

[54] DUAL POLARIZED DIPLEXER

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343/176, 343/777

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[58] **Field of Search** 325/24; 333/6, 11;
343/175, 176, 786, 854, 858, 850

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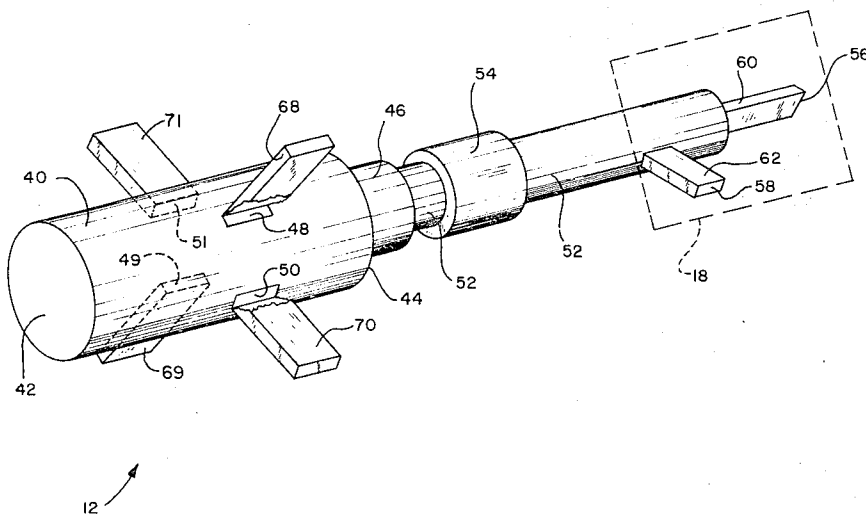
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[57] ABSTRACT

A microwave diplexer employs a section of circular waveguide having a transmit port coupled to two transmitters, an antenna port coupled to an antenna, and a receiver port including four openings symmetrically located around the periphery of the circular waveguide. Coupled to each receiver opening is a filter operative to improve the isolation between the receiver port and the transmit port for signals coming from the direction of the transmitter port. Two orthogonally related signals introduced at the transmit port are conducted along the circular waveguide to the antenna and are isolated from the receiver port by the impedance characteristics of the filters. Signals received via the antenna are isolated from the transmit port by a section of wave guide having a cutoff frequency above that of the received signal.

