

June 28, 1932.

S. LAKE

1,864,837

SUBMARINE OR SUBMERSIBLE BOAT

Original Filed Jan. 11, 1928 2 Sheets-Sheet 1

Fig. 1.

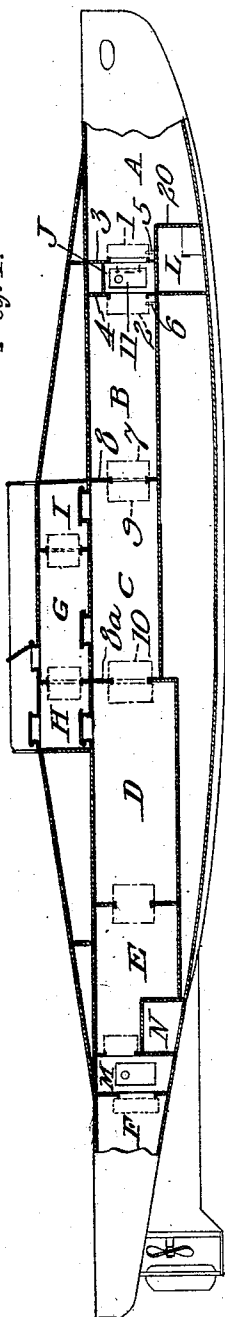


Fig. 3.

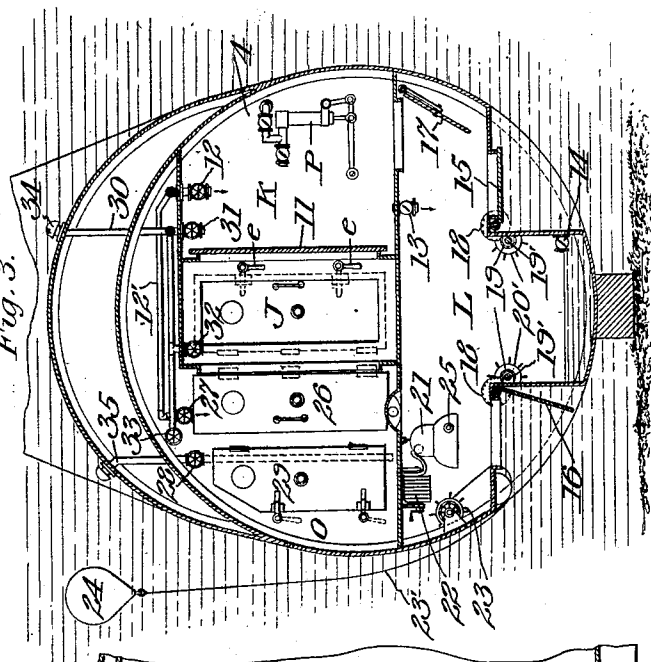
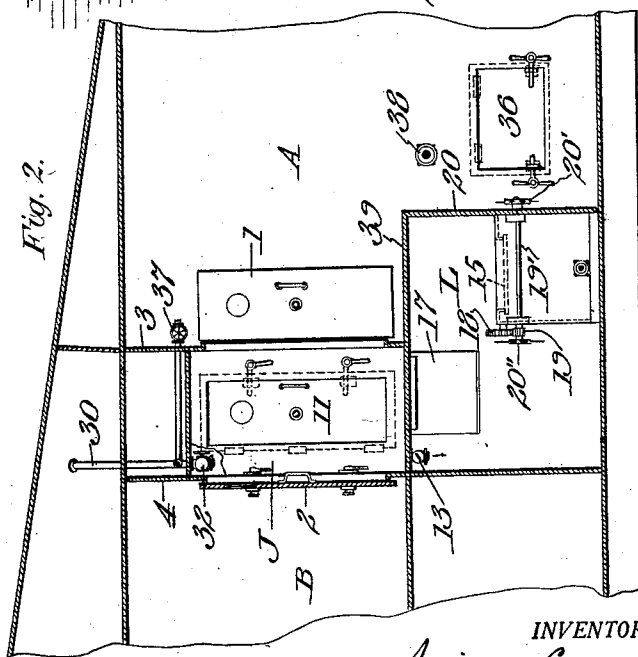


Fig. 2.



