June 8, 1965 E. R. BROADLEY 3,187,832

LOUDSPEAKER ASSEMBLY

Filed Dec. 28, 1962

Fig. 1

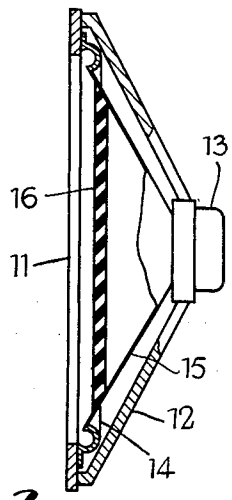


Fig. 2

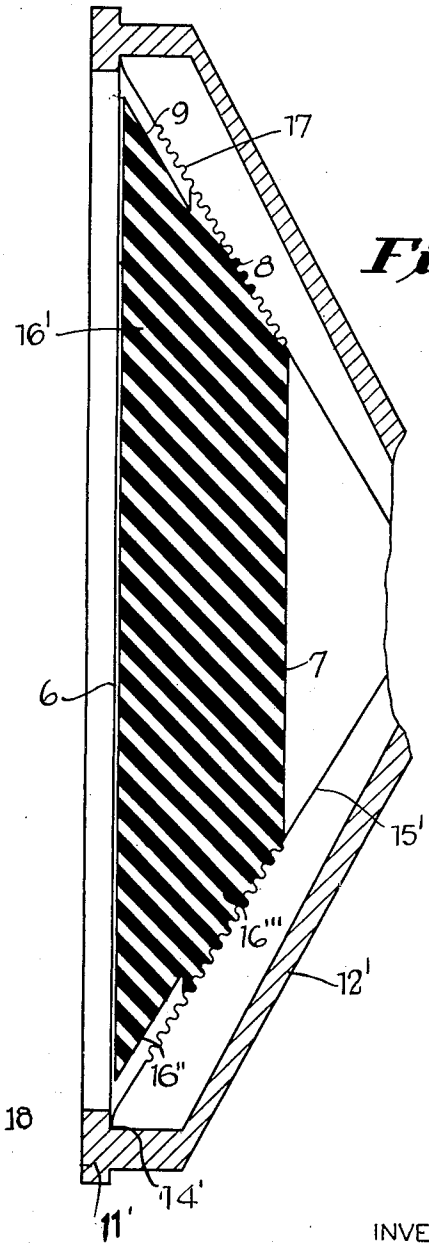
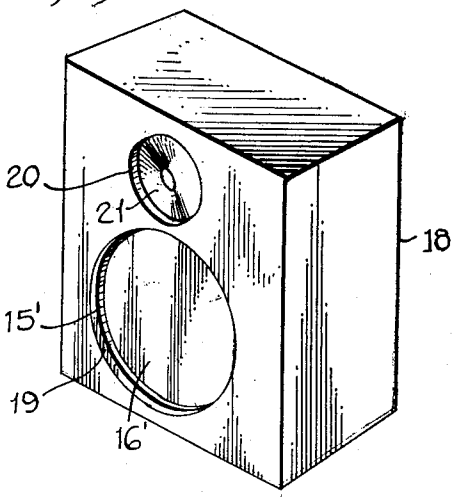


Fig. 3



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3,187,832

Patented June 8, 1965

3,187,832

LOUDSPEAKER ASSEMBLY

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Filed Dec. 28, 1962, Ser. No. 248,154
Claims priority, application Great Britain, Dec. 29, 1961, 46,738/61
6 Claims. (Cl. 181—31)

This invention relates to loudspeakers and particularly to moving-coil loudspeakers.

Such a loudspeaker is commonly mounted so that its radiating diaphragm, commonly a thin cone of fibrous paper, closes an aperture in one wall of a loudspeaker cabinet which may be otherwise closed or in which, at least, any other vents or apertures are provided with means to minimize transmission of sound from within the cabinet to external air. Alternatively, such a cabinet may be provided with two diaphragm-closed apertures, a larger aperture being closed by the diaphragm of a large loudspeaker intended for low-frequency operation and a smaller aperture being closed by the diaphragm of a smaller loudspeaker intended for middle- and/or high-audio frequency operation. If a third loudspeaker is provided separately to deal with high audio frequencies, it is normally completely shut off from the interior of the cabinet; but the rear surfaces of the diaphragms of the low-frequency and the middle-frequency or middle-and-high frequency loudspeakers are exposed directly to the air enclosed within the cabinet.

