July 5, 1927. **1,634,292**

K. M. LEDERER

ART OF THE TRANSMISSION OF SOUND

Filed March 20, 1922 2 Sheets-Sheet 1

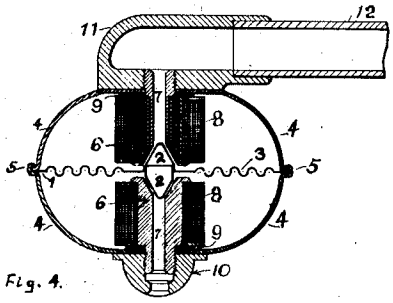


Fig. 4.

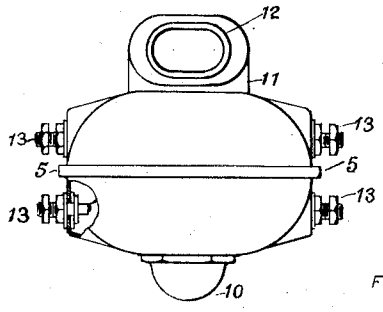


Fig. 5.

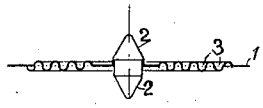
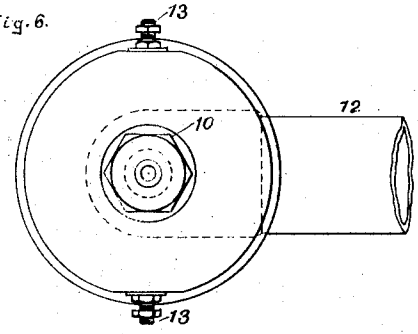


Fig. 2.

Fig. 6.



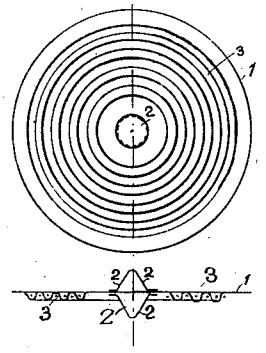


Fig. 1.

Fig. 3.

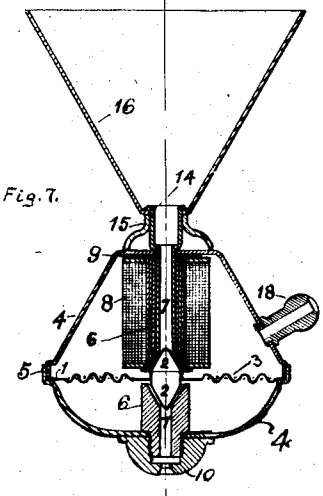


Fig. 7.

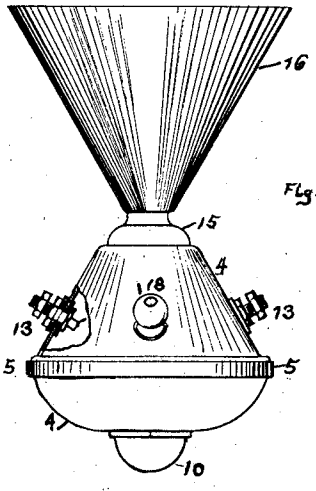


Fig. 8.

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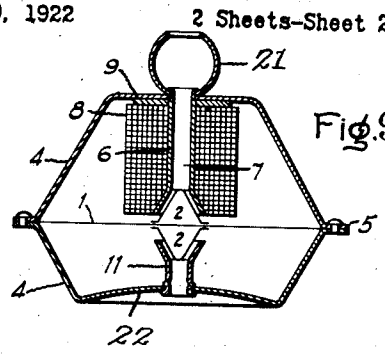


Fig. 9.

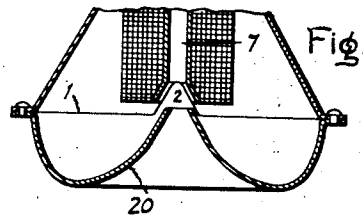


Fig. 10.

