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Cragg

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[54] **ELECTRO-ACOUSTIC ARMATURE TRANSDUCER**

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[51] **Int. Cl.**..... **H04r 11/00**

[58] **Field of Search**..... 179/114 R, 114 A, 115 R, 179/115 A, 117, 119 R, 119 A; 335/231; 148/103

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[57] **ABSTRACT**

A balanced armature electro-acoustic transducer has small permanent magnets on its armature and on the pole-pieces with each armature magnet's poles facing like poles on the pole-pieces. Thus equal centering forces are set up. The arrangement uses rare-earth/cobalt alloys, which have a very high coercivity.

3 Claims, 3 Drawing Figures

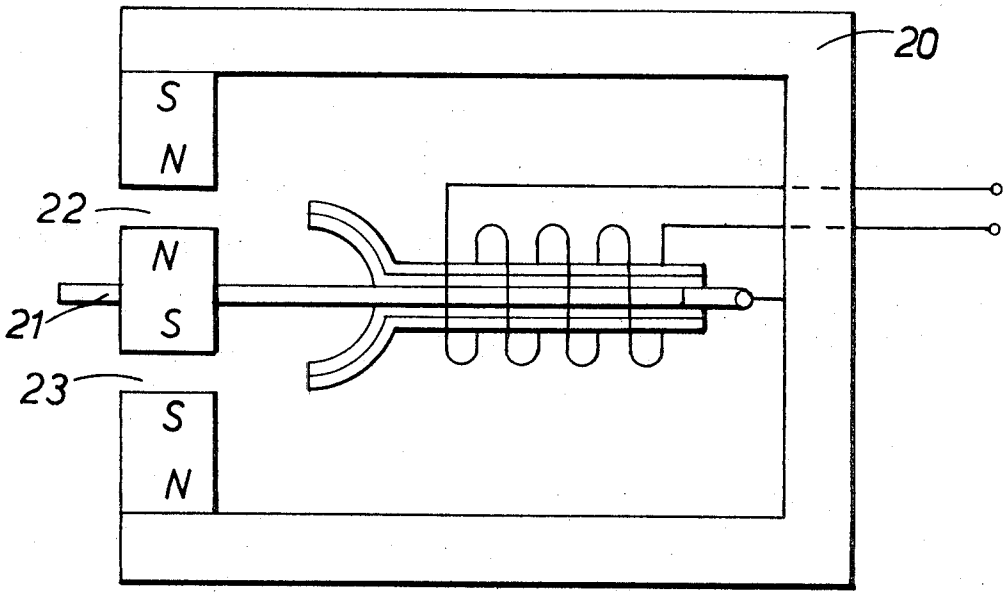


FIG.1.

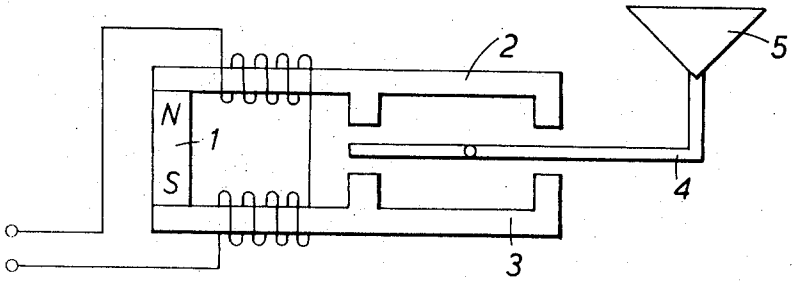


FIG.2.

