Dec. 6, 1949 L. W. MURKHAM 2,490,227

ELECTRODYNAMIC LOUDSPEAKER

Filed June 19, 1947

Fig. 1.

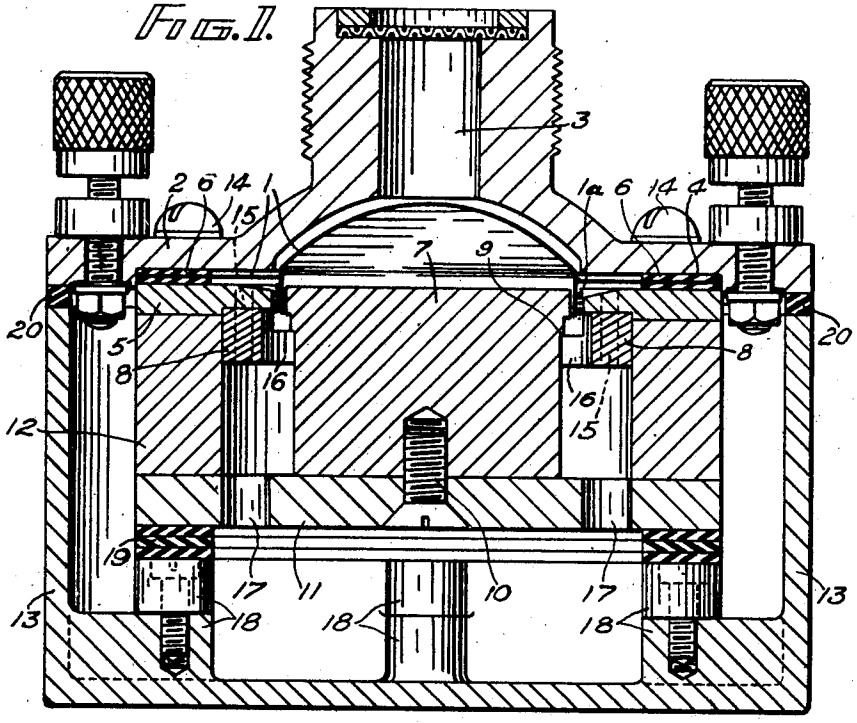


Fig. 2.

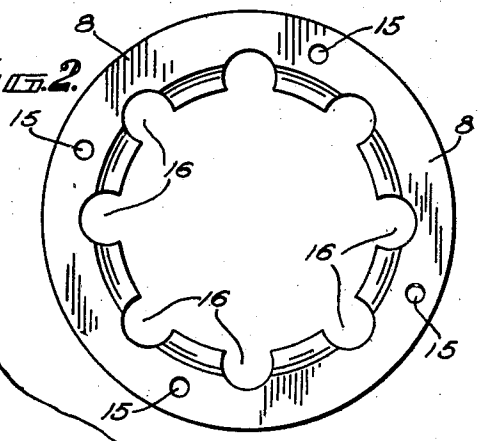
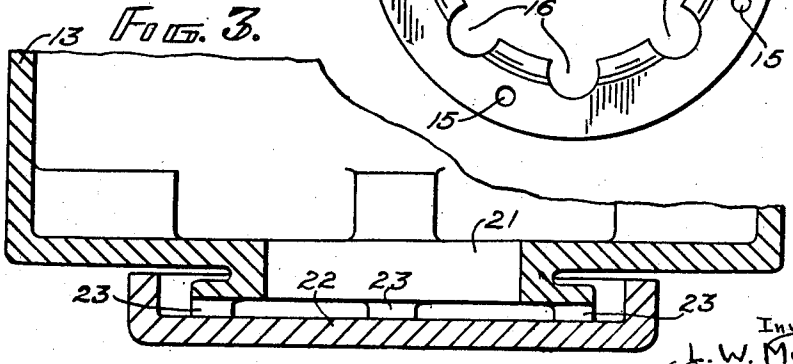


Fig. 3.



