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HORN FEED SYSTEM TO PROVIDE VERTICAL, HORIZONTAL OR CIRCULAR POLARIZATION

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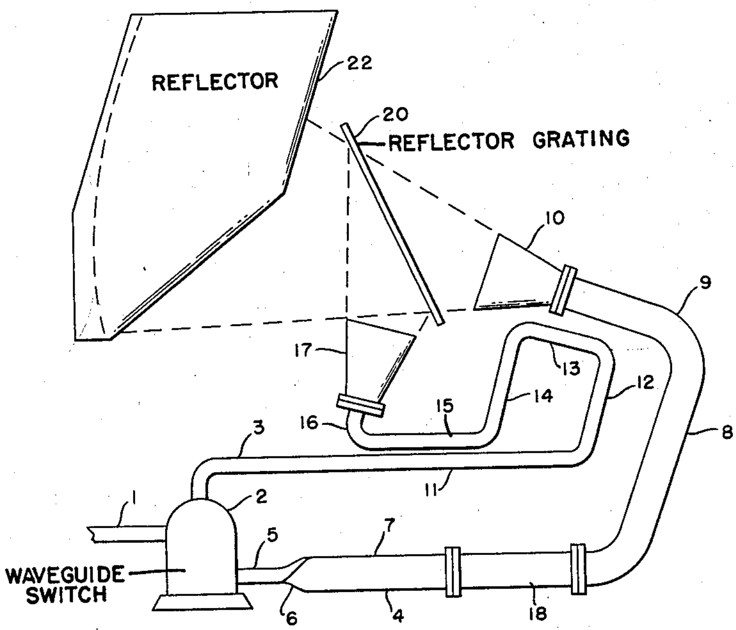

FIG. 1

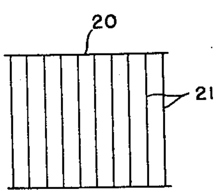

FIG. 3

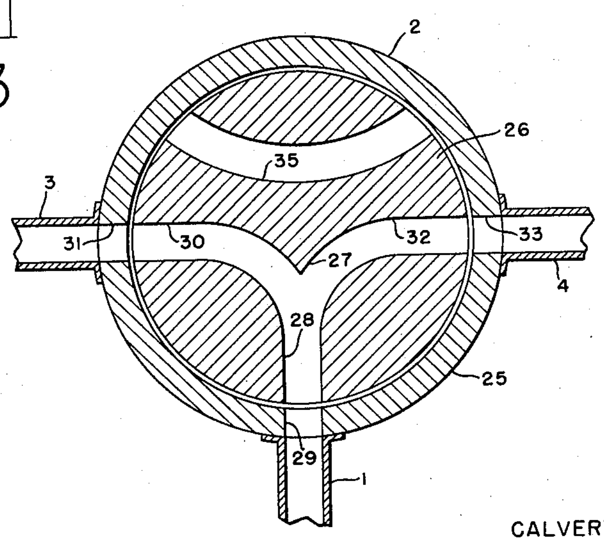

FIG. 2

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HORN FEED SYSTEM TO PROVIDE VERTICAL, HORIZONTAL, OR CIRCULAR POLARIZATION

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3 Claims. (Cl. 343—777)

This invention relates to ultra short wave antenna systems and, more particularly, to electromagnetic horn feeding arrangements for such systems.

In some antenna installations it is desirable that the system be designed for the selective use of horizontal, vertical and circular polarization. In previous systems a single horn has been used for feeding the antenna. Such a horn must be capable of transmitting either vertical or horizontal polarizations with exact patterns for both over the operating frequency range. The polarizations were obtained by means of sections of waveguide having different transmission characteristics and the use of phase shifting devices within the line. The employment of these differing sections required carefully designed transition arrangements. The use of phase correcting devices in the single horn was required to accommodate it to the various types of polarization.

It is an object of the present invention to provide a horn feed which will selectively produce vertical, horizontal or circular polarization with inherent broadband operation, and which is simple and inexpensive.

It is another object to provide such a horn feed which utilizes simple horns without the necessity for providing transitions to non-standard waveguide sections or complex phase correcting devices within the horns.

It is a further object to provide such a feed which does not require a polarizing device.

These and other objects and advantages of the invention are realized by a horn feeding system which employs separate horns for vertical and horizontal polarization with a passive reflector arranged to reflect energy of one polarization to a parabolic reflector and to pass energy of the other polarization. The horn emitting energy of said other polarization is so positioned that its energy passing through the passive reflector impinges directly on the parabolic reflector. A common feed line feeds energy to a switch which may be moved to transmit the incoming energy to either horn or to both.

