April 23, 1968 E. A. LINK 3,379,021

INHABITABLE UNDERWATER STRUCTURE

Filed Sept. 28, 1964

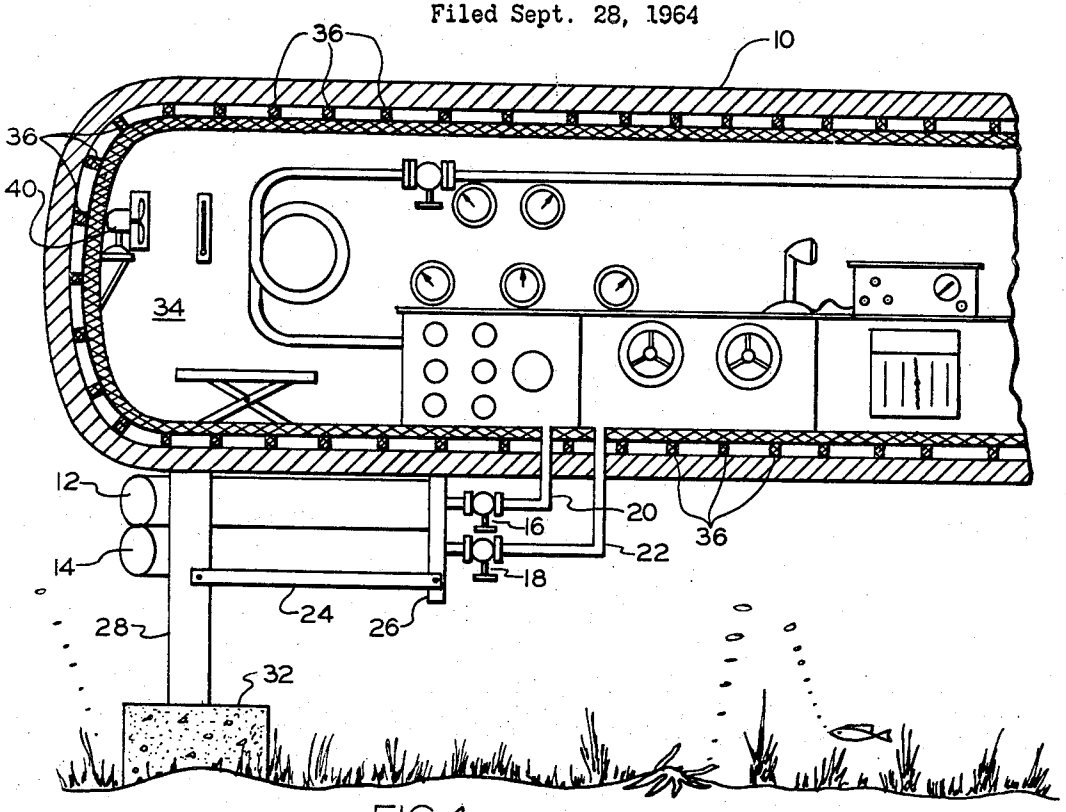


FIG. 1

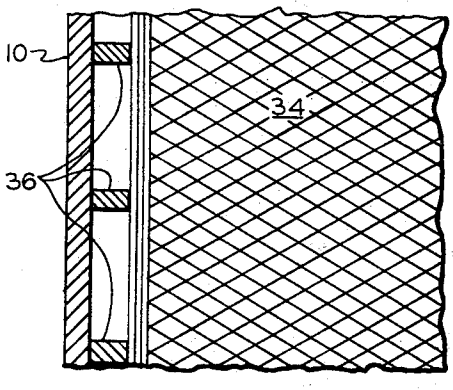


FIG. 2

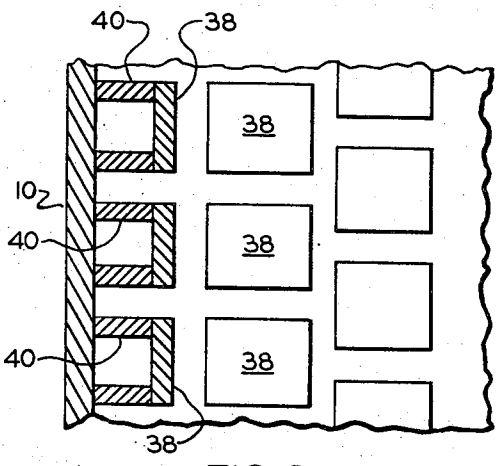


FIG. 3

*INVENTOR.*
EDWIN A. LINK
BY
ATTORNEY

United States Patent Office 3,379,021
Patented Apr. 23, 1968



3,379,021

# INHABITABLE UNDERWATER STRUCTURE

Edwin A. Link, Binghamton, N.Y., assignor, by mesne assignments, to Ocean Systems, Inc., New York, N.Y., a corporation of New York

