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M. R. HUTCHISON

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PUSH PULL ACTUATED RADIAL RESONATOR

Filed Aug. 4, 1927

Fig. 1

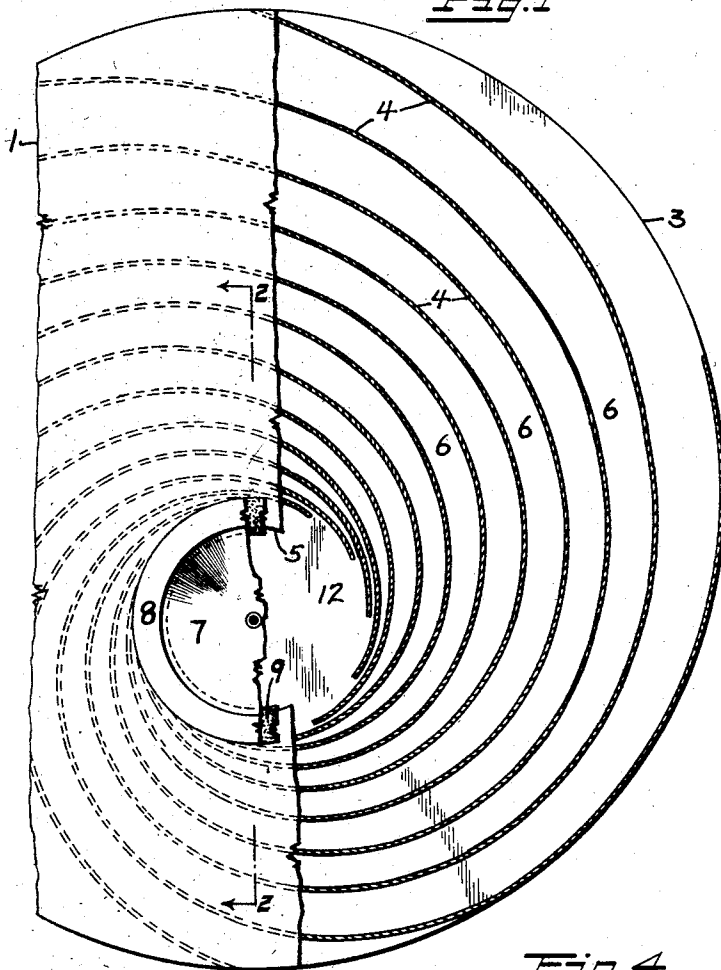


Fig. 2

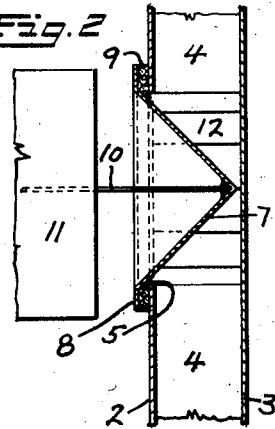


Fig. 3

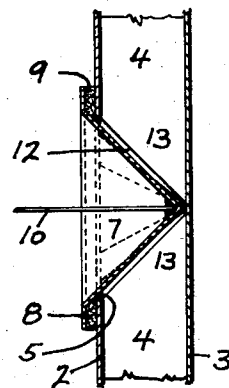


Fig. 4

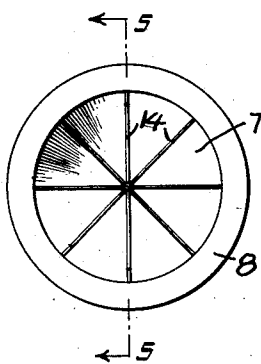


Fig. 5

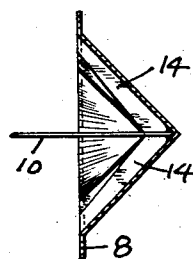
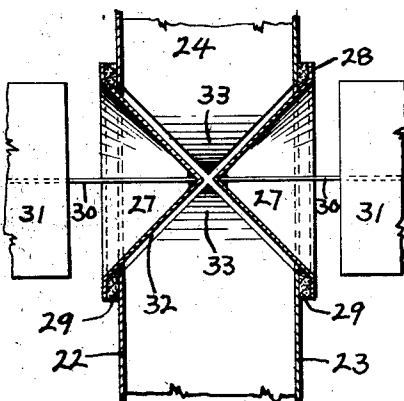


Fig. 6



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PUSH-PULL-ACTUATED RADIAL RESONATOR

Application filed August 4, 1927. Serial No. 210,551.

