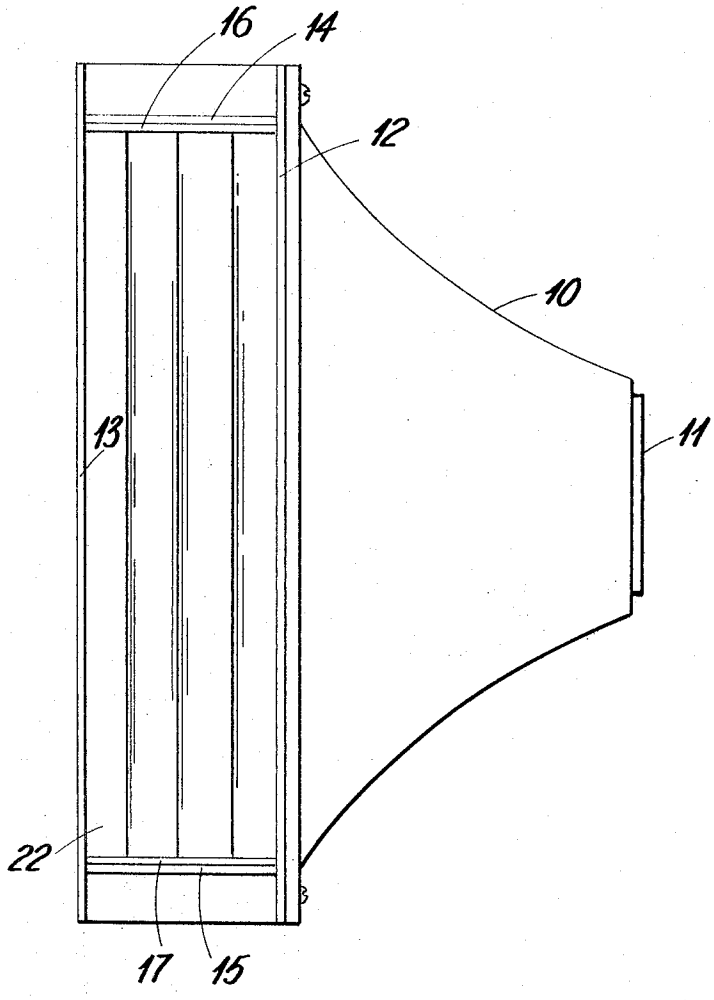
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Fig. 1.



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Fig. 2.

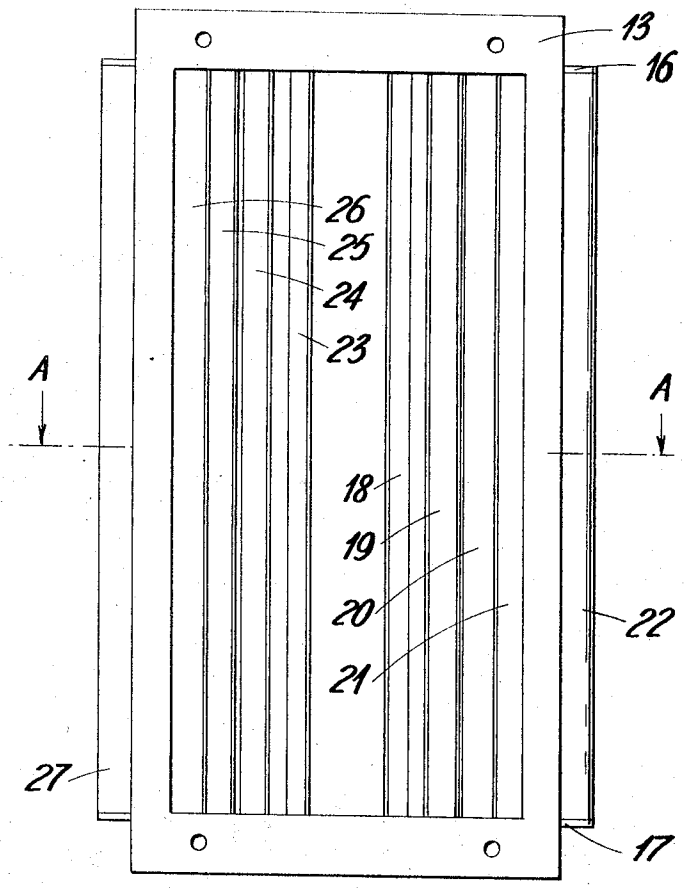
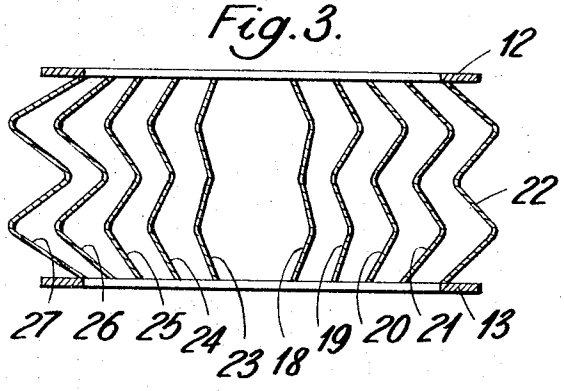


