

[54] MICROWAVE HIGH POWER PHASE SHIFTER UTILIZING CASCADED DIRECTIONAL COUPLERS AND PLASMA THYRATRONS

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[52] U.S. Cl. 333/31 A, 333/7 R;10;99 PL

[51] Int. Cl. H01p 1/18

[58] Field of Search 333/7 R, 10, 31 A, 98 S, 333/99 PL

[56]

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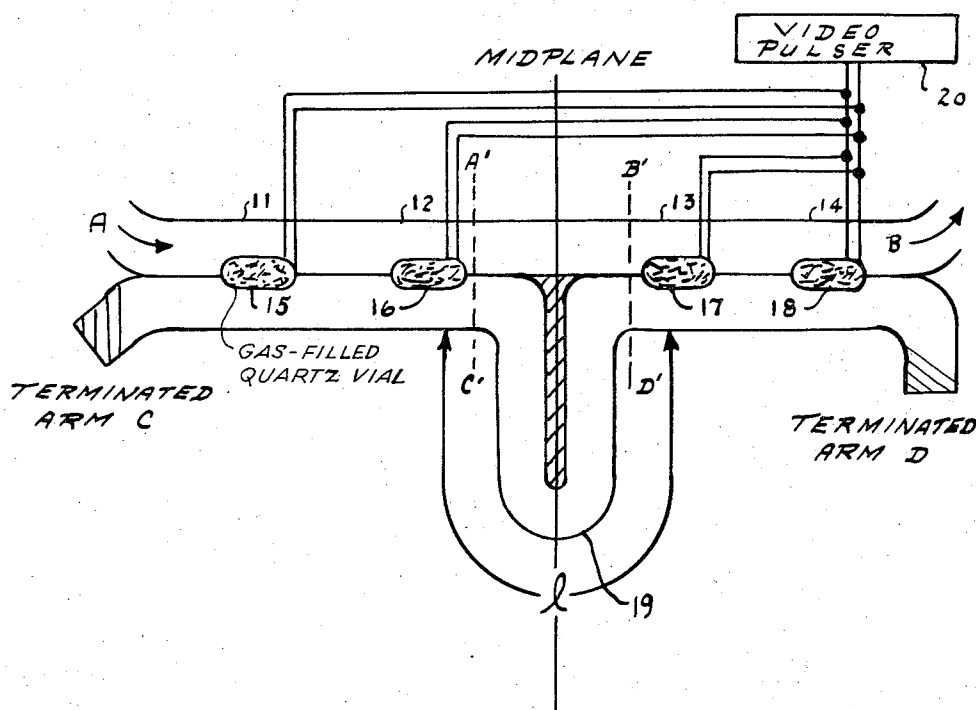
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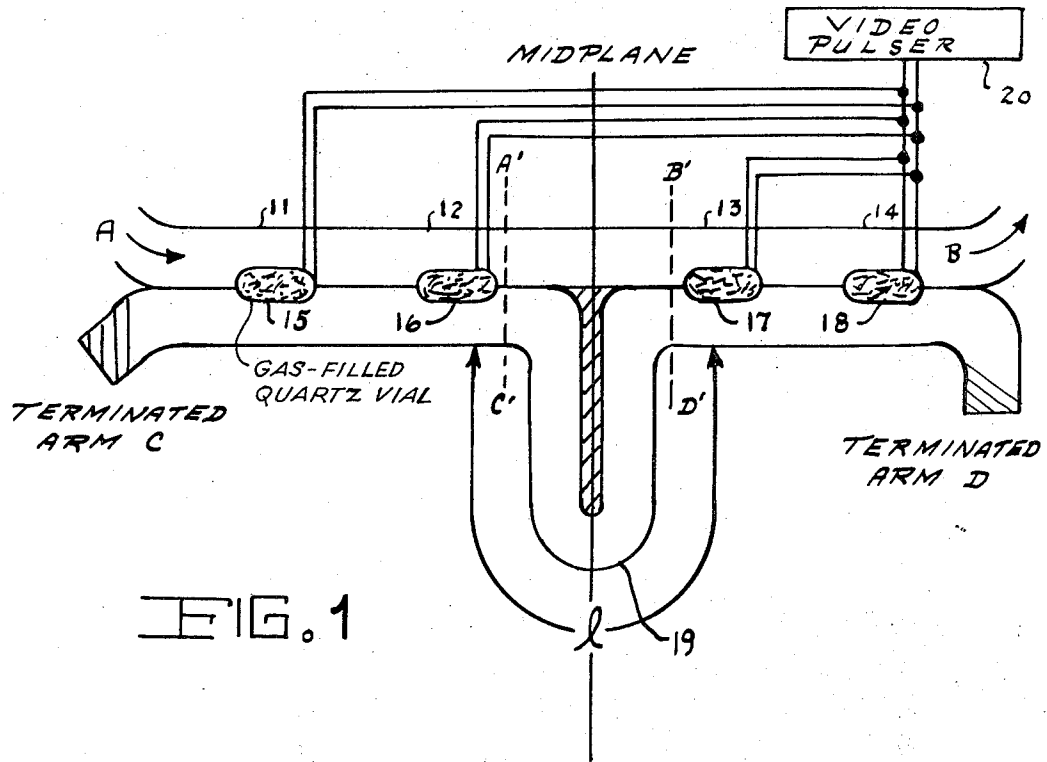
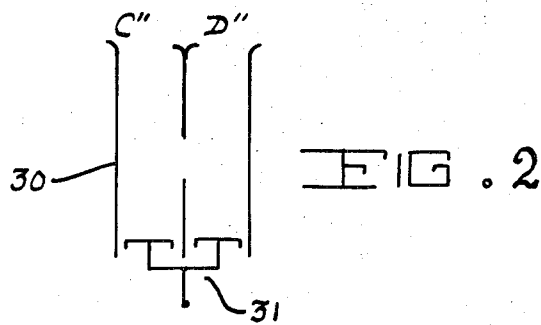
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ABSTRACT

