March 4, 1958 F. H. STEPHENS, JR 2,825,419

HIGH FIDELITY SPEAKER ENCLOSURE COMBINATION

Filed Sept. 5, 1956

5 Sheets-Sheet 1

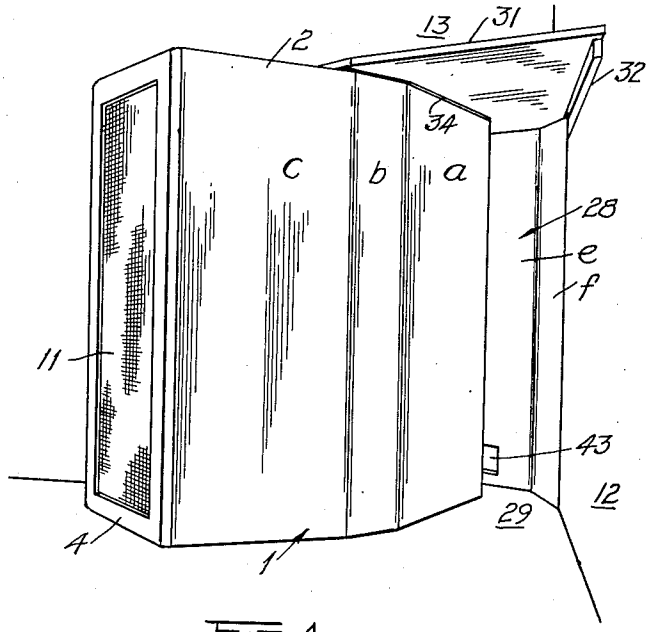


FIG. 1

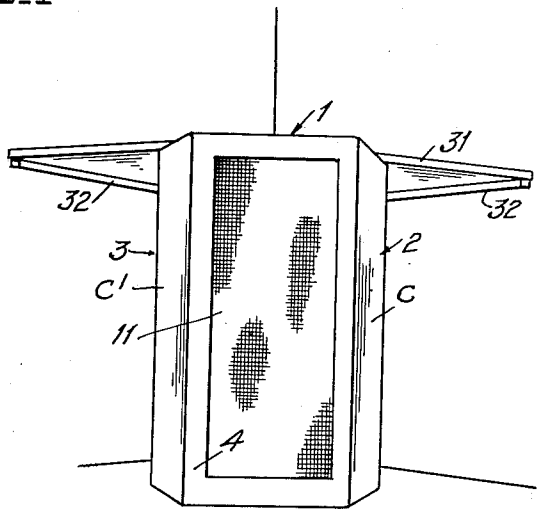


FIG. 2

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March 4, 1958 F. H. STEPHENS, JR 2,825,419

HIGH FIDELITY SPEAKER ENCLOSURE COMBINATION

Filed Sept. 5, 1956

5 Sheets-Sheet 2

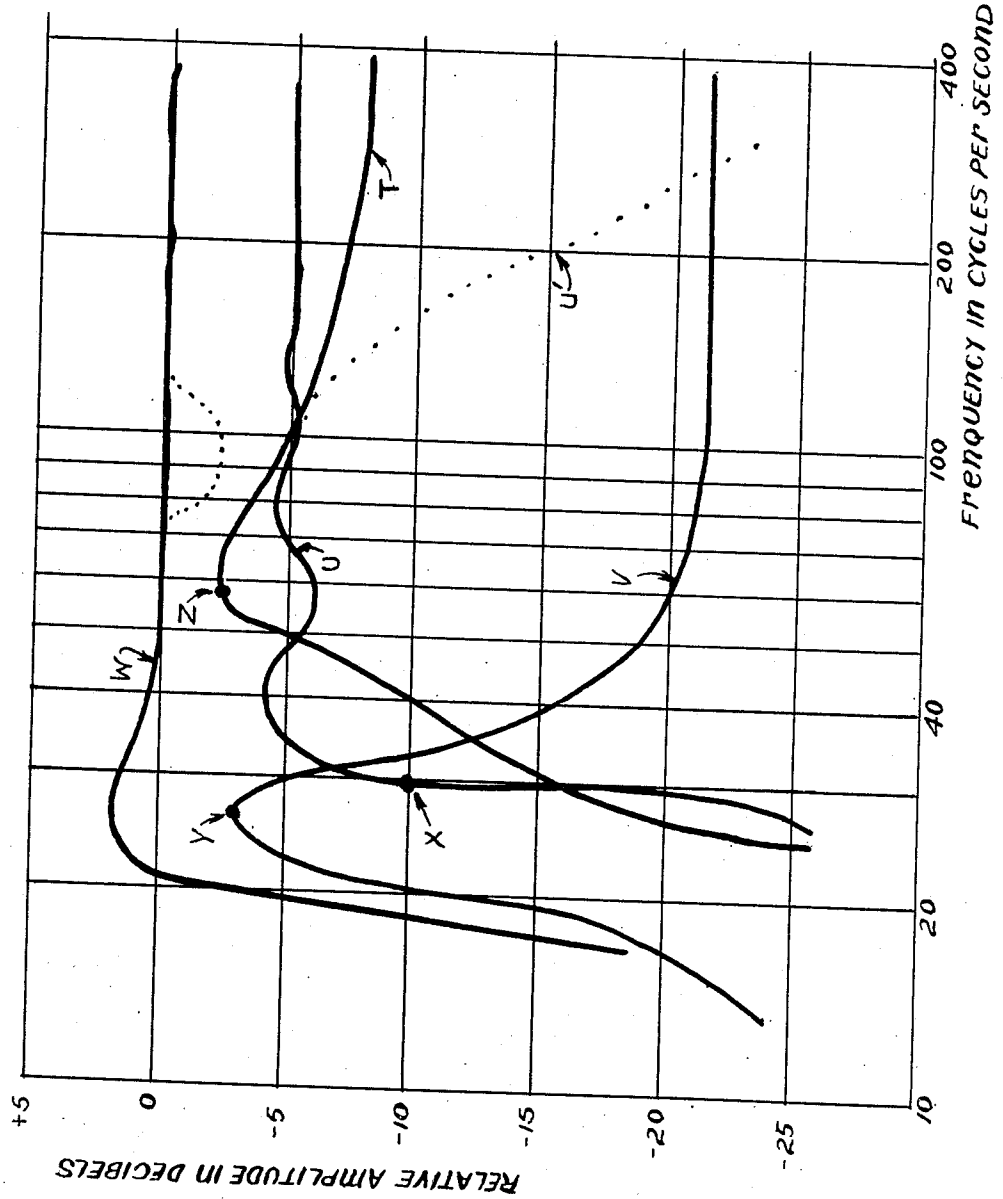


FIG. 5

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March 4, 1958 F. H. STEPHENS, JR 2,825,419

