A Brief Description and Characteristics of the Diesels

Abroad Ocean Going Vessels of the USSR

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CHAPTER IX

A BRIEF DESCRIPTION AND CHARACTERISTICS OF THE DIESELS ABOARD OCEAN GOING VESSELS OF THE USSR

SLOW SPEED TWO CYCLE HEAVY DUTY, SINGLE ACTION DIESELS

The RD-2400 Compressor Engine of the Russkiy Dizel' Plant

This is a six cylinder, reversing, crosshead type of engine. A longitudinal section of this Diesel appears in Figure 191, [Figures numbered below 191 and referred to in the text below are in previous chapters and not part of the present translation.] while a cross section along the working cylinder is shown in Figure 192.

The engine casing is of the open type and is composed of 12 individual cast iron and bored columns the inside of which connects with the scavenging air receiver.

The scavenging air receiver runs all the way around the engine and is composed of separate sections of square contour, of cast iron, and for greater facility of adjustment these are separated by V-shaped gaskets of cast iron which are located between the coupling flanges of the columns (in the upper part) and the flanges of the individual sections. By binding together all the columns, the receiver enhances the longitudinal resistance of the engine. Between the second and third, and also between the fourth and fifth cylinder, both branches of the receiver are joined by means of connecting pipes. Mounted at both ends of the engine, on the receiver, are the two safety valves. The receiver section b x h = 24 x 43 centimeters.

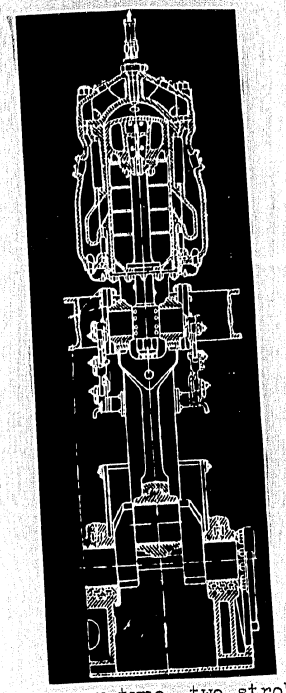

Figure 191 The compressor type, two stroke, single acting engine, produced by the "Russkiy disel" plant, RD-2400 (longitudinal section).

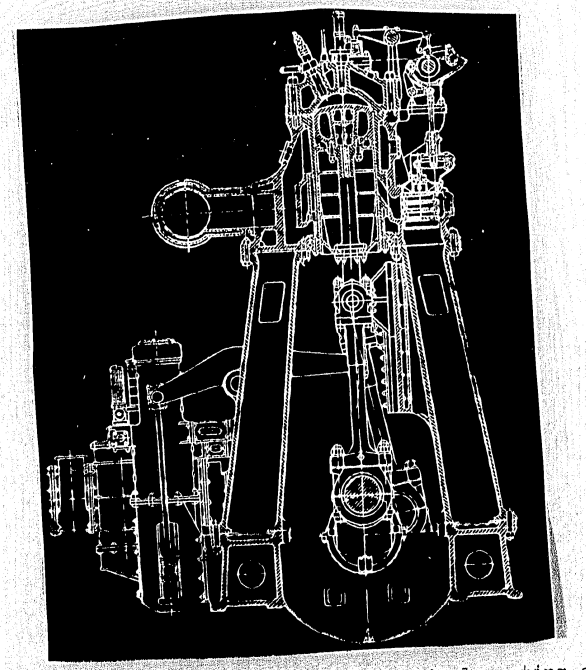

Figure 192 Compressor type, two stroke, single acting engine, produced by the "Russkiy disel' plant. RD-2400 (cross section)

The cylinders are of cast iron. Each of the cylinders is secured to two columns with the aid of bored pins. Inside one of the pins of each cylinder are mounted the feed valves which regulate the flow of scanvenging air from the receiver. The cylinders are provided with ports for the scouring away of scale from the outer jacket. Protectors, that is, zinc plates are fastened to the port covers on the side where the water is to be found.

The scavenging system is a product of the Russkiy Dizel' Plant. The height of the scavenging ports is 190 millimeters, that is 0.22 S.

The cylinder liners are of cast iron, and the area of the latter about the ports (there are seven scavenging ports and four exhaust ports) is packed with one rubber and two brass rings (see Figure 53) on either side (in a rising order). The lower part of the liners is provided with two double cast iron oil scraper rings which press inward and intercept the dirty oil which is drained off into a tank through a pipe. Such an arrangement makes it possible to reduce the length of the liner and to dispense with the oil scraper at the lower end of the piston

The bedplate is an iron casting and consists of three sections which are made fast with the aid of vertical flanges and bolts. The lower bushings of the bedplate bearings are of cast iron, lined with babbitt, and are water cooled. The upper bushings have been dispensed with, and the babbitt directly lines the cast iron cap of the bearing. The bushings are without oil grooves. The oil is delivered into the coolers of the liners from the pressure tank by gravity and additionally from the central drip

lubricator (individual lubrication).

The crankshaft is forged from carbon steel and is made up for three interchangeable parts in each of which the cranks are mounted at an angle of 180 degrees with respect to each other. All the parts are flange coupled and bolted at an agle of 120 degrees. The diameter of the crankpins is 400 millimeters the length of the shaft being 11,025 millimeters. The web thickness is 220 millimeters, and the width 600 millimeters. The flange diameter is 690 millimeters, its thickness 115 millimeters. There are 12 bolts, with a diameter of 63 millimeters (see Figure 193).

During the forward run, the order of ignition in the case of a clockwise rotation is 1-4-5-2-3-6. The length of the crankpins is 465 millimeters.

On all sections of the crankshaft for the sake of interchangeability there is a place for the worm gear which drives the control and vertical shafts. The length of this worm gear is 135 millimeters, and there is a groove for the spline. Prior to the introduction of modern design, the crankpins used to be lubricated with centrifugal lubricators where the oil was fed by gravity.

The weight of the crankshaft is 19.4 meters.

The shaft reversing mechanism is located on the rear end of the engine and is actuated by a 5 horsepower electromotor. It causes the shaft to reverse 360 degrees within 5 minutes. At the rear end of the crankshaft is to be found a cast iron flywheel to facilitate engine starting. The diameter of the flywheel is