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Fig. 5.

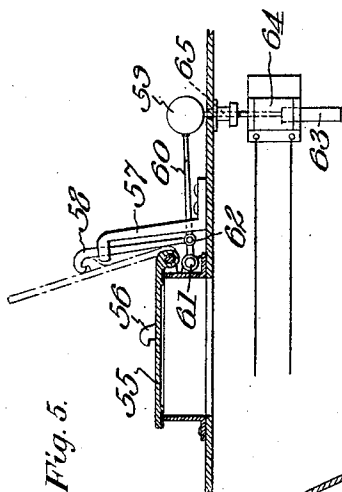
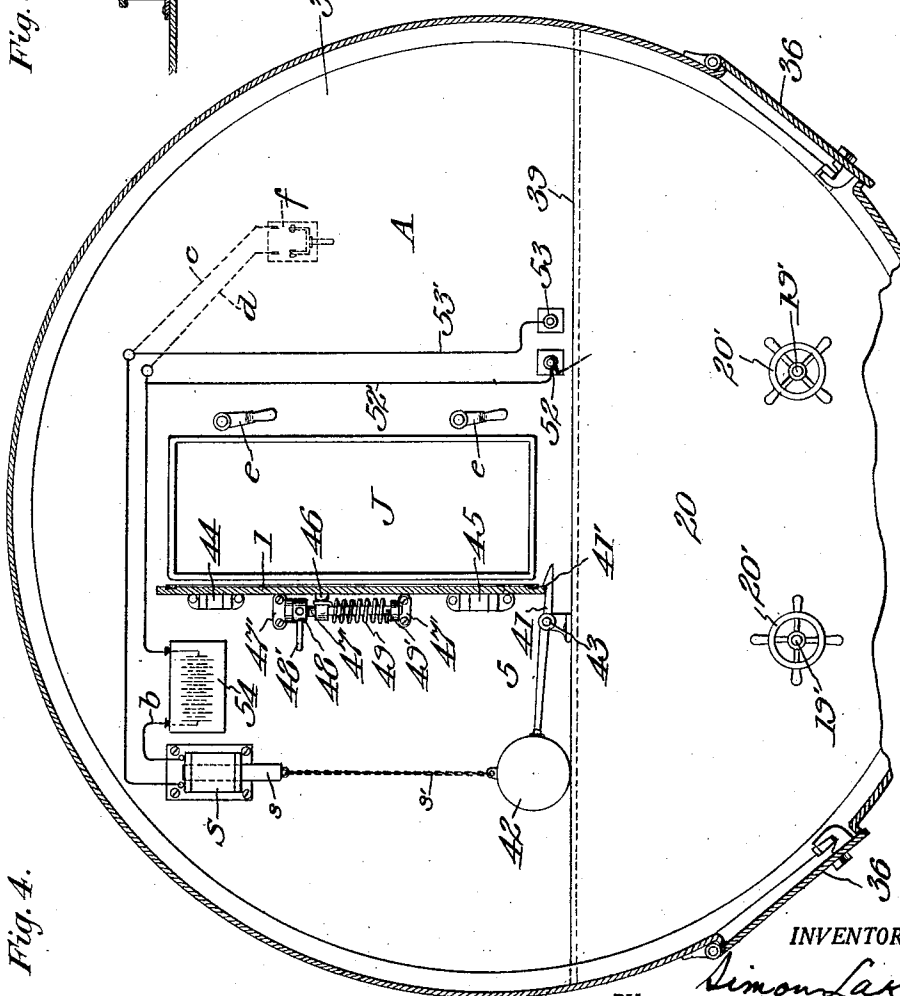


Fig. 4.



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SUBMARINE OR SUBMERSIBLE BOAT

Application filed January 11, 1928, Serial No. 246,018. Renewed November 16, 1931.

In view of the continued occurrence of tragedies in the operation of submarine or submersible vessels, it is obvious that some safety means, other than those already incorporated in such vessels, should be provided.

