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ELECTRODYNAMIC APPARATUS

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Fig. 1

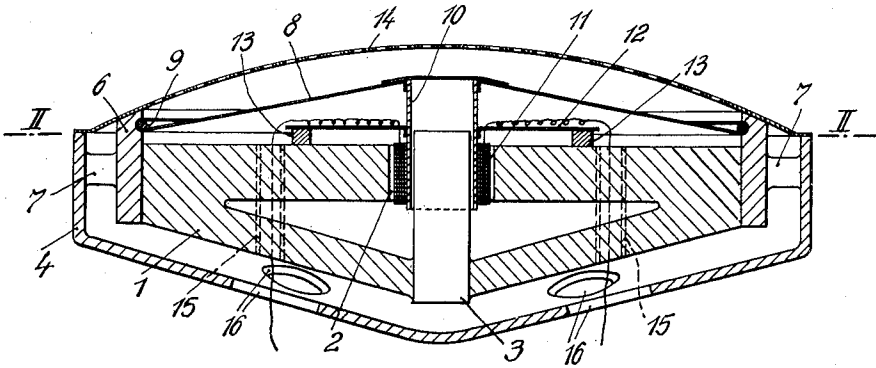
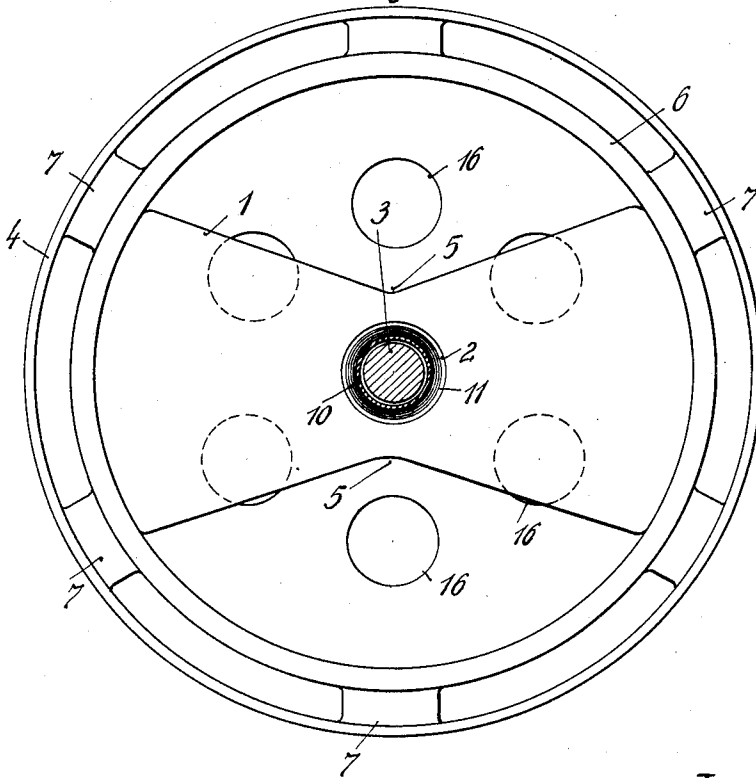


Fig. 2



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ELECTRODYNAMIC APPARATUS

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5 Claims. (Cl. 179-115.5)

The invention relates to an electrodynamic apparatus, which is intended more particularly for use as a receiver, microphone or the like. The object of the invention is to provide an apparatus of this kind, and in particular a receiver, which may be employed for public service, such as public telephone systems. The apparatus, in the manner known per se, is furnished with a diaphragm which is secured at the edge and is operated by an oscillatory coil.

The receivers hitherto employed for telephone systems operate according to the magnetic principle, that is to say—a diaphragm composed of a magnetizable material, such as iron or the like, is arranged in extremely small spacial disposal to the magnet pole, on which are located the windings traversed by the talking current. The tendency towards non-linear distortions in particular, caused primarily by the variable spacing of the diaphragm from the polar surfaces, particularly in the case of large amplitudes, has already resulted in the proposal to construct receivers having special iron armatures or to make use of symmetric and freely oscillating systems similar to those already employed for loudspeaker systems. Although certain advantages were thus obtained, these have not been such as to counterbalance the comparatively high expense associated with special constructions of this character. Moreover the frequency band reproduced is relatively narrow, and does not exceed to an appreciable extent that of the first construction referred to, so that in practice there is reproduced merely a frequency band ranging between several hundred and approximately 3,500 periods, which even then is not entirely lacking in distortion.

