

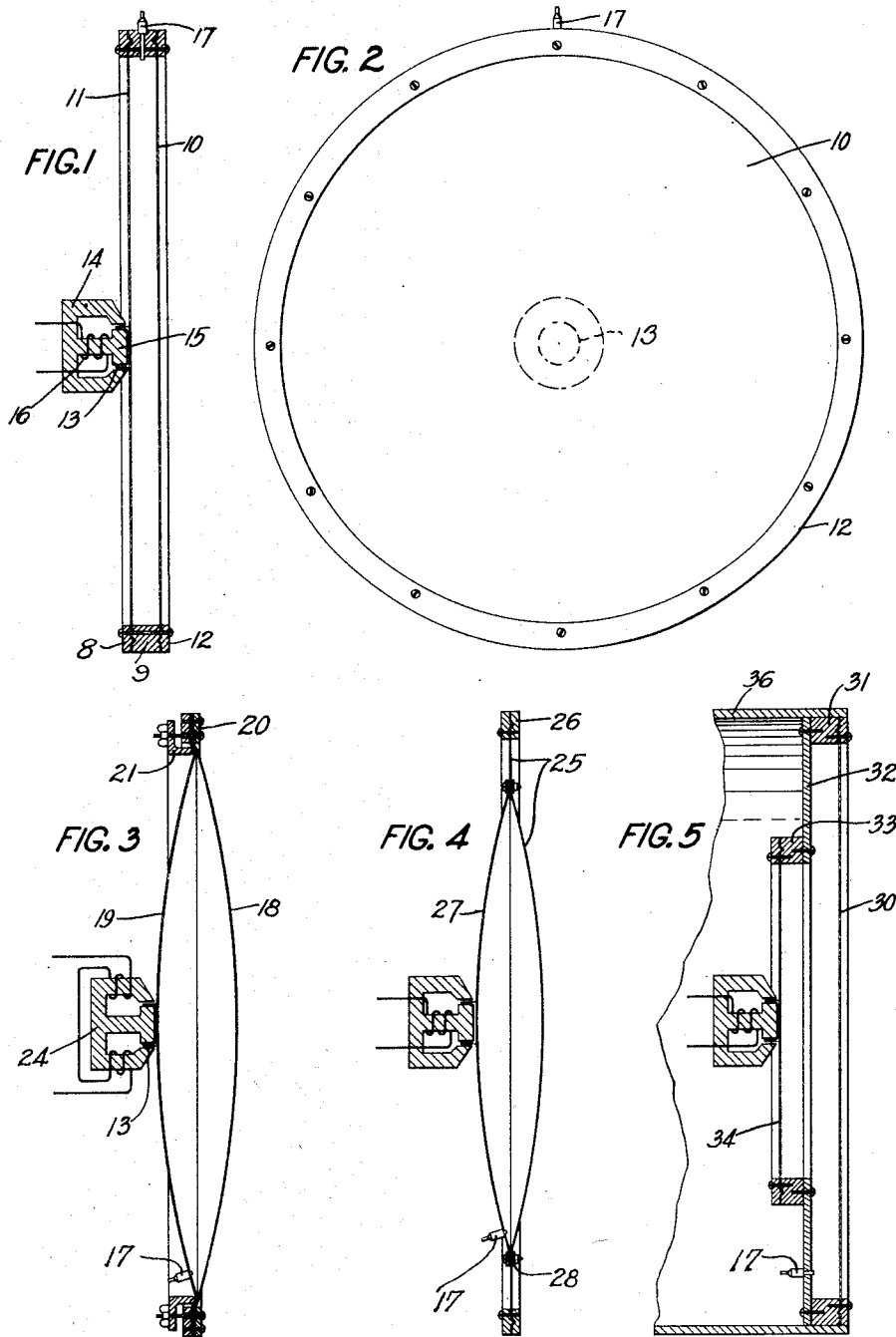
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ACOUSTIC DEVICE

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ACOUSTIC DEVICE

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This invention relates to acoustic devices and more particularly to large sound radiating surfaces acting directly in the surrounding air.

