March 10, 1931. J. F. O'ROURKE 1,795,408

SUBMARINE AIR LOCK

Filed March 24, 1928 2 Sheets-Sheet 1

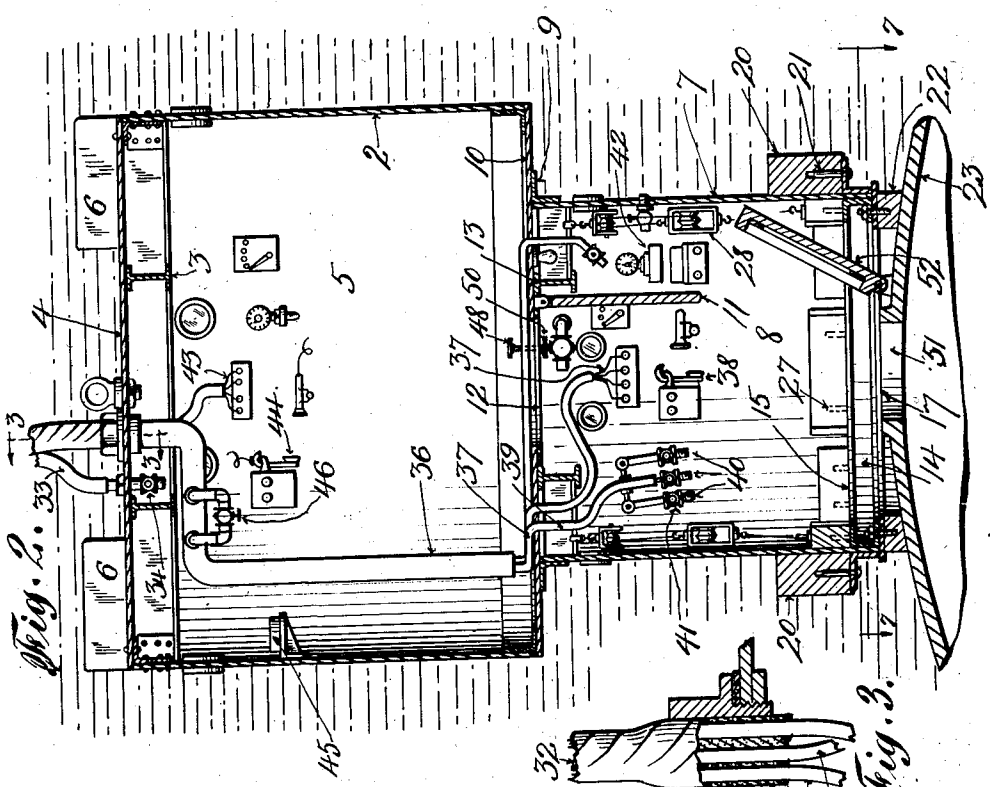

Fig. 2.



Fig. 3.