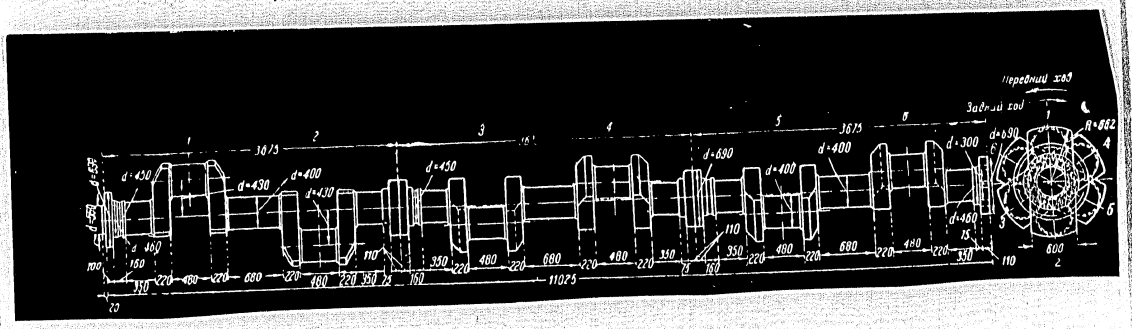

Figure 193 Crankshaft of the RD-2400 engine

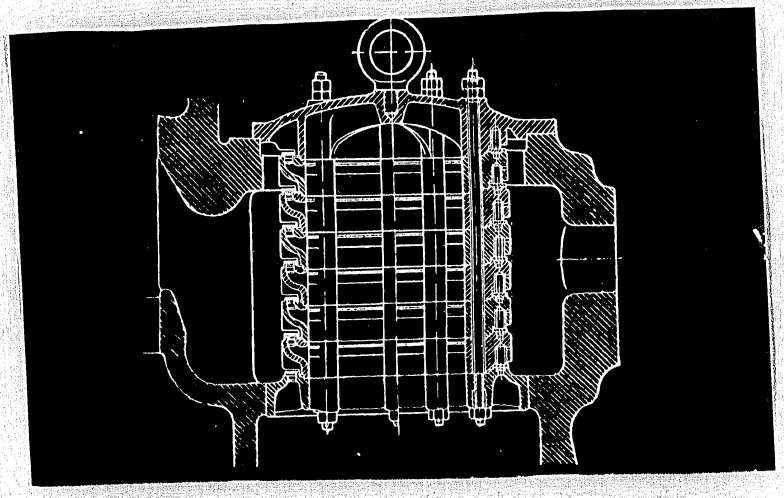

Figure 194 Automatic valve

2.3 meters, the width 0.5 meters and the weight 6.83 tons. The coefficient of irregularity $\delta = 1/30$.

The cylinder heads are of cast iron, each comprising fuel, starting, decompression and safety valves, set for a pressure of 50 atmospheres.

For the decompression valve the air enters the scavenging air receiver and serves to scavenge the cylinders as the engine is started. Figure 57 shows the head separately.

The pistons (Figure 78) are cast iron and have dismountable heads with seven piston rings. The piston head base is 45 millimeters thick, the jacket is 1180 millimeters long and the weight of the piston is 1014 kilograms.

The piston rod is tubular and forged of carbon steel. It has a diameter of 175/75 meters. By means of a ball and socket mechanism the water is channeled through the bore of the rod, being fed through the openings in the crosshead pins. This water serves to cool the piston head. The piston rod is clutch-coupled to the crosshead and made fast by a castle nut. The rod weighs 450 kilograms.

The crosshead is of steel. The crosshead pin dimensions are d x l = 260 x 255 millimeters. A steel cast shoe l x b = 800 x 540 millimeters, and 70 millimeters in thickness, is secured to the crosshead. The weight of the crosshead is 400 kilograms while that of the shoe is 350 kilograms. The specific pressure on the shoe is 3 atmospheres.

The parallel guides are unilateral with cast iron jaws

and are provided with water cooling. They are secured with the aid of bolts to special lugs on the columns.

The connecting rod is of forged carbon steel. It is yoke shaped at the small end. It weights 1720 kilograms.

The camshaft with two sets of cam plates for the forward and reverse run for each valve (except the safety valve) is located on the level of the cylinder heads. It is driven from the crankshaft with the aid of a vertical shaft mounted between the fourth and fifth cylinder, and of two pairs of helical gears. The governor shaft, located on the side of it, parallel to the vertical shaft, is also driven by the pinion of the crankshaft with the aid of a vertical shaft. On the parallel shaft are also mounted the hellical gears, with a 1:3 gear ratio, of the blow-off valve which service simultaneously both scavenging pumps, as well as the gears of the fuel pumps, grouped in a single block located between the second and the third cylinder. At the present time the slide valves are being replaced with automatic valves (Figure 194).

For reversing the reversable rollers of the valve rockers are employed, and these can be seen on Figure 57. The bell crank levers are reversed with the aid of rods connected to the reversing shaft. The levers are released when the rollers are disengaged from the plates by turning the camshaft.

The control post is located at the bottom of the forward end of the engine between the fourth and fifth cylinder and consists of control levers, compressed air servomotors and hand wheels serving to control the compressor's rate of aspiration and the fuel delivery flow.

There is a total of four control handles: a starting handle for the forward bank of cylinders, one starting handle for the after bank, a reversing handle and a handle for the manual control of the rate of fuel delivery. The first three handles are actuated by servomotors while the fuel delivery control handle is directly gear coupled to the fuel pumps. All of these handles are so interlocked that the reversing handle does not engage until both starting handles are set at "stop". The construction of the reversing-starting gear has been described above.(See Figure 124 and 125).

Near the control post is to be found a cast iron, six plunger fuel pump set in motion by the vertical transmission shaft.

The scavenging pumps are double acting with a cylinder diameter of 1050/300 millimeters and a piston stroke of 700 millimeters. They have an output affording an excess of scavenging air of 35 percent. Both pumps are actuated by the crossheads of the fourth and fifth cylinder (counting from the front) with the aid of shackles, rockers, (with an arm ratio of 108:132) crossbeam and guide trunk. The slide valve which is common to all of them is reversed by a special clutch from the control post.

The compressors as well as the scavenging pump (see Figure 172) are located at the rear of the engine. One of these compressors is a low and medium pressure unit with a cylinder diameter of 475/280 millimeters, while the other is a low and high pressure unit with a cylinder diameter of 475/125 millimeters. The piston stroke of both compressors is 580 millimeters. The compressors are

are driven by shackles, rockers and a gear from the crosshead of the third and fourth cylinder. The ratio of the rocker arm is as follows: for the low and medium pressure pump 90:132, and for the low and high pressure pump 87:132. This is to be explained by the fact that it is sought to maintain the same output as that of the TsND pistons.

The compressor output is calculated for a reserve of 25 to 30 percent in order to ensure swift replenishment of the starting receivers. The injection air pressure is 65 atmospheres. The compressor's output is regulated by a hand wheel from the control post.

There are two compressed air coolers for each set. One is a manifold cooler (with cuprite pipes) and bronze baffles one of which is adjustable as the pipes expand with heating. Per cooler there are 55 pipes, 1.6 meters in length. The pipe diameter for the N and SD is 13.5/8 millimeters, and for the VD 13.5/6 millimeters. The cooling system applied here is the counterflow type.

The engine is cooled with sea water, with the aid of three piston pumps actuated by the rockers of the third and fourth engine cylinder. Two pumps deliver the water to the parallel guides from which it passes to the cylinder jackets and heads, flowing from each cylinder separately to the funnels (for temperature control) and running on to the bilges where they are expelled to the sea with the aid of pumps. The third pump delivers the water only to the piston heads from which it also runs off into the bilge through funnels and is expelled to the sea.

The crankshaft lubricating system employed formerly, was of

the individual type, but when the oil consumption in service was found to be high (30 grams per rated horse-power hour) on some ships of the Baltic and Black Sea fleets, a switch was made to pressure lubrication. [Kuznetsov B. V., Modernization Tests on the Diesel Ship "Cmol'nyy", Gosmopuzdat, 1940]. To accomplish this, the crankshaft was bored through and two additional fuel pumps were introduced for the lubrication of the shafts and the moving parts of both main engines. The liner, compressor and crosshead pin walls are pressure-lubricated, the oil being fed with the aid of special plunger pumps. The other parts of the engine are lubricated by gravity from the oil distributor located on the camshaft casing. Light shields protected the engine on either side to prevent spraying of the oil, and oil consumption was reduced to 7 - 8 grams per rated horsepower hour.

At normal load the gas temperature in the exhaust pipe of the engine described above, is about 250° Centigrade, which is accounted for by the water jacket on the exhaust pipe.