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ELECTRODYNAMIC LOUD-SPEAKER

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4 Claims. (Cl. 179—115.5)

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This invention relates to loud speakers or the like of the moving-coil type in which the diaphragm is vibrated by means of a coil which carries the speech current and is located in the magnetic field set up by a magnet. In loud speakers of this type the moving-coil is usually connected to the diaphragm by being wound on a former in the shape of a short cylindrical shell one edge of which is attached concentrically to the diaphragm, and the magnetic field is usually the field set up across the small annular air gap between the outer cylindrical surface of an inner pole piece and the inner cylindrical surface of a surrounding outer pole piece, the said former with the coil in it projecting into this air gap. Again in such loud speakers, it is usual for the outer pole piece to take the form of a plate with a circular concentric hole in it forming the inner cylindrical surface aforesaid, and for the inner pole piece to be extended rearwardly in the direction away from the diaphragm, the magnetic circuit being completed by means of a more-or-less pot-shaped structure whose bottom joins the rear end of the inner pole piece and whose rim or edge joins the back surface of the plate forming the outer pole piece.

In loud speakers of this kind, in order to obtain maximum acoustic efficiency, it is necessary to work with the smallest possible clearances between the coil and former on the one hand and the surfaces forming the annular air gap on the other, and difficulty has been heretofore experienced in centering the coil correctly in the gap and rendering the centering immune from disturbance by mechanical shock.

The invention has among its objects the provision of improved means whereby this centering may be effected and securely maintained, the assembly of the parts in correct centre being entirely automatic. Another object is that of simplifying the magnet construction. Another object is the provision of improved means for preventing the deleterious effects of air cushioning at the back of the diaphragm.

The invention comprises the arrangement that both the diaphragm unit and the plate forming the outer pole piece are centred by fitting them accurately in a circular recess formed say in the back surface of the front plate of the outer housing which houses said diaphragm and the magnet.

The invention also comprises in constructions in which the inner pole piece is centred relative to the plate forming the outer pole piece by means of a nonferrous bush mounted on the back of said plate, in which bush the rearwardly extending part of said inner pole piece very accurately fits, effecting the attachment of the nonferrous bush to the rear surface of said plate by heat springing, a counter-sunk recess in the rear surface of said plate being shrunk, by cooling, on to said bush.

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The invention also comprises, in constructions in which the inner pole piece is centred relative to the plate forming the outer pole piece by means of a nonferrous bush mounted on the back of said plate, in which bush the rearwardly extending part of said inner pole piece very accurately fits, the arrangement that holes or cut away portions are formed in the bush for the purpose of reducing cushioning behind the diaphragm.

Other features of the invention will appear hereinafter.

In order that the invention may be the more clearly understood a loud speaker in accordance therewith will now be described, reference being made to the accompanying drawings wherein:

Figure 1 is a sectional side elevation of the whole assembly;

Figure 2 is a plan of one of the parts of Figure 1;

Figure 3 shows a construction which may be employed in the bottom of the outer container 13 of Figure 1.

Referring to Figure 1 the diaphragm 1 and the magnet are housed in a cylindrical container of nonmagnetic material, whose front end 2, which is just in front of the diaphragm, has a central opening 3 therein through which the sound waves from the diaphragm are adapted to pass. This front end has formed in its rear face a shallow circular recess 4, and both the diaphragm 1 and therefore the moving coil 1a and the circular plate 5 forming the outer pole piece of the magnet, are centred by fitting closely within this shallow recess. Thus the diaphragm, which is of the usual paper-like material or of the material generally used for this purpose, is framed in a flat ring framing 6 of some stiffer material which fits very accurately in this shallow circular recess 4, and the said circular plate 5 forming the outer pole piece of the magnet fits accurately behind the diaphragm in the same circular recess thereby clamping the frame 6 in place and ensuring that the said outer pole piece and the moving coil 1a shall both be accurately centred. The clamping action of the said circular plate is against the ring framing of the diaphragm which is slightly thicker than the diaphragm proper. This fact, added to the fact that the

front face of said outer pole piece is chamfered slightly towards its central opening as shown, ensures plenty of room for the diaphragm to vibrate in. In like manner the shallow recess 4 in the front end 2 of the housing is formed to enable the diaphragm to vibrate freely.

The inner pole piece 7 is centred, relative to this circular plate 5 forming the outer pole piece by means of a non ferrous bush 8 (see also Figure 2) mounted on the rear surface of said circular plate, in which bush the rearwardly extending part of said inner pole piece very accurately fits. Thus, the moving coil 1 and the outer pole piece 5 both being accurately centred by the shallow circular recess 4 in the front plate 2 of the container, and the inner pole piece 7 being accurately centred by the nonferrous bush 8 on the rear of the outer pole piece 5, the moving coil 1*a* will be accurately centred with respect to the annular clearance as a whole, and this centering cannot become displaced.

