# United States Patent [19]

**Ianuzzi**

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## [54] DEEP OCEAN SUBMERSIBLE


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[73] Assignee: **The United States of America as represented by the Secretary of the Navy**



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[52] **U.S. Cl.** .....**114/16 R,** 220/5 A

[51] **Int. Cl.** .....**B63g 8/00**

[58] **Field of Search** .....114/16 R, 16 E; 9/8 R; 220/5 A, 5 R



[56] **References Cited**

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*Primary Examiner*—Trygve M. Blix

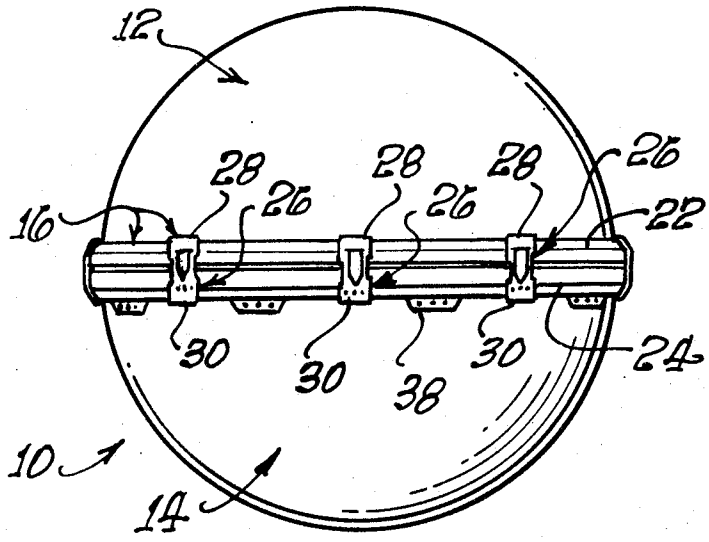
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[57] **ABSTRACT**

A deep ocean submersible including a pair of glass shells which are adapted to mate with one another about their rims to form a submersible hull; each shell having a peripheral lip which extends outwardly from the rim thereof; an elastomeric band mounted to each respective lip; and means for clamping the bands so that the shells can be tightly retained along their rims.


**9 Claims, 4 Drawing Figures**



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Fig. 1.

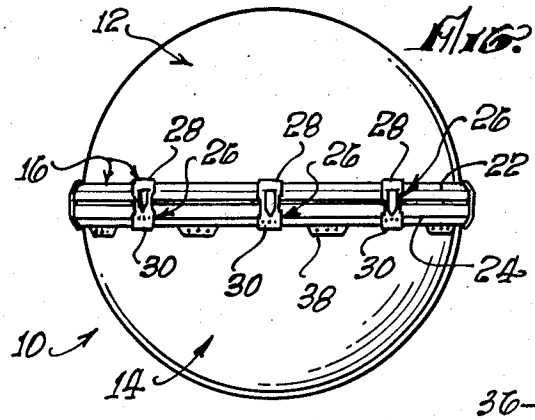



Fig. 3.

