

[54] DYNAMIC SPEAKER HAVING DOME DIAPHRAGM AND BASKET FRAME

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181/172

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157, 172

[56]

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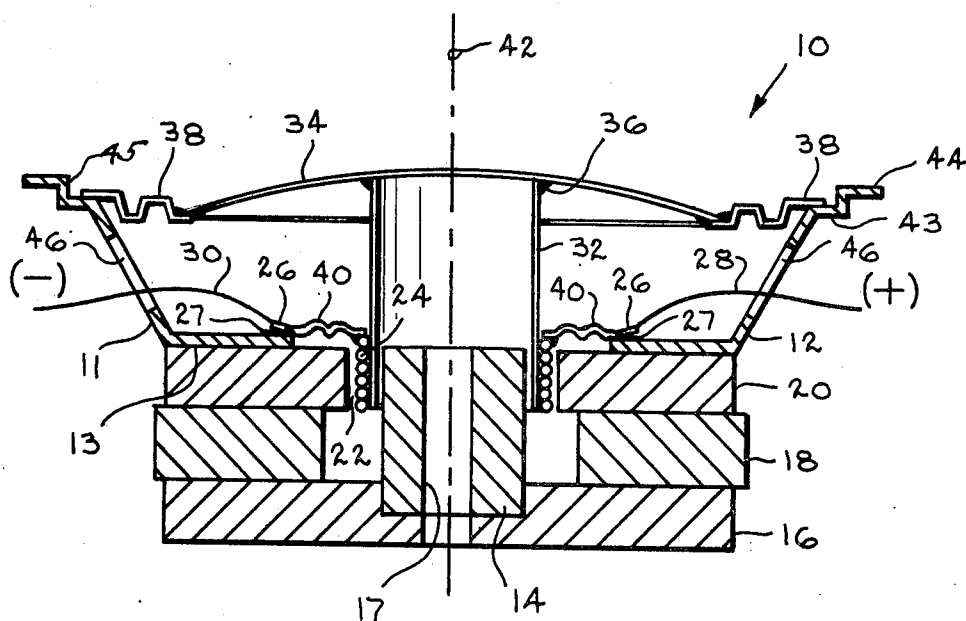
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ABSTRACT

An all-frequency loudspeaker of the type using a voice coil suspended in a magnetic field and driven by the usual audio transformer of an amplifier system. The inventor's contribution lies primarily in substituting for the usual paper cone diaphragm of the prior art an outwardly convex metal diaphragm secured near its center to an extension of the form or tube on which the voice coil is wound. As with other diaphragms, the convex metal diaphragm is secured to the rigid framework of the system by a resilient suspension at its outer periphery. A second resilient suspension extends between the framework and that part of the coil form adjacent the coil.

Also disclosed is a combination of the improved speaker with a hard surfaced, spherical shell enclosure. When using the enclosure, a section of it is removed and the speaker is mounted in the opening so that the spherical wall of the enclosure is interposed between the outwardly convex diaphragm of the speaker and its voice coil. This effectively isolates and nullifies the sound produced by the back of the speaker as the diaphragm moves backwardly, leaving only the sound produced by the front of the diaphragm to reach the listener.

