343-756 CROSS REFERENCE SEARCH ROOM

Oct. 26, 1965 A. SCHLAUD 3,214,761

AUXILIARY ANTENNAS COUPLED TO MAIN HORN FOR EQUALIZATION OF PATTERNS DUE TO PERPENDICULAR COMPONENTS OF CIRCULARLY POLARIZED WAVES

Filed June 27, 1961 3 Sheets-Sheet 1

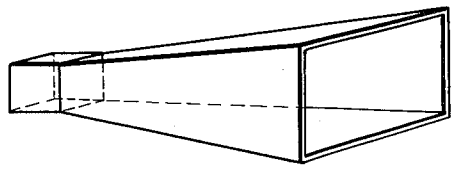


Fig. 1

PRIOR ART

Fig. 2

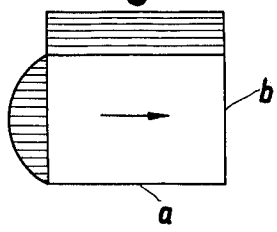


Fig. 3

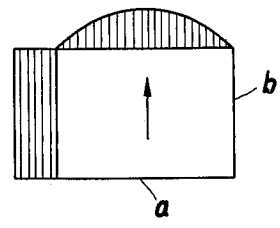
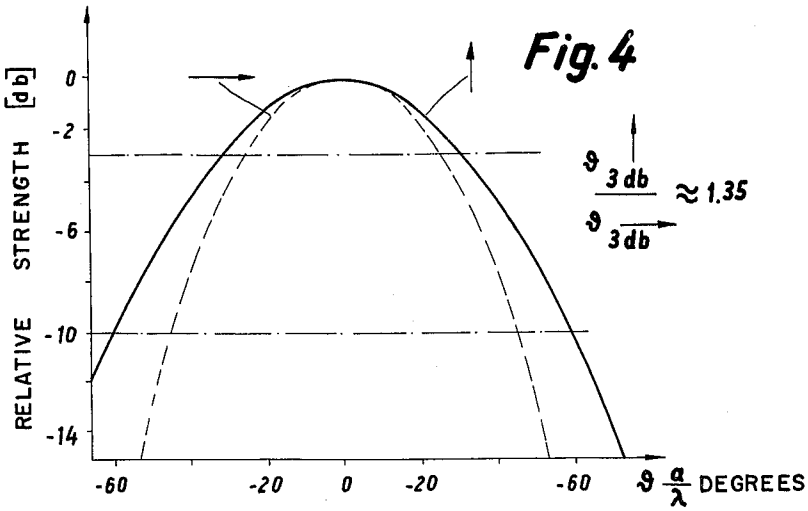


Fig. 4



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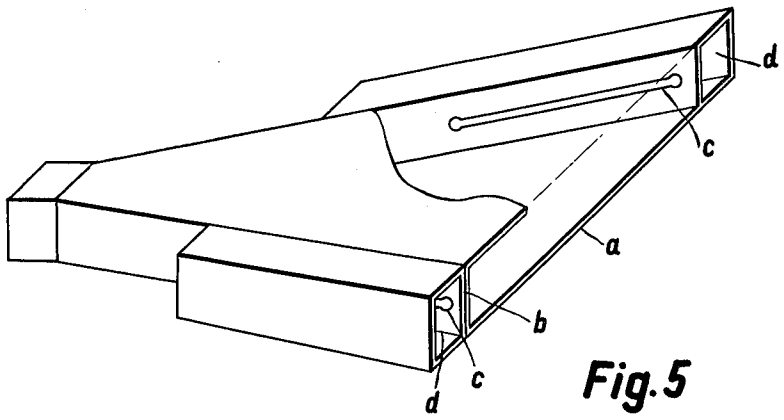


