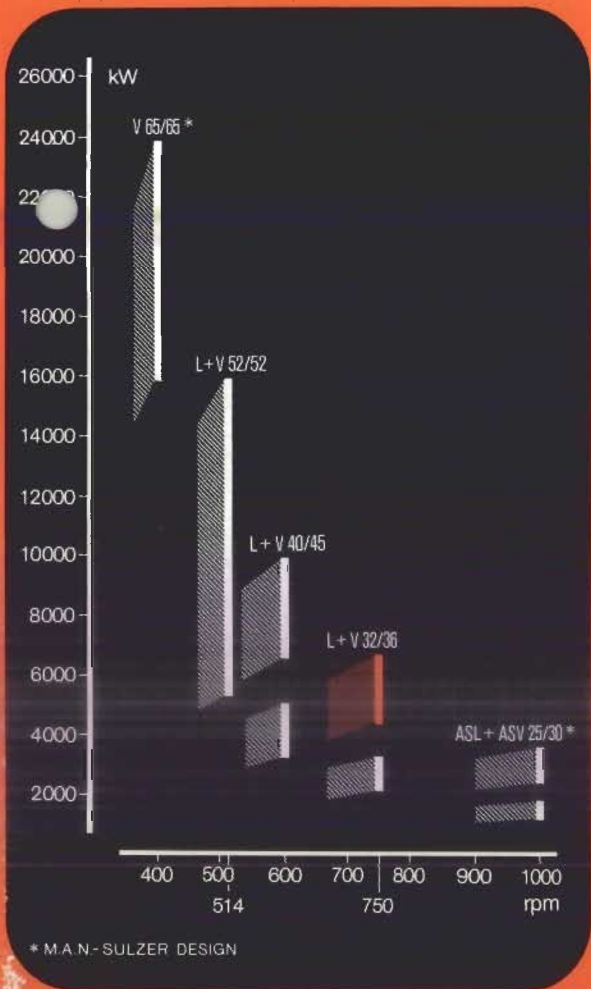
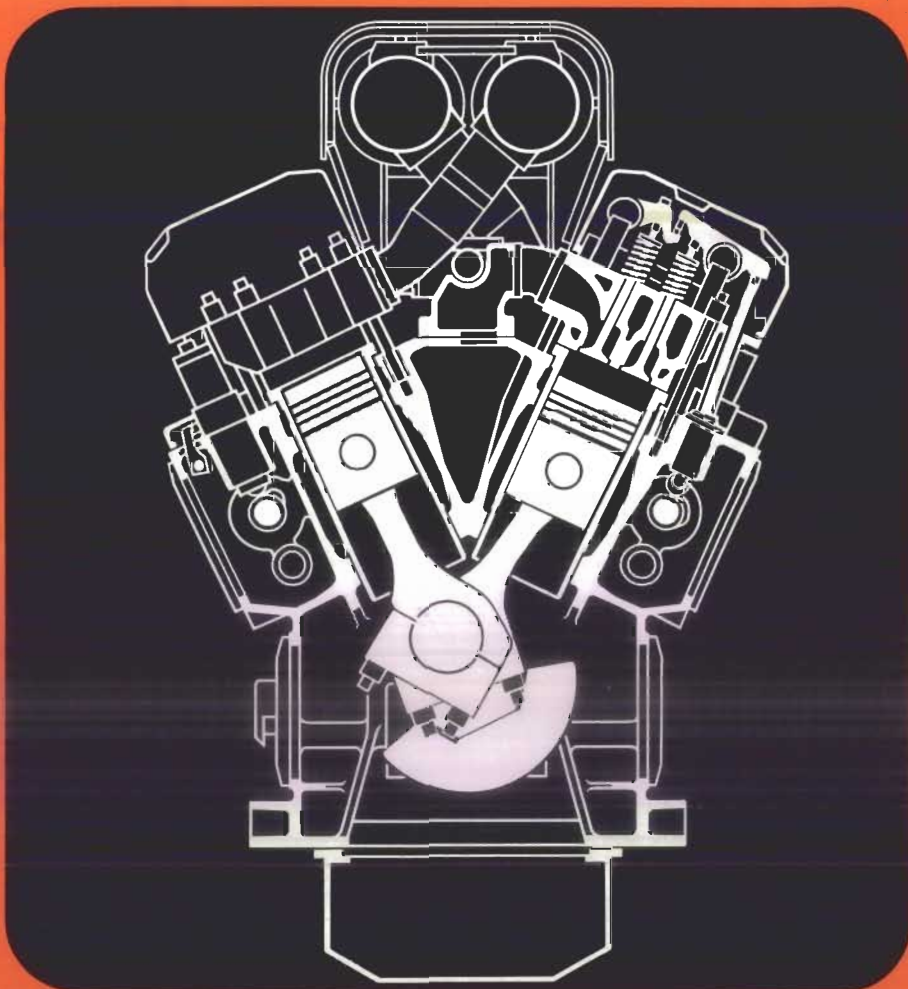
Brief Specification
Status: November 1977

M·A·N

Four-stroke Diesel engine L-V 32/36
370 kW/cyl., 750 rpm

V32/36





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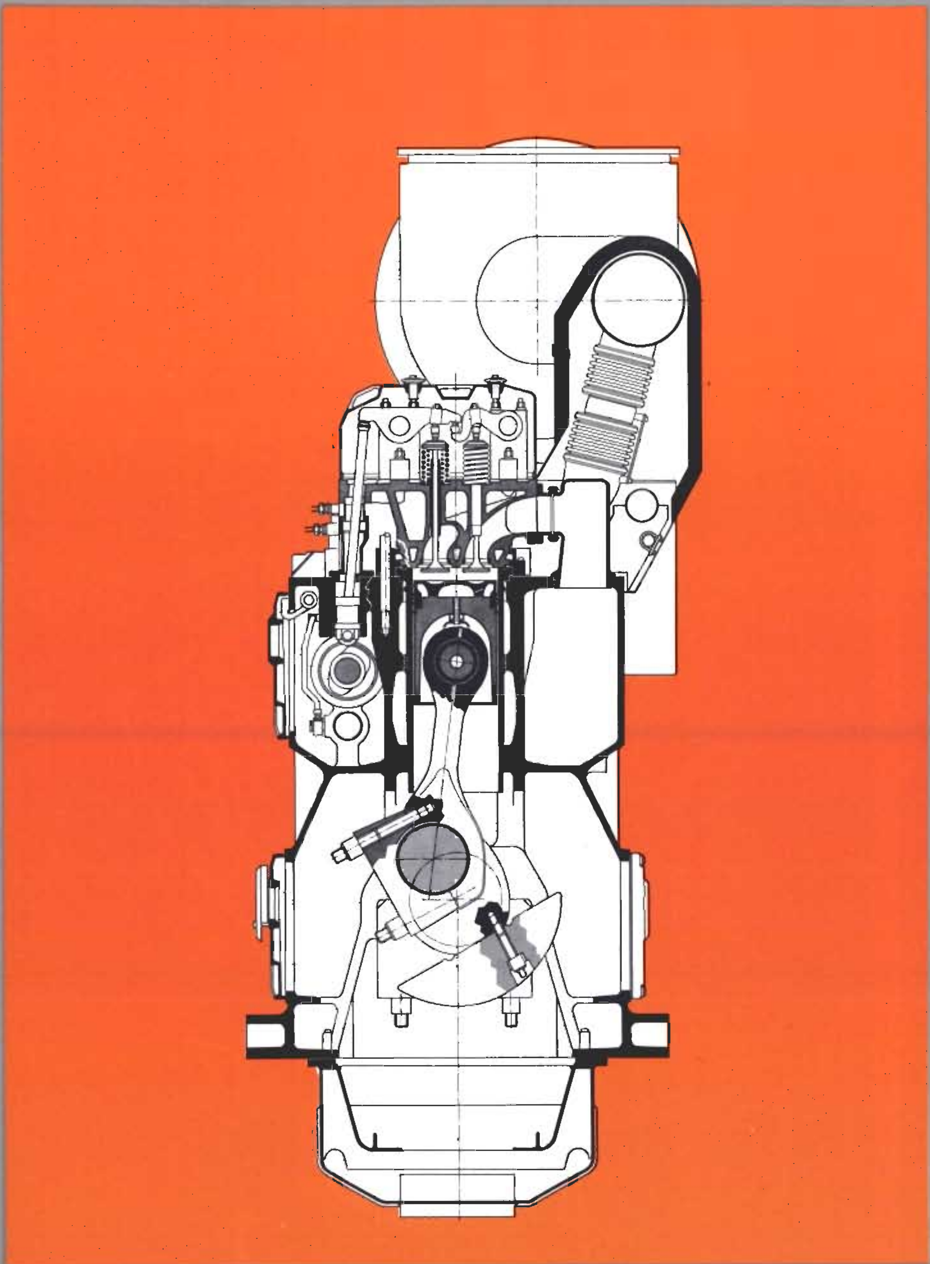