6 Claims, 4 Drawing Figures



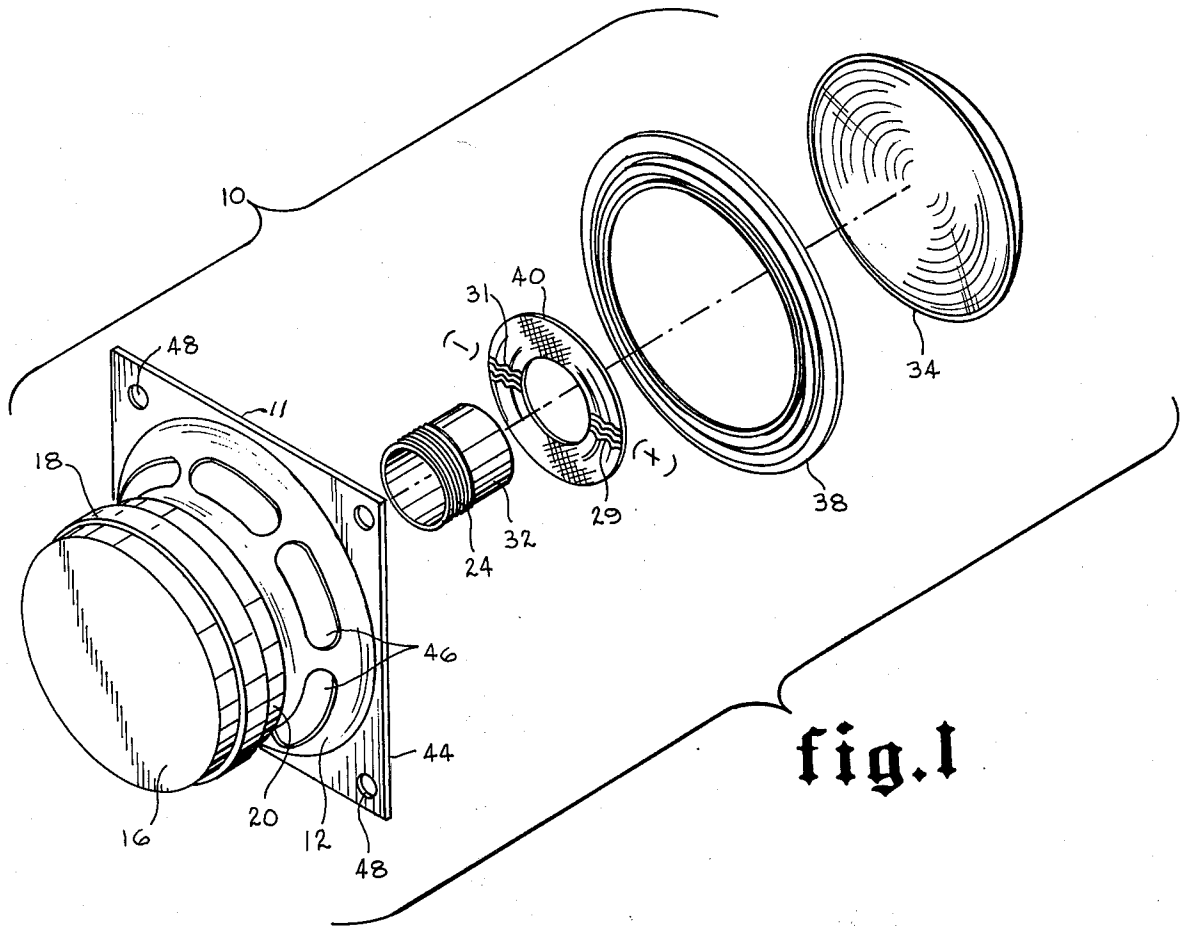


fig.1

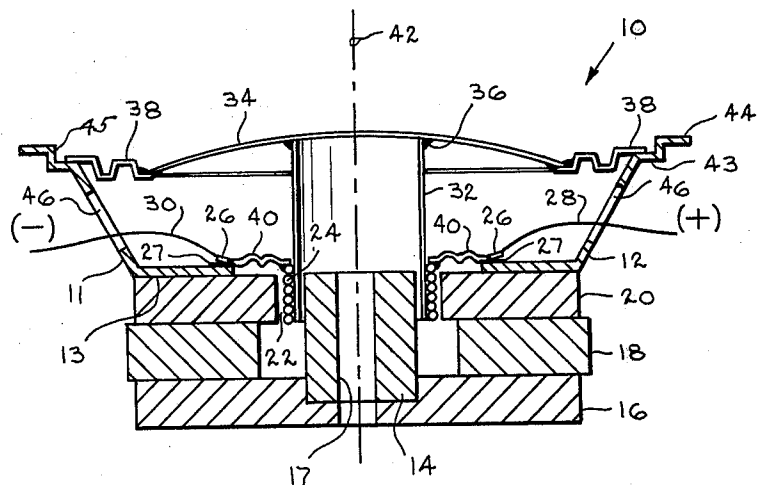


fig.2

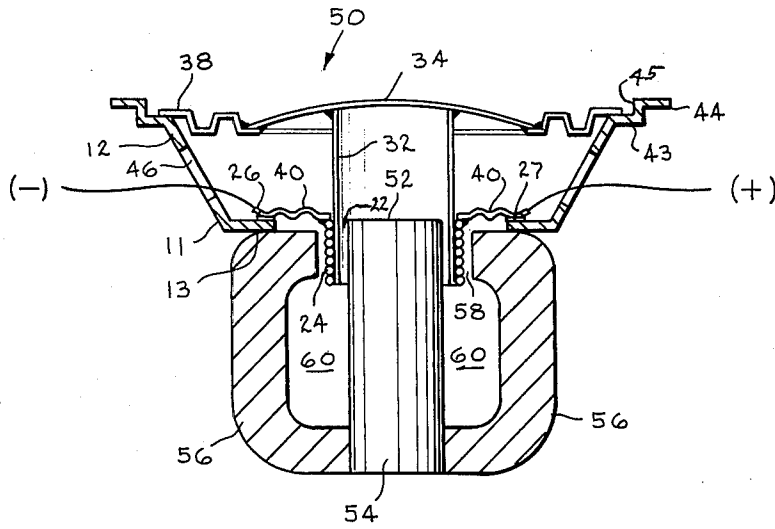


fig.3

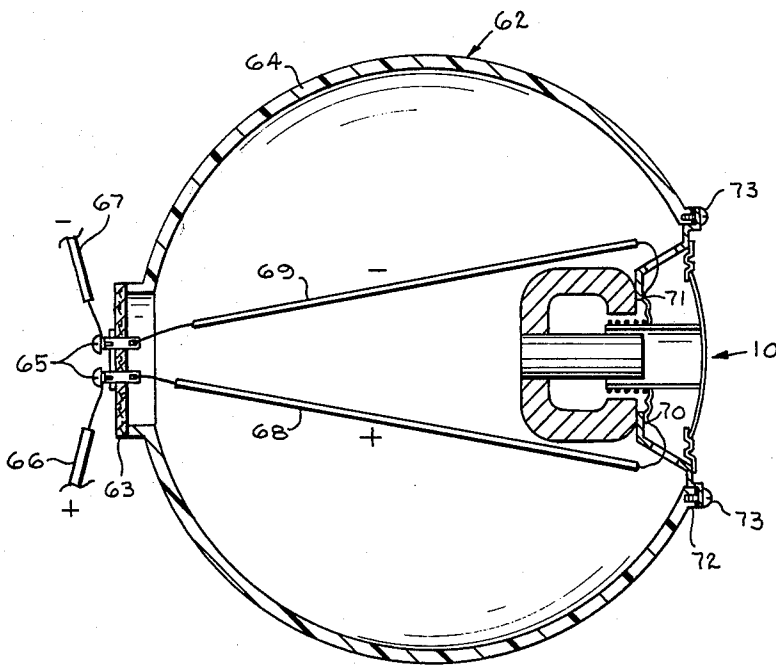


fig.4

DYNAMIC SPEAKER HAVING DOME DIAPHRAGM AND BASKET FRAME FIELD OF THE INVENTION

The present invention is concerned with improvements to direct radiating dynamic loudspeakers, in particular those utilizing a voice coil suspended in a magnetic field and driving a diaphragm to change the audio frequency currents in the voice coil to audible sound waves radiating from the diaphragm. More specifically, the invention is concerned with novel combinations of diaphragms and the means linking such diaphragms to the voice coil, novel means for suspending the linking means to the framework, such suspension having lead wires secured therein, and novel combinations of the improved speakers with speaker enclosures. Such improvements are applicable to a wide range of sizes of loudspeakers, suitable for use with all audio frequencies.

