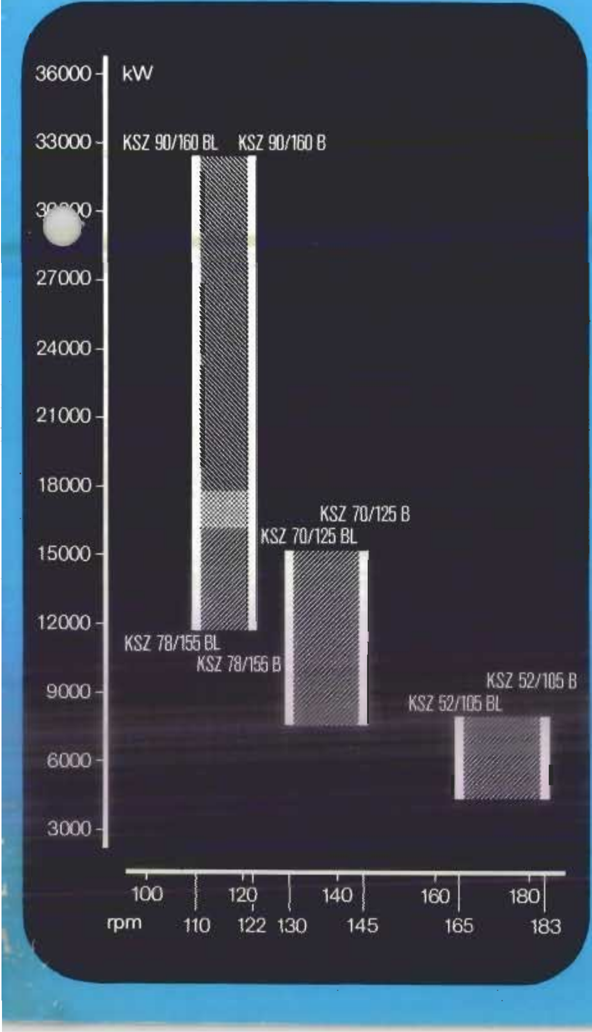
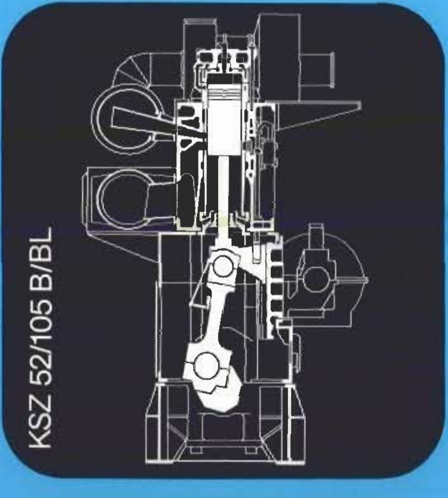
Brief Specification
Status: November 1977

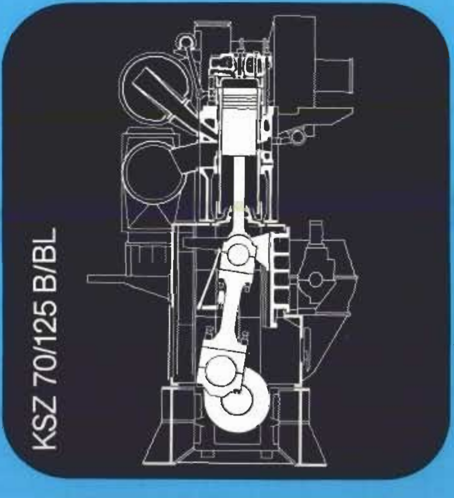
M·A·N

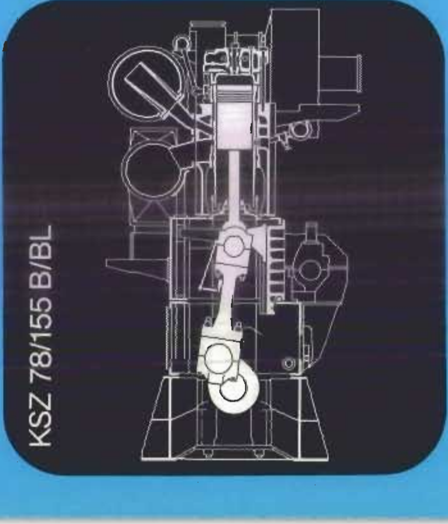
Two-stroke Diesel engines
Type KSZ-B/BL

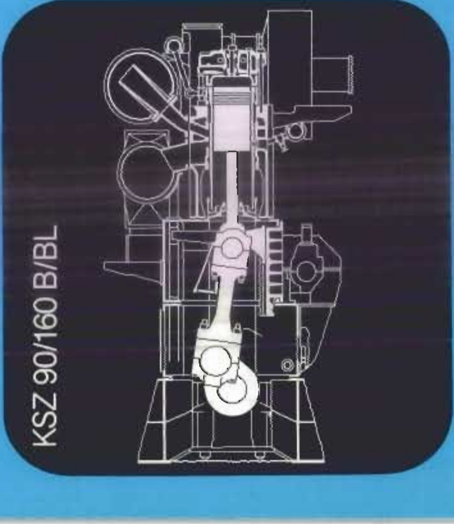
KSZ-B




KSZ 52/105 B/BL


KSZ 70/125 B/BL


KSZ 78/155 B/BL


KSZ 90/160 B/BL

Two-stroke Diesel Engines KSZ 52/105 B/BL KSZ 70/125 B/BL KSZ 78/155 B/BL KSZ 90/160 B/BL

KSZ-

General definition of diesel engine ratings (to ISO 3046/I)
Cont. rating 10% overload capacity for 1 hour's service within 12

Reference conditions:

Air temperature	300 K (27°C)
Air pressure	1 bar
Cooling water temperature before charge-air cooler	300 K (27°C)

The KSZ-B/BL model represents the new M.A.N. two-stroke engine concept embodying novel and improved elements in its design and systems engineering that more than ever meet the demands of cost-effectiveness for marine propulsion units. This concept is, to a large extent, based upon the service experience M.A.N. and their licensees have gained from the operation of several thousand slow-speed two-stroke units.

Two-stroke Diesel engine* KSZ 52/105 B KSZ 52/105 BL

Technical Data

Operating principle:	two-stroke single-acting
Scavenge process:	M.A.N. loop scavenge syst.
Number of cylinders:	5 – 9
Cylinder bore:	520 mm
Piston stroke:	1050 mm
Swept vol. per cyl.	223 dm^3
Cylinder rating:	885 kW 1200 HP
Power/weight ratio:	32.6-36.2 kg/kW 24.1-26.7 kg/HP
Cylinder coolant:	Water
Piston coolant:	Water
Starting:	by compr. air
Specific fuel consumption at full load: (Tolerance 3%)	209 g/kWH 154 g/HP-h

		KSZ-B	KSZ-BL
Speed	rpm	183	165
Mean piston speed	m/s	6.41	5.78
Mean effective pressure	bar	13.0	14.4

		kW	PS
K5SZ 52/105 B/BL	5 cyl.	4425	6000
K6SZ 52/105 B/BL	6 cyl.	5310	7200
K7SZ 52/105 B/BL	7 cyl.	6195	8400
K8SZ 52/105 B/BL	8 cyl.	7080	9600
K9SZ 52/105 B/BL	9 cyl.	7965	10800

Two-stroke Diesel engine KSZ 70/125 B KSZ 70/125 BL

Technical Data

Operating principle:	two-stroke single-acting
Scavenge process:	M.A.N. loop scavenge syst.
Number of cylinders:	5 – 10
Cylinder bore:	700 mm
Piston stroke:	1250 mm
Swept vol. per cyl.:	481 dm^3
Cylinder rating:	1520 kW 2065 HP
Power/weight ratio:	35.5-39.5 kg/kW 21.6-29.0 kg/HP
Cylinder coolant:	Water
Piston coolant:	Water
Starting:	by compr. air
Specific fuel consumption at full load: (Tolerance 3%)	209 g/kWh 154 g/HP-h

		KSZ-B	KSZ-BL
Speed	rpm	145	130
Mean piston speed	m/s	6.04	5.5
Mean effective pressure	bar	13.1	14.6

		kW	PS
K 5SZ 70/125 B/BL	5 cyl.	7600	10330
K 6SZ 70/125 B/BL	6 cyl.	9120	12390
K 7SZ 70/125 B/BL	7 cyl.	10640	14460
K 8SZ 70/125 B/BL	8 cyl.	12160	16520
K 9SZ 70/125 B/BL	9 cyl.	13680	18590
K10SZ 70/125 B/BL	10 cyl.	15200	20650

*** Engine type under development**

B/BL

Power ranges for marine propulsion engines

MCR = Maximum Continuous Rating (fuel stop power)

I = operating range for continuous service

II = operating range temporarily admissible, e.g. during acceleration, manoeuvring (torque limit)

FP = design range for fixed-pitch propeller (Fig. 1)

VP = design range for controllable-pitch propeller with combinator (Fig. 2)

Reference conditions:

Air temperature	318 K (45°C)
Air pressure	1 bar
Cooling water temperature before charge-air cooler	305 K (32°C)

Two-stroke Diesel engine KSZ 78/155 B KSZ 78/155 BL

Technical Data

Operating principle:	two-stroke single-acting
Scavenge process:	M.A.N. loop scavenge syst.
Number of cylinders:	6 – 9
Cylinder bore:	780 mm
Piston stroke:	1550 mm
Swept vol. per cyl.:	740.6 dm^3
Cylinder rating:	1960 kW 2665 HP
Power/weight ratio:	41.7-43.3 kg/kW 30.6-31.9 kg/HP
Cylinder coolant:	Water
Piston coolant:	Water
Starting:	by compr. air
Specific fuel consumption at full load: (Tolerance 3%)	205 g/kWh 151 g/HP-h