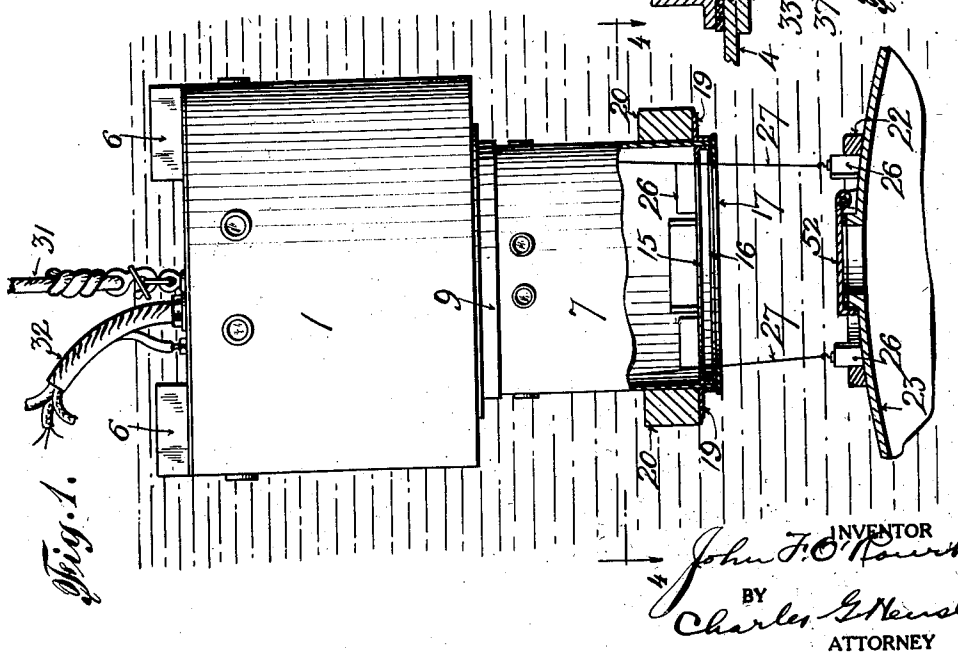

Fig. 1.

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SUBMARINE AIR LOCK

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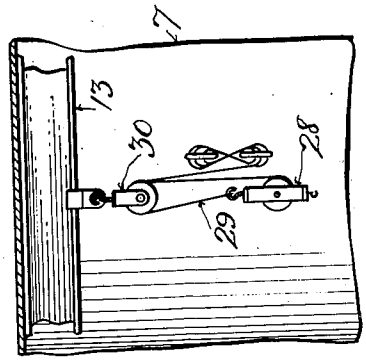


Fig. 6.

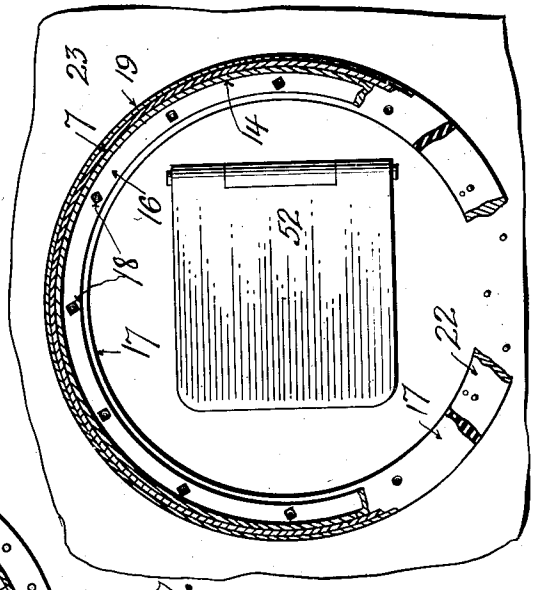


Fig. 7.

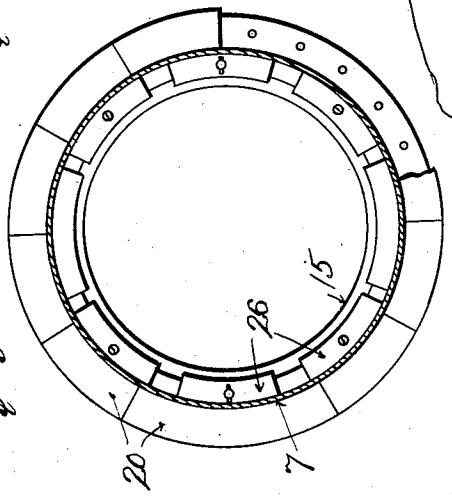


Fig. 4.

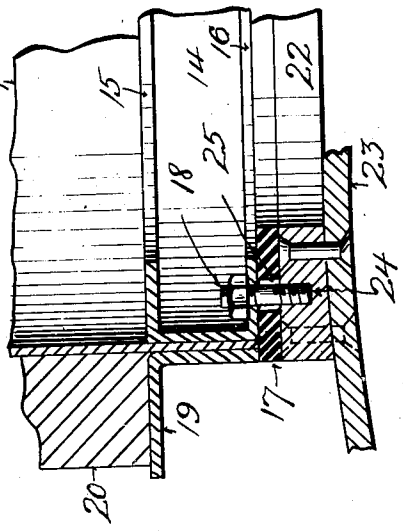


Fig. 8.

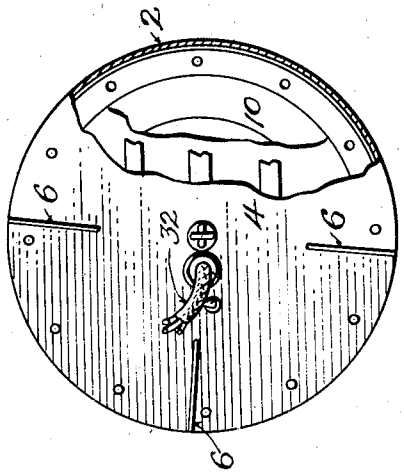


Fig. 5.

