July 29, 1958 A. B. COHEN ET AL 2,845,135

AUXILIARY WAVE PROPAGATING AND DIRECTING ATTACHMENT FOR LOUDSPEAKER DIAPHRAGMS

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Fig. 1.

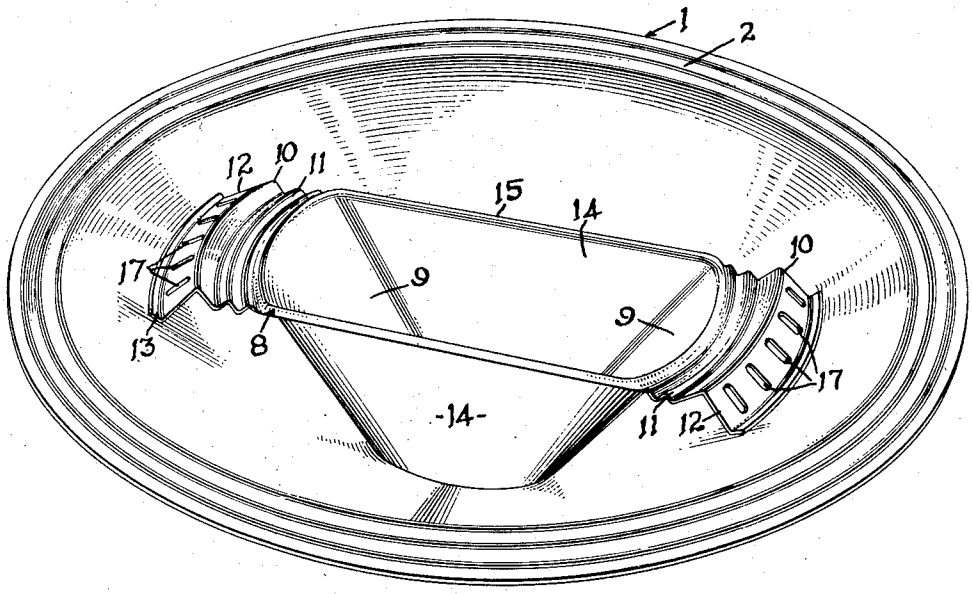
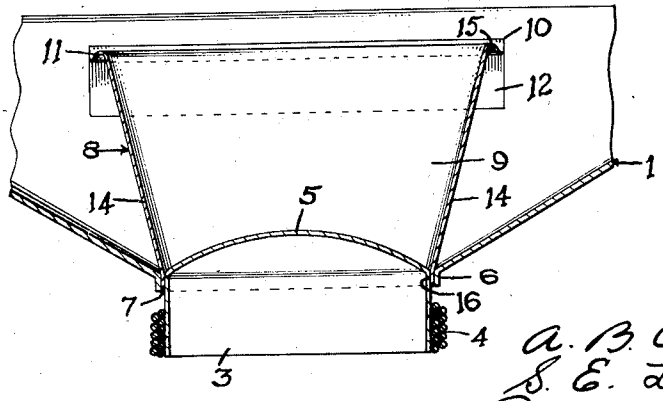


Fig. 4.



