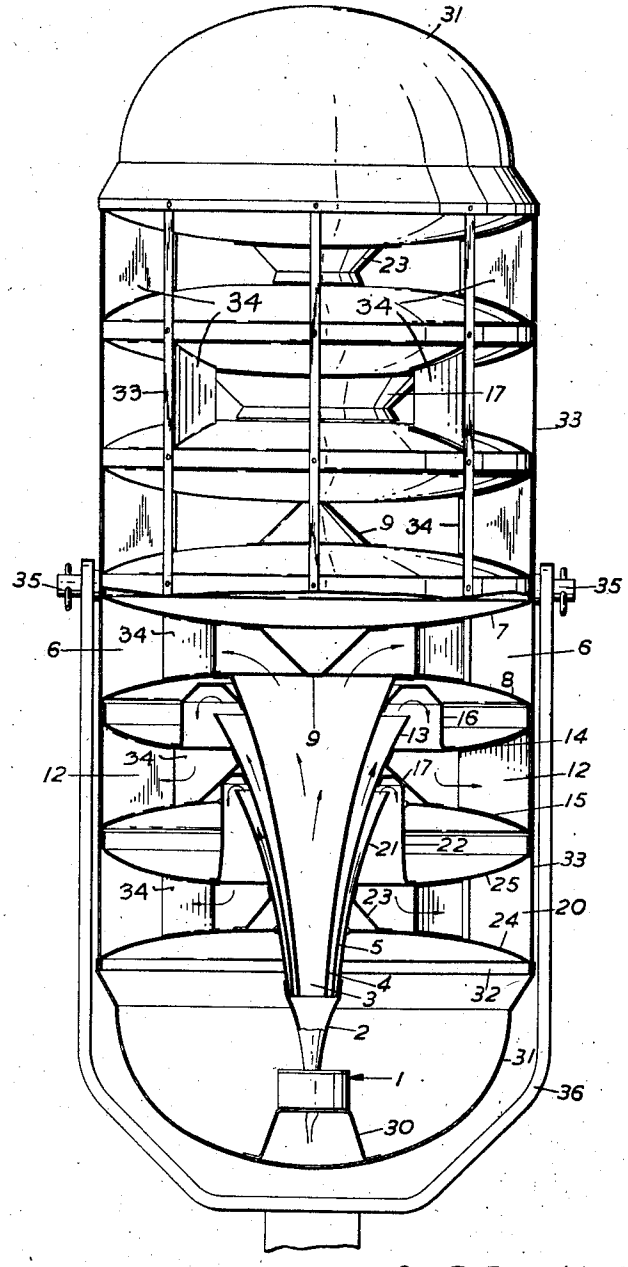
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ANNULAR DIFFUSION LOUDSPEAKER

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ANNULAR DIFFUSION LOUDSPEAKER

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This invention relates to loudspeakers of the horn type and is particularly concerned with those of 50 watts output and more.

It is well-known that the directional characteristics of such a loudspeaker depend on the shape of the mouth of the horn. In general, the concentration of sound or "directionality" as it may be called, is greatest in the plane which includes the major dimension of the mouth. If, however, the horn is flared in one particular direction so as substantially to increase the dimension of the mouth in that direction, the total increased directionality associated with such a major dimension will not occur. The reason for this is that the path of the sound up to the edge of the mouth in the region where it is flared is longer than the path to the centre of the mouth with the result that the sound reaching the edge is delayed in phase in relation to that of the centre. This gives a convex wave front, which will by its nature diverge. Thus in general there are severe limitations imposed on the selection of shape of mouth and horn development to suit the directional characteristics required.

In some cases, particular directional characteristics and a particular shape of mouth may be required which are not compatible with one another. An example of this is a so-called annular diffusion loudspeaker which is required to project sound radially in all directions in a common plane, which is generally horizontal. Any sound which diverges upwardly from the horizontal plane will be largely wasted and the directional characteristic required, therefore, is that of a substantially parallel beam of sound which radiates in all directions in the horizontal plane. The mouth of such a loudspeaker is necessarily annular or substantially annular in shape, preferably formed in a cylindrical or ellipsoidal surface, and in order to give a normal amount of development to the horn, it would be necessary to make this mouth as a relatively narrow annular slit which would not be directional in the required plane.