PRIOR ART

None of the improvements of the present applicant is known to be commercially available. Except for the high range of frequencies, the loudspeakers that are available still use the familiar paper cone diaphragm and, as resilient suspensions for the cone, corrugated members made of various materials such as textile fabrics, sometimes impregnated with a resin or plastic. It is still the standard practice to run the lead wires through holes in the conical part of the metal framework, thence through the paper cone and down along the surface of the cone to the voice coil. Such lead wires are generally left slack, and the result is that they vibrate as the cone vibrates, an action known as "wire slap." This sometimes becomes so troublesome that the lead wires fail in fatigue, and other times they puncture the cone and cause it to rattle, a phenomenon known as "cone break-up."

The commercially available enclosures for speakers are still limited to those having six or more flat sides, and many such enclosures include both a large diameter speaker for low frequencies known as a "woofer" and a small diameter speaker for high frequencies, a "tweeter," both mounted on flat walls. Such enclosure-loudspeaker combinations do not give a faithful reproduction of the original sound, but tend to distort the same, to introduce undesirable harmonics, and are prone to be highly directional.

With respect to patented and otherwise published prior art, somewhat more is known. The superiority of spherical enclosures, for instance, was disclosed by Harry F. Olson in his article "Direct Radiator Loudspeaker Enclosures," published on pp. 22-29 of *The Journal of the Audio Engineering Society*, Vol. 17, No. 1, January, 1969 — although limited to work with speakers utilizing only paper cone diaphragms. Other relevant art appears in Hamson's U.S. Pat. No. 3,032,615 (May 1, 1962), disclosing the use of silicone grease to stick lead-in wires to a suspension, and Villchur's U.S. Pat. No. 3,033,945 (May 8, 1962), disclosing the use of a domed diaphragm for tweeters made of a phenolic impregnated fabric. Villchur teaches the use of only a single resilient suspension, and secures his voice coil directly to the outermost rim of his domed diaphragm. While this may work fairly well for tweeters, which are only 1-2 inches in diameter, it has not been proven feasible for larger diaphragms, from 2½ to 6 inches in diameter.

OBJECTS OF THE INVENTION

Accordingly, the principal object of the present invention is to provide a dynamic loudspeaker which may be used to obtain high fidelity sound. A second object is to provide such a loudspeaker in combination with a spherical enclosure to further maximize the fidelity of the reproduced sound. A third object is to furnish in such loudspeaker a novel combination of an outwardly convex diaphragm and means linking such diaphragm to the tube or form on which the voice coil of the loudspeaker is tightly wound and secured. A fourth object is to provide a loudspeaker having an improved means of mounting the lead wires to the voice coil, one which avoids the wire slap of prior art loudspeakers. A fifth object is to provide a novel combination of loudspeaker elements so structurally interrelated that the diaphragm reciprocates as an entity and there are few or no vibrations in only a part of the diaphragm. A sixth object is to furnish such loudspeakers and loudspeaker-enclosure combinations which may be used in a single size to faithfully reproduce all frequencies present in the original sound. A seventh object is to provide a loudspeaker which will faithfully reproduce all audio frequencies. An eighth object is to provide better high frequency dispersion and phase characteristics in such loudspeakers.

