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TELEPHONE RECEIVER

Original Filed Aug. 2, 1922

Fig. 1

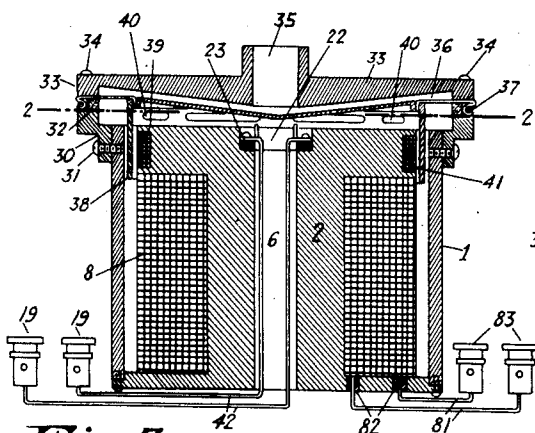


Fig. 2

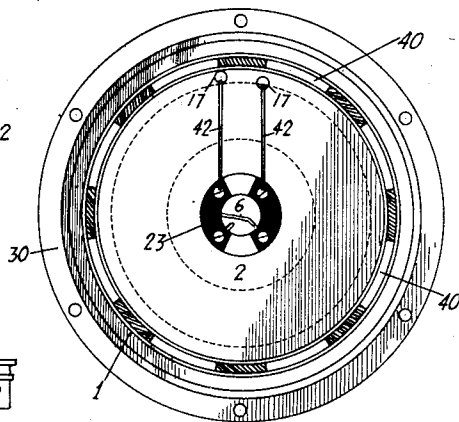
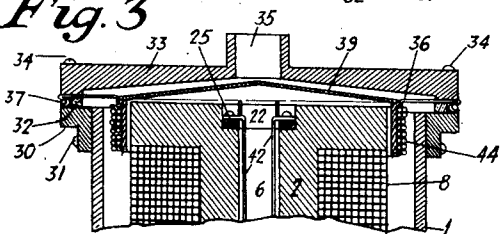


Fig. 3



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TELEPHONE RECEIVER

Continuation of application Serial No. 579,191, filed August 2, 1922. This application filed October 16,
1926, Serial No. 142,123. Renewed March 21, 1930.

This application being a continuation of application, Serial No. 579,191, for telephone receivers, filed August 2, 1922, by Richard D. Fay and applicant.

I have invented a new and useful device for transforming electrical waves into air waves whereby the air waves more accurately conform with the electrical waves than has heretofore been the case with telephone receivers.

In practically all telephone receivers designed and used up to the present time the air waves are produced by a diaphragm acted upon by an electro-magnet and this diaphragm, usually in the form of a disc, is clamped rigidly around its periphery. A plate or diaphragm supported at its edge or edges has a natural free period of its own within the audible or voice frequency range with the result that, when it is acted upon by a current of a frequency the same, or approximately the same, as the natural free periodicity of the diaphragm the tones of that frequency are amplified by resonance to such an extent as to make the waves produced in the air out of all proportion to the electrical waves exciting the diaphragm. Again when a telephone receiver having a diaphragm held rigidly around its edge or edges is acted upon with considerable energy there is a tendency for the diaphragm to vibrate in zones, thereby producing vibrations in the air different in frequency from the frequencies of the electric current passing through the electro-magnet of the receiver. It is for these reasons that the sounds produced by the telephone receivers, heretofore commonly used, are not a faithful reproduction of the telephone currents and this is particularly true when the strength of the telephone current is large.

In my invention I have eliminated a diaphragm with clamped edges and have substituted a practically rigid piston or diaphragm unit which moves to and fro under the influence of currents flowing in an electrodynamic driving means. In accordance with the invention, the diaphragm is mounted to move as a whole, is light enough to be moved in response to telephone currents with the re-

quired degree of amplitude to be useful in speech reproduction and is suspended by means exerting only a small restoring force.

In accordance with a further feature of the invention, the diaphragm is actuated by a cylindrical driving coil arranged transversely to the plane of its base and is suspended by a membranous medium extending outwardly therefrom substantially at right angles to the direction of vibration.

In the drawing, Fig. 1 is a vertical section showing an embodiment of the invention in an electrodynamic loud speaker unit.

Fig. 2 is a view in horizontal section taken on the line 2-2 of Fig. 1 and

Fig. 3 is a view in vertical section of a modification of the construction shown in Fig. 1.

As shown in the drawing, the diaphragm is of conical form being convex (Fig. 1) or concave (Fig. 3), and is suspended by flexible means forming its sole support.

The magnetic circuit is made up of a tubular magnet 1 with a core piece 2 carrying the field and armature windings 8 and 41 respectively.

