

Feb. 28, 1928.

1,660,864

F. CONRAD

TELEPHONE DEVICE

Filed Jan. 5, 1923

Fig. 1.

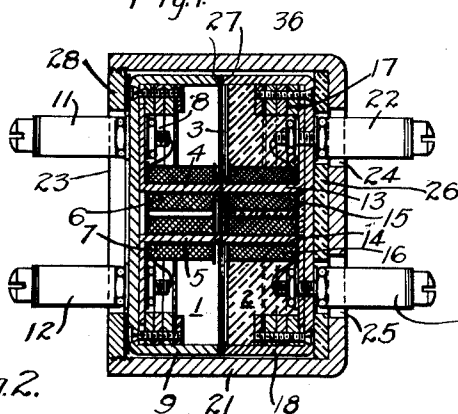


Fig. 2.

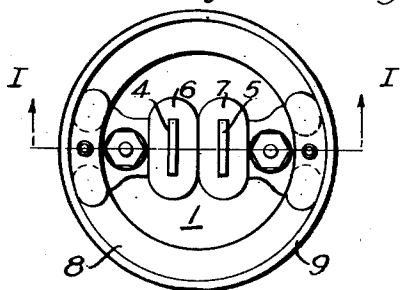


Fig. 3.

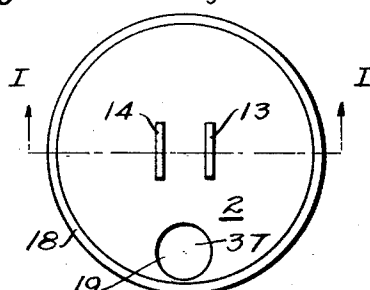


Fig. 4.

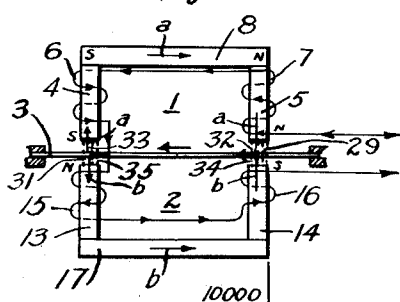


Fig. 5.

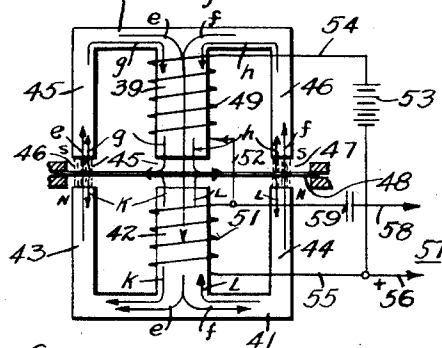
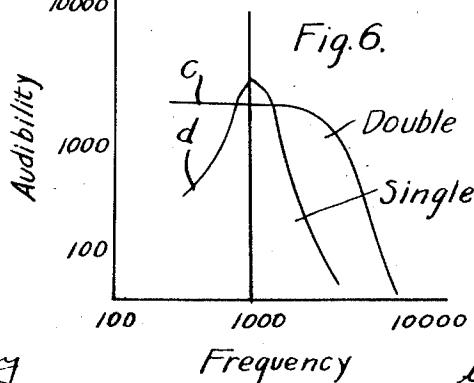


Fig. 6.



WITNESSES:

A. L. Jeffery
H. L. Godfrey

INVENTOR

Frank Conrad

BY

Wesley E. Carr
ATTORNEY

Patented Feb. 28, 1928.

1,660,864

UNITED STATES PATENT OFFICE.

FRANK CONRAD, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

TELEPHONE DEVICE.

Application filed January 5, 1923. Serial No. 610,775.

My invention relates to telephone apparatus having particular relation to sound-wave translating devices.

The principal object of my invention is to provide apparatus of the class described, wherein substantially the same intensity of response is obtained for all signal currents within the audible range, and wherein an extremely high degree of sensitivity is obtained in the translation of the signal currents into sound waves, and vice versa.

I have found that, in the ordinary telephone construction, the intensity of the permanent magnetic flux is such as to cause saturation of the diaphragm, thereby greatly decreasing the flux variations produced by the signal currents.