Fig. 5

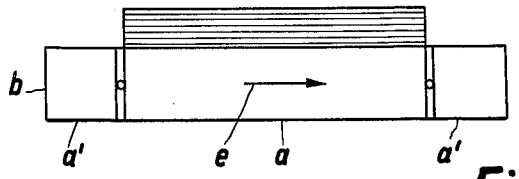


Fig. 6

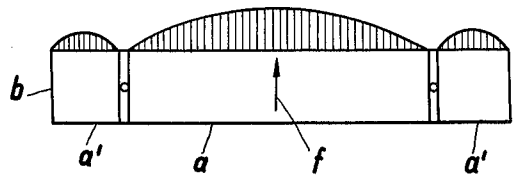


Fig. 7

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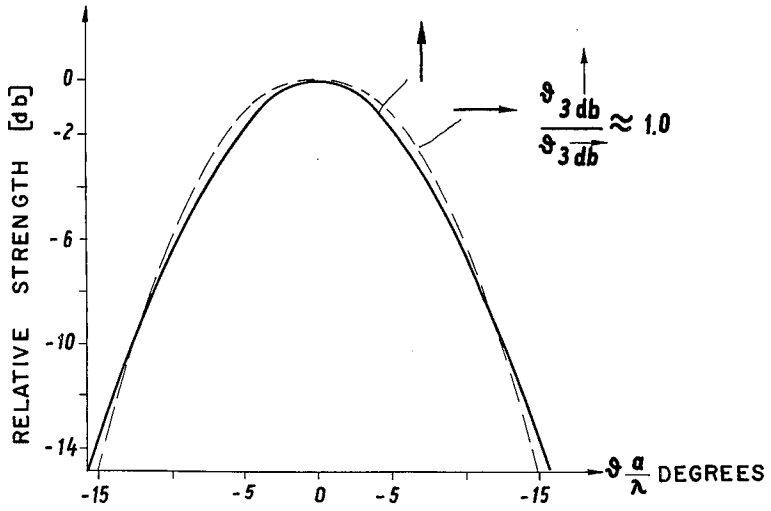


Fig. 8

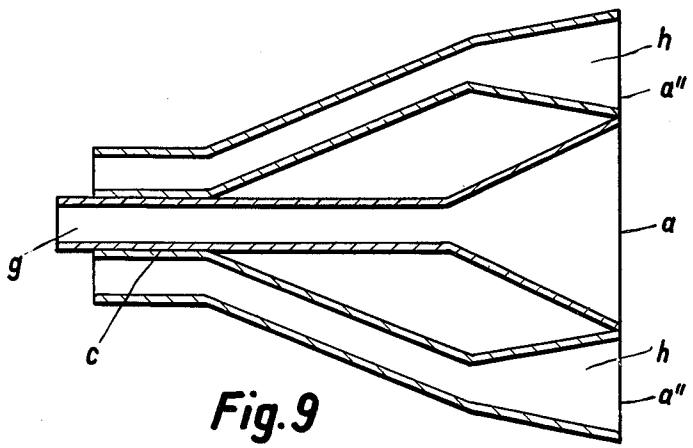


Fig. 9

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AUXILIARY ANTENNAS COUPLED TO MAIN HORN FOR EQUALIZATION OF PATTERNS DUE TO PERPENDICULAR COMPONENTS OF CIRCULARLY POLARIZED WAVES

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2 Claims. (Cl. 343—786)

The present invention relates generally to antenna arrangements for very short electromagnetic waves, and more particularly to horns for circularly or elliptically polarized waves for generating identical directional patterns for the vertical and horizontal components of which these waves are composed.

Due to the amplitude coverage of the horn aperture which is sensitive to polarization, conventional horns radiate the two components differently. The components of a circularly or elliptically polarized electromagnetic wave are at right angles to, and out of phase with, one another, and in the E-plane a directional pattern is generated which is different from that of the H-plane. Thus, the amplitude coverage in the plane parallel to the E-vector is homogeneous in the case of excitation by an H_{10}-wave, while it has a cosinusoidal shape in the plane at right angles thereto. Therefore, these horns are not suitable for radiating or even for receiving circularly or elliptically polarized waves. For example, a wave circularly polarized in the horn feeding line would be converted into elliptically polarized waves with varying axial ratios in the individual angular regions of the directional pattern.

