SPECIFICATION

FOR A

TORPEDO SUBMARINE

FOR THE POLISH NAVY

SPECIFICATION FOR A TORPEDO-SUBMARINE FOR THE POLISH NAVY

PART I.

General ship specification.

§ 1. DIMENSIONS.

Length on c. w. l.	83.— M.
Length over all	84.— M.
Maximum breadth at waterline	6.57 M.
Maximum breadth (moulded)	6.70 M.
Depth amidships from horizontal keel to superstructure	6.35 M.
Draft from underside keel amidships	4.17 M.
Draft from underside keel forward	4.17 M.
Depth from underside keel aft	4.17 M.
Displacement on surface with appendices (D_2)	1110.— M^3.
Displacement submerged with appendices (D_1)	1473.5 M^3.
Arm of surface stability	0.600 M.
Arm of submerged stability	0.225 M.
Number of propellers	2
Maximum power on surface	2 × 2370 H.P.
Maximum power submerged	2 × 550 H.P.
Maximum surface speed	20 knots
Maximum submerged speed	9 knots
Normal amount of fuel oil	67.5 tons à 1000 K.G.
Normal radius of action at 10 knots speed	3850 miles
Total amount of fuel oil	123.5 tons à 1000 K.G.
Total radius of action with total amount of fuel oil at 10 knots	7000 miles
Weight of the accumulator battery	126 tons à 1000 K.G.
Radius of action submerged at 5 knots speed	100 miles
Diving depth	80 M.
Coefficient of floatability $\frac{D_1 - D_2}{D_2}$	32.7 %

§ 2. GENERAL DESCRIPTION.

The hull is divided into eight compartments, viz. :

1. **Forward torpedo-room and crew's space.**
2. **Petty officers' quarters.**
3. **Officers' quarters.**
4. **Central station.**
5. **Auxiliary central station.**
6. **Engine room.**
7. **Main electric motor compartment.**
8. **Aft torpedo-room and crew's space.**

1. **The forward torpedo-room** contains four bow torpedo tubes, a bilge pump, a main ballast pump, the forward hydroplane gear, the anchor gear und accomodation for 14 men. The necessary berths and lockers are to be fitted. The four reserve torpedoes are stowed under the flooring. A W.C. and lavatory will be fitted near the aft bulkhead.

2. **The petty officers' quarters** contain two double berths cabins for 4 senior petty officers, the necessary berths and lockers for 15 petty officers, a shower-bath, the internal parts of the forward decktubes and one ventilating fan.

3. **The officers' quarters** contain two separate single-berth cabins and two double-berths officers' cabins, and a large living space with spare berths for 4 officers, a small pantry with cupboards, and a shower bath. The necessary cupboards, lockers, etc., are fitted.

4. **The central station** will contain no moving mechanism whatever, with the exception of periscope presses, so that an absolute silence can be maintained. The grouping of stearing gear, air valves, operating manifolds of the Kingston- and air valves will be arranged in accordance with the customs of the Polish Navy, and the indications of the Inspection Committee (hereinafter called I.C.). The steering wheel will be fitted amidships, the hydroplane operating wheels on the starboardside and the air and watervalves on the after bulkhead, and in general in agreement with the I.C. On portside a large chart table will be fitted. The operating gear of the trimming system shall be actuated from the central station.

5. **The auxiliary central station** contains the wireless cabin with the mast tube well on portside and the galley on starboardside. In the forward corner one W.C. for officers is arranged. This compartment contains further the pumps and accumulators for the hydraulic system, a ballast pump, the trim pump, two turbo-blowers, two ventilating fans and rams for operating the periscopes, the masttube, convertors for wireless etc., and the operating gear for the 40 mm twin automatic gun. The lower part of this compartment is intended for stores ; a watertight casing for ammunitions and a refrigerator also being fitted in this part.

6. **The engine room** contains the Diesel engines with auxiliary pumps, the oil-coolers, the strainers, the Vulcan couplings with their piping, manoeuvring gear and oil pumps, the Junkers high pressure air compressor, the internal part of the after deck-tubes, a main ballast pump and a lathe of a suitable type.

7. **The main electric motor compartment** contains the main electric motors with fans and the switch gear, the thrust blocks, the claw couplings, the electrically driven high pressure air compressor and a light convertor.

8. **The aft torpedo-room** contains the stern tubes, the stearing gear, the after diving gear, the aft capstan gear, a bilge pump, and a showerbath and W.C. for the crew.

The necessary lockers and berths for the accommodation of 18 men will be fitted. The four reserve torpedoes are stowed under the flooring.

The deck is to be kept clear of all projecting parts. Capstans, bollards, etc. are made to lower into the superstructure. The railings and torpedo-davit can be taken away. The bridge is well protected and consists of a covered wheelhouse containing the magnetic compass, the gyro repeater compass, the steering wheel and the engine telegraphs. The conning tower and the housing for the 40 mm twin automatic guns are situated in the streamlined bridge-superstructure.

The conning tower contains a steering wheel, the engine and torpedo telegraphs, the operating gear for torpedo-firing and periscope hoisting, a repeating compass, a tachometer and a depth-indicator, as well as other necessary apparatus as hereinafter more fully described.

In the bridge-superstructure plugs for an electric range in a galley and a lavatory are fitted.

On the superstructure-deck and in the superstructure furthermore are fitted the forward capstan, the anchor gipsy, the aft capstan, the towing hook, one real for the stream-anchor wirerope, three pairs of bollards, two sets of fairleads, the standard compass and the telephone- and salvage buoys.

The motor dinghy and the folding boat are to be carried aft under the superstructure-deck.

Stowing places are made for the accommodation ladder, the hawsers, the stream-anchor, the torpedo-davit and the gangways.

The batteries are placed in gas- and watertight tanks below the petty officers' and officers' quarters respectively. Inside the tanks a small traveling crane will be fitted for lifting and transporting the accumulator-cells to the access-opening. A central passage between the cells will be kept free.

A part of the airbottles will be fitted between the sides of the battery tank and the pressure-tight hull, and other parts will be distributed over the ship in suitable places.

§ 3. DISPLACEMENT AND DRAUGHTS.

Submerged displacement, excluding non-pressure-tight compartments	D_1	1473.50 M³.
Surface displacement with full equipment, but excluding all waterballast	D_3	1094.— M³.
Displacement on surface with full equipment and vessel regulated for diving	D_2	1110.— M³.
Difference between D_1 and the displacement of 1110 M³.		363.50 M³
Mean draught on surface with full equipment, but excluding all waterballast		4.125 M.

Freeboard in way of frame 80 at this draught	2.225 M.
Mean draught on surface with full equipment and vessel regulated for diving	4.170 M.
Freeboard in way of frame 80 at this draught	2.180 M.
Freeboard in way of frame 80 to the bridgedeck	3.780 M.

§ 4. WEIGHTS.

A.	Hull	441.100 K.G.
B.	Diesel engines	85.800 K.G.
C.	Main electric motors	24.400 K.G.
D.	Battery and outfit	130.000 K.G.
E.	Electrical installation	17.500 K.G.
F.	Steering and diving gear	13.300 K.G.
G.	Capstans	6.700 K.G.
H.	Armament	93.150 K.G.
J.	Kingstons, pumps and waterpipes	24.400 K.G.
K.	Airpressure installation	26.900 K.G.
L.	Fuel oil, lubricating oil, pipelines	77.200 K.G.
M.	Ventillation	5.200 K.G.
N.	Miscellaneous installations	24.100 K.G.
O.	Equipment, woodwork, officers' and crew's quarters	13.000 K.G.
P.	Furniture	900 K.G.
R.	Fresh water, food, crew and effects	17.600 K.G.
S.	Paint, cement, etc.	15.500 K.G.
T.	Ballast	53.500 K.G.
U.	Miscellaneous details	5.000 K.G.
V.	Spares	3.500 K.G.
W.	Weight margin	15.250 K.G.
	Total weight	1094.000 K.G.

For calculating the Washington displacement, the following weights are to be substracted :

Lubricating oil	11.900 K.G.
Fuel oil	67.500 K.G.
Fresh water	6.000 K.G.
	85.400 K.G.

Washington displacement = 1094.000 — 85.400 = 1008.600 tons of 1000 K.G.. or 992.5 tons of 1016 K.G.

§ 5. CAPACITIES OF TANKS.

The tanks will have the following capacities:

Main ballast tank No. I	Net	65.00 M³.
Main ballast tank No. II	,,	66.00 M³.
Main ballast tank No. III	,,	64.50 M³.
Main ballast tank No. IV	,,	62.50 M³.
Main ballast tank No. V	,,	55.00 M³.
Main ballast tank No. VI	,,	50.50 M³.
Forward quick dive tank	,,	4.00 M³.
Midships quick dive tank	,,	10.00 M³.
Forward trimming tank	,,	15.00 M³.
After trimming tank	,,	10.50 M³.
Regulating tank	,,	25.00 M³.
Forward compensating tank	,,	8.00 M³.
After compensating tank	,,	7.70 M³.
Oil fuel tank No. I	Net	35.80 M³.
Oil fuel tank No. II	,,	6.70 M³.
Oil fuel tank No. III	,,	6.10 M³.
Oil fuel tank No. IV	,,	7.70 M³.
Oil fuel tank No. V	,,	5.20 M³.
Oil fuel tank No. VI	,,	7.50 M³.
Oil fuel tank No. VII	,,	7.50 M³.
Total fuel oil capacity		76.50 M³.
Lubricating oil tanks together	Net	10.30 M³.
Lubricating oil sumptanks	,,	3.10 M³.
Fresh water tanks	,,	6.00 M³.

§ 6. STABILITY AND TRIM.

The distance between the metacentre and the centre of gravity emerged is to be 60 cm. at least.

The distance between the centre of buoyancy and the centre of gravity when submerged is to be 22.5 cm. at least.

The distance between the metacentre and the virtual centre of gravity remains positive, even when filling all main tanks at the same time.

When the main tanks are blown out, the vessel will come to the surface approximately on an even keel.

For trimming the vessel by the stern, the bow-buoyancy tank can be blown out.

§ 7. STRENGTH OF HULL.

The hull is constructed for a diving depth of 80 meters measured from the underside of the ballast-keel.

In determining the scantlings of the pressure-tight hull, frames, rivets, etc., the following figures shall be taken as a basis to attain a satisfactory margin of safety :

a. Factor of safety against collapse of shell according to von Mises formula (with factor 0.6) ..... 1.65.

b. Factor of safety against collapse of frame-ring (with 40 × plate thickness of shell) ..... 2.40.

c. Maximum total stress in shell according to von Sanden :
with plain frames ..... 1400 Kg/cm²
in way of bulkheads ..... 2620 Kg/cm²
for l = frame distance.

d. Maximum stress in frames of fore and after part of vessel ..... 1750 Kg/cm²

e. Maximum initial comparative bending stresse in bulkheads rarely under pressure ..... 3000 Kg/cm²
Maximum stress in bulkheads often under pressure (in tanks) 2500 Kg/cm²

f. Maximum shearing stress in rivets ..... 1200 Kg/cm²

§ 8. WATERTIGHT SUB-DIVISIONS.

The vessel is divided into 5 watertight compartments, the foremost, centre and aftermost compartments being provided with escape hatches.

The three compartments amidships are further sub-divided by a light watertight bulkhead.

The convex pressure-tight bulkheads are fitted with circular watertight doors, the flat sub-division bulkheads with larger rectangular watertight doors.

The convex watertight bulkheads are suitably dimensioned to withstand a pressure of 8 Kg/cm² ; the intermediate bulkheads are arranged to withstand a pressure of 1 Kg/cm².

In the centre escape compartment the gun tower acts as a sluice. It is fitted for this purpose with an upper- and a lower entrance cover. These covers can be opened and shut from inside the auxiliary central station.

An inlet valve for seawater is fitted in the gun-tower and can be operated from the auxiliary central station and the gun-tower.

Means are provided for blowing or pumping out the tower.

The foremost and aftermost escape compartments are fitted with special hatch trunks of which the internal part can be extended downwards. When seawater is admitted into the compartment, an air pocket is formed in the upper part, the pressure in the compartment then being the same inside and outside.

It is possible for the crew to open the hatch-cover and to escape to the surface.

Construction.

§ 9. QUALITY AND TESTS OF MATERIALS.

All materials are to be of good quality and suitable for the purposce required.

If the Constructor so desires, he may have the tests of materials carried out at the factory of origin ; the charges for same, exclusive of personal expenses, are for his account.

Copies of specifications and delivery conditions are to be sent in good time to the I. C. before placing orders.

Siemens-Martin steel shall be exclusively used in the construction. That of Polish manufacture, with a strength of 42-50 Kg/mm², being used to obtain a diving depth of 80 M. with the same factor of safety as used in the Dutch submarine K. XVIII (cf. § 7).

a. Mild Quality Steel Ship Plates.

The mechanical qualities of this steel to be :

Tensile strengt 42-50 Kg/mm², keeping to the upper limit.
Elongation with plates up to 5 mm. thick 18 % min.
Elongation with plates from 5 to 10 mm. thick 20 % min.
Elongation with plates from 10 to 18 mm. thick 22 % min.
Test pieces to be 200 mm. in length.

A cold bend test piece taken from this material is to withstand without fracture, being doubled over until the internal radius is equal to 1½ times the thickness of the test pieces, and the sides are parallel. The test pieces are to be not less than 38 mm. wide.

Hot forge test may be made by the I. C. to ensure that the material is suitable for ordinary treatment in a shipyard.

With a view to the weldability of the material, the carbon contents are to be kept as low as possible (that is to say, 0.16 %), while the percentages of phosphorus and sulphur may not exceed 0.035 and 0.06 respectively, and together may not exceed 0.08 %.

Plates which are to be heated to attain their form are to be carefully annealed on completion.

The plates shall not be heavier than the calculated weight with a specific gravity of 7.85, the tolerance in weight allowed being + 0 % and — 6 %.

The greatest tolerance allowed for difference in plate thicknesses is to be taken from the following table :

Width of plates in mm. measured across rolls	Reduction in thickness allowed in mm. with plates of following thickness in mm.			
	5—6.9	7—9.9	10—14.9	15—19.9
Up to 1000	0.6	0.8	0.8	0.8
1001 to 1500	0.8	0.8	0.8	0.9
1501 to 1900	1.1	1.0	1.0	1.0
1901 to 2200	—	1.1	1.1	1.2
2201 to 2500	—	—	1.4	1.3
2501 to 2800	—	—	1.8	1.7
2801 to 3100	—	—	1.9	1.9
3101 to 3400	—	—	—	2.5
3401 to 3700	—	—	—	3.0

The finished material is to be free from cracks, surface flaws and lamination ; it is also to have a workmanlike finish and must not have been hammer dressed. A test piece for every kind of test to be taken from every 25 plates.

b. Steel Sheets, (Tensile tested), and Steel Sheets (Non-Tensile Tested).

For the less important parts of the vessel, for instance those for which plates under 5 mm. in thickness are suitable, the Constructor may, in agreement with the I C., use material conforming to modified requirements regarding the mechanical properties. or ordinary commercial material.

c. Mild Quality Steel Angles.

The requirements for this material, mechanical properties, composition, weight margins and surface inspection, are to conform to those applied to plates of the same material.

A test piece for every kind of test will be taken from every 25 angles.

d. Mild Steel Rivets.

The material for mild steel rivets to have a tensile strength of at least 34 to 42 Kg/sq.mm. and an elongation of at least 30 percent, and generally in accordance with Netherlands Normalization Sheet No. 718.

To ensure that no segregation of sulphur occurs in the materials, prints shall be taken in the manner as prescribed by Lloyd's.

Rivets selected by the I. C. from bulk shall withstand the following tests :

(1) Cold bending the shanks and hammering until the two parts of the shanks touch without fracture on the outside of the bent.

(2) Flattening of the rivet head while hot without cracking at the edges. The head to be flattened until its diameter 2½ times the diameter of the shank.

e. Steel Forgings of Various Qualities.

Steel forgings for minor parts to have a tensile strength of 34—42 Kg/sq.mm. and an elongation of 25 percent ; those for important parts to have a tensile strength of 41—49 Kg/sq.mm. and an elongation of 20 percent. The sectional area of the body of finished forging is not to be more than $^1/_5$th of the original sectional area of the ingot, and at no place the sectional area is to exceed $^2/_3$ of the original area.

All important forgings are to be thoroughly annealed.

Generally, the forgings are to be sound ; the Constructor may, however, on his own responsibility and with the consent of the I. C., repair minor defects by welding. For important forgings, one test piece to be taken from every forging.

For the bending test, a 1" wide by $^3/_4$" thick bar machined from the forging to be bent cold over the thinner section, through an angle of 180°, the internal radius not being greater than $^1/_4$" without fracture.

f. Steel Castings of Various Qualities.

Steel castings for minor parts to comply with the following requirements :

Tensile strength 38 Kg/sq.mm. — 46 Kg/sq.mm.
Elongation 20 % minimum.
Cold bend test 180°.

Castings for important parts (sternframe, propeller brackets, bulkheads, conning tower cap and access hatches), to comply with the following requirements :

Tensile strength 45 Kg/sq.mm. — 55 Kg/sq.mm.
Elongation 16 % minimum.
Cold bend test 120°.

All castings to be thoroughly annealed, and to be clean, sound and free of twist and blow holes. The Constructor may, however, with the permission of the I. C., and on his own responsibility, repair minor defects not impairing the general strength, by welding. In case either the tensile or bend test or both fail, and it is considered that the results do not fairly represent the qualities of the casting, duplicates of the test or tests which fail are to be made, if required by the manufactorer. In such cases, the casting is to be judged by the result of the duplicate test.

Castings of suitable form are to withstand satisfactorily a drop test from 7 to 10 ft. in height.

All castings are to be hammered in order to detect any unsoundness or cracks. If necessary, drilling tests will be carried out in large sectioned parts.

g. **Weldability.**

The composition of all rolled, forged and cast steel parts to be such that they may be readily welded, and when other parts are welded to them, they shall suffer as little as possible.

§ 10. SCANTLINGS.

The scantlings mentioned in the following paragraphs have been calculated generally in accordance with the data given in § 7, „Strength of Hull". They are given, however, only bij way of information, the Constructor having the option, in agreement with the I. C., of making changes in the scantlings in every case that further detailed calculations during the preparation of the working drawings show this to be possible or advisable.

§ 11. RIVETING AND CAULKING.

The riveting work must be carried out by skilled men, who are to give it their full attention so that it may conform to the strictest requirements.

The rivets must fill the holes completely ; all inaccurate holes must be reamered out before riveting and recountersunk.

Countersinking of holes must be done with great care and the countersink drills are to be fitted with an appliance, which prevent too deep a countersink being made.

The heads of the rivets must not project too far ; neither is it permitted to beat them out over the plate and so cause a thin layer to overlap.

Where a constructional part is to be partly welded and riveted, no riveting will be allowed until the welding work is completed and has been certified correct, unless the distance between the welding and rivets is such that no influence is to be feared.

Where electric welding is to be carried out in the vicinity of the riveted work for attaining watertightness, those rivets are to be touched up with a view to slackness through shrinkage.

All rivets of 10 mm. or less may be riveted cold. Rivets for this purpose are to be of soft material yet sufficiently strong and are to be annealed.

With a weight reduction in view, double countersinking is to be applied where possible.

Rivets in open floors may be single countersunk provided the extra weights of the heads are compensated for by further reductions.

Where possible, riveting is to be done hydraulically or pneumatically before erection on board.

The dimensions of the rivets to be used, as also their kind, the dimensions of the countersinks, straps, butts, longitudinal sams etc., are to be tabulated for the information of the I. C. This table will also denote which rivets are to be driven cold or hot and shall be approved by the I. C.

For electric welding see § 12.

The flange width of bars for single riveting must be 3¼ to 4 times the rivet diameter, taking into consideration whether the bar will be caulked or whether the rivets are to be placed close in the neck such as when the bar is subject to stresses in a direction parallel to the axis of the rivets.

With single-riveted oiltight work the rivet pitch is to be 3½ D, with double oiltight work 4 D.

For ordinary and non-watertight work, bars may be riveted to plates with a pitch of 4 to 5 D, except where great shearing stresses can be expected; towards the ends the rivets are always to be shorter pitched (about 3½ D). For non-watertight work on the thin plating of the superstructures, a pitch of 6—8 D. may be used.

Before riveting faces together, they are to be carefully cleaned and scaled, and in so far as they are not oil or watertight, thoroughly coated with red lead paint.

All work in way of water or oil-tight connections will be carefully caulked.

§ 12. ELECTRIC WELDING.

The workmen carrying out the welding will give actual proof of their competence by carrying out one or more tests to the satisfaction of the I. C.

If, at actual work, the welder who has passed the above test does not carry out his work conscientiously, he may, at the request of the I. C., be replaced by another.

Electric welding by the Arc process only to be allowed, using coated electrodes.

The Constructor having an extensive experience of electric welding, shall only use those electrodes with which the welds are able to satisfy the highest demands regarding tensile strength, elongation and percussion tests.

V seams are to be utilized with plates as thick as possible. Before examination by the I. C. the closed side may not be completed.

Before commencing the welding work, a complete table of dimensions of the seams and electrodes to be used etc., must be compiled, and approved by the I. C.

During welding, the article must be kept perfectly dry. When welding in the open, the necessary precautions must be taken to shield the article from high winds. Welding shall be discontinued during severe frost. Continuous light welds are to be used when securing bars to plates in preference to interrupted welds.

Crossing of welds must be avoided.

Welded seams must be dressed by chisel and not with a grinder.

The foundations for the main and auxiliary apparatus may by welded as far as possible, but must be secured by T bars or strips welded to the circular hull, previous to the riveting.

The necessary precautions regarding the earthing, insulation, etc., are to be taken.

Important constructional parts may only be welded as far as this is possible in the workshops. The necessary connections for assembling on the slipway to be made by riveting, except light welds used for obtaining watertightness, according to the Netherlands Navy practice.

All welding to be done must be approved by the I. C. All welds to be carried out and checked under similar conditions as obtaining for modern Netherlands Navy work.

§ 13. GALVANISING AND PICKLING.

All plating and angles of 5 mm. in thickness and less exposed to the action of sea water are to be pickled and galvanised.

The galvanising is to be carried out by the hot process.

Plates and bars showing a tendency to flake during manufacture, are to be re-galvanised on completion.

The utmost care is to be taken in galvanising the various articles which come under this process.

Work which has been galvanised under too high a temperature or whose mixture contains too great a quality of hard zinc, as also that which has not been efficiently cleaned or made acid free, shall not be accepted.

§ 14. DATUM PLANES.

The necessary centre and position lines will be marked off on the rudder and hydroplanes as also the centre lines of the hull internally.

Bulkheads on the external hull and the necessary frames internally are to be marked by easily visible number plates.

§ 15. STERNPOST AND FIN.

The sternpost shall be constructed of cast steel and will be attached to the keel plate the shell and the frames by riveting.

It carries the rudder and has a second gudgeon for additional support inside the vessel.

The centre bearing for the after hydroplanes is situated in the same casting just forward of the above mentioned gudgeon. At a short distance in front of the rudder a streamlined fin will be fitted, made of cast steel or plating to protect the rudder when the vessel is grounding. A light bar is provided from this fin to the lower extremity of the rudder to fend off mine cables, etc.

§ 16. STEM.

The stem will be made of cast steel of adequate dimensions and will be made of two parts scarphed together.

At the after end of the top and bottom of the casting the shape must conform to the run of the frames. For securing cutter blades the stem shall be provided with a cast on flange, and if such be necessary, the forward keel and deck plates are to be fitted with angle bars for the same reason (see also § 51).

§ 17. KEEL.

The horizontal keel plate in way of the Kingston valves to have the dimension of 2300 × 30 mm.; in the fore and after part of the vessel, the thickness will be 14 mm.

The keel plates will be joined together by means of butt straps or by welding.

§ 18. BALLAST KEEL.

The channel keelson extends from frame 34 to frame 123, and is closed by a 14 mm. plate to make it watertight and pressuretight so that drains from compartments and ballast tanks may be led therein.

In way of the inlet valves for the main ballast tanks, portable grids are fitted to the duct keel made of steel plating 10 mm. thick.

Ballast in blocks of 50—60 K.G. will be stowed at each side of the duct keel in a casing of 5 mm. plating adjoining the above-mentioned grids.

§ 19. VERTICAL KEEL.

The vertical keel extends from frame 38 to frame 120 and consists of a vertical plate 335 × 11 mm., secured by angle bars to the circular pressure hull and by welding to the keel plate. In way of the Kingston valves, the vertical keel forms a watertight sub-division.

§ 20. FRAMING.

Between the frames 38 and 118 of the circular pressuretight hull the frames are placed on the outer circumference. They consist of channel bars of 160 × 65 × $7^1/_2$ × $10^1/_2$ mm. (N.P. No. 16); the distance apart to be 550 mm.

The ballast tank framing to consist of angle bars of 65 × 50 × 7 mm., connected to the inner hull framing by angle bars of 55 × 55 × 6 mm., and by a gusset plate in the lower part of the frame.

The frames at the inner side of the pressure hull in the fore and after part of the vessel are constructed of an anglebar of suitable dimensions, a frame plate and a strong face plate welded to the frame plate, of such scantlings, that a maximum of strength is obtained with a minimum of weight and dimensions.

Alternatively, the frames at the end of the vessel may be constructed of channel bars of suitable dimensions.

The spacing of the frames in the fore and after part of the vessel is 500 mm.

With a view to shearing, the necessary rivets are to be provided in riveting the frames to the shell plating.

§ 21. HULL PLATING.

The garboard strake has a thickness of 14 mm., also in the forward and after parts of the pressure hull, except outside the pressure hull, where it is 6 mm. and 7 mm.

