

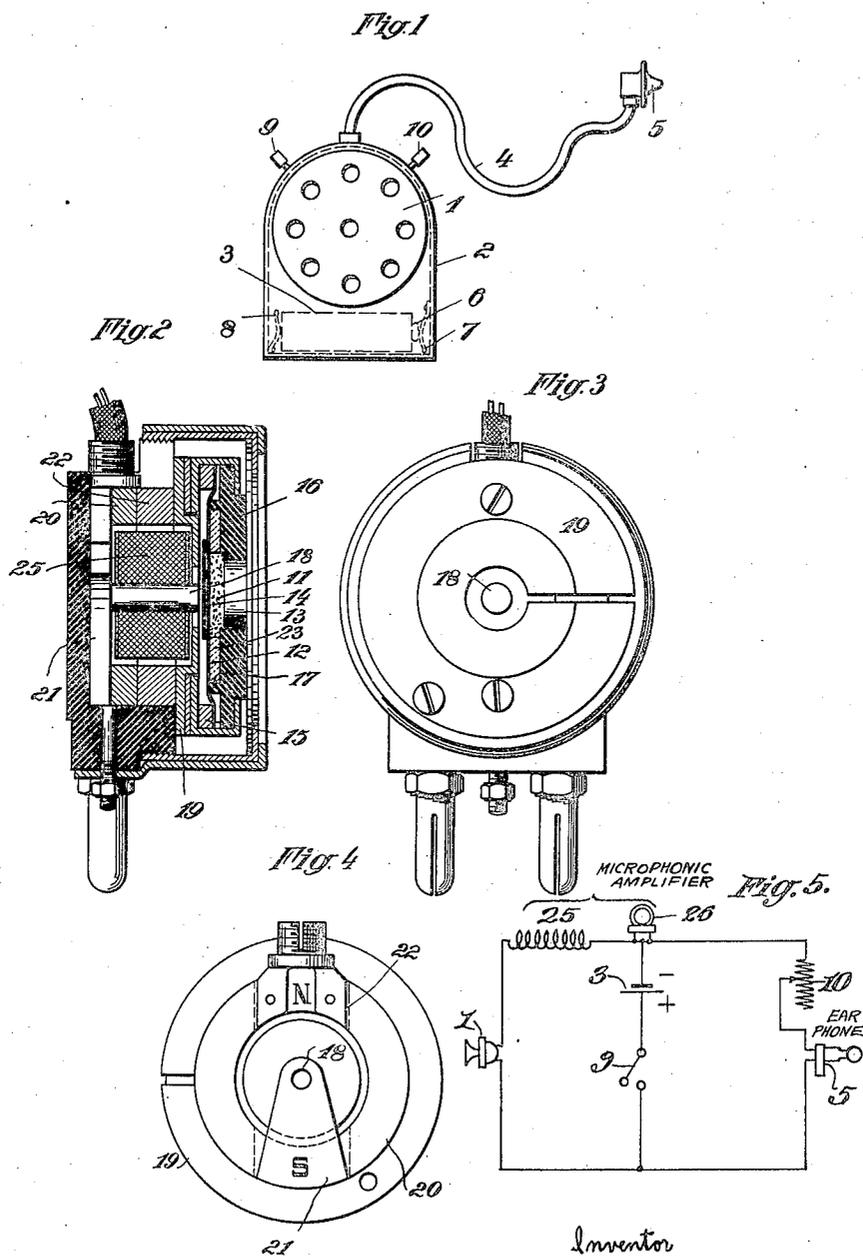
April 16, 1929.

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1,709,747

ELECTRICAL APPARATUS FOR PERSONS DEFECTIVE IN HEARING

Filed Aug. 19, 1926



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Patented Apr. 16, 1929.

1,709,747

UNITED STATES PATENT OFFICE.

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ELECTRICAL APPARATUS FOR PERSONS DEFECTIVE IN HEARING.

Application filed August 19, 1926, Serial No. 130,291, and in Germany August 27, 1925.

The invention relates to electrical apparatus for persons with defective hearing and more particularly to such apparatus in which an amplifying microphone is provided.

