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[54] SOUND SOURCE CABINETS

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[51] **Int. Cl.**..........................**G10k 13/00,** H04r 1/28
[58] **Field of Search**...........................181/31 B, 31 R

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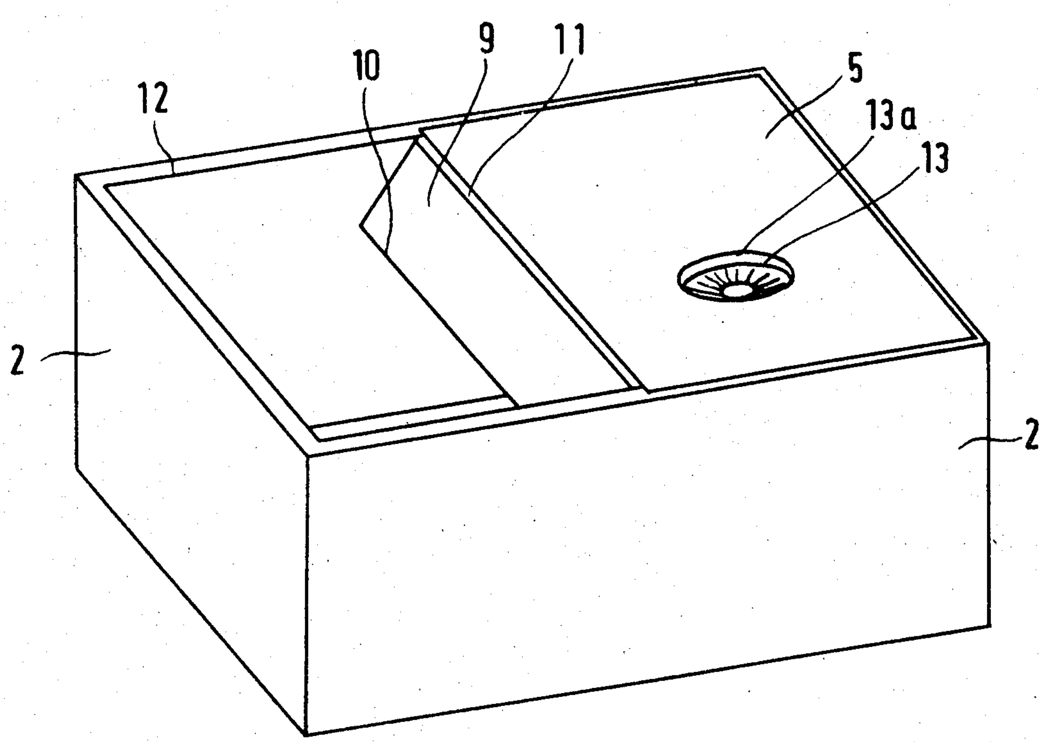
[57] **ABSTRACT**

A sound source cabinet which may contain a loudspeaker as sound source is constructed so that the cabinet defines an ever-growing horn which extends from a pressure chamber located at the rear of the sound source to an aperture defined by walls of the cabinet. At least a portion of the horn is in the form of a spiral which extends about the pressure chamber and has non-absorbing rigid walls which may be for example, plywood boards or synthetic plastics components.

18 Claims, 5 Drawing Figures



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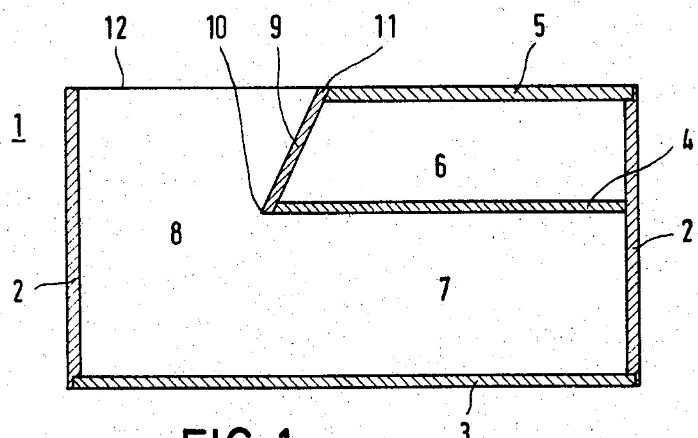

