N° 29,833 A.D. 1910

Date of Application, 22nd Dec, 1910

Complete Specification Left, 19th June, 1911—Accepted, 22nd Jan., 1912

PROVISIONAL SPECIFICATION.

Improvements relating to the Reproduction of Sound by Electrical Means.

I, SIDNEY GEORGE BROWN, of 4, Great Winchester Street, in the City and County of London, Electrical Engineer, do hereby declare the nature of this invention to be as follows:—

This invention relates to the reproduction of sound by electrical means and has particular reference to telephone receivers, the chief object being to enable a high efficiency of conversion of oscillations or variations of electric current into acoustic vibrations to be obtained.

The usual methods of electrically reproducing speed involve the use of a flexible vibrating diaphragm, as is well known. Owing to this diaphragm being gripped peripherally, the amplitude of its vibrations is greatest at the centre and progressively less at successive points the nearer these are to the periphery. Hence the activity of different portions of the diaphragm in setting up vibrations in the surrounding air decreases rapidly from the centre outwards. Moreover this inefficiency inherent in the diaphragm itself results in an inefficient transmission of its energy to the air owing to the want of similarity in the impulses imparted to different portions of the air in contact with the different portions of the diaphragm. The chief object of the present invention is to avoid this variable action of the devices referred to, and thereby increase the efficiency of such devices.

According to the present invention the member that produces the acoustic vibrations is mounted upon a vibratory member, but is in itself sufficiently rigid to move with the same or approximately the same amplitude at all points in surface; in this way a large surface or column of air can simultaneously receive impulses of equal or approximately equal value.

The aforesaid vibratory member, having a suitable period of vibration, may constitute the armature of the usual polarized electromagnet through the winding of which the line currents pass, and will hereinafter be referred to as the armature. It may conveniently take the form of a strip of iron or steel fixed at one end or at both ends to the usual casing of the receiver in a position to extend over the electromagnet core and at an appropriate distance therefrom. Part of the metal may be cut away, if desired, to increase the flexibility of the armature and to decrease its weight. Fixed to this armature, preferably at or near the point where the amplitude of the vibrations is largest, is the member that actually converts into acoustic vibrations the line currents passing through the electromagnet winding. It is to be noted that this armature serve to complete the magnetic circuit for the lines of force spreading from the electromagnet core, and that the aforesaid member is, therefore, or may be, quite independent of the magnetic circuit. This member is rigid in the sense that it is not intended to vibrate independently of the armature, and it presents a comparatively large surface to the air. It may take the form of a corrugated or otherwise stiffened disc, or it may present a conical or trumpet mouthed appearance and in such case it is the smaller end thereof that would be attached to the armature. The periphery of this member, whatever may be its shape,

[*Price* 8*d*.]

may be quite free, or it may be attached to the inner edge of a flat flexible ring, the outer edge of which is fixed to the casing, the said ring and member thus dividing the latter into two compartments. The flexibility of this ring, and the manner of its attachment to the aforesaid member, should not be such as to hamper or suppress the small vibratory movements of any part of the member to any appreciable extent. The said member may be made of any suitable material, and in this connection I may state that I have found aluminium to be satisfactory.

The working of the device described above will be readily understood. The vibratory movements of the portion of the armature to which the aforesaid member is attached are imparted to this member as a whole; this member therefore acts like a reciprocating piston and sets a large surface of air into vibration simultaneously and to the same or approximately the same extent at all points. In the case of the said member being conically shaped, the increased efficiency is probably due partly to the fact that the disturbances set up in the air in contact with the conical surface tend to converge and to arrive simultaneously at the region where the ear of the operator is situated. In any case the distinctness and audibility of messages received are largely increased, and the range of distance over which speech is practicable is also increased.

Dated this 22nd day of December, 1910.

HASELTINE, LAKE & Co.
7 & 8, Southampton Buildings, London, England, and
60, Wall Street, New York City, U.S.A.,
Agents for the Applicant.

COMPLETE SPECIFICATION.

Improvements relating to the Reproduction of Sound by Electrical Means.

I, SIDNEY GEORGE BROWN, of 4, Great Winchester Street, in the City and County of London, Electrical Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the reproduction of sound by electrical means and has particular reference to telephone receivers.