Filed Sept. 28, 1964, Ser. No. 399,546
6 Claims. (Cl. 61—69)

This invention relates to an inhabitable underwater structure, and more particularly to an improved ventilating system for an inhabitable underwater structure.

In my copending application Ser. No. 335,251, filed Jan. 2, 1964, now Patent No. 3,299,645, there are disclosed several embodiments of inhabitable underwater structures which enable one or more divers to remain submerged at depths of 400 feet or more for extended time periods in order that substantial amounts of work may be performed, without the necessity of periodically returning to the surface of the sea. A first embodiment, as therein disclosed, comprises a welded aluminum cylinder constructed to withstand the surrounding water pressure, and is provided with the necessary various life-sustaining equipments to enable the devices to remain submerged for extended time periods. Further this cylinder also is operable as an "elevator" to transport the divers between the sea bottom and the surface as more completely described in the above referenced copending application. Another embodiment described in my referenced copending application is a relatively large inflatable structure which not only includes the various necessary life-sustaining equipment, but also a number of sleeping quarters to allow the divers to remain submerged for a period of days. Additionally, since the interior of each of these embodiments is maintained at a pressure slightly greater than that exerted by the surrounding water, an opening in the lower surface thereof is provided to allow a diver to freely enter into, and leave from the interior of the structure, without the need of passing through water-tight doors, or locks, and the like.

While these structures have enabled persons to remain submerged at great depths for extended periods of time, it has been found that the low temperature of the surrounding water at depths of 400 feet or more, about 34° F. which is relatively independent of the surface temperature of the water, causes the interior surfaces of the structures to be maintained at or about this low temperature. This results in that the moisture in the pressurized oxygen-helium breathing mixture filling the interior volume of the structure, tends to condense on the interior surfaces thereof, so that the walls continuously "sweat," and the condensation runs down these surfaces and collects on the bottom or floor. If personnel within the structures accidently touch the cold "sweating" surfaces as they move about, their clothing, of course, also becomes wet. It is highly desirable, and often necessary, that the clothing remain dry, since the divers are breathing a mixture of gases with a high concentration of helium therein, and the helium becomes absorbed in the blood stream. As is well known, helium has a high heat conductivity, resulting in that the diver sustains a relatively high rate of loss of body heat with dry clothing, a temperature of about 84° F. being equivalent to a surface temperature of 68° F., and this heat loss becomes excessive when the body clothing is wet.

At first glance, it might be assumed that the above problem could readily be overcome by completely insulating the interior surfaces of the inhabitable underwater structure, so that the moisture-laden breathing mixture would not contact the cold interior surfaces, thereby preventing condensation. Such a straight forward approach, however, while preventing "sweating" creates a different, and perhaps worse, problem. If the breathing



mixture is prevented from contacting the cold surfaces, and the moisture is not condensed out of the breathing mixture, the moisture provided by a person's breathing for a rather short period of time, normally results in a dense fog being created, making it either difficult or impossible for the person to see. Furthermore, the moisture in such a case will sometimes undesirably tend to condense on pieces of electronic gear and the like, which may seriously interfere with their normal operation.

Another possible attack on the problem is to install dehumidifying equipment within the structure. The provision of such equipment, however, suffers from the disadvantage that it occupies a large portion of the available limited space, and because it requires a power source for its operation, and this power must be supplied either from a surface craft or from another submerged underwater structure.

According to the present invention, however, there is provided a simple yet highly reliable device which, while allowing the moisture to condense upon the inner surfaces of the structure, presents a dry, relatively warm surface to the personnel within the structure, and further requires no external power source. In this manner a dry fog-free environment is attained. Briefly, in a first embodiment of the invention, an inner lining is provided throughout the interior of the entire structure, and this lining is permeable by the breathing mixture, thereby allowing the moisture to condense on the cold inner surfaces of the structure. Another embodiment of the invention employs a number of spaced-apart plates which allows the breathing mixture to circulate between the planes defined by the inner surface of the structure and the plates. Additionally, a fan can be added to increase the circulation of the breathing mixture, all as more particularly hereinafter described.

