April 3, 1934. E. S. PRIDHAM 1,953,542

SOUND REPRODUCING DEVICE

Filed Aug. 6, 1929

Fig. 1.

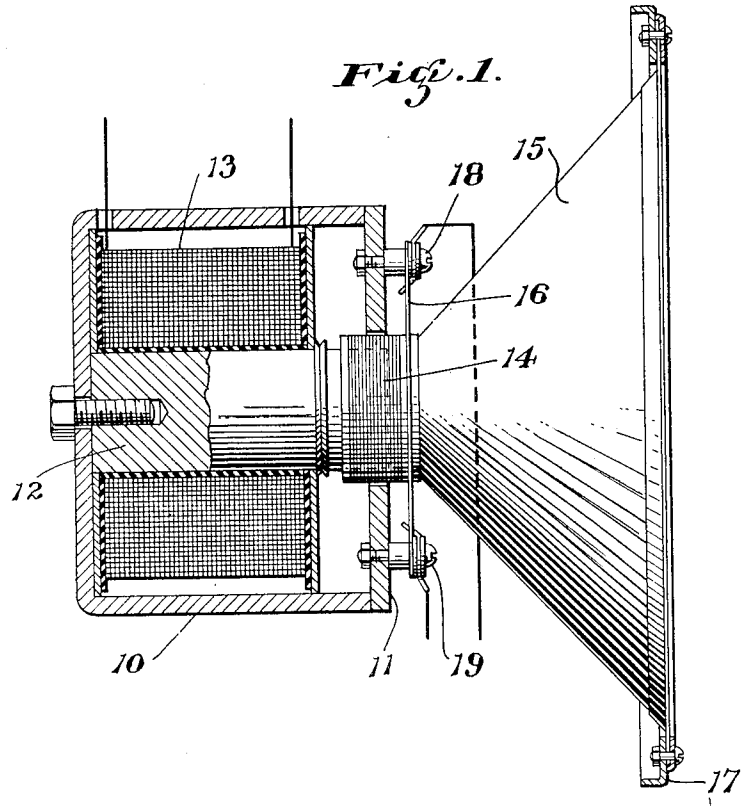


Fig. 2.

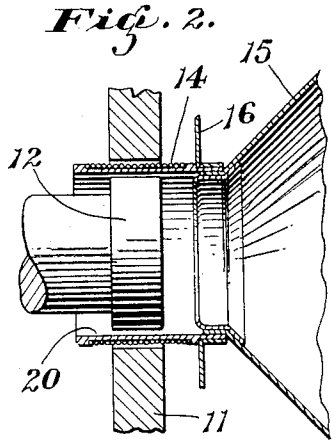


Fig. 3.

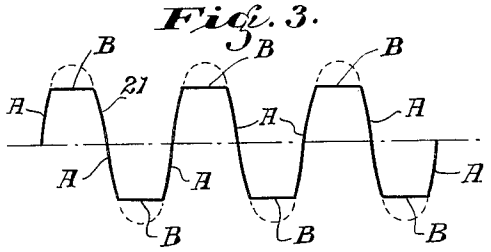
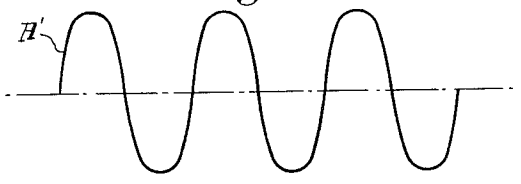


Fig. 4.



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Patented Apr. 3, 1934 1,953,542

UNITED STATES PATENT OFFICE

1,953,542

SOUND REPRODUCING DEVICE

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Application August 6, 1929, Serial No. 383,935

11 Claims. (Cl. 179—115.5)

My present invention relates to loud speakers and more particularly to a new and useful improvement in the construction and arrangement of the parts in a speaker of the so-called moving coil type.

The object of my invention is to provide an improvement in loud speakers of the moving coil type which will improve the operation thereof and render the actuating coil responsive to the voice currents imposed thereupon throughout its complete cycle of operation.

