This invention relates to sound reproducers for changing electrical oscillations into sound waves or what are more popularly known as loud speakers.

In certain radio installations space requirements are a very important factor. At present this is true particularly in automotive installations where total space available for radio equipment is a determining factor in engineering a set and also in determining the shape of the same. Most recent automotive receiving equipments consist of at least two units, one of which is a speaker unit. In order to mount the speaker unit in narrow, restricted areas it is necessary to design and build the same as compactly as possible.

Conventionally cone speakers are built with the magnet structure mounted at the apex of the cone on the outside of the speaker basket so that its dimension adds to the total depth of the unit. It is possible to mount the magnet structure for the speaker in the apex of the cone and such type of speaker is known as an inverted speaker. In these speakers advantage is taken of locating the magnet structure inside the cone and this reduces the depth dimension by the length of the magnet. However, locating the magnet structure in the apex of the cone diaphragm masks the central portion of the diaphragm and effects the emanation of sound waves therefrom to alter the form of the magnetic field. The magnet structure is miniaturized in an effort to reduce this masking effect and minimize tone impairment. The speaker is not as sensitive to electrical oscillations as it was for sound reproduction.

It is, therefore, an object in making this invention to provide an inverted speaker construction having only slight tone impairment with practically no loss of sensitivity.

It is a further object in making this invention to provide an inverted speaker construction utilizing the same sensitivity as a conventional speaker of the same size with a minimum of tone impairment.

It is also an object in making this invention to make an inverted speaker construction in which a portion of the magnet structure is mounted within the cone diaphragm to reduce the overall depth dimension.

With these and other objects in view which will become apparent as the specification proceeds, my invention will be best understood by reference to the following specification and claims and the illustrations in the accompanying drawings, in which:

FIG. 1 is a side view of a speaker embodying my invention, parts being broken away and shown in section; FIG. 2 is a rear view of the speaker taken on line 2--2 of FIG. 1;

FIG. 3 is a sectional view taken on line 3--3 of FIG. 1;

FIG. 4 is a sectional view taken on line 4--4 of FIG. 2; and,

FIG. 5 is an exploded view of the magnet and immediately associated parts to show assembly.

To overcome the more serious objection, there is shown therein a metal speaker basket 2 of conical shape within which the speaker cone 4 is to be mounted. The outer elliptical periphery of the speaker cone 4 is corrugated as shown at 6 so that the speaker may be moved axially with a piston-like movement to properly reproduce audible sound waves. The rim 8 of the speaker cone is adapted to be firmly attached to the flanged rim 10 of the speaker basket by any suitable means such as adhesive material. When mounting the speaker in place a flexible peripheral gasket 12 is fitted within the flanged edge 10 to seal against a frame and spaces the speaker diaphragm from porous facing material 15 which protects the front of the speaker and gives it an attractive appearance. This is conventional speaker construction and forms no part of the present invention.

As earlier mentioned the majority of the present speakers have the magnet structure mounted beyond the apex of the cone and outside the base of the speaker basket. In the present instance, however, in order to conserve space it is proposed to mount a portion of the magnet structure within the cone in order to lessen the total depth of the speaker structure. In this case the magnet structure consists of a permanent magnet 14, a front pole piece 16, a real pole plate 18, a front pole plate 20 together with suitable spacers 22 and securing bolts 24 and 26. The parts are perhaps best individually shown in the exploded view in FIG. 5. In assembling together a subassembly is first made of the magnet 14, pole piece 16 and pole plate 18 by first soldering the magnet to the pole plate 18 and then the pole piece 16 to the front surface of the magnet. Once these parts are in place the spacers 22 can be secured to the pole plate 18 by inserting and tightening the cap screws 26.

The central portion of the conical diaphragm 4 has a central opening therein in which is secured a cylindrical member 23 whose axis is coincident with that of the cone and which extends back into the cone to support at its innermost end the voice coil 25. The diameter of the cylinder 28 is sufficient to slide over the magnet 14 and pole piece 16 so that the voice coil when in place will lie around the periphery of the circular pole piece 16 as shown in FIG. 4. The basket 2 has a relatively flat inner end as shown at 32 having a central opening 34 therein through which the magnet 14 projects when the subassembly, consisting of the magnet 14, pole piece 16, pole plate 18 and spacers, is placed in position. The pole plate 18 is firmly secured to the outer face 32 by any suitable mechanical means such as staking, soldering, etc. At the inner end of the diaphragm 4 and surrounding the cylindrical supporting member 28 is a corrugated supporting spider member 36 which is secured to the diaphragm at its inner periphery and also cemented to the inside of the end of the basket 32 around its outer periphery as shown at 38.

