United States Patent

Clark

[15] **3,706,206**

[45] **Dec. 19, 1972**

[54] **LIGHTWEIGHT READILY PORTABLE UNDERWATER HABITATION AND METHOD OF ASSEMBLY AND EMPLACEMENT**

[72] Inventor: **James F. Clark,** 132 South Shore Drive, Toms River, N.J. 08753

[22] Filed: **Jan. 27, 1971**

[21] Appl. No.: **110,195**

[52] **U.S. Cl.** ..... **61/69 R,** 52/2

[51] **Int. Cl.** **B63c 11/00**

[58] **Field of Search** ..... 61/46.5, 69 R, 69 A, 72.3; 135/1; 52/2

[56] **References Cited**

UNITED STATES PATENTS

3,475,915	11/1969	Caplan	61/69 R
3,386,254	6/1968	Connally	61/69 R
3,113,699	12/1963	Crawford et al.	61/69 R
3,540,170	11/1970	Flowers	52/2
2,479,217	8/1949	Diamond	61/69 R
3,548,605	12/1970	Paull et al.	61/69 R
3,496,730	2/1970	Tsuji	61/69 R

Primary Examiner—J. Karl Bell
Attorney—Marvin Reich

[57] **ABSTRACT**

A lightweight readily portable underwater habitation features a rigid base frame for anchorage to natural ballast and a largely transparent flexible thin-walled inflatable body portion forming the main enclosure of the habitation. The inflatable body portion is two layered, including a transparent film and an overlay of reinforcing mesh which relieves stresses on the film and imparts the requisite strength to the flexible body portion. The habitation may embody a basic module or plural interconnected modules.

14 Claims, 8 Drawing Figures

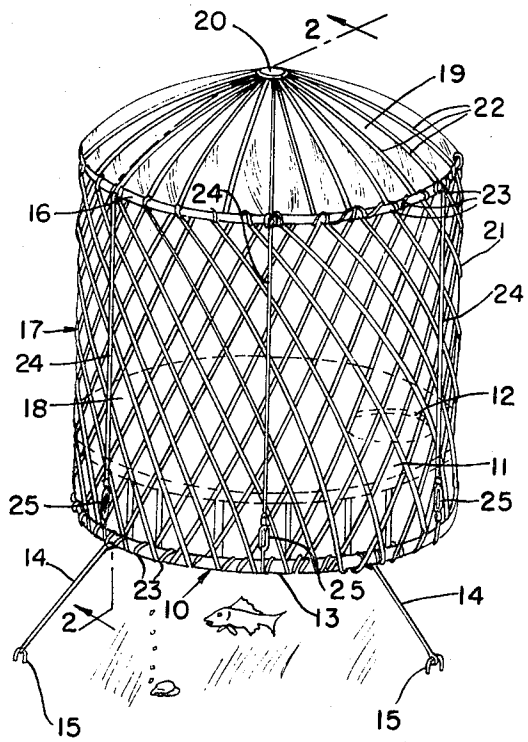


FIG. 1.

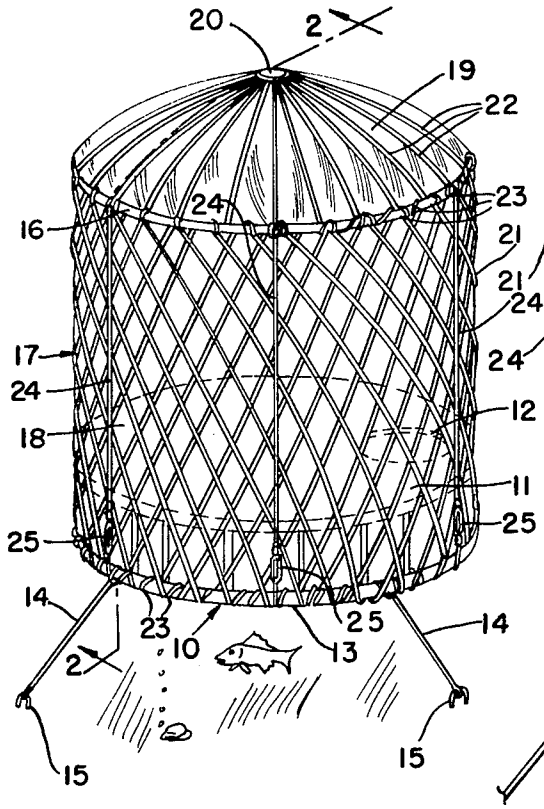


FIG. 2.