In the past, in the manufacture of loud speakers of the type contemplated by my invention, it has been customary to provide a winding upon the actuating coil which would normally lie in the field of the greatest magnetic flux and in accomplishing this result it has always been customary to provide a coil which is substantially no longer than the axial length of the magnetic field of the speaker. This construction has in the past and is at the present time giving fairly satisfactory results throughout the upper register of the musical scale, but it is, I believe, because of this fact that the lower notes have not been so well reproduced.

After a very exhaustive study of this problem, in connection with which a great many experiments were carried out, I have discovered that where the diaphragm actuating oil is constructed as above outlined, the coil in reproducing the lower notes of the musical scale actually moves to such an extent that the number of active turns of the coil within the magnetic flux is reduced so that in reproducing the low notes, the coil, instead of having a uniform number of active turns in the magnetic flux, has a smaller number of active turns in the flux and, as a result, the magnetic force upon the coil diminish as the coil approaches the end of its movement before the impelling current therein has actually diminished or reversed with respect to its direction of flow.

It is conceivable that the above objectionable features may be easily overcome by increasing the pole face areas, as by lengthening them in the direction of movement of the diaphragm operating coil to such an extent that the turns of the latter coil will not move out of the influence of the magnetic flux between the pole faces. Such a modification would, however, as will be readily understood, involve the use of pole pieces of greater thickness or pole pieces having specially formed faces. This would increase the cost of the speaker and, further, such an increase in the area of the pole faces would, in the absence of an increase in the ampere turn excitation of the field structure, result in a reduction in the flux density and, as a result, the speaker so constructed would not be efficient unless a larger exciting coil were provided.

In other words, a speaker of the construction suggested above would unquestionably cost more to produce since it will require poles of extra thickness of special construction and a greater amount of copper in the magnetic field exciting coil, as, in order to compensate for the decrease in flux density at the pole face, it will be necessary to provide a greater number of ampere turns in the field exciting coil.

In order to overcome the above objections and to provide a speaker in which the voice currents will be effective in maintaining a proper movement of the diaphragm actuating coil at all times in response to the current flowing therein and at the same time produce a construction which will not materially increase the cost or necessitate any material change in the construction of the device and particularly the magnetic field structure, I propose to construct my diaphragm actuating coil of such dimensions and shape that a uniform number of active turns thereof will be at all times maintained in the field of magnetic flux established between the magnetic pole pieces.

For a better understanding of my invention, reference should be had to the accompanying drawing, wherein I have shown by way of illustration and not of limitation, one preferred embodiment thereof.

In the drawing—

Fig. 1 is a partially sectional view in elevation showing a simple form of my invention,

Fig. 2 is an enlarged fragmentary view showing the disposition of the pole pieces and diaphragm actuating coil, and

Figs. 3 and 4 are diagrammatic views illustrating respectively the operating characteristics of the prior art devices and my improved device.

In Fig. 1, 10 designates a hollow pot of magnetic material having a cover plate 11 also of magnetic material which forms an outer or annular pole piece. The pot 10 is provided with a central core 12 which extends outwardly and centrally into an opening in the center of the cover plate 11 to form an inner pole piece. Surrounding the core 12 there is provided a coil 13 which, when energized by suitable current, will provide a circulation of flux across the air-gap provided between the extending end of the core 12 and the adjacent edges of the opening in the cover plate 11.

Disposed within the air-gap provided between the core 12 and the pole piece 11, I provide a coil 14 which is adapted to move axially within the air-gap provided as above outlined. The coil 14 is attached directly to a diaphragm 15 and, when energized, is adapted to move the diaphragm in such a manner as to propagate sound waves and reproduce sounds in a manner well understood in the art. The coil 14 and the corresponding end of the cone 15 are mounted so that they are freely movable axially of the air-gap upon a centering support 16 and the base of the cone is mounted upon a supporting rim or ring 17. The ends of the coil 14 are brought out along the support 16 to terminals 18 and 19 upon which connections may be made with a proper external circuit.

