C. N. CHURCH.

TELEPHONE RECEIVER.

APPLICATION FILED NOV. 3, 1909.

1,030,872.

Patented July 2, 1912.

2 SHEETS—SHEET 1.

Fig. 7.

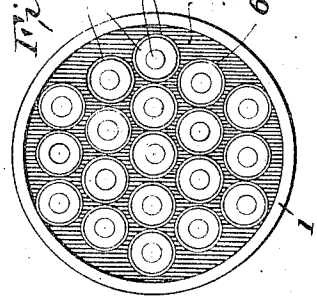


Fig. 4.

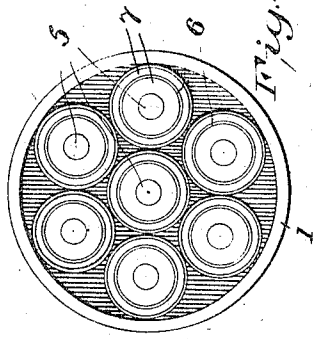


Fig. 1.

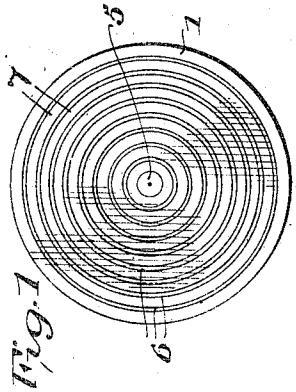


Fig. 8.

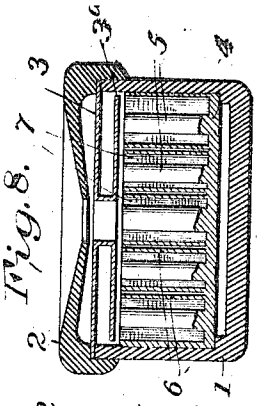


Fig. 5.

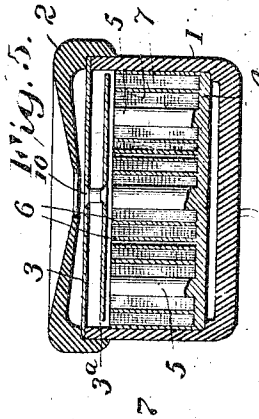


Fig. 2.

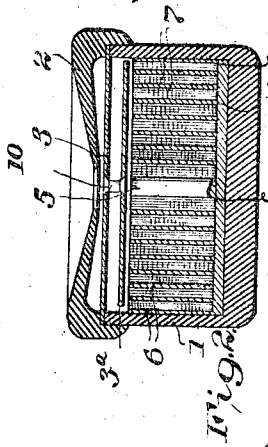


Fig. 9.

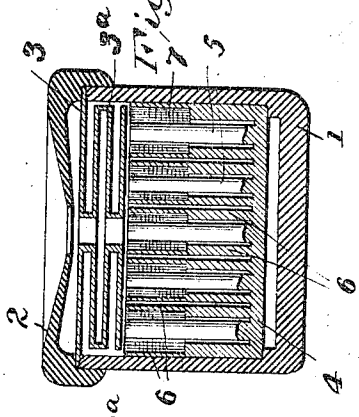


Fig. 6.

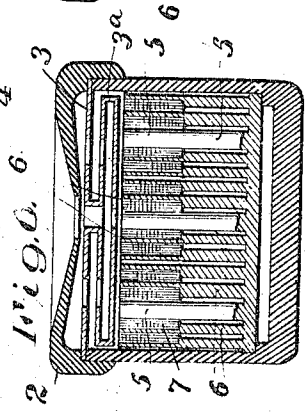
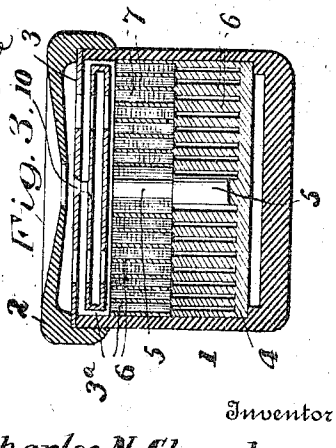


Fig. 3.



