June 29, 1937. A. E. SWICKARD 2,085,130

ACOUSTIC DEVICE

Filed June 18, 1936 2 Sheets-Sheet 1

FIG. 1

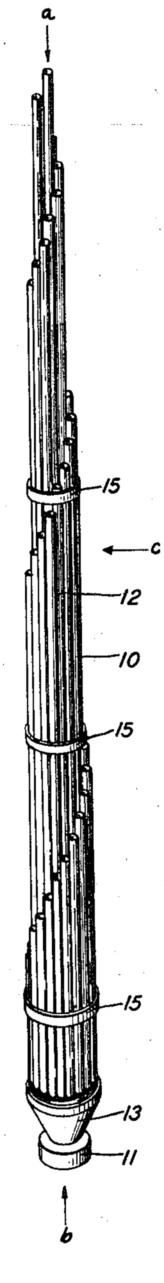


FIG. 2

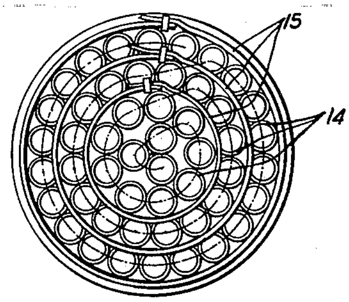
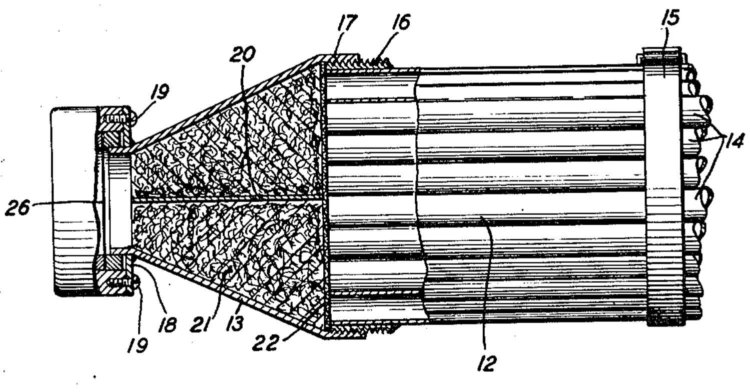


FIG. 3



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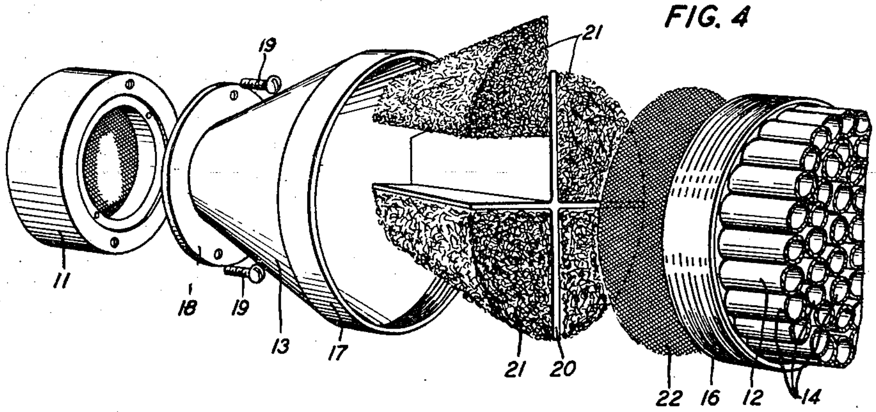
Filed June 18, 1936 2 Sheets-Sheet 2