HIGH FIDELITY SPEAKER ENCLOSURE COMBINATION

Filed Sept. 5, 1956

5 Sheets-Sheet 3

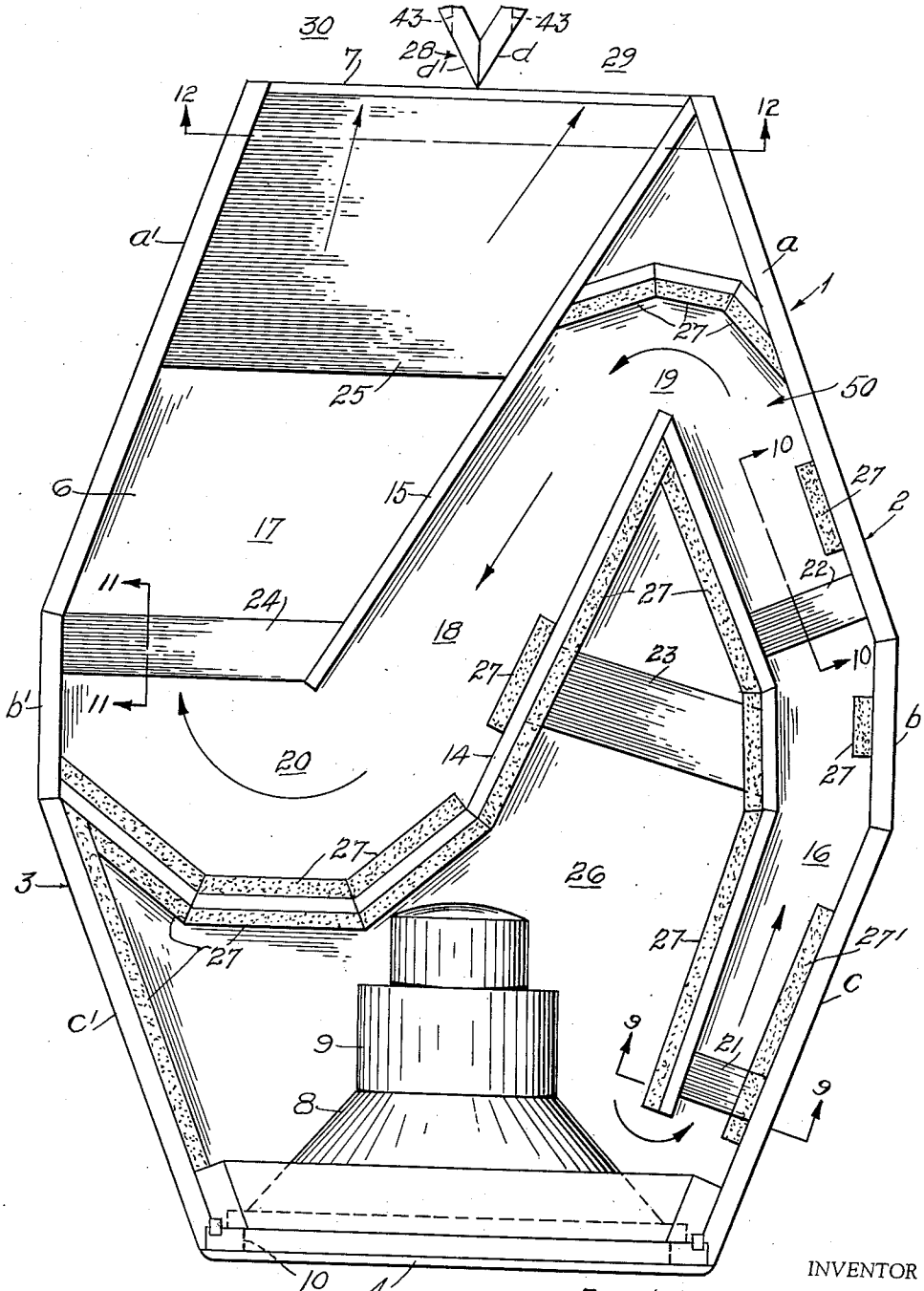


FIG 4

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March 4, 1958 F. H. STEPHENS, JR 2,825,419