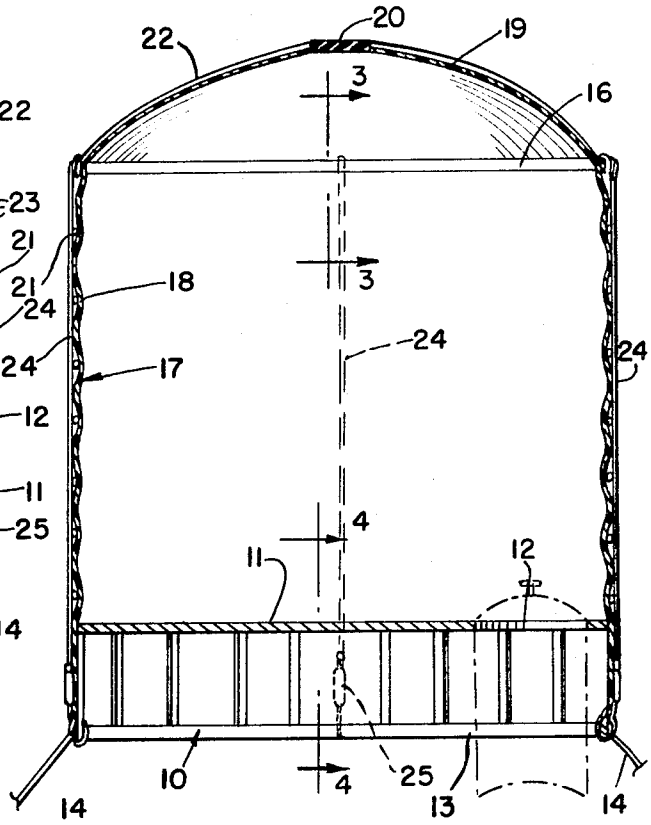
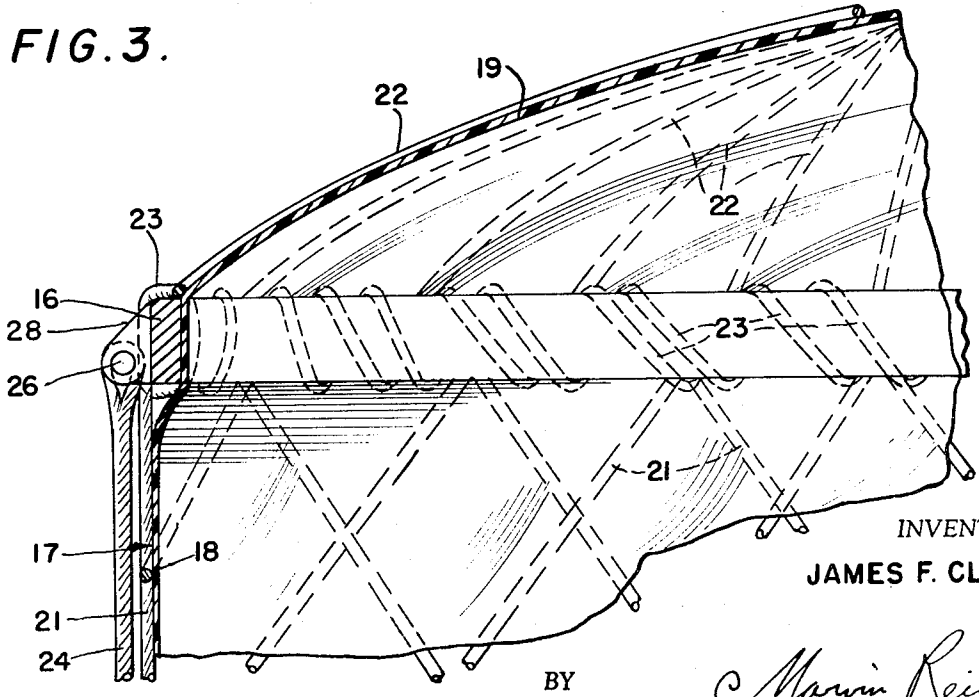


FIG. 3.