Ratings

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)

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)

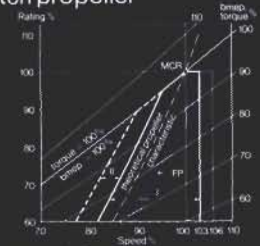
VP = design range for controllable-pitch propeller with combinator (Fig. 2)

Reference conditions:

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

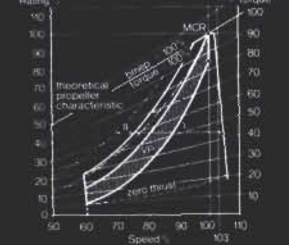
Marine propulsion engine with fixed-pitch propeller

Fig. 1



Marine propulsion engine with controllable-pitch propeller

Fig. 2



Technical Data

Working cycle:	4-stroke
Combustion process:	direct injection
Number of cylinders:	6,8,9,12,14,16,18
Cylinder bore:	320 mm
Piston stroke:	360 mm
Swept volume per cylinder:	28.95 dm^3
Cylinder output:	370 kW 500 hp
Power/weight ratio:	
L-Engine:	12.2-12.6 kg/kW 9.0- 9.3 kg/hp
V-Motor:	9.7- 9.6 kg/kW 7.1- 7.3 kg/hp
Coolant:	Water
Starting:	by compr. air
Specific fuel consumption at full load:	
L-Engine:	210 g/kWh 155 g/hp-h
V-Engine:	209 g/kWh 154 g/hp-h

(Tolerance 3%)

Performance Data:

Speed	rpm	750
Mean piston speed	m/s	9.0
Mean effective pressure	bar	20.3

		kW	hp
6L 32/36	6 cyl.	2220	3000
8L 32/36	8 cyl.	2960	4000
9L 32/36	9 cyl.	3330	4500
12V 32/36	12 cyl.	4440	6000
14V 32/36	14 cyl.	5180	7000
16V 32/36	16 cyl.	5920	8000
18V 32/36	18 cyl.	6660	9000

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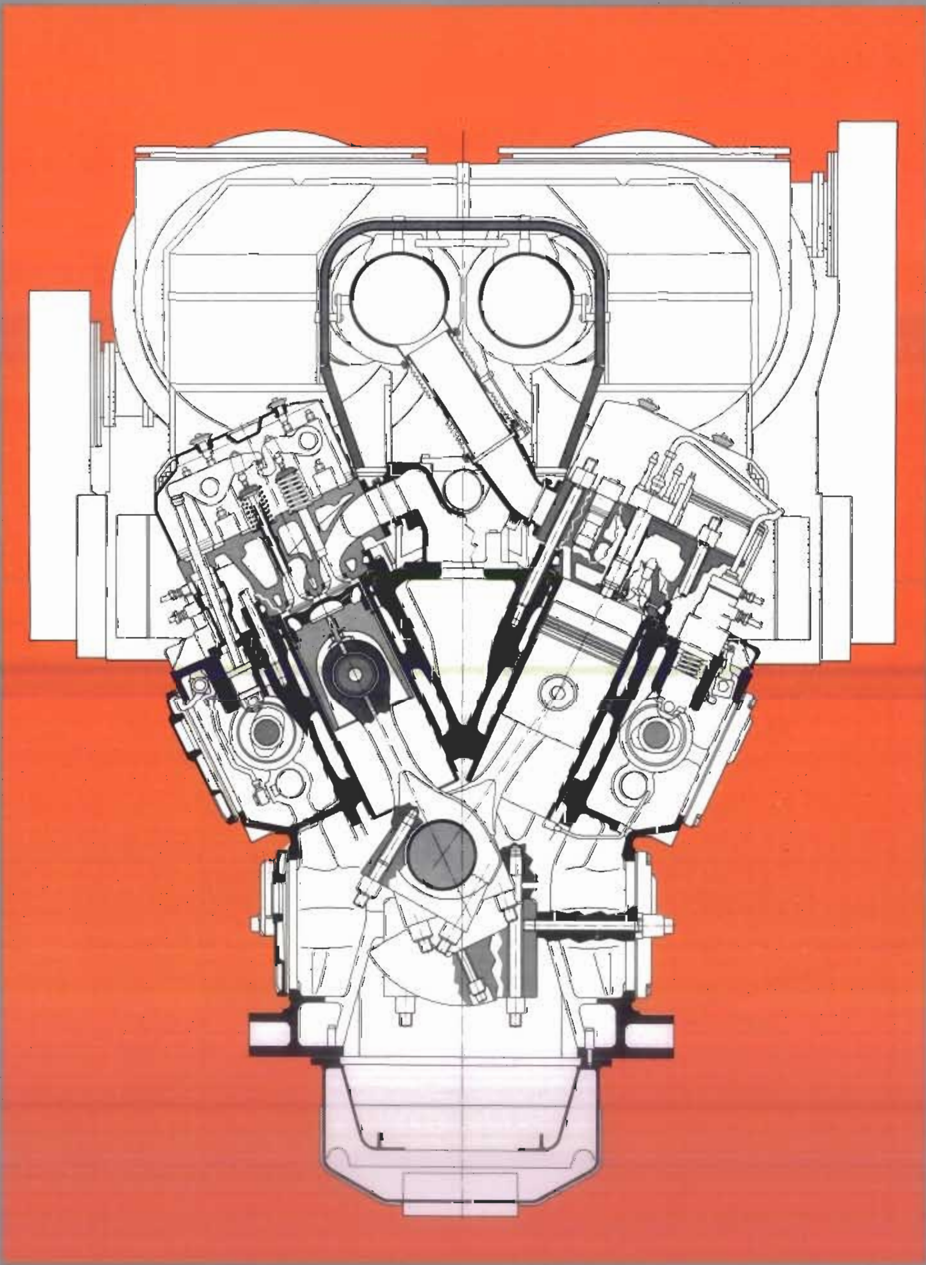
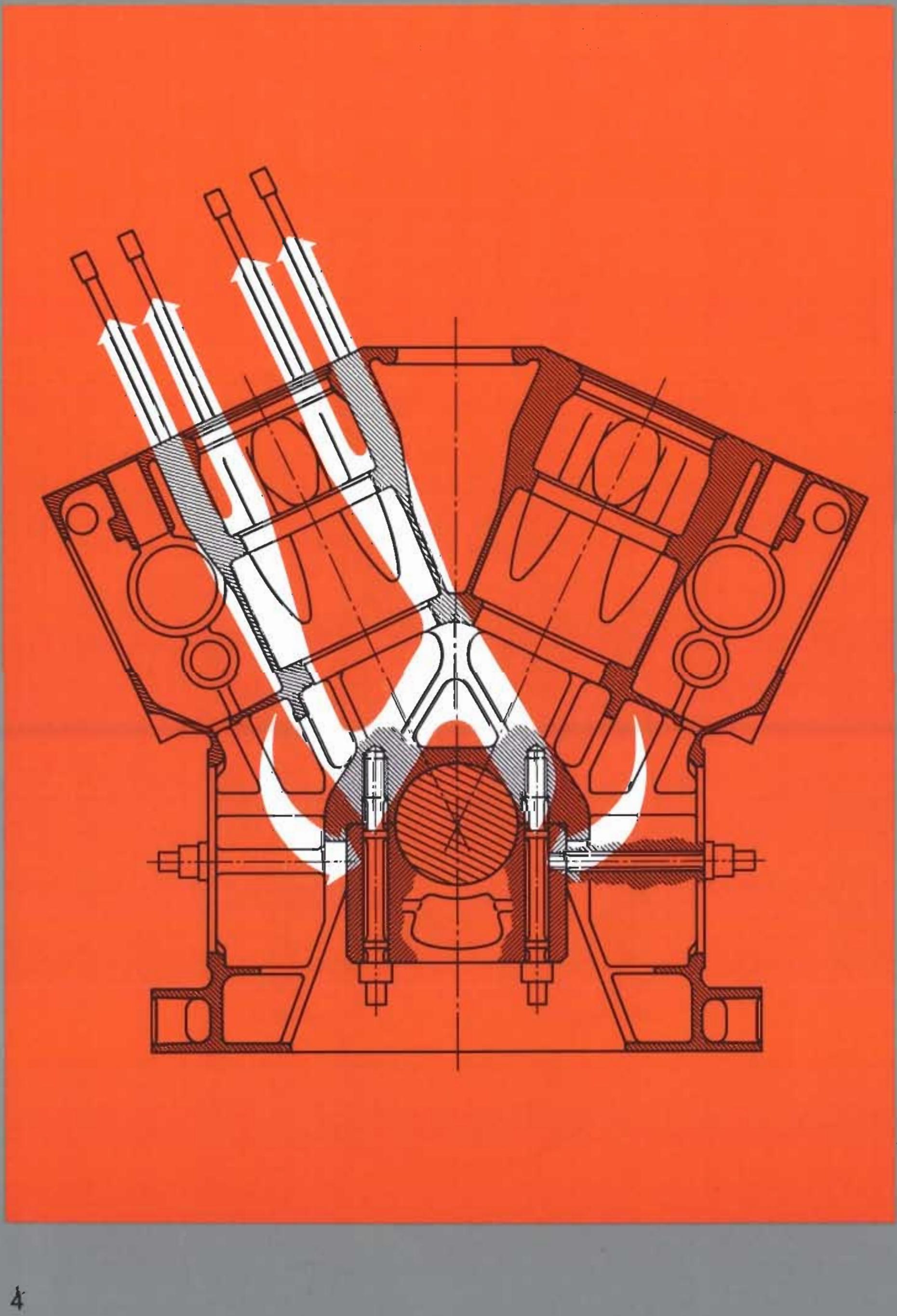


