Publ. nr 5333
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7753330-56

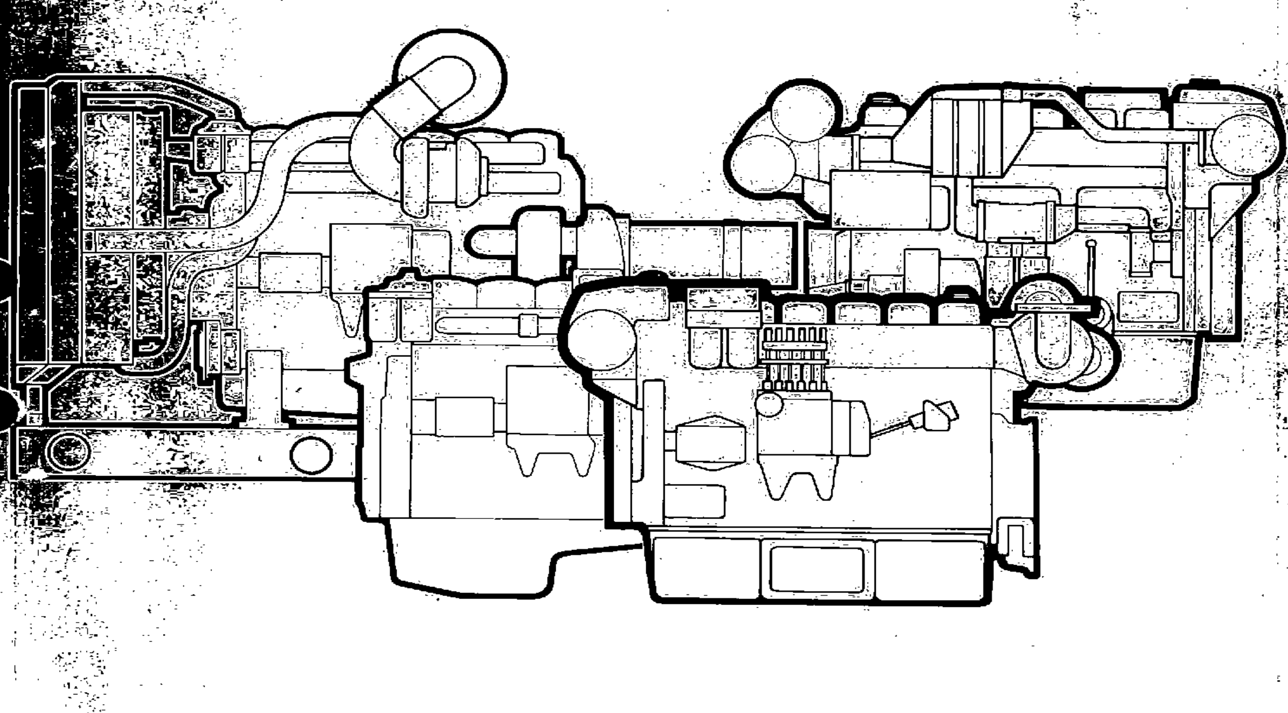
WORKSHOP MANUAL

Marine diesel engines

TMD100C
TMD121C · TAMD121C

Industrial diesel engines

TD100G · TID100K · TD121G
TD120HPP · TID120HPP
TID121FG



VOLVO
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Foreword

This Workshop Manual includes technical data, descriptions and repair instructions for all standard versions of both marine engines and industrial engines in the 100 and 120-series.

Both the engine designation and the serial number of each engine are marked on the number plate (see page 15). Both the engine designation and serial number must be clearly stated in all correspondence about an engine.

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

We reserve the right to carry out design modifications and, for this reason, the information in this book is not to be considered binding.

AB VOLVO PENTA
Technical Publications Dept.

Explanation to the engine designations

T = Turbo
A = "Aftercooler" (charger air cooler, marine engines)
I = "Intercooler" (charge air cooler, industrial engines)
M = Marine engine
D = Diesel Engine
100 or 120 = Swept volume (10 resp. 12 litres)
C, F, G, H or K = Series designation
G = Generator set engine after series designation
PP = "Powerpack" (after series designation)

Publ. No. 7734104-8
4-1991

Supplement to **Workshop Manual**

T(I)D100, 121, TMD 100, T(A)MD 121 (Publ. No. 5333)

New industrial engine versions TWD1210G, TWD1210GH replacing TID121KG

Explanation of engine designations

T = Turbocharged	1 = Generation number
W = Water-cooled boost air cooler	0 = Execution or output level
D = Diesel engine	G = Genset
12 = Swept volume in litres	H = High power output

The most important news are:

- Higher standby output
- New piston with a "Keystone" type upper compression ring
- New injection pump
- Pump setting altered
- New nozzles with larger holes
- New turbocharger (same as TID121LG-LP)
- New thermostat with lower opening temperature

TECHNICAL DATA

The Technical Data for the new engine versions is the same as for the TID121KG but with the following exceptions:

The turbo boost pressures are stated here also for TD100GG, TID100KG, TD121GG, TID121KG, TID121LG with increased output (introduced 1990).

General

Compression ration 13.9:1

Turbo charger

Make, type .... KKK, K33-4067/24,22
Radial clearance, max... 0.46 mm (0.018")
Axial clearance, max (compressor side) .... 0.16 mm (0.0063")

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Turbo boost pressure

Turbo boost pressures, min. values (measured in the engine's inlet manifold) at 100% load, full throttle and air temperature of +25°C (77°F).

	1500 r/min	1800 r/min
TWD1210G		
Prime output	120 kPa (17 psi)	140 kPa (20 psi)
TWD1210GH		
Standby output	160 kPa (23 psi)	165 kPa (24 psi)
TD100GG (prod. No. 868458, -59)		
Prime output	85 kPa (12 psi)	105 kPa (15 psi)
Standby output	95 kPa (14 psi)	115 kPa (17 psi)
TID100KG (prod. No. 868460, -61)		
Prime output	90 kPa (13 psi)	105 kPa (15 psi)
Standby output	105 kPa (15 psi)	130 kPa (19 psi)
TD121GG (prod. No. 868462, -63)		
Prime output	105 kPa (15 psi)	130 kPa (19 psi)
Standby output	120 kPa (17 psi)	150 kPa (22 psi)
TID121KG (prod. No. 868464, -65)		
Prime output	110 kPa (16 psi)	130 kPa (19 psi)
Standby output	130 kPa (19 psi)	145 kPa (21 psi)
TID121LG (prod. No. 868466, -67)		
Prime output	155 kPa (22 psi)	175 kPa (25 psi)
Standby output	175 kPa (25 psi)	190 kPa (28 psi)

Fuel system

Injection pump

Make,type .... Bosch PE6P120A320RS3206-1
Lift from base diameter .... 3.5 (+0.1) mm (0.138 + 0.004")
Setting... 20° BTDC

Injectors

Nozzles .... Bosch DLLA 150P119
Injector complete, marked 808
Opening pressure .... 27 MPa (275 kp/cm²) (3916 psi)
Setting pressure (new spring) .... 27.5 - 28.3 MPa (280 - 288 kp/cm²) (3988-4105 psi)
Hole diameter .... 5 x 0.38 mm (0.015")

Cooling system

Thermostat, starts opening at.................... 75°C (167°F)
fully open at .... 88°C (190°F)

Publ. No. 7734097-4
4-1991

Supplement to Instruction Book
Industrial engines T(I)D 100, 121 (Publ. No. 7732297-2)

New engine versions TWD1210G, TWD1210GH replacing TID121KG

Explanation of engine designations

T	= Turbocharged	1	= Generation number
W	= Water-cooled boost air cooler	0	= Execution or output level
D	= Diesel engine	G	= Genset
12	= Swept volume in litres	H	= High power output

The most important news are:

- Higher standby output
- New piston with a "Keystone" type upper compression ring
- New injection pump. Stroke position 3.5 (+ 0.1) mm (0.138 + 0.004")
- Pump setting altered to 20° BTDC (previously 24°)
- New nozzles with larger holes (5 x 0.38 mm (0.015"))
- New turbocharger (same as TID121LG-LP)
- New thermostat with lower opening temperature. The thermostat starts opening at 75°C (167°F) and is fully open at 88°C (190°F)

The procedures described in the Instruction Book also apply to the new engines.

VOLVO PENTA

Publ. No 7732286-5
12-1989

Supplement to WORKSHOP MANUAL

Publ. No 5333

Industrial Engines in the 100 and 121 series Marine Engines TMD102A, TMD122A, TAMD122A, C and D.

New engine versions have been introduced as follows:

Industrial Engines

Unchanged engine designations but with new product numbers as from engine No. 1101010220/xxxx. The year 87 is stamped after the engine designation on the engine data plate, e.g. TD100G-87.

Marine Engines

TMD102A replaces TMD100C. TMD122A, TAMD122A and TAMD122C replaces TMD121C and TAMD121D. (Introduced from engine No. 1101010220/xxxx).

The more important changes are:

100 series

- The cylinder block is prepared with a mounting surface for a partial-flow oil filter. The coolant flow round the cylinder liners is improved by the introduction of a horizontal shelf round the upper part of the liner. The oilways to the camshaft bearings have been improved.
- The bottom of the cylinder head has been made approx. 3 mm (0.118 ins) thinner which makes it more flexible. This together with new bolts and changed tightening torques gives a higher compression force on the sealing to the block.
- The exhaust valve seat has been made thinner with an increased grip of the seat in the cylinder head.
- To improve the sealing, the upper seal ring for the cylinder liner has been made thicker, 2.4 mm (0.094 ins) and in a new material - EPDM rubber.

The following changes have also been introduced to the injection equipment (the new equipment can also, with advantage, be used on earlier engines):

TD100GG (product No 868064-7)

New injection pump (part No. 862665-7) and new injectors (part No. 424530-4). Injection angle changed to 22° BTDC and stroke position to 2.6 mm/0.102 ins (prev. 3.5 mm/0.138 ins). These changes are introduced from engine No. 1101010362/199731.

TID100KG (product No. 867872-4 and 868070-4)

New injection pump (part No. 862664-0) and new injectors (part No. 424530-4).

Injection angle changed to 22° B.T.D.C (prev. 20°) and the stroke position to 2.6 mm/0.102 ins (prev. 3.5 mm/ 0.138 ins). These changes are introduced from engine No. 1101006354/193508.

Additonal to TMD102:

New five-hole nozzles with a hole diameter of 0.34 mm (0.014 ins).

New oil sump of aluminium replaces the cast iron sump. The inspection covers are still cast iron.

120, 121, 122 series

- The cylinder head has a groove for the flame barrier. The new head has the same type of grooves as earlier.
- The cylinder liner has a flame barrier. New thicker upper sealing ring 2.4 mm (0.094 ins) of new material (EDPM rubber).
- The piston pin has been made stronger by reducing the internal diameter by 2 mm (0.079 ins).

Industrial engines

TD121G, GG and TD120HP now has new pistons. The compression ratio is increased to 14.2:1 (prev. 13.3:1).

TD121GG (product No 867844-3 and 868073-8). New injection pump (part No. 862305-0) introduced from engine No. 1101005439/124170. Stroke position changed to 2.6 mm/0.102 ins (prev. 2.4 mm/0.094 ins).

TD121G, GG, GP have a new turbocharger, Holset H2D (part No. 863501-3) from engine No. 1101019805/xxxx. At the same time the injection angle is changed to 24° B.T.D.C. (prev. 26°).

New engine designations:
from engine No. 1101015277/xxxx, TD100GP is changed to **TD100HP**. TD120HP is changed to **TD121GP**.

Additional to T(A)MD122:

- New injection pump with smoke limiter.
- New vibration damper (not for TMD122A).
- Five-hole nozzles (only for TAMD122A).
- Larger turbocharger (only for TAMD122C).

TAMD122C has later been replaced by **TAMD122D** which has, among other things, higher power output, the compression ratio reduced to 14.0:1 (prev. 14.2:1), and shorter lube oil filters.

Common changes for industrial engines in the 100 and 120 series.

- New instrument panel and electrical system (refer to the Instruction Book).
- New oil dipstick fitted in the sump which allows the oil level to be read with the engine running.
- Injection pump with RSV governor and smoke limiter as standard for mobile applications.

TID121KG, KP, TID121LG, LP, TD120HP (Previously TD120HPP)

These engines were introduced at the end of 1985 and the beginning of 1986.

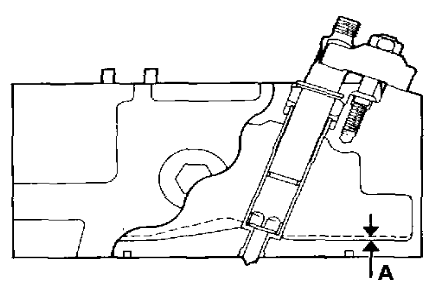
The engines have a different location for the air filters, mounted on top, similar to the 100 series. New radiator with integral expansion tank, new fan cover and fan protection. These changes have also been introduced on the TD121GG.

TID121KG, KP, LG and LP have a water cooled intercooler of the same type as TID100.

TID121LG and LP have a larger vibration damper, larger injection pump (13 mm plungers) and larger turbocharger (make KKK). These engines also have other pistons with a Keystone type upper piston ring.

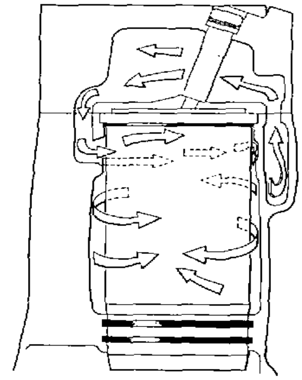
Cylinder head, 100 series 87

The bottom of the cylinder head has been made approx. 3 mm (0.118 ins) thinner. The height of the exhaust valve seat has been reduced from 11.5 to 9.5 mm (0.453-0.374 ins). The outer diameter of the seat has been increased by approx. 0.016 mm (0.0006 ins) to obtain a better grip in the cylinder head. Only this new version of cylinder head will be available as a replacement part. The cylinder head bolts have new material and higher tightening torques, refer to Technical Data. The new bolts have part No. 422086 stamped in the bolt heads and replace the previous version as replacement parts. The new tightening torques apply also for earlier engines.



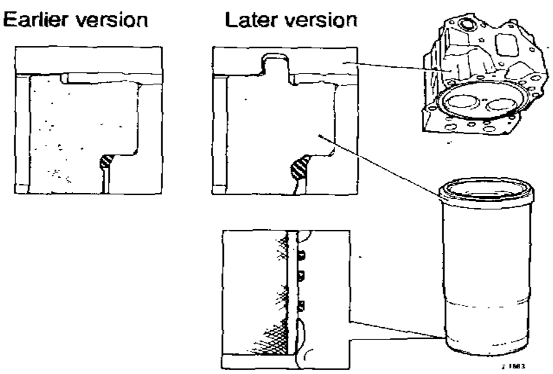
Coolant circulation, 100 series -87

The water jacket around the cylinder liner is divided by a horisontal shelf. The coolant flows from the distribution channel in the block to the cylinder head and thereafter down to the liner jacket's upper part, which is hottest and requires the most effective cooling. The coolant is led down to the lower part through a narrow passage on the opposite side and then returned forward in the block.



Cylinder head, liners, 120 series -87

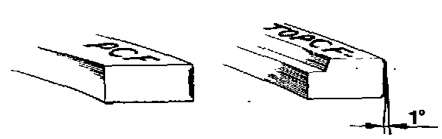
The sealing now has a flame barrier. The new cylinder head has grooves as before and therefore the milling cutter 999 9531-8 can still be used here. The sealing ring under the liner collar has its thickness increased from 1.6 mm (0.063 ins) to 2.4 mm (0.094 ins). The material is EPDM rubber.



New piston rings

100 series

New piston rings have been introduced from engine No. xxx/188057. These new rings reduce the oil consumption and can be used on earlier engines, however, not on the 100A and B series.



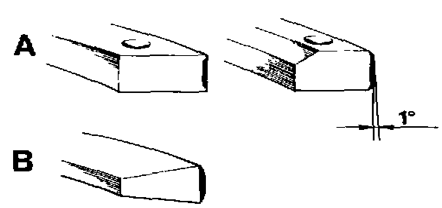
Upper ring
Molybdenum coated

Lower ring
Tapered "twist" ring

120 series

New piston rings have been introduced from engine No. xxx/114940. These new rings reduce the oil consumption and can be used on earlier engines, however, not on the 120A series.

TID121LG, LP and TAMD122D have a Keystone type upper piston ring.



Upper ring
Molybdenum coated

Lower ring
Tapered "twist" ring

A Rectangular ring
B Keystone ring

Nitro-carburated timing gears (Only fitted on industrial engines)

To allow higher power output through the timing gears (compressed air compressor, hydraulic pump, power-take-off), an adaption of the timing gears has been necessary. Nitro-carburated gears (that can withstand higher loads) have therefore been introduced.

NOTE! *These gears must* ***not*** *be fitted together with* earlier (hardened and tempered) gears.

General instructions for replacing gears with nitro-carburated gears.

When changing to nitro-carburated timing gears only the following gear combinations are allowed to be installed:

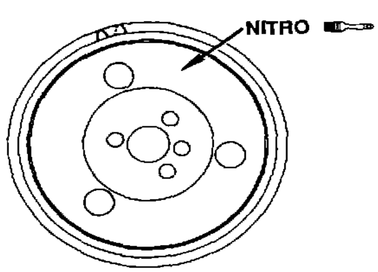
- Nitro-carburated gears (marked N or NITRO) must **never** mesh with hardened and tempered gears (marked HT). An exception to this is the gear for the cooling water pump on 121 series engines.
- Case-hardened gears (marked CH) are permitted in all gear combinations.

Gear markings	
N =	Nitro-carburated
HT =	Hardened and tempered
CH =	Case-hardened

The following information will help to distinguish nitro-carburated gears from hardened and tempered gears:

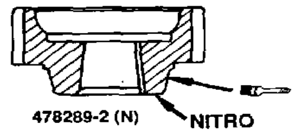
- **Nitro-carburated gears** can be easiest identified by their matt grey to grey/yellow colour. During a transition period they will also be marked with white, oil-resistant, paint and will later have an "N" or "NITRO" punched in the gear (see fig).

  Note. During a transition period (approx. 3 months), engines with nitro-carburated timing gears will have a yellow paint mark on the timing gear casing above the "compressor cover" (the timing gear casing's rear edge, right hand side).

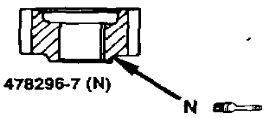


478297-5 (N)

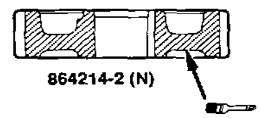
= or marked with white, oil resistant, paint for earlier versions.

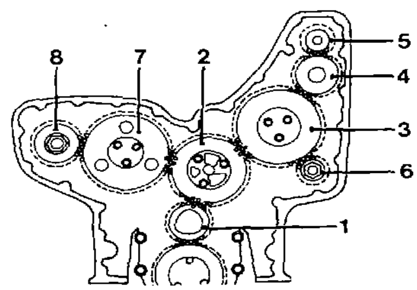


478289-2 (N)



478296-7 (N)


864214-2 (N)



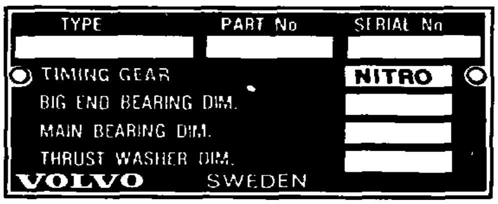
		Engines in the 100 and 120 series			
		Up to engine no 100 series: xxxx/220979 *120 series: xxxx/155515*		*From engine no* 100 series: xxxx/220980 *120 series: xxxx/155516*	
Pos	**Timing gear**	**Part No**	**Type**	**Part No**	**Type**
1	Crankshaft gear	423080-1	CH	423080-1	CH
2	*Intermediate gear*	*467461-0*	*CH*	*467461-0*	*CH*
3	Injection pump	423079-3	HT	478297-5	N
4	Hydr. pump (100 series) Interm. gear (121 series)	422087-7 470217-1*	HT N	864214-2 470217-1*	N N
5	Coolant pump (121 ser)	470265-0	N	470265-0	N
6	Hydraulic pump (121 ser)	465059-4	HT	478296-7	N
7	*Camshaft*	423079-3	*HT*	478297-5	N
8	Compr. air compressor	423087-6	HT	478289-2	N

* Note. As replacement part a complete intermediate gear part No 470231-2 (gear 470217-1 and bearing) is supplied.

Instructions for factory overhauled engines

In connection with the overhaul of engines at the factory, the production marking of nitro-carburated gears can disappear. The existing Engine Data plate on factory overhauled engines will therefore be changed as shown in the fig. below. The earlier marking "CYLINDER DIM" has been changed to "TIMING GEAR". In the box after the text, the word "NITRO" will be written for those engines with nitro-carburated gears and "HT" for engines with hardened and tempered gears.

NOTE! It is important to check the information on this plate when replacing the compressed air compressor or servo pump on factory overhauled engines to be sure of the type of gears fitted during the overhaul.

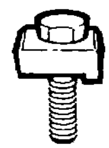


Engine data plate, later version, for factory overhauled engines.

Special Tools

For engines in the 121/122 series equipped with flame barriers, a new special tool (999 8043-5) for pressing down the cylinder liner has been produced.
Note. The new tool can **not** be used on engines without flame barriers.

A new version of piston ring compressor (999 8006-2) is available, which is suited for engines with flame barriers in the 121/122 series.
Note. The tool also fits earlier engines and therefore replaces the previous tool 999 2951-5.



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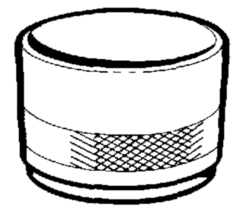


8006

TECHNICAL DATA

Compression ratio

TAMD122D	14.0:1
TD121G, GG, GP 87, TD120HP -87	14.2:1

Turbocharger

TMD102A	KKK K28-3464M0A/14.71
T(A)MD122A	Holset 4LGK267/3.0WS2
TAMD122C, D	Holset 4LGK0870/3.0WS2
TD100G, GG, GP, HP -87	Holset H2C-8640P/P25T3
TD121G, GG, GP 87, up to and incl. 1101019804	Holset 4LGK477/4.0T2
from 1101019805	Holset H2D 9351AK/S28W11
TID121KG, KP	Holset 4LGK477/4.0T2
TID121LG, LP	KKK K33-4067/24.22
Maximum permissible radial clearance (compressor side)	4LGK:0.61 mm (0.024"), H2C, -D:0.53 mm (0.021") K28, K33:0.45 mm (0.018")
Axial clearance, max	0.16 mm (0.006")

Boost pressure

Minimum values (measured at the engine intake manifold) at 100% load, full throttle and ambient temperature *of approx +25°C (77°F). If the measuring is carried out at* a different temperature, then the measured boost pressure must be corrected, see the Workshop Manual.

If full power cannot be developed this pressure will be considerably lower.

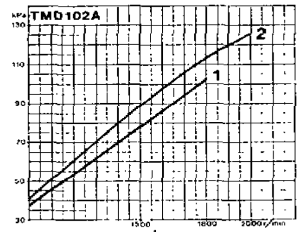
Marine engines

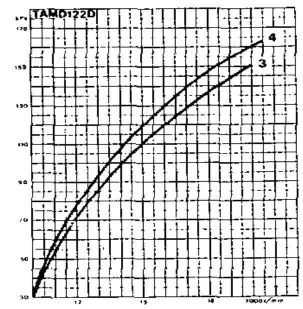
***Curve 1** applies to heavy duty (output curve HD)*

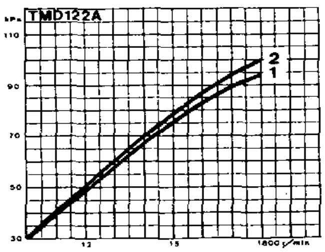
Curve 2 applies to medium duty (output curve MD)

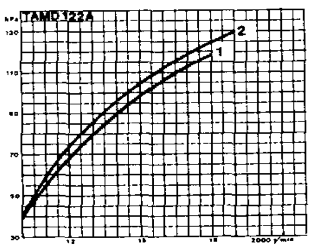
***Curve 3** applies to light duty (output curve LD)*

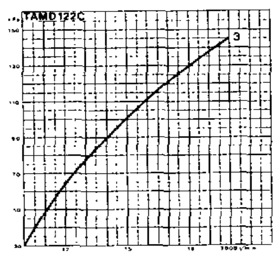
Curve 4 applies to pleasure craft duty (output curve PD)



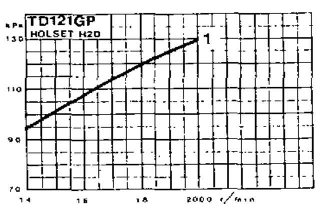




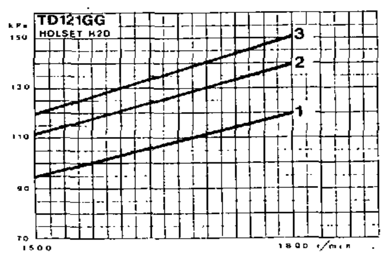




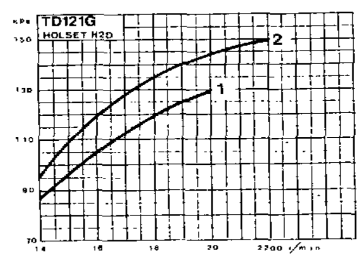
Industrial engines



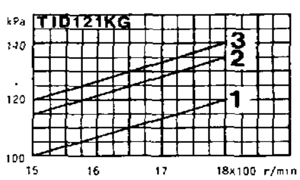
1. Continuous Power



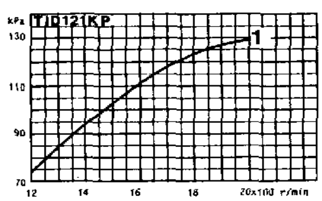
1. Standard Power
2. Overload Power
3. Standard Fuel Stop Power



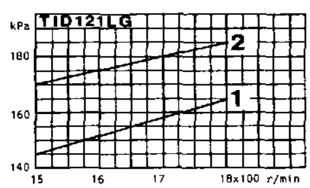
1. Continuous Power
2. Intermittent Power



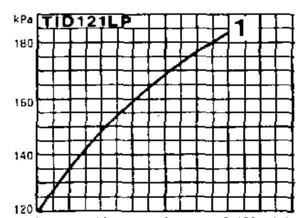
1. Standard Power
2. Overload Power
3. Standard Fuel Stop Power



1. Continuous Power



1. Standard Power
2. Overload Power



1. Continuous Power

Cylinder liners, 100, 120

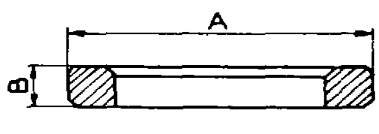
Upper sealing ring, thickness	2.4 mm (0.094")

Valve seats, 100

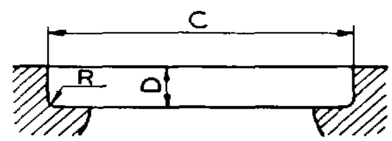
		Inlet	Exhaust
Outer diameter (dimension A)	standard	54.066-54.085 mm (2.128-2.129")	49.070-49.086 mm (1.932-1.932")
	oversize	54.266-54.285 mm (2.136-2.137")	49.270-49.286 mm (1.940-1.940")
Height (dimension B)		6.7-6.8 mm (0.264-0.2677")	9.4-9.5 mm (0.370-0.374")

Recess for valve seats 100

Diameter (dimension C)	standard	54.000-54.030 mm (2.126-2.127")	49.000-49.025 mm (1.929-1.930")
	oversize	54.200-54.230 mm (2.134-2.135")	49.200-49.225 mm (1.937-1.938")
Depth (dimension D)		9.8-9.9 mm (0.386-0.390")	11.8-11.9 mm (0.465-0.468")



Valve seat



Recess for valve seat

Injection pump

TMD102A

Injection pump	PE6P110A320RS3162[1] or PE6P120A300RS3075*
Lift from base diameter	3.5(+0.1)mm or 2.6(+0.1)mm* (0.138+0.004") or (0.102+0.0004")*
Setting	22° B.T.D.C.
Governor	RSV200-900 P1/421 or electronic governor
Feed pump	FP/KG 24P200

1) Prev. introd. on TMD100C
* Applies only to engines with electronic governor

TMD122A

Injection pump	PE6P120A320RS3206 orPE6P120A300RS3075*
Lift from base diameter	3.5(+0.1)mm or 2.6(+0.1)mm* (0.138+0.004") or (0.102+0.0004")*
Setting	24°[1] or 26°[2] B.T.D.C.
Governor	RSV250-900 P4A374-7 or RQ 750PA783-1 or electronic governor
Feed pump	FP/KG 24P200

* Applies to engine with electronic governor
1) Applies to engine with RSV or RQ governor together with electronic governor
2) Applies to engine with only electronic governor

TAMD122A

Injection pump	PE6P120A320RS3206 or PE6P120A300RS3075*
Lift from base diameter	3.5(+0.1)mm or 2.6(+0.1)mm* (0.138+0.004") or (0.102+0.0004")*
Setting	21°[3] or 22°[4] or 20°[5] B.T.D.C.
Governor	RSV250-900 P4A374-6 or RQ 750PA783-1 or electronic governor
Feed pump	FP/KG 24P200

* Applies to engine with electronic governor
3) Applies to engine with RSV governor
4) Applies to engine with electronic governor
5) Applies to engine with RQ governor

TAMD122C, D

Injection pump PE6P120A320R3206
Lift from base diameter .... 3.5(+0.1)mm (0.138+0.004")
Setting .... 21° B.T.D.C.
Governor RSV250-900 P4A374-6
Feed pump .... FP/KG 24P200

TD100G -87

Injection pump PE6P110A320RS3152
Lift from base diameter .... 3.5(+0.1)mm (0.138+0.004")
Setting .... 20° B.T.D.C.
Governor RSV200-1100 P1A515-1
Feed pump .... FP/KG 24P200

TD100GG/GGP -87

Injection pump .... PE6P120A320RS3189 or PE6P110A320RS3109*
Lift from base diameter .... 2.6(+0.1)mm or 3.5(+0.1)mm*
(0.102+0.004") or (0.138+0.004")*
Setting .... 22° B.T.D.C.
Governor .... RSV650-750 P4/421-3 or electronic
Feed pump .... FP/KG 24P200
* Applies to engine with electronic governor

TD100GP/GPB -87, TD100HP/HPB -87

Injection pump PE6P110A320RS3109
Lift from base diameter .... 3.5(+0.1)mm (0.138+0.004")
Setting .... 20° B.T.D.C.
Governor .... RSV200-900 P1/421R or electronic
Feed pump FP/K22 P22

TID100KG/KGP -87

Injection pump .... PE6P120A320RS3189 or PE6P110A320RS3109*
Lift from base diameter .... 2.6(+0.1)mm or 3.5(+0.1)mm *
(0.102+0.004") or (0.138+0.004")*
Setting .... 22° B.T.D.C. or 20° B.T.D.C.*
Governor .... RSV650-750 P4/421-3 or electronic
Feed pump .... FP/KG 24P200
* Applies to engine with electronic governor

TID100KP/KPB -87

Injection pump PE6P110A320RS3132
Lift from base diameter .... 3.5(+0.1)mm (0.138+0.004")
Setting .... 20° B.T.D.C.
Governor RSV200-1100 P1/421-1
Feed pump FP/K22 P22

TD121G -87

Injection pump PE6P120A320RS3187
Lift from base diameter .... 2.4(+0.1)mm (0.094+0.004")
Setting .... 24° B.T.D.C. or 26° B.T.D.C. **
Governor RSV250-1100 P4A523
Feed pump .... FP/KG 24P200
** Applies to engine with 4LGK turbo

TD121GG/GGP -87

Injection pump .... PE6P120A320RS3189 or PE6P120A300RS3075*
Lift from base diameter .... 2.6(+0.1)mm (0.102+0.004")
Setting .... 24° B.T.D.C. or 26° B.T.D.C. **
Governor .... RSV650-750 P4/421-3 or electronic
Feed pump .... FP/KG 24P200

* Applies to engine with electronic governor
** Applies to engine with 4LGK turbo

TD120HP/HPB -87
TD121GP/GPB -87

Injection pump PE6P120A320RS3088
Lift from base diameter .... 2.4(+0.1)mm (0.094+0.004")
Setting .... 24° B.T.D.C. or 26° B.T.D.C. **
Governor RSV200-1100 P4/421R
Feed pump FP/K22 P22

** Applies to engine with 4LGK turbo

TID121KG/KGP -87

Injection pump PE6P120A320RS3148
Lift from base diameter .... 2.6(+0.1)mm (0.102+0.004")
Setting .... 24° B.T.D.C.
Governor .... RQ750PA783 or RQ250/775PA770*
Feed pump FP/KG24 P200

* Applies to engine with electronic governor

TID121KP/KPB -87

Injection pump PE6P120A320RS3153
Lift from base diameter .... 2.6(+0.1)mm (0.102+0.004")
Setting .... 24° B.T.D.C.
Governor RSV200-1000 P1A305-3
Feed pump FP/K22 P22

TID121LG/LGP -87

Injection pump PE6P130A320RS7113
Lift from base diameter .... 3.0(+0.1)mm (0.118+0.004")
Setting .... 17° B.T.D.C.
Governor .... RQ250/775PA770 with electronic governor
Feed pump FP/KG24P307

TID121LP/LPB -87

Injection pump PE6P130A320RS7113
Lift from base diameter .... 3.0(+0.1)mm (0.118+0.004")
Setting .... 17° B.T.D.C.
Governor RSV200-900 P4A521
Feed pump FP/KG24 P307

Injectors
TMD102

Nozzle holders	KBEL 117P7/4
Nozzles	DLLA 148P149
Injectors, complete, marking	788
Opening pressure	25.5 MPa (260 kp/cm²) (3697 psi)
Setting pressure (new spring)	26.0-26.8 MPa (265-273 kp/cm²) (3768-3882 psi)
Hole diameter	5x0.34 mm (5x0.013")

TMD122, TAMD122C, D

Nozzle holders	KBEL 117P7/4
Nozzles	DLLA 150 P76
Injectors, complete, marking	834
Opening pressure	25.0 MPa (255 kp/cm²) (3626 psi)
Setting pressure (new spring)	25.5-26.3 MPa (260-268 kp/cm²) (3697-3811 psi)
Hole diameter	4x0.40 mm (4x0.016")

TAMD122A

Nozzle holders	KBEL 117P7/4
Nozzles	DLLA 148P149
Injectors, complete, marking	788
Opening pressure	25.5 MPa (260 kp/cm²) (3697 psi)
Setting pressure (new spring)	26.0-26.8 MPa (265-273 kp/cm²) (3768-3882 psi)
Hole diameter	5x0.34 mm (5x0.013")

TD100G, GG/GGP, GP/GPB, HP/HPB -87
TID100KG/KGP, KP/KPB -87

Nozzle holders	KBEL 117P7/4
Nozzles	DLLA 150P110
Injectors, complete, marking	815
Opening pressure	26.0 MPa (265 kp/cm²) (3768 psi)
Setting pressure (new spring)	26.5-27.3 MPa (270-278 kp/cm²) (3839-3953 psi)
Hole diameter	4x0.36 mm (4x0.014")

TD121G, GG/GGP, GP/GPB -87
TD120HP/HPB, TID121KG/KGP -87
TID121KP/KPB -87

Nozzle holders	KBEL 117P7/4
Nozzles	DLLA 150P31
Injectors, complete, marking	863
Opening pressure	27.0 MPa (275 kp/cm²) (3910 psi)
Setting pressure (new spring)	27.5-28.3 MPa (280-288 kp/cm²) (3982-4095 psi)
Hole diameter	5x0.36 mm (0.014")

TID121LG/LGP -87

Nozzle holders	KBEL 117P7/4
Nozzles	DLLA 150P119
Injectors, complete, marking	808
Opening pressure	27.0 MPa (275 kp/cm²) (3910 psi)
Setting pressure (new spring)	27.5-28.3 MPa (280-288 kp/cm²) (3982-4095 psi)
Hole diameter	5x0.38 mm (5x0.015")

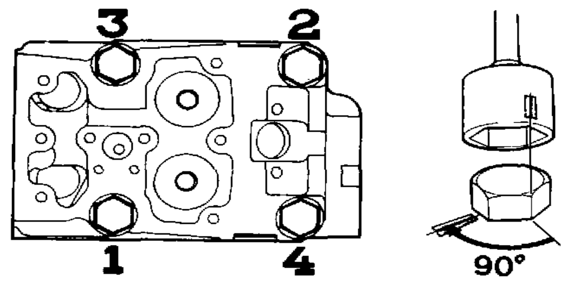
Tightening torques

100 series

The tightening torque for the cylinder head bolts is changed to 370 Nm (prev. 320 Nm). The following angle tightening is changed to 90° (prev. 60°).

The previous tightening procedure applies to earlier engines.

Tighten the cylinder head bolts in 4 steps according to the tightening sequence.
First tightening 50 Nm (5 kpm = 36 lbf.ft)
Second tightening 200 Nm (20 kpm = 145 lbf.ft)
Third tightening 370 Nm (37 kpm = 267 lbf.ft)
Final tightening (angle tightening) 90°



Tightening sequence

Publ. No. 7732286-5
12-1989

WORKSHOP MANUAL

Industrial engines
TD100G · TID100K · TD121G · TD120HPP · TID120HPP · TID121FG

Marine engines
TMD100C · TMD121C · TAMD121C

CONTENTS

TECHNICAL DATA

General

	100-series	120-series
Number of cylinders	6	6
Bore	120.65 mm (4.750")	130.175 mm (5.125")
Stroke	140 mm (5.51")	150 mm (5.91")
Displacement, total	9.6 litres (585 cu.in.)	11.97 litres (730 cu.in.)
Compression ratio	14.3:1	14.2:1 (industrial engines 13.3:1)
Compression pressure at starter motor speed, 230 r/min	2500 kPa (25 kp/cm^2) (355 p.s.i.)	
Order of firing (cyl. no. 6 nearest flywheel)	1-5-3-6-2-4	
Direction of rotation (viewed from front)	Clockwise	
Power output	See relevant engine diagram	
High idling speed/governor over-run	See "Injection data", SB file	
Low idling speed	See "Injection data", SB file	

Turbo-compressor

TMD100C	KKK K28-34640D/14.71
TMD121C, TAMD121C	Holset 4LGK 267/3.0 WS2
TD100G, TID100K	Holset H2C-8640P/P25 T3
T(I)D120, T(I)D121	Holset 4LGK-477/4.0 T2
Lubricating system	Pressure lubrication from engine
Maximum permissible radial play (compressor side)	Holset: 0.61* mm (0.024") KKK: 0.46 mm (0.018")
Axial play to remain within	Holset: 0.08–0.15 mm (0.002–0.006") KKK: max 0.16 mm (0.006")
Maximum permissible back pressure in exhaust line	See relevant data sheet in engine brochure

* Mod H2C: 0.53 mm (0.021")

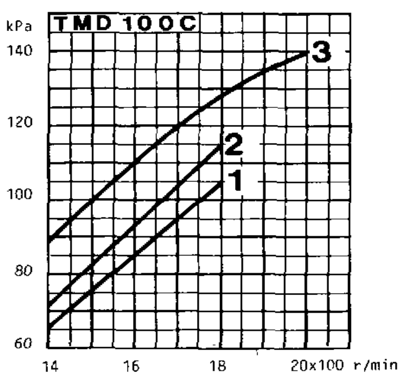
Air-charging pressure

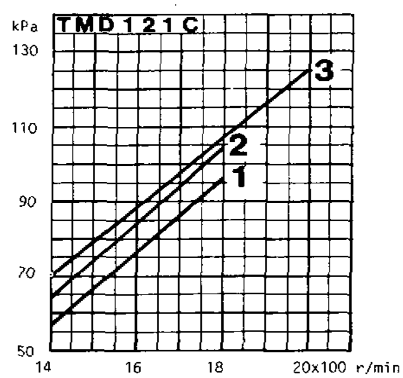
Minimum value for air-charging pressure (measured in the engine intake manifold) under 100 % loading, full throttle and ambient air temperature of +20°C. If measurement is carried out at another temperature, then the air-charging pressure measured must be corrected according to the diagram on page 81.

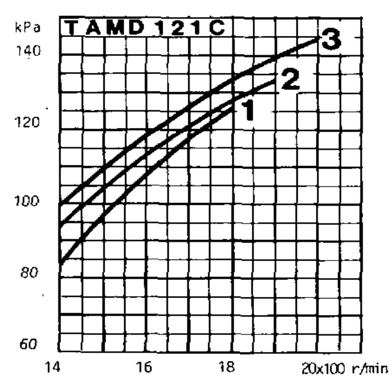
If full power cannot be developed this pressure will be considerably less.

Marine engines

Graph 1 applies to heavy commercial operation (power output graph C).
Graph 2 applies to light commercial operation (power output graph C1).
Graph 3 applies to leisure craft (power output graph B).

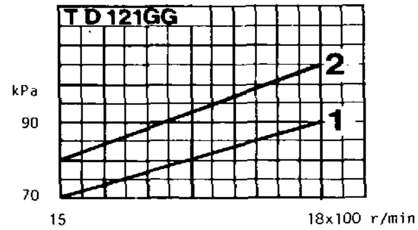


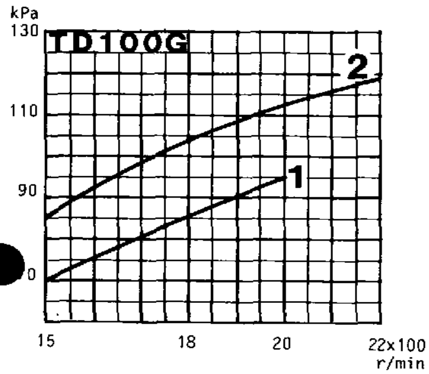


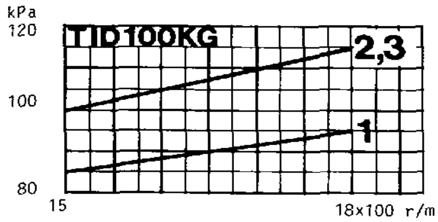


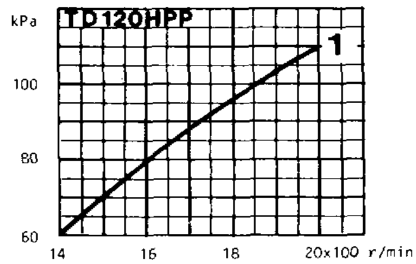
Industrial engines

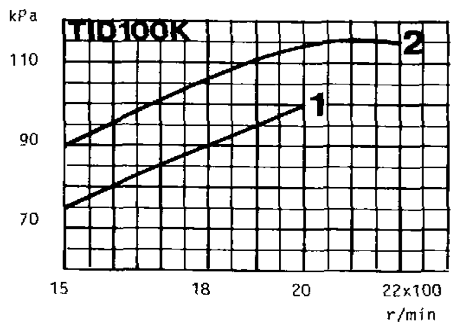
Graph 1 applies to power output according to graph 4 on the engine diagram or point 1 on the regulating graph.
Graph 2 applies to power output according to graph 2 on the engine diagram or point 2 on the regulating graph.
Graph 3 applies to power output according to point 3 on the regulating graph.

