Valve seats and valves on the inlet side have been moved down one millimetre.
2. The inlet valve has a rounded disc edge and smaller stem diameter, below the valve guide.
3. The inlet valve spring face has been moved down one millimetre.
4. The exhaust valve inside has been bevelled to improve exhaust flow.
5. New type of cast plug, of cast iron. Use lock fluid when fitting plugs of this kind. (Die tool 999 8419.)



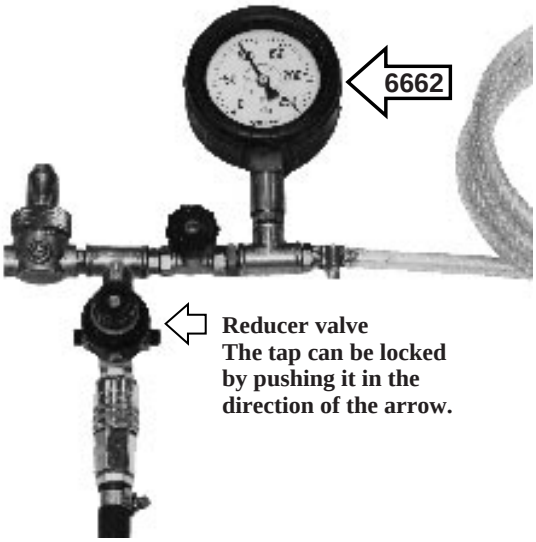
Cleaning

Disassemble the cylinder head. Clean all the parts and the cylinder block contact surface.

Rust and carbon deposits, etc., must be removed from the bolt holes and threads in the cylinder block and cylinder head.

Paint and dirt must be removed from cylinder head surfaces in contact with bolt heads otherwise there is risk of leakage and damage to seals and gaskets.

Threads and under bolt heads must be free from nicks, etc. Renew damaged bolts.



Cylinder heads, pressure-testing

Special tools:
(999) 6579 Lever (or corresponding)
6662 Pressure gauge
6686 Clamp
8077 Cover washer

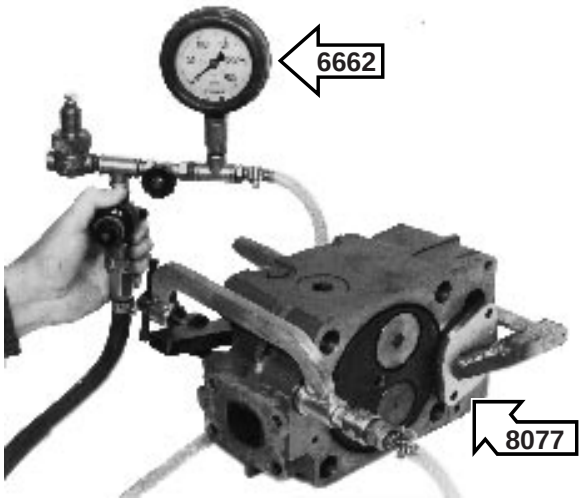
Before pressure-testing

A. Connect up pressure tester 6662 to the workshop air supply. Adjust pressure to 100 kPa (1.0 kp/cm^2) with the reducer valve tap.

B. Close the shut-off tap. No pressure is allowed to drop during two minutes while reading-off the pressure gauge.

C. Screw out the reducer valve tap.

Pressure-testing



1. Connect up the equipment. Lower the cylinder head into water with temperature approx. 70°C.

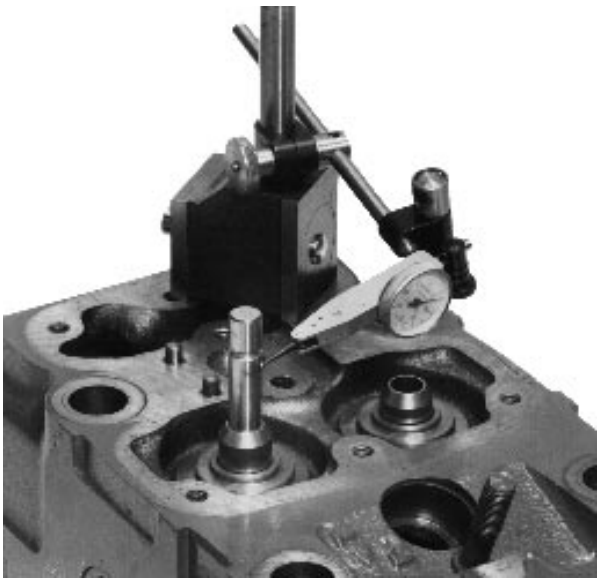
2. Connect up pressurized air to the pressure tester. Open the shut-off tap.

3. Pull out the reducer valve tap lock ring. Screw in the tap until pressure reaches **50 kPa (0.5 kp/cm^2)**. Hold this pressure for **one minute**.

   Increase pressure to **150 kPa (1.5 kp/cm^2)**. Push in the lock ring to lock the tap. Close the tap.

   After **1–2 minutes** check to see if the pressure has dropped or if air bubbles have formed in the water.

   Replace the cylinder head if leaking or damaged.



Valve guides

Special tools:
(999) 1084 Drift
6668 Drift
6669 Drift
9696 Magnetic stand
(998) 9876 Dial indicator

Valves

Max. permitted clearance between valve stem and valve guide:
– inlet valve ..... 0.15 mm
– exhaust valve ..... 0.25 mm

Replacing

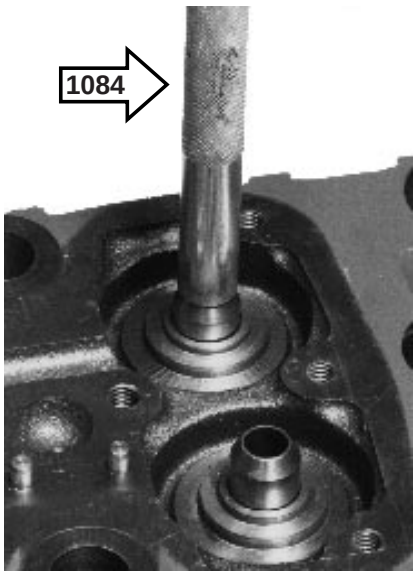
1. Press out the old valve guides with drift 1084.

2. Oil the outside of the new valve guides before installing them.

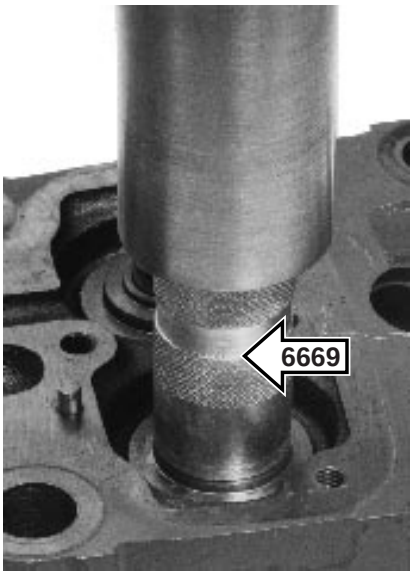
3. Installation tools automatically give correct height above spring face.

   Inlet, drift 8449
   Exhaust, drift 6669

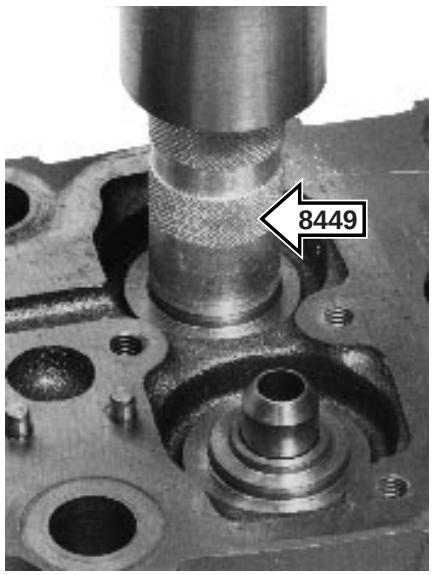
4. If necessary, ream the guides with a standard reamer.



Pressing out



Exhaust



Inlet

Valves, valve seats

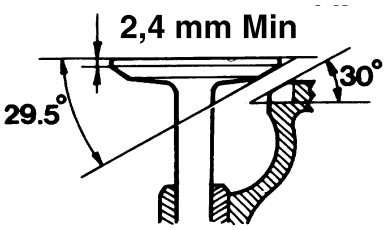
Grinding valves

Before grinding, check the valve guides for wear. Replace worn guides and ream.

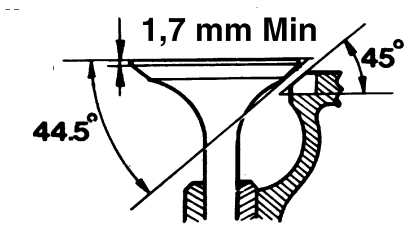
Machine the valves if the sealing surfaces are damaged.

Both inlet and exhaust valves should have a contact surface that is 1/2° smaller than the valve seat contact surface. The smaller contact surface gives better sealing with a newly ground valve. The surface difference disappears after a time to get a larger surface for heat transmission.

Grind the valve sealing surface as little as possible, just enough to clean the valve.



Inlet valve



Exhaust valve

Replace the valves if the valve disc edge is less than:
- inlet valve ..... 2.4 mm
- exhaust valve ..... 1.7 mm

Replace a valve if the stem is bent.

Valve seats

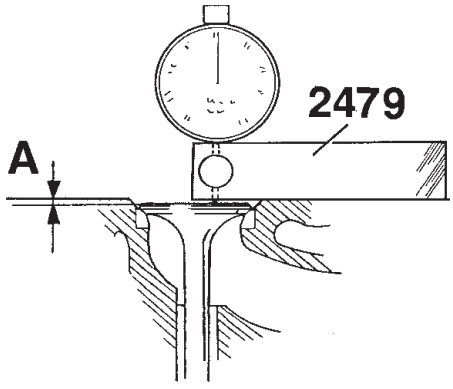
Grind the valve seat with a grinding machine. Use the self-centerer that is fitted in the valve guide. Do not grind off too much material. It is essential that the contact angle is correct and that the surface is even.

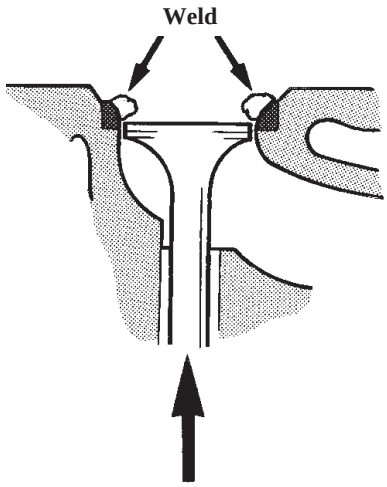
Valve seats are available in standard size and oversize. The outer diameter on an oversize is 0.2 mm greater than that on a standard size. They are used when grinding valve seat recesses.

Usually valve seat damage is quite insignificant. This means that normally it is not necessary to reduce seat width when grinding. Otherwise the grinding is limited to the measurements that apply to max. distance from the top side of the valve disc to the cylinder head contact face.

The valve seat should be renewed when the distance **A**, measured with a **new valve**, exceeds:

Exhaust	2.5 mm
Inlet	1.5 mm



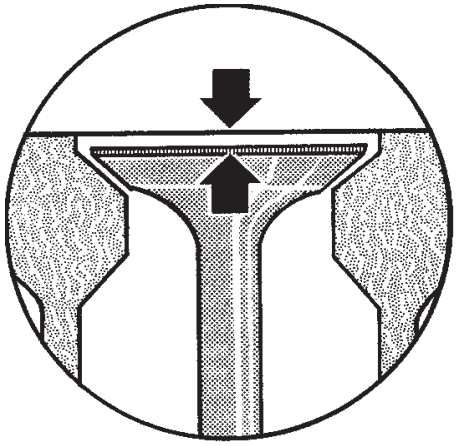


In connection with removal: grind the valve disc on an old valve so that it can be pressed down into the valve seat.

Then weld according to the illustration.

Tap out the valve seat.

Use carbon dioxide snow to cool the seat down to –70°C and –80°C **when refitting.** Then use a suitable tool to press the valve seat into position.

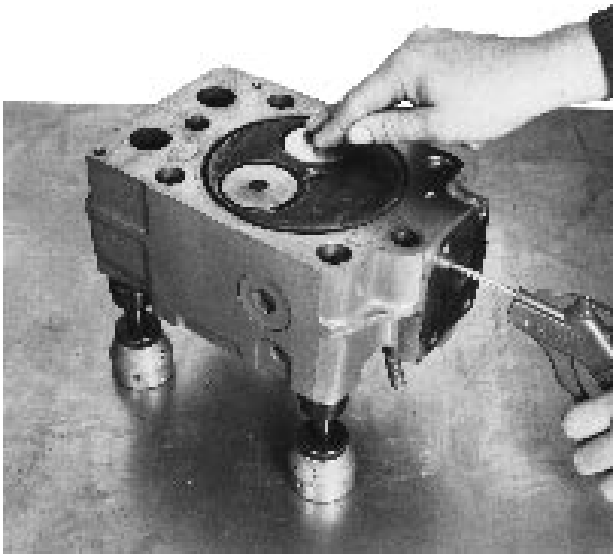


Inlet 0.5–0.50 mm
Exhaust 1.2–1.7 mm
with new valve.

New valve seats

The distance between the valve disc and cylinder head is adjusted by grinding the valve seats. Grind new valve seats so that the distance is the same as on new engines.

Do not grind existing valve seats so that the distance exceeds the max. measurement, see Specifications. Otherwise the seats must be replaced.



Checking after machining

Place the valve without springs in the cylinder head. Pour water over the valve discs. Press the valve against its seat and blow with pressurized air from underneath with pressurized air. But not so hard that the valve lifts from its seat.

If the valve leaks, air bubbles will come up round the valve disc.If this happens, re-grind, clean the seat and re-check.

Valve springs

Outer valve spring

Length unloaded	61 mm
With load of 300–390 N (30–39 kp) ..	49.6 mm

Inner valve spring

Length unloaded	53 mm
With load of 80–170 N (8–17 kp)	42.6 mm

Rocker arm mechanism

Special tools:
(999) 2677 Drift
2267 Drift

Replacing bushings

1. Press out the old bushing with drift 2677 and counterhold 2267.

2. Oil and press in the new bushing.

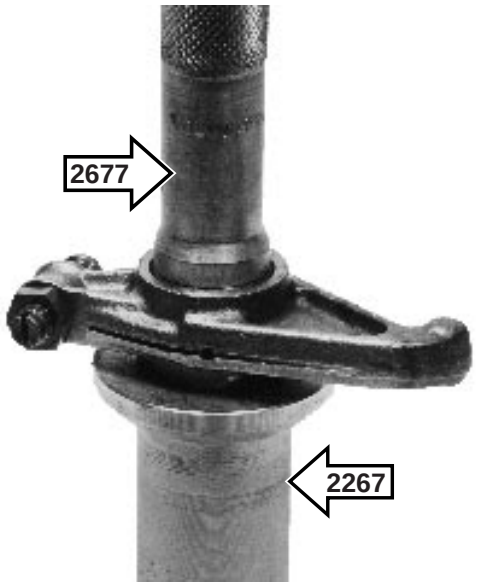
   Make sure the oil hole coincides with the oil drilling in the rocker arm.

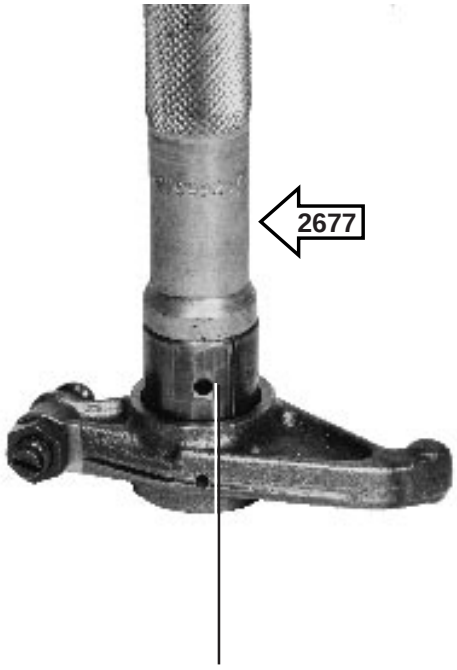
3. After pressing in, ream to 25.02–25.04 mm.

Checking

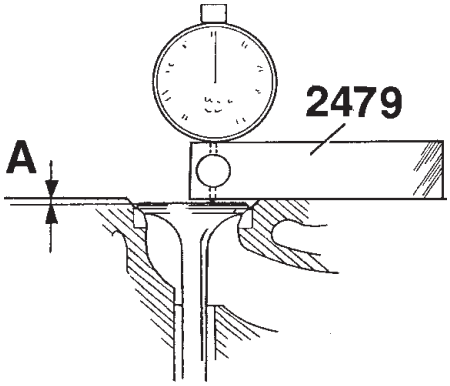
Check:

- rocker arm shaft/bushing wear
- that the adjusting screws are not deformed or worn on the surface against the push rods
- the threads on the adjusting screws and lock nut
- that the lock nut is not damaged
- that the contact face against the valve stems is not worn or damaged in any way. Minor wear can be remedied by grinding to a smooth finish.





Note the oil holes!



After machining, the distance A from valve disc top face to the cylinder head face should be.

Min.	**Inlet**	**0.05–0.5 mm**
	Exhaust	**1.2–1.7 mm**

If additional cylinder head machining is required, the valve seats must be ground down to enable the valves to sink down.

Face-grinding cylinder head

If leakage is discovered or if there is a trace of a blown head gasket, there is no reason to check for unevenness. The head must be machined or renewed anyway.

A rough check can be made with the help of a straight-steel edge. A slit of light between the straight edge and cylinder head indicates that the cylinder head should be machined.

Cylinder head unevenness must not exceed 0.01 mm within a distance of 100 mm and 0.02 mm across the entire width.

A more exact method must be used when checking cylinder head unevenness since the tolerances are very small.

Machining

It is most important that the contact face for the cylinder liners is even. Max. surface finish (roughness) is 0.006 mm.

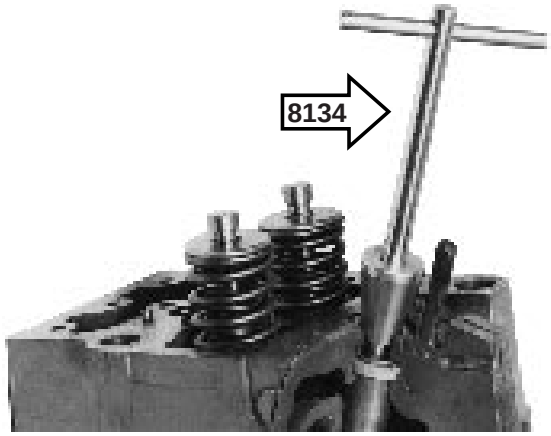
The overall height of the cylinder head after machining must be minimum 114.65 mm.

There is no need to alter the depth of the groove for the cylinder head seal, providing machining stays within permitted limits.

Copper sleeve for injectors

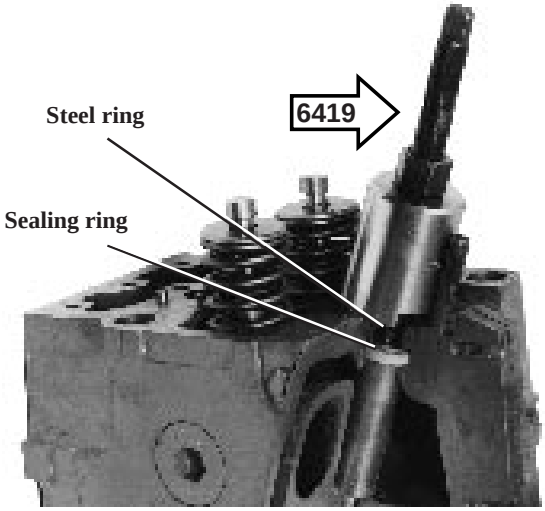
Special tools:

(999) 6419 Extractor
6647 Reaming tool
8134 Threading tool
8140 Extractor

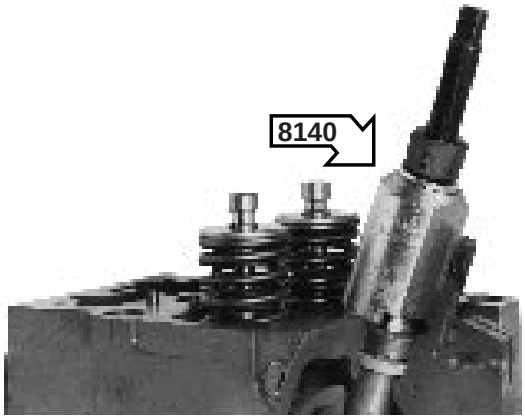


1. Make threads in the copper sleeve tap.

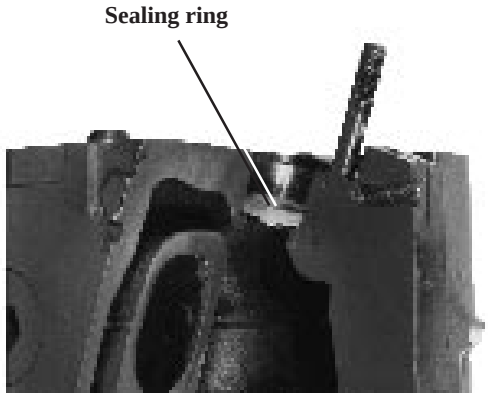
   NOTE: If threading is done with the cylinder head in the engine, the thread die must be greased to prevent thread filings from falling down into the cylinder.



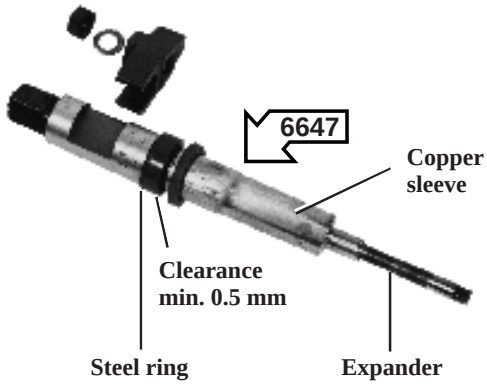
2. Pull out the steel ring.



3. Pull out the copper sleeve.

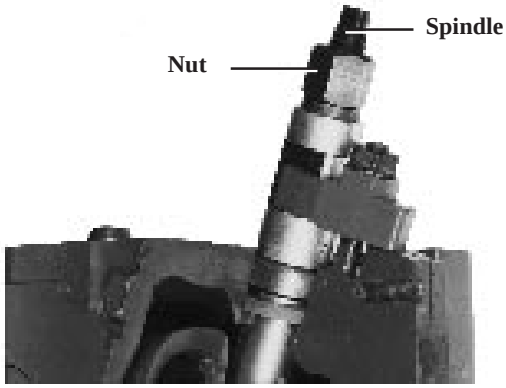


4. Smear a new rubber seal with soapy solution and fit it in the cylinder head.



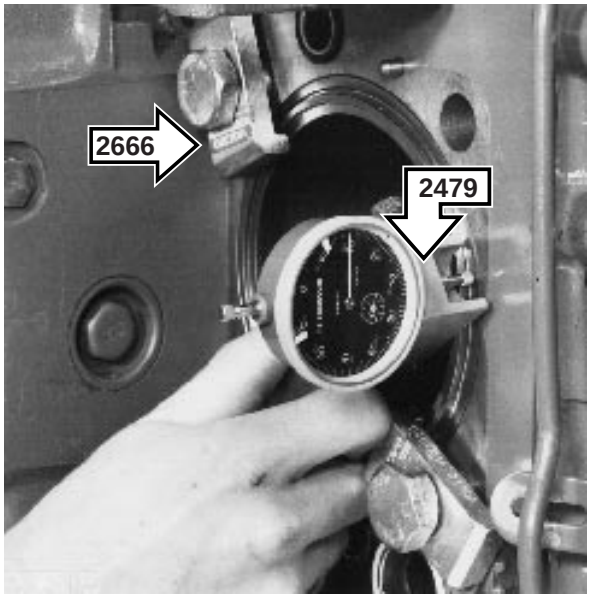
5. Fit the injector steel ring on tool 6647 and a new copper sleeve. Screw in the expander.

   Check that the clearance between the copper sleeve and the steel ring is at least 0.5 mm.



6. Smear the copper sleeve with a soapy solution and fit the sleeve in the cylinder head. Hold the stem on tool 6647 steady while tightening up the large nut. Continue until the stem loosens and the expander can be drawn through the copper sleeve.

Installing the cylinder head



Special tools:
(998) 9876 Dial indicator
(999) 2479 Stand
2666 Press tool (two)
6239 Lift chain

Clean the cylinder block face, if this has not been done already. The cylinder block contact surface against the gasket must be shiny before installing the head.

1. Check the cylinder liner height.

2. Before fitting the bolts, immerse them in rust-proofing, P/N 1161346-0, after which place them on a net to drip dry. The bolts must be drip-free before being fitted.

3. Fit a new gasket, new cylinder head sealing rings and O-rings for the inlet channel.

4. Lift the cylinder head into position. Use lift chain 6239 if necessary to guide the head into position. Fit the cylinder head bolts.

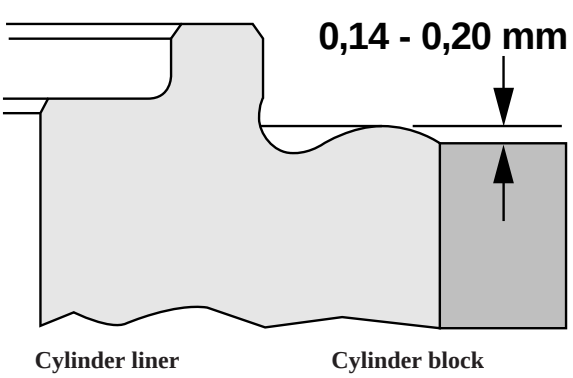
5. Tighten the bolts in the correct sequence, see instructions below under “Tightening-cylinder head bolts”.

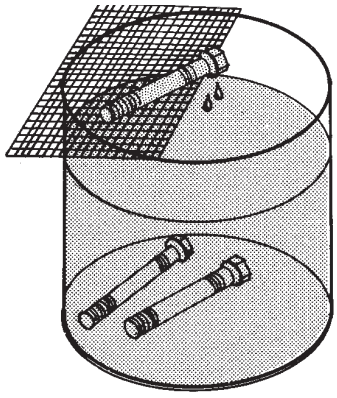
6. Fit and tighten up the bolts for the inlet and exhaust manifolds. Use lock washers to lock the exhaust manifold bolts.

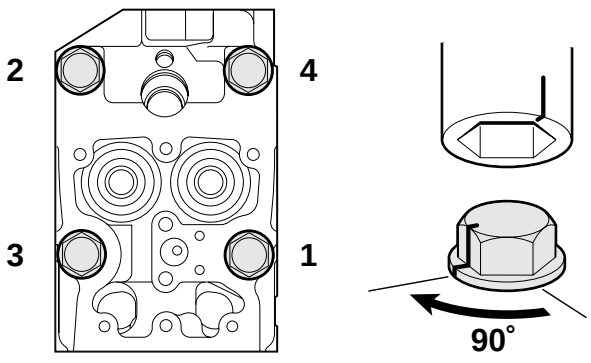
7. Fit the delivery pipes and by-pass fuel pipes together with ties, washers and brackets.

8. Fit the push rods, rocker arm mechanism and injectors.
   Tightening torque for rocker arm bracket: **40±4 Nm** (4±0.4 kpm).

9. Adjust the valves, see instructions.



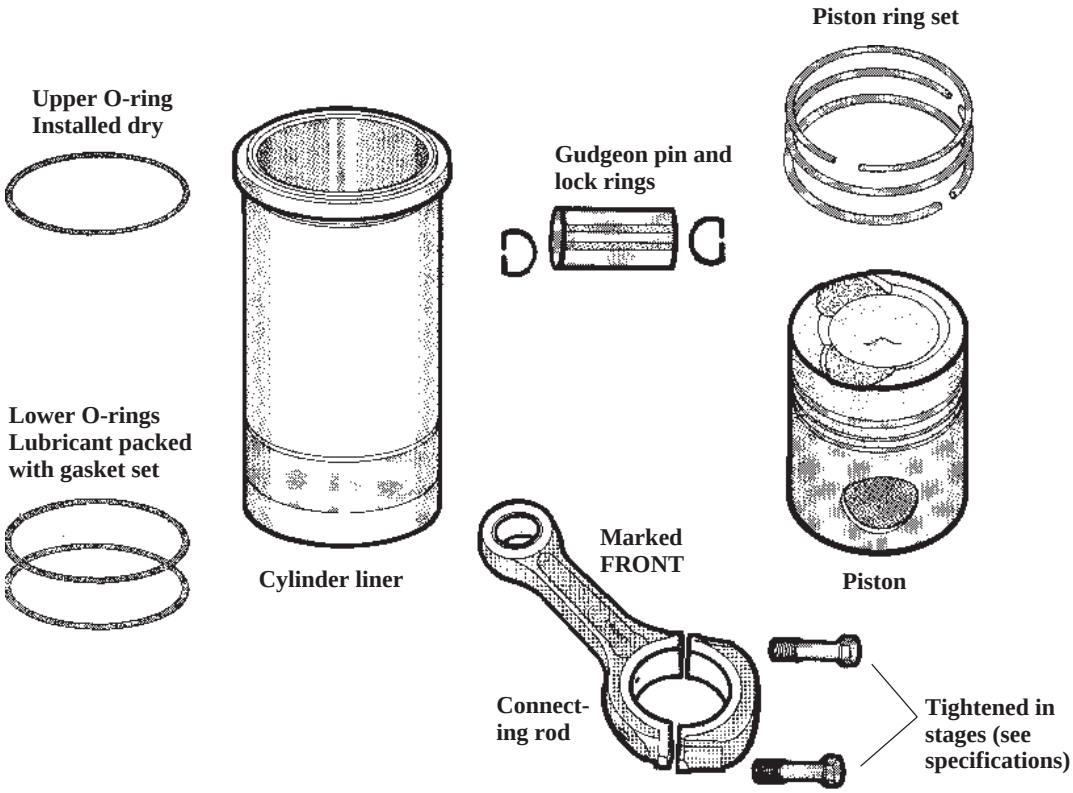




Tightening – cylinder head bolts
Tighten the bolts in stages and in the sequence illustrated here. Tighten evenly; uneven tightening impairs the bolting and has a negative effect on the sealing.

1st stage: **50 Nm** (5.0 kpm)
2nd stage: **200 Nm** (20.0 kpm)
3rd stage; **370 Nm** (37.0 kpm)
4th stage: Angle tightening **90°,** (that is, a 1/4 turn).

Cylinder liner, piston, connecting rod



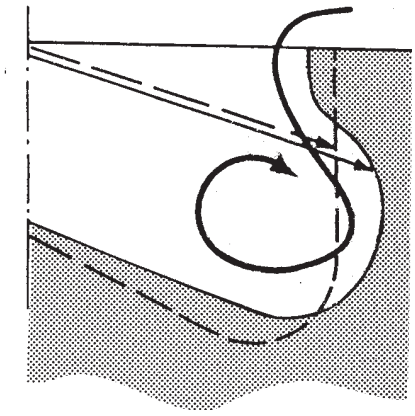
The engines have wet, replaceable cylinder liners. Characteristic of this type of liner is its immediate contact with the coolant. This ensures good cooling.

The connecting rods have angle-cut connecting-rod seats to enable them to be taken up through the cylinder liners together with the piston.

Like the pistons, the cylinder liners are grouped per class. This means that pistons are fitted in cylinder liners of the same class. Pistons and cylinder liners are supplied as spare parts only as a single unit.

The engine has pistons with so-called “re-entry” type combustion chambers. These pistons have a large area between the piston outer edge and the combustion chamber.

Precisely at the end of the compression stroke the air will find itself in the area for this surface and be rapidly compressed and pressed down into the scored section in the lower part of the combustion chamber. The width of the surface contributes essentially to rapid air rotation. The tapered projection in the middle of the piston keeps the air from the middle of the piston and presses instead the air out from the middle, thereby contributing to more effective air rotation. Not only is air rotation improved, the fuel dispersion is better.

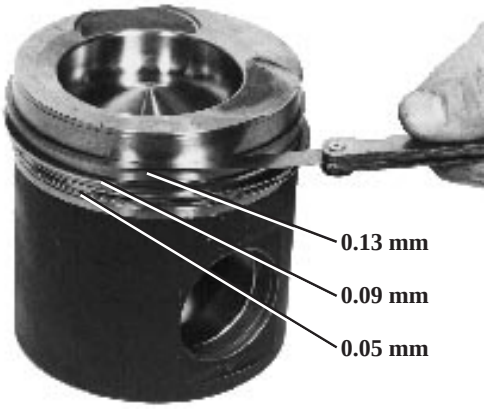


Difference between re-entry type piston and the early prod. type piston (dash line).

Piston/piston rings

Special tool:
(998) 5423 Piston ring pliers

NOTE!
To prevent damage to the piston cooling nozzles, they must first be removed before removing piston and connecting rod.



1. Remove the piston and connecting rod.

2. Measure the piston ring clearance.

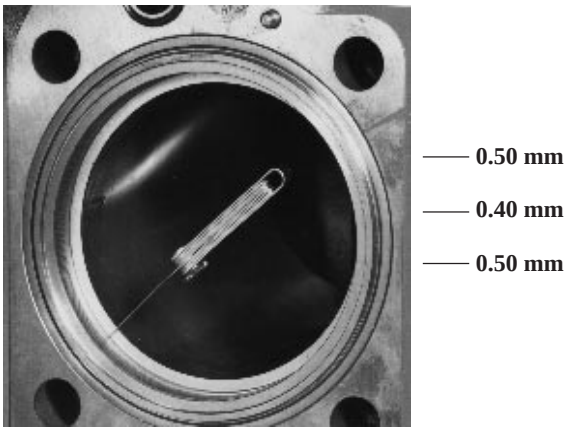
3. Remove the piston rings. Clean the piston and piston ring groove.

Checking piston rings

Check all surfaces for wear. Dark spots indicate poor contact. Where this is the case, replace the piston rings.

Replace the piston rings if there is notable wear or out-of-round, which would make it difficult to fit the rings in their original positions.

Heavy oil consumption could also be a reason for replacing piston rings.



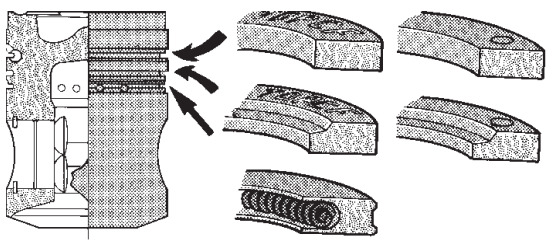
4. Measure the piston ring gap.

Checking pistons

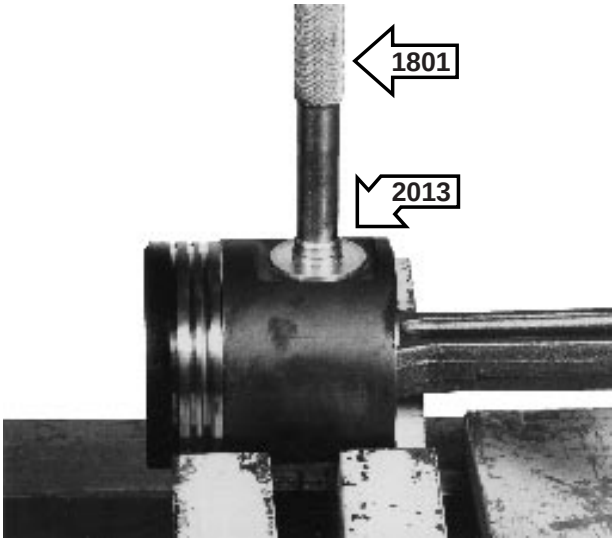
Check for cracks, broken-off sections between the piston ring grooves and also for groove wear. Pistons with seizure marks on the jackets must be scrapped.

The piston should also be renewed if there is one or several cracks in the gudgeon pin seat or in the bottom of the combustion chamber.

Piston renewal also means replacing the gudgeon pin, piston rings and cylinder liners as a complete unit.



5. Use piston ring pliers when fitting the piston rings.

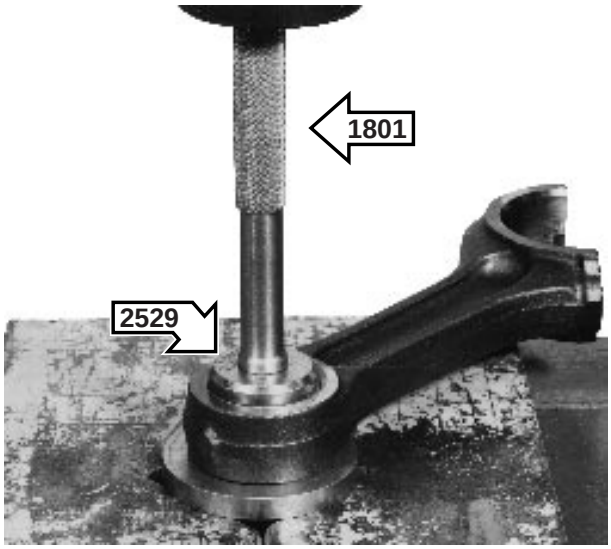


Gudgeon pin, connecting rod

Special tools:
(999) 1801 Standard handle
2013 Drift
2529 Drift

Disassembling

1. Remove the gudgeon pin lock rings.
2. Press out the gudgeon pin from the piston using drift 2013 and standard handle 1801.
3. Press the bushing out of the connecting rod using drift 2529.

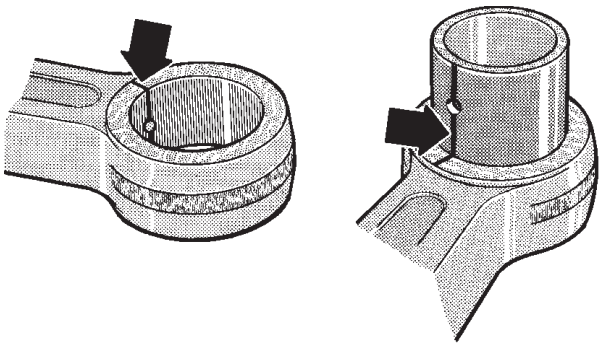


Checking connecting rods and gudgeon pins

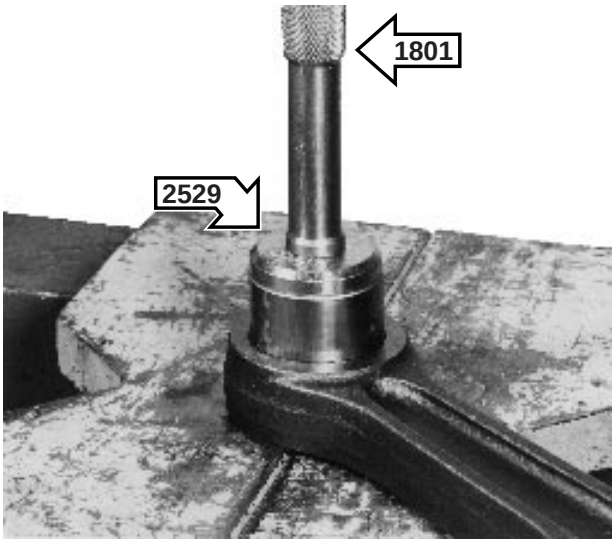
Look for cracks. Check straightness and for warp. In both cases max. permitted deviation is 0.01 mm on a measured length of 100 mm. Use the measuring fixture when measuring.

Cracked, bent or warped connecting rods must be renewed.

In cold condition, the gudgeon pin grip in the piston should be max. 0.004 mm.



It is most important that the lube hole is positioned opposite the lube drilling in the connecting rod. To ensure correct alignment, line-up mark the bushing with the connecting rod, as shown here, before pressing in the bushing.



4. The tools used for removing the old bushing can also be used for pressing in the new one. Make sure the bushing is fitted correctly.

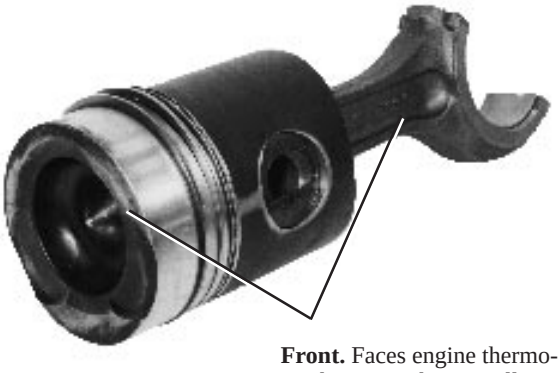
5. Ream the bushing to correct fit. **An oiled gudgeon pin should glide under its own weight through the bushing at a temperature of 17–20°C.**

Assembling

1. Fit one of the gudgeon pin lock rings. Oil the gudgeon pin and bushing.

   NOTE! Apply light pressure when pressing in the gudgeon pin. **Do not try to knock it in.**

2. Fit the other gudgeon pin lock ring.



Front. Faces engine thermostat housing when installing in engine.

Cylinder liner

Checking

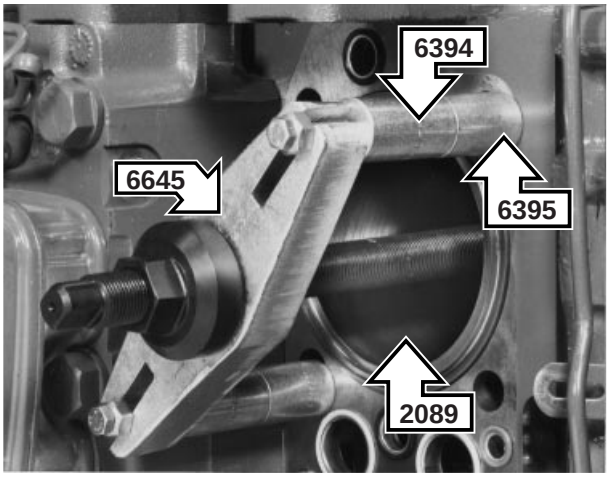
Measure the cylinder liners with a cylinder indicator. **Max. wear 0.40–0.45 mm.**

Measure cylinder liner wear with a cylinder indicator. To get max. accurate wear, first gauge the cylinder indicator with a gauge ring or micrometer.

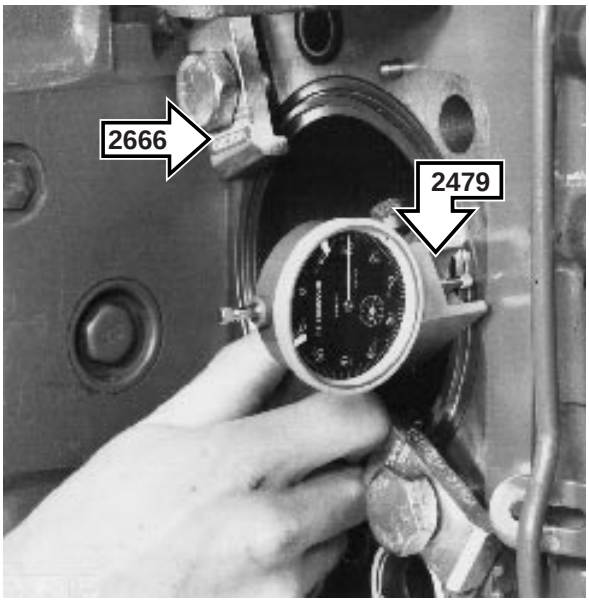
Use the cylinder liner original diameter as reference value.

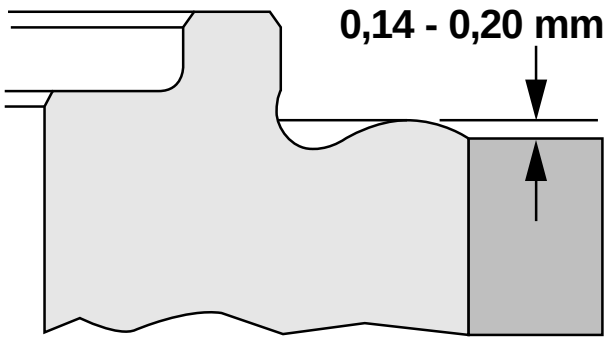
Note. Cylinder lines and pistons are co-classed.This means that the pistons must be fitted in cylinder liners of the same classification.

As spare parts, piston and cylinder liner are supplied only as a complete unit.



Mechanical puller





Cylinder liner **Cylinder block**

Removing

Special tools:
(999) 2089 Puller plate
2479 Holder
6394 Spacer (two)
6395 Spacer (two)
6645 Extractor

1. If the liner is to be refitted, mark the cylinder liner seating against the cylinder block with a coloured pen.

2. Pull the cylinder liner up out of the cylinder block.

3. Remove the sealing rings from the cylinder block.

4. Thoroughly clean the cylinder liner sealing surfaces in the cylinder block. The sealing surfaces must be entirely free of rust and deposits.

   Note: Do not use a scraper tool for this.

Checking the cylinder liner height before fitting the liner.

1. Fit the cylinder liner, but not the sealing rings, in the cylinder block.

2. Fit tool 2666 (two) to hold the cylinder in position in the block.

3. Fit a dial indicator on holder 2479. Point the dial indicator probe at the liner stepped edge and read-off the liner height above the block face.

4. This measuring should be done at several places on the liner.

   Correct cylinder liner height above the cylinder block face is **0.14–0.20 mm.**

   Adjusting cylinder liner height, refer to Machining cylinder liner height, milling.

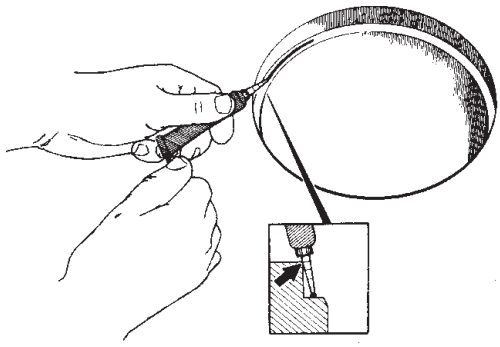
Cylinder liners and pistons – installing

Special tools:
(999) 2000 Standard handle
2666 Press tool
6599 Adapter
6664 Piston ring compressor
8068 Crank tool

1. Fit new sealing rings in the cylinder block.

   Note: Lubricate the two bottom rings with the grease contained in the packet containing the rings.

   Concerning order and location of the sealing rings, refer to installation instructions in the packet.

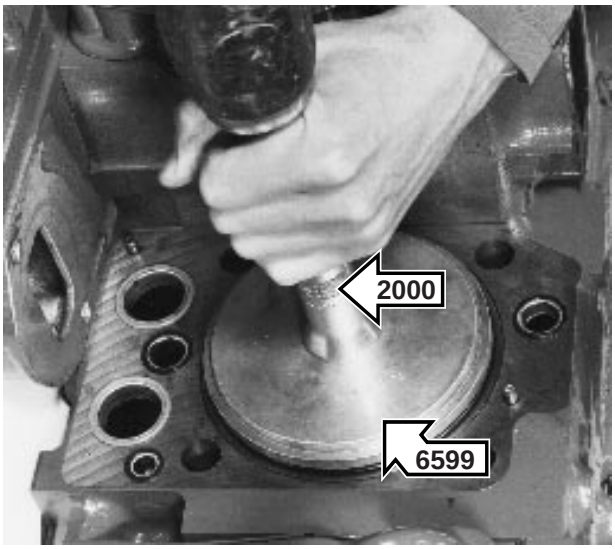


2. Thoroughly clean the cylinder liner collar. Fit a new O-ring on the cylinder liner.

   Note: The O-ring must be dry.

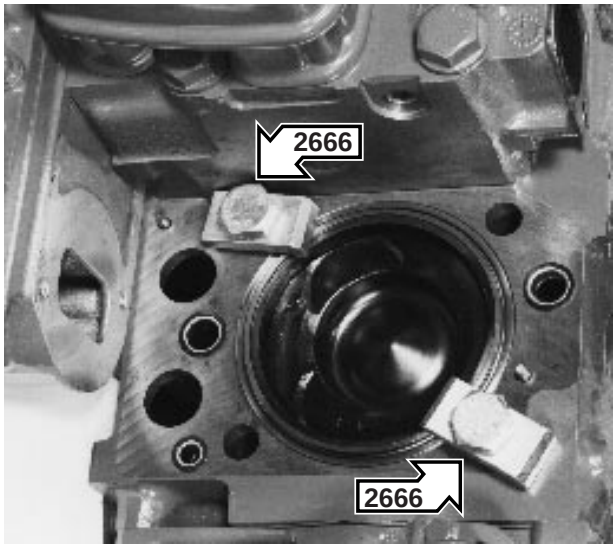
3. Apply an even, **max. 0.8 mm,** thick bead of sealant round the liner shelf.

   Within 20 minutes from the time this is done, the cylinder liner must be fitted in the cylinder block.



4. Fit the cylinder liner according to the line-up marking on the cylinder block.

5. Carefully tap the cylinder liner down into the cylinder block using drift 6599 and handle 2000.

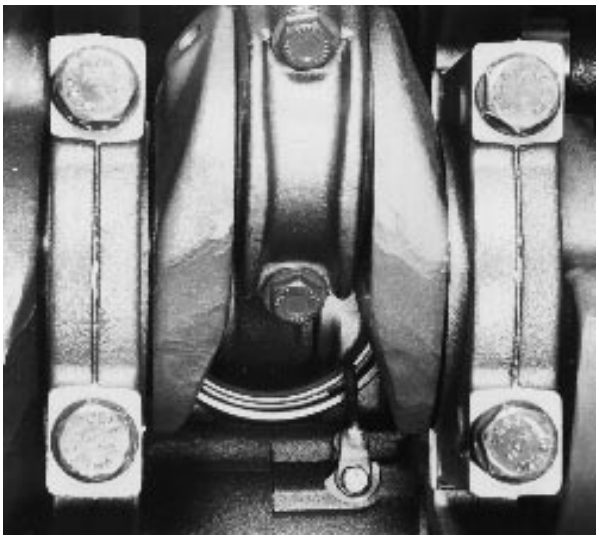


Apply load to the the cylinder liner with two tools 2666.

The load must not be taken off the cylinder liner until the cylinder head is fitted in position.

