Aug. 1, 1961 H. C. PYE 2,994,747

ELECTROACOUSTIC TRANSDUCER

Filed Aug. 8, 1960 2 Sheets-Sheet 1

FIG. 1

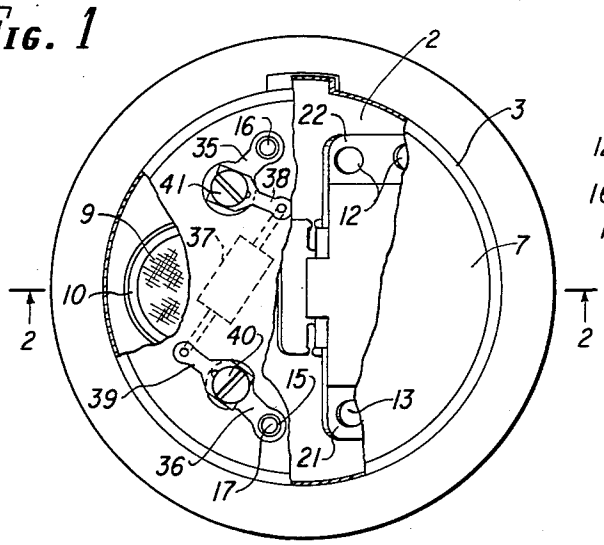
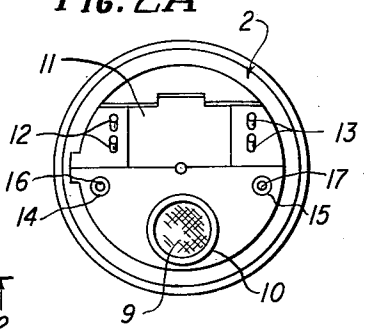


FIG. 2A



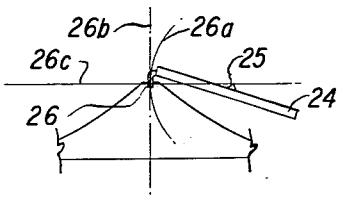
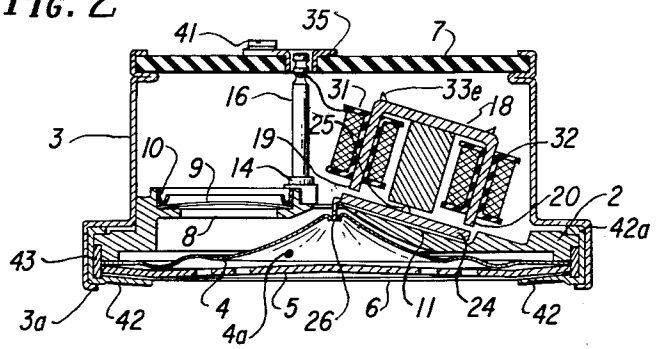


FIG. 2B

FIG. 2



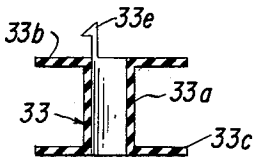


FIG. 5

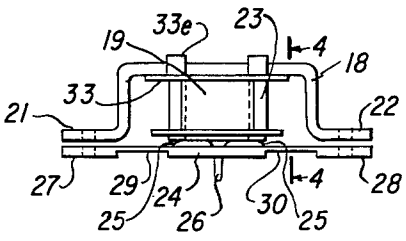


FIG. 3

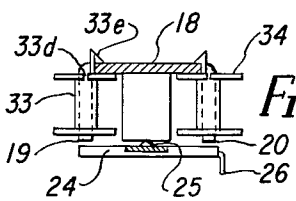


FIG. 4

INVENTOR.
Harold C. Pye

BY

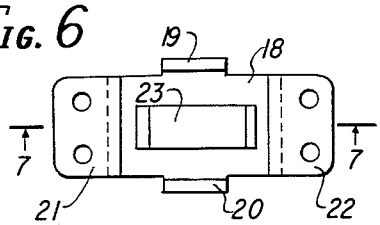
Atty.

