Dec. 5, 1967 L. L. TOMPKINS 3,356,179

HIGH FIDELITY SPEAKER ENCLOSURE

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Fig. 2

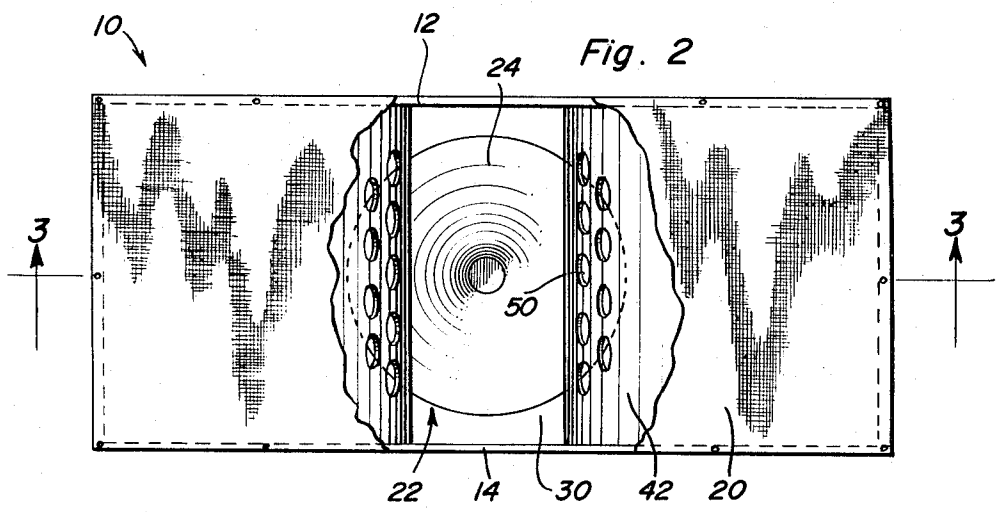

Fig. 4

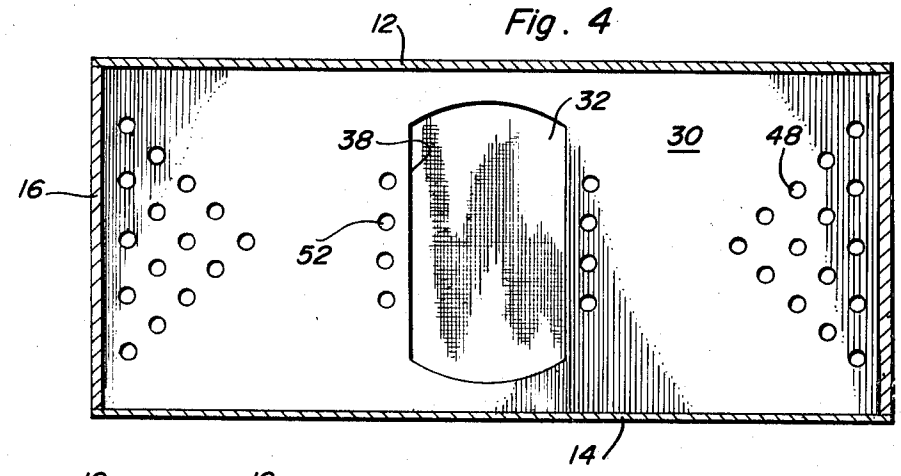

Fig. 1

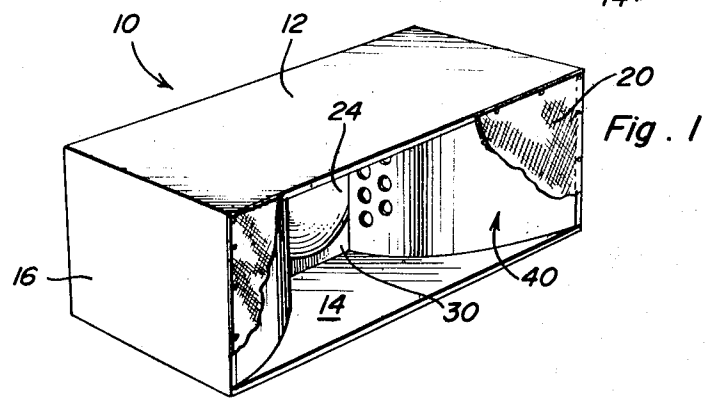

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Fig. 3

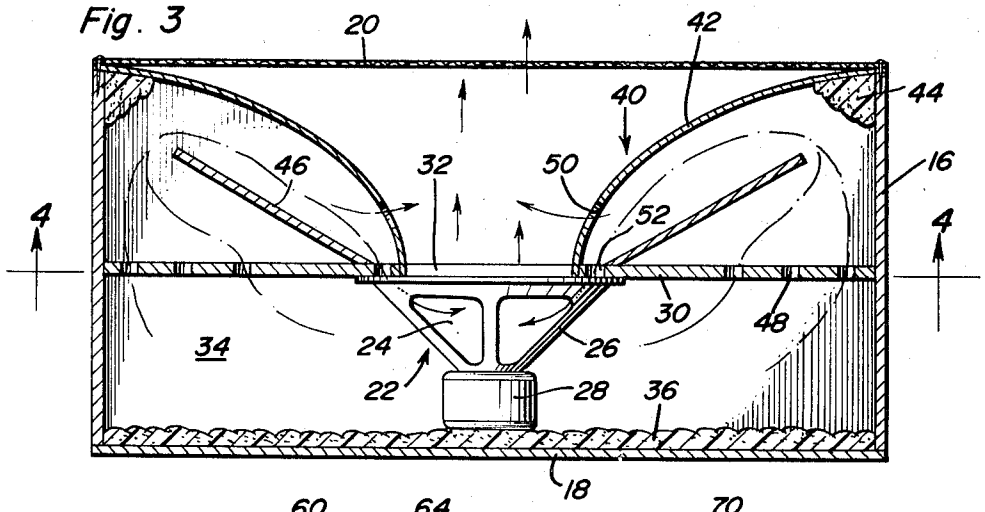
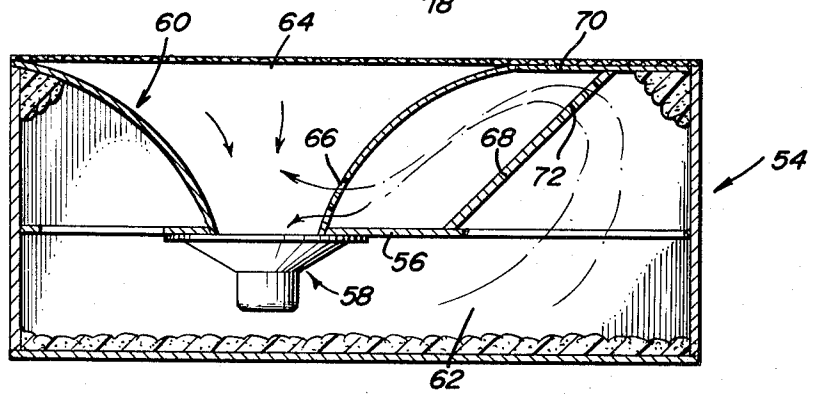


Fig. 5



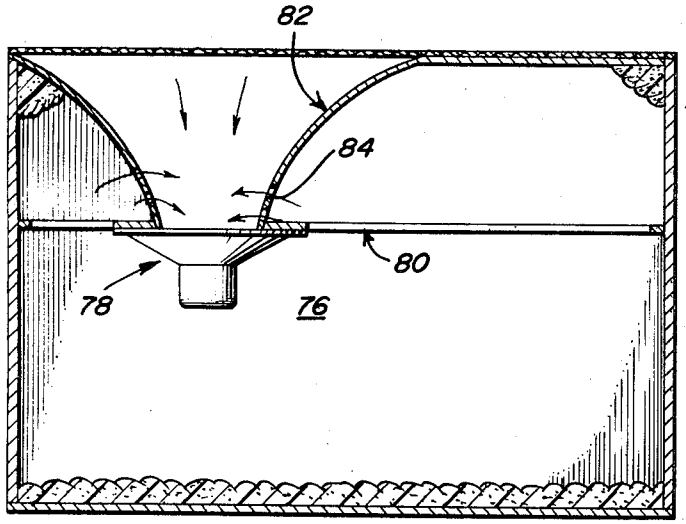


Fig. 6

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3,356,179

HIGH FIDELITY SPEAKER ENCLOSURE

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10 Claims. (Cl. 181—31)

ABSTRACT OF THE DISCLOSURE

A sound reproducing enclosure having a bass reflex chamber rearwardly loading a single, wide range, cone-type speaker and an exponential horn forwardly loading the speaker. The bass reflex chamber is ducted to conduct rearwardly radiated sound into the horn through which all sounds are propagated forwardly from a forward opening in the enclosure.

