Oct. 13, 1925. 1,557,356

E. GERLACH

ELECTRODYNAMIC LOUD SPEAKING APPARATUS

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Fig. 1

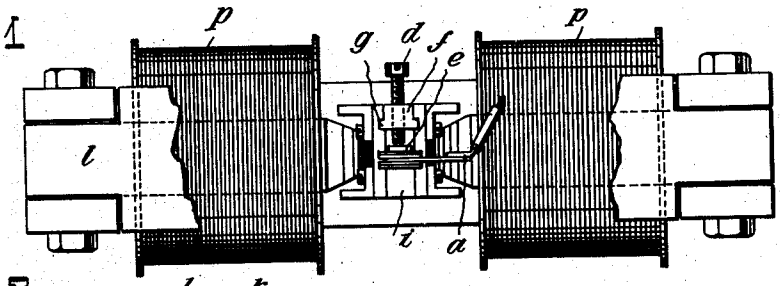
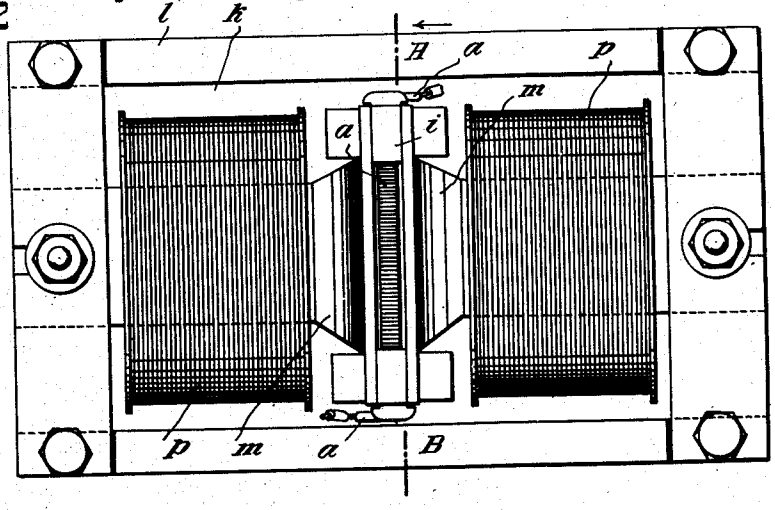


Fig. 2



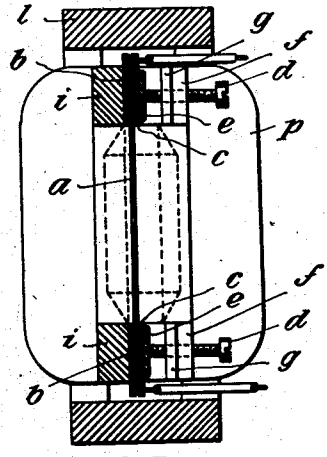


Fig. 3

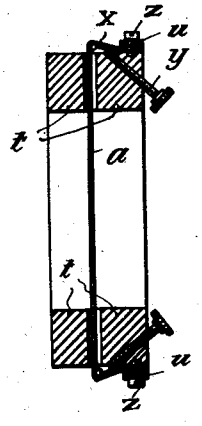


Fig. 4

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ELECTRODYNAMIC LOUD SPEAKING APPARATUS

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Fig. 6.

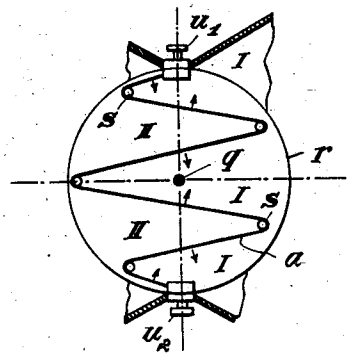
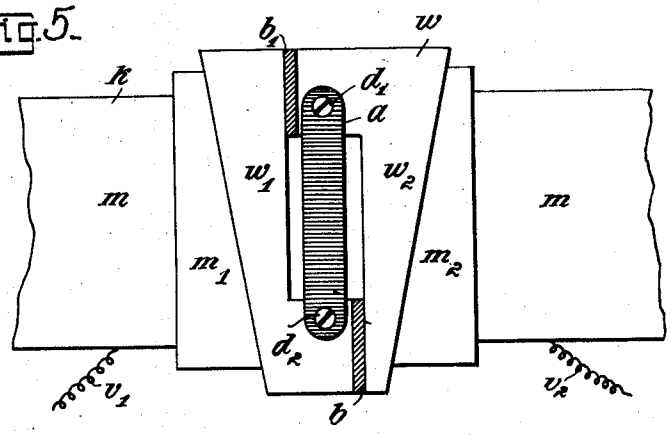


Fig. 5.



