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MULTI-CHANNEL HORN ANTENNA

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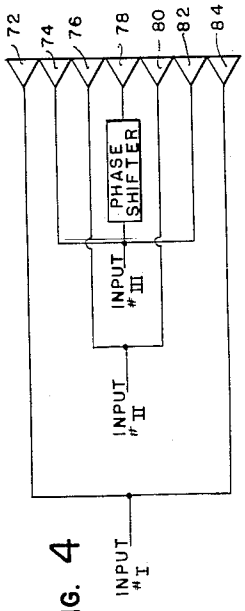


FIG. 4

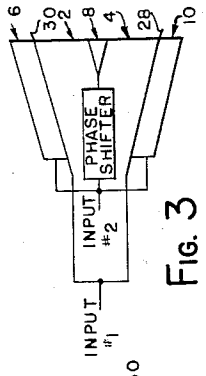


FIG. 3

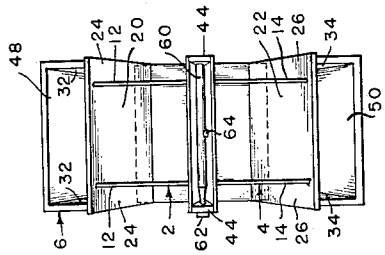


FIG. 2

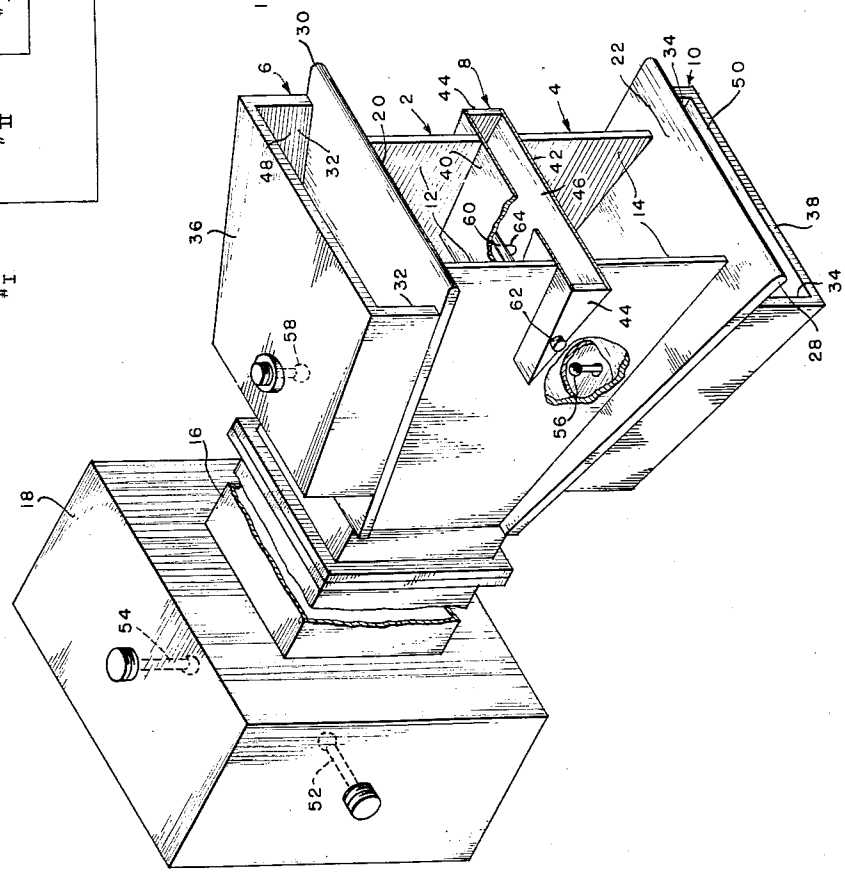


FIG. 1

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MULTI-CHANNEL HORN ANTENNA

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This invention relates to antennae and more particularly to a multi-channel horn antenna.

The principal object of the present invention is to provide a horn antenna array capable of radiating a plurality of separate beams at different frequencies from the same effective phase center with substantially the same pattern.

More specifically, it is an object of the invention to provide a horn array wherein one set of horns forming a beam at one frequency is interlaced with a second set of horns forming a beam at a second frequency so as to radiate two separate frequencies from the same effective phase center.

A still more specific object of the invention is to provide a multi-frequency horn array wherein at least two of the horns radiating one of the beams from a common input are formed by a septum which in turn is also a horn acting in concert with still other horns to radiate a beam from a second common input at a second frequency.

Another object of the invention is to provide a multi-channel horn array wherein the horns of one channel are interlaced in alternate relationship with the horns of the second channel and wherein one of the horns of one channel is formed by a horn-like septum separating two horns of the other channel.