The B, C, D and E strakes are to be 14 mm. thick, except over the length of the main ballast tanks where they are 6 mm. ; those of the non-pressure tight hull fore and aft are 6 to 7 mm. thick.

Suitable doubling plates or increased scantlings are to be provided from the bow to fr. 141 for ice protection, 1 M. broad.

The shell plates of the foreship and superstructure at the bow are to be 6 mm. and 5 mm. thick.

Straps and longitudinal seams are to be double riveted and except the joints of the keel plate to be overlapped.

The shell plating of the cylindrical pressure tight hull (the inner shell) will be 14 mm. thick. This shell will be composed of laterial rings made from plates the ends of which are joined together by means of double butt straps, which are staggered in the circumference and the edges of which are joined to form a long cylindrical tube.

The E. straks plates in way af the main ballast tanks are connected to the cylindrical inner shell by means of a flanged margin plate secured by angle bars.

The shell plate below the conning tower is 16 mm. thick.

Doubling plates will be fitted also in way of all large openings in the shell, such as anchor bridge, large sea connections, silencer, exhaust gas piping, shaft brackets, etc., and further in all such places as is deemed necessary to secure adequate strength.

All plate edges are to be squared by means of a mechanical burner or planing machine.

Straps and joints in shell plating must be efficiently staggered.

Before ordering plates, the Constructor shall construct a plating model on which the duct keel, bulkhead angle bars, longitudinal stiffeners, double bottom angle bars, doublings, etc., are marked ; this model is to be approved of by the I. C.

§ 22. PORTABLE PLATES.

Portable plates will be provided in way of the Diesel engine compartment, electro motor compartment, and forward battery compartment, in order to facilitate the shipping and unshipping of the various parts. These portable plates to be fixed by nickel steel bolts.

Rectangular openings with gastight covers to be provided in the decks of the battery tanks, directly under the entrance hatch, respectively portable plate in the hull.

§ 23. CONNING TOWER.

The circular conning tower has a diameter of 2500 mm., and is constructed of steel plate 10 mm. thick, and is closed at the top by means of cast steel cap 30 mm. thick, of material conforming to the specifications of § 9 (Materials), which also is fitted with a hatch opening to the bridge and three bushes for leading the periscopes and the mast tube through. The conning tower will be stiffened by suitable external framing.

The conning tower is supported by the circular pressure hull and is secured to the latter by means of an angle bar of 130 × 130 × 12 mm.

The edges of the conning tower plate will be joined by welding.

A second cylindrical structure of about 2100 mm. in diameter and 9 mm. plating will be built abaft the conning tower to serve as a housing for the 40 mm. twin automatic guns, and at the same time as an access and exit opening for the gunners. The cast steel cover of this structure will have separate openings with watertight hinged covers for the guns and the extrance. The shell of the cylinder will be suitably stiffened by external framing and securely connected to the pressure hull.

The gun tower shall be arranged to act as an escape sluice.

The riveting of the angle bar attaching the conning- and gun towers to the shell, shall be effected in such a way that the rivets to the towers shall give way first in case of accident.

§ 24. WATERTIGHT BULKHEADS AND FLOORS.

The watertight bulkheads in the main ballast tanks are situated as shown on the drawings.

Wash plates are fitted amidships in the main ballast tanks between tank bulkheads at the proper frames.

In the pressure tight shell 4 convex bulkheads are placed as shown on the drawings. There are also three flat bulkheads at frames, forming divisions between the Diesel and electric motor compartments, the central and auxiliary central station and Officers' and Petty Officers' quarters respectively. The convex bulkheads are constructed to stand a pressure of 8 Kg/sq.cm. on the concave side, the others to withstand a pressure of 1 Kg/sq.cm. Each of these convex bulkheads is fitted with a circular door of adequate dimensions (see Doors, § 25).

The floors in the cylindrical pressure shell are to be of plate 8 to 12 mm. thick.

The oiltight and watertight floors are situated as shown on the drawings.

The floors have large lightening holes cut in them where possible, anglebars are fitted between these holes to stiffen the floors as necessary, the dimensions being 60 · 90 × 10 mm.

§ 25. WATERTIGHT DOORS, WATERTIGHT ENTRANCE- AND TORPEDO HATCHES.

The convex bulkheads are each equipped with a circular pivoted watertight door of adequate dimensions (not less than 800 mm. in diameter) and capable of withstanding a pressure of 8 Kg sq.cm.

The doors of flat bulkheads are only required to withstand a pressure of 10 Metres water head. They are, however, of larger dimensions.

The doors are to be provided with india-rubber closing strips; the circular doors will have a closing spring, a single-handed closing movement actuated from both sides of the bulkhead, the others will be fitted with the usual clamp fasteners.

Care must be taken with the finishing of the doors to ensure that they attain a maximum amount of airtightness.

W.C. doors to be fitted with rubber liners to prevent contamination of the atmosphere.

Five outside entrance hatches in total will be fitted to the bow, midships and stern compartments, as well as to the conning and gun towers. All these hatches to be of the Netherlands Navy type and about 720 mm. in diameter. Sleeves to be fitted to the forward and aft hatches by means of which these hatches can be extended downward, so as to enable the escape from the respective compartments in case of accident.

Each main ballast tank shall be provided with a manhole at the top of the tank, all other tanks also to be provided with manholes as far as possible; where this is not possible, however, entrance shall be gained by way of an adjacent tank, which will have the necessary manhole cut in the divisional bulkhead.

The manhole covers of oil tanks will be packed by means of cardboard or canvas rings which have been well soaked in shellac and tar. For manhole covers of water-tanks rubber rings with linen insertion shall be used.

The studs for manholes shall be made of manganese bronze or steel, and the nuts of naval brass

The access hatches are cylindrical and are made of steel plate 10 mm. thick welded along the seam, and joined to the hull by means of a rivetted anglebar or by welding. The upper end is strengthened by means of a steel rim under which the jaws of the cover grip, when closing the entrance. The covers are to be fitted with quick closing devices, which can be operated both from outside and inside the vessel.

The entrance hatch of the gun tower can be quickly closed from the auxiliary central station. By the same mechanism the gear locking the hatch in open position is released.

Bronze balance springs or counterweights are to be fitted to take the weight of the covers.

The torpedo hatches of about 700 mm. in diameter are made of a curved steel plate of 14 mm. thickness, secured to the shell by means of an angle bar 130 × 75 × 12 mm., and are closed by means of a cast steel cover fitted with clamp fastenings; they are, however, not fitted with spring balancers.

The lower hatches of the gun- and conning towers are of similar design.

§ 26. PERISCOPE WELLS.

Wells for the periscopes and the mast tube shall be made of plate 6 mm. thick and shall be secured to the hull, tank top plating and double bottom in an efficient manner. The necessary draining arrangements shall be provided.

§ 27. ENGINE BEARERS.

Both Diesel engines are mounted on foundations consisting of a stiffly built lubricating oil tank and a triangular boxframed construction at each side of the circular pressure hull, strengthened with channel bars and heavy strips respectively.

§ 28. ELECTRIC MOTOR BEARERS.

The electric motors are mounted on a foundation similar in construction to those of the main engines, which, however, in this case, acts as a fuel oil tank.

§ 29. AUXILIARY MACHINERY SEATINGS.

Foundations for the auxiliary machinery shall be carried out to the instruction of the I. C.

§ 30. ACCUMULATOR SEATINGS.

The wood work in the battery tanks for the seating of the accumulators shall be of hard quality and coated with isolacite to withstand the action of acids.

§ 31. COMPENSATING TANKS.

The compensating tanks are situated between frames 25 and 28, and frames 124 and 128, respectively, and are bounded by the shell and tank top plating. They are to be tested to a pressure of 3 Kg/sq.cm., and are to be provided with safety valves.

§ 32. REGULATING TANKS.

The regulating tanks are situated on port and starboard side, between frames 77 and 81, at the outer side of the pressuretight hull. They are to be tested to a pressure of 8.5 Kg/sq.cm., without showing any permanent deformations.

The outer hull plating and framing is to be suitably re-inforced in way of these tanks.

§ 33. QUICK DIVING TANKS.

The forward quick diving tank is situated between frames 138 and 141, and is bounded by the shell and the tank top plating. The midships quick diving tank is situated between frames 80½ and 85, and is bounded by the internal pressure hull and the curved tank top plating.

Both tanks are to be tested to 8.5 Kg/sq.cm. pressure as the regulating tanks.

§ 34. TRIMMING TANKS.

The trimming tanks are situated between frames 16 and 25 and frames 128 and 138, respectively. The after trimming tank is further bounded by the shell and the stepped tank top plating, the forward trimming tank by the shell and the tank top. They are to be tested to 8.5 Kg/sq.cm. pressure as the regulating tanks.

§ 35. FUEL OIL TANKS.

Fuel oil tanks are situated as shown on the drawings.

The foundation for the main electric motors mentioned under § 28 also serves as a fuel oil tank.

The tanks situated between inner and outer shell will be tested to a pressure of 8.5 Kg/sq.cm., groupwise, those situated inside the inner hull will be tested to a pressure of 2 Kg/sq.cm.

In addition, the main ballast tanks Nos. 3 and 2 will be arranged to carry an extra supply of fuel oil, if necessary. The supply of oil carried in the tank No. 2 shall not be taken into account for determining the radius of action.

§ 36. LUBRICATING OIL TANKS.

The lubricating oil tanks are situated inside the circular pressure hull between frames 54 and 63, the top being utilised to support the Diesel motors, and between frames 52 and 63 inner and outer shell. The tanks will be tested to a pressure of 2 Kg/sq.cm., resp. 8.5 Kg/sq.cm.

§ 37. FRESH WATER TANKS.

The fresh water tanks are situated as shown on the drawings. A divisional bulkhead is to be fitted so that one section will serve as a receptacle for distilled water.

The tanks will be tested to a pressure of 2 Kg/sq.cm.

§ 38. MAIN BALLAST TANKS.

The main ballast tanks are situated between the outer and inner hull, and extend from 38 to 55, 55 to 67, 67 to 77, 81 to 91, 91 to 102, and 102 to 118. The bulkheads situated in way of frames Nos. 38, 77, 81 and 118 between the outer and inner hull, will be sufficiently strengthened to withstand a pressure of 8 Kg/sq.cm.

The tanks will be tested to a pressure of 2 Kg/sq.cm.

§ 39. WATER AND AIR TESTING.

All tanks on completion are to be tested to the specified pressure with water and shall be perfectly tight and show no appreciable permanent deformation.

The various compartments throughout the hull shall be tested under air pressure of 1 Kg/sq.cm. and soaped outside to ascertain any leakage of the pressure hull and bulkheads.

§ 40. DOUBLE BOTTOM AND LONGITUDINAL STIFFENERS.

The double bottom between frames Nos. 16 and 25 is 20 mm. thick, from frame 25 to 39 is 12 and 10 mm. thick ; the former tank top is level and stepped to the latter, which is dished at the centre line and joined to the hull plating at the sides by curved margin plates.

In the forward part of the vessel the double bottom extends from frame No. 117 to 134, where it is stepped to frame No. 141. The thicknesses of these plates being 10 to 12 mm. from frame 117—128, and 20 mm. from frame 128—141 ; it is flat throughout its length.

The curved tank top plating in way of frames 78—85 is 18 mm. thick, and is joined to the circular inner shell and bulkheads by means of suitable anglebars.

The level tank top plating between frames 85—100½ and 101½—117 is 10 mm. thick, and joined to the circular inner shell and bulkheads by an anglebar 75 × 75 × 9 mm.

A plated flat is provided forward of frame 150 above the bow torpedo tube shutters.

All the above plates will be suitably stiffened by longitudinal bars where necessary.

§ 41. MARGIN PLATES.

The main ballast tanks are bounded at the top by flanged margin plates 6 mm. thick, extending from frame 38 to 118, this plating being specially strengthened between frames 77—81, in way of the regulating tanks.

Margin plates 13 mm. thick are also fitted between the fuel oil and main ballast tanks.

§ 42. SUPERSTRUCTURE.

The dimensions of the superstructure plating and the further constructional parts are to be so chosen that they attain a maximum strength with a minimum of material and weight. The scantlings not to be less than 3 mm. thick. The necessary stiffeners must be fitted in way of the swivelling torpedo tubes, capstans, bollards, etc. The deck will be covered with teak strips.

Care is to be taken that a quick clearance of air and water is attained by cutting the necessary clearance holes and fitting scupper pipes in the most suitable positions, and by leaving a space free between the superstructure and the hull.

The part of the superstructure extending over the length of the tubes is connected to the tubes and rotates with them.

Note : If possible the deck will remain fixed.

§ 43. BATTERY TANKS.

The side plating of the battery tanks is to be 5 mm. thick, and will be efficiently secured to the circumference of the pressure hull. The sides are stiffened by means of angle and channel bars, the lateral support being given by means of flanged brackets riveted between the circular pressure hull and the battery tank sides. The forward and after ends are formed by the bulkheads at frames Nos. 85, 100½, 101½ and 117.

Anglebars are provided for supporting the top plating of 4 mm. thickness, which is provided with a suitable opening for shipping and unshipping the accumulator cells.

§ 44. GUN AND TORPEDO TUBE SUPPORTS.

The gun will be secured to a steel ring which in turn is secured to a steel ring directly attached to the circular pressure hull. This steel ring will be constructed of plate, the ends of which are welded together electrically and which will be stiffened internally by means of transverse plates.

One set of quick firing guns is mounted in a cylindrical steel structure abaft the conning tower, which is described under § 23.

Suitable steel castings are fitted to the hull for supporting the racers of the swivelling torpedo tubes.

§ 45. BRIDGE SUPERSTRUCTURE AND FAIRWATER.

The bridge superstructure is largely built of 3 mm. steel plating, exept where deemed necessary to use brass or other non-magnetic material where the compasses may be influenced.

It surrounds the 105 mm. quick firing gun casing, the conning and gun towers, galley and deck lavatory, etc., and also affords protection for the projection-compass tube, the wireless inlead, forward periscope, ammunition bins and the mast tube.

For supporting the periscopes at their upper ends adequate strong brackets shall be secured to the top of the conning tower ; these are to be carefully brought in line with the openings in the conning tower cap, to ensure the periscopes being fitted without internal stresses.

The wheelhouse at the centre of the bridge superstructure is to be built of light plating and all enclosed. Extra stiffening shall be provided where the periscopes project through it, as also in way of the mast tube, the aerial and direction finder inleads.

Large portholes are to be fitted at the forward part, and brass or other non-magnetic material is to be used in the construction of the wheelhouse where necessary, in way of the magnetic compasses within a radius of one meter.

§ 46. STERN TUBES AND SHAFT BRACKETS.

The stern tubes extend from frames No. 38 to the closing pieces at frame No. 26, and are to be made of solid drawn steel tubing. The tubes are to be provided with bronze bushes fitted with lignum vitae strips.

The shaft brackets are to be made of cast steel as delineated in § 9 (Materials). The sections of the arms are to be streamlined.

Streamlined guardplates are to be fitted to the forward ends of the bosses and securely fastened to same and the latter are to be formed to give a gradual run to the propeller bosses.

The closing pieces of the bulged frames in which the after end of the stern tubes are secured are to be manufactured of cast steel and are to be provided with flanges to secure same to the shell, and they also are to be provided with easy flowing guard plates.

§ 47. RUDDER AND RUDDER HEAD.

The rudder is to consist of a high tensile steel (55—60 Kg/sq. sm.) rudder post, the upper cylindrical portion of which is bored out internally, and a watertight plate casing of 8 mm. thick, stiffened by means of anglebars of adequate dimensions.

The rudder post has a tapered end fitted with a keyway for securing the tiller, which is held to the rudder post by means of a large nut fitted with a check.

The tiller is to be carefully fitted to the rudder post.

The rudder plating is made watertight and filled with blocks of pine carefully painted with red lead.

Stops are to be provided either on the rudder or on the rudder head.

The rudder area measured over one side is about 10 M^2.

§ 48. HYDROPLANES.

The after hydroplane consists of two separate planes mounted symmetrically with regard to the keel and sternpost, and secured by means of tapbolts to a high tensile steel forging fitted with two flanges. This shaft or spindle has a fork ended crank to which the actuating mechanism is connected.

The hydroplanes are supported at their outer ends by a gudgeon pin fitted in a bush in the hydroplane fins.

Stops are to be provided on the rudder lever.

The planes consist of a high tensile steel (55—60 Kg/sq.cm.) main piece, face plates of 6 mm. thickness adequately stiffened by means of anglebars and a filling of painted pine wood. They are to be watertight.

The leading edge has a partial filling of lead to balance the larger trailing edge, the amount being calculated to give a perfect equilibrium when submerged.

The planes area measured over one side is to be about 7.8 M^2.

The forward hydroplane consists of two symmetrically mounted planes, which can be folded horizontally into the superstructure. Each of these planes is fitted with a short stock which can be rotated in a third stock mounted horizontally athwartships. A crank is fitted to the latter which is connected to the actuating mechanism in the vessel as also the cranks and levers for folding the planes inboard.

The hydroplane stocks and other parts of the folding and actuating mechanism shall be made of high tensile steel (55—60 Kg/sq.cm.) where necessary, the foundations, carrier rings, etc., to be of cast steel conforming to the specifications as delineated in § 9 (Materials).

The hydroplanes must be provided with an efficient check to prevent movement athwartships.

The plating is to be 6 mm. thick, stiffened with anglebars ; they are to be watertight and to be filled with red leaded pine wood. When submerged they are to be in perfect equilibrium.

The area measured over one side is to be about 4.2 M^2., and the hydroplanes are to be so shaped that they will clear mine cables.

§ 49. INTERCHANGEABILITY OF RUDDERS AND HYDROPLANES.

Care is to be taken, that all rudders and hydroplanes shall be interchangeable between the two vessels to be built after this Specification.

§ 50. PROPELLER AND HYDROPLANE GUARDS.

Guards consisting of steel plating with a cast steel endpiece are to be fitted to the tailshaft brackets; they are to be treated with bitumastic and filled with pine wood blocks soaked in red lead paint.

§ 51. NET CUTTERS.

The cutter blades will be made of hardened and tempered suitable stainless steel and will be secured to the stem by means of fitted bolts.

§ 52. ANCHOR SEATING AND HAWSE PIPE.

For shipping the anchor, a suitable anchor bridge will be provided in the side plating of the bow. A vertical hawse pipe will be fitted for leading the chain to the locker.

The stream anchor will be stowed in a suitable position inside the superstructure.

§ 53. CHAIN LOCKER.

A chain locker will be fitted in the bow between the torpedo tubes and so constructed that the cable will be automatically stowed.

§ 54. LAGGING.

The hull in way of the various living compartments, shall be suitably lagged with plywood, in order to prevent undue loss of heat in cold weather. Drip guards to be fitted against condensating water wherever necessary. All lagging and woodwork, furniture included, to be fixed by screws so as to be easily detachable.

§ 55. CEMENT WORK.

Cement will be applied to the double bottom tanks to enable water to flow away easily from between the frames, the bottoms of the water tanks, as also spaces between floors and places difficult to be kept dry, are to be similarly treated.

Where this cement filling attains considerable dimensions, it will be partly mixed with larger or smaller pieces of light fireproof material to limit the weight as much as possible.

The cement to be used shall preferably consist of two parts of sand to one of cement.

Where bitumastic material has been applied to prevent corrosion, bitumen cement will be used in place of the ordinary sort.

The cement washing of fresh water tanks will be treated in § 56 „Paintwork".

§ 56. PAINTWORK.

The vessel will be painted internally and externally in the usual manner with which vessels of this class are dealt.

The paintwork is to be carried out with hand brushes by experienced workmen, and care is to be taken that painting can be commenced on the approval of the I. C. as early as possible so that the necessary attention may be given to it.

Nickel and chromium plating, and in general all polished articles, rubber closing edges, zinc plates, etc., will not be painted.

All steel work will receive three coats of red lead, and all parts exposed to view shall afterwards receive two coats of paint in the approved colours.

Galvanised work will receive one coat of red lead instead of three.

The red lead paint to be used shall have the following composition :

Red oxide of lead	6.6	parts by weight.
Whitening	1.1	parts by weight.
Boiled linseed oil	1.0	parts by weight.
Raw linseed oil	1.0	parts by weight.
Turpentine	0.2	parts by weight.
Drying oil	0.1	parts by weight.
Total	10.0	parts by weight.

Filling to be used sparingly, and parts to be varnished are to be treated with Valspar or similar varnish.

The fresh water tanks will be cement washed.

The fuel oil and lubricating oil tanks will not be painted internally.

The tops of all compartments inside the vessel will be treated with granulated cork wherever necessary to minimise sweating, down to about 600 mm. above floor level.

As little cement is to be used as possible.

The battery tanks are to be treated internally with an acid-resisting compound.

The air ducts are to be painted internally with a non-smelling acid resisting compound.

The deck torpedo tubes are to be treated with two coats of bitumastic solution and afterwards to receive treatment with Flintkote.

The Diesel engines are to be painted with aluminium paint.

§ 57. ZINC PROTECTION AGAINST CORROSION.

Zinc plates of adequate size and shape are to be fitted on all places where experience proves that strong corrosive actions are to be expected.

Wherever copper or brass and steel are in close neighbourhood such as in the vicinity of propellers, sterntube liners, brass valves, silencers, etc., adequate use shall be made of zinc slabs of rolled material, secured and guarded in an efficient manner.

§ 58. DRAUGHT MARKS.

The necessary draught marks are to be accurately marked off and punched on the stem, stern and amidships while the vessel is still on the stocks.

§ 59. DRAWINGS.

At the execution of the detail working drawings all the requirements of the agreement shall be strictly adhered to i. e. the reduction or augmentation of guaranteed figures stipulated in the agreement may only be carried out after approval of the Polish Navy.

§ 60. NUMBER OF MEN.

The normal complement shall consist of 5 officers, 19 petty officers and 32 seemen, but there shall be accommodation for 10 officers.

§ 61. OFFICERS' CABIN AND WARDROOM.

In the officers' quarters, cabins are to be provided with polished or sprayed teakwood fittings. All the officers' cabins shall be fitted out with lockers, bunks, desks and chairs, and a small washstand with a mirror, running water and discharge pipes. There shall be two single and two double cabins.

Officers' berths to be not less than 1900 mm. × 650 mm.

The fittings of the wardroom include a bookcase, lockers, 2 tables, 6 folding chairs and 2 settees, all of which are to be of polished teakwood with chromium plating fittings. The upholstery of the settees to be of naval blue velvet. The two settees are provided with swing-up backs which then form extra sleeping accommodation for 4 officers.

§ 62. OFFICERS' W.C.'S, SHOWERS AND WASH BASINS.

A small space is reserved in the officers' quarters for a shower bath with a washbasin and a mirror. The floor of this space will be suitably cemented and tiled. The officers' W.C.'s shall be arranged in the auxiliary central station and in the superstructure.

§ 63. SENIOR PETTY OFFICERS' CABINS.

In the petty officers' quarters, there are to be two double berthed cabins for senior petty officers equally fitted out entirely in polished or sprayed teakwood. Each cabin is fitted with two bunks, two chairs, two small desks, a mirror, two lockers and a washbasin with running water.

§ 64. PETTY OFFICERS' QUARTERS AND MESSROOM.

The remaining space at the sides of the petty officers' quarters is to accommodate teak faced lockers, which shall be built blockwise, and be removable.

15 bunks will be provided, of light steel frames, fitted with spring mattresses and are to be made portable for stowing out of the way during daytime.

2 tables will be provided, as well as the necessary number of suitable camp stools and benches. Two mirrors for common use to be provided. A medicine chest will be fitted, and a cupboard for mess utensils.

One light convertor and one battery fan to be placed in this compartment.

The space below the side lockers in the petty officers' quarters is to be utilised as far as possible for the fitting of drawers, which are to contain clothes, and also allow space for the stowing of personel effects of the crew.

§ 65. PETTY OFFICERS AND CREW SHOWERS, WASHBASINS AND W.C.'S.

A space for a shower bath is provided in the petty officers' compartment. In each of the forward and aft torpedo rooms a lavatory with shower bath and a W.C. is fitted ; the W.C. in the forward torpedo room also serves for the petty officers. These spaces will be suitably cemented and tiled. A washstand with mirror to be fitted in each lavatory.

§ 66. CREW'S QUARTERS.

14 bunks of similar construction to those in the petty officers' accommodation are fitted in the bow compartment and 18 in the stern compartment for use of the crew. The compartments to be lagged with plywood in way of bunks, except in way of lockers. The latter to be made of pinewood, and fitted to the shell. In each compartment, two collapsible tables will be provided, as well as the necessary camp stools and benches.

All bunks to have minimum dimensions of 1900 × 600 mm. All tables throughout the vessel to be provided with shifting strips.

Four mirrors in total to be supplied for the crew compartments. Each member of the crew shall have his own locker.

The necessary curtains will be fitted in living rooms and linoleum or any approved floor coverings will be provided.

§ 67. PETTY OFFICERS' AND CREW'S W.C. IN SUPERSTRUCTURE.

A lavatory and W.C. is to be fitted in the bridge superstructure, which will have a wood grating floor.

§ 68. GALLEYS.

A galley will be provided in the auxiliary central station, and a second galley with suitable W.T. plugs for electric hot plates shall be fitted in the bridge superstructure. The inboard galley to have suitable tiled floor ; water supply and the necessary stowing places for cooking utensils to be provided for both galleys. An electrical baking oven will be provided for 8 loaves of 2 Kg. (type „Wilk"). An electric ventilating fan of about ½ H.P. to be provided for efficient ventilation of the inner galley. Suitable means to be provided for ventilating the outer galley.

§ 69. PANTRY.

A pantry shall be provided at the portside of the after end of the officers' compartment. It shall be fitted with the necessary lockers, a folding table, racks, and a running fresh water supply with drain. This pantry shall have a suitable curtain alongside the officers' passage.