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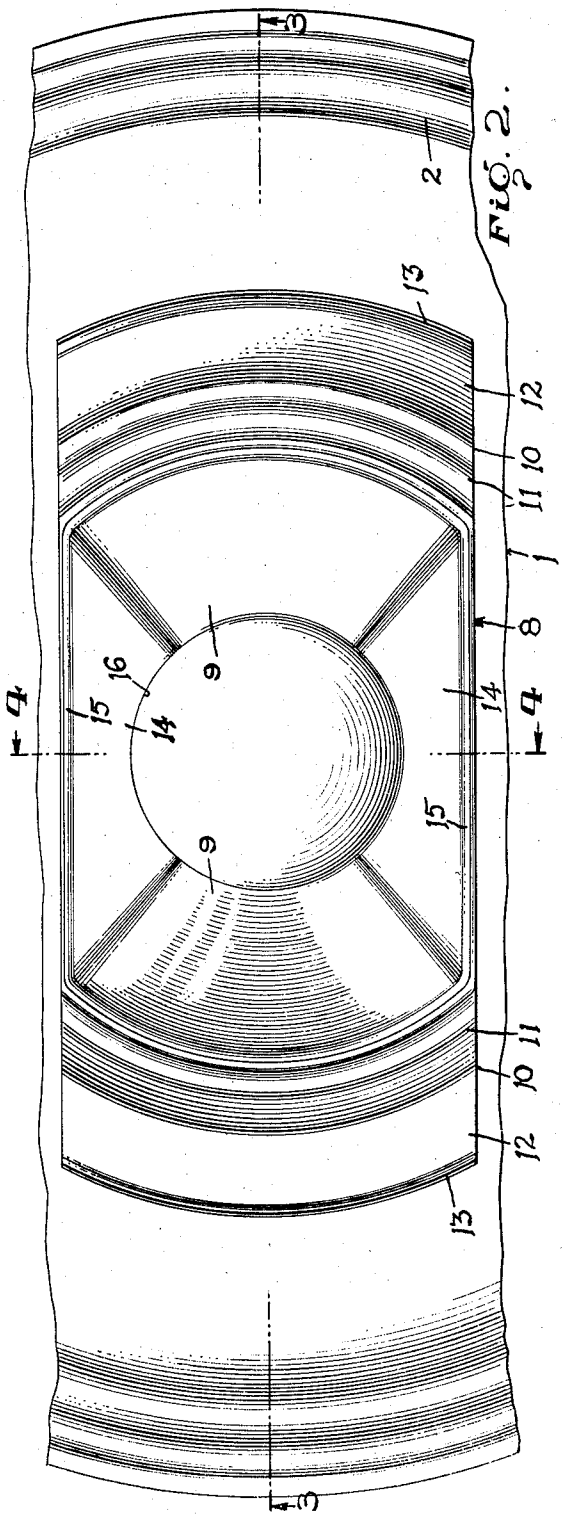


Fig. 2.

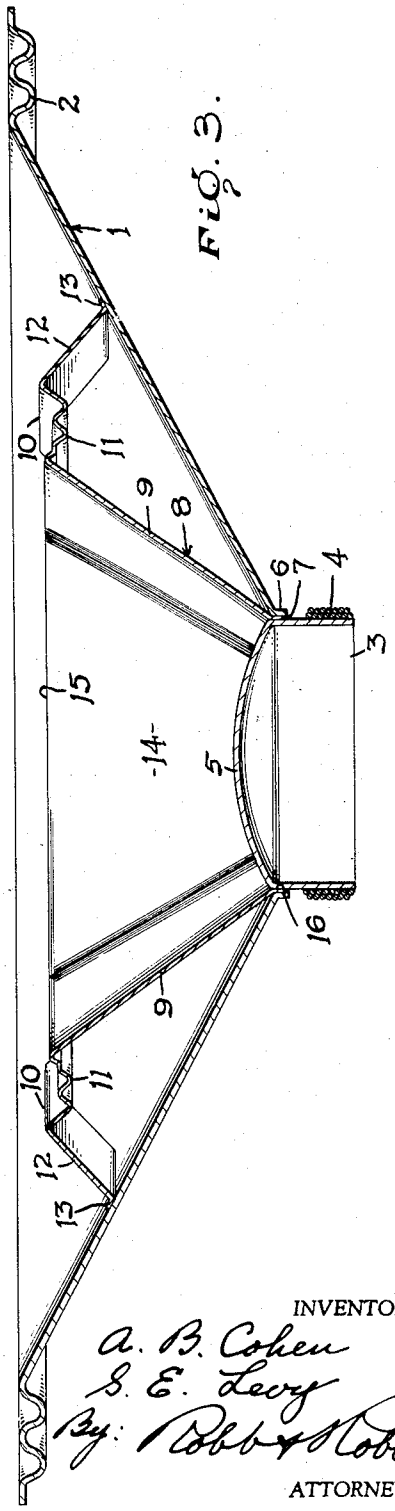


Fig. 3.