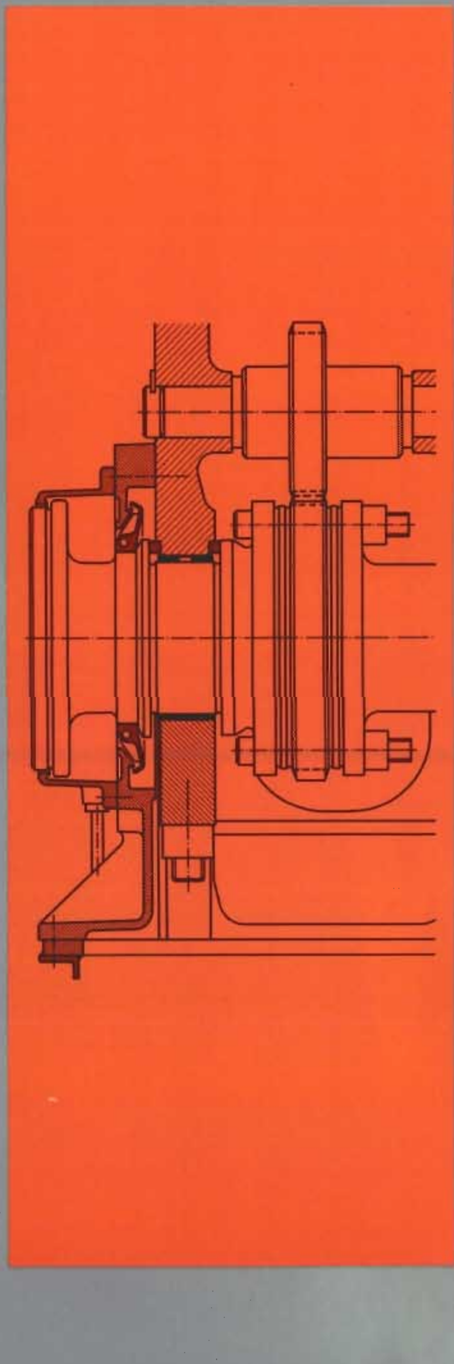
The aim underlying development of the 32/36 series was to obtain a sturdy, simple engine covering the power range from 2 000 to 7 000 kW, a range of equal importance to both marine propulsion systems and power stations. The V 32/36 has been designed with both these applications in mind and meets the same stringent requirements as the larger Diesels in M.A.N.'s four-stroke programme: the capacity to burn low-grade heavy fuel oil, an exhaust temperature before the turbine of not more than 550 °C and a piston speed not exceeding 9 m/s. Although mean effective pressure is well up to present-day standards, wear rates for piston rings, ring grooves and cylinder liners come up to operators' expectations. Thanks to advanced combustion and turbocharging systems, fuel consumption is low and the engine economical to run. Special attention has also been given to the engine's external fittings, e.g. pipes and accessories directly fitted, as simplification of these, too, enhances operational reliability.

In performance data and design, the V 32/36 is a conventional engine, but it is the wealth of details which have been improved that distinguish this engine in terms of practical operation.

Engine frame

The engine frame, rising from the mounting girders located well below the crankshaft centre line right up to the top surface of the cylinder blocks and extending over the entire length, is a monobloc casting. This one-piece frame incorporates spaces and passages to house timing gear, camshafts with bearings, injection pumps and inlet and exhaust valve tappets.
The force generated by firing flows in a straight line from the level of the cylinder head bolts down to the main bearings. The cross-sections of the frame in way of the flow of force are spaced in such a way as to minimize material stress and structural deformation. The bearing caps for the underslung crankshaft are cross-bolted, producing a ring-shaped enclosure around the bearings. This





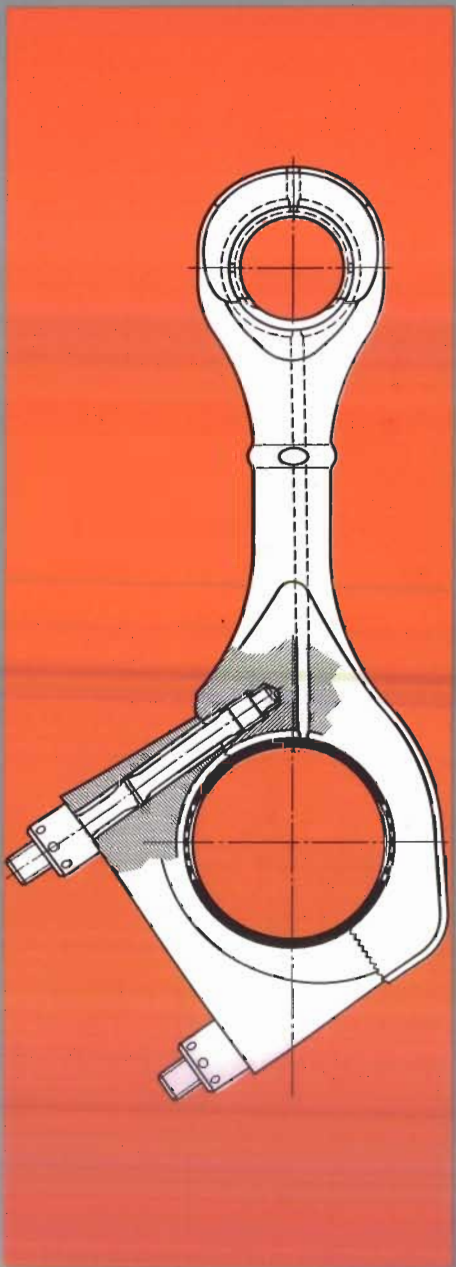
gives rise to a tunnel-shaped flow of force. The fillet between the horizontal seating surface of the bearing cap and the vertical fitting surfaces, generally considered critical, is subjected to initial compressive stressing so that the dynamic stress amplitudes, which are relatively small anyway, can be controlled even more easily by the rigid frame structure.
The frame features box-shaped cross-sections running the entire length of the engine, which enclose the camshaft and cooling water spaces around the cylinder liners and are the seat of the engine on the foundation. This lends the engine extreme longitudinal rigidity, making extra reinforcement by the foundation unnecessary. It means that the engine does not need any special form of foundation and will fit engine room and power house with equal facility.