		KSZ-B	KSZ-BL
Speed	rpm	122	110
Mean piston speed	m/s	6.3	5.7
Mean effective pressure	bar	13.0	14.4

		kW	PS
K6SZ 78/155 B/BL	6 cyl.	11760	15990
K7SZ 78/155 B/BL	7 cyl.	13720	18660
K8SZ 78/155 B/BL	8 cyl.	15680	21320
K9SZ 78/155 B/BL	9 cyl.	17640	23990

Two-stroke Diesel engine KSZ 90/160 B KSZ 90/160 BL

Technical Data

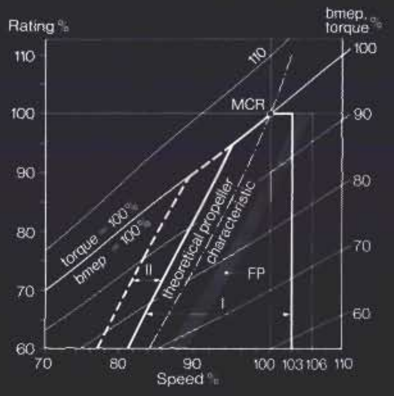
Operating principle:	two-stroke single-acting
Scavenge process:	M.A.N. loop scavenge syst.
Number of cylinders:	6 – 10, 12
Cylinder bore:	900 mm
Piston stroke:	1600 mm
Swept vol. per cyl.:	1018 dm^3
Cylinder rating:	2700 kW 3670 PS
Power/weight ratio:	35.5-38.6 kg/HP 26.1-28.4 kg/PS
Cylinder coolant:	Water
Piston coolant:	Water
Starting:	by compr. air
Specific fuel consumption at full load: (Tolerance 3%)	204 g/kWh 150 g/HP-h

		KSZ-B	KSZ-BL
Speed	rpm	122	110
Mean piston speed	m/s	6.5	5.9
Mean effective pressure	bar	13.0	14.5

		kW	PS
K 6SZ 90/160 B/BL	6 cyl.	16200	22020
K 7SZ 90/160 B/BL	7 cyl.	18900	25690
K 8SZ 90/160 B/BL	8 cyl.	21600	29360
K 9SZ 90/160 B/BL	9 cyl.	24300	33030
K10SZ 90/160 B/BL	10 cyl.	27000	36700
K12SZ 90/160 B/BL	12 cyl.	32400	44040

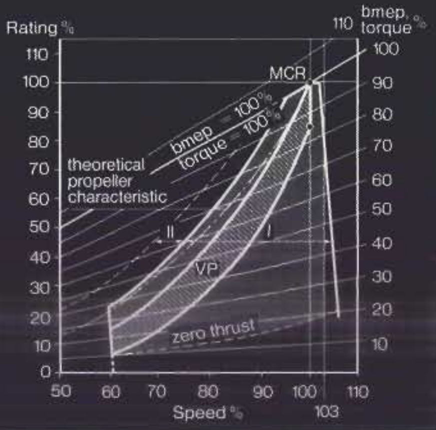
Marine Propulsion Engines with fixed-pitch propeller

Fig. 1



Marine Propulsion Engines with controllable-pitch propeller

Fig. 2



Construction

The most salient feature of the KSZ-B/BL engines is the framework constructed of box-shaped longitudinal girders combined with a deep-section single-walled bedplate and high, cast-iron cylinder jackets. In engines with a cylinder bore of more than 700 mm the longitudinal girder of the frame is divided in the horizontal plane (Fig. 1). Because of its small dimensions, the entablature of the KSZ 52/105 B/BL and 70/125 B/BL is a single-part component (Fig. 2).

A high degree of rigidity, which constitutes an inherent feature of box-girder construction, assists in a gradual reduction of deformations transmitted by the hull's double bottom, thus preventing buckling strains and abrupt changes in curvature within the engine. The crankshaft bearing lane sustains only slight deformations which are uniform with both internal and external forces. Each frame section per cylinder, conceived as an individual cellular unit, retains its extreme stability of form and the deformations caused by external forces do not lead to unduly high stress concentrations. The given stiffness characteristics diminish the risk of uncontrollable edgewise loading of the main bearings.

This benefits the piston running characteristics since the cylinder liners are only negligibly deformed by external forces at their areas of constraint and their circular shape is maintained uniformly which, in turn, meets a prime condition for low wear rates.

These interdependencies have been known for a long time and the first step taken consisted in the engine maker adopting the deep-section bedplate. Assurance of suitable stiffness conditions is now no longer left to the shipyard's exclusive discretion as all the engine maker could tell him before was that he should make the ship's foundation as stiff as possible. At the same time, the deep-section bedplate has simplified the configuration of the ship's double bottom. The interruption, previously unavoidable because of the shape of the oil pan, has now become unnecessary (Fig. 3).

The box-type framework construction is a further step towards increased rigidity. In the K8SZ 90/160 A engine, for instance, with A-type columns, the bedplate accounts for about 60% of the overall rigidity whereas in a K8SZ 90/160 B unit the bedplate contributes only about 17% to overall engine rigidity. The KSZ-B to KSZ-A rigidity ratio, exemplified by an 8-cylinder 90/160 unit, is 4 : 1.

These figures illustrate to what extent

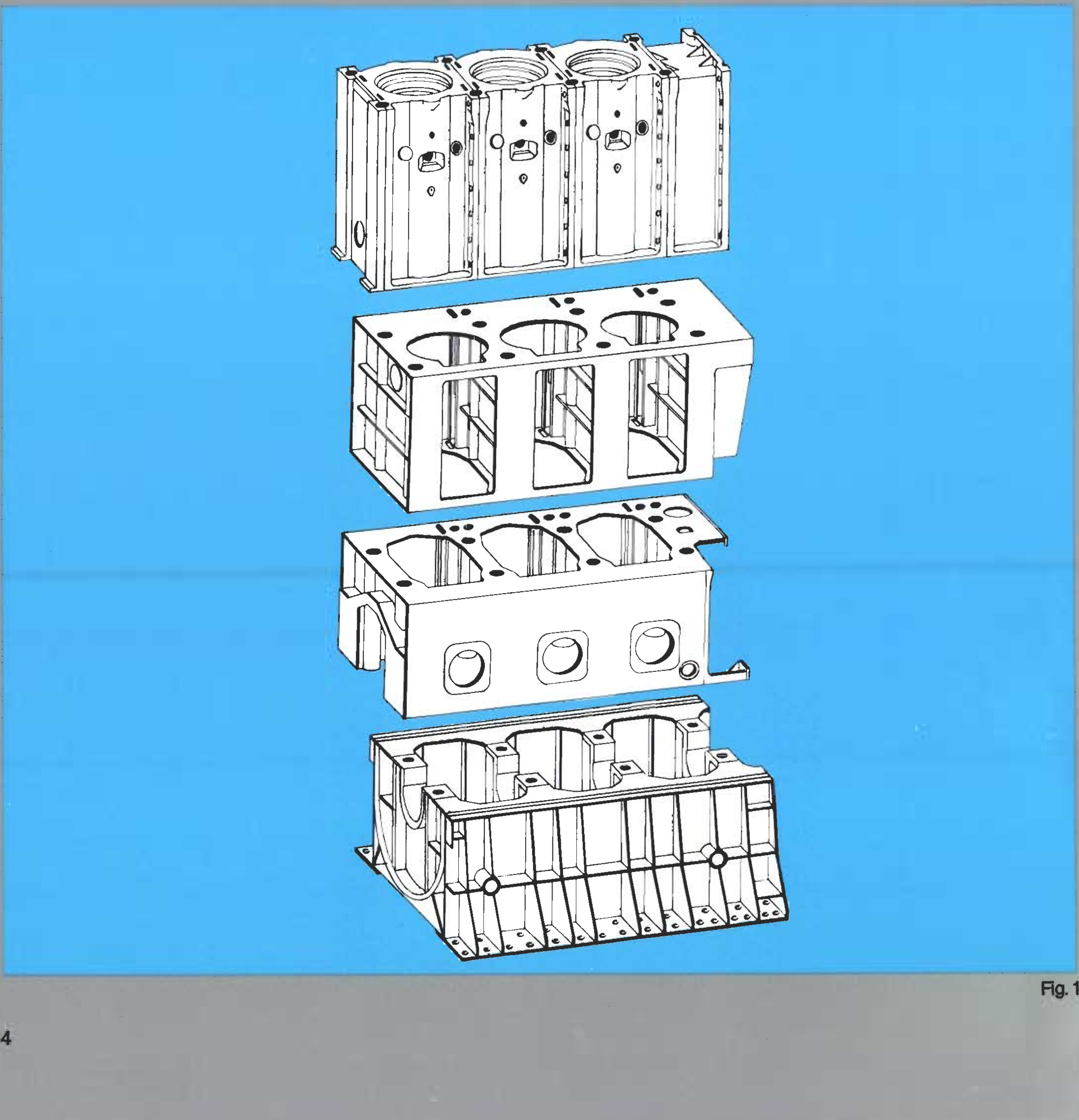


Fig. 1

the new framework construction has improved the engine's inherent capability of counteracting external deformation forces.
This meets the shipbuilders' demands who, owing to the burden of costs which necessitates optimal utilization of available materials and adoption of large plate areas, are compelled to introduce more flexible concepts.

Data on the stiffness factors of the engine are important to the shipbuilder. Within certain limits, the box-type construction of the engine lends itself readily to the well-known methods of calculation.
Thanks to the box-type principle adopted for the framework, the number of sealing faces, when compared with previous concepts, has been distinctly reduced in the KSZ-B/BL engines so that the outer faces of the engine are neat and the amount of sealing work has been kept very small.
Assembly of this engine in the ship is especially simple. The structure made up of sub-assemblies and individual components is wage-intensive. Shipyards equipped with higher-capacity cranes introduce complete engines or engines separated vertically in the middle.

In this case, it is not so important whether the engine is made up of A-columns or box-shaped girders. If the engine is sub-divided into modules the box-shaped concept offers advantages so that even shipyards without gantry-cranes are enabled to install preassembled units.
Figs. 12—18 show the assembly of a K8SZ 90/160 B/BL engine on the test-bed. The various boxes can be preassembled with their internal components such as crosshead, connecting rod, etc. mounted in the engine-room, and connected at their seating faces by tierods and bolts.