With the present tendency to minimise the volume and thickness (from a front panel formed with the diaphragm-closed aperture or apertures to an opposite rear wall) of loudspeaker cabinets, the problem of cabinet internal resonance becomes acute. For instance, a cabinet with internal volume of 1½ cu. ft., 6 inches internal thickness and 18 inches internal width, shows a main internal resonance at about 1100 c./s. (due to the 6 inch thickness) and a further, lesser resonance at about 700 c./s. (due to the 18 inch width); and in such a small enclosure these resonances, which are at notably audible frequencies, are of very high Q. The extent to which these resonances can be damped by the provision of absorbent material within the cabinet is limited; and it is found that sound at these resonant frequencies is transmitted from within the cabinet to external air, to an appreciable extent which noticeably and undesirably colors the overall sound output of the system, through the diaphragm of a loudspeaker of the conventional kind referred to above. In the case of a cabinet formed with two diaphragm-closed apertures, this unwanted tranmission of sound at the internal resonant frequencies is principally through the diaphragm of the low-frequency loudspeaker, due to its larger size.

It is an object of the present invention to provide a loudspeaker assembly including a loudspeaker having a diaphragm mounted in a hollow cabinet in which the disadvantageous transmission of sound at a resonant frequency of the cabinet through the diaphragm from within the cabinet to the exterior is reduced or substantially eliminated.

It is another object of the present invention to provide a loudspeaker assembly comprising a plurality of speakers mounted in a cabinet in which the disadvantageous transmission of sound at a resonant frequency of the cabinet initiated by one speaker operating over a higher range of frequencies than a second loudspeaker through the diaphragm of the second loudspeaker from within the cabinet to the exterior is reduced or substantially eliminated.

Preferred embodiments of a loudspeaker suitable for use in a loudspeaker assembly according to the invention, and such an assembly, are described below with reference to the accompanying drawings, in which:

FIGURE 1 is a sectional view of a first loudspeaker,

FIGURE 2 is a similar sectional view of a second loudspeaker, and

FIGURE 3 is a perspective view of a loudspeaker assembly.

The loudspeaker shown in FIGURE 1 comprises a rigid front rim **11** to which is secured a spider **12** by means of which a suitable magnet assembly **13**, of known kind, is mounted in position. Also mounted to the rim **11**, by means of a flexible surround **14** of known kind, is the outer peripheral edge of a conical diaphragm **15** which may also be of known kind. The diaphragm **15** carried at its center, in known manner, a speech coil (not shown) which is disposed in the magnetic gap of the magnet assembly **13**.

As already explained, such a loudspeaker would normally have the disadvantage that its diaphragm **15** would transmit, and radiate forwardly (i.e. to the left in the drawing) sound impinging on its rear surface. However, there is further provided a body of material **16** which is secured at its edge to the diaphragm **15** by any suitable means and which encloses the major part, or substantially the whole, of the front surface of the diaphragm **15**.

FIGURE 2 illustrates in section a second embodiment of a loudspeaker, comprising a rigid front rim **11'** to which is secured a spider **12'**. The conical diaphragm **15'** of known kind is mounted to the rim **11'** by means of a rim **14'** formed by pressing flat a small section of the diaphragm **15'** at its wide end. Flexibility in the mounting of the diaphragm **15'** is arranged by providing corrugations **17** beginning near to the wider end of the cone, and extending some way towards the narrower end. There is provided a body of material **16'** which is in the form of two differently sized superposed conical frusta **16''** and **16'''**, secured at the edges of the radially smaller frustum **16'''** to the conical diaphragm **15'** in the region of the parallel corrugations **17**, in such a manner as to leave free some corrugations **17** to provide the necessary flexibility. It will be appreciated that the body **16'** has a front surface **6** and a rear surface composed of portions **7**, **8** and **9**, the portions **8** and **9** being the conical surface parts of the frusta **16''** and **16'''**, and the portion **8** constituting a minor portion of the total rear surface. This minor portion **8** of the rear surface is secured in contact with the front surface of the diaphragm **15'** and the remaining major portion **7**, **9** of the rear surface is exposed to but spaced from the front surface of the diaphragm **15'**.

The body **16** or **16'** is preferably of expanded polystyrene as commercially available, with a density between 1 and 10, and preferably between 1 and 2, lbs./cu. ft. The thickness may be of the order of ½ to 3 inches; for example it may be about ¾ inch to 1½ inch thick if the loudspeaker, apart from the body **16** or **16'**, is comparable with a 12 inch loudspeaker of known kind. Such a body, which is of a desirably non-resonant nature, absorbs sound in a strongly frequency-dependent manner. Absorption begins to be significant at about 700 c./s. and increases with higher frequencies.