Submarine or submersible vessels as at present constructed are provided within their hulls with a plurality of compartments accessible to the crew of the vessel and separated by water-tight and air-tight bulkheads fitted with doorways which establish communication between the several compartments. These doorways are provided with doors which may, in emergency, be closed to isolate any compartment or compartments from the others. In addition to the compartments in the hull there is the conning tower, which is usually a part of the superstructure of the vessel, and this is in communication with the other compartments in the hull through suitable hatches, and is also the usual passage of egress from the hull to the deck of the vessel through hatches in the deck of the conning tower.

In case of accident, say a rupture of the hull, caused by collision or otherwise, the water entering the vessel, may, if the doors between certain of the compartments are closed, be confined to that compartment in which the rupture is located, and the crew may, up to a certain length of time survive in the other compartments. However, if the vessel goes to the bottom, some means must be provided for rescuing the crew and, if this may not be done readily, for supplying them with sufficient fresh air to sustain life.

The object of my present invention is to meet, as far as possible, these circumstances by providing for the automatic closing of hatches and compartment doors, supplying air to the trapped crew and affording means of escape for the crew from the sunken vessel.

The invention contemplates a submarine or submersible boat having a plurality of water-tight compartments and means for closing communication between such compartments, means for automatically closing such means, combined water-ballast tanks

and diving or escape compartments and means affording communication between same and the other compartments of the vessel whereby escape and rescue of a crew may be accomplished, means whereby a supply of air may be transferred from one compartment to another, and means whereby air may be introduced into the vessel from an external source, as I will proceed now to explain and finally claim.

In the accompanying drawings illustrating the invention, in the several figures of which like parts are similarly designated, Figure 1 is a partial vertical longitudinal sectional elevation showing diagrammatically a submarine or submersible torpedo boat of substantially conventional form with the features of my invention incorporated therein. Fig. 2 is an enlarged vertical longitudinal sectional view through the forward combined water-ballast tank and escape compartment and its adjuncts. Fig. 3 is a transverse vertical section through the combined water-ballast tank and escape compartment, airlock and passageway. Fig. 4 is a semi-diagrammatic view of one of the compartment doors and the automatic devices used to close the same. Fig. 5 is a semi-diagrammatic view one of the deck hatches and automatic devices used to close same.

In Fig. 1 I have shown the hull of the vessel divided into various compartments, as is now the usual practice in moderate sized submarine torpedo boats, in which A is the forward torpedo compartment, B the battery compartment, C the control compartment (in which the great variety of submerging, operating and control mechanisms are centralized), D is the engine room, and E the motor room. There is usually another small room F, in the extreme after portion of the vessel, called the tiller room and in which the steering gears are located. G is the conning tower with two escape compartments, H and I, built into the same and connected with doors and hatches arranged in a manner to permit the conning tower to be used for escape from the vessel when submerged, as will be hereinafter described.

J is a passageway connecting compart-

ments A and B and from which passageway entrance is had into the airlock K and thence into combined water-ballast tank and escape chamber L, shown in detail in Figs. 2 and 3.

5 M is a similar passageway connecting compartments E and F at the stern of the vessel and from this passageway access may be had to the aft combined water-ballast tank and escape compartment N in the same manner as will be described in relation to the forward escape compartment L. To avoid duplication of description I shall only describe the forward compartments.

10 A swinging door 1 opens outwardly from the passageway J into the forward compartment A and another door 2 opens outwardly from this passageway into compartment B. These doors are mounted on water-tight bulkheads 3 and 4 in the usual manner and are held open against springs used to close them by automatic releasing devices 5 and 6 more clearly shown in Fig. 4 and described later in detail. These automatic devices are arranged to release the doors the instant a predetermined amount of water enters the compartment into which they open, the springs forcing the doors to their seats and the rush of water or air assisting in their closing. Thus where water entering compartment A reaches a height for which the automatic device has been set to operate, door 1 will be instantly closed. If water should enter compartment B, door 2 would instantly close as would also door 7 on bulkhead 8. 15 If water entered compartment C, doors 9 and 10 on bulkheads 8 and 8a would close and similar doors on other bulkheads in the main hull or hatches on the conning tower, connecting compartments together, would operate in a similar manner upon water entering any one of such compartments. Thus, by mounting doors on both sides of the several bulkheads which separate the compartments, and thereby providing for the closing of communication between the compartments under all conditions with, rather than against, the pressure of the water, the intruding water entering through open hatches or rupture of hull can be confined to the compartment into which it originally enters, and the doors, in their operation, will function as check valves and be automatically sealed by the water pressure.

