United States Patent

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[54] **TRANSDUCER HAVING AN ARMATURE ARM SPLIT ALONG ITS LENGTH**
6 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **179/114,** 179/119
[51] **Int. Cl.** **H04r 11/06**
[50] **Field of Search** 179/114R, 115R, 119R, 178, 179

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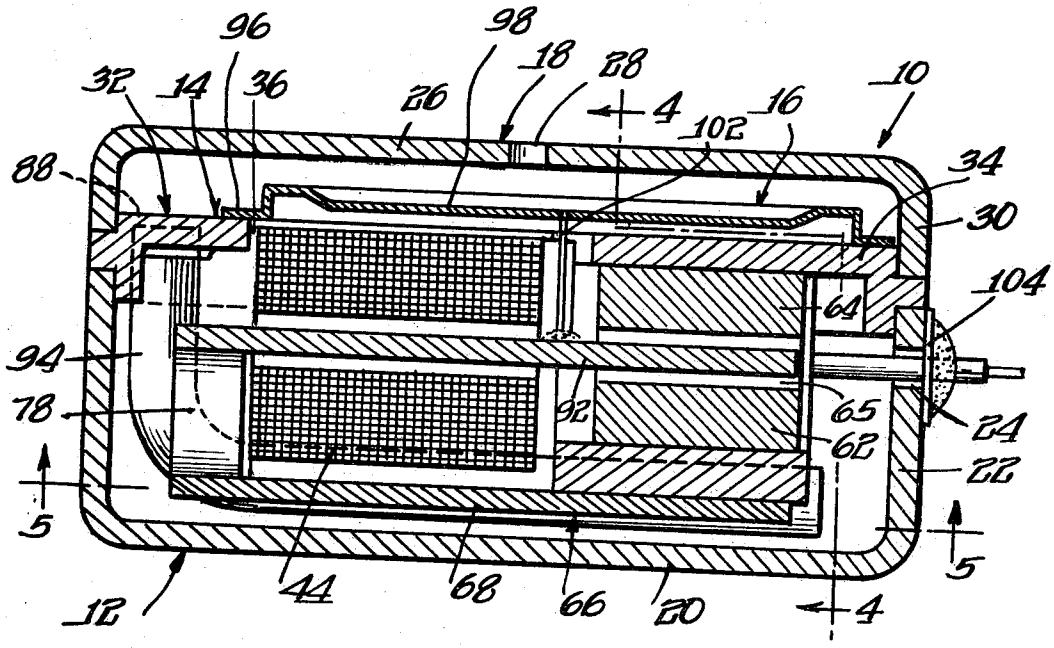
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Assistant Examiner—Thomas L. Kundert
Attorney—Stone, Zummer & Livingston

ABSTRACT: A transducer having a case and a coil mounted within the case. A pair of spaced magnets mounted in the case and spaced from the coil. An armature reed construction having a first elongated arm split along length with one end of the arm magnetically connected to the pair of spaced magnets. A pair of opposed bridges connected to the other end of the elongated arm. A second elongated arm having one end connected to the pair of bridges to form a substantially rigid section between the elongated arms. The second elongated arm positioned through the coil and between the spaced magnets.