Fig. 3.



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LOUDSPEAKER HORNS

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6 Claims. (Cl. 181—31)

This invention relates to loudspeaker horns. According to this invention, a loudspeaker horn is provided at its mouth with an acoustic lens arranged to diverge a sound wave transmitted in at least one plane.

It is the practice in sound reproducing apparatus to provide a loudspeaker with a horn shaped so that the acoustic impedance at the throat of the horn, at which the sound radiator is located, is matched to the acoustic impedance at the mouth of the horn. This arrangement enables the conversion of electric energy to sound energy to be made without loss of power resulting from mismatching of the acoustic impedances of the radiator and the medium into which the sound is to be radiated. With this construction, the equivalent radiating aperture is approximately equal to the area of the mouth. It has been found that when the wave length of the sound wave approaches that of the dimensions of the aperture and hence the mouth of the horn the radiated wave becomes very directional, that is to say the intensity of the radiation on a line normal to the radiating aperture is much greater than that at an angle to that normal. A typical radiation diagram would, for example, have a large main lobe centred about the normal to radiating aperture, and with good design, small side lobes having their axes at various angles to the normal. For many purposes, this directionality of the horn loudspeaker is undesirable. With the present invention however, the dispersive lens disposed across the mouth of the horn may delay sound waves radiated from near the edge of the horn more than those at the centre and therefore the acoustic lens tends to produce a radiated wave having an amplitude which tends to be more uniform over the whole of the aperture of the horn.

This invention would therefore find particular application for use in stereophonic sound reproducing apparatus. It is the practice to provide a pair of loudspeakers the two loudspeakers being directed so that at the intersection of the normal to the radiation apertures of the loudspeakers, the well known stereophonic effect is reproduced. It is well known however, that the stereophonic effect is satisfactorily reproduced over a small area of listening space, if the loudspeakers are very directional. With the present invention however, owing to the dispersion of the radiated sound waves, sound may be received with equal intensity from each loudspeaker to reproduce the stereophonic effect over a far greater area than that hitherto possible.

The acoustic lens may be constituted by a plurality of sound transmission paths such that the length of travel of the radiated sound waves through the aperture of the horn varies across the width of the aperture and according to this aspect of this invention, a loudspeaker horn having a radiator radiating a plane acoustic wave is provided at its mouth with a series of plates so that waves near at least one portion of the side of the mouth are constrained to travel a greater distance than those being radiated from the centre of the mouth. With this construction, the path length of the wave near the side of the horn is greater than those at the mouth and the delaying effect on the increase in path length causes a dispersion of the wave so that the original plane waves radiated from the radiator are converted by the plates into waves

having a cylindrical wave front. The above construction achieves this dispersion without attenuation of the sound waves.

The or each series of plates may be shaped to define paths of successively increasing length for each pair of plates successively nearer the side of the horn and may be shaped so that adjacent plates form a zig-zag path for a sound wave passing through the mouth of the horn. With this construction a sound wave radiated from the horn passing between two plates travels by successive reflections from the plates and the increase in path length will depend on the tangent of the angle which each successive leg of the zig-zag path makes with the normal to the radiating surface of the mouth of the horn.

