Feb. 3, 1959 J. D. HOFFMAN 2,872,516

SPEAKER ASSEMBLY

Filed March 25, 1955

2 Sheets-Sheet 1

FIG. 1.

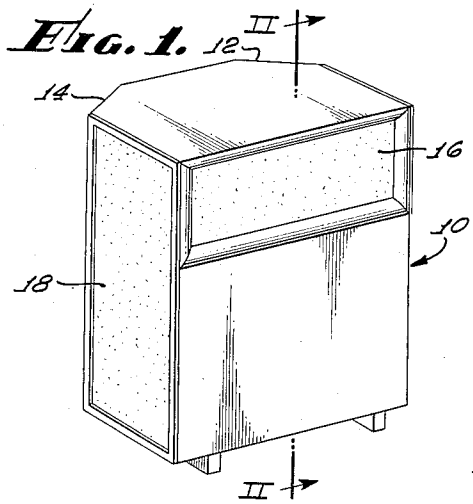


FIG. 3.

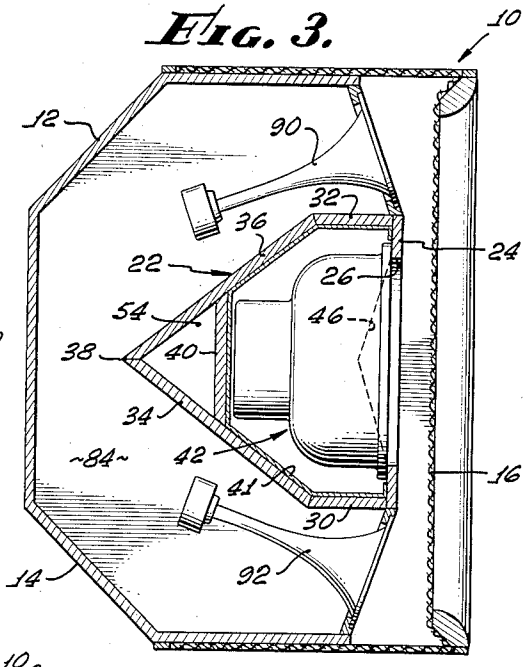


FIG. 2.

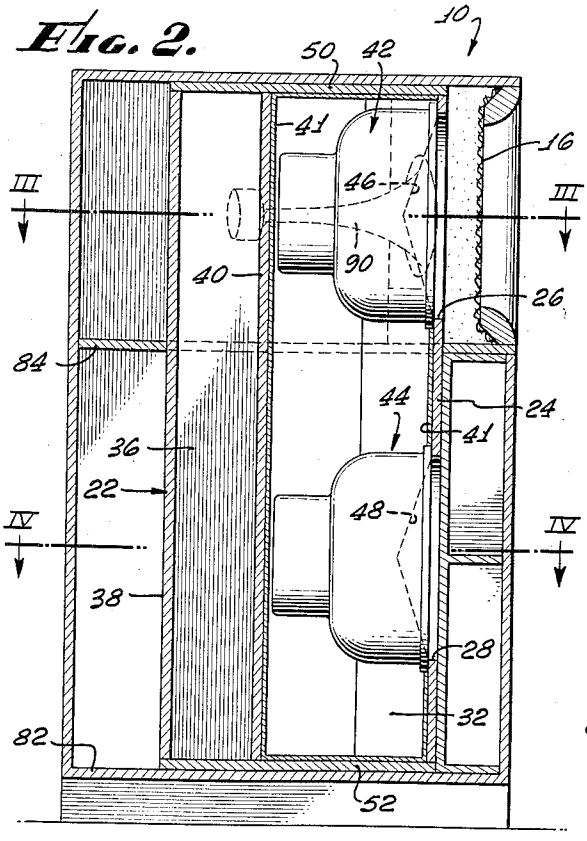
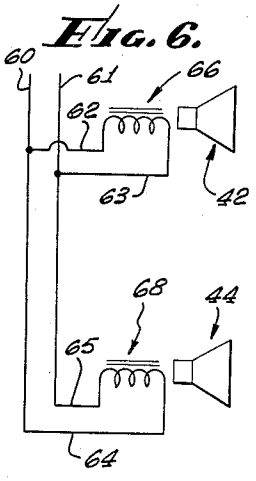


FIG. 6.