7 Claims, 3 Drawing Figures



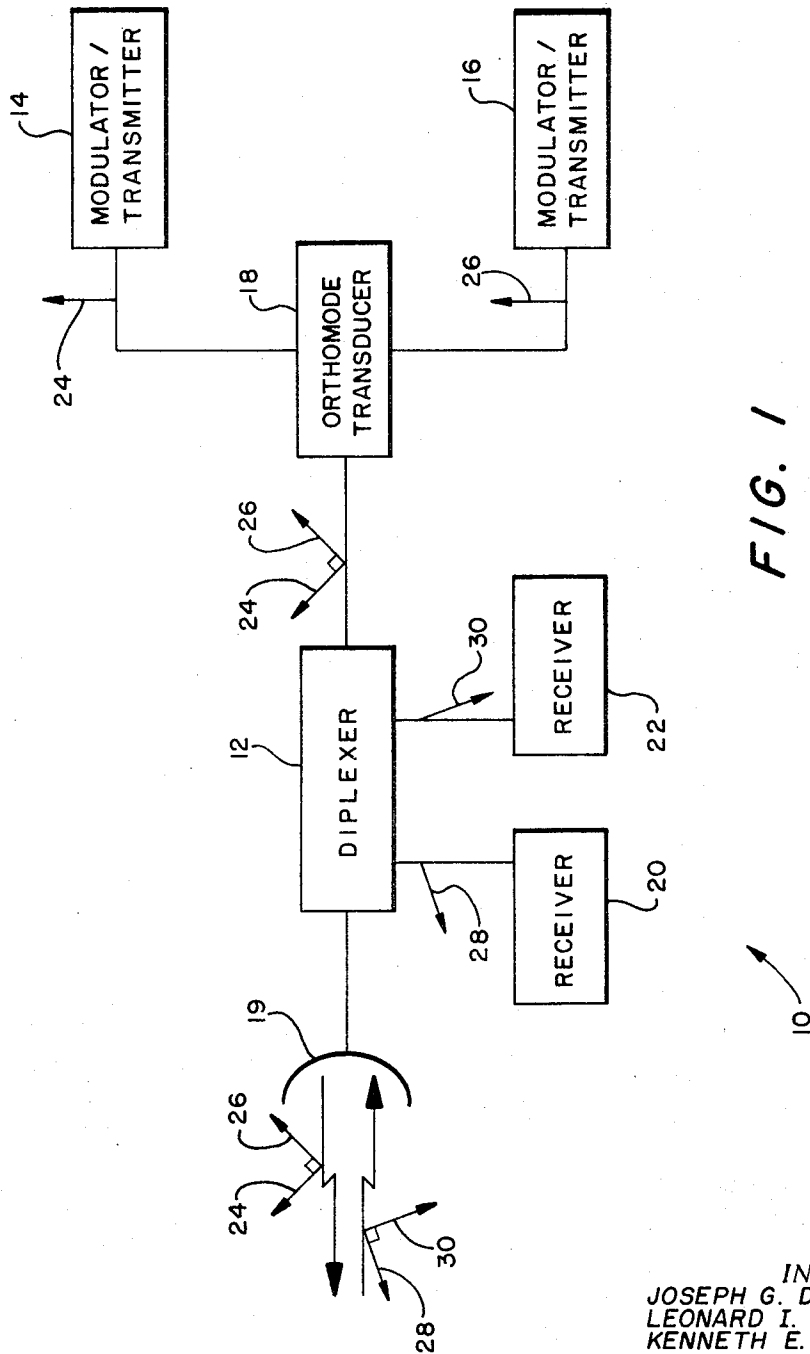


FIG. 1

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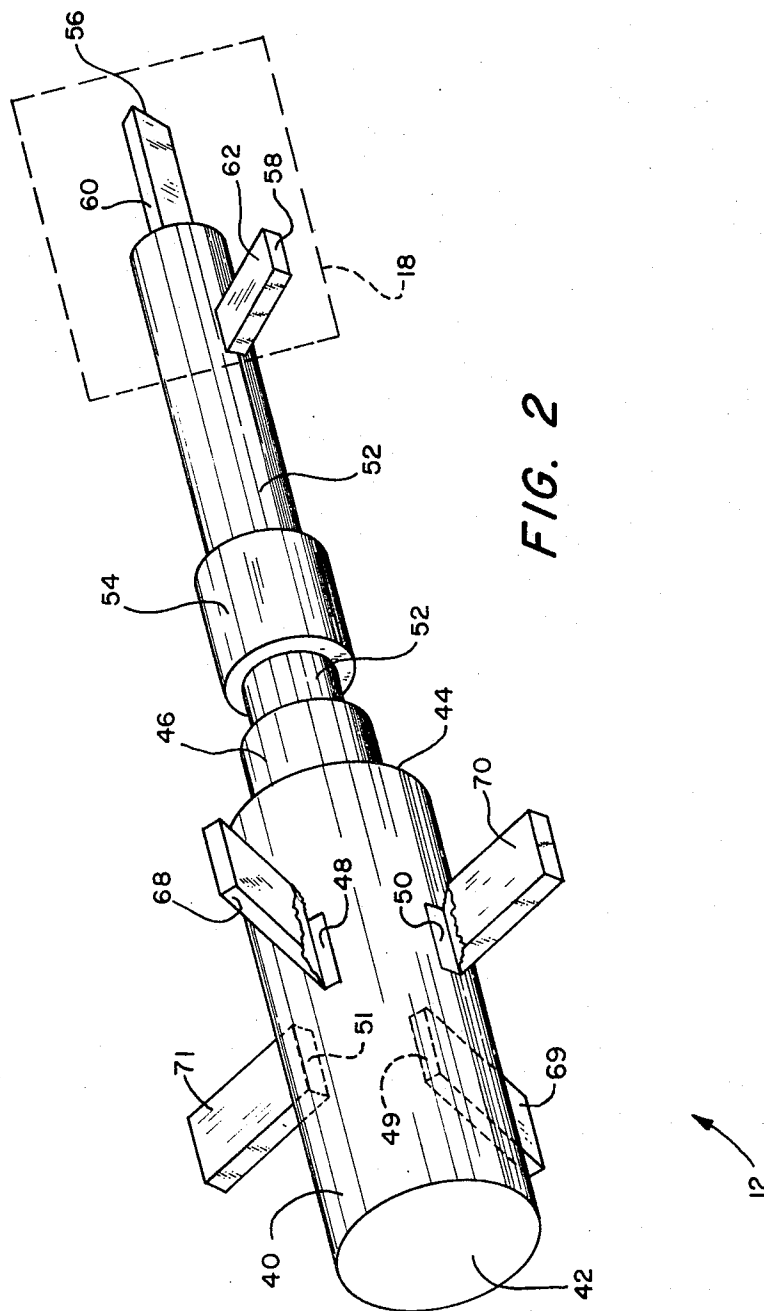