FIG. 4



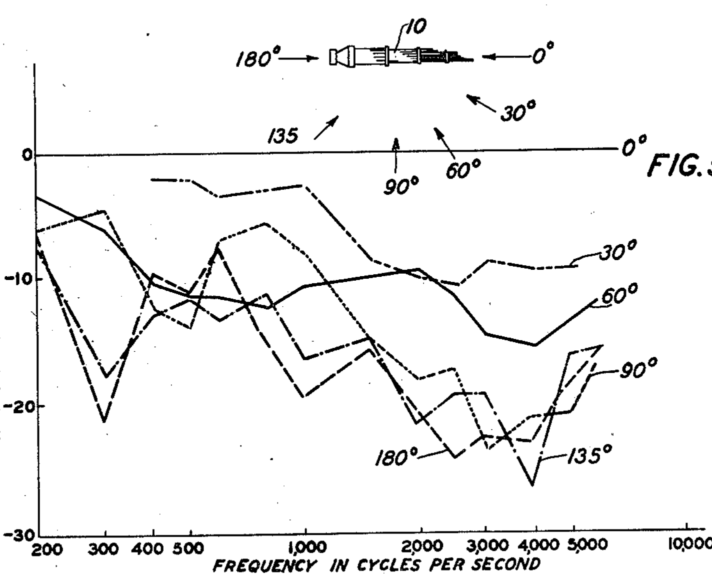


FIG. 5

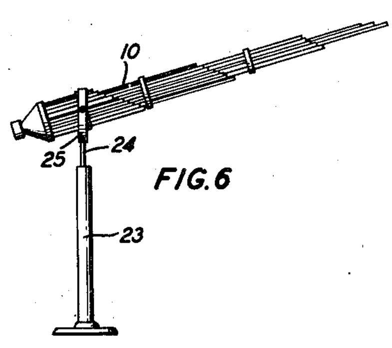


FIG. 6

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ACOUSTIC DEVICE

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4 Claims. (Cl. 181—0.5)

This invention relates to acoustic devices and, more particularly to a sound translating device for converting sound waves into electrical variations.

An object of the invention is to translate sound waves incident from a particular direction to the substantial exclusion of sound waves incident from other directions.

A feature of the invention comprises an impedance element introduced between a sound translating member or diaphragm and the source of sound waves incident on the diaphragm, comprising a cluster or group of open-end tubes or pipes in spiral formation.

Another feature comprises such an impedance element in which the tubes are of different lengths and are of progressively increasing length along the spiral.

Still another feature comprises a directional sound translating device embodying such an impedance element, a transmitter, and a coupler member uniting them, the coupling member including means for reducing resonances and reflection effects.

Other and further features will be apparent from the description that follows.

A more complete understanding of this invention will be obtained from the detailed description which follows, read with reference to the appended drawings, wherein:

Fig. 1 is a view in perspective of an acoustic device embodying this invention;

Fig. 2 is a top plan view of the device of Fig. 1;

Fig. 3 is a side view of a fragment of the device of Fig. 1, partly broken away and partly in section;

Fig. 4 shows in perspective and exploded, the transmitter end of the device of Fig. 1;

Fig. 5 shows curves illustrating the directional characteristic of the device of Fig. 1 for various angles of sound wave incidence; and

Fig. 6 is a side view of the device of Fig. 1 mounted on a suitable support.

The acoustic device 10 of the drawings is a directional sound translating device. It comprises a transmitter 11, for instance, of the electrostatic type, although a moving coil type may be used; an acoustic impedance element or member 12; and a coupler or union member 13, uniting the transmitter and the impedance element.

The impedance element comprises a plurality of tubes or pipes 14, open at each end and each of a different length, arranged in a cluster in spiral formation and held in adjacent relationship by clamping bands 15. The lower open ends of the tubes are in a common plane, the tube ends being secured within an externally threaded ring 16. There are approximately fifty tubes, each about one-half inch in diameter, the shortest being about 1.2 inches and the longest about five feet in length, the upper ends of adjacent tubes in the spiral being separated by a distance of about 1.2 inches, i. e., the tube length increases in accordance with an arithmetical progression along the spiral.

The coupler member comprises a hollow, substantially frusto-conical shell having an internally threaded open-end portion 17 engaging with the ring 16, and a flanged open-end portion 18 for securing the coupler to the transmitter by suitable fastening means, such as the screws 19. A cross-shaped spacer member 20 divides the interior of the shell into compartments, each of which is filled with damping material 21, which may be of hair felt. An acoustic resistance or screen 22, preferably of silk, having approximately the characteristic impedance of air, is disposed over the ends of the tubes adjacent the coupler member.

