WÄRTSILÄ VASA 22

PROJECT GUIDE
FOR
MARINE APPLICATIONS

WÄRTSILÄ VASA FACTORY
65100 VASA FINLAND, TELEX 74250 wva sf TELEPHONE 358/61/111 433

CONTENTS

GENERAL DATA AND OUTPUTS

The diesel engine Wärtsilä Vasa 22 is a 4-stroke, non-reversible, turbocharged and intercooled engine with direct injection of fuel.

Cylinder bore	220 mm
Stroke	240 mm
Piston displacement	9.13 l/cyl.
Number of valves	2 inlet valves 2 exhaust valves
Cylinder configuration	4,6,8 in-line 12, 16 in V-form
V-angle	55°
Compression ratio	11.4:1
Compression pressure, max.	90 bar
Firing pressure, max.	140 bar
Charging pressure	1.9 bar
Direction of rotation	Clockwise Counter-clockwise on request

TECHNICAL MAIN DATA

Speed	RPM	900	1000	1200
Cylinder output	kW	132.5	147.5	160
Cylinder output	hp	180	200	217.5
Mean effective pressure	bar	19.4	19.4	17.5
Mean piston speed	m/s	7.2	8.0	9.6
Fuel consumption	see technical data			
Lube oil consumption	see technical data			

The stated values of fuel oil consumption apply to engines equipped according to the basic engine specification and operating on a fuel with a lower calorific value of 42,000 kJ/kg (10,030 kcal/kg) and in ambient conditions according to ISO 3046/I, that is

• air pressure	1.0 bar
• air temperature	27° C
• cooling water temperature before air cooler	27° C

The values are subject to a tolerance of + 3 %

FUEL SPECIFICATION

Engines of the type Wärtsilä Vasa 22 are normally equipped for burning heavy fuel according to the following specification.

The Wärtsilä Vasa 22HF engine accepts without any load limitation fuel with the following characteristics:

Viscosity at 50°C	240 cSt
Viscosity at 100°F	2000 sRI
Density at 15°C	0.980
Conradson Carbon Residue	12 %
Sulphur content	4 %
Vanadium content	300 ppm
Sodium content	50 ppm
Ash	0.08 %
Water (before engine)	0.2 %

The Wärtsilä Vasa 22HE engine accepts without any load limitation fuel with the following characteristics:

Viscosity at 50°C	100 cSt
Viscosity at 100°F	800sRI
Density at 15°C	0.980
Conradson Carbon Residue	10 %
Sulphur content	4 %
Vanadium content	300 ppm
Sodium content	50 ppm
Ash	0.08 %
Water (before engine)	0.2 %

Booth the type 22HF and the 22HE are equally equipped. For the 22HF the maximum engine speed is 1000 RPM and for the type 22HE 1200 RPM.
For engines burning marine diesel fuel and intermediate fuel with a viscosity up to 30 cSt/50°C the load dependent cooling water system and the nozzle temperature control system can be omitted.

The basic construction is similar for all engines irrespective of the fuel quality and therefore the letters »HF» and »HE» are not used if not especially required for pointing out a certain difference.

CONTINUOUS OUTPUT

MAIN PROPULSION ENGINES

Engine	900 RPM kW	900 RPM hp	1000 RPM kW	1000 RPM hp	1200 RPM kW	1200 RPM hp
4R22	530	720	590	800	640	870
6R22	795	1080	885	1200	060	1305
8R22	1060	1440	1180	1605	1280	1740
12V22	1590	2160	1770	2405	1920	2610
16V22	2120	2885	2360	3210	1560	3480

The maximum fuel rack position is mechanically limited to 100 + 2-0 % of the continuous output.

AUXILIARY ENGINES

60 Cycle frequency

Engine	900 RPM engine kW	900 RPM alternator kVA	900 RPM alternator kW	1200 RPM engine kW	1200 RPM alternator kVA	1200 RPM alternator kW
4R22	530	625	500	640	745	600
6R22	795	935	750	960	1115	890
8R22	1060	1250	1000	1280	1490	1190
12V22	1590	1870	1500	1920	2240	1790
16V22	2120	2500	2000	2560	2985	2390

50 Cycle frequency

Engine	1000 RPM engine kW	1000 RPM alternator kVA	1000 RPM alternator kW
4R22	590	690	550
6R22	885	1040	830
6R22	885	1040	830
8R22	1180	1380	1100
12V22	1770	2080	1660
16V22	2360	2760	2200

For auxiliary engines the permissible overload is 10 % for one hour every twelve hours. The maximum fuel rack position is mechanically limited to 110 % + -2 % continuous output.

The alternator outputs are calculated for an efficiency of 0.94 and a power factor of 0.8.
The reference conditions for the stated continuous outputs are according to ISO 3046/I. The outputs also apply to an inlet sea water temperature of 32°C (low temperature fresh water inlet 38°C) and an ambient temperature of 45°C.
The above outputs are also available from the free end of the engine, if necessary.
For engines with non-synchronous speed the nominal maximum speed can be specified to any value between 800 and 1200 RPM.

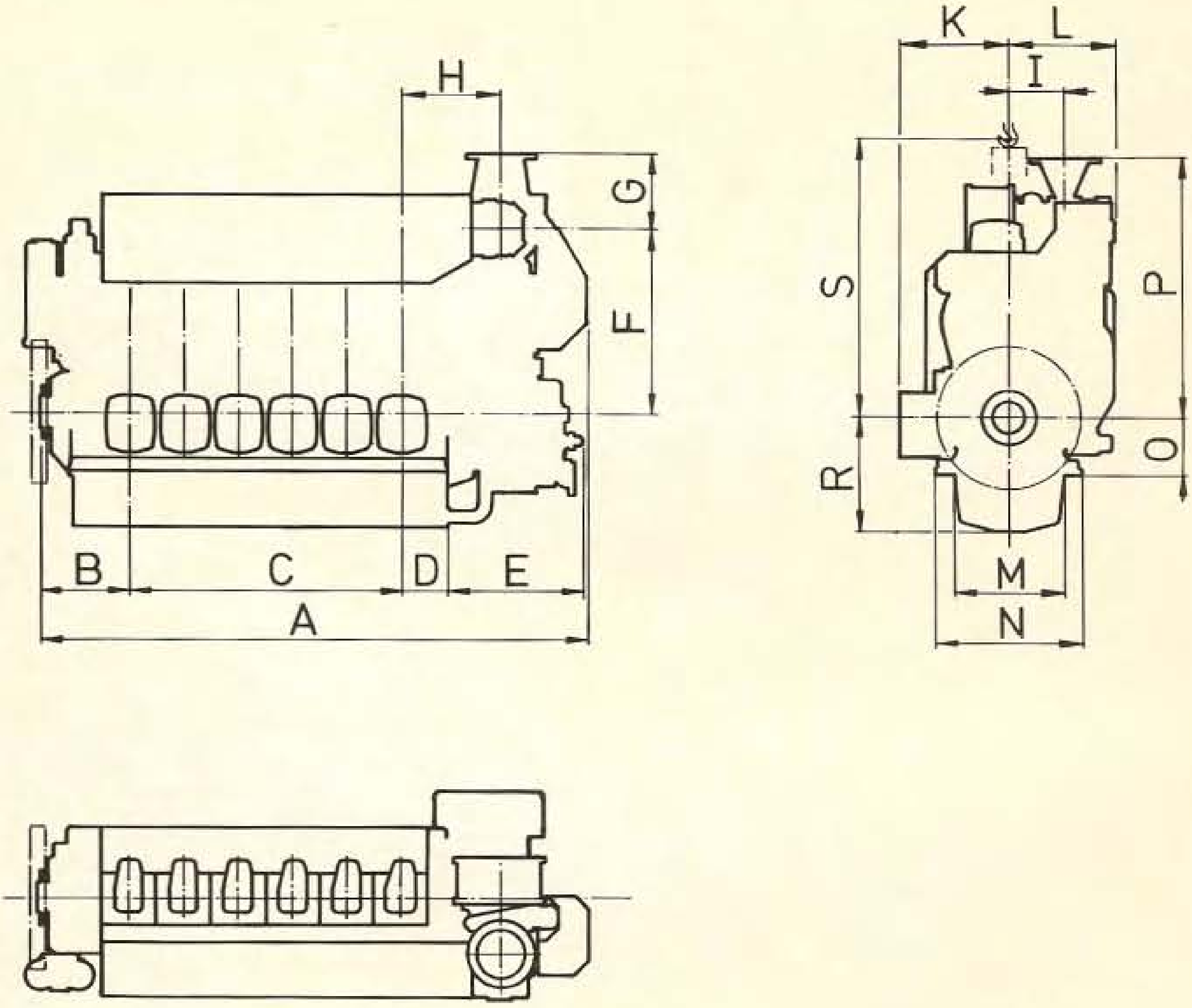
The cylinder output P_1 can be calculated as follows:

P_1(kW) = P_e(bar) x n (RPM) x 0.00760
P_1(hp) = P_e(bar) x n (RPM) x 0.01031
P_1 output per cylinder
P_e mean effective pressure
n engine speed

The maximum permissible mean effective pressure is limited by a line which can be found from the mean effective pressures at various speeds on the table »Technical data».

PRINCIPAL DIMENSIONS AND WEIGHTS

IN-LINE ENGINES R22



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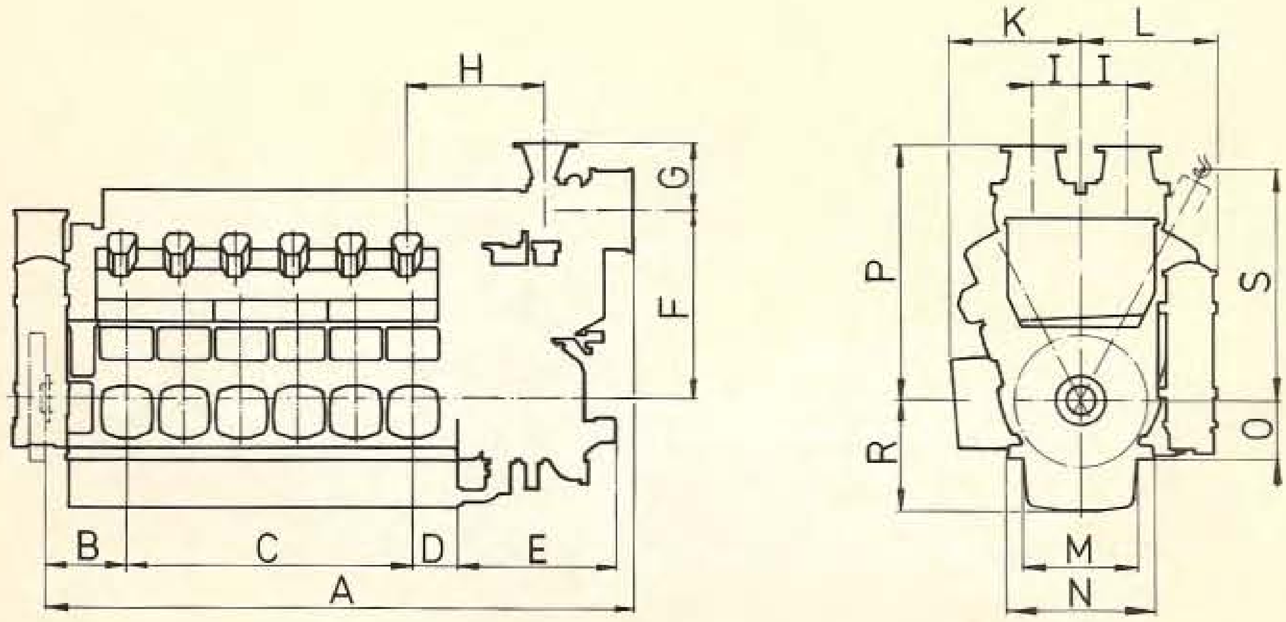
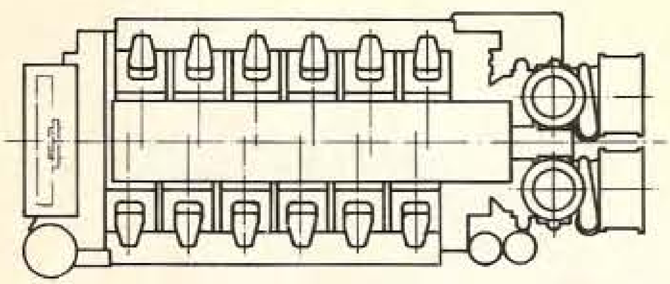
Engine	A	B	C	D	E	F	G	H	I
4R22	2770	517	1020	280	950	1132	418	625	363
6R22	3420	517	1700	280	945	1175	515	620	340
8R22	4177	517	2380	280	1000	1260	600	680	292
			M	N	O	P	R	S	Wet weight:ton exl. flywheel
4R22			660	900	355	1550	710	1750	6,5
6R22			660	900	355	1600	710	1750	9,3
8R22			660	900	355	1860	710	1750	11,3

VEE-ENGINES V22

CCGS SAMUEL RISLEY FITTED WITH 12V22 ENGINES





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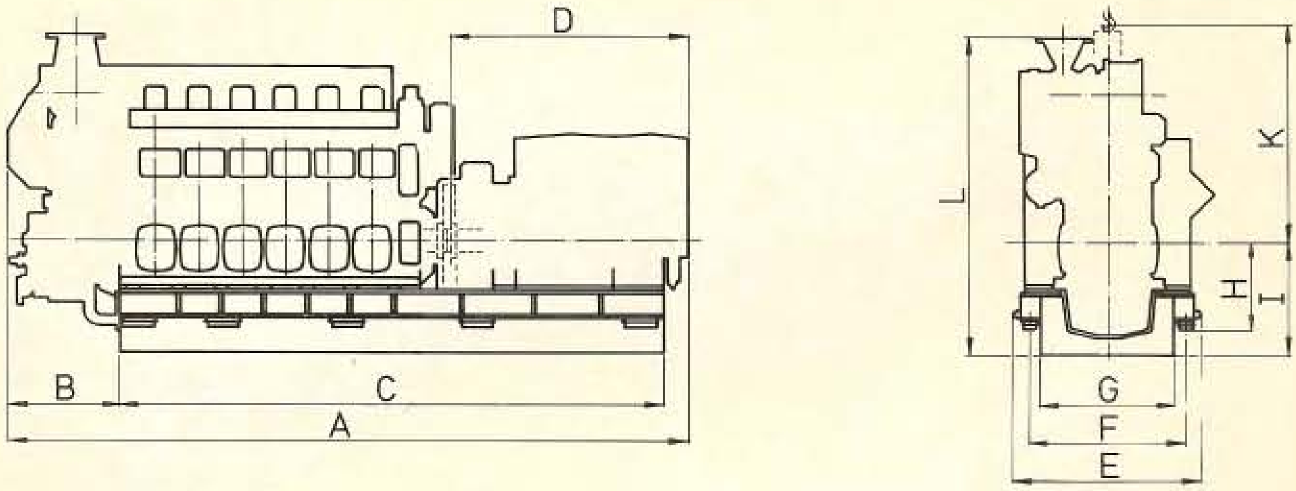
Engine	A	B	C	D	E	F	G	H	I
12V22	4010	542	1950	305	1080	1300	515	905	315
~~16V22~~	~~4852~~	~~542~~	~~2730~~	~~305~~	~~1080~~	~~1375~~	~~600~~	~~905~~	~~390~~

	K	L	M	N	O	P	R	S	Wet weight: ton excl. flywheel
12V22	1040	940	750	1000	400	1815	755	1600	15.4
~~16V22~~	~~1040~~	~~940~~	~~750~~	~~1000~~	~~400~~	~~2000~~	~~755~~	~~1600~~	~~18,0~~

GENERATING SETS R22



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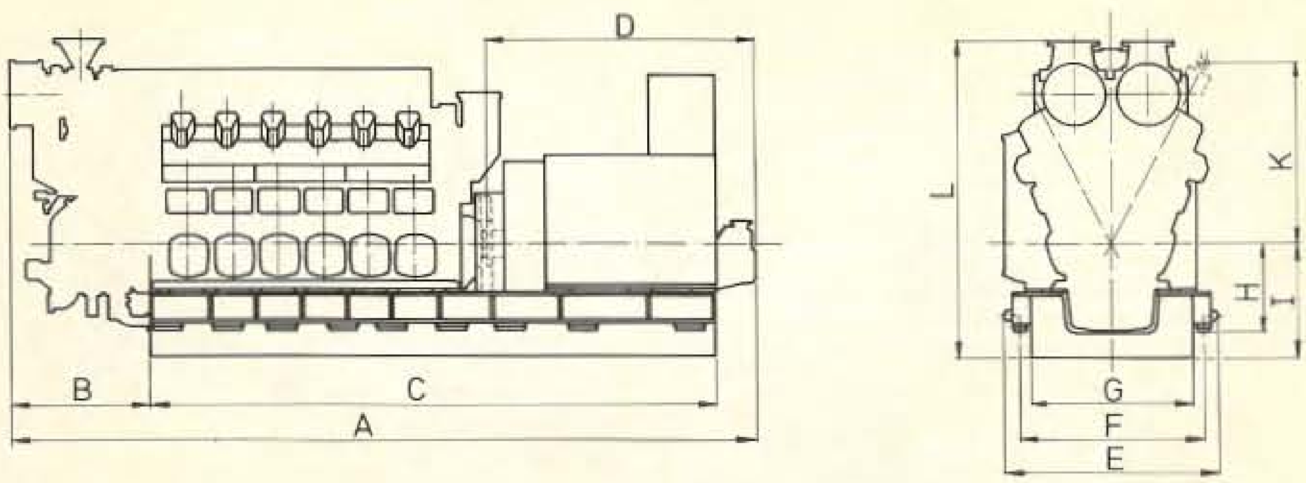
Engine	A	B	C	D	E	F	G	H	I
4R22	4610	950	3600	1850	1490	1250	1050	710	900
6R22	5500	945	4400	1850	1490	1250	1050	710	900
8R22	6270	1000	5020	1850	1490	1250	1050	710	900

	K	L	Appr.wet weight, ton
4R22	1750	2365	13,7
6R22	1750	2590	16,0
8R22	1750	2760	20,0

GENERATING SETS V22



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Engine	A	B	C	D	E	F	G	H	I
12V22	6400	1210	4900	2320	1850	1600	1410	760	1000
16V22	7320	1275	5580	2320	1850	1600	1410	760	1000

	K	L	Appr.wet weight, ton
12V22	1600	2817	30,0
16V22	1600	2980	34,8

DIMENSIONING OF PROPELLERS

• CP-PROPELLER

CP-propellers are normally designed so that the necessary engine output is 90...100 % of the maximum continuous output at nominal maximum speed.
Shaft generators or generators connected to the free end of the engine should be considered when dimensioning propellers in case continuous generator output is to be used at sea.
Overload protection or load control is recommended in all installations. In installations where several engines are connected to the same propeller, overload protection or load control is necessary.

• FP-PROPELLER

The dimensioning of FP-propellers should be estimated very thoroughly for every vessel as there are only limited possibilites to control the absorbed power.
Factors which influence the design are:

- The propulsion resistance of the ship increases with time.
- The wake factor of the ship increases with time.
- The propeller blade frictional resistance in water increases with time.
- Bollard pull requires higher torque than free running.
- Propellers rotating in ice require higher torque.

The FP-propeller should normally be designed so that it absorbs 85 % of the maximum continuous output of the engine at nominal speed when the ship is on trial, at specified speed and load.
For ships intended for towing, the propeller can be designed for 95 % of the maximum continuous output of the engine at nominal speed for bollard pull or at towing speed. The absorbed power at free running and nominal speed is usually then relatively low, 65...80 % of the output at bollard pull.
For ships intended for heavy operation in ice, the conditional torque of the ice should furthermore be considered.

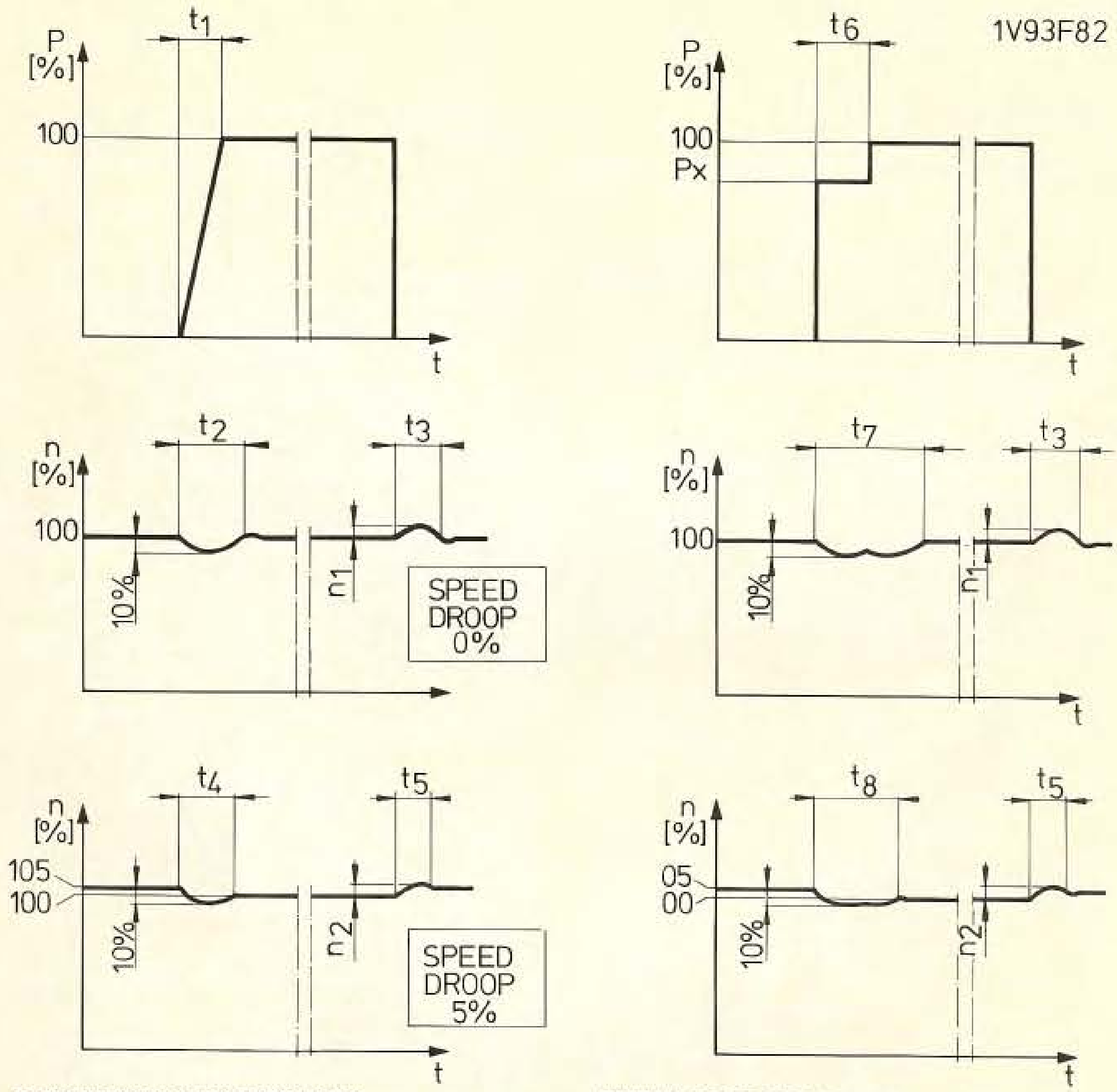
LOADING CAPACITY FOR GENERATING SETS

Provided that the engine is preheated to operating temperature or the cooling water temperature is min. 50°C, the engine can be loaded immediately after start without other restrictions than the maximum transient frequency deviation specified by the classification societies. For supercharged engines, 100 % load cannot be instantly applied due to the air deficit until the turbocharger has accelerated. At instant loading the speed and the frequency drop for a few seconds. The engine can be loaded most quickly by a successive, gradual increase in load from 0 to 100 % over a certain time (t).

Loading in two steps, with a load application in the first step by highest possible load (= max. permissible instant frequency drop) will take the longest time to achieve stable frequency.
The stated values of loading performance are guidance values, as the mass-moment of inertia of the set, the governor adjustment and nominal output influence the values.
Demands of the classification societies for generating sets at an instant speed drop of 10 %:

• American Bureau of Shipping	0 — 50 — 100 %
• Bureau Veritas	50 % on base load
• Det Norske Veritas	0 — 50 — 100 %
• Germanischer Lloyd	0 — 50 — 100 %
• Lloyd's Register of Shipping	0 — 40 — 70 — 100 %
• Register of the USSR	0 — 70 — 100 %
• Registro Italiano Navale	0 — 50 — 100 %

LOADING PERFORMANCE 1V93F82



SUCCESSIVE LOAD APPLICATION

t_1 = shortest possible time for successive, gradually increased load for a speed (and frequency) drop of max. 10 %

t_1 = 3 seconds

t_2 = time elapsing before speed has stabilized at the initial value (speed droop = 0 %)

t_2 = 6 seconds

t_4 = time elapsing before the speed has stabilized at the new value determined by the speed droop (speed droop = 5 %)

t_4 = 5.5 seconds

INSTANT LOAD APPLICATION

P_x = highest possible load which can be instantly applied to provide a speed drop of max. 10 %

P_x = 55 % 4R22
62 % 6R... 16V22

t_6 = shortest possible time elapsing between the first and second load application

t_6 = 5 seconds

t_7 = time elapsing before the speed has stabilized at the initial value (speed droop = 0 %)

t_7 = 9 seconds

t_8 = time elapsing before the speed has stabilized at the new value determined by the speed droop (speed droop = 5 %)

t_8 = 8.5 seconds

INSTANT UNLOADING

t_3 = time elapsing before the speed has stabilized at the initial value (speed droop = 0 %)

t_3 = 2 seconds

t_5 = time elapsing before the speed has stabilized at the new value determined by the speed droop (speed droop = 5 %)

t_5 = 1.8 seconds

n_1 = increase in speed at instant unloading (speed droop = 0 %)

n_1 = 8 %

n_2 = increase in speed at instant unloading (speed droop = 5 %)

n_2 = 10 %

RESTRICTIONS FOR OPERATION AT LOW AIR TEMPERATURES

When planning ships for subzero and arctic conditions special attention should be paid to the engine room ventilation. When the air temperature falls below the mentioned limits the combustion air should be preheated before entering the engine.

- To ensure starting, the inlet air temperature should be min. + 5°C if the engine is not preheated, irrespective of the cooling water system. With engines preheated to 30...50°C, the inlet air temperature should be min. —20°C and for engines without the load dependant cooling water system, the inlet air temperature should be min. —5°C.
- For continuous idling and very low load, the inlet air temperature should be min. —20°C, for engines without the load dependent cooling water system —5°C. It is recommended that the engine is partly loaded as soon as possible.
- The lowest permissible inlet air temperature at full load is —20°C.
  Without any special arrangement on the turbocharging system the recommended min. temperature is 0°C.

RESTRICTIONS FOR LOW LOAD OPERATION AND IDLING

The engine can be started, stopped and run on heavy fuel under all operating conditions. We prefer continous operation on heavy fuel rather than shifting over to diesel fuel at low load operation and manoeuvring.
The following recommendations apply to idling and low load operation:

Absolute idling (declutched main engine, unloaded generator):
- Max. 10 min. if the engine is to be stopped after the idling.
- Max. 6 hours if the engine is to be loaded after the idling.

Operation at 5...20 % load:
- Max. 100 hours continuous operation. At intervals of 100 operating hours the engine must be loaded to min. 70 % of the rated load.

Operation at higher than 20 % load:
- No restrictions.

LUBRICATING OIL QUALITY

The system oil should be of viscosity class SAE 30 (ISO VG 100). On request, an oil of viscosity class SAE 40 (ISO VG 150) can be accepted.
The content of additives should meet the requirements of MIL-L-2104C or API Service CD.
The alcalinity, TBN, of the system oil should be 20...40 (mg KOH/g); higher at higher sulphur content of the fuel.
The following lubricating oils are approved on the basis of engine tests:

• BP	Energol IC-HF 303
• Castrol	MXD 304
• Esso	Tro-Mar SR 30
• Gulf	Veritas Select 30
• Mobil	Mobilgard 324
• Nynäs	Aurelia 40
• Olje-energi	Goth Oil 325
• Shell	Argina T Oil 30
• Teboil	Teboil WARD S 30T SAE 30
• Texaco	Taro DP 30

For the turbocharger, turbine oils are preferred. A mineral oil of 52...87 cSt viscosity at 40°C can also be used.

Oil quantity

Engine	Litres
4R22	3
6R22	4
8R22	4.5
12V22	2 x 4
16V22	2 x 4.5

For the governor, both turbine and normal system oil can be used.

Oil quantity in governor and booster

Governor	Litres
Woodward UG8	1.7
Woorward PG16	1.7

OVERHAUL INTERVALS AND TIMES REQUIRED FOR OVERHAUL

The following overhaul intervals are guidance values:

	A	B	C	D	E
Piston	8000	16000	50000	50000	1,0
Cylinder head	8000	16000			0,75
Cylinder liner	16000	16000	40000	50000	0,5
Inlet valve	8000	16000	20000	24000	
Exhaust valve	8000	16000	12000	24000	
Injection valve	4000	4000			0,25
Injection valve nozzle					
Injection pump	8000	16000			0,5
Injection pump element					
Big end bearing	8000	16000	24000	32000	0,5
Main bearing shell	16000	16000	32000	48000	1,0

A = Overhaul interval in hours for running on heavy fuel

B = Overhaul interval in hours for running on marine diesel fuel.

C = Expected life time in hours for running on heavy fuel.

D = Expected life time in hours for running on marine diesel fuel.

E = Time required for the overhaul work in man hours for two men.

TECHNICAL DATA
DIESEL ENGINE WÄRTSILÄ VASA 4R22

Engine speed		RPM	900	1000	1200
Engine output		kW	530	590	640
Engine output		hp	720	800	870
Cylinder bore		mm		220	
Stroke		mm		240	
Swept volume		dm^3		36.5	
Compression ratio				11.4:1	
Compression pressure, max.		bar		90	
Firing pressure, max.		bar		140	
Charge air pressure		bar	1.9	1.9	1.8
Mean effective pressure		bar	19.4	19.4	17.5
Mean piston speed		m/s	7.2	8.0	9.6
Idling speed	1)	RPM		600	
Combustion air system					
Flow of air		kg/s	1.07	1.21	1.38
Ambient air temp., max.		°C		45	
Air temp. after air cooler		°C		40...75	
Air temp. after air cooler, alarm		°C		80	
Exhaust gas system					
Exhaust gas quantity (100 % load)		kg/s	1.10	1.25	1.42
Exhaust gas quantity (90 % load)		kg/s	1.03	1.14	1.30
Exhaust gas quantity (75 % load)		kg/s	0.90	0.98	1.12
Exhaust gas temp. after turbocharger					
(100 % load)	2)	°C	370	380	390
(90 % load)	2)	°C	350	360	370
(75 % oload)	2)	°C	320	330	340
Exhaust gas back pressure, recommended max.		bar		0.03	
Exhaust gas pipe diameter, min.		mm		300	
Heat balance	3)				
Effective output		MJ/h	1910	2120	2300
Lubricating oil		MJ/h	230	250	300
Jacket water		MJ/h	570	630	730
Charge air		MJ/h	580	650	740
Exhaust gas		MJ/h	1410	1580	1780
Radiation		MJ/h	130	140	150
Fuel system					
Pressure before built-on feed pump, nom.		bar		3	
Pressure before built-on feed pump, max.		bar		4	
Pressure before built-on feed pump, min.		bar		2	
Pressure before built-on feed pump for MDF, min.		bar		0.2	
Pressure before injection pumps		bar		9	
Pump capacity, nom. (= min.)	4)	m^3/h		0.6/0.9	
Fuel consumption (100 % load)	5)	g/kWh	211	211	218
Fuel consumption (75 % load)	5)	g/kWh	204	206	213
Fuel consumption (50 % load)	5)	g/kWh	213	213	220
Leak fuel quantity, clean fuel (100 % load)		kg/h		0.6	
Nozzle temperature control system					
Pressure before engine, nom.		bar		1.5	
Pressure before engine, alarm		bar		0.5	
Temperature before engine, nom.		°C		135	
Temperature before engine, min.		°C		130	
Temperature before engine, max.		°C		140	
Temperature before engine, alarm		°C		145/95	
Pump capacity		m^3/h		0.24	
System oil volume per engine, ca.		m^3		0.1	
Lubricating oil system					
Pressure before engine, nom.		bar	3.5	4.0	4.5
Pressure before engine, alarm		bar		2.0	
Pressure before engine, stop		bar		1.5	
Priming pressure, nom.		bar		0.8	
Priming pressure, alarm		bar		0.5	
Temperature before engine, nom.	6)	°C		70 (88)	
Temperature before engine, min.	6)	°C		65 (85)	
Temperature before engine, max.	6)	°C		74 (92)	
Temperature before engine, alarm	6)	°C		85 (100)	
Temperature after engine, nom.	6)	°C		81 (95)	
Pump capacity (main), direct driven		m^3/h	18	20	24

Pump capacity (main), separate		m^3/h	18	20	24
Pump capacity (priming)	4)	m^3/h		4.7/5.8	
Oil volume, wet sump, nom.		m^3		0.32	
Oil volume in separate system oil tank, nom.		m^3		0.8	
Filter fineness		microns		15	
Filter difference pressure, alarm		bar		1.5	
Oil consumption (100 % load), max.		g/kWh		1.2	
Cooling water system, conventional					
Jacket water system					
Pressure before engine, nom.		bar		2.5	
Pressure before engine, alarm		bar		1.0	
Pressure before engine, max.		bar		4.5	
Temperature before engine, nom.		°C		71	
Temperature before engine, min.		°C		68	
Temperature before engine, max.		°C		78	
Temperature after engine, nom.		°C		78	
Temperature after engine, max.		°C		86	
Temperature after engine, alarm		°C		90	
Temperature after engine, stop		°C		95	
Pump capacity, nom.		m^3/h	22	24	28
Pump capacity, min.		m^3/h	20	22	25
Pressure drop over engine		bar	0.4	0.5	0.7
Water volume in engine		m^3		0.09	
Pressure from gravity tank		bar		0.5...1.5	
Low temperature cooling water system					
Pressure before engine, nom.		bar		2.0	
Pressure before engine, alarm		bar		1.0	
Pressure before engine, max.		bar		5.3	
Temperature before engine, nom.		°C		25	
Temperature before engine, max.		°C		32	
Temperature before engine, min.		°C		12	
Pump capacity, nom.		m^3/h	22	24	28
Pump capacity, min.		m^3/h	20	22	25
Pressure drop over charge air cooler		br	0.15	0.20	0.25
Pressure drop over oil cooler		bar	0.20	0.25	0.30
Pressure drop over jacket water cooler		bar	0.20	0.25	0.30
Cooling water system, load dependent temp. control					
Pressure loss in fresh water cooler, nom.		bar		0.5	
Pressure loss in fresh water cooler, max.		bar		0.6	
Temperature after engine, nom.		°C		47	
Temperature after engine, max.		°C		53	
Temperature before air cooler, nom.	6)	°C		32 (75)	
Temperature before air cooler, max.		°C		38	
Capacity of built-on LT pump		m^3/h	22	24	28
Capacity of built-on HT pump		m^3/h	22	24	28
Pressure from gravity tank, nom.		bar		2.0 7)	1.0
Pressure from gravity tank, min.		bar		1.5 7)	0.7
Pressure from gravity tank, max.		bar		2.5	
Pump capacity, stand-by pump		bar	1.5	2.0	2.0
Temperature after jackets, nom.	6)	°C		78(106)	
Temperature after jackets, alarm	6)	°C		90(110)	
Temperature after jackets, stop		°C		115	
Temp. after built-on coolers, alarm	6)	°C		45 (85)	
Starting air system					
Air pressure, nom.		bar		30	
Air pressure, min. (20°C)		bar		14	
Air pressure, max.		bar		33	
Air pressure, alarm		bar		18	
Air consumption per start (20°C)	8) 9)	Nm^3		0.41	

1) The priming pump being connected, 350 RPM.
2) At an ambient temperature of 27°C.
3) The figures are without margins.
4) Capacities at 50 and 60 Hz respectively.
5) According to ISO 3046/I, lower calorific value 42,000 kJ/kg at constant engine speed, including engine driven pumps. Tolerance + —3 %.
6) At low load, for engines with load dependent temperature control of the cooling water.
7) Lower pressure and temperature allowed for certain auxiliary engines.
8) At remote and automatic starting, the consumption is 2...3 times higher.
9) With direct injection of starting air 0.20 Nm^3/start.

Edition 1981

Subject to revision without notice.