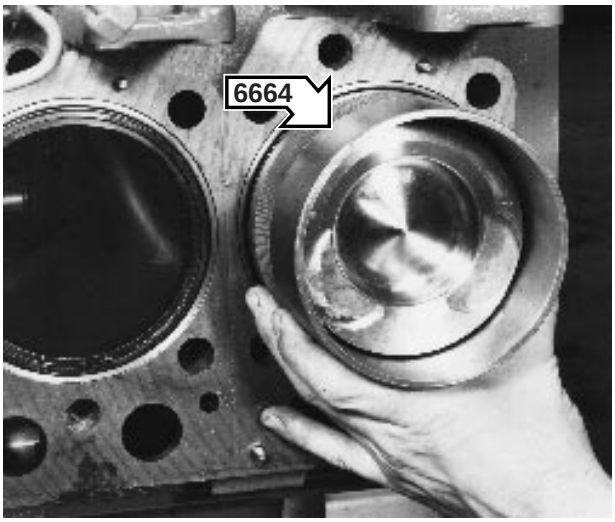
6. Place tools 6664 on top of the cylinder liner. Oil the piston. Fit piston and connecting rod in the cylinder liner with the “FRONT” markings pointing ahead.

7. Check to make sure the connecting-rod bearings are fitted correctly in the connecting rods and cap. Oil the connecting-rod bearing journals and shells with engine oil. Fit the caps according to the line-up marking.



8. Fit the piston cooling nozzle.

Important...
Follow also the instructions on page 90!



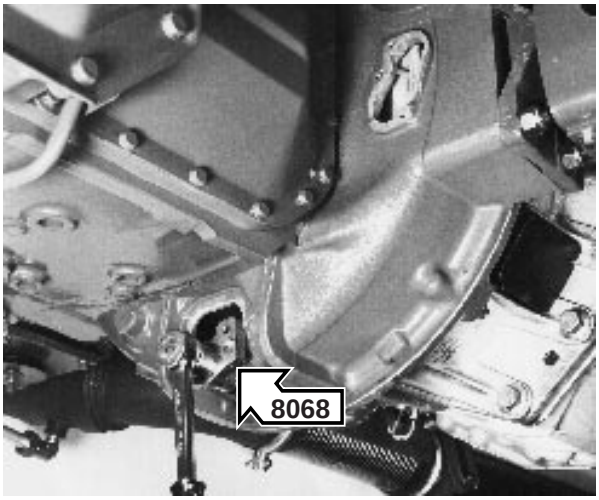
Arrow on piston should point towards the front of the engine.

9. Fit installation ring 6664 on the piston. Fit the piston, along with the connecting rod, in the cylinder.

10. Fit the connecting-rod cap along with bearing as per line-up marks.

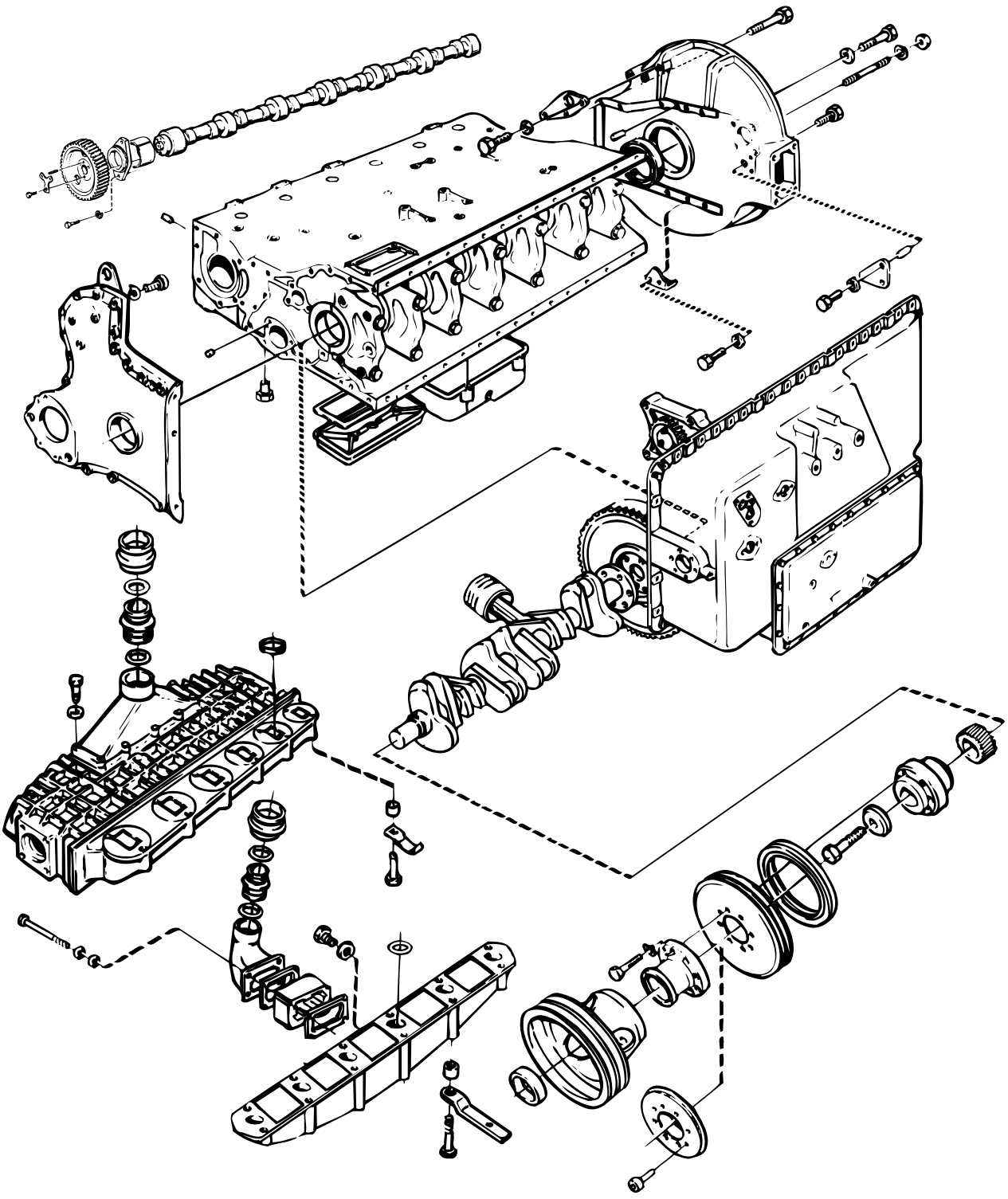
Tightening main bearing bolts
The bolts are tightened in the following stages:

First tightening **40 Nm** (4 kpm).
Second tightening **75 Nm** (7.5 kpm).
Final tightening (angle tightening) **90°.**

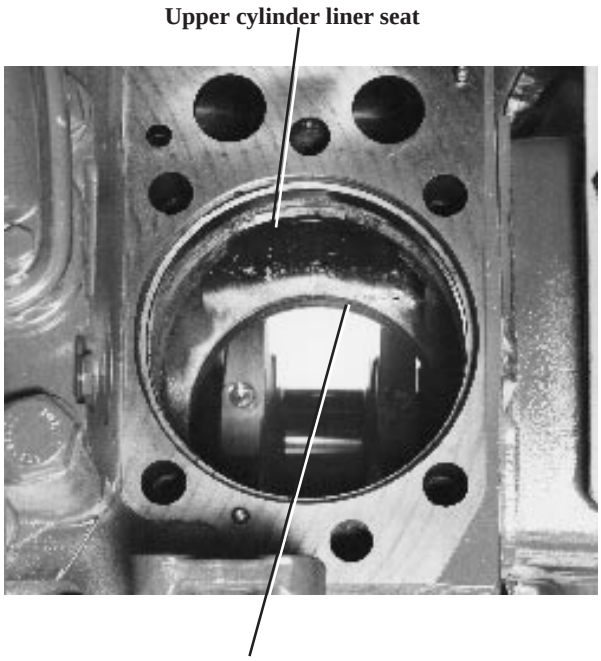


11. Crank the engine with crank tool 8068 and fit the other pistons.

Cylinder block/crank mechanism



Description

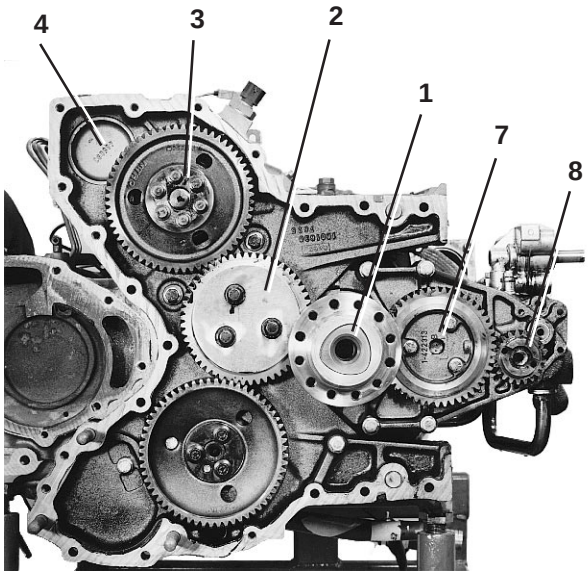


The cylinder block is one-piece cast of special alloy. Stresses on the cylinder head bolts from combustion pressure are transmited via reinforced ribbing in the cylinder block walls directly to the main bearings.

The DH10A engine has a drilling and nozzles for piston cooling.

The camshaft is journalled in seven bearings and is driven via one of the timing gears from the engine crankshaft. Its function is to operate the valves via push rods and rocker arms.

The camshaft bearings range in size starting at the front and gradually becoming smaller towards the rear. This arrangement makes it easier to install the bearing bushings in the cylinder block.



The following are the engine **timing gears**:

1. Crankshaft gear
2. Intermediate timing gear
3. Injection pump drive gear
4. Power steering oil pump drive gear
5. Camshaft gear
6. Space normally occupied by air compressor drive gear
7. Intermediate oil pump gear
8. Oil pump gear

The coolant pump is flange-driven from the oil pump gear (8). Because the gears are hardended in different ways, it is important when changing a gear that it is adjacent to one of similar hardness. See further on page 72.

Components gear-driven from the engine have a very high operational reliability.

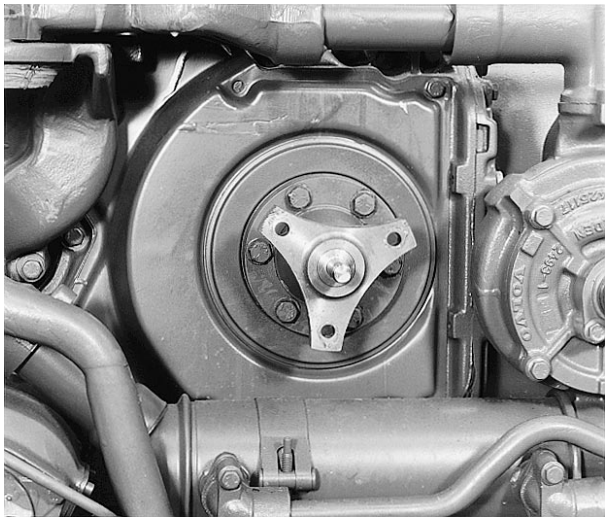
Crankshaft

The crankshaft is either nitro-carburized or induction-hardened (both alternatives exist). It has a new rear 14-bolt flange against the flywheel (previously 10 bolts).

The crankshaft is single-piece forged in special steel. The bearing surfaces are nitro-carburized to increase strength and reduce risk of cracks.

The crankshaft has seven main bearings. Each big-end bearing is placed between two main bearings. The counterweights on the crankshaft are there to even out operating surges so that torque is evenly spread out.

Up front the crankshaft has a polygon hub to which the vibration damper hub is fixed. The main bearing and big-end bearings consist of lead-indium plated and lead-bronze lined steel shells.



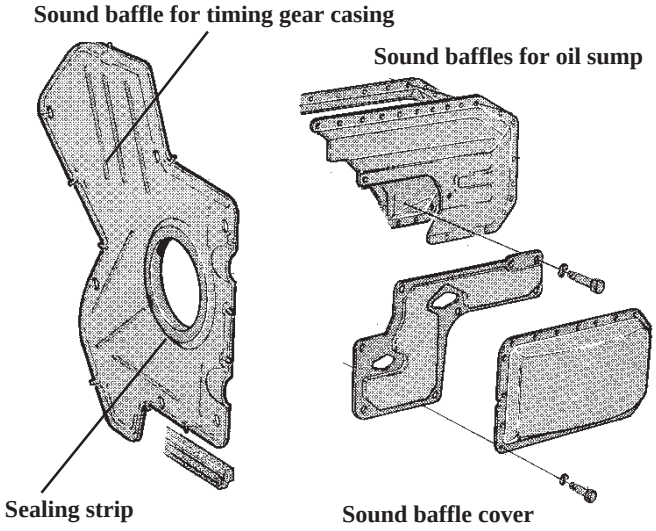
Vibration damper

To further its damping qualities, the DH10A engine has been given a more robust, built-in vibration damper. The timing gear cover has had its shaped re-designed to suit the new vibration damper.

The vibration damper consists of a housing containing a rectangular damper ring, which is surrounded by silicone oil, that acts as a speed buffer between the damper ring and the housing. Since the housing is fixed to the crankshaft, the speed buffer has a dampening effect on crankshaft oscillations. The vibration damper is placed on the inside of the timing gear cover in the figure.

Sound baffles

The engine timing gear cover and oil sump have been fitted with sound baffles. These are built up of two plastic layers with an intermediate damper layer of plastic/rubber.



Crankshaft movement

Differences compared to THD104

Flywheel

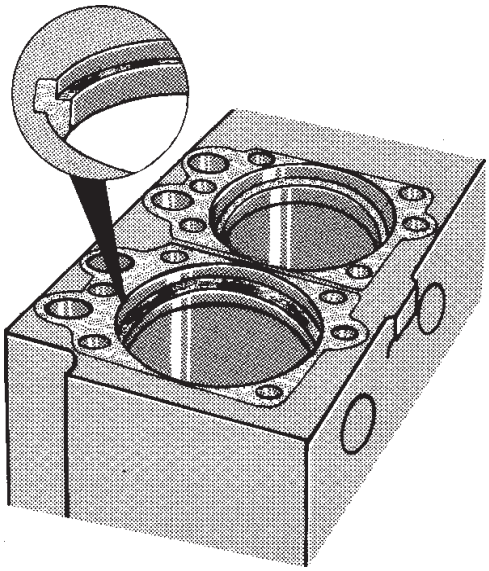
The flyhweel has 14 holes.

Connecting rods

The connecting rods have trapezoidal gudgeon pin ends.

Pistons

In design the pistons have been adapted to the trapezoidal connecting rods. The shape of the combustion chamber has been altered, resulting in altered compression ratio. Altered, too, are the specifications for the piston rings.



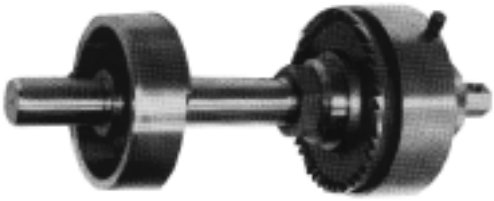
Cylinder liner seats

Checking

Coolant will leak if the cylinder liner seats and /or the underside of the cylinder liner collars are corroded. The cylinder liner must have a tight fit to prevent gas leakage.

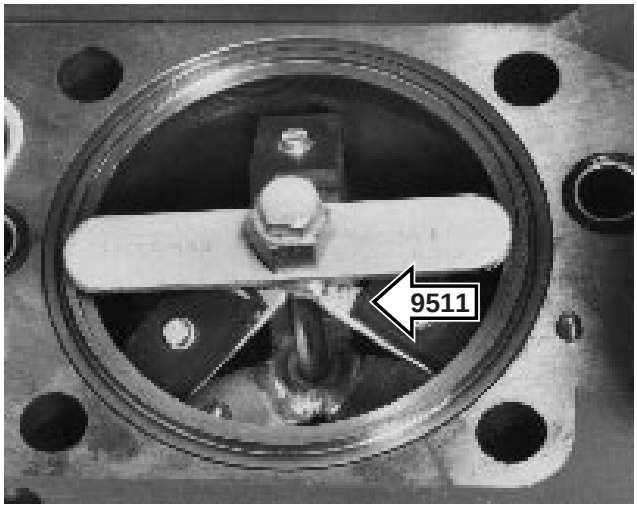
Machining

Special tools:
(999) 2479 Holder for dial indicator
2666 Press tool (holder) for cylinder liner
9511 Expander tool
9551 Milling tool



Special milling tool 9551 which is used for major damage

Where there is doubt concerning the extent of the damage, use marking colour to check the area in contact with the cylinder block liner seat.



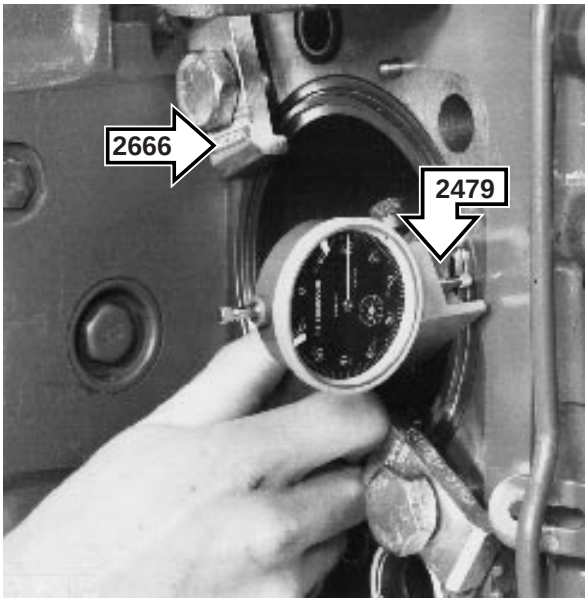
Checking cylinder liner

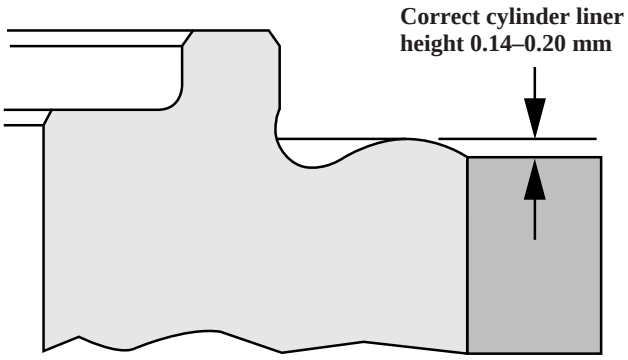
1. Remove the cylinder liner sealing rings.

2. Lightly apply marking colour underneath the seal on the cylinder liner collar. Fit the cylinder liner and rotate it back and forth with expander tool 9511 while pressing down at the same time.

3. Pull out the cylinder liner and check the contact pattern.

4. Minor defects can be rubbed off with grinding paste, which is applied to the underside of the cylinder liner collar. Use expander tool 9511 and press down. Fit the cylinder liner in position and rotate it back and forth. Clean thoroughly, recheck and if necessary repeat the grinding.





Use of special milling tool 9551

Before grinding the cylinder liner seat, measure the cylinder liner height in order to calculate the compensation space for removed material.

1. Use the dial indicator and note the measurement. Assume, for example, that the seat has sunk a bit and is 0.12 mm.

2. Remove the cylinder liner. Establish the damage. As an example of how to estimate this, let us assume that a milling of 0.20 mm would be suitable.

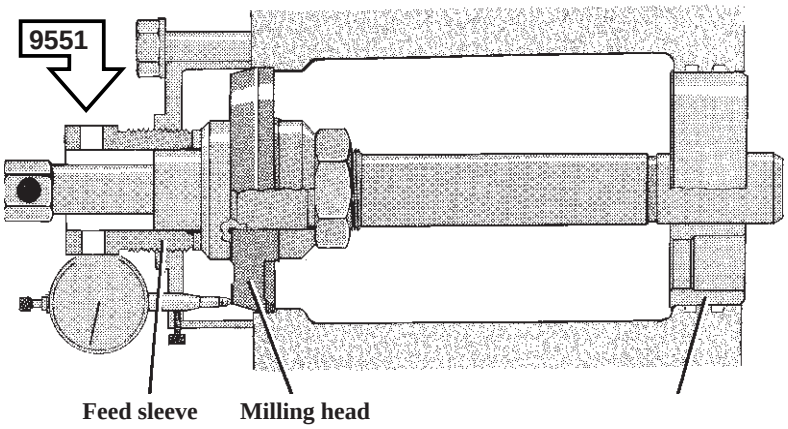
3. Before setting up the milling tool, roughen up the liner seat with emery paper.

4. Fit the used O-ring at the lower cylinder liner seal to ensure accurate centering of the milling tool.

5. Remove the small fillet in the bottom of the cylinder liner seat, if this has not been done already.

6. Use milling tool 9551, which is bolted onto the cylinder block. Use suitable flat washers under the bolt heads. Make sure the feed screw does not press against the tool and that the washer under the feed screw is clean and greased.

7. Set up the dial indicator as shown in the Fig. Screw down the feed sleeve to exert light pressure on the milling head. Zero-set the dial indicator.



Example how to calculate shim thickness and machining depth

A. Read-off the cylinder liner height (from the dial indicator, assumed to be 0.12 mm). The cylinder liner is thus 0.05 mm too low compared to the recommended measurement 0.14–0.20 mm.

B. Damage depth estimated at 0.20 mm.

C. Total of the two values: 0.25 mm.

D. An 0.30 mm shim will give a final height of 0.17 mm, if 0.25 mm is milled off.

Shims are available in thickness of 0.20, 0.30 and 0.50 mm.

Not more than one shim may be fitted under the cylinder liner collar.

8. Calculate the milling depth.

9. Use a T-handle and flexible joint to move milling tool 9551 round. Mill round in smooth even movements while turning the feed screw.

10. When the estimated depth has been reached, stop the feed and turn the tool several turns without applying pressure.

11. Check the contact surface of the cylinder liner seat.

    Note: Place the shim on the cylinder liner, NOT in the cylinder block.

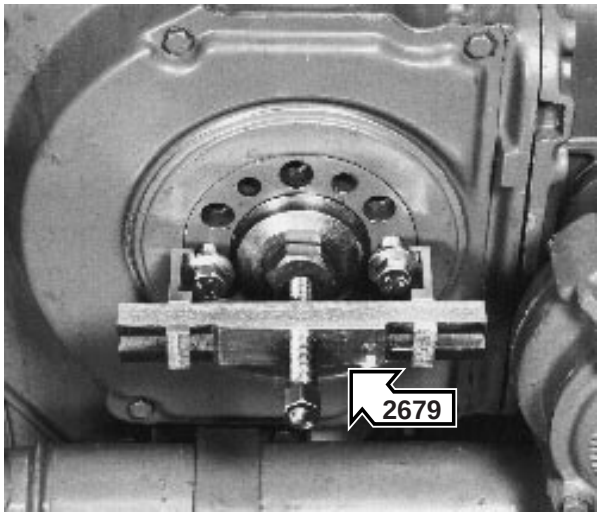
    An upper O-ring will hold the shim in position on the underside of the cylinder liner collar.

Cylinder block, face-milling

Checking

Damage round oil and coolant seals on the cylinder block require repair-milling. The cylinder block can be milled, provided piston height above the cylinder block face does not exceed **0.70 mm**.

The max. piston height must not be exceeded, otherwise the piston will knock against the cylinder head or the valves.



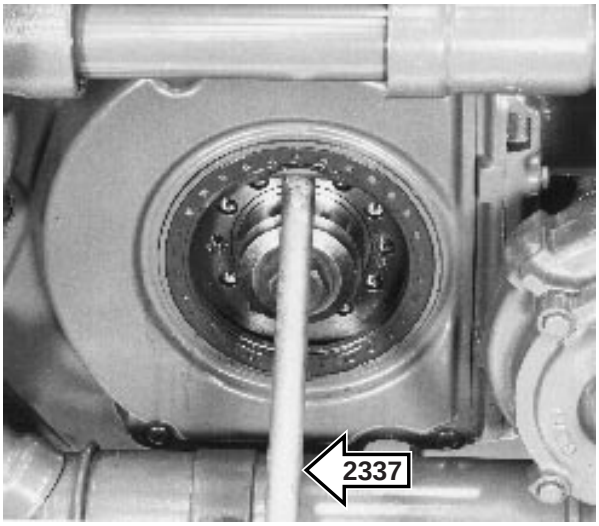
Front sealing ring

Special tools:
(999) 2000 Standard handle
2337 Lever
2679 Puller
8014 Hollow drift

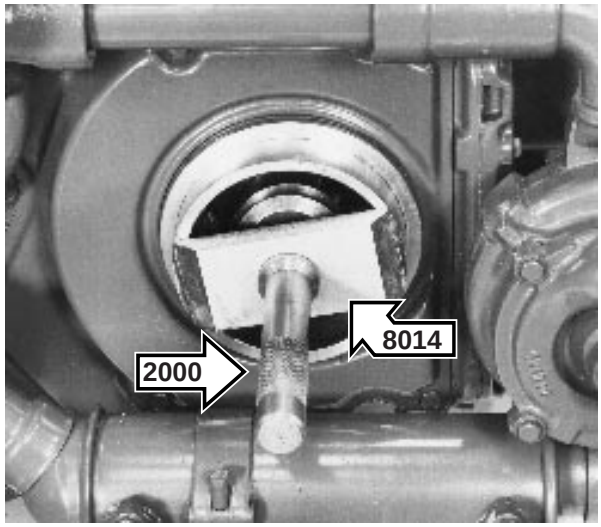
1. Remove the thrust ring.

   If necessary, use puller 2679.

   Tightening torque for thrust ring bolts: **60±6 Nm** (6.9±0.6 kpm).



Removing



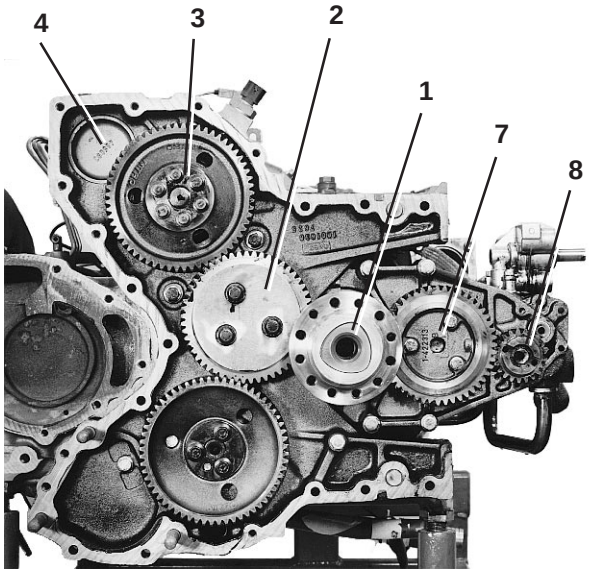
Fitting

2. Place the sealing ring on the press drift before fitting it.

3. Grease the seal lips.

4. Fit the dust cover.

Timing gears



1. Crankshaft gear
2. Intermediate timing gear
3. Injection pump drive gear
4. Power steering oil pump drive gear
5. Camshaft gear
6. Space normally occupied by air compressor drive gear
7. Intermediate oil pump gear
8. Oil pump gear

Replacing/removing timing gears

Special tools:
(999) 2337 Lever
2658 Puller
2659 Press tool
8068 Crank tool
4706 Stop
6600 Hydraulic cylinder
6222 Hydraulic pump
6796 Hollow drift
6603 Die
6413 Extension

1. Fit crank tool 8068 on the flywheel and crank until No. 1 cyl. pistion is at top dead centre, compression stroke (0° on flywheel).

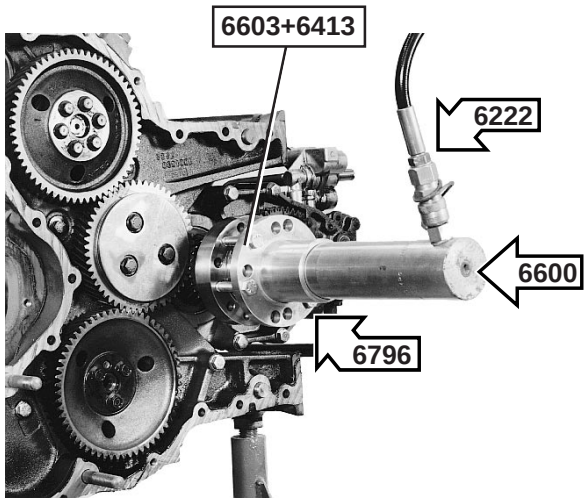
– Lock the crankshaft temporarily with stop 4706.

Check line-up marking on gear wheels before removal.

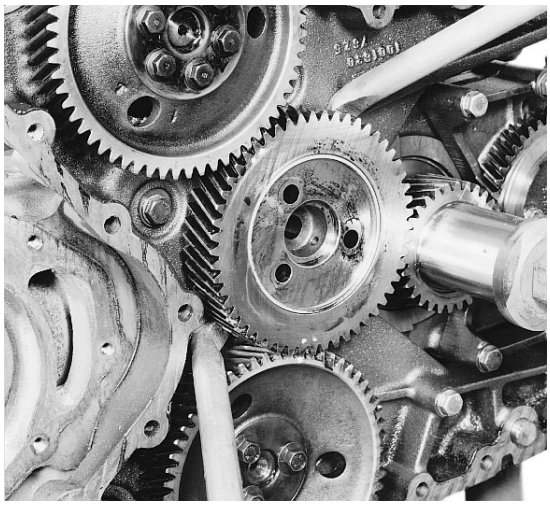
Remove:

– rocker arm cover for no. 1 cylinder
– oil sump
– front drive pulley, vibration damper
– timing gear cover

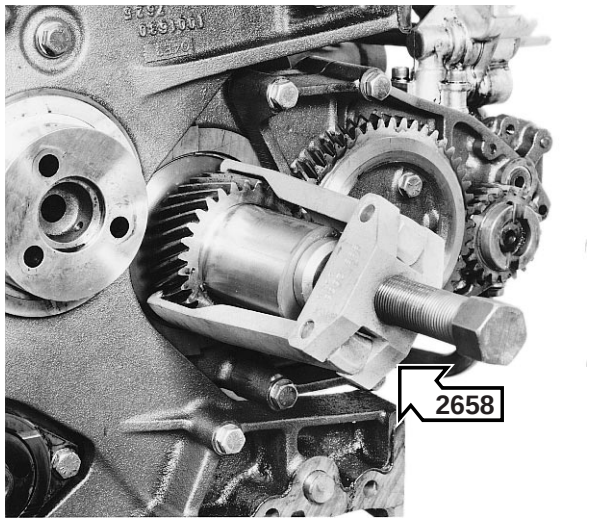
2. Removing polygon hub.



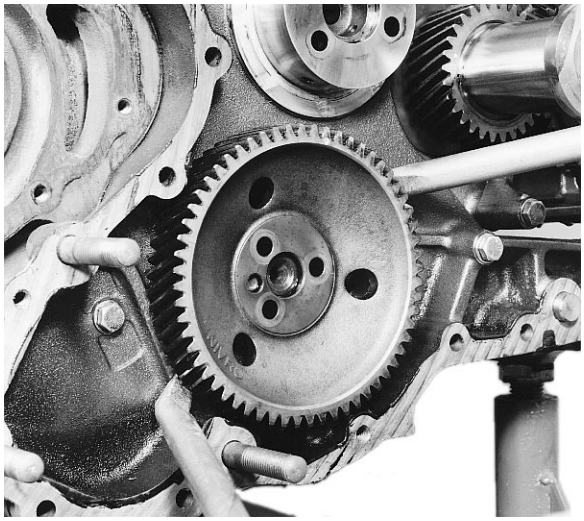
3. Release the intermediate gear using lever 2337.



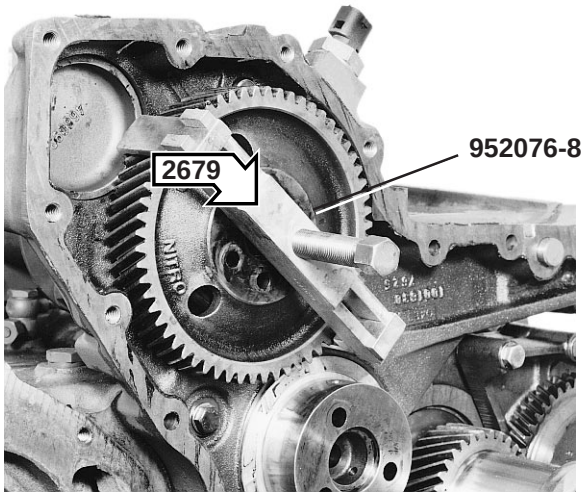
4. Pull off the crankshaft drive gear with puller 2658.



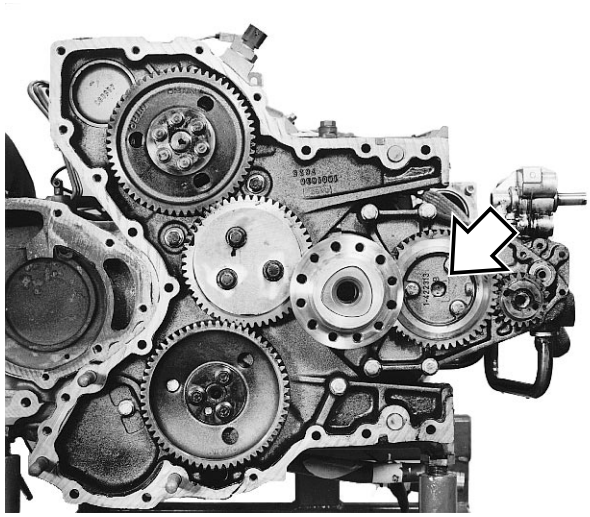
5. Camshaft drive gear.



6 Injection pump drive gear. If necesssary use standard puller 2679 with hex socket screw 952076-8.



7. Remove the oil pump intermediate gear.



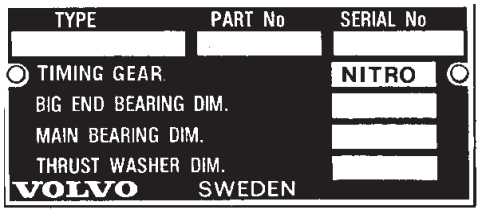
Replacing timing gears

When replacing the compressor and/or the power steering pump on a factory overhauled engine, it is important to check the data plate to make sure which type of timing gear was installed at the overhaul.

A nitro-carburized gear (“N”) must not mesh with a hard-tough gear (“HT”), but on the other hand, a case-hardened gear (“CH”) can be combined with a nitro-carburized gear (“N”).

Avoid combination “N”/“HT” when replacing timing gears on earlier engines.

Nitro-carburized gears are easily recognized by their flat grey to grey-yellow colouring. Moreover they are marked either with a white spot, or an “N” or “Nitro” punched into the gear.

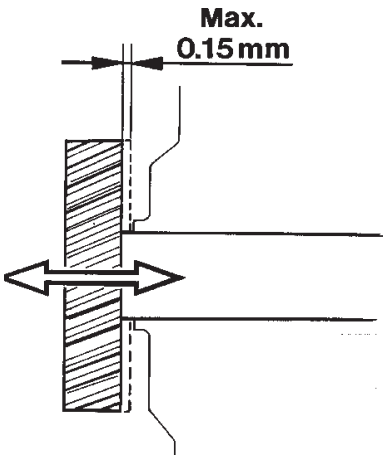


Timing gears
Checking

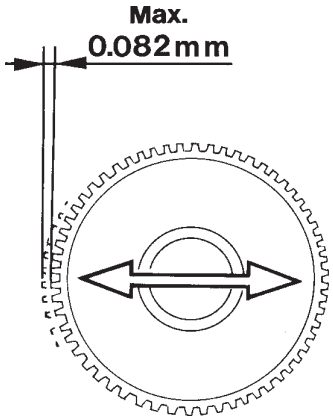
Check all clearances when fitting the timing gears.

Axial clearance for all intermediate gears: **max. 0.15 mm**.

Check the key-way in the crankshaft for damage and that it sits correctly in the crankshaft groove.

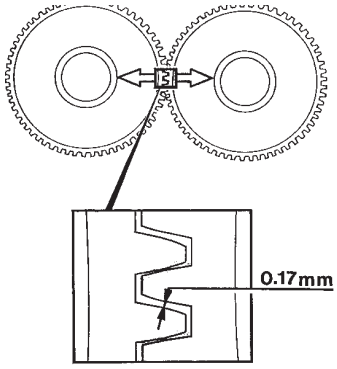


Radial clearance for all intermediate gears: **max. 0.082 mm.**



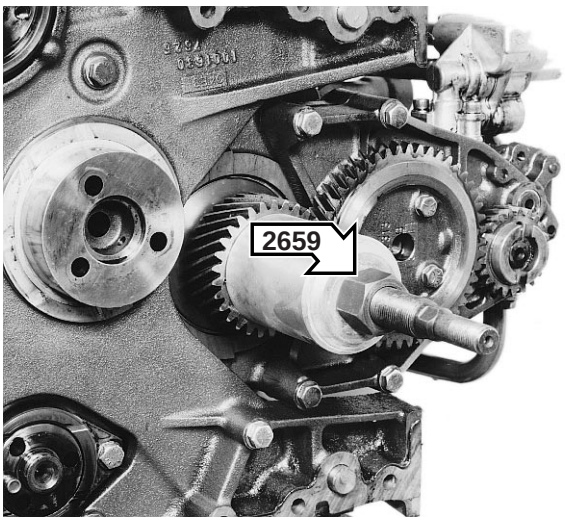
Checking

Check the timing gears. Replace worn or damaged gears. Backlash must not exceed 0.17 mm.



Timing gears
Installing

1. Make sure the crankshaft crosskey is fitted in position.Use tool 2659 and fit the crankshaft gear.



2. Make sure the camshaft drive gear guide pin is in position. Fit the camshaft drive gear. Then the intermediate gear. Ensure that the line-up marks on the intermediate gear, the crankshaft gear and the camshaft drive gear coincide.

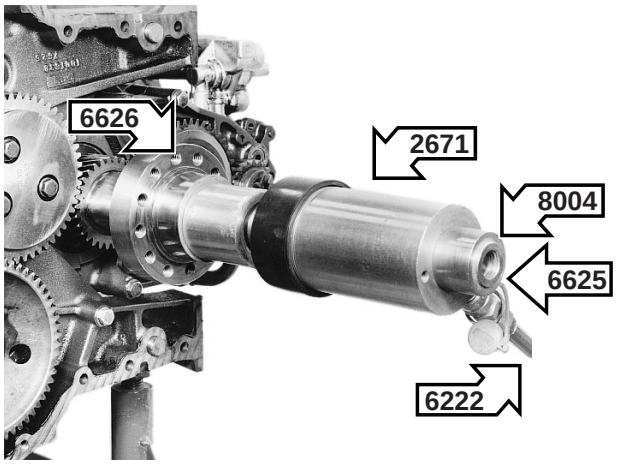
3. Fit the injection pump drive gear.

4. Tighten the gear wheel bolts to the following torque:

	Nm	kpm
Gear, camshaft (M-thread)	60±5	6.0±0.5
Gear, injection pump drive (M-thread) 6 bolts	33±4	3.3±0.4
Intermediate gear journalling	60 $^{+10}_{-5}$	6.0 $^{+1.0}_{-0.5}$
Oil pump intermediate drive gear	22±3	2.2±0.3

Pressing on crankshaft hub (polygon hub)

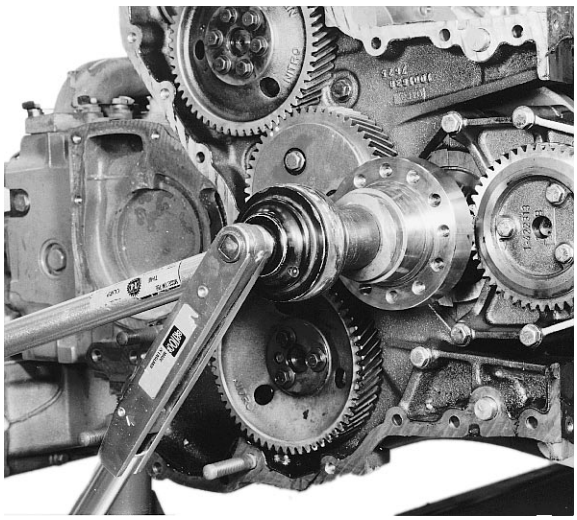
1. Smear the crankshaft end with molybdenumndisulphide grease before pressing on the crankshaft hub.



2. Temporarilly lock the crankshaft with stop 4706.

3. Fit the crankshaft hub centre bolt and washer. Tighten the centre bolt to 560±30Nm (56±3 kpm).

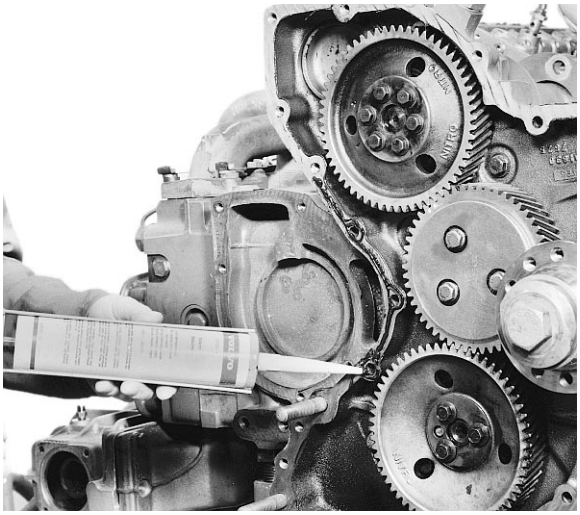
   If torque multiplier 9711 is used, the tightening torque will be 140 Nm (14 kpm).



Sealant for timing gear cover

Sealing agent Volvo P/N 1161231-4 is used instead of a gasket.

The sealing areas must be thoroughly cleaned before applying the sealant. Allow the sealing surfaces to dry. Apply an even bead of sealant about 1.5 mm in diameter. Best result is with a 1 mm nozzle hole.



Fit the cover and bolts. Tighten the bolts to a torque of **50 Nm (5 kpm)**, and then the sound baffle.

Note: The injection angle should always be checked/ adjusted after working on the timing gears.

Injection pump drive mechanism

Replacing seal, output shaft

Special tools:
(999) 6640, 8011, 8012

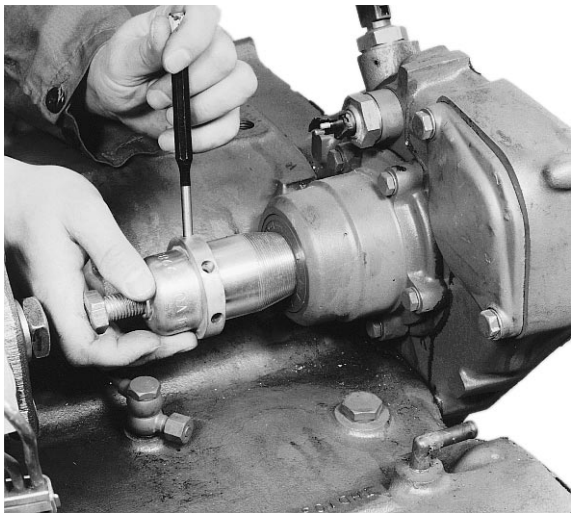
The injection pump and the pump coupling must first be removed (applies only to DH10A, 345, 360) in order to replace the sealing ring on the injection timer/drive mechanism.

For the DH10A, 245, 285 and 350 it is enough to remove the pump coupling.

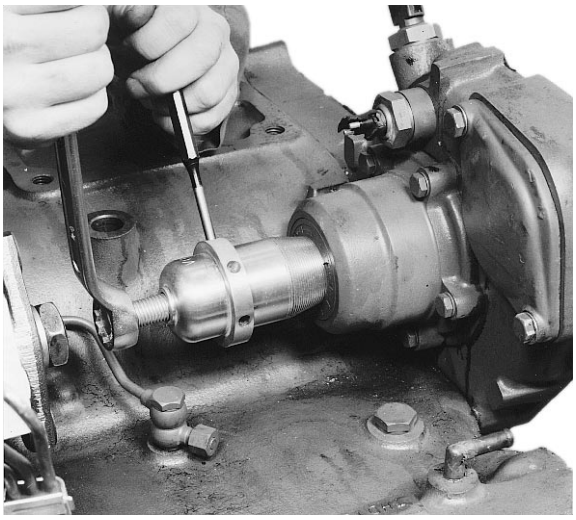
> Never try to bend or allow the fuel and delivery pipes to be deformed. This could cause cracks and result in leakage.

1. Fit drift 6640 in extractor 8011. Turn the drift with the bottom hole facing the extractor bolt.

2. Screw the extractor into the seal with the help of a drift. Press on the extractor at the same time so that the threads cut into the steel ring.



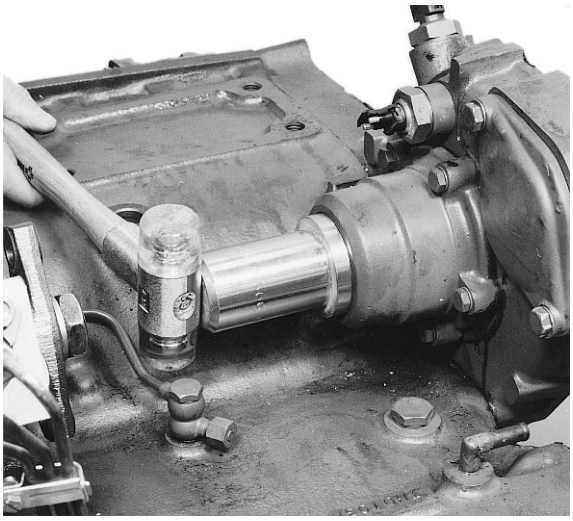
3. Pull out the old seal by screwing down the extractor. At the same time hold tight the extractor with the drift.



4. Oil the new seal and injection timer shaft.

5. Fit the sealing ring on the shaft and tap it in until it is flush with the bearing housing.

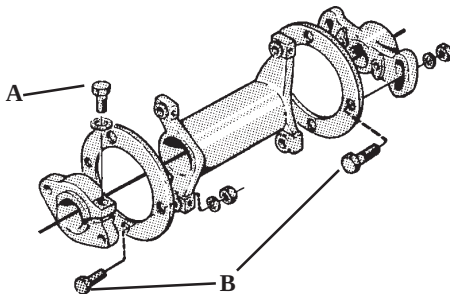
   Use drift 8012.



6. Fit the flange, pump coupling and injection pump.

   See next page under point 3.

7. Set basic timing and check the injection timing.

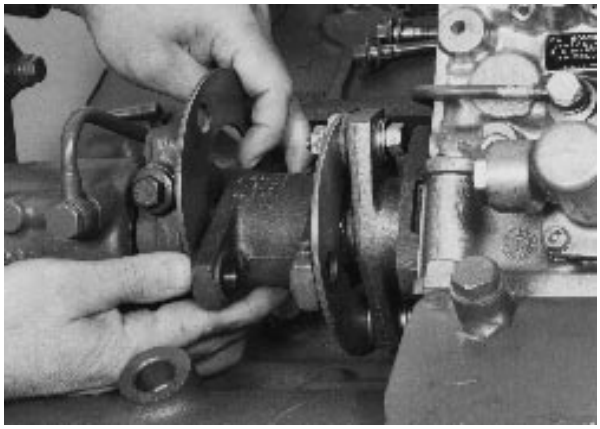


NOTE!
Because the drive mechanism does not have a wedge at the front flange, it is most important that the clamp bolt is tightened to the correct torque:

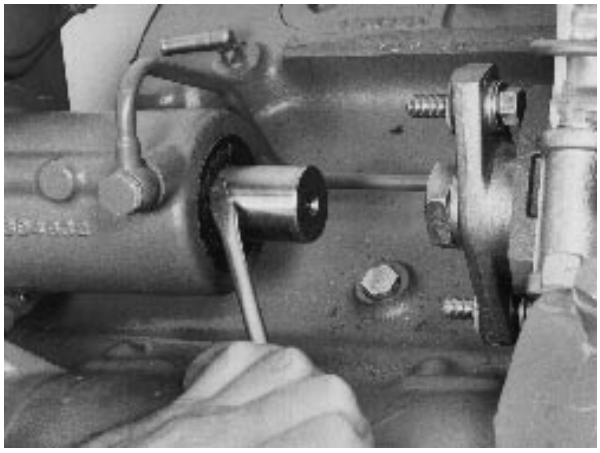
Tightening torque	**Nm**	**kpm**
Clamp bolt (A)		
M11	90±5	9.0±0.5
M12	114±10	11.4±1.0
Flange bolt (B)		
M10	62±5	6.2±0.5

Seal replacement alternative method DH10A, 345, 360

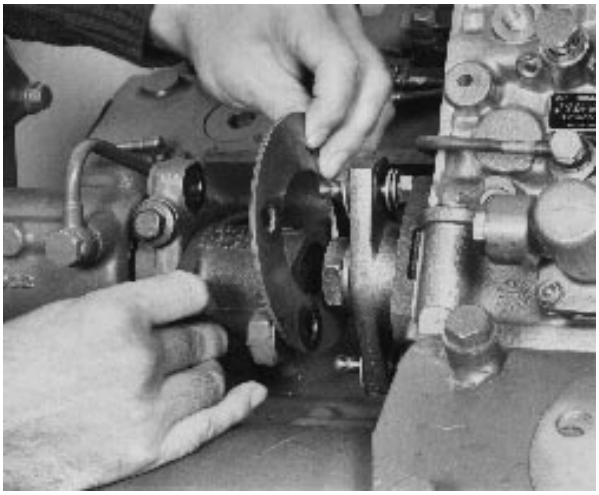
1. Release the clamp bolt. Remove the bolts and washers. Take off the front discs first. Remove the shaft.



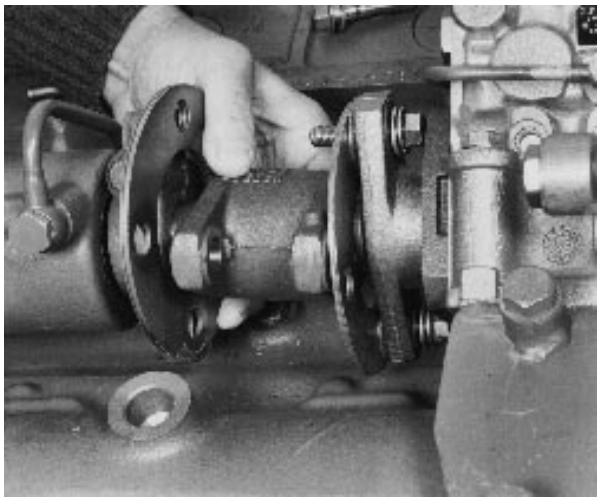
2. Tap out the sealing ring using a screwdriver.

