

Nov. 8, 1938.

E. C. WENTE

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HORN

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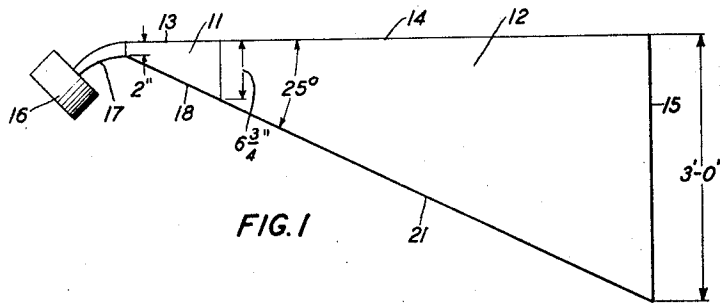


FIG. 1

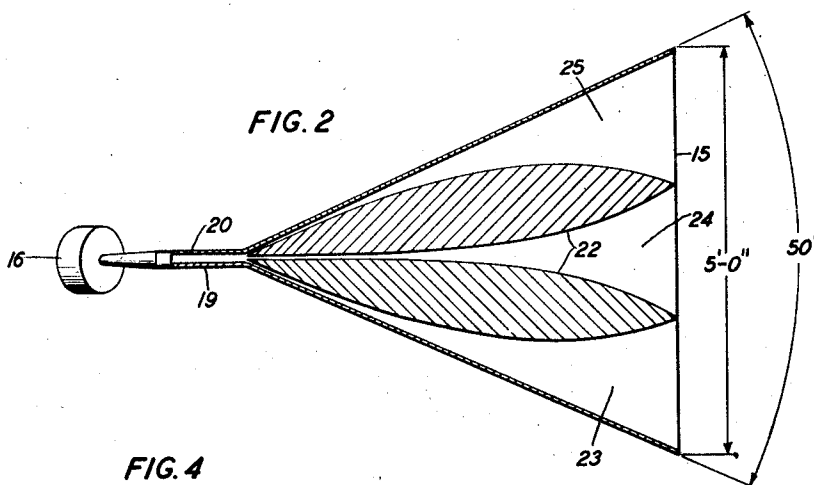


FIG. 4

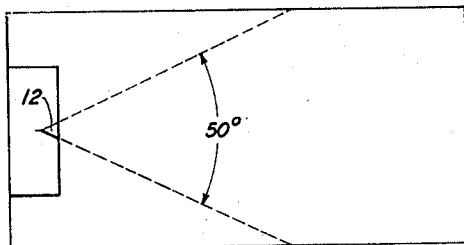


FIG. 3

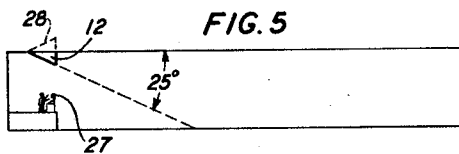
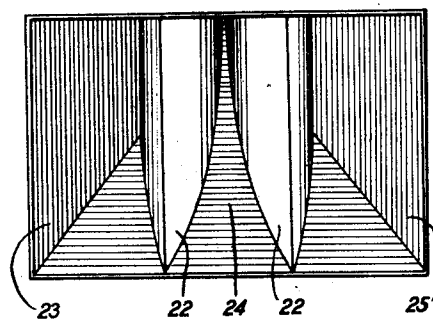


FIG. 5



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HORN

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2 Claims. (Cl. 181—27)

This invention relates to the reproduction of sound and particularly to horns for loud-speaking receivers in public address systems.

In systems of this type it is well understood that for a realistic reproduction the receiver should be located so that the sounds heard appear to come from the direction of the original source. This requires that the receiver be mounted near the sound source and it is common practice to place it above the speaker's stand. It is also well known that to enable the system to be operated at sufficient gain to give adequate coverage of the reproducing area without "singing" the pick-up microphone must be located within the acoustic shadow of the receiver.

In many cases this involves no particular problem and known apparatus and arrangements are quite satisfactory. In certain applications, however, it has been found very difficult to deliver the sound energy at adequate levels to the rear of the auditorium without causing singing or excessive loudness at the front and at the same time to preserve the illusion that the sounds are proceeding directly from the original source. This is particularly true, for example, in the case of a long narrow auditorium with a low ceiling. Such a room is in effect a long, narrow channel with its lower surface highly absorbing due to the presence of the audience so that sound projected from the front toward the rear is highly attenuated and the attenuation increases with frequency, a condition which is particularly unfavorable to the transmission of intelligible speech. Even if excessive volume levels were tolerable at the front of such rooms, the gain cannot be greatly increased to compensate for the attenuation since, because of the low ceiling height, some coupling between the microphone and the receiver cannot be avoided and when the gain is increased the system soon reaches the "singing" condition.

The object of this invention is a loud-speaking receiver horn which will distribute the sound energy more evenly over all parts of such auditoriums and which will preserve the illusion in all parts of the room of hearing the speaker's unaided voice.