The invention relates in general to acoustic apparatus, and more particularly to a loud speaker or sound reproducer in which a column of air is set into vibration by a mechanical diaphragm or piston.

The ideal diaphragm for use with a loud speaker is a rigid piston acting in a cylinder in such manner that there is no friction between the piston and the cylinder and yet the joint therebetween is sound tight. This condition, of course, is impossible to produce, although it may be closely approached if much care is taken. However, this type of diaphragm is not entirely satisfactory for commercial purposes. The usual plane flexible diaphragm, on the other hand, is free from sound leakage and frictional binding but has the disadvantage of dividing up into one or more nodal and ventral parts, vibrating at different frequencies. This action is very complicated and under certain conditions causes undesirable characteristics in the loud speaker especially in those of the multiple horn type.

According to the invention these disadvantages are overcome in a novel and efficient manner, and a loud speaker is provided which renders tones of exceptional purity and reproduces music with utmost fidelity.

According to the invention, a plurality of horns or pipes of different lengths are provided, each being resonant to a different note preferably of the chromatic scale. These pipes or horns may be arranged in curved and nested relation to save space and to present an ornamental and decorative appearance, or they may be arranged in any other desired way. Each horn communicates with a common chamber, connected to which is a rigid diaphragm preferably of the cone type and operated by a push-pull electromagnetic receiver. The diaphragm is attached to the horns by a resilient and elastic joint and moves en masse in response to vibrations communicated thereto. If desired, the cone may be suitably reinforced by strengthening ribs. Two cones may be used instead of one, the cones being disposed in opposed relation, and

each being operated by its own electromagnetic push pull receiver.

Various other features and advantages of the invention will be apparent from the following particular description and from an inspection of the accompanying drawings.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which

Fig. 1 is a side elevation, parts being broken away, of a loud speaker according to the invention;

Fig. 2 is a section on the line 2—2 of Fig. 1, the push-pull receiver being indicated diagrammatically;

Fig. 3 illustrates a slight modification of Fig. 2;

Figs. 4 and 5 show slightly modified forms of the diaphragm; and

Fig. 6 is a modification illustrating the use of opposed cone diaphragms.

In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring now to the drawings, and more particularly to Figs. 1 and 2, the loud speaker or sound reproducer comprises a horn member 1 made up of a pair of plates 2 and 3 having a generally circular outline. One of the plates 2 has an opening 5 therein off centre. Extending between the plates are a plurality of walls 4 extending from the opening to the periphery of the plates, the walls being preferably in the form of a logarithmic spiral and in nested relation to save space. The plates and walls form a plurality of horns or pipes 6 of different lengths and open at their outer ends, each pipe being tuned to resonate some particular note, preferably one of the notes of the chromatic scale. Any number of horns may be provided, there

being shown twelve to correspond to the twelve notes in an octave of the chromatic scale.

Applied to the openings 5 in one of the plates is a cone diaphragm 7, the diaphragm being provided with a radial base flange 8. A gasket or washer 9 of sponge rubber is cemented to a plane about the opening and to the radial flange. The cone diaphragm projects into the casing and has a small clearance with the opposite wall 3. Connected to the apex of the cone and extending outwardly is a stylus rod 10 extending to an energy transfer device 11 which may be any suitable type of well known push-pull electromagnetic receiver. The stylus rod 10 may be connected to the apex of the cone in any desired manner such as by solder or by nuts (not shown). The common sound chamber 12 communicating with the several horns 6 should be of as small cubic content as possible so as not to have a natural period within the range of audibility.

Referring now to Fig. 3, the construction shown is similar to that shown in Figs. 1 and 2, parts being denoted by similar reference characters. The walls 4 are provided with angular extensions 13 extending close to the surface of the cone to reduce the chamber 12 to the smallest possible size and thereby improves the operating characteristics of the loud speaker.

