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R. F. H. YANG

2,954,557

CROSS-POLARIZED DUAL FEED

Filed June 15, 1959

FIG. 1

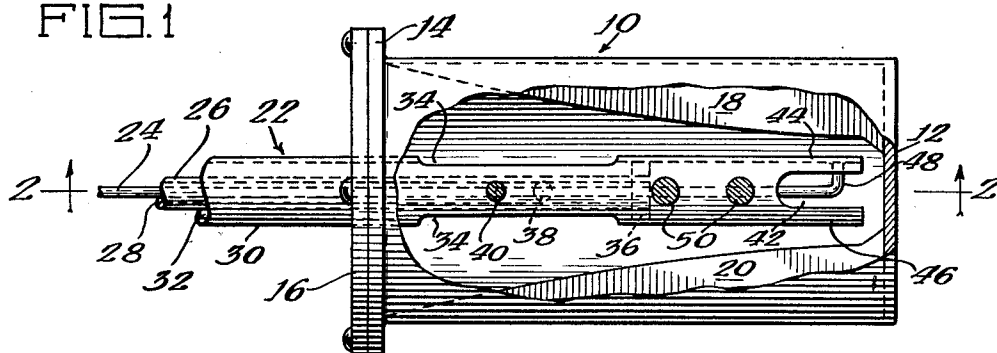


FIG. 2

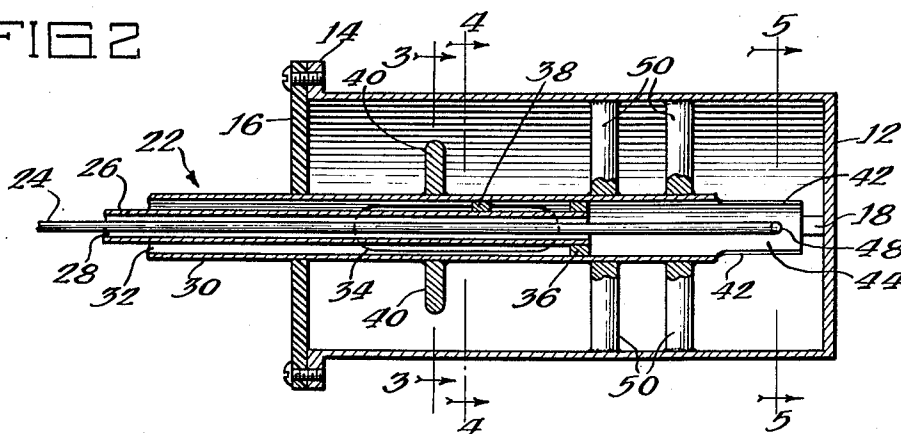


FIG. 3

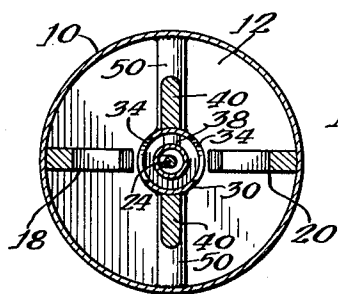


FIG. 4

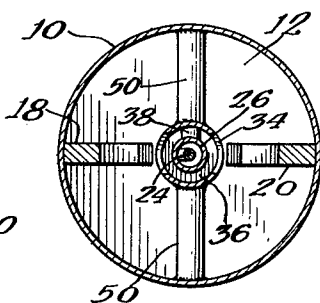
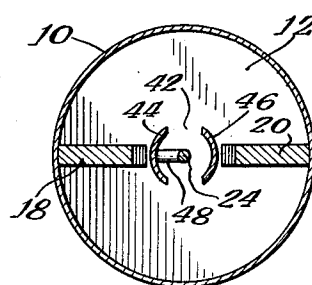


FIG. 5



Inventor:
Richard F.H. Yang
By: *Graf, Nierman & Zummeister*
Attorneys

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CROSS-POLARIZED DUAL FEED

Richard F. H. Yang, Orland Park, Ill., assignor to Andrew Corporation, Cook County, Ill., a corporation of Illinois

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7 Claims. (Cl. 343-756)

This invention relates to microwave propagation devices, and more specifically to a cross-polarized dual feed for parabolic antennas.

In a co-pending application of the same inventor, Serial No. 615,199, filed October 10, 1956, there is described and claimed an improved type of cross-polarized feed. Various embodiments of the novel feed construction are described in that application. The feed construction therein illustrated employs a horn cavity which surrounds the end of a triaxial transmission line, the electromagnetically open end of the horn facing back along the line, the end of the triaxial line within the cavity having means for exciting or energizing the cavity by the signals in the two transmission paths of the triaxial line in cross-polarized relation. The horn cavity is excited from one of the transmission paths at the anterior (open) end of the horn, and is excited from the other transmission path of the triaxial line at the posterior end, the intermediate portion having radial conducting members extending between the transmission line and the wall of the cavity in the direction parallel with the electric field vector of the anteriorly energized signal to prevent this signal from entering the posterior portion of the cavity and then again being reflected forward, the isolation of the anterior from the posterior portion for signals of the polarization of the anterior signal thus preventing radiation from the horn of anterior signals which have travelled any substantial distance in the horn. It is well known that preservation of exact direction of polarization of any given mode becomes more difficult with length of the path traversed by a signal in a waveguide or other cavity (of which a horn is merely a special case). The various embodiments illustrated in the co-pending application, by cutting off the reflected path of the anterior signal, are accordingly highly effective in aiding in preservation of the perpendicular relation between the polarizations of the transmissions excited in the anterior and posterior portions of the horn.