INVENTOR
JAMES F. CLARK

BY

Marvin Reich
ATTORNEY

FIG. 4.

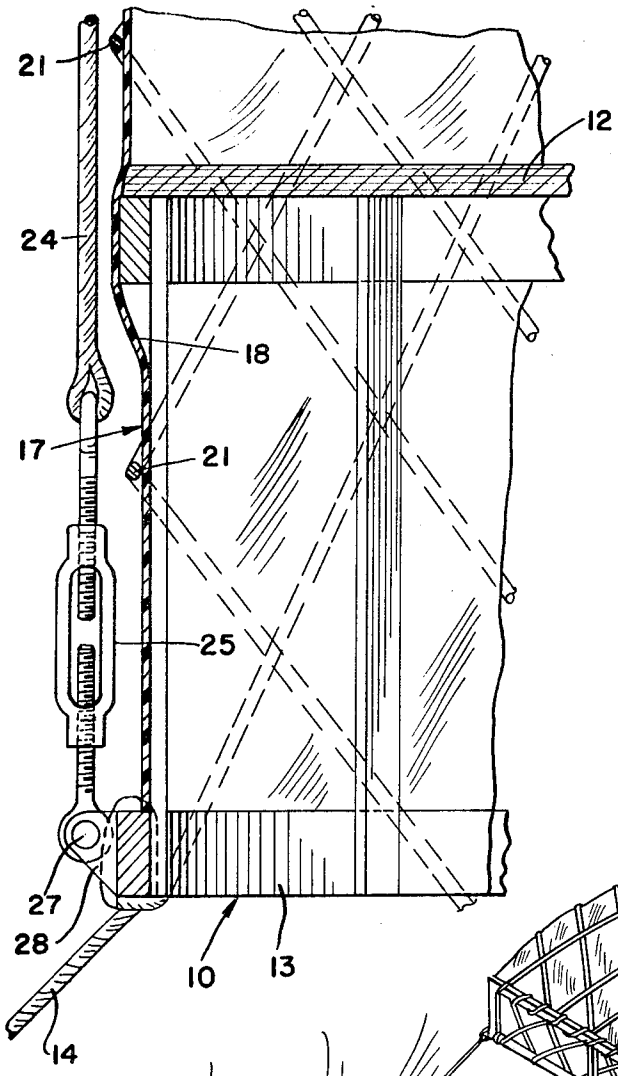


FIG. 5.

