This invention relates to improvements in loud speaker enclosures and has for object the provision of an improved loud speaker enclosure in which all of the inherent objectionable features of existing types of such enclosures are eliminated, and devised to include new and novel features hitherto unknown in this art.

Another object of the invention is to provide a speaker enclosure of the totally enclosed type having novel means in at least one wall thereof for automatically rendering the air mobile in accordance with the requirements of the sound being reproduced.

Yet another object of the invention is the provision of a passage or window in at least one wall of a loud speaker enclosure, and the provision of a freely movable low inertia gate in said window with sufficient clearance all around for free movement of said gate in accordance with the amplitude of the sounds being reproduced.

Other objects and advantages of the invention will be apparent to those skilled in the art upon a study of this specification and the accompanying drawings.

Referring to the drawings, which are given by way of example to illustrate the invention:

Figure 1 is a perspective view of a loud speaker enclosure showing the application of my improved automatic venting gate in one wall thereof;

Figure 2 is an elevation, partly in section, taken along the line 2—2 of Figure 1;

Figure 3 is an elevation of a cabinet having a modified form of automatic venting gate therein;

Figure 4 is an elevation of yet another modified form of the invention wherein the gate is comprised of a plurality of segments;

Figure 5 is an enlarged fragmentary view showing one method of freely supporting the venting gate within an opening in one wall of a speaker enclosure;

Figure 6 is an elevation, partly in section showing a further modification of the invention;

Figure 7 is an enlarged cross-sectional elevation of the hinged support of the door shown in Figure 6;

Figure 8 is an elevation showing yet another modification of the invention; and

Figure 9 is a sectional elevation taken along the line 9—9 of Figure 8.

Loud speakers of the modern "dynamic" type are provided with light tapered cones which are "floatingly" carried on a support; on the small or apex end of the cone is a hollow tubular portion upon which the voice coil is wound. This voice coil is maintained in a magnetic field which is produced by flux from a permanent magnet. Previously the magnetic field was produced by an electro-magnet which usually formed a part of the filter system of the power pack of the amplifier.

The amplified modulated currents from any reproducer such as a disc record, tape, a sound track on a film, whether it be from magnetic or optical recording, or from radio intelligence of any type, are impressed upon the voice coil (usually via a suitable transformer). As a result of this, the cone vibrates substantially in unison with such modulated currents. Sound waves emanate from both the front and the rear of the cone, and the problem is to prevent sounds from one side from cancelling out some of the sounds emanating from the other side, particular low frequency notes.

Various means have heretofore been devised to avoid, or at least minimize, this sound wave cancellation, but each has inherent defects which result in losses.

The flat or true infinite baffle, which functions as a partition between the sounds emanating from the front and the rear surfaces of the cone, must be so very large in size as to be impractical in the average home or apartment.

Attempts to shape or fold the flat baffle into the form of an open back cabinet not only fails to provide the necessary baffle area, but results in sharp volume peaks and "booming" at low frequencies, and these peaks almost invariably constitute resonant periods of the cabinet itself.

The fully enclosed cabinet with a port formed in the wall thereof near the speaker opening is generally termed a bass reflex enclosure. It creates irregular peaks at low frequencies, cabinet resonances, and requires careful and accurate adjustment of the port area relative to the cabinet size and shape. It also requires careful adjustment to the acoustic padding, and to the characteristics of the loud speaker to be used.

The caustical labyrinth type of enclosure is comprised of a series of baffles within an enclosure to provide a so-called "tortuous path" for the sound to traverse. It has a port at the end of said path in the wall of the enclosure, and it has all of the disadvantages of the bass reflex plus the fact that it is more complicated and more expensive to make.

The folded horn type, in order to operate efficiently must be of sufficient size, which would mean an exponential type of horn about eighteen feet long. It also must be constructed expressly for the particular loud speaker.

The totally enclosed baffle cabinet positively prevents the vibrations from the front and the vibrations from the rear of the cone from getting together and affecting each other, so in many respects it is the perfect answer to the speaker baffle problem.

The totally enclosed baffle, sometimes called the "infinite baffle," however, has one inherent disadvantage. The air within the enclosure is confined and consequently it imposes pressure upon the rear surface of the cone of a loud speaker mounted therein and "damps" its movement. This results in the loss of life and color from the tones reproduced.

According to my invention, I provide in at least one wall of a totally enclosed cabinet, or baffle, what might be termed a "pressure relief valve" one example of which is the formation of an opening or passage in said cabinet communicating with air therein, and supporting within this opening with suitable clearance between its perimeter and the edges of the opening, a freely swingable door. This door should be very light so as to have a minimum of inertia and it is preferably suspended within said opening with non-metallic means.

I have found that baffles made in the manner just described provide all of the advantages of the totally enclosed types, with the absence of the disadvantages described hereinbefore.

