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ACOUSTIC DEVICE WITH AN INVERTED HORN HAVING
A THROAT VENTED TO THE ATMOSPHERE
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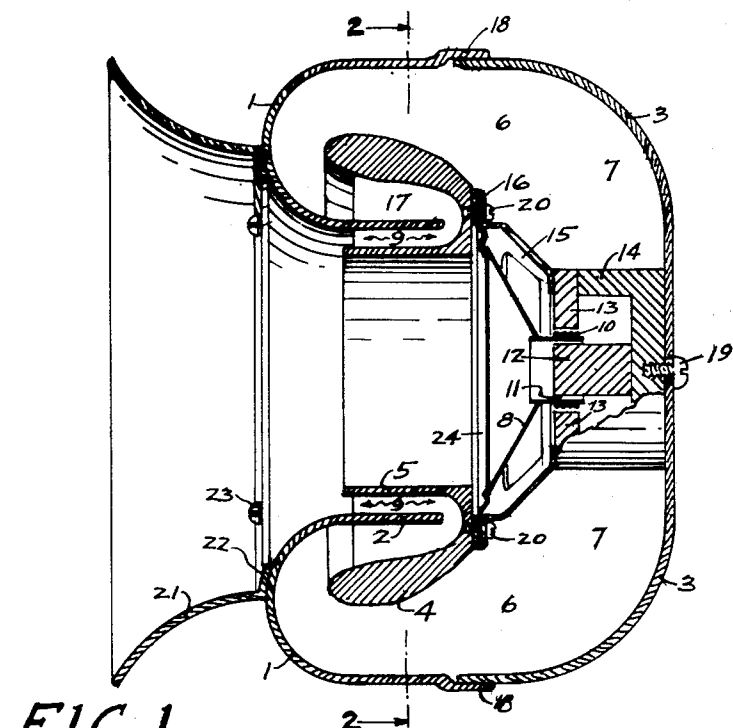


FIG. 1

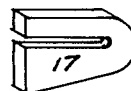


FIG. 3

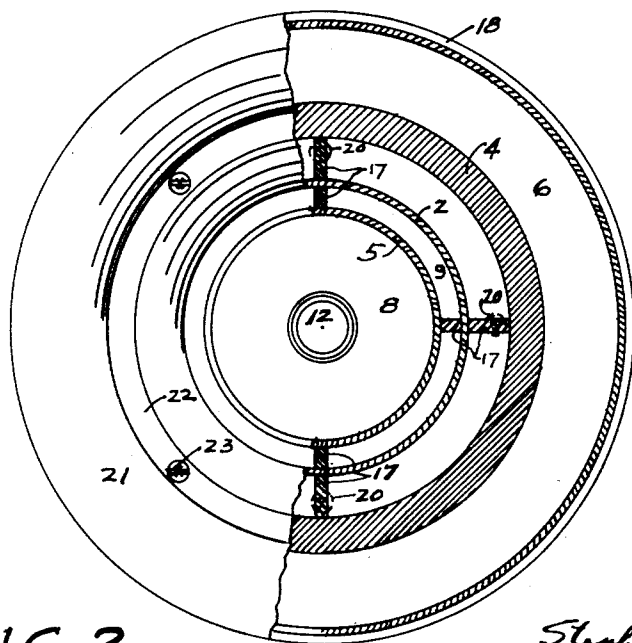


FIG. 2

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ACOUSTIC DEVICE WITH AN INVERTED
HORN HAVING A THROAT VENTED TO
THE ATMOSPHERE

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6 Claims. (Cl. 181—27)

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This invention relates to improvements in acoustic devices in which a vibratory acoustic diaphragm operated by suitable means is employed in conjunction with an air coupling device, and applies particularly to improvements in two phase sound radiators in which the sound emitted from the back of an acoustic diaphragm is utilized to reinforce the sound emitted from the front of the diaphragm.

It is well known that in order to attain satisfactory quality and efficiency in radiating sound from an acoustic diaphragm to atmosphere, that the diaphragm must act on an air load which couples the sound vibrations emanated from the acoustic diaphragm to the atmosphere or listening area.