20 Several disasters have occurred in submarines due to submerging with open hatches and therefore I apply devices embodying the same principle for closing the deck-hatches as I do for closing the compartment doors. Consequently, as soon as the water reaches a point where there would be danger of flooding the vessel, these hatches will automatically close (see Fig. 5 which will be explained more in detail later).

25 From the above description of the purposes for which these automatic doors are to be

used, it will readily be seen that if an injury or a careless operator should permit water to rush into any one or more compartments the water will be confined to that particular compartment and prevented from entering the other compartments, thus the occupants of the other compartments would be safe from drowning, providing the vessel should sink in a moderate depth of water.

Assuming that the vessel has sunk, the next problem is one of rescue of the imprisoned crew. If the vessel should be flooded in the forward compartment, the crew in after compartment could leave the boat through the aft escape compartment N. If the vessel was punctured aft, the members of the crew in the central and forward compartments could escape through compartment L. If the injury occurred in the conning tower or in compartment C, the crew in compartments A and B could escape through compartment L and the members of the crew in compartments D, E and F, could escape through chamber N.

To make a proper use of the various chambers more easily understood, we will assume that the vessel is run down by another vessel and compartment C is punctured. Doors 9 and 10 would instantly close. If the vessel was running in the surface condition, she would still float and the entire crew could be saved through the conning tower and compartments L and N. If running in the submerged condition, and the usual means of raising the vessel located in compartment C were destroyed, the vessel would sink to the bottom very quickly, but the portions of the crew remaining would be trapped in their respective compartments forward and aft, from which they could escape as follows:—Enter airlock K through door 11 which opens from passageway J, close and secure door, open air valve 12 and admit a pressure of air from main air line 12' into airlock until the air begins to escape into combined water-ballast tank and escape compartment L through check valve 13. If compartment L is filled with water ballast the compressed air will force the water out of the compartment through check valve 14 in the bottom of the compartment. 15 and 16 are the main flooding valves to the forward ballast system. These valves are made large enough to permit a man in diving dress to pass through, and one is placed on each side of the keel so that in case the vessel is heeled to one side, the other side will free of the bottom. As soon as air passes from airlock K, through check valve 13, the drop door 17 can be released and opened as shown, and the members of the crew can pass into compartment L, and when the water is blown out of compartment L down to the level of check valve 14, the flood valves 15 or 16 can be opened, if not already open. Each of these flood valves is shown secured to an arm which in turn is secured to

a shaft and is rotated by a gear 18 and pinion 19. The pinion shaft 19' extends through a stuffing box in bulkhead 20 where it may be rotated by a hand wheel 20' or crank, as desired, from compartment A. A similar crank or hand wheel 20'' on the opposite end of the shaft 19' permits it to be rotated also from within compartment L.

A diving hood 21 is shown hanging in compartment L with a suitably supplied air hose attached thereto and wound upon a reel 22. This air hose is fitted at its connection with the diving hood, with a valve, not shown, which enables the man wearing the hood to regulate the amount of air admitted to it.

23 is a reel on which is wound a rope 23', to one end of which a buoy 24 is attached. This buoy, when released, will float to the surface carrying the rope 23' with it. In order for a member of the crew to ascend to the surface, he slips the diving hood over his head and straps it down to his shoulders, steps out through the open valve casing, grasps the buoy rope extending to the surface, and then regulates the speed of his ascent. On reaching the surface he removes the diving hood and clasps the snap hook 25 carried thereby around the buoy rope 23' and the next man wishing to ascend, hauls it back down to the door of the compartment, where he may then repeat the performance as above described. If available, divers may be sent down from surface rescue ships and take with them into the compartment regulation diving suits in which the escaping members of the crew may be dressed and kept dry in their ascent.

