

Aug. 25, 1964

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3,146,453

SHORTENED HORN ANTENNA WITH MULTIPLE PHASED FEED

Filed Aug. 24, 1959

Fig. 1.

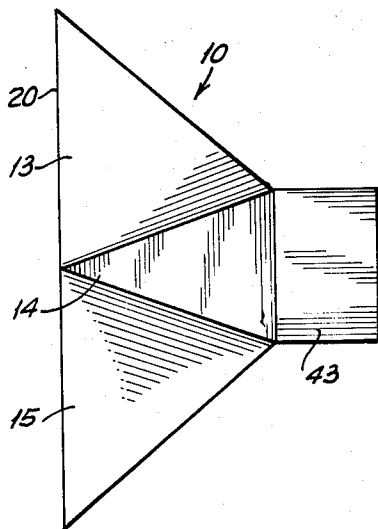


Fig. 2.

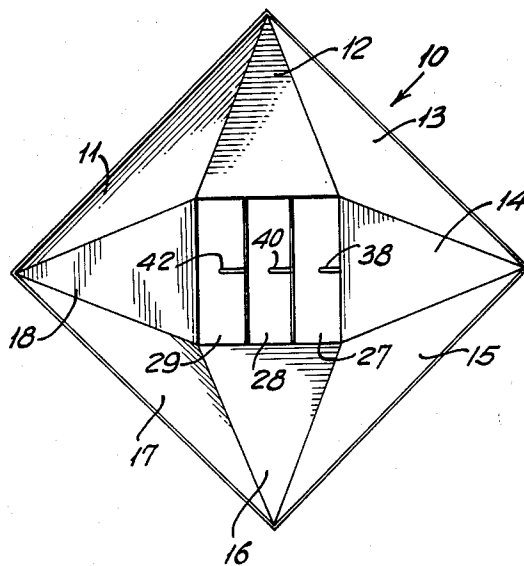
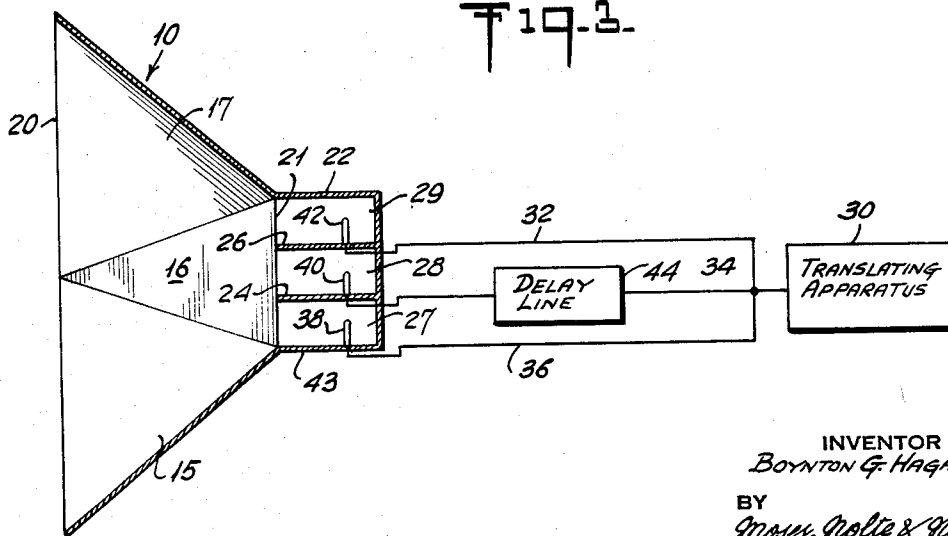


Fig. 3.



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SHORTENED HORN ANTENNA WITH MULTIPLE PHASED FEED

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Filed Aug. 24, 1959, Ser. No. 835,730
7 Claims. (Cl. 343-778)

The present invention relates to electromagnetic horn antennas and particularly to the reduction of the length of such antennas and the improvement of their operating efficiency.