SHORT STATEMENT OF THE INVENTION

The above and further objects are realized according to the concept of the present inventor by utilizing an outwardly convex diaphragm, e.g., a thin spherical shell, preferably of metal. The convex diaphragm is secured to the voice coil by extending the tube or form on which the voice coil is tightly wound and secured until the tube contacts the diaphragm, and integrating the tube end to the diaphragm by adhesives or other suitable securing means. Any suitable magnetic structure may be utilized, with the voice coil suspended in the air gap of the magnetic circuit. Customary means are used to form a resilient suspension connecting the outer periphery of the convex diaphragm to the framework of the loudspeaker, but a somewhat different and improved suspension is used to secure the extended tube of the voice coil to the framework. While the second suspension is still a resilient suspension, it is made of a virtually flat woven cloth and has the lead wires for the voice coil woven into it, wrinkled in assembly to provide the slack necessary for axial movement.

Such a speaker is preferably mounted in a spherical enclosure to obtain the maximum advantage from it.

SHORT DESCRIPTION OF THE DRAWING FIGURES

The invention is probably more easily comprehended by reference to the accompanying drawing, read together with the details below. In the drawing:

FIG. 1 is an exploded perspective view of a particular embodiment of the improved loudspeaker of the invention;

FIG. 2 is a cross section of an assembly of the same embodiment, with the addition of connectors and insulators for the lead wires;

FIG. 3 is a cross section like that of FIG. 2 but using a different magnetic structure, and

FIG. 4 is a cross section of a combination of the loudspeaker of FIG. 3 with a spherical enclosure.

DETAILED DESCRIPTION OF THE DRAWING FIGURES

The loudspeaker 10 illustrated in FIGS. 1 and 2 includes a more or less conventional framework 11 which includes a sidewall 12 joined to a horizontal base 13 extending inwardly toward its axis of symmetry 42. At its upper edge the sidewall 12 is joined to an outwardly jutting inner flange 43, which in turn is joined by a short sidewall 45 to an out-turned mounting flange 44. This flange 44 may be square, as illustrated, or any other convenient shape. It is also convenient to provide it with a number of mounting holes 48. The sidewall 12 (not necessarily conical, as shown) is preferably provided with a number of vents 46, most importantly in order to permit compressions and rarefactions of the air behind the diaphragm 34 to communicate with the surrounding air. Vents 46 also provide a convenient means for passing the voice coil lead wires 28 and 30 through the framework.

Base 13 of the framework is firmly secured to the top surface of the magnet structure comprising pole piece 14, bottom plate 16, center ring 18 and top ring 20, all of which are firmly secured together without air gaps except the gap 22 between the inner circumference of top ring 20 and pole piece 14. The through opening 17 in pole piece 14 and bottom ring 16 is an optional feature which is believed to produce somewhat superior performance. The reason for this is analogous to the reason for vents 46, as opening 17 provides a connection between the air space overlying pole piece 14 and the surrounding air, permitting the air which is variously compressed and expanded to attenuate such changes into the atmosphere. (There is an alternate but more restricted path through air gap 22.)

Mounted on the inner flange 43 of the framework by means of resilient mounting 38 is a spherical or domed diaphragm 34. Diaphragm 34 is preferably made of a quite thin sheet metal, e.g., aluminum in a thickness of about 0.01 inch. The thickness should be the minimum consistent with rigidity, as it is desirable that the diaphragm translate up and down as a whole, without any part thereof vibrating at a different rate and without lagging behind or leading the balance of the diaphragm. This thickness will naturally vary with the metal or other rigid material employed.

The "surround" or resilient suspension 38 is more or less conventional, and is tightly secured to both the framework flange 43 and the outer periphery of diaphragm 34. Typically, it is a dished or corrugated ring of fabric impregnated with a plastic to add some rigidity; the corrugations or concavity help supply the proper degree of rigidity and at the same time permit the mounting to be stretched as necessary to accommodate up and down movement of diaphragm 34.

