

[54] **DEVICE FOR UNDERWATER
OBSERVATION**

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[58] Field of Search..... **61/63, 69 R, 73.2, 71;
114/16 A; 354/64, 75**

[56]

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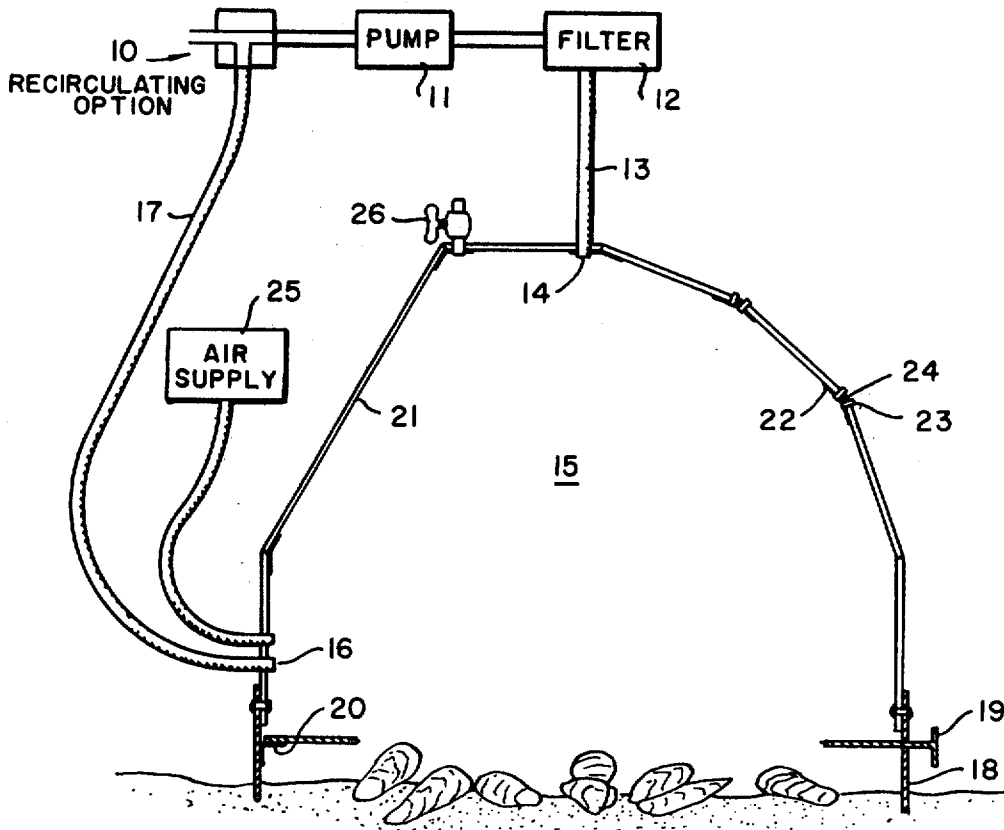
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[57]

ABSTRACT

A device permitting observation, visual or photographic, of underwater objects comprising a transparent enclosure made of plexiglass pieces, for example, fitted together in a watertight manner, for enclosing at least a portion of the object to be observed, a pump and the necessary hoses, fittings and filter to permit the environmental water in the enclosure to be pumped out and replaced with clean water from the filter. Alternatively, the environmental water may be pumped out and replaced with water from a clean-water supply source.

