No. 896,613. PATENTED AUG. 18, 1908.

G. BEHRMANN.

SUBMARINE BOAT.

APPLICATION FILED APR. 6, 1908.

2 SHEETS—SHEET 1.

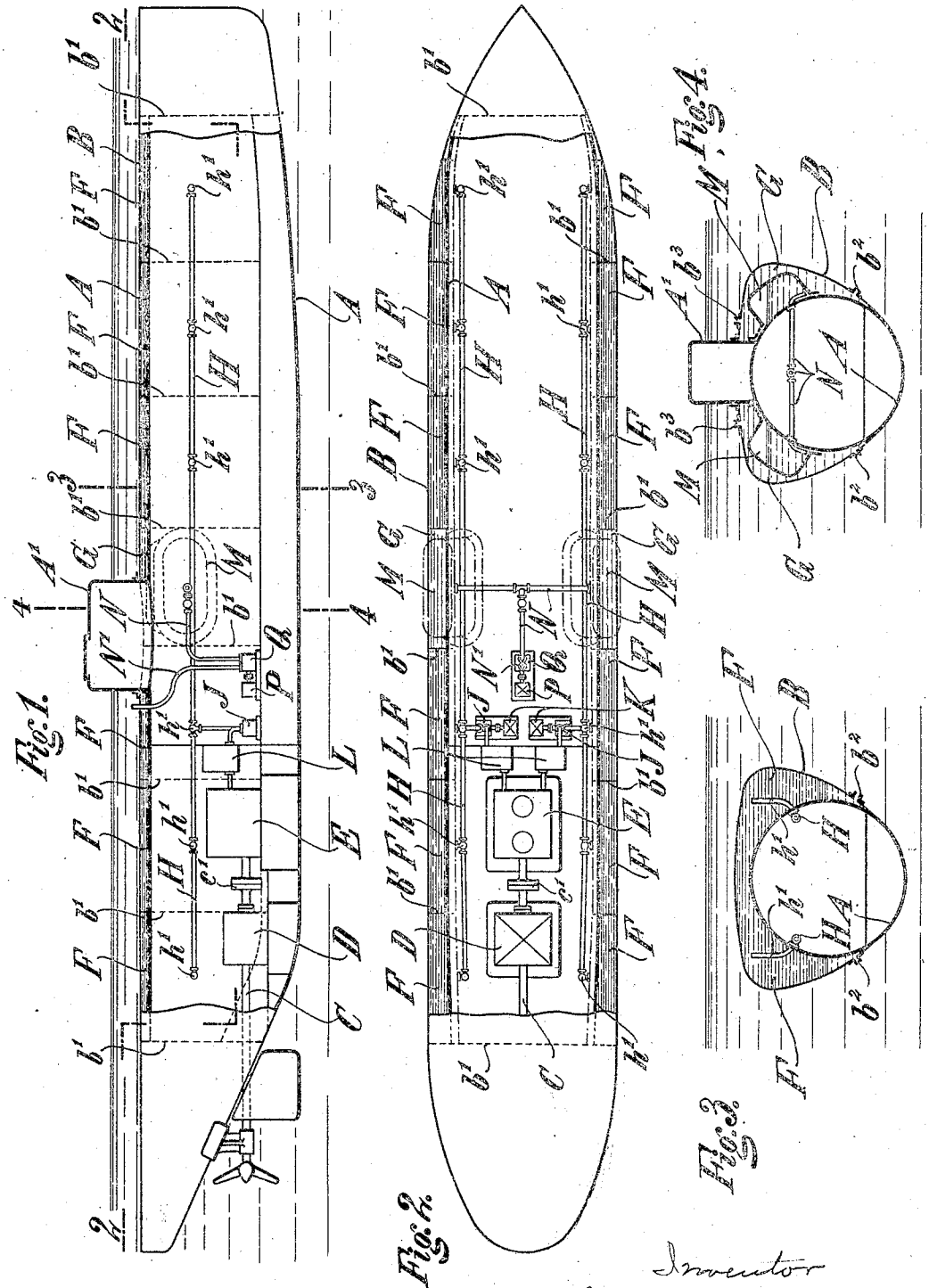

Fig. 1.

Fig. 2.

Fig. 4.

Fig. 3.

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2 SHEETS—SHEET 2.

Fig. 5.