All details in respect to the living compartments, W.C.'s, lavatories, galleys, pantry, etc., shall be executed in accordance with the instructions of the I. C.

§ 70. STAIRS AND LADDERS.

Light steel ladders are to be supplied and fitted to all deck entrances and escape hatches, and are to be provided where possible with flat steel steps.

Where ladders are provided in the superstructure leading to the bridge, they are to be of galvanised steel.

Hand and footholds are to be provided at both sides of the bridge superstructure at the forward and after ends, as also in the middle.

Rungs are also to be fitted in way of the torpedo tubes, and wherever necessary for access.

§ 71. REFRIGERATOR.

An Electrolux or similar type of refrigerator approved by the I. C. will be fitted in the general store room.

§ 72. MAGAZINES AND STORES.

A watertight magazine will be fitted in the general store room below the auxiliary central station, provided with the necessary racks or trays for carrying the ammunition.

Further watertight bins will be placed in the neighbourhood of the 105 mm. gun to hold 20 rounds of ammunition for immediate use. Inside the gun tower 8 boxes of ammunition for the 40 mm. guns will be stowed for immediate use.

Of the 20 torpedoes carried on board, 12 will be stowed in the various tubes and the other 8 will be stowed below the flooring in the bow and stern torpedo compartments, for which the necessary chocks and straps will be provided. The general store will be fitted with all necessary shelves, racks and cupboards to stow the various gear in a seaworthy condition. For the stowage of dry cereals and sugar, tin boxes of Polish pattern shall be provided.

Additional store spare will be provided in the forward torpedo compartment below the spare torpedoes and in the aft compartment, under and behind the torpedo tubes, and in general all available space throughout the vessel will be utilised and arranged for carrying the various spares, etc. The total capacity of the food stores shall be sufficient for 12 weeks cruising i. e. about 20 M^3.

§ 73. BRIDGE.

The bridge will be fitted out with a covered wheel house, containing the necessary appliances for the navigation of the vessel, such as steering column, rudder indicator, projection compass, W.T., telegraph and repeater, voice pipes, navigating table, support for repeator, gyro compass and the necessary receptacles for binoculars, telescopes, etc. The wheelhouse will be equipped with 5 large portholes. It shall be possible to fire torpedoes from the bridge.

On the top plating of the bridge superstructure, there shall be transparent windscreens of folding type. There shall be provided two places for removable pelorus stands. Two forks shall be fitted for attaching 7.9 mm. machine guns. The necessary folding wooden seats to be provided in the navigating cabin and in the bridge. A removable support for the searchlight to be fitted.

In the bridge superstructure four doors shall be provided for access to the inside from the deck. Two light hatches with ladders will be placed in the bridge for access to the passage between the galley and the lavatory, and to the 105 mm. gun.

§ 74. CENTRAL STATION.

The central station will be equipped with a steering wheel, projection and gyro-compass repeater, revolution counter, torpedo order telegraphs, telephones, the control gear for actuating Kingston and vent valves with their indicators, other indicators, the various distribution boxes for control of the vessel, hydroplane operating wheels, periscope and bins, chart table with necessary lockers, etc., and all that is necessary for handling the vessel in submerged trim. The master gyro-compass with its accesories will also be housed in this space, as well as one or more periscope rams. No other moving mechanisms will be fitted, so that absolute silence will be obtained in this compartment.

§ 75. AUXILIARY CENTRAL STATION.

This space will be fitted with the W.T. cabin, galley, W.C. for officers, and a hatch for access to the general store situated below. The following machinery will also be placed in this compartment : two turbo-blowers, the hydraulic pumps with their accumulators, a main bilge pump, a trim pump and rams for operating the periscopes ; W.T. mast, convertors for W.T., etc. ; 2 fans.

§ 76. CONNING TOWER.

The conning tower will be fitted with an auxiliary steering wheel, telegraphs and repeaters, telephone, gyro-compass repeater, two periscopes with their locking gear, voice pipes, torpedo firing gear, arrangement for trimming the revolving torpedo-tubes, depth indicator, rudder and hydroplane indicators, log repeater, sounding repeater, revolution counters, trim indicators, and navigating desk.

Note : The detailed arrangement of the conning tower, central station and auxiliary central station, shall be decided in mutual agreement between the I. C. and the Constructor.

The flooring will consist of a teakwood grating.

§ 77. ACCUMULATOR COMPARTMENT.

The accumulators will be stored in two watertight tanks fitted below the flooring of the officers' and petty officers' quarters, and provided with the necessary water- and gastight access hatches for shipping and unshipping the cells, and for entrance of the crew.

Lifting and transporting gear shall be provided to lift and transport each of the cells to the middle passage. The cells will be further transported along this passage to the hatch by means of suitable rails or other gear.

Each tank will be ventilated in accordance with the diagrammatic sketch attached to these specifications. A small hand pump with rubber hoses for rinsing-out purposes is fitted.

§ 78. W.T. CABIN.

The wireless telegraph cabin is situated in the auxiliary central station and consists of a double walled teakwood compartment with sound-proof filling material. In way of the transmitter, the woodwork will be protected with a non-combustible material. The furniture of the W.T. cabin shall be supplied by the Constructor. The complete W.T. apparatus with pressuretight porcelain isolators shall be supplied by the Polish Navy, but shall be fitted and installed on board by the Constructor. The apparatus for submarine signalling, consisting of a receiver, direction finder of multi-spot type, a compensator, amplifier and telephones and the transmitting gear, direction finder U.S. type, S.C.A.M. echo sounding apparatus, etc., shall be supplied by the Constructor and fitted in the ship according to the indications of the I. C. All internal and external cables for the W.T. installations, as well as the aerial, the entrance ducts with the necessary closing devices shall be supplied and fitted by the Constructor.

The W.T. direction finder complete shall be supplied by the Polish Navy in accordance with the Netherlands' Navy practice. It shall be fitted by the Constructor.

§ 79. ENGINEER'S WORKSHOP.

A convenient position in the engine room will be provided with a bench and vice, a rack will be fitted in the vicinity, together with necessary drawers for stowing tools.

A small portable vice and bench will be fitted in the bow compartment.

All engineer's equipment shall be provided in accordance with the equipment list.

A small lathe and electric drill will be fitted in a suitable position in the engine room.

§ 80. LABEL PLATES.

All valves will be provided with brass label plates with names, all sea connections will be marked off on the deck by means of brass plates, giving the depth of the orifice below the deck and its particular name.

Doors, hatches, bulkheads and principal frames will be provided where necessary with brass plates bearing instructions, numbers, etc., as may be required.

All junction and distribution electrical boxes, switches, and in general the whole electrical installation shall have suitable label plates. All label plates to be inscribed in Polish language as indicated by the I. C.

Celluloid faced notice boards will be fitted in convenient positions in the boat for orders or proclamations.

§ 81. LOCKS AND KEYS.

All lockers for personal effects in the officers', petty officers', and crew's quarters, as well as any other lockers and cupboards, will be provided with locks of an approved design ; each of the keys shall be of a different type ; cupboards, drawers and store spaces will be fitted with locks.

Spare keys of each of the above mentioned lockers, etc., will be provided with number tabs and will be stowed in a key locker in the commander's cabin.

Note : The dials of the various measuring apparatus shall be printed white on a black background.

PART II.

Deck fittings and equipment

§ 82. ANCHOR AND CABLE ARRANGEMENT.

One bow-anchor of 850 K.G. with 100 metres of 30 mm. chain cable with swivel and shackles will be provided. All necessary gear for handling the cables to be supplied.

The anchor can be hoved in, bearly flush with the shell into the anchor bridge.

The chain is automatically stowed in a locker, situated forward between the torpedo tubes. Means shall be provided to slip the cable from the inside of the vessel.

A stream anchor with stock of 150 K.G. weight will be stowed in a suitable position in the superstructure. It can be hoved in by means of a steel wire rope situated in a convenient place in the superstructure.

All manilla, coir, and steel wire ropes, the latter with their reels, shall be supplied in accordance with the equipment list. The manilla ropes shall be stowed in open wooden boxes with suitable hatches in the superstructure.

Provision for storing the boathooks, heavinglines, etc., will be made in convenient place in the superstructure.

§ 83. CABLE CAPSTAN AND WARPING ARRANGEMENT.

The vessel is equipped with a windlass, driven by a suitable geared air motor. The speed of hoisting the anchor shall not be less than 20 cm/sec. The air motor is fitted in the forward torpedo-room and can be operated both from that compartment and from the superstructure-deck.

The gipsy drum is situated in the forward part of the superstructure abreast the anchor bridge, and is provided with a brake-band and pawl-wheel. The brake-band can be operated from the deck ; the pawl can be lifted both from the deck and from the forward torpedo compartment. The air motor actuates the gipsy by means of shafting and gear wheels, one of these shafts inside the vessel being further provided with a smaller brake-band. The gipsy can be put in or out of gear by means of a clutch, which can be operated from the deck and from inside the vessel.

The necessary indicators will be fitted, to show the amount of cable run out. Means are provided for slipping the cable.

The same motor also actuates a capstan. The capstan can be operated from the deck as well as from inside the vessel. The warping drum can be raised or lowered into the superstructure. For inspection of the shafts, gearwheels, etc., the necessary covers are made in the superstructure-deck.

Means will be provided for the efficient lubrication of all moving parts.

The whole mechanism can also be operated by hand.

A small capstan is fitted aft, which is driven by a geared air motor of about 5 H.P., situated in the after torpedo-room. The capstan can be operated from the deck and from inside the vessel.

A pull of at least 1000 K.G. must be exercised at a speed of not less than 20 cm./sec.

The warping drum is of the same type as that of the forward capstan and can be raised or lowered into the superstructure.

The necessary covers are made in the superstructure for lubricating all moving parts.

§ 84. TOWING ARRANGEMENTS.

There is one steel towing-hook on the foreside of the superstructure-deck. The hook is so constructed, that the towing rope can be slipped from inside the vessel.

A towing fairlead to be fitted to the stem casting.

A further towing hook will be fitted near the frame 13, with releasing gear operated from the inside of the vessel.

§ 85. BOLLARDS AND FAIRLEADS.

Three sets of double bollards made of galvanised steel tubes with welded-on caps, which can be raised or lowered, will be fitted to the superstructure-deck.

Two sets of suitable fairleads with hinged tops will be fitted to the fore- and after deck. A platesteel streamlined cover can be placed over the fairleads in order to have a minimum resistance when submerged. The fairleads are to be of galvanised cast steel.

The bollards and fairleads are to be securely fastened to the deck which will be suitable stiffened for this purpose.

§ 86. MAST, YARDS AND RIGGING.

One wireless mast will be fitted, which can be hoisted by means of two, or lowered by one wire-rope, all of which are actuated by a hydraulic ram, situated in the auxiliary central station.

Heavy springs will be fitted in the lowering wires for stretching purposes.

This mast-tube allows the possibility of using the wireless installation, when navigating at periscope depth.

The mast shall be stiffly supported so as to avoid vibrations as far as possible.

The top of the mast can be hoisted to a height of 6500 mm. above the top of the superstructure. The mast-tube shall be placed as closely as possible to the plating of the conning tower.

The mast-tube will enter into the conning tower and thence into a watertight bin, situated in the wireless cabin. The stuffing box and the electric connection shall be fitted in the conning tower.

The aerial shall pass into the W.T. cabin by means of a pressuretight isolator.

Provision will be made for securing a small yard to the mast, to support the main aerial. Two small blocks are fitted to this yard for the signal flag and signal ball halyards.

Removable footplates will be provided for the lamps, etc. The mast-tube itself, as well as wireless equipment shall be furnished by the Polish Navy; all hoisting gear, stuffing boxes, glands, foundations and fittings by the Constructor.

A small winch will be placed in the bridge superstructure, operated by hand for stretching the main aerial.

§ 87. JACK AND ENSIGN STAVES.

At the foreside of the superstructure-deck a jackstaff will be placed, to which the forward ridinglight can be secured.

Ensign staves will be placed on the after part of the bridge and at the stern.

The staves are made of steel and can be removed for submerged running.

§ 88. TORPEDO DAVIT.

One sheerjib for shipping and unshipping the torpedoes of the Polish Navy type will be supplied. It is constructed of three seamless steel pipes and fitted with a swinging jib.

The necessary blocks, chocks, wire-ropes, etc. will be fitted.

It is to be suitable for weights up to 1800 K.G. and is to be tested statically to 2700 K.G.

The sheerjib is to be made portable, so that it can be removed for submerged running, stowage in the superstructure being provided. It can be placed near the torpedo hatches, the decktubes, the entrance hatches, the removable plate openings and can also be used for taking the dinghy aboard and for hoisting the battery cells.

The torpedoes are hoisted by a small chain tackle.

The deck in way of the sockets for the jib will be sufficiently stiffened in all places where provision is made for securing it.

§ 89. GUARD RAILS, RIDGE AND AWNING STANCHIONS.

Galvanised removable stanchions will be fitted to the fore and after decks, on port and starboard side from the forward to the after entrance hatch, partly 1 M. and partly 0.60 M. high; they are fitted with galvanised staybars and support a steel hand wire, which will be fitted with the necessary stretching screws, sliphooks, shackles, etc., in conformity with the Netherlands Navy practice. Stanchions are also placed near the hatches. The above mentioned stanchions will be fitted in bronze sockets, so that the whole may be easily and quickly removed for submerged cruising.

Suitable harbour awnings and stanchions shall be provided for the three entrance hatches and the bridge. Handholds will be fitted to both sides of the bridge superstructure in way of the superstructure-deck. Handrails will be fitted in such places as is deemed necessary for safety, in accordance with the indications of the I. C., as well as a central ridge rope for stormy weather, with suitable loops for attachment of storm belts.

Canvas awnings will be supplied for the superstructure-deck forward and abaft the bridge ; each of them will be about 20 M. long and of a same width as the superstructure-deck, and are to be stiffened by steel and wooden slats.

The forward awning will be supported by a steel wire, stretched between the bridge and a stanchion.

The after awning will be supported by a steel wire, stretched between the after end of the bridge and a special awning stanchion, set upon the after deck, which latter is to be removable.

The necessary stanchions stretching screws, spring hooks, etc. will be provided.

§ 90. ACCOMMODATION LADDER AND GANGWAYS.

An accommodation ladder of adequate construction is to be supplied and fitted and a convenient stowing space is to be allotted in the superstructure. One rope ladder with deck fittings to be provided.

Two gangway planks will be delivered and will be stowed and attached with a strap to the top of the superstructure-deck, or any other suitable place. In order to reduce resistance when running submerged, streamlined wooden blocks will be fitted to the deck at the forward and after ends of these gangway planks.

§ 91. CLEATS AND EYEBOLTS.

The necessary cleats and eyebolts will be fitted in way of the bridge for signal halyards, awning stretches, etc., in agreement with the I. C.

Special attention to be paid to the fact that there are to be no projections liable to catch minecables.

§ 92. WATCHBELL.

A polished bronze shipsbell of about 20 K.G. weight, with the vessel's name and year of building engraved, shall be supplied and hung in position on a suitable galvanised iron bracket.

§ 93. BOATS.

The motor dinghy and the folding boat shall be of the Polish Navy type and shall be stowed in the after deck superstructure, and will be secured in a seaworthy position by two leather sheathed galvanised steel straps, stretching screws and eyebolts.

The necessary boathooks, shackles and slings for hoisting the dinghy will be supplied.

The torpedo davit shall be used for hoisting the boat aboard.

§ 94. LIFEBUOYS.

Two lifebuoys will be supplied and hung in position at both sides of the bridge superstructure, in agreement with the I. C.

A suitable petrol tank of about 200 l. capacity shall be provided. This tank shall be pressure-proof (10 Kg/sq.cm. outside pressure), and shall be stowed in the superstructure. All necessary filling and draining arrangements to be provided.

§ 95. NAME AND RECOGNITION LETTERS.

The name of the vessel is to be cut out in brass lettering about 250 mm. high, about 10 mm. thick, and secured to both sides of the bridge superstructure.

Recognition letters will be painted on the sides of the bridge superstructure, in accordance with the Polish Navy Regulations.

§ 96. STEERING GEAR, AFTER AND FORWARD HYDROPLANE GEAR.

The tiller of the rudder is connected to the actuating mechanism by means of a connecting rod. The actuating mechanism consists of a hydraulic ram situated in the after torpedo compartment.

The ram is connected to the hydraulic main, which in turn is connected to the hydraulic accumulators. It is provided with buffer cylinders to limit the helm. The buffer cylinders are provided with escape valves and short circuiting pipelines, so that severe shocks to the rudder are taken up gradually.

The movement of the ram and the rudder is controlled by means of a regulating valve, situated in the central station, which is actuated by the steering wheels of the bridge, conning tower and central station.

In case of breakdown, the ram can also be operated by means of a handpump situated in the central station, and connected by a special pipe line directly to the rams; sufficient power reserve is available in the accumulators during the changing-over period. The latter system can also be used for submerged running when absolute silence is necessary and it is desired to save battery current.

The tiller of the after hydroplanes is also coupled by means of a connecting rod to a set of hydraulic rams, situated in the after torpedo compartment and connected in the same manner as the steering rudder. It is actuated in a similar manner as the steering rudder from the central station and is also provided with a handpump in case of breakdown, which can also be used for silent manoeuvring and saving battery current.

When running on the surface or submerged, the rudder can be locked mechanically in midships position from the inside of the vessel.

The tiller of the forward hydroplane is also coupled by means of a connecting rod to a set of hydraulic rams, situated in the forward torpedo compartment and connected in a similar manner as the after hydroplane. It is actuated in a similar manner to the after hydroplane from the central station and is also provided with a handpump in case of breakdown, which can also be used for silent manoeuvring and saving battery current.

The folding mechanism of the forward hydroplanes is operated by an air motor, situated in the forward torpedo compartment, or by hand in case of breakdown. A guard wire is fitted to the forward hydroplanes to clear minecables fore and aft. It is fixed at the bow, passes through an eyebolt at the end of the hydroplanes, to a drum actuated by a spring, and by hand from the inside of the vessel.

§ 97. STEERING CONTROL INDICATORS.

The electric rudder indicators are situated in the conning tower and the central station and Diesel room. A special watertight and pressuretight indicator is situated on the bridge.

Each hydroplane has an electrical indicator situated in the central station and in the conning tower.

The rudder as well as the hydroplanes have mechanical indicators near the hydraulic rams to verify the electrical indicators to be of the pointer type (Siemens).

For the electrical arrangement see § 232.

Note: Alternatively mechanical indicators of the Netherlands Navy type may be fitted, if approved.

§ 98. PERISCOPES.

Three periscopes will be fitted of the Barr and Stroud type, as described in the tender of Messrs. Barr and Stroud Ltd., dated June 26th, 1935.

One periscope will be fitted for observations from the central station, the other two for observations and attack from the conning tower. Each of these periscopes will be raised and lowered by means of hydraulic rams, situated in the auxiliary or main central station. There are two steel wire-ropes for hoisting and one for lowering each periscope. The lowering ropes are stretched by means of strong springs.

If necessary a well tried out safety device will be fitted, which, in the event of a cable parting, will instantly grip the periscope and effectually prevent any damage being done, conforming to the practice of the Netherlands Navy.

Spring-buffers or other means of absorbing shocks will be provided at the bottom of the periscope bins, and at the top position azimuth circles of the Netherlands Navy type to be provided.

Roller bearings are fitted in the supporting brackets, which enable the periscope to be trained easily by hand.

Stuffing boxes with rameh packing are fitted where the periscopes pass through the shell. Each periscope must be stopped in any position with an accuracy of not more than 5 cm.

The hoisting speed shall be not less than 0.40 m/sec., and the lowering speed not less than 0.50 m/sec.

§ 99. SIGNAL AIR SYRENE.

An air whistle and a syrene of approved type to be fitted to the superstructure with their respective controls on the bridge.

§ 100. NAVIGATION LIGHTS.

The red and green sidelights will be fitted to the bridge superstructure and are to be pressuretight. They will be fitted in such a manner that they offer no appreciable resistance when running submerged and are in agreement with the international regulations regarding light sectors.

The necessary top-, anchor- and sternlights will be fitted, as also a dimmed sternlight for line navigation, in agreement with the I. C. They are to be of an efficient pressure- and watertight type, as also their plug connections.

§ 101. ANTIMINE GEAR.

The antimine gear will be fitted from the foreside of the superstructure-deck to the bridge superstructure. It is made of special two copper wire-ropes, which act also as a low aerial. From the after end of the bridge superstructure to the after end of the superstructure-deck a single galvanised steel antimine-cable shall be fitted. All antimine cables shall be attached to open eyelets of approved construction, so as to liberate the cables when a vertical pull is exerted on them.

The necessary insulators and connection with the W.T. entrance duct, stretching screws, etc. will be delivered, and shall be of an approved type, so at to avoid any possibility of catching mine cables.

§ 102. TELEPHONE BUOY AND SALVAGE BUOY.

A telephone buoy will be fitted in the superstructure just abaft the bridge. The buoy is fitted with a telephone and lamp, which may be operated by morse keys, situated in the central station, and the fore and aft torpedo compartments.

The telephone is connected with the three escape compartments. The buoy can be set free from each compartment by means of a compressed air line, and shall be of an approved type.

The salvage buoy will be fitted with a flexible air hose for pumping air into the vessel, by a special pipe-line in the superstructure, and connected by non-return valves to the main circuit of high pressure air in each escape compartment. The buoy can be released from each of the three escape compartments by means of compressed air, separately from the telephone buoy. The hose shall be about 120 M. long, and the whole installation generally of the Polish Navy type.

§ 103. VOICE PIPES.

In the bridge superstructure there shall be three voice pipes, one, not watertight, running to the 105 mm. gun, and two watertight pipes to the central station. One of the latter shall be connected directly to a three-way cock in the central station, to which is further connected a voice pipe running the whole length of the vessel with mouth-pieces in each compartment. The other W.T. tube has mouth-pieces in the conning tower and in the central station, and is further continued to the magazine.

All necessary draining appliances, whistles, fittings, etc., to be provided. The materials used for the voice pipes must be of a special alloy (Alpax or similar).

The necessary quick closing valves will be fitted where the pipes pass through the pressure hull and bulkheads to obviate water entering through the voice pipes.

§ 104. COMPASS.

One pressure-tight submarine steering compass, projector type binnacle, will be fitted in the covered bridge space.

The dimensions of the optical tube for the steering compass will be made conform to the situation on board.

The compass can be read from the bridge, the conning tower and the central station.

The compass will be supplied complete, with optical tubes, magnet racks, heeling magnet bucket, compass bowls, correction spheres with brackets, sluice valves, desiccating cocks and screens.

The magnetic compass can be dried in a similar manner to the periscopes, with the desiccator for the latter.

Brass or non-magnetic suitable material will be used instead of steel for the construction of the light superstructures within a radius of one metre, measured from the centre of the compass.

PART III.

Piping, main ballasts and other tanks, air system.

§ 105. MAIN BILGE PUMPS.

On board are installed :

Three main bilge pumps each with a capacity of 350 M³. per hour against a head of 4 Metres and capable of pumping 35 M³. per hour against a head of 80 Metres.

They are vertical electric motor-driven centrifugal pumps and located in the bow torpedo-compartment, the auxiliary station and the engine room.

§ 106. AUXILIARY BILGE PUMPS.

Two auxiliary bilge pumps each with a capacity of 15 M³. per hour against a head of 15 Metres and capable of pumping 7 M³. per hour against a head of 80 Metres.

They are vertical electric motor-driven rotary pumps and located in the forward- and after torpedo-compartment.

§ 107. TRIM PUMP.

One trim pump to be used as trimpump for trimming purposes, with a capacity of about 30 M³. against a head of 40 Metres.

It is a vertical electric motor-driven rotary pump and located in the auxiliary station, and can pump both ways.

The electric operating gear of the trimpump, as well as all valves appertaining thereto shall be situated in the central station.

Note : The pumps and the electric motors must have separate shafts, coupled together with flanges. All rotating parts must be balanced to avoid vibration. The casings and rotary parts to be made of gun metal, the spindles and keys of stainless steel or other rust-proof material.

§ 108. DRAINING SERVICE.

The draining service consists of a main and an auxiliary bilgeline.

The main bilgeline is a duct keel and runs from the forward to the after torpedo compartment. The compartments, the main- and the auxiliary ballast-tanks have drain valves, connected to this line. The main- and auxiliary bilgepumps have a suction-connection to same. It shall be tested to 12 Kg/sq.cm.

The drain valves for the compartments are placed near the watertight bulkheads and can be operated from both sides of the bulkheads.

The auxiliary bilgeline is a pipeline from the forward- to the after torpedo-compartment and is mainly used for torpedo-service and for general purposes.

The auxiliary pumps in the torpedo compartments have connection to this line. Valve-boxes are connected to the torpedo-tubes, torpedo-compensating tanks, fuel tanks, deck torpedo-tube drain tank, gun and conning towers bilge-suction-boxes with non-return valves in the compartments, the main ballast- and the trim-line.

The auxiliary pumps have a suction from sea and can discharge into the trim-line for fire extinguishing purposes.

The compensating and trim-tanks can be locally filled with sea water. The pipe-lines are made of copper. The dimensions are to suit the capacities of the pumps.

§ 109. TRIMMING SERVICE.

The trimming line forms a completely independent connection between the trimming tanks. It is connected in the central station with a manifold, which is divided into a suction- and a discharge part. A revolution counter graduated in liters shall be fitted to the trim-pump in the central station.

The manifold is also connected with the auxiliary bilge-line, regulating tanks and sea.

The pipe-lines are made of copper.

§ 110. FIRE SERVICE.

The fire extinguishing valves being mounted on the trimming line, it is necessary to place valves against the trim tanks, which as a rule can remain open. In this way it is possible to use this line for fire extinguishing, while the main and auxiliary bilge-lines can be kept in service for bilge pumping.