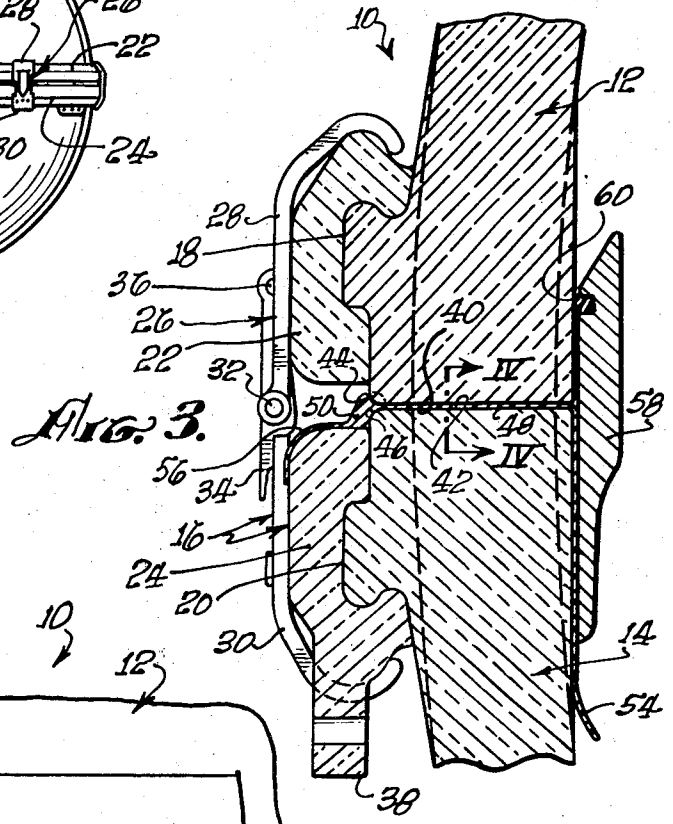



Fig. 2.

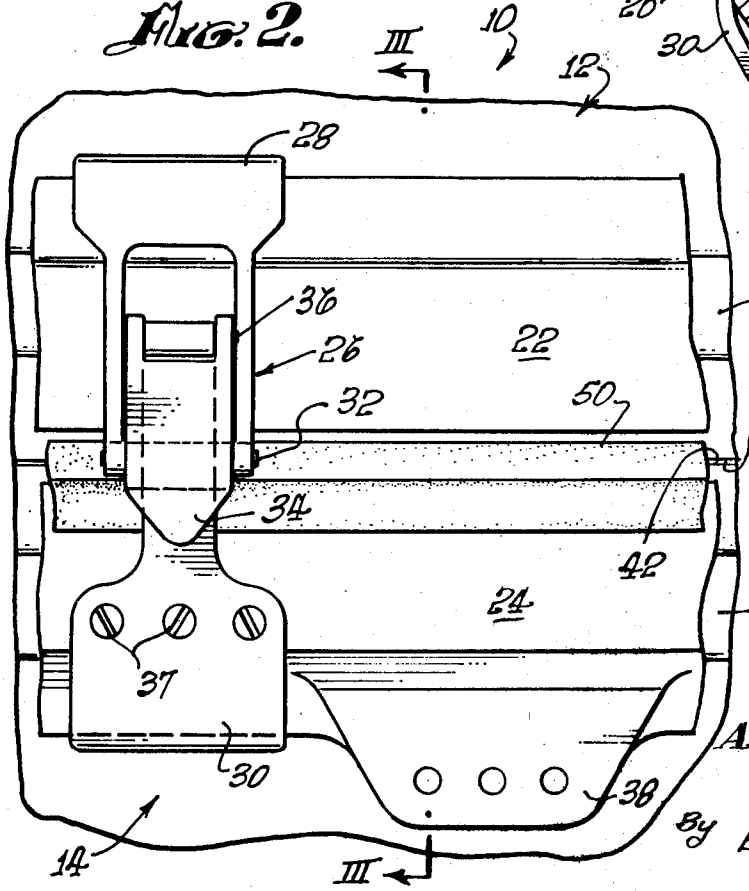
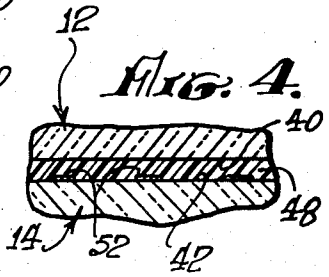



Fig. 4.




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# DEEP OCEAN SUBMERSIBLE

## STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

## BACKGROUND OF THE INVENTION

In recent years the Navy and oceanographic industries have been seeking new types of submersibles which can be taken to great depths within the ocean. A very promising approach now exists in utilizing a spherical glass shell which is split into two hemispheres and joined together about the rims thereof. It has been found that a glass sphere increases in strength as it is taken to greater depths within the ocean and provides a simple compartment for crew members to visually witness the outside ocean environment. A present means of joining the two glass hemispheres together has been a metal band which extends about the rims of the hemispheres and which may be retained by tie straps which extend from the respective rims across the hemispheres. This approach would not be satisfactory for deep ocean depths because of the difference of modulus of elasticities between steel and glass. For instance, an **80** inch glass sphere with a 2 inch wall would change in diameter, at a depth of 20,000 feet, approximately three-fourths of an inch. The change in diameter for an equivalent steel band would be about one-fourth of an inch. The difference between the two deflections would produce enormous local bending stresses where the glass joins the metal. Further, a metal fitting at the equatorial joint of the glass sphere would weigh approximately 675 lbs, thus reducing the effective payload of the submersible.

