Feb. 18, 1930. H. C. HARRISON 1,747,830

ACOUSTIC HORN

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FIG. 1.

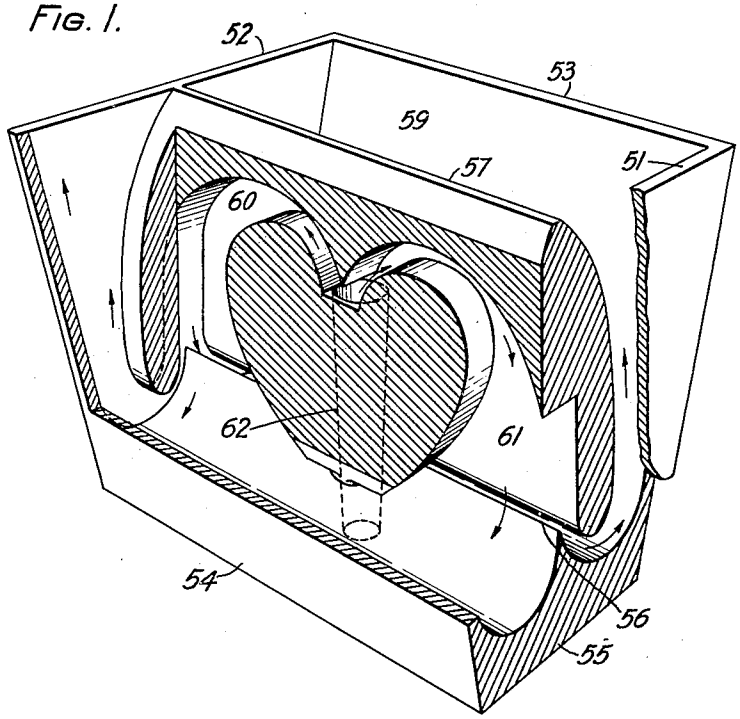


FIG. 2.

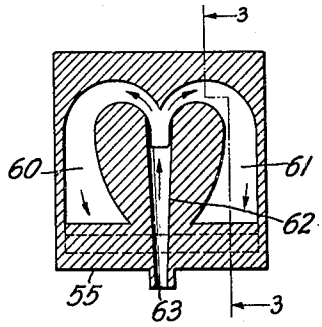
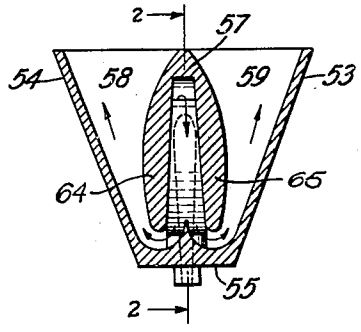


FIG. 3.



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FIG. 4.

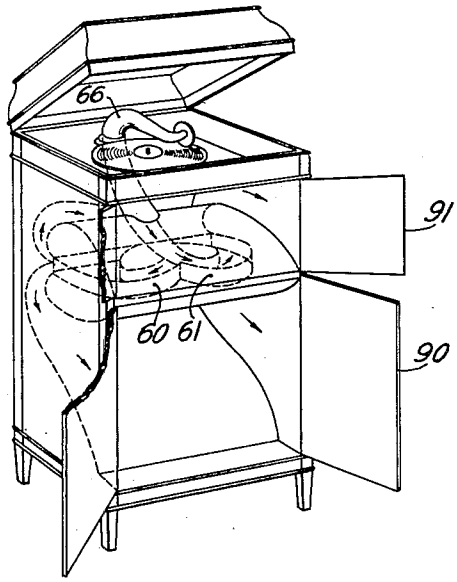
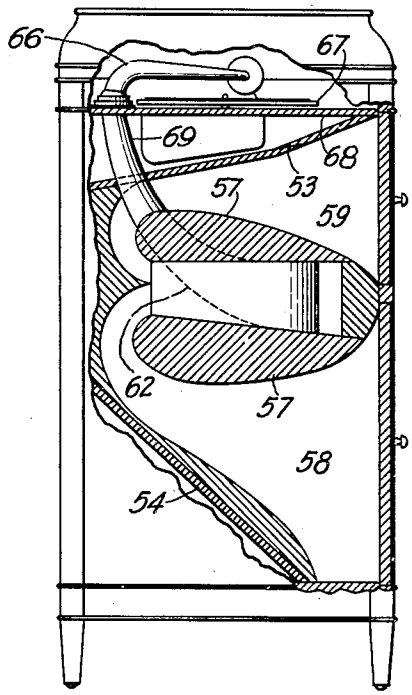


FIG. 5.



