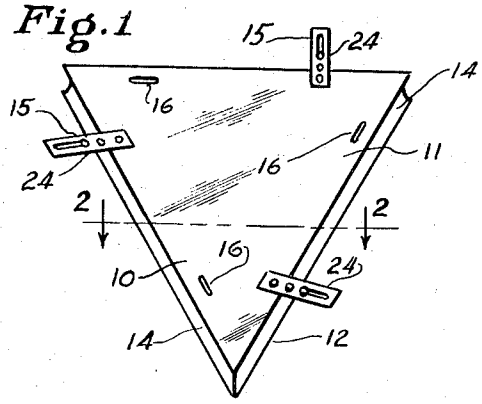
Sept. 26, 1967 W. GORDON 3,343,324

UNDERWATER STRUCTURAL UNIT

Filed March 24, 1964

Fig. 1



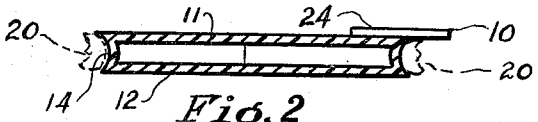


Fig. 2

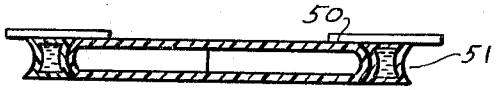


Fig. 5

Fig. 3

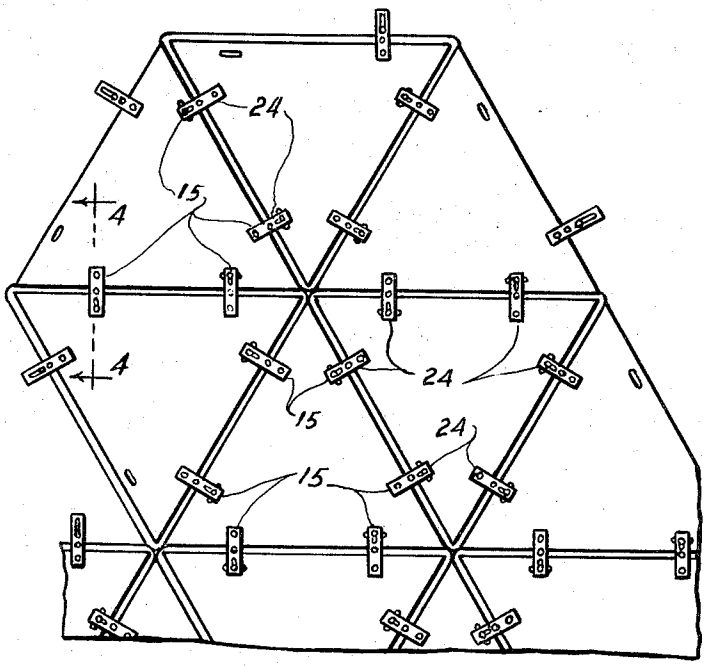


Fig. 6

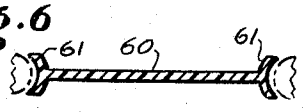
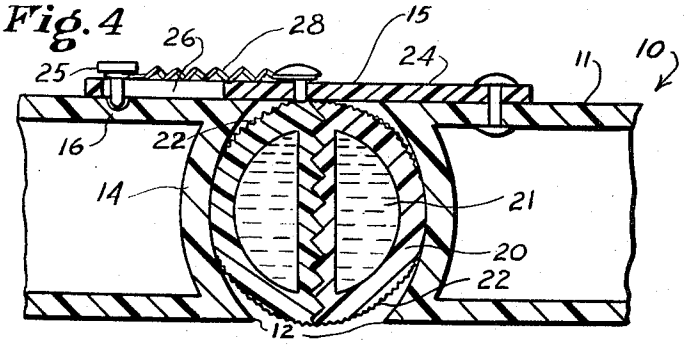


Fig. 7

Fig. 4



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UNDERWATER STRUCTURAL UNIT

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8 Claims. (Cl. 52—403)

This invention relates generally to underwater structures and the components for the fabrication thereof; more particularly it describes a method of fabricating structures under water by relatively unskilled divers; and especially sets forth an underwater structural unit of unique configuration that may be easily handled and assembled together.

