United States Patent

Hopkins

[15] **3,684,051**

[45] **Aug. 15, 1972**

[54] **ACOUSTIC DUCT SPEAKER SYSTEM**

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[52] **U.S. Cl.** ..... **181/31 B**

[51] **Int. Cl.** **G10k 13/00,** H04r 1/28

[58] **Field of Search** ..... 181/31 B, 31 R

[56] **References Cited**

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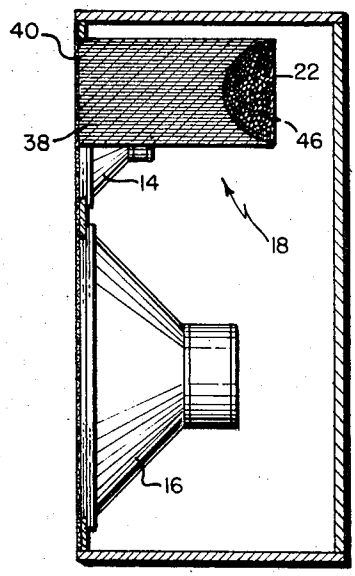
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Primary Examiner—Stephen J. Tomsky
Attorney—Pearson & Pearson

[57] **ABSTRACT**

A bass reflex cabinet speaker assembly, e.g. as for use with stereo and high-fidelity speaker systems, having a port coupling the cabinet to the air, and having mounted within said port an acoustic duct formed of a large number of contiguous conduits each of a different length, differing progressively from the center to the periphery of the duct and preferably so formed that the end of the duct is in a concave or convex parabolic shape. In the most advantageous forms of the invention, a flexible corrugated paperboard sheet—or other sheet having a series of conduits therein—may be cut generally obliquely either rectilinearly or curvilinearly and rolled up to form the acoustical duct.

14 Claims, 7 Drawing Figures



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FIG. 1

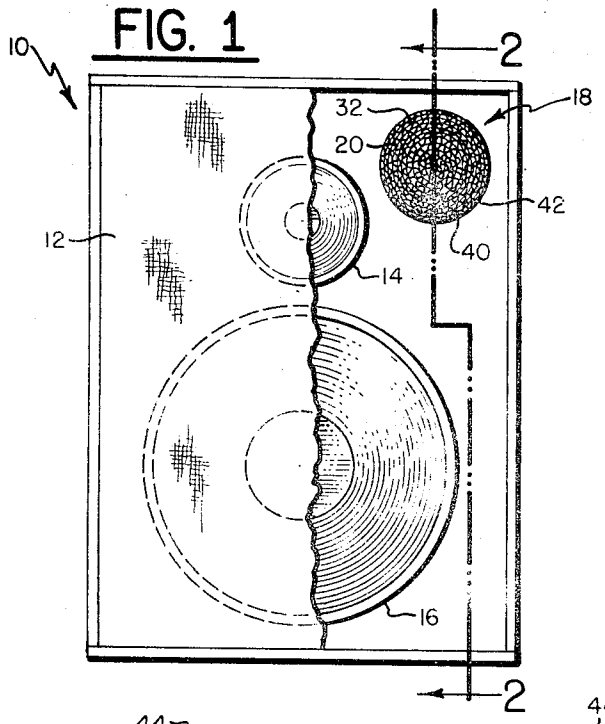
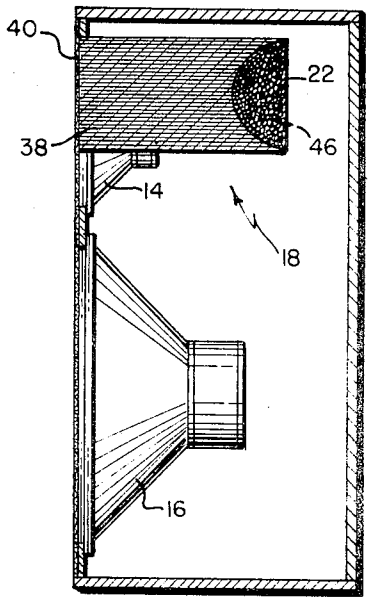


