

Oct. 18, 1960

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2,957,053

AUDIO-ELECTRIC TRANSLATING DEVICE

Filed Feb. 21, 1956

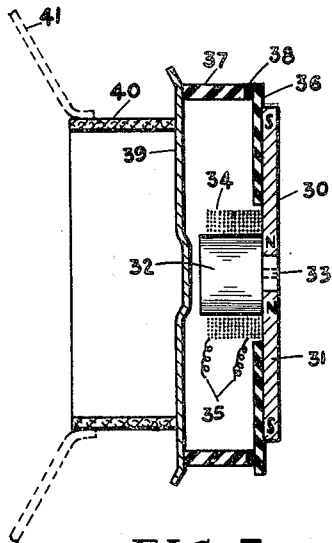


FIG. 3

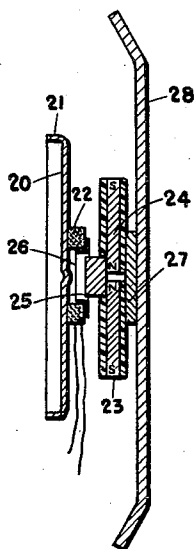


FIG. 2

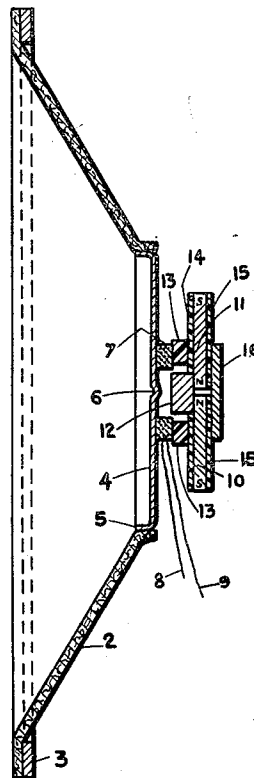


FIG. 1

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AUDIO-ELECTRIC TRANSLATING DEVICE

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Filed Feb. 21, 1956, Ser. No. 566,961

9 Claims. (Cl. 179—114)

This invention is for an audio-electric translating device applicable for use either as a device for converting electric impulses into sound, as for example a loud speaker, or for converting audible vibration into electric impulses, that is, a microphone.

My invention has for its object to provide a device of this character in which permanent magnets are used, with the magnets and related parts being more effectively arranged than heretofore to respond over a wider range of audio frequencies and secure high fidelity reproduction with a wide range of volume or amplitude.

A further object of my invention is to provide a device of this kind in which superior results are achieved with a reduction in the mass of the permanent magnets, not only reducing distortion due to inertia, but substantially reducing the cost.

A further object of my invention is to provide a device of this character in which good response is secured with higher impedance in the armature coil than may now be practically provided, better suiting the impedance of the speaker to other components of the circuit in which it is used.

These and other objects and advantages are secured by my invention which may be more fully understood by reference to the accompanying drawings, in which:

Fig. 1 is a transverse section through a cone speaker embodying one form of my invention;

Fig. 2 is a vertical section on a larger scale than Fig. 1, of a slightly modified construction; and

Fig. 3 is a transverse section through a still further modification.

In the drawings, 2 designates the parchment paper cone of customary construction as used in a loud speaker, and 3 designates the ring around the periphery of the cone providing the mounting for the cone in a housing (not shown). At the center of the cone is a soft iron or magnetizable disk 4 which is frequently made with a peripheral flange 5 to which the center portion of the cone is attached, and the center of the disk 4 may have a small button-like protuberance 6 embossed therein, but this is not necessary. Cemented to one face, preferably the rear face of the disk 4 around the central button 6, is a fine wire winding or hollow coil of disk-like form designated 7, and which is provided with lead wires 8 and 9, the convolutions of the coil being in planes at right angles to the axis of the coil, in the conventional manner.

With the present invention there are provided two small but powerful permanent bar magnets 10 and 11. High magnetic alloy metal is preferably used for these materials, typical of which is the metal (aluminum-nickel-cobalt alloy) sold under the trademark "Alnico." The two bar magnets 10 and 11 are placed in aligned confronting relation to each other with similar poles opposed. For example the two north poles are in confronting relation and separated from each other by a very small air gap. These confronting poles tend of course to repel each other, but they are held in fixed rela-

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tion to one another by a core or button 12 of soft iron which may be welded to them, or otherwise permanently secured to keep the bar magnets in fixed position. The free end of this button or pole piece 12 is of a diameter such as to fit into the central opening of the coil 7. It terminates with the end at about the level of the rear face of the coil, or with the end projecting a very small fraction of an inch into the coil. It is most effective if it just barely enters the coil, although this is not a necessary condition.

