Sept. 16, 1941. G. W. BARNES 2,256,133

REFRACTIVE EQUALIZER

Filed Oct. 26, 1940

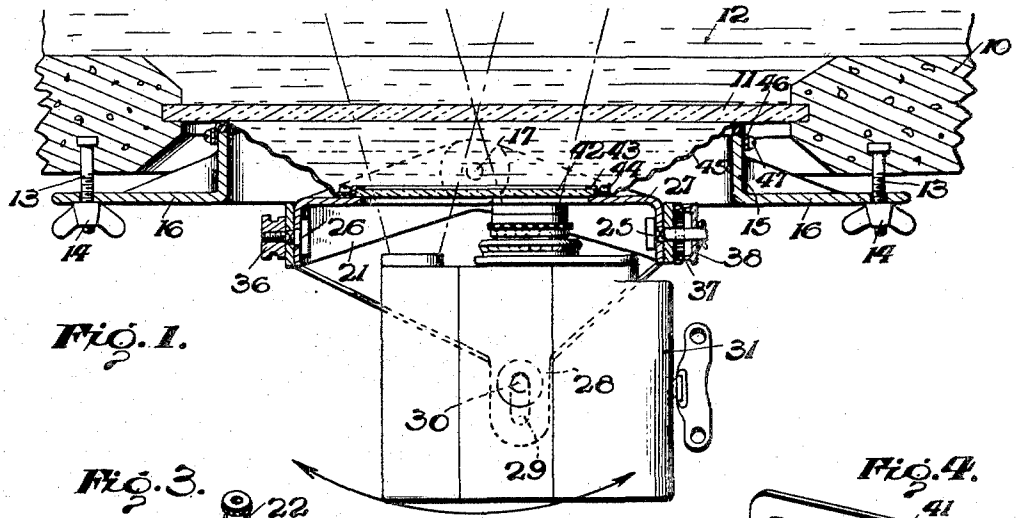

Fig. 1.

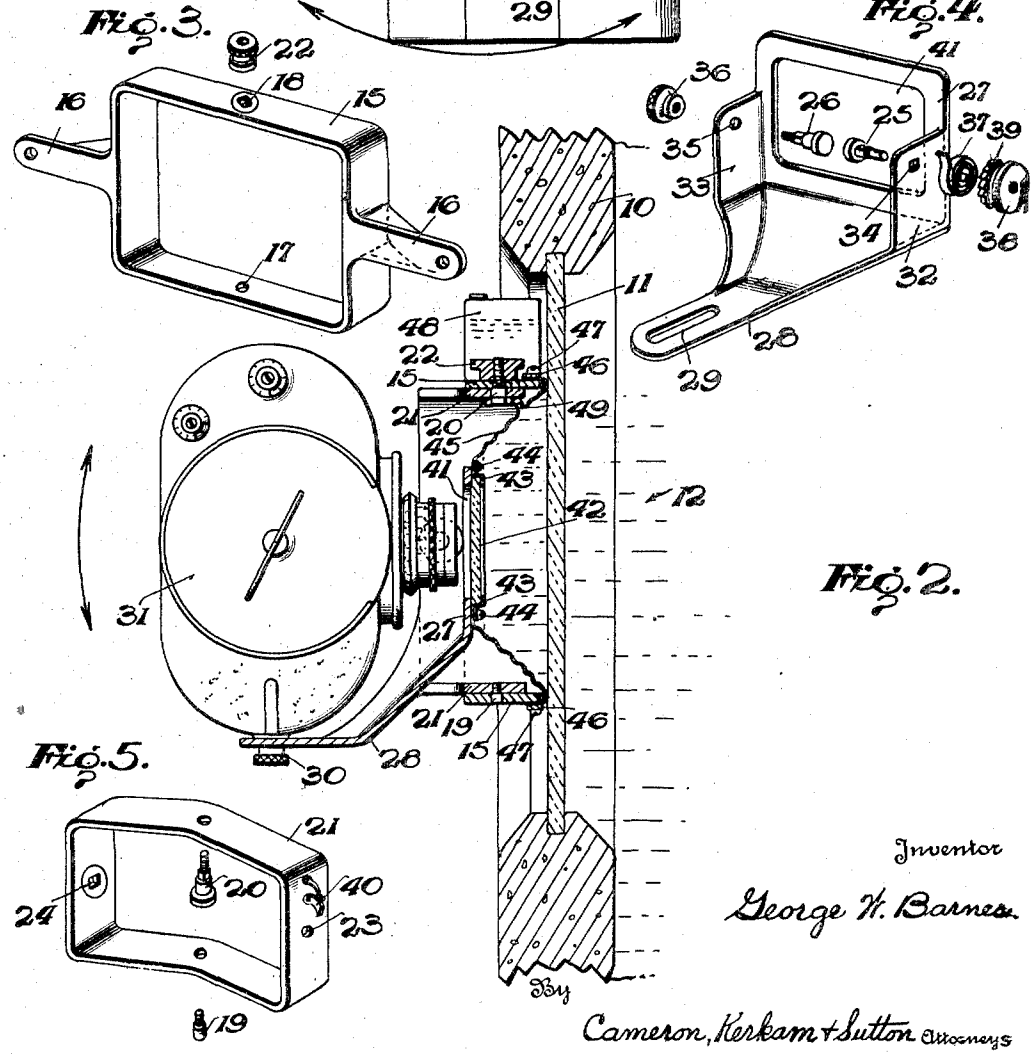

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

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UNITED STATES PATENT OFFICE

2,256,133

REFRACTIVE EQUALIZER

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Application October 26, 1940, Serial No. 363,050

15 Claims. (Cl. 95—11)

This invention relates to refractive equalizers and more particularly to improvements in refractive equalizers for viewing or photographing submerged objects.

Heretofore much difficulty has been encountered in viewing or photographing submerged objects through windows in diving bells, aquariums or the like since the window is the boundary between two media having different indices of refraction. This difficulty is, of course, reduced to the minimum when the focal line is perpendicular to the plane of the window but when the focal line is at an angle to the plane of the window then both distortion and aberration are introduced and the resulting views or photographs are blurred and indefinite. For this reason, then, it is necessary that the focal line be kept perpendicular to the plane of the window to obtain clear and distinct views or photographs and it is accordingly impossible to follow movement of the object being photographed.

Heretofore various means have been suggested to overcome the distortion and aberration present when the focal line is at an angle to the plane of the window such as the use of movable turret-type windows, but all of these means have proved too cumbersome and expensive.

The present invention provides a novel refractive equalizer wherein the focal line is maintained perpendicular to the plane of an auxiliary window moving with the viewer or camera. Between this auxiliary window and the window in the diving bell, aquarium or the like, means are provided for retaining a medium having substantially the same index of refraction as the medium in which the object being viewed or photographed is submerged. The camera can be manipulated or the viewer follow any movement of the object being photographed and as the auxiliary window follows the movement of the camera or viewer and as its plane is perpendicular to the focal line, no aberration or distortion is introduced even though the focal line may be at an angle to the plane of the window in the diving bell or the aquarium.

It is accordingly an object of the present invention to provide a novel refractive equalizer for viewing or photographing submerged objects in which the focal line is at all times maintained perpendicular to the plane of an auxiliary window so that distortion and aberration are reduced to a minimum.

Another object of the present invention is to provide a novel refractive equalizer for viewing or photographing submerged objects in which the camera or viewer may move at will to follow any movement of the object being photographed without introducing distortion and aberration.

Another object of the present invention is to provide a novel refractive equalizer for viewing or photographing submerged objects in which an auxiliary window is employed arranged for movement with respect to the window through which the object is to be viewed or photographed, the auxiliary window being so arranged that its plane remains perpendicular to the focal line, a medium having substantially the same index of refraction as that containing the object being viewed or photographed being interposed between the auxiliary window and the window so that distortion and aberration are reduced to a minimum.

The refractive equalizer of the present invention is susceptible of materialization in many embodiments both for visual and for photographic use. For the sake of simplicity an illustrative embodiment of the refractive equalizer of the present invention is shown in the accompanying drawing and is hereafter described for photographic use only. It is to be expressly understood that this illustrative embodiment of the present invention is shown and described for the purposes of illustration only since the invention is capable of visual use and it is not to be construed as a limitation of the present invention. To determine the scope of the present invention reference should be had to the appended claims.

In the accompanying drawing,

Fig. 1 is a top view, partly in section, showing an illustrative embodiment of the novel refractive equalizer of the present invention;

Fig. 2 is a vertical view partly in section of the illustrative embodiment of the present invention as shown in Fig. 1;

Fig. 3 is a view of a portion of the illustrative embodiment of the present invention as shown in Fig. 1;

Fig. 4 is a view of another part of the illustrative embodiment of the present invention as shown in Fig. 1; and

Fig. 5 is a view of another part of the illustrative embodiment of the present invention shown in Fig. 1.

