

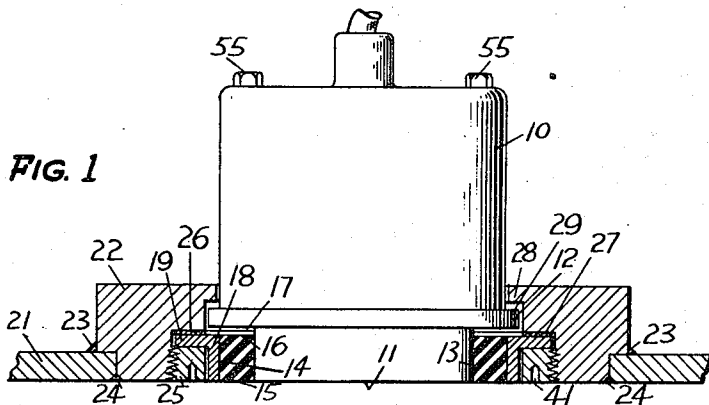
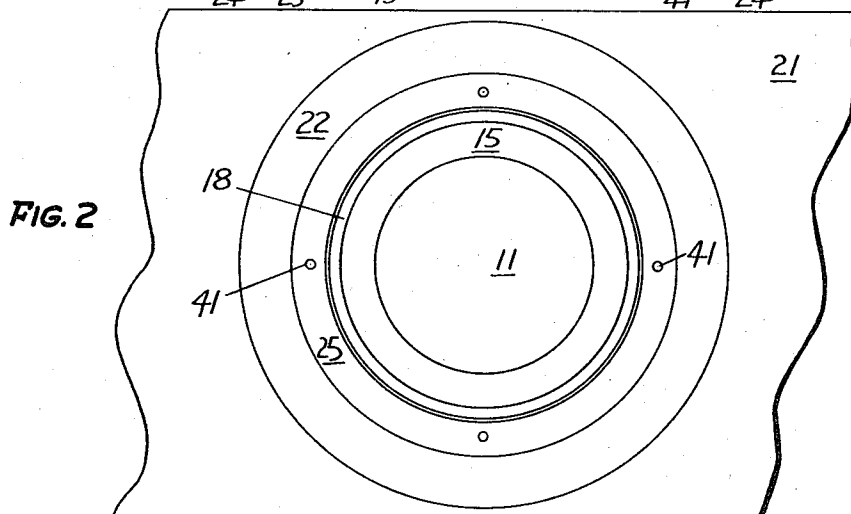
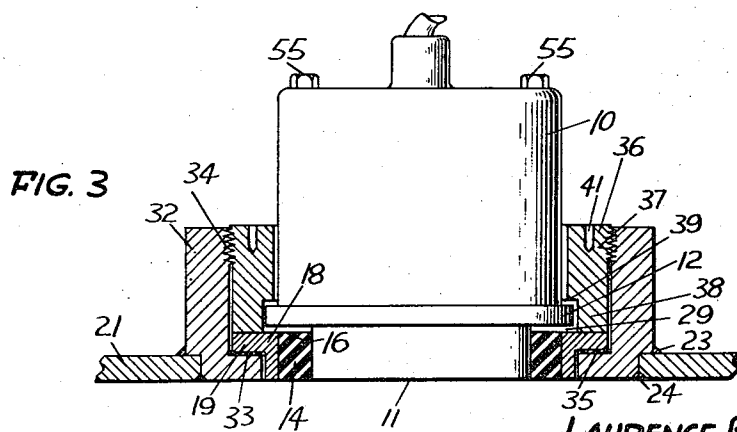
July 10, 1951