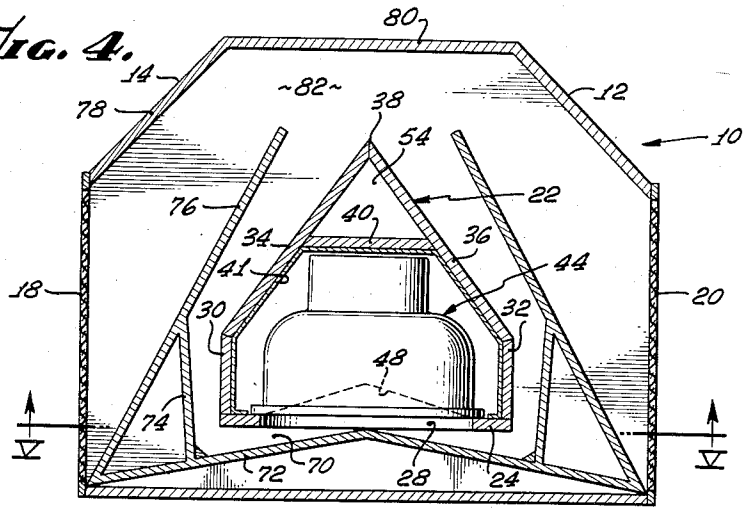
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FIG. 4.



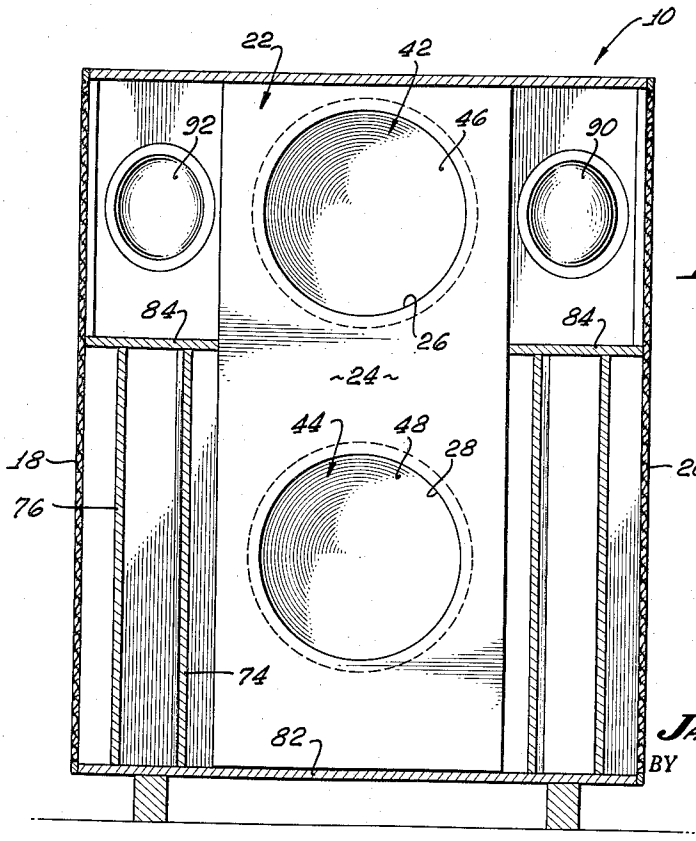


FIG. 5.

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SPEAKER ASSEMBLY

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14 Claims. (Cl. 179—1)

This invention relates generally to electroacoustic transducers and particularly describes a novel speaker assembly and its enclosure for accentuating the bass tones in music or other sound reproduced in the structure by speaker units having diaphragms of sealed or airtight construction adapted to be energized by input electric signals.

The invention, in its preferred form hereinafter shown and described, includes a pair of speakers of virtually identical characteristics, each provided with a conventional movable cone or diaphragm, the speakers being so mounted relative to a housing within the cabinet or frame of the present speaker assembly that their diaphragms form, together with such housing, a virtually airtight chamber. The two speakers are so positioned relative to the chamber and are so energized that their diaphragms move in phase opposition relative to the chamber; that is, an inward excursion of one diaphragm occurs simultaneously with an outward excursion of the other diaphragm. The chamber is constructed to have as small an internal volume as feasible, so that the cushioning effect of the air in the chamber is minimized, as will be later understood.

An acoustic horn, well known in the art, is included in the present speaker assembly and has its throat or input end in sound receiving relation with one of the two speakers above described, the other radiating directly. In order to achieve reasonable compactness in the completed speaker assembly, the acoustic horn is desirably folded, such configuration being well known in the art. The horn is adapted to reproduce notes or sounds of low frequency, that is, below approximately 300 cycles per second, and to attenuate the higher frequencies.

