Oct. 25, 1938. J. KALSEY 2,134,047

METHOD AND APPARATUS FOR SOUND TRANSMISSION AND REPRODUCTION

Filed Sept. 29, 1936 2 Sheets-Sheet 1

Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5. Fig. 6.

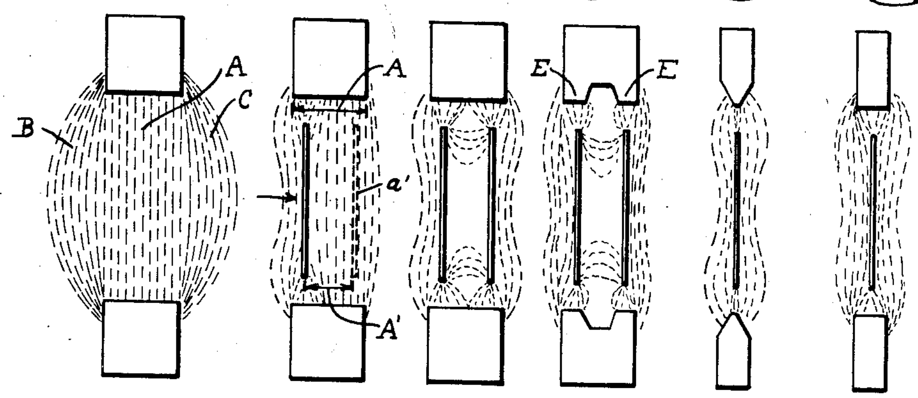


Fig. 7.

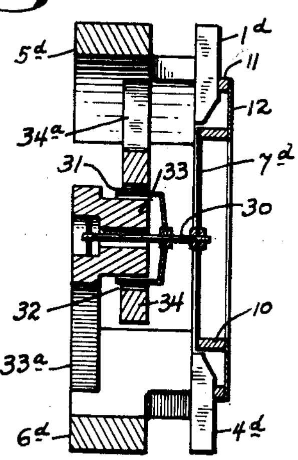


Fig. 8.

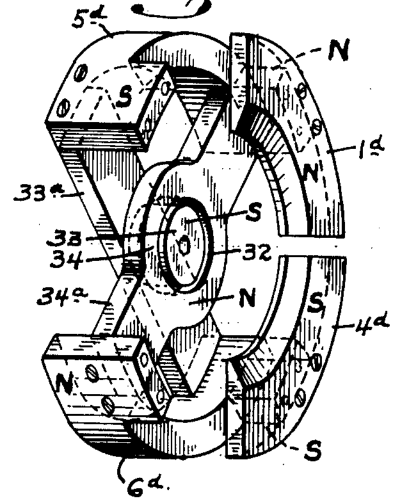
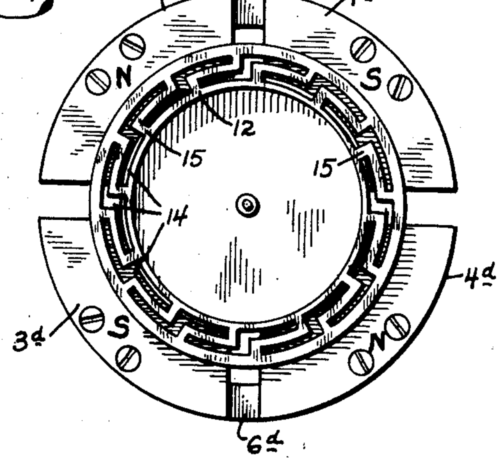


Fig. 9.



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Filed Sept. 29, 1936 2 Sheets-Sheet 2

Fig. 10.

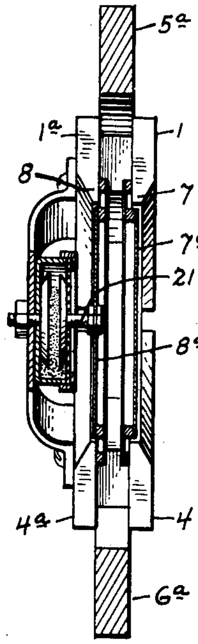


Fig. 12.