According to the presently practiced state of the art this loading or coupling is provided by various means, such as a large flat baffle, an open back box baffle, a closed back box baffle or infinite baffle, or by means of various types of vented enclosures such as the well known bass reflex type in which an aperture in the front wall of a box baffle vents a chamber on the back of an acoustic diaphragm; or by means of a rear labyrinth passage to atmosphere or by a rear radiation horn formed in various types of folded wall construction; or by means of the commonly used exponentially tapered horn on the front of an acoustic diaphragm.

An object of this invention however is to improve the quality of sound radiated by an acoustic diaphragm by improving the air coupling of such diaphragms to atmosphere or the listening area. Another object of this invention is to provide a compact efficient loud speaker combination that will reproduce sound more realistically over a wide range of sound levels and with less distortion and spurious effect than heretofore.

Accordingly this invention features an air passage in the form of a long reentrantly folded annular air column communicating from the periphery of a relatively large flat expansion chamber on the back surface of an acoustic diaphragm to an annular outlet that is coaxial with and adjacent the source of sound vibration emitted through a baffle tube projecting from the front surface of the diaphragm, and in which the sound vibrations emitted from the back of the diaphragm are compressed through a progressively reduced passage area or compression horn and conducted to and reinforce coaxially the sound vibrations emitted from the front of the diaphragm.

Another feature resides in the progressive or

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the exponential reduction of the cross section area of such compressed air column from such a chamber on the back of an acoustic diaphragm to an annular outlet coaxial with the diaphragm and presenting a high acoustic impedance to the radiation of sound vibrations emitted from the back of the diaphragm.

Another feature resides in the reduction of reverberation in an acoustic chamber on the back of an acoustic diaphragm by the peripheral venting of such chamber through an ample peripheral space intermediate the front wall or baffle wall bounding such chamber and the enclosing side walls, and such peripheral space communicating with an annular air passage in the form of an annular air column, being an acoustical damping column to an annular orifice in the proximity of the front side of the diaphragm and coaxial therewith and such air column having a relatively large area where it communicates with the periphery of the chamber and of relatively small area at the annular discharge orifice.

Another feature resides in an annular reentrant walled air passage communicating from the back of an acoustic diaphragm to an annular outlet coaxial with the diaphragm in which the air passage is tapered to the said annular outlet which is of less cross section area than the area of the diaphragm so that the sound vibrations emanated from the back of the diaphragm are continuously compressed in their travel through the passage from the back of the diaphragm to atmosphere and thence ejected to atmosphere at high acoustic intensity into the stream of sound vibrations emanated from the front of the diaphragm.

Now U. S. Patent Number 1,869,178, issued July 26, 1932, to Albert L. Thuras, also features the utilizing of the two surfaces of an acoustic diaphragm to effectively reinforce each other in providing an annular acoustic path from a chamber on the rear surface of an acoustic diaphragm to atmosphere adjacent the front surface of said diaphragm. This is particularly shown in Figures 7 and 8 on the drawings of said invention, where an annular air passage is so provided. It is evident however upon examination of the Thuras invention that his invention consists primarily of an acoustic cavity on the rear surface of an acoustic diaphragm and a direct means of venting said chamber or cavity to atmosphere adjacent the front surface of the diaphragm, and does not consist of a continuously walled air passage from the back of an acoustic diaphragm to atmosphere as does this invention.

In this invention an improvement over the Thuras invention is achieved in the feature of peripherally venting an air chamber on the back of an acoustic diaphragm, and of providing an extended continuous tapered annular walled passage therefrom to an annular outlet to atmosphere coaxially adjacent to an inner baffle tube projecting forward from an aperture in an enclosed baffle, and thus provides in effect an inverted horn having a large annular mouth looking peripherally into a relatively large flat expansion chamber on the rear surface of an acoustic diaphragm and a small annular throat open to atmosphere coaxially adjacent the said inner baffle tube on the front of the diaphragm, and the mouth and the throat of such horn connected by a tapered reentrantly folded coaxial air column.

Another feature resides in the novel construction herein shown and described which is a preferred embodiment of the objects and features of this invention.

A more complete understanding of this invention will be obtained by reference to the appended drawings wherein:

Fig. 1 is a section of an acoustical device embodying the features of this invention.

Fig. 2 is a front view of the acoustic device shown in Fig. 1, with a portion of the front removed along the line 2—2 of the device shown in Fig. 1.

Fig. 3 is a perspective view of a rigid spacing member for holding other members in fixed relationship to one another.