FIG. 2



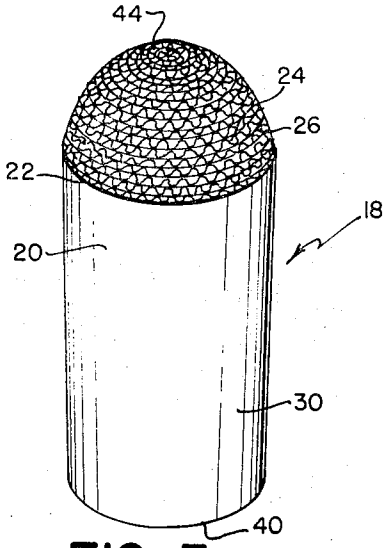


FIG. 3

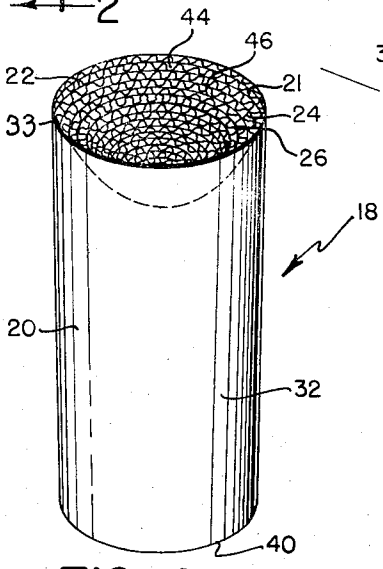


FIG. 4

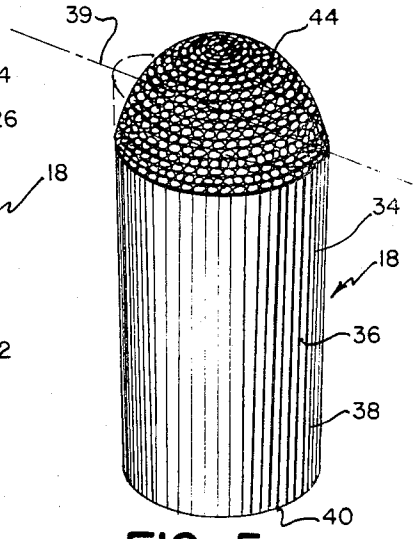


FIG. 5

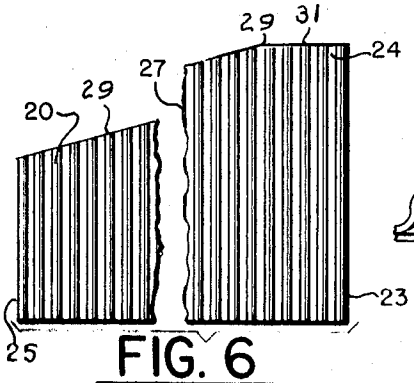


FIG. 6

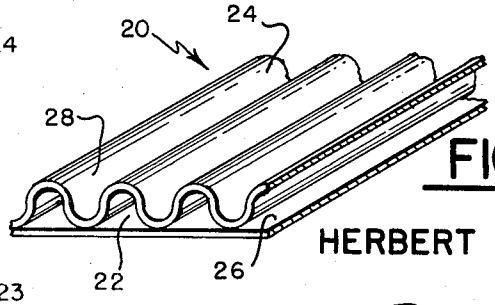


FIG. 7

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ACOUSTIC DUCT SPEAKER SYSTEM

BACKGROUND OF THE INVENTION

A considerable effort has been made to develop improved speaker systems for use in stereo and high-fidelity sound systems. The primary object of this effort has been to obtain the best possible sound output at the lowest possible cost to the manufacturer and consumer.

It is already known to achieve acoustical phase inversion by way of a port coupling the interior of a low frequency speaker cabinet to the environmental air. In such speaker systems, called bass-reflex cabinets, the effective "stiffness" of air within the cabinet is resonated with the effective mass of air associated therewith through the port. However, it has remained a problem to provide a suitable means for moderating of the air through the port, say by use of an acoustical duct, which means will allow the system to give acceptable tone reproduction and which means is (1) relatively non-critical with respect to the required precision of the turning, and (2) relatively non-critical with respect to the particular dimensions of the speaker box in which it is located.

There have been a number of attempts to improve loudspeaker systems by providing interior baffling within a loudspeaker cabinet. Most such systems, if really effective, are undesirably expensive. Witness, for example, the loudspeaker systems disclosed in U.S. Pat. No. 2,880,817 to H. S. Burns et al. wherein the interior of the loudspeaker box is divided into a plurality of passages by means of a rather complex construction technique.

SUMMARY OF THE INVENTION

Therefore, it is an object of the invention to provide an improved bass reflex loudspeaker system comprising an improved air coupling means.