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# UNITED STATES PATENT OFFICE

JOHN F. O'ROURKE, OF NEW YORK, N. Y.

## SUBMARINE AIR LOCK

Application filed March 24, 1928. Serial No. 264,523.

The object of my invention is to provide a portable air lock by means of which a crew may have access to submerged objects or vessels, or to ground underlying water, and for various other purposes where the crew must be protected against external water. In my applications, Serial Nos. 105,676 and 264,521, I showed and described apparatus for the same general purposes and the present case covers features which may be utilized in conjunction with or in addition to the features disclosed in said applications. The submarine air lock disclosed herein permits work to be carried on while it is submerged in water of considerable depth and the device is portable both in the sense that it may be moved from one location to another by means of hoisting apparatus on a vessel on the surface, and also in the sense that the crew accompanying the air lock may, in their submerged positions, move the air lock to change its position from place to place on the bottom, and also to get it into proper relation to a submerged or sunken vessel for the purpose of salvaging the latter or rescuing persons entrapped therein.

The present invention is especially useful in rescuing persons from a submerged vessel and it consists, essentially, of a chamber, preferably of cylindrical form, which is divided off into an upper compartment and a lower compartment, the former of which is preferably considerably larger than the lower compartment in order to have a large capacity for receiving the persons being rescued. The lower compartment is relatively smaller and has an open bottom and it is adapted to be supplied with compressed air to exclude the entry of water through the open bottom. This lower compartment is of suitable size to be temporarily attached by a water-excluding connection with a portion of the submerged vessel, so that the chamber surrounds and encloses a portion of the deck or hull plate of the submerged vessel in order to permit rescue operations to be carried on, either through the hatchway of the submerged vessel, or through an opening formed therein by the crew of the diving apparatus for the purpose. The lower chamber may be entirely segregated, as far as air pressures are concerned, from the larger upper chamber. The compressed air for excluding water from the open bottom during the lowering of the apparatus need only be supplied to the lower chamber, so that the upper chamber remains at atmospheric pressure. While the apparatus is being lowered and shifted into position along the bottom or onto the deck of the submerged vessel, preparatory to rescue operations, members of the crew may be located in the larger and upper compartment where there are provided suitable instruments such as telephones, lights, compressed air apparatus, and a ship compass for communicating instructions to the surface vessel regarding the desired movements of the air lock by suitable tackle on the surface vessel. Some of these instruments may also be used for controlling the admission of compressed air into the lower compartment.

During the lowering operation there is maintained compressed air in the lower compartment, sufficient to overcome the external water pressure and prevent the water entering the open bottom. During this same period the upper compartment may be at atmospheric pressure. The crew operating in the upper compartment will direct the positioning of the air lock toward the submerged vessel and finally onto the deck approximately to the final position. Compressed air is then admitted into the upper compartment until the pressures in both compartments are equalized and then the door controlling the passage between the compartments may be opened and the crew may descend to the lower compartment where they will carry on the final positioning operations. The lower compartment is preferably provided with a duplicate set of instruments for communicating with the surface vessel and for other control and positioning purposes and also with a valve controlling the admission of compressed air to the lower compartment, there being compressed air connections to the lower as well as to the upper compartment.

When the chamber has been brought into position on the submerged vessel and fastened thereto so that a water-tight connec-

tion has been established between the lower compartment of the chamber and the submerged vessel, the compressed air within the chamber may be blown off at a suitable rate of decompression to reduce the chamber either to atmospheric pressure or to that in the submerged vessel. After the attachment to the submerged vessel has been accomplished and the compressed air blown off, the rescue or salvaging operations may be carried on while the crew is working in atmospheric pressure. After the hatch of the vessel has been opened persons pass from the submerged vessel into the lower and thence into the upper compartment of the air lock. The hatch is closed and the attaching means is then released from the submerged vessel and the crew also passes into the upper compartment of the air lock. The door between the two compartments is closed, and then compressed air is admitted into the lower compartment until it equals the water pressure at the bottom of the chamber. The apparatus is then hoisted to the surface. It will be apparent from the foregoing description that the time during which members of the crew are required to be in compressed air during an entire rescue or salvaging operation is only the brief period required to shift the apparatus along the deck to the attaching ring surrounding the hatch and to secure the apparatus to the deck of the vessel. As this is a matter of a short period the crew was quickly decompressed when the compressed air was blown off just before the hatch was opened. Subsequent operations are carried on in atmospheric pressure. The rescued persons are never subjected to compressed air and neither is the crew in compressed air subsequent to the opening of the hatch.