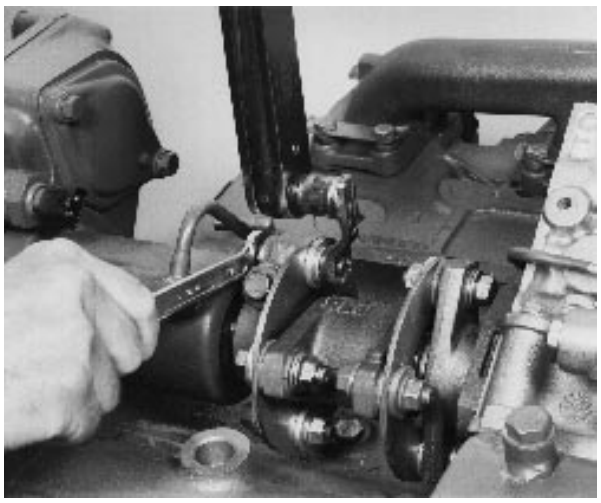


3. Fit a new sealing ring.
   Fit the shaft and the rear discs.

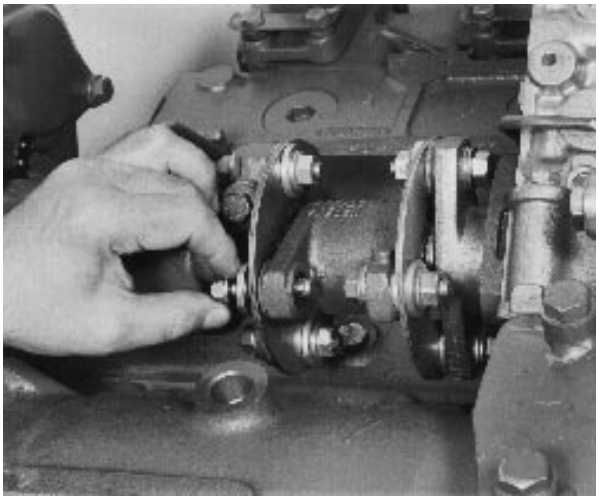


4. Fit the front discs.

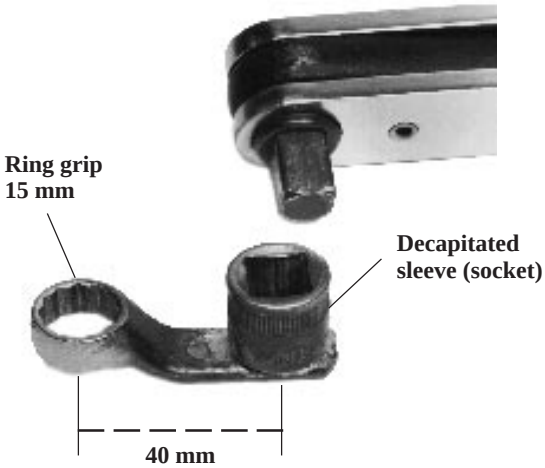




5. Fit the bolts and washers as shown in the figure.



6. To torque tighten the bolts properly, a tool like the one shown here should be made by the workshop.



7. Tightening torques:

	Nm	kpm
Clamp bolt	114±10	11.4±1.0
Flange bolt	62±5	6.2±0.5

NOTE! Torque will be 4% greater if above workshop-made tool is used.

Tightening torque
with special tool:

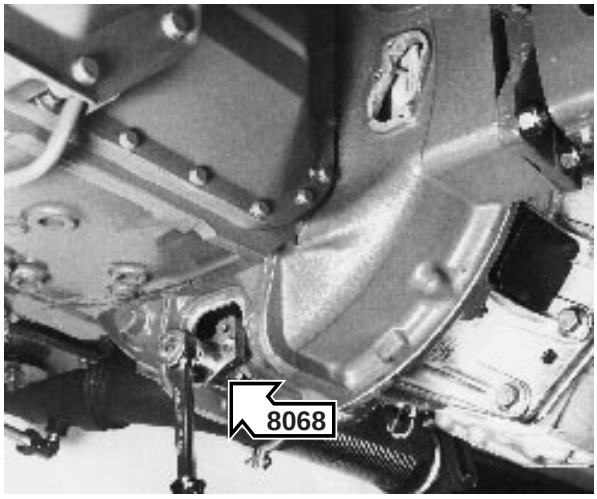
	Nm	kpm
Clamp bolt	110	11.0
Flange bolt	59.7	6.0

8. Check basic timing, see page 97.

Injection timer, removing/installing DH10A, 345, 360

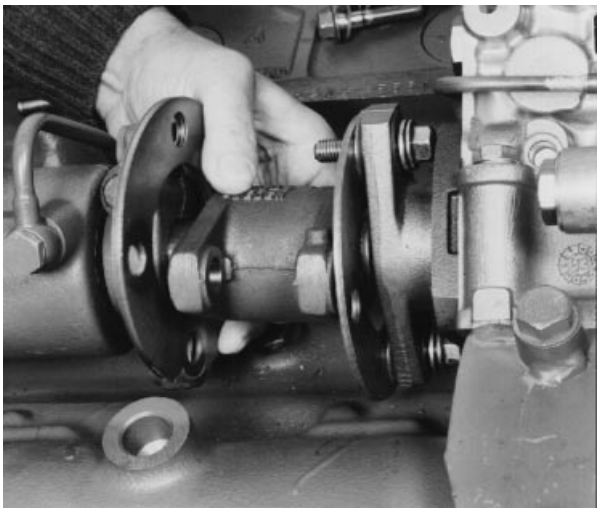
Special tools:
(999) 8068 Crank tool
2679 Puller

1. Crank the flywheel in its direction of rotation to where no. cyl. piston reaches top dead centre after compression stroke (0° on flywheel and both no. 1 cyl. valves closed).



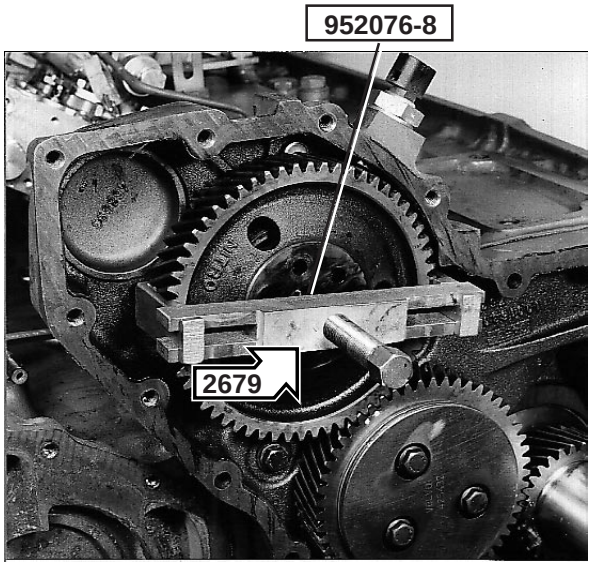
2. Remove the intermediate piece and the flange bolts. Release the clamp bolt on the front flange nearest the injection timer and remove the flange.

   Do not crank the injection pump or engine.



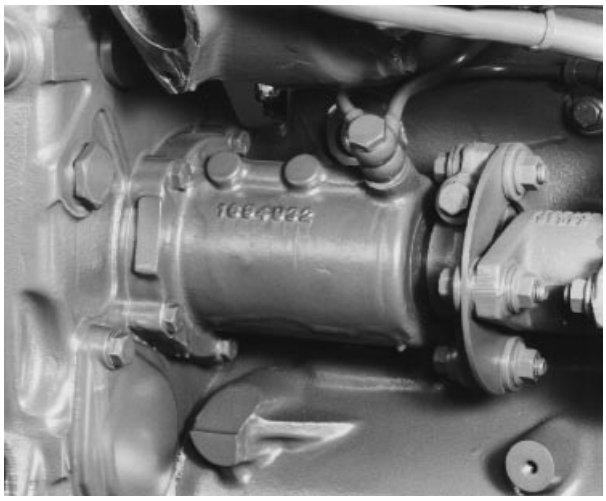
3. Remove the drive belts, pulley, vibration damper and timing gear cover.

4. Remove the injection timer drive gear bolts and lift off the gear (with stiff removal, we recommend use of a standard puller 999 2679 together with in-hex plug socket to pull off the gear).



5. Disconnect the delivery oil pipe between the timer and the cylinder block. (With installation, use new copper gasket.)

6. Remove the retaining bolts and lift out the timer.



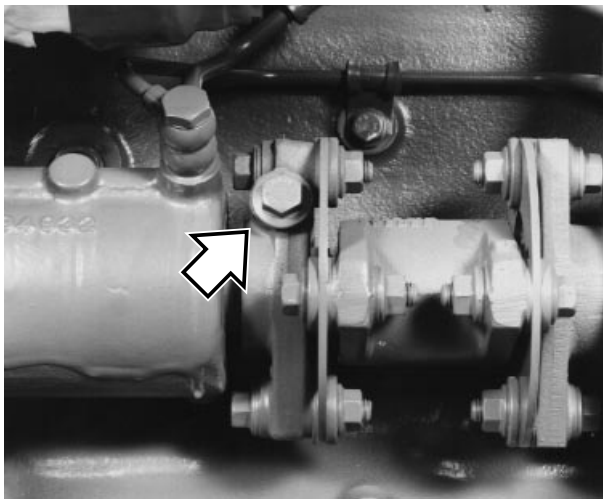
Installing

Note the following…
The sealing surface between the timer and the timing gear casing must be clean. Fit a new sealing ring on the timer.

The six bolts on the injection timer gear should be tightened to a torque of **33±4 Nm.**

The flange discs are M10-tightened to a torque of **62±5 Nm.**

Before tightening the clamp unit on the flange to the correct torque **114±10 Nm**, check the injection pump basic setting, see under "Basic setting injection pump (EDC)".



Replacing camshaft

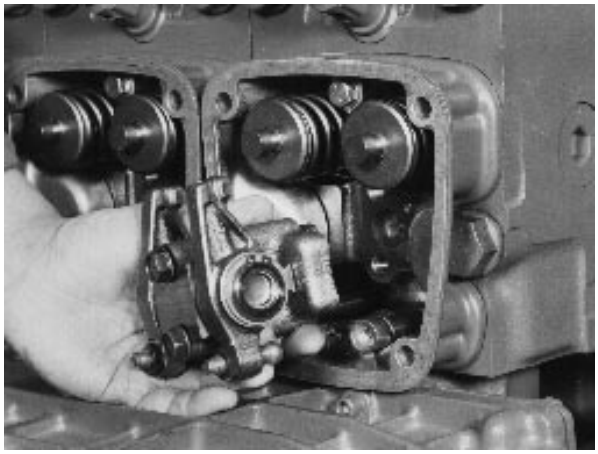
Special tools:
(999) 2337 Lever
8068 Crank tool
8079 Extractor

1. Remove…

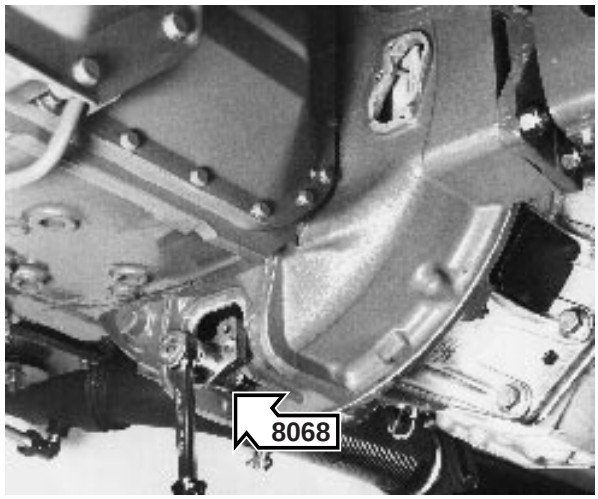
– rocker arm mechanism for all the cylinder heads

– sump

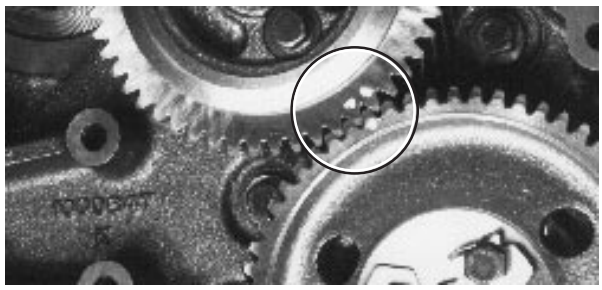
– timing gear cover



2. Crank the flywheel until no. 1 cylinder is at top dead centre, compression stroke.

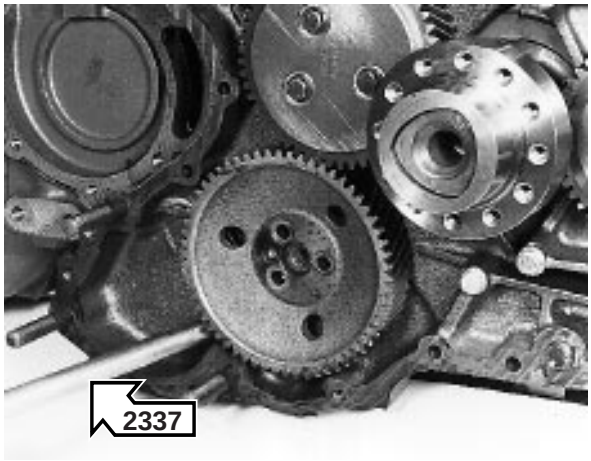


3. Line-up mark camshaft gear position with marking pen.

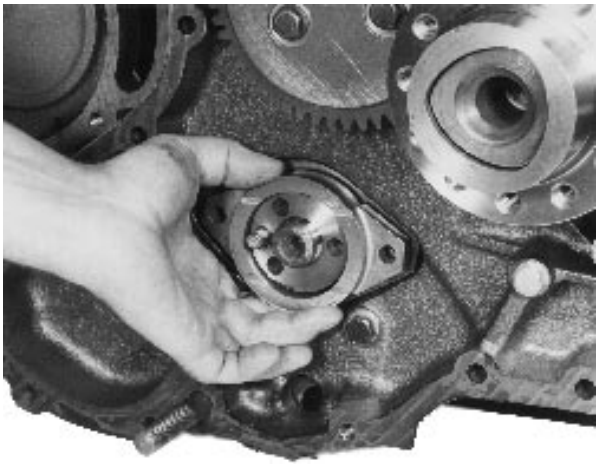


4. The guide pin on the camshaft against cylinder head = no. 1 cyl. piston at top dead centre.

5. Remove the camshaft gear.



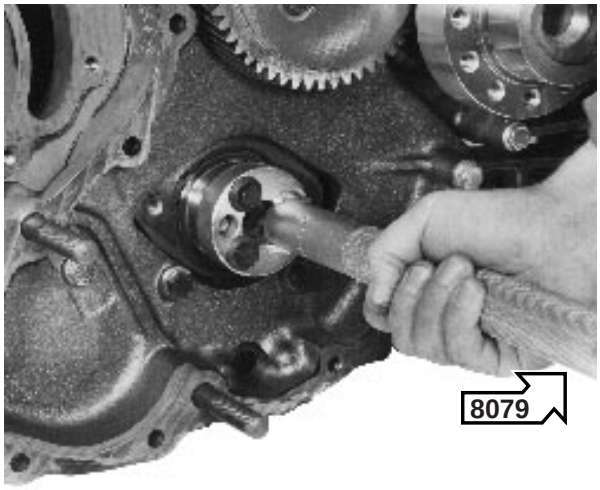
6. Remove the thrust washer.



7. Fit extractor 8079.

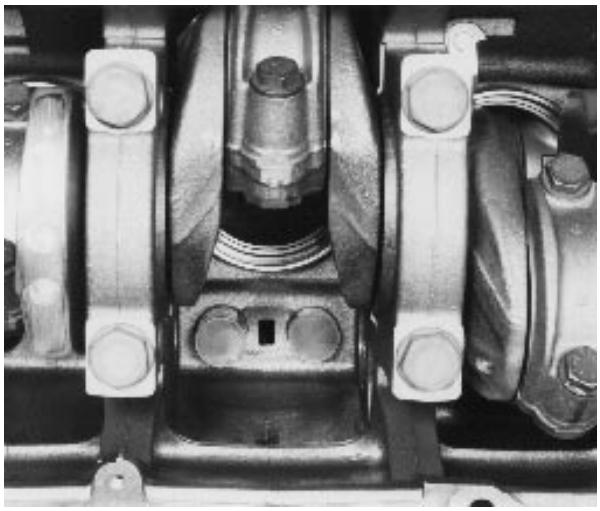
   Crank the camshaft one turn so that the valve tappets are moved aside.

8. Remove the camshaft.



9. Remove the valve tappets.

   Always check the tappets.



Checking

Check cams and bearing races for wear. Cams can wear at an angle. Slight angle wear can be remedied by honing the cams.

With more extensive damage, replace the camshaft. Use a micrometer and measure the wear on the bearing races. Max. permitted wear and out-of-round is 0.05 mm.

Check camshaft straightness with a dial indicator. Max. permitted warp is 0.04 mm. Otherwise concerning measurements for the camshaft and bearings, refer to “Specifications”.

The camshaft bearings are pressed into their seats and thereafter bored. Special tools are required for this. The camshat bearings, therefore, can only be renewed where there is proper equipment for machining the bearings.

When pressing in the bearings, check to make sure the lube holes coincide with the oil drillings in the cylinder block.

Concerning machining measurements, refer to “Specifications”.

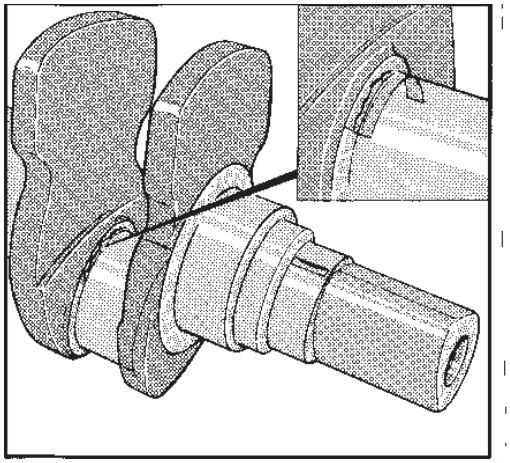
Tightening torqe	**Nm**	**kpm**
Bearing brackets for rocker arm shaft	40±4	4.0±0.4
Timing gear cover	50±5	5.0±0.5
Sump	18±2	1.8±0.2
Sump cover	24±2	2.4±0.2
Thrust washer, camshaft	40±4	4.0±0.4
Camshaft gear (M-thread)	60±5	6.0±0.5

Crankshaft

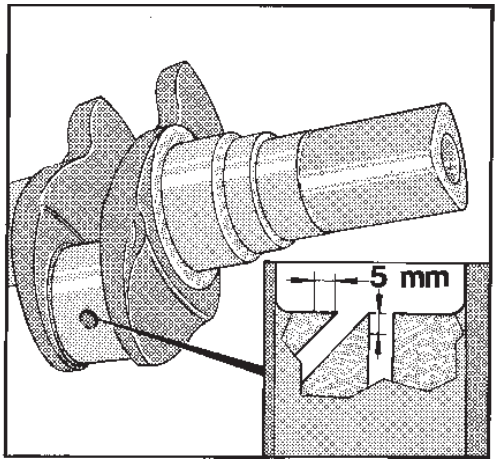
Checking

Prior to any machining, check the crankshaft for cracks. Seizure can cause overheat cracks, which can only be detected by using special equipment. The recommended test involves using a magnetic powder, type MAGNAGLO, which is fluorescent and is scrutinized under ultraviolet light. For powder type, concentration, current and magnetizing, follow the instructions of the manufacturer. See also below the types of cracks that can occur.

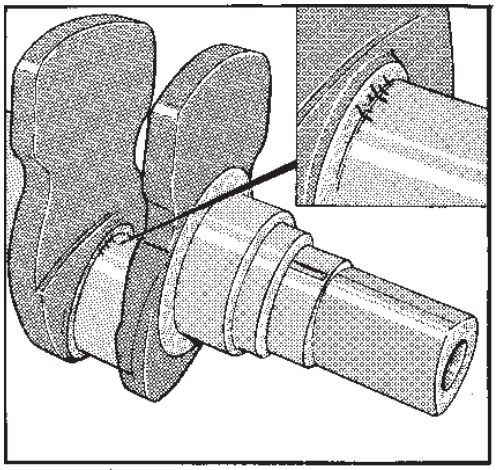
Renew crankshaft if…



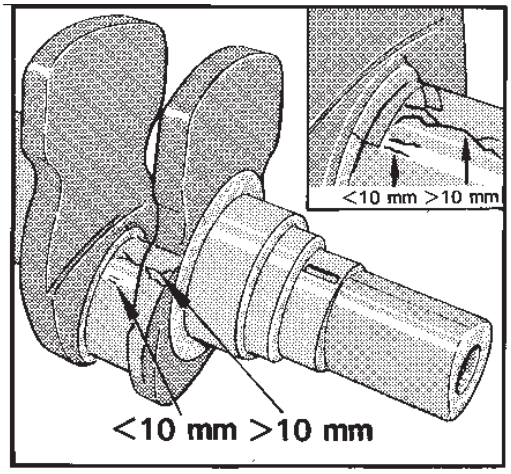
…fillets have these types of cracks



…or the crack is further than 5 mm from the lube drilling. Cracks nearer the lube drilling can be removed by machining.

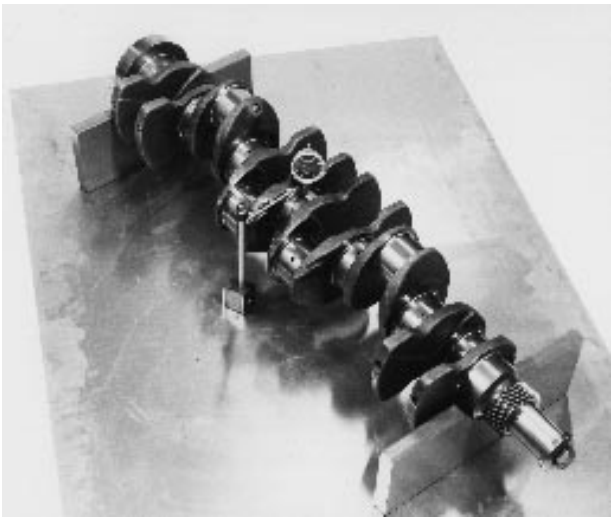


…or there are longitudinal cracks within the areas marked here.



…or when a crack is less than 10 mm outside the area marked here.

Individual cracks within 10 mm are acceptable.

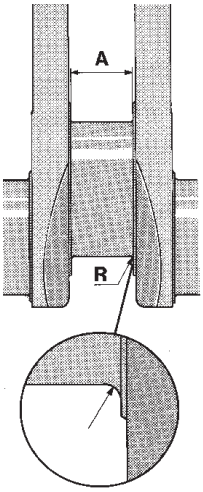


Straightening the crankshaft

To assess straightness, the crankshaft must be supported under main bearings 1 and 7 and main bearing 4 checked for out-of-round.

Below 0.2 mm	No straightening.
Between 0.2 and 0.7 mm	Careful straightening, not more than necessary.
Above 0.7 mm	Replace crankshaft.

Straightening reduces fatigue resistance and should therefore be avoided. The nitro-carburized bearing surface has a tendency to crack at the fillets between the bearing races and the webs.



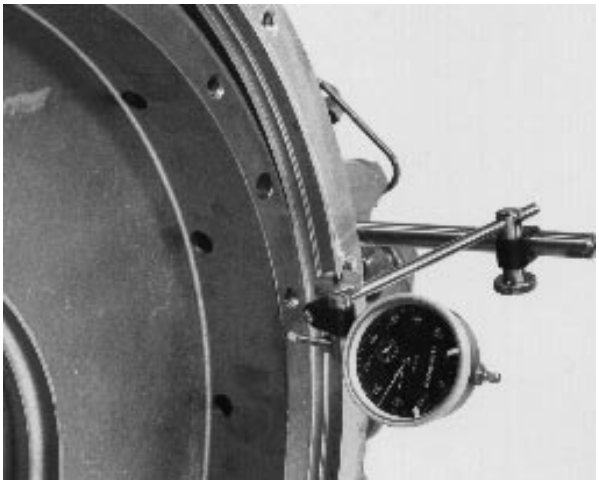
Machining

Damaged bearing surfaces should be lapped. If this is not enough, replace the crankshaft or machine it. A nitro-carburized crankshaft must be be ground more than to **second undersize**, unless the nitro-craburizing treatment is repeated. After treatment, bearing surfaces and fillets should be lapped to a surface finish of 0.002 mm.

Grinding nicks or sharp edges are not permitted, as they may cause fracture. The width measurement “A” for the pilot bearing is particularly important. Refer to “Specifications”.

After machining, thoroughly clean the crankshaft. Recheck for cracks, using the magnetic power test method and de-magnetize. Clean and flush all oil drillings.

NOTE!
It is most important that the fillets are ground to the right shape and size. They should be between 3.75–4.00 mm. Use a radial template for the measuring.



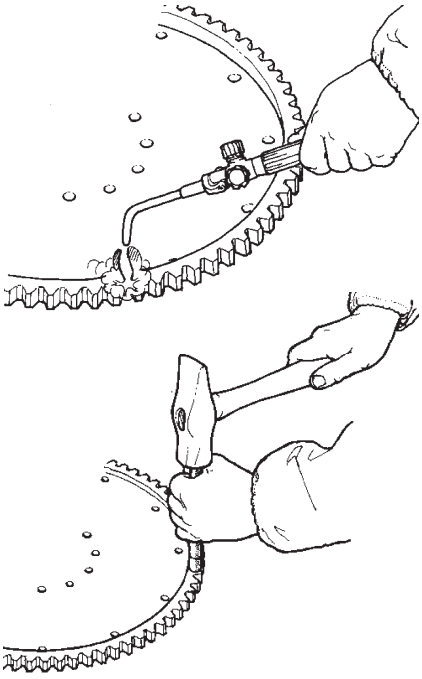
Measuring radius 150 mm

Flywheel

Checking

Crank the flyhweel to get max. throw. It must not exceed 0.15 mm.

If the throw is greater than this, remove the flywheel and check the contact surfaces for dirt or unevenness.



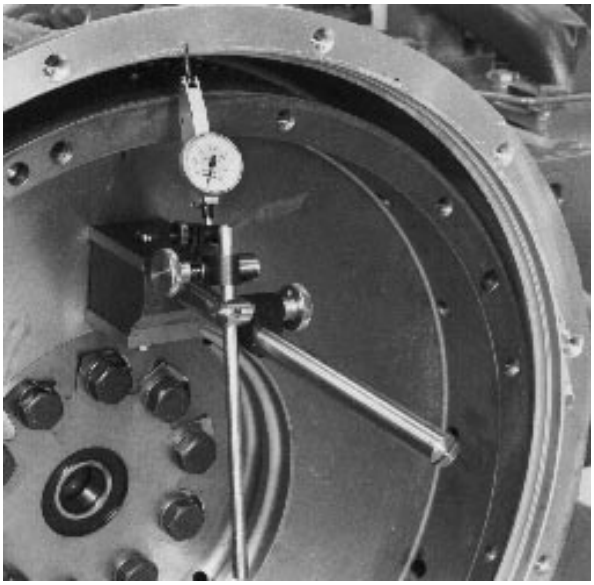
Fitting the ring gear

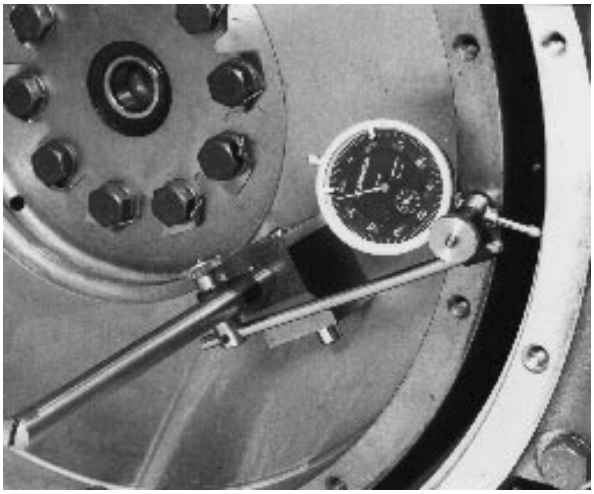
Replacing ring gear

1. Punch holes in the ring gear tooth gaps with a chisel. Crack the ring gear at the punched hole. Brush clean the contact surface.

2. Polish the ring gear to a shine at several points round the ring. Evenly blue-anneal heat the polished sections.

3. Quickly place the heated ring gear on the flywheel and tap it into position with a soft drift.





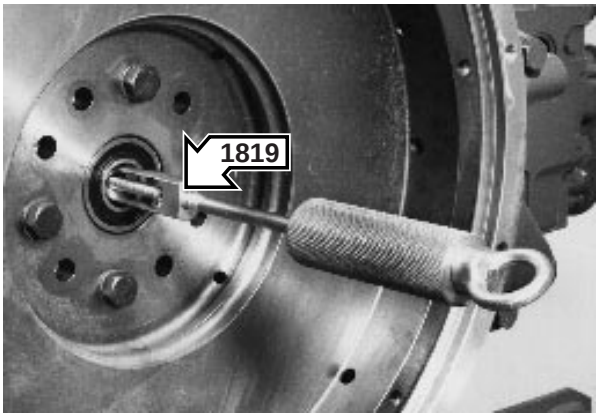
Flywheel casing

Checking

The flywheel contact surface against the clutch casing should be square to the crankshaft within 0.15 mm.

Its inner edge should be concentric with the flywheel within 0.25 mm.

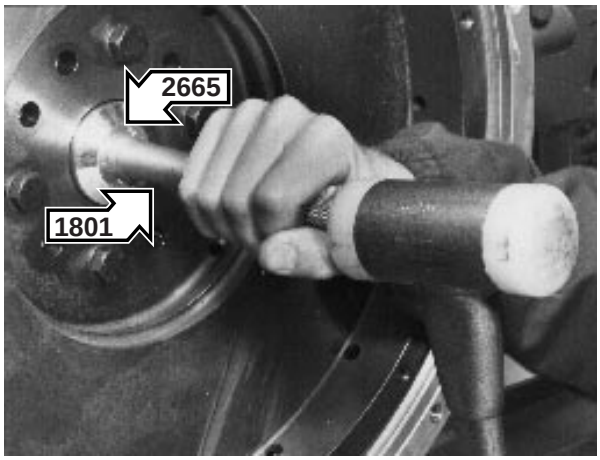
With excessive dial indicator reading, check the flywheel casing contact against the cylinder block.



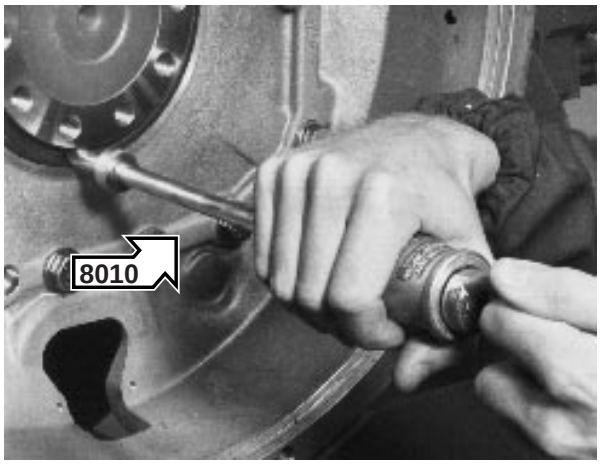
Replacing support bearings

Special tools:
(999) 1801 Standard handle
1819 Extractor
2665 Press tool

1. Remove the support bearing using extractor 1819.



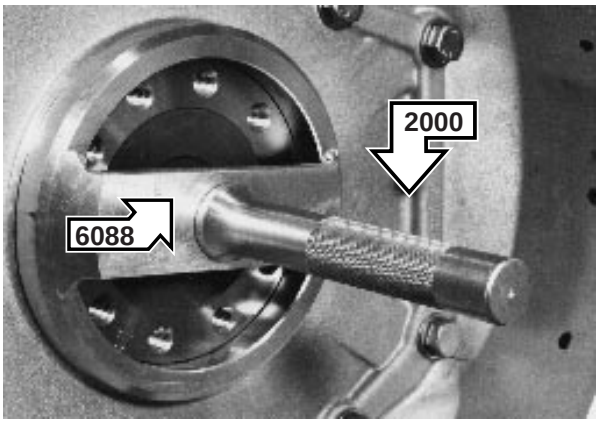
2. Tap in the new support bearing into position in the flyhweel.



Replacing crankshaft rear seal

(Clutch removed)

Special tools:
(999) 2000 Handle
6088 Drift
8010 Extractor



1. Remove the flywheel.
2. Tap out the seal using extractor 8010.
3. Clean the seal seat in the flyhweel casing.
4. Apply gasket sealant (part no. 1161277) to the seal outer circumference and fit the seal.
5. Fit the flywheel. Tighten the flyhweel, or flange disc bolts, to 185 $^{+5}_{-10}$ Nm (18.5 $^{+0.5}_{-1.0}$ kpm).

Group 22

Lubricating System

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– Description 80

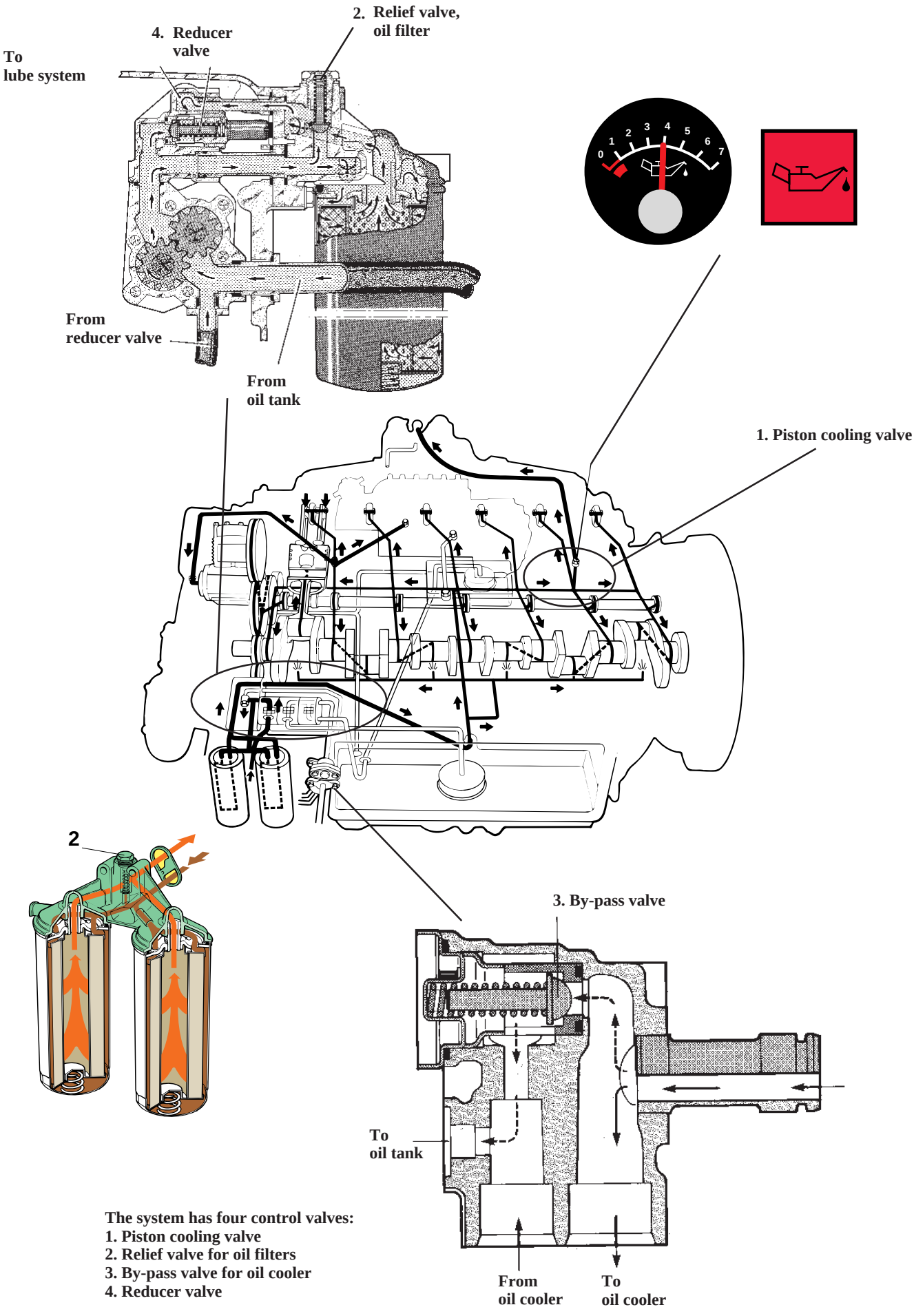
Oil pump

– Removing, installing 83
– Servicing 85

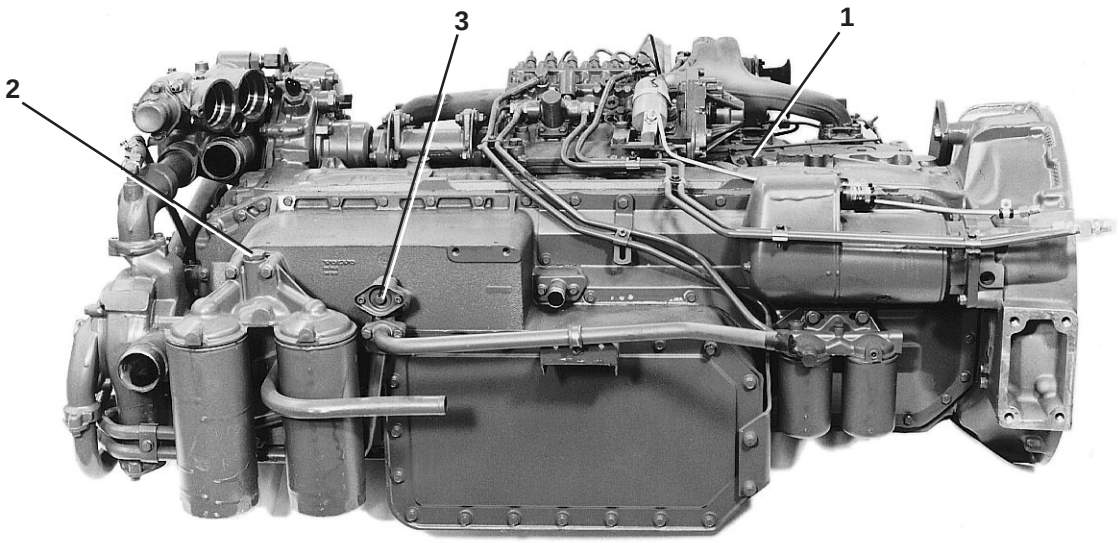
Oil cooler

– Oil cooler 87
– Oil pressure, piston cooling 87

Lubricating system



The system has four control valves:
1. Piston cooling valve
2. Relief valve for oil filters
3. By-pass valve for oil cooler
4. Reducer valve



1. **The piston cooling valve** opens when engine speed has just reached above low idle and oil pressure has increased. The oil is then led by a drilling to the piston cooling duct in the engine block. Six nozzles are connected to the piston cooling duct, one for each piston, and from these oil is sprayed against the bottom of the pistons.

2. **The relief valve for the oil filters** opens if the filters are clogged. This ensures continued lubrication.

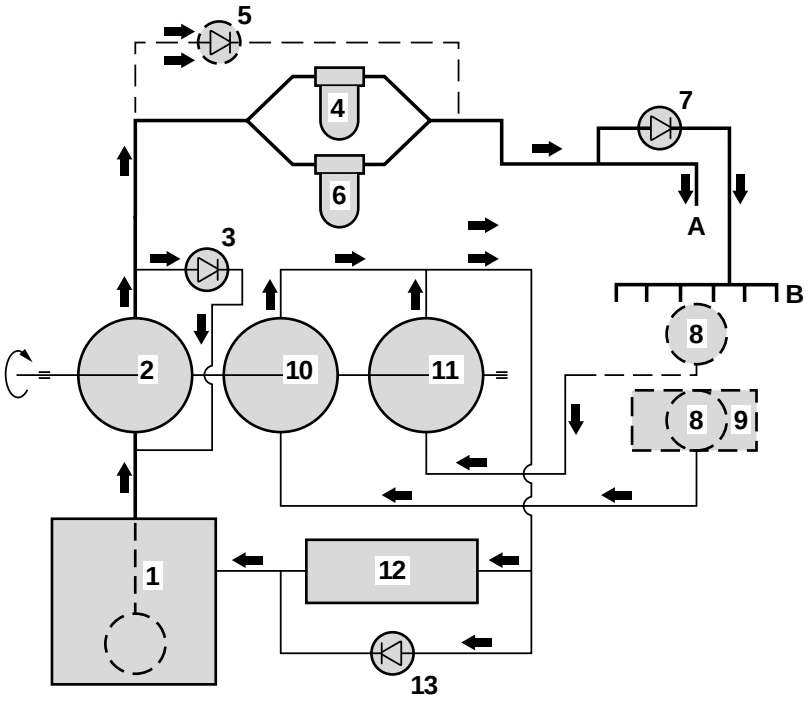
3. **The by-pass valve** opens when the pressure drop across the oil cooler is too high, e.g., at cold start. When the valve opens, the oil by-passes the oil cooler to get more quickly out to the engine lube points.

4. **The reducer valve** opens at excessive lube oil pressure to return the excess oil back to the sump.

The engine is lubricated from a pressure-lubricating system. Since the engine lies horizontally, the oil sump is of the dry type with separate oil tank.

The oil system delivery pump sucks the oil from the oil tank through a strainer. It then pressurizes the oil out to the various lube points in the lubricating system.

Return oil is pumped back to the oil tank by two scavenging pumps.



General layout, engine oil

The oil pump is of the gear type and has three pump units. The front unit functions as an oil delivery pump and the other two as scavenging pumps. They all pump the oil back to the oil tank via the oil cooler. The oil pumps are gear-driven from the crankshaft via an intermediate drive gear.

The lubricating oil filters have “spin-on” type replaceable filter inserts.

The high capacity of the oil pump places greater demands for greater lube oil filtration. It is for this reason that the engines have two full-flow oil filters (direct oil filters and no by-pass filter). The full-flow filters are coupled in parallel for best filtration.Oil pump

drive gearScavenging

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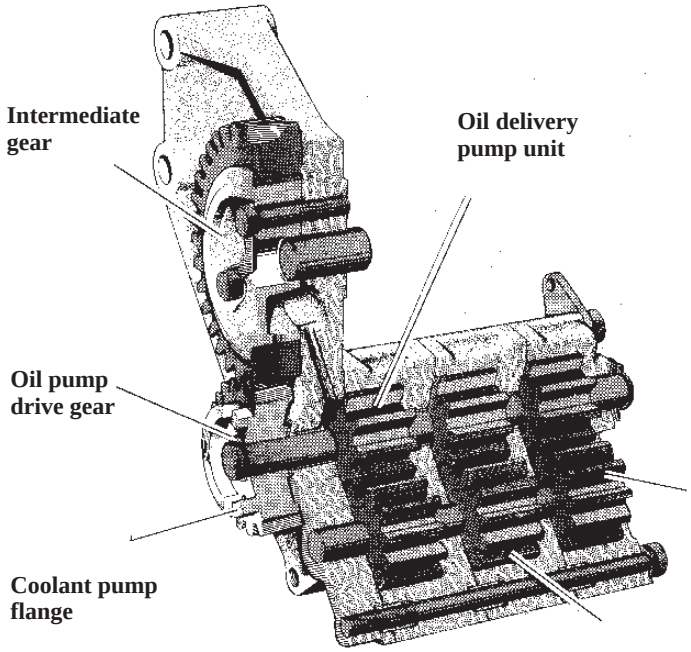
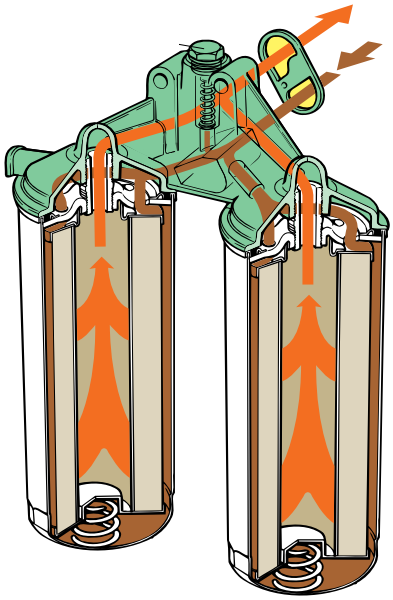


Scavenging pump unit



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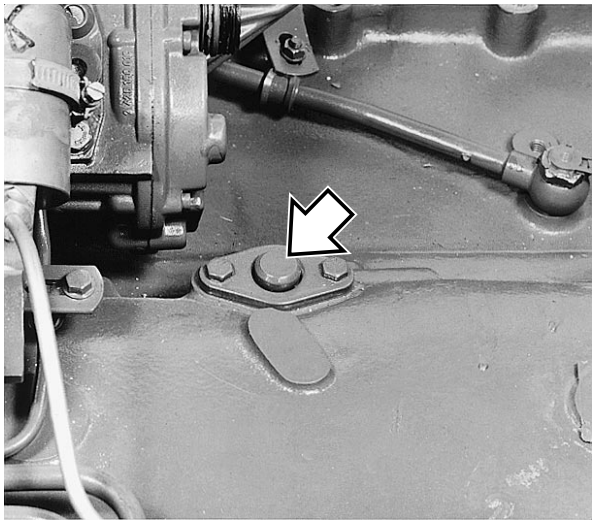


The piston-cooling valve is normally closed at low engine speed, this to prevent the oil pressure from dropping at low idle. As engine speed increases, the piston-cooling valve opens to direct the oil to six calibrated nozzles, one under each piston.

Piston-cooling nozzles

If piston cooling is cut-off, reduced or wrongly aimed, the piston will seize after a relatively short period under load. Oil for the piston cooling does not pass through the oil filters during pressure feed but from the oil tank via the oil pump and on to the piston cooling nozzles.

Therefore, the **greatest possible cleanliness** must be observed in all work connected with the oil tank, suction lines and suction strainers, likewise the piston cooling valves, the nozzles and their ducts.

The piston cooling nozzles must never be straightened or repaired in any other way. If damaged or deformed, they must be unreservedly **replaced** with new ones. Great care should, therefore, always be taken when working on pistons, connecting rods, cylinder liners in piston cooling engines so as not to damage the nozzles.

Clogged piston cooling nozzles **must not be cleaned and re-used,** because of the risk of dirt particles being left in the system. When servicing after piston seizure, **the oil cooling drillings must be blown clean and all the piston** cooling nozzles replaced.

The nozzles aim the oil jets at a carefully selected area inside the piston, see arrow.

Oil pump

Removing

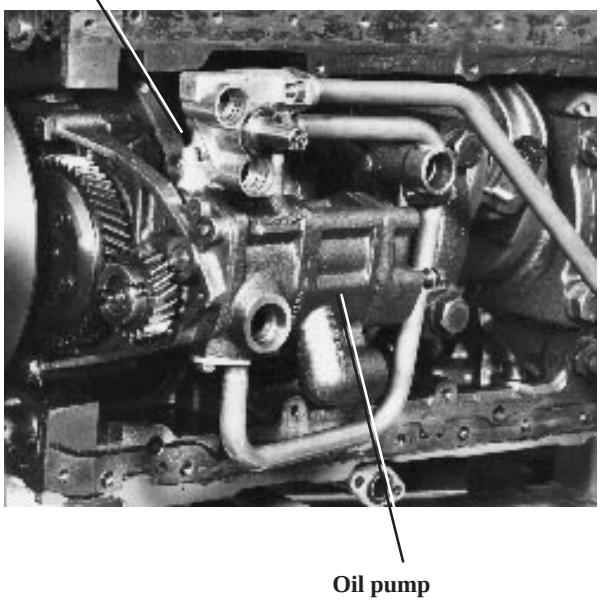
1. Remove the starter motor, oil filters, coolant pump, sump.

2. Remove the suction and delivery pipes from the oil pump, the oil pump rear bracket and housing for the relief valve.

3. Remove the front main bearing cap together with the oil pump.

4. Do not separate the oil pump from the main bearing cap.

   Should it happen that the oil pump has been separated from the main bearing cap, adjust the pump according to the instructions overleaf.



Installing

Special tools:
(999) 2807 Centering tool
6656 Centering tool

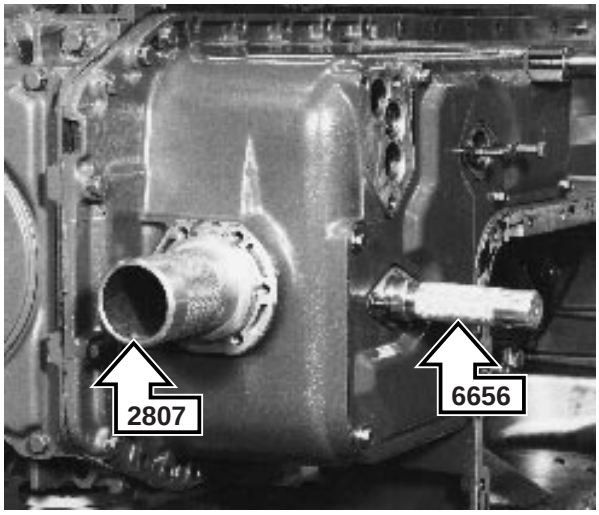
1. Connect up the pipes. Fit the sump.

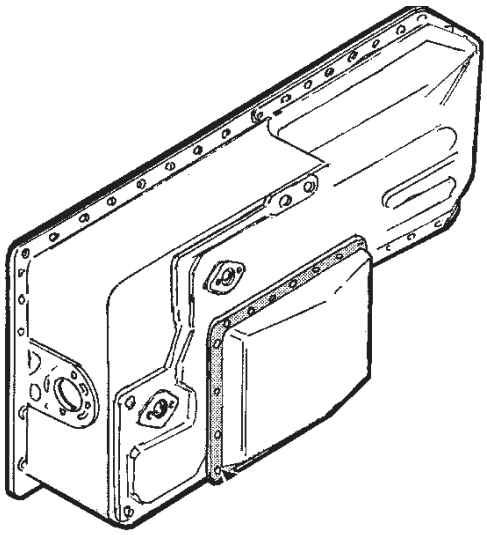
2. Insert centering tool 2807 in the crankcase hole for the drive gear. Insert centering tool 6656 in the crankcase hole for the return oil.

3. Fit and tighten up the sump bolts.

Tightening torque

	Nm	kpm
Main bearings	340±25	34.0±2.5
Sump	18±2	1.8±0.2
Sump cover	24±2	2.4±0.2





Adjusting

Secure the cap in a vice with aluminium jaws (see Fig. below).

Make sure the pump does not lie against the vice.