According to the present invention, in order to produce predetermined directional characteristics, the mouth of a horn-type annular diffusion loudspeaker is divided up by planes normal to its axis into a number of parallel substantially cylindrical sections, each with its own throat extending back to the source of sound energy, and the throats are so designed that the relative path lengths of the sound reaching the mouth are such as to produce a phase relationship between the various sections of the mouth giving the required horizontal directional characteristic, regardless of the shape of the mouth itself.

As already explained, with a mouth flared in the normal way the sound emerging at the edges is retarded in phase to give a convex wave front. By means of a sectional construction in accordance with the invention the throats of the different sections may be so designed that the sound in the centre section of the mouth is retarded in phase in relation to that of the edge sections so as to reduce the convexity of the horizontally radiating wave front and hence the degree of divergence of the sound beam in a vertical direction. Alternatively, a plane wave front giving a parallel beam of sound or even a concave wave front giving a sound beam which will come to a focus at any desired point may be obtained. Moreover, the degree of divergence or convergence of the sound beam may be adjusted in any required plane.

As previously mentioned, the problem is of particular importance in connection with an annular diffusion loudspeaker having an annular mouth and resides in the requirement to radiate the sound mainly in a generally horizontal plane. In the application of the invention to such a form of loudspeaker, therefore, the annular mouth is divided into a number of parallel, axial sections, each communicating with one of a corresponding number of co-axial throats extending along the vertical axis of the structure from the sound power unit, and the throats are so designed as to give approximately equal path lengths for the sound reaching each section of the mouth. This gives an approximately cylindrical wave front so that the sound is mainly concentrated in a generally horizontal plane as required.

Since the sections of the mouth inevitably lie at different distances from the sound power unit, the path lengths of the sound reaching them would normally be different and in order to make these path lengths equal, the throats leading to the sections of the mouth closer to the power unit may be extended in length by the provision of baffles around which the sound must pass. Each baffle may conveniently be constituted by an approximately axial extension of the wall of the throat so that the sound passes approximately axially along the throat, doubles back on itself around the end of the extension and then diverges radially towards the mouth.

It is found in practice that a relatively small number of sections will serve the required purpose and will, of course, facilitate the manufacture of the loudspeaker. Satisfactory results can be obtained by the use of three such sections so that by adjusting the phase of the central section in relation to that of the two outer sections, the general shape of the wave front can be correspondingly adjusted. In a similar manner, the amplitudes of the sound reaching the various sections can be correspondingly controlled by variation of the throat areas leading to the different sections, and in this way a further control of the directional characteristics is obtained.

An annular diffusion loudspeaker in accordance with the invention will now be described in more detail by way of example with reference to the accompanying drawing which shows the lower half of the loudspeaker in section.

The loudspeaker comprises two identical halves, the lower half being shown in section, and the upper half being inverted in relation to the lower. Referring first to the lower half of the loudspeaker, this comprises a sound power unit indicated generally at **1** which may be of fifty watts output or more. The sound output emerges along a throat **2** which merges into three separate co-axial throats **3**, **4** and **5**.

The innermost throat **3** leads to the section of the mouth which is furthest from the power unit **1**. Thus the sound passes axially along to throat **3** and then diverges radially to the corresponding section of the mouth indicated at **6**. The section of the mouth is defined by partitions **7** and **8**, which are, of course, circular in shape and which may conveniently be made as aluminium spinnings. The partition **7** is provided with a deflector **9** which diverts the sound in a radial direction and also maintains the correct development of the section of the horn.

The next section **4** of the throat leads to a section of the mouth shown as **12**, which is, of course, closer to the

sound power unit so that the path length of the sound must be correspondingly lengthened to make it approximately equal to that of the sound reaching the section of the mouth 6. For this purpose, a baffle 13 is provided which is constituted by an extension of the outer wall of the throat 4. Thus the sound passes substantially axially along the throat 4, passes around the end of extension 13 so as to double back on itself and then diverges in a radial direction towards the section of the mouth 12. This section of the mouth is defined between partitions 14 and 15 and by additional partitions 16 and 17 where the sound passes around the extension 13.

The sound passing along the outermost throat 5 of the horn to the section of the mouth 20 also has its path length increased by the provision of an extension 21 of the outer wall of the throat 5 and a reversely curved encircling partition 22 which cooperate to compensate for the shorter vertical distance between the power unit 1 and section 20 of the mouth than that between the power unit and section 12 of the mouth. The inner wall 23 of the outermost throat of the horn in the region encircling the extension 21 below and beyond the partition 22 is flared outwards and the section 20 of the mouth is defined by further circular partitions 24 and 25 connected to the adjoining edges of the partitions 23 and 22, respectively.