FIG. 2

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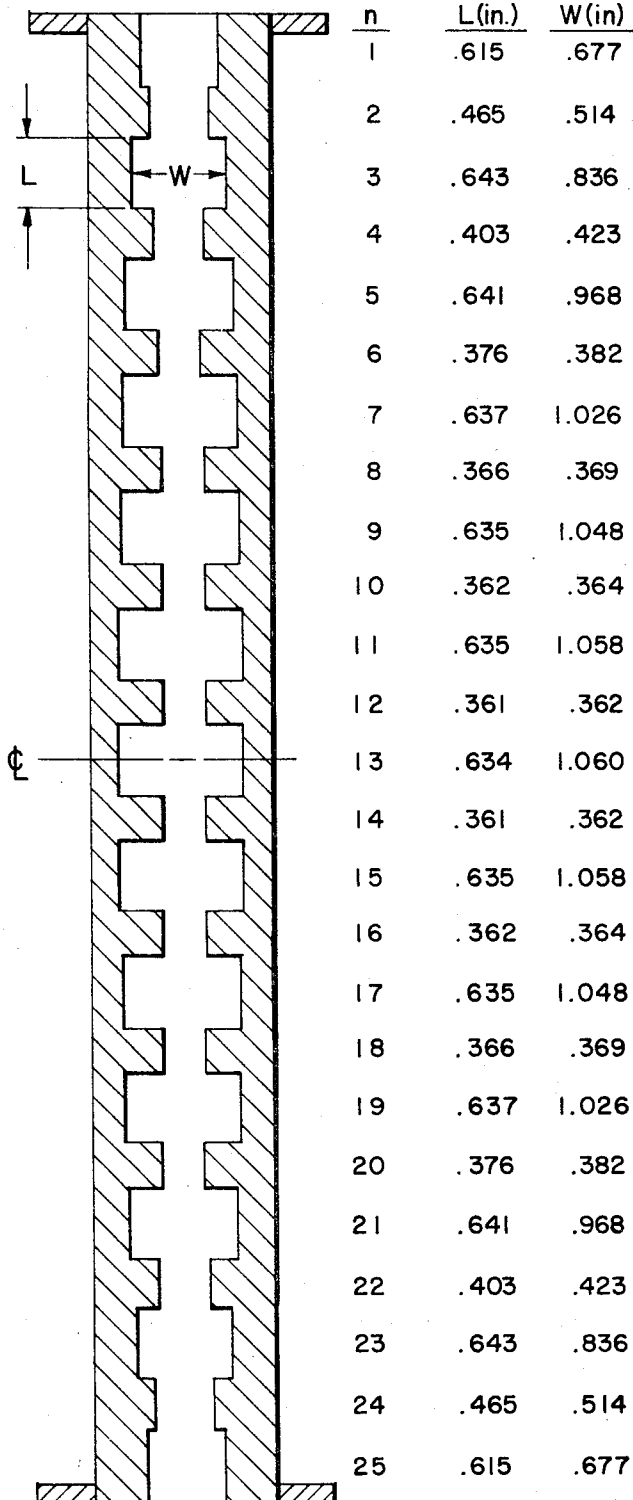


FIG. 3

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DUAL POLARIZED DIPLEXER

BACKGROUND OF THE INVENTION

This invention relates to microwave diplexers and in particular to a diplexer for handling simultaneously two transmitted signals and two received signals from a single antenna.