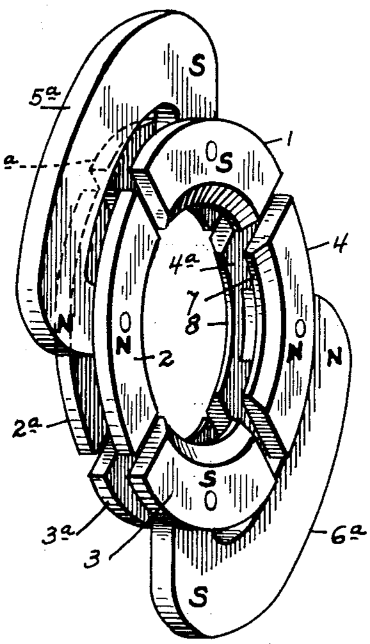


Fig. 11.

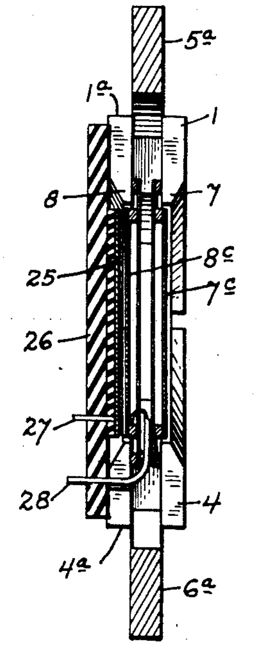


Fig. 13.

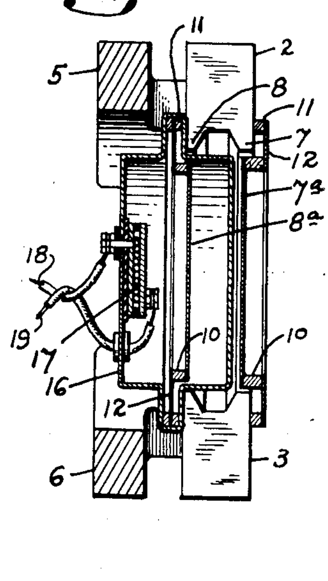
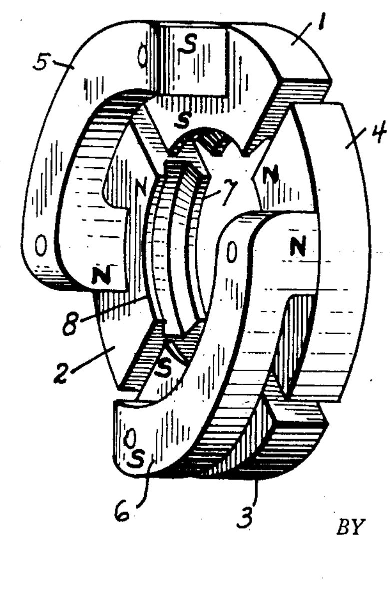


Fig. 14.



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METHOD AND APPARATUS FOR SOUND TRANSMISSION AND REPRODUCTION

John Kalsey, North Palo Alto, Calif.

Application September 29, 1936, Serial No. 103,106

15 Claims. (Cl. 179—180)

This invention relates to an improved method and apparatus for converting acoustical energy into fluctuating impulses in an electric circuit and, conversely, to convert fluctuating electric impulses into acoustic energy; apparatus of this character being known as transmitters or microphones and also as telephone receivers and loud speakers.

As far as present knowledge extends, the only practical way to change acoustical energy into fluctuations in an electric circuit by mechanical means is to subject a diaphragm or other object to the vibrations of sound waves, said diaphragm being capable of vibrating more or less in unison with the vibrations of the sounding body. This diaphragm, by various means, may change the resistance in an electric circuit, or generate electrical impulses, or do both.

The transformation of these electrical impulses into sound waves is brought about by the magnetic flux variations produced by these impulses, said flux variations producing sound vibrations in suitable responsive bodies.

From a physical standpoint, sound waves in air are very intricate to and fro motions of the gas molecules of which the air is composed, it might be assumed for the present purpose that the vibrations of the sounding body transmit these vibrations to layers of air and each air layer thus set into vibration transfers its energy to adjacent layers. The actual distance traveled by these individual layers is very minute.