TECHNICAL DATA

DIESEL ENGINE WÄRTSILÄ VASA 6R22

Engine speed		RPM	900	1000	1200
Engine output		kW	795	885	960
Engine output		hp	1080	1205	1305
Cylinder bore		mm		220	
Stroke		mm		240	
Swept volume		dm^3		54.7	
Compression ratio				11.4:1	
Compression pressure, max.		bar		90	
Firing pressure, max.		bar		140	
Charge air pressure		bar	1.9	1.9	1.8
Mean effective pressure		bar	19.4	19.4	17.5
Mean piston speed		m/s	7.2	8.0	9.6
Idling speed	1)	RPM		600	
Combustion air system					
Flow of air		kg/s	1.68	1.89	2.08
Ambient air temp., max.		°C		45	
Air temp. after air cooler		°C		40...75	
Air temp. after air cooler, alarm		°C		80	
Exhaust gas system					
Exhaust gas quantity (100 % load)		kg/s	1.72	1.94	2.13
Exhaust gas quantity (90 % load)		kg/s	1.60	1.78	1.96
Exhaust gas quantity (75 % load)		kg/s	1.39	1.53	1.68
Exhaust gas temp. after turbocharger					
(100 % load)	2)	°C	360	370	380
(90 % load)	2)	°C	340	350	360
(75 % load)	2)	°C	310	320	330
Exhaust gas back pressure, recommended max.		bar		0.03	
Exhaust gas pipe diameter, min.		mm		350	
Heat balance	3)				
Effective output		MJ/h	2860	3190	3460
Lubricating oil		MJ/h	340	370	430
Jacket water		MJ/h	840	930	1080
Charge air		MJ/h	850	960	1090
Exhaust gas		MJ/h	2030	2260	2580
Radiation		MJ/h	190	210	230
Fuel system					
Pressure before built-on feed pump, nom.		bar		3	
Pressure before built-on feed pump, max.		bar		4	
Pressure before built-on feed pump, min.		bar		2	
Pressure before built-on feed pump for MDF, min.		bar		0.2	
Pressure before injection pumps		bar		9	
Pump capacity, nom. (= min.)	4)	m^3/h		0.6/0.9	
Fuel consumption (100 % load)	5	g/kWh	207	207	214
Fuel consumption (75 % load)	5)	g/kWh	202	202	209
Fuel consumption (50 % load)	5)	g/kWh	209	209	216
Leak fuel quantity, clean fuel (100 % load)		kg/h		0.9	
Nozzle temperature control system					
Pressure before engine, nom.		bar		1.5	
Pressure before engine, alarm		bar		0.5	
Temperature before engine, nom.		°C		135	
Temperature before engine, min.		°C		130	
Temperature before engine, max.		°C		140	
Temperature before engine, alarm		°C		145/95	
Pump capacity		m^3/h		0.36	
System oil volume per engine, ca.		m^3		0.1	
Lubricating oil system					
Pressure before engine, nom.		bar	3.5	4.0	4.5
Pressure before engine, alarm		bar		2.0	
Pressure before engine, stop		bar		1.5	
Priming pressure, nom.		bar		0.8	
Priming pressure, alarm		bar		0.5	
Temperature before engine, nom.	6)	°C		70 (88)	
Temperature before engine, min.	6)	°C		65 (85)	
Temperature before engine, max.	6)	°C		74 (92)	
Temperature before engine, alarm	6)	°C		85 (100)	

Temperature after engine, nom.	6)	°C		81 (95)	
Pump capacity (main), direct driven		m³/h	28	31	37
Pump capacity (main), separate		m³/h	23	26	31
Pump capacity (priming)	4)	m³/h		4.7/5.8	
Oil volume, wet sump, nom.		m³		0.450	
Oil volume in separate system oil tank, nom.		m³		1.2	
Filter fineness		microns		15	
Filter difference pressure, alarm		bar		1.5	
Oil consumption (100 % load), max.		g/kWh		1.2	
Cooling water system, conventional					
Jacket water system					
Pressure before engine, nom.		bar		2.5	
Pressure before engine, alarm		bar		1.0	
Pressure before engine, max.		bar		4.5	
Temperature before engine, nom.		°C		71	
Temperature before engine, min.		°C		68	
Temperature before engine, max.		°C		78	
Temperature after engine, nom.		°C		78	
Temperature after engine, max.		°C		86	
Temperature after engine, alarm		°C		90	
Temperature after engine, stop		°C		95	
Pump capacity, nom.		m³/h	34	38	45
Pump capacity, min.		m³/h	31	34	41
Pressure drop over engine		bar	0.4	0.5	0.7
Water volume in engine		m³		0.12	
Pressure from gravity tank		bar		0.5...1.5	
Low temperature cooling water system					
Pressure before engine, nom.		bar		2.0	
Pressure before engine, alarm		bar		1.0	
Pressure before engine, max.		bar		5.3	
Temperature before engine, nom.		°C		25	
Temperature before engine, max.		°C		32	
Temperature before engine, min.		°C		12	
Pump capacity, nom.		m³/h	34	38	45
Pump capacity, min.		m³/h	31	34	41
Pressure drop over charge air cooler		bar	0.25	0.30	0.40
Pressure drop over oil cooler		bar	0.20	0.25	0.30
Pressure drop over jacket water cooler		bar	0.20	0.25	0.30
Cooling water system, load dependent temperature control					
Pressure loss in fresh water cooler, nom.		bar		0.5	
Pressure loss in fresh water cooler, max.		bar		0.6	
Temperature after engine, nom.		°C		46	
Temperature after engine, max.		°C		52	
Temperature before air cooler, nom.	6)	°C		32 (75)	
Temperature before air cooler, max.		°C		38	
Capacity of built-on LT pump		m³/h	34	38	45
Capacity of built-on HT pump		m³/h	34	38	45
Pressure from gravity tank, nom.		bar		2.0 7)	1.0
Pressure from gravity tank, min.		bar		1.5 7)	0.7
Pressure from gravity tank, max.		bar		2.5	
Pump capacity, stand-by pump		m³/h	34	38	45
Delivery head of stand-by pump		bar	2.0	2.0	2.8
Temperature after jackets, nom.	6)	°C		78 (106)	
Temperature after jackets, alarm	6)	°C		90 (110)	
Temperature after jackets, stop		°C		115 7)	
Temp. after built-on coolers, alarm	6)	°C		45 (85)	
Starting air system					
Air pressure, nom.		bar		30	
Air pressure, min. (20°C)		bar		11	
Air pressure, max.		bar		33	
Air pressure, alarm		bar		18	
Air consumption per start (20°C)	8)	Nm³		0.14	

1) The priming pump being connected, 350 RPM.
2) At an ambient temperature of 27°C.
3) The figures are without margins.
4) Capacities at 50 and 60 Hz respectively.
5) According to ISO 3046/I, lower calorific value 42,000 kJ/kg at constant engine speed, including engine driven pumps. Tolerance + — 3 %.
6) At low load, for engines with load dependent temperature control of the cooling water.
7) Lower pressure and temperature allowed for certain auxiliary engines.
8) At remote and automatic starting, the consumption is 2...3 times higher.

Edition 1981

Subject to revision without notice.

TECHNICAL DATA
DIESEL ENGINE WÄRTSILÄ VASA 8R22

Engine speed		RPM	900	1000	1200
Engine output		kW	1060	1180	1280
Engine output		hp	1440	1605	1740
Cylinder bore		mm		220	
Stroke		mm		240	
Swept volume		dm^3		730	
Compression ratio				11.4:1	
Compression pressure, max.		bar		90	
Firing pressure, max.		bar		140	
Charge air pressure		bar	1.9	1.9	1.8
Mean effective pressure		bar	19.4	19.4	17.5
Mean piston speed		m/s	7.2	8.0	9.6
Idling speed	1)	RPM		600	
Combustion air system					
Flow of air		kg/s	2.12	2.39	2.74
Ambient air temp., max.		°C		45	
Air temp. after air cooler		°C		40...75	
Air temp. after air cooler, alarm		°C		80	
Exhaust gas system					
Exhaust gas quantity (100 % load)		kg/s	2.18	2.46	2.81
Exhaust gas quantity (90 % load)		kg/s	2.03	2.26	2.58
Exhaust gas quantity (75 % load)		kg/s	1.77	1.94	2.21
Exhaust gas temp. after turbocharger					
(100 % load)	2)	°C	360	370	380
(90 % load)	2)	°C	340	350	360
(75 % load)	2)	°C	310	320	330
Exhaust gas back pressure, recommended max.		bar		0.03	
Exhaust gas pipe diameter, min.		mm		400	
Heat balance	3)				
Effective output		MJ/h	3820	4250	4610
Lubricating oil		MJ/h	450	500	580
Jacket water		MJ/h	1120	1240	1440
Charge air		MJ/h	1140	1270	1450
Exhaust gas		MJ/h	2690	3010	3440
Radiation		MJ/h	260	290	310
Fuel system					
Pressure before built-on feed pump, nom.		bar		3	
Pressure before built-on feed pump, max.		bar		4	
Pressure before built-on feed pump, min.		bar		2	
Pressure before built-on feed pump for MDF, min.		bar		0.2	
Pressure before injection pumps		bar		9	
Pump capacity, (= min.)	4)	m^3/h		0.6/0.9	
Fuel consumption (100 % load)	5)	g/kWh	207	207	214
Fuel consumption (75 % load)	5)	g/kWh	202	202	209
Fuel consumption (50 % load)	5)	g/kWh	209	209	216
Leak fuel quantity, clean fuel (100 % load)		kg/h		1.8	
Nozzle temperature control system					
Pressure before engine, nom.		bar		1.5	
Pressure before engine, alarm		bar		0.5	
Temperature before engine, nom.		°C		135	
Temperature before engine, min.		°C		130	
Temperature before engine, max.		°C		140	
Temperature before engine, alarm		°C		145/95	
Pump capacity		m^3/h		0.48	
System oil volume per engine, ca.		m^3		0.1	
Lubricating oil system					
Pressure before engine, nom.		bar	3.5	4.0	4.5
Pressure before engine, alarm		bar		2.0	
Pressure before engine, stop		bar		1.5	
Priming pressure, nom.		bar		0.8	
Priming pressure, alarm		bar		0.5	
Temperature before engine, nom.	6)	°C		70 (88)	
Temperature before engine, min.	6)	°C		65 (85)	
Temperature before engine, max.	6)	°C		74 (92)	
Temperature before engine, alarm	6)	°C		85 (100)	
Temperature after engine, nom.	6)	°C		81 (95)	
Pump capacity (main), direct driven		m^3/h	28	31	37
Pump capacity (main), separate		m^3/h	28	31	37
Pump capacity (priming)	4)	m^3/h		4.7/5.8	
Oil volume, wet sump, nom.		m^3		0.58	
Oil volume in separate system oil tank, nom.		m^3		1.6	
Filter fineness		microns		15	

Filter difference pressure, alarm		bar		1.5	
Oil consumption (100 % load), max.		g/kWh		1.2	
Cooling water system, conventional					
Jacket water system					
Pressure before engine, nom.		bar		2.5	
Pressure before engine, alarm		bar		1.0	
Pressure before engine, max.		bar		4.5	
Temperature before engine, nom.		°C		71	
Temperature before engine, min.		°C		68	
Temperature before engine, max.		°C		78	
Temperature after engine, nom.		°C		78	
Temperature after engine, max.		°C		86	
Temperature after engine, alarm		°C		90	
Temperature after engine, stop		°C		95	
Pump capacity, nom.		m^3/h	39	48	57
Pump capacity, min.		m^3/h	35	43	51
Pressure drop over engine		bar	0.4	0.5	0.7
Water volume in engine		m^3		0.16	
Pressure from gravity tank		bar		0.5...1.5	
Low temperature cooling water system					
Pressure before engine, nom.		bar		2.0	
Pressure before engine, alarm		bar		1.0	
Pressure before engine, max.		bar		5.3	
Temperature before engine, nom.		°C		25	
Temperature before engine, max.		°C		32	
Temperature before engine, min.		°C		12	
Pump capacity, nom.		m^3/h	39	48	57
Pump capacity, min.		m^3/h	31	43	51
Pressure drop over charge air cooler		bar	0.30	0.45	0.55
Pressure drop over oil cooler		bar	0.25	0.30	0.35
Pressure drop over jacket water cooler		bar	0.25	0.30	0.35
Cooling water system, load dependent temperature control					
Pressure loss in fresh water cooler, nom.		bar		0.5	
Pressure loss in fresh water cooler, max.		bar		0.6	
Temperature after engine, nom.		°C		47	
Temperature after engine, max.		°C		53	
Temperature before air cooler, nom.	6)	°C		32 (75)	
Temperature before air cooler, max.		°C		38	
Capacity of built-on LT pump		m^3/h	39	48	57
Capacity of built-on HT pump		m^3/h	39	48	57
Pressure from gravity tank, nom.		bar		2.0 7)	1.0
Pressure from gravity tank, min.		bar		1.5 7)	0.7
Pressure from gravity tank, max.		bar		2.5	
Pump capacity, stand-by pump		m^3/h	39	48	57
Delivery head of stand-by pump		bar	2.0	2.0	2.8
Temperature after jackets, nom.	6)	°C		78 (106)	
Temperature after jackets, alarm	6)	°C		90 (110)	
Temperature after jackets, stop		°C		115 7)	
Temp. after built-on coolers, alarm	6)	°C		45 (85)	
Starting air system					
Air pressure, nom.		bar		30	
Air pressure, min. (20°C)		bar		11	
Air pressure, max.		bar		33	
Air pressure, alarm		bar		18	
Air consumption per start (20°C)	8)	Nm^3		0.16	

1) The priming pump being connected, 350 RPM.
2) At an ambient temperature of 27°C.
3) The figures are without margins.
4) Capacities at 50 and 60 Hz respectively.
5) According to ISO 3046/I, lower calorific value 42,000 kJ/kg at constant engine speed, including engine driven pumps. Tolerance + —3 %.
6) At low load, for engines with load dependent temperature control of the cooling water.
7) Lower pressure and temperature allowed for certain auxiliary engines.
8) At remote and automatic starting, the consumption is 2...3 times higher.

Edition 1981

Subject to revision without notice.

TECHNICAL DATA

DIESEL ENGINE WÄRTSILÄ VASA 12V22

CCGS SAMUEL RISLEY

Engine speed		RPM	900	1000	1200
Engine output		kW	1590	1770	1920
Engine output		hp	2160	2405	2610
Cylinder bore		mm		220	
Stroke		mm		240	
Swept volume		dm^3		109.5	
Compression ratio				11.4:1	
Compression pressure, max.		bar		90	
Firing pressure, max.		bar		140	
Charge air pressure		bar	1.9	1.9	1.8
Mean effective pressure		bar	19.4	19.4	17.5
Mean piston speed		m/s	7.2	8.0	9.6
Idling speed	1)	RPM		600	
Combustion air system					
Flow of air		kg/s	3.36	3.79	4.11
Ambient air temp., max.		°C		45	
Air temp. after air cooler		°C		40...75	
Air temp. after air cooler, alarm		°C		80	
Exhaust gas system					
Exhaust gas quantity (100 % load)		kg/s	3.45	3.88	4.21
Exhaust gas quantity (90 % load)		kg/s	3.20	3.56	3.86
Exhaust gas quantity (75 % load)		kg/s	2.78	2.79	3.32
Exhaust gas temp. after turbocharger					
(100 % load)	2)	°C	360	370	380
(90 % load)	2)	°C	340	350	360
(75 % load)	2)	°C	310	320	330
Exhaust gas back pressure, recommended max.		bar		0.03	
Exhaust gas pipe diameter, min.		mm		500	
Heat balance	3)				
Effective output		MJ/h	5720	6370	6910
Lubricating oil		MJ/h	760	850	1000
Jacket water		MJ/h	1630	1820	2090
Charge air		MJ/h	1790	1990	2280
Exhaust gas		MJ/h	3950	4390	5020
Radiation		MJ/h	240	270	280
Fuel system					
Pressure before built-on feed pump, nom.		bar		3	
Pressure before built-on feed pump, max.		bar		4	
Pressure before built-on feed pump, min.		bar		2	
Pressure before built-on feed pump for MDF, min.		bar		0.2	
Pressure before injection pumps		bar		9	
Pump capacity, nom. (= min.)	4)	m^3/h		1.8/2.3	
Fuel consumption (100 % load)	5)	g/kWh	205	205	212
Fuel consumption (75 % load)	5)	g/kWh	200	200	207
Fuel consumption (50 % load)	5)	g/kWh	207	207	214
Leak fuel quantity, clean fuel					
(100 % load)		kg/h		1.8	
Nozzle temperature control system					
Pressure before engine, nom.		bar		1.5	
Pressure before engine, alarm		bar		0.5	
Temperature before engine, nom.		°C		135	
Temperature before engine, min.		°C		130	
Temperature before engine, max.		°C		140	
Temperature before engine, alarm		°C		145/95	
Pump capacity		m^3/h		0.72	
System oil volume per engine, ca.		m^3		0.15	
Lubricating oil system					
Pressure before engine, nom.		bar	3.5	4.0	4.5
Pressure before engine, alarm		bar		2.0	
Pressure before engine, stop		bar		1.5	
Priming pressure, nom.		bar		0.8	
Priming pressure, alarm		bar		0.5	
Temperature before engine, nom.	6)	°C		70 (88)	
Temperature before engine, min.	6)	°C		65 (85)	
Temperature before engine, max.	6)	°C		74 (92)	
Temperature before engine, alarm	6)	°C		85 (100)	
Temperature after engine, nom.	6)	°C		81 (95)	
Pump capacity (main), direct driven		m^3/h	46	51	61
Pump capacity (main), separate		m^3/h	37	41	49
Pump capacity (priming)	4)	m^3/h		8.1/9.7	

Oil volume, wet sump, nom.		m^3		0.67	
Oil volume in separate system oil tank, nom.		m^3		2.4	
Filter fineness		microns		15	
Filter difference pressure, alarm		bar		1.5	
Oil consumption (100 % load), max.		g/kWh		1.2	
Cooling water system, conventional					
Jacket water system					
Pressure before engine, nom.		bar		2.5	
Pressure before engine, alarm		bar		1.0	
Pressure before engine, max.		bar		4.5	
Temperature before engine, nom.		°C		71	
Temperature before engine, min.		°C		68	
Temperature before engine, max.		°C		78	
Temperature after engine, nom.		°C		78	
Temperature after engine, max.		°C		86	
Temperature after engine, alarm		°C		90	
Temperature after engine, stop		°C		95	
Pump capacity, nom.		m^3/h	68	75	90
Pump capacity, min.		m^3/h	61	68	81
Pressure drop over engine		bar	0.4	0.5	0.7
Water volume in engine		m^3		0.24	
Pressure from gravity tank		bar		0.5...1.5	
Low temperature cooling water system					
Pressure before engine, nom.		bar		2.0	
Pressure before engine, alarm		bar		1.0	
Pressure before engine, max.		bar		5.3	
Temperature before engine, nom.		°C		25	
Temperature before engine, max.		°C		32	
Temperature before engine, min.		°C		12	
Pump capacity, nom.		m^3/h	68	75	90
Pump capacity, min.		m^3/h	61	68	81
Pressure drop over charge air cooler		bar	0.25	0.30	0.40
Pressure drop over oil cooler		bar	0.25	0.30	0.35
Pressure drop over jacket water cooler		bar	0.25	0.30	0.35
Cooling water system, load dependent temperature control					
Pressure loss in fresh water cooler, nom.		bar		0.5	
Pressure loss in fresh water cooler, max.		bar		0.6	
Temperature after engine, nom.		°C		47	
Temperature after engine, max.		°C		53	
Temperature before air cooler, nom.	6)	°C		32 (75)	
Temperature before air cooler, max.		°C		38	
Capacity of built-on LT pump		m^3/h	68	75	90
Capacity of built-on HT pump		m^3/h	68	75	90
Pressure from gravity tank, nom.		bar		2.0 7)	1.0
Pressure from gravity tank, min.		bar		1.5 7)	0.7
Pressure from gravity tank, max.		bar		2.5	
Pump capacity, stand-by pump		m^3/h	68	75	90
Delivery head of stand-by pump		bar	2.0	2.8	
Temperature after jackets, nom.	6)	°C		78 (106)	
Temperature after jackets alarm	6)	°C		90 (110)	
Temperature after jackets, stop	6)	°C		45 (85)	
Temp. after built-on coolers, alarm		°C		115 7)	
Starting air system					
Air pressure, nom.		bar		30	
Air pressure, min. (20°C)		bar		11	
Air pressure, max.		bar		33	
Air pressure, alarm		bar		18	
Air consumption per start (20°C)	8)	Nm^3		0.18	

1) The priming pump being connected, 350 RPM.
2) At an ambient temperature of 27°C.
3) The figures are without margins.
4) Capacities at 50 and 60 Hz respectively.
5) According to ISO 3046/I, lower calorific value 42.000 kJ/kg at constant engine speed, including engine driven pumps. Tolerance + — 3 %.
6) At low load, for engines with load dependent temperature control of the cooling water.
7) Lower pressure and temperature allowed for certain auxiliary engines.
8) At remote and automatic starting, the consumption is 2...3 times higher.

Edition 1981

TECHNICAL DATA

DIESEL ENGINE WÄRTSILÄ VASA 16V22

Engine speed		RPM	900	1000	1200
Engine output		kW	2120	2360	2560
Engine output		hp	2885	3210	3480
Cylinder bore		mm		220	
Stroke		mm		240	
Swept volume		dm³		146.0	
Compression ratio				11.4:1	
Compression pressure, max.		bar		90	
Firing pressure, max.		bar		140	
Charge air pressure		bar	1.9	1.9	1.8
Mean effective pressure		bar	19.4	19.4	17.5
Mean piston speed		m/s	7.2	8.0	9.6
Idling speed	1)	RPM		600	
Combustion air system					
Flow of air		kg/s	4.24	4.78	5.48
Ambient air temp., max.		°C		45	
Air temp. after air cooler		°C		40...75	
Air temp. after air cooler, alarm		°C		80	
Exhaust gas system					
Exhaust gas quantity (100 % load)		kg/s	4.36	4.92	5.62
Exhaust gas quantity (90 % load)		kg/s	4.05	4.52	5.15
Exhaust gas quantity (75 % load)		kg/s	3.53	3.8	4.43
Exhaust gas temp. after turbocharger					
(100 % load)	2)	°C	360	370	380
(90 % load)	2)	°C	340	350	360
(75 % load)	2)	°C	310	320	330
Exhaust gas back pressure, recommended max.		bar		0.03	
Exhaust gas pipe diameter, min.		mm		600	
Heat balance	3)				
Effective output		MJ/h	7630	8500	9220
Lubricating oil		MJ/h	1010	1130	1340
Jacket water		MJ/h	2180	2420	2790
Charge air		MJ/h	2390	2660	3050
Exhaust gas		MJ/h	5260	5850	6670
Radiation		MJ/h	320	350	370
Fuel system					
Pressure before built-on feed pump, nom.		bar		3	
Pressure before built-on feed pump, max.		bar		4	
Pressure before built-on feed pump, min.		bar		2	
Pressure before built-on feed pump for MDF, min.		bar		0.2	
Pressure before injection pumps		bar		9	
Pump capacity, nom. (= min.)	4)	m³/h		1.8/2.3	
Fuel consumption (100 % load)	5)	g/kWh	205	205	212
Fuel consumption (75 % load)	5)	g/kWh	200	200	207
Fuel consumption (50 % load)	5)	g/kWh	207	207	214
Leak fuel quantity, clean fuel (100 % load)		kg/h		2.3	
Nozzle temperature control system					
Pressure before engine, nom.		bar		1.5	
Pressure before engine, alarm		bar		0.5	
Temperature before engine, nom.		°C		135	
Temperature before engine, min.		°C		130	
Temperature before engine, max.		°C		140	
Temperature before engine, alarm		°C		145/95	
Pump capacity		m³/h		0.96	
System oil volume per engine, ca.		m³		0.15	
Lubricating oil system					
Pressure before engine, nom.		bar	3.5	4.0	4.5
Pressure before engine, alarm		bar		2.0	
Pressure before engine, stop		bar		1.5	
Priming pressure, nom.		bar		0.8	
Priming pressure, alarm		bar		0.5	
Temperature before engine, nom.	6)	°C		70 (88)	
Temperature before engine, min.	6)	°C		65 (85)	
Temperature before engine, max.	6)	°C		74 (92)	
Temperature before engine, alarm	6)	°C		85 (100)	
Temperature after engine, nom,.	6)	°C		81 (95)	
Pump capacity (main), direct driven		m³/h	46	51	61
Pump capacity (main), separate		m³/h	46	51	61
Pump capacity (priming)	4)	m³/h		8.1/9.7	
Oil volume, wet sump, nom.		m³		0.87	

Oil volume in separate system oil tank, nom.		m^3		3.2	
Filter fineness		microns		15	
Filter difference pressure, alarm		bar		1.5	
Oil consumption (100 % load), max.		g/kWh		1.2	

Cooling water system, conventional
Jacket water system

Pressure before engine, nom.		bar		2.5	
Pressure before engine, alarm		bar		1.0	
Pressure before engine, max.		bar		4.5	
Temperature before engine, nom.		°C		71	
Temperature before engine, min.		°C		68	
Temperature before engine, max.		°C		78	
Temperature after engine, nom.		°C		78	
Temperature after engine, max.		°C		86	
Temperature after engine, alarm		°C		90	
Temperature after engine, stop		°C		95	
Pump capacity, nom.		m^3/h	77	86	105
Pump capacity, min.		m^3/h	69	77	95
Pressure drop over engine		bar	0.30	0.40	0.60
Water volume in engine		m^3		0.32	
Pressure from gravity tank		bar		0.5...1.5	

Low temperature cooling water system

Pressure before engine, nom.		bar		2.0	
Pressure before engine, alarm		bar		1.0	
Pressure before engine, max.		bar		5.3	
Temperature before engine, nom.		°C		25	
Temperature before engine, max.		°C		32	
Temperature before engine, min.		°C		12	
Pump capacity, nom.		m^3/h	77	86	105
Pump capacity, min.		m^3/h	69	77	95
Pressure drop over charge air cooler		bar	0.30	0.35	0.50
Pressure drop over oil cooler		bar	0.20	0.25	0.35
Pressure drop over jacket water cooler		bar	0.20	0.25	0.35

Cooling water system, load dependent temperature control

Pressure loss in fresh water cooler, nom.		bar		0.5	
Pressure loss in fresh water cooler, max.		bar		0.6	
Temperature after engine, nom.		°C		49	
Temperature after engine, max.		°C		55	
Temperature before air cooler, nom.	6)	°C		32 (75)	
Temperature before air cooler, max.		°C		38	
Capacity of built-on LT pump		m^3/h	77	86	105
Capacity of built-on HT pump		m^3/h	77	86	105
Pressure from gravity tank, nom.		bar		2.0 7)	1.0
Pressure from gravity tank, min.		bar		1.5 7)	0.7
Pressure from gravity tank, max.		bar		2.5	
Pump capacity, stand-by pump		m^3/h	77	86	105
Delivery head of stand-by pump		bar	2.0	2.0	2.8
Temperature after jackets, nom.	6)	°C		78 (106)	
Temperature after jackets, alarm	6)	°C		90 (110) 7)	
Temperature after jackets, stop		°C		115 7)	
Temp. after built-on coolers, alarm	6)	°C		45 (85)	

Starting air system

Air pressure, nom.		bar		30	
Air pressure, min. (20°C)		bar		11	
Air pressure, max.		bar		33	
Air pressure, alarm		bar		18	
Air consumption per start (20°C)	8)	Nm^3		0.20	

1. The priming pump being connected, 350 RPM.
2) At an ambient temperature of 27°C.
3) The figures are without margins.
4) Capacities at 50 and 60 Hz respectively.
5) According to ISO 3046/I, lower calorific value 42,000 kJ/kg at constant engine speed, including engine driven pumps. Tolerance + −3 %.
6) At low load, for engines with load dependent temperature control of the cooling water.
7) Lower pressure and temperature allowed for certain auxiliary engines.
8) At remote and automatic starting, the consumption is 2...3 times higher.

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ENGINE DESCRIPTION

ENGINE BLOCK

The engine block, made of Meehanite cast iron (GD-J), is cast in one piece for all cylinder numbers. It supports the underslung crankshaft and transmits the gas forces and, moreover, it incorporates the jacket water manifold, the camshaft bearings and the charge air receiver. In the V-engines the charge air receiver is located between the cylinder banks. When dimensioning, the aim has been to provide low stress level and good total rigidity to counteract, among others, the internal couples. Special attention has been paid to the deformations which influence the cylinder liners.
The bearing caps, made of nodular cast iron, are fixed from below by two hydraulically tensioned screws. They are guided sideways by the engine block at the top as well as the bottom. Horizontal side screws at the lower guiding provide a very rigid crankshaft bearing. At the end of the engine just inside the flywheel there is an extra shield bearing when needed. The crankshaft axial bearing consists of easily changeable, two-piece rails located around the first main bearing.
The crankcase covers as well as other covers tighten against the engine block by means of a closed O-ring profile and four screws. Part of the crankcase covers are equipped with safety valves.
The main oil feed pipe distributing lubricating oil to the main bearings and to the piston is integrated in the engine block design with a minimum of connections.
The oil sump, a light, welded construction, is screwed to the engine block from below and is sealed by O-ring seals. The oil sump is available in two alternative designs, i.e. wet or dry sump depending on the type of application. The wet oil sump comprises, in addition to the suction pipe to the lubricating oil pump, also suction pipe and return connection for the separator. The dry sump is drained at either end (free choice) to a separate system oil tank.
To facilitate the engine fixation to the base plate, the fixing bolts are hydraulically tightened.

CRANKSHAFT

The crankshaft is forged in one piece. It safisfies also the requirements of all classification societies. To achieve a standardization as high as possible of the details for the in-line and the V-engines the connecting rods, at the same crank pin in the V-engine, are arranged side-by-side. For the same reason the diameters of crank pins and journals are equal irrespective of the cylinder number.
To counteract the large excentric masses loading the main bearings the crankshafts of the V-engines are provided with counterweights on every web. The number of counterweights for the inline engine is partly determined also on the basis of the torsional vibration conditions in the installation concerned. All crankshafts can be provided with torsional vibration dampers at the free end of the engine where, as a matter of fact, the total output can be taken off, when necessary.

CONNECTING ROD

The connecting rods are forged and machined with round sections of alloy steel. The big end is split diagonally to enable removal of piston and connecting rod part. The two connecting rod bolts are hydraulically tightened.
The small end, as well as the gudgeon pin bushing, has been made broader at the bottom part of the bearing and thinner at the top part to achieve maximal supporting faces in bearing and piston when the gas forces are acting. The gudgeon pin bearing is made of steel lead-bronze with sliding coat, matched for the special conditions in this bearing. Through a bore in the connecting rod the oil is led to the gudgeon pin bearing and the piston.

MAIN BEARINGS AND BIG END BEARINGS

The main bearings and the big end bearings are made of steel lead-bronze or steel-light metal and are galvanized with a soft sliding coat of lead-tin.

CYLINDER LINER

The cylinder liners are centrifugally cast of special cast iron. Owing the the optimized cooling at the top part of the liner it is possible to achieve a favourable temperature distribution. At the bottom the cooling water space between the block and the liner is sealed by two O-rings.

PISTON

The piston is of the monobloc design in nodular cast iron. The piston skirt is force lubricated. Oil is fed up through the connecting rod to the cooling spaces of the piston. Piston cooling operates according to the cocktailshaker principle. The piston ring grooves in the piston head are induction hardened and ground to reduce wear in the grooves and rings to a minimum.

PISTON RINGS

The piston ring set includes three compression rings, the two top rings of which are chromium-plated and round-honed. The oil scraper ring is spring-loaded and conformable and has chromium-plated scrape edges. All rings are situated above the gudgeon pin.

CYLINDER HEAD

The cylinder head is made of grey cast iron. The flame plate which is thermally loaded, is relatively thin and is effeciently cooled by cooling water led from the periphery of the head radially against the centre. In the bridges between the valves cooling channels are drilled to provide the best possible heat transfer.
The mechanical load is absorbed by a strong intermediate deck which together with the upper deck and the side walls form a box section, in the four corners of which the hydraulically tensioned cylinder head bolts are situated.
The exhaust valve seats are direct water cooled.
The inlet valves seal against seat rings of specially alloyed cast iron with good wear resistance.
The inlet valves as well as the exhaust valves have stellite-plated seat faces and chromium-plated stems.

CAMSHAFT AND VALVE MECHANISM

The cams are integrated in the drop forged shaft material. The bearing journals are made in separate pieces which are fitted to the real camshaft pieces by means of flange connections. This solution offers, among others, the possibility of removing a cam piece and bearing sideways although the bearing housings are integrated in the engine block casting and thus are completely closed. The camshaft bearings, which are amply dimensioned, are installed and removed by means of a hydraulical tool. The camshaft covers, one for each cylinder, seal against the engine block with a closed sealing profile.
The valve tappets are of piston type with a certain self-adjustment of roller against the cam to give an even distribution of the contact pressure. In other respects the valve mechanism is normal with push rods, rocker arms and yoke.

CAMSHAFT DRIVE

The camshafts are driven by the crankshaft through a gear train. The driving gear is fixed to the crankshaft by means of flange connections.

TURBOCHARGING AND CHARGE AIR COOLING

The turbochargers are of the Brown Boveri manufacture with axial turbines, roller bearings and built-in lube oil system. The V-engines have one charger per cylinder bank. For cleaning of the turbocharger during operation there is, as standard, a water washing device for the air side and the turbine side. The air coolers are of the insert type, fitted into a housing which, at the same time, is the turbocharger console. The inserts are easy to remove for cleaning of the air side, and the water side is accessible by removing the end boxes of the cooler insert.

INJECTION EQUIPMENT

The injection equipment is of L'Orange manufacture. The injection pumps are one-cylinder pumps with built-in tappets. The delivery commencement is carefully adjusted by the manufacturer; the tolerances of the engine block and the camshaft make it possible to change an injection pump without re-adjusting the delivery commencement.
The injection pumps are through-flown to enable heavy fuel duty.
The injection valve is centrally located in the cylinder head and the fuel is admitted sideways through a high pressure connection screwed into the nozzle holder. The injection pipe between the injection pump and the high pressure connection is protected by the injection pump covers. The high pressure side of the injection system is thus completely separated from fresh air and the engine lube oil spaces. The nozzles are heated/cooled and the normal lube oil is used as medium (separate system).

EXHAUST PIPES

The exhaust pipes are made of special heat resistant alloy nodular cast iron. Metal bellows of the multi-ply type absorb heat expansion between the cylinder heads and the pipe system as well as between the turbocharger and the pipe system.
The complete exhaust system is enclosed in an insulating box built up of insulated sandwich steel sheets, easily removable and flexibly mounted on the engine. Mineral wool is used as insulating material.

BASIC ENGINE SPECIFICATION

The conception »basic engine specification» means a specification of the most essential equipment built on the engine. Supplementary external equipment is usually needed to make the system work.
Some equipment, in addition to that included according to the basic engine specification, can be mounted on the engine. This equipment always entails additional expenses.
Equipment delivered on request is included in the price of the basic engine if ordered at the same time as the engine.

1. Fuel system

- Electrically driven fuel feed pump
- Fuel oil filter of the duplex type (with 3-way cock)
- Pressure control valve

2. Nozzle temperature control system
Omitted on engines specified for burning Marine Diesel Fuel or max. 30 cSt/50°C fuel viscosity.

- Coarse filter in inlet pipe.
  Insert for manual cleaning

3. Lubricating oil system

- Oil sump, dry or wet
- Lubricating oil pump with regulating/safety valve
- Lubricating oil filter of the duplex type (with 3-way cock). Changeable paper cartridges.
- By-pass lube oil filter, centrifugal type, 1 pce for in-line engines and 2 pcs for V-engines
- Electrically driven priming pump
- Lube oil cooler
- Thermostat valve for lube oil
- Connection for stand-by lube oil pump and/or external automatic filter (if necessary)
- Interconnected valves for connections of lubricating oil separator to wet sump (auxiliary engines only)

4. Cooling water system

- Cooling water pipes including mating flanges
- Thermostat valve for high temperature circuit
- Thermostat valve for low temperature circuit
- Circulating pump and non-return valve for high temperature circuit
- Circulating pump and non-return valve for low temperature circuit

5. Starting air system

- Starting air mechanism, for 30 bar pressure, with manually and remotely controlled starting valve (solenoid 24 V DC)
- Non-return valve
- Flame arrester
- Safety valve

6. Charge air and exhaust system

- Exhaust gas turbocharger, 1 pce for in-line engine, 2 pcs for V-engine, make Brown Boveri with air filter and suction silencer
- Cleaning device for the turbocharger compressor (while running)
- Cleaning device or the turbocharger turbine (while running)
- Charge air cooler

7. Control and monitoring

- Speed governor, hydraulic-mechanical
  Main engines — Woodward PG
  Auxiliary engines — Woodward UG
- Starting fuel limiter
- Overspeed trip device, fully mechanical
- Overspeed trip device, electro-pneumatic
- Speed measuring system for engine and turbocharger speed (delivered loose for in-line engines)
- Flexibly mounted panel with the following instruments:
  - tachometer for engine and turbocharger speed with change over switch
  - running hour counter
- pressure gauges for
  - ★ fuel
  - ★ nozzle temperature control oil
  - ★ Lubricating oil
  - ★ low temperature cooling water
  - ★ High temperature cooling water, outlet
  - ★ starting air
  - ★ charge air
- Local thermometers for the following temperatures:
  - ★ Fuel, inlet
  - ★ Nozzle temperature control medium, inlet
  - ★ Nozzle temperature control medium, outlet
  - ★ Lubricating oil, inlet
  - ★ Lubricating oil, outlet
  - ★ High temperature cooling water, inlet
  - ★ High temperature cooling water, outlet
  - ★ Cooling water, turbocharger, outlet
  - ★ Low temperature cooling water, inlet
  - ★ Low temperature cooling water, outlet
  - ★ Charge air
  - ★ Exhaust gas after each cylinder
- Alarm switches, with change-over contact, for the following functions:
  Auxiliary engines:
  - ★ Fuel oil pressure low
  - ★ Nozzle temperature control medium temperature high/low
  - ★ Nozzle temperature control medium pressure low
  - ★ Lubricating oil pressure low
  - ★ Priming pressure low

* Lubricating oil temperature high
* Lubricating oil filter differential pressure high
* Fuel oil filter differential pressure high
* Lubricating oil level in sump low (wet sump engine)
* HT cooling water temperature high
* Charge air temperature high
* Overspeed device tripped

Main engines:
As for auxiliary engines and additionally:
* HT cooling water pressure low
* Overload

— Thermocouple NiCr/Ni including amplifier for exhaust gas temperatures after each cylinder (main engine)
— Switches, with change-over contacts, for automatic stop for the following functions:
* Lubricating oil pressure low
* HT circulating water temperature high

8. Miscellanseous

— Crankcase safety valves with flame arrester
— Indicator valve in each cylinder head
— Connection box with terminal connections
— Flywheel with fastening screws
For generating sets are additionally included:
— Flywheel cover
— Pressure lubrication of generator bearings (if necessary)

9. Separate equipment (supplied loose)

— Tachometer for engine speed, 1 pce per engine, dimensions 96 mm x 96 mm (main engine)
— Pressure control station and rubber hose with quick couplings for turbocharger turbine washing, 1 set per installation
— Transition piece turbocharger — exhaust pipe, including expansion bellows
— Valve for blocking of start when turning gear engaged

FUEL SYSTEM

GENERAL

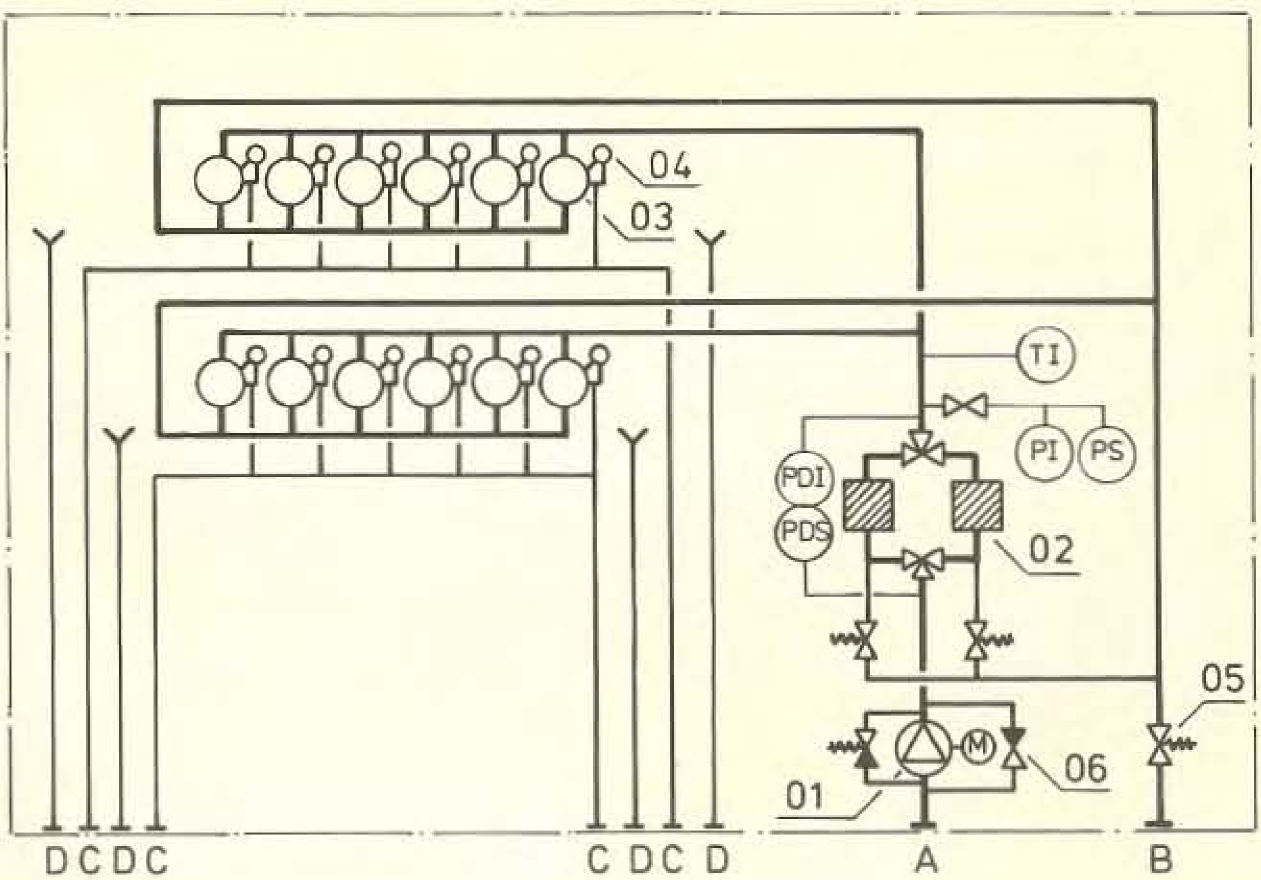
The diesel engine Wärtsilä Vasa 22 is designed for continuous heavy fuel duty. It is, however, possible to operate the engine on diesel fuel without making any alterations.
Main engines as well as the auxiliary engines can be started and stopped on heavy fuel provided that the engine, fuel system and nozzle temperature control system are preheated to operating temperature. Also stand-by engines in unattended engine rooms can be started on heavy fuel.