## SUMMARY OF THE INVENTION

The present invention provides a retainer means for the two glass hemispherical shells which would be effective at great depths within the ocean without any danger of releasing the shells or producing breaking stresses at the rims of the shells. This has been accomplished by providing each hemispherical shell with a peripheral lip which extends outwardly from the shell rim, an elastomeric band mounted to each respective lip, and means for clamping the bands so that the shells can be tightly retained about their rims. The band has substantially the same modulus of elasticity as the glass shells and therefore changes in shape substantially as the shells so as to obviate undue stresses on the glass. A slight prestressing of the elastomeric bands has been found to ensure no separation of the bands from the hemispherical shells. A unique joint has been provided between the shell rims, bands, and the clamping means which will be described in detail hereinafter. Further, a unique means has been provided for sealing the joint, preventing lateral displacement of the shells, and releasing the shells in the event of an emergency.

## STATEMENT OF THE OBJECTS OF INVENTION

An object of the present invention is to overcome the aforementioned problems associated with prior art retaining means for a pair of hemispherical glass shells.



Another object is to provide a glass deep ocean submersible which can transcend great depths within the ocean.

A further object is to provide a deep ocean glass submersible with improved retention means, releasing means, and sealing means for operation within great depths of the ocean.

Other objects and many of the attendant advantages of this invention will be readily appreciated as it becomes better understood by reference to the description and accompanying drawings which follow.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an overall view of a deep submersible glass shell with improved retention means for joining a pair of hemispherical glass shells.

FIG. **2** is an enlarged view of a portion of the retention means of the glass submersible.

FIG. **3** is a view taken along plane III—III of FIG. **2**, and

FIG. **4** is a view taken along plane IV—IV of FIG. **2**.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing wherein like reference numerals designate like or similar parts throughout the several views there is shown in FIG. **1** a deep ocean glass submersible **10**. This submersible may be a pair of substantially identical hemispherical shells **12** and **14** which are joined at their rims by a band-like retainer means **16**. This submersible may be mounted within a framework with propulsors (not shown) for exploring great depths within the ocean. Crew members within the glass sphere will have visual access to the ocean in almost every direction.

The glass shells **12** and **14** mate with one another about their rims to form the glass spherical hull. The shells **12** and **14** have peripheral lips **18** and **20** respectively, which extend outwardly from the rims thereof. The retainer means **16** may include substantially identical elastomeric bands **22** and **24** which are mounted to the lips **18** and **20** respectively. These bands are preferably constructed of fiberglas so as to have substantially the same modulus of elasticity as the glass hemispheres **12** and **14**. In the preferred embodiment these fiberglas bands **22** and **24** are mounted to the glass lips **18** and **20** by a socket or tongue and groove type connection as illustrated in FIG. **3**. Also, the bands **22** and **24** are preferably prestressed so as to ensure no departure of these bands from the lips **18** and **20** as the submersible descends within great depths of the ocean.

A means is provided for clamping the bands **22** and **24** so that the shells **12** and **14** can be tightly retained about their rims. This means may include a series of toggle clamps **26** which have top and bottom clamping members **28** and **30** which are pivoted at **32**, and a release tab **34** which is pivoted at the top of the clamp member **30** at **36**. The bottom clamp member may be fixedly secured to the bottom fiberglas band **24** by a series of screws **37**. Because of the difference in modulus of elasticities between the toggle **26** and the fiberglas bands **22** and **24** it is desirable that the top of the top band **22** and the bottom of the bottom band **24** be rounded and that the clamp members **28** and **30** arc about these rounded portions for positive retention at

all operating depths within the ocean. The bottom fiberglas band **24** may be provided with downwardly extending attachment lugs **38**, one of which is illustrated in FIG. **2**.