Background of the invention

This invention relates to speaker enclosures adapted to reproduce sounds from a single, wide range type of speaker. The enclosure is of the modified bass reflex type embodying an arrangement through which a relatively small speaker capable of reproducing high frequency sounds will also have an extended low frequency or bass response.

In order to extend the bass frequency response of a speaker, enclosures are utilized having bass reflex chambers disposed rearwardly of the speaker. In this manner, the radiating cone of the speaker is stiffened by the volume of air enclosed rearwardly thereof in order to lower the natural resonance frequency of the speaker-enclosure system.

In order to avoid interference between sounds rearwardly radiated above the resonant frequency of the speaker system with the sounds directly radiated from the front of the speaker, some systems of the bass reflex type have been limited to bass reproduction only by use of a separate speaker for reproduction of sounds above the natural frequency of the bass reflex speaker. In an attempt to avoid such interference, the outlet ports from a bass reflex chamber have been provided with deflecting surfaces peripherally surrounding the opening from which sound is directly radiated from the speaker. This proposed solution is disclosed in Patent No. 3,089,562 to Morgillo and has been found to be somewhat disappointing in results. Thus no satisfactory solution to the interference problem has been made without the use of more than one speaker for extended bass frequency speaker systems.

Summary of the invention

In accordance with the present invention, a bass reflex type of speaker enclosure is modified by porting the rear chamber through a horn forwardly loading the speaker and through which all sounds are radiated forwardly from a front opening of the speaker enclosure. In this manner, more efficient coupling between the air and sound directly radiated forwardly from this speaker is obtained for mid-range frequencies to more closely match the sound volume with the volume of the sound at the extended bass frequencies since the mass of the air within the horn because of its inertia amplifies and reinforces the pressure waves emerging from the reflex chamber. Further, since the suppression of speaker movement is increased because of the front loading effect of the horn on the speaker, the bass frequency response of the speaker system is extended. By establishing a plurality of different length air paths between the rear chamber and the front chamber enclosed by the horn, the frequency response of the system is broadened. Toward this end, ports

are formed in the walls of the horn at different distances from the driven radiating element of the speaker.

The present invention therefore provides a method of coupling a wide range speaker capable of covering the upper end of the usable audio spectrum to the air in such a manner as to allow this same speaker to reproduce the lowest frequency sound with a reduced amount of physical motion. Frequency modulation of high frequency sounds of any noticeable degree is thereby avoided. Because of the use of a single speaker surface, reproduction of sound is accomplished without phase shift between the various frequency components. This improves the reproduction of percussion in music and human voice.

An additional object of the present invention is to provide a speaker enclosure system which matches speaker movement to the outside air by a low natural resonant frequency arrangement so that the various frequency components of the sound will be reproduced close to the volume ratio associated with the electrical current driving the speaker. Also, by dampening the natural resonance of the speaker with a broadly resonant reflex circuit, large changes in impedance of the speaker coil with frequency particularly in the bass range, is avoided. Distortion due to mismatch is thereby held at a minimum.

Thus, the present invention is limited to speaker enclosures of the bass reflex type wherein sound rearwardly radiated from the speaker is conducted from the reflex chamber through paths terminating at ports formed in the walls and adjacent the inlet end of an exponential horn that forwardly loads the speaker and through which all sound is propagated forwardly from the speaker enclosure.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

Brief description of the drawings

FIGURE 1 is a perspective view showing a typical construction of a speaker enclosure in accordance with the principles of the present invention.

FIGURE 2 is a front elevational view of the speaker enclosure shown in FIGURE 1.

