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(58) Field of search
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Selected US specifications from IPC sub-class H04R

(54) Cone loudspeakers

(57) In a cone loudspeaker having a central dome (14), an annular cone (10) around the dome, and a voice coil (18), the central dome (14) is made mechanically strong and axially stiff and is an acoustic radiator in its own right. The dome (14) is preferably also radially stiff and its radial stiffness may be enhanced by a circumferential reinforcing ring. The dome is preferably hemispherical and may be made of aluminium, titanium or fibre-reinforced plastics materials.

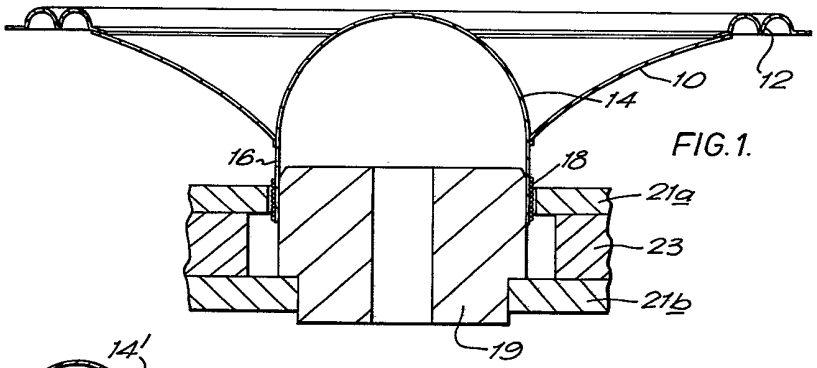

FIG. 1.

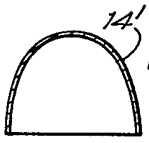

FIG. 4.

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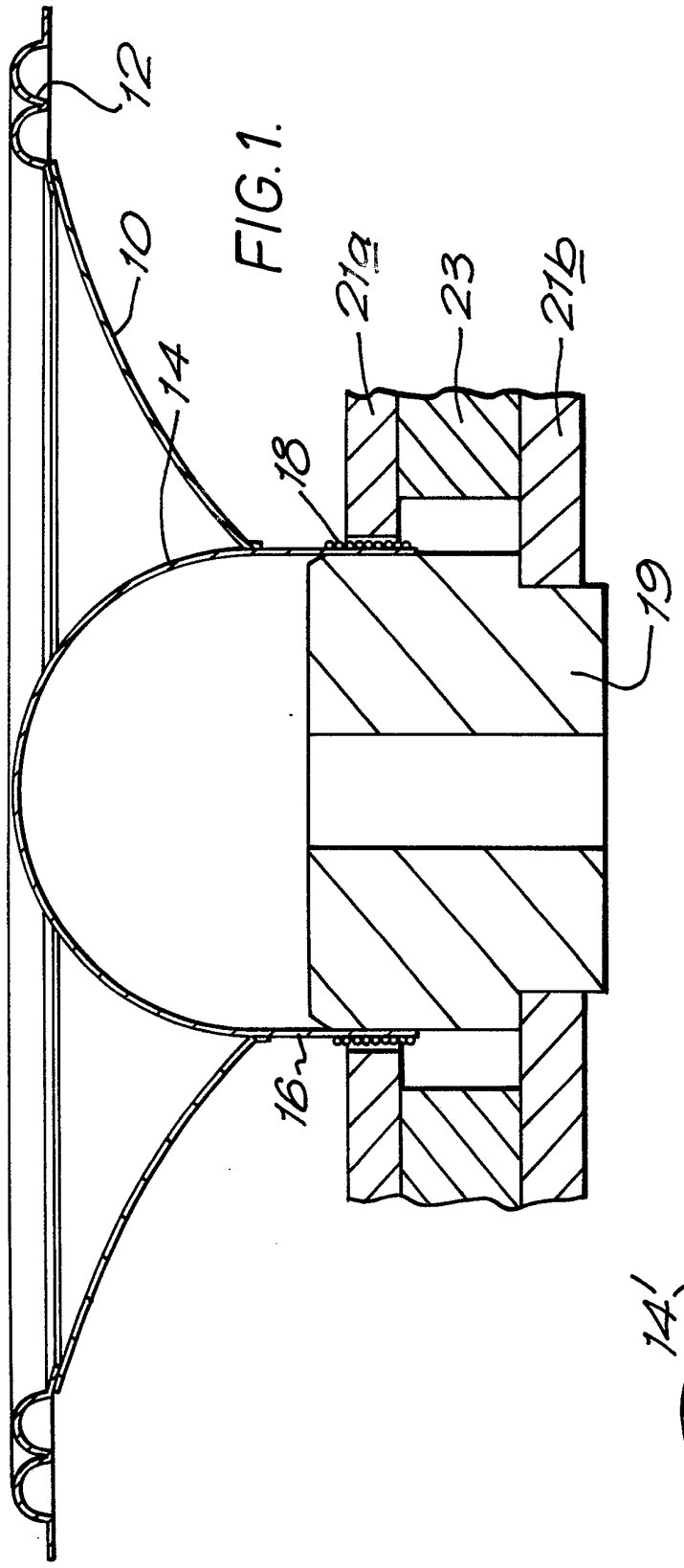