The core piece 2 contains a central depression 22, making room for insulated terminal blocks, 23, to which are attached wires 42 coming from the armature winding 41 after passing through insulating bushings 17. From the terminal blocks 23 the wires 42 pass down through a central bore 6 in the core piece 2 to binding posts 19.

The terminals 81 of the field winding 8 pass through insulating bushings 82 and thence to binding posts 83.

The upper part of the iron tubular portion of the magnet supports a brass ring 30 held rigidly by screws 31. On the ring 30 rests a ring 32 and above this ring 32 is a cap 33. Screws 34 clamp all three securely together. The cap 33 has an opening 35 in which may be inserted a horn.

The ring 32 has an exterior groove and supports an annular sheet of cloth 36 which may be bound tightly to the ring 32 by winding a wire 37 into the exterior groove. The cloth 36 is attached at its inner edge to the diaphragm unit which in this case may com-

prise an aluminum tube or hollow cylinder 38, and an aluminum diaphragm 39, the three being clamped together by having the cloth 36 turned over the edge of the cylinder 38 and the diaphragm 39 pressed so as to squeeze the cloth between it and the tube. This makes a cheap and convenient method of clamping.

The aluminum cylinder has several openings 40 made through its walls, at the upper part, near the clamped portion so that air may circulate freely through the openings and prevent an air pocket under the diaphragm. The diaphragm 39 is shaped like a cone and is made of a thin light material such as aluminum. The diaphragm is shown with its concave side upwards in Fig. 1 with the cap 33 having a cone-shaped surface of nearly the same angle, or as shown in Fig. 3, the diaphragm may be cone-shaped with the convex surface up, in which case the under surface of the cap is shaped to correspond.

Making the diaphragm cone-shaped instead of flat produces a rigid body so that all the area enclosed by the aluminum cylinder 38 will vibrate as a unit with nearly piston action instead of having the maximum amplitude of vibration at the center as is usually the case.

The cloth 36 serves as a light, airtight, flexible mounting for the vibrating system, producing practically no restoring force to the vibrating system, so that the vibrations produced are due entirely to the alternating currents which pass through the armature winding 41. As a result of these qualities when an alternating current of constant strength is applied and the frequency gradually varied over a wide range, say from 20 cycles to 10,000 cycles, the pitch of the musical note produced is gradually varied with the frequency, there being no points of pronounced increase in volume of tone.

It has been found by actual test that in a telephone receiver having a diaphragm unit constructed and mounted as herein described, the suspending means for the unit exerts so small a restoring force as compared to the mass of the unit that the natural fundamental rate of vibration of the vibrating system as a whole is below the more important, audible frequencies involved in the reproduction of speech or music and that the mass of the unit is sufficiently small to enable it to be moved in response to telephone currents with the amplitude required to cause this device to be useful in speech reproduction. A telephone receiver containing a diaphragm unit having a natural fundamental rate of vibration below the more important audible frequencies is of special value in loud speakers; in fact it enables loud speaker reproduction markedly superior to that of loud speakers of other types.

It is desirable to produce by the armature coil 41 as great a current in the hollow cyl-

inder as possible, but the cylinder is short so that it is desirable to suspend it at one end only, and since the cylinder must be kept centered so as not to strike the sides of the passage in which it moves and the width of that passage must be kept small so as to keep a high magnetic density between the two, the length of the cylinder should be small as compared to its diameter. A convenient ratio is to have its length about one-seventh of the diameter.

This type of receiver is very conveniently used in the plate circuit of a thermionic valve in which case the external impedance of the plate circuit may be considerable as the internal impedance is large. Many turns of fine wire may, therefore, be wound in the armature coil, and no transformer is needed in the plate circuit as direct current passing through the armature coil produces no permanent force upon the diaphragm.

Having fully described the invention, what is claimed is:

1. An apparatus for sound reproduction comprising a diaphragm of light weight but sufficiently rigid to render it capable of vibrating substantially as a whole, suspending means for said diaphragm consisting of a membranous medium of sufficiently flexible material to permit movement of the diaphragm as a whole without appreciable change in shape, said suspending means also being of such a nature that it produces no objectionable natural frequency of vibration of the diaphragm, and driving means for said diaphragm comprising a coil to which actuating currents may be supplied, said driving means being so arranged as to exert no stress upon the diaphragm in the absence of current in said coil.

2. An apparatus for sound reproduction, comprising a diaphragm unit consisting of a substantially cylindrical driving portion and a sound wave producing portion connected to the driving portion for movement as a whole therewith, and an annular member connected to a circumference on said sound wave producing portion for suspending the diaphragm unit, said sound wave producing portion being sufficiently rigid as to be capable of moving substantially as a whole and said annular member furnishing so little restoring force that it produces no objectionable natural frequency of vibration of the diaphragm.