FIGURE 3 is a sectional view taken substantially through a plane indicated by section line 3—3 in FIGURE 2.

FIGURE 4 is a sectional view taken substantially through a plane indicated by section line 4—4 in FIGURE 3.

FIGURE 5 is a sectional view similar to that of FIGURE 3 but showing a modified form of speaker enclosure.

FIGURE 6 is a sectional view through a speaker enclosure illustrating another form and further arrangement in accordance with the present invention.

Description of the preferred embodiments

Referring now to the drawings in detail, FIGURES 1 through 4 illustrate one form of speaker enclosure generally denoted by reference numeral **10** which includes an outer housing formed by a top wall **12**, a bottom wall **14**, side walls **16**, and a back wall **18**. The front opening of the housing through which all sounds emerge, may be closed by a mesh material **20** as is customary. It will also be appreciated that the dimensions of the housing and the volumes enclosed therein will be selected pursuant to the principles of the present invention dependent upon the size and rating of its associated single speaker **22**.

As shown in FIGURES 2 and 3, the speaker **22** is of a commercially available type having a forwardly diverging, conical radiating element **24** supported by the mounting frame **26** and driven by a coil assembly **28**. In the illus-

trated form of the invention shown in FIGURE 3, the speaker is fixedly mounted within the enclosure by means of a partition wall **30** having a central sound emitting opening **32** through which the conical, radiating element **24** of the speaker is exposed. The wall **30** also encloses within the enclosure, a rear, bass reflex chamber **34** into which sound is radiated rearwardly from the low pressure side of the conical radiating element **24**. In order to prevent resonance at undesirable frequencies, sound absorbing material **36** is mounted on the rear wall **18** of the enclosure within the chamber **34**.

The central opening **32** in the wall member **30** through which the speaker is exposed, is formed with straight vertical sides **38** conforming to the inlet end of an exponential horn **40** formed by a pair of curved vertical walls **42** that are connected to the partition wall **30** and extend from the opening **32** forwardly to the open end of the enclosure housing constituting the outlet of the horn. All sounds directly radiated from the speaker as well as those which pass through the bass reflex chamber **34**, emerge from the horn at the forward open end of the enclosure housing. Thus, the sounds rearwardly radiated into the bass reflex chamber **34** are conducted through passage spaces disposed laterally of the horn and forwardly of the partition wall **30** within which sound absorbing material **44** is placed in the corners in an amount sufficient only to prevent resonance at undesirable frequencies without resisting the flow of sound waves at the bass frequencies.

In the form of the invention illustrated in FIGURES 1 through 4, the volume of the rear bass reflex chamber **34** is maintained at a reduced value by ducting the chamber **34** through the laterally disposed passage spaces between the chamber **34** and the horn **40**. Toward this end, a pair of symmetrically disposed deflector elements **46** extend in vertical planes from the vertical partition wall **30** at approximately 45 degrees thereto in order to form a folded duct on either side of the horn. The folded ducts communicate with the reflex chamber **34** through a plurality of distributed outlet openings **48** formed in the partition wall **30** in laterally spaced relation to the central opening **32** so as to establish a plurality of extended paths of different lengths for the travel of sound into the horn **40**. Sound from the reflex chamber as shown by the arrows in FIGURE 3, enters the sound passage chamber enclosed by the horn **40** at locations adjacent the inlet end thereof in front of the forward side of the radiating cone **24** through reflex ports **50** formed in the walls **42** of the horn and ports **52** formed alongside of the central opening **32** in the partition wall **30**. The ports **50** as shown in FIGURE 2 are distributed at different distances from the inlet of the horn or radiating element **24** to broaden the tuning of the speaker system.

The provision of a plurality of distributed openings **48** prevent propagation of high frequency sounds through the folded ducts as well as to broaden resonance of the bass reflex enclosure without impeding the flow of air at bass frequencies by establishing paths of different lengths for the travel of sound as aforementioned. The loading effect of the horn **40** on the speaker is also increased because of the placement of the ports **50** adjacent the speaker. The bass response of the enclosure will therefore more closely match the resonance curve associated with the speaker in order to achieve more complete balance. Also, tighter coupling is obtained between the speaker and the air particularly during the reproduction of sound at the lower bass frequencies.