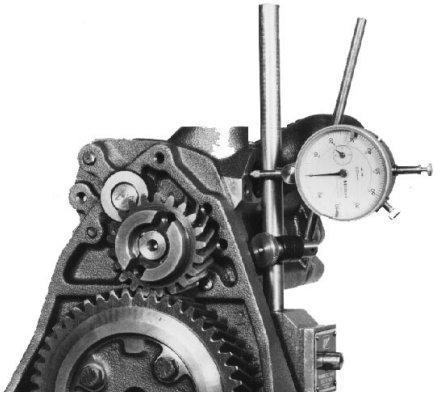
Mount a dial indicator with magnetic foot on the cap and position the probe to right angles to the pump.

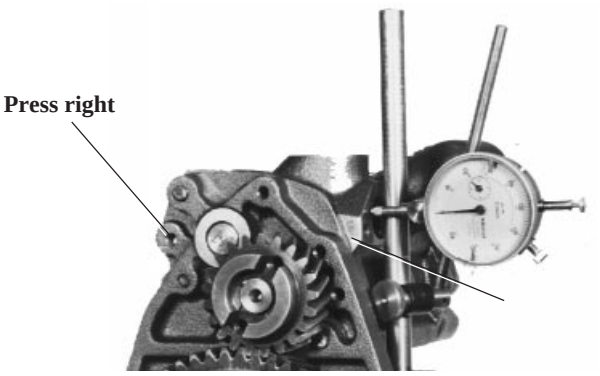
Press the pump to the left. Zero-set the indicator dial.

Press the pump to the right. Read-off the dial.

Press the pump back to half the measured value.

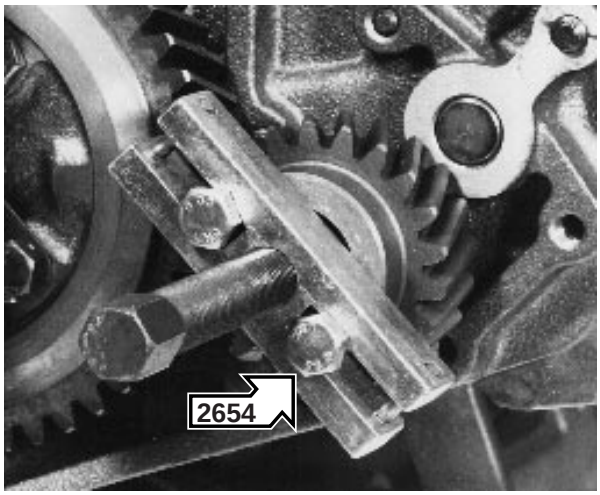
Tightening torque: **40±4 Nm** (4.0±0.4 kpm).





Servicing oil pump

Special tools:
(999) 2654 Puller
6849 Drift
6850 Reamer



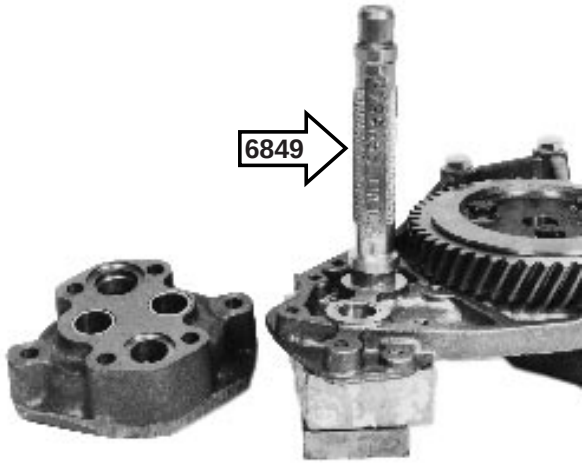
1. Use puller 2654 to remove the oil pump drive gear from the shaft.

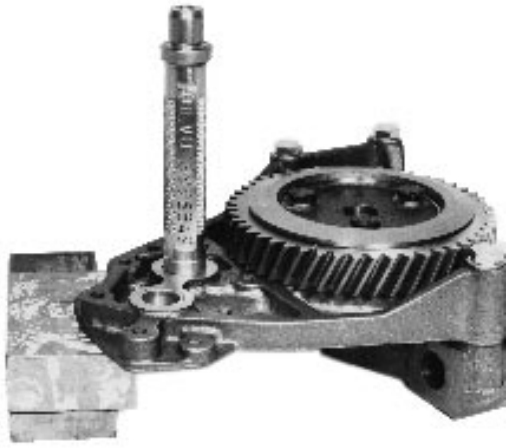
2. Dismantle the oil pump.

Check the pump body for scoring and wear also for leakage signs between the bracket and the pump body. The contact surfaces will be black if there is leakage.

Pressing out/in bushings

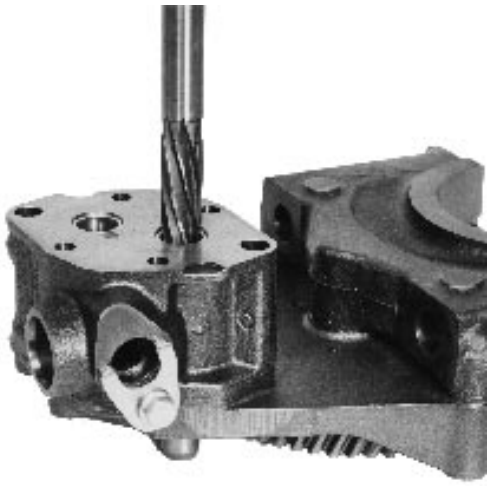
NOTE! The bushings must be pressed in from the "outside", as shown below.

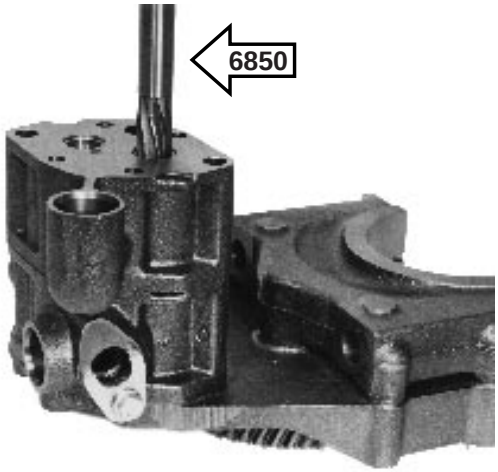




NOTE! The bushings in the middle pump bodies are a bit narrower and must be centered otherwise they will block the oil drillings.

Reaming bushings



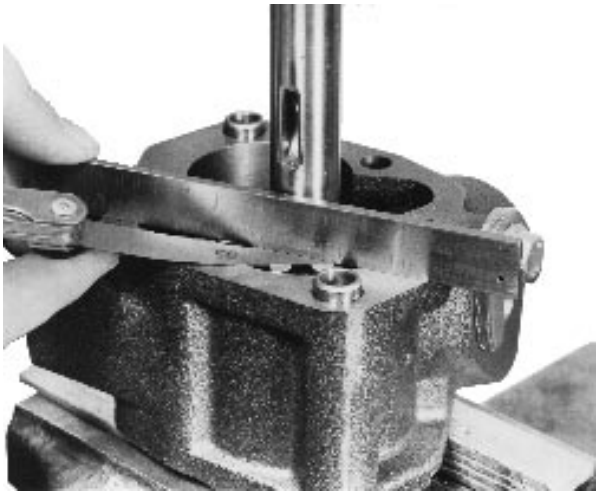


Checking pump gears axial clearance

1. Check the axial clearance for the pump gears.

   Correct clearance: **0.02–0.08 mm**.

   In both cases, place a feeler gauge 1.0–1.5 mm between the pump gear and the bracket.



2. There are two ways in which to fit the oil pump drive gear:

   – Heat the gear to approx. 180°C and tap it into position

   or

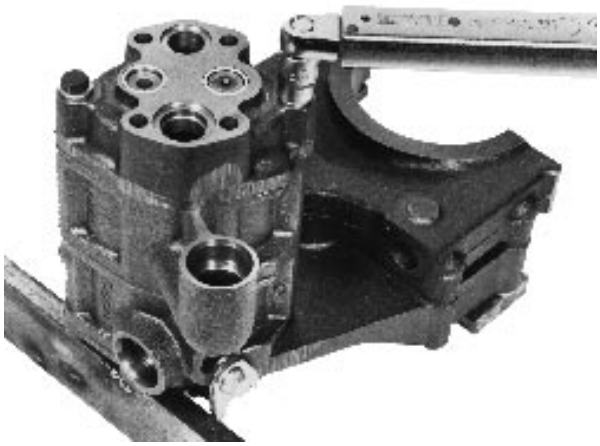
   – Place the gear under the bracket and press in the shaft.

3. Assemble the pump.

4. Draw the pump body halves together with the two bolts. Check to make sure the gears rotate easily.

NOTE! Fit the main bearing bolts before final assembly.

Tightening torque, oil pump intermediate gear: **22±3 Nm** (2.2±0.3 kpm)



Oil cooler

Pressure testing

Special tools:
(999) 2800 Test bench
8074 Nipple
8075 Cover washer

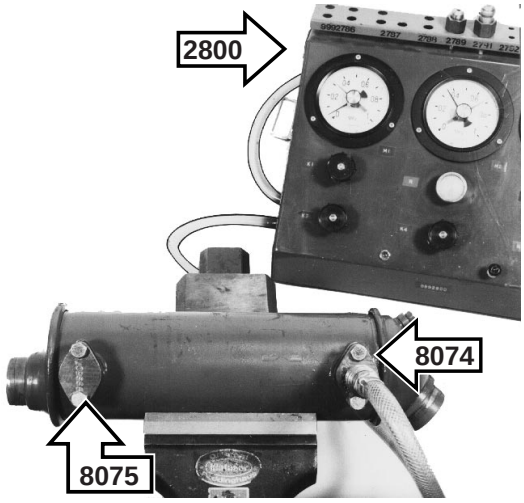
1. Drain the oil and coolant. Remove the oil cooler from the engine. Change to new O–rings before mouting the press-testing tools.

2. Fit nipple 8074 and cover washer 8075. Connect up test bench 2800.

3. Set pressure at 30 kPa (0.3 kp/cm²). Hold this pressure for one minute. No pressure drop is allowed.

4. Set pressure at 400 kPa (4 kp/cm²). Let this pressure remain for one minute. No pressure drop is allowed.

   If pressure drops, the oil cooler must be replaced since it is not permitted to repair it.

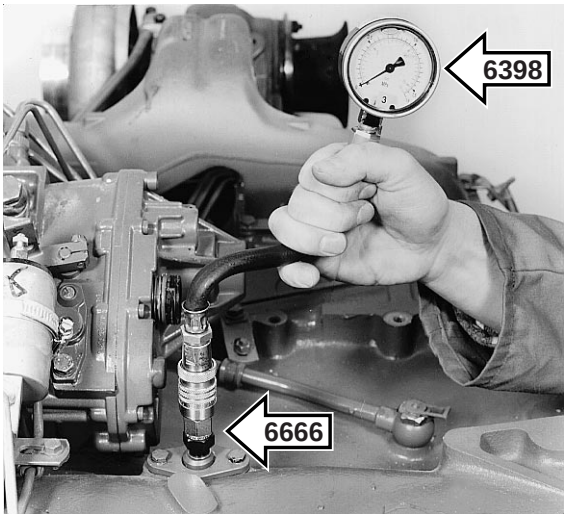


Oil pressure, piston cooling

Special tools:
(999) 6398 Pressure guage
6666 Nipple

Piston cooling oil pressure should be 0.8–1.2 kp/cm² at 1200–1500 r/min.

If the piston cooling valve does not have a measuring socket, the valve must be removed from the engine in order to drill an M10x1 mm hole.Then fit a suitable plug in the socket after completing the oil pressure check.



Group 23

Fuel System

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Injection pump

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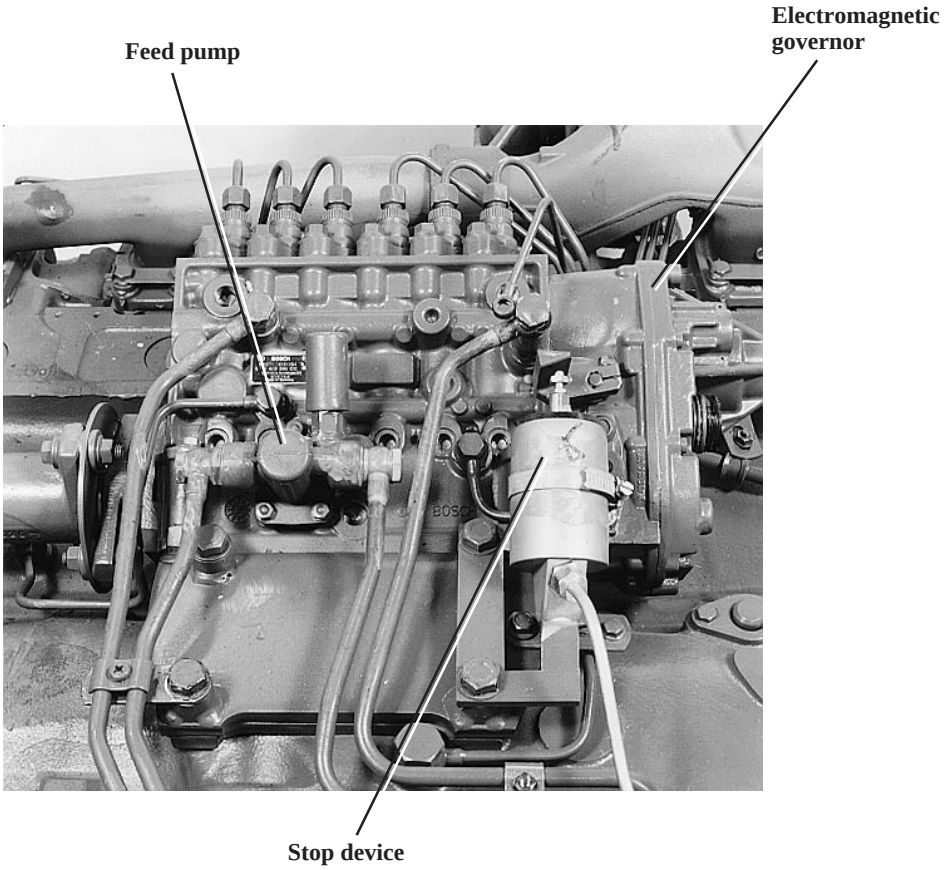
Note: For more detailed information on the fuel system (EDC), refer to Service Bulletin 2 (23) No. 18. There is also a description of the EDC-system in Service Manual 3 (37) Electrical System B10B and B12.

Fuel System

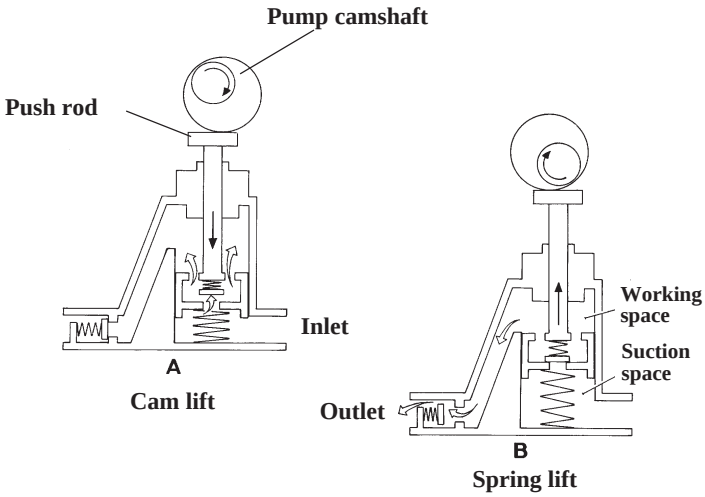


Injection pump setting values, chiefly fuel flow and pre-injection angle, differs for the various engine types. The reason for this is that these values are adapted to the properties that the engine has with regard to emissions and power output.

The feed pump supplies the injection pump with fuel under pressure. Fuel flows through the fuel filters before reaching the injection pump.

The pump camshaft pressing down the piston causes the pump chamber in the feed pump to fill with fluid. When the cam has passed its highest point and the piston spring presses back the piston, the pump discharges the fuel. In other words, fuel pressure is determined by the force of the spring.

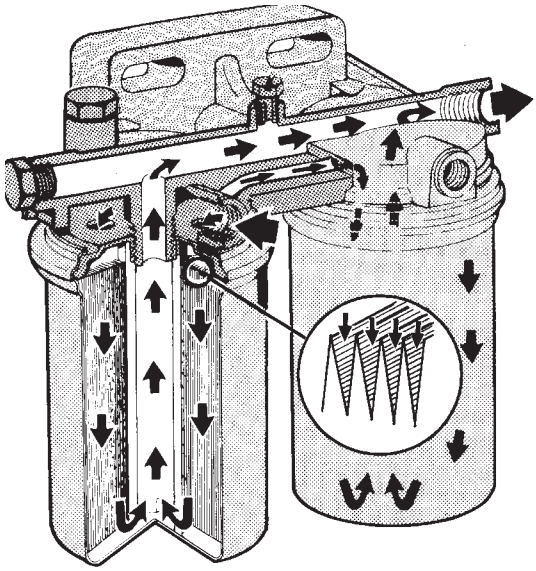
The hand primer pump is used to pump up fuel when there is no fuel in the system.



The fuel filters are of the spin-on type and are connected in parallel.

The filters have a new location compared to their location on the THD 104 engine; they are now placed under the starter motor.

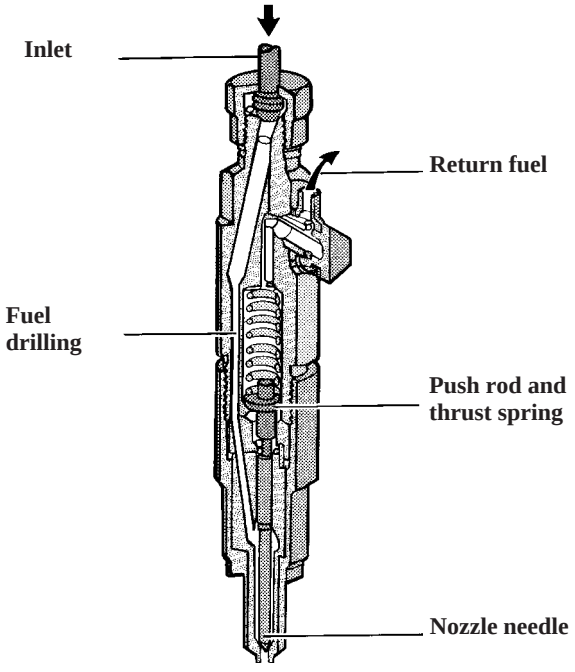
The filter element consists of a spiral-wound paper insert with very large filtration area. The layers of paper are folded so as to form pockets with openings that face upwards. The fuel flows axially through the pockets, and this separates dust particles, water, etc., from the fuel.



The injectors atomize and distribute the fuel in the engine combustion chamber. Injection is at very high pressure for maximum possible effective fuel atomization.

The push rod and thrust spring press the needle against the nozzle. Fuel is pressed into the fuel drilling by the injection pump and the high pressure overcomes the force acting against the nozzle needle so that it lifts and fuel is injected. When fuel pressure drops, the nozzle needle goes down again to shut off the opening.

The force of the spring determines the force acting against the nozzle needle. the thrust spring and thereby the injector opening pressure is adjusted with the help of shims.



Injection pump

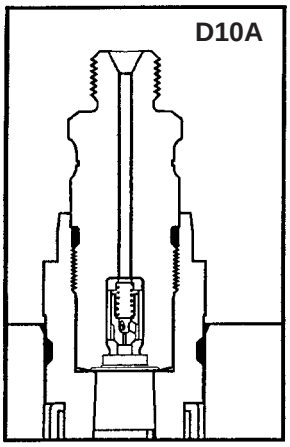
Differences

The delivery valves have been replaced by damper valves in order to maintain a higher pressure at the injectors, without having to raise the injection pump pressure.

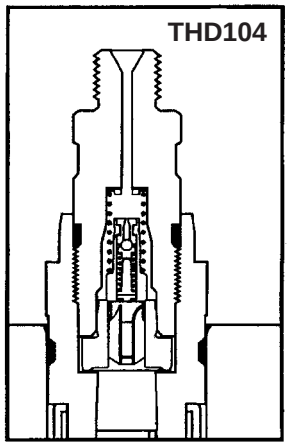
The delivery valve holders (delivery pipe connections) are now longer and have only one damper valve.

Fuel system venting has been modified to accomodate the above changes.

After normal venting at the filter bracket, venting is also required to release the delivery pipes at the injectors.



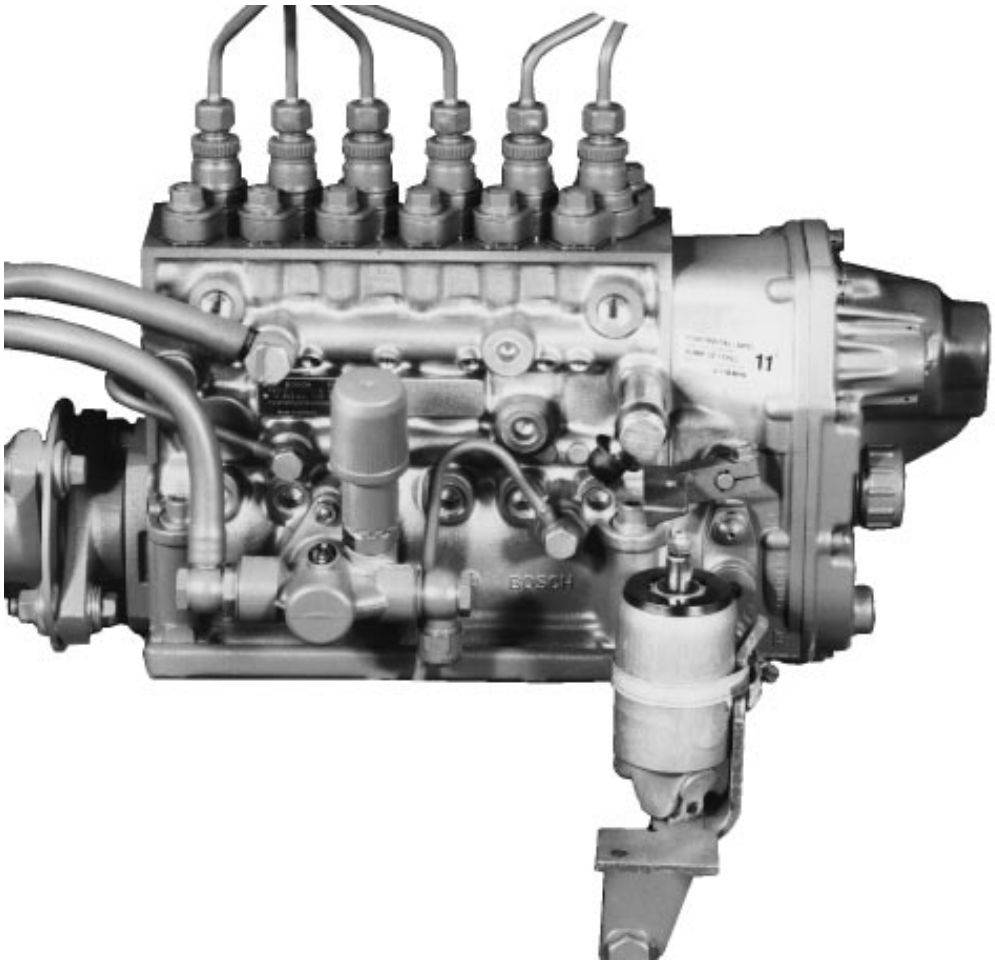
Damper ventil



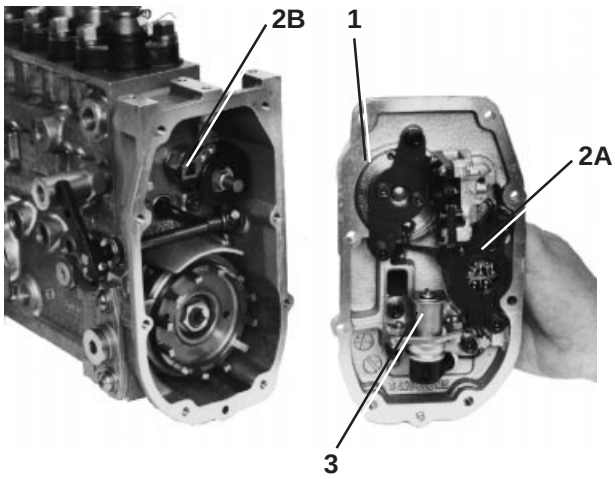
Delivery valve

Injection pump and governor

Engine DH10A has an electronically controlled injection pump (EDC). Characteristic of the EDC-system is that it works with an electromagnetic governor mounted on a standard injection pump.



The governor adjuster device (1) is placed in the governor housing end and consists of an electromagnet that works directly against the injection pump control rod. The control rod position sensor (2A and 2B) gives the control unit the opportunity of deciding if current to the adjuster device should be increased or decreased. The main speed sensor (3) in the system works against a toothed gear on the pump camshaft. In addition to the charge pressure, it is important for the control unit to know engine speed, otherwise it will not be possible for the control unit to determine fuel flow.



Injection timer

Engine DH10A, 345 and 360 have an electrically operated injection timer. Basically this is the mechanical-hydraulical timer described in Service Bulletin 2.23.21 11-93 and Service Manual 2 (20–27) Engine THD 101–104.

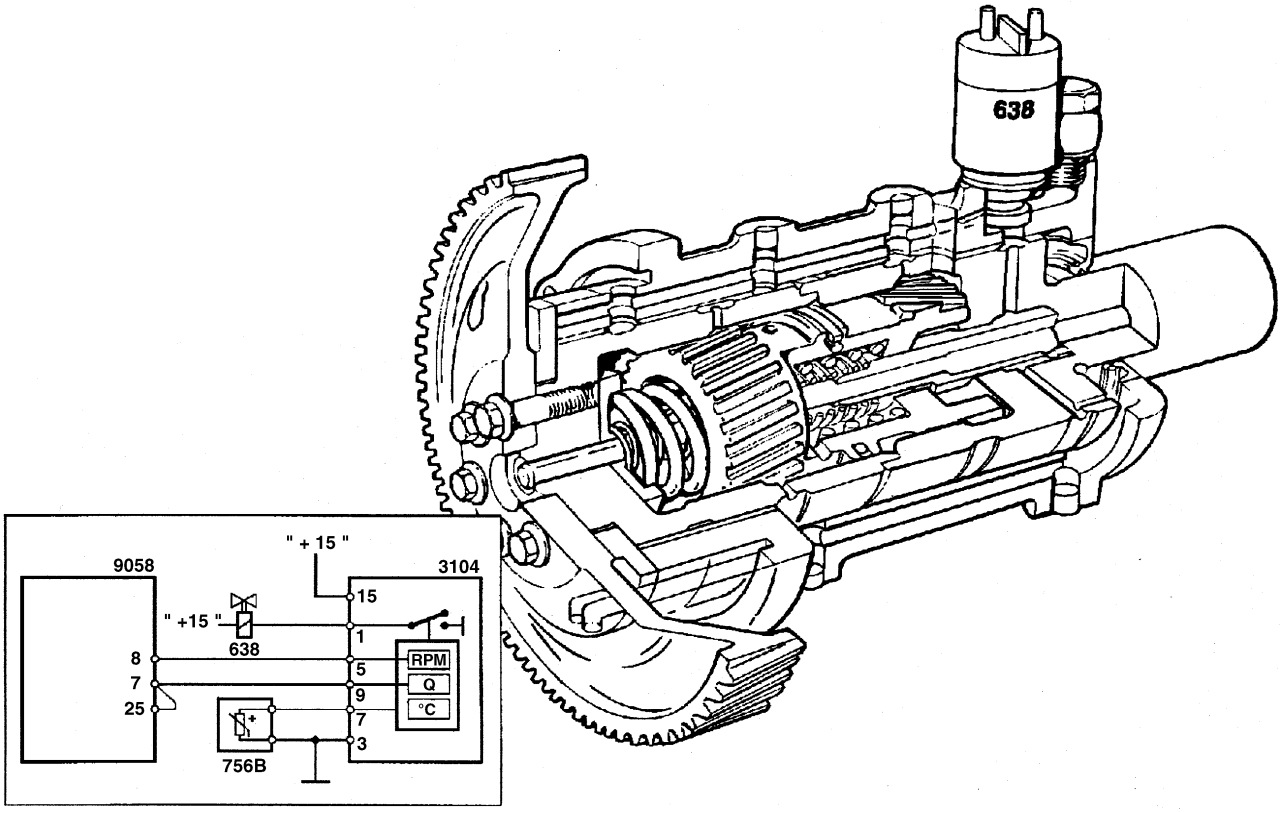
The difference is that the centrifugally activated control valves in the rear flange have been removed and, because of this, the infinite timing setting has been replaced by a 2-position timer and the maximum timing angle has been reduced from 6° to 5°.

Delivery oil flow from the engine is regulated instead by a solenoid valve (638), mounted on the timer bearing housing.

The injection timer angle setting is dependent on three different factors: speed (r/min), temperature (°C) and load (Q).

The information on engine speed and engine load is obtrained from the EDC-control unit (9058) and the temperature from the temperature sensor (756B).

A special control unit (3104), placed on the electrical distributor unit, takes care of the information and controls engagement/disengagement of the solenoid valve (638) on the injection timer.

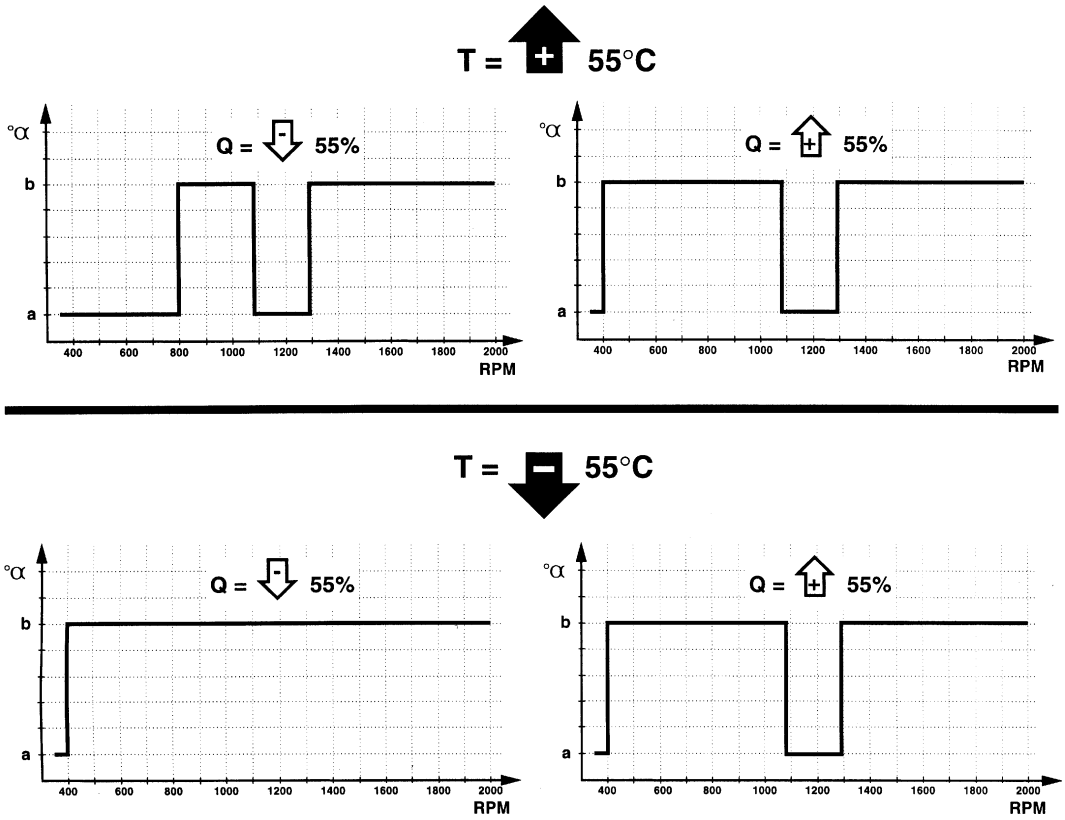


Function

The injection timer alters the α-angle to suit operating conditions, see diagram below. When there is no current in the solenoid valve, the engine α-angle is the same as the basic setting value (a). When operating conditions are such that current reaches the solenoid valve, it opens and the engine lube oil presses the internal torsion piston to compress the pressure return spring until the piston is against the internal adjuster sleeve. During this movement the piston turns so that the α-angle increases 5° to maximum α (b).

The value of a and b can be seen from the following table:

	DH10A, 345	**DH10A, 360**
Value a	5,5°	7°
Value b	10,5°	12°



The above diagrams show the angle setting (a°) in relation to the engine speed.

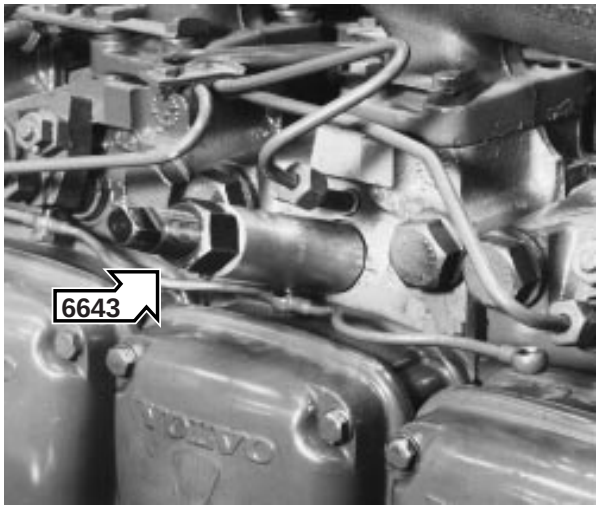
The upper diagrams refers to an engine run warm (min. 55°), with engine load (Q) less than 55%. They show that, at low engine load, there is no readjustment from idle up to 800 r/min, irrespective of load, between 1080 and 1290 r/min. At other speeds there is readjustment.

The lower diagrams refer to a cold engine (max 55°) with engine load (Q) less than 55% resp. more than 55%.

They show that, at low engine load, there is readjustment at all speeds. At high engine load there is readjustment between 1080 and 1290 r/min, otherwise adjustment takes place.

Injectors

Special tool:
(999) 6643 Puller



Replacing

1. Make sure the injector is thoroughly clean before removing or fitting it. Make sure no paint flakes stick to the sealing surfaces of the pipe ends.

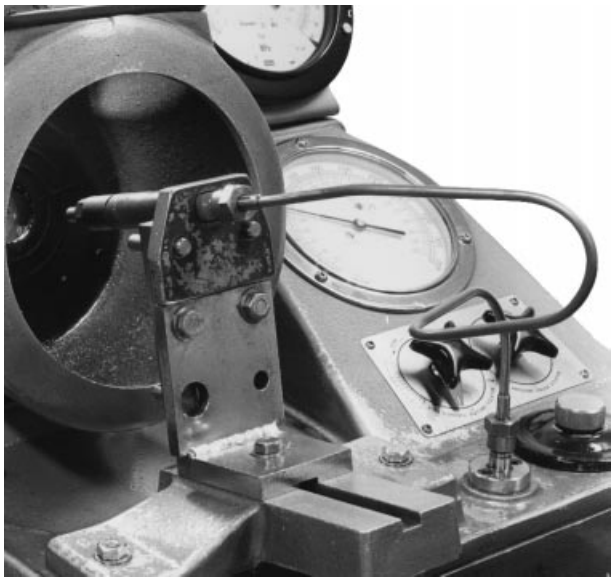
2. Remove the injector. If necessary use puller 6643.

Installing

3. Clean the copper sleeve according to instructions next page.

4. Push the injector into position. Fit a new outer sealing ring with the sealing lip facing the cylinder head.

5. Fit the retainer and retaining nut. Tighten to a torque of **50±5 Nm** (5±0.5 Nm).



Checking

There are no prescribed intervals for checking the injectors. They should be removed and checked when the engine has lost some of its power or if the exhaust emissions are unacceptable.

Injectors should be checked in an injector tester. Check results against injector data in “Specifications”.

Concerning repairs to and maintenance of injectors, refer to the instructions of the Bosch factory.

Warning!
Utmost care must be taken when testing injectors. Fuel spray from the injector MUST NOT be allowed to strike unprotected parts of the body. The jet has tremendous force and skin penetration could lead to blood poisoning.

Testing

To be able to assess injector condition properly, one must be aware that the different injectors have different spray pattern and chatter. Most important is checking the opening/adjusting pressure and tightness. Spray pattern and chatter are difficult to assess and do not provide any sure indication of injector condition. All air must be removed from the injector before testing.

Pump fuel with large pump strokes in order to get maximum fuel flow.

Shims for pressure setting

Checking/adjusting opening pressure

Connect up a pressure gauge. Slowly push down the nozzle tester lever until the nozzle opens and releases fuel. Read-off the opening pressure.

Volvo specifies an adjusting pressure in addition to the opening pressure. The adjusting pressure refers to new injectors with new thrust springs. It is higher than the opening pressure and provides a certain margin to allow for thrust spring fatigue.

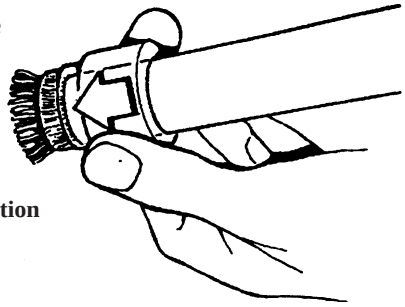
If the opening pressure obtained when testing does not comply with the specifications, adjust to the correct opening pressure with the help of adjusting shims.

Cleaning copper sleeve before installing injectors

Special tool:
(981) 2546 Sleeve brush

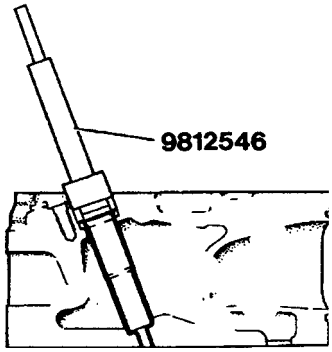
The copper sleeve seat must be cleaned in order to get proper sealing between the injector and copper sleeve.

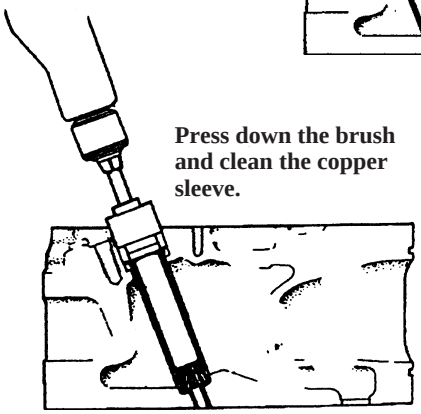
Slide the installation sleeve over the brush before fitting the brush in the machine.



Slide down the installation sleeve to compress the brush.

Place the installation sleeve over the copper sleeve.





Press down the brush and clean the copper sleeve.

Spray pattern

At a high pumping speed of 4–6 pump strokes per second, the spray pattern should be uniform and the fuel atomized.

Leakage check

Check for fuel leaks between the tip of the nozzle needle and the tapered sealing surface of the nozzle sleeve. Wipe the nozzle tip dry. Connect up a pressure gauge and pump the pressure to approx. 200 kPa below the injector opening pressure. Keep the pressure constant for 10 seconds. No fuel should drip from the nozzle tip.

Chatter test

Normally only new injectors emit a chatter noise.

The contact area between the nozzle needle and the seat is narrow as the parts are manufactured with a small angle difference.

After the injector has been in use for a short time, this difference diminishes and the contact area increases so that the chatter noise should eventually die out.

The chatter does not have any effect on the injector when installed in the engine.

Servicing nozzle tester

If the test fuel has been contaminated by dirt, etc., it must be renewed. Also the nozzle tester filter insert must be replaced or removed and cleaned in fuel.

When filling with new test fuel, flush the nozzle tester by pumping the lever, no injector fitted.

Check the pressure gauge reading at intervals, using a test gauge. If the pressure gauge shows incorrect readings, it should be replaced. Minor deviations can be corrected by checking against a correction table.

Injection pump

Removing/installing

Special tool:
(999) 8068 Crank tool

1. Remove the inspection panel from underneath the flywheel casing and fit crank tool 8068.

2. Crank the flywheel until no. 1 cyl. piston has just passed the TDC (compression stroke), (0° on the flywheel, mark on pump flange facing up).

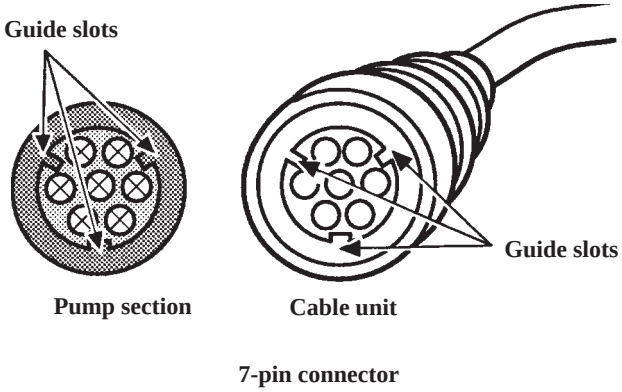
3. Remove the delivery oil pipe from the engine block.

4. Disconnect the fuel pipes and cables. Plug all open connections with plastic plugs.

5. Release the pump from the pump shelf.

Tightening torques

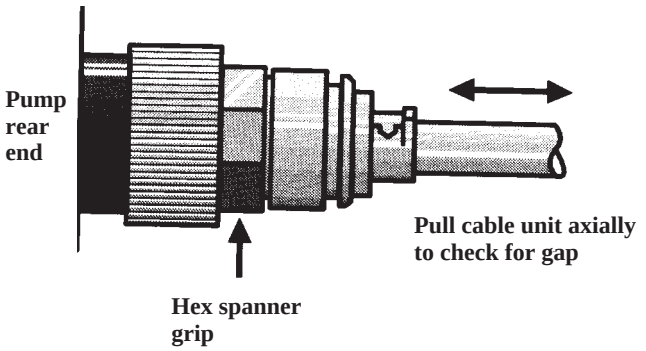
Injection pump retaining bolts	40±4 Nm (4,0±0,4 kpm)
Injection pump flange bolts	62±5 Nm (6,2±0,5 kpm)



To note when installing injection pump

Tightening cable connections

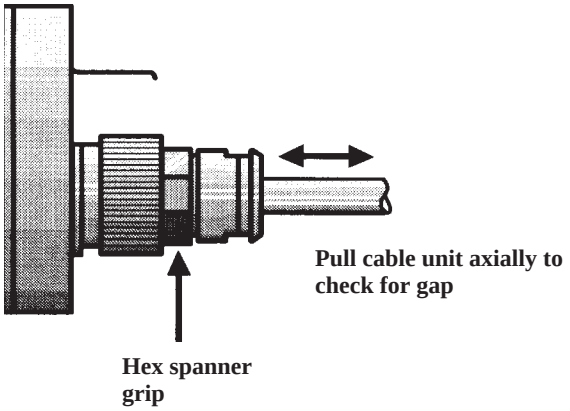
The 7-pin connection for the governor has three guide slots. The widest slot in the cable unit connection is at the bottom for correct connect-up to the governor. Connect-up is correct when the cable unit cap nut fits into the threads in the pump connection.



To make sure the cable connection is tight enough, pull the cable unit axially, see fig, to ensure there is no gap, which is the case with an improperly tightened coupling. Tighten to take in this gap, if any, and then a further hex side (approx. 60°).

NOTE! It is important that all cable connections and joints in the EDC-system are fully plugged in and that the protection sleeves are pressed fully over insulators and sensors.

Check that there is engine oil in the bottom section of the injection pump. There should be no oil in the governor.

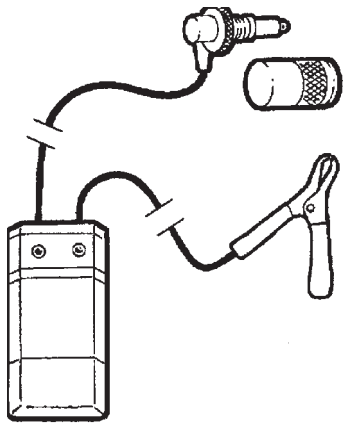


Turbopressure sensor (3-pin connector)

Delivery pipes for EDC-engines

All EDC-engines have pre-pressurized delivery pipes that tolerate high injection prsssure. This pre-pressurization is done in the manufacturing process, where the pipes are bent and subjected to approx. 3000 bar pressure in order to get rid of micro-cracks in the material.

Pre-pressurized pipes must not be bent! This could cause cracks.

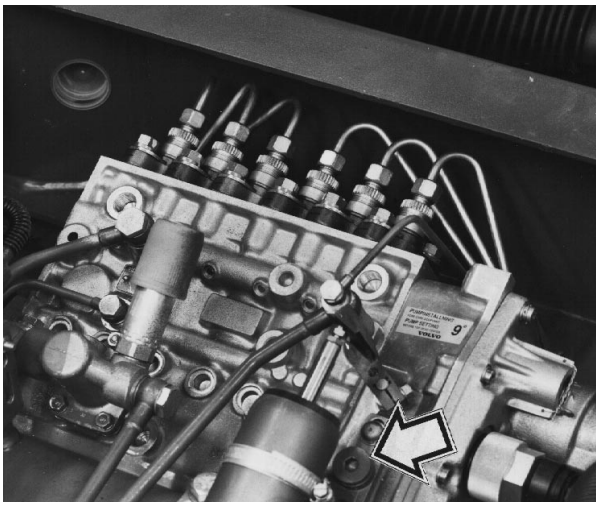


Basic timing injection pump (EDC)

Special tools:
(998) 7057 Timing tool
8068 Crank tool

1. Remove the inspection panel from underneath the flywheel casing and fit crank tool 8068.

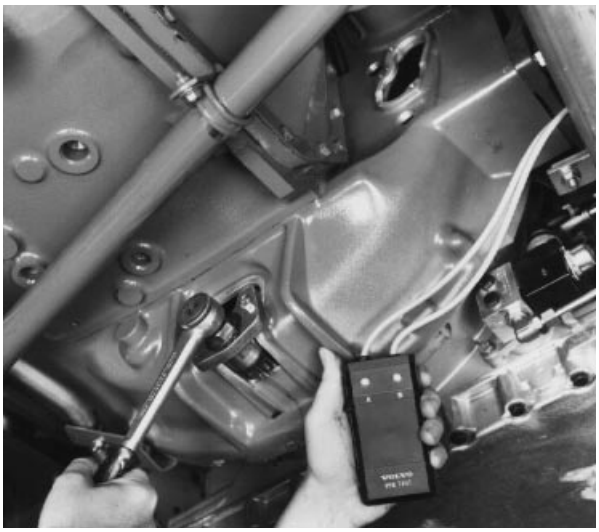
2. Crank the engine until no. cyl. piston has just passed TDC, compression stroke (0° on flywheel and both no. 1 cyl. valves closed). Crank the flywheel back past the degree for the setting.



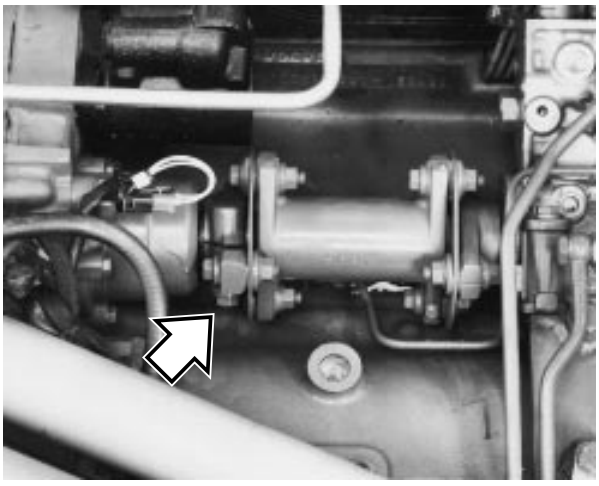
3. Remove the plug from the pump governor housing.

4. Fit on position sensor for timing tool 998 7057 in the governor housing plug hole and earth the tool.

5. Crank the flywheel in the engine direction of rotation. When both the tool diodes light, read-off the degree on the flywheel. Compare this with what is given in the Diesel Test Standard or refer to Specifications in this manual.



6. If the timing has to be altered, slacken the clamp bolt for the pump coupling and tap the pump flange until the timing is correct.



7. Tighten clamp bolt: **M11 ..... 90±5 Nm**
   M12 ..... 114±10 Nm

8. Check the timing again and adjust if necessary.

Low idling speed EDC

Setting, permanent

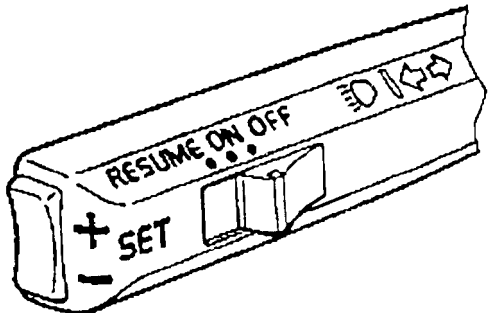
If the engine is warm (above 45°C), the bus stationary and the clutch pedal released (parking brake on and gearbox in neutral on buses with automatic transmission), idling speed can be set with the help of the breakers on the direction indicator stalk.

– Keep the brake pedal depressed. Move the slide control to “RESUME” and hold it there for min. 4 seconds.

– Still keep the brake pedal depressed and move the slide control to the neutral position. This should produce the lowest idle speed (530 r/min).

– By repeatedly depressing “SET+” or “SET–” the speed can be be altered. Each activation increases/ decreases idle speed by about 10 r/min (within the adjustable interval). When the desired idling speed has been reached, activate “RESUME” again for at least 4 seconds and then move the slide control to the neutral position.

Setting, temporary

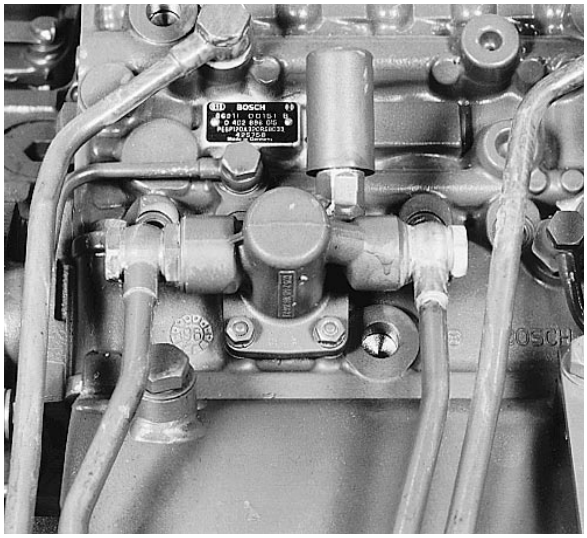


The engine idle speed can be temporarily altered by activating the rocker switch “SET+” or “SET–”, without depressing the brake pedal. If the slide control is moved to “RESUME”, the engine will run at the pre-programmed high idling speed, and if it is moved to “OFF”, the engine will go down to its lowest set idling speed. These speed variations are not stored in the control unit. Even with temporary alteration of the idling speed the clutch pedal must be released (parking brake on and gearbox in neutral on buses with automatic transmission).

