April 19, 1932. C. L. FARRAND 1,855,168

LOUD SPEAKER

Original Filed April 22, 1926 2 Sheets-Sheet 1

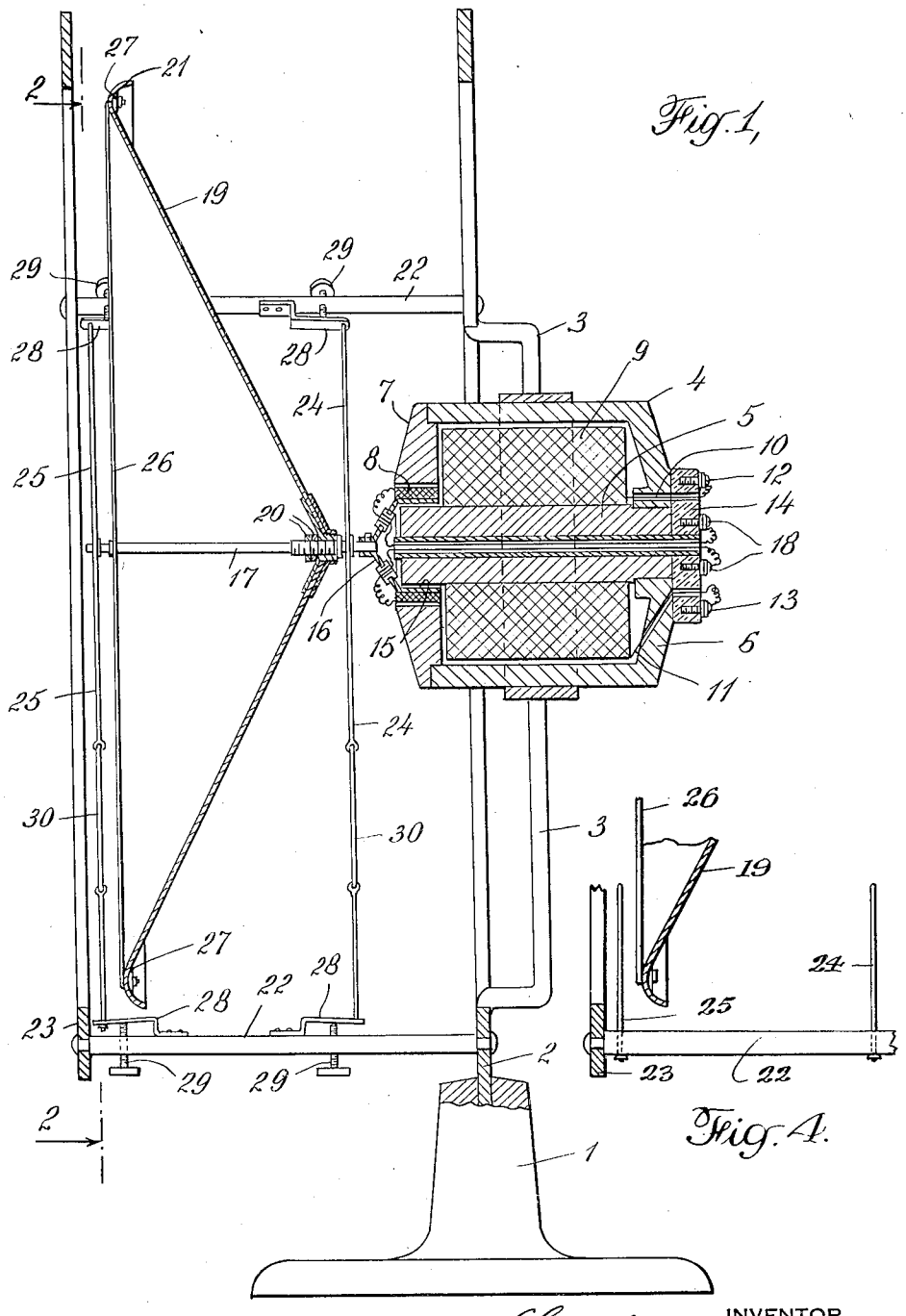

Fig. 1,

Fig. 4.