5 The known appliances for persons with defective hearing fulfil their purpose only partially, inasmuch as they render understanding possible only in the immediate vicinity. At greater distances the speech is confused
10 and unintelligible. This phenomenon depends upon the relatively great limitation of excitation of the microphone, by reason of which the falling-off of the intensity—which under natural conditions is approximately
15 quadratic—becomes disproportionately steeper. In consequence of this the higher overtones, which characterize the consonants, vanish from the sound picture, on account of their very small intensity. The gaps or lapses of
20 perception become greater and greater until, finally, speech is unintelligible. This effect is still further increased by reason of the fact that the microphone reproduces high frequencies badly. While it is possible now-a-days
25 to construct microphones which transmit speech of a better quality, this, however, is always achieved at the cost of sound amplification. This latter is greater when using a smaller quantity of relatively coarse contact
30 bodies (granules or balls), which, however produce a bad quality of speech. Accordingly, the appliances at present available for persons with defective hearing provide a compromise, which may be effected in various
35 ways, by giving precedence either to sound amplification or to quality of speech. Yet in all these appliances the sound amplification is unsatisfactory. The well known expedient of employing a plurality of microphones
40 does not, in this case, attain the desired object, for, on account of the clumsiness of the apparatus, a natural limit is quickly reached in the neighbourhood of four microphones. Nevertheless, the increased sound amplification thus obtainable is insufficient for most
45 cases, since the ear detects differences of intensity according to a logarithmic scale; thus in cases of severe deafness amplifications are necessary which differ from the ordinary
50 apparatus by several powers of ten.

An obvious solution, already proposed, is to employ a valve amplifier but, first and foremost, this is much too large and too heavy for the purpose under consideration. By rea-

son of its requirements in the way of batteries and transformers. Excepting in a few
55 cases, the practical utility of an appliance for aiding the deaf depends upon its handiness, compactness and small weight.

The present invention has for its object the construction of an appliance for the deaf embodying an amplifier which has the very highest efficiency with respect to sound amplification and quality of transmission and which is nevertheless so small that it can conveniently
60 be concealed in any pocket of the clothing (in the vest pocket, for example). With this arrangement it is of especial importance that the current consumption of the amplifier be very small, with a correspondingly low E. M. F. so that the source of current may be kept
65 quite small. In most cases a single element, giving an E. M. F. of 1.5 volt suffices.

Since primary sound amplification is no longer of paramount importance, microphones producing a particularly high quality
70 of speech may be used. For the same reason the employment of several microphones can be avoided and this measure is advantageous with respect to the speech quality, for with
75 a plurality of transmitter microphones the quality of the reproduction might be seriously impaired by incidental phase differences, which, in consequence of differing degrees of resonance, are dependent upon the frequency.

In the accompanying drawings:

Figure 1 illustrates a general view of a constructional form of the invention, while

Figures 2-4 show in section, in front elevation and in rear elevation, respectively, the amplifier which, is constructed as an amplifying microphone, as will be described more fully hereinafter, and

Figure 5 is a wiring diagram of an illustrative embodiment of the invention.

In the general arrangement, which is shown by way of example, the said amplifying microphone is housed in co-axial relation to a transmitter microphone 1 in a flat box 2, which is provided with a cut-out switch
9 and a regulating resistance 10. The said flat box 2 also contains the source of current
3, in the form of a tubular dry-cell, inserted between spring pressure circuit terminals 7
and 8 and feeding the two circuits (microphone and amplifier) through these contacts.
105 This combined construction renders connecting cords altogether unnecessary, excepting

the current lead 4 which connects the amplifying microphone to a so-called ear-telephone 5 which is inserted into the ear, and the type of which is generally known in the art, for instance as represented by my U. S. Patent No. 1,570,287 or Patent No. 1,406,510 to Weber.

Although the current consumption of this apparatus is less than that of the usual appliances, the sound amplification is extraordinarily enhanced, so that with this appliance, the faculty of good audition is secured by deaf persons whom nothing hitherto could assist. At the same time the whole appliance is smaller and handier, than those known hitherto.

Should it be desired to obtain unusually great sound amplification, more battery cells, three for instance, must be employed; then the battery is not housed in the casing of the apparatus. In this case the amplifier may be mounted on the battery. In this form the amplifier may also be employed as an auxiliary unit, in conjunction with the usual appliances for deaf persons. Speaking generally, a large number of combinations of the individual elements of the apparatus may be employed to meet various requirements.

The novel amplifier which is fully described in my U. S. Patent No. 1,624,511, comprises a microphone which is electro-magnetically controlled. Numerous devices of this sort are known, but in practice no such apparatus has given ultimate satisfaction. All amplifiers operating on this principle have been supplanted by the valve amplifier. The reason for this resides firstly in the fact that as a rule the apparatus require very fine adjustment and are exceedingly sensitive to shocks and vibrations. Further—and this is the most important point—the quality of their speech transmission suffices only for very few cases.

