

Oct. 13, 1959

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2,908,773

ELECTROACOUSTIC TRANSDUCER

Filed Dec. 27, 1956

2 Sheets-Sheet 1

FIG. 1

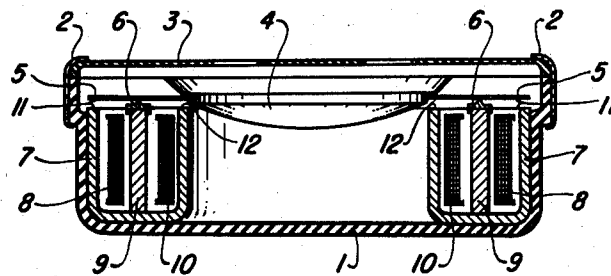
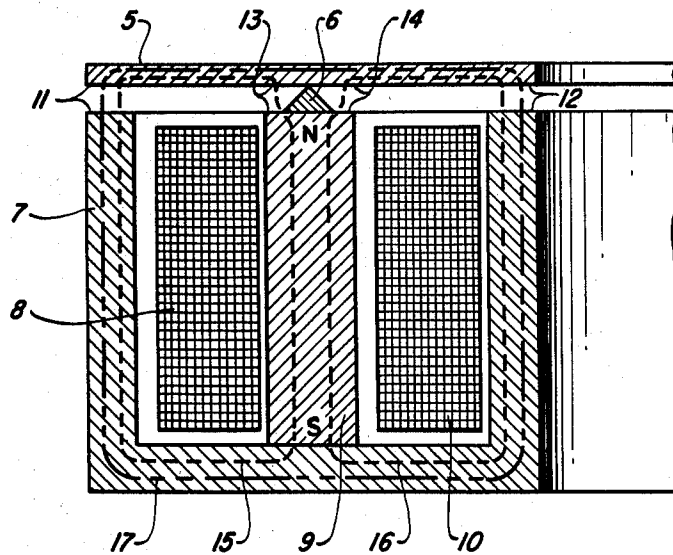


FIG. 2



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FIG. 3

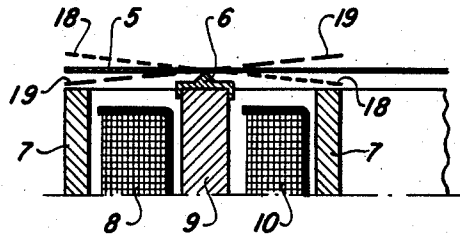


FIG. 4

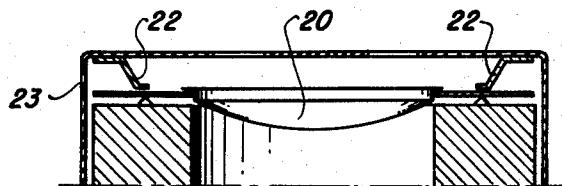
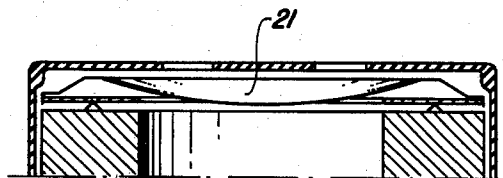


FIG. 5



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1

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ELECTROACOUSTIC TRANSDUCER

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6 Claims. (Cl. 179-114)

This invention relates to electroacoustic transducers and more particularly, to such devices of the ring armature type.

In ring armature transducers, such as disclosed in Patent 2,520,640, granted August 29, 1950 to Ralph R. Kreisel, a diaphragm is secured to a ring armature, the armature being supported at its outer edge. An air-gap is provided at the inner edge of the ring armature, and the inner edge of the armature vibrates in said air-gap. These transducers are generally provided with an annular magnetic structure that is arranged so that a portion of the structure is located both above and below the ring armature. As a result, there is a very limited amount of space wherein the diaphragm can be secured to the ring, and very little flexibility is afforded as to the shape of the diaphragm. Another disadvantage of the edge-supported ring armature is the fact that the air-gap in the voice current flux path changes when a signal is received at the transducer, with the result that the reluctance of this path also changes and introduces distortion.