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SHEET 1 OF 2

Fig. 1

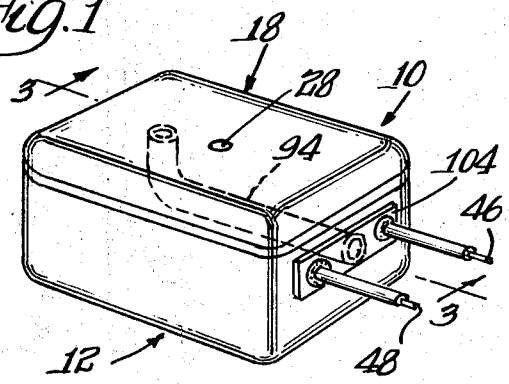


Fig. 2

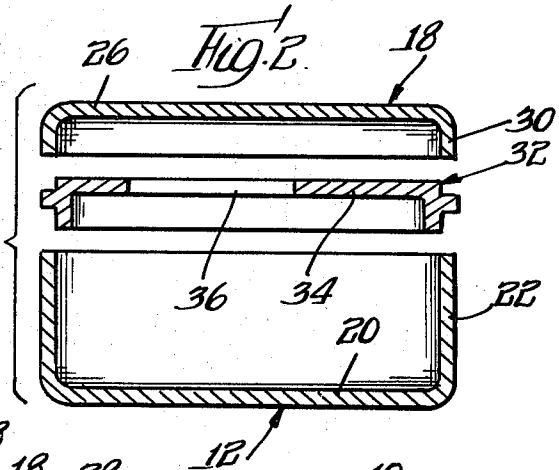


Fig. 3

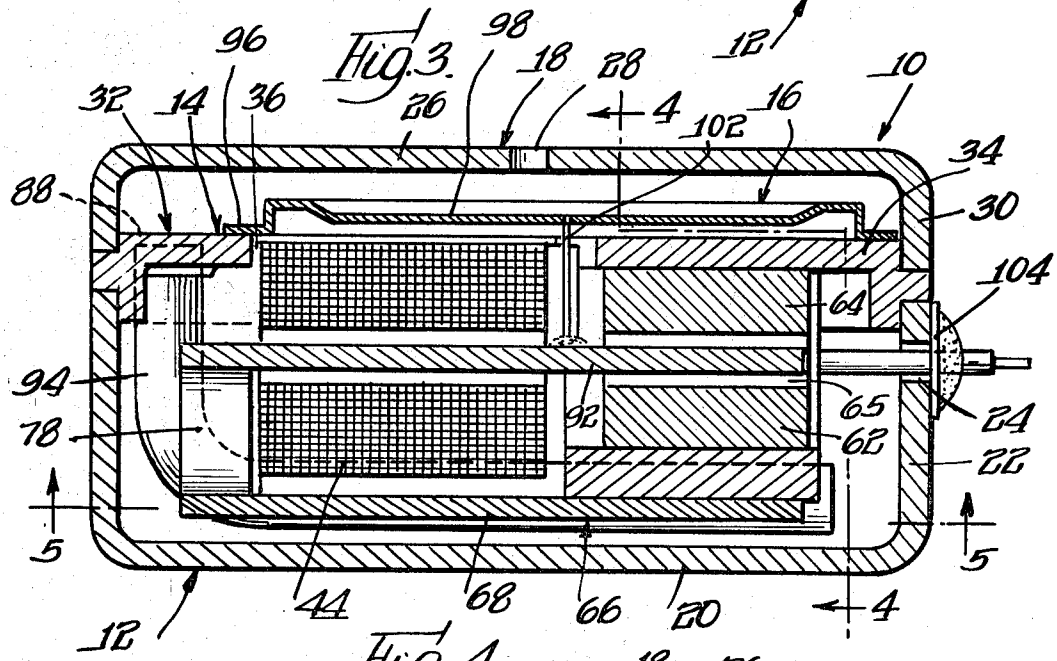
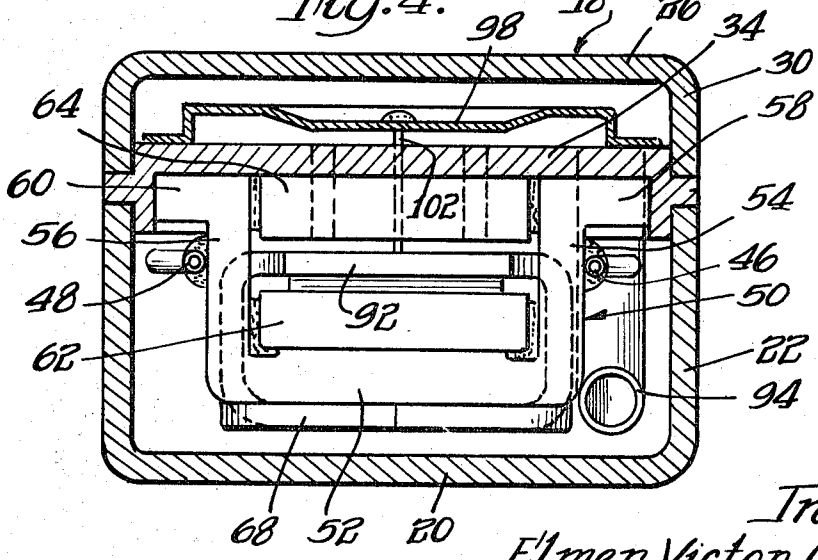


Fig. 4.