Witnesses

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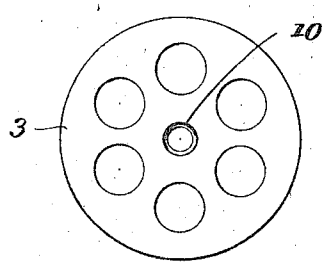

Fig. 10.

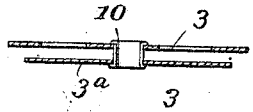

Fig. 11.

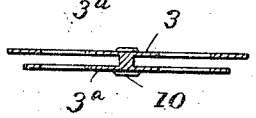

Fig. 12.

Fig. 13.

Fig. 14.

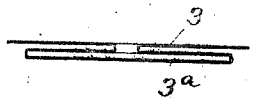

Fig. 15.

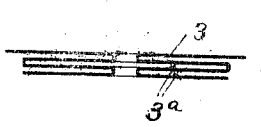

Fig. 16.

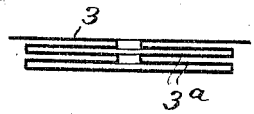

Fig. 17.

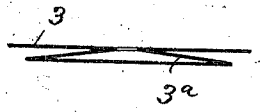

Fig. 18.

Fig. 19.

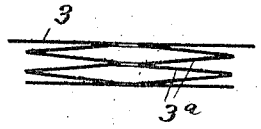

Fig. 20.

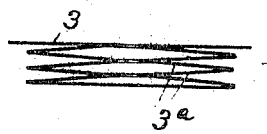

Fig. 21.

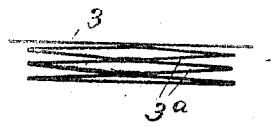

Fig. 22.

Inventor

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Witnesses

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UNITED STATES PATENT OFFICE.

CHARLES N. CHURCH, OF CAMDEN, NEW JERSEY.

TELEPHONE-RECEIVER.

1,030,872. Specification of Letters Patent. Patented July 2, 1912.

Application filed November 3, 1909. Serial No. 526,133.

To all whom it may concern:

Be it known that I, CHARLES N. CHURCH, a citizen of the United States, residing at Camden, in the county of Camden and State of New Jersey, have invented new and useful Improvements in Telephone-Receivers, of which the following is a specification.

My invention relates to telephone receivers and its object is to produce a receiver having very great sensitiveness and of increased power compared with those heretofore in use.

By means of my invention I am enabled to greatly increase the strength of the magnetic pull upon the telephone disk or diaphragm, and also to increase the amplitude of vibration due to the varying telephonic currents.

This invention will be clearly understood from the following description in connection with the accompanying drawings, in which—

Figure 1 is a top-plan view of a receiver constructed in accordance with one form of my invention, the ear-piece and diaphragm being removed; Fig. 2 is a longitudinal sectional view through the same with diaphragm and ear-piece in position; Fig. 3 is a similar view of a modified construction of the receiver illustrated in Figs. 1 and 2; Fig. 4 is a top plan view of a receiver constructed in accordance with another form of my invention; Fig. 5 is a longitudinal sectional view through the same with the diaphragm and ear-piece in position; Fig. 6 is a similar view of a modified construction of the receiver shown in Figs. 4 and 5; Fig. 7 is a top plan view of still another form of my improved receiver; Fig. 8 is a longitudinal sectional view of the same with the diaphragm and ear-piece in position; Fig. 9 is a similar view of a modified form of the receiver illustrated in Figs. 7 and 8; Fig. 10 is a top plan view of an improved form of diaphragm; Fig. 11 is a sectional view of the same; Fig. 12 is a similar view of a modified form of the diaphragm shown in Figs. 10 and 11; and Figs. 13, 14, 15, 16, 17, 18, 19, 20, 21, and 22 are sectional views of modified forms of diaphragms embodying my invention.

