

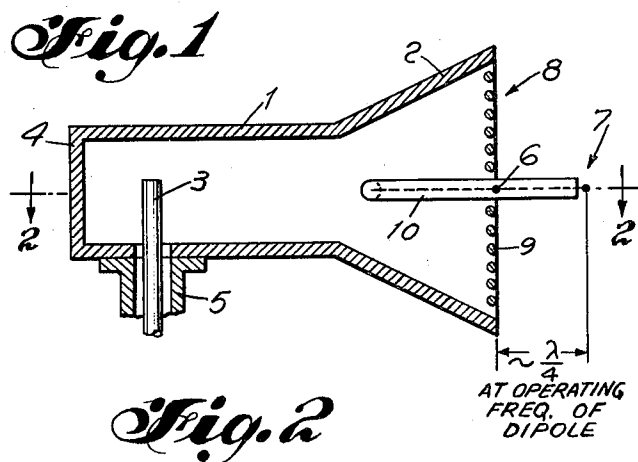
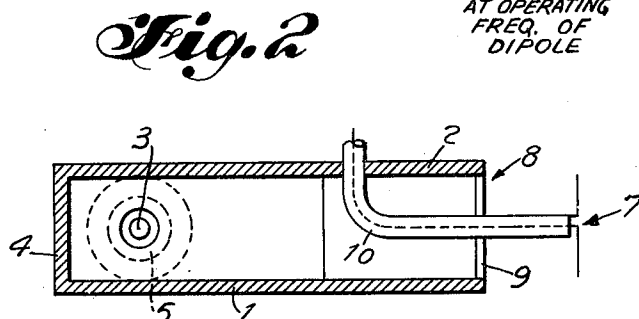
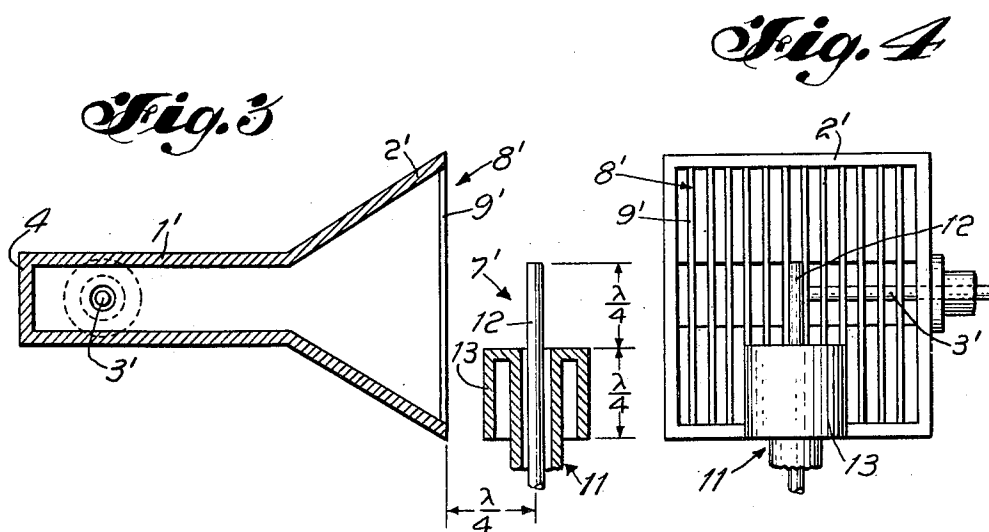
Jan. 21, 1958

W. SICHAK

2,820,965

DUAL POLARIZATION ANTENNA

Filed Feb. 16, 1956



INVENTOR
WILLIAM SICHAK
BY *Alfred C. Hill*
AGENT

1

2,820,965

DUAL POLARIZATION ANTENNA

William Sichak, Nutley, N. J., assignor to International Telephone and Telegraph Corporation, Nutley, N. J., a corporation of Maryland

Application February 16, 1956, Serial No. 565,868

8 Claims. (Cl. 343—756)

This invention relates to dual polarization antennas and more particularly to an improved dual polarization antenna capable of simultaneously radiating or receiving signals in a plurality of separated frequency bands.