It will be seen that the machining of the shallow circular recess 4, the inner and outer machining of the plate 5 forming the outer pole piece, the machining of the inner pole piece 7 and the nonferrous bush 8 and also the cutting of the outer periphery of the ring frame 6 of the diaphragm 1, and the location of the former of the coil 1*a* relatively to said outer periphery must all be very accurate. Once these parts have their surfaces accurately formed their assembly automatically becomes correct and cannot thereafter become incorrect.

The nonferrous bush 8 also serves to locate the inner pole piece 7 axially relative to the outer pole piece. Thus the inner pole piece is formed with a small shoulder 9 which engages with the bush to limit the rearward axial movement thereof relative to said outer pole piece, and, in construction, the rear end of the inner pole piece is secured, by means of a single central screw 10, to the bottom 11 of the pot portion of the magnet, the dimensions being such that, in screwing up the screw, this shoulder, engaging the bush, strains the bush slightly, thereby ensuring that the circular plate 5 forming the outer pole piece is pulled hard down on to the edge or rim of the wall 12 of the pot, which wall constitutes the permanent magnet. The said bottom 11 of the pot is made quite separate from the cylindrical wall 12 thereof, and all four parts viz. the outer pole piece 5 and bush 8, the inner pole piece 7, the pot bottom 11 and the cylindrical pot wall 12 are secured together by means of the one screw 10 aforesaid passing through the pot bottom 11 into the rear of the inner pole piece 7. The actual pole surface of the inner pole piece 7 opposite to the corresponding surface of the outer pole piece 5 is of greater diameter than the remainder of said inner pole piece. The said shoulder 9 which abuts the nonferrous bush 8 is very small and is some distance behind the said pole surface of increased diameter.

It will be appreciated that the parts of the magnet must be machined accurately to ensure that the rear end of the inner pole piece 7 abuts firmly against the rear plate 11 of the magnet, and at the same time, the cylindrical wall 12 of the magnet is clamped tightly between said rear plate and the front plate 5 forming the outer pole piece. The intensely concentrated field of the magnet adds to the mechanical strength.

The attachment of the nonferrous bush 8 to the rear surface of the circular magnet plate 5 constituting the outer pole piece is preferably effected by heat springing. Thus the central opening of said circular magnet plate is countersunk on its rear side with a shallow cylindrical recess as clearly shown and this cylindrical recess has a diameter of say .003 of an inch smaller than the outside diameter of the disc forming the bush 8. Said circular plate 5 is heated until its expansion permits the bush 8 to be fitted into this cylindrical recess and, upon cooling, the bush will be gripped tightly and secured permanently in said recess. The accurate machining, both of the inner surface of the bush 8 and of the inner and outer surfaces of the circular magnet plate 5 may be effected after this heat springing operation. It will be seen that the bush 8 projects rearwardly from said cylindrical recess. The machining of the inner surface of said bush is such that the forward portion thereof is of the same diameter as the inner or pole surface of the circular plate, the rear portion being of smaller diameter and forming the bearing surface for the inner pole piece 7. In this way also a shoulder for engaging the aforesaid small shoulder 9 on the inner pole piece is formed.

It will thus be seen that the nonferrous bush 8 is solidly attached to the magnet plate 5 without the use of any screws and in such a way that concentricity between the pole surface of the magnet plate on the one hand and the bearing surface of the bush, and therefore the pole surface of the inner pole piece 7, on the other hand, can never be disturbed.

When the one central screw 10 is screwed up, the bush 8 may be withdrawn say .015 of an inch from the cylindrical recess owing to the fact that the error in the length of the inner pole piece 7 up to the small shoulder 9 may be as much as that amount. This will cause no damage and will not in any way weaken the magnet structure in respect of its lateral or centralising strength. Once the magnetising is effected the magnetic force pulling the two magnetic plates 5 and 11 towards one another is so strong as to afford the bulk of the longitudinal strength of the magnet structure.