Thus it will be understood that the path lengths of the sound reaching the three sections of the mouth 6, 12 and 20 are approximately equal, thus giving an approximately cylindrical wave front so that the sound is mainly concentrated in a generally horizontal plane. The sound power unit 1 is mounted on a bracket 30 within a domed cover 31, which like the circular partitions may conveniently be made as an aluminium spinning. This cover fits on to a ring 32 and may readily be removed for maintenance purposes. The various partitions and other components are braced by longitudinal members 33, which may be provided with enough radial vanes 34 to make the entire structure rigid. As previously mentioned, the upper half of the loudspeaker exactly duplicates the lower half in an inverted position and corresponding reference numerals are used for convenience. A second power unit is enclosed within the upper domed cover 31 and the whole assembly is mounted on trunnions 35 in a U-shaped supporting frame 36 so that the upper half of the loudspeaker may readily be swung into the lower position so that either domed cover 31 may be removed for maintenance of the power unit contained within.

As described the mouth of each horn is divided into three sections and it is found that this is a convenient practical number. It will, of course, be understood that the mouth can be divided up into any other greater number of sections, and although this will produce slightly improved results, the manufacture is thereby complicated disproportionately. Also as shown the areas of the different sections of the throat are approximately equal, but if desired these may be varied to give different amplitudes of sound at the different sections of the mouth so as to exert a further element of control over the directional characteristics. In addition, if required more than one power unit may readily be used with each of the domed covers 31 and any other associated equipment, such as a matching transformer, may also be enclosed within the covers.

We claim:

1. A horn-type loudspeaker having an annular mouth formed in parallel sections spaced one above another on a vertical axis and adapted to radiate sound mainly in a generally horizontal plane, said loudspeaker comprising a source of sound power, means forming a plurality of co-axial throats extending from said sound source one to each section of said mouth, and means for extending the path length of sound along some only of said throats to give approximately equal path lengths for the sound reaching said mouth from said source.

2. A horn-type loudspeaker having a sound source comprising a power unit, an annular mouth having a vertical axis passing through said power unit and radiating sound through an angle of 360° mainly in a generally horizontal plane, said mouth being divided into a number of parallel axial sections, each section communicating with one of a corresponding number of co-axial throats extending along said vertical axis from the sound power unit, said throats providing approximately equal path lengths for the sound reaching each section of the mouth and thus maintaining the same phase relationship between the sound waves issuing through said mouth sections, thereby producing a cylindrical wave front having fixed directional characteristics.

3. A horn-type loudspeaker according to claim 2, in which the throats leading to the sections of the mouth closer to the sound power unit are extended in length by the provision of baffles around which the sound must pass.

4. A horn-type loudspeaker according to claim 3, in which each baffle is constituted by an approximately axial extension of the wall of the throat, so that the sound passes approximately axially along the throat, doubles back on itself around the end of the extension and then diverges radially towards the mouth.

5. A horn-type loudspeaker according to claim 2, in which the mouth is divided into a total of six sections, the lower three being supplied by a sound power unit in the base and the upper three by a unit in the top of the loudspeaker.

6. A horn-type loudspeaker according to claim 5, in which the assembly is mounted on trunnions in a supporting frame, so that the power unit which is normally at the top may be swung to the bottom for maintenance purposes.

7. A horn-type loudspeaker of the character providing annular diffusion, said loudspeaker having a substantially vertical axis and surrounding mouth formation comprising a plurality of parallel axially disposed circumferential outlets, each outlet being formed between a pair of oppositely facing diverging walls symmetrical about a vertical axis and communicating near the center with an independent channel connecting it with a common source of sound, said channels being disposed concentrically around the axis of said mouth formation and all being of the same length from end to end, thereby maintaining the same phase relationship between the sound as it emanates from said source and as it emerges from said axially spaced outlets and forms a cylindrical wave front for transmission radially outwards in all directions in a substantially horizontal beam.

8. A horn-type loudspeaker comprising a source of sound power, means forming a plurality of co-axial nested throats extending from said source, and means defining a mouth extending about and parallel to the axis of said throats and formed in parallel sections spaced one above another along said axis, each of said throats extending to a corresponding one of said sections.

9. A horn-type loudspeaker according to claim 8, in which some of the throats have provision for extending the effective path lengths of sound to their respective mouths to equalize the time required for the same sound to reach all of the mouths from said source.

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