Referring now to the drawings, there is shown in Figs. 1 and 2 an acoustic device of the loud speaking receiver type embodying features of this invention consisting of the cupped front enclosure member 1 the center portion of which is perforate and from which the baffle tube member 2 projects back or inward and the cupped rear enclosure member 3 mutually fitted with cupped front enclosure member 1 at the outer rim portions thereof, thus enclosing the inner cupped baffle member 4 having an aperture in the center portion thereof from which is extended forward or outward the short baffle tube member 5. The said baffle tubes 2 and 5 and the cupped baffle 4 are disposed coaxially and in spaced relationship to each other within the enclosure as to provide a continuous reentrantly folded annular air passage or inverted horn having a large annular mouth 6 looking peripherally into the relatively large chamber 7 on the back surface of the acoustic diaphragm 8 and communicating to atmosphere forward of the front surface of said diaphragm 8 through annular space or throat 9 intermediate the inner and the outer baffle tubes 5 and 2. Current coil 10 is attached to the inner or rear surface of the diaphragm 8 and is disposed in the magnetic air gap 11 intermediate magnet poles 12 and 13 provided by the magnet 14 which is shown as a permanent magnet but which may be either of the permanent magnet or the electromagnet type. The enclosure members 1 and 3, the cupped baffle member 4 and baffle tubes 2 and 5 are constructed of rigid material such as cast aluminum. Although cast aluminum is a preferred material, the said members may be otherwise constructed of sheet metal stampings, or of molded plastic or other composition of rigid material.

The diaphragm 8 is constructed of thin light material such as an alloy of aluminum or of compacted fibrous material such as paper or of other thin sheet material having the desired qualities. Said diaphragm comprises a conical or dished

center portion 8, a flexible rim portion 24, and is operated by current coil 10 attached in the center portion of the diaphragm and operating in magnetic gap 11.

The outer or rim portion of interior baffle 4 is increased in thickness in such form as to provide the walls of a gradually tapered air passage of suitable character, preferably at a suitable rate of exponential taper.

The outer end of baffle tube 2 is flared in conjunction with the front enclosure member 1 and forms a bell-like recess in which the sound emanated from the back and the front of diaphragm 8 are merged and projected coaxially to atmosphere or the listening area.

Annular space 9, intermediate inner baffle tube 5 and outer baffle tube 2, is the throat end of an enclosed horn, the other end of which or mouth receives the sound waves emanated radially from the rear surface of acoustic diaphragm 8. The sound waves collected in the mouth 6 of said horn from the periphery of expansion chamber 7 are thence compressed in their travel through said horn and thence ejected through throat passage 9 into the bell-like recess formed by the flared end of baffle tube 2.

The magnet 14 is supported on spokes 15 radially disposed therefrom conically, which spokes in turn are attached to the annular supporting ring member 16.

The inner baffle tube portion 5 of cupped baffle 4 projects forward or outward from the aperture in the center portion of cupped baffle 4 and the outer baffle tube portion 2 of cupped front enclosure member 1 projects backward or inward from the aperture in the center portion of the cupped front enclosure member 1 and said inner and outer baffle tube portions 5 and 2 are so disposed coaxially and in spaced relationship to one another and to the cupped baffle 4 and to the cupped front and rear enclosure members 1 and 3 as to provide a continuous annular reentrant air passage or air column from atmosphere to the back surface of acoustic diaphragm 8.

A plurality of rigid spacing members 17 are radially disposed in the annular space intermediate the inner and the outer baffle tubes 5 and 2 and the space intermediate the outer baffle tube 2 and the rim portion of the cupped baffle 4 and secured to the said portion and members in any suitable manner for example such as cementing the edges of the spacing elements 17 to said baffles. It is now evident from the drawings and the foregoing description that the tubular baffle portions 5 and 2 of the cupped baffle member 4 and the cupped front enclosure member 1 respectively are held in fixed spaced relationship to one another by the rigid spacing elements 17 secured thereto.

The cupped rear enclosure member 3 is expanded at outer rim portion to form the annular bead portion 18 which is fitted overlapping the rim portion of cupped front enclosure member 1. Cupped rear enclosure member 3 is held by screw 19 to the magnet 14 which in turn is supported by spokes 15 to supporting ring member 16 attached by screws 20 to the back of cupped baffle 4.