The resistance of magnetic receivers employed in standard telephone systems amounts generally speaking to approximately 60 ohms. In public telephone systems, however, a comparatively large number of receivers are of necessity always connected in parallel, so that there is an unproportionately high consumption of energy, which places a considerable load on the total service of an exchange.

It has already been proposed to employ electrodynamic receivers. These receivers are constructed on the basis of the knowledge and experience gained in conjunction with electrodynamic loudspeakers. Within the past few years various electrodynamic receivers have been described designed to overcome the disadvantages aforesaid and to open up a new era in the con-

struction of receivers. For this purpose, for example, there have also been provided greatly complicated diaphragm arrangements in order to obtain the necessary releasing force and in particular to avoid the partial oscillations and combination tones which are associated to a greater or smaller degree with the majority of systems and which, upon simple geometrical reduction in size of the means usual in the construction of loudspeakers, may naturally prove to be a source of considerable aggravation. In particular combined diaphragms have been proposed, which consist, for example, of the combination of two conical surfaces or of a conical surface and a calotte, and further, diaphragms which are so shaped that a cushion of air is formed between the same and a fixed counter-portion for the purpose of avoiding partial oscillations, i. e., non-linear distortions.

These arrangements, however, despite their relatively complicated and expensive construction, have not produced the desired result, apart from the fact that a comparatively large amount of energy is required for their operation. In consequence, in similar fashion to the band-type of loudspeaker, there has been adopted the practice of providing between the poles of the magnet a small and very thin strip or band of aluminium traversed by the talking current. In this connection, however, it has been difficult, if not impossible, to accommodate this arrangement within the small space of a receiver cap, apart from the fact that this arrangement also requires a comparatively large amount of current.

The disadvantages referred to are eliminated by the invention. For the purpose of an optimum reproduction with a minimum consumption of energy there are combined in the electrodynamic apparatus according to the invention a plurality of features which in part are known per se.

Experiments have shown that by reason of the combination of these features as set forth in the following a receiver is obtained which reproduces frequencies of 80 to 8,000 periods with full volume of sound and completely lacking in distortion, in addition to which the consumption of current is merely a fraction of that required by receivers hitherto employed for telephonic purposes. These experiments have shown further that the total effect obtained greatly exceeds a mere total of the single effects resulting from the different features.

The result accomplished with the electrodynamic apparatus according to the invention is of

such an overwhelming kind that the same was not to be foreseen either on the basis of theoretical considerations or in view of the experience hitherto acquired in practice.

5 It is an important point that the receiver according to the invention, whilst using comparatively simple and cheap means, may be constructed so small that it may readily be accommodated in any normal receiver casing, cap or
10 the like.

The features by reason of which the surprising effect aforesaid is obtained are the following:

1. The diaphragm is mounted so softly that it oscillates in piston-like fashion, i. e., with a
15 predominating inertia repression.
2. The diaphragm possesses an oscillatory coil, the resistance of which greatly exceeds that of a standard telephone receiver.
- 20 3. There is employed a permanent magnet field acting on the coil, the lowest density of the lines of force of which magnet field amounts to 1,500 gauss.

4. The receiver casing is furnished with openings or recesses in such fashion that there is
25 a substantially free radiation of sound on all sides.

It has already been proposed to mount a diaphragm as softly as possible so that it will oscillate in piston-like fashion. In this connection, however, it has not been considered that
30 the diaphragm also requires to radiate the sound substantially freely on all sides, and the advantages by the soft mounting are again eliminated by the casing surrounding the diaphragm, which prevents a free radiation of the sound.
35 In an attempt partially to overcome this disadvantage it has been necessary to increase the operating energy in respect of the diaphragm, i. e., to decrease the ohmic resistance of the oscillatory coil. This accordingly results in a
40 further drawback without complete elimination of the first disadvantage. If now a softly mounted diaphragm having a coil, the resistance of which exceeds the resistance of a normal telephone receiver, is mounted in a casing
45 of such kind that a free radiation of the sound on the part of the diaphragm is possible on all sides, it has also not been recognized heretofore that in addition a strong permanent magnet field is necessary, the lowest density of the lines of force of which amounts to 1,500 gauss.
50 In practice there is employed a density of the lines of force amounting to 2,000 to 2,500 gauss, or more, for obtaining a frequency range of 80 to 8,000 periods and a reproduction of adequate sound volume, in which connection there is required for the energy merely a fraction of the current necessary even for a magnetic receiver
55 of particularly good quality.

The surprising result is accordingly arrived at that with low consumption of current the apparatus according to the invention, in contradistinction to the known apparatus, provides
60 a considerably greater volume of sound and also embraces a very much wider frequency range.