In the several figures, in which like reference characters indicate similar parts, 10 is the wall of a diving bell, aquarium or the like having therein a suitable window 11 through which it is desired to photograph objects contained in the surrounding medium 12. Walls 10 are provided with suitable bolts 13 disposed on opposite sides

of window 11, bolts 13 being designed to receive suitable wing nuts 14. A suitable frame 15 is designed for close engagement with window 11 and is provided with arms 16 adapted to engage bolts 13 and be secured against window 11 by wing nuts 14. Frame 15 is provided with oppositely and vertically disposed openings 17 and 18, opening 17 being designed to receive a suitable pivot pin 19 (Fig. 5) and opening 18 being designed to receive a suitable pivot pin 20.

A second frame 21 is provided for rotation about pivots 19 and 20 within frame 15, frame 21 first being mounted upon pivot 19 and then having pivot 20 inserted and secured in place by a suitable nut 22 (Fig. 3). Frame 21 is provided with oppositely and horizontally disposed openings 23 and 24 designed to receive pivot pins 25 and 26 respectively (Fig. 4).

A third frame 27 (Fig. 4) is provided having a downwardly and outwardly extending arm 28. Arm 28 is suitably slotted, as at 29, to receive a suitable bolt 30 by which any suitable camera 31 is secured to arm 28. Frame 27 is provided with oppositely disposed extensions 32 and 33 which are provided with oppositely and horizontally disposed openings 34 and 35 adapted to receive pivot pins 25 and 26 respectively. Frame 27 is so proportioned that it fits within frame 21 and can be rotated about the horizontal pivots 25 and 26, a suitable nut 36 securing pivot 26 in place. Pivot 25 is provided with a coil spring 37 and a nut 38 having ratchet teeth 39 designed to engage a dog 40 mounted on frame 21 so that by the rotation of nut 38 spring 37 can be tensioned to counterbalance the weight of camera 31.

Frame 27 is provided with a suitable aperture 41 covered by a suitable transparent window 42 secured to frame 27 by molding 43 and screws 44. Clamped beneath molding 43 and forming a fluid-tight seal with frame 27 and extending completely around opening 41 and between the inner edges of frame 15 and window 11 to form a fluid-tight seal and secured to frame 15 by beading 46 and screws 47 is a flexible, expansible and contractible bellows-like member 45. Mounted upon frame 15 is a suitable reservoir 48 communicating, as at 49, with the interior of member 45. The interior of member 45 is filled with a medium having substantially the same index of refraction as the medium 12 through reservior 48 which acts as an overflow tank to receive fluid when member 45 is distorted by the motion of window 42 and camera 31. Camera 31 is so mounted on arm 28 that its focal line is perpendicular to window 42.

With the embodiment of the present invention set up as above described it will now be apparent that camera 31 can be rotated in vertical planes about pivots 25 and 26 and can be rotated in horizontal planes about pivots 19 and 20 while at all times maintaining its focal line perpendicular to the window 42. Inasmuch as the mediums outside window 11 and between window 11 and window 42 have substantially the same indices of refraction and as the focal line of camera 31 is always perpendicular to window 42, distortion and aberration are reduced to a minmum no matter what the angle of the focal line of camera 31 may be with respect to the plane of window 11.

It will now be apparent that the present invention provides a novel refractive equalizer for viewing or photographing submerged objects in which aberration and distortion are reduced to a minimum by maintaining the focal line perpendicular to the plane of an auxiliary window, a medium having substantially the same index of refraction as that containing the object being photographed being interposed between the auxiliary window and the window in the diving bell, aquarium or the like.

To those skilled in the art changes to or modifications of the above described illustrative embodiment of the present invention may now be suggested without departing from the concept of the present invention. For example, for visual use the camera of the above described illustrative embodiment may be omitted and in its place a suitable face-hood may be fixed to the arm 28 so that the focal line of the user is perpendicular to the auxiliary window 42. It is further apparent that the refractive equalizer of the present invention can as well be used on curved or hemispherically shaped windows as well as on the flat window shown and described above. In this case the expansible and contractible member 45 may enclose the curved or hemispherical shaped window and be fixed to the wall of the aquarium or diving bell. In some instances the illustrative embodiment of the invention described above may be simplified by having the auxiliary window secured to or mounted within the camera and the expansible and contractible member fixed to the body of the camera and to the transparent medium through which the object is being observed. In this latter instance the expansible and contractible member might be provided with a suction ring having an evacuation pump so that the device may be readily secured to any window through which the object is to be observed. It is further to be understood that it is within the scope of the present invention to incorporate, if desired, suitable coloring matter in the medium within the expansible and contractible member to filter the light rays as for example when taking natural color pictures. To determine the scope of the present invention, therefore, reference should be had to the appended claims.

What is claimed is:

1. In a refractive equalizer for photographing objects through a boundary between a medium in which the objects are contained and another medium of a different index of refraction, a window opposite said boundary, a camera having its focal line perpendicular to the plane of said window, means providing two degrees of rotational freedom for said window and said camera with respect to said boundary and means maintaining a medium having substantially the same index of refraction as the medium containing the objects between the boundary and said window.

2. In a refractive equalizer for viewing or photographing objects through a boundary between the medium in which they are contained and another medium of different index of refraction, a window arranged opposite said boundary having its plane perpendicular to the visual focal line, means providing said window with rotational freedom and means maintaining a medium between the boundary and said window having substantially the same index of refraction as the medium containing the objects.

3. In a refractive equalizer for viewing or photographing submerged objects through a window, an auxiliary window having its plane perpendicular to the visual focal line arranged opposite said

window, means providing said auxiliary window with rotational freedom and means maintaining a medium between the window and said auxiliary window having substantially the same index of refraction as that containing the objects.

4. In a refractive equalizer for viewing or photographing submerged objects through a window, an auxiliary window free to move in front of the window and having its plane perpendicular to the visual focal line, and means maintaining a medium having substantially the same index of refraction as that containing the objects between the window and said auxiliary window.

5. In a refractive equalizer for viewing or photographing submerged objects through a window, an auxiliary window free to move in front of the window and having its plane perpendicular to the visual focal line, and means maintaining a light filtering medium having substantially the same index of refraction as that containing the objects between the window and said auxiliary window.

6. In a device for photographing submerged objects including a camera and a window through which the photograph is to be taken, an auxiliary window arranged for movement opposite the first named window, means maintaining the focal line of the camera perpendicular to the plane of said auxiliary window and means maintaining a medium having substantially the same index of refraction as that of the medium containing the object being photographed between the first named window and said auxiliary window.

7. In a device for photographing submerged objects through a window, an auxiliary window, means mounting said auxiliary window opposite the first named window for movement relative to the first named window, means maintaining a medium having substantially the same index of refraction as that containing the object being photographed between the window and said auxiliary window and camera mounting means secured to said auxiliary window so constructed and arranged that the focal line of the camera is maintained perpendicular to the plane of said auxiliary window.

8. In a device for photographing submerged objects through a window, an auxiliary window, means mounting said auxiliary window opposite the first named window for movement in horizontal and vertical planes, resilient expansible and contractible means between said auxiliary window and the first named window containing a medium having substantially the same index of refraction as that containing the object being photographed and camera mounting means secured to said auxiliary window so constructed and arranged that the focal line of the camera is maintained perpendicular to the plane of said auxiliary window.

9. In a device for photographing submerged objects through a window, an auxiliary window, means mounting said auxiliary window opposite the first named window for movement, resilient expansible and contractible means between said auxiliary window and the first named window, a reservoir opening into said resilient expansible and contractible means to supply a medium to the interior of said expansible and contractible means having substantially the same index of refraction as that containing the object being photographed and affording an overflow receiver when said expansible and contractible means is distorted and camera carrying means secured to said auxiliary window so constructed and arranged that the focal line of the camera is maintained perpendicular to the plane of said auxiliary window.

10. In a device for photographing submerged objects through a window, a frame secured to said window, an auxiliary window, pivot means carried by said frame supporting said auxiliary window, a resilient expansible and contractible member carried by said frame and surrounding said auxiliary window, a fluid having substantially the same index of refraction as that containing the object being photographed within said resilient expansible and contractible member and camera supporting means secured to said auxiliary window so constructed and arranged that the focal line of the camera is maintained perpendicular to the plane of said auxiliary window.

11. In a device for photographing submerged objects through a window, a frame secured to said window, a second frame mounted on vertical pivots within said first named frame, an auxiliary window mounted on horizontal pivots withing said second named frame, resilient expansible and contractible means surrounding said auxiliary window and secured to said first named frame containing a medium having substantially the same index of refraction as that containing the object being photographed and camera mounting means secured to said auxiliary window and so constructed and arranged that the focal line of the camera is maintained perpendicular to the plane of said auxiliary window.

