No. 846,417. PATENTED MAR. 5, 1907.

S. LAKE.

PROPULSION OF SUBMARINE VESSELS.

APPLICATION FILED NOV. 17, 1905.

2 SHEETS—SHEET 1.

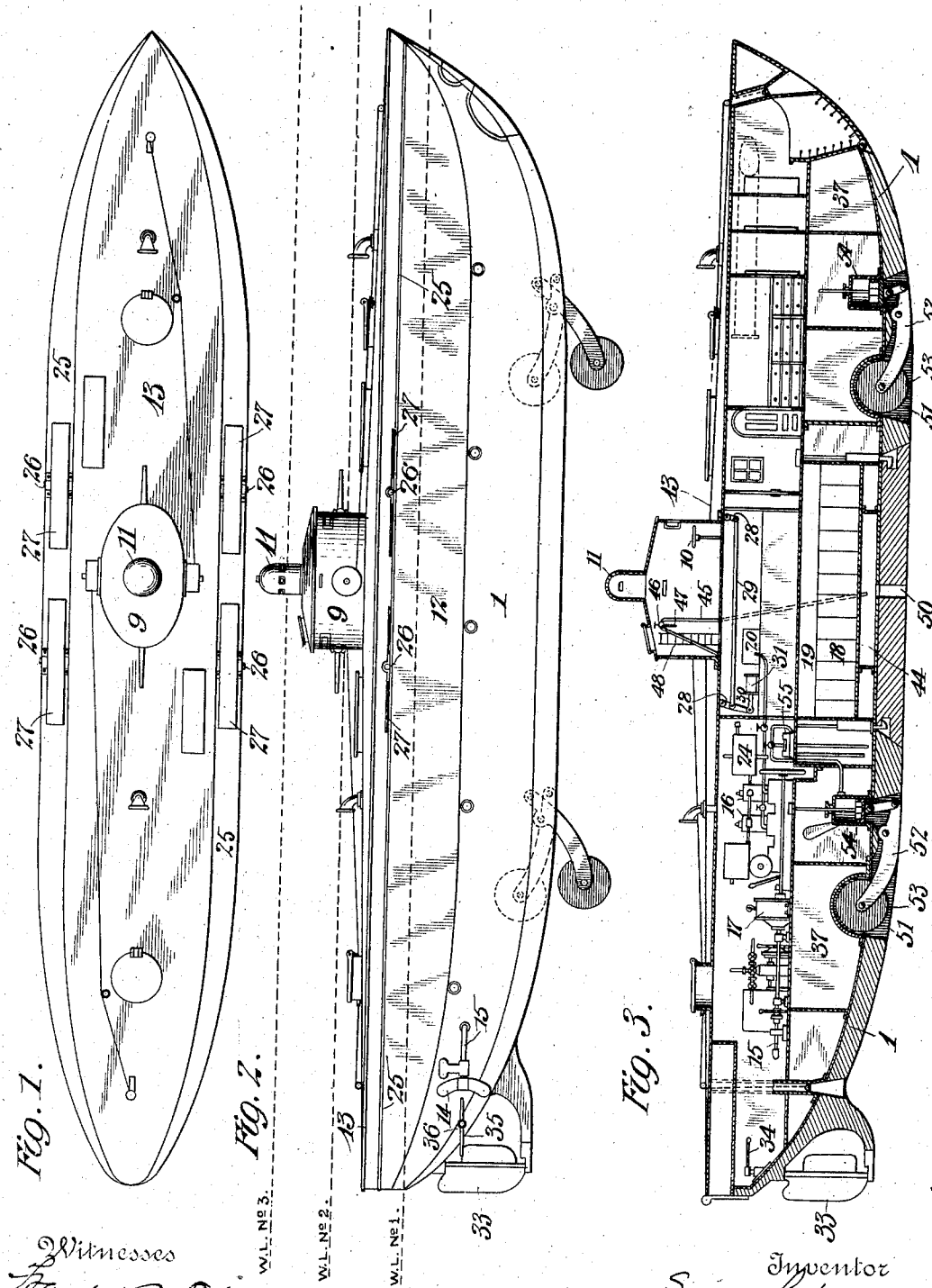


Fig. 1.