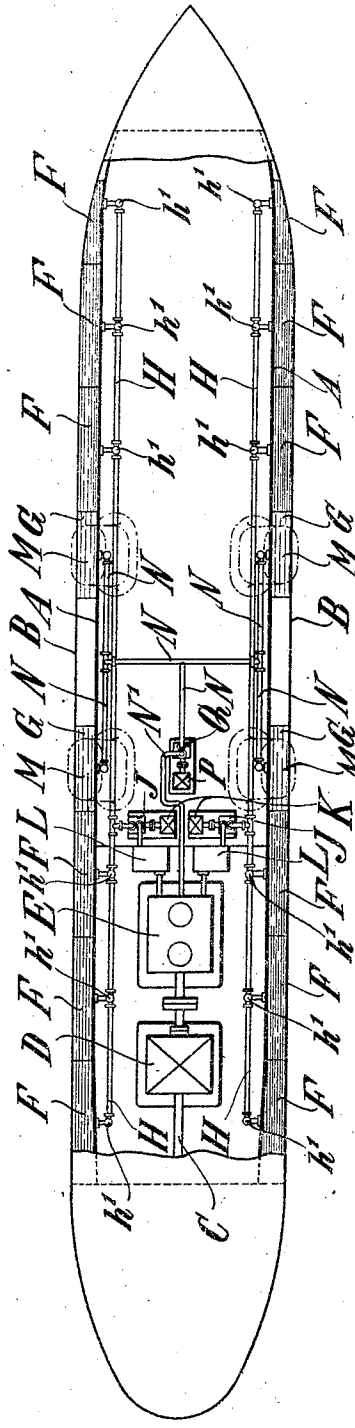
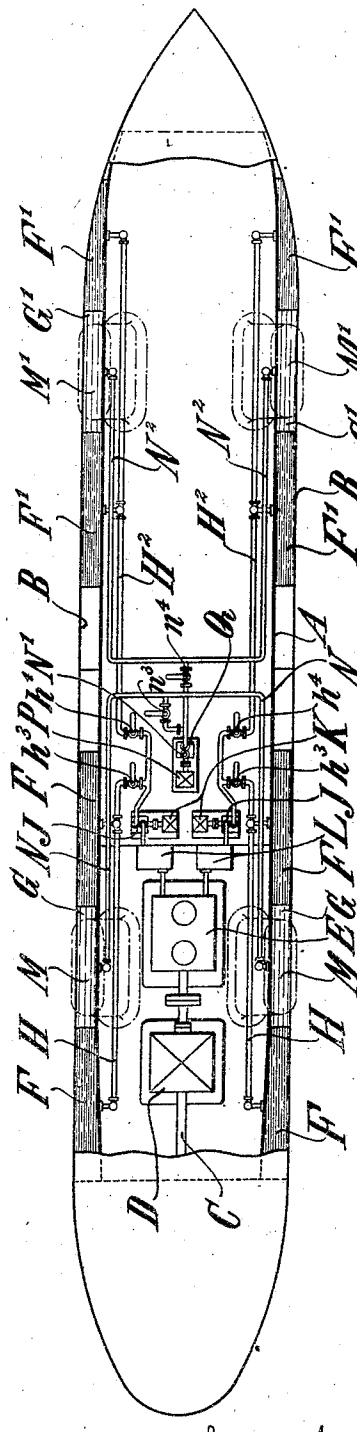


Fig. 6.



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UNITED STATES PATENT OFFICE.

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SUBMARINE BOAT.

No. 896,613. Specification of Letters Patent. Patented Aug. 18, 1908.

Application filed April 6, 1908. Serial No. 425,460.

To all whom it may concern:

Be it known that I, GEORG BEHRMANN, a subject of the Emperor of Germany, and a resident of Kiel, Germany, have invented certain new and useful Improvements in Submarine Boats, of which the following is a specification.

The present invention relates to the type of submarine boats in which liquid fuel is carried along in reservoirs which communicate with the outside water for the purpose of causing the consumed fuel to be replaced by water.

The object of the invention is to improve this type of submarine boats in such a manner that the draft and equilibrium of the boat are entirely independent of how much fuel and how much water the fuel-reservoirs at any time contain.

In accordance with the present invention the desired object is attained by providing the boat with compensating reservoirs which are arranged independently of the fuel reservoirs and have their combined center of gravity approximately coinciding with that of the fuel-reservoirs. At the commencement of the operation the compensating reservoirs are full of liquid and when fuel is withdrawn from the fuel-reservoirs the compensating reservoirs are emptied in proportion as the weight of the boat increases. The liquid thus withdrawn from the compensating reservoirs is conveyed to a place where it has no effect on the weight of the boat.

In the accompanying drawings, Figure 1 shows a vertical longitudinal section through one embodiment of the invention; Fig. 2 is a section on line 2—2, Fig. 1, looking from above; Figs. 3 and 4 are sections on lines 3—3 and 4—4, Fig. 1, looking from the left; Fig. 5 shows another embodiment of the invention in a sectional view corresponding to Fig. 2, and Fig. 6 shows a third embodiment in a view corresponding to Fig. 2.

Reference will first be had to the embodiment shown in Figs. 1 to 4.

The hull A of the boat is surrounded by an outer wall B which is spaced a suitable distance from the hull and which is of a shape that insures stability and swiftness of the boat both when it floats on the water level and when it is submerged. On the top of the hull A and in the middle of the boat is arranged a conning tower A^1 which projects through the outer wall B.

