

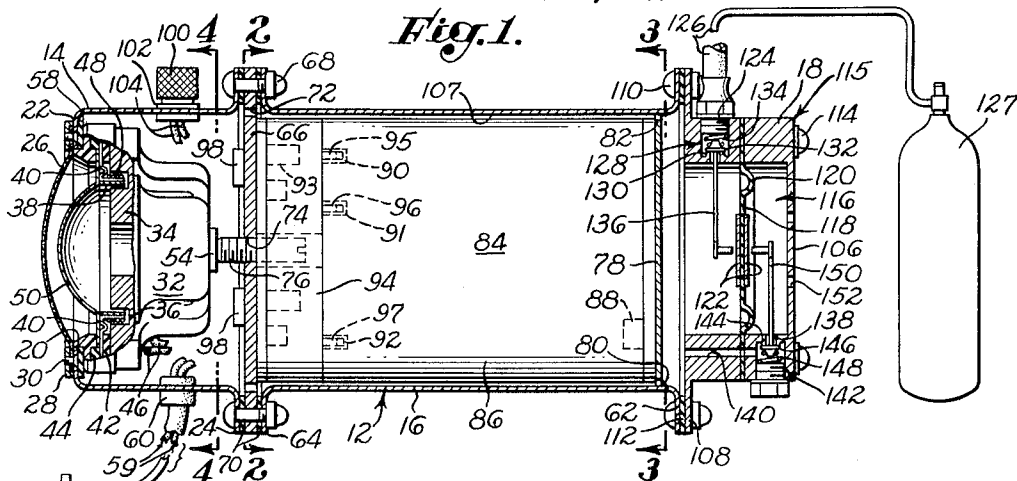
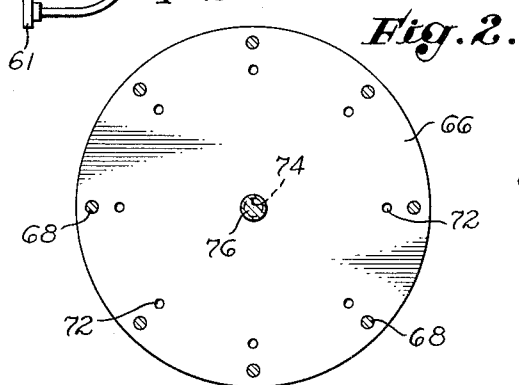
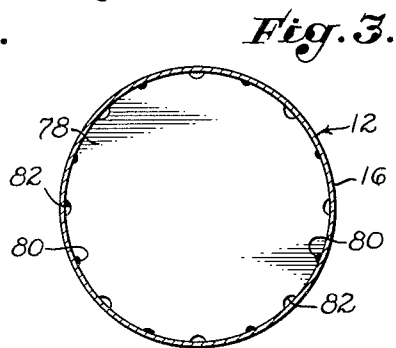
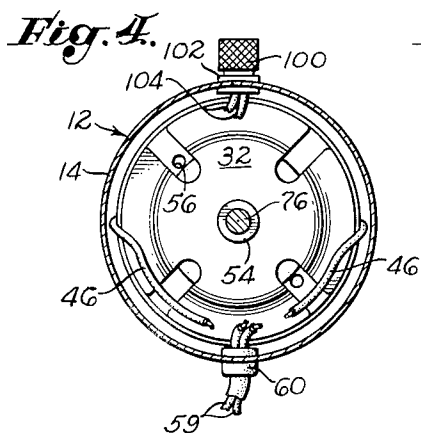
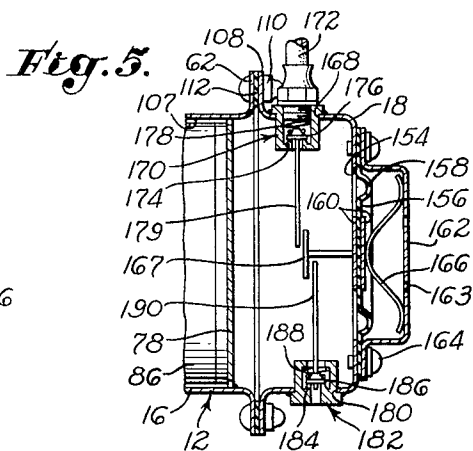
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UNDERWATER COMMUNICATOR

Filed June 28, 1963



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3,235,835

UNDERWATER COMMUNICATOR

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The present invention relates to a communication system for underwater and is particularly adapted for use in connection with self-contained underwater breathing apparatus.