Fig. 2.

Fig. 3.

Witnesses
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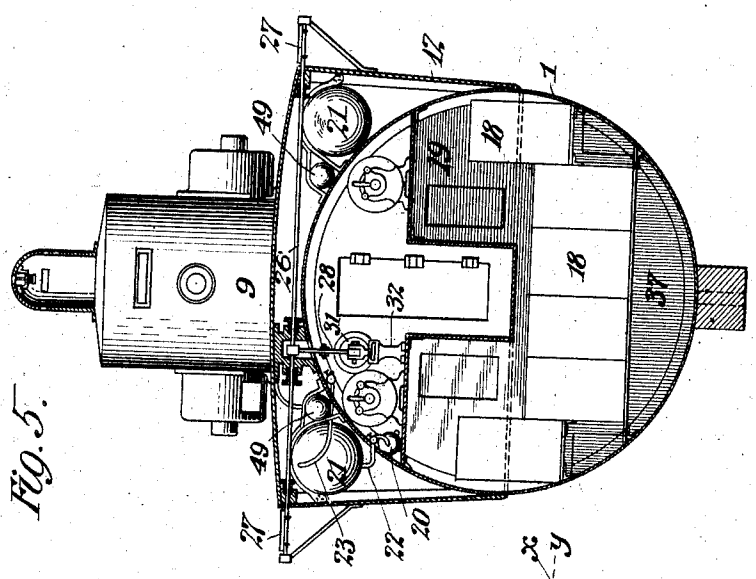


Fig. 5.

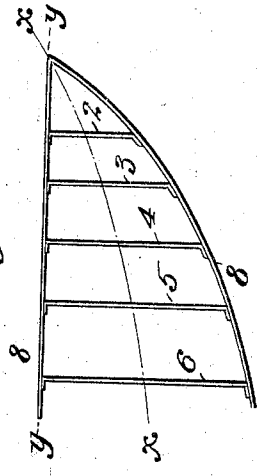


Fig. 7.

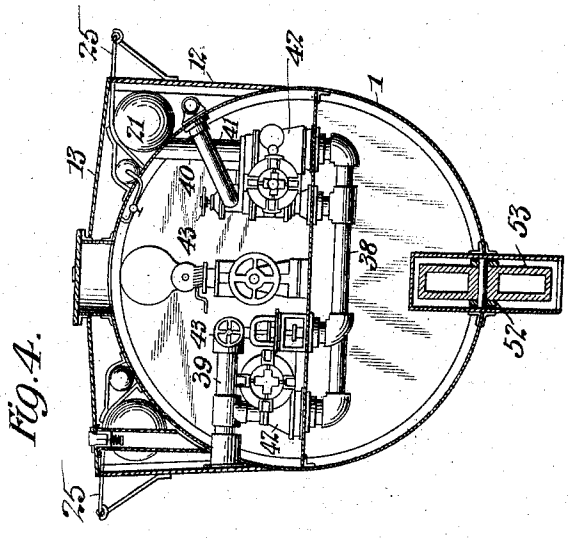


Fig. 4.

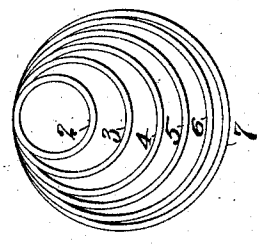


Fig. 6.

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UNITED STATES PATENT OFFICE.

SIMON LAKE, OF BRIDGEPORT, CONNECTICUT.

PROPULSION OF SUBMARINE VESSELS.

No. 846,417. Specification of Letters Patent. Patented March 5, 1907.

Continuation of application filed May 28, 1901, Serial No. 62,207. Divided and this application filed November 17, 1905. Serial No. 287,758.

To all whom it may concern:

Be it known that I, SIMON LAKE, a citizen of the United States, residing at Bridgeport, in the county of Fairfield and State of Connecticut, have invented certain new and useful Improvements in the Propulsion of Submarine Vessels, of which the following is a specification, reference being had therein to the accompanying drawings.