The usual telephone receiver consists of a polarised electro-magnet through the coil of which the line currents pass, and a flat soft iron diaphragm gripped peripherally and thereby held a short distance away from the electromagnet. Variations in the strength of the line current cause the diaphragm to vibrate, and, in so doing, to set the surrounding air into vibration.

In order to obviate the unequal extent of vibration of different points on a peripherally gripped diaphragm proposals have been made to support the diaphragm at its centre leaving the periphery free, or to provide for resiliency or flexibility between the diaphragm proper and its peripheral support, thereby obtaining a piston-like action of the diaphragm. It has been suggested to form such diaphragms of metal, ebonite, or other suitable material, and to impart to them a conical or dished appearance. The chief object of the present invention is to provide an instrument of this kind in which a high efficiency of conversion of oscillations or variations of electric current into acoustic vibrations is obtained. Apart from the actual construction and positioning of the parts of such an instrument, the conditions necessary for the transmission of the air vibrations away from the actual surface of the diaphragm are of

importance. Hitherto sufficient attention has not been paid to the volume of air set in motion and the variations of air pressure for producing the most effective transmission. The dimensions of the ear-drum and of the aural cavity may be taken as invariable factors in such considerations. Now these factors being known, there are certain relations existing between them and the size of the diaphragm, the nature of the air pressure variations, and the volume of air set in motion, for the most effective reproduction of the sounds, and the transmission of them to the ear-drum. For these and other reasons it is quite impracticable to make the diaphragm fulfil also the functions of an ear piece; a separate ear piece is a necessity.

According to the present invention the receiver comprises a light conical or similarly shaped diaphragm, a resilient member responsive to variations of current strength in a coil through which the line currents pass and carrying the diaphragm by its centre so that the latter is free to vibrate as a whole, and a cover or ear piece situated over the diaphragm at a comparatively short distance from the same. The inner surface of the cover or ear piece of the receiver is preferably formed to correspond approximately with the shape of the diaphragm, so as to reduce the excessively large space that would otherwise intervene between these parts. I have found that a conical disc formed from a very thin sheet of aluminium or aluminium alloy or steel and suitably stiffened by ribs, or corrugations, or otherwise, possesses the requisite properties to a satisfactory degree. The thin disc, if of aluminium or an alloy thereof, may conveniently be spun into the desired conical shape with a flat centre piece. It is advantageous for the strength and thickness to be greatest at the centre and progressively less towards the edge, and by starting the spinning operation at the edge and working towards the centre, this property of the spun disc will be naturally produced owing to the graduated thickness of the disc. To increase this effect several discs of different diameter may be assembled into a pile. The thickness of such discs may be of the order of $2\frac{1}{2}$ thousandths of an inch. Some idea as to the lightness of a diaphragm so formed may be gained from the fact that when it is allowed to drop to the ground it does not fall like a heavy mass of metal, but moves gently through the air. The mere conical shape of the diaphragm will ensure a considerable amount of rigidity but this may be increased by providing radial ribs or corrugations on it as above mentioned.

The vibratory member that carries the diaphragm may consist of a resilient strip or reed of magnetic metal containing within itself, by reason of a cut-away portion, its own control and that of the diaphragm. The diaphragm is preferably attached at its centre to a point on the metal strip or reed slightly away from the free end of the latter so as to be eccentric with respect to the axis of the coil through which the line currents pass. The diaphragm is so arranged as to be free to move as a whole, that is to say all points on its surface vibrate equally, and to ensure this action the periphery of the diaphragm is either quite free or is attached to the usual casing by a mere thin ring of flexible material.

In order that the invention may be clearly understood and readily carried into effect I will now describe the same more fully with reference to the accompanying drawings, in which:—

Figure 1 is a plan with the cover removed, and

Figure 2 a sectional elevation, of one constructional form of my improved receiver. These drawings represent a full size receiver, and the more important dimensions such as the diameter of the diaphragm, the extent of its eccentricity, and the volume and shape of the air space between the diaphragm and the ear-piece or cover are what I have found by experiment to give good results for hearing with the receiver close to the ear, by reason, no doubt, of the relation these dimensions bear to the diameter of the ear-drum and the volume of the aural cavity. Where it is desired to make the sounds travel out into the room, a receiver of larger size is preferable.

Figures 3 and 4 are detail sectional elevations of modifications of the receiver.