The fire valves shall be fitted in every compartment of the ship, and water supply valves shall be placed in the bridge superstructure and near the anchor gear.

§ 111. FRESH WATER SERVICE.

A fresh water line is to be fitted for washing and drinking purposes.

The fresh water tank is connected with the deck inlet by a pipe fitted with a suitable hose joint. This filling pipe has a drain valve just below the pressure hull. The discharge of the distilling plant and the suction pipes of the hand pumps are also connected to the fresh water tank, all the suction pipes shall have foot valves in the tank.

The handpump on deck must be of a very reliable type so as to ensure an easy water supply on deck. By means of a handpump the water is pumped into a tank of at least 100 L. capacity, situated in the gun tower. From this tank a pipe-line is led running from the forward to the aft torpedo-compartments, with branches leading to the lavatories, officers' and petty officers' cabins, pantry, galley, and 5 other taps indicated by the I. C.

The necessary section-valves and three water meters to be provided. All supply valves can be locked.

The lines will be further connected to two tanks of 50 L. capacity each, situated on the forward and aft escape compartments.

The fresh water pipes and tanks are made of galvanised steel and are cement washed respectively.

§ 112. DISTILLER SERVICE.

There are two evaporators heated by the exhaust gases of the Diesel engines, with a capacity of 50 Liters each per hour (for details see Machinery Specification, § 167).

The fresh water drain-tank of the distilling plant is connected by a pipe-line with the distilled water tank, which is a part of the fresh water storage-tank.

Separate tanks for distilled water for battery service with a total capacity of about 400 Liters will be supplied. These tanks are made of tinned brass plate and the fittings' copper piping must also be tinned. A special arrangement shall be provided for draining these tanks.

§ 113. OIL FUEL SERVICE.

Fuel Piping. The fuel tanks have wide filling-pipes with suitable loose strainers, and are vented to the inside of the boat, and show at the same time that the tanks are completely filled. The tanks are divided into two groups, viz. one group forward and one aft. The groups can be used together or separately. The filling of the inside tanks shall be done in about 2 hours time with a pressure of 1 Kg/sq.cm. The reserve ballast tanks will be filled through the manholes.

The consumed fuel is replaced by sea water. This is done by means of the circulating water of the Diesel-engines. In the pipe connecting the fuel tanks with the sea valve a safety valve of 1½ Kg/sq.cm. shall be fitted. The engineer can regulate the pressure in the tanks to ensure a proper flow of the fuel to the measuring tank.

Main ballast tank No. 3 and No. 2, can be used as reserve fuel tanks.

For that purpose the tanks have connection with the fuel- and compensating piping. An equalizing valve is fitted. The vents of the reserve fuel oil tanks shall be absolutely oil-tight.

The fuel tanks can be emptied by pumping or blowing. For emptying the tanks from water, the auxiliary bilge pumps are connected to same. The emptying of the fuel is done by means of compressed air or water pressure. The tanks and reserve tanks are equiped with a simple arrangement for measuring the quantity of fuel carried of the Netherlands Navy- or other type approved by the I. C.

The fuel piping is made of seamless steel and the compensating piping of copper.

§ 114. LUBRICATING OIL SERVICE.

The lubricating oil storage tanks have wide filling pipes and loose strainers, and are connected to the sumptanks of the Diesel engines, so that by means of a hand-pump oil can be pumped from the storage tanks to the sumptanks. The total capacity of the tanks is about 19 M^3.

The sumptanks are connected to the crankcase of the Diesel engines in such a way, that a proper flow of the oil is assured. The engine lubricating pumps have a suction connection to the sumptanks and discharge through filters and coolers into the engine. The lubrication must be carried out without any difficulties when the vessel is rolling 40°.

The reserve lubricating pump has a suction from the sumptanks. The separate sumptanks are assembled in this case to one tank by means of a sluice valve to avoid double piping.

An oil separator of Laval type shall be fitted.

The reserve pump can fully substitute one engine pump. (For specification of the reserve lubricating oil pump and Vulcan couplings see Machinery Specification).

The lubricating oil filling and trimming pipes are made of seamless steel. The total amount of lubricating oil shall be taken aboard in two hours time.

§ 115. AMMUNITION MAGAZINE FLOODING.

An ammunition magazine flooding arrangement must be fitted and consists of a sea-valve on a suitable place, with a pipeline to the magazine ending in a spray above the ammunition.

Bilge connection will be provided.

The operating gear of the sea valve and vent valve shall be outside the magazine in the auxiliary central station and on the superstructure-deck. They must be suitable locked and operated simultaneously. The time necessary for flooding the ammunition compartments shall not be more than 10 minutes.

§ 116. SANITARY PIPING.

The three W.C.'s shall be of the Netherlands Navy type and will have discharge pipes with double hull-valves.

The waste-water pipes of the wash basins and sinks in the officers' and petty officers' quarters shall be led by a common drain-pipe to the special tank for the forward swivelling torpedo-tubes.

The drain pipes can be cleaned with sea water by means of a flexible hose connected to the fire valves.

Note: In general all pipes passing the pressure hull shall have double valves. c.f. Netherlands Navy practice.

§ 117. HYDRAULIC SYSTEM.

A general hydraulic system will be fitted. It consists of: two special hydraulic pumps in the auxiliary central station, driven by suitable motors, two accumulators, all the necessary piping valves, and a supply tank in the return pipe.

The accumulators are automatically charged by the hydraulic pumps and are partly filled with oil and partly with compressed air. The compressed air can be taken from the air flasks of the ship. For this purpose a pipe-connection with the high pressure air system of the ship is made by a throttling valve, provided with a safety valve for 100 Kg/sq.cm., and two shutt-off valves. The necessary pressure gauges to be fitted.

The pressure medium of the hydraulic system is oil. The maximum working pressure is 100 Kg/sq.cm. Each pump is of sufficient capacity to do the normal work, so that there is 100 percent reserve. The pumps are controlled by position of the pistons in the accumulators, and come in action when the pressure falls below 100 Kg/sq.cm. The automatic control of the pumps is adjusted in such a way, that first one pump comes in action and when the pressure falls still further, the second pump comes in action. In case one of the pumps is out of action, the other pump automatically takes its place. For emergency cases a rotary handpump will be provided. The accumulators are large enough to feed the hydraulic system for a short time, if the pumps fall out unexpectedly.

The following machinery will be operated by hydraulic rams:

the steering and both hydroplane gears, the periscopes, the mast tube, the control gear of the Vulcan couplings, the trimming gear of the deck tubes, the Kingston and vent valves, the lifting gear of the 40 mm. guns, the closing and opening gear of the bin cover or the 40 mm. guns, the folding and opening gear of the fore hydroplane.

Alternatively the closing gear of the bin cover of the 40 mm. guns, and the folding gear of the hydroplane may be operated by air motors.

The steering rudder and hydroplanes can also be operated by hand from the central station by rotary tele-motors. All parts of the hydraulic system are protected by safety-valves and will be tested to 1.7 times the working pressure.

The operating gear of the ballast Kingstons and vents shall be on a separate main. This pipe shall have special reliable cut-off valves from the accumulators, so as to prevent any accidental release of the operating valves in case of an excessive pressure. This pipe shall also be used as a reserve pipe for all other mechanisms, so that in general all supply pipes are doubled up to the manoeuvring gear of each mechanism.

On the manoeuvring chests of Kingston and vent valves there shall be a special locking arrangement for the reserve fuel oil tanks.

§ 118. FUEL OIL TANKS.

The fuel oil tanks are situated amidships and aft; they are placed inside the pressure-hull, or else reinforced so as to be able to withstand the full diving pressure, so that the danger of treacherous oil traces is greatly reduced. Also some of the tanks may be carried empty, if any abnormal conditions of leading of the submarine make

this advisable. The tanks, except the inner tanks, can be emptied by pumping or blowing on a depth of 80 Meters.

For test pressure see hull-specification, § 35. For oil fuel service see piping specification, § 113.

RESERVE OIL FUEL TANK.

Main ballast tanks No. 3 and No. 2 can be used as reserve fuel tanks. For that purpose the tanks are of an oiltight construction.

§ 119. LUBRICATING OIL TANKS.

The lubricating oil tanks, the reserve lubricating oil tanks and the sump oil tanks are under the Diesel engines.

They are provided with the necessary filling blowing and pumping pipe-lines, sounding rods, gauges, etc. (See specification § 36). The total capacity of the lubricating oil tanks shall be in correspondence with the total fuel capacity, that of both reserve fuel tanks included, and shall be sufficient for the normal working of all mechanisms, as well as for the hydraulic system.

§ 120. FRESH WATER TANK.

There is a fresh water tank with a total capacity of about 6 M^3. located below the central station. Part of this tank will be separated from the rest to serve as a receptacle for distilled water. For piping see fresh water service. (For distilling plant see § 112).

§ 121. COMPENSATING TANKS.

The torpedo compensating tanks, located in convenient positions below the tubes and the reserve torpedoes, are not provided with a separate sea-valve, but can be filled from sea through the connected pipe-lines.

They are provided with the necessary air- and water pipe-lines for filling, blowing or pumping, and water gauges for an exact reading of the capacity.

The torpedo tanks are tested at 3 Kg/sq.cm.

§ 122. REGULATING TANK.

The regulating tank is divided into two parts, one on SB. and on Port Side, by a watertight bulkhead. They can be connected by means of a sluice-valve and are each provided with one Kingston valve connected to a second screwdown valve for regulating. These valves and vents, as well as the blowing arrangements must be situated in the central station.

The tank can be blown or pumped on every depth up to 80 Meters. Safety valves to be provided.

A pneumercator or any other approved gauge will be installed for an exact reading of the capacity.

The tank can be vented inside the boat.

§ 123. TRIMMING TANKS.

The trimming tanks are located in the bow and stern of the boat and are not provided with separate sea-valves, but can be filled from sea through the connected pipe-lines.

They are provided with necessary air- and water pipe-lines for trimming the water by blowing or pumping.

Electrical water indicators of an approved type for an exact reading of the capacity, will be supplied and fitted in the central station. On the trimming and regulating tanks double pressure gauges shall be fitted, showing the outside and the tank pressures.

§ 124. QUICK DIVING TANKS.

Two quick diving tanks are provided, one amidships for diving without trim, and one forward.

The tanks are flooded by hydraulically operated flood-valves (Kingstons) in the central station and locally with a hand-operated mechanism, and vented inside the boat by means of centrally operated quick vent-valves. The operating gear for flooding and venting shall be separate from the main ballast tanks operating gear. The tanks can be filled up to 40 M. and blown on every depth till 80 Meters.

§ 125. MAIN BALLAST TANKS.

There are six main ballast tanks, all situated amidships, so as to avoid large variations in trim when diving. Moreover, a small bow-tank is provided, which may be blown dry, if it is desired to trim the vessel in the surface condition by the stern.

§ 126. BALLAST VENTS.

On the S.B.- and Port top-plates of the main ballast tanks a large main vent pipe of galvanized steel is mounted and connected to a common vent-valve. The valves are operated hydraulically from the central station or manually from easily accessible positions. Rest vent-pipes to be provided to the fore and aft end of each tank.

§ 127. BALLAST KINGSTONS.

The main ballast tanks are flooded by double Kingston valves, mechanically coupled in such a way that the valves open and shut simultaneously.

The operation of the valves is hydraulically in the central station and by a hand mechanism from an easily accessible position.

The Kingstons and vent-valves of the main tanks and the forward quick diving tanks and bow buoyancy tank are equiped with electrical indicators for the open- and shut positions of approved type.

The control chest for these indicators is mounted in the central station near the wheels of the hydroplane control gear.

The valve seats of the Kingstons are streamlined.

At depths above 20 Metres the main tanks can only be blown and not pumped. In awash condition the tanks can also be blown by low pressure air from the turbo-blowers.

§ 128. AIRBOTTLES.

On board are installed about 40 high-pressure air-flasks, with a total capacity of 8000 Liters. The maximum working pressure is 225 Kg/sq.cm. and the hydraulic test-pressure 380 Kg/sq.cm. They will be manufactured of special high tensile steel. They are to be fitted each with 5 percent nickel steel plugs and valve-plugs and draining pipes, and will have special bronze valve-pipes. The remaining parts are made of Delta metal or other suitable material. Of the total amount of air, about 40 % will be carried in the auxiliary central station (also to be used for the hydraulic system), about 20 % in the battery compartments, about 10 % in the engine room (also to be used for starting the Diesel engines), and the rest fore and aft. Each group shall comprise no more than 4 flasks, and shall be provided with a section mastervalve, draining valve and a gauge in a well visible positions. The flasks are to be arranged so that in the event of leakage, the vessel shall leave no traces.

§ 129. COMPRESSED AIR SERVICE (225 atm. System).

This system consists of a circuit line to which are connected all the airflasks and the airpiping for charging the torpedoes.

The air-compressors pump into the circuitline with the necessary section valves for charging the airflasks. With closed section valves the air-compressors can charge the torpedoes to their normal pressure. In the central station the high-pressure air manifold is fitted, to which are connected the port and the starboard part of the circuitline. From this manifold a line is running to the **high-pressure reducing valves**, which reduce air to 12 atm. for general purposes; further a line to the manifold (225 atm.) for blowing the main ballast tanks and the bow buoyance tanks, and a line to the manifold (225 atm.) for blowing fore and midships quick dive tanks. Before entering these tanks, the air passes a small valve commanded by the respective kingston valves, so that it cannot enter the tanks when the kingstons are shut. These valves shall be placed inside the pressure hull, and shall be accessible. Furthermore, non-return valves are fitted directly on the tank.

Safety valves of sufficient area protect tanks against excessive pressure. The supply of the air to the main blowing manifold in the central station must be doubled.

In the escape compartments the emergency manifolds for blowing the main ballast tanks are installed. They have a direct connection to the circuitline in such a way, that connection can also be made with the exterior torpedo charging line.

Air charging from deck is possible by means of two exterior connections, one forward and one aft. In the latter bypass- and check-valves are fitted, by which it is possible to supply air to other boats.

The exterior charging-lines are connected to the high-pressure circuit. In case of emergency, pressure-air can be led into the compartments. For that purpose the necessary valves and gauges are installed on the watertight bulkheads. In the torpedo-compartments are the connections for charging the torpedoes when the latter are either inside the tubes, or fitted in their stand-by position. A similar arrangement is fitted for the deck torpedoes. To ensure the torpedoes being charged with dry air, the latter passes first through a separator and an air strainer. For the same reason the firing air-accumulators are filled from this line.

Further connections are made from the circuitline to the reducing valves for starting the Diesel engines.

The whole highpressure air-piping is made of non-electrolytic solid drawn copper with a tensile strength of 21 Kg/sq.mm.; and an elongation of 30% on 100 mm. length when annealed. The highpressure piping must have no constructional faults such as blisters, grooves, indents, etc.

The valves, cross- and T-pieces, as well as the unions are to be made to the standard of the Netherlands' Navy and are to be tested hydraulically in the workshop to a pressure of 1,7 × the working pressure. They are to be made of S.M. steel. The piping also to be tested in the same way.

On completing the whole pipeline it is to be subjected to a test under full working pressure, all connections being soaped outside in order to ascertain any leakage.

The whole air-piping circuit shall have suitable draining and relief valves, with a gauge in the auxiliary central station.

§ 130. 12 ATM. SYSTEM.

The 12 atm. airline is for general ship's service.

The regulating tanks, trimtanks, fresh-water tanks, fuel tanks, the conning and gun towers, as well as all sea inlet valves, except the main ballast-tank kingstons, are blown by this line.

Further connections are for the whistle, W.C.'s, buoys releasing gear, depth gauge piping (for blowing through). The manifolds receive their air directly from the highpressure airline by a reducing valve. Between the reducing valve and the manifold a safety valve of 12 atm. is fitted. The manifold is protected against excessive pressure by this safety valve. The manoeuvring chest of the 12 atm. air system for the regulating tanks, trimming tanks, conning and gun towers, to be fitted in the central station.

§ 131. AIR COMPRESSORS.

The compressed air is supplied by one electrically driven air compressor, located in the electric motor room, and one Junkers compressor, located in the engine room. The capacity of each of them is about 9 Ltr. per minute at full pressure (225 Kg/sq.cm.).

The compressors are to be provided with their own lubrication- and cooling-water pumps, the latter pumps being in the case of the electric compressor suitable for a pressure of 80 Meters head.

The testing pressure for all parts subjected is to be 1,7 × the working pressure

Charging and pump-separators are to be manufactured of S.M. steel.

The necessary tools and spare parts to be supplied. The exhaust of the Junkers compressor shall be brought to an efficient silencer outside the pressure hull. The closing of the silencer shall be actuated simultaneously with the stopping arrangement of the compressor, one lever to actuate the closing of the silencer's outside valve, and the stopping gear of the compressor. The inner valves shall be closed by hand. A drain valve for the exhaust shall be supplied. Suitable indicators for "open" and "shut" shall be fitted in the central station.

§ 132. TURBO-BLOWERS.

In the auxiliary station are located two horizontal electric motor-driven turbo-blowers with a capacity of each 60 M^3. free air per minute at 15° C. The delivery pressure for normal conditions is 1,55 atm. absolute, and the maximum pressure 1,70 atm. absolute, whereby the capacity will be about 46 M^3/min. each. The number of revolutions is normally 5650 per minute and can be regulated from 5200—6200 revolutions per minute. The normal power of the motor is 86 K.W. with a tolerance of ± 5 %.

The motor is calculated for three working-periods of 3 × 10 minutes per hour with 15 minutes pauses in between. Under these conditions the maximum temperatures are: stator 40° C., rotor 50° C., collector 60° C. For spare parts see detail-list.

The foundations for the blowers will be arranged as a silencer.

On the delivery side a non-return valve must be installed to prevent sea water coming into the compressor. The valve chest is to be provided with a drain valve.

For blowing the main tanks a manifold will be installed on a suitable place in the auxiliary central station.

The delivery pipes of the turbo-blowers on the main ballast tanks shall be attached to the ballast tanks separately from the high pressure blowing-pipes. Each of the turbo-blowers can supply air to any of the ballast tanks.

The pipe-lines to the main tanks must be constructed as stiff as possible to prevent resonance.

§ 133. INDICATORS FOR "OPEN" AND "SHUT".

All valves must be provided with index plates for "open" and "shut".

For indicators for "open and shut" of the main Kingstons, vent valves, etc., see electrical specification.

§ 134. VENTILATION.

There is one fan of 4000 M^3. capacity at about 150 mm. water pressure (about 4 H.P.) for both battery compartments, directly connected to each battery tank, and by a special duct to the exhaust trunk in the auxiliary central station. The necessary valves and connections are fitted so that any battery or both batteries together may be ventilated, either by this fan, or by the general exhaust fan (mentioned hereafter) by means of the general exhaust ventilating duct.

Fresh air for ventilating the batteries can be supplied either from the general fresh air supply duct, or from the living compartments (officers' and petty officers' quarters).

There are two further fans, similar to the one mentioned above, situated in the auxiliary central station. They are connected to the two general ventilating ducts each running from the forward to the aft torpedo-compartment, one for fresh air, and one for exhaust.

Furthermore, a small exhaust fan of about 1/2 H.P. is fitted for ventilating the galley and connected by the cross pipe to the discharge air duct.

The fans get their supply and discharge respectively through the outside fresh air and exhaust ventilating trunks. These trunks are situated in a suitable high place in the aft bridge superstructure, and shall be fitted with double valves ouside and inside the pressure hull. The outer valves must be of the quick closing type, and shall be operated from the inside of the vessel. Electric indicators shall be fitted in the central station. The trunks shall have draining arrangements, so as to prevent water entering the ventilating ducts.

The inside ventilating ducts are provided with double W.T. flapper valves on the bulkheads, and single W.T. valves on the battery tanks. All branches shall be fitted at their ends with adjustable air-tight closing valves. An interlocking arrangement shall be provided, to prevent the exhaust gases from the batteries being driven into the vessel.

The ventilating system enables to circulate the air from any compartment to any other, and to clean the air by passing it through the regenerating plant. The air valves of both ducts shall be placed in each compartment in such a way, that the air shall cross the compartment when ventilating.

Two ventury meters to indicate the pressure and velocity of flow in the battery ventilating ducts shall be fitted.

The intake of the Diesel engines can be connected to the suction line, so as to assist the ventilation.

The cooling air coming out of the main electric motors shall pass either into the electric motor room, or, by a duct and a special valve, partially into the Diesel engine room.

The pipe lines are made of copper, covered internally with acid resisting bituminous solution.

The details of the ventilating system shall be carried out in accordance with the indications of the I. C.

For details of the ammunition magazine ventilations see § 186.

§ 135. AIR PURIFYING DEVICE.

A "Draeger" air purifying device and oxygen supply-installation must be installed. By means of this, the carbon dioxyde contained in the exhaled air of the crew (56 men) will be removed during a period of up to 72 hours, thereby preventing the suffocating effect of CO_2 upon the lining-tissues and the blood of the crew, as soon as the CO_2 contents in the air have reached 1,5 %.

Regenerator-holders are installed as a support for the potash regenerators, and are connected to the ventilation-duct of the exhaust air. The carbon-dioxyde contained in the exhaled air is absorbed by the potash-regenerators with an obsorption-capacity

of about 400 liters of CO_2 for each regenerator. Maximum service-time of the regenerators under normal conditions : 4 hours.

In order to have a reliable control of the CO_2 contents in the air, an air-testing apparatus will be furnished with the installation. A hygrometer or polymeter shall be supplied for indicating the humidity-contents of the air.

The oxygen supply-installation must ensure a constant replacement of the oxygen, consumed by the crew.

In the main compartments oxygen supply-regulators are placed. They are connected to the oxygen pipe-line leading into the different compartments, and will be in direct communication with the oxygen cylinders.

If possible the oxygen cylinders shall be of the normal industrial type ; in order to refresh the supply of oxygen the empty cylinders shall be easily removed out of the ship and new cylinders placed instead. No leakages in the system shall occur after the cylinders have heen changed repeatedly. In this case the outboard charging connections shall not be fitted.

The oxygen cylinders shall be evenly distributed over the escape compartments. Their total capacity shall be 800 Liters.

The high-pressure oxygen in the pipe-lines (as a rule 150 atm.) is reduced by the oxygen supply-regulator to a low working pressure.

The dial of the pressure gauge-graduated according to liters of oxygen per minute and number of men present, permits an easy control over the amount of oxygen discharged into the compartment.

Bulkhead fittings are used for carrying the oxygen pipe-line through the bulkheads.

Closing valves with angle bracket — connected to the bulkhead fittings — make it possible to shut off an oxygen pipe-line in a compartment, which has to be abandoned.

The groups of oxygen cylinders shall be connected by means of suitable branch pipes with the main line leading into the different compartments. They are fitted with 6, 8, 10 or 12 outlet-connections.

Outboard filling-connections are fitted for re-filling empty oxygen cylinders in the boat, without removing the cylinders from the boat. Three-waycocks are installed in two main compartments. From there two outlet flexible copper-tubes are leading into the ventilation tubes on Starboard and Port side. A pointer can be turned either to Starboard- or Portside, and indicated into which of the two ventilation tubes oxygen is being discharged.

Re-filling devices and special charging devices for re-filling the cylinders and breathing bags of the artificial lungs are provided in each escape compartment.

Special attention and care shall be exercised in ascertaining the entire tightness of the whole oxygen installation. For this purpose a test of a duration of 24 hours shall be carried out. During this test no leakage shall occur.

§ 136. ARTIFICIAL LUNGS.

There shall be provided 56 artificial lungs of the "Draeger" type B with potash can, oxygen cylinder (0.4 Ltr.), valve, air hose with tap, rubber mouthpiece, nose clasp, relief valve on the air-bag, spanner and stowing-bag.

PART IV

Machinery specification.

§ 137. GENERAL DESCRIPTION OF MAIN ENGINES.

The Diesel engines will be of the Sulzer 6 Q.D. 42 direct reversible two stroke type, working on the solid injection principle.

They will be fitted with trunk pistons.

Scavenging air will be supplied by reciprocating pumps driven by cranks from the forward end of the crankshaft.

§ 138. PRINCIPAL DIMENSIONS.

Each engine will have six working cylinders of 420 mm. diameter and 500 mm. piston stroke.

§ 139. DESIGN MATERIAL AND WORKMANSHIP.

The engines will be specially built for submarines. Only first class materials will be used. All workmanship will be of the highest standard.

§ 140. BEDPLATE AND FRAMES.

The crankcase will consist of three separate parts, i. e. of two parts each for three working cylinders and one part for the scavenging pumps.

The frames, which will support the cylinder blocks, will be cast to the crankcases. Large openings, closed with covers of light alloy, allow for an easy access to the crankcase. The latter will have an oil sump cast on and shall be provided with a large oil drain hole.

The material of the crankcases will be cast steel with the following properties:

tensile strength: 45—55 Kg/sq.mm;

elongation: not less than 18 % for $l = 11.3 \sqrt{F.}$

bending test: a bar with a section of 25 × 25 mm. is to be bent round an angle of 90° with a radius of 50 mm. without showing any signs of fraction.

§ 141. WORKING CYLINDERS.

There will be one cylinderblock for each two working cylinders, in which separate liners will be fitted. Free expansion of the liners in the cylinderblocks will be allowed for. The packing rings will be specially chosen so as to withstand high temperature.

Cylinderblocks and liners will have scavenging ports and one row of exhaust ports. They will be interchangeable as far as possible.

The cylinder covers will be provided with an extension lined with a separate liner, so that the piston rings can be inspected and the piston heads can be removed after lifting the cylinder cover.

Each cover will have a centrally placed fuel valve, a starting air valve, a relief valve and a connection for taking indicator cards.

The material of cylinderblocks and cylinder covers will be cast steel, the properties of which will be as in § 140.