One type of communication system includes a master station and a remote station each having a transmitter and a receiver to form a two-way communication link. The information capacity of the link is governed by the amount of available band width. One method of increasing the information capacity is to include a second remote station and master station. It would therefore be advantageous to have and it is one of the objects of this invention to provide apparatus for substantially doubling the information capacity of a given band width system employing a single master station having one antenna.

SUMMARY OF THE INVENTION

A dual polarized diplexer according to the present invention includes an electromagnetic wave conducting means having first, second and third ports and being adapted to conduct first and second signals from said second port to said first port, to conduct third and fourth signals from the first port to the third port and to separate said third and fourth signals at the third port. A first rejection means, coupled to the third port of the electromagnetic wave conducting means, is adapted to reject first and second signals at the third port. A second rejection means, coupled to the second port, is adapted to reject the third and fourth signals at the second port of the electromagnetic wave conducting means.

DESCRIPTION OF THE DRAWINGS

The construction and operation of a dual polarized diplexer will be more fully understood from the following detailed description taken in conjunction with the accompanying figures in which:

FIG. 1 is a block diagram of a communication system employing a diplexer according to the present invention;

FIG. 2 is a schematic view in perspective of a diplexer according to the present invention; and

FIG. 3 is a sectional side view of a filter employed in the diplexer of FIG. 2.

DETAILED DESCRIPTION

Shown in FIG. 1 is a block diagram of a communication system 10 employing a dual polarized diplexer 12 according to the present invention. A pair of radio frequency modulator/transmitters 14 and 16 (well-known in the art) have their output connections coupled to an electric field control means such as an orthomode transducer 18. The output connection of the orthomode transducer 18 is connected to a transmit port of the diplexer 12 which also has an antenna port coupled to an antenna 19 and a pair of receive ports coupled to a pair of receivers 20 and 22.

Modulator/transmitters 14 and 16 generate two independent modulated radio frequency signals within a first frequency band. The signals are represented by the arrows 24 and 26 respectively in FIG. 1. The two

signals 24 and 26 are directed through the orthomode transducer where their electric fields are established at right angles to each other in a manner well known in the art before passing through the diplexer to the antenna.

A pair of received polarized signals 28 and 30 having their electric fields orthogonally related are received at the antenna 19 from a source (not shown). The source could be a communication system similar to that shown in FIG. 1. The received signals 28 and 30 are intercepted by the antenna 19 and coupled to receivers 20 and 22 respectively.

The diplexer 12 directs the two signals 24 and 26 from the orthomode transducer 18 to the antenna 19 without coupling energy to either of the receivers 20 or 22 and directs the two received signals 28 and 30 from the antenna 19 to the respective receivers 20 and 22 without coupling energy to the orthomode transducer 18.

An embodiment of a diplexer 12 according to the invention is shown in FIG. 2 and includes an electromagnetic wave conducting means such as the section of circular waveguide 40 having one end 42 coupled to the antenna and the other end 44 coupled to one end of an impedance matching device 46 (well-known in the art). Located in the wall of the section of circular waveguide 40 is a pair of rectangular receiver openings 48 and 50 separated circumferentially by a distance substantially equal to one-fourth of the circumference. The larger dimensions of the openings 48 and 50 are parallel to the longitudinal axis of the circular waveguide 40. While the two openings 48 and 50 are shown in radial alignment, it is to be appreciated that the openings may be separated in the longitudinal direction as long as the circumferential distances are maintained. Receiver openings 49 and 51 will be discussed hereinbelow.