12. In a device for photographing objects under water through a window, a frame secured to the window, a second frame mounted upon vertical pivots within said first named frame, a third frame mounted uopn horizontal pivots within said second named frame, an auxiliary window secured to said third named frame, resilient expansible and contractible means surrounding said auxiliary window and secured to said first named frame containing a medium having substantially the same index of refraction as the water containing the object being photographed and camera supporting means secured to said third named frame so constructed and arranged that the focal line of the camera is maintained perpendicular to the plane of said auxiliary window.

13. In a device for the photographing of objects under water through a window, a frame secured to the window, a second frame mounted on vertical pivots within said first named frame, a third frame mounted on horizontal pivots within said second named frame, camera mounting means secured to said third named frame, adjustable resilient means coacting between said second named and said third named frames to counterbalance the weight of the camera on said camera mounting means, an auxiliary window carried by said third named frame, resilient expansible and contractible means forming a fluid-tight seal about said auxiliary window and secured to and forming a fluid-tight seal with said first named frame, a medium having substantially the same index of refraction as that containing the object being photographed within said resilient expansible and contractible means, said auxiliary window and said camera mounting means being so constructed and arranged that the focal line of the camera is maintained perpendicular to the plane of said auxiliary window.

14. In a device for photographing submerged

objects through a window, an auxiliary window, means mounting said auxiliary window opposite the first named window, resilient expansible and contractible means between said auxiliary window and the first named window, a medium having substantially the same index of refraction as that containing the object being photographed within said resilient expansible and contractible means, camera carrying means secured to said auxiliary window so constructed and arranged that the focal line of the camera is manitained perpendicular to the plane of said auxiliary window and adjustable resilient means to counterbalance the weight of the camera on said camera carrying means.

15. In a device for the photographing of objects under water through a window, a frame secured to the window, a second frame mounted on vertical pivots within said first named frame, a third frame mounted on horizontal pivots within said second named frame, camera mounting means secured to said third named frame, adjustable resilient means coacting between said second named and said third named frames to counterbalance the weight of the camera on said camera carrying means, an auxiliary window carried by said third named frame, resilient expansible and contractible means forming a fluid-tight seal about said auxiliary window and secured to and forming a fluid-tight seal with said first named frame and a reservoir opening into said resilient expansible and contractible means to supply a medium to the interior of said expansible and contractible means having substantially the same index of refraction as that of the object being photographed and affording an overflow receiver when said expansible and contractible means is distorted, said auxiliary window and said camera mounting means being so constructed and arranged that the focal line of the camera is maintained perpendicular to the plane of said auxiliary window.

GEORGE W. BARNES.

March 12, 1946. E. R. F. JOHNSON 2,396,267

DEVICE FOR VIEWING UNDERWATER BODIES

Filed Oct. 27, 1942 3 Sheets-Sheet 1

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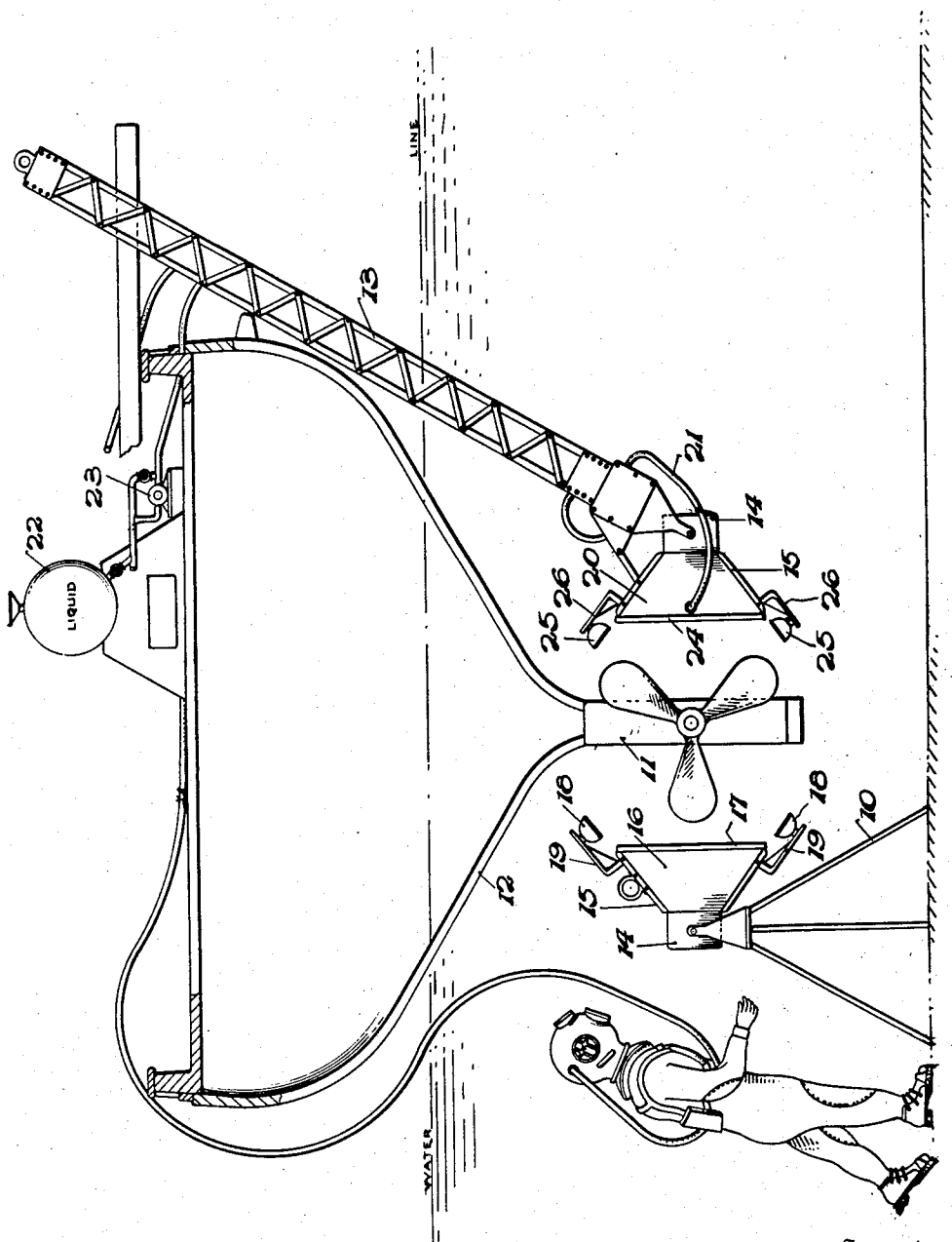

Fig. 1.

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DEVICE FOR VIEWING UNDERWATER BODIES

Filed Oct. 27, 1942 3 Sheets-Sheet 2

Fig. 3.

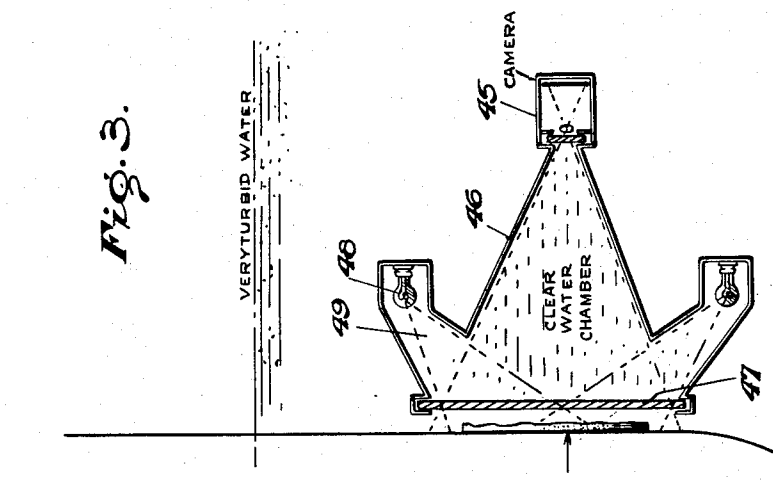
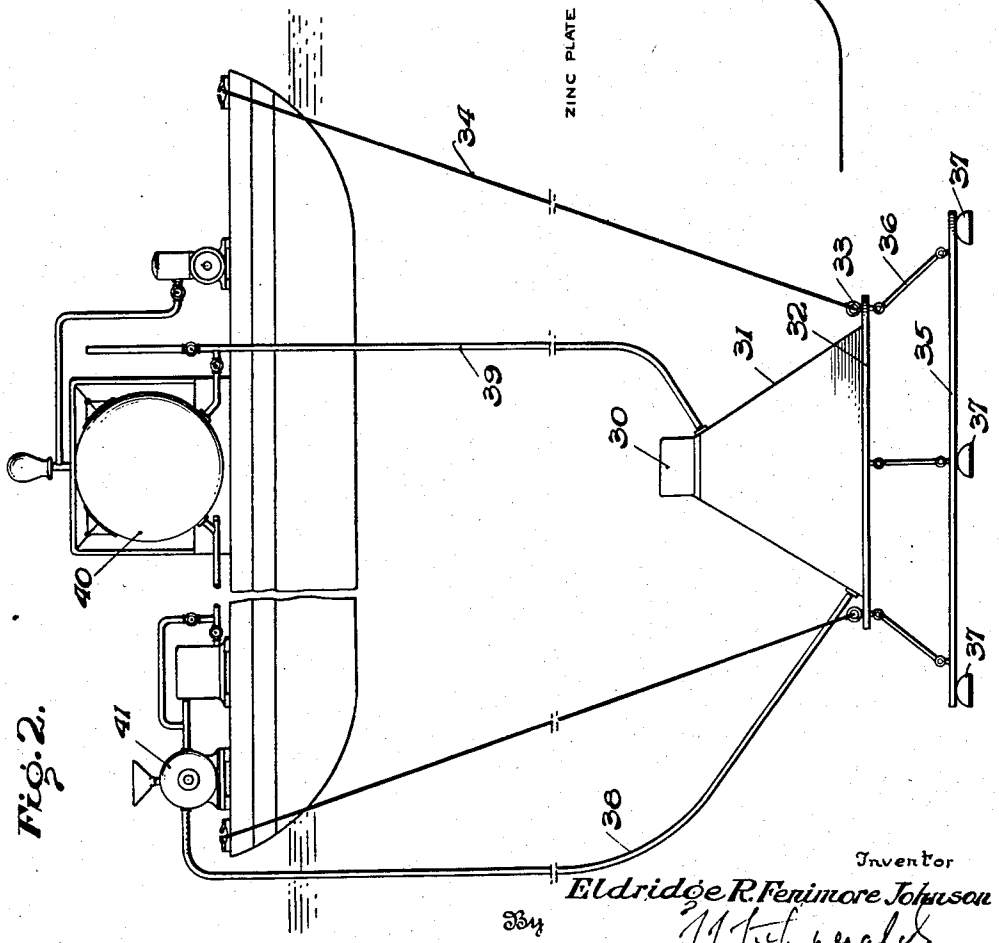