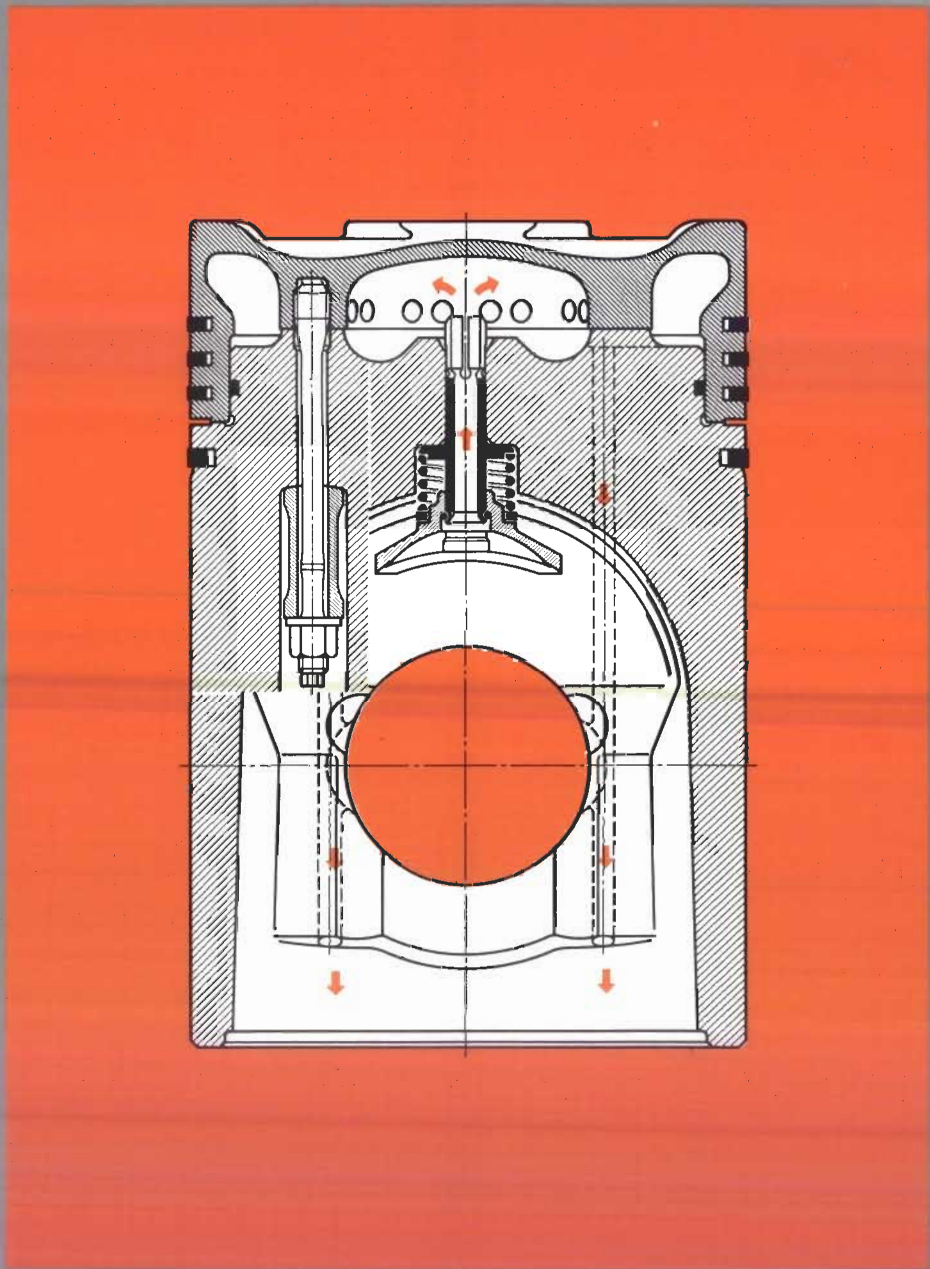
As turbochargers and charge air coolers increase in volume and weight as specific outputs rise, seating surfaces cast integral with the frame enhance the efficiency and stability of these components.
There is an outboard bearing at the coupling end permitting high radial forces at the coupling flange of the crankshaft. This is a definite advantage if single-bearing generators are used or if heavy couplings or flywheels are required in specific systems as there is no need to fit an extra outboard bearing.

Connecting rods

The connecting rods, which are angled-split at the big end with a ground serration pattern backed by years of experience, are particularly resistant to deformation. The small-end bore has an offset bearing so that a large contact area is available in both the piston and the piston-pin bearing to take the gas forces applied. As inertia forces are small, the surfaces exposed to them can be made small in turn. The big-end bearing is enclosed by a forged cap with two hydraulically tightened bolts. The bolt ends are hollow-drilled to reduce tension peaks in the connecting rod.

In view of the connecting rod's small size and light weight, no further division of the shaft is necessary. To pull a piston, only the two bolts on the bearing cap are loosened. The





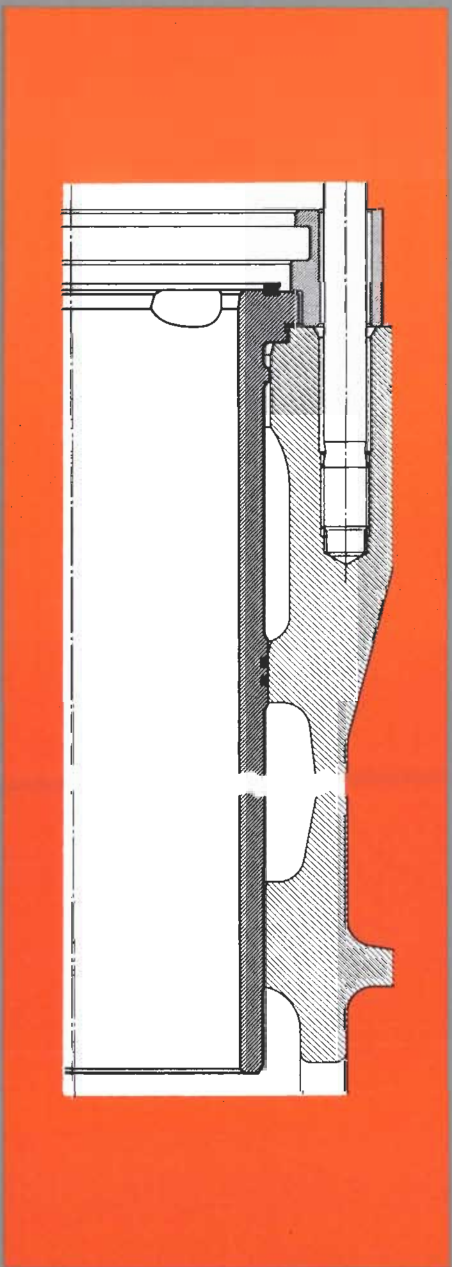
generous dimensioning and simple bolted connections of the bearing provide the necessary safety margins.

