Nov. 27, 1962 W. A. PAVLAK 3,066,200

SPEAKER DEVICE

Filed Aug. 11, 1958 2 Sheets-Sheet 1

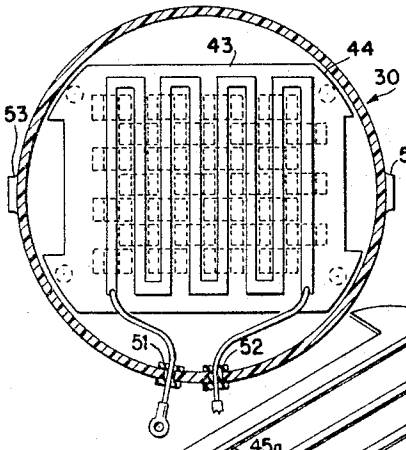


FIG. 3

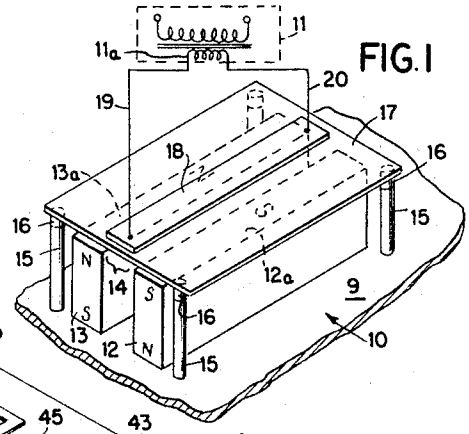


FIG. 1

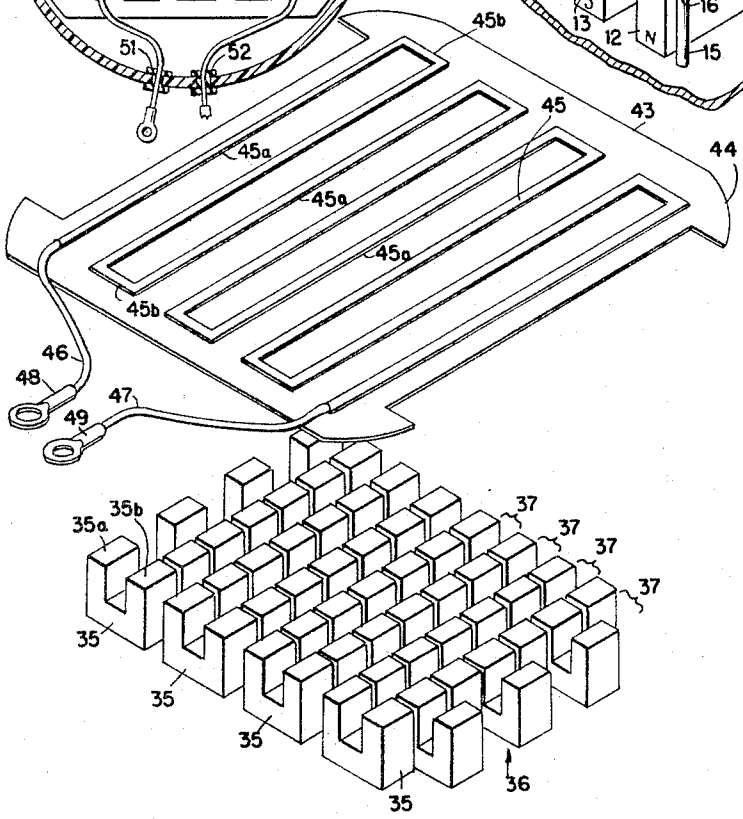
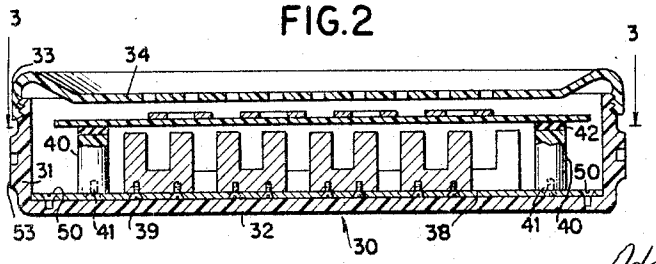