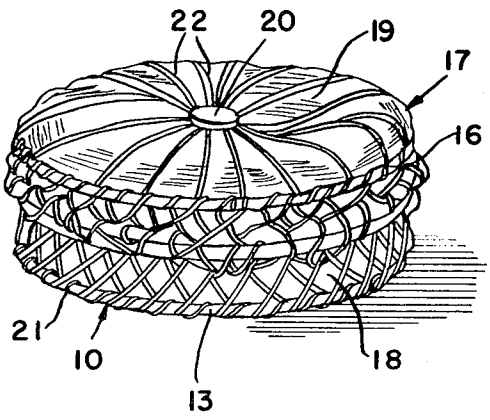
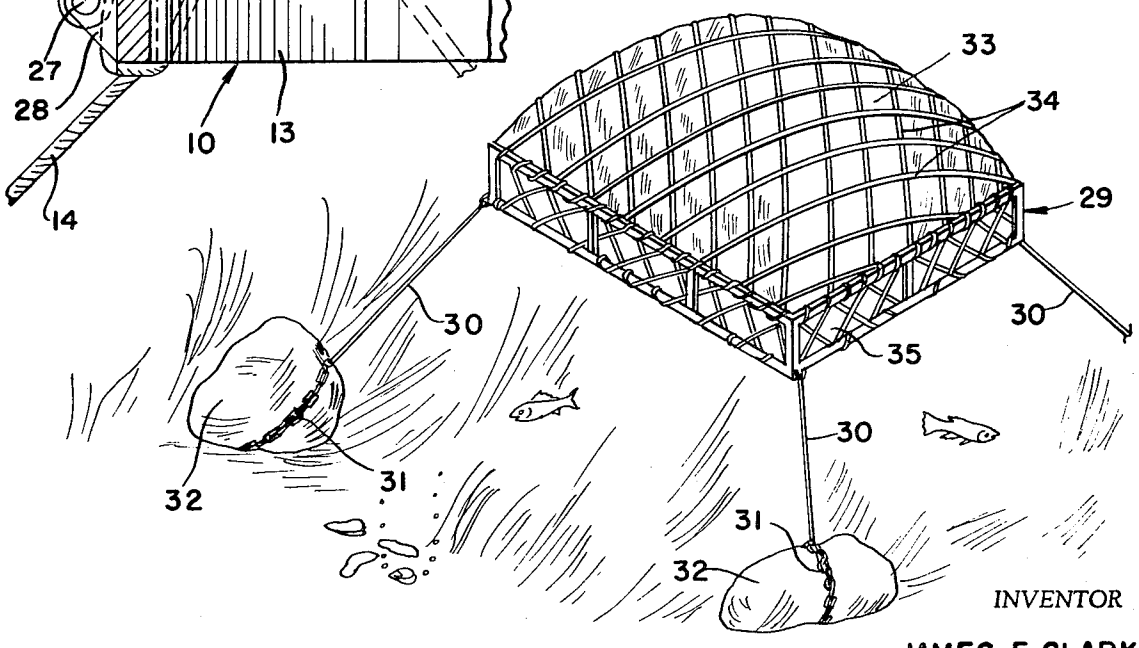


FIG. 6.