ENGINE INTERNAL FUEL SYSTEM

Depending on the engine and/or tye type of application the fuel system built on the engine can vary somewhat in design. The normal system is designed for heavy fuel duty.
The standard system comprises the following parts, built on the engine:
* heavy fuel injection pumps
* temperature controlled injection valves
* fine filter of duplex type with changeable paper cartridges
* electrically driven fuel feed pump with safety valve and non-return by-pass valve
* pressure control valve in the outlet pipe

For single engine installations the built-on electrically driven fuel feed pump is normally omitted.
All engines are furnished with injection pumps the leak fuel of which is drained to atmospheric pressure (the clean leak fuel system). The leak fuel can be reconducted to the system without treatment. Concerning quantity of leak fuel, see technical data. Other possible leak fuel (the »dirty» leak fuel system) is drained separately.
In case the engines are, exceptionally, equipped for operation on MDF or distillate fuel, only, the electrically driven fuel feed pump may be replaced by a mechanically direct driven pump.

FUEL DIAGRAM 4V69E335



System components

01. Fuel feed pump, electrically driven
02. Duplex fine filter
03. Injection pump
04. Injection valve
05. Pressure regulating valve
06. By-pass non-return valve

Pipe connections

A. Fuel inlet
B. Fuel return
C. Clean fuel leakage, outlet
D. Dirty fuel leakage, outlet

DESIGN OF EXTERNAL FUEL SYSTEM

General

The design of the external fuel system may vary from ship to ship but every system should provide well cleaned fuel with the correct temperature and pressure to each engine. When using heavy fuel it is most important that the fuel is properly cleaned from solid particles and water. In addition to the harm poorly centrifuged fuel will do to the engine a high content of water may cause big problems for the heavy fuel feed system. For the feed system, well-proven components should be used.

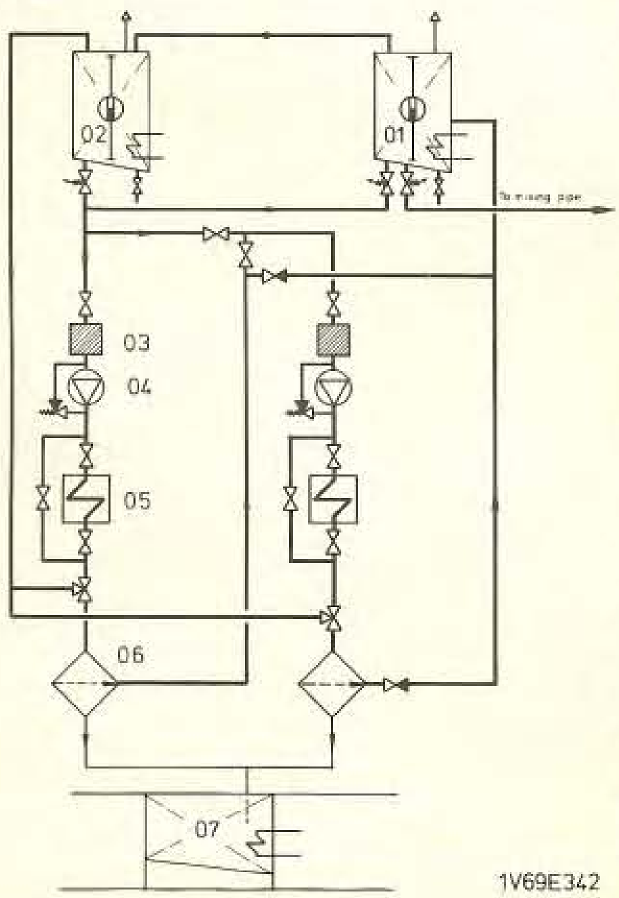
Separator system

Heavy fuel (residuals, and mixtures of residuals and distillate) must be purified in an efficient centrifugal purifier before entering the day tank. In case pure distillate fuel is used, centrifuging is still recommended as fuel may be contaminated in the storage tanks. Centrifuge rated capacity may be used provided the fuel viscosity is less than 12 cSt at centrifuging temperature. Marine Gas Oil viscosity is normally less than 12 cSt/15 °C.

Mode of operation

Two separtors, both of the same size, should be installed. The capacity of one separator to be sufficient for

the total fuel consumption. The other (stand-by) separator should also be in operation all the time. It is recommended that the separators are arranged for operation in series, the first as a purifier and the second as a clarifier. This arrangement will give the best and most disturbance free results.
Alternatively, the main and stand-by separators may be run in parallel, but this makes heavier demands on the choice of correct gravity disc and on constant flow and temperature control to achieve optimum results. For pure distillate fuel, a separate purifier should be installed.



SEPARATING DIAGRAM 1V69E342

System components
01 Day tank heavy fuel
02 Settling tank heavy fuel
03 Suction filter
04 Feed pump
05 Preheater
06 Separator
07 Sludge tank

System components

Day tank, heavy fuel (01)
See feed system

Settling tank, heavy fuel (02)
The settling tank should normally be dimensioned to ensure fuel supply for min. 24 operating hours when filled to maximum. The tank should be designed to provide the most efficient sludge and water rejecting effect. The tank is to be provided with a heating coil and should be well insulated.
To ensure constant temperature in the centrifuge, the settling tank temperature should be kept as constant as possible. The temperature in the settling tank should be between 50...70°C.
The min. level in the settling tank should be kept as high as possible. In this way the temperature will not decrease too much when filling up with cold bunker.

Suction filter (03)
A suction filter should be fitted to protect the feed pump. The filter should have two jackets and allow to be heated in case the installation place is cold. The filter can be either a duplex filter with change over valves or two separate simplex filters. The design of the filter should be such that air suction cannot occure.

★ fineness 0.5 mm

Feed pump (04)
The use of a high temperature resistant screw pump is recommended. The pump should be separate from the centrifuge and electrically driven.

Design data:
The pump should be dimensioned for the actual fuel quality and recommended throughput trough the centrifuge. The flow rate through the centrifuges should, however, not exceed the maximum fuel consumption by more than 10 %. No control valve should be used to reduce the flow of the pump.

★ operating pressure (max.)	5 bar
★ operating temperature	100°C
★ viscosity for dimensioning of electric motor	1000 cSt

Preheater (05)
The preheater is normally dimensioned according to the pump capacity and a given settling tank temperature. The heater surface temperature must not be too high in order to avoid cracking of the fuel.
The heater should be thermostatically controlled for maintaining the fuel temperature within + — 2°C. The recommended preheating temperature is given below.

Design data:
The required minimum capacity of the heater is

$$P\,(kW) = \frac{m(1/h) \times t\,(°C)}{1700}$$

m = capacity of the centrifuge feed pump
t = Temperature rise, following values can used:

Fuel viscosity (cSt at 50°C)	Temperature rise in heater °C
380	38 (60°C in settling tank)
240	38 (60 » »)
180	38 (60 » »)
120	38 (60 » »)
80	38 (50 » »)
60	36 (50 » »)
40	30 (50 » »)

Fuels having a viscosity higher than 5 cSt at 50°C need preheating before the purifier.

Separator (06)
The fuel oil purifier should be dimensioned as follows. The recommended separating temperatures are also stated below

A	B	C
380	20	98
240	25	98
180	30	98
120	35	98
80	40	88
60	45	86
40	60	80
30	65	73

A = maximum fuel oil viscosity (cSt/50°C)
B = recommended purifier flow rate (% of rated capacity)
C = recommended preheating temperature

For MDF (max. viscosity 14 cSt at 40°C) a flow rate of 80 % and a preheating temperature of 45°C are recommended. The flow rates recommended for the purifier for the grade of fuel in use are not to be exceeded. The lower the flow rate the better the efficiency.

Sludge tank (07)
The sludge tank should be placed below the separators as close as possible. The sludge pipe should be continuously falling without any horizontal parts.

FUEL FEED SYSTEM

General

The Vasa 22 engine is provided with a built-on electrically driven fuel feed pump. This pump will ensure the correct flow and pressure for each engine. Due to this arrangement there are no restrictions for the number of engines supplied from the same booster system. For single engine installations the built-on pump is omitted. The heavy fuel pipes should be properly insulated and for fuel with the viscosity from 180 cSt/50°C also heated. It should be possible to shut-off the heating of the pipes.

System components

Day tank, heavy fuel (01)
The heavy fuel day tank should normally be dimensioned to ensure fuel supply for about 24 operating hours when filled to maximum. The design of the tank should be such that water and dirt particles do not collect in the suction pipe. The tank has to be provided with a heating coil and should be well insulated.

Maximum recommended viscosity in the day tank is 140 cSt. Due to the risk of wax formation fuels with a lower viscosity than 50 cSt/50°C must be kept at higher temperatures than what the viscosity would require.

Fuel viscosity (cSt at 50°C)	Minimum day tank temperature (°C)
380	65
240	60
180	55
120	50
80	40
60	40
40	30

The tank and pumps should be placed so that a positive static pressure is obtained on the suction side. For fuel with the viscosity of 120...240 cSt the static head should be 3...5 m at all 50°C operating conditions. If a flow meter is installed between the day tank and the pumps the static head should be increased with the pressure drop over the flow meter.

Day tank, diesel fuel (02)
The diesel fuel day tank should normally be dimensioned to ensure fuel supply for 12...14 operating hours when filled to maximum.
In installations where the stand-by engines are to be fed from the diesel fuel tank at start in case of occasional black-out, the day tank should be placed min. 6 m above the engine crankshaft centre line.

De-aeration pipe (03)
The de-aeration pipe should be dimensioned as small as possible to keep at a minimum the fuel volume to be heated to high temperature.
The top of the de-aeration pipe should be 500 mm above the highest level in the day tank and bottom 1000 mm below the bottom of the day tank.
Recommended diameter of the de-aeration pipe:

...2000 kW	200 mm
2000...5000 kW	250 mm
5000... kW	300 mm

The design should be such that it provides the best possible gas separation of the outlet fuel. The return pipe should be connected below the lowest fuel level and directed to the side upwards. The de-aeration pipe is to be provided with a heating coil and should be well insulated. The fuel outlet pipe from the day tank should be provided with both insulation and heating.

Change-over valve (04)
The valve can be manually operated. It should be installed for easy access.

Fuel consumption meter (05)
If a fuel consumption meter is placed between the day tank and the de-aeration pipe the static head from the day tank to the pumps should be increased with the flow resistance of the meter. If the meter is provided with a close meshed prefilter, it is recommendable to install an alarm for high pressure difference over the filter.

Suction filter (06)
A suction filter should be fitted to protect the feed pumps. The filter should have two jackets and allow to be heated in case the installation place is cold. The filter can be either a duplex filter with change-over valves or two separate simplex filters. The design of the filter should be such that air suction cannot occur.
★ fineness 0.5 mm

Feed pump (07)
The use of a high temperature resistant screw pump is recommended as feed or circulating pump.
At short stoppages in port the pump should be continuously in operation to keep the heavy fuel in circulation.
Design data:
The capacity of the pumps should be big enough to feed all built-on pumps and compensate for a possible flush quantity from the automatic filter. For single engine installations the capacity should be 0.12 m^3/h x cyl + flush quantity from the automatic filter.
For the capacites of the built-on pumps, see technical data.

★ operating pressure, max.	10 bar
★ operating temperature	150°C
★ viscosity (for dimensioning of electric motor	1000 cSt

Preheater (08)
The preheater is normally dimensioned according to the maximally consumed fuel oil volume and a given day tank temperature.

The heater surface temperature must not be too high in order to avoid cracking of the fuel.
The preheater should normally be controlled by a viscosimeter. In emergency, the control can be arranged on the basis of temperature. The set point of the viscosity should be somewhat lower than necessary for the injection pumps to compensate for heat losses in the pipes.
Design data:
★ The required minimum capacity of the heater is:

$$P\ (kW) = \frac{m\ (l/h) \times t\ (°C)}{1700}$$

m = evaluated by multiplying the engine specific fuel consumption by the engine maximum output.
t = temperature rise, higher with increased fuel viscosity.

The following values can be used:

Fuel viscosity (cSt at 50°C)	Temperature rise in heater °C
380	85 (65°C in day tank)
240	85 (60 » »)
180	85 (55 » »)
120	85 (50 » »)
80	75 (50 » »)
60	65 (50 » »)
40	65 (40 » »)

To compensate for heat losses due to radiation the a.m. values should be increased with 10 % + 5 kW.

Automatically cleaned fine filter (09)
The use of automatically back flushing filters is recommended, normally as a duplex filter with an insert filter as the stand-by half. For back-flushing filters the feed pump capacity should be sufficient to prevent pressure drop during the flushing operation.
Design data:

★ fuel oil	240 or 380 cSt/50°C
★ operating temp.	0...150°C
★ preheating	from 180 cSt/50°C
★ flow	see technical data
★ operating pressure	10 bar
★ test pressure	fuel side 20 bar heating jacket 10 bar
★ fineness	Back flushing filter: 90 % separation above 20 microns (mesh size max. 35 microns) Insert filter: 60 % separation above 15 microns with one through flow

★ maximum recommended pressure drop for normal filters at 14 cSt

clean filter	0.2 bar
dirty filter	0.8 bar
alarm	1.5 bar

Viscosimeter (10)
The control of the preheater should necessarily be based on the viscosity. Thus, a viscosimeter should always be installed when heavy fuel is used.
The viscosimeter should be of a design which resists pressure peaks caused by the diesel engine injection pumps.
Design data:

★ viscosity range (in injection pumps)	10...14 cSt
★ operating temperature	150°C
★ operating pressure (min)	40 bar

Built-on feed pump (11)
The built-on feed pump is of the screw type and electrically driven. The pump is equipped with a safety valve
Technical data:

★ pump capacity; see technical data		
★ operating pressure, max.		10 bar
★ operating temperature		150°C
★ electric motor		
	50 Hz	60 Hz
4...8R22	1.0 kW	1.2 kW
12V22, 16V22	1.5 kW	1.7 kW

A non-return by-pass valve is mounted across the pump. The opening pressure of this valve is 0,2 bar.

Fine filter (12)
Each engine is equipped with a paper cartridge fine filter of duplex type.
Fineness: 60 % separation above 15 microns with one throughflow.

Pressure control valve (13)
The pressure control valve is installed in the outlet pipe of each engine.
★ set point 8 bar (pressure before engine 9 bar)

Overflow valve (14)
For single engine installations the external overflow valve can be substituted by a manually operated shut-off valve.
Design data:

★ set point	3 bar
★ pressure class	NP 40
★ operating temperature	150°C

The valve should have a flow range which provides a pressure as constant as possible in all operating conditions.

Leak fuel tank, clean fuel (15)
Clean leak fuel draining from the injection pumps can, if desired, be reused without repeated treatment. The fuel should then be drained to a separate leak fuel tank and, from there, be pumped to the day tank. Alternatively, the clean leak fuel tank can be drained to another tank for clean fuel, e.g. the bunker tank, the overflow tank etc.
The pipes from the engine to the drain tank should be arranged continuously sloping and should be provided with heating and insulation.

Leak fuel tank, dirty fuel (16)
Normally no fuel is leaking out of the dirty system during operation. Fuel is drained only in case of a possible leakage or similar.
The pipes to the sludge tank should, if possible, be drawn along the pipes for clean fuel in order to achieve heating, and be insulated.

Viscosimeter (10)
The control of the preheater should necessarily be based on the viscosity. Thus, a viscosimeter should always be installed when heavy fuel is used.
The viscosimeter should be of a design which resists pressure peaks caused by the diesel engine injection pumps.
Design data:

★ viscosity range (in injection pumps)	10...14 cSt
★ operating temperature	150°C
★ operating pressure (min)	40 bar

Built-on feed pump (11)
The built-on feed pump is of the screw type and electrically driven. The pump is equipped with a safety valve
Technical data:

★ pump capacity; see technical data

★ operating pressure, max.		10 bar
★ operating temperature		150°C
★ electric motor		
	50 Hz	60 Hz
4...8R22	1.0 kW	1.2 kW
12V22, 16V22	1.5 kW	1.7 kW

A non-return by-pass valve is mounted across the pump. The opening pressure of this valve is 0,2 bar.

Fine filter (12)
Each engine is equipped with a paper cartridge fine filter of duplex type.
Fineness: 60 % separation above 15 microns with one throughflow.

Pressure control valve (13)
The pressure control valve is installed in the outlet pipe of each engine.
★ set point 8 bar (pressure before engine 9 bar)

Overflow valve (14)
For single engine installations the external overflow valve can be substituted by a manually operated shutoff valve.
Design data:

★ set point	3 bar
★ pressure class	NP 40
★ operating temperature	150°C

The valve should have a flow range which provides a pressure as constant as possible in all operating conditions.

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Clean leak fuel draining from the injection pumps can, if desired, be reused without repeated treatment. The fuel should then be drained to a separate leak fuel tank and, from there, be pumped to the day tank. Alternatively, the clean leak fuel tank can be drained to another tank for clean fuel, e.g. the bunker tank, the overflow tank etc.
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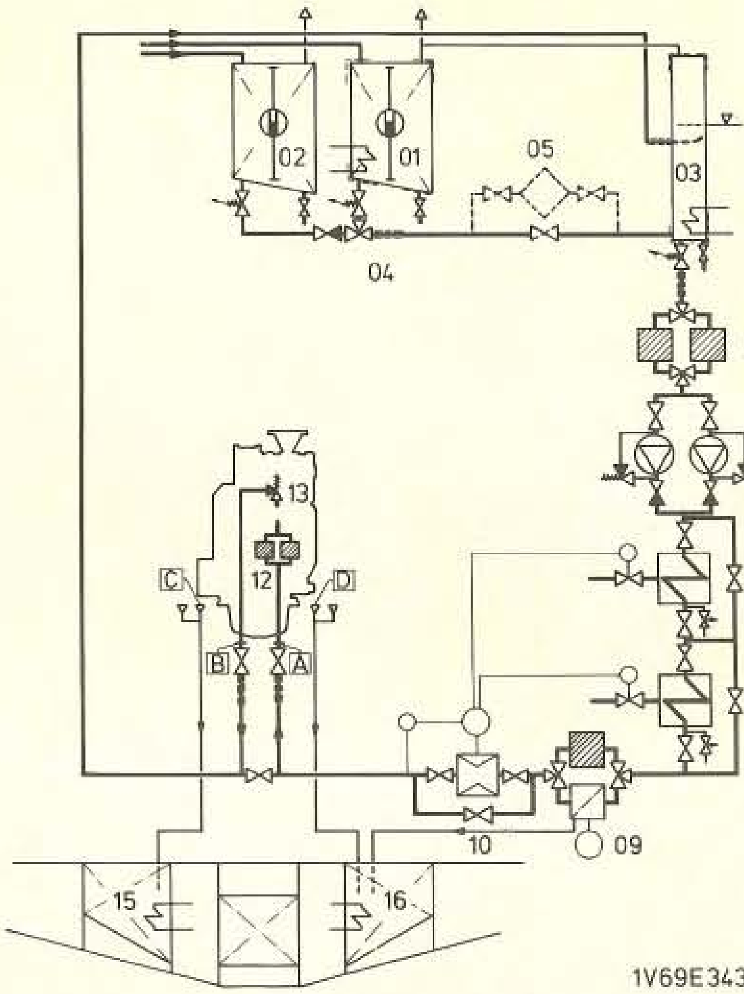
The pipes to the sludge tank should, if possible, be drawn along the pipes for clean fuel in order to achieve heating, and be insulated.

FUEL FEED DIAGRAM 1V69E343



1V69E343

System components

- 01 Day tank heavy fuel
- 02 Day tank diesel fuel
- 03 De-aeration pipe
- 04 Change-over valve
- 05 Fuel consumption meter
- 06 Suction filter
- 07 Feed pump
- 08 Preheater
- 09 Automatically cleaned fine filter
- 10 Viscosimeter
- 11 Built-on feed pump
- 12 Fine filter
- 13 Pressure control valve
- 14 Overflow valve
- 15 Leak fuel tank, clean fuel
- 16 Leak fuel tank, dirty fuel

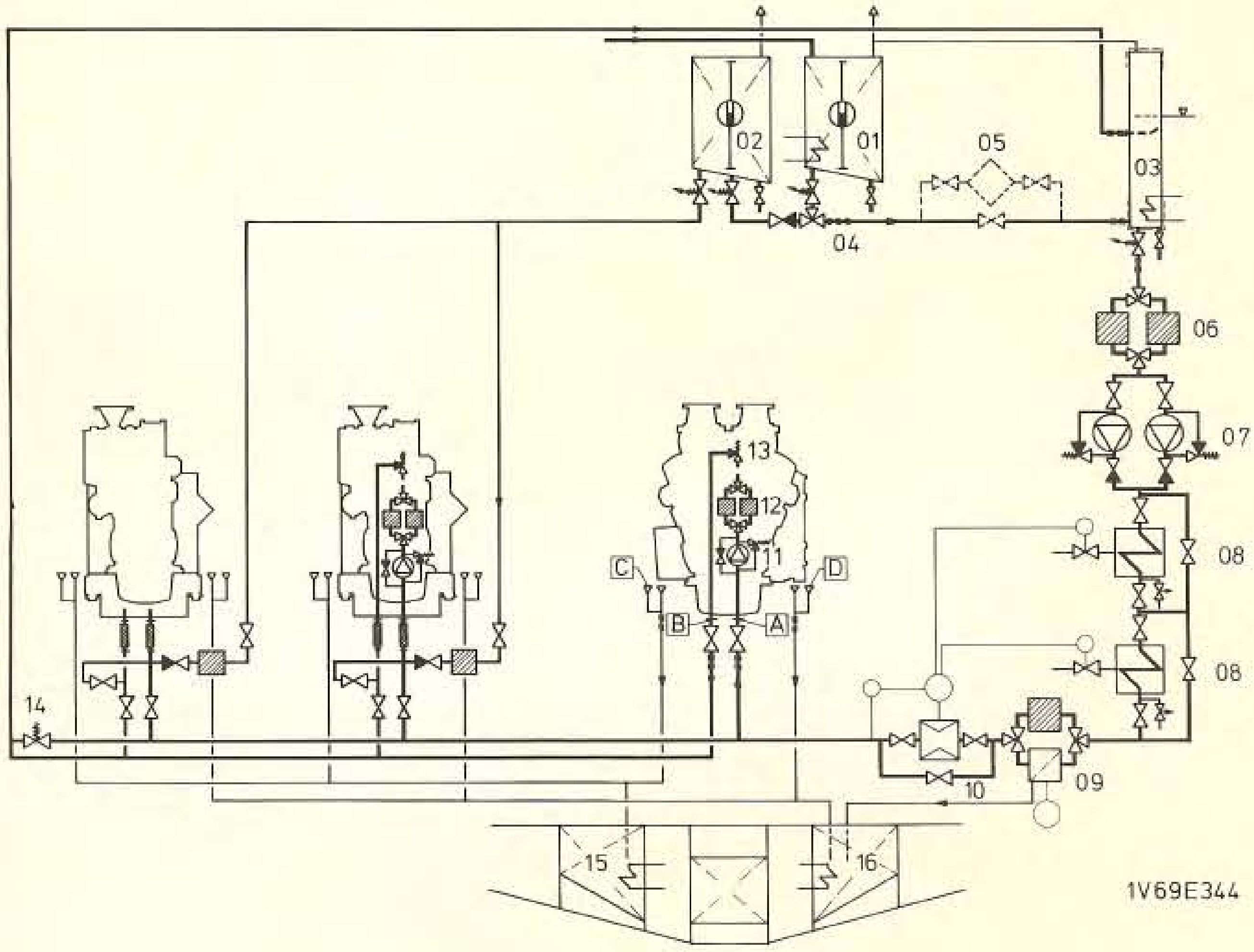
Pipe connections, engine

- A Fuel inlet
- B Fuel outlet
- C Leak fuel drainage, clean fuel
- D Leak fuel drainage, dirty fuel

Pipe dimensions

Engine	A	B	C	D
4...16V22	NS25	NS25	NS15	NS15

FUEL FEED DIAGRAM 1V69E344



System components

01 Day tank heavy fuel
02 Day tank diesel fuel
03 De-aeration pipe
04 Change-over valve
05 Fuel consumption meter
06 Suction filter
07 Feed pump
08 Preheater
09 Automatically cleaned fine filter
10 Viscosimeter
11 Built-on feed pump
12 Fine filter
13 Pressure control valve
14 Overflow valve
15 Leak fuel tank, clean fuel
16 Leak fuel tank, dirty fuel

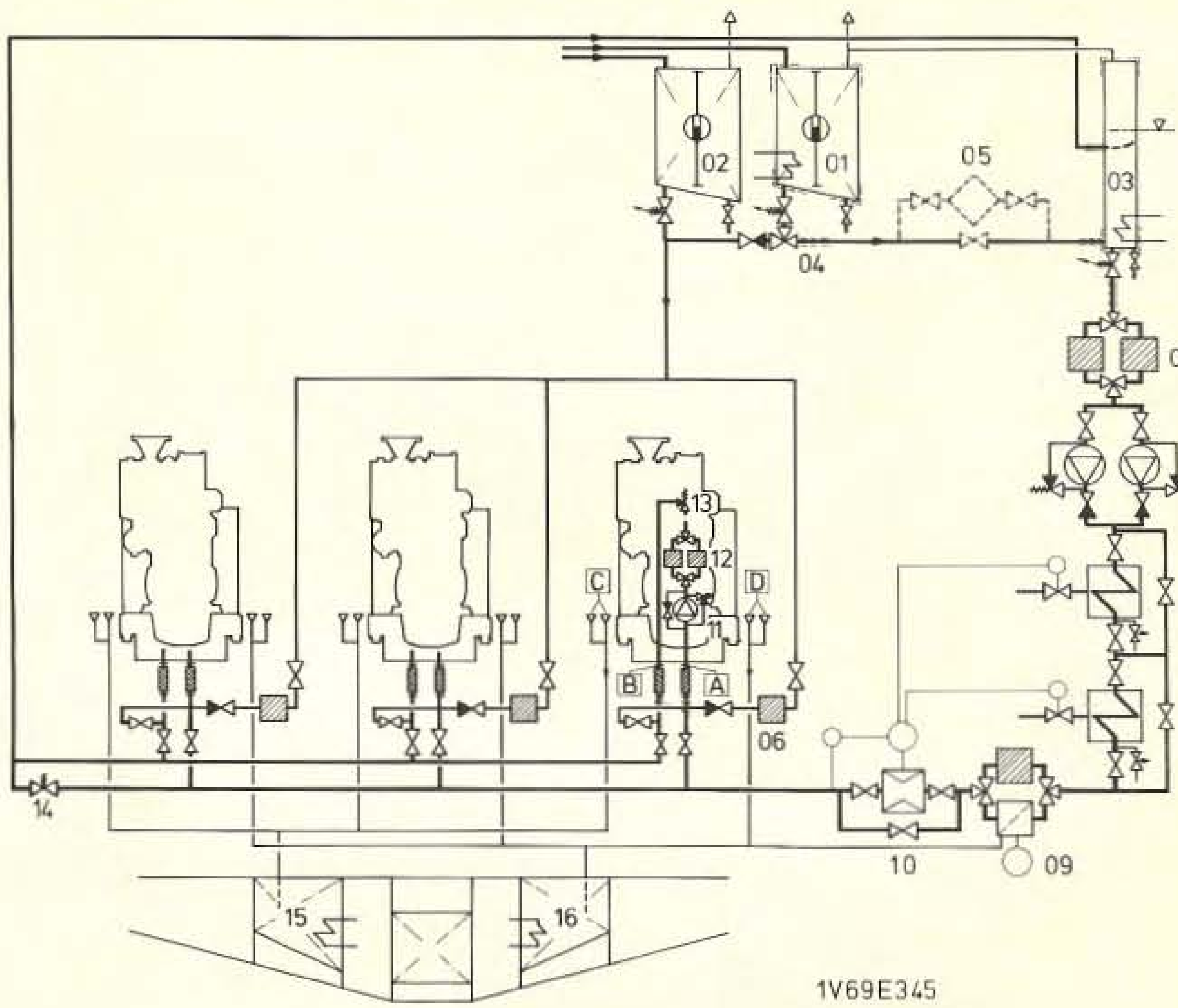
Pipe connections, engine

A Fuel inlet
B Fuel outlet
C Leak fuel drainage, clean fuel
D Leak fuel drainage, dirty fuel

Pipe dimensions

Engine	A	B	C	D
4...16V22	NS25	NS25	NS15	NS15

FUEL FEED DIAGRAM 1V69E345



1V69E345

System components

01 Day tank heavy fuel
02 Day tank diesel fuel
03 De-aeration pipe
04 Change-over valve
05 Fuel consumption meter
06 Suction filter
07 Feed pump
08 Preheater
09 Automatically cleaned fine filter
10 Viscosimeter
11 Built-on feed pump
12 Fine filter
13 Pressure control valve
14 Overflow valve
15 Leak fuel tank, clean fuel
16 Leak fuel tank, dirty fuel

Pipe connections, engine

A Fuel inlet
B Fuel outlet
C Leak fuel drainage, clean fuel
D Leak fuel drainage, dirty fuel

Pipe dimensions

Engine	A	B	C	D
4...16V22	NS25	NS25	NS15	NS15

Fuel feed unit

When necessary a complete assembled fuel feed unit can be supplied as an option.
Description:
The unit is equipped with two pumps one for operation and one for stand-by.
The stand-by pump starts automatically when fuel pressure goes below a certain value. The unit is normally equipped with two heaters, one for operation and the other as a spare.
The change over to the spare heater has to be done manually. In addition to the viscosity control of the heaters a thermostatic control is provided for emergency.
All heavy fuel pipes are insulated, when the unit is specified for 240 cSt/50°C or higher viscosity fuel, and also heated. The unit is built on a steel frame which can easily be fixed to the ship's structure.
When installing the unit only the power supply, group alarm, fuel pipes, steam (if used) and air pipes have to be connected. The unit consists of the following parts:

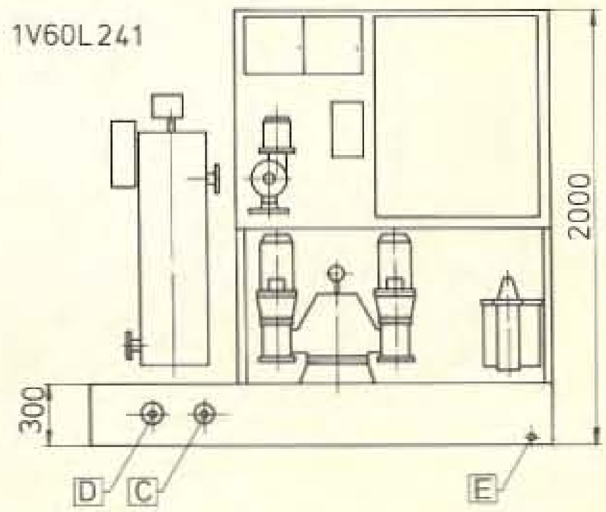
- two fuel feed pumps of the screw type with electrical motors and built-in safety valves
- two strainers
- two electrical, steam or thermal oil heaters, complete
- one automatic fuel filter with by-pass filter
- one viscosimeter comprising
  - pneumatic difference pressure transmitter
  - pneumatic PI regulator
  - air pressure reducing unit 7/2 bar
- one heater control cabinet or
- one steam or thermal oil control valve for heater
- one thermostat for emergency control of heaters
- one control cabinet for pumps and viscosimeter
- microswitches for the following alarms
  - low fuel oil pressure
  - high filter pressure drop
  - high/low viscosity
- one set of thermometers and pressure gauges

For the capacity of pumps and heaters, see the fuel feed system.

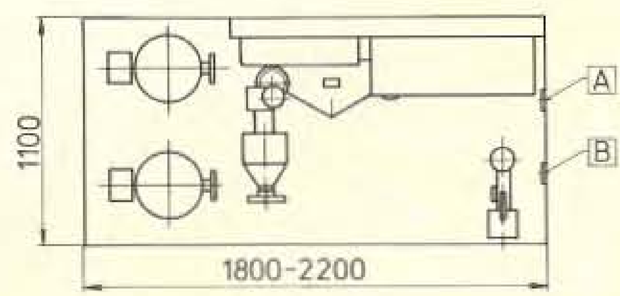
FUEL FEED UNIT 1V60L141

Pipe connections

A Fuel from de-aeration pipe
B Fuel to engine
C Steam inlet
D Condensate outlet
E Drain



Weight 1200...1700 kg



NOZZLE TEMPERATURE CONTROL SYSTEM

GENERAL

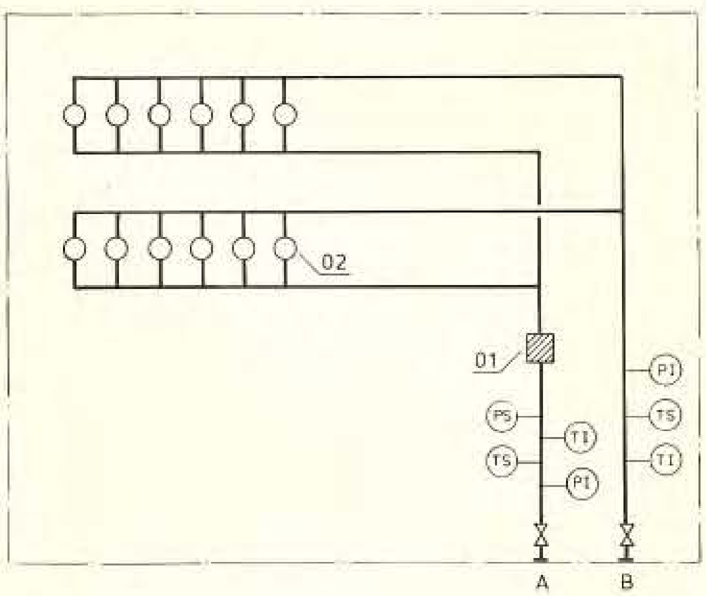
In order to make it possible to control the temperature of the injection nozzles, they are of the through-flown type. The cooling medium to be used is lubricating oil, advisably of the same type as that used in the engine lubricating oil system, i.e. an oil of the viscosity class SAE 30 or SAE 40.
When starting on heavy fuel the nozzles should be preheated to operating temperature to facilitate the starting. The nozzle temperature control medium should always circulate during operation, even when operating on diesel fuel.

In case the engine is intended for operation exclusively on distillate fuel or max. 30 cSt/50°C fuel viscosity, no nozzle temperature control system is installed. Normal interval between changes of oil is 8000 h.

Engine internal nozzle temperature control system
System conponents

The oil flow is evenly distributed to all injection valves. The system comprises the following components built on the engine:
— strainer in inlet pipe
— piping to the nozzles

NOZZLE TEMPERATURE CONTROL DIAGRAM 4V69E336



System components

01. Strainer
02. Injection valve

Pipe connections

A. Nozzle temperature control oil inlet
B. Nozzle temperature control oil outlet

DESIGN OF EXTERNAL NOZZLE TEMPERATURE CONTROL SYSTEM

The normal system maintains the oil temperature constant. In multi-engine installation, it is recommended to connect max. three engines in parallel to the same circulating sstem. The pipes in the system should be properly insulated.

System components

Oil tank (01)
The size of the oil tank should be 100...300 l. The tank is to be provided with venting, overflow and an arrangement for inspection of oil level. A tank with built-in heating and cooling coils is not recommended. In case the tank is placed in cold spaces or the operating conditions are cold, the tank as well as the pipes should be insulated. If the operating conditions are warm (+ 45°C) the tank can be completely or partly uninsulated.

