May 9, 1950 R. E. WIRSCHING 2,506,624

ELECTROACOUSTIC TRANSDUCER

Filed June 18, 1947

FIG. 1

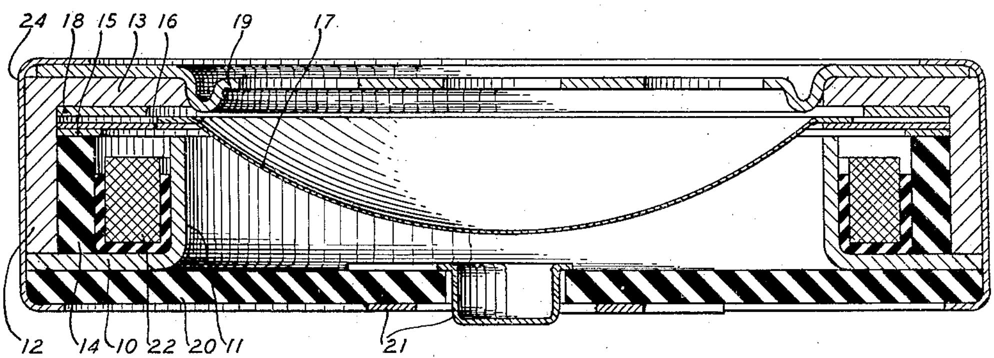


FIG. 2

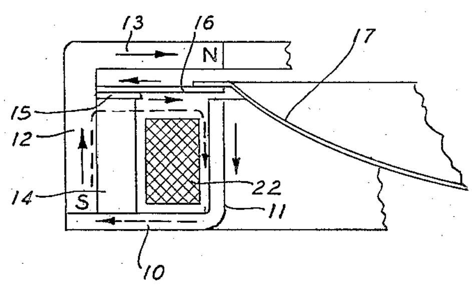
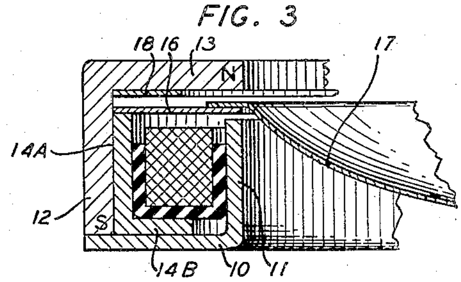


FIG. 3



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ELECTROACOUSTIC TRANSDUCER

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12 Claims. (Cl. 179—120)

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This invention relates to electroacoustic transducers and more particularly to ring armature type acoustic devices such as disclosed in the application Serial No. 704,483, filed October 19, 1946, of Edward E. Mott.

In ring armature type transducers of the general construction disclosed in the above-identified application, the magnetic system includes two magnetic circuits each of which comprises a permanent magnet and also an annular armature common to the two circuits. The armature is supported adjacent its outer portion and has its inner marginal portion extending into an air gap between juxtaposed magnetic parts of the two circuits. The magnets in the two circuits are relatively poled so that the components of flux through the armature due thereto are in opposition.

Realization of optimum performance by such construction entails manufacture of the parts constituting the magnetic system to close tolerances. In known constructions, the magnetic system comprises a relatively large number of parts so that the structure is somewhat complex and attainment of the desired relation of the parts involves manufacturing control of a correspondingly large number of parts.

One object of this invention is to simplify the structure and facilitate the manufacture of ring armature type transducers.

More specifically, objects of this invention are to reduce the requisite number of elements or parts in magnetic systems for transducers of the general construction above-described, to expedite the realization of the correlation of the elements or parts to assure optimum performance, and to facilitate the manufacture of such transducers in quantity and with substantially identical performance characteristics.

In accordance with one feature of this invention, a single permanent magnet is provided for producing the requisite direct current flux components in the two magnetic circuits of the system.

In accordance with another feature of this invention, the armature is mounted by a support member which does not constitute a part of the magnetic structure and is of readily workable material so that it may be machined easily to provide a reference surface for determining the normal position of the armature in the air-gap of the assembly. Advantageously, the support member is of non-magnetic non-metallic material so that eddy current losses in the magnetic system are minimized.

