

# WORKSHOP MANUAL

*Industrial diesel engines*    *Marine diesel engines*

**TD60D, -DG, -DPP**

**TID60D, -DG**

**TD70G, -GG, -GPP**

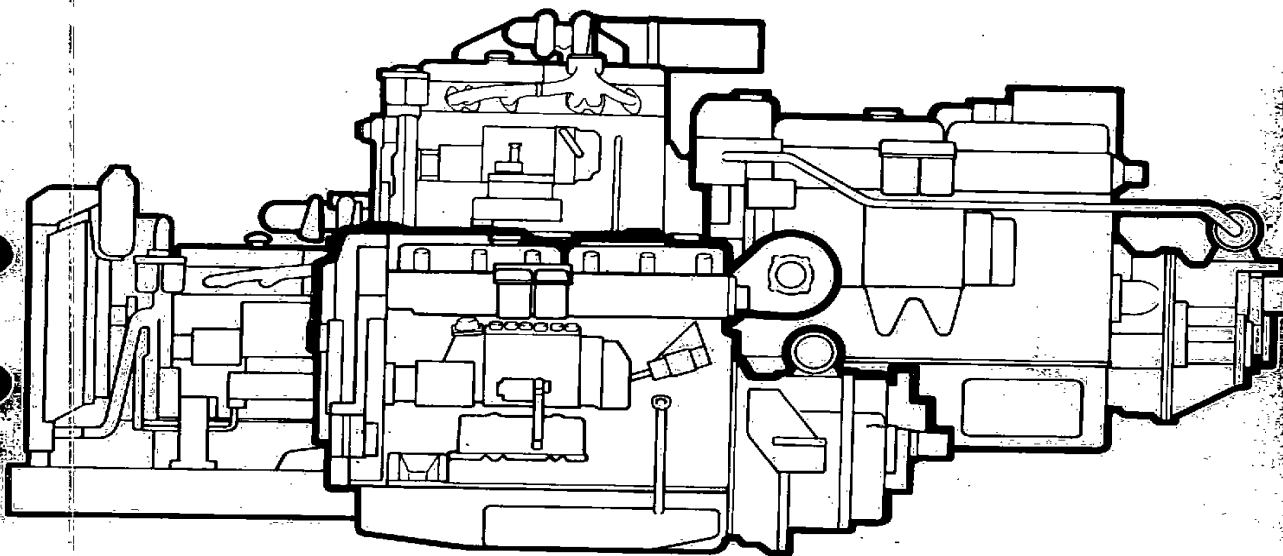
**TID70G, -GG, -GPP**

**TAMD60C**

**MD70C**

**TMD70C**

**TAMD70E**



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## Foreword

This workshop manual includes technical data, descriptions and repair instructions for all standard versions of both industrial and marine diesel engines in the 60 and 70 series.

Both the engine designation and serial numbers of each engine are given on the number plate (fig. 14). Both the engine designation and serial numbers must be clearly stated in all correspondence regarding the engine.

The instructions in this manual describe the most suitable working methods using the special tools which are shown under the heading "Special tools".

We reserve the right to carry out design modifications.

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## Explanation to the engine designations

T = Turbocharger  
A = "Aftercooler" (charge air cooler, marine engines)  
I = "Intercooler" (charge air cooler, industrial engines)  
M = Marine engine  
D = Diesel engine  
60 or 70 = Swept volume (6, resp. 7 litres)  
C, D, E or G = Series designation  
G = Generator set engine (after series designation)  
PP = "Powerpack" (after series designation)

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# WORKSHOP MANUAL

## Industrial engines

TD60D\*,-DG,-DPP · TID60D,-DG

TD70G\*\*,-GG\*\*,-GPP\*\* · TID70G,-GG,-GPP

## Marine engines

TAMD60C · MD70C\*\*\* ·

TMD70C\*\*\* · TAMD70E

\* From engine no xxxx/233432

\*\* From engine no xxxx/232481

\*\*\* From engine no xxxx/211018

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# TECHNICAL DATA

## General

	60 series	70 series
Number of cylinders.....	6	6
Bore.....	98.425 mm (3.875")	104.77 mm (4.125")
Stroke.....	120 mm (4.724")	130 mm (5.118")
Displacement, total.....	5.48 dm <sup>3</sup> (litres) (334 in <sup>3</sup> )	6.73 dm <sup>3</sup> (litres) (411 in <sup>3</sup> )
Compression ratio:		
TD60D,-DG,-DPP, and TD70G,-GG,-GPP.....	16:1	14.5:1
TID60D,-DG, and TID70G,-GG,-GPP.....	15:1	14.5:1
TAMD60C and TAMD70E.....	16:1	15:1
MD70C.....	-	17:1
TMD70C.....	-	16:1
Compression ratio at starter motor speed*:		
TD60D,-DG,-DPP and TD70G,-GG,-GPP.....	2.8 MPa (28 kp/cm <sup>2</sup> ) (398 p.s.i.)	2.6 MPa (26 kp/cm <sup>2</sup> ) (370 p.s.i.)
TID60D,-DG and TID70G,-GG,-GPP.....	2.5 MPa (25 kp/cm <sup>2</sup> ) (356 p.s.i.)	2.6 MPa (26 kp/cm <sup>2</sup> ) (370 p.s.i.)
TAMD60C and TAMD70E.....	2.5 MPa (25 kp/cm <sup>2</sup> ) (356 p.s.i.)	2.5 MPa (25 kp/cm <sup>2</sup> ) (356 p.s.i.)
MD70C.....	-	2.7 MPa (27 kp/cm <sup>2</sup> ) (384 p.s.i.)
TMD70C.....	-	2.6 MPa (26 kp/cm <sup>2</sup> ) (370 p.s.i.)
Firing order (No. 6 cylinder nearest to flywheel).....		1-5-3-6-2-4
Direction of rotation (viewed from front).....		Clockwise
Output.....		See applicable engine diagram
Torque.....		See applicable engine diagram
Weight, engine without reverse gear or clutch, approx.:		
TD60 and TD70.....	605 kg (1334 lbs)	705 kg (1554 lbs)
TID60 and TID70.....	615 kg (1356 lbs)	720 kg (1587 lbs)
TAMD60C and TAMD70E.....	670 kg (1477 lbs)	840 kg** (1852 lbs**) (820 kg/1808 lbs)
MD70C.....	-	830 kg** (1830 lbs**) (800 kg/1764 lbs)
TMD70C.....	-	835 kg** (1841 lbs**) (805 kg/1775 lbs)
Low idle.....		} See appropriate adjustment data in the Service Bulletin file
Governor overrun/high idle.....		
* Appr. 250 rpm. Use Moto-Meter compression meter with a non-return valve.		
** With tubular heat exchanger. Weight with plate heat exchanger stated within brackets below.		

## Turbocharger

Make, industrial engines.....	Garrett/AiResearch
marine engines.....	KKK (Kühnle, Kopp & Kausch)
Type:	
TD60D,-DG,-DPP and TD70G,-GG,-GPP.....	T-04B/S-3/0.84E
TID60D and TID70G,-GG,-GPP.....	T-04B/S-3/1.0E
TID60DG and TMD70C.....	TA3106/50/0.82/57
TAMD60C and TAMD70E.....	K27-3064 G/14.72
Lubricating system.....	Pressure lubrication from engine
Cooling (applies to marine engines).....	Fresh-water cooled turbine housing
Axial clearance:	
Industrial engines.....	0.03-0.10 mm (0.0012-0.004")
Marine engines.....	max. 0.16 mm (0.0063")
Radial clearance:	
Industrial engines (measured on the shaft between the bearings).....	0.08-0.18 mm (0.0032-0.0071")
Marine engines (turbine side).....	max. 0.46 mm (0.018")
Max. backpressure in exhaust line after turbo.....	See applicable engine diagram/brochure

### Turbo pressure

Turbo pressure, min. values (measured in engine intake manifold) with 100 % load and full throttle and approx. +20°C (68°F) air temperature. If the measuring is done at other temperature, the measured turbo pressure must be corrected according to the diagram on page 103.

A considerably lower pressure is obtained at less than full output.

**Curve 1:** Output according to curve 4 in the engine diagram or point 1 in the overrun curve (industrial engines), and heavy duty, output curve C (marine engines).

**Curve 2:** Output according to curve 2 in the engine diagram or point 2 in the overrun curve (industrial engines), and medium duty, output curve C1 (marine engines).

**Curve 3:** Output according to point 3 in the overrun curve (industrial engines), and light duty, output curve B (marine engines).

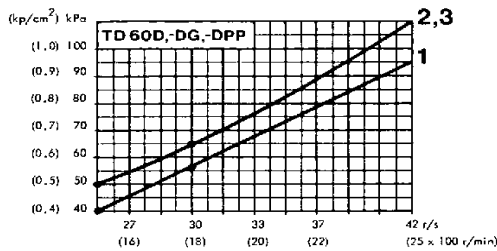


Fig. 1

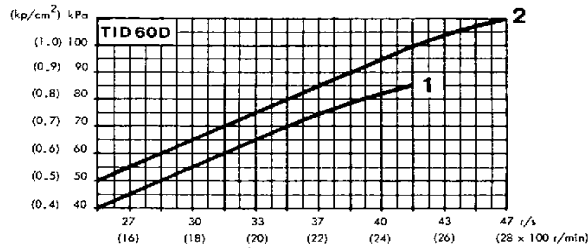


Fig. 2

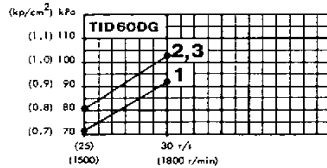


Fig. 3

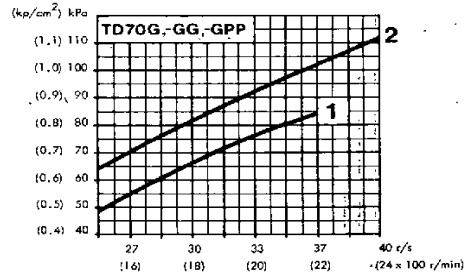


Fig. 4

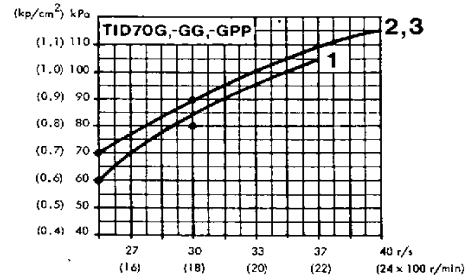


Fig. 5

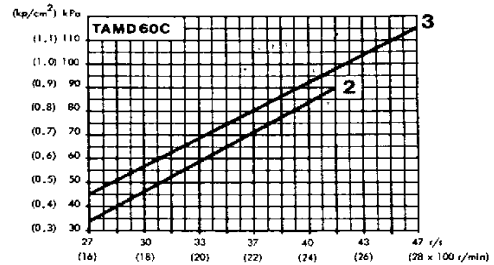


Fig. 6

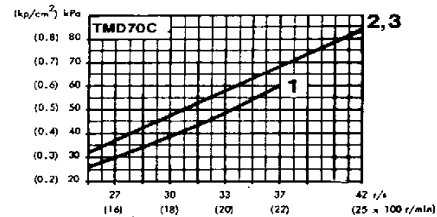


Fig. 7

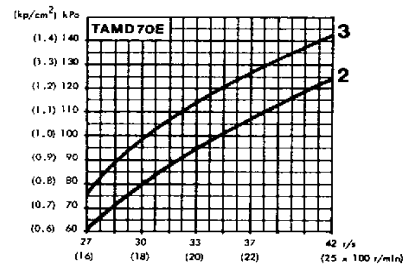


Fig. 8

## Cylinder liners

Type	60 series	70 series
	Wet, replaceable	
Bore (no oversizes available)	98.425 mm (3.875")	104.77 mm (4.125")
Height of cylinder liner above cylinder block surface	0.24–0.29 mm (0.0094–0.0114")	0.38–0.43 mm (0.0150–0.0169")
Recommended height when replacing liners	0.24–0.29 mm (0.0094–0.0114")	0.40–0.43 mm (0.0158–0.0169")
Max difference in height between liners 1, 2 and 3, and between liners 4, 5 and 6 respectively	0.02 mm (0.0008")	0.02 mm (0.0008")
Liner collar thickness	11.58–11.61 mm (0.4559–0.4571")	11.63–11.66 mm (0.4579–0.4591")
Depth of liner recess from the block surface	11.32–11.34 mm (0.4457–0.4465")	11.23–11.25 mm (0.4421–0.4429")
Seals for cylinder liners:		
Number of rubber rings, upper	1	
Thickness	1.5–1.7 mm (0.0591–0.0669")	
Number of rubber rings, lower	2	
Thickness	5.67–5.93 mm (0.2232–0.2335")	

## Pistons

Material	Light alloy with cast iron ring carrier	
	Marking on top of piston:	
TD60D, TAMD60C	Green colour line	–
TID60D	Yellow colour line	–
Combustion chamber, diameter:		
TD60D, TID60D, TAMD60C and TD70G, TID70G	57 mm (2.2441")	60 mm (2.3622")
MD70C	–	55 mm (2.1654")
TMD70C	–	58 mm (2.2835")
TAMD70E	–	65 mm (2.5591")
Combustion chamber, depth:		
TD60D, TAMD60C and TD70G, TID70G	21.8 mm (0.8583")	26.2 mm (1.0315")
TID60D and MD70C	23.5 mm (0.9252")	26.7 mm (1.0512")
TMD70C	–	25.3 mm (0.9961")
TAMD70E	–	21.6 mm (0.8504")
Overall height	124.15–124.65 mm (4.8878–4.9075")	140.8–141.3 mm (5.5433–5.5630")
Height from centre of gudgeon pin to top of piston	79.35–79.45 mm (3.1240–3.1280")	88.40–88.50 mm (3.4803–3.4843")
Piston clearance:		
TD60D, TID60D, TAMD60C and TD70G, TID70G, TAMD70E	0.13–0.15 mm (0.0051–0.0059")	0.09–0.125 mm (0.0035–0.0049")
MD70C, TMD70C	–	0.12–0.14 mm (0.0047–0.0055")
Front marking		Arrow pointing towards front end
Height above cylinder block surface when piston fitted in engine	0.05–0.55 mm (0.0020–0.0217")	0.20–0.70 mm (0.0079–0.0276")

## Piston rings

Compression rings:		
Number	2	3
Upper compression ring, height	2.362–2.375 mm (0.0930–0.0935")	2.362–2.375 mm (0.0930–0.0935")
2nd compression ring, height	3.137–3.150 mm (0.1235–0.1240")	3.124–3.150 mm (0.1230–0.1240")
3rd compression ring, height	–	3.124–3.150 mm (0.1230–0.1240")
Oil-scraping ring:		
Number	1	
Height	4.724–4.737 mm (0.1860–0.1865")	
Piston ring gap measured in cylinder liner at $\varnothing$ 98.425 mm (3.875") (60 series) and $\varnothing$ 104.78 mm (4.1252") (70 series):		
Compression rings	0.25–0.50 mm (0.0098–0.0197")	0.33–0.58 mm (0.0130–0.0228")
Oil-scraping ring	0.25–0.58 mm (0.0098–0.0228")	0.33–0.71 mm (0.0130–0.0280")

## Gudgeon pins

	60 series	70 series
Clearance, gudgeon pin – connecting rod bushing	0.014–0.022 mm (0.0006–0.0009")	0.016–0.024 mm (0.0006–0.0009")
gudgeon pin – gudgeon pin hole		Max. 0.008 mm (0.0003")
Grip fit, gudgeon pin – gudgeon pin hole		Max. 0.004 mm (0.0002")
Gudgeon pin diameter, standard	40.000–40.004 mm (1.5748–1.5750")	45.000–45.004 mm (1.7717–1.7718")
Connecting rod bushing, inner diameter	40.018–40.022 mm (1.5755–1.5757")	45.020–45.024 mm (1.7724–1.7726")
Gudgeon pin hole, diameter in piston	40.000–40.008 mm (1.5748–1.5751")	45.000–45.008 mm (1.7717–1.7720")

## Cylinder heads

Height	101 mm (3.9764")	109 mm (4.2913")
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## Crankshaft with bearings

(Replaceable bearing shells for main and big-end bearings)

Crankshaft end float	0.064–0.264 mm (0.0025–0.0104")	0.068–0.268 mm (0.0027–0.0106")
Main bearings, radial clearance	0.063–0.121 mm (0.0025–0.0048")	0.065–0.119 mm (0.0026–0.0047")

## Main bearings

### Main bearing journals

Diameter, standard	76.149–76.162 mm (2.9980–2.9985")	82.535–82.550 mm (3.2494–3.2500")
undersize 0.010"	75.895–75.908 mm (2.9880–2.9885")	82.281–82.296 mm (3.2394–3.2400")
0.020"	75.641–75.654 mm (2.9780–2.9785")	82.027–82.042 mm (3.2294–3.2300")
0.030"	75.387–75.400 mm (2.9680–2.9685")	81.773–81.788 mm (3.2194–3.2200")
0.040"	75.133–75.146 mm (2.9580–2.9585")	81.519–81.534 mm (3.2094–3.2100")
0.050"	74.879–74.892 mm (2.9480–2.9485")	81.265–81.280 mm (3.1994–3.2000")
Width on crankshaft for pilot bearing with separate thrust washers:		
Standard	43.975–44.025 mm (1.7313–1.7333")	45.975–46.025 mm (1.8100–1.8120")
Overize, 0.2 mm (thrust washers 0.1 mm overize)	44.175–44.225 mm (1.7392–1.7411")	46.175–46.225 mm (1.8179–1.8199")
0.4 mm (thrust washers 0.2 mm overize)	44.375–44.425 mm (1.7470–1.7490")	46.375–46.425 mm (1.8258–1.8278")
0.6 mm (thrust washers 0.3 mm overize)	44.575–44.625 mm (1.7549–1.7569")	46.575–46.625 mm (1.8337–1.8356")

## Main bearing shells

Diameter, bearing shell position in block	81.051–81.076 mm (3.1910–3.1920")	88.483–88.508 mm (3.4836–3.4846")
Thickness, standard	2.403–2.413 mm (0.0946–0.0950")	2.925–2.934 mm (0.1152–0.1155")
overize 0.010"	2.530–2.540 mm (0.0996–0.1000")	3.052–3.061 mm (0.1202–0.1205")
0.020"	2.657–2.667 mm (0.1046–0.1050")	3.179–3.188 mm (0.1252–0.1255")
0.030"	2.784–2.794 mm (0.1096–0.1100")	3.306–3.315 mm (0.1302–0.1305")
0.040"	2.911–2.921 mm (0.1146–0.1150")	3.433–3.442 mm (0.1352–0.1355")
0.050"	3.038–3.048 mm (0.1196–0.1200")	3.560–3.569 mm (0.1402–0.1405")

## Big-end bearings

### Big-end bearing journals

Big-end bearings, radial clearance	0.057–0.103 mm (0.0022–0.0041")	0.068–0.112 mm (0.0027–0.0044")
Length of bearing journals	41.900–42.000 mm (1.6496–1.6535")	43.900–44.000 mm (1.7283–1.7323")
Diameter, standard	63.449–63.462 mm (2.4980–2.4985")	69.837–69.850 mm (2.7495–2.7500")
undersize 0.010"	63.195–63.208 mm (2.4880–2.4885")	69.583–69.596 mm (2.7395–2.7400")
0.020"	62.941–62.954 mm (2.4780–2.4785")	69.329–69.342 mm (2.7295–2.7300")
0.030"	62.687–62.700 mm (2.4680–2.4685")	69.075–69.088 mm (2.7195–2.7200")
0.040"	62.433–62.446 mm (2.4580–2.4585")	68.821–68.834 mm (2.7095–2.7100")
0.050"	62.179–62.192 mm (2.4480–2.4485")	68.567–68.580 mm (2.6995–2.7000")

## Big-end bearing shells

	60 series	70 series
Thickness, standard.....	1.892-1.902 mm (0.0745-0.0749")	1.902-1.911 mm (0.0749-0.0752")
oversize 0.010".....	2.019-2.029 mm (0.0795-0.0799")	2.029-2.039 mm (0.0799-0.0803")
0.020".....	2.146-2.156 mm (0.0845-0.0849")	2.156-2.166 mm (0.0849-0.0853")
0.030".....	2.273-2.283 mm (0.0895-0.0899")	2.283-2.293 mm (0.0899-0.0903")
0.040".....	2.400-2.410 mm (0.0945-0.0949")	2.410-2.420 mm (0.0949-0.0953")
0.050".....	2.527-2.537 mm (0.0995-0.0999")	2.537-2.547 mm (0.0999-0.1003")

## Connecting rods

Marked 1 to 6. The "FRONT" marking on the shank must face forwards.

Fitted with replaceable bearing shells.

Diameter, connecting rod bushing bearing recess.....	43.043-43.068 mm (1.6946-1.6956")	49.887-49.912 mm (1.9641-1.9650")
bearing shell recess.....	67.323-67.336 mm (2.6505-2.6510")	73.740-73.753 mm (2.9032-2.9037")
gudgeon pin bushing.....	See under "Gudgeon pins"	
Axial clearance, connecting rod - crankshaft.....	0.15-0.35 mm (0.0059-0.0138")	

## Flywheel

Flywheel ring gear ..... 140 teeth

## Camshaft

Type of drive.....	Gear	
Number of bearings.....	7	
Front bearing journal, diameter.....	68.996-69.015 mm (2.7164-2.7171")	
2nd bearing journal, diameter.....	66.821-66.840 mm (2.6229-2.6236")	
3rd bearing journal, diameter.....	64.233-64.252 mm (2.5289-2.5296")	
4th bearing journal, diameter.....	63.446-63.465 mm (2.4979-2.4986")	
5th bearing journal, diameter.....	61.058-61.077 mm (2.4039-2.4046")	
6th bearing journal, diameter.....	60.271-60.290 mm (2.3729-2.3736")	
7th bearing journal, diameter.....	56.296-56.315 mm (2.2164-2.2171")	
End float.....	0.05-0.18 mm (0.002-0.007")	
Radial clearance, front bearing.....	0.050-0.094 mm* (0.0020-0.0037")	0.035-0.079 mm (0.0014-0.0031")
bearings 2-7.....	0.035-0.079 mm (0.0014-0.0031")	
Checking camshaft setting (cold engine and valve clearance = 0) With the flywheel at 10° after TDC, the inlet valve for No. 1 cylinder should have opened as follows**:		
TD60D, TID60D and MD70C.....	1.95 mm (0.0768")	2.00 mm (0.0787")
TAMD60C and TD70G, TID70G, TMD70C, TAMD70E.....	2.10 mm (0.0827")	3.60 mm (0.1417")

\* For camshaft bearing in parts' version 0.035-0.079 mm (0.0014-0.0031") applies

\*\* Tolerance for all measured values ±0.25 mm (0.0098")

## Camshaft bearings

Front bearing, diameter (production).....	69.065-69.090 mm (2.7191-2.7201")	69.050-69.075 mm (2.7185-2.7195")
(parts).....	69.050-69.075 mm (2.7185-2.7195")	
2nd bearing, diameter.....	66.675-66.700 mm (2.6250-2.6260")	
3rd bearing, diameter.....	64.287-64.312 mm (2.5310-2.5320")	
4th bearing, diameter.....	63.500-63.525 mm (2.5000-2.5010")	
5th bearing, diameter.....	61.112-61.137 mm (2.4060-2.4070")	
6th bearing, diameter.....	60.325-60.350 mm (2.3750-2.3760")	
7th bearing, diameter.....	56.350-56.375 mm (2.2185-2.2195")	

## Timing gears

	60 series	70 series
Backlash		0.03–0.17 mm (0.0012–0.0067")
Journal for idler gear, diameter		92.084–92.106 mm (3.6254–3.6262")
Bushing for idler gear, diameter		92.131–92.166 mm (3.6272–3.6286")
Radial clearance for idler gear		0.025–0.082 mm (0.0010–0.0032")
Axial clearance for idler gear		0.05–0.15 mm (0.002–0.006")
Crankshaft gear		28 teeth
Idler gear		53 teeth
Camshaft gear		56 teeth
Drive gear for injection pump		56 teeth
Drive gear for sea water pump alt. drive output or air compressor		33 teeth
Drive gear for servo pump (optional equipment), industrial engines		19 teeth
marine engines		32 teeth
Idler gear for lubrication pump		37 teeth
Drive gear for lubrication pump		28 teeth

## Valve system

### Valves

Intake:		
Valve disc, diameter	41 mm (1.6142")	43 mm (1.6929")
Valve stem, diameter	7.960–7.975 mm (0.3134–0.3140")	10.982–11.000 mm (0.4324–0.4331")
Valve seat angle	29.5°	29.5°
Seat angle in cylinder head	30°	30°
Valve clearance (cold engine or at operating temperature)	0.40 mm (0.0157")	0.40 mm (0.0157")
Exhaust:		
Valve disc, diameter	37 mm (1.4567")	37 mm (1.4567")
Valve stem diameter	7.935–7.950 mm (0.3124–0.3130")	10.950–10.968 mm* (0.4311–0.4318")
	–	10.966–10.984 mm** (0.4317–0.4324")
Valve seat angle	44.5°	44.5°
Seat angle in cylinder head	45°	45°
Valve clearance (cold engine or at operating temperature): engine without turbocharger	–	0.45 mm (0.0177")
engine with turbocharger	0.45 mm (0.0177")	0.55 mm (0.0217")

\* Applies to MD70 and TAMD70

\*\* Applies to all other engines in the 70 series

### Valve seats

Valve seat for intake valve:		
Diameter (dimension A), standard	43.574–43.590 mm (1.7155–1.7161")	46.064–46.080 mm (1.8135–1.8142")
oversize	43.774–43.790 mm (1.7234–1.7240")	46.264–46.280 mm (1.8214–1.8220")
Height (dimension B)	6.05–6.15 mm (0.2382–0.2421")	6.1–6.2 mm (0.2402–0.2441")
Recess for valve seat, intake valves:		
Diameter (dimension C), standard	43.500–43.525 mm (1.7126–1.7136")	46.000–46.025 mm (1.8110–1.8120")
oversize	43.700–43.725 mm (1.7205–1.7215")	46.200–46.225 mm (1.8189–1.8199")
Depth (dimension D)	8.7–8.8 mm (0.3425–0.3465")	8.95–9.05 mm (0.3524–0.3563")
Bottom radius of recess, (dimension R)	0.5–0.8 mm (0.0197–0.0315")	0.5–0.8 mm (0.0197–0.0315")
The measurement between the valve disc and the cylinder head surface should be	0.7–1.1 mm (0.0276–0.0433")	1.0–1.4 mm (0.0394–0.0551")



Fig. 9. Diagram of seat and recess for valve seat

	60 series	70 series
Valve seat for exhaust valves:		
Diameter (dimension A), standard .....	41.574–41.590 mm (1.6368–1.6374")	44.056–44.082 mm (1.7345–1.7355")
oversize .....	41.774–41.790 mm (1.6446–1.6453")	44.256–44.282 mm (1.7424–1.7434")
Height (dimension B) .....	8.8–8.9 mm (0.3465–0.3504")	8.8–9.0 mm (0.3465–0.3543")
Recess for valve seat, exhaust valves:		
Diameter (dimension C), standard .....	41.500–41.525 mm (1.6339–1.6348")	44.000–44.025 mm (1.7323–1.7333")
oversize .....	41.700–41.725 mm (1.6417–1.6427")	44.200–44.225 mm (1.7402–1.7411")
Depth (dimension D) .....	11.7–11.8 mm (0.4606–0.4646")	9.8–9.9 mm (0.3858–0.3898")
Bottom radius of recess (dimension R) .....	0.5–0.8 mm (0.0197–0.0315")	0.5–0.8 mm (0.0197–0.0315")
The dimension between the valve disc and the cylinder head surface should be .....	0.7–1.1 mm (0.0276–0.0433")	1.0–1.4 mm (0.0394–0.0551")

## Valve guides

Length .....	64.5 mm (2.54")	66 mm (2.60")
Inside diameter (fitted) .....	8.000–8.015 mm (0.3150–0.3156")	11.032–11.050 mm (0.4343–0.4350")
parts version .....	8.000–8.022 mm (0.3150–0.3158")	11.032–11.059 mm (0.4343–0.4354")
Height above cylinder head spring plane .....	23 mm (0.9055")	22 mm (0.8661")
Clearance, valve stem – valve guide:		
Intake valve .....	0.025–0.060 mm (0.0010–0.0024")	0.032–0.068 mm (0.0013–0.0027")
Exhaust valve .....	0.050–0.090 mm (0.0020–0.0035")	0.064–0.100 mm* (0.0025–0.0039")
	–	0.048–0.084 mm** (0.0019–0.0033")

\* Applies to MD70 and TAMD70

\*\* Applies to all other engines in the 70 series

## Valve springs

### Single valve springs

Length, unloaded .....	62.8 mm (2.47")	
with loading of 334–374 N (34–38 kp = 75–84 lbf) .....	51 mm (2.01")	
with loading of 676–754 N (69–77 kp = 152–170 lbf) .....	39 mm (1.54")	
fully compressed, max. ....	34.8 mm (1.37")	
Length, unloaded .....	–	approx 60 mm (2.36")
with loading of 324–363 N (33–37 kp = 73–82 lbf) .....	–	47 mm (1.85")
with loading of 647–726 N (66–74 kp = 145–163 lbf) .....	–	35 mm (1.38")
fully compressed, max. ....	–	31.5 mm (1.24")

### Double valve springs

#### Outer valve springs:

Length, unloaded .....	–	64.1 mm (2.52")
with loading of 273–313 N (27.8–31.9 kp = 61–70 lbf) .....	–	48.6 mm (1.91")
with loading of 491–571 N (50.1–58.2 kp = 110–128 lbf) .....	–	36 mm (1.42")
fully compressed, max. ....	–	32 mm (1.26")

#### Inner valve springs:

Length, unloaded .....	–	60.1 mm (2.37")
with loading of 111–131 N (11.3–13.4 kp = 25–30 lbf) .....	–	44.6 mm (1.76")
with loading of 200–240 N (20.4–24.5 kp = 45–54 lbf) .....	–	32 mm (1.26")
fully compressed, max. ....	–	28 mm (1.10")

## Rocker arm mechanism

Rocker arm bushing, diameter after pressing in and machining .....	22.020–22.041 mm (0.8669–0.8678")	25.020–25.042 mm (0.9850–0.9859")
--	--------------------------------------	--------------------------------------

## Lubricating system

Oil pressure, hot engine, operating speed.....  
 Oil pressure, idling speed.....  
 Engines with piston cooling:  
 Oil pressure, piston cooling oil at 2400 rpm.....

Oil quality in accordance with API-system.....  
 Viscosity at various ambient air temperatures.....

\* Using these oils at temperatures above +15°C (+59°F) could involve increased engine wear.  
 \*\* At temperature below -25°C (-13°F), consult your oil supplier for suitable oil.  
 NOTE! Synthetic oil is only recommended at temperatures below -25°C (-13°F)

Oil capacity, incl. lubricating oil filter and oil cooler, approx.:

### Industrial engines

TD60D, TID60D and TD70G, TID70G resp. (standard oil sump).....

TD60D, TID60D and TD70G, TID70G resp. (shallow oil sump).....

### Marine engines

TAMD60C and TAMD70E resp. (no engine inclination).....

TAMD60C and TAMD70E resp. (18° engine inclination).....

MD70C, TMD70C (no engine inclination).....

MD70C, TMD70C (15° engine inclination).....

MD70C, TMD70C (18° engine inclination).....

\* With shallow oil sump (bulb).

### Lubricating oil pump:

type.....  
 number of teeth.....  
 end float, pump gear.....  
 backlash, pump gear.....  
 diameter, idler gear bearing sleeve.....  
 diameter, idler gear bushing.....  
 radial clearance for idler gear.....  
 diameter, oil pump bushings.....  
 clearance, thrust washer - oil pump drive gear.....  
 number of teeth, drive gear.....  
 number of teeth, idler gear.....

Relief valve springs, TD70G, TID70G, TAMD70E:

Outer valve spring:  
 Length, unloaded.....  
 with a loading of 250-400 N (25.5-40.8 kp = 56.2-90.0 lbf).....  
 Inner valve spring:  
 Length, unloaded.....  
 with a loading of 52-54 N (5.3-5.4 kp = 11.7-11.9 lbf).....  
 with a loading of 70.3-72.3 N (7.2-7.4 kp = 15.9-16.3 lbf).....  
 Overflow valve spring, TD70G, TID70G:  
 Length, unloaded.....  
 with a loading of 13-15 N (1.3-1.5 kp = 2.9-3.3 lbf).....  
 with a loading of 16.9-18.9 N (1.7-1.9 kp = 3.8-4.2 lbf).....

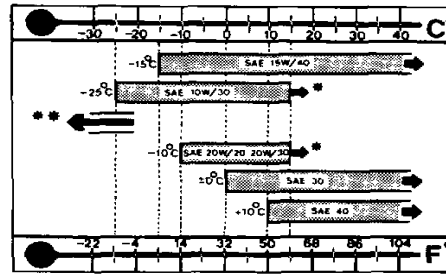
### 60 series

300-500 kPa (3-5 kp/cm<sup>2</sup> = 43-71 p.s.i.)  
 min. 50 kPa (0.5 kp/cm<sup>2</sup> = 7.1 p.s.i.)

### 70 series

80-120 kPa  
 (0.8-1.2 kp/cm<sup>2</sup>  
 = 11.4-17.1 p.s.i.)

CD



11 litres  
 (2.4 Imp.gals  
 = 2.9 US gals)

15 litres  
 (3.3 Imp.gals  
 = 4.0 US gals)

min. 18, max. 20 litres  
 (min. 4.0 Imp.gals = 4.8 US gals)  
 (max. 4.4 Imp.gals = 5.3 US gals)

20 litres  
 (4.4 Imp.gals  
 = 5.3 US gals)  
 13 litres  
 (2.9 Imp.gals  
 = 3.4 US gals)

30 litres  
 (6.6 Imp.gals  
 = 7.9 US gals)  
 19 litres  
 (4.2 Imp.gals  
 = 5.0 US gals)

32 litres  
 (7.0 Imp.gals  
 = 8.5 US gals)  
 30 litres\*  
 (6.6 Imp.gals  
 = 7.9 US gals)

19 litres  
 (4.2 Imp.gals  
 = 5.0 US gals)  
 19 litres\*  
 (4.2 Imp.gals  
 = 5.0 US gals)

### Gear

11  
 0.07-0.15 mm (0.0028-0.0059")  
 0.15-0.35 mm (0.0059-0.0138")  
 63.97-64.00 mm (2.5185-2.5197")  
 64.03-64.06 mm (2.5209-2.5220")  
 0.03-0.09 mm (0.0012-0.0035")  
 16.016-16.034 mm (0.6306-0.6313")  
 0.02-0.08 mm (0.0008-0.0032")  
 28  
 37  
 16.4-17.2 mm (0.646-0.677")  
 15 mm (0.591")  
 54-58 mm (2.13-2.28")  
 39 mm (1.54")  
 33 mm (1.30")  
 68.8 mm (2.71")  
 40 mm (1.58")  
 32 mm (1.26")

## Fuel system

Direction of rotation of injection pump viewed from the front.....  
 Order of injection.....  
 Injection quantity.....  
 Feed pressure:  
 TAM70E.....  
 All other engines.....

### 60 series

Clockwise  
 1-5-3-6-2-4  
 See governor data plate or appropriate  
 adjustment data in Service Bulletin file.

70 series  
 140-160 kPa  
 (1.4-1.6 kp/cm<sup>2</sup>  
 = 20-23 p.s.i.)

100-150 kPa  
 (1.0-1.5 kp/cm<sup>2</sup> = 14-21 p.s.i.)

## Relief valve

Make and type:  
 TAM70E.....

All other engines.....

\* Refer to "Feed pressure" above.

Agrees with Bosch  
 PVE 53S 5Z, but with  
 altered opening  
 pressure\*  
 Bosch PVE 53S 5Z

## Fuel filters

Number of filter inserts, TD60, TID60.....  
 other engines.....

1

2 connected in parallel

## Injection pump

### TD60D, TD60DPP

Make, type (flange mounted).....  
 Lift height from base radius at beginning of delivery  
 (stroke position).....  
 Setting.....  
 Pump element, diam.....  
 Governor.....  
 Governor (alternative equipm. TD60D).....  
 Feed pump.....

Bosch PES6MW100/320RS1004  
 2.8+0.1 mm (0.1102+0.0039")  
 22° B.T.D.C.  
 10 mm (0.39")  
 Bosch RSV325-1250MW0/308  
 Bosch RQV300-1300MW41  
 Bosch FP/K22MW17

### TD60DG

Make, type (flange mounted).....  
 Lift height from base radius at beginning of delivery  
 (stroke position).....  
 Setting.....  
 Pump element, diam.....  
 Governor.....  
 Feed pump.....

Bosch PES6MW100/320RS1004  
 2.8+0.1 mm (0.1102+0.0039")  
 21-22° B.T.D.C.  
 10 mm (0.39")  
 Bosch RSV650-750MW4/311-2  
 Bosch FP/K22MW17

### TID60D

Make, type (flange mounted).....  
 Lift height from base radius at beginning of delivery  
 (stroke position).....  
 Setting.....  
 Pump element, diam.....  
 Governor.....  
 Feed pump.....

Bosch PES6MW100/320RS1004-1  
 2.8+0.1 mm (0.1102+0.0039")  
 24°±0.5° B.T.D.C.  
 10 mm (0.39")  
 Bosch RSV325-1400MW2/308  
 Bosch FP/K22MW17

**TID60DG**

Make, type (flange mounted).....  
 Lift height from base radius at beginning of delivery  
 (stroke position).....  
 Setting.....  
 Pump element, diam.....  
 Governor.....  
 Feed pump.....

Bosch PES6MW100/320RS1004  
 2.8+0.1 mm (0.1102+0.0039")  
 18°±0.5° B.T.D.C.  
 10 mm (0.39")  
 Bosch RSV650-750MW4/311-3  
 Bosch FP/K22MW17

**TD70G, TD70GPP**

Make, type.....  
 Lift height from base radius at beginning of delivery  
 (stroke position).....  
 Setting.....  
 Pump element, diam.....  
 Governor.....  
 Feed pump.....

Bosch PE6P110A320RS390  
 3.0+0.1 mm (0.1181+0.0039")  
 20-21° B.T.D.C.  
 11 mm (0.43")  
 Bosch RSV200-1200P1/305R  
 Bosch FP/K22P9

**TD70G (alternative equipment)**

Make, type.....  
 Lift height from base radius at beginning of delivery  
 (stroke position).....  
 Setting.....  
 Pump element, diam.....  
 Governor.....  
 Feed pump.....

Bosch PE6P110A320RS413Z  
 3.0+0.1 mm (0.1181+0.0039")  
 20°±0.5° B.T.D.C.  
 11 mm (0.43")  
 Bosch RQV250-1200PA499  
 Bosch FP/K22P9

**TD70GG**

Make, type.....  
 Lift height from base radius at beginning of delivery  
 (stroke position).....  
 Setting.....  
 Pump element, diam.....  
 Governor.....  
 Feed pump.....

Bosch PE6P110A320RS390  
 3.0+0.1 mm (0.1181+0.0039")  
 20-21° B.T.D.C.  
 11 mm (0.43")  
 Bosch RSV650-750P4/421R  
 Bosch FP/K22P9

**TID70G, TID70GPP**

Make, type.....  
 Lift height from base radius at beginning of delivery  
 (stroke position).....  
 Setting.....  
 Pump element, diam.....  
 Governor.....  
 Feed pump.....

Bosch PE6P110A320RS465  
 3.0+0.1 mm (0.1181+0.0039")  
 20°±0.5° B.T.D.C.  
 11 mm (0.43")  
 Bosch RSV200-1200P1/305R  
 Bosch FP/K22P9

**TID70GG**

Make, type.....  
 Lift height from base radius at beginning of delivery  
 (stroke position).....  
 Setting.....  
 Pump element, diam.....  
 Governor.....  
 Governor (earlier version).....  
 Feed pump.....

Bosch PE6P110A320RS465  
 3.0+0.1 mm (0.1181+0.0039")  
 20°±0.5° B.T.D.C.  
 11 mm (0.43")  
 Bosch RSV650-750P4/421R  
 Bosch RSV200-750P4/421R  
 Bosch FP/K22P9

## TAMD60C

Make, type (flange mounted) .....	Bosch PES6MW100/320RS1111
Lift height from base radius at beginning of delivery (stroke position) .....	3.1+0.1 mm (0.1220+0.0039")
Setting .....	22° B.T.D.C.
Pump element, diam. ....	10 mm (0.39")
Governor .....	Bosch RSV325-1400MW2A314
Feed pump .....	Bosch FP/K22MW17

## MD70C

Make, type .....	Bosch PE6P110A320RS367Z
Lift height from base radius at beginning of delivery (stroke position) .....	3.0+0.1 mm (0.1181+0.0039")
Setting .....	20°±0.5° B.T.D.C.
Pump element, diam. ....	11 mm (0.43")
Governor .....	Bosch RQV250-1000PA394/2R
Feed pump .....	Bosch FP/K22P9

## TMD70C

Make, type .....	Bosch PE6P110A320RS367Y
Lift height from base radius at beginning of delivery (stroke position) .....	3.0+0.1 mm (0.1181+0.0039")
Setting .....	20°±0.5° B.T.D.C.
Pump element, diam. ....	11 mm (0.43")
Governor .....	Bosch RQV250-1000PA394/2R
Feed pump .....	Bosch FP/K22P9

## TAMD70E

Make, type .....	Bosch PE6P110A320RS260W
Lift height from base radius at beginning of delivery (stroke position) .....	2.8+0.1 mm (0.1102+0.0039")
Setting .....	22°±0.5° B.T.D.C.
Pump element, diam. ....	11 mm (0.43")
Governor .....	Bosch RSV250-1250P0/374/2R
Feed pump .....	Bosch FP/K22P9

## Injectors

### TD60D,-DG,-DPP

Nozzle holders, make and type .....	Bosch KBEL 95 P 9/4
Nozzles .....	Bosch DLLA 150 P 22
Injector complete, number marking .....	870
Opening pressure .....	27 MPa (275 kp/cm <sup>2</sup> = 3911 p.s.i.)
Adjusting pressure (new spring) .....	27.5-28.3 MPa (280-289 kp/cm <sup>2</sup> = 3983-4111 p.s.i.)
Nozzle hole diameter .....	4 x 0.32 mm (0.0126")

### TID60D,-DG, TAMD60C, TMD70C

Nozzle holders, make and type .....	Bosch KBEL 95 P 9/4
Nozzles .....	Bosch DLLA 150 P 28
Injector complete, number marking .....	865
Opening pressure .....	24 MPa (245 kp/cm <sup>2</sup> = 3485 p.s.i.)
Adjusting pressure (new spring) .....	24.5-25.3 MPa (250-258 kp/cm <sup>2</sup> = 3556-3670 p.s.i.)
Nozzle hole diameter .....	4 x 0.34 mm (0.0134")

## TD70G,-GG,-GPP, TID70G,-GG,-GPP

Nozzle holders, make and type .....	Bosch KBEL 95 P 9/4
Nozzles .....	Bosch DLLA 143 P 40
Injector complete, number marking .....	854
Opening pressure .....	27 MPa (275 kp/cm <sup>2</sup> = 3911 p.s.i.)
Adjusting pressure (new spring) .....	27.5–28.3 MPa
	(280–289 kp/cm <sup>2</sup> = 3983–4111 p.s.i.)
	4 x 0.355 mm (0.0140")

## MD70C

Nozzle holders, make and type .....	Bosch KBEL 95 P 9/4
Nozzles .....	Bosch DLLA 150 P 24
Injector complete, number marking .....	868
Opening pressure .....	27 MPa (275 kp/cm <sup>2</sup> = 3911 p.s.i.)
Adjusting pressure (new spring) .....	27.5–28.3 MPa
	(280–289 kp/cm <sup>2</sup> = 3983–4111 p.s.i.)
	4 x 0.30 mm (0.0118")

## TAMD70E

Nozzle holders, make and type .....	Bosch KBEL 95 P 9/4
Nozzles .....	Bosch DLLA 150 P 32
Injector complete, number marking .....	862
Opening pressure .....	27 MPa (275 kp/cm <sup>2</sup> = 3911 p.s.i.)
Adjusting pressure (new spring) .....	27.5–28.3 MPa
	(280–289 kp/cm <sup>2</sup> = 3983–4111 p.s.i.)
	3 x 0.46 mm (0.0181")

## Cooling system

Type .....	60 series	70 series
		Pressure type, closed cooling system
Capacity, incl. heat exchanger or standard radiator, approx.: TD60D,-DG,-DPP and TD70G,-GG,-GPP resp.: with plastic expansion tank .....	22 litres (4.8 Imp.gals = 5.8 US gals)	25 litres (5.5 Imp.gals = 6.6 US gals)
with metal expansion tank .....	28 litres (6.2 Imp.gals = 7.4 US gals)	31 litres (6.8 Imp.gals = 8.2 US gals)
TID60D,-DG and TID70G,-GG,-GPP: with plastic expansion tank .....	23 litres (5.1 Imp.gals = 6.1 US gals)	26 litres (5.7 US gals = 6.9 US gals)
with metal expansion tank .....	29 litres (6.4 Imp.gals = 7.7 US gals)	32 litres (7.0 Imp.gals = 8.5 US gals)
TAMD60C and MD70C: with plate heat exchanger .....	20, 23* litres (4.4, 5.1* Imp.gals = 5.3, 6.1* US gals)	29 litres (6.4 Imp.gals = 7.7 US gals)
with tubular heat exchanger .....	–	34 litres (7.5 Imp.gals = 9.0 US gals)
TMD70C with plate heat exchanger .....	–	30 litres (6.6 Imp.gals = 7.9 US gals)
with tubular heat exchanger .....	–	34 litres (7.5 Imp.gals 9.0 US gals)
TAMD70E with plate heat exchanger .....	–	30 litres (6.6 Imp.gals = 7.9 US gals)
with tubular heat exchanger .....	–	35 litres (7.7 Imp.gals = 9.3 US gals)
Filler cap's pressure valve opens at: Industrial engines: expansion tank (metal) .....		23–31 kPa (0.23–0.32 kp/cm <sup>2</sup> = 3.27–4.55 p.s.i.)
expansion tank (plastic) .....		30 kPa (0.3 kp/cm <sup>2</sup> = 4.3 p.s.i.)
cooler .....		no pressure valve
Marine engines: TAMD60C**, and engines with tubular heat exchanger .....		43–53 kPa (0.44–0.54 kp/cm <sup>2</sup> = 6.2–7.7 p.s.i.)
all other engines .....		23–31 kPa (0.23–0.32 kp/cm <sup>2</sup> = 3.27–4.55 p.s.i.)

\* Incl. separate expansion tank (plastic).

\*\* Applies to the engine's expansion tank. Only when optional expansion tank (plastic) is fitted.

## Thermostats

	60 series	70 series
Type .....	Wax	
Number .....	2	
TAMD60C*:		
marking .....	70°/blue paint spot	
starts opening at .....	68-72/74-78°C (154-162/165-172°F)	
fully open at .....	82-86/88-92°C (180-187/190-198°F)	
Other engines:		
marking .....	Blue paint spot	
starts opening at .....	74-78°C (165-172°F)	
fully open at .....	88-92°C (190-198°F)	

\* The thermostats have different opening temperatures.

## Electrical system

System voltage:	
TAMD60C .....	12V (alt. 24V optional equipm.)
Other engines .....	24V (alt. 12V optional equipm. marine engines)
Battery capacity:	
Marine engines and T(I)D60DG, T(I)D70GG:	
With 24V system voltage .....	2 connected in series 12V max. 143Ah*
With 12V system voltage .....	2 connected in parallel 12V, max. 110Ah*, (totally max. 220Ah*)
Other industrial engines:	
With 24V system voltage .....	2 connected in series 12V, max. 110 Ah*
Density of battery electrolyte at +20°C (68°F):	
fully charged battery .....	1.265-1.290 g/cm <sup>3</sup>
battery to be recharged at .....	1.230 g/cm <sup>3</sup>
Electrical pre-heater, rating approx.:	
TD60, TD70 .....	2.8 kW
TID60, TID70 .....	2.2 kW
Stop solenoid for injection pump, breaker point settings:	
On engines with stop solenoid the pin at the rear of the solenoid - at fully pushed back link rod - should be pushed out approx. ....	1.5-2 mm (0.059-0.079")

\* According to DIN 72311.

## Alternator

Industrial engines:		
Make .....	Paris-Rhône	
Voltage/max. current .....	28V/55A	
Output, approx. ....	1500 W	
Brush length .....	min. 3 mm (0.118")	
Marine engines:		
Alt. 1 - TAMD60C and TAMD70E resp.:		
Make .....	Paris-Rhône	
Voltage/max. current .....	14V/50A (alt. 28V/55A)	28V/55A (alt. 14V/50A)
Output, approx. ....	650W (alt. 1500W)	1500W (alt. 650W)
Brush length .....	min. 3 mm (0.118")	
Alt. 2 - MD70C, TMD70C:		
Make .....	S.E.V. Marchal	
Voltage/max. current .....	28V/25A (alt. 14V/38A)	
Output, approx. ....	650W (alt. 500W)	
Length of brush projecting from brush holder .....	min. 5 mm (0.197")	
Alt. 2 - All marine engines (optional equipment):		
Make .....	CAV	
Voltage/max. current .....	28V/60A	
Output, approx. ....	1600W	
Brush length .....	min. 8 mm (0.315")	
Brush spring force .....	2.3-2.8 N (230-280 p = 0.5-0.6 lb)	

## Starter motor

Marine engines and T(1)D60DG, T(1)D70GG:

Make, type .....  
 Brush length .....  
 Brush spring force .....  
 Other industrial engines:  
 Make, type .....  
 Brush length .....

### 60 series

### 70 series

Bosch KB  
 min. 17.5 mm (0.689")  
 12-14 N (1.2-1.4 kp = 2.6-3.1 lbf)  
 Bosch JF  
 min. 8.5 mm (0.3346")

## Wear tolerances

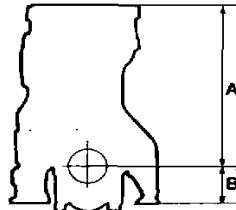
### Cylinder heads

Height ..... min. 100.65 mm (3.963") min. 108.65 mm (4.278")

### Cylinder

Cylinder liners and pistons with piston rings should be replaced when wear amounts to 0.35-0.40 mm (0.014-0.016"). The piston rings should be replaced when the piston ring gap, measured below the bottom turning point, is 1.5 mm (0.059") or more.

### Cylinder block



Height, top block surface - crankshaft centreline (A) ..... min. 368.9 mm (14.524") min. 402.9 mm (15.862")  
 bottom block surface - crankshaft centreline (B) ..... min. 89.9 mm (3.539") min. 89.9 mm (3.539")

### Crankshaft

Max. permissible out-of-round on main and big-end bearing journals ..... 0.08 mm (0.0032")  
 Max. permissible taper on main and big-end bearing journals ..... 0.05 mm (0.0020")  
 Max. end float on crankshaft ..... 0.40 mm (0.0157")

### Valves

Valve stems, max. permissible wear ..... 0.02 mm (0.0008")  
 Max. permissible clearance valve stem-valve guide:  
 Intake valves ..... 0.15 mm (0.0059")  
 Exhaust valves ..... 0.17 mm (0.0067")  
 The valve disc should be, min.:  
 Intake valves ..... 1.2 mm (0.047") 1.4 mm (0.055")  
 Exhaust valves ..... 1.2 mm (0.047") 1.0 mm (0.039")  
 The valve seat may be ground until the distance from the valve disc (new valve) to the cylinder head surface is, max. .... 1.5 mm (0.059") 2.0 mm (0.079")

### Camshaft

Max. permissible out-of round (with new bearings) ..... 0.05 mm (0.0020")  
 Bearings, max. permissible wear ..... 0.05 mm (0.0020")

## Tightening torques in Nm (kpm/lbf.ft)

	60 series	70 series
Cylinder heads*	170 (17/123)	**
Main bearings	140 (14/101)	
Big-end bearings	160 (16/116)	
Bearing bracket, rocker arm shaft	40 (4/29)	
Flange, front camshaft bearing	40 (4/29)	
Camshaft gear	45 (4.5/33)	
Pump drive gear	—	45 (4.5/33)
Idler gear journal	60 (6/43)	
Pump housing and bearing sleeve for lubricating oil pump idler gear	20 (2/15)	
Bracket, lubricating oil pump	40 (4/29)	
Rocker arm cover	10 (1/7.5)	
Auxiliary drive gear casing	20 (2/15)	
Pulley, drive output (on auxiliary drive gear casing cover)	—	150 (15/109)
Oil sump	17 (1.7/12)	
Flywheel housing	140 (14/101)	
Flywheel	170 (17/123)	
Vibration damper, attaching bolts	60 (6/43)	
Polygon hub, centre bolt	260 (26/188)	
Injection pump:		
drive hub	90 (9/65)	—
pressure valve retainers, TAMD60C***	50-60 (5-6/36-43)	—
other engines	40-50 (4-5/29-36)	80-90 (8-9/58-65)
element units, attaching nuts	20-25 (2-2.5/14.5-18)	—
Injectors, attaching nut	50 (5/36)	—

\* Dip the cylinder head bolts **completely** (including screw heads) in a rustproofing compound for a maximum of 24 hours prior to assembly. The screws should drip-dry before being fitted. Tighten in stages, see page 36.

\*\* Cylinder heads for the 70 series are subjected to a combination of torque tightening (in stages up to 160 Nm (16 kpm/116 lbf.ft) and angle tightening (60°), see page 36.

\*\*\* The threads shall be smeared with special grease (Bosch art. No. 5 963 340 110) prior to assembly.

# SPECIAL TOOLS

When ordering tools, the figures 999 shall be placed in front of the 4-digit tool numbers (e.g. 999 1801-3). The last figure (after the hyphen) is a check-digit. See pages 18 and 19.

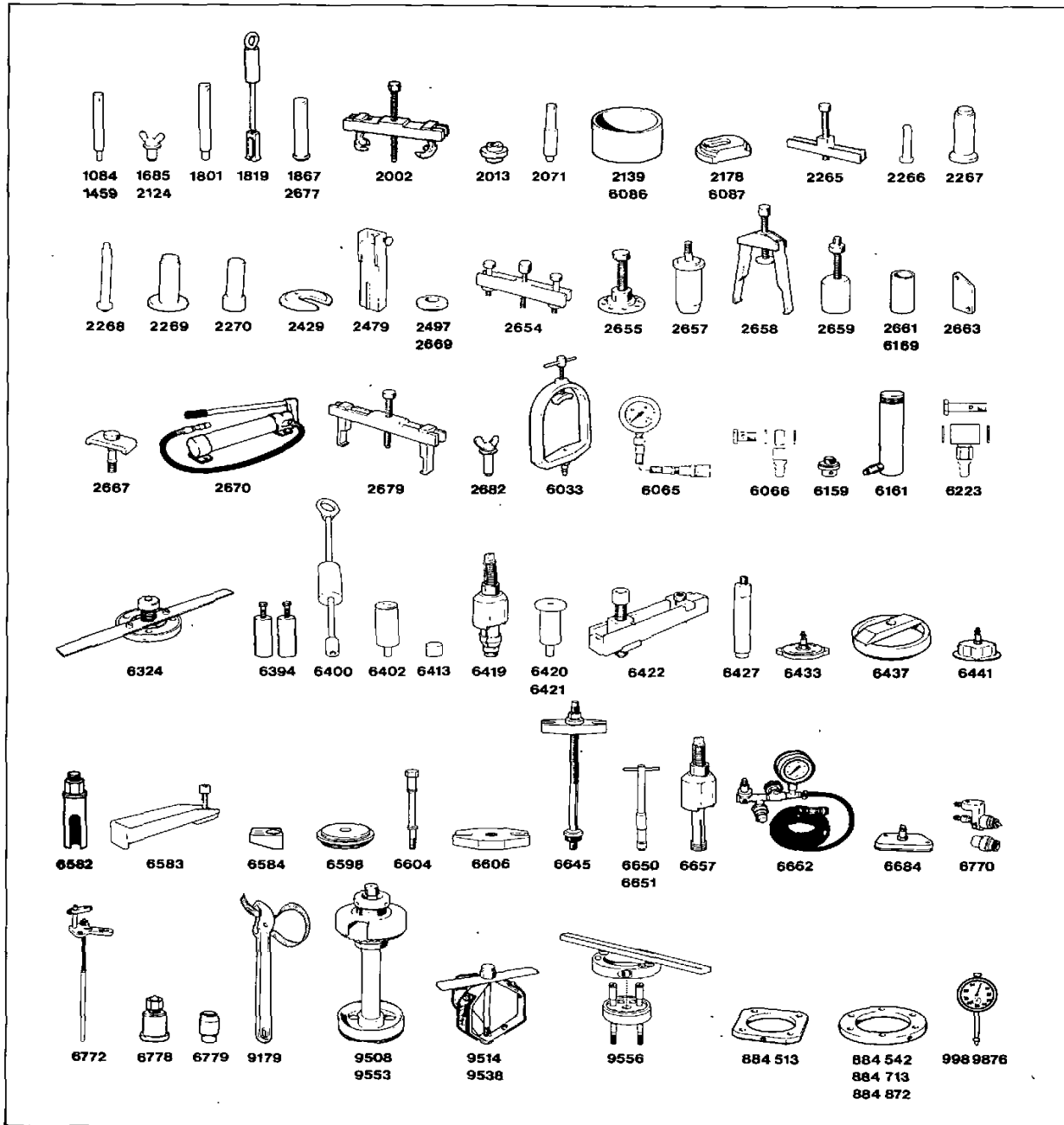


Fig. 10. Special tools

No.

999-

- 1084-6 Drift for removing valve guides, 70 series.  
 1459-0 Drift for removing valve guides, 60 series.  
 1685-0 Expander plugs (3) for pressure testing of cylinder heads, 60 series.  
 1801-3 Standard handle 18x200 mm for drifts.  
 1819-5 Extractor for ball bearing in flywheel.  
 1867-4 Drift for removing and fitting bushings in rocker arm, 60 series.  
 2002-7 Puller for pulley.  
 2013-4 Drift for fitting bearing in flywheel. Used together with 1801.  
 2071-2 Drift for removing and fitting gudgeon pins.  
 2124-9 Expander plugs for pressure-testing of cylinder heads. (6 for 60 series resp. 3 for 70 series).  
 2139-7 Installation ring for pistons, 70 series.  
 2178-5 Puller plate for cylinder liner puller 6645, 70 series.  
 2265-0 Puller for coolant pump pulley.  
 2266-8 Counterhold for removing pulley on coolant pump.  
 2267-6 Drift for removing and fitting ball bearings in pulley for coolant pump, as well as drift for fitting bearings in bearing housing of injection pump drive.  
 2268-4 Drift for removing and fitting ball bearings, shaft and seal in coolant pump.  
 2269-2 Fixture for coolant pump.  
 2270-0 Drift for fitting seal in coolant pump.  
 2429-2 Thrust washer for removing ball bearing, coolant pump.  
 2479-7 Holder for dial indicator when checking liner collar height above block face.  
 2497-9 Drift for removing and fitting bushings in connecting rods, 70 series. Used together with 1801.  
 2654-5 Puller for oil pump drive gear and injection pump flange.  
 2655-2 Puller for crankshaft polygon hub.  
 2657-8 Tool for fitting polygon hub on crankshaft.  
 2658-6 Puller for crankshaft gear.  
 2659-4 Press tool for fitting crankshaft gear.  
 2661-0 Drift for fitting valve guides, 70 series.  
 2663-6 Washer for pressure-testing of cylinder heads.  
 2667-7 Tools (2) for pressing down cylinder liners when measuring liner collar height above block face.  
 2669-3 Drift for removing and fitting bushings in connecting rods, 60 series. Used together with 1801.  
 2670-1 Hydraulic pump (hand driven). Used together with 6161.  
 2677-6 Drift for removing and fitting bushings in rocker arm, 70 series.  
 2679-2 Puller for camshaft gear, and for the 70 series also injection pump drive gear.  
 2682-6 Expander plugs (5) for pressure-testing of cylinder heads, 70 series.  
 6033-8 Clamp for pressure-testing of oil cooler, TD60.  
 6065-0 Pressure gauge with hose for connection to banjo nipple 6066 when checking fuel feed pressure, or for connection to nipple 6223 when checking turbo charging pressure on industrial engines.\*  
 6066-8 Banjo nipple with quick-coupling for connection to 6065.  
 6086-6 Installation ring for pistons, 60 series.  
 6087-4 Puller plate for cylinder liner puller 6645, 60 series.  
 6159-1 Pin for hydraulic cylinder 6161.  
 6161-7 Hydraulic cylinder for fitting cylinder liners.  
 6169-0 Drift for fitting valve guides, 60 series.  
 6223-5 Nipple with rapid-coupling for connection to 6065.  
 6324-1 Milling cutter for cutting slots in cylinder heads, 70 series.  
 6394-4 Supports (2) for puller 6645.  
 6400-9 Slide hammer. Can be used with 6419 and 6657.  
 6402-5 Drift for fitting copper sleeve for injectors.  
 6413-2 Intermediate piece for pressure plate 6598.  
 6419-9 Puller for copper sleeve steel ring.  
 6420-7 Drift for fitting copper sleeve and steel ring, 70 series.  
 6421-5 Drift for fitting copper sleeve and steel ring, 60 series.  
 6422-3 Press tool for fitting copper sleeve and steel ring, 70 series. Used together with 6402 and 6420.  
 6427-2 Adapter for measuring compression pressure.  
 6433-0 Adapter (cap). Used with 6662 on all engines except industrial engines with separate plastic expansion tank.  
 6437-1 Tool for fitting rear crankshaft seal.  
 6441-3 Adapter (cap). Used with 6662 on industrial engines with separate plastic expansion tank.  
 6582-4 Extractor for injectors.  
 6583-2 Press tool for fitting copper sleeve and steel ring, 60 series. Used together with 6402, 6421 and 6584.  
 6584-0 Counterhold for press tool 6583, 60 series.  
 6598-0 Press plate for fitting cylinder liner. Used together with 6161.  
 6604-6 Bolts (2) for yoke 6606.  
 6606-1 Yoke for hydraulic cylinder 6161.  
 6645-9 Puller for cylinder liner excl. of puller plate. Used together with 6394 (2 pcs).  
 6650-9 Milling cutter for cleaning of injector's copper sleeve seat (step II).  
 6651-7 Milling cutter for cleaning of injector's copper sleeve seat (step I).  
 6657-4 Extractor for copper sleeve for injector.  
 6662-4 Testing device\*\* for checking cylinder head and cooling system with compressed air.  
 6684-8 Connecting washer with rapid-coupling for pressure-testing of cylinder head.  
 6770-5 Tool for setting of pre-injection angle. Used with 998 9876.  
 6772-1 Tool for checking of camshaft wear. Used with 998 9876.  
 6778-8 Tool for pressing sealing ring into pump drive, 70 series.  
 6779-6 Extractor for sealing ring in pump drive, 70 series.  
 9179-6 Tool for removing fuel and oil filters.  
 9508-6 Milling cutter for reconditioning cylinder liner recess, 70 series.  
 9514-4 Expander for rotating cylinder liner, 70 series.  
 9538-3 Expander for rotating cylinder liner, 60 series.  
 9553-2 Milling cutter for reconditioning cylinder liner recess, 60 series.  
 9556-5 Milling cutter for cutting slots in cylinder heads, 60 series.