Suction filter (02)
A suction filter is installed to protect the circulating pumps. The filter can be a duplex filter with change-over valves, or two separate simplex filters. The design of the filter should be such that air suction cannot occur.
Design data:

★ fineness	0.5 mm
★ temperature	150°C
★ pressure class	NP 16

Circulating pump (03)
The circulating pump can be a gear pump or a screw pump. The pump should be designed for continuous operation.
Design data:

★ pump capacity	see technical data
★ working pressure	4 bar
★ temperature	150°C
★ viscosity, max. (for dimensioning of electric motor)	500 cSt

Preheater (04)
The preheater can be a steam or electric heater. The heater should be controlled by a thermostat to keep the inlet oil temperature constant.
The thermostat should be set to 130 $^{+}_{-}$5°C to maintain the temperature after the heater constant at all operating conditions.
The heater surface temperature must not be too high, otherwise there is risk of coking of the oil.
Design data:

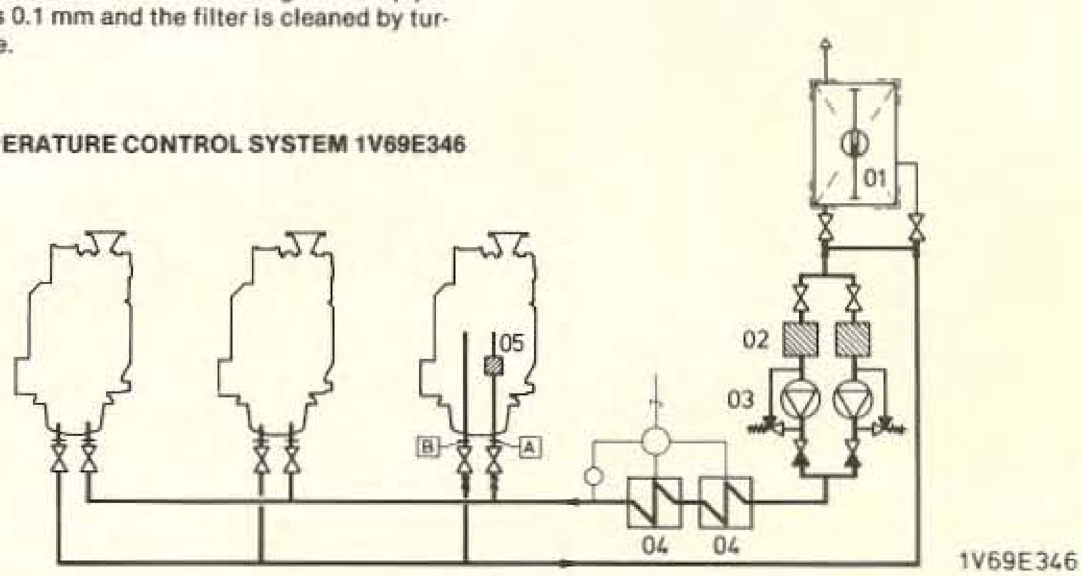
★ heater capacity	2 x 6 kW
★ pressure class	NP 16

Disc-type filter (05)
The disc-type filter is installed in the engine inlet pipe. The fineness is 0.1 mm and the filter is cleaned by turning the handle.

Nozzle temperature control unit

When necessary a complete assembled nozzle temperature control unit can be supplied as an option.
When installing the unit only the power supply, group alarm and two pipes have to be connected. The unit consists of the following parts:
- two circulating pumps of screw type with built-in safety valves and electric motors
- two strainers
- two electrical heaters, 2 x 6 kW
- one circulating tank, capacity 250 l
- one set of manometers and thermometers
- one control cabinet for control of heaters and pumps
- mircoswitches for the following alarm functions:
  - low oil level
  - high oil temperature
  - low oil temperature
  - low oil pressure

NOZZLE TEMPERATURE CONTROL SYSTEM 1V69E346



System components

01 Oil tank
02 Suction filter
03 Circulating pump
04 Preheater
05 Disc-type filter

Pipe connections

A Oil inlet
B Oil outlet

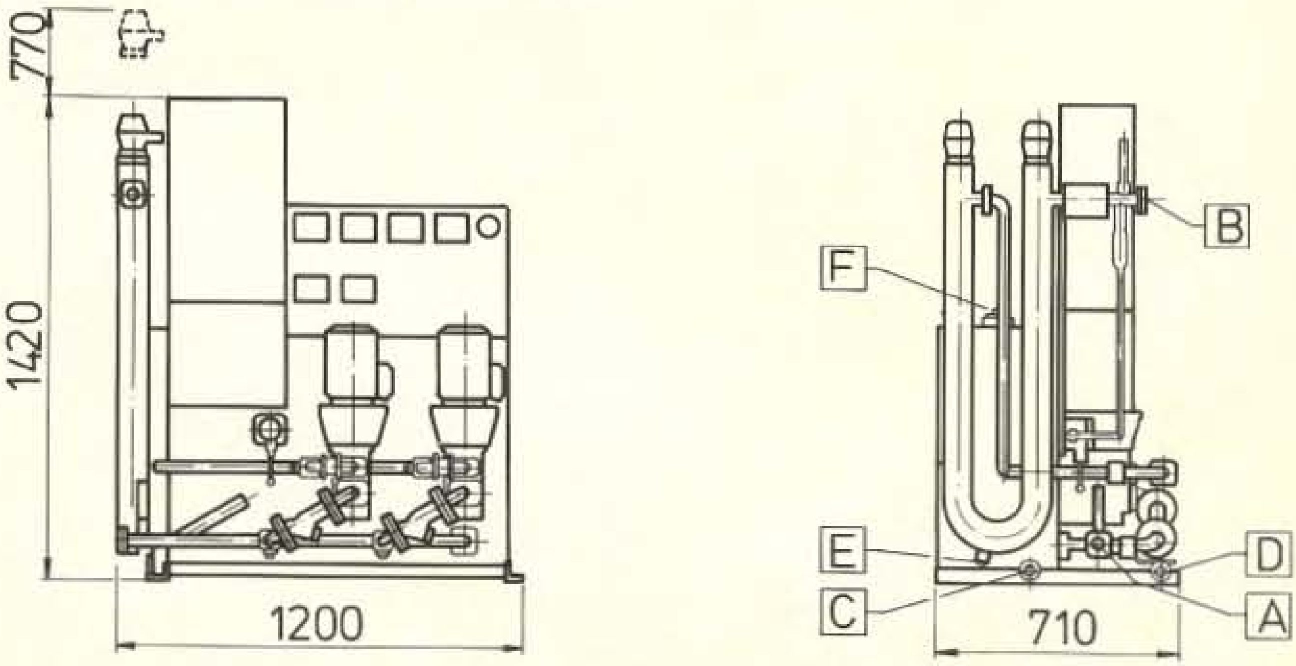
Pipe dimensions

Engine	A	B
4...16V22	NS15	NS15

For the capacity of pumps and motors, see technical data below.

Size	50 Hz			60 Hz		
	Number of cylinders	Pump capacity l/h	Electric motor kW	Number of cylinders	Pump capacity l/h	Electric motor kW
1	4...14	540	0.55	4...20	840	0.65
2	16...30	1560	1.0	22...48	2100	1.2
3	32...48	2840	1.4			

NOZZLE TEMPERATURE CONTROL UNIT 2V60L242



Weight dry 360 kg
wet 540 kg

Pipe connections:

A	Oil inlet	NS25
B	Oil outlet	NS25
C	Drain from tank	R1 in
D	Drain from unit	R1 in
E	Drain from electric heater	R 1/2 in
F	Oil filling	

2V60L242

LUBRICATING OIL SYSTEM

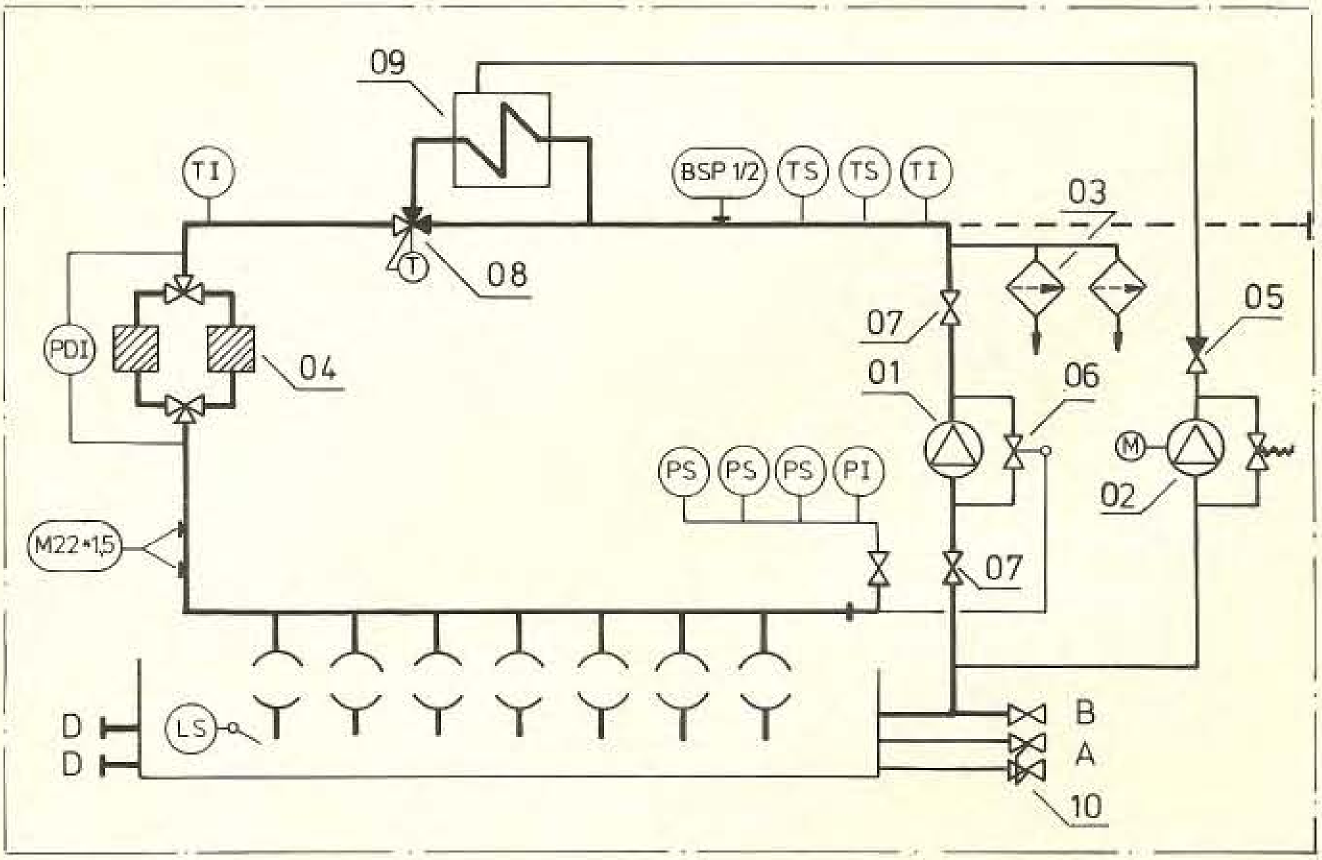
GENERAL

The lubricating oil qualities approved and recommended for the diesel engine Wärtsilä Vasa 22 appear from the section general data and outputs.

ENGINE INTERNAL LUBRICATING OIL SYSTEM

Depending on the type of engine and/or application the lubricating oil system built on the engine can vary somewhat in design.
The normal system for the Vasa 22 is a circulating system, including wet sump (auxiliary engines), built on the engine. In main engines designed for heavy fuel operation, dry sump is standard.

LUBRICATING OIL DIAGRAM 4V69E337



System components

01. Lubricating oil main pump
02. Prelubricating oil pump
03. Centrifugal filter
04. Fine filter
05. Non-return valve
06. Pressure regulating valve
07. Shut-off valves, only when stand-by pump is installed
08. Thermostat valve
09. Oil cooler
10. Shut-off valves, on auxiliary engines, only

Pipe connections

A. Connection to separator (optional)
B. Suction to stand-by pump (optional)
C. Discharge from stand-by pump (optional)
D. Draining of lubricating oil sump

DESIGN OF EXTERNAL LUBRICATING OIL SYSTEM

Each engine should have a separate lubricating oil system of its own. Main engines operating on heavy fuel should have continuous centrifuging of the lubricating oil, either according to the bypass or batch principles. Auxiliary engines with wet sump can have intermittent separation, with separation of a stopped engine. Alternatively, the used oil can be drained to a tank, from where it is separated to a storage tank for used oil.

Lubricating oil pump (01)

The direct driven lubricating oil pump is of the gear type. The pump is dimensioned to provide sufficient flow even at low speeds and is equipped with an overflow valve which is controlled from the oil inlet pipe.
If necessary, the engine is provided with pipe connections for a separate, motor driven stand-by pump.
Concerning flow rates and pressures, see technical data.
The suction height for the pump should not exceed 5 m.

Prelubricating pump (02)
The prelubricating pump is a motor driven screw pump equipped with an overflow valve.
The pump is used for:

1. filling of the diesel engine lubricating oil system before starting, e.g. when the engine has been out of operation for a long time
2. continuous prelubrication of a stopped diesel engine through which heated fuel is circulating
3. continuous prelubrication of stopped diesel engine in a multi-engine installation always when one of the engines is running
4. providing additional capacity to the direct driven lubricating oil pump in certain installations where the diesel engine speed drops below a certain value. In these cases, the pump should start and stop automatically on signals from the speed measuring system

Corcerning flows and pressures, see technical data.
The suction height for the built-on prelubricating pump should not exceed 3.5 m.

Motors for the prelubricating pump

	50 Hz	60 Hz
4...8R22	1.5 kW	1.7 kW
12V22, 16V22	2.2 kW	2.3 kW

Lubricating pump, stand-by (03)
The stand-by lubricating oil pump can be of the gear or screw type and should be provided with an overflow valve.
Design data:

- ★ capacity — see technical data
- ★ operating pressure, max. — 8 bar
- ★ operating temperature, max. — 100°C

Separator (04)

The separator should be dimensioned for continuous centrifuging. Each separate lubricating oil system should have a separator of its own. Auxiliary engines can normally have a common separator. In installations with four or more auxiliary engines two separators should be installed.
The separator system must not be designed for water mixing when centrifuging.
Design data:

- ★ flow through the separator in relation to rated capacity 20...25 %
- ★ number of through-flows of the entire oil volume per 24 h — 4...5
- ★ centrifuging temperature — 80...85°C
- ★ system oil volume — see technical data and lube oil tank

Recommended rated capacities for lubricating oil separators. The capacities apply for one engine.

Engine type	Main engine separate lube oil tank l/h	Auxiliary engine wet sump l/h
4R22	830	250
6R22	1250	380
8R22	1670	480
12V22	2500	570
16V22	3300	750

The capacities apply for automatically cleaned separators. For manually cleaned separators the capacities should be increased with 20 %.

Separator pump (05)
The separator pump can be direct driven by the separator or separately driven by a motor. The flow should be adapted to achieve the above mentioned optimal capacity.

Preheater (06)
The preheater can be a steam or an electric heater. The surface temperature of the heater must not be too high in order to avoid coking of the oil.
Design data:

- ★ In main engines when centrifuging during operation, the heater should be dimensioned for this operating condition. The temperature in the separate system oil tank in the ship's bottom is normally 65...75°C.
- ★ In auxiliary engines when centrifuging the engine being stopped, the heater should be dimensioned large enough to allow centrifuging at optimal rate of the separator without heat supply from the diesel engine.

Lubricating oil storage tank (07)
In engines with wet sump system, the lubricating oil can be filled into the engine, by using a hand oil can, through the separator pipe. The system should be arranged so that it is possible to measure the filled oil volume.

Sludge tank (08)

Valve system (09)
In auxiliary engines with wet sump operation and a common separator, the standard engine is delivered with interconnected valves to prevent erroneous operation.

Automatic filter (11)
In order to extend the operating time of the cartridges of the built-on lubricating oil filter, on request, an automatic filter can be fitted in series with the cartridge type filter.

Design data:

* lubricating oil viscosity SAE 30 (SAE 40)
* operating pressure, max. 8 bar
* test pressure, min. 12 bar
* operating temperature, max. 100°C
* fineness 90 % separation above 20 microns (absolute mesh) width max. 35 microns)
* recommended pressure drop for normal filters dirty filter 1.0 bar alarm 1.5 bar

Suction strainer (12)
If necessary, a suction strainer completed by magnetic bars can be fitted in the suction pipe to protect the lubricating oil pump.
The suction strainer as well as the suction pipe diameter should be amply dimensioned to minimize the flow loss. The suction strainer should always be provided with alarm for high differential pressure.

* fineness 0.5...1.0 mm

System oil tank (separate) (13)
The engine dry sump is drained at both ends. The pipe connection between the sump and the system oil tank should be arranged flexible enough to prevent damage due to thermal expansion.
Recommendation for the design of the tank given in the drawing of the engine room arrangement. The tank must not be placed so that the oil is cooled so much that the recommended lubricating oil temperature cannot be obtained.

Design data:

* oil volume 1.2...1.5 1 l/kW
* tank filling 75...80 %

Lubricating oil cooler (14)
The lubricating oil cooler, normally mounted on all engines, is of the tube type with a direct acting, built-on thermostat valve.

Thermostat valve (15)
A termostat valve of the direct acting type is normally installed in all engines.

Design data:

* inlet oil temperature to be kept constant, set point 71°C
* operating pressure, max. 8 bar

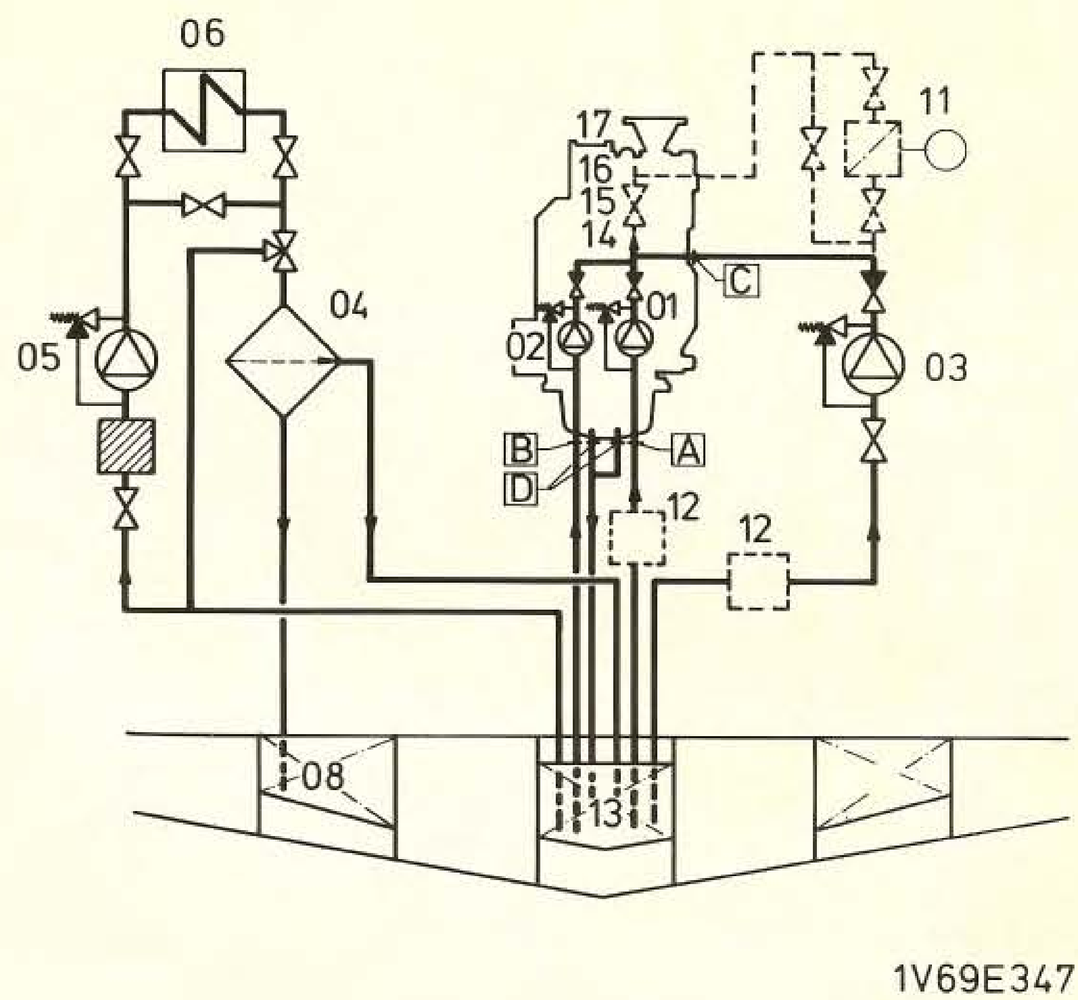
Lubricating oil fine filter (16)
The lubricating oil fine filter is a duplex filter with changeable cartridges of paper.
The filter is dimensioned for an operating time of 2000...3000 h per cartridge when running on heavy fuel.

* fineness 60 % separation above 15 microns at one through-flow

Centrifugal filter (17)
In addition to the full-flow filter the engine is equipped with centrifugal filters in by-pass.

* capacity per filter 1.1 m³/h
* filtering properties down to 1 micron

LUBRICATING OIL SYSTEM 1V69E347



System components

01 Lubricating oil pump, direct driven
02 Prelubricating oil pump, electrically driven
03 Lubricating oil pump, stand-by, electrically driven (if installed)
04 Lubricating oil separator
05 Separator pump
06 Preheater
08 Sludge tank
11 Automatic filter (if installed)
12 Suction strainer
13 System oil tank
14 Oil cooler
15 Thermostat valve
16 Fine filter

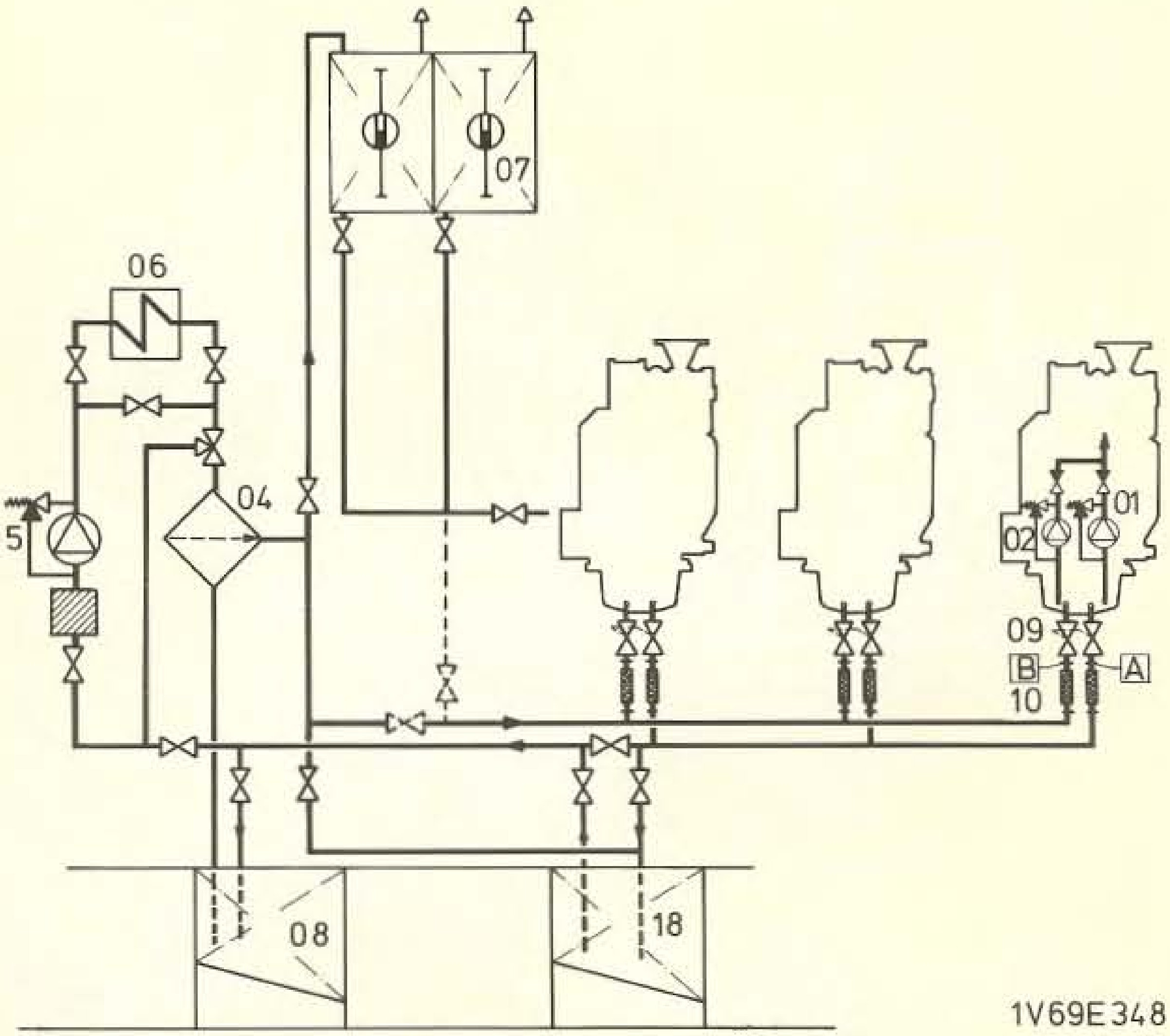
Pipe connections

A Lubricating oil suction pipe, main pump
B Lubricating oil suction pipe, prelubricating pump
C Lubricating oil inlet from stand-by pump
D Lubricating oil drainage system oil tank, 2 pcs

Pipe dimensions

Engine	A	B	C	D
4...8R22	NS65	NS40	NS50	2xNS100
12V22, 16V22	NS80	NS40	NS65	2xNS125

LUBRICATING OIL SYSTEM 1V69E348



System components

01 Lubricating oil pump, direct driven
02 Prelubricating oil pump, electrically driven
04 Lubricating oil separator
05 Separator pump
06 Preheater
07 Lubricating oil storage tank
08 Sludge tank
09 Valve system
10 Flexible pipe connection (if installed)
18 Renovating tank

Pipe connections

A Lubricating oil suction pipe to separator
B Lubricating oil return from separator

Pipe dimensions

Engine	A	B
4...8R22	NS32	NS32
12V22, 16V22	NS50	NS50

COOLING WATER SYSTEM

GENERAL

The Vasa 22 is normally equipped with a load dependent cooling water system.

The low temperature system, i.e. the charge air and oil cooling system, and the high temperature system, i.e. the jacket water system, are interconnected. Due to this the engine should be cooled with fresh water, the pH-value and hardness of which should be within normal values. The chlorine and sulphate contents should be as low as possible. To prevent rust forming in the cooling water system, a corrosion inhibitor should be added to the system according to the instructions in the instruction manual.

The cooling water pipes of the engine are made of steel.

To allow start on heavy fuel, the engine cooling water system, both the LT and the HT system, should be preheated to a temperature as near the operating temperature as possible, or min. 60°C. Engines in which full load is applied immediately after start should also be preheated before start, also when running on Marine Diesel Oil.

ENGINE INTERNAL COOLING WATER SYSTEM

Irrespective of the engine cylinder number and/or application type the internal built-on cooling water system design is similar. Each engine is as standard provided with the following built-on equipment:

- circulating pump and non-return valve for the low temperature circuit
- thermostatic valve for the low temperature circuit
- charge air cooler
- lubricating oil cooler
- circulating pump and non-return valve for the high temperature circuit
- thermostatic valve for the high temperature circuit

On request the engine can be equipped with connections for separately mounted stand-by cooling water pumps and a fresh water destiller.

The charge air cooler and the lubricating oil cooler are as standard dimensioned for an inlet cooling water temperature of 38°C.

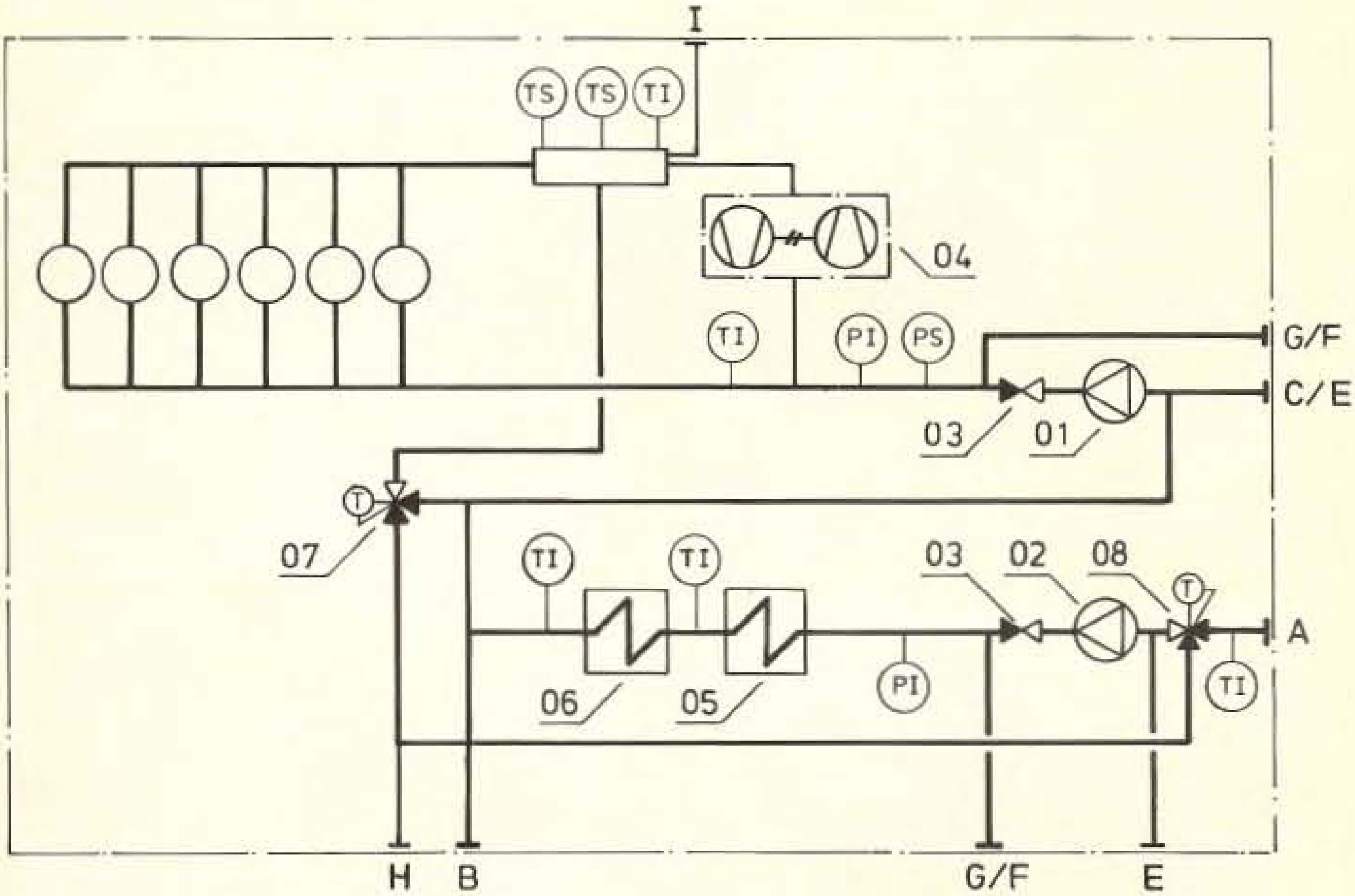
Both the low temperature and the high temperature circuits are provided with their own thermostat valve for a load dependent temperature control of the cooling water.

The set points of the thermostat valves are automatically adjusted when the load of the engine changes. When the load decreases the set point increases and vice versa. At normal high load operation the set point of the low temperature circuit inlet is 38°C and the high temperature circuit outlet 78°C. At idling, the set point of the low temperature circuit is abt. 75°C and of the high temperature circuit abt. 105°C. This requires a static pressure of abt. 2.0 bar, which means that the expansion tank must be of the closed type. For certain auxiliary engines the higher set point for the high temperature circuit can be 95°C, which makes it possible to use a normal open expansion tank.

The outlets from the low temperature and high temperature circuits are interconnected and the mixed water is cooled in a fresh water cooler.

For engines specified for burning solely Marine Diesel Fuel or intermediate fuel with the maximum viscosity of 30 cSt/50°C (250 sec.r/100°F) the load dependent cooling water system can be omitted. The following paragraph applies to the planning of the external systems for these engines.

COOLING WATER DIAGRAM 4V69E339
LOAD DEPENDENT TEMP. CONTROL



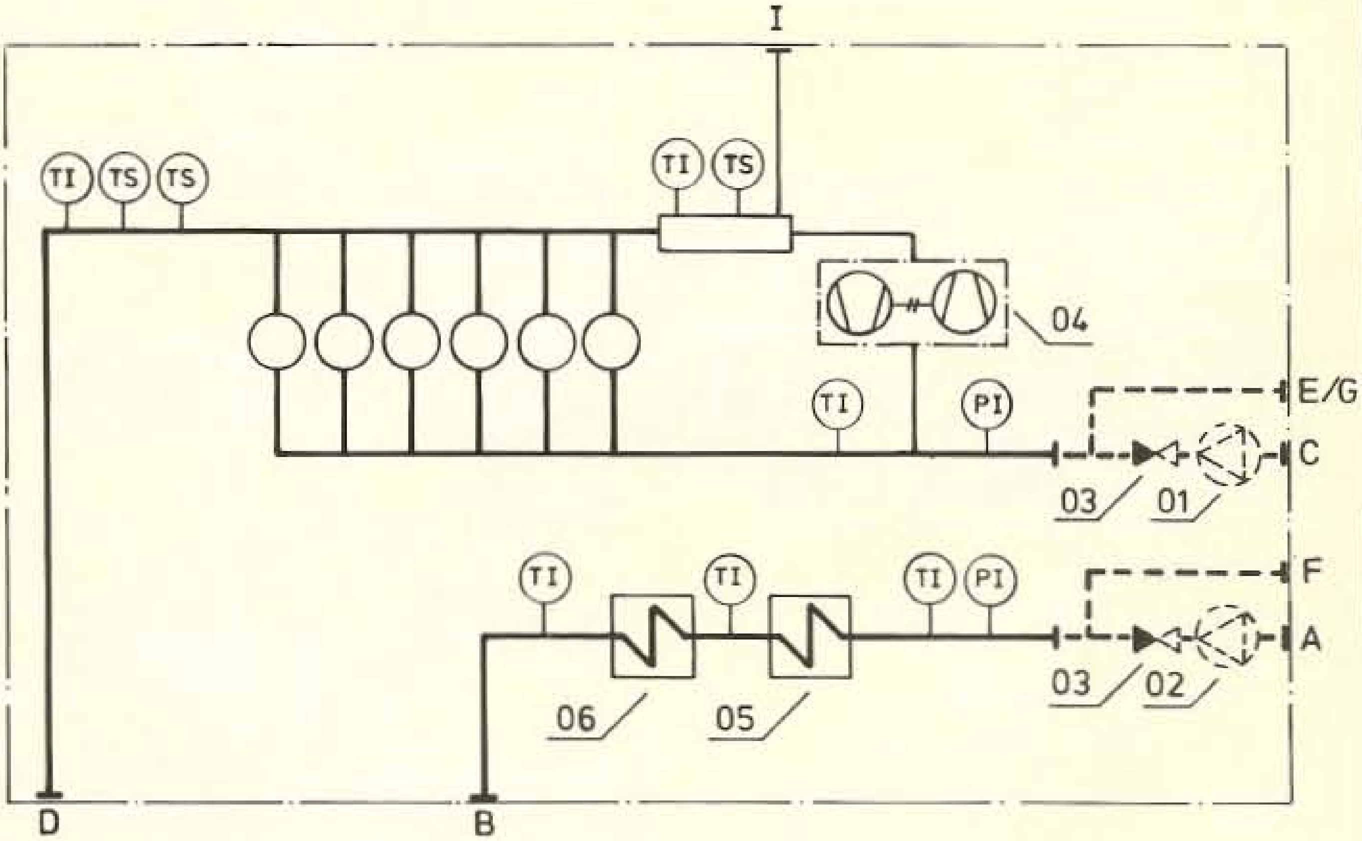
System components

01. H.T. cooling water pump
02. L.T. cooling water pump
03. Non-return valve
04. Turbocharger
05. Charge air cooler
06. Lubricating oil cooler
07. H.T. thermostat valve
08. L.T. thermostat valve

Pipe connections

A. Cooling water inlet
B. Cooling water outlet
C. Cooling water expansion
E. Stand-by pump, suction
F Stand-by pump, discharge
G. Preheating inlet (2 connections)
H. Preheating outlet
I H.T. cooling water, air venting

CONVENTIONAL TYPE COOLING WATER SYSTEM



System components
01. H.T. Cooling water pump (optional)
02. L.T. Cooling water pump (optional)
93. Non-return valve (optional)
04. Turbocharger
05. Charge air cooler
06. Lubricating oil cooler

Pipe connections
A. L.T. Cooling water inlet
B. L.T. Cooling water outlet
C. H.T. Cooling water inlet
D. H.T. Cooling water outlet
E. Preheating inlet
F. Connection for stand-by pump
G. Connection for stand-by pump
I. Cooling water air venting

DIMENSIONING OF THE EXTERNAL COOLING WATER CIRCUIT

The pipe dimensions in the cooling water system should be determined according to the following maximum water velocities:

fresh water, pressure pipe	3.0 m/s
fresh water, suction pipe	3.0 m/s
sea water, pressure side	2.5 m/s
sea water, suction side	1.5 m/s

The fresh water pipes should be designed to minimize the flow resistance as much as possible. The smaller the pressure drop in the pipes the bigger pressure drop can be used for the cooler.

Circulating pump, direct driven, high temperature circuit (01)
The direct driven cooling water pump is of the centrifugal type and is driven by the engine crankshaft through gear transmission.
On request, outlet and inlet connections for a separate stand-by pump can be provided as well as a shut-off valve on the suction side of the built-on pump.

Material

— housing:	cast iron or bronze
— impellar:	cast iron or bronze
— shaft:	stainless steel
— sealing:	mechanical

Concerning capacity, see technical data.

Circulating pump, direct driven, low temperature circuit(02)
See (01)

Stand-by circulating water pumps, LT and HT circuit (03, 04)
The pumps normally to be of the centrifugal type and driven by en electric motor. Concerning capacity, see technical data. The delivery head of the pumps should be increased with the actual flow resistance in the external pipes and valves.

Sea water pump (05)
The sea water pumps have to be electrically driven. The capacity of the pumps are determined by the type of coolers used and the heat to be dissipated.

Lubricating oil cooler (06)
The lubricating oil cooler is of the tube type, intended to be cooled by fresh water and connected in series with the charge air cooler.

Material (tube type cooler):

★ tube	CuNi30Fe or CuZn20Al
★ tube plate	CuNi30Fe or CuZn40
★ water box	Rg 10

Design data:
See technical data.