FIG. 1

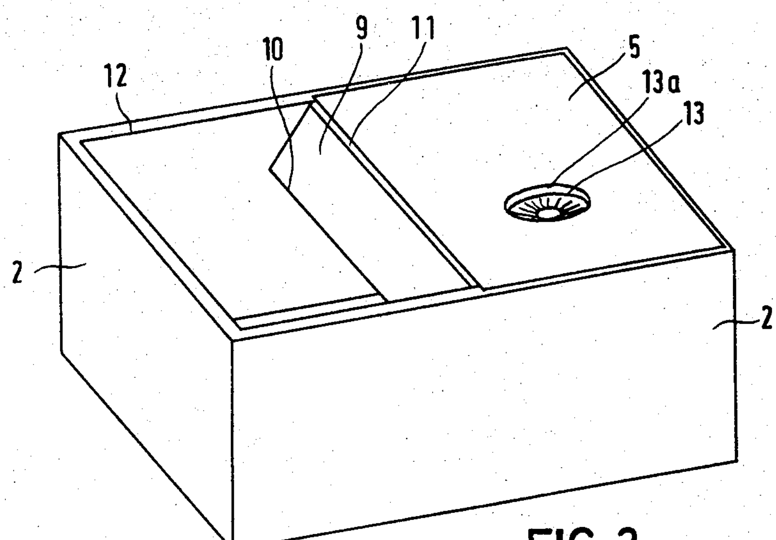

FIG. 2

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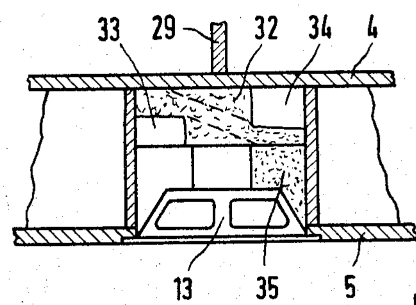
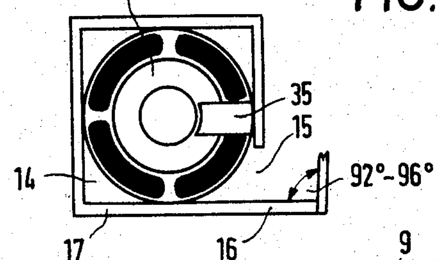


FIG. 3



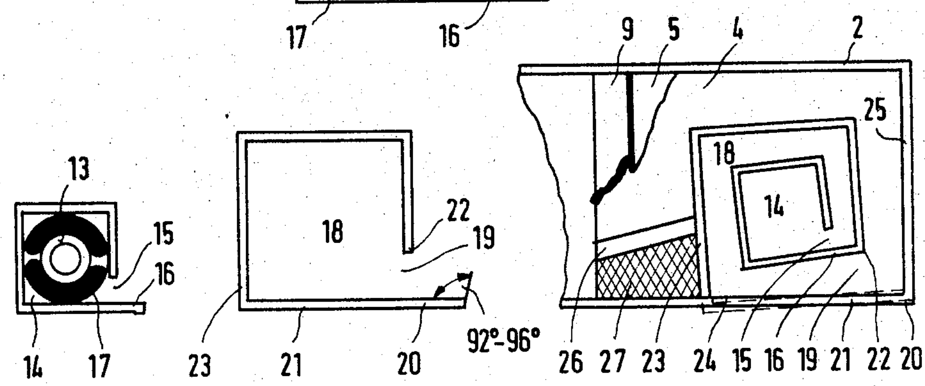


FIG. 4

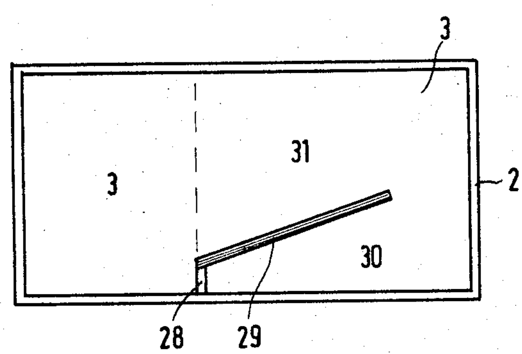


FIG. 5

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SOUND SOURCE CABINETS

BACKGROUND OF THE INVENTION

The invention relates to a sound source cabinet and is particularly applicable to a cabinet comprising a loudspeaker in combination with a horn which grows geometrically. Such a cabinet can have the external form of a rectangular furniture cabinet or box.