In the drawing:

Fig. 1 is an elevational view of a horn feeding system embodying the invention;

Fig. 2 is a cross-sectional view of the switch forming part of the system of Fig. 1; and,

Fig. 3 is a plan view of the passive reflector of the system of Fig. 1.

Referring now more particularly to the drawing, there is shown a system embodying the invention and comprising a transmission line 1 which may be a rectangular waveguide feeding into a waveguide switch 2 which is shown more clearly in Fig. 2. Leading from the waveguide switch 2 are a pair of rectangular waveguides 3 and 4. The waveguide 3 is arranged to transmit energy having vertical polarization and has its greater cross-sectional dimension extending horizontally. The waveguide 4 emerges from the switch 2 with the same orientation, as indicated at 5, and then is twisted through a 90° angle at 6 so that it has its longer cross-sectional dimension extending vertically and thus transmits energy which is horizontally polarized. Following the 90° twist at 6, the waveguide 4 extends horizontally as at 7 and then is bent upwardly as at 8 and is bent back at 9 to extend in a substantially horizontal direction to its termination in a horn 10. A fixed phase shifting section is provided at 18, which merely creates a 90° difference between the total waveguide lengths between the switch and horns 10 and 17.

The waveguide 3 has a portion 11 extending horizontally then is bent upwardly and extends upwardly as at 12. It is then bent back having a portion 13 lying in a substantially horizontal direction and a succeeding portion 14 descending substantially vertically. This is followed by the horizontally extending portion 15 and an upwardly turned portion 16, terminating in a horn 17.

The aperture of the horn 10 is directed so that the emerging beam of energy is elevated slightly above the horizontal and the horn 17 is arranged so that the axis of its beam is normal to that of the beam of the horn 10. Arranged at an angle of 45° to the axes of these beams is a passive reflector 20 which is shown in detail in Fig. 3. This may consist, as shown, of a grid of vertically extending bars 21. This arrangement will reflect the energy of vertical polarization directed upon it from the horn 17, while freely passing energy having a horizontal polarization directed upon it from the horn 10. The beams from these horns will thus impinge upon a reflector 22 which may be of a conventional parabolic form.

The waveguide switch 2, shown in detail in Fig. 2, comprises an outer stator 25 having a cylindrical recess formed within it and a cylindrical rotor 26 housed within the recess. Both the rotor and stator are metal. The inlet waveguide 1 is separated by equal angles and equal arcuate distances from the respective outlet waveguides 3 and 4. The rotor is formed with a pair of passages. In the orientation of the rotor shown in Fig. 2, one of these passages 27 is in registry with the inlet waveguide 1 and the outlet waveguides 3 and 4. As shown, this passage is of Y-shape with one portion 28 connecting to the waveguide 1 through an aperture 29 formed in the stator, a branch 30 connecting to the waveguide 3 through an aperture 31 in the stator, and a branch 32 connecting to the waveguide 4 through an aperture 33 in the stator. The remaining passage in the rotor is shown at 35 and is of arcuate shape of a length sufficient to span the aperture 29 and either of the apertures 31 or 33. Any conventional means may be employed for rotating the rotor.

In the operation of the device of Fig. 1 the energy from the inlet waveguide 1 may be applied to the reflector 22 with either a horizontal or a vertical polarization or with a circular polarization, as desired, by proper manipulation of the switch 2. With the switch in its present orientation, energy will be divided equally between the waveguides 3 and 4 and will be emitted by both horns 10 and 17. The phase shifting section 18 of the waveguide 4 will provide the proper phase relationships between the two emerging components so that the resulting composite energy beam impinging on the reflector 22 will have a circular polarization. If a vertically polarized output is desired the switch is rotated so that the passage 35 spans the apertures 29 and 31 of the stator, thus directing all the energy into the waveguide 3. The wave emitted by the horn 17 will be reflected by the reflector 20 onto the reflector 22.

If a horizontally polarized output is desired the switch is rotated until the passage 35 spans the apertures 29 and 33 of the stator, thus causing energy from the waveguide 1 to be directed into the waveguide 4. This energy will be emitted from the horn 10, will pass through the reflector 20 without hindrance and impinge upon the reflector 22.

The loop in the waveguide 3, formed of the sections 12, 13 and 14, is for the purpose of providing equal electrical lengths in the waveguides 3 and 4 to give a resultant broadband operation of this system.