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Fig. 5

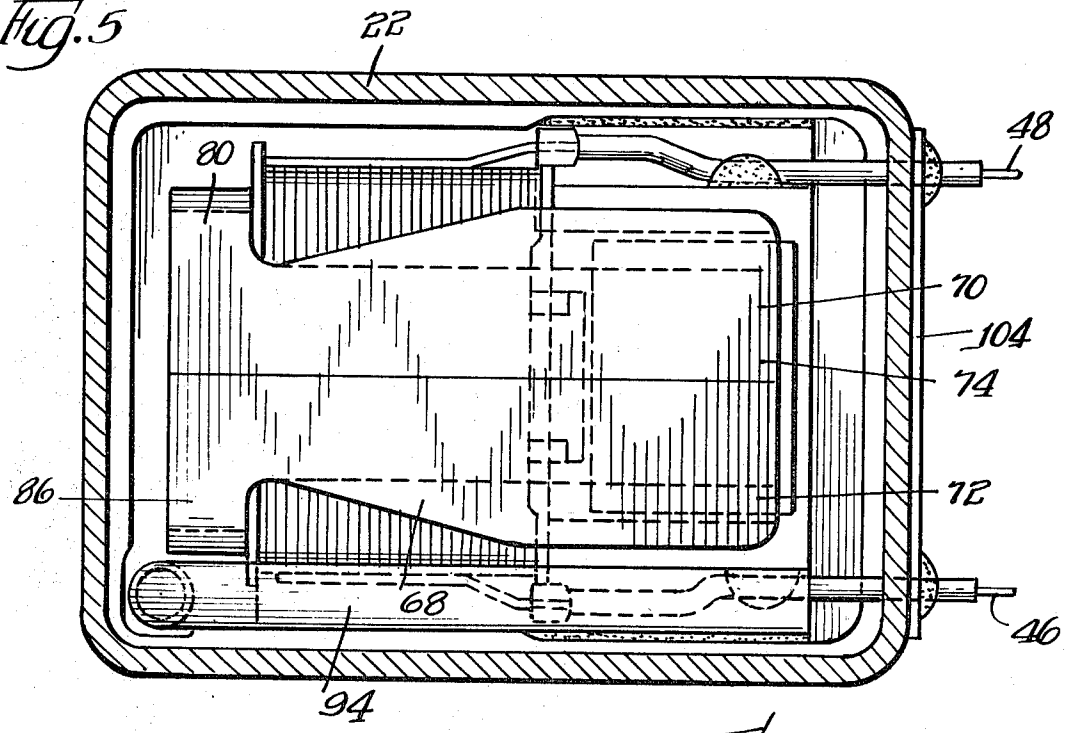


Fig. 6.

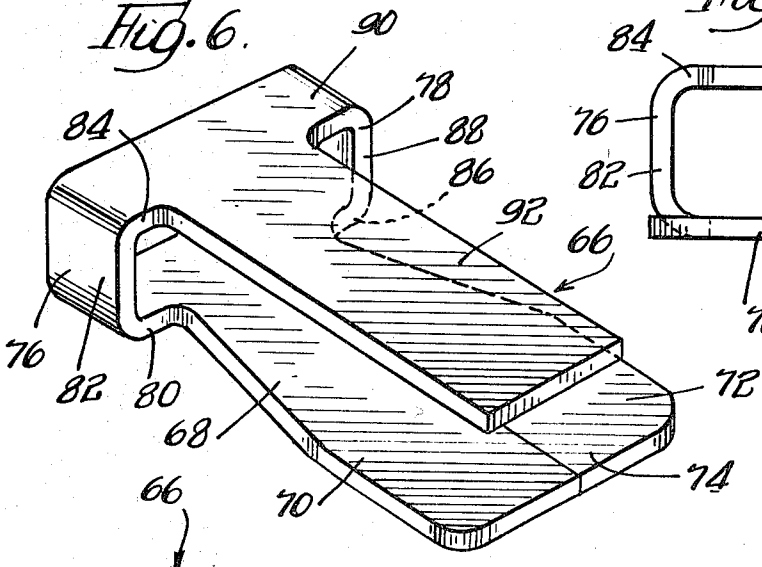


Fig. 7.