Referring now to Figs. 4 and 5, if desired, the cone diaphragms shown in Figs. 1, 2 and 3 may be provided with elemental strengthening ribs 14 extending from the apex to the radial base flange 8 on the inside of the diaphragm to insure utmost rigidity throughout the body of the cone. The stylus rod 10 is connected to the apex of the cone in any desired manner.

Referring now to Fig. 6, the horn arrangement is similar to that described above but both plates 22 and 23 are provided with a cone diaphragm 27 having a radial flange 28 at its base and having a stylus rod 30 suitably connected to the apex thereof, the stylus rod extending outwardly to an electromagnetic push-pull receiver 31, similar to that used in Fig. 2.

Each cone diaphragm 27 may be connected to its plate 22 or 23 by a sponge rubber washer or gasket 29 being cemented respectively to the plates and to the radial flange 28 of the cone diaphragm. The cone diaphragms extend inwardly, their apices being disposed in close relation. The walls 24 are provided with angular projections 33 which closely fit the cone diaphragms allowing merely enough clearance for the movement of the cone diaphragms. This construction cuts down the cubic content of the common sound chamber 32 to a minimum.

In Figs. 1 to 5 inclusive, when electric currents having sound waves impressed

thereon traverse the windings of the receiver 11, they cause the cone diaphragm 7 to vibrate in accordance with the electric currents en masse or as a unit, all the movement being taken up by the sponge rubber washer or gasket 9. Thus it will be seen that the sponge rubber washer or gasket forms both an elastic and sound-tight joint. As the cone diaphragm vibrates, the sound waves will be propagated at an angle of 45 degrees to the surface of the cone or in a direction parallel with the plane of the horns.

In the form shown in Fig. 6, the receivers 31 will be connected in such relation that the cone diaphragms 27 will approach and withdraw from each other simultaneously, causing alternate compressions and rarefactions. In this case also the sound waves will be propagated at an angle of 45 degrees from the surface of the cones, the direction being in the plane of the horns.

Thus a loud speaker has been provided which will give faithful and pleasing reproduction of electrical sound energy impressed upon the receiver. The diaphragms are rigid and move as a unit in accordance with the notes impressed thereon by the receiver. Each note will be resonated by some particular horn which is tuned either to the note itself or to a fundamental of which the note is a harmonic or overtone. It will be understood that the horns respond quite readily to the overtones or harmonics of the fundamental in addition to the fundamental itself.

The cone diaphragm moving as a unit in response to the acoustic variations, has many of the advantages, both of a simple piston and of a simple flexible diaphragm in addition to many special advantages inherent in its construction. In a diaphragm of the simple flat flexible type, the movement of the diaphragm is very complicated, since the diaphragm moves not only as a unit but it also breaks up into one or more nodal and ventral parts. This complicated action in some cases causes undesirable characteristics in the loud speaker. On the other hand, in the case of the cone diaphragm the flexible or yielding washer allows unitary movement of the diaphragm without sound leakage and without any substantial binding or resistance, and since the cone diaphragm vibrates en masse, its action is comparatively simple.

The use of the rigid cone diaphragm with the multiple resonating horns provides a loud speaker having particularly faithful sound reproducing characteristics which produces remarkably clear tones throughout the entire audible range.

While certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the forms and

details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. In acoustic apparatus, a hollow casing, a plurality of pipes communicating therewith, each pipe resonating a different note, said casing having an opening, a rigid cone diaphragm disposed over said opening, a yieldable member between said diaphragm and casing making a sound proof and yieldable joint, a stylus connected to the apex of said diaphragm, and actuating means having operative relation with said stylus.

2. In acoustic apparatus, a hollow casing, a plurality of pipes communicating therewith, each pipe resonating a different note, said casing having an opening, a rigid diaphragm disposed over said opening, a yieldable member between said diaphragm and casing, and a push pull receiver having operative relation with said diaphragm.