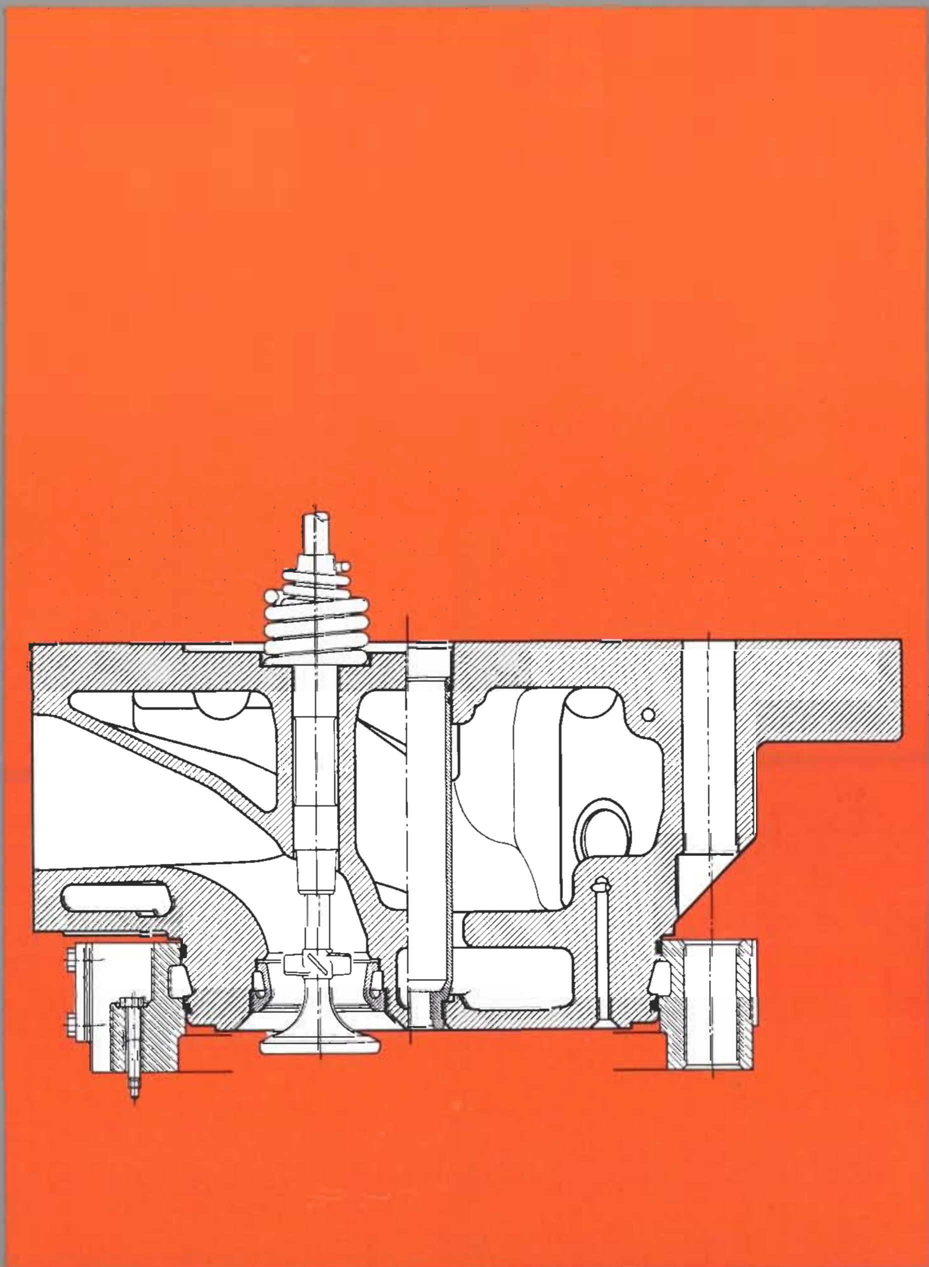
Pistons

The composite piston used for medium-speed engines of this size burning heavy fuel oil is a standard M.A.N. component. It consists of a forged aluminium skirt bolted to a forged steel crown, a design backed by a wealth of experience. As of November 1977, 779 engines totalling 9543 cylinders with pistons of this design were in service or on order.
A major feature of the engine is that it can burn heavy fuel oil, provided the fuel quality complies with M.A.N. specifications. This is obtained by means of hardened piston ring grooves in the wear-resistant forged steel crown. The first compression ring has a particularly wear-resistant running layer applied using a plasma spray technique. The piston skin has a double oval shape and hence adapts itself well to the cylinder liner surface during the reciprocating movement.

Cylinder liners

Years of experience gained in operating medium-speed engines burning heavy fuel oil have shown that wear on piston rings, cylinder liners and ring grooves, lubricating oil consumption and, of course, true running of the piston in the liner largely depend on the liner's resistance to deformation. Here, the thickness of the liner wall, shape of the collar section, type of cooling and deformation of the frame where the liner adjoins it are of prime importance. The liner itself, whose wall thickness equals 8% of its diameter, is of extremely sturdy construction. Deformation is kept to an absolute minimum thanks to the short supporting length between the thick-walled top sections of the frame and the liner and to intensive cooling of the collar only. The liner is radially supported in the top section of the frame, keeping deformations by temperature small and equal over the whole circumference.





Cylinder head

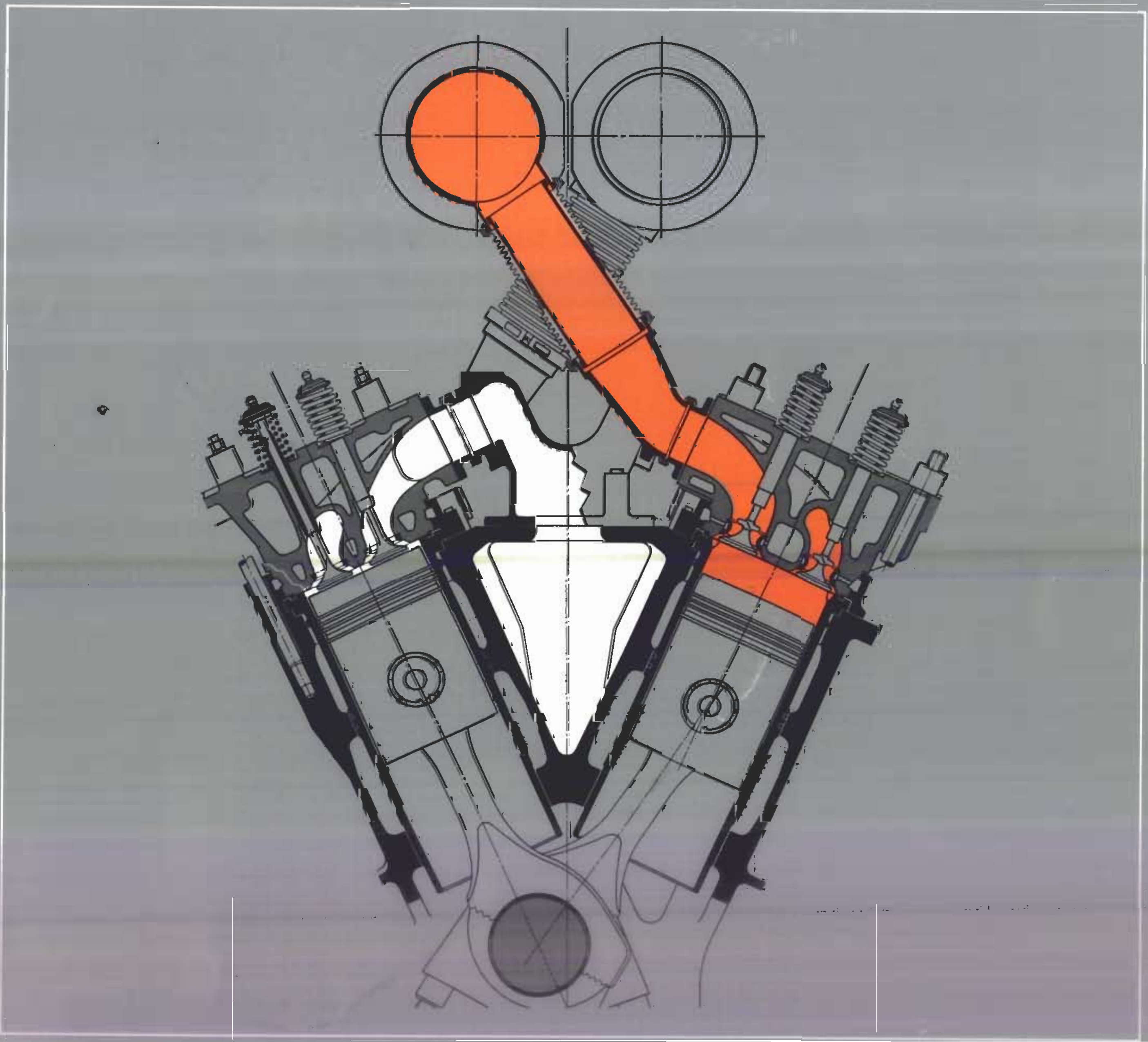
The cylinder head is handy in terms of both weight and size. With the aid of hydraulic tools, it can quickly be dismantled with the valves still in place and without removing the rocker arms. Valve cages have therefore been dispensed with and special importance attached to good air and exhaust flow paths. The exhaust valve seats are intensively cooled via the water-cooled seat rings.