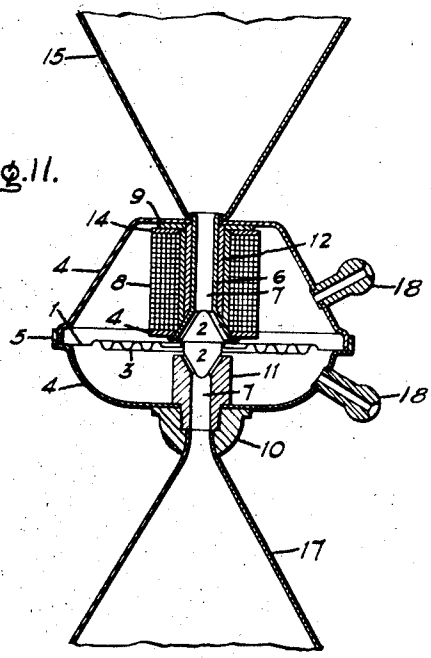


Fig. 11.

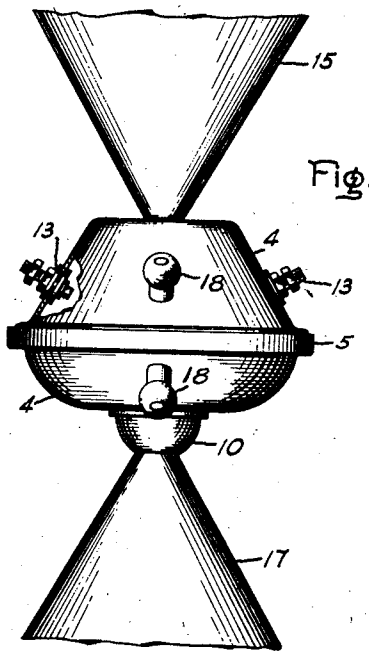


Fig. 12.

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Patented July 5, 1927. 1,634,292

UNITED STATES PATENT OFFICE.

KARL MARTIN LEDERER, OF NEWARK, NEW JERSEY.

ART OF THE TRANSMISSION OF SOUND.

Application filed March 20, 1922. Serial No. 545,293.

My invention relates to the mechanical and electromagnetical-mechanical transmission of sound by means of a diaphragm as it prevails in phonographs, telephone receivers, microphones and transmitters for ordinary as well as wireless telephony and the present invention has reference, more particularly, to a novel sound-transmisison device provided with a diaphragm which, due to its special construction and the material of which it is made is of extremely high elasticity and rigidity; and under otherwise equal conditions, will transmit and reproduce sounds more audibly than with the ordinary telephone diaphragm, since my novel diaphragm swings over a wider angle and therefore into motion a greater volume of air. The invention is also adapted for use in producing original records for phonographs, and the features above stated are also important in this respect.

When used for so-called telephone receivers with electromagnetic action, the diaphragm is provided with a cone shaped armature which shall swing between correspondingly shaped cores (or pole pieces) thereby permitting the diaphragm to swing over a wider angle than that of ordinary receivers.

The construction is also such that there is a special path provided for the oscillating air, the conical armature acting as a valve or as piston in a pump, driving the air into the ear or other channels adapted for the reception, or transmission of the sound waves of such device as the megaphone and so called loud speakers and recording devices.

By the introduction of a stream of air into the air chamber, formed by the case and diaphragm of the receiver, which stream of air, when desirable may be regulated in strength and which stream of air must eventually pass through the only path left open for it, that is the opening in the core around the cone of the diaphragm, the loudness of the sound shall be magnified still further and possibly modulated.

This principle can readily be applied for phonographs and any similar speaking devices, which depend upon a diaphragm as an agency, but with neither of the above-mentioned apparatuses or devices is the throttling action of the cone on the diaphragm an absolute necessity, and where desirable the cone may be omitted and a flat armature be applied.

With the various objects and purposes herein-above stated, the present invention consists, primarily, in the novel sound-transmitting device hereinafter more fully set forth; and, the said invention consists, furthermore in the novel arrangements and combinations of the several devices and parts, as well as in the details of the construction of the same, all of which will be described in the following specification, and then finally embodied in the clauses of the claims, which are appended to, and which form an essential part of the said specification.