Exponential horn loudspeakers have long been known. Such loudspeakers, with lengths up to 7 meters and with end openings of 4 × 4 meters, can be disposed, for example, behind projection screens in cinemas. These instruments, which have good technical transmission properties, are not to be considered as mass-production and home instruments because of their dimensions.

There have been attempts to assembly such a horn loudspeaker as a cabinet-like item of furniture the size of a bureau, at least as a bass cabinet. The horn principle has not been credited with very good treble reproduction and consequently it has not been widely used for such a purpose. Therefore, treble loudspeakers in the form of cubes, octahedrons or segments or a circle have been assembled around such a base cabinet. Apart from the expense and space required by additional treble loudspeakers, there arises one of the most difficult problems in electro-acoustics, which is the subdivision of the frequency ranges over several loudspeaker groups.

Descriptions of individual experiments speak of cabinets assembled with soft damping plates and their suspension floating on foam rubber in a plywood cabinet and, more especially, of the use of bass range loudspeaker systems. The acoustic result of such experiments can naturally also only be a bass loudspeaker, it is true with strong and purer basses, but still with the detrimental necessity of amplifying the middle and high frequency ranges at considerable additional expense. In an attempt to produce a mass-produced cabinet which will give good results over a large proportion of the audible range of frequencies particular attention has been paid to producing bass, medium tone and treble systems, with suitable frequency switches, in one cabinet. Since the human ear is not particularly inconvenienced by non-linear harmonic distortion factors in the bass frequency region, mass-produced articles have been provided by so-called compact boxes, which provide a low hearing level, despite comparison with better things, and deny true artistic hearing. Amplifier construction has also necessarily been adapted to this trend and instruments are produced with considerable accentuation of the bass, in order to balance out the defects of the loudspeakers.

The invention has for one object to provide a loudspeaker cabinet with a built-in, geometrically widening horn, known in general usage as an exponential horn, which permits relatively small cabinet dimensions substantially without acoustic disadvantages and substantially without limiting the transmission fidelity. A further object is that the cabinet should reproduce all sound images without falsification, "trimming" or "-swallowing", in studio quality, from the lower audible limit up to the upper audible limit with an efficiency up to 50 percent.

DISCUSSION OF THE DISCLOSURE

According to the present invention there is provided a sound source cabinet comprising:

a sound source disposed in said cabinet and having a sound producing vibratory member; and

a plurality of external and internal walls defining said cabinet and an aperture, some of said walls defining a pressure chamber at one side of said vibratory member of said sound source and at least some of said walls providing between said pressure chamber and said aperture a horn, at least a portion of said horn having a spiral form which extends about said pressure chamber and increases in cross-sectional area along its length and said horn having substantially non-absorbing, substantially rigid, internal surfaces.

By efficient utilization of the volume of the cabinet so that there is substantially no dead space and by correctly employing the laws of acoustics a geometrically growing horn of relatively great length and end opening may be installed in the cabinet.

Preferably the spiral portion of the horn should at no point be bent over by more than 90°.

As opposed to wind musical instruments, which are to have an individual tone fidelity due to their extremely thin metal tube walls, the horn of the cabinet should be completely free from vibration and neutral. The horn should not distort any natural pitch position, any natural tone and should not produce any changes or "distortion" in the transmission. Any natural resonance or consonance should be impossible. The walls of the horn should be completely dead to vibration and absolutely resorption-free. Since completely rigid marble would be the perfect thing as the material for horn wall plates, technically achieved "marble hardness" is hereinafter employed for the absence of vibration in the horn walls.

The aforementioned necessary property of the cabinet i.e. the marble hardness, may be provided by the horn being constructed of smooth plywood boards. The walls may be 10 to 20 mm thick. Those walls which define the spiral portion of the horn are preferably rigidly connected together at right angles or vertically one upon the other so as to define a quadrilateral cross-section for the horn's spiral portion. In this way the walls may represent surfaces clamped on all sides. It is to be noted that it is particularly important to provide the marble hardness in the first region of the horn.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

FIG. 1 is a longitudinal section of a loudspeaker cabinet or housing;

FIG. 2 is a perspective view of the cabinet of FIG. 1 with the ornamental covering removed from the entire front side;

FIG. 3 shows the pressure chamber and its fittings of the cabinet of FIG. 2;

FIG. 4 shows the systemmatic development of the horn spiral in the upper stage of the cabinet of FIG. 1;