FIG. 1.

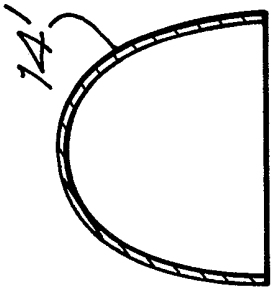

FIG. 4.

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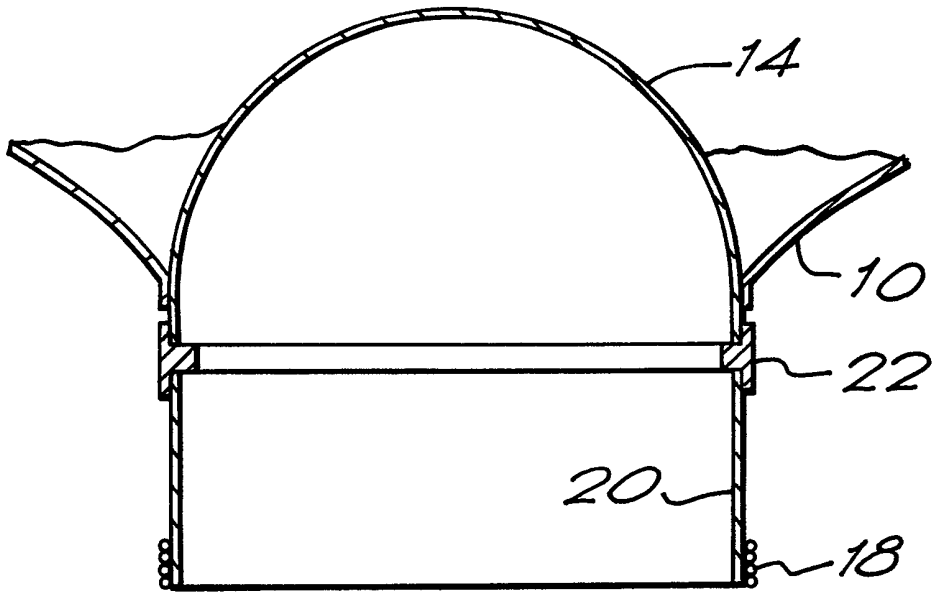

FIG.2.

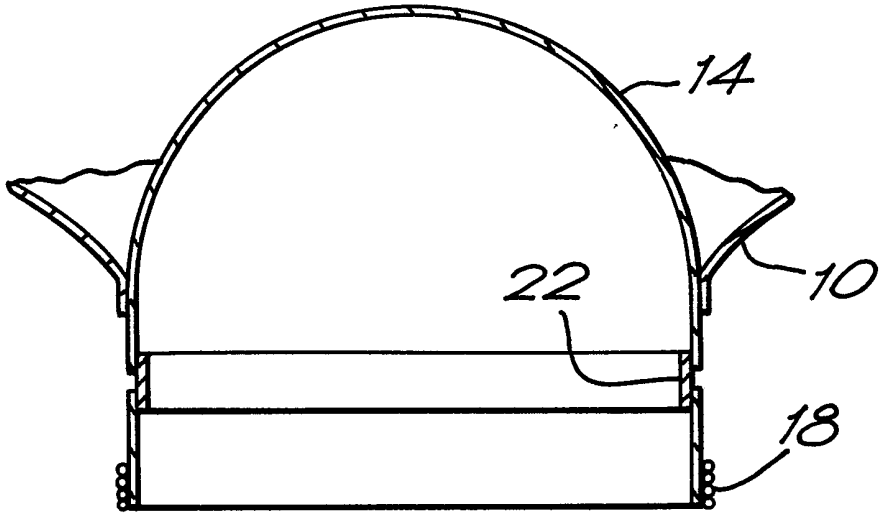

FIG.3.