Fig. 2.



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DEVICE FOR VIEWING UNDERWATER BODIES

Filed Oct. 27, 1942 3 Sheets-Sheet 3

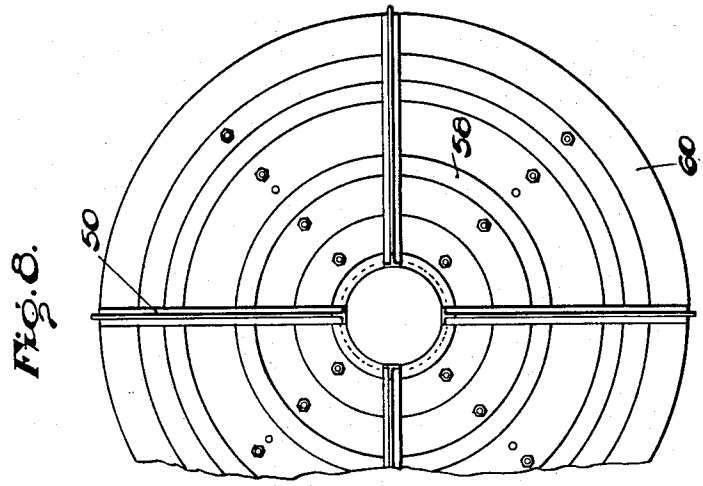

Fig. 8.

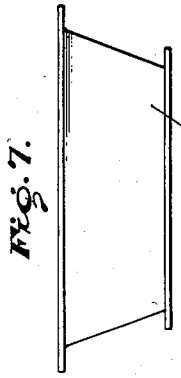

Fig. 7.

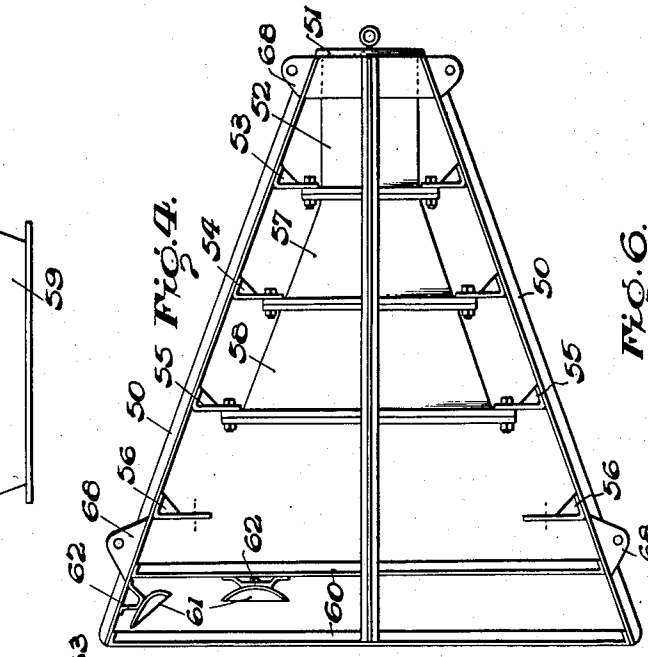

Fig. 4.

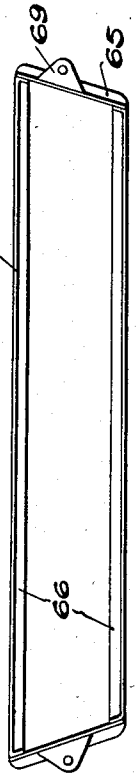

Fig. 6.

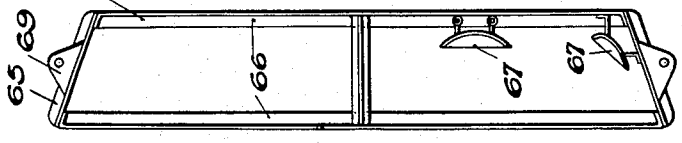

Fig. 5.

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Patented Mar. 12, 1946

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DEVICE FOR VIEWING UNDERWATER BODIES

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Application October 27, 1942, Serial No. 463,555
5 Claims. (Cl. 88—1)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

This invention relates to viewing and photographing objects submerged in turbid water, as may be encountered in rivers and harbors, for example. More particularly, the invention relates to a novel attachment for use with a water glass, a hydroscope, or an underwater camera, to enable better underwater viewing or photographing when the water is relatively turbid. A device of the character referred to is possessed of a wide utility, as for the examination of underwater bodies to determine the degree or extent of electrolysis or corrosion, surveying underwater damage in the case of vessels and other bodies, viewing or photography of submarine life in bodies of water where the turbidity is such that satisfactory views or photographs cannot otherwise be taken, etc.

It has heretofore been proposed to provide hydroscopes or hydrotelescopes for observing underwater bodies, which may be of varying or adjustable lengths, and to provide watertight cases for cameras which may be lowered on lines or extendible mounts from the surface or carried below by divers. Such devices may be equipped with a source of illumination or depend upon natural light. Some of these devices work well in clear water, and by means of them it is also possible to view or photograph objects in turbid water provided the objective end window of the device can be positioned close enough to the object so that it is within the maximum range of vision for photography over which it is possible to see or photograph in any given body of turbid water. However, the range of vision for photography is only from about eight inches to three feet in many rivers and harbors, especially in those which are commercially important. It is impracticable to use a hydroscope, hydrotelescope, or underwater camera in such rivers and harbors, probably because the area which can be viewed at any given moment, or photographed by single exposure, is too small to be of practical value when the objective window of the device must be placed within three feet of the object.

Some underwater viewing devices, for example the common glass-bottomed bucket or water glass, function only by flattening the surface of the water, that is, the boundary line between the air and the water. Others have an additional function, namely, that of displacing a mass of water from between the eye and the submerged object to be viewed.

It is characteristic of all underwater viewing devices, such as hydroscopes, submarine telescopes, and the like, that when they displace a mass of water they do so by means of an air-filled tube, either straight-sided or tapered and having walls and glass bottoms strong enough to withstand the pressure of the surrounding water. Frequently, weight must be added to their structures to overcome buoyancy, this weight being over and above the weight which is inherent in structures made to withstand water pressure. Because of the weight required to counteract buoyancy, even those viewing devices which extend only a short distance into the water have all been limited to small degrees of taper in the order of five degrees or less, as shown, for example, in the patent to Hubbard, No. 572,803. Even with this small degree of taper, devices having ten to thirty feet of submerged tube are heavy and consequently awkward to transport or use.

It is an object of this invention to provide a device which overcomes these difficulties and which is of light weight, easily transported and positioned, and capable of affording clear views and taking clear photographs of relatively large areas of underwater bodies even though the water is of the aforementioned order of turbidity.

Another object of this invention is to provide a device of the character referred to with means for illuminating the object without the introduction of glare or reflection to interfere with the clarity of the photograph, even when it is impossible to place the illuminating means either around or forward of the object window, as, for example, where the turbidity reduces the range of vision for photography to less than three feet thus making it necessary to position the window at less than three feet from the object, and it is desired to use a window six feet in diameter.