GAS DISTRIBUTION ON THE DIESEL SHIP "SMOL'NYY"

Valves	Opening	Closing
Fuel Valve	5° to VMT	40° past VMT
Starting Valve	0°	82° past VMT
Exhaust Ports (Piston)	61°25' to NMT	61°25' past NMT
Scavenging Ports (Valves)	33° to NMT	--
Decempression Valve	65°	10° to VMT

SCAVENGING PUMPS

	Upper Housing	Lower Housing
Start of Pumping	11° past VMT	13° past NMT
End of Pumping	20° past NMT	16.5° past VMT
Start of Injection	30° past NMT	25° past VMT
End of Injection	2° past VMT	2.5° past NMT

As a result of the modernization of the "Smolnyy its original output of 1600 effective horsepower at 100 rpm was augmented to 2100 effective horsepower at 110 rpm. The specific fuel oil consumption dropped from 205 to 186 grams per effective horsepower, and that of lubricating oil from 400 to 140 kilograms per 24 hour day. After replacement of the propeller, the speed of the ship rose from 11 to 13.5 knots. The number of reversing operations without replenishing the starting receivers rose from 15- to 42, a reduction also taking place in the starting time lap.

As a result of similar modernization of the Black Sea Diesel-ship, "Adzharistan", [Newspaper "Maryak", No 145, November 1940], the output of the main engines (type RD-2400 increased 27 percent and the economies effected amounted to 20 percent. The speed of the ship rose 13 percent. Speed tests have shown that the engines were reliable and steady (with smoke-free exhaust) at 108 rpm, developing 2500 rated horse power. The specific fuel consumption was 140 grams per rated horsepower per hour of 172 grams per effective horsepower-hour. The mean starting time for the engines was 7 to 8 seconds as against 15 seconds previous starting time. The engines started easily from cold at initial air pressure of 15 kilograms per square centimer.

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HIGH SPEED SINGLE ACTION DIESELS

The compressor type two stroke engine series 9 DKV 51/55 (Figures 195 and 196) produced by the Russkiy Dizel' Plant, does not have a flywheel.

This engine is a nine cylinder, non reversing, crosshead and light weight type unit thanks to the wide employment of steel castings (a prototype is the Zultser engine, series 9Q N 51/55).

The engine bedplate is a steel casting and is composed of six parts. Of these, four parts are cast for two cylinders, one part (the center) for one cylinder, and one (the forward part) for the auxiliary cylinders (of the compressor). The base of the bed is formed of thin iron plate bolted with wood screws to the beams of the bed. The third (from the rear end) engine bedplate bearing is a thrust bearing.

The scavenging air is delivered to the scavenging receiver by a separate turbo pump with two wheel stages which are actuated by a DC electric motor having a speed of 3000 revolutions per minute. The weight of the turbo lower is about six tons. The scavenging air pressure is 1.35 atmospheres. The output loss on the blower comes to about 10 percent of the engine output. The approximate output of the turbo blower is 9.4 cubic meters per effective horse-power per hour. The terminal injection pressure is regulated by a throttle valve. The automatic scavenging valves are marked by the number 2.

The casing is composed of 11 separate steel supports provided with vertical flanges at the top and bottom. These flanges

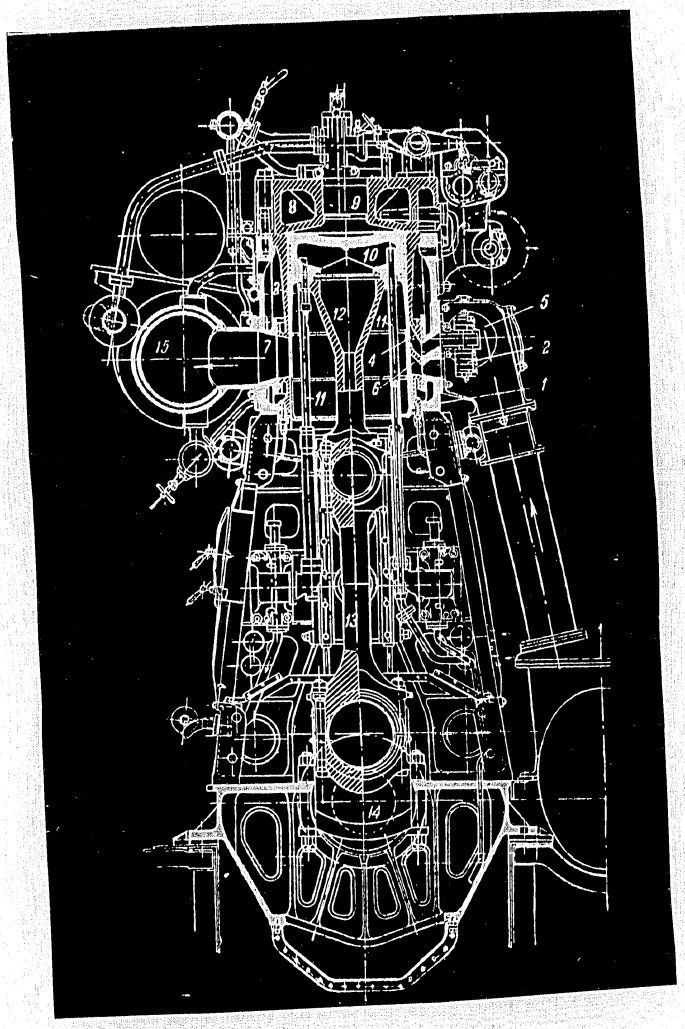

Figure 195 The 9DKV 51/55 Diesel (cross section)

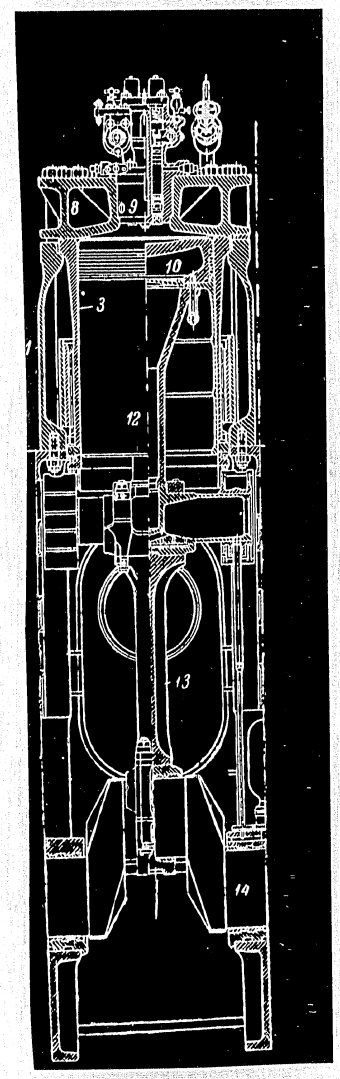

FIGURE 196 The 9DKV 51/55 Diesel (longitudinal section)

link up all of the supports and thus form a crankcase. A number of the retaining bolts are broached. On either side of the engine crankcase are suspended light shields. This design makes it easier to cast individual parts of the crankcase and also to process the parallel guides.

The cylinders (1) are individual steel castings, secured by pins to the upper crankcase flange with the aid of a lower flange. The liners (3) are perlite castings. The site where the liners pass through the port area is packed with cupruite split rings and with rubber rings. The crosspieces between the ports on the liner are provided with bores for the cooling water, sealed on the lower flange with the aid of threaded plugs.