In the drawings forming part of this application,

Figure 1 is an elevation with parts broken away and showing the air lock about to be applied to the deck of a submerged vessel,

Figure 2 is a vertical, sectional view through the air lock and a portion of the deck of the submerged vessel, and showing the air lock secured to the vessel,

Figure 3 is a sectional view taken on the line 3—3 of Figure 2,

Figure 4 is a sectional view taken on the line 4—4 of Figure 1,

Figure 5 is a plan view of the air lock with a portion broken away,

Figure 6 is a sectional view showing one of the devices for controlling the movable weights,

Figure 7 is a sectional view taken on the line 7—7 of Figure 2, and

Figure 8 is an enlarged view showing the means for connecting the air lock with the submerged vessel.

I have shown the air lock as cylindrical in form although it will be understood that I am not limited to this particular shape. The chamber 1 is composed of an upper section having a cylindrical wall 2 provided with I beams 3 extending across the top, which beams are covered by and are secured to a top wall 4. These walls form a compartment 5. Preferably there are provided fins 6 projecting upwardly from the top, which serve to prevent the device from spinning while suspended from the hoisting apparatus.

The compartment 5, formed by the construction just described, is of larger lateral dimension than the lower compartment hereinafter described, in order that it may accommodate a number of persons who may be rescued from the submerged vessel, or to hold objects which may be salvaged from the submerged vessel. The lower chamber is limited to a size which can be conveniently attached to the deck of the submerged vessel. The upper compartment may be of any size to receive a comparatively large number of persons. There is a lower, cylindrical wall 7 forming the lower compartment 8 and it is attached to the upper structure by means of the rings 9 of angle metal which are attached to the cylindrical wall 7 and to the bottom wall 10. The wall 10 forms the bottom for the upper compartment and it also divides the upper and lower compartments 5, 8 from each other, and therefore divides the air lock into the separate compartments. There is a door 11 preferably adapted to swing downwardly to close the opening 12 in the dividing wall 10 in order to complete the separation of the two compartments in an air-tight manner when closed, and to permit passage between the compartments when open. I have also shown I beams 13 extending across the upper portion of the lower compartment and connected with the dividing wall 10 to stiffen and strengthen the construction of the apparatus.

The bottom of the apparatus is preferably constructed with similar means for attaching the air lock to the sunken vessel, as is shown in my said co-pending application Serial No. 264,521, and it comprises an annular ring attached to the inner surface of the cylindrical wall 7, this ring being, preferably, made of channel metal with the vertical web 14 welded or otherwise secured to the cylindrical wall 7. This ring has an upper, horizontally disposed flange 15 which serves as a ledge or support for certain movable weights to be hereinafter referred to. The other horizontal flange 16 of this ring is here shown as lying flush with the bottom edge of the cylindrical wall 7; and it has attached to its bottom surface a gasket 17 of compressible material, preferably rubber, to form a water-tight connection between the bottom of the air lock, and a member of the submerged vessel. The flange 16 is provided with a number of apertures to receive the attaching bolts 18 by which the air

lock is temporarily connected with the submerged vessel. I have shown an angle metal ring 19 welded or otherwise secured to the outer surface of the cylindrical wall and this forms an exterior support for the weights or ballast 20 the latter being shaped to conform with the outer surface of the cylindrical wall and are held from tipping from the ring 19 by means of the pins 21 in the latter which project into apertures in the weights.