Coupled to the other end of the impedance matching device 46 is one end of a second section of circular waveguide 52 which includes a rotary joint 54. The second section of circular waveguide 52 has a diameter less than the diameter of the first, and the impedance matching device 46 matches the impedance between the first and second sections 40 and 52. The diameter of the first section of circular waveguide 40 is chosen to pass both the higher frequency signal (the transmit signals) and the lower frequency signal (the received signal) while the second section 52 passes only the higher frequency signal and is below cutoff to the lower frequency signal.

For example, at a transmitter frequency in the range of 5.925 to 6.425 GHz, the second section of circular waveguide has a diameter around 1.375 inches. For a received signal in the range of 3.7 to 4.2 GHz, the first section of circular waveguide 40 has a diameter around 2.125 inches. Therefore, the diameter of the impedance matching device 46 has a dimension between that of the first and second sections, for example, 1.975 inches.

Coupled to the other end of the second section of circular waveguide 52 is the orthomode transducer 18 which includes a pair of transmitter openings 56 and 58. The orthomode transducer 18 includes a first section of rectangular waveguide 60 coupled to one end of the second section of circular waveguide 52 and a second section of rectangular waveguide 62 coupled

through the wall of the second section of circular waveguide such that the long cross-sectional dimension of the second section 62 is parallel to the longitudinal axis of the circular waveguide 52. The first section of rectangular waveguide 60 is positioned such that its E plane is orthogonal to the E plane of the second section of rectangular waveguide 62 thereby establishing the relative polarity of signal introduced into the second section of the circular waveguide 52 via the transmitter openings 56 and 58.

The rotary joint 54 allows relative rotation of the first and second sections of circular waveguide. This feature may be employed to rotate the polarization of the transmitted signal to maximize the signal received at a remote station.

Coupled to the pair of receiver openings 48 and 50 is a pair of low pass filters 68 and 70 respectively. The purpose of the filters 68 and 70 is to increase the rejection of the transmit energy at the receiver openings 48 and 50 while passing the received energy with a minimum attenuation. The filters 68 and 70 are designed such that a low impedance or short circuit is present across the openings 48 and 50 at the reject band of the transmitted energy and reflect a matched impedance at the received frequency band. These filters are designed in accordance with the principles described in an article by Ralph Levy entitled "Tables of Element Values for the Distributed Low Pass Prototype Filter," IEEE Transactions on Microwave Theory and Techniques, September 1965. Shown in FIG. 3 are the dimensions of a filter having a reject band covering the 5.925 through 6.425 GHz range and pass band covering the 3.7 through 4.2 GHz range.

The diplexer system according to the invention combines orthogonal, independent, linearly polarized signals in the transmit band with orthogonal, independent, linearly polarized signals in the receive band. While the terms transmit and receive bands are used for discussion purposes, it is to be understood that the only requirement be that the two bands are different. It is to be further understood that reciprocity holds for the diplexer 12, that is, two signals can be inserted into the receiver openings 48 and 50 and two different signals can be extracted at the transmitter openings 56 and 58.

The operation of the diplexer 12 will be described first in the transmit mode. A transmitter output signal is fed into transmitter opening 56 and another transmitter output signal is fed into transmitter opening 58. Because of the symmetry of the orthomode transducer and the propagation properties of rectangular waveguides, the two transmitter openings are isolated from each other. The dimensions of the circular guide 52 are chosen so that only the dominant waveguide (the TE_{11} mode) is above cutoff. Under this condition, exciting the transmitter opening 56 will cause an electric field in the circular guide 52 which is polarized perpendicular to the broad wall of the first section of rectangular waveguide 60. Similarly, exciting the transmitter opening 58 causes the electric field in the circular waveguide 52 to be polarized perpendicular to the broad wall of the second section of waveguide 62. By making the broad walls of these two input ports perpendicular to each other, the transmitter openings 56 and 58 become isolated from one another while producing orthogonal fields in the circular waveguide 52.