The upper edges of the upper scavenging ports (4) are located 165 millimeters from the extreme downstroke position of the piston while the edges of the lower ports (6) are 45.1 millimeters from the same position. Their combined width is 609 millimeters (eight ports). [The height from the seat of the exhaust ports (7) is 99 millimeters and the width is 608 millimeters (eight ports)]. The angle of slope of the upper scavenging ports is 31 degrees and that of the lower ports 45 degrees.

The cylinder heads (8) are special steel castings. At the centre of the head, two injectors and a starting valve are seated in a compound connecting pipe (9). The application of two injectors ensures a more uniform distribution of fuel in the combustion chamber and also permits use of only one injector when working on a small load. The gear connecting to the camshaft (the vertical shaft) is located at the rear. From the cylinder

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jacket (where the water comes through from the autonomous centrifugal pump) the cooling water which cools the head issues through the reducer, the end of which extends through the head into the body of the injector. The water is channeled into the jacket of the scavenging pipe. The weight of the water and the fuel oil in the engine is about 3 tons. The water consumption comes to about 40 litres per effective horse-power-hour at a head of 25 - 35 meters. The oil flows at a rate of 25 litres per effective horsepower-hour at a head of 50 meters. There are branch pipes running from the exhaust pipe jacket to the cylinder jackets for the purpose of supplying heated water when the engine is being started during the cold season of the year.

The Pistons

The piston heads (10) are of forged steel (st. 5 pov.) and are provided with five gaskets. The cooling oil is fed through telescopic pipes (11). An attachment designed to augment the rate of flow of the oil, is fitted into the telescopic pipe (see Figure 77). An autonomous, gear driven, electric pump serves to deliver the fuel.

The thickness of the dished bottom end of the pistol is 50 millimeters. The height of the head is 170 millimeters. The overall height of the piston (head and jacket combined) is 770 millimeters.

A bored chrome-nickel steel rod, 120/72 millimeters in diameter and 715 millimeters in length is secured to the head with the aid of bolts. The rod is fastened to the chrome-nickel steel crosshead and pin by means of the lower flange.

The combined weight of the rod, position, crosshead and crosshead shoes is 400 kilograms. The crosshead pin has one common bearing surface and this characteristic makes it possible to employ a common type connecting rod without a yoked head. The crosshead shoe dimensions are: b x l = 115 x 340 millimeters. The parallel guides are bilateral with oil cooling and they are secured to the crankcase uprights (Figure 84).

The connecting rods (13) are forged of chrome-nickel steel, and for the sake of a lesser weight they have a double T section, of the following dimensions:

$$\frac{H}{h} = \frac{134 \text{ mm}}{90} \qquad \text{and} \qquad \frac{B}{b} = \frac{110 \text{ mm}}{16}$$

The length of the connecting rod is 1080 millimeters, and its combined weight is 180 kilograms, $\frac{L}{R} = 3.92$.

The top end of the connecting rod is secured to the crosshead pin by means of bearings with light caps located on both sides of the rod. At the lower end the babitt is introduced into the steel bushing, while at the upper end it is in direct contact with the cap. At the ends of the crossheads are to be found cast steel shoes the soles of which are lined with babbitt. A special gear driven pump serves to deliver the oil to the frictional parts of the crosshead coupling from the bedplate bearing caps through telescopic pipes and bored pins whose end faces are sealed by threaded plugs. To ensure uniformity of flow air chambers are fitted on the caps of the bedplate bearings.

The big end of the connecting rod has a second split plane to regulate the height of the compression chamber. The bushings

are of steel and are babbitt lined. The bearing cap is secured to the body with the aid of four adjuster bolts.

The crankshaft (14) is forged of steel (St. 5 pov.) and is composed of three sections, the after end section being made up of four cranks, the center section of five cranks and the forward section of two cranks for the compressor. The diameter of the crank pins is 290 millimeters. The working length of the main bearings is 312 millimeters while that of the crankpins is 176 millimeters. The web dimensions are: b x t = 140 x 440 millimeters. The overall length of the crankshaft is 4080 plus 5665 millimeters [without the forward section], while the weight is 6,000 kilograms. The dimensions of the flanges are: $D \times D_1 \times b = 515 \times 410 \times 70$ millimeters. There are 12 coupling bolts, 60 millimeters in diameter.

The order of ignition on the forward run is 1-8-5-2-9-4-3-7-6.

The lower end bushings of the bedplate bearings are of steel and are babbitt lined. In the upper halves the babbitt directly lines the bearing caps which are oil cooled.

The compressor is a two cylinder, four stage, crosshead type unit. Its output has been calculated for the simultaneous servicing of both main engines, at 75 percent of their load. The forced air pressure at full load is 80 atmospheres. The ND cooler is tubular, while the SD and VD coolers are designed in the form of a/large multiple diameter screw of stainless steel with internal and external cooling.

The above engines have been designed for powerful Sevmorput' [Northern Seaway] ice breakers(with electrical drive). That accounted for the application of compressed air fuel spraying, inasmuch as it was indispensable to ensure the maximum performance of the fuel system since under artic conditions of navigation the motor oil employed was the heavy A grade oil (OST 5262).

A precision governor which serves to maintain a fixed revolutions per minute is fitted at the after end of the crankshaft (since the engine is powered by a dynamo). This governor acts directly on the intake valves of the fuel pumps and on the valve of the oil servomotor. In turn again, the latter bears on the compressor throttle and on the lift of the injector needle, that is, it ensures the automatic feed of compressed air and the corresponding rise of the injector needles, depending on the engine load.

A special limit governor is provided for racing. When the set number of revolutions per minute has been exceeded, the engine stops. A shaft reversing mechanism is mounted at the after end of the shaft, along with an electric motor.

Low pressure compressed air is employed to set the engine in motion (25 atmospheres). For this purpose a two cylinder compressed air servomotor is used. The latter switches on in sequence, first one and than the other group of cylinders and injectors.

The control post is located at the top of the engine, on the compressor side.

The exhaust pipe (15) is an iron casting provided with a

jacket, and consists of a number of sections. The capacity of the silencer is about 10 cubic meters.

On the engine are mounted the following:

1. A two cylinder compressor
2. An 18-plunger fuel pump (one plunger for each injector), located on the side of the engine and actuated by the compressor crosshead with the aid of rockers.
3. A geared oil pump for circulation of lubricating oil
4. Geared oil pump for the lubrication of the crosshead pins.
5. A plunger-type oil pump for the lubrication of the engine and compressor cylinders.
6. The shaft reversing electric drive.

DISTRIBUTION OF GAS

Valves	Open	Closed
Fuel Valve	8° to VMT	20° past VMT
Starting Valve	5 - 8° to VMT	95-92° past VMT
Exhaust Ports (Piston)	18% S	
Scavenging Ports	30% S	
Lower (with Piston)	8.2% S	
Decompression	None	

NON COMPRESSOUR FOUR STROKE DIESELS OF THE KILOMENSKIY PLANT IMENI KUYBYSHEV

Series 38B-8 Diesel (Figures 197 and 198)

The 8 cylinder, trunk-type, non reversible engine of the

reduced weight model (prototype the MAN engine, Series W8V28/38).