This magnet assembly as shown in Fig. 1 is held in spaced relation to the coil by resilient blocks 13 of rubber, resilient silicone resin, or other compressible resilient material. The blocks 13 may be cemented to the rear face of the coil 7, and the magnet bars 10 and 11 may have fiber strips 14 adhered to their inner surfaces, which are in turn cemented to the outer faces of the blocks 13. On the outer faces of the bar magnets 10 and 11 there may be other strips 15 of non-magnetic insulating material to which there is cemented a magnetizable metal disk or connecting plate 16 which serves also to hold the parts in assembled relation.

The lines of force emanating from the opposed poles N of the bar magnets 10 and 11 of course tend to repel each other and deflect them from their normal field, so that the lines of force pass through the button 12 and emerge from the face of this button creating a very strong magnetic attraction between the face of the button 12 and the center of the disk 4. The field is thus made strongly effective in a plane perpendicular to the plane of the bar magnets. The pole piece or button 12 thus becomes a common pole piece, the polarity of which is opposite the polarity of the two remote ends of the two-bar magnet assembly.

Minute variations of current flowing through the coil 7 react with or against the field projected from the pole piece 12, either increasing or decreasing the effect of the field. An increase in the effect of the field tends to compress the blocks 13 and create relative movement between the magnet assembly and the diaphragm. A magnetic field generated by the coil opposing the field of the permanent magnet of course has the reverse effect and tends to create relative movement between the diaphragm and the magnet away from each other.

In the conventional apparatus of this kind the permanent magnet normally has its axis perpendicular to the diaphragm, and the lines of force from the pole piece extend in a more or less normal pattern, whereas in the present invention the mutually repugnant fields of the two magnets are both projected into and from the end of the common magnetizable button 12, creating an entirely different relation between the field and the magnetic coil than has heretofore been provided. Because of this relationship the device will respond with higher fidelity over the entire audible range, and respond to more minute variations of current with far less amount of metal in the permanent magnets than has heretofore been considered practical. Not only does the translating device as thus constructed respond with greater fidelity over a wider range of audio frequencies, but I have determined that the impedance of the coil 7 may be increased substantially over the impedance permitted with speakers of present design. This increases the fidelity of the reproduced sound because the impedance of the speaker can be more closely conformed and adjusted to the impedance of other elements in the circuit in which the device is used, than has heretofore been practical.

The arrangement shown in Fig. 1 is satisfactory for speakers in a lower price class, but for microphones and better quality speakers, the construction shown in Fig. 2 may be used.

In this construction, 20 designates a disk similar to disk 4, and it may be flat as shown, or have an outwardly-embossed center area as in Fig. 1. It is shown with a peripheral flange 21, but this need not be provided. There is a disk-like open-center or hollow coil 22 corresponding to coil 7 mounted on the disk. The permanent magnet assembly comprises two bar magnets 23 and 24 disposed as in Fig. 1 with their like poles in confronting closely separated relation, and a magnetizable soft iron or like button 25 is joined to them, as in Fig. 1 and holds them in fixed relation. A flanged sleeve 26 of insulating material is provided at the rear face of the coil and the button 25 has a free working fit in the outer end of the sleeve, the button or armature just barely entering the center of the field coil.

Instead of being supported on the coil as in Fig. 1, the permanent magnet assembly is secured, preferably through a magnetizable body or disk 27 insulated as is button 16 of Fig. 1 from the permanent magnets, to a supporting bridge 28 that is fixedly mounted in a housing (not shown). In other words, the mounting more nearly resembles the conventional mounting used in devices of this general character.

My invention has been described particularly with reference to so-called loud speakers, but is applicable to microphones. It provides an audio-electric translating device characterized by the provision of two permanent bar magnets in end-to-end relation with like poles in opposition and with the longitudinal axes of the bar magnets being at right angles to, or in a plane transverse to the longitudinal axis of the field coil. My invention increases the effectiveness of the opposed fields of these magnets by the provision of a pole piece of magnetizable material projecting from the confronting ends of the magnets to the end of the field coil where its effect or the electro-magnetic field of the coil is at a maximum. The coil is of flat construction, so that even when the coil is deenergized, the magnetizable disk on which the coil is mounted is influenced or biased by the field of the permanent magnet.