A microwave high power phase shifter is formed by two pairs of cascaded short slot hybrids whose slots are filled by low pressure gaseous volumes. Activation of the gas to the plasma state provides single-bit phase shifting action in the milliwatt to megawatt power range.

2 Claims, 2 Drawing Figures





MICROWAVE HIGH POWER PHASE SHIFTER UTILIZING CASCADED DIRECTIONAL COUPLERS AND PLASMA THYRATRONS

BACKGROUND OF THE INVENTION

The operation of short slot waveguide hybrids is well known and their ability to operate as a unity coupler when two are cascaded has been an important function in balanced duplexers at high power levels. The present invention uses a unique combination of four short slot hybrids whose common wall contains a gas-filled quartz vial or a plasma thyatron switch to effect a high power single-bit phase shift action. The RF voltage in the slot of a hybrid is known to be less than that in the midplane of the input waveguide. Thus, a gas filled vial/tube located in the slot will be in a region of relatively low RF voltage, thus inhibiting an RF discharge. This inability to cause a discharge in a gas under the influence of RF electric fields is referred to as holdoff. The higher the RF holdoff potential, the greater will be the RF power that can be passed without a discharge. The plasma necessary for switching action would normally be created by applying video pulses at low potentials to suitable grids located in the plasma thyatron tubes.