FIG. 4

FIG. 2



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FIG. 5

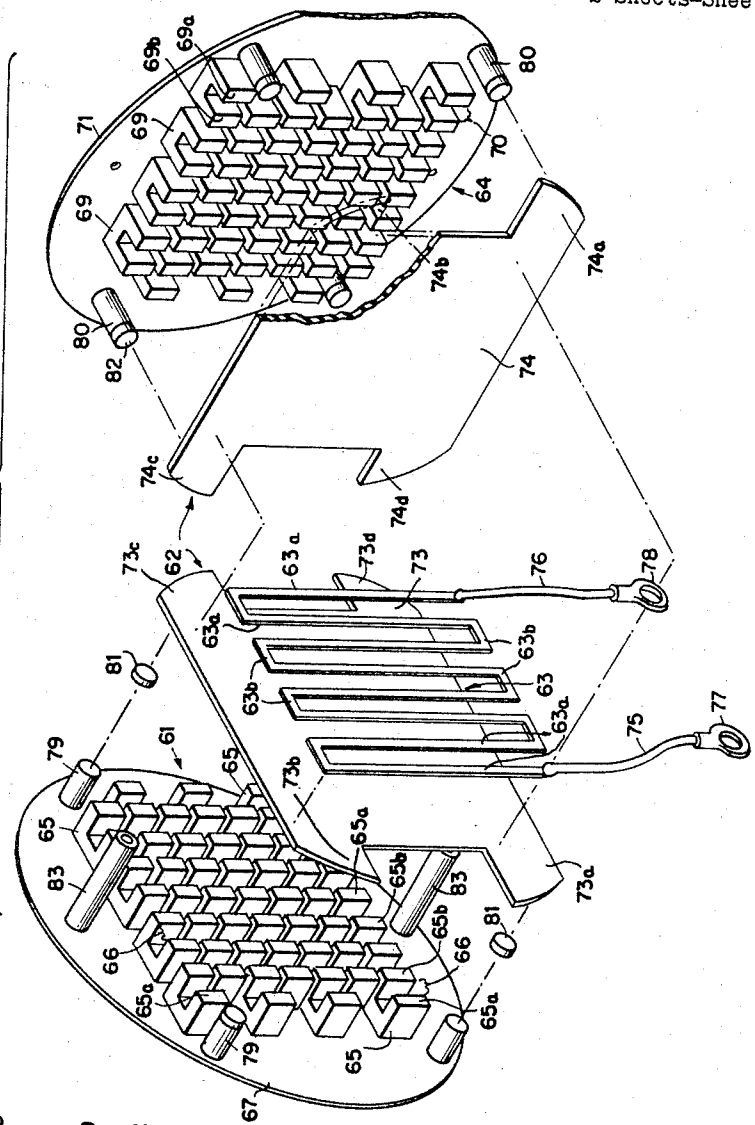


FIG. 7

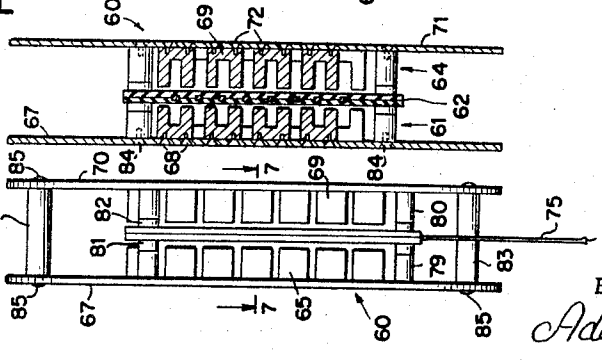


FIG. 6

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3,066,200
SPEAKER DEVICE

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8 Claims. (Cl. 179—115.5)

My invention relates to the transmission and reproduction of sound and in particular provides a transducer for converting sound into electrical signals or for converting audio frequency electrical signals into sound. The transducer of my invention is thus useful as a microphone, earphone or a loudspeaker.

In the reproduction of sound and particularly in reproducing music it is of course highly desirable to provide a speaker not only capable of reproducing the original sound without distortion but also having a frequency response extending throughout the audible range. Heretofore it has generally been necessary to provide a plurality of speaker devices for different portions of the audio frequency range in order that the entire audible range will be accurately reproduced. Such plural speaker systems nesessarily involve mechanical or electrical frequency cross-over devices for separating the original sound into the various frequency ranges to be reproduced by the individual speaker units. As a consequence, highly complicated and expensive speaker systems are required for obtaining so-called "high fidelity" sound reproduction. More particularly in the reproduction of sound by the so-called binaural system two separate speaker systems must be employed thus doubling the amount of equipment necessary for high fidelity reproduction. Many times, moreover, it is desirable to provide good quality sound reproduction under circumstances interfering with the activities of others. At present the employment of earphones to prevent such interference is unsuitable where high fidelity reproduction is required due to the high cost of providing the plural earphone system necessary to obtain full audio frequency range reproduction.

