

Feb. 11, 1947.

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2,415,407

SUBMARINE SIGNALING APPARATUS

Original Filed Dec. 9, 1942

3 Sheets-Sheet 1

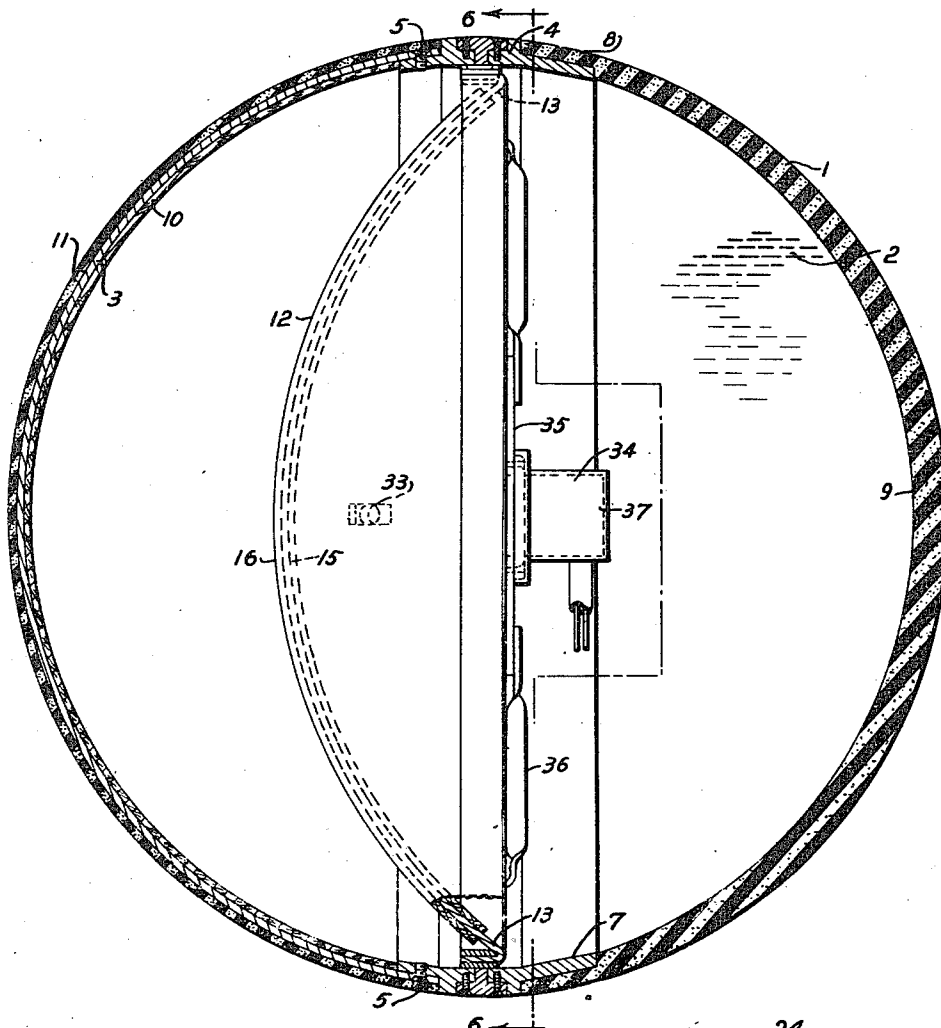


Fig. 1.

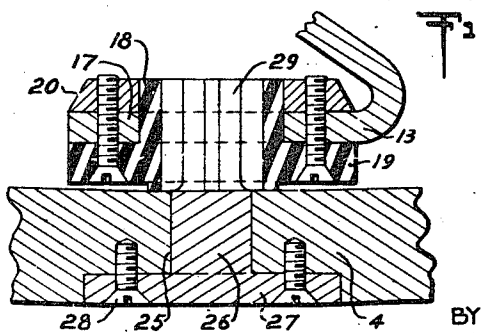


Fig. 2.

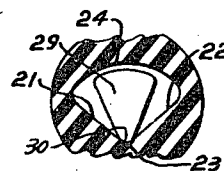


Fig. 2A.