14 Claims, 4 Drawing Figures



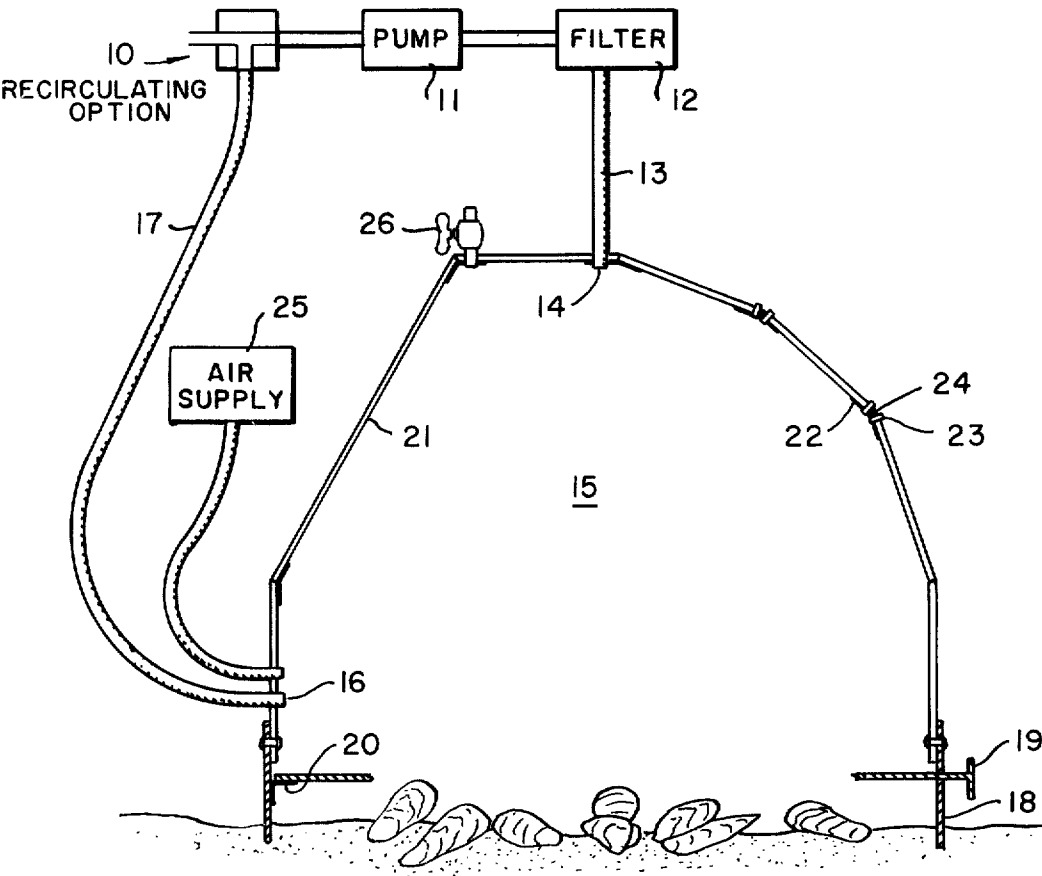


FIG. 1.

