July 10, 1945. H. ECKARDT 2,379,891

SOUND TRANSLATING DEVICE

Filed Oct. 6, 1942

FIG. 1

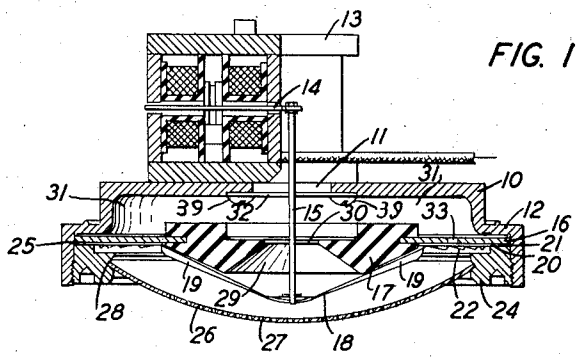
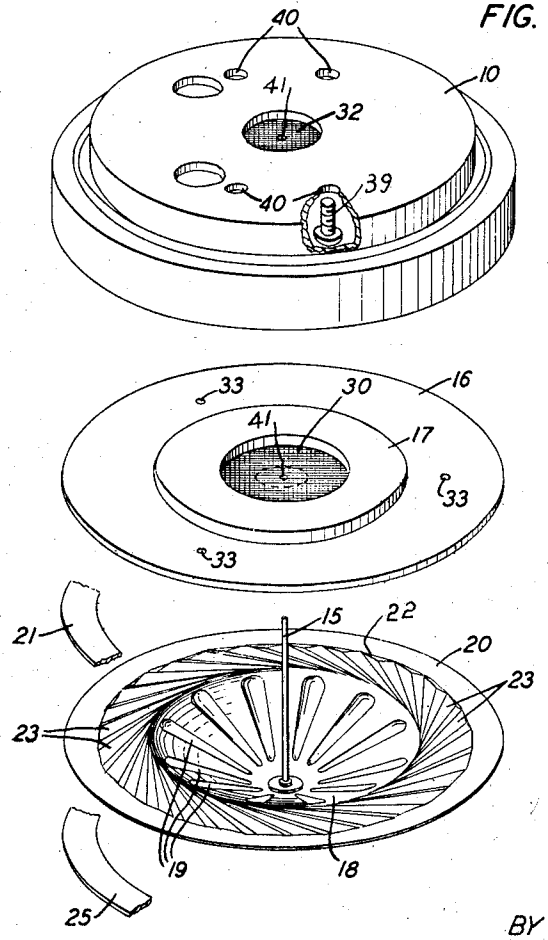


FIG. 2



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SOUND TRANSLATING DEVICE

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11 Claims. (Cl. 181—22)

This invention relates to sound translating devices and more particularly to sound powered type transmitters and receivers especially suitable for use in locations where the devices are subjected to abnormal pressures, such as on warships where high pressure waves at the devices are produced by gunfire.

Sound powered transmitters and receivers comprise, in general, a diaphragm and an electromagnetic unit, for example, a balanced armature unit, associated with the diaphragm and effective to translate vibrations of the diaphragm into corresponding signal currents and conversely to translate signal currents into corresponding vibrations of the diaphragm. Realization of high operating efficiency and response level necessitates the use of a lightweight and relatively fragile diaphragm. When such devices are employed on warships, the high pressure waves produced by gunfire may result in rupture or shearing of the diaphragm.

Furthermore, in such devices of conventional construction, the operating frequency range is quite limited and the response characteristic is not uniform, being characterized in general by a pronounced peak near the upper end of the low frequency range and by a marked falling off in the response at high frequencies.

One object of this invention is to prevent damage of the diaphragm in sound translating devices by abnormal pressure waves, such for example, as are produced on warships by gunfire.

Another object of this invention is to obtain a substantially uniform response characteristic over a wide frequency range for receivers and transmitters of the sound powered type.

A further object of this invention is to realize with a relatively simple construction substantial equalization of the response at high and low frequencies of a sound translating device.

In accordance with one feature of this invention, the diaphragm is constructed with a rigid central portion, for example, conical and provided with stiffening flutes or corrugations, a marginal mounting portion and an intermediate highly flexible portion, and stop means are provided adjacent the flexible portion and the part of the central portion adjacent the flexible portion to limit the displacement of these portions and to thus prevent rupture or shearing of the diaphragm by high pressure waves.

In accordance with another feature of this invention, acoustic resistance means is associated with the diaphragm to damp the vibration thereof and to substantially batten out the response peak due to the natural period of the diaphragm and means are provided for by-passing the resistance means at the low frequencies whereby the response at the low and intermediate frequencies is substantially equalized.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing, in which:

Fig. 1 is a side view in section of a sound translating device illustrative of one embodiment of this invention; and

Fig. 2 is an exploded perspective view of a portion of device illustrated in Fig. 1 showing the diaphragm and the stop member and acoustic network defining means associated therewith.