The passageway J may be restricted to the width necessary to permit passage of the members of the crew from one compartment to another, or it may be extended across the vessel to form a larger compartment O which may be used as a decompressing chamber on occasions where the submarine is itself used as a rescue boat to another disabled submarine, whether the latter be fitted with escape compartments similar to those described or otherwise.

In such cases the method of operation would be substantially as follows:—The rescuing submarine would anchor and submerge as near the disabled craft as possible, so as to bring the respective escape chambers of the two vessels in close proximity, and the rescue compartments L, for example, of both vessels, would then both be opened to the sea.

By following the procedure above described, a diver would then go out from the rescuing vessel and attach a line leading from the open doorway at 16 to the corresponding open doorway or valve on the disabled vessel, and instead of spending a considerable period of time in slowly ascending to the surface, (which is necessary in deep water in order to provide for stage decompression to prevent serious illness, commonly called the "bends")

the members of the crew and divers would only need to don the diving dress or diving hood and follow the line from one vessel to the other a short distance without alteration of pressure. This method would have the further advantage of enabling the rescue to be effected irrespective of surface weather and sea conditions, it being practically impossible for divers to work in very rough water.

In deep-diving the best practice calls for the gradual or stage decompression just referred to, in order to allow time for the excess nitrogen to be thrown off by the blood, and, as it would be inadvisable to tie up the airlock K for long periods, the passageway J and chamber O may be used for decompression. For purposes of illustration, we will assume the vessel to be at a depth of 200 feet, with a surrounding water pressure 86.6 lbs. per square inch above normal atmospheric pressure. This requires a corresponding air pressure within the vessel of 86.6 lbs. to keep the water from rising in compartment L. On entering compartment L the divers or rescued men go up into the airlock K, which is, at the time, in communication with compartment L, and, having previously instructed the members of the crew in the rescuing vessel to close and secure doors 1 and 2, air may be admitted into the passageway J and its connecting decompression chamber O until it equals 86.6 lbs. per square inch, also. Door 11 may now be opened, thus giving access to the passageway J. Those now wishing to return to the normal air pressure of one atmosphere, close door 26 and air pressure valve 27 and open air-exhaust valve 28 in bulkhead 4, or a corresponding valve in bulkhead 3, thus permitting the air pressure in chamber O to gradually reduce until it reaches the same pressure as in compartments B or A. Door 29 may now be opened and entry effected into compartment B, after which door 29 is again closed and compartment O is ready to receive the next person or persons desiring to return to normal air pressure within the main hull of the vessel.

All modern submarines carry compressed air in air reservoirs sufficient to operate various machines, to discharge torpedoes, and to empty water-ballast tanks. Some submarines are provided also with an attachment extending outside of the hull, through which the various air systems may be supplied with air pumped down from a surface vessel through an air hose. But, in some disasters the main air lines have been broken and all the stored supply of compressed air lost, so that the men trapped in a compartment could live only as long as the air in the particular compartment contained sufficient oxygen to sustain life. Under such conditions it is obvious that there would be no compressed air available to carry out the operations I have here-

inbefore described. To meet such an emergency, I provide in airlock K a hand-operated air pump P, shown mounted on bulkhead 4, with connecting intake pipes leading to compartments A and B. Similar hand pumps may also be located in compartments A and B. By means of these pumps a portion of the air contained in compartments A and B may be pumped into the airlock and chamber L to permit of escape of crew in the manner previously explained. These pumps may be connected up with branches of the usual pressure line 12' leading into the airlock K, combination water ballast and escape compartment L and decompression chamber O. Such branch pipes are not shown, as they are well understood by those versed in the art of submarine boat design and construction and would only add complication to the drawings.