The bedplate, is a perlite casting and has a solid base. The anchor bolts are staggered, two on each side of the uneven bedplate bearing. The total number of anchor bolts on both sides is 52 (diameter 15 millimeters). An oil manifold runs inside the bedplate, on the side of the exhaust pipe. Branch pipes of this oil manifold feed the oil donward through the connecting pipes to the bushings of the bedplate bearings. The latter are collected without the gaskets when scraping the bushing joints. The bedplate bearing caps are made fast to the upper bushings, each with the aid of two "tool clamps". The bedplates of the right and left engine are cast in the identical model. Figure 198, shows the orifice for the passage of the oil manifold, both on the right and left side in the crossbeams. The lugs for the drain pipe flange at the lower end of the bedplate are also provided on both sides.

A channel runs at the lower end, along the entire bedplate for the purpose of draining the used oil from the crankcase, while in the center or at the end, passages are bored for the connection of the drain pipe. The longitudinal beams of the bedplate have a Z section while the crossbeams under the bushings of the bedplate bearings are of the box type. The length of the bedplate is 3426 millimeters, the width is 1050 millimeters and the height 560 millimeters. The bedplate weighs 1390 kilograms.

The casing is a perlite casting and forms a single unit with the cylinder bank. This serves to reinforce the longitudinal rigidity of the engine.

At the lower end of the bank, under the horizontal shelf

where the fuel pumps are located the camshaft is mounted on the detachable bearings. It is composed of two sections and is started from the end of the engine (this is highly inconvenient since it calls for a large space for dismounting).

Large openings, covered with light shields, in the lower part of the block, ensure access to the big end and bedplate bearings. In the center of the block, on the side of the exhaust pipe, serving the purpose of cleaning the outer reaches of the jacket opposite each cylinder, there are openings which are covered with silencers on rubber gaskets. Zinc protectors are fastened to the latter on the side where the water is contained. The water space is common to all cylinders. The cooling water passes from the automatic circulating pump through the extreme (from the forward end) for the cleaning of the outer jacket area, filling the latter, and passes out to the water chamber of the cylinder heads through the connecting pipes. From the cylinders again the water flows through the branch pipes to the jacket of the exhaust pipes. On the branch pipes are fitted cocks for the regulation of the temperature of the water which issues from the heads.

Since it is not permissible to cool the engine with extremely cold water (below 3 to 5 degrees), a portion of the water which passes through the engine is channeled off by a special bypass pipe with a control cock (Figure 198) to the cooling manifold, this being done for the purpose of heating the water.

In order to secure the cylinder heads to the upper part of the cylinders, four studs, 35 millimeters in diameter, are employed for each head. [For the anchor couplings (E-10 steel) that cover the walls of the crankcase, 18 pipes, which pass through the surrounding

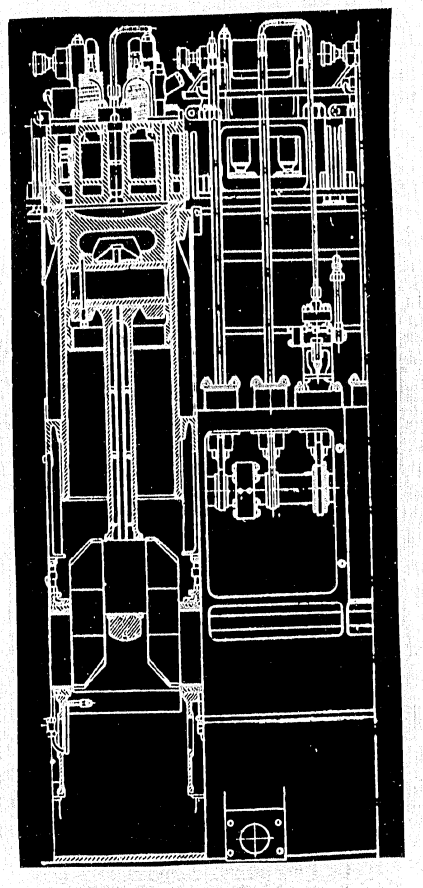

Figure 197 The 38V-8 Diesel (cross section)

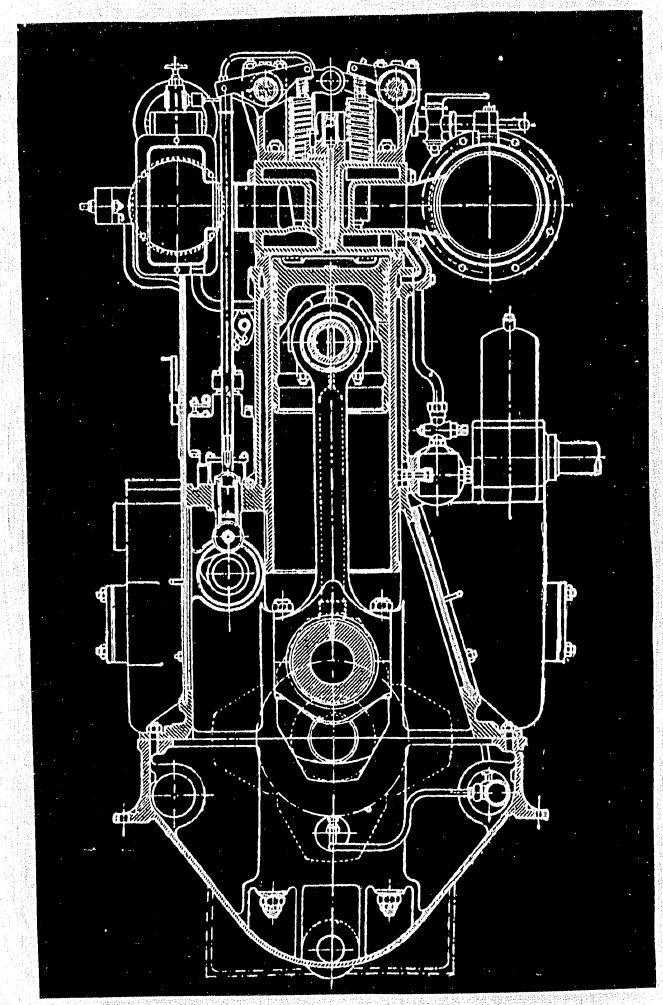

Figure 198 The 38V-8 Diesel (longitudinal section)

space, are constructed on the block mold, so that the connection will not be subjected to the action of the water. At the lower end of the block these pipes break off and continue somewhat lower. The couplings pass through them without clearance (they are fitted after painting). The upper pipe area between the couplings and the plates is connected by means of branch pipes to the intake receiver and is used for the ventilation of the crankcase. The length of the couplings is 1604 millimeters, while their dimater is 36 millimeters.

The cylinder liners ade made of perlitic cast iron and for proper mounting three precision finished collars are fitted on their outer surface. Similar collars are also on the block. The center collar of the liner has grooves cut in it for the passage of cooling water. A copper gasket under the flange or a lapped fit of the latter to the block are two methods of packing in the upper portion of the liner, while in the lower portion this is accomplished with the aid of a rubber gasket.

The cylinder heads (Figure 63) are of perlitic cast iron. They are rectangular and are provided with large square windows in the walls.

In the cylinder head are fitted two intake and two exhaust valves, an injector and a starting valve, and in addition there is also a through opening for the indicator. The intake and exhaust valves do not have separate seats.

Vertically, the cylinder head is divided into two chambers by means of a horizontal baffle plate, which gives it greater rigidity and improves the cooling of the head. At the top, two

crossheads are secured to the head on bushings, for the valve rocker shafts. The height of the head is 205 millimeters, the thickness of the lower plate is 18 millimeters. The head weighs 62 kilograms.

The joint of the head is made secure with the aid of a copper gasket under a ring collar, the dimensions of which are as follows: diameter 320/340 millimeters and height 5 millimeters.