In order to reproduce sound with absolute fidelity, the vibrating body emitting the reproduced sound must be able to copy all the motions of the transmitting body or diaphragm and this diaphragm must be capable of responding to all of the pressure characteristics imposed upon it by the original sound waves. Thus the motion or the ratio of the motion of this diaphragm must conform to the motion of the sound waves impinging upon it.

But the inertia of a conventionally suspended diaphragm does not re-act upon the substance of which this diaphragm is composed in the same way as the inertia of the gaseous bodies of which sound waves are composed act upon themselves and hence a conventional diaphragm can not truly conform to the motions of the sound waves.

It is a known fact that all bodies set in motion will tend to vibrate according to their physical characteristics commonly called natural frequency. Thus a diaphragm, unrestrained from vibrating with a natural frequency will be unable to synchronize its motions with the motions of the sound waves, hence causing distortion throughout the process of reproduction.

To minimize the effects of inertia and natural periods of inflection in practically all cases the diaphragm has been solidly clamped along its periphery and in some instances has been tightly stretched or damped by various means.

This procedure, though it reduces uncontrolled vibration, makes the diaphragm less responsive to the complex sound vibrations acting upon it and further prevents equal response to the variations in frequencies, with the result that some of the sounds are liable to become over or under emphasized and when such sounds are amplified will tend to greatly distort the final reproduction.

Another factor, one perhaps not very well known, in the case of a flexible diaphragm, where movement is prevented at its periphery, any motion of that portion within the periphery will produce molecular friction within the substance of the diaphragm. This friction produces secondary sound waves, totally unlike the original sound waves, and these secondary sound waves again set up unrelated motions in the diaphragm which produce distortion.

Another factor, (perhaps of less importance but nevertheless contributing to final distortion) is that a conventional diaphragm has varying degrees of flexibility at various points within its periphery and sound waves originating from various sources are apt to impinge upon various points of the diaphragm, which due to this varying degree of flexibility, can not respond with equal intensity.

In microphones where the diaphragm applies direct pressure upon electro-resistive or generative material, for the purpose of producing a fluctuating E. M. F., the phenomena is still further complicated, as the ability of the diaphragm to respond to sound waves is also governed by the ability of the resistive or generative material to assist or impede the free motion of the diaphragm.

Most of the remarks about microphones may be applied to telephone receivers and speakers.

Summarizing the objections to a conventional diaphragm, such as used in telephone apparatus, they are as follows:

1. Inertia action of the diaphragm is present;
2. Natural frequency vibrations in the diaphragm itself are also present;
3. The diaphragm bends or flexes, which is ob-

jectionable as it produces molecular friction within the material of the diaphragm and this friction produces sound entirely foreign to the sound waves actuating the diaphragm; also, due to the varying degrees of flexibility between the center and periphery of the diaphragm it can not respond with equal intensity throughout its surface;

4. A conventional diaphragm must be clamped, stretched or damped to partially overcome some of the above mentioned defects;

5. A conventional diaphragm is not sufficiently sensitive and responsive to complex sound vibrations to permit fidelity of sound transmission or like production;

6. The conventional diaphragm is also hampered in its action, particularly in transmitters, by the pressure required to be exerted by it on the electro-resistive or generative material co-operating therewith.

The object of the present invention is generally to improve and simplify the construction and operation of telephone apparatus of the character described; to provide a method and apparatus whereby the heretofore listed defects are substantially overcome; and, further, and more specifically stated, the object of the invention is to mount a diaphragm in a magnetic field of sufficient strength to oppose inertia forces and natural periods of vibrations in the diaphragm and, in addition thereto, to provide a floating mounting which will maintain the diaphragm parallel to the lines of magnetic flux in the magnetic field and secure the diaphragm against movement longitudinally of said lines but permit movement transverse thereof; and, further, to provide means whereby two spaced diaphragms may be mounted in common or separated magnetic fields and whereby movement may be magnetically transmitted from one diaphragm to the other in any ratio desired.