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3 Sheets-Sheet 2

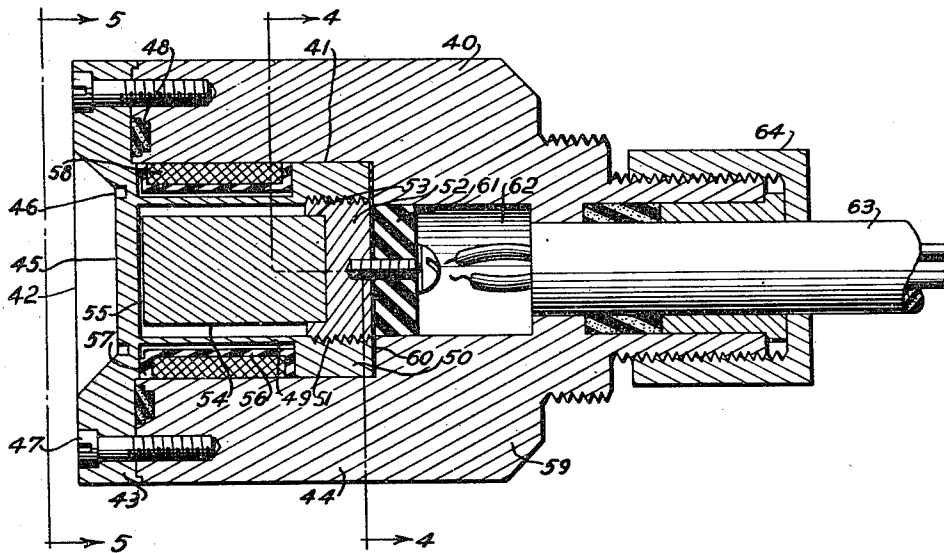


Fig. 3.

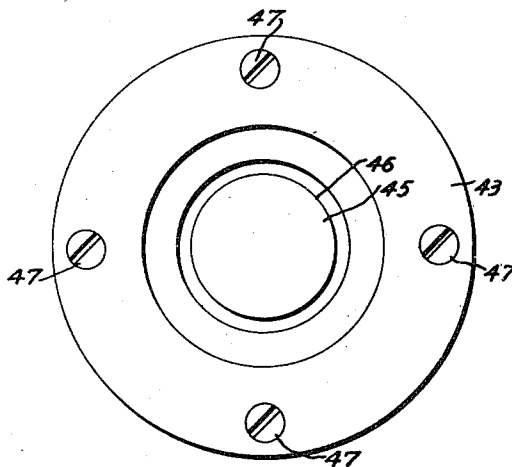


Fig. 5.

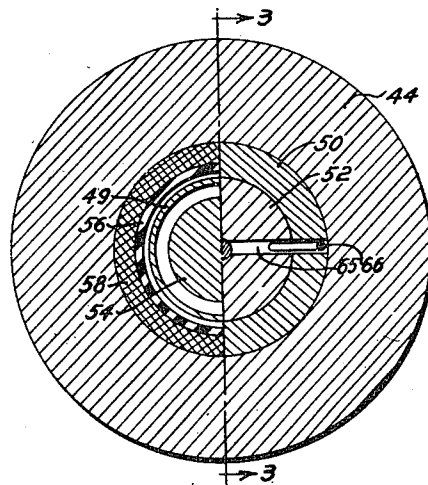


Fig. 4.