FIG. 5 is a section through the lower stage of the cabinet of FIG. 1.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a box-like loudspeaker cabinet denoted as a whole by 1 and consisting of four side walls 2 and a complete rear wall 3. The internal volume is subdivided parallel to the rear wall 3 by an intermediate member 4. This member 4 begins at one narrow side of the loudspeaker cabinet and is approximately as long as three-fourths of the rear wall 3 or somewhat less. The free end of the member 4 is connected to a front wall 5 by a wall 9 which is inclined to the said narrow side, the front wall 5 being approximately as long as one-half to two-thirds of the rear wall 3. Thus three space regions are formed: the upper stage 6, the lower stage 7 and the lateral open hood 8. The inclined wall 9 forms one side of the horn opening 12. Walls which are later to be described are installed in this hood.

The said three space regions or stages 6, 7 and 8 are in ratios, by volume, such as for example 1 : 2 : 2. Consequently, the optimal cabinet dimensions ratio is about 1 : 2 : 1 (height, width, depth). The axial lengths of the stages 6, 7 and 8 are preferably in a ratio in the range from about 4 : 2 : 1 to about 10 : 8 : 5.

More specifically, the first stage 6 is an outer chamber which, as shown in FIG. 1, is formed by the partial front wall 5, the partial partition 4, the oblique wall 9, the two long sides and the short right side of the enclosure. The second stage 7 is a rear space which, is located below outer chamber 6 and is in acoustic communication therewith through the sound passage or aperture 27 provided in the partition or intermediate wall 4 of first stage 6. The third stage of the horn of the present invention is a front (also partially rear) space 8 which adjoins and is in acoustic communication with the rear space or stage 7 and discharges sound into and through the end opening 12 on the front wall of the enclosure.

The volume of the upper stage 6 is determined as initial value by the size of the loudspeaker system 13 (FIG. 2) which again establishes the dimensions of the pressure chamber 14 (FIG. 3).

FIG. 2 shows a perspective view of the cabinet 1 with its ornamental facing removed, so that it is now also possible to see the opening 13*a* in the front wall 5 for the loudspeaker system 13.

The pressure chamber with its fittings, the formation of a horn spiral and a section through the lower stage 7 are shown in FIGS. 3 to 5.

The square pressure chamber 14 (FIGS. 3 and 4), provides a space for the fitting of the louspeaker system 13 having a diaphragm area F_M. The chamber 14 has at one corner an exit 15 extending over the full height of the stage 6 and having an opening area F_T. The ratio of the areas $F_M : F_T$ is called the velocity transformation and is preferably in the numerical range 2 to 4. The "opened" door 16 has the same width as the exit 15 and provides an extension of a wall 17.

The right-hand FIG. 4 shows that the pressure chamber 14 is fitted into a second likewise square or approximately square chamber 18 which is about 2½ times larger than the pressure chamber 14. This chamber 18 likewise has an exit 19 with an "opened" door 20 which provides an extension of a wall 21. The door 16 of the pressure chamber 14 is fixed to a door edge 22 of the chamber 18 at an angle which is in the range 92° to 96°.

The chamber 18, with its contents, is in its turn arranged in a rectangular chamber which is about five times larger than the pressure chamber 14 and which is identical with the upper stage 6. The chamber 18 is likewise attached at an angle in the range 92° to 96°, with abutment of its door 20 of a door wall 21, to a narrow side 25 of the rectangular chamber 6. In this case, however, the wall 21 with the door 20 of the chamber 18 blends with the chamber wall 24 of the rectangular chamber 6. The two walls are drawn one above the other; in the subsequent constructional elevation, these blended walls serve as sighting lines and constructional alignment points.

In this manner, a steadily enlarging spiral-like passage or tortuous path, i.e. an encircling passage is formed which winds around the central pressure chamber 14 and which, covered by the front wall 5 and the intermediate member or plate 4, is completed to form a geometrically growing horn spiral. Along its path, this horn spiral encounters in a remote corner of the upper stage 6 a passage window 27 as a portion of the horn which determines the cross-section.

Before entering this window or opening 27, the horn must still overcome a "breasting", which is a transversely disposed rail 26, which calibrates the horn cross-section associated with this point and at the same time lengthens the horn path.