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:

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Fig. 1 is a side view section of an electroacoustic transducer illustrative of one embodiment of this invention;

Fig. 2 is a detail diagrammatic view illustrating the direct current and signal flux paths in the transducer shown in Fig. 1, and

Fig. 3 is a fragmentary sectional view illustrating another embodiment of this invention.

Referring now to the drawing, the device therein illustrated is operable as either a receiver or transmitter and comprises a pole-piece having an annular base 10 and a cylindrical pole tip portion 11, the pole-piece being of a material, such as the nickel-iron alloy known commercially as Permalloy, having a high permeability. Associated with the pole-piece 10, 11 is an annular permanent magnet having a cylindrical portion 12 coaxial with the pole tip portion 11 and seated upon the base 10 and an integral annular flange 13 the inner marginal part of which is opposite and coaxial with the tip of the pole-piece portion 11. The magnet is of a high coercive force material such as the aluminum-nickel-cobalt-iron alloy known commercially as Alnico or the molybdenum-cobalt-iron alloy known commercially as Remalloy.

A cylindrical non-magnetic support 14 is seated upon and firmly affixed to the base 10, is fitted within the magnet part 12 and has its other end coplanar with the tip face of the pole-piece portion 11. Advantageously, the support is of a non-metallic material which is easily machinable so that the free end face thereof may be readily operated upon, e. g. ground, to make it accurately coplanar with the pole tip face. A suitable and illustrative material is a phenolic condensation product. Seated upon and affixed to the support 14 is an annular magnetic spacer 15, for example of Permalloy, which is fitted within the cylindrical part 12 of the magnet and forms a seat for the armature 16. The armature, which also may be of Permalloy, is annular, has its periphery immediately adjacent the magnet and has its inner marginal portion coaxial with and in juxtaposition to the face of the pole tip portion 11.

The armature mounts a dished, lightweight non-magnetic diaphragm 17, for example of thin metal such as Duralumin, a plastic such as polystyrene, or a fabric impregnated with a phenolic condensation product.

Overlying the armature and affixed to the flange 13 of the magnet is a non-magnetic annulus 18 which serves to prevent contact of the armature with the magnet flange 13 and sticking of the armature thereto.

A centrally dished and apertured disc or grid 19 is seated upon the flange 13 and serves to protect the diaphragm 17. At the other end of the structure is an insulating plate 20 mounting terminals 21 to which the ends of a cylindrical signal coil 22 mounted between the pole-piece 11 and support 14, are connected.

The several parts of the structure, specifically the magnet, pole-piece, grid and terminal plate, are firmly held together in pile-up relation by a clamping band 24 having its ends bearing against the grid and terminal plate respectively.

It will be noted that inasmuch as the support 14 is fitted within the cylindrical magnet portion 12 and is coaxial with the pole tip portion 11, the latter and the support 14 are positioned in coaxial relation with the magnet when the parts are assembled. As has been pointed out heretofore, the free end of the support is made accurately coplanar with the tip face of the pole-piece portion 11. The magnetic spacer 15 is of preassigned thickness and, thus, fixes the normal gap between the armature and the pole tip face. It will be appreciated, therefore, that the structure is capable of ready assembly and that manufacture thereof in quantity and at relatively low cost is expedited.

The magnetic system of the transducer comprises two circuits or branches having the armature common thereto. Specifically, one branch or circuit comprises the major part of the cylindrical magnet portion 12, the armature 16 and the pole-piece 10, 11; the other branch or circuit comprises the magnet portion 13, the armature 16 and a small part of the magnet portion 12. The magnetic flux paths are illustrated in Fig. 2, wherein the direct current flux paths are indicated by the full arrows and the signal flux flow is as indicated by the dotted arrows, i. e. is around the circuit comprising the armature 16, pole-piece 10, 11 and major part of portion 12 of the permanent magnet.

It will be noted that there are two oppositely directed components of direct current flux threading the armature 16. In transducers of the type disclosed, it is advantageous, as pointed out in Patent 2,249,160, granted July 15, 1941, to Edward E. Mott, that these two flux components be unequal whereby an unbalance in the two circuits or branches of the system obtains. In transducers of the construction herein disclosed such unbalance, as well as correlation of the magnetomotive forces to assure maximum efficiency and operating stability are facilely achieved.