Thus is shown and described a construction providing an inverted horn consisting of an annular reentrant folded air column having a relatively large annular mouth looking peripherally on the back of an acoustic diaphragm 8 and a relatively smaller annular throat consisting of an annular outlet forward of the diaphragm, and coaxial therewith and wherein a substantial lag is imposed on the sound wave train emitted from

the back side of said diaphragm to atmosphere as compared with the sound waves emitted directly to atmosphere from the front side of the diaphragm.

A flared directional horn 21 may be secured on the front of enclosure member 1 by inner flange portion 22 through which screws 23 are inserted and screwed to said front enclosure member.

Flared directional horn 21 provides a common channel in which the sound vibrations emitted from the back of the diaphragm are added coaxially to the sound vibrations emitted from the front of the diaphragm and thence merged and projected from said horn to atmosphere as from a single source. Acoustic diaphragm 8 is suspended by flexible rim portion 24 thereof which in turn is held by supporting ring member 16 to the back of cupped baffle 4.

When the diaphragm is caused to vibrate by the movements of coil 10 in response to the passage therethrough of electric currents which produce a variable field interacting with the fixed strength field between magnetic poles 12 and 13 of magnet 14, both the front and rear surfaces of the diaphragm will cause acoustic disturbances to be propagated through the fluid there adjacent. The sound waves generated by the rear surface of the diaphragm are conducted and compressed through the relatively long annular re-entrantly folded air column or inverted horn passage which thereby provides a relatively high acoustic impedance together with a substantial time lag to the passage of sound waves from the rear of the diaphragm to atmosphere where the delayed rear sound waves combine coaxially with the sound waves generated by the front surface of the diaphragm and thus reinforce effectively the direct radiation from the front of the diaphragm particularly at the middle and low frequencies.

If it is desired to reduce any pronounced peak in the response, or to attenuate the effect of the sound generated from the rear of the diaphragm in combining with the sound generated from the front of the diaphragm, acoustic damping material such as metallic wool is placed in the air column passage.

Although the specific embodiment of this invention as herein shown and described is a preferred embodiment it is understood that other combinations and arrangements of enclosed baffles and/or of baffle tubes may be used to embody the features of this invention and that square or angular forms of construction may be used instead of the circular form shown and that the term annular applies to other shapes of construction as well as to circular construction. This invention, therefore, consists essentially of such arrangement of baffles within an enclosure as will provide a relatively long compressive air column or inverted horn communicating from a chamber on the back of an acoustic diaphragm to atmosphere adjacent a relatively short direct passage from the front of the diaphragm to atmosphere, so that the compressed rear radiation will combine in a delayed time phase relationship with and reinforce the direct radiation from the front of the diaphragm to atmosphere. It is also understood that this invention is applicable to acoustic devices translating acoustic vibrations to electrical vibrations as well as the embodiment described and shown which translates electrical vibrations to acoustical vibrations.

This invention therefore is not to be restricted

except as is necessitated by prior art and by the spirit of the appended claims.

What is claimed is:

1. An acoustic device comprising an acoustic diaphragm in an aperture at one end of a baffle tube and in the center portion of a cupped baffle, said baffle in an enclosure composed of two cupped members the rims of which are mutually fitted one to the other, a vent aperture and a baffle tube extended inward therefrom in the center portion of one of the cupped enclosure members, an acoustic chamber defined by the convex side of said cupped baffle in co-operation with the inner side of the other said cupped enclosure member, the cupped baffle positioned in spaced relationship to the interior surfaces of the enclosure members so that one end of the baffle tube portion thereof extends telescopically into one end of the other baffle tube, an inverted horn of annular cross section defined by the concave side of said cupped baffle in co-operation with said baffle tubes and the first said cupped enclosure member, said horn having the mouth or larger end communicating with said chamber at the periphery of said cupped baffle, said horn inwardly re-entrant at the periphery of said cupped baffle, the throat or smaller end of said horn defined by said baffle tubes telescopically interposed in spaced relationship and said throat vented to atmosphere.