It is an object of the invention, therefore, to provide an inhabitable underwater structure.

Another object of the invention is to provide an improved ventilating system for an inhabitable underwater structure.

Still another object of the invention is to provide an inhabitable underwater structure which is not only free of "sweating" interior surfaces in order that the occupants may remain dry, but also in which the normal moisture in the pressurized breathing mixture is automatically condensed, so that the continued breathing by an occupant does not result in the creation of a fog.

Yet another object of the invention is to provide an inhabitable underwater structure in which the natural low temperature of the surrounding water is utilized as a cold sink to condense moisture from the pressurized breathing mixture within the structure, and in which little or no power need be supplied to the structure in order to provide a fog-free environment.

These and other objects of the invention will in part be obvious, and in part more particularly hereinafter described.

The invention accordingly comprises the features of construction, combinations of elements, and arrangements of parts, which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a cross-sectional view of one embodiment of the inhabitable underwater structure according to the invention.

FIG. 2 illustrates a preferred embodiment of a permeable lining for use in the inhabitable underwater structure shown in FIG. 1.

FIG. 3 illustrates another preferred embodiment of a permeable lining for use in the inhabitable underwater structure shown in FIG. 1.

Referring now to the drawings, FIG. 1 illustrates a cross-sectional view of one embodiment of the inhabitable underwater structure of the invention. As there shown, an inflatable underwater structure **10** is provided for one or more divers to supply the necessary undersea living quarters. Secured to structure **10** are a plurality of pressurized tanks of breathing mixture **12** and **14**. It should be understood that although only a pair of tanks are illustrated in FIG. 1, in most installations a far greater number of such tanks are normally employed, depending on the number of divers being supported by structure **10**, as well as the expected duration of the particular undersea operation. The mixture of gases from tanks **12** and **14**, or individual gases such as oxygen from tank **12** and helium from tank **14**, by way of example, is supplied to the interior of structure **10**, through individual regulating valves **16** and **18** and along a pair of conduits **20** and **22**, respectively. Each of the tanks is secured by mounting brackets **24** and **26**, supported by an anchor leg **28**. Alternatively, of course, structure **10** could be directly supplied with the required breathing mixture from a surface craft. As should now be apparent, structure **10** can have any desired dimensions sufficient to provide life support and housing conditions for a predetermined number of divers. Further, as shown in FIG. 1, structure **10** is secured to the sea bottom **30** by a number of anchors **32**, only one of which is illustrated in FIG. 1, although other and different devices may be so employed if desired.

During the extended period through which the diver or divers remain at the selected depth, which may be about 400 feet, structure **10** is employed as the living quarters, and, as will be understood, the inflatable underwater house contains the necessary life support and communication systems including breathing support systems, diving suits such as those described in my copending application Ser. No. 350,836, filed Mar. 10, 1964, living comfort equipment such as sleeping bags and cots, electric blankets, water, food, and waste containers, closed circuit TV systems, and the necessary bio-medical instrumentation, all of which is pictorially illustrated in FIG. 1. It should be noted that the uninflated structure **10**, when released from the surface craft, rapidly descends to the sea bottom through the action of anchor weights **32**, yet when inflated by one or more divers, thereafter provides comfortable quarters for the divers living therein. Additionally, since structure **10** is generally inflated to a pressure greater than that of the surrounding sea water, an opening (not shown) provides an exit and entranceway for the divers, without any danger of water entering into and flooding the internal volume of the structure. Further details of inhabitable underwater structure **10**, as well as various other such structures, is to be found in the above-referenced copending application Ser. No. 335,251.

A central concept of the present invention, however, contemplates the provision within the structure of an inner skin or lining **34** permeable by the breathing mixture, which is effective to permit the breathing mixture to permeate the lining and thereafter contact the relatively cold walls of structure **10**. This results in that moisture in the breathing mixture condenses on the walls, but a dry, relatively warm inner surface is presented to the occupants of the structure. The inner skin or lining may take a variety of forms, it being important only that the lining allow the breathing mixture to pass through, and contact, the colder walls of structure **10**, and, further, it is preferred that the lining be formed of a material having low heat conductivity. In some embodiments of the present invention, the inner skin or lining may comprise a soft, flexible cloth of the open mesh type, preferably woven or otherwise formed into several layers from an inorganic material which will not otherwise deteriorate when subjected to high humidity conditions. In other embodiments of the present invention, the lining may comprise plates or walls spaced inwardly from the relatively cold walls of structure **10**, which allows the breathing mixture to freely circulate between the lining and the walls. Additionally, if desired, a fan or equivalent device may be provided to increase the circulation of the breathing mixture to further insure that a fog-free environment is maintained.