The orthogonal transmit signals pass through the rotary joint 54, the impedance matching device 46 and the first section of circular waveguide 40 to the antenna. Because of the low impedance of the reject filters 68 and 70 at the transmitted frequency, the orthogonal transmit signals cannot enter the receiver openings 48 and 50 thus providing the requisite isolation.

On reception a pair of orthogonally related signals, directed from the antenna to the first port 42 of the diplexer 12, is isolated from the transmitter openings 56 and 58 by the action of the smaller diameter circular waveguide 52 which is below cutoff at the received frequency. Hence, when the received signals enter the diplexer 12, they exit only through the receiver openings 48 and 50 and the filters 68 and 70. The received signals must be polarized perpendicular to each other to be independent and each signal must be perpendicular to one of the broad walls of the receiver openings 48 and 50 to maximize the received output signals at the filters 68 and 70.

To maintain symmetry in the first section of circular waveguide 40 and thereby reduce the excitation of the higher order modes, a second set of receiver openings 49 and 51 and filters 69 and 71 may be included diametrically opposite respective receiver openings 48 and 50. The received energy is then split four ways such that half of the received energy of one polarization exits through receiver opening 48 and the other half through the diametrically opposite opening 49. Similarly one-half of the received energy at the second polarization exits at each of the receiver openings 50 and 51. After passing through the filters, energy from each set of diametrically opposite openings can be combined, for example, in a hybrid device well-known in the art.

While there has been shown and described what is considered a preferred embodiment of the present invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention.

What is claimed is:

1. A diplexer device comprising:

electromagnetic wave conducting means having first, second and third ports and being adapted to conduct first and second signals from said second port to said first port, said first and second signals being in a first frequency band and being orthogonally polarized with respect to each other, to conduct third and fourth signals from said first port to said third port, and to separate said third and fourth signals at said third port, said third and fourth signals being in a second frequency band and being orthogonally polarized with respect to each other; first rejection means coupled to said second port and being adapted to reject said third and fourth signals; and second rejection means coupled to said third port and being adapted to reject said first and second signals at said third port.

2. A diplexer device according to claim 1 wherein said electromagnetic wave conducting means includes a first section of circular waveguide having an opening at one end corresponding to said first port, an opening at the other end corresponding to said second port and a pair of openings in the walls thereof corresponding to said third port, said pair of openings being circum-

ferentially displaced from each other by a distance substantially equal to one-fourth of the circumference of said circular waveguide.

3. A diplexer according to claim 1 wherein said electromagnetic wave conducting means includes a first section of circular waveguide having an opening at one end corresponding to said first port, an opening at the other end corresponding to said second port, and four openings in the walls thereof corresponding to said third port, said four openings being symmetrically located around the circumference of said circular waveguide, said first section of circular waveguide having a first predetermined diameter.

4. A diplexer device according to claim 3 wherein said second rejection means includes a plurality of filters, each one coupled to a separate one of said four openings in the walls of said first section of circular waveguide, each of said filters being adapted to reflect a short circuit across its corresponding opening for said first and second signals in said first frequency band and to reflect a matched impedance to said third and fourth signals in said second frequency band.

5. A diplexer device according to claim 3 wherein said first rejection means includes:

a second section of circular waveguide having an input end and an output end and having a second

predetermined diameter smaller than the first predetermined diameter of said first section of circular waveguide and being adapted to cutoff signals having a frequency below the frequency band of said first and second signals; and

impedance matching means coupled between said other end of said first section of circular waveguide and the output end of said second section of circular waveguide and being adapted to match the impedance between said first and second sections of circular waveguide.

6. A diplexer device according to claim 7 including coupling means having an output port connected to the input end of said second section of circular waveguide and first and second input ports and being adapted to convert signals in said first frequency band at its first and second input ports to a pair of orthogonally polarized signals at its output port.

7. A diplexer device according to claim 6 including a rotary joint coupled between the output port of said coupling means and the second port of said electromagnetic wave conducting means and being adapted to permit rotation of the polarization of said orthogonally polarized signals.

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