Accordingly, it is the principal object of this invention to improve the efficiency and fidelity of translation of electroacoustic transducers.

Another object is to provide a ring armature transducer that will minimize the above mentioned distortion, while at the same time providing greater flexibility as to the diaphragm design.

More specifically, a ring armature transducer is provided wherein the ring is supported approximately midway between its inner and outer edges, with an air-gap provided at each edge. The armature rocks about said support, or fulcrum, in response to a voice signal, with the result that as one air-gap decreases the other air-gap increases, and the reluctance of the flux path is thereby maintained at a relatively constant value.

Another object of this invention is to simplify the structure of ring armature transducers, and the assembly thereof, and thereby to facilitate the fabrication and reduce the cost of manufacture.

A further object of the invention is to simplify the structure so as to minimize the number of rejects, and thereby to reduce the cost of manufacture.

Other objects and features will appear in the following description, taken in conjunction with the accompanying drawings in which:

Fig. 1 is a cross sectional view of the transducer.

Fig. 2 is an enlarged cross sectional view of the magnetic structure, showing the magnetic flux paths.

Fig. 3 is an enlarged fragmentary section of the transducer illustrated in Figs. 1 and 2, showing the ring armature in its operated positions.

Figs. 4 and 5 are cross sectional views of the transducer, wherein different diaphragm and acoustical control features are shown.

Referring now to the drawings, the transducer shown in Fig. 1 comprises a housing 1, a cover 3, and a clamping ring 2, which are secured together as shown to provide

2

the overall enclosure. The circular, dished diaphragm 4, which is preferably made of a non-magnetic material such as aluminum, is held in a fixed position at its periphery by being clamped between items 1 and 3. The ring armature 5 is made of a material with a high permeability and engages a shoulder of diaphragm 4 to which it is secured by a suitable cement or the equivalent, being held against lateral movement by the fixed position of the diaphragm. The armature is also held in a fixed position relative to the magnetic structure by the magnetic forces acting therein, as will be described below.

The magnetic structure consists of an annular core 7 having a U shaped cross section. This core is made of a magnetic material having high permeability and a high specific resistivity (Allegheny metal or similar), which is arranged to fit snugly against the inner bottom and side walls of housing 1 as shown. An annular permanent magnet 9, having a rectangular cross section, and which is made from an alloy having a high coercive force, is mounted in the center of annular core 7. An annular fulcrum 6, or spacer ring, is mounted on the top edge of magnet 9 as shown, so as to engage ring armature 5 near the center thereof. These components are designed so as to provide air-gaps 11 and 12 between each edge of the armature and the corresponding edge of the annular core. Two exciting coils 8 and 10 are provided and mounted between the permanent magnet 9 and annular core 7 as shown.

Applicant's invention will be more readily understood after an examination of Fig. 2, which illustrates the magnetic circuits. Since the components shown in Fig. 2 are identical to those of Fig. 1, the same identifying numbers have been used. Three flux paths are shown in Fig. 2, and these are numbered 15, 16 and 17. Paths 15 and 16 indicate the flux set up by permanent magnet 9, which path 17 illustrates the path that is followed by flux set up by exciting coils 8 and 10.

For purposes of illustration, it will now be assumed that permanent magnet 9 is arranged so that spacer ring 6 is mounted upon the north magnetic pole of the magnet, and that the south magnetic pole engages annular core 7. This is indicated on Fig. 2 by the letters N and S. The flux set up by this magnet follows two major paths, indicated as 15 and 16. Path 15 can be traced out of the north pole of magnet 9, through air-gap 13, through the left side of ring armature 5, down through air-gap 11, through the left vertical and bottom left sections of core 7, and into the south magnetic pole of magnet 9. Flux path 16 can be traced out of the north magnetic pole of magnet 9, through air-gap 14, through the right hand section of armature 5, down through air-gap 12, through the right vertical and bottom sections of core 7, and into the south magnetic pole of magnet 9. Thus, it is seen that the magnetic flux set up by magnet 9 flows downward through both of the air-gaps, 11 and 12. Both edges of the ring armature are thereby attracted to the annular core, with the result that the armature is held in a fixed normal position by the magnetic forces acting thereon. The components of the magnetic structure are arranged so as to maintain equal forces at both the inner and outer edges of the ring, so as to equalize air-gaps 11 and 12, and thereby hold the ring in a fixed level position with regard to the remaining portion of the magnetic structure.