The seat rings for the inlet and exhaust valves are of wear-resistant material. But the special experience applied involves matching the right materials for valve seat ring and hard facing.

Thanks to the sturdy deck plate of the cylinder head, to which the gas forces are directly transmitted vertically, the flame plate can be made particularly thin. This plus the very intensive flow of cooling water to the centre of combustion yields such low stress values that material strain is only slight. Cast iron is used despite the high stresses applied.
Six bolts on each cylinder head with hydraulically tightened nuts symmetrically hold the cylinder head to the collar and frame so that the liner remains perfectly round during operation.
Just as in the larger four-stroke engines, the exhaust valves are rotated by vanes fitted to the stem and driven by the gases expelled from the cylinder. The main advantage of this rotator is that the valve still has sufficient momentum to turn as the head comes to touch the seat, thus scraping off the thin deposits formed, particularly in heavy fuel oil operation.

Turbocharging system

The advantages of applying constant-pressure turbocharging to an engine developing 370 kW per cylinder (500 hp/cyl.) have already been fully realized, and this same system is used in the V 32/36 as in other M.A.N. medium-speed Diesels. The charge-air pipe is housed in the Vee (of the Vee engine) between the two cylinder banks to reduce sound radiation and enhance accessibility to the sides of the engine. Air is fed to the cylinder heads by pipes fastened by V-shaped band clips. For each cylinder bank an exhaust manifold without expansion joints is arranged above the charge-air pipe. With the resultant expansion, the turbocharger is the fixed point against which it abuts. Bellows on the pipe connecting cylinder head to manifold ensure a certain freedom of movement and prevent gas leakage.



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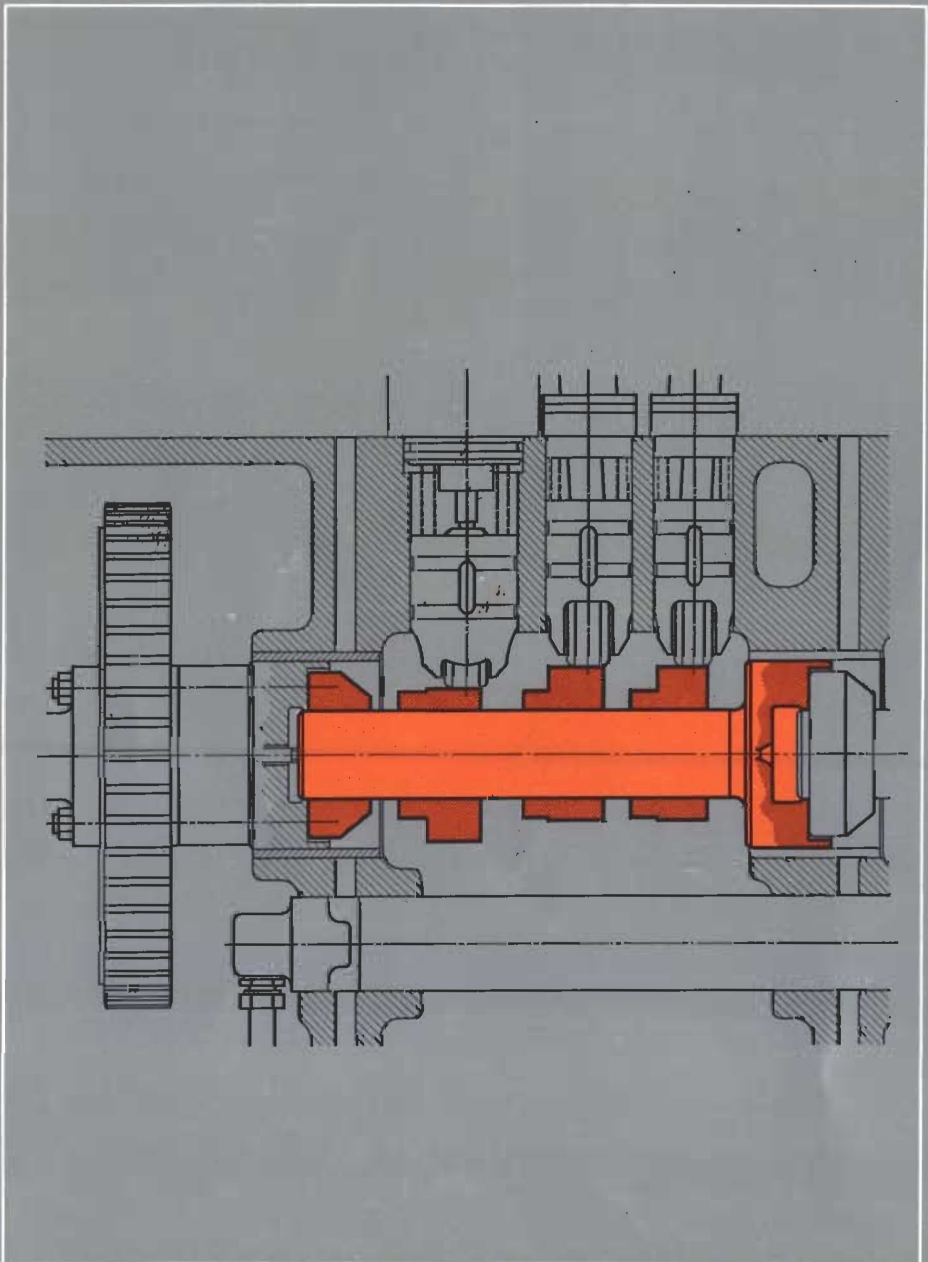
All pipe connections in the exhaust system are fitted with quick-acting locks and can be readily dismantled. Deformations caused by temperature changes are defined in their magnitude and direction, and the layout of the pipes and flanges guarantees maximum operational reliability of the exhaust system. In the case of the in-line engine the charge air manifold is also an integral part of the engine casing. Above the charge air pipe, the exhaust pipe leading to the turbocharger at the end of the engine is connected. Straightforward piping and low susceptibility to failure are the essential requirements for effective sound and thermal insulation of the exhaust system, demands which are steadily gaining in importance. The turbocharger(s) can be arranged either on the coupling side or at the "free" end as desired.