Still another object of the invention is to provide a multi-channel horn antenna array which permits the channels forming the beams of separate frequencies to be independently polarized.

A still further object of the invention is to provide a multi-channel horn array which may be extended to provide a radiation source for any number of channels with the same or different radiation patterns and polarizations for each channel as desired.

Other objects and their attendant advantages will become apparent as the following detailed description is read in conjunction with the accompanying drawings wherein:

Fig. 1 is a perspective view of a multi-channel horn antenna incorporating the features of the present invention;

Fig. 2 is a front elevational view on a reduced scale of the antenna of Fig. 1;

Fig. 3 is a schematic diagram of the arrangement of Fig. 1; and

Fig. 4 is a schematic diagram illustrating the manner in which the horn array of the invention can be extended to handle any of the plurality of separate channels.

In the transmission of directional radio waves it is frequently desirable that at least two different beams operating at different frequencies with different polarizations be transmitted simultaneously with substantially the same pattern. For example, in a typical Radar System an IFF signal at one frequency is desirably transmitted simultaneously with a search signal at a different frequency with a different polarization from that of the IFF signal. The present invention is particularly adapted, though by no means limited, to such simultaneous radiation and

with reference to Fig. 1, the horn array comprises two sets of interlaced horns with each set being adapted to radiate a single beam. One set forming one beam comprises the horns 2 and 4 and the set forming the second beam comprises the horns 6, 8 and 10.

Ths horns 2 and 4 of the first set are formed in part by the horn 8, later described in detail, which serves not only as a horn in its own right but also as a wedge-shaped septum for effecting in a known manner horizontally polarized waves derived from a common input for the horns 2 and 4 as will become more fully apparent.

Each of the horns 2 and 4 above and below horn 8 have parallel side walls 12 and 14 formed of unitary sheet members which taper rearwardly to merge with the corresponding sides of a rectangular guide 16 leading to an energy source indicated generally by a rectangular box-like member designated by the numeral 18. The upper wall 20 of horn 2 and the lower wall 22 of horn 4 are formed of sheet members having side edges which diverge forwardly from the upper edge of the guide portion 16, the divergence being such that the forward side edges of the sheet members 22, 24 extend laterally on opposite sides of the vertical wall to provide overhanging portions 24 and 26 as clearly seen in Fig. 2. Additionally the members 20 and 22 extend forwardly beyond the apertures of horns 2 and 4 to provide fins 28, 30 to separate horn 2 from horn 6 and horn 4 from horn 10.

Horns 6 and 10 are formed in part by the outer surfaces of sheet members 20 and 22 with the side walls 32 and 34 of the respective horns diverging outwardly and being integrally fixed with the outer edges of respective cover members 36 and 38.

The horn 8, which acts in concert with the horns 6 and 10 is wedge-shaped in cross-section with diverging upper and lower walls 40 and 42, and diverging side walls 44 whose forward ends have preferably the same lateral spacing at the aperture 46 as do the horns 6 and 8 at their respective apertures 48 and 50.

As illustrated, the horns 2 and 4 produce circularly polarized radiations derived from horizontal and vertical input probes 52 and 54 connected to suitable transducer means (not shown) with the horns 2 and 4 being energized in parallel relationship and the horizontally polarized component of the radiation being shaped in the usual manner by the horn 8 acting as a septum as mentioned heretofore. The horns 6 and 10 are energized from a common source with energy being fed to the horns by means of probes 56 and 58. The horn 8, since it lies in the path of radiation leading from guide 16 to horns 2 and 4 and cannot be energized by means which might lie in the radiation path, is therefore energized by a transverse transmission member 60 which extends between the walls 44 with one end 62 projecting through one of the walls 44 for connection to a suitable conductor. In order to adjust the impedance of horn 8 to the desired value, a boss 64 engaging the transmission member 60 and a wall 42 of the horn is provided so as to be slidable initially to the optimum position with respect to the member 60 and then be permanently fixed in place.

The sets of horns, namely, the first set formed by the horns 2 and 4 and the second set formed by the horns 6, 8 and 10, are shown arranged with respect to each other so that the first set transmits higher frequencies than the second set. In accordance with the invention, the horns of the second set could be arranged to transmit frequencies which are higher than the first set by decreasing the lateral width of the apertures of horns 6, 8, 10 so that they have less width than the apertures of horns 2 and 4. This could be accomplished, for example, by adjusting the spacing of the side wall members 32, 44, 34 of the respective horns 6, 8, and 10.