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Fig. 5.

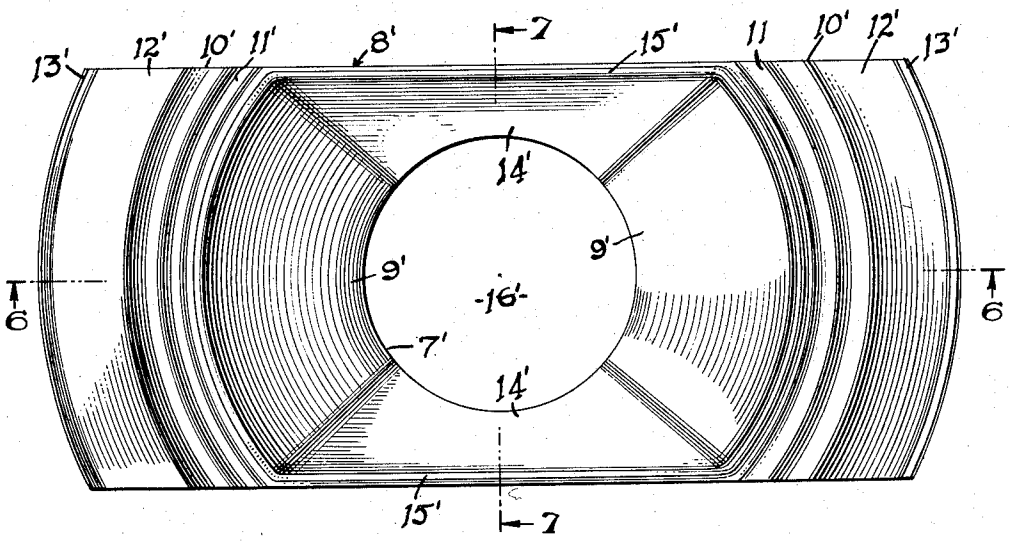


Fig. 6.

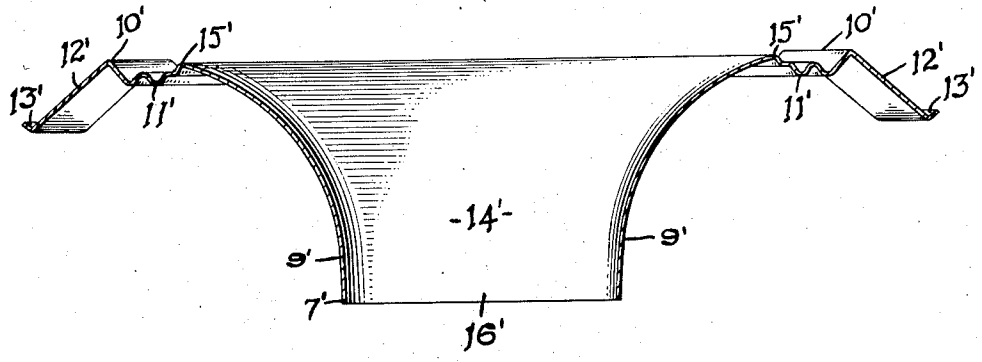
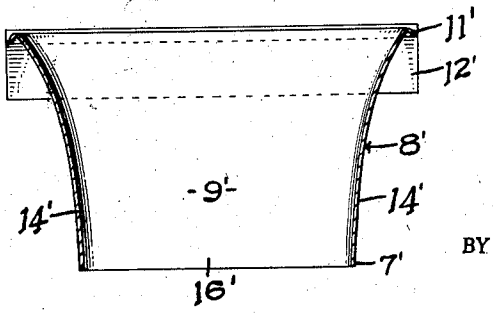


Fig. 7.