Tightly secured to the underside of diaphragm 34 by an adhesive or other suitable connection 36 is the tube or form 32 which is centered on the axis of symmetry 42 and extends downwardly into the air gap 22. Also in the air gap and tightly wound on the lower portion of form 32 is the voice coil 24. Voice coil 24 is made of an appropriate wire gauge and with an appropriate number of turns so that the currents passing through it will react with the magnetic force in the field passing through air gap 22 to cause a force upward or downward from the coil, in the well-known manner.

Form 32 is partially supported in air gap 22 by a lower resilient support 40. This lower support 40 is

tightly secured at one end to the form and is tightly secured at its other end to the inner end of base 13 of the framework. While resilient support 40 is similar in its action to the upper resilient support 38, it differs therefrom in that it is made of essentially a flat piece of cloth which is wrinkled in assembly for the up and down motion of the form 32.

The lower resilient support 40 also differs from previously known such supports in that it includes the leads 29 and 31 from the pair of ends of voice coil 24. Such leads 29 and 31 are preferably actually woven into the fabric of support 40, and are provided at their outer ends with metallic connectors 26 which are soldered or otherwise electrically and mechanically connected to the wire ends of the leads 29 and 31. Since these connectors immediately adjoin the metallic framework member 13, it is preferable to secure under each lead or each connector 26 an insulating wafer 27, to avoid short circuits. Each connector 26 is then connected to one of the external leads 28 and 30 to the audio amplifier (not shown). The preferred construction is with both of the woven end leads 29 and 31 and the external leads 28 and 30 disposed at diametrically opposed positions, the better to balance the weight carried by the lower resilient support 40 and thus to avoid any imbalance which may interfere with optimum operation of the speaker.

The loudspeaker illustrated in FIG. 3 is similar to that shown in FIGS. 1 and 2, differing only in the magnet structure. While the magnetic structure of the FIGS. 1 and 2 embodiment utilizes a core of ceramic material, that of FIG. 3 utilizes an Alnico core for pole piece 54. Mounted on this pole piece 54 are a pair of ferromagnetic arms 56, having the U-shaped configuration shown in the figure. Except at their tops and bottoms arms 56 do not have the circular geometry of the FIGS. 1 and 2 embodiment, and thus the air spaces 60 between parts 54 and 56 are open to the surrounding atmosphere. At their upper ends the arms 56 are necked down as shown, and an air gap 22 is provided between pole piece 54 and the inner ends of the connecting arms 56, corresponding to the gap 22 in FIGS. 1 and 2. As in the previously described embodiment, this air gap contains the suspended coil form 32 having coil 24 tightly secured thereon. In other respects, the structure 50 of the FIG. 3 embodiment is the same as that previously described, and the same identifying numerals have been used to delineate its parts.

FIG. 4 illustrates another aspect of the present invention, a combination of one of the speakers previously described with a primary enclosure adapted to improve its response characteristics, in particular its omnidirectionality and its uniform loudness response to the entire frequency spectrum. In this combination, as illustrated, one of the loudspeakers 10 shown in FIGS. 1 and 2 is shown mounted in an enclosure 64 made of a hard material such as glass, Plexiglas, or other relatively rigid plastic. The enclosure 64 is a sphere of anywhere from about 8 inches in diameter on up, the larger the better. Its front end is opened to provide a mounting space for loudspeaker 50, and it is there provided with a thickened lip 72 as shown to receive the mounting screws 73 extending through the mounting holes in the speaker and threaded into tapped openings in the enclosure itself. At its opposite end, the sphere is provided with a second opening on which is mounted a removable cap 63. The sphere is preferably sealed shut by the members mounted in the openings, and connectors 65 are

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provided through cap 63. External leads 66 and 67 are connected to these terminals on the outside, and on the inside relatively taut leads 68 and 69 connect the terminals to terminals 26 of the loudspeaker, which connect internally to the ends of the voice coil, as previously described.