Venting fuel system

1. Open the vent screw on the fuel filter housing.

2. With the feed pump hand primer pump fuel into the fuel system until fuel free from air bubbles flows out. Then close the vent screw.



3. In the same way slacken each delivery pipe and use the feed pump hand primer to get fuel free from air bubbles and then tighten up the pipes while the fuel is still flowing out.

4. Check for leakage and the function.

Injection timer, checking DH10A, 345, 360

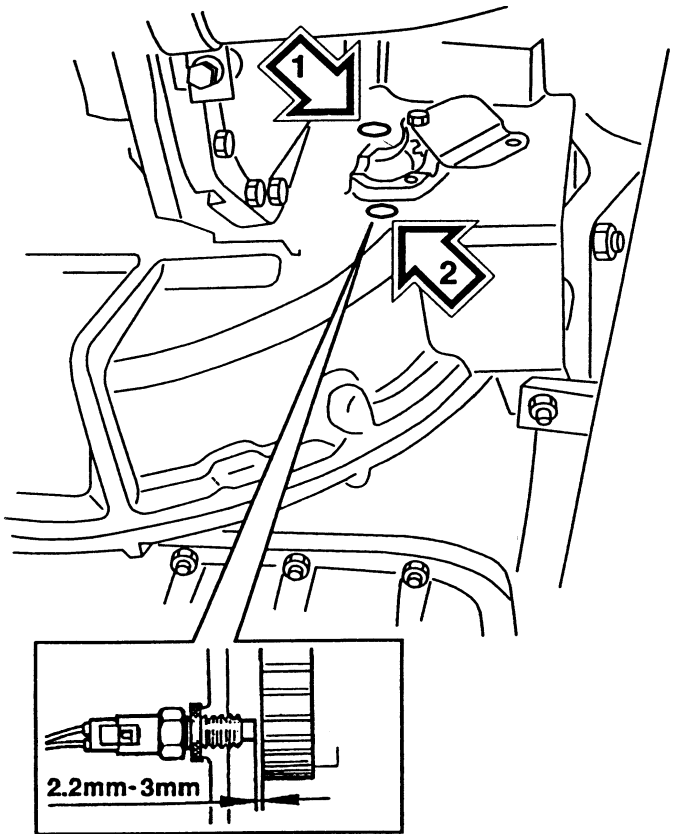
Special tools:
(999) 8060 Crank tool
8190 Measuring instrument

1. Crank the flyhweel to where the 0° mark is opposite the indication pin.

2. Connect up the measuring instrument's two sensors: one on the injection pump governor housing and the other on the right-hand side of the flywheel casing; the upper inner hole (1) is used if the bus has automatic transmission. The lower outer (2) is used for a manual gearbox and for the Voith automatic transmission.

3. Check the basic timing for the injection pump by reading-off the instrument at low idle. Compare the reading with the value in the diesel test standard for the engine in question. If necessary, adjust the basic timing.

4. Increase engine speed to 1200 r/min and check the timing value on the measuring instrument. The increase engine speed to 1800 r/min and check the pre-timing value. The pre-timing value should increase 6±1° between 1200 and 1800 r/min. If the pre-timing does not change between 1200–1800 r/min, overhaul or replace the injection timer.



It is important that the sensor distance to the flywheel/flex plate is accurately set. This is done by screwing in the sensor by hand to the flywheel/flex plate and then by backing the sensor 1.5–2 turns and locking it with the lock nut.

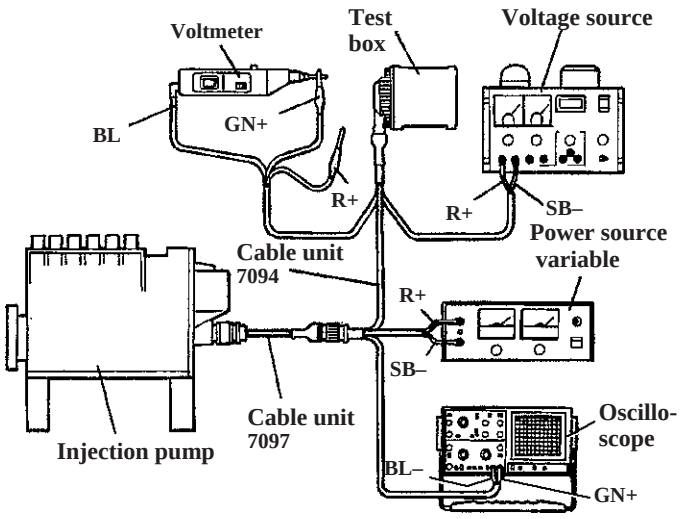
NOTE! Some flex plates either have a hole or a plate riveted on that the sensor senses. If the flex plate has a riveted-on plate, the engine must be cranked round so that the plate comes opposite the hole where the sensor should sit. It is then that the sensor distance must be adjusted otherwise the plate will break up the sensor when the engine starts.

Testing injection pump, DH10A

Before testing the injection pump, fill the injection pump with engine oil SAE 20W20 up to the level of the lube oil return outlet.

Concerning adjustment details, refer to the diesel test standard sheet, Service Bulletin, Group 23.

7085 Test control unit



Special tools:

(998) 6551 Bracket
7057 Setting tol
7059 Power source, variable 12 V/15 A
– Power sources, fixed voltage 12 V/3 A alt. on 12 V battery is used
7075 Oscilloscope (needed only for checking speed sensor)
7085 Test control unit (control unit for testing pump)
7094 Cable unit
7097 Cable unit
(951) 0060 Voltmeter, accuracy <± mV (Digital)
Bosch KDEP 1701 Setting tool

Set the pump up on the test bench and connect up the test equipment as shown in the Fig.

Before testing

Before testing, the voltage from the test control unit should be checked/calculated as follows:

1. Connect up the voltmeter. Blue contact to "–" and red to "+" on the voltmeter.

   Note: After the test, connect up the green contact instead of the red one.

2. Connect up power sources for 12 V constant voltage.

   Read-off the working voltage (U/ref) on the voltmeter. Should be 4.99–5.01 V.

   If the working voltage is not within 4.99–5.10 V and deviation is not greater than 10%, voltage required for further testing can still be calculated. These voltages should then be used instead of the values given for the U/norm. The diesel test standard sheet new values we call U/RV/a = calculated standard value. Use the following formula for the calculation:

$$U/RV/a = \frac{U/norm \times 5.00}{U/ref}$$

Ex. measured working voltage (U/ref) = 4.97 V
For test in question: U/norm = 3.10 V

$$U/RV/a = \frac{3.10 \times 5.00}{4.97} \approx 3.12V$$ to be used for test in question

C. Adjuster device

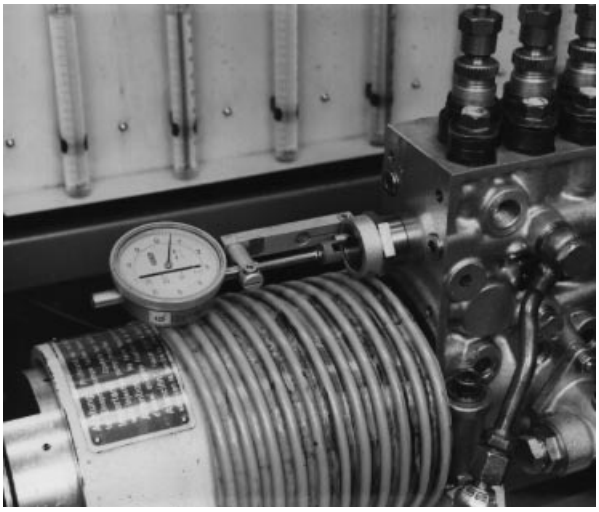
The first to check on the injection pump is the control rod travel.

Position sensor for control rod travel
(pump speed 0/min)

Test No.			
1	U_{norm} Control rod travel:	3.10 12.95–13.05 12.90–13.10	V mm (Setting value) mm (check value)
2	U_{norm} Control rod travel:	1.70 5.90–6.40 5.85–6.45	V mm (Setting value) mm (check value)
3	U_{norm} Control rod travel:	min 0.5–1.0 0.4–1.1	V mm (Setting value) mm (check value)

1. Fit the fuel feed line and return line to the pump. Run the pump warm (600 r/min) for 3 minutes. Unorm = 2.5 V.

2. Fit the bracket and dial indicator (Volov P/N 998 6551) at the front of the injection pump to measure control rod travel. The Fig. shows an adapted bracket.



3. Switch on the power sources with constant 12 V voltage to the test control unit.

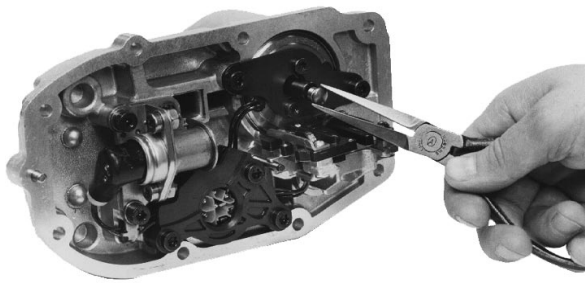
4. Switch on the variable power source and slowly increase the voltage until you can hear the adjuster device going to its end position.

   Note: The adjuster device may only be in the end position for **max. 1 minute**, otherwise there is risk of it catching fire.

5. Check to make sure the dial indicator measuring probe has contact with the travelled control rod. Set the dial indicator to 21 mm.

6. Reduce the variable voltage to 0 V and read-off the dial indicator. Compare the measured value with the value given in the diesel standard sheet at C. Adjuster device with U/norm = min. 0.4–1.1 mm.

   If the control rod travel is not within the tolerance, adjust by replacing the setting device end pin, which is available in different sizes.



   When calculating the size of the end pin, bear in mind that there must be a 0.1–0.3 mm gap between the control rod and the end pin when the control rod is in the non-travel position and the adjuster device off-circuit.

7. Thereafter carry out tests 1 and 2 under C. Adjuster device adjustment as per diesel test standards sheet. Tips: Carry out the tests at low pump rotation, e.g., 200 r/min.

   Compare the measured values with those given in the diesel test standards sheet.

A. Synchronizing

Fit the bracket and dial indicator on the rear side of the pump to measure the lift from the basic circle on no. 1 pump piston. Crank the pump so that no. 1 pump piston is at its bottom position. Zero-set the dial indicator.

Test sequence:

A. SYNCHRONISATION

①	Lift from base circle at start of supply	4.05±0.05 4.05±0.10	mm (initial value) mm (check value)
	At control voltage U_{norm}	2.6±0.1	V
	Injection sequence	1 5 3 6 2 4	
	Rotational direction	Clockwise	
	Supply pressure	2.5–2.7 (360–390)	MPa (psi)
③	Tolerance between cylinders	±0.50 ±0.75	° (initial value) ° (check value)
②	Pulse wheel cam should match the impact point on cylinder no. 1		
	Tolerance	±0.20 ±0.75	° (initial value) ° (check value)

①

Lift from basic circle at start of measuring

1. Set no. 1 pump piston to its bottom position. Zero-set the dial indicator. Remove the relief valve from the injection pump. Connect the test bench high-pressure hose to the pump fuel inlet. Plug the pump fuel outlet.

2. Start high-pressure feed on the test bench. Check that the feed pressure is the same as that recommended in the diesel test standards sheet.

   Note: The test bench must be disconnected.

3. Open the tap on the test bench injector for no. 1 cylinder.

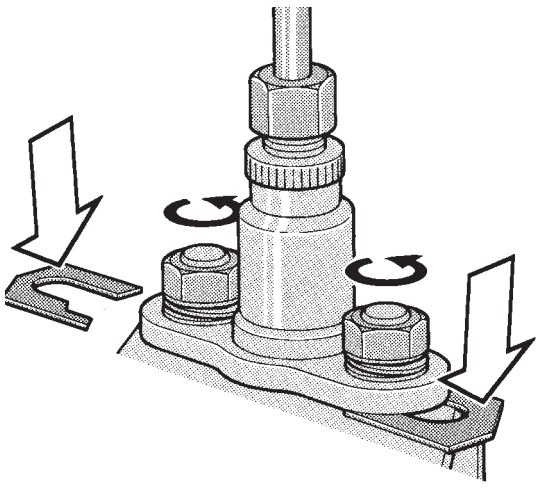
   Increase the voltage to the adjuster device (control rod travel voltage Unorm) to correspond to the value given in the standards sheet.

4. Crank the pump drive coupling in the pump direction of rotation to when the tap on no. 1 injector changes to drip form. Read-off the dial indicator.

   Crank back the pump and repeat the test. Compare the read-off value on the dial indicator with the value given in the diesel test standard.

If necessary, adjust stroke by fitting/removing shims under the flange bushing.

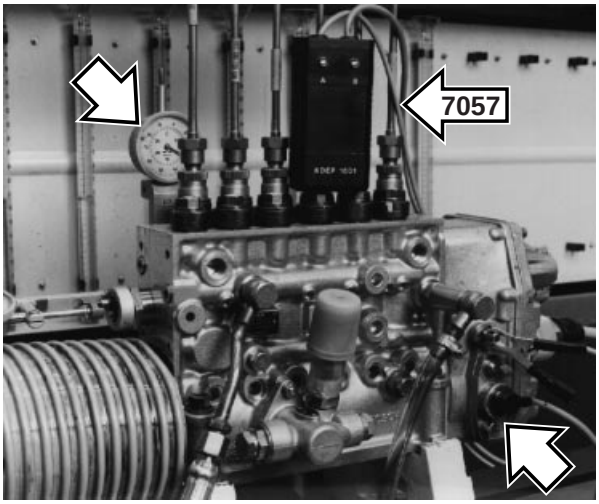
If the pump piston stroke is too early, fit thicker shims. Fit thinner ones if the stroke is delayed.



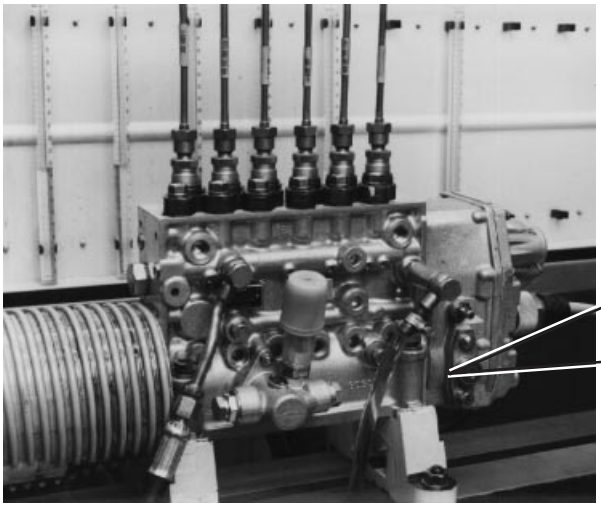
(2)

Checking pulse gear cam

Fit special tool 998 7057 on the injection pump and earth the tool.



Both the diodes should light when no. 1 pump piston is in stroke position. If both diodes light, carefully crank the pump and at the same time read-off the protractor on the test bench. Compare the difference in degrees between no. 1 stroke position and when both diodes light with the value permitted in the diesel test standards.



Adjusting: Set no. 1 piston to stroke position, adjust the pump up-down until both the diodes light.

(3)

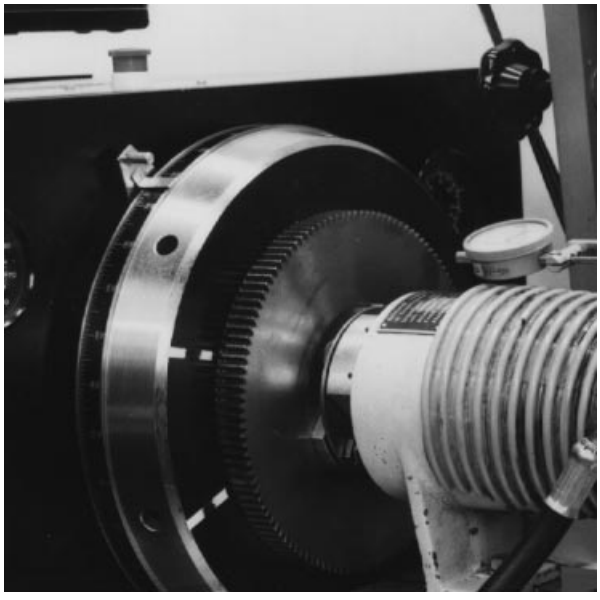
Tolerance between pump cylinders

The other 5 pump elements are checked and if necessary adjusted in accordance with engine firing sequence 1-5-3-6-2-4.

The dial indicator is used only on no. 1 tappet. The other pump elements are adjusted with the help of the test bench protractor. Mark the stroke position for no. 1 pump element on the test bench protractor. Then remove the dial indicator.

The pump camshaft is cranked 60° for each pump element. Compare the angle deviation with the value prescribed in the diesel test standards (see tolerance between the cylinders).

If necessary, adjust with shims under the flange bushing.



D. Speed sensor

This check is carried out only if there are problems with speed control or when the sensor/toothed gear has been removed.

D. SPEED SENSOR (Control rod in stop position)

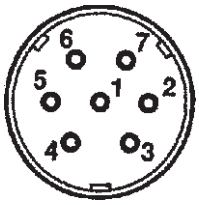
Pump speed:	**60**	**r/min**	**Positive amplitude** **Positive amplitude**	**0.8–2.0** **0.6–3.0**	**V (Setting value)** **V (Control value)**
Pump speed	**600**	**r/min**	**Difference in ampl.**	**1.4**	**V**

* U_{norm} = reglervägspänning

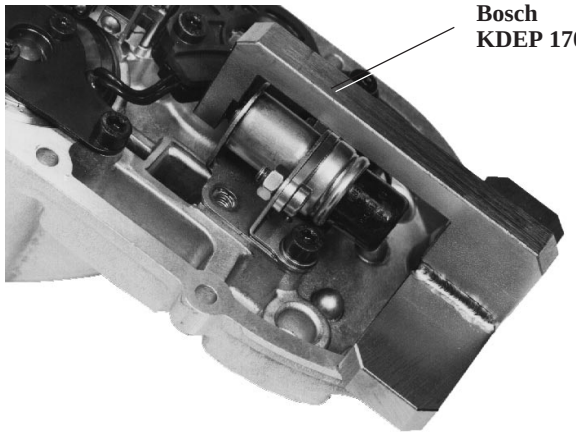
– An oscilloscope is required to check the speed sensor.

– Connect the cables with blue and green contacts from the test equipment to the oscilloscope. Start the test bench and compare the read-offs with the values given in the diesel test standards.

With different values, check the speed sensor pins 3–4 in the contact unit, check value 900–1100 ohms and the sensor setting with special tool Bosch KDEP 1701. The sensor attachment mounting has oval holes to allow for sensor position adjustment.



Contact unit on pump



Bosch KDEP 1701

B. Check and setting fuel flows

Run the injection pump up to normal operating temperature.

Note: With continuous driving at altitudes of 2000–4000 metres above sea level, fuel flow must be reduced by 10%. At 4000 metres and above 20%. Note that with altered fuel flow, the engine data programmed into the control unit when the engine was delivered from the factory must be accordingly altered.

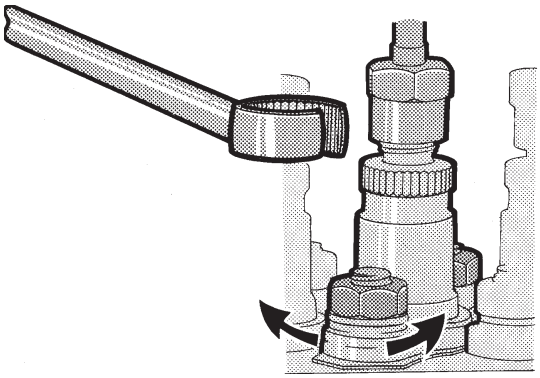
B. CHECKING AND SETTING FUEL FLOWS

	Test no.	Pump speed r/s (r/min)	Total strokes	Control rod voltage U_{norm} (V)	Delivery flow cm³	Difference max. cm³
Pump setting values	1	10,8 (650)	1000	2,80	296 ± 1	8
	2	16,7 (1000)	1000	2,80	258 ± 3	10
	3	16,7 (1000)	1000	2,20	176 ± 3	-
	4	16,7 (1000)	1000	0,90	0	-
	5	5,0 (300)	1000	1,40	26 ± 2	5
	6					
Pump check values	7	10,8 (650)	1000	2,80	296 ± 4	11
	8	16,7 (1000)	1000	2,80	258 ± 6	14
	9	16,7 (1000)	1000	2,20	176 ± 6	-
	10	16,7 (1000)	1000	0,90	0	-
	11	5,0 (300)	1000	1,40	26 ± 4	8
	12					

Run the tests as specified in the diesel test standards and check that the flow difference between the pump elements is as little as possible. The difference must not exceed “Difference max. cm^3”.

Adjust fuel flow and the differences by turning the pump element flange bushings within the area for oblong holes.

Slacken the retaining nuts and turn with Bosch tool 1687 950 525.



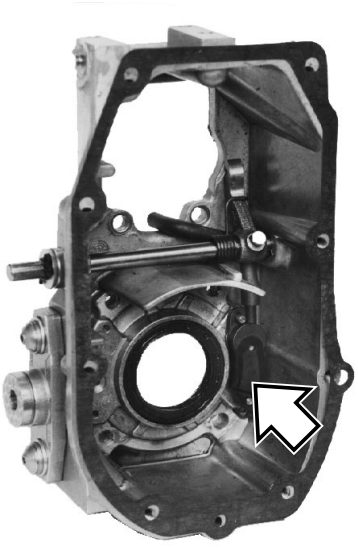
E. CHECKING THE VACUUM

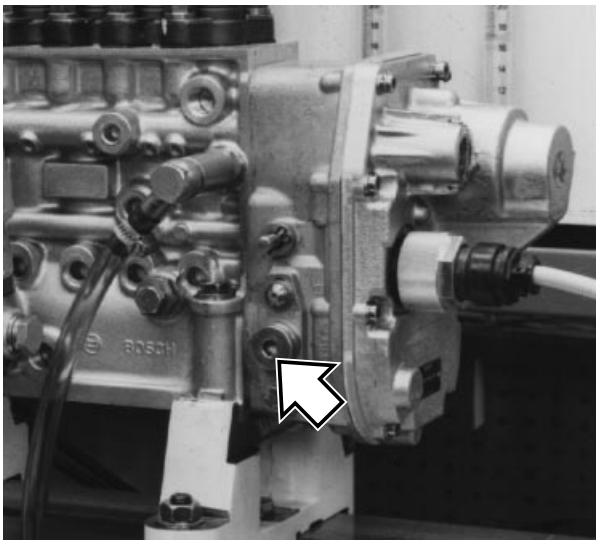
Speed r/s (r/min)	Requirement	
16,7 (1000)	After 10 seconds vacuum must be higher than 40 mbar (0.6 psi)	Setting
16,7 (1000)	After 10 seconds vacuum must be higher than 30 mbar (0.45 psi)	Check

E. Checking oil pump (vacuum)

Check the oil pump if its function is unsatisfactory (too much oil collects in governor housing) or when the oil pump has been removed. It should also be checked when the entire injection pump has been dismantled. The oil pump is checked by measuring the vacuum created by the pump in the governor housing.

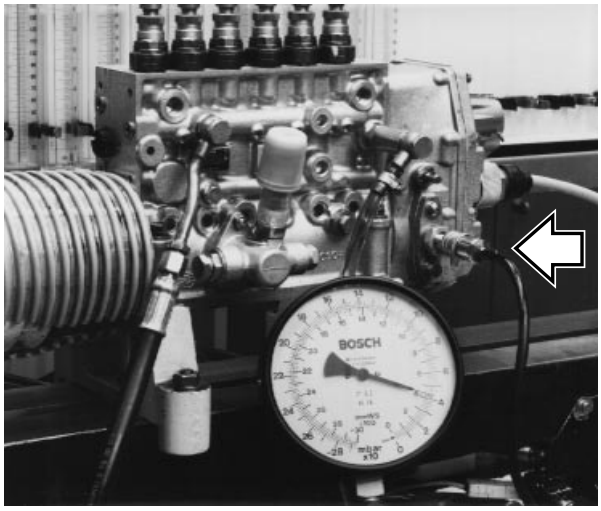
The function of the oil pump is to pump back oil that has leaked into the governor housing.There will always be a small amount of oil in the housing to ensure oil pump lubrication.





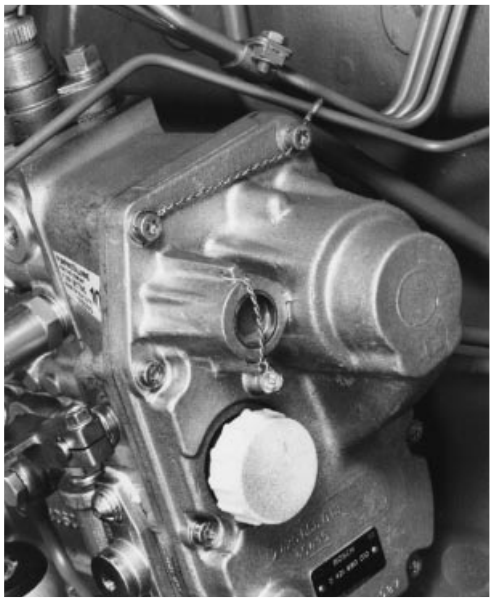
Checking oil pump, cont…

Fill the governor housing with engine oil up to the hole (see arrow).



Connect a vacuum guage to the hole in the governor housing. Remove the plug at the front of the pump (where the control rod travel is measured).

Start the test bench and run the pump according to the diesel test standards. Compare the vacuum measured with that in the standards.



F. Anti-tamper sealing

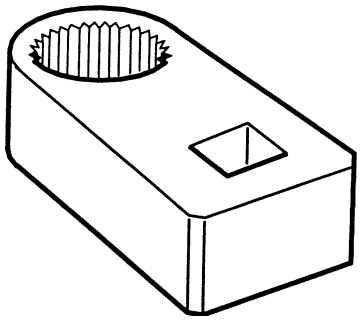
Anti-tamper seal the pump and the governor with the two screws on the governor cover.

Replacing damper valve holder, injection pump

Special tool:
425973 Removal/installation tool

Remember that cleanliness is of utmost importance when working on the injection system.

1. Thoroughly clean the injection pump and its surrounding area. Blow dry.
2. Slacken the delivery pipes cap nuts at both ends. Do not remove them.
3. Thoroughly clean round the nuts and pipes. Remove them.
4. Slacken all six valve holders with the special tool (see below). Do not remove the valve holders.

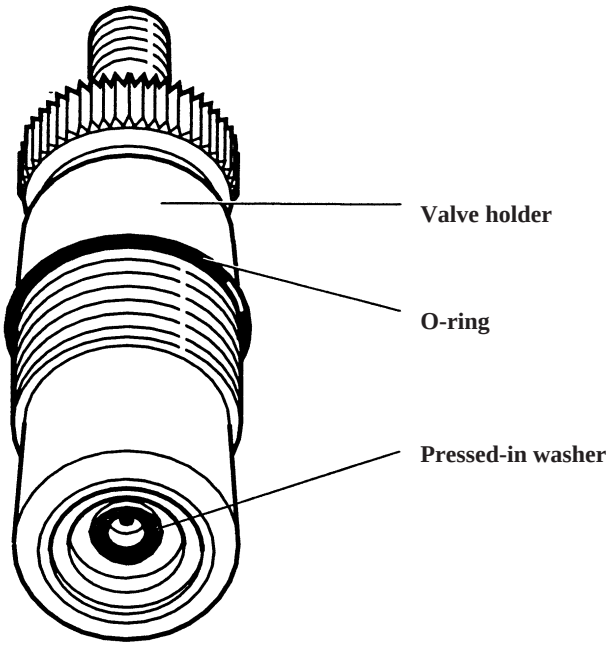


Special tool 425973 for removing and installing valve holders on bus type engines

Important:
Make sure the flange bushing (yoke) does not move under the two nuts. If the flange bushing turns, the injection pump must be removed from the bus and adjusted in a test bench.

5. Clean very thoroughly round the old valve holders.
6. Dip the new valve holderss (with new O-rings fitted) in straight transmission oil SAE 80W/90.
7. Replace the valve holders, one by one.
8. Check that the bottom of the removed valve holder is in order, that is, the washer has not loosened. (Compare with a new.)
9. Also check the uncovered upper part of the pump looks alright.

Important!
If the washer has fallen down, in all probability the injection pump is damaged and must be repaired. If the pump is damaged, the delivery pipes and the injectors will also have to be replaced.



10. Tighten the new valve holder in two stages with the special tool. First to 50 Nm (5 kpm) and then to 110±5 Nm (11±0.5 kpm).
11. Refit the injection pump pipes and tighten the caps by hand.
12. Tighten the nuts at the pump to 25 Nm (2.5 kpm). Be careful not to deform (twist) the pipes.
13. Vent the fuel system by priming with the hand primer. The system is full when fuel drips from the delivery pipes at the injector end.
14. Tighten the nuts at the injectors to 25 Nm (2.5 kpm). Be careful not to deform (twist) the pipes.
15. Mark that the valve holders have been replaced by punching two puch marks on the injection pump product plate, see Fig. on the previous page.
16. Destroy the replaced valve holders, e.g., by substantially deforming the threads with a heavy hammer.

Group 25

Inlet and Exhaust Systems

Contents

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Turbocompressor

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– Servicing DH10A, 245, 285 121
– Wastegate 120

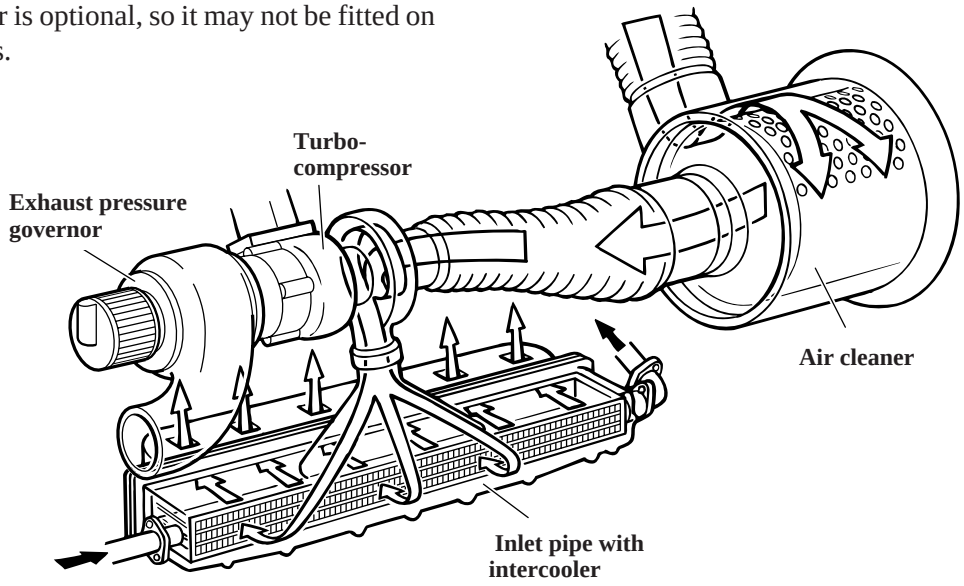
Exhaust pressure governor

– Description 125
– Servicing 126

Description

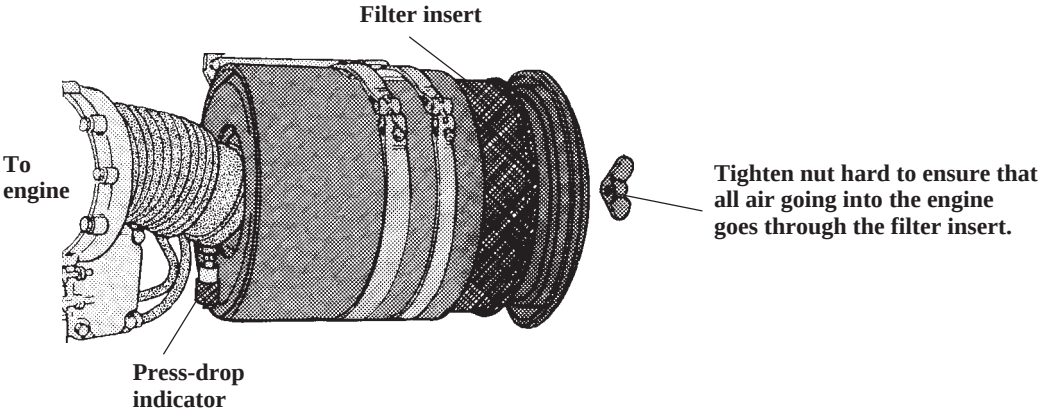
The intake system for the air is entirely separated from the fuel system. It consists of four main parts:

– air intake with inlet pipe
– air cleaner
– turbocompressor
– inlet manifold with starting pre-heater (including intercooler on engines with intercooler). The starting pre-heater is optional, so it may not be fitted on some engines.



Air cleaner

The air cleaner is of the dry filter type. Air flows through it from the outside to the inside.



Air cleaner, single filter insert type

The filter insert should be replaced when the pressure-drop indicator window shows red or if the filter has been in use for 18 months.

For more details, look up the Service Manual “Service and Maintenance”.

The air cleaner may have one or two filter inserts. The inner insert in the double filter variant does not need to be replaced as often as the outer one.

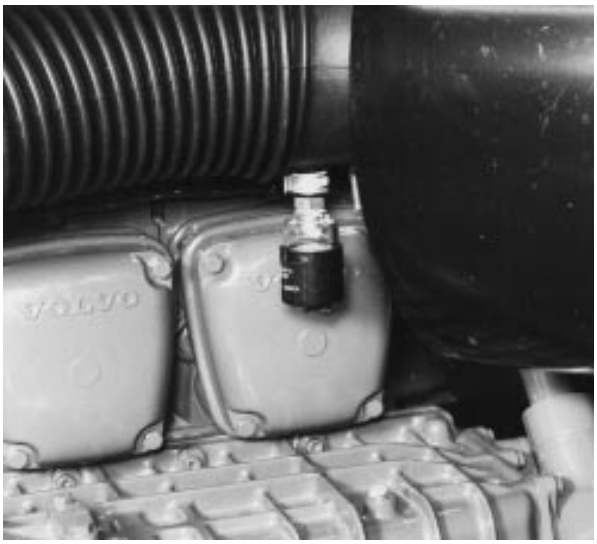
Buses fitted with double filter inserts usually also have a cyclone filter. This is mounted next to the air cleaner intake. It swirls the incoming air so that large dust and dirt particles drop down. When the engine stops, these fall down through a rubber valve in the bottom of the cyclone filter sleeve.

The rubber valve should be squeezed now and again just to make sure no dirt has stuck inside.

Intercooler

All the DH10A-engines have the single-circuit type intercooler with a separate cooling circuit, radiator and pump.

The intercooler lowers the temperature of the inlet air and this has a better effect on engine power. The system cools the inlet air down to approx. 60°C. Concerning pressure testing and description of the coolant circuits, refer to “Cooling system”.



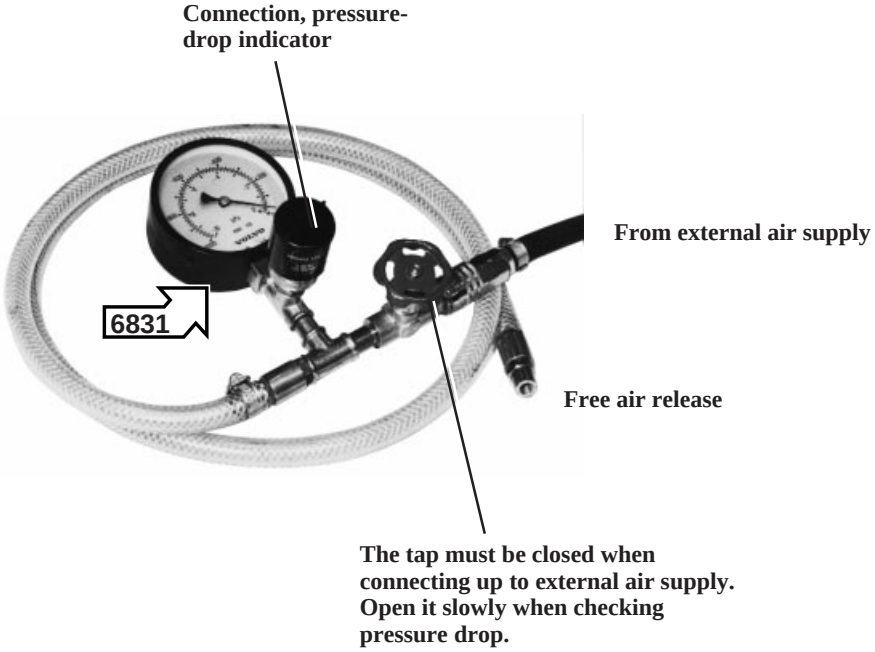
Pressure-drop indicator

Checking

The pressure-drop indicator should show full red at the Vp vacuum value given in the Specifications. If the indicator is not faulty, depress the reset button.

If faulty, replace the pressure-drop indicator.

When fitting the pressure-drop indicator, make sure it is screwed on tight. There must not be any air leakage on the “clean” side of the air cleaner.



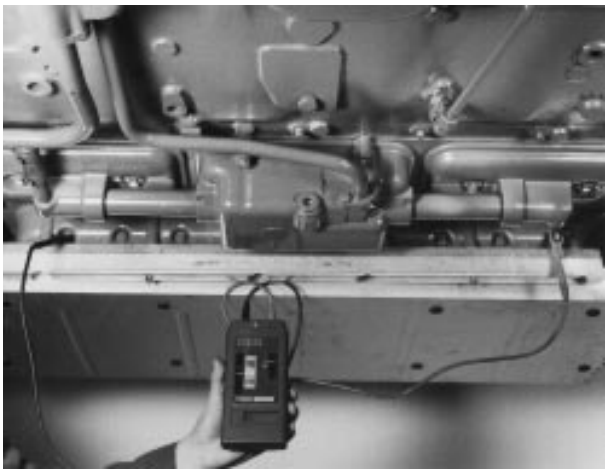
Starting pre-heater

Troubleshooting

An indicator lamp lights when the starting pre-heater is engaged. Should it light during testing, the fault is in the power supply circuit or in the operating circuit. But first check the fuses and also relay 312.

If cable failure or short-circuit is suspected, carry out the following checks:

1. Engage the starting pre-heater and feel with the hand the inside of the manifold where the retaining bolts and cable connection are. Slight heat should be felt after about 50 seconds.



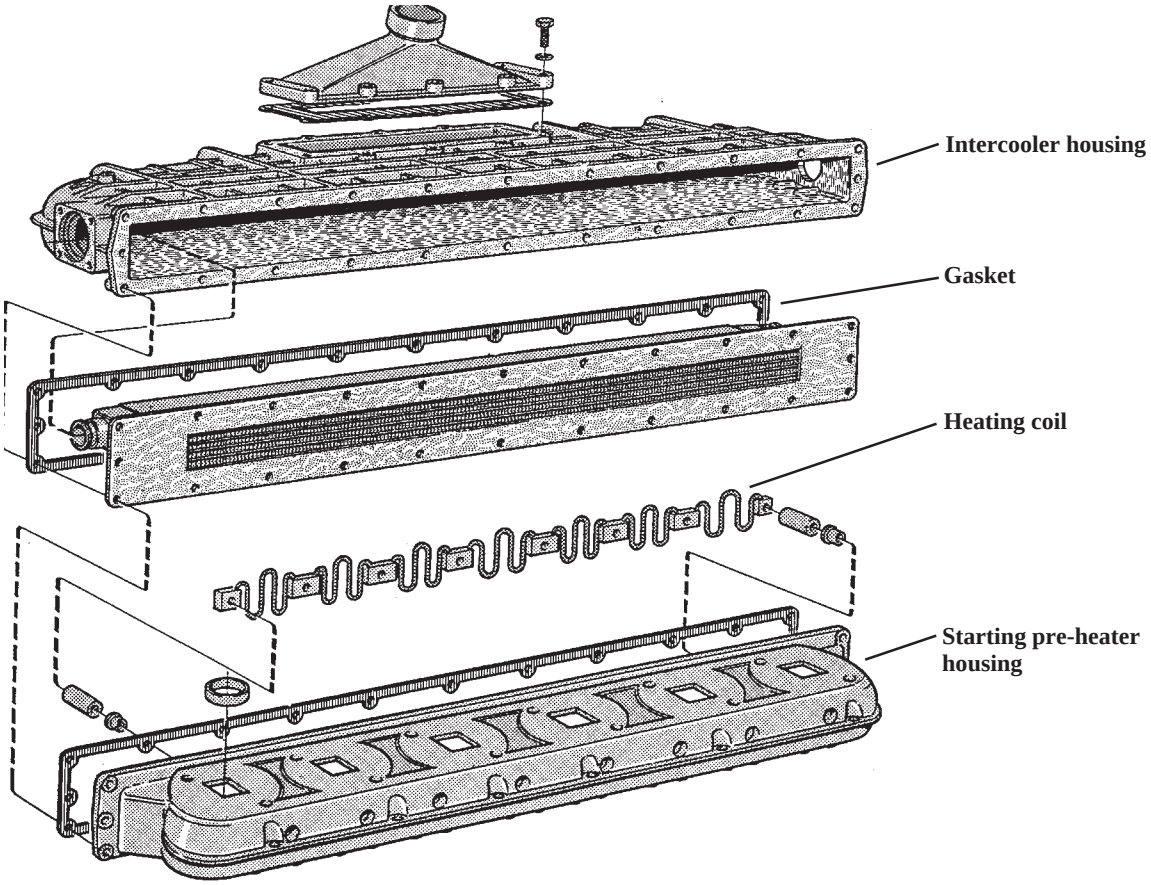
2. Measure the resistance through the heater coil between the stud where the cable is connected and the outer retaining bolt at the other end. This resistance should be approx. 0.3 ohm. High resistance indicates failure. Low resistance points to short-circuit, in which case the starting pre-heater fuse has momentarily popped out when the starting pre-heater engaged.

3. Measure the power consumption with the current gun aimed at the starting pre-heater cable. This should be approx. 160 amperes at 24 volts.

   No power consumption = cable failure.

   High power consumption, or if starting pre-heater fuse has popped out = short-circuit.

Switch off the electric circuits when about to replace the starting pre-heater!



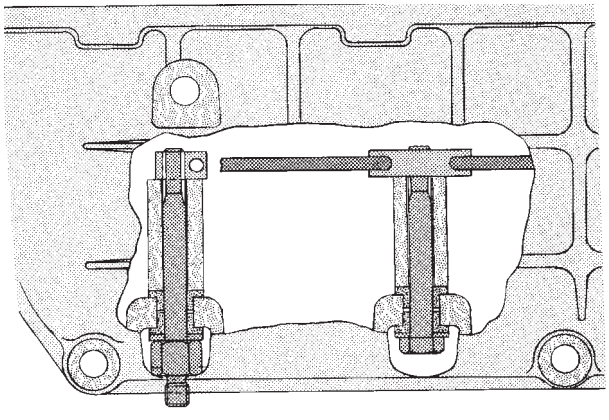
Replacing heating coil

Remove the intercooler housing and starting pre-heater housing as a complete unit. Separate these housings on the work bench in order to get at the coil.

This procedure makes it easier to align correctly the intercooler assembly with the starting pre-heater housing gasket.

When installing a new heating coil, it is important to de-insulate all retaining screws except the earth screw. The earth screw is insulated on the inside but has good earth contact on the outside. Current flows through this screw to engine earthing.

After installing the coil, switch it on and see that it reaches operating temperature. Then allow it to cool and check-tighten the screws.



The screws must not be check-tightened after installing the intercooler housing, as this would mean it would not be possible to check the heating coil without twisting it and causing a short-ciruit.

Turbocompressor

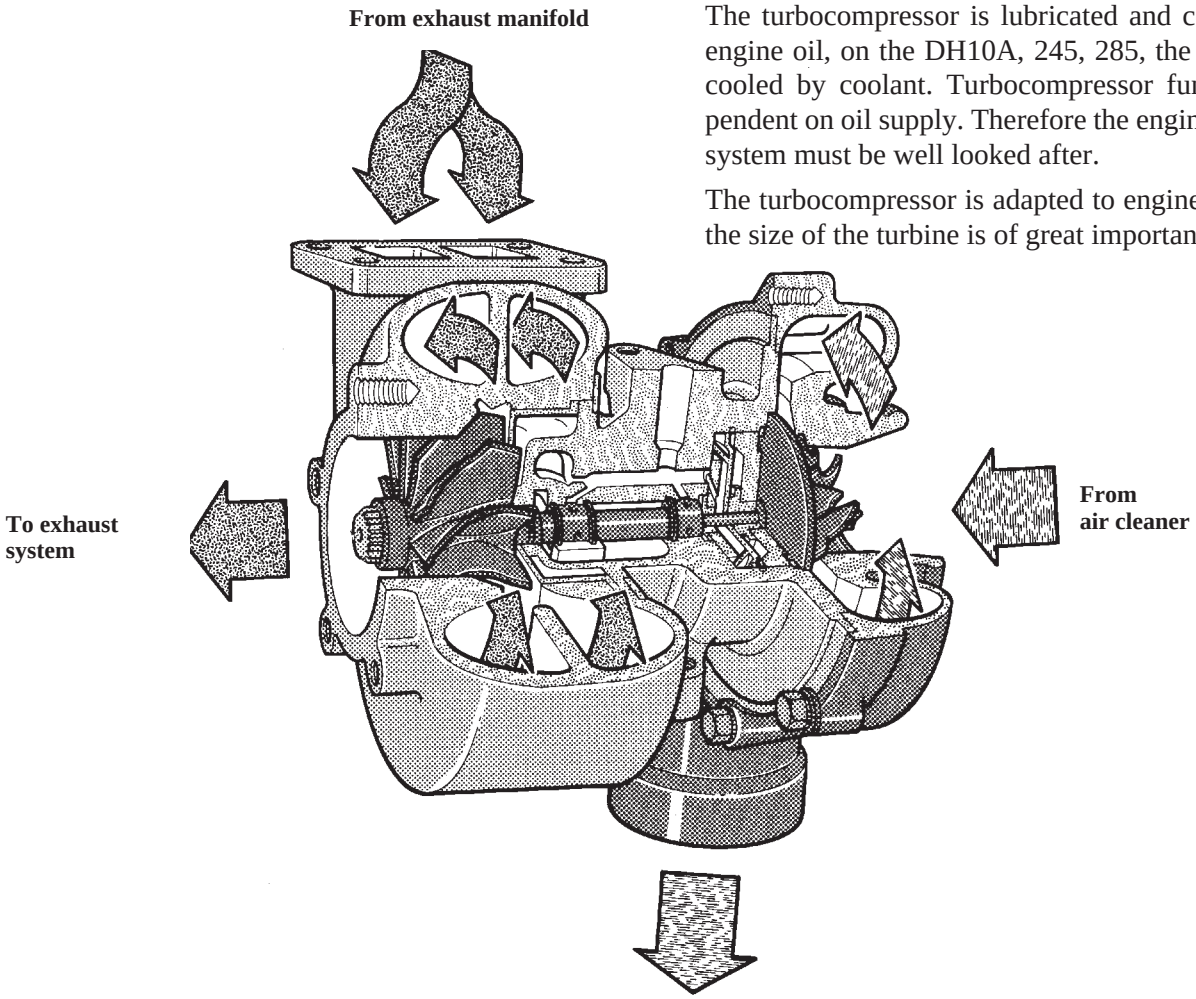
General

Use is made of the engine exhaust gases to drive the turbocompressor turbine wheel.

The turbine wheel and compressor wheel are mounted on the same shaft. When the compressor wheel rotates, it sucks air in from the air cleaner, the turbocompressor compresses it and presses it through the intercooler to the engine. Concerning the charge pressure, refer to "Condition test".

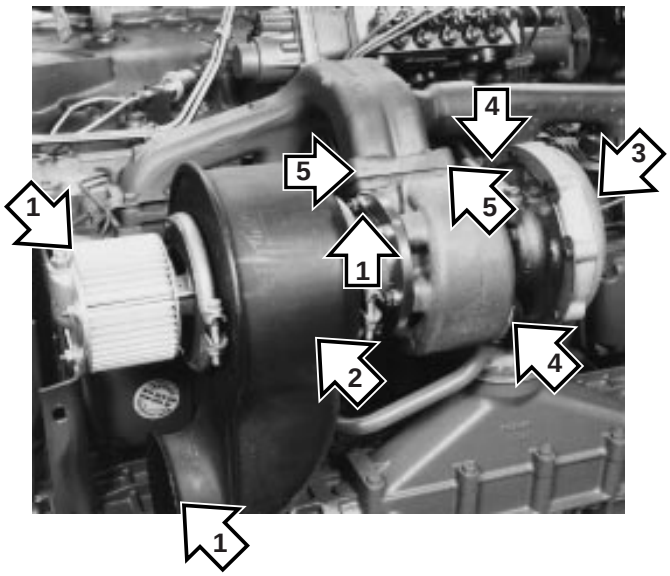
The turbocompressor is lubricated and cooled by the engine oil, on the DH10A, 245, 285, the turbo is also cooled by coolant. Turbocompressor function is dependent on oil supply. Therefore the engine lubricating system must be well looked after.

The turbocompressor is adapted to engine type, where the size of the turbine is of great importance.



