# United States Patent [19]

**Haugsjaa et al.**

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[45] **May 7, 1974**


[54] **ELECTRET TRANSDUCING DEVICE**


[75] Inventors: **Paul O. Haugsjaa,** Plainview, N.Y.; **Adam Heller,** Sharon, Mass.; **William F. Nelson,** Port Washington; **Anthony Bocchimuzzo,** Bronx, both of N.Y.

[73] Assignee: **GTE Laboratories Incorporated,** Waltham, Mass.



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[21] Appl. No.: **218,101**

[52] **U.S. Cl.** ..... **179/100.41 B,** 179/100.41 G 179/100.41 K, 179/111 E, 307/88 ET

[51] **Int. Cl.** ..... **H04r 23/00**

[58] **Field of Search** ..... 179/100.41 B, 100.41 G, 179/100.41 K, 111 R, 111 E; 367/88 ET; 178/6, DIG. 10



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*Primary Examiner*—Raymond F. Cardillo, Jr.
*Attorney, Agent, or Firm*—Irving M. Kriegsman; Robert A. Walsh



[57] **ABSTRACT**

An electret transducer is described which includes an electret formed from a relatively thin elongated body of electrically insulating dielectric material which is polarized for establishing a residual electrostatic field within the body. First and second relatively thin elongated bodies of electrically conductive material are positioned adjacent opposite surfaces of the electret body and extend substantially coextensively with the electret body. The conductive bodies thereby sandwich the electret and provide electrodes for the transducer. This sandwich configuration is formed into a convolute shaped transducer assembly and includes electrical conductors which are coupled to each of the electrodes and between which a transducer output signal is provided upon mechanical excitation of the convolute shaped transducer assembly. The transducer thus provided comprises a displacement transducer which advantageously can be employed in acoustical detection and reproduction systems.