It is a principal object of my invention to provide a simple speaker device for reproducing electrical signals as sound having a wide frequency response range extending throughout the principal audible range. It is also an object of my invention to provide such a speaker device which can be constructed in a relatively small space such that it can be suitably employed as an earphone. It is still a further object of my invention to provide a speaker device which is simple in mechanical construction and which can be connected directly to the output of an audio amplifier without the employment of electrical or mechanical cross-over networks. It is yet another object of my invention to provide such a speaker device which is inexpensive to manufacture and which is extremely light in weight.

While the general object of my invention is to provide a speaker device for reproducing sound, the same device with minimum modification provides an excellent microphone for faithfully converting sound extending throughout the principal audible range into electrical signals which can be simply connected to the input of an audio amplifier, recording equipment or other conventional devices.

In keeping with these general purposes my invention thus provides a speaker device which can suitably be employed for high fidelity sound reproduction. In pairs, such speakers can be employed for binaural sound reproduction when connected to separate amplifiers. Simulated binaural effects can be developed employing a pair of such speaker devices as earphones where a capacitance is included in one of the earphones to permit control of the bass and treble response in such earphones. As will be evident later, the speaker device of my invention can

also be constructed to provide a limited frequency range accentuating the treble response or bass response as desired. Thus, simulated binaural effects can be obtained employing one earphone constructed to emphasize the bass frequency range of the music and one constructed to emphasize the treble range. It is also possible, employing the speaker device of my invention in multiples, to provide a thin loudspeaker which can be hung against a wall. A "picture frame" speaker, thus constructed using the device in multiples, can be provided having a thickness of one inch or less and which is capable of reproducing faithfully the original sound throughout the audible range.

These and other objects of my invention which will become more apparent hereinafter are essentially obtained by positioning a pair of magnets spaced from each other such that a pole face of one and a pole face of the second having opposite polarity lie in a common plane spaced slightly from each other to define an elongated narrow magnetic gap. A thin diaphragm of non-magnetic material is supported extended across and along the magnetic gap in a free floating position, and an elongated conductor is affixed to the diaphragm extending lengthwise of the gap between the two pole faces.

When the speaker is to be employed for sound reproduction the ends of the conductor are connected to a conventional low impedance output of an audio amplifier such that electrical output signals of the amplifier are passed through the elongated conductor to cause the conductor together with the diaphragm to which it is affixed to vibrate toward and away from the magnetic gap corresponding such electrical output signals. The movement of the diaphragm thus sets up sound waves reproducing the original sound used to generate the signals in the amplifier.

When the speaker device of my invention is to be employed for sound transmission, however, the ends of the conductor are connected instead to a conventional low impedance input of an audio amplifier. Thus, when the diaphragm is vibrated by sound waves which impinge against it, the movement of the elongated conductor in the magnetic gap generates electrical currents in the conductor which correspond to the impinging sound waves and are coupled to the input of the amplifier to drive the amplifier.

In a more specific aspect I employ a system of magnets arranged to provide a plurality of such magnetic gaps extending parallel to each other and arrange the conductor, as it leaves one gap, to turn on itself and enter the next adjacent gap, thus permitting the employment of a relatively square or round diaphragm of which almost every portion is actuated simultaneously by movement of the conductor under the influence of the application of electrical signals.

In another aspect, particularly where the speaker device of my invention is employed as a microphone, I have found it advantageous to provide a second pair of magnets similarly spaced from each other, such that a pole face of one and a pole face of a second having opposite polarity lie in a common plane spaced slightly from each other to define a second elongated narrow magnetic gap. The second pair of magnets is positioned confronting the first pair of magnets with pole faces of like polarity spaced closely together. Thus, the two elongated narrow magnetic gaps confront each other with their magnetic force lines lying in the same direction. The diaphragm is supported extended across the two gaps and lengthwise between the confronting pole faces of the two pairs of magnets with the elongated conductor extending lengthwise between the two confronting magnetic gaps. This arrangement is possible because, surprisingly, accurate reproduction can be obtained if the diaphragm is oriented such that the sound

waves which are to be converted to electrical signals are directed into the speaker device edgewise of the diaphragm.

For a more complete understanding of the practical application of the principles of my invention, reference is made to the appended drawings in which:

FIGURE 1 is a diagrammatic illustration of the underlying principle of operation employed in my speaker;

FIGURE 2 is a cross-section through a practical construction embodying the principles of my invention to provide an earphone type speaker;

FIGURE 3 is a section taken at line 3—3 in FIGURE 2;

FIGURE 4 is an exploded view of a portion of the device shown in FIGURES 2 and 3;

FIGURE 5 is an exploded view of another device constructed in accordance with the principles of my invention;

FIGURE 6 is an elevational view of the assembled construction of FIGURE 5; and

FIGURE 7 is a cross-section taken at line 7—7 in FIGURE 6.