Prior underwater communication systems have utilized both an electrical transmitting means carried by the speaker and an electrical receiving means carried by the listener. It is an object of this invention to provide an underwater communicator which transmits sound waves directly through the ambient water medium and which may be heard without the aid of an artificial receiver.

It is another object of this invention to provide a small and light underwater communicator particularly suitable for use in connection with self-contained underwater breathing apparatus and one which is portable and carries its own self-contained power supply. Another object of this invention is to provide an underwater communicator having a heat sink therein which is in contact with the ambient water medium for dissipating heat generated within the communicator to the ambient water medium.

It is a further object of this invention to provide an underwater communicator incorporating a dynamic transducer having a movable membrane communicating directly with the ambient water medium solely on the front side thereof and a voice coil having an electrical resistance of approximately one-half ohm.

Still another important object of this invention is to provide such an underwater communicator including a pressure regulating means for equalizing the pressures exerted on the front and rear sides of the movable membrane. A still further object of this invention is to provide an underwater communicator with a pressure regulating means which utilizes the compressed breathing air of the self-contained underwater breathing apparatus for equalizing the pressures exerted on the front and rear sides of the movable membrane.

It is an object of this invention to provide an underwater communicator, including the combination of a housing, a transducer positioned within the housing having a movable membrane communicating with the ambient water medium solely on the front side thereof, a power supply positioned within the housing for actuating the transducer, an amplifier unit within the housing connected between the power supply and the transducer, means for coupling an externally positioned microphone as an input to said amplifier unit, and a pressure regulating means mounted within the housing for controlling the difference in pressures exerted on the front and rear sides of the movable membrane.

Still another important object of this invention is to provide an underwater communicator, including the combination of a housing, a transducer positioned within the housing and having a movable membrane communicating with the ambient water medium solely on the front side thereof, a power supply positioned within the housing for actuating the transducer, an amplifier unit within the housing connected between the power supply and the transducer, means for coupling an externally positioned microphone as an input to said amplifier unit, and a pressure regulating means including a pressure chamber with at least one aperture communicating with the ambient water medium, a flexible diaphragm mounted between

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the aperture and the remaining interior of the housing and movable between extended and compressed positions in response to the pressure differential between the interior of the housing and the ambient water medium for controlling the difference in pressures exerted on both the front and rear sides of the movable membrane, first movable valve means positioned in the housing interior of the flexible diaphragm, means for coupling a source of compressed air to the first valve means, with the valve means being movably actuable by the diaphragm when in a compressed position for admitting compressed air into the housing, and second movable valve means communicating with the housing interior of the flexible diaphragm and movably actuable by the diaphragm when in an extended position for exhausting air from the housing.

A further object of the invention is to provide a pressure regulating means for an underwater device, including the combination of a housing for the device, a pressure chamber located within the housing with at least one aperture communicating with the ambient water medium, a flexible diaphragm mounted between the aperture and the remaining interior of the housing and movable between extended and compressed positions in response to the pressure differential between the interior of the housing and the ambient water medium for controlling the pressure differential therebetween, first movable valve means positioned within the housing interior of the diaphragm, means for coupling a source of compressed air to the first valve means, the first valve means being movably actuable by the flexible diaphragm when in a compressed position for admitting compressed air into the housing, and second movable valve means positioned within the housing communicating with the housing interior of the diaphragm and movably actuable by the diaphragm when in an extended position for exhausting air from the housing.

The foregoing objects, advantages, features and results of the present invention, together with various other objects, advantages, features and results thereof which will be evident to those skilled in the art to which the invention pertains, may be achieved with the exemplary embodiments described in detail hereinafter and illustrated in the accompanying drawing, in which:

FIG. 1 is a longitudinal cross-sectional view of the present invention;

FIG. 2 is a vertical sectional view of the invention taken along the line 2—2 of FIG. 1;

FIG. 3 is a vertical sectional view of the invention taken along the line 3—3 of FIG. 1;

FIG. 4 is a vertical sectional view of the invention taken along the line 4—4 of FIG. 1; and

FIG. 5 is a partial longitudinal cross-sectional view of an alternative embodiment of the present invention.