HIGH FIDELITY SPEAKER ENCLOSURE COMBINATION

Filed Sept. 5, 1956

5 Sheets-Sheet 4

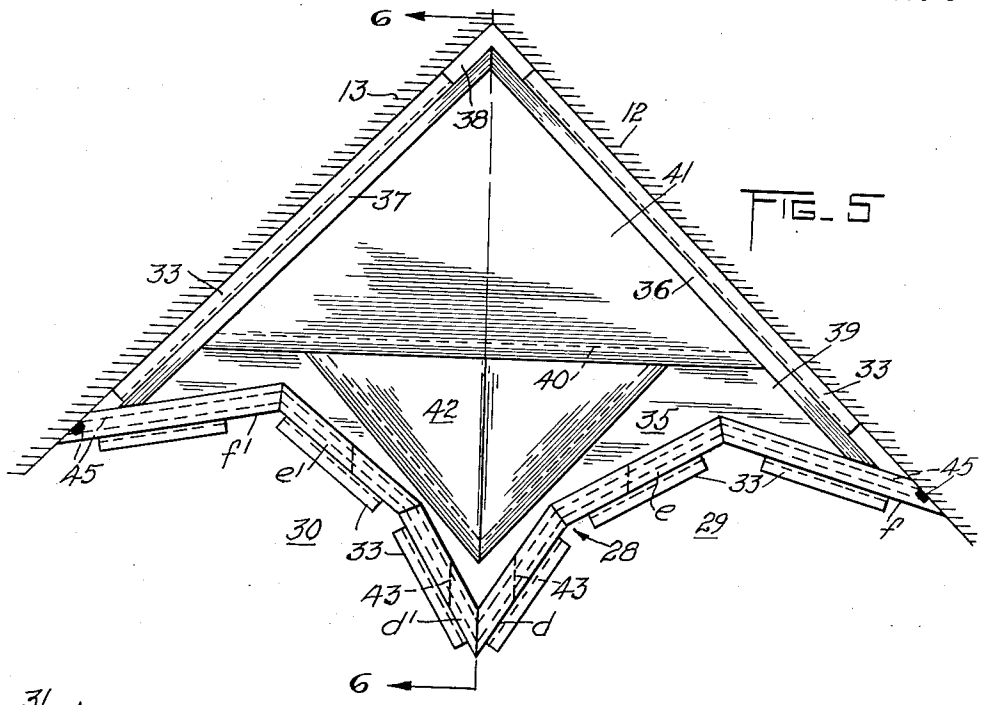


FIG. 5

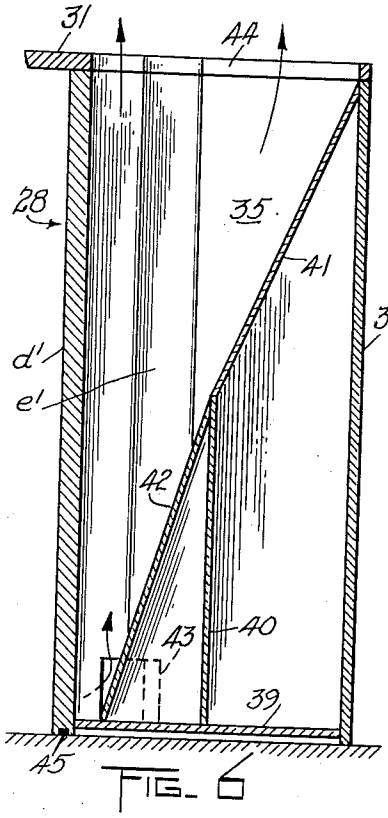


FIG. 6

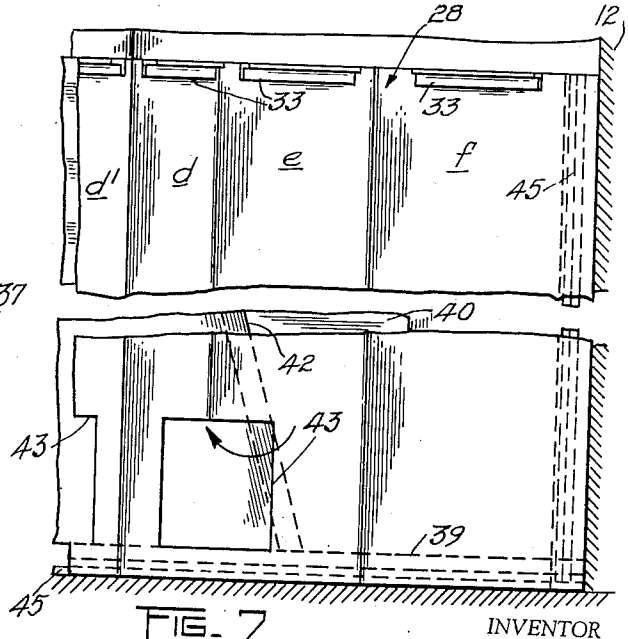


FIG. 7

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March 4, 1958 F. H. STEPHENS, JR 2,825,419

