Oct. 8, 1957 D. M. CHAVE 2,808,895

LOUDSPEAKERS

Filed Jan. 3, 1955

Fig. 1.

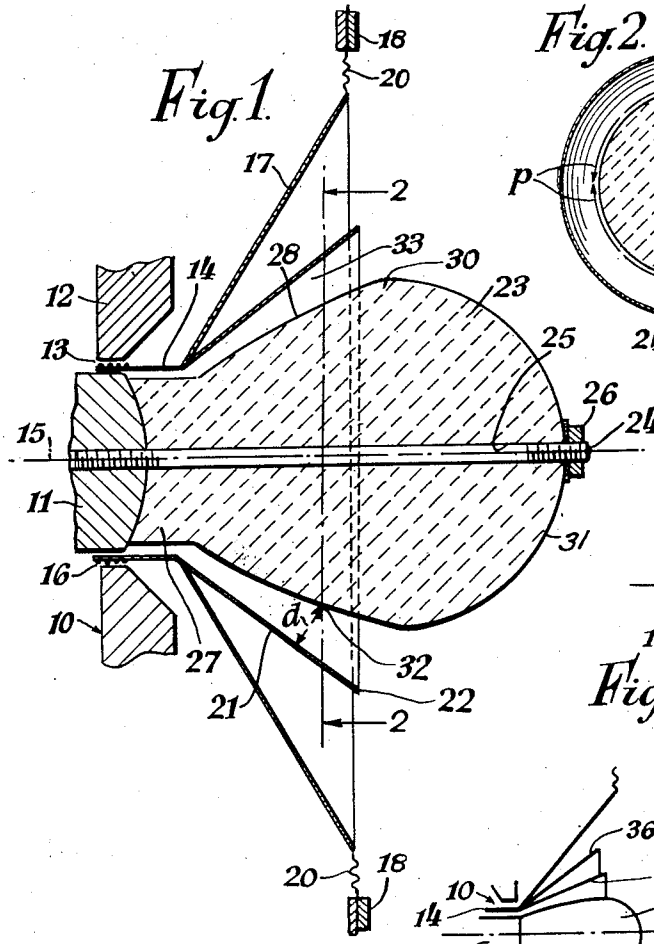
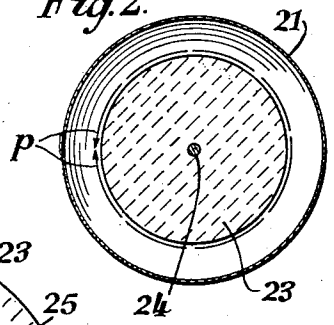


Fig. 2.



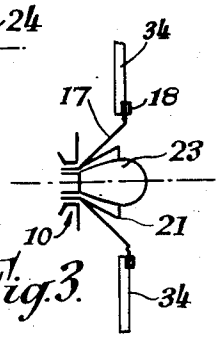


Fig. 3.

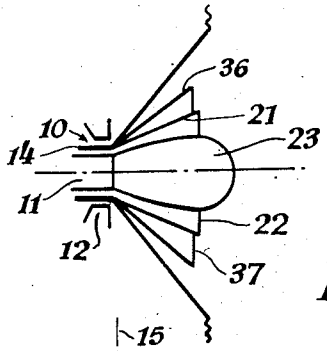


Fig. 5.

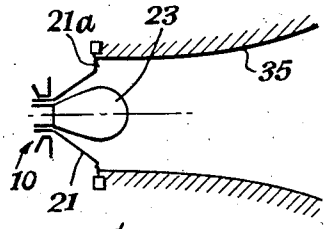


Fig. 4.

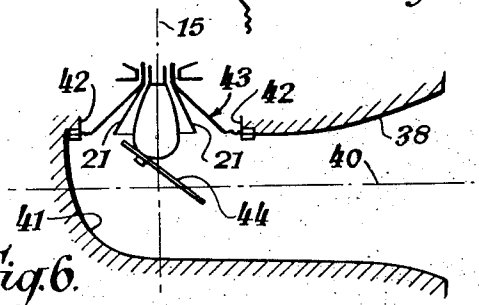


Fig. 6.

INVENTOR
Donald Maynard Chave
BY
Sterne, Davis, Miller & Moore
ATTORNEYS

United States Patent Office

2,808,895

Patented Oct. 8, 1957

2,808,895

LOUDSPEAKERS

Donald Maynard Chave, Bromley, England

Application January 3, 1955, Serial No. 479,624

Claims priority, application Great Britain January 5, 1954

7 Claims. (Cl. 181—31)

This invention relates to loudspeakers and other sound reproducers, and particularly to those which are required to radiate sound waves whose wavelength is of the order of dimensions of the moving parts of the reproducer, for example reproducers for "treble" sounds in music.