The invention is illustrated in the accompanying drawings, in which:—

Figure 1 is a plan view of a diaphragm, showing one embodiment of the principles of the present invention; Figure 2 is a vertical section of the same; and Figure 3 is a vertical section of a slightly modified form of diaphragm.

Figure 4 is a transverse vertical section; Figure 5 a side elevation; and Figure 6 a plan view of a telephone receiver embracing the novel features of the present invention.

Figure 7 is a vertical sectional representation of another design of receiver or transmitter; and Figure 8 is a side elevation of the same, with a portion of the device being represented in section.

Figures 9 and 10 are vertical sectional representations of other slightly modified forms of receivers; Figure 11 is a transverse vertical section of a double-acting loud-speaking receiver embodying the principles of the present invention; and Figure 12 is a side elevation of the same.

Similar characters of reference are employed in all of the said above described views to indicate corresponding parts.

Referring now more particularly to said Figures 1, 2 and 3, the numeral (1) represents the diaphragm disk, (2) the armature, which, in all figures where visible, has the shape of a single or double cone, but which may also be only a plain part of the diaphragm or which may in the case of a non-magnetic diaphragm consist of a magnetic disk or a flat ring.

The armature (2) may be part of the dia-

phragm as in upper part of Figure (2) or in upper part at left hand side of the view in Figure (3); or it may be staked in, as in lower part (2) in Figure (2); or it may be cemented, riveted, or screwed to the diaphragm as indicated in right hand side section of Figure (3).

The diaphragm is provided with an arrangement of annular grooves and ribs (3) which serve to increase flexibility and strength of the diaphragm. The grooves and ribs (3) in Figure (2) are arranged symmetrically to the original plane of the diaphragm, while the grooves in Figure (3) are all on one side of the original plane of the diaphragm. This latter form possesses certain advantages of manufacture. The cross-section of such a diaphragm shall show V or U shaped grooves or grooves of a sinusoidal character.

Wherever the diaphragm disk is an integral part of the path of the magnetic flux it must be of a magnetic material. In cases, however, where it is acting solely mechanically, the principal requirements are, high flexibility, durability and permanency. Besides the already well known materials used for this purpose such as steel, iron, mica, phosphor bronze, aluminum, aluminum alloys, etc., I may use hardened and properly tempered steel, cellon, celluloid and bakelite, condensite, and any other suitable compound or material capable of being moulded, pressed, machined or otherwise formed into the desired shape.

Referring now to Figure (4) the numerals (4), (4) indicate the two sections of pressed steel or iron, connected to provide a suitable case which may serve either as a permanent magnet or as the yoke for an electromagnet. The joint 5—5, between the two sections of the case is preferably made in the form of annular bands folded over the two sections of the case for holding them together, the diaphragm (3) being suspended between the two sections of the case. The tubular core (6) of the electromagnet may either be solid or laminated (with laminations arranged in a spiralic tube) as indicated in Figures 4 and 11, or it may be drawn in the form of a tube as shown in Figures 9 and 10.

This core is hollow so as to provide for an air path (7) and it is widened out towards the center of the diaphragm for reception of the armature 2.

The winding (8) of the electromagnet may either be wound on a light spool or may be made selfsupporting as shown in Figures 9, 10 and 11. One end of each of the cores in Figure (4) is screw threaded and the lower core is held in place by means of a suitable nut (10). This nut serves also as an ear funnel, by means of which the sound waves are directed into the ear. The upper core is screwed into an outlet (11) which carries a tubular extension (12) by means of which acoustic connection may be established to the other ear, thereby providing a double acting phone. Numeral (9) indicates a washer which insulates the winding from the case and (13), (13) are binding posts for the electrical connection from the winding of the electromagnet to the external electrical circuit.