In assembling this structure the subassembly of the pole plate 18, magnet 14 and pole piece 16 may be firmly secured to the outer end of the basket with the spacers 22 extending through notches 23 provided in the basket, and notches 25 in the edge of the spider 36. The diaphragm is then inserted into the basket with the cylindrical member 28 fitted down over the magnet 14 and pole piece 16. The spacers 22 are located and fitted through openings 27 in the diaphragm, the assembly nearing completion. The openings 27 are of sufficient size so they easily clear the outer surface of the spacers and will not rub thereagainst. When these members are all in place the front pole plate 20 is placed in position around the outer periphery of the voice coil 30 so that the central opening 42 therein is equally spaced on all sides. The cap screws 24 are threaded down into the mating threaded openings in the spacers 22 and the assembly tightened. Lastly, of course, the outer periphery 8 of the diaphragm 4 is secured to the flange 10 and gasket 12 and fabric or other decorative or protective member 15 is cemented to the front of the speaker.

The magnetic structure consisting of magnet 14, rear...
pole plate 18, rear cap screws 26, spacers 22, front pole plate 20, front cap screws 24, and pole piece 16 functions as a unit. Each of the plates, spacers and screws must be designed of good magnetic material and of sufficient cross-sectional area to provide a low reluctance path for the magnetic lines of force produced by magnet 14. Thus, it is seen that spacers 22 not only locate front pole plate 20 with respect to rear pole plate 18 but also they provide a low reluctance magnetic path between the two plates.

It will be seen that with this construction the majority of the magnet structure is located within an area from the apex of the cone inward and that the magnet structure does not increase the overall depth of the speaker structure to any extent and further that the magnet structure has not been miniaturized or made smaller than usual so that the sensitivity of the speaker has not been reduced and yet it does not materially mask the diaphragm to prevent its tonal reproduction.

What is claimed is:

1. In an electro-acoustic transducer, a conical shaped frame having an annular peripheral section and a reduced planar apical section parallel to the plane of the annular peripheral section, a conical diaphragm member of similar configuration to the frame and having annular flexible supporting portions secured to said frame at both the annular peripheral section and the apical section to support said diaphragm member for axial movement, a hollow cylindrical member secured to and extending through the apical section of the diaphragm member on its axis, a voice coil supported on said cylindrical member inside the conical diaphragm member, a short cylindrical permanent magnet supported on the planar apical section of the frame and extending inside the cylindrical member, a pole piece mounted on the inner end of the permanent magnet and located within the voice coil and a pole plate having a central opening therein of larger diameter than the voice coil mounted in planar alignment with the pole plate and supported solely by means extending to the apical section of the frame to provide an air gap for the voice coil with the pole piece.

2. In an electro-acoustic transducer having a conical frame and a conical diaphragm supported therein for axial movement to reproduce audible sounds, said diaphragm and frame having matching central openings therein at the juxtapositioned apical ends of each, a cylindrical magnetic assembly including a permanent magnet and pole pieces mounted on the face of the frame adjacent the apical openings and extending through the openings to a position within said conical diaphragm, a cylindrical member mounted on said diaphragm surrounding the magnet assembly, a voice coil mounted on said cylindrical member in alignment with one of the pole pieces, and a pole plate having a central opening therein supported entirely by said frame mounted in planar alignment with the voice coil and forming an air gap with said pole piece within which said voice coil may lie.

3. In an electro-acoustic transducer having a conical frame and a similarly shaped flexible diaphragm mounted therein for axial movement to reproduce audible sounds, said diaphragm having a central axial opening therein at its apical end, a magnet assembly including a permanent magnet and pole pieces mounted in the apical end of the frame and extending into the flexible diaphragm through the central opening, a pole plate carried by the apical end of the frame and having an opening therein lying in planar relation with the inner end of the magnet assembly and forming an annular air gap therewith and a voice coil supported by the diaphragm in the annular air gap so formed to drive the diaphragm.

4. In an electro-acoustic transducer having a conical frame and a similarly shaped flexible diaphragm mounted therein for axial movement to reproduce audible sounds, said diaphragm having a central axial opening therein at its apical end, a magnet assembly including a permanent magnet and pole pieces mounted on the apical end of the frame and extending into the flexible diaphragm through the central opening, a pole plate carried by the apical end of the frame and having an opening therein lying in planar relation with the inner end of the magnet assembly, and forming an annular air gap therewith, a cylindrical sleeve carried by the inner end of the flexible diaphragm and enclosing the magnet assembly but of sufficient inner diameter to be spaced therefrom and also of insufficient outside diameter to engage the surface of the opening in the pole plate and a voice coil carried by the cylindrical sleeve in the annular air gap to drive the diaphragm.

5. In an electro-acoustic transducer having a conical frame and a similarly shaped flexible diaphragm mounted therein for axial movement to reproduce audible sounds, said diaphragm having a central axial opening therein at its apical end, a magnet assembly including a permanent magnet and pole pieces mounted on the apical end of the frame and extending into the flexible diaphragm through the central opening, a cylindrical sleeve carried by the inner end of the flexible diaphragm but in spaced relation to the magnet assembly, supporting means carried by the apical end of the frame adjacent the magnet assembly and extending through openings in the flexible diaphragm, a pole plate mounted on said supporting means having a central opening therein to fit over the inner end of the magnet assembly and mounted in planar relation therewith to provide an annular air gap in which the cylindrical sleeve is positioned and a voice coil carried by said sleeve in said annular gap to drive the diaphragm.

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