\* NOTE! The same tool must not be used for checking both fuel feed pressure and turbo pressure.

\*\* Must be used with kit 998 9860-3 (only applicable for Sweden).

- Part No.**  
 884 513-3 Flange kit complete, for measuring exhaust back pressure, engines TAMD60, TMD70 and TAMD70.  
 884 542-2 Flange kit complete, for measuring exhaust back pressure, engines TD60 and TID60D.  
 884 713-9 Flange kit complete, for measuring exhaust back pressure, engines TD70 and TID70.  
 884 872-3 Flange kit complete, for measuring exhaust back pressure, engine TID60DG.  
 998 9876-9 Dial indicator.

### Turbocharger

The tools shown in figures 11–13 are not sold by Volvo Penta, but can be made by the individual workshop.

Dimensions in mm

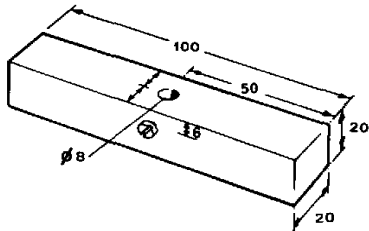
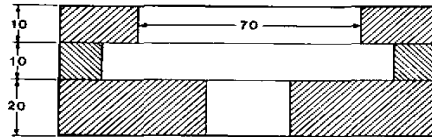
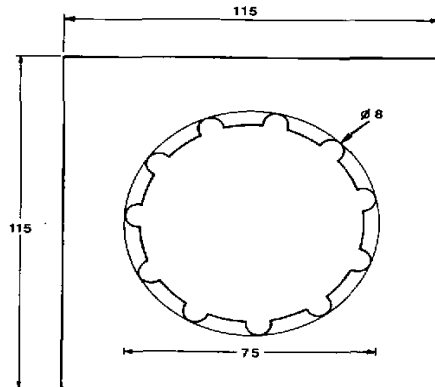


Fig. 11. Sketch of special tool

Holder for dial indicator when measuring axial clearance.



### AiResearch

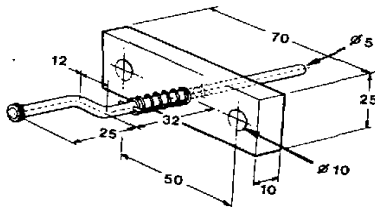


Fig. 12. Sketch of special tool AiResearch.

Fig. 13. Sketch of special tool AiResearch. The fixture is made of plywood, hardwood or aluminium.

# PRESENTATION

The engines are straight 6 cylinder, 4 stroke diesel engines fitted with overhead valves. The engines are direct injected and have thermostat controlled water-cooled blocks and cylinder heads. The marine engines have a cooling system divided into a fresh-water system and a sea-water system. The sea-water cools the fresh-water system via a heat exchanger.

Lubrication is by a pressure lubricating system in which an oil pump supplies oil under pressure to all lubrication points.

The fuel system is protected from contamination by replaceable fine filters.

The engines have wet replaceable cylinder liners and two separate cylinder heads, each covering three cylinders. The cylinder heads are interchangeable.

On engines fitted with a turbocharger, the cylinders are supplied with air under pressure which results in a surplus of air. This enables the injected fuel quantity to be increased, resulting in increased engine output. The turbo-

charger which is lubricated and cooled by the engine lubricating oil, is driven by the engine exhaust gases, utilizing the otherwise wasted exhaust gas energy. The turbocharger's turbine housing on the marine engines is fresh-water cooled to reduce heat radiation to the engine compartment. TID60, TID70 and TAMD60, TAMD70 are also equipped with a water cooled charge air cooler (sea-water cooled on the marine engines) in which the intake air is cooled down after passing through the turbocharger. This reduces the volume of air and increases the quantity of air (oxygen) which can be supplied, thereby burning a greater quantity of fuel, i.e. power output is further increased. By cooling the intake air, the temperature of combustion and exhaust gases are kept to a suitable level despite the increased power output.

The industrial engines are supplied with an electrical pre-heater for easier starting and reduced smoke emission when starting in cold weather.



Basic engine no.      Conversion no.      Engine designation

Fig. 14. Number plate, example

Engine	Location of number plate
TD60, TID60	On the right hand side of the cylinder block diagonally above the starter motor.
TAMD60	On the right hand side of the cylinder block in front of the lube oil filters.
70 series	On the left hand side of the cylinder block above the protection plate above the injection pump drive shaft.

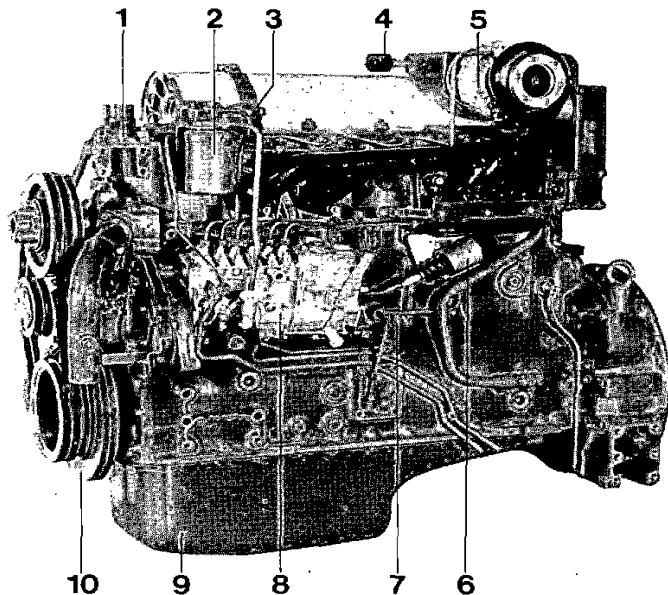


Fig. 15. TD60DG

1. Thermostat housing
2. Fuel filter
3. Oil filler cap
4. Pressure drop indicator
5. Turbocharger
6. Stop solenoid
7. Oil dipstick
8. Injection pump
9. Oil sump
10. Vibration damper

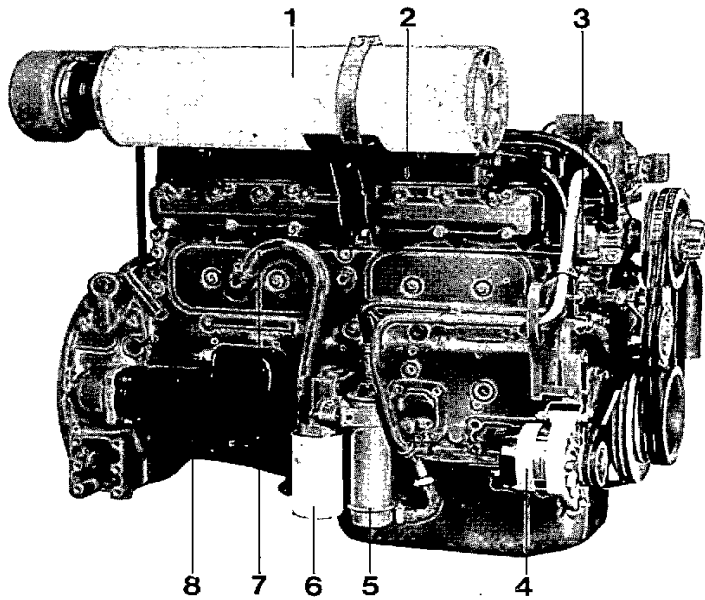


Fig. 16. TID60DG

1. Air filter
2. Intercooler
3. Coolant pump
4. Alternator
5. Oil cooler filter
6. Lube oil filter
7. Crankcase ventilation
8. Starter motor

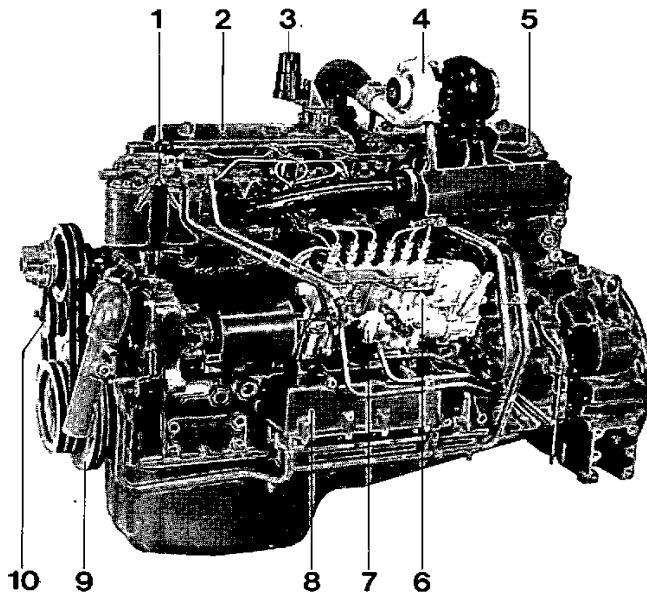


Fig. 17. TD70G

1. Fuel filters
2. Valve cover
3. Relay for el. pre-heater
4. Turbocharger
5. Injector
6. Injection pump
7. Feed pump
8. Oil cooler
9. Vibration damper
10. Automatic belt tensioner

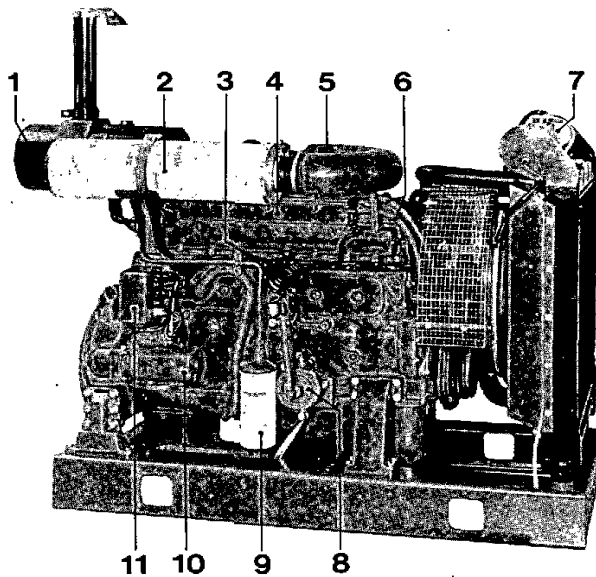


Fig. 18. TID70GPP

1. Silencer
2. Air filter
3. Signal horn
4. Intercooler
5. Pressure drop indicator
6. Coolant hoses to/from the intercooler
7. Expansion tank
8. Oil scavenging pump
9. Lube oil filter
10. Starter motor
11. Connector box with automatic fuse

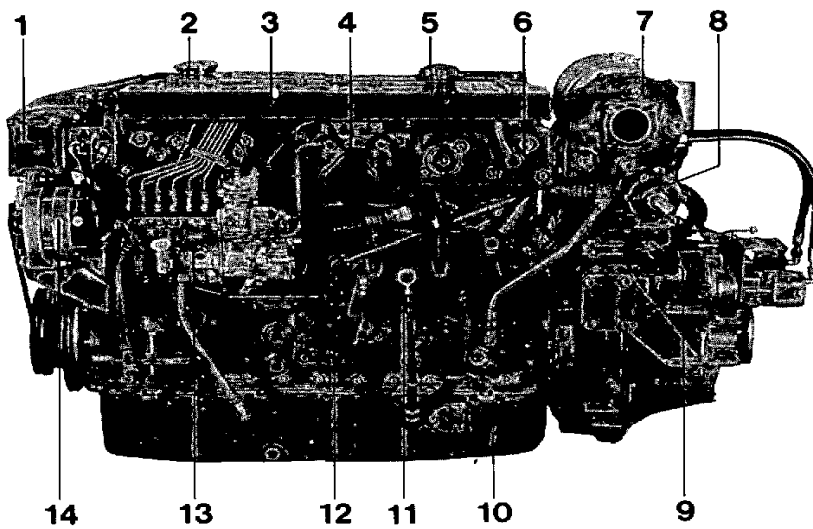


Fig. 19. TAMD60C

1. Heat exchanger
2. Cap (coolant)
3. Protection plate
4. Fuel filters
5. Oil filler cap
6. Water-cooled exhaust manifold
7. Turbocharger
8. Oil cooler, reverse gear
9. Oil dipstick, reverse gear
10. Oil sump
11. Oil dipstick, engine
12. Stop solenoid
13. Injection pump
14. Alternator

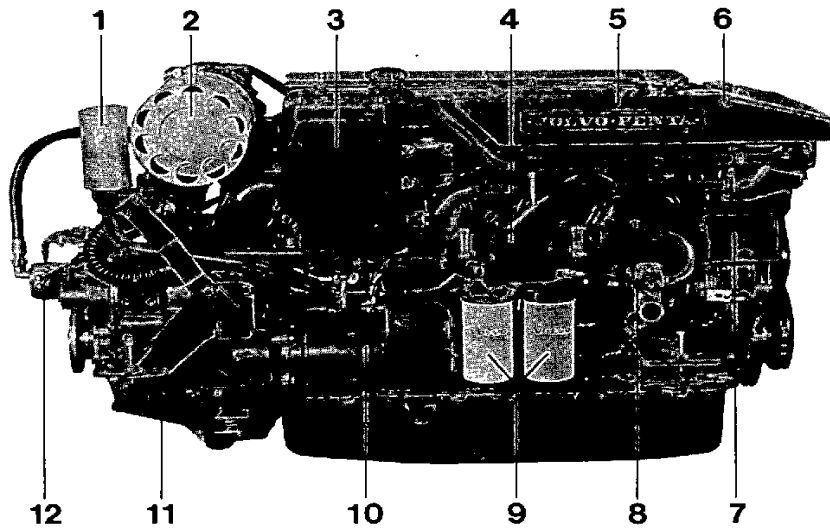


Fig. 20. TAMD60C

1. Filter for crankcase ventilation
2. Air filter
3. Aftercooler
4. Oil cooler for engine
5. Expansion tank (cooling system)
6. Connection for expansion tank (optional equipm.)
7. Connector box with automatic fuses
8. Sea-water pump
9. Lube oil filters
10. Starter motor
11. Reverse gear, TD MG 506
12. Oil pump

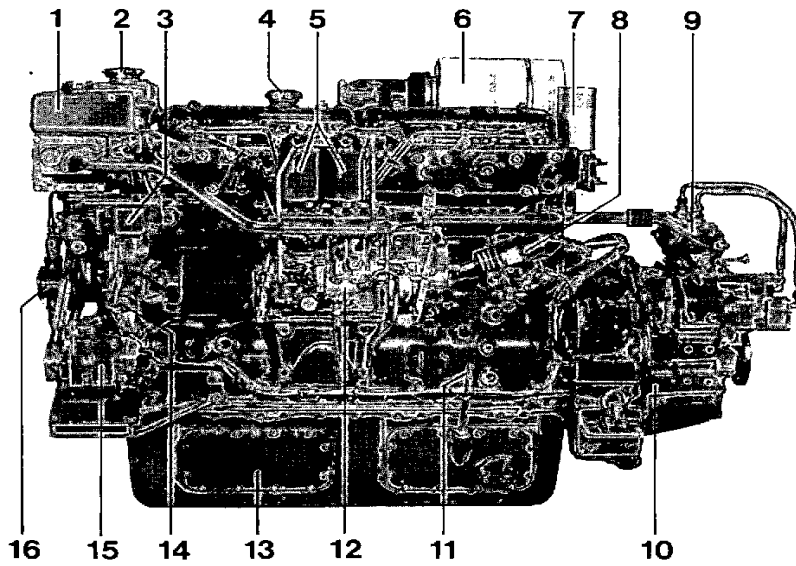


Fig. 21. MD70C with plate heat exchanger

1. Expansion tank
2. Fresh-water filler cap
3. Voltage regulator
4. Oil filler cap
5. Fuel filters
6. Air filter
7. Filter for crankcase ventilation
8. Stop solenoid
9. Oil cooler, reverse gear
10. Reverse gear
11. Oil dipstick
12. Injection pump
13. Inspection cover
14. Engine speed sender
15. Alternator
16. Bilge pump (optional equipm.)

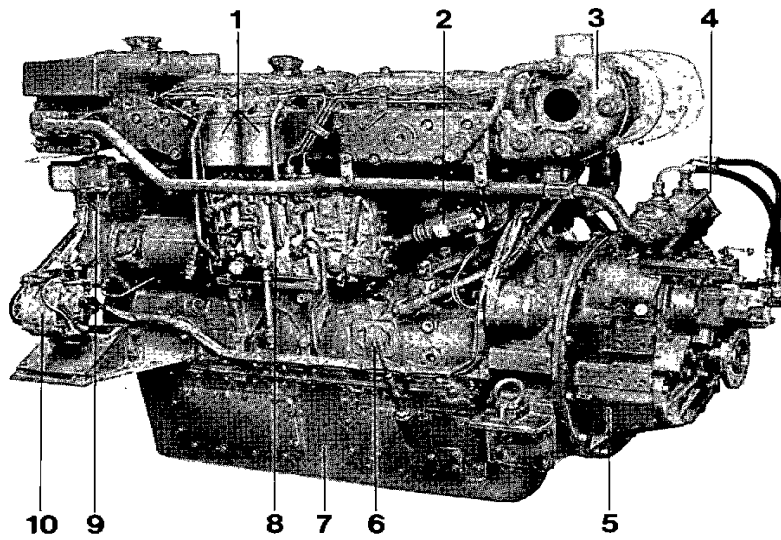


Fig. 22. TMD70C with plate heat exchanger

1. Fuel filters
2. Stop solenoid
3. Turbocharger
4. Oil cooler for reverse gear
5. Reverse gear TD MG 506
6. Oil dipstick
7. Deep oil sump (with inspection covers)
8. Injection pump
9. Voltage regulator
10. Alternator

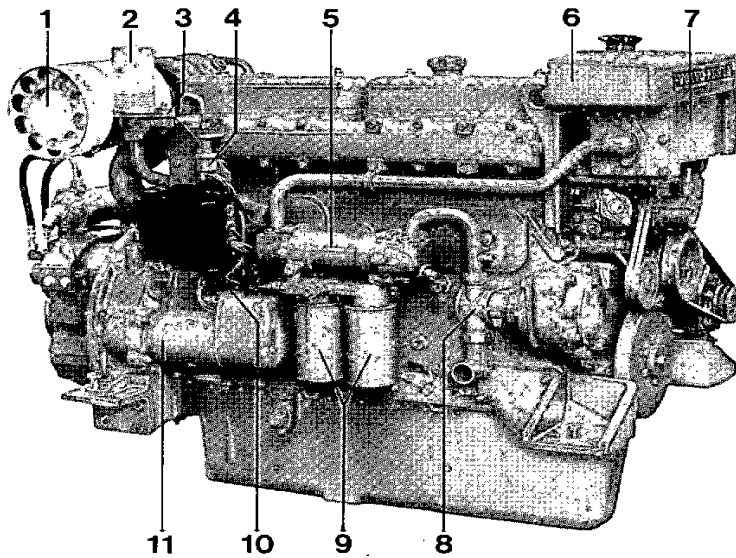


Fig. 23. TMD70C with plate heat exchanger

1. Air filter
2. Filter for crankcase ventilation
3. Valve for crankcase ventilation (steps opening at certain pressure)
4. Sender for charging pressure (optional equipm.)
5. Oil cooler
6. Expansion tank
7. Plate heat exchanger
8. Sea-water pump
9. Oil filters
10. Connector box
11. Starter motor

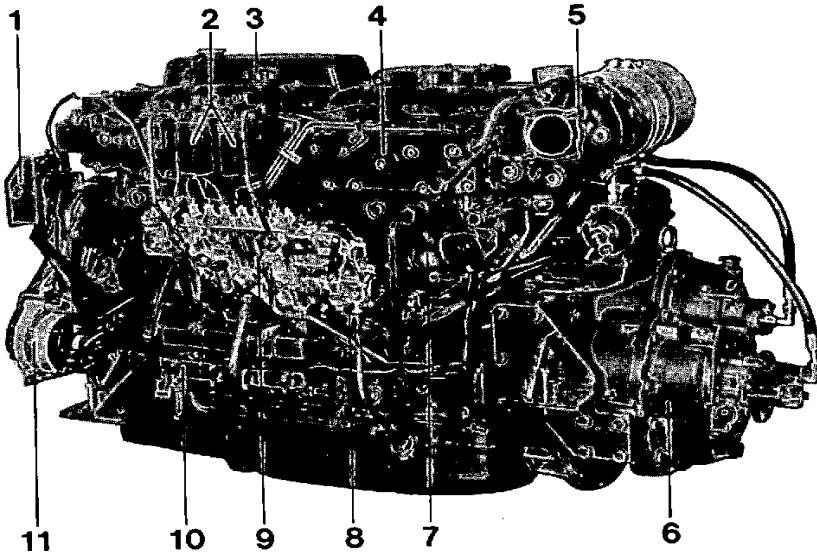


Fig. 24. TAMD70E with tubular heat exchanger

1. El. connector box with autom. fuses
2. Fuel filters
3. Oil filler cap
4. Exhaust manifold
5. Turbocharger
6. Reverse gear TD MG 507
7. Stop solenoid
8. Oil dipstick
9. Injection pump
10. Oil cooler for engine
11. Alternator

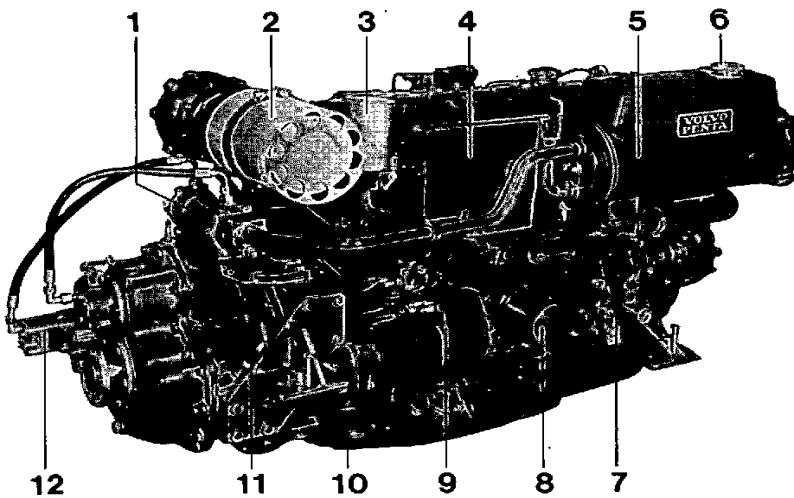


Fig. 25. TAMD70E with tubular heat exchanger

1. Oil cooler for reverse gear
2. Air filter
3. Filter for crankcase ventilation
4. Aftercooler
5. Tubular heat exchanger
6. Coolant filler cap
7. Sea-water pump
8. Lube oil filter
9. Starter motor
10. Oil sump
11. Oil dipstick, reverse gear
12. Oil pump

# ENGINE

## DESCRIPTION

### Cylinder heads

The engine has two cylinder heads each of which cover three cylinders. Each cylinder head is attached to the cylinder block with thirteen 9/16" bolts per head.

The cylinder head material is special-alloyed cast iron. The cylinder head gaskets are made of solid steel.

The cylinder head face has special sealing grooves. These grooves control the sealing surface area so that the required sealing pressure is obtained without high tightening torques with risk of deforming the cylinder liner recess in the block.

On the 60 series the sealing consists of V-shaped grooves, whereas the 70 series has two concentric wide grooves sunk into the cylinder head face directly above the cylinder liner collar (fig. 40).

On the 70 series the cylinder head attaching bolts are tightened by a combination of torque and angle tightening.

### Cylinder block

The cylinder block is a monobloc casting in special-alloyed cast iron. The combustion pressure force in the cylinder head bolts is transferred via reinforced sections in the cylinder block walls direct to the main bearings.

The camshaft bearings are bored to the correct dimension after assembly.

### Pistons

The pistons are made of light-alloy. The upper compression ring, which distributes most of the heat conducted via the piston rings is located in a special-alloyed cast-iron ring carrier, integrally cast into the piston. This provides a long life to the piston ring groove, despite the heat stresses. The piston ring grooves for other piston rings are machined directly in the piston.

TD70, TID70, and TAMD70 engines are fitted with piston cooling. The pistons for these engines have a circular space inside the upper section of the piston through which the oil flows to cool the piston. See "Piston cooling", page 59.

The engine combustion chambers are formed completely in the piston crown. Piston and liner are supplied as parts only as a complete unit.

**Piston marking:** See fig. 26 (applies to 60 series).

### Piston rings

#### 60 series

Each piston is fitted with three piston rings. The sliding surface against the cylinder liner wall is chrome-plated and on the upper ring slightly rounded.

The second compression ring has a machined internal chamfer. To prevent incorrect assembly the ring is marked TOP. The marking should face upwards.

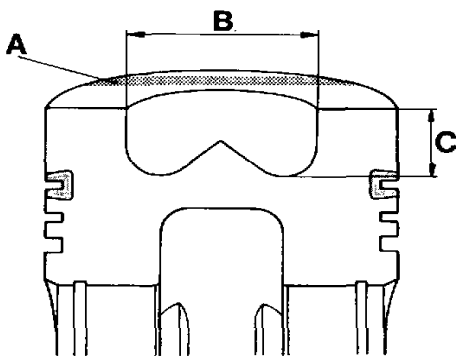


Fig. 26. Type of piston

A: Piston marking (60 series)

TD60D, TAMD60C: Green colour line  
TID60D: Yellow colour line

B: Combustion chamber, diameter.\*

C: Combustion chamber, depth.\*

\* See Technical data, page 4.

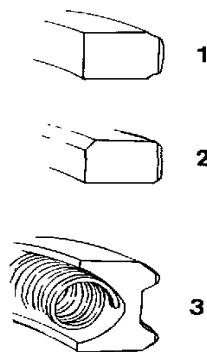


Fig. 27. Piston rings, 60 series

1. Upper compression ring
2. Lower compression ring
3. Oil ring

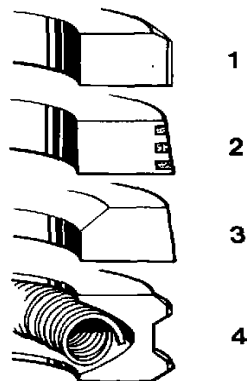


Fig. 28. Piston rings, 70 series  
1-3. Compression rings  
4. Oil ring

The oil ring has two scraping edges which are pressed against the cylinder liner wall; partly due to the ring's own spring force and partly due to an expander spring located on the inside of the ring. The expander causes the ring to follow the cylinder wall more effectively, thus reducing the oil consumption.

#### 70 series

Each piston is fitted with four piston rings, three compression rings and one oil ring.

The upper compression ring in the piston ring kits and in the cylinder liner kits for the industrial engines has its sliding surface against the cylinder liner wall chrome-plated as well as a machined external chamfer. The ring is marked TOP to prevent incorrect assembly. This marking (-) should face upwards.

The second and third compression rings are slightly tapered and surface-treated with ferrox. The second compression ring is also provided with three ferrox-filled grooves. (Ferrox absorbs oil and thus has lubricating properties). The third compression ring has a machined internal chamfer. The rings are marked TOP. The oil ring is of the same type as for the 60 series, see above.

The cylinder liner kits for the marine engines contain an other type of piston rings. The upper compression ring (chrome-plated) has no marking and can be turned either way. The third compression ring is of the same type as the 2nd ring, i.e. with three ferrox-filled grooves.

#### Cylinder liners

The cylinder liners are replaceable and of the "wet" type. They are made of cast iron and centrifugally cast.

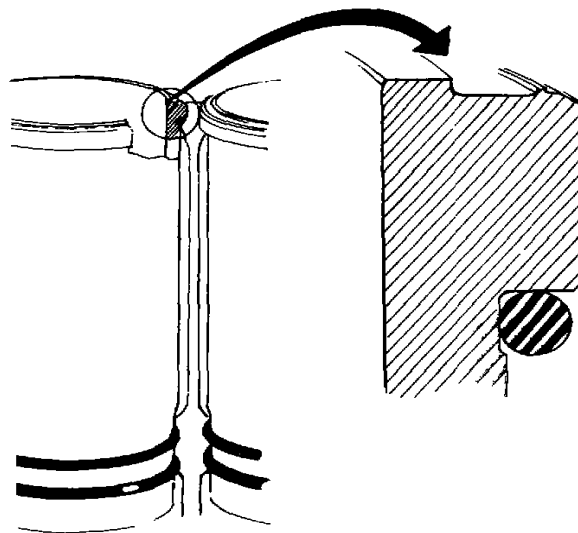


Fig. 29. Cylinder liner with seals

The cylinder liners are sealed externally by three rubber O-rings. The lower rings are located in turned grooves in the cylinder block. These rings are made of different materials. The black ring with a colour coding is of fluorocarbon and the black ring with no marking is of nitrile rubber.

Note. In the parts kits for most engines both the lower sealing rings are similar and of fluorocarbon (with colour coding). The cylinder liner kits for certain engines, however, contain one ring of nitrile rubber and one of fluorocarbon. Note, that the ring with colour coding always should be placed furthest down to prevent risk of coolant leakage.

The cylinder liner's upper edge is sealed by an O-ring under the liner flange and by the pressure of the cylinder head gasket (cylinder head) pressing the cylinder liner flange down onto the cylinder block recess.

#### Valve system

##### Valves and valve seats

The valves are made of chrome-nickel steel. The valve stems are chrome-plated. The exhaust valves have stellite welded sealing surface in order to achieve the required degree of heat resistance. The special steel valve seats are replaceable. Both standard and oversize seats are available as replacement parts. The outside diameter of the oversize seats is 0.2 mm (0.0079") larger and is used in cases where the cylinder head seat recess requires machining.

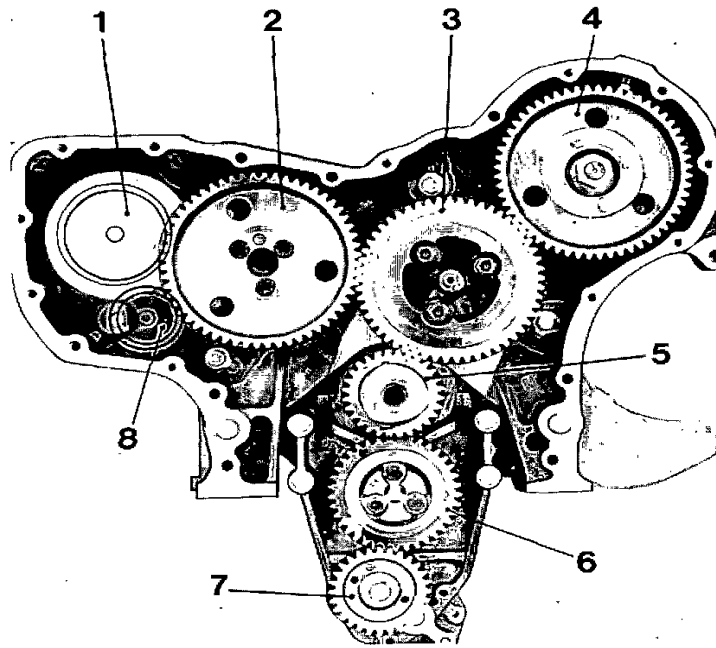


Fig. 30. Timing gears

1. Sea-water pump drive (marine engines, or air compressor drive (industrial engines, optional equipm.).
2. Camshaft gear (used also as intermediate gear for sea-water pump, air compressor or servo-pump, where applicable).
3. Idler gear, timing gear
4. Injection pump drive gear
5. Crankshaft gear
6. Intermediate gear for oil pump.
7. Oil pump drive gear
8. Servo-pump drive (industrial engines, optional equipm.).

### Camshaft

The camshaft is journalled in seven bearings. The axial play is determined by the camshaft gear, the shoulder on the front bearing journal and the thrust washer bolted to the front surface of the block.

### Timing gears

The drive gear assembly consists of cylindrical gears with helically cut teeth.

The injection pump and camshaft are driven by the crankshaft via an idler gear. The engine's lube oil pump is also driven by the crankshaft via an idler drive gear.

**60 series:** Apart from the camshaft, the camshaft drive also drives the sea-water pump drive gear (marine engines), as well as air compressor, if fitted (optional equipm., industrial engines). The servo-pump, if fitted (optional equipm.), is also driven by the camshaft drive gear. See fig. 30.

**70 series:** Apart from the camshaft, the camshaft drive also drives the sea-water pump drive gear as well as the drive output for the alternator and coolant pump (marine engines). The drive output is pressure lubricated by means of a pipe. Any servo-pump and air compressor fitted, (optional equipm., industrial engines) are also driven by the camshaft gear. On marine engines the optional servo-pump is driven by the injection pump drive gear. See fig. 30.

### Crank mechanism

#### Crankshaft

The crankshaft is journalled in seven main bearings. The axial bearing consists of thrust washers located at the centre main bearing. The crankshaft is balanced both statically and dynamically. The front end of the crankshaft has a polygon profile and the rear end has a flange to which the flywheel is bolted.

**60 series:** The crankshaft is nitrocarburated. Provided that the shaft does **not** require straightening before grinding, grinding to max. 2:nd undersize can be done without renewed nitrocarburated.

**70 series:** The crankshaft is induction hardened and can be ground to all undersizes without re-hardening.

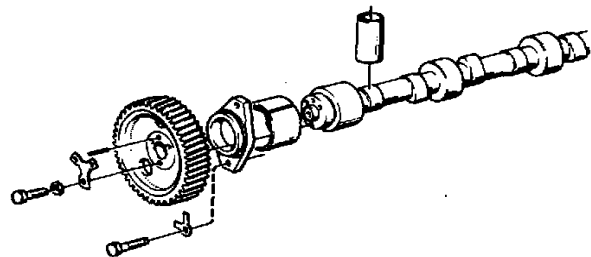


Fig. 31. Camshaft

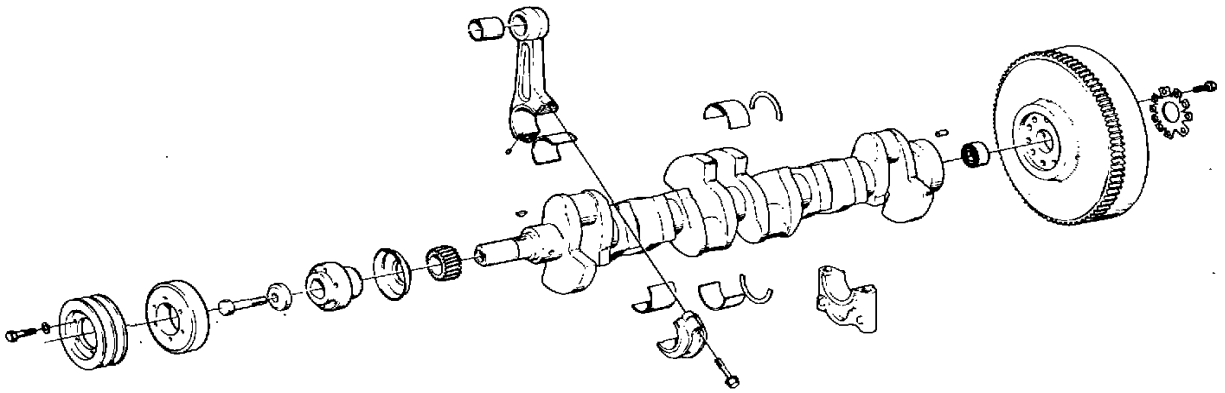


Fig. 32. Crank mechanism

### Main and big-end bearings

The main and big-end bearings consist of indium-plated, lead-bronze lined, steel shells. These bearings are of the precision type and are ready for fitting. Five oversizes are available as parts. The thrust washers for the crankshaft axial bearing are available in three oversizes.

### Connecting rods

The connecting rods are of the I-profile type and are drilled right through for pressure lubrication of the gudgeon pin. Since the connecting rods have diagonally split bearing recesses, the rods can be removed through the cylinder liners when the engine is being disassembled.

The gudgeon pin bushings are of steel with a bronze-alloy facing.

On the 70 series the connecting rods have trapezoidal gudgeon pin end in order to obtain a larger effective bearing surface against the gudgeon pin (fig. 33).

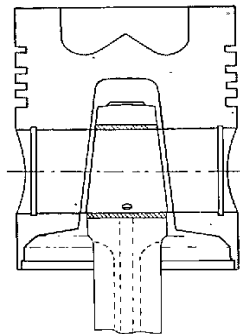


Fig. 33. Connecting rod with trapezoidal gudgeon pin end, 70 series.

### Vibration damper

The vibration damper consists of a hermetically sealed housing in which there is a mass of steel with a rectangular cross-section. This mass (the damper ring) is carried in the centre on a bushing and is surrounded on all other sides by a viscous liquid (silicon).

### Flywheel

The flywheel is bolted to a flange on the rear end of the crankshaft. It is statically balanced and fully machined. The starter ring gear is shrunk onto the front edge of the flywheel.

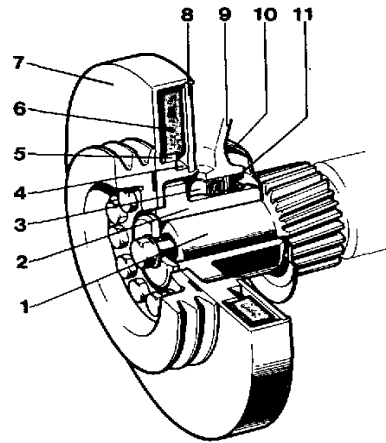


Fig. 34. Vibration damper

- |                  |                                |
|------------------|--------------------------------|
| 1. Crankshaft    | 7. Housing                     |
| 2. Hub           | 8. Cover                       |
| 3. Felt ring     | 9. Auxiliary drive gear casing |
| 4. Liquid cavity | 10. Deflector ring             |
| 5. Bushing       | 11. Sealing ring (rubber)      |
| 6. Damper mass   |                                |

# REPAIR INSTRUCTIONS

## Cylinder heads

### Removing the cylinder heads

Special tool: 6582

#### Marine engines

1. Disconnect both battery cables.
2. Close the bottom valve and drain off the coolant.
3. **MD70, TMD70:** When necessary, loosen the voltage regulator bracket from the timing gear cover and hang it up.  
**TAMD70:** Loosen the connector box from the timing gear cover and hang it up.
4. **TAMD70 and MD70, TMD70 with tubular heat exchanger:** Remove the heat exchanger and thermostat housing.
5. **TAMD60, TAMD70:** Dismantle the aftercooler cover. Loosen the hose clamp under the cooler on TAMD70. Lift out the insert.
6. Remove the air filter and, when necessary, the pipe between the turbocharger and the aftercooler/engine intake manifold. Remove the air filter bracket.
7. **TAMD60:** Remove the pipe between the expansion tank and the heat exchanger. Dismantle the attaching bolts for the expansion tank and remove the tank.
8. **TAMD60:** Remove the coolant hose between the oil cooler and the aftercooler. Dismantle the aftercooler housing from the intake manifold.
9. **70 series:** Remove the crankcase ventilation filter.
10. Remove the intake manifold.
11. **TAMD60:** Remove the protection plate over the injectors.
12. Close the fuel cocks. Remove the fuel lines to the fine filters, the delivery pipes and the leak-off line. Remove the fuel filters and, where applicable, the pipe between the smoke limiter and the engine intake manifold. Fit protective caps.
13. Dismantle the injectors.\* Remove the yoke and rotate the injector with a wrench (PU-15) pulling it upwards at the same time. If the injector will not come out, use puller 6582. This prevents the copper sleeve from being removed at the same time.
14. Remove the coolant and lube oil pipes to the turbocharger, where fitted. Fit protective caps.
15. Loosen the exhaust line from the turbocharger/exhaust manifold. Remove the turbocharger, where fitted. Remove the exhaust manifold.
16. Remove the valve covers. Unscrew the bolts attaching the rocker arm bearing brackets and remove the rocker arm mechanism and the push-rods.
17. Remove the cylinder head bolts and lift off the cylinder heads.
18. Remove the cylinder head gaskets, rubber seals and their guides from the block.

\* If great care is taken so that the injector nozzles are not damaged, the cylinder heads can also be removed with the injectors still in place.

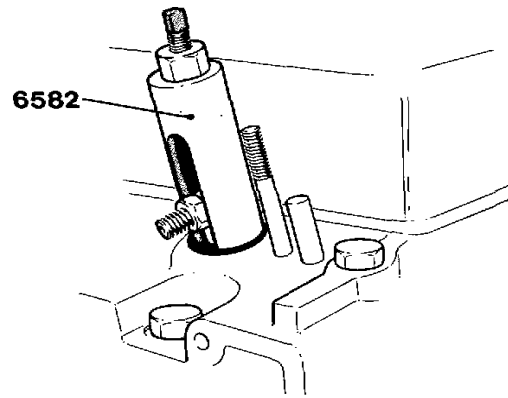


Fig. 35. Removing an injector

#### Industrial engines

1. Disconnect the battery earth connection.
2. Drain the coolant.
3. Remove the air filter and the intake pipe between the filter and the turbocharger. Remove the air filter bracket.
4. **TID60, TID70:** Loosen the coolant hoses from the intercooler.
5. Remove the cables to the pre-heater and operating relay.
6. **TD60:** Remove the connection pipe between the engine intake manifold and the turbocharger, complete with pre-heater and relay.  
**TID60, TID70:** Remove the pipe between the turbocharger and the housing over the intercooler.
7. Remove the heat shield at the rear end of the exhaust manifold. Remove the lube oil pipes to the turbocharger. Fit protective caps.  
**Engine with RQV-regulator:** Remove the pipe between smoke limiter and engine intake manifold.
8. Remove the intake manifold (complete with pre-heater and relay on TD70, and complete with intercooler, pre-heater and relay on TID60 and TID70).  
**Note!** Do not loosen the bolts (8 pcs) attaching the pre-heater to TID60 and TID70 (fitted at an angle diagonally upwards).
9. Close the fuel cocks. Remove the fuel lines to the fine filters, leak-off line and delivery pipes. Fit protective caps.
10. Disconnect the coolant hoses from the thermostat housing. Remove the thermostat housing and fuel filter from the cylinder head.
11. Disconnect the exhaust pipe from the turbocharger. Dismantle the turbocharger and the exhaust manifold.
12. Remove the coolant connection between the cylinder heads.

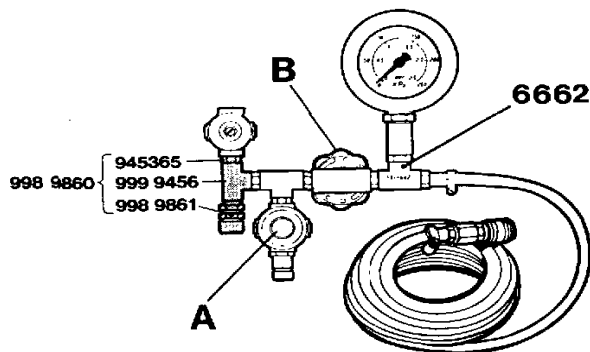


Fig. 36. Mounting of kit 998 9860 on the pressure-testing device 6662 (Sweden only).

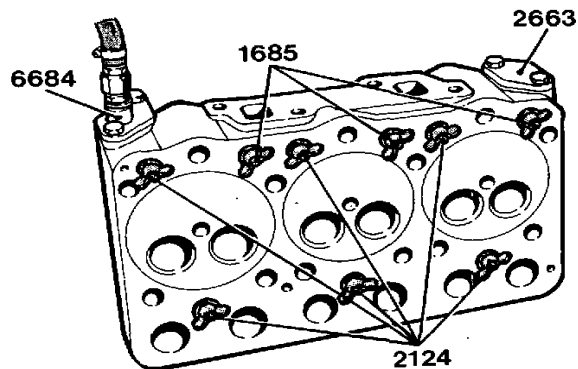


Fig. 37. Pressure-testing cylinder heads, 60 series

13. Dismantle the injectors.\* Remove the yoke and rotate the injector with a wrench (PU-15) pulling it upwards at the same time. If the injector will not come out, use puller 6582. This also prevents the copper sleeve from being removed.
14. Remove the valve covers. Unscrew the bolts attaching the rocker arm bearing brackets and remove the rocker arm mechanism and the push-rods.
15. Remove the cylinder head bolts and lift off the cylinder heads. Remove the cylinder head gaskets, rubber seals and their guides from the block.

\* If great care is taken so that the injector nozzles are not damaged, the cylinder heads can also be removed with the injectors still in place.

### Disassembling the cylinder heads

1. Remove the valves and valve springs. Use valve spring compressor to remove the valve collets. Place the valves in the correct order in a rack.
2. Clean all parts. Be specially careful with oil and coolant channels. Check for leakage by pressure-testing.
3. Remove any layers of carbon and deposits from the cylinder head sealing surfaces. Clean the sealing grooves with a suitable scraper (designed to follow the groove's contour).

Note! Rotating steel brushes or other tools must never be moved across the sealing grooves. This breaks down and ruins the edges. Furthermore, steel brushes must never be used to clean the cylinder head bolt threads or under the bolt heads.

### Pressure-testing cylinder heads

*Special tools, 60 series: 1685, 2124, 2663, 6662, 6684, 998 9860\**  
*70 series: 2124, 2663, 2682, 6662, 6684, 998 9860\**

\* **Only Sweden:** According to the Arbetarskyddsstyrelsens recommendations the pressure-testing device 6662 must be complemented with an extra relief valve. Besides the relief valve there is even a T-pipe and a double nipple. These parts are included in kit 998 9860. Check that the relief valve and other parts are assembled as in fig. 36.

### Checking the pressure-testing device 6662

Before using the pressure-testing device it must be checked as follows:

1. Check that the knob on the relief valve (A, fig. 36) is screwed out and connect the test device to the compressed air system. Open cock (B) and adjust the relief valve until a pressure of 100 kPa (1.0 kp/cm<sup>2</sup> = 14 p.s.i.) is indicated on the gauge.

**NOTE!** The relief valve's knob can be locked with a locking ring which is moved axially.

**NOTE!** Always follow applicable safety regulations.

2. Close cock (B). The pressure must not drop for a period of 2 minutes if the test device is to be regarded as reliable.

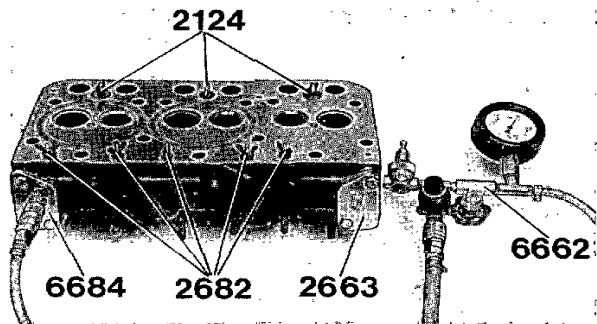


Fig. 38. Pressure testing cylinder heads, 70 series

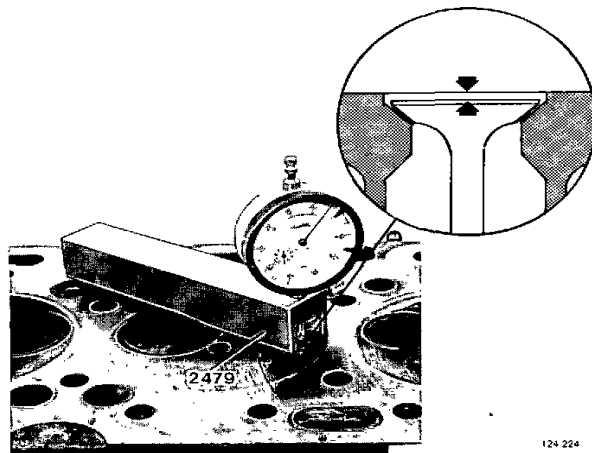


Fig. 39. Checking the distance between the cylinder head surface and the valves

### Pressure-testing

1. Fit the sealing washer 2663 and connector washer 6684, see figs. 37 and 38.
2. **60 series:** Fit the expander bolts 1685 (3 pcs), resp. 2124 (6 pcs) according to fig. 37.  
**70 series:** Fit the expander plugs 2124 (3 pcs), resp. 2682 (5 pcs) according to fig. 38.  
Do not tighten the wing nuts so hard that the rubber seals become damaged.

3. Check that the knob on the reduction valve (A, fig. 36) is screwed out and connect the hose from the pressure-testing device to the connector washer.
4. Immerse the cylinder head in a water bath, abt. 70°C (158°F).
5. Connect the test device to the compressed air system and open cock (B).
6. Pull out the locking ring for the knob on the reduction valve. Increase the pressure by screwing in the knob until the pressure gauge shows 50 kPa (0.5 kp/cm<sup>2</sup> = 7.1 p.s.i.). Maintain the pressure for 1 minute. Increase thereafter the pressure to 150 kPa (1.5 kp/cm<sup>2</sup> = 21 p.s.i.). Lock the knob by pressing in the locking ring and close the cock (B). Check after 1–2 minutes if the pressure has reduced or if there are air bubbles in the water bath.

**NOTE! Always follow applicable safety regulations. Do not stand bent over the expander plugs.**

7. Remove the test equipment.

An leakage from the injector's copper sleeves is repaired according to instructions on pages 82–83.

### Inspecting the cylinder head

The cylinder head warp must never exceed 0.03 mm (0.0012"). This test is carried out with a feeler gauge and a straight edge, the sides of which have been shaved to a

degree of accuracy specified in DIN 874/Normal. If warping exceeds the max.-value, the cylinder head must be ground flat or replaced. If leakage has been established or if the cylinder head has blow-out stripes on it, any separate measuring is unnecessary, as the cylinder head must be ground flat or replaced.

The sealing grooves over the centre of the cylinder liner collars must be undamaged. Regarding the sealing grooves, see next section – "Grinding the cylinder heads".

Check the valve seats and that the stud bolts are tight. Regarding the replacement of valve seats, see page 47.

**Always replace the cylinder head gaskets and rubber seals.**

### Grinding the cylinder heads

(Special tool: 2479)

The cylinder head has sealing grooves over the centre of the cylinder liner collars.

**60 series:** If the head is to be ground by more than 0.1 mm (0.0039"), the sealing grooves must be completely removed and new grooves are to be cut after the grinding.

**70 series:** The earlier sealing grooves must always be removed completely and new grooves cut after grinding.

1. Grind the cylinder head so that earlier sealing grooves are removed and the cylinder head is flat. Check the flatness according to the instruction under "Inspecting the cylinder heads". The grinding finish can be max. 6 μ.

The height of the cylinder head after grinding must not be lower than 100.65 mm (3.963") for the 60 series, resp. 108.65 mm (4.278") for the 70 series.

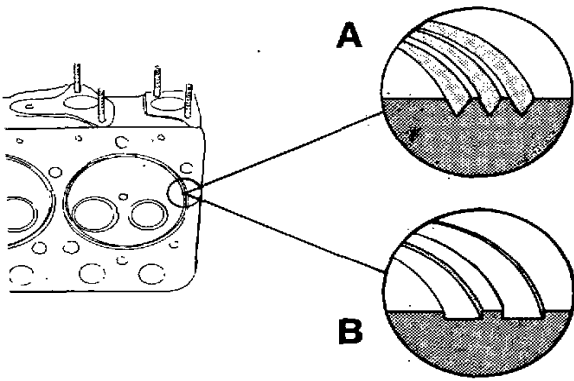


Fig. 40. Sealing grooves in cylinder head  
A. 60 series B. 70 series

2. Check that the distance from valve disc level to the cylinder head surface is not less than 0.7 mm (0.0276") for the 60 series, resp. 1.0 mm (0.039") for the 70 series. See fig. 39. If extra machining of the cylinder head is necessary the valve seat recesses must be milled down. The distance from the valve disc level to the cylinder head surface must not exceed 1.1 mm (0.0433") for the 60 series, resp. 1.4 mm (0.055") for the 70 series.

Regarding the replacing of valve seats, see page 47.

3. Cut new sealing grooves in the cylinder head according to the instructions in the following sections.  
Clean the cylinder head after machining.

### Cutting sealing grooves in cylinder heads

The sealing grooves in the cylinder heads for the 60 series are formed by V-shaped grooves, while the 70 series have the grooves formed by two concentric broad grooves sunk into the cylinder head surface directly above the cylinder liner collar. See fig. 40.

Check that the valve guides are not worn. The milling tool guides are fixed with guide pins through the valve guides.

#### Milling the grooves, 60 series

*Special tool: 9556*

Check that the milling cutter is marked D60.

Before milling the new grooves, all traces of the old grooves must be completely removed by grinding.

1. Adjust the height of the cutters by placing the tool as shown in fig. 42. Loosen the cutter holder's bolts and let the cutter (A) sink down in the cut-out in template (B), whereafter the holder bolts are tightened. Repeat

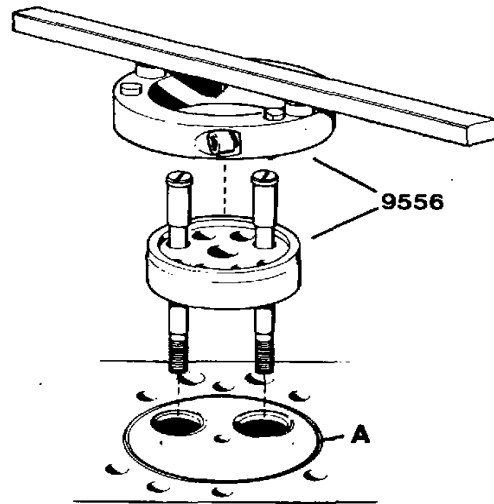


Fig. 41. Cutting sealing grooves, 60 series  
A. Grooves

this procedure with the other two cutters. Check that the template is for the right engine type.

**NOTE!** Never place the tool on a hard surface with the cutting edge downwards.

2. Set up the cylinder head in a vice.
3. Locate both the guide pins in the valve guides and tighten the tool's guide plate. The hole marked "IN 60" on the guide plate must always be placed **above the inlet valve guide** (largest valve seat). Always make sure that the correct holes are used so that the tool is located symmetrically with the cylinder bore. In the tool guide plate there are two holes for each locating pin depending on what location the inlet port has relative to the exhaust port.

**NOTE!** Do not tighten the guide pin nuts too hard. The valve guides can be pressed into the cylinder head.

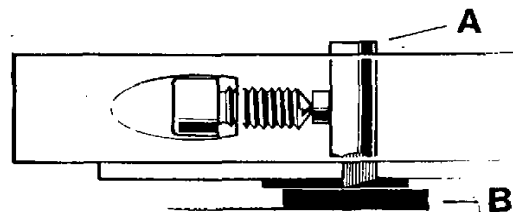


Fig. 42. Adjusting the cutter, 60-series  
A. Cutter B. Template

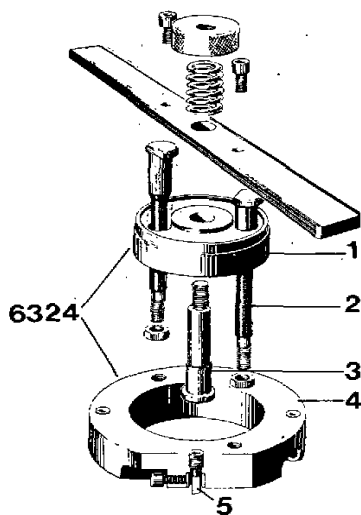


Fig. 43. Milling tool 6324, 70 series

- |                |                 |
|----------------|-----------------|
| 1. Guide plate | 4. Milling head |
| 2. Guide pins  | 5. Cutter       |
| 3. Spindle     |                 |

4. Rotate the tool without pressing downwards until the cutter stops cutting. Remove the tool and clean the cylinder head surface thoroughly to remove all traces of swarf.

**NOTE!** When the cutter is to be sharpened this is done by "front grinding", i.e. on the same side as the stem is flat.

The diagonal surfaces of the cutter are not to be sharpened as this can result in the point of the cutter changing its location in relation to the centre-line and thereby also the distance between the slots.

### Cutting sealing grooves, 70 series

#### Special tool: 6324

Before milling the new grooves, the cylinder head must be ground flat so that all traces of the old grooves are completely removed.

1. Set the cutting depth. See next section. **NOTE!** Never place the tool on a hard surface with the cutter facing downwards.
2. Place the cylinder head in a vice.
3. Locate both the guide pins in the valve guides and tighten the guide plate (1 fig. 43) with the spindle (3) on the cylinder head. The plate should be placed so that it is centred between the holes for the cylinder head bolts. The hole marked "IN" on the guide plate should always be placed **above the guide of the inlet valve** (the largest valve seat).

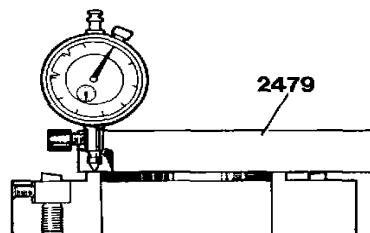


Fig. 44. Zero setting the dial indicator

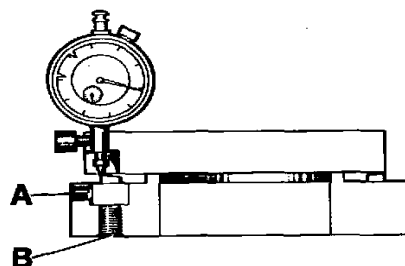


Fig. 45. Adjusting the cutter

- A. Locking screw  
B. Adjusting screw

**NOTE!** Do not tighten the nuts for the guide pins too hard, as the valve guides can be pressed into the cylinder head.

4. Check that the cylinder head surface is completely clean. Apply a little oil to the inner diameter of the milling head and lower it onto the guide plate, carefully and with a rotary movement so that it does not stick.
5. Put the spring and nut on the handle's upper face and tighten the nut loosely.
6. Turn the milling tool clockwise and with an even movement until the cutters stop cutting.
7. Remove the nut and lift up the milling head. Clean the cylinder head carefully.
8. Check the depth of the grooves. Replace the milling head (without the spring and nut) and rotate it several turns using hand pressure. If the tool does not cut, then the grooves are at the right depth. This check should always be carried out, as metal swarf can get under the shoulder of the milling head preventing the cutter to cut to the right depth.

The burrs which occur at the sides of the grooves should be left. If these burrs are broken off, the edges can be damaged, impairing the sealing function.

**NOTE!** The first time the milling tool is used after the cutters have been adjusted the finished grooves must be checked using a dial indicator. For this check, any burrs at the edges of the slots must be carefully removed so that the holder for the dial indicator is located correctly against the cylinder head.

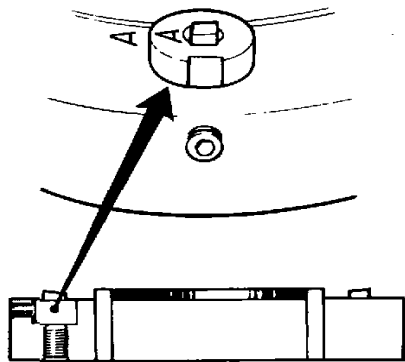


Fig. 46. Placing the cutter holder in the milling head

### Setting the cutters on milling tool 6324

#### Special tool: 2479

1. Place the milling head in a vice with the cutters turned upwards.
2. Place a dial indicator in holder 2479 and place it on the ring-shaped shoulder of the tool (fig. 44). Zero set the dial indicator against the shoulder.
3. Push the holder with the dial indicator sideways so that the indicator point is resting against the highest point on one of the cutters and read off the indicator. Correct cutter height (cutting depth): 0.10 mm (0.0039").
4. If necessary loosen the locking screw A, fig. 45 (Allen key 4 mm = 5/32") and the adjusting screw B (Allen key 5 mm = 3/16") a few turns. Press down the cutter holder and tighten the locking screw somewhat so that it presses against the holder.
5. Place the indicator tip against the highest point of the cutter and screw the adjuster screw (B) upwards until the indicator shows 0.10 mm (0.0039"). Tighten the locking screw (A).