L. BATCHELDER
HYDROPHONE MOUNTING

2,560,066

Filed Nov. 27, 1948

2 Sheets-Sheet 1



INVENTOR
LAURENCE BATCHELDER
BY *Chas. J. Fox*
ATTORNEY

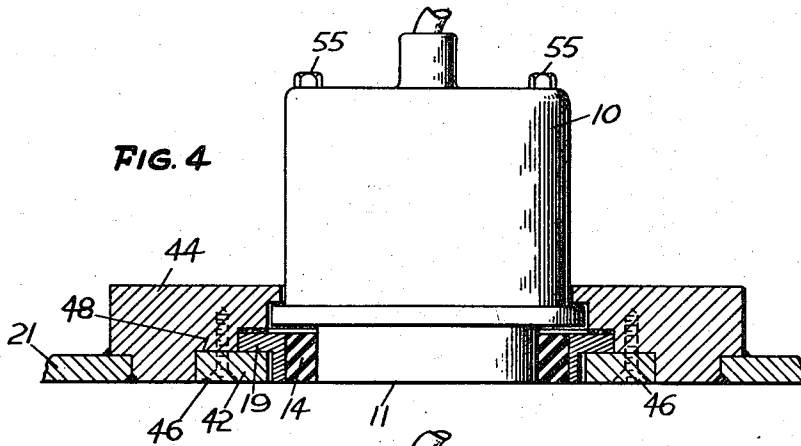
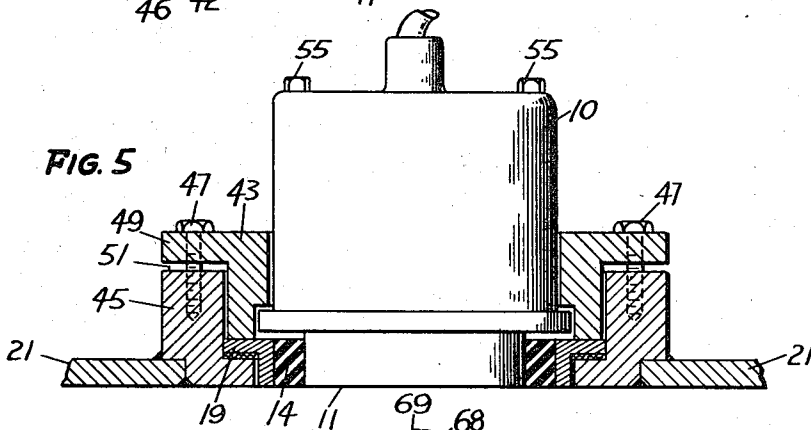
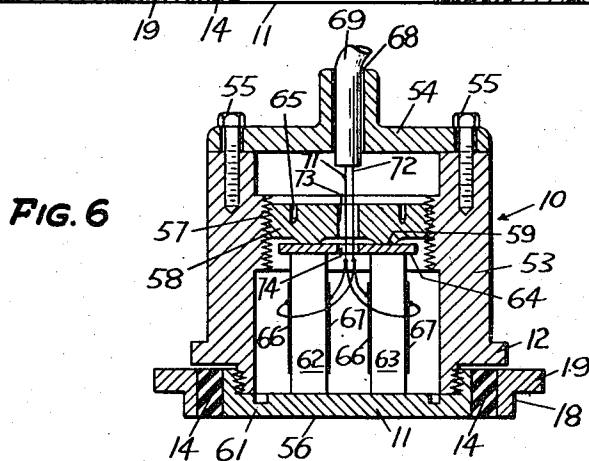
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2 Sheets-Sheet 2



INVENTOR
LAURENCE BATCHELDER
BY *Chas. J. Jones*
ATTORNEY

UNITED STATES PATENT OFFICE

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HYDROPHONE MOUNTING

Laurence Batchelder, Cambridge, Mass., assignor
to Raytheon Manufacturing Company, a cor-
poration of Delaware

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6 Claims. (Cl. 177—386)

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This invention relates to hydrophone mount-
ings and more particularly to means for mount-
ing a hydrophone in the skin of a ship or the like
which simultaneously supports the hydrophone
and isolates it from hull vibrations.

It is an object of the invention to provide a
mounting means for a hydrophone which attenu-
ates hull vibrations to which the hydrophone
would otherwise normally be sensitive.