There are many instances when it is desired to assemble a structure under water. At present, this may be accomplished only by utilizing the conventionally available above-ground type building blocks. The blocks are assembled under water in the usual manner. This, of course, is extremely difficult for even skilled divers. Additionally, a structure so assembled is not water-tight and is, therefore, unsatisfactory for many purposes. Still further, such structures even when assembled and satisfactory for use, are easily damaged as by shifting currents and can be considered satisfactory for use only when provided with separate struts, braces or supporting means.

Sufficient to say, that despite the considerable work done in the construction industry toward the provision of more efficient and economical methods of construction, there has, to date, been no satisfactory method provided for constructing safe and water-tight units under water even when assembled by unskilled divers.

It is a cardinal object of this invention, therefore, to provide a method and means for constructing a unit under water which will be relatively strong, rigid, efficient, durable and economical.

Another primary object hereof is the provision of an underwater structure which is constructed and arranged so as to be assembled and disassembled under water by divers.

Another object of the present invention is to provide an underwater structure which will be self-supporting and which will maintain its desired shape without the necessity of utilizing external or internal structural elements.

A still further purpose of this invention is to describe a structural unit for under water construction which will be easy to handle under water, and will be relatively light in weight.

These objects are accomplished by providing a plurality of structural units, and a method of assembling the said units under water in a tight manner by unskilled divers. This invention may be utilized for example to construct and erect temporary and permanent under water enclosures such as for use as living and working quarters, for storage space, or the like.

Essentially, the structural units consist of equilateral triangular sections or units, each having means to interlock with adjoining units, in a water-tight manner.

Such units may be assembled under water by a systematic procedure by divers. Such a system may include the utilization of miniature scale model units such as described hereinafter to construct a miniature scale model of the desired underwater enclosure.

Once such a scale model is constructed, full size structural units will be appropriately marked to correspond with the scale model units to be assembled in the desired manner under water. The structural units may be appropriately marked in a visual manner by, for example, a code marking with a fluorescent tape or fluorescent spray paint or the like. Other markings which can be utilized to code the structural units may be projections on the face of the structural units, such projections being coded and

of sufficient size to be sensed even through the glove generally worn by a diver.

It will be realized that even other methods may be utilized to serially code the structural units as by connecting the units in a flexible manner while above the water by a light detachable line. Any number of additional similar methods may be utilized.

In the construction of certain shapes, it may be desirable to construct the underwater enclosure a zone at a time. The individual zones may be assembled, and then the assembled zones connected to each other to complete the erection of the enclosure.

With these objects in view, the invention consists of the novel features of construction and arrangement of parts which will appear in the following specification and recited in the appended claims, reference being had to the accompanying drawings wherein the following reference numerals indicate the same parts throughout the various figures, and in which:

FIG. 1 is a view in perspective showing one face of one of the building units constructed according to this invention.

FIG. 2 is a sectional view taken substantially along line 2—2 of FIG. 1 and showing the seal ring in phantom.

FIG. 3 is a fractional view broken away showing a portion of a structure constructed according to this invention.

FIG. 4 is a sectional view on an enlarged scale taken substantially along line 4—4 of FIG. 3, showing the assembly of two of the units and one of their connecting members.

FIG. 5 is a view corresponding to FIG. 2 but showing an alternate construction.

FIG. 6 is a view corresponding to FIG. 2 but showing a second alternate construction.

FIG. 7 is a view corresponding to FIG. 2 but showing a third alternate construction.

Referring to the drawings, and particularly to FIGS. 1 and 2, the structural unit **10** comprising the basic building block of the instant invention is preferably fabricated as a triangle. In the embodiment illustrated, the unit **10** will have parallely spaced equilateral inner and outer faces **11** and **12** interconnected by a triangular edge portion **14**. As will be seen particularly in FIG. 2, the triangular edge portion **14** will be shaped in a concave manner whereby the area between the peripheries of the inner and outer faces **11** and **12** is curved inward. This curve of the edge portion **14** of the structural unit **10** will permit a seal ring to be assembled in position as will be described in greater detail hereinafter.