DIAMETER AND LIFT OF VALVES

Valves	Angle of Slope of the Head	d	h
Intake	45°	95 mm	23 mm
Exhaust	45°	80 mm	22 mm
Starting	-	30 mm	7 mm
Injector sleeve	-	40 mm	-

The crankshaft is of seamless forged steel (St. 5 pov.) and tubular ($\frac{d}{d_0}$ = 195/100 millimeters)with a specular arrangement of the cranks. The ignition sequence of the right engine is as follows: 1-4-2-6-8-5-7-3, while that of the left engine is: 1-3-7-5-8-6-2-4.

At the ends the crank pin bores are sealed with plugs, on pressboard gaskets tightened with bolds. The crank webs are provided with oblique bores for the delivery of the oil from the housing pins to the crank pins. For this reason each crank pin has a radial bore while each of the housing pins has two diametrically opposite bores.

The length of the case and crank pin is 100 millimeters. The web dimensions are b x t = 85 x 270 millimeters. The distance between the axes of adjacent cylinders is 400 millimeters. The overall length of the shaft is 3540 millimeters, and the weight 1070 kilograms.

At the forward end of the shaft is mounted a cylindrical gear of the oil and fuel transfer pump drive. At the after end, a gear wheel of the drive communicating to the camshaft is mounted on spines. The gear is composed of two parts. The drive proper is made up of several gear wheels.

The connecting rods are of circular section and are forged of St 5 pov [steel]. They are provided with a longitudinal bore for the delivery of oil to the small end bearing. The diameter of the connecting rod body $\frac{d}{d_o} = \frac{70}{16}$ millimeters while the length is 750 millimeters. $\frac{L}{R} = 3.96$. The weight of the connecting rod assembly is 55 kilograms (see Figure 89).

The small end of the connecting rod has a press fitted bushing of special bronze, plugged with a countersunk wood screw (see Figure 87). The lower end has neither gaskets nor linings. The babbitt lines the connecting rod body directly and is also applied directly to the cap of the big end bearing. The diameter of the connecting rod bolts is 48 millimeters. In disassembling, the connecting rod is removed together with the piston through the liner.

The pistons are cast of an aluminum alloy (see Figure 66). The weight of the entire piston assembly is 37.1 kilograms. The thickness of the head is 28 millimeters. The dimensions of the

pin d x l = 105 x 125 millimeters, while that of the bosses d x l = 105 x 63 millimeters x 2. The pin bore, or d, is 75 millimeters. There are five piston rings and two oil scrapers. The full piston length is 367 millimeters, the working length is 225 millimeters, while the working width is 135 millimeters (in circumference).

The engine valves are shown in Figure 99, whereas their assembly is described in Chapters V and VI (Figures 107 and 136).

The drain pipe is provided with a water jacket and is iron cast (d = 240 millimeters), while the intake pipe is welded of thin iron plates, with a rectangular section, b x h = 135 x 270 millimeters. The pipes which feed air to the intake valves have bushings fitted inside of them, so as to provide a passage for the valve rocker push rods.

The fuel pump is of the Bosch type (Figure 142). The diameter and stroke of the plunger is 17 -15 millimeters. The pump develops a pressure of 350 to 500 kilograms per square centimeter.

The drive coupling the governor with the cutoff valve and the servmotor are shown separately in Figure 129.

[See table on following page]

SERIES 42 BM-6 DIESEL (FIGURES 199 AND 200)

This is a six cylinder trunk engine, non reversible of the standard type (prototype of this one is the engine of the MAN plant, Series F6Vu $\frac{45}{42}$).

The bedplate is composed of three parts, each a steel casting, and the bed is of solid plate. A channel runs the entire length of

DISTRIBUTION OF GAS

Valves	Open	Closed
Intake	37 degrees to VMT	47 degrees past NMT
Exhaust	52 degrees to NMT	32 degrees past VMT
Starting (Fuel Feed)	18 degrees to VMT	40 degrees to NMT
Feed of the roller	24 degrees to VMT	-
Cut off	-	6 degrees past VMT

the housing at the bottom; on the lateral lugs (both sides) and on the after side there are ports through which the oil flows down to the drain sump. For the sake of greater engine rigidity, the bed plate is cast as one piece with the engine casing.

The brasses of the bedplate bearings are forged of steel and are lined with babbitt. At the joints between the brasses are fitted the packing assemblies. The end bearing from the stern is a thrust bearing and its brasses are also faced with babbit. The lubricating oil is delivered to the bearings through the caps, from the common manifold.

The dimensions of the housing L x B x H = 4890 x 1140 x 912 millimeters. All casings weigh 3728 kilograms.

The cylinder bank is a steel casting composed of six distinct sections, coupled with the aid of vertical flanges and bolts, the terminal bolts being staggered (Figure 45).

The cylinder liners are cast of perlitic cast iron and rest on the upper part of the bank through the intermediary of

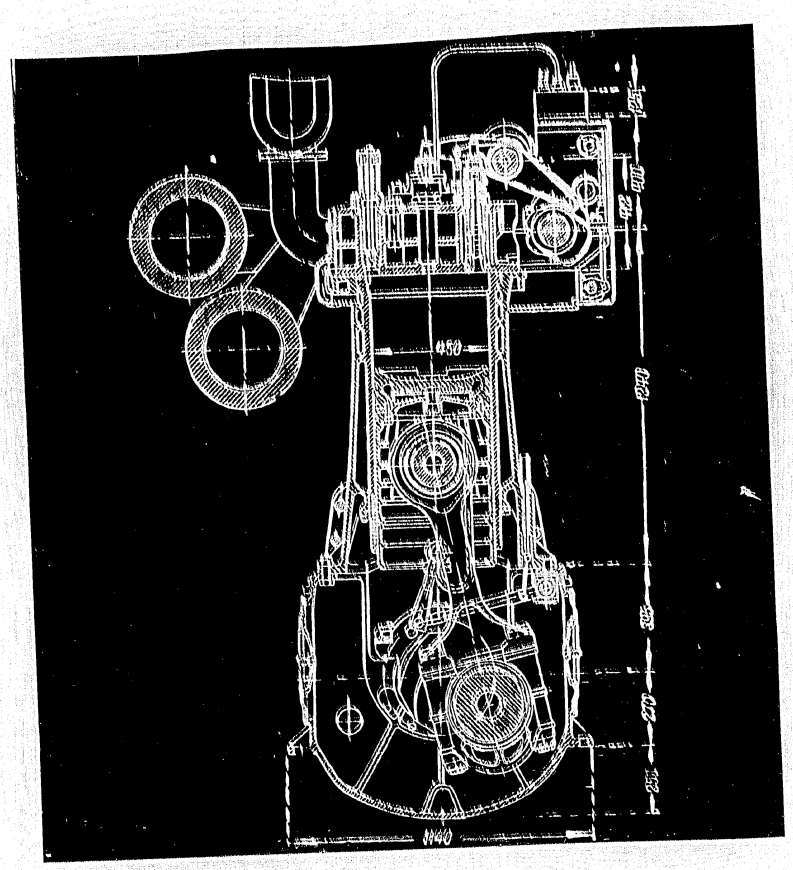

Figure 10C The M28M-6 (cross section)