Referring first to Figures 1 and 2, a totally enclosed and sometimes called "infinite baffle" speaker enclosure 10 has a front wall 11 having an opening 12 therein and upon which a loud speaker 13 of the dynamic type is mounted. The cabinet also has side walls 14 and 15, a bottom wall 16, a top wall 17 and a rear wall 18.

The rear wall 18 has a rectangular hole 19 formed therein preferably in line with the rear of the speaker. A rectangular frame 20 which may be formed of metal, plas-
tic or any suitable material has a tubular portion 21 which extends into the rectangular hole 19 and it has a flange portion 22 which lies flat against the outer surface of the rear wall 18, and is secured thereon in any suitable manner, for example, by means of screws 23. This leaves the opening 19 framed with an opening 24 therein.

A door element 25 which is slightly smaller in width and height than the width and height of the opening to provide an all-around clearance is suspended within the opening substantially equidistant from the adjacent edges of the element 25. The suspension of the door 25 may be effected in a number of different ways the main object being to use a form of suspension which will not materially retard the free movement of the door. In the form shown in Figures 1 and 2, 1 employ a nylon cord or the like 26 which is looped through corresponding holes 27 and 28 in the frame element 20 and the door 25, respectively, so that the door hangs freely and is moved in accordance with the amplitudes of the sound being reproduced. The action within the enclosure may be likened to a pump, the cone of the speaker comprising the pump element and its movements inwardly of the enclosure tend to increase the pressure of the air within the enclosure and of course the movement of the cone in the opposite direction tending to reduce the pressure. This is the way the totally enclosed enclosure operates.

However with my improved arrangement such as that shown in Figures 1 and 2, any increase in pressure effective on one cone of the speaker is moving inwardly, causes the door 25 to swing outwardly while on the other hand any movement of the cone in the opposite direction tends to cause the door 25 to swing inwardly. This action is automatic and in accordance with the movements of the cone of the loud speaker; thus in the arrangement above described I provide an automatic pressure relief which is simply within the wall of the enclosure and thereby I obtain all of the advantages of the infinite baffle enclosure and at the same time, I automatically eliminate the disadvantages.

Figure 3 shows a modified form of my new and improved infinite baffle relief system, wherein a door 30 instead of being rectangular like the door 25, is generally disc-like in form and is comprised of a round portion 29 and a tongue-like extension 31 thereof which defines an edge which is suspended within a corresponding rectangular portion 33 of a frame element 32. The frame element 33 is provided to be mounted in a round hole in the cabinet wall and this hole has a rectangular extension to accommodate the portion 33. The door 30, as may best be seen in Figure 5, is suspended within the opening 34 of the frame 32 with suitable clearance space 35 all around by means of the threads or filaments 36 which extend through adjacent and corresponding holes 37 and 38 in the frame member 32 and in the door 30, respectively. Thus, the door 30 may freely swing back and forth within this opening in accordance with the movements of the loud speaker cone within the enclosure and thus the pressures upon the air within the enclosure are automatically disposed of.

Referring now to Figure 4, I show a modified form of the arrangement shown in Figure 1 and 2 wherein substantially the same elements are employed with the exception of the door. So in this figure, like elements are given the same reference numerals as those in Figures 1 and 2. The enclosure has a rectangular frame 20a which is substantially identical to the frame 20 except that the upper portion 36 thereof is provided with a series of four pairs of holes 37, and instead of a single door 25, as shown in Figures 1 and 2, a segmented door is provided and this is formed of segments 28, 39, 40 and 41. Each segment has sufficient clearance between itself, the opening in the frame 20a and between itself and its neighbor to provide free movement, and each segment is suspended from its pair of holes 37 by means of a filament 42 passing through holes 37 and corresponding and aligned holes 43 so that all four of the segments are freely movable and may automatically move in accordance with the movement of the speaker cone and thus relieve air pressures emitted within the enclosure by means of the loud speaker cone.

In the modification shown in Figures 6 and 7, a frame element 45 is similar to the frame elements 26, 20a and 32 with the exception that within the opening 46 near the top thereof are aligned holes 47 and 48. These holes, as may be seen in Figure 7, are comparatively shallow and their upper extremities are closely adjacent to and are substantially in alignment with the upper edge of the opening 46. The door 50 may be formed of any suitable material, for example, a plastic, and at the top thereof, it is provided with tab-like extensions 49 which have the upper corners removed or beveled, as, for example, along the line 51 and they are so dimensioned that when positioned in the aligned holes 47 and 48, the door is suspended by means of the contact of the lower surfaces 52 with the interiors of the holes 47 and 48 and the beveled portion 51 just clears the perimeter 53 forming the outer boundary of the holes 47 and 48. The surfaces 52, it will be noted, support the door and they may be made horizontal or they may also be angular and both forms tend to maintain the door 50 centrally within the opening 46. The door 50 may be formed of plastic or any other suitable material, and for installing it, may be flexed so that the tabs 49 may be inserted in the holes 47 and 48, respectively, and then the door is released so that it may be restored to its original width, thereby leaving the door 50 suspended within the opening and freely movable therein due to all-around clearance between the door and the inner surfaces of the frame 45.