Specifically, in the manufacture of the transducer, the magnet 12, 13 is magnetized to produce poles of opposite polarity at its extremities as indicated at N and S in Fig. 2. Then a current is supplied to the coil 22 in the direction to demagnetize the magnet part 12 thereof, in steps to the point corresponding to maximum efficiency. Finally, the portion 13 of the magnet is demagnetized in steps, as by an electromagnet applied across the ends thereof, to the point corresponding to a desirable operating stability for the transducer. In the completed device, then, the direct current flux component in the armature which flows in the branch or circuit including the pole-piece and magnet part 12 is greater than the component which flows in the branch or circuit including the magnet part 13.

In the embodiment of the invention illustrated in Fig. 3, the armature support comprises a cylindrical part 14A fitted within the magnet portion 12 and an annular flange 14B seated upon and affixed to the base flange 10 of the pole-piece. The support may be of insulating material and have its portion 14B cemented to the pole-piece flange 10. Alternatively, the support may be of a high resistivity metal having slight permeability and have its portion 14B welded to the flange 10. In the latter case, the support provides eddy current shielding of the magnet part 12.

The free end of the support portion 14A and the tip of pole-piece portion 11 are ground plane and are in parallel planes, and the armature 16 is seated directly upon the support 14. In the fabrication of the device, the free end of magnet part 12 is ground to establish a prescribed distance between the plane of this end and the magnet part 13. Then the free end of support portion 14A is ground to fix the distance thereof from the free end of magnet part 12 at a prescribed value. Finally, the tip of pole-piece portion 11 is ground so that it is in a plane a preassigned distance from the plane of the free end of support portion 14A. Consequently, when the elements are assembled, preassigned normal spacings between the armature and the tip of pole-piece portion 11 and the magnet part 13 obtain.

As in the device illustrated in Figs. 1 and 2, in the construction shown in Fig. 3, the magnet is magnetized to produce poles at its extremes and then is demagnetized sectionally to establish the desired unbalance between the two circuits or branches of the magnetic system and realize maximum efficiency and a desirable operating stability.

Although specific embodiments of the invention have been shown and described, it will be understood that they are 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. An electroacoustic transducer comprising a pole-piece having a base and a cylindrical portion extending from said base, a magnet having a cylindrical portion extending from said base and coaxial with said cylindrical portion of said pole-piece, said magnet having also a flange portion in juxtaposition to said cylindrical portion of said pole-piece and defining an air gap therewith, an annular armature having one margin adjacent a part of said magnet intermediate the poles thereof and having a portion extending into said air gap, and means supporting said armature for vibratory motion of said portion thereof.

2. An electroacoustic transducer comprising a magnet having a cylindrical portion and an annular flange extending inwardly from one end of said cylindrical portion, a pole-piece extending inwardly from the other end of said cylindrical portion and having an annular pole tip in juxtaposition to said flange and defining an air gap therewith, an annular armature having its periphery adjacent said cylindrical portion of said magnet and having a portion in said air gap, and means supporting said armature adjacent said periphery thereof.

3. An electroacoustic transducer comprising a pole-piece having a base and a pole tip portion extending from said base, a magnet having a portion one end of which is adjacent said base and having also a flange extending from the other end of said portion, said flange having its free end in juxtaposition to said pole tip portion and defining an air gap therewith, said magnet being magnetized to produce poles of opposite polarity at said one and free ends and such that parts extending from said one and other ends are of unequal strength, and an armature having one margin immediately adjacent an intermediate portion of said magnet and extending into said air gap.

4. An electroacoustic transducer comprising a magnet having a cylindrical portion and an an-

nular flange extending from one end of said cylindrical portion, a pole-piece having a base extending from the other end of said cylindrical portion and having also a cylindrical pole tip in juxtaposition to and coaxial with the free end of said flange and defining an air gap therewith, said magnet being magnetized locally to produce poles of opposite polarity at said one end thereof and said end of said flange and such that said cylindrical portion and flange are of unequal strength, an annular armature having one margin immediately adjacent the junction of said cylindrical portion and flange and its other margin in said air gap, and means supporting said armature adjacent said one margin thereof.