Dual polarization antennas capable of operating at a plurality of frequencies broadly are not new in the antenna field. The prior art discloses that horn-type antennas have been used to receive or transmit dual polarized signal waves at widely separated frequency bands. This has been accomplished in the prior art by employing energizing antennas, or pickup means, depending upon whether the horn is used for transmission or reception, judiciously positioned within the small end of a flared waveguide. The two signals of different frequency are radiated or received with their polarizations crossed in order to eliminate interaction. The horn-like structure is common to both energizing antennas, or pickup means. Thus, the horn-like structure will respond differently to the two frequency bands. This means that for one frequency band the radiation pattern will have a given shape and for the other frequency band the radiation pattern will be different, sharper or broader than the pattern of the first signal, due to a difference in the frequency response of the horn. This is a decided disadvantage in certain radio diversity systems where it is desired to have the signals of the two polarizations and, hence, the two frequencies correspond as close as possible in their radiation pattern so that substantially the same area is covered by each signal.

It is, therefore, an object of this invention to provide a dual polarization antenna having a novel arrangement of independent frequency signal translators.

Another object of this invention is to provide a dual polarization antenna having a radiation pattern for each polarization which has coincident focusing points.

Still another object of this invention is to provide a dual polarization antenna having two radiating elements responsive to widely separated frequency bands and orthogonally related signal waves, the radiating elements each having substantially identical radiation patterns originating from substantially the same focusing point.

A feature of this invention is a dual polarization antenna comprising a waveguide having an open end shaped to determine a given space radiation pattern. A grille of parallel conductive elements is disposed crosswise the open end of said waveguide to pass a first polarized wave energy, said grille being located to contain substantially in the plane thereof the focusing point of said given radiation pattern. An antenna means responsive to a second polarized wave energy orthogonal with respect to said first polarized wave energy is disposed forward of said grille by a predetermined amount to cause the focusing point of the radiation pattern of said second polarized wave energy to coincide with said first-mentioned focusing point.

Another feature of this invention is the provision in the

2

above structure to have widely separated frequency bands carried by the polarized wave energies and to have the open end of the waveguide shaped to provide substantially identical space radiation patterns for the polarized wave energies.

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a longitudinal cross-sectional view of an embodiment of this invention;

Fig. 2 is a cross-sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is a longitudinal cross-sectional view of an alternative embodiment of this invention; and

Fig. 4 is an end elevation of Fig. 3.

In the description of the drawing that follows, the embodiments will be described in terms of a transmitting antenna, but it is to be understood that the antenna is a reciprocal device and can be utilized to receive the same type of energy in substantially the same manner.

Referring to Figs. 1 and 2, the antenna of this invention is illustrated as comprising a waveguide 1 having an open end 2. A probe 3 is inserted in the waveguide 1 in a manner to inject vertically polarized wave energy therein. Probe 3 is disposed a given distance from the end 4 of waveguide 1, in the order of a quarter wavelength at the operating frequency, the exact distance being determined by considerations of impedance matching. The distance is preferably so chosen that the resultant impedance of the probe 3 is equal to the surge impedance of the transmission line 5 whereby reflections of energy along line 5 are avoided. For the waveguide 1 to properly support vertical polarization propagation, the horizontal dimension of the waveguide 1 in the immediate vicinity of probe 3 must be larger than the critical dimension, in other words, greater than a half wavelength at the operating frequency of the vertically polarized wave energy. The vertical dimension of the waveguide with respect to the vertically polarized wave energy may be arbitrarily chosen. Thus, from the open end 2 of waveguide 1 is radiated vertically polarized wave energy in a given band of frequencies. The radiated energy from waveguide 1 will have a given radiation pattern depending upon the shape of end 2. In Fig. 1, the open end 2 is illustrated to be flared to provide a specified coverage for its radiated energy. The focusing point of the radiation pattern will be centrally located in the opening of end 2 as indicated at point 6.