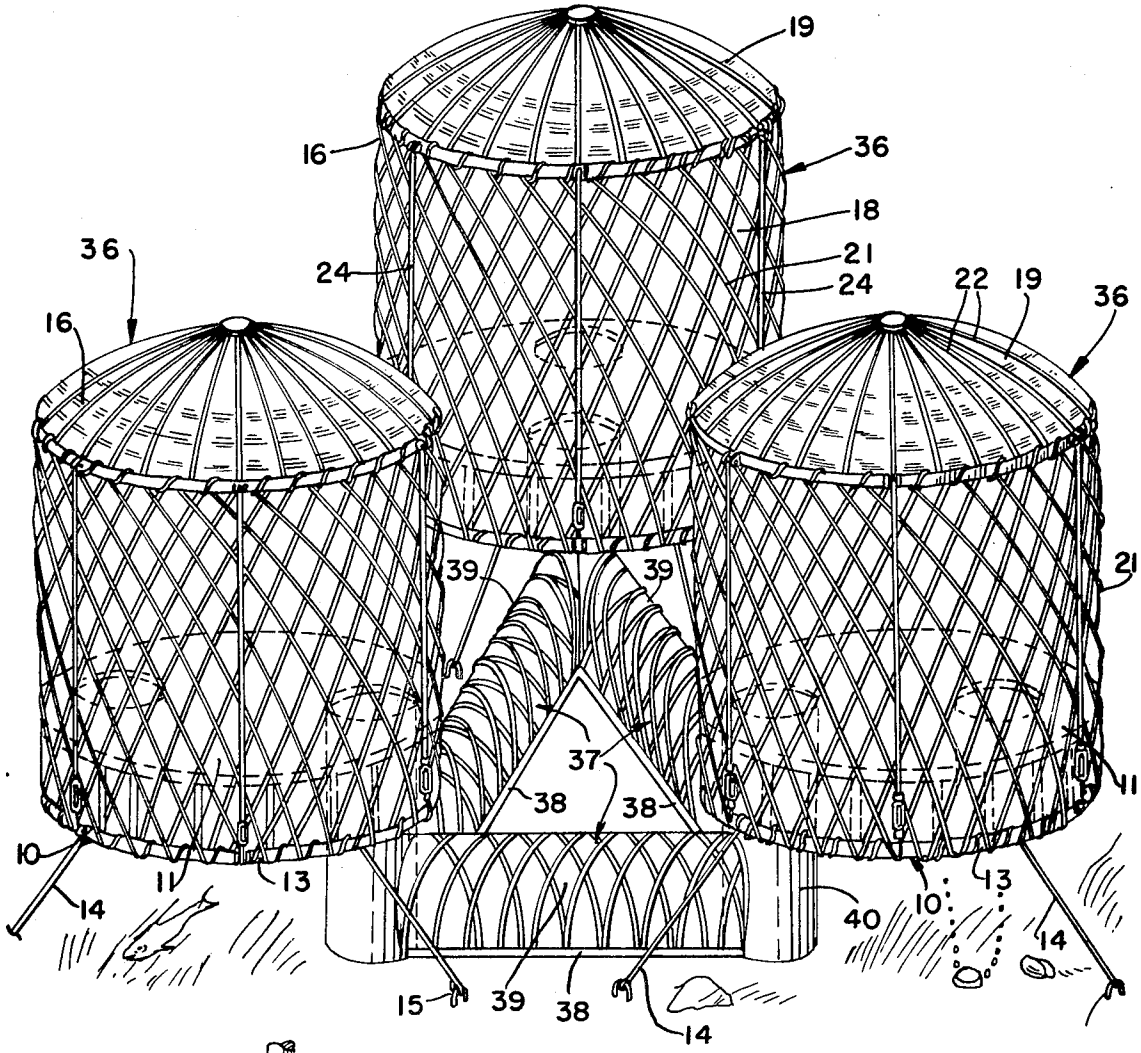
INVENTOR

JAMES F. CLARK

BY

ATTORNEY

FIG. 7.



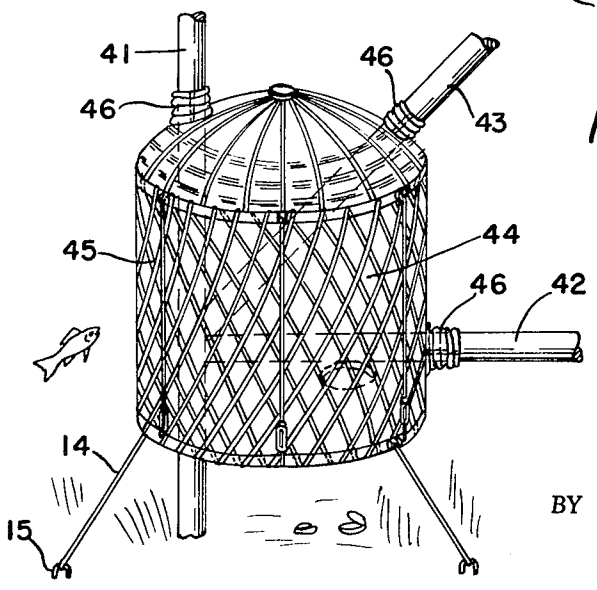


FIG. 8.

INVENTOR
JAMES F. CLARK

BY

ATTORNEY

LIGHTWEIGHT READILY PORTABLE UNDERWATER HABITATION AND METHOD OF ASSEMBLY AND EMPLACEMENT

BACKGROUND OF THE INVENTION

Existing undersea habitations in general have been excessively costly and very difficult to transport and to emplace on the floor of the sea. This is largely due to the great weight of the structures and particularly to the tremendous weight of ballast which is necessary to counteract the buoyancy of the gas-filled chamber in which men live and work underwater. Existing habitations have generally permitted only a very limited view of the submarine environment through porthole-like windows.

In light of the above prior art deficiencies of underwater habitations, the main objectives of this invention are to provide a habitation which is lightweight and readily collapsible to a compact form for ease of transportation, economical in construction and in the materials employed for construction, largely transparent so as to provide an almost unrestricted view of the surrounding environment, and capable of being anchored by lightweight anchoring devices which are securable underwater to natural ballast which does not have to be lifted or transported; said natural ballast being weight present in the environment which does not have to be lifted nor transported to moor the habitation. The provision of a nearly totally transparent living enclosure largely overcomes the claustrophobia problem in addition to permitting visual contact with the environment in all directions.

Other objects, features and advantages of the invention will be apparent during the course of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

FIG. 1 is a perspective view of a basic module or unit of an underwater habitation embodying the invention with the same inflated for use and anchored to the sea bed or the like.