Camshaft drive

The stiff box-shaped construction of the framework forms a highly deformation resistant casing to accommodate the timing gear train (Fig. 4).
All engine sizes are therefore suitable for a gear train with only one idle wheel and straight toothing. This drive is easy to assemble.
The design concept of the framework boxes, which fully exploits the machining precision achievable on large machine tools, makes for suitable seating faces so that adequate parallelism of crankshaft and camshaft is ensured.

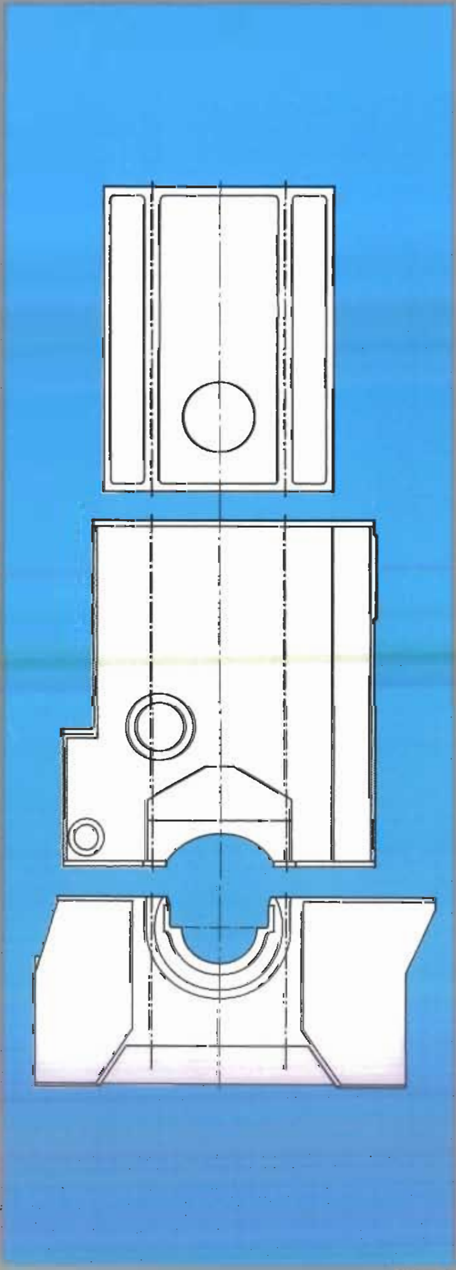


Fig. 2

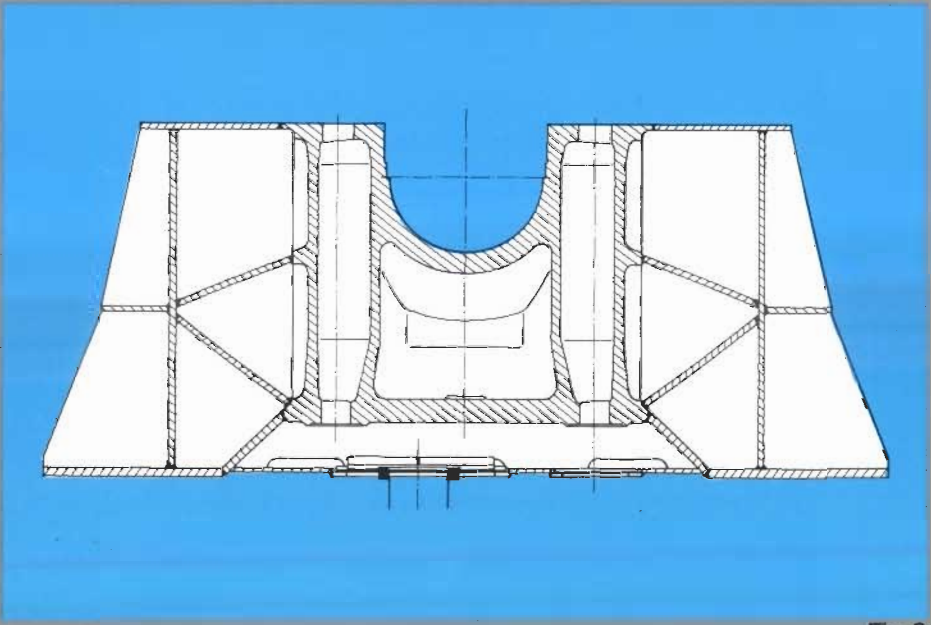


Fig. 3

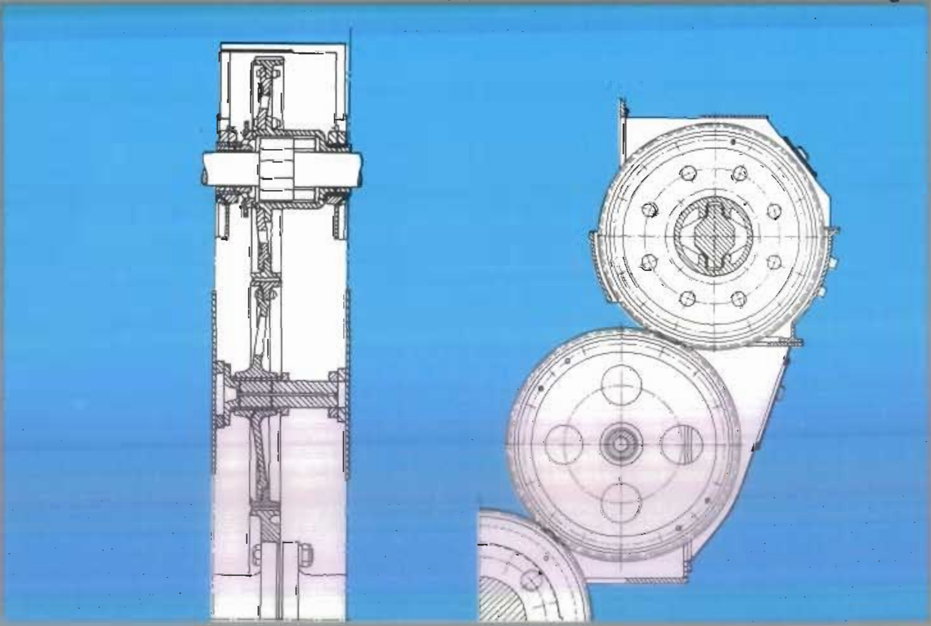


Fig. 4

The idle wheel is adjusted by setting bolts acting upon the seating of the idle wheel axle in the framework. Tooth contact pattern and meshing clearance can be adjusted by means of this simple device.

KSZ 52/105 and the 5- and 6-cylinder versions of the other engine types have their camshaft drive at the power take-off end. With these cylinder numbers the crankshaft gearwheel is clamped directly upon the thrust bearing flange as a 2-part component. No extra flange is therefore required for the camshaft drive with the result that the engine has become shorter.

Components forming the combustion chamber

The components adjacent to the combustion chamber, that is, primarily piston and cylinder cover, are subject to thermal load by quasi-stable combustion space temperatures and, chiefly, by the temperature fluctuations at load changes. To this must be added the firing stresses which directly affect the component.

With regard to these components, the KSZ-B/BL engines apply the principle of separation of functions. Thin-walled, intensively cooled components are used for absorbing thermal loads. The mechanical forces are introduced into supports which are mainly subject to thrust loads.

The piston crown is of high-temperature-resistant steel. The gas forces flow from the thin-walled, intensively-cooled piston crown through substantial cross-sections of the piston backing structure to the piston rod (Fig. 5). A new principle, necessitated by component size, is applied in the case of the KSZ 52/105 B/BL engines. The piston crown underface features a number of bores. These are cooled intensively by water, the velocity of which is determined by the nozzle bores of an insert. The cylinder cover is constructed to a similar design principle. The thin-walled flame deck, of heat-resistant steel, bears against an inherently rigid supporting body of grey casting. The preloading between cap and flame deck, necessary to avoid micromovements, is achieved by cylinder cover bolts and a row of inner studs. All contacting faces are connected nonpositively (Figs. 5, 6).
The cylinder liners of the KSZ-B/BL engines are of one-part construction and only cooled intensively by port bar and flange cooling where it is necessary.