The invention is shown by way of illustration in the accompanying drawings, in which—

Fig. 1 is a diagrammatic view showing two magnetic poles of opposite polarity, said poles having parallel faces of equal area;

Fig. 2 is a similar view showing how the lines of flux are deflected when a thin iron disc is inserted between the poles;

Fig. 3 is a similar view showing the insertion of two thin iron discs between the poles, said view further showing how the lines of flux are deflected;

Fig. 4 is a diagrammatic view of two poles of opposite polarity in which the lines of flux are concentrated by projections E—E formed on the opposing faces of the poles and also by the insertion of thin iron discs between the projections;

Fig. 5 is a diagrammatic view showing how it is possible to further concentrate the magnetic field;

Fig. 6 is a diagrammatic view showing a magnetic field of less concentration than that disclosed in Fig. 5;

Fig. 7 is a vertical, central section showing one method of suspending a thin iron disc diaphragm in a magnetic field, said view further showing the diaphragm connected with a voice coil;

Fig. 8 is a perspective view showing the arrangement of permanent magnets and two of the poles energized thereby;

Fig. 9 is a front view of Fig. 7;

Fig. 10 is a central, vertical section showing the arrangement of two diaphragms in a magnetic field and one of said diaphragms being connected with a dust box;

Fig. 11 is a central, vertical section showing a condenser type of telephone apparatus;

Fig. 12 is a perspective view showing the arrangement of the permanent magnets and the poles energized thereby, said arrangement being employed in the structure shown in Figs. 10 and 11;

Fig. 13 is a central, vertical section showing another type of telephone apparatus; and

Fig. 14 is a perspective showing the arrangement of the permanent magnets and the pole-piece energized thereby as employed in the structure of Fig. 13.

Extensive experiments with magnetic circuits have convinced me that a field of force existing between two opposing magnetic poles of equal strength, having equal areas parallel to each other, consists of parallel lines of energy, provided the field is not influenced by external forces. I have also determined that the lines wholly within the area bounded by the magnet's poles are neutral with respect to each other but capable of exerting a force upon the magnetic lines located outside this field.

Fig. 1 shows two such poles where the lines A are parallel and the lines B and C are curved.

It can be shown that the lines in area B and C are weaker than the lines in area A, and further that the forces exerted by the lines B and C are proportionate to the degree of their curvature and to the forces developed in area A.

Referring to Fig. 2. If a magnetic object, such as a thin iron disc is placed within the field A, the lines within same will be distorted; a number of these lines will function through the substance of which the disc is composed and the number of lines thus affected will depend upon the number of sympathetic atomic structures within the disc as compared to the number of like structures within the magnet itself.

Provided these atomic structures within the disc are so proportioned as to be negligibly affected by the forces of gravitation as compared to the forces exerted by the magnet, practically all of the inertia forces inherent in these structures are subordinated to the forces within said field.

Inasmuch as magnetic forces are not affected by inertia, such a structure, if placed within the concentrated field designated as A', will be devoid of motion in the absence of external motivating forces. When motivating pressures are applied, the resulting motion will only continue as long as this pressure maintains.

Again referring to Fig. 2, it can be experimentally demonstrated that if the aforesaid structure is placed within the field A' as shown, and a force is applied in the direction depicted by the arrow, and such force is just sufficient to cause motion of the structure, this same force, if continued, will move the structure to the position at *a'*, and when this force is removed, the structure will remain at *a'*.

To continue moving the structure beyond the point *a'* would require a steadily increasing force and after the removal of this force, either gradually or suddenly, the structure will return to the position *a'*.

I have also found that if two discs are placed in the magnetic field, as shown in Fig. 3, that they will separate due to repulsive action between them; that is, when a magnetic field of this character is established and two spaced magnetic discs or diaphragms are placed therein the lines of flux tend to divide and concentrate about the individual discs. At the same time due to the flux action of the magnetic field, a secondary magnetic flux is induced in the respective diaphragms causing magnetic poles to form in the diaphragms themselves. The opposing poles formed will be alike and a repulsive action is thereby set up between the diaphragms tending to separate them. This is of considerable importance as it is due to this repulsive or separating action that motion transmitted to one diaphragm by the impact of sound waves will transmit motion to a second diaphragm, as will hereinafter be more fully described.