The underwater communicator of FIG. 1 includes a housing 12 comprising a first section 14, a second section 16, and a third section 18.

The first section 14 is cylindrical and provides an axial opening 20 at the forward end thereof defined by a radially inwardly directed flange 22 and a radially outwardly directed flange 24 located at the rearward end thereof. A perforated screen or grill 26 covers the axial opening 20 and is mounted on the exterior face of the flange 22 by a mounting ring 28 and screws 30.

A dynamic transducer 32 is mounted within the first section 14 on the interior side of the flange 22. The transducer 32 includes an annular permanent magnet 34 having an annular slot 36 located therein, an annular coil form 38 receivable within the slot 36 and longitudinally movable therewithin, and a pair of lead-in contacts 40 having a slightly altered L-shape, the short leg of the L engaging the exterior surface of the coil form 38 and the longer leg of the L being secured between two

annular insulating rings 42, 44 and connected to a lead-in wire 46. The transducer 32 also includes a coil 48 which is wound about the coil form 38, thus securing the short leg of the L-shaped lead-in contacts 40 between the coil 48 and the coil form 38, the coil having a resistance of approximately one-half ohm allowing for maximum power output within the confined space provided the transducer 32. The use of the one-half ohm voice coil 48 is particularly desirable since it can be used in a small space, is inexpensive, and does not require an output transformer in the amplifier unit 93. A movable membrane 50 comprised of a tough, flexible film such as Mylar or the like, is secured adjacent the pair of lead-in contacts 40 in fixed engagement with the forward edge of the coil form 38. A central abutment pad 54 is disposed at the rear of the magnet 34. Apertures 56 in the magnet (FIG. 4) provide for air passage between the face and rear thereof. A seal ring 58 is mounted between the transducer 32 and the interior of the flange 22. A pair of microphone wires 59 pass to the exterior of the housing 12 through a compression seal 60 and may extend to a standard throat microphone 61 worn about the neck of the user.

The second section 16 of the housing 12 is mounted adjacent the first section 14 and is also cylindrical and provides a radially outwardly extending flange 62 at the rearward end thereof and another radially outwardly extending flange 64 at the forward end thereof. A transverse heat sink 66 spans the interior of the housing 12 and is mounted between the first section 14 and the second section 16. More specifically, the radial flange 24 of the first section 14 and the radial flange 64 of the second section 16 are joined together by a plurality of bolt and nut combinations 68. The transverse heat sink 66 is positioned between the respective radial flanges, 24 and 64, and a pair of annular ring seals 70. A plurality of ports 72 is located in the heat sink 66 to permit the free flow of air between the first section 14 and the second section 16. A threaded axial port 74 in the heat sink 66 has a threaded setscrew 76 extending therethrough, which setscrew is longitudinally engageable with the abutment pad 54 at the rearward end of the transducer 32 for urging the transducer 32 forwardly into a seal fit against the radial flange 22 of the first section 14. A transverse plate 78 spans the interior of the second section 16 and is spot welded at points 80 to the housing 12 adjacent the rearward end of the second section 16. A plurality of peripheral ports 82 is located in the transverse plate 78.

Located within the second section 16 is a power supply unit 84 including a twelve-volt direct current battery pack 86. A disposable battery pack or a rechargeable battery pack may be used. If the rechargeable battery pack is utilized, a recharging input jack 88 may be positioned at the rear of the power supply unit 84. Three sockets 90, 91 and 92 comprise the output connections for the battery pack 86.

An amplifier unit 93 is mounted on the rearward side of the heat sink 66. The amplifier unit 93 is encased in a block of epoxy resin 94 and provides three pins 95, 96 and 97 which extend outwardly from the epoxy resin block and mate with the sockets 90, 91 and 92 of the battery pack 86. Transistors 98 used in connection with the amplifier unit 93 are shown as extending outwardly from the front side of the heat sink 66. An amplifier on-off, rotary type, two-position switch 100 is mounted on the exterior of the first section 14 and is connected to the interior of the housing 12 through a water-tight seal 102. The switch 100 is connected to the amplifier 93 by wires 104.

An air space 107 located circumferentially of the power supply unit 84 and within the second section 16 permits the free flow of air between the ports 72 in the heat sink 66 and the ports 82 in the transverse plate 78.