5 An object of the invention is to distribute the driving force over a large area of the sound radiating surface to increase the efficiency and response of the acoustic device.

10 Another object is to increase the rate of propagation of energy in a large surface sound radiator.

15 A feature of the invention is a pneumatic coupling between two radiating surfaces to impress uniform sound energy on one of said surfaces through the coupling between the two surfaces.

20 Another feature of the invention is the stretching of the surfaces of an acoustic device to a high tension by injecting a fluid medium between the surfaces of the device.

25 In accordance with this invention two large radiating surfaces or diaphragms are clamped in a frame which engages the periphery of both surfaces. The diaphragms are arranged in parallel relation with an intervening space therebetween and this space may be filled with a lighter than air medium, for instance, a light gas, such as helium or hydrogen, to a suitable pressure. An annular vibrating coil is attached to the center of one of the diaphragms and is movable in a magnetic field of an electromagnet, to impart vibration to the diaphragm to which the coil is attached. Due to the pneumatic gas coupling between the two diaphragms the distribution of the driving force will be transmitted to a large area of the diaphragm coupled to the driven diaphragm and the response frequency curve will be uniform and smooth.

30 In another embodiment of the invention the two diaphragms may be clamped in a frame with their surfaces in contact and a suitable light gas forced between the surfaces to a relatively high pressure to stretch the diaphragms and cause them to be maintained in a highly tensioned state. This arrangement increases the velocity of disturbance in the diaphragms and also increases the efficiency provided the velocity of disturbance does not exceed the velocity of sound in air.

When hydrogen is used to expand the two radiating diaphragms, the coupled diaphragm will receive a uniform pressure since the velocity of sound in hydrogen is several times greater than in air.

A more detailed description of the invention follows and is illustrated in the accompanying drawing.

Fig. 1 is a cross-sectional view showing two flat diaphragms pneumatically coupled together in accordance with this invention,

Fig. 2 is a front view of the sound radiator shown in Fig. 1,

Fig. 3 is a cross-sectional view of another form of the invention in which the composite diaphragm is stretched to a high tension by the gaseous filling between the surfaces,

Fig. 4 is a modification of Fig. 3 in which the composite stretched diaphragm is provided with a non-rigid termination and coupled to a low tensioned surface supported in a frame, and

Fig. 5 shows in cross-section a modification of the invention similar to Fig. 1 in which the composite sound radiator is made up of two diaphragms of different diameter.

Referring to Figs. 1 and 2 the acoustic device comprises two large diaphragms or membranes 10 and 11 of circular form and preferably of a light metal such as an aluminum alloy. This material is particularly suitable for this type of sound radiator due to its low mass and high tensile strength. The diaphragms are supported in parallel relation in a circular frame 12 which maintains the diaphragms under a suitable tension. The frame 12 may consist of an annular member 9 having an annular groove in each face and annular members 8 having an annular ridge on each inner surface capable of engaging with the grooves of the member 9. Diaphragms 10 and 11 are placed between the members 7 and 8. The members 8 are clamped down by bolts or screws producing an annular corrugation in each diaphragm. It is obvious that the diaphragm may be tensioned in this way; but, when, as outlined below, a gaseous medium is injected between the diaphragms 10 and 11 at a pressure greater or less than atmospheric, the clamped