The device which forms the subject matter of this invention is free from these deficiencies. This result has been obtained by a particular construction both of the microphone and of the existing system. It is known that an essential cause of distortion in microphones is to be found in the properties of the diaphragm. That is to say, the diaphragms usually employed generally exhibit, within certain ranges of frequencies, very pronounced natural oscillations, which accentuate individual frequencies of the transmitted sound. This phenomenon is noticeable to an unpleasant degree in the common application of the microphone in conjunction with telephones. It is incomparably emphasized, however, when such a microphone is used as one element of a microphonic amplifier.

A further cause of distortion lies in defective functioning of the microphonic contacts. Apart from the distortions brought about by

the diaphragm, the current fluctuations do not completely correspond to the impressed oscillations. The cause of this phenomenon lies in the fact that in microphones, as a rule, a relatively small number of contacts between the carbons come into operation, which are influenced mechanically in an absolutely uncontrollable manner. As a rule, carbon diaphragms are employed and constitute one electrode of the microphone, while the other electrode is formed of a block of carbon provided with pan-shaped depressions in which are located little carbon bodies (balls or granules) which form contacts with the diaphragm, on the one hand, and with the depressions, on the other hand. In such devices the full potential is necessarily applied to the more or less point-like places of contact between the carbon particles and the diaphragm or the depressions. These places are therefore very heavily loaded so that they work unreliably from a microphonic point of view. In the new amplifying microphone, on the contrary, the potential differences directly at the diaphragm, where the amplitude is greatest, are lowered as much as possible and distributed over the whole of the carbon path.

According to the invention, the microphone comprises a granule chamber 11 closed at one side by a thin stretched metal foil 12 having its surface covered with a precious metal (for instance by gold plating), while the opposite side is likewise bounded by a plane surface, constituted as an insulating body 16, having a central conducting portion 13 in the same plane. This disc-shaped chamber, which has a thickness of a few millimetres, with a diameter of, say, 25 millimetres, is completely filled with proportionately fine carbon granules, to such a degree, however, that these granules are only under the pressure due to their own weight. The fine granule filling produces very good average transmission for all loads, since very many contacts come into operation.

The diaphragm used in the microphone, in co-operation with the carbon granules possesses special physical properties. The diaphragm is made of a metal of high elasticity, phosphor bronze, for preference. It has a thickness of about 1/100th m. m. To its center is soldered a disc-shaped armature 14 of about 10 m. m. diameter of a thickness of about 2/10th m. m. The foil is fastened to a carrier ring 15, preferably by soldering and is stretched radially by a suitable annular ridge 17 on the insulating body 16 which forms the chamber.

With an unfilled chamber, the diaphragm, so stretched possesses a pronounced natural frequency but, in contradistinction to other diaphragms, no overtones. These would determine the formation of nodal lines. For the production of these, it is necessary that the

masses present on both sides of the nodal lines be similar. On account of the much greater mass of the iron armature, in comparison with the mass of the tin foil the formation of nodal lines is not possible with the present dimensions. They must necessarily fall within the armature where, on account of its stiffness they cannot persist. Since the diaphragm, in the arrangement described is of very small weight, its natural frequency, which, as aforesaid, is strongly marked in the open air, if no other precautions be taken, can easily be damped out. When the chamber is filled with granules, the damping, as a rule, is dead-beat. This is also the case when, as shown in Figure 2 a felt ring 23 is inserted in the chamber, so as to provide in the granule filling a central blind spot which may suitably have the same diameter as the armature 14 of the diaphragm. Thus, in general, the diaphragm no longer exhibits natural oscillations.

For the proper working of the amplifier an excitation is necessary which operates uniformly over the entire armature surface. For this purpose the magnet system is provided with concentric poles, one of which surrounds the other, one being a central rod 18, an annular plate 19 surrounding the same. The rod 18 and plate 19 are, by means of suitable pole pieces 21 and 22 magnetically connected to the poles of a permanent magnet 20, which consists of a diametrically magnetized ring. With the uniform effect of an exciter system thus constructed the advantage is secured, according to the invention that the mass of the armature may be very small. In the usual magnet systems the two-poles are as a rule rather widely separated on account of the winding interposed between them. Consequently the armature in such systems must be larger. Stouter material must also be chosen, because the magnetic path is longer. On the contrary, in the arrangement above described, the magnet properties of the armature are utilized to the fullest advantage.