HIGH FIDELITY SPEAKER ENCLOSURE COMBINATION

Filed Sept. 5, 1956

5 Sheets-Sheet 5

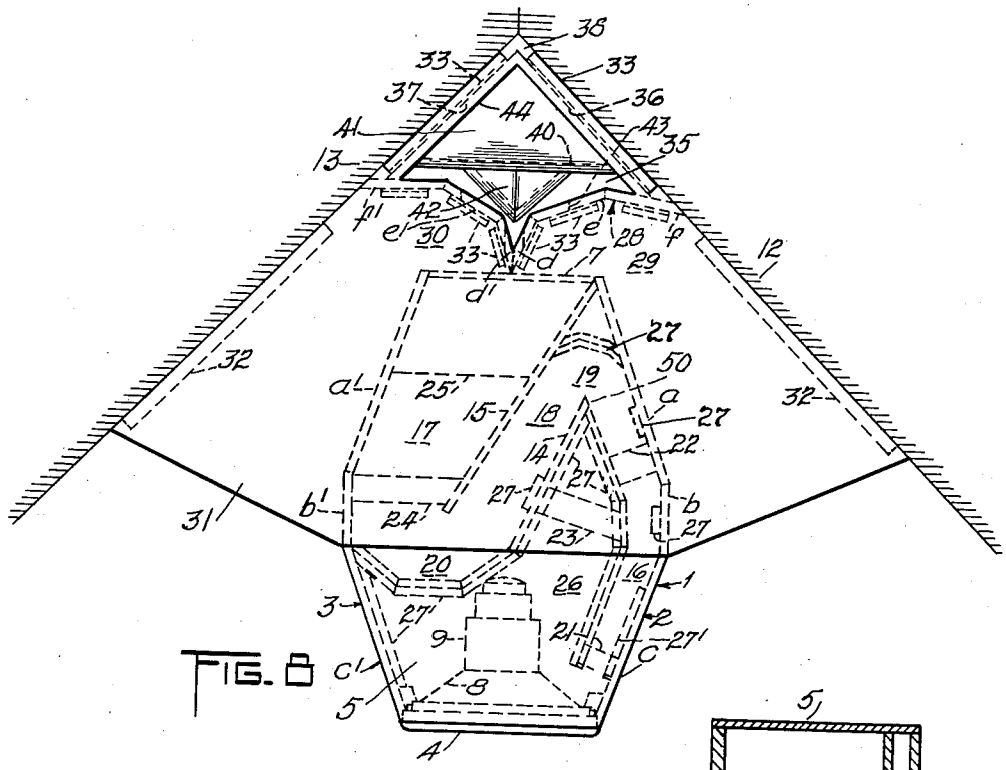


FIG. 8

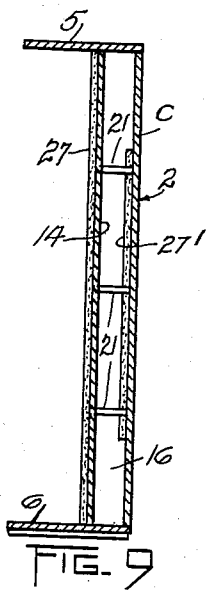


FIG. 9

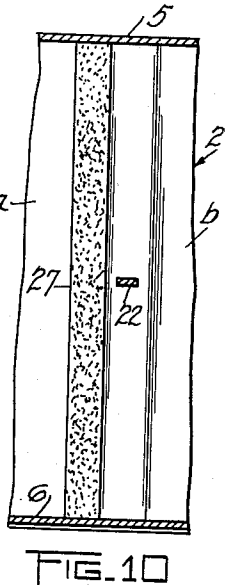


FIG. 10

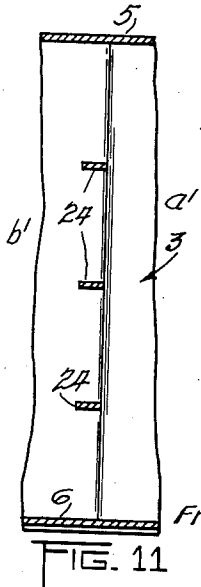


FIG. 11

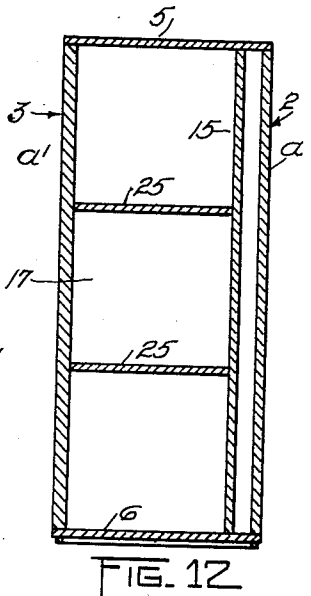


FIG. 12

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United States Patent Office 2,825,419
Patented Mar. 4, 1958

2,825,419

HIGH FIDELITY SPEAKER ENCLOSURE COMBINATION

Frank H. Stephens, Jr., Miami, Fla.

Application September 5, 1956, Serial No. 608,121

13 Claims. (Cl. 181—31)

The present invention relates to corner type, back-loaded horn loud speaker enclosures and more particularly to a certain new and improved construction and arrangement of parts which provides a wider frequency range and greater fidelity of sound and music than has heretofore been available.

Briefly summarized, the invention consists of a loud speaker system comprising a speaker unit and a cabinet or enclosure, the cabinet being designed for use with high quality speaker units of modern design.

The speaker enclosure, exclusive of the speaker unit, consists of three parts which, when assembled in the corner of a room, comprise the entire system. These three parts are the cabinet and driving unit, a combined dispersion unit and vertical horn and a top cover, the latter having wing portions two side edges of which are at right angles to each other and abut the walls of the room diverging from the corner in which the enclosure is placed.

The cabinet, holding the driving unit, is an eight-sided box as viewed from the top. The speaker itself is mounted in the front wall of the cabinet and radiates sound directly into the room. Back radiation from the cone of the speaker is entrapped in an irregularly shaped air chamber behind the speaker. Also in the cabinet is a folded, hyperbolically expanding exponential horn whose throat is coupled to the aforesaid chamber. The throat of the horn is offset laterally from the axis of the speaker so as to provide poor coupling at the higher frequencies, this offset coupling arrangement being one of the features of the invention.

Another object of the invention is to reduce internal resonances and reflections, this being accomplished by the asymmetrically constructed air chamber behind the speaker, no two sides of said air chamber being parallel. A further object is to so construct and acoustically treat the horn passage and the back loading chamber communicating therewith so as to provide a low-pass filter, that is, one passing sounds below 120 cycles per second.

The frequency range of the horn is restricted to less than three octaves and consequently produces less undesirable phase and frequency distortion over the range where these would be most noticeable. Any discontinuities or distortion that may exist at the higher frequencies above the desired range are not passed by the horn because of its acoustic treatment and low pass characteristics.

The horn is smoothly tapered and devoid of sharp corners at the two major bends along its path, the purpose of this being to accomplish a further object of the invention which is to minimize discontinuities and prevent the generation of distortion at these bends.

The design formula of the horn is substantially a hyperbolic function and the horn construction is an approximation to the desired curve. The discontinuities in the approximated curve are practically non-existent when considered as an influence at the frequencies or wavelengths over which the horn is active. At frequencies

above that at which the horn is efficiently coupled the air chamber behind the speaker acts as a compliance. The mass reactance of the horn throat resonates with the compliance of the air in the chamber behind the speaker at approximately 26 C. P. S. in the structure as illustrated. High efficiency remains as low as 22 C. P. S. and response is maintained up to the frequency of speaker cone resonance (approximately 60 C. P. S.).

The horn exhausts at the rear of the cabinet and its configuration is continued by the surfaces formed by the front of the dispersion unit, the walls of the room and the sides of the cabinet, the floor and the wing portions of the top cover providing the other two necessary surfaces.

A still further object of the invention is the provision of an additional sound path beginning at the rear of the cabinet and constituting a vertical horn, the front wall of which is the aforesaid dispersion unit. The throat of this vertical horn is at the bottom near the floor and is joined to the path of the folded horn behind the cabinet by two small ports in the front of the dispersion unit, the mouth of the vertical horn corresponding with an irregular opening in the top cover.

The invention with the aforesaid and other objects in view will be clearly set forth in the following more detailed description and particularly defined in the appended claims.