Although it is preferable to mount my improved device in the rear wall of the enclosed speaker enclosure, I have found that the device is effective in any wall of the enclosure and also that it may be reduced in size and several of them mounted in one or different walls of the enclosure. I have further found that the size of the device is not critical. To show the versatility of the invention, I have mounted several speakers within an enclosure which was, according to existing standards, considered too small for one speaker alone (by pass reflex standards) and I have obtained therefrom superior sound reproduction which no closure of any type was able to produce and I believe this is very important because in many places particularly in small apartments, there is insufficient room to use large enclosures. In other words, the trend has been toward miniaturization with the result that the cabinet has to be experimented with (by varying the slot of a bass reflex cabinet where its resonance matches the resonance of the speaker to be used). In most instances, this is a very fussy operation because in the small enclosure, the values are critical and great care must be exercised in making this match. Contrasted with this, no matching of the resonance of the enclosure and the speaker is necessary and since the size of the valved opening is not critical, my arrangement is more flexible than has heretofore been attained with any other enclosure arrangement. Although I have herein shown and described by way of example, several forms of the invention, these were given to illustrate the invention and to teach others how to use it and is consequently not intended to be limiting.

I claim:
1. In an enclosed loud speaker enclosure having a speaker opening in one wall thereof, a speaker mounted in said enclosure and having a cone thereof forming a closure for said opening, pressure relief means movably mounted in an opening formed in a wall of said enclosure for placing the interior of the enclosure in communication with the atmosphere and thereby relieving pressures exerted by the air column within said
enclosure upon the rear face of the cone of said speaker and thereby permitting it to move freely and reproduce sound with a minimum loss of life, color and timbre.

2. In a loudspeaker enclosure of the infinite baffle type having enclosing walls of substantial thickness, means forming at least two openings in said walls, a loudspeaker forming a closure for one of said openings, and pressure relief valve means cooperatively mounted in and forming a closure for the other of said openings, said pressure relief means being sufficiently sensitive to be actuated by variations of pressures within said enclosure exerted by the cone of said speaker upon the air column, thereby placing said air column in communication with the atmosphere and minimizing the damping effect of said air column upon said cone.

3. In a loudspeaker enclosure of the infinite baffle type having enclosing walls of substantial thickness, means forming at least two openings in said walls, a loudspeaker forming a closure for one of said openings, and pressure relief valve means cooperating with the edges of and forming a closure for the other of said openings, said pressure relief valve means being sufficiently sensitive to be actuated by increases and decreases of pressures on the air column within said enclosure exerted by the cone of said speaker, thereby placing said air column in communication with the atmosphere and minimizing the damping effect exerted by said air column upon said cone.

4. In an enclosed loudspeaker baffle means defining a speaker opening in one wall thereof, a speaker mounted in said wall in co-operative relation with said opening, means defining a second opening in a wall of said baffle and communicating with air in the interior thereof, and a door movably suspended within said second opening, closely adjacent to the borders thereof and sensitive to variations of the pressure of said air, for placing said air in communication with the atmosphere and interrupting said communication in accordance with said variations.

5. In an enclosed loudspeaker baffle of the infinite type, means defining a speaker opening in at least one wall thereof, a speaker mounted in said wall in co-operative relation with said opening, means forming another opening in a wall of said baffle, and a comparatively thin and light closure pivotally mounted within said last opening under the influence of means tending to centralize it therein, whereby said closure may function as a pressure relief valve sensitive to variations of pressure imposed by said speaker upon the air within said baffle, thereby placing said air in communication with and removing it from communication with the atmosphere outside said baffle.

6. In an enclosed loudspeaker baffle of the infinite type formed of walls of substantial thickness, means defining a speaker opening in at least one wall thereof, a speaker mounted on said baffle and having a diaphragm thereof closing said opening, means defining another opening in a wall of said baffle, and a comparatively thin and light closure movably suspended in said last mentioned opening with sufficient clearance between its edges and the adjacent edges of said last opening to prevent dragging, said clearance defining a minimum line of communication between air within said baffle and the atmosphere, and said closure being sensitive to and moved by variations of the pressure of said air.