When coils 8 and 10 are excited by an incoming voice-frequency signal, magnetic flux is caused to flow through the magnetic structure along path 17. This path includes ring armature 5, annular core 7, and air-gaps 11 and 12. Flux does not flow through magnet 9 as a result of the incoming signal, due to the comparatively high reluctance of the magnet as compared with the other elements in flux path 17. Upon examination of

this flux path, it is seen that when flux is flowing downward through air-gap 11 in response to the first half cycle of an incoming signal, an equal amount of flux is flowing upward through air-gap 12. Thus, referring again to the assumed polarity for permanent magnet 9, the voice signal flux is seen to aid the permanent magnet magnet flux in air-gap 11, while opposing the permanent magnet flux in air-gap 12. As a result, armature 5 rocks over on fulcrum 6 to the position shown as line 19 in Fig. 3. During the subsequent half cycle of the incoming voice frequency signal, the voice frequency flux would be reversed in direction so as to flow upward through air-gap 11 and downward through air-gap 12, thereby opposing the permanent magnet flux at the left edge of armature 5 while aiding the flux at the right edge of the armature. This reversal would therefore cause the armature to rock back through its normal position to a position along line 18 of Fig. 3, air-gap 11 being increased in length while air-gap 12 is decreased in length. Thus, as an input signal is received at coils 8 and 10, ring armature 5 is seen to rock back and forth on fulcrum 6 under the influence of the magnetic forces acting thereon. The air-gap in the alternating flux path remains very nearly constant, since an increase in the length of air-gap 11 will cause a corresponding decrease in the length of air-gap 12, and vice versa.

The armature movement causes a corresponding movement of diaphragm 4, which is secured to the inner edge of the armature, as shown in Fig. 1. The rocking action of the armature thereby causes the diaphragm to vibrate, and sound waves are thereupon transmitted from the device.

It will now be assumed that applicant's transducer is being used as a transmitter, and that a sound wave is impinging upon diaphragm 4. This sound wave causes diaphragm 4 to vibrate, and armature 5 is thereby caused to rock back and forth on fulcrum 6. When the diaphragm has moved into position 18 of Fig. 3, the reluctance of flux path 16 (Fig. 2) will be less than the reluctance of path 15, with the result that most of the permanent magnet flux will flow over path 16. Conversely, when the armature is in position 19, more of the permanent magnet flux flows over path 15. These flux variations cause an electrical signal to be set up in coils 8 and 10, said electrical signal corresponding to the incoming sound signal.

As mentioned above, applicant's transducer offers considerable flexibility as to the various types of diaphragms that can be provided, two possible alternates being shown in Figs. 4 and 5. Diaphragm 20 in Fig. 4 is very similar to the diaphragms shown in previously patented ring armature transducers, such as the Kreisel patent previously referred to. Diaphragm 20, preferably of aluminum, is mounted on the inner edge of the ring armature by cement or other suitable means, as shown. Other types of diaphragms can also be provided, one of these being item 21 in Fig. 5, wherein the diaphragm is secured to the outer edge of the ring type armature. Various other diaphragm designs suggest themselves, and the flexibility of the system is readily apparent.