Set the other cutters in the same way.

**NOTE!** Check that the upper edge of the cutter holder is flush with the milling head. If they are not flush, the dial indicator has moved one turn too many.

### Replacing cutter sets

1. Loosen the locking screw (A, fig. 45) and screw the adjuster screw (B) upwards so that the cutter holder can be removed from the cutter head.
2. The cutter holders are marked with a letter (A, B, C or D) and the same letter is stamped on the cutter head where the cutter holder should be placed (Fig. 46).

**NOTE!** The two Allen bolts in the cutter holder are not to be moved.

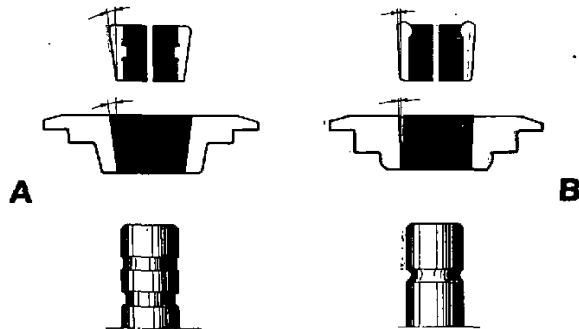


Fig. 47. Valve parts

- A. Engines with single valve springs  
B. Engines with double valve springs

3. Place the cutter holders in the milling head according to the letter markings and with the grooves turned to face the locking bolts. Adjust the cutting height according to the earlier instructions.

### Assembling the cylinder heads

**NOTE!** There are two different versions of valve parts for the 70 series. These must never be mixed.

Engines with single valve springs (MD70C) have valve collets with locking cutters with a rectangular cross-section, placed approximately in the centre of the collet. Engines with double valve springs (other engines in the 70 series) have valve collets with rounded locking cutters, placed at the upper edge of the collet, as well as a smaller cone angle, which also applies to the associated valve spring washers. The differences between the valve collets also effect the valve stem locking grooves.

It is possible to fit the valve collets and washer, "type B" (fig. 47) to a valve of "type A" without noticing it. Therefore always check carefully that the right parts are being used.

1. Oil the valve stems and fit a valve in its guide. Place the valve spring/valve springs and spring washer in place, press the spring using a spring compressor and fit the valve collets.

Fit the sealing rings, and on the 70 series also the valve caps after all the valves have been fitted.

2. Fit the seal plugs if they have been removed.

**Note.** The plugs under the valve covers should be fitted using a sealing agent such as Permatex and **aluminium washers**. The other seal plugs should be fitted dry without sealing agent and with plastic washers. Note that the plastic washers require a considerably **lower** tightening torque than the aluminium washers. Power tools must therefore not be used when assembling.

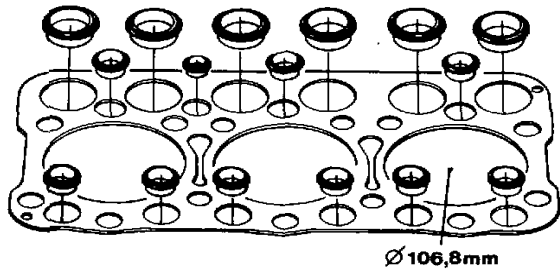


Fig. 48. Cylinder head gasket, 60 series

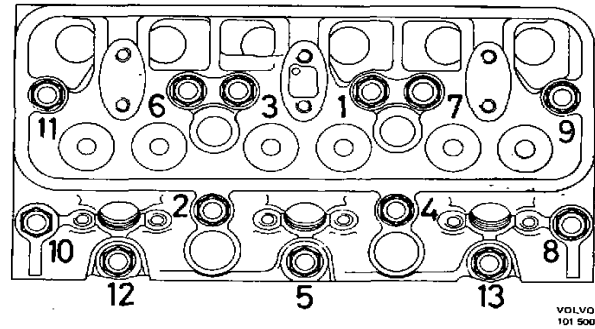


Fig. 49. Tightening sequence, 60 series

### Fitting the cylinder heads

1. Clean the contact surfaces of the cylinder heads and the block. Remove any rust and carbon from the bolt holes and from the threads of the cylinder head bolts. Use a 15 mm (0.59") drill and turn it by hand. Clean the threads using a 9/16"-12 UNC tap. Remove all loose particles using a vacuum-cleaner or compressed air.
2. Check cylinder liner height. For liner height see "Cylinder liners", page 4. The height difference between the liners under the same cylinder head must not exceed 0.02 mm (0.0008").

Regarding measuring and adjusting, see page 44.

3. Fit the sealing rings and lay on the cylinder head gaskets.

**60 series:** Check that the correct cylinder head gaskets are being used. It is possible that the gaskets for the earlier 50 series can be confused with those for the 60 series. Check therefore that the diameter for the bores are 106.8 mm (4.205"). (The equivalent diameters in the gaskets for the 50 series are 104.6 mm = 4.118"). The correct gasket set has also 16 seals for each cylinder head (fig. 48).

4. Completely immerse the cylinder head bolts (even the bolt heads) in rust-proofing agent, part No. 282036-3 (or a mixture of 75 % Tectyl 511 and 25 % white spirit) and let the bolts drain off on a net. The bolts should be drop-free at the time of assembly (otherwise oil can find its way up and be regarded as leakage).

**NOTE!** The bolts are phosphate-coated and must not be cleaned with a wire brush.

**Note!** If the cylinder heads are to be painted it is important that the contact surfaces for the cylinder head bolts are completely free from paint. The pulling pressure of the bolts will otherwise be impaired.

5. Place the two rear cylinder head bolts in the cylinder head and fit it.
6. Torque the cylinder head bolts in stages as shown in the tightening sequence, fig. 49 for the 60 series, fig. 50 for the 70 series. The 70 series are also to be angle tightened.

### 60 series:

1st tightening: 40 Nm (4 kpm = 29 lbf.ft) in the numbered sequence.

2nd tightening: 120 Nm (12 kpm = 87 lbf.ft) in the numbered sequence.

Final tightening: 170 Nm (17 kpm = 123 lbf.ft) in the numbered sequence.

Re-tightening after a period of operation is not necessary.

### 70 series:

1st tightening: 40-80 Nm (4-8 kpm = 29-58 lbf.ft) in the numbered sequence.

2nd tightening: 160 Nm (16 kpm = 116 lbf.ft) in the numbered sequence.

3rd tightening: 160 Nm (16 kpm = 116 lbf.ft) in the numbered sequence (check-tightening).

Final tightening: Angle tighten the bolts 60° in the numbered sequence according to the following:

Mark the position of the bolt heads with a chalk mark on the bolt and cylinder head. Place the marks according to fig. 51. Do not use a centre punch or scriber since this can lead to confusion with future tightenings.

Mark up a 13/6" socket as shown in fig. 51. Place the socket as shown in the same figure i.e. with the socket mark offset one hexagonal edge anti-clockwise in relation to the chalk mark on the cylinder head.

Then carry out angle-tightening by tightening until the socket mark and the chalk mark on the cylinder head come into alignment with each other.

Tightening is complete when all the bolts have been angle-tightened 60°. Re-tightening after running the engine a short time is not necessary.

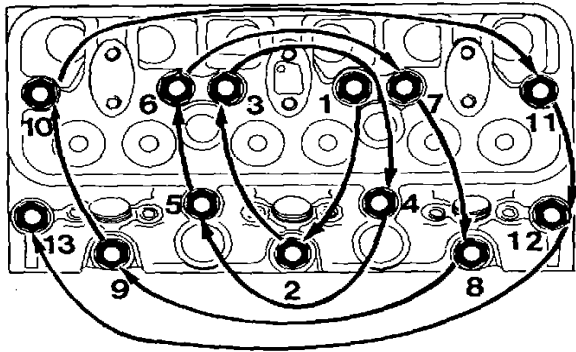


Fig. 50. Tightening sequence, 70 series

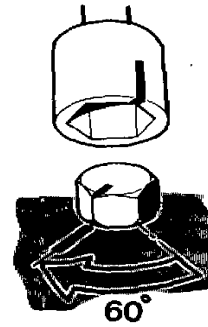


Fig. 51. Angle tightening, 70 series

7. Fit the push rods and the rocker arm mechanism. Tightening torque 40 Nm (4 kpm = 29 lbf.ft).
8. Adjust the valve clearance according to the instructions on page 46. Fit the valve covers. Tighten the bolts to 10 Nm (1 kpm = 7 lbf.ft).
9. Fit the injectors. Tightening torque 50 Nm (5 kpm = 36 lbf.ft).
10. Fit the inlet manifold (complete with intercooler, if fitted, pre-heater, and relay on certain industrial engines). Use new gaskets.  
**TID60, TID70:** Connect the coolant hoses to the intercooler.
11. **Industrial engines:** Fit the coolant connection between the cylinder heads.  
**70 series:** Assemble the exhaust manifold. Make sure that the piston rings for the joint sealings have their gaps placed 180° apart from each other.
12. Fit new gaskets for the exhaust manifold.  
**Industrial engines in the 70 series: Note.** The gaskets for the third and sixth cylinders are to be turned so that the clipped-off edge points straight forwards.
13. Fit the exhaust manifold.
14. Fit the turbocharger and connect the lubricating oil lines and any coolant lines (MD70C does not have a turbo).  
**TD60, TID60, TID70:** Fit the connecting pipe between the turbo and the engine (complete with pre-heater and relay on TD60).
15. **Industrial engines:** Connect the cables to the pre-heater and its operating relay. See the wiring diagram on page 116.  
**NOTE!** When tightening the nut on each terminal bolt, the bolt must be held still (fig. 52). Otherwise the wire element inside the pre-heater can be twisted and cause short-circuiting.
16. Fit the thermostat housing and fuel filters. Connect the fuel lines and vent the system according to the instructions on page 80. Where applicable, fit the pipe between the smoke limiter and the engine's inlet manifold.

17. **TAMD60:** Fit the protector plate over the injectors.  
**Industrial engines:** Fit the heat shield to the exhaust manifold's rear part.
18. **Marine engines:** Depending on engine version, fit the heat exchanger, aftercooler, and expansion tank.  
**70 series:** Fit the crankcase ventilation filter.
19. **Marine engines:** Where applicable, fit the connecting pipe between the turbo and the aftercooler/engine's inlet manifold. Fit the coolant pipes.  
**70 series:** Fit the electrical connector box, or in applicable cases the bracket for the voltage regulator to the cover of the timing gear casing.
20. Fit the air filter together with the bracket and possible connecting pipe. Connect the exhaust pipe.
21. Fill with coolant and vent the system. See "Filling with coolant" on page 88.
22. Connect the battery cables.

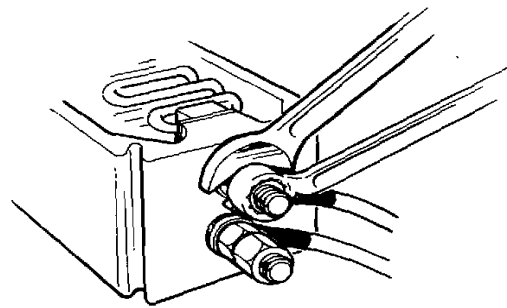


Fig. 52. Tightening the nuts on terminal bolts, TD60, TD70

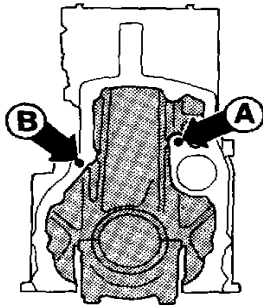


Fig. 53. Cylinder block seen from the back  
 A. Distribution channel – lubrication  
 B. Distribution channel – piston cooling

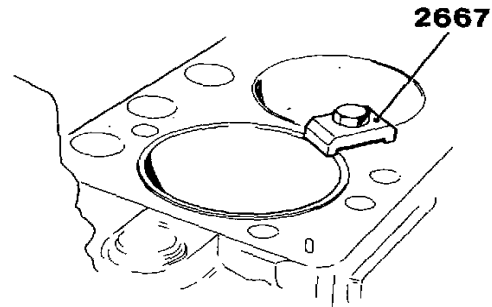


Fig. 54. Holder for cylinder liners

## Cylinder block

### Inspection of cylinder block

Clean the cylinder block thoroughly. Check that all the channels are free from deposits and that the block has no cracks anywhere. Slight cracks can be repaired by hot welding. If welding is carried out on the upper face, then the cylinder block must later be ground flat. In the event of major defects, fit a new cylinder block.

To make it possible to clean the longitudinal oil channels more thoroughly, the cylinder blocks supplied as parts are delivered without cap plugs. **It is important that the plugs, (part No. 955082-3) are put into place after cleaning has been carried out.** The 60 series requires 3 caps and the 70 series 2 alt. 4 plugs.

The distribution channel on the camshaft side (A, fig. 53) must always be plugged at the front and rear of the cylinder block (for the 60 series 2 plugs are used at the rear).

A common cylinder block for all engines in the 70 series is carried as a spare part. Engines with piston cooling (TD70G, TID70G and TAMD70E) must have the distribution channel (B) for the piston cooling plugged and also the piston cooling valve and required jets fitted. Engines without piston cooling (MD70C and TMD70C) do not need the plugs for the piston cooling channels to be fitted as no oil passes through this channel.

### Grinding the cylinder block

If the cylinder block needs to be planed, it is necessary that the minimum measurements given under "Wear tolerances" on page 15 are observed. **NOTE!** After grinding the top block face the piston height above the cylinder block's surface must be checked. Max. height: 0.55 mm (0.0217") 60 series, and 0.70 mm (0.0276") for the 70 series.

## Pressure-testing the cylinder block

### Special tool: 6684

When pressure-testing it is advisable to use the cylinder heads with gaskets as seals.

The water supply can be connected to the front head water connection using connector 6684. The water intake at the front of the block is sealed with a plate. If the engine is fitted with a water-cooled exhaust manifold (marine engines), this also must be sealed at the front. The water pressure should be about 300 kPa (3 kp/cm<sup>2</sup> = 43 p.s.i.). Allow the block to remain under pressure and check for leaks.

If leakage occurs at the cylinder block upper liner recesses, the mating surfaces can be ground with grinding compound or specially milled, see page 44. Leakage at the lower cylinder liner seats can be caused by faulty O-ring seals or damage to the outside of the cylinder liner, i.e. scratches, crater formations etc.

For leakage at seal plugs, see note on page 35.

**Note.** This pressure-testing only includes the cylinder block and heads, and possible water-cooled exhaust manifold. If cooler or heat exchanger are fitted, the pressure-testing should be carried out according to the instructions on page 90.

## Dismantling pistons, piston rings, and connecting rods

### Special tools: 2071, 2667

1. Drain the cooling system and drain or suck out the engine oil.
2. Remove the cylinder heads. See "Removing the cylinder heads" on page 30.

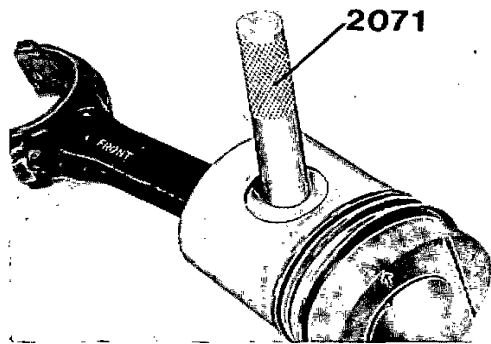


Fig. 55. Removing the gudgeon pin

3. **MD70, TMD70 with deep oil sump:** Remove the sump's inspection covers and loosen the oil pump's suction strainer from the bottom of the sump.
4. Remove the oil sump. This does not apply to engines type MD70 and TMD70 with deep sumps where the big-end bearing caps can be removed through the sump's inspection covers.
5. Remove the oil pump's suction line.
6. Fit the cylinder liner retainers 2667 before removing the pistons. If any cylinder liner should slide up when removing a piston, then it must be removed as there is a risk of deposits, etc. falling down between the liner and the block causing leakage.
7. Rotate the engine until the piston which is to be removed is at its bottom dead centre position. Remove the big-end bearing cap.
8. Tap the connecting rod together with the piston gently upwards until the piston rings come clear of the cylinder liner. **NOTE!** Exercise care so as not to damage any piston cooling jets (where applicable). Lift out the piston together with the connecting rod.
9. Remove the piston rings using piston ring pliers.
10. Remove the circlips for the gudgeon pin and remove the pin using drift 2071.

### Inspecting and checking the piston rings

Check the wear faces and the sides. Black patches on the surfaces indicate poor contact which means the rings should be replaced. Oil consumption is also of decisive importance for the time when the piston rings should be replaced.

Check the piston ring gap (fig. 56). When measuring, push the ring down **below the lower turning point** using a piston. Replace the piston rings if the gap is 1.5 mm (0.059") or more.

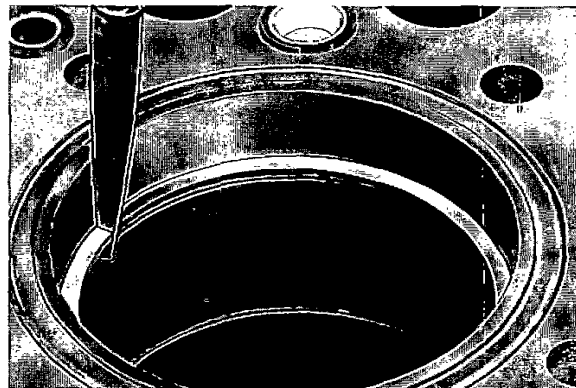


Fig. 56. Checking the piston ring gap

Otherwise the piston rings should be replaced if there is noticeable wear or ovality in the cylinder since the rings do not usually return to the same position they had before being removed.

Check the piston ring gap also on new rings. Regarding measurements, see "Technical Data".

### Inspecting and measuring pistons

Check the pistons for cracks, broken piston ring lands and worn piston ring grooves. If a piston has deep stripes in its skirt, then the piston (liner kit) must be discarded. The same applies if the piston has one or more cracks in the gudgeon (piston) pin hole or in the bottom of the combustion chamber. Cracks in the edge of the piston top around the combustion chamber are usually of no importance. The crack test is carried out according to the "lime white" method. If cracks are found the injection equipment should also be checked.

If the gudgeon pin bushing is worn although the piston is otherwise approved, then the existing bushing in the connecting rod can be machined to the gudgeon (piston) pin oversize. There are two oversize dimensions 0.05 mm (0.0020") and 0.20 mm (0.0079"). When the fit is correct, an oiled-in gudgeon pin should slide slowly through the bushing under the effect of its own weight (temp. 17–20°C = 62–68°F). Measure the connecting rod.

The gudgeon pin should be a grip-fit (max. 0.004 mm = 0.00016") in the piston when cold, thus the gudgeon pin hole in the piston must also be reamed in certain cases.

### Piston fit

In common with the cylinder liners, the pistons are also classified and this means that a piston must be fitted in the corresponding class of cylinder liner. A piston of class B is to be fitted with a liner of class B, a class C piston to a class C cylinder liner and so on.

Pistons and cylinder liners are for parts only supplied as complete units.

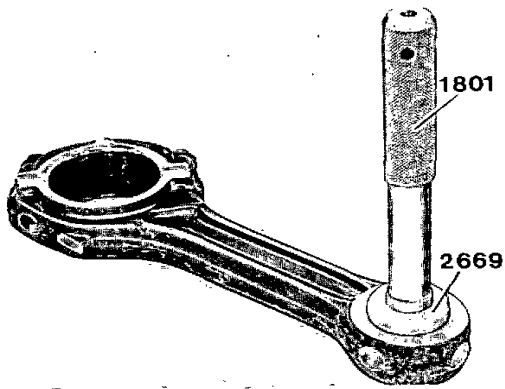


Fig. 57. Replacing the connecting rod bushing, 60 series

### Inspecting the connecting rods

Check for cracks. Check straightness and twist. The maximum deviation in both cases: 0.01 mm (0.0004") over a measured length of 100 mm (4"). Measuring is carried out in a control fixture for connecting rods.

Replace curved or twisted connecting rods. Also check the connecting rod bushings which can be done most conveniently by using a gudgeon (piston) pin as a reference. There must be no noticeable looseness.

### Replacing connecting rod bushings (piston removed)

*Special tools, 60 series: 1801, 2669*  
*70 series: 1801, 2497*

1. Press out the old bushing. Use the standard handle 1801 together with drift 2669 for the 60 series, or drift 2497 for the 70 series.
2. Press in the new bushing using the same tool. The bushing is to be fitted according to fig. 58.

**NOTE!** Make sure that the oil hole in the bushing is aligned with the oil channel in the connecting rod. Draw a line over the holes in the bushing and the connecting rod using a felt pen (fig. 58). Check after pushing in the bushing that the oil channel is open.

**Note,** a new connecting rod bushing with only one oil hole has been introduced on the 70 series. (The earlier bushing (fig. 59) had three holes and an external turned groove.)

3. **60 series:** Ream the bushing.  
**70 series:** Bore the bushing.

When the fit is correct, an oiled-in gudgeon pin should under its own weight (at a temperature of 17–20°C/ 62–68°F) slide slowly through the bushing.

4. Measure the connecting rod.

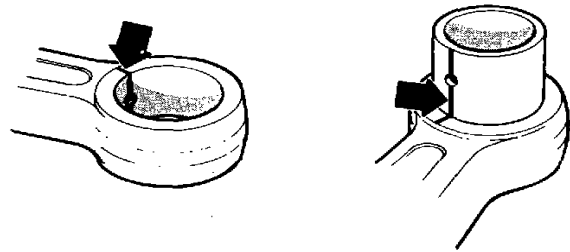


Fig. 58. Fitting the connecting rod bushing

### Assembling piston, piston rings, and connecting rod

*Special tool: 2071*

**Note.** When replacing the piston (cylinder liner kit), check that the liner kit contains the correct piston. See fig. 26.

1. Fit one circlip in the piston.
  2. Oil in the gudgeon pin and the connecting rod bushing.
  3. Heat up the piston to about 100°C (212°F). Locate the piston and connecting rod so that the arrow on the piston crown and the "FRONT" marking on the connecting rod faces the same way. Press in the gudgeon pin using drift 2071.
- NOTE!** It must be possible to press in the gudgeon pin easily, it must never be knocked in.
4. Fit the other circlip.
  5. Check that the connecting rod does not turn stiffly in the gudgeon pin bushing.
  6. Check the piston ring gap in the cylinder bore (fig. 56) and check the piston ring clearance in the piston ring groove.

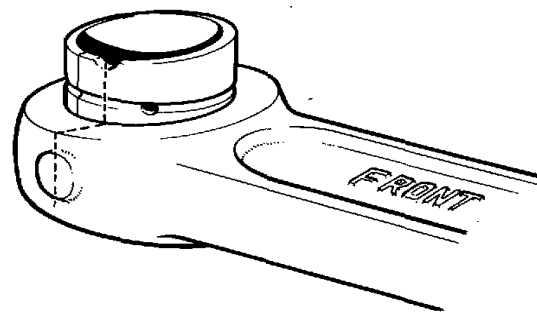


Fig. 59. Connecting rod bushing, earlier type, 70 series

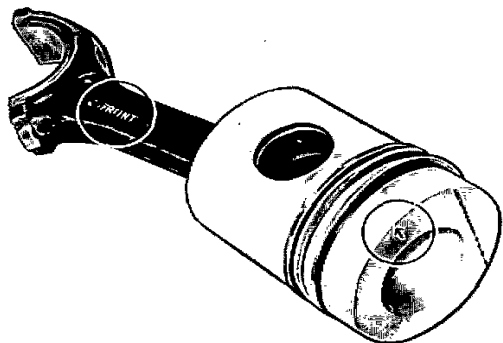


Fig. 60. Piston and connecting rod, front marking

7. Fit the piston rings onto the piston with piston ring pliers. The oil ring is fitted first and can be turned to face any direction. The opening in the expander spring should be placed opposite to the oil ring gap.

**60 series:** The second compression ring has an internal chamfer and should be assembled with the "TOP" marking (→) facing upwards. The upper compression ring can face in any direction.

**70 series:** The second and third compression rings are tapered and are to be fitted as shown in fig. 61, with the TOP or (→) marking facing upwards. The rings are surface-treated with ferrox. The second compression ring has also three ferrox-filled grooves and the third (in the piston ring kit) has an internal chamfer. The upper compressing ring (chrome-plated) is to be fitted with the TOP-marking (→) facing upwards.

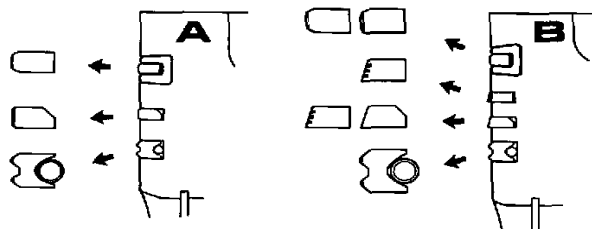


Fig. 61. Positioning the piston rings  
A. 60 series      B. 70 series

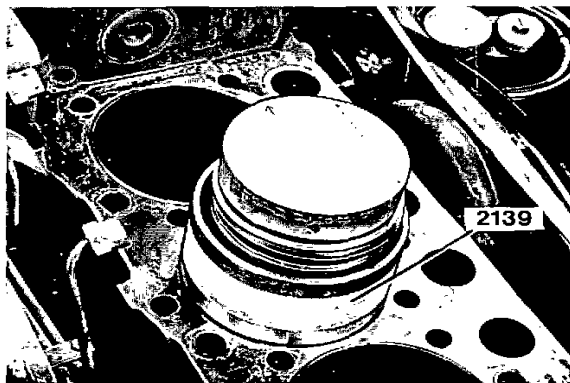


Fig. 62. Fitting a piston in the cylinder, 70 series

### Fitting the pistons in cylinders

*Special tools, 60 series: 6086  
70 series: 2139*

1. Smear the piston and rings with engine oil and turn the rings so that the gaps are equally spaced around the piston.
2. Check that the arrow on the piston crown and the "FRONT" marking on the connecting rod are facing in the same direction. Fit the pistons with connecting rods into the respective cylinders. The arrow on the piston crown should point forwards. Use fitting ring 6086 for the 60 series, or 2139 for the 70 series (fig. 62).

**TD70, TID70, TAMD70:** Exercise great care when assembling so as not to damage or bend the piston cooling jets.

3. Place the big end bearing shells in place in the connecting rods and caps. The connecting rod bearing recesses have slots for the bearing shell locating lugs. It is important that the bearing shells are turned the right way during assembly so that the locating lugs engage in the slots and that the oil holes are located directly opposite the oil holes in the connecting rods.

**70 series:** Check that the big-end bearing shells are of the right type. In order to prevent early production bearing shells from being fitted and causing the oil supply to be cut off (the oil hole has been changed), the bearing shells locating lugs have a different placing than on earlier versions.

Check when assembling that the pins locating the connecting rod bearing cap axially are firmly in position.

4. Smear the crankshaft bearing journal with engine oil, fit the bearing cap and tighten the connecting rod bolts to a torque of 160 Nm (16 kpm = 116 lbf.ft). Undamaged connecting rod bolts can be reused.
5. **TD70, TID70, TAMD70:** Rotate the crankshaft and check that the piston cooling jets are pointing towards the oil channels in each piston, when the piston is at the bottom turning point (fig. 63).

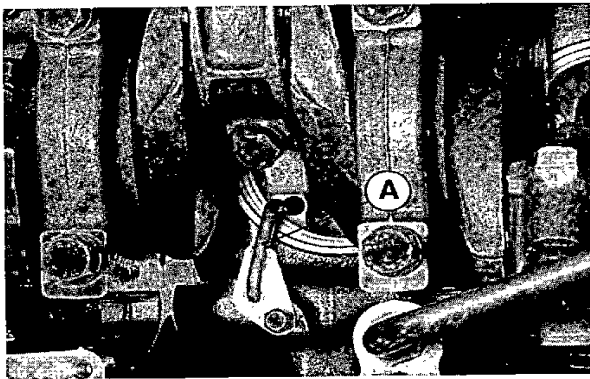


Fig. 63. Piston cooling jet (A)

## Cylinder liners

### Measuring and inspecting the cylinder liners

The checking consists of measuring the wear and the checking for cracks. Clean the liners thoroughly before measuring them.

The wear is usually greatest at the top turning point where the temperature is higher.

Liner wear is determined most easily by placing a new piston ring in the upper turning position (fig. 56) and measuring the piston ring gap. This is then compared with the piston ring gap below the lower turning point. Divide the difference between the two measured values by 3.14 to establish the amount of wear.

#### For example:

Piston ring gap in unworn section. . . . .	0.35 mm (0.014")
Piston ring gap at upper turning point. . . . .	1.30 mm (0.051")
Difference: 1.30-0.35 mm	
0.051"-0.014") . . . . .	0.95 mm (0.037")
Diameter wear: $\frac{0.95 \text{ mm (0.037")}}{3.14}$ . . . . .	0.30 mm (0.012")

If the wear is as much as 0.35-0.40 mm (0.014-0.016") the liner should be replaced. Magnaglo testing is the most effective way of checking for cracks.

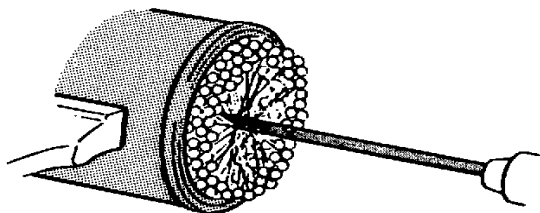


Fig. 63A. Flexhoning the cylinder liner

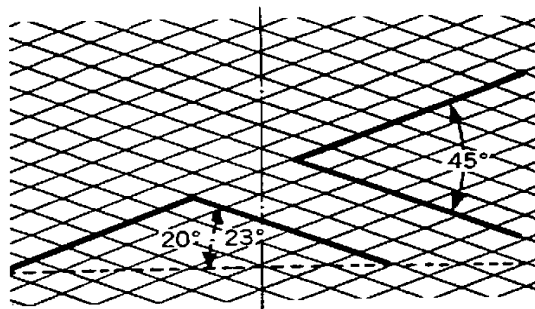


Fig. 63B. Honing pattern in the cylinder liner

For good lubrication and sealing it is important that the liner walls retain the original honing pattern, see fig. 63B. Honing to restore the pattern is therefore to be carried out when e.g.

- the cylinder liner has scratches (ring seizure, dirt)
- the cylinder liner has bright spots (polishing)

### Flexhoning the cylinder liners

1. Before removing the cylinder liners they should be marked to make sure that the same piston and liner is refitted in the same place as before.
2. Place the liner in a vice, (fig. 63A). Flexhoning of the cylinder liner when it is installed is not recommended due to the oil channels becoming clogged and also the difficulties to feed correctly.
3. Remove the carbon edge at the top of the liner. Clean also under the liner collar and the recess in the block.
4. Use a low speed drilling machine with a speed of 200-400 r.p.m. and a flex-honing tool type GBD 108 mm (4.25"), grade size 80.
 

Lubricate the cylinder liner with light engine oil before and during honing. Move the honing tool in and out of the cylinder liner at 60 strokes/min (one inward and outward stroke per second).
5. The cylinder liner has a honing pattern where the angles are carefully calculated to give optimal life (fig. 63B).

When honing in connection with a piston ring change the original honing pattern must be followed to keep the lubrication properties.

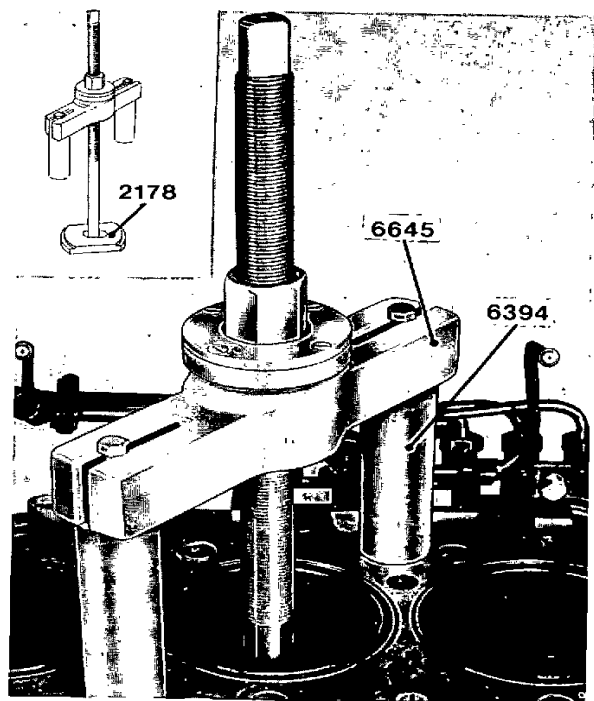


Fig. 64. Removing a cylinder liner, 70 series

The honing marks must be formed uniformly and cut in both directions all over the cylinder surface.

**NOTE!** The correct speed must be maintained to obtain the correct pattern.

6. **Clean the liner thoroughly after honing.** Use warm water, a brush and detergent (never use thinners, paraffin or diesel oil). Dry the liner using paper or a cloth which does not leave any fluff. After drying, lubricate the liner with light engine oil.

### Removing the cylinder liners

*Special tools, 60 series: 6087, 6394 (2 pcs), 6645  
70 series: 2178, 6394 (2 pcs), 6645*

**NOTE!** Removal should not be carried out until it has been found that replacement is necessary by measuring or other methods.

1. Drain the cooling system and drain or suck out the engine oil.

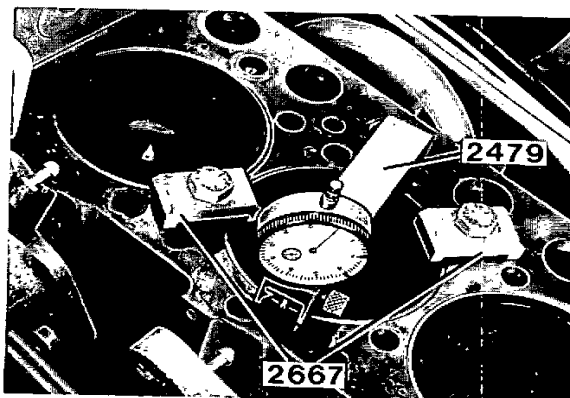


Fig. 65. Checking the cylinder liner height above the cylinder block face.

2. **MD70, TMD70 with deep oil sump:** Remove the sump's inspection covers and loosen the oil pump suction strainer from the bottom of the sump. (The big end bearing caps can be removed through the inspection covers).
- Other engines:** Remove the oil sump.
3. Remove the oil pump suction line.
  4. Remove the cylinder heads, pistons and connecting rods.
  5. Remove the cylinder liners. Use puller 6645, supports 6394 (2 pcs) together with the puller plate 6087 for the 60 series, or 2178 for the 70 series. See fig. 64. Remove the sealing rings.

### Fitting the cylinder liners

*Special tools: 2479, 2667, 2670, 6159, 6161, 6413, 6598, 6604, 6606, and 9538 (60 series) and 9514 (70 series)*

Clean the liner collar contact surfaces and the areas around the sealing rings carefully. The sealing surfaces against the liner must be completely free from deposits etc. Clean the upper and lower liner recesses with a brush and cleaning liquid. Blow dry with compressed air. **Scraper tools must never be used.**

**NOTE!** It is very important that the stepped edge on the cylinder liner is protected from damage. For this reason, leave the plastic cover on the new cylinder liner until the liner is about to be fitted.

**TD70, TID70, TAM70:** Great care must be taken not to damage or bend the piston cooling jets during fitting.

1. Smear the underside of the liner flange with a thin coating of marking dye.
2. Press the liner down onto the liner recess, without the sealing rings and rotate it against the recess. Use expander 9538 for the 60 series or 9514 for the 70 series.

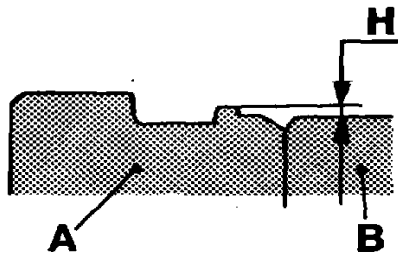


Fig. 66. The cylinder liner height above the block (H)  
 A. Cylinder liner B. Cylinder block

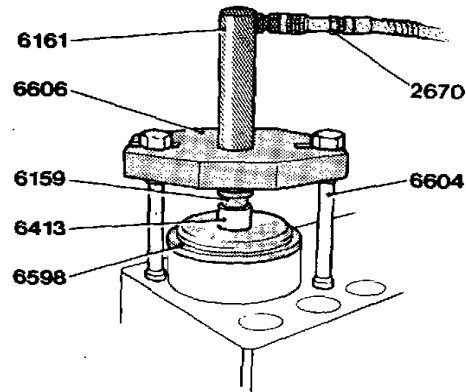


Fig. 67. Pressing down the cylinder liner

3. Remove the liner and check if the dye is evenly spread over the whole recessed surface. If the marking indicates poor contact, slight adjustments can be made by grinding with grinding compound. Larger defects necessitate milling of the recess with a special cutter, the material removed being compensated for by fitting steel shims. See next section, "Reconditioning the liner recesses".
4. Attach a couple of clamp washers 2667 so that the liner is held against the liner recess. (Clamp washers should **always** be used regardless of whether the O-rings in the lower liner guide are fitted or not).
5. Check that the stepped edge of the liner (H, fig. 66) lies 0.24–0.29 mm (0.0094–0.0114") above the cylinder block surface on the 60 series, and 0.38–0.43 mm (0.0149–0.0169") (recommended height when **overhauling**: 0.40–0.43 mm (0.0157–0.0169") on the 70 series. This check is carried out by using a dial indicator and holder 2479. The measurements should be made at 4 diametrically opposite points. Check that the block surface is not damaged when zeroing the dial indicator. Set the dial to zero with the pointer sliding on the surface of the block. Transfer the indicator to the liner flange step. The holder should always move longitudinally along the block.

Check also that the height variation between liners under the same cylinder head is not greater than 0.02 mm (0.0008"). Adjust as necessary according to point 3.

6. Fit the upper sealing ring to the liner under the flange. Smear the lower sealing rings and the liner's lower guide with soft soap and also fit the sealing rings in the block. **NOTE!** If grease is used instead of soap, some of the grease can accompany the coolant after the engine has been started and can be misinterpreted as oil leakage.

**Note!** In the parts kits to the majority of engines both the lower sealing rings are the same (black with a colour marking – yellow, green, etc. depending on the manufacturer). In the cylinder liner kits for certain engines there can be rings of different materials. The ring which is **colour-marked** should, however, always be placed **furthest down**.

7. Place the liner in the block and press it down as far as possible by hand. Do not use any force or knock the liner down.
8. Place the pressure plate 6598 on the liner collar together with the intermediate piece 6413, see fig. 67. Fit the hydraulic cylinder 6161, yoke 6606, pin 6159, and the bolts 6604. Connect the hydraulic pump 2670 and press down the cylinder liner to the bottom position.
9. **When replacing liner kits:** Remove the old piston from the connecting rod and fit the new one. See instructions on pages 39 and 40.
10. Fit the piston and connecting rod according to the instructions on page 41. Fit the cylinder head and oil sump.

**MD70, TMD70 with deep oil sump:** Tighten the oil pump's suction strainer in the bottom of the sump. Refit the sump's inspection covers.

11. Fill with lubrication oil and coolant. Adjust the valve clearances according to the instructions on page 46.

### Reconditioning the cylinder liner recesses (cylinder head and oil sump removed)

*Special tools, 60 series: 2479, 2667, 9538, 9553  
 70 series: 2479, 2667, 9508, 9514*

Remove the sealing rings in lower cylinder liner guide. Then **clean** the upper and lower liner recesses **thoroughly**. The upper recess must be absolutely free from carbon deposits.

Check the upper liner recess contact face with marking dye if there is any doubt concerning the extent of the damage. Refer to the previous section "Fitting the cylinder liners". Slight damage can be adjusted with grinding paste, see point 9. More extensive damage can be adjusted by using milling cutter 9553 for the 60 series, and 9508 for the 70 series, as follows:

1. Insert the cylinder liner to be fitted to the engine and check the liner height. See "Fitting the cylinder liners", points 4 and 5. Read off the dial indicator and note the reading.
2. Ground-off material must be compensated for by the use of steel shims, which are available in three thicknesses for the 60 series - 0.20, 0.30, 0.40 mm (0.0079, 0.0118, 0.0157") and four thicknesses for the 70 series - 0.12, 0.20, 0.30 och 0.50 mm (0.0047, 0.0079, 0.0118, 0.0197"). Preferably only **one** shim should be placed under the liner collar.

**NOTE!** If shims are to be used, a certain amount of machining of the liner recesses must be done even if the recesses in the cylinder block are undamaged, due to the fact that the fillet radii furthest down in the liner recesses must be removed so that the shims have the correct contact face.

Calculate the thickness of shim required with respect to the extent of damage and the height of the liner collar above the cylinder block face. After milling the cylinder liner recess it may be necessary to grind the mating surfaces using grinding compound, in which case a grinding allowance of 0.02 mm (0.0008") should be allowed for. Note, however, point 9!

3. So as not to blunt the sharp edges of the milling cutter, the liner recess should be roughened up using emery cloth and cleaned thoroughly before milling. This is especially important if the liner recess has previously been ground with grinding compound. Alternatively, the liner recess, after thorough cleaning can be shaved by using a suitable steel tool.
4. Lubricate the O-rings for the lower cylinder liner guide with soap and fit them in the block. Place the guide for the milling tool 9553 (60 series) or 9508 (70 series) in the liner seat, fig. 68. Ensure that the collar of the guide clears the intermediate wall in the block.
5. Check that the washer under the tool feed screw is clean and well oiled. Insert the milling tool into the liner recess and fit the yoke. Carefully centralize the yoke and secure the tool to the cylinder block with the two screws and flat washers. Check that the feed sleeve does not press on the milling cutter.
6. Attach a dial indicator as shown in fig. 68 and screw down the feed sleeve so that it presses lightly on the milling cutter.

Use a T-bar (not a ratchet handle) equipped with a flexible joint and a socket for turning the milling cutter. Turn the milling cutter so that the radius in the bottom of the liner recess is removed. Check that the feed sleeve presses lightly against the milling cutter and set the dial indicator to zero. Zero setting and reading should be made from the same point on the milling cutter. A paintmark adjacent to the ground surface on the upper edge of the milling cutter gives a reliable "reading position".

7. Turn smoothly and evenly, at the same time as the feed sleeve is turned to ensure an even feed. When the dial indicator reading shows the measurement to

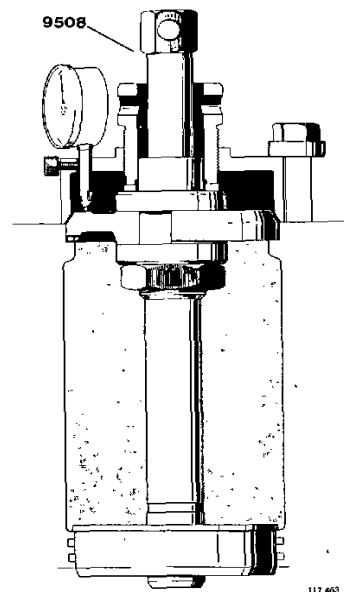


Fig. 68. Reconditioning the liner recess, 70 series

which the liner recess is to be adjusted, stop feeding and turn the milling cutter a few revolutions without any feed. Check the contact surface of the liner recess.

8. Check liner height again.
9. Take great care and if these instructions have been carefully followed, it should not generally be necessary to grind with grinding compound after milling without any risk of obtaining an inferior result.

If the damage to the cylinder liner recess is so slight that the milling tool need not be used, remove the O-rings and smear the underside of the liner collar with grinding compound. Insert the liner into the block and then turn the liner backwards and forwards until the compound is used up. Remove the liner and wipe off the grinding compound. Repeat the grinding operation until good contact is obtained. To turn the liner use expander 9538 for the 60 series, and 9514 for the 70 series.

10. Check the contact with marking dye and **mark the liner so that it comes into the same position when fitted as it was when the contact was checked.**
11. Clean all parts thoroughly. Check especially the contact surfaces on the liner collar and in the cylinder block.
12. Fit shim, if required. The shim should be placed on the liner (under the liner collar), **not in the cylinder block.** Fit the upper cylinder liner O-ring seal after locating the shim in place.

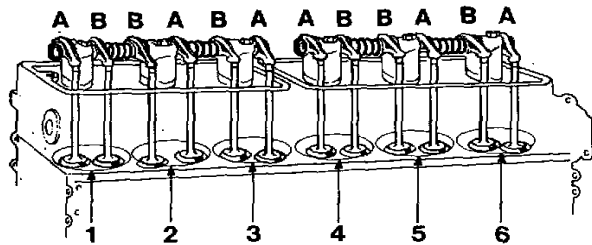


Fig. 69. Valve location and cylinder numbering

Valves A = IN B = OUT  
No. 6 cylinder is nearest to the flywheel

## Valve mechanism

### Adjusting the valves

**Note!** Never check the valve clearance while the engine is running, but when the engine is stopped, either cold or at operating temperature.

Valve location and cylinder numbering is shown in fig. 69.

Valve clearance	60 series	70 series
Intake:	0.40 mm (0.016")	0.40 mm (0.016")
Exhaust:	0.45 mm (0.018")	0.55 mm (0.022") (engines with turbo-charger) 0.45 mm (0.018") (engines without turbo-charger)

- Remove the rocker arm covers. Check and adjust the clearance if necessary on cylinder No. 1 when it is in its firing position. The valves on cylinder No. 6 will then "rock".
- Turn the engine over one third of a revolution in its correct direction of rotation and check the clearances on cylinder No. 5. The valves on cylinder No. 2 will then "rock". Check the valve clearance in the order of firing for the other cylinders.

Order of firing	1	5	3	6	2	4
Corresponding cylinder on which valves will "rock"	6	2	4	1	5	3

- Clean the rocker arm covers and fit them. Replace damaged gaskets. Test run the engine and check for oil leakage.

## Grinding valves and valve seats

### (cylinder head removed)

- Remove valve collets, valve spring washers, springs, and valves. Place the parts in a valve rack.
- Clean all parts.

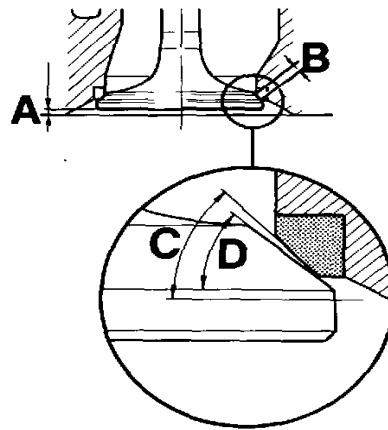


Fig. 70. Valve and valve seat

- A. 60 series: Max. 1.5 mm (0.059")  
70 series: Max. 2.0 mm (0.078")
- B.  $1.6 \pm 0.4$  mm ( $0.063 \pm 0.016$ ")
- C. Intake = 30°, exhaust = 45°
- D. Intake = 29.5°, exhaust = 44.5°

- Grind the valves in a valve grinding machine.

Valve sealing surfaces, D. fig. 70:

Intake ..... 29.5°  
Exhaust ..... 44.5°

Grind the sealing surface as little as possible, although sufficient to make them "clean". If the valve disc edge, after grinding is less than 1.2 mm (0.047") for the 60 series or 1.4 mm (0.055") (inlet) and 1.0 mm (0.039") (exhaust) for the 70 series the valve should be discarded. Discard also valves with bent stems.

- Check the valve guides for wear (see "Checking the valve guides") before machining the valve seats.
- Ream or grind the valve seats. When grinding, take care to grind away only as much material as is required to give the valve seats its correct form and sealing surface. Replace valve seats when the measurement "A" measured with a new valve exceeds 1.5 mm (0.059") for the 60 series, and 2.0 mm (0.079") for the 70 series.

New seats should be ground down until the distance between the cylinder head surface and the valves upper surface "A", is 0.7–1.1 mm (0.028–0.043") for the 60 series, and 1.0–1.4 mm (0.039–0.055") for the 70 series for both intake and exhaust valves.

Grind in the valves with grinding compound and check the contact surfaces with marking dye.

- Fit the valves, valve springs, spring washers, valve collets, and sealing rings. On the 70 series there are also valve caps. See "Assembling the cylinder head" on page 35.

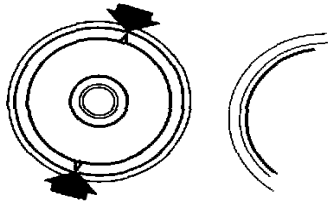


Fig. 71. Crack marks in the valve seat

### Replacing valve seats

Valve seats should be replaced when the distance "A" (fig. 70) measured with a **new valve** exceeds 1.5 mm (0.059") for the 60 series and 2.0 mm (0.079") for the 70 series.

1. Remove the old valve seat by grinding two crack marks in the seat (fig. 71) and cracking it with a chisel. Alternatively a used valve can be electrically welded to the seat and then knock out the seat.

**NOTE!** Be careful not to damage the cylinder head.

2. Clean the seat recess in the head thoroughly and check the head for cracks.
3. Measure the diameter of the valve seat recess. Use this to check the possibility of fitting a standard size seat or whether an oversize is needed. The valve seat recesses must be machined if oversizes are needed.
4. Cool the seat with carbon dioxide snow to a temperature of minus 60°–70°C (–76°–94°F) and if necessary, heat up the cylinder head with hot water by flushing it or by some other means. Then press in the seat using a drift.
5. Machine the seats to the correct angle and width.

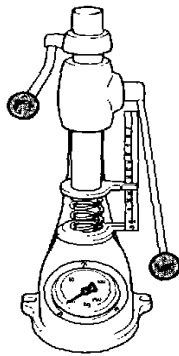


Fig. 71A. Spring tester

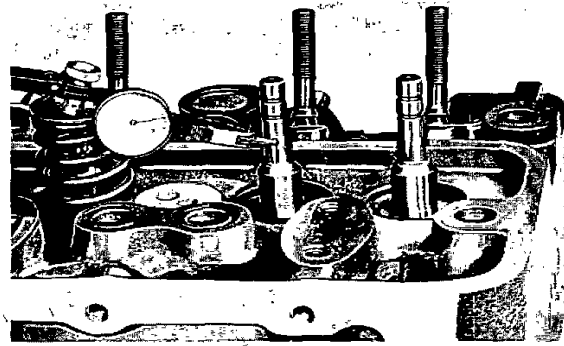


Fig. 72. Checking the valve guide wear.

### Checking valve springs

Check the free and loaded lengths of the valve springs. This should be carried out using a spring tester. The springs should comply with the values given in "Technical Data".

### Checking the valve guides

In order to check guide wear, place a **new valve** in the guide and then measure the clearance with an indicator (fig. 72).

Wear limits:

- Intake valve clearance, max. . . . . 0.15 mm (0.0059")
- Exhaust valve clearance, max. . . . . 0.17 mm (0.0067")

If these values are exceeded, the valve guides must be replaced

### Replacing valve guides

*Special tools, 60 series: 1459, 6169*  
*70 series: 1084, 2661*

1. Press out the valve guides with drift 1459 for the 60 series (fig. 73), and drift 1084 for the 70 series.
2. Oil in the new guides externally and press them in with the tool 6169 for the 60 series (fig. 75), and 2661 for the 70 series. The tool gives the guide the correct height above the cylinder head spring face – 23 mm (0.906") (60 series), and 22 mm (0.866") (70 series).
3. Ream the valve guide if necessary. Clearance for valve stem-valve guide, see "Technical Data".

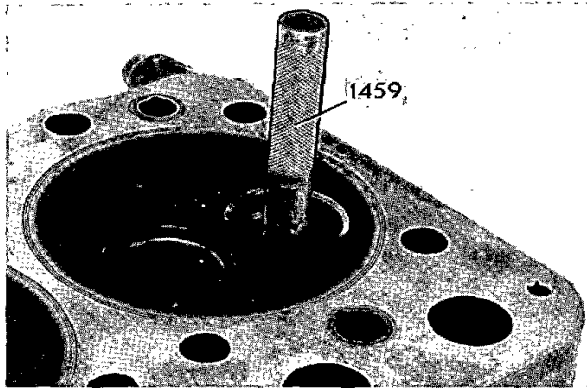


Fig. 73. Removing a valve guide, 60 series

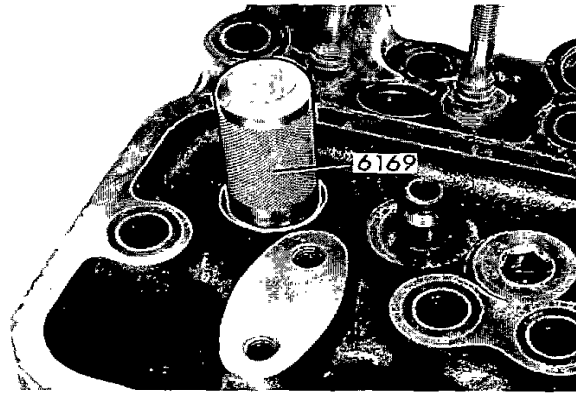


Fig. 75. Fitting a valve guide, 60 series

### Overhauling the rocker arm mechanism (removed)

*Special tools: 60 series 1867  
70 series 2677*

1. Remove the circlips from the rocker arm shaft and remove the rocker arms, bearing brackets and springs.
2. Clean the parts. Be particularly thorough with the oil drillings in the bearing bracket and the rocker arm shaft as well as the rocker arm oil holes.
3. Check wear on the rocker arm shaft and check the shaft end cap plugs for leakage. Also check to ensure that the spherical part of each ball pin is not deformed or worn. The threads on the pins and lock nuts must be free from damage. The hexagon on each nut must also be in good condition. The rocker arm contact sphere against the valve/valve cap must not be worn or pitted. Minor wear can be adjusted by grinding.
4. Replace rocker arm bushings if they have worn oval. Drift 1867 for the 60 series, or 2677 for the 70 series, is used to press out the old bushing and press in the new one. The new bushings must be pressed in so that the oil drillings in each bushing and rocker arm coincide. After being pressed in the bushing must be reamed until a close running fit is obtained on the shaft (22.020–22.041 mm = 0.8669–0.8678" for the 60 series, and 25.020–25.042 mm = 0.9850–0.9859" for the 70 series). Remove all traces of metal chips and swarf.

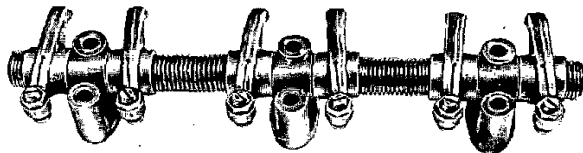


Fig. 74. Rocker arm mechanism, 60 series

5. Oil in the rocker arm shaft and assemble the various parts. Note that the rocker arms on the 60 series are placed opposite each other in pairs, fig. 74. On the 70 series the rocker arms are completely identical and can be placed optionally with respect to each other on the shaft. Ensure that the circlips in the ends of the rocker arm shaft are correctly located in their grooves.

### Auxiliary drive (timing gears)

#### Removing auxiliary drive gears

*Special tools: 2655, 2658, 2679*

**Industrial engines:** Drain the coolant. Remove the belt guard, radiator with fan cover and hoses, the fan and the thick coolant pipe to the coolant pump.

**TAMD70:** Drain the coolant in the fresh-water system.

1. Disconnect both battery cables.
2. Remove the belts and the belt tensioner, and in certain cases the alternator.

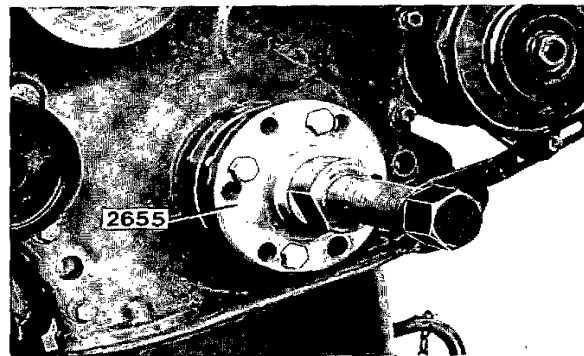


Fig. 76. Removing the polygon hub.

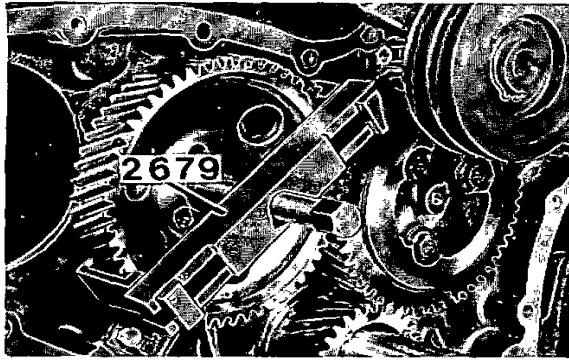


Fig. 77. Removing the camshaft gear

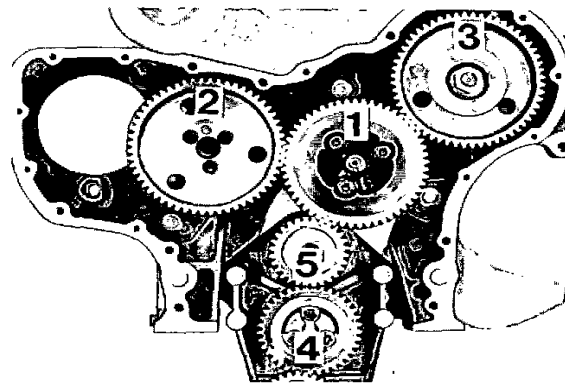


Fig. 79. Auxiliary drive gears

3. **MD70, TMD70:** Loosen the bracket for the voltage regulator from the auxiliary drive cover and hang it up.
- TAMD60, TAMD70:** Loosen the connector box from the auxiliary drive cover and hang it up.
4. Remove the crankshaft belt pulley if one is fitted and the vibration damper, which are bolted to the polygon hub.
 

**NOTE!** Always protect the vibration damper from blows and impact since its characteristics can change completely if the carefully calculated cavity for liquid has its form or volume changed.
5. Loosen the polygon hub centre bolt and then remove the polygon hub using puller 2655 (fig. 76).
6. **TAMD70, TD70, TID70:** Remove the coolant pipe between the engine oil cooler and the coolant pump/pipe.
7. **MD70, TMD70, TAMD70:** Remove the pressure oil pipe to the drive outlet in the auxiliary drive cover. Remove the drive outlet.

8. Remove the auxiliary drive cover. Dismantle the oil deflector from the crankshaft journal.
9. Remove the rubber plug in the flywheel cover and turn the engine until No. 1 piston is at T.D.C. after the compression stroke (0° on the flywheel). Replace the rubber plug.
10. Remove the idler gear (1, fig. 79) together with the bearing journal, the bearing shield, and thrust washer.
11. Remove the camshaft drive gear (2). Use puller 2679 (fig. 77) if necessary. The same procedure applies to the injection pump drive gear on the **70 series**.
12. **60 series:** Remove the injection pump drive gear (3).
13. Remove the splash plate in front of the oil pump idler gear. (The 60 series is not fitted with splash plate, except for the TD60 and TID60 with shallow oil sump for large inclinations).  
Remove the oil pump idler gear (4).
14. Remove the crankshaft gear (5) using the puller 2658 (fig. 78).

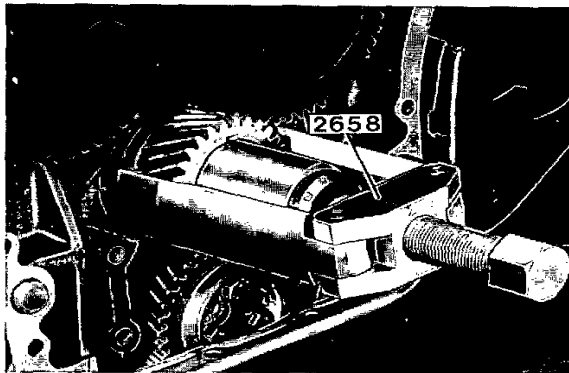


Fig. 78. Removing the crankshaft gear

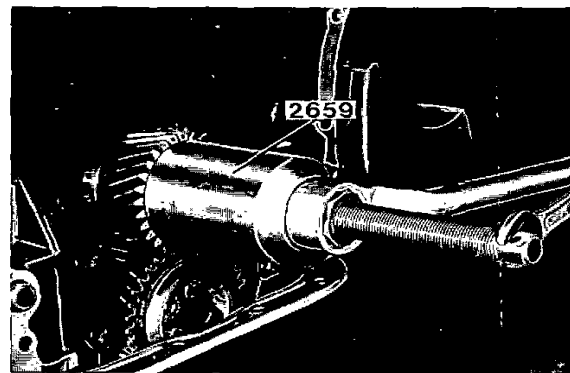


Fig. 80. Fitting the crankshaft gear

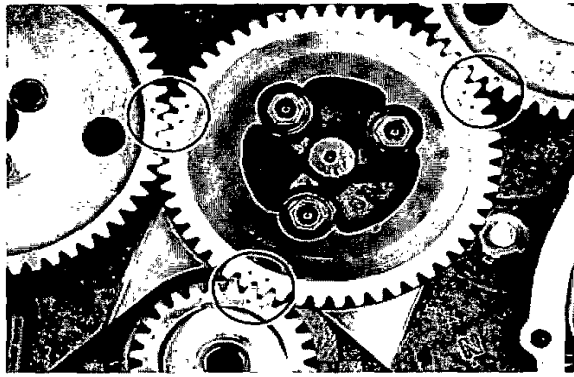


Fig. 81. Auxiliary drive gears, basic setting

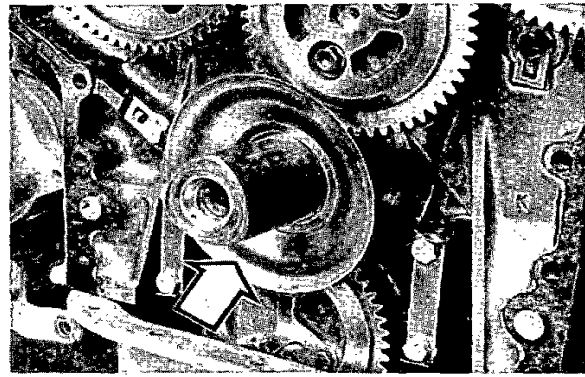


Fig. 83. Oil deflector ring

### Inspecting the auxiliary drive gears

Clean the auxiliary drive gears and other parts and check them carefully. Replace badly worn or damaged gears. The maximum permissible backlash is 0.17 mm (0.0067").