According to my invention, I provide a telephone construction which obviates the aforementioned difficulties by directing the unidirectional flux of the permanent magnet through the diaphragm transversely to the plane thereof. The telephone construction comprises a magnetizable member having pole pieces, a second magnetizable member having similar pole pieces, the pole pieces of one magnetizable member being so disposed as to face, in spaced relation, the pole pieces, of opposite sign, of the other magnetizable member, a magnetizable diaphragm vibratably positioned in the space intermediate said pole pieces, and signal current windings carried by said pole pieces.

With these and other objects in view, my invention further consists in the details of construction and in the operation and circuit arrangement set forth in the following description and claims and illustrated in the accompanying drawing, wherein,

Figure 1 is a horizontal sectional view of one embodiment of my invention, the section being taken on the lines I—I of Figs. 2 and 3,

Figs. 2 and 3 are detail views of the receivers shown in Fig. 1,

Fig. 4 is a diagrammatic view of the circuits and apparatus of the previous figures,

Fig. 5 is a diagrammatic view of circuits and apparatus embodying my invention, as applied to a telephone transmitter, and

Fig. 6 is a curve diagram illustrating one advantage of my construction over that of the ordinary telephone device.

In Figs. 1, 2 and 4, is shown a particular embodiment of my invention, which has

proved satisfactory, comprising a pair of telephone receivers 1 and 2, of the magnetic type, having a common vibratory diaphragm element 3.

The receiver 1 comprises a pair of soft-iron pole pieces 4 and 5 carrying magnetizing windings 6 and 7, respectively, said pole pieces serving as pole terminals for a permanent magnet 8. The several foregoing elements may be embodied in a casing 9 of non-magnetizable material, and secured in any well known manner therein. The casing 9 may carry binding posts 11 and 12 for the magnetizing windings 6 and 7.

The receiver 2 is similar to the receiver 1 and comprises a corresponding pair of soft-iron pole pieces 13 and 14 carrying magnetizable windings 15 and 16, respectively, said pole pieces serving as pole terminals for a permanent magnet 17. The several elements may be supported in a casing 18 in any well known manner. The casing 18 may be provided with a perforation 19 for reasons which will appear hereinafter. Binding posts 22 and 22', which are carried by the receiver casing 18, serve as external connectors for the magnetizing windings 15 and 16.

The telephone receivers 1 and 2 may be brought together to form a completed structure, as shown in Fig. 1, by means of a cylindrical outer casing 21 of such dimensions as to removably receive the telephone receivers 1 and 2 from an open end 23. The opposite end of the casing is provided with perforations 24 and 25 for receiving the binding posts 22 and 22' and with a perforation (not shown) corresponding to the perforation 19 in the telephone-receiver casing 18.

In assembling the telephone receivers 1 and 2 within the main casing 21, the telephone receiver 18 is first positioned within the main casing 21 with the binding posts 22 and 22' extending, respectively, through the perforations 24 and 25 and with the perforation 19 registering with the previously mentioned one (not shown) in the casing 21. A resilient washer 26 may be interposed between the receiver casing 18 and the main casing 21 to provide a resilient support for the several receiver casings. The diaphragm 3, with one or more spacing members 27, is next positioned over the pole pieces 13 and 14 and the receiver 1 is then inserted in the main casing 21, with the pole.

pieces 4 and 5 thereof also facing the diaphragm 3. The several parts within the casing 21 may be secured in position by means of a threaded clamping member 28 engaging the casing 9 of the receiver 1.

The relative position of the two receivers 1 and 2 is such that the north pole, say 5, of the receiver 1 is directly opposite to the south pole, say 14, of the receiver 2 while the south pole 4 of the receiver 1 is directly opposite to the north pole 13 of the receiver 2. Thus, a magnetic circuit is established which includes the permanent magnet 8, the pole piece 5, and air gap 29 between the pole pieces 5 and 14 including the diaphragm 3, the pole piece 14, the permanent magnet 17, the pole piece 13, and air gap 31, between the pole pieces 13 and 14 also including the diaphragm 3, and the pole piece 4. Since the unidirectional fluxes entering and leaving the portions of the diaphragm 3 disposed in the air gaps 29 and 31 are equal, the magnetic forces operating on said diaphragm 3 balance. Moreover, the constant magnetic flux component passes through the diaphragm 3 transversely to the plane thereof, hence preventing the saturation of the same.