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ACOUSTIC HORN

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FIG. 6.

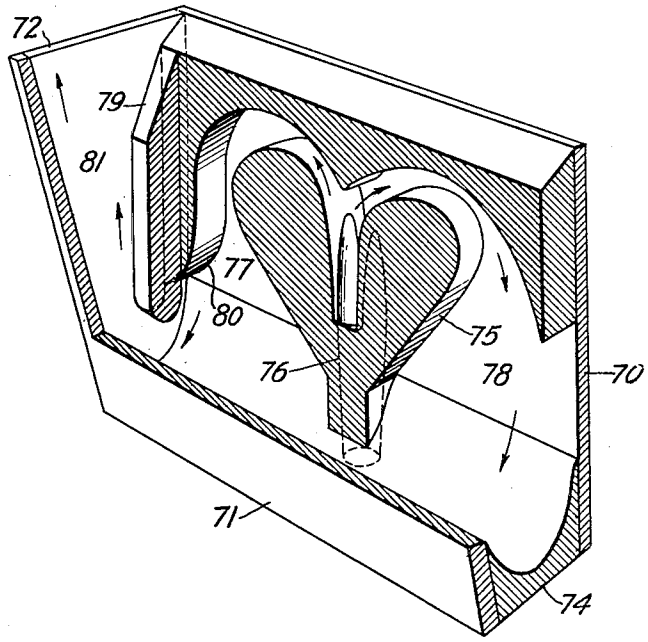


FIG. 7.

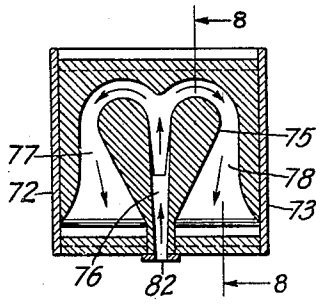
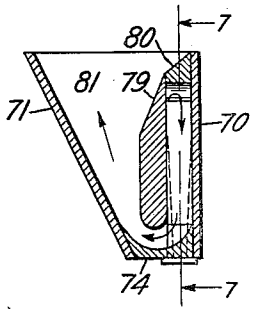


FIG. 8.



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1,747,830

UNITED STATES PATENT OFFICE

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ACOUSTIC HORN

Application filed October 6, 1928, Serial No. 310,750, and in Germany October 21, 1923.

This invention relates to acoustic horns, and has for its object to secure compactness in the construction of horns whereby they may more readily be mounted in cabinets of relatively small dimensions. The subject matter of this application relating to the broad features of the invention is disclosed in my co-pending application Serial No. 628,168, filed March 28, 1923, and the subject matter relating to the application of the invention to a phonograph horn is disclosed in my copending application Serial No. 33,619, filed May 29, 1925.

The compact form may be obtained by providing a reentrant horn in which the sound waves traverse the space within the enclosing walls a plurality of times and expand progressively at a suitable rate in their passage therethrough. One form of compact structure may be produced by dividing a chamber, constituting the bell or flare portion, into two tapering passages by means of a partition within which are located two tapered passages constituting the body or intermediate portion of the horn, these passages opening at their larger ends into the smaller ends of the passages constituting the bell, and at their smaller ends into a tapered portion forming the neck or throat of the horn. The throat portion of the horn may extend from a point within the partition member through the rear enclosing wall of the bell to a loud speaking telephone receiver or to the tone arm of a mechanical phonograph. When the folded horn of the invention is used in connection with a mechanical phonograph, it may be mounted in a cabinet underneath the platform on which the record table is mounted, in which case the throat portion may be brought out through the upper wall of the bell and led up to a tone arm coupling in the platform.