Referring now to FIG. 5, in the lower stage 7, which is about 1.3 to 1.7 times higher as compared with the upper stage 6, the horn path (from a single inclined wall 29 and its connecting piece 28) is defined closely past the adjacent external wall into two juxtaposed opposite horn sections 30 and 31 which have substantially no dead space and which are defined by a single inclined wall 29 and its connecting piece 28. The inclined wall 29 is positioned symmetrically below the middle of the pressure chamber 14 of the upper stage 6 and braces the latter, together with the intermediate plate 4 and front wall 5, with the rear wall 3 to form an absolutely rigid, vibration-free marble-hard structure and wall assembly.

The horn section 31 of the lower stage 7 opens into the horn end section 8 with the end opening 12, this section lying alongside the two stage complexes which have been described. This part is limited by the external walls of the box and the edge 10 of the intermediate plate 4 and finally by the edge 11 of the front wall 5, that is to say, by the inclined closure wall 9 of the upper stage 6.

We will consider now in detail various aspects of the embodiment which have already been described briefly.

Firstly, the loudspeaker system 13.

As a loudspeaker system, only an extremely highly efficient system can be satisfactory. For home studio instruments, and for the best loudspeaker boxes in general, the maximum diaphragm diameter should be at 20 cm. The lowest limit, with miniaturization, likewise without serious acoustic defects occurring and without audible distortion factors should be 7 to 7.5 cm.

Starting from a standard box, if the loudspeaker diaphragm diameters are in a ratio such as 1 : 3, then also the box volumes should be in the same ratio 1 : 3.

Considering now the pressure chamber **14** in detail, the pressure chamber **14** (FIG. **3**) is a chamber of smallest possible air volume. The chassis basket of the loudspeaker **13** passes straight in, possibly with partial recesses in the chamber walls. Fitted behind the magnet of the loudspeaker **13** is a hard foam block **32** with the internal dimensional size of the chamber **14**, this block **32** filling the space behind the magnet. The block **32** has on the side facing the diaphragm a helical recess **33** so that a worm rising up to the pressure chamber exit **15** is formed in the pressure chamber **14** between the hard foam block and the loudspeaker basket. The back of the block **32** can likewise have congruently thereof a recess **34** which is filled with cottonwool. A wall section **35** of hard foam is stuck before the underside of the block and extends as far as the loudspeaker basket. The two measures do not prevent the system being assembled from the front and, according to the invention, have the following purposes:

a. The air volume of the pressure chamber **14** becomes as small as possible,

b. The other side of the diaphragm becomes substantially reflection-free,

c. The horn spiral already starts in outline in the pressure chamber,

d. The directional orientation of the sound in the direction of growth of the spiral portion to the door **15** is caused by the wall section **35**. This wall section does not have to be applied in pressure-tight manner to the loudspeaker system. By this means, a desired interference of the sounds along the path of the spiral portion is established with the sounds issuing directly from the wall section **35**, for cancelling out the shock waves,

e. The filling of the recess **34** at the back with cottonwool also prevents shockwaves being set up.

The pressure chamber **14** does however have a sound-dead worm which widens out and builds up the sound progression, this worm, in the space behind the diaphragm — as the actual form-supplying "tone pump" — directing the stroke volume immediately as it is formed and already with correct flow and direction around the magnet to the horn mouth of the said chamber door **15**. Therefore, it is not first of all a piston compression which is established, but the immediate initiation of a directed acceleration of the air mass to the horn.

We will consider now the first part of the horn spiral in the upper stage **6**.

The inclination relative to one another of the nested chambers **14**, **18** and **6** (having their volumes in ratios such as 1 : 2.5 : 5) at an angle of 2° to 6° greater than 90° produces a steady increase in cross-section of the horn spiral. At the start of a progressively growing horn, the deviation of the increase in cross-section of a horn defined by a logarithmic curve, for example from a horn defined by a quadratic curve, can in practice scarcely be drawn, can certainly not be constructed and in any case cannot be audibly distinguished.

By this means, therefore, the series manufacture of a high quality studio loudspeaker without deterioration in quality is greatly simplified and hence made less costly, and the cabinet may therefore be made available to a very large range of purchasers.