The small mass of the permanent magnets is not only a very economical advantage from the standpoint of cost, as is also the absence of closely machined parts, but the low mass decreases the inertia and increases sensitivity. Much greater volume without "blasting" is also secured. As a microphone of the electromagnetic type, it is highly satisfactory and appears to perform in a manner equal to or superior to much more costly microphones of other types, both as to sensitivity and fidelity.

In the modification shown in Fig. 3 the magnet assembly is substantially the same as that before described, but the coil instead of being placed on the armature disk, is placed on the magnetizable pole piece. In this construction the bar magnets are designated 30 and 31. As heretofore described, they are so positioned that their like poles are in confronting relation. In this figure, however, the magnetizable pole piece 32 is shown as having a small extension 33 that is interposed between these confronting ends of the magnets. The coil 34 is positioned around the magnetizable pole piece 32 and has its inner face resting against the magnets 30 and 31. The lead wires to the coil are designated 35. The magnets in addition to having their ends secured to the pole piece 32 are mounted on a non-magnetic disk 36 which may be made of insulating material such as plastic. The disk 36 is supported at its periphery on a collar 37 which may be formed of plastic, or which may be of aluminum. A resilient gasket 38 is preferably interposed between the disk 36 and the collar 37.

The magnetizable diaphragm 39 is supported at its periphery on the collar 37. The center of this disk is spaced a slight distance from the magnetizable core 32. All of the parts are cemented together so that there can be no free vibration. I have found that superior results can be obtained by securing to the front of the disk a fiber collar 40. The collar 40 may be secured to the diaphragm 39 by suitable cement. The collar 40 is in turn

mounted on the support for the speaker which, in the case shown in Fig. 3, constitutes the center portion of a cone 41.

It is to be noted that the fiber ring 40 is spaced inwardly from the periphery of the disk 39. The fiber ring 40 should be of sufficiently less diameter than the collar 37 that the disk 39 will overhang the collar 40 a substantial distance. As thus constructed it will be seen that the collar 40 in a sense provides a fulcrum between the center of the disk which is attracted by the magnet 32 and the periphery to which the magnet assembly is secured to the disk. The collar 40 not only provides a support for the disk 39 intermediate its center and edge, but it also provides a sound throat which appears to improve the acoustical properties of the speaker.

The speaker as thus constructed is easy to assemble and economical to manufacture. By placing the coil 34 about the magnetizable pole piece 32 instead of placing it on the armature as in the construction heretofore described, it is possible to use a much larger coil and thereby increase the impedance. One difficulty with speakers as heretofore constructed has been the relatively low impedance which it has been possible to introduce into the coil. By using a higher impedance in the coil it is possible to eliminate the transformer between the last stage of the amplifier and the loud speaker, and thereby connect the speaker directly into the plate circuit of the last stage of amplification. This in turn allows a higher fidelity of reproduction and eliminates a part from the reproducing circuit. The speaker responds well over the entire normal audible range, and while it will operate at a loud volume of sound without "blasting," it is unnecessary to operate at great volume in order to hear the bass notes. The bass notes will be distinctly audible even though the speaker is turned to a very low volume of sound.

While Fig. 3 shows the magnetizable pole piece 32 as having an extension 33 interposed between the ends of the bar magnet, this construction is not necessary and the arrangement shown in Figs. 1 and 2 may be used. Also the arrangement shown in Fig. 3 could of course be used in the devices shown in Figs. 1 and 2. The use of the extension 33 on the magnetizable pole piece may have some advantage in assembly operations since it will act as a spacer in positioning the magnet during the assembly of the speaker. The collar 40 may be used with the arrangements shown in Figs. 1 and 2, but its use in Fig. 3 is especially desirable because of the cantilever effect obtained by having the magnet assembly supported on the periphery of the disk with the collar 40 inwardly from the periphery.

While I have shown and described certain specific embodiments of my invention, various structural changes and modifications may be made in the specific adaptation of it to its ultimate commercial form.