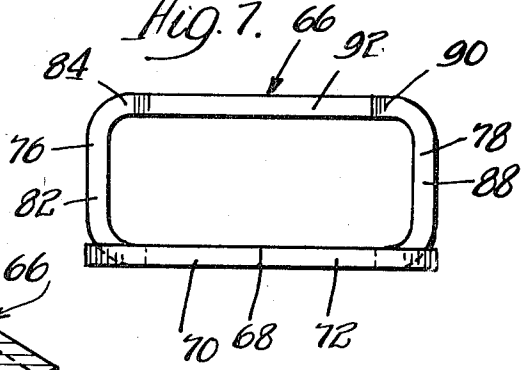
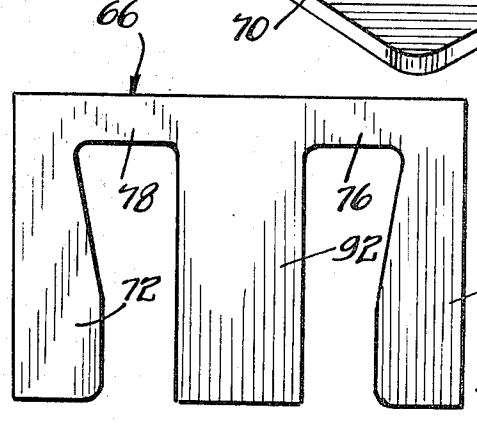


Fig. 8.



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TRANSDUCER HAVING AN ARMATURE ARM SPLIT ALONG ITS LENGTH

BACKGROUND OF THE INVENTION

Transducers have a variety of applications for converting mechanical energy to electric energy and vice versa. An important application for transducers is in the acoustic field where acoustic energy is converted to electric energy and vice versa. In the acoustic field, miniature transducers are used in hearing aids as microphones or receivers. Hearing aids have recently received a high degree of acceptance because hearing aids have become more acceptable cosmetically. One of the reasons that hearing aids are more acceptable cosmetically is that hearing aid manufacturers have been able to make hearing aids smaller. One factor which has contributed substantially to the shrinkage of the size of hearing aids is the miniaturization of transducers.

Although the advantages of small hearing aids and transducers are great, the smallness of transducers has also generated a number of problems. As the transducer has become smaller, a much higher degree of precision in manufacture and adjustment is required in the miniature transducer than in the older and larger transducers. For instance, in one type of miniature transducer, the tip of the armature reed must be positioned within 1 micron in its final adjustment. It may be appreciated that during usage of the hearing aid, should the armature reed be forced out of adjustment, the hearing aid would be defective or not operable.

In order to reduce the size of the hearing aid, the hearing aid designer must make certain design compromises. In a small hearing aid, the hearing aid designer customarily reduces the amount of shock absorbing material surrounding the transducer, which renders the transducer more susceptible to shock damage. At least one transducer manufacturer has found that between 80 and 90 percent of returned transducers from the field are damaged due to shock loading on the transducer. It appears that the smaller hearing aids may be readily dropped and are dropped in the field.

Inasmuch as elderly people have a greater need of hearing aids, the small hearing aids are worn with spectacles or in behind-the-ear hearing aids for the cosmetic effect. The older people ordinarily have a lesser degree of manual dexterity and coordination than younger people, and such older people are more prone to drop a hearing aid when they are positioning a hearing aid on the head.

In one study which was made to determine the effect of shock on the transducer, it was found that when a transducer was dropped from a height of 1 meter onto a hard surface, the mean deceleration upon impact was approximately 3,000 G, and a maximum of 15,000 G was attained. Considering that a small transducer has an approximate weight of 1 gram, it may be stated that the mean force applied to the transducer was approximately 3,000 grams and the maximum force was 15,000 grams. It is therefore readily apparent that a transducer having high precision construction may be readily damaged by dropping it on a hard surface, such as, a ceramic tiled bathroom floor.

SUMMARY OF THE INVENTION

The instant transducer is one which is conventional in its construction in that it includes a case, a coil mounted in the case, a pair of spaced magnets mounted in the case and spaced from the coil, and an armature reed, which armature reed provides a flux path connecting the coil, the magnetic gap between the magnets and the magnets. The improvement of the instant transducer lies in the armature reed construction. The armature reed has a first elongated arm having one end magnetically connected to the pair of spaced magnets. A pair of opposed bridges is connected to the other end of the elongated arm. Each of said bridges has one end connected to an opposed edge of the elongated arm. A second elongated arm which is substantially parallel to the first elongated arm has one end connected to the bridges, which bridges are connected to opposed edges of the second elongated arm. The second elongated arm extends through the coil and is positioned between the magnets.

