Sept. 1, 1964 R. B. EBBETS ETAL 3,146,750

SUBMARINE RESCUE APPARATUS

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Fig. 1.

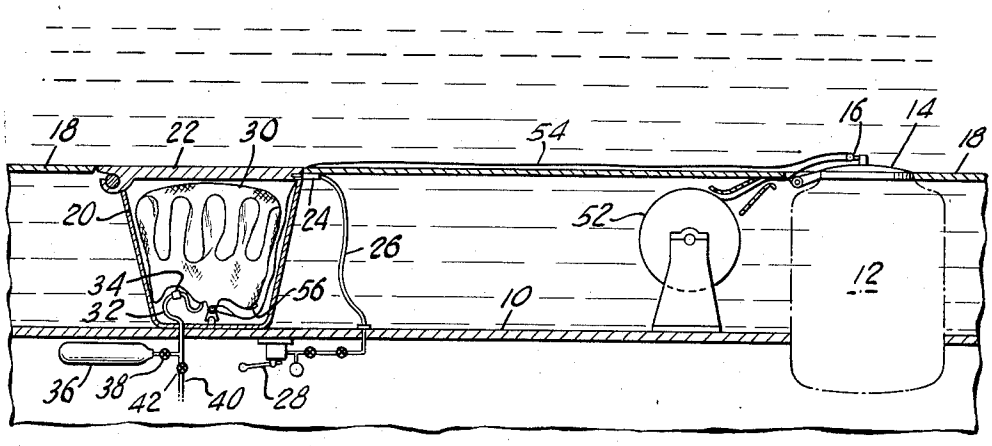

Fig. 4.

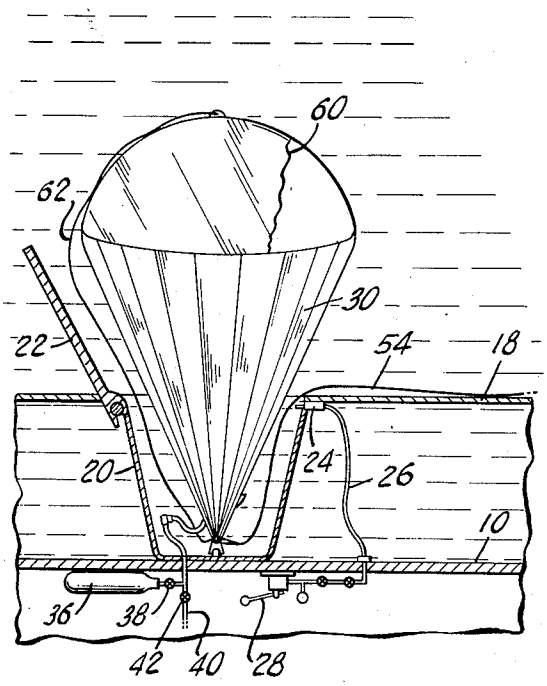

Fig. 2.

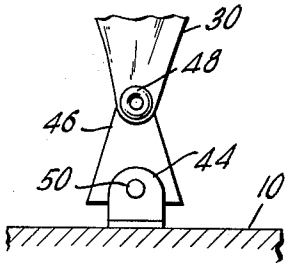

Fig. 3.