Reproducers have been made and described in which a conical moving member such as a diaphragm is caused to vibrate along the axis of the cone, and also in which a second smaller conical moving sound emitter of lesser vertical angle is attached to the first moving member. I have found that the response of such a system to a range of high frequencies is apt to vary undesirably with frequency because standing circular waves are set up at certain frequencies in the material of the sound emitter, the mouth of which vibrates about its normal circular or other shape. I have found that another cause of such variation is the setting up of standing longitudinal waves in the material of the emitter. Variations of response due to the second cause are especially liable to occur with the double-cone type of reproducer, whose inner cone or emitter has normally a completely free mouth, which thus presents a discontinuity to longitudinal vibrations.

It is an object of the present invention to provide an improved construction for sound reproducers whereby these disadvantages are eliminated or reduced, and the radiation of the highest frequency sounds required from a given reproducer is made more efficient and more uniform.

According to the invention a sound reproducer has in combination a moving sound emitter which is mounted to vibrate along an axis and has walls which extend longitudinally of said axis, and a fixed core member also extending along said axis for at least the whole axial length of the emitter, the maximum spacing of the core member from the emitter at any cross section of the core member perpendicular to the axis being less than one ninth the outer periphery of the core member at that section. Thus the reproducer may comprise a moving sound emitter which is mounted to vibrate along an axis and has a circumferentially continuous wall which extends longitudinally of said axis, and a fixed core member also extending along said axis for at least the whole axial length of the emitter, one end of the core member projecting beyond the edge of the moving sound emitter and being convexly rounded off, the maximum spacing of the core member from the emitter at any cross section of the core member perpendicular to the axis being less than one ninth the outer periphery of the core member at that section.

According to another aspect of the invention a sound reproducer comprises a magnet system defining a gap across which magnetic flux is concentrated, an electric inductor mounted to move within said gap under the effects of current in the inductor, a moving sound emitter in the form of a funnel operatively coupled to move as one with said inductor, and a fixed core member

which is disposed inside the sound emitter and is attached to the magnet system, the fixed core member extending for the full axial length of the said sound emitter.

Sound reproducers to which my invention is applicable are usually constructed with conical or trumpet-shaped moving sound emitters, whose cross-sections have a circular periphery, but my invention is equally applicable to cases in which the moving member is an elliptical cone, a pyramid, or to other shapes.

I have found that the occurrence of circular standing waves is reduced when the compliance per unit area of the air between the fixed and moving members is reduced by reducing the gap, and that this gap may advantageously be substantially less than the amount of one ninth (or preferably one tenth) of the periphery quoted as an effective limit.

I have also found that longitudinal standing waves may be minimised by continuing the fixed member along the axis, for example by terminating it with a hemispherical or other convex rounded end.

In certain constructions further improvements may be made by providing the fixed member with blind or communicating holes. It may be made of sound-reflectant or sound-absorbent material, such as plaster of Paris.

In addition to the advantages herebefore described, the improved arrangement distributes the radiation of high-frequency sound (for example, frequencies above 4000 cycles per second) more uniformly over the azimuthal range from the axis of the loudspeaker.

The invention is illustrated by way of example in the accompanying diagrammatic drawings, in which:

Figure 1 is a fragmentary sectional elevation of the front of an improved sound reproducer;

Figure 2 is a transverse sectional elevation taken on the line 2—2 of Figure 1 and drawn to a reduced scale;

Figure 3 is a diagram showing the improved reproducer installed in a baffle board;

Figure 4 is a diagram of an improved reproducer feeding a horn;

Figure 5 is a diagrammatic section of a modified construction; and

Figure 6 shows the reproducer feeding a horn substantially at right angles.

The reproducer shown in Figures 1 and 2 is of the moving coil type and has a magnet system which is indicated generally at **10** including a central pole piece **11** disposed within the aperture of an outer pole piece **12** to form an annular gap **13** across which there is an intense magnetic field. A tubular former **14** is mounted so as to extend into the gap **13** with freedom to oscillate within narrow limits along an axis which is indicated at **15**, and it carries an inductor in the form of a coil of insulated wire **16**, the mounting (not shown) being arranged, as is well known in the art, so that neither the former **14** nor the coil **16** will touch either of the pole pieces **11**, **12**, despite the narrowness of the gap **13**. When an alternating current is passed through the coil **16** the interaction of the produced magnetic flux with the flux crossing the gap **13**, of course causes the coil **16** to reciprocate along the axis **15** and thus drive the former **14** correspondingly. Attached to the front end of the former **14** is a frusto-conical diaphragm **17** which has its rim connected to an annular supporting frame **18** by a flexible surround **20** adapted to allow the diaphragm **17** to reciprocate with the former **14**.