In accordance with the general features of the invention the horn has an angle of projection limited in both lateral and vertical directions as required by the configuration of the area to be covered but within this angle it combines the uniform distribution of energy obtainable with a conical horn with the high conversion efficiency of the exponential type. It diverges from a

throat portion which is small to a mouth which is large as compared with the wave-lengths of the frequencies within the range to be projected. The four boundary walls are all plane surfaces to give the spherical wave front of a conical type horn and the mouth portion is subdivided by vertical partition walls which are contoured in such a way that each longitudinal horn section varies in cross-section exponentially. The width of each section is made small enough so that the directive beam effect at the higher frequencies is not excessive. With a horn of this construction the waves are projected at high efficiency and uniform quality over the solid angle defined by the bounding walls without substantial diffraction at the horn mouth.

In order to limit the projection angle in the vertical plane so that the pick-up microphone may be kept within the acoustic shadow of the horn the vertical dimension of the mouth must be large but such a horn is impractical in auditoriums with low ceilings. A further feature of this invention is a horn with one bounding wall normal to the mouth opening, the horn being mounted with this wall against the ceiling of the auditorium. This is the equivalent of dividing a horn along its axis of symmetry and using only one-half of the horn structure. Since there is no flow of energy across the axis of symmetry, this division does not affect the wave front and from the standpoint of diffraction in the vertical plane it gives the effect of a horn of twice its actual vertical dimension.

In the drawing:

Fig. 1 is a side view of a horn according to the invention;

Fig. 2 is a horizontal sectional view of the horn;

Fig. 3 is a front view of the horn; and

Figs. 4 and 5 are plan and sectional views of an auditorium showing the projection angle of the horn.

Referring now to Figs. 1, 2 and 3 the horn shown has a throat portion 11 and a mouth portion 12, of which the upper bounding walls 13 and 14 are coplanar and normal to the plane of the mouth 15 so that the horn may be mounted directly against the ceiling of an auditorium. The receiver unit 16 is connected by means of suitably curved and tapered tube 17 to the throat portion 11 the lower wall 18 of which slopes downwardly at angle of 25 degrees. In the vertical plane the sound waves, therefore, spread out with circular wave fronts as in a conical horn. The vertical walls 19 and 20 (Fig. 2) of the throat may be substantially plane parallel since most of

the flare necessary for an exponential variation is obtained by the divergence of the lower wall 18.

In the mouth portion 12 the upper and lower walls 14 and 21 continue in line with the corresponding walls of the throat but the vertical walls diverge in planes forming an angle of 50 degrees. The mouth portion is bounded by four plane walls and if not subdivided would therefore have substantially the transmission characteristics of a conical horn (that is to say, the sound waves would emerge from the mouth with spherical wave fronts and would proceed toward the rear of the auditorium without substantial diffraction but the conversion efficiency of such a horn is relatively low as compared with an exponential horn).

In order to improve the efficiency and at the same time retain the advantages of the conical horn two or more partitions 22 are disposed vertically in the mouth portion and divide it into three sections 23, 24 and 25 of the same cross-sectional area at equal distances from the horn throat. These partitions may be composed of balsa wood or other non-resonant material and are contoured so that each section has an exponential taper. The sound waves entering the mouth portion are intercepted by the partitions and pass along the three sections 23, 24 and 25 substantially as sections of a spherical wave front which merge into a spherical wave at the mouth opening and continue out without material increase in divergence through diffraction since the combined wave front at the horn mouth is large as compared with the wave-length down to quite low frequencies.

When this horn is mounted against the ceiling of an auditorium as illustrated in Fig. 5 above the speaker's stand 26 most of the sound will be projected toward the rear within the boundary angles shown in Figs. 4 and 5. There will, therefore, be very little coupling between the output of the horn and the microphone 27 so that the system may be operated at a high gain

without singing and this higher output level is projected principally toward the rear where an increase in level is most needed.

As will be seen from Fig. 5 the downward projection of sound is limited to the same angle at which it would be if the horn were symmetrical about the line of the ceiling as indicated by the dotted portion 28. If the horn were of the symmetrical construction indicated, however, it would be much more conspicuous and would extend down so near to the microphone that the system could not be operated at adequate output level.

For the auditorium shown, which is 55 feet wide, 110 feet long and only 18 feet high, good results are obtained with a loud-speaker of the type described having a mouth opening 5 feet wide and 3 feet high and a lower cut-off frequency of about 100 cycles. It will be obvious, however, that the taper of the walls, the number of partitions, the angle of projection and other factors may be varied to suit the requirements of a particular case within the scope of the following claims.

What is claimed is:

1. A horn for loud-speaking receivers bounded on all sides throughout its length by plane surfaces diverging from a throat portion, which is small compared to the wave-lengths of the frequencies to be projected, to a mouth which is large compared to said wave-lengths, said mouth having contoured partition walls dividing it into a plurality of sound passages each decreasing in cross-section exponentially throughout its length and extending back between the plane surfaces toward the throat of the horn to a point where the width of each passage is small as compared to said wave-lengths.

2. A horn according to claim 1 in which one of the bounding walls is normal to the mouth opening and is adapted to be mounted against the ceiling of an auditorium to increase the effective height of the mouth opening.

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