Sept. 1, 1925. 1,552,065

C. W. LARNER

BALLAST TANK VALVE

Filed May 19, 1921

Fig. 2.

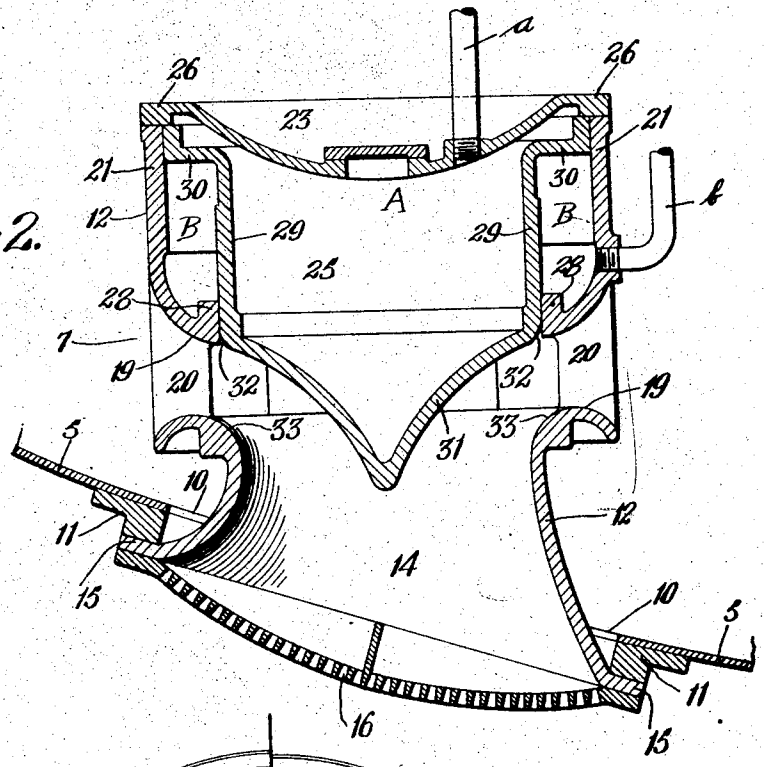
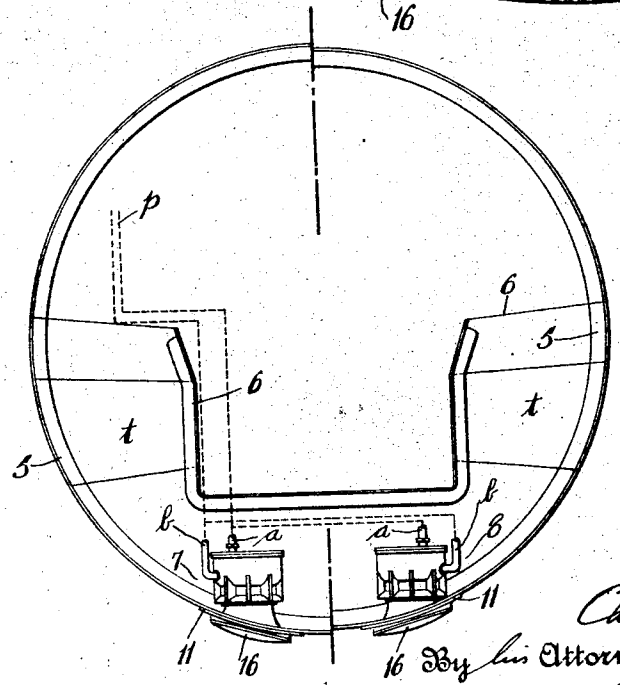



Fig. 1.

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# UNITED STATES PATENT OFFICE.

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## BALLAST-TANK VALVE.

Application filed May 19, 1921. Serial No. 470,815.

*To all whom it may concern:*

Be it known that I, CHESTER W. LARNER, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Ballast-Tank Valves, of which the following is a specification.

This invention relates to valves and particularly to valves for the ballast tanks of a vessel such as a submarine. In submarines these ballast tanks are used for submerging the vessel and it is of vital importance that the valves for these tanks should be dependable in operation at all times.

The chief object of the invention is to provide a valve for such a ballast tank, which will be simple in structure and operation without complicated moving parts and at the same time which will give a tight closure or clear opening in reliable manner in service.

A further object of the invention is to provide such a valve which will be operable solely by fluid pressures without requiring extended mechanical connections from within the hull.

In the accompanying drawings illustrating the invention

Fig. 1 is a diagrammatic sectional view of a portion of a submarine showing valves submerged in one of the ballast tanks, and

Fig. 2 is a sectional view of one of the valves.