Check the axial and radial clearances of the idler gear.

Axial clearance . . . . . 0.05–0.15 mm (0.002–0.006")

Radial clearance . . . . . 0.025–0.082 mm (0.0010–0.0032")

Clean the auxiliary drive cover and cover contact surface on the engine (auxiliary drive gear casing).

### Assembling and settings

*Special tools: 2657, 2659*

**All the gears in the auxiliary drive assembly influencing the settings are marked with a punch opposite the respective tooth or tooth-gap (fig. 81).**

1. Check that the crankshaft key is fitted. Fit the crankshaft gear using tool 2659 (fig. 80).
2. Check that the camshaft gear locating pin is fitted. Install the camshaft gear (2, fig. 79). Tightening torque 45 Nm (4.5 kpm = 33 lbf.ft). Lock the bolts with the lock washer.

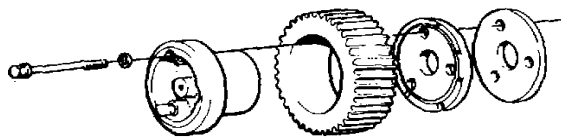


Fig. 82. Idler gear, auxiliary drive gears

3. Set the crankshaft with No. 1 piston in its T.D.C. position (keyway in crankshaft facing straight upwards). Assemble the idler gear (1, fig. 79) according to the marking (fig. 81). The bearing shield and thrust washer are located as shown in fig. 82.  
Tightening torque 60 Nm (6 kpm = 44 lbf.ft). Check that the axial clearance is 0.05–0.15 mm (0.002–0.006").
4. **60 series:** Fit the injection pump drive (3) with the intermediate piece without tightening the bolts. Check that the markings coincide as shown in fig. 81.  
**70 series:** Check that the guide pin is fitted in the shaft for the fuel injection pump and fit the pump drive. Make sure that the markings coincide as shown in fig. 81.
5. Fit the oil pump idler gear. Fit the splash plate in front of the oil pump idler gear and lock the bolts by folding over the corners of the plate. (The 60 series engines are not fitted with splash plate, except for the TD60 and TID60 with shallow sump for large inclinations.)
6. **60 series:** Adjust and check the injection pump setting. See "Setting the injection angle" on pages 74–75.

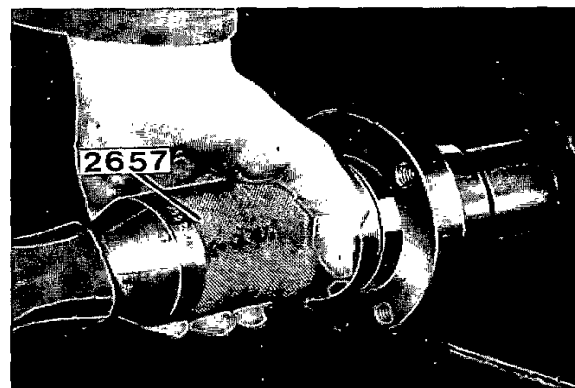


Fig. 84. Fitting the polygon hub

7. Check that there are no seizure marks on the crankshaft journal and polygon hub. Rub off any marks with an emery cloth.
8. Fit the oil deflector onto the crankshaft journal with the dish facing outwards (forwards).
9. Fit the crankshaft seal in the auxiliary drive gear cover. This seal consists of a felt ring and a rubber ring. The felt ring should be fitted on the outside.  
**Drench the felt ring and dip the rubber ring in engine oil before fitting.**
10. Apply sealant to the mating surfaces and assemble the auxiliary drive cover with a new gasket. Where applicable, fit the connector box, or bracket with the voltage regulator and the alternator bracket.
11. Grease the crankshaft journal with molybdenum disulphide. Fit the centering part of drift 2657 on the crankshaft journal. Heat up the polygon hub to about 100°C (212°F). Knock the hub quickly onto the journal to within about 5 mm (0.20") of the gear surface (fig. 84).
12. Fit the washer and centre bolt and tighten the bolt to 200 Nm (20 kpm = 145 lbf.ft). Let the hub cool and tighten the screw to 260 Nm (26 kpm = 188 lbf.ft).
13. Assemble the vibration damper and pulley, if fitted. Tighten the bolts to 60 Nm (6 kpm = 44 lbf.ft).
14. **MD70, TMD70, TAMD70:** Fit the drive output in the auxiliary drive gear cover. Connect the pressure oil pipe to the drive output.
15. **Industrial engines:** Fit the large coolant pipe to the coolant pump.
16. **TAMD60, TD70, TID70:** Fit the coolant pipe between the engine's oil cooler and the coolant pump/pipe.
17. Fit the alternator, if it has been removed. Assemble the belt tensioner and all drive belts. Adjust the belt tension. It should be possible to press in the belts approx. 10 mm (0.4") between the pulleys. (TD70 and TID70 are fitted with an automatic belt tensioner for the fan belts.)
18. **Industrial engines:** Fit the fan, radiator with fan cover, hose connections and the belt protector.
19. **TAMD70 and industrial engines:** Fill with coolant and vent the system. See "Filling with coolant" on page 88.
20. Connect the battery cables.

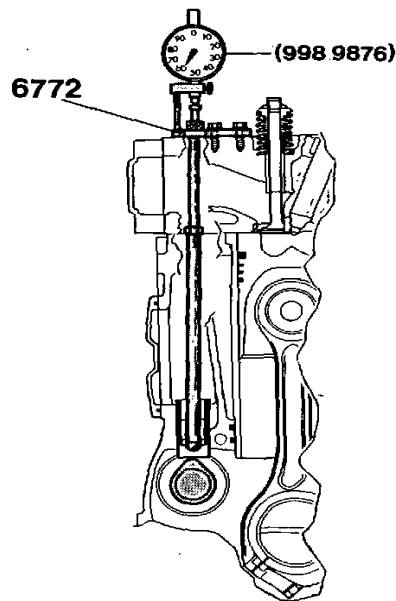


Fig. 85. Checking the camshaft wear

2. Fit the tool 6772 to the front lifter (fig. 85). Adjust the length of the rod on the tool so that it makes contact with the lifter with pre-tension.
3. Rotate the engine until the rod (lifter) is in its bottom position. Check that the rod is pre-tensioned and set the dial indicator to zero.
4. Rotate the engine until the rod (lifter) is in its top position. Read off the dial indicator and compare with the values in the table below.
5. Fit push rods and rocker arm mechanism after measuring all cams. Adjust the valve clearances. See instruction on page 46.

## Camshaft

### Checking the camshaft wear (camshaft fitted)

*Special tools: 6772 together with dial indicator, e.g. 998 9876*

1. Remove the valve covers. Unscrew the bolts for the rocker arms' bearing brackets and remove the rocker arm mechanism. Lift out the push rods.

	Camshaft lift height in mm (ins)		Min. lift height in mm (ins)	
	Inlet	Exhaust	Inlet	Exhaust
TD60D, TID60D,	8.000	8.000	7.4	7.4
TAMD60C.....	(0.3150")	(0.3150")	(0.2913")	(0.2913")
MD70C.....	8.006	8.006	7.4	7.4
	(0.3152")	(0.3152")	(0.2913")	(0.2913")
TD70G, TID70G,				
TMD70C,	8.006	8.268	7.4	7.7
TAMD70E.....	(0.3152")	(0.3255")	(0.2913")	(0.3031")

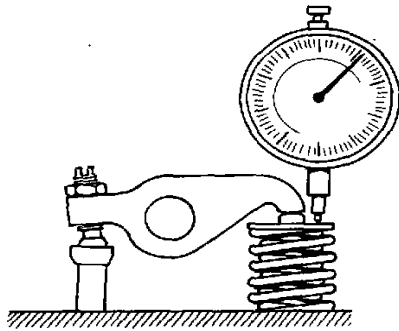


Fig. 85A. Checking the valve timing

### Checking the valve timing

1. Remove the front valve cover. Rotate the crankshaft until the valves for cylinder No. 1 rock. Then rotate the crankshaft against the direction of rotation until the inlet valve is completely closed. Temporarily adjust the valve clearance for the inlet valve to  $\pm 0$  mm.
2. Place a dial indicator with the measuring point against the upper valve spring washer. Fit the indicator with approx. 5 mm (0.2") pre-tensioning.
3. At the same time as an assistant continues to rotate the engine in the direction of rotation by hand, with the stop control pulled out, the dial indicator should be watched. The dial indicator deflects when the inlet valve starts opening. Set the indicator's 1/100 scale to zero at exactly this opening point.
4. Continue rotating the engine past the 0 degree marking on the flywheel to the 10° marking after the top dead centre. Make sure that the setting degree marking is opposite the pointer on the flywheel cover.

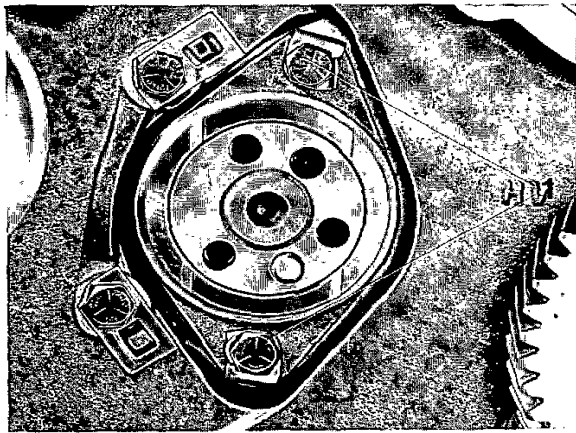


Fig. 86. Attaching bolts (1) for camshaft flange.

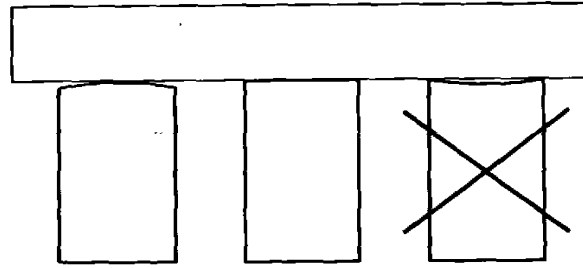


Fig. 86A. Checking the valve lifters

Check that the deflection of the dial indicator is in accordance with the values given in "Technical Data" on page 6.

### Removing the camshaft

*Special tools: 2655, 2679*

**Industrial engines:** Drain the coolant. Remove the belt protector, radiator with fan cover and hoses, fan, and the thick coolant pipe to the coolant pump.

**TAMD70:** Close the bottom valve and drain off the coolant in the fresh-water and sea-water systems.

1. Disconnect both the battery cables.
2. **TD60, TID60, TAMD70:** Remove the air filter.
3. **Industrial engines:** Remove the intake pipe between the air filter and the turbocharger.
4. Remove the valve covers and dismantle the rocker arm mechanism. Lift out the push rods.
5. **TAMD70 with tubular heat exchanger:** Remove the coolant pipe between the heat exchanger and the reverse gear oil cooler.
6. **TAMD70:** Remove the connection pipe between the turbocharger and the aftercooler.
7. **Marine engines:** Remove the crankcase ventilation filter complete with filter housing.
8. Dismantle the crankcase ventilation pipe.
9. Remove both inspection covers opposite the valve lifters.
10. Lift up the valve lifters and place them in order in a rack.
11. Carry out the operations under points 1-8 under the heading "Removing the auxiliary drive gears" on pages 48 and 49.
12. Remove the camshaft gear (2, fig. 79). Use puller 2679 (fig. 77) if necessary.
13. Dismantle the camshaft flange (fig. 86). Carefully pull out the camshaft to avoid damaging the bearings. Use a suitable lever (fig. 87).

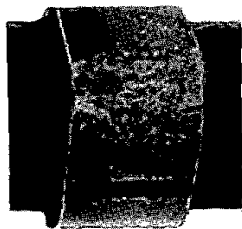
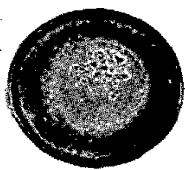


Fig. 86B. Small pitting damage to valve lifter (A) and camshaft (B)

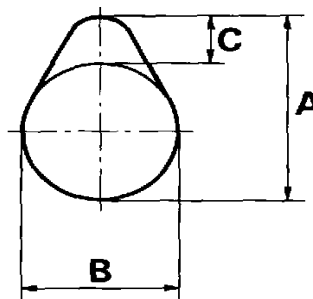


Fig. 86C. Checking the camshaft lift C (cam height)  
 $C = A - B$

### Inspecting the lifters and camshaft

Check, using a metal ruler, that the valve lifters' contact surface against the camshaft is ball-shaped (convex). It can also be completely flat, but absolutely not concave (fig. 86A). If the light is visible in the middle of the lifter surface between the ruler and lifter, the lifter shall be replaced.

**NOTE!** If the lifter is worn across the lifter face, the lifter shall be discarded. The "groove" shows that the lifter has not rotated. A dark stripe around the outside of the lifter face indicates that the surface is not worn. The condition of the valve lifters decides if the camshaft wear is needed to be checked.

Check the lifter surfaces with respect to pitting damage. Pitting damage can occur due to different reasons. The damage consists of small metal particles being loosened from the hardened surface. The valve lifters and the camshaft can be re-used, even with slight pitting damage (fig. 86B). It has been noticed that the damage very seldom gets worse.

Check the camshaft's bearing races and cam profiles with respect to wear. The cams can e.g. be worn obliquely in an axial direction. In minor cases this can be adjusted by honing the cams. If the damage is more serious or the camshaft is worn, it must be replaced. When replacing the camshaft, all the valve lifters must also be replaced.

### Measuring the camshaft

Wear on the camshaft bearing races is measured using a micrometer. The maximum permissible wear and out-of-round is 0.07 mm (0.0028"). The straightness of the camshaft is checked by using a dial gauge. The maximum permissible radial throw relative to the end bearings is 0.04 mm (0.0016"). The lift height (cam height) is measured using a sliding caliper according to fig. 86C.

The measurement information for the camshaft and camshaft bearings can be found under "Technical Data". Regarding lift height, see the table on page 51.

An understanding of the cam wear can be obtained without removing the camshaft, see "Checking the camshaft wear" on page 51.

### Replacing the camshaft bearings

The bearings are pressed in their recesses and must be rebored after being pressed in. Replacement of the camshaft bearings can only be carried out in connection with a complete engine overhaul.

When pressing in the bearings check that the oil holes are located directly opposite the corresponding drillings in the cylinder block.

The front camshaft bearing should be fitted with the groove facing forward.

### Fitting the camshaft

*Special tool: 2657*

1. Oil in the camshaft bearing journals and slide the camshaft in carefully to avoid damaging the bearings. Use a suitable lever (fig. 87).
2. Fit the camshaft flange. Tighten the bolts to 40 Nm (4 kpm = 29 lbf.ft).

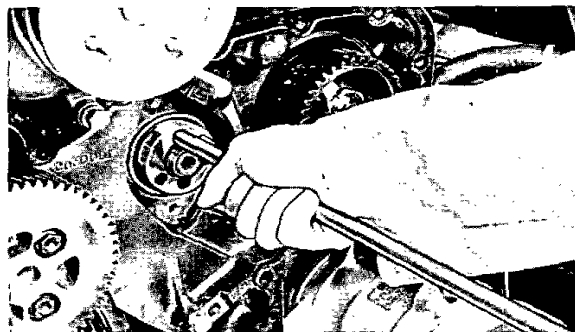


Fig. 87. Fitting the camshaft

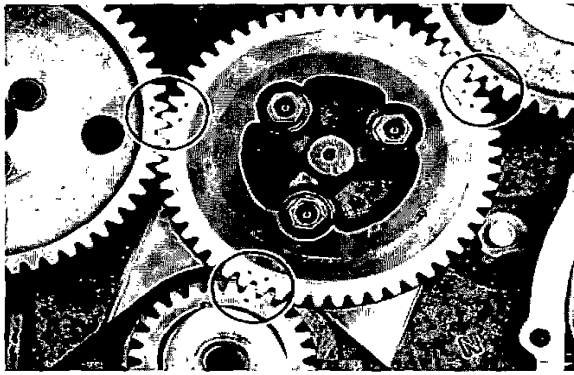


Fig. 88. Auxiliary drive gears, basic setting

3. Rotate the engine until No. 1 piston is at T.D.C. after the compression stroke ( $0^\circ$  on the flywheel). Check that the markings on the auxiliary gear drive coincide (fig. 88).
4. Check that the camshaft drive gear locating pin is fitted. Fit the camshaft drive gear (2, fig. 79) according to the marking. Tightening torque 45 Nm (4.5 kpm = 33 lbf.ft). Lock the bolts with the lock washer.
5. Carry out the operations according to points 7–12 under the heading "Assembling and settings" (auxiliary gears) on page 51.
6. Lubricate the valve lifters' contact surfaces against the camshaft with molybdenum disulphide and use oil to lubricate the guides in the cylinder block. Fit the valve lifters in the correct order.
7. Fit the push rods and the rocker arm mechanism. Tightening torque 40 Nm (4 kpm = 29 lbf.ft).
8. Fit the inspection covers opposite the valve lifters together with the gaskets.  
**Note!** Fit the oil deflector plate on the cover that has the connection for the crankcase ventilation. (The front cover on TAM60, the rear cover on other engines).
9. Fit the pipe and, where applicable, the filter for the crankcase ventilation.
10. **TAMD70:** Fit the connection pipe between the turbo and the aftercooler. Fit the cooling water pipe between the heat exchanger and the reverse gear's oil cooler on engines with tubular heat exchangers.
11. Adjust the valve clearance according to instructions on page 46. Refit the valve covers.
12. **Industrial engines:** Fit the inlet line between the turbo and air filter.
13. Fit the air filter if it has been removed.
14. Carry out the operations Nos. 13–20 under section "Assembling and settings" (auxiliary gears) on page 51.

## Crank mechanism

### Removing the crankshaft

(engine removed)

Special tool: 2655

1. Drain or suck out the engine oil.
2. **MD70, TMD70 with deep oil sump:** Remove the rear inspection cover on the oil sump and unscrew the suction strainer from the bottom of the sump.
3. Remove the oil sump. Remove the oil pump suction and pressure lines.
4. Remove the crankshaft belt pulley, vibration damper, polygon hub and auxiliary drive cover. See "Removing the auxiliary drive gears", on pages 48 and 49.
5. Dismantle the reverse gear, or coupling if fitted, flywheel and flywheel cover.
6. Remove the big-end and connecting rod bearing caps. (The lubricating oil pump is removed together with the front main bearing cap.)
7. Lift out the crankshaft, preferably using a lifting block designed for crankshafts.

### Inspection of crankshaft and bearings

After removal, the crankshaft and all its drillings must be thoroughly cleaned. Measure wear and out-of-round using a micrometer. Shearing damage can cause cracks due to overheating which can only be found with special test equipment. Any cracks or indications of fractures are most dependably located by a magnetic powder test, of type Magnaglo, i.e. using fluorescent powder and observing the effects under ultra-violet light. Refer to the equipment manufacturer's instructions regarding the procedures. The crankshaft must be demagnetised after such a test.

The largest possible out-of-round for the main and big-end bearing journals is 0.08 mm (0.0032"), and maximum taper 0.05 mm (0.0020"). If these values are exceeded then the crankshaft must be ground to a suitable undersize.

On the 60 series the crankshaft is nitro-carburated (marked "&" on the counterweight closest to the flywheel flange). The nitro-carburated bearing surface differs from the induction hardened surfaces (70 series) mainly by its hardness. It is therefore important in certain cases to take other considerations than before when inspecting crankshaft and when deciding on what is to be done.

After a long period of operation small particles can loosen from the thin surface cover. This process can easily be interpreted as dirt scratches, but the difference is that these scratches do not go completely around the bearing journal and also have uneven edges. These defects do not necessarily mean that the crankshaft is to be ground. Usually it is enough to polish the bearing journals lightly with emery cloth and fit new bearing shells.

Check main and big-end bearing shells. Replace worn bearing shells or those with flaked lead-bronze coating.

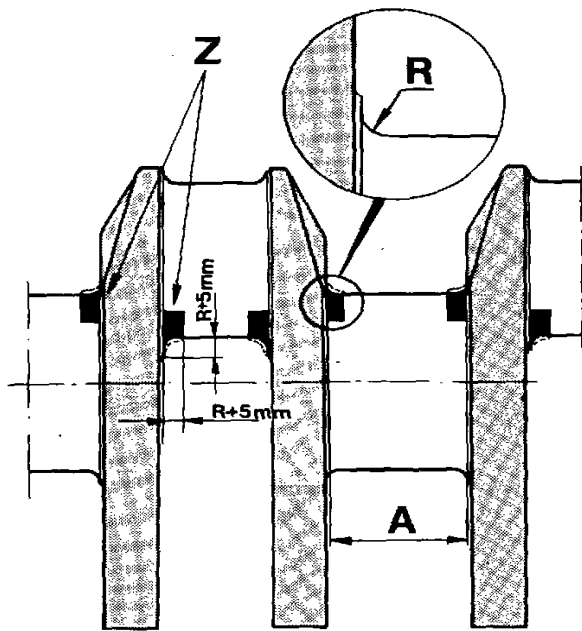


Fig. 89. Crankshaft

### Grinding the crankshaft

In general, both re-grinding and straightening the crankshaft reduces the fatigue resistance. Do not therefore grind a crankshaft (especially nitro-carburated ones) without there being strong reasons for re-grinding, e.g. incorrect measurements (wear, out-of-round, conicity) or that there is serious surface damage where polishing is not sufficient.

Out-of-straightness is measured as throw-out (i.e. the total indicator reading) on the fourth main bearing journal with the shaft suspended by main bearing journals one and seven. All straightening of finished crankshafts (irrespective of hardening method) should be avoided.

**60 series:** The crankshaft is nitro-carburated. On condition that the shaft does not need to be straightened before grinding, the shaft can be ground to maximum the 2nd undersize without re-newing the nitro-carburated. If the crankshaft is so out-of-true that it must be straightened before re-grinding, then it must be re-nitro-carburated after the grinding.

The crankshaft must be carefully lapped and cleaned after the nitro-carburated.

**70 series:** The crankshaft is induction-hardened and can be ground to all the undersizes without re-hardening.

The crankshaft shall always (irrespective of the method of hardening) be magnaglo-tested before and after any straightening and grinding. See also "Inspecting the crankshaft and bearings" on the previous page. Cracks of the following type and location make crankshaft unserviceable and must therefore be replaced:

- Transversal cracks on bearing journals and in the fillets.
- Longitudinal cracks within the area marked Z, fig. 89.
- Cracks longer than 5 mm (0.2") adjacent to the drillings for the oil channels. Shorter cracks can be removed through grinding.
- Cracks longer than 10 mm (0.4") outside the area marked Z, including groups of small cracks if their total length exceeds 10 mm (0.4").

Cracks in the unmachined surface on the balance weights can be ground away, as long as they are not deeper than 3 mm (0.118").

One condition for reaching a satisfactory result by grinding, is that the right method is being used. The following grinding data is recommended:

Grinding disc: Naxos 33A60 M6VK or 33A46 M6VK or Norton 23A60 M5VK or 23A46 M5VK.

Diameter: New disc  $\varnothing$  36"-42" (914-1067 mm) (the disc can be used down to a diameter of about  $\varnothing$  720 mm (28.4").

Peripheral speed: grinding disc .. 28-33 m/s (92-108 ft/s)  
crankshaft .. max. 0.25 m/s (49.2 ft/min)

Cooling: 3 % oil emulsion (Soluble). It is important that the cooling is very effectful, preferably with flushing from below as well as from above.

The disc can be sharpened with a single stone diamond.  
peripheral feed..... 0.1 mm (0.004")/revolution  
side feed ..... 0.2 mm (0.008")/revolution  
cutting depth ..... max. 0.03 mm (0.0012")

The surface finish (profile depth) for the bearing surfaces and the fillet radii are  $2\mu$ , average surface deviation  $0.5\mu$ . This surface finish is obtained by lapping. The lapping is done in the direction of rotation opposite to the grinding.

1. The crankshaft is ground to the suitable undersize as specified in "Technical Data" in a crankshaft grinding machine.
2. When grinding the crankshaft it is extremely important that the fillet radii maintain the correct measurement,  $R=4.2-4.4$  mm (0.165-0.173") for the 60 series or  $R=3.75-4.00$  mm (0.148-0.157") for the 70 series, and the right form and surface finish. Measure the radius with a radius template. The form must follow fig. 89. Grinding marks and sharp edges must not be present as these can give rise to crankshaft fracture.
3. Particular care is needed when grinding the centre bearing journal regarding the width A for the pilot bearing, fig. 89. Regarding measurements, see "Technical Data" on page 5.

**NOTE!** If sharp edges occur at the oil drilling inlets when the bearing races are ground down, then these edges should be honed using a grinding pin or emery cloth.

4. Clean the shaft thoroughly removing all swarf, filings and other impurities. Flush and clean out the oilways. Check the crankshaft using a dial indicator. The crankshaft throw must not be more than 0.05 mm (0.0020") radially.
5. Carry out Magnaglo-testing of the crankshaft and then de-magnetise it.

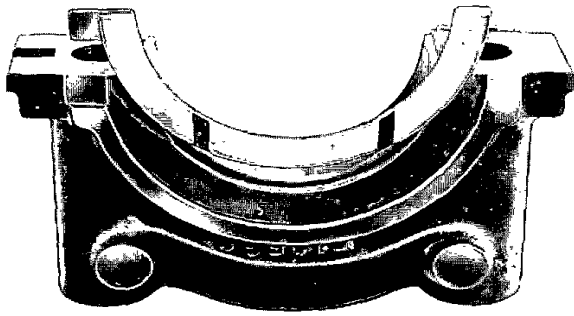


Fig. 90. Fitting the thrust washers

## Fitting the crankshaft

*Special tool: 2657*

1. Check that the crankshaft oil drillings and bearing surfaces, cylinder block and caps are thoroughly clean.
2. Place the main and big-end bearing shells in position. *Make sure that the lubricating holes in the bearing shells are located directly opposite the oil drillings and that there are no burrs or dents in the bearing shells and caps. Oil the bearings.*
3. Lubricate the bearing journals with engine oil and lift the crankshaft carefully in position. Make sure that the markings on the auxiliary drive gears coincide, if the gears were left in position.
4. Fit the thrust washers for the centre main bearing (pilot bearing). Locating slots are provided so that the washers can only be fitted in their correct position (fig. 90).
5. Fit the main bearing caps. The centre main bearing cap has a recess which is to be turned so that it coincides with the locating pin. This means that the bearing cap is always correctly located axially. Check the numbers on the main bearing caps which indicate their positions.
6. Fit the main bearing bolts after their threads have been oiled. Tightening torque 140 Nm (14 kpm = 101 lbf.ft).
7. Check the end float of the crankshaft. See "Technical Data".
8. Check that the connection rods' "Front" marking faces forwards and that the guide pins for the caps are properly fitted. Fit the big-end bearing caps and tighten the bolts to a torque of 160 Nm (16 kpm = 116 lbf.ft).

## Main and big-end bearings

### Inspection

Check the bearing shells. Replace worn bearing shells or those with flaked lead-bronze coatings.

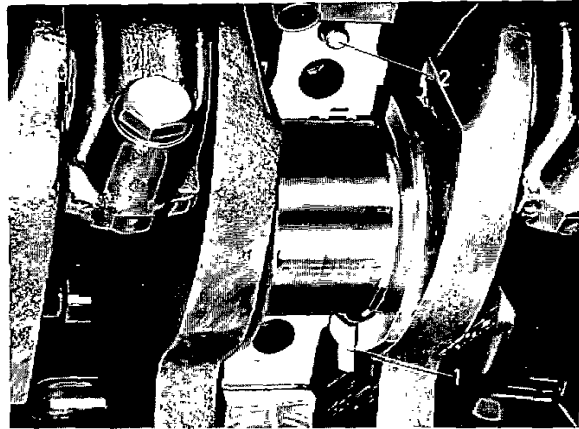


Fig. 91. Pilot slot (1) and locating pin for main bearing cap (2)

## Replacing main bearings

(crankshaft not removed)

1. Drain or suck out the engine oil.
2. **MD70, TMD70 with deep oil sump:** Remove the inspection covers from the oil sump.  
**Other engines:** Remove the oil sump.
3. Remove the oil pump suction line and strainer and the suction line(s) between the pump and cylinder block.
4. *Unscrew the main bearing bolts and take off a main bearing cap and bearing shell. (The front main bearing cap is removed together with the lubricating oil pump).*
5. *Loosen the injectors so that the engine can be turned over more easily.*
6. Turn the crankshaft until its oil hole is exposed. Place a stud in this hole. The stud must be of such a dimension that, when the crankshaft is rotated, it takes with it the upper shell (fig. 92).  
The bearing shells have a pressed out lug which locates in a slot in the crankcase bearing recess. This lug makes it necessary to rotate the crankshaft in the **normal direction of engine rotation** (clockwise) when rolling out the bearing shells.
7. Clean the bearing journal and examine carefully for damage. If there are marked signs of wear, or out-of-roundness is suspected then, if a crankshaft measuring device is not available, the crankshaft must be removed for measuring.
8. Check when replacing that the bearings are of the correct size.
9. Fit the new bearing shells, the upper shell being rolled in by using the stud described in point 6 above. This time the crankshaft is rotated in the **opposite direction** to engine rotation (anti-clockwise). Check that the lugs pressed out of the bearing shells engage correctly. Remove the stud from the oil hole and fit the lower bearing shell and cap. Tighten the bolts to a torque of 140 Nm (14 kpm = 101 lbf.ft).
10. Carry out the operations Nos. 3, 4, 5, and 6 as described under "Fitting the oil pump" on page 65.

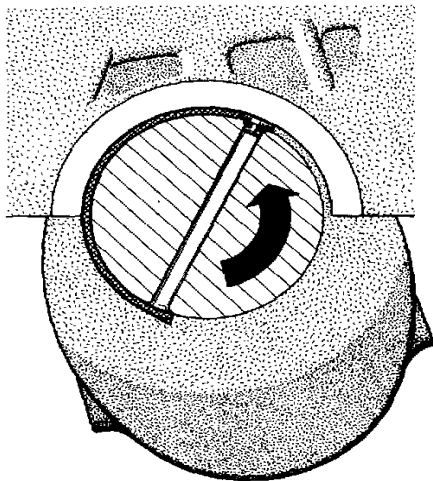


Fig. 92. Replacing main bearing shell

### Inspecting the flywheel

Check the flywheel for cracks or other damage. Also check that the ring gear is not damaged or worn. Replace if necessary.

With minor scoring or cracks in the friction surface of a flywheel on engines fitted with a single disc clutch of truck type the flywheel can be reconditioned by grinding, but no more than 0.5 mm (0.020") may be machined off. If the damage is more extensive, then the flywheel must be replaced.

The flywheel depth measurement, i.e. the distance from the clutch disc face to the surface of the clutch attaching plate, must be maintained. This means that the surface for the attaching plate must be ground down as much as the clutch disc face.

### Replacing the flywheel ring gear

1. Remove the flywheel.
2. Drill one or two holes between two teeth of the ring gear and then crack it with a chisel so that the ring gear can be removed.
3. Brush clean the contact face of the flywheel using a wire brush.
4. Heat up the new ring gear in an oven so that the ring gear is evenly heated all the way round. If a welding torch flame is used, which is not so suitable, great care must be taken not to overheat the ring gear which can result in annealing. In order to check the heating, polish the ring gear bright in a few places and then stop heating when these areas are blued (180–200°C = 356–392°F).
5. Lay the heated ring gear on the flywheel and knock it into position using a soft drift and a hammer. Then allow the ring gear to cool in the open air.

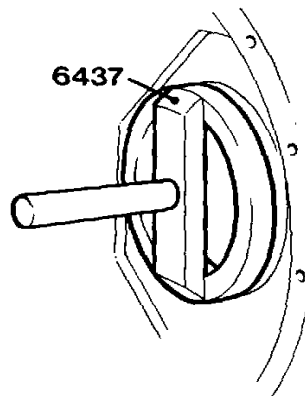


Fig. 93. Fitting the rear crankshaft seal

6. Clean the mating surfaces on the flywheel and crankshaft. Check the location pin in the crankshaft flange and the rear crankshaft seal. Replace if necessary.
7. Fit the flywheel. Tightening torque 160–180 Nm (16–18 kpm = 118–133 lbf.ft).

### Replacing crankshaft seals

Special tools, front seal: 2655, 2657

rear seal: 6437

The front seal can be replaced after the polygon hub on the crankshaft journal has been removed. Refer to "Auxiliary drive gears, removing/fitting" on pages 48–51. The seal consists of a rubber ring and a felt ring. **Drench the felt ring and dip the rubber ring in engine oil before fitting.**

The rear sealing ring is a rubber ring and is accessible after the flywheel has been removed.

1. Knock in one side of the sealing ring using a hammer and a narrow drift. The other side of the ring is pressed out and the ring can be removed using a screwdriver.
2. Clean the sealing ring's recess in the flywheel cover.
3. Apply sealing agent, e.g. Permatex, to the seal's outer edge, and grease the sealing lip. Place the sealing ring on special tool 6437 and knock it in to its position. (The tool positions the sealing ring somewhat deeper and therefore creates a new contact area against the crankshaft.)
4. Fit the flywheel together with a new locking washer. Tightening torque 170 Nm (17 kpm = 125 lbf.ft).

# LUBRICATING SYSTEM

## DESCRIPTION

### General

The engines are equipped with a force-feed lubrication system with oil filters of the full flow type and oil cooler.

TD70G, TID70G, and TAM70E are also fitted with piston cooling.

The oil pump is situated at the front of the oil sump and is driven by the crankshaft through an idler gear.

All the bearings and gudgeon pins as well as the valve mechanism and the auxiliary drive gear bearings are force-feed lubricated.

The auxiliary drive gears are intermittently lubricated from the idler gear bearing journal which is connected to the main oil gallery through oil drillings.

The fuel injection pump and turbocharger are force-feed lubricated. On the 70 series marine engines the drive for the alternator and coolant pump is also force-feed lubricated by a pipe. The air compressor, if fitted, is also connected to the engine's pressure lubricating system.

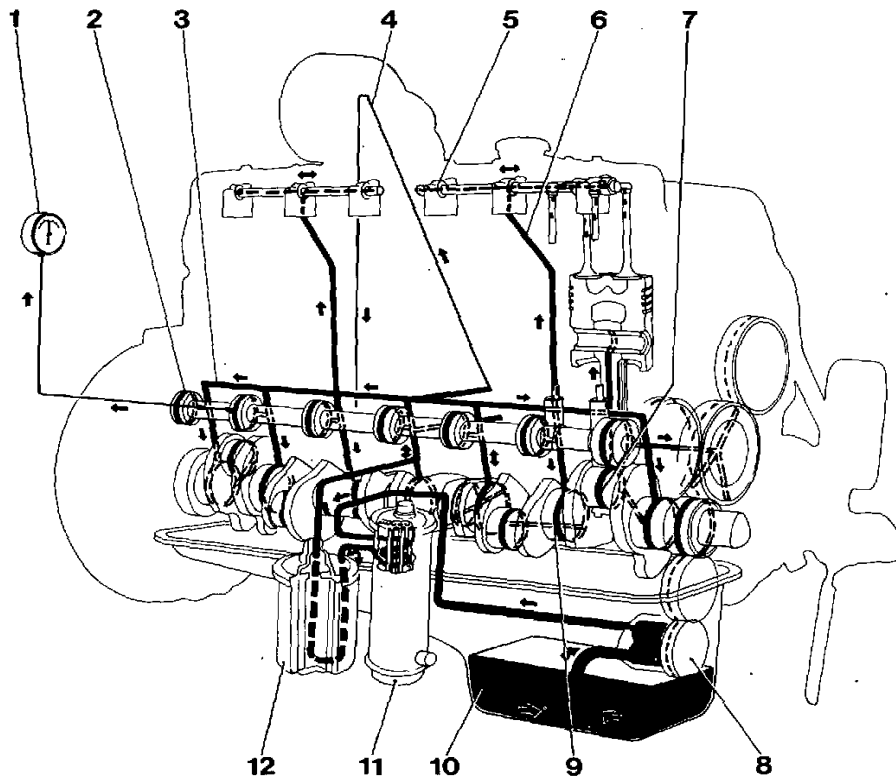


Fig. 94. Lubricating system

- |                                    |  |                  |
|------------------------------------|--|------------------|
| 1. Oil pressure gauge              | 5. Rocker arm mechanism                | 9. Main bearings |
| 2. Camshaft bearing                | 6. Oil drilling for rocker arm bearing | 10. Oil sump     |
| 3. Main oil supply line            | 7. Big-end bearings                    | 11. Oil cooler   |
| 4. Pressure oil line, turbocharger | 8. Oil pump                            | 12. Oil filter   |

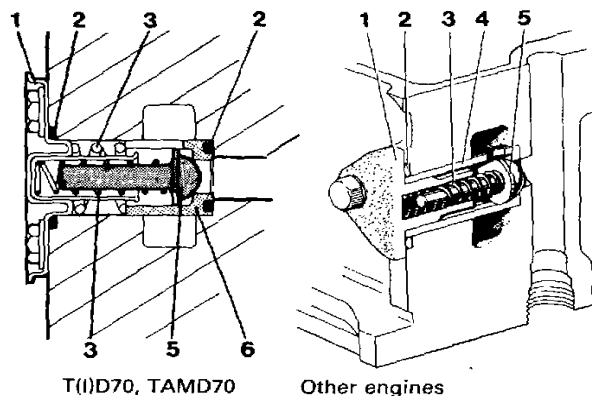


Fig. 95. Relief valve

- |           |                         |
|-----------|-------------------------|
| 1. Cover  | 4. Relief valve housing |
| 2. O-ring | 5. Valve peg            |
| 3. Spring | 6. Valve seat           |

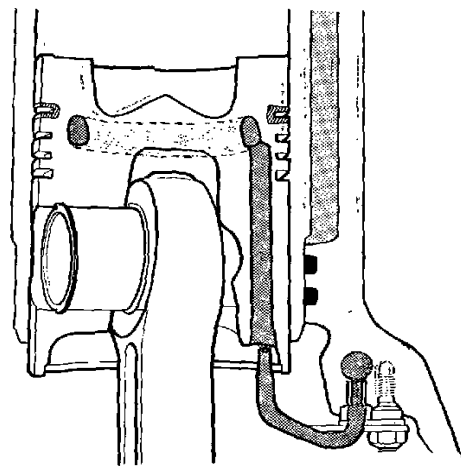


Fig. 96. Piston cooling

### Oil pump

The oil pump (fig. 105) is of the gear type. The pump sucks oil through the strainer and suction pipe to the suction side.

The lubricating oil strainer, which is a steel gauze strainer, prevents large particles which may be present in the oil, from entering the pump.

Oil is fed from the delivery side of the pump, through the lubricating oil filter (or filters) out to the drillings, passages etc. which comprise the lubricating system.

Engines fitted with a shallow oil sump for large inclinations have a somewhat different lubricating oil pump, fig. 108. The pump consists of two pairs of gears, where one pair comprises the oil pump (discharge pump) and the other pair the scavenging pump. The scavenging pump transport the oil from a separator plate under the crankshaft at the rear end of the oil sump to a container at the front of the sump, where the oil pump suction strainer is placed.

### Relief valve

The lubricating oil pressure is limited by a relief valve (fig. 95). The valve is placed in the lubricating system immediately before the oil filter (filters) and is fitted on the right hand side of the cylinder block under the lubricating oil filter (inside the rear oil filter when two are fitted). The valve opens at an excessively high lubricating oil pressure and feeds oil back to the sump.

For the 60 series and for (T)MD70 the valve is supplied as a complete unit.

### Piston cooling

The cooling function of the lubricating oil is used for TD70G, TID70G and TAM70E as the pistons are cooled by the oil.

This cooling gives a marked reduction of the piston temperature, which in turn helps to give longer life to piston rings and liners, less risk of carbon build-up on the cylinder surface and lower oil consumption.

From the oil pump, oil is supplied both via the lubricating oil filter to the various engine lubricating points and also via a spring-loaded valve (piston cooling valve) out to fixed nozzles, one for each cylinder. From the nozzles oil is injected up against the underside of the pistons, where the oil spray for each piston is guided into a drilling at the bottom of the piston when the piston is near the bottom dead centre, fig. 96. Through the drilling in the piston, the oil is injected up to a cooling channel in the piston upper section. After the oil has circulated round the top of the piston, it leaves through the drain channels carrying away heat.

### Piston cooling valve

The supply of oil to the piston cooling system is controlled by a piston cooling valve. The valve shuts off the oil supply at low engine speeds, allowing all the oil to be used for lubricating the engine when starting or running at low idle. The piston cooling valve also limits the oil pressure to the piston cooling at high speeds.

On engines with piston cooling the oil cooler is connected to the piston cooling system, and therefore the oil flow through the oil cooler is also regulated by the piston cooling valve on these engines.

The piston cooling valve is placed inside a cover in the cylinder block on the left side of the engine (directly below the injection pump throttle arm). An outlet is located above the cover, to which a pressure gauge can be connected to check the piston cooling oil pressure. See instructions on page 62. This connection is fitted with a threaded plug (fig. 103).

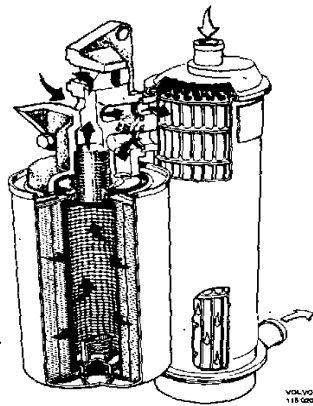


Fig. 97. Oil cooler and oil filter, T(I)D60

### Oil cooler

The lube oil carries away heat from the engine's most heated parts and evens out the temperature difference within the engine during its circulation. In the oil cooler the heat is removed from the lube oil.

TD70G, TID70G and TAMD70E have a cellular cooler for the lubricating oil, placed on the left-hand side of the engine under the injection pump, fig. 182. Coolant circulates inside the cooler assembly whilst the lubricating oil passes between the cellular plates. Other engines have a cooler of the tubular type, placed together with the oil filter(s) on the right hand side of the engine, fig. 97. The coolant passes through the longitudinal tubes whilst the lubricating oil circulates around the tubes.

On marine engines cooling is by means of sea water except on TAMD70E, which has the engine oil cooler connected to the fresh-water system.

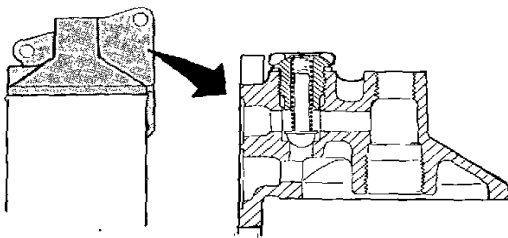


Fig. 98. Relief valve in filter bracket, T(I)D70G

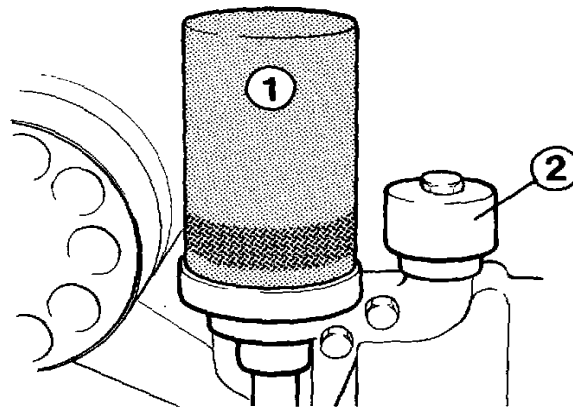


Fig. 99. Filter for crankcase ventilation

1. Filter 2. Pressure valve

### Oil filters

The oil filter(s) is(are) of the full-flow type, which means that all oil is filtered before reaching the bearing points. The oil for the piston cooling (TD70G, TID70G, TAMD70E) does, however, not pass through the filters. The filter consists of a housing (bracket) into which the filter cartridge is screwed. The housing is fitted at the right-hand side of the cylinder block.

The filter element consists of folded filter paper. The bottom of the filter contains (with the exception of the TD70G and TID70G filters) a built-in relief valve which opens and allows oil to flow past the filter should the filter become clogged. On the TD70G and TID70G the relief valve is located in the filter bracket, fig. 98. The filters are of the non-reusable type and should be discarded after use.

TAMD60, MD70 and TMD70 are fitted with double filters connected in parallel. Other engines have one filter.

### Crankcase ventilation

In order to prevent excess pressure and remove fuel fumes and water vapour and other gaseous combustion products the engine is fitted with a ventilation device, mounted on one of the inspection covers for the valve lifter housing.

On marine engines the crankcase gases pass through a replaceable paper filter which separates any oil mist before the gases are lead out. The filter holder also has a pressure valve which opens if the pressure in the crankcase becomes too high due to a clogged filter. The filter is placed in connection to the air filter.

The paper filter for crankcase ventilation is also available for industrial engines as optional equipment (fig. 100).

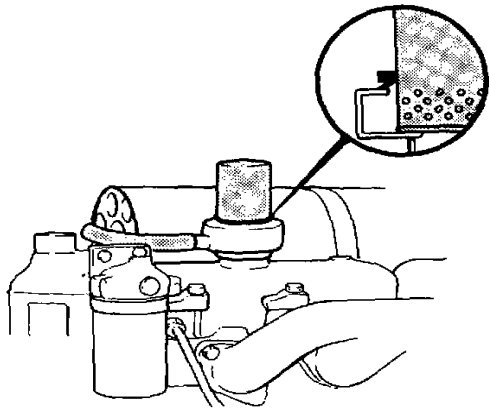


Fig. 100. Crankcase ventilation, industrial engines (optional equipment)

Industrial engines provided with a shallow oil sump for large inclinations are equipped with a special crankcase ventilation (fig. 101) to prevent oil from being thrown out through the crankcase ventilation in the event of extreme inclinations together with sudden side movements.

### Shallow oil sump

Engines which operate at particularly large inclination angles, can be fitted with a shallow oil sump, fig. 102. This is so designed that when the engine inclines backwards, oil is sucked up from a separating plate under the crankshaft by a scavenging pump and is conveyed to a container at the front of the sump where the suction strainer of the oil pump (discharge pump) is placed. The pump can therefore suck oil even when the engine is at a steep angle. The scavenging pump is integrally built with the ordinary oil pump (discharge pump) and is driven from the auxiliary drive gears.

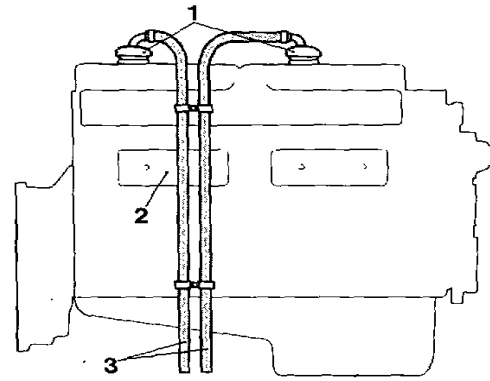


Fig. 101. Diagram of crankcase ventilation, engine with shallow oil sump for large inclinations

1. Comb. ventilation/oil filler caps
2. Inspection cover without connection for crankcase ventilation
3. Rubber hoses

## REPAIR INSTRUCTIONS

### Checking the oil pressure

Lubricating oil pressure can be checked by connecting up a pressure gauge with hose to the connection (thread size 1/8"-27 NPSF) for the oil pressure gauge sender. At operating speed and temperature, the oil pressure should be 300-500 kPa (3-5 kp/cm<sup>2</sup> = 42-71 p.s.i.).

If the oil pressure is too low at running speed, replace first of all the relief valve, after which the oil pressure should be re-checked.

If the oil pressure is too low at low speeds and with normal oil temperature on an engine with piston cooling, first replace the piston cooling valve. Check also that the end caps in the rocker arm shafts ends seal properly.

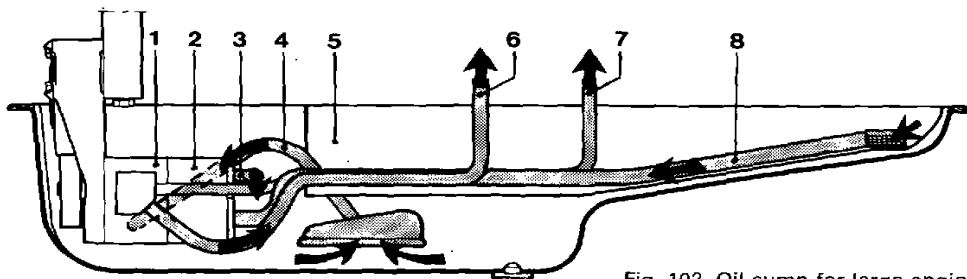


Fig. 102. Oil sump for large engine inclinations

- |                                      |   |
|--------------------------------------|---|
| 1. Oil pump for pressure oil         | 6. Pressure oil for lubricating system  |
| 2. Oil scavenging pump               | 7. Pressure oil to piston cooling<br>(applies to engines with piston cooling) |
| 3. Outlet for oil from sump rear end | 8. Scavenging pipe  |
| 4. Suction pipe                      |   |
| 5. Separator plate                   |   |

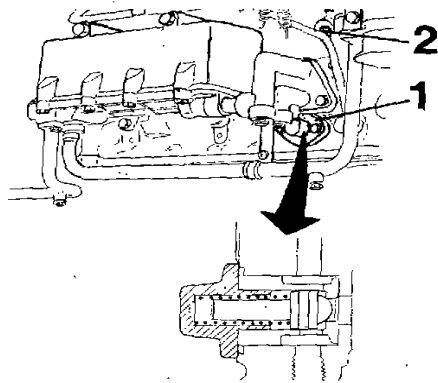


Fig. 103

1. Piston cooling valve      2. Plug

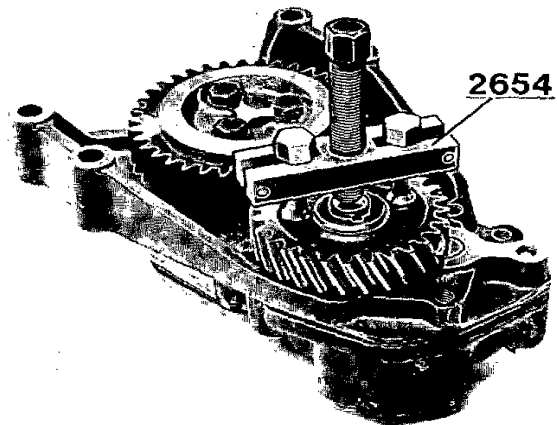


Fig. 104. Removing the drive gear

### Checking oil pressure to piston cooling (Applies to TD70G, TID70G, TAMD70E)

Remove the plug 2, fig. 103 in the cylinder block (use a 1/4" square wrench) and connect a pressure gauge (thread 1/4"-18 NPSF).

When the engine is warm and running the oil pressure in the piston cooling system should be 80–120 kPa (0.8–1.2 kp/cm<sup>2</sup> = 11.4–17.1 p.s.i.) at 2400 r.p.m.

**NOTE!** At speeds below 700–800 r.p.m. the piston cooling valve should be closed in order to ensure sufficient lubrication for the engine when starting and operating at low speeds.

### Oil pump

#### Removing the oil pump

1. Drain or suck out the engine oil.
2. **MD70, TMD70 with deep oil sump:** Remove the oil sump inspection covers and unscrew the oil pump suction strainer from the bottom of the sump.  
**Other engines:** Remove the oil sump.
3. Disconnect and remove the oil pipes between pump and strainer and between pump and cylinder block.
4. Unscrew the front main bearing cap bolts and remove the cap together with oil pump. Unscrew the oil pump from the cap.

### Disassembling the oil pump

*Special tool: 2654*

When disassembling, be careful not to damage the polished surfaces.

1. Pull off the drive gear with puller 2654 (fig. 104). Remove the key and the axial washer (5, fig. 105) from the shaft.
2. Remove the idler gear (11). The gear is held in position by three bolts and journalled on a bearing sleeve.
3. Unscrew the attaching bolts for the pump housing (17) and remove the housing.  
If the pump housing remains in position it can be pressed out by using two 5/16" bolts.
4. Press out the drive shaft with pump gear.
5. Remove the idler gear (18) from the housing. Press out the shaft (1) if it has to be replaced.

### Inspecting the oil pump

Clean all parts carefully. Check the housing for scoring and wear and also check the seal between the bracket and the pump housing. The surfaces are black if leakage has occurred. There must be no scoring due to wear. Minor defects can be rectified by using emery cloth. The bushings in the pump housing and bracket must be replaced if the radial clearance between the shaft and the bushing has reached 0.15 mm (0.006") or more.

Ream the new bushings to a close running fit (16.016–16.034 mm = 0.6305–0.6313"). Before reaming, bolt the housing and bracket together so that they are centered by the guide sleeves (19, fig. 105).

In the case of an excessively large radial clearance (more than 0.20 mm = 0.008") between the idler gear and bearing sleeve, the idler gear complete with bushing must be replaced.

Check the pump gears for wear on the tooth flanks, external diameter and end faces.

Check the axial clearance (0.07–0.15 mm = 0.0028–0.0059") fig. 106 and gear backlash (0.15–0.35 mm = 0.0059–0.0138") fig. 107.

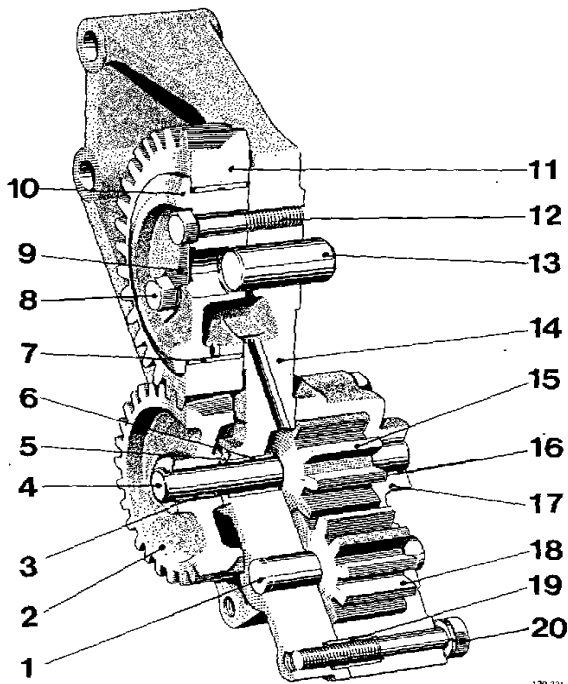


Fig. 105. Lubricating oil pump

1. Journal
2. Drive gear
3. Key
4. Drive spindle
5. Axial washer
6. Bushing
7. Bushing
8. Attaching bolt
9. Lock washer
10. Bearing sleeve
11. Idler gear
12. Attaching bolt
13. Guide pin
14. Bracket
15. Pump gear (driving)
16. Bushing
17. Pump housing
18. Driven pump gear (idler gear)
19. Guide sleeve
20. Attaching bolt

### Assembling the oil pump

1. If the bushings for the drive gear have been removed, press in new bushings and ream them to 16.016–16.034 mm (0.6305–0.6313”).
2. Press in the idler gear shaft if it has been removed.
3. Fit the drive spindle (4, fig. 105) with its gear in the bracket.
4. Fit the axial washer (5) on the shaft journal (a new axial washer is included in the repair kit). Fit the key and press on the outer drive gear.

NOTE! There must be a clearance of 0.02–0.08 mm (0.0008–0.0032”) between the axial washer and gear. A feeler gauge of 0.05 mm (0.0020”) should be inserted in the clearance when assembling.

5. Fit the idler gear (18) and the pump housing. Tighten the pump housing at the bracket. Check that the pump can be easily turned round by hand.
6. Fit the idler gear and tighten the bearing sleeve. Lock the bolts with the lock washer.

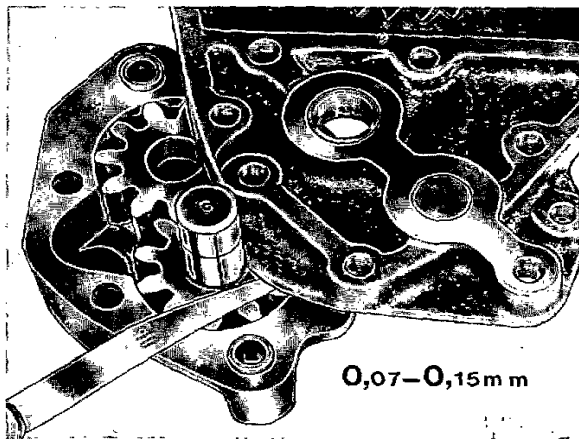


Fig. 106. Checking the axial clearance.

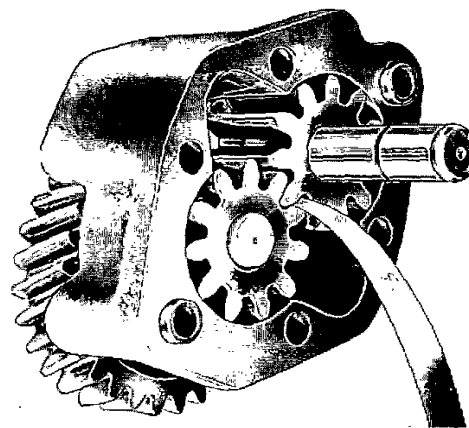


Fig. 107. Checking the backlash.

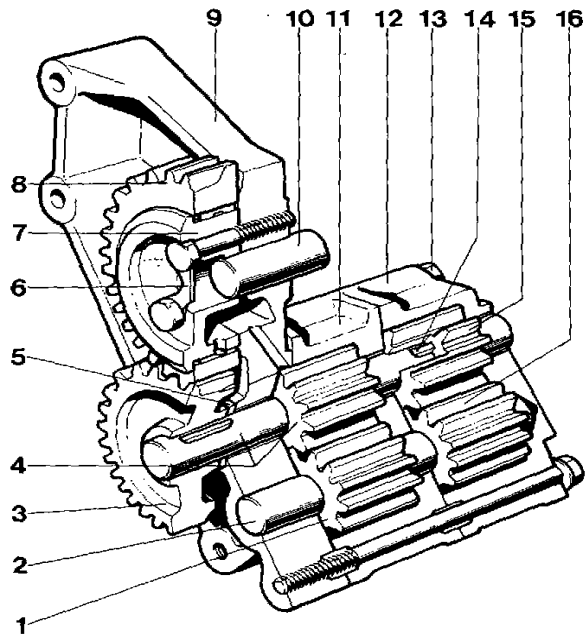


Fig. 108. Lubricating oil pump. Engines with shallow sump for large inclinations.

1. Discharge pump idler gear
2. Idler gear shaft
3. Drive gear
4. Discharge pump gear with shaft, driving
5. Axial washer
6. Lock washer
7. Bearing sleeve
8. Idler gear
9. Bracket
10. Guide pin
11. Discharge pump housing
12. Scavenging pump housing
13. Attaching bolt
14. Key
15. Scavenging pump gear, driving
16. Scavenging pump idler gear

### Disassembling the oil pump

(applies to engines with shallow oil sump for large inclinations)

*Special tool: 2654*

When disassembling be careful not to damage the polished surfaces.

1. **TD70G, TID70G, TAMD70E:** Remove the distribution housing on the side of the pump.
2. Remove the idler gear (8, fig. 108). The gear is held in position by three bolts and is journaled on a bearing sleeve.
3. Pull off the drive gear (3) with puller 2654 (fig. 104). Remove the key and the axial washer (5, fig. 108) from the shaft.
4. Remove the attaching bolts (13) holding the pump housings. Remove the bracket (9), the idler gear shaft (2) will accompany it. If the pump housing remains in position at the bracket, it can be pressed out using two 5/16" bolts.
5. Remove the discharge pump idler gear (1). Press out the shaft (2) if it has to be replaced.
6. Remove the scavenging pump housing (12) by prising with a chisel, in the machined grooves between the discharge and scavenging pump. Remove the scavenging pump idler gear (16).
7. Place some kind of support under the front end of the discharge pump and press the shaft out with the discharge pump drive gear (4) about 2.5 mm (0.1"). **NOTE!** If the shaft is pressed further, the key (14) will go against the pump housing.
8. Press back the shaft so that there is a gap at the scavenging pump drive gear. Pull off the gear. Remove the key and polish off any burr.
9. Remove the drive shaft with the discharge pump drive gear. This gear is fixed on the shaft and cannot be removed.

### Inspecting the oil pump

See page 62.