7. In an enclosed loudspeaker baffle of the infinite type having enclosing walls of substantial thickness, means defining a speaker opening in at least one wall thereof, a loudspeaker mounted on said baffle and having a cone therein forming a closure for said speaker opening, means defining a pressure relief opening in one of said walls, said opening being rectangular in form, and a rectangular door suspended in said second opening and having sufficient clearance between its edges and the edges of said opening to insure its sensitivity to variations of pressure imposed upon the air within said baffle by said cone.

8. In an enclosed loudspeaker baffle of the infinite type having enclosing walls of substantial thickness, means defining a speaker opening in at least one wall thereof, a loudspeaker mounted on said baffle and having a cone therein forming a closure for said speaker opening, means defining a generally round opening in one of said walls, a disc-like door oriented in and suspended in said second opening and having an all around clearance to prevent its edges from contacting the adjacent edges of said second opening, thereby insuring the sensitivity of said door to variations of pressure imposed upon the air within said baffle by one surface of said cone.

9. In an enclosed loudspeaker baffle of the infinite type having enclosing walls of substantial thickness, means defining a speaker opening in at least one wall thereof, a loudspeaker mounted on said baffle and having a cone therein forming a closure for said speaker opening, other means defining a rectangular opening in one of said walls, a rectangular door suspended in said second opening, said door being slightly smaller than said opening to provide just sufficient clearance to prevent its edges from dragging, thereby insuring the sensitivity of said door to variations of pressure imposed by said speaker upon the air within said baffle.

10. In an enclosed loudspeaker baffle of the infinite type having enclosing walls of substantial thickness, means defining a speaker opening in at least one wall thereof, a loudspeaker mounted on said baffle and having a cone therein forming a closure for said speaker opening, other means defining a rectangular opening in one of said walls, a frame positioned in said opening and defining a precisely dimensioned pressure relief passage between air within said baffle and the atmosphere, a rectangular door suspended in said passage and having sufficient all around clearance to prevent its edges from contacting the edges of said passage, thereby insuring that said door will be sensitive to variations of pressure imposed by said speaker upon said air.

11. In an enclosed loudspeaker baffle of the infinite type having enclosing walls of substantial thickness, means defining a speaker opening in at least one wall thereof, a loudspeaker mounted on said baffle and having a cone therein forming a closure for said speaker opening, other means defining a somewhat round opening in one of said walls, a frame conforming to said opening and defining a precisely dimensioned pressure relief passage between air within said baffle and the atmosphere, said passage having a straight upper portion substantially parallel to the base of said baffle, a light door conforming to the shape of said passage and having an all around clearance between its outer edges and the edges of said passage to insure the sensitivity of said door to fluctuations of the pressure imposed upon said air by said speaker.

12. In an enclosed loudspeaker baffle of the infinite type having enclosing walls of substantial thickness, means defining a speaker opening in at least one wall thereof, a loudspeaker mounted on said baffle and having a cone therein forming a closure for said speaker opening, other means defining a rectangular opening in one of said walls, a frame mounted in said opening and defining a precisely dimensioned pressure relief passage between air within said baffle and the atmosphere, a sectional rectangular door suspended within said passage and comprised of a plurality of individually suspended sections, sufficient clearance being provided between said sections to prevent the interior of said passage and also clearance between the individual segments thereof to insure freedom of movement of all of them when variations of pressure are exerted upon the air within said enclosure by the action of the moving element of said speaker, thereby ensuring that said door will be sensitive to variations of pressure imposed by said speaker upon said air.

13. In an enclosed loudspeaker baffle of the infinite type having enclosing walls of substantial thickness,
means defining a speaker opening in at least one wall thereof, a loud speaker mounted on said baffle and having a cone therein forming a closure for said speaker opening, other means forming a pressure relief opening in one of said walls, said last opening being triangular in form with an apex thereof extending downwardly, and a triangular door suspended by its base in said last opening and having sufficient clearance between its edges and the edges of said opening to insure its sensitivity to variations of pressure upon the air within said baffle when the speaker is in operation.

14. The invention according to claim 13 in which a frame element within said pressure relief opening forms a support from which said door is suspended.

15. In an enclosed loud speaker baffle of the infinite type having enclosing walls of substantial thickness, means defining a speaker opening in at least one wall thereof, a loud speaker mounted on said baffle and having a cone therein forming a closure for said speaker opening, other means defining a rectangular pressure relief opening in one of said walls, said opening being generally rectangular in form, a rectangular frame positioned within said last opening and having aligned holes therein lying on a line substantially parallel to the plane of said frame and closely adjacent to the upper edge of said frame and a rectangular door suspended in said passage and having generally triangular tabs formed integral therewith adjacent to the top edge thereof on each end, said triangular tabs being placed in cooperative relation with said aligned holes and each having its apex extending into the hole which it contacts, said door being slightly smaller in dimensions than said passage thereby providing a minimum of clearance between the edges of said door and the edges of said frame.

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