**1 Claim, 11 Drawing Figures**

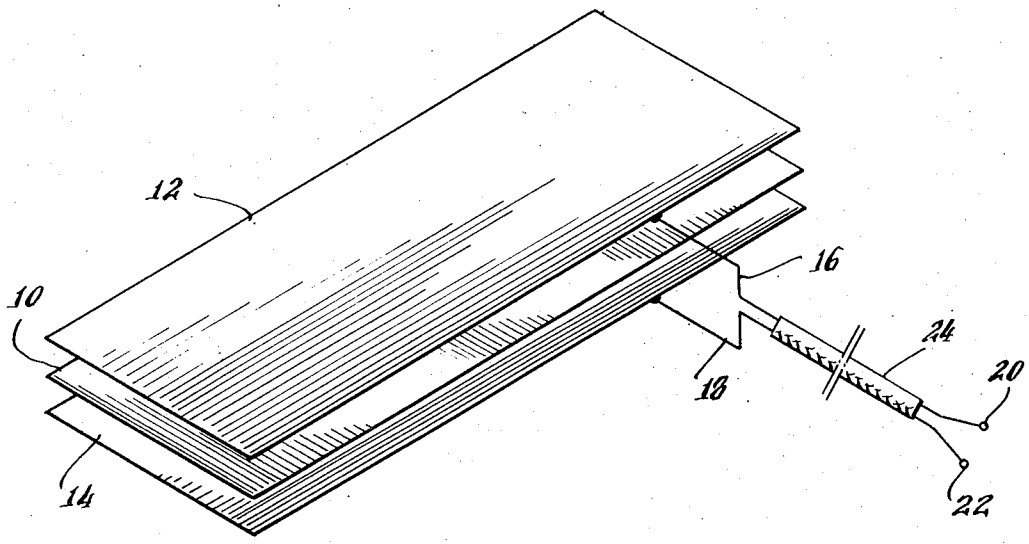


Fig. 1

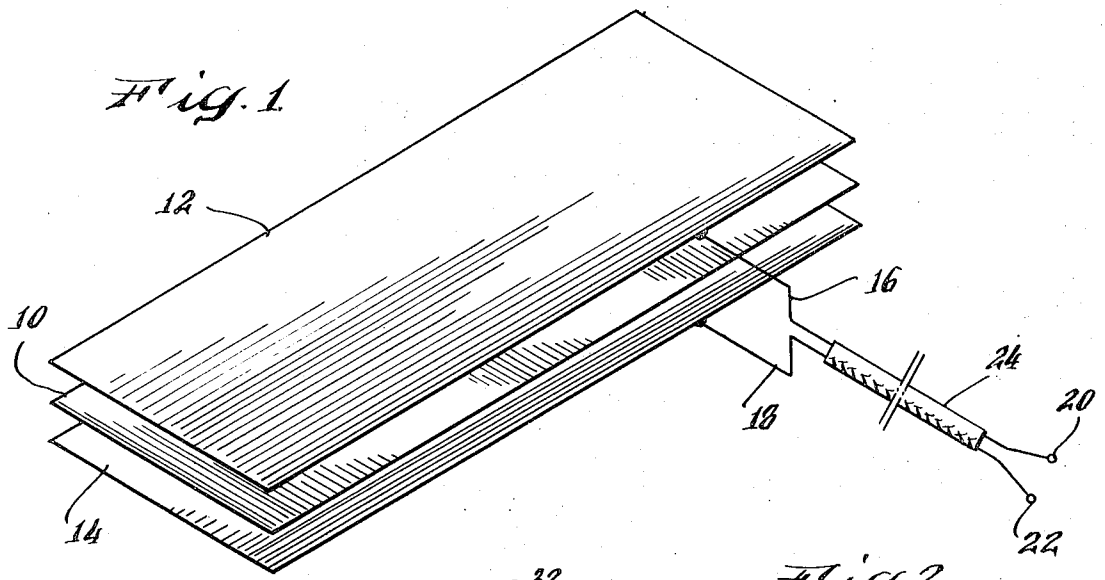



Fig. 2

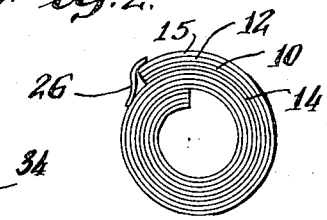



Fig. 3

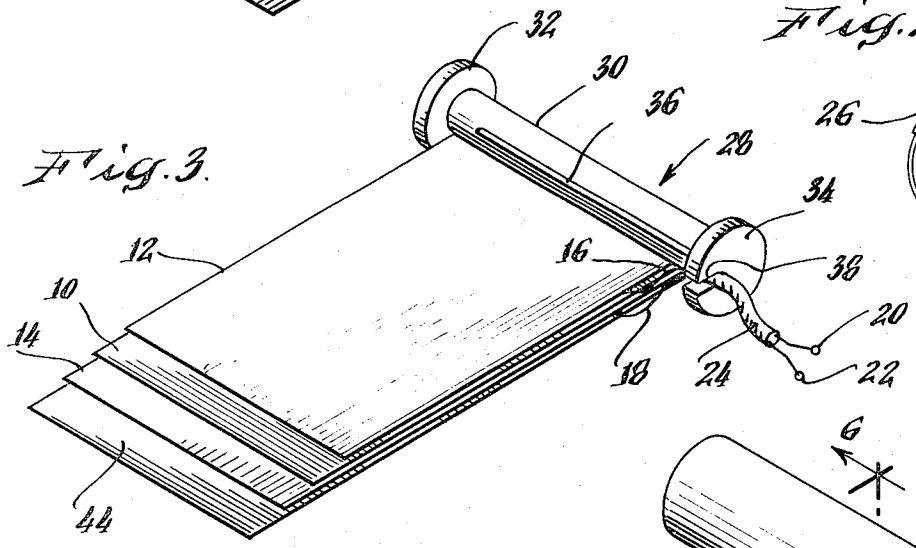
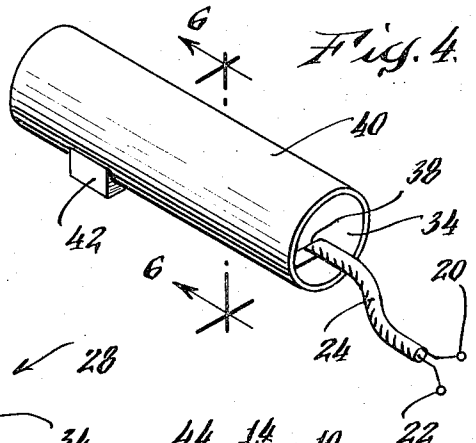