### Assembling the oil pump

(applies to engines with shallow sump for large inclinations)

1. If the bushings for the drive gear have been removed, press in new bushings and ream them to 16.016–16.034 mm (0.6305–0.6313").
2. Press in the idler gear shaft if it has been removed.
3. Fit the drive spindle with its gear in the bracket.
4. Place the axial washer (5, fig. 108) on the shaft journal. Fit the key and press on the outer drive gear (3). **NOTE!** There must be a clearance of 0.02–0.08 mm (0.0008–0.0032") between the axial washer and gear. A feeler gauge of 0.05 mm (0.002") should be inserted in the clearance when assembling.
5. Fit the idler gear (1) and the discharge pump housing.
6. Fit the key for the scavenging pump gear (15) and press on the gear. **NOTE!** In order to obtain the correct clearance between the drive gear (15) and the discharge pump housing (11), a feeler gauge of 0.05 mm (0.002") should be inserted in the clearance when assembling.
7. Fit the idler gear (16) and the scavenging pump housing. Tighten the pump housings at the bracket. Check that the pump can be easily turned round by hand.
8. Fit the idler gear and tighten the bearing sleeve. Lock the bolts with the lock washer.
9. **TD70G, TID70G, TAMD70E:** Fit the distribution housing on the pump side. Use a new O-ring.

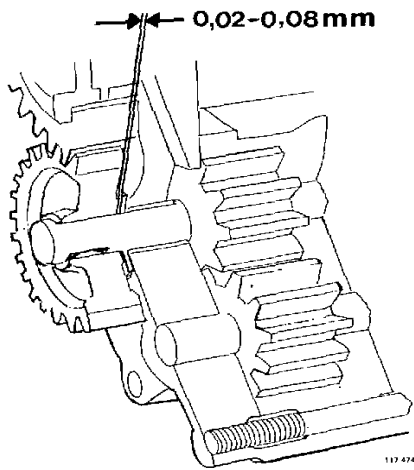


Fig. 109. Axial clearance, drive for oil pump

### Fitting the oil pump

1. Place the main bearing bolts in the bearing cap and bolt the oil pump to the main bearing cap. **NOTE!** Use new lock washers (60 series), and a new splash protection plate (70 series and TD60, TID60 with shallow oil sump for large inclinations). Lock the bolts by bending over the corners of the plate.

2. Clean the bearing shell and journal. Oil in the bearing shell and fit the bearing cap. Tightening torque 140 Nm (14 kpm = 103 lbf.ft).

3. Connect the oil pipes to the pump and cylinder block. Use new O-rings. **NOTE!** The pipe connections shall be fitted as follows:

Dip the entire connection in oil and screw it in by hand until it bottoms. Mark one of the hexagonal edges on the connection and make a corresponding mark on the block or pump with a coloured pencil (fig. 110). Knock in the pipe until it stops and tighten the connection 120° (2 hexagonal edges). Check that the pipe is firmly attached.

4. Fit the splash plate where applicable. Clamp the pipes and bolt the suction pipe with strainer. Use a new O-ring.
5. **MD70, TMD70 with deep sump:** Bolt the oil pump suction strainer in the bottom of the sump. Fit the inspection covers.



Fig. 110

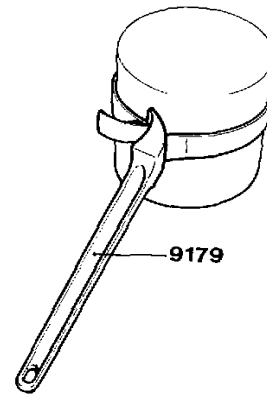


Fig. 111. Removing oil filter

**Other engines:** Glue on a new gasket for the oil sump. Use sealing compound such as Permatex on the joints. **NOTE!** Turn the gasket right so that all bolt holes in sump and gasket coincide. Fit the oil sump.

6. Fill up the engine with oil.

### Replacing the oil filters

**Special tool: 9179**

1. Unscrew the oil filters and discard them. Use tool 9179.
2. Oil in the rubber seals on the new filters and check their contact faces on the bracket.
3. Screw on the new filters by hand until the seal contacts the sealing face. Then tighten the filters another half turn but not more.
4. If necessary top up the engine with oil and start it. Check for leakage.
5. Stop the engine and check the oil level.

### Oil drillings

In connection with major engine overhauls the oil drillings in the cylinder block must be cleaned and flushed through with cleaning agent and then with steam or with flushing oil under pressure 300-400 kPa (3-4 kp/cm<sup>2</sup> = 42-57 p.s.i.).

The drilled oil passages in the cylinder block, crankshaft and connecting rods must be brushed clean by using special brushes.

# FUEL SYSTEM

## DESCRIPTION

### General

Fuel is sucked by the feed pump from the fuel tank and then pumped through fine filters to the injection pump. Surplus fuel is returned via the relief valve, placed on the injection pump. The injection pump then pumps at high pressure through the delivery pipes to the injectors an amount of fuel corresponding to the output developed. The injectors atomise the high-pressure fuel into the engine combustion chambers. Return fuel from the injectors is conveyed through the fuel leak-off line via the relief valve and return line back to the tank.

### Injection pump

The injection pump is placed on the left-hand side of the engine and is driven from the auxiliary drive gears. On the 60-series the pump is flange mounted.

The pump is of the piston type and operates with a constant stroke. A control rod can rotate the pump plungers during running and thereby control the amount of fuel injected by the pump. The injection pump is provided with a centrifugal governor.

The injection pump is force-feed lubricated by the engine oil system.

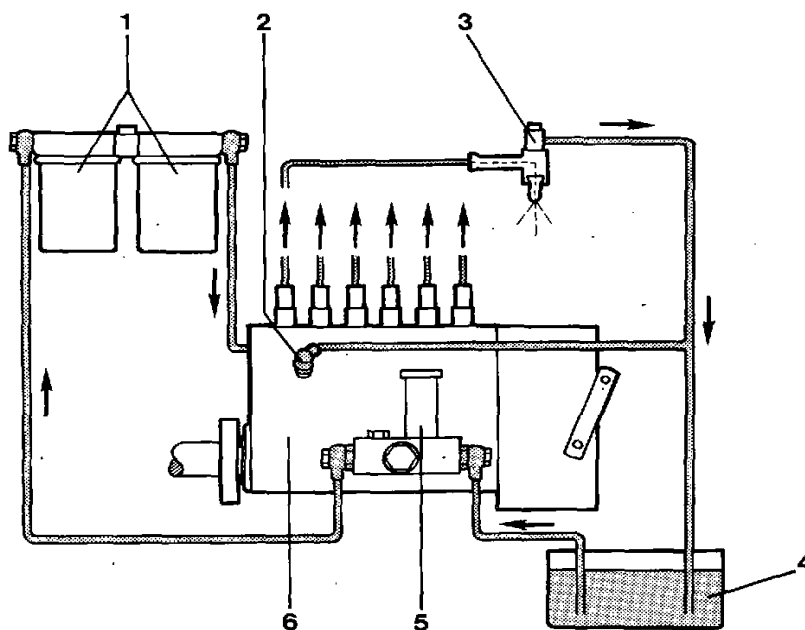


Fig. 112. Fuel system, diagram

1. Fuel fine filters
2. Relief valve
3. Injector
4. Fuel tank
5. Feed pump
6. Injection pump

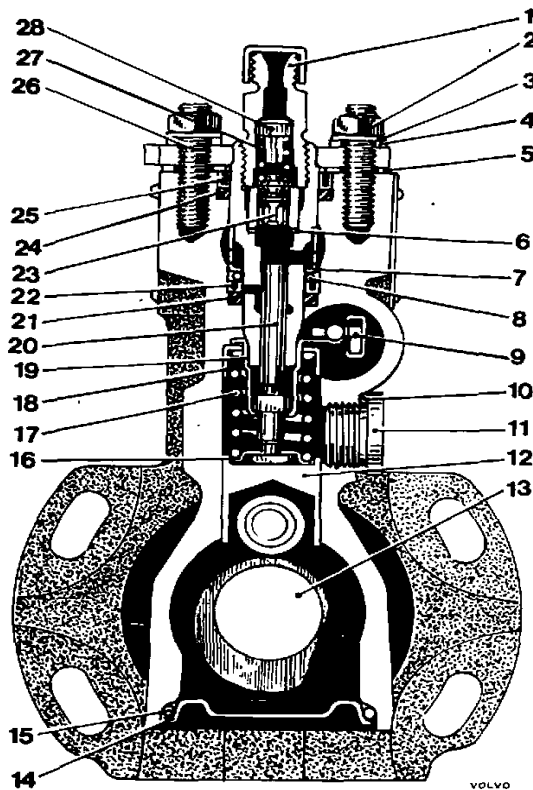


Fig. 113. Injection pump, 60 series (cross section)

1. Pressure valve holder
2. Fixing nut for element unit
3. Spring washer
4. Flat washer
5. Adjuster plate for stroke position
6. Sealing washer
7. Relief sleeve
8. Lock ring
9. Control rod
10. Gasket
11. Plug for checking stroke position
12. Lifter
13. Pump camshaft
14. Bottom cover
15. Gasket
16. Lower spring disc
17. Piston spring
18. Piston spring disc
19. Control sleeve
20. Pump element
21. O-ring
22. Spacer ring
23. Pressure valve with valve seat
24. O-ring
25. Spacer ring
26. Stud bolt for element unit
27. Pressure valve spring
28. Filler plug

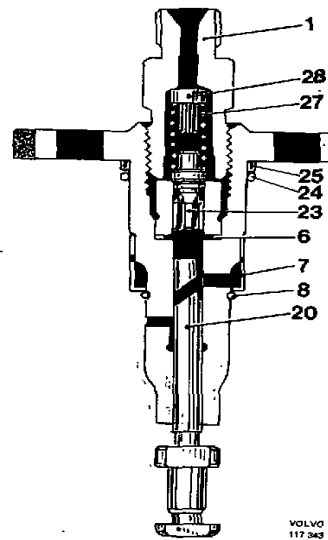


Fig. 114. Element unit, 60 series  
(See pos. explanations fig. 113)

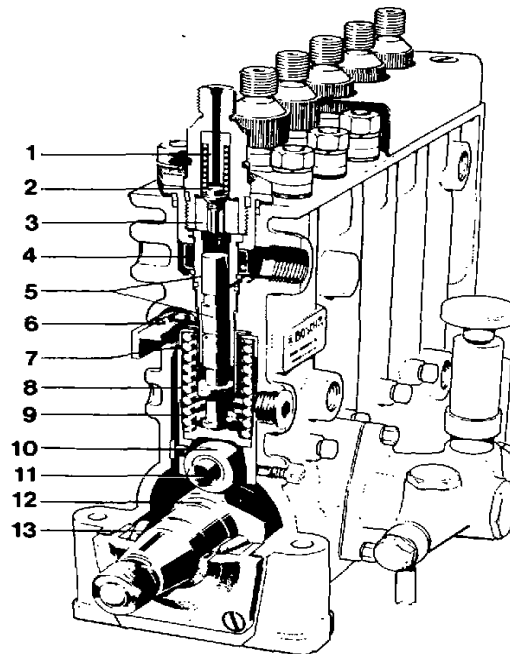


Fig. 115. Injection pump, 70 series

- |                        |                      |
|------------------------|----------------------|
| 1. Filler plug         | 8. Guide pin groove  |
| 2. Pressure valve      | 9. Lower spring disc |
| 3. Pressure valve seat | 10. Lifter           |
| 4. Damping plate       | 11. Lifter pin       |
| 5. Pump element        | 12. Camshaft         |
| 6. Control rod         | 13. Roller bearing   |
| 7. Upper spring disc   |                      |

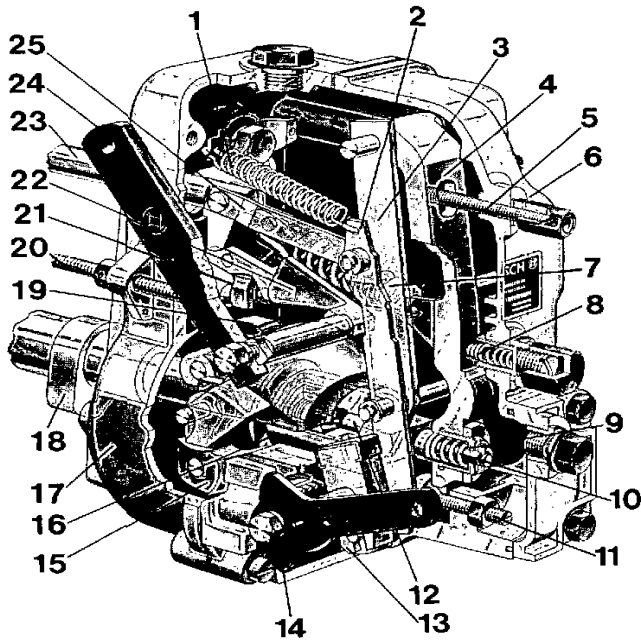


Fig. 116. Centrifugal governor, RSV

1. Starting spring
2. Governor lever
3. Guide lever
4. Tensioning lever
5. Idle stop screw
6. Governor cover
7. Governor spring
8. Auxiliary idle-speed spring
9. Shims
10. Compensating spring speed stabilizer
11. Full load stop (max. delivery)
12. Pre-setting pin on guide lever
13. Stop device
14. Stop lever
15. Flyweight
16. Sliding sleeve
17. Governor housing
18. Cam in injection pump
19. Hub
20. Stop screw for max. speed
21. Rocker arm
22. Swivelling lever
23. Control rod
24. Speed control lever (speed setting)
25. Link rod

### Centrifugal governor

The governors are mechanical and work by means of speed-sensing governor flyweights. The speed is regulated throughout the entire speed range of the engine, from low idling to high idling (variable speed type).

Fig. 117. Centrifugal governor, RQV

1. Pivot lug
2. Guide screw
3. Lock ring
4. Stud (joint coupling)
5. Plug
6. Shaft
7. Link arm
8. Pin
9. Curve plate
10. Sliding piece
11. Speed control lever
12. Governor lever
13. Cover
14. Link rod
15. Adjuster nut
16. Spring disc
17. Governor spring
18. Flyweight
19. Angle lever
20. Lock washer
21. Guide shaft
22. Housing

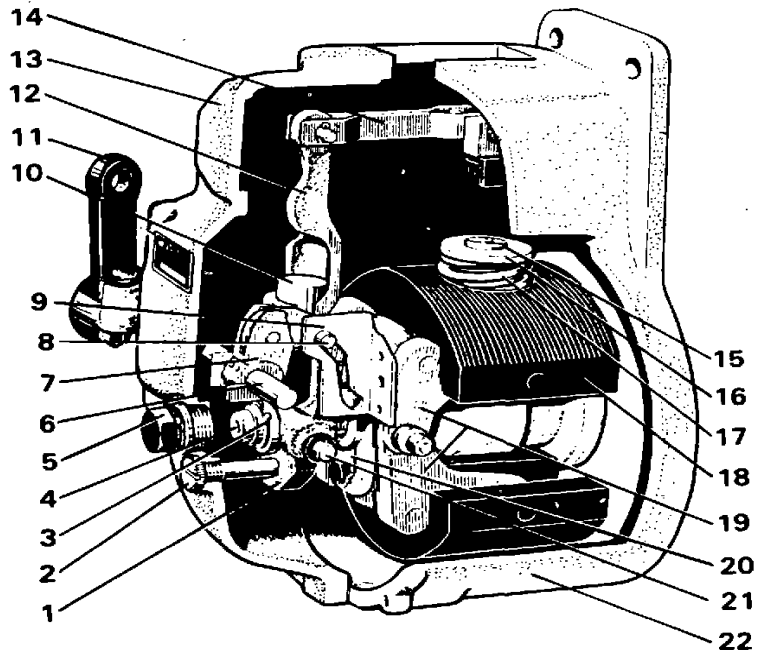
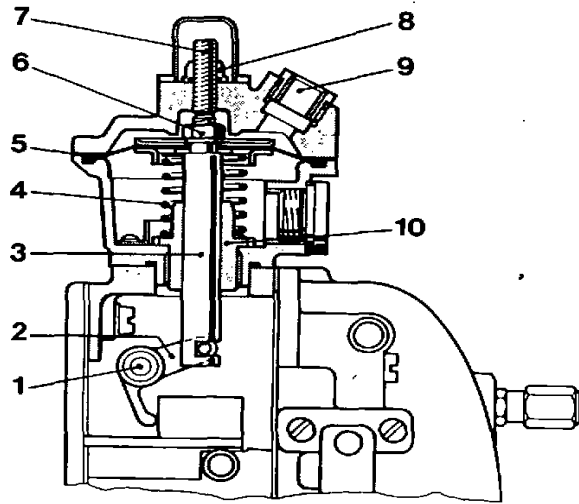


Fig. 118. Pressure-dependent full-load stop (60 series)

1. Cold start shaft
2. Angle lever
3. Diaphragm rod
4. Thrust spring
5. Diaphragm
6. Nut
7. Adjusting screw
8. Lock nut
9. Connection for pressure line
10. Adjusting nut



### Pressure-dependent full-load stop (smoke limiter)

On TD60D and TD70G with RQV governor, and on TAMD60C and TAMD70E a pressure-dependent full-load stop (smoke limiter) is fitted. On TD60D and TAMD60C it is located on the centrifugal governor at the rear end of the injection pump (fig. 118). On other engines it is located at the front of the injection pump (fig. 121). Its function is to prevent exhaust smoke during fast acceleration from low speed by limiting the control rod stroke (fuel quantity), until the turbocharger gets sufficient amount of exhaust to give full air quantity.

When pressure conditions alter in the inlet manifold the diaphragm 3, fig. 121, is actuated. The diaphragm movement is transmitted via a link system to the angle lever (10), at the bottom section of which the adjusting screw for low max. quantity (9) is located. This screw limits the movement of the control rod at low charging pressure, fig. 119, "A". At high charging pressure the other end of the screw moves against the stop bolt (11) for high max. quantity, fig. 120, "B".

Pressure-dependent full-load stop is also fitted on the MD70C and TMD70C engines. In these cases it only acts as a cold-start device (the diaphragm pressure line is plugged).

Figure text, figs. 119 and 120  
Operation, pressure-dependent full-load stop (70 series)

- A. Low charging pressure, small full-load quantity.
- B. High charging pressure, large full-load quantity.

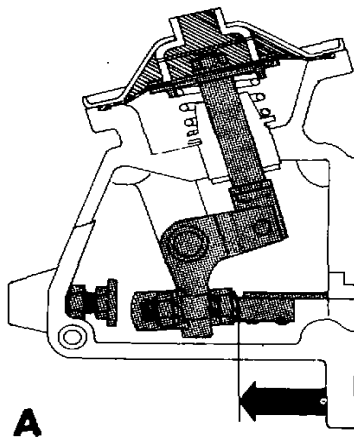


Fig. 119

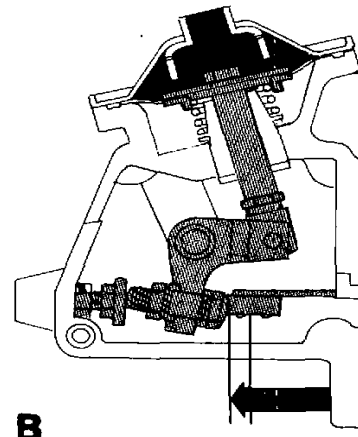


Fig. 120

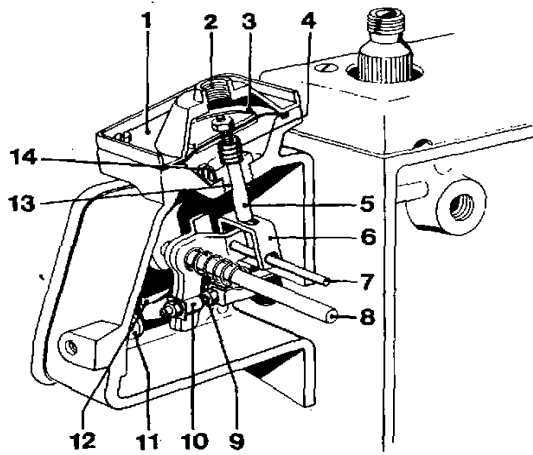


Fig. 121. Pressure-dependent full-load stop (70 series)

1. Cover
2. Connection for pressure line
3. Diaphragm
4. Diaphragm spring
5. Diaphragm rod
6. Yoke
7. Pin
8. Centre spindle
9. Adjusting screw for low max. quantity
10. Angle lever
11. Stop bolt for high max. quantity (on engines with RSV governor the stop screw on governor 11, fig. 116 should be used)
12. Leaf spring (not on engines with RSV governor)
13. Adjuster bushing for breaker points
14. Leaf spring

### Cold-starting

On TD60D with RQV-governor and on TAMD60C the cold-start device is located in the centrifugal governor (under the pressure-dependent full-load stop) at the rear end of the injection pump (fig. 118). On engines of the 70 series with pressure dependent full-load stop the cold-start device is combined with this (fig. 121). Engagement takes place when the centre spindle (1, fig. 118 or 8, fig. 121) is drawn out after setting the key switch in running position and the control lever in max. position. The control rod travel is thereby increased, this resulting in more fuel being supplied. TD70G with RQV-governor can also be fitted with a cold-start device with electro-magnetic engagement as optional equipment.

On other engines the control rod is automatically pushed forward in the cold-start position by a spring in the centrifugal governor when the throttle arm is set to max. during starting.

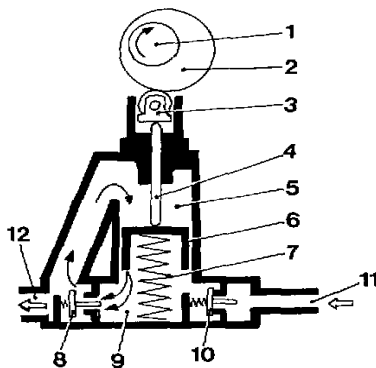
### Feed pump

Fuel must be supplied at a certain pressure if the injection pump is to function. This function is performed by the feed pump, which is of piston type.

The pump shaft eccentric presses down the feed pump plunger by means of the lifter roller (3, fig. 122) and the plunger rod (4). Thus a predetermined quantity of fuel is transferred from the suction chamber to the delivery chamber via the non-return valve on the delivery side and the plunger spring is compressed (intermediate-stroke).

The plunger rod, lifter roller and plunger lie freely against each other. After the eccentric cam has performed its stroke, the plunger, plunger rod and lifter follow upwards due to the pressure of the plunger spring. A quantity of fuel from the delivery chamber is thereby pumped through the filter to the injection pump (pumpstroke). At the same time fuel is sucked from the fuel tank through the non-return valve on the suction side to the suction chamber.

In this way the feed pump delivers nearly all the required quantity of fuel to the injection pump during its pumpstroke. A small quantity, equivalent to the volume of the plunger rod in the delivery chamber is delivered during the intermediate stroke.



Pump and suction stroke Fig. 122. Feed pump

1. Pump camshaft
2. Cam
3. Lifter roller
4. Plunger rod
5. Delivery chamber
6. Plunger
7. Plunger spring
8. Non-return valve (delivery side)
9. Suction chamber
10. Non-return valve (suction side)
11. Inlet
12. Outlet



Fig. 127. Flywheel setting

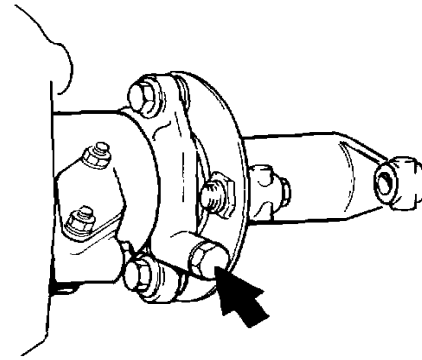


Fig. 128. Clamp bolt in pump coupling, 70 series

6. Fit the lube oil pipe and the fuel pipe between the inner side of the pump (towards the cylinder block) and the fuel filter/filters. Fit the pressure pipes. Make sure that they are fitted correctly and tighten the nuts. Tightening torque 15–25 Nm (1.5–2.5 kpm/11–18 lbf.ft). Where applicable connect the pressure pipe to the pressure-dependent full-load stop (smoke limiter).
7. Connect the controls. Fit the rev. counter sender on the auxiliary gear cover.
8. Fit the intermediate piece, lock washer and bolts for the pump drive (fig. 125). Tighten the bolts a little so that only the pump can be rotated. Make sure that the correct bolt length is used.
9. Remove the socket-head plug with washer (fig. 129), so that the No. 1 lifter is seen. (Allen key 8 mm = 5/16").  
Make sure that the lifter is in its lowest position (fig. 131).
10. Adjust the setting of the injection pump. Carry out the instructions in points 8, 9 and 10 under the heading "Setting the injection angle" on page 74.
11. Rotate the pump shaft with a socket wrench (27 mm = 1 1/16") in the normal direction of rotation (clockwise) until the lift from the base circle (stroke position) mentioned in "Technical Data" is reached on the dial indicator. Tighten the bolts in the pump drive (fig. 125).
12. Check the setting. Carry out instructions under points 7, 10, 11, 12 and 20 to and incl. 25 under the heading "Setting the injection angle" on pages 74 and 75.
13. **TAMD60C:** Fit the protector plate over the exhaust manifold.

#### 70 series

1. Remove the front valve cover. Remove the rubber plug from the inspection hole in the flywheel casing.

2. Turn over the engine in the correct direction of rotation until both valves for the No. 1 cylinder are closed (compression stroke).
3. Continue turning over the engine until the graduation mark on the flywheel (see "Technical Data") is seen opposite the pointer on the flywheel housing (fig. 127).
4. Rotate the pump shaft so that the line-up mark on the shaft flange coincides with the line-up mark on the pump end adjusting plate (fig. 126), or is placed right against the adjusting plate if line-up mark is missing (new pump).
5. Release the clamp bolt (fig. 128) and push the coupling forward on the shaft. Fit the injection pump on the bracket and tighten up. Check that the pump shaft adjustment is not altered.
6. Push back the pump coupling on the drive shaft and join together the coupling intermediate part with the pump flange. Make sure that the dished washers are placed between the rear flange of the coupling and the steel discs. Tighten up the bolts (fig. 126). **NOTE! The nuts must be kept steady** in order not to damage the steel discs.
7. Lock the front flange on the drive shaft by tightening the clamp bolt (fig. 128). Check that the steel discs are flat and are not distorted axially.
8. Fit the oil return pipe between the injection pump and the cylinder block (the thickest oil pipe).
9. Fit the pressure pipes. Make sure that they are fitted straight and tighten the nuts. Tightening torque 15–25 Nm (1.5–2.5 kpm/11–18 lbf.ft). Where applicable connect the pressure pipe to the pressure-dependent full-load stop (smoke limiter). Connect the controls.
10. Check the injection pump setting. Carry out points 4, 6–12, and 20–25 under the heading "Setting the injection angle" on pages 74 and 75.

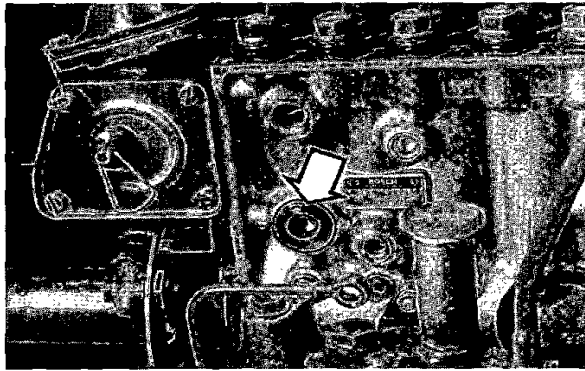


Fig. 129. Socket-head plug

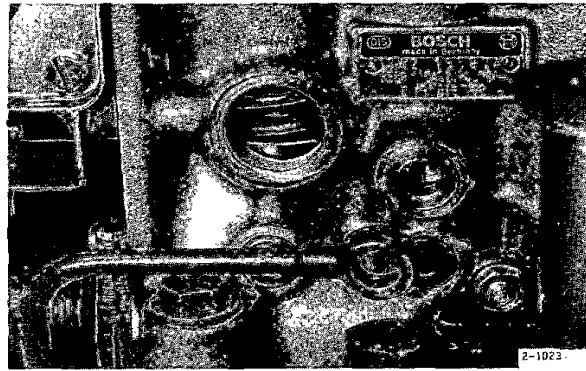


Fig. 131. Lifter in its lowest position

### Setting the injection angle

*Special tool: 6770 together with dial indicator\*, e.g. 998 9876*

\* Measuring field 0.01–20 mm (0.0004–0.8").

**Clean the injection pump before work is commenced.**

1. Close the fuel cocks. Remove the fuel pipe between the feed pump and the fuel filters' cover.
2. Remove the leak-off fuel pipe between the injectors and the relief valve. Remove the return pipe. Remove the relief valve.
3. **70 series:** Disconnect the lube oil pipe at the front of the injection pump and bend it out a few cm (abt. 1"). Remove the protector plate over the pump coupling.
4. Remove the socket-head plug with washer (fig. 129), so that the No. 1 lifter is seen. (Allen key 8 mm (5/16"), 60 series and 12 mm (15/32"), 70 series).
5. Remove the front valve cover. Remove the rubber plug from the inspection hole in the flywheel casing.
6. Turn over the engine in the correct direction of rotation until both valves for cylinder No. 1 are closed (compression stroke). Continue turning over the en-

gine until the indicator point in the flywheel casing points at 0°.

7. Turn the engine back against the direction of rotation abt. 1/4 turn. Check that the lifter is in its lowest position (fig. 131).
8. Fit the screw socket to the tool 6770 on the injection pump (fig. 132). **NOTE! Without washer.** (The socket with inner quadrangular form fits the 60 series and the socket with outer hexagonal form fits the 70 series).
9. Fit the fixture together with the dial indicator and the measuring point on the screw socket (fig. 133). Turn the measuring point according to fig. 134 and lift it up so that it rests against the lifter.
10. Set the dial indicator to zero.
11. Turn over the engine in the correct direction of rotation.
12. Continue turning over the engine in the direction of rotation until the stated lift from the base diameter (stroke position) is reached on the dial indicator. Read off the graduation mark on the flywheel and compare with the value given in "Technical Data".

**Note!** Make sure that the zero setting of the dial indicator remains, when starting to turn.

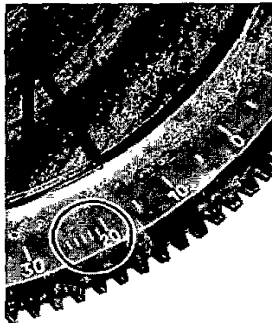


Fig. 130. Graduation mark on flywheel

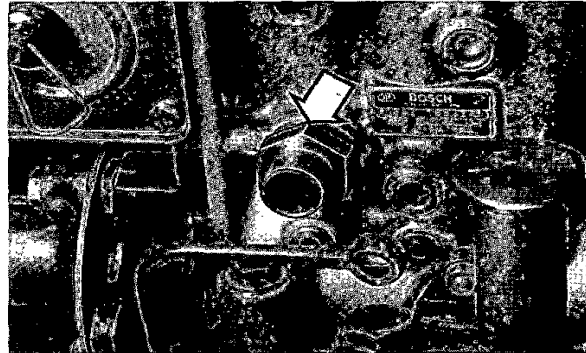


Fig. 132. Fitting of screw socket to tool 6770

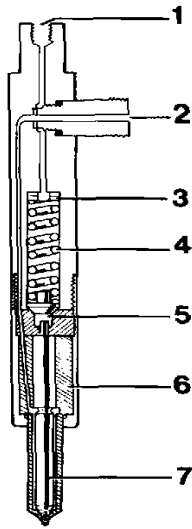


Fig. 123. Injector, KBEL

1. Leak-off pipe connection
2. Delivery pipe connection
3. Shims to adjust opening pressure
4. Thrust spring
5. Thrust pin
6. Nozzle sleeve
7. Nozzle needle

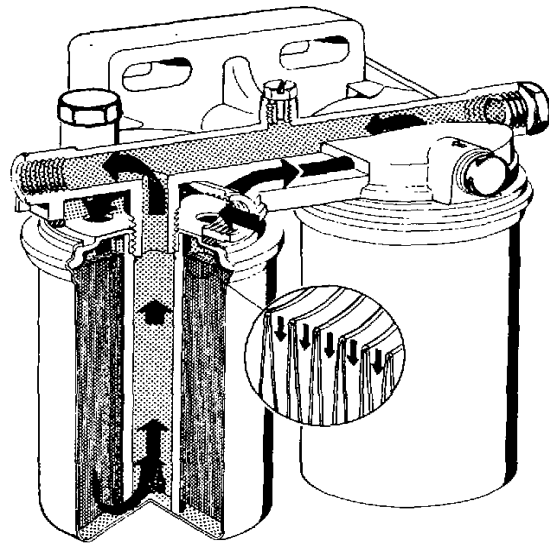


Fig. 124. Fuel filter

If the pressure in the fuel pipe exceeds a certain value, the plunger spring pushes the plunger upwards for only part of its stroke. The fuel quantity delivered per stroke is thus correspondingly less. The greater the pressure in the fuel pipe the less the quantity of fuel delivered.

The hand primer pump is placed above the inlet valve. Using the hand primer pump fuel can be pumped to the filter and injection pump when the engine is stationary.

### Relief valve

The purpose of the relief valve is to limit the feed pressure and to provide continuous venting of the fuel system. When the feed pressure is too high the valve opens and fuel passes through the return pipe back to the tank.

The relief valve is situated on the injection pump. This means that the return fuel flushes the injection pump before it is fed back to the tank. The fuel flow thereby cools the fuel in the pump fuel chamber, at the same time as the temperature, and thus the viscosity of the fuel in the fuel chamber is equalized. The quantities of fuel delivered to each cylinder is, in this way, more evenly distributed.

### Injectors

Each injector consists mainly off a nozzle holder and a nozzle (jet).

When the fuel pressure reaches the set value (opening pressure) the nozzle needle (7, fig. 123), which is pressed against its seat by a thrust spring (4), lifts and finely atomized fuel is injected into the engine through accurately calibrated holes in the nozzle sleeve.

The pressure of the thrust spring, which determines the opening pressure of the injector is adjusted by means of shims (3).

### Fuel filters

The fuel system is fitted with two fuel filters which are connected in parallel and have the same cover, except for TD60 and TID60 that have one filter. The fuel filters are of the disposable type and the filter element of a spiral-wound paper filter. Fig. 124 shows the path of the fuel through the filters.

Classifiable engines are equipped with a special type of filter which makes it possible to change the filter inserts and venting without having to stop the engine (fig. 146).

### Air filter

The air filter is of the dry type and are disposable with a filter element of folded paper. Industrial engines are fitted with a pressure drop indicator which shows red when the filter is clogged and needs replacing (fig. 159).

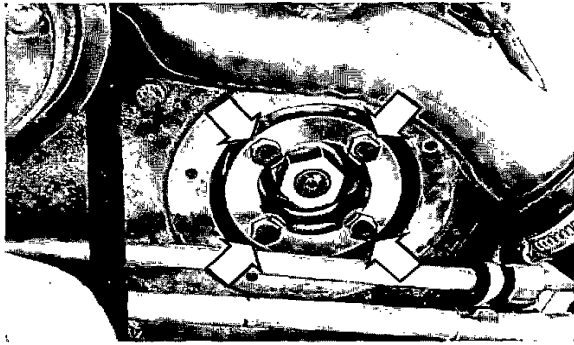


Fig. 125. Pump drive (60 series)

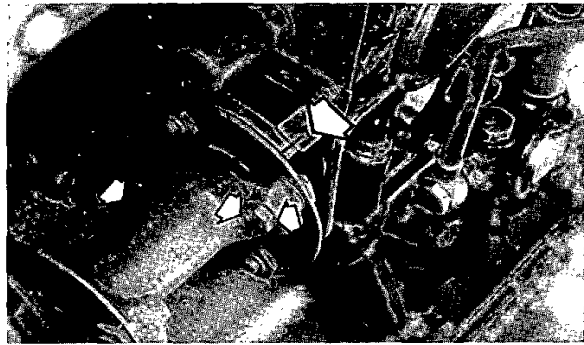


Fig. 126. Pump coupling, 70 series (protector plate removed)

## REPAIR INSTRUCTIONS

Always observe the greatest cleanliness when carrying out work on the fuel system.

### Injection pump

#### Removing the injection pump

**NOTE!** Repair work which requires disassembling the injection pump which can alter its settings may only be carried out by specially trained mechanics who have at their disposal the necessary tools and test devices.

All warranty on the engine becomes null and void if the seals are broken by an unauthorized person.

1. Wash the injection pump, pipe lines and the parts of the engine nearest to the pump very thoroughly.
2. **TAMD60:** Remove the protector plate over the exhaust manifold.
3. Close the fuel cocks and disconnect the delivery pipes as well as the other lines and the controls for the pump. **Fit protective caps on all connections.**
4. **60 series:** Remove the cover from the auxiliary gear cover, right in front of the injection pump. Turn up the lock washer flanges and unscrew the bolts attaching the intermediate piece to the pump drive. Remove the intermediate piece.
5. **60 series:** Remove the rev. counter sender from the auxiliary gear cover. Remove the pump attaching nuts at the rear edge of the auxiliary gear cover and lift out the pump.
6. **70 series:** Remove the guard plate over the pump coupling and unscrew the bolts (fig. 126) on the pump coupling. **NOTE!** The nuts must be held steady in order not to damage the steel discs.

7. **70 series:** Unscrew the pump attaching bolts and lift off the pump. Be careful not to damage the steel discs. On MD70 and TMD70 the pump can be removed together with the bracket, and then the pump shall be removed from the bracket.
8. Send the pump to an authorized diesel workshop (Bosch) for overhaul if the workshop does not have specially trained personnel with the necessary test equipment.

#### Fitting the injection pump

Check that the pump is in good condition and, if necessary, it has also been tested and approved, before fitting. Fill with engine oil in the hole where the oil pressure pipe for pump lubrication is to be fitted. Approx. 0.5 litre (0.11 Imp.gals/0.13 US gals) for RSV governor, and approx. 0.85 litre (0.19 Imp.gals/0.22 US gals) for RQV governor.

Do not remove the protective plugs before connecting up the pipes.

#### 60 series

1. Remove the front valve cover. Remove the rubber plug from the inspection hole in the flywheel casing.
2. Turn over the engine in the correct direction of rotation until both valves for the No. 1 cylinder are closed (compression stroke).
3. *Continue turning over the engine until the graduation mark on the flywheel (see "Technical Data") is seen opposite the pointer on the flywheel housing (fig. 127).*
4. Place the pump camshaft so that the line-up mark on the shaft end points at a right angle to the left ("nine o'clock") in relation to the pump (seen from the front) when fitting.
5. Smear the sealing ring at the front of the pump with grease. Place the pump by the auxiliary gear cover and turn it outwards towards stop. Tighten the pump.

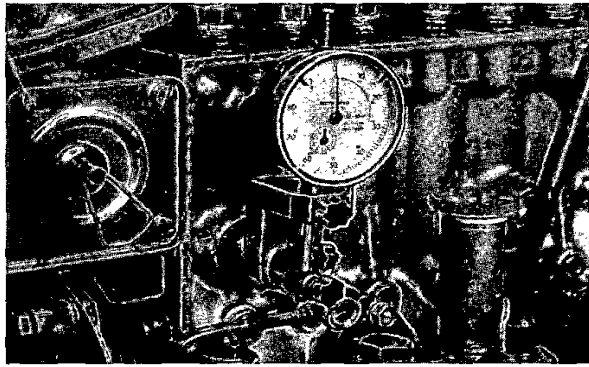


Fig. 133. Location of fixture and dial indicator

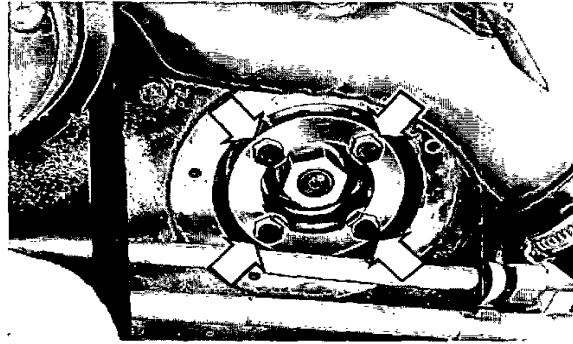


Fig. 135. Pump drive (60 series)

**Note.** Make sure that the line of sight from the mark on the flywheel over the indicator point to the eye is at a right angle from the flywheel. A difference of several degrees can result if the marks are seen from the side.

13. Adjust the setting, if necessary, by turning the engine back a little and then in the direction of rotation again until the stated graduation mark on the flywheel, and continue thereafter according to points 14–19.
14. **60 series:** Remove the cover from the auxiliary gear cover, right in front of the injection pump. Turn up the lock washer flanges and unscrew the bolts in the pump drive (fig. 135).
15. **60 series:** Fit a new lock washer and refit the bolts. Tighten loosely so that only the pump can be rotated.
16. **60 series:** Rotate the pump shaft with a socket wrench (27 mm = 1 1/16") until the dial indicator shows the correct value. Tighten the pump drive bolts (fig. 135).
17. **70 series:** Loosen the bolts (1, fig. 136) in the pump coupling. **NOTE!** The nuts (2) must be kept steady in order not to damage the steel discs.
18. **70 series:** Turn the injection pump flange until the dial indicator shows the correct value and tighten the bolts (1).

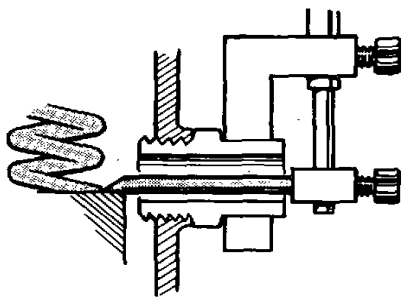


Fig. 134. Location of measuring point for tool 6770

19. Repeat points 7, 10, 11, and 12 after any adjusting.
20. Remove the dial indicator and the fixture from the screw socket. Remove the screw socket.
21. Fit the socket-head plug with the copper washer on the injection pump. (Allen key 8 mm (5/16"), 60 series and 12 mm (15/32"), 70 series).
22. Fit the relief valve and the fuel pipes.  
**60 series:** Lock the pump drive bolts with the lock washer and fit the cover on the auxiliary gear cover.  
**70 series:** Fit the lube oil pipe.
23. Fit the front valve cover and the rubber plug in the flywheel casing.
24. Open the fuel cocks and vent the fuel system according to instructions on page 80.
25. Start the engine and check for leakage.

**70 series: NOTE!** After starting, make sure that the pump coupling is fitted correctly and is not askew.

Adjust, when necessary, by releasing the clamp bolt at the front flange (fig. 128) so that the pump coupling can be pushed. Tighten the clamp bolt. Stop the engine and fit the protector plate over the pump coupling.

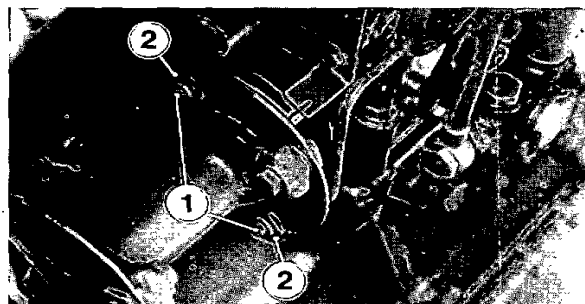


Fig. 136. Pump coupling (protector plate removed)

1. Bolts      2. Nuts on coupling

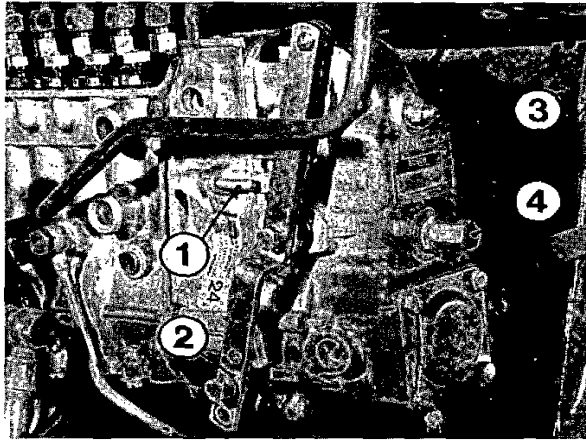


Fig. 137. Setting the speed, RSV governor

1. Stop screw for max. speed (sealed)
2. Speed control lever
3. Adjuster screw for low idling
4. Dome nut (stabilizing idling)

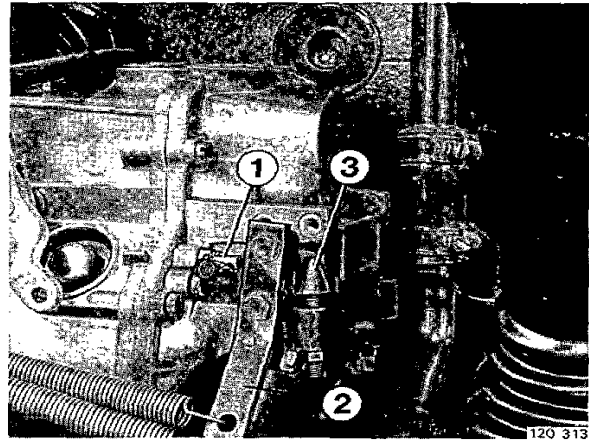


Fig. 138. Setting the speed, RQV governor

1. Stop screw for max. speed (sealed)
2. Speed control lever
3. Stop screw for low idling

### Setting the engine speed

Check that the speed control functions normally and that the injection pump speed control lever comes against the idling stop when the control is moved to the idle position. Check also that it presses against the max. stop when the control is moved to max. position. Adjust the controls if required. Check also that the air filter is not blocked.

#### Low idle

1. Run the engine warm.
2. Run the engine at low idling and check the speed. For engine speed see "Data and settings" in SB binder.
3. Adjust the speed, if necessary, by screwing the adjuster screw (3, fig. 137 or 3 fig. 138) out or in.

**RVS governor:** If the speed becomes irregular, adjust idle damping as follows:

1. Remove the dome nut (4, fig. 137) and release the lock nut as well as turn the damping bolt carefully clockwise while observing the speed.
2. Check that the high idle speed has not been changed. If it has, then the damping screw has been screwed in too far.
3. Lock the adjuster screw and screw on and lead-seal the dome nut after having carried out the adjustment.

#### High idle

The stop for max. speed is sealed. The seal must only be broken by specially trained personnel.

1. Run the engine warm.
2. Run the engine unloaded at max. speed.
3. Check the engine speed using a rev. counter. Adjust the stop 1, fig. 137 or 1, fig. 138, if necessary, to obtain the correct engine speed. For engine speed, see "Data and settings" in the SB binder.
4. Re-seal the screw.

### Feed-pump

#### Removing the feed-pump

1. Clean around the pump.
2. Close the fuel cocks. Disconnect the fuel pipes from the pump.
3. Remove the feed-pump from the injection pump.

#### Disassembling the feed-pump

1. Screw the pump onto a frame, which is clamped in a vice.
2. Unscrew the hand pump and the plug/screw union above the outlet valve.

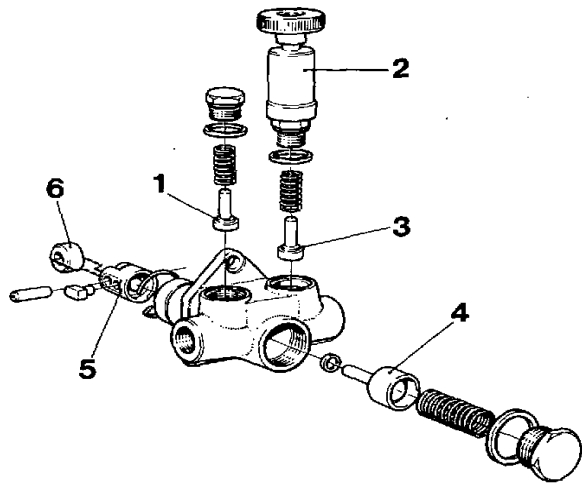


Fig. 139. Feed pump

- |                 |            |
|-----------------|------------|
| 1. Outlet valve | 4. Plunger |
| 2. Hand pump    | 5. Lifter  |
| 3. Inlet valve  | 6. Roller  |

3. Lift out the valves and springs.
4. Loosen the plug for the pump plunger. Remove the spring, plunger, and plunger rod.
5. Press in the roller lifter and retain it there by using a small screwdriver or similar tool. Then knock out the stop pin and lift out the roller lifter.
6. Wash all components in clean diesel oil.

### Inspection of the feed pump

Inspect the feed pump valve seats. If the sealing surface is damaged, this can often be remedied by using a grinding tool and grinding compound. Examine the sealing surface on the valves. Replace valves with damaged sealing surfaces.

Check the plunger seal in the barrel and the tension of the plunger spring.

Examine the other parts and replace any if damaged or worn.

### Assembling the feed pump

Observe the strictest cleanliness and rinse the parts in clean diesel oil before assembling. Fit protective caps on the connections unless the pump is to be installed immediately.

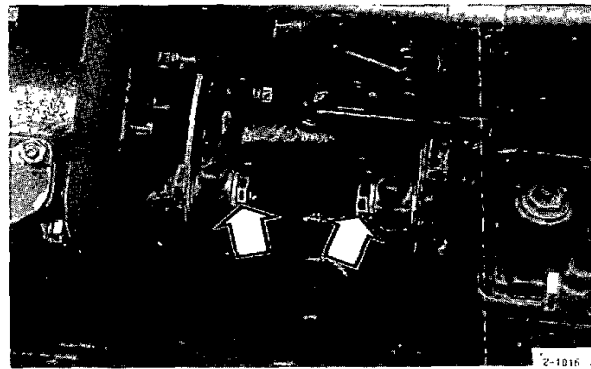


Fig. 140. Bolts in the pump coupling.

### Changing the sealing in the pump drive (70 series)

*Special tools: 6778, 6779*

1. Remove the protector plate above the pump coupling.
2. Unscrew the four bolts (fig. 140) for the pump coupling. **NOTE! Do not turn the nuts** to avoid damage to the steel discs. Remove the nuts.
- Note!** Do not remove the bolts attaching the steel discs to the flanges. The injection pump setting can then be altered. **Do not rotate injection pump or engine.**
3. Remove the pump coupling. Keep the washers between the steel discs and the coupling.
4. Loosen the clamp bolt (fig. 141) and remove the flange from the shaft journal. Remove the key.
5. Screw the puller 6779 into the sealing (fig. 142). Press on the puller so that its grooves cut into the steel ring on the sealing. Pull out the sealing by screwing in the bolt.
6. Oil the new sealing and the shaft journal. Place the sealing on the shaft.

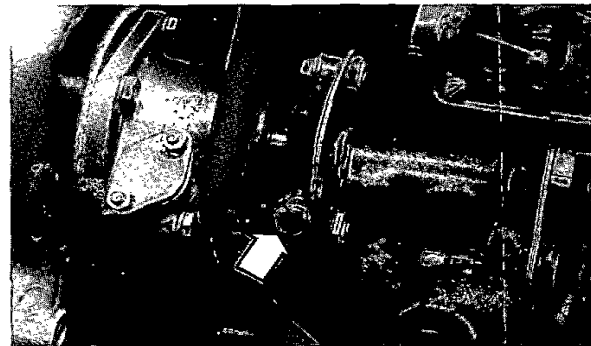


Fig. 141. Clamp bolt for front flange

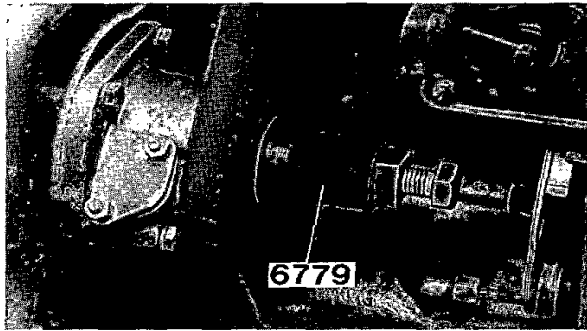


Fig. 142. Disassembling the sealing ring

7. Press in the sealing with tool 6778 until the sealing is level with the housing (fig. 143).
8. Fit the key and mount the flange on the drive shaft.
9. Mount the pump coupling together with the dished washers between coupling and steel discs. Tighten the bolts (fig. 140). **NOTE! The nuts must be held steady** in order not to damage the steel discs. Check that the nuts are not damaged and lock properly, and that the marking on the pump and coupling coincide.
10. Lock the front flange on the drive shaft by tightening the clamp bolt. **Start the engine and check that the pump coupling is not askew.**
11. Stop the engine and fit the protector plate above the pump coupling.

### Removing the pump drive (70 series)

To be able to remove the drive (fig. 144), the crankshaft pulley, if fitted, vibration damper, any rev. counter drive, and the injection pump drive must be removed first. After

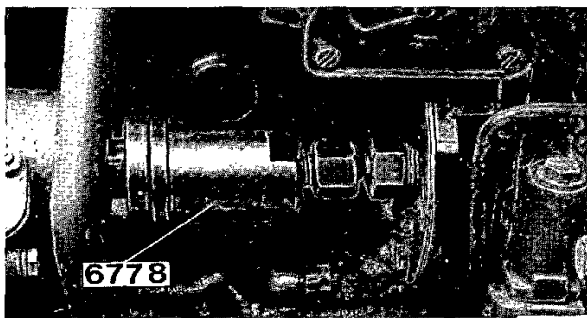


Fig. 143. Mounting the sealing ring

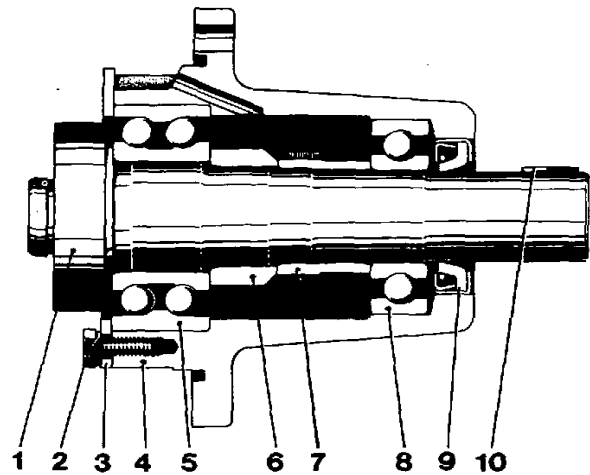


Fig. 144. Injection pump drive

- |                   |                                      |
|-------------------|--------------------------------------|
| 1. Shaft          | 6. Stop ring                         |
| 2. Attaching bolt | 7. Drive for mechanical rev. counter |
| 3. Washer         | 8. Rear bearing                      |
| 4. Housing        | 9. Sealing                           |
| 5. Front bearing  | 10. Key                              |

carrying out the above, loosen the pump drive attaching bolts on the rear side of the auxiliary gear cover and pull out the drive backwards.

### Disassembling the pump drive (70 series)

1. Remove the key (10, fig. 144).
2. Remove the attaching bolts (2) and the washer (3).
3. Press the shaft with bearings, stop ring, and drive out of the housing. In case the bearing (8) will not come out, the removal is carried out in two steps. Remove the bearings, drive and stop ring from the shaft.
4. Remove the shaft sealing (9) from the housing.

### Assembling the pump drive (70 series)

*Special tool: 2267*

1. Fit the rear bearing (8, fig. 144) in the housing. Use drift 2267.
2. Press the front bearing (5) onto the shaft. Fit the stop ring (6) and the drive (7) on the shaft.
3. Press the entire unit into the housing after fitting a counterhold against the rear bearing (8) inner ring. Press until the different parts of the drive bottom against each other.

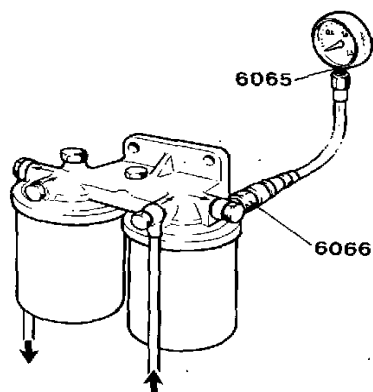


Fig. 145. Checking feed pressure

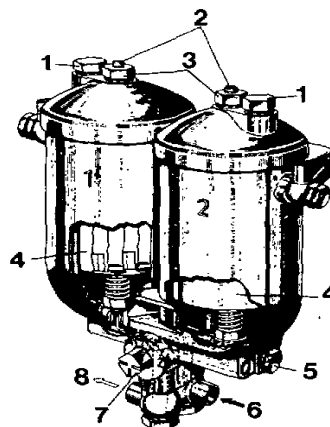


Fig. 146. Switch-over type fuel filters

- |                       |                   |
|-----------------------|-------------------|
| 1. Filler plug        | 5. Draining plug  |
| 2. Venting screw      | 6. Fuel inlet     |
| 3. Centre tension nut | 7. Three-way cock |
| 4. Filter insert      | 8. Fuel outlet    |

- Fit the washer (3) and lock washers and attaching bolts (2). Tighten the bolts and lock them with the locking washers.
- Press the sealing ring (9) into the housing. Fit the key (10).

### Checking fuel feed pressure

*Special tools: 6065, 6066*

- Connect the nipple 6066 to the existing connection on the **outlet side** of the fuel filter, see the arrow on the filter cover. (The pressure is measured after the fuel has passed through the fuel filter.)
- Run the engine at increased engine speed. Reduce speed to idling and read the pressure within one minute. The feed pressure must not be less than 140 kPa (1.4 kp/cm<sup>2</sup> = 20 p.s.i.) for TAM70E, and 100 kPa (1 kp/cm<sup>2</sup> = 14 p.s.i.) for other engines.

### Replacing the fuel filters

*Special tool: 9179*

- Wash around the outside edge of the filter cover.
- Screw off and scrap the old filters. Use if necessary tool 9179.
- Check to make sure the new filters are absolutely clean and that the gaskets are in good condition.
- Screw on the new filters by hand until the gasket makes contact with the cover. Tighten the filters a further 1/2 turn by hand.
- Vent the fuel system according to the instructions on next page. Start the engine and check for leakage around the filters.

### Replacing filter inserts, switch-over type filters

The filter inserts can be changed (one at a time) without stopping the engine.

- Turn the three-way cock (7, fig. 146) to position C, fig. 147.
- Open the venting screw (2) on the filter housing No. 1. Unscrew the draining plug (5) on the same container and drain the fuel into a collecting vessel.
- Unscrew the centre nut (3) and remove the cover. Lift out the filter insert.
- Rinse out the housing with clean diesel oil. Fit the draining plug and place the new insert in the housing.
- Fit the cover with a new gasket. Loosen the filler plug (1) and fill the housing with diesel fuel. Screw tight the plug.
- Turn the cock to position A, Fig. 147 and allow the engine to run for a few minutes to vent the filter housing.
- Then turn the cock to position B and replace the filter insert in housing No. 2 in the same way.

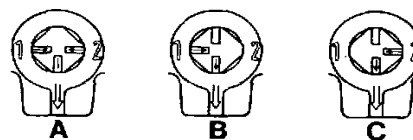


Fig. 147. Positions for three-way cock, switch-over type fuel filters

- |  |  |  |
|--|--|--|
| Position A<br>Both filters<br>being used | Position B<br>Filter housing<br>No. 2 can be cleaned | Position C<br>Filter housing<br>No. 1 can be cleaned |
|--|--|--|

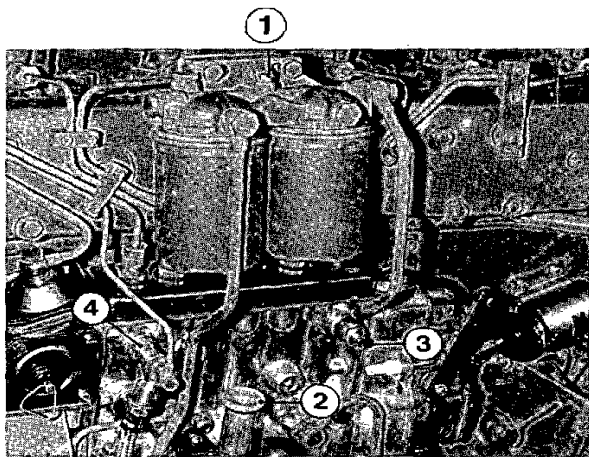


Fig. 148. Venting the fuel system

- |                                  |                  |
|----------------------------------|------------------|
| 1. Venting screw on filter cover | 3. Venting screw |
| 2. Hand primer                   | 4. Relief valve  |

### Venting the fuel system

1. Open the venting screw (1, fig. 148) on the fuel filter cover.
2. Pump up fuel using the feed pump hand primer (2) until the fuel is free from air bubbles. Tighten the screw whilst fuel is flowing out. (The handle on the pump is loosened by unscrewing anti-clockwise).
3. **MD70, TMD70, TAM70:** Open the venting screw (3) on the injection pump and continue as above.
4. Continue pumping until a proper feed pressure is reached. Normally further venting is not needed.

If the injection pump still needs venting, loosen the connection for the relief valve (4) at the pump and continue pumping by hand until air-free fuel runs out. Tighten the connection whilst fuel is flowing out. Continue pumping until a proper feed pressure is obtained. Check to make sure that the connections seal properly.

Screw on the pump handle.

**Note!** Venting must not be carried out at the pressure equalizer! Because of the location of the pressure equalizer the sealing washer between the equalizer and the injection pump can become incorrectly located after removal, thus causing leakage.

5. Start the engine. If the engine will not start after a short while, loosen the delivery pipes at the injectors a few turns. Set the injection pump speed control lever to max. position and turn the engine with the starter motor until fuel flows from the delivery pipes. Tighten the delivery pipe nuts.