The accompanying drawings illustrating the invention and forming a part of this specification are as follows:

Fig. 1 is a perspective view of outside of the speaker enclosure.

Fig. 2 is a perspective view directly from the front of the outside of the speaker enclosure.

Fig. 3 is a graphical illustration hereinafter explained.

Fig. 4, drawn to a larger scale than Figs. 1 and 2, is a plan view of the speaker cabinet, the top plate being removed to show the folded horn.

Fig. 5 is a like plan view of the vertical horn with top cover removed.

Fig. 6 is a vertical section on the line **6—6** of Fig. 5 but drawn to a smaller scale.

Fig. 7 is a view in elevation of the right hand portion of Fig. 5.

Fig. 8 is a plan view of the speaker enclosure shown in the corner of the room, the scale being reduced from that of Figs. 4 and 5.

Fig. 9 is a vertical cross section on the line **9—9** of Fig. 4 taken through the throat of the folded horn.

Figs. 10, 11 and 12 are sectional views similar to Fig. 9 taken on the lines **10—10**, **11—11** and **12—12**, respectively of Fig. 4. The top plate, not shown in Fig. 4, is shown in Figs. 6, 7, 9, 10, 11 and 12. These sectional views show the acoustical insulation and bracing pieces at their respective locations.

In the drawings similar reference numerals refer to similar parts throughout the several views.

The cabinet, indicated in general by numeral **1**, has side walls **2** and **3** and a front wall **4** extending vertically between horizontal top and bottom plate members **5** and **6**, the rear face **7** of the cabinet being open. Each side wall is formed of three panels, those of wall **2** being designated *a*, *b* and *c* while *a'*, *b'* and *c'* are the corresponding panels of wall **3**. The comparatively narrow intermediate panels *b* and *b'* are parallel and define the widest part of the cabinet. Converging from the intermediate panels *b* and *b'* are the panels *a* and *a'* which terminate at the open rear face **7** and also converging from the panels *b* and *b'* are the panels *c* and *c'* which along their front edges are joined to the front wall **4**, the panels *c* and *c'*, it will be observed, being of less width than the rear panels *a* and *a'*.

At **8**, in Figs. 4 and 8, is seen a cone type speaker **9**,

This speaker 9 is mounted on the front wall 4 of the cabinet 1 directly behind an opening 10 through which, and the customary screen 11, the speaker radiates directly into the room. The walls forming the room corner in which the speaker enclosure is placed are designated 12 and 13.

Standing vertically in the cabinet 1 and extending from top 5 to bottom 6 are front and rear baffles 14 and 15, respectively. These baffles 14 and 15 with the panels *a*, *b* and *c* of side wall 2 and panels *a'* and *b'* of side wall 3 form the sides of the aforementioned hyperbolically expanding exponential horn, indicated generally at 50, the top member 5 and the bottom or floor member 6 providing the other two necessary surfaces.

The folds in the horn 50 are the throat section 16 along the contour line of side wall panels *c*, *b* and *a*, the exhaust section 17 along the contour line of side wall panels *b'* and *a'*, and an intermediate oblique section 18 connected to the throat section 16 and exhaust section 17 by opposing return bends 19 and 20, respectively, the end of that portion of the exhaust section 17 within the cabinet 1 being the entire open face 7 of the cabinet.

From Fig. 4 and sectional views, Figs. 9, 10, 11 and 12, it will be observed that the cabinet 1 and built in horn 50 are reinforced by horizontal bracing pieces 21, 22, 23, 24 and 25 which vary in width and number according to their location. There is but one each of the braces 22 and 23. In locations where there are a plurality of braces, the braces are equally spaced one above the other as shown. Construction design of the cabinet 1 provides for air-tight joints and prevents pressure leaks from one part to another and from its interior to the outside.

The walls surrounding chamber 26 in which the speaker 9 is housed are asymmetrically arranged, no two of these walls being parallel, to reduce internal resonances and reflections within the chamber. The horn 50 being coupled to the chamber 26 adjacent a side wall of the cabinet, instead of axially of the speaker 9, provides poor coupling at high frequencies.

The walls of chamber 26, the back wall of which is the front baffle 14, are acoustically treated, preferably in the manner shown, by adjoining strips 27 of fiber glass board extending the full interior height of the cabinet 1 and neoprene coated on both sides. Like strips 27 of acoustic material line the major bends 19 and 20 of the horn passage and occasional strips 27 are placed in spaced relation, as shown, in its throat section 16 and the oblique section 18, the strip indicated at 27' at the entrance to the throat section 16 being considerably wider but of less height than 27.

In the rear of the cabinet 1 is the dispersion unit comprising a vertically extending baffle 28 which in width is the hypotenuse of a right angle triangle the sides of the triangle being the room walls 12 and 13. This baffle 28 in horizontal sections is of irregular configuration and to the right, with respect to Fig. 4, of a vertical plane bisecting the angle between the walls 12 and 13 is formed of angularly disposed adjoining panels *d*, *e* and *f*. The corresponding panels *d'*, *e'* and *f'* to the left of the said vertical plane differ in width and angular arrangement from the panels *d*, *e* and *f*.

Panels *d* and *d'* are opposing sides of an acute angle the apex of which abuts and bisects vertically the open rear face 7 of the cabinet 1. Consequently the exhaust section 17 of the folded horn 50 at the rear of the cabinet is divided into diverging passages 29 and 30. Passage 29 being bounded on the sides by panels *d*, *e* and *f* of baffle 28, the room wall 12 and side wall 2 of cabinet 1. Similarly, passage 30 is bounded by panels *d'*, *e'* and *f'* of baffle 28, room wall 13 and the cabinet side wall 3. Both passages 29 and 30 follow the design curve of the folded, hyperbolically expanding exponential horn 50.

It will be observed however that the axis of the exhaust section 17 within the cabinet 1 is at an angle to the vertical plane bisecting the corner angle of the room.

Because of this, and in order that both passages 29 and 30 follow the same design curve, the sides to the right and left of the vertical center of baffle 28 differ in pattern as shown and just above described. The other necessary surfaces of sound passages 29 and 30 are the floor of the room and cover, the latter being indicated at 31 and described in the foregoing brief summary of the system.