Turbocompressor

Removing/installing



1. Remove…

– the compressed-air pipe for the exhaust pressure governor,

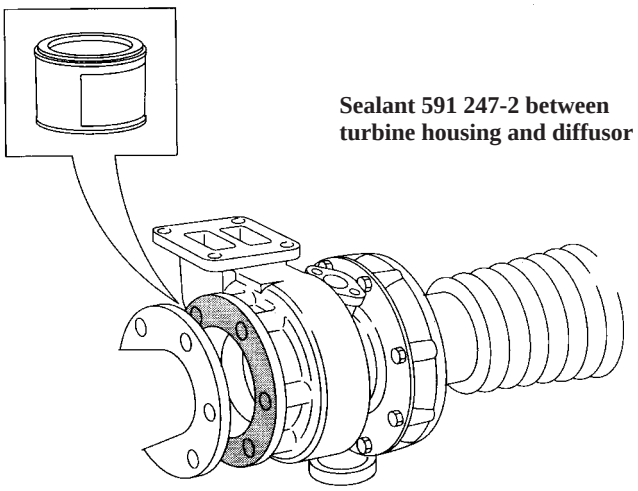
– the clamp between the shutter housing and the exhaust pipe,

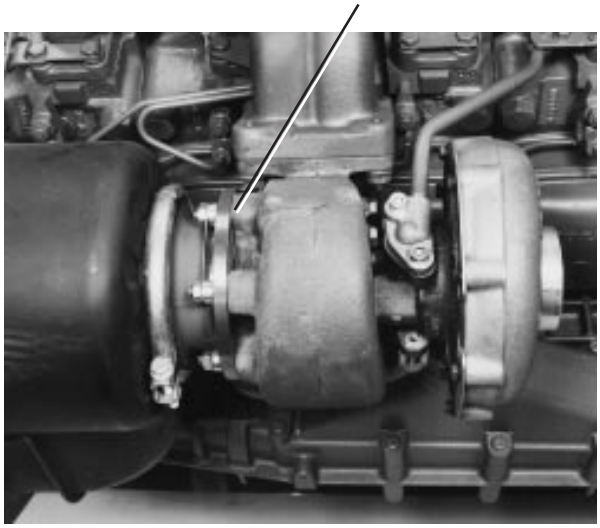
– the nuts for the diffusor.

2. Lift out the shutter housing.
3. Remove the inlet hose.
4. Disconnect the delivery and return oil pipes from the turbo.
5. For DH10A, 245, 285: Disconnect the coolant connections (do not disconnect the wastegate and control rod).
6. Remove the turbocompressor from the exhaust manifold.

Installing

Fit new gaskets on the
- exhaust manifold
- delivery oil pipe
- return oil pipe
- coolant connections (DH10A, 245, 285).



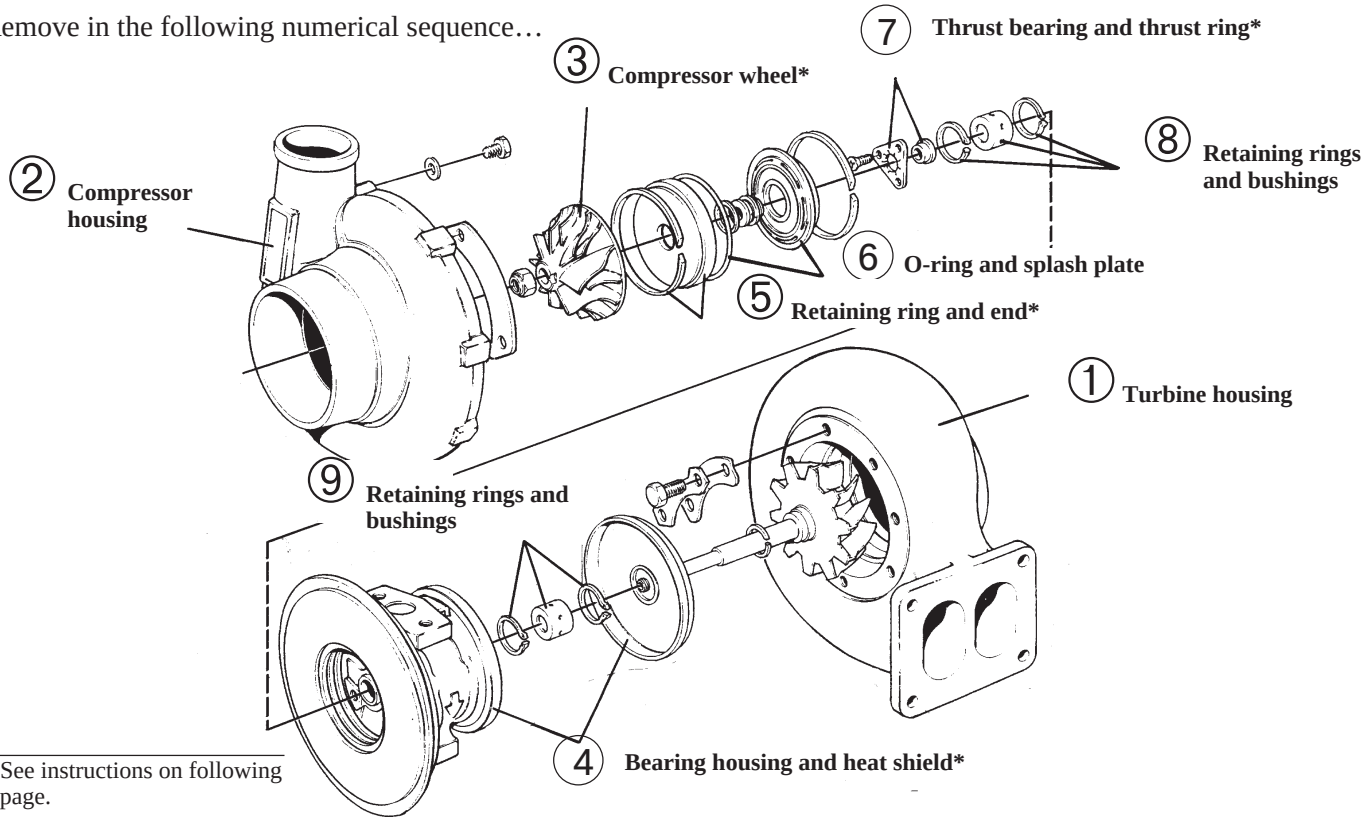


Servicing turbocompressor, DH10A, 345, 350, 360

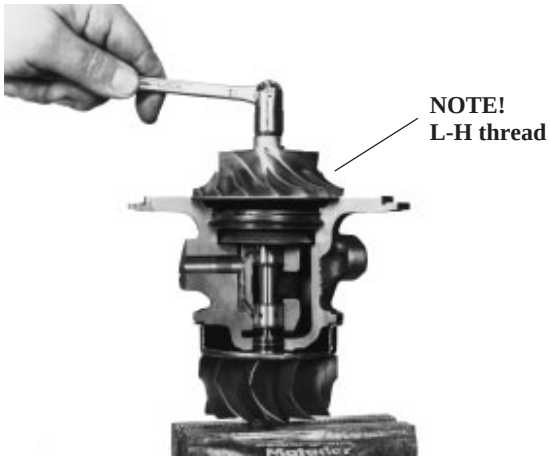
Special tools:
(998) 7600 Adapter
(999) 9708 Torque wrench

Always line-up mark the position for the turbine housing (1) and compressor housing (2) before starting the disassembling.

Remove in the following numerical sequence…



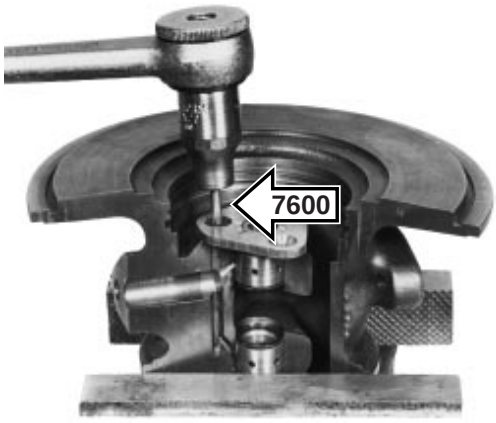
* See instructions on following page.



③

④

⑤



⑦

Circled digits refer to previous page.

Axial clearance, checking

Cleaning

Some parts are sensitive to corrosive cleaners. Such cleaners should therefore be avoided.

Make sure all areas adjacent to wheels and housings are free from deposits, are clean and smooth.

Let the parts seep in the cleaner until deposits drop off.

Use a plastic scraper or soft brush for cleaning the aluminium parts.

Note: A steel brush or metal scraper must never be used. Steam wash can also be used providing that shafts and other bearing surfaces are adequately protected.

Checking

Check all parts for wear. Always replace bearings, seals, circlip, lock washer with new ones from the repair kit.

Radial clearance, checking

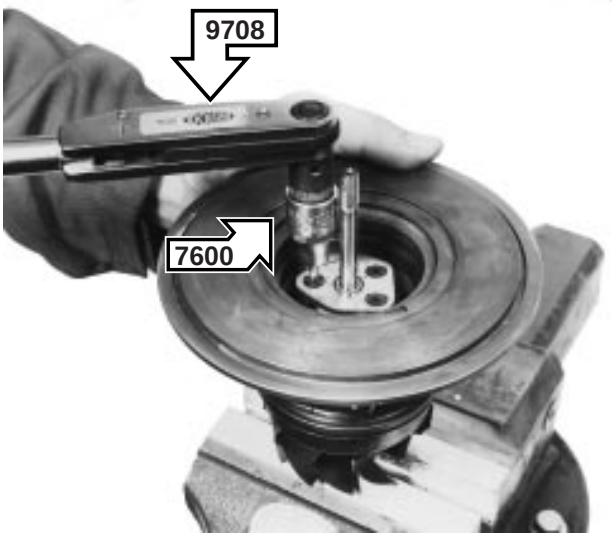
Checking, cont.

A damaged shaft with scored bearing surfaces must not be refitted. Minor scratches are acceptable.

A damaged turbine or compressor wheel must always be replaced. Do not try to straighten out a deformed blade. The housing should be replaced if it has cracks or has been exposed to overheating.

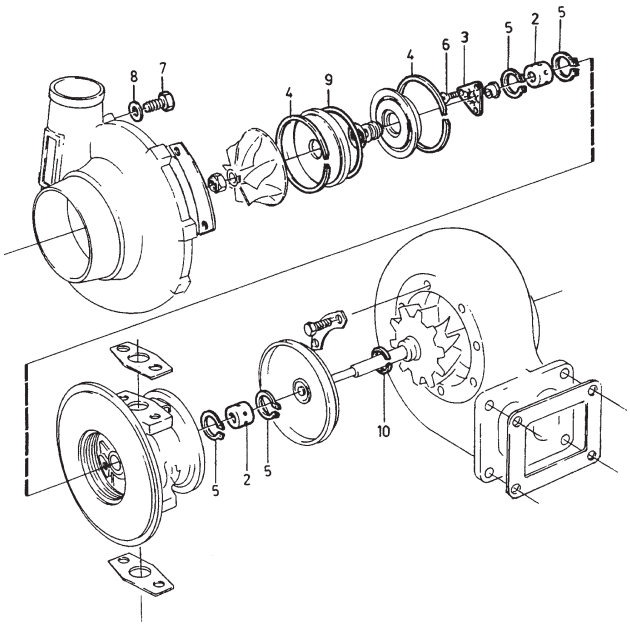
Very often the best alternative is to replace the entire compressor (exchange unit) if, e.g., the shaft, housing or some blades are damaged.

Axial clearance, rotor	0.10–0.16 mm
Radial clearance at	
compressor wheel, max.	0.635 mm
new bearings	0.37–0.56 mm
Throw, at shaft smallest diameter ..	max. 0.015 mm
Throw, turbine wheel rear	max. 0.16 mm



To note when assembling

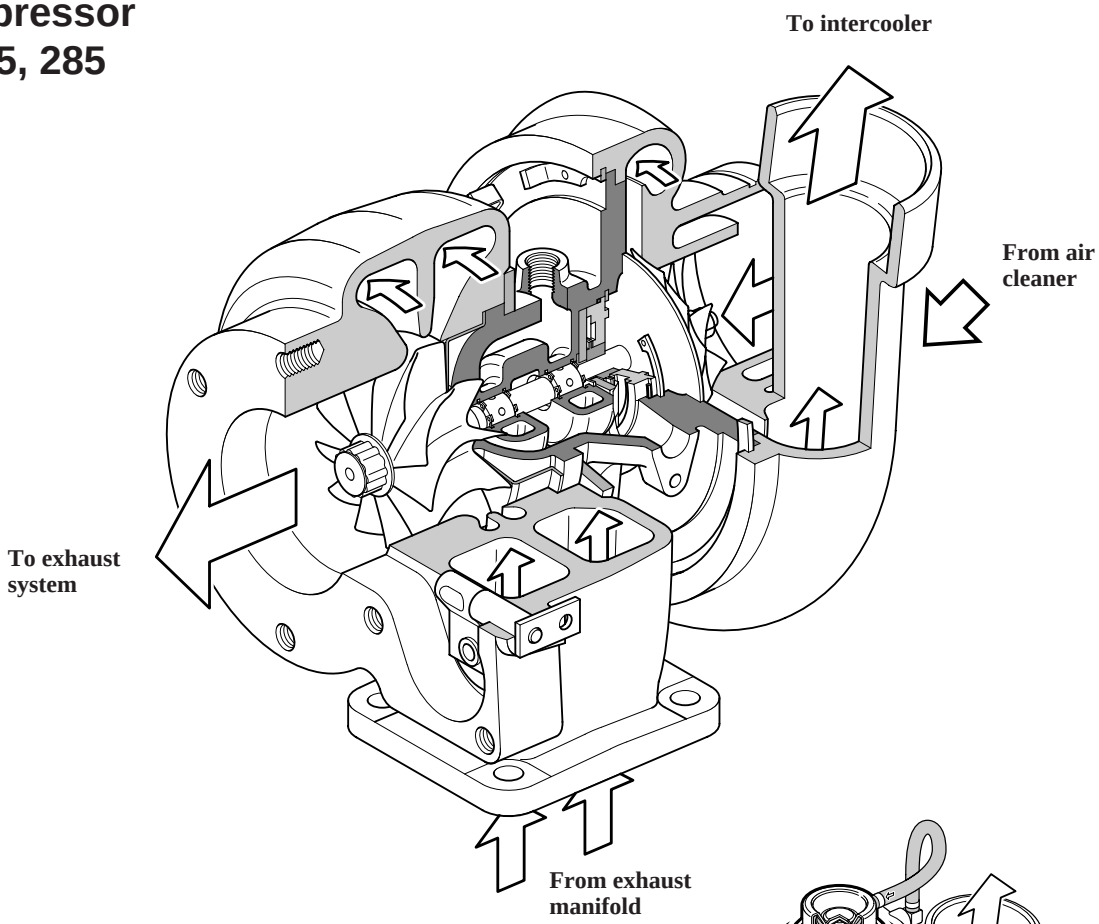
- Oil the bearing bushings and piston rings with straight engine oil.
- Make doubly sure that the piston ring seals centre correctly against the bearing bushings.
- Tightening torque for thrust bearing three bolts is **4.5 Nm** (0.45 kpm). Torque wrench 999 9708 and adapter 998 7600.
- Tightening torque for compressor wheel lock nut **17 Nm** (1.7 kpm). **NOTE!** L-H thread.
- Tightening torque for turbine housing bolts **13.6 Nm** (1.4 kpm) and compressor housing bolts **5.7 Nm** (0.6 kpm).



Repair kit

1. **–**
2. **Bearing bushing**
3. **Thrust bearing**
4. **Lock ring**
5. **Circlip**
6. **Screw**
7. **Screw**
8. **Lock washer**
9. **O-ring**
10. **Piston ring seal**

Turbocompressor DH10A, 245, 285

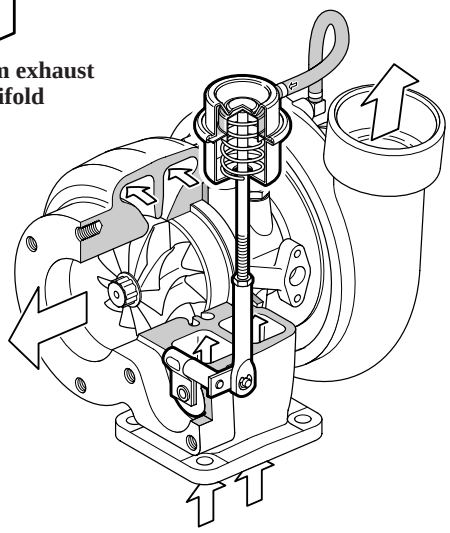


The turbocompressor on engine DH10A, 245 and 285, has a wastegate function that limits charge pressure at high power output. The wastegate-shutter functions as a by-pass valve for the exhaust turbine. The shutter is activated by a pressure box that, together with a hose connection, senses the charge pressure in the compressor housing.

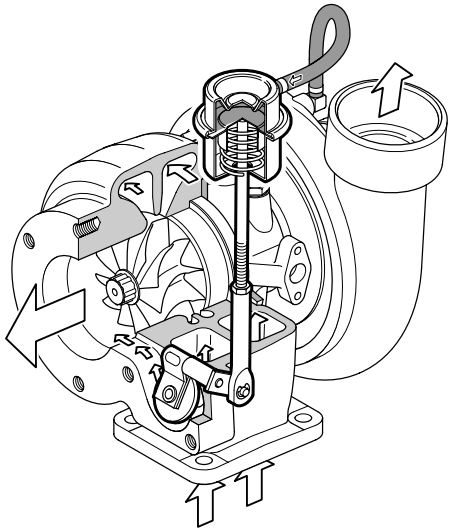
At low charge pressure, the pressure box spring keeps the shutter closed with a control rod. When the charge pressure reaches the pressure box opening pressure, the shutter starts to open to by-pass the exhaust pressure directly to the exhaust pipe. This offloads the exhaust turbine and the turbo speed drops.

The above function provides the turbocompressor with a broader working range and this results in an engine characteristic that has a wide high torque range and a limited charge pressure at full power output.

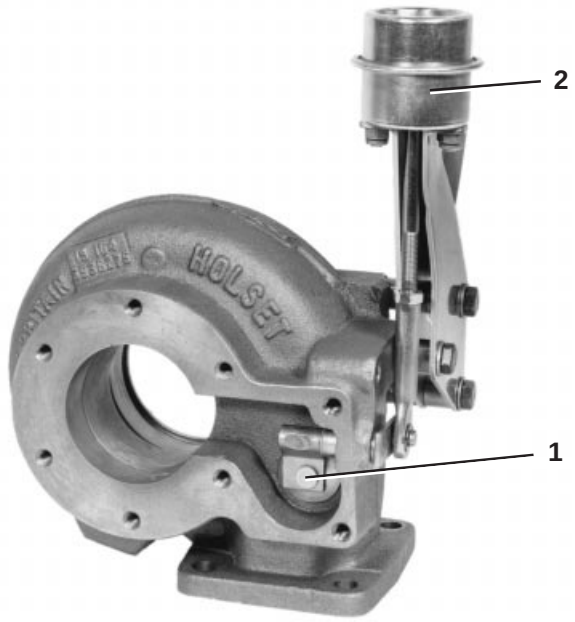
The turbine shaft journalling is lubricated and cooled by the engine pressure-lubricating system. Since engine DH10A, 245 and 285, is a typical city bus engine, which often has sound encapsulation, the bearing housing is moreover cooled by a coolant feed connected to the engine cooling system. Oil supply is essential to the function of the turbo compressor. That is why it is vitally important that the engine lubricating system is maintained according to instructions and that lube oil of the right quality and viscosity is used.

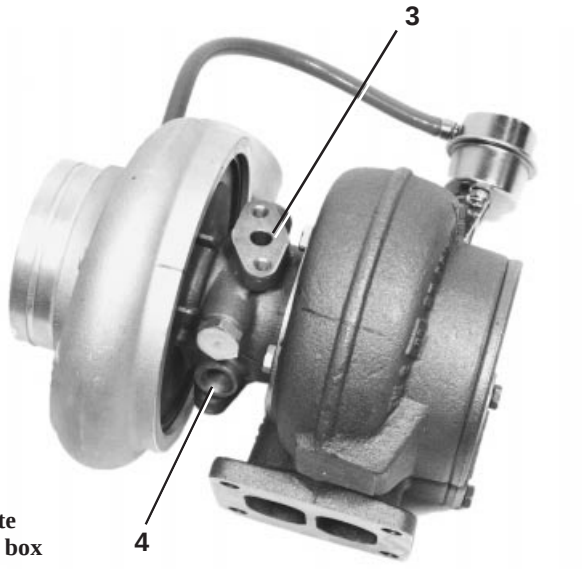


Closed



Open





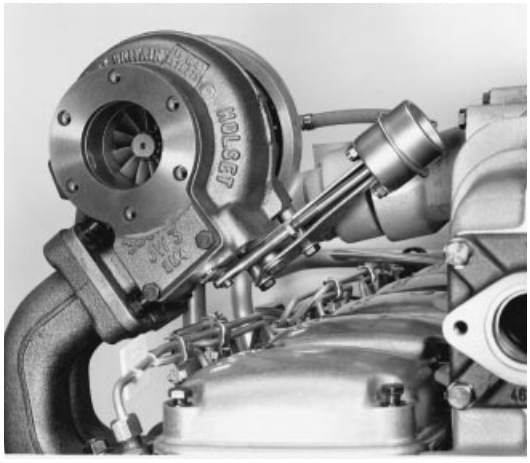
1. **Wastegate**
2. **Pressure box**
3. **Lube oil**
4. **Coolant**

Wastegate, checking opening pressure

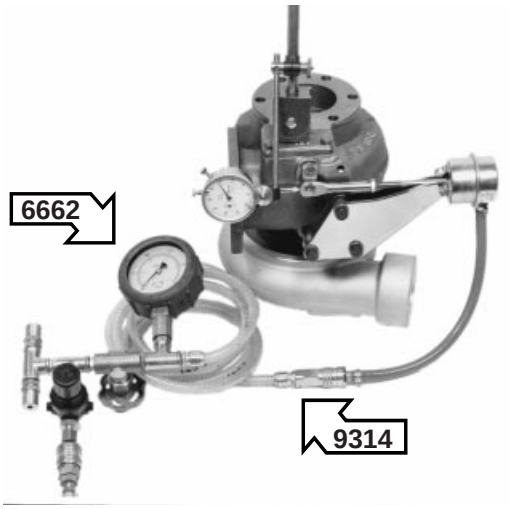
Special tools:
(999) 6662 Pressure gauge
9324 Nipple

Opening pressure	Control rod opening
155 kPa	1.0±0.3 mm when adjusting
	0.5–1.5 mm control value

If you suspect that the charge pressure is incorrect, check the wastegate opening pressure according to below. First check that the pressure box diaphragm seals correctly, but replace the pressure box if it leaks. Carefully follow the installation instructions supplied with the exchange kit for the pressure box. A wrongly mounted pressure box will result in an incorrect opening pressure.



1. Place a dial indicator (0–20 mm) with magnetic holder on the turbocompressor so that the measuring probe is in line with the control rod from the pressure box.
2. Remove the hose from the pressure box at the compressor housing and connect nipple 999 9314 to the hose. Connect pressure tester 999 6662 to the nipple. Always check to make sure the pressure gauge is correctly calibrated.



3. With the reducer valve on 6662 carefully let in pressure to the pressure box and observe the dial indicator at the same time. Read-off the indicator exactly when the control rod has opened 1 mm. Opening pressure must not exceed 155 kPa. Should the control rod opening deviate 0.5 mm or more from the specified value (1.0 mm) at correct opening pressure, adjust according to below.
4. If necessary adjust the control rod length, increased length lowers the opening pressure. The indicated opening must be maintained within a tolerance of ±0.3 mm at specified opening pressure.
5. Tighten the lock nut on the control rod, and renew the lock ring at the lever if necessary. Refit the pressure box hose to the nipple on the compressor housing using a new hose clamp.

Turbocompressor, repairs

Important!
Refers to repairs to turbo on DH10A, 245, 285.

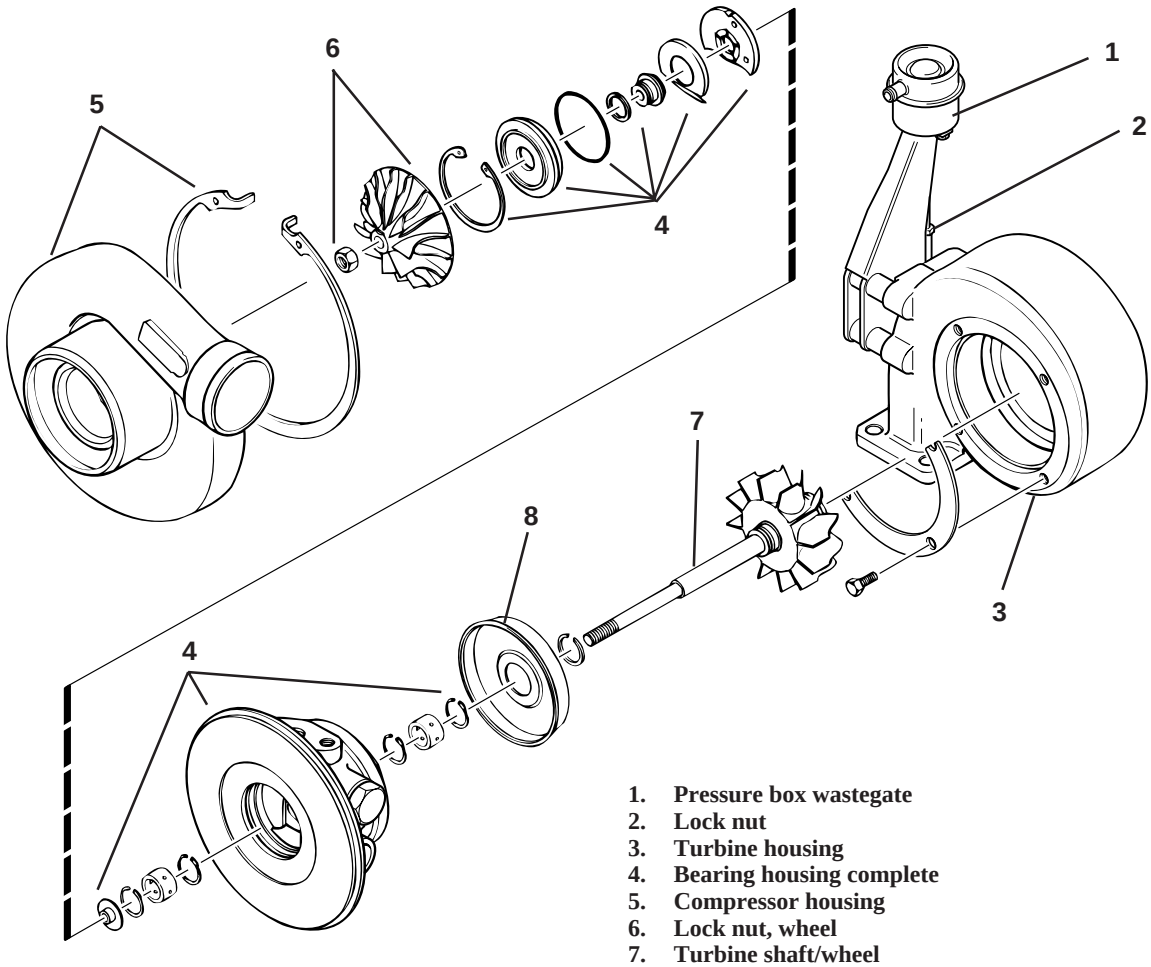
The wastegate with pressure box and bracket is not to be removed from the turbine housing. Nor is the lock nut on the push rod to be released. But, if it has to be released, the push rod must be adjusted, in which case refer to Checking wastegate opening pressure.

If the pressure box has to be replaced, use the repair kit for this (see Parts Catalogue). The kit contains a service tool (fixture) and necessary instructions for a correct mounting of the wastegate.

Always line-up mark the position of the turbine housing (1) in relation to the compressor housing (2) before disassembling.

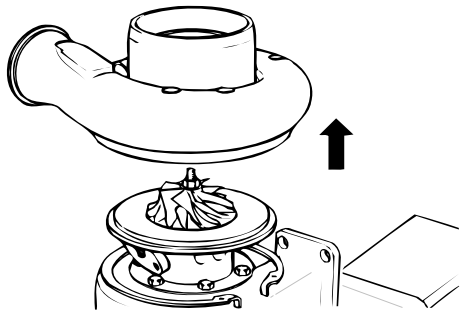
Remove:

- **Compressor housing (5).**
- **Bearing housing (4), compressor wheel (6) and turbine wheel (7). Avoid damage to the wheel blades.**



1. **Pressure box wastegate**
2. **Lock nut**
3. **Turbine housing**
4. **Bearing housing complete**
5. **Compressor housing**
6. **Lock nut, wheel**
7. **Turbine shaft/wheel**
8. **Heat shield**

– Observe due care when removing the compressor housing/turbine housing not to damage the blades on the wheels.



– The lock nut on the compressor wheel (6) has a l-h thread.

– Line-up mark the position of the axial bearing and the oil guide plate.

Cleaning

Corossive cleaners can damage certain parts and should therefore be avoided.

Make sure all surfaces adjacent to the wheels and housings are free from deposits and are clean and smooth.

Allow the parts to seep in a cleaner until the deposits drop off.

Use a plastic scraper or soft brush on the aluminium parts.

Note: A steel brush or metal scraper must never be used. Steam can be used on condition that shafts and other bearing surfaces are not damaged.

Blow all parts clean with pressurized air; check particularly to make sure that all drillings and slide surfaces are free from dirt.

Checking

Check all parts for wear. Bearings, seals, lock rings and circlips requiring replacement should be replaced with the corresponding parts from the repair kit.

A damaged shaft with scoring on the bearing surfaces must not be re-fitted. Minor scores are acceptable.

If damaged, the turbine and compressor wheels must always be replaced. Do not attempt to straighten out a deformed blade. The housing is replaced if it is cracked or been exposed to overheating.

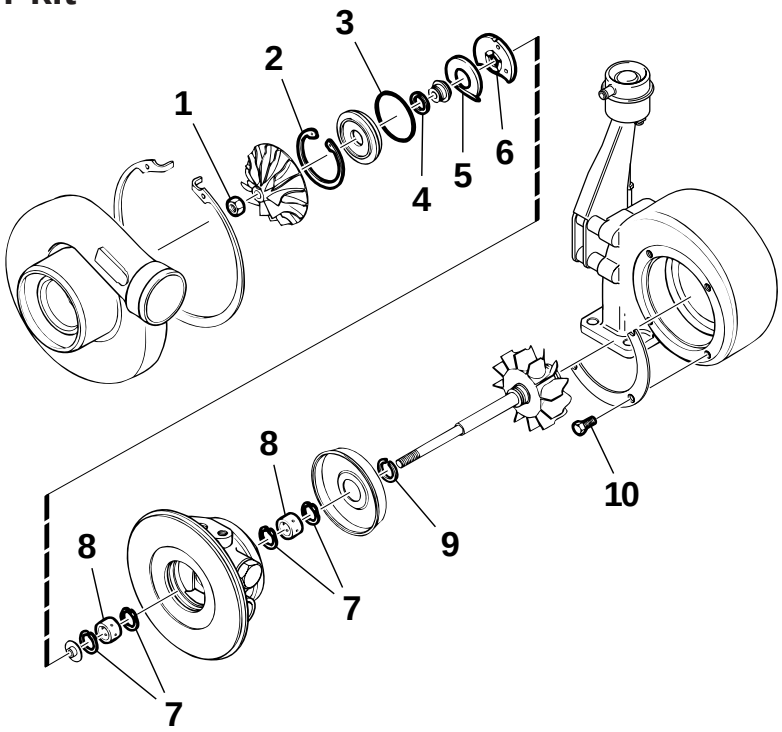
Very often the better alternative is to replace the entire compressor (exchange unit) if, e.g., the shaft, housing or some blades are damaged.

For DH10, 245, 285

Check to make sure the wastegate pressure box is not leaking air.

NOTE! Max. test pressure 155 kPa (1.55 kp/cm^2). With leakage, replace the pressure box.

Repair kit

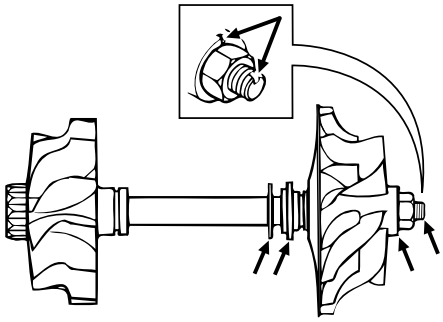


1. **Lock nut**
2. **Circlip**
3. **O-ring**
4. **Piston ring seal**
5. **Oil guide plate**
6. **Axial bearing**
7. **Retaining rings**
8. **Bearing bushings**
9. **Piston ring seal**
10. **Screw**

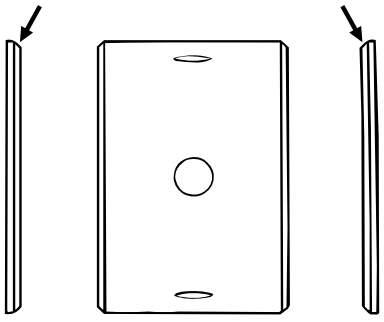
Installing

Important!

– Always make sure that the balance mark is in line on the rotor when assembling the turbo.



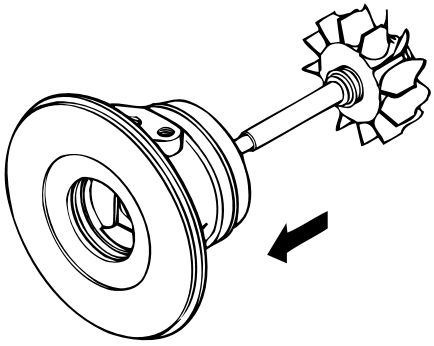
– Note when fitting the retaining rings (7) that the bevelled side faces the bearing bushing (8).



– Use straight engine oil and oil the bearing parts and the piston ring seals.

– Turn the piston ring seal on the turbine shaft so that its opening coincides with the oil drain hole (180° from the oil drain hole).

  Fitting the piston ring seal is made easier by rotating the shaft while carefully pressing the turbine wheel together with the bearing housing.



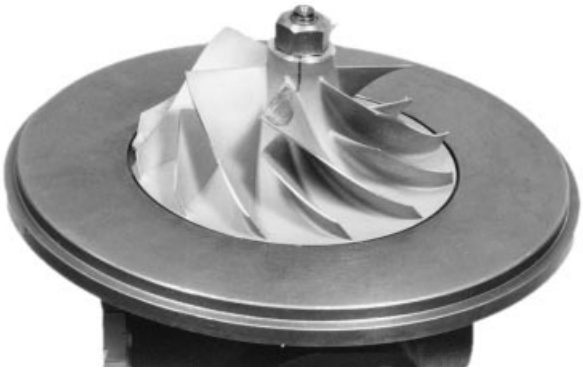
– Line-up the balance mark on the oil guide plate with the mark on the axial bearing (6) and the mark on the shaft end.

  Oil the O-ring (3) on the oil seal and make sure that the axial bearing and oil guide plate are placed correctly.

– Fit the circlip (2), with the bevelled side facing the bearing bushing. Check to make sure the circlip properly locates in the groove.

– Align the compressor wheel balance mark.

  Mount the wheel and tighten the lock nut (1) to 17 Nm. Note that the nut has a l-h thread.



– Align the line-up marks on the bearing housing and the turbine housing. Tighten the screws (10) to 14 Nm.

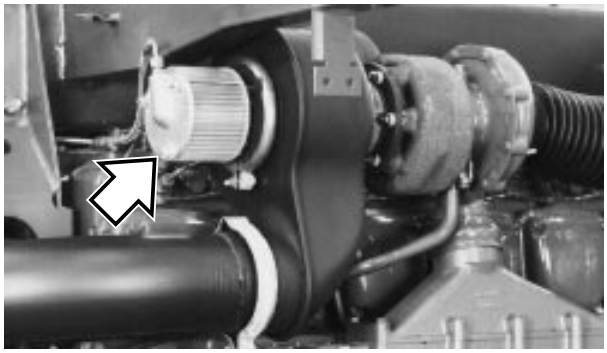
– Secure the turbine housing and check-measure radial and axial clearance with the help of a dial indicator.

Axial clearance: For DH10A, 245, 285

Radial clearance: For DH10A, 245, 285

– Align and carefully fit the compressor housing.

  Make sure that the circlip locates properly in the groove.

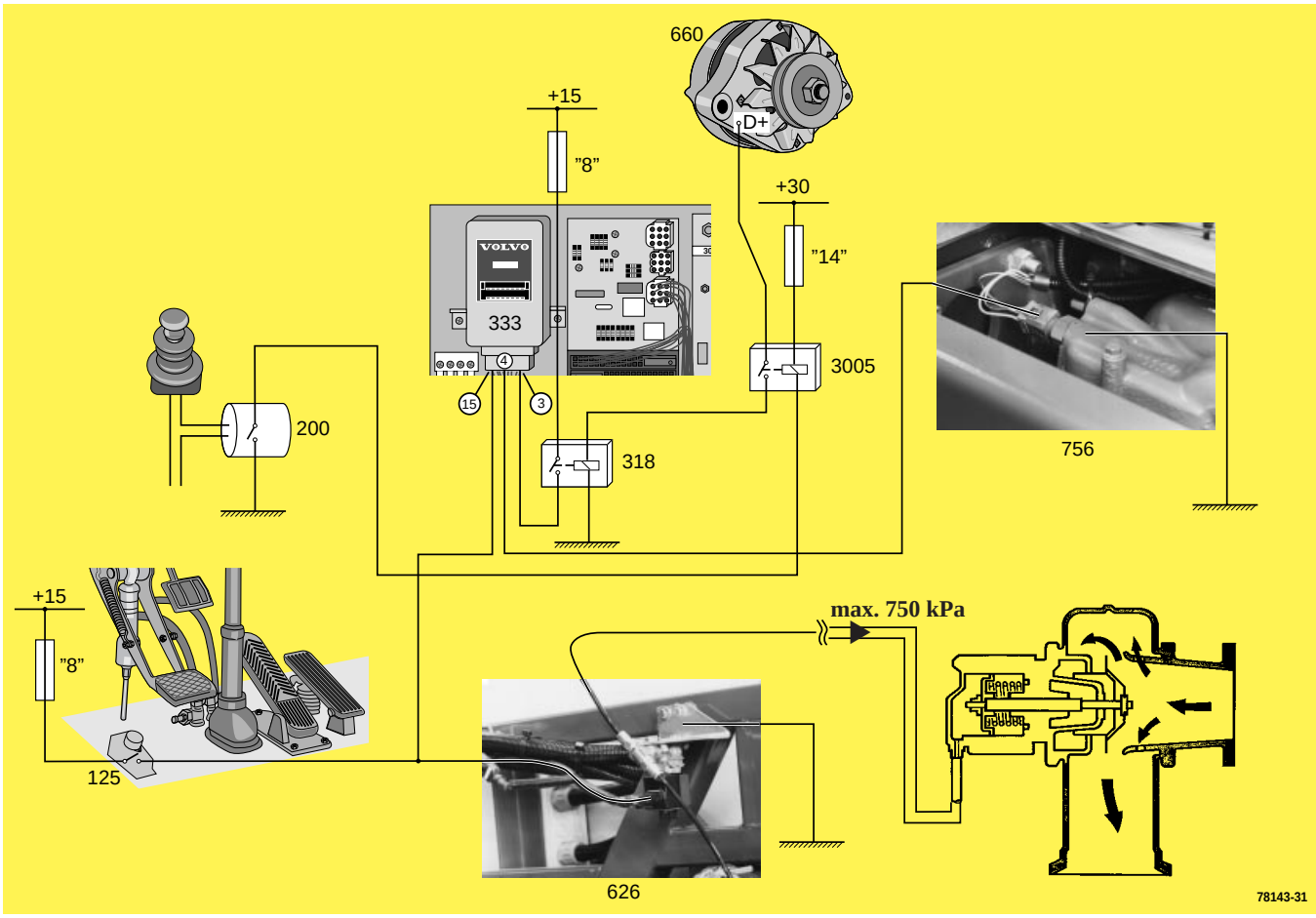


Exhaust Pressure Governor (EPG)

The engine has been fitted with an exhaust pressure governor (EPG) the function of which is to provide cleaner exhaust gases while the engine is warming up.When the parking brake is on and coolant temperature is below 70°C, the governor shutter closes off the exhaust gases so that the engine works against a certain backpressure and this reduces hydrocarbon emissions and white smoke. The EPG is controlled by pressurized air via a solenoid valve and a reducer valve.

The EPG also functions as an exhaust brake when the exhaust brake switch is activated.

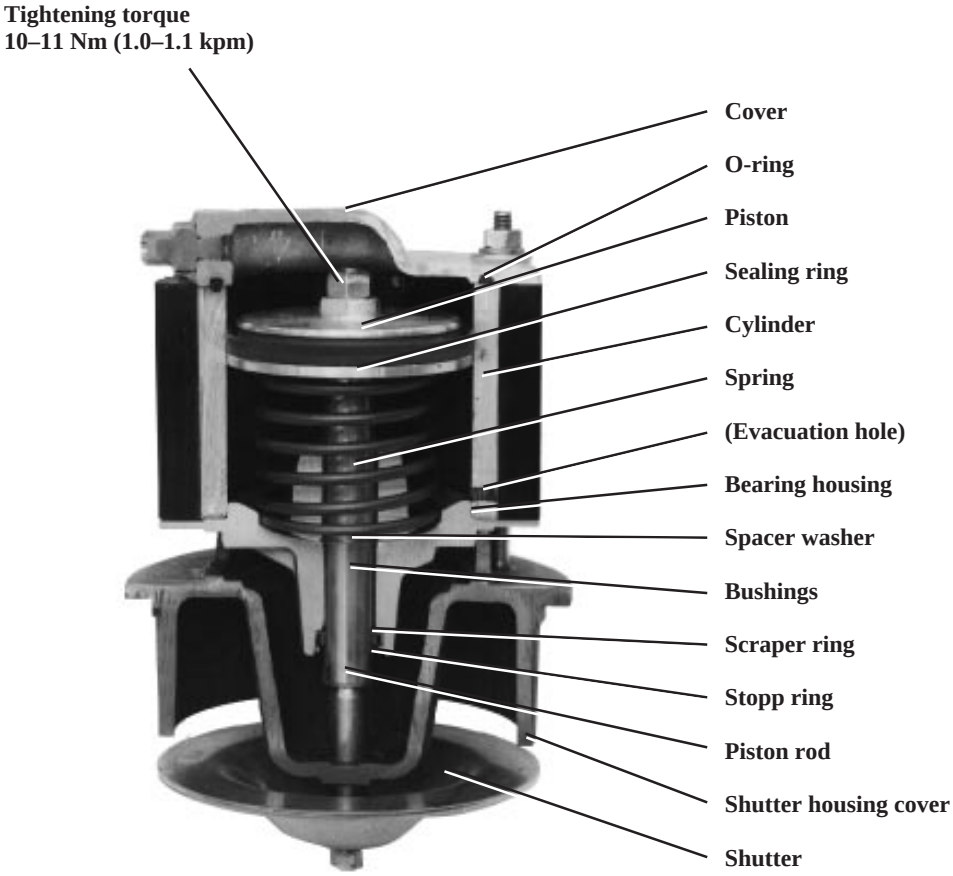
Note. The same control pressure is used for the EPG during warm-up as for exhaust braking, which is max. 750 kPa.



Electric and compressed-air circuits for exhaust pressure governor

Exhaust pressure governor, servicing

Special tool:
(999) 6068 Drift



Disassembling

1. Remove
   – cover
   – piston
   – spring

2. Remove
   – cylinder
   – bearing housing
   – spacer washer

3. Remove
   – piston rod
   – shutter

4. Replace parts that are damaged and worn.

   Use drift 6068 for changing bushings in bearing housing.

Assembling

5. Fix the shutter in a vice.

6. Fit on the shutter housing cover.

7. Fit the bearing housing and piston rod.

8. Fit the cylinder. Make sure the evacuation hole faces down.

9. Fit the spacer washer, spring and piston.

10. Fit the cover.

Group 26

Cooling System

Contents

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– Pressure valve 131

Coolant pump
– Disassembling/assembling 131

Intercooler
– Pressure-testing 135

Cooling fan
– Description 137
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• Coolant temperature sensors 142

Fan drive
– Fan drive with drive belts 143
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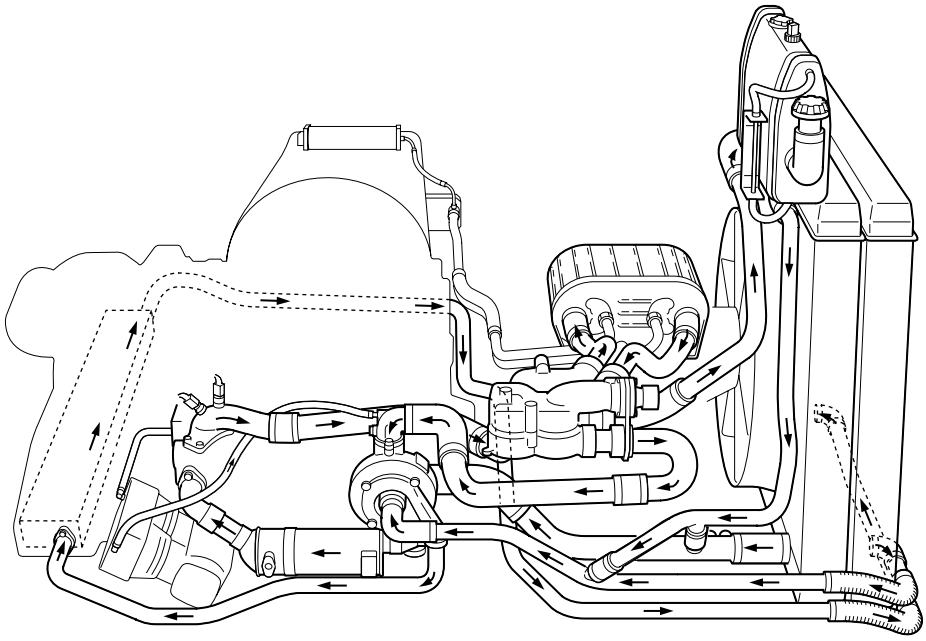
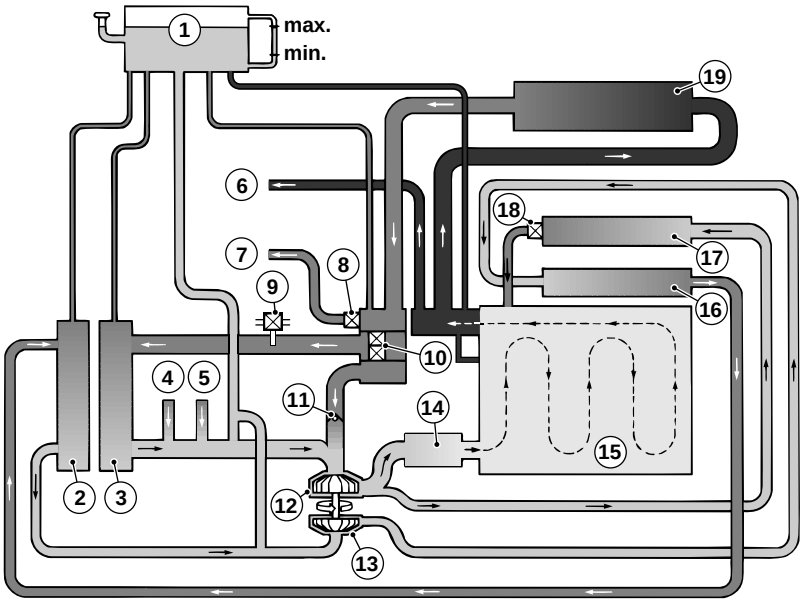
Cooling system – description

The function of the cooling system is to cool the engine, and if the bus has a separate hydraulic retarder or retarder built into the gearbox, also the oil for the retarder or gearbox. The engine gets its cooling from coolant pumped round the engine in the coolant drillings and by the coolant also flowing through the oil cooler, this contributing to engine cooling by lowering the engine oil temperature. Two piston type main thermostats regulate the engine coolant temperature. The system also has two other thermostats: a heating system thermostat and a thermostat for the retarder (or gearbox) oil cooler. The thermostats direct the coolant flow to the respective circuit to the extent they are influenced by the coolant temperature.



Layout diagram, cooling system



1. **Expansion tank**
2. **Radiator for intercooler 2**
3. **Radiator for engine circuit and intercooler circuit 1**
4. **From bus interior radiators**
5. **From windscreen defroster and possibly heated lube oil tank**
6. **To windscreen defroster and possibly heated lube oil tank**
7. **To bus interior radiators**
8. **Thermostat, interior heaters**
9. **Thermostat for regulating fan speed**
10. **Thermostats, engine**
11. **Pressure retaining valve**
12. **Coolant pump, engine circuit and intercooler circuit 1**
13. **Coolant pump, intercooler circuit 2**
14. **Oil cooler, engine**
15. **Engine**
16. **Intercooler element 2**
17. **Intercooler element 1**
18. **Thermostat, intercooler circuit 1**
19. **Oil cooler in gearbox/retarder**

The engine and intercooler circuits are connected up as before. The cooling circuit for the hydraulic retarder and the automatic transmission are coupled in series with the engine cooling circuit. If the bus does not have an hydraulic retarder or automatic transmission (pos. 19), their connections on the thermostat housing are inter-coupled with a pipe elbow and the thermostat housing has only one vent hose.

Pos. 9 is the thermostat valve that controls the hydraulic pump and thereby the fan speed. (Hydraulic-driven fan.)

Cooling system vent lines, B10M

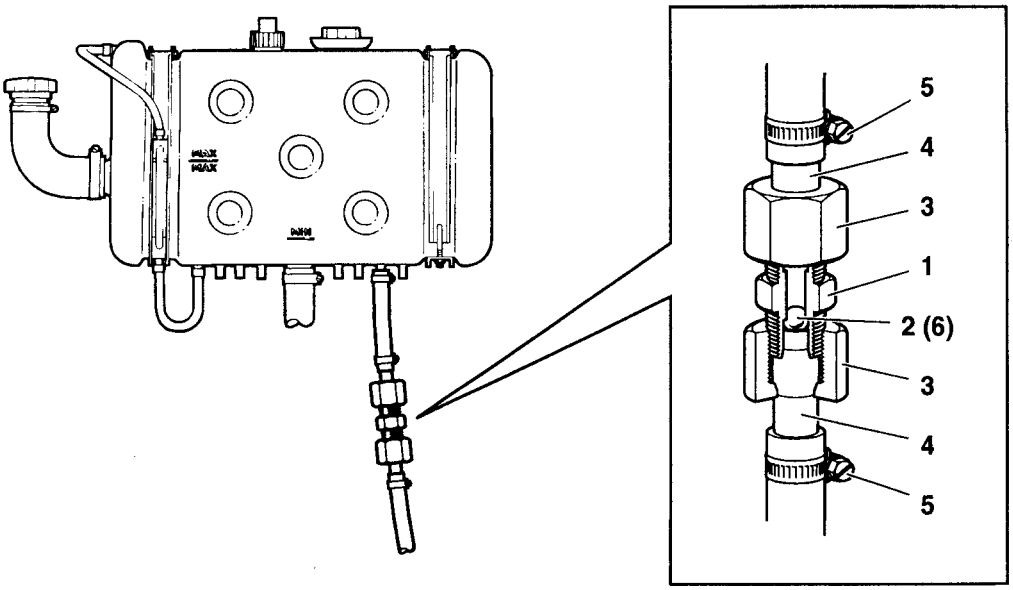
To prevent air from getting into the cooling system a vent line from the radiator lies in the bottom of the expansion tank, that is, below coolant level. This, however, makes for slower venting when filling an empty cooling system from the expansion tank. For this reason, we recommend filling via the evacuation connection in the bottom of the cooler, using filler unit 9812271-6.