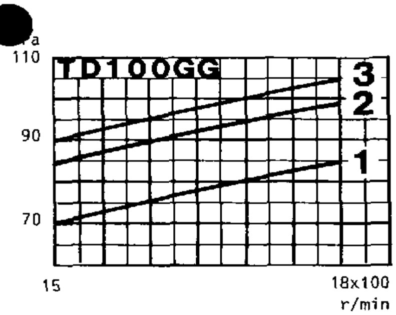


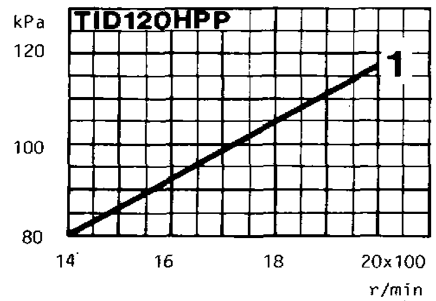


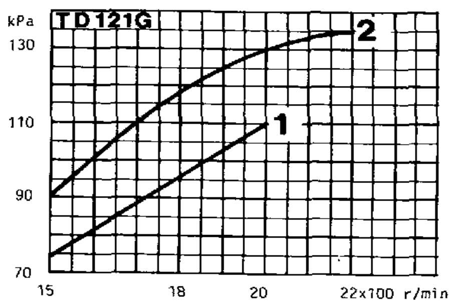


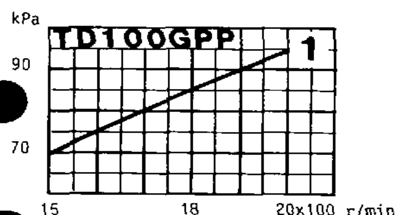


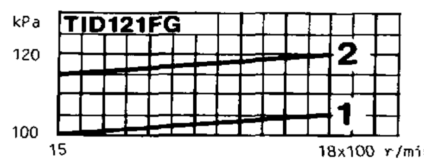












Cylinder liners

	100-series	120-series
Type	Wet, replaceable	
Bore (no oversizes available)	120.65 mm (4.75")	130.175 mm (5.125")
Liner collar height (from gasket mating surface)	11.52 mm (0.453")	10.52 mm (0.414")
Cylinder liner height above block face	0.15–0.20 mm (0.006–0.008")	0.47–0.52 mm (0.019–0.020")

Pistons

	100-series	120-series
Piston height above block face	0.15–0.65 mm (0.006–0.026")	–0.05 to +0.45 mm (–0.002 to +0.018")
Piston clearance	0.15–0.18 mm (0.006–0.007")	0.12–0.15 mm (0.005–0.006")
Front marking	Arrow faces front	

Piston rings

	100-series	120-series
Number of compression rings	2	
Number of oil control rings	1	
Piston ring gap with bores of 120.65 mm (4.75") and 130.75 mm (5.125") respectively		
Upper compression ring	0.41–0.66 mm (0.016–0.026")	0.56–0.79 mm (0.022–0.031")
2nd compression ring	0.33–0.58 mm (0.013–0.023")	0.46–0.69 mm (0.018–0.027")
Oil control ring	0.33–0.77 mm (0.013–0.030")	0.43–0.81 mm (0.017–0.032")

Gudgeon (piston) pins

	100-series	120-series
Clearance, gudgeon (piston) pin – connecting rod bushing	0.018–0.026 mm (0.0007–0.0010")	
Clearance, gudgeon (piston) pin – gudgeon (piston) pin hole	max. 0.008 mm (0.0003")	
Grip fit, gudgeon (piston) pin – gudgeon (piston) pin hole	max. 0.004 mm (0.0002")	
Gudgeon (piston) pin diameter	52.000–52.004 mm (2.0472–2.0474")	55.000–55.004 mm (2.1654–2.1655")
Internal diameter of connecting rod bushing	52.022–52.026 mm (2.0481–2.0483")	55.022–55.026 mm (2.1662–2.1664")
Gudgeon (piston) pin hole diameter in piston	52.000–52.008 mm (2.0472–2.0476")	55.000–55.008 mm (2.1654–2.1657")

Cylinder heads

	100-series	120-series
Height	115 mm (4.53")	125 mm (4.92")
Depth of sealing groove		0.20 mm (0.008")

Crankshaft

	100-series	120-series
Axial clearance (end float) of crankshaft	0.06–0.27 mm (0.0023–0.0106")	0.06–0.32 mm (0.0023–0.0125")
Main bearings, radial clearance	0.07–0.14 mm (0.0027–0.0055")	0.07–0.14 mm (0.0027–0.0055")

Main bearing journals

	100-series	120-series
Diameter, standard	99.978–100.000 mm (3.9361–3.9370")	107.915–107.937 mm (4.2486–4.2495")
Diameter, undersize, 0.25 mm (0.010")	99.724–99.746 mm (3.9261–3.9270")	107.661–107.683 mm (4.2386–4.2395")
0.50 mm (0.020")	99.470–99.492 mm (3.9161–3.9170")	107.407–107.429 mm (4.2286–4.2295")
0.75 mm (0.030")	99.216–99.238 mm (3.9061–3.9070")	107.153–107.175 mm (4.2186–4.2195")
1.00 mm (0.040")	98.962–98.984 mm (3.8961–3.8970")	
1.25 mm (0.050")	98.708–98.730 mm (3.8860–3.8870")	
Width, main bearing journal, axial bearing: Standard	45.975–46.025 mm (1.8100–1.8120")	
Oversize, 0.2 mm (0.0078") (axial bearing 0.1 mm (0.0039") oversize)	46.175–46.225 mm (1.8179–1.8199")	
0.4 mm (0.0157") (axial bearing 0.2 mm (0.0078") oversize)	46.375–46.425 mm (1.8258–1.8278")	
0.6 mm (0.236") (axial bearing 0.3 mm (0.0181") oversize)	46.575–46.625 mm (1.8337–1.8356")	

Main bearing shells

Thickness, standard	2.442–2.451 mm (0.0961–0.0964")
oversize, 0.25 mm (0.010")	2.569–2.578 mm (0.1011–0.1014")
0.50 mm (0.020")	2.696–2.705 mm (0.1061–0.1064")
0.75 mm (0.030")	2.823–2.832 mm (0.1111–0.1114")
1.00 mm (0.040")	2.950–2.959 mm* (0.1161–0.1164")
1.25 mm (0.50")	3.077–3.086 mm* (0.1211–0.1214")

* Not for 120-series

Connecting rod journals

	100-series	120-series
Radial clearance, big-end (connecting rod) bearings	0.071–0.121 mm (0.0028–0.0048")	0.068–0.110 mm (0.0027–0.0043")
Width of bearing surface	53.90–54.00 mm (2.122–2.126")	54.90–55.00 mm (2.161–2.165")
Diameter, standard	86.003–86.018 mm (3.3859–3.3865")	92.028–92.043 mm (3.6231–3.6237")
undersize, 0.25 mm (0.010")	85.753–85.768 mm (3.3761–3.3767")	91.778–91.793 mm (3.6133–3.6139")
undersize, 0.50 mm (0.020")	85.503–85.518 mm (3.3663–3.3669")	91.528–91.543 mm (3.6035–3.6041")
0.75 mm (0.030")	85.253–85.268 mm (3.3564–3.3570")	91.278–91.293 mm (3.5936–3.5942")
1.00 mm (0.040")	85.003–85.018 mm (3.3466–3.3472")	
1.25 mm (0.050")	84.753–84.768 mm (3.3367–3.3373")	

Big-end bearing shells

Thickness, standard	2.408–2.417 mm (0.0948–0.0952")
oversize, 0.25 mm (0.010")	2.535–2.544 mm (0.0998–0.1002")
0.50 mm (0.020")	2.662–2.671 mm (0.1048–0.1052")
0.75 mm (0.030")	2.789–2.798 mm (0.1098–0.1102")
1.00 mm (0.040")	2.916–2.925 mm* (0.1148–0.1152")
1.25 mm (0.050")	3.043–3.052 mm* (0.1198–0.1202")

* Not for 120-series

Connecting rods

Marked 1 to 6.
The "FRONT" marking on the shank is to face forwards.
Gudgeon (piston) pin bushing inner diameter. See under heading "Gudgeon (piston) pins".

	100-series	120-series
Diameter, connecting rod bushing bearing recess in connecting rod	57.300–57.346 mm (2.2559–2.2577")	60.300–60.346 mm (2.3740–2.3758")
Diameter, big-end bearing shell recess	90.925–90.940 mm (3.5797–3.5803")	96.835–96.850 mm (3.8124–3.8130")
Axial clearance (end float) at crankshaft	0.15–0.35 mm (0.006–0.014")	

Camshaft

Drive	Gear drive
Number of bearings	7
Front bearing journal, diameter	68.996–69.015 mm (2.7164–2.7171")
2nd bearing journal, diameter	66.621–66.640 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")
Axial clearance (end float)	0.05–0.13 mm (0.002–0.005")
Radial clearance (for all bearings)	0.035–0.079 mm (0.0014–0.0031")
Camshaft setting check (cold engine and valve clearance = 0): With the flywheel at 10° after T.D.C., the inlet valve on cylinder no. 1 must have opened by	4.47±0.25 mm (0.176±0.010")

For lifting height, see page 40.

Camshaft bearings

Front bearing, diameter	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	61.112–61.138 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")

Auxiliary drive gears

	100-series	120-series
Gear backlash		0.03–0.17 mm (0.0012–0.0067")
Radial clearance for idler gear		0.03–0.09 mm (0.0012–0.0035")
Axial clearance for idler gear		0.05–0.15 mm (0.002–0.006")
Idler gear journal, diameter		92.084–92.106 mm (3.625–3.626")
Number of teeth, crankshaft gear		30
idler gear		53
camshaft gear		60
injection pump drive gear		60
drive gear for fresh-water pump and generator (marine engines)		17
idler gear, coolant pump, industrial 120-series		31
drive gear, *coolant pump, industrial* 120-series		19
idler gear, oil pump		48
drive gear, oil pump		21
drive gear for sea-water pump[2]		33

[2] Compressor on industrial engines

Valves

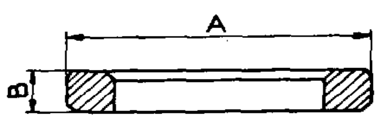
100-series

	Inlet	Exhaust
Valve disc diameter	50 mm (1.969")	46 mm (1.811")
Valve stem diameter	10.982–11.000 mm (0.4324–0.4331")	10.950–10.968 mm (0.4311–0.4318")
Valve seat angle	29.5°	44.5°
Seat angle in cylinder head	30°	45°
Valve clearance	0.40 mm (0.016")	0.70 mm (0.028")

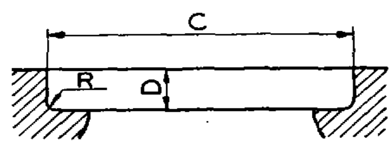
120-series

	Inlet	Exhaust
Valve disc diameter	54 mm (2.126")	50 mm (1.969")
Valve stem diameter	10.982–11.000 mm (0.4324–0.4331")	10.966–10.984 mm (0.4317–0.4324")
Valve seat angle	29.5°	44.5°
Seat angle in cylinder head	30°	45°
Valve clearance	0.40 mm (0.016")	0.70 mm (0.028")

Valve seats



Valve seat



Valve seat recess

100-series

	Inlet	Exhaust
Valve seat:		
Diameter, standard (dimension A)	54.10–54.12 mm (2.1300–2.1307")	51.10–51.12 mm (2.0119–2.0126")
oversize	54.30–54.32 mm (2.1378–2.1386")	51.30–51.32 mm (2.0197–2.0205")
Height (dimension B)	6.7–6.8 mm (0.264–0.268")	9.4–9.5 mm (0.370–0.374")
Recess for valve seat:		
Diameter, standard (dimension C)	54.00–54.03 mm (2.1260–2.1272")	51.00–51.03 mm (2.0079–2.0090")
oversize	54.20–54.23 mm (2.1339–2.1350")	51.20–51.23 mm (2.0157–2.0170")
Depth (dimension D)	9.8–9.9 mm (0.386–0.390")	13.8–13.9 mm (0.543–0.547")
Bottom radius of recess, max. (dimension R)	0.5–0.8 mm (0.02–0.03")	
Measurement between the valve disc and cylinder head face should be	1.20–1.70 mm (0.047–0.067")	

120-series

	Inlet	Exhaust
Valve seat:		
Diameter, standard (dimension A)	59.10–59.12 mm (2.3268–2.3276")	56.58–56.60 mm (2.2276–2.2283")
oversize	59.30–59.32 mm (2.3346–2.3354")	56.78–56.80 mm (2.2323–2.2362")
Height (dimension B)	6.7–6.8 mm (0.264–0.268")	9.4–9.5 mm (0.370–0.374")

	Inlet	Exhaust
Recess for valve seat:		
Diameter, standard (dimension C)	59.00–59.03 mm (2.3228–2.3240")	56.50–56.53 mm (2.2244–2.2256")
oversize	59.20–59.23 mm (2.3307–2.3319")	56.70–56.73 mm (2.2323–2.2335")
Depth (dimension D)	8.8–8.9 mm (0.346–0.350")	10.8–10.9 mm (0.425–0.429")
Bottom radius of recess, max. (dimension R)	0.5–0.8 mm (0.02–0.03")	
Measurement between the valve disc and cylinder head face should be	0.20–0.70 mm (0.008–0.028")	

Valve guides

	100-series	120-series
Length, intake valve guides	82 mm (3.23")	
exhaust valve guides	66 mm (2.60")	
Inner diameter, intake/exhaust (fitted)	11.032–11.050 mm (0.4343–0.4350")	
spare part version	11.032–11.059 mm (0.4343–0.4353")	
Clearance, valve stem – valve guide:		
Inlet	0.03–0.07 mm (0.0012–0.0028")	
Exhaust	0.06–0.10 mm (0.0024–0.0039")	0.05–0.08 mm (0.0020–0.0031")

Valve springs

100-series

Outer valve spring

Length, unloaded	approx. 62 mm (2.44")
loaded with 300–390 N (66–86 lbf.)	50 mm (1.97")
loaded with 690–840 N (152–185 lbf.)	35 mm (1.38")
fully compressed, max.	32.6 mm (1.28")

Inner valve spring

Length, unloaded	approx. 54 mm (2.13")
loaded with 300–390 N (66–86 lbf.)	43 mm (1.69")
loaded with 690–840 N (152–185 lbf.)	28 mm (1.10")
fully compressed, max.	25.6 mm (1.008")

120-series

Outer valve spring

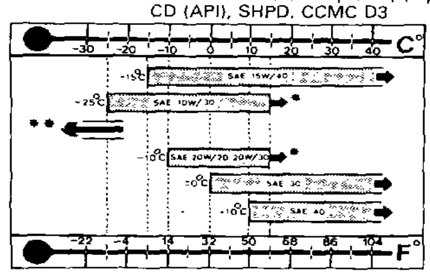
Length, unloaded	approx. 73 mm (2.87")
loaded with 310–400 N (69–90 lbf.)	54 mm (2.13")
loaded with 550–700 N (124–157 lbf.)	40 mm (1.57")
fully compressed, max.	37 mm (1.46")

Inner valve spring

Length, unloaded	approx. 67 mm (2.64")
loaded with 90–180 N (20–40 lbf.)	48 mm (1.89")
loaded with 160–310 N (36–69 lbf.)	34 mm (1.34")
fully compressed, max.	31 mm (1.22")

Lubricating system

Oil pressure, warm engine at running speed	300–500 kPa (3–5 kp/cm²) (43–71 p.s.i.)
Oil pressure, idling speed	at least 50 kPa (0.5 kp/cm²) (7 p.s.i.)
Oil grade	CD (API), SHPD, CCMC D3
Oil viscosity at various external air temperatures	



* Using these oils at temperatures above +15°C (59°F) can cause increased engine wear.

** For temperatures below –25°C (–13°F), seek the advice for your oil supplier. NOTE! Synthetic oil is only recommended at temperatures below –25°C (–13°F)

Oil capacity including lubricating oil filter and oil cooler, approx.:	100-series	120-series
Marine engines		
15° engine inclination	30 litre (6.5 Imp.gals = 7.9 US gals.)	
No engine inclination	50 litre (11.0 Imp. gals = 13.2 US gals)	
Industrial engines		
Standard sump	25 litre (5.5 Imp. gals = 6.6 US gals.)	38 litre (8.3 Imp. gals = 10.0 US gals.)
Shallow sump	min. 21 litre (4.6 Imp. gals = 5.5 US gals.) max. 27 litre (5.9 Imp. gals = 7.1 US gals.)	–

	100-series	120-series

Lubricating oil pump, type	Gear pump
number of teeth	11
axial clearance, gears	0.07–0.15 mm (0.003–0.006")
gear backlash	0.15–0.35 mm (0.006–0.014")
idler gear, number of teeth	48
idler gear journal, diameter	92.084–92.106 mm (3.6253–3.6262")
idler gear radial clearance	0.03–0.09 mm (0.0012–0.0035")
drive gear, number of teeth	21

100-series

	100-series
Relief valve spring, outer	
Length, unloaded	16.9±0.4 mm (0.665±0.016")
loaded with $335\pm^{100}_{25}$ N ($75\pm^{23}_{6}$ lbf.)	15 mm (0.59")
Relief valve spring, inner	
Length, unloaded	53.4±0.2 mm (2.102±0.008")
loaded with 46±2 N (10.3±0.5 lbf.)	*39 mm (1.535")*
64±2 N (14.4±0.5 lbf.)	33 mm (1.299")

120-series

	100-series	120-series
Relief valve spring, outer		
Length, unloaded		16.9±0.4 mm (0.665±0.016")
loaded with $335\pm^{100}_{25}$ N ($75\pm^{23}_{6}$ lbf.)		15 mm (0.59")
Relief valve spring, inner		
Length, unloaded		60.8±0.2 mm (2.394±0.008")
loaded with 65.7±1.5 N (14.8±0.3 lbf.)		*39 mm (1.535")*
84.8±1.5 N (18.1±0.3 lbf.)		33 mm (1.299")
Spring for relief valve, oil filter		
Length, unloaded	68.8 mm (2.709")	
loaded with 13–15 N (2.9–3.4 lbf.)	40 mm (1.575")	
16.9–18.9 N (3.8–4.3 lbf.)	32 mm (1.260")	
Spring for piston cooling valve, 120-series		
Length, unloaded		62 mm (2.44")
loaded with 30.4–32.4 N (6.8–7.3 lbf.)		41 mm (1.61")
42–45 N (9.4–10.1 lbf.)		33 mm (1.299")

Fuel system

Direction of rotation of injection pump viewed from front	*Clockwise*
Order of injection	1-5-3-6-2-4
Injection quantity	Refer to regulator plate or appropriate setting data in SB file
Feed pump operating pressure	100–150 kPa (1.0–1.5 kp/cm^2) (14.2–21.3 p.s.i.)

Injection pump

TMD100C

Make, type	Bosch PE 6P 110A320 RS 3109-1
Setting	20° B.T.D.C.
Pump element, diameter	11 mm (0.43")
Lift from base diameter	3.5 (+0.1) mm (0.138+0.004")
Regulator	Bosch RSV 200–900 P1/421

TMD121C

Make, type	Bosch PE 6P 120A 320RS3122
Setting	24° B.T.D.C.
Pump element, diameter	12 mm (0.47")
Lift from base diameter	2.6 (+0.1) mm (0.102+0.004")
Regulator	Bosch RSV 200–900 P4/421R

TAMD121C

Make, type	Bosch PE 6P 120A 320RS3121
Setting	22° B.T.D.C.
Pump element, diameter	12 mm (0.47")
Lift from base diameter	2.6 (+0.1) mm (0.102+0.004")
Regulator	Bosch RSV 200–900 P4/421R

TD100G,-GG,-GPP, TID100K, -KG

Make, type	Bosch PE 6P 110A 320RS3109 (TID100K: RS3132)
Setting	20° B.T.D.C.
Pump element, diameter	11 mm (0.43")
Lift from base diameter	3.5 (+0.1) mm (0.138+0.004")
Regulator	Bosch RSV 200–900 P1/421R*

* TD100GG: RSV 200–750 P4/421, TID100K: RSV 200–1100 P1/421/1, TID100KG: RSV 650–750 P4/421

TD121G, TD120HPP

Make, type	Bosch PE 6P 120A 320RS3088
Setting	26° B.T.D.C.
Pump element, diameter	12 mm (0.47")
Lift from base diameter	2.4 (+0.1) mm (0.094+0.004")
Regulator	Bosch RSV200–1000 P4/421R

TD121GG

Make, type	Bosch PE 6P 120A 320RS3088-2
Setting	26° B.T.D.C.
Pump element, diameter	12 mm (0.47")
Lift from base diameter	2.4 (+0.1) mm (0.094+0.004")
Regulator	Bosch RSV 650–750 P4/421R

TID120HPP

Make, type	Bosch PE 6P 120A 320RS3075
Setting	24° B.T.D.C.
Pump element, diameter	12 mm (0.47")
Lift from base diameter	2.6 (+0.1) mm (0.102+0.004")
Regulator	Bosch RSV 200–1000 P4/421R

TID121FG

Make, type	Bosch PE 6P 120A 300RS3075
Setting	24° B.T.D.C.
Pump element, diameter	12 mm (0.47")
Lift from base diameter	2.6 (+0.1) mm (0.102+0.004")
Regulator	Electrical

Injectors

TMD100C

Nozzle holders, make and type	Bosch KBEL 117 P7/4
Nozzles	Bosch DLLA 150 P52
Injectors complete, marking	848
Opening pressure	25.5 MPa (260 kp/cm^2) (3698 p.s.i.)
Setting pressure (new spring)	26.0 MPa (265 kp/cm^2) (3771 p.s.i.)
Nozzle hole diameter	4x0.38 mm (0.015")

TMD121C

Nozzle holders, make and type	Bosch KBEL 117 P7/4
Nozzles	Bosch DLLA 150 P43
Injectors complete, marking	852
Opening pressure	26.5 MPa (270 kp/cm^2) (3844 p.s.i.)
Setting pressure (new spring)	27.0 MPa (275 kp/cm^2) (3916 p.s.i.)
Nozzle hole diameter	4x0.40 mm (0.016")

TAMD121C

Nozzle holders, make and type	Bosch KBEL 117 P7/4
Nozzles	Bosch DLLA 150 P76
Injectors complete, marking	834
Opening pressure	25.0 MPa (255 kp/cm^2) (3626 p.s.i.)
Setting pressure (new spring)	*25.5 MPa (260 kp/cm^2) (3698 p.s.i.)*
Nozzle hole diameter	4x0.40 mm (0.016")

TD100G,-GG,-GPP, TID100K,-KG

Nozzle holders, make and type	Bosch KBEL 117 P7/4
Nozzles	Bosch DLLA 150 P31
Injectors complete, marking	848
Opening pressure	25.5 MPa (260 kp/cm^2) (3698 p.s.i.)
Setting pressure (new spring)	26.0 MPa (265 kp/cm^2) (3771 p.s.i.)
Nozzle hole diameter	*4x0.38 mm (0.015")*

TD121G,-GG, TD120HPP

Nozzle holders, make and type	Bosch KBEL 117 P7/4
Nozzles	Bosch DLLA 150 P31
Injectors complete, marking	863
Opening pressure	26.5 MPa (270 kp/cm^2) (3844 p.s.i.)
Setting pressure (new spring)	27.0 MPa (275 kp/cm^2) (3916 p.s.i.)
Nozzle hole diameter	5x0.36 mm (0.014")

TID120HPP, TID121FG

Nozzle holders, make and type	Bosch KBEL 117 P7/4
Nozzles	Bosch DLLA 150 P31
Injectors complete, marking	863
Opening pressure	26.5 MPa (270 kp/cm^2) (3844 p.s.i.)
Setting pressure (new spring)	27.0 MPa (275 kp/cm^2) (3916 p.s.i.)
Nozzle hole diameter	5x0.36 mm (0.014")

Cooling system

	100-series	120-series
Type	Pressure type, sealed system	
Filler cap valve opens at	23–32 kPa (0.23–0.32 kp/cm^2) *(3.34–4.64 p.s.i.)*	

Marine engines

	100-series	120-series
Capacity of fresh-water system including heat exchanger	approx. 40 litres (8.8 Imp. gals = 10.6 US gals.)	approx. 50 litres (11.0 Imp gals = 13.2 US gals.)
Thermostats (3) begin to open at	81°C (177.8°C)	
fully open at	94°C (201.2°F)	

Industrial engines

	100-series	120-series
Capacity of cooling system including standard radiator, approx.	36 litres (7.9 Imp. gals = 9.5 US gals) (TID100KG: 50 litres, 11.0 Imp. gals = 13.2 US gals)	45 litres (9.9 Imp.gals = 11.9 US gals.)
Thermostat (TD100G has 3) begins to open at	76°C* (168.8°F)	82°C (179.6°F)
fully open at	90°C** (194°F)	95°C (203.0°F)

* TID100K: 82° (179.6°F)
** TID100K: 95°C (203.0°F)

Electrical system

	100-series	120-series
System voltage	24V	
Capacity of batteries (2x12V), max.	143 Ah	210 Ah
Specific gravity of battery electrolyte at +20°C (68°F)		
fully charged battery	1.275–1.285 g/cm^3	
battery needs recharging at	1.230 g/cm^3	
Stop solenoid for injection pump, setting of breaker contacts:		
Distance between contacts with pull rod fully retracted	1.5–2 mm (0.06–0.08")	
Pre-heater, output, approx.	4000 W	

Alternator — 100-series / 120-series

Make	Paris-Rhône
Voltage/maximum charging current	28V/55A
Rating, approx.	1500 W
Brush length	min. 3 mm (0.118")
Make	CAV AC7B24-218C2M
Voltage/maximum charging current	28V/60A
Rating, approx.	1600 W
Brush length	min. 8 mm (0.315")
Brush spring force	2.3–2.8 N (0.5–0.6 lbf.)

Starter motor

Make, type	Bosch KB 24V
Brush spring force	13–14 N (2.9–3.15 lbf.)

Wear tolerances

Cylinder heads:

	100-series	120-series
Height	min. 114.65 mm (4.514")	min. 124.65 mm (4.907")

Cylinders:

Cylinder liners (and pistons with piston rings) should be replaced when wear reaches 0.40–0.45 mm (0.016–0.018")

Crankshaft:

Permissible out-of-round on main and big-end (connecting rod) bearing journals, max.	0.08 mm (0.003")
Permissible taper on main and big-end (connecting rod) bearing journals, max.	0.05 mm (0.002")
Max. axial clearance (end float) on crankshaft	0.40 mm (0.016")

Valves:

Valve stems, max. permissible wear	0.02 mm (0.0008")
Permissible clearance between valve stem and valve guide, max:	
Intake valve	0.15 mm (0.006")
Exhaust valve	0.25 mm (0.01")
Valve disc edge thickness to be least	Intake: 1.7 mm (0.067") Exhaust: 1.2 mm (0.047")

	100-series	120-series
Valve seats may be ground down until the distance from the valve disc (new valve) to the cylinder head face is max.	2.5 mm (0.1")	1.5 mm (0.06")

Camshaft:

Permissible out-of-round (with new bearings), max.	0.05 mm (0.002")
Permissible wear on bearings, max.	0.05 (0.002")
Tappets (valve filters), max. permissible radial clearance	0.08 mm (0.003")

Tightening torques

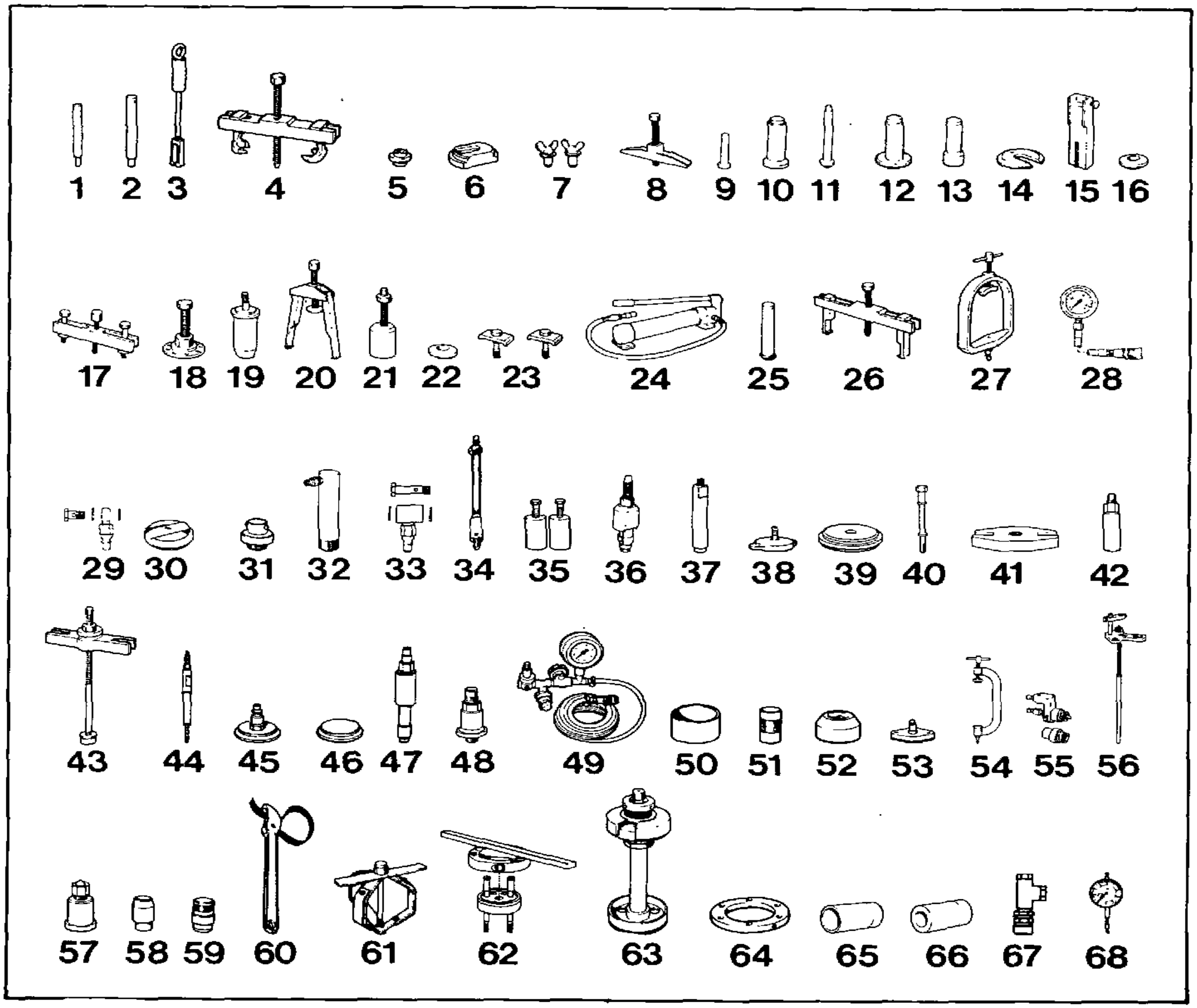
	100-series	120-series
Cylinder heads[1]	320 Nm[2] (32 kpm = 231 lbf.ft.)	190 Nm[2] (19 kpm = 137 lbf.ft.)
Main bearings	330 Nm (33 kpm = 243 lbf.ft.)	340 Nm (34 kpm = 251 lbf.ft.)

Big-end (connecting rod) bearings	230 Nm (23 kpm = 166 lbf.ft.)
Flange, front camshaft bearing	40 Nm (4 kpm = 29 lbf.ft.)
Camshaft gear	45 Nm (4.5 kpm = 33 lbf.ft.)
Pump drive gear	45 Nm (4.5 kpm = 33 lbf.ft.)
Idler gear journal	60 Nm (6 kpm = 43 lbf.ft.)
Pump housing and bearing sleeve for lubricating oil pump idler gear	20 Nm (2 kpm = 15 lbf.ft.)

1) Dip the cylinder head bolts completely (even the bolt heads) in anti-corrosion agent a maximum of 24 hours prior to fitting. The bolts should not drip at all when being fitted. Tightening should be done in stages and in accordance with the sequences on page 29.
2) Tightening is finished off by angle-tightening, see page 29.

	100-series	120-series
Bracket, lubricating oil pump		40 Nm (4 kpm = 29 lbf.ft.)
Bearing bracket, rocker arm shaft		40 Nm (4 kpm = 29 lbf.ft.)
Oil sump		17 Nm (1.7 kpm = 12 lbf.ft.)
Oil sump drain plug		80 Nm (8 kpm = 58 lbf.ft.)
Auxiliary drive gear casing		40 Nm (4 kpm = 29 lbf.ft.)
Rocker arm casings		10 Nm (1 kpm = 7 lbf.ft.)
Exhaust manifold		50 Nm (5 kpm = 36 lbf.ft.)
Flywheel		170 Nm (17 kpm = 123 lbf.ft.)
Vibration damper, attaching bolts		60 Nm (6 kpm = 43 lbf.ft.)
hub centre bolt		550 Nm (55 kpm = 400 lbf.ft.)
Injection pump, delivery valve retainers		85 Nm (8.5 kpm = 62 lbf.ft.)
Injectors, nut on stud		50 Nm (5 kpm = 36 lbf.ft.)
Pulley on drive for generator and fresh-water pump (marine engines)		150 Nm (15 kpm = 109 lbf.ft.)

SPECIAL TOOLS

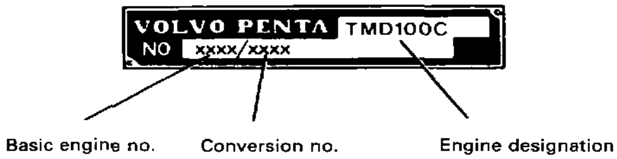


Pos. No.	Part No.	
1 =	999 1094-6	Drift for removing valve guides
2 =	999 1801-3	Standard handle 18x200 mm (3/4"x8")
3 =	999 1819-5	Puller for ball bearing in flywheel
4 =	999 2002-7	Puller for belt pulley
5 =	999 2013-4	Drift for removing and installing gudgeon (piston) pins. Used together with 1801.
6 =	999 2089-4 999 2955-6	Puller for cylinder liners, 100 and 120-series respectively. Used together with 6645 and 6394.
7 =	999 2124-9	Expander plugs (2) for pressure-testing of cylinder heads
8 =	999 2265-0	Puller for fan hub and pulley, coolant pump
9 =	999 2266-8	Counterhold for removing pulley, coolant pump
10 =	999 2267-6	Drift for removing and installing ball bearing in pulley, coolant pump (belt-driven). Drift for fitting ball bearing in bearing housing, injection pump drive
11 =	999 2268-4	Drift for removing and installing ball bearing, shaft and seal in coolant pump
12 =	999 2269-2	Fixture, coolant pump (belt-driven)
13 =	999 2270-0	Drift for installing seal, coolant pump
14 =	999 2429-2	Press washer for removing ball bearing, coolant pump (belt-driven)
15 =	999 2479-7	Retainer for dial gauge indicator when checking cylinder liner collar height above block face
16 =	999 2529-9 999 2952-3	Drift for removing and installing connecting rod bushings, 100 and 120-series respectively

Pos. No.	Part No.	
17 =	999 2654-5	Puller for oil pump drive gear and injection pump drive flange
18 =	999 2655-2	Puller for polygon hub on crankshaft
19 =	999 2656-0	Installing tool, polygon hub on crankshaft
20 =	999 2658-6	Puller for crankshaft gear
21 =	999 2659-4	Press tool for installing crankshaft gear
22 =	999 2665-1	Drift for installing ball bearing in flywheel. Used together with 1801
23 =	999 2666-9 999 2667-7	Tools (2) for pressing down cylinder liners when measuring liner collar height above block face, 100 and 120-series respectively
24 =	999 2670-1	Pump for pressing in cylinder liners
25 =	999 2677-6	Drift for removing and installing rocker arm bushings
26 =	999 2679-2	Puller for camshaft gear and injection pump drive gear
27 =	999 6033-8	Clamp for pressure-testing oil cooler, industrial engines
28 =	999 6065-0	Pressure gauge with hose and connection to banjo nipple 6066 when checking fuel feed pressure, or for connection to nipple 6223 when checking turbo-charging pressure* (nipple 6223 only fits industrial engines)
29 =	999 6066-8	Banjo nipple with rapid-coupling for connection to 6065
30 =	999 6088-2	Mounting tool for rear crankshaft seal
31 =	999 6159-1	Tool for pressing in cylinder liners
32 =	999 6161-7	Hydraulic cylinder for pressing in cylinder liners
33 =	999 6223	Nipple with rapid coupling for connection to 6065
34 =	999 6372-0	Puller for copper sleeve pin
35 =	999 6394-4	Leg (2) for cylinder liner puller 6645
36 =	999 6419-9	Puller for copper sleeve ring
37 =	999 6427-2	Adapter for measuring compression pressure
38 =	999 6433-0	Adapter (cylinder head) used together with 6662
39 =	999 6599-8	Plate for pressing in cylinder liners
40 =	999 6604-6 999 6605-3	Screw (2) for pressing in cylinder liners, 100 and 120-series respectively
41 =	999 6606-1	Yoke for pressing in cylinder liners
42 =	999 6643-4	Puller for injectors
43 =	999 6645-9	Puller for cylinder liners, used together with 6394 (replaces 1531)
44 =	999 6647-5	Flaring tool for copper sleeve
45 =	999 6652-5	Connecting washer for pressure-testing of inter-cooler, TID120, TID121
46 =	999 6653-3	Sealing washer for pressure-testing of inter-cooler, TID120, TID121
47 =	999 6657-4	Puller for copper sleeve
48 =	999 6661-6	Mounting tool for belt pulley, industrial engines in 120-series
49 =	999 6662-4	Pressure-testing device for cooling system, used together with 9989 861 (replaces 2680)
50 =	999 6664-0 999 2951-5	Piston fitting ring, 100 and 120-series engines respectively
51 =	999 6668-1	Drift for installing valve guide (intake), 100-series
	999 6669-9	Drift for installing valve guide (exhaust), 100-series
	999 2953-1	Drift for installing valve guides, 120-series
52 =	999 6682-2	Tool for idler gear nut, gear-driven water pump
53 =	999 6683-0	Connecting washer for pressure-testing of cylinder head, 120-series (replaces 2954)
54 =	999 6685-5	Clamp for pressure-testing cylinder head, 100-series (replaces 2668)
55 =	999 6848-9	Fixture for checking injection angle, used together with 998 9876
56 =	999 6772-1	Tool for checking camshaft lift height
57 =	999 6778-8	Tool for pressing in sealing ring for injection pump drive
58 =	999 6779-6	Tool for removing sealing ring for injection pump drive
59 =	999 6781-2	Drift for fitting sealing ring for piston thermostat
60 =	999 9179-6	Tool for removing fuel and oil filters
61 =	999 9511-0 999 9903-9	Expander for rotating cylinder liner, 100 and 120-series respectively
62 =	999 9531-8	Milling cutter for cutting sealing grooves in cylinder heads, 120 series
63 =	999 9551-6 999 9902-1	Milling cutter for reconditioning cylinder liner recess, 100 and 120-series respectively
64 =	884510-9 884513-3 884778-2	Flange kit complete, for measuring exhaust counter pressure, 120-series, TMD100C, and TD100G, TID100K respectively
65 =	884679-2	Drift for installing bearing in water pump (belt-driven)
66 =	884680-0	Drift for installing bearing in water pump (belt-driven)
67 =	9989860-3	Supplementary equipment for pressure-testing device 6662
68 =	9989876-9	Dial gauge indicator for checking injection angle

* NOTE! Do not use the same tool for checking both the fuel feed and the turbo-charging pressure.

PRESENTATION



Number plate

Engine	Location of number plate
TMD100C TD100G TID100K T(I)D121G	On the rear left-hand side of the engine block (under the exhaust manifold)
TMD121C TAMD121C T(I)D120HPP	On the front right-hand side of the engine block (under the intake manifold)

The engines are six-cylinder, four stroke diesel units with direct injection and thermostat-controlled water cooling. The cooling system of marine engines is divided into a fresh-water and a sea-water system. The sea-water cools the fresh-water system via a heat exchanger.

The engines are fitted with wet replaceable cylinder liners and separate cylinder heads, one for each cylinder.

On the 120-series the pistons are cooled by the lubricating oil by means of special jets placed in engine block.

All engines are fitted with a turbo-compressor, which is driven by the exhaust gases and is lubricated by the engine lubricating system. The turbo-compressor supplies the engine with a greater quality of air, thus allowing the quantity of fuel injected to be increased, which in turn provides increased engine output.

TID100K, TAMD121C, TID120HPP and TID121FG are also equipped with a cooler which lowers the temperature of the intake air, thus enabling the engine output to be raised further.

