Aug. 22, 1961 J. A. HASSAN 2,997,549

LOUDSPEAKER CONSTRUCTION

Filed March 20, 1958 2 Sheets-Sheet 1

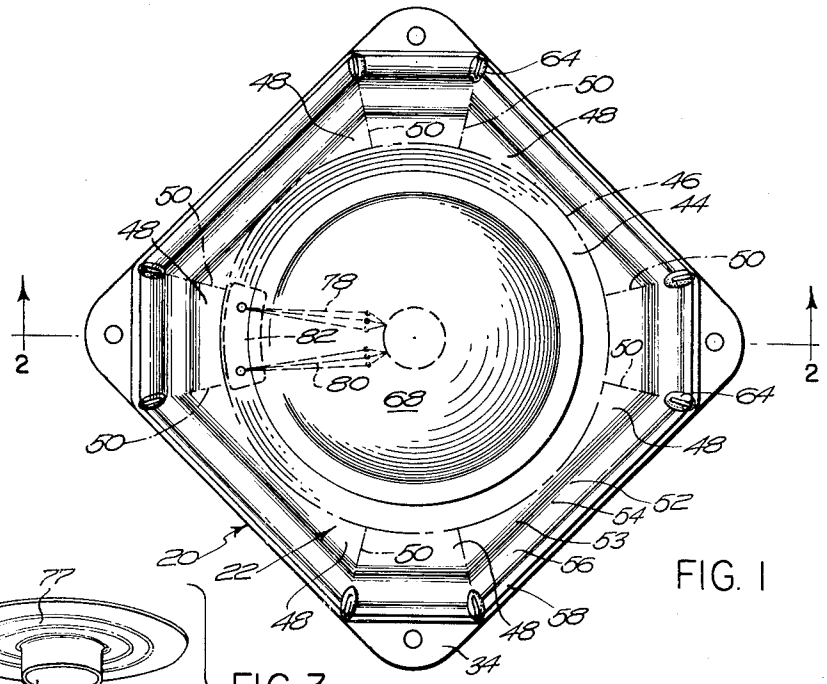


FIG. 1

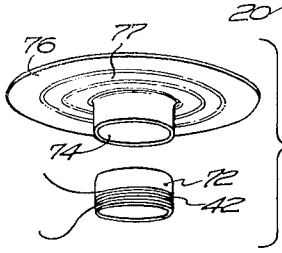


FIG. 3

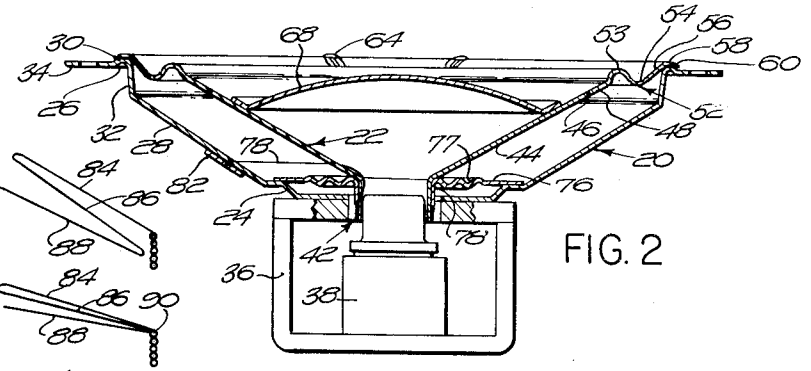


FIG. 2

FIG. 4

FIG. 5



FIG. 6

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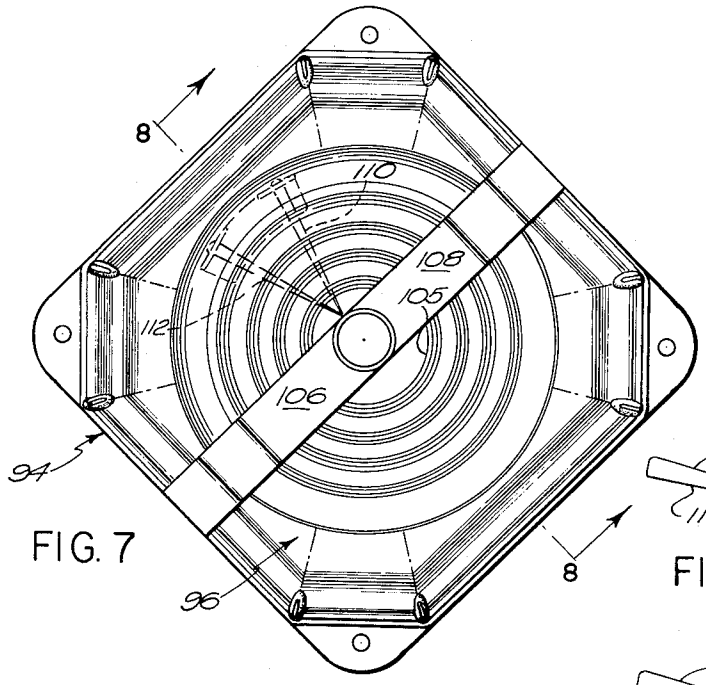