The cylinder liners will be of special close grained cast iron with a Brinell hardness of about 190.

The liners of the cylinder head extension will be made of special cast iron, having a high Brinell hardness.

Cylinder blocks and crankcases will be bolted together by means of bolts of special steel.

All cooling water spaces will be provided with openings so that they may be scaled and cleaned with ease. The exhaust pipe will be provided with a drain cock, which in submerged condition will generally be open.

The engine cooling system will be provided with a drain cock situated at the lowest possible level, for draining it.

§ 142. SCAVENGING VALVES.

The scavenging ports will be fitted with automatic non-return valves of the ring-plate type.

§ 143. FUEL VALVES.

The fuel valves will be spring operated needle valves and will be actuated by the pressure of the fuel oil.

§ 144. STARTING AIR VALVES.

The starting air valves will be pneumatically controlled by means of air pistons directly working upon the valve spindles.

§ 145. WORKING PISTONS.

The piston skirts will be of special cast iron, the hardness of which will be about the same as that of the cylinder liners. They will be fitted with scraper rings.

The cylinder heads will be of S.M. steel, with the following properties :

tensile strength : 50—58 Kg/mm².

yield point : not less than 28 Kg/mm².

elongation : not less than 18 % for $l = 11.3 \sqrt{F.}$

Each piston head will have 5 piston rings of the Ramsbottom type.

The gudgeon pins are secured to the pistons by means of bolts.

The gudgeon pins will be of special steel.

§ 146. CONNECTING RODS OF WORKING CYLINDERS.

The connecting rods will be of S.M. steel with the following properties :

tensile strength : 50—58 Kg.p.mm².

yield point : not less than 28 Kg/mm².

elongation : not less than 18 % for $l = 11.3 \sqrt{F.}$

They will be machined all over.

The gudgeon pin and big end bearings will be of cast steel, and will be lined with white metal.

§ 147. CRANKSHAFT.

The crankshaft of the working cylinders will be connected to the coupling shaft and to the scavenging pump shaft by means of a flange with rimered holes. The material of the crankshaft will be S.M. steel, properties as in § 145.

§ 148. MAIN BEARINGS.

The main bearings will be secured to the side of the frames by means of keys. They will be of steel lined with white metal.

The side of one main bearing will also be lined with white metal to take up the thrust of the hydraulic coupling.

§ 149. TURNING WHEEL AND TURNING GEAR.

The turning wheel will be of steel, with bronze rim with carefully machined teeth. There will be one air motor working by means of gearing upon the turning wheels of both engines. The gearings will be easily disconnected from the wheels, and will be interlocked with the manoeuvring handle so that starting cannot be affected without disengaging the turning gear.

Means will be provided for turning the engines by hand.

§ 150. CAMSHAFT.

There will be a camshaft running alongside the bedplate which will actuate the plungers of the fuel pumps. This shaft will be driven from the crankshaft by carefully machined gear wheels. There will be only one cam for ahead as well as astern working.

§ 151. FUEL PUMPS.

There will be one fuel pump for each cylinder, the delivery of which will be regulated by varying the moment of the closing of the suction valves. The pump will be easily accessible. Any pump can be detached without interrupting the working of the other pumps.

The plungers will be of special nitrate-hardened steel and will be grounded in the sleeves.

§ 152. FUEL OIL SERVICE AND MEASURING TANK.

Each engine is to be provided with its own measuring tank ; they are to be of the pagoda type, i. e. a series of small tanks joined together by means of a bottle-neck and fitted with a gauge glass ; their action is such that when each tank is emptied the fuel level drops very quickly in the constriction and so enables the time to be taken for the consumption of the oil in the tanks. The tanks will be provided with suitable draining arrangements.

§ 153. SCAVENGING PUMPS.

Each engine will have two double acting piston pumps.

The pumps will be fitted with automatic plate valves.

The pump cylinders and covers will be of light metal.

The pistons will not be provided with piston rings but will have a rim lined with white metal.

The connecting rods will be of Cr. Ni. steel with a tensile strength of 75 Kg/mm^2 and an elongation of not less than 15 % for $l = 11.3 \sqrt{F}$.

The suction of the pumps will be connected to a W.T. valve in the pressure hull and thence by a pressure tight tube to the gun tower. The section of this pipe to be sufficient for a speed of not less thans 10 knots. At higher speeds the air is taken directly from the engine-room by means of large valves of light construction.

A connection to the ship's suction ventilating duct shall be provided.

§ 154. COOLING.

The cylinder jackets and covers will be cooled by seawater, which will also be used for circulating the oil and fresh water coolers. Zinc protectors shall be fitted where necessary.

The working pistons will be cooled by oil, which will be supplied to the piston heads by means of telescopic pipes.

The fuel valves will be cooled by fresh water.

§ 155. COOLERS.

There will be one oil cooler for each engine. The cooling surface will be such, that the maximum temperature of the piston cooling oil near the outlet of the pistons shall not exceed 50° C. with a sea water temperature of 20° C. and at full power.

Tubeplates and pipes will be made of cupronickel, the water ends of bronze, the shell of S.M. steel.

There will be also a small fresh water cooler for each engine, with a cooling surface of about 1 m^2. each ; material as for oil coolers.

§ 156. CIRCULATING PUMPS.

There will be one sea water circulating pump for each engine with a capacity sufficient for cooling both engines at a speed of 10 knots and at a sea water temperature of 20° C. The pump will be of the centrifugal type, and will be driven by means of bevel gears from the scavenging pump crankshaft. The capacity of the pump will be about the same whether running ahead or astern, and non-return valves are not provided for. The pumps will be made entirely of bronze. The pumps will also supply cooling water of the cooling system of thrust blocks and sterntubes, when navigating on the surface.

§ 157. ENGINE DRIVEN OIL PUMPS.

There will be one oil pump for each engine with a capacity sufficient for supplying both engines at a speed of 10 knots and at a sea water temperature of 20° C. This pump will be of the gear wheel type and will be provided with non-return valves and relief valves, and will be driven in a similar way as the circulating pump.

§ 158. STANDBY OIL PUMP.

There will be one electrically driven oil pump for both engines, this pump being of large enough capacity to supply the oil to one engine at full power or to both engines at a power corresponding to a speed of at least 10 knots. This pump will be of the vertical triple worm type, and will be driven by a 20 H.P. electric motor.

§ 159. FRESH WATER PUMP.

There will be a small fresh water pump with a capacity of about 1 ton p. hour, driven by the vertical shaft of each engine. This pump will be of the gear wheel type.

§ 160. FILTERS.

There will be a duplex oil filter in the oil delivery pipe of each lubricating oil pump.

Each fuel valve will be provided with a small filter, but there will also be a duplex filter for each engine in the combined suction pipe of the fuel pumps.

§ 161. LUBRICATION.

All important engine parts c.f. the motors for the K XIX and XX will be forced lubricated, the oil being supplied from the combined cooling and lubricating oil pump.

The cylinders will be lubricated by means of separate H.P. lubricators. The indicators in the lubricating oil piping will be visible from the engine platform.

A Laval type 3016 separator with electric heater and pump will be supplied and fitted.

§ 162. LUBRICATING OIL SERVICE TANK.

A small tank will be placed in the engine room, for the filling of cans and lubricators. This tank will be filled by means of a hand pump.

§ 163. MANOEUVRING AND STARTING GEAR.

The manoeuvring gear will be at the aft end of the engines.

The pilot valves will be controlled by the starting air lever which also acts as a reversing lever.

A fuel lever controlls the lift of the fuel pump suction valves.

There will be an interlocking gear which prevents the engine from firing when running in a direction which does not correspond with the position of the reversing lever. The same gear stops the engine when the lubricating oil supply fails.

§ 164. EMERGENCY GOVERNOR.

An emergency governor will be fitted to each engine and will be driven by means of spur wheels from the camshaft. The emergency governor cuts off the fuel supply at a speed exceeding by not more than 10 % the normal speed corresponding to the position of the fuel lever, provided the engine is running at ¼ load or more.

§ 165. STARTING AIR SUPPLY.

High pressure air flasks with a total capacity of 800 L. will be placed in the engine room and will be specially arranged for supplying starting air for the Diesel engines.

The air pressure will be 225 Kg/cm².

The flasks will be of special high tensile steel and are provided with a drain valve. In the air lines to the Diesel engines there will be an automatic reducing valve, for reducing the pressure to 60 Kg/cm². This air will be used for starting the engine and for actuating the pneumatically controlled manoeuvring valves.

§ 166. EXHAUST MANIFOLD.

The exhaust manifold will be of bronze and will be entirely cooled by sea water. The cooling water spares are provided with openings so that they may be scaled and cleaned with ease.

§ 167. DISTILLER AND DISTILLER PUMPS.

Two evaporators will be supplied for evaporating sea water by means of the exhaust gases of the Diesel engines, of a capacity of about 50 Liters per hour at a speed of about 13 knots, with one engine working. They will be easily accessible.

The distillate will be led into a distilling condensor and into a separator.

A hand pump will be provided for pumping the distillate into the fresh water tank.

§ 168. SILENCER.

There will be an efficient silencer, which exhausts into the atmosphere, or under water, as may be desired by the I. C., against a reduction in price of Fl. 1000.—. If the silencer is to be double walled and cooled, the extra price will be Fl. 3000.—.

The engine cooling water will be led into the silencer. If necessary a venting valve will be fitted to reduce the necessary time for filling the silencers. All flange connections shall be gastight.

§ 169. SEAVALVES FOR EXHAUST.

Each main exhaust pipe is to be fitted with two valves. They are to be so arranged that if the outer valve leaks, the pressure on the inner valve shall be above the valve lid and so tend to close the latter.

Special care will be taken to see that both valves are adequately cooled, for which purpose both are to be fitted with cooling mantles.

The spindles for these valves shall be of Monel metal or a good quality of stainless steel.

The constructional arrangements are to be such that the outer shipside valve closes when the engines are stopped, and that the valve cannot become heated and so cause distortion which will result in leaking valves when the vessel submerges. The outer valve will be fitted with an air piston which will keep the valve open while the engines are running, and it also must be fitted with an arrangement which will enable it to be turned by hand when they are stopped.

A large drain cock of at least 50 mm. bore must be fitted between both valves.

§ 170. REVOLUTION INDICATORS AND COUNTERS.

Each engine will be fitted with a revolution and direction indicator and with a revolution counter, all of first class make.

§ 171. GAUGES.

Each individual outlet of the piston cooling oil will be provided with a thermometer. There will be also a pyrometer in the common exhaust pipe of each engine and the usual thermometers in cooling oil, lubricating oil and circulating water pipes where necessary. (**Note**: More pyrometers will be fitted if desired by the I. C. against a price to be agreed upon. The necessary holes for inserting the pyrometers shall be provided without charge.) All thermometers shall be distance thermometers of a type approved by the I. C., and visible from the manoeuvring platform.

There will be pressure gauges for starting and scavenging air, lubricating and cooling oil, fresh and saltwater, which will be visible from the manoeuvring platform.

All thermometers and gauges will be of first class make, and will be placed in easily accessible places. All dials will be black with white inscriptions. They will be provided with brass index plates.

§ 172. HYDRAULIC COUPLINGS.

The power of each engine will be transmitted by means of hydraulic couplings of the Vulcan type, size K. 138. For these couplings the same oil will be used as for the Diesel engines, but there will be separate pumps which draw from the drain tanks and will deliver into the couplings.

The outlet of the oil from the couplings into the drain tanks will be regulated by means of a sleeve fitted at the circumference of the couplings. The filling of the couplings will be done by means of a valve at the aft end of the casing. This valve, as well as the outlet sleeve will be hydraulically controlled from the manoeuvring platform at the aft end of the Diesel engines.

The coupling rotors will be of steel, the casing will be of steel sheet, the glands will be of light alloy.

The primary rotors will be coupled to the crankshaft by means of an intermediate shaft. The secondary rotor will be carried by a short shaft which will be supported by a bearing of ample size, lined with white metal. An indicator showing the engagement or disengagement of the Vulcan couplings shall be placed in the electric motor room and in the engine room.

§ 175. OILPUMPS FOR COUPLINGS.

There will be two electrically driven oil pumps of the self-priming centrifugal or other approved type with a capacity of 25 M^3. p. hour. Each pump will be of sufficient capacity for both couplings at full power, the other pump remaining as a standby. Each electric motor will have a power of about 8 H.P.

§ 174. PROPELLER- AND INTERMEDIATE SHAFT.

The propeller shafts, thrust and intermediate shafts are to be of S.M. steel with a tensile strength of 50—60 Kg/mm^2, and an elongation of at least 19 % for

$$l = 11.3 \sqrt{F.}$$

The propeller shafts will be fitted with phosphor-bronze liners, and they will run in lignum vitae bearings outboard.

The plumberblocks will be made of cast steel and are to be lined with white metal.

§ 175. STERNTUBES.

The sterntubes will be made of weldless steel tubes, fitted with bronze bushes, lined with lignum-vitae.

§ 176. GLANDS FOR SHAFTING.

The stuffing boxes will be made in two separate halves, the material will be phosphor-bronze. The glands will be tightened by means of a toothed rim and gearing, which can be actuated at both sides of the bulkhead.

§ 177. PROPELLERS.

The propellers will be made of special bronze with a tensile strength of at least 45 Kg/mm^2, and an elongation of the least 22 % measured at a length of 20 cm. A test piece will be bent over an angle of 60—90° at a radius of 25 mm. without showing any signs of fraction ; the section of the test piece will be 25 × 25 mm.

§ 178. THRUSTBLOCKS.

The thrustblocks will be of the latest special Marine type according to the Michell principle.

They will be provided with a thrust indicator for measuring the propeller thrust when running ahead and are to be connected to the central cooling water system. The thrustblocks will give ample reserve, so as to permit uninterrupted working of the engines at full speed, without showing any signs of overheating, (60° C. maximum).

§ 179. CLUTCHES.

Between the electric motor- and propellershaft a clutch of the claw type will be fitted. The clutches will be enclosed in a oiltight casing in such a way that when running, the claws are submerged in oil.

The clutches are hand-operated by means of a suitable device.

§ 180. BRAKES.

Two hand-operated brakes will be provided for, which will lock the shafting in any position at a speed of at least 7 knots. Indicators, showing the position of these brakes shall be provided in the electric motor room and engine room.

§ 181. TELEGRAPHS.

Communication between bridge, conning tower, Diesel engines and switchboards of the main electric motors will be possible by means of electric telegraphs. (For description see specification of Electric Installation, § 212).

§ 182. WORKSHOP.

There will be a working bench with vice and a locker for storing tools etc., see § 79. All special tools necessary for the Diesel engines and shafting will be provided. They will be stowed, as far as possible in suitable boxes or lockers.

§ 183. TESTPRESSURES.

Engine parts will be tested as follows:

Cylinder covers	80 Kg.p.cm².
Cylinder liners upper part	80 Kg.p.cm².
Cooling water spaces	8 Kg.p.cm².
Oil coolers oil side	10 Kg.p.cm².
Oil coolers water side	8 Kg.p.cm².
Scavenging pumps	0.8 Kg.p.cm².
Fuel pumps	1000 Kg.p.cm².
Fuel filters	10 Kg.p.cm².
Fuel pipes	1000 Kg.p.cm².
Cooling water pipes	10 Kg.p.cm².
Exhaust pipes inside	3 Kg.p.cm².
Exhaust pipes outside	10 Kg.p.cm².

High pressure air lines ..... 1.7 × the maximum working pressure.

§ 184. TESTBED TRIALS.

The first engine will be tested as follows:

60 — hours at full load	=	2370 B.H.P. at 455 r.p.m.
4 — hours at 3/4 load	=	1700 B.H.P. at 415 r.p.m.
4 — hours at 1/2 load	=	1150 B.H.P. at 365 r.p.m.
4 — hours at 1/4 load	=	575 B.H.P. at 290 r.p.m.
1/4 — hours at 10 % overl. ...	=	2500 B.H.P. at 465 r.p.m.

1/2 — hours at lowest possible speed (about 60 r.p.m.).
2 — hours at 3/4 load astern.

Each next engine will be tested as follows:

24 — hours	at full load.
4 — hours	at 3/4 load.
4 — hours	at 1/2 load.
4 — hours	at 1/4 load.
1/4 — hours	at 10 % overload.
1/2 — hours	at lowest possible speed.
1 — hours	at 3/4 load astern.

During these tests the fuel oil consumption will be:

Full load	175 grams p. B.H.P. p. hour.
3/4 load	170 grams p. B.H.P. p. hour.
1/2 load	178 grams p. B.H.P. p. hour.
1/4 load	205 grams p. B.H.P. p. hour.
1/10 load	250 grams p. B.H.P. p. hour.
10 % overload	180 grams p. B.H.P. p. hour.

This consumption will refer to Gasoil with a lower caloric value of 10.150 cal.p.Kg. and will hold good with a tolerance of 5 %.

The lubricating oil consumption will be, with a tolerance of 10 % (inclusive auxiliaries, driven by main engine):

Full load	3 grams p. B.H.P. p. hour.
3/4 load	4 grams p. B.H.P. p. hour.
1/2 load	5.5 grams p. B.H.P. p. hour.
1/4 load	8 grams p B.H.P. p. hour.
10 % overload	3 grams p. B.H.P. p. hour.

One of the engines will be fitted with a Vulcan coupling, the others will be directly coupled to the brake. Horsepower, revolutions and fuel consumption will refer to the Diesel engine coupling flange in all cases.

Starting, reversing and governor tests will be carried out with all the engines.

Governor tests: when suddenly unloading the engine by emptying brake or Vulcan coupling while running at full power the revolutions will not exceed by 10 % the normal speed. Corresponding tests to be carried out at 3/4, 1/2 and 1/4 load, cf. § 164.

With the engine fitted with the Vulcan coupling all tests will be carried out to prove its reliability and easy working. The slip of this coupling will not exceed 2.9 % of the engine speed, with a tolerance of 1/2 %, when using lubricating oil of about 50° Cent. and a viscosity of 7—10° Engler at this temperature.

PART V.

Armament.

§ 185. GUN ARMAMENT.

The gun armament of the boat consists of :

1 Bofors 105 mm. gun, L 40.

1 Bofors 40 mm. twin automatic gun, L 60.

The 105 mm. Bofors gun is fitted in a housing of light plating, which reduces the resistance, when running in submerged condition and protects the crew against waves. The housing and platform rotate with the gun, as the latter is trained.

The 40 mm. twin automatic gun is housed in a cylindrical watertight bin, which serves also as an entrance hatch.

These guns can be quickly raised by a hydraulic ram and can be locked in their firing position. The watertight cover of the bin can be closed and opened by a pneumatic gear or a hydraulic ram, to be decided later in agreement with the I. C.

The small arms will be fitted and stowed as may be required by the I. C. ; all necessary racks and boxes shall be supplied.

§ 186. MAGAZINES AND STOWAGE ARRANGEMENTS.

The ammunition is stowed in the general store-room below the floorplates in the auxiliary central station.

The ammunition store is built in a tank which can be flooded by a seavalve. This valve and the vent shall be distant operated, as mentioned before. The ammunition will be stowed in racks of the Netherlands Navy- or other approved type. All wood used in the ammunition magazine must be fire-proofed. It is accessible from a passage in the middle of the space and can be taken out quickly for use at the guns. Watertight bins for 20 rounds of ammunition will be stowed near the 105 mm. gun in the bridge superstructure ; a suitable small place, but not in the ammunition magazine, shall be arranged for armourers tool, oil, and spare parts. The ready ammunition for the 40 mm. automatic guns will be stowed in the watertight bin of the guns itself.

The total amount of ammunition which is stowed in the general store and near the guns will be :

125 rounds for the 105 mm. gun,
1200 rounds for the 40 mm. automatic guns,
about 10.000 rounds for small arms.

The ammunition magazine must be ventilated from the bottom and the top, to the exhaust duct, to ensure a change of air three times per minute. The supply branch shall be fitted with protecting net, and both the exhaust and supply branches shall have suitable watertight closing valves. No electric cables shall pass inside the ammunition magazine.

§ 187. AMMUNITION HOISTS.

An ammunition hoist of simple design will be fitted for the 105 mm. gun. It consists of a tube which passes through the shellplating and is closed by a top and bottom cover. Four catches hold the cartridge case which is pushed through the tube by a loading stick and can be taken out on deck by hand.

The ammunition boxes for the 40 mm. automatic guns will be handed through the hatch in the watertight bin.

§ 188. TORPEDO TUBES.

There are four tubes in the bow, four in the stern and four swivelling tubes in the superstructure of the boat.

All inside tubes are suitable for torpedoes of 550 mm. diameter of the French type 6400 mm. long and of 533.4 mm. diameter of the English type 7200 mm. long ; in the latter case the caliber must be reduced by guide strips and rings, which can be fitted in the tubes. If it should be impossible to place all the openings necessary for handling both types of torpedoes on the tubes, the I. C. will decide which openings shall be fitted.

The bow and stern torpedo tubes are made of steel plate. Guide strips and rings of bronze or of an other non-corrosive material are connected to a welded steel tube of circular section by riveting. The strips and guide rings are bored out to the exact diameter in the tube. The tube is connected to the cast steel bulkhead of the boat by means of a ring of two halves which is inserted in an external circular groove of the tube. All axial forces on the tube are taken by the bulkhead.

All parts of the tube which are exposed to sea pressure are tested with 12 atm. water pressure.

The torpedo tube is closed by an inner and an outer door. The inner door is locked by a bayonet ring. The outer door is pivoted on a vertical shaft and is connected to the bow or stern shutter in such a way, that the shutter is operated simultaneously with the outer door.

The outer door is closed by a pneumatic gear, and in case of necessity, by hand. The opening movement is arranged in the following way : from the conning tower the air is admitted electrically into the pneumatic cylinder. This opens first the outer door by a very small amount, so as to fill the torpedo tube with sea water. As soon as the pressures are equalised, the movement is continued, and the outer door and the shutter fully opened. The total time taken for these movements shall be not more than about 30 seconds, and at a depth of 30 M. By interlocking the different parts of the tubes, wrong operations must be prevented.

The inner and outer doors are interlocked in such a way that only one of the doors can be opened at a time. It is impossible to fire the tube if the outer door is not fully opened. There are openings in the tube, which make it possible to adjust the torpedo in the tube.

The following adjustments can be made: depth setting, distance setting, gyro setting, handling of the charging and shut- of valves.

The gyro setting can be readjusted at any time by an adjusting gear. The torpedo is held in position by the holding bolt, which is withdrawn when the torpedo is discharged by the piston of an air cylinder.

The starting lever of the torpedo is operated by the starting bolt, which is connected to the inner door in such a way, that the bolt is withdrawn when the inner door is opened for loading the torpedo.

The torpedo is discharged by compressed air of about 40 atm. pressure, which is stored in an accumulator of about 80 l. capacity. The air is admitted to the tube by the reducing discharge valve at 4 to 5 atm. pressure.

The torpedo tube can be fired from the conning tower by a switch and in the torpedo tube compartment by the firing lever on the tube.

The torpedo tubes in the superstructure (only suitable for the 533.4 mm. torpedoes mentioned above) are twin tubes, which can be trained at any desired angle from within the ship with a hydraulic motor driven training gear.

These tubes are also welded of steel plates with guide strips and rings riveted to the inner wells of the tube and bored to the correct size. Two tubes are connected to each other and to a central pivot and a roller race, forming thus a revolving unit.

The part of the superstructure extending over the length of the tubes is connected to the tubes and is revolving together with them, reference is made, however, to § 42.

All pipes and rods for the firing gear pass through the pivot.

The gun can be trained at a speed of about 8° per second, by a worm drive, driven by hydraulic motor or by hand at a lower speed. The worm wheel is connected to the lower end of the pivot. The worm drive is self-locking. The tubes are closed by breach doors, which are locked by a bayonet ring. The muzzle of the tube is closed by a cover, which is operated pneumatically in the manner similar to that described for the inboard tubes. When the tubes are turned in the midship position they are fixed by a bolt, which can also be operated from within the ship.

The tubes will be cylindrical over their entire length.

The firing gear is pneumatic, with all controlling parts inside the boat. Only the firing reducing valve is outside on the tubes. The holding bolts are withdrawn by a pneumatic piston on the lower part of the pivot and are connected with the piston by rods, which pass through a stuffing box in the pivot.

The air for discharging the torpedo is stored in two air accumulators at about 40 atm. pressure. These accumulators are outside the boat connected to the firing valve, but can be charged through a pipe which goes through the pivot, from within the boat. The tube can be fired by hand at the tube end by a magnet operated valve electrically from the conning tower or the central station. An interlocking gear prevents firing the tubes in the unsafe sectors when the tubes are not free from the superstructure. The unsafe sectors shall be abt 120° in total.

The tubes can be drained by pipes which pass through the pivot.

The tubes can be heated by an electric heater to ensure good working of the torpedo tubes and the torpedo when the outside temperature is 20° C. below Zero.

§ 189. COMPRESSED AIR FOR TORPEDO SERVICE.

In the torpedo compartments are the connections for charging the torpedoes, when the latter are either inside the tubes or stowed in the boat. A similar arrangement is fitted for the deck-tubes in the superstructure.

To ensure the torpedoes being charged with dry air, the latter passes through a separator and an airstrainer.

Also the discharging air flasks are filled by air which passes the separator and airstrainer.

The refilling of the discharge air flasks for the swivelling torpedotubes shall be carried out from inside the ship by suitable valves with pressure gauges.

§ 190. AIR SUPPRESSING ARRANGEMENT.

When the torpedo is discharged, the compressed air which is admitted to the tube by the automatic discharge valve, expands in the tube to about the outside pressure. At this moment a vent valve is automatically opened and the air in the case of the internal tubes is discharged into the compensating tanks or into the bilge, as may be approved. The water of the forward swivelling tubes is let into a special tank, that of the aft swivelling tubes into the engine-room bilge.