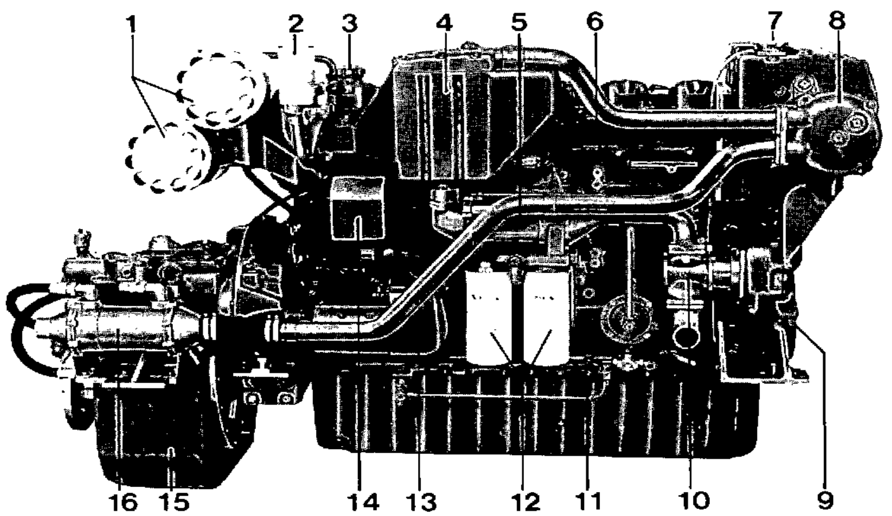
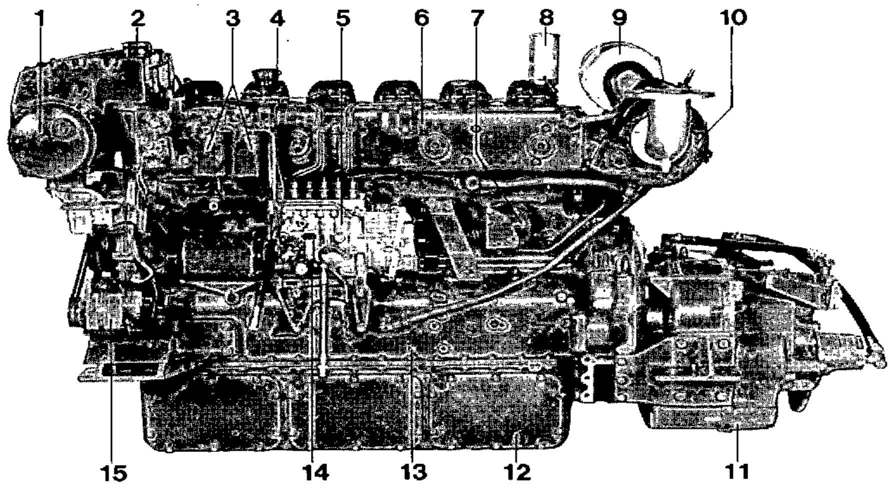


Fig. 1. TAMD121C

1. Air cleaner
2. Filter for crankcase ventilation
3. Oil filler
4. After-cooler
5. Oil cooler
6. Intake manifold
7. Coolant filler
8. Heat exchanger
9. Vibration damper
10. Sea-water pump
11. Pipe for oil sump scavenging
12. Oil filter
13. Starter motor
14. Connection box with fuses
15. Reverse gear
16. Oil cooler, reverse gear

Fig. 2. TMD121C

1. Heat exchanger
2. Coolant filler
3. Fuel filter
4. Oil filler
5. Injection pump
6. Exhaust manifold
7. Stop solenoid
8. Filter for crankcase ventilation
9. Air cleaner
10. Turbo-compressor
11. Reverse gear
12. Inspection cover
13. Oil dipstick
14. Feed pump
15. Alternator



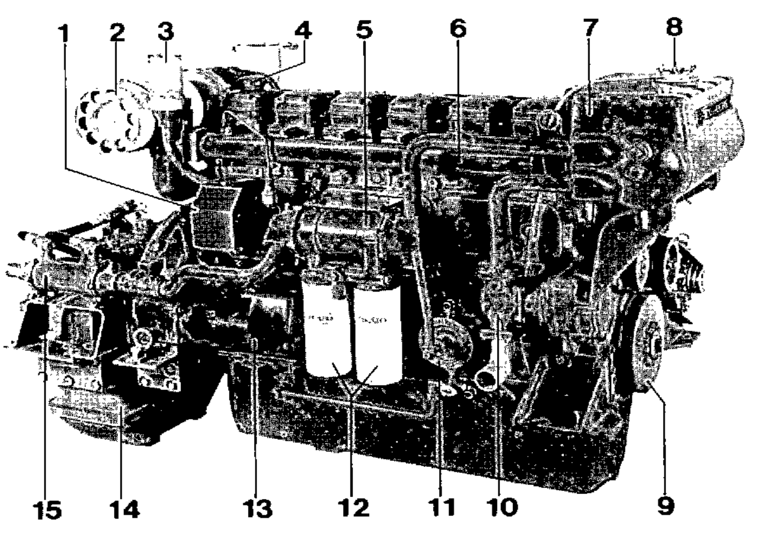


Fig. 3. TMD100C

1. Connection box with automatic fuses
2. Air cleaner
3. Filter for crankcase ventilation
4. Oil filler
5. Oil cooler
6. Intake manifold
7. Expansion tank
8. Coolant filler
9. Vibration damper
10. Sea-water pump
11. Oil scavenging pump
12. Oil filter
13. Starter motor
14. Reverse gear
15. Oil cooler, reverse gear

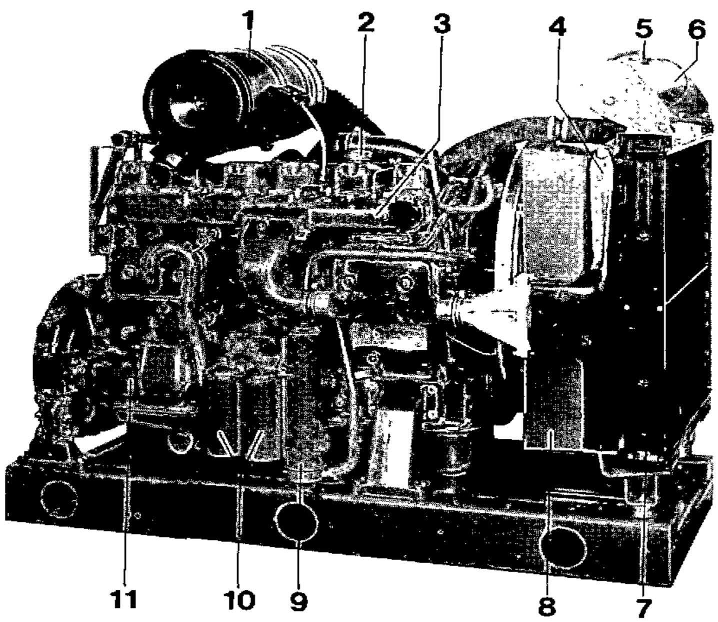
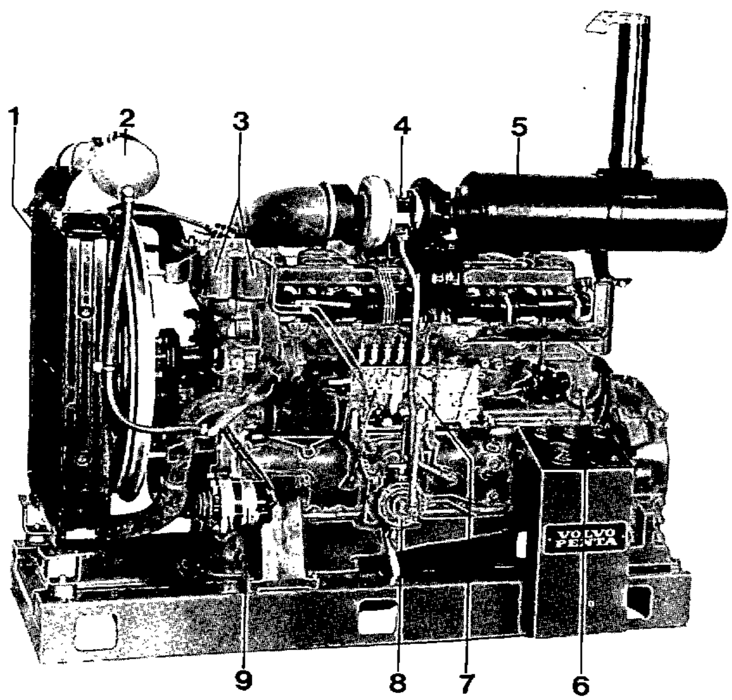


Fig. 4. TID121FG

1. Air cleaner
2. Filler cap, oil
3. Intake manifold
4. Inter-cooler
5. Filler cap, coolant
6. Expansion vessel
7. Radiator
8. Fan shroud
9. Oil cooler
10. Lubricating oil filter
11. Starter motor

Fig. 5. TD120HPP

1. Radiator
2. Expansion vessel
3. Fuel filter
4. Turbo-compressor
5. Silencer
6. Instrument panel
7. Injection pump
8. Oil scavenging pump
9. Generator



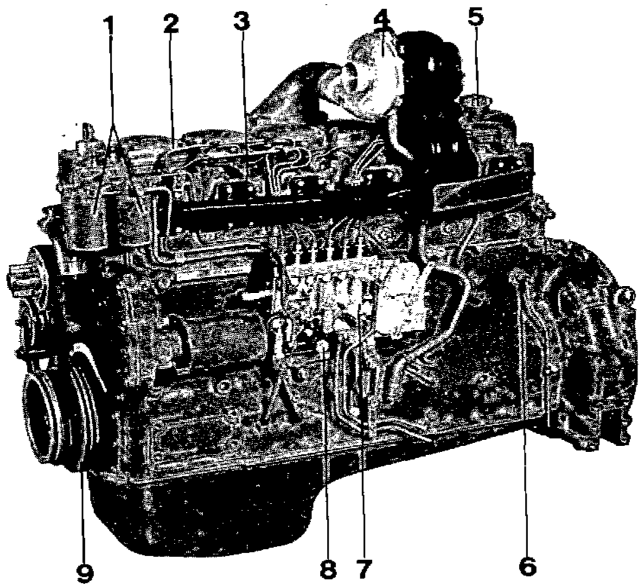
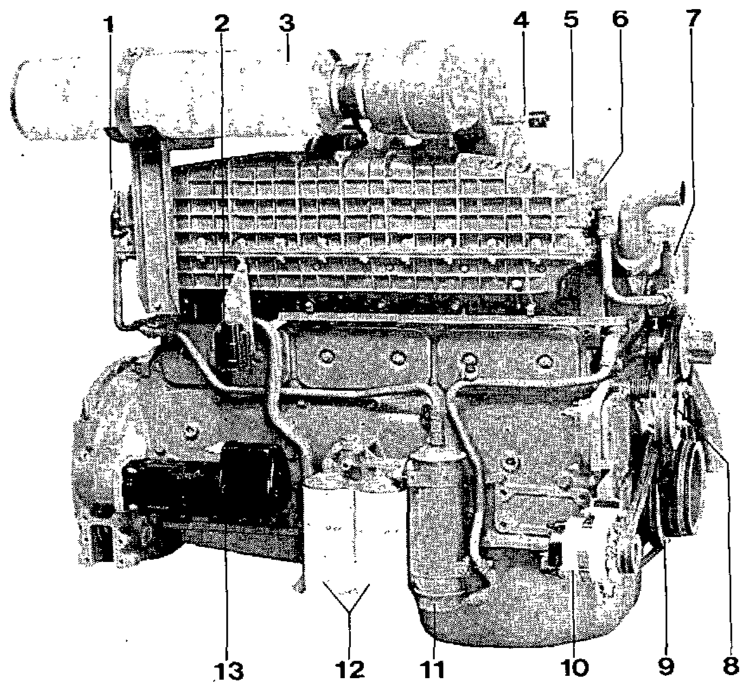


Fig. 6. TD100G

1. Fuel filter
2. Rocker arm casing
3. Exhaust manifold
4. Turbo-compressor
5. Oil filler
6. Drain plug, coolant
7. Injection pump
8. Feed pump
9. Vibration damper

Fig. 7. TID100KG

1. Air-venting cock
2. Starter element (pre-heater) relay
3. Air cleaner
4. Pressure drop indicator
5. Inter-cooler
6. Lifting eyelet
7. Fuel filter
8. Belt tensioner
9. Vibration damper
10. Alternator
11. Oil cooler
12. Oil filter
13. Starter motor



DESCRIPTION

Cylinder block

The cylinder block is cast in special-alloy cast iron in one piece. The combustion pressure force in the cylinder head bolts is transfered via reinforced sections in the cylinder block walls direct to the main bearings, thus making the block resistant to deformation.

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

The 120-series has three O-ring seals at the lower end of the cylinder liners, the 100-series has two O-rings.

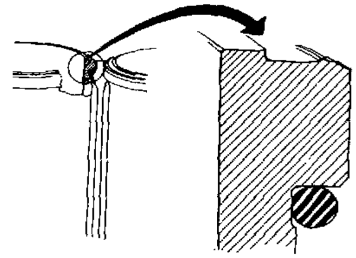


Fig. 9. Cylinder liner, 120-series

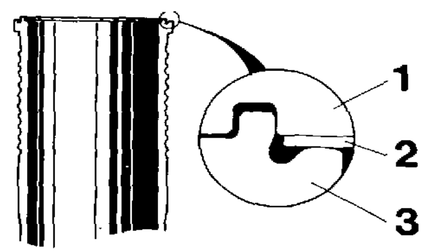


Fig. 10. Cylinder liner seal, 100-series

1. Cylinder head
2. Gasket
3. Cylinder liner

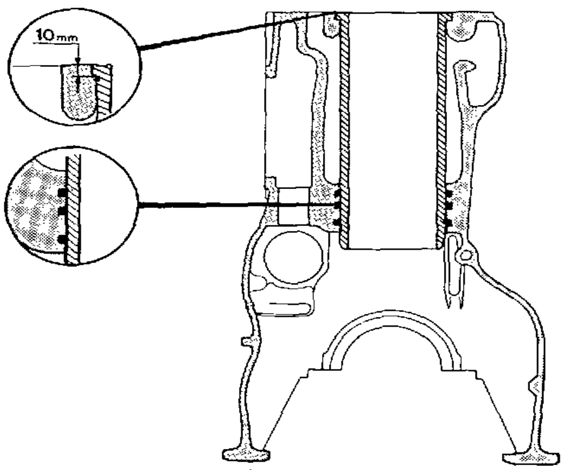


Fig. 8. Cylinder block, 120-series

Cylinder head

The engine has one cylinder head for each cylinder. On the 120-series the cylinder head face has special sealing grooves, see fig. 11. The 100-series has a deeper groove in the cylinder head which engages with the so-called "flame ridge" on the cylinder liner, see fig. 10.

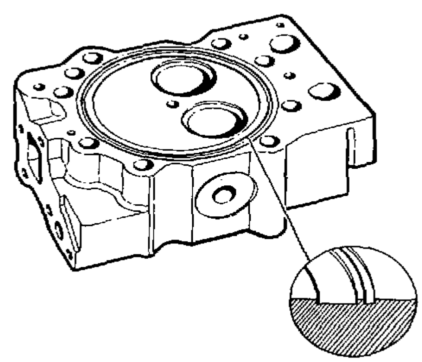


Fig. 11. Cylinder head sealing grooves, 120-series

Cylinder liners

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

On the 100-series the outer surface is serated to provide better cooling. These liners also have a so-called "flame ridge", which locates in a groove in the cylinder head, see fig. 10. On the 120-series the liner collar thickness is less than on earlier models.

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 high-alloy cast iron carrier, integrally cast into the piston, thus giving long life to the piston ring groove, despite the heat stresses.

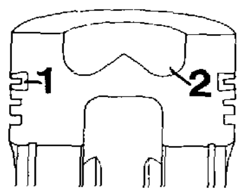


Fig. 12. Piston top

1. Ring carrier
2. Combustion chamber

All the 120-series engines are fitted with piston cooling. Lubricating oil is sprayed up onto the under side of the pistons by means of jets placed in the block.

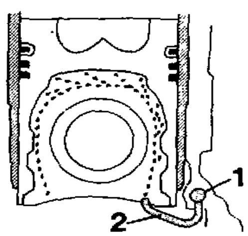


Fig. 13. Piston cooling, 120-series

1. Oil passage 2. Jet

Camshaft

The camshaft is carried in seven bearings, which are bored to the correct dimension after fitting. 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.

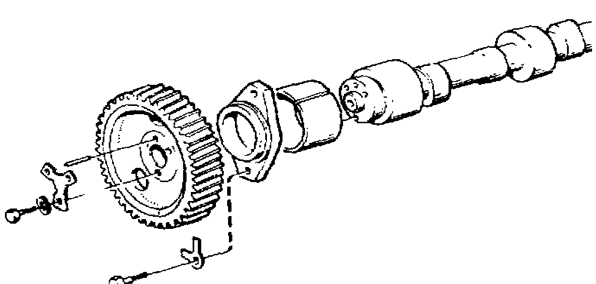


Fig. 14. Camshaft

Crankshaft

The crankshaft is carried in seven main bearings. The axial bearing consists of thrust washers fitted to the centre main bearing. The crankshaft has a polygon profile at its front end and the rear end has a flange, to which the flywheel is attached.

The crankshaft is hardened by nitro-carburizing for high fatigue strength. The crankshaft can be ground to the 2nd undersize without re-hardening, assuming that the crankshaft does not require straightening.

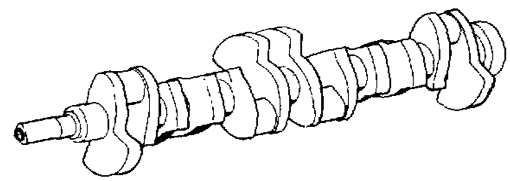


Fig. 15. Crankshaft

Main and big-end (connecting rod) bearings

The main and big-end (connecting rod) bearings consists of indium plated and lead bronze lined steel shells. Several oversize dimensions are available as spare parts. The thrust washers for the crankshaft axial bearing are also available in oversizes.

Connecting rods

The connecting rods are I-section. Each connecting rod is drilled right through for pressure lubricating of the gudgeon (piston) pin. The connecting rods have diagonally divided bearing recesses to facilitate removal up through the cylinder liners.

The gudgeon (piston) pin bushings are steel with bronze alloy lining.

For later models the location of the oil hole has been changed in both the connecting rod and connecting rod bearing. The connecting rod bushing has also been changed and the bearing cap guide pin has been deleted.

Flywheel

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

Auxiliary drive gears

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

The injection pump and the camshaft are driven by the crankshaft via an idler gear. Apart from the camshaft, the camshaft drive also drives the sea-water pump drive gear on marine engines and the compressed air compressor (optional equipment), if fitted, on industrial engines. The lubricating oil pump is driven by the crankshaft gear via an idler drive gear. On industrial engines in the 120-series the coolant pump is driven by the injection pump drive via an idler gear.

Vibration damper

The vibration damper consists of a hermetically sealed housing containing a steel mass in the form of a rectangular section steel ring. This mass (damper ring) is carried on its inner diameter by a bushing whilst being surrounded on all other sides by a viscous liquid (silicone).

On industrial engines in the 120-series, from and including engine no. 91926/xxxx, the deflector ring (pos. 10, fig. 17) has been deleted. These engines have a protector ring on the polygon hub and a corresponding groove in the auxiliary drive cover.

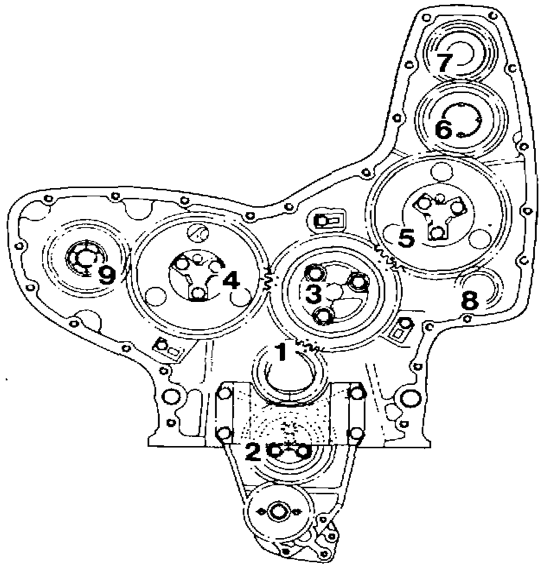


Fig. 16. Auxiliary drive gears, T(I)D120, T(I)D121

1. Crankshaft drive
2. Oil pump idler gear
3. Idler gear
4. Camshaft drive
5. Injection pump drive
6. Coolant pump idler drive
7. Coolant pump drive
8. Drive for servo pump (if fitted)
9. Compressed air compressor drive (if fitted)

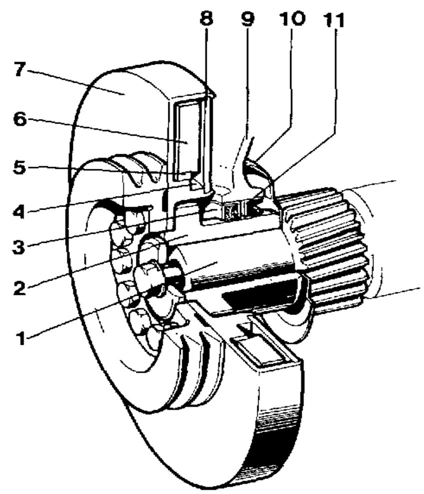


Fig. 17. Vibration damper

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

Repair Instructions

Cylinder heads

Removing the cylinder heads

Special tools: 999 6643-4

1. Close the bottom valve (marine engines). Drain off the coolant.
2. Shut off the fuel cocks. Remove the battery connections.
3. Remove the air cleaner and connection pipes to the turbo-compressor. TID120, 121: Remove the connection pipes to the inter-cooler.
4. Remove the turbo-compressor. TAMD121: Unscrew the after-cooler and the upper sea-water pipe.
5. Remove the delivery lines, leak-off lines and the fuel filter. Fit new protective caps.
6. Remove the intake and exhaust manifolds and, on *T(I)D120 and T(I)D121-series, the coolant pipe which is* attached to the cylinder heads.
7. Dismantle the injectors. Rotate the injector with a wrench (PU-15) whilst pulling upwards at the same time. Use the puller 6643, if necessary.
8. Remove the rocker arm casings, the rocker arm mechanism and the push rods. 100-series: Remove the lower rocker arm casings.
9. Remove the cylinder heads. 100-series: Remove the plug-in seals between the cylinder heads. Remove the cylinder heads.
10. Remove the cylinder head gaskets, rubber seals and their guides from the block.

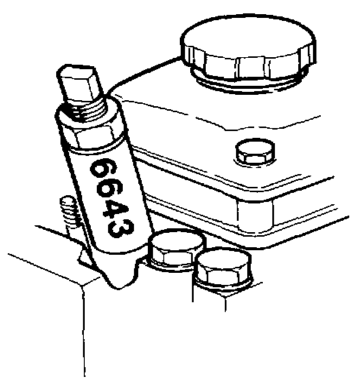


Fig. 18. Removing an injector

Disassembling the cylinder heads

1. Remove the valve springs, using a valve spring compressor. Place the valves in the correct order in a stand.
2. Clean all parts. Be specially careful with oil and coolant drillings. Check for leakage by pressure testing, see page 23.
3. Remove any layers of carbon and deposits from the cylinder head sealing surfaces. Use a drill to clean the holes for the attachment bolts (diam. 19.5 mm, 0.768", for the 100-series and 15 mm, 0.591", for the 120-series).

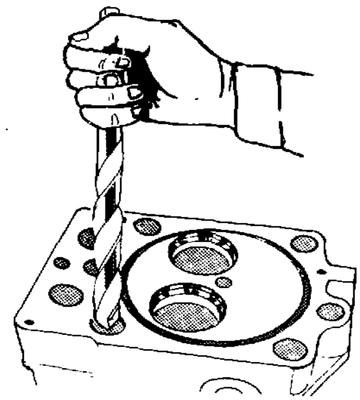


Fig. 19. Cleaning the attachment bolt holes

4. 120-series: Clean the sealing grooves. Take care not to damage the edges.

Inspecting the cylinder heads

Cylinder head warp must never exceed a maximum of 0.02 mm (0.0008"). This check is carried out by using a straight-edge, the sides of which have been scraped to a degree of accuracy specified in DIN 874/Normal. The sealing grooves directly above the cylinder collars must be undamaged. If leakage has been discovered or if the cylinder head has blow-out strips on it, special measurement is unnecessary since the cylinder head must in any case be ground flat or replaced.

Check that the valve seats and stud bolts (if fitted) are tight.

Always replace the cylinder head gaskets and rubber seals.

Pressure-testing a cylinder head

*Special tools, 100-series: 999 2124-9, 999 6662-4, 999 6685-5[1], 9989860-3**
*120-series: 999 2124-9, 999 6662-4, 999 6683-0[2], 9989860-3**

[1] Replaces 2668
[2] Replaces 2954

* **Only Sweden:** According to the Arbetarskyddsstyrelsens recommendations the pressure-testing device 6662 must be complementet 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. 20.

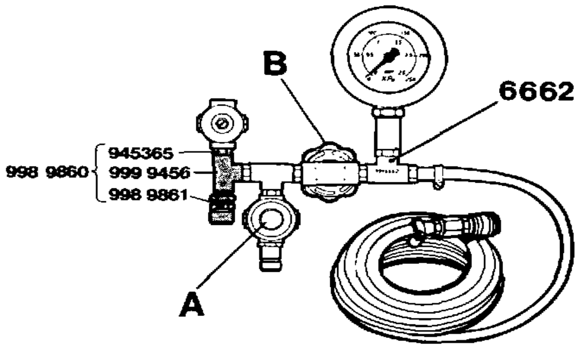


Fig. 20. Pressure-testing device

Checking the pressure-testing device 6662

Check the pressure-testing device before using, as follows:

1. Check that the wheel on the reducing valve (A, fig. 20) is unscrewed and connect the pressure-testing device to the compressed air supply. Open the cock (B) and, using the reducing valve, adjust to a pressure of 100 kPa (14.5 p.s.i.) on the gauge.

   NOTE! The reducing valve wheel can be locked by a locking ring which moves axially.

   NOTE! Follow the valid safety regulations.

2. Close the cock (B). The pressure-testing device is reliable if the pressure does not fall during a period of two minutes.

Pressure-testing

1. 100-series: Fit the clamp 6685 and the expander screws 2124 (2x), see fig. 21.

   120-series: Fit the connecting washer 6683 and expander screws 2124 (2x), see fig. 22.

   Do not tighten the wing nuts so much so as to cause damage to the rubber gaskets.

2. Check that the reducing valve wheel (A, fig. 20) is unscrewed and connect the hose from the pressure-testing device to the cylinder head.

3. Immerse the cylinder head in a water tank, approx. 70°C (158°F).

4. Connect the pressure-testing device to the compressed air supply and open the cock (B).

5. Pull out the reducing valve wheel locking ring. Increase the pressure by screwing in the wheel until the gauge shows 50 kPa (7.75 p.s.i.). Hold this pressure for 1 minute. Then raise the pressure to 150 kPa (22.25 p.s.i.). Lock the wheel by pushing in the locking ring and close the cock (B). After 1–2 minutes check if the pressure has fallen or if air-bubbles are visible in the water tank.

   NOTE! Follow relevant safety regulations.

   Do not lean over the expander screws.

6. Remove the pressure-testing device.

   In the event of leakage at the injector copper sleeves, follow the instructions on page 64.

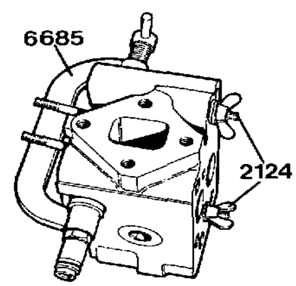


Fig. 21. Pressure-testing cylinder head, 100-series

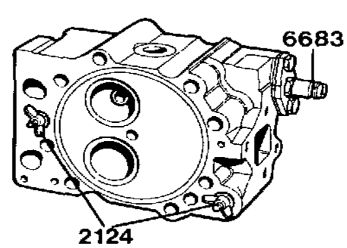


Fig. 22. Pressure-testing cylinder head, 120-series

Grinding a cylinder head flat

1. Grind the cylinder head so that the sealing grooves disappear (120-series) and until the surface is flat. Check the flatness according to the instructions under "Inspecting the cylinder heads". The height of a cylinder head after grinding must not be less than 114.65 mm (4.514") for the 100-series or 124.65 mm (4.907") for the 120-series. Clean the cylinder heads after machining.
2. Check that the distance from the valve disc level to the face of the cylinder head after grinding is within the values shown in fig. 23. In certain cases it may be necessary to mill down the valve seat recesses.
3. 120-series: Mill new sealing grooves in the heads as described bellow.

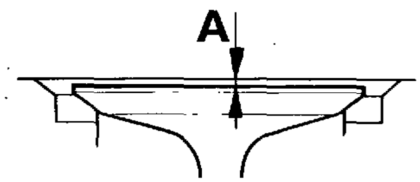


Fig. 23. Dimension A, 100-series: 1.20–1.70 mm (0.047–0.067"), max. 2.5 mm (0.10")
120-series: 0.20–0.70 mm (0.008–0.028"), max. 1.5 mm (0.06")

Cutting new grooves in cylinder heads, 120-series

Special tool: 999 9531-8

Before milling new grooves the cylinder head must be ground so that the previous grooves are completely removed.

The height of the cylinder head as well as the distance between the face of the valve disc and that of the cylinder head should not be less than the dimensions given in the specifications.

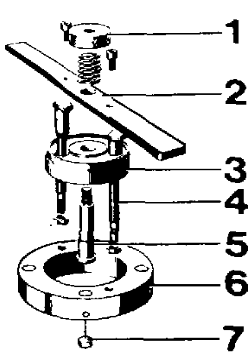


Fig. 24

1. Nut
2. Handle
3. Guide plate
4. Guide pins
5. Stem
6. Milling head
7. Cutter holder

Also check that the valve guides are not worn, since the groove milling tool fixture is guided by means of guide pins which locate in the valve guides.

Setting the cutting depth of the tool

NOTE! Do not use a setting guide.

1. Secure the tool in a vice with the cutters turned upwards.
2. Secure a dial indicator in the holder 2479 and place it over the grooving tool's ring-shaped shoulder.
3. Set the dial indicator to zero against the shoulder.

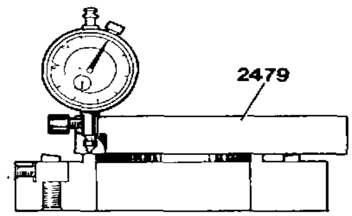


Fig. 25

4. Move the holder and the dial sideways so that the dial pointer rests on the hightest point of one of the cutters. The correct cutting depth (cutter height) is 0.20 mm (0.008").

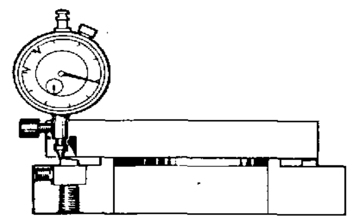


Fig. 26

Adjusting

5. Loosen the locking screw A (4 mm socket head) and the adjuster screw B (5 mm socket head), a few turns.

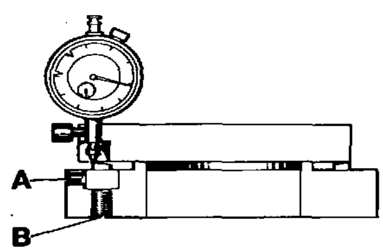


Fig. 27

6. Push down the cutter holder and tighten the locking screw so that it presses against the holder.
7. Place the dial pointer against the cutter's highest point and screw the adjuster screw upwards until the correct cutter height is obtained.
8. Tighten the locking screw.

   NOTE! Check that the upper edge of the cutter holder lies on the same plane as the milling head. If this is not the case then the dial indicator has rotated one turn too many.

7. Carefully clean the cylinder head. Then check the groove depth by replacing the milling head, without spring and nut and rotating it several turns under hand pressure. If the tool does not cut then the grooves are of the right depth. This check should always be carried out since metal cuttings can get in under the shoulder of the milling head. The burrs which have been made at the edges of the grooves should be left. Any breakage to these burrs could cause damage to the edges and impair the groove's sealing function.

NOTE! The first time the groove cutting tool is used after adjustment of the cutters, the finished groove must have its measurements checked using a dial indicator. In this check the burrs at the edges of the grooves must be carefully removed so that the holder for the dial indicator abuts properly against the cylinder head.

Milling the grooves

1. Place the cylinder head in a vice.
2. Screw tight the guide plate on the cylinder head. The plate should be placed so that it is centered between the cylinder head attachment bolt holes.

   NOTE! Do not tighten the nuts for the guide pins too hard, as the valve guides can be pressed into the cylinder head.
3. Apply a little oil to the inner diameter of the milling head. Ensure that the face of the cylinder head is completely clean and lower the milling head onto the guide plate carefully and with a rotary movement to prevent it jamming.
4. Put the spring and nut in place and tighten the nut loosely.

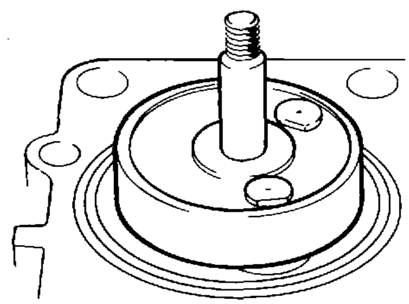


Fig. 29

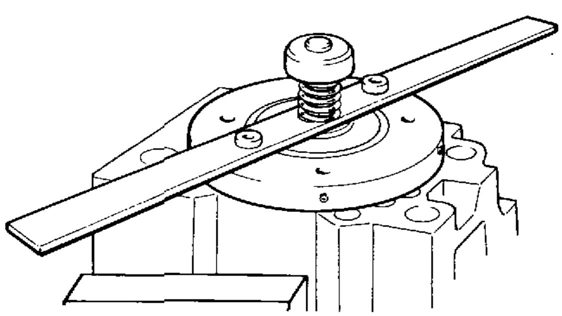


Fig. 28.

5. Turn the milling tool in a clockwise direction and with an even movement. The cutting feed occurs automatically due to the nut following the rotation and compressing the spring.
6. Rotate the tool until the cutters stop cutting. Then remove the nut and lift up the milling head.

Replacing cutting sets

1. Unscrew the locking screw several turns and screw the adjusting screw 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 corresponding letter is stamped on the cutting head where the cutter holder should be placed. NOTE! The two socket-head screws in the cutter holder should **not** be touched.
3. Place the cutter holders in the milling head according to the letter markings and with the grooves turned to face the locking screws. Adjust the cutting height according to the previous instructions.

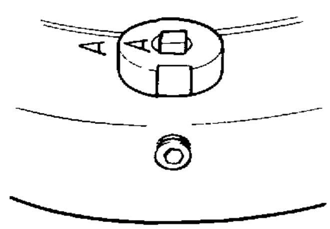


Fig. 30

Checking the valve guides

In order to check guide wear, place a new valve in the guide and measure the clearance with an indicator (fig. 31).

Wear limits

Inlet valve clearance, max. .... 0.15 mm (0.006")
Exhaust valve clearance, max. .... 0.25 mm (0.01")

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

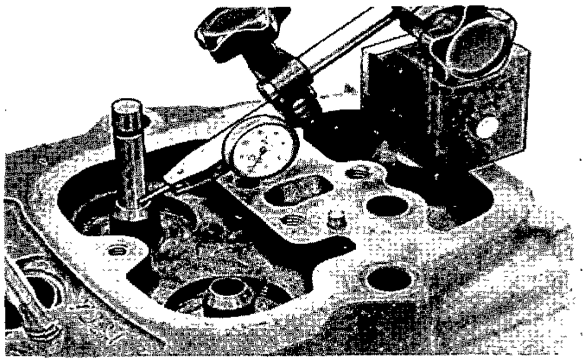


Fig. 31. Checking valve guide wear.

Replacing valve guides

Special tools: 100-series: 999 1084-6, 999 6668-1, 999 6669-9
120-series: 999 1084-6, 999 2953-1

1. Press out the valve guides with drift 1084.

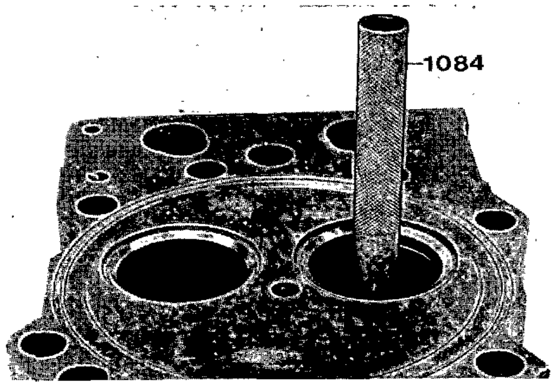


Fig. 32. Pressing out the valve guides

2. Oil in the new guides externally and press them in with fitting drift 6668 (inlet) and 6669 (exhaust) for the 100-series and 2953 for the 120-series. These tools give the correct respective height above the cylinder head spring face.

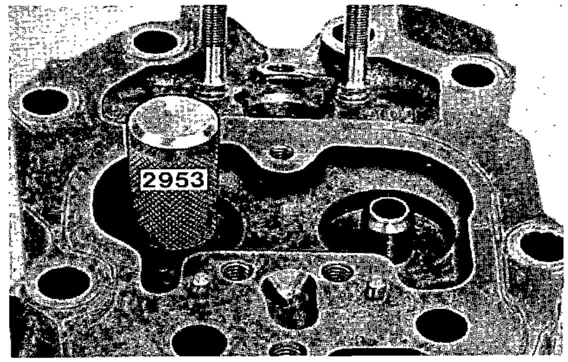


Fig. 33. Fitting the valve guides, 120 series

3. *Ream the valve guides if necessary. Clearance* valve–valve guide: Refer to "Technical Data".

Grinding valves and valve seats

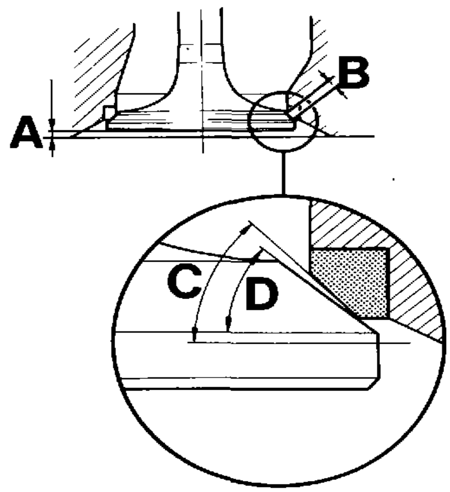


Fig. 34. Valve and valve seat

A. 100-series: 1.20–1.70 mm (0.047–0.067"), max. 2.5 mm (0.10")
120-series: 0.20–0.70 mm (0.008–0.028"), max. 1.5 mm (0.06")
B. 3–4 mm (0.118–0.157")
C. Inlet = 30°, exhaust = 45°
D. Inlet = 29.5°, exhaust = 44.5°

1. Clean the valves and grind them in a machine. Set the grinding machine at 44.5° and 29.5° respectively. Only grind off sufficient to give a "clean" surface. If the thickness of the valve disc edge is less than 1.2 mm (0.047") on exhaust valves and 1.7 mm (0.067") on inlet valves after grinding, reject the valve. Also reject valves with distorted stems.

2. Check valve guide wear (see "Checking the valve guides") before machining the valve seats.
3. Ream or grind the valve seats (only enough to provide a good shape and contact). The seat angle should be 45° and 30° respectively. NOTE! If the dimension "A" (fig. 34), when measured with a new valve, exceeds 2.5 mm (0.10") for the 100-series or 1.5 mm (0.06") for the 120-series, then the valve seat should be replaced.
4. Grind in the valves with grinding compound and check face contact with marking dye.

Replacing valve seats

Valve seats should be replaced when the distance "A" in fig. 34, measured with a new valve exceeds 2.5 mm (0.10") for the 100-series or 1.5 mm (0.06") for the 120-series.

1. Remove the old valve seat by grinding two diametrically opposed notches. Be careful not to damage the cylinder head. Crack the seat with a sharp chisel.

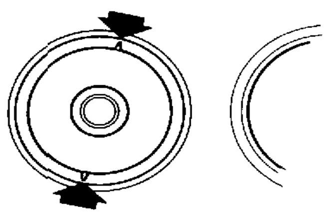


Fig. 35. Valve seat notch marks

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 determine whether an oversize is needed. If necessary, machine the valve seat recess.
4. Cool the seat with carbon dioxide snow to a temperature of minus 60–70°C (–76 to –94°F) and heat up the cylinder head by flushing with hot water or by some other suitable method. Then press in the seat using a drift.
5. Machine the seat to the correct angle and width.

Checking the valve springs

Check the free length of the valve springs and also their length under loading. This should be done using a spring tester. The spring should maintain the values given in "Technical Data".

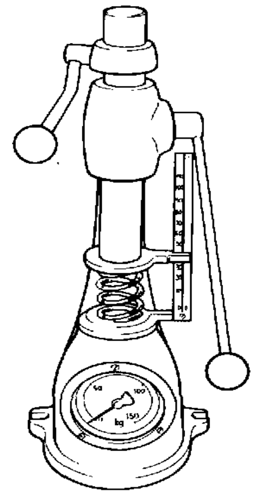


Fig. 36. Spring tester

Overhauling the rocker arm mechanism

Special tool: 999 2677-6

1. Remove the circlips from the rocker arm shaft, rocker arms and bearing brackets.

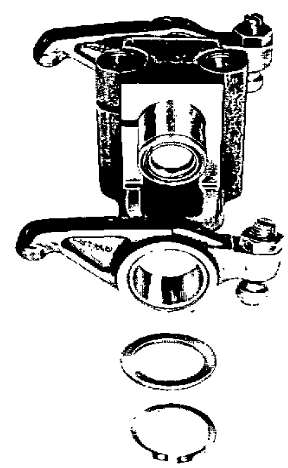


Fig. 37. Rocker arm mechanism

2. Clean the parts, being particularly thorough with the oil drillings in the bearing brackets as well as the oil holes in the rocker arm shaft and the rocker arms.

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 rocker arm contact sphere against the valve must not be worn or pitted. Adjustment by grinding is possible if the wear is not too excessive.
4. Replace rocker arm bushings which have worn oval. Drift 2677 is used to press out old bushings and press in the new ones. The new bushings must be pressed in so that the oil hole is located directly opposite the oil drilling in the rocker arm.

   The bushing is to be reamed after being press in. Remove all metal chips.

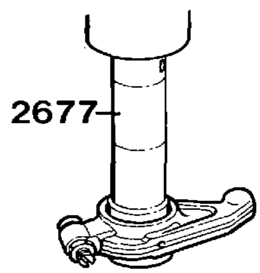


Fig. 38. Pressing in the rocker arm bushing

5. When assembling the rocker arm mechanism, oil in the shaft and then fit the other parts.

   Fit the guide pin in the bearing bracket slot.
6. Fit the rocker arms and secure with the circlips. The rocker arms are completely identical and can be placed in any order on the shaft.

Assembling a cylinder head

1. 120-series: Place the lower valve spring washers on the cylinder head.
2. Oil in the valve stems and fit the valves in their guides. Fit the springs and the upper washers.
3. Compress the springs using a valve spring tool and fit the valve collets. Fit the valve caps.

Fitting the cylinder heads

Special tools: 999 2479-7, 100-series: 999 2666-9
120-series: 999 2667-7

1. Clean the cylinder block face. A square section straight bar with emery cloth is suitable or a fine file.

   Remove rust and carbon deposits from the bolt holes and the threads for the cylinder head attachment bolts. Use a drill (19.5 mm for the 100-series and 15 mm for the 120-series) and rotate by hand.

   Clean the threads with a thread tap (3/4"-10 UNC for the 100-series and 9/16"-12 UNC for the 120-series).

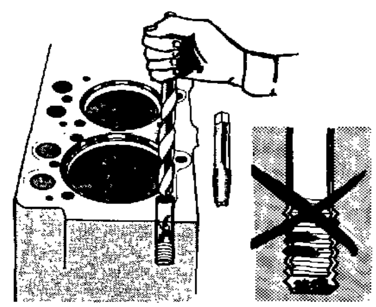


Fig. 39. Cleaning the cylinder head bolt holes

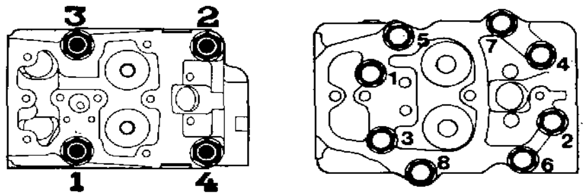
2. Check the liner height, refer to page 31 for measurement and adjustments.
3. Fit the sealing rings in their respective holes in the cylinder block and fit new cylinder head gaskets.

   100-series: Clean the contact faces for the plug-in seals between the heads, use a fine emery cloth.
4. Place the cylinder heads on the block.
5. Check the cylinder head bolts.

   NOTE! The bolts are phosphated and must not be cleaned with a wire brush. If there are cutting marks under the bolt heads or in the threads they should be replaced.

Fig. 40. Cylinder head bolt

Completely immerse the cylinder head bolts (including the bolt heads) in rust-proofing agent, part number 282036 (or a mixture of 75 % Tectyl 511 and 25 % white spirit). The bolts should be drip-free at the time of assembly (otherwise oil can find its way up and easily be mistaken for leakage).



100-series 120-series

Fig. 41. Tightening sequence for cylinder head bolts

6. 100-series: Tighten the cylinder head bolts as shown in fig. 41. Tighten in stages to 20 Nm (2 kpm = 15 lbf.ft.), 100 Nm (10 kpm = 74 lbf.ft.), 200 Nm (20 kpm = 148 lbf.ft.), 320 Nm (32 kpm = 236 lbf.ft.). Re-check all the bolts for correct tightness and then angle-tighten according to point 8.
7. 120-series: Tighten the cylinder head bolts as shown in fig. 41. Tighten in stages to 50 Nm (5 kpm = 37 lbf.ft.), 150 Nm (15 kpm = 111 lbf.ft.), 190 Nm (19 kpm = 140 lbf.ft.). Angle-tighten according to point 8.

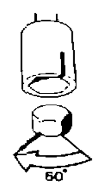


Fig. 42. Angle-tightening

8. Use a socket with a mark just in front of one of the hexagonal edges.

   Make a mark on the cylinder head just in front of one of the bolt head hexagonal edges (mark with a coloured pencil or crayon – no permanent mark must be made). Place the socket with the mark offset one hexagonal edge before the mark on the cylinder head and then tighten until the marks come into alignment with each other.
9. 100-series: Fit the lower sections of the rocker arm casings. Tighten the attachment bolts to 10 Nm (1 kpm = 7.4 lbf.ft.). Note! Harder tightening risks causing damage to the seal. Coat the plug-in seals with grease and fit them.
10. All engines: Fit the push rods and the rocker arm mechanism. Adjust the valves (see below). Fit the rocker arm casings.
11. Fit the injectors. Tightening torque 50 Nm (5 kpm = 37 lbf.ft.). Fit the other equipment.

    NOTE! Some industrial engines in the 100-series do not have gaskets between the cylinder head and the exhaust manifold. Use gaskets to all engines.

    On industrial engines in the 120-series the section of the exhaust manifold which attaches to the turbo must be fitted so that the lug (see fig. 42b.) points downwards.

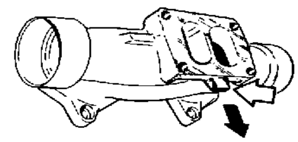


Fig. 42b.

Adjusting the valves

Note! The valves must never be adjusted while the engine is running, but when stationary, cold or at operating temperature.

Valve clearances: Inlet 0.40 mm (0.016")
Exhaust 0.70 mm (0.028")

Cylinder number 6 is that closest to the flywheel.

1. Remove the rocker arm casings. Adjust the valve clearances on no. 1 cylinder when it is in its firing position. The valves on cylinder no. 6 will then "rock".

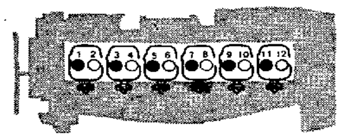


Fig. 43. Location of valves, 100 series

● Exhaust ○ Inlet

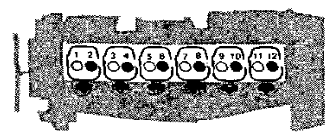


Fig. 44. Location of valves, 120-series

● Exhaust ○ Inlet

2. 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 clearances in the order of firing for the other cylinders.

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

3. Clean the rocker arm casings and fit them. Replace damaged gaskets. Check for oil leaks.

Cylinder block

Inspection

Clean the cylinder block thoroughly. Check that all the channels and drillings are free from deposits and that the block is not cracked.

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.

Corrosion damage to the cylinder liner recesses and/or the underside of the cylinder liner collars means that there is a risk of coolant liquid leakage. A flat, smooth mating surface for the cylinder liner is also necessary for good gas-tight sealing.

The cylinder liner recesses can be reconditioned by special milling according to the instructions on page 34.

Material thus removed must be compensated for by the use of shims under the cylinder liner collar.