Various horns are already known which generate substantially identical directional patterns for the two linearly polarized components of a circularly or elliptically polarized wave. In one of these horns, a dielectric plate is provided which fills only a part of the width of the aperture and lies in the plane in which the adjustment of the directional pattern is to be achieved. Another horn has triangular conducting plates for pattern adjustment arranged at right angles to the inner wall in the plane of the direction of wave propagation. It is also known to provide a conducting partition wall in the center of the aperture in the plane of the direction of wave propagation.

However, all these known horns have considerable drawbacks, especially regarding width of band, backward damping, mismatch, mechanical stability, and minimum over-all length.

With these defects of the prior art in mind, it is a main object of the present invention to provide a horn having a directional radiation pattern which is independent of the polarization of the waves of energy fed to the horn.

Another object of the present invention is to provide a simple horn arrangement which will obviate the above-mentioned defects of known horns.

According to the instant invention, a horn assembly is provided for generating a directional pattern independent of the polarization of the waves of energy fed to it, which assembly includes additional hollow-tube antennas or auxiliary funnel-type antennas coupled with the horn means including the main horn and its feeding line by coupling means which are sensitive to polarization.

Additional objects and advantages of the present invention will become apparent upon consideration of the following description when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a diagrammatic perspective view of a conventional prior-art horn with a rectangular aperture.

FIGURE 2 is a diagram illustrating the amplitude coverage of the aperture of the horn according to FIGURE 1 in the case of horizontal polarization.

FIGURE 3 is a diagram illustrating the amplitude coverage of the aperture of the horn according to FIGURE 1 in the case of vertical polarization.

FIGURE 4 is a graph showing the directional patterns of the horn according to FIGURE 1 in the case of vertical and horizontal polarization.

FIGURE 5 is a perspective view of an embodiment of a horn according to the invention.

FIGURE 6 is a diagram illustrating the amplitude coverage of the aperture of the horn according to FIGURE 5 in the case of horizontal polarization.

FIGURE 7 is a diagram illustrating the amplitude coverage of the aperture of the horn according to FIGURE 5 in the case of vertical polarization.

FIGURE 8 is a graph showing the directional patterns of the horn according to FIGURE 5 for vertical and horizontal polarization.

FIGURE 9 is a horizontal sectional view of a further embodiment of the instant invention.

Referring now to the drawings in detail, FIGURE 1 shows a conventional horn. If it is excited by a horizontally polarized H_{10}-wave, an amplitude distribution is produced as indicated by the lined areas in FIGURE 2 which show the horn aperture having sides a and b forming a rectangle. The arrow indicates the direction of polarization. In the vertical plane, the coverage is cosinusoidal, and in the horizontal plane, the coverage is homogeneous. In the case of excitation by vertical polarization, however, the amplitude distribution is inverse, as may be seen from FIGURE 3. The widths at half transmission for vertical polarization

$$(\vartheta_{3\,\overset{\uparrow}{\mathrm{db}}})$$

and horizontal polarization

$$(\vartheta_{3\,\overset{\rightarrow}{\mathrm{db}}})$$

differ, in the cases of coverage indicated in FIGURES 2 and 3, by a factor of about 1.35, as also follows from the directional patterns acording to FIGURE 4. In FIGURE 4, the radiated energy (in db relative to the radiation maximum) is plotted, for the horizontal plane, against the radiation angle ϑ (relative to the horn axis), standardized to a/λ.

The symbols represent the following:

ϑ=radiation angle
a=dimension of the aperture in the horizontal plane
λ=wave length
Continuous line=vertical polarization ($\uparrow$)
Dotted line=horizontal polarization ($\rightarrow$)

The same factor 1.35 is obtained for the vertical plane. This behaviour is independent of the ratio a/b of the sides of the aperture, and is thus true also for quadratic horns.