Referring more particulary to FIGURE 1, the reference numeral **10** indicates the basic device of my invention which is schematically shown connected to the output transformer **11** of a typical conventional audio amplifier. Speaker device **10** basically includes a pair of bar magnets **12** and **13** constructed to any suitable magnetic substance having high coercive force and rententivity such as Alnico No. 5.

Magnets **12** and **13** are erected on a suitable flat surface **9** to which they are affixed to hold them parallel and spaced a short distance from each other with the south pole face **12***a* on the upper side of magnet **12** and with the north pole face **13***a* on the upper side of magnet **13**. Thus at their upper ends, magnets **12** and **13** define an elongated narrow magnetic gap **14**.

Four non-magnetic posts **15** affixed at their lower ends on surface **9** are erected with one post **15** adjacent each outer corner of the rectangular solid space occupied by magnets **12** and **13**. Posts **15** have approximately the same height as magnets **12** and **13** and at their upper ends carry short cushions **16** of sponge rubber or similar relatively elastic and freely compressed and stretched material. Cushions **16** are cemented at their lower ends to the upper ends of posts **15** and extend slightly above the pole faces **12***a* and **13***a*.

The thin diaphragm **17**, in the illustrated case of rectangular shape, is positioned horizontally above the upper ends **12***a* and **13***a* of magnets **12** and **13** and is cemented at its corners on the upper ends of cushions **16** which thus support diaphragm **17** spaced slightly above the upper ends **12***a* and **13***a* of magnets **12** and **13** with diaphragm **17** extended across and along magnetic gap **14**. Diaphragm **17** is constructed typically of polyvinyl chloride sheet material but can be made of almost any non-magnetic material such as wood, paper, cloth, glass or the like. The material of construction of diaphragm **17** can be either soft or hard, it can be relatively elastic or relatively inelastic, it can be freely flexible or it can be quite stiff. Depending upon the variations of these characteristics different frequency response patterns can be obtained. A treble response is accentuated by harder, more inelastic and stiffer materials, while bass response is accentuated by softer, relatively more elastic and flexible material.

A ribbon conductor **18** is cemented to the upper surface of diaphragm **17** and extends lengthwise over gap **14**. Preferably conductor **18** has the flat ribbon-shaped appearance shown in FIGURE 1 and is aligned along its edges with the adjacent edges of the upper surfaces **12***a* and **13***a* of magnets **12** and **13** between which magnetic gap **14** is defined. The employment of a flat ribbon type conductor is not essential, however, and wire conductors can also be employed, however with less efficiency. Conductor **18** in the illustrated case is a strip of aluminum foil cemented to diaphragm **17**. It, however, obviously can be applied to diaphragm **17** in the same manner as printed circuits are manufactured; it can be heat-sealed between a pair of thin sheets of material from which diaphragm **17** is constructed, and it can be applied in other obvious ways.

The ends of conductor **18** are connected to flexible electrical lead wires **19** and **20** which connect conductor **18** in series with the low impedance secondary winding **11***a* of output transformer **11**. The impedance of winding **11***a* is not particularly critical and typically will range up to several hundred ohms but typically will be on the order of 2 to 8 ohms.

In operation where transformer **11** is the output transformer of an amplifier connected to a source, such as a phonograph, providing electrical signals in the audio frequency range, the sound is reproduced by vertical vibration of diaphragm **17** as conductor **18**, by reason of the passage of electrical current through it, is caused to move vertically in magnetic gap **14**. It will be self-evident that the closer to gap **14** that conductor **18** is positioned, the lesser the distortion introduced will be. However, conductor **18** is limited in its position relative to gap **14** by the fact that diaphragm **17** must have room to vibrate freely. Alternatively, transformer **11** can be an input transformer of a conventional audo amplifier, in which case winding **11***a* will be the primary winding and typically will have a relatively low impedance. In the latter case, sound impinging against diaphragm **17** will cause vibration of conductor **18** vertically in magnetic gap **14**. This movement will generate electric currents in conductor **18** which, being coupled by leads **19** and **20** to primary winding **11***a* of transformer **11**, will drive the audio amplifier to which transformer **11** is connected. Thus sound striking diaphragm **17** will be reproduced as an electric signal which can be utilized to drive conventional audio equipment.

FIGURES 2, 3 and 4 illustrate a practical arrangement of a speaker constructed in accordance with my invention, having particular utility as an earphone. In FIGURES 2, 3 and 4 the earphone of my invention is designated basically by the reference numeral **30** and is suitably housed in a short cylindrical casing **31** having one end closed by an integral bottom **32** and externally threaded at the other end as indicated by the reference numeral **33**. A perforated cap **34** is threadedly engaged with casing **31** received on threads **33** to close the housing of earphone **30**. Casing **31** and cap, i.e., earpiece **34** are suitably constructed of hard plastic material such as a phenolic resin or other suitable non-magnetic material.