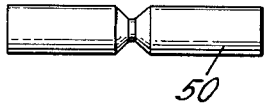

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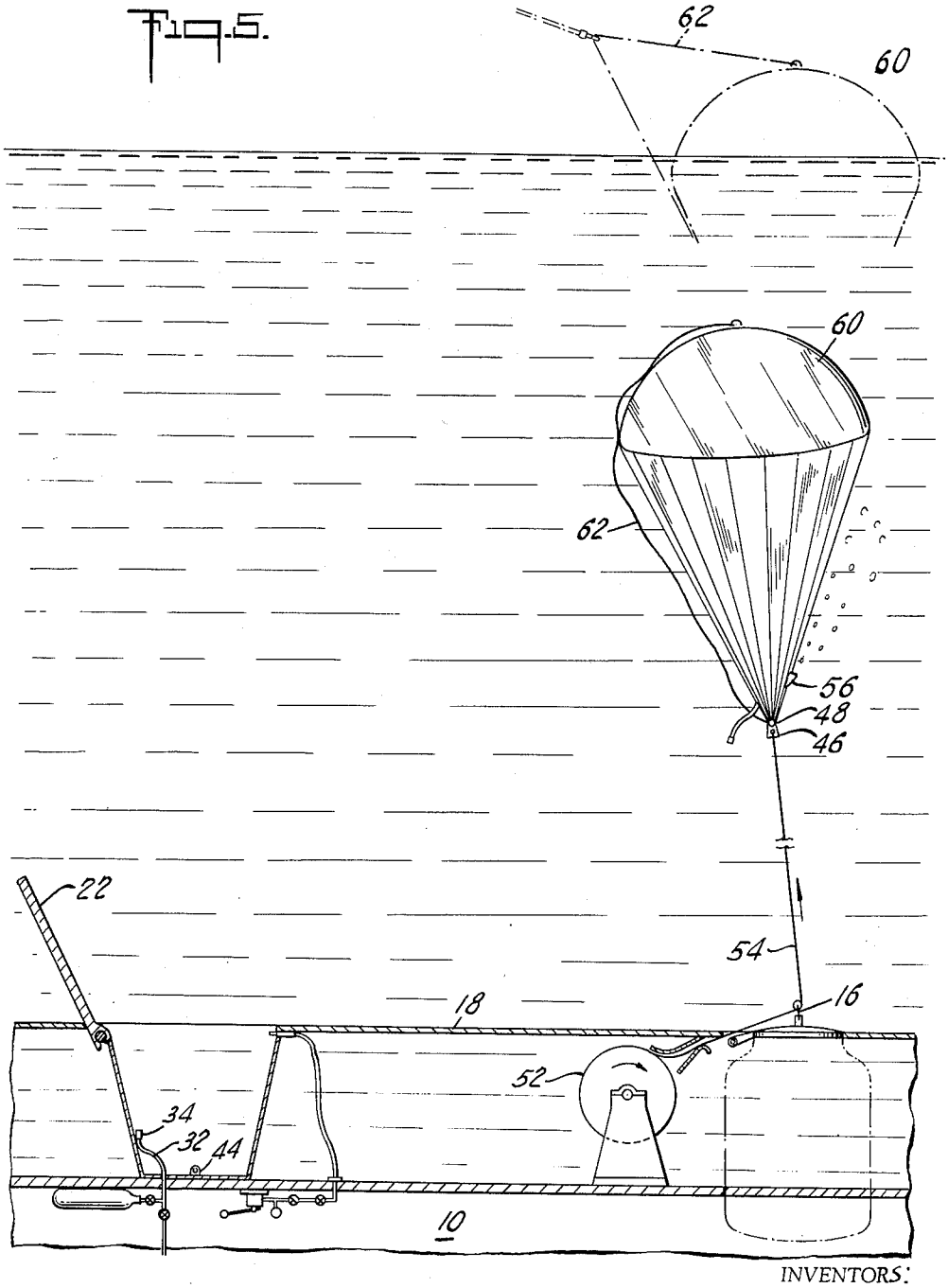
Fig. 5.



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SUBMARINE RESCUE APPARATUS

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3 Claims. (Cl. 114—16.5)

This invention relates to submarine rescue and more particularly to improved methods and apparatus for raising a cable from a bottomed or disabled submarine to the surface for use in guiding and downhauling a rescue chamber from a submarine rescue vessel to the bottomed submarine for as many trips as required to rescue personnel from the submarine.

U.S. Navy submarine rescue vessels carry a rescue chamber on board as part of their standard equipment. In use, the rescue chamber is manned by a crew of two. The rescue chamber is generally bell-shaped having an open bottom and a water-tight wall intermediate top and bottom. The wall includes a hatch. Each submarine has an escape hatch. The open end of the rescue chamber is designed to seat in water-tight engagement with the structure around the escape hatch and with adequate clearance between the subarine escape hatch and the wall in the rescue chamber for personnel to leave the submarine and enter the upper part of the rescue chamber. The submarine rescue vessel is equipped with a hoist to raise and lower the rescue chamber between the rescue vessel and the water. A compressed air supply, power for lighting, and a communication link extends between the submarine rescue vessel and the upper part of the rescue chamber. The rescue chamber carries within the lower portion a compressed air hoist controllable by the crew of the rescue chamber. One end of a downhaul cable is raised to the surface by a buoy and the cable end is secured to the hoist in the rescue chamber. The hoist is operable to take up the cable and is thus guided to its seat over the escape hatch. The hoist pays out the cable during ascent. The submarine has an escape chamber just inside the escape hatch which can be entered from inside the submarine and then sealed off from the interior of the submarine. An apparatus and escape method generally similar to that above is described in greater detail in the McGraw-Hill Encyclopedia of Science and Technology, copyright 1960.