It is essential that a perfect seal be made between the glass hemispheres **12** and **14**. As illustrated in FIG. **3** the rims of the hemispheres have flat faces **40** and **42** and rounded exterior edges **44** and **46**. A gasket **48** is disposed between the flat faces of the shell rims and has an outer peripheral enlargement **50** which is squeezed between the rounded exterior edges when the glass hemispheres are brought into mating engagement. In this manner a very desirable seal is made about the rims of the glass hemispheres.

In an emergency situation it may be desirable for the crew within the deep submersible to release the toggles **26** and open the hemispheres for escape purposes. In order to accomplish this the pivots **32** and **36** of the toggle **26** may include an explosive bolt which may be actuated by an electric current from within the glass submersible. In order to feed this current to the explosive bolts foil leads **52** may be embedded within the gasket **48** and may follow the gasket from an interior extension **54** of the gasket to an exterior extension **56** thereof. The foil leads **52** within the exterior extension **56** of the gasket are electrically connected to the explosive bolts within the pivots **32** and **36** (not shown).

After the toggle **26** has been released from the glass hemispheres it will be necessary for the crew to apply some parting force for separation. This may be accomplished by providing a rigid peripheral extension or guide **58** which is connected along the interior surface of the bottom glass hemisphere **14** and which extends upwardly in close proximity with the interior surface of the top glass hemisphere **12**. Within the guide **58** is a quad ring **60** which makes peripheral sealing engagement with the interior surface of the top hemisphere **12**. With such an arrangement the crew can utilize a gas bottle for applying a pressure within the submersible which is slightly greater than ambient so as to separate the glass hemispheres **12** and **14**. The peripheral guide **58** also serves as a means for guiding mating engagement of the glass hemispheres **12** and **14** and preventing lateral displacement thereof.

It is now readily apparent that the present invention provides a glass submersible which has many unique advantages. The retaining means for the pair of glass hemispheres has substantially the same modulus of elasticity as the hemispheres and will not cause undue stresses during deep ocean operations. A sealing means is provided for ensuring a perfect seal at great depths within the ocean and a means is provided for releasing the hemispheres in case of an emergency situation.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

**1**. A deep ocean submersible comprising:
- a pair of glass shells which are adapted to mate with one another about their rims to form a submersible hull;
- each shell having an integral peripheral lip which extends outwardly from the rim thereof;
- an elastomeric band mounted to each respective lip; and
- means for clamping the bands so that the shells can be tightly retained along their rims.

**2**. A deep ocean submersible as claimed in claim **1** including:
- the bands being fiberglass and prestressed about the respective lips of the shells.

**3**. A deep ocean submersible as claimed in claim **2** including:
- each of the bands being shaped to the respective lip in a socket-type mounting.

**4**. A deep ocean submersible as claimed in claim **1** including:
- a rigid peripheral guide mounted along the interior surface of one of the shells and extending beyond the rim thereof; and
- the extension of the guide having means for peripherally sealing against the interior surface of the other shell.

**5**. A deep ocean submersible as claimed in claim **1** including:
- each of the rims having a flat face and a rounded exterior edge; and
- a gasket disposed between the shell rims and having an outer peripheral enlargement which is adapted to be squeezed between the rounded exterior edges of the rims.

**6**. A deep ocean submersible as claimed in claim **5** including:
- explosive bolt means for releasing the clamping means; and
- foil conductors embedded in the gasket for feeding an electrical current from a power source in the submersible to said explosive bolt means.

**7**. A deep ocean submersible as claimed in claim **6** including:
- the bands being fiberglas and prestressed about the respective flanges of the shells.

**8**. A deep ocean submersible as claimed in claim **7** including:
- each of the bands being shaped to the respective lip in a socket-type mounting.

**9**. A deep ocean submersible as claimed in claim **8** including:
- a rigid peripheral guide mounted along the interior surface of one of the shells and extending beyond the rim thereof; and
- the extension of the guide having means for peripherally sealing against the interior surface of the other shell.

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