It is known that the flare angle of electromagnetic horns must be kept rather small by increasing their length relative to the width of the aperture, otherwise the waves arrive at the aperture in different phases, thereby decreasing the radiation efficiency of the horn and reducing its directivity. For this reason as well as the fact that the radiating aperture of the horn must generally have a width equal to several wave lengths, horns have been used in the past only for very short wavelengths and particularly for microwaves. When horn antennas are used for wavelengths of as much as a hundred meters, or even more, the dimensions of the horn and particularly its length become very great. Horns of such size are expensive to construct and maintain and require a very large land area. The large length of an efficient horn is a drawback also at shorter wavelengths, particularly where only a limited antenna mounting area is available or where there are wind resistance difficulties and other problems due to the size of the antenna. For all these reasons it is obviously important to reduce the length of a horn antenna without impairing its operating efficiency, or conversely, to improve the operating efficiency of a given horn antenna.

According to the present invention, the length of a horn antenna can be reduced considerably or its aperture efficiency adjusted. This is accomplished by exciting the antenna with waves having different phase relationships such that after the waves travel different distances to the radiating aperture of the antenna, they arrive at the aperture at controllably different phases, or nearly in the same phase so as to enable the antenna to maintain a high radiation efficiency. An object of the invention is to accomplish this result without impairing or obstructing the transmission of waves through the horn.

Another object of the invention is to vary or adjust the aperture efficiency of a horn antenna, and consequently its beamwidth or directivity, over a considerable range by adjusting the relative phase delay between the waves in a center feed section and end feed sections of the horn.

Other objects and advantages of the invention will become apparent and the invention will be fully understood from the following description and the drawings in which:

FIG. 1 is a top view of the antenna with a portion of the wave guide wall broken away;

FIG. 2 is a side view of the horn antenna; and

FIG. 3 is a view looking into the aperture of the horn.

The invention will be described particularly with respect to a horn antenna of the type disclosed in my co-pending application, Serial No. 791,248, now Patent No. 2,992,429. Antennas of this type may be used for relatively long wavelengths of a hundred meters or even more. Such antennas, of course, have dimensions of many hundred feet and require an extensive supporting arrangement, which is not a part of the present invention and not necessary to a full understanding thereof. It may also be noted that antennas of this size and intended for rather long wavelengths need not be constructed of solid metallic material but may consist of metallic mesh or wires.

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The particular horn shown in the drawing has a polygonal aperture the maximum dimensions of which are in horizontal and vertical planes. The horn 10 has eight triangular sides 11-18 forming a flared horn with a square aperture. It will be understood, of course, that other types of horns of known design and constructed in various ways may be used. It will be assumed that it is desired to utilize the horn for transmission, although it will be understood that the same antenna can also be used for reception and that the antenna is to be excited with waves having a horizontal polarization.

Opposite the aperture 20 the small end 21 of the horn is connected to a wave guide 22. The wave guide is herein shown as a rectangular guide. A plurality of partitions 24, 26 formed of metal divide the wave guide into a plurality of separate compartments. Partitions or walls 24, 26 are in vertical planes. Each compartment or section 27, 28, 29 of the wave guide is separately energized by waves from the same source 30. The apparatus 30 may, of course, be a receiver, when the horn is being used for radio reception. The translating apparatus 30 is connected by a plurality of feed lines 32, 34 and 36 to horizontally extending radiators 38, 40 and 42. Radiators 38, 40 and 42 may be any suitable antennas, such as linear probes extending horizontally for producing linearly polarized waves in the several sections of wave guide 20. Feed line 34 includes a preferably adjustable delay device or delay line 44 connected to the radiator 40.

When waves are supplied from source 30 by lines 32, 34 and 36 and delay device 44 to the wave guide 22, the waves arrive at antennas 40 in section 28 with a given delay relative to the waves produced in wave guide sections 27 and 29. The waves emanating from the wave guide section 28 travel an approximate distance L to the aperture 20 along the central portion of the horn while the waves in wave guide sections 27 and 29 travel a greater distance indicated by R along the sides of the horn to the end of the aperture. The longer wave length path R produces a phase delay with respect to the wave travelling the shorter path L. This phase delay is compensated by the delay introduced by the delay line 44. Thus, by the use of only one delay device connected to the central radiator 40 a considerable correction of the phase variation across the aperture 20 can be accomplished, thereby increasing the radiation efficiency and the directivity of the horn, and permitting the horn to have a short length. Adjustment of delay device 44 permits the aperture efficiency to be controlled. Inasmuch as the directivity or beamwidth of the horn is related to its aperture efficiency, the delay device 44 constitutes a means of varying the directivity of the horn over a considerable range. This variation of beamwidth is extremely advantageous where it is desired to cover a large or small target with the same antenna.