Another object of this invention is to provide a device of the character referred to with means of illumination which do not produce mirrored images of the illuminating means reflected into the eye or camera lens.

Another object of this invention is to provide a device of the character referred to which may be made in relatively small light units or intermediate units or large heavy units, depending upon the size of the area to be viewed, and the depths and turbidity of the water through which the area is to be viewed, or depending upon the size of the area to be photographed and the turbidity of the water through which the area is to be photographed.

Another object of this invention is to provide a device of the character referred to which may be composed of readily built-up units so as to

vary the size in conformity with the service to be performed.

Another object of this invention is to provide a device of the character referred to wherein the accessory elements may be conveniently located above the surface of the water.

Another object of this invention is to provide a device of the character referred to which may be conveniently associated with a camera for use on a tripod or operated from a station at or above the surface of the water as convenience requires.

Another object of this invention is to provide a device of the character referred to which is highly flexible in use and capable of a wide variety of applications in improving photographs taken in relatively turbid water.

Other objects will appear as the description of the invention proceeds.

As previously indicated, it has heretofore been proposed to view or photograph underwater bodies by means of a hydrotelescope or other tubular structure wherein an objective lens or window is disposed at the end of a tube, the walls of which may diverge at angles of the order of five degrees depending upon the ratio of the objective lens, or the window, to the eyepiece as determined by the optical train employed, and which may have sources of illumination with or without reflectors disposed at or adjacent the objective lens or window, and which utilize the displacement of water by the more transparent medium of air. However, the present invention utilizes the displacement of turbid water by the more transparent medium of clear water, as hereinafter explained in detail, being thus freed of both buoyancy and the tendency to collapse under the weight of surrounding water. Large, thin and even flexible chamber walls are used which diverge at angles of thirty to ninety degrees and are closed at the large end by a transparent pane six feet or more in diameter, thus greatly increasing the area which may be viewed or photographed in turbid water. Again, whereas it is old to provide a hydrotelescope or glass-ended structure with illuminating and reflecting means at or adjacent to the objective lens or window, the present invention, broadly considered, eliminates glare, reflection, etc., by employing a body of transparent medium, clear water, as above referred to, having an index of refraction which is only slightly different from a glass or plastic window pane and equal to the surrounding turbid water, and thus, if illumination of the object viewed or photographed from forward of the end window is not feasible or desirable, the source of illumination may be placed behind the end window without causing it to glare and is so placed and shielded that its image on the inner surface of the end window is not visible to the eye or camera.

Referring in detail to the accompanying drawings, wherein the same reference characters are employed to designate corresponding parts in the several figures,

Fig. 1 is a somewhat schematic view illustrating two embodiments of the invention attached to underwater cameras mounted in different ways;

Fig. 2 is another schematic illustration showing another embodiment of the present invention attached to a camera;

Fig. 3 is a diagrammatic cross section illustrating a third embodiment of the present invention attached to a camera;

Fig. 4 is a schematic elevation of another embodiment of the present invention attached to an underwater camera with both the camera and the embodiment mounted in a framework;

Figs. 5, 6 and 7 are schematic elevations of additional units for use with the embodiment of Fig. 4; and

Fig. 8 is an end view, partly broken away, of the embodiment of Fig. 4.

Referring in detail to the accompanying drawings, the several embodiments illustrated are characterized by means, in association with a camera, or an underwater camera, a water glass, or a hydroscope, etc., which may be of any suitable size, character and construction and which forms no part of the present invention. Such means may take the form of an attachment for a camera or water glass, etc., or may take the form of a continuation of a housing of a camera or the continuation of the tubular structure of a water glass, providing an additional chamber for the retention in place between the camera or water glass and the object to be viewed or photographed, of a mass of clear liquid, preferably filtered or distilled water. The transparent wall at the base of the conical or pyramidal container for the clear liquid is preferably made slightly convex so that water flowing across the external surface will not entrain air or form cavitation at the external or end surface to interfere with the clarity of vision or photography. By using a material for the transparent pane having an index of refraction nearly equal to the surrounding turbid water and the contained clear liquid, such slight convexity will not materially distort either vision or photography.

The object to be photographed may be illuminated in any suitable way, as by sources of illumination supported at, around, or outside or in adjacency to the aforesaid front face of the end or object window pane. However, where the device is to be used with its front face relatively close to the photographic or viewed object, so that it is not feasible to place the sources of illumination in front of the front face, the present invention involves the feature of disposing the sources of illumination behind the object end window at such an angle that the mirrored images of the sources of illumination appearing on the said front wall will not be reflected into the eye or camera lens. This may be done when the transparent window pane confining the clear liquid has about the same index of refraction as the clear liquid retained thereby. For example, when the clear liquid is filtered water and the front window is a transparent pane of glass or Lucite, only mirrored images without appreciable surrounding surface glare are formed on said pane by the sources of illumination and by properly selecting the angles of incident said mirrored images may be kept out of the visual or photographic field of view.

Referring now to Fig. 1, the invention is illustrated as embodied in two devices employing the principle of the present invention, one a device attached to an underwater camera mounted on a tripod 10, as when a diver desires to take a photograph in turbid water of an underwater body, such as the keel 11 of a vessel 12, and the other in the form of a device attached to an underwater camera supported by a long boom 13 which may be mounted in any suitable way from the deck of the vessel 12 and which, as illustrated, may take the form of a lazy tongs device so that the depth of immersion may be varied as desired and from which the member 15 may be supported

or suspended in any suitable way. In each of these embodiments the camera 14, which may be of any suitable character, has associated therewith, either integrally or by suitable attachment, a conical or pyramidal member 15 adapted to constitute a fluid-tight wall of a windowed chamber for confining a clear liquid. The angle defined by the member 15 preferably coincides approximately with the cone of vision of the camera 14, usually thirty to ninety degrees, and may be made of any suitable length.

The member 15 at the left of Figure 1 may be taken as typical of small size embodiments wherein the transparent medium is a confined body of clear gas such as air, or a clear liquid of such small weight that the device may be filled while on deck, lifted and put overboard, in which case the front wall of the chamber 16 confining said fluid is constituted by a transparent pane 17, preferably having a front face that is slightly convex as above explained, and which is secured in any suitable way in fluid-tight engagement with the lateral wall of the member 15. In this embodiment illumination is provided by one or more lamps 18, with or without reflectors, suitably supported by brackets 19 from the member 15 and disposed forwardly of the pane 17, and at a suitable angle, so as properly to illuminate the object to be photographed.

The member 15 at the right of Figure 1 may be taken as typical of embodiments wherein the length of the member may be increased to the point where it is not practicable to charge it with the clear liquid until the depth of immersion can be kept even with the rise of the water level in the chamber 20, so that the transparent pane 24 will not be broken by pressure either internal or external exerted by a weight of water. In this embodiment the chamber 20 is shown as communicating with a pipe or other suitable conduit 21 through which the liquid that fills said chamber may be suitably supplied from any suitable source, as the container 22 placed on the deck of the vessel 12, a pump being diagrammatically illustrated at 23 for filling and emptying said chamber. As in the first described embodiment, the front of the chamber 20 is completed by a transparent pane 24, preferably having a front surface that is slightly convex as above explained, said pane also preferably having an index of refraction which closely approximates that of the liquid in which the device is immersed, and also the liquid occupying the chamber 20. As in the first described embodiment, illumination may be provided by one or more lamps 25, with or without reflectors, suitably supported in front of the pane 24 as by brackets 26.

The embodiment of Fig. 2 is a form particularly adapted for photographing the bottom, and as here shown the camera 30, of any suitable character, has associated therewith a conical or pyramidal member 31 the angle of whose sides approximates the cone of vision of said camera. The forward face of said member is closed by a transparent pane as before described. As here shown, the larger end of said member 31 is provided with a suitable ring 32 carrying eyebolts 33 so that the device may be suitably suspended from a vessel, float, etc., as by cables 34. In this embodiment a second ring or frame structure 35 is suspended from the ring 32 by suitable links 36 and carries suitable sources of illumination at 37. As illustrated, the member 31 is of the type providing a chamber adapted to be filled with a clear liquid, and to this end said chamber has a suitable conduit 38 communicating therewith and with a source of liquid, a pump 41 being provided for filling from or emptying to the tank 40 the chamber provided by the member 31. The material of which the member 31 is made may be sheet metal of any suitable thickness or may be a flexible waterproof textile fabric. When this member is made of flexible fabric, it may be distended and held in shape by hydraulic force, if the head of water in conduit 38 and container 40 is sufficient to bear the submerged weight of the underwater camera 30. If it is not sufficient, then additional force may be exerted on the head of water by means of the air pump 42.