It is another object to devise such a mounting
which is universally adaptable for inboard or
outboard installation.

It is a further object to devise such a mount-
ing which will hold the hydrophone in the desired
position for normal operation, and which has
means constantly ready to prevent the hydro-
phone from being torn away in the presence of
abnormal shock.

It is a further object to devise such a mounting
which provides a smooth unbroken surface to the
surrounding water and sacrifices none of the ad-
vantages heretofore available.

Other and further objects of the invention will
become apparent from the description of certain
embodiments thereof which follows, reference
being made to the accompanying drawing,
wherein:

Fig. 1 is a side elevation partly in section of a
hydrophone mounting in accordance with the
invention;

Fig. 2 is a bottom view of Fig. 1;

Fig. 3 is a side elevation partly in section of an-
other embodiment of the invention;

Fig. 4 is a modification of Fig. 1;

Fig. 5 is a modification of Fig. 3; and

Fig. 6 is a vertical section showing a typical
hydrophone of the general type with which the
invention is concerned.

Referring now to Figs. 1 and 2, a hydrophone
10 of generally cylindrical shape has a diaphragm
11 at one end thereof. The diaphragm is sensi-
tive to pressure waves, as is well known to those
skilled in the art. The hydrophone is further
provided around its sides at a distance from the
diaphragm end with a raised circumferential
projection 12 which is used as a keeper to prevent
the hydrophone from being torn away in the
presence of a wave of abnormally large ampli-
tude. The diameter of the hydrophone is re-
duced at 13 in the region between the keeper 12
and the diaphragm 11. A rubber annulus 14 is
fitted over and bonded to this portion 13 of the
side wall of the hydrophone. This annulus is
flush at one side 15 with the face of the dia-
phragm 11, and the other side 16 does not reach

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as far as the keeper 12, but rather there is a
space 17 between the keeper and the rubber an-
nulus. A metallic annulus 18 surrounds and is
tightly bonded to the rubber annulus 14. The
metallic annulus is of similar axial width to the
rubber annulus and is provided with a radially
outwardly projecting flange 19 at the side there-
of nearer to the keeper 12. This flange is used
for mounting the hydrophone in an opening in
the skin of a ship or other suitable wall, as will
now be described.

The wall 21 wherein the hydrophone is mount-
ed, which may, for example, be the skin of a ship,
is provided with a ring 22 of substantially greater
mass than the wall material and preferably weld-
ed thereto as at 23, 24. The mass ring 22 serves
to a certain degree to prevent vibrations present
in the wall 21 from reaching the hydrophone 10.
It has been found, however, that this ring does
not function perfectly, and that some vibrations
which are present in the wall 21 continue to reach
the hydrophone. The flange 19 is clamped
against a first shoulder 27 on the mass ring 22
by means of a clamping ring 25 which is thread-
edly fitted into the mass ring. The clamping
ring 25 fits loosely about the metallic annulus 18,
and a gasket 26 is provided at the side of the
flange 19 nearer the mass ring 22. The mass ring
22 is provided with the first shoulder 27 by re-
ducing the inner diameter thereof by a suitable
amount at a distance in from the outer surface
of the wall 21. This reduction in inner diameter
is such that the keeper 12 of the hydrophone 10
fits loosely in the portion of reduced diameter
when the flange 19 rests against the first shoul-
der 27. The mass ring 22 is provided with a sec-
ond shoulder 28 formed by further reducing the
inner diameter thereof at the inner side above
the keeper 12. The shoulder 28 and the flange 19
now provide a recess 29 wherein the keeper 12
loosely rests. The keeper 12 is not in contact
with any part of this recess so long as the rubber
annulus 14 is not seriously deformed, as it might
be by a wave of abnormally great amplitude.
Should the rubber annulus 14 be so deformed,
the keeper 12 would come in contact with either
the second shoulder 28 or the flange 19, and the
hydrophone could not be torn away. The hydro-
phone 10 is, however, normally supported only by
the rubber annulus 14.