SPECIFICATION

Cone loudspeakers

This invention relates to cone loudspeakers, and is particularly concerned with improving the acoustic behaviour of such loudspeakers.

It is already known to produce a one-piece metal dome and voice coil former for cone loudspeakers. This known product uses a metal dome primarily for heat sink purposes and the dome is a shallow, generally "flat" dome with only a small amount of curvature. With this known product, due to misbehaviour of the dome, and also of the cone, one encounters break-up of the acoustic response at relatively low frequencies. Roll-off due to this misbehaviour can start at as low as 2 to 3 kHz.

Starting from the basis of a cone loudspeaker having a central dome, the following are among the objects of the present invention:

1. To achieve an accurate response at the higher frequency end of the audio range;

2. To drive the point at which the audio response breaks up either fully above the audio range or at east into the upper region of that range;

3. Substantially to prevent the occurrence of vibrating modes;

4. Substantially to prevent parasitic resonance of the dome;

5. Substantially to prevent the occurrence of self-resonant modes over the full audio band;

6. To use a dome which is designed for its acoustic behaviour, and not just as a heat sink;

7. To make the central dome "behave" through at least the greater part of the audio range;

8. To provide a central dome which is a clean radiator in its own right and which is mechanically strong.

The fulfilment of these objects gives rise to a number of advantages which are achieved by the loudspeaker of the present invention. Among these advantages are the following:

1. A more stable acoustic response;

2. The prevention of break-up in the audio band;

3. It is easier to achieve smooth cross-overs in multi-way systems;

4. One achieves a more realistic response at cross-over frequencies;

5. The high frequency output of the loudspeaker sounds subjectively like a tweeter;

6. It is then feasible to use electronic equalisation to make it possible to produce an accurate full-range loudspeaker. Electronic equalisation use with conventional loudspeakers of this type will boost the flaws in the acoustic characteristic.

These objects and advantages are acheived in accordance with the present invention by a cone loudspeaker comprising an annular cone and a central dome which is mechanically strong, which is axially stiff and which is an acoustic radiator in its own right.

Preferably the dome is also radially stiff.

The shape and configuration of the central dome, and the material or materials from which it is made, are chosen to optimise the behaviour of the dome, and in particular to minimise misbehaviour in the upper end of the audio range. It is desirable that the material of the dome should have a very high stiffness to weight ratio.

One way to achieve the desired axial stiffness of the dome, coupled with it acting as a clean radiator, is to shape the dome with relatively steep sides. Preferably, the outside wall of the dome as it falls away from the apex is at least as steep-sided as a hemisphere. It has been found that a dome of substantially hemispherical shape is particularly suitable.

So far as materials are concerned, although the choice of materials is determined by a wide range of different considerations, it has been found that aluminium and titanium are particularly suitable materials for the central dome. Non-metallic materials such as plastics materials reinforced with carbon fibre or glass fibre may also be used. Such materials have a particularly high stiffness to weight ratio.

Within the context of the present invention, the central dome of the loudspeaker may be made as one with the voice coil former, or the dome and voice coil former could be separate, possibly with an intermediate stiffening ring.

A number of embodiments of cone loudspeaker in accordance with the invention will now be described by way of example and with reference to the accompanying drawings, in which:

Fig. 1 is a schematic partial representation of a first embodiment of cone loudspeaker in accordance with the present invention;

Fig. 2 is a partial view of a slightly modified dome construction;

Fig. 3 is a partial view of an alternative modified dome construction; and

Fig. 4 is a schematic illustration of a dome having an alternative shape.

As shown in the drawings, the loudspeaker comprises a conventional annular cone 10 with a compliant surround 12 around its periphery. A dome 14 is positioned centrally within the cone. In Figs. 1 to 3 the central dome 14 is a substantially hemispherical element. In Fig. 1 an integral cylindrical skirt portion 16 extends axially of the open end of the dome. The cone 10 is fixed to the outside of the central dome at approximately the position where the hemispherical dome element 14 and the skirt portion 16 meet. The apex of the central dome 14 here lies substantially in the plane of the outer perimeter of the cone 10. However, in other embodiments, the dome apex could lie above or below this plane.