According to experience, it is important in the first part of the horn of the upper stage **6**, to guarantee an absolute technical marble hardness. This is achieved by the following measures:

a. By the horn being wound unidirectionally around the square pressure chamber **14** the horn walls bear tightly one against the other, are glued at right angles one upon another and thus in each case are to be considered as plywood boards with a thickness of 10 to 20 mm rigidly clamped on all sides. Boards clamped in this way can be considered as having no elasticity.

b. In addition, these walls are acted upon from both sides by the same flow of sound, of which the pressure impulses from the same acoustic waves are perpendicularly of the wall plates or boards; they are effective in equal strength and in opposition from both sides and thus are cancelled out. The walls are therefore unable to vibrate and also do not need to vibrate.

c. The marble hardness of the first portion of the horn is completed by that partition **29** of the lower stage **7** which is situated beneath the horn spiral of the upper stage **6** (see below).

Considering now the opening **27** in detail, the passage opening **27** connects the horn spiral of the upper stage **6** to the lower stage **7** and is suitably cut out of the intermediate plate **4**; dimensions and shape are determined by the following points:

a. By the horn cross-section which here is necessary in accordance with calculations,

b. By the position of the external wall **23** of the horn spiral chamber **18** of the upper stage **6**,

c. By the position of the intermediate plate edge **10**, determined in cross-section for the end portion **8** of the horn,

d. By the inclined position of the wall **9** of the upper stage **6**, and

e. By the position of the partition **29** of the lower stage **7**, which fixes the horn sections **30** and **31**.

Considering now the lower stage **7** of the cabinet, in the lower stage **7** (FIGS. **1**, **2** and **5**) the sound coming from the opening **27** is guided by the partition provided by the walls **28** and **29** into two horn sections **30** and **31**. The partition is positioned such that the horn sections **30** and **31** are formed substantially without any dead space and with their always correct widening. In addition, the wall **29** is disposed symmetrically below the center of the pressure chamber **14**, beneath the "-marble-hard" structure of the upper stage **6**. The wall **29** enhances the marble hardness of the cabinet by bracing the front wall **5**, by way of the horn spirals **14** and **18** and the partition **4**, against the rear wall **3** thus giving a cabinet construction of uniform hardness. When it is also considered that the long lateral walls **2** of the cabinet are likewise stiffened by the stiffened intermediate member **4**, it can be seen that the cabinet, which is stiffened on all sides and in all directions with a dense internal structure and which consists of plywood walls with a thickness of 20 mm, provides a structure which is entirely unlike wood and which, conforming to the technical requirement, incorporates marble hardness. This can be shown by the fact that when such a cabinet is tapped no wooden box sound is heard, but the clear sound of a tapped, solid, tree-trunk.

In addition, the partition formed of walls **28** and **29** is acted upon by sound waves on both sides in the lower stage **7** and is hence automatically steady to vibration.

Considering now the end section **8** of the horn, the end section **8** has the maximum growth over a relatively short horn length. Its entry from **31** is bent by the edge **10** of the intermediate plate **4** as far as possible towards the left-hand free narrow wall **2** of the cabinet (FIG. 2) in order to lengthen the horn as much as possible. The end opening **12** itself is limited by the free edge **11** of the front wall **5**.

As ultra-pure bass outputs are transmitted by the acknowledged good horn characteristic, so the construction of a loudspeaker cabinet in accordance with the considerations described hereinbefore also bring the most freely radiating, highest high points of the tone spectrum, which are indeed integrated like the basses in the listening room volume. The former guiding characteristics of the high tone producers in the narrow region perpendicular to the plane of the loudspeaker diaphragm are now dispensed with.

Hence, also the restricting provisions of a seating arrangement perpendicularly to the high tone producers is also avoided.

The known high efficiency (up to 50 percent) of the horn does however also show an extraordinary property which has not so far been recognized. Because of the ready response of the loudspeaker, because of the automatic nature of the radiation resistance, already with loudest and softest tones, a loudspeaker cabinet constructed in accordance with the considerations described hereinbefore according to the invention also reproduces the softest reverberation or echo which decays into silence. Hence, with a degree of fineness not previously known, it reproduces the room atmosphere of the original presentation. It is here that there is found the basis for the advancing and fundamental inventive idea of the cabinet, with which no one has fundamentally concerned himself, because the progressive horn loudspeaker has with prejudice been limited to the sphere of ungainly bass loudspeakers.

There will be no departure from the underlying feature of the invention if other shapes of housings or cabinets are used, other subdivisions of the content of the cabinet into partial volumes differing according to number, size or position or other means of conveying or producing sound.