grooved members comprising the frame will hold the diaphragms rigidly at their peripheral portions and under tension as the diaphragms expand outwardly or inwardly. Attached to the center of the diaphragm 11 is a movable coil 13 which extends into the magnetic field of an electromagnet 14. The magnet structure 14 is provided with a center pole 15 which together with the outer pole of the magnet forms a narrow gap in which the coil 13 is located. The winding 16 serves to magnetize the magnet 14 and produces a magnetic flux in the gap between the poles of the magnet. A valve 17, preferably of the self-closing type, extends from the periphery of the frame 12 and communicates with the space between the diaphragms 10 and 11. A suitable pneumatic medium such as air, or a light inert gas, such as helium or other suitable gas such as nitrogen or hydrogen, may be forced into the space between the diaphragms through the valve 17 to any suitable pressure. When hydrogen is used as the coupling medium between the diaphragm surfaces the vibrations imparted to the diaphragm 11 by the movable coil 13 are distributed over a large area of the diaphragm 10 through the pneumatic coupling between the diaphragms. The velocity of disturbance through the hydrogen gas is several times greater than through a similar coupling medium of air so that there is very little lag between the vibrations set up in the diaphragm 11 and the vibrations imparted to the diaphragm 10. Due to the diaphragm 10 receiving the vibrations over a large area this surface acts as a piston to a large extent and reflection is greatly diminished. Furthermore, the response characteristic of the energy imparted to the air is more uniform over a large part of the important speech frequency range and the efficiency of the sound radiator is increased. When an inert gas, such as helium, is used, a chemically inactive, non-inflammable, coupling gaseous medium is provided. An acoustic device employing such a gaseous medium may be used without the fear of fire or explosion which might be present with other gaseous mediums.

The sound radiating device shown in Fig. 3 comprises two diaphragms 18 and 19 which are clamped in a frame 20 along their edges and the diaphragms lie before pumping in face to face contact over their whole area. The diaphragms 18 and 19 are preferably formed of aluminum alloy or other suitable material and the mounted composite diaphragm is clamped to a frame 21 of L shaped cross-section, to stretch the diaphragm to any desired tension. A valve 17 is affixed to the diaphragm 19 to permit injection of the gas, such as helium or hydrogen, into the space between the two diaphragms, to expand and stretch the diaphragms to a high degree of

tension. As shown in Fig. 3 the diaphragms 18 and 19 when stretched internally by the pressure of gas between the surfaces causes them to assume an outwardly curved shape. A coil 13 may be attached to the diaphragm 19 and this coil is located in the magnetic field of the magnet 24. In this arrangement the high tension of the diaphragm surfaces and the pressure of the gas coupling enclosed by the diaphragms, increases the velocity of disturbance between the two diaphragms. Consequently the diaphragm 18 will receive a more uniform sound pressure than is possible with a single diaphragm. In the modification shown in Fig. 4 a single diaphragm 25 is clamped to a peripheral frame 26 and a circular diaphragm 27 of smaller diameter is suitably attached to the diaphragm 25 either by cementing or soldering the edge of the diaphragm 27 to the surface of the diaphragm 25, or by riveting as shown at 28. A valve 17 inserted near the edge of the diaphragm 27 provides an inlet for the gas filling which may be maintained at a high pressure depending on the tension which is desired in the composite diaphragm surface. In this arrangement the composite stretched diaphragm is provided with a non-rigid termination 28 and coupled to an annular vibrating portion which is under a different degree of tension than the composite diaphragm, so that the composite diaphragm can vibrate as a plunger at very low frequency and the stiffness of the plunger will not be increased to a large extent due to the low tension annular portion of the diaphragm 25.

In Fig. 5 the acoustic device comprises a diaphragm 30 clamped to a large supporting frame 31 which is provided with an apertured rear wall 32 supporting a light frame 33 of smaller diameter than the frame 31. A diaphragm 34 is clamped and stretched in the frame 33 to form a composite vibrating surface having diaphragms of different diameters. A valve 17 is fitted in the wall 32 to permit injection of a filling of gas between the radiating surfaces 30 and 34 to any desirable pressure. The rear of the composite diaphragm may be enclosed in a casing 36, to prevent sound waves radiating from diaphragm 30 reaching the rear of the radiating surface to cause distortion. The mechanical impedance of the two diaphragms will be different due to the difference in diameter of the diaphragms 30 and 34. However, the large radiating surface 30 will not appreciably raise the lower cut-off frequency of diaphragm 34 due to its small stiffness.