FIG. 7

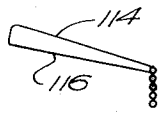


FIG. 9

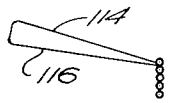


FIG. 10

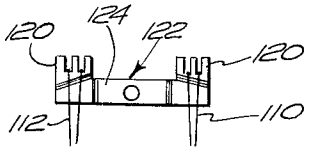


FIG. 11

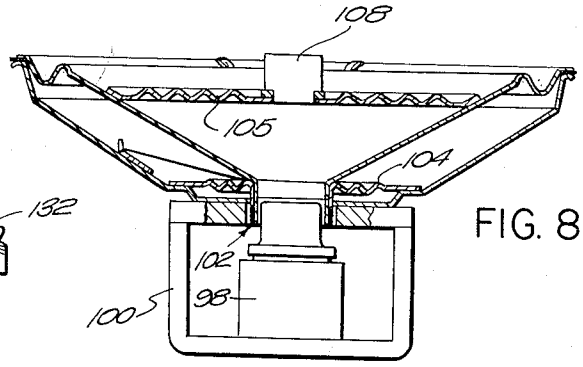


FIG. 8

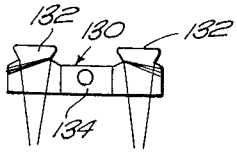


FIG. 12

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LOUDSPEAKER CONSTRUCTION

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8 Claims. (Cl. 179—115.5)

The present invention relates to acoustic devices and, more particularly, to loudspeakers of the type comprising a frame carrying a voice coil, and a diaphragm integrally including a tapering piston portion, the apex of which is associated with the coil, and a peripheral convoluted portion, the outer edge of which is connected to the frame. Generally, if the piston portion is to generate frequencies within a desirable sound range, particularly bass frequencies, its diameter should not be too small. Generally, the peripheral convoluted portion, if it is not to restrict unduly the diameter of the piston portion or otherwise affect adversely its operation, must be carefully designed to occupy minimum space and to vibrate freely.

Primary objects of the present invention are to provide, in a loudspeaker of the foregoing type, a plurality of novel components, which are capable of cooperating individually with associated conventional components or collectively with each other in a compact unit of exceptional acoustic range. These components include: novel diaphragm means having straight peripheral edges; novel reinforcing means associated with a loudspeaker diaphragm; novel mounting means for associating the coil with a loudspeaker diaphragm; and novel electrical leads for transmitting signals to and from a loudspeaker coil.

Other objects of the present invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the device possessing the features, properties and relation of elements which will be exemplified in the device hereinafter described and the scope of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIGURE 1 is a top plan view of a loudspeaker embodying the present invention;

FIG. 2 is a cross-sectional view of the loudspeaker of FIG. 1, taken substantially along the lines 2—2;

FIG. 3 is an exploded view of a component of the loudspeaker of FIG. 1;

FIGS. 4, 5 and 6 illustrate steps in a process of fabricating a component of the loudspeaker of FIG. 1;

FIG. 7 is a top plan view of an alternative loudspeaker embodying the present invention;

FIG. 8 is a cross-sectional view of the loudspeaker of FIG. 7, taken substantially along the lines 8—8;

FIGS. 9 and 10 illustrate the steps of a process for fabricating one of the components of the loudspeaker of FIG. 7.

FIG. 11 illustrates a component of the loudspeaker of FIG. 7; and

FIG. 12 illustrates a modification of the component of FIG. 11.

The loudspeaker of FIGS. 1 and 2, in accordance with the present invention, comprises a reticulated metal frame **20** and a generally conical diaphragm **22**, composed of a light but still fibrous material such as paper or cardboard.