This application constitutes a continuation of an application filed by me May 28, 1901, Serial No. 62,207.

The present invention has for its object an improvement in that class of submarine vessels constructed with a large measure of fore-and-aft stability and adapted to maintain at all times an even keel, even during the operations of submergence and emergence, such kind of vessel being exemplified in the United States Patent No. 650,758, granted to me May 29, 1900.

The invention has for its object to adapt such class of vessels for submergence and emergence while under way in a manner somewhat resembling that of the so-called "diving" type of vessel, while retaining the essential fore-and-aft stability notably lacking in the diving type.

To this end the invention consists, essentially, in a hull preferably provided with a substantially flat deck and fixed lateral guide planes serving to maintain a fixed direction of travel in a given plane of motion under the impulse of its propellers operating in a substantially parallel plane, combined with a rudder near one end of the vessel mounted upon a horizontal pivotal support and adapted to be inclined thereon to forcibly overcome the steadying tendency of said flat deck and guide planes.

The invention will be understood by reference to the drawings annexed, in which—

Figure 1 is a plan, Fig. 2 an external elevation, and Fig. 3 a sectional elevation, of a vessel embodying the present improvements. Figs. 4 and 5 are enlarged transverse sectional views of the vessel at different points amidship. Fig. 6 is an end view of the framing of the hull with the skin-plates detached; and Fig. 7, a sectional elevation of the forward end of the hull, showing the skin-plates and transverse frames.

As illustrated in general form in Figs. 1, 2, and 3 and in detail in Figs. 6 and 7, the hull 1 is of rounded or circular cross-section throughout its length and is shown constructed with a series of circular frames 2, 3, 4, 5, 6, and 7 of gradually-reduced size from the middle portion toward both ends, the top of each frame being upon substantially the same level, while their centers are arranged in a center or axial line upwardly inclined and preferably curved, as indicated by the dotted line $x\,x$ in Fig. 7, toward the substantially horizontal line $y\,y$ through their uppermost points, which it intersects at the bow and stern, respectively. When viewed from either end, as in Fig. 6, the several frames present series of eccentric rings, of which the extreme upper portions have a common point of tangency and their centers are progressively arranged with respect of that of the amidship-section in a vertical longitudinal plane passing through each, the center of the smallest being at the top and the largest at the bottom of the series. The skin or sheathing plates 8 are applied to these frames in the usual manner, the outer surface of the hull being shown in the drawings as terminating in a point at the bow, but having the apex of the conical stern portion cut away to form a slightly-flattened extremity, which latter slight deviation from the shape of the bow portion is obviously not material to the general form and consequent efficiency of the hull. This peculiar form of hull not only adapts the body for efficient propulsion, especially when cruising upon the surface, by obviating the formation of "dead-water" and avoiding the suction of air downward to the path of movement of the screw, and so causing an excessive slip of the latter and corresponding reduction of its efficiency, but obviously raises the center of buoyancy and increases the available capacity for machinery, &c., as the necessarily level floor approaches the bottom of the contracted end portions and affords head-room in such portions, which is lacking in boats of models heretofore designed.

Surmounting the hull and preferably disposed directly over its centers of buoyancy and gravity is the conning-tower or turret 9, containing the steering-wheel 10 and certain other devices for controlling either directly or indirectly the operation of the boat. The conning-tower or turret is provided at the top with an inspection-dome 11, having suit-

able dead-lights in the sides for purposes of inspection, the lookout stationed in the conning-tower, whose head is introduced therein, being thereby enabled to observe the maneuvers of an enemy, while the greater portion of the boat is permitted to sink wholly beneath the surface, as indicated by the dotted line designated W L No. 3 in Fig. 2.

The hull is shown provided with a superstructure composed of the vertical sides 12, rising tangentially from the outer portions of the rounded hull, and the substantially flat deck 13, which joins the sides along their edges throughout the length of the boat, but herein represented as slightly arched both athwartship and fore and aft toward the conning-tower or turret, which rises from its highest portion.

