

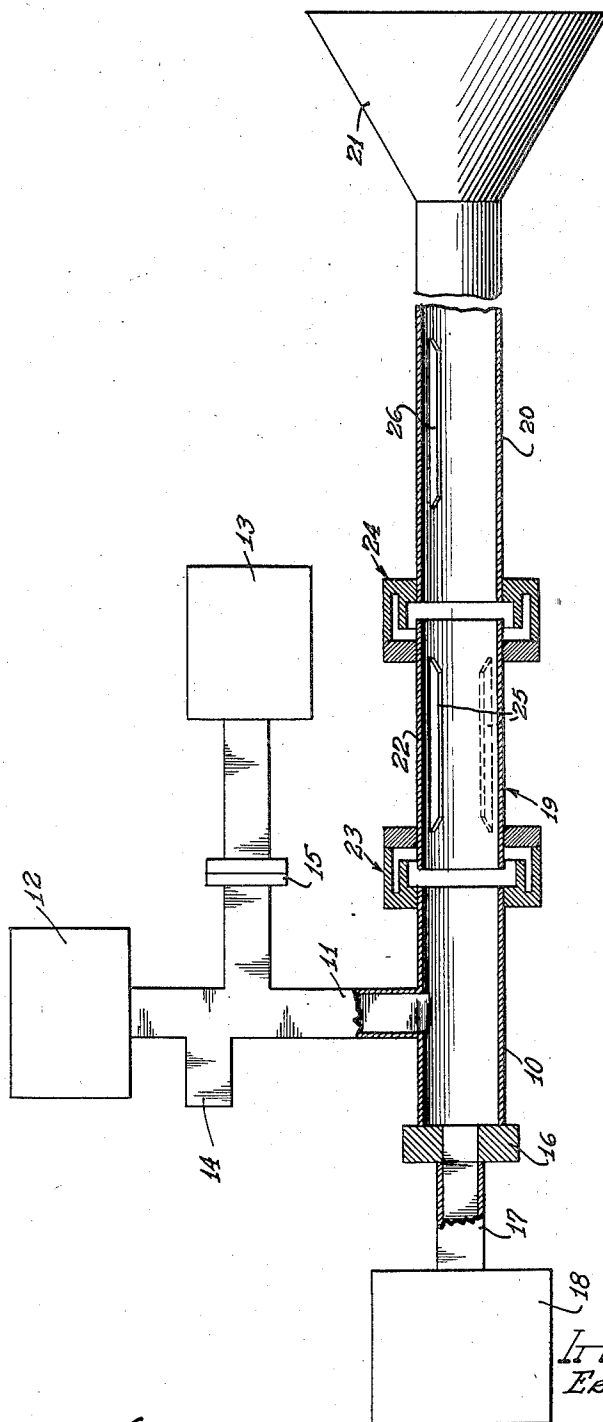
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WAVE-GUIDE SYSTEM

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1

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WAVE-GUIDE SYSTEM

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This invention relates to a wave-guide system and more particularly to a wave-guide system in which waves of two different polarizations may be selectively transmitted and simultaneously received through a common antenna and guide.

According to this invention, a round wave guide section, which is adapted for transmission of two plane polarized electromagnetic waves disposed at right angles to each other, is connected through a rectangular wave-guide to a transmitter and receiver combination and is connected through a second rectangular guide to a second receiver, the first rectangular guide being arranged to couple one plane polarized wave and the second rectangular guide being arranged to couple the other plane polarized wave. The first round wave-guide section is connected to a second round wave-guide section through phase shifter means arranged to change one of the plane polarized waves to a right-hand circularly polarized wave by shifting the phase of one of two right-angularly disposed components of the wave relative to the other or arranged to change the other of the plane polarized waves to a left-hand circularly polarized wave. The second wave-guide section may be coupled directly to an antenna which is adapted to radiate circularly polarized waves. The first receiver will receive waves which are either right-hand or left-hand circularly polarized while the second receiver will receive waves polarized in the opposite direction.

If desired, the second round wave-guide section may be coupled to the antenna through a second phase shifter means arranged to change a right-hand circularly polarized wave to a plane wave polarized in one direction and simultaneously change a left-hand circularly polarized wave to a plane wave polarized in a direction at right angles to said one direction. With this feature, the first receiver will respond to waves polarized in one direction while the second receiver will respond to waves polarized in a direction at right angles to said one direction.