Charge air cooler (07)
The charge air cooler built on the engine — one for the in-line engine and two for the V-engine — is of the insert type with removable cooler inserts.

Material

★ tubes	CuNi30Fe or CuNi10Fe
★ tube plates	CuZn40 or steel
★ water box	Rg 7 or GG25

Design data:
See technical data

Fresh water central cooler (08)
The fresh water cooler can be of either tube or plate type. Due to smaller dimensions of the plate cooler, this type is normally used. The fresh water cooler can be common for several engines, also one independent cooler per engine is used.

Design data:
Fresh water flow: see technical data
Pressure drop on fresh water side:
max. 0.6 bar.
If the flow resistance in the external pipes is high it should be observed when designing the cooler.
Sea water flow: according to cooler manufacturer.
Normally 1.2...1.5 x the fresh water flow

Pressure drop on seawater side:
according to cooler manufacturer.
Normally 0.8...1.4 bar
Fresh water temperature after cooler (before engine): max 38°C. Heat to be dissipated: see technical data
Safety margin to be added: 15 % + margin for fouling

Separate fresh water coolers can be supplied as option.

Thermostat valve, high temperature circuit (09) and low temperature circuit (10)
The cooling water thermostat valves fitted on the engine are of the direct acting type. The valves have two different built-in temperature sensing elements, one for normal high load operation and one for low load operation. The selection of element in operation is done automatically according to the charge air pressure.

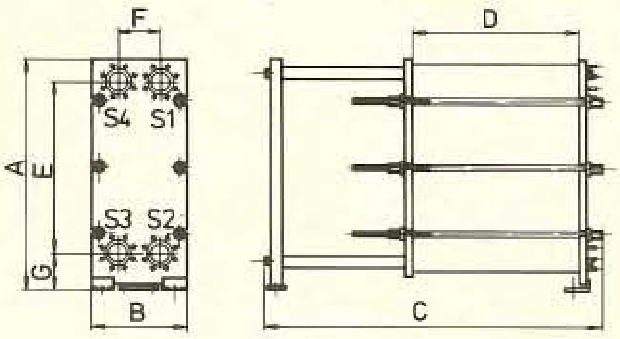
Set values of the thermostat valves:

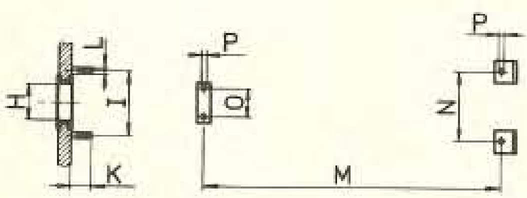
HT circuit:	78°C/105°C
LT circuit:	38°C/75°C

The thermostat valve for high temperature circuit is arranged to control the outlet temperature of the water and the valve for the low temperature circuit to control the inlet temperature to the pump.

CENTRAL COOLER, MAIN DIMENSIONS 1V7F01

The coolers are of the type with titanium plates, the thickness of which is 0.6 mm, and with nitrite gaskets.





Connection type

1V47F01

900 RPM

Inst	Cooler size	FW flow m³/h	SW flow m³/h	SW op mwc	C	D	M
1x4R22	1	22	29	11	1085	109	875
2x4R22	1	44	55	10	1085	202	875
3x4R22	1	68	79	9	1460	318	1250
1x6R22	1	34	41	10	1085	159	875
2x6R22	1	68	79	9	1460	318	1250
3x6R22	1	102	133	10	1460	498	1250
1x8R22	1	39	52	12	1085	181	875
2x8R22	1	78	100	11	1460	361	1250
3x8R22	2	117	160	12	1450	336	1348
1x12V22	1	68	79	9	1460	318	1250
2x12V22	2	136	190	13	1450	348	1348
1x16V22	1	77	100	11	1460	361	1250
2x16V22	2	154	220	13	2050	436	1948

1000

Inst.	Cooler size	FW flow m³/h	SW flow m³/h	SW op mwc	C	D	M
1x4R22	1	24	30	11	1085	116	875
2x4R22	1	48	58	10	1085	224	875
3x4R22	1	72	88	9	1460	346	1250
1x6R22	1	38	47	9	1085	181	875
2x6R22	1	76	88	9	1460	346	1250
3x6R22	1	114	127	8	1835	541	1625
1x8R22	1	48	58	10	1085	224	875
2x8R22	1	96	110	9	1460	447	1250
3x8R22	2	144	200	14	1450	364	1348
1x12V22	1	75	88	9	1460	346	1250
2x12V22	2	150	210	13	1450	388	1348
1x16V22	1	86	112	11	1460	397	1250
2x16V22	2	172	240	12	2050	492	1048

1200 RPM

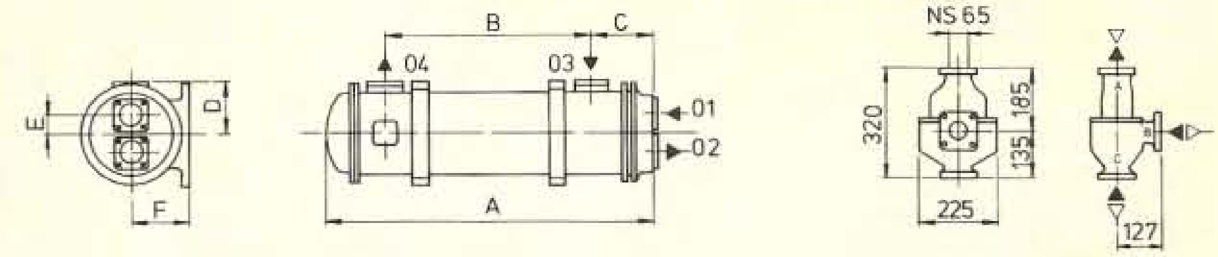
	Cooler size	FW flow m³/h	SW flow m³/h	SW op mwc	C	D	M
1x4R22	1	29	31	8	1085	138	875
2x4R22	1	58	68	9	1085	267	875
3x4R22	1	87	110	8	1460	397	1250
1x6R22	1	45	50	8	1085	210	875
2x6R22	1	90	110	8	1460	447	1250
3x6R22	2	135	190	13	1450	348	1348
1x8R22	1	58	68	9	1085	267	875
2x8R22	1	116	128	8	1835	548	1625
3x8R22	2	174	240	14	2050	492	2050
3x8R22	2	174	240	14	2050	492	1948
1x12V22	1	90	110	8	1460	447	1250
2x12V22	2	180	260	15	2050	436	1948
1x16V22	1	105	128	10	1460	498	1250
2x16V22	2	210	300	14	2050	572	1948

Cooler size	A	B	E	F	G	H	I	K	L	N	O	P
1	1265	520	945	230	200	100	180	55	M16	390	160	28
2	1965	720	1315	350	265	150	240	65	M20	560	240	40

JACKET WATER COOLER AND THERMOSTAT VALVE

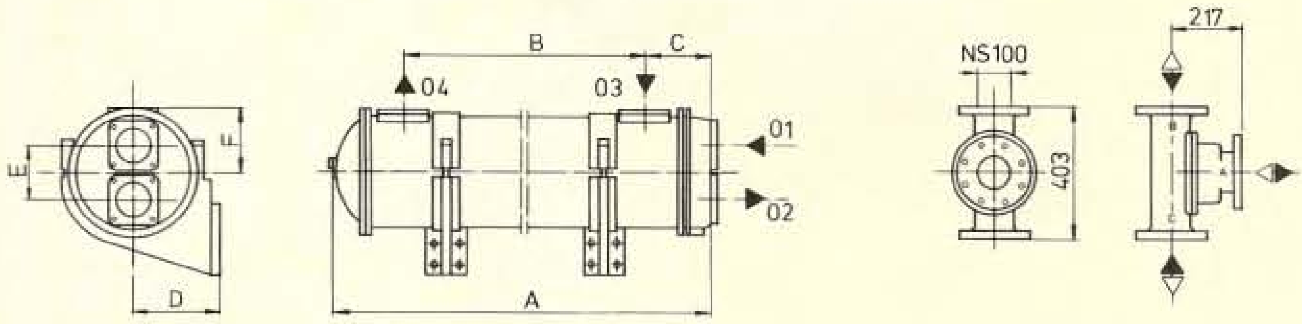
IN-LINE ENGINES

Engine	A	B	C	D	E	F
4R22	1110	800	165	118	55	170
6R22	1128	808	165	142	55	170
8R22	1328	1007	165	142	55	170



VEE-ENGINES

Engine	A	B	C	D	E	F
12V22	1513	1100	196	185	78	255
16V22	1513	1100	196	185	78	255



01 Sea water inlet
02 Sea water outlet
03 Jacket water from engine
04 Jacket water to engine

A From engine alt. to engine
B By-pass
C To cooler alt. from cooler

CENTRAL COOLER, MAIN DIMENSIONS 1V7F01

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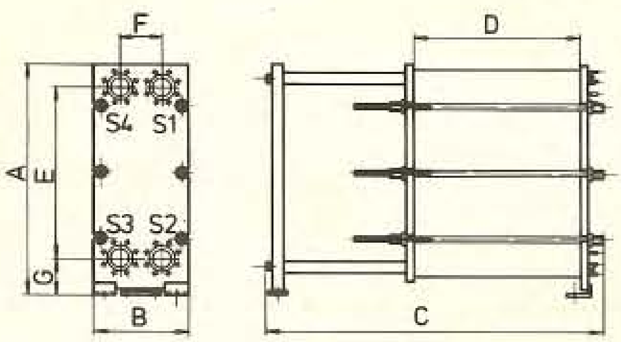

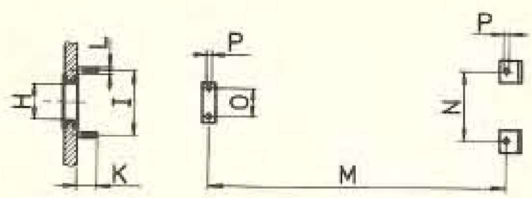

Connection type

1V47F01

900 RPM

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JACKET WATER COOLER AND THERMOSTAT VALVE

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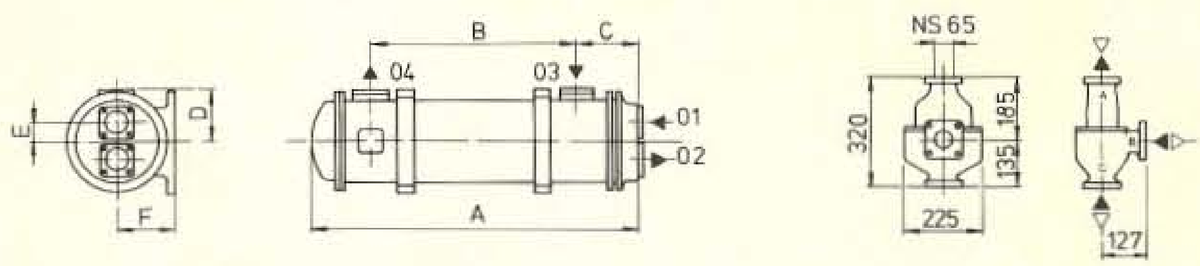

VEE-ENGINES

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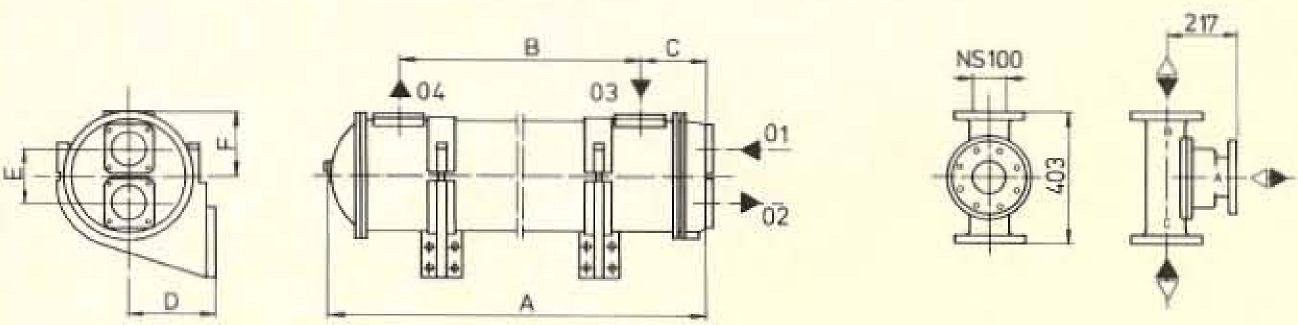


01 Sea water inlet
02 Sea water outlet
03 Jacket water from engine
04 Jacket water to engine

A From engine alt. to engine
B By-pass
C To cooler alt. from cooler

Expansion tank (11)
The expansion tank should compensate for volume changes in the cooling water system, serve as venting arrangement and provide sufficient static pressure on the cooling water.

★ Pressure from the expansion tank
Due to the increased temperatures of the high temperature cooling water at low load the static pressure obtained from the expansion tank should be within 1.5...2.5 bar. In smaller ships the expansion tanks have to be the closed type. For certain auxiliary engines a static pressure of min. 0.7 bar can be accepted.

★ Volume: min. 10 % of the system water volume, however, min. 100 litres
Concerning engine water volumes, see technical data.

The tank should be equipped so that it is possible to dose water treatment agents.
The vent pipe of each engine should be drawn to the tank separately, continuosly rising, and so that oxidation of the water cannot occur (the outlet should be below the water level).

Sea water filter (12)
★ fineness 3...5 mm

Preheating pump (14)
Engines which are started on heavy fuel require preheating of the low temperature and high temperature cooling water. Stand-by auxiliary engines should have preheated cooling water, also if in stand-by on MDF.

Desing data of the pump:

★ capacity: 0.5 m³/h x cyl.
★ pressure: abt. 1 bar

Preheater (15)
The energy required for heating of the cooling water in the main and auxiliary engines can be taken from a running engine or a separate source. In both cases a separate circulating pump should be used. With an engine with the load dependent cooling water system there is no risk that the water of a running engine is cooled below the permissible value.
If the cooling water systems of the main and auxiliary engines are separated from each other in other respects, the energy is recommended to be transmitted through heat exhangers.
When preheating, the cooling water temperature of the engines should be kept as near the operating value as possible.

Design data:

★ preheating temperature: min. 60 °C
★ required heating power per engine in kW:

	P_1	P_2
4R22	19	6
6R22	26	8
8R22	31	11
12V22	36	13
16V22	45	16

P_1 = heating power required to raise the engine temperature 40 °C in 1.5 h
P_2 = continuous heating power required to keep the engine temperature 40 °C above ambient temperature

Preheating unit

A complete preheating unit can be supplied as option. The unit consists of the following parts

— electric heaters (coils)
— circulating pump
— control cabinet for heaters and pump
— safety valve
— one set of thermometers

Technical data for preheating unit

Size	Number of cylinders	Heater capacity kW	Pump capacity m³/h
1	4	6	3
2	6	9	3
3	8	12	3
4	12...18	18	8
5	20...28	27	8
6	30...36	36	8

For installations with several engines the preheater unit can be chosen for heating up two engines. The heat from a running engine can be used and therefore the power consumption of the heaters will be less than the nominal capacity.

Circulating pump for recovery of waste heat (16)
An electrically driven circulating pump is necessary to ensure a (constant) flow through the waste heat recovery equipment. For a single engine installation, the pump may be omitted.

Heat exchanger for recovery of waste heat (17)

Design data:

★ flow: according to optimum temperature program
★ heat to be dissipated:
$Q = kM$
k = load factor, see graph below
M = heat to be dissipated at 100 % load, (see technical data)

★ cooling water temperature:

The temperature of the high temperature cooling water out from the engine is 78° at normal high load operation the corresponding temperature is 105°C and the flow is very small.

The thermostat valve should control the cooling water temperature out from the heat recovery heat exchanger. If the temperature is low enough the water will flow directly to the suction side of the high temperature cooling water pump, otherwise to the central cooler.

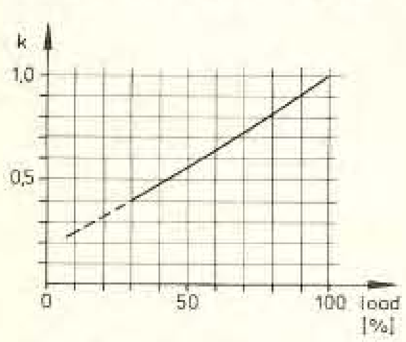
Recommended set point: 71°C

With this set point, the total water flow from the high temperature circuit can be used.

When recovery of the total available amount of heat energy is not required, the thermostat valve can be omitted. The water flow out from the high temperature circuit will depend on the load of the engine and is approximately 20 % of the nominal flow of the built-on cooling water pumps at full load and 10 % at 55 % load.

When the cooling water temperature out from the heat recovery unit is approximately 45°C the total available heat energy can be utilized also without the thermostat valve. Then, however, a circulating pump is necessary, also for single engine installations.

HEAT TO BE DISSIPATED FROM THE HIGH TEMPERATURE CIRCUIT



Heat to be dissipated

$Q = k \times M$

k = load factor

M = heat to be dissipated at 100 % load (see technical data)

CONVENTIONAL TYPE COOLING WATER SYSTEM

For engines specified for burning solely Marine Diesel Fuel or intermediate fuel with the maximum viscosity of 30 cSt/50°C the load dependent cooling water system can be omitted. The following paragraph applies to the planning of the external systems for these engines.

Charge air cooler (07)

The charge air cooler built on the engine — one for the in-line engine and two or the V-engine — is of the insert type with removable cooling inserts.

Material:

★ tubes	CuNi30Fe
★ tube plate	CuNi30Fe
★ water box	bronze

Design data:

★ pressure drop, water side	see technical data

Jacket water cooler (08)

The jacket water cooler delivered with the engine is normally of the tube type, intended to be cooled by sea water and connected in series to the oil and charge air coolers.

A cooler common for several engines can be used. However, it is recommendable to connect maximum two engines to the same cooler.

Material:

★ tubes	CuNi30Fe
★ tube plates	CuNi30Fe
★ water box	bronze

Concerning design data, see technical data.

Thermostat valve, jacket water (09)

The jacket water thermostat valve delivered with the engine is normally of the direct acting type. The valve is placed so that inlet water temperature is kept constant.

A common thermostat valve for several engines can be used provided that the temperatures of all engines are the same.

Design data:

★ temperature (set point): 71°C

When the thermostat valve is of the direct acting type and placed far from the engines, it may be necessary to use a set point about 5°C higher to compensate for heat losses in the pipes.

Thermostat valve, sea water (10)

In ships operating on old seas, the sea water inlet temperature to the coolers should be increased by recirculation. A thermolstat valve is recommended for this purpose.

The thermostat valve should be of a very rigid design. With several engines connected to the same system, the thermostat valve should control the inlet temperature to the engines. Set point: 25°C. For one engine per system, the thermostat valve can control either the outlet temperature after the coolers, set point 38°C.

Expansion tank (11)
The expansion tank should compensate for volume changes in the cooling water system, serve as venting arrangement and provide sufficient static pressure on the cooling water.
The tank should be equipped so that it is possible to dose water treatment agents.
The vent pipe of each engine should be drawn to the tank separately, continuously rising, and so that oxidation of the water cannot occur (the outlet should be below the water level).

★ height above the engine crankshaft centre line:	min. 5 m max. 15 m
★ volume	min. 10 % of the system water volume however, min. 100 litres.

Concerning engine water volume, see technical data.

Sea water filter (12)
★ Fineness 3...5 m

Preheating pump (14)
Main engines require preheating of the jacket water when starting on heavy fuel. Normally, the main engines should be heated during stoppage in port.
Stand-by auxiliary engines should have preheated jacket water.

Design data of the pump:
★ capacity 0.3 m³/h x cyl.
★ pressure ca 1 bar

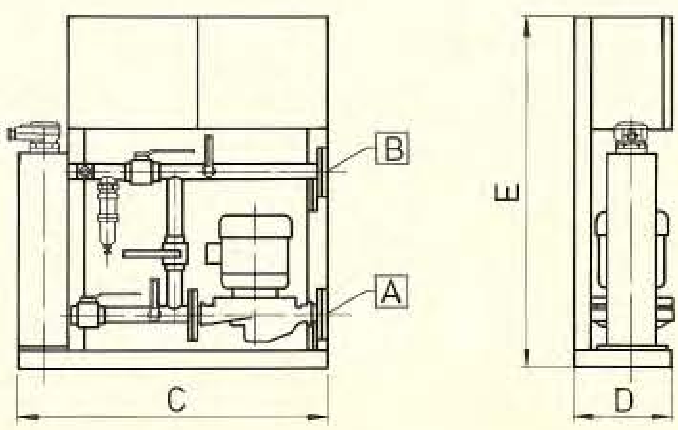
Jacket water preheater (15)
The energy required for heating of the jacket water in main and auxiliary engines can be taken from a running auxiliary engine or a separate source. In case heat is recovered from a running engine, the system should be designed so that the temperature of the engine concerned is not allowed to drop below a permissible value.
If the cooling water systems of the main and auxiliary engines are separated from each other in other respects, the energy is recommended to be transmitted through heat exchangers.
When preheating, the cooling water temperature of the engines should be kept as near the operating value as possible.
Design data:
★ preheating temperature: min. 50°C
★ required heating power per engine in kW:

	P_1	P_2
4R22	10	3
6R22	13	4
8R22	16	6
12V22	18	7
16V22	23	8

P_1 = heating power required to raise the engine temperature 30°C in 1.5 h
P_2 = continuous heating power required to keep the engine temperature 30°C above the ambient temperature

Fresh water distiller (17)
A fresh water distiller or an equivalent arrangement must absolutely not be connected to the circuit so that the inlet water temperature goes belov 70°C.

PREHEATER UNIT 2V60L243



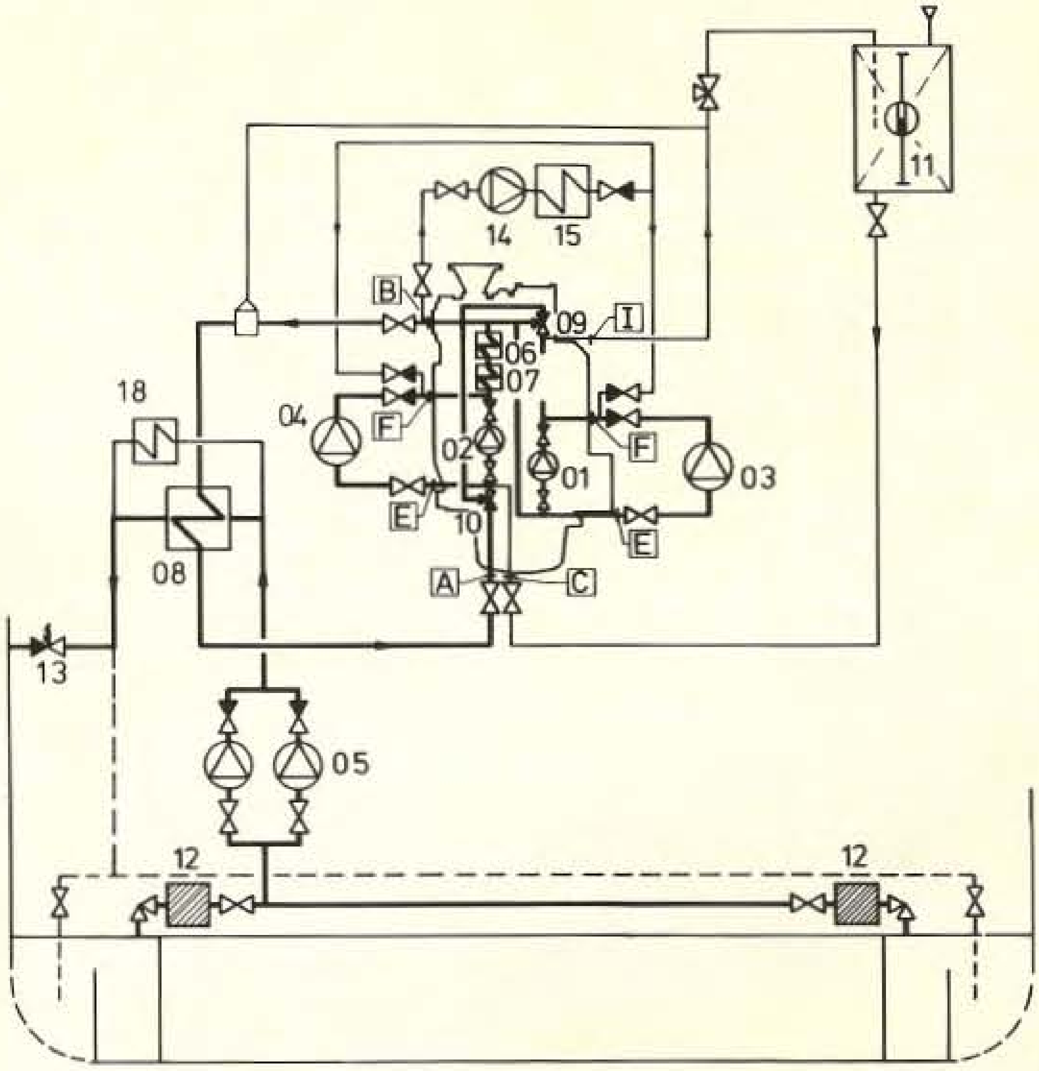
Type/kW	A	B	C	D	E
6, 9, 12	NS32	NS32	850	300	960
18, 27, 36	NS50	NS50	950	300	1000

Pipe connections

A Water inlet to preheater

B Water outlet from preheater

COOLING WATER DIAGRAM 1V69E349



System components

01 H.T. Cooling water pump
02 L.T. Cooling water pump
03 H.T. Stand-by pump
04 L.T. Stand-by pump
05 Sea water pump
06 Lubricating oil cooler
07 Charge air cooler
08 Fresh water (central) cooler
09 Thermostat valve H.T. circuit
10 Thermostat valve L.T. circuit
11 Expansion tank
12 Sea water filter
13 Discharge valve
14 Preheating pump
15 Preheater

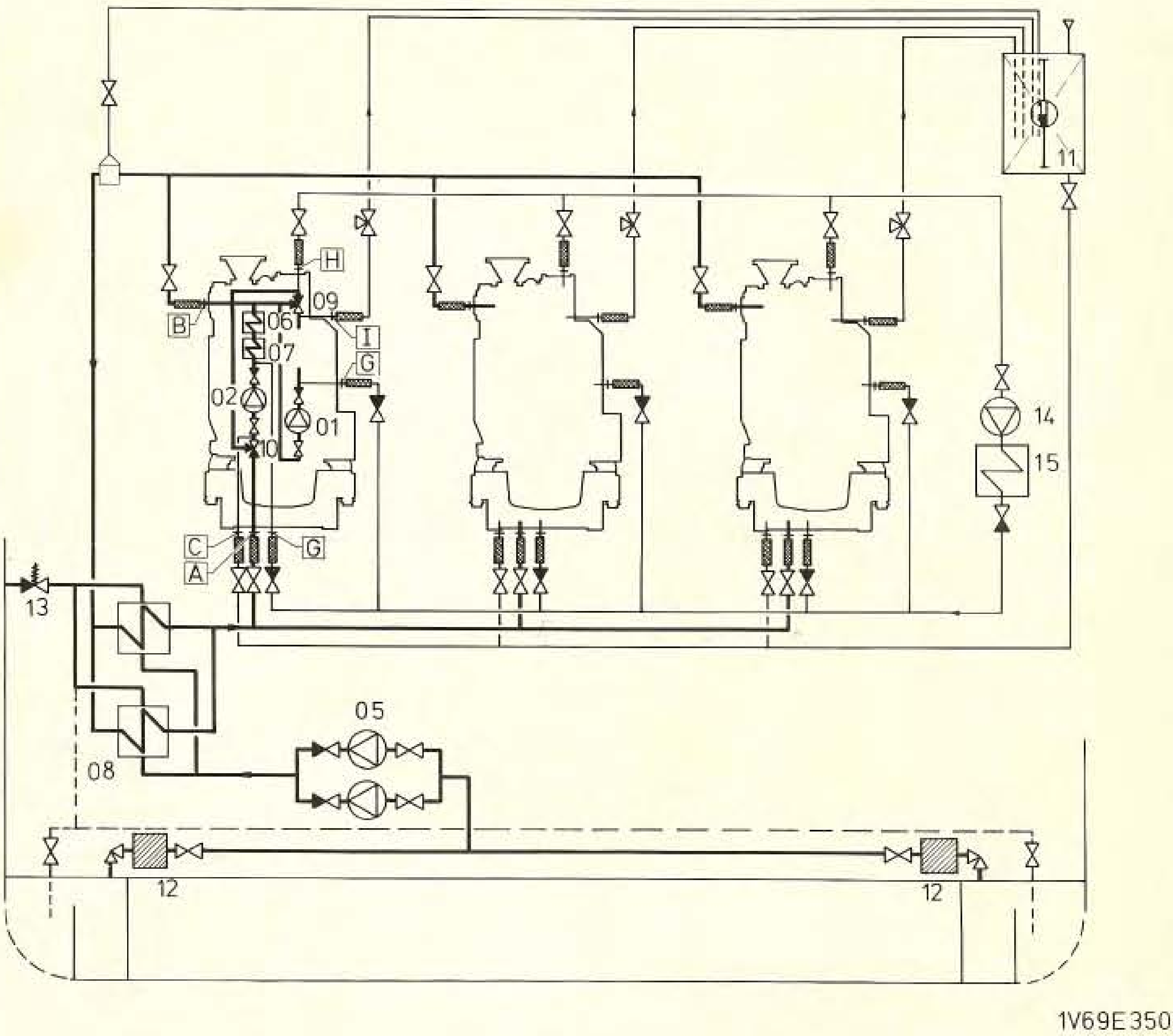
Pipe connections, engine

A Cooling water inlet
B Cooling water outlet
C Cooling water expansion
E Stand-by pump suction
F Stand-by pump discharge
I Cooling water air venting

Pipe dimensions

Engine	A	B	C	E	F	I
4...8R22	NS80	NS80	NS25	NS80	NS80	NS10
12V22, 16V22	NS100	NS100	NS25	NS100	NS100	NS10

COOLING WATER DIAGRAM 1V69E350



System components

01 H.T. Cooling water pump
02 L.T. Cooling water pump
03 H.T. Stand-by pump
04 L.T. Stand-by pump
05 Sea water pump
06 Lubricating oil cooler
07 Charge air cooler
08 Fresh water (central) cooler
09 Thermostat valve H.T. circuit
10 Thermostat valve L.T. circuit
11 Expansion tank
12 Sea water filter
13 Discharge valve
14 Preheating pump
15 Preheater

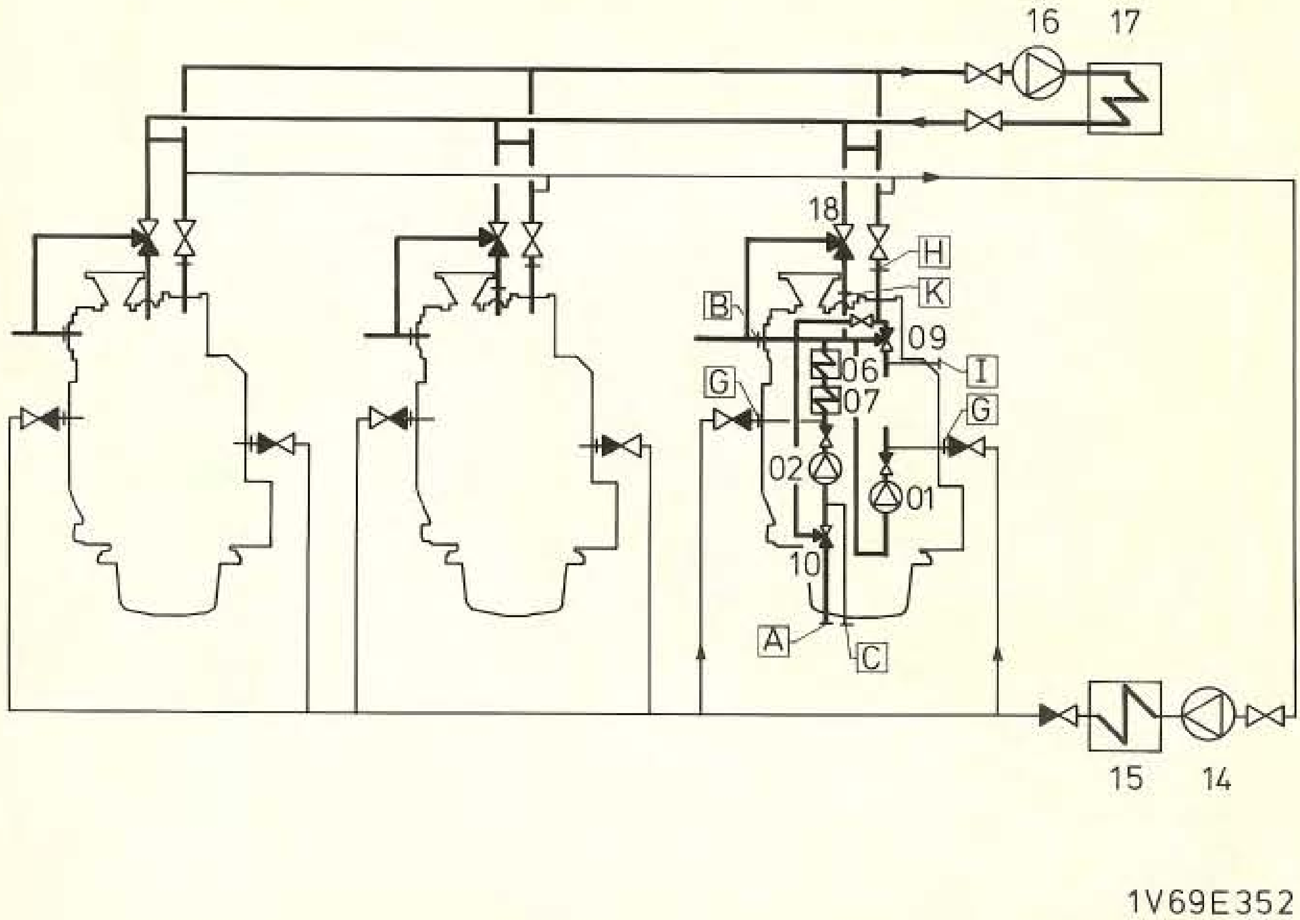
Pipe connections, engine

A Cooling water, inlet
B Cooling water, outlet
C Cooling water expansion
G Preheating water inlet (2 connections)
H Preheating water outlet
I Cooling water air venting

Pipe dimensions

Engine	A	B	C	G	H	I
4...8R22	NS80	NS80	NS25	NS25	NS25	NS10
12V22, 16V22	NS100	NS100	NS25	NS32	NS32	NS10

HEAT RECOVERY AND PREHEATING DIAGRAM 1V69E352



System components

01 H.T. Cooling water pump
02 L.T. Cooling water pump
06 Lubricating oil cooler
07 Charge air cooler
09 Thermostat valve, H.T. circuit
10 Thermostat valve, L.T. circuit
14 Preheater pump
15 Preheater
16 Circulating pump for recovery of waste heat
17 Heat exchanger for recovery of waste heat
18 Thermostat valve

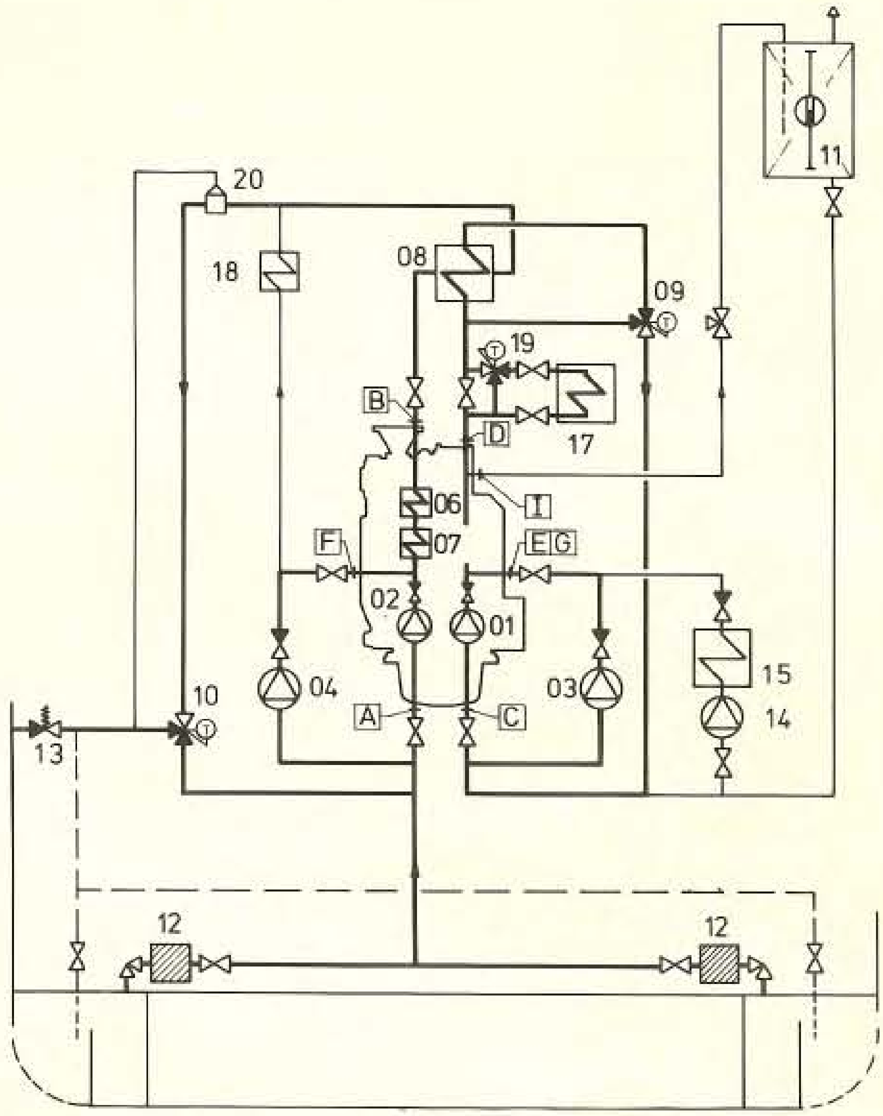
Pipe connections, engine

G Preheating inlet
H Waste heat outlet
K Return from heat recovery

Pipe dimensions

Engine	G	H	K
4...8R22	NS25	NS40	NS40
12V22, 16V22	NS32	NS50	NS50

COOLING WATER DIAGRAM 1V69E351 (CONVENTIONAL SEA WATER COOLING)



1V69E351

System components

01 H.T. Cooling water pump
02 L.T. Cooling water (sea water) pump
03 H.T. Stand-by pump
04 L.T. Stand-by pump
06 Lubricating oil cooler
07 Charge air, cooler
08 H.T. Cooling water cooler
09 Thermostat valve, H.T. circuit
10 Thermostat valve, L.T. circuit
11 Expansion tank
12 Sea water filter
13 Discharge valve
14 Preheating pump
15 Preheater
17 Fresh water destiller
18 Reduction, gear oil cooler
19 Thermostat valve
20 Air venting from L.T. circuit

Pipe connections, engine

A Sea water suction
B Sea water outlet
C H.T. Cooling water suction
D H.T. Cooling water outlet
E H.T. Cooling water stand-by pump
F Sea water stand-by pump
G Preheating inlet
I H.T. Cooling water air venting

Pipe dimensions

Engine	A	B	C	D	E	F	
4...8R22	NS80	NS80	NS80	NS80	NS80	NS80	NS25
12V22, 16V22	NS100	NS100	NS100	NS100	NS100	NS100	NS32

STARTING AIR SYSTEM

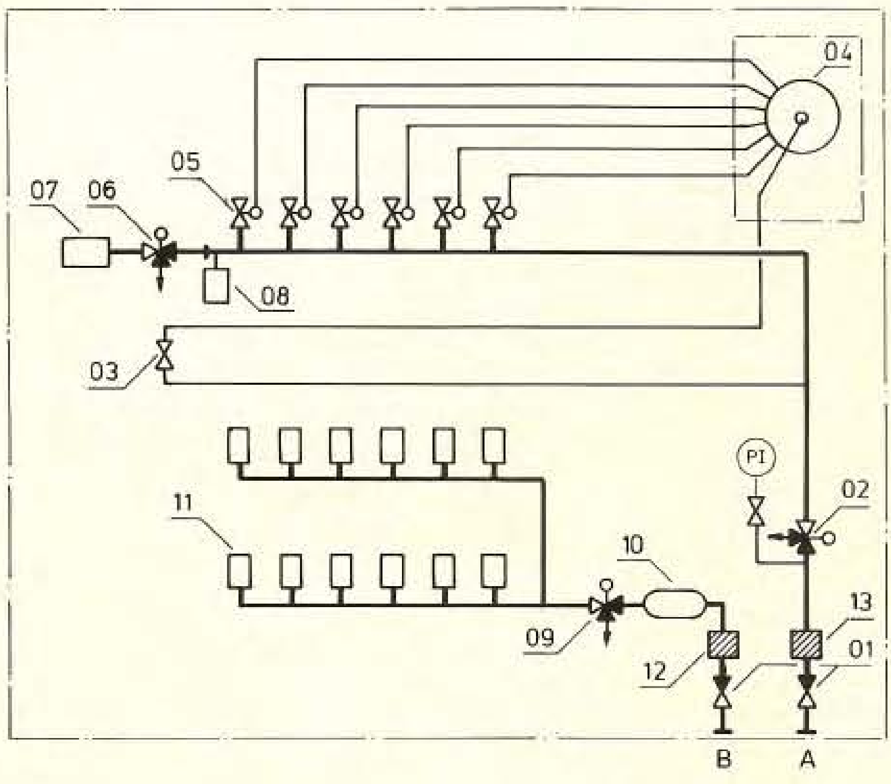
ENGINE INTERNAL STARTING AIR SYSTEM

All engines, independent of cylinder number, are started by means of compressed air with a nominal maximum pressure of 30 bar. The start is performed by direct injection of air into the cylinders through the starting air valves in the cylinder heads. The V-engines are provided with starting air valves for the cylinders on one bank. The master starting valve is built on the engine and can be operated both manually and electrically.