It is a further object of the invention to provide improved acoustical tubes for use in such a bass reflex loudspeaker.

Another object of the invention is to provide a novel process for making an acoustical duct having a very large number of tubes or passages each of a different length and, consequently, each of a different resonant frequency.

Other objects of the invention will be obvious to those skilled in the art on their reading of the instant application.

The above objects have been substantially achieved by mounting an improved acoustical duct in a port of a bass reflex box. This acoustical duct is advantageously formed of a single, flexible, sheet material having a row of parallel flutes, tubes or conduits, which may be rolled up to form a duct. A corrugated paperboard sheet would be one example of such a material. When the sheet of pre-selected length is cut at a pre-selected angle, or curvilinear line, the desired distribution of any conduit lengths is readily achieved.

The flexible sheet can be formed of a number of other materials, such as, for example, honeycombed material or ribbed or a sinusoidally-shaped material which winds upon itself in such a way as to provide a plurality of conduits through a roll formed thereof. It has been found that use of multiple tubes of different lengths not only results in a broader resonant band but also minimizes the effect of self-resonance developed within the duct structure.

It should be noted that a loudspeaker can comprise one or more of the acoustic ducts of the invention. Indeed, a single duct can be constructed to cover different resonant ranges—by, for example, forming a core section of a duct having conduits of varying length and of one diameter and forming an outer section of the same duct from a sheet material having conduits also of varying length but of significantly larger or smaller diameters. Instead of varying diameters of the individual conduits, it is possible to form compound ducts having tubes of two or more distinctly different length ranges.

In the most advantageous embodiments of the invention, the conduits formed in the acoustic tube are from about three quarters of an inch to about twelve inches in length and from about two inches to about ten inches in diameter. The total number of conduits are conveniently from one hundred to four hundred conduits per acoustic tube.

ILLUSTRATIVE EMBODIMENT OF THE INVENTION

In this application and accompanying drawings there is shown and described a preferred embodiment of the invention and there are suggested various alternatives and modifications thereof, but it is to be understood that these are not intended to be exhaustive and that other changes and modifications can be made within the scope of the invention. These suggestions herein are selected and included for purposes of illustration in order that others skilled in the art will more fully understand the invention and the principles thereof and will be able to modify it and embody it in a variety of forms, each as may be best suited in the condition of a particular case.

IN THE DRAWINGS

FIG. **1** is a front elevation of a typical bass reflex loudspeaker cabinet with my acoustic duct mounted therein;

FIG. **2** is a side elevation thereof in section on line **2—2**;

FIGS. **3** and **4** each show an acoustic duct prepared from rolled corrugated paperboard;

FIG. **5** shows an acoustic duct formed of a plurality of tubes of differing lengths;

FIG. **6** shows a corrugated paperboard piece before it is rolled up to form the acoustic duct shown in FIG. **3**; and

FIG. **7** shows a section of flexible corrugated sheet material which can be used to form an acoustic duct according to the invention.

DESCRIPTION OF PREFERRED EMBODIMENT

In FIGS. **1** and **2** is illustrated a bass-reflex loudspeaker cabinet **10** having mounted in front panel **12** thereof a high-frequency speaker **14**, a low-frequency speaker **16** and an acoustic duct means **18**. In typical dimensions, the acoustic duct **18** is preferably cylindrical, about 3½ inches in diameter and about 8 inches long, high frequency speaker **14** is about 4 inches in diameter and low frequency speaker **16** is about 15 inches in diameter. The cabinet, or box **10**, itself is 21 inches wide by 29 inches high and 16½ inches deep.

FIG. 7 shows a piece 20 of "single-sided" corrugated paperboard, a material suitable for winding into a duct 18 of the type shown in FIGS. 3 and 4. Corrugated paperboard 20 comprises conduits, or tubes, 22, which are formed between fluted or sinusoidal member 24 and flat member, or liner, 26. Further conduits 21 are formed on helically coiling of paperboard 20 when flutes 28 become pressed against the adjacent convolution of liner 26.

FIG. 6 illustrates a typical blank 27 cut generally obliquely from a flat rectangular sheet and at such an angle, or simple, or compound curve as to be useful in pre-forming the corrugated paperboard 20 before it is wound into an acoustical duct 30 as seen in FIG. 3 (or an acoustical duct 32 as illustrated in FIG. 4), depending on the direction in which the corrugated paperboard 20 is wound into a coil, and depending on whether the high side 23 or the low side 25 is at the center of the coil.