I claim:

1. An audio-electric translating device comprising a magnetizable diaphragm member, a magnetizable pole member having one end extending toward and terminating in spaced relation to one face of the diaphragm member, a pair of bar magnets having ends of like sign in confronting relation with said ends positioned over that end of the pole member which is remote from the diaphragm, the magnets being in a common plane perpendicular to the axis of the pole member, a coil mounted on one of said members and located in the space between them, a supporting disk for the bar magnets, a collar interposed between the periphery of the supporting disk and the diaphragm and secured to the disk and the diaphragm, and means for supporting the diaphragm.

2. An audio-electric translating device as defined in claim 1 wherein the coil surrounds and is mounted on the pole member.

3. An audio-electric translating device as defined in claim 1 wherein the supporting means comprises a fiber sleeve concentrically positioned on that face of the dia-

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phragm which is opposite the face confronting the pole member, the sleeve being smaller in diameter than the diaphragm and of less diameter than said collar interposed between the diaphragm and the disk.

4. An audio-electric translating device as defined in claim 1 in which the bar magnets are mounted on a non-magnetizable disk, the collar being interposed between the periphery of said disk and the periphery of the diaphragm and secured to both the diaphragm and the disk, a resilient gasket on the collar effective between the diaphragm and the disk which supports the bar magnets, and a second collar of less diameter than the first concentrically positioned on and secured to the opposite face of the disk.

5. An audio-electric translating device as defined in claim 4 in which there is a cone attached at its center to the second collar.

6. An audio-electric translating device of the class described having a permanent magnet assembly comprised of a pair of permanent bar magnets in fixed end-to-end position and with like poles in confronting relation but with an air gap between them, a magnetizable button member on the faces of the bar magnet at the confronting poles spanning the gap between them, a magnetizable diaphragm in a plane parallel to the plane of the two bar magnets and perpendicular to the axis of the button and spaced from that end of the button remote from the bar magnets but in close proximity thereto and centered over the button, the magnetic circuit from the remote ends of the bar magnets being open and free of any metallic conducting path from the plane of the bar magnets toward the plane of the diaphragm, and a coil interposed between the diaphragm and the bar magnets concentric about the axis of the magnetizable button.

7. An audio-electric translating device of the class described having a permanent magnet assembly comprised of a pair of permanent bar magnets in fixed end-to-end position and with like poles in confronting relation but with an air gap between them, a magnetizable button member on the faces of the bar magnet at the confronting poles spanning the gap between them, a magnetizable diaphragm in a plane parallel to the plane of the two bar magnets and perpendicular to the axis of the button and spaced from that end of the button remote from the bar magnets but in close proximity thereto and centered over the button, the magnetic circuit from the remote ends of the bar magnets being open and free of any metallic conducting path from the plane of the bar magnets towards the plane of the diaphragm, and a coil interposed between the diaphragm and the bar magnets concentric about the axis of the magnetiz-

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able button, the coil being a flattened coil carried on the diaphragm with one plane of the coil being in substantially the plane of the end of the button remote from the bar magnets.

8. An audio-electric translating device of the class described having a permanent magnet assembly comprised of a pair of permanent bar magnets in fixed end-to-end position and with like poles in confronting relation but with an air gap between them, a magnetizable button member on the faces of the bar magnet at the confronting poles spanning the gap between them, a magnetizable diaphragm in a plane parallel to the plane of the two bar magnets and perpendicular to the axis of the button and spaced from that end of the button remote from the bar magnets but in close proximity thereto and centered over the button, the magnetic circuit from the remote ends of the bar magnets being open and free of any metallic conducting path from the plane of the bar magnets toward the plane of the diaphragm, a coil interposed between the diaphragm and the bar magnets concentric about the axis of the magnetizable button, and resilient means holding the diaphragm in permanent magnet assembly in the aforesaid relationship.

9. An audio-electric translating device having a diaphragm, a hollow coil on the diaphragm, a permanent magnet assembly mounted adjacent the coil and diaphragm comprising two separate permanent bar magnets with like poles in closely spaced confronting relation, the magnets being in a plane transverse to the axis of the coil, a magnetizable pole piece on the confronting ends of the two bar magnets and projecting therefrom toward the diaphragm, and a resilient pad directly interposed between the magnet assembly and that face of the coil which confronts the magnet assembly and surrounding the pole piece.

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