It may be added that the cover 31 is supported by horizontal cleats 32 secured to the room walls 12 and 13 and by angle bars 33 along the irregular top edge of the baffle 28.

From the corner of the room the cover 31 extends forward over cabinet 1 to a transverse line coincident with the juncture of side wall panels *b* and *c* and *b'* and *c'*. A sheet 34 of fabric is placed over the top plate 5 of the cabinet to fill the slight clearance space between such plate and the top cover 31.

In rear of cabinet 1 and built to fit the corner of the room is a vertical horn indicated generally at 35. This horn 35 has side walls 36 and 37 paralleling the room walls 12 and 13 but spaced slightly from said room walls 12 and 13 to provide a space to allow for irregularities in walls 12 and 13 and to allow space for angle brackets 33. The side walls 36 and 37 of the horn 35 form the legs of a right triangle and are upstanding from a bottom plate 39. The baffle 28 is also the front wall of horn 35. The air passage through the vertical horn also follows the design curve of the folded horn 50. To this end its rear wall is a baffle comprising a vertical lower portion 40 extending transversely between the side walls 36 and 37, and a rearwardly inclined triangular upper portion 41 the apex of which is at the junction of the side walls 36 and 37 at their top edges. Astride the vertical center of baffle part 40 is a baffle 42 comprising two adjacent sides of a partial pyramid the vertex of which is at the line of juncture of the baffle parts 40 and 41.

At the bottom of the baffle 28, on each side of its center, are two port openings 43. These openings are the throat of the horn 35 the mouth of which corresponds with an irregular opening 44 in the top cover 31, its configuration being defined by the side walls 28, 36 and 37 of the horn. A rubber strip 45 around the edge of baffle 28 serves as an air seal.

The operation of the speaker enclosure is as follows: Direct radiation of all frequencies occurs from the front of the speaker 9 into the room. In other words, considering only the radiated sound from the front surface of the speaker cone, operation may be said to be similar to that provided by a speaker enclosed in an infinite baffle. It is well known that when this is the case the cone-type radiator provides relatively good efficiency above its primary resonant frequency which for speakers from 12 to 15 inches in diameter enclosed in small cabinets may be considered to be the order of 50 to 70 C. P. S. Due to inefficient coupling below this frequency insufficient transfer of energy is attained and speaker cone excursions become excessive. In addition to a drop-off of frequency response, at a rate of approximately 12 db or more per octave below this frequency a high percentage of distortion is generated due to nonlinear operating conditions caused by the excessive speaker cone travel and poor acoustical damping factor. This condition limits the operation of the speaker to a frequency range in general above that of primary cone resonance, certainly not extending much further than 25% below this frequency.

The speaker enclosure of the instant invention is designed to alleviate this condition by providing efficient coupling to the air at frequencies below primary speaker cone resonance in order to enhance frequency response characteristics and prevent excessive travel of the speaker cone during operation.

When considered together, the speaker and cabinet are an unmatched combination. This means that the speaker's natural resonant frequency does not match that

of the cabinet. The speaker cabinet **1** itself is a resonant system in which the resonant frequency is determined by the mass reactance at the mouth of the horn **50** acting in conjunction with the compliance of the air mass in the chamber **26** directly behind the speaker. The air chamber **26** when considered in conjunction with the throat **16** of the horn forms in effect a Helmholtz resonator and if there were no horn at this point, but merely an opening into the room, we would have in effect a base-reflex enclosure. The horn, however, is coupled to this chamber **26** and provides an efficient impedance matching device for transferring the energy appearing at the throat **16** of the horn, into the room. The horn is used in this enclosure primarily at low frequencies where an increase of efficiency and energy transfer is desirable.

The acoustic material **27** used in the cabinet **1** attenuates the higher frequencies and prevents their propagation through the length of the horn. This is done in order to eliminate as much as possible phase interference and cancellation between the energy radiated by the horn and the front of the speaker cone **8** at higher frequencies. Propagation of the higher frequencies through the horn is undesirable for other reasons. Because of the fact that the horn is folded, acoustic discontinuities exist in it. When the wave lengths of the sound propagated through the horn approach the physical dimensions of some of the folds within the horn, these discontinuities become serious. Even in a straight horn of ideal design, distortion generated within the horn increases as a function of the bandwidth transmitted through the horn and for this reason it is desirable to limit the operation of the horn to two or three octaves. The acoustic material **27** shown at the bends **19** and **20** in the horn prevents reflection of the higher frequencies from these points and reduces both transmission and distortion.

Because of the acoustic treatment of the cabinet **1**, the horn **50** and air cavity **26** behind the speaker **9** operate as an acoustic low pass filter with a cut-off somewhere in the neighborhood of 120 cycles. The top **5** and bottom **6** of the horn passages **16**, **17** and **18** and air chamber **26** are not acoustically treated. The horn **50** has been observed to propagate some energy between 450 and 750 C. P. S. This may be due to the fact that the top **5** and bottom **6** of the cabinet are not treated. Propagation of these frequencies has been found not to be undesirable and therefore has not been eliminated.

The speaker and cabinet comprise an unmatched system. In one instance the cone resonant frequency of the speaker when mounted in the cabinet was 53 cycles per second while the resonant frequency of the cabinet was 26 C. P. S.

In designing my horn the equation used in determining the taper was that of Salmon, as given in "Electrical Engineers Handbook" 4th ed. by Pender-McIlwain at page 13–05. As an illustration, the configuration of the horn **50** is substantially a hyperbolic function. It is designed for flare cut-off of 30 C. P. S. and the horn contour parameter "T" is 0.65. With the speaker cone resonance of 53 C. P. S. and a cabinet resonance of 26 C. P. S. high efficiency is maintained below the speaker resonant frequency down to approximately 20 to 22 C. P. S.

The above design is based on a horn throat area of 88.2 square inches which is aproximately one half of the area of the 15 inch speaker cone. The ratio of the area of the horn throat to the area of the speaker cone determines the coupling of the speaker cone to the system. This ratio may vary over a considerable range and will affect the operation of the system.