It is the principal object of the present invention to further improve the type of feed shown in the co-pending application by providing a structure in which the posteriorly excited signal is also brought to the mouth of the horn in its exact intended polarization, and to provide a simple manner of accomplishing this object with a minimum of effect on the anteriorly energized signal.

In the attainment of this principal object, there has been developed a novel type of mode-transition construction which, although being of peculiar utility in cross-polarized dual feeds of the general type shown in the co-pending application, will also be found to be of more general utility in launching transmissions from or to concentric lines, particularly where exactness of direction of polarization is required and where the concentric line impedance is to be matched for radiation in space and similar purposes.

For understanding of the invention, and the manner in which the objects stated above are accomplished, and other advantages of the invention obtained, reference is

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made to the embodiment of the invention illustrated in the annexed drawing, in which:

Figure 1 is a side view, partially broken away in section, of a dual feed made in accordance with the teachings of the invention;

Figure 2 is a view taken along the line 2-2 of Figure 1;

Figure 3 is a transverse sectional view taken along the line 3-3 of Figure 2;

Figure 4 is a transverse sectional view taken along the line 4-4 of Figure 2; and

Figure 5 is a transverse sectional view taken along the line 5-5 of Figure 2.

The feed illustrated in the drawing employs a horn cavity 10 of circular cross-section, having a closure 12 on the posterior end and a flange 14 on the anterior end, to which is suitably secured a dielectric window 16, thus forming a cup-shaped cavity which is electromagnetically open at one end. In the illustrated embodiment, the horn 10 is of uniform diameter throughout its length, since the illustrated feed is designed for uniform illumination of a parabola from a short distance, the feed being supported on the axis of the parabola by a triaxial line; employment of the illustrated structure in a flared horn, circular or non-circular, will, however, be obvious.

The horn cavity 10 contains diametrically opposed fins or ridges 18 and 20 which are relatively wide at the posterior end of the cavity and are continuously tapered so that the gap between them widens to the full diameter of the cavity at the extreme anterior end. Entering the cavity centrally of the window 16 is a triaxial line 22, having an inner conductor 24 and an intermediate conductor 26 forming, in the annulus therebetween, an inner transmission path, and an outer conductor 30, the latter forming with the intermediate conductor 26 an outer transmission path 32. The end portion of the triaxial line 22 is within the cavity 10, extending in the gap between the fins to a point just short of the posterior end closure 12.

In the portion of the outer conductor 30 at the anterior end of the cavity are diametrically opposed longitudinal slots 34, preferably half-wave slot radiators at the frequency of transmission of the outer transmission path. The intermediate conductor 26 terminates in the central longitudinal portion of the cavity and is there joined to the outer conductor 30 by an annular conducting end wall 36, thus constituting the portion of the triaxial line rearward of this termination of the outer transmission path a coaxial extension of the inner transmission path, employing the innermost conductor 24 and the outermost conductor 30 as its concentric conductors in this region.

The intermediate conductor 26 is joined by a radial short circuit connection 38 in a plane perpendicular to the plane formed by the slots 34, in a position of longitudinal correspondence with the slots. Dipole elements 40 extend radially from the outer surface of the outer conductor 30 in the direction perpendicular to the plane of the slots 34.

It will be seen that the outer transmission path of the triaxial cable is provided with the means above described for coupling a signal in the outer path to the cavity, the slots 34 and the short at 38 cooperating to convert the radially symmetrical transmission mode of the coaxial line to the TE₁₁ propagation mode in the cavity, the central electric field vector in this mode being aligned along a diameter, the two halves of the outer conductor 30 on opposite sides of the plane of the slots being in opposite phase. The dipole elements 40, in alignment with this electric field vector, serve to aid in coupling the mode thus energized to the cavity. It will be observed that the manner of coupling the transmissions of the outer path to the anterior portion of the cavity, as illus-

trated and described, is substantially identical with that shown in some of the embodiments of the invention described and claimed in the co-pending application.

The extreme end portion of the outer conductor 30 has diametrically opposed quarter-wave slots 42 in the plane perpendicular to the plane formed by the slots 34, and also perpendicular to the plane of the fins 18 and 20, which lie in the same plane as that of the slots 34. The slots 42 divide the end of the outer conductor 30 into portions 44 and 46 which are respectively adjacent to, but spaced from, the edges of the fins 18 and 20, the extreme end of the inner transmission path of the triaxial line 22 thus lying in the narrow portion of the gap between the fins. The central conductor 24 is shorted at 48 radially to the end portion 44, thus producing collapse of the electric field in this region, and converting the circularly symmetrical coaxial cable propagation mode to a mode wherein the end portions 44 and 46 are at opposite potential, in a manner similar to that previously described in connection with the energizing of the anterior portion.