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Fig. 2,

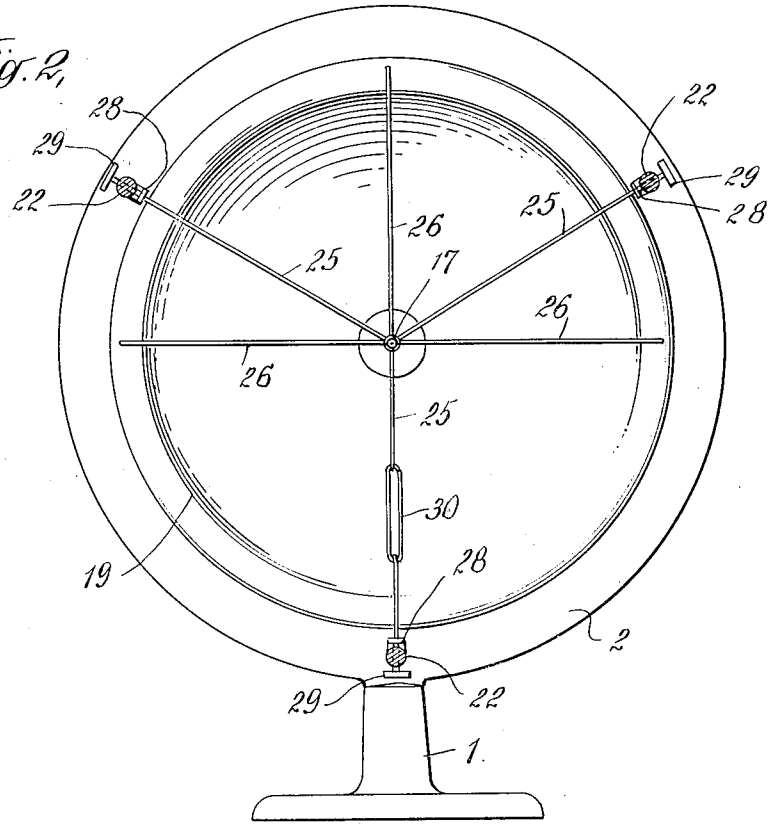
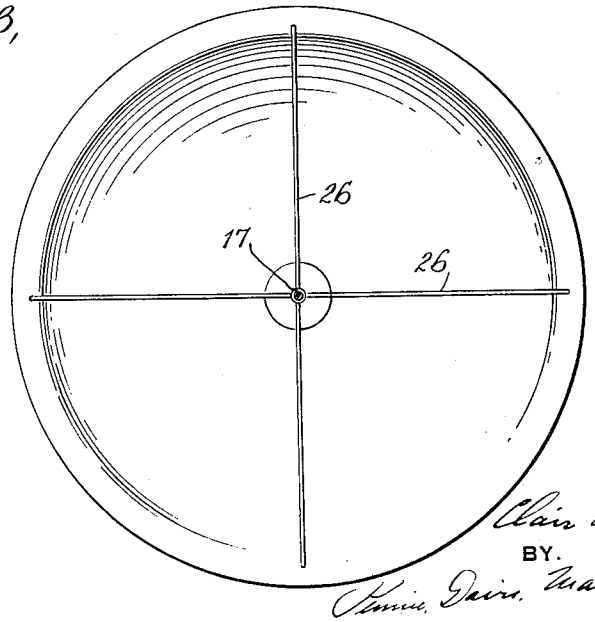


Fig. 3,



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LOUD SPEAKER

Original application filed April 22, 1926, Serial No. 103,844. Divided and this application filed October 17, 1929. Serial No. 400,352.

This application is a division of my copending application Serial No. 103,844 filed April 22, 1926.

The invention relates to apparatus for interconverting electrical energy and sound waves such as loudspeakers and so-called "pick-ups". The device to be herein disclosed may be used interchangeably as a loudspeaker or as a pick-up and for convenience it will hereinafter be referred to only by the name loudspeaker.

The invention relates particularly to direct-acting loudspeakers of the cone type whose actuating motor has an armature connected with the apex portion of the cone and which is movable in a path parallel with the pole faces of the field magnet. The so-called "dynamic" speaker is of this type. The motor armature of a dynamic speaker is a coil coaxially connected with the cone and which moves axially in an annular air gap. The cone of a dynamic loudspeaker should be supported so that it has small elastic restoring force and so that it is capable of a large amplitude of movement at low frequencies. It has been found that when the cone is so supported and when there is no other means of support for the armature coil except the cone itself any displacement of the cone (other than the vibratory displacement in a true axial direction) also displaces the coil, either tilting it or moving it laterally in its air gap so that it is likely to strike the pole faces and interfere with the operation of the device.

The principal object of this invention is to provide a loudspeaker of the above described general type in which the flexible support for the diaphragm is supplemented by a special flexible support for the armature, which will permit the armature to move freely in an axial direction but will hold the armature, or assist the flexible support for the cone in holding it, in the proper aligned position in the air gap.

