June 13, 1950 G. G. LAVERY 2,511,114

POLARIZED ELECTROMAGNET

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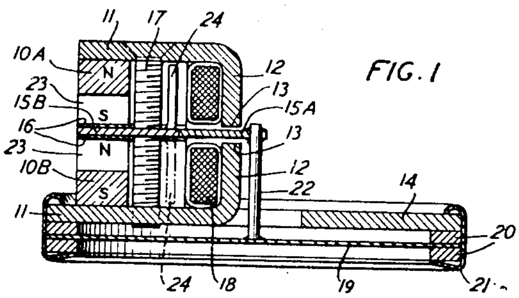


FIG. 1

FIG. 2

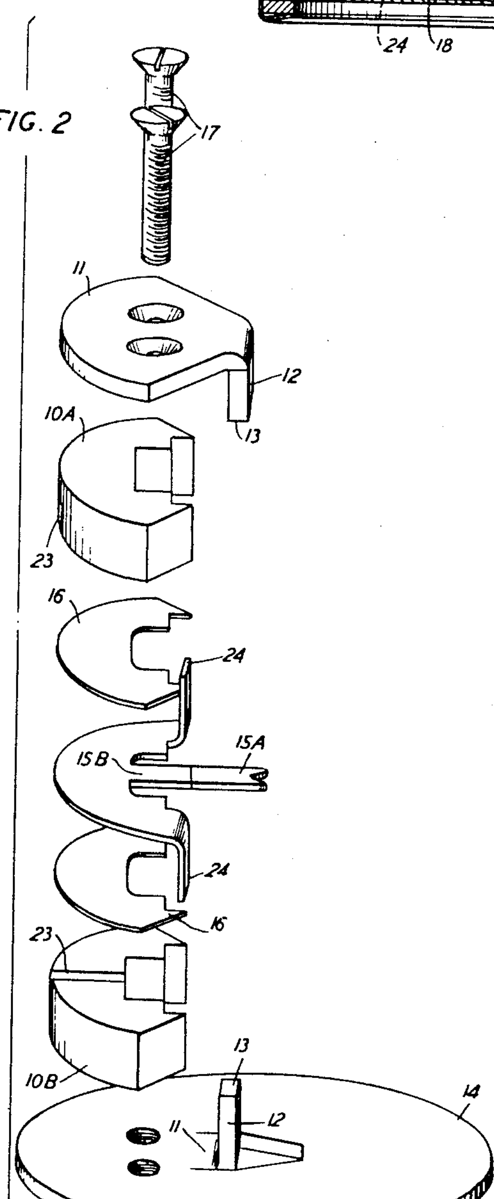
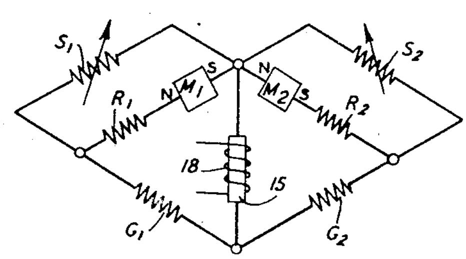


FIG. 3



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POLARIZED ELECTROMAGNET

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9 Claims. (Cl. 175—339)

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This invention relates to electromagnetic translating devices and more particularly to armature type electromagnetic units especially suitable for use in telephone receivers and transmitters.

One known type of electroacoustic transducer comprises, generally, a magnetic armature fixed at one end and having its other end extending into a gap between a pair of pole pieces between which a direct current flux is maintained by one or more permanent magnets. A signal coil is associated with the magnetic circuit including the armature for varying the flux in the circuit thereby to cause vibrations of the armature in accordance with signal currents supplied to the coil or, conversely, for establishing a signaling current in accordance with vibrations of the armature.

One object of this invention is to simplify the construction and to facilitate the manufacture of electroacoustic transducers of the general type above described.

Another object of this invention is to expedite the attainment of substantially exact magnetic balance of the armature in the absence of signaling currents in the signal coil.

A further object of this invention is to increase the magnetic and operating efficiencies of armature type electromagnetic translating devices.

In accordance with one feature of this invention, the elements, including the armature, pole pieces and magnets, of the magnetic system are constructed and arranged so that when the elements are assembled in pile-up relation the free end of the armature is substantially centered automatically in the gap between juxtaposed faces of the pole pieces and preassigned magnetic gaps between the armature and these faces obtain.