With a view to improving the emission of sounds in the higher frequency range (say 1000 cycles per second and higher) a frusto-conical emitter member **21** is fixedly secured to the former **14** or to the centre of the diaphragm **17** so as to extend forwards truly concentric with the axis **15**, its free edge **22** conveniently being

approximately co-planar with the periphery of the diaphargm 17.

In order to stabilise the emitter member 21 against unwanted modes of vibration, and also to improve the distribution of sound from said emitter member, a central core member 23 is rigidly mounted upon the centre pole piece 11, say by means of an axial stud 24 threaded into the pole piece and passing snugly through a bore 25 in the core member, the latter being held in position by a nut 26. The core member 23, which is preferably made of plaster, such as plaster of Paris, has a cylindrical neck 27 adjoining the pole piece 11, and its outer surface then diverges in the forward direction, the profile being curved, as indicated at 28, until the position of maximum diameter is reached at 30, this being just forward of the rim 22 of the emitter member 21. From this point the front of the core member is rounded off to form a substantially hemispherical nose 31. The core member 23 must extend for the whole axial length of the emitter 21 in order to produce the desired control over the vibrations of the emitter, and it is important that its outer surface should lie relatively closely to the inner surface of the emitter. Experiments have shown that the maximum distance from the outside of the core member 23 (at any given cross section perpendicular to the axis 15) to the inside surface of the emitter 21 should be less than one ninth the length of the periphery of the core member at that section. Probably one tenth is the working limit. Thus taking point 32 on the core member at the cross section denoted by the line 2—2 (which is of course at right angles to the axis 15) the nearest distance d to the inside surface of the emitter member 21, when the latter is in its natural position, must be less than one ninth of the periphery p of the core member 23 at that section, as shown in Figure 2. This applies in all cases, irrespective of whether the core member is concentric with the emitter member, and for different cross sectional shapes of emitter members and/or core members. In Figure 1 the ratio of d/p is approximately 1/20 at the plane 2—2 and is about 1/16 at the plane of the free edge 22.

It will be seen in Figure 1, that there is an annular passage 33 formed between the core member 23 and the emitter member 21, and that this increases in cross sectional area as it progressively gets larger in diameter in the forward direction away from the former 14. Indeed the inner surface of the emitter member 21 diverges at a greater rate than the outside of the core member so that the passage 33 increases in radial width, the curved profile 28 of the core member, enabling the passage 33 to be designed to have specific sound propagating characteristics in the nature of a horn.

The improved form of sound reproducer may be modified in construction to suit the use for which it is required. Thus a unit similar to that shown in Figures 1 and 2 may be provided with a baffle board and will radiate a wide band of frequencies covering practically the whole of the audible range, the lower limit being dependent on the size of the baffle board. This arrangement is shown in Figure 3, the baffle board being attached to the frame 18 and being indicated at 34.

In Figure 4 the emitter member 21 is provided with a flexible surround 21a by which it is connected to the entry of a horn 35, the core member 23 being rigidly mounted upon the magnet assembly 10 so as to extend axially within the frusto-conical emitter member 21 and control the mode of vibration thereof.

If desired a plurality of emitter members may be arranged one within the other, the core member being of course disposed within the inner one as is shown in Figure 5. The construction is the same as that in Figure 1 and the corresponding parts are indicated by the same reference numerals. One additional emitter member 36 is disposed between the diaphragm 17 and the emitter member 21 and is conveniently attached rigidly to the coil former 14, its front edge 37 being free.

In some cases, such as in sound reproducers of the form described in my co-pending application Serial No. 479,599, filed January 3, 1955, it may be desirable to have the axis 15 of the reproducer unit disposed at an angle to the length of a horn or like sound delivery device, and the arrangement shown in Figure 6 may advantageously be used. A horn 38 whose axis is shown at 40 has its lower wall curved upwards at 41 to meet a horizontal inlet aperture 42 over which the sound reproducer is fixed with its axis 15 substantially vertical, said reproducer being indicated generally at 43 and being of the same construction as that in Figures 1 and 2. In order that the higher frequency vibrations from the emitter member 21 may be more efficiently delivered along the axis 40 of the horn 38, a plate 44 is fastened in an oblique position upon the core member 23, and this acts in the manner of a reflector for sound waves passing downwards from the emitter member 21.