In the construction represented in Figures 7 and 8 the joint (5), (5) between the two sections of the case is made either by a tight fit or by screwing one section into the other. The lower case has a recess into which the diaphragm (3) is fitted. The upper section of case (4) has the shape of a cone and is increased in height at the expense of the lower section as there is only one winding (8) used in said lower section being formed with an inwardly extending and suitably curved portion, as 17.

The tubular core (6) in Figure (7) has an extension (14) to which is secured by means of a collar (15) (which however could also be omitted) a horn or megaphone (16). The tubular core (6) as has been described in connection with the device shown in Figure (4), but it may be added that in Figure (6) the lower core is staked or screwed into the ear funnel (10). It is obvious that, when desirable, another megaphone, as 17, could be attached for the other side of the diaphragm as indicated in Figures 11 and 12 of the drawings. If however only one megaphone is to be used and both sides of the diaphragm shall be utilized and connected to it, then acoustic connection has to be made so that said connections shall be in opposition, since there exists a phase difference of 180 degrees between the two sides of the diaphragm.

In the upper section of Figures (7) and (8) a nozzle (18) is shown through which a continuous stream of gas (air) is passed whereby the sound is amplified, the action and purposes of which has been previously stated. It is obvious that both sides of the receiver could be provided with such gas (air) amplifiers, as indicated in said Figures 11 and 12 of the drawings.

Referring now to the modification shown in Figure 7 of the drawings, the two sections 4, 4 are held together by the screws or rivets 5, whereby the diaphragm is properly positioned and securely clamped in place.

This construction of the device differs from the device herein-before described, in that the core 6 is in the form of a tube, suitably widened at the bottom for reception of the armature 2 therein. In its upper end, the core is staked or spun into the case, where it also carries a nozzle 21 with which, by means of a flexible tube, acoustic connection (which is not shown) may be established to the other ear. The lower section

of the case 4 is caved in at 22 to perform the functions of an ordinary receiver of a head set. A short pole piece 11 also of a tubing, is staked to the member 22 on the inner side of the case; but the latter could also assume this function if it were drawn and spun out as will be evident.

Figure 10 differs from Figure 9 only in the lower part of the case and the form of diaphragm applied. Only one view has been given of the modifications represented by Figures 9 and 10, as it is thought, that the other views with the rest of the ordinary details could readily be imagined. Figure 10 represents a receiver transmitter with a single cone-shaped armature and one may speak into the lower section of the case 20, which approaches the form of a mouth piece of a transmitter and which is to be made preferably of metal, but which could naturally be made of composition. One could also receive messages at the upper end, when acoustic connection to one or both ears is established by means of flexible or semi-flexible tubes and earpieces. It can readily be imagined that such a receiver transmitter could be provided with bands, straps, etc., to be carried on the head by any telephone operator without being held in any way by the hand, as such is already done when separate instruments are provided for transmitter and receiver. Contrary to the ordinary receiver, the receiver and receiver transmitter just described can successfully be operated over long and high resistance lines, as their windings consist of a great many turns over an iron core of substantial cross section and an impedance (of several thousands of ohms) which can readily be made congruent to the resistance, inductance and capacitance of long lines.

The improved diaphragm, when same is combined with the air amplifier can readily be used in the microphone of a phonograph, and similar devices, and the available motive power can be utilized to drive a small fan, turbine or bellows to furnish a continuous stream of air for the air amplifier.

As there is in a receiver, wound and constructed for high impedance, with substantial iron core and thousands of turns, etc., a comparatively large amount of energy available, especially if said phone is provided with a highly flexible diaphragm a cone shaped armature and suitable core and pole pieces, it can be also used for the recording of telephone messages directly into phonograph records (even over long distance lines), if the necessary recording mechanism has been provided and has been connected to the diaphragm of the receiver.

And again, reversing conditions, a phone, as just described, may be used for the reproduction of phonograph records over long telephone lines or by means of wireless telephony. Instead of using carbon microphones, or the like, I use one or a number of receiver transmitters and then employ the well known means of transmission for ordinary or wireless telephone.