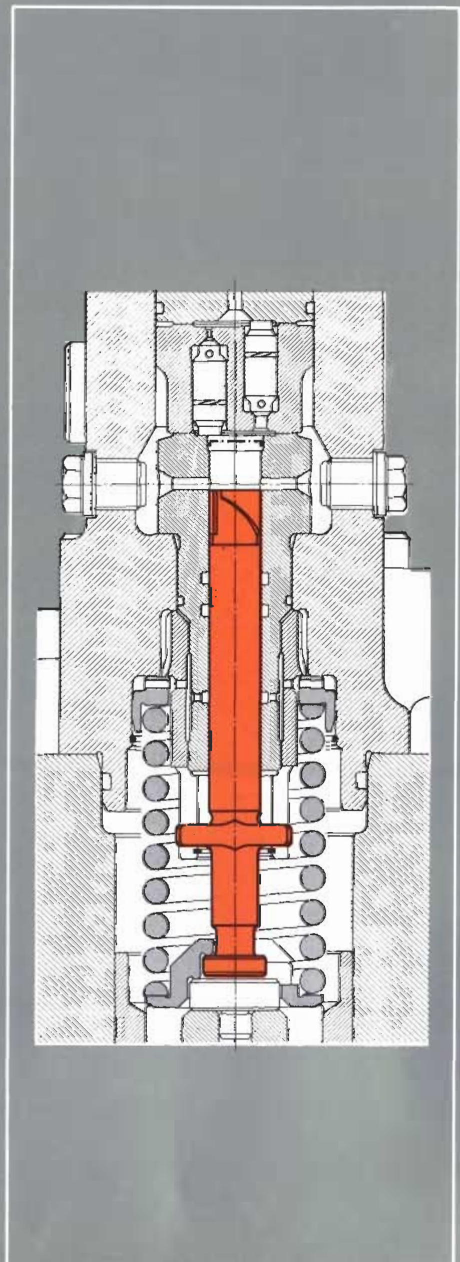
Camshafts

Each camshaft is made up of several sections equal in length to the distance between two cylinders. The camshafts are mounted in passages in the frame running the entire length of the engine. Each section of the camshaft can easily be removed and changed. The special cam geometry affords smooth valve drive.

Injection system

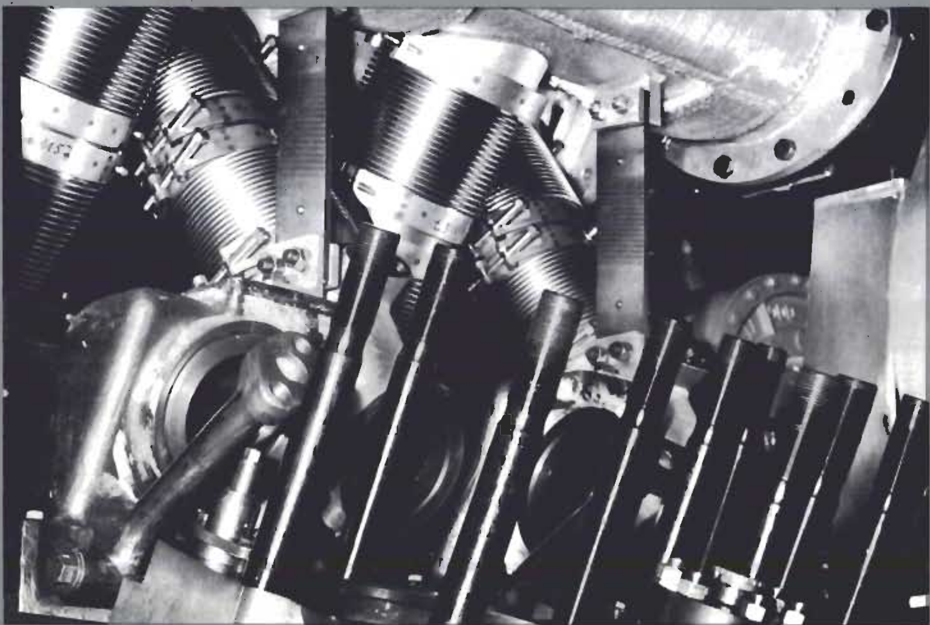
The engine is fitted with individual pumps designed for high pressures. Each plunger is fitted with not one, but two control edges of differing pitch, so that fuel is released in stages at the end of delivery and peak pres-

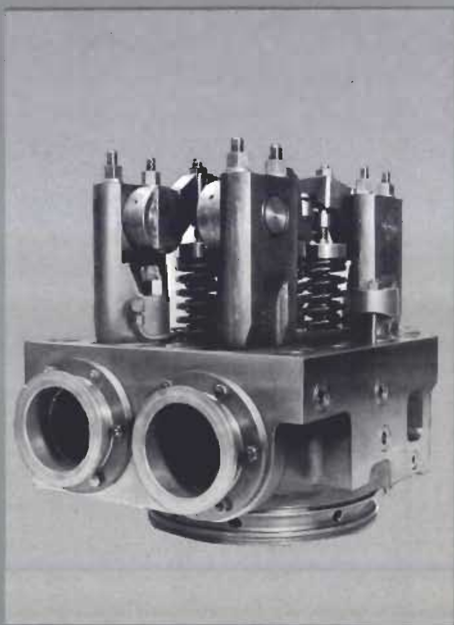


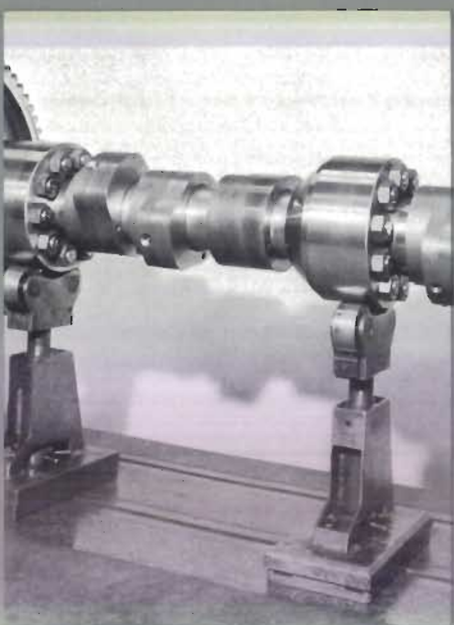


sures in the spill pipe are reduced. Flow corrosion and erosion of pump barrels and casings are thus prevented. The pump barrel contains three annular grooves.
The top groove reduces the pressure between plunger and barrel to that of the suction space. The bottom groove conducts lubricating oil. The middle groove permits the mixture of fuel and lubricating oil formed to be removed without pressure, thus preventing contamination of the lubricating oil by the fuel. Pump action is smooth because the plunger is amply lubricated and fuel control components are not fouled by fuel.
The needle valve is located outside the two valve covers for easy removal, so that there can be no mixing of fuel, water and lubricating oil. The fuel delivery pipe is particularly easy to detach.

L and V engines have been deliberately designed so as to make their components identical as far as possible and reasonable. This applies to all cylinder parts, such as cylinder head, piston, liner, connecting rod, injection parts, exhaust gas pipe compensators, camshaft drive gear-wheels and even camshaft sections, which are connected to one another in such a way as to enable them to be used for both L and V engines. The crankcases have been designed to the same principle. The crankcase of the L engines is shorter, since there is only one connecting rod per crankpin. The advantages of this design are reduced spare parts stock-keeping and interchangeability of service experience between the two types.







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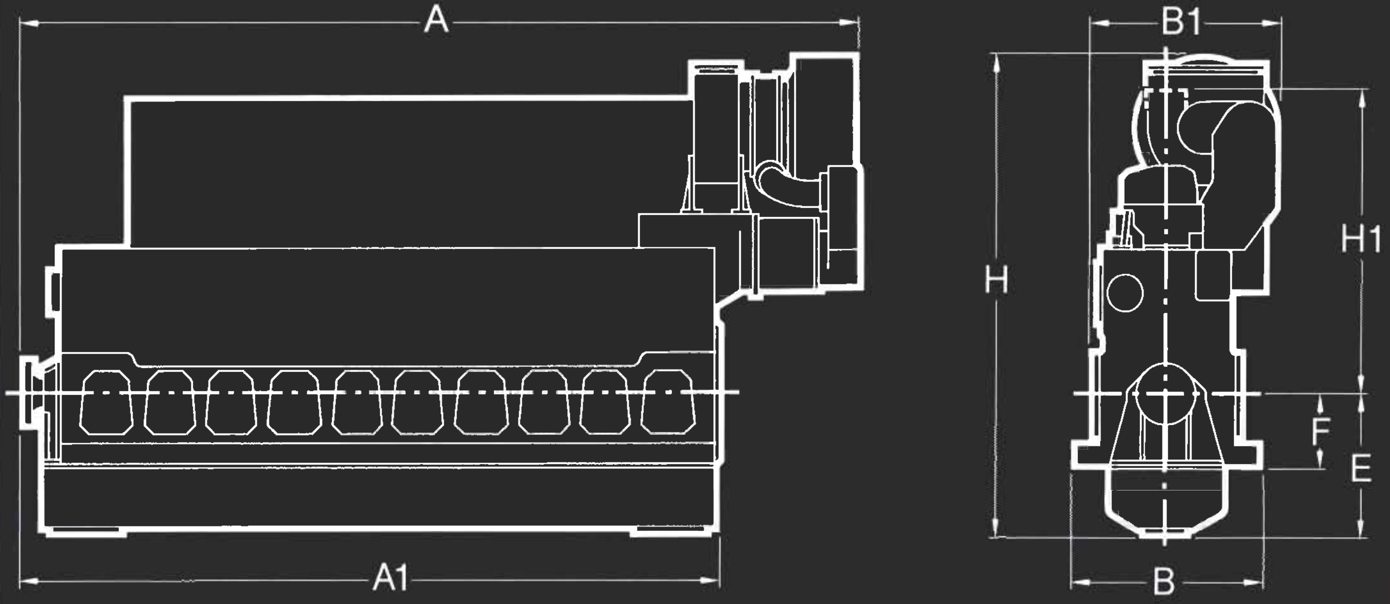