The horns 10 and 17 may easily be individually matched to their feed lines by conventional means, a distinct advantage over existing systems. It is apparent that the arrangement is simple and provides a means of obtaining circular polarization without requiring the usual polarizer and complicated horn system.

It is also apparent that the orientation of the waveguides 3 and 4 may be reversed, if desired, so that 4 conveys the vertically polarized wave and 3 the horizontally polarized wave. In this case the passive reflector 20 must be placed with its rods horizontal.

Either right hand (clockwise) or left hand (counterclockwise) circular polarization may be obtained by making the difference in electrical lengths, between waveguides 3 and 4, 90° or 270°, 90° for clockwise and 270° for counterclockwise.

What I claim is:

1. A horn feed system for feeding electromagnetic wave energy to a reflector, comprising a first rectangular waveguide, a pair of rectangular waveguides, a switch interposed between said first waveguide and said pair of waveguides, said switch in one position interconnecting said first waveguide with both waveguides of said pair, said switch being operable to two other positions, in each of which it interconnects said first waveguide and a respective one of said pair of waveguides, said waveguides of said pair being arranged with their extremities remote from said switch lying in a plane passing through said reflector, the long cross-sectional dimension of one of said extremities being parallel to said plane and that of the other being normal to it, a pair of horns each terminating a respective one of said extremities, and being so oriented that the energy beam thereof is bisected by said plane, said energy beam of one of said horns being directed toward said reflector and that of the other being so directed that the axes of said beams are normal to each other, and a planar passive reflector located at the point of intersection of said beams, said passive reflector being so constructed and positioned as to transmit without interruption said beam which is directed toward said reflector and to reflect the other of said beams toward said reflector, the electrical paths between said switch and said passive reflector, including the respective waveguides of said pair, differing by an odd number of quarter-wavelengths of the energy traversing them, whereby, when said switch is in said one position, energy fed into said system by way of said first waveguide will be applied to the first mentioned reflector in a circularly polarized state.

2. A horn feed system for feeding electromagnetic wave energy to a reflector, comprising a first rectangular waveguide, a pair of rectangular waveguides, a switch interposed between said first waveguide and said pair of waveguides, said switch in one position interconnecting

said first waveguide with both waveguides of said pair, said switch being operable to two other positions, in each of which it interconnects said first waveguide and a respective one of said pair of waveguides, said waveguides of said pair being arranged with their extremities remote from said switch lying in a plane passing through said reflector, the long cross-sectional dimension of one of said extremities being parallel to said plane and that of the other being normal to it, a pair of horns each terminating a respective one of said extremities, and being so oriented that the energy beam thereof is bisected by said plane, said energy beam of one of said horns being directed toward said reflector and that of the other being so directed that the axes of said beams are normal to each other, a planar passive reflector located at the point of intersection of said beams, said passive reflector being so constructed and positioned as to transmit without interruption said beam which is directed toward said reflector and to reflect the other of said beams toward said reflector, and phase shifting means in one of the waveguides of said pair, said phase shifting means shifting the phase of the energy in said waveguide by an amount such that the energy wave resulting from superimposition of the beams from said horns is circularly polarized.

3. A horn feed system for feeding electromagnetic wave energy to a reflector, comprising a first rectangular waveguide, a pair of rectangular waveguides, means interposed between said first waveguide and said pair of waveguides, operable to selectively interconnect said first waveguide with either or both waveguides of said pair, said waveguides of said pair being arranged with their extremities remote from said means lying in a plane passing through said reflector, the long dimension of one of said extremities being parallel to said plane and that of the other being normal to it, a pair of horns each terminating a respective one of said extremities, and being so oriented that the energy beam thereof is bisected by said plane, said energy beam of one of said horns being directed toward said reflector and that of the other being so directed that the axes of said beams are normal to each other, and a planar passive reflector located at the point of intersection of said beams, said passive reflector being so constructed and positioned as to transmit without interruption said beam which is directed toward said reflector and to reflect the other of said beams toward said reflector, the electrical paths between said selective interconnecting means and said passive reflector including the respective waveguides of said pair, differing by an odd number of quarter-wavelengths of the energy traversing them, whereby, when said first waveguide is connected with both waveguides of said pair, energy fed into said system by way of said first waveguide will be applied to the first mentioned reflector in a circularly polarized state.

References Cited in the file of this patent

UNITED STATES PATENTS

238,928	Switzerland	Nov. 16, 1945
743,533	Great Britain	Jan. 18, 1956