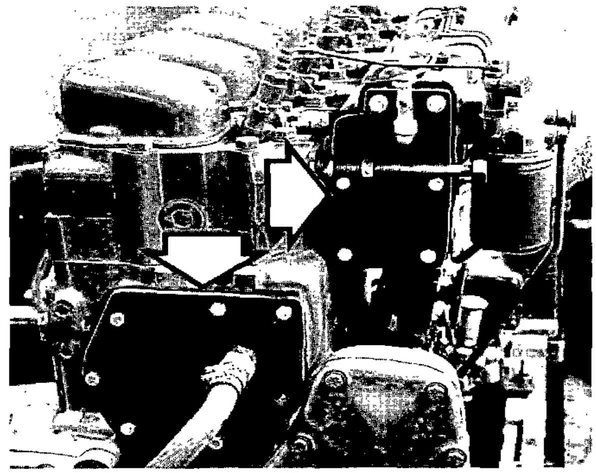


Fig. 46. Pressure-testing the cylinder block

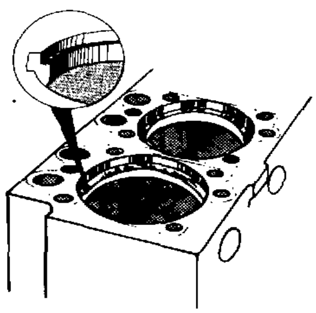


Fig. 45

Pressure-testing the cylinder block

When pressure-testing it is advisable to use the cylinder heads with gaskets as seals. The water supply can be connected up as shown in fig. 46. If the engine is fitted with a water-cooled exhaust manifold, then this must be sealed at the front edge. The pressure should be about 300 kPa (3 kp/cm^2 = 42 p.s.i.).

NOTE! Pressure-testing here concerns only the cylinder block and heads. If a heat exchanger or radiator are fitted, then the method described on page 70 must be used (pressure: 70 kPa = 0.7 kp/cm^2 = 10 p.s.i.).

If leakage occurs at the cylinder block upper liner recesses the mating surfaces can be improved by the use of grinding compound or by special milling, see page 34. Leakage at the lower cylinder liner recesses can be caused by faulty O-ring seals or damage to the outside of the cylinder liner, such as scratches, crater formation etc.

Removing the cylinder liners and pistons

Special tools: 999 1801-3, 999 2013-4, 999 6394-4 (2x), 999 6645-9
100-series: 999 2809-4, 999 2666-9
120-series: 999 2667-7, 999 2955-6

NOTE! Removal should not be carried out until it has been found that the cylinder liner concerned cannot be used due to wear or damage. On marine engines the liners and pistons can be removed without removing the oil sump.

1. Remove the cylinder heads and oil sump. NOTE! Before removing the oil sump on TMD100C, the rear inspection cover on the sump must be removed and the oil strainer unscrewed from the sump.

   If the cylinder liner is to remain on the engine when the piston is removed, the holders 2666 (100-series) or 2667 (120-series) must be fitted so that the liner is not disturbed in its recess, see fig. 49. If the liner should slide up when the piston is being removed, then it too should also be removed since there is a great risk that deposits etc. can fall down between the liner and the block and cause leakage.

2. Remove the big-end bearing cap, carefully tap up the connecting rod until the piston rings are free of the cylinder liner. Note! Make sure that any piston cooling jets (if fitted) are not damaged. Lift out the piston together with the connecting rod.

3. Remove the cylinder liners using puller 6645 and support legs 6394 together with puller plate 2089 for the 100-series and puller plate 2955 for the 120-series (see fig. 47.)

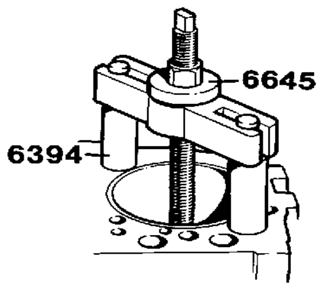


Fig. 47. Removing a cylinder liner

4. Remove the circlips for the gudgeon (piston) pin. Remove the gudgeon pin carefully using 1801 and 2013.

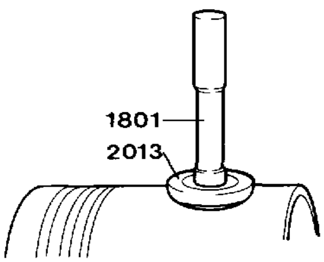


Fig. 48. Pressing out the gudgeon (piston) pin

Fitting the cylinder liners and pistons

Special tools: 999 2479-7, 999 2670-1, 999 6159-1, 999 6161-7, 999 6599-8, 999 6606-1.
100-series: 999 2666-9, 999 6605-3, 999 6664-0, 999 9511-0.
120-series: 999 2667-7, 999 2951-5, 999 6604-6, 999 9903.9.

All the mating sealing surfaces around the liners must be clean and completely free from deposits etc. Clean the upper and lower liner recesses with a brush and cleaning fluid. 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.

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 having been inserted and rotate it against the recess. Use expander 9511 for the 100-series and 9903 for the 120-series.
3. Remove the liner and check if the dye is evenly spread over the whole recess surface. If the marking indicates poor contact, slight adjustments can be made by using grinding compound. Larger defects necessitate milling of the recess with a special cutter, the material removed being compensated for by fitting steel shims. See "Reconditioning the liner recesses".
4. Attach a pair of clamp washers, 2666 for 100-series and 2667 for the 120-series 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. Measure the liner height (dimension "A" in fig. 50) *using a dial indicator and holder 2479 (fig. 49).* The measurements should be made at four diametrically opposite points. Check that the block surface is not damaged when zero setting 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 stepped edge.

*The liner height (dimension "A") shall be: for the 100-*series, 0.15–0.20 mm (0.006–0.008") and for the 120-series, 0.47–0.52 mm (0.019–0.020").

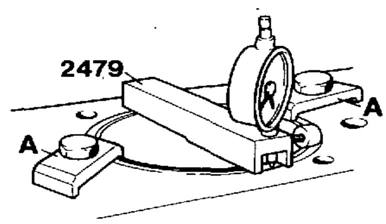
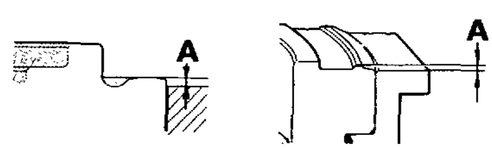


Fig. 49. Checking cylinder liner height
A = 2666 for 100-series and 2667 for 120-series



100-series
A = 0.15–0.20 mm
(0.006–0.008")

120-series
A = 0.47–0.52 mm
(0.019–0.020")

Fig. 50. Cylinder liner height above the cylinder block face

6. Fit the lower sealing rings in the block and the upper sealing ring under the liner collar.
7. Smear the cylinder liner lower guide and the sealing rings with soap. Because the sealing rings are made of "Teflon", the liner will be harder to press down. NOTE! The liner must never be knocked or tapped down.

   Use the pressing tool as shown in fig. 51 and press the liner down slowly.

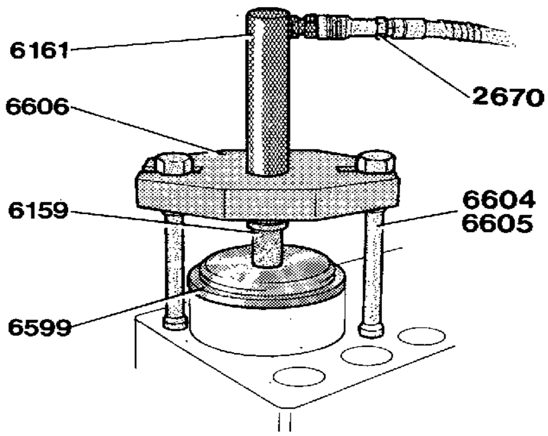


Fig. 51. Pressing down the cylinder liner

8. Fit the big-end (connecting rod) bearing shells in place in the connecting rods and bearing caps. The connecting rod bearing recesses have slots for locating the bearing shell locating lugs. It is important that the bearing shells are fitted the correct way during installation so that the locating lugs engage in their slots and the oil holes align with the oil holes in the connecting rods. NOTE! Check that the correct type of bearing shell is fitted. On later model connecting rods the oil hole has been moved, the connecting rod bushing modified and the locating pin for the connecting rod bearing cap deleted.

   Smear the crankshaft bearing journal with engine oil.
9. Smear the piston and rings with engine oil and turn the rings so that the gaps are equally spaced around the piston.

   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, take care so as not to damage the piston cooling jets, if fitted. The arrow on the piston crown should point forwards. Use fitting ring 6664 (100-series) and 2951 (120-series).
10. Fit the connecting rod bearing caps. Make sure that the "Front" marking on the connecting rod faces forwards and that the bearing cap locating pin, if fitted, is properly attached. Tighten the connecting rod bolts to a torque of 230 Nm (23 kpm = 170 lbf.ft.).

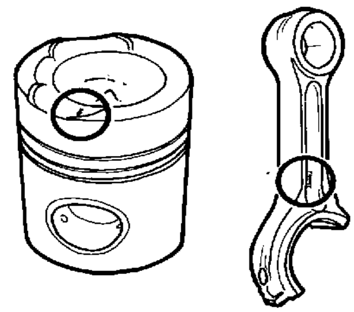


Fig. 52. Front marking

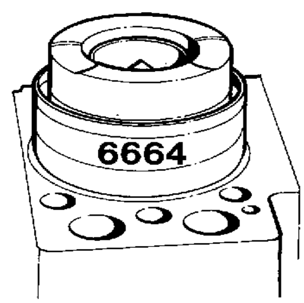


Fig. 53. Fitting a piston, 100-series

Measuring and inspecting the cylinder liners

The check consists of measuring wear and checking for cracks. Clean the liners thoroughly before measuring them. For accurate measurement use a cylinder indicator.

Cylinder liner wear can also be measured by measuring the piston ring gap using a new piston ring at the upper turning point and at a position below the lower turning point. Divide the difference between the two measured values by 3.14 to establish the amount of wear.

Example

Piston ring gap in unworn section = 0.60 mm (0.024")
Piston ring gap at upper turning point = 1.70 mm (0.067")
Difference 1.70–0.60 (0.067–0.024") = 1.10 mm (0.043")

Diametrical bore wear: $\frac{1.10\ (0.043'')}{3.14}$ = 0.35 mm (0.014")

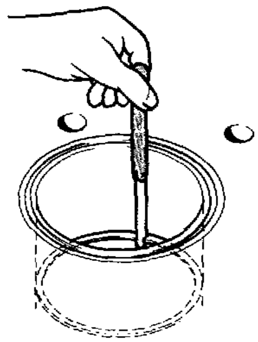


Fig. 54. Measuring piston ring gap

If the cylinder liner wear is as much as 0.40–0.45 mm (0.016–0.018") then the cylinder liner kit should be replaced. The Magnaflux method is the most convenient for the detection of cracks.

Flexhoning the cylinder liners

For good lubrication and sealing it is important that the cylinder walls retain their original honing pattern, see fig. 56. It is therefore advisable to carry out honing to restore the pattern when:

- the cylinder liner is scratched (ring scores or foreign matter)
- the cylinder liners has smooth patches (polishing)

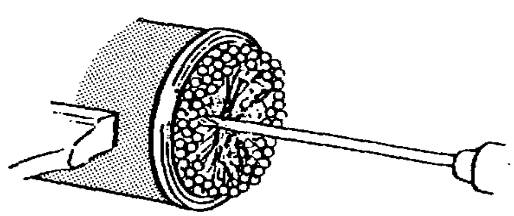


Fig. 55. Flexhoning the cylinder liner

1. Secure the cylinder liner in a vice, fig. 55. Flexhoning with the cylinder liner in situ is not recommended because of the risk of blockage of the oil passages and the difficulty of carrying out accurate feed.
2. When honing, use flex-hone tool type GBD 127 (5"), grade 80 for the 100-series and GBD 140 (5 1/2") for the 120-series respectively.
3. Use a low speed drilling machine at 200–400 r/min. The honing tool being fed in and out in the cylinder bore at the rate of 60 strokes/min (one in and out stroke per second).

   Lubricate the cylinder liner with thin engine oil before and during honing.
4. The cylinder liner has a honing pattern, the angles of which have been carefully calculated to give optimum life, see fig. 56.

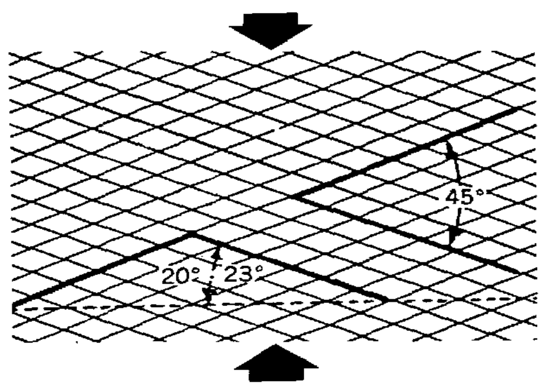


Fig. 56.

When honing in connection with piston ring replacement, the original honing pattern must be followed in order to retain correct lubricating function.

The pattern of honing scores must be regular and cut in both directions over the complete cylinder surface.

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

5. After honing it is very important that the liner is cleaned very thoroughly with warm water, brush and cleansing agent (never use solvents, paraffin or diesel oil). Dry the cylinder liner with paper or fluff-free cloth. After drying, lubricate the cylinder liner with thin engine oil.

Reconditioning the liner recesses

Special tools: 999 2479-7, 100-series: 999 2666-9, 999 9511-0, 999 9551-6. 120-series: 999 2667-7 999 9902-1, 999 9903-9

Remove the sealing rings in the lower cylinder liner guide. Then clean both 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 damage, refer to "Fitting the cylinder liners and pistons". In the case of slight damage, adjustment can be carried out by grinding with grinding compound, see point 7. In the case of major damage, adjustment is carried out using milling tool 9551 (100-series) and 9902 (120-series) in accordance with the following instructions:

1. *Insert the cylinder liner and measure the liner height.* Refer to "Fitting cylinder liners and pistons", points 4 *and 5. Read off the dial indicator and note the reading.* If it is judged necessary to grind in the liner recess with *grinding compound after milling, account should be* taken of a grinding allowance of a further 0.02 mm *(0.0007"). Pay attention however to point 8!*

   Ground off material must be compensated for by the use of steel shims, which are available in three thicknesses 0.02, 0.30 and 0.50 mm (0.0008", 0.012" and 0.0197"). Preferably not more than one shim should be placed under the liner collar.

   Note! If shims are used, certain machining of the liner recesses must be carried out even if the liner recesses in the cylinder block are undamaged since the fillet radii in the bottom of the recesses must be removed so that the shims seat correctly.

   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.

2. Fit the lower cylinder liner O-ring seals and place the guide for the milling tool in the lower cylinder seat, fig. 57. Ensure that the collar of the guide clears the intermediary wall in the block.
3. *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 plain washers. Check that the feed* sleeve does not press on the milling cutter.
4. Attach a dial indicator as shown in fig. 57 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 fillet 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 paint-mark adjacent to the ground surface on the upper edge of the milling cutter gives a reliable "Reading position".
5. Turn the milling cutter, smoothly and evenly, at the same time as the feed sleeve is turned to ensure even feed. When the dial indicator reading shows the measurement to 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.
6. Check the liner height again.
7. Provided that great care has been taken and the instructions have been carefully followed, it should not generally be necessary to grind with grinding compound after milling.

   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 this grinding operation until good contact is obtained. To turn the liner use expander 9511 (100-series) and 9903 (120-series).*
8. 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.
9. Clean all parts thoroughly.
10. 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.*

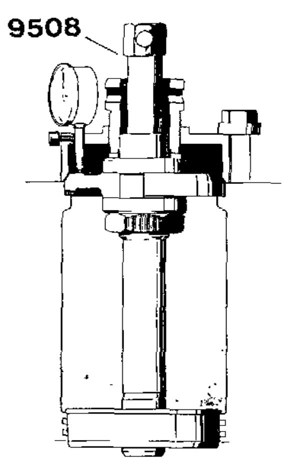


Fig. 57. Tool for reconditioning the liner seat

Inspecting the pistons

Check the pistons for cracks and other damage. If a piston has deep scores in its skirt outer surface then the piston (liner kit) must be discarded and replaced. Likewise, if a piston has one or more cracks in the gudgeon (piston) pin hole or in the bottom of the combustion chamber. Cracks at the edge of the piston crown around the combustion chamber are generally not serious. Note! If cracks occur in the pistons the injection quantity should be checked.

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 C is to be fitted with a liner of class C, a class D piston to a class D liner and so on.

Piston and cylinder linders are supplied only as complete units.

Piston clearance: 100-series: 0.15–0.18 mm (0.006–0.007")
0.12–0.15 mm (0.0047–0.006")

Checking the piston rings and piston fit

Check the wear faces and the sides. Black patches on the surfaces indicate poor contact, which means that the rings should be replaced.

Oil consumption is also of decisive importance for determining when piston ring replacement should be carried out.

Check the piston ring gap according to fig. 58. When measuring the piston ring gap, push the ring down below the lower turning point with the help of a piston. If the gap is as much as 1.5 mm (0.06") or more, then the rings must be replaced. Check even the new piston ring gap. Concerning dimensions, see "Technical Data".

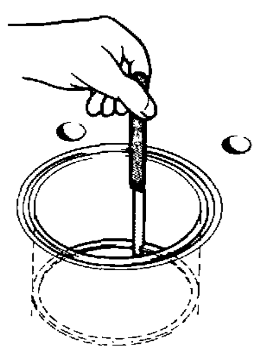


Fig. 58. Checking piston ring gap

Inspecting connecting rods

Check for cracks. Check straightness and twist. Maximum deviation in both cases: 0.01 mm (0.0004") over a measured length of 100 mm (3.937"). Measurement is carried out in a control fixture for connecting rods. Discard curved or twisted connecting rods.

Check the connecting rod bushings, which can be done most conveniently by using a gudgeon (piston) pin as a gauge. There must be no noticeable looseness.

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

Replacing connecting rod bushing

Special tools: 999 1801-3, 100-series: 999 2529-9
120-series: 999 2952-3

1. Press out the old bushing using drift 2529 (100-series) or 2952 (120-series).

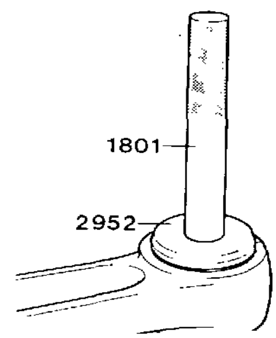


Fig. 59. Pressing out the connecting rod bushing, 120-series

2. Press in the new bushing by using the same tool.

   NOTE! Make sure that the hole in the bushing corresponds with the hole in the connecting rod (applies to later type connecting rods). Using a felt-tip pen, draw a line across the hole in the bushing and connecting rod. After fitting, check that the oil passage is open.

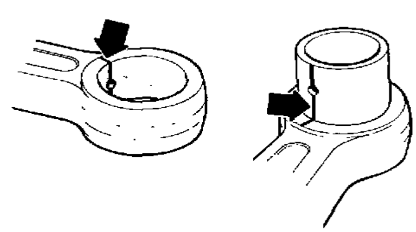


Fig. 60. Fitting a connecting rod bushing

3. Ream the bushing. When the fit is correct, an oiled-in gudgeon (piston) pin must slide slowly through the bushing under its own weight (temp. 17–20°C = 62–68°F).

Assembling piston, rings and connecting rod

Special tools: 999 1801-3, 999 2013-4

1. Fit the circlip (lock ring).
2. Oil in the gudgeon (piston) pin and the connecting rod bushing.
3. Heat up the piston to about 100°C (212°F). Assemble the piston and connecting rod so that the "Front" marking on the piston and connecting rod face the same direction. Press in the gudgeon (piston) pin using drift 2013 and standard handle 1801.

   NOTE! The gudgeon (piston) pin should be a light push fit, it must never be knocked in.

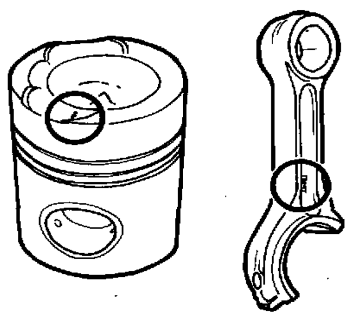


Fig. 61. Front marking

4. Fit the other circlip (lock ring).
5. Check that the connecting rod does not turn stiffly in the gudgeon (piston) pin bushing.
6. Fit the new piston rings in the cylinder bore (fig. 58).
7. Fit the rings on the piston using piston ring pliers. The oil ring and upper compression ring can be turned to face any direction. The other rings are to be fitted with the "TOP" marking facing upwards. The opening in the expander spring should be placed directly opposite to the oil scraper ring gap.

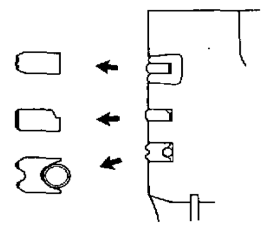


Fig. 62. Location of the piston rings

Auxiliary drive

Removing the auxiliary drive gears

Special tools: 999 2655-2, 999 2658-6, 999 2679-2, (999 6682-2, 999 2952-3)

Industrial engines: Drain the cooling system. Remove the radiator, fan shroud, belt guard and fan.

Marine engines: Remove the heat exchanger brackets, the drive output for the alternator and the scavenger pump (if fitted).

1. Remove both battery cables and the alternator, if necessary. Remove belt tensioners and belts.
2. Remove the vibration damper and the crankshaft belt pulley, if fitted.

   NOTE! Always protect the vibration damper from blows and impact since its characteristics can change completely if the carefully calculated shape and volume of the liquid cavity is changed.
3. Loosen the polygon hub centre bolt, remove the washer and pull off the hub using puller 2655 (fig. 63).

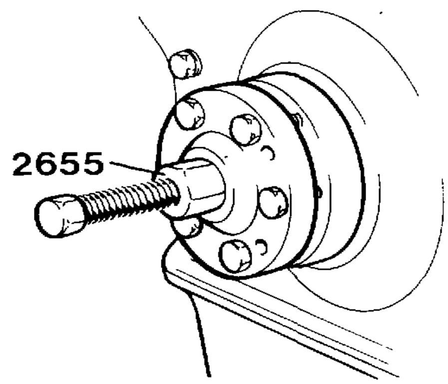


Fig. 63. Removing the polygon hub

4. Remove the auxiliary drive cover. Remove the oil deflector, if fitted, from the crankshaft journal.
5. Remove the idler gear and its bearing journal, after loosening the three attaching bolts.
6. Remove the camshaft gear after the three attaching bolts have been loosened. If necessary use puller 2679, see fig. 64. Remove the injection pump drive gear in the same way.

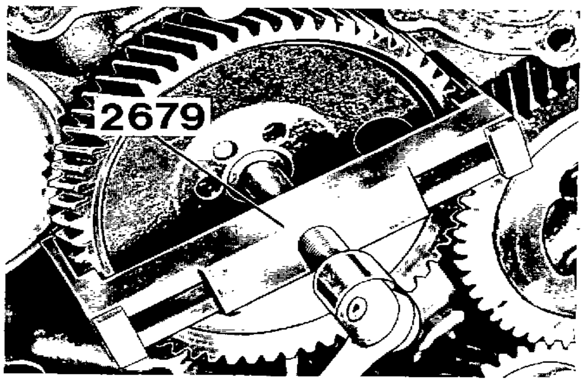


Fig. 64. Removing the camshaft gear

7. Remove the oil pump idler gear.
8. Remove the crankshaft gear using puller 2658, (fig. 65).

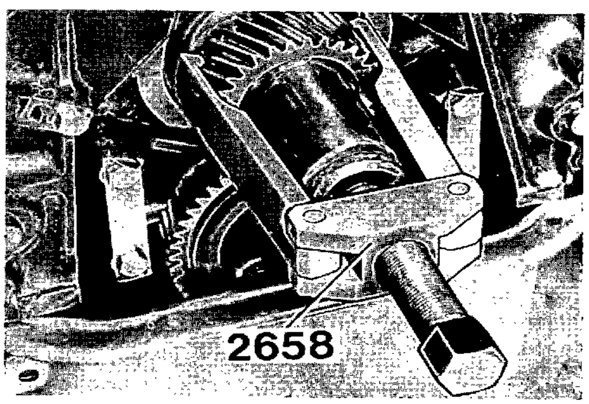


Fig. 65. Removing the crankshaft gear

9. If the water pump idler gear must be removed (industrial engines in the 120-series): Remove the water pump. Unscrew the nut using tool 6682. Tap the back of the gear to loosen it. Pull out the inner bearing using the standard puller. The bearing race in the gear can be removed and fitted with drift 2952.

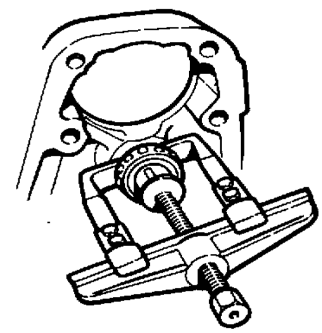


Fig. 66. Removing the coolant pump idler inner bearing

Inspecting the auxiliary drive gears

Carefully inspect the auxiliary drive gears and parts after they have been cleaned. Replace badly worn or damaged gears, for dimensions refer to "Technical Data". Engines with gear-driven coolant pump: Check the idler gear bearing. Clean the auxiliary drive cover and its mating surface on the engine (auxiliary drive casing).

Assembling and settings

Special tools: 999 2656-0, 999 2659-4 (999 2267-6, 999 6682-2)

All the gears in the auxiliary drive assembly which influence the settings are marked with a punch mark opposite the respective tooth or tooth gap (fig. 68).

1. Check that the crankshaft key is fitted. Fit the crankshaft gear using tool 2659 (fig. 67).

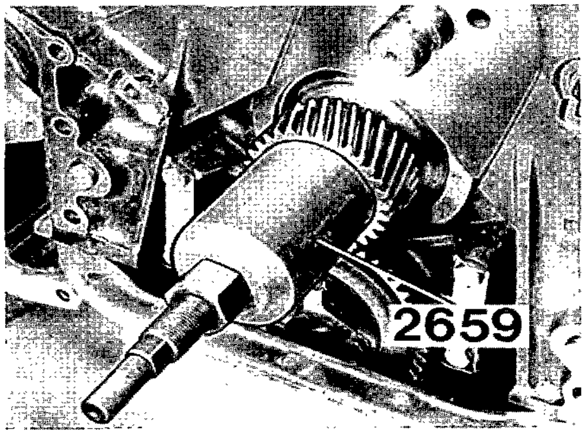


Fig. 67. Fitting the crankshaft gear

2. Check that the camshaft gear locating pin is fitted. Install the camshaft gear. Tightening torque 45 Nm (4.5 kpm = 33 lbf.ft.). Lock the bolts with the lock washer.
3. Rotate the crankshaft so that no. 1 piston is in the top dead centre position. Assemble the idler gear according to the marking (fig. 68). The bearing shield and thrust washer are located as shown in fig. 69. Tightening torque 60 Nm (6 kpm = 44 lbf.ft.). Check that the axial clearance is 0.05–0.15 mm (0.002–0.006").

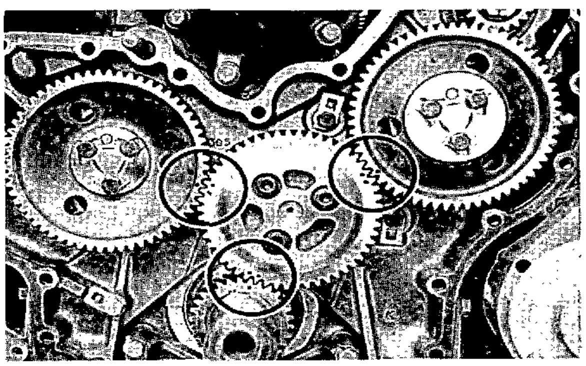


Fig. 68. Basic setting of auxiliary drive gears

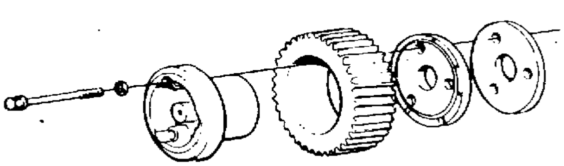


Fig. 69. Idler gear

4. Check that the locating pin is fitted in the shaft for the injection pump and fit the pump drive. Make sure that the markings correspond with fig. 68.
5. Fit the oil pump idler gear.
6. Fit the oil deflector on the crankshaft journal with the dish facing forwards (fig. 70). The oil deflector has been deleted on the 120-series from and incl. engine no. 91926/xxxx, see page 21.

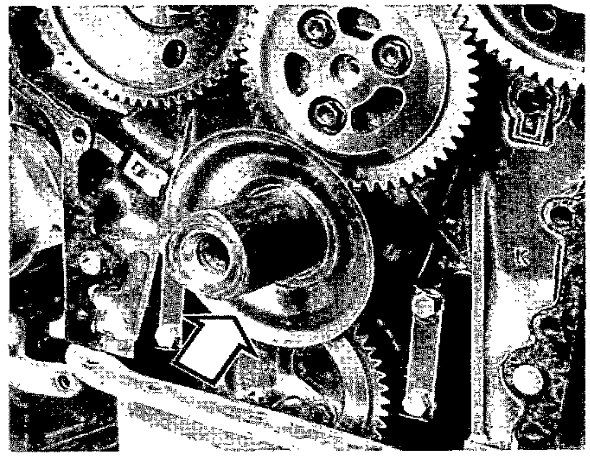


Fig. 70. Oil deflector

7. Engines with gear-driven water pump: Fit the inner gear ball bearing using drift 2267. Install the gear together with the outer bearing using drift 2267. Fit the tab washer and the nut. Tighten the nut to 120 Nm (12 kpm = 88.5 lbf.ft.), use tool 6682. Lock the nut with the tab washer.

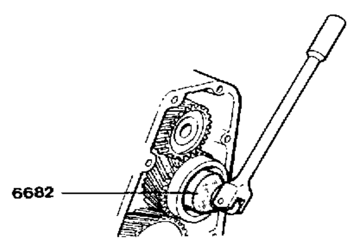


Fig. 71. Tightening the coolant pump idler gear

8. Dip a new felt ring and seal ring in oil and fit them in the auxiliary drive gear cover (with the felt ring outermost). Fit the gasket and then the cover. The cover is centered by means of the two locating pins.

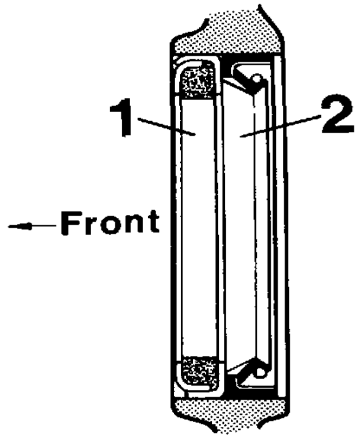


Fig. 72. Front crankshaft seal
1. Felt ring 2. Rubber ring

9. Check the polygon hub and its contact face on the crankshaft. Any cutting marks are to be removed with fine emery cloth. Grease the crankshaft journal with molybdenum disulphide. Fit centering section of drift 2656 on the crankshaft journal.

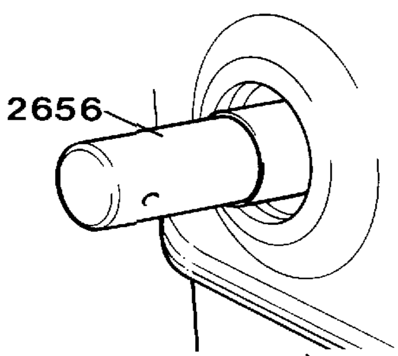


Fig. 73. Locating the centering section of drift 2656

10. Warm the polygon hub to approx. 100°C (212°F). Knock the hub quickly onto the journal using drift 2656, fig. 74.

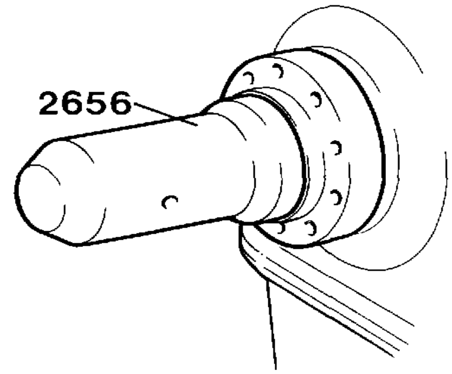


Fig. 74. Fitting the polygon hub

11. Fit the washer and the centre bolt and tighten the hub whilst it is hot. Tightening torque 400 Nm (40 kpm = 289 lbf.ft.). Once the hub has cooled retighten the bolt to 550 Nm (55 kpm = 397.8 lbf.ft.).

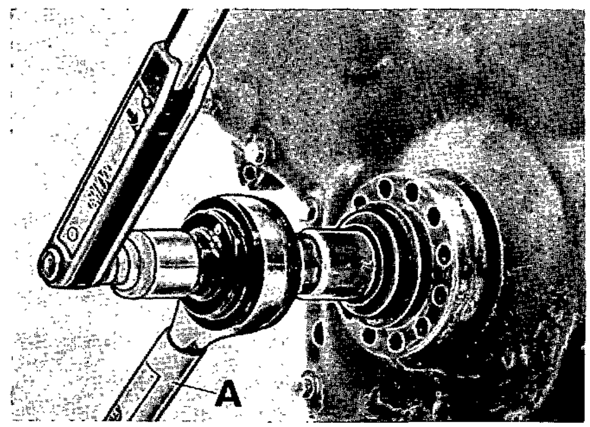


Fig. 75. Tightening the polygon hub
A. Torque amplifier

12. Fit the vibration damper and pulley, if fitted. Tightening torque 60 Nm (6 kpm = 44 lbf.ft.). Fit the remaining equipment. If necessary top up lubricating oil and coolant. Test-run the engine.

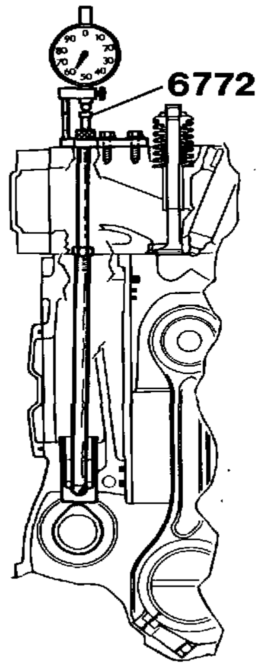


Fig. 76. Checking the lift height

Camshaft and tappets

Checking lift height

Special tool: 999 6772-1

An indication as to the state of camshaft wear can be obtained by rotating the engine by hand and measuring the lift height with a dial indicator as shown in fig. 76.

	Inlet	Exhaust
Minimum permissible lift height	8.0 mm (0.315")	8.6 mm (0.339")
Lift height, new camshaft	8.6 mm (0.339")	9.2 mm (0.362")

Checking valve timing

1. Remove the front rocker arm casing. Rotate the crankshaft until the valves for no. 1 cylinder "rock". Then rotate the crankshaft against the direction of engine rotation until the inlet valve is completely closed. Temporarily adjust the inlet valve clearance to ±0 mm.
2. Place the dial indicator with its measuring tip against the upper spring washer, see fig. 77. Fit the dial indicator with approx. 5 mm (0.1968") pretension.

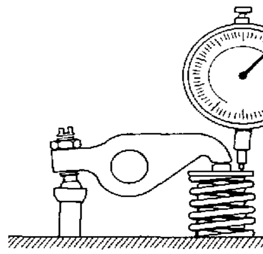


Fig. 77.

3. At the same time as an assistant continues to turn over the engine by hand in the direction of engine rotation, observe the dial indiator. The dial indicator gives a reading when the inlet valve begins to open. Set the indicator 1/100 scale to zero precisely at this opening point.
4. Continue rotating the engine past the degree graduations on the flywheel up to the mark for 10° after top dead centre. Make sure that the indicator tip on the flywheel casing is directly opposite the setting reading.

   Check that the measurement agrees with that given in "Technical Data".

Removing the camshaft

Special tools: 999 2655-2, 999 2679-2

1. Remove the rocker arm casings.
2. Loosen and remove the rocker arm mechanism.
3. Lift out the push rods.
4. Loosen and remove the three inspection covers directly opposite the tappets (valve lifters). Lift up the tappets (valve lifters) and place them in order in a stand.
5. Carry out the work described in points 1 to 4 inclusive under the heading "Removing the auxiliary drive gears".
6. Remove the camshaft gear. Use puller 2679 (fig. 64), if necessary.

7. Remove the idler gear.
8. Remove the flange (fig. 78) and then pull out the camshaft carefully to avoid damaging the bearings.

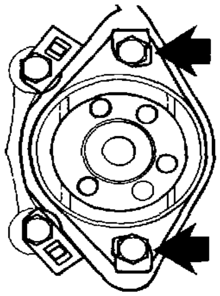


Fig. 78. Attaching bolts for camshaft flange

Inspection of tappets and camshaft

Check the lift surface on the tappets with a steel straight edge. The surface should be convex, but may even be completely flat. If light can be seen under the straight edge in the middle of the tappet (valve lifter), then the tappet (valve lifter) must be replaced.

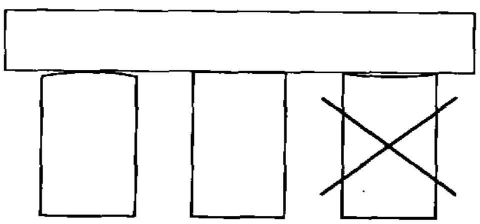


Fig. 79. Checking the tappets

Check the lift surface with respect to pitting damage. The damage is caused by the loosening of small metal particles from the hardened surface. Tappets with only slight pitting damage can be reused, see fig. 80, since it is extremely unlikely that this amount of pitting can lead to any further damage.

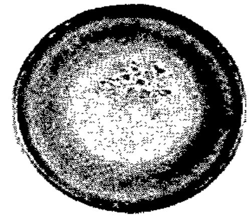


Fig. 80. Slight pitting damage to tappet lift surface

Also check the camshaft for pitting damage. As in the case of the tappets, slight pitting damage does not necessitate replacement, see fig. 81. Measure the lift height with a vernier caliper. For dimensions, refer to the table on page 40. The cam wear may slope in an axial direction. This may be remedied by honing in cases of slight obliquity.

Measure the camshaft bearings with a micrometer. Max. wear and ovality: 0.07 mm (0.0028"). Check the camshaft for straightness by indexing. Max. permissible radial throw relative to the end bearing: 0.04 mm (0.0016").

Dimensions for camshaft journals and bearings are given in "Technical Data".

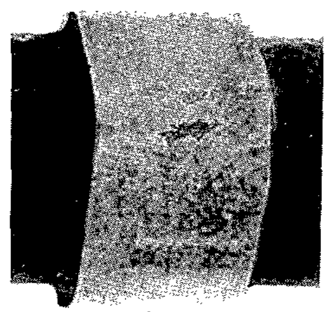


Fig. 81. Slight pitting damage to the camshaft

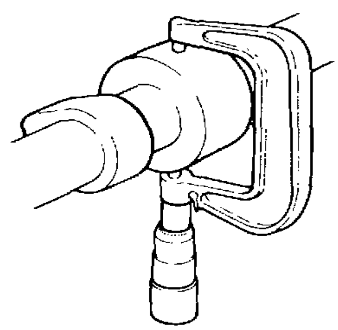


Fig. 82. Measuring the camshaft bearings

Replacing the camshaft bearings

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

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

Fitting the camshaft

Special tool: 999 2656-0

1. Oil in the bearings and slide in the camshaft carefully to avoid damaging the bearings, use a suitable lever. *Fit the flange which locates the camshaft axially. Tighten the bolts and lock them.*

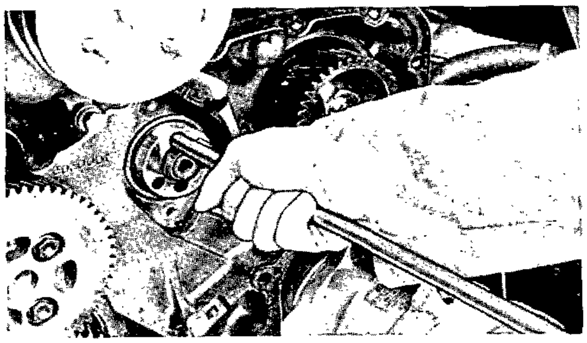


Fig. 83. Fitting the camshaft

2. Fit the camshaft gear. Lock the bolts with the tab washer.
3. Fit the idler gear so that the markings are aligned (fig. 84).

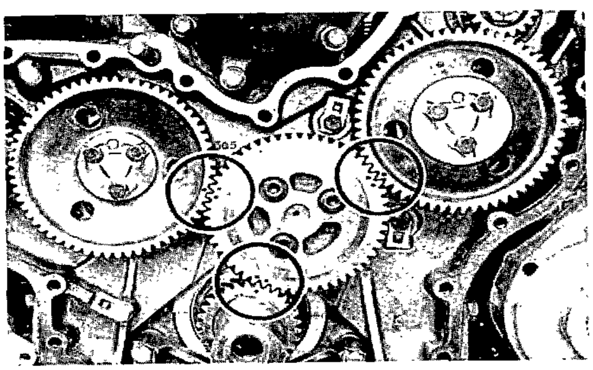


Fig. 84. Basic setting of auxiliary drive gears

4. Carry out the work described in points 6, 8, 9, 10, 11 and 12 on pages 38 and 39.
5. Fit the tappets (valve lifters) in the same order in which they were fitted earlier. Fit the inspection covers.
6. Fit the push rods and rocker arm mechanism. Adjust the valves and fit the rocker arm casings.
7. Fit the remaining equipment and fill up with lubricating oil and coolant, if necessary. Test-run the engine.

Removing the crankshaft

Special tool: 999 2655-2

1. Unbolt the engine mountings and lift out the engine. Drain off the lubricating oil.
2. Remove the auxiliary drive gear cover (see page 36).
3. Remove the sump, oil strainer and oil pipes. NOTE! On TMD100 the rear inspection cover on the oil sump must be removed and the oil strainer unscrewed before removing the sump.
4. Remove the reverse gear or coupling, if fitted, the flywheel and the flywheel housing.
5. Remove the connecting rods and main bearing caps. Lift out the crankshaft.

Inspecting the crankshaft and bearings

When the crankshaft has been removed from the engine, all its drillings and passages must be cleaned thoroughly. Measure wear and out-of-round using a micrometer. The most reliable way to localize any cracks, slag lines and fracture indications is by Magnaflux testing. The crankshaft must be demagnetized after Magnaflux testing.

The largest permissible out-of-round on the main and big-end (connecting rod) journals is 0.08 mm (0.0032") and maximum taper is 0.05 mm (0.002"). If these values are exceeded, the crankshaft must be ground to a suitable undersize.

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

Grinding the crankshaft

In general, both re-grinding and straightening cause a reduction in fatigue strength. Do not, therefore, re-grind the crankshaft (particularly nitro-carburized) without having very good reason for doing so; such as in the case of dimensional defects (wear, ovality and taper) or in the case of serious surface damage which cannot be remedied by lapping.

Out-of-straightness is measured as "throw" (i.e. total indicator reading) at the fourth main bearing journal with the shaft supported on main bearing journals number one and seven. Any straightening of the finished crankshaft (irrespective of the hardening method) should be avoided.

The crankshaft is nitro-carburized. On condition that the shaft does **not** require straightening prior to re-grinding, then grinding down to the 2nd undersize is permissible without re-nitro-carburizing. If the crankshaft is so out-of-straight that it requires straightening prior to re-grinding, then it must be re-nitro-carburized after grinding.

The crankshaft must be lapped and cleaned with great care after nitro-carburizing.

The crankshaft should always be checked using the Magnaflux method both before and after strightening or grinding. See under "Inspecting the crankshaft and bearings". Cracks of the following type and location necessitate that the crankshaft be discarded.

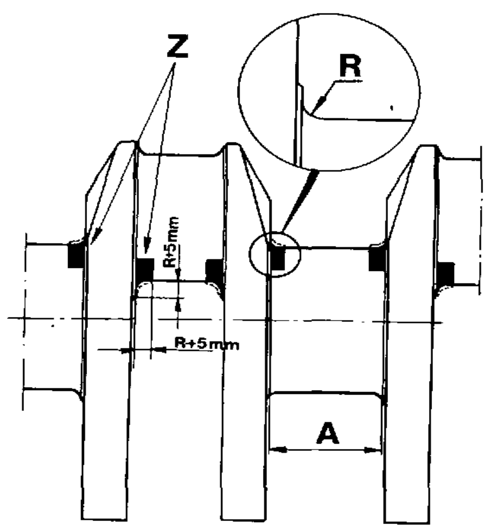


Fig. 85. Pilot bearing width dimension

R = 3.75–4.00 mm (0.148–0.158")

Measurement "A", fig. 85, must be:

Standard 45.975–46.025 mm (1.8100–1.8120")

Oversize 0.2 mm = 0.008" (thrust washers 0.1 mm oversize) 46.175–46.225 mm (1.8179–1.8199")

Oversize 0.4 mm = 0.016" (thrust washers 0.2 mm oversize) 46.375–46.425 mm (1.8258–1.8278")

Oversize 0.6 mm = 0.024" (thrust washers 0.3 mm oversize) 46.575–46.625 mm (1.8337–1.8356")

- Cross-wise cracks on the bearing journals and fillets.
- Length-wise cracks within the zone marked "Z", fig. 85:
- Cracks longer than 5 mm (0.2") adjacent to the oil drilling entry holes. Shorter cracks can be removed by grinding.
- Cracks longer than 10 mm (0.4") outside the zone marked "Z", including groups of small cracks if their total length exceeds 10 mm (0.4")

Cracks on the non-machined outer surface of the balance weights can be ground away, although not deeper than 3 mm (0.12").