When the torpedo tube is entirely filled with water, which displaces the air, water will be discharged into the above-mentioned tanks or bilges. The automatic discharge valve must then be closed. This is accomplished by a four way cock by hand.

The automatic air discharge of the decktubes and of the bow and stern tubes is similar.

The automatic vent valves of the decktubes are on the tubes outside the ship and the air is discharged into the ship by pipes which pass through the pivot. The moment when the torpedo tubes are filled with water, can be observed by a sight glass in the above-mentioned discharge pipe in the pivot.

As all the air, which is used to launch the torpedo is discharged into the ship, the air bubble, which is otherwise visible on the surface will be entirely suppressed.

§ 191. TORPEDO FIRE CONTROL.

The torpedo tubes can be filled and fired electrically from the conning tower and the central station, mechanically from the bridge, and locally by hand. The swivelling tubes can be trained from the central station and the conning tower.

The position of the swivelling tubes will be shown in the central station and the conning tower by means of mechanical or electric indicators, with an accuracy of at least 2°.

Indicator lamps will be branched on each firing and filling system in the conning tower and central station, and near each tube.

For the forward and aft tubes the following commanding gear shall be supplied:

a) One lamp telegraph for six lamps for each group;

b) One electric telegraph for twenty four orders.

For each of the swivelling tubes will be provided a lamp telegraph with three lamps.

Each of the above-mentioned telegraphs can be actuated from the conning tower and the central station, and has counter indicators there.

§ 192. TORPEDO STOWAGE AND TRANSPORT.

There are 20 torpedoes on board, 12 of which are stowed in the torpedo tubes. The spare torpedoes are stowed in the bow and stern compartments in a space under the floorplating. The torpedoes are shipped through the torpedo hatches.

On deck a torpedo davit is provided for handling the torpedoes. (See § 88). Suitable rails, boggeys, blocks, tackles, etc., will be provided for transporting and loading the torpedoes expeditiously. If possible, there shall be provided an arrangement in the fore- and aft torpedo compartments above the floor, to stow 4 extra reserve torpedoes (2 in each compartment).

To reduce friction, an ample use of ballbearings is made for the torpedo transport gear. The torpedo lifting straps will be of strong construction with 2 rollers on each side which run on 2 rails in the torpedo hatch when the torpedo is brought on board.

For the loading of the decktorpedo tubes a platform can be fixed to the starboard and portside of the superstructure, near each set of tubes.

§ 193. GUN TRIALS.

The guns will be tested during the trials, to prove that the foundations are sufficiently rigid and strong.

The gun trials consists of :

8—10 shots with the 105 mm. gun, two of which with a reduced charge ;

40—50 shots with the 40 mm. automatic twin gun, from each gun.

The shots will be fired under different elevations and training angles, the maximum elevation included.

The interlocking of the firing gear of the guns will be tried to prove that it is impossible to fire the gun in the unsafe training angles and elevations. The interlocking gear forms part of the gun and will be supplied by the manufacturer of the gun. When alterations should be needed in this interlocking mechanism, these will be carried out at the expense of the manufacturer of the gun.

The ammunition for the trials will be supplied free of charge by the Polish Government.

§ 194. TORPEDO TRIALS.

The torpedo tubes will be tested in the workshop and on board during the trials In the workshop all parts which are subject to pressure, will be tested with water pressure. Two gauges 400 mm. long and with a diameter 2,5 mm. larger than the diameter of the 550 mm. and 533,4 mm. torpedoes, will be passed through the torpedo tube. The bore of the torpedo tube with fixed guide pieces will be 2,6 mm. bigger than the diameter of the 550 mm. torpedo, with a tolerance of $\pm$ 0,5 — 0,0 mm.

The bore of the tube with the guide pieces for the 533,4 mm. torpedo will be 2,6 mm. larger than the diameter of the torpedo, with a tolerance of + 0,5 — 0,0 mm.

The working of the firing gear will be subjected to a preliminary test in the workshop by firing the tube with fully charged air accumulators, the tube being empty and the covers open.

A torpedo of 550 mm. and one of 533,4 mm. diameter will be passed in the tube to prove that the starting lever is working satisfactorily. When the torpedoes of 550 mm. and 533,4 mm. are in the tubes, it shall be verified that all the openings in the torpedo tubes correspond with the torpedo gear.

During the trials of the vessel the satisfactory working of the torpedo tubes will be tested by the following trial shots :

At the maximum speed submerged and at 15 knots on the surface, 1 shot with a 533,4 mm. torpedo of each stern and bow tube.

With each decktube 1 shot only, submerged, at maximum speed of 5 knots, trained at 90° to the fore and aft line.

The speed of discharge of the torpedoes will be about 10—12 m/sec. Practically no air bubbles of the torpedo tube may be seen on the surface when launching torpedoes in submerged condition. This is to be tested with a dummy torpedo, which has no exhaust.

The guides for the 533,4 mm. torpedo will be fitted of 550 mm. in two of the tubes at the option of the Acceptance Committee and one torpedo will be discharged from each of these tubes.

PART VI.

Electrical Installation.

§ 195. GENERAL.

The workmanship of every part of the electrical installation will be generally in accordance with the Netherlands' Navy practice and indications of the I. C. All the installation material shall be of first class quality. All apparatus and auxiliary motors, exclusive of the entirely closed motors, must be protected against splashwater from ship's hull or other causes, and ventilating of the different parts shall be provided.

The insulating tests will be in accordance with the International Rules, if not contrary to the Netherlands' Navy requirements.

The "Electrical Installation" in this description contains and includes the following :

Supply, mounting, connection, maintenance during building of the ship and the trials of all electrical parts of the installation, **excluding** the supply of the wireless telegraph- and wireless telephone-installations, and the Radio\Direction Finder installation.

§ 196. SCHEME OF SUPPLY.

The Constructor will supply the following :

The main battery, total 200 cells, manufactured by the "Zaklady Akumulatorowe Syst. "Tudor", Spolka Akcyjna", completely placed and fitted with the necessary electrical connections between each cell and between the end cells, as also the main battery-switchboards ;

2 main electromotors, complete with ventilating arrangements ;

2 main switchboards, complete with main motor-starting resistance, volt- and ampèremeters, and further necessary apparatus ;

The auxiliary electric motors, complete with automatic manoeuvring apparatus, viz. :

No.	Number	NAME	Volts	H.P. K.W.	Rev.	Vert. Horizont.
I	2	Main motor ventilators	175/275	6 H.P.	1400/2000	H
II	3	Main ballast pumps	175/275	20	1500/2200	V
III	2	Bilge pumps	175/275	5	1500/2400	V
IV	1	Trimming pump .	175/275	8	1500/2400	V
V	1	Air-compressor ..	175/275	44	700	H
VI	2	Turbo-compressors ...	175	86 K.W.	5200/6200	H
VII	2	Hydraulic pumps	175/275	18	1500/2000	V
VIII	1	Lubr. oil pump ..	175/275	18	1800/2250	V
IX	2	Conv. for lighting	175/275 / 120	10 K.W.	3000 50 ~	H
X	3	Ventilators	175/275	4	800/2700	H
XI	1	Cook. range ventilator	175/275	1/2	2000	H
XII	1	Lathe	175	1	1400	H
XIII	2	Vulcan couplings	175/275	4	1700/2200	V
XIV	1	Refrigerator				

conv. for S.M. signal .....
,, ,, Gyro .....
,, ,, Ultra Sonore .....
} as supplied by manufacturers of these installations.

,, ,, Wireless, (provided by Polish Navy).

The complete lighting installation ;
The apparatus for heating and cooking ;
The signalling installation, as claxons, bells, etc. ;
The electric tachometer installation ;
The engine telegraph installation ;
The torpedo telegraph installation ;
The rudder indicators (if electrical);
The Kingston and vent. valves indicators ;
The torpedo-firing installation ;
The telephone installation ;
The Gyro compass installation ;
The S.M. signalling installation (oscillating apparatus);

The S.M. multispot receiver installation ;
The Ultra Sonore installation ;
The echo sounding installation ;
The sallog installation ;
One portable searchlight of 500 Watt ;
The ventilating arrangement for battery and main motors ;
The cabin ventilators for local ventilation of the ship (16);
All necessary distributing and fuse-boxes for lighting and power installations and further circuits ;
All cables for the complete electric installation, including cable for the wireless telegraph- and telephone installations and for the telephone apparatus for communication between the compartments.

The apparatus of the wireless installation, the radio direction finder-goniometer-installation are not included in the Constructor's supply, but the installation and fitting on board will be carried out by the Constructor.

§ 197. MAIN MOTORS.

The main motors shall be in accordance with the tender of Messrs. Rohn-Zielinski, Sp. Akc., dated December 23 and 24, 1935, and January 3 and 4, 1936, i. e.

Type of Motor :

Double armature, one for S.B. and one for P.S., direct current, with auxiliary poles and light compound-windings, separate ventilating system which is mounted direct above the motor.

Motor Ratings :

H.P.	TIME	Revolutions	Voltage	Armatures
550	1½ hours	265	170	switched
520	continuously	260	180	in parallel
204	continuously	190	180	
204	continuously	190	180	switched
39.5	continuously	110	180	in series
39.5	continuously	110	90	switched
ca. 5	continuously	55	90	in series

The main motors can run, with small regulating steps, from ca. 55 Revs.p.m. with ca. 5 H.P. till 260 Revs.p.m. with 520 H.P. continuously.

After this, the running time decreases and is, by 265 Revs.p.m. and 550 H.P., still 1½ hour, when starting from cold temperature. Regulating of the revolutions is possible by means of switching on whole or half battery (100 or 50 cells); by switching the both armatures in parallel or series and by regulating the current of the main poles by means of resistances.

Generator Ratings :

Ampère	Voltage	Time	Revolutions	Armatures
1400	240	—	360	parallel
700	260	—	ca. 200	series
350	275	—	ca. 210	series
700	260	—	ca. 390	parallel
350	275	—	ca. 415	parallel

Exciting.

The shuntwindings of the main poles of each half motor are normally switched in parallel : in case of large decrease of the magnetfield they are switched in series.

Motor Efficiency (Exciting and Ventilating Included).

H.P.	Revolutions	Voltage	Percent
550	265	170	90.6
520	260	180	90.6
81	140	90	87.2
30	100	90	80.0

These efficiencies are subject to a margin of 10 percent of the total losses.

Temperature.

In case of the above-mentioned Motor and Generator ratings the temperature shall be not higher than :

for winding with A insulation ..... 50° C.
for winding with B insulation ..... 65° C.
for commutators ..... 55° C.

provided that the temperature of the air in the main motor-compartment will be not higher than 45° C.

For determining the temperature of the windings the resistance method will be used.

High tension tests will be in accordance with the Rules of the R.E.M.

Dimensions.

Length over bearing outer edge ..... ca. 2900 mm.
Diameter of motor casing ..... ca. 1250 mm.
Flywheel effect of armature about ..... 930 Kg.m².

Specification of Main Motor.

Each main motor will be a compound wound DC machine of the double armature type, with interpoles, reversible separately, ventilated and enclosed.

All noises due to commutation, ventilation, etc., will be reduced to a minimum.

Stators.

Intermediate piece and end housings will be horizontally split for facilitating erection and dismantling.

The design of the stators will be such that also the bottom coils can be readily removed without the necessity of removing the armature. This will be accomplished by having the magnet frame or yoke separate of the main frame, and consisting of cylindrical rings of steel machined all over. The yoke will be rotated within the main frame by means of a gear and worm, the teeth of the gear being machined into the outer surface of the yoke while the worm is attached to the main frame. The yokes will be securely locked in the normal position by means of bolts extending through the frame into the yokes.

The lower half of the motor casing will be entirely watertight.

The end housings will be fitted with openings for ventilation and with covered hand holes for the purpose of adjustment and inspection of brushes.

The lowest points of the motor frame will be provided with drains.

All stator windings will be provided with class "B" insulation.

The bearings will be of the spherical seat, self-alining, disc lubricated type. One lubricating disc on each main motor will be designed to take the end thrust of the Vulcan coupling.

Means will be provided for raising the shaft off the bearings to facilitate the removal of the bearings.

Gauges for measuring wear of the bearings will be furnished.

Oil gauges and drain cocks will be provided.

The armature will be so designed that loosening of the laminations or breakage of the shaft due to the hunting running torque of the Diesel engine is excluded.

The armature coils will be of bar copper insulated with mica, formed and pressed on the copper for that portion which lies in the slot. Outside of the slots the copper will be insulated with mica tape. The armature when completely wound will be repeatedly dipped in insulation varnish and backed.

The brush ring will be permanently marked and pinned in its neutral position, but will be designed that when the motor is idle and the neutral pin and bolts to electrical connections are removed, the entire brush rigging may be rotated around the commutator, thus providing for inspection and replacement of brushes which are normally beneath the commutator.

The ventilating set will be mounted on top of the main motor and will consist of a blower directly connected to its driving motor. The blower takes the air directly from the compartment and delivers it into the main motor casing. The warm air outlet in the motor end housings will be protected against splash water; the air outlets have tubes of special size and form.

§ 198. MAIN MOTOR VENTILATOR.

1 Ventilator constructed for about 1,8 M^3. per second, pressure about 60 mm. water ;

1 Direct current motor of the Splash-waterproof type.
H.P. by 175 volt = 6.
Voltage = 175/275.
Revolutions = 2000 p. m.

This motor can also run with 1400 Revs.p.m. by means of a second step in the starting apparatus.

Weight :

1 main motor complete with ventilating set total 10.500 K.G.
Margin : — 5 %, + 0 %.

§ 199. MAIN SWITCH PLANT.

Each main battery is connected to a main battery switchboard by means of 3 sets of cables, positive-, negative and neutral wire. The neutral wire is connected on the connections between cell 50 and 51 ; in this cable a neutral wire fusebox is mounted. Each main battery switchboard contains the following apparatus :

2 main battery fuses
1 main switch
1 shunt for the ampère- and amperhourmeter
2 main fuses for the auxiliary powercircuit
1 change-over switch for the auxiliary powercircuit
4 fuses for the 2 lighting convertors
3 fuses for voltmeter and earth contact indicator.

The neutral or middle wire switch of each main battery switchboard is connected to a box containing 2 shunts for the middle wire ampèremeters, 1 shunt for a middle wire differential A.H. meter and the necessary fuses.

Ampèremeters and a differential A.H. meter will be installed in the main motor room.

The differential meter shows which battery-half has been discharged to a larger extent.

The main batteries are normally always switched in parallel ; in one of the parallel connectings there is a main battery-parallel max. current switch. This switch will be also installed in the main motor room.

Note : Changes may be made in the main electrical switchplant, according to indications of the I. C., readjustment of price, if any, being made in mutual agreement.

§ 200. MAIN MOTOR SWITCHBOARD.

Each switchboard contains :

1 maximum current circuit breaker of the main battery ;

1 main motor switch for disconnecting the main motor from the batteries ;
The switches for feeding the main motor with full or half battery.
(**Note :** These switches are interlocked to prevent that the S.B. and P.S. motors can be connected to the same half battery.)
The contactor for short-circuiting the starting resistance ;
The starting current limiting relay for controlling contactor ;
The armature series or parallel switch ;

The reversing switches for changing the direction of main motor ;
The armature current maximum switches ;
The fieldcurrent regulators ;
The necessary controlling lamps for automatic switches ;
The measuring instruments, comprising ;

1 General voltmeter with change-over switch ;
1 General ampèremeter, connected to the shunt in the main battery board ;
2 Ampèremeters for the motor armatures ;
2 Voltmeters for the motor armatures ;
2 Temperature-indicators for the main motor valves ;
1 Ampèremeter for the differential connection between the main motor-armatures in case of parallel connection.

The main motor switchboards are mounted directly above the main motors and by means of the necessary cables connected directly to the main battery switchboards.

Starting-Resistance for the Main Motor.

This will be of the dripwater-proof type, having grid iron resistance-elements. These apparatus are separately installed in the main motor compartment.

§ 201. ACCUMULATORS.

The main battery consists of 2 parts, each having 100 cells of the type P.M. 25. The dimensions of the rubber containers are as follows :

Length 500 mm. ..... $\begin{cases} + 0 \text{ mm.} \\ - 4 \text{ mm.} \end{cases}$

Width 396 mm. ..... $\begin{cases} + 0 \text{ mm.} \\ - 4 \text{ mm.} \end{cases}$

Height 1127 mm. ..... $\begin{cases} + 0 \text{ mm.} \\ - 4 \text{ mm.} \end{cases}$

Height including terminals, 1145 mm.

The weight of a full cell, without connections is :

630 K.G. ..... $\begin{cases} + 15 \text{ K.G.} \\ - 25 \text{ K.G.} \end{cases}$

The nominal capacity per cell used for determining the radius of action under water shall be :

Hours	Watt-hours
25	17125
20	16500
15	15700
10	14400
5	12400
4	11600
3	10620
2	9200
1.1	7400

Testing of the Containers.

The first test will be a "Impact test" under the following conditions :

Balls of metal with a diameter of 100 mm., and a weight of 2 and 5 K.G., the latter depending from the kind of test, or a ball with a diameter of 135 mm. and a weight of 10 K.G. will be suspended by means of a wire of such length that the distance between the centre of the ball and the point of suspension will be 4 meters.

The container, which has to be tested, is filled with water of 20° C. and placed against a wall in such a way that the ball touches the container when at rest.

After this, the ball is lifted over a certain angle, which is variable and which is indicated on a segment ; then the ball will be dropped against the largest side of the container.

Care is to be taken, that the container will be fixed on its place during the test.

The following specification shows the tests, which the containers will have to withstand without damage.

Test	Weight of Ball	Angle	Angle	Angle
1	2 K.G.	20°	30°	40°
2	5 K.G.	20°	30°	—
3	10 K.G.	20°	—	—

One tenth (1/10) of the containers of each battery to be chosen by the Representative of the Polish Navy, will be tested in the following manner :

The container closed by its own cover is, without pressure, filled with water, having a temperature of 65° C.

After the water has cooled down and before the containers are emptied, the deformation will be measured.

The average deflections shall be no more than 3 mm. with a maximum of 4 mm.

Further, each container will be tested by means of electricity at a tension, which corresponds to a sparklength of 30 mm.

Before this experiment, the porosity of the container will be tested by filling same with water during 48 hours ; after this time the container will be dried by means of cotton waste but not by a current of air.

The electricity-test will follow immediately after this.

Capacity-Test.

The tests will be made at the workshops of the manufacturer or in the Naval Base at Gdynia, and will consist of three (3) series in the following order of succession :

1. Test on quick discharge ;
2. Test of capacity ;
3. Test of self-discharge.

Test 1.

After all cells are fully charged they will discharge regularly, corresponding to a rate of discharge of 6250 Watt and to a discharge time of 1¼ hour. The above-mentioned test will be carried out with the whole battery.

The discharging will be switched-off at the moment when the average voltage is 1,6 volt.

The time of discharge shall be not less than 70 minutes (1 hour 10 minutes).

Test 2.

The capacity tests, totalling three (3) will be taken from the whole battery after the quick discharge test has been held.

Four (4) discharges will be taken in accordance with the following specification.

The capacity tests shall be carried out at a density of the electrolyte of 26° B and the capacity shall be in such case at most 10 percent less than the figures mentioned below. The figures correspond to a density of 30° B.

Discharge Watt	Capacity in Watt-hours on average temperature	End Voltage
670	17200 (1 + 0,007 (T-25°))	1.75
810	16200 (1 + 0,0075 (T-25°))	1.70
1240	15100 (1 + 0,008 (T-30°))	1.70
2380	12600 (1 + 0,009 (T-40°))	1.65

The temperature T is a factor of correction and is the average temperature of all tested cells, checked with a time interval of one hour during the whole time of discharging.

The above-mentioned temperatures will be checked from a quantity of acid taken from the tested cells. Before these discharging tests the batteries must be charged by a current of intensity of 600 Amp. up to 2,4 Volts and by a current of 300 Amp. over 2,4 Volts.

A preliminary and an official discharge shall be carried out. The overcharging, which is given to the cells for each official discharge test, should not be higher than one half of the quantity of Amp-hours given during the preliminary discharge.

Each of the 4 official discharge tests will begin 4 hours after the end of the charging-test.

The discharge will be stopped when the average voltage of the cells reaches the limit, which is stated in the above specification.

When regulating the discharge during the quick-discharge tests, as well as during the capacity tests, the losses in the connections between the cells will be taken into consideration.

The voltage- and current intensity are checked in corresponding time-intervals, and the current is regulated during each period in such a way, that the product of the current intensity and the average voltage of the cells, which is measured at the beginning of the period, will be equal to the number of Watts which is prescribed for this rate of discharge. When one of the tests gives results which are lower than given in the above specification, a second test will take place on the same cell; this will be done after the cell, which has shown itself unsuitable, has been repaired.

A second repair is not allowed and each cell which is found unsuitable for the second time, has to be replaced by a new cell.

Test 3.

After the charging and overcharging of the whole battery, an acid-density-check shall be carried out after a period of 48 hours. The temperature of the acid shall be carefully measured during the check-test. After a ten (10) days' period the same check-test shall be carried out again, and the density of acid then obtained shall not be more than 0.3° B. less than the previously measured density. During this check-test, the temperature of the acid shall be the same as during the first measurement. The measurements shall be done with the same apparatus (aerometer).

The cells are, if possible, placed in the same conditions as aboard, i. e. the containers will have its own cover and during the whole test at the working conditions they will not be discharged.

Care has to be taken that all cells have the same temperature.

The tightness of the cells will be tested on two (2) cells, which are filled with water or acid by heeling the container over an angle of 45° into two directions.

For these tests the cell is closed by the cover and sealed, while air is led into the upper part through a small tube.

The batteries can be charged by means of the main motors, working as generators and being driven by the Diesel engines, as well as from shore ; special terminals and watertight plugs (1200 Amp.) are provided for this purpose on the superstructure deck.

Each battery of 100 cells has a connection on the neutral point, also between cells 50 and 51, for regulating the number of revolutions of the main motors. The two batteries of 100 cells each are normally connected in parallel, so that the voltage with batteries at rest is about 200 Volts ; during discharge the voltage is lower.

Each of the batteries can be charged separately as well as connected in parallel. For charging the battery by Diesel generator the maincurrent is as given in the load-table in the main motor description.

For charging the batteries from shore, the shore charging-terminals in the superstructure are connected to the main motor switchboards by means of cables for a current of 1200 Amp.

For internal parts of the battery switchboard see full description of these apparatus The Constructor shall charge the battery at suitable intervals after it has been received at his works, and generally do what is necessary to keep it in proper condition.

§ 202. AMPEREHOURMETERS.

The conditions of charging and discharging the batteries can be checked by means of two electrolytic ampèrehourmeters, placed in the neighbourhood of the battery switchboards ; further, there is a differential ampèrehourmeter, which is switched between the neutral points of the two batteries of 100 cells each.

The last-named differential AH-meter, placed in the neighbourhood of the main motor switchboards, checks the ampèrehours in case of unequal discharge of the battery halves.

§ 203. CIRCUITS.

The lighting circuit consists of a double pole wiring system with double pole fuses and double pole switches for the lamps or lamp-groups.

The lighting circuit is mainly divided into two parts, namely S.B. and P.S., each part having a main fuse distributing box and a distributing box in each compartment, also 2 main distributing boxes and 2 x 8 compartments distributing boxes.

The main distributing boxes are connected to 2 groups of 3 change-over-switches.

To obtain a constant voltage, two lighting convertors are provided, each having an automatic voltage-regulator on the secondary or generator-side. The primary or motor-side is, by means of a change-over-switch, connected to the lighting main fuses which are mounted in the main battery switchboards.

The normal tension for lighting is 120 Volt, alternating current 50 ∞. It must be possible to stop the lighting convertors when the vessel is submerged. In that case the lighting circuits can be switched over on the main battery-half ; the lighting voltage is then about 90-100 Volts, and the lamps will give less light.

Further it is possible to switch the lighting circuit on the alternating current-system on the shore. The capacity of each lighting convertor is sufficient for the normal lighting inside the ship. During the time that extra decklight or similar lighting is used, both convertors have to be used, the first for the S.B. side, the second for the P.S.

By means of the above-mentioned 2 x 3 change-over-switches, it is now possible to connect the lighting circuits on :

1) on convertors — or — shore or battery
2) on convertor I — or — convertor II
3) on battery — or — shore.

The main distributing-boxes for lighting are arranged in the auxiliary motor compartment.

For decklights and navigating lights separate distributing boxes are provided ; the 4 navigating lamps, S.B.-, P.S.-, Top- and Sternlight, are provided with an indicator in the central station.

The circuits of the auxiliary motors or other apparatus are connected to the full voltage of the main battery, i. e. about 200/180 Volts. The circuits are divided as follows :

In both main battery switchboards there are 2 fuses for auxiliary circuits and 1 change-over-switch by which it is possible to connect the auxiliary circuits before the main battery fuses or after the main battery switch.

The last-named change-over-switches are further connected to 2 main distributing boxes for auxiliary circuits. Both main distributing boxes are connected to distributing boxes in the compartments.

In each compartment-distributing-box is a change-over-switch to connect these boxes to the fore- or after battery. In the auxiliary motor-compartment are two distributing boxes for auxiliary circuits, in other compartments only one.

There are 8 auxiliary power-distributing-boxes, which are divided as follows :

1 in the forward torpedo room
1 in the forward battery room
1 in the after battery room
1 in the central station
2 in the auxiliary motor space
1 in the Diesel engine room
1 in the main electromotor room.

§ 204. CABLES.

The dimensions and quality of all cables will be generally in accordance with the International Rules or the Polish Navy requirements.