As represented in the drawings, the vessel is provided with twin screws 14, mounted upon shafts 15, driven by means of gasolene or other explosive engines 16 when cruising upon the surface or by electric motors 17, deriving electric current from a series of storage batteries 18, arranged in a closed battery-compartment 19 in the hull, suitable clutches being provided for coupling and uncoupling the shafts alternately to and from the different types of motors as occasion may require.

The gasolene-engines draw their fuel from the small auxiliary storage-tank 20, which in turn is fed by the main storage tanks or reservoirs 21, placed in a superstructure, and which is connected therewith by valved pipes 22 and with the interior of the hull by the vent-pipes 23, having check-valves permitting the inflow of air to replace the fuel drawn out for the consumption of the engines, but preventing the flow of air or fumes therefrom into the interior of the hull. The engines are connected with an exhaust-tank 24, from which the products of combustion are led by means of suitable pipes to the exterior of the vessel. The air-supply tank is fed by air flowing in through its inlet-check-valve directly from the engine-room.

As represented in the drawings, the superstructure is provided near the level of the deck with the fixed guide planes 25, extending throughout the entire length of the vessel and in a plane substantially parallel with the deck of the superstructure and provided at points amidship near the conning-tower with suitable apertures in which are journaled the transverse shafts 26 of the oscillating hydroplanes 27, two of which are arranged on each side of the vessel. The shafts of the hydroplanes are provided each with a depending crank-arm 28, connected to vibrate correspondingly by means of a link 29, the rearward crank-arm 28 being extended downwardly to receive a pivotal connection with the piston-rod 30 of a hydraulic cylinder 31, supported, as represented in Fig. 5, upon a suitable stand 32 and provided with any well-known or suitable means for introducing and discharging water from its opposite ends for moving the piston for inclining the hydroplanes when desired.

The vessel is shown herein provided at the stern with a vertical rudder 33 for giving direction thereto in a horizontal plane, the same being in practice provided with a connection between the shaft of the steering-wheel 10 and the tiller-bar 34, applied to its vertical spindle, and with the horizontally-mounted rudders 35, supported on the horizontal shaft 36, which is in practice rocked to vary the inclination of the rudder 35 by any suitable or well-known means.

The means represented herein for controlling the contents of the water-ballast compartments 37, provided in the lower portion of the hull, are as follows: Referring particularly to Fig. 4, a system of water-pipes 38 is provided having branches 39 and 40, connected with the exterior of the boat at the side and above the deck, respectively, and another branch 41, connected with the interior of the superstructure, pumps 42 and valves 43 being interposed in said system, by means of which and various other branch pipes connected with the several closed water-ballast tanks or compartments water may be supplied to or drawn from the individual parts of the boat designed to regulate its condition as to buoyancy.

As represented herein, the vessel is provided with a permanently open amidship ballast-tank 44, from the top of which an air-pipe 45 leads upwardly to a three-way valve 46 in the conning-tower, having a branch 47 opening into the conning-tower and another branch 48 leading downwardly and through the body of the hull to one of the compressed-air tanks 49, confined within the superstructure. When the valve 46 is adjusted to connect the tank 44 with the interior of the conning-tower through the pipes 45 and 47, water is permitted to enter such tank through the inlet-opening 50 in the bottom of the same, and such water may be expelled from the tank by turning the valve 46 to close the air-outlet branch 47 and open the air-supply pipe 48 to admit compressed air through the pipe 45 to the tank 44, so as to displace the contained water, the valve 46 being properly manipulated at the end of each of such operations to close the pipes 45 and 48 in a manner which will be obvious.

The vessel is herein represented as provided in its bottom with suitable wells 51, in which are pivoted the swinging arms 52, provided at their outer ends with bearing-wheels 53 and pivotally connected at the opposite ends by means of suitable links with the trunk-pistons of the hydraulic cylinders 54, having suitable pipe connections with a hydraulic pump 55 and operated as described

in the United States Patent No. 726,705, granted to me April 28, 1903, for cushioning the contact of the vessel with the water-bed when the same is permitted to sink to the latter.