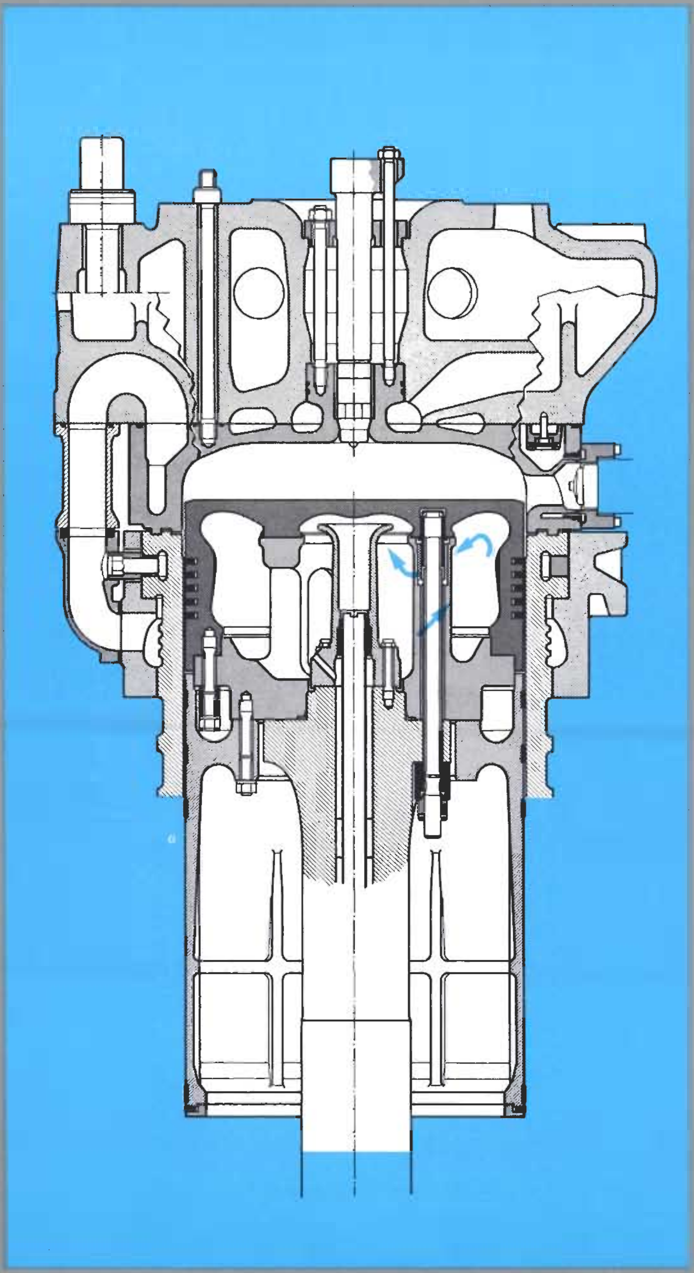


Fig. 5

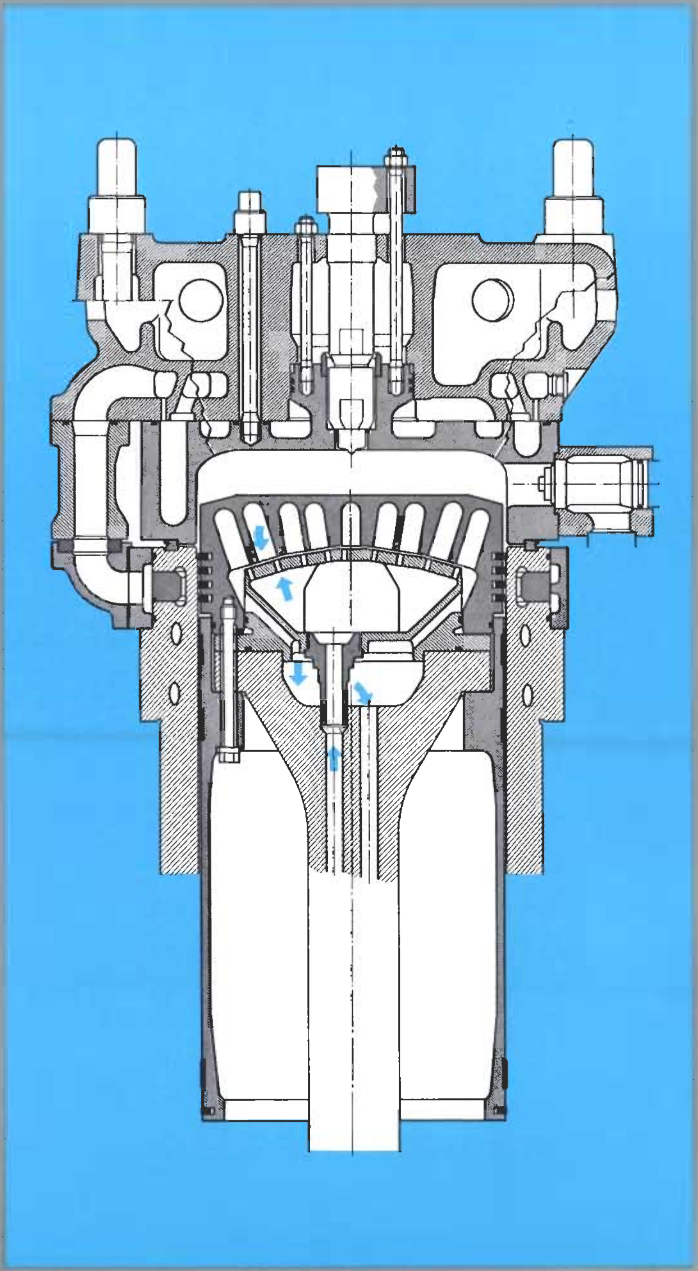


Fig. 6

Balancing of 2nd-order free moments

Slow-speed two-stroke engines developing some 7500 kW (approx. 10 000 hp) are especially in demand and sometimes the engines required should have the smallest number of cylinders possible. A 70/125 B/BL 5-cylinder unit is well suited for these applications since its box-shaped deformation resistant construction makes it possible to integrate a balancer (Fig. 7). In the planning stage it is often not certain whether such a balancer is actually required for the type of ship in question. The balancer of the KSZ B/BL engines is so conceived that it can be fitted subsequently, that is, for instance, after the sea trials.

Turbocharging system

The turbocharger efficiencies achievable today and current mean effective pressures with the associated boosting pressures appreciably reduce the additional air volume to be delivered to the turbocharger. In the case of the KSZ-A engines, M.A.N. have already placed electrically driven auxiliary blowers ahead of the compressors of the turbochargers which, in support of the turbochargers, supply air to the engine up to about half-load. There is one radial-flow blower per turbocharger which is cut in by means of a star-delta switch before engine start-up. Cut-in and cut-out of the auxiliary blowers is automatic as a function of scavenging air pressure. The power required by the auxiliary blowers amounts to approximately 0.8% of the engine output.

The turbocharging system, depicted diagrammatically in Fig. 8 embodies low-resistance scavenge air and exhaust gas piping with the associated diffusors as shown in the illustration. Arrangement and number of turbochargers are to achieve maximum efficiency of the overall turbocharging system since this is one of the essentials for low fuel consumption rates. Optimization therefore had to reconcile maximum blower wheel diameter, reliability, and arrangement on the engine. Outputs of up to 7500 kW (approx. 10 000 hp) can be handled by one turbocharger whereas two turbochargers are required for all engines of higher rating. They are attached at the ends of the engine or can be placed as a unit together with the auxiliary blower on a separate foundation frame in the engine room casing.

