Oct. 21, 1930 F. CUTTING ET AL 1,779,114

ELECTRICAL VIBRATING MOTOR

Filed April 9, 1928

Fig. 3

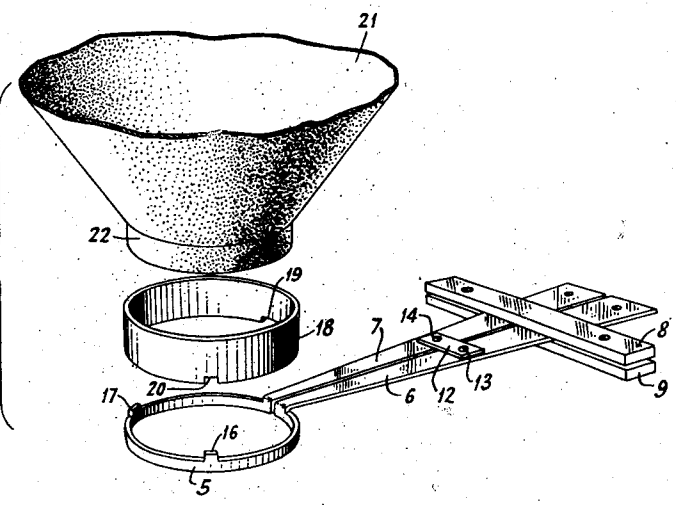


Fig. 2

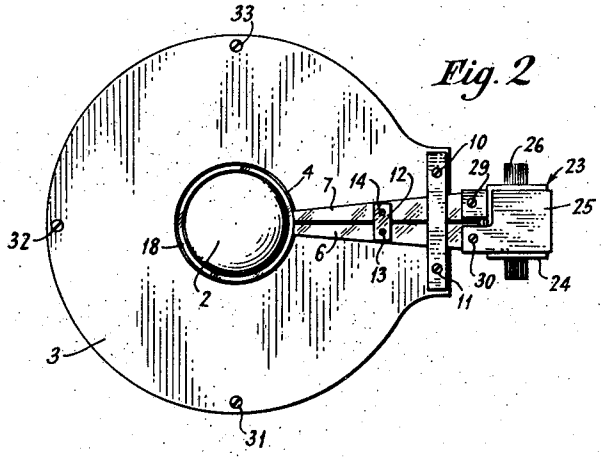


Fig. 4

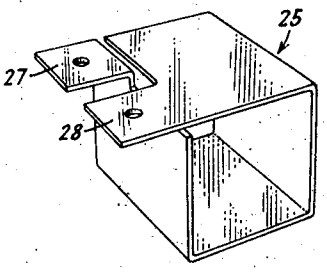
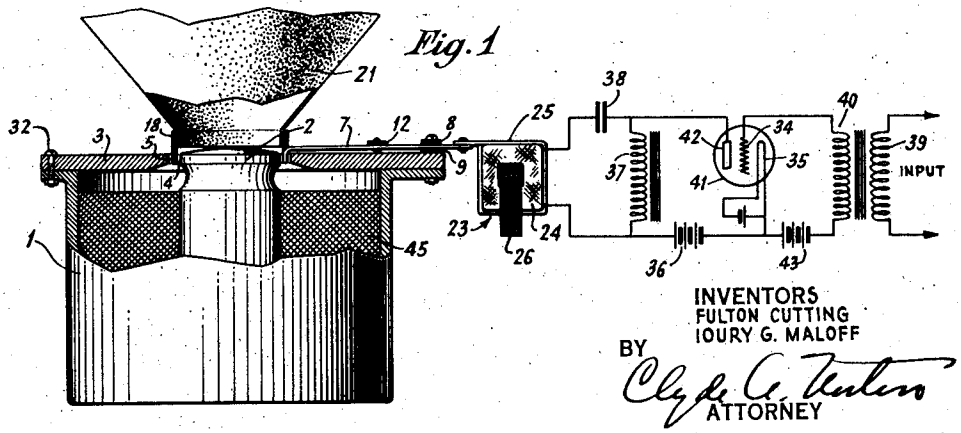


Fig. 1



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UNITED STATES PATENT OFFICE

FULTON CUTTING, OF NEW YORK, AND IOURY G. MALOFF, OF WHITE PLAINS, NEW YORK; SAID MALOFF ASSIGNOR TO UNITED REPRODUCERS CORPORATION, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW JERSEY

ELECTRICAL VIBRATING MOTOR

Application filed April 9, 1928. Serial No. 268,776.

This invention relates broadly to an electromechanical vibrating motor, and more particularly to a sound reproducing system utilizing such a motor.