As has been already set forth, the hydrophone
is sensitive to pressure wave vibrations arriving
at the diaphragm 11. Vibrations in the hull, or
wall 21, and the mass ring 22 in the direction of
a line normal to the diaphragm normally tend

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to move the body of the hydrophone, and with it the face of the diaphragm, toward and away from the water, thereby creating pressure waves on the diaphragm. The hydrophone is highly sensitive to such waves. However, these vibrations are transmitted to the hydrophone 10 as shear waves in the rubber of the annulus 14. It is well known that rubber offers a high degree of attenuation to shear waves. Vibrations in the hull, or wall 21, in directions parallel to the surface of the diaphragm 11, may be transmitted by the rubber annulus 14 as compressional waves, the rubber being compressed thereby, but the diaphragm is moved parallel to its surface by such waves, and not toward and away from the water, so that the hydrophone 10 is comparatively insensitive to such vibrations. From another point of view, it may be said that the rubber ring 14 prevents hull vibrations from moving the hydrophone in such a fashion as to cause it to be actuated as a velocity device. The vibrations in the wall 21 which would normally tend to move the body of the hydrophone toward and away from the water cause velocity actuation of the hydrophone, whereas normally the body of the hydrophone is still and actuation is effected by causing pressure changes on the diaphragm. The present invention thus eliminates the very source of spurious signals.

It will be noted that the diaphragm 11 is maintained in direct contact with the water or other medium outside the wall 21. In fact, the face of the diaphragm 11 is in register or flush with the outer surface of the hull, or wall 21, so that this surface is not broken and does not interfere with the flow of water by it.

The arrangement shown in Fig. 1 is designed for mounting the hydrophone from outside the wall 21. In the case of a ship or the like, this would require that the ship be dry-docked. The arrangement shown in Fig. 3 is designed for in-board mounting. With this arrangement, the hydrophone could, under the proper circumstances, be installed without resorting to dry-docking. In the arrangement of Fig. 3, the hull ring 32 is provided with one shoulder 33 at the outer side thereof and is internally threaded at the inner side 34 thereof. The normal inside diameter of this hull ring is of sufficient size to accept the flange 19 of the hydrophone mounting freely with the flange resting upon the shoulder 33. A gasket 35 is provided between the flange and the shoulder. A clamping ring 36, threaded at the upper end 37 of its outer periphery, fits into the hull ring 32 and is threadably engaged therewith to hold the flange 19 against the shoulder 33. This clamping ring has a portion of large inside diameter at the lower end 38 thereof, which portion fits loosely around the keeper 12, and the remainder is of smaller diameter, providing a shoulder 39 over but not touching the keeper. The shoulder 39 and flange 19 cooperate to provide again the recess 29 wherein the keeper 12 rests.

In Figs. 1 and 3 the clamping rings 25 and 36, respectively, are threadably engaged with the hull rings 22 and 32, respectively, being put in place by means of a spanner wrench or the like which engages suitably placed holes 41 in the clamping rings. In Figs. 4 and 5 the clamping rings 25 and 36 are replaced by clamping rings 42 and 43, respectively, of a different form, which are attached to the hull or mass rings 44 and 45, respectively, by means of screws 46 or bolts 47, as may be suitable.

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Referring particularly to Fig. 4, the mass ring 44 differs from the mass ring 22 of Fig. 1 only in that the inner diameter thereof is increased at the front or outside surface to provide an additional shoulder 48 against which the clamping ring 42 rests, and into which the clamping screws 46 are driven.

Referring now particularly to Fig. 5, the mass ring 45 differs from the mass ring 32 of Fig. 3 in that it is shorter, while the clamping ring 43 is provided with a portion 49 of expanded diameter at the top thereof. This portion 49 of expanded diameter overhangs the top surface 51 of the mass ring 45, and the bolts 47 are driven into the mass ring through this top surface. In all other respects, the arrangements shown in Figs. 4 and 5 are similar to the arrangements shown in Figs. 1 and 3, respectively.