The meaning of KSZ-B and BL

In many single-screw vessels, as the engine speed decreases,

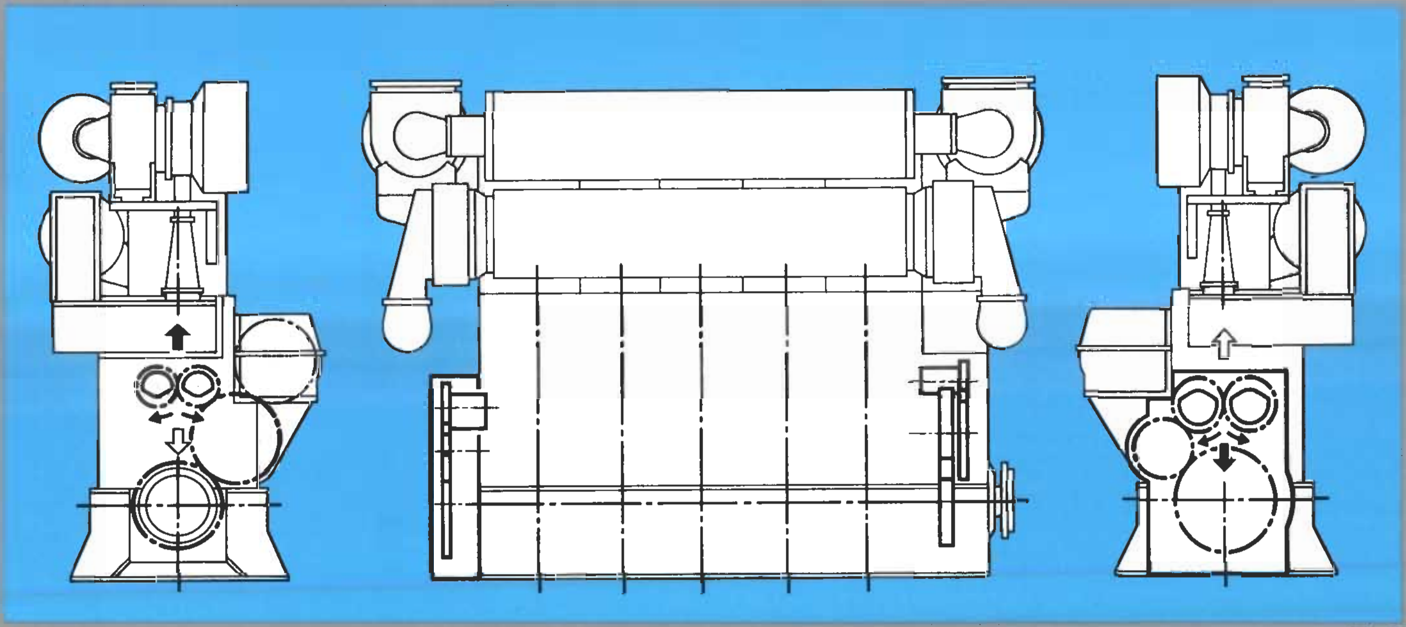


Fig. 7

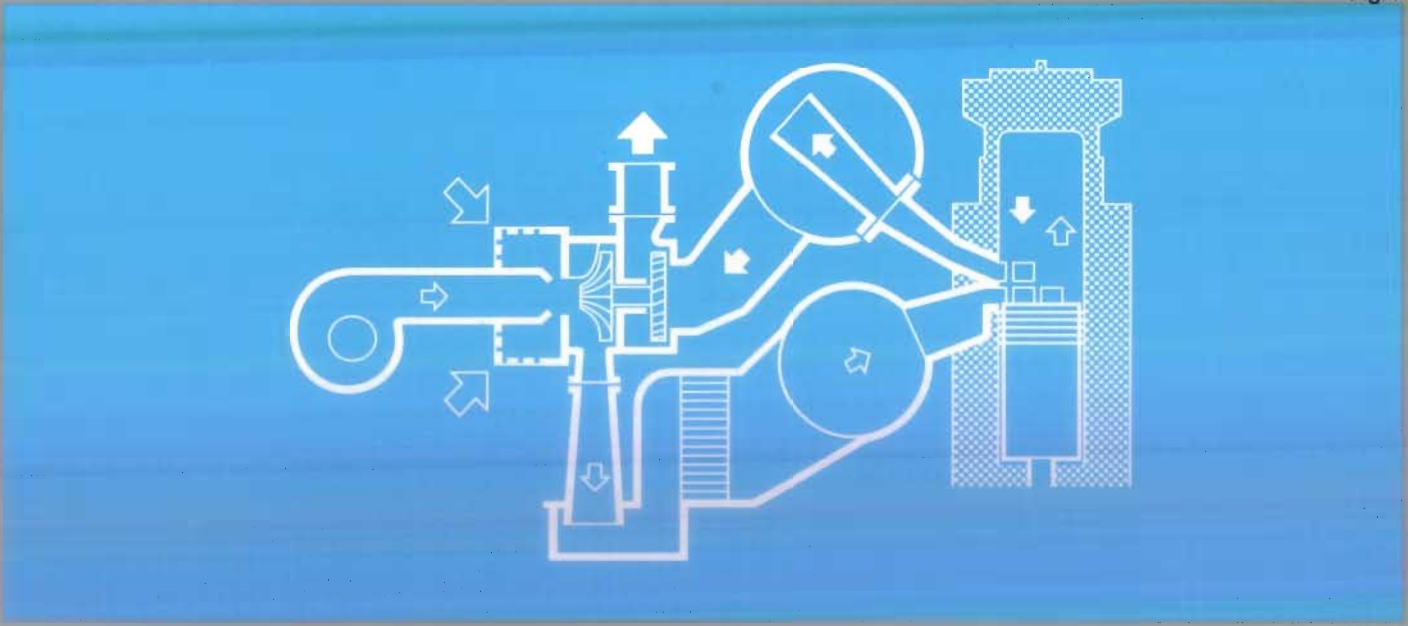


Fig. 8

Two-stroke Diesel engine K8SZ 90/160 B/BL

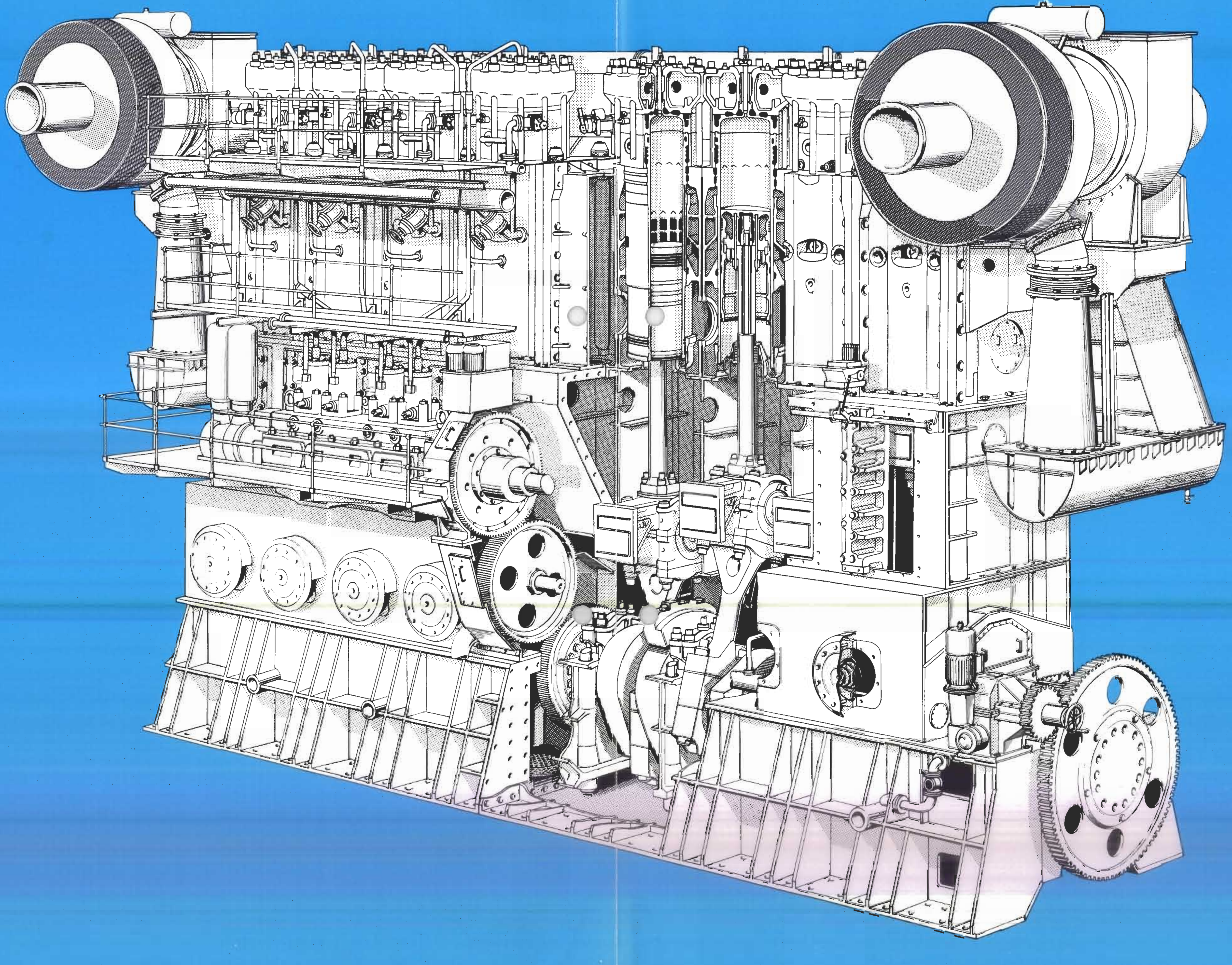


Fig. 9

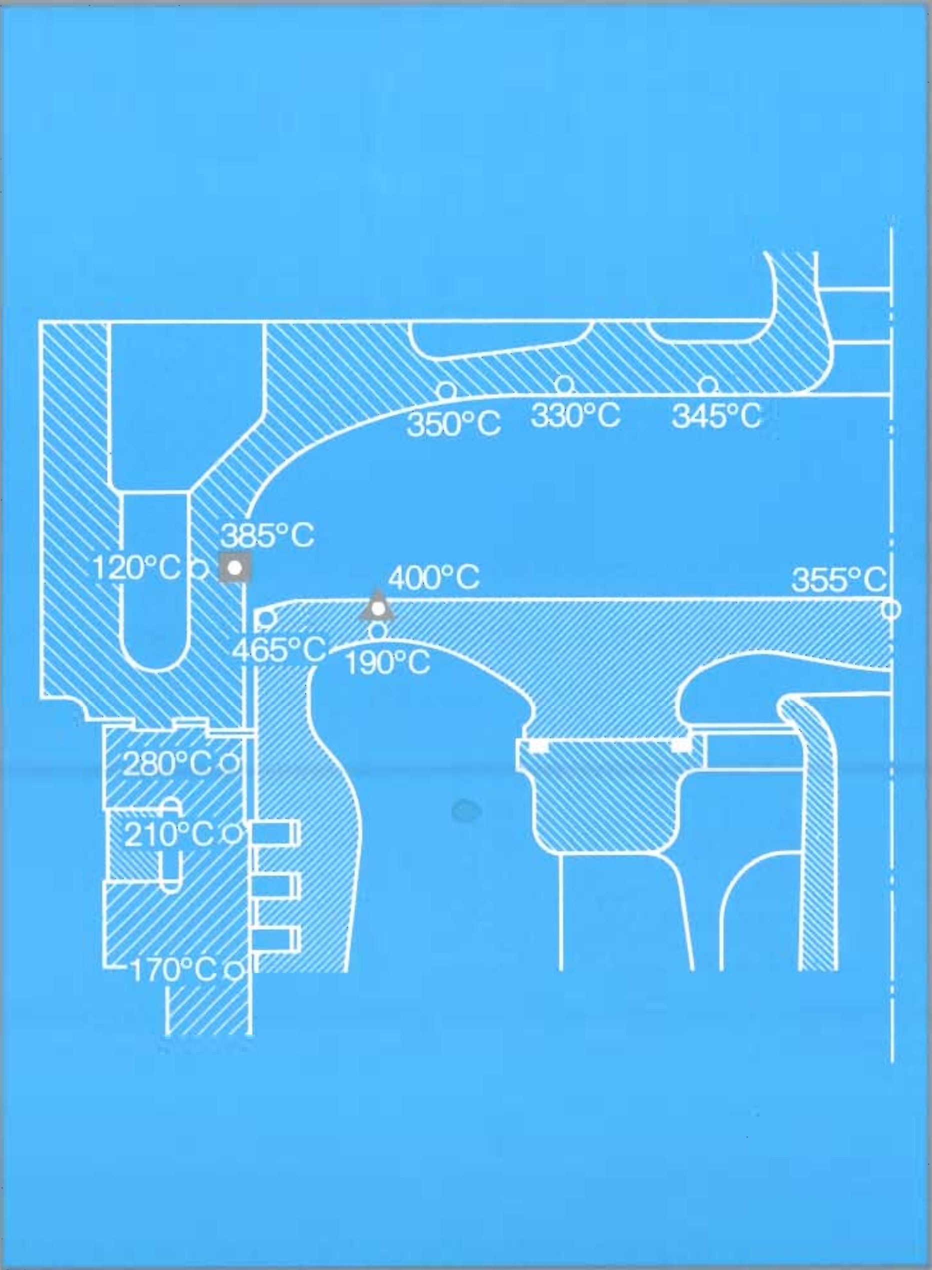
propulsive efficiency increases. Lowering of the hitherto usual speeds of slow-running two-stroke engines can be effected by a gearbox in connection with a flexible coupling or by increasing the piston stroke. Since M.A.N. did not want to adopt these measures, which have rather far-reaching consequences for the propulsion concept or the engine design, they have chosen the following solution:

Based on the empirical fact that in the two-stroke Diesel engine thermal loading of the components is, to a great extent, in proportion to the product of piston speed and mean effective pressure, in lowering the engine speed, i.e. piston speed, the mean effective pressure was raised by the same percentage. In order to keep the loadings in question within known orders of magnitude, a 10% reduction in speed and therefore a 10% increase in mean effective pressure was chosen as a variant with respect to the hitherto usual design values. Output at the 10% lower speed was then given the letter L = "lower speed". The fact that the letter B, which stands for the design level, has been retained means that the two engines are identical if one disregards the altered matching of the turbocharger. The KSZ-B/BL concept means that at a 10% difference in speed, with the same design level and therefore with identical constructional features, the same output can be developed.