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3 Sheets-Sheet 3

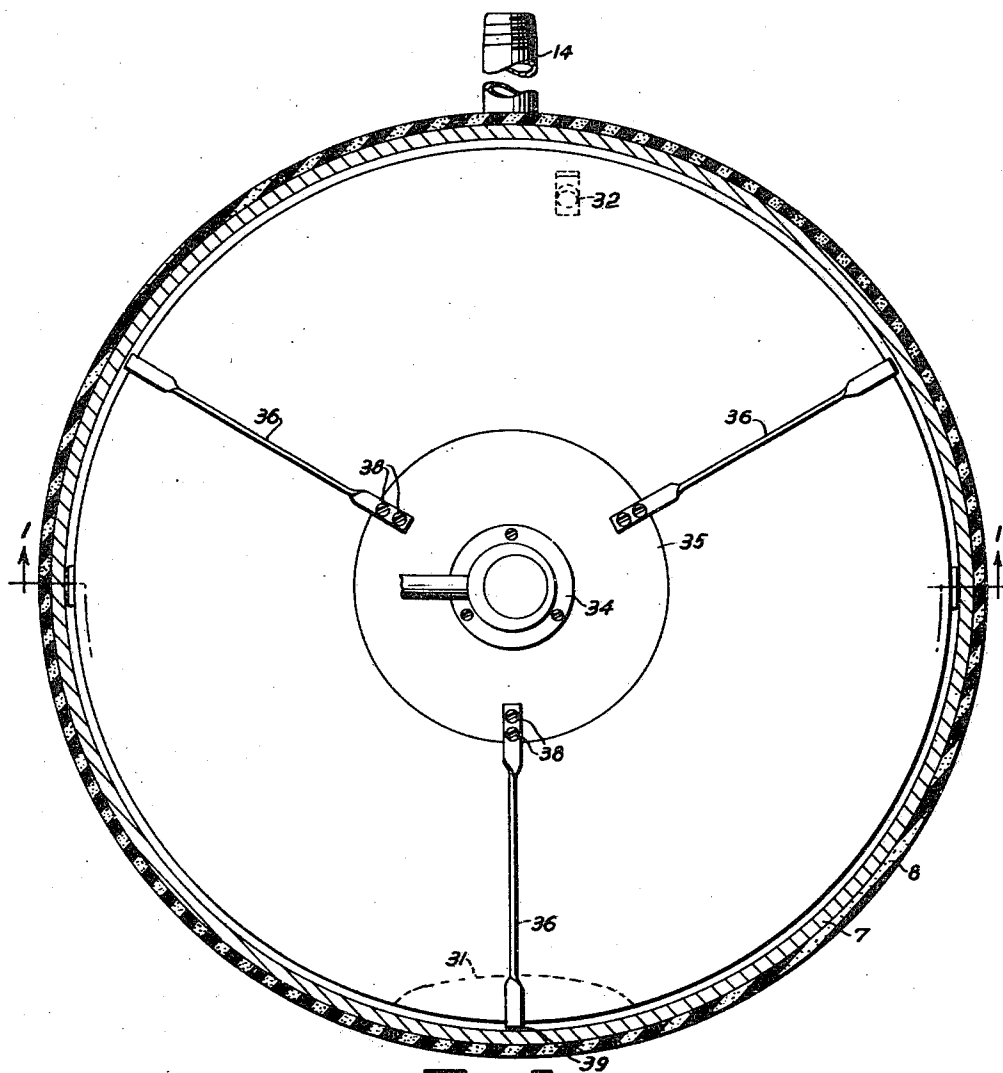


Fig. 6.

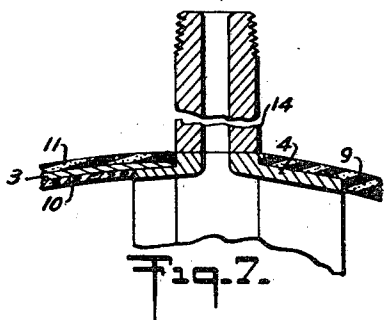


Fig. 7.

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SUBMARINE SIGNALING APPARATUS

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Original application December 9, 1942, Serial No. 468,435. Divided and this application November 26, 1943, Serial No. 511,888

4 Claims. (Cl. 177—386)

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The present application is a division of application Serial No. 468,435, filed December 9, 1942.

The present invention relates to apparatus for acoustic signaling and reception, and more particularly to the art of signaling with the use of high frequency sound vibrations near and above the audible range of frequency.

The invention finds particular application in the art of submarine signaling as a means for determining the direction of a sound source, or for transmission in a given direction.

The present invention uses a sound reflector at the focus of which is a pickup unit of a type particularly adaptable to receive the waves reflected to it by the reflector.