When the above-described loudspeaker is driven by energising its speech coil at low frequencies, the diaphragm **15** and the body **16** whose edge it supports move together due to the effective rigidity of the body, and low frequency sounds are radiated from the front surface of the body. The performance even at low frequencies, compared with what it would be if the body **16** were omitted, is improved in that, firstly, the added mass due to the body lowers the bass resonant frequency of the

loudspeaker itself by perhaps 5 c./s. and increases the low-frequency efficiency and secondly, the support given by the body to the diaphragm assists in preventing "cone break-up" of the diaphragm.

The disc-like bodies 16 and 16' of the loudspeaker described above with reference to FIGURES 1 and 2 provide, however, more important improvements when such a loudspeaker is combined with a cabinet having resonant frequency of its own, in a loudspeaker assembly such as that shown by way of example in FIGURE 3. The loudspeaker assembly shown in FIGURE 3 comprises a cabinet 18 which has an internal volume of 1½ cu. ft., it being of internal height 2 ft., width 1½ ft., and depth from front to back 6 inches, and which, by reason of these dimensions, has a main internal resonant frequency at about 1100 c./s. and a lesser internal resonant frequency at about 700 c./s. The cabinet totally encloses the space within it except that its front wall is formed with a large aperture 19 and a smaller aperture 20. Within the cabinet are mounted two loudspeakers which cover these two apertures. The smaller aperture 20 is covered internally by a small loudspeaker of conventional kind, of which the conical diaphragm 21 is visible in FIGURE 3. The larger aperture 19 is similarly covered internally by a loudspeaker as shown in FIGURE 1 or FIGURE 2, of which the diaphragm 15 or 15' (15' as indicated in FIGURE 3) is only slightly visible in FIGURE 3 since a major part of it is concealed, as viewed through the aperture 19, by the disc-like body 16 or 16' (16' as indicated in FIGURE 3). The two loudspeakers comprised by this assembly and comprising the diaphragms 21 and 15', respectively, are arranged (by means of electrical connections, not shown) to be operative in an upper frequency range and a lower frequency range respectively, the said internal resonant frequencies of the cabinet falling within the upper frequency range. In the absence of the disc-like body 16', resonant vibrations generated within the cabinet by the upper-frequency loudspeaker would be transmitted through the diaphrgam 15' and radiated through the aperture 19 to be heard as an undesired coloring of the total sound output of the assembly. However, the provision of the disc-like body 16', which may be said to act as an acoustic filter, is effective to cure this defect in large measure, since such unwanted sound, though transmitted through the diaphragm 15', is then absorbed by the disc-like body 16' and is consequently radiated from the aperture 19 either not at all or to a substantially reduced extent.

What I claim is:

1. A loudspeaker assembly comprising a cabinet, having a wall with a main aperture therein, and a loudspeaker mounted within the cabinet and covering said main aperture, the loudspeaker comprising a vibratable diaphragm having a rear surface exposed to the interior of the cabinet, and a front surface, means rigidly supporting the diaphragm peripherally thereof, and drive means at the center of the diaphragm for vibrating the same, the diaphragm being such that it is transmissive, through its thickness from its rear surface to its front surface, of sound of a frequency at which the cabinet has an internal resonance, wherein the loudspeaker is provided with a disc of substantiallly rigid but porous material, of a density in the range 1–10 pounds per cubic foot, which is absorptive of sound at the said frequency, the disc having a front surface which is exposed by the said main aperture and a rear surface of which a minor portion is secured in contact with the front surface of the diaphragm, whereby the disc and the diaphrgam are constrained to vibrate in unison, and of which the remaining major portion is exposed to but spaced from the front surface of the diaphragm, the disc being of such size that it conceals at least a major part of the front surface of the diaphragm as viewed through the said main aperture.

2. A loudspeaker assembly as claimed in claim 1, wherein the cabinet is formed with a further aperture in a wall thereof and there is provided a second loudspeaker mounted within the cabinet and covering said further aperture, the second loudspeaker and the loudspeaker covering the said main aperture being arranged to be operative in an upper frequency range and a lower frequency range respectively and the said internal resonance of the cabinet being in the said upper frequency range.

3. A loudspeaker assembly as claimed in claim 1, wherein the said disc is frusto conical, having a plane front surface and a rear surface comprised by a plane central portion and a frusto conical peripheral portion which is secured in contact with the diaphragm.

4. A loudspeaker assembly as claimed in claim 1, wherein the disc is in the form of two differently sized conical frusta integral with one another, the disc having a plane front surface and a rear surface comprising a plane central portion and two frusto conical portions of which that one which is immediately contiguous to the said plane central portion is secured in contact with the diaphragm.

5. A loudspeaker assembly as claimed in claim 1, wherein the material of the disc is expanded polystyrene.

6. A loudspeaker assembly as claimed in claim 1, wherein the density of the said material is in the range 1–2 pounds per cubic foot.

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