By referring now to Fig. 2, it will be seen that the coil 14 is wound upon a cylindrical form 20 so that its turns extend out beyond the normal path of flux between the pole piece 12 and the pole piece 11. In this illustration, it will be noted that the turns of the coil 14 extend to a position substantially three-sixteenths of an inch to either side of the pole pieces. In my experiments I have found that this dimension is sufficient for a coil having dimensions substantially the same as in this illustration, as I have discovered that in reproducing the low notes of the musical scale the diaphragm very seldom, if ever, moves over three-sixteenths of an inch. The above dimensions, however, are not to be taken in a limiting sense, as it will be readily understood that with different sized diaphragms the movement thereof may be considerably larger in reproducing the low notes.

As stated hereinbefore, it is my belief that the inability to reproduce the low notes in a round and smooth manner has been due in the past to the fact that the diaphragm operating coil moved out of the field of flux between the pole pieces and for this reason, instead of the coil getting the full benefit of the currents flowing therein corresponding to the frequency being reproduced, the coil was robbed of some of this force by reason of a number of its turns moving out of the field of flux. In other words, since the number of active turns was reduced in this manner, the effective ampere-turns were decreased.

In Fig. 3 of the drawing the curve 21 diagrammatically represents what in my opinion takes place in the coils of the prior art speakers when reproducing low pitched notes. My explanation of this curve is that as the voice currents flow through the coil 14 with a full number of active turns in the flux, the forces imposed thereupon will correspond to the parts of the curve marked A and will tend to move it in one direction or the other and, as shown here, when the coil reaches a point where some of its turns are moved out of the flux, the force curve will not follow a true sine wave, but will be flattened out as at the points B of this curve and thus the forces corresponding to the dotted portion of this curve will be lost and, as a result, the diaphragm will not be actuated in a smooth manner as would be the case if the number of turns in the air-gap remained constant.

In Fig. 4 I have illustrated a force curve which diagrammatically represents the forces which will be exerted upon a diaphragm by a coil constructed and disposed in the air-gap in accordance with my present invention. In this illustration it will be seen that the forces exerted by the coil 14 and represented by the curve A' follow at all times a smooth curve so that, as a result, the operation of the diaphragm 15 will be smooth and uniform during any cycle of its operation. In other words, there will not be introduced into the movement of the diaphragm any characteristic which is not the result of a change of current in the coil 14.

From the above, it will be seen that I have provided a new and novel improvement in loud speakers in which the movement of the diaphragm actuating coil will always be in response to the ampere-turns of the coil as controlled by the actuating current. A further advantage of this construction is in the fact that, in addition to a uniform number of active turns in the magnetic field, there will also be a uniform number of inactive turns in the coil and, as a result, the impedance of the coil will always be the same.

In addition to the above, it will also be evident that the improvements contemplated by my invention may be readily embodied in the present standard types of loud speakers without necessitating any material increase in cost or sacrifice in efficiency; and while I have shown and illustrated only one preferred embodiment thereof, I desire to have it understood that various changes and modifications thereof may be made without departing from the spirit and scope of my invention as defined in the accompanying claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a sound reproducing device of the moving coil type, a magnetic field structure adapted to provide a field of magnetic flux of definite width, a coil disposed for limited movement in said magnetic field adapted to move transversely thereof having a length greater than the width of said field of magnetic flux, and a flexible support for said coil adapted to permit a limited axial movement thereof, whereby a uniform number of turns less than the total number of turns of the coil will be maintained at all times in the field of magentic flux.

2. In a sound reproducing device of the moving coil type, a magnetic field maintaining structure adapted to provide an annular field of magnetic flux of definite width, a coil disposed in said magnetic flux adapted to move a limited distance in each direction transversely thereof having a length at least equal to the width of said field of flux plus its distance of movement in each direction and its turns uniformly disposed so that an equal number of turns of the coil will be maintained at all times in said magnetic flux, and a flexible support for said coil adapted to permit a limited axial movement thereof, whereby no magnetic force upon said coil will be lost as a result of its end turns moving out of the magnetic flux.