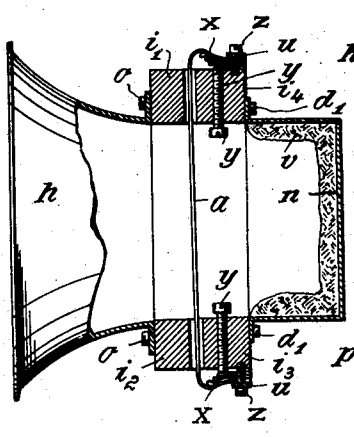


Fig. 8.

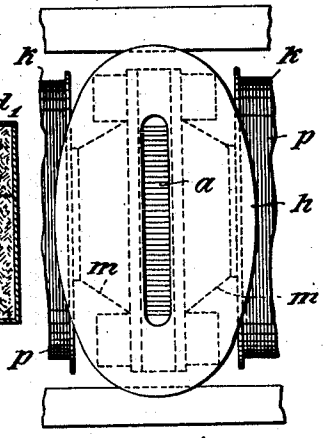


Fig. 7.

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UNITED STATES PATENT OFFICE.

ERWIN GERLACH, OF SIEMENSSTADT, NEAR BERLIN, GERMANY, ASSIGNOR TO SIEMENS & HALSKE, AKTIENGESELLSCHAFT, OF SIEMENSSTADT, NEAR BERLIN, GERMANY, A CORPORATION OF GERMANY.

ELECTRODYNAMIC LOUD-SPEAKING APPARATUS.

Application filed January 12, 1924. Serial No. 685,812.

To all whom it may concern:

Be it known that I, ERWIN GERLACH, a citizen of the German Empire, residing at Siemensstadt, near Berlin, Germany, have invented certain new and useful Improvements in Electrodynamic Loud-Speaking Apparatus, of which the following is a specification.

My invention relates to improvements in electrodynamic acoustic devices.

It has already been proposed to design electrodynamic sound responsive devices, such as microphones or loud-speaking telephones in such a manner, that the diaphragm itself forms the current carrying conductor and is stretched between the two poles of a magnet. The diaphragm is set in oscillations by the influence of the magnetic field.

Such devices have, however, such great disadvantages, that their practical application was hitherto not possible, particularly for the reason that the diaphragm does not comply with the requirements made upon it and that the entire arrangement leaves much to be desired.

My invention relates to an electrodynamic sound responsive device of this kind which satisfies all the demands made upon it. Above all an exceedingly natural reproduction of the actual sound of the human voice is attained.

It is obvious to any one skilled in the art that the devices described and shown herein may serve for the conversion of electrical energy into sound energy as well as for converting sound energy into electrical energy without changing the construction of the device. In other words, the devices shown may serve as a telephone and a microphone as well, though in the specification in general the device is described as a "loud speaker."

The diaphragm, which consists of a very fine metal foil, for instance aluminum, is resiliently arranged under light tension in such a manner that it may perform oscillations of large and approximately equal amplitude almost across its entire surface. This is preferably attained by constructing the diaphragm so that it possesses a high resiliency, for instance by transversely corrugating and subsequently stretching it during the clamping. Preferably the diaphragm is passed over the rounded edges of adjustable flat springs. The weight of the diaphragm is preferably chosen equal to the weight of the volume of air taking part in the oscillations. A suitable confinement of the air chamber can be effected by means of funnel-shaped sound guides. In order to facilitate the changing of the diaphragm it is suitably disposed on a special carrier, preferably of wedge-shape, whereby a very convenient supply of the electric current is ensured.

In order to attain very loud reproduction, it is in some cases, particularly when it is desired to save space, advisable to employ instead of a plurality of diaphragms a single one, which is disposed in zigzag between the poles of the magnet.

If the loud speaker is intended to emanate sound in one direction only, the other side of the diaphragm is preferably enclosed by a sound-damping, adjustable cavity.