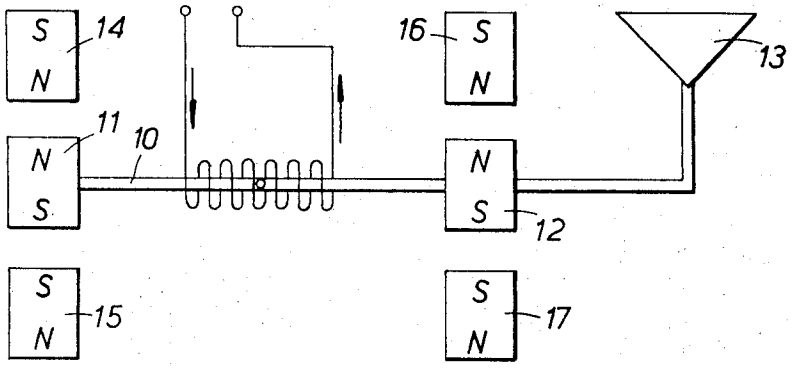
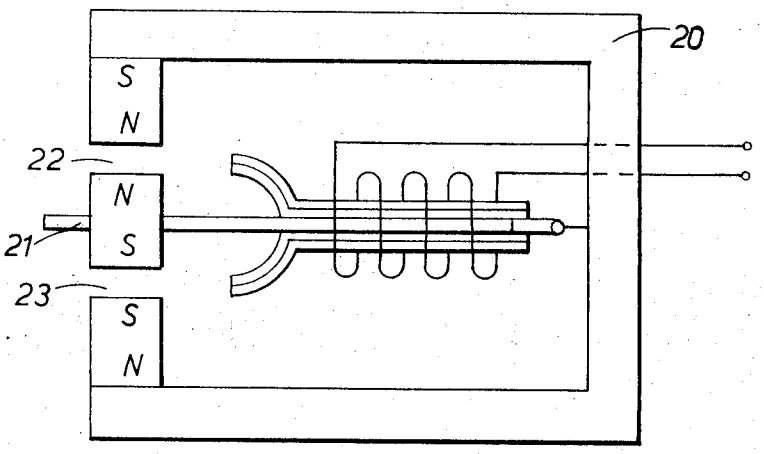


FIG.3.



ELECTRO-ACOUSTIC ARMATURE TRANSDUCER

The present invention relates to an electro-acoustic transducer of the so-called moving-iron type, i.e. to one in which the armature which drives (in the case of a loudspeaker or a telephone earpiece) or is driven by (in the case of a microphone) the diaphragm is a member of a ferro-magnetic material.

SUMMARY OF THE INVENTION

According to the present invention there is provided an electro-acoustic transducer in which an armature of a magnetically soft material is pivotally mounted so as to drive, or to be driven by a diaphragm, in which the armature has at least one of its ends located between two pole-pieces, in which each said pole-piece is formed by a permanent magnet, in which said one end is also a permanent magnet, in which the directions in which said magnets are poled is such that each magnet pole on the armature faces a pole of the same polarity as itself, in which said magnets are physically small compared with said armature but are of relatively high coercivity material, and in which one or more coils are provided for the magnetic circuit to which driving currents are applied or from which currents due to sound incident on the diaphragm are taken.

It will be appreciated that the invention is applicable to microphones, loudspeakers and telephone earpieces, and that a fully balanced armature arrangement can be used in which the armature is centrally pivoted. In such a case the armature carries a magnet at each of its ends, each such magnet cooperating with two stationary magnets, as set out above.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 shows for explanatory purposes a conventional rocking armature transducer;

FIG. 2 is an explanatory diagram of one embodiment of the present invention; and

FIG. 3 is a slightly more detailed representation of a second embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In one conventional rocking armature transducer, a permanent magnet 1 is provided with two pole-piece members 2, 3, each of which has two pole-pieces as shown. Between these pole-pieces there is a pivoted armature 4 to one end of which is coupled a diaphragm 5. Coils are mounted on the pole-piece members 2 and 3. In the case of a telephone earpiece, the application of speech currents to the coils causes the armature 4 to rock about its central pivot and thus to drive the diaphragm 5. The transducer has certain practical limitations in that if the armature is deflected too far it is liable to stick (or freeze) to the pole pieces, and that to keep it in a central position a high stiffness is needed in its pivot bearing.