The method of construction enables horns of great length and large mouth opening to be assembled in cabinets of the size generally used for phonographs. The sound passage preferably has its cross-sectional area tapered according to an exponential law, in the manner explained in my copending application Serial No. 225,500, filed October 11, 1927. This not only improves the acoustical qualities of the horn, but provides a sound passage which is relatively small in cross-section for a large portion of its length, and may therefore more readily be made to follow a curved path to provide the reentrant structure. The reentrant construction is also simplified by the subdivision of the bell and of the body portions into two parallel paths of smaller cross-sectional area.

Fig. 1 is a perspective view, partly in section, of a horn embodying the invention; Fig. 2 is a sectional view through the center of the horn along the line 2—2 of Fig. 3; and Fig. 3 is a sectional view along the line 3—3 of Fig. 2. Figs. 4 and 5 illustrate an adaptation of the invention to a phonograph. Figs. 6, 7 and 8 illustrate another embodiment of the invention, Fig. 7 being a sectional view of the horn along the line 7—7 of Fig. 8 which is a sectional view along the line 8—8 of Fig. 7.

Figs. 1, 2 and 3 illustrate the invention in a preferred form and show the paths of the sound waves. The horn is contained in a bell portion rectangular in cross-section having two parallel walls 51 and 52 and two walls 53 and 54 divergent from a back 55. The back 55 is formed with a transverse inwardly projecting ridge 56 on the inside extending across the bell midway between the divergent walls and parallel thereto. Extending between the parallel walls, in front of the ridge 56 and spaced therefrom except at the center, is a partition 57 dividing the bell into two equal chambers 58 and 59. Within the partition 57 are two curved channels 60 and 61 branching symmetrically to each side from a central throat 62 and turning rearwardly towards the ridge 56 where they connect with the chambers 58 and 59. The throat 62 extends through a heart shaped piece formed in the center of the partition by passages 60 and 61 to the back 55 of the bell and terminates in a neck 63 to which a loud speaking receiver may be connected. Each of the channels 60 and 61 communicates with both chambers 58 and 59 of the bell. The paths of the sound waves are indicated by the arrows.

In the horn shown, the sound waves enter-

ing the throat or the primary portion 62 are divided and reflexed through an angle of approximately 180° by the intermediate portion or chambers 60 and 61 in which the wave front expansion is practically all in one dimension there being little or no expansion in the other dimension. At the exits of chambers 60 and 61 the sound waves are turned forward again through an angle of approximately 180° into the bell portion or chambers 58 and 59 in which the wave front expansion is practically all in one dimension and perpendicular to the wave front expansion in chambers 60 and 61. The walls 64 and 65 are common to the intermediate portion containing chambers 60 and 61 and the bell portion containing chambers 59 and 58. In both of the chambers 60 and 61 they define two opposite walls and in each of the chambers 58 and 59 they define but one wall respectively. By providing two intermediate chambers the sound wave fronts may be expanded to substantially the full width of the bell portion between its parallel walls without becoming deeply curved thereby minimizing the phase displacement at the entrance of the bell portion.

The wave front expansion in the outlet chamber 58 takes place between the diverging walls 54 and 64 and in chamber 59 between the diverging walls 65 and 53, the walls 52 and 51 being substantially parallel.

Although it may be desirable that the horn be made symmetrical, this is not essential. The progressive horn areas can be made with the desired degree of increasing values even though one of the tortuous paths is made larger in cross-sectional area than the other. In this case, the intermediate partition is not centrally located.

Figs. 4 and 5 illustrate the application of the invention in a stylus operated phonograph. The horn is housed within the phonograph cabinet beneath a platform 68 in the upper portion thereof on which is mounted the tone arm 66 and the record turntable 67. The horn is essentially similar to that of Figs. 1 to 3, but is modified in such a way that the throat 62 instead of projecting through the back of the bell passes through the upper wall of the partition member 57 and is carried upward through one wall 53 of the bell by a curved neck portion 69 to the platform 68 where it connects with the tone arm 66. Swinging doors 90 and 91 are provided at the mouth of the horn, which may be closed when the horn is not in use. In the illustration an unsymmetrical horn is shown, the lower portion 58 of the bell being greater in cross-sectional area than the upper portion 59. This will frequently be found convenient for use in existing types of phonographs in which the upper doors are smaller than the lower ones. Furthermore, it is found that a slightly greater effective horn length may be obtainable by the use of the dissymmetrical form. The horn fills the entire compartment of the phonograph beneath the supporting platform 68 for the record table 67 and tone arm, and has an effective length more than twice the physical length of the cabinet from front to back. Such a horn, by virtue of the method of folding can be adapted to fit in many forms of cabinet, thereby enabling the advantages of great length and large mouth opening to be obtained in a relatively small cubic space.