The instant armature reed has a pair of elongated arms which are connected to each other by a substantially rigid section. The section is formed by the pair of bridges and ends of the elongated arms. The bridges are substantially perpendicular to the planes of the elongated arms, and the planes of the bridges are substantially parallel to the length of the arms. It is therefore a principal object of the instant invention to provide an improved transducer construction wherein the transducer includes a pair of flat, substantially parallel elongated arms joined by a substantially rigid section to minimize permanent distortion of the armature reed upon shock loading of the transducer.

It is a further object of the present invention to provide a transducer construction having an armature reed which has two substantially flat elongated arms connected by a lightweight substantially rigid section.

It is another object of the herein-disclosed invention to provide a transducer construction having an armature reed which includes a pair of flat elongated arms having a pair of thin bridges connecting the elongated arms.

It is still another object of the present invention to provide an improved transducer construction, which transducer is economical to manufacture and easy to assemble and maintain.

Other objects and uses of the herein-disclosed invention will become readily apparent to those skilled in the art upon a perusal of the following description in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a transducer embodying the herein-disclosed invention;

FIG. **2** is an exploded view of parts of the transducer shown in FIG. **1** showing the interrelationship between a case, a bulkhead and a cover;

FIG. **3** is a cross-sectional side elevational view of the transducer shown in FIG. **1** and taken on line **3–3** of FIG. **1**, showing the interior construction of the subject transducer;

FIG. **4** is a cross-sectional and elevational view taken on line **4–4** of FIG. **3**;

FIG. **5** is a cross-sectional view taken on line **5–5** of FIG. **3** and shows a flared portion of an elongated arm, which constitutes a part of the armature reed, connected to a pair of magnets;

FIG. **6** is a perspective view of the armature reed which constitutes a portion of the instant transducer;

FIG. **7** is an end view of the armature reed shown in FIG. **6**; and

FIG. **8** is a plan view of the armature reed shown in FIG. **6**, but the armature reed being shown flat rather than in its folded attitude.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and especially, to FIG. **3**, a transducer **10**, being a specific embodiment of the subject invention, is shown therein, and generally consists of a case **12**, a motor unit **14** mounted therein, a diaphragm assembly **16** connected to the motor unit and a cover **18** connected to the motor unit.

The case **12**, which may be made of magnetic material, includes a floor **20** and a sidewall **22**. A lead aperture **24** is formed in one end of the sidewall, as may be seen in FIG. **3**.

The cover **18** includes a top **26**, which has a sound aperture **28** centrally formed therein. The top **26** has an edge wall **30** connected to the outer periphery of the top so that the edge of the edge wall is registerable with the edge of sidewall **22**.

The motor unit **14** includes a bulkhead **32** which has a flat platform **34**. The platform has near its center an enlarged aperture **36** and a tube aperture **38**. The platform **34** is mateable with the interior of sidewall **22** and edge wall **30**.

An armature coil **44** is positioned in aperture **36** and is held therein by an adhesive. Thus, the coil is securely positioned relative to the bulkhead, and the platform presents a substantially flat surface adjacent to the cover. The coil includes a pair of leads **46** and **48** which are electrically connected to the coil. Aperture **24** provides an opening for the leads and a means for conducting electrical current to and from coil **44**.

A U-shaped or omega-shaped magnet support **50** is secured to platform **34** adjacent to the coil. The magnet support includes a substantially flat bench **52** which is mounted parallel to platform **34**. The bench has a pair of pedestals or arms **54** and **56** and a pair of feet **58** and **60** on arms **54** and **56**, respectively. The feet are secured to the platform.

As may be seen in FIGS. **3** and **4**, a first magnet **62** is secured to bench **52** of magnet support **50**. A second magnet **64** is secured to platform **34** between pedestals **54** and **56** and adjacent to the first magnet. The positioning of the magnets as described above provides a magnetic air gap **65** for the subject transducer.