The magnetic lines of force induced in magnetic material not only vary with the number of turns of wire, the current being the same, but also according to the proximity of the wire to the magnetic material forming the magnetic circuit. It is evident then that by bringing the wire closer to the magnetic material forming the magnetic circuit the magnetic lines of force will be increased, and the magnetic pull upon the armature, which constitutes the diaphragm of the telephone receiver, will be greatly enhanced, thereby increasing the sensitiveness of the telephone and its responsiveness to weak currents. For the purpose of utilizing this increased magnetic pull to strengthen and increase the volume of sound, I combine with this magnetic construction a compound diaphragm one portion of which receives the magnetic pull and transmits the same to the center of the sound-producing portion, thereby largely increasing the amplitude of vibration of the latter. I also provide a means for equalizing the air-pressure upon the opposite sides of the diaphragm and permitting the free vibration thereof.

Referring now to the drawings and first to the construction shown in Figs. 1 and 2, the numeral 1 designates the casing of hard-rubber or other suitable material of a telephone receiver of the watch-case type. The ear-piece 2 is secured to the casing by screw-threading or in any suitable manner, and clamps the main diaphragm 3 in position.

The magnetic structure of my receiver comprises a plate 4 of magnetic material having projecting therefrom the central bar or rod 5 and the concentric rings 6. The rod and rings may be integral with the plate 4 or may be suitably secured thereto or held in close contact therewith. The rod and concentric rings constitute the core structure of the magnetic system, connected by means of a yoke piece constituted by the plate 4. The annular spaces between the rings or core structure form winding spaces which are completely filled with the insulated wire forming the magnet windings 7. The alternate windings or coils are wound and connected so that the electric current flows in opposite directions in adjacent coils and the coils are preferably all connected in series. By means of this circuit arrangement the current flowing at any instant will cause adjacent concentric rings 6 to be of opposite polarity, the north and south magnetic poles alternating in the different rings. It will be apparent from this that each ring will have induced therein magnetic fluxes

by both the inner and outer magnet coils adjacent to it, and that the flux induced by both inner and outer coils will be in the same direction, and combine to produce the same polarity. By making the coils relatively thin and separated by thin magnetic walls constituted by the rings, I am enabled to keep the electric and the magnetic elements of the system in close proximity, which enormously increases the efficiency and produces a maximum of flux lines for the number of ampere turns of the magnet.

It will be obvious from the above description that each ring forms the return magnetic circuit for the adjacent rings because they are of opposite polarities. The magnetic flux passing from one ring enters a portion of the diaphragm which lies just above these rings, viz: the auxiliary diaphragm 3^a. Each magnetic circuit, therefore, is completed through the diaphragm, and is a nearly closed magnetic circuit producing the most efficient magnetic system.

In order that I may use the great strength or pull of this magnetic system, I have devised a compound diaphragm in which there is secured to the main diaphragm 3 an auxiliary diaphragm 3^a, rigidly secured thereto at the center, preferably by means of a tubular rivet which allows the free passage of the air from the inside to the outside of the diaphragm. The pull upon the auxiliary diaphragm 3^a will be substantially uniform over its entire area, and the pull which is distributed over its entire face will be transmitted by means of the central rivet to the center of the outer or main sound-producing diaphragm 3, and thus transmit a maximum amplitude of vibration to said outer diaphragm. By supporting the power-transmitting diaphragm 3^a only at the center, leaving its entire circumference free from contact with the casing, I am enabled to secure a direct pull over the entire area and out to the very circumference of the diaphragm 3^a, and to transmit the combined pull due to the attraction of the several concentric magnetic circuits constituting my combined magnetic system.