I do provide, however, an independent air pipe 30 leading from the deck through the main hull and having branches leading into airlock K, passageway J and decompression chamber O provided with valves 31, 32 and 33 respectively.

A diver descending from a surface vessel may attach an air hose to this pipe 30 by removing a cap 34, or opening a valve in lieu of the cap, or the pipe 30 may receive air from a buoy normally carried in the superstructure and allowed to float to the surface carrying an air hose attached to the pipe 30. I have heretofore used such a buoyed air hose with success. It is essential not only to admit fresh air to the vessel but to also provide for the escape of the foul air which may accumulate from exhalations of the crew and from other sources. The exhalations of the crew are principally carbonic acid gas, which is much heavier than normal atmospheric air and will gravitate to the decks or floors of the compartments. With this characteristic of the foul air in mind, I provide in each compartment, in which men may be trapped, an exhaust pipe 35 which leads from outboard through the main hull down into the compartment, and terminates at a point adjacent to the floor or deck of the compartment. Each of these exhaust pipes may be provided with a valve, which may be opened after a diver has attached a hose leading to the surface, so that pure fresh air admitted to the compartments through pipe 30 and its branches will drive the foul air out through pipes 35. In this manner the air pressure in the compartments will be raised only slightly above the normal atmospheric pressure. With such pipes installed, it will be practical to have outwardly-opening doors 36 located near the floors or decks of the forward and after compartments, with locking bolts that can be released from either the interior or exterior of the vessel. Then, by closing doors 1 and 11 and opening valve 37, (Fig. 2), air may be forced into compart-

ment A until it begins to flow outboard through outgoing check valve 38 (Fig. 2), when door 36 may be opened. The water will not rise higher than the top of the door so long as the air pressure in compartment A is maintained equal to the pressure due to the column of water above the top of the open door. Moreover, these doors 36 form a means of access to the hull of the vessel when sunk and completely disabled, it being possible for divers working from outside to open them when the pressures outside and in compartment A balance, as would be the case were such compartment flooded.

In Fig. 4, I show an enlarged semi-diagrammatic view of means for closing the compartment doors. In this arrangement, 39 is the floor or deck of one of the compartments. In this instance we will assume it to be compartment A with door 1 leading into passageway J. The door is locked open by a hooked arm 41 with its hook 41' engaging the bottom edge of the door. A float 42 is carried at the outer end of arm 41 and the arm is mounted in a pivot bearing 43 which permits the float to rise and fall. 44 and 45 are hinges which carry the door, and 46 is a lever arm swinging freely on shaft 47, which shaft is mounted in suitable bearings 47' and is provided with a head 48 which is drilled through for the insertion of a pin 48'. 49 is a coil spring encircling the shaft 47, and one end of this spring is secured to the shaft at 49' and the other end to the lever arm 46. By rotating the shaft, by means of pin 48' inserted in its head, the spring 49 may be adjusted so that any desired pressure may be exerted on lever arm 46, which, bearing against the face of the door, tends to close it. The operation of this device is as follows:—The spring is adjusted to a tension that will cause the door to close rapidly, but normally it is held open by hook 41'. However, upon the entrance of water into the compartment, and its rise therein to a predetermined level, the float 42 will rise and the door being thereby released from hook 41' will close. Any great rush of water will seal the door tight, but the usual locking dogs e, having operating means extending through stuffing boxes in the bulkhead, may be set to tighten the door.

An alternative means for automatically or manually releasing hook 41' and which may be actuated by control means located at any remote points in the vessel is also shown. In this means, 52 and 53 are copper anodes slightly separated and mounted on suitable insulators, S is a solenoid, with its plunger s shown down and provided with a chain s' which may be attached either to the float 42 or to the lever arm 41. 54 is a battery with its positive pole connected to the anode 52 by wire 52'. A wire 53' leads from the other anode 53 to the solenoid. Another wire b

leads from the solenoid to the negative pole of the battery. When water rises between the anodes, the circuit is completed, the solenoid becomes magnetized and the plunger is lifted thereby pulling up the lever arm 41, and permitting the door to close. Branch wires *c* and *d* may also be led from the solenoid-controlling circuit to the poles of a switch *f*, by means of which the circuit through the solenoid *S* may be manually controlled. Such switches, whereby all doors and hatches may be controlled, may be placed at any desired points about the vessel, on the bridge, in the conning tower, etc., so that upon the first sign of collision any switch may be closed and all compartments isolated from each other.