I have also discovered that division of the magnetic field is further promoted by providing the magnets with annular projections, such as shown at E—E in Fig. 4, and that these fields may be narrowed, as shown in Fig. 5, or widened, as shown in Fig. 6. This is also of considerable importance as it provides means for restricting motion of the diaphragms in a direction transverse, or at right angles, to the lines of flux. When the field is narrow, as shown in Fig. 5, it restricts the movement of the diaphragm and, conversely, if the field is widened, as shown in Fig. 6, the diaphragm may be given a greater freedom or latitude of transverse movement. In addition to the above features, it may be stated that when the magnetic field is comparatively narrow, as shown in Figs. 5 and 6, and particularly Fig. 5, the diaphragm will tend to assume a position centrally of the field and if pressure is exerted to move it out of the field in a direction transverse to the lines of flux it will return to the center of the field the moment the activating force is removed.

Again, as previously pointed out, where the field is wide, as for instance in Fig. 1, the lines of flux are parallel and are substantially neutral with relation to each other and in that case the diaphragm may be positioned within the field at substantially any point desired and will remain in the position in which it is placed but when the diaphragm is moved toward the outer edges of the field it is effected by the lines indicated at B and C and movement out of the field is then resisted.

By proper application of the fundamentals pointed out in connection with the Figs. 1 to 6, it is possible to oppose inertia forces in a diaphragm and the natural periods of vibration in the diaphragm. It is, furthermore, possible to employ a comparatively rigid diaphragm which does not depend upon flexing action, but instead will move as a whole when impacted by sound waves. Again, it is possible to restrict movement of the diaphragm, or to permit greater latitude of movement than has heretofore been possible, this phenomena being important where two diaphragms are employed as motion can be magnetically transmitted from one diaphragm to another at substantially any ratio desired.

Fig. 13 illustrates a practical application of the phenomena or principles just explained. The structure disclosed is a telephone transmitter. It consists of a plurality of segmental shaped magnets, indicated at 1, 2, 3 and 4, which are separated with relation to each other but positioned to form a ring. The magnetic sections are energized from a pair of permanent magnets 5 and 6, or the like, so disposed that each pole of each magnet contacts one segment of the ring and they are further disposed to cause the north and south poles formed in the segments to oppose each other, as shown in Fig. 8, so that the four segments of the ring become four magnetic poles separated by four wide and equally spaced air gaps.

The magnetic field formed in the circular space between the segments is divided into two concentrated fields by the formation of annular projections 7 and 8 on the inner faces of the segments and these fields are further concentrated by placing circular disc-like magnetic diaphragms, such as shown at 7^a and 8^a, in the respective fields. The diaphragms tend to assume a position centrally of each field, that is, midway of the width of the respective fields but are, nevertheless, freely movable laterally thereof, or within the width of the field, the range of movement being determined by increasing or decreasing the width of the fields. A circular disc placed in a field of this character, which is surrounded by magnetic poles and with a small air gap between its peripheral edge and the poles, would naturally tend to move radially towards one pole or another, unless held absolutely centrally positioned between the same, means must accordingly be provided to prevent radial movement and said means must at the same time permit lateral movement of the diaphragm with relation to the respective magnetic fields. This is accomplished by securing a ring 10 to the peripheral edge of each diaphragm and similar rings 11 to the opposite faces of the segments and then securing to said rings retainer rings 12, composed of thin fabric paper or similar material. The retainer ring is best shown in Fig. 9. It is cut out, as indicated at 14, to form a series of arms 15. These arms secure the diaphragm against radial movement with relation to the magnetic poles but at the same time permit free movement laterally thereof. The diaphragm 8^a is preferably enclosed by a housing 16 constructed of non-magnetic material and this housing is evacuated to permit free movement of the diaphragm. Within this housing is mounted a variable resistance element, generally indicated at 17, of the type disclosed in my copending application entitled "Variable resistance" filed January 4, 1936, Serial Number 57,541. This resistance is magnetically actuated. It consists of a pair of electrodes spaced apart with a para-magnetic material between them. The electrodes are connected with a source of current supply through wires 18 and 19. When the para-magnetic material is subjected to the flux action of a magnetic field it forms a conductor between the electrodes and permits a current flow and as the flux strength increases, the conductivity increases and consequently the current flow increases; vice versa, as the flux strength decreases conductivity decreases and current flow decreases, hence by moving the diaphragm 8^a toward or away from the variable resistance element the current flow therethrough will fluctuate and movements of the diaphragm caused by sound wave impact will, accordingly, be converted into electrical impulses and these may, in turn, be converted into sound.