The third section 18 of the housing 12, as shown in

FIG. 1 of the drawing, includes an end plate 106 located at the rear thereof and a radially outwardly extending flange 108 at the forward end thereof. The third section 18 is secured to the second section 16 by securing the radial flange 108 thereof to the radial flange 62 of the second section 16 by a plurality of bolt and nut combinations 110. Secured between the respective radial flanges 62 and 108 is an annular seal ring 112. The end plate 106 is secured to the housing 12 by screws 114.

The third section 18 includes a pressure regulating unit 115 including a pressure chamber 116. Mounted between the end plate 106 of the third section 18 and the housing 12 and spanning the pressure chamber 116 is a flexible diaphragm 118 comprised of rubber or the like. The flexible diaphragm 118 has an annular groove 120 and a pair of axially located metal engaging plates 122 on the interior and exterior sides thereof.

An inlet aperture 124 is located in the outer wall of the third section 18 and a line 126 leading to a compressed air supply 127, such as that of the diver's self-contained underwater breathing apparatus, is connected thereto. Positioned within the inlet aperture 124 is a tilt valve 128 including a valve seat 130, a valve member 132 movably engageable with the valve seat 130, a spring 134 biasing the valve member into engagement with the valve seat 130, and a tilt arm 136 extending from the valve member 132 and movably engageable with the flexible diaphragm 118 when the diaphragm is in a compressed position for dislodging the valve member 132 from the valve seat 130.

Located in the third section 18 of the housing 12 is an outlet aperture 138 positioned exterior of the flexible diaphragm 118 but connected to the housing space interior of the diaphragm 118 by an air conduit 140. Mounted within the outlet aperture 138 is a tilt valve 142 including a valve seat 144, a valve member 146 movably engageable with the valve seat 144, a biasing spring 148 engageable with the valve member 146 for urging it into engagement with the valve seat 144, and a tilt arm 150 extending from the valve member 146 and movably engageable with the flexible diaphragm 118 when the diaphragm is in an extended position for dislodging the valve member 146 from engagement with the valve seat 144.

The end plate 106 of the third section 18 provides a plurality of apertures 152 therein permitting the ambient water medium to flow therethrough and exert a pressure on the flexible diaphragm 118.

An alternative embodiment of the pressure regulating unit 115 is shown in FIG. 5 of the drawing. Here the third section 18 is shown as having an opening 154 spanned by a flexible diaphragm 156 having an annular groove 158, a pair of axially located engaging plates 160, and a T-shaped engaging arm 167 extending forwardly from the inner side thereof. The periphery of the diaphragm 156 is mounted on the third section 18 between the housing 12 and a cap member 162, which is secured thereto by screws 164. The cap member 162 has apertures 163 therein to permit the passage of the ambient water medium therethrough in order to communicate with the diaphragm 156. In addition, a biasing spring 166 is positioned within the cap 162 so as to exert an inward force on the diaphragm 156.

An inlet aperture 168 is located in the third section 18 and has a tilt valve 170 positioned therewithin. A compressed air inlet line 172 is connected between the tilt valve 170 and the compressed air supply. The tilt valve 170 includes a valve seat 174, a valve member 176 movably engageable with the valve seat, a spring 178 biasing the member 176 into engagement with the seat 174, and a tilt arm 179 extending from the valve member 176 and movably engageable with the T-shaped arm 167 of the diaphragm 156 when the diaphragm is in a compressed position for dislodging the valve member 176 from engagement with the valve seat 174.

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An outlet aperture 180 is similarly located in the third section 18, interior of the diaphragm 156 and has a tilt valve 182 positioned therewithin. The valve 182 includes a valve seat 184, a valve member 186 movably engageable with the valve seat, a spring 188 biasing the member 186 into engagement with the seat 184, and a tilt arm 190 extending from the valve member 186 and movably engageable with the T-shaped arm 167 of the diaphragm 156 when the diaphragm is in an extended position for dislodging the valve member 186 from engagement with the valve seat 184.

In actual operation, the underwater communicator may be mounted on the back of an underwater diver and will normally be positioned on top of or adjacent to the compressed air supply tanks used in connection with underwater breathing apparatus. The user may at any time manually actuate the underwater communicator by turning on the switch 100 mounted on the exterior of the first section 14. Similarly the device may be manually turned off at any time by the diver for the purpose of conserving power when not in use.