Another embodiment of the present invention is illustrated in Fig. 3 showing a preferred construction when the device of the present invention is desirably placed so close to the object to be photographed that the mounting of the sources of illumination in front of the larger end of the device is not feasible. As here shown, the camera 45 has associated therewith a conical or pyramidal member 46. As in embodiments earlier described, the large end of the chamber provided by said member 46 is closed by a transparent pane 47 having a fluid tight seal with said member 46 and taking any of the forms heretofore described. In this embodiment, the sources of illumination 48 are disposed in chambers 49 which branch from the main chamber within member 46 and are so constructed and arranged, as illustrated by dotted lines in Fig. 3 that the images of the sources of illumination on the pane 47 are not reflected into the camera lens as may be effected by selecting suitable angles of incidence on the wall 47. The index of refraction of the pane 47 and of the liquid within the chamber 46 is preferably made substantially the same and substantially the same as the liquid in which the device is immersed, whereby only mirrored images of the sources of illumination are formed on the pane 47, and by suitably selecting the angles of incidence these mirrored images may be so located as not to be visible along the optical axis of the camera. There is no wall between the main body of the chamber and the branch chambers 49, so that the lamps 48 are immersed in the clear liquid.

The embodiment of Figs. 4 to 8 illustrates a built-up structure which may be made of any suitable size depending upon the service to be performed. As here shown, a conical or pyramidal frame composed of a suitable number of longitudinal members 50 is mounted on any suitable base ring 51 which may be attached to or form a part of a camera housing here diagrammatically indicated at 52. Frame members 50 carry any suitable number of sets of inwardly extending brackets 53, 54, 55 and 56, to which may be suitably attached, as by bolting, one or more complementary conical or pyramidal structures 57, 58 and 59 (Fig. 7) which may be containers for transparent fluid as heretofore described. Fig. 4 shows two of such members, 57 and 58, in position, and Fig. 7 illustrates at 59 a detached member which may be mounted on the brackets 56 in extension and continuation of the members 57 and 58 if a more extended displacement of the turbid medium is desired. At their outer extremities, the longitudinal members 50 are connected by one or more peripheral rings 60 which may be provided with light sources, with or without reflectors, as indicated at 61 carried by brackets 62 from said longitudinal members or peripheral

rings. The frame itself is preferably provided with sections which may be added when extension is desired and removed for compactness in transportation and storage, one section being shown at **63** in Fig. 5, and a second section being shown at **64** in Fig. 6, the latter being of such a size that it can be added to the left-hand side of the section **63** of Fig. 5 as viewed in the drawings. Succeeding sections may be attached to the main frame and to each other in any suitable way. Each of said sections has longitudinally extending members **65** with peripheral rings **66** at their extremities, and one or more of such extensions may be provided with means supplying sources of light as shown at **67** in Fig. 5, so that as the length of the structure as a whole is extended the lights may be advanced to a position at or adjacent to the larger end thereof. The main frame structure **50** is provided with suitable brackets **68** whereby the device may be readily supported or suspended within the turbid medium, and each of the extension pieces, as **63** and **64** in Figs. 5 and 6, is also provided with a similar bracket **69** so that when added to the structure the latter may have one of its supports at or adjacent to the larger end of the assembled device. As will be apparent, when the weight of the structure as a whole is about equal to the weight of the turbid liquid displaced there is almost no limit to the practical size that can be employed by adding sections both to the frame structure and to the means forming or enclosing the transparent medium. The sections **57**, **58**, **59**, etc., may be placed in communication by using a pane only at the forward end of the largest section. In this embodiment the stiffness of the structure as a whole is effected by using a rigid frame construction. However, as next to appear, rigidity may be obtained with use of an otherwise non-rigid structure by employing as the transparent medium a liquid which is maintained under suitable pressure.

The present invention may also be readily embodied in structures that are collapsible, or composed of collapsible sections, to facilitate installation as well as storage and transportation. For example, the embodiment shown in Fig. 2, particularly when built in relatively large sizes, may have member **31** of collapsible construction, composed for example of waterproof reenforced canvas. Such a collapsible unit is much easier to set up in operating position, as well as to store or transport, and when filled with transparent liquid in conformity with the present invention, and the liquid placed under pressure, the desired rigidity may be obtained.

Any suitable means may be employed for imposing the desired pressure on the liquid. Preferably the pressure is imposed by means of a compressible gas, such as air. Thus in the embodiment of Fig. 2 compressed air may be applied to the liquid in member **31** through pipe **39** which is in communication with an air dome **40** associated with any suitable air compressor. By employing compressed gas for imposing pressure on the liquid the amount of pressure can be readily controlled while shocks can be absorbed with less likelihood of damage. At the same time, the liquid in the member **31** being incompressible, the pressure of the gas used to obtain proper rigidity may be the same notwithstanding variations in the depth of submergence. However, within the broader aspects of the present invention the pressure may be applied to the liquid in any other suitable way rather than by gas pressure, as by a mechanical means such as a plunger and weight.

While in the embodiments illustrated on the drawings, and in conformity with the preferred practice, the windowed bag or chamber confining the transparent medium, that is, clear liquid, has been indicated as of conical or pyramidal shape, the invention is not limited thereto, as any other suitable shape of bag or chamber providing the requisite cone of vision may be employed. Thus, for example, the bag or chamber could be of cubical or other suitable polyhedral shape provided the forward face is of the proper size to carry into effect the principles of the present invention.

By using a medium or mediums having an index or indices of refraction not much different from the displaced liquid, glare from the observer's side or the camera's side of all boundary planes between the displaced liquid and said medium or mediums is substantially eliminated when the source of illumination is on the same side of the plane of contact between the displaced liquid and the transparent medium as the camera or the eye of the observer. Then, by increasing the angle between the rays from the source and the axis of the objective, whether the eye or a camera lens, where they intersect upon the boundary between the displaced liquid and the transparent medium, and at the same time shielding the source of the rays so that they cannot cross the axis of the objective lens until they have passed beyond said boundary plane, reflection of the image of the source into the eye of the observer or the lens of the camera is avoided. This involves, as will now be apparent, not only the selection of the angle of incidence but the shielding of the source of illumination as hereinbefore explained. While in the embodiments illustrated the source of illumination has been shown as composed of separate properly shielded lamps, the source of illumination may if desired take any other suitable form as a ring of light in an annular chamber attached to the main member providing the transparent medium, the chamber containing the source of illumination and surrounding said main member being circular or polygonal depending upon the contour of said member.

It will therefore be perceived that by the present invention means have been provided whereby greatly improved photographs may be taken of underwater bodies in relatively turbid water. This has been accomplished with provision for adequate illumination and without the danger of glare that has heretofore been characteristic of devices employing sources of illumination in submarine telescopes or glass-ended structures. The invention may be readily incorporated in camera structures or provided as an accessory therefor. It enables the water-displacing means to have a wide variety of sizes and weights so that it may be satisfactorily used either in small sizes for mounting upon a tripod or in larger sizes, in which event it may be readily operated from above the surface of the water. The apparatus of the present invention may be readily made collapsible, or composed of sections which may be disconnected, for compactness in storage and transportation, and when composed of sections sections may be added to or subtracted to vary the size of the device in conformity with the character of the service to be performed. Difficulties heretofore encountered from glare have been largely avoided. By making the for-

ward face of the transparent mass slightly convex the danger of flowing water introducing difficulties because of bodies of air therein has been substantially if not entirely eliminated. While the invention may be used with sources of illumination in front of the apparatus so as to adequately illuminate the photographic object, the present invention also enables the apparatus to be brought closely adjacent the object to be photographed with disposition of the sources of illumination to the rear of the forward face of the apparatus without introducing the difficulties of glare and reflection heretofore encountered. The device is also relatively simple in character and easily manipulated.

In the appended claims it is to be understood that reference to "viewing" underwater bodies is intended to embrace inspection as well as photographing, and reference to an objective lens is intended to embrace not only the objective lens of a camera but also the objective lens of any suitable optical train or the human eye.

While certain embodiments of the invention have been illustrated with considerable particularity, it is to be expressly understood that they are not intended to indicate the limits of the invention, but rather they have been selected to exemplify different expressions of the invention, others of which will now readily suggest themselves to those skilled in the art, while numerous changes may be made in the details of construction, arrangement, proportion, etc., and certain features may be used without other features, without departing from the spirit of the invention. Reference is therefore to be had to the appended claims for a definition of said invention.

The invention herein described 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.

What is claimed is:

1. In an apparatus for viewing an underwater body at a distance in turbid water and having an air chamber provided with a viewing location for receiving an objective lens for viewing the body, the combination of a hollow, closed member covering and aligned with said location and displacing a sufficient portion of the turbid water from the cone of vision from said location to embrace an angle on the order of said cone of vision, the member extending a substantial distance from said location and approximately to said body to be viewed and having a transparent forward end wall aligned with said location and substantially coinciding with said cone of vision, and a clear liquid confined by said member and having generally the same index of refraction as the water, said liquid substantially filling the member whereby the apparatus is of substantially the same specific gravity as the water.