The invention is particularly adaptable for use overboard of a vessel or when projected through the skin of the vessel. For this purpose the reflector is enclosed in a spherical housing which is supported by a shaft by which the whole housing may be rotated. The reflector itself is mounted in such a way so that the desired direction of the reflector is preserved even though the shaft may be inclined at varying angles. For this purpose a knife-edge support is preferable to a bearing surface for maintaining the reflector positioned in the desired direction.

Other features of the present invention reside in part in the construction and arrangements of the elements making up the apparatus and will be more fully and readily understood from the specification describing an embodiment of the invention in connection with the drawings in which Fig. 1 shows an elevation of the invention with parts in section; Figs. 2 and 2a show details of Fig. 1; Fig. 3 shows a further detail of a modification of the sound pickup unit shown in Fig. 1; Fig. 4 shows a section on the line 4—4 of Fig. 3; Fig. 5 shows a section on the line 5—5 of Fig. 3; Fig. 6 shows a detail for the support of the pickup unit of Fig. 1; and Fig. 7 shows a detail of the support for the spherical unit.

In the drawings there is provided a spherical shell 1 which may be filled with any liquid or sound-conveying medium 2. The spherical shell comprises preferably a metallic back half or hemi-spherical portion 3 which may be made out of any suitable metal plate such, for instance, as aluminum or stainless steel. At the peripheral diameter of this half shell there is a supporting belt 4 or sector extending all the way around the hemisphere. On one side this belt is joined by suitable means as, for instance, a row of screws 5, 5 to the back shell 3, and on the other side the belt has a long flange 7 to which is

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cemented around its peripheral edge 8, a rubber hemisphere 9 or some other suitable material which must be substantially sound transparent for the sound waves impinging against it. For this purpose sound transparent rubber or some other material such as some suitable plastic may be used. Preferably the joint between the flange 7 and the front cover 9 or shell is made so that a continuous smooth surface is provided between the outer surface of the sector 4 and that of the cover 9. The back cover or hemisphere 3 is preferably lined on the inside with a lining 10 of some good sound-reflecting material as, for instance, cork or "linoleum" or the like, and the outside 15 with some sound-absorbing and protective material such, for instance, as a soft rubber covering 11 which will help to protect the metal shell 3 from dents. Cork may well be used on both sides of the shell 3.

Mounted and supported within the spherical shell formed by the elements described there is provided a reflector 12 which may take the form of a parabola of revolution or some such similar surface. This reflector is provided at its edge 25 with a turned lip or rim 13 extending all the way around the reflector. This rim is provided at opposite ends of one diameter with perforations or holes 17 by which the reflector is supported. The reflector 12 is covered on both sides with thin layers of cork 15 and 16 to provide a good reflecting surface and to prevent vibration being picked up by the reflector itself so that it will act simply as a reflector for the energy which impinges against it.

The perforations 17 by which the reflector is supported are lined with a sleeve 18 made out of fabric Bakelite element or other suitable material which also provides a durable bearing surface under corrosive conditions such as sea water. This sleeve is fastened through a flange 19 on one side of the lip 13 and the other side by a clamping plate 20. The sleeve 18 is shaped as indicated in Fig. 2a with an opening with two straight sides 21 and 22 inclined to each other and coming together at a vertex 23. The opening is arched over at the top as indicated by the curve 24.

The supporting sector or band 4 is pivoted with a perforation 25 through which a projecting shaft 26 extends. This shaft has at its end a plate 27 which is held tightly to the band or sector 4 by means of screws 28. The shaft 26 as it extends inwardly through the band 4 is provided with a knife-edge element 29, the knife-edge 30 of which rests in the vertex 23 formed by the

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two straight sides 21 and 22 of the supporting sleeve 18. The supporting sleeve 18 must have such a surface that the knife-edge element 29 can freely be pivoted in it.