2. In an acoustic device, an acoustic diaphragm in an aperture at one end of a baffle tube extended inward from the center portion of an inner cupped baffle, an outer cupped baffle having an aperture in the center portion thereof and another baffle tube extended inward therefrom, said baffles interpositioned telescopically in spaced relationship to each other, a cupped enclosure wall in conjunction with said outer cupped baffle enclosing said inner cupped baffle, said cupped enclosure wall and the convex side of said inner cupped baffle defining an acoustic chamber, the concave side of said inner cupped baffle in co-operation with said baffle tubes and the concave side of said outer cupped baffle defining a re-entrantly folded inverted horn of annular cross section, said horn inwardly re-entrant from the periphery of said inner cupped baffle and having an annular mouth or larger end communicating with said chamber at said periphery, and said horn having an annular throat or smaller end defined by said baffle tubes telescopically interposed in spaced relationship to each other, and said throat vented to atmosphere.

3. An acoustic device comprising an acoustic diaphragm in an aperture at one end of a baffle tube and in the center portion of a cupped baffle, said baffle being surrounded by a walled enclosure and having another baffle tube of larger diameter extended inward from a vent aperture in a wall of said enclosure, an acoustic chamber defined by the convex side of said cupped baffle in co-operation with another wall of said enclosure, said cupped baffle positioned in spaced relationship to the inner surface of said enclosure walls so that said baffle tubes are interpositioned telescopically and in spaced relationship to each other and so that an inverted horn of annular cross section is defined by the concave face of said cupped baffle in co-operation with said baffle tubes and said vented wall of said enclosure, the mouth or larger end of said inverted horn communicating with said chamber at the periphery of said cupped baffle, said horn inwardly re-entrant from the periphery of said cupped baffle, the throat or smaller end of said inverted horn

defined by said baffle tubes telescopically interposed in spaced relationship, and said throat vented to atmosphere.

4. In an acoustic device having a baffle for an acoustic diaphragm, in which one side of said diaphragm emits sound waves into one end of a conduit the other end of which conduit is open to atmosphere, and in which the other side of said diaphragm emits sound waves into a chamber, said chamber peripherally vented through a sound conducting passage of annular cross section, said passage progressively decreasing in diameter and cross section area from the beginning at the periphery of the chamber to the other end vented to atmosphere, said baffle being cupped, said chamber defined on one side by the convex surface of said cupped baffle, the walls of said passage forming a folded inverted horn defined on one side by the concave surface of said cupped baffle, said inverted horn inwardly re-entrant from the periphery of said cupped baffle, the mouth or larger end of said inverted horn communicating with said chamber at the periphery of said cupped baffle, the throat or smaller end of said inverted horn having an annular vent defined on the inner side by the outer surface of said conduit, and said throat vented to atmosphere.

5. An acoustic device for acoustically loading an acoustic diaphragm comprising a cupped baffle, a walled enclosure comprising a front wall, a rear wall and connecting side wall, means supporting said cupped baffle in spaced relationship with the interior face of said enclosure walls, an aperture for said diaphragm and an inwardly projecting baffle tube therefrom in the center portion of said cupped baffle, a wall vent aperture and a second inwardly projecting baffle tube therefrom in said front wall of said enclosure, said baffle tubes interposed telescopically and in spaced relationship to each other, an acoustic chamber defined by the outer or convex face of said cupped baffle in co-operation with said rear wall of said enclosure, a re-entrantly folded horn of annular cross section defined by the inner or concave face of said cupped baffle in co-operation with said baffle tubes and said front enclosure wall, said horn re-entrantly folded inward from the periphery of said cupped baffle and having the

mouth or larger end of said horn communicating with the periphery of said chamber at the periphery of said cupped baffle, the throat or smaller end of said horn of annular cross section defined by said baffle tubes telescopically interposed in spaced relationship to each other, and said throat vented to atmosphere.

6. In an acoustic device for acoustically loading an acoustic diaphragm operating in an aperture in the center portion of a cupped baffle, one side of said diaphragm radiating sound into an acoustic chamber and the other side of said diaphragm radiating sound to atmosphere; the combination of an acoustic chamber defined by the outer or convex side of said cupped baffle in co-operation with an enclosure wall, a peripheral venting of said chamber at the periphery of said cupped baffle and communicating thereat with the larger end or mouth of a folded horn passage, said horn passage folded re-entrantly inward from the periphery of said cupped baffle, the smaller end or throat of said horn passage defined by telescopically interposed baffle tubes in spaced relationship to each other, said baffle tubes axially disposed with relation to said acoustic diaphragm, and said throat venting to atmosphere.

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