Armoured (steelwire braid) rubber-lead cables are to be used. The cables, in general, are led and secured to perforated steel strips, the main and other heavy cables are secured in a construction of light steel anglebars and strips. The last-named construction gives a very strong cable foundation with a slight weight.

All connections between cables and motors, including their apparatus, are made by means of brass cable shoes. Cable-connections to instruments, as telegraphs, telephones, etc., are made by special connections.

All motors, starting apparatus for auxiliary motors, and other apparatus have watertight cable stuffing boxes: the construction of these is in accordance with the Netherlands' Navy practice.

Cables passing through bulkheads are made watertight by special boxes, fitted to the bulkheads.

Generally, main-cables and cables for auxiliary circuits are kept separate, so that cables of the mainplant come into one box and cables of auxiliary circuits are being led in others.

Cables on S.B. and P.S. have separate cable passing boxes. By using this method, the bulkhead in front of the main motors has 4 cable passing boxes; the bulkhead about the forward torpedo-room has 2 of these.

After all cables are fitted and mounted (this in concert with the shipbuilding department), the cable-boxes will be filled up with a special quality of Marine glue, having a low melding temperature, a high insulating resistance, and very high adhesive power to cable armouring and bulkheads.

By applying this method, according to the Netherlands' Navy practice, a sufficient tightness is obtained.

Cables passing through the hull, for navigating lights or other purposes are made by means of special bronze stuffing boxes, according to the Netherlands' Navy practice.

For lines outside the hull special pressure- and watertight cable is used.

All outside cables shall be laid in pressure- and watertight pipes resisting 8,5 Kg/cm^2. pressure. Alternatively, special pressure tight cable may be used.

For connection between the telephone buoy and the vessel a special kind of cable with a bronze wire core shall be used.

This cable will be of the multicore type, according to the necessity and of such construction that it will be able to withstand the full immersion-pressure.

The length of the cable shall be about 120 meters.

For cables of portable lamps a corresponding quality as used by the Polish Navy will be provided.

§ 205. AUXILIARY SWITCHBOARDS.

For lighting purposes 2 mainfuse-distributing-boxes are fitted, each of these can be switched to both lighting-convertors, or to a battery-half, or to the alternating current shore terminals.

These boxes contain 12 double pole fuses, the cable is led in and out by means of watertight stuffing-boxes. In each compartment are 2 lighting-distributing-boxes for the lamp-groups.

One is connected to the first main distributing-box, the other to the second main distributing-box.

For the auxiliary power and other circuits 2 main distributing-boxes and 8 distributing-boxes are arranged, divided over the compartments.

Each of the above-mentioned 8 distributing-boxes are provided with a change-over-switch by which each compartment can always receive current from two independent supplies.

To prevent a large unequal load of the auxiliary mainfuses, it is preferable to have the change-over-switches in such position that the load is approximately equally divided over the 2 main distributing-boxes. The auxiliary power-distributing-boxes also have watertight cable-stuffing-boxes.

The necessary plugs and sockets inside the ship are watertight.

The necessary external socket connections are pressure-watertight, suitable for pressure of 12 Kgs/cm^2; in that case, the plugs are screwed off and the socket covers are closed by means of a spanner. The junction-boxes of the fixed outside lamps are also constructed for a pressure of 12 Kgs/cm^2.

§ 206. CONTROL AND MEASURING APPARATUS.

All Volt- and Ampèremeters are of the system Deprez d'Arsonval, with the exception of some of the instruments belonging to alternating current apparatus, f. i. gyrocompass, etc., which shall be of the moving coil type.

All instruments of the electric installation are to be watertight, with the exception of the very small instruments as used by the multispot receiver installation, etc.

For checking the charge and discharge of the main batteries, 2 electrolytic ampère-hour meters will be fitted; they are of the Siemens or other approved type.

The shunts of these instruments are fitted inside the main battery switchboards, the main current ampèremeter of the main motor switchboard is connected to the same shunt. A differential ampèrehourmeter of Siemens or other approved type, is provided to detect unequal discharge of the battery-halves.

In the neighbourhood of the switchboards for cooking-range and baking-oven, an ampère- and voltmeter are fitted, so that the heating elements can be switched over at the right moment during the charging of the battery to prevent burning out of the elements.

In the auxiliary central station a special switchboard for charging all small accumulators will be fitted.

§ 207. LIGHTING.

Two lighting convertors are fitted, each consisting of a direct current motor and an alternating current generator with a capacity of 10 K.W., 120 Volts, 50 cycles, 0,3 = cos φ.

Note: In common agreement between the Constructor and the I. C. the capacity and the number of convertors may be changed.

To each generator belongs a Volt- and Ampèremeter.

The internal lighting installation consists of about 120 lamps for normal lighting.

The periscopes, instruments, etc., will be provided with the necessary additional lights of the Netherlands' Navy type. For distributing the lighting current, each compartment has two 10 Amp. double pole automatic switches and the switches

and plugs mounted where necessary. Besides the above mentioned lamps there are 16 portable lamps, large and small, with cable and plug contact. For the external lighting a separate distributing box is fitted and for the navigating lamps a separate indicator-box is provided.

The external lighting consists of 4 navigating lamps and about 12 other decklights.

The compartments in the superstructure, i. e. galley and lavatories shall have fixed electric lights of the pressure-watertight type.

The navigating lamps and the keel-waterlights (blue) are pressure- and watertight for the decklamps ; besides these pressure- and watertight plugs and sockets are provided in the superstructure compartments.

A special pressure- and watertight top signalling light is provided, complete with a morse key in the conning tower.

The searchlight, 500 Watt, 25 cM., is portable and can be electrically connected to a special pressure- and watertight plug connection.

For emergency purposes 10 portable handlamps with accumulator of the nickel-iron type will be provided.

§ 208. HEATING.

The compartments can be electrically heated by means of tube-heating elements, with low surface temperature, and a range of 0.5—2.5 K.W.

The total capacity of the elements will be about 50 K.W. The swivelling tubes shall be heated with alternating current heating device of the Polish Navy type.

The heating tubes shall be of the Polish Navy type and of such construction, that they normally work at 200 Volts, but can also resist a tension of 220 Volts continuously.

They shall work with direct current from the battery or with alternating current from the shore supply.

The division of the tubes must be such, that all 3 phases of the 3-phase alternating-current system on the shore are about equally loaded.

Each tube shall be fitted with a fixed or separate three-heat switch.

The whole heating plant shall be in accordance with the indications of the I. C.

§ 209. REFRIGERATION.

A normal refrigerating set of the Frigidaire or Electrolux type will be provided. The whole apparatus will suit submarine requirements, and will be of about 500 Watt.

§ 210. VENTILATION.

For ventilating the main-battery tanks one exhaust fan shall be provided.

For general ventilating of the ship one supply and one exhaust fan shall be provided.

A small exhaust-fan shall be fitted in a galley.

Indicators for ventilating control will be provided.

For ventilating the main motors, each will be provided with its own fan, for capacity and regulation of this fan see description of the main power plant.

For local ventilation of the compartments 16 portable cabin or table fans are fitted, which will be connected to the lighting circuit by means of cables and plugs.

These fans shall be of the Polish Navy type ; they must be able to work on direct current as well as on alternating current.

§ 211. GALLEYS.

An electric range is provided with one oven and three hot plates of 3 K.W. capacity each. For regulating the temperature there is a switchboard containing the necessary three heat switches, main switch and fuses.

Electric vessels of suitable size shall be supplied sufficient for the crew, i. e. 2 à 30 Liters, 1 à 20 Liters, 1 à 10 Liters, 1 à 5 Liters, 1 hotplate 240 mm. diam., 1 hotplate 320 mm. diam.

For regulating the temperature of the hotplates, fixed or separate three heat-switches are provided.

A switchboard containing the necessary fuses and connectors for hotplates and electric vessels will be fitted. A baking oven with a capacity of 8 loaves of 2 K.G. each is also connected to this switchboard.

In the superstructure galley a suitable number of water- and pressuretight plugs and sockets to be provided. The electric vessels shall be brought to this galley for the surface-cooking.

§ 212. COMMUNICATION.

Telephone apparatus for communication between the compartments are provided ; this installation consists of 9 telephones complete with 10 ways electro-switch at each apparatus.

The telephone in the central station shall have separate connections to any compartment's telephone, as well as a common connection to all compartment's telephones instantaneously.

The central station telephone shall have also connection to the shore telephone lines.

A buoy-telephone-arrangement will be provided ; this is an independent installation in accordance with the Netherlands' Navy practice. For current supply special nickel-iron accumulators shall be utilized. There are three stations provided with the necessary throwover switches and morsekey, viz. 1 in the forward-torpedo-room, 1 in the after-torpedo-room and 1 in the central station.

A further telephone is provided in the buoy itself.

The buoy will be provided with a morse or signalling lamp and this lamp is connected to the telephone buoy circuit. The buoy is connected to the vessel by 120 Meter special telephone buoy-cable.

Two special telephones, with a loose cable of about 200 Meters, will be provided.

The necessary fittings, pressure-watertight sockets, stuffing-boxes, etc., to be supplied.

For alarm-signalling each compartment is provided with one claxon ; these are operated simultaneously from the central station and conning tower by means of a switch or pushbutton, and also mechanically from the bridge.

For internal signalling a bell will be provided in the galley and two pushbuttons in the wardroom.

In surface condition a special portable bell will be provided, with a pushbutton in the wardroom for the watch on deck.

In each compartment one signal bell to be installed, and for each bell one push-button in the central station near the speaking-tubes.

The current supply of these signalling apparatus will be provided by 2 small nickel-iron accumulators ; the tension is 24 Volts and for charging these batteries a charging-switchboard, in the auxiliary central station, containing the necessary charging lamps and switches is provided. On this board a 4 pole change-over switch will be arranged to make it possible that one battery is charging while the second is discharging and vice versa.

The engine telegraphs, the torpedo telegraphs, the hydroplanes- and rudder indicators are of the Siemens or similar direct current type and these installations consist of :

2 engine-telegraph combinations, one P.S., and one for S.B., each with transmitters in conning tower and receivers in the engine room and electromotor-room. The telegraphs to be of the reply type approved by the I. C.

The transmitters can also be operated from the bridge and a pressure-watertight receiver is also placed there.

The torpedo telegraph-installation consists of :

for the 4 forward tordedo room tubes in total, 1 electric telegraph near the tubes, 1 in the central station and 1 in the conning tower ; each of these telegraphs suitable for 24 orders ;

furthermore, 1 lamp-telegraph near the tubes, 1 lamp-telegraph in the central station and 1 in the conning tower, each of these lamp-telegraphs suitable for 6 orders by means of 6 lamps ;

for the 4 tubes in the aft torpedo-room the same combination as mentioned above will be fitted ;

for the forward swivelling tubes will be fitted only 1 lamp-telegraph near the pivot inside the ship, 1 in the central station and 1 in the conning tower. Each of these lamp-telegraphs suitable for 3 orders by means of 3 lamps ;

for the aft swivelling tubes the same combination as mentioned above will be fitted.

The rudder installation consists of :

One combination for the forward hydroplanes,
One combination for the steering gear,
One combination for the after hydroplanes.

Each combination has a transmitter at the rudder-mechanism and a receiver in the central station and in the conning tower.

Besides this apparatus there is also a receiver in the engine room, conning tower and a pressure watertight one on the bridge for the steering rudder.

For the trimming and regulating tanks electric indicators shall be fitted in a suitable place in the central station.

§ 213. TACHOMETER INSTALLATION.

An electric tachometer installation of Siemens or similar system will be provided.

The installation consists of 2 combinations, one for the P.S. and one for the S.B. engine.

Each shaft has one transmitter, indicators are placed in the central station, the conning tower, in the Diesel-engine room and electromotor-room. The transmitters and receivers of the telegraph installation, the receivers of the rudder telegraph, and the receivers of the tachometer-installation are all provided with inside illumination.

§ 214. TORPEDO FIRING INSTALLATION.

The torpedo firing installation is connected to a suitable circuit of the electric installation.

The torpedo-tubes can be fired and filled electrically from the conning tower and the central station, mechanically from the bridge and locally by hand.

This installation consists of solenoids mechanically connected to the firing and filling arrangement.

Each solenoid has a protecting lamp switched parallel on the solenoid near the tubes.

Indicator lamps will be fitted on each firing and filling system for control in the central station, and conning tower.

The position of the swivelling tubes will be shown in the central station and the conning tower by means of mechanical or electrical indication, with an accuracy of at least 2°.

§ 215. INDICATOR LAMPS.

The principal Kingston and venting valves are provided with a pilot-lamp-indicator.

For this purpose a special watertight switch is fitted near the valve mechanism.

An indicator-box, containing the necessary pilot-lamps, marked "open" or "shut" and coloured red and green, is fitted in the central station.

Further indicators of similar construction for the following parts are fitted :

1. External valve of exhaust of Diesel engines.
2. External valve of exhaust of Junkers engine.
3. Engine circulating water system.
4. Two ventilating tubes.
5. Two hatches of the gun-tower.
6. All torpedo firing and filling systems.

All indicators, except lamp indicators will be doubled and each of them will be connected to any switchboard.

§ 216. VARIOUS SERVICES.

The following installations will be supplied by the Polish Navy and **are not included** in the Constructor's supply :

1. Wireless telegraph installation.
2. Radio Direction finder installation.

The Constructor will, however, install on the vessel all that will be supplied by the Polish Navy, making all necessary connections.

A Sallog "Selsyn" installation will be provided conforming with the tender of Messrs. Koopman & Co., of December 24, 1935.

An electric echo-sounding installation will be provided, manufactured by the Atlas Werke, conforming with the tender of Messrs. W. C. en K. de Wit, of January 2, 1936, or any other approved type.

A submarine listening installation with direction-finder of the multispot type will be provided, conforming to the tender of W. C. en K. de Wit, of January 2, 1936, or other approved type.

The whole installation of the multispot-receiver will be such, that the use of the apparatus shall be good at the submerged and surface conditions.

A submarine signalling installation (oscillator) will be fitted, conforming to the tender of W. C. en K. de Wit, of January 2, 1936, or other approved type.

An approved "Ultra Sonore" installation for direction finding and signalling purposes will be fitted, conforming to the tender of "SCAM", of November 16, 1935, with all necessary equipment and gear. The apparatus will be used with equal ease in submerged and surface conditions.

An "Anschütz" type of submarine gyro-compass will be fitted, conforming to the tender of Messrs. "Giro", of December 18, 1935, e. e.

1 Master compass with cooling pump,
1 convertor,
3 repeater compasses,
1 special watertight repeater for the bridge,
and all the necessary switches, fuses, distributing and regulating apparatus.

§ 217. TESTS AND TRIALS OF ALL APPARATUS.

All motors, batteries, switchgear, cables, instruments, etc., will be tested at the works of the manufacturer.

After mounting the different parts on board all apparatus and motors must again be tested during the trials of the ship.

On completion of the whole installation the insulation of the entire installation must be not less than 200 x 1000 Ohm. For this test the main batteries will be disconnected.

The insulating resistance during the trials at the factory of origin must be according to the International Rules.

All tests of materials ordered in Poland shall be performed according to the Polish Navy regulations and requirements, the material ordered in Holland will be tested according to the Netherlands' Navy regulations.

§ 218. SHOP TESTS.

1. (a) The insulation of sections of the armature shall be verified as follows: three sections per armature freely selected, completely finished, impregnated and

dried, shall be immerged in sea water during twelve hours in such a way that their non-insulated ends will remain above water ; after that time of immersion three sections must show in the water an insulation of at least 2.500 Ohms. When rubbed dry, without having been heated, they must withstand a test under the pressure of 700 Volts alternating current at 50 cycles per second during one minute. The alternating pressure shall be applied progressively so that the total application will last at least two minutes, the full pressure being applied during at least one minute ; the poles of the alternating current supply shall be connected to the circuit of the section on one part, and to the staniol paper wrapped around the insulated part of the section on the other part.

(b) Test of the di-electric resistance of the insulating material. This test shall be made at 1.500 Volts alternating current effective of 50 cycles per second on each motor completely assembled with the brushes resting on the collector.

The electric power shall be applied progressively in such a manner that the time of application of the full pressure shall be at least one minute ; the poles of the alternating current supply shall be connected to the circuits of the motor on one part and to the housing on the other part.

The switches and change-over switches, the field regulators, the starters, and other manoeuvring gear shall be submitted to a test of individual resistance at 1000 Volts. Furthermore, each manoeuvring switchboard, completely assembled, shall be submitted to a trial at 1000 Volts, and precautions will be taken that this pressure is not applied between the housing and circuits of the measuring apparatus. The tests of the di-electric resistance, both for motors and dynamos, as well as for the manoeuvring gear shall be repeated twice :

before the trials, when cold, and
after the trials, but before cooling down.

(c) Insulation trials of armatures and pole coils of the motors :

One or two armatures and pole coils selected at random, after the good working trials of each set of motors are completed, shall be submerged in fresh water of about 20° C. during twelve hours in such a way that collectors and the non-insulated ends of the coils shall remain above water. After the water has dripped off, and after they have been superficially dried without heating, they shall be submitted to the alternating pressure of 700 Volts effective during one minute, in accordance with the Test No. 1 (a).

2. **Working Trial and Measuring of the Efficiency.**

A. Auxiliary motors, converter sets, and ventilators will be subject to the above tests, which will be effected in conformity with the Polish regulations P.N.E. 32, No. 23.

B. The main electrical motors of each vessel will undergo these trials, which shall be effected as follows :

An exterior power supply A will feed in series or in parallel, as desired by the Constructor, the motors B and C coupled on the same shaft, and separately excited.

The armature B will function as a motor, the armature C as a generator. The efficiency shall be calculated as follows :

(a) Connection in series b = tension at the brushes of B ; c = the tension at the brushes of C ; w = the power in Watt absorbed by the total excitation of B and C (included the power used for the field resistance and ventilators), i = the current circulating at the moment of test The efficiency will be defined by the following formulæ :

$$R = \frac{(b - c)\ i + w}{(b + c)\ i + w}$$

(b) Mounted in parallel, I = to define the current in armature B ; I' = current in the armature C ; w = the power in Watts absorbed by the total excitation of B and C (included the power used for the field resistance and ventilators), V = the common tension at the ends of the motors.

The efficiency shall be defined by the following formulæ :

$$R = \frac{(I - I')\ V + w}{(I + I')\ V + w}$$

The definite efficiency shall be calculated on the basis of an average of measurements made during five minutes. However, to allow the motor sufficient time for approaching to its normal temperature, the first measurement shall only be made after the test has been going on for half on hour.

The trials will include :

(a) a trial during one hour and a half, at a power of 550 H.P. and at 170 Volts ;
(b) a trial during one hour and a half, at the power foreseen when the vessel proceeds at a speed of 5 knots ;
(c) a trial at a power of 520 H.P. and at 180 Volts, until the final temperature is definitely reached ;
(d) a trial during one hour and a half, at the power corresponding to 100 revolutions of the propeller shaft on board.

On one of the sets of motors the necessary measurements will be made to draw up a complete curve of efficiency as a function of the number of revolutions N, the effective power on the shaft corresponding to the speed N, accepted to be equal to

$$F = 550 \times \left(\frac{N}{265}\right)^3$$

3. **A maximum field trial at 180 Volts** (collectors in parallel). Only one of the motors shall be submitted to a six hours' trial at a maximum pressure of 180 Volts at the terminals (or about 190 r.p.m. and at a power corresponding to the formulæ):

$$F = 550 \times \left(\frac{N}{265}\right)^3$$

The efficiency shall be measured.

4. **A maximum field trial at 90 Volts** (collectors in series). Only one of the motors shall be submitted to a three hours' trial at a maximum field at 90 Volts, the collectors being in series.

The speed shall be about 55 r.p.m. and the power shall be determined as described above.

The efficiency shall be measured.

5. **Progressive trial from 55 to 265 r.p.m.** It shall be verified whether the speed can be varied continuously from 55 to 265 r.p.m. by using for the acceleration of the motor the starting gear of the motor, and its field regulating resistance. This trial can be performed without load.

It shall be verified whether 10 seconds will be sufficient to change the excitation from minimum to maximum.

It shall also be verified that all precautions have been taken as far as possible to diminish the noise resulting from the forced ventilation.

6. **Trials of Generation** (collectors coupled in parallel).

The following trials shall be effected :

(a) a three hours trial during which the intensity shall be 1400 Amp., the voltage at the terminals of the generator 200 Volts, and the revolutions per minute 360 ;

(b) a six hours trial during which the intensity shall be 1200 Amp., the voltage at the terminals of the generator 120 Volts, and the number of revolutions per minute about 265 ;

(c) a six hours trial during which the intensity shall be 1200 Amp., the voltage at the terminals of the generator 265 Volts, and the number of revolutions per minute 360.

7. **Testing of the Manoeuvring Apparatus.**

The good working of each of the various manoeuvring apparatus, distribution switchboards, and couplings will be checked.

A three hours trial will be held, during which a current of an intensity equal to the maximum intensity on trial will be led through each of the component parts of the switchboards, manoeuvring boards, and distributing boxes. It will be verified that the temperature for different component parts does not raise for the connection pieces by more than 45° C., and for the contact pieces by more than 60° C. As regards the carbon pieces, the only condition imposed is, that they do not turn red. It will be verified that the heating of resistances when submitted to a current of a maximum intensity which they will have to withstand in the service, does not exceed :

1) 150° C. for the motor resistance, which can remain connected to the circuit during practically an unlimited time ;
2) 200° C. for the motor resistance, which normally remains connected to the circuit only during a fraction of manoeuvring periods.

For the first type of resistance the measurements will by made when the maximum temperature has been reached, and for the second type, after the application of current during a period of five minutes.

The temperature of the resistances shall be determined by means of thermometers placed alongside of the resistance wires and properly protected.

Furthermore, the I. C. shall perform such trials as it will deem proper, particularly sufficient number of manoeuvring with different switches (under load) will be effected. The I. C. will verify the good working of the measuring apparatus.

8. **Trial of Mechanical Resistance.**

Each motor shall be submitted to the trial of mechanical resistance during two hours at 500 revolutions per minute.

9. **The exchange armature** will be submitted to the trial of mechanical resistance after which it shall be assembled in place on a motor which will undergo a trial of 550 H.P. 265 r.p.m. mentioned above.

10. **Common Conditions for all Shop Tests.**

Immediately after each of the above-mentioned trials have been performed, the heating of the circuits shall be measured with reference to the surrounding temperature. This heating shall be such that if the surrounding temperature is assumed to be 45° C., the temperature of the inductors shall not exceed 110° C. of the armature, the compensation windings and the auxiliary poles 95° C., and of the collector 100° C. If the surrounding temperature at the moment of measuring will be less than 45° C., the permitted heating shall be reduced proportionately. As regards the inductors and the armature, the temperature shall be electrically measured by means of variations in the resistance when hot and cold; it shall be assumed that the resistance R at t degrees is given as a function of the resistance R^0 at 0° C., per formulæ:

$$R = R^0 (1 + 0{,}004\ t)$$

As regards the collectors, the temperature shall be measured by means of thermometers placed directly on the corresponding parts, covered by pieces of wool or flannel, and left in that condition until the mercury ceases to raise.

The measurements will also be made of the cooling ventilator. Temperatures of the circuits and collectors shall not exceed the limits fixed for the motor after each of the trials performed.

The insulation of circuits of each motor shall be measured after each trial, and shall equal at least 1 megohm.

§ 219. NOTE:

The following prices have heen included in the lump price:

(1) Supply, fitting and mounting of 24 indicator systems for torpedo firing and filling arrangements:

Specification of 1 system:

1 special switch	Fls.	45.—
1 signalling light	,,	20.—
cable and further material	,,	50.—
wages and charges	,,	60.—
Total for 1 system	Fls.	175.—

For 24 systems 24 x Fls. 175.— ..... Fls. 4.200,—

(2) Supply, fitting and mounting of 9 indicator systems for gun-tower hatches, ventilating tubes etc., each system with a connection to two circuits.
For 9 systems 9 x Fls. 175.— ... . Fls. 1.575,—

(3) Supply, fitting and mounting of apparatus for the automatic torpedo filling arrangements :

12 special electro-magnets	Fls.	1.400,—
24 switches	,,	480.—
cable and further material	,,	660.—
wages and charges	,,	820.—
Total price	Fls.	3.400,—

(4) Supply, fitting and mounting of lamp telegraphs for the torpedo tube arrangements, viz. :

For the forward tubes :
1 telegraph near the tubes, 1 in the central station and 1 in the conning tower, each of these apparatus has 6 orders and 6 contra-orders ;

For the aft tubes :
the same apparatus as used with the forward tubes ;

For the swivelling tubes :
2 telegraphs near the tubes, 2 in the central station and 2 in the conning tower.
Each of these swivelling-tube telegraphs has 3 orders and 3 contra-orders.

Specification forward and aft tubes telegraphs :

6 telegraphs	Fls.	1,500.—
2 change-over switches	,,	40.—
cable and further material	,,	300.—
wages and charges	,,	320.—
Total	Fls.	2,160.—

Specification for swivelling tube-telegraphs :

6 telegraphs	Fls.	1.320,—
2 switches	,,	40.—
cable and further material	,,	250.—
wages and charges	,,	290.—
Total	Fls.	1.900.—

Total Fls. 2.160.— + Fls. 1.900.— ..... Fls. 4.060.—

If necessary these prices may be reduced in agreement with the I. C. after all detail arrangements for these items have been settled and the actual price is known.

§ 220. SPECIAL INSTALLATIONS.

In the main lump price the following items are included, according to the tenders mentioned below, which tenders have been handed over to the Polish Navy.