When the boat travels while submerged the propeller-shaft C may be driven by an electromotor D which receives its current from a suitable accumulator-battery (not shown) and when the boat travels on the water level the propeller-shaft is driven by an explosion-engine E which has its shaft connected to the propeller-shaft by means of a releasable coupling c^1.

By means of transverse partitions b^1 the space between the walls A and B is divided into a plurality of separate compartments, F and G, which communicate with the outer water through the medium of openings b^2 located near the lowermost places of the compartments. The compartments F serve for holding liquid fuel. From the upper part of the inner space of each reservoir F lead two pipes h^1 (see especially Fig. 3) which pass through the hull A to pipe-conduits H which extend longitudinally of the boat and connect with pumps J. The pumps may be driven by electromotors K and, through the medium of short pipe-conduits the pumps are connected with two fuel-reservoirs L from which the fuel required for operating the explosion-engine E can be directly taken.

Within the reservoir G and on the outer surface of the hull A are arranged reservoirs M (see especially Fig. 4) which are adapted to contain water. Through the medium of a pipe-conduit N the inner space of the reservoirs M connect with a pump Q which may be driven by an electromotor P and which communicates with the outside water through the medium of a pipe-conduit N^1. Besides having the openings b^2 the reservoirs G have openings b^3 on their top whereby the reservoirs are partly or completely filled with water according to how much the boat is submerged.

The hull A, the tower A^1 and the reservoirs M have walls of such thickness that they are capable of withstanding the pressure of the outside water at the greatest depth to which the boat is submerged. The outer wall B of the boat is less thick because the pressure outside of and within the reservoirs F and G can be equalized through the openings b^2 and b^3. In the drawings the difference in thickness of the walls is indicated by lines of different thickness. The reservoirs M are arranged in such a manner that their combined center of gravity approxi-

mately coincides with the combined center of gravity of the reservoirs F. The relative dimensions and working capacity of the pumping devices P Q and K J are preferably selected in such a manner that, when the two devices are operated simultaneously, the pump Q removes from the reservoirs M an amount of water the weight of which is equal to the difference in weight between the fuel drawn off by the pumps J and the amount of outside water entering the fuel reservoirs.

In the following description of the mode of operation it will be assumed that the fuel reservoirs F and L are completely filled with a liquid fuel, which has a smaller specific gravity than sea-water, and that the reservoirs M are completely filled with water. To operate the explosion-engine E fuel is taken from the reservoirs L. When it becomes necessary to re-fill the reservoirs L the pumping devices J K are caused to draw fuel from the reservoirs F through the pipe-conduits h^1 H to the reservoirs L. As the fuel is being withdrawn from the reservoirs F the pressure of the outside water causes an equal volume of outside water to pass through the openings b^2 into the reservoirs F. However, the specific gravity of the water being greater than that of the fuel the inflow of water would result in an undesirable increase in the weight of the boat, thereby changing the draft of the boat. To prevent this action from taking place the pumping devices P Q are put in operation simultaneously with the pumping devices J K. The pumping devices P Q draw from the reservoirs M an amount of water corresponding to the increase in weight of the boat and forces the water overboard through the pipe-conduit N^1. When the increase in weight has been entirely compensated for the filling relations in the reservoirs F and M are, for instance, as indicated diagrammatically in Figs. 3 and 4 in which the liquid fuel is indicated by close section-lines and the water by wider section-lines.

If the compensating reservoirs M were arranged at any place on the boat the partial emptying of the compensating reservoirs would cause a disturbance of the equilibrium of the boat. As afore-stated this is avoided by the arrangement of the reservoirs M in such a manner that their combined center of gravity coincides with the combined center of gravity of the fuel-reservoirs F.

In order to avoid a disturbance of the equilibrium by the withdrawal of fuel from the separate reservoirs F the fuel is drawn out simultaneously from all the reservoirs F.

The embodiment shown in Fig. 5 differs from the embodiment shown in Figs. 1 to 4 in having four compensating reservoirs M instead of only two, the combined center of gravity of the compensating reservoirs also in this instance approximately coinciding with the combined center of gravity of the reservoirs F. Furthermore this embodiment also differs from the first embodiment in having the compensating reservoirs M filled with fuel instead of with water. The withdrawal of fuel from the reservoirs F and the drawing off of the fuel serving as compensating liquid, from the reservoirs M is also in this instance effected by pumping devices J K and P Q; however there is the difference that the pipe conduit N^1 leads to the explosion-engine E so as to provide for immediate consumption of the fuel drawn off from the reservoirs M.