The spherical shell is supported in the band 4 as indicated by Fig. 7. This support has its axis in a direction perpendicular to the plane in which the section of Fig. 1 is shown so that if the shaft 14 is held in a vertical direction, the axis of the parabola will be horizontal. To provide equilibrium for the reflector and the receiving unit mounted with it, the parabola may be weighted at the bottom by lead or other suitable means as indicated at 31. The reflector is so mounted that it may swing for a considerable arc about its horizontal pivot. Its motion is prevented beyond a given amount by stops 32 and 33 suitably placed on the inside of the shell in such a way that as the reflector swings, it will hit against these stops. The angular position of these stops is such that the reflector will be stopped before the sides of the knife-edge 29 lie against the inclined surfaces 21 and 22 in the swing of the reflector.

The sound collected by means of the reflector 12 is reflected to the hydrophone unit 34 mounted at the focus and supported in a centrally located opening in the disc 35 which, in turn, is held by a frame made up of supporting brackets 36, 36, 36, fastened at one end to the plate 35 and at the other end to the edge or lip 13 of the parabola. The plate 35 and the hydrophone unit 34 are completely lined on their back faces with a sound-reflecting cork layer 37, or other reflecting layer of material to reflect the sound direct from sources and thereby prevent it from exciting the hydrophone. Without the plate 35 covered as described, sound waves in the vicinity of the hydrophone would be picked up by the receiving element of the hydrophone and be made to indicate in the system. In this manner the directivity of the receiving unit would be impaired. The action of the plate 35 in its covered state is to reflect such sound waves as might otherwise affect the hydrophone away from the hydrophone. This action eliminates sounds coming from directions other than that in which the reflector is pointed and thereby makes the unit more highly directive and provides a greater ratio of sound energy from the required direction to that coming from unwanted directions.

The bars or brackets 36, which are fastened at one end, as indicated in Fig. 6, by screws 38 to disc 35, are bent over the lip 13 and fastened in their extensions 39 to the edge or lip of the reflector. The receiving unit 34 is mounted with its receiving diaphragm at right angles to the direction of the axis of the reflector and facing the reflector. This hydrophone is shown more in detail in Figs. 3, 4 and 5. The only difference between the units shown in Figs. 1 and 3 is that in the latter figure the cable connections are taken out at the end of the casing instead of at the side of the casing as shown in Fig. 1.

The hydrophone of Fig. 3 is made of a heavy casing 40 preferably of metal which has a recess 41 to receive the operating elements of the unit. The unit otherwise comprises a cover member 42 which is made with a heavy outer ring 43 fitting against the face of the side wall 44 of the casing and an inner recessed thin diaphragm 45 which has a groove cut around its periphery forming a thin compliance web 46 which joins the central vibratory diaphragm 45 to the heavy supporting ring 43.

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The diaphragm is clamped to the casing by means of screws 47 spaced around the periphery of the supporting ring as indicated in Fig. 5. The casing is made watertight by the usual means indicated here by a rubber gasket 48 seated in the wall 44 of the heavy casing. Joined to the diaphragm and formed as an integral part of it is a thin cylindrical shell 49 of magnetostrictive material which extends from the rear of the diaphragm at or near the edge of the compliance web 46 but on the inside of the casing which is not exposed to the water medium. This cylindrical shell has at its end a heavy ring element 50 which is threaded at the inside at 51 to receive a cylindrical element 52 which is recessed at 53 on its inside face to receive the permanent magnet 54 which is retained tightly within the recess 53 in a forced fit joint or by some other suitable means. The permanent magnet 54 has its end surface 55 parallel to the inside of the diaphragm member 45 and closely adjacent to it. Surrounding the cylinder 49 is a coil form 56 which at its front end has an outwardly extending flange 57 seated in the heavy rim 43 so that the coil is held outside of the vibrating portion of the diaphragm and will not therefore interfere with it. The coil form carries a coil 58 which is energized by the vibrations of the magnetostrictive cylinder 49.

The end surface of the heavy ring element 50 rests in a shoulder 59 at the bottom of the casing and is cemented in place by a layer of cement 60 in order to provide acoustic contact. A Bakelite disc 61 is fastened at the rear face of the cylindrical plug or threaded member 52 and this disc extends into a recess 62 extending from the back of the casing through which the connecting cable 63 passes. A watertight joint is made for this cable by means of a suitable stuffing box 64. The leads from the cable passing through holes in the Bakelite disc 61 are connected through the grooves 65 and 66 in the heavy ring 50 to connect to the coil 58.