As shown in Fig. 1, a voice coil 18 is wound around the outside of the outer end of the skirt portion 16 of the central dome. A central pole-piece 19 is fitted into the skirt portion 16. Front and rear plates 21*a* and 21*b* which sandwich an annular magnet 23 are positioned outwardly of the coil.

In Fig. 2 the voice coil 18 is shown wound on a voice-coil former 20 which is separated from the central dome 14, with the two components held

together by an intermediate stiffening ring 22 which is of T-shaped cross-section with the leg of the T lying within the gap between the dome 14 and the former 20. In this case the dome 14 and coil former 20 would be manufactured as separate items. The coil former 20 may be of metal or may be non-metallic.

The stiffening ring 22 provided around the dome 14 preferably lies approximately at the equator of the hemisphere, and either internally or externally of the dome. Fig. 2 shows an arrangement with a T-shaped ring having the head of the T externally of the dome, whereas Fig. 3 shows the ring internally of the dome and bridging the gap between the dome and the former. This reinforcing ring 22 is preferably of metal, for example aluminium or magnesium, and is provided to enhance the radial stiffness of the dome.

The central dome 14 of the loudspeaker of the present invention is a "hard" dome, designed for good behaviour acoustically. Although a wide range of materials could be used for the dome 14, it has been found that titanium and aluminium are particularly good materials for this purpose. Although the need to provide relatively steep sides for the dome has been shown in Figs. 1 to 3 as being achieved by the use of a hemispherical dome, other shapes and configurations of dome could be used. For example, as shown in Fig. 4, a more elongate dome 14', tending towards a semi-ovoid shape, could alternatively be used. In each case, the dome 14 is axially stiff and mechanically strong and the dome acts as a clean radiator in its own right, without misbehaving in the upper frequency range of the audio band, for example up to about 17 kHz and preferably up to in excess of 20 kHz.

The term "radial" as used herein is to be understood as meaning a direction across the equator of the dome, whereas the term "axial" as used herein is to be understood as meaning the direction in which the dome vibrates in use.

CLAIMS

1. A cone loudspeaker comprising an annular cone and a central dome which is mechanically strong, which is axially stiff and which is an acoustic radiator in its own right.

2. A cone loudspeaker as claimed in claim 1, in which the dome is radially stiff.

3. A cone loudspeaker as claimed in claim 1 or 2, in which the dome has a high stiffness to weight ratio.

4. A cone loudspeaker as claimed in any preceding claim, in which the dome is of titanium or aluminium.

5. A cone loudspeaker as claimed in any of claims 1 to 3, in which the dome is of fibre-reinforced plastics material.

6. A cone loudspaker as claimed in any preceding claim, in which the outside wall of the dome as it falls away from the apex is at least as steep-sided as a hemisphere.

7. A cone loudspeaker as claimed in claim 6, in which the dome is substantially hemispherical.

8. A cone loudspeaker as claimed in any of claims 1 to 6, in which the dome is semi-ovoid in shape.

9. A cone loudspeaker as claimed in any preceding claim, in which the central dome is integral with a voice coil former which comprises a skirt portion extending axially of the open end of the dome.

10. A cone loudspeaker as claimed in claim 9, in which the cone is fixed adjacent to the junction of the dome and the former.

11. A cone loudspeaker as claimed in any of claims 1 to 8, which includes a voice coil former made separately from the dome, and means to enhance the radial stiffness of the dome connecting the dome and former together.

12. A cone loudspeaker as claimed in claim 11, in which the means to enhance the radial stiffness of the dome comprising a ring member positioned around the dome and former at their junction.

13. A cone loudspeaker as claimed in claim 12, in which the reinforcing ring member is of metal, preferably aluminium or magnesium.

14. A cone loudspeaker as claimed in claim 12 or 13, in which the dome is hemispherical and the reinforcing ring member is positioned substantially at the equator of the dome.

15. A cone loudspeaker comprising a cone, and a central dome which is mechanically strong, which is axially and radially stiff and which is an acoustic radiator in its own right, the shape and configuration of the dome and the material of which it is made being such that break-up of the audio response does not occur below a frequency of the order of 17 kHz.

16. A cone loudspeaker as claimed in claim 15, in which break-up of the audio response does not occur below a frequency of the order of 20 kHz.

17. A cone loudspeaker substantially as hereinbefore described with reference to the accompanying drawings.

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