At least some of the internal walls of the cabinet could be smooth, moulded, synthetic plastics components. For example, the chambers and spirals of the upper stage **6** and the horn chambers of the lower stage **7** could be produced by filling a negative mould made of wood, for example, with a synthetic plastic gypsum. The pressure chamber **14** could be approximately circular in cross-section and the horn spiral could have a gentle rounding in an almost perfect form, the pressure chamber **14**, and horn spiral, being fitted closely, substantially free from dead spaces, into the cabinet stages.

Whatever method is used to construct the cabinet, it may be advantageous for the internal and external walls thereof to be so arranged that if the horn is considered as a plurality of horn sections arranged one after the other from said pressure chamber to said aperture every one of said sections increases in cross-sectional area along its length, the increase of each of said sections, apart from the first, being at a greater rate with respect to horn section length than the increase of the cross-sectional area of the preceding section.

I claim:

1. A loudspeaker enclosure including a loudspeaker, front, rear and side walls, and a plurality of inner walls formed of vibrationless material located in predetermined positions with respect to each other to define a horn, said front wall having a first opening therein defining one end of said horn and a second opening therein located in superimposed relation to said speaker and defining a sound opening therefore, said horn having a first and second horn stages, said first horn stage consisting of three chambers which are obliquely nested with respect to each other, said three chambers being defined by certain of said inner walls which extend perpendicularly to said front wall and provide sequential acoustic communication between said chambers along a tortuous spiral-like sound path whose cross-sectional area increases as said path moves outwardly from its center, said loudspeaker being located in the centermost of said chambers wherein said centermost chamber defines a pressure chamber; said second horn stage comprising a rear space in said enclosure defined between said rear and side walls and an intermediate inner wall behind said first horn section, said intermediate wall having an opening therein providing acoustic communication between said third chamber and said rear space; and said enclosure having a third space defined therein in alignment with said first opening and in acoustic communication with said rear space.

2. The loudspeaker enclosure as defined in claim **1** wherein said front wall is shorter than said rear wall, thereby to define said first opening, and wherein said side walls include a pair of relatively long parallel side walls and a pair of shorter parallel side walls extending perpendicularly to said long side walls; said intermediate inner wall extending parallel to said rear wall and having a length which is longer than said front wall and shorter than said rear wall, and an oblique wall member connecting said front wall and said intermediate inner wall adjacent said first opening.

3. The loudspeaker enclosure as defined in claim **2** wherein said front wall has a length which is equal to 50 to 60 percent of the length of said rear wall and the length of said intermediate inner wall is 60 to 75 percent of the length of said rear wall.

4. The loudspeaker enclosure as defined in claim **2** wherein the enclosure walls are dimensioned to provide the outermost of said three first horn stage chambers, said second horn stage and said third space with a volume ratio to each other of 1:2:2; and horn section lengths in the ratios of between 4:2:1 to 10:8:5 respectively.

5. The loudspeaker enclosures as defined in claim **2** wherein said walls of said enclosure are formed of plywood boards having a thickness of between **10** to **20** mm.

6. The loudspeaker as defined in claim **2** wherein the outermost of said three chambers in said first horn section is defined between said front wall, said intermediate inner wall, said oblique wall, said pair of long side walls and one of said shorter side walls.

7. The loudspeaker enclosure as defined in claim 6 wherein said opening in said intermediate inner wall is generally wedge shaped having its narrow edge portion adjacent said oblique wall and its wide edge portion adjacent one of the perpendicularly extending inner walls defining the intermediate chamber of said three nested first horn stage chambers, said opening having a first side defined by one of said long side walls and a second side extending angularly away from said first side from said oblique wall to said one of the perpendicularly extending inner walls.

8. The loudspeaker enclosure as defined in claim 7 including a first baffle wall secured to said intermediate wall within said second horn stage adjacent said angularly extending side of the opening in said intermediate wall, said first baffle wall extending perpendicularly between said rear wall and said intermediate wall and being in soundproof engagement therewith, said baffle compelling sound emerging from the opening in said intermediate wall to travel through said second horn stage prior to passage through said third space and said first opening in the enclosure.

9. The loudspeaker as defined in claim 8 wherein said first baffle wall is longer than said second side of the opening in said intermediate wall and extends beyond the wide edge portion thereof.

10. The loudspeaker as defined in claim 9 wherein the opening in said intermediate wall has an area which is between one half and one quarter of the area of the diaphragm surface of said loudspeaker.