Referring now to the drawing, the second translating device illustrated comprises a dished frame or support 10, for example, of metal, having a central aperture 11 in the base thereof and provided with an annular shoulder portion 12. Secured to the base of the frame or support 10, as by screws or bolts 39, only one of which is shown in Fig. 2, extending into apertures 40 in the frame, is an electromagnetic unit 13, for example of the construction disclosed in Patent 2,267,808 granted December 30, 1941, to Nelson Blount, the unit 13 including a balanced armature 14 to one end of which a connecting rod 15 is secured.

Seated upon the inside of the annular shoulder 12 is a rigid annular plate member 16, for example, of metal, which mounts a stop member 17 of a construction to be described hereinafter. A diaphragm, which may be formed in one piece of thin sheet metal such as a beryllium copper alloy, overlies the plate member 16 and stop member 17, and comprises a dished, substantially conical portion 18 provided with radial stiffening flutes or corrugations 19, so that the portion 18 is rigid and substantially bodily vibratile, the connecting rod 15 being secured to the center of the conical diaphragm portion 18. The diaphragm includes also a flat, marginal mounting portion 20, which is spaced from the annular member 16 by a washer 21, and an intermediate portion 22 which is provided with corrugations 23 substantially tangential to the base of the conical portion 18, rendering the intermediate portion 22 highly flexible.

The diaphragm is held in position by a clamping ring 24 which is threaded to the frame or

support 10 and bears against a washer 25 engaging the mounting portion 20 of the diaphragm. The clamping ring mounts a dished cover member 26 provided with apertures 27 and sprung into an annular groove 28 in the clamping ring.

The annular plate member 16, it will be noted, is positioned immediately adjacent the flexible portion 22 of the diaphragm and the outer part of the surface of the stop member 17 toward the diaphragm is immediately adjacent the outer half of the conical portion 18 of the diaphragm and conforms thereto. The clearance between the stop member 17 and the diaphragm portion 18, and between the plate member 16 and the flexible portion 22 of the diaphragm, is slightly greater than the maximum travel of the rod 15 when the armature vibrates to drive the diaphragm and is driven by the diaphragm.

In devices used on warships, the diaphragm may be subjected to very high pressure waves occasioned by gunfire and shearing or rupture of the diaphragm due to the high pressures might result. Such shearing or rupture, it has been found, is most apt to occur at and in the vicinity of the junction of the central portion 18 and the flexible portion 22 of the diaphragm. The plate member 16 and stop member 17, however, limit the possible inward movement of the diaphragm and by engaging the portions of the diaphragm in juxtaposition thereto prevent shearing or rupture of the diaphragm when it is subjected to high pressure waves.

The diaphragm and the armature constitute a vibrating system having a natural period within the range of frequencies to be translated, for example, at about 1200 cycles per second, so that the response characteristic of this system in itself would be characterized by a pronounced peak in the vicinity of the natural period noted and by a marked falling off at high frequencies, whereby non-uniform response and a limited frequency range of translation would result. In devices constructed in accordance with one feature of this invention, this peak is substantially suppressed and the response at low and high frequencies is equalized whereby a substantially uniform response throughout a wide frequency range, for example, from about 400 cycles to about 5000 cycles is obtained.

As shown clearly in Fig. 1, the stop member 17 is of such form that the passageway or opening 29 therein is frusto-conical with the smaller end thereof away from the diaphragm. This smaller end has extending thereacross a sheet 30 of acoustic resistance material, such as acoustic silk. The passageway 29 leads to the chamber 31 between the frame member 10 and the annular and stop members 16 and 17, respectively. The opening 11 in this chamber has extending thereacross a sheet 32 of acoustic resistance material, such as acoustic silk. The sheets 30 and 32 are provided with central apertures 41 through which the connecting rod 15 extends.

It will be noted that the sheets 30 and 32 provide resistance in series with the diaphragm impedance and thus serve to damp vibration of the diaphragm. In order to obtain sufficient resistance to substantially suppress the response peak due to the natural period of the diaphragm and armature without substantially reducing the response at lower frequencies and to equalize the response throughout the operating frequency range, the acoustic resistance 30 is by-passed for the lower frequencies by a plurality, for example three, of equally spaced apertures 33 in the annular plate member 16. These apertures are of very small cross section, for example, of the order of 0.041 inch in diameter, and hence present a high impedance to the passage of intermediate and high frequency energy therethrough but do not attenuate substantially the lower frequencies.