NOTE!
The radiator vent line must not be inter-coupled with the other vent lines as this could risk air feedback.

Better use of cooling system heating capacity

Check valve between intercooler and expansion tank

When the coolant diverts heat from the engine, some of the coolant goes up to the cooling system expansion tank. At the same time a small amount of coolant flows from the intercooler circuit also up to the expansion tank. This coolant is much cooler than the coolant that comes from the remaining part of the engine. From the point of view of heating, this is not a good mixture, particularly at low ambient temperatures. It is estimated that up to 5% of the heating capacity is lost. This corresponds to an approx. 3–5°C loss in temperature for the coolant flowing into the bus heating system. To reduce these losses and thereby raise the temperature of the bus heating system, a check valve has been installed in the vent hose between the LLK-radiator and the expansion tank. The check valve prevents coolant circulation but does not prevent venting.



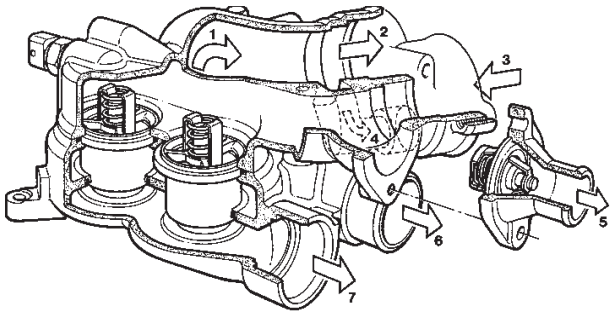
Check valve

Pos.	Description
1.	Nipple
2.	Ball (B10B)
3.	Nuts
4.	Nipple
5.	Hose clamps
6.	Ball (B10M)

Main thermostat

The thermostat housing contains two thermostats for maintaining temperature in the engine cooling circuit and one thermostat for the bus interior heating system.

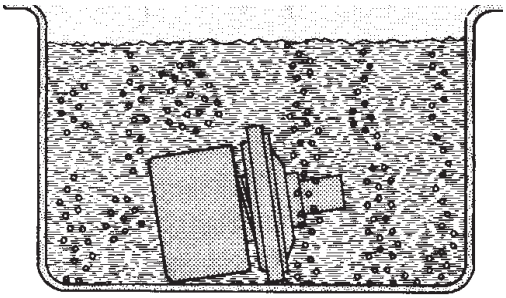
If the bus does not have an hydraulic retarder or automatic transmission with oil cooler, their connections 2 and 3 on the thermostat housing are inter-coupled with a pipe elbow and the housing has only one vent hose.



The following is the flow in the thermostat housing:

1. **From engine**
2. **To oil cooler in gearbox/retarder**
3. **From oil cooler in gearbox/retarder**
4. **To windscreen defroster and (if fitted) heated lube oil tank**
5. **To bus interior heating circuit**
6. **To radiator**
7. **To coolant pump**

Main thermostat, checking

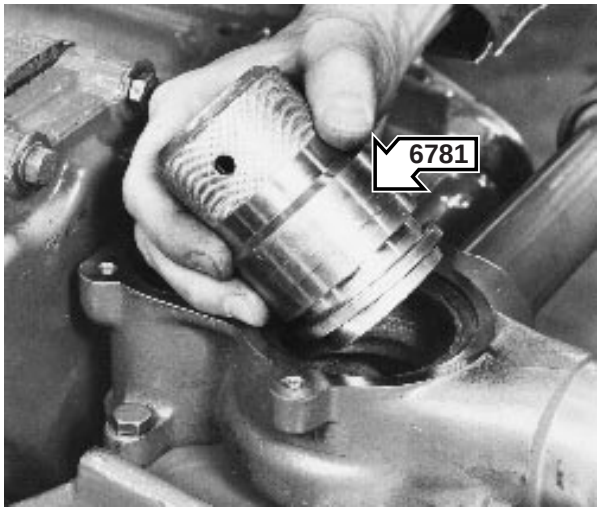


1. Check to make sure the thermostat is fully closed. To confirm this hold the thermostat up against a light. No light may shine through where the joints meet. If it does, this means that the thermostat cannot be closed and must, therefore, be replaced.

2. Heat the water to 75°C and insert the thermostat.

3. After at least 30 seconds check to see if the thermostat is still closed.

4. Heat the water to boiling point (100°C). After the water has been on the boil for at least 30 seconds, check to see if the thermostat has opened at least 7 mm. If the thermostat has not opened, replace it.

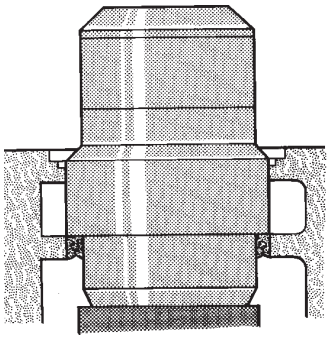


Replacing main thermostat sealing ring

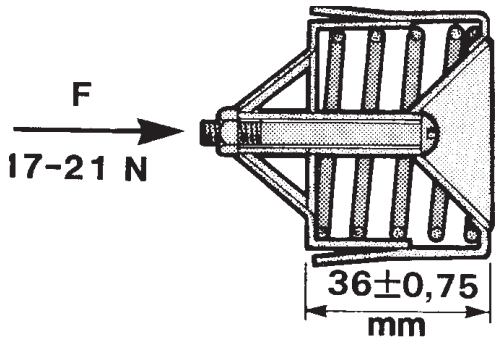
Special tool:
(999) 6781 Drift

Use the special drift, 6781, to locate the sealing ring properly in relation to the thermostat contact surface.

1. Place the new sealing ring on drift 6781.



2. Carefully tap in the sealing ring until the drift bottoms in the thermostat housing.

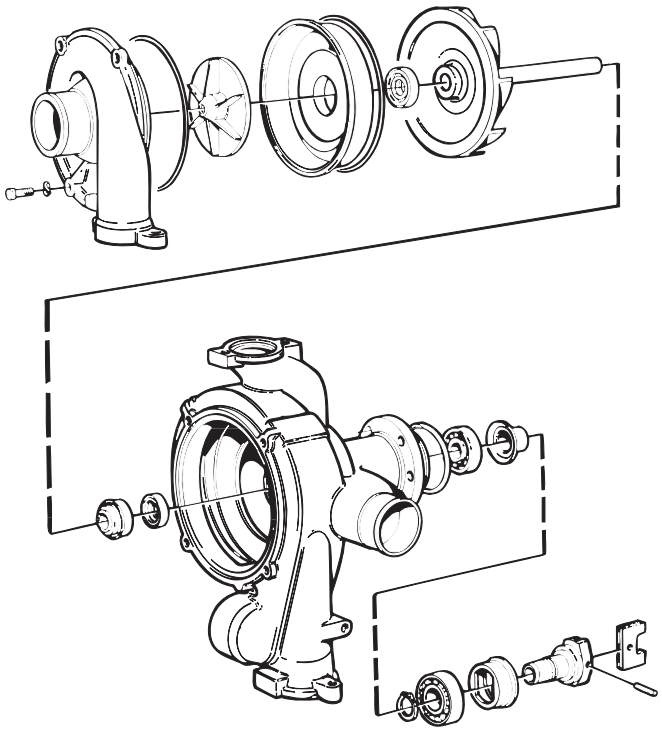


The **pressure valve,** which is placed in the tube between the thermostat housing and the coolant pump, increases the pressure in the inner circuit when the main thermostat is closed, especially at low engine speed. This improves circulation in the heating system circuits.

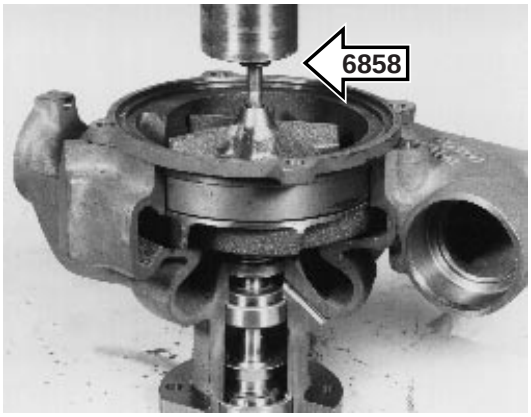
The Fig. shows valve opening under load.

Coolant pump

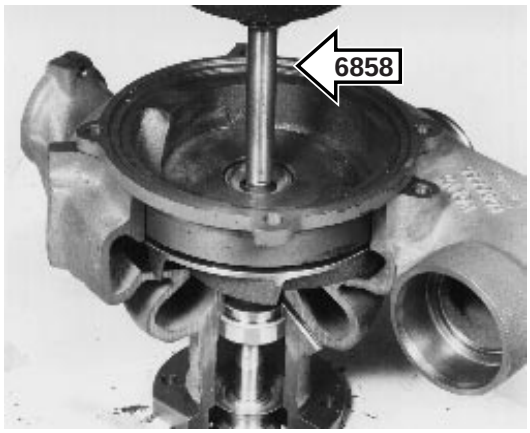
Special tools:
(999) 2268 Drift
2269 Counterhold
6858 Drift
8039 Drift
8113 Drift
6859 Counterhold



1. Remove the pump cover and flange.
   Press out the shaft enough to loosen the impeller.

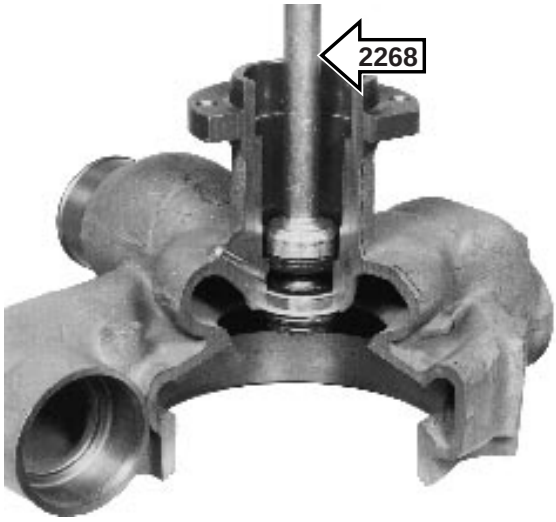


2. Press out the shaft.



Cont. next page…

3. Tap out the seals.

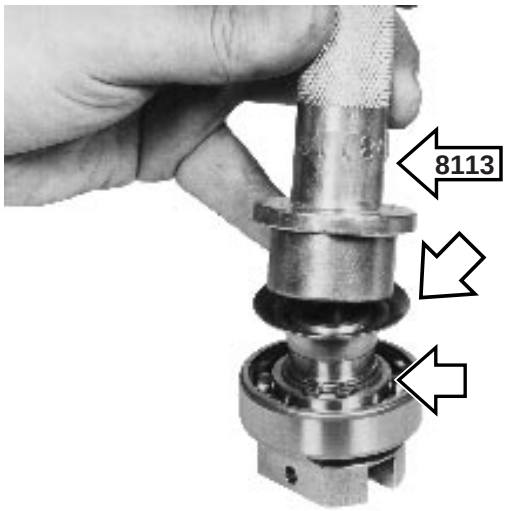


4. Remove the circlip.
   Press out the outer bearing and the deflector ring.

5. Press the shaft out of the bearing cage.

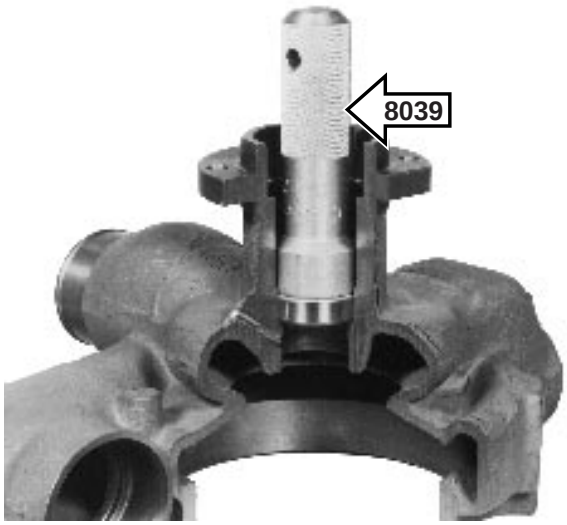
6. Press a new bearing into the bearing cage.

7. Fit the circlip.
   Tap on the deflector ring.



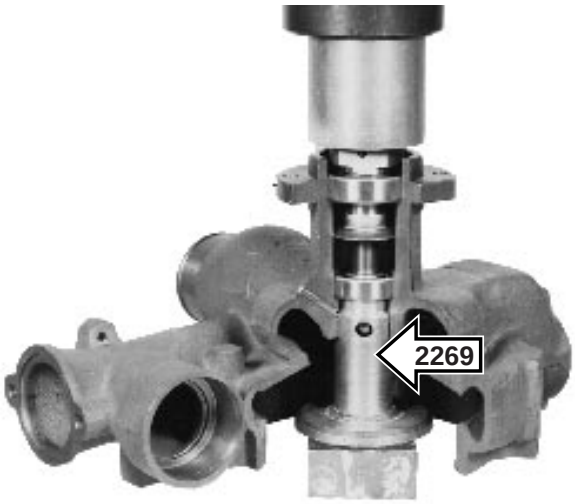
8. Mark the shaft 37 mm from its end.
   Press the shaft in up to the mark.

9. Tap the inner bearing into the bearing housing.

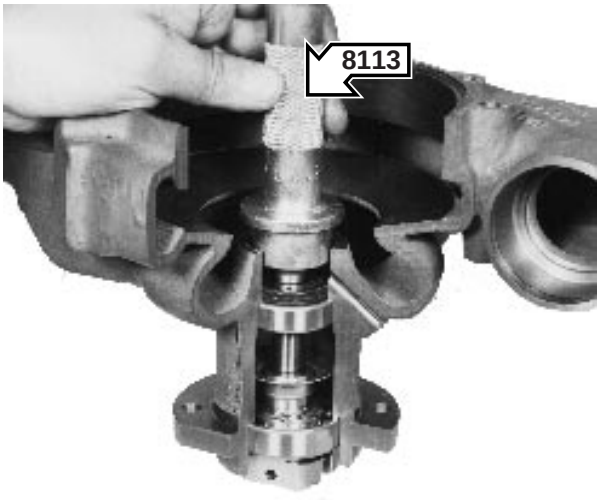


10. Press in the shaft, bearing and bearing cage.

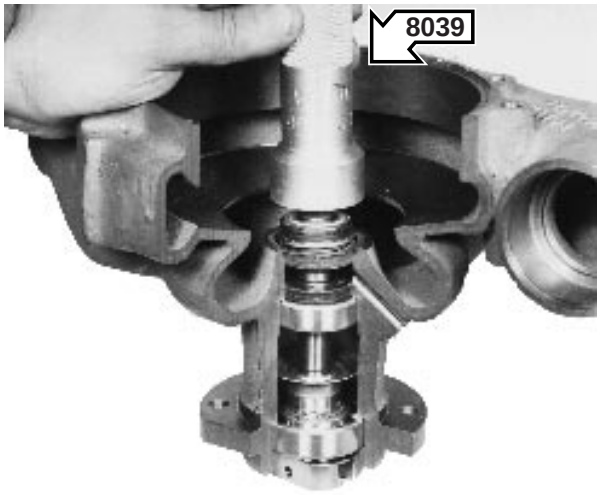
    First use counterhold 2269 as a counterhold. Then continue with drift 8113, using the handle as a counterhold.



11. Carefully press down the seal, past the drain drilling.



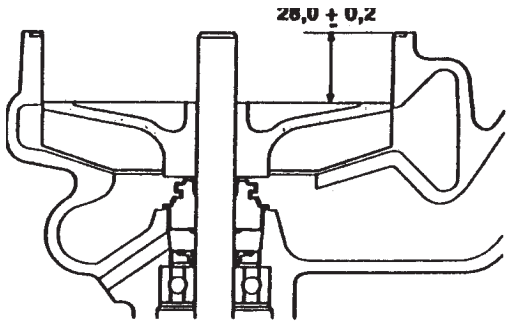
12. Tap down the unit seal.



13. Press the impeller about 10 mm down on the shaft.

14. Place counterhold 6859 as a support under the impeller and press on the impeller.

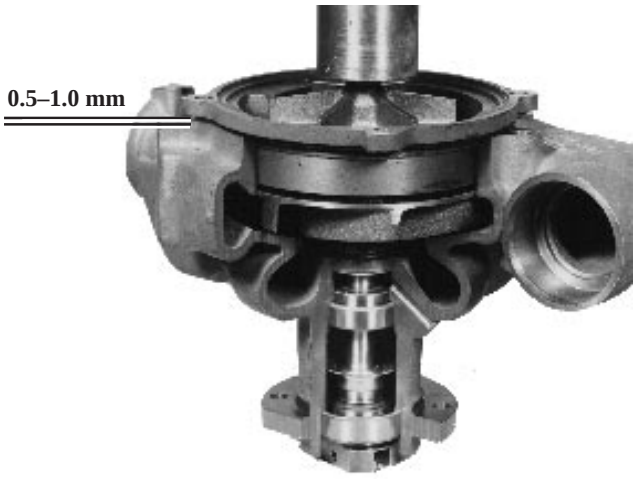
15. Check the distance.



16. Tap the seal into the intermediate cover.

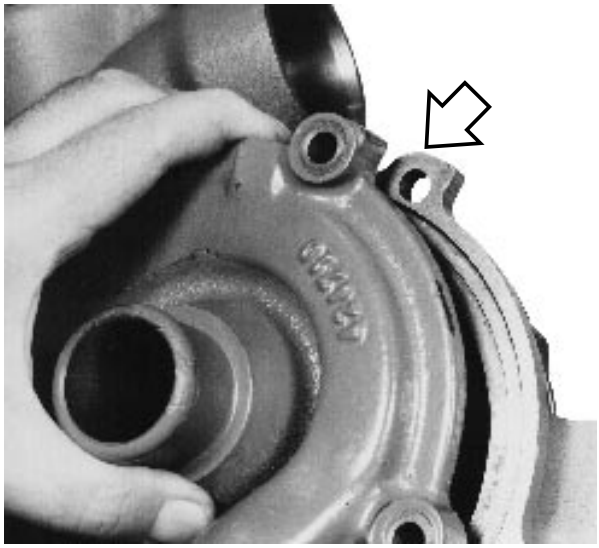
    NOTE! With the sealing edge facing down.

17. Fit the O-ring and the intermediate cover. Press on the intermediate cover and impeller at the same time. Stop pressing down when the gap between the pump housing and the cover is 0.5–1.0 mm.



18. Fit the O-ring and the outer cover.

    NOTE! The marks on the intermediate cover and the outer cover must coincide.



Intercooler

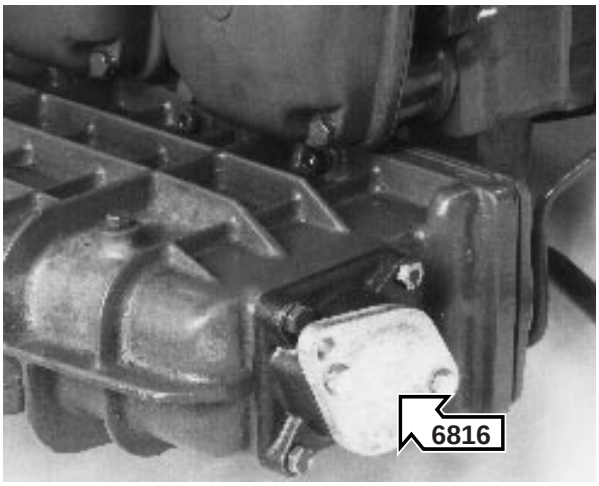
Pressure-testing

For single-circuit system
Special tools:
(999) 6662 Pressure gauge
6815 Connection washer
6816 Sealing washer

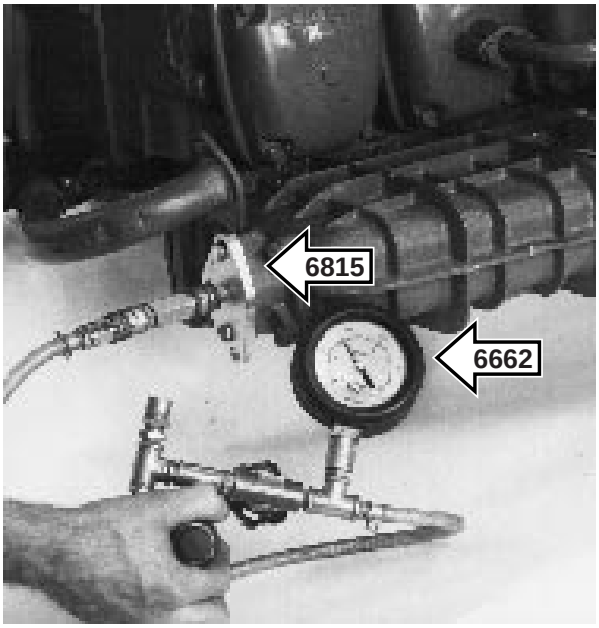
For two-circuit system
Special tool:
(999) 6662 Pressure gauge

1. Connect the pressure gauge to the compressed-air system. Set pressure at 50 kPa (0.5 kp/cm^2).

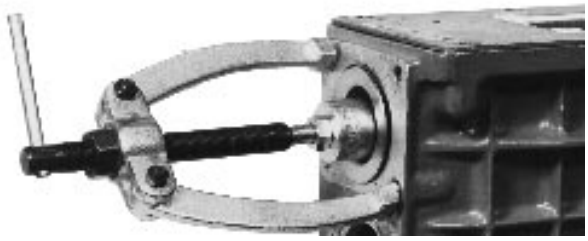
2. Fit the cover washer.



3. Connect the pressure gauge to the nipple and test the pressure. It must not drop during one minute. If it does, replace the intercooler!



4. Increase pressure to 150 kPa (1.5 kp/cm^2). Pressure must not drop during one minute. If it does, replace the intercooler!



Disassembling

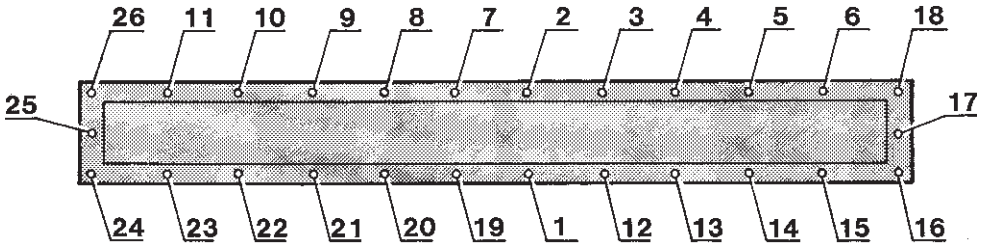
Use a standard puller and pull out the intercooler tubular sleeves.

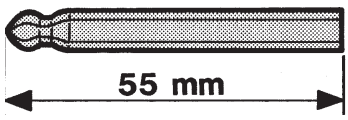
Assembling

Tighten the screws in two stages in the sequence shown below.

Stage 1: Tighten the screws until the screw head makes contact with the block.

Stage 2: Tighten the screws to 20±2 Nm (2±0.2 kpm).





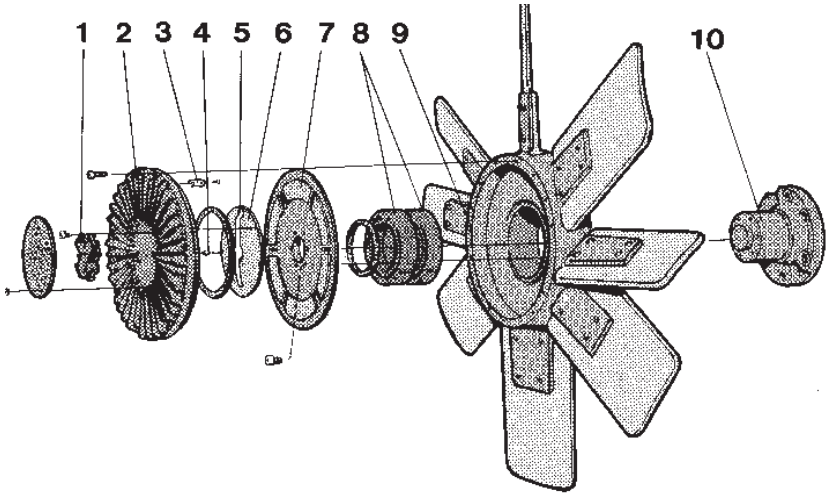
Check-tightening screws difficult to access on the intercooler requires a special tool with P/N 1158239.

Cooling fan

Up front the temperature-controlled cooling fan has two temperature-sensitive bi-metal plates that regulate fan engagement.

The bi-metal plates start to bend when the cooling air reaches a temperature of approx. 40°C. The hotter the air flowing through, the greater the bending. A control pin (4) transfers the bi-metal washer movements to a spring-loaded valve (5) in the fan hub.

> A thermostat-controlled fan should always be in the vertical position. Placed horizontally could cause leakage and impair the efficiency of the fan.



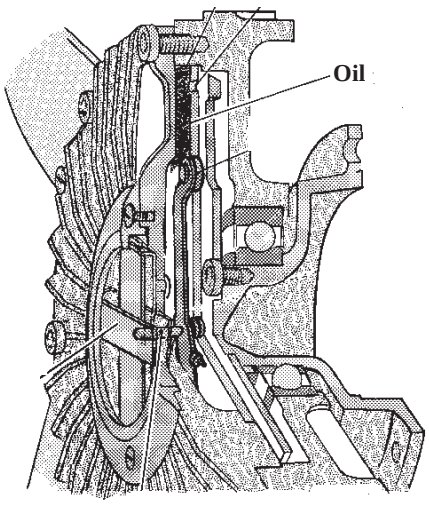
1. **Temperature-sensitive bi-metal plate**
2. **Cover**
3. **Oil scraper**
4. **Control pin**
5. **Spring-loaded valve**
6. **Intermediate plate with valve arm**
7. **Drive plate**
8. **Fan bearings**
9. **Coupling housing**
10. **Drive shaft hub**

The fan engagement fluid is a silicone oil of high viscosity. At temperatures below approx. 40°C, the spring-loaded valve (5) is fully closed. Oil can then go through a return channel from the coupling housing (9) to the space in the cover (2). In this mode, the fan speed is reduced to approx. 1/4 of the drive shaft (10) speed. This is the lowest stage at which engagement takes place.

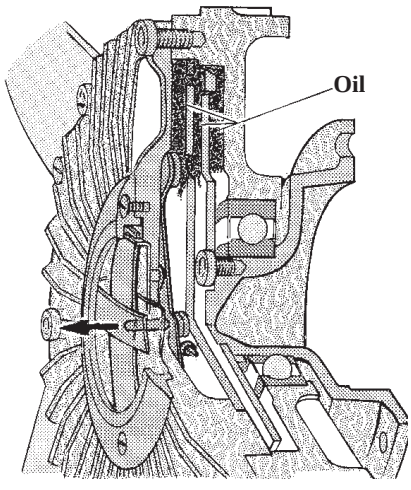
As the temperature increases, the valve starts to open and the degree of engagement increases to full engagement at approx. 65°C, at which the spring-loaded valve is fully open.

However, because of slip caused by the silicone oil, fan speed will never be higher than 95% of the drive shaft speed.

When the cooling air temperature drops, the fan speed decreases, rapidly between 60°C and 50°C, but fan speed reduction is slower when the temperature drops down towards 37°C.

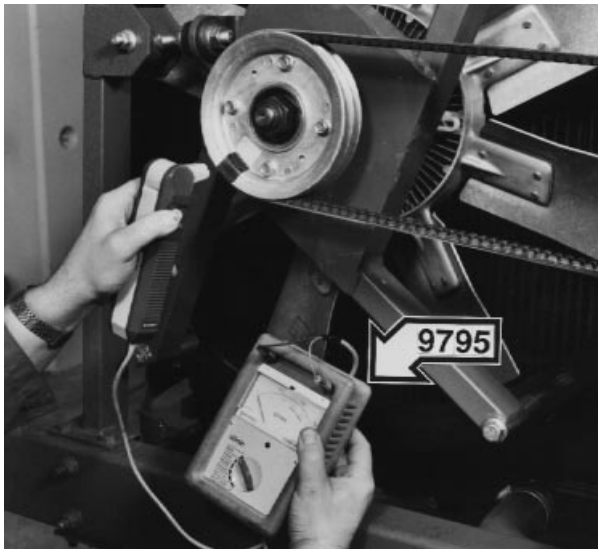


Closed control valve – reduced fan speed



Open valve – full fan speed

Cooling fan speed B10B



Checking

Expensive testing equipment is required to do a complete check on the thermostat-regulated cooling fan. One of the reasons for this is that it is difficult to measure the air temperature round the bi-metal plates. If the cooling fan does not seem to work, there is a simple way in which to check the fan.

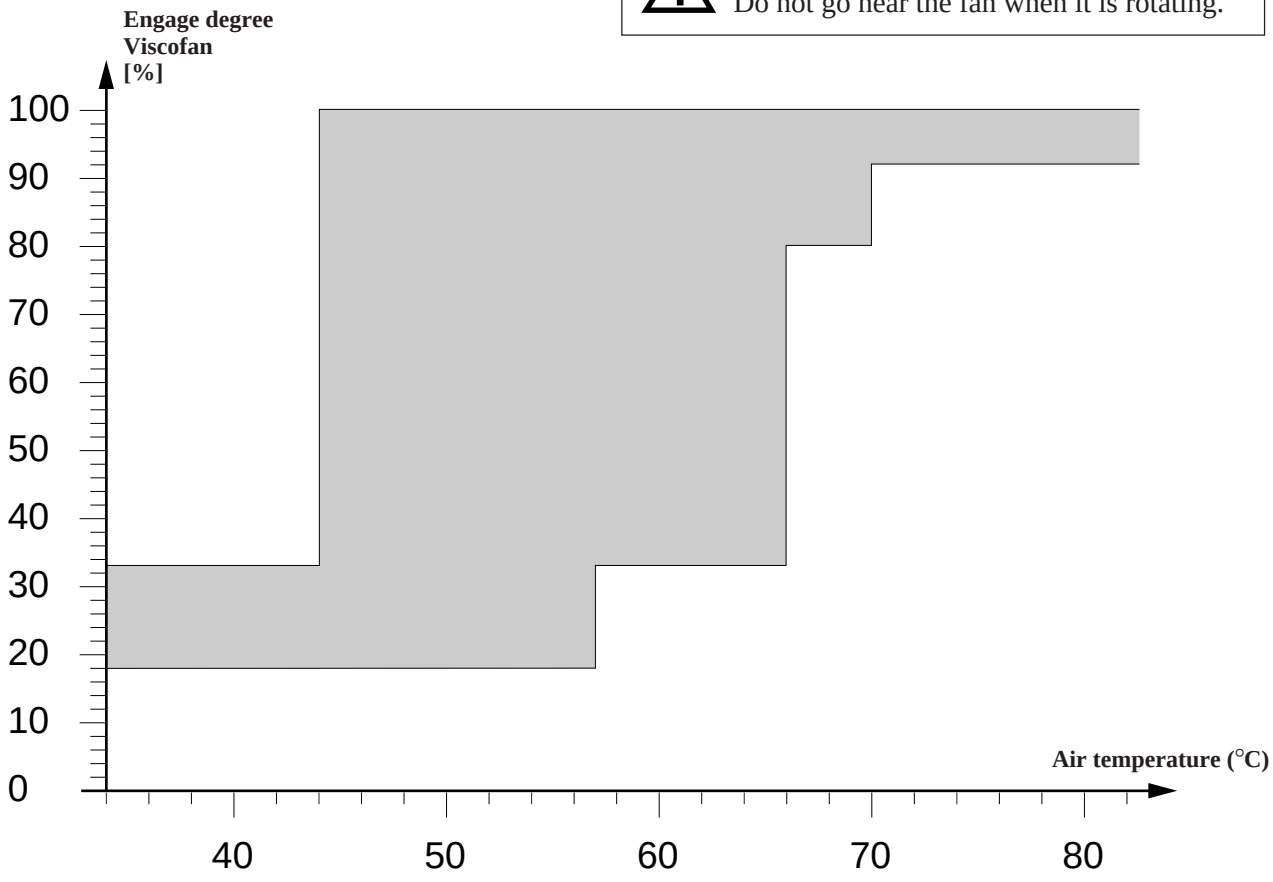
Fan speed and drive shaft speed can be measured with an optical tachometer that works with reflection tape. A piece of this tape is stuck on a fan blade and another piece next to the fan drive shaft. Start the check with a cold engine and an ambient temperature of max. 25°C. Then run the engine to about 2000 r/min. If fan speed increases at temperatures below 25°C, then there is something wrong with fan control mechanism.

The fan control mechanism is functioning properly if the degree of engagement is within the gray-marked sector in the diagram below.

Note, however, that it is fully normal if the fan engages at full speed to begin with. Wait, therefore, until the fan speed has stabilized before checking.

Engine speed = 2000 r/min
Pulley with fan journalling = 1.05x2000 = 2100 r/min

Warning!
Do not go near the fan when it is rotating.

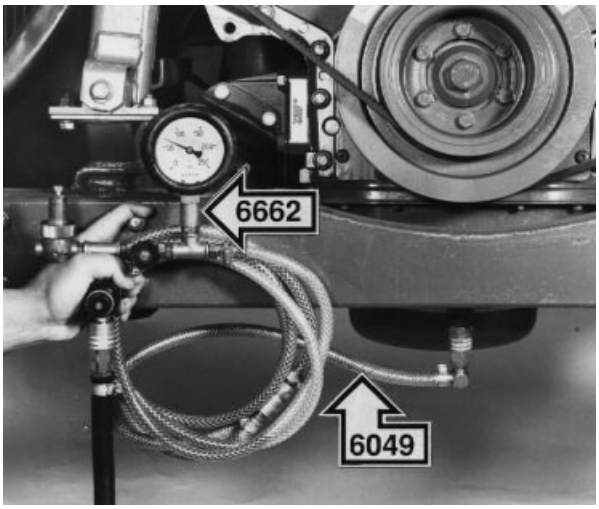


Pressure-testing cooling system

Special tools:

(999) 6662 Pressure tester
6049 Hose (with nipple)
6441 Test cap for expansion tank with thread

Stage 1



From compressed-air workshop supply

Check the coolant hoses for ageing (hardness), cracks, etc. Replace damaged or worn hoses before checking for leakage. If necessary, top-up before pressure testing.

Place or hang up the pressure tester gauge above the radiator to prevent coolant from getting into it.

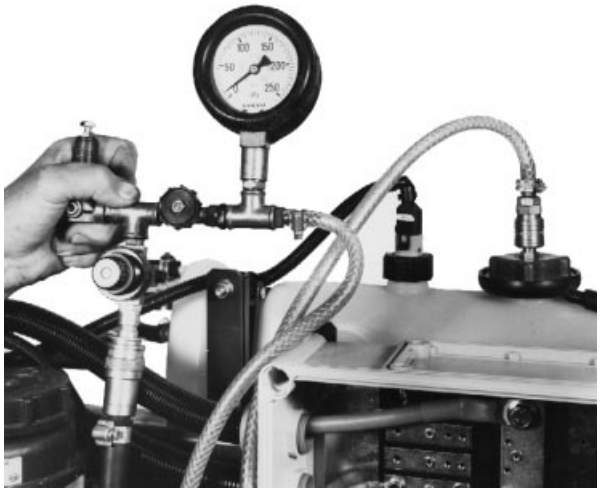
Slowly raise the pressure to above 40 kPa (0.4 kp/cm^2) to build up the pressure in the cooling system. At approx. 50 kPa (0.5 kp/cm^2), the pressure cap overflow function should start to release the pressure. If the pressure cap does not work in this way, renew it.

Lower the pressure in the system and disconnect the pressure tester from the engine drain nipple.

Temporarily connect the pressure tester along with the test cap in place of the pressure cap. Test at a pressure of 70 kPa (0.7 kp/cm^2).

When pressure has stabilized, check all the components in the system for leakage – radiator, connections, hoses, coolant pump, heating system, etc. If the pressure gauge indicates pressure drop, then there is leakage, which must be remedied without delay.

Stage 2



Level sensor

Because of the different types of impurities that can get into the expansion tank, the level sensor should be taken out and cleaned at least at the annual service.

Coolant

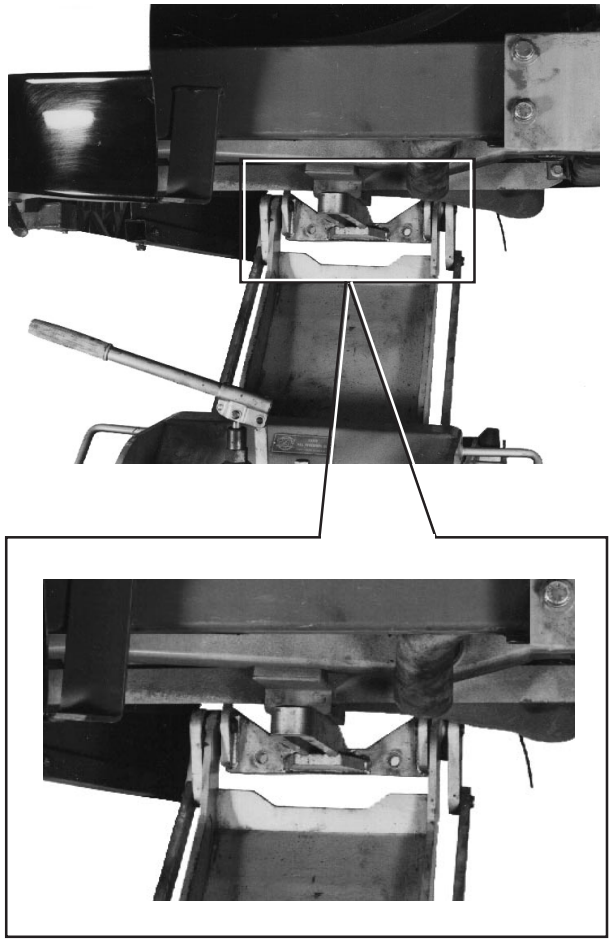
The mixture in the Volvo coolant should be between 40% and 60%. Less than 40% will not provide protection against rust, in some cases it may even increase.

⚠ **WARNING!** Coolant is poisonous.

Mix per cent for	40%	45%	50%	60%
protection against	–25°C	–30°C	–40°C	–56°C
frost down to	–13°F	–23°F	–40°F	–69°F

Radiator, removing/installing

Special tool:
(999) 9954 Component lift



1. Close the taps for the bus heating system.

   Drain the coolant.
2. Take off the drive belts and remove the fan.
3. Remove…

– the hoses for the coolant and intercooler

– the engine rear plate on the inside of the air cleaner

– both the edge plates in front of the radiator assembly.

4 Place lift 9954 under the radiator assembly.

5. Remove…

– the upper retaining iron bars

– the outer lower bracket with rubber pads

– the inner lower bracket without rubber pads.

6. Lower as far as possible the radiator assembly with the lift.

   Raise the bus and pull out the radiator assembly.

Installing

1. Place the radiator assembly on lift 9954.

   Raise the bus enough to run the radiator assembly in underneath.
2. Lower the bus and raise the lift far enough so that the assembly mount brackets can be bolted on.

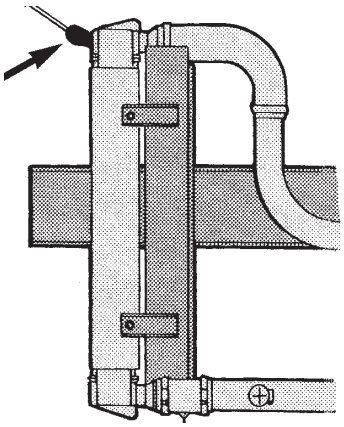
   Fit and tighten all the bracket bolts and lower the lift.
3. Connect up the hoses for the intercooler and coolant.

   Install the fan and fit the drive belts.

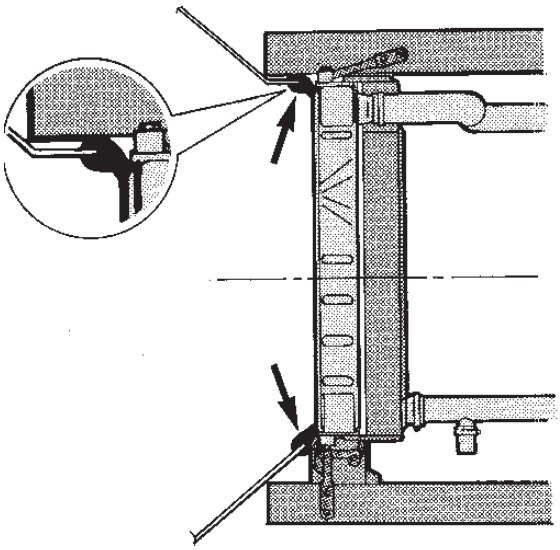
   Adjust the drive belts.
4. Fill with coolant and open the taps in the bus heating system.

   Start the engine and check for leakage.

   Top-up with coolant if necessary.
5. Fit the edge plates and the engine rear plate.



Upper seal
(viewed from left side)



Side seals
(viewed from above)

High coolant temperature

Radiator

Check the radiator for clogging and for deformed fins or for poor coolant flow to the radiator pipes. If necessary clean the radiator.

NOTE! Observe great care not to damage the fins when cleaning the radiator. **Do not use high-pressure flushing**. Pressurized air can be used from the rear side of the radiator.

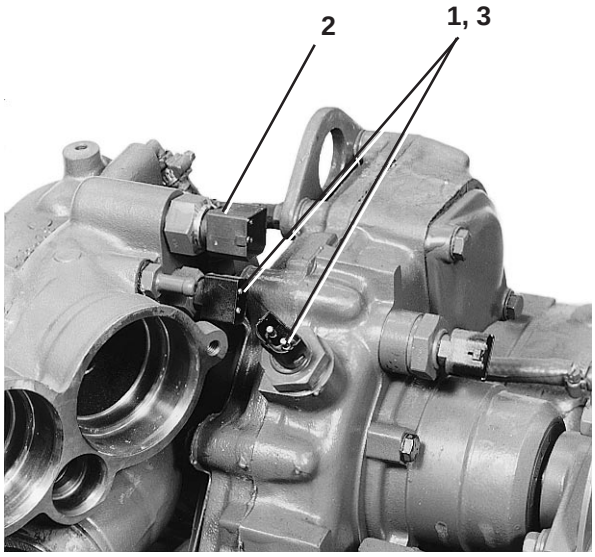
A radiator with loose or damaged fins should be replaced.

Sealing round radiator

Make sure the gap between the radiator and the body is properly sealed. Side seals should go all the way down to the frame flange bottom edge. Defective sealing can be rectified with rubber stripping or similar.

Also check that the sealing ring between the fan shroud and the fan ring is in good condition and makes a tight fit against the fan shroud. If necessary, adjust the lie of the sealing ring.

Coolant temperature sensors



Temp. sensor EDC P/N 1619819 (2-pin) max. test current 1mA

C°	Ω
60	615±62
90	255±29
120	119±15

Temp. sensor, temp. gauge P/N 1619819 (2-pin) max. test current 1mA

between pins 1–3		between pins 2–3	
C°	Ω	C°	Ω
60	116.6±14.2	0	1634±21
90	45.9±4.5	25	2000±22
100	34.9±3.1		

Warning lamp activation is controlled by an electronic circuit in the temp. gauge.
Thus, the temp. sensor does not have this function. Activation temp. is 102± 3°C.

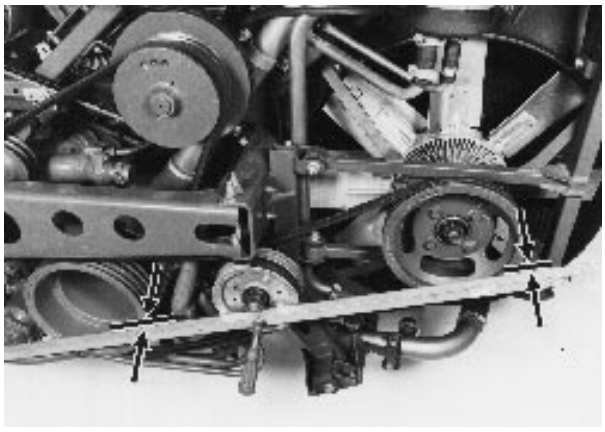
Temp. sensor EDC (4-pin) max. test current 1 mA P/N 3944 168

between pins 1–2		between pins 3–4	
C°	Ω	C°	Ω
60	607.5±59	0	1634±21
90	250.6±26.8	25	2000±22
120	116.6±14.0		

Fan drive with drive belts B10B

Adjusting drive belts

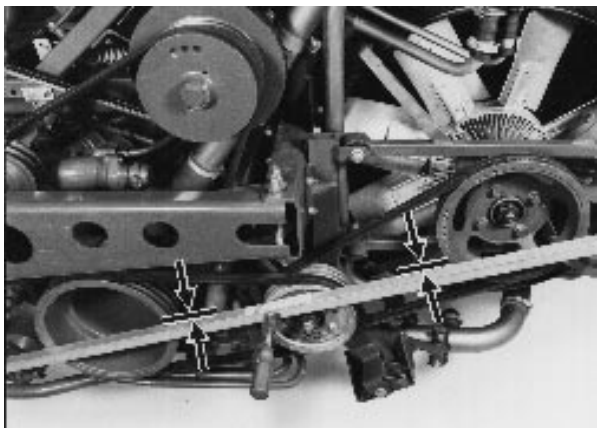
1. Check to make sure that the tension on the fan drive belts is correct: 13–14 mm deflection at 50 N (5 kp) midway between the pulleys. Check pulleys inter-level with a straight edge.



Position of tensioned belts

2. With incorrect relationship between the belt tensioner and pulleys, adjust the belt tensioner position.

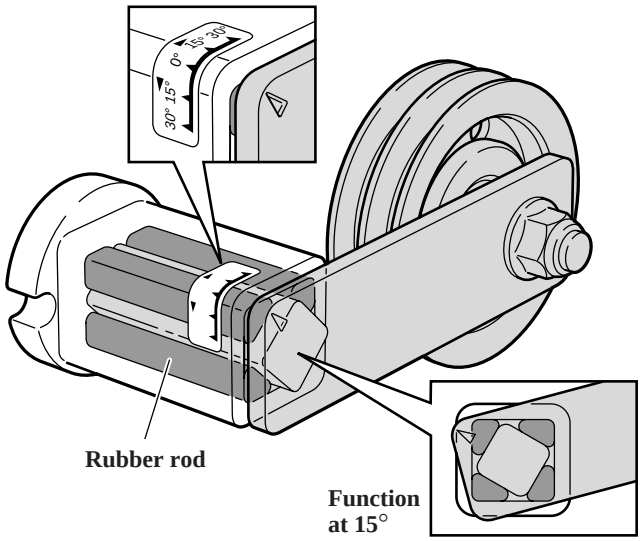
3. Tension the drive belts as shown in the Fig. Tighten the lock bolt and check the belt tensioner position again according to pos. 1.



Rotational centre/angle setting

Check-tighten the drive belt tension twice: Check 1 after 500–1500 km; check 2 after 3000–5000 km.

Belt tensioner



The spring-loaded belt tensioner automatically adjusts to correct belt tension and this makes for quieter belt transmission, among other things.

As a result of the selected geometry in the tensioner movement the belts slacken when the engine switches off and the mass force in the fan draws the belt transmission. This eases up tensions on the other components in the fan transmission.

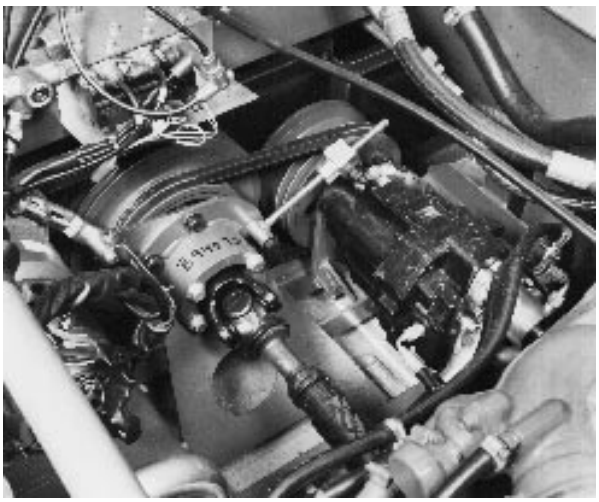
Tension is created by means of the four rubber elements (rods) mounted between the two square pipes.

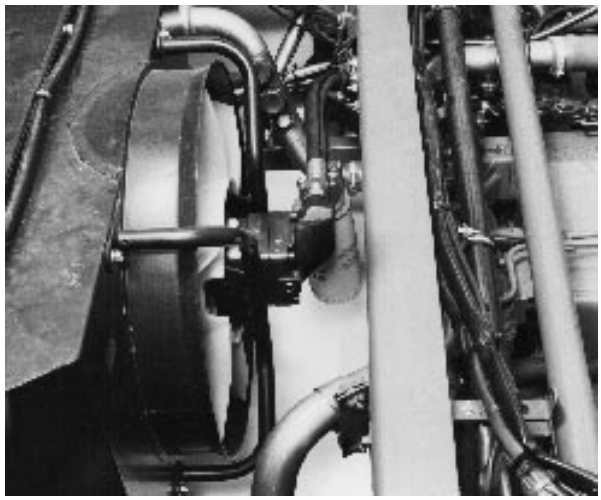
Belt tensioning

The tensioner has a scale. Adjust the pre-tension to 15° on the scale. This corresponds to correct belt tensioning. Tighten up the lock bolt.