In one embodiment of the invention illustrated herein, the structural unit **10** is shown as being hollow, but it will be realized that the said unit may be filled with any desired substance for specific needs.

Each of the exterior sides of the inner face **11** and/or the outer face **12** will have a locking member **15** and a locking member groove **16**. This will permit the units **10** to be secured together in a straight and aligned or in a geodesic pattern. The material comprising the structural unit **10** should preferably be relatively rigid so that the resulting structure of the units **10**, when assembled, will be self-supporting and relatively rigid. However, the separate structural units **10** have resilient connections as hereinafter shown and may thus be articulated with respect to each other so that the resultant structure may be formed into a geodesic dome-like shape and be not only self-supporting and relatively rigid, but, also free to sway with ocean currents.

A section of a wall assembled in accordance with this invention is illustrated in FIG. 3. The structural units **10** are assembled so that peripheral edges are in contact. In

that the units **10** each have equal sides, the units **10** may be connected in a regular pattern as shown.

Each of the seal rings **20** may be constructed to fully surround one of the structural units **10**. A section through one portion of one of the seal rings is shown in an enlarged manner in FIG. 4. The seal ring **20** will be in the shape substantially of a hollow doughnut, with the center of each of the arms of the seal ring **20** filled with an appropriate hydraulic fluid **21**. The hydraulic fluid **21** may be utilized to transmit pressure at any one portion of the seal ring **20** to other portions thereof thereby assuring that the pressure about the said ring **20** is uniform. The ring **20** is, therefore, constructed of a flexible material such as rubber or plastic to provide the continuously hollow center to be filled with the hydraulic fluid **21**.

The seal ring **20** may have grooves **22** thereabout to insure a more water-tight fit. The outward side of each ring **20** will be shaped to mate with the adjacent ring. Suitable grooves will be provided about the periphery of the seal ring to insure a water-tight construction.

It will be necessary to provide means **15** to releasably lock the structural units **10** together in a secure manner for assembly. There is shown in the drawings, for this purpose, a plurality of resilient connector clamps **24**. In the illustrated embodiment, at least one of the clamps **24** is affixed adjacent each of the sides of the unit **10**. Referring to FIG. 4, the free end of the clamp **24** will have a catch **25** adapted to move within a slot **26**. The catch **25** will be biased towards the unit **10** by a spring **28** affixed at one end to the body of the clamp **24** and at the other end to the catch **25**. Each of the units **10** will have a groove **16** at each of the sides thereof to accommodate connecting clamps **24** from the next unit **10** to be assembled thereto.

Thus, it will be evident by reference to FIGS. 3 and 4, when the units **10** are assembled each connecting clamp **24** will be joined to the corresponding groove **16**. Each catch **25** may be biased outward until it fits within the appropriate groove **16** and then released. When in the released position as shown in FIG. 4, it will fit within the groove **16** thus preventing the unit **10** from spontaneously or inadvertently disassembling. The connecting force exerted by the spring **28** will be sufficient to insure that the seal ring **20** between each of the units **10** is in the desired degree of compression whereby the entire assembly and especially the joints between the units **10** will be water-tight.

Thus, it will be realized that any number of the units **10** as described hereinabove may be assembled quickly and conveniently under water by divers to fabricate an underwater, water-tight enclosure.

It will be realized, however, that other forms of structural units may be incorporated within the scope of this invention.

For example, there is shown in FIG. 5 a unit **50** constructed substantially similar to that shown in FIG. 2, but with convex peripheries. The operation of this embodiment of the invention is otherwise as described above, except for an appropriate change in the seal ring **51**. The said seal ring **51** should have a concave side to insure water-tight sealing.