**Note!** The electrical pre-heater on industrial engines is connected at the same time as the starter motor. Save the batteries, if using the starter motor, by only running the engine on the starter motor for short periods during venting.

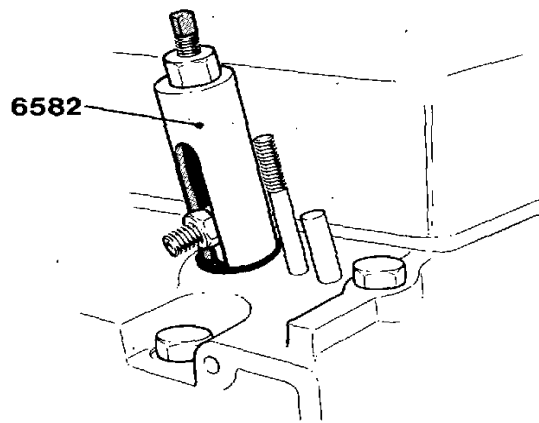


Fig. 149. Removing the injectors

### Injectors

#### Replacing the injectors

*Special tool: 6582*

1. Clean around the injectors.
2. Remove the leak-off fuel pipe and the delivery pipes. Remove the attaching yoke for the injector.
3. Rotate the injector with a wrench (PU-15) and pull it upwards at the same time. If the injector refuses to move, use puller 6582. This avoids any risk of the copper sleeve being removed as well with the risk of cooling water entering the engine. If tool 6582 is not being used, the cooling water can be drained before removal as a safety precaution.
4. Clean the surface of the copper sleeve which mates with the injector.
5. Fit the new injector (with protection ring 1, fig. 151 on marine engines). Tightening torque 50 Nm (5 kpm = 36 lbf.ft).
6. Fit the delivery pipes. Make sure that they are straight and tighten the nuts. Tightening torque 15–25 Nm (1.5–2.5 kpm = 11–18 lbf.ft). Fit the leak-off fuel pipe.
7. Fill cooling water in the engine, if it has been drained. Start the engine and check for leakage.

#### Overhauling the injectors

1. Clean the injectors externally.
2. Disassemble the injector. Pull the nozzle needle out of the nozzle sleeve and place the parts in decarbonizing liquid. Ensure that the nozzle needles and nozzle sleeves, which belong together, do not become mixed up.

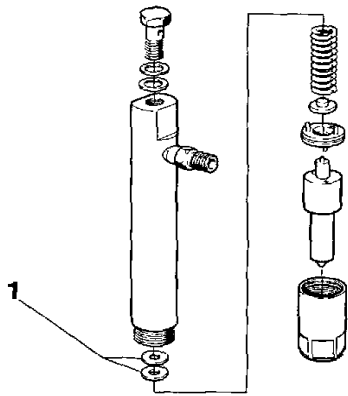


Fig. 150A. Injector

1. Adjuster washers for setting opening pressure

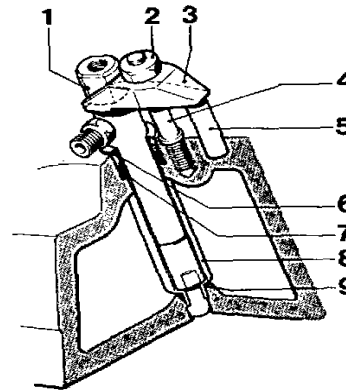


Fig. 150B. Installed injector

- |                |                  |
|----------------|------------------|
| 1. Injector    | 6. Steel ring    |
| 2. Nut         | 7. Sealing ring  |
| 3. Yoke        | 8. Copper sleeve |
| 4. Stud        | 9. O-ring        |
| 5. Support pin |                  |

if several nozzles are being cleaned at the same time. The nozzles should therefore be placed in a nozzle rack or in separate holders to avoid confusion.

When cleaning the nozzles, a suitable nozzle cleaning tool must be available, e.g. Bosch KDEP 2900. As cleaning agent use cleaning petrol (gasoline), diesel oil or white spirit.

3. Check the nozzle carefully. Examination is carried out using a magnifying lamp (e.g. Bosch EFAW 25B) or nozzle microscope. The nozzle sleeve can also be examined in the nozzle microscope. If the seat is damaged the nozzle needle must be replaced together with the nozzle sleeve. If the damage is slight, they can be lapped in a lapping or nozzle grinding machine (e.g. Bosch EFEP 164).
4. Check the remaining components.
5. When fitting a **new** nozzle it is important that the inhibiting oil is washed off the nozzle needle and sleeve before assembling the injector. Pull the nozzle needle out of the sleeve (avoid skin contact with the needle sliding surface) and dip the parts in clean benzine. Put the nozzle needle back into its sleeve and check that it slides freely without binding.

Dip the nozzle components in clean diesel or testing oil, and assemble the injector. Use the same thickness of washer(s) for adjusting the opening pressure.

### Testing

Testing is carried out using a nozzle tester. Most important are the opening/setting pressure and leakage test. The spray pattern and "creaking" are more difficult to evaluate and do not provide any reliable indication as to the condition of the nozzle.

### Warning!

Take care when testing injectors so that unprotected parts of the body are not hit by the fuel spray from a nozzle. The spray has great penetrating force and can penetrate deep into the skin and cause blood poisoning.

### Opening pressure

Two different pressures apply. One pressure for "run-in" injectors (see Technical Data under Opening pressure) and another pressure for new or reconditioned injectors with new pressure springs (setting pressure). The second value is somewhat higher to allow the spring to sag.

Connect the pressure gauge and press the injector tester lever down slowly until the nozzle opens and releases oil. Read off the opening pressure at this moment. If this pressure does not correspond with the specified value, then the setting must be adjusted. This is carried out by using adjustment washers (1, fig. 150A).

### Leakage

The leakage-test examines the fuel leakage which can occur between the point of the nozzle needle and the tapered sealing surface of the nozzle sleeve.

Wipe off the nozzle tip so that it is dry. Pump up the pressure, with a pressure gauge connected, to approx. 2 MPa (20 kP/cm<sup>2</sup> = 285 p.s.i.) below the injector opening pressure. Keep the pressure constant for 10 seconds. During this time no drop of fuel should leave the tip of the nozzle. A damp nozzle tip is acceptable.

### Spray pattern and "creak" test

Refer to instructions from the nozzle manufacturer.

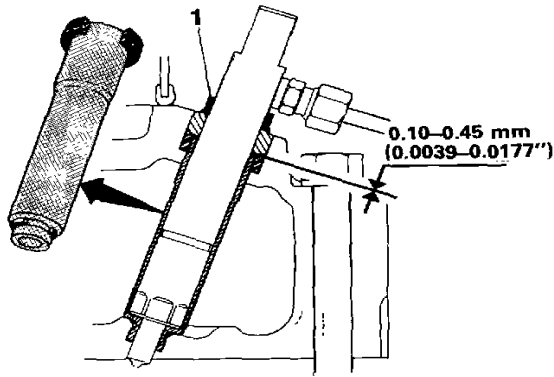


Fig. 151. Injector copper sleeve  
1. Protective ring (marine engines)

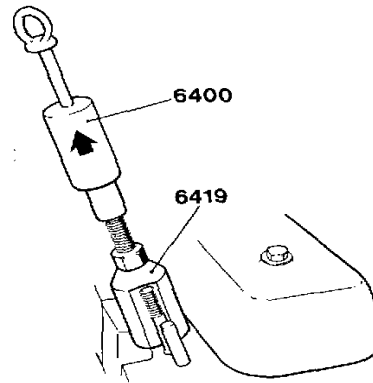


Fig. 153. Removing the steel ring

### Replacing injector copper sleeves (cylinder head fitted)

Special tools, 60 series: (6400), 6402, 6419, 6421, 6582, 6583, 6584, 6657  
70 series: (6400), 6402, 6419, 6420, 6422, 6582, 6657

1. Drain the coolant (fresh water system on marine engines).
2. Wash the area around the injectors. Remove the leak-off fuel line from the injectors.
3. Disassemble the delivery pipe and yoke for the injector where the copper sleeve is to be replaced. Rotate the injector with a wrench (PU-15) pulling it upwards at the same time. If the injector refuses to move use puller 6582.
4. **70 series:** Remove the yoke on the nearest adjacent injector.
5. Pull out the steel ring (6, fig. 150B) above the copper sleeve with the puller 6419 (fig. 153).

**Note!** To avoid damage to the bolt when using a puller, the bolt must be held steady and the pulling is carried out with the nut. It is the nut that shall perform the work.

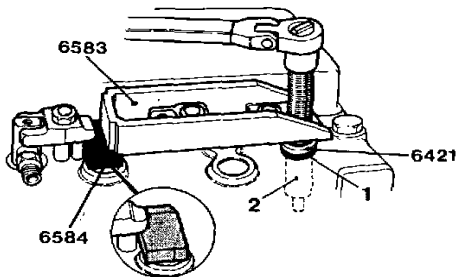


Fig. 152. Fitting the copper sleeve and steel ring (60 series)

1. Steel ring
2. Copper sleeve and drift

- The tool can be complemented with the slide hammer 6400.
6. Pull out the copper sleeve using the puller 6657. The tool can be complemented with the slide hammer 6400. Check that the O-ring comes up with the copper sleeve and that the lower sealing surface is clean. If necessary, the copper sleeve seat can be cleaned with a cutter after first removing the cylinder head, see next paragraph.
  7. Remove the upper sealing ring (7, fig. 150B). Clean the upper and lower guides in the cylinder head.
  8. Oil in a new upper sealing ring (7) and the upper guide in the cylinder head. Do not allow oil to enter the coolant passages. Fit the sealing ring into the cylinder head.
  9. Fit a new O-ring on the new copper sleeve lower guide (9). Press the sleeve into the cylinder head.
  10. Place a new steel ring (6) into position. Guide the drift 6421 (60 series), or 6420 (70 series) through the ring and the copper sleeve.

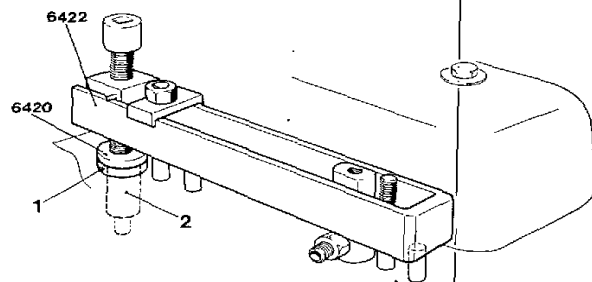


Fig. 154. Fitting the copper sleeve and steel ring (70 series)

1. Steel ring
2. Copper sleeve and drift

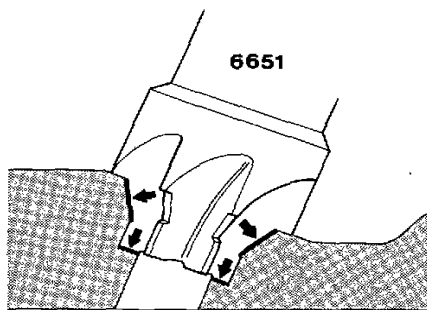


Fig. 155. Cutting the seat for the copper sleeve (step 1)

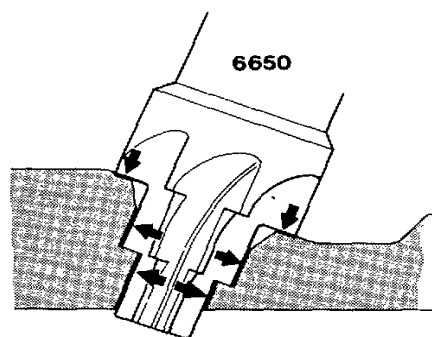


Fig. 156. Cutting the seat for the copper sleeve (step 2).

**NOTE!** In order to get the correct clearance (0.10–0.45 mm/0.0039–0.0177") between the injector's copper sleeve and steel ring both components must be replaced at the same time.

11. **60 series:** Fit the counterhold 6584 over one of the cylinder head bolt heads in order that it will support the press tool 6583 (fig. 152). Screw on the press tool with the injector attaching nut so that it is parallel with the cylinder head.
12. **70 series:** Assemble the press tool 6422 as shown in fig. 154. The tool sliding attachment is secured to the stud of the copper sleeve in question, at the same time as the tool frame is supported against the support pin of the adjacent injector. Alternatively, the tool can be screwed onto two studs depending on which cylinder work is to be carried out on.  
Check that the tool is mounted parallel with the cylinder head.
13. Screw down the tool screw on to the drift and press down the steel ring by tightening with a torque wrench to 68 Nm (6.8 kpm = 50 lbf.ft).
14. Loosen the press tool and replace the drift with the drift 6402.
15. Re-fit the press tool and check that it is located parallel with the cylinder head. Press down the copper sleeve by tightening to 58 Nm (5.8 kpm = 42 lbf.ft) with a torque wrench.

**NOTE!** The steel ring and copper sleeve must be pressed down in two stages in order to obtain the correct pressing force on the copper sleeve as well as the correct clearance between the ring and the sleeve (fig. 151).

16. Remove the press tool and the drift.
17. Fit the injector (with protective ring 1, fig. 151 on marine engines) and the yoke. Tightening torque 50 Nm (5 kpm = 37 lbf.ft). Fit the leak-off fuel line and the delivery pipes.
18. Check for leakage. See "Pressure testing the cooling system" on page 90.
19. Fill with coolant. See "Filling with coolant" on page 88.

### Cutting the copper sleeve seat (cylinder head removed)

*Special tools: 6650, 6651*

Rust and carbon deposits on the copper sleeve contact surface in the cylinder head should be removed with a cutting tool as follows. It is very important that the contact surface is in good condition.

**NOTE!** Cutting should only be carried out if it is necessary, as the position of the nozzle is altered after each cutting.

Note that the cutting may only be carried out in cylinder heads that have been **removed**, due to the risk of dirt and metal particles entering the engine.

1. First clean with cutting tool 6651 until the tool bottoms against the seat's upper sealing surface and stops cutting. The tool cuts where the arrows point, fig. 155.
2. Then clean with cutting tool 6650 until the tool bottoms against the surface under the cone and stops cutting. The tool cuts where the arrows point, fig. 156.

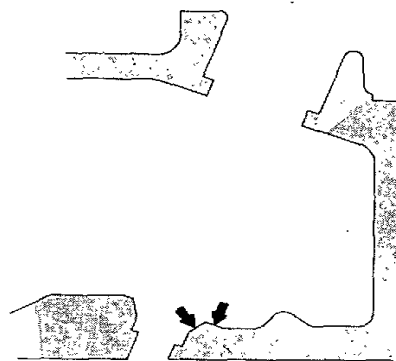


Fig. 157. Checking the upper sealing surface and cone.

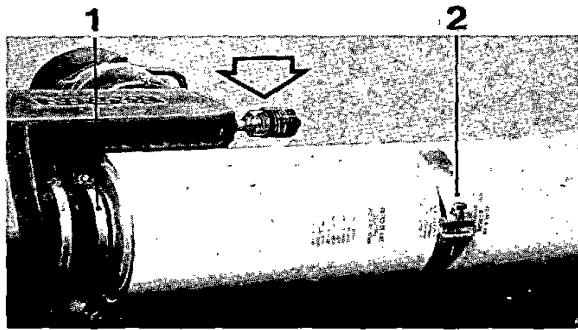


Fig. 158. Replacing the air filter (the picture shows TD60)

1. Hose clamp      2. Attaching clamp

3. Check the upper sealing surface of the seat and the cone. If they are still not clean, repeat the cutting procedure.
4. Clean the cylinder head thoroughly.

## Air filter

### Replacing the air filter

1. Clean the rubber hose to the filter. Loosen the hose clamp (1, fig. 158) and the filter attaching clamp (2).
2. Remove the old filter and discard it.
3. Check that the rubber hose is not damaged. Take a new filter, check that it is absolutely clean and fit it.
4. Check for leakage.

**NOTE!** No contaminant particles may enter the engine.

**Industrial engines:** Re-set the pressure drop indicator by pressing in the lever 3, fig. 159.



Fig. 159. Pressure drop indicator

1. Indicator shows no reading      3. Lever, press in to reset  
 2. Indicator shows replacement of filter is necessary

### Checking the pressure drop indicator

The pressure drop indicator (fig. 159) on industrial engines indicates when the air filter needs replacing by showing a completely red "window" (2).

1. Connect the pressure drop indicator according to fig. 160.
2. Suck on the pipe (6). The pressure drop indicator should show completely red at 440–560 mm (17–22") (water column). Replace pressure drop indicator, if faulty.

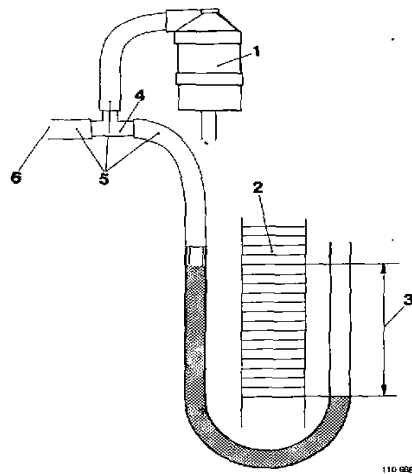


Fig. 160. Fluid manometer, connected when checking pressure drop indicator

1. Pressure drop indicator      4. T-piece  
 2. Measuring scale              5. Hoses  
 3. Pressure drop reading      6. Partial vacuum

# COOLING SYSTEM

## DESCRIPTION

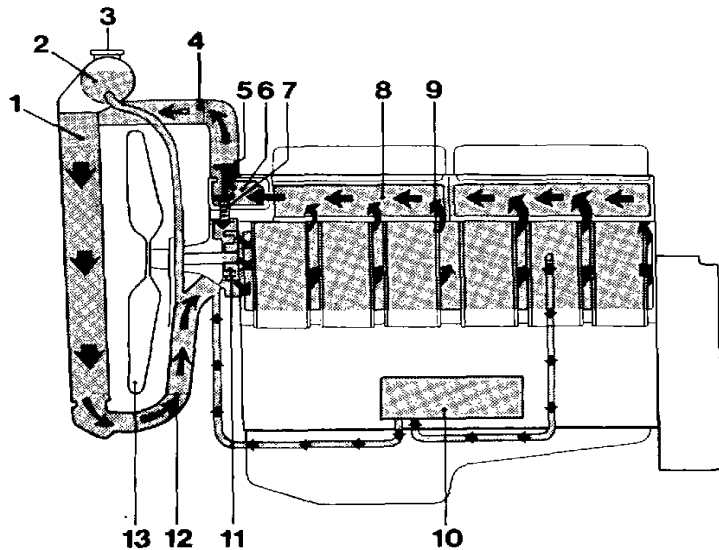


Fig. 161. Cooling system, TD70, TID70

1. Radiator
2. Expansion tank
3. Filler cap
4. Line (thermostat housing - upper radiator tank)
5. Thermostat
6. Thermostat housing
7. By-pass line
8. Cylinder head
9. Cylinder liner
10. Oil cooler
11. Circulation pump
12. Line to water pump suction side
13. Fan

### General

The engines are water cooled and equipped with a closed cooling system. On marine engines the cooling system is divided into two separate systems, a fresh-water system and a sea-water system.

The coolant circulation in the engine (fresh-water system, marine engines) is taken care of by a V-belt driven centrifugal pump (fig. 198).

The coolant is pumped by the coolant pump (circulation pump) into the distribution channel in the cylinder block and taken round the cylinder liners and then up through the cylinder heads. At the front end of the cylinder block the coolant is carried up to the thermostat housing. Coolant temperature is regulated by two thermostats. As long as the coolant is cold the thermostats shut off coolant flow to the radiator (heat exchanger, marine engines). Instead, the coolant passes through the by-pass lines under the thermostats directly back to the suction side of the pump. With this arrangement, the engine rapidly reaches operating temperature, while at the same time the engine temperature is prevented from becoming too low during cold weather. When the coolant temperature has risen to a certain value, the thermostats open and release coolant to the radiator or heat exchanger, while the by-pass lines close at the same time. In this way the engine attains a suitable working temperature.

The coolant is cooled down in the radiator/heat exchanger before being sucked into the coolant pump again. Heat is transferred from the radiator to the air by means of the radiator fan. On marine engines heat is transferred to the sea-water system by means of the heat exchanger. Large quantities of heat are also removed by the lubricating oil which removes heat via the oil cooler. Lubricating oil is also used on certain engines to remove heat from the pistons (see "Piston cooling" on page 59).

The cooling system can operate with a certain excess pressure, thus reducing the risk of boiling if the temperature should become too high. Should the pressure rise above normal, a pressure valve in the filler cap opens.

Throughflow in the sea-water system (marine engines) is taken care of by a impeller-type pump, mounted on the right hand side of the engine. The pump is driven from the auxiliary drive gears. The sea-water passes through the engine oil cooler (except on the TAMD70E), aftercooler (TAMD60, TAMD70), heat exchanger and reverse gear oil cooler. To protect against corrosion from galvanic current, zinc electrodes are built into the aftercooler, heat exchanger and oil cooler.

On TAMD70E the engine oil cooler is connected to the fresh-water system.

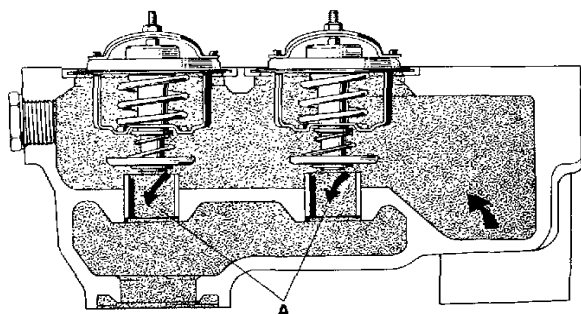


Fig. 162. Thermostat function during heating up

A = By-pass line for coolant reflux in the engine

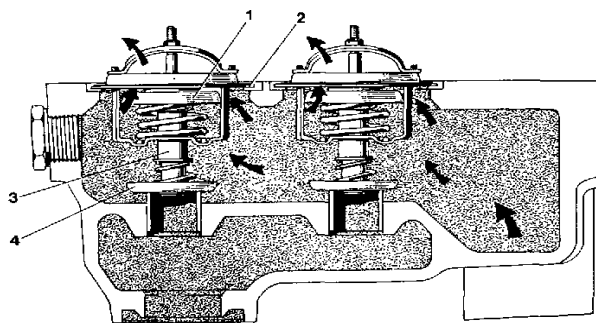


Fig. 163. Thermostats, full circulation

- 1. Thermostat valve
- 2. Retainer
- 3. Feeler tube
- 4. By-pass valve

## Thermostats

The engine is fitted with two thermostats. The thermostats' sensors contain wax. When the engine is cold the thermostats keep the passages to the heat exchanger/radiator completely closed. Coolant then being fed through a by-pass line directly back to the engine. As the engine warms up, the volume of the wax increases causing the thermostat valve to successively open the passage to the heat exchanger/radiator, fig. 163. At the same time a valve in the lower part of the thermostat closes the by-pass line. For opening temperatures and marking, see "Technical Data".

glycol additive. This coolant mixture gives frost protection down to approx.  $-25^{\circ}\text{C}$  ( $-13^{\circ}\text{F}$ ).

The lower temperatures a greater quantity of glycol is required according to the table below:

## Volumes

Cooling system capacity in litres (imp.gals/US gals) approx.	Amount of glycol in litres (imp.gals/US gals) for frost protection down to:			
	$-25^{\circ}\text{C}$ ( $-13^{\circ}\text{F}$ )	$-30^{\circ}\text{C}$ ( $-22^{\circ}\text{F}$ )	$-40^{\circ}\text{C}$ ( $-40^{\circ}\text{F}$ )	$-56^{\circ}\text{C}$ ( $-69^{\circ}\text{F}$ )
TD60D,-DG,-DPP	22* (4.8/5.8) 28** (6.2/7.4)	9 (2.0/2.4) 11.5 (2.5/3.0)	10 (2.2/2.6) 13 (2.9/3.4)	12 (2.6/3.2) 15.3 (3.4/4.0) 16.8 (3.7/4.4)
TID60D,-DG	23* (5.1/6.1) 29** (6.4/7.7)	9.5 (2.1/2.5) 12 (2.6/3.2)	11 (2.4/2.9) 13.5 (3.0/3.6) 16 (3.5/4.2)	14 (3.1/3.7) 17.4 (3.8/4.6)
TD70G,-GG,-GPP	25* (5.5/6.6) 31** (6.8/8.2)	10.1 (2.2/2.7) 12.7 (2.8/3.4)	11.5 (2.5/3.0) 14.4 (3.2/3.8) 17 (3.7/4.5)	15 (3.3/4.0) 18.6 (4.1/4.9)
TID70G,-GG,-GPP	26* (5.7/6.9) 32** (7.0/8.5)	10.7 (2.4/2.8) 13 (2.9/3.4)	12 (2.6/3.2) 14.6 (3.2/3.9) 17.3 (3.8/4.6)	15.6 (3.4/4.1) 19.2 (4.2/5.1)
TAMD60C	20 (4.4/5.3) 23* (5.1/6.1)	8.5 (1.9/2.2) 9.5 (2.1/2.5)	9.5 (2.1/2.5) 11 (2.4/2.9) 13 (2.9/3.4)	12 (2.6/3.2) 14 (3.1/3.7)
MD70C***	29 (6.4/7.7)	12 (2.6/3.2)	13.5 (3.0/3.6)	16 (3.5/4.2) 17.4 (3.8/4.6)
TMD70C*** TAMD70E***	30 (6.6/7.9)	12.3 (2.7/3.3)	14 (3.1/3.7)	16.5 (3.6/4.4) 18 (4.0/4.8)
(T)MD70C****	34 (7.5/9.0)	14 (3.1/3.7)	15.5 (3.4/4.1)	18.4 (4.1/4.9) 20.4 (4.5/5.4)
TAMD70E****	35 (7.7/9.3)	14.3 (3.2/3.8)	16 (3.5/4.2)	19 (4.2/5.0) 21 (4.6/5.6)

\* Incl. separate expansion tank (plastic)

\*\* Incl. separate expansion tank (metal)

\*\*\* With plate heat exchanger

\*\*\*\* With tubular heat exchanger

## REPAIR INSTRUCTIONS

**NOTE!** Close the sea cock before starting work in the cooling system on marine engines.

### Coolant

The coolant should consist of a mixture of anti-corrosion additive and water or, when there is a risk of freezing, glycol and water, see below.

When replacing the coolant, the whole cooling system should be flushed clean with water. At the same time check all hoses and connections and repair any leakage. Replace all loose, swollen or otherwise damaged hoses.

### Glykol

We recommend the use of **Volvo Original ethylene glycol\***, which contains correctly balanced additives for the neutralisation of corrosive forming substances in the cooling water. If this red glycol is used it is sufficient to replace the coolant once a year, preferably in the autumn.

The anti-freeze additive fulfills a dual purpose, to prevent damage to the cooling system due to freezing, and to protect against corrosion. Therefore, always use a glycol additive of at least 40%. This means that topping-up, whenever necessary, should be done with the corresponding

\* Part No. 1129616-7, 1 kg, appr. 0.9 litres  
(1.6 Imp.pts/1.9 US pts)

Part No. 1129617-5, 5 kg, appr. 4.5 litres  
(1.0 Imp.gal/1.2 US gals)

Part No. 282012-4, 235 kg, appr. 208 litres  
(45 Imp.gals/55 US gals)

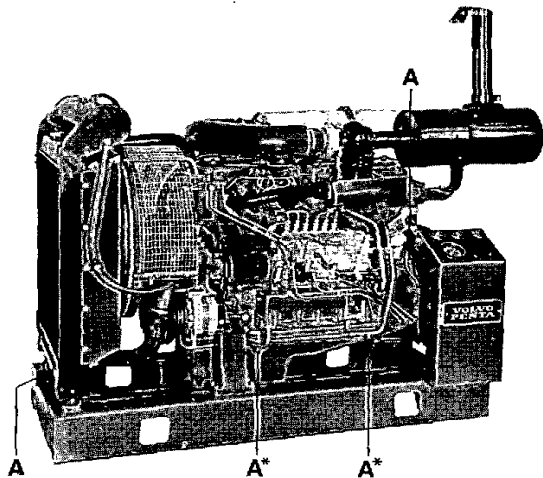


Fig. 164. Drain cock/plug (A), industrial engines  
\* Only TD70, TID70

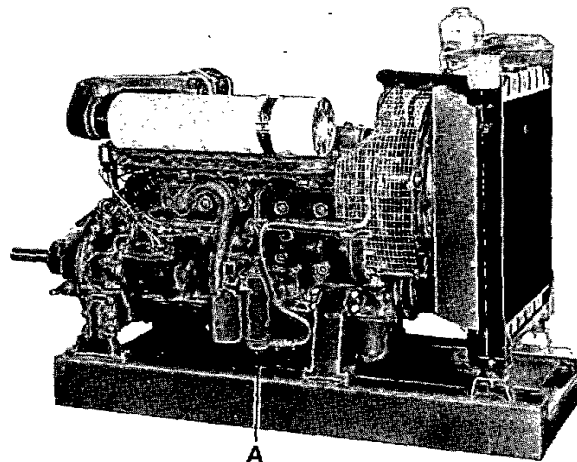


Fig. 165. Drain plug (A), T(II)D60

Protection against freezing can be obtained down to  $-56^{\circ}\text{C}$  ( $-69^{\circ}\text{F}$ ) (60 % glycol). **Increasing the quantity past this point reduces the protection against freezing.**

Mix the glycol with water in a separate vessel prior to filling the cooling system.

**NOTE!** Glycol is dangerous (poisonous if consumed).

#### Corrosion inhibitor

To prevent corrosion, it is simplest to use a suitable mixture of genuine Volvo glycol all year round (at least 40 %). Replacement should be carried out every autumn.

In those cases where glycol is not used, corrosion inhibitor should be added to the coolant. Use Volvo corrosion inhibiting additive (part No. 1129709-0), which is available in quantities of 1/2 litre. Three cans (1.5 litres) are required for MD70 with tubular heat exchanger, all TMD70 and TAMD70, and for TD70 and TID70 with metal expansion tank. For all other engines 2 cans (1 litre) are required.

Clean the cooling system thoroughly before filling. Run the engine warm soonest after filling to give the best possible effect from the additive.

To maintain the protection against corrosion, the coolant should thereafter be **supplemented** with a further 1/2 litre (1 can) every **400th hour of operation**.

**NOTE!** Other types of anti-corrosion additive, glycol or anti-freeze **must never** be mixed with this corrosion inhibitor. The corrosion inhibitor **does not** prevent the formation of ice and should only be used where the temperature is always above  $0^{\circ}\text{C}$  ( $+32^{\circ}\text{F}$ ).

#### Checking the coolant level

On engines with separate expansion tank the level, with the engine cold, should be somewhat above the middle of the tank (never below the MIN mark on the plastic expansion tank). On other engines the level should be approx 4–5 cm (2") below the filler cap sealing edge. There must be an air space to allow for expansion of the coolant.

**NOTE!** Open the filler cap very carefully when the engine is warm. Hot steam or fluid can spray out.

If, for some reason, the coolant level has sunk so low that it cannot be seen through the filler opening, then the system must be vented during filling, see "Filling with coolant".

**An insufficient quantity of coolant can lead to poor circulation, which increases the risk of overheating, resulting in damage to the engine.**

#### Draining the coolant

**Before draining the coolant, stop the engine, screw off the filler cap and, in the case of marine engines, close the bottom valve in the boat.**

See figs. 164–172 for the location of drain cocks and plugs. If compressed air compressor is fitted (industrial engines) there is also a drain cock on this. Unscrew the coolant filter, if fitted.

If the sea-water system is also to be drained (marine engines) any cocks/plugs fitted on the lowest points on coolant and exhaust lines should also be opened. Unscrew the cover on the sea-water pump, also the cover on an extra bilge pump if fitted.

Check carefully to make sure that all water runs out.

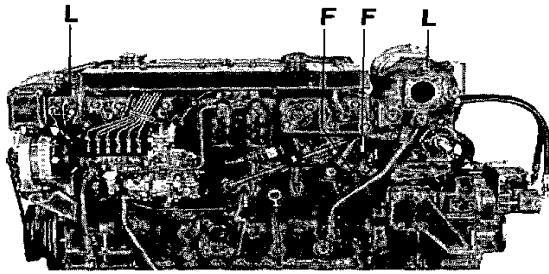


Fig. 166. Drain and venting cocks, TAMD60  
F = Fresh water cocks L = Venting cocks

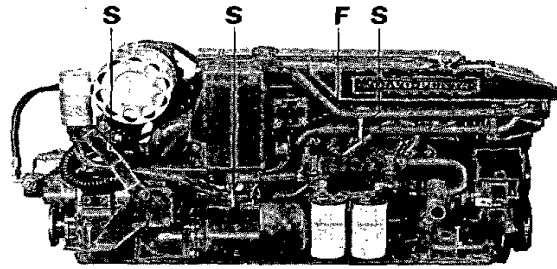


Fig. 168. Drain cocks, TAMD60  
F = Fresh water-cocks S = Sea-water cocks

### Filling with coolant

Filling must not be carried out so rapidly that air pockets form in the system. Air must be given the opportunity to pass out through the filler opening.

**Filling should be carried out with the engine switched off.** The engine must not be started until the system has been vented and completely filled. If a heater system is connected to the engine cooling system, then the heat control valve should be fully opened and the heater system vented during filling.

Flush clean the cooling system before filling with coolant. Check all hoses and connections and repair any leaks. Screw on a new fresh-water filter (optional equipment). Close the drain cocks.

**NOTE!** When filling with coolant, the venting cock on the thermostat housing should be opened on MD70, TMD70 with tubular heat exchanger, and on TAMD60 and TAMD70. The MD70 and TAMD70 engines that are fitted with plate heat exchanger have a venting cock on the rear side of the expansion tank. On TAMD60, TMD70, and TAMD70 there is also a venting cock on the turbocharger. See figs. 166–172. On the industrial engines venting takes place automatically in connection with filling the coolant, and for this reason these engines do not have a venting cock.

Fill with coolant to the correct level (see "Checking the coolant level") and vent the system. Check that the cooling system is properly vented by **carefully opening the venting cocks** after the engine has been started and reached operating temperature. Any remaining air is thus evacuated.

**NOTE!** Open the filler cap very carefully when the engine is warm. Topping-up should be carried out with same mixture as that already in the cooling system.

On industrial engines and on TAMD60 the filling of large quantities is carried out direct through the filler opening on the cooler/heat exchanger until the system is vented and completely filled (remove the hexagonal plug 2, fig. 173 on TAMD60). Close the venting cocks (TAMD60), screw on the filler cap and fill the expansion tank to the correct level, see "Checking the coolant level").

On TAMD60 with separate plastic expansion tank, however, the expansion tank on the engine should be filled completely. Fit the cap and finally top-up the separate expansion tank to between the MIN and MAX marks.

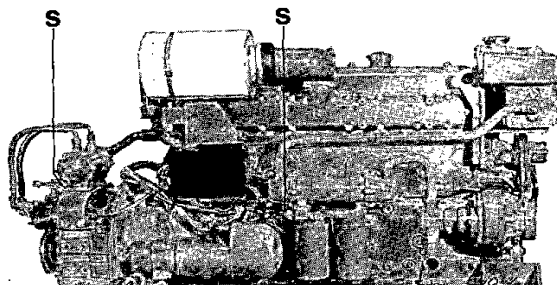


Fig. 167. Drain cocks, (T)MD70  
S = Sea-water cocks

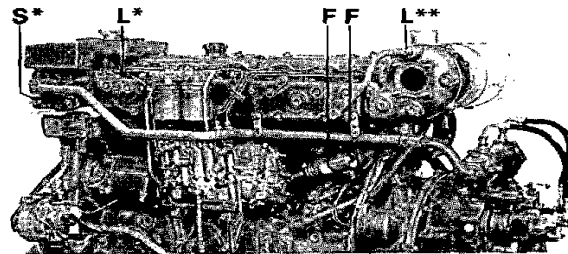


Fig. 169. Drain and venting cocks, (T)MD70  
F = Fresh-water cocks L = Venting cocks  
S = Sea-water cock

\* Only engines with plate heat exchanger  
\*\* Only TMD70

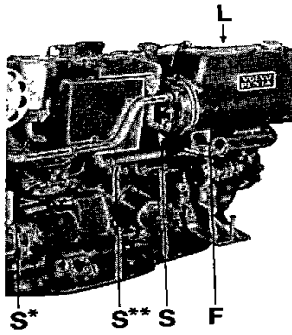


Fig. 170. Drain and venting cocks, (T)MD70, TAMD70 with tubular heat exchanger

\* Only MD70, TMD70  
\*\* Only TAMD70

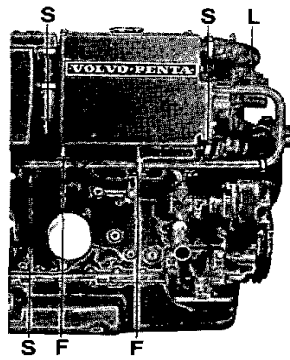


Fig. 171. Drain and venting cocks, TAMD70 with plate heat exchanger

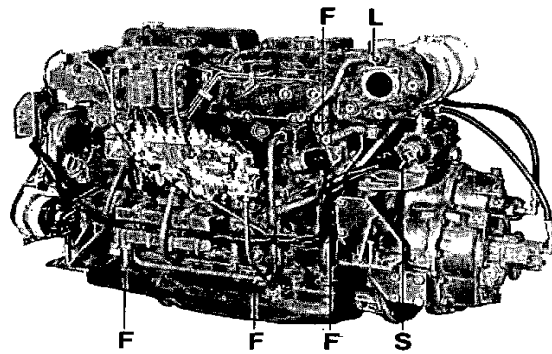


Fig. 172. Drain and venting cocks, TAMD70

**Figs. 170–172. F = Fresh-water cocks  
L = Venting cocks  
S = Sea-water cocks**

### Coolant temperature, too high

Too high a coolant temperature can be caused by:

- Low coolant level, air in the system
- Reduced air flow through the radiator, dirty radiator (applies to industrial engines)
- Poor drive belt tension
- Blocked cooling system
- Faulty thermostats
- Faulty temperature gauge
- Faulty setting of injection pump with regard to the injection angle
- Worn sea-water pump impeller (applies to marine engines)
- Blocked sea-water filter, optional equipment (applies to marine engines)

### Coolant temperature, too low

Too low a coolant temperature can be caused by:

- Faulty thermostats
- Faulty temperature gauge

### Checking the temperature gauge

Remove the temperature sender and connect the cables to the temperature gauge. Immerse the sender in hot water and compare the temperature gauge reading with the value from a thermometer.

### Coolant loss

Loss of coolant can occur in two ways:

- Loss of coolant whilst running
- Loss of coolant after stopping warm engine

Coolant loss while running can be due to leaks in the cooling system or to air or combustion gas pressure in the system causing coolant to be forced through the pressure valve. The fault can lie in the compressed air compressor, if fitted, or be caused by cylinder head gasket leakage.

Loss of coolant after stopping the engine when warm is generally due to a faulty pressure cap.

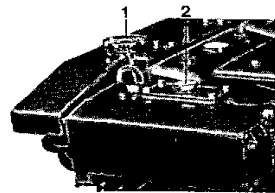


Fig. 173. TAMD60  
1. Expansion tank filler cap. Topping-up  
2. Hexagonal plug on heat exchanger. Filling

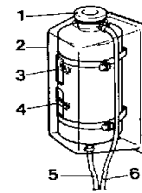


Fig. 174. Separate expansion tank  
1. Filler cap 5. Hose from the engine  
2. Cover 6. Hose with open end  
3. MAX level  
4. MIN level

## Checking the radiator (industrial engines)

Check that the radiator pipe system is not blocked externally by insects or other particles which can restrict the flow of air. Rinse clean with water if necessary. Straighten out any bent ribs on the pipe system.

Also check that the sealing strip fitted between the fan ring and fan cover as well as in certain cases the radiator and forward section has not become loose or there is some other kind of leakage.

## Adjusting the drive belts

Replace belts which have become oily, worn or damaged in any way. **NOTE!** Replace both belts that work in pairs at the same time.

Tension the belts after loosening the tension roller or alternator. Correct tension is obtained when the belts can be pushed in 10 mm (0.400") midway between the pulleys. In the centre of the tension roller is a wrench grip for 12.5 mm (1/2") square socket. Use a socket wrench handle direct on the wrench grip, hold the belts tensioned and tighten the nut to 120 Nm (12 kpm = 87 lbf.ft).

TD70 and TID70 are equipped with an automatic belt tensioner for the fan belts.

## Cleaning the cooling system

Cleaning of the cooling system should be carried out in connection with coolant replacement.

It is generally sufficient to flush through with clean water, but if the cooling system (fresh-water system on marine engines) have large rust and mud deposits we recommend the following method of cleaning.

**NOTE! TAMD60 and TAMD70 with plate heat exchanger have certain parts of the cooling system in light-alloy, and for this reason only clean water may be used for cleaning.**

1. Empty and flush the system clean. Dissolve 1 kg (2.2 lbs) of oxalic acid\* in 5 litres (= quarts) of hot water and pour into the cooling system. Top up with clean water.

**Warning! Take care of hands and face. Oxalic acid is poisonous and damaging to the skin.**

2. Run the engine until it reaches normal operating temperature and then **for at least another 2 hours, however, max. 12 hours** (the longer time of running the better the result).

**NOTE!** If heater is fitted, the control must be on "hot".

3. Drain the system and **flush out immediately and thoroughly with clean water**. For this purpose the thermostat housing (thermostats), upper and lower radiator hoses, drain cocks and plugs should be removed to give the best possible drainage speed. Do not forget the engine heater or heater element, if fitted. Continue flushing until the water running out is clean. It is important to remove the oxalic acid thoroughly, otherwise the remains can increase the risk of further corrosion.

4. Dissolve 200 gram (7 ozs.) of bicarbonate\* in 5 litres (= quarts) of water and pour into the cooling system. Top-up with clean water.

**NOTE!** Never use soda (sodium carbonate  $\text{Na}_2\text{CO}_3$ ) as incorrect handling can result in severe corrosive damage.

5. Run the engine at normal operating temperature for approx. 10–15 mins. This point must be carefully carried out in order to neutralize the oxalic acid.
6. Flush the system thoroughly according to point 3. Increased flushing effect can be obtained by mixing air with water, in which case flushing must, **without question, be carried out from bottom to top (radiator), and from the drain cock on the cylinder block.**

**NOTE!** Remove the filler cap from the expansion tank/radiator. In the case of separate expansion tank, this should also be flushed from the bottom and up with the filler cap removed for efficient cleaning. Flush the heater, if fitted, with hoses removed to be sure to get rid of remaining deposits.

7. If there are still deposits in the cooling system, repeat the measures under points 1–6.

In connection with cleaning, check that all hoses are free from defects. Replace if necessary.

8. Fill the system with Volvo Penta recommended coolant. See "Coolant" page 86.

\* Not marketed by Volvo Penta, should be purchased from chemical stores.

Chemical formula for oxalic acid:  $\text{C}_2\text{H}_2\text{O}_4$ .

Chemical formula for sodium hydro carbonate:  $\text{Na HC O}_3$ .

## Pressure testing the cooling system

**Special tools:** 6662, 998 9860\* together with compressed air and 6433 (6441 for industrial engines with separate plastic expansion tank). Alternatively a standard type of pressure testing device can be used.

\* See note under the heading "Pressure testing the cylinder heads" on page 31.

Check the pressure testing device 6662 according to the instructions on page 31 before it is used.

Regarding pressure testing of separate heat exchangers, intercoolers, oil coolers and cylinder blocks and heads, see pages 93–95, 38, and 31.

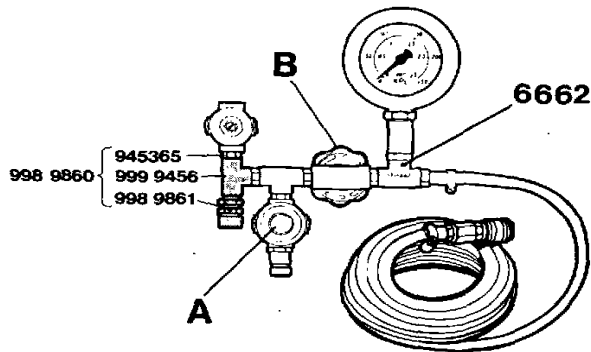


Fig. 175. Fitting of kit 998 9860 on the pressure testing device 6662 (Sweden only)

1. Remove the coolant filler cap. (The cap on the **expansion tank** on industrial engines, and the cap on the **engine expansion tank** on TAMD60).
2. Ensure that the knob on the relief valve (A, fig. 175) is screwed out and connect the hose from the pressure testing device to the cap 6433 or 6441.
3. Seal the drain line from the filler pipe and the pipe to the plastic expansion tank, if fitted, on TAMD60. The plastic expansion tank for industrial engines are not fitted with drain lines.
4. Connect the pressure testing device 6662 to the compressed air system and open the cock (B).
5. Pull out the lock ring on the relief valve wheel. Increase the pressure by screwing the knob inwards until the pressure gauge reads 70 kPa (0.7 kp/cm<sup>2</sup>/10 p.s.i.). Lock the knob (B).
6. Check during one minute that the pressure does not drop. If there is difficulty in locating the leak, drain the coolant, re-pressurize the system and apply soapy water to hose connections, drain cocks etc. until the leak is found.

**Note!** Ensure that the pressure never exceeds 70 kPa (0.7 kp/cm<sup>2</sup>/10 p.s.i.). Increased pressure can, amongst other things, damage the coolant pump seal.

**Note!** Follow applicable safety instructions.

7. Remove the testing device.

### Checking the pressure valve

The pressure valve is located in the filler cap. For this test the same pressure testing device is used as for testing for leakage in the cooling system. See above section.

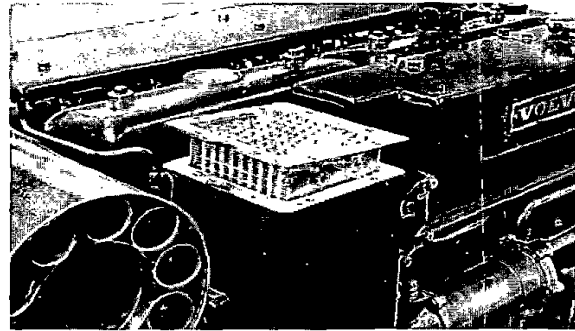


Fig. 176. Aftercooler TAMD60

1. Drain part of the coolant and connect the pressure testing device with a nipple to any plugged hole in the cooling system.
2. Extend the draining hose from the filler pipe with a hose which opens out into a vessel containing water. Industrial engines with a plastic expansion tank are not fitted with drain lines. In those cases the expansion tank can be removed from its bracket and placed with the filler cap just under the surface in a vessel containing water.
3. Apply the pressure, see "Pressure testing the cooling system" previous section and read off the pressure gauge when the valve opens (water will bubble in the vessel from around the drain line/filler cap).  
See "Technical Data" page 13 for valve opening pressure.
4. Remove the testing equipment. Fit the cock and fill the engine with coolant.

### Cleaning the heat exchanger and aftercooler

(applies to marine engines)

#### TAMD60

1. Close the bottom valve and drain the sea and fresh water systems.
2. Remove the cover over the aftercooler. Remove the coolant pipe between the heat exchanger and the aftercooler cover. Lift out the insert.
3. Remove the end covers on the heat exchanger. Remove the rubber boot.

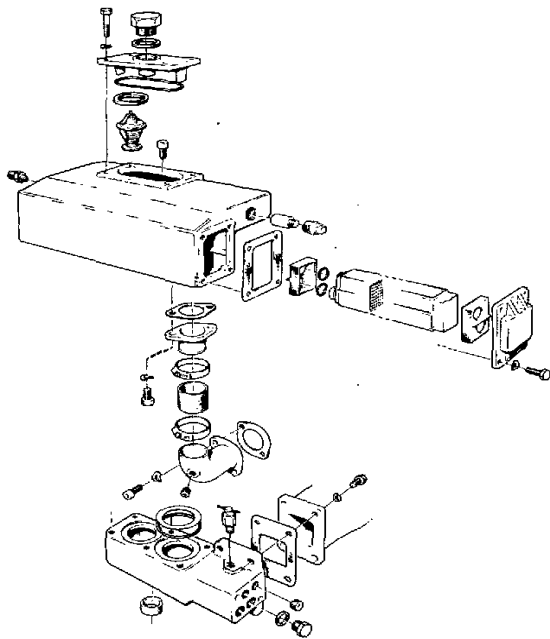


Fig. 177. Heat exchanger, thermostat housing TAMD60

4. Press carefully out the insert with e.g. the handle of a hammer. Keep the other rubber boot.
5. Flush and clean the inserts inside and out. Clean also the housings. Make sure that the draining hole ( $\varnothing 1.5 \text{ mm} = 0.059''$ ) in the aftercooler housing is open.

**Make sure that no impurities get into the engine inlet manifold.**

6. Fit the parts in reverse order. Use new gaskets and sealing rings. Grease the heat exchanger pipe connections and the connections to the aftercooler with water-resistant grease before fitting.
7. Fill the engine with coolant. Open the bottom valve, start the engine and check for leakage.

**(T)MD70, TAMD70 with tubular heat exchanger**

1. Close the bottom valve and drain the sea and fresh water systems.
2. Remove the coolant pipes to the heat exchanger's rear end cover.
3. Remove the four attaching bolts from around the front end cover. Remove the centre bolts for both end covers and take off the covers.

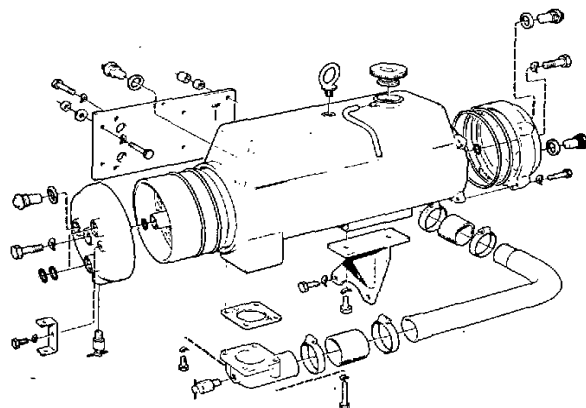


Fig. 178. Tubular heat exchanger, MD70, TMD70, TAMD70

4. Pull out the insert forwards and clean it inside and out with suitable brushes. Also clean accessible surfaces in the heat exchanger housing. Rinse the parts.
5. Check when fitting that the holes in the insert casing are placed opposite the holes in the housing. Replace all sealing rings and apply a little soap solution before fitting.
6. **TAMD70:** Clean the aftercooler, see under the heading "TAMD70 with plate heat exchanger" on next page.
7. Fill the engine with coolant. Open the bottom valve, start the engine and check for leakage.

**MD70, TMD70 with plate heat exchanger**

1. Close the bottom valve and drain the sea and fresh water systems.
2. Remove the coolant pipes between the heat exchanger and the oil cooler of the engine and reverse gear.
3. Remove the bolts for both end covers on the heat exchanger and remove the covers. Pull out the insert.
4. Flush and clean the insert inside and out. Also clean the heat exchanger housing.
5. Fit the parts in reverse order. Use new gaskets and sealing rings. Grease the heat exchanger pipe connection with water-resistant grease before fitting.
6. Fill the engine with coolant. Open the bottom valve, start the engine and check for leakage.

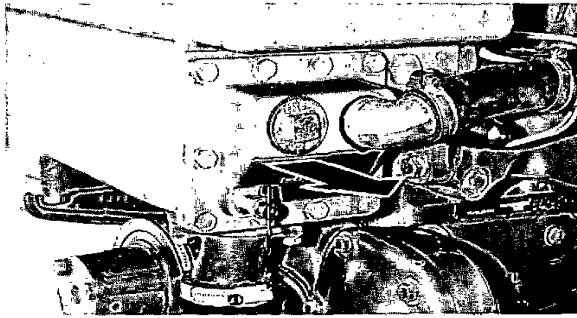


Fig. 179. Plate heat exchanger, MD70, TMD70

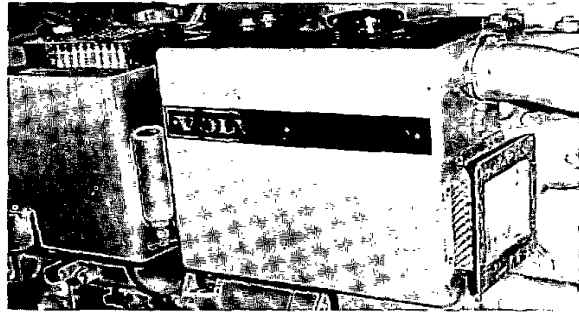


Fig. 180. Aftercooler and heat exchanger TAMD70

### TAMD70 with plate heat exchanger

1. Close the bottom valve and drain the sea and fresh-water systems.
2. Remove the bolts securing the coolant pipe between the heat exchanger end cover and the reverse gear oil cooler.
3. Loosen the coolant pipe from the end cover.
4. Slacken the hose clamp on the coolant line under the aftercooler, and also the hose clamp under the aftercooler cover.
5. Remove the bolts securing the end cover at the front of the heat exchanger and the cover over the aftercooler. Remove the covers and pull out the inserts.
6. Flush and clean the inserts inside and out. Clean also the inside of the housings. Make sure that the draining hole ( $\varnothing 1.5 \text{ mm} = 0.059''$ ) in the bottom of the aftercooler housing is open.

**Make sure that no impurities get into the engine inlet manifold.**

7. Fit the parts in reverse order. Use new gaskets and sealing rings.
8. Fill the engine with coolant. Open the bottom valve, start the engine and check for leakage.

### Pressure testing

If leakage is suspected the heat exchanger or aftercooler insert should be removed from the engine and pressure tested separately. Use water for pressure testing. Apply pressure during one minute. No pressure drop shall be allowed.

Pressure test the intercooler for TID60 and TID70 with 70 kPa ( $0.7 \text{ kp/cm}^2 = 10 \text{ p.s.i.}$ ), other engines with 200 kPa ( $2 \text{ kp/cm}^2 = 28 \text{ p.s.i.}$ ).

**NOTE! The heat exchanger insert for TAMD60 must be supported from the sides according to fig. 181 before pressure testing.**

**NOTE! Follow applicable safety instructions.**

### Cleaning the oil cooler

#### TD60, TID60

1. Drain the coolant.
2. Remove the cooler from the filter bracket and drain the oil out into a vessel. The cooler is manufactured as a unit and cannot be disassembled.
3. Flush the cooler with cleaning liquid and blow dry with compressed air.
4. Fit the cooler with new O-rings.
5. Fill the engine with coolant. See "Filling with coolant" on page 88. Top-up, if necessary, with lube oil. Start the engine and check for leakage.

#### TD70, TID70, TAMD70

1. Drain the coolant (fresh-water system on TAMD70). Remove the coolant pipes to the oil cooler.
2. Place a collecting vessel for the oil under the oil cooler and remove the oil distributor housing from the cylinder block. Pull out the connections from the oil cooler cover.

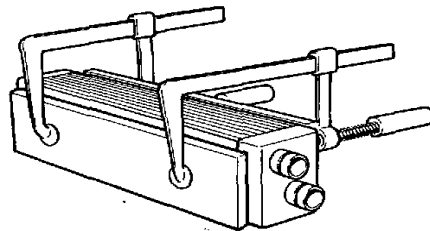


Fig. 181. Fitting side supports prior to pressure testing the heat exchanger, TAMD60.

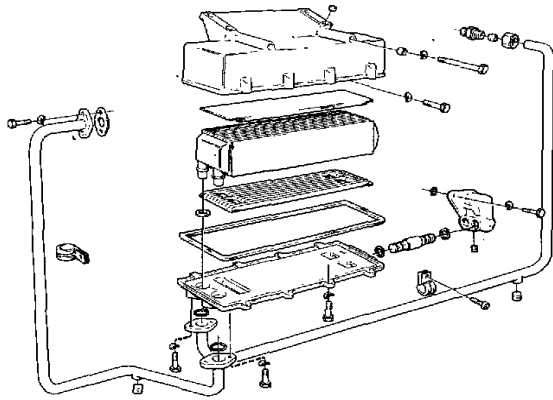


Fig. 182. Oil cooler, TD70, TID70, TAMD70

3. Remove the cover and take out the insert. Keep the insert's upper and lower flat seal (rubber).
4. Wash the insert in white spirit, flush it inside and blow dry with compressed air. Clean the housing.
5. Refit the parts in reverse order. Note that the lower flat seal has cut outs for the oil flow. Use new sealing rings. Grease the cooler insert pipe connections with water resistant grease before connecting the coolant pipes.
6. Fill the engine with coolant. See "Filling with coolant" on page 88. Top-up with lube oil, if necessary. Start the engine and check for leakage.

#### TAMD60

1. Close the bottom valve and drain the water in the sea-water system.
2. Remove the pipe between the sea-water pump and the engine oil cooler. Remove the cooler's front end cover.
3. Loosen the pipe between the oil cooler and the after-cooler. Loosen the oil cooler's rear end cover and remove cover and pipe.
4. Pull out the cooler insert. The insert can only be pulled out forwards, as it has a flange on the front end.
5. Wash the insert in white spirit and blow dry with compressed air. Clean the tubes inside with a suitable brush. Also clean the housing.
6. Refit the parts in reverse order. Use new gaskets and O-rings. Open the bottom valve, start the engine and check for leakage.

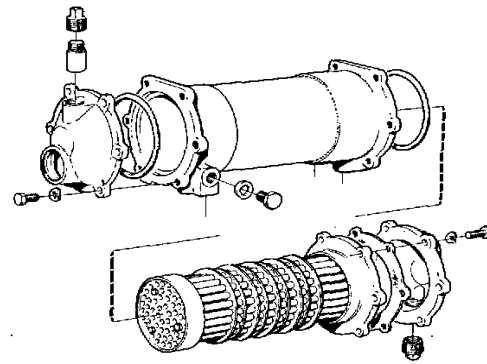


Fig. 183. Oil cooler, TAMD60

#### MD70C, TMD70C and reverse gears

1. Close the bottom valve and drain the water in the sea-water system.
2. Remove the coolant pipes to the oil cooler.
3. Remove both end covers and press out the insert. Certain reverse gears have an insert with a flange on one end and can consequently only be pulled out one way.
4. Wash the insert in white spirit and blow dry with compressed air. Clean the tubes inside with a suitable brush. Also clean the housing and the end covers.
5. Fit the insert with new gaskets.
6. Open the bottom valve, start the engine and check for leakage.

#### Pressure testing the oil cooler

If leakage is suspected, remove the oil cooler from the engine or reverse gear and pressure test separately.

**NOTE!** Follow applicable safety instructions.

#### TD60, TID60

*Special tool: 6033 together with a pressure testing device of fluid-type*

1. Drain the coolant and remove the oil cooler from the engine. Let the O-rings remain in the flange of the oil cooler for connection to the oil system.
2. Fit the tool 6033, fig. 184. Check that it seals properly against the O-rings.

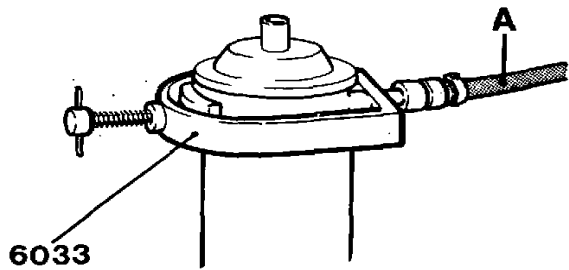


Fig. 184. Pressure testing the oil cooler, TD60, TID60  
A. Conn. to pressure testing device with pressure gauge.

3. Connect the tool to a pressure testing device of fluid-type.
4. Set to a pressure of 30 kPa ( $0.3 \text{ kp/cm}^2 = 4.3 \text{ p.s.i.}$ ) and maintain the pressure for 1 minute. No pressure-drop is permitted.
5. Increase the pressure to 500 kPa ( $5 \text{ kp/cm}^2 = 71 \text{ p.s.i.}$ ) and maintain pressure for 1 minute. No pressure drop is permitted.

If the pressure drops, then there is leakage which means that the complete oil cooler must be replaced. Repair of the oil cooler is not permitted.

#### TD70, TID70, TAMD70

1. Drain the coolant (fresh-water system on TAMD70) and remove the oil cooler insert from the engine. See "Cleaning the oil cooler", above engines on page 93.
2. Connect the oil cooler to a pressure testing device of fluid-type. Pressure test with 200 kPa ( $2 \text{ kp/cm}^2 = 28 \text{ p.s.i.}$ ) and maintain the pressure for 5 minutes. No pressure drop is permitted.

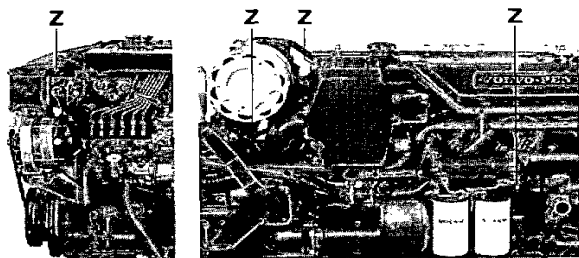


Fig. 185. TAMD60  
Z = Zinc electrodes

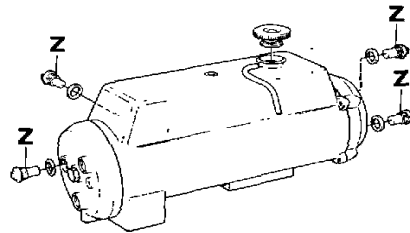


Fig. 186. Tubular heat exchanger, MD70, TMD70, TAMD70  
Z = Zinc electrodes

#### Other marine engines

1. Close the bottom valve and drain the water in the sea-water system.
2. Remove the oil cooler from the engine or the reverse gear.
3. Pressure test the oil side of the engine's oil cooler with a pressure of 800 kPa ( $8 \text{ kp/cm}^2 = 114 \text{ p.s.i.}$ ). The oil side of the reverse gear's oil cooler is pressure tested with a pressure of 3 MPa ( $30 \text{ kp/cm}^2 = 427 \text{ p.s.i.}$ ). Use paraffin for pressure testing.