Higher mean effective pressure means higher firing pressure and therefore higher mechanical load, i.e. approx. 7%. The surface temperatures to which the combustion chamber components are subjected drop even slightly as may be noted from the comparison in Fig. 10 of one of the hottest points on the piston crown. The framework, owing to its torsionally and flexurally rigid box-girder construction, is excellently suited to absorb the higher mechanical loads.

The simplified map in Fig. 11 shows the firing pressures and specific fuel consumption rates of a K8SZ 90/160 B/BL engine. By this it appears that the fuel consumption rate, taking into account the parameters mentioned, is only negligibly affected by the increase in mean effective pressure.

The turbocharging system and, in particular, its careful tuning and close matching play a decisive part in this development step.



Engine KSZ 90/160			B	BL
Output per cyl.	P_e	kW	2700	2700
Mean eff. press.	P_e	bar	13.0	14.5
Engine speed	n_M	rpm	122	110
Max. cylinder pressure	P_{Zmax}	bar	97	105
Specific air consumption	l_e	kg : kW · h	8.85	8.95
Temperatures				
Piston	▲	°C	400	396
Cylinder head	■	°C	385	381

Fig. 10

Other M.A.N.-specific elements:

Piston rod

The piston rod is aligned in relation to the cylinder axis by means of two eccentric rings. This feature simplifies an adjustment which is extremely important for a low wear rate of piston rings and liners.

Crosshead and slipper

The crosshead features hydrostatic lubrication, a principle which ensures adequate oil film thickness in all service conditions. The high oil pressure required for this purpose is generated by double-plunger high-pressure lubricators and two linkages driven directly off the connecting rod and forcing oil under pressure into the lower crosshead bearing shell.

Fuel pump

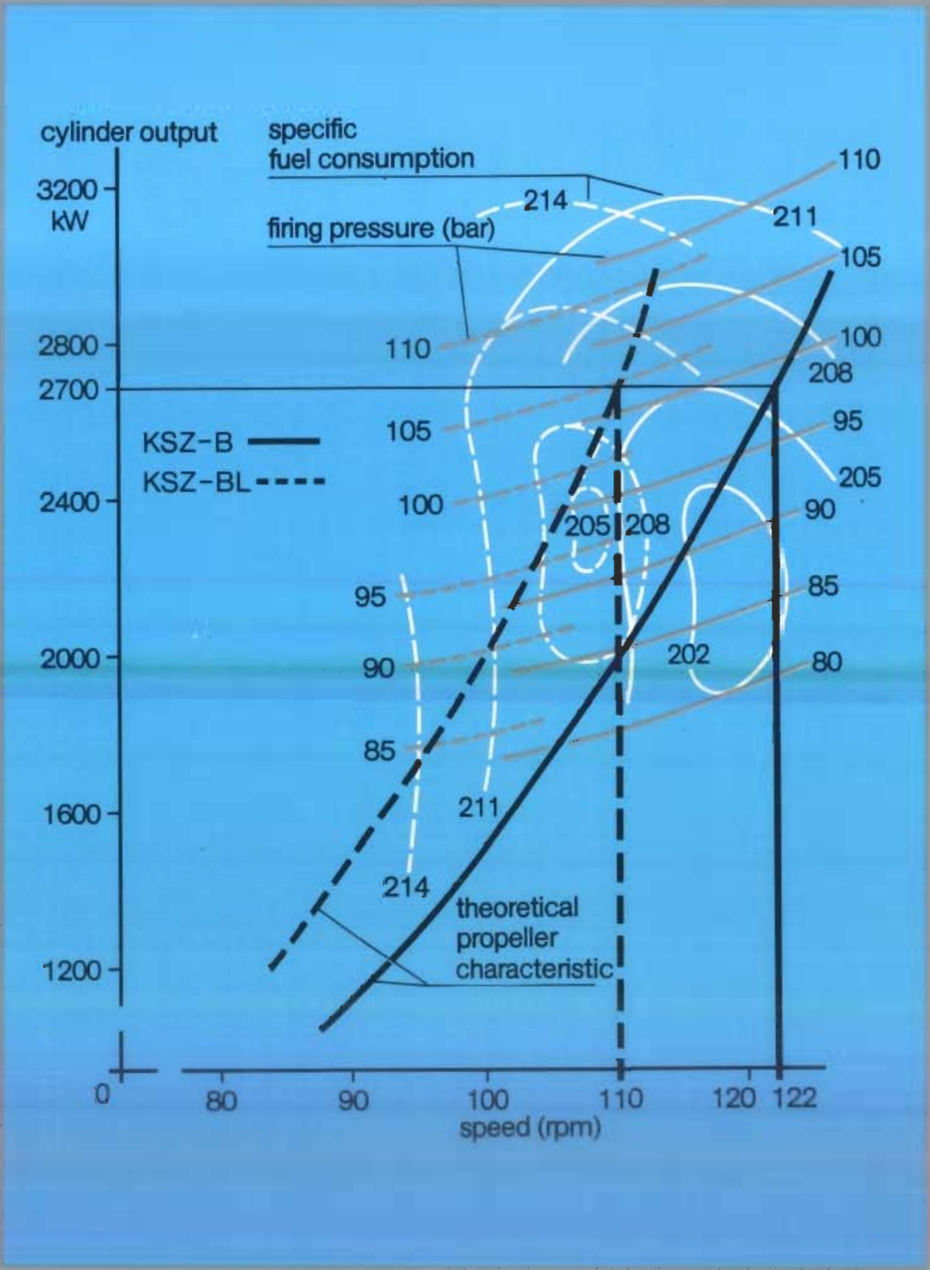
Each cylinder has its own injection pump with helical edge control. The two control edges of the delivery end are slightly offset in relation to each other so that the recoiling of the camshaft is damped. Each fuel pump has a pneumatically operated emergency shut-down plunger whereby the control rack, independently of fuel regulating linkage and governor, can be moved to the "no fuel" position.

Cylinder lubrication

The amount of lubricating oil fed to the several cylinders is engine speed as well as load dependent. The lub.oil quantity delivered by each pump element can be checked.

Tightening of bolts

The tierods and bolts in the main, crankpin and crosshead bearings as well as the piston rod palms, cylinder covers, piston crowns, and fuel cams are designed for application of hydraulic devices for tightening and slackening. Ready accessibility to all important components and special devices shorten maintenance times and relieve personnel of heavy physical work.



Simplified map of K8SZ 90/160 B/BL

Reference conditions:	
Air temperature	318 K (45°C)
Air pressure	1 bar
Cooling water temp. bef. charge-air cooler	305 K (32°C)
Specific fuel consump. without Tolerance	[g/kWh]