Casing **31** contains a modified version of speaker device **10** providing a preferred construction for obtaining maximum efficiency in sound reproduction while at the same time obtaining full frequency range response. To be more specific, casing **31** is provided with a system **36** of U-shaped, i.e. channel shaped, magnets **35** which, as seen more clearly in FIGURE 4, are disposed in staggered arrangement to define eight elongated narrow magnetic gaps **37** of the type denoted by reference numeral **14** in FIGURE 1.

The magnet system **36** is thus composed of twenty-eight identical channel-shaped magnets **35** arranged in seven parallel rows with four magnets in each row. In each row the four magnets **35** are disposed in a line presenting alternating north pole faces **35***a* and south pole faces **35***b*. The four magnets **35** in each row are spaced from each other a distance identical to the spacing of the opposite pole faces **35***a* and **35***b* of each individual magnet **35**. The seven rows of magnets, as indicated above, are parallel and each adjacent pair of rows are arranged with their respective magnets closely adjacent but staggered lengthwise such that in any given pair of adjacent rows of magnets the channel centers of the magnets **35** in one row register with the spaces between magnets in the other row. In each adjacent pair of rows, however, the pole faces of the magnets are aligned. Accordingly,

the magnets in each adjacent pair of rows are disposed in reversed orders of polarity. In any adjacent pair of rows of magnets, the pole face of a magnet in one row adjacent the pole face of another magnet in the second row are not only aligned but have identical polarity. Thus, the magnet system **36** includes parallel lines of pole faces **35***a* and **35***b* which define between them eight elongated parallel magnetic gaps **37** extending perpendicularly to the parallel rows of magnets **35**. Along one side of each gap **37**, magnets **35** all present their north pole faces **35***a*, and along the other side of each gap **37**, magnets **35** all present their south pole faces **35***b*.

The system **36** of magnets **35** is maintained in position on a brass plate **38** (see FIGURE 2) to which magnets **35** are affixed on their under sides by means of small machine screws **39**. Plate **38** also supports four diaphragm support posts **40** which on their under ends (in FIGURE 2) are similarly affixed to brass plate **38** by means of small machine screws **41**. Posts **40** are identical in height with magnets **35**, and on their upper ends are provided with short sponge rubber cushions **42**. Posts **40** are, moreover, located at the four corners of the space occupied by magnet system **36** and are constructed of non-magnetic material, such as polystyrene rod.

A diaphragm **43** of generally rectangular shape provided with corner ears **44** (see FIGURES 3 and 4) is positioned across magnet system **36** above pole faces **35***a* and **35***b* and gaps **37** with ears **44** resting on cushions **42** to which diaphragm **43** is cemented to retain it in position. Diaphragm **43** supports a flat metallic ribbon conductor **45** which is cemented on the upper surface of diaphragm **43** following a tortuous path including eight parallel straight portions **45***a* which are aligned over gaps **37** and which are inter-connected at alternate pairs of adjacent ends by connecting portions **45***b*. Thus the instantaneous electrical current flowing in a given direction through conductor **45** is flowing in alternating directions in adjacent straight portions **45***a*. The free ends of conductor **45** are electrcally and mechanically connected to flexible lead wires **46** and **47**, which terminate with conventional lugs **48** and **49**, respectively, for connections to the output of an audio amplifier.

The assembly of base plate **38**, magnet system **36**, diaphragm **43** and conductor **45** is positioned in the bottom **32** of casing **31** with base plate **38** resting against bottom **32** to which it is secured by means of screws **50**, thus positioning diaphragm **43** adjacent the threaded end **33** of casing **31** over which perforated cap **34** is positioned. Leads **46** and **47** are brought through suitable insulated bushings **51** and **52**, respectively, mounted in the side wall portion of casing **31**.

In operation, lugs **48** and **49** are connected to the low impedance output of an audio amplifier in a conventional manner and earphone **30** is mounted in a head set, for example, by providing center bored bosses **53** on the exterior of casing **31** for receiving the pivot pins of the head set.

In a construction typified by FIGURES 2, 3 and 4 employing twenty-eight channel shaped Alnico No. 5 magnets $\frac{7}{16}$ inch high, $\frac{7}{16}$ inch across the poles and $\frac{5}{16}$ inch lengthwise of the gap with gap **37** $\frac{5}{32}$ inch wide, in which the seven rows of magnets are spaced slightly to provide a gap **37** length of 2.3 inches, where diaphragm **43** was constructed of soft pliable polyvinyl chloride having a thickness of 0.0005 inch, in which conductor **45** is cut from equal thickness of aluminum foil exactly equal in width to the gap width and in which diaphragm **43** was positioned one-eighth inch above the upper faces **35***a* and **35***b* of magnets **35**, the earphone **30** driven by an 8 ohm tap on the output transformer of a conventional 10 watt amplifier gave uniform reproduction throughout a frequency range of 40 to 12,000 cycles per second, with some attenuation below and above that range.