When the several magnetizing windings are connected in the manner illustrated diagrammatically in Fig. 4 and when the currents are caused to traverse the same in the direction indicated, the magnetic flux established by magnetizing windings of the receivers 1 and 2 is caused to traverse paths indicated by arrows *a* and *b*, respectively. The magnetic circuit of the magnetizable windings of the receiver 1 includes the magnetizable pole pieces 5, a space 32 between the end of the pole piece 5 and the diaphragm 3, the diaphragm 3, a space 33 between the diaphragm 3 and the pole piece 4, the pole piece 4 and the permanent magnet 8, all as indicated by arrow *a*. The magnetic circuit for the exciting windings of the receiver 2 includes the pole piece 14, a space 34 between the pole piece 14 and the diaphragm 3, the diaphragm 3, a space 35 between the diaphragm 3 and the pole piece 13, and the permanent magnet 17, all as indicated by arrow *b*.

The flux produced by the windings 6 and 7 of the receiver 1 is in the same direction as the flux of the permanent magnets in the air-gap spaces 29 and 33, thereby increasing the forces operating to move the diaphragm 3 toward the pole pieces 4 and 5. The flux produced by the magnetizable windings 15 and 16 is in the opposite direction with respect to the flux of the permanent magnets in the air-gap spaces 34 and 35 and hence decrease the forces operating to move the diaphragm 3 toward the pole pieces 13 and 14. The result is an unbalancing of the forces operating on the diaphragm 3, and hence a movement of the latter. When the direction

of the current through the several exciting windings reverses, there is a corresponding change in the direction of the unbalancing of the forces operating on the diaphragm 3, causing motion in an opposite direction. Thus, it is seen that, when vibratory electrical energy is supplied to the several magnetizing windings, the diaphragm 3 is vibrated in accordance with the frequency of such energy to produce sound waves.

It is again noted, that the unidirectional flux passes through the diaphragm 3 transversely to the plane thereof, thereby preventing the saturation of the diaphragm 3. Hence, the intensity of the flux established by the magnetizing windings may be greatly increased over value heretofore considered possible without saturating the diaphragm 3, resulting in a receiver of greatly increased efficiency.

The audibility-frequency operating characteristic of the device embodying my invention, as compared with that of the ordinary receiver, is shown by curves *c* and *d*, respectively, in Fig. 6, where the abscissae represent frequency and the ordinates audibility. By the designating, say "1000 audibility", is meant a response of such intensity that the signal current may be reduced 1000 times without rendering the signals inaudible, further reduction however, rendering the same inaudible. Referring to curve *d* for the ordinary receiver, it is noted that the audibility of the receiver increases from a relatively low value to a maximum value at 1000 cycles and then decreases with further increase in frequency. The intensity or audibility of incoming signals for a receiver having such curve varies greatly for slight change in frequency, thereby introducing distortion, particularly disturbing in the reception of music. Such undesirable result, however, is not present in the operation of my invention, as shown by curve *c*, since the audibility curve remains substantially flat for all frequencies within the normal audible-frequency range.

I have found that improved results are obtained by decreasing the dimensions of the chamber formed by the casing 18 and connected with air by the perforation 19 therein. In the drawing is shown one method for accomplishing this result which consists in filling said chamber with an insulating material and leaving a small space between its outer surface and the surface of the diaphragm 3. A perforation 37 may be provided in the wax, which is so disposed as to register with the perforation (not shown) in the casing 18, thereby connecting the diaphragm 3 with air.

In the foregoing portions of the specification, my invention has been described in the form of a telephone receiver but, of course, it is also operable as a telephone transmitter.