3. In acoustic apparatus, a casing, a plurality of pipes communicating with said casing, each pipe resonating a different note, said casing having an opening, a sponge rubber washer cemented around said opening, a cone diaphragm having a radial base flange cemented to said washer, a plurality of strengthening ribs extending from the apex of said diaphragm to said flange, said ribs being disposed on the inside of said cone diaphragm, the apex of said diaphragm extending within said casing, a stylus rod connected to said apex and actuating means operatively connected to said stylus rod.

4. In acoustic apparatus, a casing, a plurality of pipes communicating with said casing, each pipe resonating a different note, said casing having an opening, a soft resilient member secured around said opening, a cone diaphragm having a radial base flange secured to said member, the apex of said diaphragm extending within said casing, a stylus rod connected to said apex and extending through said opening, and actuating means operatively connected to said stylus rod.

5. In acoustic apparatus, a pair of first and second plates, said first plate having an opening, a plurality of nested curved walls connecting said plates and extending from said opening to the outer edges of said plates and forming a plurality of pipes of different lengths each resonating a different note of the chromatic scale, a sponge rubber washer cemented to said first plate around the opening therein, a cone diaphragm having a radial base flange cemented to said washer, a plurality of strengthening ribs extending from the apex of said diaphragm to the flange thereof and disposed within the diaphragm, said walls having angular projections extending close to said diaphragm, said diaphragm having a stylus secured to its apex and extending

outwardly, and actuating means connected to said stylus.

6. In acoustic apparatus, a pair of first and second plates, said first plate having an opening, a plurality of walls connecting said plates and extending from said opening to the outer edges of said plates and forming a plurality of pipes of different lengths each resonating a different note, a yieldable washer secured to said plate around the opening therein, a cone diaphragm having a radial base flange secured to said washer, said walls having angular projections extending close to said diaphragm, said diaphragm having a stylus secured to its apex and extending outwardly, and actuating means connected to said stylus.

7. In acoustic apparatus, a pair of first and second plates, said first plate having an opening, a plurality of walls connecting said plates and extending outwardly from said opening forming a plurality of horns, a cone diaphragm disposed over said opening and between said plates, said walls having angular projections extending close to said diaphragm, and energy transfer means having operative connection with said diaphragm.

8. In acoustic apparatus, a hollow casing, a plurality of pipes communicating therewith, each pipe resonating a different note, said casing having opposed openings, a rigid diaphragm disposed over each opening, a yieldable joint between each diaphragm and said casing, each diaphragm having operatively connected thereto an energy transfer device.

9. In acoustic apparatus, a hollow casing, a plurality of pipes communicating therewith, each pipe resonating a different note, said casing having opposed openings, a cone diaphragm disposed in each opening, the apices of said diaphragm being in close relation, a stylus connected to the apex of each diaphragm and extending outwardly, and energy transfer means connected to said styli.

10. In a loud speaker, a pair of plates each having an opening, a plurality of nested, curved, walls connecting said plates and extending from said openings to the outer edges of said plates and forming a plurality of pipes of different lengths each resonating a different note of the chromatic scale, a sponge rubber washer cemented to each plate around the opening therein, a cone diaphragm having a radial base flange cemented to each said washer, a plurality of strengthening ribs extending from the apex of each diaphragm to the flange thereof and disposed within the diaphragm, said diaphragms extending towards each other, the apices of said diaphragms being disposed in close relation, said walls having angular projections extending into the space between said diaphragms and close thereto, each diaphragm having a stylus rod secured to its apex and extending out-

wardly, and actuating means connected to each stylus.

11. In a loud speaker, a pair of plates, each having an opening, a plurality of walls connecting said plates and extending from said openings to the outer edges of said plates and forming a plurality of pipes of different lengths each resonating a different note, a yieldable washer secured to each plate around the opening therein, a cone diaphragm having a radial base flange secured to each said washer, said diaphragms extending towards each other, the apices of said diaphragms being disposed in close relation, each diaphragm having a stylus rod secured to its apex and extending outwardly, and energy transfer means connected to each stylus.

Signed at New York, in the county of New York and State of New York, this 2d day of August, A. D. 1927.

MILLER REESE HUTCHISON.