It should be pointed out that it is highly essential that diaphragm **43** be floated. Damping is undesirable and accordingly, as illustrated, the diaphragm is mounted on sponge rubber cushions. Any other type of diaphragm mounting which would provide a minimum of damping effect could, of course, be substituted. Small strips of plastic or fabric could obviously be employed. The housing is unessential from an acoustical standpoint, but of course is desirable in order to present a neat and attractive device and also in order to prevent damage to the delicate diaphragm employed. The housing suitably is constructed of a non-magnetic material to simplify problems of insulation and disturbance with the electrical circuit. The conductor for the same reason should be constructed of non-magnetic conductor material such as aluminum or copper.

As indicated above, variation in the material of construction of the diaphragm can be employed to produce varied frequency responses. The soft, pliable polyvinyl chloride sheet described above gives an overall wide frequency response. Stiffer materials, having harder surfaces, such as cellulose acetate sheet, will tend to give a response peaked in the treble range, while softer materials, on the other hand, will tend to emphasize bass response.

Also as indicated above, the speaker device of my invention has practical utility as a microphone, as, for example, illustrated in FIGURES 5, 6 and 7. Referring to these figures, the reference numeral **60** designates a microphone which has been constructed in accordance with my invention, and which includes fundamentally a first magnet system **61**, a diaphragm **62** including an imbedded conductor **63**, and a second magnet system **64**.

Magnet system **61**, as is seen more clearly in FIGURE 5, is composed of twenty-eight channel-shaped magnets **65** disposed in seven parallel rows of four in a manner identical to the disposition of magnets **35** in magnet system **36** described with reference to FIGURES 2, 3 and 4, and thus defining eight parallel elongated narrow magnetic gaps **66**. Along one side of each gap **66** magnets **65** all present their north pole faces **65***a*, and along the other side of each gap **66** magnets **65** all present their south pole faces **65***b*. Magnet system **61** is secured to a circular brass disk **67** by means of small machine screws **68** in the same manner as magnets **35** are secured to brass base plate **68** of earphone **30**.

Magnet system **64** is composed of twenty-eight channel-shaped magnets **69** which are disposed in seven parallel rows of four in a manner exactly complementary to magnet system **61**, such that when the two magnet systems are presented in a position confronting each other, a magnet **65** confronts each magnet **69** with the north pole face **65***a* of each magnet **65** confronting the north pole face **69***a* and with the south pole face **65***b* of each magnet **65** confronting the south pole face **69***b* of a magnet **69**. Similarly, the eight parallel elongated narrow magnetic gaps **70** defined by magnets **69** thus can be presented confronting and aligned with the eight magnetic gaps **66** of magnet system **61** with the lines of force of magnetic gaps **70** running in the same alternate directions as the lines of force of magnetic gaps **66**. Magnet system **64** is similarly affixed to a circular brass plate **71** by means of small machine screws **72**.

Diaphragm **62** includes two sheets **73** and **74** of soft, pliable film material such as saran, cut to identical shape and size. Each sheet **73**, **74** is thus generally rectangular, having dimensions slightly greater than the width and breadth of complementary magnet systems **61**, **64**. At each corner sheets **73**, **74** are provided with small extensions or tabs denoted by the reference numerals **73***a*, **73***b*, **73***c*, **73***d* in the case of sheet **73**, by the reference numerals **74***a*, **74***b*, **74***c*, **74***d* in the case of sheet **74**.

Conductor **63** consists of a flat ribbon of aluminum foil including eight parallel straight lengths **63***a* interconnected in series by seven connecting strips **63***b* which connect alternate pairs of ends of straight portions

63*a*. The free ends of conductor **63** are electrically and mechanically connected to flexible lead wires **75, 76** which terminate with conventional lugs **77, 78**, respectively, for connection to the input terminals of an audio amplifier.

Conductor **63** is assembled with diaphragm **62** by first cementing conductor **63** to the face of one sheet **73, 74** with straight portions **63***a* parallel to one pair of opposite sides of the sheet and with connecting portions **63***b* closely adjacent the other pair of opposite sides of the sheet. The second sheet **73, 74** is then cemented to the first sheet on which conductor **63** has been previously cemented, so that conductor **63** is sandwiched between sheets **73, 74** and so that sheet **73, 74** are perfectly aligned with tabs **73***a*, **73***b*, **73***c*, **73***d* being aligned with tabs **74***a*, **74***b*, **74***c*, **74***d*. Each straight portion **63***a* of conductor **63** is slightly longer than magnetic gaps **66, 70** and is slightly narrower than such gaps. Straight portions **63***a* are, moreover, spaced exactly as magnetic gaps **66, 70** are spaced in their respective magnet system **61, 64**.