In one illustrative construction, the magnetic system comprises a pair of longitudinally magnetized, bar permanent magnets mounted in alignment, with the juxtaposed pole faces thereof of unlike polarity, a pair of pole pieces each seated upon the other pole face of a respective magnet and having a pole tip coplanar with the respective one of the juxtaposed pole faces, an armature having one end portion extending between the pole tips and another portion extending between the juxtaposed pole faces, and magnetic shims interposed between and spacing the armature from the juxtaposed magnet pole faces. The shims are of equal preassigned thickness so that when the elements are assembled in pile-up relation, equal magnetic gaps of prescribed length obtain between the armature and the tips of the pole pieces.

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In accordance with another feature of this invention, the magnets are provided with grooves in the juxtaposed pole faces to permit the insertion of a tool therethrough in the assembled structure, for effecting bending of the armature adjacent the magnets thereby to adjust the armature-pole piece spacings if necessary or desired.

In accordance with a further feature of this invention, the armature is provided with one or more extensions, for example tabs extending from the fixed portion thereof, in juxtaposition to the magnets, these extensions constituting magnetic shunts across the magnet or magnets and being adjustable relative to the latter to compensate for magnetic unbalances in the magnetic system.

In accordance with still another feature of this invention, the armature is formed of two portions having different magnetic characteristics, to enhance the magnetic and, hence, the operating efficiency of the device. More specifically, in accordance with this feature of the invention, the portion of the armature extending between the juxtaposed faces of the magnets is constructed of a material having a higher reversible permeability at low flux densities and lower coercive force than the part of the armature which extends between the tips of the pole pieces.

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:

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

Fig. 2 is an exploded perspective view of the magnetic unit included in the transducer illustrated in Fig. 1; and

Fig. 3 is a diagram illustrating the magnetic circuit included in the transducer shown in Fig. 1.

Referring now to the drawing, the electromagnetic device therein illustrated is operable as either a telephone receiver or transmitter and comprises a pair of substantially identical bar or block magnets 10A and 10B, advantageously of a high coercive force magnetic material such as an aluminum-nickel-cobalt-iron alloy known commercially as "Alnico." The magnets are positioned in alignment with each other, are equally magnetized in the direction of their alignment and have the juxtaposed ends or pole faces thereof of unlike polarity, as indicated in Fig. 1. Each magnet has affixed thereto, as by soldering, an L-shaped pole piece 11 having a flange 12 terminating in a pole tip face 13, the pole pieces being of high permeability material, such as a nickel-iron alloy known commercially as "Permalloy." In the fabrication of the device, each pole piece is affixed to the respective magnet and the pole tip face and respective magnet face are made accurately coplanar, as by grinding or lapping thereof.

One of the pole pieces, specifically the lower pole piece in Fig. 1, may be formed as an integral part of a foundation plate 14, the function of which will appear presently.

A rectangular armature 15A, 15B extends between the pole tip faces 13 and the magnets 10 and is spaced from the latter by substantially identical, high permeability, e. g. "Permalloy," shims 16. These shims are made of preassigned thickness, for example .004 inch, so that, inasmuch as the pole tip faces and the respective magnet faces are coplanar, the armature to pole tip face spacings are equal and fixed at a desired value by the shims.

The magnets 10, pole pieces 11, armature 15 and shims 16 are assembled in pile-up relation and are fixedly clamped together as by a pair of screws 17 extending between the pole pieces and threaded into one of them.

A signal coil 18 is mounted between the pole pieces 11 and encompasses the armature 15.

The plate 14 serves as a mount for a circular, non-magnetic diaphragm 19 which, together with annular washers 20, may be secured to the plate by an annular clamping band 21. The diaphragm 19 is coupled at its center to the free end of the armature 15 by a connecting link or drive rod 22.

It is apparent that faithful translation of sound into electrical signals or vice versa, and also high efficiency, require that in the absence of current in the coil 18 or when the diaphragm 19 is at rest, the armature be magnetically and mechanically balanced. As has been indicated heretofore, when the elements constituting the magnetic system are assembled, the free end portion of the armature is centered in the air gap between the pole tip faces 13. However, because of a number of factors, such as, for example, differences in the strengths or reluctances of the two magnets or dimensional variations in the shims 16, the desired exact balance may not obtain.