A standard throat microphone may be secured to the user's neck adjacent the larynx or a microphone may be located in the user's underwater breathing mask. In either situation, the signal generated by the user when speaking into the microphone will pass through the microphone lines 59, through the amplifier 93, and into the transducer 32 through the lead-in wires 46. The change in current in the voice coil 48 caused by the user's voice will cause the coil form 38 to oscillate longitudinally within the annular slot 36 of the permanent magnet 34, thus causing the movable membrane 50 to vibrate and transmit direct audible impulses to the ambient water medium. In this connection, it should be noted that the movable membrane 50 is firmly secured at its periphery within the first section 14 of the housing 12 and the rearward side of the membrane 50 is completely sealed from exposure to the ambient water medium. Thus, the housing 12 serves as a totally enclosed type of loudspeaker enclosure preventing the impulses emanating from the rear side of the moving membrane from damping out those emanating from the front side thereof.

While under water, a pressure differential will occur across the face of the movable membrane 50 of the transducer 32. Initially the interior of the housing 12, and correspondingly the rear side of the movable membrane 50, will normally have the standard air pressure of the atmosphere just above the water surface. The exterior or front side of the movable membrane 50 will be subjected to an increased pressure due to its exposure to the ambient water medium.

In order to provide maximum efficiency of the movable membrane 50 and prevent damage thereto, it is desirable to control the difference in pressures on the front and rear sides thereof; the underwater communicator provides a pressure-regulating unit 115 which serves this purpose. As illustrated in FIG. 1, for example, the ambient water medium will penetrate the pressure chamber 116 via the apertures 152 in the end plate 106 and the ambient water medium will come in contact with the flexible diaphragm 118 and exert an inward pressure thereon, causing the flexible diaphragm 118 to move toward a compressed position. As the flexible diaphragm 118 moves inwardly owing to the increased pressure of the ambient water medium as the diver descends, the interior engaging plate 122 will engage the tilt arm 136 of the tilt valve 128. The tilt arm 136 will pivot and dislodge the valve member 132 from engagement with the valve seat 130. The opening of the tilt valve 128 admits compressed air to the housing 12 through the compressed air supply line 126 secured to the inlet aperture 124. The incoming compressed air will enter the housing interior of the flexible diaphragm 118 and flow equally throughout the interior of the housing 12 through the ports 82 in the transverse plate 78, the ports 72 in the heat sink 66,

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and the ports 56 in the transducer case 52. Therefore, the rear side of the movable membrane 50 will be exposed to the increased air pressure within the housing 12, resulting in a pressure balance between the front and rear sides on the movable membrane 50.

When a driver is ascending the adjusted increased pressure within the housing 12 may be in excess of the pressure exerted on the front side of the movable membrane 50 by the ambient water medium. In this situation, the flexible diaphragm 118 will be urged rearwardly by the increased interior pressure. As the flexible diaphragm 118 moves toward an extended position, the exterior engaging plate 122 will engage the tilt arm 150 of the tilt valve 142. As the tilt arm 150 is moved by the extending diaphragm 118, the valve member 146 will be dislodged from engagement with the valve seat 144 and the compressed air within the housing 12 will pass through the air conduit 110 and out through the outlet aperture 138. This exhaust operation will continue until the pressure differential between the interior of the housing 12 and the ambient water medium is such that the diaphragm 118 relaxes toward a neutral position thus seating the valve member 146 again in engagement with the valve seat 144. It will be noted that the flexible diaphragm 118 may relax to a neutral position while the pressure within the housing is slightly higher than that exerted by the ambient water medium. This feature will prevent water leakage around the valve seat 144.

In the alternative embodiment exhibited in FIG. 5 of the drawing, the pressure regulating procedure is the same although the structure is slightly modified. Herein, the T-shaped arm 167 extends from the interior side of the flexible diaphragm 156 and during compression of the flexible diaphragm 156 engages the tilt arm 179 of the tilt valve 170 and during extension of the flexible diaphragm 156 engages the tilt arm 190 of the tilt valve 182. In addition, the third section 18 provides an end cap 162 mounted exterior of the flexible diaphragm 156 having apertures 163 therein to provide communication between the ambient water medium and the flexible diaphragm 156. Further, mounted within the end cap 162 is a leaf spring 160 which is loaded between the end cap 162 and the flexible diaphragm 156. Thus, an inward biasing is provided by the spring 160 against the flexible diaphragm 156. This feature of the invention is provided to assure the diver that during ascent, when the interior pressure in the housing 12 is greater than the pressure exerted by ambient water medium, a slightly higher pressure will always remain within the housing 12. The slightly higher pressure within the housing 12 which exists during the exhaust operation when compressed air is passing out through the tilt valve 182 insures that no water will leak into the housing around the valve seat 184.