Microphone **60** is assembled by means of four posts **79**, four posts **80**, four sponge rubber cushions **81**, four sponge rubber cushions **82** and two spacer tubes **83**. Posts **79** are constructed of non-magnetic material such as polystyrene, brass or the like, and have a length exactly equal to the height of each magnet **65** (measured from the pole faces to the opposite face of the channel portion connecting the poles). Posts **79** are secured to brass plate **67** by means of small machine screws **84** just beyond the four corners of magnet system **61** such that the ends of posts **79** remote from brass plate **67** lie in approximately the plate of pole faces **65***a*, **65***b*. Cushions **81** are then cemented on such ends of posts **79**, and diaphragm **62**, previously assembled with conductor **63** as described above, is then positioned with tabs **73***a*, **73***b*, **73***c*, **73***d* resting against cushions **81** to which the tabs are thereupon cemented. In such operation of assembling diaphragm **62**, care should be taken that each straight portion **63***a* of conductor **63** is centered lengthwise over a magnetic gap **66** with connecting portions **63***b* lying just beyond the ends of gaps **66**.

Posts **80** are similarly of non-magnetic material and approximately equal magnets **69** in height. Posts **80** are secured to base plate **71** similarly adjacent the four corners of magnet system **64** and carry cushions **82** cemented to their outer ends which lie approximately in the plane of pole faces **69***a*, **69***b*. Base plate **71**, with magnet system **64**, posts **80** and cushions **82**, is then positioned on the side of diaphragm **62** opposite magnet system **61** with cushions **82** being cemented to diaphragm **62** at tabs **74***a*, **74***b*, **74***c*, **74***d*, and with magnet system **64** exactly aligned with magnet system **61** such that pole faces **69***a* confront pole faces **65***a*, pole faces **69***b* confront pole faces **65***b* and magnet gaps **70** confront magnetic gaps **66**. Thus, diaphragm **62** is positioned floating on cushions **81** and **82** in the narrow space between the confronting magnetic systems **61, 64**.

Since cushions **81** and **82** do not hold the assembly rigid, spacer tubes **83** are provided to secure base plate **67** to base plate **71**. Thus, spacer tubes **83** are preferably constructed of non-magnetic material, such as brass, and have a length equal to the combined lengths of a post **79**, a cushion **81**, a cushion **82** and a post **80**, plus the thickness of diaphragm **62**. Spacer tubes **83** are positioned between plates **67** and **71** on opposite sides of magnet systems **61, 64** slightly beyond the edges of diaphragm **62**, and are held in place by means of rivets **85**.

The assembled microphone **60** desirably can be encased with copper or other non-magnetic wire mesh and is provided with suitable external mountings as desired. It will be apparent that sound passing between side plates **67, 71** of microphone **60** will cause vibration of diaphragm **62** and consequently cause conductor **63** to move laterally through the fields of force set up by confronting magnetic gaps **66, 70**. Thus, electric currents will be generated in straight portions **63***a* of conductor **63** which will have the same instantaneous polarity in conductor **63** because of the alternate directions of flux in adjacent gaps **66** and their confronting adjacent gaps **70**, and because of the alternate end connections **63***b*. Accordingly, currents generated in conductor **63** by movement of diaphragm **62** will produce an electric signal at lugs **77, 78**, which, when connected to a suitable low level, low impedance input of an audio amplifier, can be utilized to drive the amplifier.

In a microphone having the same general magnet dimensions described above with respect to earphone **30**, and also having the same diaphragm-to-magnet spacing, as in the case of earphone **30**, a pre-amplifier of the type employed with reluctance-type phonograph cartridges will generally be required, however preferably without equalization normal required in such pre-amplifiers to compensate for bass attentuation and treble emphasis usually employed in phonograph recording.

I claim:

1. A transducer which includes a first magnetized body defining a first pole face, a second magnetized body defining a second pole face of polarity opposite that of said first pole face, said first and second magnetized bodies being disposed with said first and second pole faces spaced apart and extending adjacent each other in a common plane defining an elongated, narrow magnetic gap with said first and second magnetized bodies disposed to one side of said common plane, a thin diaphragm of non-magnetic material, means supporting said diaphragm in floating position extended across and along said gap on the other side of said common plane and spaced a short distance from said pole faces, and an elongated conductor positioned entirely on said other side of said common plane extended lengthwise of said gap affixed between said pole faces to said diaphragm.