Current methods of raising a downhaul cable from a submarine to the surface for use in guiding a rescue chamber to the seat around the escape hatch of the submarine utilize a metal buoyancy chamber of fixed displacement. Some buoyancy chambers are spherical while others are cylindrical and capped with hemispherical ends. The submarine is designed for stowing the full volume of the fixed displacement buoyancy chamber.

As submarine technology advances and the designed operating depth of submarines increases, the volume of the metal buoyancy chamber must be increased. Increased sea pressure demands increased structural strength in the metal buoyancy chamber and this leads to an increase in the weight/displacement ratio unless the displacement of the buoy is increased. Also increasing the maximum depth at which the metal buoy is expected to operate increases the length of the downhaul cable which the buoy must tow to the surface. The net result of these two factors is that the displacement and weight of a metal buoy must be increased substantially with increase in operating depth.

An object of this invention is to provide an improved method and apparatus for raising from the deck of a bottomed or disabled submarine to the surface of the

water the downhaul cable for a submarine rescue chamber.

A further object is to provide an improved method and apparatus for rescue from deep diving submarines.

Other objects and advantages will appear from the following description of an example of the invention, and the novel features will be particularly pointed out in the appended claims.

FIG. 1 illustrates partly in section and partly in side elevation an embodiment of this invention including only that part of a submarine that is functionally related to the invention,

FIG. 2 illustrates on a larger scale than in FIG. 1 a mechanical link that is part of the embodiment shown in FIG. 1,

FIG. 3 shows a notched clevis pin that is part of the link shown in FIG. 2,

FIG. 4 shows the embodiment of the invention in FIG. 1 when the buoy is inflated, and

FIG. 5 shows the buoy during ascent.

There are severe limitations to the use of fixed displacement rigid messenger buoy for raising downhaul cable. Because of practical size limitations a fixed displacement buoy cannot lift the heavy downhaul cable directly from deep diving submarines. The messenger buoy may be used for carrying a nylon heaving line for pulling up the heavier downhaul cable but experience with a nylon line has indicated that great care is required to prevent chafing, jamming, or otherwise breaking the line itself, and the transition between the light flexible nylon line and the heavy stiff downhaul cable is troublesome when leading the cable through a sharp bend. The risk of failure in service with a nylon heaving line is unacceptably great.

The messenger buoy may be used for carrying a more reliable but heavier heaving line, e.g., a wire rope heaving line for pulling. The lightest practical buoy contruction is a hollow steel sphere. The weight/buoyancy ratio of such sphere for full submergence pressure at a depth on the order of 1000 feet with reasonable factor of safety and with minimum attachments is about 0.25. The shell of the spherical buoy could be made lighter by filling with gas under pressure. This expedient is unreliable. The shell could be made lighter by filling the interior with a foamed plastic. The latter actually increases the weight/displacement ratio. Assuming that the heaving line must be no lighter than $\frac{5}{16}$ inch wire rope. A $\frac{5}{16}$ inch diameter 7 x 19 wire rope 1400 feet long weighs 79 pounds in sea water. A spherical buoy 25 inches diameter carrying this load would float on the surface half exposed and would displace about 316 pounds or 4.94 cubic feet. A rigid buoy of minimum size incorporating the considerations described above has three serious disadvantages. Firstly, it requires an intricate mechanism installed in the submarine to control the paying out of both the light heaving line and the heavy downhaul cable, which mechanism is too risky to use being subject to jamming and other failure. Secondly, a buoy on the order of size described above is too small to be located easily on the surface of the sea either visually or by radar and is too small to carry lights unless the lights are buoyant. Thirdly, a light heaving line sags with the tidal current and may become entangled on the submarine.

In the embodiment of the invention illustrated in FIG. 1, the wall 10 shown in section represents an upper portion of the pressure hull of a submarine. A conventional escape chamber or escape trunk 12 shown in outline extends through the pressure hull. The hatch between the interior of the submarine and the escape trunk is not shown. An escape hatch 14 is hinged to and seals the upper end of the escape trunk. The escape hatch in-

cludes a bail 16 on its upper surface. The upper end of the escape trunk terminates at approximately the level of the deck 18 of the submarine.