Fig. 11

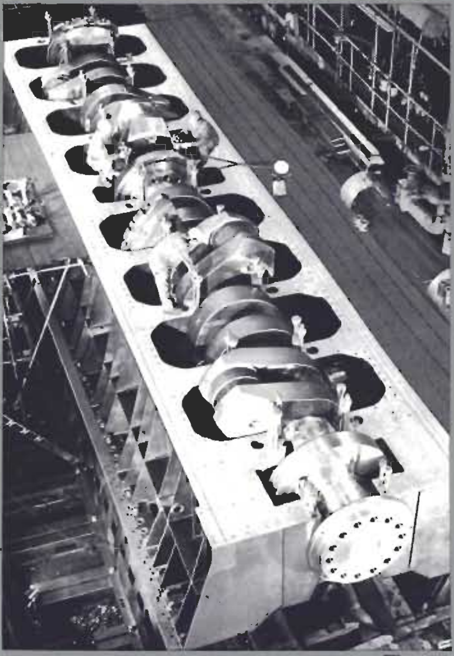


Fig. 12

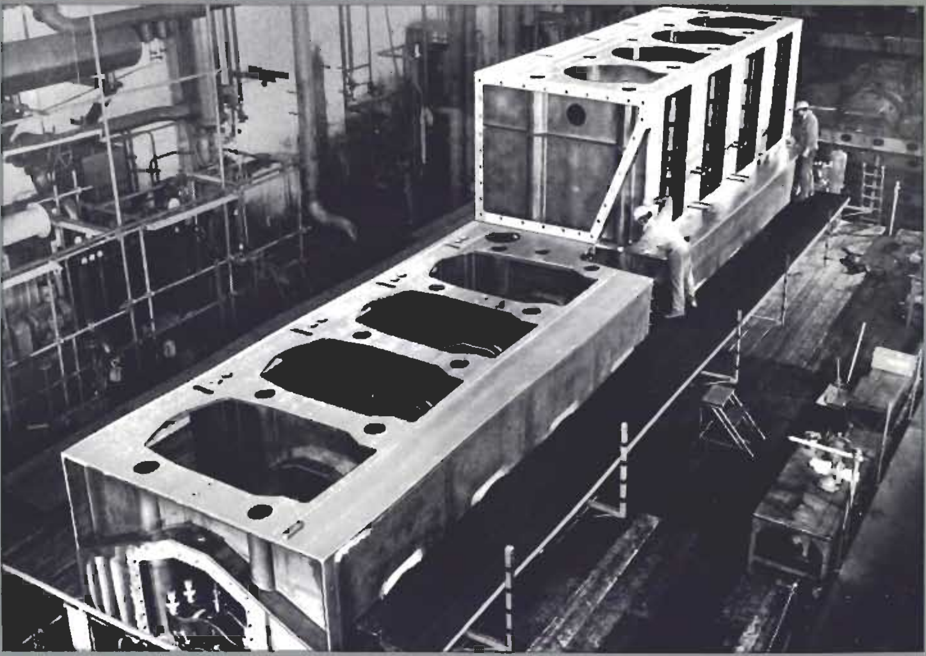


Fig. 13

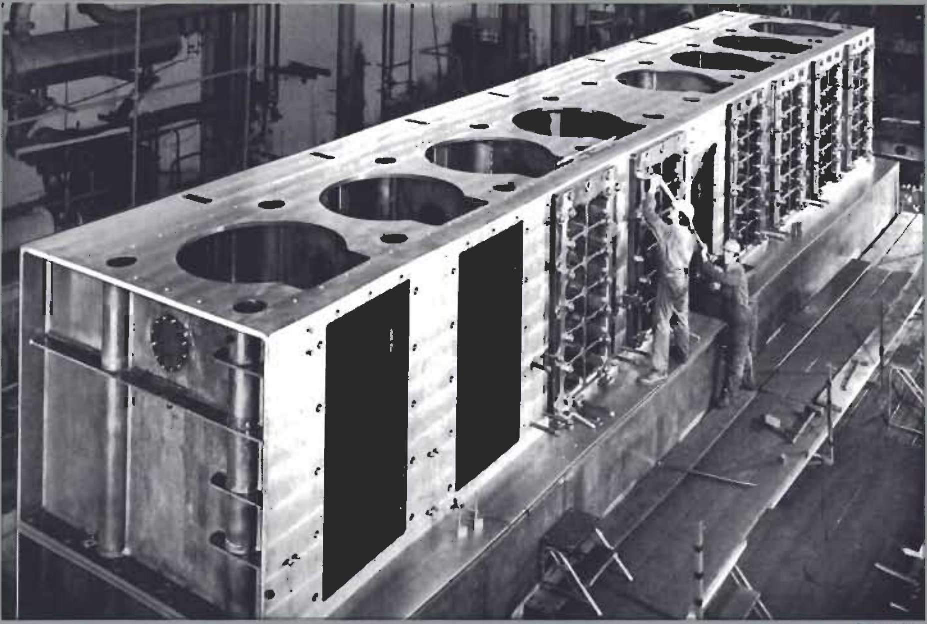


Fig. 14

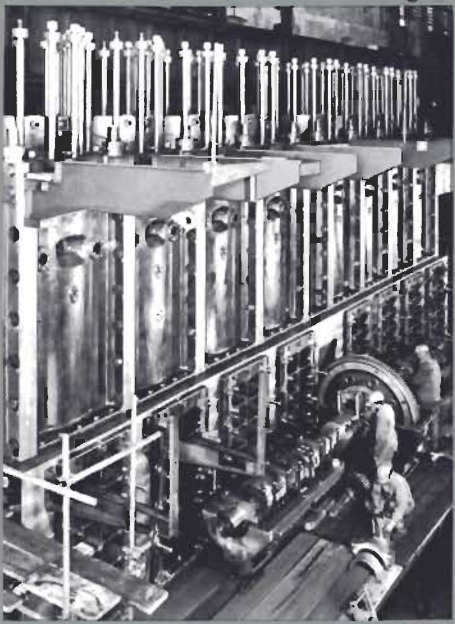


Fig. 15

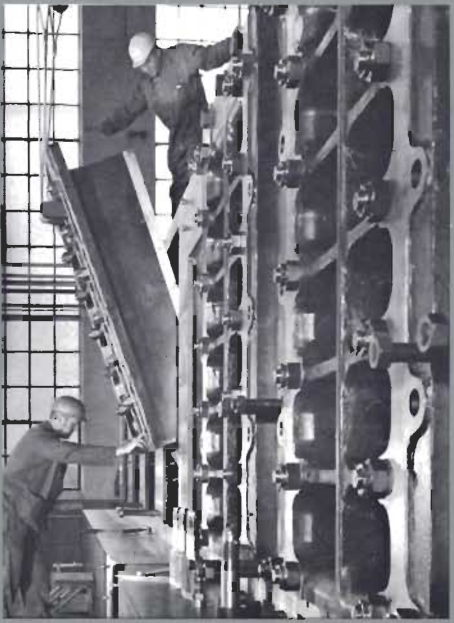


Fig. 16

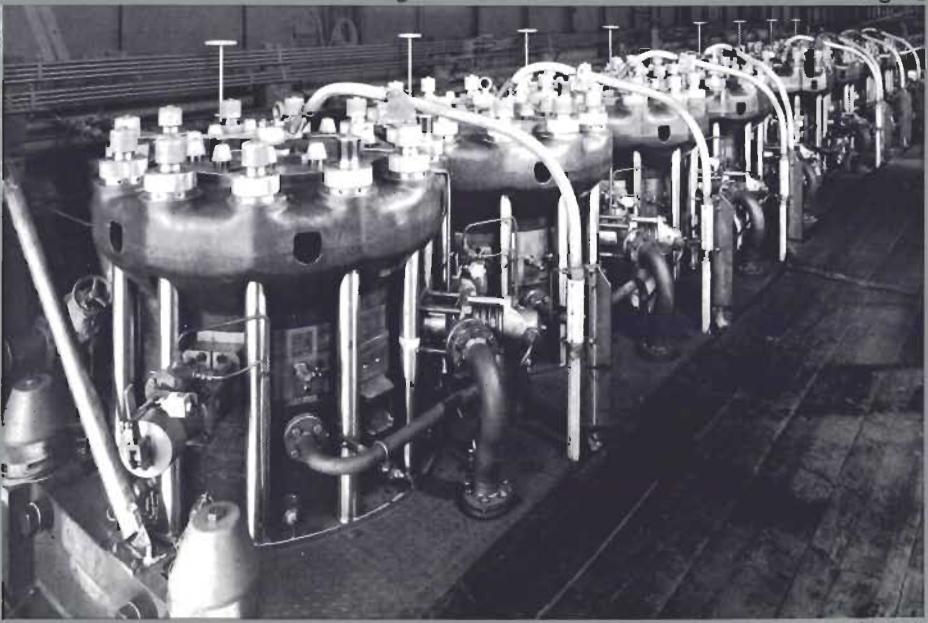


Fig. 17

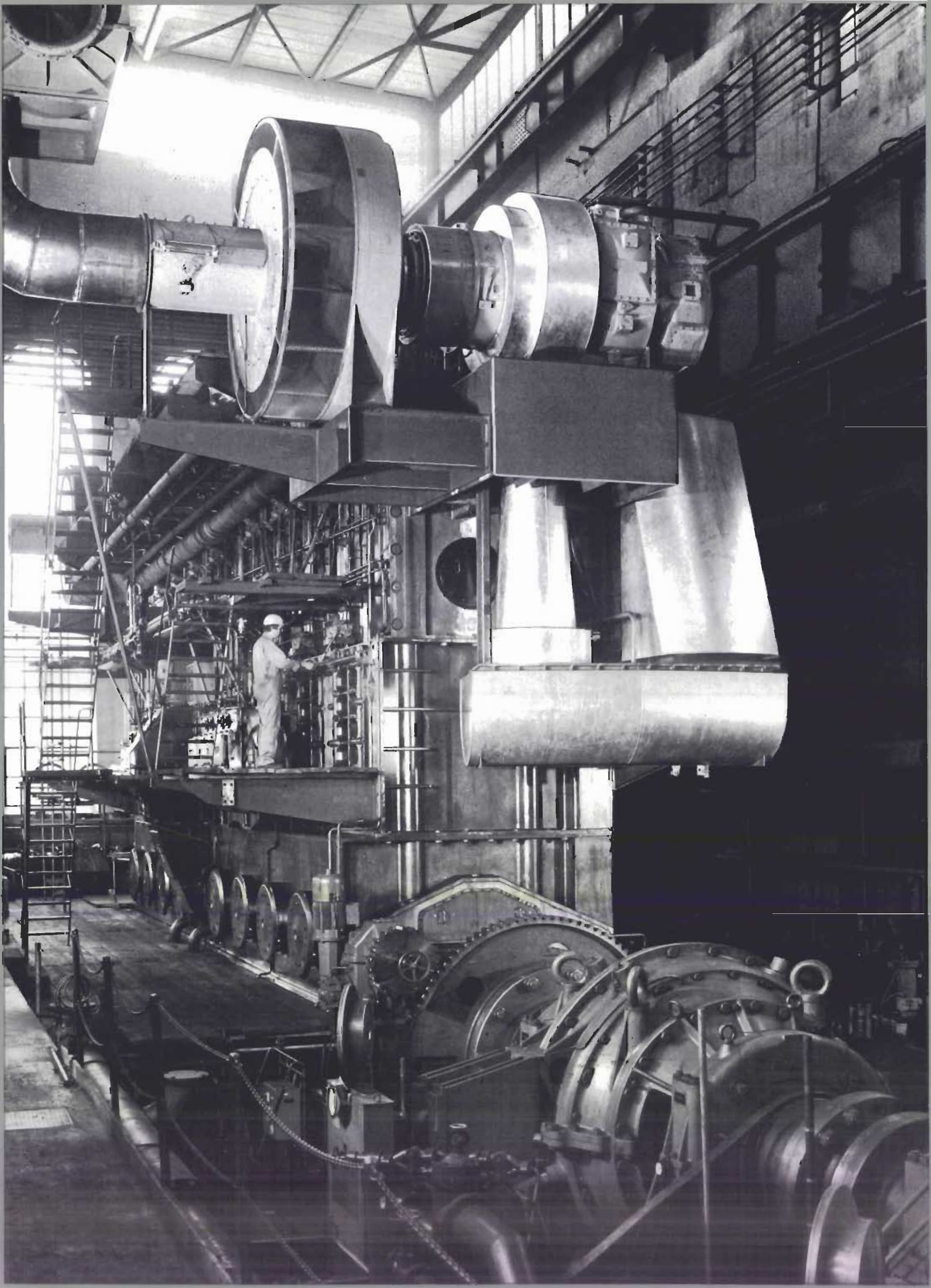
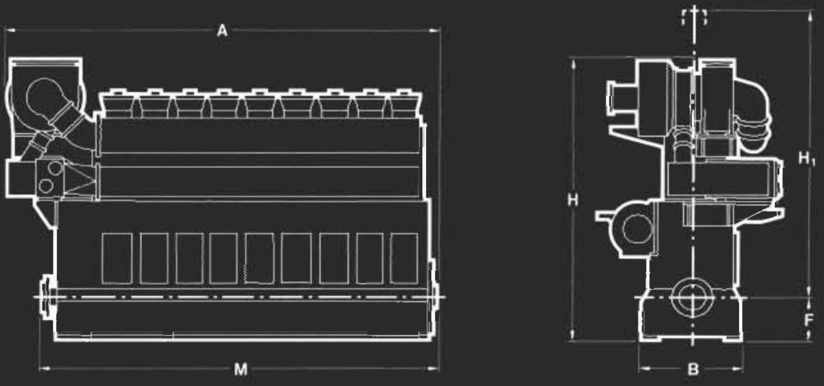