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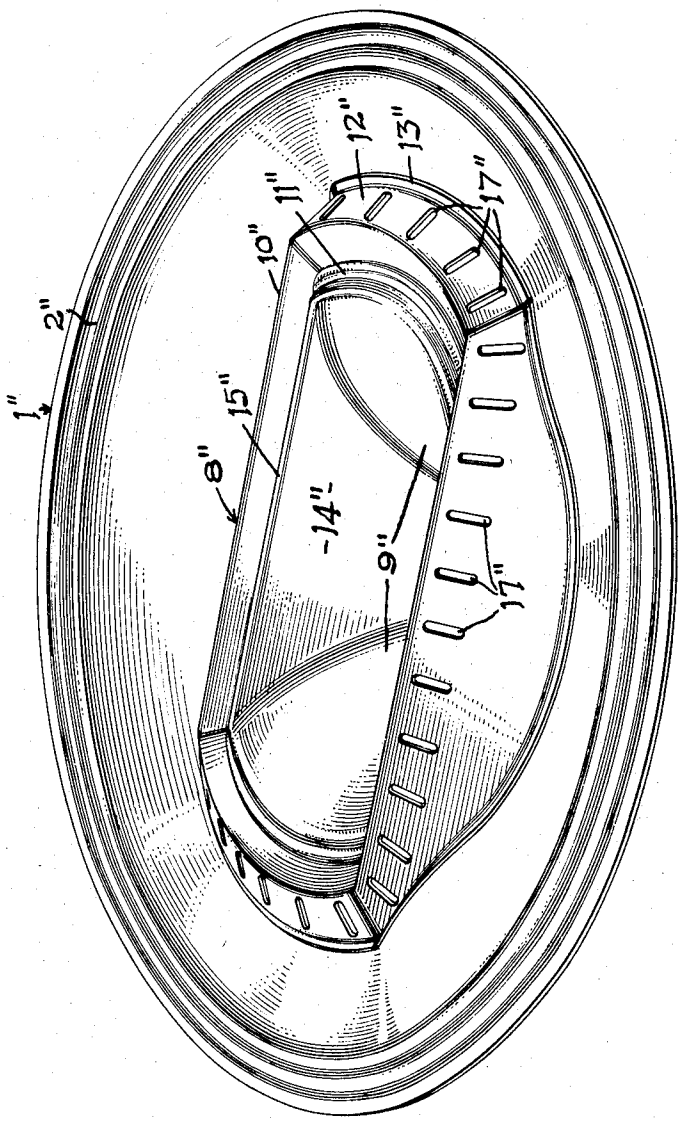


FIG. 8.

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United States Patent Office 2,845,135 Patented July 29, 1958

2,845,135

AUXILIARY WAVE PROPAGATING AND DIRECTING ATTACHMENT FOR LOUDSPEAKER DIAPHRAGMS

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Application September 26, 1955, Serial No. 536,624

5 Claims. (Cl. 181—31)

The present invention relates to attachments for loudspeaker diaphragms, and more particularly to a novel attachment which is adapted to be associated with a loudspeaker diaphragm in such a manner and which is so constructed as to improve the mid-frequency and high frequency response of a loudspeaker embodying the invention.

Heretofore, loudspeaker diaphragms have been provided with supplemental or auxiliary sound diffusing attachments adapted to increase the spread or dispersion of the mid-frequency or high frequency sound waves generated by the diaphragm, wherein the attachments were in the form of transversely arched stiffeners of circular form. Such stiffeners were generally provided with apertures therethrough, whereby sound generated behind the stiffeners was diffused at the apertures and dispersed in all directions or concentrated and directed towards the axis of the path of sound travel.

In other previous types of loudspeakers, specially designed horns have been developed for producing more uniform dispersion of sound over the horizontally extended area in front of the speaker, while limiting vertical spread or dispersion of the sound waves.

The present invention contemplates as its primary objective combining in a sound reproducing structure the desirable characteristics of a diffuser and a special horn, both as above referred to, whereby the mid-frequency and high frequency response of a loudspeaker is improved.

Another object is to provide a conventional conical loudspeaker diaphragm with an auxiliary or supplementary sound propagating or diffusing attachment which is so constructed as to direct middle or high frequency sound waves generated adjacent to the apex or center of the diaphragm, or by the attachment itself, axially, while maintaining at a minimum sound radiation or dispersion in vertical directions, thus conserving signal energy which is utilized to expand horizontal sound radiation or dispersion.