Four-cylinder engines intended for automatic start are provided with a pneumatic starting motor which drives the engine through a gear ring on the flywheel. The starting air pressure is 30 bar also in this case. All engines started with direct injection of air have built-on on-return valves and flame arresters.

The electro-pneumatic overspeed trip for the main engines has a separate air supply. On auxiliary engines, the overspeed trip device is internally connected to the starting air system of the engines.

STARTING AIR DIAGRAM 4V69E340



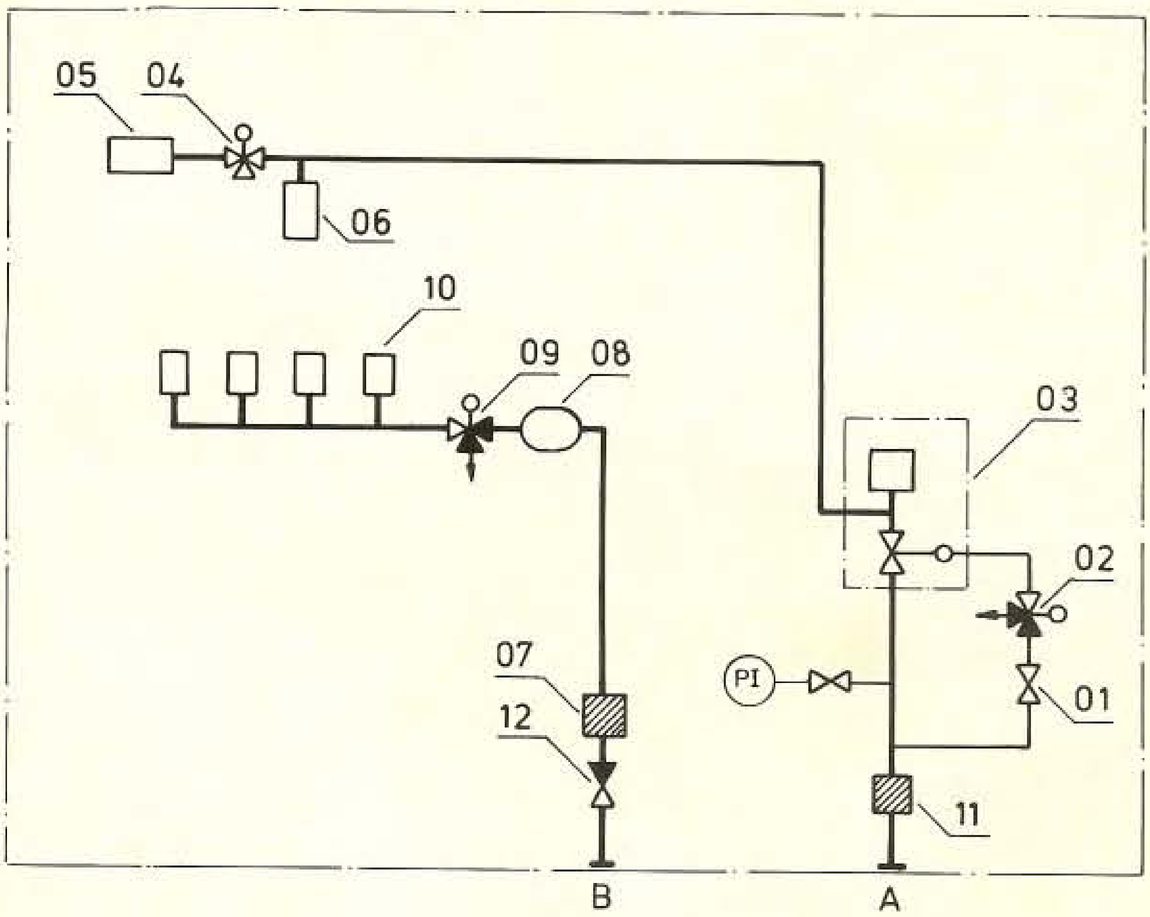
System components

01. Non-return valve
02. Starting air master solenoid valve
03. Valve for blocking starting when turning gear engaged
04. Starting air distributor
05. Starting air valve in cylinder head
06. Solenoid valve for starting fuel limiter
07. Starting fuel limiter
08. Booster for governor
09. Solenoid valve for electro-pneumatic overspeed trip
10. Air container
11. Pneumatic cylinder at each injection pump
12. Air filter
13. Air filter

Pipe connections

A. Starting air inlet
B. Control air inlet

STARTING AIR DIAGRAM 4V69E341
AIR MOTOR STARTER



4V69E341

System components

01. Valve for blocking starting when turning gear engaged
02. Starting air solenoid valve
03. Air starter
04. Solenoid valve for starting fuel limiter
05. Starting fuel limiter
06. Booster for governor
07. Air filter
08. Air container
09. Solenoid valve for electro-pneumatic overspeed trip
10. Pneumatic cylinder at each injection pump
11. Air filter

Pipe connections

A. Starting air inlet
B. Control air inlet

DESIGN OF EXTERNAL STARTING AIR SYSTEM

The design of the starting air system is, in part, determined by the rules of the classification societies. The number of starts required by the classification societies for the Vasa 22 engine (non-reversible):

★ American Bureau of Shipping	ABS	6 starts
★ Bureau Veritas	BV	6 "
★ Det Norske Veritas	DNV	6 " ★
★ Germanischer Lloyd	GL	8 "
★ Lloyd's Register of Shipping	LRS	6 "
★ Register of the USSR	MR	6 " ★
★ Registro Italiano Navale	RINA	6 "

★ In multi-engine installations, the number of starts is dependent on the number of engines.

To determine the required volume of the starting air vessel the following values can be used:

		A	B	C
4R22	with starting motor	30	14	0.41
4R22	with direct injection of air	30	14	0.20
6R22	— " —	30	11	0.14
8R22	— " —	30	11	0.16
12V22	— " —	30	11	0.18
16V22	— " —	30	11	0.20

A = Nominal maximum pressure in bar (absolute maximum pressure 33 bar)

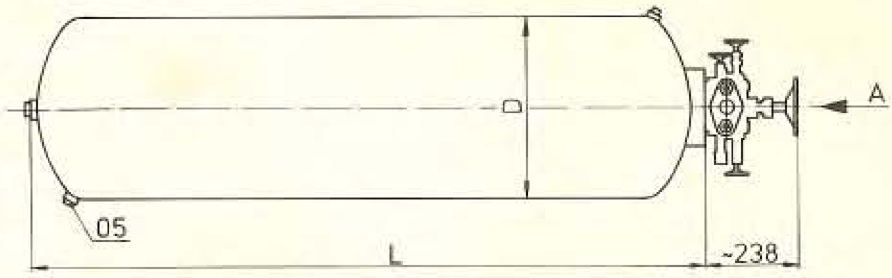
B = Minimum air pressure in bar for a safe start. Applies to an engine room temperature of 20°C. At lower temperature higher pressure is required.

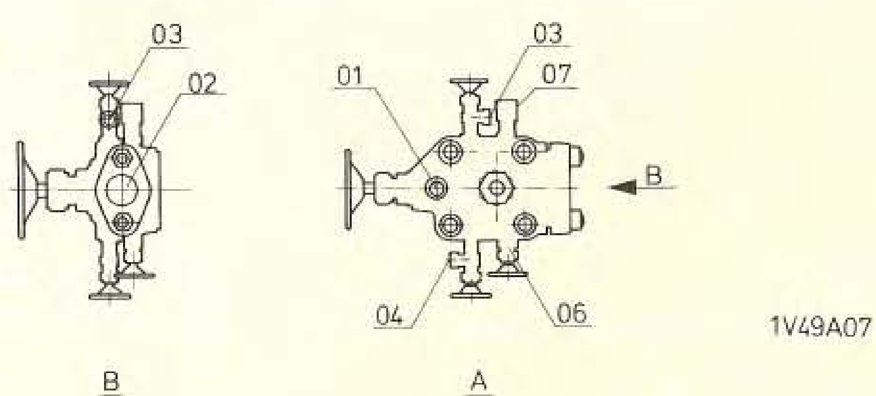
C = Starting air consumption (average) per start, in Nm^3, at 20°C.

At remote and automatic starting the consumption may be 2...3 times higher.

Starting air vessel (01)
The starting air vessel should be dimensioned for a nominal maximum pressure of 30 bar.

STARTING AIR VESSEL 1V49A07





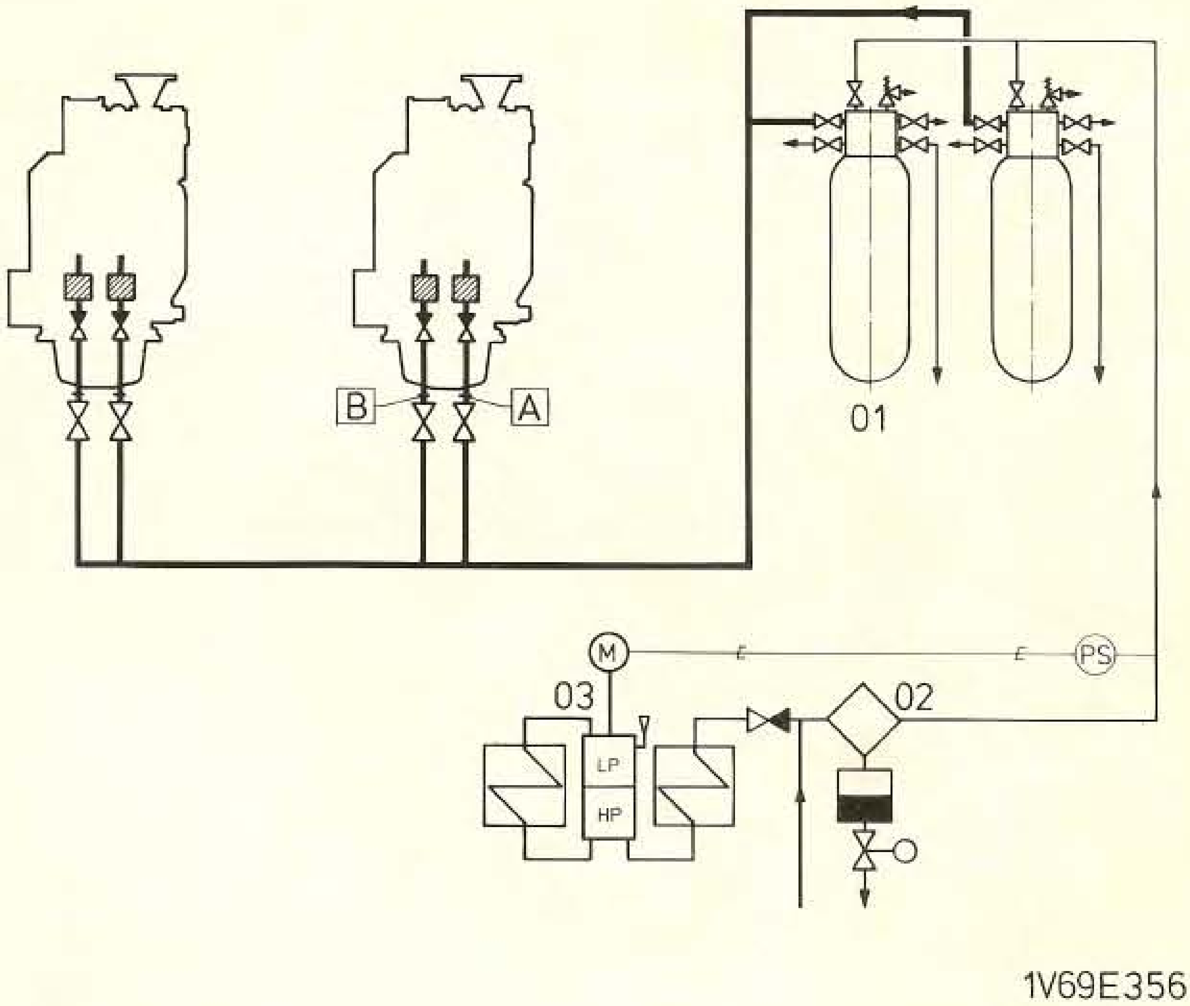
Connections

01	Filling	R3/4 in
02	Outlet	ø 38
03	Pressure gauge	R 1/4 in
04	Drain	R 1/4 in
05	Drain	R 1/2 in
06	Venting	
07	Safety valve	R 1/2 in

Size

Litres	L	D
125	1807	320
250	1767	480
500	3204	480

STARTING AIR DIAGRAM 1V69E356



System components

01 Starting air vessel
02 Oil and water separator
03 Starting air compressor

Pipe connection, engine

A Starting air to engine
B Control air to engine

Pipe dimensions

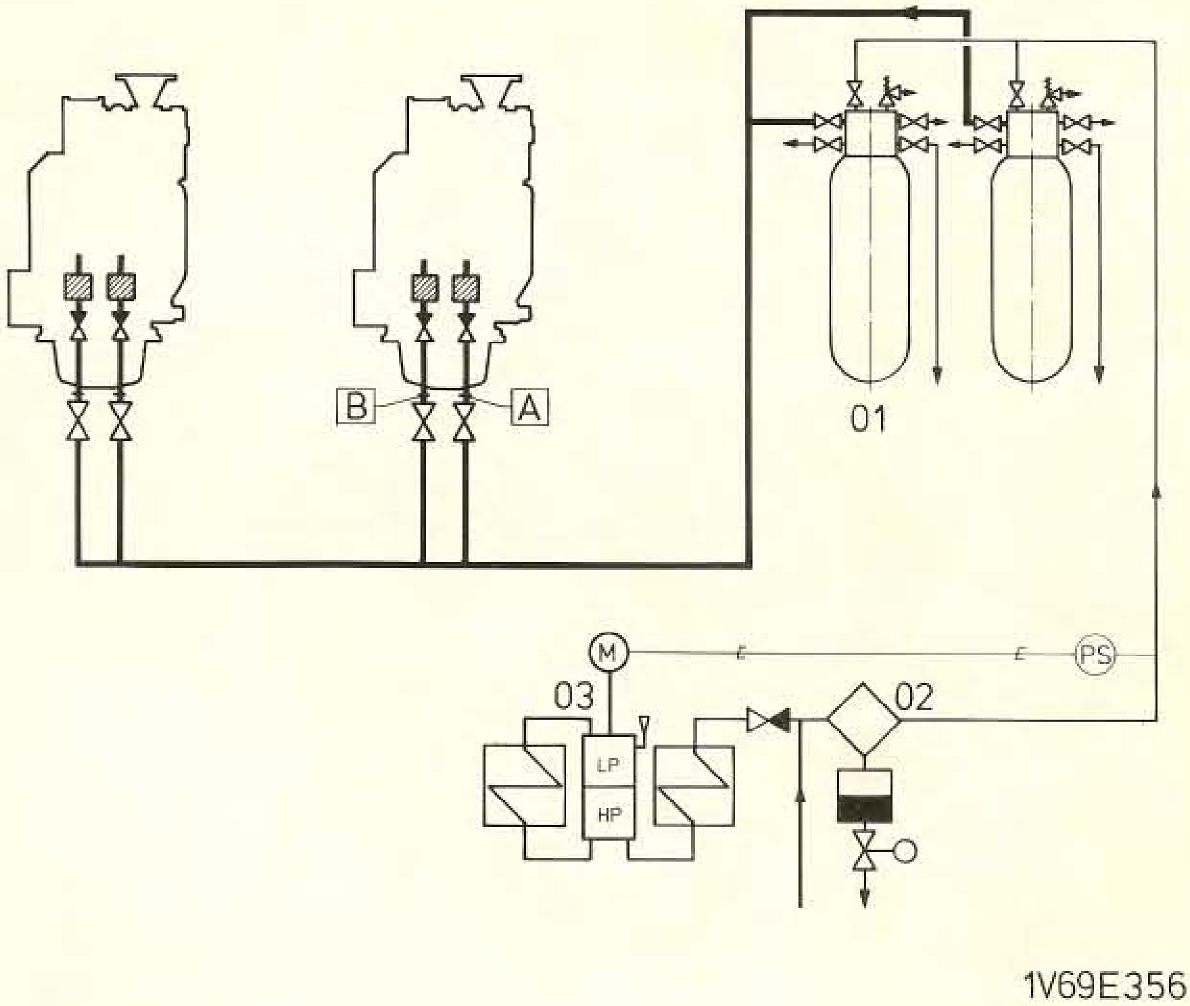
Engine	A
4R...16V22	NS25

Oil and water separator (02)
An oil and water separator should always be installed in the pipe between the compressor and the air vessel. Depending on the operating conditions of the installation, an oil and water separator may be needed in the pipe tube between the air vessel and the engine.
The starting air pipes should always be drawn with slope and be arranged with manual or automatic draining at the lowest points.

All pipes and components in the starting air system should be efficiently treated with rust inhibitors.

Starting air compressor (03)
The starting air vessel should allow to be filled from minimum to maximum pressure in 15...30 minutes. For exact determination of the capacity, the rules of the classification societies should be followed.

STARTING AIR DIAGRAM 1V69E356



System components

01 Starting air vessel
02 Oil and water separator
03 Starting air compressor

Pipe connection, engine

A Starting air to engine
B Control air to engine

Pipe dimensions

Engine	A
4R...16V22	NS25

Oil and water separator (02)
An oil and water separator should always be installed in the pipe between the compressor and the air vessel. Depending on the operating conditions of the installation, an oil and water separator may be needed in the pipe tube between the air vessel and the engine.
The starting air pipes should always be drawn with slope and be arranged with manual or automatic draining at the lowest points.

All pipes and components in the starting air system should be efficiently treated with rust inhibitors.

Starting air compressor (03)
The starting air vessel should allow to be filled from minimum to maximum pressure in 15...30 minutes. For exact determination of the capacity, the rules of the classification societies should be followed.

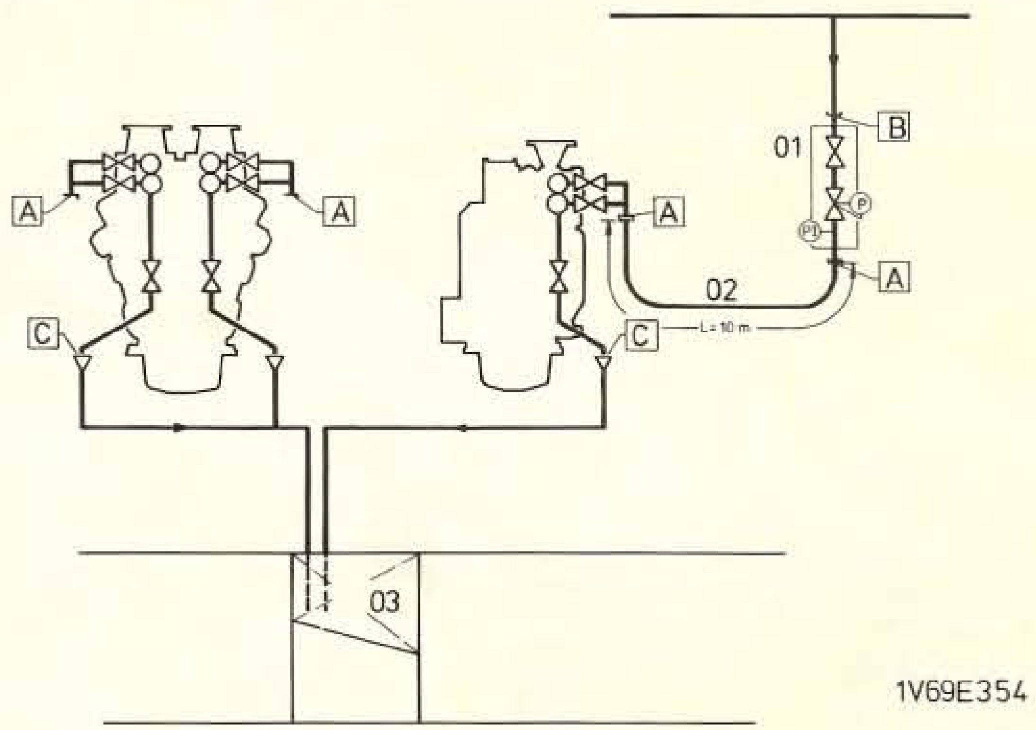
TURBINE WASHING SYSTEM

For washing of the turbocharger turbine side, fresh water of min. 1 bar is required.
The washing is carried out during operation at regular intervals, depending on the quality of the heavy fuel, 100...500 h.
Water volume required for each turbine washing:

4R22	30 l
6R22	45 l
8R22	70 l
12V22	2 x 45 l
16V22	2 x 70 l

The values apply for a normal 10 minute washing
The dirty washing water, containing soot, should be conducted to a tank intended for this purpose.

TURBINE WASHING DIAGRAM 1V69E354



System components

01 Pressure reducing unit
02 Rubber hose
03 Bilge or sludge tank

Pipe connections, engine

A Water to engine
B Water to pressure reducing unit
C Draining from turbocharger

Pipe dimensions

Engine	A	B	C
4R...16V22	NS15	NS15	NS25

COMBUSTION AIR SYSTEM

Normally, the engine draws the combustion air from the engine room through the suction filter fitted on the turbocharger. The air intake should be placed and designed so that water foam or sand cannot enter the engine room.
When situating and designing the air intakes in the engine room, the following factors should be taken into consideration:

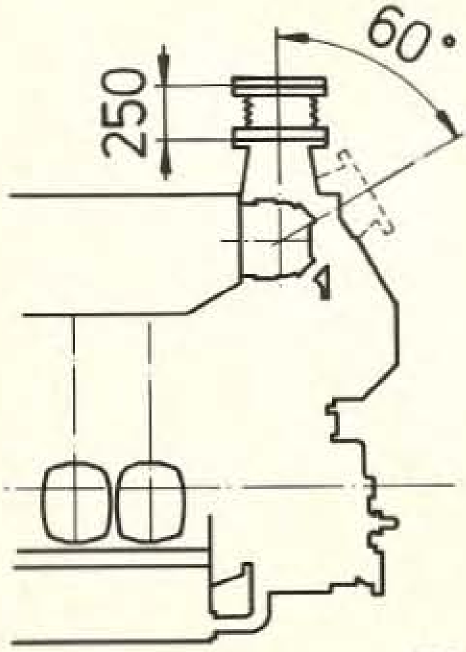
* The air pipe discharges should be placed near, and be directed towards the air intakes on the turbochargers. The arrangement implies that the air is absolutely water free.
* A smaller air flow should be evenly distributed alongside the engine/coupling/reduction gear/generator to transport away the radiated heat.

Concerning the air volume required for combustion as well as the radiation heat emitted from the engine, see technical data.

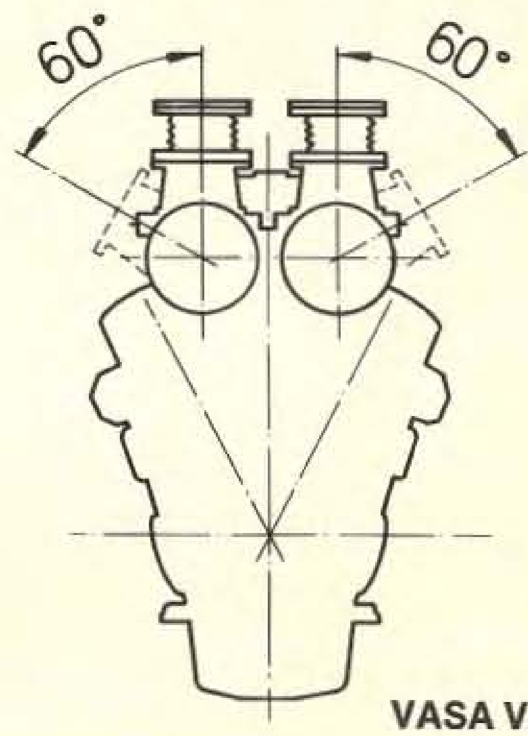
Installations intendent for operation in cold air conditions should be provided with preheating of the combustion air. Concerning required suction air temperatures, see RESTRICTIONS FOR OPERATION AT LOW AIR TEMPERATURE.
If necessary, the air intake pipe can be direct connected to the turbocharger, which then is provided with a connection piece without filter. In such cases, a filter should be built in the air pipe.

CRANKCASE VENTILATION SYSTEM

The crankcase venting should be arranged separately for each engine. The vent pipe should be drawn so that the risk of water condensation in the pipe is eliminated. The use of an automatic water separator before the engine is recommended. The connection engine-pipe is made flexible.



VASA R22



VASA V22

EXHAUST PIPE CONNECTIONS 2V60A334

Engine	
4R22	NS300
6R22	NS350
8R22	NS400
12V22	2xNS350
16V22	2xNS400

Flanges drilled acc. to DIN 2501 ND6, one loose flange.

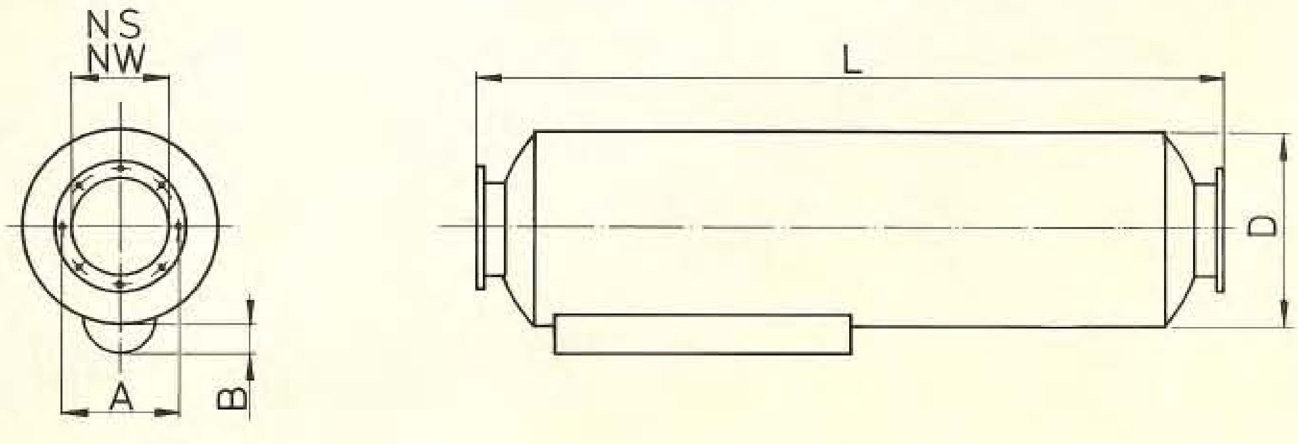
EXHAUST SYSTEM

Design of exhaust system
Each engine should have a separate exhaust pipe. The piping should be arranged to avoid unnecessary bends and pipe distances. The bends should be made with the largest possible bending radius, minimum radius used should be 1.5 D.
The exhaust pipe should be insulated all the way from the turbocharger and the insulation is to be protected by a covering plate or similar to keep the insulation intact.
The exhaust pipes and/or silencers should be provided with water separating pockets and drainage. Recommended maximum exhaust gas back pressure is 0.03 bar at full load.
Recommended maximum flow velocity in the exhaust pipe is 50 m/s at full load.
Concerning exhaust gas quantities and temperatures, see technical data.

Connection turbocharger/exhaust pipe
A piece of flexible bellows is to be mounted directly to the round transition piece on the turbocharger outlet. The bellows are part of the basic engine delivery.
The figure shows various alternative positions of the exhaust gas outlet.
The turbocharger(s) can only be mounted in the free end (= the end opposite the driving end)

Silencer
When included in the delivery, the silencer is normally of the absorption type. The standard silencer noise attenuation is 25 and 35 dB(A).
The silencer should be provided with spark arrester and soot collector and water drainage arrangement.

Exhaust gas boiler
Each engine should have a separate exhaust gas boiler or, alternatively, a common boiler with separate gas ducts.
Concerning exhaust gas quantities and temperatures, see technical data.



1V49E62

EXHAUST SILENCER 1V49E62

Engine	NS	D	E	B	Attenuation 25dB(A) L	35dB(A) L
4R22	300	700	395	150	2600	3600
6R22	350	850	445	180	2640	3640
8R22	400	950	495	205	3180	4180
12V22	500	1100	600	240	3680	4930
16V22	600	1300	705	300	4010	5260

CONTROL SYSTEM

NORMAL START AND STOP OF THE DIESEL ENGINE

★ Main engine:

The engine can be started by operating the master starting valve, either manually or, at remote starting, through the solenoid built on the master starting valve. Note that the start is mechanically blocked if the stop lever on the engine is in STOP position or pneumatically if the turning gear is engaged.

It should be possible to block the remote start with a lockable switch near the engine. This switch is not included in the diesel engine delivery.

When starting, the diesel engine accelerates to the speed set by the governor. Normally, the start is performed at minimum speed (idle speed), i.e. the lever on the bridge or in the control room is set at zero (when the speed can be controlled steplessly), but the engine can also started at maximum speed.

When starting manually, the acceleration can be controlled by the stop lever. At remote start through the starting solenoid (as well as at manual start), a pneumatically operated limiting cylinder is automatically engaged to optimize the fuel injection during the acceleration period. A solenoid valve mounted on the engine controls the limiting cylinder, which limits the fuel injection as follows:

1. The solenoid valve is energized always when the diesel engine is shut down and the air pipe is open to the limiting cylinder which receives air at the same time as the starting valve is operated.
2. When the engine speed has reached a preset value — 100 RPM below the nominal speed or minimum speed, the speed measuring system cuts the voltage after a time delay of about 2 sec. The limiting cylinder is vented and full injection is possible.

The automatic starting fuel limiter is installed on all engines except on those driving fixed pitch propellers; in these engines the fuel injection limiting device is incorporated in the governor. At remote start, the starting solenoid should be energized for 4 seconds + —2 seconds through a time relay.

A relay in the speed measuring system, the switching point of which is 300 RPM, will indicate when the diesel engine is running.

The engine can be stopped either manually by turning the stop lever to STOP position, or remotely by energizing the shut-down solenoid mounted on all governors.

The shut-down solenoid, which is delivered as standard, stops the engine when energized. At the same time, also the solenoid in the overspeed trip device should be energized. To ensure that the engine stops, the solenoids should be energized for about 60 seconds through a time relay. During this time the engine cannot be started.

When the stop solenoids are activated, remote control of the start solenoid should be prohibited.

A shut-down solenoid which stops the engine when de-energized can be delivered if separately specified.

When two or several engines are arranged to a common reduction gear it is recommended that the clutches for stopped engines are blocked in the »OUT« position, i.e. normally the respective clutches should not be allowed to be engaged before the engine is running.

When one engines is stopped, the clutch should open to prevent the engine from being driven by a running engine. At a stop signal for overspeed the clutch should remain closed.

★ Auxiliary engine:

Local and remote start of the auxiliary engine can be performed in the same way as on main engines. All auxiliary engines are provided with the above described starting fuel limiter. Also the local and remote shut down of the auxiliary engine is done as on main engines.

The start is normally performed automatically at black-outs or when an operating generating set reaches the preset output for the start up of the next set.

The start can be performed by a start program making e.g. 3 starting attempts. Time between each starting attempt of abt. 4 sec. should be abt. 20 sec. The starting program should be disconnected when the engine starts.

A normal generating set reaches the nominal speed 6...8 seconds after the starting impulse. The acceleration time for 4R22 sets is somewhat longer, or 10...12 seconds.

AUTOMATIC AND EMERGENCY STOP; OVERSPEED TRIP

The engine is provided with the following shut-down solenoids:

- ★ a solenoid in the speed governor
- ★ a solenoid for control of the electropneumatic overspeed trip

Automatic stop, as well as remote stop, is accomplished by energizing the shutdown solenoids for about 60 seconds. All engines are delivered with ON/OFF switches for

- ★ low lubricating oil pressure
- ★ high cooling water temperature

These micro-switches should energize the shut-down solenoids when the lubricating oil pressure drops below or the cooling water temperature exceeds the preset values. The required relay automatics are not included in the diesel engine delivery.

To enable starting of the engine, the micro-switch for low lubricating oil pressure should be blocked at engine start. This is most conveniently done by arranging voltage supply through the 300 RPM relay in the speed measuring system of the engine. Further, a time relay of about 3...10 seconds is to be installed in the circuit to allow a sufficient lubricating oil pressure to be established. This applies to engines with direct driven lubricating oil pumps.

An oil mist detector should be connected to the same relay automatics in case automatic stop is required at high concentration of oil mist in the crankcase. The remote emergency stop push buttons on e.g. bridge should energize the stop solenoids directly and not through a relay automatics.

When arranging a 5 second delay for the autostop it is possible to prevent the engine from stopping by overriding the signal before the stop solenoids are energized.

All engines are provided with an electro-pneumatic overspeed trip in addition to the all-mechanical overspeed trip. The electro-pneumatic overspeed trip is activated when a tachorelay in the speed measuring system energizes a solenoid valve built on the engine and this valve allows air to the shut-down cylinders on each injection pump. This overspeed trip is built on the engine. When the main engine speed has decreased to a preset value the solenoid valve is de-energized and the speed is again controlled by the governor before the engine needs to stop. The overspeed should be indicated on all control stations by means of a signal lamp which has re-set in the engine room, near the engine.

Auxiliary engines are always stopped if the overspeed trip has been activated. At the same time as the overspeed trip is activated, the shut-down solenoid is also energized on auxiliary engines. The tripping speeds for the overspeed trip are as follows:

900 RPM	1040 ± 15	1070 ± 15
1000 RPM	1150 ± 15	1180 ± 15
1200 RPM	1350 ± 15	1380 ± 15

If the mechanical overspeed trip device has been released, the engine cannot start before the spring has been manually loaded again.

SPEED CONTROL, MAIN ENGINE

The engine are normally provided with mechanical-hydraulical governors designed for pneumatic or electric remote control.

The standard types of governors used:

- ★ Stepless pneumatic speed setting (Woodward PGA 16, Woodward UG8L). These governors are usually provided with shut-down solenoids as the only electrical equipment.
- ★ Fixed speed steps, electric speed setting (Woodward PGE 16). This governor is controlled by relay automatics. When used, separate wiring diagrams and instructions are given for each installation.
- ★ Stepless electric speed setting (Woodward UG8D). These governors are provided with speed setting motors for synchronizing and load sharing as well as with normal shut-down solenoids. The synchronizing is by ON/OFF control as »INCREASE» or DECREAS».

The idling speed is set separately for each installation, for CP-propeller installations normally at 60...70 % of the nominal speed and for FP-propeller installations at 30...40%.

The standard control air pressure for pneumatically controlled governors is:

$p = 0.00692 \times n - 1.925$

p = control air pressure (bar)

N = engine speed (RPM)

On request, the PG-governor is provided with a load control valve to be connected to the propeller pitch control for automatic propeller pitch reduction at overload.

PG-governors for engines in FP-propeller installations are provided with a smoke limiter function which limits the fuel injections as a function of the charge air pressure.

Governor for engines connected to a common reduction gear are specially adapted and adjusted for the same speed droop, normally 5...6 %, to obtain base load sharing. In addition, it is recommendable to arrange external load sharing controlled by the fuel rack position transducer then mounted on the engine.

PG-governors are, as standard, equipped with a built-in delay of the speed change rate so that the time for speed acceleration from idle to nominal speed, and vice versa at speed decrease, is 10...12 seconds.