In Fig. 5 is shown a preferred construction for use in transmitter circuits. The structure there shown comprises a permanent magnet 38 of U-shape having a control magnetizable polar projection 39. A second permanent magnet 41 of U-shape, having a similar magnetizable polar projection 42, is positioned in spaced relation with respect to the first mentioned permanent magnet in such manner that poles 42, 43 and 44 thereof face opposite poles 39, 45 and 46 of the permanent magnet 38.

The two permanent magnets 38 and 41 form a pair of parallel-connected magnetic circuits, as indicated by arrows *e* and *f*, having air gaps 45, 46 and 47, therein, respectively. A diaphragm member 48 may be positioned in the air gaps 45, 46 and 47 intermediate the several poles. The magnetizable polar projections 39 and 42 may be provided with magnetizing windings 49 and 51. The inner ends of the magnetizing windings may be connected by a conductor 52, while the outer ends may be connected to a source 53 of direct-current energy by means of a conductor 54 and 55, respectively.

The two paths for the flux established by the magnetizing winding 49, are indicated by arrows *g* and *h*, while the two paths for the flux established by the magnetizing winding 51 are indicated by the arrows *k* and *l*.

In operation, when the diaphragm 48 is caused to vibrate, the reluctance of the magnetic circuits of the magnetizing coils is increased in the case of one coil and decreased in the case of the other coil, thereby decreasing and increasing, respectively, the intensity of the flux traversing the magnetizing coils. The effect of such variations in the intensity of the flux is to cause corresponding potential variations across the terminals of said magnetizing coils. Such potential variations may be translated into useful current variations by connecting one conductor 56 of an external circuit 57 to either of the outer ends of the magnetizing coils 49 and 51 and by connecting the other conductor 58 of said circuit to the conductor 52 connecting the inner ends of the coils 49 and 51. A condenser 59, having low impedance to currents of signal frequency, is included in either of the conductors 56 and 58 to prevent the energy source 53 from short-circuiting through the external circuit 57.

In order to simplify the description of my invention and to facilitate a clear understanding of the same, I have eliminated from the drawings such structural details as are not absolutely necessary to my invention.

While I have described two embodiments of my invention in detail and while I have pointed out certain of the most obvious principles, I do not intend that the language employed in the following claims shall be

limited to the precise features described, but I intend that the claims shall be construed to cover the patentable novelty in view of the prior art, regardless of the details and functions mentioned in the description or illustrated in the drawing.

I claim as my invention:

1. In combination, a pair of spaced pole pieces, a second pair of spaced pole pieces, means for establishing a unidirectional magnetic flux between the pole pieces of each pair, the flux between one pair of pole pieces being oppositely directed with respect to that between the other pair, a diaphragm vibratably positioned in the space intermediate said pole pieces, the forces exerted on said diaphragm by said pole pieces balancing, magnetizing windings magnetically associated with said pole pieces for disturbing the balanced condition of said diaphragm, a casing enclosing said foregoing elements and formed substantially into two chambers by said diaphragm, and means for decreasing the inner dimensions of one of said chambers, said casing having a perforation for connecting said chamber with air.

2. In combination, a sound-wave translating device of the magnetic type having pole pieces carrying exciting windings, a second device having corresponding parts, the poles of one device being spaced from the poles of the other device, a magnetizable member vibratably positioned in the space intermediate said poles, a casing enclosing said elements forming a chamber on each side of said magnetizable member, said casing having a perforation connecting one of said chambers with air, and means for defining the dimensions of the open space between said diaphragm and said perforation.

3. In combination, a sound-wave translating device of the magnetic type having pole pieces and magnetizing windings operatively associated therewith, a second device having substantially corresponding parts, said device being so arranged that the poles of one device face the poles of the other device in spaced relation, a magnetizable diaphragm member vibratably positioned in the space intermediate said poles, a casing enclosing said elements forming a chamber on each side of said diaphragm, and an insulating material disposed within one of said containers and forming a relatively small open space between the exposed surface thereof and said diaphragm, said casing and said insulating material having a perforation connecting said small open space with air.

In testimony whereof, I have hereunto subscribed my name this 27th day of December 1922.

FRANK CONRAD.