In the cruising trim of the vessel the same is given ample freeboard by expelling water ballast from the tanks 37 and 44 to bring the water-line to the position indicated by the dotted line designated W. L. No. 1 in Fig. 2, and the hull may be sunk beneath the surface and the water-line brought to the position indicated by the dotted line designated W. L. No. 2 by sufficiently filling the ballast-compartments 37 to effect such result, thereby reducing the target presented to hostile vessels, while maintaining its offensive character above the surface for use of the guns with which the conning-tower or turret is preferably provided. The last step in the manipulation of water ballast for submergence is preferably effected by filling the amidship tank 44, as previously described, whereby the boat is lowered to the level designated W. L. No. 3, in which position the dead-lights of the sighting-hood 11 are still exposed above the surface, but the vessel has only a very slight reserve buoyancy.

As already stated, the vessel has a very strong tendency to maintain its horizontal position by reason of its low center of gravity and high center of buoyancy produced by the peculiar shape of the hull, with its upwardly-tapering end portions materially increased by the large upwardly-extending conning-tower, which itself possesses a considerable buoyancy, operating with a comparatively long leverage about the center of gravity to produce an effective righting moment to counteract any careening tendency that might be imposed by either internal or external conditions. Under the described conditions two different means are provided for effecting the submergence of the vessel when in motion. One of these comprises the hydroplanes 27, whose forward ends may be depressed by means of the hydraulic cylinder 31 and its connections therewith, so as to afford inclined vanes acting to force the vessel downwardly bodily upon an even keel. It is evident that the reverse inclination of the hydroplanes 27 will produce an upward tendency to restore the vessel to initial position in reference to the surface of the water. The other method of operation involves the overcoming to a slight degree of the fore-and-aft stability of the vessel by means of the horizontal rudder 35, the upward inclination of the same causing the slight rise of the stern, thereby forcibly inclining to a slight degree the steadying members, comprising the flat deck 13 and fixed guide planes 25, and causing the vessel to continue its travel at a slight inclination with the surface of the water, whereby the depth of the hull beneath the same is gradually increased to the desired point, at which a reciprocal movement of the horizontal rudders 35 may be effected to again overcome the tendency of the deck and guide planes to maintain such inclined direction of travel to cause the vessel to continue its movement in a direction parallel with the surface of the water or to ascend to the initial level in a similar slightly-inclined direction.

The hydroplanes 27 constitute continuations of the guide planes afforded by the substantially flat deck 13 and fixed guide-fins 25 for maintaining the direction of the vessel in a given path of movement, and therefore coöperate with the horizontal rudders 35 in the manipulation of the vessel as just described, while they also perform an additional function in acting as deflecting-vanes for forcibly thrusting the vessel bodily from its straight course when they are inclined from parallelism with the guide planes, as before described.

The mere method of submerging by means of the horizontal rudders 35, as above described, is not herein claimed as novel of itself, as the use of such expedient in boats of the diving type has long been known. Such method of submersion as employed in connection with the designedly-unstable vessels of the diving type has been found exceedingly dangerous, for the reason that such unstable vessels when inclined at the requisite angle for submergence have frequently proved uncontrollable, their inclination continuing after the safe angle has been reached, with the ultimate effect of causing the bow of the boat to become embedded in the water-bed, thus endangering the vessel itself and the lives of its crew. By the application of a horizontal rudder at one end of a vessel of the settling or sinking type which has great fore-and-aft stability and temporarily forcibly overcoming such stability and the strong tendency of the steadying means of flat guide planes afforded by the flat deck or lateral fins disposed parallel with the plane of action of the propeller or propellers I am enabled to effect the necessary inclination of the vessel for the purpose described without endangering in the slightest degree its safety or that of its crew by loss of control of its direction of travel.

In my United States Patent No. 650,758, before referred to, some of the elements which I regard as essential to the present improvement were associated together; but the pivoted vanes in the forward and after portions of the vessel by which its inclination could be varied were automatically operated to actually prevent as far as possible any inclination from the horizontal which would produce submergence and emergence in the manner above described. It will be observed that in the use of the horizontal rudders 35 at one end only, as represented here-

in, any inclination of the same will produce a corresponding tendency of such end to rise or fall, while the disposition of such rudders immediately astern of the propeller-wheels 14 places them directly in the current of water thrown backwardly by the propellers and gives them sufficient power to overcome the stability of the vessel before described.