In Figs. 6, 7 and 8 is illustrated another form of horn embodying the invention. The horn is contained in a bell portion rectangular in cross-section consisting of the four walls 70, 71, 72 and 73 and a back 74. The walls 72 and 73 are parallel and perpendicular to the back 74. The wall 71 is divergent from the back with respect to the wall 70 which is perpendicular to the back. Attached to the wall 70 is the portion 75 containing the throat 76 which extends through the back to a neck 82 at which point a loud speaking unit may be attached. The throat divides into two rearwardly directed channels 77 and 78 formed by partitions 79 and 80. The channels 77 and 78 communicate at the rear with the chamber 81 of the bell.

The invention is not limited to the specific constructions herein illustrated. Variations in details of construction to suit the circumstances would not lie beyond the scope of the invention. For example, some of the walls are shown parallel and perpendicular to the back. This is not an essential feature, as a horn having the proper progressive increase in cross-sectional areas can be made with some other arrangement of walls.

What is claimed is:

1. A horn having a bell portion, a partition dividing said bell portion into two chambers, a pair of channels in said partition intermediate said chambers and communicating therewith and a throat portion communicating with said channels.

2. A horn having a bell portion, a partition dividing said bell portion into two equal chambers, a pair of similar channels symmetrically disposed within said partition, each channel communicating with both of said chambers, and a throat portion common to said channels.

3. A horn comprising a bell portion, a partition dividing said bell portion into two similar chambers, channels in said partition opening rearwardly, a ridge in said bell portion bisecting the openings in said channels, and a throat through said ridge communicating with said channels.

4. A horn comprising a bell portion having two chambers, a body portion having two channels jointly communicating with said chambers, the plane of expansion of the sound wave fronts in the channels of said body por-

tion being at right angles to the plane of expansion of the sound wave fronts in the chambers of said bell portion.

5. A horn having two tortuous sound passages communicating with each other intermediate their ends, and a common throat for said sections.

6. A horn comprising a bell portion, a throat portion, and an intermediate portion connecting said throat and bell portions and supported by and extending between opposite walls of said bell portions, said intermediate portion consisting of two oppositely curved substantially flat chambers having one wall in common with said bell portion.

7. A horn having a bell portion of rectangular cross section, a throat portion, and an intermediate portion of rectangular cross section connecting said bell and throat portions and having substantially parallel opposite walls, said intermediate portion being curved through an angle of approximately 180° between said walls.

8. A horn comprising a bell portion having two parallel walls and two diverging walls, a throat portion, and an intermediate portion comprising two similar reversely curved sound passages of rectangular cross-section connecting said throat and bell portions, said intermediate portion having diverging walls for expanding the sound wave fronts in one dimension to substantially the width of the bell portion between the parallel walls with substantially no expansion in the other dimension.

9. A horn comprising a main portion having a curved rear wall, a throat and a thin expansion chamber having substantially parallel walls for connecting said throat and said main portion, said chamber being curved through an angle of substantially 180° between its parallel walls and adapted to direct the sound waves against said curved wall.

10. A horn comprising a bell portion having flat oppositely diverging walls, a throat portion, and an intermediate portion between said diverging walls connecting said bell and throat portions said intermediate portion having substantially parallel walls and curved through an angle of approximately 180° between said walls.

11. A horn comprising a bell shaped portion of rectangular cross-section having diverging walls, a throat portion and a substantially flat intermediate portion of rectangular cross-section connecting said bell and throat portions, said intermediate portion being curved through an angle of approximately 180° and having one wall in common with said bell portion.