2. In an apparatus for viewing an underwater body at a distance in turbid water and having an air chamber provided with a viewing location for receiving an objective lens for viewing the body, the combination of a hollow, closed member covering and aligned with said location and displacing a sufficient portion of the turbid water from the cone of vision from said location to embrace an angle on the order of said cone of vision, the member extending a substantial distance from said location and approximately to said body to be viewed and having a transparent forward end wall aligned with said location and substantially coinciding with said cone of vision, a clear liquid confined by said member and having generally the same index of refraction as the water, said liquid substantially filling the member whereby the apparatus is of substantially the same specific gravity as the water, and illuminating means mounted on the member rearwardly of said forward end wall for illuminating through said wall the body to be viewed.

3. In an apparatus for viewing an underwater body at a distance in turbid water and having an air chamber provided with a viewing location for receiving an objective lens for viewing the body, the combination of a hollow, closed member covering and aligned with said location and displacing a sufficient portion of the turbid water from the cone of vision from said location to embrace an angle on the order of said cone of vision, the member extending a substantial distance from said location and approximately to said body to be viewed and having a transparent forward end wall aligned with said location and substantially coinciding with said cone of vision, a clear liquid confined by said member and having generally the same index of refraction as the water, said liquid substantially filling the member whereby the apparatus is of substantially the same specific gravity as the water, illuminating means mounted on the member rearwardly of said forward end wall for illuminating through said wall the body to be viewed, and shielding means associated with said illuminating means to prevent reflection of the images of said illuminating means along the axis of the cone of vision from said location.

4. In an apparatus for viewing an underwater body at a distance in turbid water and having an air chamber provided with a viewing location for receiving an objective lens for viewing the body, the combination of a hollow, collapsible member covering and aligned with said location and displacing a sufficient portion of the turbid water from the cone of vision from said location to embrace an angle on the order of said cone of vision, the member extending a substantial distance from said location and approximately to said body to be viewed and having a transparent forward end wall aligned with said location and substantially coinciding with said cone of vision, and a clear liquid confined by said collapsible member and having generally the same index of refraction as the water, said liquid substantially filling the member whereby the apparatus is of substantially the same specific gravity as the water.

5. In an apparatus for viewing an underwater body at a distance in turbid water and having an air chamber provided with a viewing location for receiving an objective lens for viewing the body, the combination of a hollow, collapsible member covering and aligned with said location and displacing a sufficient portion of the turbid water from the cone of vision from said location to embrace an angle on the order of said cone of vision, the member extending a substantial distance from said location and approximately to said body to be viewed and having a transparent forward end wall aligned with said location and substantially coinciding with said cone of vision, a clear liquid confined by said collapsible member and having generally the same index of refraction as the water, said liquid substantially filling the member whereby the apparatus is of substantially the same specific gravity as the water, and means for substantially filling the collapsible member with said liquid from above the surface of the water.

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United States Patent [19]

Clark

[11] **3,879,953**

[45] **Apr. 29, 1975**

[54] **DEVICE FOR UNDERWATER OBSERVATION**

[76] Inventor: **James Freeman Clark**, Sunderland River Rd., Arlington, Vt. 05250

[22] Filed: **May 22, 1974**

[21] Appl. No.: **472,402**

[52] **U.S. Cl.** ..... **61/63**; 61/69 R

[51] **Int. Cl.** **B63c 11/00**; B63c 11/48

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

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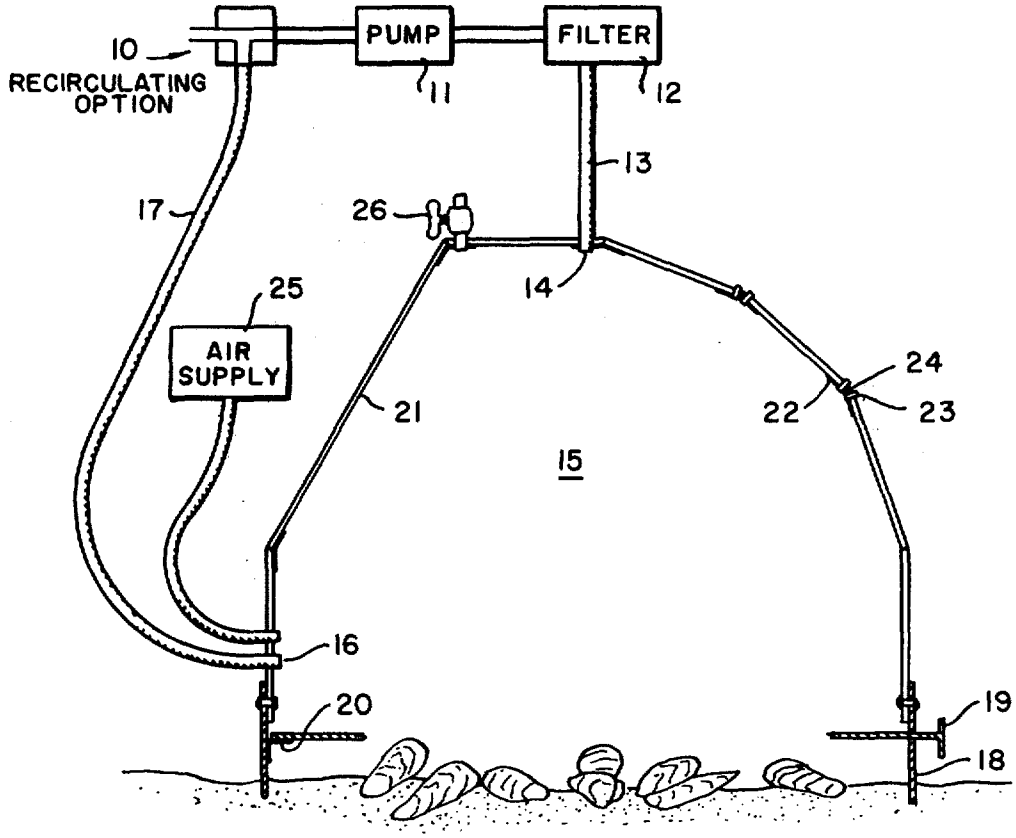
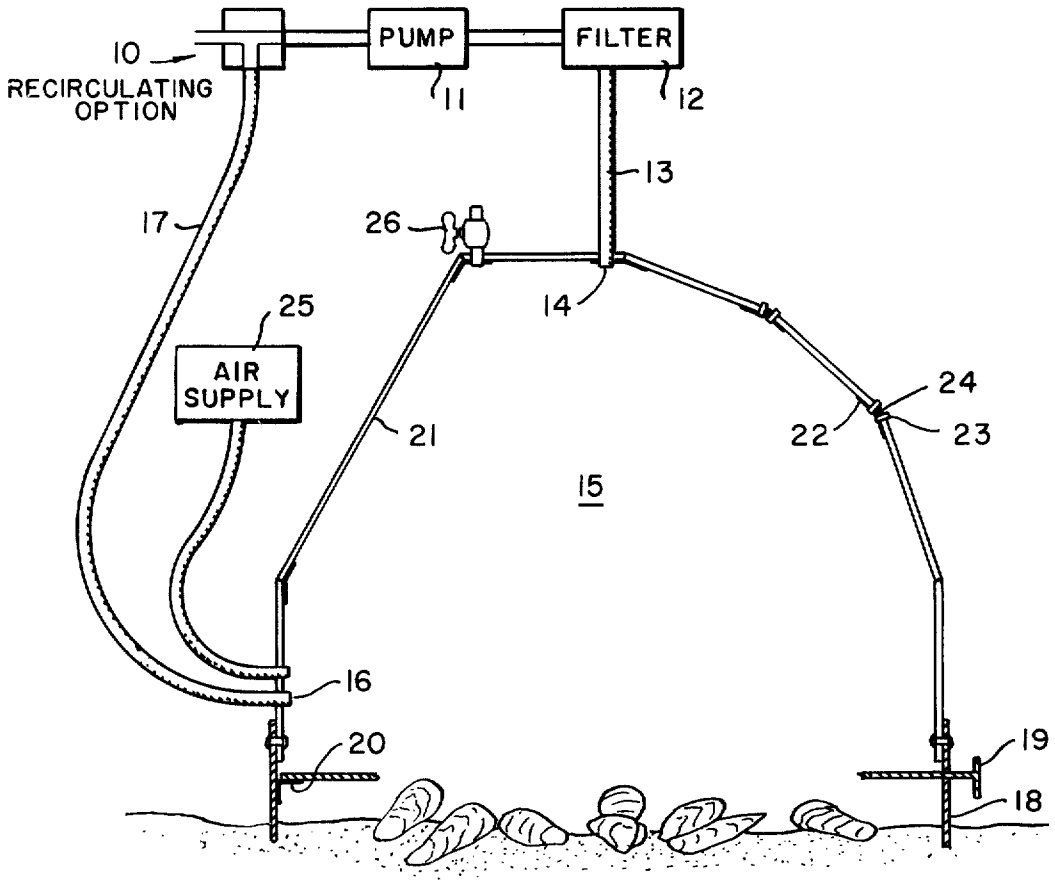
Assistant Examiner—Alex Grosz
Attorney, Agent, or Firm—R. S. Sciascia; P. Schneider

[57] **ABSTRACT**

A device permitting observation, visual or photograpahic, 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

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PUMP
11
FILTER
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AIR SUPPLY
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22
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24
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FIG. 1.