The cylindrical housing of nonmagnetic material consists of the aforesaid front end 2 and an integral pot-shaped portion 13. When the magnet as a whole has been assembled, the assembly of the remainder is effected by locating first the diaphragm 1 and then the outer pole piece 5 of the magnet, in the shallow circular recess 4 in the rear face of the front end 2 of the outer container, then placing the pot portion 13 of the outer container in position against the said front end and then screwing said front end to said pot portion by means of a number of screws 14 screwed into thickened portions of the wall of said pot portion. The dimensions are such that this presses the outer pole piece 5 of the magnet against the ring framing 6 of the diaphragm and completes the clamping action as described.

To obviate the disadvantages of air cushioning at the rear of the diaphragm 1, which tends to reduce the bass output and give artificial accentuation elsewhere, a number of, say four, holes 15 are drilled through the circular plate 5 forming the outer pole piece, say in the chamfered area as close as possible to the gap without interfering with the magnetic path. (These holes must also pass through the nonferrous bush 8.) This prevents air cushioning behind the part of the diaphragm outside of the coil 1*a*. Additional holes or cut away portions 16 are also formed in the bush 8 in line with the annular clearance, i. e,

in line with the coil 1*a*, thus preventing serious cushioning behind the part of the diaphragm inside of the coil as air is permitted to escape through the annular gap, though it is true that this narrow gap does offer some resistance. Also, to allow air to escape from within the magnet pot a number of holes 17 are formed in the rear plate 11 of the magnet structure. Alternatively the air could be arranged to escape past the rear plate of the magnet structure, the latter being spaced by spacers from the cylindrical wall 12, but this is not usually so satisfactory. The outer container is very considerably larger than the magnet and thus the trapping of air therein is not deleterious. To enable the container to be thus larger than the magnet the latter abuts against pedestals 18 extending from the bottom of the container pot.

Rubber pads or spring washers or plastic rings 19 or other form of compressible packing may be interposed between the plate 11 and the pedestals 18 or rear of the housing. Similar packing 20 may also form a water tight joint between the front and the pot-portion of the outer housing.

In cases where the loud speaker will not have to be installed out of doors the outer container could be formed with openings to the atmosphere. Where the loud speaker may have to be installed out of doors and openings to atmosphere are required, the arrangement illustrated in Figure 3 may be employed. In this arrangement the bottom of the pot portion 13 has a central hole 21 formed in it and this hole is covered by means of a cap 22 which is spaced away from the bottom of the pot portion 13 by means of lugs 23 integral with said pot portion 13. Air can flow freely out of the hole 21 and then between the lugs 23 and over the rim of the cap 22 but no matter at what angle the loud speaker is mounted rain water cannot have access to the housing 13.

In the above described apparatus the magnet is preferably made of one or other of the alloys known to be used for making such magnets from such alloys as they permit of a large reduction of weight without efficiency loss.

It will be appreciated that the invention may be applied not only to pressure type loud speakers but also to all moving coil types and to dynamic microphones.

I claim:

1. A loud speaker or the like of the moving coil type, comprising a diaphragm, an adjacent speech-current-carrying coil for vibrating said diaphragm, radially spaced and concentric inner and outer pole pieces providing an annular air gap space therebetween, the outer pole piece comprising a circular plate having a hole into which the inner pole piece projects, an outer housing having a front opening, a front closure plate detachably secured to said housing for closing said front opening, said front closure plate having a circular recess in its rear surface, said diaphragm and outer pole piece being secured in said recess in said front closure plate.

2. A loud speaker or the like according to claim 1, wherein said diaphragm unit comprises the diaphragm proper and a flat ring framing therefor of some stiffer material which fits very accurately in said circular recess and said circular plate fits accurately in said recess behind said diaphragm and thereby clamps said framing in place.

3. A loud speaker or the like according to claim 1, wherein said diaphragm unit comprises the diaphragm proper and a flat ring framing therefor of some stiffer material which fits very accurately in said circular recess and said circular plate fits accurately in said recess behind said diaphragm and thereby clamps said framing in place, and wherein said framing is slightly thicker than said diaphragm proper.

4. A loud speaker or the like according to claim 1 and wherein the inner pole piece is centred relative to said circular plate by means of a nonferrous bush mounted on the back of said circular plate, in which bush the rearwardly extending part of said inner pole piece very accurately fits, said bush having a plurality of holes in is rim and a plurality of cut-away portions along its inner edge.

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