12. A horn comprising an outlet chamber having parallel and diverging walls, a throat portion and a substantially flat rectangular intermediate portion curved through an angle of approximately 180° in a plane perpendicular to the parallel walls of said chamber and disposed substantially flat against one of the diverging walls of said chamber.

13. A horn comprising an outlet chamber of rectangular cross-section, and a substantially flat portion of rectangular cross-section communicating therewith and curved through an angle of approximately 180° in a plane substantially parallel to and in contact with one side of said chamber.

14. A compact horn comprising an outlet chamber having four walls (51, 52, 53, 65) and an adjacent sound passage (61) opening into said chamber, said sound passage having one wall member (65) in common with said chamber, the major expansion of said chamber and said sound passage being in directions at right angles to each other.

15. A horn comprising a throat portion, an intermediate portion having two chambers, one end of each chamber communicating with said throat portion, and a bell portion having two chambers, each chamber of said bell portion communicating with the other ends of both of the chambers in said intermediate portion.

16. A phonograph comprising a tone arm and a horn having a rectangular bell portion, an intermediate portion dividing said bell portion into two sections, and a third portion connecting said intermediate portion to said tone arm, said third portion extending through one of the sections of said bell portion.

17. A phonograph in accordance with the preceding claim, wherein each section of the bell portion has a different mouth opening.

18. A phonograph comprising a tone arm and a horn having a rectangular bell portion and a third portion connecting said horn to said tone arm, said third portion extending through two walls of said bell portion.

19. The combination with a phonograph or like cabinet, of a sound amplifier divided into two flare portions extending from the front substantially to the back of the cabinet, an intermediate portion comprising tapered passages, a sound conduit having an opening through a top wall of the cabinet near the rear thereof, and a neck portion connected centrally of the intermediate portion and leading upwardly therefrom to the opening of the sound conduit and ahead of the rear walls of the flare portions.

20. The combination with a phonograph or like cabinet, of a sound amplifier having two flare portions opening through the front of the cabinet and extending approximately to the rear thereof, a sound conduit having an opening through the top wall of the cabinet near the rear thereof, an intermediate tapered portion connected with the flare portions, and a neck portion connected centrally of said intermediate portion and extending

upwardly to said conduit opening ahead of the rear of the flaring passages.

21. In a phonograph in combination, a cabinet, a record and tone arm platform for said cabinet located near the upper end thereof, a tone arm on said platform and opening through the platform near the rear of the cabinet and a horn located in the cabinet below the platform, the horn comprising a neck portion and a folded portion combined to give an over-all length equal to substantially the depth of the cabinet from front to back and an effective length for sound amplification equal to two or more times the depth of the cabinet from front to back, the neck portion connecting at its upper end with the tone arm opening through the platform and lying within vertical planes defining the depth of the horn from front to back of the cabinet and the folded portion of the horn being located between horizontal planes defining the extent of the mouth opening of the horn.

22. In a phonograph in combination, a cabinet, a horizontally arranged record and tone arm supporting platform in the cabinet having an opening therethrough for one end of the tone arm, and a horn or sound amplifier in said cabinet below the platform and comprising two substantially semi-circular passages at right angles to one another, the neck of said horn being connected with the tone arm opening in the platform and the mouth of said horn opening through a side wall of the cabinet.

23. A phonograph according to claim 22 wherein the plane of one of the bends of the horn is substantially vertical and the plane of the other bend is substantially horizontal.

24. In a phonograph in combination, a cabinet, a tone arm, a supporting platform therefor, a horn having a greater effective length than over-all length and including a flare and a neck portion extending through one wall of the horn into engagement with the tone arm.

25. A horn comprising a bell portion, an inlet portion communicating with the rear of said bell portion and dividing it into two separate chambers, said inlet portion extending forwardly and then rearwardly between said chambers.

26. A horn comprising a bell portion having two outlet chambers tapering from front to rear, an intermediate portion lying between the fronts and backs of said outlet chambers, said intermediate portion having inlet and outlet openings, the outlet opening being near the rear of said outlet chambers, and a throat portion between said chambers and associated with the inlet opening of said intermediate portion.

In witness whereof, I hereunto subscribe my name this 5th day of October, 1928.

HENRY C. HARRISON.