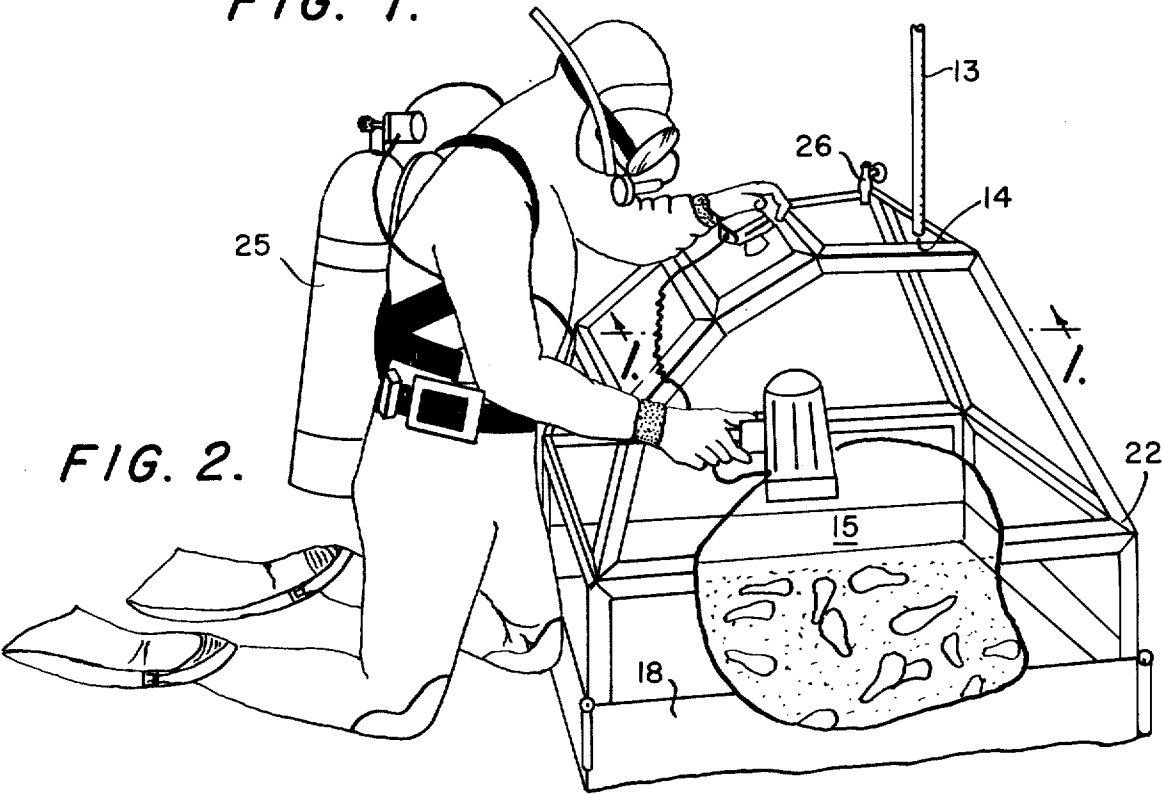
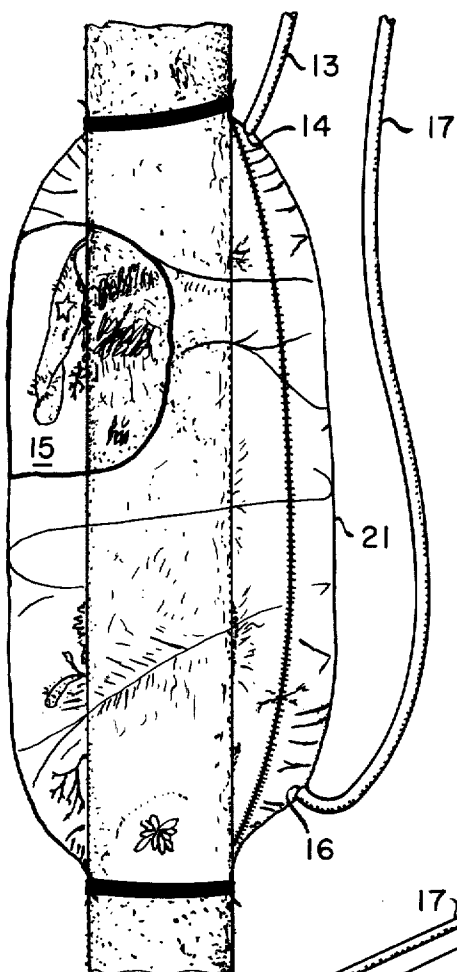
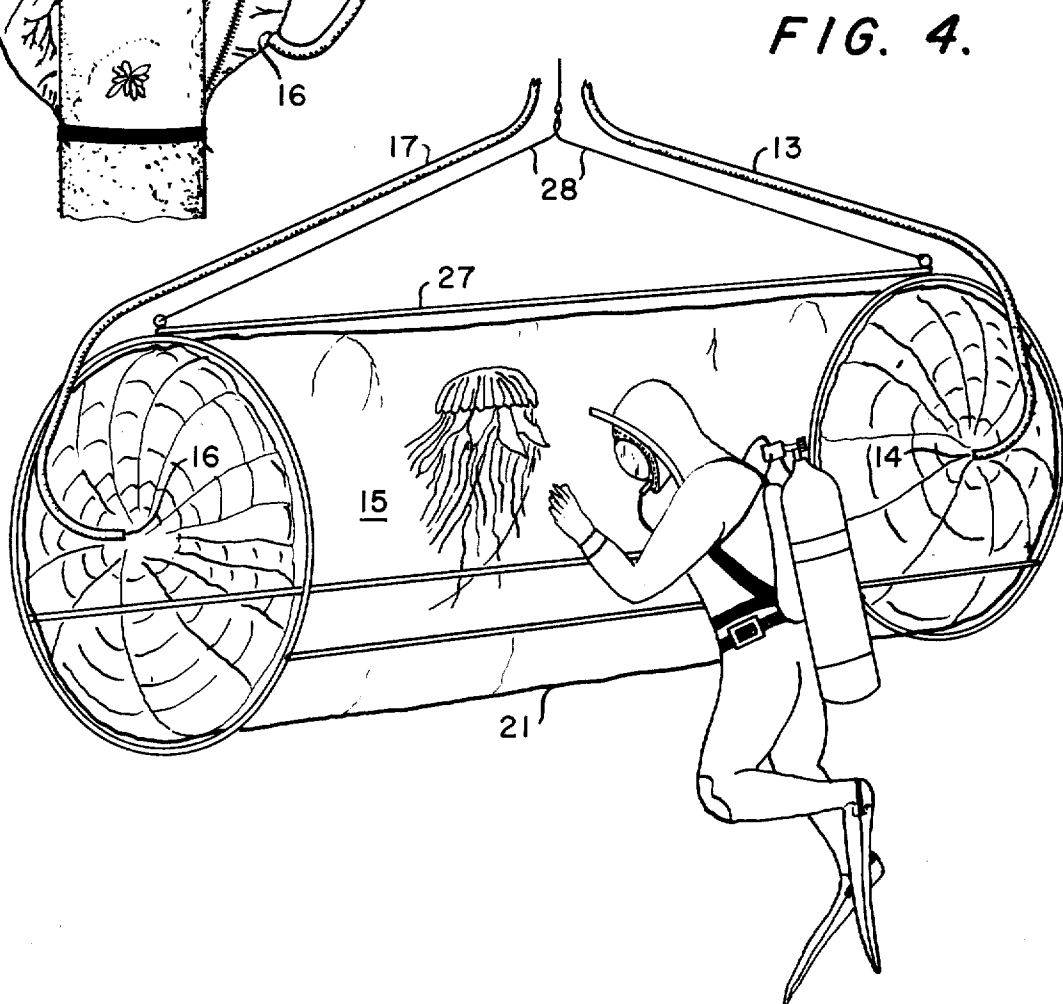