The embodiment shown in Fig. 6 differs from the other embodiments in having the fuel-reservoirs arranged in two groups F and F^1 for each of which two compensating reservoirs M and M^1 are provided. The arrangement is selected in such a manner that the combined center of gravity of the compensating reservoirs M and M^1 approximately coincides with the combined center of gravity of the corresponding group of fuel-reservoirs F and F^1. The arrangement of the pumping devices J K and P Q is the same as in the other embodiments with the exception that the pipe-conduits leading from the pumps J and P to the fuel-reservoirs and compensating reservoirs are bifurcated to form branch-conduits H H^2 and N N^2 to correspond to the groupwise arrangement of the reservoirs. The branch-conduits may be closed by means of cocks h^3 h^4 and n^3 n^4. By opening all the cocks the operator can draw off fuel and compensating water simultaneously from both groups of reservoirs and by opening only the cocks h^3 n^3 or the cocks h^4 n^4 he can draw off fuel and water from one of the groups only. The groupwise withdrawal of fuel cannot cause a disturbance of the draft and equilibrium of the boat when the weight-compensation made necessary by the entrance of outside water into the fuel-reservoirs is effected by simultaneous withdrawal of liquid from the compensating reservoirs M and M^1 of the appurtenant group.

More than two groups of fuel-reservoirs and compensating reservoirs may be provided. Furthermore the several groups of reservoirs may be of different volume if only they comply with the requirements that the combined center of gravity of the compensating reservoirs approximately coincide with the combined center of gravity of the fuel-reservoirs and that the fuel is simultaneously withdrawn from all the fuel-reservoirs of one group. Finally as many groups of reservoirs might be provided as there are fuel-reservoirs. In such case each fuel-reservoir would have to be provided with at least one compensating reservoir having its center of gravity approximately coinciding with the center of gravity of the fuel-reservoir, the compensating reservoir preferably being ar-

ranged within the fuel - reservoir. If the available space permits it the compensating reservoirs might be arranged in the interior of the boat instead of on the exterior thereof.

In order to gain space the two pumping devices J K and P Q would preferably be confined into a single pumping device in such a manner that one part of the pump in a certain time conveys a certain amount of fuel while the other part of the pump in the same time draws off from the compensating reservoirs as much liquid as is necessary for the weight-compensation.

In the submarine boat according to the present invention the compensating reservoirs are arranged entirely independently of the fuel-reservoirs as contradistinct from a known weight-compensating device in which the compensating reservoirs at the same time serve as dispensing reservoirs for the entire supply of fuel carried along on the boat.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:—

1. In a submarine boat, a fuel reservoir, means providing communication between the fuel reservoir and the water exterior thereto to cause the water to enter the reservoir as fuel is being withdrawn therefrom, and means for compensating for the increase in weight caused by the water entering the fuel reservoir, said means comprising a reservoir arranged independently of the fuel reservoir, and adapted to contain a liquid, and means for withdrawing the liquid from said last-named reservoir as the weight of the boat increases.

2. In a submarine boat, a plurality of fuel reservoirs, means providing communication between said reservoirs and the water exterior thereto to cause the water to enter the reservoirs as fuel is being withdrawn therefrom, and means for compensating for the increase in weight caused by the water entering the fuel reservoirs; said means comprising a plurality of reservoirs adapted to contain liquid and arranged independently of said fuel reservoirs, and means for withdrawing liquid from said last-named reservoirs as the weight of the boat increases; said compensating reservoirs having their combined center of gravity approximately coinciding with the combined center of gravity of the fuel reservoirs.

3. In a submarine boat, a plurality of fuel reservoirs arranged in groups, means providing communication between said reservoirs and the water exterior thereto to cause the water to enter the reservoirs as fuel is being withdrawn therefrom, and means for compensating for the increase in weight caused by the water entering the fuel reservoirs, said means comprising a reservoir for each group adapted to contain liquid and arranged independently of the fuel reservoirs, and means for withdrawing liquid from said last-named reservoir as the weight of the boat increases; the compensating reservoir of each group having its center of gravity approximately coinciding with the combined center of gravity of the fuel reservoirs of the same group.

4. In a submarine boat, a plurality of fuel reservoirs arranged in groups, means for simultaneously withdrawing fuel from all the reservoirs of the same group, means providing communication between said reservoirs and the water exterior thereto to cause the water to enter the reservoirs as fuel is being withdrawn therefrom, and means for compensating for the increase in weight caused by the water entering the fuel reservoirs, said means comprising a reservoir for each group adapted to contain liquid and arranged independently of the fuel reservoirs, and means for withdrawing liquid from said last-named reservoir as the weight of the boat increases; the compensating reservoir of each group having its center of gravity approximately coinciding with the combined center of gravity of the fuel reservoirs of the same group.

The foregoing specification signed at Kiel, Germany, this 9th day of March, 1908.

GEORG BEHRMANN.

In presence of—
JULIUS RÖPKE,
FERDINAND ROHWEDDER.