Fig. 4



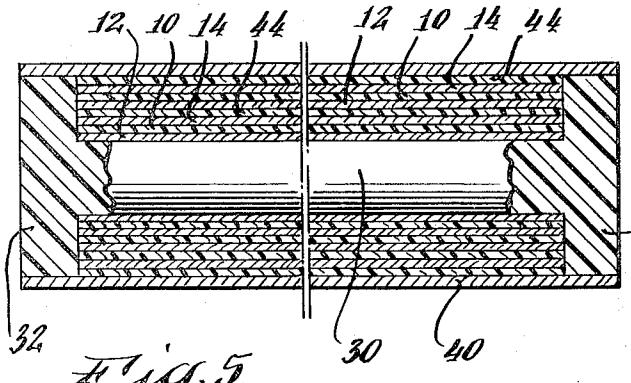




Fig. 5

Fig. 6

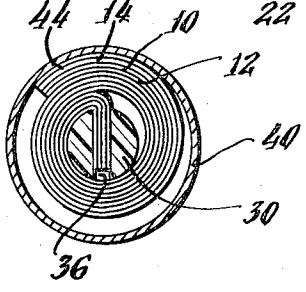


Fig. 7.

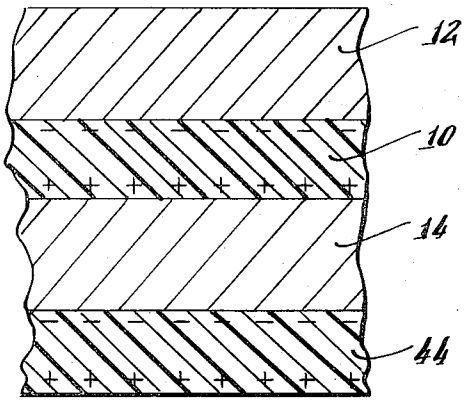
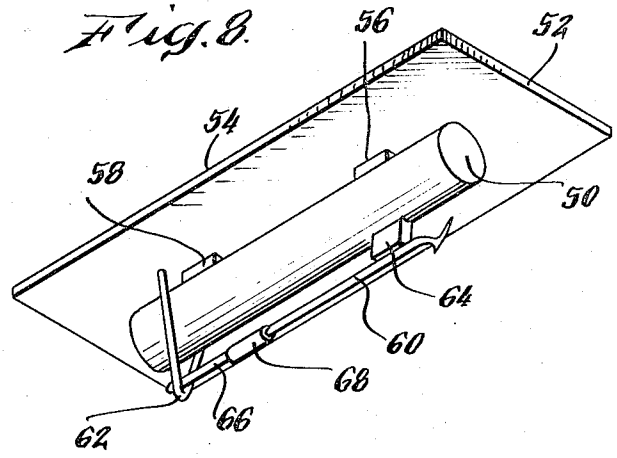



Fig. 8.



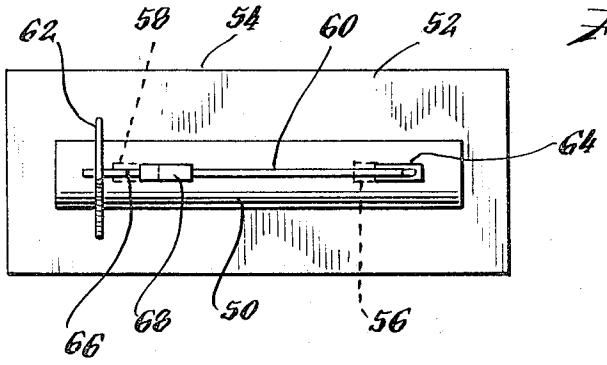




Fig. 9.