FIG. 2.



DEVICE FOR UNDERWATER OBSERVATION

STATEMENT OF GOVERNMENT INTEREST

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

BACKGROUND OF THE INVENTION

This invention relates to underwater observations and especially a device permitting clear underwater observation, including photographic observation, despite the turbid condition of the surrounding environment.

In areas where the turbidity of the water severely limits underwater visibility, the accuracy of observations and the resolution of photography are markedly reduced. It is precisely in such areas of restricted underwater visibility, however, that accurate observations and photographic documentation of ship hulls, harbor structures and the like are often required.

Sophisticated optical systems have been developed to enhance the image quality of photographs made in turbid waters, but these systems are limited in their degree of image enhancement, are very expensive and require highly skilled personnel and sophisticated processing manipulation.

Photography under difficult conditions of turbidity has also been attempted by attaching an enclosure of clear water to the front of an underwater camera, thereby reducing the amount of turbid water between the subject and the camera. (U.S. Pat. Nos. 2,358,231 and 2,396,267, E. R. F. Johnson; Bundesrepublik Deutschland Patentschrift 969065, W. Thomsen and H. Hunger) This method is unwieldy, particularly in a current. It often creates a sediment cloud or otherwise disturbs the object of interest as the device is positioned, and satisfactory positioning is rendered very difficult because of limited underwater visibility. Even if this conventional device can be properly positioned, a layer of turbid water still blankets the object of interest and becomes highly objectionable if a depth-of-field of more than a few inches past the container is required. As the depth-of-field necessary to view or photograph the subject increases, so does the thickness of the "blanket" of turbid water surrounding the object, thus reducing the image quality. In an attempt to minimize this problem, flexible "bag-like" containers have been employed as enclosures for the clear water. Since a flexible bag conforms to the shape of the object of interest, it effectively displaces the "blanket" of turbid water between camera and subject. Practical experience has shown, however, that because of handling difficulties, such a device is very susceptible to puncture. An even greater problem is the disturbance of the substrate and marine life as they are crushed beneath the water-filled bag.