In actual operation the sound waves will impact the diaphragm indicated at 7^a and it will, accordingly, move back and forth in its magnetic field in substantial unison with the sound waves. This movement will, in turn, be magnetically transmitted to the second diaphragm 8^a due to the repulsive action maintained between the same and also to the flux action of the main field, and the movement of the diaphragm 8^a will, in turn, actuate the variable resistance and thereby electric fluctuations will be produced. As previously stated, the range of movement of the diaphragm 8^a with relation to the diaphragm 7^a may be substantially the same or it may be decreased. For instance, by widening the magnetic field in which the diaphragm 7^a is placed substantially any movement desired may be maintained. On the other hand, by narrowing the magnetic field in which the diaphragm 8^a is disposed the movement thereof will be decreased but it will be relative to the movement of the diaphragm 7^a.

A ratio of movement between the two diaphragms is not absolutely essential with the type of structure shown in Fig. 4 but it is essential when used in connection with a conventional variable resistance or commonly called "dust box" such as illustrated in Fig. 10. Where a variable resistance of that character is employed the movement of the diaphragm will be hampered as the diaphragm is directly connected with the dust box through means of a piston, such as shown at 21. That is, when movement is applied to the diaphragm it is transmitted to the dust box through means of the piston. This applies a direct pressure upon the electro-resistive or generative material contained therein and as the material compresses it obviously affords a resistance to the movement of the diaphragm, hence in installations of this character the employment of two diaphragms is advisable as the outer diaphragm may in that instance be freely movable while the inner diaphragm, which is connected with the dust box, may have a comparatively small movement, the movement being, however, in direct ratio to the movement of the outer diaphragm. Where the relative movement is reduced, as in this instance, the resistive action of the dust box does not hamper the movement of the diaphragm to a detrimental extent and fidelity of transmission results.

In the structure disclosed in Fig. 10 annular projections, such as shown at 7 and 8 (see Fig. 13), are not required as the pole segments are made in pairs, as shown at $1—1^a$, $2—2^a$, $3—3^a$ and $4—4^a$, with the legs of the permanent magnets 5^a and 6^a disposed between them as clearly shown in Fig. 12. In Fig. 13 the pole pieces 1, 2, 3 and 4 are single, hence the necessity for the annular projections 7 and 8 where a division of the magnetic field is desired. The permanent magnets employed in connection with the structure shown in Fig. 13 are secured to the segments, as shown in Fig. 14.

In Fig. 11 a condenser type of microphone is illustrated. The permanent magnets and pole structure used in conjunction therewith are identical to that shown in Fig. 12. In this instance a non-magnetic plate 25 is provided which is stationary and secured to a back panel 26 and insulated therefrom. The diaphragm 8^c is positioned close thereto and is parallel and forms a movable plate or diaphragm of the condenser while the plate 25 forms the stationary plate. The plates are connected with a suitable source of current supply with wires 27 and 28. The impact of the sound waves causes vibrating movement of the diaphragm 7^c. This, in turn, transmits movement to the diaphragm 8^c and as it moves with relation to the stationary plate 25, the current flow through the wires 27 and 28 will fluctuate, etc.

In Figs. 7 and 8 a dynamic type of loud speaker is shown. In this instance a single diaphragm 7^a is employed which is maintained in the magnetic field formed between the pole pieces 1^d, 2^d, 3^d and 4^d, said pole pieces being connected to the respective legs of the permanent magnets 5^d and 6^d, as shown in Fig. 8. The diaphragm is connected with a piston 30. Otherwise, the method of suspending the diaphragm is essentially the same as in the other structures. The piston carries a small coil 31 (commonly called the voice coil) and this is, in turn, maintained in a magnetic circular air gap 32 formed between the south and north pole pieces 33 and 34 which are energized by the arms 33^a and 34^a through means of the permanent magnets.

