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RADIO-FREQUENCY TRANSMISSION LINE SWITCHING SYSTEM

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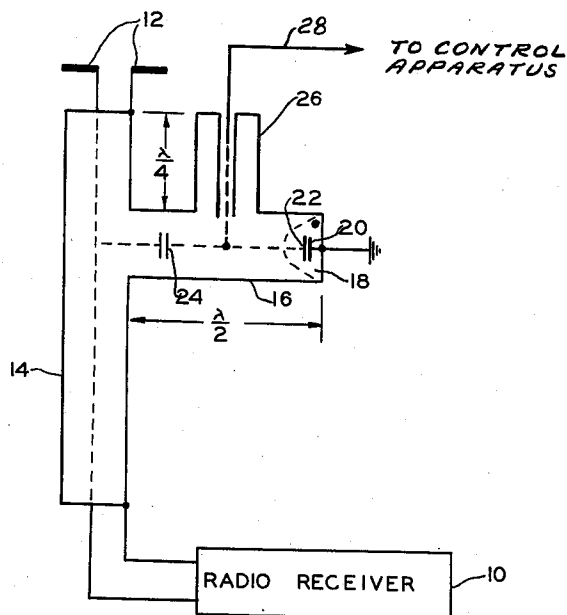


FIG. 1.

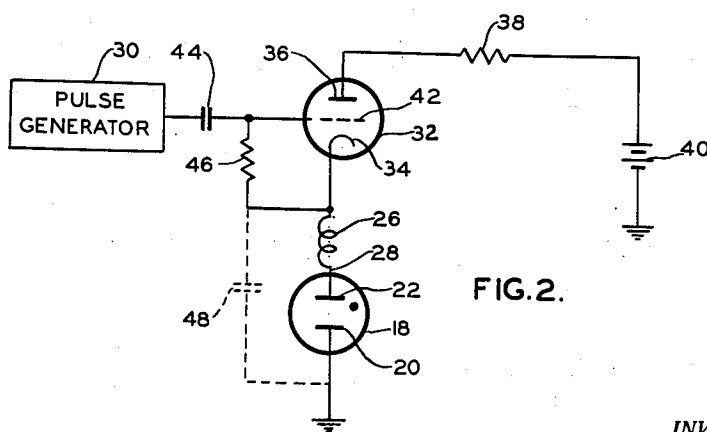


FIG. 2.

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RADIO-FREQUENCY TRANSMISSION LINE
SWITCHING SYSTEMWilliam Todd, Neptune City, N. J., assignor to the
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sec. 266)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

The invention relates to electronic switches and to electronic switch control means.

In the electronic art it is frequently necessary to render a transmission line alternately conductive and non-conductive at a very high alternation rate. Various mechanical switches have been devised, but it has been found impossible to devise a practical mechanical switch that will alternately open and close a transmission line in a few microseconds.

It is therefore an object of this invention to provide a switch of a novel character that will be extremely rapid in operation.

It is also an object of the invention to provide a switch that will be stable in operation and that will require a minimum expenditure of power to operate the same.

These objects, together with other objects and advantages which will be apparent from a reading of the following specification, are attained, in a preferred embodiment of the invention, by means of a gas tube shunted across the free end of a half wave stub line of a main concentric transmission line. The characteristic of a half wave transmission line is such that when the free end is open it behaves as a parallel resonant circuit and presents a high impedance, whereas when the free end is terminated, or shorted, it behaves as a series resonant circuit and presents a low impedance. Thus, when the gas tube is ionized, the free end of the stub line is shorted, and the stub line reflects a low impedance into the main transmission line which arrests the flow of radio-frequency energy therein. Electronic circuit means of a novel character are provided by the invention to alternately ionize and extinguish the gaseous discharge device at a very rapid rate and to maintain the current flow through the gas tube constant during conduction, whereby a constant impedance is presented.

For a better understanding of the invention, reference is made to the following specification of a preferred embodiment of the invention, the said specification to be read in conjunction with the accompanying drawings, in which,

Figure 1 is a schematic drawing of a preferred embodiment of the invention showing the invention applied as a switch between a dipole antenna and a radio receiver, and

Figure 2 is a schematic drawing showing the gas tube of Figure 1 together with a control apparatus in accordance with the invention.