SUMMARY OF THE INVENTION

The invention comprises an enclosure which can be fitted around at least a portion of an underwater object which it is desired to observe visually or photographically. The enclosure can be pumped so that the environmental water in it is circulated through a filter to clear the water, or the environmental water can be pumped out and clear water pumped to replace it.

OBJECTS OF THE INVENTION

An objection of the invention is to permit observation, including photographic observation, of objects in a turbid underwater environment.

Another object is to provide a simple, inexpensive, easily handled and emplaced device which will permit observation of underwater objects despite turbid conditions.

Other objects, advantages, and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts the generalized pumping scheme for providing filtered water to an underwater enclosure and additionally depicts a central vertical section of the embodiment of the device as shown in FIG. 2, said vertical section being taken on line 2—2 of FIG. 2.

FIG. 2 is a perspective view of a device to permit photography in turbid water so configured as to provide for observation and/or photography of the substrate or other surface and objects thereon.

FIG. 3 is a perspective view of a device to permit photography in turbid water so configured as to provide for the observation and/or photography of an object partially enclosed by the device.

FIG. 4 is a perspective view of the device so configured as to provide for the observation and/or photography of an object entirely enclosed by the device.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings in detail, wherein like numerals designate like parts, numeral 10 (see FIG. 1) designates a simple series of valves acting to provide a recirculating option. Depending upon the type of pump 11 employed, the desired clarity of the contained water, and the time available for operation, water can be recirculated from pump 11 through the filter 12, incurrent hose 13 and port 14, enclosure 15 and excurrent port 16 and hose 17 through the recirculating option 10 to the beginning of another cycle, thus forming a "closed-circuit system." Alternatively, water can be circulated through the system just described and discharged into the environment upon reaching the recirculating option 10, thus permitting an "open-circuit system." The recirculating option 10 can also be utilized to add water to a "closed-circuit" pumping system if water is lost through leaks during the pumping cycle.

The pump 11, depending upon its type and construction, can be submersed with the enclosure 15 or located at or above the water's surface. Similarly, the filter 12, depending upon its construction, can be submersed with the enclosure 15, attached to the pump 11 or located in some other convenient position.

The equipment ancillary to the underwater enclosure 15 is conventional. The connecting components, for example, incurrent hose 13, will be suited to the distance between major components (pumps, filters, enclosures) which can vary with different applications of the system and the various major components which could be employed.

The enclosure 15 may be varied in construction as is shown in FIGS. 2-4 although in each case it acts to surround the object of interest with clear water so that

photography or other observations can be made by conventional methods. FIG. 2 depicts the enclosure 15 contiguous to a surface. This surface may be the seabed in which case the base 18 of the enclosure 15 would be constructed so as to penetrate the substrate. If the surface of interest was solid such as a ship's hull or seawall, the base 18 would be constructed so that it could be welded, bolted, magnetically or adhesively affixed or otherwise attached to the surface in question. If the surface was both solid and very irregular, a flexible base structure would be employed to attach the enclosure to that surface. A base plate 19 may optionally be utilized to separate the main body of the enclosure 15 from the water immediately above the substrate. This prevents the sediment disturbed during the emplacement of the device from increasing the turbidity of the enclosed water even beyond ambient conditions. After the disturbed sediment has settled somewhat, the base plate 19 can be removed by sliding it along the base plate supports 20 so that only a small amount of "substrate-derived sediment" must then be displaced from the enclosure.