The horn assembly according to the present invention, which is shown in FIGURE 5, provides a substantial adjustment of the vertical and horizontal patterns to one another, and thus a comparative factor of about 1.0 may be achieved for the width at half transmission.

Additional hollow-tube antennas d are coupled with the conventional horn via coupling slits c which are sensitive to polarization in the small sides. The conventional horn is rectangular in cross section and has an aperture determined by the dimensions a and b. In horizontal polarization, the additional antennas do not become effective since, as in the known measuring sections, the slits lying

in the central plane of the cross section of such an additional antenna do not couple out any energy. However, in vertical polarization they are coupled which results in the amplitude coverages shown in FIGURES 6 and 7, analogous to those in FIGURES 2 and 3. Thus, for horizontal polarization, as indicated in FIGURE 6 by the horizontal arrow *e*, only the wide side *a* of the horn determines the homogeneous coverage. For vertical polarization in the direction of the arrow *f*, the cosinusoidal coverage extends over the sides *a* of the horn and *a'* of the additional antennas, so that a good adjustment of the directional patterns for horizontal and vertical polarization may be thereby achieved. The coverage may easily be varied by varying the coefficient of coupling. Thus, the focusing in the horizontal plane may be largely adjusted at will.

FIGURE 8, which is similar to FIGURE 4, illustrates the curves obtained when the radiated energy is plotted against the radiation angle when using the present invention, such as the horn arrangement disclosed in FIGURE 5. From this figure it may be seen that the comparative factor will be about 1.0.

Other known means sensitive to polarization may be used for the coupling, such as pin couplings, loop couplings, hole couplings, or general directional couplings. In order to achieve width of band in the horn according to the present invention, a resonance coupling should be avoided as much as possible. Such a coupling may yield advantages if the strength of the coverage of the additional antennas cannot be adjusted large enough in aperiodic coupling. In slit couplers, the strength of the resonance coupling is a function of $n \cdot \lambda/2$, with $n=1, 2, 3 \ldots$ and λ=wave length. It should be borne in mind that the wave length in the additional antennas is different from that in the horn.

In order to achieve a uniform phase front of the radiated energy, phase-shifting means known per se (not shown) may be provided for equalizing the phase frequencies which are different in the horn and in the additional antennas.

If a hole coupling is used in the central plane of the cross section, it is advisable to provide several holes whose diameters taper off outwardly to both sides.

The coupling of the auxiliary funnel-type antennas with the horn does not have to be done directly in the manner previously described, but may also be done with the feeding line *g*, as in the embodiment of the invention according to FIGURE 9. The additional antennas may have

the cross section of normal waveguides, as in the embodiment according to FIGURE 5, or they may be designed as funnel-type antennas *h* with the wide side *a''* of the aperture according to FIGURE 9.

Compensating means known per se, for example, pins or disks, may be provided, in the main horn and/or in the additional antennas, to compensate for the mismatch of the horn according to the invention.

It will be understood that the above description of the present invention is susceptible to various modifications, changes, and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

What is claimed is:

1. A horn assembly for generating a directional radiation pattern independent of the polarization of the waves of energy fed to it, comprising a main horn having a single feeding line and expanding away from said line; additional antennas external of said main horn; and coupling means sensitive to the polarization for coupling said additional antennas to said main horn.

2. A horn assembly for generating a directional radiation pattern which is independent of the polarization of the waves of energy fed to it, comprising a main horn having a feeding line, the ratio of the polarization components to each other in the feeding line being different from the ratio of the polarization components to each other in the horn aperture whereby said horn is sensitive to polarization; additional antennas; and coupling means coupling said additional antennas to said main horn and sensitive to polarization for compensating for the difference in ratio of the polarization components in the main horn with respect to the feeding line, whereby the pattern of said assembly is independent of the polarization fed thereto.

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