3. A loud speaker device comprising a diaphragm unit consisting of a relatively light and rigid conical portion and a cylindrical driving portion connected thereto, and means for suspending said unit to permit movement as a whole, said means comprising a membraneous medium of more flexible material than that of the diaphragm unit connected to the edge of the conical portion and extending there from in a plane approximate-

ly perpendicular to the line of motion of said conical portion.

4. An apparatus for sound reproduction comprising a diaphragm unit consisting of a relatively light and rigid conical portion and a cylindrical driving portion connected therewith, and means for suspending said unit to permit movement as a whole, said means comprising an annular membrane of more flexible material than the diaphragm unit connected to a circumference of said conical portion and extending outwardly therefrom in a direction approximately perpendicular to the axis of said cylindrical driving portion.

5. A loud speaker device comprising a diaphragm unit consisting of a cylindrical driving portion and a relatively light and rigid conical portion, means for vibrating the unit, and means for suspending the unit to permit movement as a whole in a direction substantially along the axis of said cylindrical driving portion, said suspending means comprising a membranous medium extending outwardly from the unit substantially at right angles to the line of vibration of the unit and constructed to exert so little restoring force as compared to the mass of the diaphragm unit that the natural period of vibration of the unit and suspending means will be outside of the normal audible frequency range.

6. An apparatus for sound reproduction comprising a diaphragm unit including a driving portion and a relatively light and rigid conical portion, means for vibrating the unit and means for suspending the unit to permit movement as a whole, said suspending means consisting of an annular flexible membrane connected to the peripheral edge of said conical portion in a manner to exert so little restoring force as compared to the mass of the diaphragm unit that the natural fundamental rate of vibration of the unit and suspending means will not be included in the more important voice frequencies.

7. An apparatus for sound reproduction comprising a diaphragm unit of such form as to be relatively light and rigid, means for vibrating the unit, means for suspending the unit to permit movement as a whole, said suspending means being constructed to exert only a small restoring force as compared with the mass of the unit, and means for preventing air cushioning from giving to the diaphragm a higher natural fundamental frequency than that established by the mass of the diaphragm unit and the restoring force of the suspending means.

8. An apparatus for sound reproduction comprising a diaphragm unit including a relatively light and rigid conical portion and a cylindrical driving portion joined along an edge therewith, means for vibrating the unit and means for suspending the unit to permit

movement as a whole, said diaphragm unit being mounted free from any mechanically-imposed restraint except that exerted by the suspending means and said suspending means consisting solely of a membranous medium of more flexible material than the diaphragm arranged substantially at right angles to the line of vibration of the unit.

9. A loud speaker device comprising a diaphragm unit including a diaphragm portion and a driving coil secured thereto, the diaphragm unit including the driving coil being relatively light and rigid, a supporting member surrounding said diaphragm portion and spaced therefrom, and a strip of membranous material joining said diaphragm portion with said supporting member for suspending said unit to permit movement as a whole, said membranous material exerting a restoring force which is small as compared to the mass of the diaphragm unit, the ratio of restoring force to the mass of the diaphragm unit being such that the natural period of vibration of the unit will not lie within the more important voice frequencies, and means adapted to act in conjunction with said coil to vibrate the unit.

10. A loud speaker device comprising a diaphragm unit including a conical diaphragm portion and a driving coil secured thereto, the diaphragm unit including the driving coil being relatively light and rigid, and means connected to a circumference on said conical diaphragm portion for suspending said unit to permit movement as a whole, said means comprising an air impervious membranous medium exerting a restoring force which is small as compared to the mass of the diaphragm unit, the ratio of restoring force to the mass of the diaphragm unit being such that the natural period of vibration of the unit will not be within the limits of the more important voice frequencies so that the response within these limits will not contain any resonant peaks.

11. An apparatus for sound reproduction, comprising a diaphragm unit consisting of a conical diaphragm portion, a cylindrical member secured to an edge of said diaphragm and extending therefrom substantially at right angles to the plane of the base of the diaphragm, a coil wound around the periphery of the cylindrical member, means co-operating with the coil to transmit driving forces uniformly to the diaphragm, a supporting member surrounding said diaphragm unit and spaced a substantial distance therefrom, and an annular sheet of membranous material connected between the peripheral edge of said conical diaphragm portion and said supporting member for suspending said diaphragm unit for movement as a whole, said sheet of membranous material extending from said diaphragm unit in a plane sub-

stantially perpendicular to said cylindrical member.

12. A loud speaker device comprising a diaphragm unit consisting of a conical diaphragm, a cylindrical member extending therefrom substantially at right angles to the plane of the base of the diaphragm and a coil wound around the periphery of the cylindrical member, means for suspending the diaphragm unit to permit movement as a whole, and means co-operating with the coil to transmit driving forces uniformly to the diaphragm, said diaphragm unit being perforated to prevent air cushioning from giving a higher natural frequency than that established by the mass of the diaphragm unit and the restoring force of said suspending means.