FIG. 2 is a central vertical section through the habitation taken on line 2—2 of FIG. 1.

FIG. 3 is an enlarged fragmentary vertical section taken on line 3—3 of FIG. 2.

FIG. 4 is a similar section taken on line 4—4 of FIG. 2.

FIG. 5 is a perspective view showing the module deflated and collapsed.

FIG. 6 is a perspective view of a modification.

FIG. 7 is a perspective view of a habitation consisting of plural modules and interconnecting crawlways.

FIG. 8 is a perspective view of a modified habitation particularly for underwater welding or other repair operations.

DETAILED DESCRIPTION

Referring to the drawings in detail, wherein like numerals designate like parts, reference being had first to FIGS. 1 through 5, wherein the numeral 10 designates a relatively low elevation, preferably circular, rigid base frame formed of steel or the like adapted to support a floor element 11 having an entrance port 12 comprising an entrance well and hatch. Preferably, although

not necessarily, the base frame 10 is formed in sections which can be separated for ease of shipment and storage and emplacement in confined underwater places. The details of construction of the base frame are omitted for simplicity and because these may be conventional.

The base frame 10 includes a lower ring member 13 to which mooring cables 14 are secured at circumferentially spaced intervals and the number and spacing of these cables may be varied to suit the needs of a particular installation. The mooring cables 14 may be anchored to the sea bed by suitable embedment anchors 15 or may be secured to natural ballast, as depicted in FIG. 6, showing a modification of the invention. The natural ballast anchoring will be further discussed. In any case, an important feature of the invention is that the need for extremely heavy and cumbersome artificial ballast or built-in weight commonly employed to anchor conventional undersea habitations is dispensed with.

The basic habitation unit or module illustrated in FIGS. 1 through 5 further comprises an upper shaping ring 16 of approximately the same diameter as the base frame 10 and formed separately therefrom and also made of steel or the like. As will be seen, the ring 16 imparts a desirable shape to the flexible enclosure body portion of the habitat, to be described, and also forms the top anchorage for certain tensioning cables, yet to be described.

The mentioned flexible enclosure body portion of the module is designated generally by the numeral 17 and embodies a two layer, flexible wall structure including an interior wall 18 formed of a suitable thin, flexible, optionally transparent plastic which is resistant to tearing and generally sufficiently tough to be entirely practical for the intended use. Such plastic materials are readily available on the open market. The interior wall or layer 18, when expanded, as shown in FIGS. 1 and 2, is substantially cylindrical and upright and a domed roof extension 19 of the same material preferably integral with the cylindrical side wall portion is provided. At the top of the roof portion 19, a conventional purge valve 20 is provided on the structure permitting all air to be emptied therefrom at the proper times. A floor liner of plastic material may be optionally sealed to the wall 18, both the floor and the plastic floor liner may be transparent.

The wall structure 17 further includes an outer layer or covering 21 of sturdy open mesh reinforcing material, such as nylon or the like, including a multiplicity of side wall covering crossing strands and upwardly converging roof covering strands 22. This outer mesh layer or covering encloses and confines the entire interior transparent wall or layer 18 and materially reinforces it and greatly relives the interior layer of stresses and assures that the forces on the layer 18 are widely distributed over its surface area and that the forces are mainly normal to the layer 18. The mesh covering 21, therefore imparts to the flexible enclosure body portion the necessary strength while allowing the body portion to be extremely lightweight and substantially transparent. The wide open mesh covering does not materially obstruct the view from within the enclosure in any direction.

When erecting the habitation module, as will be discussed step-by-step, the plastic inner layer **18** which may be entirely open at the bottom is placed over the margin of the base frame **10** and the outer mesh layer or covering is also applied. As best shown in FIGS. **3** and **4**, the individual side wall and roof strands of the mesh layer **21** are suitably lashed to the rings **13** and **16** as indicated by the numeral **23**. The method of lashing or tying the mesh covering to the rings may be varied in some cases and the invention is not limited in this detail.