This is assisted by the particular dimensioning of the oscillatory coil and of the winding provided on the oscillatory coil. There are applied
70 to the coil several layers, for example approximately seven in number, of a very thin wire having a diameter of .035 to .04 mm. The diameter of the coil will depend on the number of ampere windings.

75 Experiments have shown that the resistance

of the oscillatory coil may be raised to 230 ohms or more.

In order, however, to obtain the effect according to the invention it is absolutely essential to make provision for, as far as possible,
5 a free and unobstructed radiation of the sound by the diaphragm, which should operate as far as possible in purely piston-like fashion, and in connection with which any partial oscillation or the formation of combination tones
10 should be avoided. Any compression of the air, or the formation of air cushions or the like, which act adversely on a natural reproduction, are detrimental and should, therefore, also be
15 avoided.

In consequence the casing in which the electrodynamic receiver according to the invention is enclosed may be so constructed, for the purpose of protecting the receiver against mechanical effects, that a radiation of the sound is able
20 to occur towards the front and the rear. The front and rear cover portions, and if desired also the side walls, must accordingly be furnished with recesses of a sufficiently large size, or should be covered by meshwork or similar
25 means.

In order on the other hand to prevent foreign matter, and more particularly dust, from penetrating through the relatively large apertures into the interior of the receiver, and above
30 all from settling on the diaphragm and affecting the function thereof, an additional seal is effected with the aid of thin gauze, artificial silk or the like, which in practice does not obstruct the radiation of the sound to any appreciable extent.
35

It has been found to be desirable to construct the permanent magnet, the mass of which is partly responsible for the density of the magnetic field, and which in any case in view of the
40 restricted space cannot be made excessively large, in such fashion that it does not entirely fill out the interior of the casing, but is furnished with recesses, in which manner a compressive action on the air is avoided and the
45 sound is able to emerge more or less freely, particularly towards the rear. In order to retain the requisite high magnetic qualities it is sufficient, for example, to provide circularly confined or similarly shaped recesses in the body
50 of the magnet, as shown in the accompanying drawing illustrating the receiver in plan and elevation.

The electrodynamic apparatus according to the invention may be employed not only as a
55 receiver for telephonic, radio and similar purposes, in which it is primarily a matter of maximum intelligibility and natural reproduction, but is also of particular importance for medicinal purposes. Owing to its properties aforesaid the receiver according to the invention is
60 particularly suitable for those afflicted with deafness, who with a large sound amplitude are enabled to distinguish speech, and also for examining heart and lungs, in which fine differences in the reproduction play an important part
65 which are reproduced either not at all or merely inadequately by electro-magnetic systems.

Moreover, the dynamic apparatus according to the invention may be employed not only as reproducing apparatus but also as a recording
70 means, i. e., as microphone, as in this connection the same remarks also apply as set forth relative to the reproduction. The sound amplitudes reaching the diaphragm are converted true
75

to form into speech or music modulated alternating currents, which may be utilised in the usual fashion. Accordingly the invention acquires particular importance as a microphone, also for medicinal purposes.

Further, the electro-dynamic apparatus according to the invention may also be employed for other purposes; for example it may be used with advantage for recording and reproducing sound records on supports of any desired kind, in which connection a particularly natural effect is ensured.

The invention is illustrated by way of example in the accompanying drawing, in which

Fig. 1 is an elevational view of the apparatus in partial section, whilst

Fig. 2 is a section according to the line II—II in Fig. 1.

The apparatus comprises a permanent magnet 1 having the air gap 2 and the core 3. This magnet is of a double-penthouse form, the apex of the angle formed by the two inclined faces being directed away from the diaphragm.

Fig. 2 shows clearly that the permanent magnet fills out merely a portion of the casing 4 surrounding the magnet, and moreover is furnished with recesses or constrictions 5, resulting in the advantages previously referred to. The permanent magnet is surrounded by a supporting ring 6. This ring may be a die-casting or the like. The magnet 1 is supported by the ring 6 in relation to the casing 4 by means of ribs or arms 7. It is also ensured that the magnet in a manner of speaking is suspended freely in the casing, so that recesses are formed of such shape that a detrimental compression of air is essentially avoided.

8 is the diaphragm, which possesses a convex form and may be said to be arranged in symmetrical opposition to the permanent magnet. The diaphragm is secured to the ring 6 by a split ring 9 and carries at the centre the oscillatory coil cylinder 10, on which is mounted the oscillatory coil 11. The oscillatory coil together with its support and also the diaphragm are additionally supported on the flat face of the permanent magnet 1 by the spider 12 with the supports 13.

The entire system is covered wholly or in part at the top by a screen 14. The leads to the oscillatory coil are passed to the outside through tubular passages 15 and orifices 16 in the wall of the casing.