The basic pre-condition for achieving satisfactory results when grinding is that the correct method is used.

The following grinding data is recommended:

Grinding disc: Naxos 33A 60 M6VK or 33A M6VK o4
Norton 23A 60 M5VK or 23A 46 M5VK

Diameter: new disc dia. 36"–42" (914–1067 mm)
(the disc can be used down to approx: dia. 720 mm (28")

Peripheral speed: grinding disc . 28–33 m/s (92–108 ft./s.)
crankshaft... max. 0.25 m/s (0.82 ft./s)

Cooling: 3 % oil emulsion (Soluble). Effective cooling is of the utmost importance, preferably with jets feeding from both above and below.

The disc should be sharpened using a single-stone diamond.

peripheral feed.................. 0.1 mm (0.004")/rev.
side feed .... 0.2 mm (0.008")/rev.
cutting depth .... max. 0.03 mm (0.0012")

The surface finish (profile depth) for bearing surfaces and fillet radii is 2μ, mean deviation 0.5μ. This surface finish is achieved by lapping. Lapping is carried out in the opposite direction of rotation to grinding.

1. Grinding is carried out in a crankshaft grinding machine to undersize as specified in the "Technical Data".
2. When grinding, it is very important to ensure that the fillet radii retain their correct dimension, R = 3.75–4.00 mm (0.148–0.158") and their correct shape and finish. Measure the radius with a radius template. The shape must be as fig. 85. There must be no grinding hacks or sharp edges since these can give rise to crankshaft fracture.
3. Particular care is needed when grinding the centre bearing journal with respect to the pilot bearing width "A" in fig. 85.

   NOTE! If sharp edges form at the oil drilling entry holes as a result of grinding carried out on the bearing journals, round off these edges with a grinding rod or with emery cloth.
4. After grinding, the crankshaft is to be thoroughly cleaned to remove all traces of swarf and other impurities. Flush through and clean the drillings and the passages. Register crankshaft rotation. The largest permissible radial throw is 0.05 mm (0.002").
5. Magnaflux-test the crankshaft. Demagnetize after testing.

Fitting the crankshaft

Special tool: 999 2656-0

1. Check that all the crankshaft drillings, passages and bearing surfaces are clean. Check also the cylinder block and bearing caps.
2. Place the main bearing shells and the big-end (connecting rod) bearing shells in position. Make sure that the holes in the upper bearing shells align with the oil drillings and that the bearing shells and recesses are free from burrs or deformations. Oil in the bearings.
3. Smear the bearing journals with engine oil and lift the crankshaft carefully into position. If the auxiliary drive gear is still fitted, make sure that its marking is correctly located.
4. Fit the thrust washers to the centre main bearing (pilot bearing). Location recesses ensure that the washers can only be fitted one way (fig. 86).

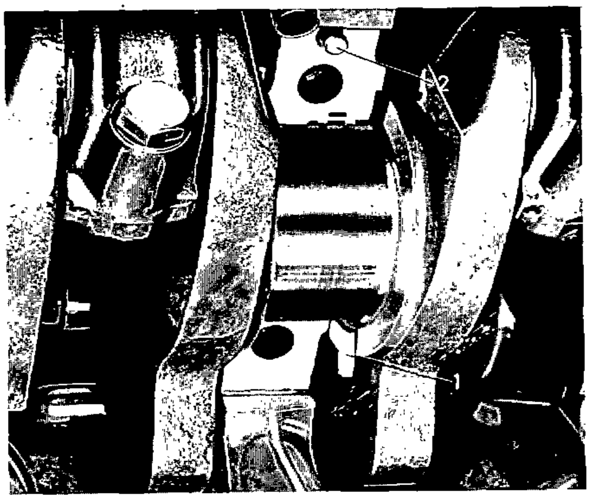


Fig. 86. Pilot slot (1) and locating pin for main bearing cap (2).

5. Fit the main bearing caps. The centre bearing cap has a recess which should be turned to fit the locating pin. This means that the bearing cap is always correctly located axially. Note the number on each main bearing cap which indicates position.
6. Fit the main bearing bolts after the threads have been oiled in. Tightening torque 330 Nm (33 kpm = 243 lbf.ft.) for 100-engines and 340 Nm (34 kpm = 251 lbf.ft.) for 120-engines.
7. Check the crankshaft axial cleararnce (see "Technical Data").
8. Make sure that the "Front" marking on the connecting rods face forwards and that the cap locating pin, if fitted, is securely located. Fit the big-end (connecting rod) bearing caps and tighten the connecting rod bolts to a torque of 230 Nm (23 kpm = 166 lbf.ft.).

Main and big-end bearings

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

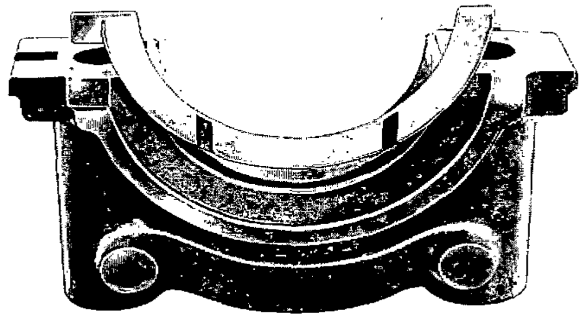


Fig. 87. Fitting thrust washers

Replacing main bearing

(crankshaft in position in engine)

1. Drain off the engine oil. Remove the oil sump (industrial engines). On marine engines, remove the sump inspection covers.
2. Loosen the main bearing bolts and then take off the main bearing caps with the bearing shells. The front main bearing cap can be removed together with the oil pump.
3. Loosen the injectors so that the engine can be turned over more easily.
4. Turn the crankshaft until its oil hole is exposed. Place a pin in this hole, the pin having such dimensions that when the crankshaft is rotated it takes with it the upper shell, see fig. 88. Note! The engine is turned over in its normal direction of rotation when bearing shells are being rolled out.

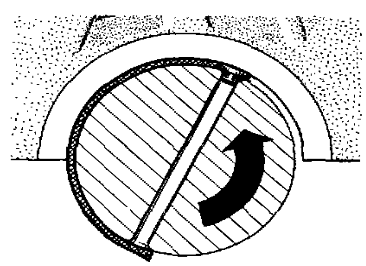


Fig. 88. Removing the upper bearing shell

5. Clean off the bearing journals and examine them closely for damage. If there are signs fo marked wear or if out-of-round is too much, the crankshaft must be ground.
6. Fit the new bearing shells in the same way as they were removed. This time the crankshaft is rotated the reverse way. Check that the lugs pressed out of the bearing shells engage correctly and also check that the oil hole in the upper bearing aligns with the oil drilling in the block. Fit the lower bearing shell and cap. Tighten the bolts to a torque of 330 Nm (33 kpm = 243 lbf.ft.) on the 100-series and 340 Nm (34 kpm = 251 lbf.ft.) on the 120-series.

Replacing crankshaft seals

Special tools: 999 2655-2, 999 2656-0, 999 6088-2

The rear seal ring is accessible after the flywheel has been removed. The old ring is removed by using a screwdriver. If the seal ring has caused a wear groove deeper than 0.20 mm (0.008") the spacer ring, located in front of the seal ring, can be removed so that the new seal ring can be pressed further inwards, see fig. 89.

Oil in the new seal ring, thread it into the tool 6088 and knock it into its recess, if necessary using a drift (see fig. 90).

The front seal rings (a felt ring and a rubber ring) can be replaced after the polygon hub has been removed from the crankshaft (see "Removing auxiliary drive gears"). The felt ring is fitted outermost.

Soak the felt ring and dip the rubber ring in engine oil before fitting them.

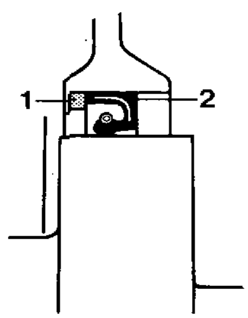


Fig. 89. Rear crankshaft seal

1. Spacer ring
2. Seal ring

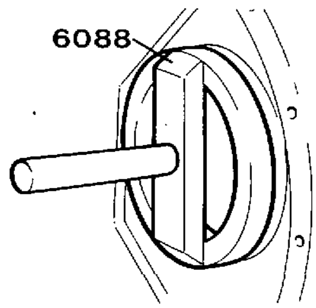


Fig. 90. Fitting the rear crankshaft seal

Flywheel

Check that the ring gear is in sufficiently good condition. Replace the ring gear if it is worn or if any teeth are broken.

Check the flywheel for cracks and other forms of damage.

Flywheel with automotive clutch

In the case of light scratches, scoring or cracks in the friction face, the flywheel can be reconditioned by grinding, but not more then 0.5 mm (0.02") of the material may be

Replacing the flywheel ring gear

1. Remove the flywheel.
2. Drill one or two holes between two teeth of the ring gear and then split it with a chisel.
3. Brush clean the contact face on the flywheel using a wire brush.
4. Heat up the new ring gear in an oven to approx. 180°C (356°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.
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 170 Nm (17 kpm = 125 lbf.ft.).

DESCRIPTION

General

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

From the delivery side of the pump, oil is fed through an oil cooler and lubricating oil filters and out to the channels, passages etc. which comprise the lubricating system. All bearings and gudgeon (piston) pins, valve mechanism and auxiliary drive gear bearings are pressure lubricated.

The auxiliary drive is "shot" lubricated from the idler gear journal which is connected by passages to the main oil system.

The injection pump and turbo-compressor are pressure lubricated. If a compressed air compressor is fitted this is also connected to the engine's pressure lubricating system.

The lubricating oil pressure is limited by means of a relief valve (fig. 91). The valve is located on the right-hand side of the cylinder block behind the lubricating oil filters, the valve opens if the oil pressure becomes too high and diverts oil back to the sump.

The 120-series engines are fitted with a piston cooling system where lubricating oil is sprayed up onto the underside of the pistons from a fixed jet for each cylinder.

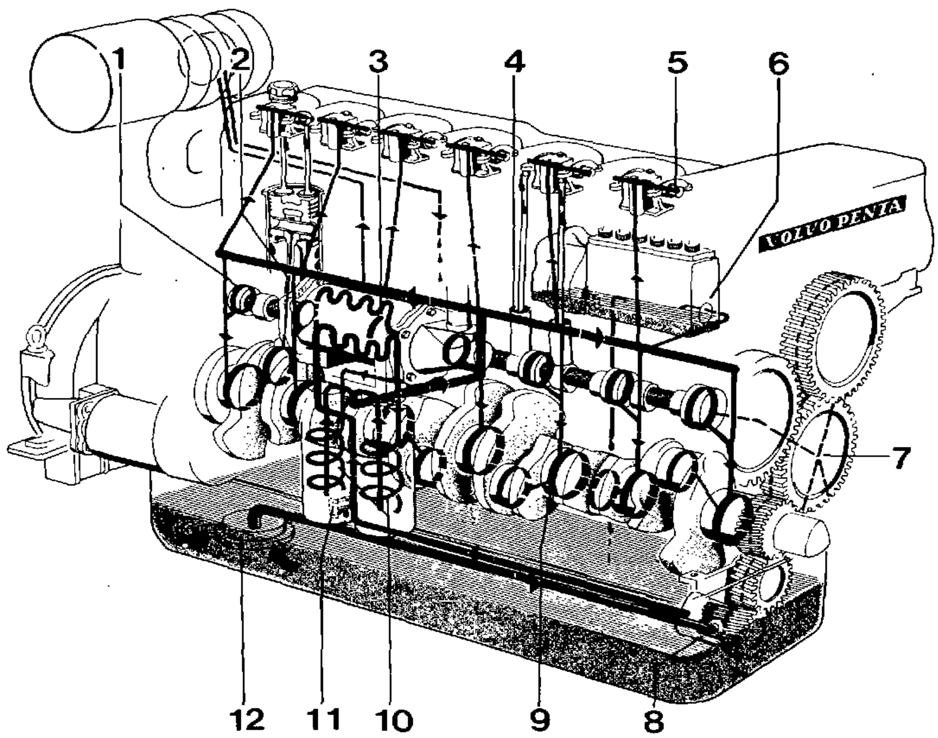
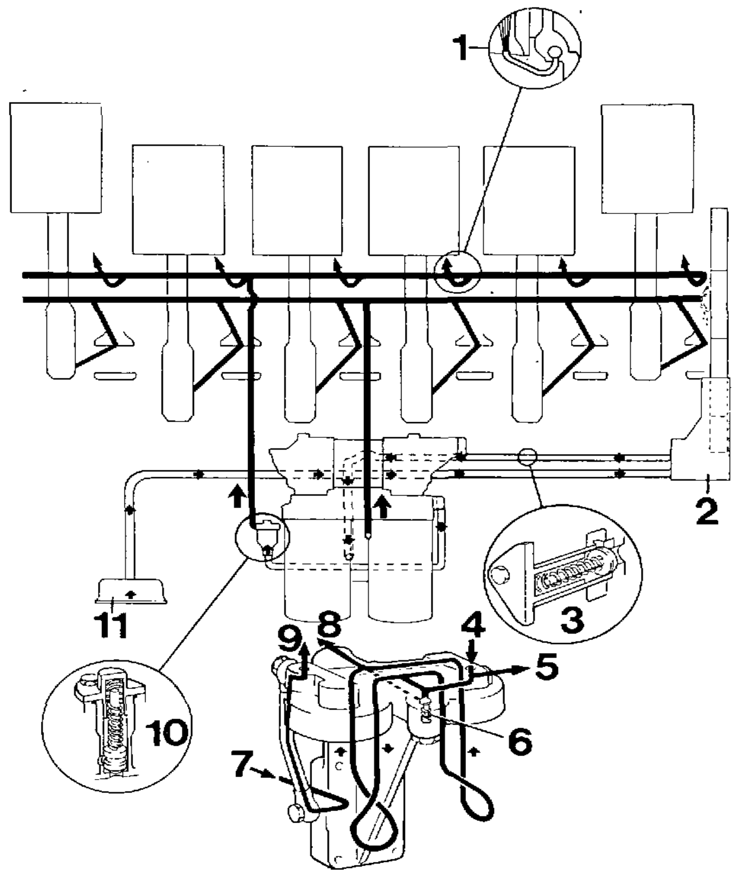


Fig. 91. Lubricating system, TMD100C

1. Camshaft
2. Drilling through connecting rod
3. Oil cooler
4. Tappet (valve filter)
5. Rocker arm shaft
6. Injection pump
7. Auxiliary drive gears
8. Oil pump
9. Crankshaft
10. Oil filter
11. Relief valve
12. Oil strainer

Fig. 92. Lubricating system, T(A)MD121

1. Piston cooling jet
2. Oil pump
3. Relief valve
4. Oil from oil cooler
5. Oil to piston cooling
6. Relief valve (allows oil to by-pass if the filter is blocked)
7. Oil from oil pump
8. Oil to lubricating points
9. Oil to oil cooler
10. Piston cooling valve
11. Suction strainer



Piston cooling

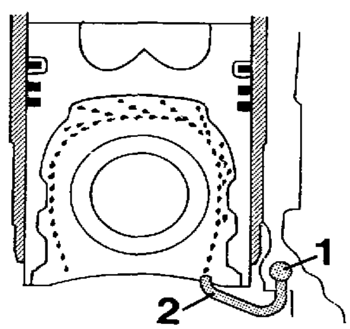


Fig. 93. Piston cooling

1. Oil passage 2. Jet

Oil cooling reduces the temperature by approx. 20°C (68°F) measured at the upper piston ring carrier.

The oil supply to the piston cooling system is controlled by a piston cooling valve. The valve does not open before the engine speed has reached approx. 700–800 r/min, which ensures that the engine is sufficiently lubricated even when starting and at low r.p.m. The opening pressure is approx. 90–120 kPa (0.9–1.2 kp/cm^2 = 12.8–17 p.s.i.).

Relief valve

Oil pressure is limited by means of a relief valve, located in the engine block behind the oil filters. On engines fitted with a shallow sump, the relief valve is fitted to the oil pump pressure line inside the sump.

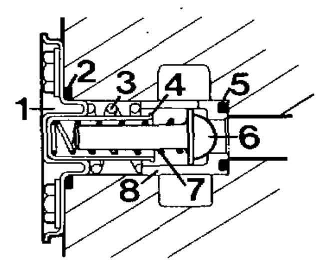


Fig. 94. Relief valve

1. Cover
2. O-ring
3. Spring
4. Sleeve
5. O-ring
6. Valve
7. Spring
8. Seat

Oil filter

The oil filter is of the full-flow type, i.e. all the oil flows through the filters before passing to the engine lubrication points. The filter elements consists of corrugated filter paper.

The relief valve, which allows oil to by-pas if the filters become clogged, is located in the filter bracket.

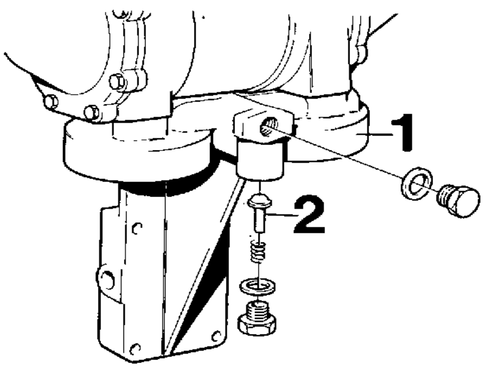


Fig. 95. Filter bracket, marine engines

1. Filter bracket
2. Relief valve

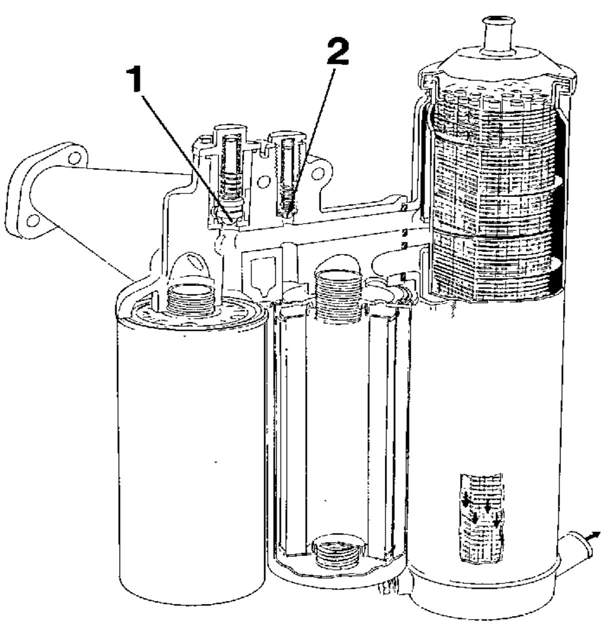


Fig. 96. Oil filter and oil cooler, industrial engines, 120-series

1. Piston cooling valve
2. Relief valve

Oil cooler

The oil cooler is located adjacent to the oil filters. The cooler is of the tubular type, and coolant passes through, while oil circulates round the tubes. On marine engines sea-water acts as coolant.

The purpose of the oil cooler is to reduce oil temperature, especially when the engine is operating under high loads.

Crankcase ventilation

To prevent overpressure and to divert fuel vapour, steam, and other gaseous products of combustion the engine is fitted with a ventilation device.

All marine engines have a replaceable paper filter which separates any oil vapour before the gases are routed out. There is also an overpressure valve on the filter holder which opens if the pressure in the crankcase becomes too high as the result of a blocked filter.

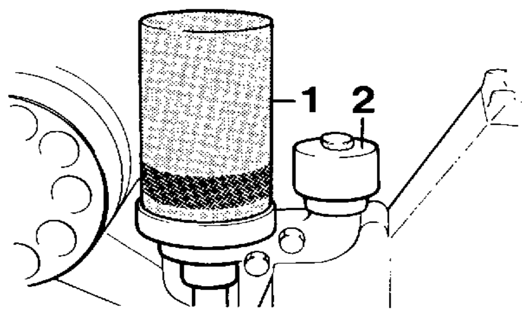


Fig. 97. Crankcase ventilation filter

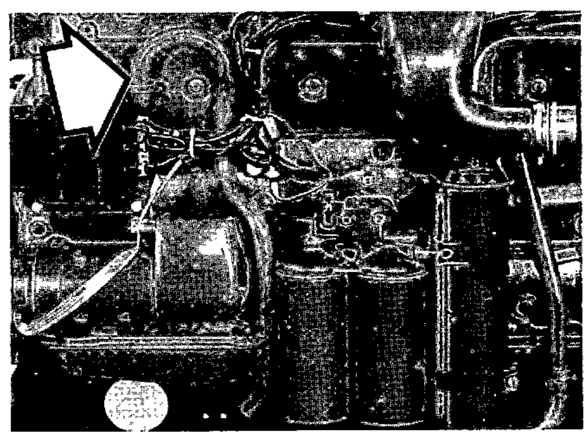


Fig. 98. Crankcase ventilation, industrial engines

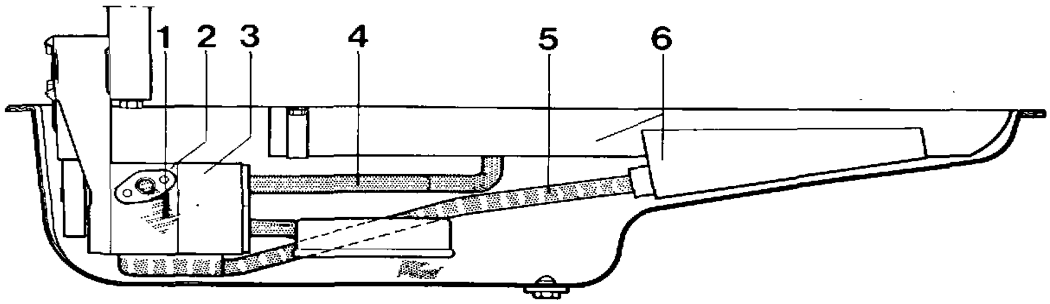


Fig. 99. Shallow oil sump for large inclinations, TD100G

1. Outlet for oil from rear part of sump
2. Oil pump for scavenging
3. Oil pump for pressure oil
4. Delivery pipe
5. Scavenger pipe
6. Boggie plate

Shallow oil sump

Industrial engines in the 100-series which operate at particularly large inclination angles, can be fitted with a shallow oil sump, fig. 99. This is so designed that when the engine inclines backwards, oil is sucked up from a limiting 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 (delivery pump) is placed. In other words, the pump sucks oil even when the engine is at a steep angle. The scavenging pump is integrally built with the ordinary oil pump (delivery pump) and is driven from the auxiliary drive gears.

REPAIR INSTRUCTIONS

Checking oil pressure

Lubricating oil pressure can be checked by connecting a pressure gauge with hose to the connection for the oil pressure sender (thread dimension 1/8"–27 NPSF). At operating speed and temperature the oil pressure should be 300–500 kPa (3–5 kp/cm^2 = 42–70 p.s.i.).

If the oil pressure is too low, first replace the relief valve and then check the oil pressure again.

Oil pump

Removing the oil pump

1. Drain off or suck out the engine oil.
2. **Industrial engines**: Remove the sump.

   Marine engines: Remove the front inspection cover from the sump.
3. Unscrew the oil pipes from the pump.
4. Unscrew the front main bearing bolts and remove the cap together with the oil pump. Unscrew the oil pump from the cap.

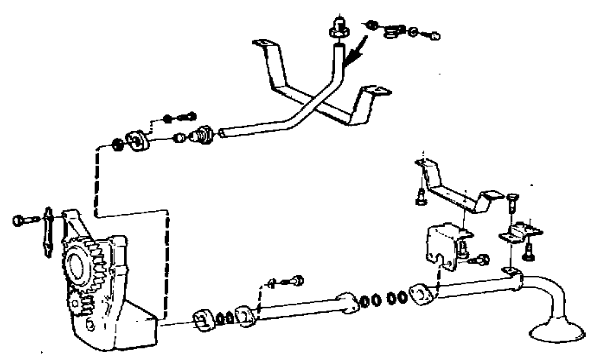


Fig. 100. Oil pump, T(A)MD121

Disassembling the oil pump

Special tool: 999 2654-5

When disassembling be careful not to damage the ground surfaces.

1. Pull off the drive gear using the puller 2654. Remove the key and axial washer from the shaft.

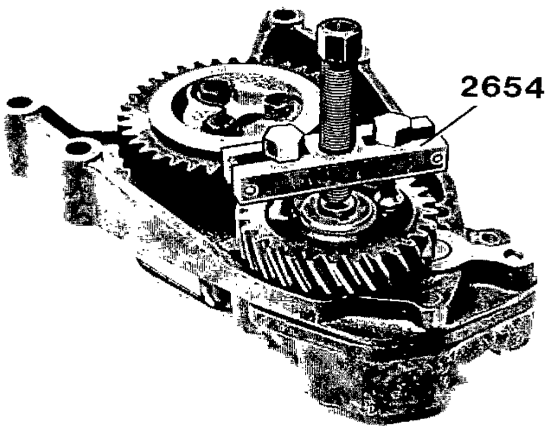


Fig. 101. Removing the drive gear

2. Remove the idler gear. The gear is held in position by three bolts and carried on a bearing sleeve.
3. Unscrew the bolts attaching the pump housing and remove the housing. If the housing will not loosen, drive it out by using two 5/16" bolts.
4. Press out the drive shaft with the pump gear.
5. Remove the idler gear from the housing. Press out the shaft if it needs replacing.

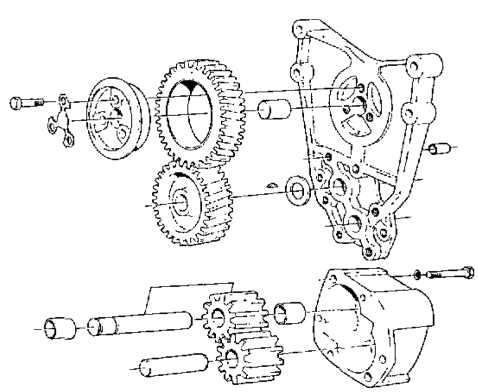


Fig. 102. Oil pump

Inspecting the oil pump

Clean all parts carefully and check the pump housing for scoring and wear and also check the seal between the bracket and the housing. The surfaces are black if leakage has occurred. There must be no scoring through wear. Minor defects can be rectified by using emery cloth. The bushings in the pump housing and bracket must be replaced if 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 (diam. 0.6305–0.6312"). Before reaming, bolt the housing and bracket together so that they are centralized by the guide sleeves.

In the case of 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, outer diameter and end faces.

Check the pump gear axial clearance (0.07–0.15 mm) (0.003–0.006") fig. 103 and backlash (0.15–0.35 mm) (0.006–0.014") fig. 104.

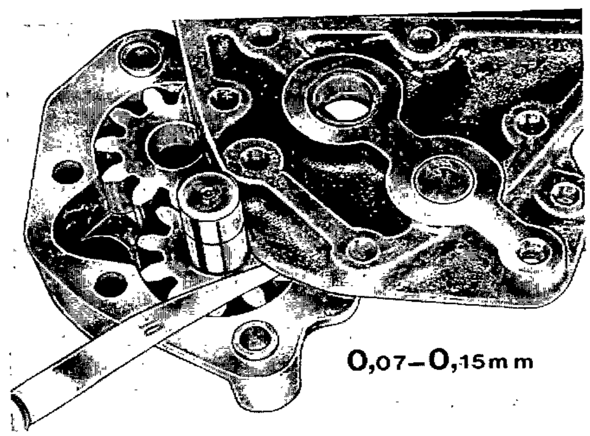


Fig. 103. Checking the axial clearance (0.07–0.15 mm) (0.003–0.006")

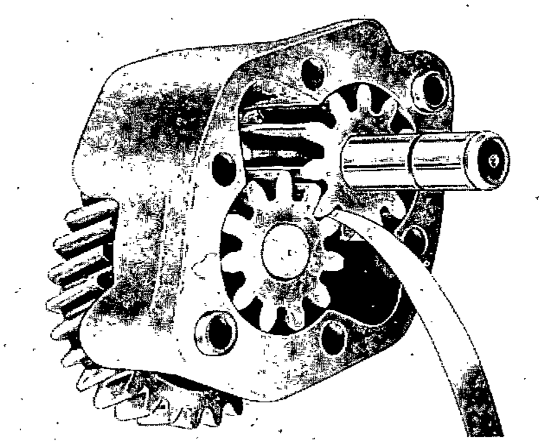


Fig. 104. Checking the backlash (0.15–0.35 mm) (0.006–0.014")

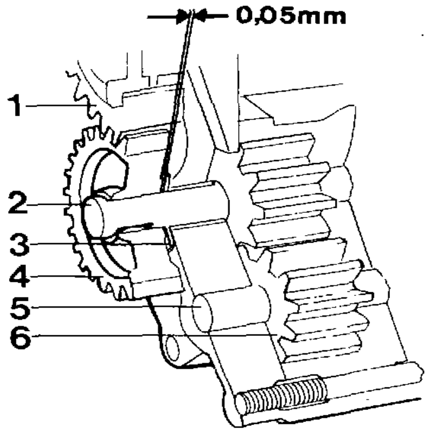


Fig. 105. Oil pump (standard)

1. Idler gear
2. Drive shaft
3. Axial washer
4. Drive gear
5. Idler gear shaft
6. Idler gear

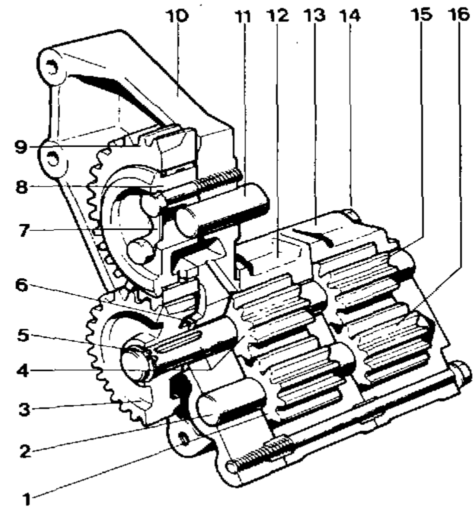


Fig. 106. Oil pump, for engines with shallow sump for large inclinations

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

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 (0.6305–0.6312"). The 120 series engines also have bushings for the idler shaft.
2. Press in the idler gear shaft if it has been removed.
3. Fit the drive shaft with its gear in the bracket.
4. Place the axial washer (3, fig. 105) on the shaft journal (a new axial washer is included in the repair kit). Fit the key and press on the drive gear. NOTE! There should be a clearance of 0.02–0.08 mm (0.001–0.003") between the axial washer and gear. A 0.05 mm (0.002") feeler gauge should be placed in the gap when fitting.
5. Fit the idler gear (6), and the pump housing. Tighten the pump housing to the bracket. Check that the pump can be rotated easily by hand.
6. Fit the idler gear and tighten the bearing sleeve. Lock the bolts with the lock washer.

Disassembling the oil pump

(for engines with shallow sump for large inclinations)

Special tools: 999 2654-5

Care should be taken when disassembling so that the ground surfaces are not damaged.

1. Remove the idler gear (9, fig. 106).
2. Remove the circlip and pull off the drive gear with puller 2654 (fig. 101). Remove the key and the axial washer from the shaft.
3. Remove the attaching bolts (14) for the pump housings. Remove the bracket (10), the idler gear shaft (2) will accompany it. If the pump housing remains attached to the bracket it can be released by using two 5/16" bolts to press it out.
4. Remove the delivery pump idler gear (1) from the housing. Press out the shaft (2) if this needs replacing.
5. Remove the scavenging pump housing (13) by prising with a screwdriver in the machined grooves between the delivery and scavenging pump. Remove the scavenging pump idler gear (16).
6. Place a support under the front end of the delivery pump and press the shaft out with the delivery pump drive gear (4) about 2.5 mm (0.10"). NOTE! Pressing out further is prevented by the key fouling with the pump housing.
7. 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 burrs.
8. Remove the drive shaft with the delivery pump drive gear. This gear is fixed on the shaft and cannot be removed.

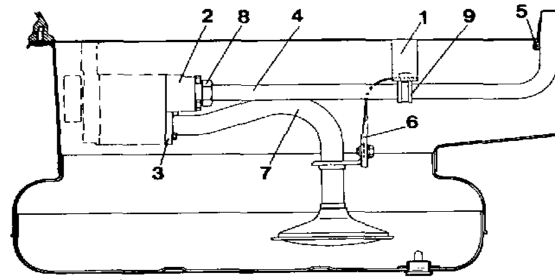
Inspecting the oil pump

See page 50.

Assembling the oil pump

(for engines with shallow sump for large inclinations)

1. If the bushings for the drive shaft have been removed, new bushings are pressed in and reamed to 16.016–16.034 mm (0.6305–0.6312").
2. Press in the idler gear shaft if it has been removed.
3. Fit the drive shaft with its gear in the bracket.
4. *Position the axial washer (6, fig. 106) on the journal.* Fit the key and press on the outer drive gear (3). NOTE! There should be a clearance of 0.02–0.08 mm (0.001–0.003") between the axial washer and the drive gear, use a feeler gauge of 0.05 mm (0.002") inserted in the gap when assembling. Fit the circlip (5).
5. Fit the idler gear (1) and the delivery pump housing.
6. Position the key for the scavenger pump gear (15) and press on the gear. NOTE! In order to obtain the correct clearance between the drive gear (15) and the delivery pump housing (12), 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. Secure the pump housings to the bracket. Check that the pump can be easily turned around by *hand.*
8. Fit the idler gear and tighten the bearing sleeve! Lock the bolts with the lock washer.



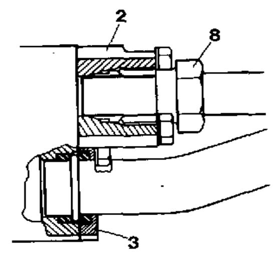


Fig. 107. Oil pipes, 120-series

1. Bracket
2. Adaptor
3. Flange
4. Delivery pipe
5. Screwed coupling
6. Bracket
7. Suction pipe
8. Fitting ring
9. Rubber clamp

Fitting the oil pump

1. Attach the pump to the main bearing cap. Lock the screws with the tab washers. Use a new splash protection plate on engines with shallow sump for large *inclinations.* Lock the bolts by bending over the corners of the plate.
2. Clean the bearing shells and journal. Oil in the bearing shells and fit the bearing cap. Tightening torque: 330 Nm (33 kpm = 243 lbf.ft.) for 100-series and 340 Nm (34 kpm = 251 lbf.ft.) for 120-series.
3. Connect the suction and delivery pipes to the pump and cylinder block. Fit new O-rings. The screwed coupling to the cylinder block (5, fig. 107) should be angle-tightened 60° (one hexagonal edge) when refitting. This also applies to pos. 8, fig. 107 for the 120-series, if this coupling has been removed. For fitting a new delivery pipe, see below.

Fitting a new oil delivery pipe

1. *100-series: Smear the sealing ring with grease and fit* the coupling flange and the sealing ring to the end of the pipe which is to be connected to the oil pump. NOTE! Press the sealing ring into the flange with a 20 mm socket, for example.

   120-series: Feed the fitting ring, together with the screwed coupling (8, fig. 107) and the adaptor onto the delivery pipe.
2. Put the clamp (9) onto the pipe. Dip the screwed *coupling (5) in oil and feed it onto the pipe.*
3. Push the pipe into the block until it bottoms and tighten the coupling by hand as far as it will go.
4. 100-series: Screw the flange to the oil pump.

   120-series: Screw the adaptor to the oil pump. Screw the coupling into the adaptor by hand as far as it will go. Tighten the coupling 270–300°, as shown in fig. 108.
5. Tighten the coupling to the block 120° as shown in fig. 108. Tighten the clamp.

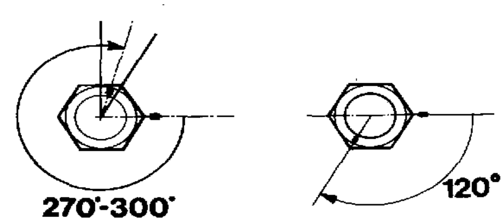


Fig. 108. Angle-tightening

Pressure testing the oil cooler

Industrial engines

For pressure-testing the oil cooler on marine engines, refer to page 71.

Special tools: 999 6033-8

NOTE! Follow valid safety regulations.

1. Disassemble the oil cooler from the engine.
2. Allow the O-rings to remain in place on the oil cooler flange.
3. Assemble the pressure-testing equipment 6033 as shown in fig. 109. Check that it is sealed properly against the O-rings.
4. Connect the oil cooler to a pressure testing device of a liquid type.
5. Set a pressure of 30 kPa (0.3 kp/cm^2 = 4.27 p.s.i.) and let the pressure remain for 1 min. No drop in pressure is allowable.
6. Increase the pressure to 500 kPa (5 kp/cm^2 = 71 p.s.i.) and let the pressure remain for 1 min. Replace the oil cooler if the pressure drops.

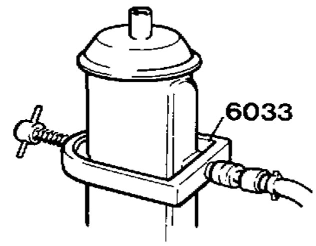


Fig. 109

Oil channels

In connection with major engine overhauls the oil passages in the cylinder block must be cleaned and flushed through with cleansing agent and then with steam or with flusing oil under pressure, 300–400 kPa (3–4 kp/cm^2 = 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

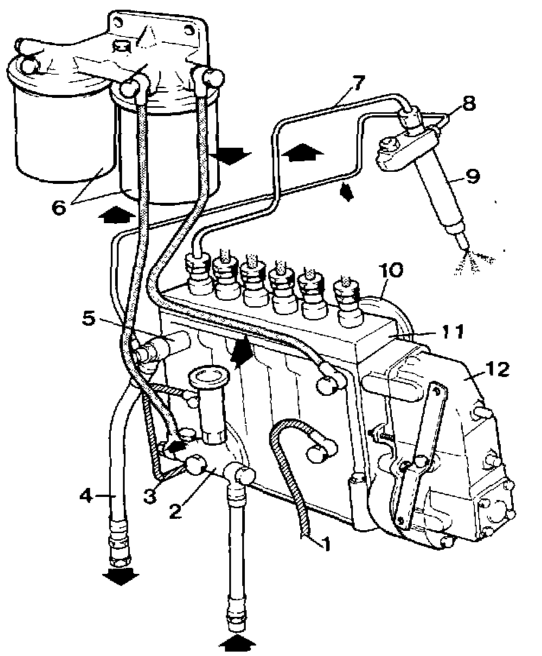


Fig. 110. Fuel system

1. Lubricating oil pipe, return to engine
2. Feed pump
3. Lubricating oil pipe from engine to injection pump
4. Return pipe to tank
5. Relief valve
6. Fuel filters
7. Delivery pipe
8. Leak-off fuel line
9. Injector
10. Pressure equalizer
11. Injection pump
12. Governor

General

Fuel is sucked from the fuel tank by the feed pump and pumped through the filters to the injection pump. The injection pump then forces the fuel oil to the injectors and the engine cylinders at very high pressure.

Return fuel from the relief valve and leak-off fuel from the injectors is taken back to the fuel tank.

Fuel filters

The fuel system is fitted with two "spin-on" fuel filters, connected in parallel by a common filter cover. The filter cartridges are disposable with helically – wound paper filter elements. Fig. 111 shows the direction of fuel flow through the filters.

Classified engines are fitted with a special filter model which makes it possible to replace the filter elements and carry out air-venting without having to stop the engine (fig. 131).

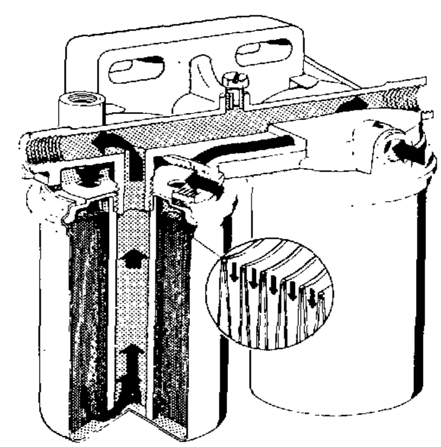


Fig. 111. Fuel filter of spin-on type

Feed pump

The feed pump is fitted on the injection pump and driven *directly by the injection pump camshaft*. Feed pump capacity is balanced so that the amount of fuel being fed considerably exceeds the requirements of the injection pump. Surplus fuel is taken through a relief valve and a return line to the tank. This provides continuous air-venting of the fuel system.

The feed pump is also fitted with a hand primer.

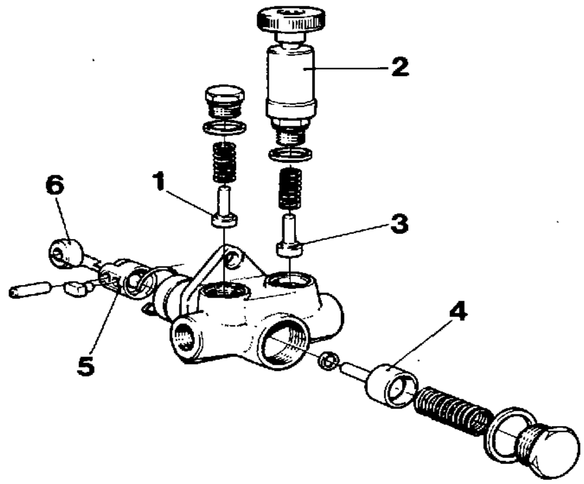


Fig. 112. Feed pump

1. Outlet valve
2. Hand primer
3. Inlet valve
4. Piston
5. Lifter
6. Roller

Injection pump

The injection pump is driven by a gear from the idler gear in the auxiliary drive. The pump is of the plunger type and operates with constant stroke. The injection pump is driven through a steel disc coupling.

A control rod can turn the pump plungers while they are operating and the amount of fuel injected by the pump can thereby be controlled.

The injection pump is lubricated by the engine lubricating oil system. The built-in cold starting unit automatically engages when the speed control is moved to the maximum position before the engine is started. The cold starting device cuts out when the engine has started.

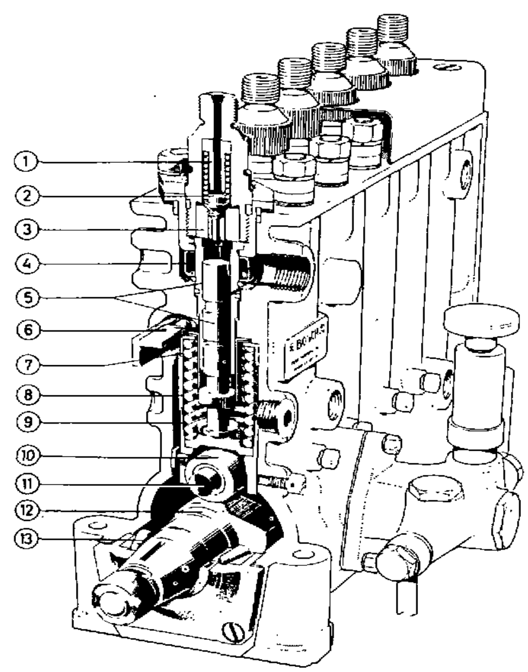
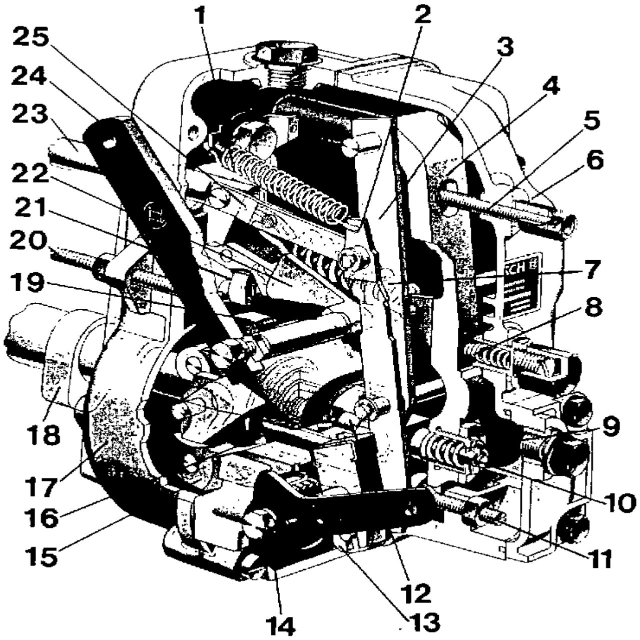


Fig. 113. Fuel injection pump

1. Filler plug
2. Delivery valve
3. Delivery valve seat
4. Damper
5. Pump element
6. Control rod
7. Upper spring disc
8. Slot for guide pin
9. Lower spring disc
10. Lifter
11. Lifter pin
12. Camshaft
13. Roller bearing

Fig. 114. Centrifugal governor, RSV

1. Starting spring
2. Fulcrum 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 centrifugal governor is fitted to the rear end of the injection pump and controls the set engine speed within the engine speed range by regulating the amount of fuel being injected into the engine.