To add further security to the flexible enclosure body, a series of vertical cables **24** at regularly spaced intervals around the circumference of the module is provided, and each cable preferably has a turnbuckle **25** connected therein by means of which the tension of the individual cables can be adjusted to control the tension in the flexible wall of the enclosure formed by the layers **18** and **21** and to further adjust the shape of the enclosure. As shown in FIGS. **3** and **4**, the top and bottom ends of the cable **24** are securely connected as at **26** and **27** to the rigid rings **16** and **13** through lug projections **28** or the like on the rings. The habitation may be conveniently assemblied ashore, on board ship or under water. In certain restrictive underwater areas, such as the interior of a sunken ship, it may be necessary to assemble the habitat under water.

In order to emplace the basic module, FIGS. **1–5**, at the desired underwater location, the following procedure is carried out. The sectional base frame **10** is assembled and moored or anchored to the bottom with embedment anchors, as in FIG. **1**, or by securing to natural ballast, such as large boulders, coral reefs, sunken ships equipment, or structures, or the like. The two layer flexible enclosure body is then placed over the base frame and floor **11** and these elements are firmly attached to the rings **13** and **16**, as described. The interior of the structure is then inflated with air and the module will float in spaced relation to the sea bottom as limited by the appropriate lengths of the mooring cables **14** necessary to maintain the habitation in the desired orientation. The heavy tension on these mooring cables is imparted to the rigid base frame **10** and not to the lightweight flexible body portion or enclosure.

When the module is deflated, it will collapse into a flat formation, as shown in FIG. **5**, for ready portability. If desired, the sectional base frame and the shaping ring **16** can be further dismantled and it should be mentioned that the floor **11** can be constructed in folding, hinged sections. These are refinements which are optional and not entirely necessary to successful use of the invention.

Access to and egress from the interior of the habitation module is by way of the floor port **12**, the frame **10** being elevated sufficiently from the bottom on the mooring cables to render the entering and exiting operations easy.

It may now be seen that the basic structure provides a very lightweight and readily portable underwater habitation which may be almost completely transparent and which has an inflatable and collapsible reinforced flexible body portion including means to relieve the thin transparent layer of heavy stresses.

FIG. **6** shows a modification of the invention embodying a small size habitation consisting of a rigid base frame **29** which may be rectangular, and corner mooring cables **30** lashed by chains **31** to underwater natural ballast, such as boulders **32**. In some cases, the cables **30** may be secured to coral formations or other forms of natural ballast.

The habitation unit in FIG. **6** also includes the interior plastic enclosure layer **33**, which may be transparent or opaque, and the outer open mesh reinforcing layer **34** generally as described in the previous embodiment and for the same purpose. If the layer **33** is opaque, then the unit shown in FIG. **6** will have an observation post or chamber **35** preferably in one corner of the frame **29** providing a view of the surrounding environment.

FIG. **7** shows an underwater habitation in the form of a system of interconnected modules **36** where each individual module is constructed as described in the basic embodiment in FIGS. **1–5**. In FIG. **7**, the bottoms of the three moored units are interconnected by crawlways **37**, as shown. Each crawlway has a rigid base **38**, or platform, and has a two layer flexible wall structure **39** constructed generally in accordance with the teachings of the previous embodiments, namely including an interior thin plastic layer and an outer covering of reinforcing mesh. Access to one module **36** from the outside is through an entrance trunk or cylinder **40** and from this truck an entranceway to the crawlways or tunnels is provided and hence to the other habitation units or modules. The modular system possesses the same attributes of lightness, portability, ease of emplacement and full visibility, as described in the basic unit, FIGS. **1–5**. The modular system can be expanded indefinitely to meet any practical need for more working or living space.

FIG. **8** illustrates a specialized underwater unit to facilitate underwater construction, repair and other activities involving intruding or contiguous surface and requiring a dry or gas environment, for example, for welding at the interstices of risers **41** and lateral members **42** and **43** of a Texas tower. The advantages here of a self-adjusting flexible walled enclosure are very clear. A conventional hard shell welding habitation would have to be made at great cost for each single welding operation. The cost of fabrication of the flexible wall module in FIG. **8** is minimal. The plastic enclosure layer **44**, not necessarily transparent, but reinforced with the outer mesh covering **45**, as described, is emplaced at the required site and sealed around each member **41**, **42** and **43** of the tower by an airtight flexible boot **46**, preferably having an airtight zipper closure or the like. The form or shape of the enclosure body for welding does not have to be precise as in the case of a module used for living quarters or general working underwater where good visibility is required. The advantages of the construction for this and similar underwater welding tasks should be obvious to anyone skilled in the art. It is noted that the inner flexible wall self adjusts within the reinforcing layer to minimize strains and that the habitation may in some cases be moored to the work site.