Because of the interconnecting air chamber between the two speakers, the physical displacement or excursion of their diaphragms will be of considerably greater magnitude than would be the case were each diaphragm acting alone. This is for the reason that the two speakers, being arranged for their diaphragm movement to be in phase opposition, assist one another in physical response to an input signal fed thereto. In view of this assistance and the acoustic coupling of the horn to the output of one of these speakers, a greatly magnified reproduction of low frequency sounds results from the combination. It may be observed that a pair of speakers comprising together three or more individual transducers may be operatively associated with the air chamber above referred to. Under such conditions, for a given input signal the volume displacement of the speaker comprising one or more transducers having their outputs acoustically coupled to the horn should approximately equal the volume displacement of the other speaker comprising one or more transducers in direct radiation. It will accordingly be understood that the term "speaker" as used herein may include two or more transducers adapted to produce an inphase acoustic output in response to an input signal.

In certain forms of the invention I may prefer to make the effective length of the horn equal to approximately

one-half the wave length of the frequency of sound reproduction which is desired to be most accentuated by the system. Under these conditions, if the output end of the acoustic horn is located fairly close to the speaker to which the horn is not acoustically coupled, any tendency for the output of the horn and the output of the other speaker to mutually cancel is minimized. Exemplarily, the effective length of the folded horn may be approximately 7.5 feet, corresponding to a half wave length of a note of about 73 cps., and at that frequency the horn effectively reverses the phase of a note fed to it. Since the horn-coupled speaker is itself energized in phase opposition to the speaker in direct radiation, the outputs of the horn and of the direct radiator are substantially in phase, and the two reinforce and supplement one another. It is to be further noted that, at higher or lower frequencies, the two outputs are out of phase, but any tendency for the two acoustic outputs to cancel one another is counteracted and prevented by, at higher frequencies, the attenuation of such frequencies by the horn, and, at lower frequencies, the greatly lowered coupling efficiency of the direct radiator.

In addition to the components above described, the speaker assembly in accordance with the present invention may also include one or more high frequency speakers or "tweeters" of known design. The entire assembly is therefore well adapted to reproduce sounds extending over the entire audible range.

In construction the present speaker assembly preferably includes a cabinet having a vertical panel provided with a lower opening and one or more upper openings. Speakers are mounted so that their diaphragms are hermetically joined to the panel surrounding the openings. The acoustic horn above referred to may then be folded in substantially horizontal orientation, acoustically coupled to the lower speaker.

An object of the invention is therefore to disclose a novel acoustic speaker assembly including two speakers having virtually identical characteristics.

Another object of the invention is to provide a speaker assembly employing two speakers of virtually identical characteristics acoustically coupled by means of a fully enclosed air chamber and energized in phase opposition.

A further object of the invention is to disclose a speaker assembly of the above nature wherein the output of one of the speakers is acoustically fed into an acoustic horn adapted to efficiently couple with the air for reproducing sounds of low frequency.

Another object is to provide a speaker assembly having a folded acoustic horn coupled to one or more, but less than all, of a plurality of speakers, the horn having an effective length such that its output is not cancelled by the directly radiated output of the remaining speaker or speakers at frequencies below those substantially attenuated by the horn.

These and other and allied purposes and objects of the invention will become clear from a study of the following description of a preferred embodiment of the invention taken in connection with the accompanying drawing in which:

Fig. 1 is a perspective view of a speaker and cabinet embodying the present invention.

Fig. 2 is a sectional view taken on central vertical plane II—II of Fig. 1.

Fig. 3 is a sectional view taken on plane III—III of Fig. 2.

Fig. 4 is a sectional view taken on plane IV—IV of Fig. 2.

Fig. 5 is a front view of the speaker assembly with the front portions of the horn and cabinet removed, taken substantially on plane V—V of Fig. 4.

Fig. 6 is a simplified schematic wiring diagram showing

a typical mode by which two of the speakers in the present invention may be caused to operate in phase opposition.

Referring now in detail to the drawings, in Fig. 1 there is shown a cabinet indicated generally at 10 in which the speaker assembly of the present invention may be conveniently mounted. The cabinet 10 may be made of wood or similar material and in the form shown is adapted to be positioned in the corner of a room, the edges 12 and 14 fitting against adjacent intersecting walls of a room. The cabinet 10 includes acoustic output areas by which sound waves are fed into the room, such areas including an upper transverse portion 16, a side vertical portion 18 and a second side vertical portion symmetrical to the portion 18, indicated at 20 (see Fig. 4). Each of these acoustic output areas may be covered by a sheet of cloth or similar fabric, as is conventional.