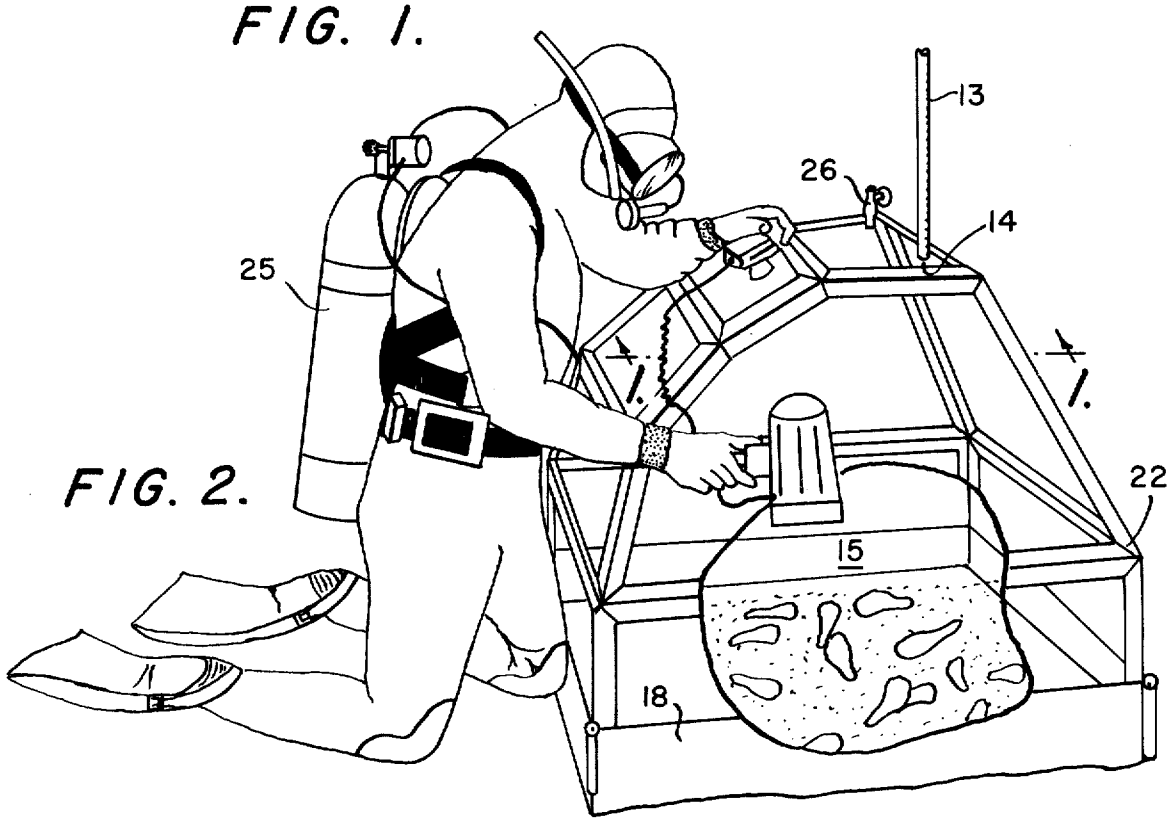
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FIG. 2.

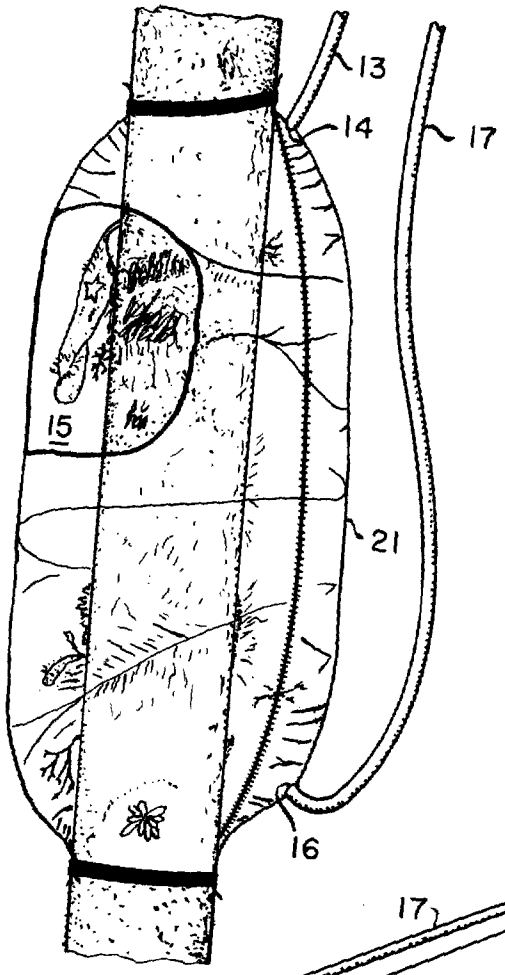
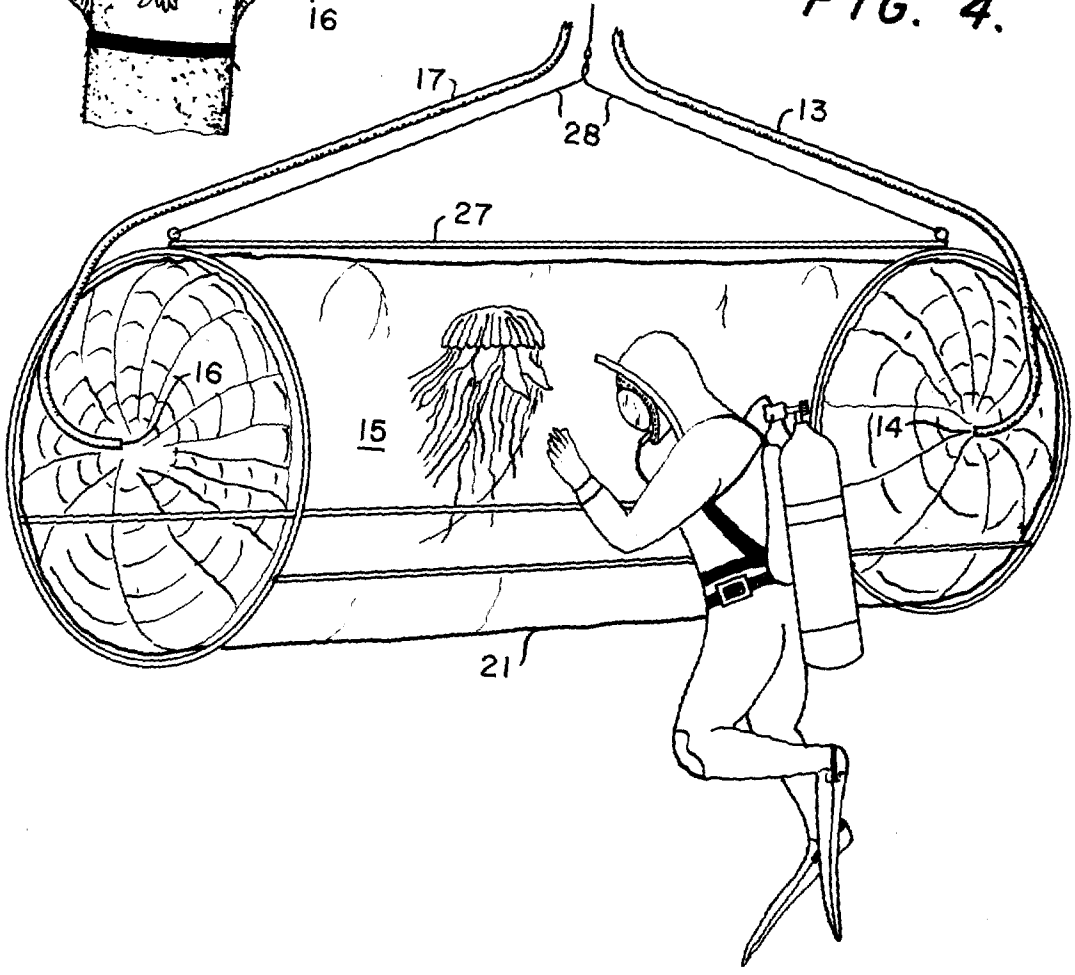


FIG. 3.

FIG. 4.



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 royalities 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 its 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 like 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 configures 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, transporation 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-

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 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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