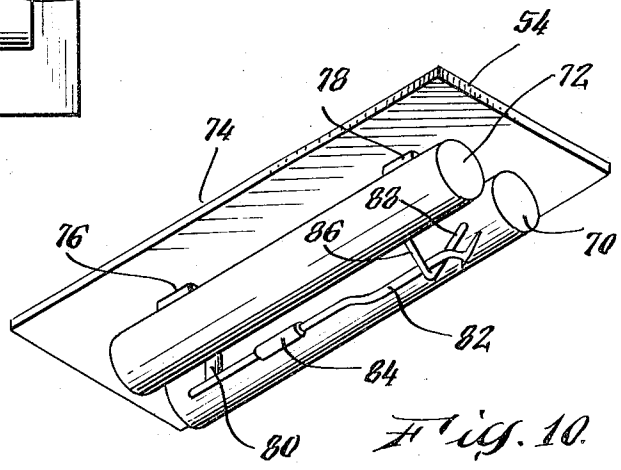
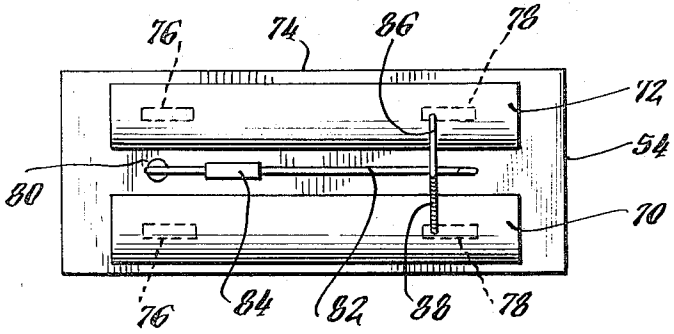



Fig. 10.

Fig. 11.



# ELECTRET TRANSDUCING DEVICE

This invention relates to transducing devices. The invention relates more particularly to an improved form of electret transducing device.

The electret is a known device which is the electrostatic analogue of a permanent magnet. An electret comprises a body of dielectric material which exhibits relatively long term persistent dielectric polarization. The long term dielectric polarization characteristics may be achieved in one process by heating a body of dielectric material to a relatively high temperature under a relatively intense electric field for a period of time and then cooling the material while still subjecting it to the intense electric field. An electrode arrangement is provided with the dielectric material in order to adapt the electrical characteristics of the electret for use in a circuit arrangement.

Various transducer arrangements have been provided which employ polarization characteristics of the electret. In one transducer, the electret body is mechanically supported in fixed relationship with respect to a first electrode and a second electrode of the transducer is displaced with respect to the electret body in response to input information which is mechanically coupled to the second electrode. For example, in one known arrangement the electret transducer comprises a phonograph pickup wherein the second electrode is a displaceable electrode which is mechanically coupled to a stylus and is vibrated by the stylus in accordance with information recorded on a phonograph record.

Prior forms of electret transducers particularly in the areas of the reproduction arts have been relatively bulky and complex and have not lent themselves to low cost fabrication.

Accordingly, it is an object of this invention to provide an improved form of electret transducer.

Another object of the invention is to provide a relatively low cost electret transducer.

Another object of the invention is to provide an improved electret and electrode assembly.

A further object of the invention is to provide an improved electret transducer and housing therefor.

Another object of the invention is to provide an improved means for exciting an electret transducer.

Still another object of the invention is to provide an improved form of electret phonographic pickup device.

Another object of the invention is to provide an improved form of stereophonic pickup device for use with phonographic recordings.

In accordance with features of the present invention, an electret transducer includes an electret formed from a relatively thin elongated body of electrically insulating dielectric material which is polarized for establishing a residual electrostatic field within the body. First and second relatively thin elongated bodies of electrically conductive material are positioned adjacent opposite surfaces of the electret body and extend substantially coextensively with the electret body. The conductive bodies thereby sandwich the electret and provide electrodes for the transducer. This sandwich configuration is formed into a convolute shaped transducer assembly and includes electrical conductors which are coupled to each of the electrodes and between which a transducer output signal is provided upon mechanical excitation of the convolute shaped transducer assembly. The transducer thus provided comprises a displacement transducer which advantageously can be employed in acoustical detection and reproduction systems.