In Fig. 4 I have shown a modification in which a plurality of concentric magnetic elements are placed side by side, instead of arranging all of the elements concentrically as in Fig. 1. Instead of employing two magnetizing coils in each of the elements of the magnetic system as shown in Fig. 4, I may employ an arrangement such as shown in Fig. 7, in which each of the elements comprises a single magnetizing coil 7, wound around a central magnetic core 5 and surrounded by a magnetic sleeve 6, each element thus constituting a complete magnetic circuit which is closed through the diaphragm. Instead of using a shallow watch-case type of receiver, as shown in Figs. 2, 5, and 8, I may extend the casing, as shown in Figs. 3, 6, and 9, and use a magnetic system having a greater core length. In this case I prefer to form the concentric rings of greater thickness at their inner ends joining the yoke-plate 4, the outer portions being of reduced thickness, and the magnetizing coils being of a length sufficient to extend only over the reduced thinner portions of the magnetic rings or shells, as illustrated. In all of the forms shown, I prefer to use a yoke-plate which is permanently magnetized, and it is preferable that the rods 5 and concentric shells or rings 6 should also be likewise permanently magnetized, the adjacent rings being of opposite polarity, as previously explained.

The main and auxiliary portions of the diaphragm may be secured together by means of a hollow rivet 10, as shown in Figs. 1 and 5, or the parts may be made integral or otherwise secured together, as shown in Fig. 8.

Instead of constructing the auxiliary diaphragm 3^a of a single plate, as shown in Fig. 2, I may form the same of two or more plates secured together in the manner shown in Figs. 3, 6, and 9. In addition to the aperture or passage through the central portion of the combined diaphragm, I may also provide additional apertures as shown in Figs. 3 and 6. By thus perforating the diaphragm the air pressure upon opposite sides is equalized at all times and the inner or auxiliary diaphragm is free to move within the chamber lying between the main diaphragm 3 and the compound magnet. Furthermore, in this manner, the vibrations of the air within the chamber occupied by the auxiliary diaphragm are communicated to the outer air passage through the earpiece and act to increase the volume of sound which is transmitted.

In Figs. 10 to 22, I have shown various arrangements which may be employed in constructing a diaphragm in accordance with my present invention. Fig. 10 is a plan view of which Fig. 11 is a cross-section, showing one manner of perforating the main diaphragm or disk. In Fig. 12, I have shown the main and auxiliary diaphragms secured by means of a solid rivet, both disks being perforated. In the remaining figures specified, I have shown diagrammatically in cross-section a number of different arrangements which may be employed, and in these constructions I sometimes find it advisable to make portions or even the entire auxiliary diaphragm resilient, as well as the main diaphragm. In all of the constructions, however, it will be observed that the auxiliary power-transmitting diaphragm is connected to the main diaphragm only at the center, in which the

amplitude of vibration of the main diaphragm is greatest, the entire area of the auxiliary diaphragm being free to move toward and from the magnetic system.

The advantages derived from my invention will be appreciated by those skilled in this art. It will be apparent that the arrangement of concentric rings or sheets of magnetic material to constitute the core or magnetic paths for the flux lines with interposed magnetizing coils, effects a large increase in the flux generated by the electric current by bringing the windings into close proximity with magnetic paths on both sides, so that the magnetic rings intercept the flux lines where they are most dense, viz: close to the current-carrying conductors. Moreover, by the construction described I am enabled to use a larger number of turns of greater cross-section than in previous telephone receivers with which I am familiar, thereby securing a very large increase in the number of ampere-turns for the same value of ohmic resistance. Again, by means of my compound diaphragm, I am enabled to utilize the combined pull of the magnetic system which is distributed over the entire area covered by the diaphragm, instead of being exerted at one or two points as in the bar or horse-shoe magnets. As previously explained, the auxiliary diaphragm is unrestrained at its periphery and is free to move bodily toward and from the poles of the magnetic system and transmits the combined pull, which is the resultant of several concentric magnets, to the center of the main diaphragm to thus enhance the amplitude of vibration at the point of maximum effect.