In the accompanying drawings embodiments of my invention are illustrated diagrammatically in the form of a loud speaker. The drawings represent in:—

Fig. 1, a plan of one construction of my improved loud speaker,

Fig. 2, a side elevation of Fig. 1,

Fig. 3, a cross-section along line A—B of Fig. 2,

Fig. 4 some details of the manner of supporting the diaphragm,

Fig. 5 the arrangement of the diaphragm upon a special carrier,

Fig. 6, a diaphragm disposed in zigzag,

Fig. 7 the arrangement of a sound guiding device in front view and

Fig. 8 a vertical cross-section through a loud-speaking telephone the diaphragm of which is enclosed at one side by a sound-damping chamber, while at its other side it is provided with a sound funnel.

Similar parts are indicated by the same reference characters in all figures.

Referring to Figs. 1–3, it will be seen that the diaphragm *a* constructed in the form of a straight strip of aluminum is transversely grooved or corrugated and clamped at each end with a certain light preliminary tension between an insulating piece *b* and a contact piece *c*. An adjusting screw *d* abutting with its point against a washer *e* serves for clamping the diaphragm in posi-

tion. The adjusting screw d is journaled in a T-shaped piece f, which engages grooves g of a U-shaped bearing piece i in which the ends of the diaphragm are disposed.

The electromagnet has preferably a rectangular yoke l with poles m arranged in axial alinement and upon which are mounted coils p traversed by energizing direct current, provided an electromagnet is employed. A permanent magnet may, however, equally well be employed. According to whether the device is used as a loud speaker or a microphone, the speech current is supplied to the diaphragm a or carried away from it respectively by means of the contact pieces c connected with the line adapted to conduct these currents. The ribbon diaphragm is disposed between the poles of the magnet so that its plane stands in line with the direction of the magnetic lines of force, these lines passing across the ribbon.

The diaphragm may preferably be given a light preliminary tension in the direction of its length, a suitable device, for this purpose being illustrated in Fig. 4. Referring to this figure it will be seen that the diaphragm a disposed between the poles of the magnet passes at its ends over flat springs x rounded at their ends and which are adapted to be forced outwards by means of screws y thus putting the diaphragm under tension. The diaphragm and the springs are fixed between the abutments t and the washers u by screws z.

Referring to Fig. 5 the diaphragm is shown mounted on a special carrier. On the poles m of the magnet k are mounted the wedge-shaped pole shoes m_1 and m_2. Between the pole shoes is fixed the diaphragm carrier w upon which the diaphragm a is attached by means of screws d_1, d_2, preferably by means of guide grooves. The carrier w which consists of the parts w_1 and w_2 separated by the insulating layers b_1 and b_2 possesses a central recess across which the diaphragm a is stretched. The magnet core is preferably furnished with an electrically insulated break, so that the alternating current can be passed to the diaphragm a by means of the conductors v_1 and v_2 across the poles m, the pole shoes m_1 and m_2 and the carrier parts w_1 and w_2. In order to improve the contact faces of the diaphragm carrier, which make contact with the pole shoes, are preferably provided with a well conducting metal covering, which may consist of copper, silver and the like.

The arrangement of the diaphragm upon a special carrier is applicable for any kind of diaphragm, in particular for such which are stretched in zigzag, as shown in Fig. 6. Referring to this figure, it will be seen that one of the magnet poles is formed or provided with a pin q upon which is placed a thin disc r. Upon this disc are provided at the top and at the bottom the two clamps u_1 and u_2, for stretching the diaphragm ribbon and pins s, which consist of non-magnetic material, such as brass with a coating of shellac or enamel in order to insulate the ribbon passed around these pins.

In order to facilitate the insertion of the ribbon, the pins s and the bore holes for their reception are preferably provided with screw thread, and the pins inserted only when the ribbon is stretched across the disc.

At a certain moment during the talk the ribbon will perform the movement indicated by the arrows, for instance. The air will then be compressed in the spaces I and expanded in the spaces II as indicated by arrows. From the two sides of the diaphragm thus two sound waves emanate simultaneously, which waves possess a phase difference of 180°.

The Figure 7 shows in front view the arrangement of funnel-shaped sound guides for the purpose of limiting the volume of air taking part in the oscillations of the diaphragm.