Referring first to Figures 1 and 2, A is the casing and B the ear-piece or cover of the receiver. E is a metal reed one end of which is held down upon a bridge piece E^1 on the casing E by two adjusting screws E^2. N and S represents the north and south poles, respectively, of a polarised electromagnet to the ends of which are attached L-shaped pieces the vertical members of which, constituting the cores D, have the coil C wound around them; the ends of the said vertical members slope towards one another so as to be directly under the metal reed E. A portion E^3 of the reed E is cut away to increase its flexibility and decrease its weight. I have found that a suitable free period for the reed is from eight hundred to one thousand two hundred. The extent to which the reed E can approach the core D may be regulated by packing some layers of paper between these parts or by arranging a set screw to make contact with the reed, the provision of a set screw being shewn at D^1 Figure 3. This set screw D^1 may be tipped with gold or platinum so as to serve in conjunction with the reed E as a make and break arrangement in a circuit connected in parallel with the coil C. In this way any damage to the permanent magnetism of the core D owing to an extra heavy current passing through the coil C at any time is avoided, since the closing of the shunt circuit by the contact of the reed E with the set screw D^1 diverts the current away from the coil C.

F is a light aluminium diaphragm of conical form. It is attached at its centre to the reed E at a point eccentric with respect to the axis of the core D, the eccentricity being towards the fixed end of the reed. Although I have shown the best position for attaching the diaphragm in the particular receiver illustrated, the best position on any reed can be found by experiment by means of a stethoscope and by exploring the reed with the aid of a movable diaphragm.

The diaphragm F is either of such a size that its periphery is close up against the casing A or other adjacent stationary part, or, if an appreciable gap exists between these parts, the periphery of the diaphragm is flexibly attached to the casing or to a removable internal flange thereon by resorting to the known expedient of a ring of tissue paper, silk, or other suitable material F^1 that will not exert any appreciable mechanical constraint upon the diaphragm; this ring F^1 may be attached to the diaphragm and to the aforesaid flange by adhesive. In either case the space on the two sides of the diaphragm is divided into two separate air regions.

In the modification, shown in Figure 4, the north pole of the polarised electromagnet is surrounded by a ring-shaped south pole. In the annular space between these poles is situated a circular frame C^1 on which is wound the coil C. The frame C^1 is carried by the metal reed E. Variations in the strength of the current traversing the coil C cause this coil C to move vertically and thereby cause the frame C^1 to vibrate the reed E, and consequently the diaphragm F also. In this construction it is to be noted that the movements of the reed E do not materially affect the magnetic field between the poles of the electromagnet.

It will be understood that owing to the extreme lightness of the diaphragm and to its freedom from peripheral constraint, it will be highly responsive to movements of the reed E and will vibrate as a whole.

It will also be observed that the function of the reed E is not to set the air in motion but only to carry the diaphragm and control its movement. This reed contains within itself, by reason of its cut away portion E^1, the means of its own control and that of the diaphragm, and, in the arrangement shown in Figures 1 and 2, also serves to complete the magnetic circuit; the diaphragm forms no part of this circuit. The inner face of the cover or ear-piece B conforms approximately to the shape of the diaphragm, and its distance from the diaphragm is such as to give only the requisite air space between these two parts. The sectional area of the central hole or holes in the ear-piece is suitably proportioned to the aforesaid air space.

Although the invention has been described and illustrated with reference to a "watch" type of receiver, it is of course equally applicable to the long handle type of receiver. It has been proved by actual experiment that receivers possessing the constructive features hereinbefore described considerably increase the maximum distance over which distinct speech can be conveyed.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A telephone receiver comprising a light conical or similarly shaped diaphragm, a resilient member responsive to variations of current strength in a coil through which the line currents pass and carrying the diaphragm by its centre, and a cover or ear piece situated over the diaphragm, substantially as and for the purposes specified.

2. A telephone receiver in which the inner surface of the cover or ear piece situated over the conical or similarly shaped diaphragm corresponds approximately with the shape of the diaphragm, substantially as and for the purpose specified.

3. A telephone receiver comprising a casing, a resilient member responsive to variations in the strength of the line current, a light conical or similarly shaped diaphragm carried at its centre by the resilient member, and a ring of thin flexible material connecting the periphery of the diaphragm with the adjacent wall of the casing or other stationary part, substantially as and for the purpose specified.

4. A telephone receiver, in which the diaphragm attached to the resilient member that is responsive to variations in the line current is situated eccentrically with respect to the electro-magnet, the eccentricity being towards the fixed end of the resilient member, substantially as described.