Another object of the invention is to provide an improved suspension system for the cone-armature unit of that type of speaker in which a cone and armature vibrate axially as a unit, the suspension being such that the armature as well as the cone will be guided in a true axial direction and will be held against lateral tilting or displacement such as might cause the armature to strike the pole faces of the field magnet.

One form of the invention is illustrated in the accompanying drawings, in which

Fig. 1 is a vertical section of a loudspeaker constructed in accordance with the invention;

Fig. 2 is a vertical section taken on the line 2—2 of Fig. 1;

Fig. 3 is a front elevation of the diaphragm; and

Fig. 4 is a fragmentary sectional view showing a modification of one of the details of construction.

The loudspeaker illustrated in the drawings comprises a base 1 which supports an annular ring 2. Radial arms 3 extend inwardly from the ring 2 and support a cup-shaped magnetic field member 4. A central core 5 is secured to and projects from the bottom 6 of the cup-shaped member 4. The other end of the cup-shaped member 4 is provided with a circular pole piece 7 which extends radially inward toward the core 5 but only a sufficient distance to form with the end of the core an annular air gap within which a coil 8 may operate. The cup-shaped member 4, the core 5, and the circular pole piece 7 are made of cast iron or other suitable magnetizable material. A coil 9 surrounds the core 5 and when energized produces a strong magnetic field across the annular air gap in which the coil 8 operates. The leads 10 and 11 from coil 9 pass rearwardly through suitable openings in the bottom of the cup-shaped member 4 and are attached to binding posts 12 and 13 carried by an insulating support 14. The coil 8 is mounted on a cylindrical support 15 of insulating material carried by or associated with a spider 16. The leads from the coil 8 extend through a central opening in the core 5 and are connected with binding posts 18 carried by the insulating support 14. The parts so far described constitute a driving motor of the so-called electro-dynamic type. The cone to which the armature coil 8 is connected is

shown at 19. So far as the flexible support for the coil (to be hereinafter described) is concerned the cone may be supported in any suitable manner which will give it small elastic reaction and which will permit it to have a large amplitude of movement at low frequencies. In the form of the device shown in the drawings the cone is supported as follows: The apex of the cone is connected to a rod 17 by means of the nuts 20. The armature coil 8 is also connected to this rod by means of the spider 16. The outer end of the rod 17 is connected to the edge portion of the cone by a number of radial cords or wires 26, in order that the periphery of the cone will be held in a fixed position relative to the rod 17. The cords or wires 26 may be attached in any suitable way to the cone as by means of buttons or the like 27. The cords or wires 26 move bodily with the rod 17 and the cone 19 and in no way constrain the axial movement of the cone. The outer end of the rod 17 is also connected by means of radially extending wires or cords 25 to a plurality of rods 22 which connect the annular ring 2 to a spaced annular ring 23. The annular rings 2 and 23 together with the connecting rods 22 constitute a skeleton framework inside of which the cone and the armature coil are suspended. The cords or wires 25 constitute a flexible support for the cone located substantially in the plane of its base and which permits the cone to move freely in an axial direction with very small elastic reaction. The resilient support for the armature coil, in the form of the device shown in the drawings, is substantially like the resilient support for the cone. It comprises a number of radially extending wires or cords 24 connected at their inner ends to the rod 17 near the coil 8 and at their outer ends to the rods 22. This flexible support prevents lateral displacement of the coil 8, permits free axial movement of it, imposes a minimum amount of elastic reaction on the coil and perhaps with some aid from the set of cords 25 guides the coil 8 in a true axial direction in a path parallel with the pole faces of the field magnet without tilting or lateral movement such as would cause it to strike the pole faces.

In Figures 1 and 2 the wires or cords 24 and 25 are shown connected to the rods 22 through the intermediary of spring members 28 each of which may be adjusted by means of an adjusting screw 29. By regulating the screws 29 the position of the rod 17 and the coil 8 may be adjusted radially so that the coil will occupy the proper position in the air gap and so that the axis of the cone will be in proper alignment with the axis of the motor. If desired the wires or cords 24 and 25 may be connected directly to the rods 22 as shown in Figure 4. It may be desirable to provide at least one of the cords 24 and at least one of the cords 25 with a resilient portion 30 in order to produce a slight tension on all of the cords. The resilient portion 30 may be made of rubber or other suitable material.

The cone 19 is preferably made of fibrous material such as paper and is of shallow conical form. It is of sufficient size to directly reproduce the sounds without the use of a sound box or horn. In other words, it is a direct-acting diaphragm. The edge of the cone may be bent back as shown at 21 to provide a circular reinforcement which assists in maintaining the circular shape of the edge of the cone.