Fig. 1 in particular shows that by reason of the free suspension of the magnet system in the casing, by the provision of several apertures 16 and by the use of the screen 14 there is rendered possible a free and unobstructed radiation of the sound.

What I claim as new and desire to secure by Letters Patent is:

1. In a device of the character described, the combination of a casing having a circumferential outer wall, and an inner ring spaced therefrom, a bottom wall provided with openings and a top wall provided with openings, a permanent magnet fixedly supported by said ring and spaced from the outer wall, the upper wall and the lower wall the interior of the casing being free of obstructions between the magnet and the casing, a central pole piece secured to said permanent magnet and projecting through the same with clearance, a diaphragm fixedly mounted along its edge free of said magnet and subject to a predominating inertia repression, a tubular

coil support centrally mounted on the diaphragm, and a voice coil carried by said tubular support within the annular gap between said central pole piece and the permanent magnet, the vibrations inducible in said diaphragm upon energization of said coil being adapted to move freely into and out of the casing through the openings in the opposite walls thereof.

2. In a device of the character described, the combination of a circular casing having a perforated bottom wall and a perforated top wall, a permanent magnet fixedly mounted in said casing and spaced from said walls, a central pole piece fixed to said magnet and projecting with clearance from one portion of said magnet into another portion thereof centrally of the casing, a diaphragm fixedly supported along its margin subject to predominating inertia repression the distance between the central portion of the diaphragm and the top of the pole piece being greater than the distance between the marginal portion of the diaphragm and the magnet, a tubular coil support centrally mounted on said diaphragm and projecting from a part of the diaphragm above the top of the pole piece into the clearance between said central pole piece and said magnet, and a coil mounted on said tubular support within said clearance, whereby upon vibration of the diaphragm induced by energization of said coil, the air impelled by said diaphragm can freely move in opposite directions into and out of said casing.

3. In a device of the character described, the combination of a flat circular casing having an apertured bottom wall and an apertured top closure, an annular support in the interior of the casing, equidistantly spaced and in fixed relation to the circumferential wall, a permanent magnet fixed to said annular support within the casing, a central pole piece projecting from one portion of the permanent magnet into another portion of the same with clearance between said other portion and said pole piece, a diaphragm of substantially conical shape marginally fixed on the casing subject to predominating inertia repression, a tubular coil support mounted on the highest portion of said diaphragm and projecting into the clearance space between said central pole piece and said other portion of the magnet, a coil carried by said tubular support within said clearance space, the coil having a minimum resistance of 120 ohm, whereby upon impression of currents of greatly varying frequency upon the coil, the resistance remains substantially unaltered, the openings in the casing being adapted to freely permit ingress and egress of air under the influence of the vibrations of the casing induced by the impression of alternating current on the coil.

4. In a device of the character described, the combination of a circular casing having a perforated top closure and a bottom wall provided with apertures, an annular support fixedly united to the circumferential wall of the circular casing and spaced therefrom so as to leave an annular interspace between said circumferential wall and said annular support, a permanent magnet fixed to said annular support within the casing spaced from all of the walls thereof, said permanent magnet being in engagement with said annular support along opposite arcuate portions, the central portion of the permanent magnet being of less width than the arcuate portions at which it is mounted on said annular support, a central pole piece projecting through said per-

manent magnet with clearance around said pole piece, a diaphragm fixedly secured at its margin within the interior of the casing and subject to predominating inertia repression, a coil support centrally secured to said diaphragm, and a coil carried by said support in the clearance space between said central pole piece and said permanent magnet, said coil having a minimum resistance of 120 ohm, whereby currents of voice frequency and greater than voice frequency when passed through the coil will encounter substantially constant resistance.

5. In a device of the character described, the combination of a flat circular casing having a bottom wall provided with openings and a top closure provided with openings, a permanent magnet secured within said casing so as to be spaced from all of the walls of the same, said permanent magnet having an upper portion and

a lower portion joined together at their outer edges, said outer edges being arcuate and opposite each other and occupying an arcuate extent of considerably less than 360 degrees, whereby upon both sides of said permanent magnet, the interior of said casing remains unoccupied, a central pole piece secured to the lower portion of said permanent magnet and projecting through the upper portion thereof with clearance around said pole piece, a diaphragm marginally fixed in the interior of the casing for predominating inertia repression, a tubular support centrally secured to said diaphragm and projecting in direction towards said pole piece, a coil carried by said tubular support in said clearance space, and means on the magnet for guiding said tubular coil support for rectilinear movements towards and away from said central pole piece.

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