According to an important feature of the invention, the first phase shifter means is selectively adjustable between a first position in which the plane-polarized wave coupled to the first rectangular guide is changed to a right-hand circularly polarized wave in the second round wave-guide section and a second position in which the wave coupled to the first rectangular guide is changed to a left-hand circularly polarized wave in the second round wave guide section, the wave coupled to the second rectangular guide being reversed from left-hand to right-hand circularly polarized waves in a similar manner. By this feature, the direction of polarization of the waves radiated or received by the antenna is reversed with respect to the receivers.

It will be apparent that this wave-guide system has a great variety of advantageous applications such as, for example, in radar systems in which one receiver may respond to waves polarized in one direction while the

2

other receiver will respond to waves polarized in the opposite direction.

An object of this invention, accordingly, is to provide an improved wave-guide system in which waves polarized in opposite directions may be received or transmitted separately.

Another object of the invention is to provide a wave-guide system in which right-hand or left-hand circularly polarized waves are transmitted and both polarizations are received simultaneously.

This invention contemplates other objects, features and advantages which will become more fully apparent from the following detailed description taken in conjunction with the accompanying drawing which illustrates a preferred embodiment and in which the single figure illustrates a wave guide system embodying the principles of the present invention.

Reference numeral 10 designates a round wave-guide section which, of course, is adapted for transmission of two plane polarized electromagnetic waves disposed at right angles to each other. One of these plane polarized waves is coupled through a rectangular wave-guide 11 to a transmitter 12 and a receiver 13. The transmitter 12 and the receiver 13 may be arranged to transmit and receive radar pulses with switching devices 14 and 15, such as gas tubes of a conventional radar duplexer arrangement.

The other of the right-angularly disposed plane polarized waves in the round wave-guide section 10 is coupled through an impedance transformer 16 and a rectangular wave-guide 17 to a second receiver 18. Thus the first receiver 13 will respond to plane polarized waves of one direction in the round wave-guide section 10 while the second receiver 18 will respond to waves that are plane polarized in a direction at right angles to said one direction.

The round wave-guide section 10 is coupled through a first phase shifter generally designated by reference numeral 19 and through a second round wave-guide section 20 to an antenna 21 which is preferably of a type adapted to radiate and receive circularly polarized waves.

The phase shifter 19 is arranged to change one of the plane polarized waves in the first wave-guide section 10 to a right-hand circularly polarized wave in the second wave-guide section 20 and vice versa and is arranged to change the other of the plane polarized waves in the first round wave-guide section 10 to a left-hand circularly polarized wave in the second round wave-guide section 20 and vice versa. In addition, the phase shifter 19 is preferably designed so as to be selectively movable between a first position in which the wave coupled to the first rectangular guide 11 is changed to a right-hand circularly polarized wave in the second round wave-guide section 20 and a second position in which the wave coupled to the first rectangular guide 11 is changed to a left-hand circularly polarized wave in the second round wave-guide section 20 with a similar reversal of direction of polarization with respect to the plane polarized wave coupled to the rectangular guide 17.

For these purposes, the phase shifter 19 may preferably take the form as illustrated in the drawing. A round wave-guide section 22 preferably having the same diameter as the round wave-guide sections 10 and 20 is disposed therebetween and rotatable about its axis. To allow this rotation with a minimum of energy loss at the junctions between the guide section 22 and the guide sections 10 and 20, a pair of choke joints 23 and 24 are provided. A quarter-wave plate 25 projects radially inwardly from the inner surface of the round guide section 22 and is movable, by rotation of the guide 22 about its axis, between a first position as illustrated in full lines and a second position as illustrated in

3.

broken lines, the two positions being 90° apart and the quarter-wave plate, in each position, projecting at an angle of 45° relative to the plane polarized wave in the round guide section 10 which is coupled to the rectangular guide 11 and hence at an angle of 45° relative to the plane polarized wave coupled to the rectangular guide 17, the two plane polarized waves being at right angles to each other.