It is found that with the core member in position, the sounds of higher frequency are more uniformly dispersed, instead of tending to concentrate on the axis of the reproducer as at present, and moreover the usual cancellation effects at the edges and sides of the emitter are largely avoided. This applies especially to the reproduction of frequencies of over 4000 cycles per second. Moreover the core member offers an air loading to the emitter member, and also defines a short funnel or horn (of annular cross section) through which air vibrations from the coil itself are transmitted to the front of the loudspeaker. The radial width of this funnel or horn space is substantially less than the wavelength of the sounds which are to be reproduced therethrough.

The above details are given by way of example only and it will be apparent that various modifications may be made to suit requirements.

What I claim is:

1. A sound reproducer comprising a sound emitter member in the form of a hollow frusto-cone having a rim portion and a central root portion, driving means at the root portion for vibrating the emitter member along its axis, a fixed support member adjacent the root portion of the emitter member, and a rigid core member which is fixedly mounted upon the support member and extends inside said sound emitter member, which core member comprises a divergent portion extending from the support member for the full axial length of the emitter member and a front portion which is wholly in front of the rim portion of the emitter member and is of domed shape.

2. A sound reproducer comprising a sound emitter member in the form of a hollow frusto-cone having a rim portion and a central root portion, driving means at the root portion for vibrating the emitter member along its axis, a fixed support member adjacent the root portion of the emitter member, and a rigid core member which is fixedly mounted upon the support member and extends inside said sound emitter member, which core member comprises a divergent portion extending from the support member for the full axial length of the emitter member and a front portion which is wholly in front of the rim portion of the emitter member and is a substantially hemispherical shape.

3. A sound reproducer comprising a sound emitter member in the form of a hollow frusto-cone having a central root portion by which the emitter member is supported, and a rim portion which is free, driving means at the root portion for vibrating the emitter member along its axis, a fixed support member adjacent the root portion of the emitter member, and a rigid core member which is fixedly mounted upon the support member and extends inside said sound emitter member, which core member comprises a divergent portion extending from the support member for the full axial length of the emitter member and a front portion which is wholly in front of the rim portion of the emitter member and is of domed shape.

4. A sound reproducer comprising a sound emitter

member in the form of a hollow frusto-cone having a central root portion by which the emitter member is supported, and a rim portion which is free, driving means at the root portion for vibrating the emitter member along its axis, a fixed support adjacent the root portion of the emitter member, and a rigid core member which is fixedly mounted upon the support member and extends inside said sound emitter member, which core member comprises a divergent portion extending from the support member for the full axial length of the emitter member and a front portion which is wholly in front of the rim portion of the emitter member and is of substantially hemispherical shape.

5. A sound reproducer comprising a sound emitter member in the form of a hollow frusto-cone having a rim portion and a central root portion, driving means at the root portion for vibrating the emitter member along its axis, a fixed support member adjacent the root portion of the emitter member, and a rigid core member which is fixedly mounted upon the support member and extends inside said sound emitter member, which core member comprises a divergent portion extending from the support member for the full axial length of the emitter member and a front portion which is wholly in front of the rim portion of the emitter member and is of substantially hemispherical shape, the distance of every point on the said divergent portion of the core member from the nearest point on the interior of the emitter member being less than one-ninth of the perimeter of the core member at the said point.

6. A sound reproducer comprising a sound emitter member constituted by a flexibly mounted diaphragm and a hollow frusto-cone having a central root portion secured

to the diaphragm and a free outer rim portion, driving means at the root portion for vibrating the emitter member along its axis, a fixed support member adjacent the root portion of the emitter member, and a rigid core member which is fixedly mounted upon the support member and extends inside said sound emitter member, which core member comprises a divergent portion extending from the support member for the full axial length of the emitter member and a front portion which is wholly in front of the rim portion of the emitter member and is of domed shape.

7. A sound reproducer comprising a sound emitter member constituted by a flexibly mounted diaphragm and a hollow frusto-cone having a central root portion secured to the diaphragm and a free outer rim portion, driving means at the root portion for vibrating the emitter member along its axis, a fixed support member adjacent the root portion of the emitter member, and a rigid core member which is fixedly mounted upon the support member and extends inside said sound emitter member, which core member comprises a divergent portion extending from the support member for the full axial length of the emitter member and a front portion which is wholly in front of the rim portion of the emitter member and is of substantially hemispherical shape, the whole of said front portion being in front of the said diaphragm.

References Cited in the file of this patent

UNITED STATES PATENTS

2,115,924	Fisher	May 3, 1938
2,124,597	Tiedje	July 26, 1938
2,706,529	Brittain	Apr. 19, 1955