The basic construction of one form of floating armature transducer according to the invention is shown in FIG. 2. In this arrangement, the armature 10 carries small magnets 11, 12 at each of its ends, and (as in the device of FIG. 1) is coupled to a diaphragm 13. The magnet 11 is between two similar magnets 14 and 15, while the magnet 12 is between two similar magnets 16 and 17. With the magnets poled as indicated in FIG. 2, it will be seen that the repulsive forces between the magnets causes the armature to float freely in a central position.

The armature 10 is softly magnetic and has a coil wound on it to carry a signal current. If this current is in such a direction (as shown) as to make the left-hand end of the armature of a South polarity, then the left-hand end of the armature 10 moves upwards towards the magnet 14. When the current reverts to zero the armature, by virtue of the respulsive forces on it, is immediately re-centralized. Thus it will be seen that with an alternating current in the coil, the armature oscillates in sympathy with that current to drive the armature 13. As long as the alternating fluxes due to the signal are small compared with the steady flux, the movement is linearly related to the input electrical signal.

The magnets used are rare-earth cobalt magnets whose coercivity is of the order of 10,000 oersted, compared with which Alnico V has a coercivity of about 500. Thus the magnets can be small, and in the case of one transducer using magnets of a Samarium-cobalt alloy they were 1mm cubes. With such an arrangement it is possible to obtain a floating armature with a low stiffness. The central magnet/armature arrangement is highly stable since any deflection closes the spacing between magnetic poles of like polarity, which increases the centering force. Thus it is possible to obtain an armature mounting of nearly zero stiffness, so that the overall acoustic impedance of the transducer can be reduced until it is comparable with the ear impedance or with the air-loaded impedance in the case of a microphone.

The magnets themselves form the pole-pieces, and since they work in a demagnetizing field they can exist in isolation without the usual soft magnetic circuit. As will be seen below, however, the latter can still be used where this is convenient. As will be seen from the above discussion the magnets can be very small, i.e. 1 mm cubes, so that their dimensions are comparable with the dimensions of the other parts of the device.

If the magnetic fields of the device shown schematically in FIG. 2 are plotted, it will be found that at each end of the armature one gap simulates a unipolar South pole while the other gap simulates a unipolar North pole.

When the arrangement is used as a microphone, it will be seen that a diaphragm will deflect the armature from its central position, with the result that flux is switched through the armature in one direction or the other, to give an induced current in the coil.

The transducer shown in FIG. 3 has a soft iron return path 20 to the center of which is pivoted an armature 21, the left-hand end of which drives (or is driven by) a diaphragm. The armature and also the ends of the return path 20 carry small magnets poled as shown so that "magnetically speaking" the device of FIG. 3 is half that of FIG. 2, but with a soft iron return path.

The armature is laminated with the outer laminae bent as shown into "horns" as at 22, 23 aimed at the two air gaps. The coil is wound about the armature 21. In this arrangement the central magnet provides positive stiffness to the armature vibrations, while the outer laminae act like a conventional balanced armature giving negative stiffness. The dimensions are such that over small excursions from a central position the addi-

tion of the positive and negative stiffnesses approach zero, and that for larger excursions positive stiffness exceeds negative stiffness.

Note that in FIG. **3**, the coils can be mounted on the soft iron member **20** if this is considered preferable to mounting them about the armature **21**.

It is to be understood that the foregoing description of specific examples of this invention is made by way of example only and is not to be considered as a limitation on its scope.

I claim:

1. An electro-acoustic transducer of the type having an armature pivotably mounted within a magnetic field, an electromagnetic coil for moving said armature within said field, and a diaphragm responsive to the movement of said armature wherein the improvement comprises:

an armature of laminated construction having a central lamina which carries a permanent magnet, two other lamina one on each side of said central lamina, wherein each said other lamina has one of its ends formed to a horn-like portion extending towards said magnetic field.

2. A transducer as claimed in claim **1**, and in which the coil embraces the armature.

3. A transducer according to claim **1** wherein said magnet is comprised of rare-earth cobalt alloys having a coercivity in the order of 10,000 oersteds.

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