Each of the two plane polarized waves which may exist in the round wave-guide section 10 may be considered as composed of two equal right-angularly related components one of which is parallel to the quarter-wave plate 25 and one of which is at right angles relative thereto. The quarter-wave plate will thus shift the phase of one component relative to the other to produce a resultant wave in the round guide section 20 which will be at least partially composed of a circularly polarized component. By proper dimensioning of the quarter-wave plate 25, one component of a plane polarized wave in the round wave-guide section 10 may be shifted 90° in phase so that the plane polarized wave will be transformed entirely into a circularly polarized wave in the second round wave-guide section 20. The operation of the quarter-wave plate 25 is, of course, reversible so that a circularly polarized wave in the round guide section 20 will be transformed into a plane polarized wave in the first guide section 10, the plane of polarization of the resultant wave in the first guide section 10 being dependent upon whether the circularly polarized wave in the second section 20 is right or left hand polarized and dependent upon whether the quarter-wave plate is in the full line position or the dotted line position.

It will thus be apparent that one of the rectangular wave-guides 11 and 17 may be coupled to a right-hand circular polarization at the antenna while the other rectangular guide is coupled to a left-hand circular polarization at the antenna.

The wave-guide system of this invention may preferably be such that the rectangular guide 11 may be coupled to a plane polarized wave of one direction at the antenna 21 while the rectangular guide 17 is coupled to a plane polarized wave of a direction at right angles relative to said one direction. For this purpose, a second phase shifter may be provided in the round wave-guide section 20. This phase shifter may preferably comprise a quarter-wave plate 26 having an operation like that of the quarter-wave plate 25 as described in detail above.

It will be understood that the phase shifters may take other forms and that other modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

I claim as my invention:

1. In a wave-guide system, a first round wave-guide section adapted for transmission of two plane polarized electromagnetic waves disposed at right angles to each other, first coupling means for coupling one of said waves to a transmitter and a first receiver, second coupling means for coupling the other of said waves to a second receiver, a second round wave-guide section adapted to transmit circularly polarized waves, first phase shifter means between said wave-guide sections arranged to selectively shift the phase of one of two equal right-angularly disposed components of a wave

4

either one-quarter wave length ahead or one-quarter wave length behind, and second phase shifter means arranged to couple said second wave-guide section to an antenna and arranged to shift the phase of one of two equal right-angularly disposed components by one-quarter wave length.

2. In a wave-guide system, a transmitter, first and second receivers, a first round wave-guide section adapted for transmission of two plane polarized electromagnetic waves disposed at right angles to each other, a first rectangular guide for coupling one of said waves to said transmitter and to said first receiver, a second rectangular guide for coupling the other of said waves to said second receiver, a second round wave-guide section adapted to transmit circularly polarized waves, phase shifter means between said first and second round wave-guide sections arranged to change one of said plane polarized waves to a right-hand circularly polarized wave and vice versa and arranged to change the other of said waves to a left-hand circularly polarized wave and vice versa, an antenna adapted to radiate circularly polarized waves, a third round wave-guide section coupling said second wave-guide section to said antenna, and second phase shifter means in said third round wave-guide section arranged to change a right-hand circularly polarized wave to a wave in one plane and arranged to change a left-hand circularly polarized wave to a wave in the plane at right angles to said one plane.

3. In a wave-guide system, a transmitter, first and second receivers, a first round wave-guide section adapted for transmission of two plane polarized electromagnetic waves disposed at right angles to each other, a first rectangular guide for coupling one of said waves to said transmitter and to said first receiver, a second rectangular guide for coupling the other of said waves to said second receiver, a second round wave-guide section adapted to transmit circularly polarized waves, phase shifter means between said first and second round wave-guide sections arranged to change one of said plane polarized waves to a right-hand circularly polarized wave and vice versa and arranged to change the other of said waves to a left-hand circularly polarized wave and vice versa, an antenna adapted to radiate circularly polarized waves, a third round wave-guide section coupling said second wave-guide section to said antenna, and second phase shifter means in said third round wave-guide section arranged to change a right-hand circularly polarized wave to a wave in one plane and arrange to change a left-hand circularly polarized wave to a wave in the plane at right angles to said one plane, said first phase shifter means being selectively movable between a first position in which the wave coupled to said first rectangular guide is changed to a right-hand circularly polarized wave in said second round wave-guide section and a second position in which the wave coupled to said first rectangular guide is changed to a left-hand circularly polarized wave in said second round wave-guide section.

References Cited in the file of this patent

UNITED STATES PATENTS

2,606,248	Dicke	Aug. 5, 1952
2,607,849	Purcell	Aug. 19, 1952
2,713,151	Farr	July 12, 1955