Although exemplary embodiments of this invention have been disclosed herein for purposes of illustration, it will be understood that various changes, modifications, and substitutions may be incorporated in such embodiments without departing from the spirit of the invention as defined by the claims which follow.

We claim as our invention:

1. In an underwater communicator, the combination of:
 - a housing;
 - a transducer positioned within said housing and having a movable membrane communicating with the ambient water medium solely on the front side thereof;
 - a power supply positioned within said housing for actuating said transducer;
 - an amplifier unit within said housing connected between said power supply and said transducer; an externally positioned microphone;
 - means connectable to said externally positioned microphone as an input to said amplifier unit;

pressure regulating means mounted in said housing for controlling the difference in pressures exerted on the front and rear sides of said movable membrane including a pressure chamber with at least one aperture communicating with the ambient water medium, a flexible diaphragm mounted between said aperture and the interior of said housing and movable between extended and compressed positions in response to the pressure differential between the interior of said housing and the ambient water medium for controlling the difference in pressures exerted on the front and rear sides of said movable membrane, first movable valve means positioned within said housing interior of said flexible diaphragm, a source of compressed air, means coupling said source of compressed air to said first valve means, with said valve means movably actuable by said diaphragm when in a compressed position for admitting compressed air into said housing, and second movable valve means communicating with the interior of said housing and movably actuable by said diaphragm when in an extended position for exhausting air from said housing.

2. An underwater communicator, as defined in claim 1, in which said pressure regulating means includes:

- an inlet aperture positioned in the wall of said housing interior of said flexible diaphragm;
- said coupling means connecting said compressed air source to said inlet aperture;
- said first valve means located in said inlet aperture comprising a tilt valve movably actuable by said diaphragm when in a compressed position for admitting compressed air into said housing;
- an outlet aperture located in the wall of said pressure chamber interior of said flexible diaphragm; and
- said second valve means positioned in said outlet aperture comprising a tilt valve movably actuable by said flexible diaphragm when in an extended position for exhausting air from the interior of said housing.

3. An underwater communicator, as defined in claim 2, in which said second valve means is positioned exterior of said flexible diaphragm, and in which a conduit means is provided between said outlet aperture and said second valve means.

4. In an underwater communicator, the combination of:

- a housing;
- a transducer positioned within said housing and having a movable membrane communicating with the ambient water medium solely on the front side thereof;
- a power supply positioned within said housing for actuating said transducer;
- an amplifier unit within said housing connected between said power supply and said transducer; an externally positioned microphone;
- means connectable to said externally positioned microphone as an input to said amplifier unit; and
- pressure regulating means mounted in said housing for controlling the difference in pressures exerted on the front and rear sides of said movable membrane including a pressure chamber with at least one aperture communicating with the ambient water medium, a flexible diaphragm mounted between said aperture and the interior of said housing and movable between extended and compressed positions in response to the pressure differential between the interior of said housing and the ambient water medium for controlling the difference in pressures exerted on the front and rearward sides of said movable membrane, first movable valve means positioned in said housing interior of said diaphragm, a source of compressed air, means coupling said source of compressed air to said first valve means, with said valve means movably actuable by said diaphragm when in a compressed position for admitting compressed air into said housing,

second movable valve means positioned in said housing interior of said diaphragm and movably actuable by said diaphragm when in an extended position for exhausting air from said housing, and actuating means extending from said flexible diaphragm for movably engaging said first and second valve means when said diaphragm is in said compressed and extended positions, respectively.