Preferably, the vessel on which the rescue operations are to be carried out is provided in advance with a coaming or an annular ring 22 which is riveted or otherwise secured to the deck plate 23 of the submerged vessel, and remains a permanent part of the equipment thereof. Submarines or any other vessels may be regularly equipped with this ring. The deck ring is provided with tapped holes 24 on its upper side, into which the attaching bolts 18 are adapted to be screwed. These bolts pass through the apertures in the flange 16, thence through the apertures 25 in the gasket 17, and are screwed into the holes 24 in the deck ring 22, so that they draw the flange 16 toward the ring 22 and place the gasket 17 under compression to form a watertight connection between the lower end of the air lock and the submerged vessel. Where the ring 22 is applied to a crowned portion of the deck plate, as shown in Figure 2, the top surface of the ring will nevertheless be made flat, in order to conform to the under surface of the flange 16.

The outer weights 20 are employed to overcome the major portion of the buoyancy of the air lock and these require no manipulation while the diving operations are being carried out. However, for the same reasons as disclosed in my said co-pending applications, I prefer to provide a number of movable weights 26 which may be located inside the chamber and around the top of the flange 15 where they are held detachably mounted on the pins 27; and these weights are adapted to be manipulated by the crew through the open bottom of the air lock or otherwise. These weights are connected by the cables 27 with the tackle 28 which latter is connected by suitable cables 29 with the blocks 30 which are mounted upon the I beams 13 forming part of the chamber structure. By means of the cables and tackle the members of the crew, while located in the lower compartment 8, may manipulate the movable weights through the open bottom of the chamber, and by means thereof effect the shifting of the air lock in relation to the submerged vessel in order to accurately locate it in relation to the ring 22 on the vessel. Or they may lift and move the air lock bodily into position and lower the weights to permit the air lock to rise any desired distance from the deck when necessary. The method of manipulating these weights is set forth in the aforesaid applications.

The air lock is adapted to be raised and lowered from a surface vessel (not shown) by suitable apparatus, operating through the supporting cable 31 which is attached to the top of the air lock. There is a cable 32 in which are enclosed various wires and tubes for feeding compressed air from the surface vessel to the air lock and for atmospheric air connection with the surface. For instance, this cable encloses the tube 33 which is connected by means of a water-tight connection to the top wall of the air lock and this tube is adapted to feed air at atmospheric pressure into the upper compartment 5 and it is controlled by a valve 34 within this compartment. A portion of the cable 32 passes through a water-tight connection in the top wall 4 and passes thence radially, as shown at 35, and thence down the inner side of the cylindrical wall 2 at 36, thence across the dividing wall 10, thence through this dividing wall and into the lower compartment 8. Connections for the upper compartment are taken off cable 32. The cable 32 contains the necessary wires 37 to provide communication between the telephone instrument 38 located within the lower compartment 8 to a similar instrument on the surface vessel for transmitting instructions or orders from the members of the crew while in the lower compartment, to those on board the surface vessel, so that the lowering and positioning operations may be effected according to the transmitted orders. This portion of the cable also includes the tube 39 for furnishing compressed air to the lower compartment 8; and I have shown a manifold 40 connected with this tube and having several outlets controlled by the valves 41. Compressed air may be discharged from any connection on the manifold into the lower compartment, or the manifold may be used to supply compressed air to diving suits worn by members of the crew while working through the open bottom of the air lock, where this is desirable, or to operate pneumatic tools. I have also shown a ship compass 42 located in the lower compartment, which may be referred to by the members of the crew while in this compartment, for giving instructions to those on the surface vessel regarding shifting of the air lock.

The main cable 32 also encloses the wires 43 which form connections between the telephone instrument 44, located within the upper compartment 5 and corresponding instruments arranged on the surface vessel. I have also shown a ship compass 45 located in the upper compartment, so that the controlling operations may be carried on by the crew of the air lock while located either in the upper or lower compartment.