A. Tender of Messrs. Barr and Stroud, dated June 26, 1935, for three periscopes, viz. :

(1) 1 attack periscope with range estimator, direct reading scale, lixed line in space for "Anschütz" repeater, optical length 8000 mm. and diameter 150 mm.
(2) Cruising periscope with special sloping window and a line of sight, which can be raised up to 70° for sky searching, the angular field being 40°. Optical length 8000 mm. and diameter 150 mm.
(3) Night periscope, angular fields 40° and 10°, diameter of exit pupil 5 mm. Optical length 8000 mm. and diameter 150 mm.
(4) 1 motor-driven dessicator for attaching to the periscopes ;
(5) 4 boxes of spares.

Total price ..... Fls. 21.630.—

B. Tender of Messrs. Koopman & Co., dated December 24, 1935, for one Sal-Selsyn Log installation, including :

(1) 1 bottom arrangement for double bottom ships ;
(2) 1 Sal-Selsyn log apparatus (Master log), direct indicating the speed on the linear scale ; at the same time the log apparatus indicates directly the distance passed in nautical miles on a mileage counter ;
(3) 1 switchbox ;
(4) 1 junction box ;
(5) 1 box with tools and spares ;
(6) 1 combined speed indicator and distance recorder to be mounted in the tower.

Total price ..... Fls. 7.835.—

C. Tender of Messrs. W. C. en K. de Wit, of January 2, 1936, for submarine signalling, direction finding and echo-sounding gear, viz. :

(a) Submarine signalling installation, comprising 6 transmitters arranged 3 and 3 on each side of the hull, 1 high frequency convertor, complete with automatic starting apparatus and further switchboard containing the necessary receiving instrument and morse key ;
(b) 1 submarine direction finder installation of the multispot type, comprising 18 receivers, 9 to be fitted on each side of the bow, further one compensator apparatus with amplifier, telephones, batteries, regulating apparatus, and the necessary instruments ;
(c) 1 echo sounding apparatus, comprising 2 oscilators to be fitted in the ship's bottom, 1 special convertor, 1 indicating apparatus.

Total price ..... Fls. 31.710.—

D. Tender of Messrs. N.V. „GIRO", dated December 18, 1935, and May 9, 1935, for one Anschütz type of submarine giro-compass installation, comprising 1 master compass with cooling pump, 1 convertor, 3 repeater compasses, 1 special watertight repeater for the bridge, and further the necessary switches, fuses, distributing and regulating apparatus.

Total price ..... Fls. 19.770.—

E. Tender of Messrs. Société de Condensation et d'Applications Mécaniques, dated November 16, 1935, for one ultra-sonore apparatus for detection and inter-communication, with complete gear for lifting and training the apparatus by means of an electric motor.

Total price ..... French Frs. 239.300.—

F. Tender of Messrs. W. E. Mingramm, dated July 2, 1935, for one air purifying device, as discribed in § 135, and for artificial lungs, as discribed in § 136:

Price for the purifying device ..... Fls. 5875.—
Price for the artificial lungs ..... Fls. 4813.—

At the option of the Polish Navy other similar installations manufactured by other firms shall be supplied and fitted, the difference in net invoice price being in that case added or deducted from the main lump price for the vessels. The decision of the Polish Navy in connection with these matters shall be communicated to the Constructor not later than six months after the signature of this Agreement. If, however, the time during which any tender is open, is limited and cannot be prolonged, the Polish Navy shall, at the request of the Constructor, communicate its decision within the period of the tender.

PART VII.

Equipments.

The following equipment shall be supplied:

1) Detail ZEEINSTUMENTEN (Nautical instruments) approved by Min. Res. 4-7-1931, IV A No. 89, altered by Min. Res. 1-8-1931, A No. III, with the exception of leads for electric sounding winch, books, instructions and charts.
2) Detail SCHIPPER (Boatswains Store) approved by Min. Res. 4-7-1931, IV A No. 89, altered by Min. Res. 1-8-1931, IV No. III (corrected for 56 men).
3) Detail BOTTELIER (Stewards store) approved by Min. Res. 4-7-1931, IV A No. 89 (corrected for 56 men).
4) Detail KOMMALIEWANT (Messroom) approved by Min. Res. 4-7-1931, IV A No. 89 (corrected for 56 men).
5) Detail MACHINIST (Engineers store) approved by Min. Res. 5-10-1932, IV A No. 60.
6) Electricians equipment and tools as hereunder:

ELECTRICAL EQUIPMENT.

MATERIAL	NUMBER
Accumulators 6 Volt	10
Accumulator element 6 Volts with positive and negative pole	1 set
Batteries for handtorch, large	24
Batteries for handtorch, small	24
Lamps for 6 Volts accumulator handlamps	10
Dry batteries for portable lamp	5
Portable electric lamps with cable and plug	20
Portable navigating lamps	3
Morse lamp	1
Portable electric lamp "Ratur"	1

ELECTRICAL EQUIPMENT.

MATERIAL	NUMBER
Cabin table lamp	15
Portable projector	1
Handtorch	24
Riding lights (electric)	2
Navigating light	1
Glass shade for external lights (pressure proof)	5
Glass shade for portable lamps	3
Glass shade for ceiling lamps	10
Glass shade for cabin lamps	15
Accumulator battery for telephone apparatus	1
Normal swan fittings	25
Small swan fittings	25
Brass ring for navigating lights	1
Portable fans	16
Sockets for portable lamps	10
Sockets for portable lamps (pressure proof)	6
Electric bulb, metal, vacuum, 3,2 V. Ed. Swarf	60
,, ,, ,, ,, 3/4 V. Ed. Swarf	12
,, ,, ,, ,, 12/16 V. 50 W. S.F.	15
,, ,, ,, ,, 12/16 V. small S.F.	12
,, ,, ,, ,, 6/8 V. 6 W., S.F.	20
,, ,, ,, ,, 120 V. 60 W. S.F.	10
,, ,, ,, ,, 120 V. 40 W. S.F.	120
,, ,, ,, ,, 120 V. 25 W. S.F.	300
,, ,, ,, ,, 120 V. 25 W. (45 x 62) S.F.	100
,, ,, for hand torches	60
,, ,, carbon, 120 V. 60 W.	12
,, ,, metal, 120 V. 15 W. (20 x 50) S.S.F.	100
,, ,, ,, 120 V. 1000 W. C.F.	5
,, ,, ,, 40 V. 5 W. S.S.F.	15
,, ,, ,, 40 V. 25 W. S.F.	12
,, ,, carbon, 120 V. 3 W. S.F.	520
,, ,, ,, 120 V. 3 W. S.S.F.	170
,, ,, metal, 120 V. 15 W. S.F.	4
,, ,, ,, 130 V. 5 W. S.F. Red/blue	4
,, ,, ,, 20 V. 5 W. Red/blue	4
,, ,, ,, 120 V. 25 W. (32 x 96) S.F.	10
Armoured cable for portable lamps	500 Meters
,, ,, ,, projector 2 x 2 mm.	20 ,,
,, ,, 3 x 2 mm.	70 ,,
,, ,, 3 x 6 mm.	50 ,,
Cable for telephone, 4 x 1,25	150 ,,
Flexible cable, 2 x 1,6	120 ,,
One core cable, 1 x 1,5	25 ,,
Silk cable for cabin lamp, 2 x 1	60 ,,
Silk cable, 2 x 1	60 ,,

MATERIAL	NUMBER
Cable for shore, 2 x 1	90 Meters
„ „ „ 2 x 16	180 „
„ „ „ 2 x 2	20 „
„ „ „ 4 x 35	80 „
„ „ „ 4 x 1,5	20 „
„ „ telephone	60 „
Armoured cable for submarine towing :	
16 core, 0,4 mm. 12 steel — 4 copper wires	440 „
Telegraph cable	100 „
Flexible cable, 2 x 1	100 „
„ „ 2 x 2,5	50 „
„ „ 4 x 1,5	50 „
2 pole w.t. plugs 6 amp.	5 pieces
2 pole for external lights	6
2 pole for portable lamp	10
Internal fittings of switch	30
Internal fittings of change-over-switch	10
Spring for change-over-switch main boards	20
Box for shunts	1
Small portable ampère meter 0—100	1
Portable voltmeter, scale 3—15 — 30—300—450 volt	3
Pocket voltmeter 12—120 volt	3
Pocket voltmeter 0—4,5 volt	2
Shunts 10 amp.	1
„ 2 „	1
„ 50 „	1
„ 100 „	1
„ 500 „	1
Insulation control	1
Ohmmeter	1
Banc for inspecting the accumulators	1
Rubber mattrass for inspecting the accumulators	1
Wrench for connecting units	2
Bedplates 700 x 300 x 15 for discharge of accumulators	4
Cables with 2 terminals for excluding of the circuit spoiled cells of the battery	4
Small bag for cleaning the joins	1
Hard-rubber syphon pipe for accumulator 15 x 20 mm.	10 Meter
Base plate for hoisting the accumulator	2
Rubber pipe 28 x 20 mm. for filling accumulators	20 Meter
Set of tools for deducting iron in the electrolye	1 set
Glass eprouvette with stand and bec, scale 100 cM^3.	2
Conic bottle 500 cM^3.	1
Burette with wooden stand, scale 1/10 cM^3, till 35 cM^3.	1
Glass rod	2
Special thermometer, scale 0—60° C.	2

MATERIAL	NUMBER
Pipes for portable lamps for inspecting cells	1
Protecting masks	1
Bogies for transport of cells, fore and aft	1
Bogies for transport of cells by block transverse	1
Hard rubber mixing spoon	1
Glass eprouvette of 250 cM^3., with scale	2
Rubber gloves, large	2
Rubber gloves, small	2
Areometer	2
Rubber syringe with hard rubber tip	1
Insulated joints for measuring intensity of current	1
Insulated joints for measuring currents, 25 mm. diam.	1
Thermometers, maximum, for battery tanks	2
Stone pigs, 3 liter	2
Switch joints for charging battery from shore	2
Box tube spanner, special, for lamps	3
Monkey spanner	2
File, round, smooth, 250 mm.	1
,, round, smooth, 350 mm.	1
,, half round, smooth, 200 mm.	1
,, half round, smooth, 250 mm.	1
,, square, half smooth, 100 mm.	1
,, flat, smooth, 300 mm.	1
,, triangular, smooth, 250 mm.	1
,, triangular, half smooth, 100 mm.	1
,, oval, 200 mm.	1
,, oval, 350 mm.	1
,, flat, bastard, 400 mm.	1
,, flat, half smooth, 100 mm.	1
,, half round, half smooth, 200 mm.	1
,, half round, half smooth, 250 mm.	1
Hacksaw blades	6
Adjustable hacksaw	1
Pliers for wire cutting, 125 mm.	2
,, for wire cutting, face	1
,, for wire cutting	1
,, round nose, 150 mm.	2
,, flat, 150—160—170 mm.	4
Universal pliers, with shares	1
Universal pliers, with side cutting	2
Adjustable wrenches for taps, 120 mm.	1
Hand drilling post, 450 mm.	1
Drills, with cylindrical fitting, 2, 3, 4, 5, 6, 7, 8, 9, 10	1 set = 9
Screwdrivers, fixed, 150, 200, 300	1 set = 3
Graiser	1
Handhammer, 300, 1000 gram	1 set = 2

ELECTRICAL EQUIPMENT.

MATERIAL	NUMBER
Handvice, 3.5 Kg.	1
Stocks and dies, taps and wrenches, metric threards, 2, 3, 4, 5, 6, 7, 8 mm.	1 set = 7
Soldering bit, 300 gr., 800 gr.	1 set = 2
Cable tip compressor	1 set
Safety goggles, white	2
Steel folding meter (1 Meter)	1
Dustbrush	2
Paint brush Polish No. 4, 5, 6	1 set = 3
Flat spanner, double end, 1 set, from 5 x 5.5 mm. till 32 x 35 mm.	24
Flat spanner, single end, 1 set, from 12 till 26 mm.	3
Tube box spanners, double ended, 1 set, from 9 x 11 till 14 x 16 mm.	4
Handles for hammers	2
Screw drivers, double ended, 1 set from 100 till 175 mm.	4

7) Armourer's equipment and tools (see list herein below):

ARMOURER'S EQUIPMENT.

DESCRIPTION	NUMBER
Tools for mounting periscopes	1 set
Tools for heaving periscopes	1 ,,
Tools for torpedo-launching-installations	1 ,,
Spanners	5
Tongs	2 pairs
Screw drivers	2
Chisels	4
Hocksaw (frame)	1
Handdrill	1
Drills of differend sizes from 1 mm. — 5 mm. diam.	25
File brushes	2
Steel hook (90°)	1
Hammers	3
File-handgrips	7
Paint-brushes	2
Compass rod	1
Scissors	1 pair
Dutch wrench	1
Wrenches	2
Files of different sizes	22
Tools for H.P. air armatures	1 set
Tools for L.P. air armatures	1 ,,
Tools for loading torpedo-tubes	1 ,,
Tools for mounting air bottles	1 ,,
Cans, etc. for oil	1 ,,
Spanners for torpedo slings	3

PART VIII.

Spare Parts.

The following spare parts are tabulated, below, specified as follows:

I. **SHIP.**
- A. Spare parts per vessel.
- B. Common spares.

II. **ELECTRICITY.**
- A. Spare parts per vessel.
- B. Common spares.

III. **MACHINERY.**
- A. 1. Spare parts per vessel to be carried on board.
- 2. Spare parts per vessel not to be carried on board.
- B. Common spares.

For the total order of 2 submarines, the spare parts per vessel shall be supplied twice, the common spares once.

SHIP.

SPARE PARTS.

A. Per vessel:

4 — sets of spares for periscopes

B. Per two vessels:

1 — set of three periscopes

1 — anchor with chain, complete.

ELECTRICITY.

SPARE PARTS.

A. Per vessel :

2 — sets spanners, flat and tube for diazed fuses
2 — sets spanners, flat and tubes for carbon brushholders
2 — sets of tools for dismantling couplings, fans and ball-bearinigs
1 — set tools for dismantling mainpole and auxiliary pole coils of the main motors
2 — pieces polishing blocks for each kind of commutator
1 — wooden box, divided into compartments, containing carbon brushes, brushholders, springs and screws for brushholders

B. Per two vessels :

Main Motors.

1 — double armature, complete with half coupling
1 — set of complete bearings
1 — complete main pole coil
1 — complete auxiliary pole coil
1 — brushholder shaft with insulation
1 — brushholder for one shaft
1 — set carbon brushes for two commutators
1 — set springs for brushholder of one shaft
1 — commutator, polishing apparatus, complete

Main Motor Ventilator Motors.

2 — armatures, complete with half coupling
2 — sets complete bearings
2 — complete main pole coils
2— complete auxiliary pole coils
2 — brushholder shafts with insulation
2 — sets of brushholders for one shaft
2 — sets carbon brushes
2 — sets springs for brushholders of one shaft

Main Ballast Pump Motors.

2 — armatures, complete with half coupling
2 — sets of complete bearings
2 — complete mainpole coils
2 — complete auxiliary pole coils
2 — brushholder shafts with insulation
2 — sets of brushholders for one shaft
2 — sets carbon brushes
2 — sets springs for brushholders of one shaft

Bilge Pump Motors.

2 — armatures, complete with half coupling
2 — sets of complete bearings
2 — complete mainpole coils
2 — auxiliary pole coils
2 — brushholder shafts with insulation
2 — sets of brushholders for one shaft
2 — sets carbon brushes
2 — sets springs for brushholders of one shaft

Trimming Pumpmotor.

1 — armature, complete with half coupling
1 — set complete bearings
1 — complete mainpole coil
1 — complete auxiliary pole coil
1 — brushholder shaft with insulation
1 — set brushholders for one shaft
1 — set carbon brushes
1 — set springs for brushholders of one shaft

Air-Compressor Motor

1 — armature, complete with half coupling
1 — set complete bearings
1 — complete mainpole coil
1 — complete auxiliary pole coil
1 — brushholder shaft with insulation
1 — set brushholders for one shaft
1 — set carbon brushes
1 — set springs for brushholders of one shaft

Turbo-Compressor Motors.

2 — armatures, complete with screw wheels for oilpump and rings
2 — sets complete bearings
2 — complete mainpole coils
2 — complete auxiliary pole coils
2 — brushholder shafts with insulation
2 — sets of brushholders for one shaft
2 — sets carbon brushes
2 — sets springs for brushholders of one shaft

Hydraulic Pumpmotors.

2 — armatures, complete with half coupling
2 — sets complete bearings
2 — complete mainpole coils

2 — complete auxiliary pole coils
2 — brushholder shafts with insulation
2 — sets of brushholders for one shaft
2 — sets carbon brushes
2 — sets springs for brushholders of one shaft

Lubricating Oil Pumpmotor.

1 — armature, complete with half coupling
1 — set complete bearings
1 — complete mainpole coil
1 — complete auxiliary pole coil
1 — brushholder shaft with insulation
1 — set brushholders for one shaft
1 — set carbon brushes
1 — set springs for brushholders of one shaft

Lighting Convertors.

2 — double armatures, complete with half coupling
2 — sets complete bearings
2 — complete mainpole coils for motor and generator
2 — complete auxiliary pole coils for motor
2 — brushholders with insulation for motor and generator
2 — sets brushholders for one shaft, for motor and generator
2 — sets carbon brushes for motor and generator
2 — sets springs for brushholders of one shaft, for motor and generator

Battery and Ship Ventilating Motors.

2 — armatures, complete with half coupling
2 — sets complete bearings
2 — complete mainpole coils
2 — complete auxiliary pole coils
2 — brushholder shafts with insulation
2 — sets of brushholders for one shaft
2 — sets carbon brushes
2 — sets springs for brushholders of one shaft

Cooking Ventilator Motor.

1 — armature, complete with half coupling
1 — set complete bearings
1 — complete mainpole coil
1 — complete auxiliary pole coil
1 — brushholder shaft with insulation
1 — set brushholders for one shaft
1 — set carbon brushes
1 — set springs for brushholders of one shaft

Lathe Drive Motor.

1 — armature, complete with pully
1 — set complete bearings
1 — complete mainpole coil
1 — complete auxiliary pole coil
1 — brushholder shaft with insulation
1 — set brushholders for one shaft
1 — set carbon brushes
1 — set springs for brushholders of one shaft

Vulcan Coupling Pumpmotor

2 — armatures, complete with half coupling
2 — sets complete bearings
2 — complete mainpole coils
2 — complete auxiliary pole coils
2 — brushholder shafts with insulation
2 — sets of brushholders for one shaft
2 — sets carbon brushes
2 — sets springs for brushholders of one shaft

Convertors and motors for Giro, S.M. signalling and U.S. installation.

1 — armature for motor and generator
1 — set of complete bearings
1 — complete mainpole coil for motor and generator
1 — complete auxiliary coil for motor and generator
1 — set of brushholders with insulation for motor and generator
1 — set of brushholders for one shaft, for motor and generator
1 — set of carbon brushes for motor and generator
1 — set of springs for brushholder of one schaft, for one motor and generator.

Auxiliary Motor Starting Apparatus.

1 — contact piece for starting apparatus, fixed.
1 — set of :
contact pieces for starting apparatus, sparking
contact pieces for starting automatic switches, fixed
contact pieces for starting automatic switches, sparking
3 — of each :
contact fingers and springs for controllers
contact pieces for controllers, fixed
contact pieces for controllers, sparking
sparking-boards for controllers

Mainswitch Gear.

3 — complete knives for each type of change-over switch
3 — complete knives for each type of switch
3 — sets of spark-horns for battery automates
2 — sets of spark-horns for motor automates
2 — sets of spark-horns for starting automates
1 — switching-in coil for starting automates
1 — switching-in coil for current automates
1 — set of contacts for current automates
1 — set of sliding contacts for each type of switch
2 — sets of flat springs for sliding contacts of field regulator
2 — sets of sliding contacts for field regulator
1 — set of auxiliary contacts
1 — set of starting resistances
1 — set of signal lamps
1 — of each kind and size of spiral spring used
1 — of each kind and size of screws used
1 — box with compartments and lock for the above.

Telephone Installation.

2 — apparatus with selector.

MACHINERY.

SPARE PARTS.

A. Per vessel :

(1) to be carried on board :

Main Diesel engines :

2 — piston heads with rings
2 — crankshaft-bearings working cylinders
2 — crankshaft end bearings
1 — crankshaft bearing scavenging pump
2 — bolts for piston pin bearings
2 — bolts for crank-pin-bearings working cylinder
2 — bolts for crank-pin-bearings scavenging pumps
2 — brushes for crosshead slippers scavenging pumps
2 — brushes for crosshead pin scavenging pumps
2 — brushes for piston rod scavenging pumps
1 — gland, complete for piston rod scavenging pumps
4 — fuel valves, complete
12 — nozzles with needles
2 — fuel pumps, complete
6 — suction valves, fuel pump
6 — delivery valves, fuel pump
2 — safety valves, fuel pump

6 — plungers with bushes, fuel pump
6 — cams, fuel pump
6 — rollers, fuel pump
2 — camshaft bearings
1 — camshaft end bearing
2 — sets of piston rings for one piston
1 — set of scrape rings for one piston
2 — sets of gland rings scavenging pump
2 — sets of plate valves
2 — sets of plate valves scavenging pump
2 — seats for plate valves scavenging ports
1 — set of bolts for cylinder-cover
1 — pressure gauge for lubricating oil
1 — pressure gauge for fuel oil
1 — pressure gauge for cooling water
2 — spindles for starting air valves
2 — sets of connecting bolts for crankshaft
1/4 — set of bolts and nuts for one engine
1 — set of springs for one engine
2 — sets of packing rings for one engine
6 — fuel pipes
1 — set of gear wheels for cooling and oil-pump
1 — set of ball bearings for cooling and oil-pump
1 — set of gear wheels for governor
2 — springs for governor
1 — impeller for cooling water-pump
2 — connecting rod small end bearing working cylinder
2 — connecting rod big end bearing working cylinder
1 — connecting rod small end bearing scavenging pump
1 — connecting rod big end bearing scavenging pump
12 — guide bushes telescopic pipes
4 — sets of telescopic pipes
1 — piston with rod scavenging pump
2 — safety valves for working cylinders
1 — valve, seats and bushes reducing valve
1 — set of bearings Vulcan shaft
1 — set of glands Vulcan shaft
1 — tube stack for distiller
1 — set of thrust pads S.B. thrust shaft
1 — set of thrust pads Port thrust shaft
1 — set of bearings thrust shaft
1 — set of small spares centrifugal separator
1 — set of rotating parts standby lubric. oilpump
1 — set of rotating parts Vulcan oil pump
1 — set of small spares turbo-blower

Electrically driven air campressor :

1 — safety valve for H.P. cylinder

1 — safety valve for L.P. cylinder
2 — delivery valves for H.P. cylinder
2 — delivery valves for L.P. cylinder
1 — suction valve for H.P. cylinder
1 — suction valve for H.P. cylinder, complete with seat and spring
3 — suction valves for L.P. cylinder
1 — suction valve for L.P. cylinder, complete with seat and spring
2 — suction valves for cooling-waterpump, complete
2 — delivery valves for cooling-waterpump, complete
1 — valve for soap-water pump
2 — springs for safety-valve H.P. cylinder
2 — springs for safety-valve L.P. cylinder
2 — springs for delivery-valve H.P. cylinder
4 — springs for delivery-valve L.P. cylinder
2 — springs for suction valve H.P. cylinder
8 — springs for suction-valve L.P. cylinder
4 — springs for suction-valve cooling water-pumps
4 — springs for delivery valve cooling water-pumps
2 — springs for valve soap-water pump
2 — packing rings for H.P. cover
2 — packing rings for L.P. cover
8 — packing rings for suction-valve seats L.P.
2 — packing rings for suction-valve seats H.P.
2 — packing rings for nut plugs H.P. suction-valve
4 — packing rings for nut plugs L.P. delivery-valve
2 — packing rings for nut plugs H.P. delivery-valve
2 — packing rings for safety valve L.P. cylinder

Junkers air compressor :

1 — fuel nozzle
1 — needle for fuel valve
1 — fuel pipe with pressure valve
1 — valve casing
6 — stop bolts
8 — ball valves, complete
1 — lever
23 — valve seats
1 — set of small parts fuel pump
1 — fuel pump piston
1 — fuel cam
1 — set of springs
1 — set of packing rings
2 — balls 5 diam.
1 — ball 9 diam.
2 — balls 6 diam.
20 — needles for needle bearings
2 — fire sleeves

6 — piston rings
2 — piston rings 1st stage
4 — piston rings 2nd stage
5 — piston rings 3rd stage
12 — piston rings 4th stage
1 — cam
1 — gear wheel
1 — shaft with impeller and brasses main bilge pump
1 — set of rotating parts aux. ballast- and bilge-pump
1 — set of packing rings for air bottles
1 — set of small spares for H.P. and L.P. air lines
1 — set of small spares for oxygen pipe line
1 — set of spares lancing tubes

(2) **not to be carried on board :**

Main Diesel engines :

2 — cylinders cover with liner, without valves
2 — liners for cylinder-cover
2 — cylinder liners
2 — pistons, complete
1 — set of coupling bolts
2 — starting air valves
1 — set of gear wheels for camshaft
4 — brackets for piston cooling
1 — cylinder lubricator
2 — valve seats for scavenging pump
2 — crankcase covers
3/4 — sets of bolts and nuts for one engine
1 — scavenging air receiver cover
2 — gauzes fuel and lubricating oil filters
1 — set of coupling bolts intermediate shafts
1 — set of gland rings propeller shaft
1 — bearing brass plumber block
1 — valve for interior exhaust valve
1 — valve for exterior exhaust valve
1 — S.B. propeller
1 — Port propeller

B. Per two vessels :

1 — crankshaft for six working cylinders
3 — cylinderblocks, each for two working cylinders
1 — scavenging pump cylinder
1 — scavenging pump top cover
1 — scavenging pump centre cover
1 — tube stack for oil cooler
1 — connecting rod without counterweights
1 — connecting rod with counterweights
1 — connecting rod scavenging pump.

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