The material 21 of the enclosure is largely transparent but may be either rigid or flexible. For an enclosure such as depicted in FIG. 2, a rigid structure might be preferred since any motion of the walls of the enclosure could disturb sediment from the substrate, thereby increasing the turbidity of the enclosed water mass. This factor would have to be balanced against the ease of handling resulting from an enclosure of "flexible-walled" construction.

One of the possible methods of construction of a rigid-walled enclosure is depicted in FIG. 1. The material 21 of the enclosure may, for example, be plexiglass or fiberglass with the plates being joined to each other by angle stock 22 and securing bolts 23. The joints are made substantially water-tight by caulking compound 24. This means of connection is used at all joints although shown in FIG. 1 at only two places. Any other means for joining the pieces and keeping the seams watertight may be used, if desired.

If the enclosure and associated equipment is heavy in weight, its underwater handling can be facilitated by utilizing the enclosure 15 itself as a variable-buoyancy system. The air supply 25, consisting, for example, of a surface compressor or high-pressure storage tank, permits a controlled volume of air to enter the enclosure. Water within the enclosure is displaced and the entire structure can be adjusted to neutral buoyancy. A gate valve 26 on the upper surface of the enclosure 15 permits the air contained therein to be released. This technique of buoyancy adjustment permits the system to be conveniently handled by divers or raised to the surface without accessory equipment.

FIG. 3 depicts the enclosure 15 configured so as to partially surround an object such as a piling. Such an enclosure would be most conveniently formed from, although not limited to, a flexible, transparent plastic film. This material is emplaced by zipping the side to form a cylinder surrounding the piling which is then gasketed at the top and bottom to form an enclosure 15 around the portion of the piling to be examined. A substantially water-tight enclosure can be formed with conventional zippering and gasketing techniques.

FIG. 4 depicts the enclosure 15 so configured as to completely surround the object of interest. This type of enclosure would again be conveniently formed from,

although not limited to, a plastic film. Such an enclosure could be supported by a simple arrangement of structural members 27, attached to a surface float by supporting cables 28.

In use, the enclosure 15 is emplaced by any of the aforementioned methods so that the water contained therein and surrounding the object of interest is effectively separated from the ambient environment. Since the pump creates slight pressure in the system, any small inadequacies in sealing the enclosure 15 will not affect the clarity of the water contained therein because the clear filtered water will leak into the turbid ambient environment rather than vice versa.

After a suitable interval of pumping, the initially ambient water within the enclosure 15 will be diluted and displaced by clear filtered water so that observation and photography of the subject can be undertaken. A source of fresh water can be used to clear the enclosure 15 or ambient water can be used subsequent to filtration. The latter method is to be preferred if marine life is to be observed since all parameters of the ambient water, with the exception of turbidity, remain constant.

Once the enclosed water mass has obtained sufficient clarity, observation and photography can be initiated by conventional means. A camera can be placed immediately adjacent to the material 21 of the enclosure if it is transparent or to viewing ports embedded in the material. Alternatively, a camera can be affixed to the interior of the enclosure and remotely operated. If the enclosure is of sufficient size, it can be emplaced around a diver or a diver can enter through a double-door system which would permit the enclosure to remain effectively sealed from the ambient water outside. The diver is then able to employ conventional diving techniques with much greater efficiency and accuracy than under conditions of very poor visibility.

The invention as described herein embodies several advantages over the prior art. Despite turbid conditions, virtually any underwater subject can be studied and/or photographed since the device can be so configured that the enclosed body of water is contiguous to, partly surrounding or completely surrounding the object of interest. Depth-of-field is a function of the manner in which the device is configured and emplaced but is not dependent upon the turbidity of the ambient water.

The invention is simply constructed of readily available materials, is easily handled in the water and permits any diver to employ conventional techniques of inspection and photography despite near zero visibility.

The variable buoyancy system described herein permits configurations of the invention which are heavy in weight to be readily handled by divers.