In accordance with more particular features of the invention, the transducer assembly is formed into a scroll shaped configuration upon an elongated support body and is positioned within an elongated tubular shaped housing. A pickup such as a phonograph stylus is mechanically coupled to the tubular housing for transmitting information in the form of mechanical vibrations to the housing.

These and the objects and features of the invention will become apparent with reference to the following specification and drawings wherein:

FIG. 1 is a perspective view of an electret transducer assembly illustrating the relative positioning of transducer members prior to forming of a scroll shaped configuration in accordance with features of this invention;

FIG. 2 is an elevation view in section of the electret transducer of FIG. 1 formed into a scroll shaped configuration;

FIG. 3 is a perspective view of an alternative embodiment of an electret transducer of this invention which is arranged for mounting on a support body;

FIG. 4 is a perspective view of the electret transducer of FIG. 3 positioned within a housing member;

FIG. 5 is a sectional view of the transducer of FIG. 4 taken along lines 5—5 of FIG. 4;

FIG. 6 is a sectional view of the transducer of FIG. 4 taken along lines 6—6 of FIG. 4;

FIG. 7 is an enlarged partial view in cross-section of the electret transducer of FIG. 3 illustrating the relative electrical polarity of electret members of the assembly;

FIG. 8 is a perspective view of a phonographic pickup constructed in accordance with features of this invention;

FIG. 9 is a bottom view of the phonograph pickup of FIG. 8;

FIG. 10 is a perspective view of a stereophonic phonographic pickup constructed in accordance with features of this invention; and,

FIG. 11 is a bottom view of the sterophonic phonographic pickup of FIG. 10.

Referring now to FIG. 1, an electret transducer is shown to include an electret member 10 formed from a relatively thin elongated body of dielectric material which is sandwiched between electrode members 12 and 14. The dielectric body 10 exhibits a residual polarization across its thickness thereby providing an electrical field across the thickness of this member. Electrode members 12 and 14 are formed of relatively thin elongated bodies of conductive material such as strips of aluminum which extend substantially coextensively with the electret member 10. Displacement of the electret member 10 with respect to the electrode members upon mechanical excitation cause the generation of an electrical signal between the electrodes 12 and 14 (upon mechanical excitation) and this signal is made available for application in circuit arrangements by conductive leads 16 and 18 which are mounted in conductive contact with the electrodes 12 and 14 respectively by suitable means such as by soldering, by an adhesive, or by tape. An output signal is coupled by the leads 16 and 18 to output terminals 20 and 22 respec-

tively via a shielded cable **24.** Another electret member **15** may be positioned adjacent one of the electrode members **12** and **14** and this assembly of dielectric material and electrodes is rolled or formed convolutely into a scroll shaped configuration as illustrated in FIG. **2.** The outer overlapping layers are secured to a lower layer by an adhesive tape **26** which inhibits the assembly from unrolling.

An electrical signal is generated by the electret transducer of FIG. **2** upon mechanical excitation of this scroll shaped assembly. Excitation is provided by vibrating the scroll shaped assembly through a mechanical coupling with the transducer or alternatively by positioning the transducer in a medium which transmits pressure variation representative of information. Typical media can be the atmosphere or a liquid.

In a preferred embodiment, the electret member **10** is formed of FEP (fluorinated ethylpropylene polymer) Teflon of about 1 mil thickness which is sandwiched between aluminum electrodes **12** and **14** each having a thickness of about 3 mils. The electrodes comprise loose laying strips or they alternatively comprise electrode strips which adhere to the electret. In the latter case, it is noted that at least one electrode must be displaceable with respect to the member **10** in order to sense potential variations accompanying displacements of the electret member **10.** Adherence of electrodes to the member can be provided by an adhesive or alternatively, the electrode can be vapor deposited on the surfaces of the member **10.** The electret member is polarized in accordance with one process by heating the assembly with one of the electrodes in relatively close contact with the electret member for about 12 hours at 190°C. under a relatively constant potential of 10,000 volts d.c. applied between the electrodes. The electret can be polarized alternatively by charging the member **10** with an accelerated electron or ion beam.