The results of this design apear graphically in Figure 3. Curve T shows relative acoustical frequency response of typical loud speaker driver unit when mounted in an infinite baffle. Curve U shows relative acoustic resistance of horn throat with respect to frequency. Curve U is

also indicative of acoustic frequency response obtainable using a constant impedance pressure source.

Curve V shows relative acoustic pressure in cabinet and at horn throat due to cabinet volume-horn throat reactance resonance, as a function of frequency.

The increase in acoustic pressure in the cabinet to a maximum at point Y is shown in curve V. This causes an increase in energy propagated through the horn and offsets the drop off due to horn flare cut off and impedance characteristics which are shown at point X and curve U, thereby extending the low frequency response of the system and maintaining good coupling with the speaker cone. This prevents excessive cone travel and distortion at low frequencies where damping and coupling are usually lost in the ordinary speaker system.

Curve W shows relative frequency response of the system of my invention showing extended bass response of combination.

Curve U' shows loss in response due to high frequency cut off characteristics of horn. The dip in curve W, a dotted line, shows result of interference between cone and horn radiated energy which varies depending on the acoustical conditions of the environment. In the above curves no absolute scale is implied. On the frequency scale the point X represents the flare cut off frequency of the horn; the point Y represents the horn-cabinet resonant frequency; and point Z represents the speaker cone resonant frequency.

These graphs show the improved bass frequency response of the system herein described, curve W, as compared with the same driver unit mounted in an infinite baffle, curve T.

It should be emphasized that the above data and graphical examples are for illustration only. Other designs can be used with different values for horn contour parameter, "T." Although in the illustration one speaker **9** has been shown actually additional speakers could be mounted either coaxially or elsewhere in the front wall **4**. Different suitable materials of construction could also be used. Any of these changes could be made without departing from the spirit or scope of my invention.

The cabinet resonant frequency was measured by observation of the speaker cone excursion showing a definite minimum at about 26 C. P. S. with a maximum excursion somewhere between 26 and 53 C. P. S. which, however, does not reach undesirable limits. Below 26 C. P. S. there is again an increase of cone excursion. Considerable power can be handled down to 22 C. P. S. and useful energy possibly down to 16 C. P. S. However at 20 C. P. S. cone excursion becomes excessive. It would therefore be desirable to place a lower limit on the frequency range of energy supplied to the speaker at approximately 20 C. P. S.

The cabinet's resonant frequency may be adjusted by varying the area of the throat of the horn. By decreasing the area of the horn throat the reactance is increased and the resultant frequency of the cabinet is lowered. In general it seems desirable to place the cabinet resonant frequency about an octave below speaker resonant frequency and to place the horn flare cut-off slightly above the cabinet resonant frequency. By adjusting these parameters it is possible to obtain very good and uniform efficiency to about an octave and a half below the speaker cone resonance.

The electrical impedance of this type of speaker is by no means constant, especially in the vicinity of cone and cabinet resonance. There is a large maximum at cone resonance and a minimum at cabinet resonance. These points however cannot be easily picked out by ear even when the speaker is excited from a generator of zero impedance. There is an apparent increase in bass response near the resonant speaker frequency when a high impedance generator is used, which would be expected. However, when used with high fidelity amplifiers current-

ly being sold on the commercial market, response through these points is fairly uniform.

The bass reproduction provided by the cabinet has been found to be extremely clear and pleasing. It would appear that this is due to the fact that cabinet resonance is placed at a very low frequency, almost at a point where musical notes lose their identity. In all probability, the phase shift and undesirable qualities of cabinet resonance are not too noticeable because they are placed in this range, whereas with a regular bass reflex cabinet, cabinet resonance will enter the musical range and, unless extremely well designed, properly loaded and damped, produce very undesirable muddying and coloring of the tonal characteristics of the music or program material.

Radiation in the critical range between 120 and 350 C. P. S. is primarily all from the front of the speaker cone and no coloration of tonal characteristics of music can be observed as being supplied by the speaker or enclosure. Aside from the extreme range of bass response of the enclosure the most noticeable characteristic is the clarity and cleanness of sound and lack of coloration.

Because the cabinet is very much unlike the ordinary bass reflex enclosure, all the boominess associated with that type of enclosure is missing and upon first hearing the enclosure in operation a person who is accustomed to listening to the average bass reflex enclosure is apt to believe that there is something missing. Because of the lack of boominess in the bass range listener fatigue is reduced tremendously.

As would be expected, there is some interference between cone and horn radiation. The region wherein this interference occurs is between 70 and 115 C. P. S., however the addition of the vertical horn **35** in the corner assists materially in dispersion of the bass frequencies in this region and because of this, phase interference is less noticeable.

The vertical corner horn **35** also reduces the effects of directivity of the bass generally observable in corner type folded horns. This means that it is possible to sit much closer to the speaker without observing undesirable effects.

Care should be taken to see that the room in which the enclosure is installed is fairly well acoustically damped and of sufficient size to allow good propagation, especially at the lower frequencies. In the average room a tremendous increase in bass frequencies will be noticed in corners and if tests are run, almost complete cancellation at certain frequencies will be noticeable at certain points in the room.

Due to the low frequency sound produced, it is preferable that the corner in which the speaker is mounted is quite solid and that the walls at the sides extend outward as far as possible, without obstruction. Because of the extremely efficient bass radiation it may be necessary in a number of cases when using the enclosure in conjunction with a phonograph to mechanically isolate the phonograph from the structure of the house or room in which it is used in order to avoid mechanically coupling the speaker and phonograph pick-up and reduce distortion caused by such coupling and possibly prevent acoustic feed-back. Mechanical rumble in turntables, and recorded rumble in records is very noticeable due to the low frequency response and it might be desirable to include a variable filter in the system to limit the low frequency response when excessive rumble is present.

The cabinet of my invention utilizes a 15 inch coaxial speaker. The area of the horn throat is approximately 88 square inches. A speaker smaller than 15 inches in diameter would not be properly loaded and cone excursion might be too great.