As shown in FIG. 6, the generally oblique cut line 29 preferably terminates proximate the outer end of the duct in a terminal portion 31, parallel to the base, thereby forming a cuff 33 (FIG. 4) of uniform length which encircles the concave or convex end, lends strength and permits the parabolic end to be adhered in port 42 if desired.

In each of the acoustic ducts of FIGS. 3, 4 or 5, the close packed mass 38 of elongated tubes 22 includes a flat, planar end 40, filling the sound balancing port 42 in cabinet 10. The tubes are in parallelism, and of uniform cross section from end to end, and the mass terminates in preferably the exterior parabolic end face 44 as in FIG. 3 or the interior parabolic end face 46 of FIG. 4. The mass 38 of individual tubes 36 of FIG. 5 is not satisfactory when the mass is cut at an angle 39 because some of the tubes 36 will be of equal length and equal resonance. Therefore it is preferred that each tube 36 be cut while in the flat configuration of FIG. 6 and then rolled and adhered into a mass of tubes such as 38.

It will be understood that the acoustic ducts of the invention may have both ends concave, convex and parabolic so long as the individual tubes, or conduits, are all of different lengths.

In FIG. 5, the acoustical duct 34 is preferably formed of thin-walled polymer tubes 36 fastened together by adhesives.

It is to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which might be said to fall therebetween.

What is claimed is:

1. In a loudspeaker cabinet of the bass-reflex type, the improvement wherein an acoustic duct mounted in a wall thereof, and thereby forming a conduit between the interior of the loudspeaker cabinet and the surrounding air, is formed of a large number of conduits of differing lengths, all said conduits being formed into an integral acoustic duct of generally cylindrical shape said conduits being of progressively different lengths between the center and the circumference thereof.

2. A loudspeaker as defined in claim 1 wherein said acoustic duct is formed of at least one continuous flexible sheet so cut that the ends of the conduits terminating within the loudspeaker cabinet all terminate at different distances from the wall of said loudspeaker cabinet.

3. A loudspeaker as defined in claim 2 wherein the flexible sheet is so cut that the ends of the conduits terminating within the loudspeaker cabinet form a parabola-shaped end on said duct.

4. A loudspeaker as defined in claim 1 wherein said large number of conduits of differing lengths are formed by cutting a flexible corrugated sheet at an angle and rolling said sheet up to form a cylinder.

5. A loudspeaker as defined in claim 4 wherein said flexible corrugated sheet is corrugated paperboard.

6. In combination with a loudspeaker cabinet of the bass reflex type,

a generally cylindrical acoustic duct mounted in a wall of said cabinet, said duct comprising a large number of elongated, small diameter conduits all of differing lengths, said conduits being from about three quarters of an inch to about 12 inches in length, said duct being from about 2 inches to about 10 inches in diameter and said conduits being of progressively different lengths from the center to the periphery of said cylindrical acoustic duct.

7. An acoustic duct as defined in claim 6 wherein said ducts are formed of a sheet of corrugated material cut generally obliquely and rolled up upon itself.

8. An acoustic duct as defined in claim 6 wherein said ducts are formed of corrugated paperboard.

9. An acoustic duct as defined in claim 6 wherein said cylindrical duct is formed by adhering together at least about two hundred tubes to form said conduit, each tube being of a different length but of identical diameter.

10. In a low frequency loudspeaker cabinet having a port for balancing sound to improve reception:

a close packed mass of elongated tubes, jointly defining an acoustic duct, said duct having one end mounted in said port for passing sound from inside said cabinet through said tubes to outside said cabinet;

each said tube being of a different length, and having a different resonant frequency from the remaining said tubes in said mass;

said tubes varying progressively in length from the center to the periphery of said mass,

whereby a broader resonant band results which minimizes self resonance within said duct.

11. An acoustic duct as specified in claim 10, wherein:

each said tube is of uniform cross section from one end to the other thereof.

12. An acoustic duct as specified in claim 10, wherein:

said tubes are formed by the corrugated flutes and liner of a corrugated paperboard-like sheet material rolled into a helical configuration.

13. An acoustic duct as specified in claim 10, wherein:

the said one end of said duct is flat and planar, said tubes are in parallelism, and the said other end of said duct defines a parabolic configuration.

14. An acoustic duct as specified in claim 10 wherein:

said duct is of predetermined length and diameter to tune the cabinet to a desired frequency.

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