11. The loudspeaker as defined in claim 9 including a second baffle wall secured to said intermediate wall within said first horn stage adjacent said angularly extending side of the opening in said intermediate wall, said second baffle wall extending generally perpendicularly to said intermediate wall and having a height which is less than the distance between said intermediate wall and said front wall.

12. The loudspeaker enclosure as defined in Claim 2 wherein the innermost and intermediate chambers of said three nested chambers in the first horn section are respectively defined by a plurality of said perpendicularly extending inner wall members, said perpendicularly extending inner wall members being sequentially connected to each other in a spiral-like path to define said nested chambers, said nested chambers each including one wall which is shorter than the other walls and a wall which is longer than the other walls, said short walls extending generally perpendicularly to said longer wall to define a generally rectangular acoustical opening in their associated chamber, with the long wall of said first chamber being connected to the short wall of said second chamber at an angle of between 92° and 96°, thereby to provide said tortuous spiral-like sound path therebetween, said acoustical opening of said second chamber providing communication with said third chamber, said third chamber being defined by said side walls of said enclosure and one of said walls of said second chamber being connected to one of said side walls at an angle of 92° to 96°, thereby to continue said tortuous sound path into said third chamber.

13. The loudspeaker enclosure as defined in claim 12 wherein said three chambers of the first horn stage have a volumetric ratio of 1:2.5:5.

14. The loudspeaker enclosure as defined in claim 12 wherein the innermost of said chambers in said first horn stage includes a rigid foam block mounted therein between said intermediate wall and the magnet system of said speaker, said block having two helical recesses formed therein which are mirror images of each other, one of said recesses, on the side of said block adjacent said loudspeaker, having its minimum cross-sectional area located adjacent the acoustical opening between said first and second chambers and expanding along the short wall of said first chamber to its maximum cross-sectional area adjacent the long wall of said first chamber, thereby to conduct sound radiated from the rear of the diaphragm along an expanding path to said second chamber; the other of said recesses in said block being formed on the side thereof adjacent said intermediate wall and having its maximum cross-sectional area above the minimum cross-sectional area of said one recess and its minimum cross-sectional area above the maximum cross-sectional area of said one recess, said minimum cross-sectional area of said other recess decreasing to zero to form a closure for that recess.

15. The loudspeaker enclosure as defined in claim 14 including a damping material filling said other recess.

16. The loudspeaker enclosure as defined in claim 15 wherein said damping material is wadding.

17. The loudspeaker enclosure as defined in claim 1 wherein said second opening is dimensioned to permit said loudspeaker to be inserted in said enclosure through said front wall.

18. A loudspeaker enclosure for a loudspeaker of the type having front and back sound radiating surfaces, said enclosure comprising a housing having back, side and front walls, said front wall having first and second openings therein for radiating sounds respectively from said back and front surfaces of said speaker, and a plurality of inner walls mounted in said speaker and cooperating with said enclosure walls to define an acoustic horn having first, second, and third stages and defining a tortuous sound path between the back surface of said speaker and said first opening, said first opening in said front wall comprising a relatively large rectangular opening at one end of said front wall in acoustic communication with said third stage; said first stage comprising an intermediate wall in said enclosure extending parallel to said front and rear walls and extending between said side walls and said bottom wall, said intermediate wall being shorter than said rear wall and having a free edge located adjacent said first opening, and a wall connecting said free edge to said front wall at said first opening thereby to define an enclosure chamber for said first horn stage, a plurality of walls mounted in said first horn stage and sequentially connected to each other in a spiral-like pattern and extending perpendicularly between said intermediate wall and said front wall to define a tortuous spiral-like sound path whose cross-sectional area increases as said path moves outwardly from its center, said second opening being located in said front wall above the center of said path and said loudspeaker being mounted in the centermost portion of said path to define a pressure chamber therein; said second horn stage comprising the space between said intermediate wall and said rear wall, said intermediate wall having an aperture therein providing

acoustic communication between the end of said spiral-like sound path and said second horn stage, and baffle means secured in said enclosure between said rear and intermediate walls and adjacent said aperture for compelling sound emerging from said aperture in said intermediate wall to travel through said second horn stage, said third horn stage comprising a space defined between said rear wall, side walls and said first opening, and located in acoustic communication with said second horn stage.

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