An armature reed **66** has one end mounted on and magnetically connected to the magnet support. A portion of the armature reed extends through the coil **44** and has its other end positioned in the magnetic gap, as may be best seen in FIG. **3**.

The armature reed includes a flat split first elongated arm **68**. The elongated arm **68** includes a pair of wings **70** and **72**. These wings may have an enlarged portion to form a flared portion **74** of the arm. The wings are secured to the magnet support, thereby mounting and magnetically connecting the arm to the magnet support at the flared portion to provide improved magnetic linkage between the magnet support and the armature reed. At the free end of arm **68**, a pair of opposed U-shaped bridges **76** and **78** are formed integral with opposed edges of wings **70** and **72**, respectively. Bridge **76** includes a first ear **80**, which is formed integral with wing **70**, and a span **82**, which span is formed integral with the ear **80** and is perpendicular to the plane of the first elongated arm **68**. Bridge **72** includes a second ear **84** which is formed integral with the span **82** and is perpendicular to said span. The bridge **78** includes a first ear **86**, which is formed integral with wing **72**, and a span **88**, which span is formed integral with the ear **86** and is substantially perpendicular to the plane of the arm **68**. The bridge **78** includes a second ear **90** formed integral with the span **88** and is substantially parallel to the first ear **86**. A second elongated arm **92** has opposed edges formed integral with the second ears **84** and **90**, and the second arm **92** extends through the coil **44** and is positioned in the magnetic gap **65**. The second arm **92** is parallel to the first elongated member **68**.

It is important to note that the bridges on opposite edges of the elongated arms form with the ends of the arms a closed section which provides a relatively rigid connection between the two arms. It is apparent that though the section formed by the ends of the elongated arms and the bridges is a relatively rigid construction, the weight is held to a minimum, and the armature reed may be easily and simply formed, as will be described hereinafter.

A conventional inertance tube **94** is connected to the bulkhead **32** at tube aperture **38**.

The diaphragm assembly **16** includes a surround **96** which is secured to platform **34**. A diaphragm **98** is mounted within the surround **96** and has an aperture **100**. Mounted in aperture **100** and secured therein is one end of a rod or drive pin **102** which has its other end secured to the elongated member **92**, so that the diaphragm is mechanically connected to the armature reed. The drive pin extends through aperture **36** between the coil and the magnet **64** as may be seen in FIG. **3**.

The armature reed **66** is simply and economically manufactured with a high degree of precision. The armature reed is stamped out of a sheet of magnetic material having uniform thickness as a blank, as shown in FIG. **8**. The blank is then folded with dies to the form shown in FIG. **6**. The mechanical operations of stamping the blank and folding the blank are well known, and it is obvious that these operations may be done with a high degree of precision with relatively simple and well-known mechanical devices.

It is evident that the motor unit **14** may be easily and conveniently assembled. Coil **44** is positioned in aperture **36** and is secured therein. The magnet support **50** is secured to the bulkhead adjacent to the coil and the magnets **62** and **64** are attached to the magnet support and the bulkhead, respectively. The armature reed has arm **92** positioned through the coil and in the magnetic gap, and wings **70** and **72** of arm **68** are mechanically and magnetically connected with the support.

It is evident that since the motor unit is complete, it may be easily and conveniently tested and adjusted prior to insertion into the case. The elongated arm **92** of the armature reed may be conveniently adjusted in the magnetic gap with a high degree of precision. After the motor unit is adjusted, it is then mounted in case **12** and secured therein. It should be further noted that the subject construction of the motor unit has a further advantage in that the major components of the magnet circuit such as the magnets, the magnet support and the armature reed are not connected directly to the case so that the effect of changes in the case is minimized.

The diaphragm assembly is mounted on the bulkhead and the drive pin **102** is then positioned in the case **12** and the leads **46** and **48** are positioned in the lead aperture **24**. A plate **104** is secured to sidewall **22** to cover it and to seal closed the lead aperture. The cover **18** is secured to the bulkhead to enclose the diaphragm assembly.