A short distance from the escape trunk 12, there is mounted on the exterior of the pressure hull a tub-shaped container 20 that extends between the pressure hull and the deck. A cover 22 is hinged to the container 20, spring-loaded, not shown, to open position and restrained in closed position by a hydraulically operable latch assembly 24. The cover 22 is flush with the deck, offering no resistance to flow. The latch assembly may be any that has a latch element spring-loaded to extended position and that is withdrawn against the urging of the spring by hydraulic pressure. A hydraulic line 26 extends from the latch assembly 24, through the pressure hull to a manually operable hydraulic pumping unit 28. The covered container 20 is free flooding.

An inflatable bag 30 is stored in deflated condition in the container 20. The bag occupies a volume of less than ten cubic feet when deflated and has an inflated volume on the order of several hundred cubic feet. A high pressure air hose 32 including a quick disconnect air fitting similar to those used on railroad equipment for air brake connections, extend from an air supply inside the hull to the air hose 32. The part of the disconnect fitting on the hose attached to the buoy contains a conventional check valve. The air supply is an air flask 36 having a manually operable valve 38 and a conduit 40 with a manually operable valve 42 leading to the high pressure air system of the submarine joined by a cross connection. The air flask is of sufficient size and contains air at pressure sufficiently higher than the pressure at the maximum operating depth of the submarine to inflate the bag. In an alternate arrangement, the flask 36 may be supported in the container 20.

A padeye 44 is welded to bottom of the tub-shaped container. A shackle 46 passes through and is carried by a grommet on the bottom of the inflatable bag adjacent to the air hose end joined to the bag. A notched clevis pin 50 extends through the shackle and the padeye and is designed to fail and release the buoy when it has gained a specified degree of buoyancy.

A conventional reel 52 is mounted between the pressure hull and the deck. Friction braking means, not shown, operates to restrain the reel against overrunning. A downhaul cable 54 is coiled on the reel 52 and secured at one end to the reel structure. The length of the downhaul cable exceeds the maximum operating depth of the submarine to a sufficient extent to allow for slope and curvature of the cable between the submarine and the surface.

In FIG. 4, the bag is shown in approximately fully inflated condition just prior to release. The bag has a relief check valve near its shackled end. The relief valve is operable to exhaust air from the bag at a very low pressure differential, e.g., less than five pounds. It is expected that relief valve operating at a pressure differential of less than one pound provides satisfactory results. The purpose of the valve is to prevent over-pressurization during inflation at depths less than the maximum designed for and during ascent as sea pressure decreases. A low pressure relief valve suitable for this purpose is the rubber "bronx cheer" type of check valve, e.g., one similar to that used on a Momsen lung. The bag itself is made of heavy multiply rubberized or plasticized fabric, similar to that used for inflatable life rafts, seaplane buoys etc. The upper part of the buoy, that is the part that will extend above the surface has an outer covering 60 of fabric containing metallic foil or thread for high radar reflectivity.

The downhaul cable is attached to the same grommet on the bottom of the buoy as the shackle. The downhaul cable leads up the side of the container 20, between the container and its cover, one of which is notched for this purpose, along the deck, through the hatch bail and down to the cable reel. A recovery lanyard is attached to an eye, not shown, in the end of the downhaul cable and to a ring in the top of the buoy to assist a rescue vessel in picking up the downhaul cable.

An inflatable buoy in accordance with this invention can function at any depth within the operating range of the submarine without modification. The buoy in deflated stowed condition may be termed miniature being well below any practical limit of size. On the other hand, it can exceed the displacement of the largest practical fixed displacement buoy many fold. An inflatable buoy at least several hundred cubic feet displacement can readily tow one end of a downhaul cable from a deep diving submarine to the surface without the added complication of a light heaving line and reel required by a fixed displacement rigid buoy. Furthermore, the part of inflatable buoy above the surface is sufficiently large to be easily located visually. Also, it can carry lights, not shown, and a radar target surface to facilitate locating the buoy at night or in thick weather. While an inflatable buoy may require somewhat more frequent inspections than a fixed displacement rigid metal buoy, the inflatable buoy can be interchangeable for all vessels in which they are installed, whereby inspection of the inflatable buoy can be readily accomplished ashore after the submarine has departed with a replacement buoy.