The foregoing objective may be obtained by the utilization of a supplementary horn-like attachment which is so formed as to be capable of being attached to a conventional conical diaphragm adjacent to its center axis or adjacent to the usual voice coil bobbin with which such loudspeaker diaphragms are usually provided, and which is formed with side walls which flare laterally or horizontally to a larger extent than the top and bottom walls do vertically, and so that a substantially rectangular mouth is provided.

As will hereinafter appear, the supplementary horn-like attachment may be of a number of different forms, and instead of having a rectangular mouth defined by lateral or vertical walls which are farther spaced apart than the top and bottom horizontal walls, the mouth may be square.

In addition, the flare or expansion of the horn-like attachment may be produced in various manners, as by the provision of relatively straight diverging walls, longitudinally arched walls, or walls having compound angles

of divergence. In the latter case, the compound angle of divergence or expansion of the opposed walls of the attachment is preferably such that dispersion of sound waves is predominantly in a vertical direction initially, but subsequently dispersion of the sound waves is predominantly in a horizontal direction, and during the subsequent stage of dispersion, the opposed top and bottom walls, in restricting vertical dispersion, build up pressure which increases the signal energy or amplitude in a horizontal direction.

A further object is to provide a sound reproducing assembly comprising a pair of coaxially arranged sound propagating elements adapted to be actuated or vibrated by a common voice coil to produce sound waves, one of said elements being so constructed as to generate mid- or high frequency sounds and being so configurated as to effect dispersion of sounds generated thereby over a wide angle in one plane, while restricting such sound waves to limit the dispersion in a plane normal to the first-mentioned plane.

Other objects and advantages will be hereinafter described or will become apparent to those skilled in the art, and the novel features of the invention will be defined in the appended claims.

In the drawings:

Fig. 1 is a view in perspective, showing a loudspeaker diaphragm with one form of horn-like attachment mounted in assembled relation to the diaphragm in accordance with our invention;

Fig. 2 is a fragmentary plan view, showing another horn-like attachment somewhat similar to that of Fig. 1 mounted in assembled relation with a loudspeaker diaphragm;

Fig. 3 is a view in section, as taken on the line 3—3 of Fig. 2;

Fig. 4 is a view in section, as taken on the line 4—4 of Fig. 2;

Fig. 5 is a plan view of a modified form of horn-like attachment;

Fig. 6 is a view in section, as taken on the line 6—6 of Fig. 5;

Fig. 7 is a view in section, as taken on the line 7—7 of Fig. 5; and

Fig. 8 is a view in perspective, showing a further modified form of horn-like attachment mounted in assembled relation with a loudspeaker diaphragm.

Referring first to Figs. 1 through 4, **1** denotes a conventional cone-type loudspeaker diaphragm having an enlarged mouth bordered by a compliant corrugated marginal flange **2** adapted to be mounted on a suitable support (not shown). The diaphragm **1** tapers towards its end remote from the flange **2** and is provided with a central opening in which is adapted to be disposed the usual cylindrical voice coil support or bobbin **3** on which is disposed a voice coil winding **4**. Bridging the end of the voice coil bobbin **3** in a conventional manner to provide a dust cap or closure to preclude the passage of dust or the like through the bobbin into the area behind the diaphragm, is a domed closure **5** which is preferably formed integrally on the bobbin **3**.

All of the parts above described are conventional, and ordinarily the apex or small end of the diaphragm **1** would be attached, as by cementing, to the outer periphery of the bobbin **3**, and therefore, the diaphragm is shown as having thereon a short axially extended flange **6** at its apex end which would enable attachment of the diaphragm **1** to the voice coil bobbin **3**. However, in the illustrative embodiment of the present invention, an attachment tab or flange **7** of a horn-like attachment generally designated **8** is interposed between the bobbin **3** and diaphragm flange **6**, and these elements are prefera-

bly secured together in an assembly as by cementing or the like.