The transducer 10 may have the internal structure shown in Fig. 6. The casing is made of a generally cylindrical portion 53 whereon the keeper 12 is found, a top closure 54 which is attached to the cylindrical portion 53 by bolts 55, for example, and a bottom closure 56 which is threadably engaged on the cylindrical portion 53, and includes the diaphragm 11. The cylindrical portion 53 is internally threaded at a portion 57 intermediate the ends thereof, and a pressure ring 58 is engaged in the threads. The pressure ring has a circular boss or raised portion 59 on the lower surface thereof for a purpose which will presently be explained. The diaphragm 11 is formed as an integral part of the lower closure 56 by removing an annular portion of the inner side of the closure at or very close to the side wall to provide a thin rim 61. The diaphragm 11 vibrates somewhat as a piston supported by this thin rim. Crystals 62 and 63 are clamped between the diaphragm 11 and a clamping plate 64. The boss 59 is in contact with the upper surface of the clamping plate 64, and the clamping pressure is determined by the clamping ring 58, which may be turned by a spanner wrench or the like, engaging holes 65 therein.

The crystals 62 and 63 are each provided with two electrodes 66 and 67, one on each side thereof, through which electrical signals corresponding to the pressure waves incident upon the diaphragm 11 are taken. The top closure 54 is provided with a passage 68 through which an electrical cable 69 passes. This cable has two conductors 71 and 72. The clamping ring 58 and clamping plate 64 are provided with passages 73 and 74 through which the conductors 71 and 72 pass. The crystals 62 and 63 are shown connected in parallel to these conductors, but it will be appreciated by those skilled in the art that the connection may be in series if desired.

The details of the hydrophone shown in Fig. 6 are shown merely to illustrate the type of hydrophone with which the invention is concerned, namely, a hydrophone which is sensitive to pressure waves arriving at the diaphragm 11. It should be definitely understood that other characteristics may be varied in any manner desired. For example, more crystals may be used, other types of electromechanical converting devices may be used, and various mechanical arrangements of the parts too numerous to discuss here may also be used. Many other modifications and variations of the invention will occur to those skilled in the art, and it is accordingly intended that the claims that follow should not be limited by the details of the embodiments of the invention disclosed herein, but only by the prior art.

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What is claimed is:

1. In combination, a hydrophone having a pressure wave sensitive diaphragm at the front and a substantially rigid cylinder supporting said diaphragm across an end thereof, a resilient perimetric cylindrical element fastened at its inner cylindrical surface to the outer side surface of said cylinder, and a substantially rigid perimetric cylindrical element secured about and bonded to said resilient element, said cylinder being otherwise telescopically fitted loosely within said rigid element, said resilient element being of a material which strongly attenuates shear waves, the dimensions of said cylinder, said resilient element and said rigid element being chosen so that said resilient element is not anywhere compressed between the outer surface of said cylinder and the inner surface of said rigid element, the only normal support for said hydrophone in said rigid element being afforded by bonding of said resilient element to each of said outer surface of said cylinder and said inner surface of said rigid element, and said resilient element having no support members projecting thereinto.

2. In combination, a hydrophone having a pressure wave sensitive diaphragm at the front and a substantially rigid cylinder supporting said diaphragm across an end thereof, a rubber perimetric cylindrical element bonded at its inner cylindrical surface to the outer side surface of said cylinder, and a substantially rigid perimetric cylindrical element surrounding said rubber element and bonded thereto, and spaced from said hydrophone by said rubber element, said cylinder being otherwise telescopically fitted loosely within said rigid element, the dimension of said cylinder, said rubber element and said rigid element being chosen so that said resilient element is not anywhere compressed between the outer surface of said rigid element, the only normal support for said hydrophone in said rigid element being afforded by the bonding of said rubber element to each of said outer surface of said surface and said inner surface of said rigid element, and said resilient element having no support members projecting thereinto.