The sequence of operation is as follows. First, the hydraulic lid release pump is operated until the latch is withdrawn and the spring-loaded cover opens. Then the air supply valves are opened to begin inflation. As the buoy inflates it begins to rise out of the container and as its buoyancy increases, it will begin straining at the holddown shackle as shown in FIG. 4. The inflation air hose has sufficient slack in it to allow for movement of the buoy by water current during inflation. When the buoy is inflated to a predetermined state of buoyancy beyond that required to overcome the cable reel braking action, the notched clevis pin will fail allowing the buoy to rise out of the container. As it does so, the railroad type air fittings separate and the buoy begins pulling the downhaul cable through the hatch bail and off the cable reel, working against the reel brake as shown in FIG. 5. As the buoy rises and sea pressure on the buoy decreases, the relief valve releases air from the buoy. When the buoy surfaces, the reel brake prevents additional cable from paying out. When the surfaced end of the downhaul cable is secured to the winch of a rescue chamber and the winch is operated, the downhaul cable remaining on the reel is taken up by the winch before the rescue chamber is drawn down to the escape hatch. When the rescue chamber returns to the surface, the winch pays out the downhaul cable.

It will be understood that various changes in the details, materials and arrangements of parts (and steps), which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

We claim:

1. A messenger buoy for a submarine comprising:
   (*a*) a collapsible bag having a pressure relief valve operable to exhaust gas from the bag when the pressure within the bag exceeds the pressure outside the bag by a predetermined pressure differential,
   (*b*) and a compressed air hose including a quick disconnect coupling joined at one end in pneumatic communication with the interior of the bag,
   (*c*) the part of said fitting on that part of the hose secured to the bag having a check valve to prevent exhaust of air from the bag, and
   (*d*) a mechanical link for anchoring the bag and operable to rupture when the bag is inflated to a predetermined volume.
2. In combination with a submarine,
   (*a*) a collapsible bag having a pressure relief valve operable to exhaust gas from the bag when the

pressure within the bag exceeds the pressure outside the bag by a predetermined pressure differential,

(*b*) said submarine having a container outside its pressure hull and below its deck for nesting the bag in deflated condition,

(*c*) a source of compressed gas connected to said bag and having a valve manually operable inside the submarine,

(*d*) a compressed air hose including a quick disconnect coupling between the ends thereof secured at one end to the source of compressed air and at the other end to the collapsible bag for channeling gas from the bottle to the bag,

(*e*) a check valve in the portion of said coupling joined to the bag,

(*f*) a mechanical link joining the bag to the container operable to rupture when the bag is inflated to a predetermined volume,

(*g*) a braked reel of downhaul cable mounted on said submarine outside the pressure hull, the free end of the downhaul cable secured to said bag, for paying out from said reel when the bag is inflated sufficiently to part said mechanical link and buoy toward the surface of the water and to cease paying out when the inflated bag reaches the surface.

3. A submarine comprising:

(*a*) a tub-shaped container between the deck and pressure hull and having a cover hinged thereto, spring-loaded to open position, and serving as part of the deck surface when in closed position,

(*b*) said tub being free-flooding when the cover is in closed position,

(*c*) a hydraulically operable latch for restraining said cover in closed position,

(*d*) a hydraulic mechanism extending from within the pressure hull to the latch and manually operable for urging the latch out of cover restraining position,

(*e*) a source of compressed air having a valve manually operable inside the pressure hull,

(*f*) an inflatable bag occupying a volume less than order of ten cubic feet when deflated and occupying a volume of several hundred cubic feet when inflated,

(*g*) said bag having two openings,

(*h*) a pressure relief valve mounted in and extending across one of the openings and operable at a predetermined pressure differential of less than five pounds,

(*i*) a compressed air hose including a breakaway quick disconnect coupling between the ends thereof joined at one end to the compressed air source and joined at the other end to the bag across the other of the two openings,

(*j*) a check valve in the portion of the coupling attached to the hose section joined to the bag,

(*k*) a mechanical link securing the bag to the bottom of the tub-shaped container and operable to part under the tension exerted by the bag when inflated to a predetermined volume,

(*l*) and a downhaul cable secured at one end to the submarine and at the other end to the bag

(*m*) whereby when the bag is inflated, the mechanical link parts and the bag rises upward towing the cable, the relief valve releasing gas from the bag as it rises to limit the pressure differential across the wall of the bag.

References Cited in the file of this patent

UNITED STATES PATENTS

284,667	Powers	Sept. 11, 1883
1,296,983	London	Mar. 11, 1919
2,030,768	Schultz	Feb. 11, 1936
2,320,948	Marthey	June 1, 1943
2,903,718	Wright	Sept. 15, 1959

FOREIGN PATENTS

719,567	France	Nov. 23, 1931