FIGURE 5 shows an outer enclosure housing **54** similar to the enclosure housing shown in FIGURES 1 through 4. In this form of the invention, a mounting wall **56** mounts the speaker **58** non-symmetrically within the enclosure so as to form a folded duct on only one lateral side of a forwardly loading horn **60** to correspondingly form a rear bass reflex chamber **62** of larger volume than that associated with the speaker system shown in FIGURES 1–4. The horn **60** therefore forms a passage through which all

sound is propagated forwardly between the non-symmetrically mounted speaker **58** and a forward opening **64** of the reduced dimension. The horn is provided with reflex ports **66** on only one side thereof in communication with the folded duct established by the deflector wall **68** interconnected between the mounting wall **56** and a front wall **70** in laterally spaced relation to the speaker **58**. Distributed openings **72** in the form of the invention illustrated in FIGURE 5, are formed in the duct wall **68** functioning similar to the distributed openings **48** associated with the enclosure shown in FIGURES 1–4. Except for the lack of symmetry, the reduced ducting and correspondingly enlarged volume of the reflex chamber **62**, the speaker enclosure shown in FIGURE 5 operates in a fashion similar to that described in connection with FIGURES 1–4.

In FIGURE 6, the speaker enclosure **74** is volumetrically increased to form a larger bass reflex chamber **76** rearwardly of the speaker **78**. The speaker is fixedly mounted in non-symmetrical relation between the side walls of the enclosure housing by an open spider frame **80**. The volume of the reflex chamber **76** is enlarged inasmuch as no ducting is utilized in the form of the invention shown in FIGURE 6. Further, in view of the enlargement of the reflex chamber volume, no ducts are necessary. However, both sides of the horn **82** which forwardly loads the speaker are provided with reflex ports **84** as in the case of the horn **40** shown in FIGURES 1–4 so as to obtain the advantages hereinbefore indicated with regard to such reflex ports.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. In combination with a speaker having a sound radiating element, an enclosure comprising a bass reflex chamber loading one side of said element, a horn having side walls enclosing a forward sound chamber loading the other side of said element through which all sounds are radiated and passage means extending between said bass reflex and forward sound chambers including ports formed in the side walls of the horn adjacent to said other side of the sound radiating element to establish air paths of different lengths between said chambers.

2. The combination of claim **1** wherein said passage means further includes a folded duct establishing fluid communication between said chambers through said ports.

3. The combination of claim **1** wherein said passage means further includes distributed outlet openings in the bass reflex chamber.

4. In combination with a speaker having a sound radiating element and an enclosure having a front opening, means mounting the radiating element within the enclosure spaced from the front opening forming a bass reflex chamber rearwardly of the radiating element, a horn extending forwardly from the radiating element to said front opening radiating all sounds forwardly and having distributed ports formed therein, and passage means extending laterally of the radiating element from the bass reflex chamber to said ports in the horn, said distributed ports being spaced by different distances from the radiating element in the direction in which sound is propagated through the horn.

5. The combination of claim **4** wherein said passage means further includes a deflector connected to the mounting means extending forwardly from the bass reflex chamber in spaced relation to the horn to form a folded duct between the chamber and said ports in the horn.

6. The combination of claim **5** wherein said mounting means includes a partitioning wall mounted internally of the enclosure having a sound emitting opening adjacent

an inlet end of the horn, said partitioning wall having a plurality of distributed outlet openings laterally spaced from the radiating element between the bass reflex chamber and the passage means.

7. The combination of claim 4 wherein said mounting means includes a partitioning wall mounted internally of the enclosure having a sound emitting opening adjacent an inlet end of the horn.

8. The combination of claim 6 wherein said passage means includes a deflector connected to the mounting means extending forwardly from the bass reflex chamber in spaced relation to the horn to form a folded duct.

9. The combination of claim 8 wherein said deflector is provided with distributed openings spaced from the radiating element and the horn.

10. The combination of claim 4 wherein said horn is

formed by walls enclosing an exponential passage having an inlet extending forwardly from the radiating element, said distributed ports being formed in the walls adjacent to the inlet.

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