Hydraulic fan drive

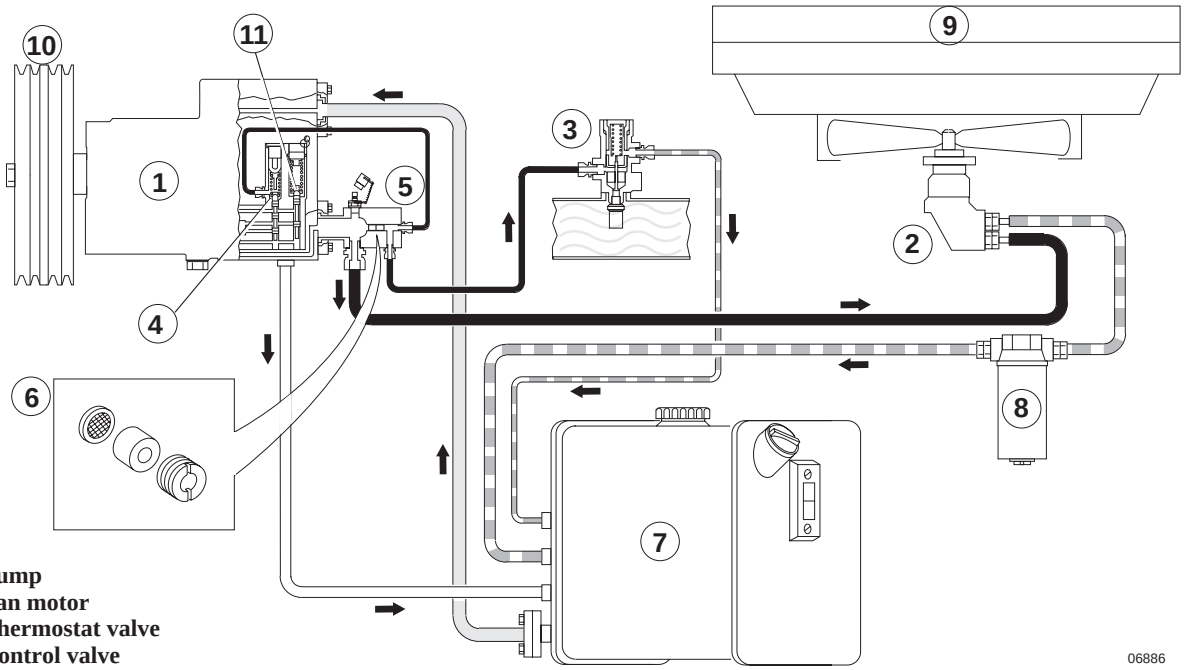
An alternative to the mechanical fan drive is the hydraulic version, which is to be found on both the B10M and B10B.





Fan drive, B10M

System layout, hydraulic fan drive



1. **Pump**
2. **Fan motor**
3. **Thermostat valve**
4. **Control valve**
5. **Modulator**
6. **Restrictor**
7. **Oil tank**
8. **Oil filter**
9. **Radiator assembly**
10. **Pulley**
11. **Max. pressure valve**

Delivery line
By-pass oil line
Suction line
Return line

Concerning troubleshooting, servicing the hydraulic pump, hydraulic motor, refer to Service Manual, Section 2 (26) Hydraulic Fan.

Group 27

Engine Controls

Contents

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EDC – Electronic Diesel Control

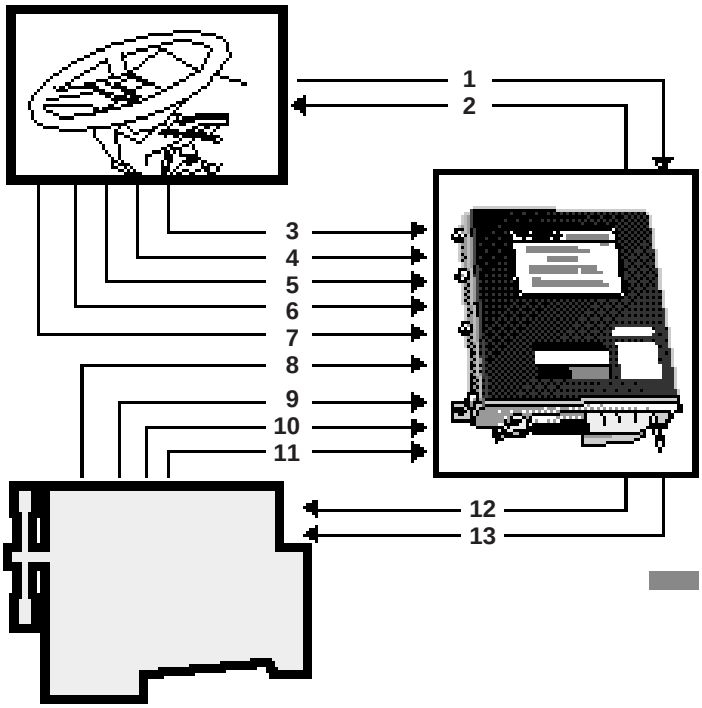
EDC is an electric system for regulating and monitoring the engine fuel injection.

Characteristic of the system is that it works with an electromagnetic governor mounted on a standard injection pump. On the engine and in the driver area there are a number of sensors that send different signals to the electronic control unit, which processes incoming signals and converts them to signals that go to the electromagnetic governor on the injection pump.

The EDC-system also has capacity for cruise control and, possibly, an adjuster function for low and raised idling.

Compared to a conventional fuel system, the advantages of the EDC is that it has greater opportunities to control fuel flow. The electromagnetic governor reacts more rapidly and provides a more precise fuel control compared to a mechanical governor.

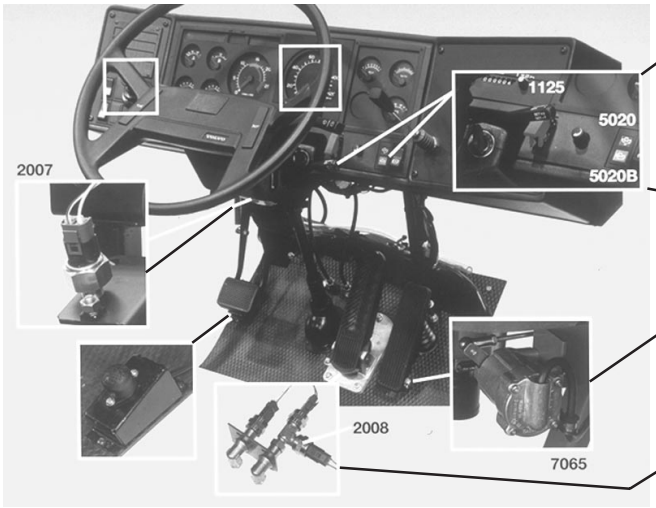
This chapter contains a description of the system, check/remedy measures when one or several fault codes have been registered and instructions for adjusting the accelerator pedal and the setting of the injection pump on the engine.



1. **Rev/speed control**
2. **Diagnosis**
3. **Accelerator pedal**
4. **Speed**
5. **Brake pedal**
6. **Clutch pedal**
7. **Exhaust brake**
8. **Turbo pressure (charge pressure)**
9. **Intercooler temp.**
10. **Coolant temp.**
11. **Speed**
12. **Regulated fuel flow**
13. **Engine switch off**

Function of sensors, driver area

Clutch pedal position breaker
Controlled mechanically by the clutch pedal. When the clutch pedal is depressed, this position breaker disengages the cruise control.



A speed signal is despatched as information to the control unit from the speedometer/tachograph.

Cruise control
Used for three different functions:
- Idle speed, setting.
- Raised idle speed (so-called “constant speed hold”).
- Cruise control.

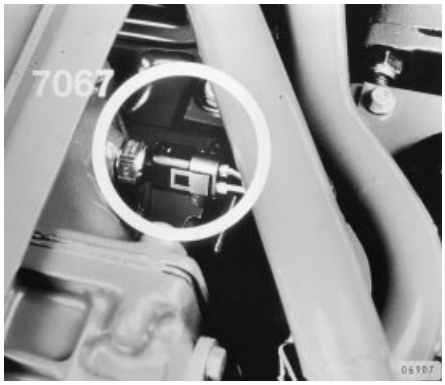
The EDC-system has a diagnostic function that indicates a fault via the diagnostic lamp.

Accelerator pedal position sensor
Provides information about accelerator pedal position (and kick-down for buses with automatic transmission).

Brake pedal breaker
Disengages the cruise control with braking. Applies also to activated exhaust brake.

Sensors on engine

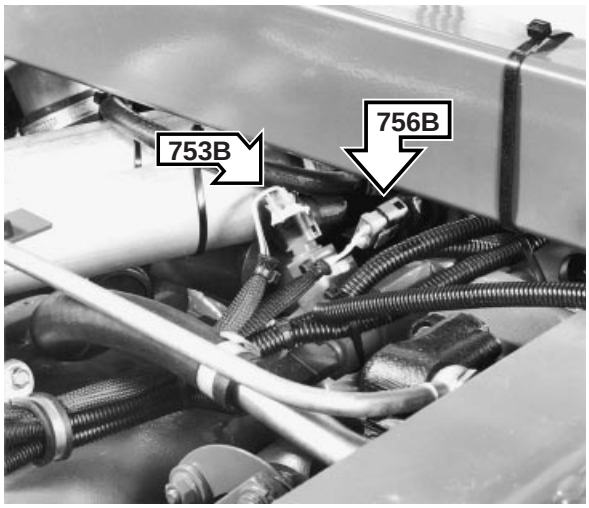
Charge pressure sensor 7066
It is the charge pressure that determines the fuel flow to the engine at a particular speed.



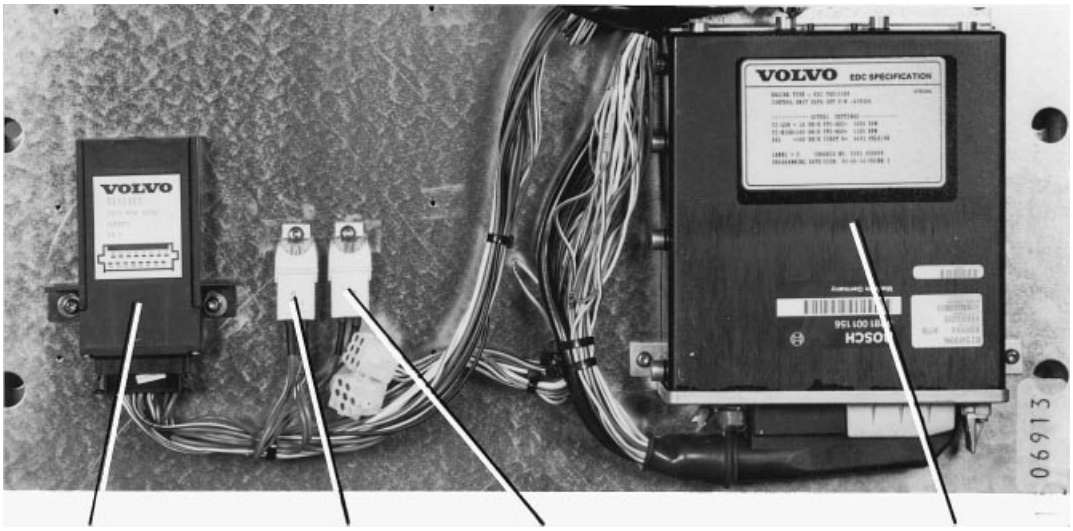
Intercooler air temp. sensor 7067
The intercooler air temperature uses the control unit in order to reduce fuel flow with abnormally high intercooling air temperature.

Coolant temperature sensor 756B
The coolant temperature uses the control unit to determine the following: start fuel flow, fuel flow at full load (should the coolant temperature exceed a fixed value), low idle speed with cold engine, speed limitation during a certain period after starting.

Extra speed sensor 753B
In addition to the charge pressure, it is important that the control unit knows the engine speed, otherwise it cannot determine the fuel flow. The function of the EDC requires at least one speed signal. For this reason the speed signals are doubled.



EDC-components in electrical distributor unit



Relay box 3060 | **Fuse 45 for normal voltage feed** | **Fuse 44 for cruise control stalk** | **Control unit 9058**

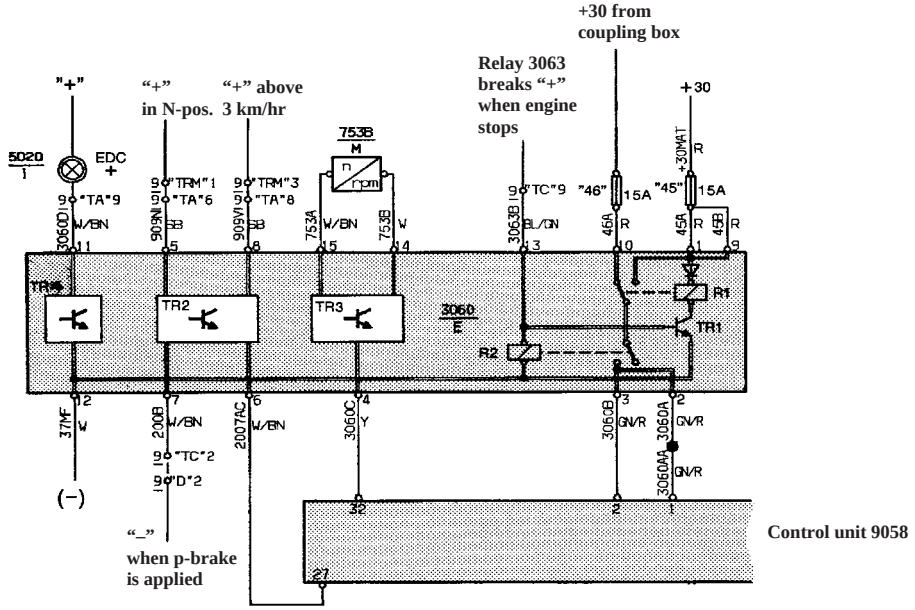
Relay box

Relay box 3060 contains relays for voltage feeding the system and three small electronic circuits, which mainly contain transistors. Normal voltage feed, from fuse 45, comes in to pins 1 and 9. At input to R1, there is a diode that prevents reverse current. Before R1 can close, TR1 must open, which it does at a (+) via 3063 relay (engine shut-off). This (+) also closes R2. On the strength of the power available, R2 distributes the feed to the two lines going to the control unit.

Electronic circuit TR3 converts engine speed sensor (753B) impulses, which vary between –12V and +12 V up to pin 15, to a pulse signal from 0–24V, which is fed to pin 32 in the control unit. Pin 14 is earthed.

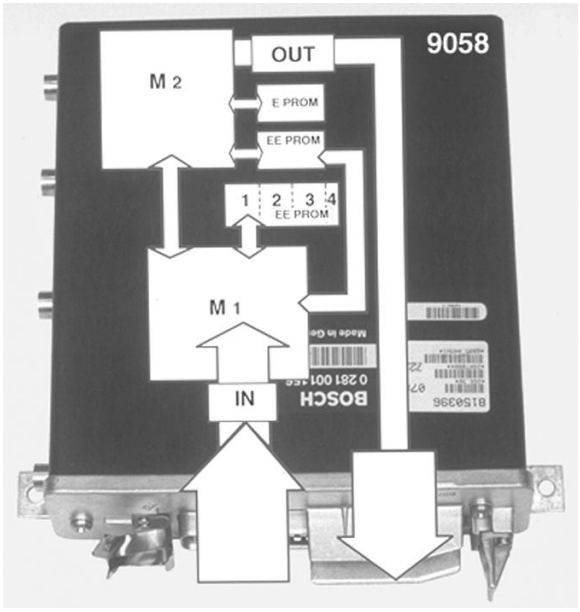
TR2 circuit is wired to the automatic transmission and parking brake. Its function is to simulate “clutch pedal” up. It must be possible, namely, to earth pin 27 on the control unit, even if the hus has automatic transmission and thus does not have a clutch pedal. “+” in the N-position is used when the bus is stationary and gives (–) on pin 6 when the parking brake is on. “+” above 3 km/h is converted by the TR2 circuit to (–) on pin 6 during driving.

With no voltage at pins 1 and 9, relay R1 remains in the inactive position and voltage is fed instead from pin 10. The TR4-circuit then lights warning lamp EDC+ by giving a (–) at pin 11.



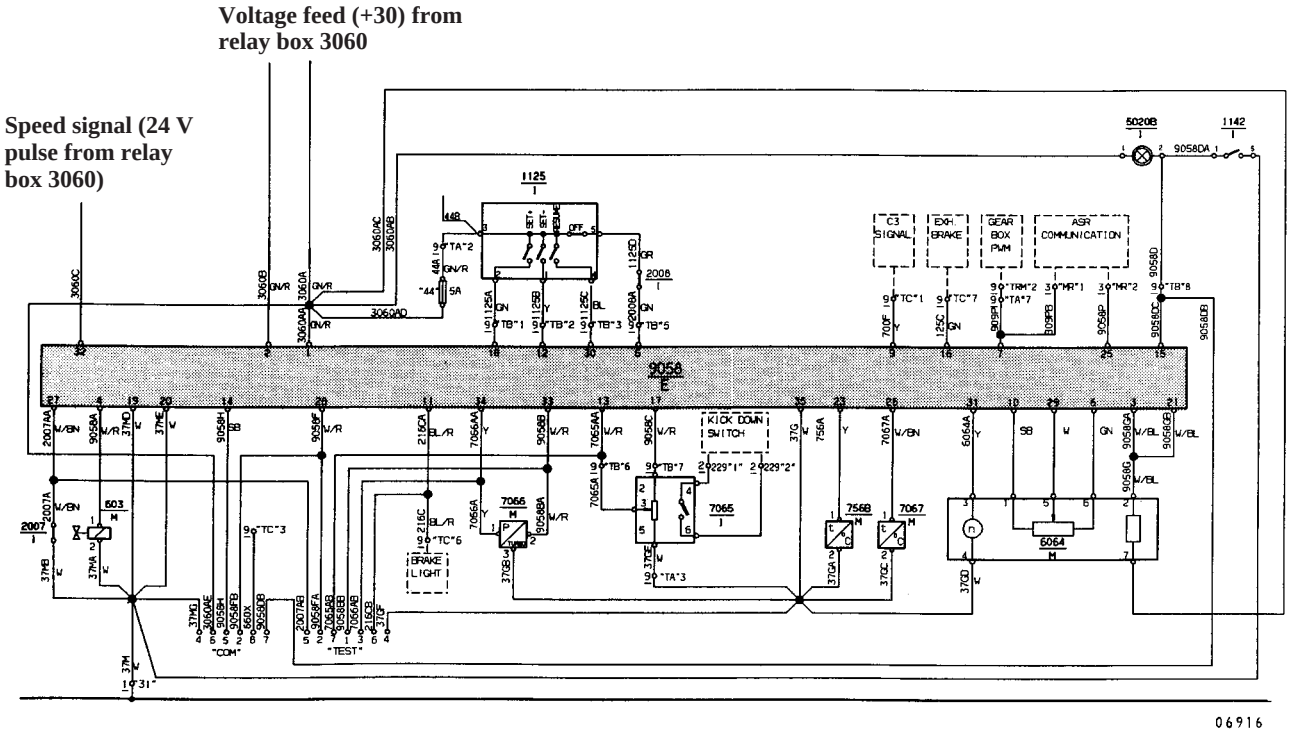
Control unit

Control unit 9058 houses the electronics for regulating fuel flow. The electronic system has two microprocessors, a main processor M1, that normally looks after all engine and vehicle control, and another microprocessor that takes care of fault diagnostics, communication with the other control units, that is, ABS/ASR and EST 18. M2 also monitors processor M1and takes over its functions should M1 break down.



In its original form, the control unit is generally programmed (part (1) in one of the EE programs) and cannot be used until it has been programmed with engine data for some engine variants. For each engine variant there is a so-called “engine data statement” stored in a disk. With the help of a PC, the data statement can be stored in part 2 in the EE program.

Moreover, each control unit is programmed with the bus data (3), that is, the drive line reduction ratios for the bus in which the control unit in question is installed. So-called “customer data” (4), that is, the cruise control limits and possibly speed limitation are also programmable.



Pin	Signals to/from control unit 9058
32	Speed signal from relay box 3060
2/1	Voltage feed
18/12/30/5	Signals from “cruise control” (1125). In series between pin 5 and the cruise control stalk there is also a pressure breaker (2008) that breaks the current during braking.
9	C3-signal from speedometer/tachograph.
16	Voltage from activated exhaust brake (breaks cruise control function) and accelerator pedal function.
7	PWM (Pulse Wide Modulated) voltage signal to automatic transmission and ASR-system (Anti-Slip Regulation) passes on information on the throttle position.
25	Signal from ASR-system concerning dethrottling with skidding.
15	Input and output for diagnostic lamp.
21/3	Outsignal to adjuster device on governor (6064) for regulating throttle.
6/29/10	Control rod position from sensor in governor (6064).
31	Speed from sensor in governor (6064).
26	Intercooler temp. from sensor (7067) in inlet pipe.
23	Coolant temp. from sensor (756B) in thermostat housing cover on B10B and in discharge pipe after engine (to retarder) pn B12.
35	Sensor earth.
17/13	Accelerator pedal position from position sensor, accelerator pedal (7065). In the EDC-system, the kick-down breaker for automatic transmission is housed in the position sensor.
33/34	Intercooler pressure sensor (7066). A 5 V reference voltage (outsignal) comes in from 33 and a voltage of 1.3–2.5V is sent to 34, depending on the charge pressure.
11	Voltage from activated brake lights (breaks cruise control function).
28	Control rod position signal from control unit.
14	Not used.
20/19	Earth connection.
4	Doubled engine shut-off (apart from switching off power to adjuster device on governor) is effected by a “+” to the solenoid valve (603) which, via a compressed-air cylinder (emergency stop) activates the injection pump stop lever. Breaking “+” to the solenoid valve 603 opens the valve.
27	Position breaker (2007) on the clutch pedal earths when the clutch pedal is released. (Applies only to manual gearbox – for automatic transmission, see pin 6 relay box.)

Fault diagnosis

The EDC-system monitors sensors, functions and the governor adjuster device. With fault, the diagnostic lamp lights, either continuously or with blinks. Fault coding is based on diagnostic lamp blinks. To get this, depress the diagnostic switch (button). Several faults can be stored simultaneously in the control unit memory.

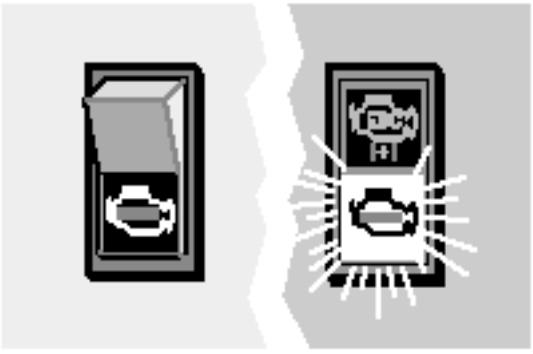
Activating fault diagnosis

Turn the start key to the drive position, depress the diagnostic switch. Release it after a few seconds and count the number of blinks. Note the number. It corresponds to a specific fault code. If two or more faults are stored, the lamp will show them after each other. The diagnostic switch must be depressed to start the next blink sequence. The lamp shows all the blink codes when it returns to the first one.

How to erase stored fault codes:

Turn the start key to the “0” position. Keep the diagnostic switch depressed and at the same time turn the start key (feed selector switch) to the drive position. Do not release the diagnostic switch. Keep it depressed for about 3 seconds. Release the diagnostic switch. This should erase all stored fault codes.

With failure in the normal voltage feed to the control unit, the indicator lamp EDC+ for voltage feed comes on and gives a steady light. If there is nothing wrong with the voltage feed, the control unit is doubly protected against voltage failure and the lamp goes out. Should the lamp light when driving, the bus can be driven as usual but. to avoid risk of total voltage breakdown, which would mean that the engine would stop, it is recommended that the fault be put right without delay.



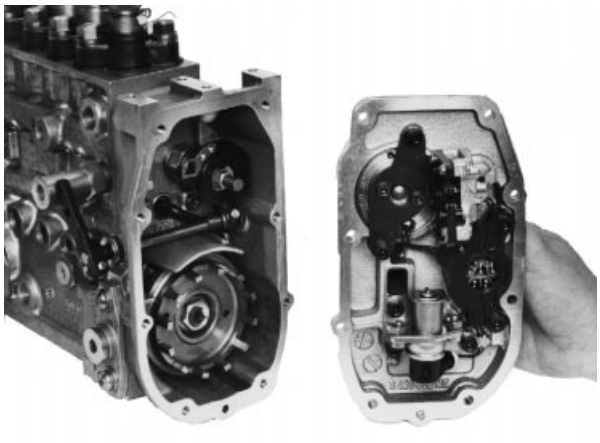
Fault code/ Diagnosis	Probable fault(reaction)	Check/action
2B	The control unit is not programmed (engine will not start)	Program the control unit with the data statement specified for the engine, see further page 9.
3HE	Brake indication faulty or not checked (cruise control does not function)	Turn the start key to the drive (feed selector switch) position. Depress the brake pedal and keep it depressed for about 4 seconds. The lamp should then go out. "+" must not be in the connector TB "5" when the brake pedal is depressed hard, "+" on the other hand should be in TC "6".
4E	No main or assist speed signal (engine does not start)	Check the resistance in the sensors, see below fault code 5 B. If there is nothing wrong with the sensors, check for failure in cables to pins 31 and 32.
5B	Main speed signal faulty (reduced engine power)	The sensor is housed inside the injection pump governor. Sensor resistance between pins 3 and 4 on the governor 0.8–1.2 Ω.
6HE	Assist speed signal faulty	The sensor is place on the engine. Correct resistance is 1050±100 Ω between the sensor connection pins.
7B	Speedometer/tachograph indicates abnormally high speed (reduced max. engine speed)	Incorrect values from speedometer/tachograph C3 signal. Check speedometer/tachograph calibration and that C3 does not have "+".
8B	No speed signal	Measure the voltage between the C3 signal and earth. At 0 km/h, voltage should be 1.0–1.4 V. Voltage should increase 0.2–0.3 V for every speed increase of 10 km/h.
9B	Intercooler temp. abnormally high (90° C) (reduced engine power)	Check the intercooling. If both fault codes 9 and 11 are indicated, measure the sensor resistance which should be 220–280 Ω at 90°C, (1mA) between the sensor connection pins.
10B	Intercooler temp. abnormally low (reduced engine power)	Check for failure in the cables and connections.
11B	Intercooler temp. abnormally high (higher than 100° C)	Sensor resistance between the sensor connection pins should be 100–130 Ω at 120°C (1 mA).
12B	Coolant temp. abnormally low	Failure to/or in sensor 756 B. Sensor resistance between sensor connection pins should be 500–800 Ω at 55–65°C. Check the cooling system thermostat.
13B	Collant temp. abnormally high (reduced engine power)	Check the cooling system. Check the temp. sensor resistance, which should be 220–280 Ω at 90°C (1mA).
14B	Charge pressure abnormally low (reduced engine power)	Check the fuel filters, feed pressure, air cleaner and charge pressure. Refer to specifications for respective engine.
15B	–	

Fault code/ Diagnosis	Probable fault(reaction)	Check/action
16B	Accelerator pedal indicates abnormally low voltage (does not react to throttling, remains at low idle)	Check voltage in connector TB“7”. Should be 5V. Voltage in TB“6” should be 0.5V with accelerator pedal released.
17B	Accelerator pedal indicates high voltage (does not react to throttling, remains at low idle)	Check for earth failure, pin TA“3”. **Note:** With accelerator pedal released, the voltage range for the accelerator pedal sensor, measured in “TEST7”, should be 0.5 V and with the accelerator pedal depressed 2.8–3.5 V. Voltage in connector TB“7” must not exceed 5 V.
18BE	Cruise control faulty	Check fuse 44. Measure the voltage (24 V) in TB “5”. Depress the brake pedal and check that voltage cuts-out at 2008 (extra brake pressure breaker). Set cruise control to “RESUME”, measure the voltage (24 V) in TB “3”, in “SET-”, in TB“2” and in “SET+” and in TB “1”.
19H	System fault (communication error)	Fault inside control unit. Engine can start and be driven but with reduced power and lower engine speed.
20–24 BE	System fault EDC	Fault code 20. Control problem, general 21. Control problem, control rod position extremely low 22. Control problem, control rod position extremely high 23. Control problem, internal communication fault 24. – Fault codes 20–24 can also be indicated through external electromagnetic disturbances. Therefore, erase the control unit fault memory and check to see if the fault code returns.

Note: “B” indicates blinking warning lamp
“H” indicates that the warning lamp gives a steady light
“E” indicates that the fault is not stored in the fault memory
This information is obtained without having to depress the diagnostic switch.

Injection pump governor

The governor adjuster device (1) is placed in the governor housing end and consists of an electromagnet that works directly against the injection pump control rod. (2A) and (2B) function as position sensors for the control rod. They enable the control unit to decide at every moment if current to the adjuster device has to be increased or decreased. (3) is the main speed sensor in the system and it works against the toothed gear on the pump camshaft.



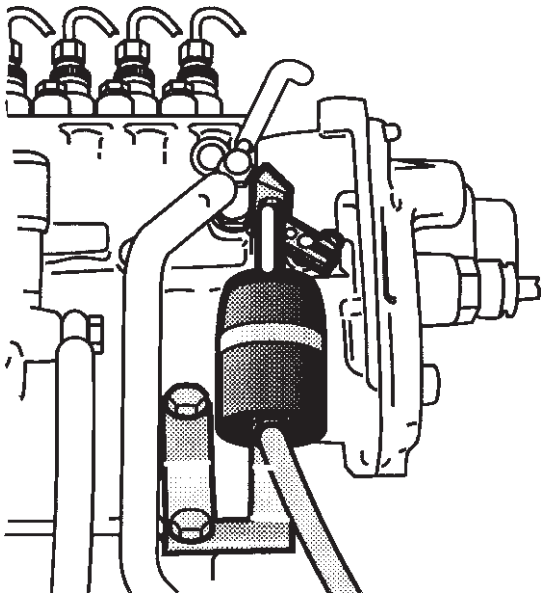
Compressed-air cylinder for emergency stop

For safety reasons, there is a compressed-air cylinder for emergency engine switch-off. It is placed on the injection pump.

Normally the engine shuts down when the feed voltage to the EDC control unit is broken by turning the start switch to position “0”. The compressed-air cylinder then turns the governor stop lever to the stop position.

The chief function of the compressed-air cylinder is, nevertheless, to act as an emergency stop in order to eliminate negative results from involuntary throttling caused by cable failure between the control unit and the injection pump. A signal is sent out from the EDC control unit to cut out voltage to the compressed-air cylinder solenoid valve and this activates the compressed-air cylinder to engage emergency stop.

In some cases there may also be a stop control in the engine compartment or next to the battery box. This control must be pushed in before the engine can be restarted.



Adjusting

The clearance between the stop lever and the stop cylinder push rod, when the stop cylinder is activated, should be, on the THD103 engine, 0.3–0.6 mm. Adjustment is made with the push rod adjuster screw.

Adjustment is made on the engine by adjusting the position of the stop cylinder with the attachment adjuster nuts. Remove the push rod from the stop lever. Turn the top lever to the **stop position** and pull the stop cylinder push rod out to the end position. Adjust the position of the stop cylinder to get a clearance of 1–2 mm between the push rod and the lever.

Accelerator pedal, adjusting

At full throttle or kick-down position, the stop screw for the accelerator pedal should be able to stop pedal movement precisely before the throttle control reaches the max. throttle stop lug for the position sensor.

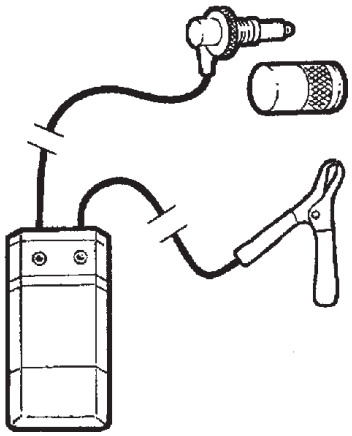
For buses with automatic transmission, the stop screw should be screwed up 1–2 mm from the position where the throttle control has stopped against the position sensor stop lug.

Change over from full throttle to kick-down is felt through more resistance from the accelerator pedal.

Injection pump, adjusting on engine

For adjusting the injection pump on the engine, use adjuster tool 998 7057 and crank tool 999 6956. See page 97.

Obs!. Vridverktyg 999 6956 finns inte under Specialverktyg och på sid. 97 nämns 998 8068? Översättarens anm.



EDC – wiring diagram

See Service Manual, Electrical system for respective bus model, Section 3 (37)

Fuse	Power	Circuit(s) (protected by fuse)
“44”	5A	EDC-control and warning lamp on redundant power supply.
“45”	15A	EDC-system.
“46”	15A	Redundant power supply, EDC-system.

No.	Component
753B	Speed sensor
756B	Temp. sensor, coolant
1125	EDC-control (cruise control stalk)
1142	Breaker, EDC-diagnosis (may be marked 1131)
2007	Breaker, clutch pedal
2008	Breaker, brake pressure
3060	Relay box
5020	Warning lamp, redundant power supply
5020B	Diagnostic lamp. EDC-diagnosis
6064	Regulator
7065	Sensor, accelerator pedal
7066	Sensor, intercooler temp.
7067	Sensor, intercooler temp.
9058	Control unit, EDC
“COM”	Communictions socket
“TEST”	Test socket

EDC, troubleshooting with multimeter

Troubleshooting with a multimeter is a complement to the EDC-system fault codes. In the first place, the system’s fault codes should be checked, see page 150, and in the second place, troubleshooting can be done with a multimeter. Troubleshooting is done either with the engine switched off or with it running.

For troubleshooting with a multimeter, use 60-unit test box P/N 981 3190 and 35-pin adapter P/N 981 3192. With the test box and adapter it is possible to do a more realistic troubleshooting on the signals to and from the control unit in a very simple way.

Special tools:
(999) 5009 Pedal support
(951) 0060 Multimeter
(981) 3190 Test box 60-pin
(981) 3192 Adapter 35-pin

Troubleshooting requires a multimeter with a fault tolerance of max. 0.4% and 2 decimal display when measuring voltage between 0–24 V. (Multimeter (999) 6525 does not meet this accuracy requirement.)

Test box 60-pin
P/N 981 3190

Adpater 35-pin
P/N 981 3192

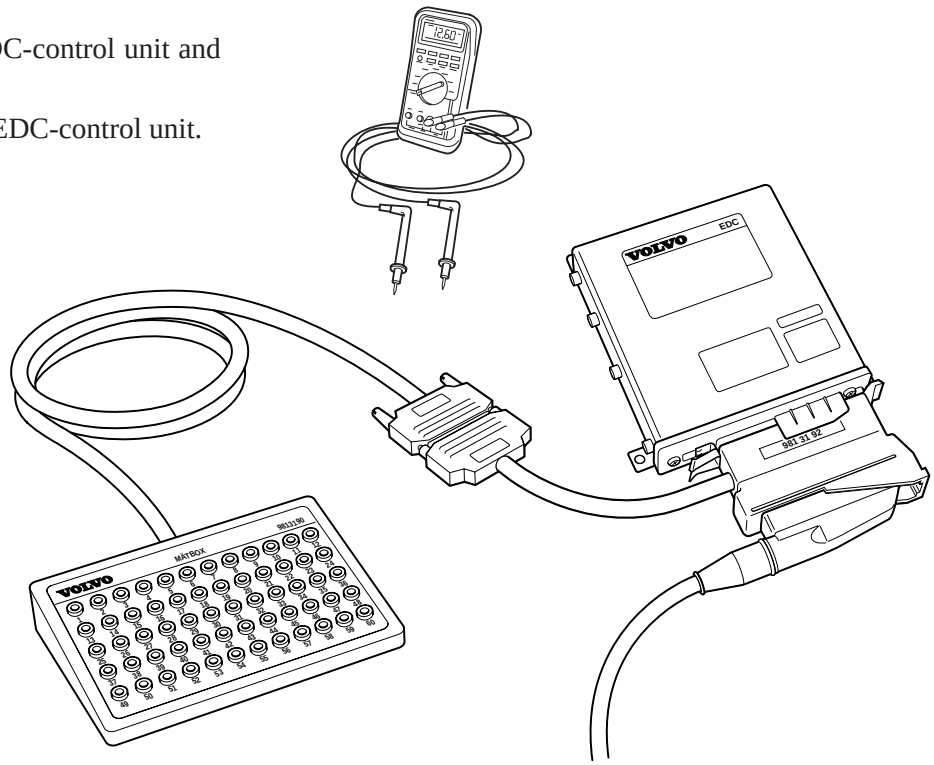
Connecting-up

Switch off the power with the battery main switch.

NOTE! Never pull out or plug in the control unit cable contact when the power supply (ignition) is on.

Disconnect the connector to the EDC-control unit and connect it to the test box.

Connect the other connector to the EDC-control unit.



Measuring voltage (start/feed selector switch in drive position, engine off). Measuring range D.C. voltage unless stated otherwise

	Testbox			
Pin+	**Pin–**	**Nominal value**	**Component**	**Remarks**
1	19	Battery voltage	Feed to control unit	
2	20	Battery voltage	Feed to control unit	
1	15	Battery voltage	Diagnostic lamp	
32	19	19 V	Speed sensor, engine	*5*
33	19	4.6–4.9 V	Reference voltage, intercooler pressure	*9*
34	19	1.3–1.5 V	Voltage from intercooler pressure sensor	*9*
21	19	Battery voltage	Adjuster device, injection pump	
3	19	Battery voltage	Adjuster device, injection pump	
4	19	Battery voltage	To solenoid valve for engine switch-off	
31	35	0 V	Speed sensor, injection pump	*10*
17	35	4.6–4.9 V	Reference voltage, accelerator pedal	
13	19	2.75–3.5 V	Depressed accelerator pedal	
13	19	0.32–0.5 V	Released accelerator pedal	
9	19	0.3–1.4 V	Speed signal (C3)	
27	19	0–1.3 V	Clutch pedal released	*1* (automatic transmission)
27	19	3–5 V	Clutch pedal depressed	*1* (automatic transmission)
16	19	0–1 V	Exhaust brake, not activated	

cont. …

Test box				
Pin+	**Pin–**	**Nominal value**	**Component**	**Remarks**
16	19	Battery voltage	Exhaust brake, activated	
28	35	0.3–0.6 V	Control rod travel, accelerator pedal released	*2*
28	35	2.8–3.5 V	Control rod traval, accelerator pedal depressed	
7	19	2.1–2.5 V	Position signal to automatic transmission and ASR	*3*
25	19	2.1–2.5 V	Without ASR	
25	19	approx. 20 V	With ASR	*4*
11	19	0–1 V	Brake pedal released	
11	19	Battery voltage	Brake pedal depressed	
11	19	Battery voltage	Retarder control, activated	
5	19	0–1 V	Brake pedal depressed	
5	19	Battery voltage	Brake pedal released	
5	19	0–1 V	EDC-control, held in “OFF” position	
5	19	Battery voltage	EDC-control, held in “SET+”, “SET–”, “RESUME” or neutral position	
12	19	Battery voltage	EDC-control, held in “SET–” position	
12	19	0–1 V	EDC-control, held in “OFF”, “SET+”, “RESUME” or neutral position	
18	19	Battery voltage	EDC-control, held in “SET+” position	
18	19	0–1 V	EDC-control, held in “OFF”, “SET–”, “RESUME” or neutral position	
30	19	Battery voltage	EDC-control, held in “OFF”, “SET–”, “SET+”	
30	19	0–1 V	EDC-control, held in “OFF”, “SET–”, “SET+” or neutral position	

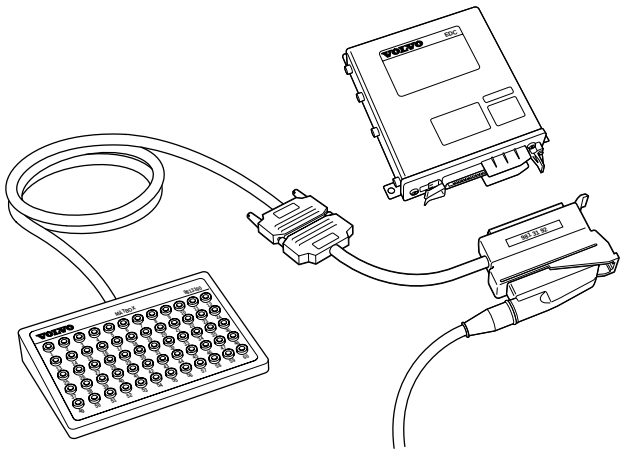
The following measurements are made with the engine started

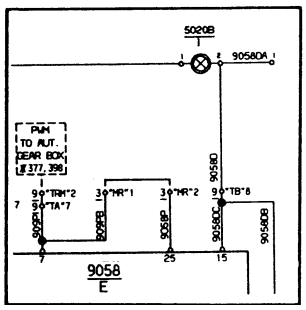
Pin+	Pin–	Nominal value	Component	Remarks
32	19	9.7 V ~ (300 Hz)	Speed sensor, engine	low idle *5*
32	19	9.4 V ~ (840 Hz)	Speed sensor, engine	1650 rpm *5*
9	19	1.3–2.5 V ~ (70 Hz)	Speed signal, C3	30 km/h *6*
9	19	2.2–3.3 V ~ (150 Hz)	Speed signal, C3	60 km/h *6*
26	35	2.5–3.9 V	Intercooler temp. sensor	60°C *7*
23	35	0.9–1.85 V	Coolant temp. sensor	60°C *8*
34	19	2.5–4.0 V*	Turbopressure sensor	110–165 kPa *9*
25	19	6.9–7.3 V ~	Without ASR	low idle
25	19	10–11.5 V ~	Without ASR	approx. 1650 rpm
25	19	ca 5.5 V~	With ASR	*4*
7	19	6.9–7.3 V ~	Signal to Automatic transmission and AST control unit. Control value low idle	*3*
7	19	10–11.5 V ~	Signal to Automatic transmission and ASR control unit. Control value 1650 rpm	*3*
28	35	2.6–3.05 V*	Control rod travel, accelerator pedal in max. position and engine max. loaded. Measured while driving.	*2*
31	35	**	Speed sensor, injection pump	*10*

* Depending on engine variant, see Specifications.
** Measured with oscilloscope.

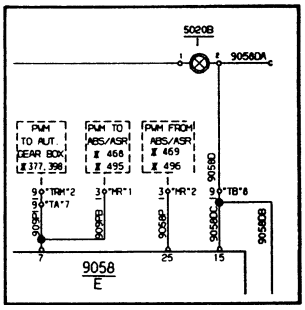
Measuring resistance, control unit disconnected

NOTE! Never pull out or plug in the control unit cable contact when the power supply (ignition) is on.





Without ASR



With ASR

Extract from “Wiring diagram EDC-system”

6	29	18–24 ohm	Control rod travel sensor, injection pump	*2*
6	10	18–24 ohm	Control rod travel sensor, injection pump	*2*
31	35	0.9–1.1 ohm	Speed sensor, injection pump	*10*
1	21	0.5–1.2 ohm	Adjuster device, injection pump	
19	earth	ca 0 ohm	Control, earth connection	
20	earth	ca 0 ohm	Control, earth connection	

Remarks

1. If the bus has automatic transmission, the relay box earths pin 27 when the transmission is in neutral and the parking brake on or if speed exceeds 3 km/h. To simulate a depressed clutch pedal on an automatic transmission, depress the D-button on the gear selector panel or release the parking brake.

   NOTE! The engine must be switched off and the bus wheels chocked to prevent it from rolling.

2. Control rod travel: the voltage is in proportion to the position of the control rod travel. In other words, the position sensor in the injection pump informs the control unit what voltage it should give to pin 28. To be able to compare the measured voltage value for max. control rod travel with the value given in the specifications for the engine in question, it is necessary to correct the value with a view to the fact that the reference voltage can vary (pins 17 and 35). The new value we call Unorm.

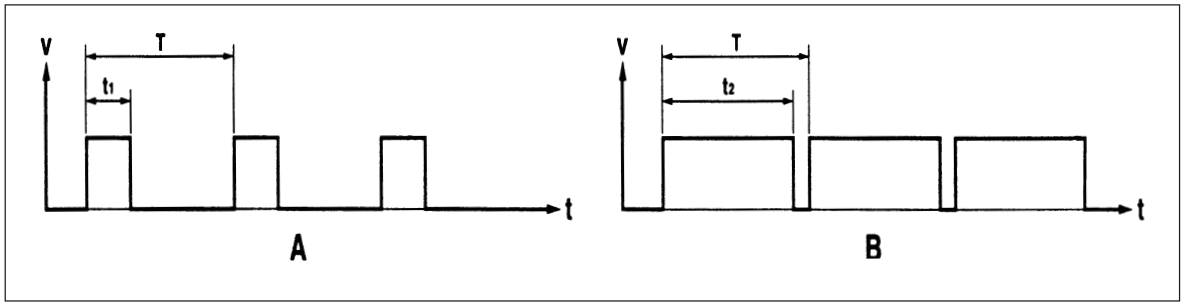
   $$\text{Unorm} = \text{measured voltage value, control rod travel} \times \frac{5}{\text{measured reference voltage}}$$

   Also check the resistance, see page 157 (control rod travel sensor, injection pump)

3. Signal to control unit for ABS/ASR and automatic transmission. It is the socalled “pulse wide modulated signal” and indicates the throttle position to the control units for the automatic transmission and ABS/ASR. When measuring with an average-forming voltmeter on a pulse wide modulated signal, the voltage increases with greater pulse width (measuring in the alternating current position).

   If there is no ASR, “MR” 1 and “MR” 2 loop together (see page 157).

Ex. of pulse wide modulated signal



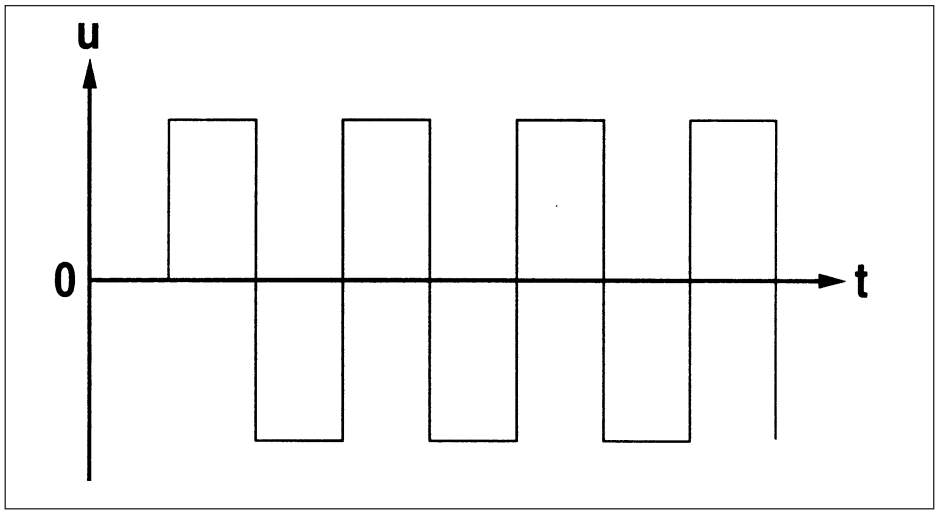
A signal at low idle
200 Hz
10% pulse wide ratio

B signal at 1650 rpm
200 Hz
40% pulse wide ratio

The pulse wide ratio is estimated as t/T* 100 (%).

4. Signal from ABS/ASR (pulse wide modulated) that indicates if dethrottling is necessary. When dethrottling is not required, the signal should have a pulse wide ratio of 90% (fixed value). When a power reduction is required, a 10–90% signal is emitted. 10% of this corresponds to low idle.

5. Pulse signals from the engine speed sensor, so-called “square” signal (but not a pulse wide modulated signal). Frequency increases with increased speed. Should be measured with an oscilloscope. Low idle (550 r/min) 270–300 Hz.



Ex. of a square signal

6. The speed signal from the tachograph is a so-called “square” with varying width on the pusle interval. Amplitude is approx. 7 V and the pulse width is 2.5 ms long (varies according to setting on the dip-switches on the tachograph). At approx. 100 km/h, the pulse-interval ratio is 1:1, frequency 200 Hz. The pulse width is constant, but it alters with speed (frequency changes).

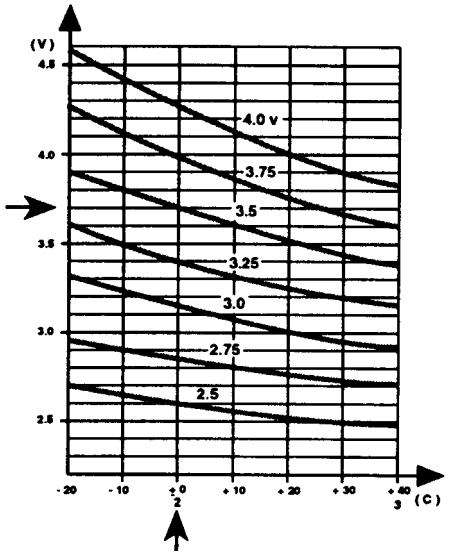
7. Sensor of type NTC-resistance. Temperature-dependent resistance reduces with increased temperature.

8. Sensor of type NTC-resistance. Temperature-dependent resistance reduces with increased temperature.

9. Turbopressure sensor. To be able to compare the measured voltage value for max. turbo pressure with the value given in the specifications for the engine in question, it is necessary to correct the value with a view to the fact that the reference voltage can vary. The new value we call Unorm.

$$\text{Unorm} = \text{measured voltage value, control rod travel} \times \frac{5}{\text{measured reference voltage}}$$

If the measuring is done at a temperature other than +20°C, then the value must also be corrected in order to be able to compare it with the voltage value specified in the specifications. The estimated Unorm value is corrected as per the following graph.



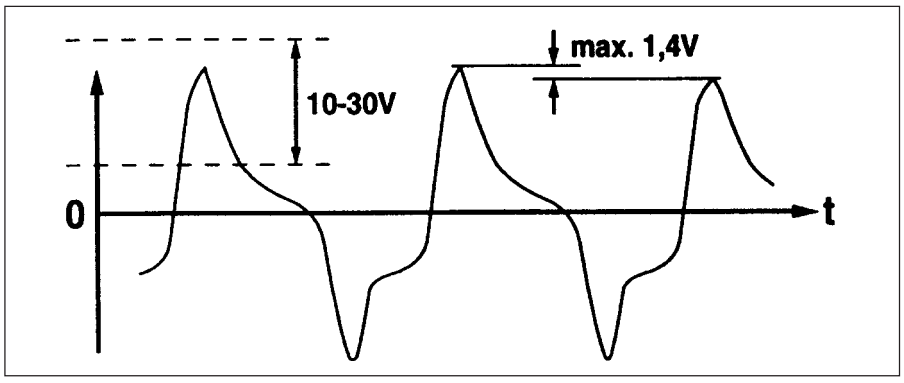
Example

The voltage for the turbo pressure Unorm is estimated at 3.7 V at an ambient temperature of 0°C.

– Go in on the vertical axis in the diagram to 3.7 V.
– Follow the horizontal axis to the right until it intersects the vertical line for 0°C ambient temperature.
– The corrected voltage is read-off on the respective curve in the diagram. In our example 3.5 V, which corresponds to the voltage at 20°C.

10. An oscilloscope is required for a complete check on the injection pump speed sensor. Max. difference in positive amplitude 1.4 V. Positive amplitude should lie between 10–30 V at 1200 r/min engine speed (injection pump revs 600 r/min).

At low idle (550 r/min), positive amplitude should lie between 2.3–11.6 V (50–60 Hz). Average A.C. voltage 2.2–2.4 V (average reading voltmeter).



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