I have shown a number of different forms which may be used in the embodiment of my invention, but other modifications will occur to those skilled in this art and I do not wish to be restricted, therefore, to the particular arrangement of parts illustrated, intending to cover all changes which are embraced within the spirit of my invention and included within the scope of the appended claims.

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

1. A telephone receiver comprising a magnetic system having a yoke plate, permanently magnetized in concentric bands alternating in polarity, and concentric rings of magnetic material projecting from said plate and coinciding with said magnetized bands, and magnetizing coils interposed between said rings.

2. A telephone receiver comprising a casing, a magnetic system therein having a plurality of concentric magnetic elements and interposed magnetizing coils, said elements having adjacent polar faces of opposite polarity, an ear-piece secured to said casing, and a compound diaphragm having a main portion clamped between said ear-piece and said casing, and an auxiliary portion having a single central support secured to said main portion and lying closely adjacent to said magnetic system.

3. In a telephone receiver, a compound diaphragm comprising a main sound-producing portion supported at its periphery and an auxiliary sound-producing portion substantially coextensive with the interior of the receiver-casing, said auxiliary portion being unsupported at its periphery and centrally secured to said main portion and otherwise free to move bodily toward and from the main portion.

4. In a telephone receiver, a compound diaphragm comprising a main sound-producing portion and an auxiliary sound-producing portion substantially coextensive with the interior of the receiver casing, said auxiliary portion being centrally secured thereto and otherwise free to move bodily toward and from the main portion, said main and auxiliary diaphragm portions being perforated to permit the free passage of air therethrough.

5. A telephone receiver comprising a casing, a magnetic system therein having a plurality of concentric elements whose magnetic poles terminate in a common plane the adjacent poles being of opposite polarity, a main diaphragm restrained at its periphery, and an auxiliary diaphragm secured to the center of the main diaphragm and otherwise unrestrained, said auxiliary diaphragm being adjacent to said plane of magnetic poles.

6. A telephone receiver comprising a casing, a magnetic system therein having a plurality of concentric elements whose magnetic poles alternate in polarity and terminate in a common plane, a main diaphragm restrained at its periphery in the walls of the casing, a chamber between said diaphragm and the plane of said magnetic poles, an auxiliary diaphragm within said chamber and movable bodily toward and from said magnetic poles, and means connecting said main and auxiliary diaphragms.

7. A telephone receiver comprising a casing, a magnetic system therein comprising a yoke plate and a plurality of concentric elements projecting therefrom having magnetic poles alternating in polarity and terminating in a common plane, magnetizing coils interposed between said concentric elements, a main diaphragm restrained at its periphery in the walls of the casing and perforated to permit the passage of sound waves, a chamber between said diaphragm and the plane of said magnetic poles, and an auxiliary diaphragm within said cham-

ber centrally secured to said main diaphragm and otherwise free to move bodily toward and from said magnetic poles.

8. A telephone receiver comprising a casing, a magnetic system therein comprising a yoke plate and a plurality of concentric elements projecting therefrom having magnetic poles alternating in polarity and terminating in a common plane, magnetizing coils interposed between said concentric elements, a main diaphragm restrained at its periphery in the walls of the casing, a chamber between said diaphragm and the plane of said magnetic poles, and an auxiliary diaphragm within said chamber centrally secured to said main diaphragm and otherwise free to move bodily toward and from said magnetic poles, said main and auxiliary diaphragms being perforated to permit the passage of sound waves.

9. A telephone receiver comprising a magnetic system having a yoke plate and concentric rings projecting therefrom forming adjacent magnetic paths, magnetizing coils interposed between said rings and arranged to cause adjacent magnetic paths to be of opposite magnetic polarity, a main diaphragm restrained at its periphery, and an auxiliary diaphragm centrally secured to the main diaphragm and otherwise unrestrained, said main and auxiliary diaphragms being perforated to permit the passage of sound waves.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

CHAS. N. CHURCH.

Witnesses:
CHARLES N. MURRAY,
E. C. BROWN.