It should be mentioned, that the loudspeakers of the present invention have frequency responses and dispersion which are so good over the entire range of the audio frequency spectrum that they can be used to replace all prior speakers, making the use of separate tweeters and woofers obsolete. The preferred size range, in terms of the diameter of diaphragm 34, are from 2½ up to 6 inches, and it should be remembered that in each case the diaphragm is buttressed and supported by the extended voice coil form to which it is rigidly secured. The entire mass — diaphragm, voice coil form and voice coil are translated together as an entity, removing the prior disadvantage of speakers with large diaphragms, regardless of their configuration. This in itself is the major contribution of the present inventor. Nevertheless, the auxiliary improvements should not be overlooked, namely the use of voice coil leads woven or otherwise secured to the lower resilient suspension and the combination of the speakers with the primary enclosure in the form of a relatively rigid spherical shell.

What is claimed is:

1. In combination, a loudspeaker and a primary enclosure

therefor, said enclosure being of hard material and having the general form of a spherical shell, said loudspeaker being secured to the wall of said enclosure at an opening therein, said loudspeaker comprising a framework, a magnet structure secured to one end of the framework and having an air gap therein, an outwardly convex diaphragm at the other end of said framework with its outer edge resiliently supported thereby, a voice coil form secured to the center portion of

said diaphragm on the concave side thereof and extending down to said magnet structure

and into the air gap therein, a voice coil securely wound on the lower end of said form and disposed in said air

gap, a second resilient support extending between said framework and the voice coil form adjacent the voice coil thereon, and lead wires from said voice coil to the outside of the loudspeaker tightly secured to said second suspension.

2. The dynamic loudspeaker of claim 1 in which said outwardly convex diaphragm is made of a metal and is between 2½ and 6 inches in diameter.

3. A dynamic loudspeaker comprising a framework, a magnet structure secured to one end of the framework and having an air gap as said end, an outwardly convex, rigid diaphragm disposed at the other end of said framework with its outer periph-

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ery resiliently supported thereon, a voice coil form having one end secured to the center portion of said diaphragm on the concave side thereof and extending to said magnet with its other end disposed in said air gap, and a voice coil securely mounted on said other end of the form and also disposed in said air gap.

4. The dynamic loudspeaker of claim 3 which also includes a second resilient suspension, said second resilient suspension extending between said one end of the framework and said voice coil form from adjacent the voice coil thereon, and a pair of lead wires from the ends of said voice coil, said lead wires being tightly secured to said second suspension.

5. A dynamic loudspeaker comprising a framework which

includes a sidewall and an inwardly extending flange at one end, a magnetic structure secured to said flange of the framework and having an annular slot therein forming an air gap, a dielectric tube and a voice coil would thereon disposed

in said air gap, said dielectric tube projecting out of said slot approximately to the outer end of said framework, a convex metal diaphragm disposed at said outer end of the framework and secured thereto by an annularly corrugated resilient suspension permitting limited reciprocating motion of the diaphragm along an axial line of motion coinciding with the axis of said tube, said diaphragm being secured to said projecting end of the tube adjacent the center of the diaphragm, so that all of the diaphragm, tube and voice coil reciprocate in unison, a second resilient suspension between said tube and said framework adjacent but spaced from the secured end of the framework, and a pair of leads extending from the ends of said voice coil to the outside of the framework.

6. In a moving coil loudspeaker of the type ordinarily employing a paper cone diaphragm having its large end secured to the large end of a conical framework by means of a first resilient suspension and its small or apical end secured to both the moving coil and, by means of a second resilient suspension, to the small end of said framework, the improvement comprising a convex metal diaphragm replacing such paper cone and disposed at such larger end of the framework, a resilient suspension supporting said convex metal diaphragm and connecting it to the outer end of the framework, said moving coil being tightly mounted on a form which projects above the coil and extends into contact with the center portion of said metal diaphragm and is tightly secured thereto, and a

second resilient suspension secured to said form above and adjacent the coil would thereon, the outer edge of the second suspension being secured to the small end of the framework.

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