Very conveniently two series of plates may be disposed on either side of the mouth, the length of the path length defined by adjacent plates being constant along the length of the plates transverse to the said path. As has been mentioned previously such a loudspeaker horn would normally be used for stereophonic sound reproducing and the dispersion of the sound waves in one plane which would, of course, usually be the horizontal plane, enables the stereophonic effect to be appreciated over a wide area of a room in which the loudspeakers were located. However, it would usually be undesirable to have the same dispersion in the vertical plane since this would result in radiated energy being absorbed by the floor and ceiling of the room. With the construction as just described, the sound wave radiated from the horn is allowed to be directional in the vertical plane so that loss of energy owing to absorption by the floor and ceiling of the room is avoided.

The dispersive lens of the present invention would as previously mentioned usually be used with a radiator radiating a plane wave. Such a radiator may be a ribbon loudspeaker, since the light weight of the ribbon facilitates the matching of the acoustic impedances of the loudspeaker and the irradiated medium. Using such a loudspeaker, a cylindrical wave may be produced in the manner described by delaying the waves at the side of the horn. With a cone-type loudspeaker, the centre of the radiated wave would be considerably behind the wave at the side of the loudspeaker and it would be necessary to provide a greater increase in path length of the outside waves in order to produce the cylindrical wave.

Conveniently the plates are so disposed so that the zig-zag path through adjacent plates makes four changes of direction as the sound wave is traversing through the mouth of the horn. This construction is selected so that the width of the plates may be kept sufficiently far apart to avoid cross resonance caused by the plates being the same distance apart as successive nodes in the wave structure of the radiated wave, which would lead to an increase of acoustic impedance of the path between the plates and which would therefore attenuate the radiated wave.

In the following description reference will be made to the accompanying drawings in which:

FIGURE 1 is a view in elevation of a loudspeaker horn;

FIGURE 2 is a view of the front of the loudspeaker horn; and

FIGURE 3 is a sectional view through the apparatus shown in FIGURES 1 and 2.

Referring to the drawings, a loudspeaker horn **10** is shown having a plane radiator, illustrated diagrammatically at **11**, at its throat, the horn extending outwardly to a mouth defined by the plates **12**, **13** separated by plates **14** and **15**. The aperture of the horn is rectangular, the sides of the horn **10** curving outwardly from a rectangularly shaped throat to the full aperture at the plate **12**. Two series of serrated plates **18**, **19**, **20**, **21** and **22** and **23**, **24**, **25**, **26** and **27** are arranged between the plates **12**

and 13, opposite ends of the plate structure being closed by the plates 16 and 17 shaped to have a cross section defined by the edges of the plates 12, 13 and the outer plates 22 and 27. The successive plates of each series define a path for sound waves to travel through the aperture, and successive plates have portions disposed at a slightly greater angle to the normal so that the path length through successive pairs of plates increases towards the outside of the aperture. The separation between the plates is constant in the vertical plane so that directionality is achieved for that plane of radiation, whereas a dispersive effect is achieved in the orthogonal, that is to say horizontal plane of radiation.

What is claimed is:

1. Sound distributing apparatus comprising two parallel spaced walls respectively defining first and second aligned apertures of similar shape and substantially equal area; side, top and bottom walls extending between said spaced walls to enclose a volume between said aligned apertures; a plurality of vertically disposed plates located in said volume between said apertures, said plates each having a zig-zag section in the horizontal plane together defining a plurality of zig-zag sound transmission paths between adjacent plates from said first aperture to said second aperture, said plates providing an acoustic delay in each zig-zag path, said delay increasing for each path successively nearer said side walls; whereby an acoustic wave travelling through said volume between said first and second apertures is dispersed in the horizontal plane.

2. Sound distributing apparatus as set forth in claim 1 wherein said plates extends from top to bottom of said volume and are arranged side by side across said aperture, the length of a zig-zag path being greater for each successive path successively nearer a side wall of said volume.

3. Sound distributing apparatus as set forth in claim 2 wherein the separation of adjacent plates is invariant with height.

4. Sound distributing apparatus as set forth in claim 3 wherein the two innermost plates define between them a central path whose direction is straight, said central path's width being greater than the width of any one of the zig-zag paths.

5. Sound distributing apparatus as set forth in claim 4 wherein each plate is symmetrically shaped about a plane midway between said first and second apertures.

6. Sound distributing apparatus as set forth in claim 5 further defined by said apertures being identical and rectangular.

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