Within the cabinet 10 there is a vertically extending housing indicated generally at 22 (see Figs. 3 and 4). The housing 22 is made up of a front vertically disposed panel 24 provided with a pair of vertically spaced openings 26 and 28. Extending rearwardly from the side edges of front panel 24 are a pair of side wall panel members 30 and 32, and angularly related convergent panels 34 and 36 continue rearwardly from the rear edges of side panels 30 and 32 and meet at the rear vertical edge 38. Forwardly of edge 38 there is disposed within the housing 22 a solid vertical panel 40 parallel with front panel 24 and joining at either side with the angularly related panels 34 and 36. The inner surface of the housing is covered with acoustically absorbent padding 41 of conventional composition having the property of absorbing high frequencies but not low frequencies, as is known in the art.

Within the housing 22 there is mounted a pair of electroacoustic transducers or speakers indicated generally at 42 and 44, respectively. Each of the speakers 42 and 44 is provided with an imperforate cone or diaphragm 46 and 48 respectively which is vibratable in accordance with electric input signals to the speaker in known manner. The periphery of each of the diaphragms 46 and 48 is hermetically sealed around one of the two openings 26 and 28 respectively formed in the front vertical panel 24. The housing 22 is bounded above and below by horizontal members 50 and 52, respectively, and all of the component members making up the housing 22 are securely joined to one another in order to provide a virtually airtight chamber within the housing. It may be noted that the small triangular area 54 immediately to the rear of the interior vertical panel 40 is not a part of the airtight chamber just referred to, but is included in the present embodiment of the invention in order to best accommodate the folded acoustic horns referred to hereinafter.

The two speakers 42 and 44 are so actuated that their respective diaphragms 46 and 48 move in phase opposition in response to input electric signals thereto. As is well known in the art, this may be accomplished in any of many ways; the schematic showing of Fig. 6 is illustrative only of one of such ways. As there shown an input signal may be fed to the conductors 60 and 61 from an outside source such as an amplifier, a radio receiving set, etc. The input signal is fed to the upper speaker 42 through leads 62 and 63 and the same signal is fed to the electrical elements of speaker 44 through leads 64 and 65. It will be noted that the leads 62 and 63 are connected to the electrical component of speaker 42, indicated generally at 66, in an opposite sense from the way in which the input signal is fed to the electrical component 68 of speaker 44.

Accordingly it will be seen that the virtually airtight chamber formed within the housing 22 and including therewith the speakers 42 and 44 affords direct acoustic connection between the acoustic output member or diaphragm 46 of speaker 42 and the acoustic output member or diaphragm 48 of speaker 44. Moreover, since

the speakers are energized in phase opposition, an excursion of the diaphragm of one speaker inwardly relative to the air chamber formed within housing 22 is accompanied by a simultaneous outward excursion of the diaphragm of the other speaker. In this way, the amplitude of an excursion is made considerably greater than would be the case with one speaker alone. The path through the air chamber of housing 22 between the two speakers 42 and 44 is desirably not more than about two feet in length, which is less than the wavelengths of low frequency tones.

Means are provided for amplifying the low frequency output of one of the two speakers thus acoustically coupled through the air chamber of housing 22. In the present illustrative embodiment of the invention these means include a pair of folded horns symmetrically disposed about a vertical central plane through the entire speaker assembly. With particular reference to the left half of Fig. 4, the throat of a horn is indicated at 70 and is formed between the edge of the panel 24 and an angularly disposed vertical panel 72. Thus the side walls of the horn initially consist of the panels 24 and 72. To the left of the throat 70 it is seen that the horn is folded through substantially a right angle, its side walls now being defined by the vertical panel 30 and an angularly disposed vertical panel 74. Continuing rearwardly the side walls of the horn progressively diverge, being formed by the panels 34 and 76. At the extreme rear of the cabinet 10 the horn is again turned through an angle, here virtually 180°, and proceeds leftwardly and forwardly, the horn being defined by the panel 76 and the panel 78 and terminating at the output area 18. A similar folded horn construction is provided on the right side of the speaker assembly. The two symmetrical horn assemblies meet at the rear of the speaker assembly formed by rear panel 38, but no adverse interference results from this juncture, since the sound waves travelling through the horn are in phase by reason of the symmetry of the system. The lower wall of both horns is made up of the horizontally disposed bottom 82 of the cabinet, and the upper wall by the horizontal partition 84.

I have found that very satisfactory sound reproduction is produced by the assembly above described. However, if additional strength of reproduction of high frequencies is desired, the present construction is well adapted to accommodate high frequency speakers or "tweeters." A pair of such speakers is shown at 90 and 92, being positioned in the upper portion of the cabinet 10 flanking the speaker 42. The tweeters are electrically connected to an input circuit, through a filter or dividing network if desired, in known manner.