There is thus produced at the posterior end of the cavity, in response to the signals of the inner transmission path of the triaxial line, a mode of substantially the same characteristics as that produced in the anterior portion from the outer transmission path, except that in the posterior portion the field pattern is rotated by 90°, the fins 18 and 20 being coupled by proximity to the oppositely phased end portions 44 and 46 of the line.

The TE₁₁ mode generated in the posterior portion is coupled to the exterior of the horn by the tapered fins, which serve both to provide the desired impedance transformation for optimum radiation and to preserve the exact direction of polarization of the posteriorly excited signal.

It will be noted that the illustrated manner of coupling the posterior signal to the cavity and thence to the exterior produces a minimum of interference with the preservation of proper polarization of the anteriorly launched signal. The latter signal is prevented from entering the posterior portion of the cavity by shorting posts 50 which connect the outer conductor of the triaxial cable to the walls of the cavity in the intermediate region between the two mode-transition assemblies, these shorting posts being parallel with the dipole elements 40 and thus in the direction of the diametric electric field vector of the anteriorly launched signal. Thus propagation of the anteriorly launched signal is confined to the anterior region of the cavity. In this region of the cavity, the fins 18 and 20 are of substantially reduced width. In addition, because of the relative relation of the elements described, the electric field vector of the TE₁₁ mode launched anteriorly is, in the region of the fins 18 and 20, perpendicular to these fins, so that not only does the presence of these fins in the relatively short distance of propagation of the anterior signal to the window not change the polarization of the anterior signal, but in addition the attenuation of the anterior signal is extremely small.

It will thus be seen that the illustrated embodiment in all respects provides, in a very simple manner, highly desirable characteristics for the transmission of cross-polarized signals with a minimum of cross-talk and attenuation. It will also be seen, however, that many modifications, some obvious and some apparent only on study, may be made without impairing the advantages obtained by the invention. Additionally, those skilled in the art will readily observe that the novel manner of coupling the concentric line to the cavity used at the posterior end may readily be employed in other types of structures. Accordingly, the scope of the protection to be given the invention should not be considered to be limited by the particular embodiments shown, but should

extend to the structures defined in the appended claims, and equivalents thereof.

What is claimed is:

1. A cross-polarized antenna feed comprising a triaxial transmission line having concentric annular transmission paths each having innermost and outermost conductors, a cavity surrounding the end portion of the transmission line and having an electromagnetically open end facing back along the transmission line, diametrically opposed longitudinal slots in the outermost conductor of the outer transmission path in the anterior portion of the cavity, diametrically opposed longitudinal slots in the extreme end of the outermost conductor of the inner transmission path in a plane perpendicular to the plane of the first slots, means within the respective transmission paths for producing electric fields across said respective pairs of slots, oppositely disposed fin members on the walls of the cavity in the plane of the first slots, tapering in width from the posterior to the anterior portion of the cavity, and oppositely disposed radially extending shorting members connecting the wall of the cavity with the transmission line in the longitudinal region between the pairs of slots and in the plane of the second pair of slots.

2. An antenna feed horn comprising a coaxial transmission line, a cavity surrounding the end of the transmission line and having an electromagnetically open end facing back along the line, oppositely disposed fin members on the wall of the cavity tapering in width from the posterior to the anterior portion of the cavity, the end of the transmission line being in the posterior portion of the cavity between the fin members, and mode transition means on the end of the transmission line to produce an electric field between the portions of the outer conductor adjacent to respective fin members.

3. A microwave mode-transition assembly comprising opposed tapered fins forming a tapered gap having wide and narrow longitudinal portions, a coaxial transmission line having the end thereof in the narrow portion of the gap closely adjacent to, but spaced from, the fins and extending midway in the gap from said end toward the wide portion of the gap, and mode-conversion means on said end of the transmission line for transforming the coaxial-cable mode to a mode having an electric field in the direction crosswise of the gap.

4. The assembly of claim 3 wherein the mode-conversion means comprises longitudinal quarter-wave slots in the end of the outer conductor of the transmission line in a plane perpendicular to the plane of the fins and a radially extending short-circuit extending from the inner to the outer conductor in the plane of the fins.

5. A cross-polarized dual mode-transition assembly comprising the assembly of claim 3 wherein the coaxial line comprises one of the transmission paths of a triaxial line, and there are provided means on the end portion of the line to couple the other transmission path to the exterior in a mode having an electric field perpendicular to the gap.

6. A cross-polarized feed for parabolic antennas comprising the mode-transition assembly of claim 5 having a cavity surrounding the end portion of the triaxial line and electromagnetically open at the end facing back along the line, the fins being on opposite walls of the cavity.

7. The cross-polarized feed of claim 6 having the coupling means for said other transmission path in the anterior portion of the cavity, the narrow portion of the gap being in the posterior portion, and having radial shorting members in the intermediate portion of the cavity in the plane perpendicular to the gap to isolate the two coupling means and provide support for the transmission line.