From the foregoing description it will be observed that the present invention differs essentially from the diving type of submarines in that the hull with its contents is designed to possess the greatest possible fore-and-aft stability, which the horizontal rudders are designed to forcibly overcome, as distinguished from vessels whose hulls and contents are so designed as to bring their centers of gravity and buoyancy nearly coincident, with the direct object of producing a condition of equilibrium for easy steering by a horizontal rudder. In other words, with the diving type the vessel is constructed and ballasted to have the utmost sensitiveness for easy variation of its course by means of the horizontal rudder, while with the present improvement the vessel is designed to maintain its level with the greatest possible tenacity, the horizontal rudders acting in direct opposition to such tendency.

The present improvement differs essentially from that type exemplified in my United States Patent No. 650,758 in the provision of means for overcoming the tendency with which such vessels are designed of maintaining their parallelism under all conditions with the surface of the water.

Having thus set forth the nature of the invention, what I claim herein is—

1. A submarine vessel comprising a hull constructed with a high center of buoyancy and low center of gravity and provided with a series of ballast tanks or compartments and means whereby water may be admitted to and expelled from the same, a propeller-wheel mounted upon a suitable shaft and means for driving the same, a guide plane or planes fixed to the hull in a position substantially parallel with the direction of operation of said propeller-wheel, and a pivotally-mounted horizontal rudder disposed immediately in the rear of said propeller-wheel and in the direct line of action of the same and operating, when inclined, to forcibly raise or lower the stern of the vessel to incline it from its normal horizontal relation.

2. A submarine vessel comprising a hull constructed with a high center of buoyancy and low center of gravity and provided with a series of ballast tanks or compartments and means whereby water may be admitted to and expelled from the same, a conning-tower rising materially above said hull and disposed directly over its center of buoyancy, a propeller-wheel mounted upon a suitable shaft and means for driving the same, a guide plane or planes fixed to the hull in a position substantially parallel with the direction of operation of said propeller-wheel, and a pivotally-mounted horizontal rudder disposed immediately in the rear of said propeller-wheel and in the direct line of action of the same and operating, when inclined, to forcibly raise or lower the stern of the vessel to incline it from its normal horizontal relation.

3. A submarine vessel comprising a hull constructed with a body of rounded cross-section throughout with cylindrical amidship portion and upwardly-tapered end portions having their upper sides at the same level, a conning-tower rising materially above the same from the amidship portion, a closed superstructure applied to the upper side of the body portion with upright sides and substantially flat deck, flat lateral fins extending lengthwise of the vessel as substantial continuations of said flat deck to constitute guide planes for steadying the direction of travel of the vessel, a propeller-wheel mounted upon a suitable shaft with means for driving the same and disposed in a plane substantially parallel with said guide plane, and a pivotally-mounted horizontal rudder disposed immediately in the rear of said propeller-wheel and in the direct line of action of the same and operating, when inclined, to forcibly raise or lower the stern of the vessel to incline it from its normal horizontal relation.

4. A submarine vessel comprising a hull constructed with a high center of buoyancy and low center of gravity and provided with a series of ballast tanks or compartments and means whereby water may be admitted to and expelled from the same, a propeller-wheel mounted upon a suitable shaft and means for driving the same, a guide plane or planes fixed to the hull in a position substantially parallel with the direction of operation of said propeller-wheel, pivotally-mounted horizontal hydroplanes normally maintained in parallel relation with said fixed guide plane or planes and provided with means for inclining the same in reference thereto, and a pivotally-mounted horizontal rudder disposed immediately in the rear of said propeller-wheel and in the direct line of action of the same and operating, when inclined, to forcibly raise or lower the stern of the vessel to incline it from its normal horizontal relation.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

SIMON LAKE.

Witnesses:
WOLDEMAR HAUPT,
HENRY HASPER.