Thus there is provided a speaker assembly affording excellent reproduction of tones over virtually the entire audible range of frequencies and embodying a novel physical construction by which to attain this result economically both in terms of electrical components used and physical space required. Modifications and changes from the specific preferred form of the invention herein shown and described may be made without departing from the spirit of the invention and all such changes are intended to be embraced within the scope of the appended claims.

I claim:

1. In an acoustic speaker assembly, in combination: a housing having an airtight chamber therein; a first speaker including a diaphragm, said diaphragm constituting a portion of the walls defining said chamber; a second speaker including a diaphragm constituting a portion of the walls defining said chamber, said speakers having similar acoustic responses to an input signal; means for electrically driving said diaphragms by an input signal in phase opposition; and acoustic horn means receiving and amplifying the output of said first speaker.

2. The invention as stated in claim 1 wherein the output end of said horn is adjacent said second speaker and

the horn effectively reverses the phase of acoustic energy fed thereto at a selected low frequency.

3. A speaker assembly comprising: a housing having a planar front panel provided with a pair of openings therein; speakers having acoustic output members hermetically closing each of said openings; means within the housing forming with said output members an airtight chamber; an acoustic horn having its input end in sound-receiving relation with the output member of one of said speakers; and means for energizing said speakers in phase opposition whereby an excursion of one output member inwardly relative to said chamber is accompanied by an excursion of the other output member outwardly thereof.

4. A speaker assembly comprising: a hollow housing having a planar front wall panel provided with a pair of spaced openings; electro-acoustic speakers each having a movable diaphragm, said speakers being mounted upon the wall panel with the diaphragms closing said openings and hermetically sealed therearound, the diaphragms and housing constituting an airtight chamber; means for electrically energizing said speakers so the diaphragms move in phase opposition relative to the interior of said housing; and an acoustic horn having an input end in sound-receiving relation with one of said diaphragms and receiving the entire acoustic output thereof.

5. In a speaker assembly, in combination: a first speaker; a second speaker, said speakers having similar acoustic responses to an input signal; means acoustically coupling said speakers; an acoustic horn having an input end in sound-receiving relation with said first speaker; means effectively preventing direct acoustic radiation by said first speaker; and means for energizing said speakers in phase opposition in response to an input signal.

6. A speaker assembly comprising: a pair of speakers having diaphragms and having similar acoustic responses to an input signal; means acoustically coupling corresponding sides of said diaphragms; an acoustic horn having its input end in sound-receiving relation with the other side of the diaphragm of one said speaker, said horn being adapted to reverse the phase of the entire acoustic output of said one speaker at a selected low frequency; and means for energizing said speakers in phase opposition.

7. The invention as stated in claim 6 wherein the other side of the diaphragm of the other of said speakers is adapted to radiate directly to the air.

8. The invention as stated in claim 6 wherein the other side of the diaphragm of the other of said speakers and

the output end of said horn are adapted to feed acoustic energy to a common sound-transmitting medium.

9. The invention as stated in claim 6 wherein said coupling means is adapted to attenuate transmission of high frequency sound waves.

10. In a speaker assembly, in combination: first and second speakers having similar acoustic responses to an input signal; means forming an air chamber for acoustically coupling said speakers; means for preventing direct acoustic radiation from said first speaker; and means for energizing said speakers in phase opposition in response to an input signal thereto.

11. In a speaker assembly, in combination: first and second speakers having similar acoustic responses to an input signal; means acoustically coupling said speakers; means for acoustically amplifying and reversing the phase of the entire output of said first speaker at a selected low frequency; and means for energizing said speakers in phase opposition in response to an input signal thereto.

12. In a speaker assembly, in combination: first and second speakers having similar acoustic responses to an input signal; means for acoustically amplifying and reversing the phase of the entire output of said first speaker at a selected low frequency; and means for energizing said speakers in phase opposition in response to an input signal thereto.

13. In a speaker assembly, in combination: first and second speakers having similar acoustic responses to an input signal; means acoustically coupling said speakers; means for reversing the phase of the entire output of said first speaker at a selected low frequency; and means for energizing said speakers in phase opposition in response to an input signal thereto.

14. In a speaker assembly, in combination; first and second speakers; means forming an air chamber for acoustically coupling said speakers; means for preventing direct acoustic radiation from said first speaker; and means for energizing said speakers in phase opposition in response to an input signal thereto.

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