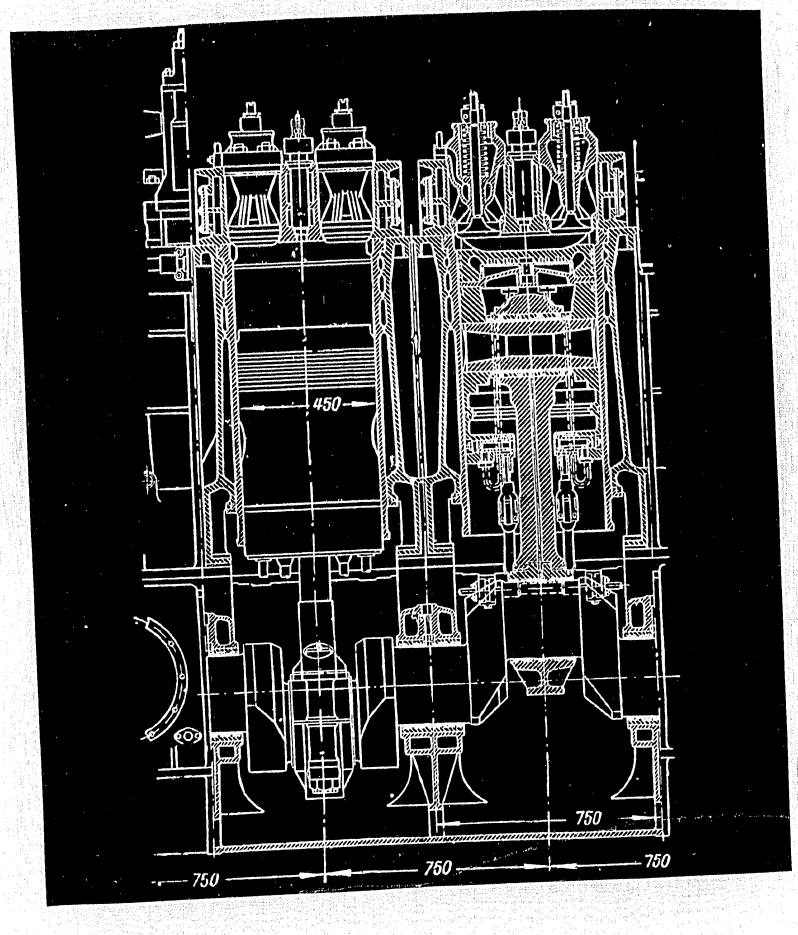

Figure 200 The 42BM-6 Diesel (longitudinal section)

collars which are provided underneath with cuprite sheet gaskets. Under the collars on the outer surface of the liners there are three ring collars which enhance the rigidity of the liners and reduce the section of the jackets, so that the rate of speed of the water flow is increased and the heat transfer is improved. Appropriate slots are made in the belts, affording a passage to the water.

In the upper part of the liners, lateral pockets are provided for the lowering of the valve heads. In the lower part, the sites where the liners come out, glands used to be employed for packing, whereas recently the glands have been replaced with two round gaskets seated on special ring grooves provided on the liners.

The liners are oil lubricated, the oil being sprayed by the connecting rods. When the engine is started, additional lubrication is provided through oil flow from the lower part of the liner (Figure 49), issuing from the common manifold through special pipes which come through to the outside of the cylinder bank on the distribution side.

Eight studs (d = 48.5 millimeters) for each cylinder are screwed in at the top surface of the bank for the purpose of reinforcing the heads, and the camshaft bearings are mounted on special bosses. The toothed gear drive of the camshaft from the crankshaft is fitted on the after side of the engine. The fuel pumps are also mounted on these bosses, between the cylinders. Lubricating oil is delivered to camshaft bearings through the axial bore and the radial openings.

A limiting governor and a control post are secured to the forward end of the bank, along with a gear driven oil and fuel transfer pumps, as well as a two cylinder, plunger type circulating pump.

The cylinder banks is bolted to the crankcase, and the four terminal bolts of each bank section are staggered.

The cylinder heads are perlite castings and comprise the following: the injector which is located at the center, while the intake and exhaust valves are on the sides. On the distributor side is to be found the starting valve, while the safety valves are located on the side of the exhaust pipe.

Valves	d	h	Head Angle of Slope
Intake	145 mm	38 mm	30 degrees
Exhaust	145 mm	38 mm	30 degrees
Starting	54 mm	10 mm	-
Injector Sleeve	56 mm	(Open type injector)	-

The height of the head is 250 millimeters, while the thickness of the lower plate is 26 millimeters. The diameter of the intake and of the outlet pipe is 150 millimeters. The head weighs 247 kilograms. The diameter of the collar is 544/524 and the height 5 millimeters. The sections of the head are shown separately on Figure 62. The nuts fastening the head are countersunk in the latter (see Figure 64). A sheet cuprite gasket is inserted underneath the collar for the purpose of sealing the joint.

The piston is shown in Figure 67. It has a dismountable head of forged steel. The thickness of the head is 31 millimeters. At the lower end it is secured with circular ribs (Figure 69) and it is oil cooled by means of rocking devices (Figure 76). The head is made fast to the cast iron body of the piston with the aid of 14

bolts each having a diameter of 14 millimeters. The overal height of the piston is 753 millimeters. The entire piston assembly weighs 333 kilograms. The pin dimensions are d x l $_{rab}$ = 63 millimeters x 2. There are six piston rings, two of these being oil scrapers.

The connecting rod (St 5 pov) is shown in Figure 85. It is of annular section, with a diameter of 108 millimeters. The bore diameter is 25 millimeters. $\frac{L}{R} = \frac{912}{210}$ millimeters. The total weight of the piston is 290 kilograms.

The small end of the connecting rod is of the closed type while the big end has a second split face for the control of the compression chamber head. The dimensions of the big end are d x l $_{rab}$ = 260 x 210 millimeters. There are two adjuster bolts with a diameter of 61.5 millimeters. The distance between the axes of the bolts is 340 millimeters. E-10 steel is used for the bolts.

The crankshaft is seamless forged (St 5 pov) and bored through. The diameter of the pins $\frac{d}{d_0} = \frac{260}{210}$ millimeters while the length of the casing and crank pins is 210 millimeters. The dimensions of the webs, b x t = 130 x 380 millimeters. In the webs are to be found oblique bores to interlink the inner area of the casing and crank pins. The pin bores are sealed with plugs which are made fast with the aid of threaded pressboard couplings (see Figure 90).

The cranks of the second half of the shaft are in specular arrangement with respect to the corresponding cranks of the first half. The angle between the cranks of the adjacent cylinders is 120 degrees. The ignition sequence (for the forward run) of the

right engine is: 1-3-5-6-4-2 (counting the cylinders from the forward end).

The distance between the axes of adjacent cylinders is 755 millimeters. The overall length of the shaft is 5100 millimeters while the weight is 3030 kilograms. The diameter of the coupling flanges is 570 millimeters, the thickness being 42 millimeters. There are 10 coupling bolts with a diameter of 52 millimeters.

The valve and fuel pump assembly have been described in Chapters V and VI (Figures 101 and 140).

GAS DISTRIBUTION

Valves	Open	Closed
Intake	20° 50' to VMT	29° 16' past NMT
Exhaust	32° 20' to NMT	11° 40' past VMT
Starting	10° to VMT	43° 16' to NMT

The basic data pertaining to the engines discussed in the foregoing are combined into Table 11.

[See Table 11 on next page]

The Kolomenskiy Plant produces non-reversing and reversing engines with and without supercharging.