The module is inflated underwater in one of two ways. A compressor on the surface of the water can deliver compressed gas through a hose to the interior of

the module through the port 12 to force all water from the same. Alternatively, a tank or bottle of compressed gas may be submerged and the contents delivered directly into the module to expel water therefrom.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred examples of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of the invention or scope of the subjoined claims.

I claim:

1. An underwater habitation unit comprising a substantially rigid base including flooring adapted to be moored to the bottom of a body of water, a flexible thin-walled inflatable enclosure body secured to the base and enclosing the top of the base and extending above the base when inflated to provide a substantially dry enclosure space above said base and flooring, and an exterior shaping, reinforcing and stress-relieving flexible mesh covering having viewing spaces formed by the flexible mesh for the enclosure body secured to the base and collapsible with the enclosure body onto the base when deflated.

2. The structure of claim 1, and a shaping ring separate from the base and attached to the enclosure body and flexible mesh covering near the top of the enclosure body to impart a desired shape to the enclosure body.

3. The structure of claim 2, and individually adjustable tension cables interconnecting said shaping ring and base.

4. The structure of claim 1, and said base comprising a substantially rigid frame having a bottom ring member and a top floor support member, flooring mounted on said top floor support member and including an entrance and exit port, and cable means to moor said frame to the bottom of the body of water.

5. The structure of claim 4, and said cable means including means attachable to natural underwater ballast.

6. The structure of claim 4, and said cable means including anchor elements adapted to penetrate the bottom surface beneath a body of water.

7. The structure of claim 1, and said enclosure body and reinforcing covering including side wall and roof portions which are substantially transparent to provide a clear view of the underwater environment in all directions above the base and floor means.

8. The structure of claim 7, and a substantially rigid shaping ring separate from the rigid base and secured to the flexible enclosure body substantially at the juncture of the side wall and roof portions to impart to the side wall portion a substantially cylindrical shape.

9. The structure of claim 1, and adjustable tensioning and shaping means for the enclosure body secured to the base.

10. An underwater habitation comprising a plurality of underwater habitation modules each having a rigid base including a floor with an access port and means for anchoring the rigid base underwater, a flexible inflatable at least partially transparent enclosure body on each module and extending above the base of the module when inflated to form a dry living area, the dry living area including the top of the base, and interconnecting passage means for the individual modules including an access opening, whereby passage is permitted between all the interconnected modules.

11. The structure of claim 10, and said interconnecting passage means comprising tunnels having connections with the bases of said modules and including flexible inflatable walls.

12. An underwater welding or construction unit comprising a substantially rigid base, means to anchor said base underwater at a desired location, and an inflatable flexible enclosure body on the base and forming a dry enclosure space above the base when inflated, and including the top of the base, the base having an access opening, the enclosure body having spaced openings to receive members to be welded or repaired within the dry enclosure space, seals for said members attached to the enclosure body adjacent the openings thereof, and an exterior shaping, reinforcing and stress-relieving flexible mesh covering having viewing spaces formed by the flexible mesh for the enclosure body secured to the base.

13. The structure of claim 12, and said seals comprising flexible sleeve members on the enclosure body and having fluid-tight closures enabling the sleeve members to snugly receive the members to be welded or repaired.

14. An underwater habitation comprising a plurality of underwater habitation modules, each module having an access port and interconnecting passage means comprising tunnels having connections with the access ports of said habitation modules, said tunnels having flexible inflatable transparent walls, said transparent walls having an exterior shaping reinforcing and stress-relieving flexible mesh covering having viewing spaces formed by the flexible mesh for the tunnel whereby passage is permitted between all the interconnected modules.

* * * * *