*Operation*

The air lock will be lowered over the side of surface vessel by means of the cable 31 and with suitable apparatus on the surface vessel. When the air lock is about to be lowered, all members of the crew may be in the chamber 5 having passed upwardly therein through the lower compartment and through the opening 12 and the door 11 may then be closed. The members of the crew may, therefore, remain in the upper compartment which can be maintained at atmospheric pressure throughout most of the operations. As the air lock is lowered in the water, the valve 46 may be manipulated in the upper compartment for the purpose of admitting compressed air, supplied through the tube 39, to the lower compartment 8, and as the door 11 is closed, the compressed air will only be admitted to the lower compartment, and will, therefore, not affect the members of the crew who are in the upper compartment. The compressed air admitted into the lower compartment will be sufficient to exclude water entering the air lock. It will be understood that during this lowering operation one or more members of the crew may be located in the lower compartment, in which case only such members will be operating in compressed air, but this will usually be unnecessary. The crew in the upper compartment may transmit orders to the surface vessel, or if some members of the crew are in the lower compartment orders may be transmitted from this location, so that the air lock will be manipulated to bring the same to rest upon the deck. When this position has been arrived at, then compressed air is admitted into the upper compartment until the pressure in the two compartments is equalized to permit the door 11 to be opened, so that the crew may pass from the upper into the lower compartment, from which they can shift the apparatus to final position on the deck ring 22. The crew in the compartment 8 may screw the bolts 18 into the holes 24 in the deck ring 22 in order to draw the flange 16 toward the deck ring and to compress the gasket 17 for the purpose of forming a water-tight connection between the air lock and the submerged vessel. When the bolts 18 have been attached, or even some of them, compressed air may be blown off by means of the valve 34 so that both compartments of the air lock are now at atmospheric pressure; or, they may be at such pressure as will correspond with whatever pressure may exist in the submerged vessel, if any. This blowing off will be at a rate to safely decompress the crew. The air lock having been attached to the deck ring 22, forms an enclosure around the hatchway 51 of the vessel and as the pressure above the hatch 52 has been reduced, this hatch may be opened to permit access to the submerged vessel when pressure on both sides is equalized. Persons within the latter may then pass into the lower compartment 8 of the air lock and thence through the opening 12 into the upper compartment 5. The latter being of large size, will accommodate a large number of persons. On the other hand, various objects may be moved from the submerged vessel into the upper compartment for salvaging.

When the persons have passed from the submerged vessel into the upper compartment 5, or as many as the compartment will hold, the hatch 52 is again closed. If desired, some of the movable weights 26 may be placed on the deck of the submerged vessel within the deck ring 22, as shown in Figure 1, so that these weights and the hand lines connected with them may be subsequently used in guiding the air lock back to proper position on the deck ring of the submerged vessel in making subsequent trips until all persons are rescued, or for salvaging and repairs. The crew within the air lock will close the hatch and release the bolts 18 from the deck ring. The crew may then pass through the opening 12 into the upper compartment 5, whereupon the door 11 will be closed. The valve 46 is then opened to admit compressed air into the lower compartment until it equals the water pressure at the bottom, whereupon the air lock may be detached from the vessel and hoisted to the surface by the surface vessel. During the raising operation water is prevented from entering the open bottom of the chamber 8 by the compressed air therein. When the air lock has been hoisted to the surface the compressed air will have escaped from the lower compartment, so that the door 11 may be opened and all persons within the air lock may pass outwardly through the open bottom.

The rescued persons are not in compressed air during any part of the rescue operations, so that they do not have to go through a decompression operation and may immediately leave the air lock as soon as the latter has been raised to the deck of the surface vessel. The air lock can be immediately returned to the submerged vessel for the carrying on of further rescue or salvaging or repair operations. The only time any member of the crew is required to be in compressed air is for the brief time required to shift the apparatus onto the ring after the chamber has been positioned on the deck of of the submerged vessel and while securing bolts 18 to the deck ring, or coaming which will ordinarily be but a short time, and therefore they will not have to go through a decompression operation. This permits rescue operations to be carried on to greater depths than would be practicable for divers to work in. It is desirable to accomplish the rescue operations without subject-

ing the rescued persons to compressed air, both on account of avoiding injurious effects upon the persons, as well as to permit their rapid egress from the air lock after it has been raised. In the present device the rescued persons need at no time be in compressed air.

Having described my invention, what I claim is:

1. A submarine air lock comprising a chamber having an open bottom, means dividing said chamber into an upper and a lower compartment having a door to permit passage between said compartments, means operable by the crew within the lower compartment for connecting the open bottom thereof with a coaming surrounding a hatch of a submerged vessel to provide a water-excluding connection between said chamber and the vessel, means for supplying compressed air to said lower compartment, means for selectively maintaining air under atmospheric or greater than atmospheric pressure within said upper compartment, means under the control of the crew within said chamber for regulating the buoyancy of said air lock, and means movably carried by said chamber, also controllable by the crew, for effecting lateral movements of said air lock.