Injectors

Each injector consists mainly of a nozzle and a nozzle holder. When the fuel pressure increases to its set value (opening pressure) the nozzle needle (7, fig. 115), which is held against its seat by the thrust spring (4), is lifted and finely atomized fuel is sprayed into the engine via accurately calibrated holes in the nozzle sleeve.

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

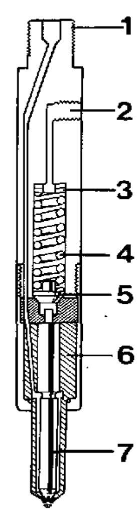


Fig. 115. Injector

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

REPAIR INSTRUCTIONS

Always exercise the greastest cleanliness when carrying out work on the fuel system and its equipment.

Injection pump

NOTE! Repair work which makes necessary operations on the inside of the injection pump and which can change its settings may only be carried out by specially trained mechanics who have at their disposal the necessary tools and test equipment.

Any warranty supplied concerning the engine becomes null and void if the seals are broken by unauthorized persons.

When a Wilbär pipe or similar device is being used to adjust the injection angle, check to ensure that the control rod is not in the cold starting position. If the cold starting device is engaged, the setting will be wrong by 10–12°.

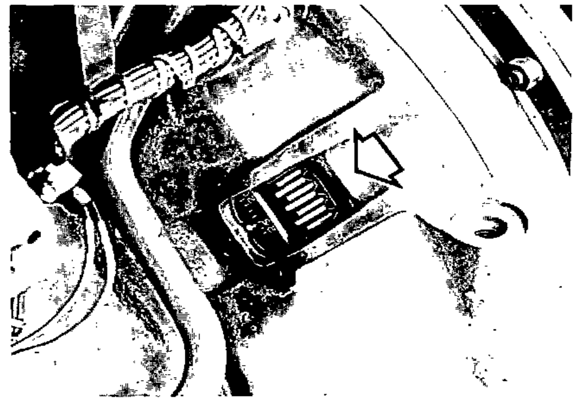


Fig. 117. Angle graduation markings on flywheel

Removing the injection pump

1. Thoroughly clean around the injection pump, the pipe connections and the engine nearest the pump. Remove the guard plate for the pump coupling.
2. Loosen the delivery pipes, fuel and lubricating oil lines at the pump as well as the control connections. Fit protective caps.
3. Loosen the bolts (2, fig. 116) in the pump coupling. NOTE! The nuts (1) must be held still to avoid damaging the steel discs. Undo the pump attaching bolts and lift out the pump.

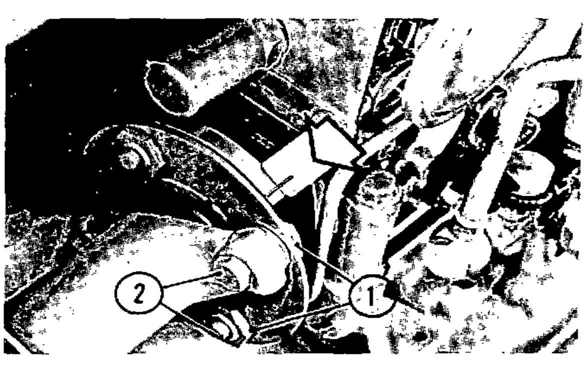


Fig. 116. Pump coupling

Fitting and setting

NOTE! Check that the pump and governor have been filled with about 1 litre of engine oil before fitting the injection pump. Filling is done through the governor housing.

1. Remove the front rocker arm casing and turn the engine over in its direction of rotation until both valves on cylinder no. 1 are closed (compression stroke).
2. Continue to turn the engine until the pointer on the flywheel casing indicates the correct setting angle (see "Technical Data") on the flywheel. Fit the rocker arm casing.
3. Turn the injection pump shaft in its correct direction of rotation until the marking on the pump coupling indexes with the marking on the plate as shown in fig. 116.
4. Fit the injection pump. Bolt the coupling together so that the markings correspond, see fig. 116. Secure by tightening the bolts (2) whilst holding the nuts still. NOTE! The 120-series does not have slots in the coupling. If the markings do not correspond, loosen the clamp screw at the front of the coupling (see fig. 121) and turn the coupling so that the markings come into alignment. Tighten the clamp screw securely.
5. Check the injection angle, see page 58.
6. Tighten the delivery pipes. Connect up the fuel and lubricating oil lines and controls.
7. Air-vent the fuel system and test-run the engine.

   NOTE! Check after starting the engine that the pump coupling is correctly fitted and free from warp. If it is warped, adjustment must be made so as to eliminate axial tensions.

Checking the injection angle

*Special tools: 999 6770-5, 998 9876-9**

1. Disconnect the fuel pipe between the fuel filters and the feed pump. On marine engines the relief valve must also be removed.
2. Loosen the front lubricating oil pipe from the injection pump and bend it out slightly.
3. Remove the socket-head plug and washer, so that the lifter for no. 1 cylinder is visible (fig. 118).

   * Dial indicator, measuring range 0.01–20 mm (0.0004–0.8").

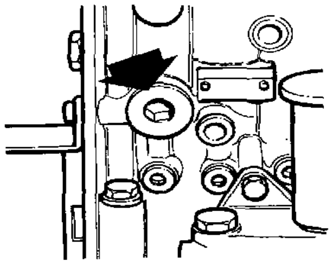


Fig. 118

4. Turn the engine to the compression position for no. 1 cylinder, *the 0° mark on the flywheel (valves on cylinder no. 6 "rock").*

   Turn the engine in the reverse direction about a 1/4 of a revolution.
5. Check that the lifter is in its lowest position.
6. *Fit the tool's screwed sleeve, "A", fig. 119, to the in*jection pump. **NOTE! Without washer.**
7. Raise the measuring pointer and fit the dial indicator together with the fixture to the screwed sleeve. Set the dial indicator to zero.

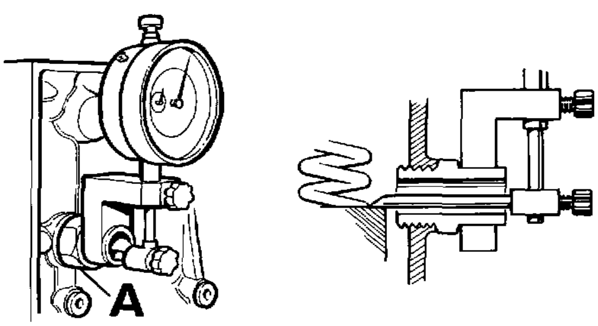


Fig. 119

8. Turn the flywheel in the direction of engine rotation, as the engine begins to turn, check that the zero setting is maintained.
9. Continue to rotate the flywheel in the direction of engine rotation until the given value for lift from the base *diameter (see "Technical Data") is shown on the dial* indicator. Read off the graduation angle on the flywheel and check it against the value in "Technical Data".
10. Adjust the setting angle if necessary. On the 100-series the pump shaft can be rotated after loosening the pump coupling bolts. NOTE! The nuts must be kept still to avoid damaging the steel discs. On 120-series loosen the clamp screw, see fig. 121.

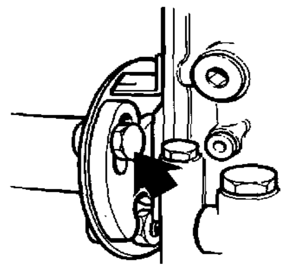


Fig. 120. Pump coupling, 100-series

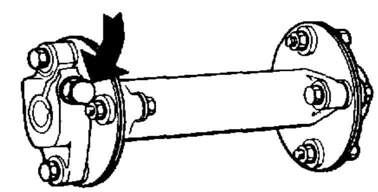


Fig. 121. Pump coupling, 120-series

11. After adjusting, repeat points 4–11.
12. Remove the fixture and the screwed sleeve. Fit the socket-head plug together with the copper washer.
13. Connect the fuel and lubricating oil pipes. Air-vent the fuel system.

Injection pump drive

Removal

1. Remove the auxiliary drive gear cover, pump coupling and injection pump drive.
2. Remove any rev. counter, if fitted on the drive unit. Remove the attaching screws and lift out the drive unit.

Disassembling

1. Remove the key (11, fig. 122), if fitted.
2. Remove the attaching bolts (2) and the washer (39).
3. Press the shaft with bearings, spacer sleeves and revolution counter (tachometer) drive out of the housing. If the bearing (9) does not come out straight away, then disassembly is carried out in two stages. Remove the bearings and the revolution counter (tachometer) drive from the shaft.
4. Remove the shaft seal (10) from the housing.

Assembling

Special tools: 999 2267-6, 999 6778-8

1. Fit the rear bearing (9) in the housing by using tool 2267.
2. Press the front bearing (5) onto the shaft. Fit the spacer sleeve (6) and then press on the revolution counter (tachometer) drive (7). Fit the spacer sleeve (8) on the shaft.
3. Press the whole assembly into the housing after a counterhold has been applied against the inner race of the rear bearing (9). Exert pressure until the various parts of the drive bottom against each other.
4. Fit the washer (3) and tighten the attaching bolts (2). Secure them with the tab washers.
5. Press the seal ring (10) into the housing using tool 6778. Fit the key (11) on 100-series.

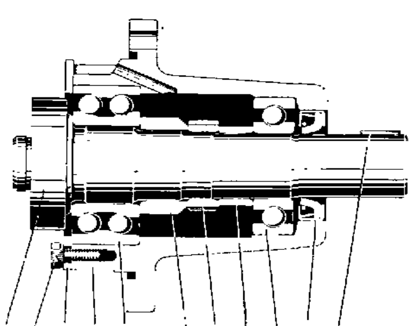


Fig. 122. Injection pump drive

1. Shaft
2. Attaching bolt
3. Lock washer
4. Housing
5. Front bearing
6. Spacer sleeve
7. Drive for revolution counter or hours run meter
8. Spacer sleeve
9. Rear bearing
10. Seal
11. Key (not fitted on 100-series)

Replacing the injection pump drive sealing ring

Special tools: 999 6778-8, 999 6779-6

1. Remove the pump coupling shield plate. Remove the intermediate shaft bolts (4x), (1, fig. 123). Note! Do not remove the bolts which hold the drive flange discs on the drive flanges since this can alter the injection pump setting. Do not turn the injection pump or the engine.
2. Loosen the clamp screw (2) and remove the drive flange and key, if fitted, from the drive shaft.

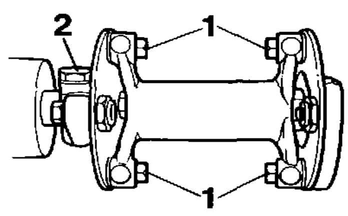


Fig. 123.

3. Screw the puller 6779 into the seal. Push in the puller at the same time so that the threads cut into the seal's steel ring. Pull out the seal by screwing in the screw.

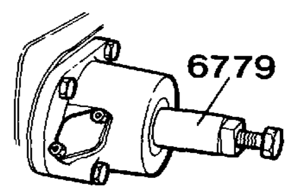


Fig. 124.

4. Oil-in the new sealing ring and the drive shaft. Place the sealing ring onto the drive shaft.

   Push in the seal, using tool 6778, until it is flush with the housing.

   On the 100-series, place an 11/16" socket on the injection pump drive flange as a counterhold (fig. 125). On the 120-series use an 11/16" socket with a short extension as a counterhold.

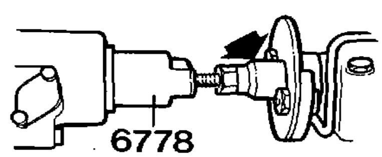


Fig. 125.

5. Fit the key (100-series) and the drive flange. Tighten the clamp screw.
6. Fit the intermediate shaft. NOTE! Tighten by means of the bolts, the nuts must be held still.
7. Tighten the clamp screw to 50 Nm (5 kpm = 37 lbf.ft.).

Setting the engine speed

Check that the speed control functions normally, i.e. that *the injection pump speed control lever comes against the* idling stop when the speed controls are moved to the idle position and that it presses against the max stop when the controls are moved to max position. Adjust the controls if required. Check also that the air cleaner is not blocked. For speed refer to "Data and settings" in SB binder.

Idling speed

1. Run the engine warm.
2. Run the engine at idling and check the speed.
3. Adjust the speed if necessary by screwing the stop screw 3, fig. 126 in or out.

Maximum unloaded speed

The stop for maximum 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 (tachometer). Adjust the stop 1, to obtain the correct engine speed. Re-seal the screw.

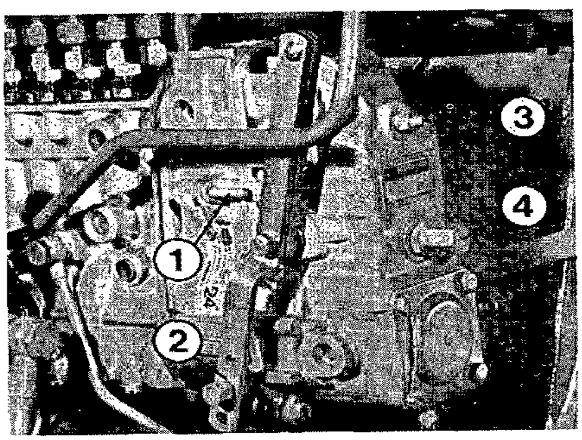


Fig. 126. Setting the speed
1. Adjuster screw for max. speed (sealed)
2. Speed control lever
3. Adjuster screw for low idle
4. Dome nut (stabilizing idling)

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.

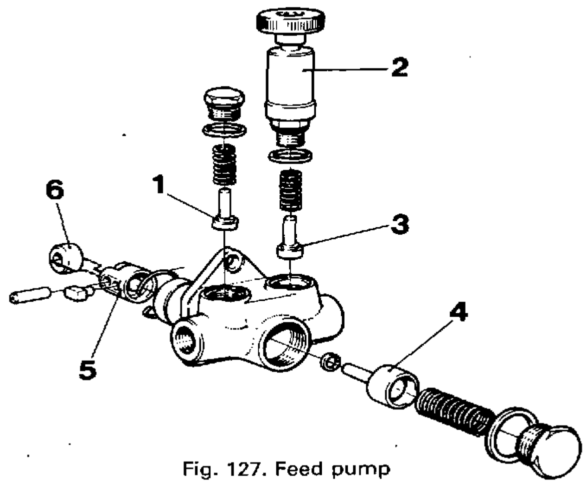


Fig. 127. Feed pump
1. Outlet valve
2. Hand primer
3. Inlet valve
4. Plunger
5. Lifter
6. Roller

Disassembling the feed pump

1. Attach the pump to a frame, and secure in a vice.
2. Unscrew the valve plugs.
3. Lift out the valves and springs.
4. Remove the pump plunger plug. Remove the spring, plunger and plunger rod.
5. Press in the lifter and hold it in place with a small screwdriver or similar. Push out the stop pin and remove the lifter and the spring.
6. Wash all components in clean diesel oil.

Inspecting the feed pump

Examine the feed pump valve seats. Damage to the sealing surface can usually be remedied by using a grinding tool and grinding compound. Examine the valve sealing surface and replace valves which are damaged.

Check the plunger seal in the cylinder and the plunger spring tension.

Examine the remaining components and replace those which are damaged or worn.

Assembling the feed pump

Exercise the greatest possible degree of cleanliness and wash the parts in clean diesel oil before assembling. Fit protective caps to the connections if the pump is not to be used immediately.

Checking fuel feed pressure

Special tools: 999 6065-0, 999 6066-8

1. Connect the banjo nipple 6066 to the existing outlet on the outlet side of the fuel filter, see the arrow on the filter cover. (The pressure being measured after the fuel has passed through the fuel filters.)
2. Run the engine at increased engine speed and then reduce to idling speed and read the pressure within one minute.

   Feed pressure must not be less than 100 kPa (1.0 kp/cm^2 = 14 p.s.i.).

Low feed pressure may de bue to clogged filters, faulty relief valve or defective feed pump.

The relief valve must not be adjusted but should be replaced if it is faulty.

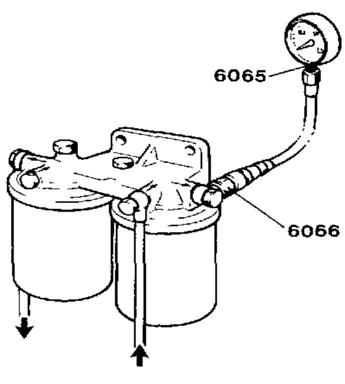


Fig. 128. Checking feed pressure

Replacing fuel filters

Special tool: 999 9179-6

1. Wash the filter cover thoroughly, unscrew and discard the old fuel filters.
2. Check that the new filters are absolutely clean and that the gaskets are in good condition.
3. Screw on the new filters by hand until the gaskets make contact with the cover. Then tighten the filters a further 1/2 turn by hand.
4. Air-vent the fuel system. Pump up feed pressure and check for leakage.

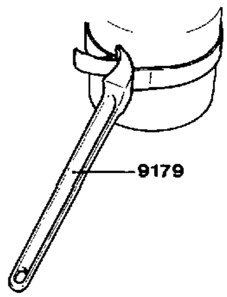


Fig. 129. Tool for removing filter

Air venting the fuel system

1. Open the venting screw (1). Pump out about half a litre (one pint) of fuel using the hand primer pump (2) until fuel free from air bubbles flows out. Tighten the screw. (The handle on the pump is loosened by screwing it anti-clockwise).
2. Close the venting screw and loosen the pressure equalizer (3) on the injection pump.

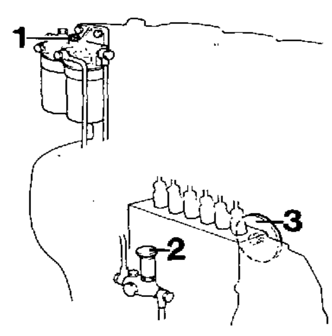


Fig. 130. Venting the fuel system

3. Continue pumping fuel until the air bubbles at the pressure equalizer connection disappear.
4. Tighten the pressure equalizer. Continue pumping to obtain sufficient feed pressure. Start the engine. If the engine does not start after a couple of attempts, slacken the delivery pipes at the injectors (only a few turns) and run with the starter motor until fuel is forced forward. Screw tight the delivery pipes.

Replacing filter elements, switch-over type filters

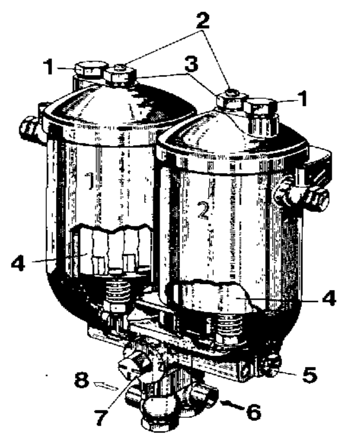


Fig. 131. Switch-over fuel filters

1.	Filler plug	5.	Draining plug
2.	Air-venting screw	6.	Fuel inlet
3.	Tightening nut	7.	Three-way cock
4.	Filter element	8.	Fuel outlet

1. Turn the three-way cock (7, fig. 131) to position "C" (fig. 132).
2. Open the air-venting screw (2) for filter housing no. 1. Unscrew the draining plug (5) on the same housing and drain off the fuel into a vessel.
3. Unscrew the tightening nut (3), lift off the cover and then lift out the filter element.
4. Rinse out the housing with clean diesel fuel. Tighten the draining plug and then fit a new filter element in the housing.
5. Fit a new gasket and tighten the cover. Loosen the filler plug (1) and fill the housing with diesel fuel. Tighten the plug.
6. Turn the three-way cock to position "A", fig. 132 and allow the engine to run for a few minutes to air-vent the housing.
7. Turn the cock to position "B" and replace the filter element in housing no. 2 in the same way.

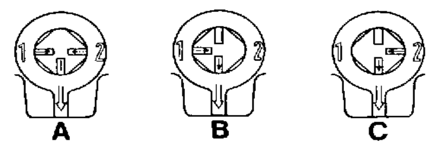


Fig. 132. Positions for three-way cock, switch-over fuel filters

Position A Both filters being used	Position B Filter housing no. 2 can be cleaned	Position C Filter housing no. 1 can be cleaned

Injectors

Replacing the injectors

Special tools: 999 6643-4

1. Wash clean around the injector.
2. Remove the leak-off fuel pipe and the delivery pipe. Remove the yoke which secures the injector.
3. Turn the injector using a wrench (PU-15) and pull upwards at the same time. If the injector will not loosen, use the puller 6643. Note! If the injector sits fast and requires the use of the puller tool, drain off some of the coolant to avoid water entering the engine if the copper sleeve should loosen during removal of the injector.

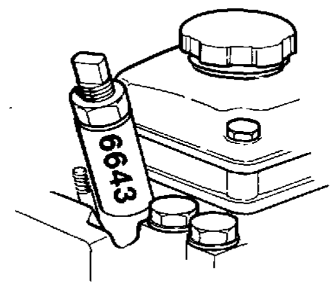


Fig. 133. Tool for removing the injector.

4. Clean the surface of the copper sleeve which mates with the injector.
5. Fit the new injector together with the protective ring. Tightening torque 50 Nm (5 kpm = 37 lbf.ft.).
6. Connect the delivery pipe. Tightening torque 15–25 Nm (1.5–2.5 kpm = 11–18 lbf.ft.). Fit the leak-off fuel pipe.
7. Fill the engine with coolant if it has been drained. Start the engine and check that there are no leakages.

Reconditioning the injectors

1. *Clean the injector externally.*
2. Disassemble the injectors. Pull each nozzle needle out of the nozzle sleeve and immerse the parts in resin solvent. Since the nozzle needles and nozzle sleeves are matched to each other in pairs, it is important not *to mix them up if they are all cleaned at the same time.* For this reason, the nozzles should be placed in a nozzle rack or in separate compartments.

   When cleaning the nozzles, a suitable nozzle tool must be available, for example. Bosch KDEP 2900. Suitable *cleaning fluids are benzine, diesel oil or white spirit.*

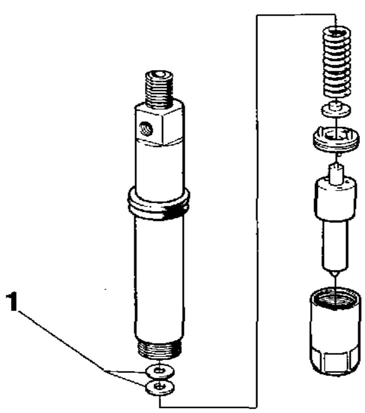


Fig. 134. Injector
1. Adjustment shim

3. Inspect the nozzle carefully. Examine by using a magnifying lamp (Bosch EFA W 25B, for example) or a nozzle microscope. The nozzle microscope can also be used to examine the nozzle sleeve. If the seat shows signs of impact wear then both the nozzle needle and the nozzle sleeve must be replaced. If, however, the wear is only slight, this may be remedied by lapping in a lapping machine or a nozzle grinding machine (Bosch EFEP 164, for example).
4. Check the other components.
5. Dip the nozzle components in clean diesel oil or testing oil and fit the injectors. NOTE! New injectors are treated with conserverving oil and must, therefore, be cleaned as follows: Pull the nozzle needle out of the sleeve (avoid skin contact with the needle sliding surface) and dip the parts in clean benzine. Shake the parts and then dip them in diesel oil. Put the nozzle *needle back into its sleeve and check that it slides freely* without binding. Use the original adjustment shim(s) thickness for setting the opening pressure.

Testing

Carry out testing in a nozzle tester. The most important tests are the opening/setting pressure and leakage-test. The spray pattern and chatter-test are more difficult to judge and do not provide positive indication as regards the condition of the nozzle.

Warning!

When testing, take care that no unprotected parts of the body come into contact with the fuel spray from a nozzle. The spray 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 a pressure for new or reconditioned injectors with new thrust springs ("Setting pressure"). The second named value is somewhat higher since it is necessary to allow for fatigue of the spring.

With the pressure gauge connected, press the nozzle-tester arm slowly downwards until the nozzle opens and releases oil. Read off the pressure at the moment when oil is released. If this reading does not agree with the specified value then the setting must be adjusted. This is carried out *by using adjustment shims (1, fig. 134).*

Leakage-test

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 the point of the needle so that it is dry. With the pressure gauge connected, pump up the pressure to about 2 MPa (20 kp/cm^2 = 284 p.s.i.) below the injector opening pressure. Maintain this pressure for 10 seconds. No fuel drops must leave the point of the nozzle needle during this period of time. Dampness on the point of the needle can be accepted.

Spray pattern and chatter-test

See nozzle manufacturer's instructions.

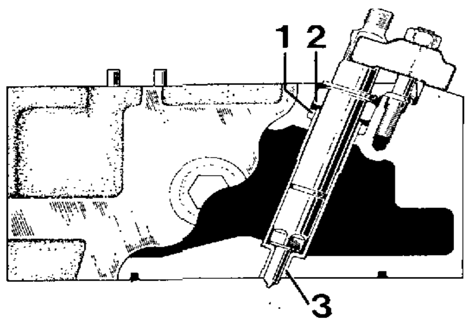


Fig. 135. Injector

1. O-ring
2. Steel ring
3. Copper sleeve

Replacing injector copper sleeve

(cylinder head fitted)

Special tools: 999 6372-0, 999 6419-9, 999 6643-4, 999 6647-5, 999 6657-4

1. Drain off the coolant (fresh-water system for marine engines).
2. Remove the injector, see page 62.
3. Pull out the steel ring using the puller 6419.

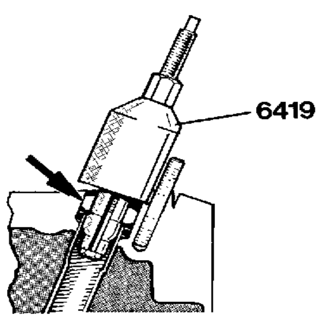


Fig. 136. Removing the steel ring

4. Pull out the copper sleeve using the puller 6657. If the copper sleeve extension in the cylinder has broken off use puller 6372. The O-ring in the upper section of the cylinder head comes out with the copper sleeve.

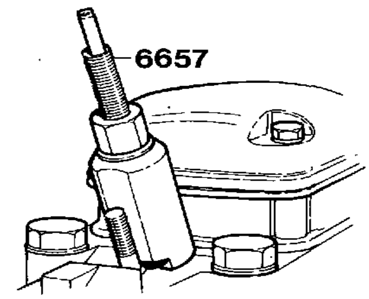


Fig. 137. Removing the copper sleeve

5. Clean the sealing surface between the cylinder head and the copper sleeve.
6. Turn the engine until the piston, in the cylinder where replacement of the copper sleeve is being carried out, is at bottom dead centre.
7. Unscrew the "flaring" pin from the tool 6647. Screw out the nut on the tool stem.
8. Place the new copper sleeve on the tool. Screw in the flaring pin.

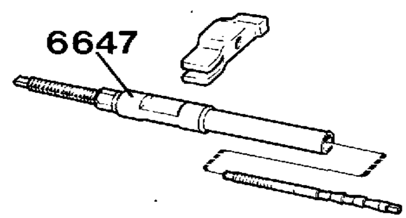


Fig. 138. Flaring tool

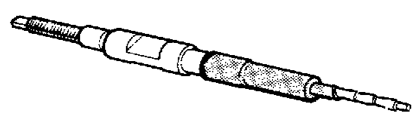


Fig. 139.

9. Oil-in a new O-ring and place it in the cylinder head.
10. Push the sleeve and the tool into the cylinder head. Check that the sleeve index mark (cut-out) is pointing upwards.

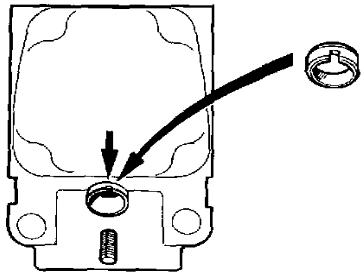


Fig. 140. Index mark

11. Pull down the flaring tool by tightening the injector attaching nut, until the copper sleeve bottoms in the cylinder head.
12. Secure the tool stem and screw down the large nut, thus pressing the 'flaring" pin through the lower end of the copper sleeve (fig. 141).

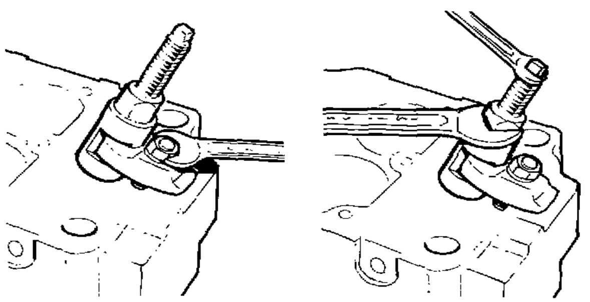


Fig. 141. Flaring the copper sleeve

13. Screw down the nut until the tool stem is released from the sleeve. Pull out the stem and dismantle the rest of the tool from the cylinder head.
14. Feed the steel ring onto the tool 6647 (without the stem and flaring pin) and tap the ring carefully down into the cylinder head. NOTE! The distance between the steel ring and the copper sleeve should be 0.5 mm (0.02") (fig. 142). Check the gap with a angled feeler gauge.
15. Fit the injector (tightening torque 50 Nm (5 kpm = 37 lbf.ft.). Connect the fuel pipe.
16. Fill with coolant.

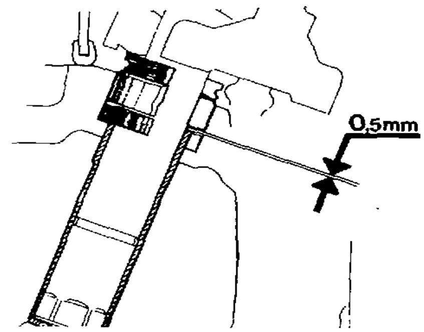


Fig. 142.

DESCRIPTION

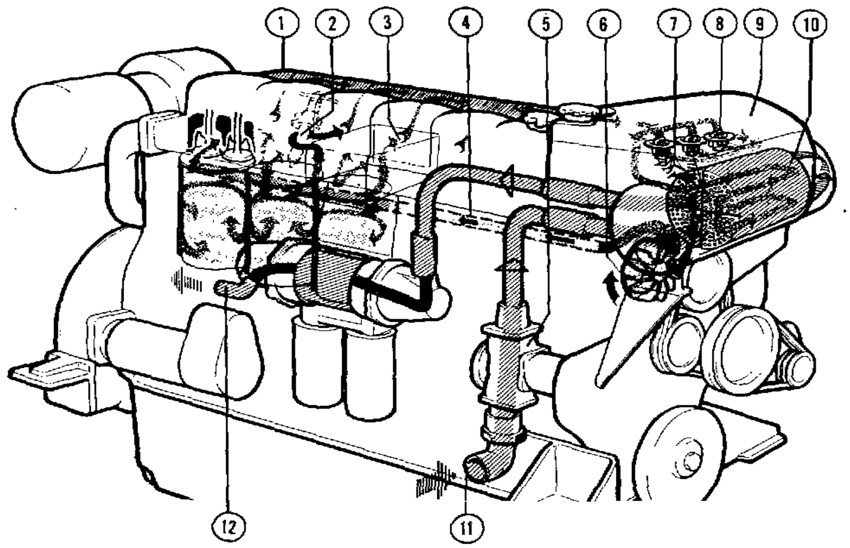
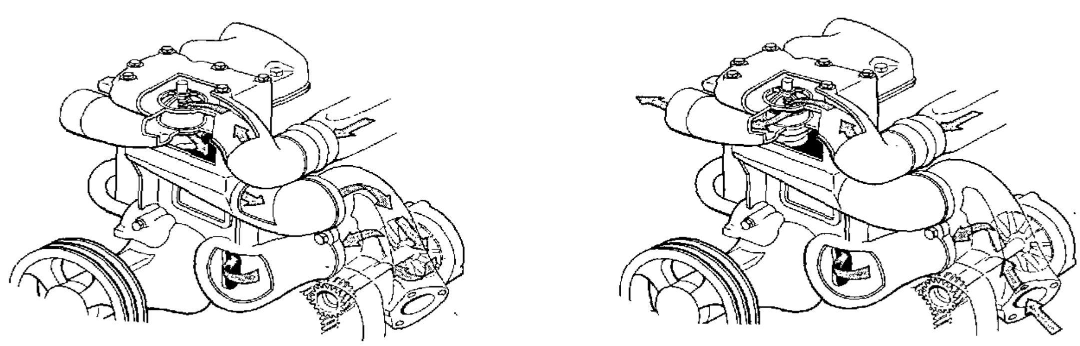


Fig. 143. Cooling system, TMD121

1. Fresh-water cooled exhaust manifold
2. Injector with copper sleeve
3. Coolant return holes (calibrated)
4. Distribution channel
5. Sea-water pump
6. Fresh-water pump
7. By-pass lines
8. Thermostats
9. Expansion tank
10. Heat exchanger
11. Inlet, sea-water
12. Outlet, sea-water



Cold engine | Hot engine

Fig. 144. Coolant pump and thermostat housing, industrial engines in the 120-series.

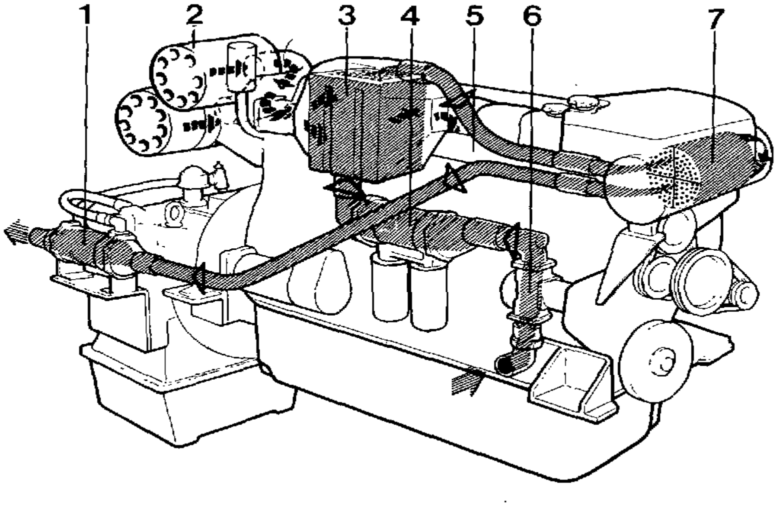


Fig. 145. Sea-water system, TAMD121

= Sea water = Air

1. Oil cooler, reverse gear
2. Air cleaner
3. After-cooler
4. Oil cooler, engine
5. Intake manifold
6. Sea-water pump
7. Heat exchanger insert

General

The engines are fitted with a sealed cooling system of the pressure type. The marine engines are also fitted with a separate sea-water system (fig. 143 and fig. 145). As long as the coolant is cold, the thermostats remain closed and block the flow to the radiator or heat exchanger. Instead the coolant passes through by-pass lines under the thermostats directly back to the suction side of the pump. This means that the engine rapidly attains its operating temperature at the ame time as engine temperature is prevented from becoming too low in cold weather. Coolant circulates throughout the engine with the aid of a centrifugal circulation pump.

The sea-water system in the marine engines includes an impeller pump which circulates sea water through the system.

Coolant

The fresh-water system should contain at least 40 % approved ethylene glycol all the year round to avoid frost and corrosion damage, see "Glycol" below. Before winter the coolant freezing point should be checked and more ethylene glycol added, if necessary.

Glycol

We recommend the use of **Volvo Original ethylene glycol,*** which has exactly the right amount of additives to neutralise the corrosive compounds in the cooling water. If this red glycol is used it should be replaced once a year, preferably in the autumn.

* Part no. 1129616, 1 kg, about 0.9 litres (= qts.)
Part no. 1129617, 5 kg, about 4.5 litres (= qts.)

Anti-freeze additive performs two functions, one is to protect the cooling system against damage due to freezing, the other is to prevent corrosion. A coolant mixture containing at least 40 % glycol should therefore always be used. This means that the same mixture must also be used when topping-up, if this is found to be necessary. This mixture gives frost protection down to about –25°C (–13°F). For lower temperatures a greater percentage of glycol additive is required.

The maximum reduction in the freezing point is to –56°C (–69°F) (60 % glycol). **Any increase of the glycol content above this reduces frost protection.**

Flush the cooling system clean before filling with anti-freeze mixture. Check hoses and connections and remedy any leakages.

Mix the glycol with water in a separate vessel before filling the system.

NOTE! Glycol is aggressive (dangerous to inhale).

Anti-corrosive additive

The most convenient method of avoiding corrosion is to use a suitable mixture of Volvo original glycol all the year round (minimum 40 %). Replacement should be made every autumn.

If glycol is not used, an anti-corrosive medium should be added to the cooling water. Use Volvo's anti-corrosive additive (part no. 1129709-0) which is available in 1/2 litre packages.

Clean the cooling system thoroughly before filling. Run the engine warm immediately after filling in order that the additive shall have the best possible effect.

To maintain corrosion protection, a further 1/2 litre of anti-corrosive medium should be **added after every 400 hours of running.**

NOTE! Glycol or anti-freeze of any other type must absolutely never be mixed with this anti-corrosive medium. The anti-corrosive additive does not give any protection against freezing, and therefore, it may only be used where the temperature is permanently above 0°C (32°F).

REPAIR INSTRUCTIONS

NOTE! Close the bottom valve and drain off the coolant before doing any work on the cooling system on marine engines.

Refer to the relevant instruction book for draining and topping up with coolant.

Replacing the coolant

The whole cooling system should be flushed clean with water prior to replacing the coolant. Also check all hoses and connections and cure any leaks. Replace all cracked or otherwise damaged hoses.

Top-up while the engine is stopped. The engine must not be started until after air-venting has been carried out and the system completely filled.

Coolant temperature too high

Too high a coolant temperature can be caused by:

- Low coolant level
- 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 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 immerse in hot water. Use a thermometer to read the temperature. Compare with the temperature gauge reading.

Checking the radiator (industrial engines)

Check that the radiator pipe system is not blocked externally by insects etc. which can restrict the flow of air. Rinse clean with water if necessary.

Straighten out any bent fins on the pipe system. This also applies to the inter-cooler on TID120HPP, TID121FG.

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 filler cap 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.

Cleaning the cooling system

It is convenient to carry out cleaning in connection with coolant replacement. It is generally sufficient to flush through with water but, if necessary, cleansing agent can be used, as follows:

1. Empty the system and flush through with water. Dissolve 1 kg (2.2 lb.) of oxalic acid[1] in 5 litres (= quarts) of hot water and pour into the cooling system. Then top up with clean water. Run the engine at normal operating temperature for at least 2 hours (max. 12 hrs).

   Warning! Be careful with your hands and face. The oxalic-acid solution is poisonous as well as being harmful to the skin.

2. Empty the cooling system and immediately flush it very thoroughly with clean water. The thermostat housing (thermostats), the lower and upper radiator hoses, drain cocks and plugs should be removed in order to provide the highest possible draining speed. Do not forget the engine heater or heater element, if fitted. Continue flushing with water until the water flowing out is clean.

[1] Chemical formula for oxalic acid: $C_2H_2O_4 + 2H_2O$

3. Mix 200 grams (7 ozs.) bicarbonate[2] in 5 litres (= quarts) of water and pour this into the cooling system. (NOTE! On no account use caustic soda.) Top up with pure water. Run the engine at normal operating temperature for about 15 minutes. This point must be carried out thoroughly in order to neutralize the oxalic acid.
4. Thoroughly flush the cooling system clean according to point 2. In order to increase the effect of the cleaning, water plus air can be used, in which case flushing must take place from the bottom upwards.

   Check in conjunction with cleaning that all hoses are in good condition and replace those that are not.
5. Fill the system with a coolant recommended by Volvo Penta.

[2] Chemical formula for sodium hydro carbonate, $NaHCO_3$.

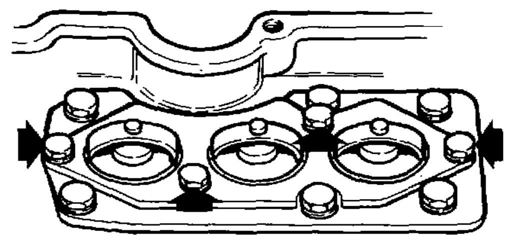


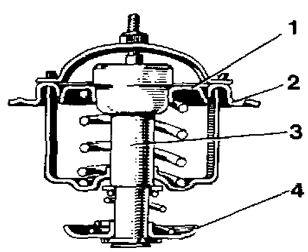
Fig. 148. Screws for thermostat holder, marine engines

THERMOSTATS

The thermostat sensor body contains wax. When heated the volume of the wax increases causing the thermostat valve to open and allow coolant to circulate through the radiator, whilst at the same time closing the engine re-circulation passage.

Fig. 146. Thermostat

1. Thermostat valve
2. Holder
3. Sensor body
4. By-pass valve



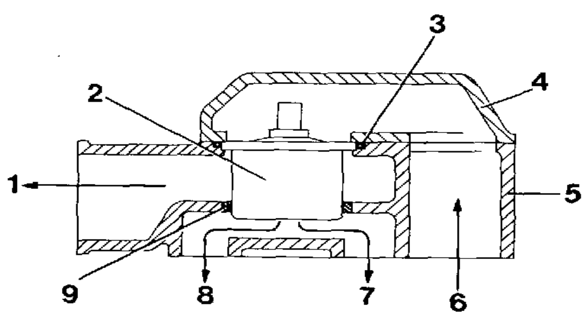


Fig. 147. Piston thermostat

1. To radiator
2. Thermostat
3. O-ring
4. Upper section
5. Intermediate section
6. From engine
7. By-pass
8. By-pass
9. Sealing ring

Removing the thermostats

1. Drain off some of the coolant.
2. **Industrial engines**: Remove the thermostat housing cover and lift out the thermostats (the 120-series and TID100K have only one thermostat).

   Marine engines: Remove the heat exchanger cover, unscrew the thermostat holder and lift out the thermostats.
3. Check the function of the thermostats in heated water. The thermostats must open at the temperatures shown in the "Technical Data". Also check that no impurities have become trapped between the thermostat valves and seats. Note! If a thermostat does not close completely, the engine runs at a temperature that is too low.

Replacing sealing ring for piston thermostat

Special tool: 999 6781-2

1. Knock out the old sealing ring using a drift.
2. Place the new ring on the drift 6781 and carefully tap down until the drift bottoms in the housing.

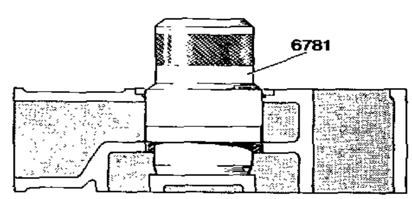


Fig. 149. Fitting the sealing ring.

Checking for leakage

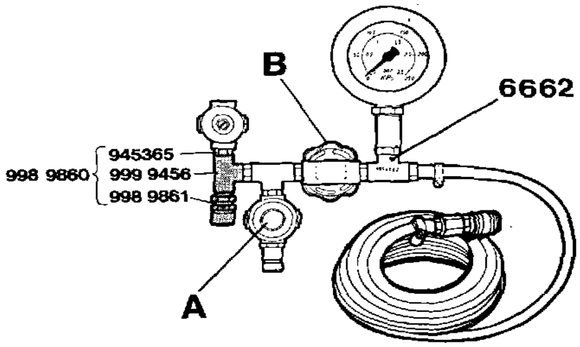


Fig. 150. Pressure-testing device

Special tools: 999 6662-4, 9989860-3* together with compressed air and 6433. Alternatively a standard type of pressure-testing device can be used.

* See notes under heading "Pressure-testing the cylinder head" on page 23.

Before using, check the pressure-testing device 6662 in accordance with the instructions on page 23. Concerning the pressure-testing of separate heat exchanger, after-cooler, oil cooler and cylinder block with cylinder head, see pages 71, 72 and 30.