Great advantages in ease of handling, transportation and storage may be realized if the invention is constructed of a flexible and therefore collapsible material.

Obviously, many modifications and variations of the present invention are possible in 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.

What is claimed is:

1. In the oceanic and riverine environments, a device for permitting underwater objects to be clearly observed in situ even in turbid water comprising:

enclosure means for watertightly enclosing at least a portion of an underwater object which is to be ob-

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served, said enclosure means being submerged in the watery environment, the material of which the enclosure is made being transparent; and water-clearing means for removing turbid water from said enclosure and replacing it with clear water.

2. A device as in claim 1, wherein said enclosure is made from pieces of clear plastic which are joined together in a watertight manner.

3. A device as in claim 2, wherein said water-clearing means includes, in series, a hose fitting mounted on said enclosure, an excurrent hose connected to said hose fitting, a pump connected to said excurrent hose, a filter connected to said pump, an incurrent hose connected to said filter and a second hose fitting connected to said incurrent hose, whereby the environmental water is pumped out of said enclosure through said filter, is cleaned by said filter and then is pumped back into said enclosure as clean water.

4. A device as in claim 2, wherein said water-clearing means includes means for pumping environmental water out of said enclosure, means for coupling to a supply of clean water and means connected to said coupling means for pumping said clean water into said enclosure.

5. A device as in claim 2, wherein said enclosure is made from pieces of plexiglass.

6. A device as claimed in claim 1, further including a fitting for connecting a source of air to said enclosure, said fitting being mounted on said enclosure so that air may be pumped therethrough from the outside to the inside of said enclosure.

7. A device as in claim 1, wherein said water-clearing means includes, in series, a hose fitting mounted on said enclosure, an excurrent hose connected to said hose fitting, a pump connected to said excurrent hose, a filter connected to said pump, an incurrent hose connected to said filter and a second hose fitting mounted on said enclosure and connected to said incurrent hose, whereby the environmental water is pumped out of said enclosure through said filter, is cleaned by said filter and then is pumped back into said enclosure as clean water.

8. A device as in claim 1, wherein said water-clearing means includes means for pumping environmental water out of said enclosure, means for coupling to a supply of clean water and means connected to said coupling means for pumping said clean water into said enclosure.

9. In the oceanic and riverine environments, a device

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for permitting underwater objects to be clearly observed in situ even in turbid water comprising:

enclosure means for watertightly enclosing at least a portion of an underwater object which is to be observed, said enclosure means being submerged in the watery environment, the material of which the enclosure is made being transparent; and

water-clearing means for removing turbid water from said enclosure and replacing it with clear water,

said water clearing means including, in series a hose fitting mounted on said enclosure, an excurrent hose connected to said hose fitting, a pump connected to said excurrent hose, a filter connected to said pump, an incurrent hose connected to said filter and a second hose fitting mounted on said enclosure and connected to said incurrent hose, whereby the environmental water is pumped out of said enclosure through said filter, is cleaned by said filter and then is pumped back into said enclosure as clear water.

10. A device as in claim 9, wherein said enclosure is made from pieces of clear plastic which are joined together in a watertight manner.

11. A device as in claim 9, wherein said enclosure is made from pieces of clear fiberglass which are joined together in a watertight manner.

12. In the oceanic and riverine environments, a device for permitting underwater objects to be clearly observed in situ even in turbid water comprising:

enclosure means for watertightly enclosing at least a portion of an underwater object which is to be observed, said enclosure means being submerged in the watery environment, the material of which the enclosure is made being transparent; and

water-clearing means for removing turbid water from said enclosure and replacing it with clear water,

said water-clearing means including means for pumping environmental water out of said enclosure, means for coupling to a supply of clean water and means connected to said coupling means for pumping said clean water into said enclosure.

13. A device as in claim 12, wherein said enclosure is made from pieces of clear plastic which are joined together in a watertight manner.

14. A device as in claim 12, wherein said enclosure is made from pieces of clear fiberglass which are joined together in a watertight manner.

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