SPEED/OUTPUT CONTROL, AUXILIARY ENGINES

Generator engines are normally provided with mechanical-hydraulical governors for electric speed setting (Woodward UG8D, Woodward PGG16). The governors are equipped with speed setting motors for synchronizing and load sharing and shutdown solenoids. The synchronizing is operated by ON/OFF control as »INCREASE» or »DECREASE».

Normal speed change rate is

UG8 about 0.25 Hz/s
PGG16 about 0.3 Hz/s

Engines, which are to be run in parallel, have governors specially adapted for the same speed droop, about 5 %, to obtain base load sharing.

SPEED MEASURING SYSTEM

The speed measuring system mounted on the engine includes magnetic pick-ups for engine and turbocharger speed as well as a central unit with power supply, measuring converters and relay outputs. A separate drawing of the speed measuring system is supplied for each installation.

The following equipment is ready wired on the engine:

* 1 magnetic pick-up for engine speed
* 1 magnetic pick-up for turbocharger speed (R22) alternatively 2 (V22)
* indicator for engine speed installed in the engine instrument panel
* hour counter installed in the engine instrument panel
* 1 solenoid for starting fuel limiter.

As standard, the engine is provided with possibilities for the following external connections:

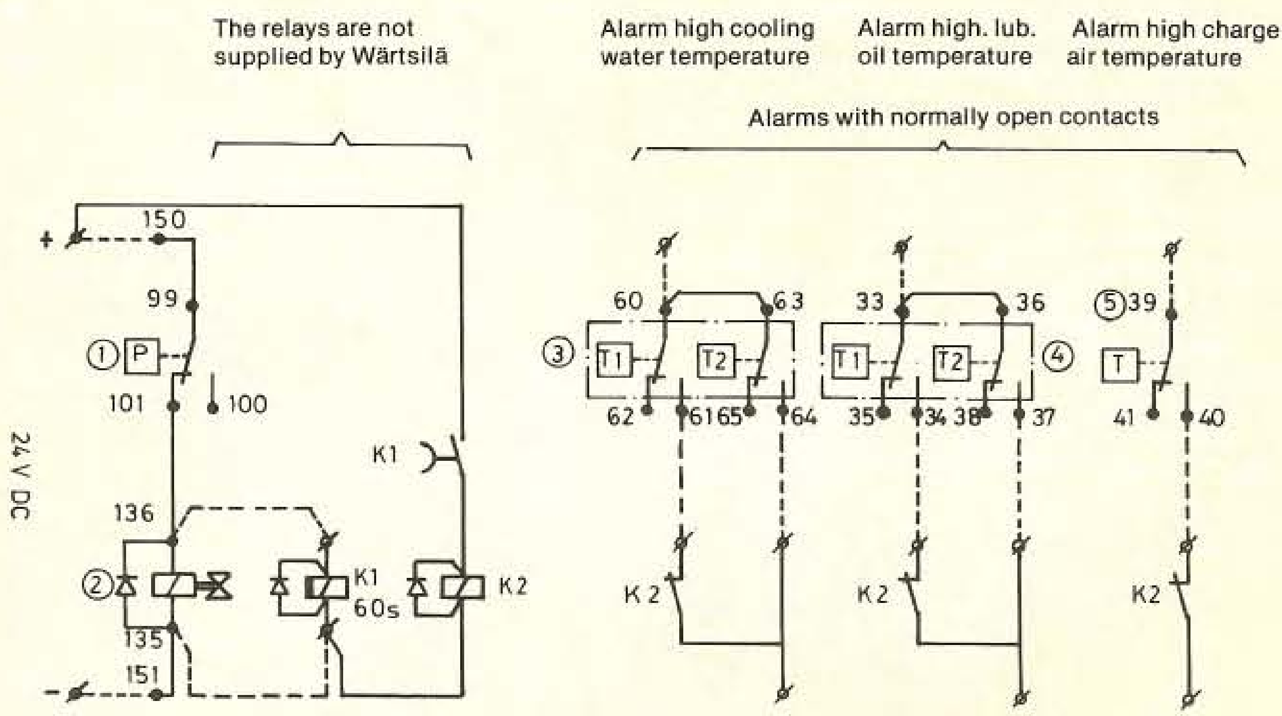
* analogue signal indicating the engine speed 0...10 V DC (0...1500 RPM)
* analogue signal indicating the turbocharged speed 0...10 V DC (0...50.000 RPM)
* relay, switch point 15 % above nominal speed
* relay, switch point 300 RPM
* relay, optional switch point

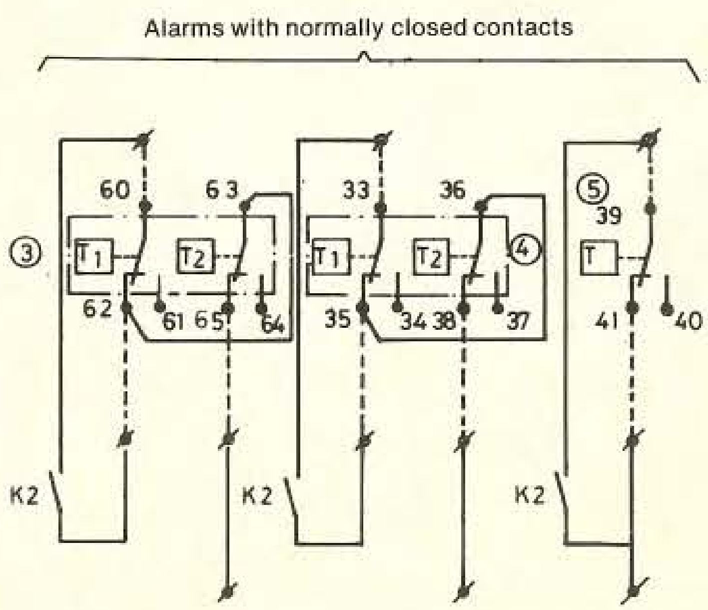
Each relay can be loaded with 24...110 V DC, 30 VA.

BLOCKING OF ALARMS

The diesel engine Vasa 22 is as standard equipped with the load dependant cooling water system. With this system two different cooling water temperature levels are maintained in both the low temperature and the high temperature circuit, normal level at high loads and higher level at low engine load. For the alarms for high cooling water temperature after the cylinders and high lubricating oil temperature, dual switch alarms are used. If an analogue sensor is used, two alarm channels per sensor are to be reserved. At low load, the lower set point of the cooling water temperature and lubricating oil temperature alarms as well as the alarm for high charge air temperature have to be blocked as shown in the diagram below. The relay automatics is not included in the diesel engine delivery.

BLOCKING OF ALARMS, DUE TO LOAD DEPENDING COOLING WATER SYSTEM





1. Control pressure switch. Charge air pressure Drawn in low load position.
2. Control valve for thermostat valves
3.4. Temperature switch with' two independent set points
5. Temperature switch

• Terminals in-DE connecting box

ELECTRIC PRELUBRICATING PUMP

All diesel engines are equipped with an electric prelubricating pump. The pump is normally used in the following cases:

1. For filling the lubricating oil system of the diesel engine before start, for exemple when the engine has not run for a long time.
2. For continuous prelubrication of a standing diesel engine, through which heated heavy fuel is circulating.
3. For continuous prelubrication of a standing diesel engine in a multiengine installation always one of the engines is in operation.

To ensure that the requirement mentioned in point 2 above will always be fulfilled, an automatic starting of the prelubricating pump in question is recommended when starting the heavy fuel feed pump. Automatic stopping of the pump is recommended when starting the respective diesel.
Automatic starting/stopping of the pump can be controlled by the speed sensing relay, whose switching point is 300 RPM.

ELECTRIC BUILT-ON FUEL FEED PUMP

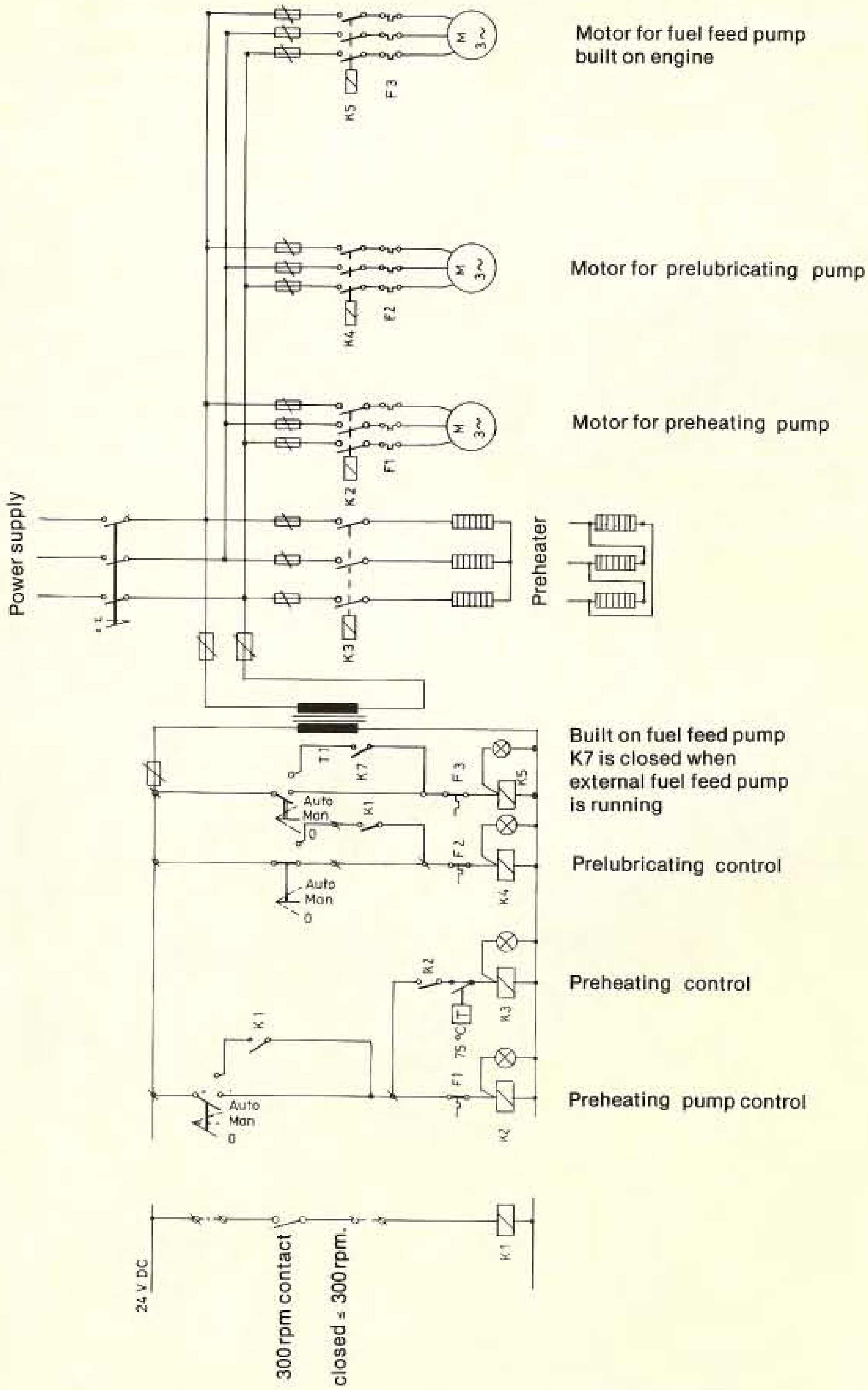
All diesel engines are as standard equipped with an electric fuel feed pump except for engines in single engine installations. The pump is used as follows:

1. For continuous circulation of heavy fuel through the engine if the engine is running on, or is in stand-by on heavy fuel.
2. To start before the engine starts when running on Marine Diesel Fuel and stop with the engine.

PREHEATING OF COOLING WATER

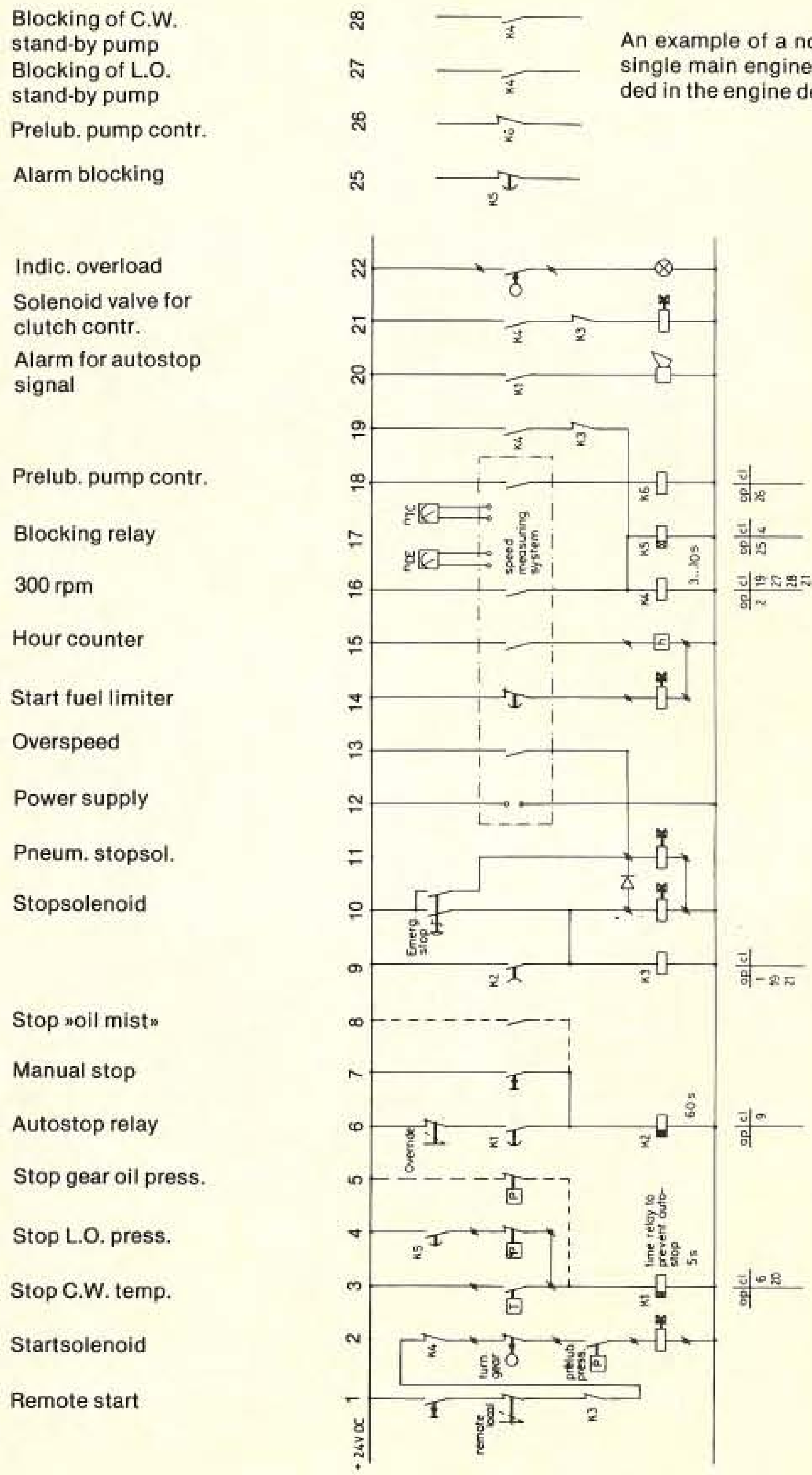
Preheating of the cooling water has to be arranged on engines which are in stand-by on heavy fuel and for all engines which are arranged for instant load application. Preheating is preferably controlled automatically. The circulating pump should start when one diesel stops, and stop when all engines are running. In some main engine installations at prolonged idling, the circulating pump needs to be running. For these cases special instructions are given.
The cooling water preheater should be controlled by a thermostat which keeps the temperature of the preheating water into the engine at 70...75°C.
The preheating equipment is not included as standard equipment in the diesel engine delivery.

WIRING DIAGRAM FOR THE PREHEATER FOR COOLING WATER, PRELUBRICATING AND BUILT ON FUEL FEED PUMP



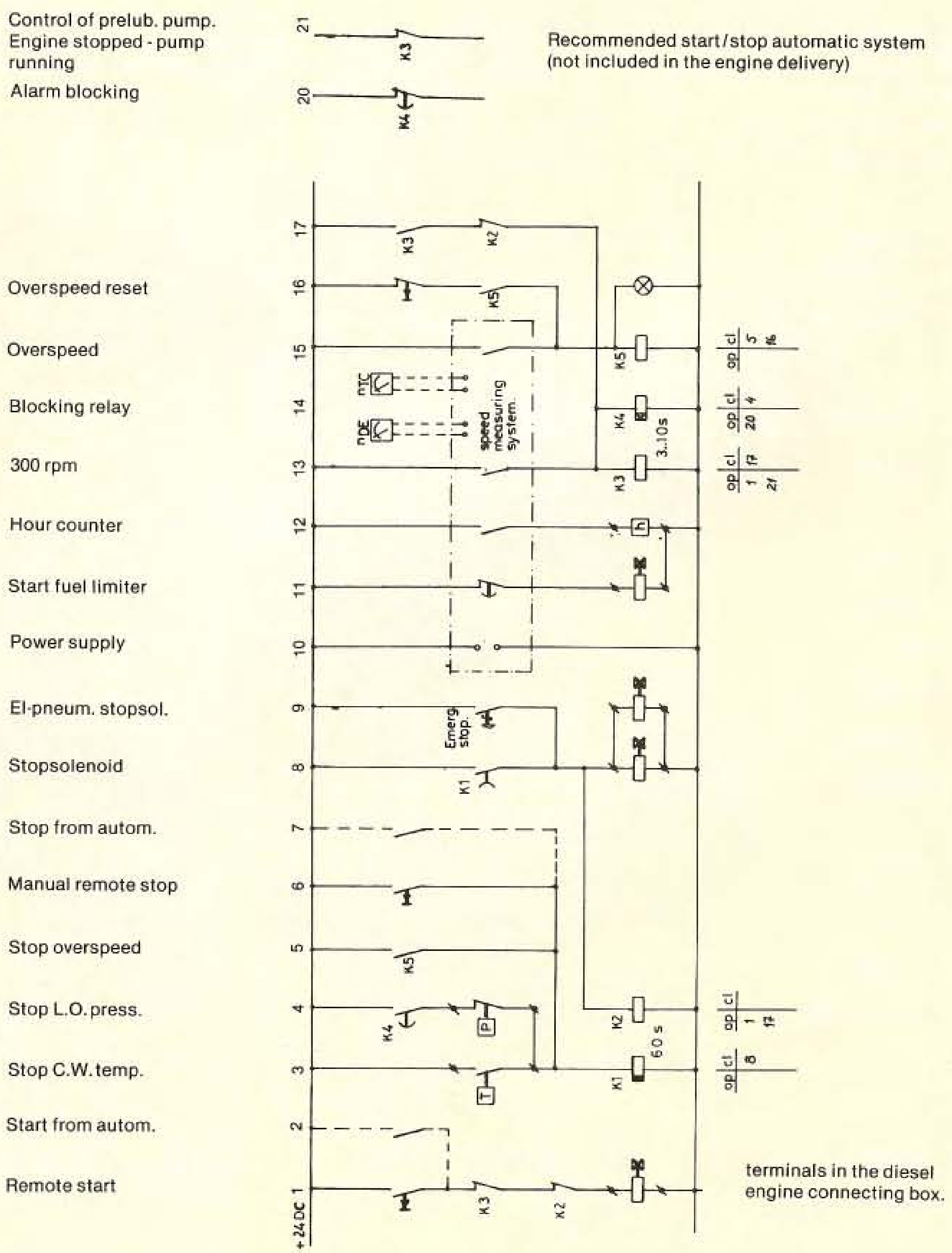
PRINCIPAL START/STOP WIRING DIAGRAM FOR A SINGLE MAIN ENGINE

An example of a normal start/stop arrangement for a single main engine. The relay automatics is not included in the engine delivery.



terminals in the diesel engine connecting box

PRINCIPAL START/STOP WIRING DIAGRAM FOR AN AUXILIARY ENGINE



MONITORING SYSTEM

ENGINE INTERNAL MONITORING EQUIPMENT

The set of the micro switches/analogue transducers built on the engine can vary from one installation to another. The actual set of transducers can be found in the electric wiring diagram which is supplied for each installation. All micro swithes are of the NO/NC type with three wires connected to the terminal strips in the terminal box.

Data for transducers mounted according to the basic engine specification appear from the following table

	Alarm		Stop		Type		Set point	Unit	Connection to engine
	L	H	L	H	O	A			
Fuel system									
Pressure before engine	•				•		5	bar	M 10 × 1
Pressure drop over filter		•			•		1,5	bar	M 10 × 1
Nozzle temperature control system 1)									
Pressure before engine	•				•		0,5	bar	M 10 × 1
Temp. before engine	•				•		95	°C	R3/4 in L = 75
Temp. after engine		•			•		145	°C	R3/4 in L = 75
Lubr. oil system									
Pressure before engine			•		•		1.5	bar	M 10 × 1
Pressure before engine	•				•		2,0	bar	M 10 × 1
Pressure before engine	•				•		2,0	bar	M 10 × 1
Pressure before engine (priming)	•				•		0,5	bar	M 10 x 1
Temp. before engine					•		85/100	°C	R3/4 in L = 75
Level in oil sump 2)	•				•				
Pressure drop over filter		•			•		1,5	bar	M 10 × 1
Cooling water system									
Temp. after engine H.T				•	•		115	°C	R3/4 in L = 75
Temp. after engine H.T		•			•		90/110 3)	°C	R3/4 in L = 75
Pressure before engine H.T	•				•		4)	bar	M 10 × 1
Pressure before engine L.T	•				•		4)	bar	M 10 × 1
Charge air									
Temperature in receiver		•			•		75/-	°C	R3/4 in L = 75
Exhaust gas									
Temperature after cyl		•				•		°C	R1/2 in L = 125
Miscellaneous									
Released overspeed trip device		•			•				
Engaged turning gear					•				
Overload		•			•				

1) Omitted for MDF engines
2) Wet sump engines only
3) In certain aux. engine installations 90/100
4) Idling pressure - 0,3 bar

L Low
H High
O On off
A Analogue

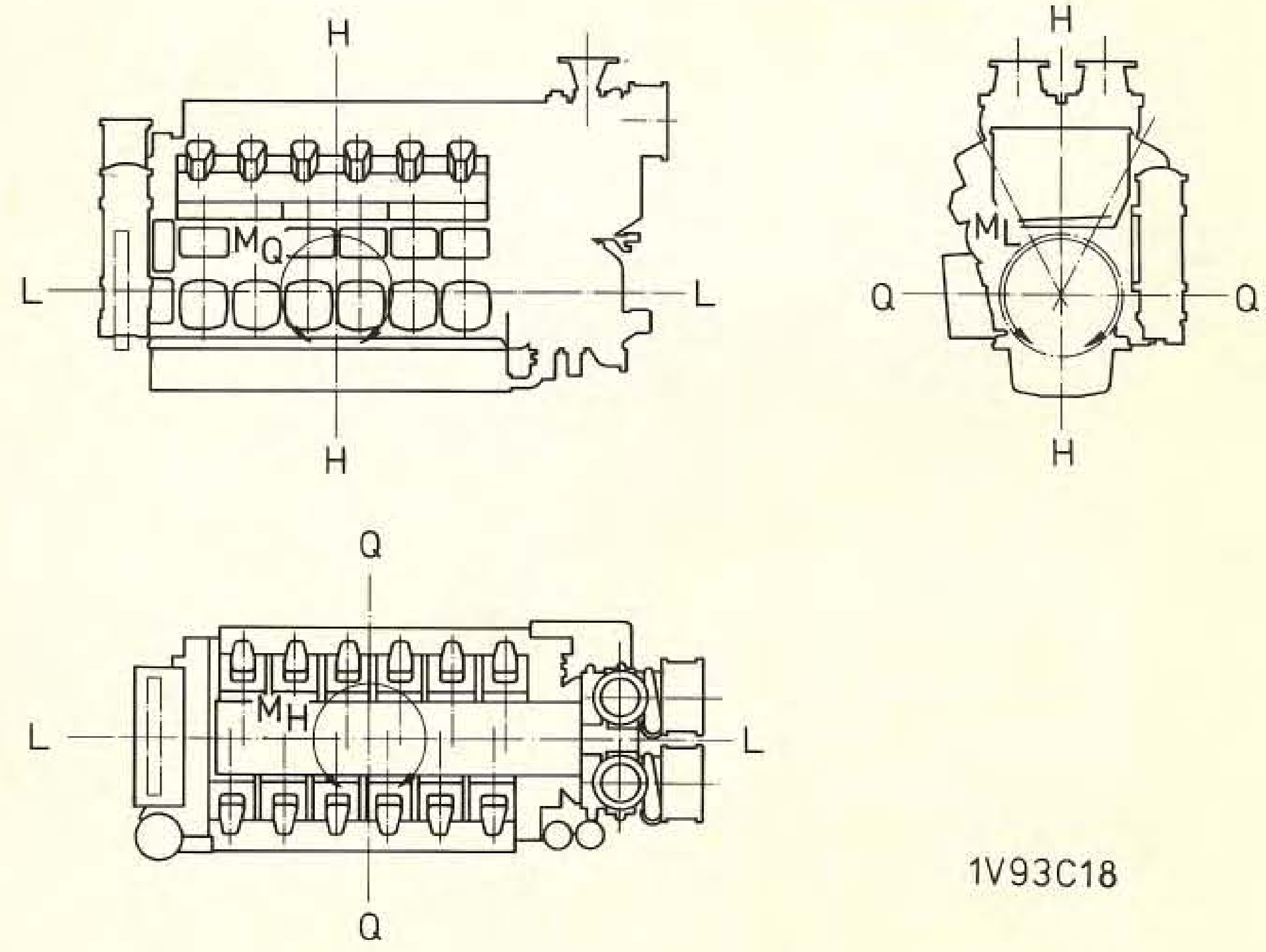
The exhaust gas temperature transducers are thermo couples (NiCr/Ni) each of which is connected through compensating cables to its own amplifier mounted on the engine.

Alarm for deviation from the average temperature is to be set as follows:

30 % load ± 70°C
100 % load ± 50°C

FOUNDATION

The main engines are normally rigidly mounted to the foundation, either on metal or plastic chocks. The auxiliary engines are flexibly mounted on rubber elements.
The foundation should be as stiff as possible in all directiolns to absorb the dynamic forces caused by the engine, among others. Especially the foundation of the propeller thrust bearing (the reduction gear) should be dimensioned and designed so that harmful deformations are avoided.
Dynamic forces caused by the engine appear from the table.



1V93C18

Fitting on steel chocks

The rider plates of the engine girders are usually inclined outwards with regard to the centre line of the engine. The inclination of the supporting surface should be 1/100. Otherwise, the rider plate should be designed so that the wedge-type chocks can easily be fitted into their positions.
The size of the wedge-type chocks should be 90 x 120 mm. The material can be cast iron or steel.

When fitting the chocks, the supporting surface of the rider plate is planed by means of a grinding wheel and a face plate until a bearing surface of min. 80 % is obtained. The chock should be fitted so that the distance to the edges is equal at both sides of the bolt. The clearance hole in the chock and the rider plats should have a diameter about 2 mm bigger than the bolt diameter for all chocks except those which are to be reamed and equipped with fitted bolts.

FREE FORCES F = O for all cylinder numbers

EXTERNAL COUPLES M = O for all cylinder numbers

TORQUE VARIATION + Nm/frequency 1/s

Engine	Speed RPM		M_L	
4R22HF	900	4600/30 6750/30 *	5580/60	2020/90
	1000	2600/33.3 9150/33.3 *	5450/66.7	2020/100
	1200	3700/40 14500/40 *	5350/80	2020/120
6R22HF	900	8650/45	3050/90	
	1000	7500/50	3050/100	
	1200	5150/60	3050/120	
8R22HF	900	10950/60	1260/120	
	1000	10800/66.7	1260/133.3	
	1200	10650/80	1260/160	
12V22HF	900	2270/45	5870/90	
	1000	1960/50	5870/100	
	1200	1340/60	5870/120	
16V22HF	900	7570/60	1940/120	
	1000	7480/66.7	1940/33.3	
	1200	7370/80	1940/160	

* At zero load

The side supports should be installed for all engines. On six, eight, twelve and sixteen cylinder engines there should be two supports on both sides. The side supports are to be welded to the rider plate before aligning the engine and fitting the chocks. The side support wedges should be fitted in so that a bearing surface of 80 % is obtained in case the welding and the engine alignment only allow.
The foundation bolts are usually through-bolts with lock nuts at both the lower and the upper end. One fitted bolt is used on each side of the engine nearest to the flywheel. Other bolts are provided with clearance holes.
The design of the various foundation bolts appear from the foundation drawing. The bolts are normally dimensioned for use of the material St50. However, high tensile steel is recommended mainly owing to its better machining qualities. To avoid a gradual reduction of tightening tension due to, among others, uneveness in threads, the threads should be machined to a finer tolerance than the normal threads.
In order to avoid extra bending stresses in the bolts, the rider plate should be counterbored. The horizontal rider plates should also be counterbored because they usually bend owing to welding stresses.
The foundation bolts are tightened to about 60 % of the material yield point.

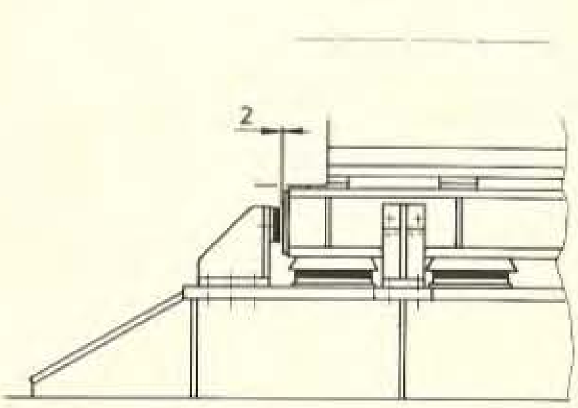
FITTING ON RESIN CHOCKS

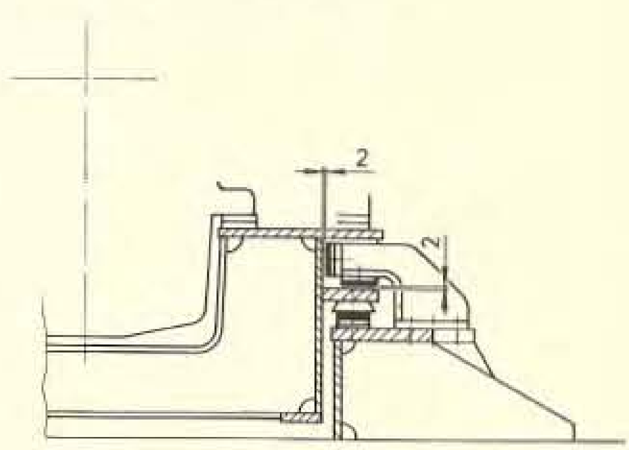
Installation of main engines on plastic chocks (synthetic resin) is possible provided that the requirements of the classification societies are fulfilled. During normal conditions, the support face of the engine feet has a maximum temperature of about 75°C, and at low load (load dependent cooling water system) up to 95°C, which should be considered when choosing the type of resin. Depending on the make of resin heat insulating plates can be necessary. The diameter of the fitting bolts should be smaller than when using steel chocks, because of the restrictions in permissible surface pressure of the plastic material. When designing the bolts it should be noticed that they are tightened to about 60 % of the material yield point.
In addition to the side supports used with metal chocks, one side support per side is required at the flywheel end of the engine.

FITTING OF GENERATOR SETS

Generator sets, where the engine and the generator are mounted on a common base plate, are flexibly mounted on rubber elements. The foundation is made as shown in the foundation drawing. The rubber elements are of the sandwich type with vulcanized steel sheets on the upper and the lower sides. To prevent excessive movement of the set e.g. in heavy sea, side supports and buffers are necessary. When mounting the buffers the required clearance of 2.0 mm is to be properly adjusted.
The flexible suspension is subcritical (soft rubber elements) and the absorption of the forces emitted from the set is about 70 %.
Normal displacement amplitudes of flexibly suspended generating set are:

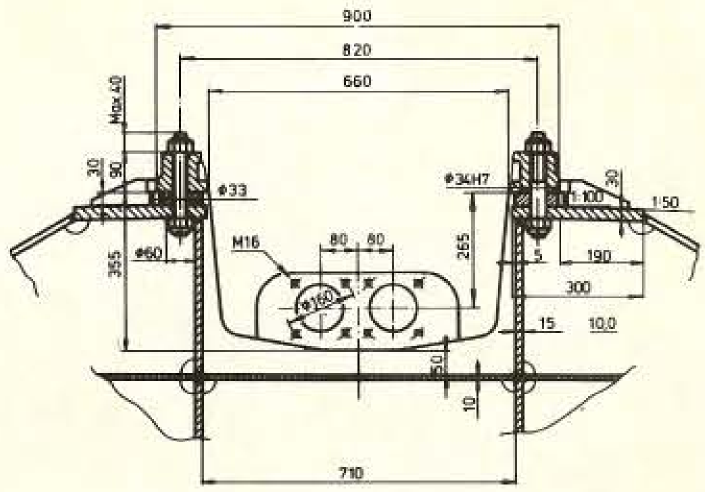
In-line engines	+ - 0.01...0.04 mm
Vee-engines	+ - 0.01...0.03 mm