3. In combination, a wall having a cylindrical opening therein, a hydrophone having substantially rigid side walls and a pressure wave sensitive diaphragm disposed in said opening with said diaphragm flush in the surface of said wall, said side walls being cylindrical, of lesser diameter than said opening, and telescopically fitted therein, and a resilient hollow cylindrical member bonded only at its inner and outer cylindrical surfaces to the inner cylindrical surface of the opening in said wall and said side walls of said hydrophone, respectively, filling the space between said hydrophone and said wall, said resilient member being of a material which strongly attenuates shear waves, the dimensions of said opening, said resilient member and the cylinder providing said side walls being chosen so that the resilient member is not anywhere compressed between said side walls and the material of said wall defining said opening, the only normal support for said hydrophone in said wall being afforded by said bonding, and said resilient member having no rigid support members projecting thereinto.

4. In combination, a hydrophone having a pressure wave sensitive diaphragm at the front and a substantially rigid cylinder supporting said diaphragm across an end thereof, a resilient

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perimetric cylindrical element fastened at its inner cylindrical surface to the outer side surface of said cylinder, a substantially rigid perimetric cylindrical element secured about and bonded to said resilient element, said cylinder being otherwise telescopically fitted loosely within said rigid element, said resilient element being of a material which strongly attenuates shear waves, the dimensions of said cylinder, said resilient element and said rigid element being chosen so that said resilient element is not anywhere compressed between the outer surface of said cylinder and the inner surface of said rigid element, the only normal support for said hydrophone in said rigid element being afforded by bonding of said resilient element to each of said outer surface of said cylinder and said inner surface of said rigid element, and said resilient element having no support members projecting thereinto, and a radially outwardly extending flange on said rigid element whereby said hydrophone may be secured to the skin of a ship.

5. In combination, a hydrophone having a pressure wave sensitive diaphragm at the front and a substantially rigid cylinder supporting said diaphragm across an end thereof, a resilient perimetric cylindrical element fastened at its inner cylindrical surface to the outer side surface of said cylinder, a substantially rigid perimetric cylindrical element secured about and bonded to said resilient element, said cylinder being otherwise telescopically fitted loosely within said rigid element, said resilient element being of a material which strongly attenuates shear waves, the dimensions of said cylinder, said resilient element and said rigid element being chosen so that said resilient element is not anywhere compressed between the outer surface of said cylinder and the inner surface of said rigid element, the only normal support for said hydrophone in said rigid element being afforded by bonding of said resilient element to each of said outer surface of said cylinder and said inner surface of said rigid element, and said resilient element having no support members projecting thereinto, a radially outwardly extending flange on said rigid element, a radially outwardly extending keeper flange on said supporting cylinder in a region removed from the resilient element, a wall having an opening in which said rigid element is mounted by said radially outwardly extending flange, said wall bearing an element having a groove wherein said keeper flange reposes out of contact with said grooved element.

6. In combination, a wall having a cylindrical opening therein, a hydrophone having substantially rigid side walls and a pressure wave sensitive diaphragm disposed in said opening with said diaphragm flush in the surface of said wall, said side walls being cylindrical, of lesser diameter than said opening, and telescopically fitted therein, and a resilient hollow cylindrical member bonded only at its inner and outer cylindrical surfaces to the inner cylindrical surface of the opening in said wall and said side walls only of said hydrophone, respectively, filling the space between said hydrophone and said wall, the hydrophone being normally free from engagement with any other support structure and the resilient member therefore constituting normally the sole support for said hydrophone, said resilient member being of a material which strongly attenuates shear waves, a radially outwardly extending keeper flange mounted on said cylindrical side walls at a region removed from the resilient

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member, and means rigidly mounted on said wall providing with said wall a recess wherein said flange fits, said recess being larger than said flange and having its wall surface normally free from contact therewith, the material of said means being positioned to restrain said hydrophone from complete removal from said wall in the event said resilient member is stressed by a wave which otherwise might tear away said resilient member, and thereby to prevent excessive stress on said resilient member.

LAURENCE BATCHELDER.

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