A dipole or similar antenna 7 is disposed forward of the open end 2 a distance approximately equal to a quarter wavelength at the operating frequency of antenna 7 to cause the focusing point of its radiation pattern to coincide with the focusing point 6 of the radiation pattern of the waveguide 1. The antenna 7 is so oriented with respect to the end 2 of waveguide 1 that horizontally polarized wave energy is radiated therefrom.

A grille 8 including a plurality of horizontal conductive elements 9 is disposed crosswise the open end 2. This grille allows the vertically polarized waves from waveguide 1 to freely pass therethrough while at the same time effectively forming a totally reflecting wall for the horizontally polarized wave energy radiated from antenna 7. Since the antenna 7 is at right angles to the electric components of the field radiated from waveguide 1, the antenna 7 is not affected thereby. Due to the conductive elements 9 being parallel to antenna 7, the grille is substantially as effective as a reflector of radiation from antenna 7 as the solid end wall 4 is with respect to radiation from probe 3. Thus, grille 8 prevents interaction between the radiation sources of the crossed polarized wave energy,

The frequency of the vertical and horizontal wave energy may be the same, may be closely spaced in frequency, or may be in widely separated frequency bands. The antenna of this invention finds its greatest utilization where the wave energy of each polarization is situated in widely separated frequency bands, particularly where it is necessary to have substantially identical radiation patterns for the wave energy of both frequency bands.

The antenna 7, such as a dipole, and its reflective surface as afforded by grille 8 establish a given radiation pattern at its operating frequency with the focusing point located at 6. The waveguide 1 is dimensioned and its open end 2 is shaped to provide a radiation pattern substantially identical with the pattern of antenna 7 and having its focusing point also located at 6. It has been contemplated that antenna 7 may have a frequency of 2,000 megacycles and the radiation of waveguide 1 may be in the order of 1,000 megacycles. It is to be understood, however, that the frequencies could be reversed or in any suitable frequency range with one or the other of the polarized energies being radiated at the higher frequency range.

In accordance with Figs. 1 and 2, the energy for radiation from antenna 7 is coupled by means of coaxial line 10 through the wall of waveguide 1 and out the opening of open end 2 and, hence, to the antenna 7. An alternative feeding arrangement for antenna 7 is illustrated in Figs. 3 and 4. There is illustrated therein a coaxial line 11 whose center conductor 12 is extended a quarter wavelength at the operating frequency thereof beyond the outer conductor 13. Outer conductor 13 is formed or otherwise shaped to provide a quarter wavelength choke unit to aid in the radiation of wave energy from antenna 7'. This is known as a "skin-back" or a "flag-pole" antenna. By employing this latter type of antenna arrangement, it is possible to feed the antenna 7 or 7' along the axis thereof.

The antenna discussed in Figs. 3 and 4 is substantially identical to the antenna of Figs. 1 and 2 with the exception of the feeding arrangement for the dipole antenna, which may be employed in either one of the configurations illustrated, and the arrangement of the two antennas, which enables horizontal polarized radiation from the waveguide and vertical polarized radiation from the dipole-type antenna.

To provide horizontal polarized wave energy from waveguide 1', the probe 3' is inserted in the side wall thereof approximately a quarter wavelength from the end plate 4' at the operating frequency thereof. The same considerations hold here with respect to the impedance match required as it did with respect to probe 3 and end wall 4 of Figs. 1 and 2. The waveguide 1' should be dimensioned such that the vertical dimension of the waveguide in the immediate vicinity of probe 3' is larger than the critical dimension at its operating frequency. That is, the vertical dimension must be greater than a half wavelength at the operating frequency. The horizontal dimension may be arbitrarily chosen as far as the horizontal polarized wave is concerned.

Antenna 7' is disposed forward of the open end 2' a distance equal to approximately a quarter wavelength at the operating frequency thereof. Antenna 7' is further oriented with respect to the open end 2' to provide vertical polarized wave energy. As in Figs. 1 and 2, grille 8' is disposed crosswise open end 2' and includes in this instance vertically disposed parallel conductive elements 9' to provide an effective reflecting surface for the vertical polarization of antenna 7' and an open circuit with respect to the horizontal polarization of waveguide 1'.