It will be understood that I have described the invention in its simplest form, and it will be quite apparent to those skilled in the art that the wave guide 22 might be divided into any number of separate sections and that any number of exciting antennas might be placed in each section. Since many variations and modifications of my invention disclosed herein will be apparent to those skilled in the art, the invention is not to be construed as limited except as defined in the following claims.

What is claimed is:

1. An electromagnetic wave antenna comprising a flared horn having a short length and an aperture lying in a given plane, a rectangular wave guide connected to the small end of said horn, said wave guide having a plurality of longitudinally extending metallic walls dividing the wave guide into inner and outer sections, whereby the inner wave guide section illuminates predominantly

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the middle portion of the horn aperture and outer sections of the wave guide illuminate predominantly the end portions of the horn aperture, a source of radio waves, means for supplying the radio waves from said source to said wave guide, and means for compensating for the relative phase differences between waves arriving at the aperture of said horn, said compensating means comprising means for delaying the waves supplied from said source to the inner wave guide section relative to the waves supplied to said outer wave guide sections.

2. An antenna comprising a flared horn having a short length and an aperture lying in a single plane, a rectangular wave guide connected to the small end of said horn, said wave guide having a plurality of longitudinally extending metallic partitions dividing it into intermediate and outer wave guides, a first exciting means in said intermediate wave guide for illuminating predominantly the middle portion of the horn aperture and additional exciting means in said outer wave guides for illuminating the peripheral portions of the horn aperture, a source of radio waves, means for supplying the radio waves from said source to said exciting means, and means for compensating for the relative phase differences between waves arriving at the aperture of said horn, said compensating means comprising means for delaying the waves supplied from said source to the first exciting means relative to the waves supplied from the source to said additional exciting means.

3. An antenna according to claim 2, wherein said exciting means include parallel linear radiators extending perpendicularly to said partitions.

4. An antenna according to claim 3, the horn being formed and fixed to said wave guide so that the width of the aperture in the direction perpendicular to said linear radiators is a maximum at the middle thereof and tapers to minimum values at the ends of the aperture.

5. In combination, a flared horn having a large flare angle and a short length, a rectangular wave guide connected to the small end of said horn, said wave guide including a first antenna means including a linear radiator coupled predominantly to the middle portion of the horn aperture and additional antenna means including

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linear radiators coupled predominantly to the end portions of the horn aperture, radio wave transmission means connected to said antenna means, and means for compensating for the relative phase differences between waves arriving at the aperture of said horn, said compensating means comprising means for delaying the waves supplied to the first antenna means relative to the waves supplied to said additional antenna means, the horn being formed so that the width of the aperture in the direction perpendicular to said linear radiators is a maximum at the middle thereof and tapers to minimum values at the ends of the aperture.

6. In combination, a flared horn having at least two relatively rapidly diverging walls, a wave guide connected to the small end of said horn, said wave guide including first wave supply means communicating predominantly with the middle portion of the horn, and additional wave supply means communicating predominantly with the portions of the horn adjacent said diverging walls, radio wave transmission means connected to said wave supply means, and means for compensating for the relative phase differences between waves arriving at the aperture of said horn, said compensating means comprising means for producing a phase delay in the waves supplied to the first wave supply means relative to the waves supplied to said additional wave supply means, said delay being proportional to the difference between the length of said middle portion and the length of said end portions.

7. An antenna according to claim 6, wherein said waveguide is of a rectangular cross-section and said horn comprises eight triangular sides, the bases of four of said sides being fixed to respective walls of said waveguide.

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