13. In apparatus for sound reproduction, a magnet formed to provide an annular air gap between its poles, a diaphragm unit adapted to move as a whole, said unit having a driving portion fitting into the air gap and a sound wave producing portion extending transversely of the driving portion, a supporting member, and an annular rim of flexible membrane connected between the periphery of said sound wave producing portion and said supporting member for suspending the diaphragm unit, said flexible membrane having such small restoring force as to produce no objectionable natural frequency of vibration of the diaphragm.

14. A loud speaker device comprising a magnet having a pair of concentric pole pieces with an annular air gap between them, a diaphragm unit consisting of a conical diaphragm, a cylindrical member extending therefrom substantially at right angles to the plane of the base of the diaphragm and into said air gap and a driving coil wound upon said cylindrical member, and means for suspending the diaphragm unit to permit movement as a whole, said diaphragm unit being freely mounted except for said suspending means, said suspending means comprising a membranous medium of more flexible material than the diaphragm, arranged substantially at right angles to the line of vibration of the diaphragm unit.

15. In apparatus for sound reproduction, a magnet comprising a pair of concentric pole pieces with an annular air gap between them, a diaphragm unit consisting of a conical diaphragm, a cylindrical member extending therefrom substantially at right angles to the plane of the base of the diaphragm and into said air gap and a driving coil wound upon said cylindrical member, and means for suspending the diaphragm unit to permit movement as a whole, said suspending means comprising a membranous medium arranged substantially at right angles to the line of vibration of the diaphragm unit, said cylindrical member being perforated to prevent

air cushioning from giving to the diaphragm unit a higher natural fundamental frequency of vibration than that established by the mass of the unit and the restoring force of the suspending means.

16. A loud speaker device comprising a magnet having a pair of concentric pole pieces with an annular air gap between them, a diaphragm unit consisting of a conical diaphragm portion, a cylindrical member extending therefrom substantially at right angles to the plane of the base of the conical diaphragm portion and into said air gap, a driving coil wound upon said cylindrical member, and a rim of membranous material clamped between said conical diaphragm portion and said cylindrical member for suspending the diaphragm unit to permit movement as a whole, said membranous material exerting so little restoring force as compared to the mass of the diaphragm unit that the diaphragm unit does not have a natural period of vibration within the limits of the more important audible frequencies.

17. In a sound reproducing device, the combination with a diaphragm, of means secured to said diaphragm for vibrating the same, a support, and flexible membranous means fastened to the peripheral edge of said diaphragm and connected to said support for mounting the same in said support.

18. A sound reproducing device having, in combination, a relatively inflexible formed diaphragm of sufficient area to reproduce self-sustaining sound waves in free air, a relatively inflexible member secured about the periphery thereof, a support for said diaphragm and flexible means secured to said diaphragm for mounting the same in said support, and means for vibrating said diaphragm.

19. In a sound reproducing device, the combination with a diaphragm of sufficient area to reproduce self-sustaining sound waves in free air and means for vibrating said diaphragm, of a support, a flexible ring of material fastened to said diaphragm about the periphery thereof and to said support and a reinforcing member encircling the periphery of said diaphragm and connected to said flexible ring of material.

20. In a sound reproducing device the combination with a diaphragm of sufficient area to reproduce self-sustaining sound waves in free air and means for vibrating said diaphragm, stiffening means for reinforcing the edge of said diaphragm, of a support for said diaphragm and a flexible ring of material for mounting said diaphragm in said support so that the whole diaphragm is free to move as a unit under the impulses of the vibrations communicated thereto.

21. In a sound reproducing device, the combination with a diaphragm of conical shape of sufficient area to reproduce self-

sustaining sound waves in free air, of means for vibrating said diaphragm, means secured about the periphery of said cone so as to reinforce the same, a rim member and flexible means extending between said rim member and said last mentioned means for maintaining said diaphragm in position for actuation by said second mentioned means.

22. In a sound reproducing device, the combination with a diaphragm of conical shape of sufficient area to reproduce self-sustaining sound waves in free air and means for vibrating said diaphragm, of a support, flexible means secured to said diaphragm and constituting the mounting therefor in said support, and means secured about the periphery of said cone so as to reinforce the same, said flexible means being interposed between the cone and the reinforcing means.

23. In a sound reproducing device the combination with a diaphragm, of a driving coil secured to said diaphragm for vibrating the same, a support, a rim of membranous material more flexible than the diaphragm material fastened to the peripheral edge of said diaphragm and connected to said support for mounting the diaphragm in said support, said rim of membranous material having a very small restoring force.

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