In the embodiment of the invention shown in the drawings the circular hull 5 of the submarine is provided with a ballast tank *t* having the inner wall 6 and the valves 7 and 8. Each valve is set in an opening 10 in the hull 5 and around this opening is a flange ring 11 supporting the valve structure from the hull.

In service and when the submarine is to submerge, sea water is admitted by opening the valves 7, 8 and allowing the water to flow in by its own pressure. When rising the water is expelled either by pumping out the tank with centrifugal pumps or by forcing the water out through the valves 7, 8 by means of compressed air admitted to the tanks. In the first instance the valves 7, 8 are closed before any attempt is made to empty the tank and in the second case the valves are left open. The valves 7, 8 must therefore be capable of remaining open during either entrance or discharge of the flow and of remaining closed against sea pressure from without. It is also desirable to have the open valve passages large in comparison with the overall dimensions of the valve structure, and smooth and free for the easy passing of the flow in each direction with as little contraction of the stream as possible at entrance to the valve structure.

The valves which it has been customary to use for the ballast tanks have been flat disc valves mounted on the end of a vertical stem which passes through the top of the ballast tank and which is ordinarily operated by screws, levers or some other type of mechanism capable of developing sufficient force to unseat the valves against sea pressure; that is to say, the valve opens outwardly and they and their operating mechanism are open to serious objections in service. In the first place, the interior of a submarine is crowded with machinery and mechanism of all sorts and it is a difficult matter to provide the necessary space for the operating gear, particularly on the larger boats where this mechanism is correspondingly large and complicated.

A second objection is that the valves themselves cannot be located in a compact group. There are ordinarily three main ballast tanks, each with two or more valves. This necessitates several groups of valves widely separated and consequently several groups of operating mechanism also widely separated. It is very desirable to have a central control station from which all of the valves can be operated simultaneously or individually according to the requirements and with the valve of this invention this can be accomplished by piping the several groups of valves to a central control station.

Another important advantage which the valve of this invention has over the ordinary valve is its hydraulic efficiency or high coefficient of discharge. The aperture through which the water must flow when the ordinary valve is opened is merely a hole in the hull without tapering passages leading to it and it is well known that the coefficient of discharge under such conditions is very low, due to the high contraction of the jet of water passing through the aperture. This condition is aggravated by the position of

the valve disc when open. It stands directly in the passage of the water either entering or leaving the tank.

The valve structures 7, 8 of this invention each comprise a casting 12 having flaring mouth 14 terminating in the flange 15 fastened to the ring 11 (Fig. 2). A trash screen 16 is provided over this mouth 14. At its inner portion the casting 12 has the annular opening 19 spanned by a circular series of stays 20 carrying cylindrical portion 21 at the inner end the valve casing thus has within the tank an annular opening 19 flaring into the tank and communicating with opening 14 in the casing flaring to the sea, the opening 14 flaring also into the opening 19.

A cover 23 is fastened by its flange 26 to the end of the cylindrical portion 21 of the casting 12. The valve plunger 25 comprises the cylindrical portion 29 sliding in the annular flange 28 of the casting 12, and piston 30 sliding in cylinder 21 of casting 12; and the cylindrical portion 29 of the plunger has the conical nose 31 forming a pointed wedge extending toward the mouth 14 of the valve. The open poistion of this plunger is shown in Fig. 2; in closed position the annular edge 32 of this plunger seats tightly against the seat 33 at the inner end of the mouth portion 14 of casting 12.

Two pressure chambers are thus provided, a central chamber A above the plunger 25 and an outer annular chamber B beneath the piston portion 30 of the plunger. The chambers A and B are connected by pipes *a* and *b* respectively with a four way cock which in one position closes the valve by admittitng sea pressure to chamber A and exhausting chamber B to atmosphere, and in another position opens the valve by exhausting pressure from chamber A and admitting it to chamber B. In this way the valve may be operated by the pressure of the water without extra pumps or extended mechanical connections. In closed position the valve is held tight to its seat against the pressure of the sea by sea pressure in chamber A while chamber B is kept exhausted to atmosphere; that is to a waste tank or some similar chamber in the hull of the boat. The symmetrical circular formation of the valve parts enables them to be accurately fitted with the valve seat ground to register with the plunger while the even distribution of the stresses avoids all tendency to warp or wear unevenly.

The valve in addition to being operated by the pressure of the sea may also be operated by compressed air from the air tanks which the submarine always carries. This pressure, of course, is very much higher than sea pressure and will operate the valves more rapidly, and in addition to this, it may be used when the vessel is on the surface for holding the valves open or closed more positively than is possible by use of the sea pressure which, of course, is quite low under such conditions, due to the fact that the valves are submerged only a few feet below the water surface. The air pressure is connected into the supply pipe which draws water from outside of the hull. This pipe has a check valve between the sea and the air connection which prevents the escape of the air when it is admitted to this line. The air admitted to the supply line exerts pressure immediately in the chambers of the valves according to the setting of the control valves.