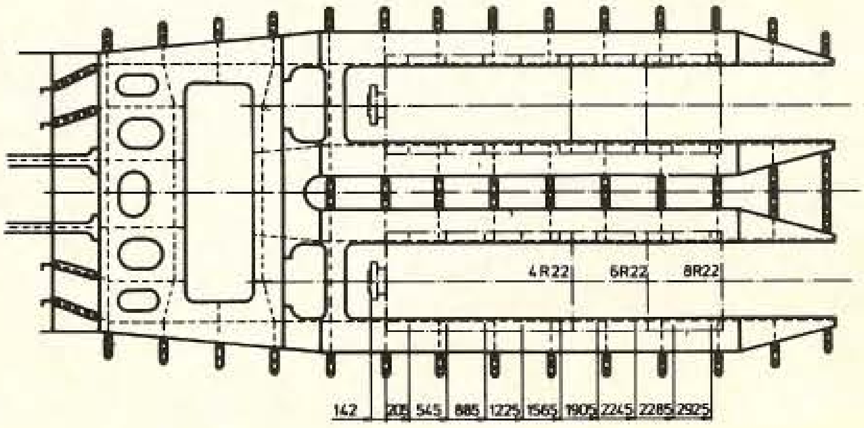




3V46L86

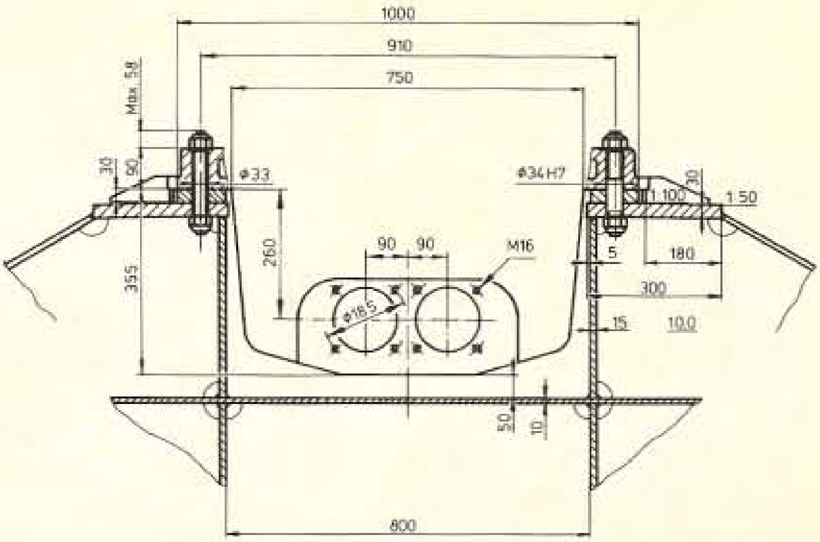
ENGINE FOUNDATION IN-LINE ENGINES
DRY OIL SUMP

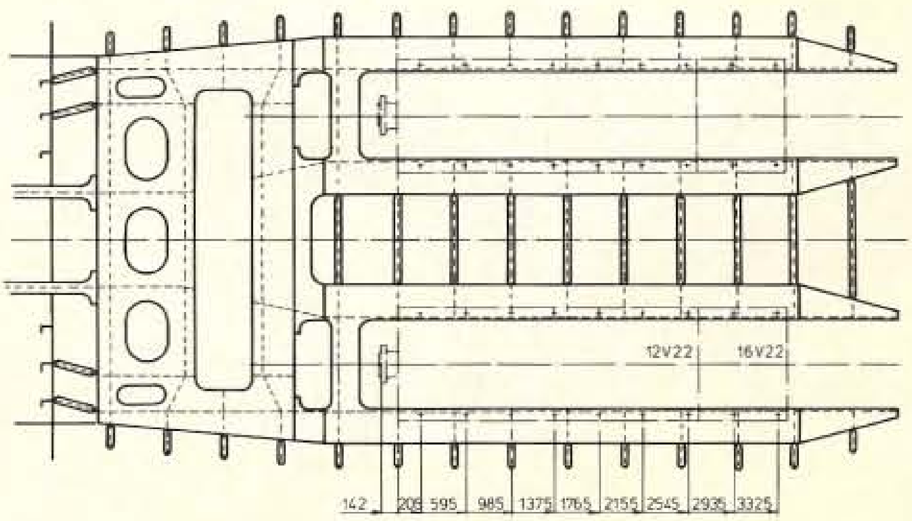




1V69A30

ENGINE FOUNDATION VEE-ENGINES
DRY OIL SUMP

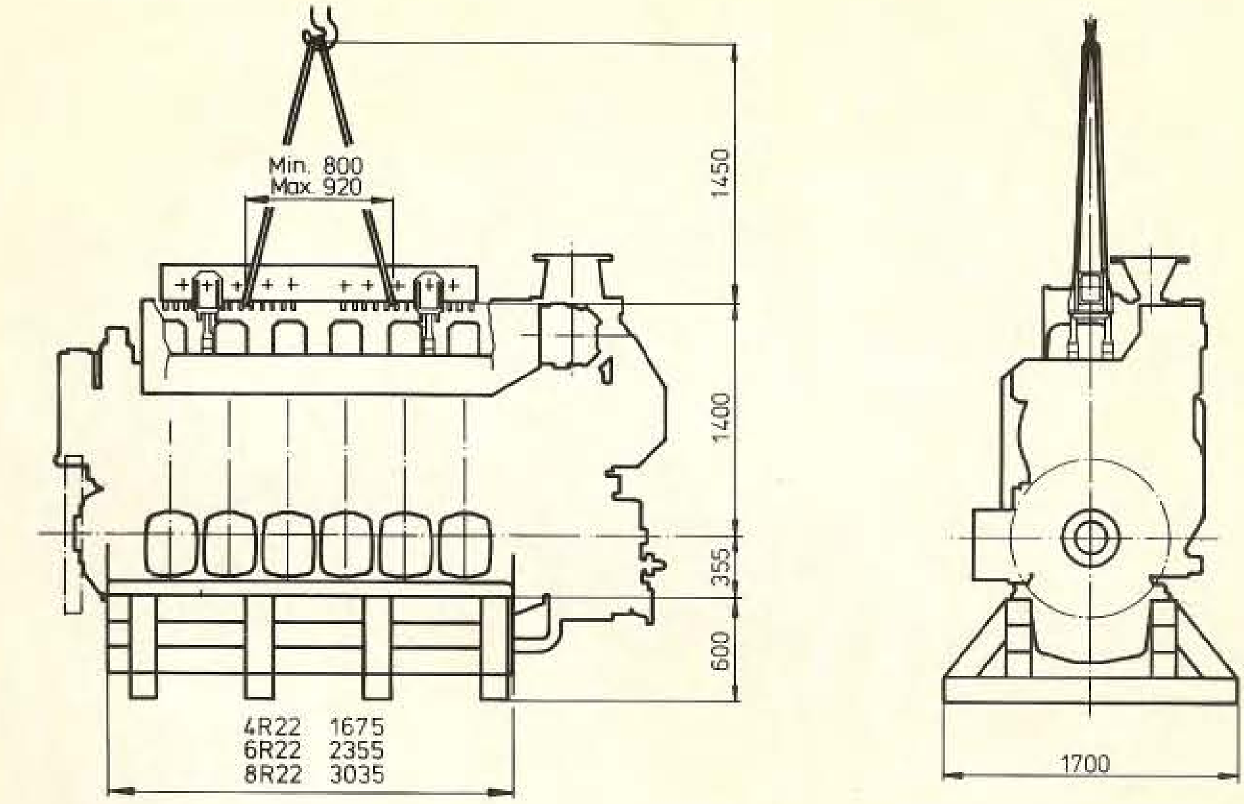


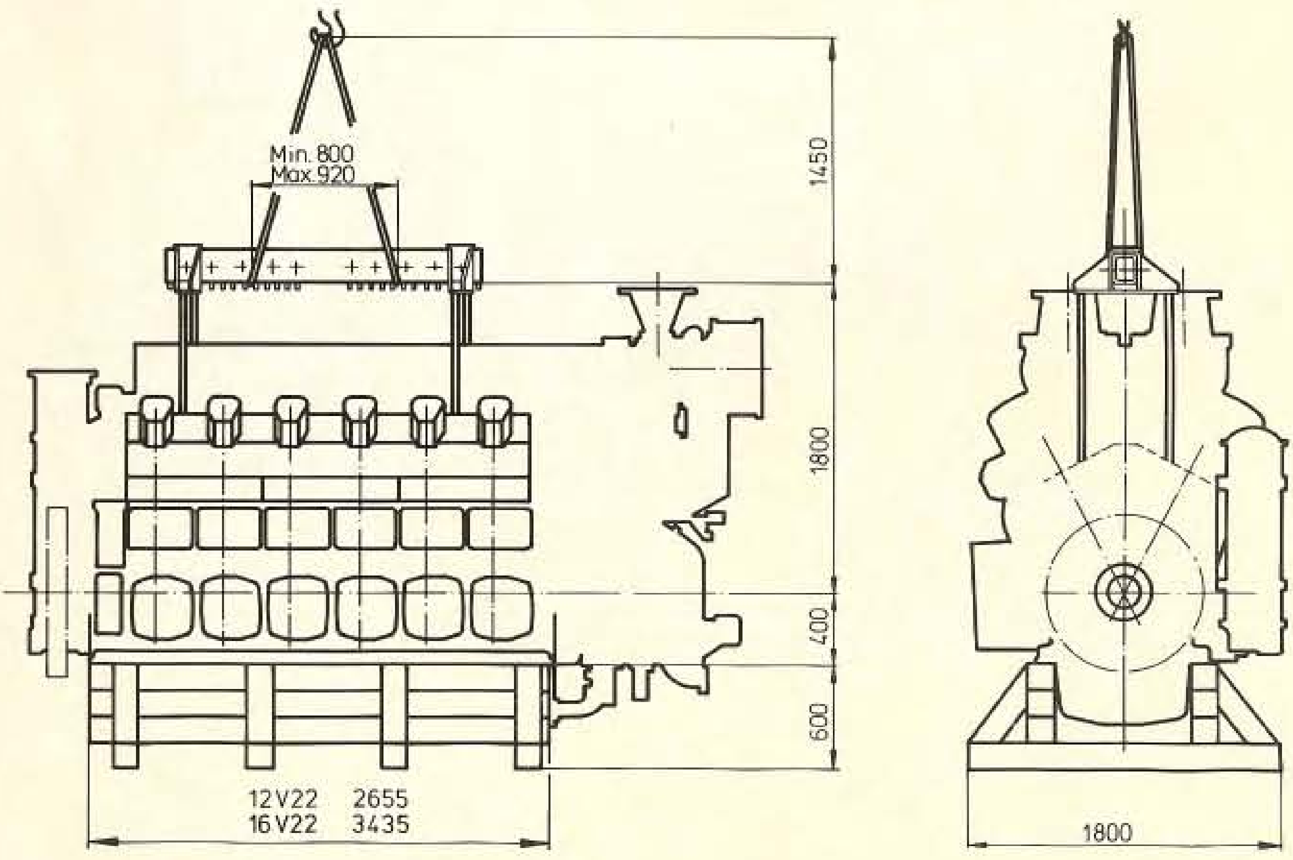


1V69A31

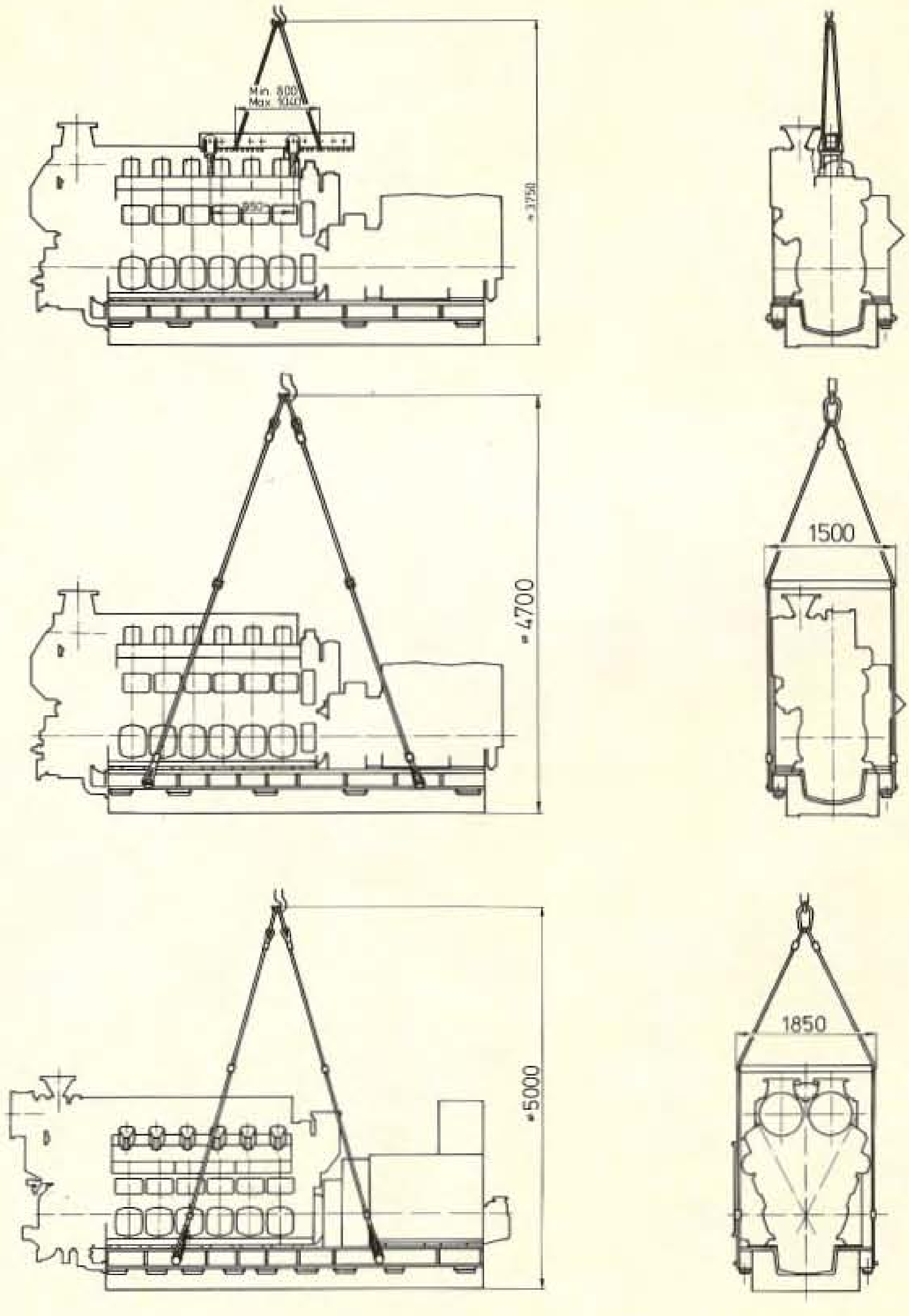
LIFTING OF ENGINES

LIFTING OF ENGINES





LIFTING OF GENERATING SETS



1V83D97

POWER TRANSMISSION

The power transmission of the propulsion engines is accomplished through a flexible coupling mounted on the flywheel, or through a combination of a flexible coupling and a clutch. The type of coupling is determined separately in each case on the basis of the torsional vibration calculations.

An extra shield bearing is built in the engine and therefore even relatively heavy couplings can be mounted on the flywheel without intermediate bearings.

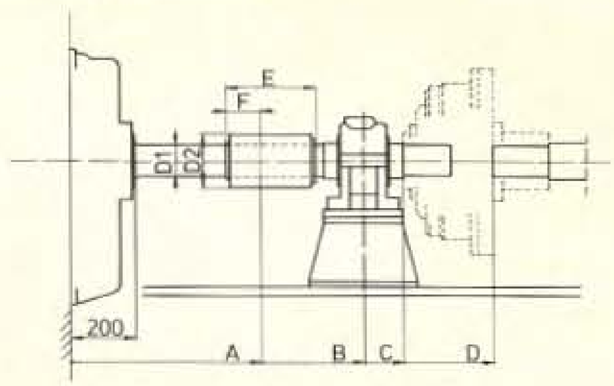
Full engine output can be taken off also at the free end of the engine.

The mass-moments of inertia of the engines, including the flywheel, are as follows (propulsion engine):

	J kgm^2	GD^2 kgm^2
4R22	50...110	200...440
6R22	50...120	200...480
8R22	55...125	220...500
12V22	70...150	280...600
16V22	85...165	340...660

A torsional vibration calculation is made for each installation. For this purpose, exact data of all components included in the shaft system are required.

POWER TAKE OFF AT FREE END 2V62L50



Rating			R22HF			V22HF		
kW/RPM	D1	D2	A	B	C	A	B	C
1,02	100	170	525	1150	1260	943	1250	1360
1,36	110	185	705	1150	1260	935	1250	1360
1,77	120	200	720	1150	1260	920	1250	1360
1,97	130	215				895	1250	1370
2,25	130	215				895	1250	1370
2,81	140	230				875	1250	1370

R22			V22				
A	B	C	A	B	C	E	F
525	832	942	525	832	942	280	108
705	1020	1130	705	1020	1130	300	118
720	1050	1160	720	1050	1160	325	130
			745	1100	1220	350	140
			745	1100	1220	350	140
			775	1150	1270	380	150

DATA FOR ALTERNATOR INSTALLATION

Date: ....

Signed: ....

1. Alternator manufacturer: ....

2. Alternator model: .... Series: ....

   Design acc. to DIN 42950: B16 ☐

   B20 ☐

   other: ....

3. Output: .... kVA; cos phi = ...

4. Efficiency .... at full load and cos phi as in 3.

5. Voltage .... V; Current .... A; Frequency .... Hz

6. Excitation voltage .... V; Current .... A

7. Efficiency at the following part loads when cos phi 1,0

Load %	10	25	50	75	100	110
%						

8. Damping windings ☐

   Damping rings ☐

9. Alternator shaft earthed ☐

   Alternator shaft not earthed ☐

10. J = ... kgm^2 $(J = GD^2/4)$

11. Synchronizing power, Pr = ... kW/electrical radian

12. Formula for the torsional damping coefficient

    $C = \overline{} \left(\frac{Nms}{rad}\right)$

13. Please check the electrical resonance and the running in parallel.

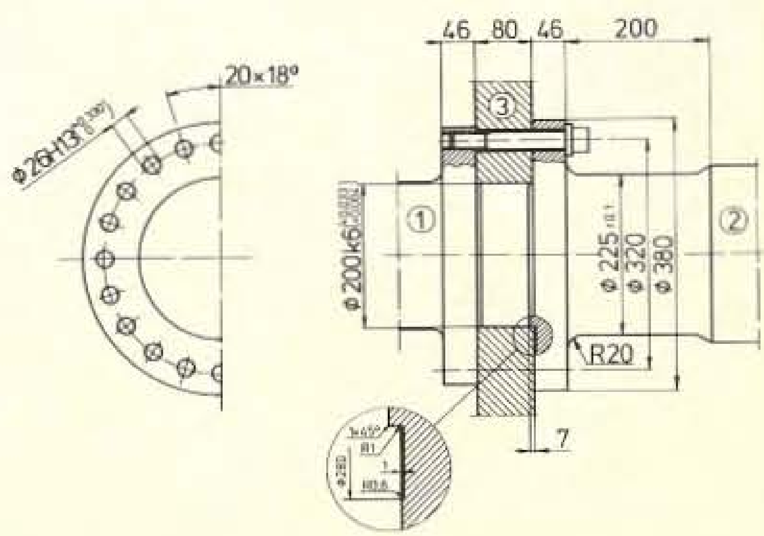
14. Enclose dimension drawings in scale 1:10 (2 exx.), and shaft drawings (5 exx.), drawings Nos.

15. Please send us assembly instructions for the alternator in 2 exx.

Note: a) The alternator shaft rotation viewed from the engine: anti-clockwise

b) Diesel engine speed at nominal load .... RPM

c) Diesel engine speed at idling .... RPM



2V64L13

DATA FOR PROPELLER INSTALLATION

Date: ....

Signed: ....

1. Main engine: Wärtsilä Vasa ....
   Engine output: ....kW; speed: .... RPM
   Direction of rotation: ....
   Preliminary inertia of engine J = ... kgm^2
2. Combined clutch/flexible coupling: ....
   Flexible coupling: ....
3. Reduction gear box, manufacturer and type: ....
   Reduction ratio i = ... Z_1/Z_2 ..../................
   Integral disc clutch yes/no
   PTO yes/no
4. Propeller manufacturer and type: ....
   No. of blades: ....
   Propeller diameter .... mm
   P/D ....
   Area ratio Fa/Fo ....
   Propeller speed at max. cont. rating .... RPM
   Direction of propeller rotation: ....
   Designed for constant RPM ☐
   Designed for variable RPM ☐
5. Data for torsional vibration calculations
   J_1 Propeller
   J_2 Gear box flange
   J_3 Gear wheel
   J_4 Gear wheel
   J_5 Clutch
   J_6 Clutch
   Propeller inertia J (kgm^2) without entrained water:

	J_1 = prop.	J_2	J_3	J_4	J_5	J_6
From shaft Total						

Inertia of entrained water at nominal speed:

Pitch	0 %	75 %	100 %
Entrained water J/kgm²			
Propeller torque/Nm			

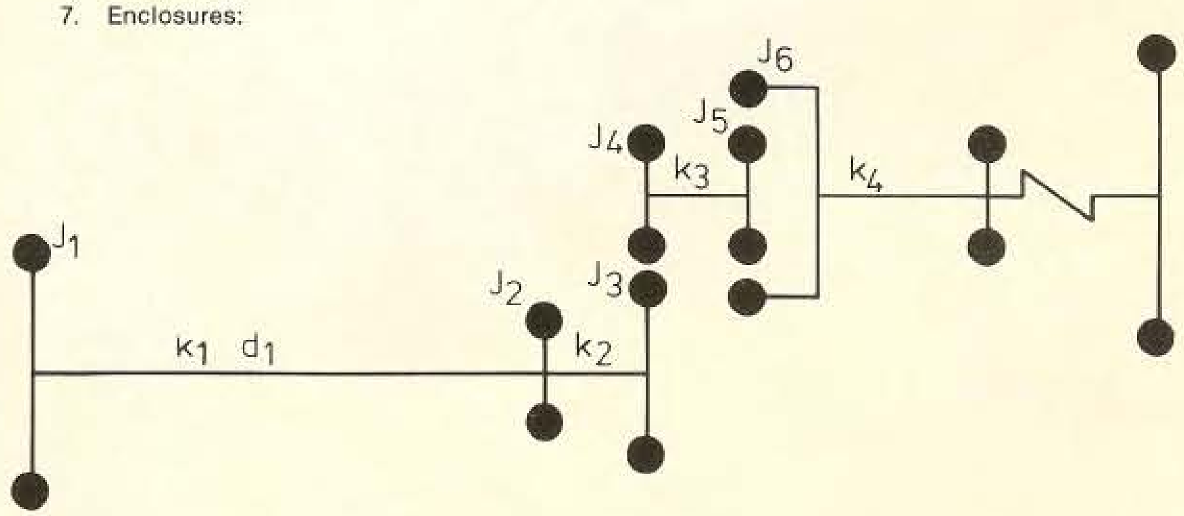
Shaft stiffness k (Nm/rad), min. shaft diameter d (mm) and hole diameter d_H (mm):

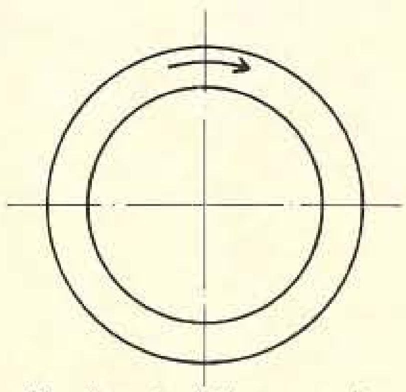
	1	2	3	4
k				
d				
d_H				

Note: $J = GD^2/4$

The values in the tables correspond to the shaft own speed (i.e. not reduced values).

6. Classification and ice class:
7. Enclosures:



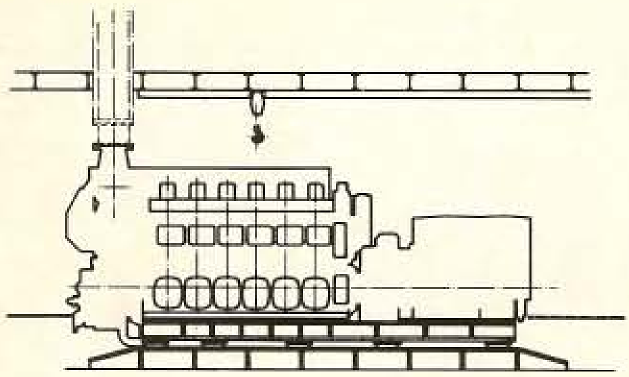


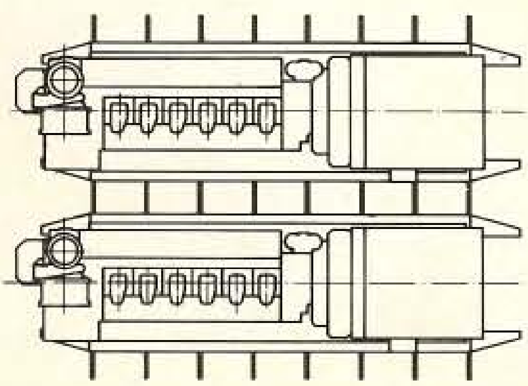
Direction of rotation, normally

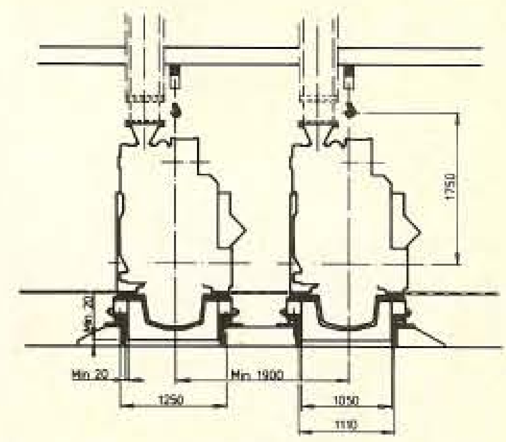
Flywheel viewed
from gear

ENGINE ROOM ARRANGEMENT

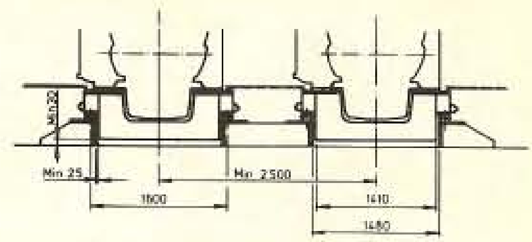
GENERATING SETS







R22

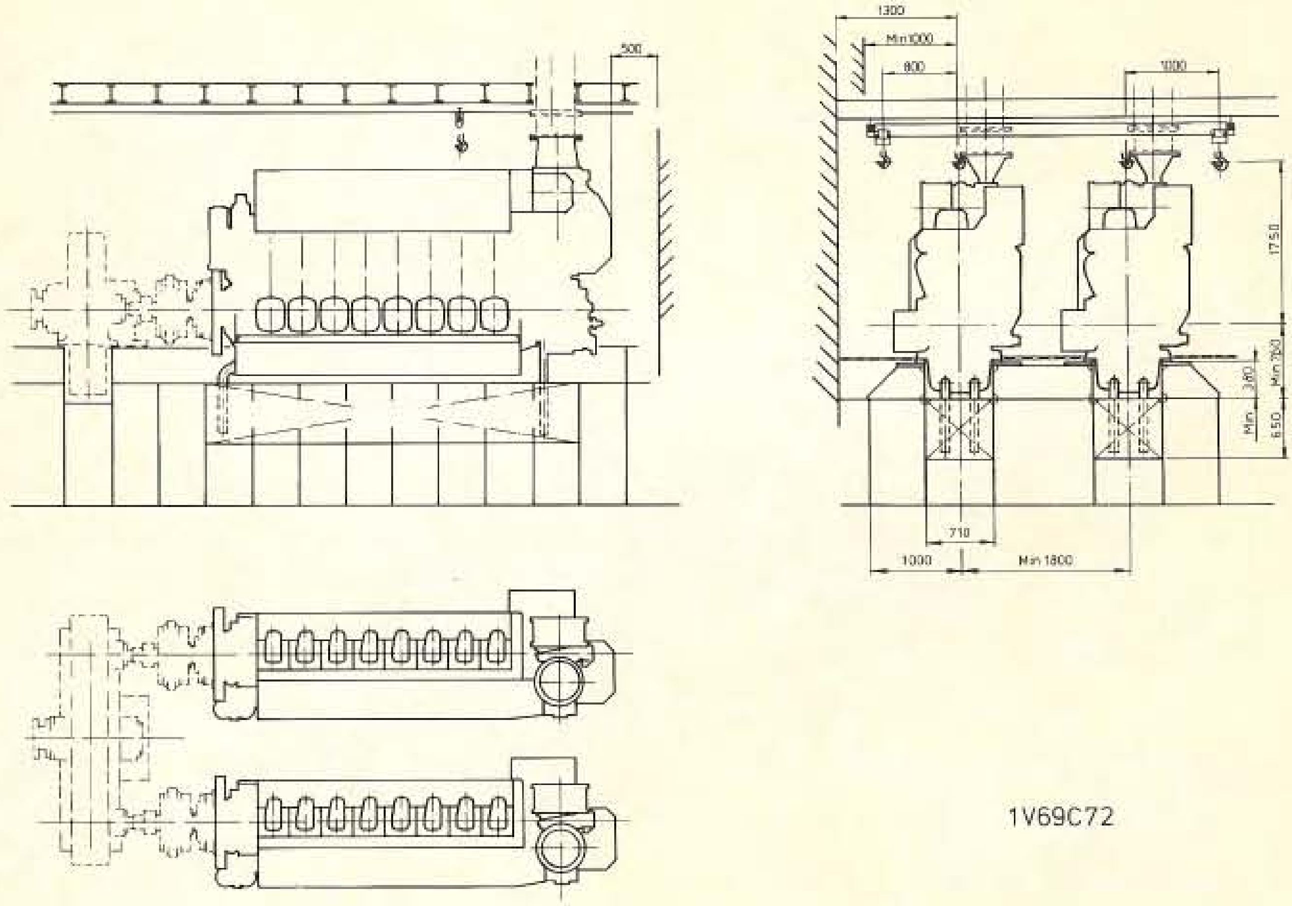


V22

1V69C70

ENGINE ROOM ARRANGEMENT

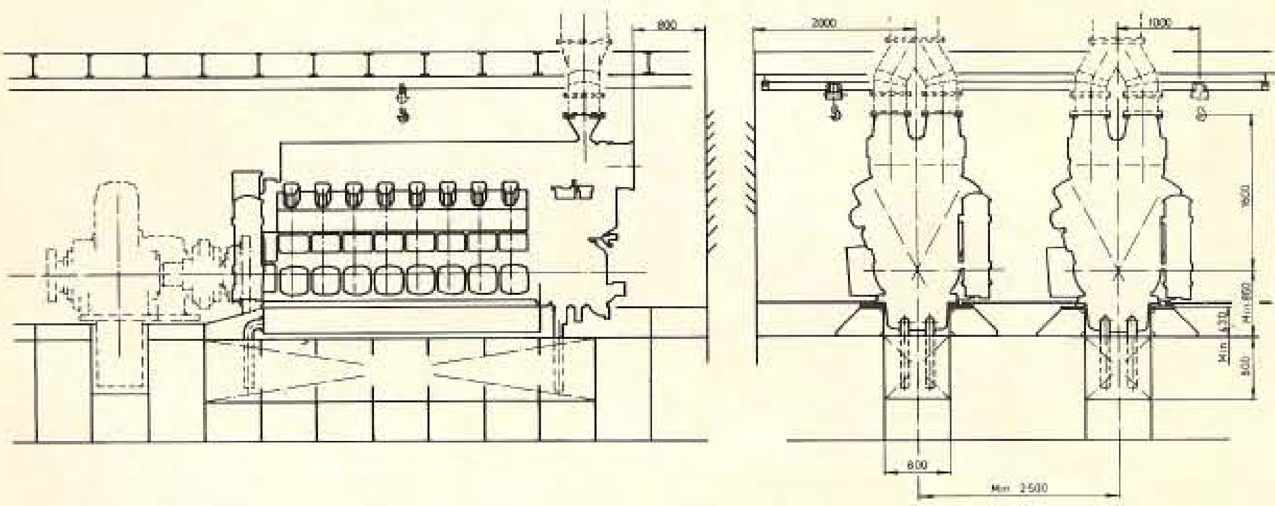
IN-LINE MAIN ENGINES

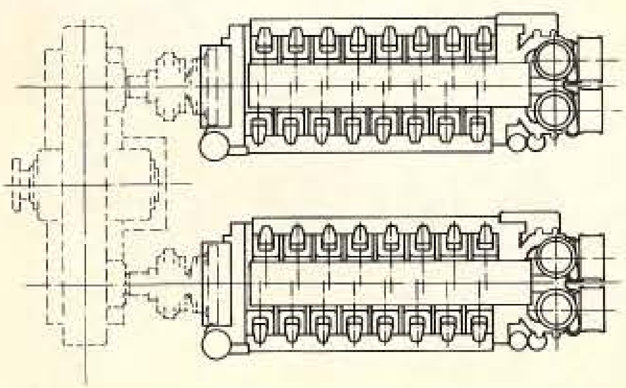


1V69C72

ENGINE ROOM ARRANGEMENT

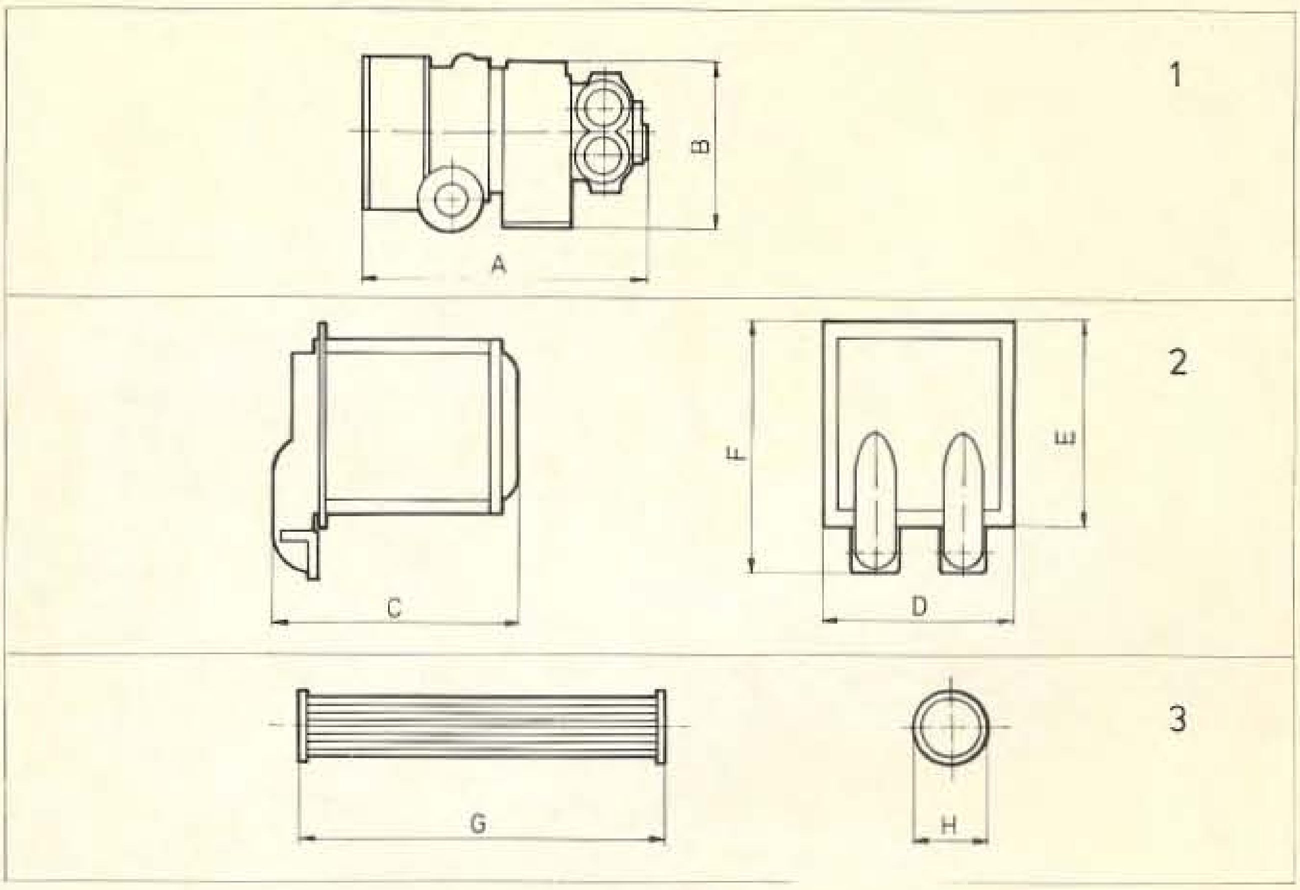
VEE-FORM MAIN ENGINES





0V69C73

TURBOCHARGER AND COOLER-INSERTS 2V92L434



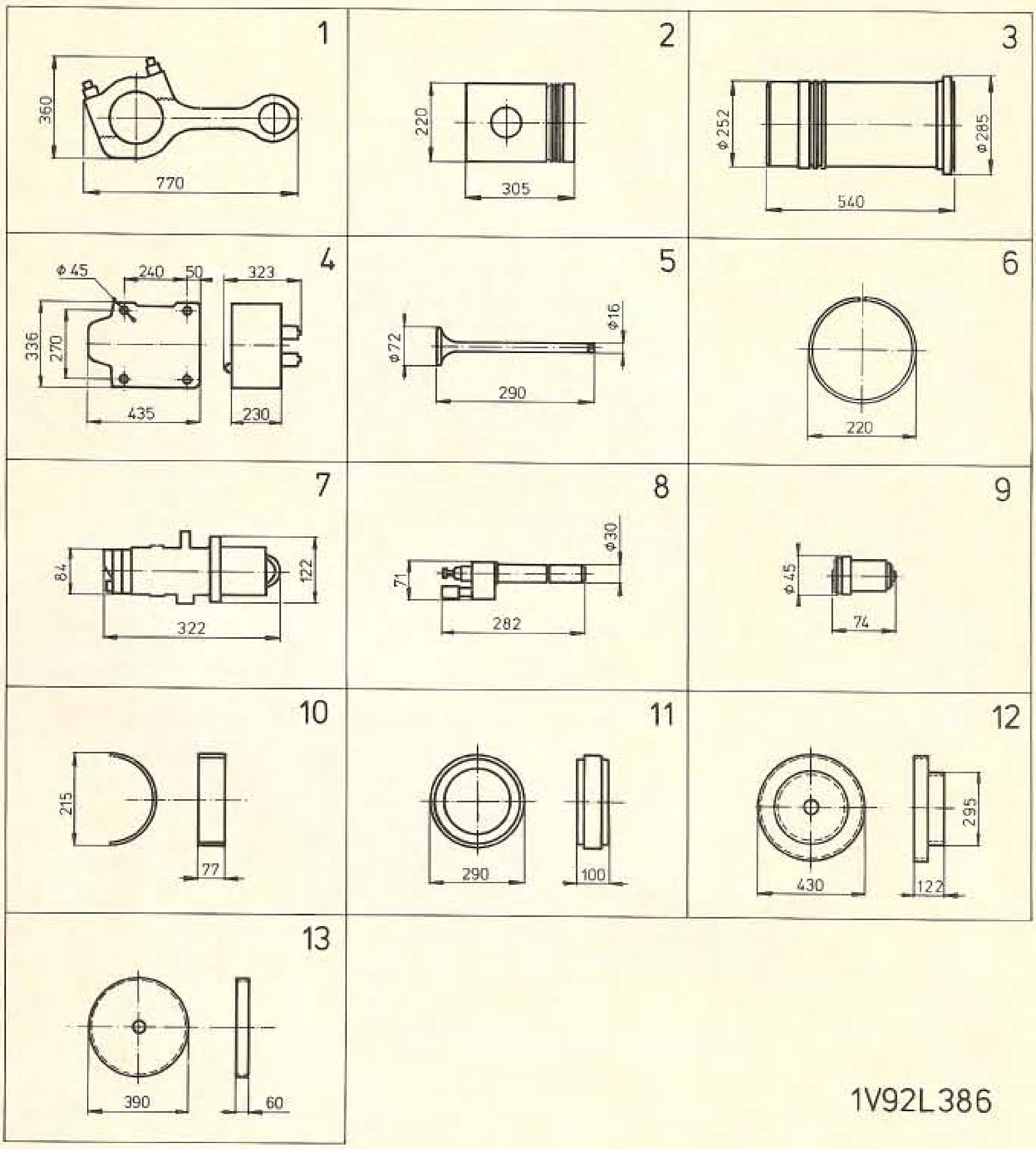
Item weight kg

2V92L434

Engine	1. Turbocharger	2. Charge air cooler insert		3. Lubricating oil Cooler insert
4R22	230	FW	SW	
4R22	230	110	105	28
6R22	250	155	148	53
8R22	430	175	165	62
12V22	2 x 250	2 x 155	2 x 148	120
16V22	2 x 430	2 x 175	2 x 165	140

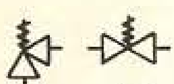
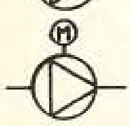
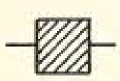
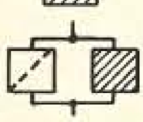
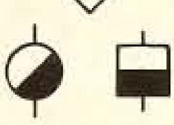
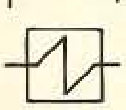
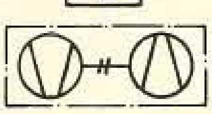
	A	B	C	D	E	F	G	H
4R22	948	543	490	460	410	520	990	205
6R22	961	515	600	460	510	620	1000	252
8R22	1170	655	700	460	510	620	1200	252
12V22	961	515	600	460	510	620	1340	336
16V22	1170	65	700	460	510	620	1340	336

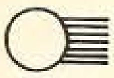
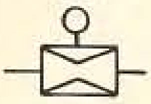
MAJOR SPARE PARTS 1V92L386



Item		Weight/kg	Item		Weight/kg
1	Connecting rod	40	7	Injection pump	15
2	Piston	20	8	Injection valve	1,5
3	Cylinder liner	51	9	Starting air valve	0,8
4	Cylinder head	75	10	Main bearing shell	1,4
5	Valve	0,8	11	Split gear wheel for crankshaft	18
6	Piston ring	0,2	12	Intermed, gear for camshaft drive	42
			13	Camshaft drive gear	20

SYMBOLS

Symbols	Description
	Valve, general sign
	Three-way valve, general sign
	Non-return valve, general sign
	Automatic actuating valve
 (1) (2)	Spring-loaded overflow valve (1) Angle (2) Straight
	Self-contained
	Solenoid valve
	Pump, general sign
	Electrically driven pump
	Filter or strainer
	Automatic filter with by-pass filter
	Centrifugal filter
	Water, oil and condensate separator, general sign
	Heater, cooler
	Charger, of centrifugal type

Symbols	Description
	Receiver
	Starting air distributor
	Viscosity meter
	Insulated pipe
	Heated pipe
	Tank, insulated
TI	Thermometer
TS	Temperature switch
PI	Pressure gauge
PS	Pressure switch
TZ	Temperature switch, shut-down
PZ	Pressure switch, shut-down
LS	Level switch
PDI	Differential pressure indicating
PDS	Differential pressure switch
R3/4	Connection with R3/4 in threads

WÄRTSILÄ DIESEL

P.O.Box 244, 65100 Vasa Finland. TEL. 61-111 433, TLX 74250 wva sf

Brochure WV 8211T5E

KIRJAPAINO FRAM BOKTRYCKERI