As in the case of the arrangement of Figs. 1 and 2, the waveguide 1' and antenna 7' may be responsive simultaneously to separate frequencies in two widely separated frequency bands. The open end 2' may be shaped to provide identical coincident radiation patterns each having coincident focusing points when the individual antennas

are operating at the same frequency or at widely separated frequencies.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. A dual polarization antenna comprising a waveguide having an open end shaped to determine the space radiation pattern desired, a grille disposed crosswise of said open end to pass a first polarized wave energy, said grille being located to contain substantially in the plane thereof the focusing point of said radiation pattern, and antenna means responsive to a second polarized wave energy orthogonal with respect to said first polarized wave energy, said antenna means being disposed forward of said grille by a predetermined amount to cause the focusing point of the radiation pattern of said second polarized wave energy to coincide substantially with said first-mentioned focusing point.

2. An antenna according to claim 1, wherein said open end is shaped to cause the radiation pattern of said first polarized wave energy to be substantially identical with the radiation pattern of said second polarized wave energy.

3. An antenna according to claim 1, wherein said open end is flared into a horn-like opening to cause the radiation pattern of said first polarized wave energy to be substantially identical with the radiation pattern of said second polarized wave energy.

4. An antenna according to claim 1, wherein said antenna means includes a dipole-type antenna and a coaxial feed line extending through one wall of said waveguide and passing through said grille for coupling to said dipole-type antenna.

5. An antenna according to claim 1, wherein said antenna means includes a coaxial feed line having an inner conductor and an outer conductor, said inner conductor being extended a quarter wavelength at the operating frequency beyond the end of said outer conductor and said outer conductor being shaped to provide a quarter wavelength choke section at the operating frequency.

6. A dual polarization antenna comprising a waveguide having a horn-like open end to determine the space radiation pattern desired, a grille disposed crosswise of said open end to pass a first polarized wave energy at a frequency in a first frequency band, said grille being located to contain substantially in the plane thereof the focusing point of said radiation pattern, and antenna means responsive to a second polarized wave energy orthogonal with respect to said first polarized wave energy at a frequency in a second frequency band, said antenna means being disposed forward of said grille by a predetermined amount to cause the focusing point of the radiation pattern of said second polarized wave energy to coincide substantially with said first-mentioned focusing point, and said horn-like open end being flared at an angle to cause the radiation pattern of the first polarized wave energy of said first frequency band to be substantially identical with the radiation pattern of the second polarized wave energy of said second frequency band.

7. A dual polarization antenna comprising a waveguide having an open end shaped to determine the space radiation pattern desired, a grille of horizontal, parallel, spaced conductive elements disposed crosswise of said open end to pass a first polarized wave energy, said grille being located to contain substantially in the plane thereof the focusing point of said radiation pattern, and antenna means responsive to a second polarized wave energy orthogonal with respect to said first polarized wave energy, said antenna means being disposed forward of said grille by a predetermined amount and parallel to said conductive elements to cause the focusing point of the radiation

5

pattern of said second polarized wave energy to coincide substantially with said first-mentioned focusing point.

8. A dual polarization antenna comprising a waveguide having an open end shaped to determine the space radiation pattern desired, a grille of vertical, parallel, spaced conductive elements disposed crosswise of said open end to pass a first polarized wave energy, said grille being located to contain substantially in the plane thereof the focusing point of said radiation pattern, and antenna means responsive to a second polarized wave energy orthogonal with respect to said first polarized wave energy, said antenna means being disposed forward of said grille

6

by a predetermined amount and parallel to said conductive elements to cause the focusing point of the radiation pattern of said second polarized wave energy to coincide substantially with said first-mentioned focusing point.

References Cited in the file of this patent

UNITED STATES PATENTS

2,398,096 Katzin ----- Apr. 9, 1946

OTHER REFERENCES

Electronics, September 1954, pages 162-164.