5. An underwater communicator, as defined in claim 4 having:

- an inlet aperture located in the wall of said housing interior of said flexible diaphragm;
- said coupling means connecting said compressed air source to said inlet aperture;
- said first valve means positioned within said inlet aperture comprising a tilt valve movably actuable by said diaphragm when in a compressed position for admitting compressed air into said housing;
- an outlet aperture located in the wall of said pressure chamber interior of said flexible diaphragm;
- said second valve means located within said outlet aperture comprising a tilt valve movably actuable by said diaphragm when in an extended position for exhausting air from said housing; and
- an actuating means extending from said flexible diaphragm movably engaging the respective tilt valves of said first and second valve means when said flexible diaphragm is in compressed and extended positions, respectively.

6. An underwater communicator, as defined in claim 5, in which a constant biasing means is provided exterior of said flexible diaphragm for exerting an inward pressure thereon.

7. In a pressure regulating means for an underwater device, the combination of:

- a housing for said device;
- a pressure chamber located within said housing with at least one aperture communicating with the ambient water medium;
- a flexible diaphragm mounted between said pressure chamber and the interior of said housing and movable between extended and compressed positions in response to the pressure differential between the interior of said housing and the ambient water medium for controlling the pressure differential;
- first movable valve means positioned within said housing interior of said diaphragm; a source of compressed air;
- means coupling said source of compressed air to said said valve means, said first valve means being movably actuable by said diaphragm when in a compressed position for admitting compressed air into said housing; and
- second movable valve means positioned within said housing communicating with the housing interior of said diaphragm and movably actuable by said diaphragm when in an extended position for exhausting air from said housing.

8. A pressure regulating means as defined in claim 7, in which said second movable valve means is positioned exterior of said diaphragm, and in which a conduit means is provided between the housing interior of said diaphragm and said second movable valve means.

9. A pressure regulating means as defined in claim 7, in which said second movable valve means is positioned within said housing interior of said flexible diaphragm, and including actuating means extending from said flexible diaphragm and movably engageable with said first and second valve means when said flexible diaphragm is in compressed and extended positions, respectively, and biasing means exterior of said flexible diaphragm for providing an inward pressure on said flexible diaphragm.

10. In an underwater communicator, the combination:

- a watertight housing having axially aligned first, second, and third chambers therewithin;

a transducer mounted within said first chamber and having a movable membrane communicating with the ambient water medium solely on the front side thereof, and communicating with an air space within said first chamber on the rearward side thereof; 5

a heat sink mounted between said first and second chambers, said heat sink having a first portion extending to the exterior of said housing and communicating with the ambient water medium, and a second portion extending transversely within said housing and having a plurality of ports therein communicating with the air space within said first chamber; 10

a power supply located within said second chamber for actuating said transducer, said power supply being spaced radially inwardly from the exterior wall of said housing and defining an air space between the exterior of said power supply and said housing, which air space communicates with the ports located in said heat sink; 15

an amplifier unit mounted on said heat sink and connected between said power supply and said transducer and spaced radially inwardly from the exterior wall of said housing to permit communication between the air space defined between said power supply and the exterior wall of said housing and the plurality of ports located in said heat sink; an externally positioned microphone; 20

means connectable to said externally positioned microphone as an input to said amplifier unit; and

pressure regulating means mounted within said third chamber for controlling the difference in pressures exerted on the front and rear sides of said movable membrane including a pressure chamber with at least one aperture communicating with the ambient water medium, a flexible diaphragm mounted between said aperture and the interior of said housing and movable between extended and compressed positions in response to the pressure differential between the interior of said housing and the ambient water medium for controlling the difference in pressures exerted on the front and rear sides of said movable membrane, a source of compressed air, means responsive to the movement of said flexible diaphragm toward a com-

pressed position for introducing compressed air from said source into said housing when the pressure within the housing is less than the ambient water pressure, means responsive to the movement of said flexible diaphragm toward an extended position for exhausting air from said housing into the ambient water medium when the pressure within the housing is greater than the ambient water pressure, and an aperture in said third chamber communicating with the air space defined within said second chamber to permit free flow of the compressed air introduced by said pressure regulating means throughout the interior of said housing and to the rearward side of the movable membrane of said transducer.

11. An underwater communicator as defined in claim 10, in which said pressure regulating means includes first movable valve means positioned within said housing interior of said flexible diaphragm, means coupling said source of compressed air to said first valve means, said first valve means being movably actuable by said diaphragm when in a position for admitting compressed air into said housing, and second movable valve means positioned within said housing communicating with the housing interior of said flexible diaphragm and movably actuable by said diaphragm when in an extended position for exhausting air from said housing. 25

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