The embodiment of the invention disclosed in FIG. 6 is substantially the same as disclosed hereinabove except for the replacement of the hollow structural unit **10** previously described by a unit **60** with a solid center member. Such a unit **60** will be somewhat less expensive to construct. Arcuate peripheral members **61** surround the member **60** for attachment with a seal ring as described in detail hereinbefore. Of course, although the peripheral member **61** shown herein is concave, it could equally well be constructed in a convex manner.

For certain embodiments, it is contemplated that it may be more efficient to surround every second structural unit with its own seal ring, having each seal ring shaped to contact the adjacent unit **10**. Such an embodiment is shown in FIG. 7. In that view, one of the structural units **70** will have a sealing ring **71** and the opposite structural unit **70***a* will seal against the same seal ring **71**. When the parts are assembled as was described hereinbefore, the seal rings will interlock presenting a water-tight and yet structurally sound seal.

For ease of construction of any of the embodiments of the invention, the buoyancy of the completely assembled structural units, including all the attachments and appurtenances, will be adjusted to an optimum value to facilitate manipulation under water before and after the said units are connected to form underwater enclosures. The buoyancy adjustment can be accomplished by adding buoyant material to the units as for instance, when said units are constructed of vitreous material or of a metal coated with vitreous material than a suitable buoyant material such as foamed glass can be attached to the outer face of the units so as to form a layer or coating of the buoyant material in sufficient quantity to adequately adjust the buoyancy.

The construction set forth herein permits assembly of the units in an angular manner, in addition to the straight line manner illustrated. As for example, each of the units **10** may be at an angle to its adjacent unit **10** when forming a portion of a sphere or the like.

While there are above disclosed but a limited number of embodiments of the structure and product of the invention herein presented, it is possible to produce still other embodiments without departing from the inventive concept herein disclosed, and it is desired, therefore, that only such limitations be imposed on the appended claims as are stated therein or required by the prior art.

Having thus described my invention and illustrated its use, what I claim as new and desire to secure by Letters Patent is:

1. An underwater structural unit forming an enclosure under water comprising a plurality of construction elements in edge to edge relationship, each element comprising: a polygonal member having an inner and an outer surface and a substantially arcuate contoured peripheral portion; an annular flexible sealing member having an inside surface engaging said contoured peripheral portion, said sealing member being distortable and having at least its inside surface corresponding in shape to the contour of said peripheral portion for sealing engagement with said peripheral portion and extending about the entire periphery of said polygonal member; flexible connecting means flexibly securing said construction elements into sealing articulate engagement along their respectively adjacent edges for limited relative movement; whereby a water-tight articulate geodesic dome-like structure suitable for underwater use may be formed allowing relative movement of the elements.

2. An underwater structural unit according to claim **1** wherein said polygonal member is an equilateral triangle.

3. An underwater structural unit according to claim **1** wherein said contoured peripheral portion is of uniform cross section about the entire periphery of said polygonal member.

4. An underwater structural unit according to claim **3** wherein said contoured peripheral portion is concave and of semi-circular cross section.

5. An underwater structural unit according to claim **3** wherein said contoured peripheral portion is convex and of semi-circular cross section.

6. An underwater structural unit according to claim **1** wherein both the outside and the inside surfaces of the said annular flexible sealing member corresponds in shape to the contour of said peripheral portion.

7. An underwater structural unit according to claim **1**, said connecting means being flexible members secured to both the inner and outer surfaces of adjacent members.

8. An underwater structural unit according to claim **6**, further including a plurality of second polygonal members having an inner and outer surface and a contoured

peripheral portion, said second polygonal members being alternately spaced and between adjacent first mentioned polygonal members.

References Cited

UNITED STATES PATENTS

2,825,941	3/1958	Lux	52—202
2,934,075	4/1960	Richardson	52—2
2,979,064	4/1961	Fischer	52—2
3,093,259	6/1963	Morrison	52—2
3,114,176	12/1963	Miller	52—81
3,159,884	12/1964	Hankey	52—2

FOREIGN PATENTS

1,089,634	1954	France.
561,250	1932	Germany.

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