A number of the valves of this invention when installed in the ballast tanks may be connected by piping so as to be operated in simple manner from a single control point *p*. The smooth efficient opening through tapering passages in each direction gives a maximum inflow or outflow of water. When the valve is open a wide passage is provided for the flow opening inward and outward through a complete 360° and having its walls smoothly curving to impose a minimum resistance to the flow in either direction.

Careful theoretical analysis indicates that for the same area of opening the valve of this invention will discharge from two or three times as much water as the ordinary valve. This difference of discharge becomes highly important in connection with vessels of large size such as are customary at the present time. The stresses in the hull of a submarine at maximum submergence are very high and it is very difficult to provide large openings for the valves. At the same time, the tanks are large and they require large valves in order to empty or fill them in the short time which is usually desirable.

The whole valve structure forms a unit which may be inserted into the hull opening from the outside and supported thereon without further supports to other parts between which relative stressing would be likely to occur.

I claim:—

1. In a ballast tank structure for a vessel, a valve adapted to control an opening between said tank and the water surrounding the hull of said vessel, comprising a unitary body fastened to the hull and carrying a valve seat adjacent to the hull and a relatively movable valve plunger having its closing movement toward the outside of the hull, and means for opening said plunger and closing said plunger against said seat by the pressure of said water comprising a piston moving in a chamber in said unitary body.

2. In a valve structure for a ballast tank the combination with a supporting member adapted to be attached to the hull of a vessel, of an inner structure supported by

said member and forming therewith an annular passage adapted to pass the flow into and out of the ballast tank, a hollow valve plunger carried by said inner structure and fluid pressure operated means for moving said plunger to close it against the pressure of the surrounding water comprising a piston member moving in a chamber in said inner structure.

3. In a valve structure for a ballast tank the combination with a supporting member adapted to be attached to the hull of a vessel, stays carried by said supporting member, an inner structure supported by said stays and forming therewith an annular passage adapted to pass the flow into and out of the ballast tank, a hollow valve plunger carried by said inner structure and fluid pressure operated means for moving said plunger to close it against the pressure of the surrounding water comprising a piston member moving in a chamber in said inner structure.

4. The combination with a ballast tank having an opening submerged in surrounding water, of a valve structure at said opening and comprising a valve movable outwardly against a seat in said opening, and fluid pressure operated means for moving said valve to closed position comprising a piston operated by the pressure of said water and a cylindrical casing carried by said valve structure and enclosing said piston.

5. The combination with a ballast tank having an opening submerged in the surrounding water, of a valve structure for said opening comprising a casing having a passage flaring into the tank, a valve seat in said passage and a valve plunger moving outwardly to engage said seat and close said passage and fluid pressure means for operating said plunger comprising a piston moving in a chamber in said casing and operating said valve by the pressure of said water.

6. The combination with a ballast tank having an opening submerged in the surrounding water, of a valve structure for said opening comprising a casing having a passage flaring into the tank, and a valve seat therein, stays across said passage, an inner structure carried by said stays and supporting a valve plunger adapted to move outward against said seat to close said passage and means for operating said valve comprising a cylinder formed by said inner structure and a piston movable in said cylinder.

7. The combination with a ballast tank having an opening submerged in the surrounding water, of a valve structure for said opening comprising a casing having an opening therethrough smoothly flaring in each direction to give efficient flow conditions for the inflow or outflow of water.

8. The combination with a ballast tank having an opening submerged in the surrounding water, of a valve structure for said opening comprising a casing having an annular opening within the tank and a flaring opening to the sea, said openings smoothly merging together to give efficient flow conditions for the inflow or outflow of water.

9. The combination with a ballast tank having an opening in the hull submerged in the surrounding water, of a valve structure for said opening comprising a casing adapted to be inserted through said opening and fastened to the outside of said tank and a movable valve member carried by said casing and positioned entirely within the hull and moving outwardly to close said opening.

10. The combination with a ballast tank having an opening in the hull submerged in the surrounding water, of a valve structure for said opening comprising a casing attached to the hull and having an opening therethrough, an inner cylindrical casing supported from said first named casing by stays, a valve plunger moving in said inner casing and having its end tapered along a stream line surface to cooperate with the inner surface of said first named casing to form an annular passage for the flow, and a piston on said plunger moving in said inner casing, said piston and inner casing providing fluid pressure chambers for operating said valve plunger.

CHESTER W. LARNER.