The attachment **8**, as seen in Figs. 1 through 4, has a pair of opposed longitudinally extended straight lateral walls **9**, **9** which diverge away from the flange **7** and are generally arcuate in cross section. At the outer or forward end of the walls **9**, they are each turned radially outwardly to form a flange **10**, each flange **10** being corrugated so as to form a compliant section **11**. Outwardly of the compliant sections **11**, each flange **10** preferably has a section **12** projecting towards the diaphragm **1** and having a terminal tab **13** for attachment as by cementing to the diaphragm.

Interconnecting the lateral walls **9** of the horn-like attachment **8**, is a pair of opposed top and bottom walls **14**, **14**, each of which is transversely arched where it merges with the flange **7**, these walls **14** diverging away from the flange **7**, with the arch in each wall **14** progressively enlarging until the wall becomes flat at its forward extremity and terminates in planar relation with the lateral walls **9**. The forward extremity of each wall **14** is preferably turned outwardly and back upon itself to form a reinforcing bead **15** which preferably merges and blends with the initial corrugation of compliant sections **11** of lateral walls **9**.

Accordingly, it will be seen that the attachment has at its so-called rear end a circular central opening **16** defined by the flange or tab **7**, and the opposed walls **9** and **14** diverge away from the opening **16** to form the horn-like member. Preferably, the angle of divergence of the lateral walls **9** is larger than the angle of divergence of the opposed top and bottom walls, so that a generally rectangular mouth is provided, said mouth having a greater lateral extent than its vertical extent, as best seen in Figs. 1 and 2.

In addition, the angular relation of the walls **9** and **14** is such that the progressive internal expansion or flare of the horn-like attachment **8** is in accordance with one of the conventional exponential rates which may be readily determined by the use of any well-known formula for determining the flare or expansion factor of loudspeaker horns.

As illustrated in Fig. 1, the flange **10** on each lateral wall **9** of the attachment **8** is preferably provided with a plurality of longitudinally extended openings **17** disposed in side-by-side laterally spaced relation. Therefore, in operation of the sound reproducing assembly, sound waves generated by diaphragm **1** behind the flanges **10** will not be trapped or reflected, but will pass through the respective openings **17** and be dispersed in wavelets emanating from each opening.

Moreover, the form of the horn-like attachment **8** will cause mid- and high frequency sound waves generated thereby or at the rear end of the assembly to be directed primarily in a wide horizontal area in front of the assembly, while limiting vertical spread or dispersion of such mid- and high frequency sounds. While in this specific illustrative embodiment, the horn-like attachment **8** is shown as secured to the outer periphery of the voice coil bobbin **3**, it should be understood that the rear end of the attachment **8** may be secured at other points without departing from the invention, as on the domed cap **5** of the bobbin **3** or on the body of diaphragm **1** at a position forwardly spaced from the bobbin **3**.

Referring to Figs. 5, 6 and 7, there is shown a slightly modified form of horn-like attachment generally designated **8'**. In this modified form, the body of the attachment, instead of having relatively straight divergent walls, is formed so as to be arched longitudinally, thus flaring on a curve. While at the small or rear end **7'**, the horn-like attachment **8'** is annular in cross section, vertical expansion of the attachment **8'** is progressively less than lateral expansion of the attachment as the continuous walls of the body thereof approach the forward end of the attachment, and therefore, the cross-sectional form of the horn changes from an annular or circular form through a progressively lengthening elliptical form, until the forward extremity of the attachment is reached. Preferably, at its forward extremity, the horn-like attachment **8'** has its upper and lower margins straight and provided with a reinforcing bead **15'**, while the lateral sides of the attachment **8'** are arcuate in cross section at the forward extremity and are provided with compliant attaching flanges **10'** as previously described in connection with Figs. 1 through 4.

Where applicable, primed reference numerals corresponding to those used in Figs. 1 through 4 are applied to Figs. 5, 6 and 7 to designate corresponding or equivalent parts, and therefore, the remaining details of the horn-like attachment **8'** need not be further described.

It should be understood, that the horn-like attachment **8'**, if desired, may also be provided with a plurality of longitudinally extended openings such as those designated **17** in Fig. 1.