Aug. 1, 1961 H. C. PYE 2,994,747

ELECTROACOUSTIC TRANSDUCER

Filed Aug. 8, 1960 2 Sheets-Sheet 2

FIG. 6



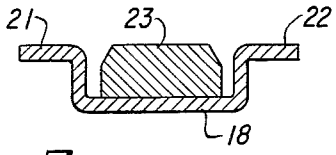


FIG. 7

FIG. 8

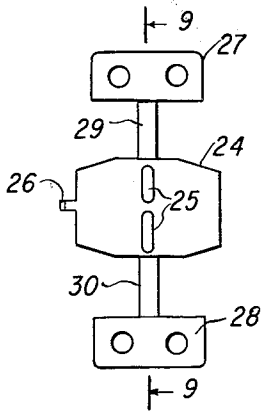
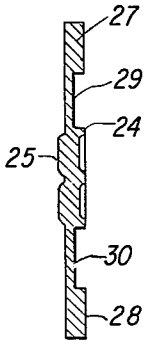


FIG. 9



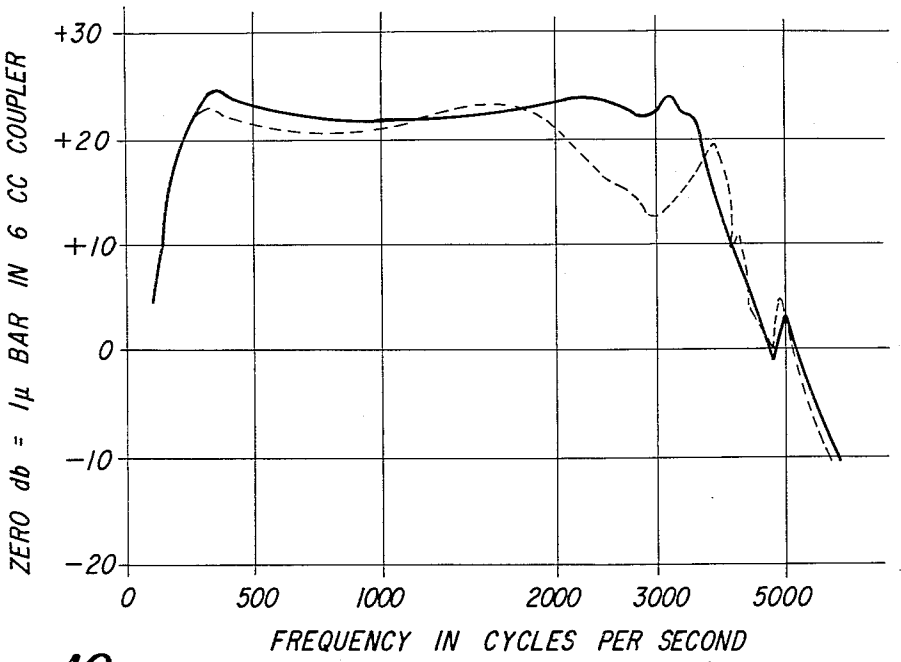


FIG. 10

INVENTOR.
Harold C. Pye
BY
C. A. Gulbrandsen
Atty.

United States Patent Office 2,994,747 Patented Aug. 1, 1961

2,994,747

ELECTROACOUSTIC TRANSDUCER

Harold C. Pye, Wheaton, Ill., assignor to Automatic Electric Laboratories, Inc., Northlake, Ill., a corporation of Delaware

Filed Aug. 8, 1960, Ser. No. 48,094
12 Claims. (Cl. 179—114)

My invention relates in general to an improved electroacoustic transducer and more specifically to a transducer of the so called rocking armature type which may be used as a telephone transmitter or receiver.

The transducer of my improved design has been primarily designed for use as a telephone receiver of high efficiency and comprises the magnet structure including a pair of pole pieces with a permanent magnet located between the pole pieces and a rocking armature mounted in proper relation to the magnet and pole pieces so that a pair of coils surrounding the pole pieces cause the armature to rock on a fulcrum which consists of a ridge or bossed surface on the side of the armature adjacent the permanent magnet. One side of the armature has a link connecting the armature to a non-magnetic cone shaped diaphragm.

One of the main features of improvement in the present transducer is the mounting of the rocking armature, and the magnetic structure supporting it, at an acute angle to the plane of the diaphragm and this angle has been chosen to give the transducer the greatest response to all frequencies within the voice frequency range without distortion.

I have provided certain other features of improvement such as the novel construction of the spools upon which the coils of the receiver are wound and which are designed to have snap hooks or latches which snap in place over a section of the pole piece structure to rigidly hold the coils in place thereon, and also provide means whereby the spools may be readily removed by bending the hooks aside.

In previous transducers of the rocking armature type, the armature has been mounted in a plane parallel to the plane of the diaphragm, and there has been a tendency for the diaphragm to be distorted when vibrated at certain frequencies to thereby cause distortion in the sound produced especially at high frequencies.

Certain other features of novelty will be apparent from the following specification referring to the accompanying two sheets of drawings.

FIG. 1 is an enlarged rear view of the transducer with certain parts of the back plate broken away to show the magnet structure.

FIG. 2 is a sectional view taken in the direction of the arrows along line 2—2 in FIG. 1.

FIG. 2A is a rear view, in actual size, of the mounting plate 2 showing the configuration of its rear surface.

FIG. 2B is a diagram illustrating the arc of vibration of the armature relative to the diaphragm.

FIG. 3 is an enlarged side view of the magnet and rocking armature assembly.

FIG. 4 is a sectional view of the magnet and armature assembly taken in the direction of the arrows along the line 4—4 in FIG. 3.

FIG. 5 is a sectional view of one of the coil spools showing one of the flexible clips or snaps which secure the spool to the assembly.

FIG. 6 is a top view of the pole piece and permament magnet assembly.

FIG. 7 is a sectional view of the pole piece assembly taken in the direction of the arrows along line 7—7 in FIG. 6.

FIG. 8 is an enlarged view taken from the under side of the rocking armature showing the ridges or bosses

formed therein and upon which the armature rocks as a fulcrum.

FIG. 9 is a sectional view of the armature of FIG. 8 taken along line 9—9.

FIG. 10 shows a pair of curves comparing the response of the present transducer to different frequencies of sound to that of a similar transducer whose magnetic structure was mounted parallel to the diaphragm.

Referring now to the drawings the transducer comprises a mounting plate 2 upon which the various components are mounted, a shell 3, a cone shaped diaphragm 4 having the usual breather hole 4*a*, a perforated front plate 5, a thin membrane 6 of "Mylar" or the like to keep out moisture, the back plate 7 of insulating material carrying the various terminals, the magnetic structure and other elements which will be described.

The mounting plate 2 has approximately one half of its front surface formed of a shape to conform to the shape of the cone shaped diaphragm and spaced slightly away from the same. The other half of the front surface of the plate is cut back to form a resonating chamber communicating with an opening 8 which is covered by a damping disc or ring 9 which is held against the opening 8 by a clamping ring 10. The damping disc 9 may consist of a disc of finely meshed screen of such as a twilled weave of stainless steel or the like.

In FIG. 2A I have shown a rear view, at actual size, of the mounting plate 2 showing the damping disc 9 in the opening at the left and the depression 11 forming a flat surface sloping downward from the center to the right side of the plate at an angle to provide a mounting space for the magnet structure and armature. The two upper studs 12 and the lower studs 13 are rigid with plate 2 and are flattened down after the magnet and armature are assembled thereon, to rigidly secure the magnetic operating structure in place as in FIG. 1. The two bushings 14 and 15 are of insulating material rigid with plate 2 and mounted in holes therein to support the terminal pins 16 and 17, which are inserted in holes in the top of the bushings and are therefore insulated from each other and from plate 2.

The complete magnetic structure, including the rocking armature, is shown in FIGS. 2, 3 and 4. This structure includes the bracket 18 shown in enlarged views in FIGS. 6 and 7. This bracket may be formed of annealed nickel iron alloy. The bracket 18 has two inwardly bent portions forming the pole pieces 19 and 20 and the two end portions bent inward to form the two L-shaped mounting portions 21 and 22. The mounting portions each have a pair of holes into which the studs 12 and 13 of plate 2 fit when mounted. The bracket 18 also has a permanent magnet 23 rigidly mounted thereon by welding or the like and the upper surfaces of magnet 23, of mounting portions 21 and 22, and the upper surfaces of the pole pieces 19 and 20 are lapped or milled so that all such surfaces lie in the same plane. The armature 24 is shown in detail in FIGS. 8 and 9 and is formed of annealed nickel iron alloy having the enlarged center or armature portion with two embossed portions 25 in the center thereof to form the fulcrum upon which the armature rocks, and a bent up hook or link 26 which is to be secured to the center of the diaphragm. The center portion is joined to the two end or mounting portions 27 and 28 by connection portions 29 and 30 of reduced width and thickness. The connecting portions form torsional legs of such elasticity that they permit free vibration of the center portion of the armature while maintaining the same in a central position after the structure is mounted on pins 12 and 13 and such pins are flattened as shown in FIG. 1 to rigidly clamp the whole structure together and to plate 2. The other item of the magnetic structure are the two coils

31 and 32 wound on the two spools 33 and 34 which are molded from a material such as nylon. The construction of the spools 33 and 34 is novel and is clearly shown in FIGS. 3, 4 and 5. Each spool includes the hollow spool section 33*a* with the spool heads 33*b* and 33*c* one of which has a slot in one side such as 33*d* in FIG. 4 to provide a lead out slot for one end of the wire which forms the winding. Formed integrally with each spool are a pair of latches or hooks such as 33*e* (FIG. 5) which are flexible and which are arranged so that the catches thereon snap over the sharp edge portions of bracket 18 directly alongside of the pole piece such as 19 over which the spool is mounted after it is wound. The coils may thus be easily assembled on the pole pieces and also, by applying a slight side pressure on the pair of hooks on the two hooks 33*e*, the hooks are unlatched from the bracket and the coils may be readily removed from the pole pieces. FIG. 2 shows the coils 31 and 32 in place with the hooks 33*e* latched in place over the edge of bracket 18. The two coils are serially wound as is usual in such receivers and the two ends of the wires are wrapped around the grooves in the outer ends of pins 16 and 17 shown in FIG. 2. There are a pair of terminals 35 and 36 in the back plate 7 in the form of bushings passing through the plate 7 and which register with pins 16 and 17. After the units are assembled as shown in FIGS. 1 and 2 a drop of solder is placed over the end of pins 16 and 17 in the openings of terminals 35 and 36 to complete the connections. In FIG. 1 I have shown in dotted lines a radio interference suppressor 37 which is linked to a pair of terminals 38 and 39 so that the unit may be connected across terminals 35 and 36 and the terminals clamped in place by screws 40 and 41 which also provide means for connecting up the usual lead out wires to the transducer.

In assembling the transducer, the mylar membrane 6, the perforated plate 5 and the diaphragm 4 are placed in the cup shaped ring 42 with the metallic spacing ring 43 around the outer edges. The mounting plate 2 with its various elements mounted thereon is then placed in the ring 42 as shown in FIG. 2 and the upper edge of cup 42 turned over as shown at 42*a* to clamp these elements together. A small amount of adhesive such as epoxy resin is now inserted around link 26 to secure it in a somewhat flexible manner to diaphragm 4. The outer casing 3 with its back plate 7 is now applied as shown in FIG. 2 and the front edge turned over as at 3*a* to secure the cover in place. A small amount of solder is then applied to the openings of terminals 35 and 36 to secure the pins 16 and 17 and the ends of the windings of the coils thereto.

As previously stated it has been found that when the armature of a magnetic structure is mounted parallel to the front surface of a diaphragm as in previous designs, that there is a tendency for the diaphragm to be distorted due to certain sidewise movements of the diaphragm when the magnet armature is operated in response to certain frequencies of voice currents, and this causes a drop in the level of the sound produced by the diaphragm and certain distortion in the sound produced. In FIG. 10 the curve shown in dotted lines indicates at point X this drop in the response of such a device.

With the armature of such a rocking armature device mounted at the angle shown in FIG. 2, I have found that most of this distortion is eliminated and that a response corresponding to that shown by the solid line curve of FIG. 10 is produced. The armature in the present unit is mounted at an angle of approximately 17 degrees to the plane of the front edge of the diaphragm. In other words the surface 11 of plate 2 as shown in FIGS. 2 and 2*a* is sloped downward from the center to the right hand side of the plate at approximately 17 degrees. With the armature mounted at this angle, the arc of vibration of the part 26, which is secured flexibly to the diaphragm, more nearly coincides with a vertical line passing through the center of diaphragm 4 at right angles to the plane of its front surface.

The reason for the resulting distortion in previous transducers of the rocking armature type is because the curve, representing the arc of vibration of that point on the armature which is linked to the diaphragm, is not in true tangential relation to the perpendicular line from the center of the diaphragm. The arc of vibration intersects such a line and the sidewise movement, occasioned by such movement, distorts the diaphragm. This arc of vibration will depart to a greater degree from such line on one side of the point of linkage than on the other side to produce greater distortion. The thickness of the armature and the fact that the fulcrum is out on one side of the armature and not in its center and that the linkage to the diaphragm is on the opposite side is the reason for distortion.

With the armature mounted as shown in FIG. 2 at an acute angle to the plane of the diaphragm, the perpendicular line from the center of the diaphragm will be tangential to the curve representing the arc of vibration of the armature at the point where it is linked to the diaphragm. This feature is illustrated in FIG. 2B which represents the armature 24 with its pivot point at fulcrum 25, the arc of vibration 26*a* in tangential relation to the perpendicular 26*b*. It will be seen that the arc 26*a* coincides with perpendicular 26*b* to a greater degree and departs from such line to the same degree on either side of point 26. The dotted line 26*c* which is a radius line between pivot 25 and point 26 is seen to be parallel to the plane of the diaphragm and at right angles to perpendicular 26*b*. Any sidewise movements of the diaphragm are equalized and distortion reduced.

It will thus be seen that I have provided a rocking armature transducer having a number of novel features or construction and one which is compact and light in weight while giving an improved response in decibels to all frequencies within the voice range. It may also be used as a transmitter or receiver without any change.

Having fully described and ascertained the features and aspects of my invention, what I consider to be novel and desire to have protected by Letters Patent will be pointed out in the appended claims.

What is claimed is:

1. In a transducer, a cone shaped diaphragm, a magnetic structure including a bracket having a pair of pole pieces with a permanent magnet secured between the pole pieces, a rocking armature having a ridge in the center thereof engaging the top of said magnet and acting as a fulcrum for the armature, means including a pair of torsional arms for securing the armature in position in the structure, a mounting plate supporting said structure, said plate having one surface lying in a plane at an acute angle to the plane of the front surface of the diaphragm, and means for securing said structure to said angling surface to thereby mount the armature at a corresponding angle, a link connecting one side of the armature to the center of the diaphragm, vibrations of the armature causing corresponding vibrations of said diaphragm.

2. In a transducer having a cone shaped diaphragm and a rocking armature magnetic structure with an armature linked to the center of the diaphragm, a mounting plate having its outer front edge parallel to the outer front surface of the diaphragm and clamped thereto, an inner front surface of the plate having a portion conforming to the shape of the rear surface of the diaphragm and slightly spaced therefrom, another section of the front surface of the plate recessed to form a resonating chamber and having an opening therein with a damping disc mounted therein, a portion of the rear surface of said plate sloping at an acute angle to the plane of its front outer surface and to the front outer surface of the diaphragm, said magnetic structure mounted adjacent said sloping surface with its armature lying in a plane parallel to said sloping surface.

3. In a transducer, a magnetic structure comprising; a bracket having a recessed center portion and a pair of L-shaped mounting legs at each end thereof, an elongated permanent magnet rigidly secured to the center of the recessed portion and lying lengthwise thereof, a pair of pole pieces formed from the bracket and lying on either side of said magnet, said pole pieces bent forward from the sides of said recessed portion, the front edges of said pole pieces, said magnet and said end pieces all lapped or ground so that all such surfaces lie in the same plane, a pair of spools formed in one piece from molded nylon or like insulating material, said spools having a pair of spool heads and a hollow cylindrical portion upon which coils of wire are wound, a pair of hooks extending outward from one end of each spool said spools slipped over the pole pieces so that said hooks engage the outer surface of said recessed portion of the bracket and snap over the edge of said surface to lock said spools in place on the pole pieces.

4. In a transducer, a diaphragm, a mounting plate, means for securing said diaphragm to the front side of said plate, a magnetic structure mounted on the rear side of said plate, said structure having an armature lying in a plane at an acute angle to the plane of the front surface of said diaphragm, and a link connecting one side of the armature to the center of the diaphragm through an opening in said plate, the arc of vibration of said one side of said armature coinciding throughout a portion of its length with a line through the center of the diaphragm perpendicular to the plane of the front surface of the diaphragm.

5. In a transducer, a cone shaped diaphragm, a mounting plate, means for securing the outer edge of the plate to the outer edge of the diaphragm, part of the front surface of said plate conforming to the shape of the rear side of the diaphragm and spaced slightly apart therefrom, a flat surface formed in one side of the rear surface of said plate, a pair of studs extending outward from said rear surface at each end of said flat surface, said flat surface lying in a plane at an acute angle to the plane of the outer edge of the front surface of the diaphragm, a magnetic structure comprising; a bracket including a pair of pole pieces, a permanent magnet and an armature, said bracket and said armature each having mounting extensions at each end thereof including a pair of holes in each extension spaced apart to coincide with the position of said studs, the holes in said bracket and armature placed over said studs and said studs flattened on their outer ends to clamp the bracket and armature in position with the armature parallel to said flat surface, and a link connecting one edge of the armature to the center of the diaphragm through an opening in said plate.

6. In a transducer, a diaphragm, a magnetic structure including a bracket having a permanent magnet in the center thereof and a pair of pole pieces one on each side of the magnet, a pair of coils mounted one on each pole piece and an armature having a ridge in the center thereof engaging said magnet and rocked thereon by current in said coils, each coil wound on a spool formed in one piece of nylon or like insulating material and having a pair of projections extending from one end of the spool, a hook or latch on each projection, said projections being flexible and bending as the spool is pushed down over the pole piece to cause said hooks to snap over an edge of said bracket to lock the coils in place, the flexibility of said projections permitting said hooks to be released from the edge of the bracket to unlatch the hooks to remove the coils from the pole pieces.

7. In a transducer, a mounting plate having a magnetic structure, including a magnet, operating coils and an armature, mounted at an angle on the rear of the plate and linked to a diaphragm on the other side of the plate, a perforated disc in front of the diaphragm, and a flexible membrane in front of the disc, a clamping ring clamped over said plate, said disc and said membrane to form a unitary assembly, a pair of insulating bushings mounted in said plate and a pair of connecting pins inserted in said bushings, the ends of the wires of said coils wrapped around the outer ends of said pins, a thin metal cover having a back plate of insulating material, the front edge of said cover clamped over the outer edge of said assembly to secure the cover in place, a pair of metallic bushings in the back plate having openings therethrough through which the ends of said pins project when the cover is attached to the assembly, said pins and the ends of the coils wrapped thereon secured to said bushings by a drop of solder placed in the outer opening of the bushings surrounding the ends of said pins.

8. A magnetic structure including a pair of pole pieces formed from a bracket of nickel iron alloy which has a pair of shoulders adjacent said pole pieces, a pair of coils wound on a pair of spools and mounted on said pole pieces, each spool formed in one piece from molded nylon or like insulating material and having a hollow body portion with the opening conforming to the outer shape of the pole pieces and having a pair of spool heads, said spool heads each having a pair of elongated flexible extensions formed integral with the spool and extending outward from one of the heads, a hook latch on the outer end of each extension, said latches arranged to hook over the shoulders on each side of the pole piece when a spool is pressed downward over a pole piece, the flexibility of said extensions permitting said latches to be disengaged from the shoulders to remove the spools from the pole pieces.

9. A magnetic structure such as claimed in claim 8 in which there is a slot in one of the spool heads of each spool said slot extending from the outer edge of the spool to the body portion of the spool, and forming an outlet for the end of the coil winding.

10. In a magnetic structure, a coil spool, and mounting means therefor including a pole piece on which said spool may be placed, said spool having a hollow body portion with an opening conforming in shape to the shape of the pole piece, said mounting means having an edge portion and the hollow body portion of said spool having integrally formed thereon a pair of spoolheads and a flexible extension with a hook at its outer end, said hook latching over the edge portion of said mounting means when the spool is placed on said pole piece, the flexibility of the extension permitting bending thereof to unlatch said hook to remove the spool from the pole piece.

11. A transducer comprising; a cone shaped diaphragm and a magnetic structure of the rocking armature type having an armature with the fulcrum on one side of the armature and having one side linked to the center of the diaphragm, means for rocking the armature through an arc of vibration about said fulcrum, said armature mounted in a plane lying at an acute angle to the plane passing through the front surface of the diaphragm, a perpendicular line drawn through the center of the diaphragm at right angles to the plane of the front surface thereof forming a tangential line to the circle including the arc of vibration of the armature point linked to the diaphragm.

12. A magnetic structure including a cone shaped diaphragm with an armature having one side thereof linked to the center of the diaphragm, a fulcrum for the armature comprising; an embossed portion protruding from the center of the armature, a permanent magnet on which said fulcrum rests, a pair of coils and pole pieces adjacent said magnet and armature for causing said armature to vibrate through an arc with said fulcrum as its center point, said armature mounted at an acute angle to the plane of the front of the diaphragm so that a line drawn through the pivot point and the point linking the armature to the diaphragm is at right angles to a line drawn through the center of the diaphragm perpendicular to the plane of the front surface of the diaphragm.

No references cited.