And, going one step further, I establish a direct mechanical transmission of the motions of a needle or lever, following with one end the indentations of a (phonograph or gramophone, etc.) record, to the diaphragm of a receiver transmitter of the proper impedance and electrodynamic capacity, so that by the motions of the diaphragm, electrical currents are generated in the phone congruent to the motions of the diaphragm and the original sound ways graphically imbedded in the record.

It is evident, that by the latter procedure, less distortion of sound and electrical current waves will result; because one step of the transformation is entirely eliminated, (the step from the diaphragm of the phonograph to the diaphragm of the microphone) and the process of reproduction, especially with regards to clearness, has been materially improved. In this respect (acoustically) the receiver is by far superior to the microphone, and last but not least, the whole energy set free by the mechanically operated diaphragm of the phonograph receiver transmitter is available for the generation of electrical currents and the efficiency must therefore reach a maximum.

From the foregoing description it will be evident, that I have produced a diaphragm, made of any suitable material, such as celluloid, cellon, and of analogous material, or of metal, for uses in devices for the transmission of sound, and it is understood that such devices also include those for recording sound waves, devices for taking original phonographic records, gramophones, and the like, and such other devices which serve more strictly in the transmission of sounds, as in telephone receivers, transmitters, microphones, and the like.

I claim:—

1. A diaphragm for devices of the character specified comprising a disk-shaped element provided with a cone-shaped armature, and concentrically disposed annular grooves.

2. A diaphragm for devices of the character specified comprising a disk-shaped element provided upon its opposite faces with cone-shaped armatures, and concentrically disposed annular grooves.

3. A diaphragm for devices of the character specified comprising a disk-shaped element provided with a cone-shaped armature of magnetic material, and concentrically disposed annular grooves.

4. A diaphragm for devices of the character specified comprising a disk-shaped element provided upon its opposite faces with

cone-shaped armatures of magnetic material, and concentrically disposed annular grooves.

5. In a device for the transmission of sound, and similar apparatus, a diaphragm, associated with a tubular core, consisting of spirally wound laminations, and a coil wound upon said core.

6. In a device for the transmission of sound, and similar apparatus, a diaphragm comprising a disk-shaped element provided with a cone-shaped armature, associated with a tubular core provided with a cone-shaped opening fitted over said armature, and a coil wound upon said core.

7. In a device for the transmission of sound, and similar apparatus, a diaphragm comprising a disk-shaped element provided with a cone-shaped armature, associated with a tubular core consisting of spirally wound laminations and provided with a cone-shaped opening fitted over said armature, and a coil wound upon said core.

8. In a device for the transmission of sound, and similar apparatus, a casing comprising a pair of sections, a diaphragm disposed between and held in place by said sections, means connected with said casing for admitting air into the same, associated with a tubular core, and a coil sound upon said core.

9. In a device for the transmission of sound, and similar apparatus, a casing comprising a pair of sections, a diaphragm disposed between and held in place by said sections, means connected with said casing for admitting air into the same, a cone-shaped armature associated with said diaphragm, a tubular core provided with a cone-shaped opening fitted over said armature, and a coil wound upon said core.

10. In a device for the transmission of sound, and similar apparatus, a casing comprising a pair of sections, a diaphragm disposed between and held in place by said sections, and each section being provided with an air-inlet for admission of a continuous stream of air into said casing and about the diaphragm.

11. In a device for the transmission of sound, and similar apparatus, a casing comprising a pair of sections, a diaphragm disposed between and held in place by said sections, and each section being provided with an air-inlet for admission of a continuous stream of air into said casing and about the diaphragm, associated with a tubular core, and a coil wound upon said core.

12. In a device for the transmission of sound, and similar apparatus, a casing comprising a pair of sections, a diaphragm disposed between and held in place by said sections, and each section being provided with an air-inlet for admission of a continuous stream of air into said casing and about the diaphragm, a cone-shaped armature associated with said diaphragm, a tubular cone provided with a cone-shaped opening fitted over said armature, and a coil wound upon said core.

In testimony whereof, I have subscribed my name.

KARL MARTIN LEDERER.