The parameters involved in the magnetic system will be understood from Fig. 3 wherein M_1 and M_2, are the magnetomotive forces of the two magnets, R_1 and R_2 are the reluctances of the magnets and G_1 and G_2 are the reluctances of the two gaps between the armature and the pole tip faces. The reluctances of the pole pieces are so small, usually, as to be negligible. In order that magnetic balance may exist, it is obvious that the parameters involved in the system must be such that the flux through the armature be zero.

Desirably, of course, G_1 and G_2 should be exactly equal. This desideratum is obtainable readily in devices constructed in accordance with a feature of this invention. Specifically, the juxtaposed pole faces of the two magnets are provided with parallel grooves 23 through which a tool may be inserted to effect a permanent bending of the armature adjacent the magnets whereby to exactly center the armature in the gap between the pole tip faces 13.

To allow compensation for inequalities in the two magnets, the armature 15 is provided with integral extensions or tabs 24 adjacent the magnets. These tabs, represented by S_1 and S_2 in Fig. 3, constitute adjustable shunts across the magnets. Adjustment is effected by bending the tabs to increase or decrease the spacing thereof from the magnets to establish exact equality of the two arms, R_1, M_1, S_1 and R_2, M_2, S_2, of the magnetic bridge circuit. Adjustment of these tabs is equivalent to a vernier mechanical adjustment of the position of the armature in the two air gaps.

Thus, in the construction illustrated and described, it will be noted that the air gaps may be equalized and the two arms, above-noted, of the magnetic circuit also may be equalized, whereby both mechanical and magnetic balance of the system are attained and, therefore, high efficiency and faithful translation of signals are realized.

The magnetic and, hence, the operating efficiency of the transducer is dependent upon the magnetic character of the armature 15 particularly upon its reversible permeability, which is one aspect of its magnetic character. The tractive force on the armature is a positive function of its reversible permeability, which is therefore a measure of the displacement response of the armature to variations in that force. In accordance with a feature of this invention, substantially optimum magnetic characteristics for the armature are realized. Specifically, as illustrated clearly in Fig. 2, the armature 15 is constructed of two sections 15A and 15B joined end to end, as by butt welding. The two sections are of different magnetic materials, the section 15B having a higher reversible permeability at low flux densities and lower coercive force than the portion or section 15A, which has a higher reversible permeability at high flux densities than the portion 15B. In an illustrative construction, the portion or section 15A may be of 45% Permalloy (45% nickel and balance iron) and the portion or section 15B may be molypermalloy (4% molybdenum, 79% nickel and balance iron). The latter portion is at a low superimposed flux density in the operation of the device, being adjacent the neutral point of the two permanent magnets and having a larger effective area which the flux traverses than the portion 15A adjacent the small pole tip areas. Because of the low coercive force of the portion 15B, positional variations of the armature due to residual flux in the armature following mechanical or magnetic displacement of the armature are reduced whereby the stability of the magnetic unit is increased. Additionally, the possibility of the armature freezing to one of the pole tip faces is minimized, whereby very short air gaps between the armature and the pole tip faces may be employed.

Although a specific embodiment of the invention has been shown and described, it will be understood that it is 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 electromagnetic translating device comprising a pair of substantially equal permanent magnets positioned in alignment and magnetized in the direction of their alignment, one pole face of one magnet being in juxtaposition to the pole

face of unlike polarity of the other magnnet, a pair of pole pieces each extending from the other pole face of a respective magnet and having a pole tip face coplanar with the respective one of the juxtaposed pole faces, the pole tip faces defining a gap, a unitary magnetic sheet metal armature assembly having an integral armature with one portion in said gap and another portion clamped between said juxtaposed pole faces, a signal coil in electromagnetic relation with said armature, and a pair of spacer members each interposed between said another portion of said armature and one of said pole faces, said armature assembly also comprising two integral magnetic shunt elements separately extending from between said magnets with each shunt element extending along a different one of the two magnets away from the other magnet to a point of substantially different magnetic polarity.