When the transducer **10** is utilized as a microphone, sound enters the aperture **28**. The sound impinges upon diaphragm **98** to deflect the armature reed, since the armature reed is connected to the diaphragm by means of drive pin **102**. When the armature reed is deflected, the elongated member **92** moves closer to one of the magnets and away from the other magnet, thereby causing a change of the magnet flux through the armature reed. As is conventional, a voltage is induced in the coil. It should be noted that there are two magnetic flux circuits in the magnet support **50**. In one of the circuits, the flux flows through the magnets, a portion of the platform, along pedestal **56** and through a portion of the bench **52**. In the other circuit, the flux flows through the magnets, another portion of the platform, along pedestal **54** and through another portion of bench **52**.

It is apparent that when the armature reed is closer to one of the magnets, the density of the flux between the magnet and arm **92** is increased and a portion of the flux flows along the reed back to the magnet support. It should be therefore noted that by utilizing the subject construction, the magnet support provides an improved flux path without increasing the overall length of the transducer. Furthermore, the instant construction allows the maximum point of displacement of the armature reed to occur in the magnetic gap and still maintain a small minimum overall length of the motor unit. Although the magnetic circuit for the subject transducer has been described in terms of a microphone, it is apparent that the operation of a speaker is similar, though the source of energy is electrical to operate the diaphragm.

It is important to note that the subject transducer construction provides a construction wherein the effect of shock loadings on the armature reed is substantially minimized. The section of the armature reed having the bridges **76** and **78** is relatively rigid so that there is a minimum of strain at this particular portion of the armature reed. Even through a severe load may be applied to the end in the air gap, the section has a great resistance to permanent deformation. Thus, should the transducer be dropped, the position of arm **92** in the magnetic gap would not be readily permanently distorted.

Although a specific embodiment of the herein-disclosed invention has been described in detail above and shown in the accompanying drawings, it is to be expressly understood that those skilled in the art may make various modifications and changes in the construction shown herein without departing from the spirit and scope of the invention. It is to be expressly understood that the present invention is limited only by the appended claims.

I claim:

1. In a transducer having a case, a coil mounted in said case, a pair of spaced magnets mounted in the case, a first elongated arm having one end magnetically connected to said pair of spaced magnets, said first elongated arm is split along its length, a pair of bridges connected to the other end of said first elongated arm, and a second elongated arm having one end connected to the pair of bridges and having one portion movably positioned in the coil and another portion movably positioned between the spaced magnets.

2. A transducer as described in claim 1 wherein the first elongated arm has an enlarged portion at the end connected to the magnets.

3. A transducer as described in claim 1 wherein each of the bridges has each of its opposed ends formed integral with the respective elongated arms.

4. A transducer as described in claim 1 in which the first elongated arm has an enlarged portion at the end connected to the magnets and each of the bridges has each of its ends formed integral with each of the respective arms.

5. An armature reed for use in a transducer comprising, a substantially flat elongated arm adapted for positioning in a magnetic gap, a pair of opposed bridges formed integral with opposed edges of the elongated arm, and being substantially perpendicular to the elongated arm, and a second elongated arm substantially parallel to the first-mentioned elongated arm formed integral with the bridges, said second elongated arm is split along its length into two halves, whereby the bridges and the arms form a substantially rigid section connecting the arms.

6. A transducer comprising, in combination, a case having a generally rectangular floor and a sidewall formed integral with the outer periphery of said floor, a bulkhead having a generally rectangular outline and having an edge formed integral with the outer periphery thereof mateably positioned within the sidewall, said edge having an annular flange extending outwardly therefrom and positioned in engagement with the sidewall to support the bulkhead on the sidewall, a cover having an acoustic aperture therein mounted on the annular flange in engagement with the edge of the bulkhead, a diaphragm mounted on the bulkhead within the cover, said bulkhead having an aperture contained therein, a coil mounted in said aperture and adhesively secured to the bulkhead, a generally U-shaped magnet support fixed to the bulkhead adjacent to said coil within said case, said magnet support having a pair of feet adjacent to the edge for positioning relative to the bulkhead, a first magnet secured to the magnet support adjacent to the bulkhead, a second magnet secured to the bulkhead adjacent to the first magnet, a first elongated arm having a flared portion mounted on the magnet support, said first elongated arm being longitudinally split into two halves, a first bridge formed integral with one edge of the first elongated arm, a second bridge formed integral with the opposite edge of said elongated arm, and a second elongated arm having opposed edges formed integral with the bridges extending through the coil and positioned in the magnetic gap, wherein the ends of the elongated arms with the bridges form a substantially rigid section connecting the elongated arms.