It is an object of this invention to provide such a motor in which the losses heretofore usual are eliminated or very substantially reduced, and in which, as a result, the efficiency is greatly increased.

It is a further object of our invention to provide a device of the class described, which shall be extremely simple and economical in construction, rugged and reliable in operation, and capable of manufacture and assembly without requiring extremely precise and careful workmanship.

Still other objects and advantages of our invention will be apparent from the specification.

The features of novelty which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our invention itself, however, both as to its fundamental principles and as to its particular applications will best be understood by reference to the specification and accompanying drawing, in which:—

Figure 1 is a diagrammatic view of a system in accordance with our invention and showing a sound reproducer partly broken away.

Figure 2 is an elevation view of a driving motor in accordance with our invention showing the sound radiating diaphragm removed.

Figure 3 is an exploded perspective view of the vibrating system utilized in accordance with our invention; and,

Figure 4 is a perspective view of the secondary of the transformer utilized for supplying currents to the sound reproducer.

In accordance with our invention, we utilize a vibrating motor consisting of a conductor mounted in a magnetic field and supplied with currents which it is desired to convert into motion. Preferably, although not necessarily, the vibrating conductor is in the form of a ring or coil mounted for axial motion in an air gap of corresponding shape.

In devices of the class described as heretofore utilized, the vibrating coil has been formed by being wound up of a number of turns of relatively fine wire. The fine wire utilized requires a coil form or support to hold the winding in shape, and it has resulted in the past, that a considerable portion of the space in the air gap has been taken up by the winding support, which contributes nothing to the operation of the diaphragm. This has, in turn, resulted in the proportional part of the air gap occupied by the active conductors driving the diaphragm being relatively much smaller than desired, with the result that a considerably greater field strength has been required than would have been necessary if such a support were not used. This, in turn, has required the use of a larger and more expensive magnetic structure for a predetermined sound output or an increase in the power supplied to the vibrating coil with a consequent increase in the cost of apparatus for supplying the currents.

In accordance with our invention, we utilize a conductor which is of sufficient size and strength to maintain its form and shape without additional support, thereby permitting the use of a considerably greater amount of copper in the conductor with normal clearances in the air gap than has heretofore been possible. We also provide the conductor with extensions attached thereto and preferably formed integral therewith, which extensions form the leads supplying current to the coil and which are preferably but not necessarily made sufficiently stiff and strong to act as the support for the vibrating coil. By forming and shaping the leads in a manner which will be described later, the moving coil is supported for substantial axial movement, while at the same time lateral movement or wobbling is substantially prevented. At the same time by utilizing a particular construction of the leads, it is possible to control the natural frequency of the vibrating system, by properly designing the leads, to give one or more natural periods at frequencies desired to compensate for depressions in the response curve of the associated apparatus, or for other reasons.

Referring now more particularly to Figure

1, 1 designates a casing of magnetic material, such for example as iron or other suitable magnetic material, having an inner projection or pole piece 2, and provided with a cover 3 having a central opening therein, surrounding the inner pole piece 2 and defining an annular air gap 4, in which the coil 5 is mounted for vibration. The coil 5 is formed preferably from a single piece of relatively heavy copper, for example $\frac{1}{16}$" thick, stamped and bent to shape, and provided with extensions 6 and 7, which form the leads for supplying currents to the coil 5. Extensions 6 and 7 are secured to a support, such for example as cross members 8 and 9 mounted upon the top plate 3 of the magnet and held firmly in position by screws 10 and 11, which clamp the top clamp 8 upon the bottom member 9. The clamps 8 and 9, if of metal, will be insulated from one or both of the extensions 6 and 7 to prevent short circuiting of the coil 5; in addition, a brace 12 secured to the leads 6 and 7 may be used to increase the rigidity of the leads and to prevent undesired motion without interfering with the normal vibration thereof. The brace 12 may be in the form of a strip of bakelite, held in position on the leads 6 and 7 by screws 13 and 14.

For the purpose of radiating sound, a carrier ring 18 of suitable material, such as bakelite, may be mounted upon the conductor 5. The ring 18 will preferably be of substantially the same size and thickness as the conductor 5, and is provided at its lower edge with notches 19 and 20, and an additional notch, not shown, which receive the projections 16 and 17 on the conductor 5, and also receive the inner ends of the leads 6 and 7. The ring 18 is secured in position, for example, by cementing, and a suitable sound radiating diaphragm, such as cone 21 is secured to the ring 18, as for example by means of flange 22 inserted within the ring 18 and cemented.