2. A transducer according to claim 1 in which said magnetized bodies constitute opposite end portions of a channel-shaped magnet.

3. A transducer according to claim 1 further includes a third magnetized body defining a third pole face of the same polarity as said first pole face, and a fourth magnetized body defining a fourth pole face of the same polarity as said second pole face, said third and fourth magnetized bodies being disposed spaced a short distance from said diaphragm on the side of said diaphragm opposite said first and second magnetized bodies with said third pole face confronting said first pole face, with said fourth pole face confronting said second pole face, and with said third and fourth pole faces spaced apart and extending adjacent each other in a second common plane defining a second elongated, narrow magnetic gap confronting said first named gap, said conductor being positioned entirely on the side of said second common plane remote from said third and fourth magnetized bodies.

4. A transducer which includes a plurality of magnetized bodies, each defining a pole face, said plurality of magnetized bodies being disposed with their respective pole faces parallel, spaced apart and extending adjacent each other in a common plane with said magnetized bodies disposed to one side of said common plane, said pole faces being of alternating polarity thereby defining a plurality of parallel, elongated, narrow magnetic gaps, a thin diaphragm of non-magnetic material, means supporting said diaphragm in floating position extending across and along said gaps on the other side of said common plane and spaced a short distance from said pole faces, and an elongated conductor positioned entirely on said other side of said common plane affixed to said diaphragm including a plurality of straight portions each extending lengthwise of one said magnetic gap between the adjacent pole faces defining said one gap and a plurality of end connections serially connecting alternate pairs of adjacent ends of said straight portions whereby said straight portions are interconnected in series.

5. A transducer according to claim 4 in which said magnetized bodies constitute opposite end portions of a plurality of channel-shaped magnets.

6. A transducer according to claim 4 in which said conductor is ribbon shaped.

7. A transducer which includes a first magnetized body defining a first pole face, a second magnetized body defining a second pole face of polarity opposite that of said first pole face, a third magnetized body defining a third pole face of the same polarity as said first pole face, and a fourth magnetized body defining a fourth pole face of the same polarity as said second pole face, said first and second magnetized bodies being disposed with said first and second pole faces spaced apart and extending adjacent each other in a common plane defining an elongated, narrow magnetic gap with said first and second magnetized bodies disposed to one side of said common plane, a thin diaphragm of non-magnetic material, means supporting said diaphragm in floating position extended across and along said gap on the other side of said common plane and spaced a short distance from said pole faces, said third and fourth magnetized bodies being disposed spaced a short distance from said diaphragm on the side of said diaphragm opposite said first and second magnetized bodies with said third pole face confronting said first pole face, with said fourth pole face confronting said second pole face, and with said third and fourth pole faces spaced apart and extending adjacent each other in a second common plane defining a second elongated, narrow magnetic gap confronting said first named gap, and an elongated flat conductor positioned entirely between said first named and said second common planes extending lengthwise of said gaps affixed between said pole faces to said diaphragm.

8. A transducer which includes a plurality of magnetized bodies each being respectively disposed with a pole face parallel with a pole face of each of said magnetiezd bodies in a common plane, said magnetized bodies being disposed on one side of said common plane, the pole faces in said common plane being disposed adjacent and spaced apart in pairs of opposite polarity, said pairs

of pole faces each defining therebetween one of a plurality of elongated, narrow, magnetic gaps, a thin diaphragm of non-magnetic material, means supporting said diaphragm in suspended position extending across and along said gaps on the other side of said common plane and spaced a short distance from said pole faces, a plurality of flat conductors contacting with and affixed to said diaphragm and lying in a plane parallel thereto also positioned entirely on the other side of said common plane, each conductor extending lengthwise of one of said magnetic gaps between one of said pairs of adjacent pole faces, a first terminal and a second terminal, each of said conductors having a first end and a second end, said conductors being interconnected between said first terminal and said second terminal, said first end of each of said conductors being connected in closer electrical relationship to said first terminal, and said second end of each of said conductors being connected in closer electrical relationship to said second terminal, the orientation of each of said conductors and the pair of magnetized bodies associated therewith in respect of said first end and said second end of said conductor and in respect of the polarity of each of said pair of magnetized bodies associated therewith, being identical as viewed from a point on a normal to said common plane.

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Disclaimer

3,066,200.—*Walter A. Pavlak*, Newark, N.J. SPEAKER DEVICE. Patent dated Nov. 27, 1962. Disclaimer filed Aug. 23, 1966, by the assignee, *William Ward Jackson*; the inventor assenting.

Hereby enters this disclaimer to claims 3 and 7 of said patent.

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