#### Checking the zinc electrodes

(applies to marine engines)

Close the bottom valve and drain the water from the cooling system.

Unscrew the electrodes and remove any deposits there may be on them by scraping or using a wire brush. If an electrode is consumed by more than 50 % of its original size, it must be replaced.

When fitting, make sure that good metallic contact is maintained between the electrodes and the material.

Close the drain cocks, fill the fresh-water system with coolant and vent the system. See "Filling with coolant" on page 88. Open the bottom valve before starting the engine.

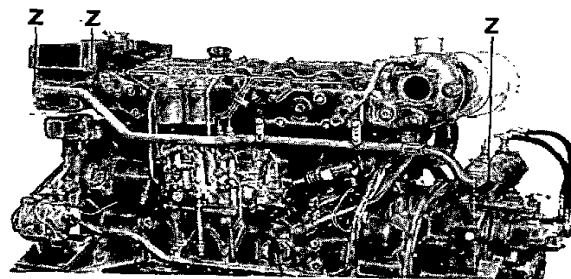


Fig. 187. MD70, TMD70 with plate heat exchanger  
Z = Zinc electrodes

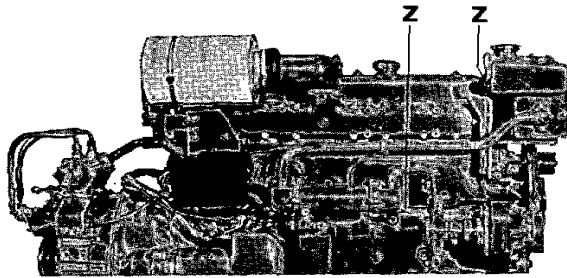


Fig. 188. MD70, TMD70 with plate heat exchanger

Z = Zinc electrodes

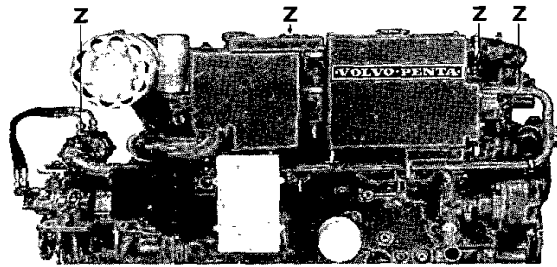


Fig. 190. TAMD70 with plate heat exchanger

Z = Zinc electrodes

## Sea-water pump

(applies to marine engines)

### Replacing the impeller

1. Close the bottom valve and drain the water in the sea-water system.
2. Remove the pump end cover. Pull out the impeller using a polygrip.
3. Clean the housing internally. Grease the pump housing and the inside of the cover with some lubricating grease.
4. Press in the new impeller with a rotating movement (clockwise). Fit the sealing washers in the outer end of the impeller centre, unless this has been done earlier.
5. Fit the cover using a new gasket. Always carry a spare impeller and gasket.
6. Close the drain cocks and open the bottom valve before starting the engine.

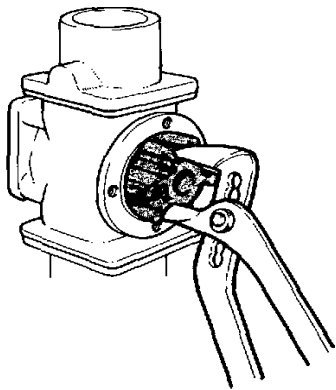


Fig. 189. Removing the impeller

### Removing the sea-water pump

1. Close the bottom valve and drain the water in the sea-water system.
2. Remove the trickle-feed line to the optional bilge pump, if fitted.  
**TAMD60:** Loosen the line from the pump inlet. Remove the flange with the hose attachment together with the pipe to the oil cooler.  
**70 series:** Disconnect the pipe connections from the pump inlet and outlet.
3. Remove the pump (intermediate flange) from the auxiliary drive gear casing.

### Replacing the seals

1. Remove the pump from the engine and dismantle the cover.
2. Pull out the impeller using a polygrip.
3. Remove the circlip from the shaft journal. Dismantle the pump housing together with the sealing rings. Remove the sealing ring located in the housing.
4. Place the new ceramic ring (6, fig. 191) in the pump housing with the rubber casing downwards. **NOTE!** The ceramic ring must not come into contact with grease or be touched with the fingers since this can impair the sealing. Lay a piece of transparent plastic foil over the ceramic ring as protection and then press the ring into position using the handle of a hammer.
5. Check that the ring (8) is located on the journal. Fit the pump housing in place without tightening the bolts.
6. Press down the brass sleeve with the carbon ring (5) facing the ceramic ring. **NOTE!** The carbon ring must not come into contact with grease or be touched with the fingers. Place the circlip (4) on the shaft.
7. Grease the pump housing and the inside of the cover with some lubricating grease. Press in the impeller with a rotating movement (clockwise). Make sure that the sealing washers in the outer end of the impeller centre are fitted. Bolt the cover firmly in position using a new gasket.
8. Fit the pump on the engine. See "Fitting the sea-water pump".

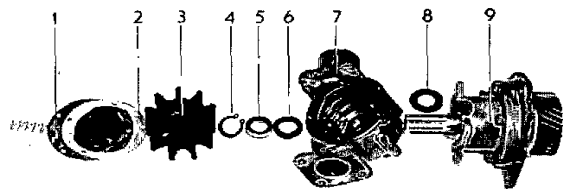


Fig. 191. Sea water pump

- |                |                    |
|----------------|--------------------|
| 1. Cover       | 6. Ceramic ring    |
| 2. Gasket      | 7. Pump housing    |
| 3. Impeller    | 8. Deflector ring  |
| 4. Circlip     | 9. Bearing housing |
| 5. Carbon ring |                    |

### Replacing the bearings

1. Remove the pump from the engine, and then dismantle the impeller, seals and pump housing. See "Replacing the seals".
2. Unscrew the shaft nut and pull off the gear. Remove the key.
3. Remove the circlip and press out the shaft end bearings. Remove the sealing ring located in the bearing housing.
4. Fit a new sealing ring in the bearing housing. The side with the spring must face the bearings.
5. Grease the bearings and fit the bearings and shaft in the housing. Fit the circlip. Fit the key and press on the gear. Tighten the shaft nut and lock it with the washer.
6. Fit the other parts, see "Replacing the seals".

### Fitting the sea-water pump

Use new sealing rings when assembling. Do not forget the sealing against the auxiliary drive gear casing.

1. Bolt the pump firmly to the auxiliary drive gear casing and turn the pump housing to the correct position.
2. **TAMD60:** Fit the flange with the water connections.  
**70 series:** Connect outlet and inlet pipes and tighten them.
3. Tighten the bolt securing the pump housing to the bearing housing.
4. Check the rubber hose at the inlet. Replace the hose if it is cracked or damaged in any other way. Connect the hose and tighten the hose clamps. Fit the trickle-feed line to the bilge pump, if fitted, (optional equipment).

Close the drain cocks and open the bottom valve before starting the engine.

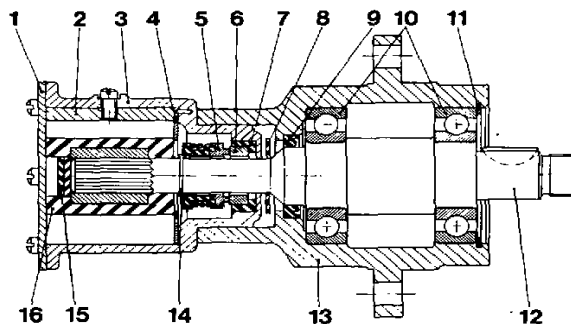


Fig. 192. Sea-water pump

- |                   |                     |
|-------------------|---------------------|
| 1. Cover          | 9. Sealing ring     |
| 2. Cam disc       | 10. Ball bearing    |
| 3. Pump housing   | 11. Circlip         |
| 4. Wear ring      | 12. Shaft           |
| 5. Carbon ring    | 13. Bearing housing |
| 6. Ceramic ring   | 14. Circlip         |
| 7. Rubber cover   | 15. Sealing washers |
| 8. Deflector ring | 16. Impeller        |

### Thermostats

#### Replacing the thermostats

##### T(I)D60, T(I)D70, TAMD70, and (T)MD70 with tubular heat exchanger

1. Drain a sufficient amount of coolant (fresh-water system on the marine engines).
2. Disconnect the upper coolant hose from the thermostat housing cover. Remove the cover and lift off the thermostats.
3. Fit rubber gaskets on the new thermostats. Clean the contact surfaces in the thermostat housing and in the cover.
4. Place the thermostats in the housing and fit the cover with a new gasket. Connect the hose.
5. Fill with coolant. See "Filling with coolant" on page 88.

##### TAMD60

1. Drain a sufficient amount of coolant from the fresh-water system.
2. Remove the cover over the heat exchanger housing. Lift off the thermostats.
3. Fit rubber gaskets on the new thermostats. Clean the contact surfaces in the thermostat housing.

4. Place the thermostat holder rings and the O-rings in the correct place in the housing. Check that the thermostats are equipped with a venting valve. The position between the thermostats is of no importance.
5. Fit the cover on the heat exchanger housing with a new sealing ring.
6. Fill with coolant and vent the system. See "Filling with coolant" on page 88.

#### MD70, TMD70 with plate heat exchanger

1. Drain a sufficient amount of coolant from the fresh-water system.
2. Remove the expansion tank cover.
3. Remove the thermostat holder and lift off the thermostats.
4. Fit rubber gaskets on the new thermostats. Clean the contact surfaces in the expansion tank and insert the thermostats. Fit the holder.
5. Fit the cover on the expansion tank with a new gasket.
6. Fill with coolant and vent the system. See "Filling with coolant" on page 88.

#### Checking the thermostats

1. Lower the thermostats into heated water.
2. Check with a thermometer when the thermostats start to open and when they are fully open. For temperatures, see under "Technical Data".
3. Check the closing function and that the thermostats seal properly against the seats. **NOTE!** If the thermostats do not close fully, the engine will run at too low a temperature.

Remove any rust flakes, deposits, etc. Replace damaged thermostats or thermostats which do not maintain the opening temperatures indicated.

#### Coolant pump

##### Removing the coolant pump

1. Drain the cooling system (fresh-water system on marine engines).
2. **Industrial engines:** Dismantle the belt guard and remove the radiator with fan housing, also remove the cooling fan on engines with this equipment.
3. Dismantle the belt tensioner and remove the drive belts.
4. **MD70C, TMD70C, TAMD70E:** Remove the belt pulley on the drive output for the coolant pump and alternator.

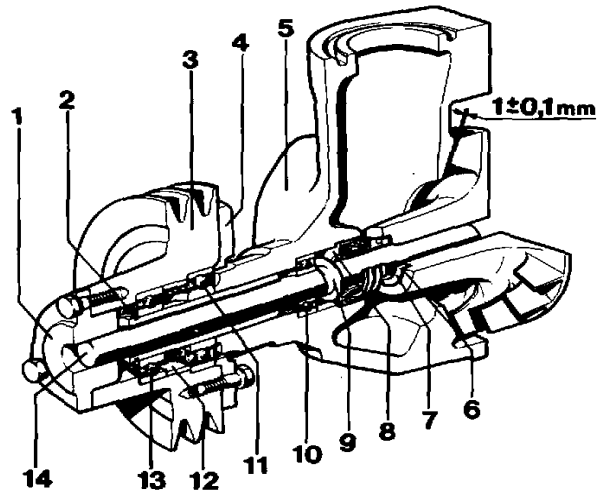


Fig. 193. Coolant pump, (T)MD70, TAMD70

- |                 |                          |
|-----------------|--------------------------|
| 1. Flange       | 8. Seal                  |
| 2. Circlip      | 9. Deflector ring        |
| 3. Belt pulley  | 10. Rear bearing         |
| 4. Lock plate   | 11. Intermediate bearing |
| 5. Pump housing | 12. Spacer sleeve        |
| 6. Rubber ring  | 13. Front bearing        |
| 7. Ceramic ring | 14. Shaft with impeller  |

5. Disconnect the coolant connections to the pump.
6. Unscrew the bolts attaching the pump to the block/intermediate piece and lift out the pump.
7. **TD60, TID60:** Remove the intermediate piece between the pump housing and the cylinder block.

#### Disassembling the coolant pump

*Special tool:* 2265, 2266, 2267, 2268, 2429

1. **MD70C, TMD70C, TAMD70E:** Unscrew the bolts to the pulley hub flange.

**Other engines:** Unscrew the fan hub attachment bolts.

2. Place the pump as shown in fig. 194 and knock out the pump shaft downwards until the hub (or flange) is free, using a  $\varnothing$  14 mm (1/2") drift.

3. **MD70C, TMD70C, TAMD70E:** Remove the flange.

**Other engines:** Remove the belt pulley hub.

4. Use drift 2268 to press out impeller, shaft, seal, deflector ring and rear bearing in one operation (fig. 195).

**NOTE!** The deflector ring will be damaged in connection with this and a new ring must always be fitted. If the rear bearing should stick on the shaft during the pressing out operation, remove the bearing from the shaft by using press washer 2429.

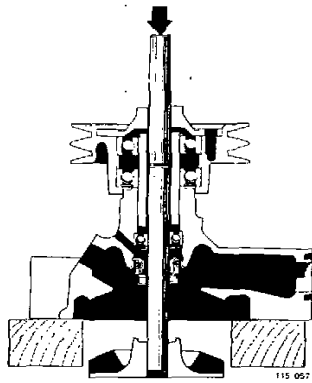


Fig. 194. Removing the fan hub

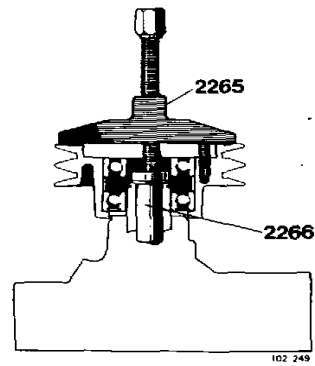


Fig. 196. Removing the pulley

5. Remove the circlip for the outer pulley bearing.
6. Place the counterhold 2266 (fig. 196) in the pump housing's extended bearing journal.

**Points 7, 8 and 9 apply only for MD70C, TMD70C, and TAMD70E**

7. Fit a universal puller and pull off the pulley with the bearings.
8. Fasten the pulley hub in a vice and remove the bolts securing the lock plate at the rear of the pulley. Remove the lock plate.
9. Place the pulley on a suitable counterhold and press out the bearings using drift 2267.

**Points 10, and 11 apply for all other engines**

10. Apply puller 2265 and pull off the pulley with the bearings.

11. Place the pulley as shown in fig. 197 and press out the bearings using the drift 2267.
12. Clean the pump thoroughly. Make sure that all old grease is removed.

**Inspecting the coolant pump**

Check the bearings. They must not chafe and must run lightly. The balls and races must not be "blued". Also check the fit of the bearings against the bearing journal and pulley. The bearing races must not have rotated. Replace damaged parts.

Make sure that the impeller is in good condition. The impeller and shaft are only available as replacement parts as one integral unit.

Replace the seal, the wear ring (ceramic ring) in the impeller and the deflector ring in connection with each reconditioning operation.

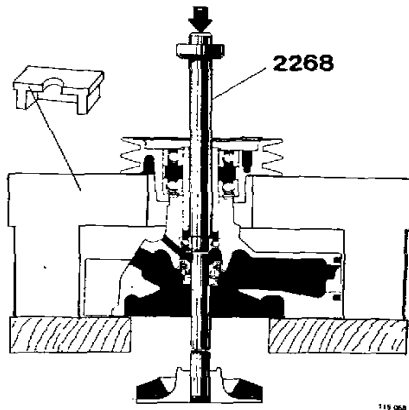


Fig. 195. Removing the impeller, bearing and seal

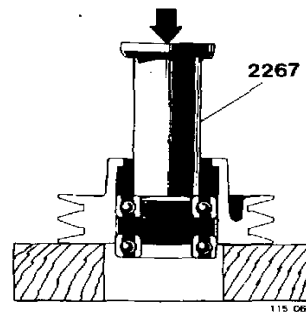


Fig. 197. Removing the bearings

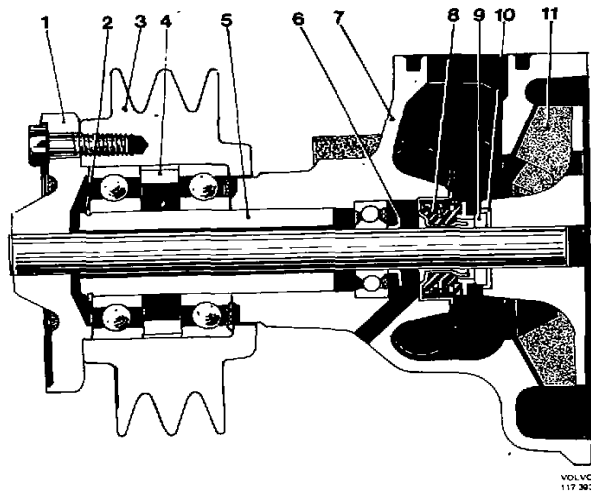


Fig. 198. Coolant pump, other engines

- |                           |                         |
|---------------------------|-------------------------|
| 1. Pulley hub (flange)    | 7. Pump housing         |
| 2. Circlip                | 8. Pump seal            |
| 3. Pulley                 | 9. Wear ring            |
| 4. Spacer sleeve          | 10. Rubber seal         |
| 5. Journal (pump housing) | 11. Impeller with shaft |
| 6. Deflector ring         |                         |

### Assembling the coolant pump

Special tools: 2267, 2268, 2269, 2270

**NOTE!** Use Volvo grease, part No. 1161121-7 (225 grams tube) or equivalent (e.g. Chevron SRI grease 2).

1. Fill each bearing for the pulley with grease.

#### Points 2–5 apply to MD70C, TMD70C, and TAMD70E

2. Using drift 2267 press the front bearing into the pulley.
3. Fit the spacer ring after filling the space all round with approx. 7 cm<sup>3</sup> (0.43 in<sup>3</sup>) of grease. Press the rear bearing into the pulley using drift 2267. The sealed side of the bearing should face upwards.
4. Secure the pulley hub in a vice. Fit the lock plate (4, fig. 193) at the rear of the pulley.
5. Place the fixture 2269 in place of the impeller (fig. 200). Press on the pulley with bearings until the circlip (2, fig. 198) can be fitted accurately. Fit the circlip.

6. Fit the flange in the pulley hub and tighten the bolts.

#### Points 7–10 apply for all other engines

7. Using drift 2267 press the rear bearing into the pulley (fig. 199). The sealed side of the bearing should face downwards.
8. Place fixture 2269 in the place of the impeller (fig. 200). Use drift 2267 and press on the pulley together with the rear bearing, but stop when the bearing inner is approx. 0.5 mm (0.020") from the bottom seat against the pump housing (fig. 200).
9. Fit the spacer ring after filling the space all round with approx. 7 cm<sup>3</sup> (0.43 in<sup>3</sup>) of grease. Press the front bearing in the pulley using drift 2267 until the circlip can be accurately fitted. Fit the circlip.
10. Press on the fan hub and tighten the hub attaching bolts.
11. Place the pump in a counterhold as per fig. 201. Press the bearing into the pump housing using drift 2268.

**Note!** In those cases where the bearing is only sealed on one side, the bearing should be filled with grease and a further approx. 0.9 cm<sup>3</sup> (0.05 in<sup>3</sup>) of grease placed in the space inside the bearing recess. The sealed side of the bearing should be turned to face upwards (against the water side). Double sealed bearings are filled with grease by the manufacturer.

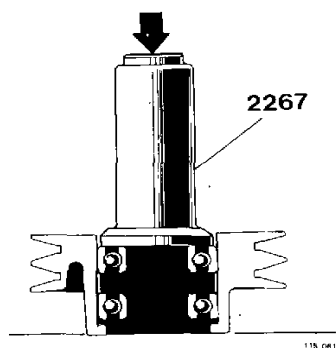


Fig. 199. Fitting front and rear bearing into the pulley

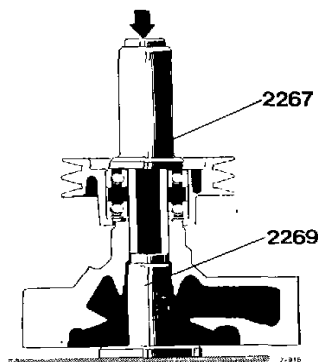


Fig. 200. Fitting the pulley and bearings

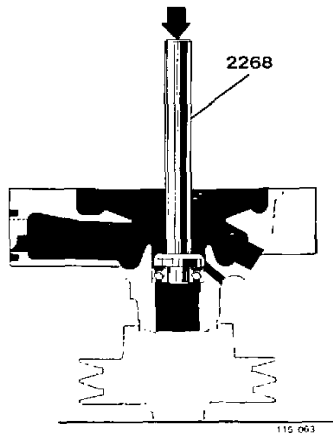


Fig. 201. Fitting the rear bearing in housing

12. Fit the deflector ring with the flange facing away from the bearing and press in the shaft seal against the seat using drift 2270 (fig. 202).

**NOTE!** The carbon ring and the ceramic ring included in the seal must not come into contact with grease or be touched with the fingers.

13. Immerse the rubber ring and the wear ring (ceramic ring) in soapy water. Fit the rubber ring into the impeller and carefully press the wear ring into position.
14. Place the pump in such a way that the counterhold is against the bearing journal. (The pump shaft should be able to go free). Make sure that the deflector ring is fitted properly and insert the shaft through the seal. Press in the shaft and impeller so far that there is a clearance of 0.9–1.1 mm (0.035–0.043") between the pump housing and the impeller blades.
15. Check the pump by rotating the pulley.

**NOTE!** The tubular pin in some overhaul kits should not need to be fitted.

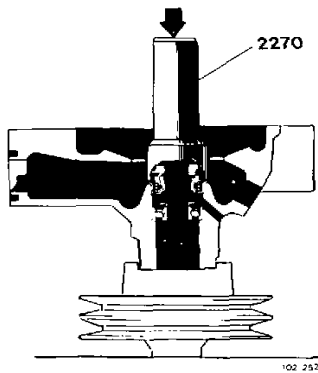


Fig. 202. Fitting the seal

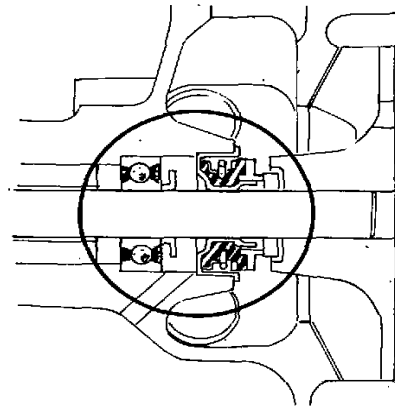


Fig. 203. Inner bearing and sealing

### Fitting the coolant pump

1. **TD60, TID60:** Fit the intermediate piece between the cylinder block and pump with a new gasket.
2. Fit the pump with a new gasket between the cylinder block/intermediate piece and the pump, and also a new sealing ring between the pump housing and the thermostat housing/heat exchanger.
3. **MD70C, TMD70C, TAMD70E:** Fit the pulley on the drive take-off in the auxiliary drive gear cover. Tightening torque 150 Nm (15 kpm = 109 lbf.ft).
4. Check the drive belts, replace if necessary. Fit the belts and adjust the belt tension in accordance with the instructions on page 90. (TD70 and TID70 are equipped with an automatic belt tensioner).
5. Fit the coolant lines and other components. Fill with coolant, see "Filling with coolant" on page 88.

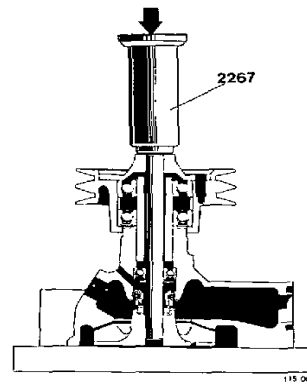


Fig. 204. Fitting the fan hub

# TURBOCHARGER

## DESCRIPTION

### General

All engines except the MD70C are fitted with turbocharger. On the industrial engines a turbocharger of the make Garrett/AiResearch is used, whereas the marine engines have a turbocharger of the make K.K.K. The working principle is, however, the same. The turbo units have floating bearings and consist of an exhaust turbine, bearing housing, and compressor.

The exhaust gases pass through the turbine housing (4), causing the turbine rotor (3) to rotate, before passing out through the exhaust system. The turbine rotor thus drives the compressor rotor (2) since the turbine and the compressor rotors are mounted on the same shaft. The compressor rotor is located in a compressor housing (1) which is connected between the air channel from the air filter and the engine inlet manifold.

Rotation of the compressor rotor sucks in and compresses air from the air cleaner before forcing it, under pressure (supercharging pressure) into the engine cylinders. This surplus air means that the amount of fuel injected can be increased, at the same time as combustion efficiency is improved, resulting in higher output, lower specific fuel consumption and cleaner exhaust gases.

The turbocharger is lubricated and cooled by the engine lubricating oil. The oil is circulated through the outer pipe line connections. On marine engines the turbine housing is fresh-water cooled to reduce heat radiation to the engine compartment.

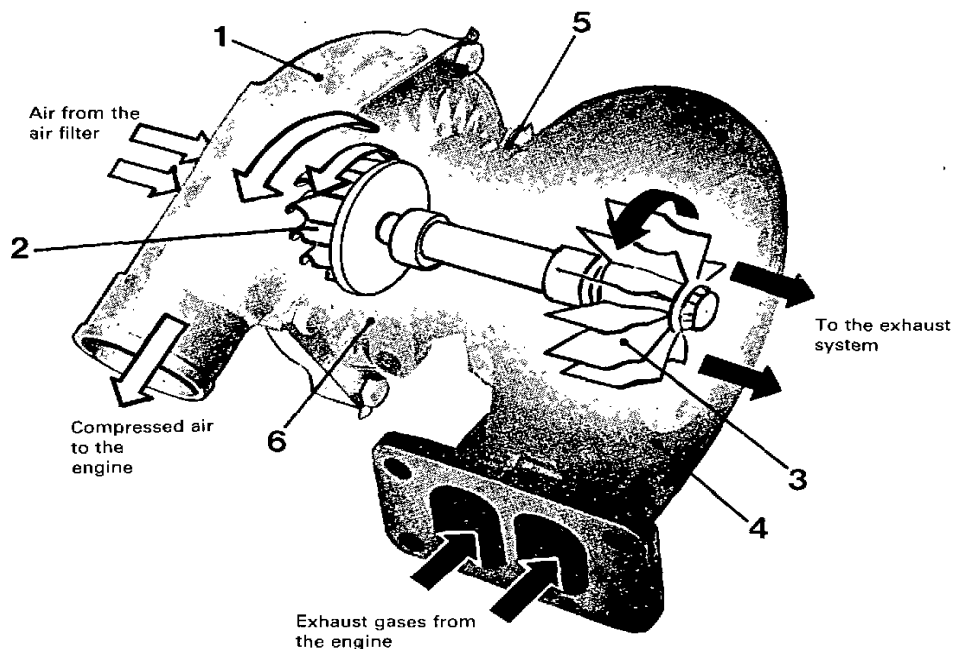


Fig. 205. Turbocharger, working principle

- |                       |                    |
|-----------------------|--------------------|
| 1. Compressor housing | 4. Turbine housing |
| 2. Compressor rotor   | 5. Oil intake      |
| 3. Turbine rotor      | 6. Oil outlet      |

## REPAIR INSTRUCTIONS

In the case of excessive exhaust smoke or if the engine output is particularly low, there can be reason to suspect a defect in the function of the turbocharger. Thus the supercharging pressure should be checked.

### Checking supercharging pressure

1. Connect a pressure gauge to the measuring connection on the inlet manifold which has a 1/8"-27 NPSF thread. The pressure gauge should have a sufficiently long connecting hose, so as to facilitate read-off in a convenient location. On industrial engines the pressure gauge 6065 can be used together with the nipple 6223 (5/16"-18 UNC thread.)
2. Measurement should be carried out continuously under full loading at full throttle while engine speed relatively slowly passes a certain value which is specified for the engine type concerned, see "Technical Data" figs. 1-8. The turbo pressure must not be less than the minimum specified value.

Check the engine speed by using a hand revolution counter (tachometer).

**NOTE!** In order to obtain true results, it is important to maintain **full loading for a sufficient length of time to enable the pressure to become stabilized.** Also note that the **pressure varies with the temperature of the intake air** (ambient air temperature) as shown in fig. 206.

The charging pressure is stated at +20°C (68°F) which implies that the pressure measured must be corrected as shown in the diagram if the intake air does not have this temperature at the time when measurement is carried out.

Example: A pressure of 80 kPa (0.8 kp/cm<sup>2</sup> = 11.3 p.s.i.) measured at -10°C (+14°F) corresponds to 70 kPa (0.7 kp/cm<sup>2</sup> = 10 p.s.i.) at +20°C (68°F), that is to say the pressure decreases as the temperature rises (lower air density).

### Measures to be carried out when charging pressure is too low

1. **Air intake**  
Check that the air intake to the engine compartment is sufficiently great. Refer to the installation instructions.
2. **Dirty air filter**  
Check that the air cleaner is not blocked. Replace filter if necessary, see page 84.
3. **Leakage**  
The inlet and exhaust manifolds, the hoses and connections etc. must not leak. Also check the joints between the compressor bearing housing, the turbine housing and compressor housing.
4. **Engine speed control**  
Check that the controls can move the injection pump throttle lever to its maximum position.

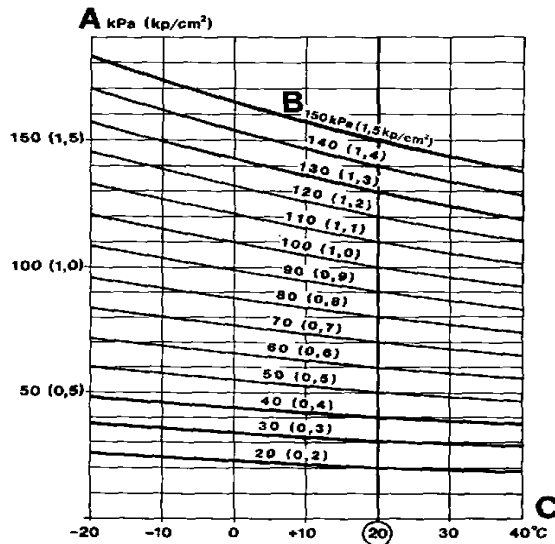


Fig. 206. Charging pressure at different temperatures

- A. Measured charging pressure
  - B. Correction curves
  - C. Intake air temperature
- (1 p.s.i. = 7 kPa/0.070 kp/cm<sup>2</sup>)

### 5. Turbocharger

Check if the rotor shaft runs stiffly or if the turbine or compressor rotors rub on their respective housings. Rotate the rotor, first with a light pressure and then with the application of a light axial load. If the rotor is difficult to turn, the turbocharger must be replaced or reconditioned as soon as possible. Check the blades on the rotors for damage.

For daily running in dusty or oil contaminated air, regular cleaning of the compressor housing and compressor rotor is recommended. A dirty compressor section can cause low charging pressure.

The compressor section can be cleaned with the unit still in position on the engine as follows:

Remove the compressor housing. Clean the compressor housing, the compressor rotor and the end cover with an agent such as white spirit. Fit the compressor housing and re-measure the charging pressure.

Also the turbine unit might need cleaning. Then the turbocharger must be removed from the engine.

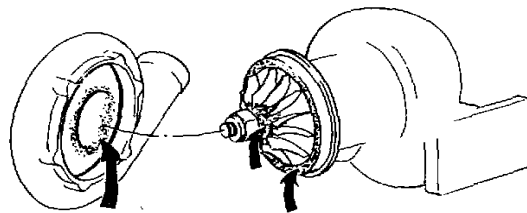


Fig. 207. Cleaning the compressor

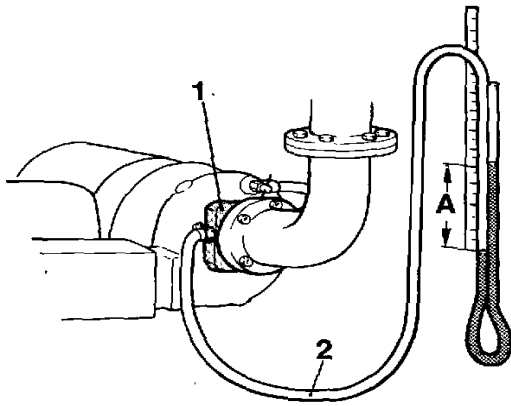


Fig. 208. Checking the exhaust counter-pressure

1. Flange for measuring
2. Transparent plastic hose, partly filled with water

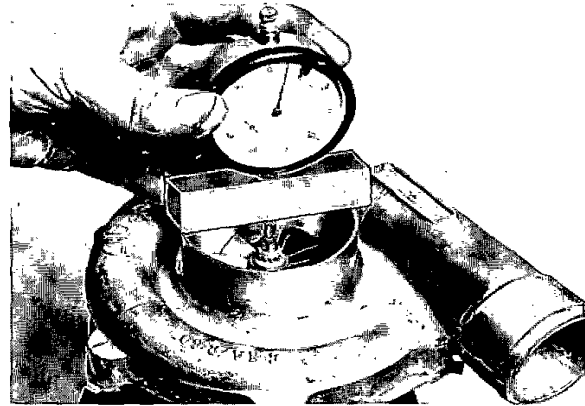


Fig. 209. Measuring the axial clearance

#### 6. Back-pressure

Check that the back-pressure in the exhaust system is not too high when the installation is complete. See under the following heading "Checking the exhaust back-pressure".

#### 7. Injection pump

Check the pre-injection angle and the max. unloaded speed. Also check the smoke limiter's breaker points, for leakage and the diaphragm if the pump is fitted with a smoke limiter (pressure-dependent full-load stop).

If necessary, check the entire injection pump in a test bench.

#### 8. Feed pressure

If necessary, replace the fuel fine filters and any optional pre-filter, if fitted. There must be no fuel leakage.

#### 9. Injectors, delivery pipes

Make sure that the injectors are of the right type, and check the opening pressure and spray pattern. Check that the delivery pipes are in good condition.

#### 10. Condition of the engine

Check the valve clearance and compression pressure.

If the supercharging pressure is still unsatisfactory in spite of the fact that the points mentioned above have been checked and found to be in good order, the turbocharger should be re-conditioned or replaced.

### Checking the exhaust back-pressure

*Special tools:* TD60D, TID60D – Flange kit 884542  
 TID60DG – Flange kit 884872  
 TD70G, TID70G – Flange kit 884713  
 TAMD60C, TMD70C, TAMD70E –  
 Flange kit 884513

1. Remove the exhaust pipe from the turbocharger exhaust outlet. Remove the stud bolts.

2. Clean the contact surfaces. Fit the longer stud bolts included in the flange kit.
3. Fit the measuring flange to the turbine housing with gaskets on both sides. Fit the exhaust pipe.
4. Connect a transparent plastic pipe to the measuring flange as shown in fig. 208 or, alternatively a low pressure manometer.

The difference between water column "A" gives the back pressure of the exhaust system in mm (in.) water column.

5. Run the engine at full load and full throttle for a few minutes and check that the back-pressure does not exceed specified values. Regarding maximum back-pressure, see applicable engine diagram/engine brochure.

An exhaust system with excessively high back-pressure decreases the turbocharging pressure, gives reduced engine power output and also increased exhaust smoke and exhaust gas temperature which, in its turn can lead to burnt valves and turbocharger failure.

### Checking the bearing clearances

The axial and radial clearances are normally only checked in connection with reconditioning, to determine the degree of wear in the unit.

### Measuring axial clearance

*Special tool:* According to fig. 11.

1. Place a dial indicator with an 8 mm (5/16") shank in the holder as shown in fig. 209. Secure the dial indicator.
2. Place the holder on the compressor housing. Make sure that the measuring point rests against the centre of the shaft. In certain cases it may be necessary to fit an extension to the pointer.

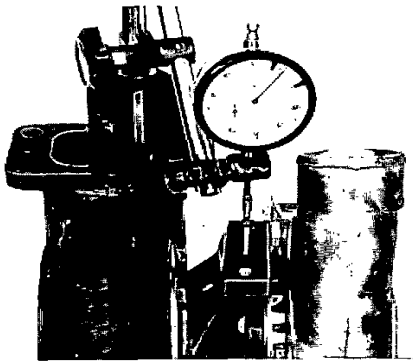


Fig. 210. Measuring radial clearance, AiResearch

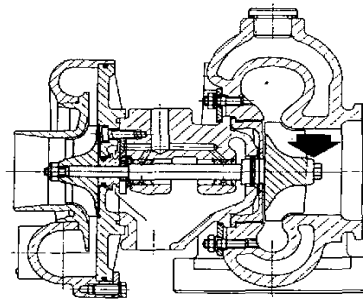


Fig. 211. Measuring position (radial clearance), KKK

3. Press the holder against the compressor intake, at the same time press the turbine rotor up and down by hand. Read off the dial indicator reading.

**Axial clearance:**

AiResearch ..... 0.03–0.10 mm (0.0012–0.0040")  
 KKK ..... max. 0.16 mm (0.0063")

3. Push the rotor, upon which the indicator arm is resting, upwards, at the same time as the rotor at the opposite end of the shaft is pushed downwards. Measure the radial clearance. Rotate the rotor through 90° and repeat the measuring procedure. Max. radial clearance 0.46 mm (0.018") (turbine side).

### Measuring radial clearance

#### AiResearch turbo

*Special tool: As shown in fig. 12.*

1. Insert the tool's bent measuring attachment through the oil outlet in the bearing housing. The end of the measuring attachment should rest against the turbine rotor shaft. Secure the tool plate with the oil return pipe bolts.
2. Place a dial indicator as shown in fig. 210, so that the measuring point rests against the tool measuring attachment.
3. Take hold of the compressor rotor and turbine rotor, push and pull the turbine shaft in a radial direction with even force.
4. Read off the dial indicator readings. The radial clearance should lie within 0.08–0.18 mm (0.0032–0.0071").

#### KKK turbo

1. Place a rocking arm dial indicator with its measuring point on the turbine rotor hub as shown in fig. 211.
2. Press the rotor, upon which the indicator arm is resting, downwards, at the same time as the rotor at the opposite end of the shaft is pushed upwards. Set the indicator to zero.

### Removing the turbocharger

In order for the turbo assembly to function satisfactorily it is vital that the engine lubrication system is maintained in good condition and that the correct type of oil is used (see "Technical Data"). The engine oil and filter should preferably be replaced **before** removing the turbo unit, so that the engine can run for some minutes with the new oil.

1. Wash clean the areas around the turbocharger.
2. Disconnect the exhaust line at the turbo outlet.

#### Points 3 and 4 apply only to marine engines

3. Drain off some of the coolant from the fresh-water system and disconnect coolant connections to and from the turbo.
4. Remove the air filter and connecting pipe between the turbocharger and the after-cooler/engine's intake manifold.

#### Points 5, 6, and 7 apply only to industrial engines

5. Remove the air filter and the intake pipe between the filter and the turbocharger.
6. **TD60, TD70:** Disconnect the battery connection.  
**TD60:** Remove the cables from the engine's cable harness to the pre-heater's operating relay.
7. **TD60:** Remove the connecting pipe between the turbocharger and the engine intake manifold complete with pre-heater and relay.  
**TD70:** Remove the connecting pipe between the turbocharger and the pre-heater. Hang up the bracket with the pre-heater's operating relay.
8. Disconnect the oil pipes to and from the turbo.
9. Bend up the lock tabs and remove the turbo from the exhaust manifold.

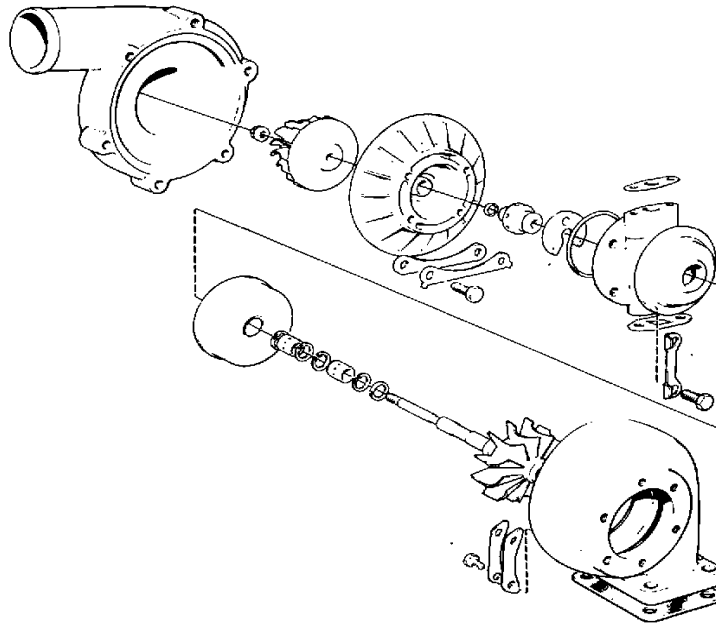


Fig. 212. Turbocharger, AiResearch

### Disassembling AiResearch

1. Make line-up marks between the turbine housing, bearing housing and compressor housing.
2. Remove the bolts, lock tabs and clamp washers which attach the compressor housing and turbine housing to the bearing housing. Tap, if necessary, with a soft hammer to separate the components.

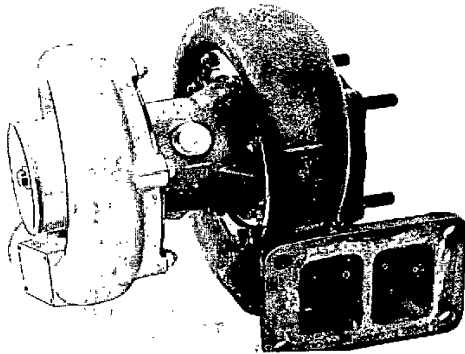


Fig. 213. Line-up marking prior to disassembly

**Note!** Be careful when dismantling the housings so as not to damage the compressor or turbine rotors. These components cannot be repaired but must be replaced if damaged.

3. Place the rotor unit in a suitable fixture (fig. 13) to prevent the turbine rotor from damage when disassembling.
4. Hold the turbine rotor with a suitable socket and unscrew the compressor rotor nut. Use a T-bar and a socket so as not to apply oblique load to the turbine rotor shaft. Lift off the compressor rotor.
5. Pull the turbine rotor shaft out of the bearing housing. Remove the protective cover (8, fig. 214).

**Note.** The turbine rotor shaft is not locked in the bearing housing and can easily fall out once the compressor rotor nut has been removed.

6. Remove the bolts and lock tabs which hold the end cover (14) to the bearing housing. Tap off the end cover with a soft hammer.
7. Remove the thrust sleeve (3) and the thrust bearing (13) from the bearing housing.
8. Dismantle the lock rings and bearing bushings from the bearing housing.

### Cleaning and inspection

See pages 109 and 110.

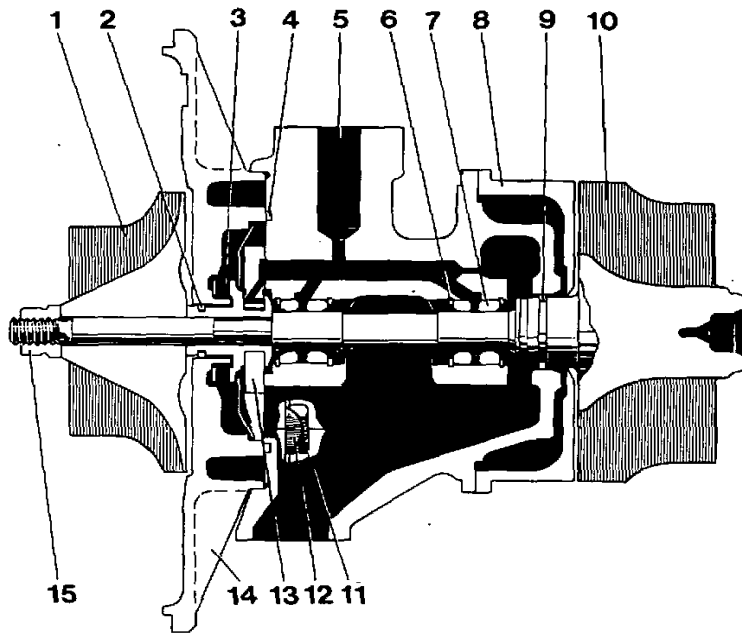


Fig. 214. Rotor unit, AiResearch

1. Compressor rotor
2. Piston ring seal, compressor side
3. Thrust sleeve
4. O-ring seal
5. Bearing housing
6. Circlip
7. Bearing bushing
8. Protective cover
9. Piston ring seal, turbine side
10. Turbine rotor with shaft
11. Fixture screw for end cover
12. Lock washer
13. Axial thrust bearing
14. End cover
15. Lock nut for compressor rotor

### Assembling AiResearch

Before assembling check that all components are properly cleaned. It is very important that no contaminant particles enter the turbo during assembly. Oil in all moving parts with clean engine oil at assembly.

1. Fit the inner circlips for the bearing bushings. Locate the bushings in place and fit the outer circlips.
2. Turn the bearing housing so that the turbine rotor side (the end without bolt holes) faces upwards. Place the protective cover (8, fig. 214) on the bearing housing.
3. Fit the piston type ring in its groove on the turbine rotor shaft. Guide the shaft through the cover and the bearing housing bushings.
4. Fit the piston type ring to the thrust sleeve (3). Place the thrust bearing (13) over the thrust sleeve.
5. Fit the thrust sleeve onto the turbine rotor shaft. Turn the thrust bearing so that it engages with the location pins in the bearing housing.
6. Place the rubber ring (4) in the bearing housing groove.
7. Check that the thrust spring is fitted in the end cover (14). Place the end cover onto the shaft and thrust sleeve. Turn the end cover so as to bring the bolt holes in the end cover and the bearing housing into alignment.
8. Fit the end cover. Take care not to break the piston type ring when inserting the seal in the end cover. The end cover is assembled easiest if the ends of the piston type ring are inserted into the end cover first. Tighten the bolts to 8.6–10 Nm (86–104 kpcm = 75–90 lbf.in.) and lock them with the lock tabs.
9. Place the bearing housing with the turbine rotor in the fixture (fig. 13). Check that the front surface of the compressor rotor hub and the shaft nut contact surfaces are even and clean. Fit the compressor rotor. Oil the nut thread and the contact surface against the hub and tighten the nut to 2.1–2.3 Nm (21–23 kpcm = 18–20 lbf.in.). Tighten the nut a further 110°. Use a T-bar and a socket so as not to apply an oblique load to the turbine rotor shaft.
10. Check the axial clearance (0.03–0.10 mm = 0.0012–0.0039") and that there is clearance between the protective cover (8) and the turbine rotor (10).
11. Fit the compressor housing onto the bearing housing using the line-up marks made earlier and tighten the bolts. Tightening torque 16.5–18.6 Nm (167–190 kpcm = 145–165 lbf.in.) for TA-3106 turbo (TID60DG), and 12.5–15 Nm (130–150 kpcm = 113–130 lbf.in.) for T-04B (other engines). Lock the bolts with the lock tabs on the T-04B turbo.
12. Smear the turbine housing contact surface against the bearing housing and the attachment bolt threads with graphite grease. Fit the turbine housing using the line-up marks made earlier. Tighten the bolts and lock them with the lock tabs. Tightening torque 18.5–21.9 Nm (190–224 kpcm = 165–195 lbf.in.) for TA-3106 turbo (TID60DG), and 11.3–14.7 Nm (115–150 kpcm = 100–130 lbf.in.) for T-04B (other engines).
13. Check that the rotors rotate freely by spinning the shaft at the same time as pressing the turbine rotor inwards. Afterwards, press in the compressor rotor and perform the same check.
14. Spray oil into the bearing housing. Fit protective caps over all openings if the unit is not to be fitted immediately.

With regard to fitting the turbocharger to the engine, see pages 110 and 111.

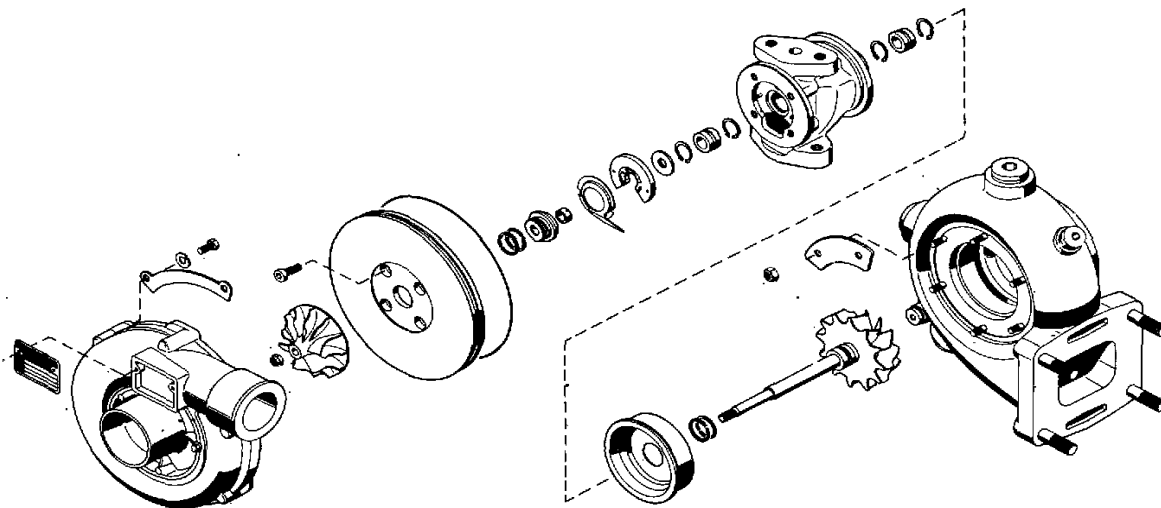


Fig. 215. Turbocharger KKK-K27

### Disassembling KKK

1. Make line-up marks between the turbine housing (7, fig. 217), bearing housing (6) and the compressor housing (1).
2. Remove the compressor housing and turbine housing.  
**NOTE!** Be careful when dismantling the housings so as not to damage the compressor or turbine rotors. These components cannot be repaired but must be replaced if damaged.
3. Secure the turbine rotor hub in a vice (use soft jaws). Be careful with the turbine rotor vanes. Mark up the location of the compressor rotor in relation to the turbine rotor shaft.
4. Unscrew the compressor rotor shaft nut. Use a T-bar and a socket so as not to apply oblique load to the turbine shaft. Lift off the compressor rotor. Press out the shaft if the rotor is a tight fit.
5. Remove the end cover (15) and press out the piston ring holder (2). Remove the piston rings.
6. Remove the oil deflector plate (13), the thrust bearing (4), the bushing (16) and the thrust washer (5). Lift off the bearing housing (6) and the heat shield (8) from the shaft.

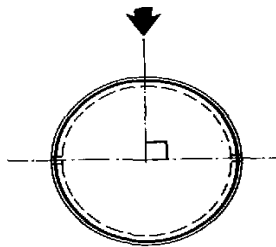


Fig. 216. Location of piston ring gaps, KKK-turbo

7. Remove the piston rings (10) and dismantle the lock rings and bearing bushings (12) from the bearing housing.

### Cleaning and inspection

See pages 109 and 110.

### Assembling KKK

Before assembling, check that all components are properly cleaned. It is very important that no foreign particles enter the turbo during assembly. Oil in all moving parts with clean engine oil during assembly.

1. Fit the inner circlips for the bearing bushings. Fit the bushing on the bearing housing turbine side and fit the outer circlip.
2. Fit the heat shield (8, fig. 217) to the bearing housing.
3. Secure the turbine rotor hub in vice (use soft jaws). Take care with the turbine rotor vanes.
4. Fit the piston rings (10) in the groove in the turbine shaft and carefully place the bearing housing over the shaft.
5. Locate the piston rings so that their gaps are at 180° in relation to each other. Press the rings together and fit them into the bearing housing with the piston ring gaps located at 90° in relation to the oil inlet (fig. 216). Check that the heat shield rotates freely.
6. Fit the bushing and the outer circlip on the compressor side of the bearing housing.

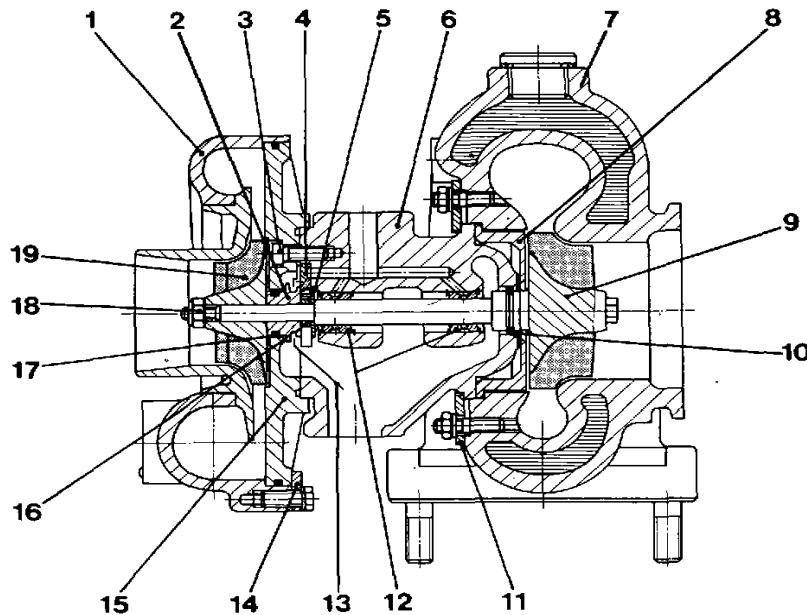


Fig. 217. Turbocharger KKK

1. Compressor housing
2. Piston ring holder
3. Screw
4. Thrust bearing
5. Thrust washer
6. Bearing housing
7. Turbine housing
8. Heat shield
9. Turbine rotor with shaft
10. Piston ring seals
11. Retaining washer
12. Bearing bushings
13. Oil deflector plate
14. Retaining washer
15. End cover
16. Bushing
17. Piston ring seals
18. Nut
19. Compressor rotor

7. Fit the thrust washer (5, fig. 217), the thrust bearing (4), the bushing (16) and the oil deflector plate (13).
8. Fit the piston rings on the piston ring holder (2). Locate the piston ring gaps in the same way as for the turbine rotor side and fit the holder into the end cover (15).
9. Apply a thin coat of sealant to the end cover sealing surfaces and attach it to the bearing housing with new self-locking screws (3). (If the old screws are used these should be secured with Loctite locking fluid.)  
Tightening torque 8 Nm (80 kpcm = 6 lbf.ft)
10. Heat up the compressor rotor (19) to about 100°C (212°F) and fit to the shaft so that the line-up marks coincide. Tighten the shaft nut to a torque of 10 Nm (100 kpcm = 7.2 lbf.ft). Use a T-bar and a socket so as to avoid oblique loading of the shaft. Allow the compressor rotor to cool down to about +30°C (86°F) ("hand warm"). Unfasten the nut and re-tighten using the same torque.
11. Place the O-ring on the end cover and fit the compressor housing (1) according to the previously made line-up marks. Tighten the screws to 7 Nm (70 kpcm = 5.1 lbf.ft).
12. Fit the turbine housing (7) according to the previously made line-up marks. Tighten the screws to 20 Nm (200 kpcm = 14.5 lbf.ft).
13. Check that the rotors rotate freely by spinning the shaft at the same time as pressing the turbine rotor inwards. Press in the compressor rotor and perform the same check.
14. Spray oil into the bearing housing. Fit protective caps over all openings if the unit is not to be fitted immediately.

For fitting the turbocharger to the engine, see pages 110-111.

### Cleaning the turbocharger components

The same method of cleaning is suitable for all makes of turbocharger. The greatest cleanliness must be exercised when cleaning and each component must be given special attention.

Examine all parts prior to cleaning for signs of friction marks, heat damage and other indications which do not show up so clearly after cleaning.

Immerse the parts in decarbonising agent. The washing solution must not be corrosive. Remove any residual deposits with a stiff bristle brush after soaking. Dry the parts carefully.

**NOTE!** Wire brushes must not be used when cleaning since they can cause scratches.

### Inspection

Carry out a systematic inspection of the compressor parts after careful cleaning. Small marks can be ground or polished out. Use cleaning cloth with silicon carbide as a grinding agent for aluminium parts and finishing grinding compound for steel parts. Clean the parts carefully before assembly. Always replace bushings and their lock rings, piston type ring seals, compressor rotor shaft nut, seal rings, turbine housing bolts and lock tabs in connection with reconditioning.

For more detailed reconditioning information, see respective turbo manufacturer's instructions.

### **Bearing housing**

Check the bearing housing for signs of contact with the rotating parts. The contact surface to the piston ring seal on the turbine side must not be scored or worn and the oil channels must be clean and free from constrictions. Also check the bushing recesses.

### **Turbine rotor and shaft**

Check that the turbine rotor does not have friction marks and that the vanes are not cracked, bent or so worn that the edges are sharp. The shaft may only have inconsequential marks, scratches or bearing binding damage. Check that the piston ring grooves are not conically worn. A damaged turbine rotor or shaft cannot be realigned but must be replaced as a complete unit.

Damage to the vanes can be caused by abnormal bearing wear but can also be due to loose particles from the exhaust channels and exhaust manifold. These components should therefore be checked in the event of such damage. *Damage due to bearing seizure is usually the result of poor maintenance of the engine lubricating system.*

With regard to balancing when replacing rotating parts, see "Balancing the rotor shaft" on this page.

### **Compressor rotor**

Check that the compressor rotor is free from cracks or other damage. Replace the compressor rotor if it is deformed. See also under heading "Turbine rotor and shaft".

### **Bushings, piston ring seals**

Replace bushings and piston ring seals each time reconditioning is carried out. Note that the bushings should have a floating fit in the bearing housing.

### **Thrust bearing and thrust washers**

Wear on the thrust bearing and the thrust washers can be determined by measuring the turbocharger axial clearance before disassembling. See "Measurement of axial clearance" on page 104. The parts are included in the reconditioning kit and should be replaced each time reconditioning is carried out.

### **End cover**

Check the end cover for signs of contact with rotating parts. Contact surfaces for the piston ring seal on the compressor side must not be scored or worn.

### **Piston ring retainer, thrust sleeve**

Check the retainer/sleeve side surfaces and piston ring groove. The groove width and conical tolerance is checked with a special measuring tool. Replace piston ring retainer/thrust sleeve if the groove is conically, or otherwise worn. The thrust sleeve should also be replaced if it shows signs of cracking, scoring, glazed deposits or contaminant particles embedded in the surfaces.

### **Compressor housing, turbine housing**

Check the housings for damage. Cracks or signs of contact with rotating parts necessitate replacement of the housing.

### **Balancing the rotor shaft**

All rotating parts are balanced separately. This means that no balancing operation is needed, no matter which component is replaced. This presumes, however, that rotating parts are replaced in the case of the slightest damage. If however, a balancing machine is available co-balancing can be advantageous from the service life point of view.

Further information concerning balancing machines, methods of balancing, max. permissible out of balance and where material can be removed from the various components, can be obtained from the turbo manufacturer. Balancing machines are normally profitable only for specialist workshops.

### **Fitting the turbocharger**

**NOTE!** Always determine the reason for replacing the turbo. Repair any sources of damage before fitting the new turbo unit.

In order for the turbo to function satisfactorily it is vital that the engine lubricating system and intake system is maintained in good condition, i.e. that the oil is replaced at the correct intervals with the right type of oil, and, most important of all, that the lubricating oil filter and air filter are properly maintained.

1. **Change the engine oil and replace the engine oil filter** if this has not already been carried out at the time of removing the turbo unit from the engine. **Clean the turbocharger delivery and return oil lines.**

Bearing damage in the turbocharger is nearly always caused by sludge deposits from the engine lubricating system. The presence of sludge deposits can be established by removing a rocker-arm casing. If sludge is present, the complete lubricating system must be cleaned thoroughly before fitting a new or reconditioned turbocharger.

Use the correct oil quality (see "Technical Data"). Oil replacement should be carried out according to the instruction book in order to keep the engine clean.

2. Clean loose carbon or metal particles etc. from the exhaust manifold and fit the turbocharger to the engine.

**Note.** To facilitate the handling of parts only turbochargers with one of the different angles between the compressor outlet and the turbine exhaust flange are being stocked in certain cases. This means that the angle relation might need adjusting for the turbocharger to fit the engine. Compare with the turbocharger that has been fitted on the engine.

3. Clean the intake pipe between the compressor and the engine. In the event of a turbo break-down, foreign objects, e.g. particles from a broken compressor rotor, can remain, which could destroy the new compressor or turbine rotor.
4. **Engines with intercooler:** It is important that also the intercooler is checked and cleaned. In the event of a turbo break-down with compressor rotor breakage, the intercooler must be removed and pressure-tested according to the instructions on page 93.
5. Fit the rubber hose on the compressor outlet after checking its condition. Replace the hose if it is dried out or cracked. Fit the connection pipe between the turbo and the engine intake manifold (complete with pre-heater/relay, if fitted, on certain versions). Tighten the hose clamps on the rubber hose.
6. **TD60:** Fit the heat shield over the hose. Fit the cables to the pre-heater and its operating relay as per the wiring diagram on page 116.