The electret transducer assembly may be formed of materials having thicknesses which provide a relatively durable, self-supporting structure when formed into the scroll shaped configuration of FIG. **2.** Alternatively, the electret transducer may be convolutely formed on a support body as illustrated in FIGS. **3** through **6.** In FIG. **3,** those elements of the transducer which perform the same function as similar elements referred to with respect to FIG. **1** bear the same reference numerals. A support body for the transducer comprises a spool or bobbin **28** having an elongated cylindrically shaped segment **30** and integrally formed segment **32** and **34** of relatively larger diameter than the segment **30.** A slot **36** is formed in the thickness of a segment **30** along a portion of its length for facilitating the convolute formation of the transducer. In this case, the end portion of the transducer members are positioned in the slot **36** and the bobbin is then rolled until the electret is formed into a scroll shaped configuration between end members **32** and **34** on the segment **30.** A slot **38** is formed in the end segment **34** through which the conductors **16** and **18** are dressed.

In accordance with another feature of the invention, a housing is provided for the scroll shaped electret assembly. A housing can be conveniently tubular formed (as illustrated in FIGS. **4, 5** and **6**) for receiving the bobbin supported transducer assembly of FIG. **3.** While the end segments **32** and **38** of the bobbin **28** are employed as end walls of the housing, alternative arrangements may be provided wherein the housing includes integral closure end segments. The tubular housing thus provides electrical shielding, serves as a dust shield for the transducer and additionally functions for transmitting vibrations to the scroll shaped transducer assembly which is positioned within the housing. A transducer pad **42** formed of butyl rubber for example is secured to an outer surface of the housing and functions as a coupling device for coupling mechanical vibrations in the housing. Alternatively, the transducer of FIGS. **4–6** can be excited by positioning the transducer in a medium such as air or a liquid which can transmit information to the housing in the form of pressure variations.

Although the housing **40** may be formed of a variety of materials such as plastic, it is preferably that the housing be formed of a nonmagnetic metallic material such as aluminum, brass or the like. The use of such a material provides the additional feature of electrostatic shielding for the transducer. In this case, the housing **40** can be maintained at ground potential during use and an electrode strip which contacts an inner surface of the grounded housing functions as a grounded electrode. Alternatively, the electrode **14,** for example, can be electrically insulated from the inner surface of a metallic housing **40** by a strip of electrical insulating material **44** as illustrated in FIGS. **3, 5** and **6.** In accordance with another feature of this invention, this electrical insulating material **44** may itself comprise a relatively thin elongated body of polarized dielectric material. The body **44** may be similarly formed of a one mil thickness of FEP Teflon as described hereinbefore. The relative polarizations of the electret members **10** and **44** is illustrated in FIG. **7.** This arrangement provides for an effective series coupling of the electric fields provided by the electret members.

A phonographic pickup employing features of this invention is illustrated in FIGS. **8** and **9.** The phonographic pickup comprises an electret transducer **50** of the type described hereinbefore and which is supported from a lower surface **52** of a support plate **54.** The support plate **54** is dimensioned so as to be positioned and mounted in a conventional phonographic pickup arm. Isolation pads **56** and **58** are provided for supporting the transducer **50** from the plate **54.** The pads **56** and **58** comprise for example, foam rubber such as Koran rubber and are secured between the plate **54** and the transducer **50** by an adhesive such as Eastman Kodak 910 Adhesive. The pads **56** and **58** damp mechanical coupling between the transducer **50** and the plate **54.** A phonographic stylus **60** is provided and is supported between a yoke shaped stylus mounting post **62** and a coupling pad **64.** The yoke shaped mounting post **62** is secured to the plate **54** by suitable means such as by a friction fit or by an adhesive. Coupling pad **64** is formed of a soft rubber such as neoprene and is adapted for coupling vibration from the stylus **60** to the transducer **50.** A support member **66** extends longitudinally from the stylus mounting post **62** and terminates in a flexible coupling sleeve **68.** The flexible coupling sleeve **68** is formed of a relatively soft rubber which contains silicon oil for damping the coupling of vibrations between the stylus **60** and the mounting post **62.**