In addition to changing the design of the diaphragm, various other devices could be provided to facilitate the emission of sound from the transducer. Item 22 in Fig. 4 is an annular projection from cover 23, and is provided to impede the passage of air around the armature and into or from the internal cavity of the receiver. Other acoustical control devices could also be provided, such as acoustical damping, to improve the response characteristics of the transducer. Various acoustical damping systems are well-known in the art, and would be readily adaptable to applicant's transducer.

During an analysis of applicant's disclosure, it has been pointed out that two exciting coils are provided, numbered 8 and 10 on the drawings. It should be remembered that the use of both coils is not essential to

operation of applicant's transducer, and that only one of the two coils would suffice. Furthermore, depending upon the desired impedance characteristics, the two coils when used could be connected either in series or in parallel, thereby providing a four to one ratio of impedance.

Although specific embodiments of the invention have been shown and described, it should be understood that they are merely illustrative and that various modifications may be made therein without departing from the scope and spirit of the invention as defined in the appended claims.

What is claimed is:

1. An electroacoustic transducer, comprising an annular permanent magnet, a fixed annular core of magnetic material, a ring shaped magnetic armature, a diaphragm, and an exciting coil, said magnet and said exciting coil mounted within said core, means for positioning said armature adjacent to said core forming thereby two air-gaps separating said armature from said core, said armature maintained in said position by the tractive influence of said permanent magnet, said armature secured to said diaphragm, excitation of said coil with voice current varying said tractive influence to cause both said air-gaps to alternately open and close, thereby imparting a vibratory motion to said diaphragm causing sound waves to be emitted therefrom.

2. An acoustical device comprising an annular magnetic structure and a ring armature, a spacer ring included within said structure having a diameter less than the outer diameter of said armature, said spacer ring located so as to support said armature in spaced relation to said structure and serve as a fulcrum for said armature, thereby delineating a pair of air-gaps between said armature and said structure, a diaphragm, said armature linked to said diaphragm, and means including said diaphragm for transmitting a sound wave from said device corresponding to an incoming electrical signal, and for transmitting an electrical signal from said structure corresponding to sound waves impinging upon said diaphragm.

3. An electroacoustic transducer comprising a ring armature, an annular magnetic structure, and a spacer ring having a diameter less than the outer diameter of said armature, said ring mounted so as to support said armature in spaced relation to said structure with a first air-gap separating the inside edge of said armature from said structure and a second air-gap separating the outside edge of said armature from said structure, and means including said structure for causing magnetic flux to flow over two paths through said armature, the first path including said first air-gap and the second path including said second air-gap.

4. An acoustic device comprising a non-magnetic dished circular diaphragm, a housing, an annular magnetic core having two circular pole pieces, said core mounted within said housing and adjacent to the base thereof, a cylindrical permanent magnet, an exciting coil, said permanent magnet and exciting coil mounted within said core, a magnetic ring armature, said armature secured to said diaphragm, a spacing ring mounted on said magnet, said spacing ring having a diameter less than the outer diameter of said armature, said armature supported by said spacing ring so as to maintain each edge of said armature in juxtaposition to each of said pole pieces with an air-gap separating each edge from its corresponding pole piece, said armature maintained in said position by the magnetic forces acting thereon.

5. An acoustic device as claimed in claim 4, including means securing the periphery of said diaphragm to said housing, thereby preventing lateral movement of said armature with respect to said core.

6. An electroacoustic transducer, comprising an annular permanent magnet, a fixed annular core of magnetic material, a ring shaped magnetic armature, a dia-

5

phragm, and a pair of exciting coils, said magnet and said exciting coils mounted within said core, means for positioning said armature adjacent to said core forming thereby two air gaps separating said armature from said core, means comprising the interconnection in series of said pair of exciting coils for obtaining a first impedance, second means comprising the connection in parallel of said pair of exciting coils for obtaining a second impedance, said armature secured to said diaphragm, said coils controlled in said series and parallel connection 10 being responsive to the application thereto of voice frequency for varying the attraction between said core

6

and said armature to alternately cause one air-gap to close while the other air-gap opens, thereby imparting a vibratory motion to said diaphragm.

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