When a fluctuating current is introduced in the voice coil the coil will generate a flux of its own, which at times enhances the field strength and at other times will weaken same. This will cause the coil to vibrate in unison with the electric fluctuations producing identical vibrations in the diaphragm, which thus produce sound waves. This type of apparatus will work equally well as a microphone or a receiver.

From the foregoing it will be noted that in some forms of the apparatus two diaphragms are desirable while in others one diaphragm will suffice and that some of the structures may be operated either as microphones or receivers. Be that as it may, numerous other forms of telephone apparatus employing the principles here disclosed could be depicted but for the purpose of illustration and description it is thought that those already submitted should be sufficient.

In all of the structures disclosed the diaphragms, whether there be one or two in number, are maintained in a magnetic field and this field is of sufficient strength to oppose inertia forces and natural periods of vibrations in the diaphragms. The magnetic fields in which the diaphragms are maintained also function to return the diaphragms to a neutral or inactive position when the force or forces applied thereto are reduced or removed. The magnetic fields, furthermore, provide a means whereby the movement of the diaphragms laterally of the fields may be increased or decreased and, furthermore, permits transmission of movement from one diaphragm to another at substantially any ratio desired. The result is a telephone apparatus in which distortion of sound waves, whether from one source or another, is substantially eliminated and in which the diaphragm is so sensitive to sound waves that it is able to follow the intricate to and fro motions of the waves thus insuring fidelity and true sound or tone-like production and transmission.

While certain features of the present invention have been more or less specifically described and illustrated, I wish it understood that various changes may be resorted to within the scope of the appended claims. Similarly, that the materials and finish of the several parts employed may be such as the manufacturer may decide, or varying conditions or uses may demand.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:—

1. A method of magnetically counteracting inertia forces and natural frequency vibrations in sound translating diaphragms, which consists in bodily suspending the diaphragm in a magnetic field and parallel to the magnetic flux in the field, and securing the diaphragm against bodily movement longitudinally of the flux but permitting movement transversely thereof.

2. A method of magnetically counteracting in-

ertia forces and natural frequency vibrations in sound translating diaphragms, which consists in bodily suspending the diaphragm in a magnetic field and parallel to the magnetic flux in the field, securing the diaphragm against bodily movement longitudinally of the flux but permitting movement transverse thereof, and controlling transverse movement of the diaphragm.

3. In a sound translating apparatus having a pair of spaced diaphragms, a method of transmitting motion from one diaphragm to the other, which consists in placing the diaphragms in a magnetic field in which the flux is parallel to the faces of the diaphragms and maintaining the direction of the flux so that a magnetic repulsion force is set up between the diaphragms whereby movement imparted to one diaphragm is magnetically transmitted to the other.

4. In a sound translating apparatus having a pair of spaced diaphragms, a method of transmitting motion from one diaphragm to the other, which consists in placing the diaphragms in a magnetic field in which the flux is parallel to the faces of the diaphragms and maintaining the direction of the flux so that a magnetic repulsion force is set up between the diaphragms whereby movement imparted to one diaphragm is magnetically transmitted to the other and concentrating the flux to varying degrees with relation to the faces of the respective diaphragms to regulate the movement of one diaphragm with relation to the other.

5. A method of controlling movement imparted to sound translating diaphragms which consists in bodily suspending the diaphragm in a magnetic field between a plurality of surrounding magnets and parallel to the magnetic flux in the field, and limiting the field transversely to control bodily movement of the diaphragm transverse to the field.

6. A method of controlling movement imparted to sound translating diaphragms which consists in bodily suspending the diaphragm in a magnetic field between a plurality of surrounding magnets and parallel to the magnetic flux in the field, and limiting the field with relation to the faces of the diaphragm to control bodily movement of the diaphragm transverse to the field.

7. A method of controlling movement imparted to sound translating diaphragms which consists in bodily suspending the diaphragm in a magnetic field between a plurality of surrounding magnets and parallel to the magnetic flux in the field, and limiting the field in the direction of movement of the diaphragm to control bodily movement of the diaphragm.