A stereophonic phonographic pickup constructed in accordance with features of this invention is illustrated in FIGS. **10** and **11.** The stereophonic pickup includes first electret transducer **70** and a second electret trans-

ducer 72 each of a type described hereinbefore with respect to FIGS. 1 through 7. The transducer 72 is secured to the mounting plate 74 by isolation pads 76 and 78. The transducer 70 is similarly supported from the plate 74 by isolation pads. A stylus mounting post 80 extends from the plate 74 and supports a stylus 82 through a flexible coupling 84, as described hereinbefore with respect to FIGS. 8 and 9. The stylus 82 is supported at another end by the transducers 70 and 72 through coupling pads 86 and 88 respectively. The stylus is secured to these pads by an adhesive so as to provide a yoke shaped support frame. Mechanical excitation of the stylus as is provided in tracking phonographic recording will provide motion of the transducers 70 and 72 corresponding to vertical and lateral displacement of the stylus. Since the stereophonic sounds are associated with these displacements, the transducer 70 will reproduce one channel while the transducer 72 will reproduce the other channel.

The following illustrative example describes a preferred embodiment of a stereophonic pickup constructed in accordance with features of the invention. An electret transducer is arranged in accordance with the construction of FIG. 3 wherein the electret member 10 comprises a strip of FEP Teflon having a thickness of about 1 mil, a width of about 15/16 inch, and a length of about 6 inches. The electret member 44 comprises a strip of FEP Teflon having a thickness of about 1 mil, a width of about 1 inch and a length of about 6 inches. The electrode 14 comprises a strip of aluminum having a thickness of about 1 mil, a width of about 1 inch, and a length of about 6 inches. The electrode 12 comprises a strip of aluminum having a thickness of about 1 mil, a width of about 7/8 inch, and a length of about 6 inches. The conductors 16 and 18 are secured to the electrodes 12 and 14 respectively by cellulose acetate adhesive tape. The transducer assembly is rolled on the bobbin which is formed of nylon and wherein the segment 30 has a diameter of about 1/8 inch and a length of about 1 inch and the segments 32 and 34 each have a diameter of about 5/16 inch. The assembled transducer is positioned in a tubular housing 40 which is formed of aluminum of about seven mil thickness and which has a length of about 1⅛ inches. Two such transducers 70 and 72 are provided and are mounted as shown in FIG. 10 on a support plate 74 which is formed of glass. The transducers are supported at positions along their length by foam rubber isolation pads. The stylus mounting post 80 is formed of wood and is secured to the glass plate 74 by an adhesive consisting of Eastman Kodak 910 Adhesive. The stylus 82 comprises a TETRAD 72D. The stylus is secured to each of the transducers by butyl rubber trsnsducer pads. The stylus is coupled by a rubber sleeve to a horizontal extension of the post and contains silicon oil within the sleeve for damping the mechanical coupling between the stylus mounting post and the stylus. The pickup was employed with a phonograph recording which provided a lateral velocity of about 5 centimeters per second and had recorded thereon a one kilocycle tone. A 0.3 millivolt peak to peak output signal is measured between the terminals of each of the transducers.

An improved form of electret transducer has thus been described which is relatively rugged and compact and which can be fabricated at relatively low cost. Improved monophonic and stereophonic phonographic pickups having electret transducers of this invention are also provided.

While there has been described and illustrated various embodiments of the invention, other modifications will occur to those skilled in the art without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. An electret transducer comprising:

an elongated body of electrical dielectric material, said dielectric material polarized for providing a residual electrostatic field;

first and second elongated electrode bodies of electrically conductive material positioned adjacent opposite surfaces of said dielectric body and extending substantially coextensively with said dielectric body thereby sandwiching said dielectric body between said electrodes;

said electrode bodies and dielectric body formed into a convolute shaped assembly;

a support form located within and supporting said convolute shaped assembly which is wound around said form;

electrical conductor means coupled to said electrodes for providing a transducer output signal between said conductor means upon excitation of said transducer; and

further including a second elongated body of dielectric material which is positioned adjacent one of said electrode bodies and is convolutely wound therewith.

* * * * *