Engine	No. of cyls.	A mm	A_1 mm	B mm	B_1 mm	H mm	E mm	F mm	H_1 mm	Wt t
6L 32/36	6	5600	4800	1600	2250	3550	850	600	2600	27
8L 32/36	8	6900	5880	1600	2350	3650	850	600	2600	37
9L 32/36	9	7400	6420	1600	2350	3650	850	600	2600	42

H_1 = Height required for removing cylinder liner and piston

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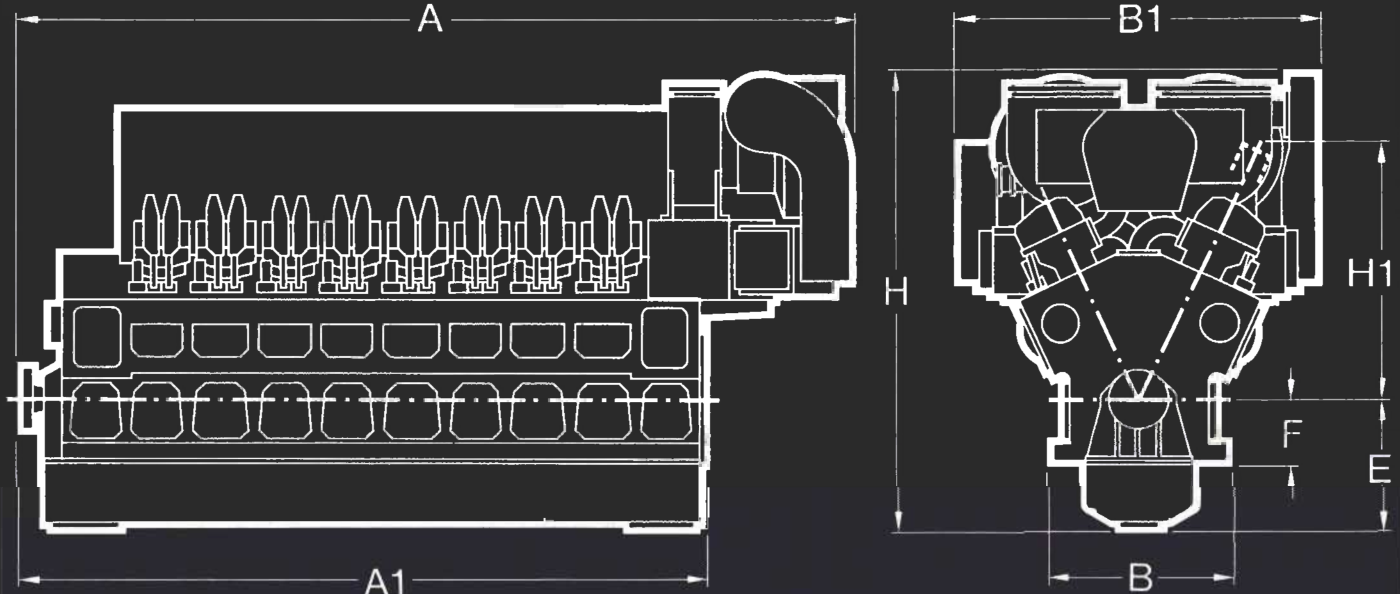


Engine	No. of cyls.	A mm	A_1 mm	B mm	B_1 mm	H mm	E mm	F mm	H_1 mm	Wt t
12V 32/36	12	6350	4980	1600	3300	3650	850	600	2300	44
14V 32/36	14	6900	5550	1600	3300	3750	850	600	2300	50
16V 32/36	16	7500	6120	1600	3300	3750	850	600	2300	58
18V 32/36	18	8050	6690	1600	3300	3750	850	600	2300	65

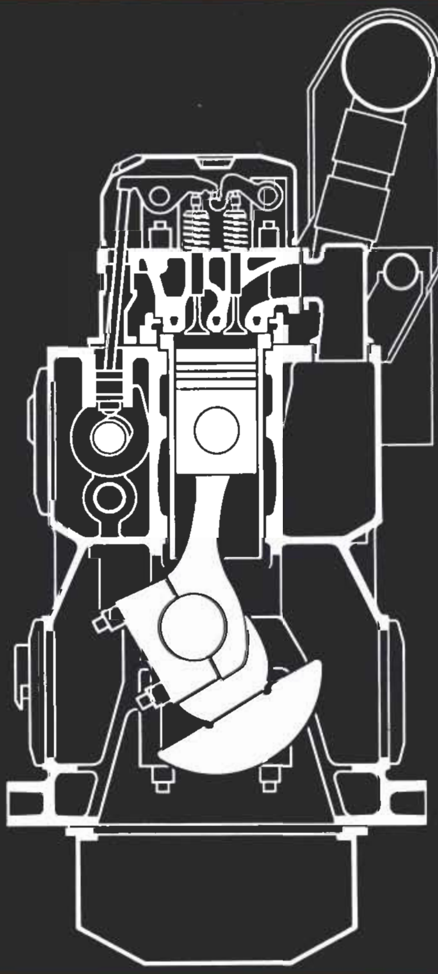
H_1 = Height required for removing cylinder liner and piston

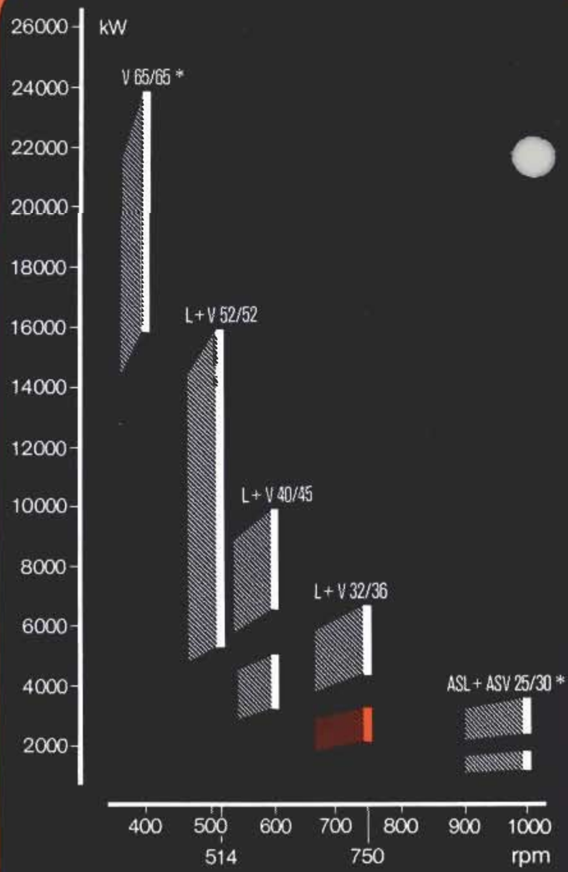
M·A·N
DIESEL ENGINES

Stadtbachstrasse 1
D 8900 Augsburg
Telephone (0821) 3221
Telex 05-3751

D 2365211 E Printed in W. Germany st. 11776

L32/36





* M.A.N-SULZER DESIGN