The cover member with its heavy metal ring 43 and its central metal vibratory diaphragm 45 as well as the magnetostrictive cylindrical element 49 and the heavy metal ring 50 may be and are preferably all one piece of material, and in the present modification of Fig. 3 are therefore of magnetostrictive material with the cylindrical threaded member 52 of magnetic material and the member 54 a permanent magnet. It will be noted that the sides of the housing, the heavy supporting ring, the threaded member 52 and the magnet support provide a low reluctance path for the magnetic flux surrounding the coil.

In the operation of the device above described, the whole apparatus may be lowered into the water and rotated on its shaft 14. The hydrophone will receive sound approaching in the direction of the axis of the reflector and will not receive sounds approaching from other directions. The sound which passes through the opening between the central baffle and the edge of the reflector, if at angles inclined to the axis of the reflector, will not come to a focus on the receiving diaphragm 45, but will be reflected outward from the reflector through the opening between the edge and the baffle. The sound approaching the reflector in directions substantially parallel to the axis of the reflector will all be reflected and focused to the diaphragm and will therefore add up to increase the sound intensity approaching from the direction of the axis of the reflector.

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If the device is installed upon a moving vessel in which the shaft 14 does not retain its vertical position, then the pivoting of the reflector which itself carries the receiving unit makes it possible for the axis of the reflector always to be directed horizontally.

Having now described my invention, I claim:

1. In a system for directive transmission and reception of acoustic vibrations, a transducing device comprising a heavy housing, a diaphragm member joined in a compliance web to a heavy supporting ring, means holding said heavy ring to said housing, said diaphragm having joined to it, adjacent the compliance web, a magnetostrictive cylindrical member having an enlarged outwardly extending cylindrical flange at its other end resting in a shoulder in said heavy housing, and means acoustically joining said heavy cylindrical flange to said housing.

2. In a system for directive transmission and reception of acoustic vibrations, a transducing device comprising a heavy housing, a diaphragm member joined in a compliance web to a heavy supporting ring, means holding said heavy ring to said housing, said diaphragm having joined to it, adjacent the compliance web, a magnetostrictive cylindrical member having an enlarged outwardly extending cylindrical flange at its other end resting in a shoulder in said heavy housing, and means acoustically joining said heavy cylindrical flange to said housing, a permanent magnet positioned within the magnetostrictive cylinder, a supporting base therefor, and means retaining the supporting base within the cylindrical flange.

3. In a system for directive transmission and reception of acoustic vibrations, a transducing device comprising a heavy housing, a diaphragm member joined in a compliance web to a heavy supporting ring, means holding said heavy ring to said housing, said diaphragm having joined to it, adjacent the compliance web, a magnetostrictive cylindrical member having an enlarged outwardly extending cylindrical flange at its other end resting in a shoulder in said heavy housing, means acoustically joining said heavy cylindrical flange to said housing, a permanent magnet positioned within the magnetostrictive cylinder, a supporting base therefor, means re-

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taining the supporting base within the cylindrical flange, and an energizing coil surrounding the magnetostrictive cylinder and supported between said extending cylindrical flange and the inner face of the heavy supporting ring.

4. In a system for directive transmission and reception of acoustic vibrations, a transducing device comprising a heavy housing, a diaphragm member joined in a compliance web to a heavy supporting ring, means holding said heavy ring to said housing, said diaphragm having joined to it, adjacent the compliance web, a magnetostrictive cylindrical member having an enlarged outwardly extending cylindrical flange at its other end resting in a shoulder in said heavy housing, means acoustically joining said heavy cylindrical flange to said housing, a permanent magnet positioned within the magnetostrictive cylinder, a supporting base therefor, means retaining the supporting base within the cylindrical flange, an energizing coil surrounding the magnetostrictive cylinder and supported between said extending cylindrical flange and the inner face of the heavy supporting ring, the sides of the housing surrounding the energizing coil, the heavy supporting ring and the means supporting the permanent magnet providing a low reluctance path for the magnetic flux surrounding the coil.

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