SUMMARY OF THE INVENTION

A microwave high power phase shifter is provided utilizing four short slot hybrids and four plasma thyratrons. The phase shifter uses two waveguide sections arranged in parallel having a common wall. Both arms of the lower waveguide are terminated. Four plasma thyratrons are contained in the common wall and the lower waveguide includes an extra line length. With power incident at the input to the open waveguide, a delay will occur depending upon the firing of thyratrons. In a modification, the extra line length is made adjustable.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an embodiment of the invention including four cascaded short slot hybrids, four associated thyratrons, and an inserted line length; and

FIG. 2 illustrates schematically a modification of FIG. 1 wherein an adjustable short slot hybrid is substituted for the aforesaid inserted line length.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Now referring to FIG. 1, there is shown four cascaded short slot hybrids 11, 12, 13 and 14 containing four gas-filled quartz vials 15, 16, 17 and 18 in their respective common-wall openings. At the input there is provided arm A, and at the output, arm B. Arms C and D are terminated with any conventional RF absorbent material. By inserting transmission line 19 with a preselected length l , a high power single-bit phase shifter is formed. Transmission line 19 is compatible with short slot hybrids. Vials 15, 16, 17 and 18 are connected to low potential video pulse 20, each pulse resulting in plasma for switching.

In the operation of the phase shifter, with power incident at arm A, the input power splits in hybrid 11 and recombines in hybrid 12 in C' with C and A' decou-

pled. This action is well known and is covered in many papers, as for example, "Design Aspects of Short Slot Hybrids", by R. J. Mohr in Microwave Journal, published June, 1962, and "The Short Slot Junction", by H. V. Riblet in IRE Proceedings, published February, 1952. After traveling the line length l , the same action occurs from D' to B in hybrids 13 and 14. When the plasma switches are active, the common-wall slots become conductors, the RF conductivity depending strongly on the electron density in the plasma, and the power incident at arm A travels unperturbed to output arm B. The phase shift occurs because of the difference in signal travel length in each path. A further adaptation is shown in FIG. 2, where the extra path length is adjustable.

Now referring in detail to FIG. 2, there is shown short slot hybrid 30 in schematic form. Movable plunger 31 is provided so that adjustment thereof in short slot hybrid 30 is possible. Line 19 in FIG. 1 is removed and hybrid 30 is substituted. The structure at C' and D' is fitted at C' and D', respectively; in place of line 19, thus providing a line so that the phase length is adjustable.

Referring again to FIG. 1, there is shown therein gas filled quartz vials 15, 16, 17 and 18, it is emphasized that in place thereof there may be substituted plasma thyatron tubes and the necessary plasma for switching action would be created by applying video pulses at low potentials to suitable grids located in the plasma thyatron tubes. These techniques are well known in the art.

It is emphasized that the present invention provides a unique combination of short slot hybrids containing active elements in the common-wall slot region (such as gas vials, triggered plasma thyratrons, or other active elements). A single-bit two-part waveguide phase shifter is formed which will operate over a broad range of power levels. The phase shift magnitude can be made trimmable by using a short slot hybrid with ganged plungers as the added line length.

What is claimed is:

1. A microwave high power phase shifter comprised of first, second, third and fourth thyratrons normally in the passive state, first, second, third and fourth short slot hybrids cascaded in the recited numerical sequence, said short slot hybrids having a common-wall with an opening in said common-wall of each of said short slot hybrids, an input RF power and output arm at said first and fourth hybrid, respectively, a terminated arm at each of said first and fourth hybrids, a transmission line of preselected length in accordance with a desired phase shift, said transmission line being inserted at the junction of said second and third short slot hybrids, each of said openings in each of said short slot hybrids containing one of said thyratrons, each of said thyratrons being located in each of its respective openings to be in a region of relatively low RF voltage to inhibit an RF discharge, and means to video pulse said thyratrons to provide plasma therein for switching to effect a high power single-bit phase shift action.

2. A microwave high power phase shifter as described in claim 1 wherein said inserted transmission line is adjustable to provide a trimming of said phase shift action.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,801,932

Dated April 2, 1974

Inventor(s) Harry Goldie

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On front page, after Data Element Identifier [19]
change "Coldie" to -- Goldie --.

On front page, after Data Element Identifier [75]
change "Coldie" to -- Goldie --.

Signed and sealed this 5th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents