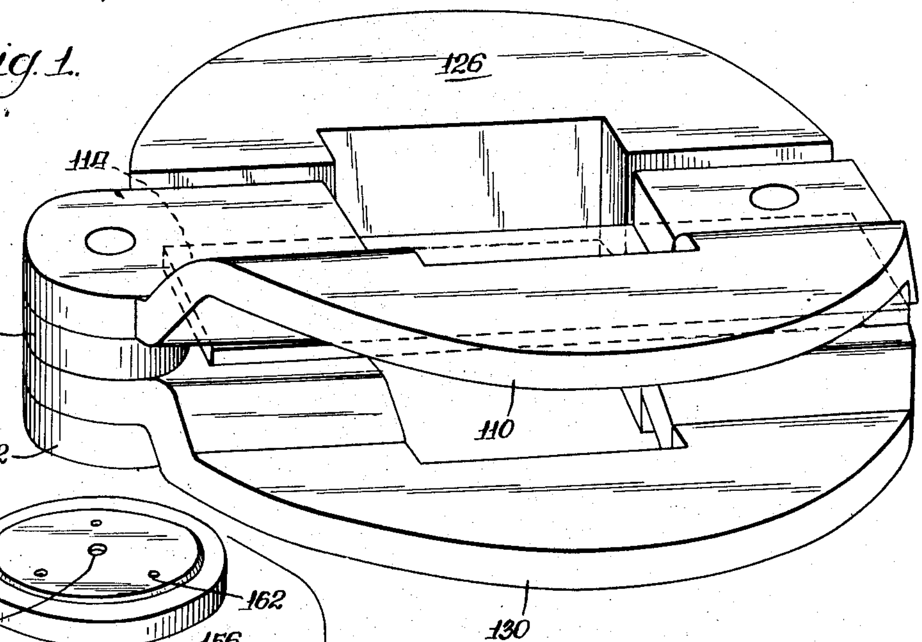
Nov. 10, 1959 H. S. KNOWLES ET AL 2,912,522

# ELECTRO-MECHANICAL TRANSDUCING DEVICE

Filed June 14, 1954 2 Sheets-Sheet 1

Fig. 1.



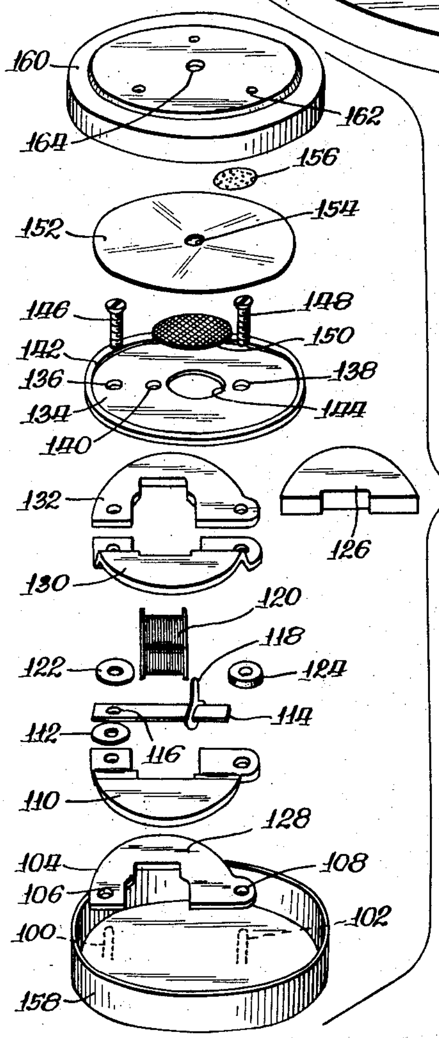
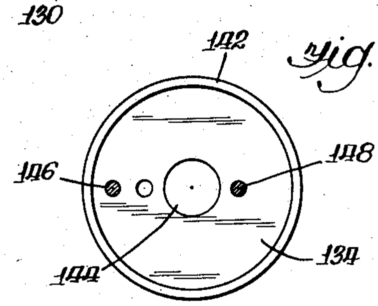




Fig. 2.

Fig. 3.



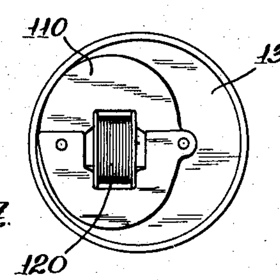




Fig. 4.

INVENTORS.
Hugh S. Knowles
William A. Plice
Wiguor S Stone
Atty.

ELECTRO-MECHANICAL TRANSDUCING DEVICE

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Fig. 5.

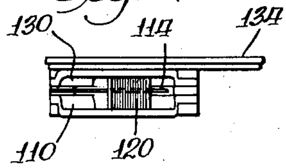



Fig. 6.

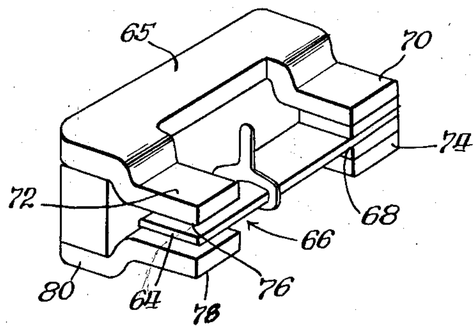



Fig. 7.

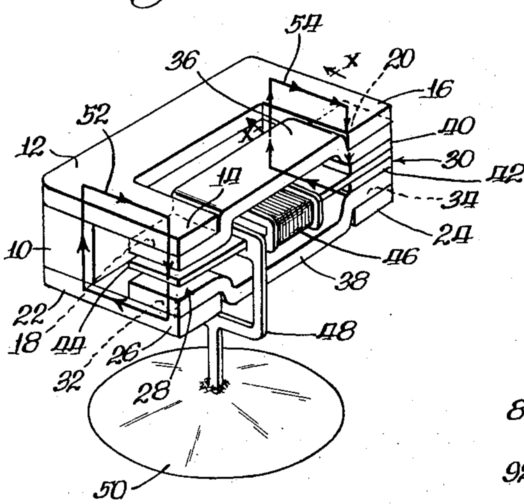
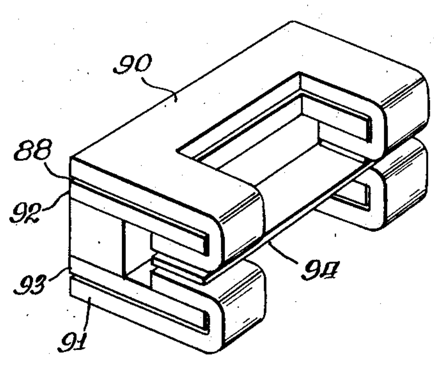



Fig. 8.



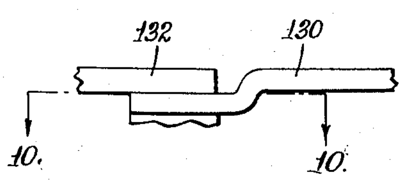
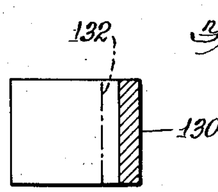




Fig. 9.

Fig. 10.




INVENTORS.
Hugh S. Knowles
William A. Plice
[signature]
Atty

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# ELECTRO-MECHANICAL TRANSDUCING DEVICE

Hugh S. Knowles, Glen Ellyn, and William A. Plice, Waukegan, Ill., assignors to Industrial Research Products Inc., Franklin Park, Ill., a corporation of Delaware

Application June 14, 1954, Serial No. 436,416

25 Claims. (Cl. 179—108)

This invention relates to electro-mechanical transducing devices which include devices for translating sound into electrical impulses, and conversely, electrical impulses into sound. One example of the former is a microphone. An example of the latter is a speaker.

The object of all such devices is to attain fidelity, that is, faithful reproduction of a sound from an electrical impulse, or faithful reproduction of an electrical impulse from a sound. One class of these devices has a magnet with pole pieces which establish two spaced gaps, in one of which is mounted a vibratable end of an armature or flux-conducting reed. A coil is disposed about the armature and its vibratable end is connected to a diaphragm. The operation of the device depends upon the interaction of the two magnetic flux circuits, one called the main or direct flux circuit which is established by the magnet across the two gaps, and the other, the variable or alternating flux circuit, which is established by the coil.

When the armature is moved by the diaphragm, a portion of the main flux is shunted through the armature and sets up a magnetic flux through the coil. The magnetic flux is of short duration and its direction reverses when the diaphragm becomes displaced in the opposite direction. This variable magnetic flux set up by displacement of the armature is effective in inducing an electrical current in the coil and the magnitude of this current is determined by the reluctance of the magnetic path of the field of the coil.

Similarly, where a variable current is flowing through the coil, that is, when the device is being used as a speaker, the coil sets up a variable field around itself. The magnitude of this field is, in like manner, determined by the reluctance of its path, and hence the efficiency of the transducer depends upon the reluctance of the coil's path.

Unfortunately, the permeability of a given element of ferro-magnetic material for small alternating magnetic fluxes in the presence of large steady magnetic fluxes decreases rapidly as the steady flux is increased. These alternating flux fields are very weak and of necessity must be completed through parts of the path carrying the heavy direct flux from the magnet. As engineers have long recognized, this establishes a somewhat irreconcilable conflict. The material of which the pole pieces of the magnet is formed is selected because of its ability to transmit a high volume of flux per unit of cross section, and as is well recognized, a ferro-magnetic material saturating at a high flux density has low permeance or high reluctance. As a result, the particular material requirements for the alternating flux are exactly the opposite to the requirements for the steady flux. In the past, efforts have been made to reduce the portion of the direct flux path which is also utilized by the alternating flux paths by eliminating the steady flux path from the armature. However, a portion of the alternating flux path has been superimposed upon the balance of the direct flux path in these constructions. Because the materials in the joint path were selected to meet the requirements of the direct flux, the requirements of the alternating flux path have been compromised. Expressed differently, the alternating flux path has been accommodated to the direct flux path. And this despite the fact that it is upon the variable flux path that fidelity principally depends.



The principal object of this invention is to improve the permeability of the alternating flux path. The principal feature of the invention is the provision of an ideal path for the variable flux and of a direct flux path which uses a portion of the variable flux path. In this portion, the requirements of the direct flux path are sacrificed. In other words, the inventors have provided an electro-mechanical transducer with two gaps with a vibratable armature in one, and then essentially a separate direct flux path and an alternating flux path so as to interfere as little as possible with the material requirements of each, the two paths having common portions only through the gaps and adjacent pole faces. Separate flux paths are provided by highly permeable shunt bars disposed between like poles of the gaps, the term "shunt bar" being used because they shunt the alternating field instead of causing it to pass through the pole piece and even through the magnet.

The second object of the invention is to attain an ideal positioning of the ends of the shunt bar with respect to the gaps. As will become clearer in the disclosure that follows, the inventors originally connected these shunt bars to the pole faces outside of the gaps. A feature of the invention is positioning the ends of these shunt bars between the work faces of the pole pieces and the armature itself, so that the ends of the shunt bars are in fact the faces that form the gaps. While the earlier structure functioned, the second is superior.

Another object of this invention arises from the employment of the shunt bars. The shunt bars themselves have the same polarity and are at about the same magnetic potential as the pole pieces to which they are attached. They, therefore, create fields around themselves and result in flux leakage between themselves and any part of the device of opposite polarity. As a result of this object of the invention, the inventors have provided three different embodiments of the invention, one employing the shortest possible shunt bars but subject to the greatest criticism of flux leakage; a second, employing shunt bars which extend away from the pole pieces and make possible a comparatively flat device; and a third, wherein the shunt bars are close to and registered with the associated pole piece of each whereby there is little if any more leakage in the device as a whole than there would be with the shunt bars completely absent.

These and such other objects as may hereinafter appear are attained in the embodiments of the invention shown in the accompanying drawings wherein:

Fig. 1 is a perspective view of the commercial embodiment of the inventors' motor with the pole piece away from the bulkhead uppermost and removed to disclose the magnet;

Fig. 2 is an exploded view of the inventors' translating device with the bulkhead uppermost and with the parts in gravitational alignment for assembly;

Fig. 3 is a plan view from the bulkhead side of the device;

Fig. 4 is a rear view of the motor;

Fig. 5 is a front elevation, similar to Fig. 1.

Figs. 3, 4 and 5 are twice actual size of the commercial device.

Fig. 6 illustrates the original motor with the straight armature between the gaps;

Fig. 7 is the second embodiment of the invention showing the short shunt bars;

Fig. 8 is a third embodiment of the invention showing the shunt bars adjacent the associated pole pieces respectively so as to reduce flux leakage;

Fig. 9 is a fragmentary portion of the shunt bar and upper pole piece of one of applicants' transducers as if taken from the left-hand side of Figure 1; and,

Fig. 10 is a view taken on the line **10—10** of Fig. 9.

The invention will be best understood by considering a construction presented in schematic form only. This construction is shown in Fig. 7, and is chosen because it lends itself best to diagrammatic illustration of lines of force. Referring to this figure, the numeral **10** identifies a permanent magnet whose molecules have been polarized so that the upper surface is of one polarity, as for example, south, and its lower surface is of the opposite polarity. Mounted on the upper pole of the magnet is a pole piece **12** made of a ferro-magnetic composition having a high capacity to transmit flux. This pole piece **12** is U- or horseshoe-shaped. Its arms are designated by the numerals **14** and **16**. The lower sides of the arms, indicated by the dotted lead lines **18** and **20** may be considered its faces. The maximum quantity of flux that can be transmitted by the magnet, or any magnet, to the pole face **18** or **20** is determined by the smallest cross section of the two arms **14** and **16** which in this instance is the section along the lines *x—x*. A second pole piece **22** of similar size, weight, configuration and cross section is similarly mounted on the other, or north, pole of the magnet, and its arms **24** and **26** form with arms **14** and **16** two gaps **28** and **30**. The configuration of the magnet assembly, therefore, is that of a U when viewed from the top or the side. The faces **18** and **20** are both south while the faces **32** and **34** on the pole piece **22** are both north. Connecting the two faces **18** and **20** is a shunt bar **36** of highly flux-permeable material; and similarly, connecting faces **32** and **34** is a shunt bar **38** of identical highly flux-permeable material. Mounted between two equally thick non-magnetic spacers **40** and **42** in the gap **30** is what the inventors call a reed, but which will be referred to here as an armature. The near end of the armature **44** is free to vibrate. Disposed around the armature **44** is a coil **46** and also a link **48** which is connected to a diaphragm **50**.

When the entire apparatus is quiescent, there is a flow of flux as indicated by the two heavy loops **52** and **54**. The air gap **28** has a thickness and presents a magnetic reluctance under these conditions identical with that of the gap **30**. The cross section of the armature is constant. The two shunt bars **36** and **38** are identical. The two pole pieces **12** and **22** are identical. The parts are assembled together so that the flux path through the faces **20** and **34** has an identical capacity to the flux path through the faces **18** and **32**. There is no flux through the armature. Each shunt bar has the polarity of its associated pole piece.

Considering now the operation of the device as a microphone, a downward movement of the diaphragm **50** causes a like movement of the linkage **48** which pulls down the armature **44**, thereby widening the upper gap and narrowing the gap between the armature **44** and the adjacent pole faces **32**. The easiest path for the flux from the pole piece **12** to the pole piece **22** is through the non-magnetic gap **40**, the armature **44**, and the lower portion of air gap **28**. This flow of flux through the armature **44** generates a current in the coil **42**, which in turn sets up a magnetic field around itself. This flux is commonly called the alternating flux because it is constantly changing direction, due to the vibrations of the diaphragm **50** and the armature **44**. The alternating flux circuit is established through the armature **44** and the adjacent shunt bars, in this case predominately shunt bar **38**. This circuit has high permeability at all points excepting air gap **28** and the non-magnetic spacers **40** and **42**.



Conversely, if the diaphragm **50** raises the armature **44**, a portion of the direct flux circuit will be established from the arm **14** through the armature **44** to the lower arm **24**. The predominant alternating flux circuit will then be established through the armature **44**, the upper portion of air gap **28**, the upper shunt bar **36** and the dielectric spacer **40**. The advantages of the circuit reside in the fact that the pole pieces **12** and **22** of these transducing devices are almost saturated with the direct flux, and the material of which they are constructed is selected to saturate at a high flux density. Also the alternating flux flows through a path with high permeability and one which for the most part does not also carry the steady magnetic flux.

The shunt bars **36** and **38** perform substantially the same service when the device is used as a speaker as when it is used as a microphone although the operation is somewhat different. It will be observed that where the device is used as a microphone, all flux circuits are derived from the flux in the magnet. When used as a speaker, an alternating current is received by the coil **46**. This generates a weak flux through the armature **44**, the gaps **28** and **30**, and the shunt bars **36** and **38**. Assuming that the pole piece **12** is polarized south, and that the field through the armature places a south pole on the near end of the armature, the end of the armature **44** will move downward and the predominant alternating flux will momentarily flow through the armature **44**, the lower portion of air gap **28**, shorting bar **38**, and non-magnetic gap **42**. Also, a substantial flow of flux from the magnet **10** will move down the armature **44**. In either case, the path for the alternating flux circuit is formed except for the gaps **28** and **30** through highly permeable material.

The inventors believe that the two U-shaped pole pieces **12** and **22**, which make it possible to position a straight armature **44** between the two gaps **28** and **30** without increasing the flux leakage between the pole pieces is important. This structure is shown in Fig. 6, and is the inventors' original design before the conception of the shunt bars. The central portion of the armature **64** between the points **66** and **68** is farther from the pole pieces **65** and **80** than is that part of the armature **64** between the pole faces **76** and **78**, and **70** and **74**, and while there are a few stray fields, they do not appreciably reduce the flux through the gaps **28** and **30**. In this construction, however, the alternating field circuit is completed through one or the other of the pole pieces **65** and **80**, and since the pole pieces possess high reluctance to the alternating flux, the alternating field is diminished.

Returning to the embodiment shown in Fig. 7, the shunt bars **36** and **38** will be at a potential comparable to that of their respective pole pieces, and it follows that there will be flux leakage between them. In Fig. 8, there is illustrated an embodiment wherein the high permeance flux bars **90** and **91** are U-shaped members conforming to the pole pieces **92** and **93**, and disposed adjacent to the pole pieces. The flux bars **90** and **91** are wrapped around the ends of the pole pieces **92** and **93**. The pole pieces **92** and **93** should be magnetically insulated from the flux bars **90** and **91**, such as by a slight spacing **88** between each shorting bar and the adjacent pole piece, which indeed may be nothing more than a non-magnetic coating. Since the shunt bar **90** is of the same polarity as the pole piece **92**, there will be substantially no leakage between them. The embodiment shown in Fig. 8 will function substantially the same as that illustrated in Fig. 7 excepting that there will be less leakage. It is useful in applications where the total height of the device is not limited.

Examining now a commercial embodiment of the invention, and referring to Figs. 1 through 5, a pair of disappearing pins on a workman's table are suggested by the dotted pins **100** and **102** in Fig. 2. First dropped onto these pins is the pole piece **104** which has two threaded holes **106** and **108**. Next positioned on the pins **100** and **102** is a lower shunt bar **110**. There is next positioned on the left-hand pin **100** a dielectric spacer **112** followed by an armature **114** having the hole **116**. The armature carries a link **118** and a coil **120** is positioned about the armature but does not contact it. The coil **120** is supported on the pole piece **104** and shunt bar **110**. Then follows a non-magnetic spacer **122** on the pin **100**. A non-magnetic spacer **124** is placed on the pin **102**, and has a thickness equal to the spacers **112** and **122** and the armature **114**. A magnet **126** is then glued to the surface **128** of the lower pole piece **104**.

The upper shunt bar **130** is next mounted on the pins **100** and **102**, followed by the upper pole piece **132**. The upper surface of the magnet is spread with glue and fastened to the under surface of the pole piece **132**. A bulkhead **134** is next mounted on the pins **100** by means of the holes **136** and **138**. This bulkhead has an additional hole **140** through which a tool may be inserted for centering the armature immediately after assembly. The bulkhead, which acts as a frame, has a raised peripheral shoulder **142**, and a central opening **144** through which the shank of the link **118** passes. Screws **146** and **148** are then pressed down to eject the disappearing pins **100** and **102**, and are screwed respectively into the holes **106** and **108** to provide a compact assembly. A matrix **150** of any suitable material is next impaled over the pin of the link **118** and glued to the top of the bulkhead **134**. After centering the armature **114** so that without excitation the flow of flux through the two opposite poles are exactly equal and no flux flows down the armature, the screws **146** and **148** are pulled tight. The hole **140** is plugged, usually with plastic.

The diaphragm is a delicate aluminum disk **152** whose peripheral edge is fastened in airtight relationship with the raised peripheral shoulder **142** on the bulkhead **134**. The pin of the link **118** just penetrates the opening **154**. When the pin has been exactly centered, a spot of quick hardening glue **156** is applied.

The entire motor and diaphragm is conveniently housed in a cylindrical cavity **158** having desirable acoustic properties and is closed by a cover or lid **160**. The cover **160** carries a plurality of openings **162** and a central opening **164** which permit vibrations in the air to reach the diaphragm **152**.

The complete unit in the container **158** and cover **160** is compact and has suitable electrodes through the wall for connection of the leads to the coil **120**.

The basic assembly shown in Fig. 6 is important because it provides a very rigid mounting for the armature, a rigidity which is not disturbed by extended use. Referring to Fig. 1, the arrangement of the flat pole pieces and offset flat shunt bars in a stacking relationship of which the armature is a part, makes it possible to draw the elements into permanent rigid relationship by pulling down the screws, which is a great advantage.

As is now clear, the variable or alternating flux path and the direct flux path pass through the same pieces of metal only immediately adjacent the two gaps. Referring to Fig. 9, the direct flux comes in from the pole piece **132** and goes through the thickness of the end of the shunt bar **130**. The variable flux goes into the bottom of the end portion of the shunt bar **130** and thence on through the main portion of the bar. In describing this common path, the inventors use the words "coincide" or "intercept," referring to the relationship of the two paths. Two paths at this point react upon each other, but both are using the molecules in this particular portion of the shunt bar.

If the source of the stray field is in a plane parallel to the flat surface of the armature and at any point around the transducer, it is evident that the stray field will encounter metallic conductive paths, some of great permeability, long before penetrating of the armature. The shunts and the magnets act as shields. On the other hand, if the source of the stray field is in a line through the opening containing the coil **120**, either above or below, the fact that the pole piece has two faces of like polarity will tend to cause the stray field to affect the flux through the armature equally and in counter directions and thereby not affect the faithfulness of the signal whether mechanical or electrical.

Having thus described their invention, what is claimed is:

1. An electro-mechanical transducer comprising flux conductive plates forming between them two spaced, transversely aligned gaps of low flux conductivity, a permanent magnet having one pole flux conductively associated with one plate and its other pole flux conductively associated with the other plate, an armature positioned in both gaps and vibratable in one, a coil around the armature, means for holding the components in assembled relationship, and a shunt bar made of a material more flux permeable than that of the plates and having portions flux conductively associated with like poles of each gap.

2. The transducer of claim 1 wherein the shunt bar is in contact with one plate at both gaps and a second and a similar shunt bar is in contact with the other plate at both gaps.

3. In combination with that type of electro-mechanical transducer wherein a flux conductive armature disposed within a coil is positioned in two like gaps of low flux conductivity formed between flux conductors of opposite polarity maintained by a permanent magnet, a shunt bar having portions flux conductively associated with one conductor at both gaps, said shunt bar being formed of a material more flux permeable than that of the conductors.

4. The transducer of claim 3 wherein each end of the shunt bar lies in the gap between the conductor and spaced from the armature.

5. An electro-mechanical transducer comprising a pair of U-shaped pole plates disposed in spaced, side-by-side, registered relationship, a permanent magnet flux conductively positioned between the base portions of said pole plates, a flux conductive armature disposed between the facing inside walls of the arms respectively of the pole plates, a coil around the armature, a drive link connected to the armature, and means for holding the components in assembled relationship, said armature being vibratable between one pair of facing arms of the pole plates.

6. A transducing device comprising a pair of like elongated bars made of highly flux-permeable material mounted in spaced, side-by-side relationship, an elongated armature vibratable at one end and mounted in fixed position between said bars in spaced relationship thereto, a coil disposed around said armature and between the two elongated bars, a U-shaped pole piece of lower flux permeability than the elongated bars mounted on each bar with the ends of its arms engaging the opposite ends of the associated bar on the side away from the armature, and means for oppositely magnetizing said pole pieces.

7. A transducing device comprising a pair of flat U-shaped pole plates arranged in spaced, laterally aligned relationship so that the facing sides of the ends of their arms form two like, spaced high reluctance gaps, a magnet positioned between the base portions of said U-shaped pole plates, an armature positioned between two non-magnetic washers in one of the gaps with a free portion vibratable between the other gap, a coil disposed around said armature, and means for clamping the pole plates together at the gap containing the washers so as to hold all of the parts including the armature in rigid relationship at the transverse line of the washers.

8. A transducing device comprising a pair of U-shaped pole pieces arranged in spaced, side-by-side relationship so that the facing sides of the ends of the arms form two like, spaced high reluctance gaps, means for oppositely magnetizing said pole pieces, a pair of U-shaped, shunt

bars having a plan configuration similar to that of the pole pieces, reversely turned ends on the arms of the shunt bars, each shunt bar having the reversely turned ends slipped under the ends of the arms of an associated pole piece so that the ends of the shunt bars form the faces of the two gaps, a flux-conductive armature rigidly mounted in one gap and having a free portion centered in the other gap, and a coil disposed about a portion of the armature intermediate the gaps.

9. A transducing device comprising a pair of flat, U-shaped pole pieces arranged in spaced, side-by-side relationship so that the facing sides of the ends of the arms form two like, spaced high reluctance gaps, means for oppositely magnetizing said pole pieces, a pair of arcuate shaped flat shunt bars, the same flat surface of the ends of each shunt bar engaging the gap side of an associated pole piece so that the shunt bars form the conductive face at the gap, an armature having a portion rigidly mounted in one gap and having a free portion centered in the other gap, and a coil disposed about a portion of the armature intermediate the gaps.

10. The transducing device of claim 9 wherein a link is fastened to the armature and extends outwardly thereof in the space between a shunt bar and a pole piece.

11. A transducing device comprising two flat U-shaped members made of magnetic material, a second pair of flat U-shaped members made of a material more flux permeable than the material of the first U-shaped members, the arms of each of the first two members overlapping the ends of the arms of a facing high permeable member so as to form a flat ringlike construction with an opening in the middle, said pairs of members being in registered relationship and spaced so as to form two gaps between associated pairs of arms, an armature extending across the opening in flux-conductive association with both gaps and having one end vibratable in one gap, means for impressing a uni-directional magnetic flux path through the two first U-shaped members, and a coil disposed around the armature and lying recessed in said openings whereby the armature is shielded by the U-shaped members and coil from penetration of external stray fields.

12. A transducing device comprising a pair of substantially flat U-shaped pole plates disposed in side-by-side, spaced, registered relationship so that the facing sides of the ends of their arms form laterally two spaced, high flux reluctance gaps, a permanent magnet positioned between portions of said pole plates, a flux-conductive armature having a portion rigidly mounted with respect to said pole plates, another portion of said armature being positioned in and vibratable in one of the gaps, and a coil disposed about a portion of the armature intermediate the gaps and between the arms of the pole pieces.

13. A transducer comprising two spaced, generally parallel, laterally registered, flux-conductive plates, an elongated magnet magnetized normal to its length positioned between portions of the plates with one pole face conductively connected to the inside surface of one plate and the other pole face conductively connected to the inside surface of the other plate, an elongated armature, a coil around said armature, and means holding a portion of said armature in fixed relationship to said plates so that another portion of the armature may vibrate between the plates, the flux leaving the plates through their inside walls.

14. A transducer comprising two spaced, generally parallel flux-conductive plates, an elongated magnet magnetized normal to its length positioned between the plates with one pole engaging the inside surface of one plate and the other pole engaging the inside surface of the other plate, an elongated armature positioned between the plates, a coil around said armature, means holding a portion of said armature in fixed relationship to said plates so that another portion of the armature may vibrate between the plates, and flux-conductive means on the inner side of one plate adjacent the vibratable portion of the armature extending inwardly toward the armature so as to form a face on a comparatively thin gap in which the armature vibrates.