Referring now to Fig. 8, there is illustrated a further modified horn-like attachment generally designated **8''** which is adapted to be connected with a diaphragm **1''** in the same manner as has been previously described. The illustrative attachment **8''** is shown as having opposed side walls **9''**, **9''** and opposed top and bottom walls **14''**, **14''**, but instead of having attaching flanges only at the lateral ends of the rectangular mouth of the attachment **8''**, the mouth is provided with a compliant flange portion **11''** extending about the entire forward extremity of the attachment **8''**, and a portion **12''** extending from the compliant portion **11''** towards the diaphragm **1''** completely about the attachment **8''**, the latter portion having a marginal edge **13''** adapted to be cemented to the diaphragm **1''**. In addition, the flange portion **12''** is preferably provided with spaced openings **17''** disposed in side-by-side relation about the entire flange, as is clearly illustrated.

The body of attachment **8''**, in lieu of the form shown in Fig. 8, may alternately have the form of Figs. 5, 6 and 7, as should be apparent.

The respective horn-like attachments herein disclosed are preferably fabricated of paper of a fibrous character capable of being molded, but these attachments may be made of other materials without departing from the spirit of the invention, such as thin plastic, aluminum, or other suitable materials which are light in weight and have sufficient rigidity to maintain their form without distortion under vibration.

Other changes and alterations may be made without departing from the spirit of the invention as defined in the appended claims.

We claim:

1. In a sound reproducing device including a vibratory diaphragm and a longitudinally extended horn-like attachment mounted coaxially with relation to said diaphragm and connected thereto for vibration therewith, said attachment having a small end and a large end and progressively expanding in cross-sectional area from the small end to the large end, that improvement wherein the horn-like attachment expands in one plane at a greater angle than in a plane normal to the first-mentioned plane, and said horn-like attachment having a flange at its large end projecting into engagement with said diaphragm and secured to said diaphragm, said flange having a compliant section interposed between the diaphragm and the main body of the attachment.

2. In a sound reproducing device including a vibratory diaphragm and a longitudinally extended horn-like attachment mounted coaxially with relation to said diaphragm and connected thereto for vibration therewith, said attachment having a small end and a large end and progressively expanding in cross-sectional area from the small end to the large end, that improvement wherein the horn-like attachment expands in one plane at a greater angle than in a plane normal to the first-mentioned

plane, and said horn-like attachment having a flange at its large end projecting into engagement with said diaphragm and secured to said diaphragm, said flange having a plurality of sound diffusing openings therein for liberating and diffusing sound waves generated by said diaphragm behind said flange.

3. In a sound reproducing device including a vibratory diaphragm and a longitudinally extended horn-like attachment mounted coaxially with relation to said diaphragm and connected thereto for vibration therewith, said attachment having a small end and a large end and progressively expanding in cross-sectional area from the small end to the large end, that improvement wherein the horn-like attachment expands in one plane at a greater angle than in a plane normal to the first-mentioned plane, and said horn-like attachment having a flange at its large end projecting into engagement with said diaphragm and secured to said diaphragm, said flange having a plurality of sound diffusing openings therein for liberating and diffusing sound waves generated by said diaphragm behind said flange, and said flange extending completely about the periphery of the large end of said horn-like attachment.

4. An attachment for vibratory loudspeaker diaphragm assemblies, comprising a longitudinally extended horn-like member having one end adapted to be connected to the diaphragm assembly for vibration therewith, said

member expanding in cross-sectional area towards its opposite end and having a generally rectangular mouth, and said member having a laterally projecting flange adjacent its mouth and adapted to be secured to the diaphragm aforesaid, said flange having a compliant portion adjacent to the point of attachment of the flange to the diaphragm.

5. An attachment for vibratory loudspeaker diaphragm assemblies, comprising a longitudinally extended horn-like member having one end adapted to be connected to the diaphragm assembly for vibration therewith, said member expanding in cross-sectional area toward its opposite end and having a generally rectangular mouth, and said member having a laterally projecting flange adjacent its mouth and adapted to be secured to the diaphragm aforesaid, said flange having a plurality of sound diffusing openings therethrough.

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