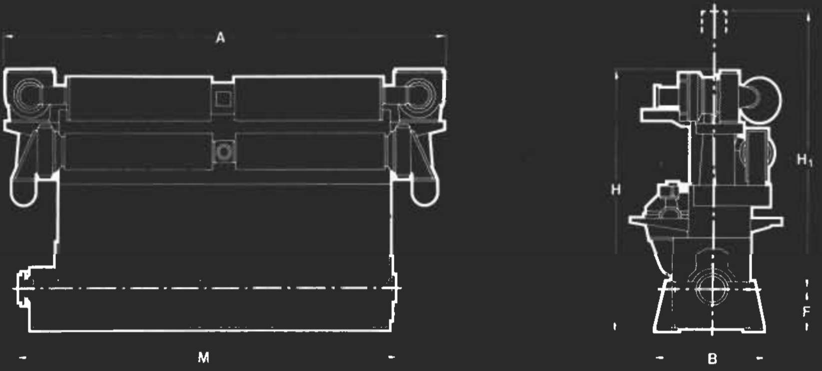
Fig. 18

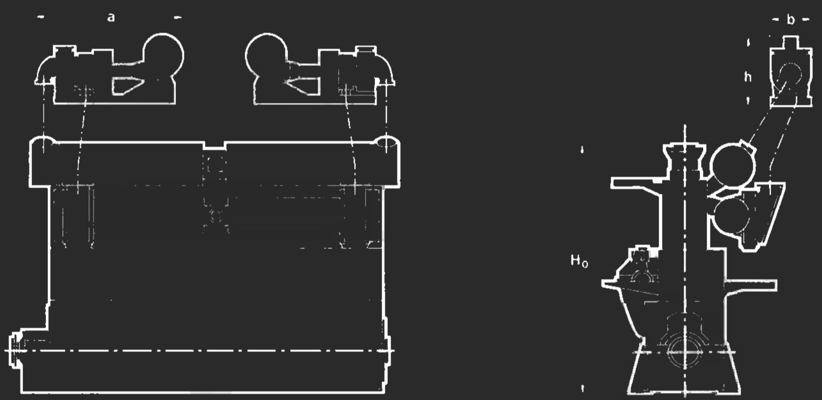
Two-stroke Diesel Engines KSZ 52/105 B/BL KSZ 70/125 B/BL KSZ 78/155 B/BL KSZ 90/160 B/BL

KSZ 52/105 B/BL
K5SZ 70/125 B/BL



KSZ 70/125 B/BL
KSZ 78/155 B/BL
KSZ 90/160 B/BL





Turbocharger, placed away from the engine.

Dimensions
Weights

Engine	No. of cyls.	A mm	M** mm	B mm	F mm	H mm	H_0 mm	H_1 mm	a mm	b mm	h mm	Weight t
K5SZ 52/105 B/BL	5*	7600	6660	2480	1070	7300	6600	8000	5950	3150	2400	160
K6SZ 52/105 B/BL	6*	8700	7640	2480	1070	7600	6600	8000	6350	3150	2550	185
K7SZ 52/105 B/BL	7*	9600	8620	2480	1070	7600	6600	8000	6400	3350	2550	210
K8SZ 52/105 B/BL	8*	10800	9600	2480	1070	7900	6600	8000	7050	3700	2850	235
K9SZ 52/105 B/BL	9*	11800	10580	2480	1070	7900	6600	8000	7850	3800	3050	260

* Camshaft drive at coupling end; thrust bearing integrated in camshaft drive. ** Crankshaft length.

Engine	No. of cyls.	A mm	M** mm	B mm	F mm	H mm	H_0 mm	H_1 mm	a mm	b mm	h mm	Weight t
K 5SZ 70/125 B/BL	5*	9300	8406	3240	1250	8200	7900	9600	7850	3800	3050	300
K 6SZ 70/125 B/BL	6*	12100	9706	3240	1250	8000	7900	9600	5050	1950	2500	345
K 7SZ 70/125 B/BL	7	14100	11758	3240	1250	8000	7900	9600	5050	2100	2500	400
K 8SZ 70/125 B/BL	8	15400	13058	3240	1250	8000	7900	9600	5050	2100	2500	450
K 9SZ 70/125 B/BL	9	17200	14358	3240	1250	8200	7900	9600	6400	2050	3000	495
K10SZ 70/125 B/BL	10	18500	15658	3240	1250	8200	7900	9600	6400	2200	3000	540

* Camshaft drive at coupling end; thrust bearing integrated in camshaft drive. ** Crankshaft length.

Engine	No. of cyls.	A mm	M** mm	B mm	F mm	H mm	H_0 mm	H_1 mm	a mm	b mm	h mm	Weight t
K6SZ 78/155 B/BL	6*	13200	10745	3900	1550	9600	9600	11700	5050	2100	2500	500
K7SZ 78/155 B/BL	7	15800	13225	3900	1550	9800	9600	11700	6400	2050	3000	595
K8SZ 78/155 B/BL	8	17300	14675	3900	1550	9800	9600	11700	6400	2200	3000	665
K9SZ 78/155 B/BL	9	18700	16125	3900	1550	9800	9600	11700	6400	2200	3000	735

* Camshaft drive at coupling end; thrust bearing integrated in camshaft drive. ** Crankshaft length.

Engine	No. of cyls.	A mm	M** mm	B mm	F mm	H mm	H_0 mm	H_1 mm	a mm	b mm	h mm	Weight t
K 6SZ 90/160 B/BL	6*	14100	12023	4460	1600	10500	10100	12300	6400	2200	3000	615
K 7SZ 90/160 B/BL	7	16700	14493	4460	1600	10500	10100	12300	6400	2200	3000	730
K 8SZ 90/160 B/BL	8	19800	16093	4460	1600	10900	10100	12300	7650	2400	3500	820
K 9SZ 90/160 B/BL	9	21400	17693	4460	1600	10900	10100	12300	7650	2400	3500	895
K10SZ 90/160 B/BL	10	23000	19293	4460	1600	10900	10100	12300	7650	2800	3500	980
K12SZ 90/160 B/BL	12	26700	22493	4460	1600	10800	10100	12300	8400	2800	4050	1150

* Camshaft drive at coupling end; thrust bearing integrated in camshaft drive. ** Crankshaft length.

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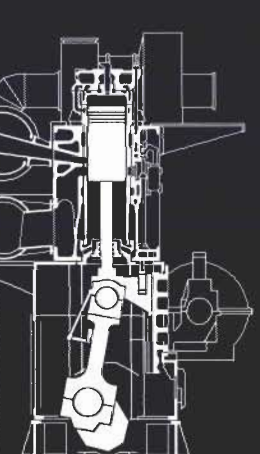
KSZ-BL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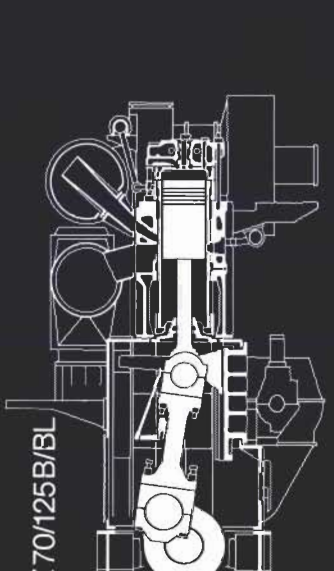
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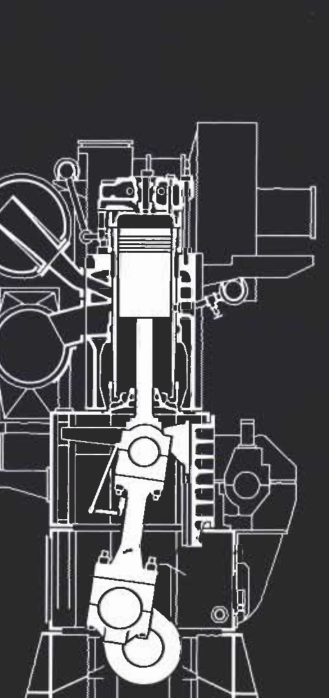
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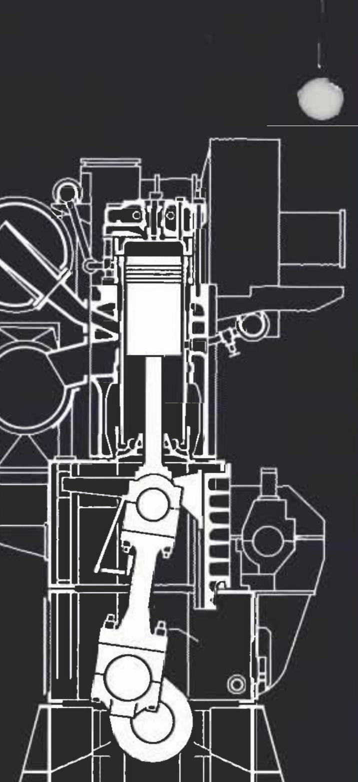
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