As shown, frame **20**, in the form of a dish-shaped basket, includes a rear inward base **24** of relatively small extent and a front outward rim **26** of relatively great extent. Rim **26** is integrally joined to base **24** by rearwardly converging webbing **28**. Rim **26** presents a forward face **30** lying in a plane that is perpendicular to its

axis. Rim **26** includes an inner, substantially hexagonal tube **32** disposd about the axis of the rim and extending longitudinally thereof a substantial distance, for a reason to become apparent below. Extending outwardly from rim **26** at spaced 90° intervals, in a plane rearwardly of the plane of face **30**, are four mounting extension **34**, the free edges of which lie generally along the four sides of a square. Extending rearwardly from base **24** is a flux loop **36** in the form of a magnetic metal strap, the legs of which are affixed to the base. A magnetic core **38** extends forwardly from the bite of flux loop **36**, its forward portion being received by a reciprocable voice coil **42**.

Diaphragm **22**, the apex of which is connected to the forward end of voice coil **42**, diverges forwardly with respect to the diaphrgm axis at an angle of from 20° to 45°. The inward portion **44** of diaphragm **22**, extending to the circle shown in phantom lines at **46**, is substantially conical. The medial portion of diaphragm **22**, extending outwardly from circle **46**, includes eight panels **48**, the inner portions of which are generally conical and the outer portions of which are generally planar. These panels are separated form each other by creases **50**, which increase in sharpness outwardly. These panels **48** are integrally joined to a series of straight longitudinal convoluted portions **52**, each of which includes, in integral sequence as shown in FIG. 2, a forwardly convex peripheral ridge **53**, a spacing continuation **56**, and the flange **58**, which is affixed to face **30** by cement **60**. It will be noted that, with respect to the axis of diaphragm **22**, the slope of trough **54** immediately adjacent to the panels of medial section **48** is greater than the slope of the medial sections with respect to the axis of diaphragm **22**. It will also be noted that the cross-sectional length of the inner half of trough **54** is less than the cross-sectional length of the outer half of trough **54** plus the length of spacer **56**. The notches **62**, between adjacent extremities of convoluted portions **52**, are covered with leaf-like tabs **64** of an elastomeric cement, for example, containing as its characteristic ingredient a rubbery polymer such as natural or synthetic rubber.

In consequence of the longitudinal design of convoluted sections **52**, inner and medial portions **44** and **48** of diaphragm **22** may tend to be supported too loosely. In order to overcome any such tendency, a support in the form of a dome **68** is provided. Dome **68**, which is composed of a relatively stiff but extremely porous material, for example, an unwoven fabric such as paper or a woven fabric such as cloth, is secured at its periphery to diaphragm **22** by means of cement.

Coil **42** is mounted in a manner that permits it to be expediently and inexpensively centered about core **38**. As best shown in FIG. 3, coil **42** is wound about the lower extremity of a cylinder **72** formed from a single ply of extremely thin paper. The forward portion of cylinder **72** fits snugly into a tube **74** extending integrally from a spider **76**, the peripheral edges of which are secured to base **24** of frame **20**. In conventional fashion, spider **76** includes a series of concentric troughs and ridges **77** which permit the center of the spider to vibrate axially. As shown, the apex of diaphragm **22** is secured to the inner edges of tubular portion **74**, as at **78**. This construction makes possible simple fabrication, perfect alignment, minimum coil diameter, lightness and sturdiness.

In accordance with the present invention a pair of novel leads **78** and **80** are provided between the terminals of coil **42** and a terminal plate **82**. The manner of constructing each of these leads is shown in FIGS. 4, 5 and 6. As shown, the wire of which coil **42** is formed, instead of being severed at the coil, is permitted to extend a considerable unwound distance before being cut.

As shown in FIG. 4, this wire is then bent in zigzag fashion upon itself to provide a series of strands **84**, **86**, **88**, the inner extremities of which, as shown in FIG. 5, are soldered at **90**. The outer joints between any two strands, that are connected at their outer ends, next are severed, as shown in FIG. 6. Finally, the strands are threaded through openings in diaphragm **22** and joined at terminal plate **32** by solder. Thereafter the strands are sealed within their respective openings through diaphragm **22** by means of a rubber cement of the type above described. This construction reduces the expense of the lead wires themselves, as well as the unnecessary manufacturing costs of joining discrete lead wires to the terminals of the coil and reduces the restraint upon movement of diaphragm **22** by distributing the various strands for projection through the diaphragm at different points while providing an adequate current path.