5. An electroacoustic transducer comprising a magnet having a cylindrical portion and an annular flange extending inwardly from said cylindrical portion, a pole-piece comprising a base extending inwardly from one end of said cylindrical portion and a cylindrical pole tip portion coaxial with said flange and terminating in a tip in juxtaposition to the inner margin of said flange and defining an air gap therewith, said magnet being magnetized locally to produce poles of unlike polarity at said one end and margin and such that said cylindrical portion is more highly magnetized than said flange, an annular armature having its outer edge adjacent the junction of said cylindrical portion and flange and its inner edge portion in said air gap, and means supporting said armature adjacent said outer edge thereof.

6. An electroacoustic transducer comprising a pole-piece having a cylindrical portion terminating in a pole tip and having also a flange extending from said cylindrical portion, a magnet having a cylindrical part seated upon said flange and spaced from said cylindrical pole-piece portion and having also a flange overlying said pole tip and defining an air gap therewith, a cylindrical support between said cylindrical magnet part and said cylindrical pole-piece portion, and an annular armature seated adjacent one margin upon said support and extending into said air gap.

7. An electroacoustic transducer in accordance with claim 6 wherein said support is affixed to said pole-piece in coaxial relation with said cylindrical pole-piece portion and is fitted to said cylindrical magnet part, whereby said cylindrical portion is positioned coaxially with respect to said part.

8. An electroacoustic transducer in accordance with claim 6 wherein said support is affixed at one end to said flange of said pole-piece and has its other end coplanar with said pole tip, said transducer comprising also a spacer member upon said other end of said support, and said armature being seated upon said spacer member.

9. An electroacoustic transducer in accordance with claim 6 wherein said support is of insulating material.

10. An electroacoustic transducer comprising a pole-piece having a cylindrical portion terminating at one end in an annular pole tip and having also an annular flange extending outwardly from the other end of said portion, a permanent magnet having a cylindrical part coaxial with said cylindrical portion and seated at one end upon said flange, said magnet having also an annular flange extending inwardly from the other end of said cylindrical part and with its inner margin in juxtaposition to and defining an air gap with said pole tip, a cylindrical non-magnetic support encompassing said cylindrical pole-piece portion and adjacent said cylindrical magnet part, said support being seated at one end upon said pole-piece part and having its other end coplanar with said pole tip, a spacer member upon said other end of said support, and an annular armature having its outer marginal part seated upon said spacer member and its inner marginal part in said air gap, said magnet being magnetized to produce poles of opposite polarity at said one end thereof and said inner margin of said flange and such that said cylindrical part is more highly magnetized than said flange.

11. An electroacoustic transducer comprising a magnet having a cylindrical portion and an annular flange extending from one end of said cylindrical portion, an annular armature having one margin adjacent said cylindrical portion and its other margin opposite the free end of said flange, said flange and armature together with the gap therebetween and a portion of said cylindrical portion defining a first magnetic circuit, a pole-piece extending from the other end of said cylindrical portion and having a pole tip in juxtaposition to said other margin of said armature, said pole-piece and armature together with the gap therebetween and the remainder of said cylindrical magnet portion defining a second magnetic circuit, and a signal coil linked to said second circuit, said magnet being magnetized to produce poles of unlike polarity at said other end of said cylindrical portion and said free end of said flange and such that the direct current magnetomotive force in said second circuit is greater than that in said first circuit.

12. An electroacoustic transducer comprising a permanent magnet having a cylindrical portion and an annular flange extending inwardly from one end of said cylindrical portion, a pole-piece extending inwardly from the other end of said cylindrical portion and having an annular pole tip in juxtaposition to and coaxial with the inner margin of said flange, an annular armature having its periphery adjacent said one end of said cylindrical portion and having its inner marginal part in the gap between said pole tip and said inner margin of said flange, and a signal coil linked to said pole-piece, said magnet being magnetized to produce poles of unlike polarity at said other end of said cylindrical portion and at said inner margin of said flange and such that the direct current flux in the magnetic circuit including said armature and said pole-piece exceeds that in the magnetic circuit including said armature and said flange.

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