2. A submarine air lock comprising a chamber having an open bottom, means dividing said chamber into an upper and a lower compartment having a door to permit passage between said compartments, means operable by the crew within the lower compartment for connecting the open bottom thereof with a coaming surrounding a hatch of a submerged vessel to provide a water-excluding connection between said chamber and the vessel, means for supplying compressed air to said lower compartment, means for selectively maintaining air under atmospheric or greater than atmospheric pressure within said upper compartment, and means movably carried by said chamber, controllable by the crew thereof, for effecting movements of the apparatus necessary to reach the attaching position, said means comprising loose weights for regulating the buoyancy of the air lock, and weights flexibly connected to said air lock for also regulating the buoyancy thereof and providing anchoring means therefor.

3. A submarine air lock comprising a chamber having an open bottom, means dividing said chamber into an upper and a lower compartment having a door to permit passage between said compartments, means operable by the crew within the lower compartment for connecting the open bottom thereof with a coaming surrounding a hatch of a submerged vessel to provide a water-excluding connection between said chamber and the vessel, means for supplying compressed air to said lower compartment, means for selectively maintaining air under atmospheric or greater than atmospheric pressure within said upper compartment, and weights flexibly and extensibly connected to said air lock, controllable by the crew thereof, providing shiftable anchoring means therefor.

4. A submarine air lock comprising a chamber having an open bottom, means dividing said chamber into an upper and a lower compartment having a door to permit passage between said compartments, means operable by the crew within the lower compartment for connecting the open bottom thereof with a coaming surrounding a hatch of a submerged vessel to provide a water-excluding connection between said chamber and the vessel, means for selectively or collectively supplying compressed air to said compartments, means controllable from within said upper compartment for establishing or cutting off communication between said compartment and the atmosphere, and means movably carried by said chamber, controllable by the crew thereof, for effecting movements of the apparatus necessary to reach the attaching position, said means comprising loose weights for regulating the buoyancy of the air lock, and weights flexibly connected to said air lock for also regulating the buoyancy thereof and providing anchoring means therefor.

5. A submarine air lock comprising a chamber having an open bottom, means dividing said chamber into an upper and a lower compartment having a door to permit passage between said compartments, means operable by the crew within the lower compartment for connecting the open bottom thereof with a coaming surrounding a hatch of a submerged vessel to provide a water-excluding connection between said chamber and the vessel, means for supplying compressed air to said lower compartment, means for selectively maintaining air under atmospheric or greater than atmospheric pressure within said upper compartment, and means movably carried by said chamber, controllable by the crew thereof, for effecting movements of the apparatus necessary to reach the attaching position, said means comprising loose weights for regulating the buoyancy of the air lock, flexible elements extensible through said open bottom, and weights on said flexible elements for also regulating the buoyancy of the air lock and providing anchoring means.

6. A submarine air lock comprising a chamber having an open bottom, means dividing said chamber into an upper and a lower compartment having a door to permit passage between said compartments, means operable by the crew within the lower compartment for connecting the open bottom thereof with a coaming surrounding a hatch of a submerged vessel to provide a water-excluding connection between said chamber and the ves-

sel, means for supplying compressed air to said lower compartment, means for selectively maintaining air under atmospheric or greater than atmospheric pressure within said upper compartment, and weights, flexible connections for the weights extensibly connected to said air lock and projectable through the said open bottom, the said flexible connections being controllable by the crew of the air lock, and providing shiftable anchoring means therefor.

7. A submarine air lock comprising a chamber having an open bottom, means dividing said chamber into an upper and a lower compartment having a door to permit passage between said compartments, means operable by the crew within the lower compartment for connecting the open bottom thereof with a coaming surrounding a hatch of a submerged vessel to provide a water-excluding connection between said chamber and the vessel, means for selectively or collectively supplying compressed air to said compartments, means controllable from within said upper compartment for establishing or cutting off communication between said compartment and the atmosphere, and means movably carried by said chamber, controllable by the crew thereof, for effecting movements of the apparatus necessary to reach the attaching position, said means comprising loose weights for regulating the buoyancy of the air lock, and flexible members connected to the air lock and to said weights and extensible through the open bottom of said air lock for also regulating the buoyancy of the air lock and producing anchoring means therefor.

Signed at the city, county and State of New York, the 21st day of March, 1928.

JOHN F. O'ROURKE.