2. An electromagnetic translating device comprising a pair of substantially equal permanent magnets positioned in alignment and magnetized in the direction of their alignment, one pole face of one magnet being in juxtaposition to the pole face of unlike polarity of the other magnet, a pair of pole pieces each extending from the other pole face of a respective magnet and having a pole tip face coplanar with the respective one of the juxtaposed pole faces, the pole tip faces defining a gap, a unitary magnetic sheet metal armature assembly clamped between the magnets comprising an integral armature having one portion in said gap, another portion between said juxtaposed pole faces and magnetic shunt means comprising an element extending substantially perpendicular to said armature along each of the two magnets away from the other magnet, a signal coil in electromagnetic coupling relation with said armature, and a pair of spacer members each interposed between said another portion of said armature and one of said pole faces.

3. An electromagnetic translating device comprising a pair of aligned, juxtaposed, block permanent magnets magnetized in the direction of their alignment and having their juxtaposed pole faces of unlike polarity, a pair of pole pieces having pole tip portions spaced to define a gap, each of said pole pieces extending from the other pole face of a respective magnet, a unitary magnetic sheet metal armature assembly comprising an armature having one end portion in said gap and an intermediate portion clamped between said juxtaposed pole faces, said one end portion being of a material having a higher reversible permeability at high flux densities than the material of said intermediate portion and said intermediate portion being of material having a higher reversible permeability at low flux densities than the material of said one portion, and a signal coil in electromagnetic coupling relation with said armature, said armature assembly also comprising two integral magnetic shunt elements separately extending from between said magnets with each shunt element extending along a different one of the two magnets away from the other magnet to a point of substantially different magnetic polarity.

4. An electromagnetic translating device comprising a pair of aligned, juxtaposed, block permanent magnets magnetized in the direction of their alignment and having their juxtaposed faces of unlike polarity, a pair of pole pieces having pole tip portions spaced to define a gap, each of said pole pieces extending from the other pole face of a respective magnet, a unitary magnetic sheet metal armature assembly comprising an armature having one end portion in said gap, an intermediate portion between said juxtaposed pole faces and integral magnetic shunt means comprising an element extending substantially perpendicular to said armature along each of the two magnets away from the other magnet, said one end portion of said armature being of material having a higher reversible permeability at high flux densities than the material of said intermediate portion and said intermediate portion being of material having a higher reversible permeability at low flux densities than the material of said one portion, and a signal coil in electromagnetic coupling relation with said armature.

5. An electromagnetic translating device comprising means defining a magnetic circuit having an air gap therein, a vibratile armature having a first portion in said air gap and a second portion coupled to a region in said circuit removed from said air gap, said first portion being of a material having a higher reversible permeability at high flux densities than the material of said second portion and said second portion being of a material having a higher reversible permeability at low flux densities than the material of said first portion, and a signal coil in electromagnetic coupling relation with said armature.

6. An electromagnetic translating device comprising means including permanent magnet means having a neutral point and pole pieces spaced to form an air gap, defining a magnetic circuit, an armature extending from adjacent said neutral point and projecting into said air gap, and a signal coil in electromagnetic coupling relation with said armature, the portion of said armature adjacent said neutral point having a higher reversible permeability at low flux densities and a lower reversible permeability at high flux densities than the armature portion in said air gap.

7. An electromagnetic translating device comprising a pair of magnets disposed with one pole of one magnet in juxtaposition to the unlike pole of the other magnet, a pair of pole pieces each extending from the other pole of a respective magnet, said pole pieces having juxtaposed tips defining an air gap, an armature having a first portion between the juxtaposed poles of said magnets and having a second portion in said air gap, said first portion having a higher reversible permeability at low flux densities than said second portion and said second portion having a higher reversible permeability at high flux densities than said first portion, and a signal coil in electromagnetic coupling relation with said armature.

8. An electromagnetic translating device in accordance with claim 7, wherein said first armature portion is of an alloy of substantially 4% molybdenum, 79% nickel and balance iron and said second portion is of an alloy of substantially 45% nickel and balance iron.

9. An electromagnetic translating device comprising a pair of aligned bar magnets substantially equally magnetized in the direction of their alignment and having unlike pole faces in juxtaposition, a pair of pole pieces each extending from the other pole face of a respective magnet, said pole pieces having juxtaposed tips defining an air gap, an armature having a first portion fixed between said juxtaposed pole faces and having a second portion in said air gap, and a signal coil in electromagnetic coupling relation with said armature, said first portion having a higher reversible permeability at low flux densities and

lower coercive force than said second portion and said second portion having a higher reversible permeability at high flux densities than said first portion.

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