Because of the small spacing between the stop member 17 and the central portion 18 of the diaphragm and between the plate member 16 and the flexible portion 22 of the diaphragm, there is produced an appreciable stiffness component of impedance which is effective to counteract the mass component of impedance of the diaphragm and of the sheets 30 and 32 and thus to reduce the total impedance of the vibratory system at the higher frequencies in the operating range whereby the response at these frequencies is enhanced. Also the chamber 31 produces an additional stiffness component effectively aiding in the enhancement of the high frequency response.

The construction, therefore, effects substantial suppression of the response peak due to the natural period of the diaphragm and armature and relative enhancement of the higher frequencies so that substantially uniform response throughout a wide frequency range, for example, from 400 to 5000 cycles per second as noted heretofore, is obtained.

Although a specific embodiment of the invention has been shown and described, it will be understood that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. A sound translating device comprising a diaphragm, a member adjacent said diaphragm and having a relatively large aperture therein, and a sheet of acoustic resistance material extending across said opening, said member having therein also a restricted opening constituting a low frequency by-pass around the acoustic resistance.

2. A sound translating device comprising a diaphragm, an annular member on one side of said diaphragm, coaxial therewith and having portions immediately adjacent an annular portion of said diaphragm to define therewith a thin air space, said annular member having a relatively large aperture adjacent the central portion of said diaphragm and having also a plurality of restricted openings therein disposed around said aperture, and acoustic resistance material extending across said aperture.

3. A sound translating device comprising a diaphragm, a member adjacent said diaphragm and having a large aperture therein, acoustic resistance means extending across said aperture, said member having also a restricted opening therein by-passing said resistance at low frequencies, and means defining with said member a chamber having communication with said aperture and said opening.

4. A sound translating device in accordance with claim 3 wherein said last-mentioned means is provided with an opening remote from said member and having acoustic resistance material extending thereacross.

5. A sound translating device comprising a diaphragm having a dished central portion, a peripheral mounting portion and an intermediate flexible portion, support means engaging said mounting portion, actuating means connected to said central portion, means defining with said diaphragm a chamber opposite one face thereof

and substantially coextensive with said face, a centrally apertured member within said chamber having a portion immediately adjacent said flexible portion and a part of said central portion adjacent said flexible portion, and acoustic resistance means extending across the aperture in said member, said member having also a plurality of restricted apertures therein opposite said flexible portion of said diaphragm.

6. A sound translating device in accordance with claim 5 wherein said chamber is provided with an aperture and comprising acoustic resistance means extending across said aperture in said chamber.

7. A sound translating device comprising a diaphragm having one surface exposed to the atmosphere, said diaphragm having a rigid central portion, a peripheral mounting portion and an intermediate flexible portion joining said central and peripheral portions, support means engaging said mounting portion, and stop means opposite the other surface of said diaphragm, said stop means comprising an annular member immediately adjacent said intermediate portion and an annular member immediately adjacent a part of said central portion adjacent the juncture thereof and said intermediate portion.

8. A sound translating device comprising a diaphragm having one surface exposed to the atmosphere, said diaphragm having a dished central portion, a peripheral mounting portion and an intermediate flexible portion joining said central and peripheral portions, support means secured to said peripheral portion, and stop means opposite the other surface of said diaphragm, said stop means comprising a rigid annular member immediately adjacent said intermediate portion and a second annular member mounted on said member and having a surface immediately adjacent and substantially conforming to approximately the outer half of said central portion.

9. A sound translating device in accordance with claim 8 wherein the aperture in said second annular member has extending thereacross a sheet of acoustic resistance material and said first annular member is provided with restricted apertures constituting a low frequency by-pass around the resistance due to said sheet.

10. A sound translating device comprising a diaphragm having a natural period of the order of 1200 cycles per second, translating means cooperatively associated with said diaphragm, and means for substantially equalizing the response of said diaphragm throughout a wide band of frequencies including means defining with said diaphragm a chamber opposite one surface thereof and substantially laterally coextensive therewith, a member adjacent said surface and having a central aperture therein, and acoustic resistance means extending across said aperture effective to reduce the response peak due to the natural period of said diaphragm, said member having a portion immediately adjacent a part of said surface defining therewith a high stiffness chamber effective to substantially counteract the mass reactance of said diaphragm, and said portion having therein restricted apertures constituting a by-pass around said acoustic resistance means at low frequencies.

11. A sound translating device comprising a diaphragm, means defining with said diaphragm a chamber adjacent one surface of said diaphragm, said chamber being provided with a plurality of openings, acoustic resistance material across one of said openings for damping said diaphragm, other of said openings being unobstructed to by-pass the acoustic resistance at low frequencies.

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