**NOTE!** When tightening the terminal nuts on the pre-heater, the terminals must always be held tight (fig. 218). The wire element can otherwise be turned and cause a short-circuit.

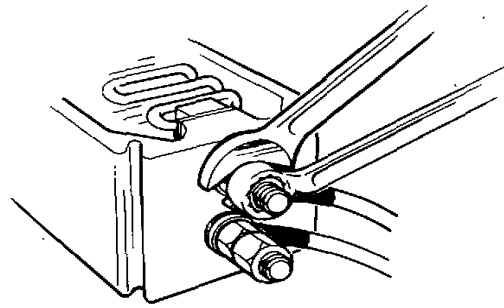


Fig. 218. Tightening the terminal nuts, TD60, TD70

7. **Industrial engines:** Clean the intake pipe which connect the compressor to the air filter. Check that the rubber hoses are not damaged and fit the intake pipe.
8. Fit a new air filter. (Particles from e.g. a broken compressor rotor can be carried against the air flow and out into the air filter).
9. Fit the turbocharger oil return pipe. Note that the rubber hose at the lower connection must be **oil resistant**.
10. **Marine engines:** Fit the coolant lines to the turbine housing. Fill with coolant and vent the system according to instructions on page 88.
11. Connect the exhaust line to the turbocharger.
12. **TD60, TD70:** Attach the battery connections.
13. Spray lubricating oil into the turbocharger bearing housing with an oil can. Fit the oil delivery line.
14. Place a suitable vessel for collecting oil under the compressor oil return connection. To avoid damage to the turbocharger, the engine should be **turned using the starter motor and with the stop solenoid connected/stop control pulled out, until oil pressure is obtained**. Then start the engine. Loosen immediately the oil return connection under the turbo and check that the oil is circulating properly. Tighten the oil return line and check for leakage. Take away the oil collecting vessel.

# ELECTRICAL SYSTEM

## DESCRIPTION

### General

The engines are equipped with a 2-pole\* electrical system with alternator. The starter motor, however, is single pole on the industrial engines, except for the T(1)D60DG and T(1)D70GG engines. The system voltage is 24V for industrial engines, and 24V (alt. 12V) for marine engines except for TAMD60C which has 12V (alt. 24V) system voltage.

The industrial engines are fitted with an electrical pre-heater.

The wiring diagrams are shown on pages 115-126.

\* TAMD60C and TAMD70E can also be equipped with a single pole electrical system (optional equipm.)

### Important

1. **Never break the circuit between the alternator and the battery while the engine is running. If a main switch is fitted it must never be switched off until the engine has stopped.** No cable may be disconnected while the engine is running, since this can damage the voltage regulator.

2. Check the batteries, battery cables and cable terminals at regular intervals. The battery terminals must be kept very clean and the terminal clamps must always be well tightened and thoroughly greased to avoid any interruptions. All cables should be well tightened. There must be no loose connections.

**NOTE!** Never reverse the battery positive and negative poles when installing the batteries. Compare with the wiring diagram. Check the drive belt tension regularly.

3. **When starting with the aid of an auxiliary battery refer to instructions on the next page.**
4. **Before carrying out any repairs on the alternator equipment, always first remove both the battery cables.** The same applies when rapid charging the batteries.

**NOTE!** Follow applicable safety regulations when charging batteries.

5. Never place a screwdriver or similar tool against any connection to see if there is any spark.
6. **Electrical welding**

When carrying out electrical welding the following measures should be taken:

Disconnect both battery cables. Then remove all cables to the alternator (and voltage regulator if mounted separately). Insulate the cables and reconnect the battery cables. Remember to disconnect the battery cables again before reconnecting the cables to the alternator and voltage regulator.

Connect the welding cables so that no current passes through any bearing.

### Pre-heater

The industrial engines are equipped as standard with an electrical pre-heater. Its function is to make starting easier and to reduce exhaust smoke when starting in cold weather.

On TD60 and TD70 the pre-heater consists of three wire elements connected in series (fig. 219) and is placed between the connection pipe from the turbocharger and the engine intake manifold. The output is approx. 2.8 kW. The pre-heater on TID60 and TID70 is placed in the engine intake manifold and consists of seven wire elements connected in series (fig. 221). The output is approx. 2.2 kW.

The pre-heater is engaged by the key switch, which has five positions: 0 position – stop position – running position – pre-heater position – starting position. When the starter key is set to pre-heater position, current is fed to a time relay, which via a switching relay closes the circuit to the pre-heater and keeps it engaged for abt. 50 seconds at the same time as the pre-heater indicator lamp in the instrument panel is lit. This results in powerful heating of the element so that it becomes red hot (approx. 700°C = 1300°F). The heater then warms the surrounding air in the intake pipe.

From the pre-heater position the starter key is turned further to the right to the starting position, where the starter motor is engaged. As the key passes the pre-heater position when it is turned back to running position, the pre-heater is engaged for another 50 seconds to reduce the exhaust smoke after starting a cold engine.

**Note.** It is vital that the starter key is turned to position 0 after stopping the engine. Otherwise the batteries will be discharged (e.g. the stop solenoid remains engaged.)

### Fuses

The industrial engines are fitted with one and TAMD60C, TAMD70E with two automatic fuses located in the connector box. The connector box is mounted on the right hand side of the engine on industrial engines and TAMD60C, and on the engine front on TAMD70E. The fuses can be reset by pressing the button on the side of the box (fig. 220).

TAMD60C and TAMD70E with the bigger alternator (CAV, 28V/60A) also have two 80A fuses for the alternator, see the wiring diagram (not fitted by Volvo Penta).

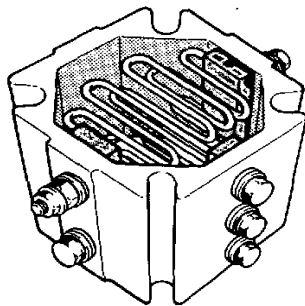


Fig. 219. Pre-heater, TD60, TD70

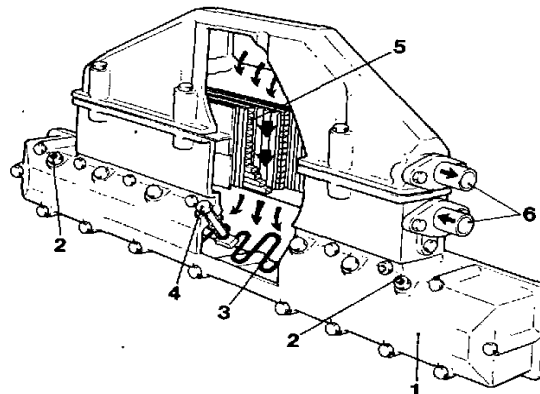


Fig. 221. Location of pre-heater, TID60, TID70

- |                    |                                   |
|--------------------|-----------------------------------|
| 1. Intake manifold | 4. Attaching bolts for pre-heater |
| 2. Terminals       | 5. Intercooler                    |
| 3. Pre-heater      | 6. Coolant connections            |

**MD70 and TMD70** have fuses for engine and alternator in the connector box on the right hand side of the engine (fig. 222).

When replacing fuses, bend first off the cover in the direction of the arrows. Replace the damaged fuse by a new one. Make sure that the terminal (2) is in its groove and press back the cover again. Make sure that the sealing rings are fitted properly.

### Stop solenoid

The stop solenoid is fitted as standard equipment to marine engines and to industrial engines of -G and -PP versions. For other engines stop solenoids are available as optional equipment.

The solenoid can either be live when the engine is running or live when the engine stops. When the engine is stopped, the current in the first case is disconnected, and for the second case connected.

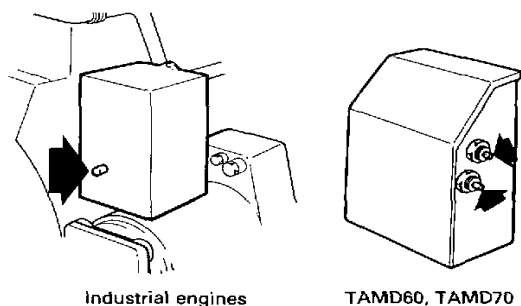


Fig. 220. Connector box with automatic fuse(es)

## REPAIR INSTRUCTIONS

### Starting with the aid of an auxiliary battery

#### Warning!

Batteries (especially auxiliary batteries) contain an oxyhydrogen gas mixture which is very explosive. Any spark which can be generated if the jump leads are wrongly connected is sufficient to cause the battery to explode resulting in both bodily injury and material damage.

If the batteries have frozen they must first be thawed out before attempting to start with the aid of an auxiliary battery.

1. Check that the auxiliary batteries are connected (in series or parallel) so that the voltage shown agrees with the system voltage of the engine.

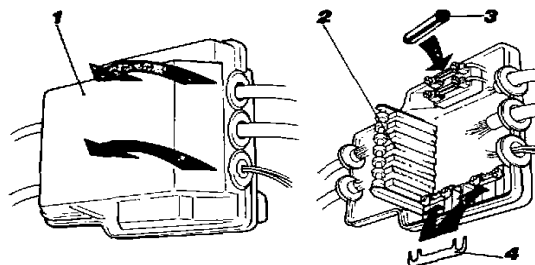


Fig. 222. Connector box with fuses, MD70, TMD70

1. Cover
2. Terminal
3. Fuses (25A, engine)
4. Fuses 50A for small alternator, and 80A for large alternator (CAV, 28V/60A)

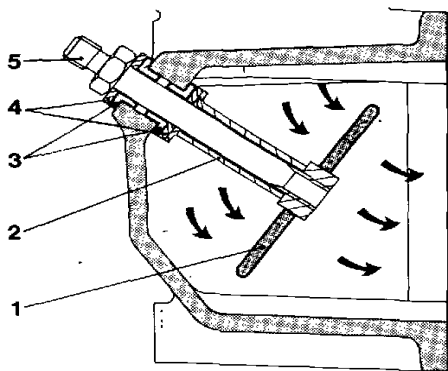


Fig. 223. Cross section, intake manifold – TID60, TID70

- |                     |                            |
|---------------------|----------------------------|
| 1. Pre-heater       | 4. Washers                 |
| 2. Spacer sleeve    | 5. Terminal/attaching bolt |
| 3. Plastic bushings |                            |

2. Connect the one end of the red jump lead to the positive terminal of the auxiliary battery (marked with red paint, P, or +). Always check that the clamps are properly fitted so that no sparks occur when attempting to start.
3. Connect the other end of the red lead to the positive terminal of the discharged battery where the positive lead to the starter motor is connected.
4. Connect one end of the black jump lead to the negative terminal of the auxiliary battery (marked with blue paint, N, or –).
5. Connect the other end of the black lead to a location **some way from the discharged batteries**, i.e. at a main switch on the negative lead or at the negative lead connection to the engine.
6. Start the engine. **NOTE! Do not interfere with the connections when attempting to start (there is risk for sparking) and do not stand bent over any of the batteries.**
7. Remove the cables in exactly the reverse order as they were connected. **NOTE! The usual cables to the standard batteries must on no account be disconnected.**

### Checking the pre-heater

Turn the key switch to pre-heater position and check the voltage to the pre-heater with a voltmeter.

If there is no voltage after engaging, or if the voltage is low, the following should be checked:

- Battery voltage. Charge the batteries if necessary.
- Electrical cables, poor connections or breakages.
- Key switch. Check by by-passing the key switch.
- Relays. Check by by-passing time relay and switching relay with a thick electrical cable.

Remove both the battery cables and then the cables to the pre-heater. Use an ohmmeter to check that there is no breakage in the element.

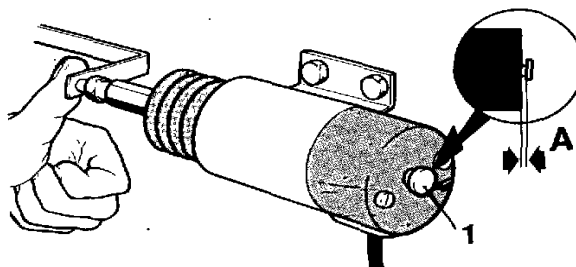


Fig. 224. Checking the contact gap, stop solenoid

1. Stop position indicator (pin)
- A. Approx. 1.5–2.0 mm (0.06–0.08")

If the function of the pre-heater is still not acceptable the pre-heater should be replaced.

**TID60, TID70:** Tightening torque for terminals/attaching bolts (5, fig. 223) 11–14 Nm (1.1–1.4 kpm = 8–10 lbf.ft). Engage the pre-heater after assembly so that the wire elements become red hot. Then break the current and let the element cool. Thereafter re-tighten all bolts with the same torque.

For TD60 and TD70 the pre-heater is sold as a complete unit.

**NOTE!** When loosening and tightening the pre-heater's terminal nuts, the terminals must always be held tight (fig. 218). The wire element can otherwise be turned inside the pre-heater and cause a short-circuit.

**Warning! Never use start spray, ether or similar to assist starting. The gas can be ignited by the hot pre-heater and cause an explosion, resulting in a ruined compressor rotor in the turbo and damage to the air intake. Risk of bodily injury.**

In an emergency situation where malfunction of the pre-heater is suspected, a start spray can, with care, be used. A strict condition, however, is that the heater is first disconnected by removing and insulating the cables. Check, by feeling with the hand, that the pipe is not warm in the area where the heater elements are located.

### Checking the stop solenoid

If the stop solenoid is loosened or replaced, the following checks should be made after fitting.

1. Disconnect the current. Remove the battery cables.
2. Press the solenoid pull-rod in by hand and check that the stop position indicator (pin) 1, fig. 224 at the rear end of the solenoid is pushed out approx. 1.5–2.0 mm (0.06–0.08") when the pull-rod is completely pushed back.
3. Adjust, if necessary, by turning the pull-rod adjusting nut. Connect the battery cables.

# WIRING DIAGRAMS – INDUSTRIAL ENGINES

TD60, TID60, TD70, TID70

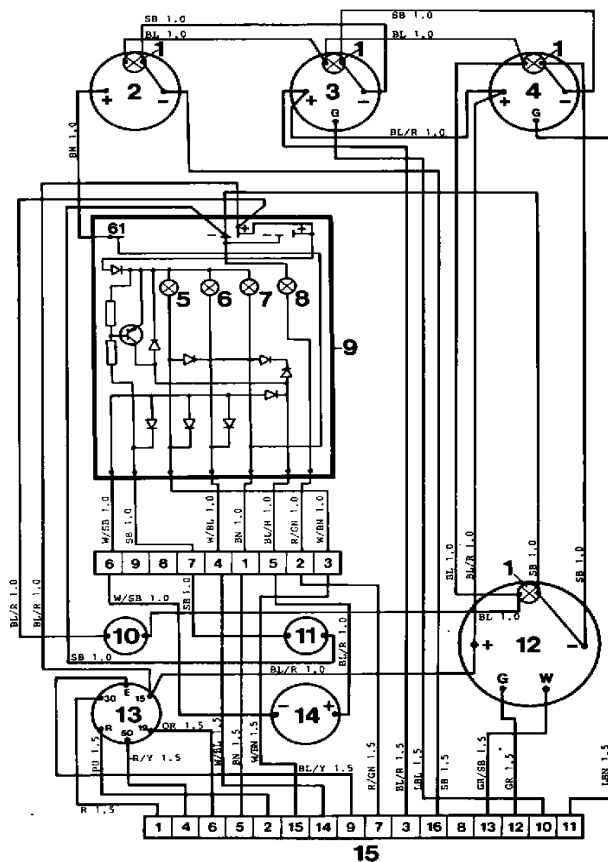


Fig. 225. Instrument panel

1. Instrument lighting
2. Hour meter
3. Oil pressure gauge
4. Coolant temperature gauge
5. Warning lamp, coolant temperature
6. Warning lamp, oil pressure
7. Warning lamp, charging
8. Indicator lamp, pre-heater
9. Printed circuit
10. Switch, instrument lighting
11. Switch, alarm test
12. Rev. counter
13. Key switch
14. Alarm
15. 16-pole connector

### Cable colours

GR = Grey	OR = Orange
SB = Black	GN = Green
BN = Brown	Y = Yellow
LBN = Light brown	W = White
R = Red	BL = Blue
PU = Purple	LBL = Light blue

Cable areas are given in mm<sup>2</sup>

### Conversion mm<sup>2</sup>/AWG\*

\* American Wiring Gauge

mm <sup>2</sup>	1.0	1.5
AWG	16 (17)	15 (16)

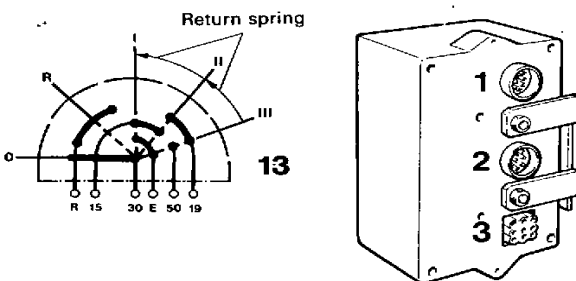


Fig. 226. Connector box

1. 16-pole connector for engine cables (senders, switches etc.)
2. 16-pole connector for instrument cables
3. 9-pole connector for engine cables (starter motor, stop solenoid, signal horn)

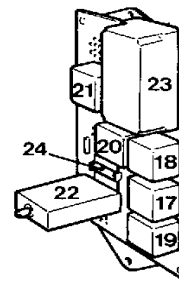


Fig. 227. Connector box

- 17.\* Stop relay (for stop solenoid live with engine running)
18. Starting relay
19. Stop relay
20. Interlocking relay (-PP version)
21. Earth relay
22. Automatic fuse 8A
23. Time relay
24. Fuse 35A (by-pass)

\* Same pos. Nos. as in the wiring diagram on next page.

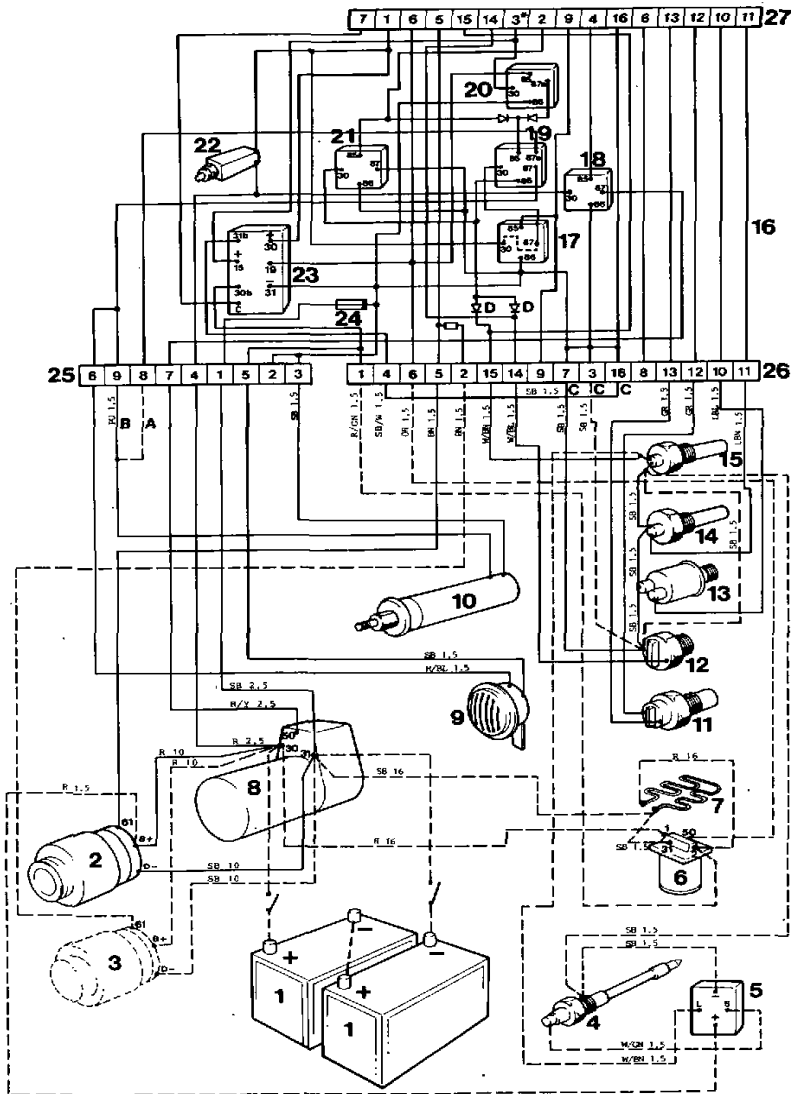


Fig. 228. Engine

1. Battery
2. Alternator
3. Extra alternator
4. Coolant level switch
5. Relay
6. Relay for pre-heater
7. Pre-heater
8. Starter motor\*\*
9. Signal horn
10. Stop solenoid
11. Rev. counter sender
12. Oil pressure switch
13. Oil pressure sender
14. Coolant temperature sender
15. Coolant temperature switch
16. Printed circuit
17. Stop relay\*\*\*, only fitted when the stop solenoid is live with the engine running. When the stop solenoid is live when stopped, a by-pass is connected between 30 and 87 (dashed line).
18. Starting relay\*\*\*
19. Stop relay\*\*\*
20. Interlocking relay (-PP version)\*\*\*
21. Earth relay\*\*\*
22. Automatic fuse, 8A\*\*\*
23. Time relay\*\*\*
24. Fuse, 35A (by-pass)\*\*\*
25. 9-pole connector\*\*\*
26. 16-pole connector\*\*\*
27. 16-pole connector\*\*\* (for instrument cables)

\* Should be dead during start.  
 \*\* Engines of standard and -PP versions have a 1-pole starter motor. The starter motor's connector 31 is omitted and these cables are led to a separate earth bolt instead.  
 \*\*\* Located in the connector box.

**Cable colours**

- |                   |                  |
|-------------------|------------------|
| GR = Grey         | BL = Blue        |
| SB = Black        | LBL = Light blue |
| BN = Brown        |                  |
| LBN = Light brown |                  |
| R = Red           |                  |
| PU = Purple       |                  |
| OR = Orange       |                  |
| GN = Green        |                  |
| Y = Yellow        |                  |
| W = White         |                  |

- A. Connected when the stop solenoid is live when running
- B. Connected when the stop solenoid is live when stopping
- C. Negative connections
- D. Diodes (only fitted on engines with automatic stop)

**Conversion mm<sup>2</sup>/AWG**

mm <sup>2</sup>	1.5	2.5	10	16
AWG	15 (16)	13	7	5

Cable areas are given in mm<sup>2</sup>

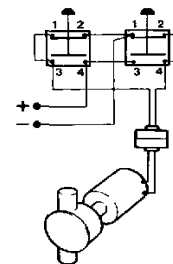


Fig. 229. Suggested wiring of oil scavenging pump (draining and filling) Cable area 1.5 mm<sup>2</sup>.

# WIRING DIAGRAMS – MARINE ENGINES

## TAMD60C, TAMD70E

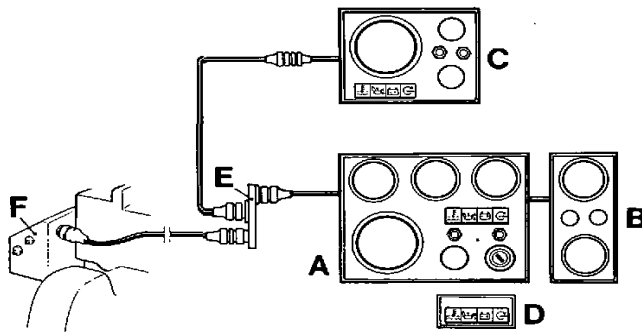
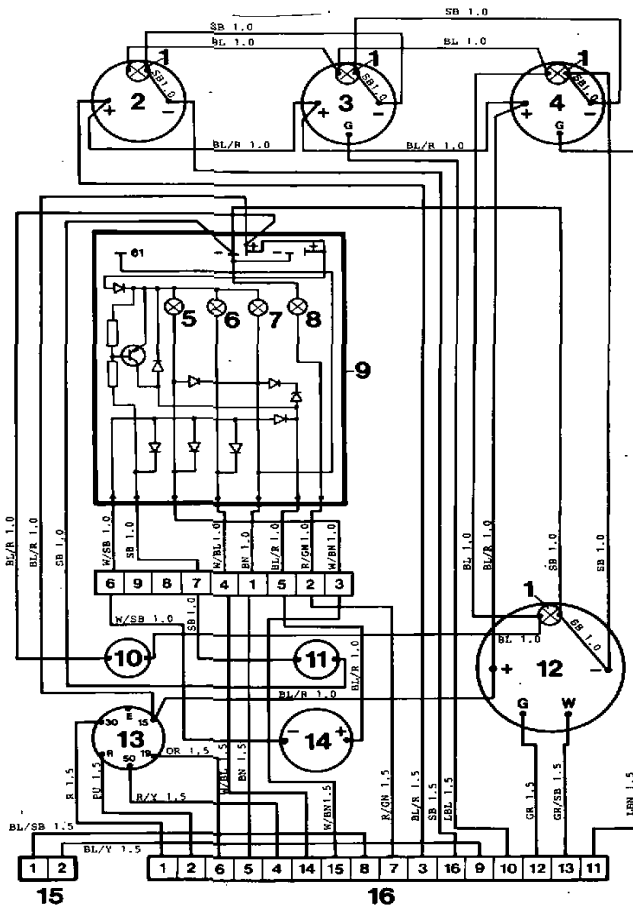


Fig. 230. Block diagram

- A. Basic panel
- B. Supplementary panel
- C. Panel for alternative steering place (Flying Bridge)\*
- D. Alarm panel (Only used when the basic panel "A" is not fitted)
- E. T-connection
- F. Connector box with fuses

\* The basic panel "A" can also be fitted on the alternative steering place. (The senders for temperature and oil pressure must then be replaced.)

Cable areas are given in mm<sup>2</sup>

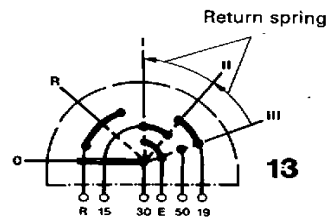


### Cable colours

- |                   |                  |
|-------------------|------------------|
| GR = Grey         | OR = Orange      |
| SB = Black        | GN = Green       |
| BN = Brown        | Y = Yellow       |
| LBN = Light brown | W = White        |
| R = Red           | BL = Blue        |
| PU = Purple       | LBL = Light blue |

Fig. 231. Instruments, basic panel

- 1. Instrument lighting
- 2. Voltmeter
- 3. Oil pressure gauge
- 4. Coolant temperature gauge
- 5. Warning lamp, coolant temperature
- 6. Warning lamp, oil pressure
- 7. Warning lamp, charging
- 8. Indicator lamp (not used)
- 9. Printed circuit
- 10. Switch, instrument lighting
- 11. Switch, alarm test
- 12. Rev. counter
- 13. Key switch
- 14. Alarm
- 15. 2-pole connector (for supplementary panel, if fitted)
- 16. 16-pole connector



### Conversion mm<sup>2</sup>/AWG\*

\* American Wiring Gauge

mm <sup>2</sup>	1.0	1.5
AWG	16 (17)	15 (16)

TAMD60C, TAMD70E

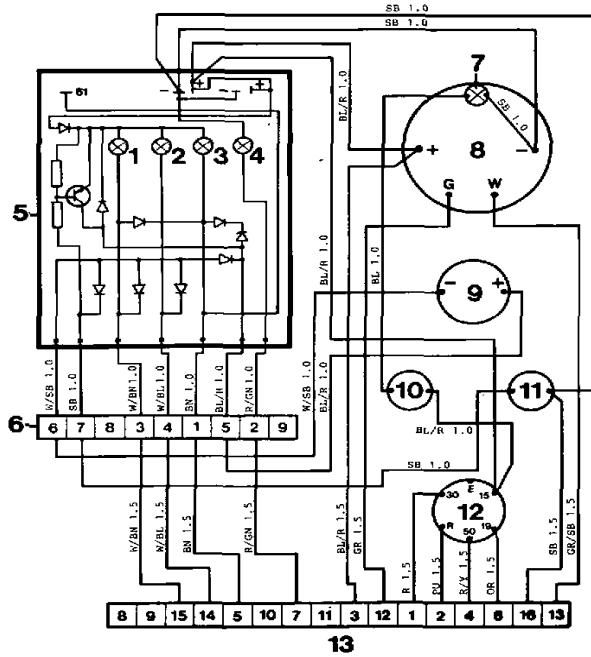
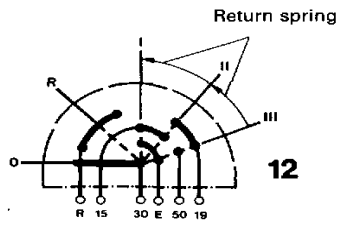


Fig. 232. Panel for alternative steering place (Flying Bridge)

1. Warning lamp, coolant temperature
2. Warning lamp, oil pressure
3. Warning lamp, charging
4. Indicator lamp (not used)
5. Printed circuit
6. 9-pole connector
7. Instrument lighting
8. Rev. counter
9. Alarm
10. Switch, instrument lighting
11. Switch, alarm test
12. Key switch
13. 16-pole connector



Cable colours

- |                   |                  |
|-------------------|------------------|
| GR = Grey         | OR = Orange      |
| SB = Black        | GN = Green       |
| BN = Brown        | Y = Yellow       |
| LBN = Light brown | W = White        |
| R = Red           | BL = Blue        |
| PU = Purple       | LBL = Light blue |

Cable areas are given in mm<sup>2</sup>

Conversion mm<sup>2</sup>/AWG

mm <sup>2</sup>	1.0	1.5
AWG	16 (17)	15 (16)

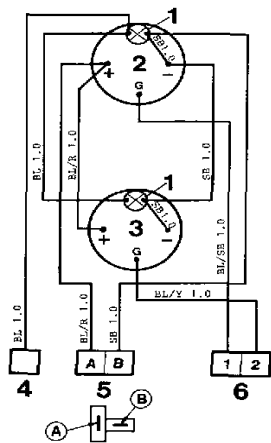


Fig. 233. Supplementary panel

1. Instrument lighting
2. Oil pressure gauge - reverse gear
3. Turbo charging pressure gauge
4. Connection to instrument lighting on basic panel
5. Connection to printed circuit on basic panel
6. Connection to connector (15) on basic panel

**TAMD60C, TAMD70E**  
Engines with Paris-Rhône alternator (28V/55A), alt. (14V/50A)  
**2-pole system**

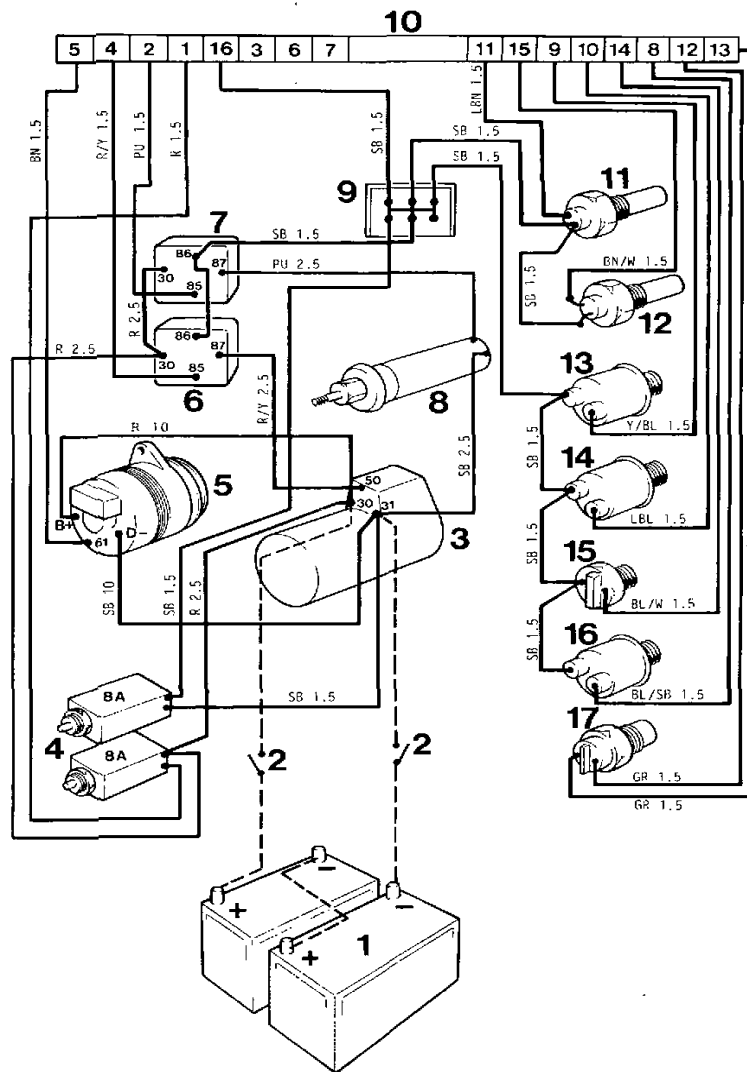


Fig. 234. Engine

1. Battery
2. Main switch
3. Starter motor
4. Automatic fuses\*
5. Alternator
6. Start relay (16MS)\*
7. Stop relay (16S)\*
8. Stop solenoid
9. Earth terminal\*
10. Connector, 16-pole\*
11. Coolant temperature sender
12. Coolant temperature switch
13. Pressure sender, turbo
14. Oil pressure sender, engine
15. Oil pressure switch
16. Oil pressure sender, reverse gear
17. Rev. counter sender

\* Located in the connector box

Cable areas are given in mm<sup>2</sup>

Conversion mm<sup>2</sup>/AWG

**Cable colours**

- GR = Grey
- SB = Black
- BN = Brown
- LBN = Light brown
- R = Red
- PU = Purple
- GN = Green
- Y = Yellow
- W = White
- BL = Blue
- LBL = Light blue

**TAMD60C, TAMD70E**  
Engines with Paris-Rhône alternator (28V/55A), alt. (14V/50A)  
**Single-pole system**

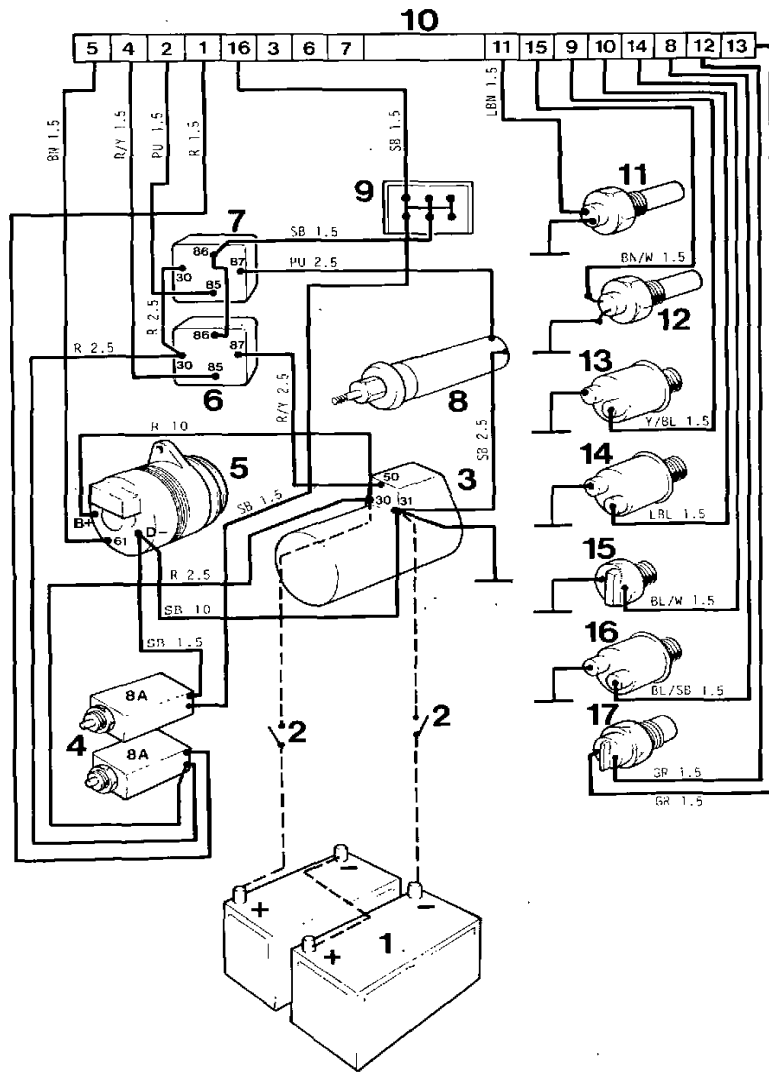


Fig. 235. Engine

1. Battery
2. Main switch
3. Starter motor
4. Automatic fuses\*
5. Alternator
6. Start relay (16MS)\*
7. Stop relay (16S)\*
8. Stop solenoid
9. Earth terminal\*
10. Connector, 16-pole\*
11. Coolant temperature sender
12. Coolant temperature switch
13. Pressure sender, turbo
14. Oil pressure sender, engine
15. Oil pressure switch
16. Oil pressure sender, reverse gear
17. Rev. counter sender

\* Located in the connector box.

Cable areas are given in mm<sup>2</sup>

Conversion mm<sup>2</sup>/AWG

mm <sup>2</sup>	1.5	2.5	10
AWG	15 (16)	13	7

**Cable colours**

- GR = Grey
- SB = Black
- BN = Brown
- LBN = Light brown
- R = Red
- PU = Purple
- GN = Green
- Y = Yellow
- W = White
- BL = Blue
- LBL = Light blue

**TAMD60C, TAMD70E**  
Engines with CAV-alternator (28V/60A), optional equipment  
**2-pole system**

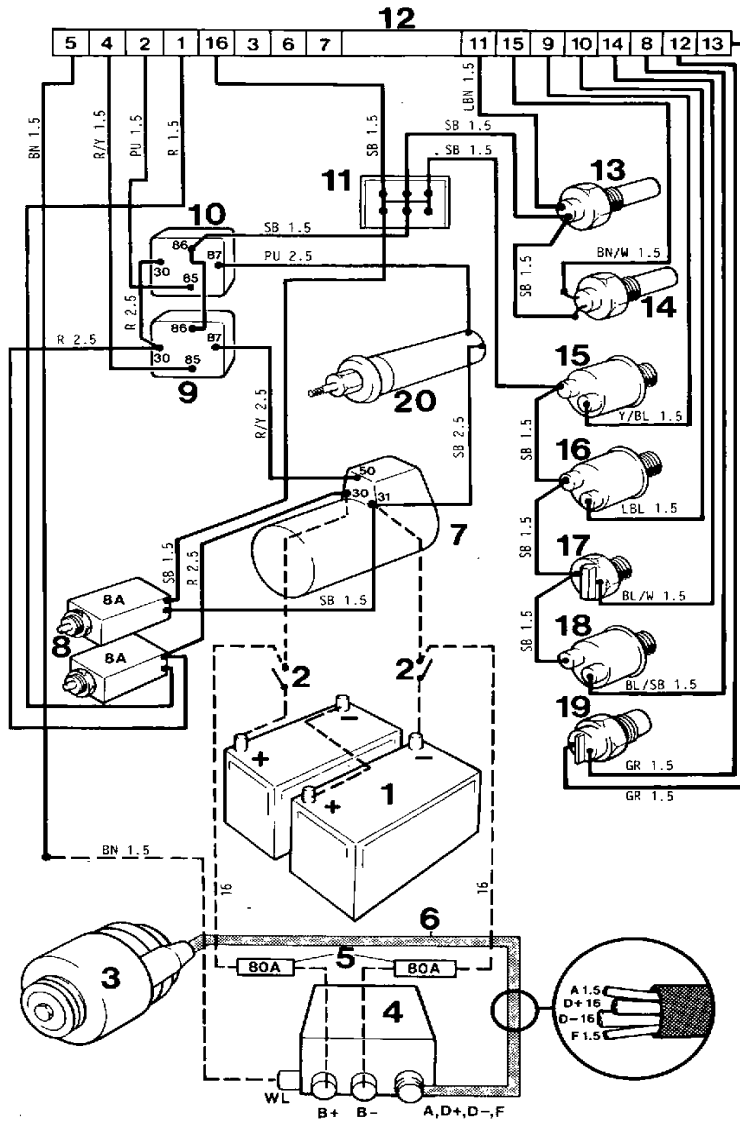


Fig. 236. Engine

1. Battery
2. Main switch
3. Alternator (make CAV)
4. Regulator box
5. Fuses
6. Shielded ship's cable
7. Starter motor
8. Automatic fuses\*
9. Start relay (16MS)\*
10. Stop relay (16S)\*
11. Earth terminal\*
12. Connector, 16-pole\*
13. Coolant temperature sender
14. Coolant temperature switch
15. Pressure sender, turbo
16. Oil pressure sender, engine
17. Oil pressure switch
18. Oil pressure sender, reverse gear
19. Rev. counter sender
20. Stop solenoid

\* Located in the connector box.

Cable areas are given in mm<sup>2</sup>

Conversion mm<sup>2</sup>/AWG

mm <sup>2</sup>	1.5	2.5	16
AWG	15 (16)	13	5

**Cable colours**

- GR = Grey
- SB = Black
- BN = Brown
- LBN = Light brown
- R = Red
- PU = Purple
- GN = Green
- Y = Yellow
- W = White
- BL = Blue
- LBL = Light blue

**Block diagram  
MD70C, TMD70C**

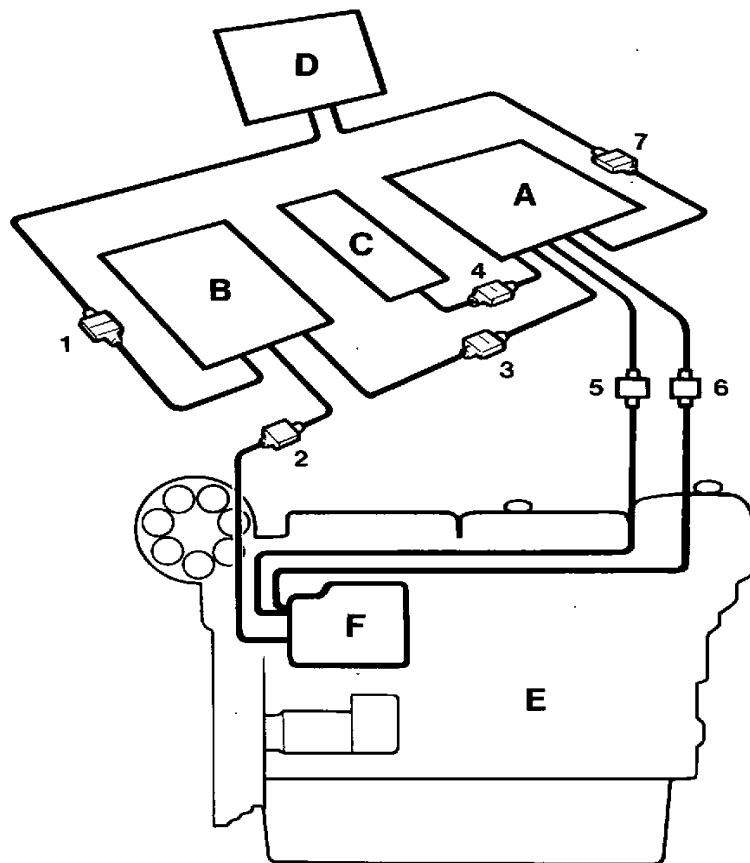


Fig. 237. Block diagram, MD70C, TMD70C

- A. Basic panel
- B. Panel with supplementary instruments (e.g. alarm)
- C. Panel with fuel gauge and rudder indicator
- D. Panel for alternative steering place (Flying Bridge)
- E. Engine
- F. Connector box with fuses

- 1. Connector (male and female). Red, 8-pole
- 2. Connector (male and female). Red, 8-pole
- 3. Connector (male and female). Black, 4-pole
- 4. Connector (male and female). Black, 4-pole
- 5. Connector (male and female). Black, 8-pole
- 6. Connector (male and female). Black, 8-pole
- 7. Connector (male and female). Green, 8-pole

Related male and female connectors have the same colour.

If the panel D is fitted and B is not, connector No. 1 from the Flying Bridge panel is connected together with connector No. 2 from the engine. Connectors No. 1 and 7 are **not** to be connected together if panel D is not fitted.

When only the basic panel A is fitted, contacts 5 and 6 only are wired together.

Excess connectors are not to be connected together, but are to be insulated, hung up and protected individually. The cables should not be cut.

# MD70C, TMD70C

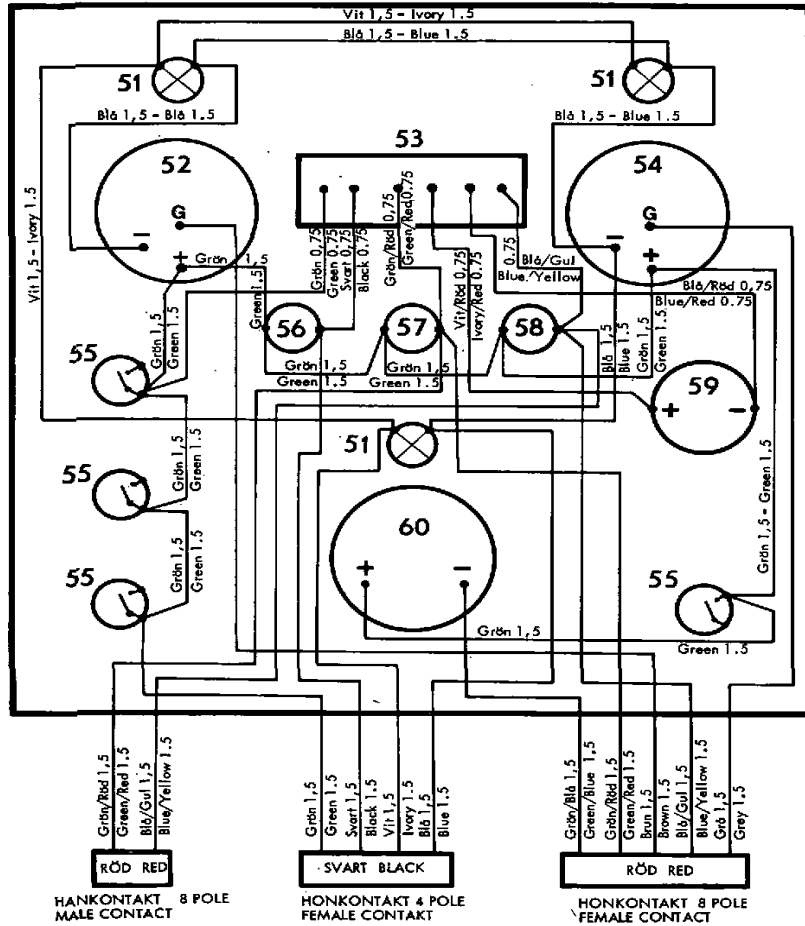


Fig. 240. Panel with supplementary instruments (e.g. alarm)

See also Block diagram, page 122.

- 51. Instrument lighting
- 52. Oil pressure gauge – reverse gear
- 53. Alarm separator
- 54. Pressure gauge, turbo (not MD70C)
- 55. Extra switches (max. 5A per switch)
- 56. Charging warning lamp
- 57. Warning lamp for oil pressure – engine
- 58. Warning lamp for coolant temperature
- 59. Buzzer
- 60. Hour meter

Cable areas are given in mm<sup>2</sup>

Conversion mm<sup>2</sup>/AWG

mm <sup>2</sup>	0.75	1.5
AWG	19	15 (16)

# MD70C, TMD70C

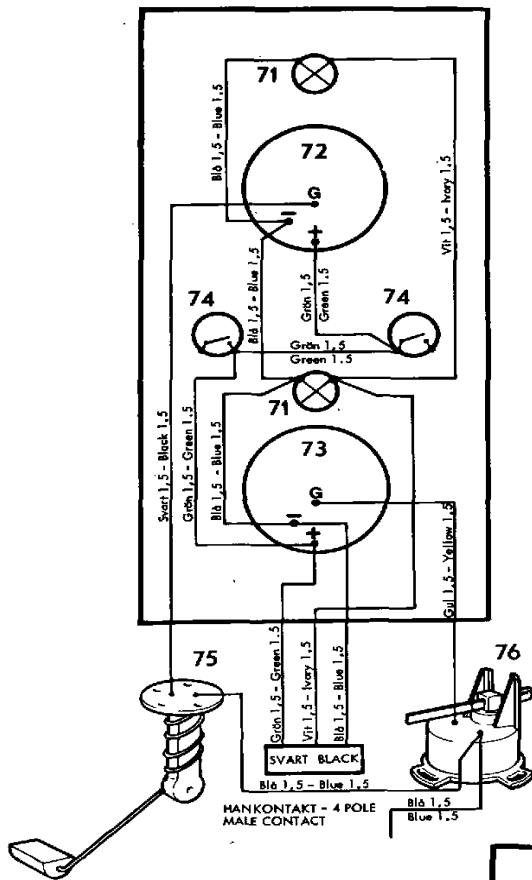


Fig. 241. Panel with fuel gauge and rudder indicator  
See also Block diagram, page 122.

- 71. Instrument lighting
- 72. Fuel gauge
- 73. Rudder indicator
- 74. Extra switches (max. 5A per switch)
- 75. Sender, fuel gauge
- 76. Sender, rudder indicator (the free blue 1.5 mm<sup>2</sup> cable is to be connected to 104 in the engine's connector box)

Cable areas are given in mm<sup>2</sup>

Conversion mm<sup>2</sup>/AWG

mm <sup>2</sup>	0.75	1.5	2.5
AWG	19	15 (16)	13

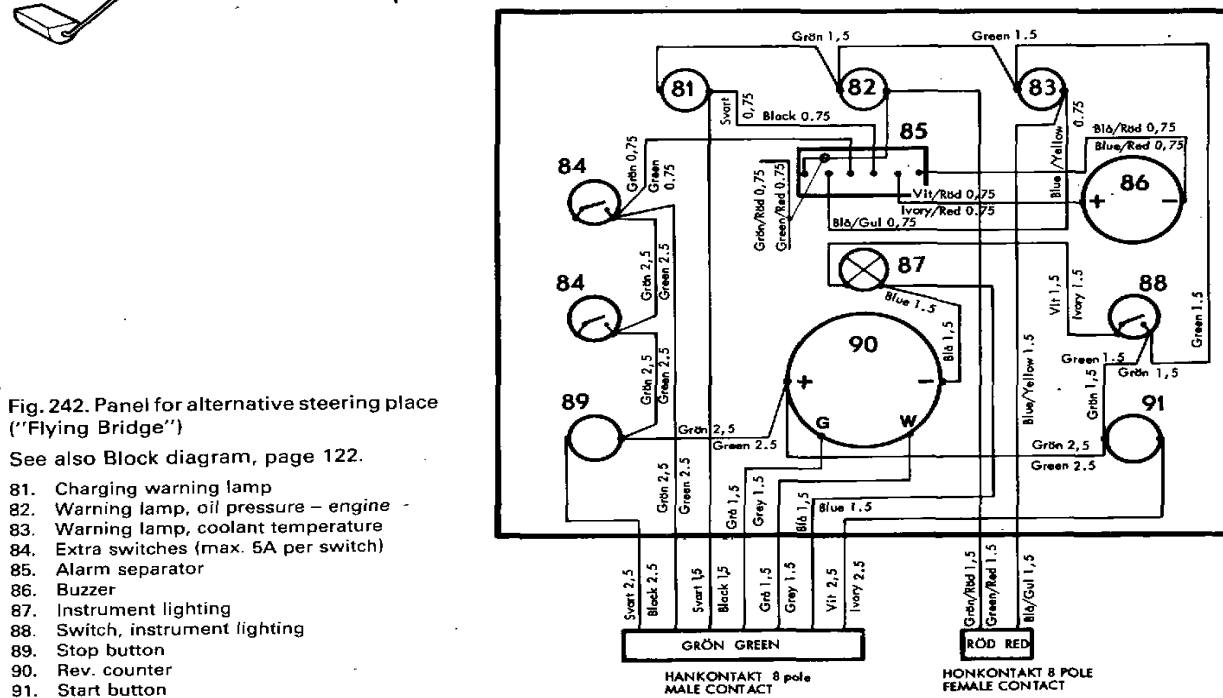


Fig. 242. Panel for alternative steering place ("Flying Bridge")

See also Block diagram, page 122.

- 81. Charging warning lamp
- 82. Warning lamp, oil pressure - engine
- 83. Warning lamp, coolant temperature
- 84. Extra switches (max. 5A per switch)
- 85. Alarm separator
- 86. Buzzer
- 87. Instrument lighting
- 88. Switch, instrument lighting
- 89. Stop button
- 90. Rev. counter
- 91. Start button

MD70C, TMD70C

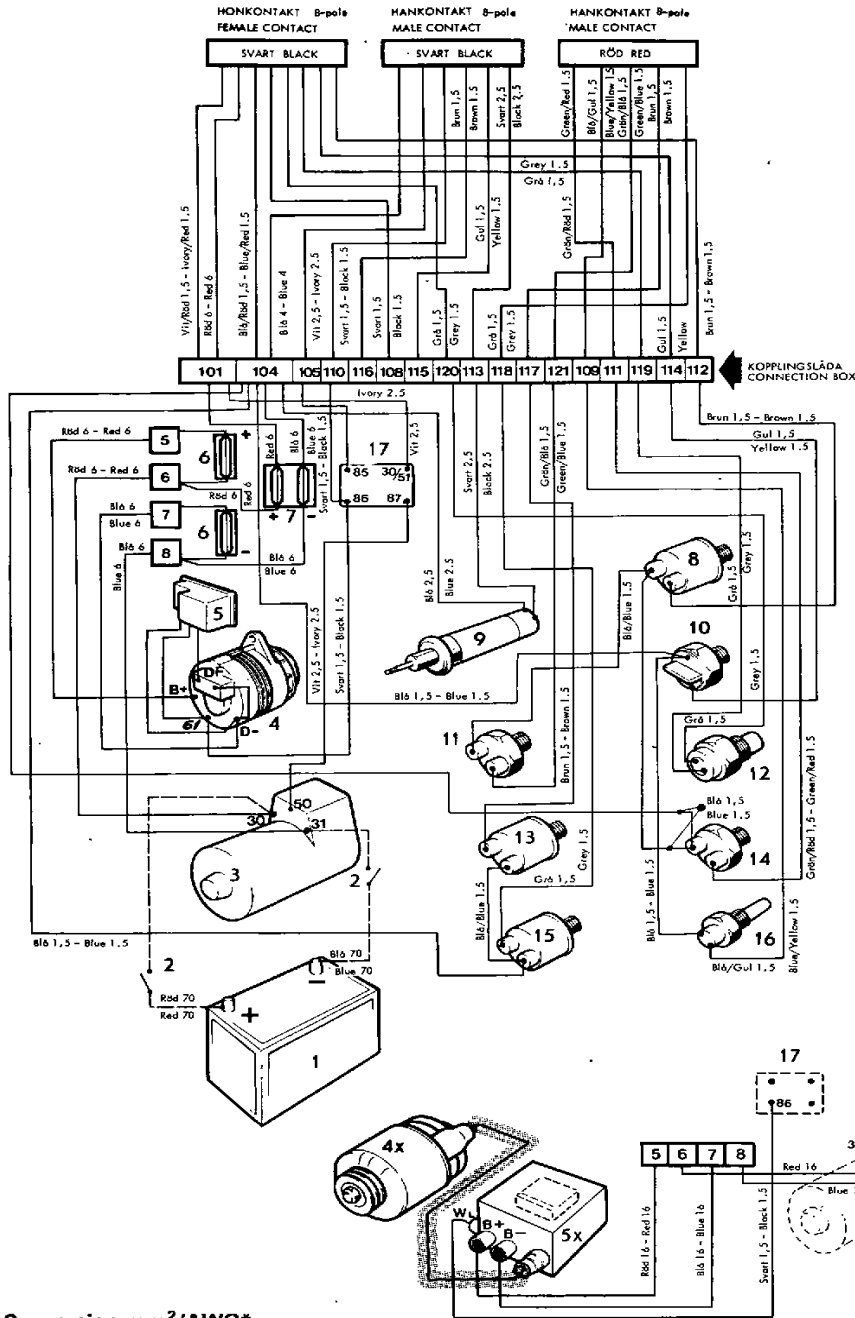


Fig. 238. Engine

See also Block diagram, page 122.

1. Batteries. For capacity see "Technical Data"
2. Main switch
3. Starter motor
4. Alternator
- 4x. Alternator (1600W, optional equipment)
5. Voltage regulator
- 5x. Voltage regulator (optional equipment). Must not be fitted on the engine.
6. Fuses 50A for standard alternator\* (80A for 1600W alternator)\*
7. Fuses 25A (in both cases)\*
8. Oil pressure sender - engine
9. Stop solenoid
10. Coolant temperature sender
11. Oil pressure switch (for hour meter)
12. Engine speed sender
13. Oil pressure sender, reverse gear
14. Oil pressure switch
15. Pressure sender - turbo (not MD70)
16. Coolant temperature switch
17. Starter cut-out relay\*

\* Located in the connector box.

Conversion mm<sup>2</sup>/AWG\*

\* American Wiring Gauge

mm <sup>2</sup>	1.5	2.5	4	6	16	70
AWG	15 (16)	13	11	9 (10)	5	2/0

Cable areas are given in mm<sup>2</sup>

MD70C, TMD70C

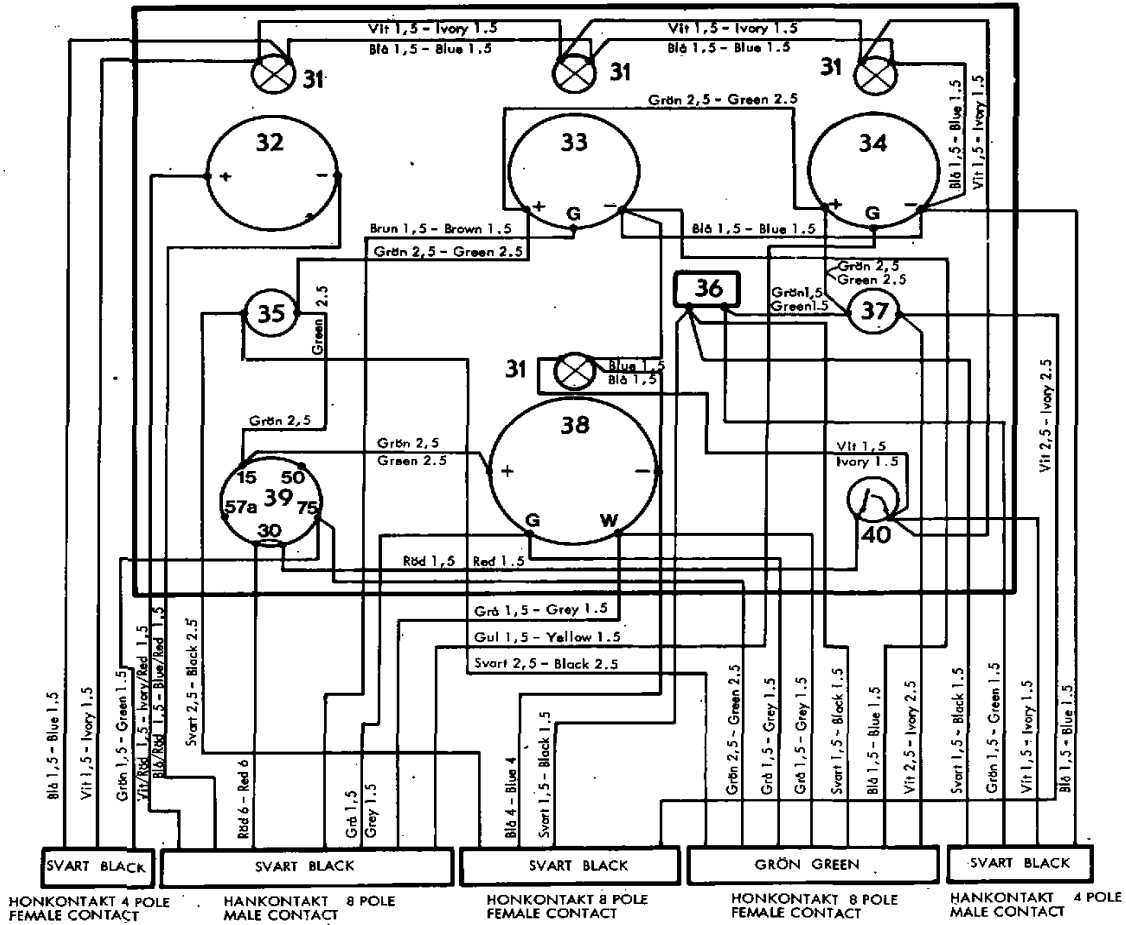


Fig. 239. Instruments, basic panel  
See also Block diagram, page 122.

- 31. Instrument lighting
- 32. Voltmeter
- 33. Oil pressure gauge
- 34. Coolant temperature gauge
- 35. Stop button
- 36. Series resistance
- 37. Start button
- 38. Rev. counter
- 39. Key switch
- 40. Rheostat for instrument lighting

Cable areas are given in mm<sup>2</sup>

Conversion mm<sup>2</sup>/AWG

mm <sup>2</sup>	1.5	2.5	4	6
AWG	15 (16)	13	11	9 (10)



**VOLVO  
PENTA**

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Technical Publications Dept.  
S-405 08 Göteborg, Sweden