15. The transducer of claim 14 wherein the flux-conductive means is an offset pressed in one plate toward the other plate.

16. A transducer comprising two substantially flat pole plates spaced by a comparatively short distance from each other and laterally registered, an elongated, transversely magnetized magnet positioned between said plates with one pole engaging one plate and the other pole engaging the other plate, a solid means of low flux conductivity material positioned on the inner surface of each plate and spaced from the magnet, said means being transversely aligned, an armature having a portion positioned between said solid means and having a second portion vibratable between the two plates, and means clamping the plates through the solid means and armature in assembled relationship.

17. The transducer of claim 16 wherein the clamping means is a shaft passing through the pole plates, both solid means and the armature.

18. The transducer of claim 16 wherein the solid means are washers and the clamping means is a shaft passing through both pole plates, the washers and the armature.

19. A transducer comprising a flux-conductive plate, a low flux-conductive spacer having a surface area smaller than the plate mounted on one surface of said plate, an armature disposed on the spacer and extending laterally thereof adjacent the plate, a second similar spacer mounted on the armature in vertical alignment with the first spacer, a second flux-conductive plate disposed on the top of the second spacer, a third spacer having a thickness equal to the combined thickness of the first two spacers and the armature positioned between the two plates and near another portion of the armature, a magnet positioned between the plates with its poles contacting the two plates respectively, a coil around the armature, means clamping the plates to the spacers and armature, and means clamping the plates to each other through the third spacer.

20. The transducer of claim 19, wherein the clamping means are bolts through the plates, spacers and armature.

21. A transducer comprising two spaced, generally parallel, flux-conductive plates, an elongated magnet magnetized normal to its length positioned between portions of the plate with one pole engaging the inside surface of one plate and the other pole engaging the inside surface of the other plate, an elongated armature rigidly mounted between other portions of the plates at a selected point, a coil around said armature and spaced from the holding means, and an opening in each plate in transverse alignment with that portion of the armature lying between the coil and the holding means.

22. A transducer comprising a flux-conductive plate, a low flux-conductive spacer having a surface area smaller than the plate mounted on one surface of said plate, an armature disposed on the spacer and extending laterally thereof adjacent the plate, a second similar spacer mounted on the armature in transverse alignment with the first spacer, a second flux-conductive plate disposed on the top of the second spacer, means for clamping the plates to the spacers and armature, a coil around the armature and spaced from the spacers, a permanent magnet positioned between the plates with one pole engaging one plate and the other pole engaging the second plate, and an opening through each plate in transverse alignment with that portion of the armature between the coil and the spacers.

23. A transducer comprising two spaced, generally parallel, flux-conductive plates, a magnet positioned between the plates with one pole engaging the inside sur-

face of one plate and the other pole engaging the inside surface of the other plate, an armature positioned between the plates, means between the plates holding a portion of the armature in fixed relationship to the plates, another portion of the armature being vibratable between the plates, a coil around the armature and spaced from the armature holding means and from the vibratable portion between the plates, a hole through each plate providing access to that part of the armature between the coil and the holding means, a hole through one of the plates providing access to that part of the armature adjacent the other end of the coil, and a drive pin mounted on the armature and extending through said last-named hole.

24. The transducer of claim 23 together with a base plate constituting a back wall of a sound cavity, said base plate being mounted on the transducer adjacent the pole plate having the single hole in it with that portion of said base plate adjacent the vibratory center of a diaphragm to be mounted in the back cavity in transverse alignment with said hole.

25. A transducer comprising a pair of U-shaped pole pieces arranged in spaced, side-by-side relationship so that the facing sides of the ends of the arms form two like, spaced, high reluctance gaps, means for oppositely magnetizing said pole pieces, an elongated flux-conductive armature having one portion rigidly fastened in one gap and extending to another portion vibratably positioned in the other gap, a recess on the inside edge of the base portion of each U-shaped pole piece, said recess being narrower than the distance between the high reluctance gaps, and a coil wound on a bobbin, said bobbin being positioned around the armature and press fitted into the recesses in both pole pieces.

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UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 2,912,522 November 10, 1959

Hugh S. Knowles et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 7, and column 5, line 3, for "dielectric", each occurrence, read -- non-magnetic --.

Signed and sealed this 26th day of July 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

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