1. Check that the reducing valve wheel (A, fig. 150) is unscrewed and connect the hose from the pressure-testing device to the adapter, 6433.
2. Remove the cover on the expansion tank (radiator cap on TD100G-series). Fit the adapter, 6433.
3. Seal the drain hose from the filler pipe.
4. Connect the pressure-testing device 6662 to the compressed air supply and open the cock (B).
5. Pull out the reducing valve wheel locking ring. Increase the pressure by screwing in the wheel until the gauge shows 70 kPa (0.7 kp/cm^2 = 10 p.s.i.). Lock the wheel by pushing in the locking ring and close the cock (B).
6. Check that the pressure has not fallen after one minute. If difficulty is experienced in locating the source of any leakage – drain the coolant and re-pressurize while brushing the hose connections, drain plugs etc. with soapy water until the leak is traced.

   Note! Make sure that the pressure never exceeds 70 kPa (0.7 kp/cm^2 = 10 p.s.i.). Higher pressure can, for example, damage the circulation pump seal.

   NOTE! Follow valid safety regulations.
7. Remove the test-equipment.

Checking the pressure cap valve

The pressure valve is located in the filler cap. The same pressure-testing equipment is used as for the leakage check in the previous paragraphs.

1. Drain off some of the coolant and connect the pressure-testing device with a union nipple to one of the cooling system's plugged holes.
2. Extend the drain hose from the filler pipe with a hose which feeds into a vessel containing water.
3. Pressurize the system, see "Checking for leakage", in the previous paragraphs and note the gauge reading when the valve opens (the water begins to "bubble" in the vessel into which the drain hose extension, feeds).

   The valve should open at 23–32 kPa (0.23–0.32 kp/cm^2 = 3.27–4.55 p.s.i.).
4. Remove the test equipment. Re-fit the plug and fill the engine with coolant.

Pressure-testing the inter-cooler TID120, TID121

Special tools: 999 6652-5, 999 6653-3, 999 6662-4, 999 9989860-3*

* See notes under heading "Pressure-testing the cylinder head" on page 23.

Before using, check the pressure-testing device 6662 in accordance with the instructions on page 23.

1. Remove the charge air pipe from the turbo and fit the connecting washer, 6652.
2. Secure where the pipes join with steel wire so that they do not come apart during pressure-testing.

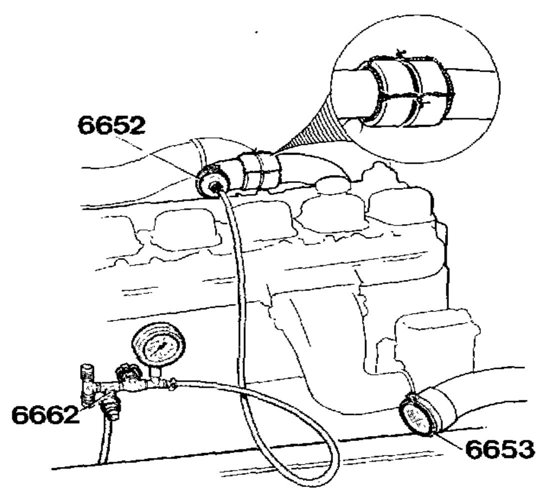


Fig. 151. Pressure-testing the inter-cooler.

3. Unscrew the hose from the inlet pipe and fit the sealing washer 6653 to the hose.
4. Connect the pressure-testing device 6662 to the compressed air supply and screw out the reducing valve in order to make sure that the pressure is not set too high.
5. Connect 6662 to the connecting washer 6652. Open the shut-off valve and set the gauge to 70 kPa (0.7 kp/cm^2 = 10 p.s.i.) with the reducing valve.
6. Close the shut-off valve. The pressure must not fall by more than 20 kPa (0.2 kp/cm^2 = 2.8 p.s.i.) during a period of one minute, if the charge-air system is to be approved.
7. If leakage is discovered, repeat the test a few times and localize the source of the leakage with the help of soapy water. Check the testing device's hoses and connections.
8. Disconnect the testing equipment and the steel wire and connect the pipes and hoses.

Cleaning the engine oil-cooler

Standard version industrial engine oil coolers cannot be dismantled and can thus only be flushed through. In the case of industrial engines with the oil cooler placed in front of the auxiliary drive gears, at the bottom, cleaning can be done in the same way as on marine engines.

Marine engines

1. Remove both ends and take out the insert (see fig. 152).
2. Wash the insert in petrol (gasoline) and blow dry with compressed air. Use a suitable brush for washing.
3. Use new seals when fitting. When pressure-testing a separate detached oil cooler, use white spirit at a pressure of 800 kPa (8 kp/cm^2 = 100 p.s.i.). **Note! Follow valid safety regulations.**

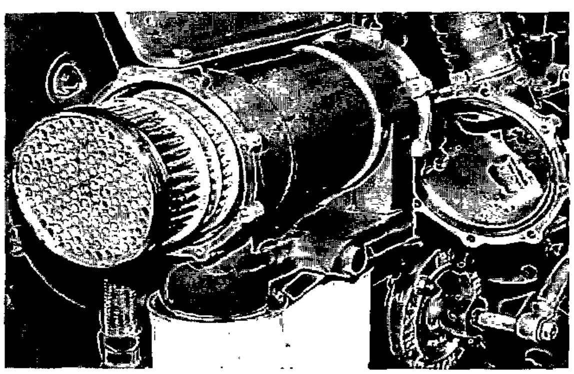


Fig. 152. Oil cooler, marine engines

Cleaning the reverse gear oil cooler

Use the same method as that used for the engine oil cooler. When pressure-testing a separate detached reverse gear oil cooler, use white spirit at a pressure of 3000 kPa (30 kp/cm^2 = 425 p.s.i.).

Note! Follow valid safety regulations.

Cleaning the heat exchanger insert (marine engines)

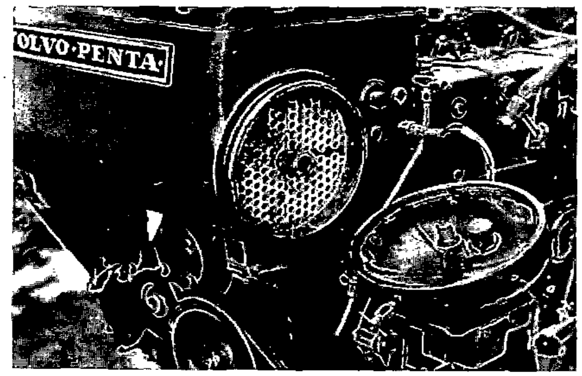


Fig. 153. Heat exchanger, marine engines

1. Remove the coolant pipes from the heat exchanger end cover, right-hand side.
2. Loosen the attaching screws on both end covers and remove the covers. On T(A)MD121 engines, the covers are attached by means of four screws and, on the right-hand side, also by a centre bolt. On TMD100 engines, the covers are retained by means of centre bolts.
3. Pull out the insert and clean it outside and in using suitable brushes. Also clean the accessible surfaces in the heat exchanger housing. Rinse off the parts.
4. When fitting, make sure that the holes in the insert casing are aligned with the holes in the housing. Replace all seal rings and smear a little grease on them before fitting.
5. When pressure-testing a separate detached heat exchanger, use water at a pressure of 200 kPa (2 kp/cm^2 = 28 p.s.i.).

Note! Follow valid safety regulations.

Cleaning the after-cooler, TAMD121

NOTE! If considerable amounts of water run out through the draining hole in the bottom of the housing, then the insert must be removed and pressure-tested with water at a pressure of 200 kPa (2 kp/cm^2 = 28 p.s.i.). The housing is pressure-tested with air at a pressure of 100 kPa (1 kp/cm^2 = 14 p.s.i.). **Note! follow valid safety regulations.**

1. Disconnect the upper coolant hose (1) from the heat exchanger.

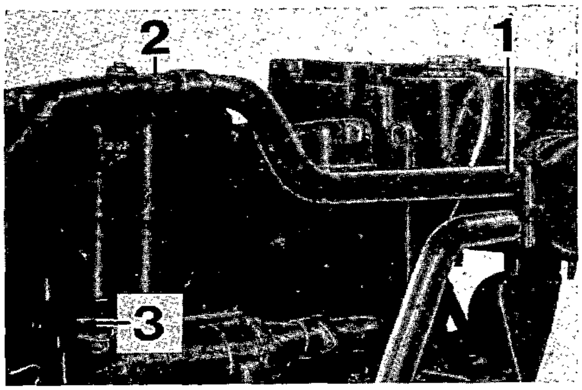


Fig. 154. Cleaning the after-cooler, TAMD121

2. Unscrew the cover (2). Remove the cover and the coolant pipe.
3. Remove the two screws securing the flange (3). The flange seals against the insert by means of the two O-rings.
4. Carefully prize up the insert with the help of two screwdrivers.
5. Flush and clean the insert outside and in. Clean the housing as well, if necessary. The housing is made of light alloy and no material likely to damage it must be used for cleaning purposes. NOTE! Ensure that no dirt gets into the engine via the intake manifold.

   Check that the drain hole in the bottom of the housing is open or clean it. Replace the gaskets and O-rings, if necessary. Fit the components.

Checking the zinc electrodes (marine engines)

Close the bottom valve and drain off some of the coolant. Remove 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 obtained between the electrodes and the engine material.

If an electrode is not consumed at all, this may be due to poor contact between the engine material and the zinc plug. Scrape the mating surfaces clean and check that the zinc plug is not loose in the holder. Replace if necessary.

Close the drain cocks, open the bottom valve. Re-fill the coolant previously drained from the fresh-water system.

The electrodes are similarly located on all engines.

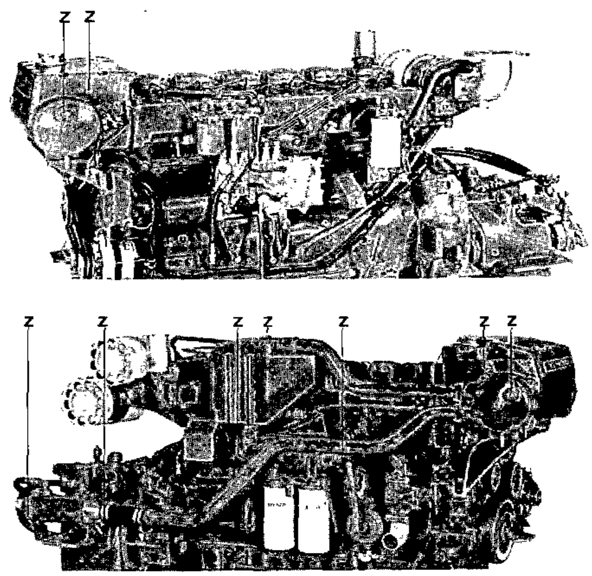


Fig. 155. Z = Zinc electrodes

Sea-water pump (marine engines)

Replacing the impeller

1. Loosen the bolts on the cover and remove the cover. Twist and pull out the impeller using a polygrip.
2. Clean the housing internally. Smear the inside of the pump housing and the cover with a little grease.

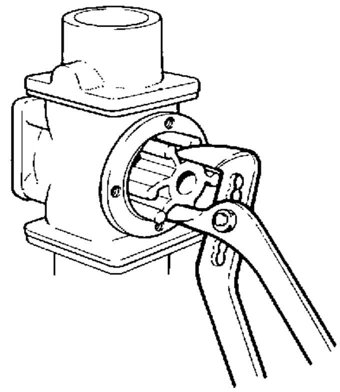


Fig. 156. Replacing the impeller

3. Press in the new impeller with a rotating motion (clockwise). Fit the sealing washers in the outer end of the impeller centre, if this has not already been done. Fit the cover with a new gasket.

Replacing the seals in the sea-water pump

1. Unscrew the pump and remove the cover.
2. Twist and pull out the impeller using a polygrip.

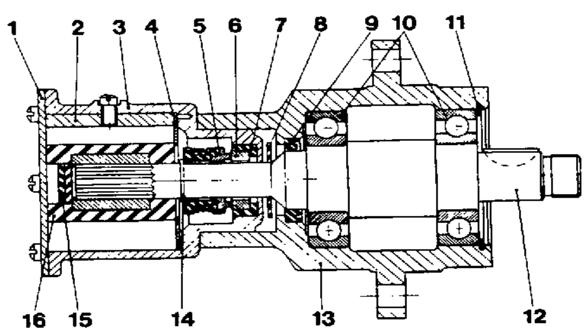


Fig. 157. Sea-water pump

1. Cover
2. Cam disc
3. Pump housing
4. Wear washer
5. Carbon ring
6. Ceramic ring
7. Rubber casing
8. Deflector ring
9. Sealing ring
10. Ball bearing
11. Circlip
12. Shaft
13. Bearing housing
14. Circlip
15. Sealing washer
16. Impeller

3. Remove the circlip from the shaft journal. Remove the locking screw and remove the pump housing together with the sealing rings. Remove the sealing ring in the housing.
4. Place the new ceramic ring (6, fig. 157) 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 result in poor 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 deflector ring (8) is located on the shaft journal. Fit the pump housing without tightening it.
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 (14) on the shaft.
7. Smear the inside of the pump housing and the cover with a little grease.

   Press in the impeller with a rotating motion (clockwise). Make sure that the sealing washers in the outer end of the impeller centre are fitted. Bolt the cover firmly into position using a new gasket.
8. Fit the pump on the engine. Do not forget the sealing ring on the auxiliary drive gear casing. Tighten the screw which secures the pump housing to the bearing housing.

Replacing the bearings in the sea-water pump

1. Remove the pump and then remove the impeller, seals and pump housing, see "Replacing the seals".
2. Unscrew the shaft nut and pull out the gear. Remove the key.
3. Remove the circlip and press out the shaft and bearings. Remove the sealing ring located in the bearing housing.
4. Check the bearings and replace if defective. Fit a new sealing ring in the bearing housing. The side with the spring must face the bearing.
5. Grease the bearings and then fit the bearings and shaft in the housing. Fit the circlip, fit the key and press on the gear.
6. Fit the washer and tighten the nut thoroughly. Fit the remaining parts, see "Replacing the seals".

Coolant pump (fresh-water pump)

Removing

1. Drain off some of the coolant and remove the fan.
2. Disconnect the hoses at the pump.
3. Unscrew the six bolts holding the pump and thermostat housing together. Loosen the pump and remove it.

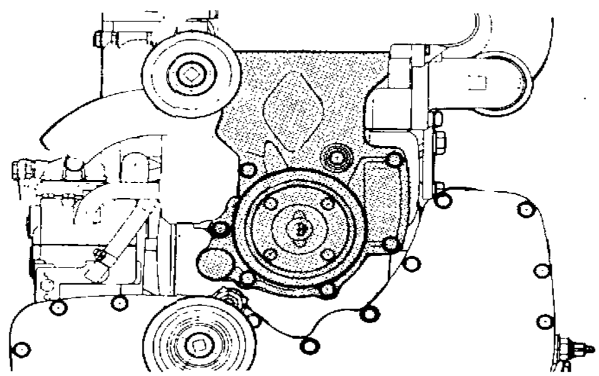


Fig. 158. Coolant pump, TD100G

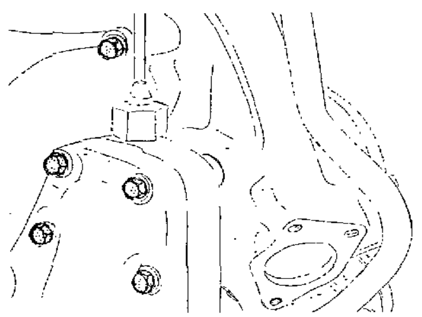


Fig. 159. Attaching bolts for gear-driven coolant pump

Marine engines

1. Unscrew the tensioner roller and remove the vee-belts.
2. Remove the pulley on the driver for the fresh-water pump and generator.
3. Drain off some of the coolant, unscrew the heat exchanger and lift it out.

   Note! In order to remove the heat exchanger, the cover must be taken off and the bolts retaining the heat exchanger at the pump housing must be unscrewed (see fig. 160).
4. Unscrew the pump and lift it out.

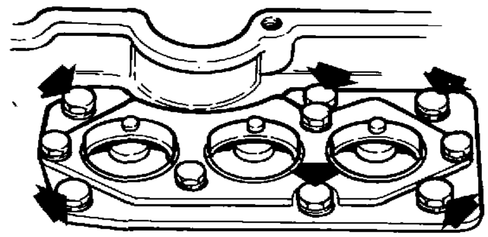


Fig. 160. Attaching bolts for heat exchanger

Reconditioning the coolant pump,
marine engines and TD100G, TID100K

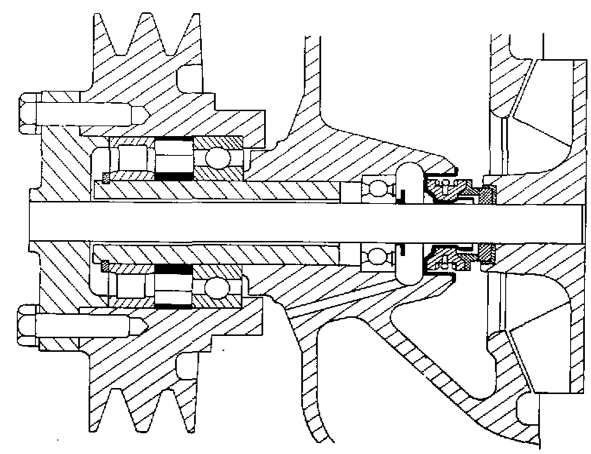


Fig. 161. Coolant pump

Disassembling

Special tools: 999 2265-0, 999 2266-8, 999 2267-6, 999 2268-4

1. **Marine engines**: Remove the bolts holding the drive flange. Knock out the spring pin which locks the drive flange to the pump shaft.
2. Press the shaft out of the drive flange using a 14 mm (0.55") drift.
3. Place a support under the pump housing and, using drift 2268, press out the shaft with the impeller, shaft seal, deflector ring and rear bearing all in one operation.

1. **TD100G, TID100K:** Remove the bolts holding the drive flange.
2. Press the shaft out of the impeller using a 14 mm (0.55") drift.

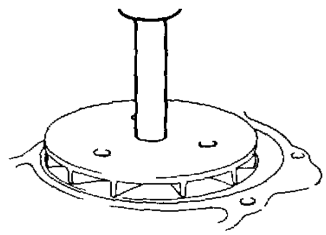


Fig. 162

3. Remove the impeller and press the shaft out of the inner bearing using drift 2268.
4. **All variants:** Press out the inner bearing and seal using drift 2268.

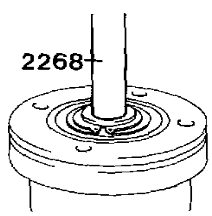


Fig. 163.

5. Remove the circlip and pull off the hub/belt pulley using tool 2265. (Place the drift 2266 in the shaft journal hole, as counterhold).

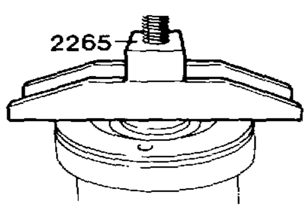


Fig. 164.

6. Lift the outer bearing inner race and the inner spacer ring out of the hub. Press both the bearings and the spacer ring out of the hub. Use 2267 as shown in fig. 165.

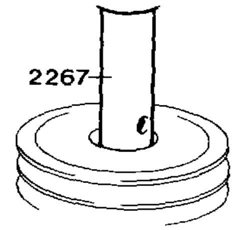


Fig. 165.

7. Check dimension A, which should be 46.45–46.55 mm (1.829–1.833"). If the dimension does not agree then the pump housing must be replaced.

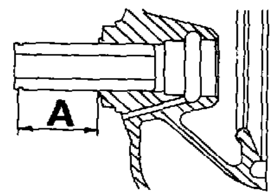


Fig. 166.

Assembling

Special tools: 999 2267-6, 999 2269-2, 999 2270-0, 884679-2, 884680-0

NOTE! Use grease, Volvo part no. 1161121 or equivalent high temperature resistant grease.

1. Fill the large ball bearing with approx. 4 cm^3 (0.24 cu.in.) grease. Turn the sealed side downwards and press the bearing down into the hub/belt pulley using the drift 2267.

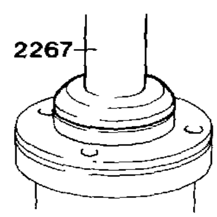


Fig. 167.

2. Pack the space in front of the bearing with approx. 8 cm³ (0.49 cu.in.) grease and fit the outer spacer ring.

Remove the loose inner ring from the roller bearing and press the outer ring and rollers into the hub/belt pulley, using drift 2267.

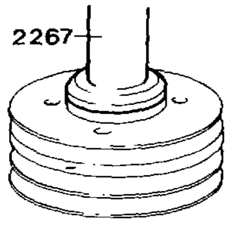


Fig. 168.

3. Place the fixture 2269 where the impeller fits (fig. 169). Press the hub/belt pulley onto the pump housing shaft journal, use sleeve 884679.

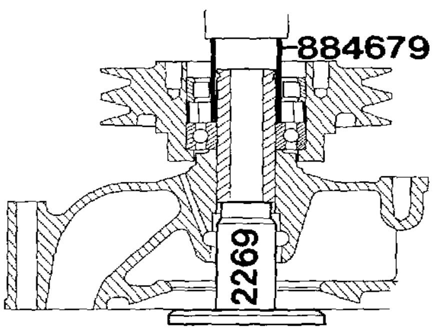


Fig. 169.

4. *Fit the inner spacer ring. Pack the roller bearing with approx. 4 cm³ (0.24 cu.in.) of grease. Then press in the roller bearing inner ring until the circlip can be fitted, use sleeve 884679. Turn the hub/belt pulley while pressing to prevent scoring. Fit the circlip onto the shaft journal.*

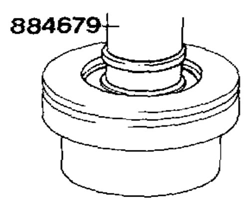


Fig. 170.

5. Secure the drive flange to the hub/belt pulley by tightening the screws.

Note. *In the repair kit for TD100G, TID100K the shaft is pressed into the drive flange.*

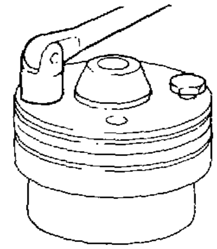


Fig. 171.

6. Fill the space inside the small bearing with approx. 1 cm³ (0.06 cu.in.) grease and pack the bearing with a similar amount. Use a support under the pump housing and press in the bearing using the sleeve 884680. NOTE! Turn the bearing so that the side with the seal faces upwards (towards the impeller).

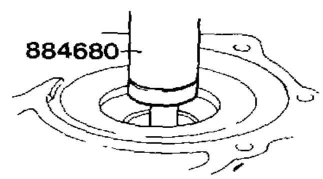


Fig. 172.

7. **TD100G, TID100K**: *Fit the deflector ring onto the shaft with the flat side upwards.*

Marine engines: Place the deflector ring on the inner ball bearing. Turn the flat side upwards.

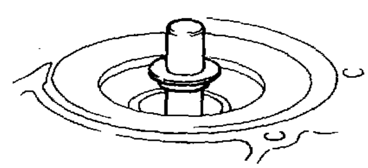


Fig. 173.

8. Press on the seal using tool 2270. NOTE! On older tools the depth of the centre hole must be increased in order that it may be used on TD100G, TID100K. Note! The mating surfaces of the carbon ring and the ceramic ring included in the seal must not come into contact with grease or be touched with the fingers.

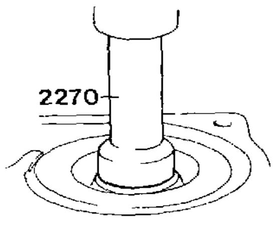


Fig. 174.

9. **TD100G, TID100K**: Dip the wear ring in soapy water and assemble it together with the rubber seat onto the impeller.

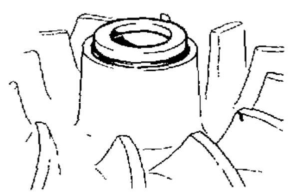


Fig. 175.

10. **TD100G, TID100K**: Use a support under the drive flange and press on the impeller so that a clearance of 1 mm (0.04") is obtained between the impeller and the housing. Check that the pump rotates freely.
11. **Marine engines**: Make sure that the deflector ring is fitted correctly and push the shaft through the seal. Press in the shaft together with the impeller until there is a clearance of 1.0 mm (0.04") between the pump housing and the impeller.

    Press on the drive flange. If the shaft and impeller have been replaced then a hole must be drilled for the spring pin. Knock in the spring pin. Screw in and tighten the drive flange attachment bolts.

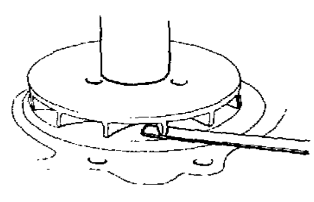


Fig. 176.

Reconditioning gear-driven coolant pump

Special tool: 999 2266-8

Dismantling

1. Remove the O-rings from the pump. Secure the pump in a vice with the end cover upwards.
2. Disassemble the end cover and remove the O-ring from the cover.
3. Open the locking tabs for the bearing attachment screws and remove the screws.
4. Place a counterhold under the pump housing. Note that it must be possible for the impeller to pass clear of the counterhold. Press the pump shaft out of the bearing journal and inner bearing using a drift 14x200 mm (0.55x7.87"). Note that the pump shaft and impeller should be pressed out. The pump shaft must not be knocked due to risk of damaging the double ball-bearing.

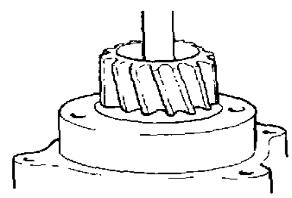


Fig. 177.

5. Tap out the inner bearing with a drift, if it remains in the pump housing.
6. Place the pump housing in a press with a counterhold under the housing (on the drive side) and press out, using the drift 2266, the inner front sealing ring and the bearing journal together with the double ball-bearing and the gear.

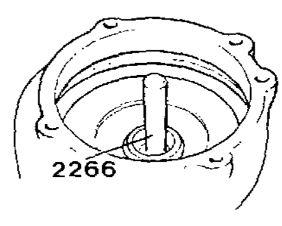


Fig. 178.

7. Press out the bearing journal with the drift 2266.
8. Clean all the parts. Replace all damaged or worn parts. The impeller seal and remaining seals should always be replaced when reconditioning.

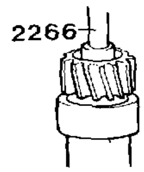


Fig. 179.

Assembling

Special tools: 999 2268-4, 999 2270-0

1. Fit the inner seal into the housing using the drift 2268. *Grease the inner ball bearing (Volvo grease, part no.* 1161121) and place approx. 0.5 cm^3 (0.03 cu.in.) grease between the seal and the bearing.

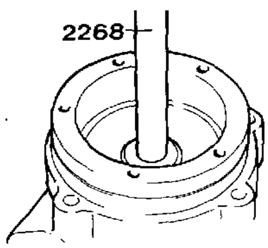


Fig. 180.

2. Fit the inner bearing into the housing with the encased side against the impeller. Use the drift 2268.

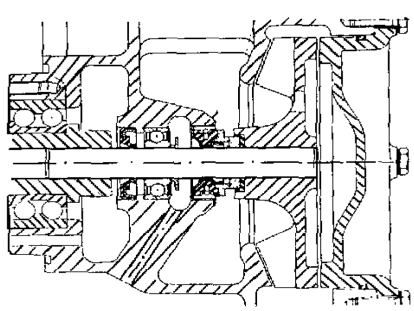


Fig. 181.

3. Fit the deflector ring. Smear the impeller seal externally with Permatex and press in the seal to mate with the surface in the pump housing, using the drift 2270.

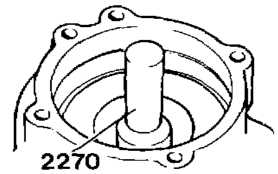


Fig. 182.

4. *Grease the double ball-bearing, place the drive gear* and the double ball-bearing in the press and press down the bearing journal.

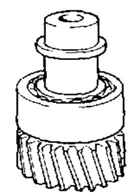


Fig. 183.

5. Press the bearing, together with the gear, into the pump housing.

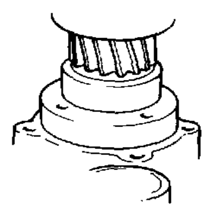


Fig. 184.

6. Dip the wear ring into soapy water and fit it onto the impeller. Press the impeller and shaft into the housing until the rear side of the impeller lies 24.3–24.7 mm (0.956–0.972") below the housing mating surface for the cover.

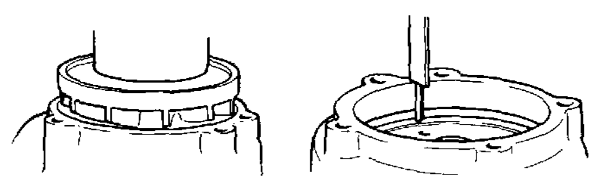


Fig. 185.

7. Check, by measuring, the position of the pump shaft in the bearing journal. The distance from the end of the gear shaft to the end of the pump shaft should be 38.8–39.2 mm (1.527–1.543"), see fig. 186.
8. Assemble the screws, washers, and bearing locking tabs and lock the screws with the locking tabs.
9. Fit the cover together with a new O-ring.

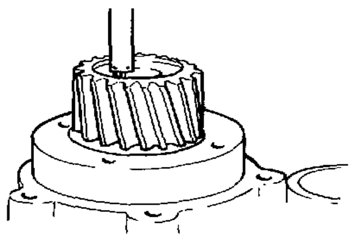


Fig. 186.

Replacing the bearing in the fan belt pulley, T(I)D120, 121

Special tools: 999 2002-7, 999 2266-8, 999 2267-6, 999 6661-6, thread tap M20x2.5

1. Remove the fan, the fan hub and the fan belts.
2. Remove the circlip from the shaft journal.
3. Fit the drift, 2266 into the belt pulley shaft journal. Pull off the belt pulley using 2002 (fig. 187).
4. Press the bearings out of the belt pulley with the drift, 2267 (fig. 188).

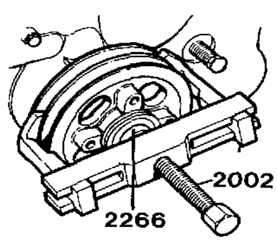


Fig. 187.

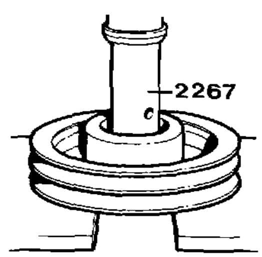


Fig. 188.

5. Pack each new bearing with approx. 4 cm^3 (0.24 cu.in.) of grease (part no. 1161121-7). Press the inner bearing into the belt pulley with the encased side downwards (fig. 189).

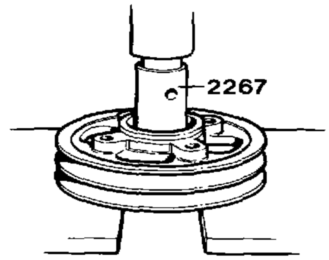


Fig. 189.

6. Cut a thread in the shaft journal hole using a M20 x 2.5 thread tap to a depth of approx. 30 mm (1.18"). Preferably, use a taper tap to simplify guiding.

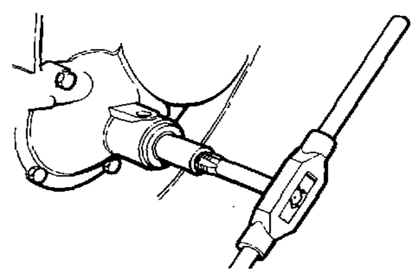


Fig. 190.

7. Screw the shaft of tool 6661 into the shaft journal. Fit the belt pulley onto the shaft journal, assemble the sleeve and the nut and press the belt pulley into place (fig. 191).
8. Remove the tool sleeve, fit the spacer ring and the outer bearing into place in the belt pulley. The encased side of the bearing facing outwards. Re-fit the sleeve and the nut and press in the bearing (fig. 192).

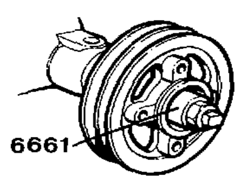


Fig. 191.

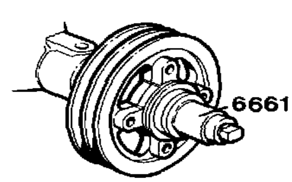


Fig. 192.

9. Fit the circlip onto the shaft journal. Fit the fan belts, the fan hub and the fan.

DESCRIPTION

The turbine unit consists of an exhaust turbine, bearing housing and compressor.

The exhaust gases pass through the turbine housing (9), causing the turbine rotor (10) to rotate, before passing out through the exhaust system. The turbine rotor thus drives the compressor rotor (18) since the turbine and the compressor rotors are mounted on the same shaft. The compressor rotor is located in a compressor housing (20) which is connected between the air channel from the air cleaner and the engine intake manifold.

Rotation of the compressor rotor sucks in and compresses air from the air cleaner before forcing it, under pressure (charging 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 turbo-compressor is lubricated and cooled by the engine lubricating oil. The oil is supplied and drained by external pipe line connections. On certain engines the turbine housing is fresh-water cooled.

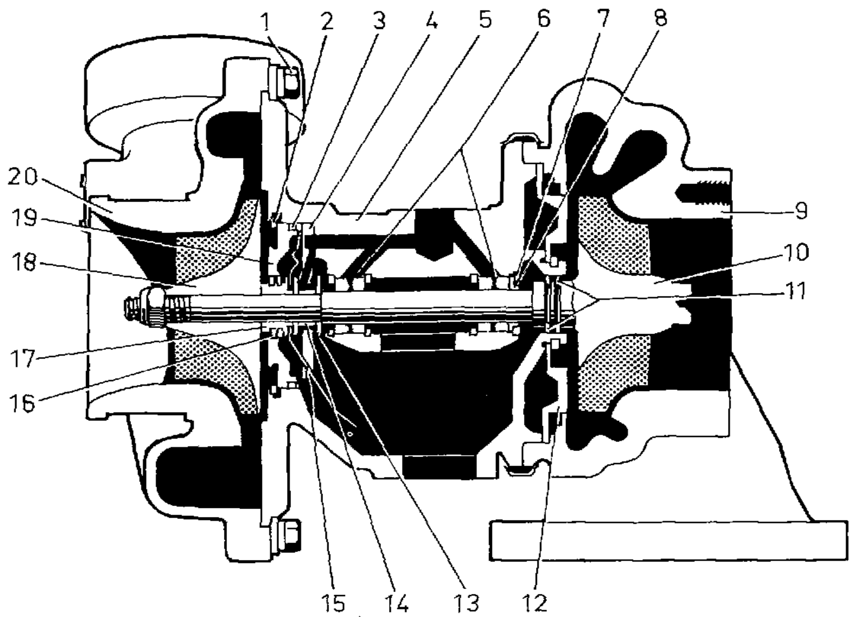


Fig. 193. Turbo-compressor, Holset

1. Attaching bolt for compressor housing
2. Circlip
3. O-ring
4. Thrust bearing
5. Bearing housing
6. Bearing bushings
7. Circlip
8. Oil deflector ring
9. Turbine housing
10. Turbine rotor
11. Piston ring seals
12. Radiation shield
13. Thrust washer
14. Spacer ring
15. Oil guide plate
16. Piston ring seals
17. Retainer for piston ring seals
18. Compressor rotor
19. Cover
20. Compressor housing

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 turbo-compressor. Thus the charging pressure should be checked.

Checking the charging pressure

1. Connect a pressure gauge (6065), to the measuring connection on the intake manifold which has a 1/8"-27 NPSF thread. 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 under full loading at max. speed control setting while engine speed relatively slowly passes a certain value which is specified for the engine type concerned, see "Technical Data". The charging pressure must not be less than the minimum specified value for the engine type.

   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. 194. The charging pressure is stated +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^2 = 11.3 p.s.i.) measured at −10°C (14°F) corresponds to 70 kPa (0.7 kp/cm^2 = 9.9 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 adequately large. Refer to the installation instructions.
2. **Clogged air cleaner.**

   Check that the air cleaner is not clogged. Replace cleaner if necessary.
3. **Leakage**

   The intake and exhaust manifolds, the hoses and connections etc. must not leak. Also check the joints between the compressor bearing housing and turbine housing; and the compressor bearing housing and compressor housing.
4. **Speed control system**

   Check that the control can move the injection pump speed control lever to its maximum position.

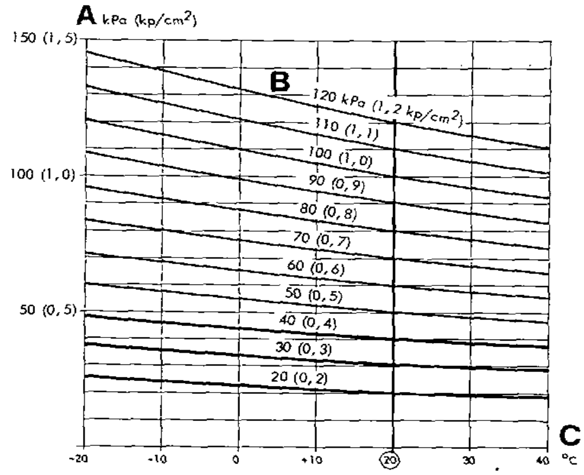


Fig. 194. Charging pressure at different temperatures

A. Measured charging pressure
B. Correction curves
C. Intake air temperature

5. **Turbo-compressor**

   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 pull. If the rotor is difficult to turn, the turbo-compressor must be replaced or reconditioned as soon as possible. Check 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 white spirit or equivalent. Fit the compressor housing and re-measure the charging pressure.

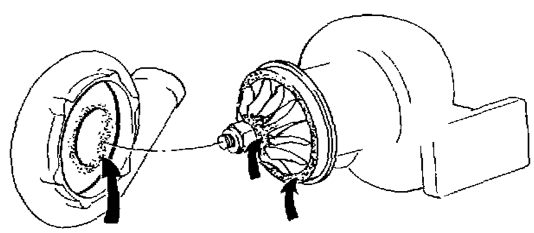


Fig. 195.

6. **Counter-pressure**

   Check that the counter-pressure (back-pressure) in the exhaust system is not too great when the installation is complete. Refer to the next section "Checking the exhaust counter-pressure".

7. **Injection pump**

   Check the injection advance angle and the max. unloaded speed.

   If necessary, check the entire injection pump in a test bench.

8. **Feed pressure**

   If necessary, replace the fuel filters. 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 not damaged.

10. ***Condition of the engine***

    Check the valve clearance and compression pressure.

    If the charging 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 turbo-compressor should be reconditioned or replaced.

Checking the exhaust counter-pressure

Special tools: Measuring flange kit 884510-9 (120-series), 884513-3 (TMD100), 884778-2 (TD100)

1. Remove the exhaust pipe from the turbo-compressor 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. 195 or, alternatively a low pressure manometer.

   The difference between the water columns "A" is the exhaust system counter-pressure in mm water column.
5. *Run the engine with* **full-loading** *and* full *speed setting for some minutes and check the counter-pressure.* For permitted counter-pressure, refer to relevent data sheet or engine brochure.

   An exhaust system with excessively large counter-pressure decreases the charging pressure, gives reduced engine power output and also increases exhaust smoke and exhaust gas temperature which, in its turn can lead to burnt valves and turbo-compressor breakdown.

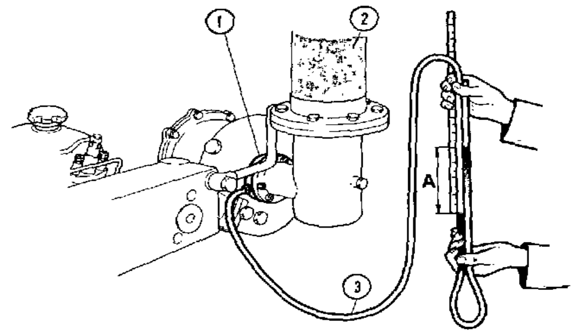


Fig. 196. Checking exhaust counter-pressure

1. *Measuring flange*
2. Exhaust line
3. Transparent plastic hose, partly filled with water

Checking the bearing clearance

Checking the axial and radial clearance is normally done only in conjunction with reconditioning when it is required to ascertain the degree of wear in the unit.

Axial clearance

Zero-set the measuring point of the dial indicator against the end of the turbine shaft.

Press up the compressor rotor towards the dial indicator up to the stop and read off the reading.

Press the turbine rotor down to the stop and read off the dial indicator.

Axial clearance:

Holset	max. 0.15 mm (0.0059")
KKK	max. 0.16 mm (0.0063")

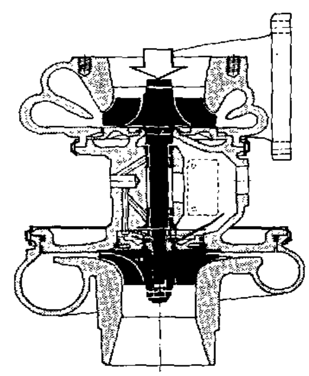


Fig. 197. Measuring the axial clearance

Radial clearance

Radial clearance only requires checking on the turbine side.

Measuring with the dial indicator

Place the indicator measuring tip as shown by the arrow in the fig. Press the turbine rotor downwards and read off the reading.

Press the turbine rotor in the opposite direction and read off the reading.

Radial clearance:
Holset . . . . max. 0.61 mm (0.024")*
KKK . . . . max. 0.46 mm (0.018")

* H2C: Max. 0.53 mm (0.021")

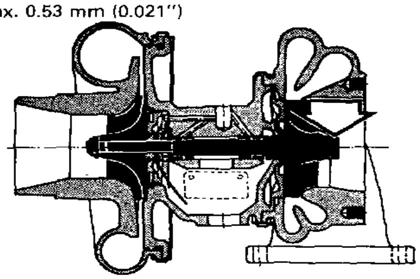


Fig. 198. Measuring radial clearance

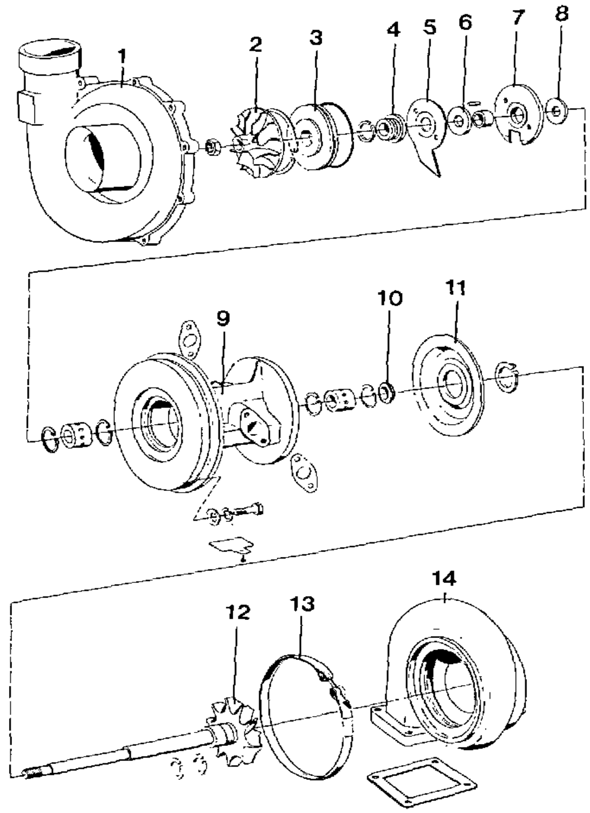


Fig. 199. Holset 4L

Removing the turbo-compressor

1. Clean round the turbo-compressor.
2. If the turbo-compressor is liquid-cooled: Drain off part of the coolant and slacken the coolant pipes at the turbo-compressor.
3. Remove the connection on the compressor side. Disconnect the oil pipes.
4. Disconnect the exhaust pipe connection at the turbo. Remove the turbo-compressor attaching nuts and lift off the unit.

Disassembling

(Models 4L and H2 differ from each other in respect of the oil deflector ring and thrust bearing, for example).

1. Secure the turbo exhaust flange in a vice.
2. Make line-up marks between the turbo housing (14, fig. 199), the bearing housing (9) and the compressor housing (1).

   It is important that these parts are placed in their original positions when re-assembling.
3. Dismantle the compressor housing. Tap if necessary, with a soft hammer to separate the components.

   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.
4. Slacken the clamp ring (13) and remove the bearing housing (9).
5. Carefully clamp the turbine rotor hub in a vice (with soft jaws). Be careful of the turbine rotor vanes.
6. Unscrew the compressor rotor shaft nut. Use a T-bar and a socket so as not to apply oblique load to the turbine rotor shaft. NOTE! Model H2 has a left-hand thread. Remove the compressor rotor.
7. Remove the circlip and lift up the cover (3) using two screwdrivers. Remove the ring retainer and the O-ring from the cover.