SLOW SPEED, DOUBLE ACTING DIESELS

The need of high powered engines aboard ocean liners of large displacement brought about the appearance of two stroke, double

TABLE 11

CHARACTERISTICS OF MARINE DIESELS

Unit - Make - Type

Characteristics	Crosshead Type Nobel' RD-2400 Compressor Type	Crosshead Type (Lighter) Zul'tser 9QN51/55 9DKB51/55 Compressor Type	Four Stroke MAN Trunk Engine (Lighter) W8V28/38 38B-8 Kolom. 3-D	Four Stroke MAN Standard Non Compressor F6V45/42 42BM-6 Kolom. 3-D
[1]	[2]	[3]	[4]	[5]
N_e - HP/Z	2000/6	3000/9	685/8	1100/6
n - rpm	105	300	600	425
D - Millimeter	650	510	280	450
S - Millimeter	860	550	380	420
P_i - kg/cm^2	6.7	6.4	6.86	7.7
P_e - kg/cm^2	5.02	4.6	5.5	5.8
η_m -	0.75	0.72	0.80	0.75
C_m - m/sec	3.0	5.5	7.6	5.95
P_c - kg/cm^2	36	36.5-37.5	31	29.5
$\varepsilon\phi/\varepsilon$ -	17.0/13.5	15.63/13.0	None/13.8	None/12.8
P_z - kg/cm^2	36	42-43	55	50
P_ε - kg/cm^2	1.12	1.2-2.25	-	-
C_e - kg/hp	0.197	0.195	0.183	0.173
G - (dry) T	250	67	9.2	29.4
G_3 - kg/hp	125	22.3	13.5	27

[1]	[2]	[3]	[4]	[5]
L - along shaft (meters)	11.0	10.1	3.94	5.735
B - (along casing) (meters)	3.4	1.5	1.05	1.14
H_1 - m	6.0	2.9	1.58	2.155
H_2 - m	1.0	0.76	0.58	0.52
H_1 - m	7.4.	3.2	2.15	2.64
L/R	4.8	3.92	3.96	4.34
Weight of reciprocating parts: (kg/cm^2)	0.90	0.235	0.10	0.27
$\frac{\Sigma z_1}{\pi D} \Big/ \frac{\Sigma z_2}{\pi D}$	0.225/0.326	0.38/0.38	-	-
Ignition Sequence	1-4-5-2-3-6	1-8-5-2-9-4-3-7-6-	1-4-2-6-8-5-7-3	1-3-5-6-4-2
$\frac{h_s}{S}$	0.221	0.18	-	-

N_e - Effective Power

n - revolutions per minute

D and S- Piston Diameter and Stroke

P_i and P_e- Mean Gauge and Effective pressure

η_m - Mechanical kpd [efficiency]

C_m - Mean Piston Speed

P_c - End Pressure

$\varepsilon\phi$ and ε - Nominal and Actual Pressure Degree

P_z and P_s- Pressure at the End of Combustion and Scavenging Air Pressure

C_e - Fuel Decomposition

G - Specific Weight

L and B - Length and Width of Engine

H_1 and H_2 - Height from Axis of Shaft both up and down

H_3 - Height for Stripping

$\frac{L}{R}$ - Relation of Connecting Rod Length to the Radius of the Crankshaft

$\frac{h_s}{S}$ - Lost Fraction of Stroke

$\frac{\Sigma z_1}{\pi D}$ and $\frac{\Sigma z_2}{\pi D}$ - The utilization of the circumference by the intake and outlet ports

acting engines. The problems that presented itself with respect to the planning and production of such engines were those that were met in regard to the design of the cylinder end. It was essential to have a combustion chamber of suitable shaped in the lower section, a stuffing box with packing that would be able to withstand high pressures as well as high temperatures, and to provide cooling for the pistol rod. Lastly, a way had to be found to fit the valves to the very best advantage in the lower section of the cylinder. All these problems have now been mastered and many plants are producing double acting Diesels which give flawless performance on a series of motorships.

Figure 201 furnishes a section (cross-section) of a non compressor, double stroke, double acting, four cylinder Diesel which is produced by the MAN plant. It develops 1800 effective horse power at 95 revolutions per minute. This engine has been installed on the Sovtorgflot motorships, "Zhan Zhores" [Jean Jaurez] "Engel's". The diameter

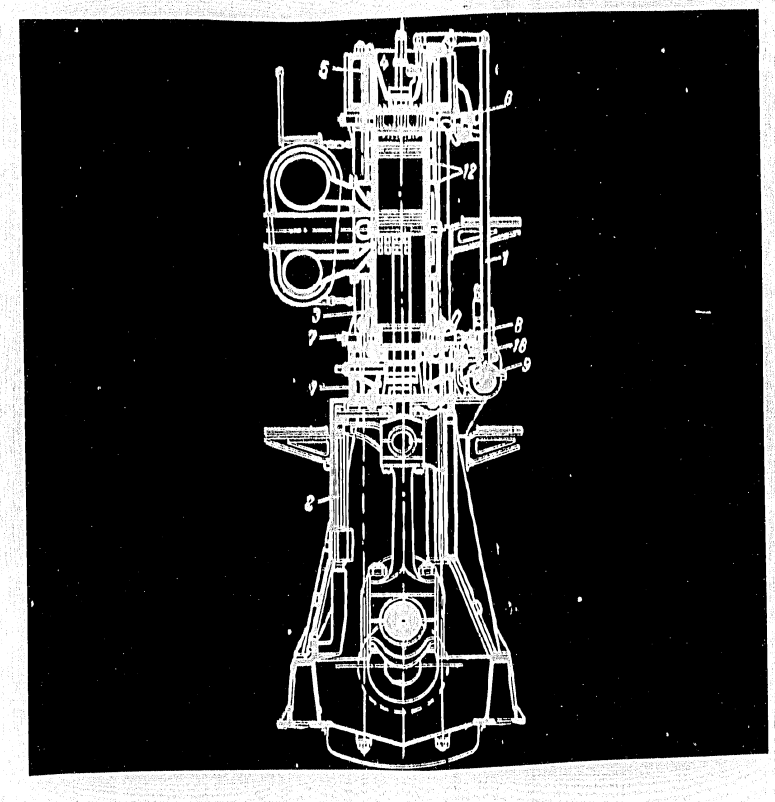

Figure 200 The two stroke, double acting Diesel produced by the MAN Plant (cross section)

of the cylinders is 600 millimeters, and the piston stroke is 900 millimeters. The specific weight of the engine is 65 kilograms per effective horsepower, and the fuel consumption is 175 grams per effective horsepower-hour.

The scavenging ports are located on the same side of the cylinder where the exhaust ports are to be found. The cylinder heads are composed of two sections, that is, a center section which is of cast steel and the outer section which is of cast iron. There are two gear driven, tandem type scavenging pumps to service the engine.

In the cylinder head are to be found, the injector (4), the starving valve (6), and the safety valve. At the cylinder end are located two injectors (8), a starting valve (7) and a safety valve. These are mounted horizontally. The valves are actuated from the camshaft (9), the upper ones with the aid of long rods (1), and the lower ones by means of short bell crank levers.

The casing is braced with the aid of long anchor couplings (5) which transmit to the engine bed the stress brought to bear by the gases against the cover. The piston is cooled with the aid of telescopic pipes (2). Inside the jackets are fitted guide ribs (3) the function of which is to increase the flow of water.

The Krasnoye Sormovo Plant produces such engines, with 3, 4, 5 and 6 cylinders, with 600 effective horsepower per cylinder. These engines are installed aboard the ships of the maritime fleet. (The engine Series is known as 90DPR).