The sound waves which after proper amplification are to be transmitted to the ear of the user by means of the ear telephone 5, first strike the receiving microphone 1, which may be of a conventional construction not specifically shown here, but which should be of such character that it reproduces electrically a high quality of speech as aforementioned. The speaking currents produced in the well known manner by the resistance variation in the carbon granule filling of the microphone are not, as it was customary heretofore, directly transmitted to the ear phone 5, but are conducted into the energizing coil 25 of the microphonic amplifier shown in Figures 2, 3 and 4, which is placed directly behind the receiving microphone 1 in the casing 2 of the apparatus shown in Figure 1. This coil 25 constitutes the electro-magnetic portion of

the amplifying microphone. The effect of these currents in the latter microphone is the setting into vibration of the diaphragm 12, so that the latter can transmit its vibrations to the carbon filling 11 of the amplifier, and thereby change the contact resistance between the carbon granules. By arranging and constructing the diaphragm in the manner described hereinbefore, the effect is obtained that all sound waves, whether they originate through mere extraneous noises, or through speech or otherwise, striking the microphonic amplifier directly have substantially no effect on the latter. In other words, the amplifier will not directly respond to these sound waves, but only to the speaking currents fed into it through its energizing coil 25 from the receiving microphone 1. The speaking currents which are in turn reproduced in amplified form in the microphonic amplifier in the circuit, which includes the carbon filling 11, are then conducted in well known manner through flexible cord 4 to the ear phone 5. The circuits which also include the battery 6 and in which the receiving and amplifying microphone and the telephone 5 are located, are all of conventional character and have been omitted in the drawings.

A further advantage apparent in this construction is that modulation of the microphone may be much more powerful than with ordinary microphones. Having regard to the quality of transmission, modulation reaches a limit where the excitation is so strong that the carbon particles no longer oscillate about fixed points of balance but move freely in relation to each other and fail to return to their original positions (tossing action). Already ordinary microphones can relatively easily be over-modulated acoustically. In contradistinction the microphone of the new amplifier is acoustically very stable. Thus it scarcely reacts at all to sounds striking it directly from the air, such as articulate sounds or tones and it reacts only very slightly or not at all to bodily movement and shaking so that it will transmit and amplify only what is fed into it through the desired channels. Excitation can only be brought about by a comparatively large force and then the reaction takes place only at a very small amplitude, also the exciting energy is not all absorbed at the start at the contact points between the diaphragm and the contact bodies, on the contrary, the absorption is distributed through the whole of the carbon path. The strength of modulation determines the degree to which the current expended is utilized. In ordinary microphones, by far the greater part of the energy expended is best in the form of Joulic heat, since the very large direct current component is superimposed upon only the very smallest of current fluctuations, which alone are effective. With the amplifier the modulation is

very much higher, so that, for the same current consumption a disproportionately greater effect is obtained.

5 What I claim as my invention and desire to secure by Letters Patent is:—

10 1. Electrical hearing apparatus for persons defective in hearing, comprising in combination a receiving microphone for receiving the sound, an amplifying microphonic device electrically connected in cascade to the receiving microphone and being itself substantially insensitive to direct sound striking it from outside, a telephone receiver connected to said amplifying microphone, and
15 a source of current suitably connected to said receiving and said amplifying microphone and to said telephone for energizing said instrumentalities.

20 2. Electrical hearing apparatus for persons defective in hearing, comprising in combination a receiving microphone for receiving the sound, an amplifying microphonic device electrically connected in cascade to the receiving microphone, a casing surrounding said amplifying device to make it substantially sound proof against direct sounds striking it from outside, a telephone receiver connected to said amplifying microphone, and
25 a source of current suitably connected to said receiving and amplifying microphones and to said telephone for energizing said instrumentalities.

30 3. Electrical hearing apparatus for persons defective in hearing, comprising in combination a receiving microphone for receiving the sound, an amplifying microphonic

device electrically connected in cascade to said receiving microphone and being itself substantially insensitive to direct sound striking it from outside, the speech reproducing qualities of said receiving microphone being higher than those of said amplifying device while the sound sensitivity of the receiving microphone is lower than that of the amplifying device, a telephone receiver connected to said amplifying microphone, and a source of current suitably connected to said receiving and said amplifying microphone and to said telephone for energizing said instrumentalities. 40 45

50 4. Electrical hearing apparatus for persons defective in hearing, comprising in combination a receiving microphone for receiving the sound, an amplifying microphonic device electrically connected in cascade to the receiving microphone, the speech reproducing qualities of said receiving microphone being higher than those of said amplifying device while the sound sensitivity of the receiving microphone is lower than that of the amplifying device, a casing surrounding said amplifying device to make it substantially sound proof against direct sounds striking it from the outside, a telephone receiver connected to said amplifying microphone, and
55 60 65 a source of current suitably connected to said receiving and said amplifying microphone and to said telephone for energizing said instrumentalities.

In testimony whereof I affix my signature

HELMUT SELL.