8. A method of magnetically counteracting inertia forces and natural frequency vibrations in sound translating diaphragms which consists in surrounding the diaphragm with a plurality of magnetic poles to establish a magnetic field parallel to the faces of the diaphragm, positioning the poles with alike poles opposing each other so as to maintain a uniform magnetic field about the diaphragm, and securing the diaphragm against movement longitudinally of the flux but permitting bodily movement transverse thereof.

9. A method of magnetically counteracting inertia forces and natural frequency vibrations in sound translating diaphragms which consists in surrounding the diaphragm with a plurality of magnetic poles to establish a magnetic field parallel to the faces of the diaphragm, positioning the poles with alike poles opposing each other so as to maintain a uniform magnetic field about the diaphragm securing the diaphragm against movement longitudinally of the flux but permitting bodily movement transverse thereof, and limiting the width of the field to control movement imparted to the diaphragm.

10. A method of mounting a sound translating diaphragm which consists in placing a plurality of magnetic poles in circular formation, with alike poles opposing each other to establish a uniform magnetic field between the poles, placing a magnetic circular diaphragm centrally in the field formed between the poles with an air gap between the peripheral edge of the diaphragm and the poles and securing the diaphragm against radial movement, said securing means permitting bodily movement of the diaphragm at right angles to the field.

11. In a sound translating apparatus of the character described a flat circular magnetic diaphragm, a plurality of segment-shaped magnetic poles arranged in circular formation around the diaphragm and spaced therefrom to form a circular air gap and to form a magnetic field in which the flux is parallel to the opposite faces of the diaphragm, and means securing the diaphragm against radial movement between the magnets, said means permitting bodily movement of the diaphragm in a direction transverse to the magnets.

12. In a sound translating apparatus of the character described a flat circular magnetic diaphragm, a plurality of segment-shaped magnetic poles arranged in circular formation around the diaphragm and spaced therefrom to form a circular air gap and to form a magnetic field in which the flux is parallel to the opposite faces of the diaphragm, and a flexible retaining ring attached to the peripheral edge of the diaphragm and securing it against radial movement with relation to the magnetic poles but permitting free bodily movement of the diaphragm transverse of the magnetic field.

13. In a sound translating apparatus of the character described a pair of spaced flat circular magnetic diaphragms, a plurality of magnets surrounding the diaphragms, said magnets terminating in poles with alike poles diametrically opposite each other to form a magnetic field between the poles in which the flux is parallel to the faces of the diaphragms and to establish a secondary flux in the diaphragms which form alike opposing poles on the diaphragms and thereby produces a repulsion action between the diaphragms, whereby when movement is imparted to one diaphragm said movement will be imparted to the other diaphragm.

14. In a sound translating apparatus of the character described a pair of spaced flat circular magnetic diaphragms, a plurality of magnets surrounding the diaphragms, said magnets terminating in poles with alike poles diametrically opposite each other to form a magnetic field between the poles in which the flux is parallel to the faces of the diaphragms and to establish a secondary flux in the diaphragms which form alike opposing poles on the diaphragms and thereby produce a repulsion action between the diaphrams, whereby when movement is imparted to one diaphragm said movement will be imparted to the other diaphragm, and means securing the diaphragms against radial movement in the magnetic field but permitting movement of the diaphragms transverse thereof.

15. In a sound translating apparatus of the character described a pair of spaced flat circular magnetic diaphragms, a plurality of magnets surrounding the diaphragms, said magnets terminating in poles with alike poles diametrically opposite each other to form a magnetic field between the poles in which the flux is parallel to the faces of the diaphragms and to establish a secondary flux in the diaphragms which form alike opposing poles on the diaphragms and thereby produce a repulsion action between the diaphragms, whereby when movement is imparted to one diaphragm, said movement will be imparted to the other diaphragm, means securing the diaphragms against radial movement in the magnetic field but permitting movement of the diaphragms transverse thereof, and means for concentrating the magnetic field to varying degrees with relation to the faces of the respective diaphragms to control movement of the diaphragms transverse of the magnetic fields.

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