The sound translating device may be mounted on any suitable support, for example, a floor or table stand 23. The cradle portion 24 is preferably rotatable so that the sound translating device may be adjusted in a horizontal plane, and the portion 25 is preferably U-shaped so that the device is adjustable in a vertical plane as well in order that it may be directed at a particular source of sound.

A directional sound translating device is one that discriminates against sound that is being propagated in or from directions other than the desired one. In the device described hereinabove, sound waves enter the ends of the tubes, pass through them to and through the acoustic resistance, and into the chamber defined by the coupler member. The sound pressure developed therein reacts upon the diaphragm 26 of the transmitter and sound translation occurs or the sound waves are "picked up". When a sound wave progresses in a direction (vector *a*) which is toward the sound translating device and along the axis of the tubes, all of the sound reaches the screen 22 at the same time regardless of whether it passes through a long tube or a short tube since, in a good sized tube, the velocity of sound is practically the same as that in open air. The sound waves, in such circumstances, are in phase and when they combine in the coupler member, a reenforcing effect occurs. When the sound waves are incident in any other direction, (for example, vectors *b*, *c*) they will reach the screen in different times through the various tubes, since the length of the path depends upon the tube that is traversed. Consequently, there will be an out of phase relationship at the entrance to the coupler member, no reenforcing action takes place in the coupler member, and only a small pressure is exerted on the transmitter diaphragm.

The length of the longest tube should be comparable to the wave-length of the lowest frequency sound wave for which the device is to be directional; the number of tubes must be fairly great if the directional effect is to be pronounced; the acoustic screen should have an acoustic reresistance comparable to the characteristic impedance of air, i. e., about 41 mechanical ohms per square centimeter, otherwise reflections may result in resonances and phase shifts impairing the response of the device; the volume of the coupler member should be large so that its acoustic impedance is much lower than that of the acoustic screen. The spacer tends to prevent resonances in a radial direction if any should be present; and the hair felt filling reduces resonances which may occur in the coupler member.

Any type of transmitter may be used since it merely "picks up" the sound waves after the directional action has been accomplished by the tubes and associated acoustic elements. If desired, the coupler member may be omitted and the sound translating device may comprise merely the transmitter and the impedance element secured together so that the ends of the tubes are in a common plane and in close spaced relation to the diaphragm of the transmitter.

A device in accordance with this invention was constructed and tested. With the sound waves incident along the axis of the impedance element, i. e., at 0 degrees, and successively at angles of 30 degrees, 60 degrees, 90 degrees and 135 degrees to this axis, and along the axis but from the rear of the device, i. e., at 180 degrees from the initial position, readings of the response of the device were made. Taking the response at 0 degrees as a base, the relative response in decibels at the other angles of sound incidence were plotted to give the curves shown by Fig. 5, evidencing the marked directional characteristic of the device.

While this invention has been disclosed with reference to a specific embodiment, it will be understood that it is not limited thereto but by the scope of the appended claims only.

What is claimed is:

1. A sound translating device comprising a diaphragm, a group of parallel open-ended tubular members having a common end spaced from the diaphragm, means defining an air chamber between said common end and said diaphragm, and impedance means at said common end to prevent reflection of sound waves therefrom.

2. A sound translating device comprising a diaphragm, a group of parallel open-ended tubular members having a common end spaced from the diaphragm, means defining an air chamber between said common end and said diaphragm, impedance means at said common end to prevent reflection of said waves therefrom, and means in said air chamber for preventing resonance therein.

3. A sound translating device comprising a diaphmragm, a plurality of open-ended tubular members, and a member coupling one end of said tubular members to said translating member, said coupling member containing damping material and a layer of acoustic resistance material disposed over said one end of the tubular members.

4. A directional sound translating device comprising a transmitter, a cluster of tubes in spiral formation of different lengths and open at each end, the open ends of the tubes being in a common plane, an acoustic screen disposed over the open ends in said plane, a hollow member coupling said transmitter and said cluster, means dividing the interior of said member into a plurality of compartments, and damping material in said compartments.

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