Also, separate switches may be centrally located so that any particular door or hatch may be released.

Fig. 5 shows, semi-diagrammatically, a hatch-cover provided with means operating in a manner similar to the control means for the doors. In this embodiment, 55 is the hatch cover with locking lug 56 secured to it. 57 is a bracket, secured to the superstructure or conning tower deck, and carrying a locking bar 58 which is provided with a hook adapted to drop down over lug 56 when the hatch cover is raised into the position shown in dotted lines. 59 is a float secured to a lever arm 60 pivoted to hatch combing at 61, and to locking bar 58 at 62.

In navigating on the surface, spray may break over the vessel without closing the door, but, on submerging, the water rushes into the superstructure and raises the float which lifts locking bar 58, and the door becomes a check valve and instantly seats itself and prevents the inflow of water. I also provide means whereby the officer on the bridge, noting an approaching danger of collision, may press a button and cause the plunger 63 in solenoid 64 to rise and lift the float 59 by means of an extension 65, thus releasing the locking bar 58 and permitting the hatch to close.

It will thus be seen that, by my invention, I not only provide means whereby the various compartments of a submarine or submersible vessel may be automatically sealed, but I provide means of escape for the crew and means whereby the crew may be supplied, when trapped, with fresh air, and means whereby air under pressure may be supplied for performing various functions necessary for the escape of the crew. And it is to be noted that all of these safety means are incorporated in the vessel without necessitating radical departures from established practice in design and construction.

One of the arguments advanced against the inclusion in military submarine boats of so-called diving compartments, that is com-

partments whereby divers may leave and enter the boat while submerged, is that they consume so much of the little available space within the hull as to impair or reduce the military efficiency of the boat.

This argument is met in a boat designed and constructed in accordance with my invention, for the reason that the diving or escape compartment *L* is normally one of the necessary water ballast tanks of the boat, and is utilized as a diving or escape compartment only in case of emergency. This compartment, therefore, being confined to a space never used as a storage space or as quarters for the crew, but only as a water-ballast tank, in which capacity it still functions, does not in any sense reduce the military efficiency of the boat. The compartments *J*, *K* and *O* are relatively small and take very little space from the adjoining compartments. In fact the airlock *K* and decompression chamber *O* may be used as storage compartments during normal conditions and need only be cleared in case of emergency. The passageway *J* must, of course, be clear at all normal times to afford communication between the compartments *A* and *B*.

The same is true of the similar arrangement of compartments at the stern of the boat.

It would seem that, in view of the safety factors provided with so little actual loss of military efficiency, a slight concession in favor of safety is warranted.

Various changes are deemed to be within the spirit of the invention and the scope of the following claims.

What I claim is:—

1. In a submarine or submersible boat, bulkheads dividing the hull thereof into a plurality of compartments, one of said compartments serving as a combined water-ballast tank and diving compartment, another of said compartments adjacent thereto serving as an airlock, and means affording communication between said combined water-ballast tank and diving compartment and said airlock when the former is used for diving purposes, and a flood-valve affording communication between said combined water-ballast and diving compartment and the sea whereby a diver may leave the boat, said valve operable to admit water to said compartment when same is functioning as a water-ballast tank.

2. In a submarine or submersible boat, bulkheads dividing the hull thereof into a plurality of compartments, certain of said bulkheads so arranged as to form between them in association a combined water-ballast tank, an airlock, a passageway, and a decompression chamber, means for isolating these four compartments from the hull of the boat,

means for isolating each of the four from the others, and means whereby they may be used in combination for performing diving and rescue operations.

5 In testimony whereof I have hereunto set my hand this 10th day of January, A. D. 1928.

SIMON LAKE.

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