If the device is used as a loudspeaker the coil 9 is energized from any suitable source of direct current by connecting conductors to the binding posts 12 and 13. This will produce a strong magnetic field across the air gap in which the coil 8 operates. The coil 8 is connected in the output circuit of a radio receiving set or the like through the binding post 18. The variations in current through the coil 8 will cause it to vibrate in a well known manner and these vibrations are transmitted through the rod 17 to the cone 19. If the device is used as a pick-up the coil 9 is energized as before but the coil 8 is connected through the binding posts 18 to the input circuit of any system in which it is desired to utilize the current generated by the movement of the coil 8. Sound waves which impinge upon the cone 19 cause it to vibrate and these vibrations are transmitted to the coil 8. The coil 8 moving in the magnetic field will generate a current which varies in accordance with the vibrations of the cone 19 in the well known manner.

Inasmuch as the important feature of the invention is the resilient support for the motor armature, the resilient support for the cone may take other forms than that herein disclosed, but it should preferably be substantially at the plane of the base of the cone and should permit the cone to vibrate freely in an axial direction with small elastic reaction and with a large amplitude of movement at low frequencies. Of course, such a support at or near the base of the cone assists somewhat the flexible support for the coil in bringing about the results hereinbefore described, but it is obvious that without the special flexible support for the coil, the cone support would not of itself maintain the coil in its proper position in the air gap.

Likewise, the resilient support for the coil may take other forms than that herein disclosed. It may be considered as a flexible support, other than or supplementary to, the flexible support located at or in the vicinity of the plane of the base of the cone and comprising at least three radially extending flexible members connected at one portion to the armature structure close to the armature and

at another portion to a rigid part of the device.

The flexible members 24 in conjunction with the flexible members 25 may be considered as an improved suspension system for the unit made up of the cone 19 and the armature coil 8 which serves to flexibly support the unit (and thereby the armature) in such a way that the unit is held against lateral displacement or tilting movements such as might cause the armature to strike the pole faces of the field magnet.

I claim:

1. A loudspeaker comprising a direct-acting cone, supporting means for the cone located substantially at the plane of the base of the cone and having flexibility to permit axial vibration of the cone, an actuating motor having a field magnet structure provided with pole pieces having opposing faces which form an air gap, an armature connected with the apex portion of the cone and movable between the pole faces within the air gap and in a rectilinear path parallel with the pole faces, and supporting means for said armature in addition to said supporting means for the cone, said armature supporting means having flexibility to permit vibration of the armature in its path parallel with the pole faces but adapted to hold the armature against displacement in all directions at right angles to said path.

2. The combination of a direct-acting cone which is free to vibrate axially with negligible elastic reaction, an armature connected with the apex portion of said cone, a field magnet structure having pole pieces whose faces form an air gap in which said armature moves in a path parallel with said faces and parallel with the axis of the cone, and a flexible support for armature located adjacent to it and permitting free axial vibration of the armature while preventing its displacement in all radial direction.

3. The combination of a direct-acting cone which is free to vibrate axially with negligible elastic reaction, an armature connected with the apex portion of said cone, a field magnet structure having pole pieces whose faces form an air gap in which said armature moves in a path parallel with said faces and parallel with the axis of the cone, and a flexible support for the unit formed by the cone and armature comprising a plurality of flexible members rigidly supported at one portion and connected at another portion to said unit adjacent to the armature, said members preventing movement of the armature in all radial directions while permitting free axial vibration thereof.

4. A loudspeaker comprising a direct-acting cone, supporting means for the cone located substantially at the plane of the base of the cone and having flexibility to permit axial vibration of the cone, an actuating motor having a field magnet structure provided with pole pieces whose faces form an air gap, an armature connected with the apex portion of the cone and movable in a path parallel with the faces of said poles, and supporting means for said armature in addition to said supporting means for the cone, said armature supporting means comprising at least three radially extending flexible members rigidly supported at one portion and connected at another portion to the armature structure near the armature.

5. A loudspeaker comprising a direct-acting cone, a flexible support for the cone permitting it to vibrate axially, an actuating motor comprising a field magnet structure having pole faces forming an annular air gap and an annular armature connected with the apex portion of the cone and reciprocable axially in said gap between said pole faces, and a support for the armature having flexibility to permit vibration of the armature in the direction of its axis but adapted to hold the armature against displacement in all radial directions.

In testimony whereof I affix my signature.

CLAIR L. FARRAND.