The coil 5 is fed from the transformer 23 having a primary winding 24, a secondary winding 25, and a core of magnetic material 26. In the operation of the sound reproducer in its preferred form, the currents to be reproduced are supplied to the input circuit 40 of a thermionic vacuum tube amplifier 41 by means of the primary winding 39 leading to the source of currents. The vacuum tube amplifier comprises an anode 42, a control electrode 34 and a cathode 35. The output circuit is energized by a suitable source of potential 36, and for the purpose of preventing the flow of direct current in the primary of the transformer, a choke 37 and a condenser 38 connected in the usual manner may be utilized. A suitable C battery 43 will usually be provided in the input circuit of the amplifier 32. In case the direct current flowing in the output circuit is permitted to traverse the primary winding 24, a gap will preferably be formed in the magnetic core 26 to prevent saturation thereof.

The secondary winding 25 of the transformer is in the form of a heavy coil with a small number of turns, one or two being usually sufficient and the turn ratio will preferably be greater than 1000 to 1. The secondary 25 is provided with terminal portions 27 and 28. The terminal portions 27 and 28 are connected to leads 7 and 6 respectively, and secured in position by screws 29 and 30, and by soldering if desired, care being taken to establish a good electrical contact over a wide surface.

While the conductor 5 and the secondary 25 are shown herein as single turn coils, and while we prefer to construct them in this manner, this is not essential as both may be made to have several turns, it being borne in mind, however, that the maximum possible amount of copper should be used in the air gap 4, and the resistance of the secondary 25, leads 6 and 7 and coil 5 should be kept as low as possible. On the other hand, the number of turns in the primary winding 24 will be very large and the winding will preferably be wound of fine wire; the resistance of the secondary 25, leads 6 and 7 should be made much smaller than that of coil 5. The magnetic field across the air gap 4 may be established by the use of a field winding 45 or by the use of a permanent magnet system, as will be understood.

The sound radiating diaphragm 21 is herein shown as a cone, from which we have obtained particularly satisfactory results, but it will be understood that other forms of sound radiating diaphragms may be utilized. However, for best results, the mass of the diaphragm 21 should be kept small and its area should be made sufficiently large so that megaphone or horn amplification is not necessary. In case the coil 5 is supported independently of the driving mechanism, the leads 6 and 7 may be made freely flexible, as by being formed of copper braid. It is possible to control the frequency response of the vibrating system by suitably designing the leads 6 and 7: for example, by increasing the stiffness, which may be done by increasing the thickness of the leads, the natural frequency of the vibrating system may be increased, and correspondingly, by making the leads thinner, it may be lowered, also, by the provision of notches of various sizes and in various positions, several different natural frequencies may be imparted to the vibrating system as desired, in order to compensate for lack of uniformity in the frequency characteristic of the associated apparatus.

While we have shown and described our invention as applied to a sound reproducer, it will be understood that the vibrating motor herein described is essentially reversible,

and may be operated as a generator, and that it is possible to utilize the apparatus according to our invention in microphones, phonograph pick-ups and various other apparatus, as will be readily understood. It will also be understood that while we have shown and described certain preferred embodiments of our invention, that modifications and changes may be made without departing from the spirit and scope of our invention, as will be readily understood by those skilled in the art.

We claim:—

1. An electro-magnetic vibrating motor comprising a conductor disposed in a magnetic field, and terminating in leads secured to a support, said leads having their constants so chosen as to give the vibrating system a natural period of vibration at a predetermined frequency.

2. An electro-magnetic vibrating motor comprising a conductor disposed in a magnetic field and terminating in leads secured to a support, said leads having their constants so chosen as to give the vibrating system a plurality of natural periods of vibration at predetermined frequencies.

3. An electro-magnetic vibrating motor comprising a magnet having pole pieces defining an air gap, and a conductor mounted for vibration therein, said conductor being of sufficient size and stiffness to maintain its form without support, and having a portion extending out of said gap and secured to a support, the stiffness of said extending portion being sufficient to maintain the position of said conductor in said gap while permitting vibration thereof, and having its constants so chosen as to impart to the vibrating system a predetermined frequency characteristic.

4. A sound reproducer comprising in combination a magnet having pole pieces defining an air gap; a conductor mounted for vibration in said gap, leads secured to said conductor and to a support, and a sounding board of relatively light weight secured to said conductor for vibration thereby, said leads having their constants so chosen as to impart to the vibrating system a predetermined frequency characteristic.

5. A sound reproducer comprising, in combination, a rigid conductor in the form of a loop, open at one point, a conical sounding board of light weight having its apex secured to said loop and flexible leads secured to opposite ends of said loop and to an external support.

Signed at New York city in the county of New York and State of New York, this 6th day of April, A. D. 1928.

FULTON CUTTING.
IOURY G. MALOFF.