Referring again now to FIG. 1, woven lining **34** is shown supported by a number of separators **36**, although other and different support methods may be substituted as desired. Also, for reasons of clarity, an enlarged section of lining **34** and separators **36** is illustrated in FIG. 2. Further, it should be noted that lining **34** includes a floor section also spaced from the lower portion of the inside chamber provided by structure **10**, wherein the floor section is additionally spaced apart from the side walls to allow moisture condensing on the walls to run underneath the floor section. In this manner, the "sweating" of the walls does not interfere with the normally dry upper surface provided by the floor section.

FIG. 3 illustrates another embodiment of the lining provided by the invention. As there shown, a number of plates or wall panels **38** are spaced inwardly from the walls of structure **10**, by a group of supporters **40**, and these panels define a number of parallel channels through which the breathing mixture may freely circulate, the moisture therein again condensing on the walls cooled by the surrounding sea water. It should also be understood that this embodiment of the invention is likewise provided with a floor section spaced apart from the side walls to allow the moisture which condenses on the walls to run underneath the floor section as above described, in order that the "sweating" of the walls does not interfere with the normally dry upper surface provided by the floor section.

What has been described is an improved inhabitable underwater structure which employs a simple yet highly reliable device which, while allowing the moisture contained in a pressurized breathing mixture to condense on the inner surfaces, or walls, of the structure, additionally presents a dry, relatively warm surface to the personnel within the structure. In a first embodiment of the invention, the device comprises a lining or inner skin of soft, flexible cloth of the open mesh type which is permeable to the breathing mixture, and, in a second embodiment of the invention, the device comprises a lining of a number of spaced-apart plates or wall panels which allows the breathing mixture to circulate between the planes defined by the inner surfaces of the structure and the plates.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained, and since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

**1.** An inhabitable underwater structure comprising,

a pressurized vessel having walls defining an inside chamber, said inside chamber being adapted to accommodate an occupant and the outside of said walls being adapted to contact the sea water when the vessel is submerged in order that said walls assume the approximate temperature of the surrounding sea water;

means for supplying a breathing mixture to said chamber; and

an inner lining of low heat conductive material inside said chamber and positioned adjacent said walls of said vessel and substantially coextensive with said

walls and being effective to isolate said occupant from the walls of said chamber and fluid circulation space means being provided intermediate said lining and said walls and being interconnected with the chamber by passages extending transversely through the lining to permit said breathing mixture to circulate from the chamber and contact said walls of said chamber.

2. A structure according to claim 1 wherein said inner lining comprises a multi-layer open-mesh fabric.

3. A structure according to claim 1 in which said inner lining comprises plate means attached to said walls and spaced inwardly therefrom to provide a passageway between said plate means and said walls through which said breathing mixture may circulate.

4. A structure according to claim 3 having means for forcing said mixture through said passageway.

5. A structure according to claim 1 further including a floor spaced from the lower portion of said inside chamber, said floor having openings adjacent said walls to allow moisture condensing on said walls to run underneath said floor.



6. A structure as claimed in claim 1 wherein said inner lining is formed of a flexible cloth of the open mesh type which is permeable to the breathing mixture and which is positioned in spaced coextensive relationship with the walls of said structure, whereby the moisture within the breathing gas supplied to said structure will condense only upon the walls of said structure, and not upon said permeable inner lining.

**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 6,250 | 4/1849 | Richards et al. | 61—69 |
| 638,335 | 12/1899 | Holland | 61—69 |
| 773,146 | 10/1904 | Huguet et al. | 61—69 |
| 1,165,535 | 12/1915 | Nelson | 114—16 |
| 2,685,858 | 8/1954 | Harrison | 114—16 |
| 3,090,345 | 5/1963 | Hulbert | 115—6.1 |

EARL J. WITMER, *Primary Examiner.*