8. Lift off the oil guide plate, the thrust washer, the thrust bearing, the spacer ring and the inner thrust washer. Do not remove the two slotted pins in the bearing housing.
9. Lift off the bearing housing from the shaft. Remove the circlip and lift out the radiation shield (11).
10. Remove the circlip for the bearing bushing on the compressor side. Take care not to damage the bearing housing.

    Remove the bearing bushing and, if necesary, the circlip inside the bushing.
11. *Remove the circlip for the bearing bu$hing on the turbine rotor side. Lift off the oil deflector ring and remove the bearing bushing and, if necessary, the circlip inside the bushing.*
12. *Remove the piston rings from the ring retainer and the turbine shaft.*

Cleaning and inspection

See page 87.

Assembling, Holset

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. Insert the bearing bushings and circlips in the bearing housing. Do not forget the oil deflector ring on the turbine side. **Check that the bushings can rotate.**
2. Fit the heat radiation shield on the turbine side of the bearing housing together with the circlip.

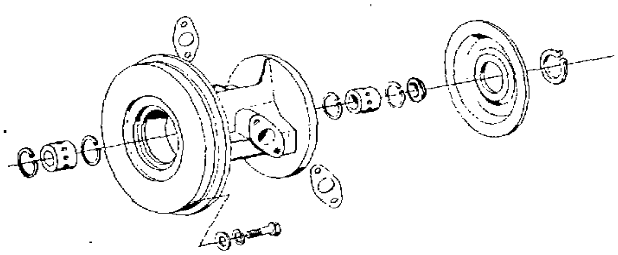


Fig. 200.

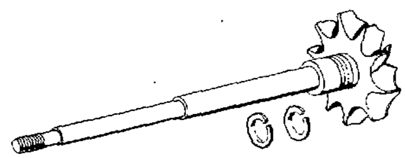


Fig. 201.

3. *Fit the piston type rings on the turbine rotor shaft. Be careful not to break them or damage the bearing surfaces.*
4. *Centre the piston type rings. Make sure the gaps are offset and insert the turbine rotor with shaft into the bearing housing. The shaft must* ***never be forced*** *down into the bearing housing.*
5. *Fit the inner thrust washer (5, fig. 202), the spacer ring (4), the thrust bearing (3), the outer thrust washer (2) and the oil guide plate (1).*

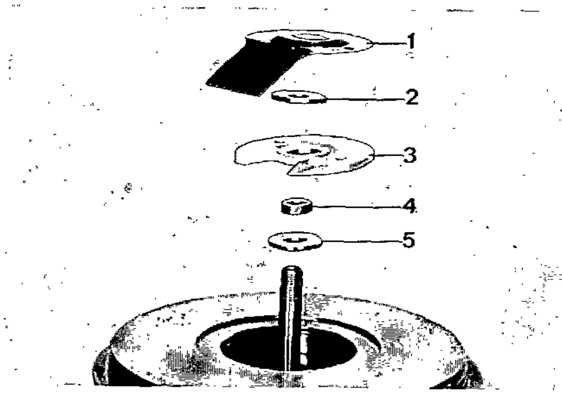


Fig. 202. Axial bearing, 4L

1. Oil guide plate
2. Thrust washer
3. Thrust bearing
4. Spacer ring
5. Thrust washer

6. Fit the piston type rings on the ring retainer. Turn the piston ring gaps so that they are each located at 90° on either side of the bearing housing oil inlet.

    Place the ring retainer in the cover and fit the cover together with the O-ring.

7. Fit the circlip with the bevel facing outwards.
8. Fit the compressor rotor and tighten the lock nut. NOTE! Model H2 has a left-hand thread. Tightening torque, 34 Nm (3.4 kpm = 25 lbf.ft.) for 4L and 17 Nm (1.7 kpm = 12.5 lbf.ft.) for H2.
9. Secure the turbine housing in a vice. Smear the sealing surfaces in the turbine housing and bearing housing with a thin coating of sealing agent. Place the clamp ring on the bearing housing and assemble the bearing housing onto the turbine housing using the marks made earlier.
10. Fit the compressor housing according to the line-up marks.
11. 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.
12. Spray oil into the bearing housing. Fit protective caps over all openings if the unit is not to be fitted immediately.

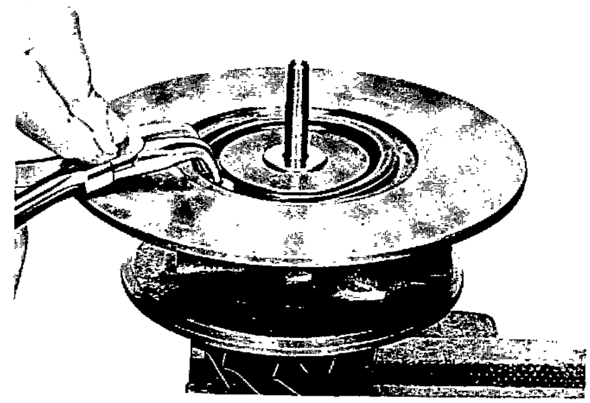


Fig. 203. Fitting the circlip

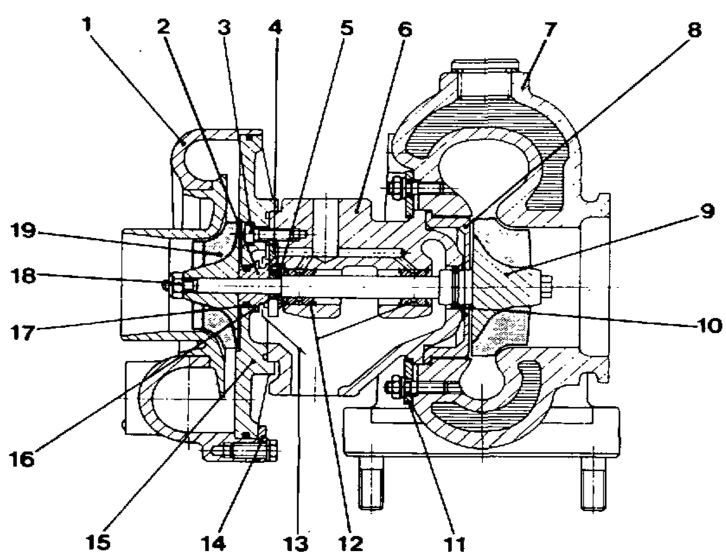
Disassembling, KKK

1. Make line-up marks between the turbine housing (7, fig. 204), the bearing housing (6) and the compressor housing (1).
2. Dismantle 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. Carefully clamp the turbine rotor hub in a vice (with soft jaws). Be careful of the turbine rotor vanes. Mark the compressor rotor position 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 rotor shaft. Remove the compressor rotor. Press out the shaft if the rotor remains attached.
5. Remove the end cover (15) and press out the piston ring seal retainer (2). Remove the piston type rings.

Fig. 204. Turbo-compressor KKK

1. Compressor housing
2. Retainer for piston ring seals
3. Screw
4. Axial bearing
5. Thrust washer
6. Bearing housing
7. Turbine housing
8. Heat radiation shield
9. Turbine rotor with shaft
10. Piston ring seals
11. Clamp washer
12. Bearing bushings
13. Oil guide plate
14. Clamp washer
15. End cover
16. Bushing
17. Piston ring seals
18. Nut
19. Compressor rotor



6. Remove the oil guide plate (13), axial bearing (4) and the bushing (16) together with the thrust washer (5). Lift off the bearing housing (6) and the radiation shield (8) from the shaft.
7. Remove the piston type rings (10) and remove the circlips and bearing bushings (12) from the bearing housing.

Cleaning and inspection

See page 87.

Assembling, KKK

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. Fit the bushing on the turbine side of the bearing housing and fit the outer circlip.
2. Fit the radiation shield (8, fig. 204) to the bearing housing.
3. Carefully secure the turbine rotor hub in a vice (with soft jaws). Be careful of the turbine rotor vanes.
4. Fit the piston type rings (10) in the grooves in the turbine rotor shaft and carefully feed the bearing housing over the shaft.
5. *Adjust the piston type rings so that their gaps are dis*placed at 180° to each other. Press the rings together and push them into the bearing housing with the gaps displaced at 90° to the oil inlet (fig. 205). Check that the radiation shield rotates freely.
6. Fit the bushing and the outer circlip on the compressor side of the bearing housing.
7. Fit the thrust washer (5, fig. 204), the axial bearing (4), *the bushing (16) and the oil guide plate (13).*
8. Fit the piston type rings on the ring retainer (2). Locate the piston ring gaps in the same way as on the turbine rotor side and fit the retainer into the end cover (15).

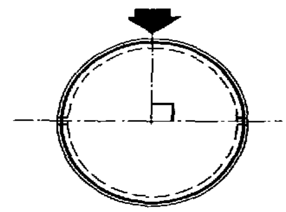


Fig. 205. Piston ring gap location, KKK-turbo

9. Smear the end cover sealing surfaces with a thin coating of sealing agent and tighten it to the bearing housing with new self-locking screws (3). (If the old screws are re-used, then they must be locked with Loctite *locking fluid).*

   Tightening torque, 8 Nm (0.8 kpm = 5.9 lbf.ft.).
10. Heat the compressor rotor (19) to approx. 100°C *(212°F) and assemble it onto the shaft so that the mark*ings agree. Tighten the shaft nut to 10 Nm (1.0 kpm = 7.4 lbf.ft.). *Use a* T-bar and a socket so as not to apply oblique load to the shaft. Let the compressor rotor cool down to about +30°C (86°F) ("hand-hot"). Loosen the nut and re-tighten it to the same torque.
11. Fit the O-ring on the end cover and assemble the com*pressor housing* (1) according to the line-up marks made earlier. Tighten the screws to 7 Nm (0.7 kpm = 5.2 lbf.ft.).

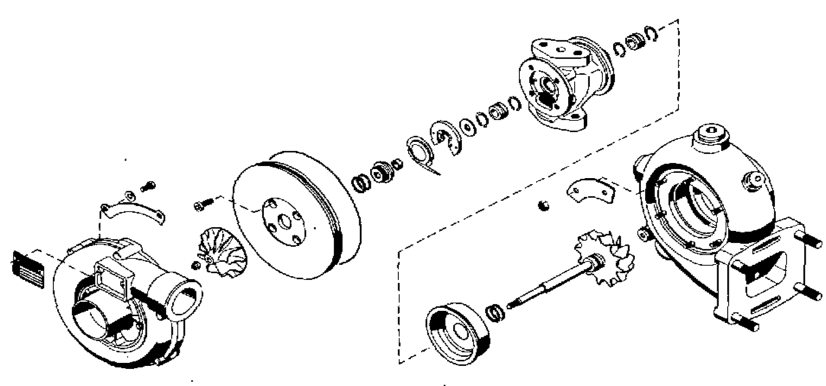


Fig. 206. Turbo-compressor, KKK

12. Assemble the turbine housing (7) according to the previously made line-up marks. Tighten the screws to 20 Nm (2.0 kpm = 14.7 lbf.ft.).
13. Check that the rotors turn 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 information concerning fitting the turbo-compressor to the engine, see page 88.

Cleaning

With respect to cleaning, the same method of cleaning applies irrespective of the make of turbo. Cleaning must be carried out thoroughly with meticulous attention being paid to every component.

Prior to cleaning, examine all parts for signs of friction marks, heat or other kinds of damage which cannot be seen so clearly after cleaning.

Immerse the parts in a carbon dissolving cleaning agent. The washing fluid must not be corrosive. After soaking, remove the deposits with a stiff bristle brush and carefully dry the parts.

NOTE! A wire brush must not be used for cleaning since this can cause scratches.

Inspection

Carry out systematic inspection of the compressor components after careful cleaning. Slight damage can be polished or rubbed away. Use silicon carbide emery cloth for the aluminium parts and finishing grinding compound for the steel parts. Clean the parts thoroughly before fitting. Always replace the bushings and their circlips, piston ring seals, the compressor rotor shaft nut, sealing rings, turbine housing screws and locking tabs in connection with reconditioning.

For more detailed reconditioning data, refer to the relevant turbo manufacturer's instructions.

Bearing housing

Check the bearing housing for signs of contact with rotating parts. The mating surface for the piston ring seals on the turbine side must not be worn or grooved and the oil channel must be clean and free from obstructions. Also check the bushing recesses.

Turbine rotor and shaft

Check that the turbine rotor is free from friction marks and that the vanes are not cracked, bent or so worn that the edges have become sharp. The shaft may only show insignificant marks, scratches or signs of binding damage at the bearing locations. Check that the piston ring grooves are not conically worn. A damaged turbine rotor or shaft must never be straightened but must be replaced complete.

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 parts should therefore be examined in the event of such damage. Binding damage on the bearing surfaces can be the result of insufficient lubrication caused by inadequate maintenance of the engine lubrication system.

With respect to balancing when replacing rotating parts, see "Balancing the rotor shaft".

Compressor rotor

Check that the compressor rotor is free from cracks or other damage. Replace the compressor rotor if it is deformed. Otherwise, see under heading "Turbine rotor and shaft".

Bushings, piston ring seals

Always replace bearings/bushings and piston ring seals when reconditioning. Note that the bushings must always be a "floating fit" in the bearing housing.

Thrust bearings and thrust washers

Wear on thrust bearings and thrust washers can be determined by measuring the turbo-compressor axial clearance before disassembling. See "Measuring the axial clearance" on page 82. These components are included in the reconditioning kit and must be replaced when reconditioning.

End cover

Check the end cover for signs of contact with the rotating parts. The mating surface for the piston ring seal on the compressor side must not be worn or grooved.

Piston ring retainer, thrust washers

Check the side surfaces of the retainer and the piston ring grooves. Check the width and conicity with a special gauge. Replace the piston ring retainer if the grooves are conically or otherwise worn. This also applies to thrust washers which are cracked or scored or have glazed deposits or foreign particles embedded in their surfaces.

Compressor housing, turbine housing

Check the housings for damage. Housings which are cracked or show signs of contact with the rotating parts must be replaced.

Balancing the rotor shaft

All the rotating parts are individually balanced. Thus it is unnecessary to carry out balancing irrespective of which component has been replaced; assuming of course that rotating parts are replaced at the first signs of damage. If, however, a balancing machine is available it can be advantageous (from the point of view of length of life) to carry out balancing of the complete assembly.

Further information concerning balancing machines, how to carry out balancing, max. permissible out-of-balance and from where material may be removed on each respective component can be obtained from the turbo manufacturer. Generally, balancing machinery is only economical for specialist workshops.

Fitting the turbo-compressor

NOTE! Always determine the reason for replacing the turbo. Deal with any sources of damage before fitting the new turbo unit.

Bearing damage in the turbo-compressor 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 turbo-compressor.

Use the correct oil grade. Oil replacement should be carried out according to the instruction book in order to keep the engine clean.

1. **Replace the engine oil and the engine oil filter**. Clean the turbo-compressor delivery and return oil lines.
2. Clean loose carbon or metal particles etc. from the exhaust manifold and fit the turbo-compressor to the engine.
3. Clean the intake manifold between the compressor and the engine. After turbo breakdown it is possible that foreign matter, such as bits of a broken compressor rotor, still remain.

   These remnants can find their way into the engine or destroy the new compressor or turbine rotor. If the engine is fitted with an after-cooler, then this should also be examined.
4. Fit a new air cleaner.
5. **Fit the turbo-compressor on the engine**. Connect up the rubber hoses at the turbo after having ensured that they are in good condition. Always replace hoses that have become too dry or cracked. Fit the compressor return oil line.
6. **Inject lubricating oil into the turbo-compressor bearing housing** and fit the delivery oil line.
7. If the turbo is liquid-cooled: Connect up the coolant lines to the turbine housing. Fill the system with coolant and air-vent it.
8. Connect the exhaust line to the turbo-compressor.
9. Place a suitable vessel for collecting oil under the compressor return oil connection.

   Then start the engine. Immediately disconnect the screw union for the return oil line under the turbo and check that the oil is circulating properly. Tighten up the return line and check to ensure there is no leakage.

The engines are equipped with a 2-pole, 24V, electrical system.

Wiring diagrams are to be found on pages 92–97.

Important

The following applies to engines fitted with alternators.

1. **Never interrupt 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 completely.** 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 confuse the 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 the next section.**
4. Before carrying out any repairs on the alternator equipment, always first remove both the battery cables. The same applies concerning rapid charging of the batteries.

   NOTE! Observe valid safety regulations when charging batteries.
5. Never place a screwdriver or similar tool against a connection to see if there is any spark.
6. **Electrical welding**

When carrying out electrical welding the following measures should be taken:

Disconnect the battery earth connection and then all cables to the alternator. Insulate the alternator cables and reconnect the battery earth connection. Remember to disconnect the battery earth connection again before reconnecting the alternator cables.

Connect the welding clamp so that no current flows through any bearing.

Starting with auxiliary batteries

Warning!

Batteries (especially auxiliary batteries) contain hydrogas which is highly explosive. A spark which can be caused by wrongly connecting the jump leads is enough to cause the batteries to explode, resulting in personal injury and material damage.

If the batteries have frozen they must be thawed out before attempting to start using an auxiliary battery.

1. Check that the auxiliary batteries are connected (in series or parallel) so that the voltage rating agrees with that of the electrical system of the engine.
2. Connect one end of the red jump lead to the positive terminal of the auxiliary battery, (marked with red paint, P or +). Check that the clamps are properly fitted so that no sparks occur when trying to start.
3. Connect the other end of the red cable to the positive terminal of the discharged battery where the positive cable to the starter motor is connected.
4. Connect one end of the black cable to the negative terminal of the auxiliary battery (marked with blue paint, N or –).
5. Connect the other end of the block cable to a point which **is some way from the discharged batteries,** e.g. at the main switch on the negative cable or the negative cable connection to the engine.
6. Start up the engine. **NOTE! Do not disturb these connections when attempting to start (risk of causing sparks) and do not stand with your head over the batteries.**
7. Remove the cables in exactly the reverse order to that in which they were fitted. **NOTE! The permanent cables to the standard batteries must under no circumstances be removed.**

Fuses

The engines are fitted with automatic fuses located in the connection box (marine engines have 2 fuses). The fuses are re-set by pressing a button on the outside of the box.

Engines fitted with the larger alternator (CAV, 28V/60A) also have two 80A fuses for the alternator. See wiring diagram.

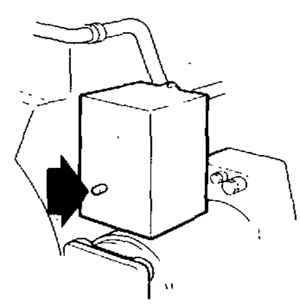


Fig. 207. Automatic fuses, industrial engines

Pre-heater (starter element)

The pre-heater consists of a series connected wire element assembled in a housing. On TID100K the element is integrated in the inter-cooler. Output is 4 kW.

When the starter key is turned to "glow", current is fed to a switching relay, which in its turn completes the circuit to the pre-heater. The element is thus heated up to glowing red (approx. 700°C = 1300°F). A time relay keeps the element engaged for about 50 seconds.

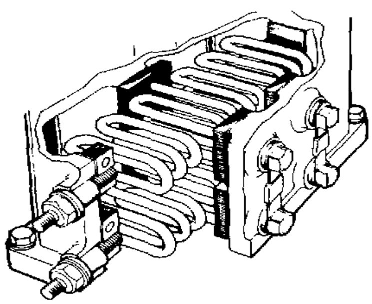


Fig. 208. Pre-heater (starter) element

NOTE! Never use start spray or similar starting aid on engines fitted with a pre-heater. The gases may be ignited by the hot element resulting in an explosion which could destroy the compressor rotor in the turbo and damage the air intake. Risk of personal injury!

In an emergency situation where it is suspected that the pre-heater is not functioning, start spray may be used – on the strict pre-condition that the **electricity supply to the pre-heater is first disconnected** by removing and insulating the cables. Feel by hand to check that the element housing is not hot before using the spray.

Stop solenoid

The stop solenoid is fitted as standard on marine engines but is an item of optional equipment on industrial engines.

The solenoid can either conduct current when the engine is running or when the engine stops. When stopping the engine the circuit is interrupted in the first case and connected in the second.

REPAIR INSTRUCTIONS

Checking the pre-heater

NOTE! Disconnect the battery cables before starting work on the pre-heater.

When loosening and tightening the nut on the terminal screw, the screw must be held. If this is not done, the wire element may rotate and cause a short-circuit.

Disconnect the cables at the element. Use a ohmmeter to check that there is no breakage in the element. Reconnect the cables. Set the key switch to the "glow" position and check that battery potential is obtained at the element. If battery potential is not obtained, check the following:

- Battery potential across the terminals. Charge the batteries if necessary.
- Electrical cables, poor connections or breakages.
- Starter key switch. Check by by-passing.
- Relay. Check by by-passing with a heavy electrical cable.

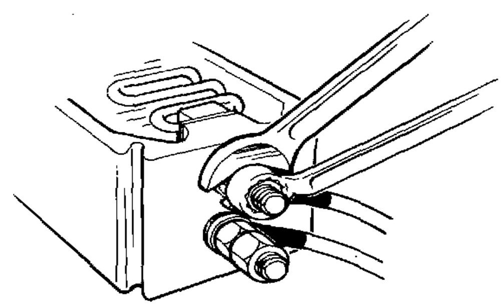


Fig. 209. Tightening the nut on the terminal screw

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 battery cables.

2. Press the solenoid pull rod in by hand and check that the stop position indicator (pin), 1 fig. 210 at the rear end of the solenoid is pushed out approx. 1.5–2 mm (0.06–0,08") when the pull rod is completely pushed back.

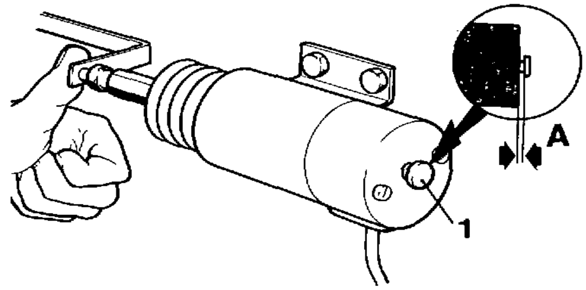


Fig. 210. Checking the contact gap
1. Stop position indicator (pin)
A. Approx. 1.5–2 mm (0.06–0.08")

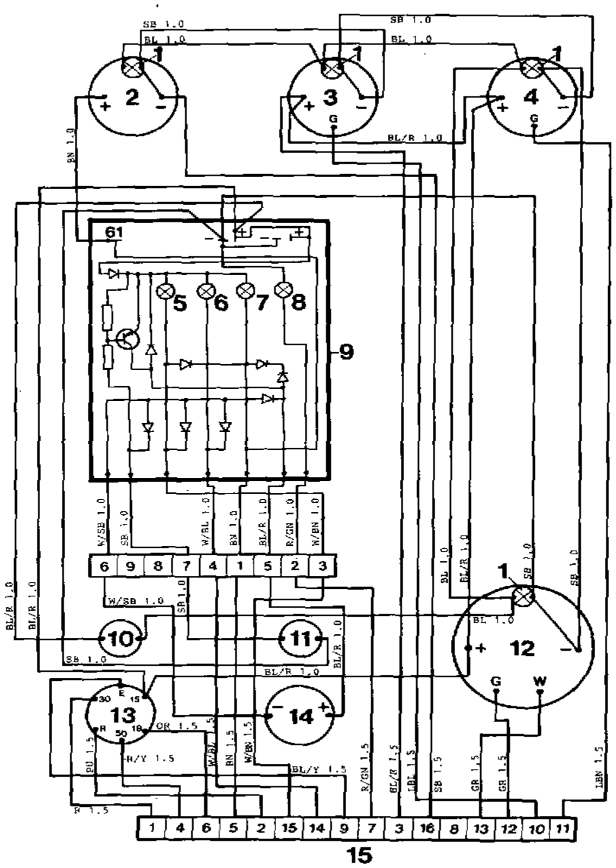


Fig. 211. INSTRUMENT PANEL

1. Instrument lighting
2. Hours run meter
3. Oil pressure gauge
4. Cooling water temperature gauge
5. Warning lamp, cooling water temp.
6. Warning lamp, oil pressure
7. Warning lamp, charging
8. Warning lamp, pre-heating
9. Printed circuit card
10. Switch, instrument lighting
11. Switch, alarm test
12. Revolution counter
13. Key switch
14. Alarm
15. 16-pole connector

Cable colours

GR	= Grey	GN	= Green
SB	= Black	Y	= Yellow
BN	= Brown	W	= White
LBN	= Light brown	BL	= Blue
R	= Red	LBL	= Light blue
PU	= Purple	OR	= Orange

Cable cross-section area in mm²

Relationship mm²/AWG

mm²	1.0	1.5
AWG	16 (17)	15 (16)

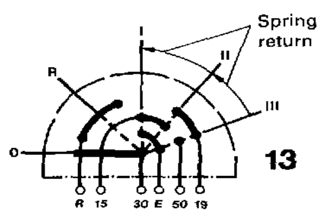


Fig. 211A

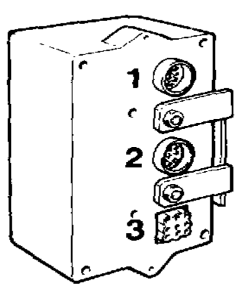


Fig. 212. Connection box

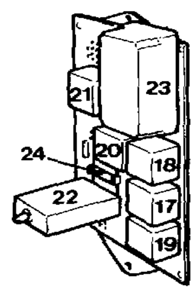


Fig. 213. Connection box

1. 16-pole connector for engine wiring (senders, switches etc.)
2. 16-pole connector for instrument wiring
3. 9-pole connector for engine wiring (starter motor, stop solenoid, signal horn)

17.* Stop relay (for current carrying stop solenoid when running)
18. Start relay
19. Stop relay
20. Interlock relay
21. Earthing relay
22. Automatic fuse 8A
23. Time relay
24. Fuse 35A (transition connection)

** Same position no. as in wiring diagram on next page.*

Wiring Diagram

Industrial engines

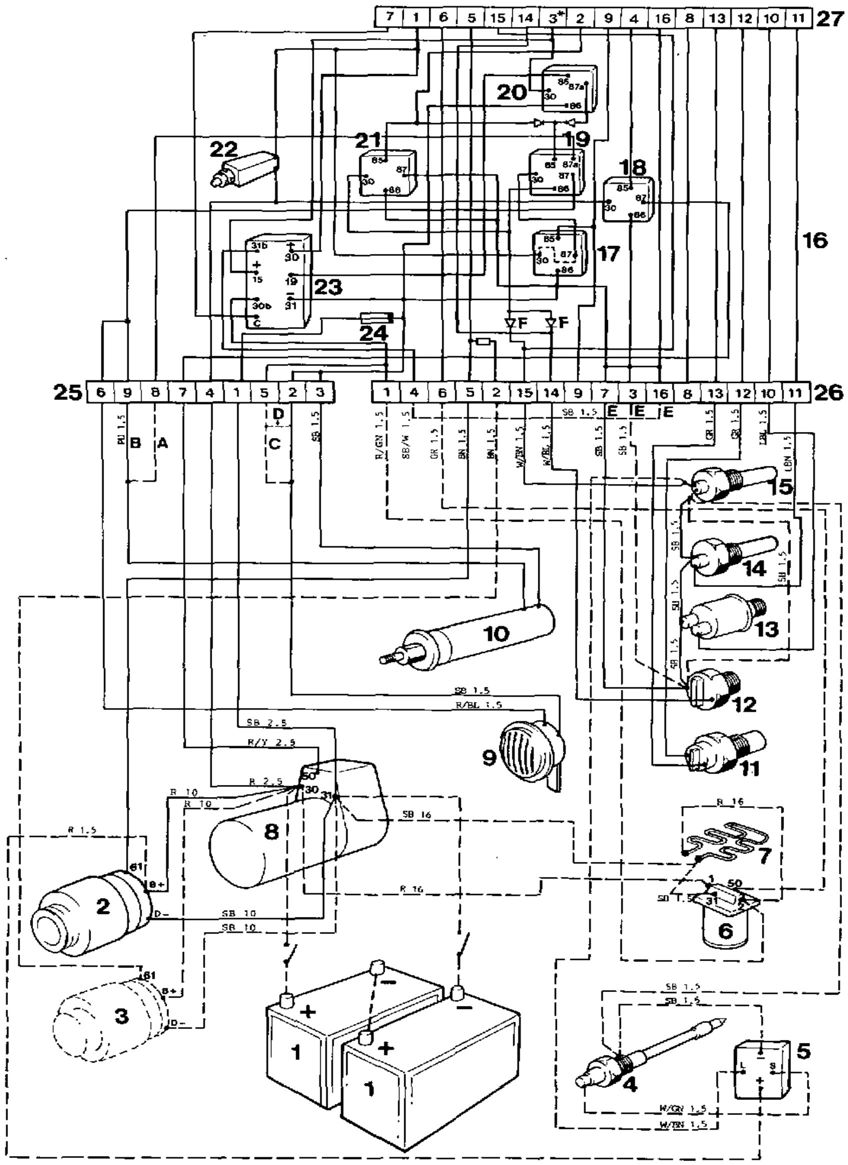


Fig. 214. ENGINE

1. Battery
2. Alternator
3. Extra alternator
4. Coolant level warner
5. Relay
6. Relay for pre-heater
7. Pre-heater
8. Starter motor
9. Signal horn
10. Stop solenoid
11. Speed sender
12. Oil pressure switch
13. Oil pressure sender
14. Coolant temperature sender
15. Coolant temperature switch
16. Printed circuit card
17. Stop relay,[1] fitted only for current carrying stop solenoid when running. When stop solenoid is current carrying when stopped, connect across 30 and 87 (dotted line).
18. Start relay[1]
19. Stop relay[1]
20. Inerlock relay[1]
21. Earthing relay[1]
22. Automatic fuse, 8A[1]
23. Time relay[1]
24. Fuse 35A (transition connection)
25. 9-pole connector[1]
26. 16-pole connector[1]
27. 16-pole connector[1] (for instrument wiring)

A. Connected for current carrying stop solenoid when running.
B. Connected for current carrying stop solenoid when stopped.
C. When pre-heater is used, move cable from terminal 2 to terminal 5. Remove transition connection D.
D. Only fitted on engines without pre-heater.
E. Negative connections.
F. Diodes (only on engines with auto stop).

* Must be no voltage when starting.
[1] Located in connection box.

Cable colours

GR	= Grey	W	= White
SB	= Black	BL	= Blue
BN	= Brown	LBL	= Light blue
LBN	= Light brown	OR	= Orange
R	= Red		
PU	= Purple		
GN	= Green		
Y	= Yellow		

Cable cross-section areas in mm²

Relationship mm²/AWG

mm²	1.5	2.5	10	16
AWG	15 (16)	13	7	5

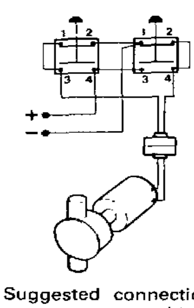


Fig. 215. Suggested connection for oil scavenger pump (draining and filling). Cable area 1.5 mm.

Wiring Diagram

Marine engines

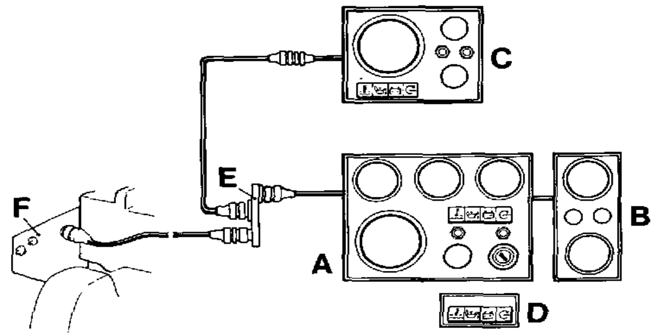


Fig. 216. Block diagram

A. Basic instrument panel.
B. Supplementary panel.
C. Panel for alternative manoeuvre position (Flying Bridge)*.
D. Alarm panel (used only when basic panel "A" is not fitted).
E. T-connector.
F. Connection box with fuses.

* *The basic panel (A) can also be fitted in the alternative manoeuvre position.* (The temperature and oil pressure senders must therefore be exchanged).

Cable colours

GR	= Grey	GN	= Green
SB	= Black	Y	= Yellow
BN	= Brown	W	= White
LBN	= Light brown	BL	= Blue
R	= Red	LBL	= Light blue
PU	= Purple	OR	= Orange

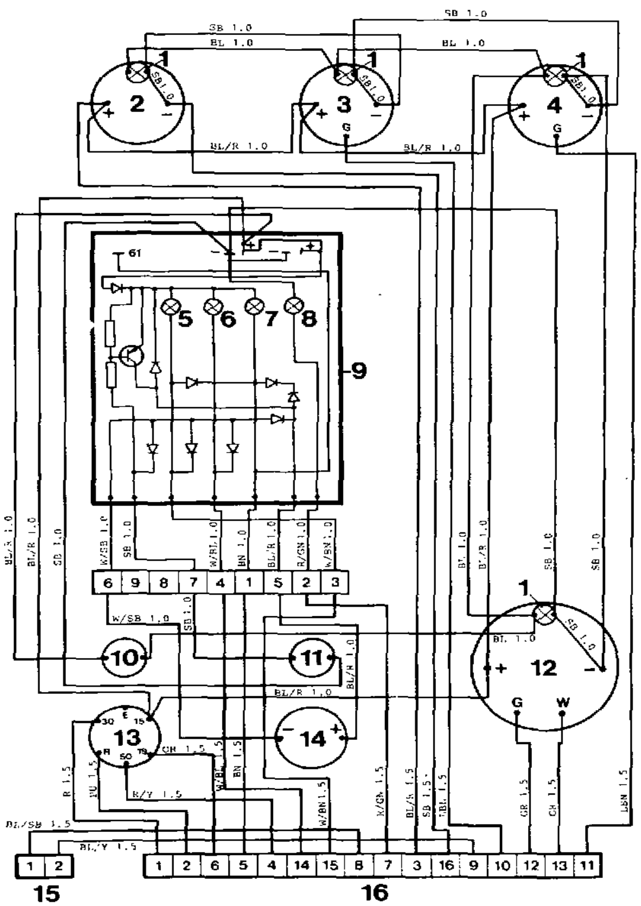
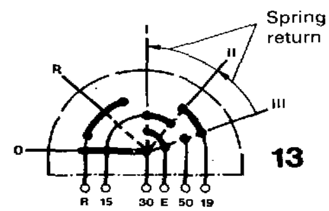


Fig. 217. Basic instrument panel

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. Control lamp (not used)
9. Printed circuit card
10. Switch, instrument lighting
11. Switch, alarm test
12. Revolution counter
13. Key switch
14. Alarm
15. 2-pole connector (for supplementary instrument panel)
16. 16-pole connector



Cable cross-section areas in mm²

Relationship mm²/AWG

mm²	1.0	1.5
AWG	16 (17)	15 (16)

Wiring Diagram

Marine engines

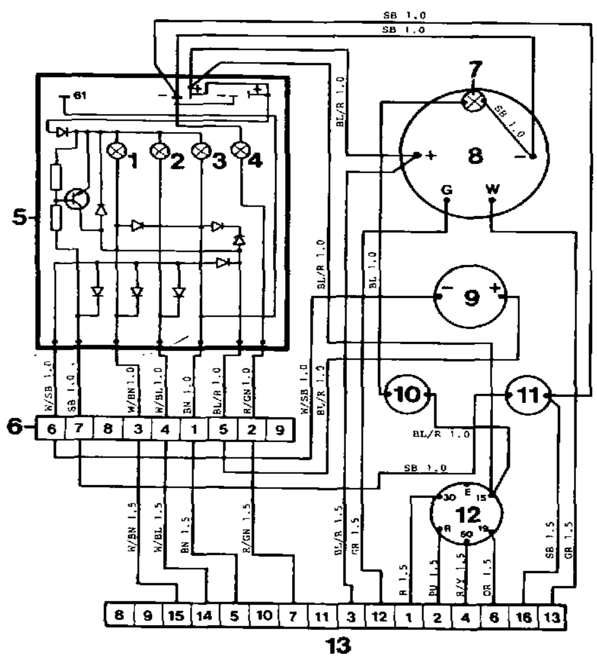
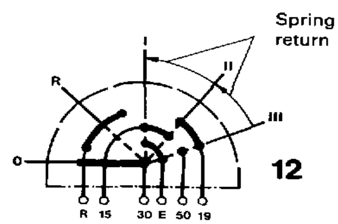


Fig. 218. Panel for alternative manoeuvre position (Flying Bridge)

1. Warning lamp, cooling water temperature
2. Warning lamp, oil pressure
3. Warning lamp, charging
4. Control lamp (not used)
5. Printed circuit card
6. 9-pole connector
7. Instrument lighting
8. Revolution counter
9. Alarm
10. Switch, instrument lighting
11. Switch, alarm test
12. Key switch
13. 16-pole connector



Cable colours

GR	= Grey	GN	= Green
SB	= Black	Y	= Yellow
BN	= Brown	W	= White
LBN	= Light brown	BL	= Blue
R	= Red	LBL	= Light blue
PU	= Purple	OR	= Orange

Cable cross-section areas in mm²

Relationship mm²/AWG

mm²	1.0	1.5
AWG	16 (17)	15 (16)

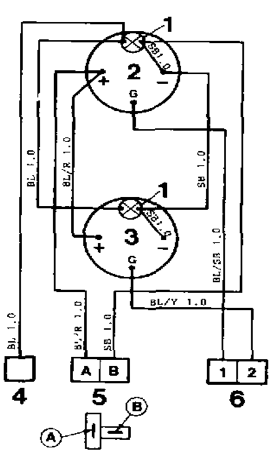


Fig. 219. Supplementary panel

1. Instrument lighting
2. Oil pressure – reverse gear
3. Pressure gauge – turbo charging pressure
4. Connection to instrument lighting on basic panel
5. Connection to printed circuit card on basic panel
6. Connection to connector (15) on basic panel

Wiring Diagram

Marine engines

Engines with Paris-Rhône alternator (28V/55A)

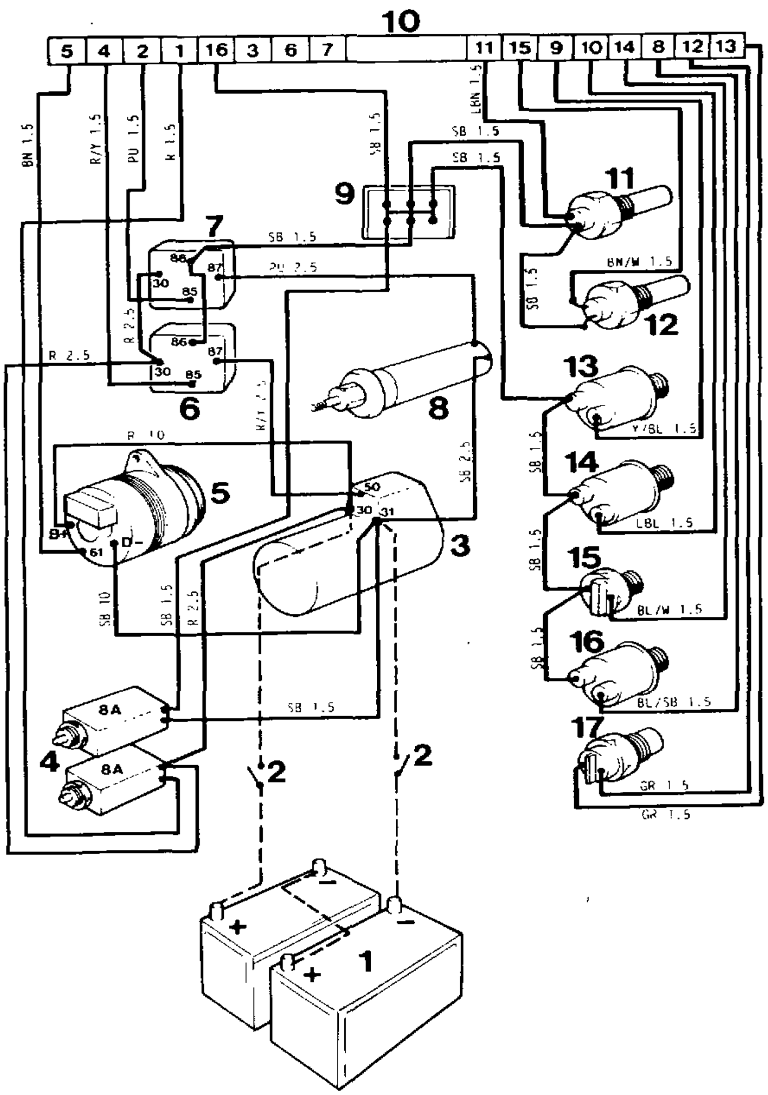


Fig. 220. Engine

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*
11. Cooling water temperature sender
12. Cooling water temperature switch
13. Pressure sender, turbo
14. Oil pressure sender, engine
15. Oil pressure switch
16. Oil pressure sender, reverse gear
17. Speed sender

* Located in connection box

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

Cable cross-section areas in mm²

Relationship mm²/AWG

mm²	1.5	2.5	10
AWG	15 (16)	13	7

Wiring Diagrams

Marine engines

Engines with CAV-alternator (28V/60A), optional equipment

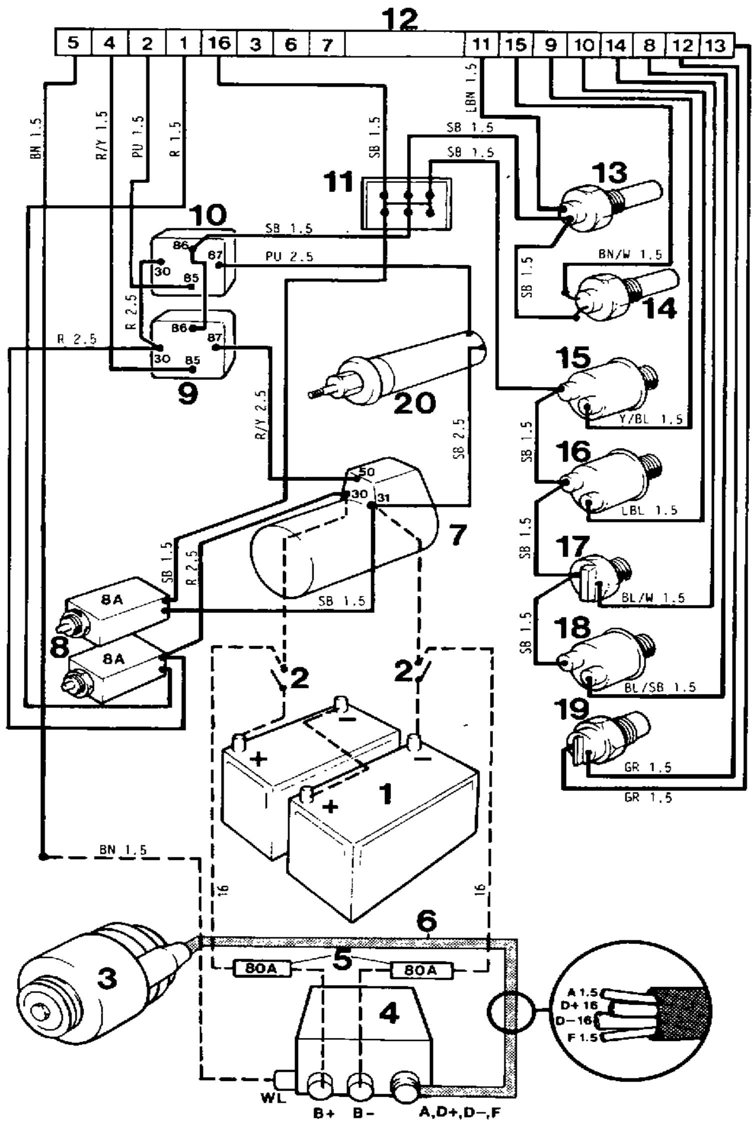


Fig. 221. Motor

1. Battery
2. Main switch
3. Alternator (CAV)
4. Regulator box
5. Fuses*
6. Shielded ships cable
7. Starter motor
8. Automatic fuses*
9. Start relay (16MS)*
10. Stop relay (16S)*
11. Earth terminal*
12. Connector*
13. Cooling water temperture sender
14. Cooling water temperature switch
15. Pressure sender, turbo
16. Oil pressure sender, engine
17. Oil pressure switch
18. Oil pressure sender, reverse gear
19. Revolution counter
20. Stop solenoid

* Located in connection box

Cable cross-section areas in mm²

Relationship mm²/AWG

mm²	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

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