3. In a sound reproducing device of the moving coil type, a pair of pole pieces arranged concentrically with respect to each other to provide an annular air-gap of definite width, a moving coil yieldingly supported within said air-gap so that it can move a limited distance in each direction and having an axial length greater than the width of the air-gap by an amount equal to the distance it moves in each direction, and a flexible support for said coil adapted to permit a limited axial movement thereof, whereby a uniform number of the active turns of said coil will be maintained in said air-gap under all conditions of operation.

4. In a sound reproducing device of the moving coil type, a pair of pole pieces arranged to provide an air-gap of definite width, a diaphragm operating coil yieldingly supported within said air-gap having a length in its direction of movement

substantially greater than the width of the air-gap, and a flexible support for said coil having a restoring force sufficient to maintain said coil in said air-gap, whereby a uniform number of the turns of said coil will be disposed in said air-gap under all conditions of operation.

5. In a sound reproducing device of the moving coil type, a pair of pole pieces arranged concentrically with respect to each other to provide an annular air-gap of definite width, a coil support disposed in said air-gap and mounted to have a limited movement in each direction, a winding upon said coil support having its turns uniformly disposed upon the support over a length greater than the width of said air-gap, and a flexible centering means for said coil support having a restoring force sufficient to maintain said winding in the air-gap so that a uniform number less than the total number of turns of said coil will be maintained in said air-gap.

6. In a loud speaker of the moving coil type, a pair of pole pieces arranged concentrically with respect to each other to provide an annular air-gap of definite width, a cylindrical coil support adapted to actuate a diaphragm yieldingly supported in said air-gap, a winding upon said coil support adapted to be energized by a modulated current, said winding having its turns disposed upon said support with respect to said air-gap so that the winding will have a length greater than the width of said air-gap, and means for maintaining said cylindrical coil support in said air-gap, whereby a uniform number less than the total turns of said coil will be maintained in said air-gap as the coil support moves with the diaphragm.

7. In a moving coil sound reproducer, a magnetic field producing element having an air-gap of definite width in which a coil may move, a movable coil mounted so as to have a limited movement within said air-gap characterized by the fact that it extends to both sides of the air-gap a distance at least equal to its maximum distance of movement, and a yielding support for maintaining said coil in the air-gap having a restoring force sufficient to prevent said coil moving a distance in either direction greater than the distance the turns of the coil project beyond the air-gap, whereby a constant length of active conductor is always in a position of maximum flux in the air-gap.

8. In a loud speaker of the moving coil type, a magnetic field producing structure adapted to provide a field of magnetic flux of definite width, a movable diaphragm actuating coil disposed in said field of magnetic flux, said coil having a length greater than the width of said field of magnetic flux, and a flexible support for said coil adapted to permit a limited axial movement thereof and maintain a constant number of the effective turns of the coil in the field of magnetic flux.

9. In a loud speaker of the moving coil type, a pair of pole pieces arranged concentrically with respect to each other to provide an annular air-gap of definite width, a diaphragm actuating coil disposed in said air-gap adapted to be energized by a modulated current, said coil having its turns disposed with respect to said air-gap so that it will have a length greater than the width of said air-gap, and a flexible support for maintaining said coil in said air-gap so that a uniform number less than the total turns of said coil will be maintained at all times within said air-gap.

10. In a loud speaker of the moving coil type, the combination of a pair of spaced magnetic pole pieces, means associated with said pole pieces for creating a magnetic flux there between, a coil disposed in said magnetic flux adapted to actuate a sound reproducing diaphragm, and a flexible support for said coil adapted to permit the coil to move sufficiently to actuate the diaphragm, said coil being of such a length that a uniform number of turns thereof will be maintained in said field of magnetic flux under all conditions of operation permitted by said flexible support.

11. In a sound reproducing device of the moving coil type, the combination of a pair of spaced magnetic pole pieces having an air-gap there between, means associated with said pole pieces for creating a field of magnetic flux in said air-gap, a coil disposed in the magnetic flux of said air-gap, and a flexible support for said coil adapted to permit the coil to move in said air-gap when in operation, said coil being of such a length that a uniform number of turns thereof will be maintained in said field of magnetic flux under all conditions of operation permitted by said flexible support.

EDWIN S. PRIDHAM.