An alternative embodiment of the present invention is shown in FIGS. 7 and 8 as comprising a frame **94**, a diaphragm **96**, a core **98**, a flux loop **100**, a coil **102**, and a spider **104**, generally similar to their counterparts in the construction of FIGS. 1 and 2. As shown, however, the internal support for diaphragm **96** is a spider **105**. The center of spider **105** is mounted upon a pair of arms **106** and **108** that extend inwardly from frame **94**. The outer periphery of spider **105** is secured, as by means of cement, to diaphragm **96**.

Leads **110** and **112** extending from the terminals of coil **102** are fabricated as shown in FIGS. 9 and 10. Each of leads **110** and **112** initially constitutes an unwound extension of coil **102**, which is bent upon itself to provide a pair of strands **114** and **116**. These strands are soldered at their inner extremity to provide an outer loop. This loop is retained between the upstanding legs of a pair of electrically conducting forks **120** of a terminal plate **122**, the medial mounting portion **124** of which is electrically insulating.

Alternatively terminal plate **122** may be replaced by a terminal plate **130**, having at its opposite extremity a pair of oppositely notched, electrically conducting tabs **132**, and at its center an electrically non-conducting mounting portion **134**.

In operation, the illustrated loudspeakers occupy minimum space, present large diaphragm piston area, have broad frequency range, and are precisely aligned by virtue of the novel design of the diaphragm, the diaphragm support, the speaker coil and the speaker coil leads.

Since certain changes may be made in the foregoing devices without departing from the scope of the invention herein involved, it is to be understood that all matter mentioned in the foregoing description or shown in the accompanying drawings is to be interpreted in an illustrative and not in a limiting sense.

What is claimed is:

1. A loudspeaker comprising a frame, a tapering diaphragm having outer extremities secured to said frame, a speaker coil mounted at the apex of said diaphragm, a support connecting a medial portion of said diaphragm to said frame, and leads extending from said speaker coil, said diaphragm having convoluted peripheral sections extending linearly along its edges, said speaker coil enveloping a thin sleeve, magnetic means defining a magnetic flux gap into which said speaker coil projects, a spider integrally including a periphery connected to said diaphragm and a central tubular portion receiving a portion of said sleeve, said support including a fabric element having a periphery cemented to said diaphragm, said leads constituting a plurality of strands of the wire of said coil.

2. The loudspeaker of claim 1 wherein said support includes a rod connecting the center of said element and a core about which said coil is disposed.

3. The loudspeaker of claim 1 wherein said support includes arms extending from said frame.

4. A loudspeaker comprising a frame, a tapering diaphragm having outer extremities secured to said frame, a speaker coil mounted at the apex of said diaphragm, a support connecting a medial portion of said diaphragm to said frame, and leads extending from said speaker coil, said diaphragm having convoluted sections extending linearly along its edges, magnetic means defining a magnetic flux into which said speaker coil projects, said diaphragm having openings therethrough which separate the ends of said convoluted sections, and elastomeric seals covering said openings.

5. A loudspeaker comprising a frame, a tapering diaphragm having outer extremities secured to said frame, a speaker coil mounted at the apex of said diaphragm, a support connecting a medial portion of said diaphragm to said frame, and leads extending from said speaker coil, said diaphragm having convoluted sections extending linearly along its edges, said diaphragm having notches separating the ends of said convoluted sections, magnetic means defining a magnetic flux gap into which said speaker coil projects, the inward portion of said diaphragm being substantially conical, the medial portion of said diaphragm including a plurality of panels extending between said inner portion and said convoluted sections.

6. A loudspeaker comprising a frame, a tapering diaphragm having outer extremities secured to said frame, a speaker coil mounted at the apex of said diaphragm, a support connecting a medial portion of said diaphragm to said frame, and leads extending from said speaker coil, said diaphragm having convoluted peripheral sections extending linearly along its edges, said speaker coil enveloping a thin sleeve, a spider integrally including a periphery connected to said frame and a central tubular portion connected to said apex of said diaphragm and receiving a portion of said sleeve, said support including a fabric element having a periphery cemented to interior portions of said diaphragm, said diaphragm having openings separating the ends of said convoluted peripheral sections, and elastomeric seals covering said openings.

7. The loudspeaker of claim 5 wherein said element is a dome.

8. The loudspeaker of claim 6 wherein said support includes means for mechanically connecting the center of said fabric element to said frame.

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