5. In a telephone receiver, a conical diaphragm built up, or radially corrugated or ribbed, or spun from a disc, in such a way as to be strongest at the centre and of diminishing strength towards the periphery, substantially as described.

6. A telephone receiver, comprising a polarised electro-magnet through the coil of which the line currents pass, a magnetic armature having a cut-away portion to impart resiliency to it, a conical aluminium diaphragm attached to the armature eccentrically with respect to the electromagnet and towards the fixed end of the armature, and a thin flexible ring of material connecting the periphery of the diaphragm to an internal removable flange on the casing, the latter having a conical inner face conforming approximately to the shape of the diaphragm, substantially as described.

7. A telephone receiver having its parts constructed arranged, and adapted to operate, substantially as hereinbefore described with reference to the accompanying drawings and for the purposes specified.

Dated this 19th day of June, 1911.

HASELTINE, LAKE & Co.,
7 & 8, Southampton Buildings, London, England, and
60, Wall Street, New York City, U.S.A.,
Agents for the Applicant.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1912.

A.D. 1910. Dec. 22. N° 29,833.
BROWN'S Complete Specification.

(1 SHEET)

[This Drawing is a full-size reproduction of the Original.]

Fig. 1.

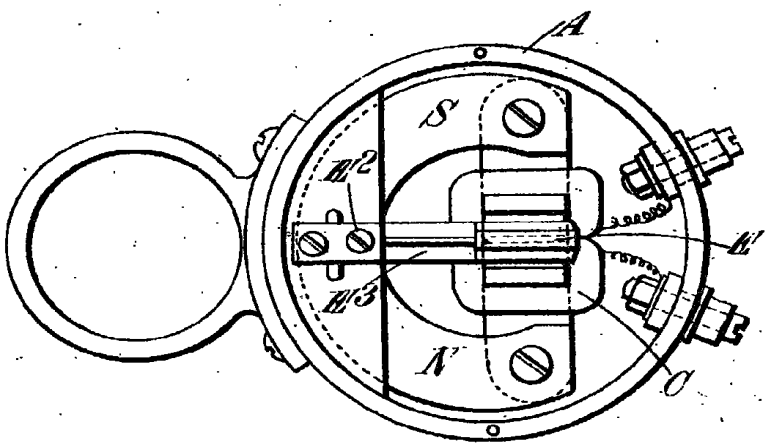


Fig. 2.

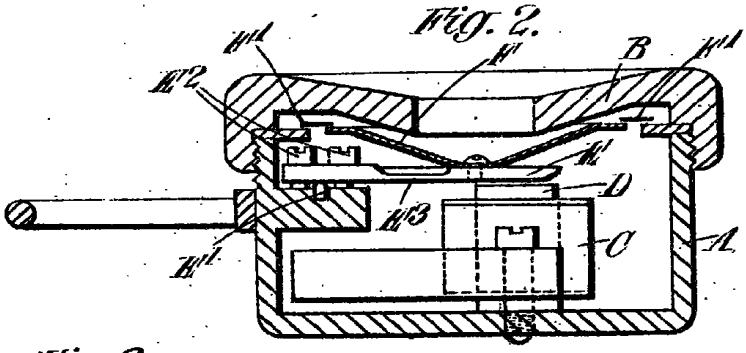


Fig. 3.

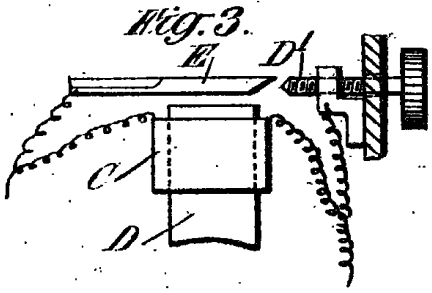
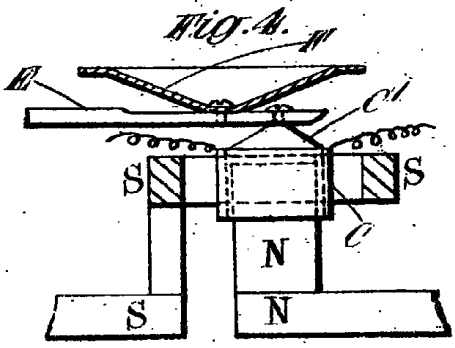


Fig. 4.



Malby&Sons, Photo-Litho.