The diaphragms of the various forms of the invention are stretched to a high degree and preferably to a degree such that the rate of propagation of sound therein approaches the rate of propagation of sound in air.

While the invention has been disclosed in

various forms to represent structural differences it is to be understood that various modifications may be made in the structures without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. An acoustic device comprising two large direct-acting sound radiating diaphragms having a filling of lighter than air gas between them, a frame member engaging the periphery of said diaphragms, and means for driving one of said diaphragms, said other diaphragm being driven through the pneumatic coupling between said diaphragms.
2. An acoustic device comprising a plurality of large direct-acting diaphragms stretched to such a degree that the rate of propagation of sound therein approaches the rate of propagation of sound in air, means attached to one of said diaphragms for driving it, and a gaseous filling between said diaphragms having a rate of propagation of sound therein greater than the rate of propagation of sound in air, said filling serving as a coupler between the diaphragm to which the driving means is attached and the other of said diaphragms.
3. An acoustic device comprising two large direct-acting sound radiating diaphragms coupled together at their peripheries, means for driving one of said diaphragms, and a layer of lighter than air medium between said diaphragms.
4. An acoustic device comprising two large direct-acting sound radiating diaphragms coupled together at their peripheries, means for driving one of said diaphragms, and a layer of light gas between said diaphragms.
5. An acoustic device comprising two large direct-acting sound radiating diaphragms, a frame member engaging the peripheries of said diaphragms, means for driving one of said diaphragms, and a layer of inert gas between said diaphragms.
6. An acoustic device comprising two large direct-acting sound radiating diaphragms having their inner surfaces initially adjacent, a frame member engaging the peripheries of said diaphragms, a filling of gas for expanding said diaphragms, and means for driving one of said diaphragms.
7. An acoustic device comprising a double vibratory portion and an annular single vibratory portion, said double portion being expanded internally.
8. An acoustic device comprising two large metallic diaphragms, and a gas filling between said diaphragms, said diaphragms being subjected to a stress due to said gas filling.
9. An acoustic device comprising two direct-acting metallic diaphragms, and a gaseous medium in the area between said diaphragms at greater than atmospheric pressure.
10. An acoustic device comprising two di-

rect-acting metallic diaphragms, and a gaseous medium filling the area between said diaphragms, said medium being a gas, the velocity of sound through which exceeds the velocity of sound in air.

11. An acoustic device comprising a driving diaphragm and a driven diaphragm, and a gaseous coupling between said diaphragms, the wave motion in said driving diaphragm being transmitted through said gaseous coupling and impressed substantially simultaneously on all portions of said driven diaphragm.

12. An acoustic device comprising a plurality of diaphragms separated from each other, and driving means attached to one of said diaphragms, the space between said diaphragms being filled with a lighter than air gas, whereby the speed of sound propagation between said diaphragms is increased over the speed of sound in air.

13. An acoustic device comprising a frame, a pair of diaphragms attached at their peripheries to each other, a vibratory member coupled to the peripheries of said diaphragms and supported by said frame, means for initially tensioning said diaphragms and vibratory members and a light gas between said diaphragms, for causing a further tension in said diaphragms and vibratory members.

14. The method of stretching a metallic sound radiating surface having an adjacent wall clamped to said surface on the periphery thereof, which comprises injecting a lighter-than-air gaseous medium between the radiating surface and the adjacent wall.

15. The method of stretching a metallic sound radiating surface having an adjacent wall clamped to said surface on the periphery thereof, which comprises filling the space between said surface and wall with a light gas of sufficient density and pressure to expand said radiating surface.

16. The method of stretching two sound radiating diaphragms joined at their edges, which comprises injecting an inert gas between said diaphragms until each of said diaphragms assumes an outwardly curved surface.

In witness whereof, I hereunto subscribe my name this 18th day of July 1928.

VESPER A. SCHLENKER.