My speaker system due to its design efficiently reproduces low frequency sounds which would only be possible to produce otherwise by the use of a very large horn of impractically large size. This is accomplished by the combination of the folded horn of hyperbolic function design, an asymmetric air chamber and a vertical horn, all as described above.

Certain variations in design will be apparent to those skilled in the art and my invention is to be limited only by the following claims:

What I claim is:

1. In a corner type back-loaded horn loudspeaker enclosure, the combination of separate parts, comprising a cabinet and driving unit, a dispersion unit and a top cover; said cabinet including a top plate, a bottom plate, side walls, a front wall and having an open rear face, a cone type loudspeaker mounted in said front wall and radiating sound directly into the room, and a pair of non-parallel baffles extending vertically from said bottom plate to said top plate, one in front of the other, and with said side walls forming an asymmetric folded hyperbolic exponentially expanding horn having its throat offset laterally from the axis of said loudspeaker and exhausting through the said open rear face of the cabinet, the front one of said baffles with the said front and side walls of the cabinet forming an air chamber behind said loudspeaker and coupled to the throat of said horn; said dispersion unit with the adjoining walls of the room in which the enclosure is placed forming a triangular space in rear of said cabinet and having two side portions diverging from a median line of juncture bisecting from top to bottom the said open rear face of said cabinet, thus dividing the mouth of said horn into two passages each of which follows the design curve of said horn, the said sides of said dispersion unit with their respective sides of said cabinet and room walls forming the sides of said passages, the floor of the room and the said cover providing the other two necessary resonating surfaces; said top cover extending horizontally from the corner of the room over said dispersion unit and approximately the rear half of said cabinet with two side edges aligned with and abutting said room walls, and means independent of said cabinet for supporting said cover.

2. A loudspeaker enclosure according to claim 1 but characterized by said air chamber behind the said loudspeaker being asymmetrically constructed having no two side walls parallel, to avoid internal resonances and reflections.

3. A loudspeaker enclosure according to claim 1 in which the connecting bends of adjacent folds of said horn, the said air chamber behind the said loudspeaker, the outer walls of the bends of said horn and spaced intervals along the said throat section and said intermediate section of said horn are acoustically treated so that the horn passage and said air chamber function as a low pass filter.

4. A loudspeaker enclosure according to claim 3 in which the said bends of adjacent folds of said horn are rounded to avoid introducing extreme acoustical discontinuities which would cause reflections and the generation of distortion.

5. A loudspeaker enclosure according to claim 1 in which each side of the said dispersion unit comprises a plurality of adjoining vertical panels, adjacent panels being angularly disposed with respect to each other, the panels on one side of said unit differing in width and angular arrangement from corresponding panels on the other side.

6. A loudspeaker enclosure in accordance with claim 2 in which the air mass in said asymmetric chamber acts as a compliance and resonates with the reactance of the said horn throat at a frequency somewhat below the designed flare cut off frequency of said horn.

7. A loudspeaker enclosure according to claim 1 but characterized by the said combination comprising a cabinet and driving unit, a combined dispersion unit and vertical horn and a top cover, by said dispersion unit being the front wall of a three sided structure forming said vertical horn, the other two sides of said vertical horn structure being at a right angle to each other and

fitted into the said triangular space formed by said dispersion unit and the said room walls, by the throat of said vertical horn consisting of at least one opening through said dispersion unit at the bottom thereof, by the mouth of said vertical horn being an opening through said top cover, and by said vertical horn structure including a bottom plate.

8. A loudspeaker enclosure according to claim 7 including a rearwardly flaring baffle extending from the said bottom plate of said vertical horn to said top cover, and characterized by there being two of said throat openings in the bottom of said dispersion unit, one through each of the said diverging sides of said dispersion unit, by the sound passage through said vertical horn also following the design curve of said folded horn, and by the perimeter of the mouth of said vertical horn being coincident with the top inner edges of the said three sides of such horn.

9. A unit of a corner type back-loaded loudspeaker enclosure system comprising a cabinet including a top, a bottom, side walls, a front wall and an open rear face parallel to said front wall, said side walls being spaced farther apart at the center with respect to the depth of the cabinet from front to back and converging toward said open rear face and said front wall, a cone type loudspeaker mounted in said front wall, two baffles, one being a front baffle and the other a rear baffle, extending vertically between said top and said bottom, the said front baffle with said front and side walls forming an asymmetric air chamber surrounding the cone of said loudspeaker, and an asymmetrically folded hyperbolic exponentially expanding horn built within said cabinet, the said horn comprising a throat section formed by one of said side walls and said front baffle, an exhaust section formed by the other of said side walls and said rear baffle,

and an oblique intermediate section terminating in opposing return bends connecting it with said throat and said exhaust sections, said intermediate section and said bends being formed by the said two baffles, said throat section being coupled to said asymmetric air chamber at a point offset from the axis of said loudspeaker and the mouth of said exhaust section being the said open rear face of the cabinet, the said top and bottom being the other two necessary surfaces of said horn.

10. A unit of a corner type back loaded horn loudspeaker enclosure system in accordance with claim 9 in which the mouth of said exhaust section being said open rear face of the cabinet is divided by a dispersion unit which together with the sides of said cabinet and walls of the room corner in which said system is installed form the sides, the floor of the room and a top cover form the bottom and top respectively of two passages extending forwardly into the room said passages expanding along substantially the same design curve as said horn.

11. A loudspeaker cabinet according to claim 9 characterized by the sides of said air chamber, said bends and certain portions of said throat and oblique sections of said horn being acoustically treated as and in the manner set forth.

12. A loudspeaker enclosure in accordance with claim 9 in which the air mass in said asymmetric air chamber acts as a compliance and resonates with the reactance of the said horn throat at a frequency somewhat below the designed flare cut-off frequency of said horn.

13. A corner type back-loaded horn loudspeaker enclosure in accordance with claim 1 in which the cabinet resonant frequency is about an octave below the speaker resonant frequency and the horn flare cut-off is slightly above the cabinet resonant frequency.

No references cited.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,825,419 March 4, 1958

Frank H. Stephens, Jr.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, line 33, strike out "resonating".

Signed and sealed this 19th day of August 1958.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

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