In Fig. 8 the arrangement of a sound-damping chamber at the other side of the diaphragm is shown in vertical longitudinal section.

Referring to these figures, it will be seen that the diaphragm a is arranged between the poles m of an electromagnet k. Upon the poles are mounted the coils p. The space between the edges of the diaphragm and the poles is preferably chosen smaller than half the width of the diaphragm. The diaphragm is disposed between bearing pieces i_1 to i_4 and is subjected to a light preliminary stretching by means of springs x consisting of superimposed leaves, in the manner of carriage springs, fixed by set screws z and washers u upon the bearing pieces i_3 and i_4 and adapted to be forced outwards by adjusting screws y. Upon the bearing pieces i_1 and i_2 a funnel-shaped structure h, which may, for instance, consist of aluminium sheet metal coated with a suitable varnish, is fixed by means of screws passing through bores in the edge of the funnel h bent off at substantially right angles. At the other side of the diaphragm a casing or cap n is mounted upon the supporting pieces i_3, i_4 by means of screws d_1, which cap is lined with a sound absorbing material, such as felt or the like. The volume of this cap may be made adjustable, if desired.

It will be understood, that the funnel h may be attached in any other suitable manner, for instance by means of special carriers. Care must be taken, however, that it comes up so closely to the diaphragm, that as far as possible the entire oscillation energy of the diaphragm radiating from that particular side is transmitted to and

taken up by the body of air in the funnel without the production of disturbing oscillations.

For loud-speaking telephones, which should be effective towards both sides on each of the two sides of the diaphragm a funnel should preferably be provided as sound guide. In case interferences are to be anticipated funnels the dimensions of which differ from each other are chosen.

It will be understood that I do not limit myself to the exact details of the constructions described and shown by way of example, but that modifications within the scope of the claims will suggest themselves to persons skilled in the art, without departing from the spirit of my invention or sacrificing any of its advantages.

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

1. In an acoustic device for converting electrical energy into sound energy or sound energy into electrical energy, a light ribbon-shaped conductive diaphragm, disposed between the poles of a constant field magnet and adapted to carry alternating speaking currents, said diaphragm having means for rendering it elastic to enable it to perform motions transversely to its plane of approximately equal amplitude over its entire length.

2. In an acoustic device for converting electrical energy into sound energy or sound energy into electrical energy, a light ribbon-shaped conductive diaphragm, disposed between the poles of a constant field magnet and adapted to carry alternating speaking currents, said diaphragm having means for rendering it elastic to enable it to perform motions transversely to its plane of approximately equal amplitude over its entire length, and means for maintaining said diaphragm under slight tension.

3. In an acoustic device for converting electrical energy into sound energy or sound energy into electrical energy, a light ribbon-shaped conductive diaphragm, disposed between the poles of a constant field magnet and adapted to carry alternating speaking currents, said diaphragm having transverse corrugations for rendering it elastic to enable it to perform motions transversely to its plane of approximately equal amplitude over its entire length.

4. In an acoustic device for converting electrical energy into sound energy or sound energy into electrical energy, a light ribbon-shaped conductive diaphragm, disposed between the poles of a constant field magnet and adapted to carry alternating speaking currents, said diaphragm having transverse corrugations for rendering it elastic to enable it to perform motions transversely to its plane of approximately equal amplitude over its entire length, and means for maintaining said diaphragm under slight tension.

5. In an acoustic device for converting electrical energy into sound energy or sound energy into electrical energy, a ribbon-shaped conductive diaphragm disposed between the poles of a constant field magnet and adapted to carry alternating currents, said diaphragm being of a weight substantially equal to the weight of the volume of air between which volume and the diaphragm the energy exchange occurs, said diaphragm having transverse corrugations and means for maintaining it at slight tension to enable it to perform motions transversely to its plane of approximately equal amplitude over its entire length.

6. In an acoustic device for converting electrical energy into sound energy or sound energy into electrical energy, a ribbon-shaped diaphragm consisting of aluminum foil not substantially exceeding one-hundredth of a millimeter in thickness and being provided with transverse corrugations, said diaphragm being disposed between the poles of a constant field magnet and adapted to carry alternating currents and means for maintaining said diaphragm under slight tension to enable it to perform large motions transversely to its plane of approximately equal amplitude over its entire length.

In testimony whereof I affix my signature.

ERWIN GERLACH.