Fig. 3 is a schematic diagram of the horns illustrated

in Figs. 1 and 2. The main axis of either beam radiated by its set of horns may be positioned by phase adjustment of the individual horns and in order to feed a beam perpendicular to the face of the array, it is necessary that the energy radiated by the horns from either input be in phase at the apertures. This is accomplished at input #1 of Fig. 3 for horns 2 and 4 by means of horn 8 in its capacity as a septum in an electromagnetic horn acting as a power divider with equal phase change to horns 2 and 4. The horns 6, 8, 10 fed by a common input #2 are kept in phase by virtue of transmission lines of equal electrical length. Outer horns 6, 10 are fed by symmetrical lines whereas the electrical length of the line to horn 8 is adjusted by means of a phase shifter in the line.

Fig. 4 illustrates schematically a multi-channel horn array arranged in accordance with the invention to transmit three beams at different frequencies. The inputs I, II and III feed the respective horns for each input with the center horn 78 of the array being also a power dividing septum forming horns 76, 80 of one set radiating one beam as described heretofore. The horns 74, 82 form with horn 78 another set and the horns 72, 84 compose the third set. From the foregoing it will be apparent that the invention permits an indefinite stacking or interlacing of sets of horns each of which transmits a separate beam at a different frequency. The number of horns composing each set can be varied as desired.

In Figs. 1 and 2, the horn array of the invention has been described as radiating through the horns of 6, 8, 10 a vertically polarized channel. The horns 2 and 4 have been shown and described as radiating a circularly polarized channel. It will be apparent that either vertical or horizontal polarization can be radiated from horns 2 and 4. The array of the invention, therefore, permits versatility in the selection of polarization and, in addition, by simple structural changes, permits a frequency relationship between each set of horns to be selected so that one set, depending on use or need, can transmit a beam at either a lower or a higher frequency than the other. The use of a septum acting both as a power divider for one set of horns and also as a horn by itself is unique in the art of horn antennas and enables two beams at different frequencies to be radiated simultaneously from the same source with substantially the same pattern.

It will of course be apparent to those skilled in the art that the present invention described and shown herein is susceptible of various modifications and changes without, however, departing from the scope and spirit of the appended claims.

What is claimed is:

1. A multi-frequency horn antenna array comprising a plurality of interlaced sets of horns, each set being adapted to radiate a beam independently of a beam radiated by a second set, one set of horns including a pair of apertures and guide means connecting said aperture to common energy transmitting means, a wedge-shaped septum projecting into said guide means to separate said first apertures and having a radiating aperture lying substantially in the same plane as said first apertures, said second set of horns including a pair of horns adjacent said first set of horns on opposite sides thereof from said septum, said second set of horns having apertures lying substantially in the same plane as the apertures of said wedge-shaped septum and the first apertures, and energy transmitting means for delivering energy simultaneously from a common source to said last named horns and said septum for producing a beam capable of simultaneous radiation with the beam radiated from said first set of horns.

2. A multi-frequency horn antenna array including separate sets of horns each capable of radiating a single beam at a frequency different from the beam radiated by another set, the horns of each set being arranged in symmetrical stacked relationship with each horn of one set being alternately arranged with respect to each horn of another set, said first set of horns including a wave guide having diverging top and bottom walls and side walls, a wedge-shaped septum mounted mediantly in said side walls to form at the mount of said guide two horns having apertures with collinear dimensions, said septum having inwardly converging top and bottom walls and laterally spaced side walls all forming a radiating aperture lying substantially in the same plane as the first mentioned apertures, said second set of horns comprising said septum and including a pair of horns located adjacent the top and bottom wall of said wave guide, said last named horns having apertures lying substantially in the same plane as the aperture of said septum, and means for feeding energy simultaneously and in phase from a common input to said second set of horns.

3. The array of claim 2 wherein the means for feeding energy to said second set of horns includes conductors of the same electrical length connecting the common input to the pair of horns and a conductor including a phase shifter for connecting the septum to said common input.

4. The array of claim 2 wherein energy is fed to said septum through one side wall thereof so as not to interfere with energy transmitted through said guide to the apertures of said first set of horns.

5. The array of claim 2 wherein the lateral spacing of the side walls of said septum is greater than the spacing of the side walls of said guide and wherein the apertures of said second pair of horns is collinear with the aperture of said septum to enable said second set of horns to radiate energy at a lower frequency than said first set.

6. A horn antenna array comprising a first horn; a waveguide coupled to said horn; a hollow wedge extending transversely across said horn with a conductive exterior surface to separate said horn into two substantially equal apertures; said wedge consisting of two conductive plates intersecting along one edge within said horn and spaced at the opposite edges, and triangular side walls, said spaced opposite edges and side walls defining an open end wall forming an aperture substantially in the plane of said equal apertures; and coupling means for electromagnetic energy projecting through one of said side walls for communicating with the interior surface of said wedge.

References Cited in the file of this patent

UNITED STATES PATENTS

2,425,488 Peterson et al. ---------- Aug. 12, 1947