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Referring to the drawing, and particularly to Figure 1, a radio receiver 10 is connected to a dipole antenna 12 through a main concentric transmission line 14 having a half wave length stub arm 16 one quarter of a wave length from the antenna, or input, end of line 14. A gas tube 18, having electrodes 20 and 22, is positioned across the closed end of the stub arm 16. The electrode 20 is grounded to the outer conductor and the electrode 22 is connected to the inner conductor of the arm 16. A blocking condenser 24 is provided along the inner conductor of arm 16 between the electrode 22 and the transmission line 14, and a quarter wave length radio frequency isolating stub 26 is formed integral with the outer conductor of the arm 16. The conductor 28 of stub 26 is connected to the inner conductor of arm 16 whereby connection may be made to the control apparatus of Figure 2.

It will be seen that when the gas tube is ionized, radio frequency energy cannot flow in the concentric line 14 at the base of stub arm 16 since the low impedance which the gas tube 18 presents is reflected by the half wave stub arm 16 to that point, which results in a short circuit at the input antenna end of line 14. Thus when the gas tube is ionized the concentric line 14 is effectively switched closed, preventing the passage of signal voltage from the antenna 12 to the receiver 10. The ionization of the gas tube 18 is controlled by voltage pulses from a square wave pulse generator 30 shown in Figure 2.

Referring now to Figure 2, a triode 32 is shown having its cathode 34 connected to the electrode 22 of the gas tube 18 and having its plate 36 connected to the grounded electrode 20 through a load 38 and a "B" supply battery 40. The grid 42 of the triode 32 is connected to the pulse generator 30 through a condenser 44. A grid resistor 46 is connected between the grid 42 and the cathode 34. The stray capacity of the system is indicated by a condenser 48 shown in broken lines and the radio frequency isolating stub 26 is represented by the radio frequency choke 26 shown in broken lines. The purpose of the stub 26 is to isolate transmission line 16 from the control apparatus and thus prevent the radio frequency energy on line 16 from leaking off through the control apparatus.

A square wave generated by the pulse generator 30 is applied across the grid resistor 46 in series with the condenser 44 and the stray capacity condenser 48. The flow of current through the grid resistor 46 is a differential current wave, which current produces an instantaneous difference in potential between the cathode

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34 and the grid 42 of the triode 32. This difference in potential effectively reduces the internal resistance of the triode 32 and thereby raises the voltage across the gas tube 18 which results in its firing. Turn-off of the gas tube 18 is accomplished in the reverse manner; namely by applying the negative pip of the differential wave to the grid resistor 46.

The action of the triode 32 is similar to a normal current regulating discharge device, since the action of the triode is to cause the gas tube 18 to be either completely fired or completely extinguished. Although a triode 32 has been shown herein, it will be obvious that any multi-element tube may be used.

It will be seen that the operation of the gas tube 18 is controlled by the relatively small amount of power generated by the pulse generator 30. The positive pip of the differential wave is sufficient to cause the tube 18 to fire completely and the negative pip is sufficient to cause the gas tube to be completely extinguished. It will be noted that since a pulse generator is an essential part of most high frequency apparatus, a minimum of extra equipment is used.

It will be obvious that many modifications and changes might be made. For example, the branch arm 16 could be a quarter wave length rather than a half wave length long, in which case the impedance characteristic of the switching operation would be reversed. It is therefore intended that the invention be defined by the following claims.

What is claimed is:

1. A radio frequency switching system comprising a coaxial transmission line, a half wavelength coaxial stub line having its outer conductor at one end thereof connected to the outer conductor of said transmission line and having its inner conductor at said one end thereof connected to the inner conductor of said transmission line; a gas tube having a first electrode connected to the outer conductor of said stub line at the other end thereof and having a second electrode connected to the inner conductor of said stub line at said other end thereof; a source of plate voltage of a value at least sufficient to fire said gas tube; an electron discharge device; a radio frequency choke connecting the cathode of said device to the second-named electrode of said gas tube; means connecting the plate of said device to the first electrode of said gas tube through said source of plate voltage; a grid resistor connecting the grid of said device to said cathode; a condenser; a pulse generator connected to the grid of said electron discharge device through said condenser; said condenser and resistor constituting a differentiating means for deriving pulses of opposite polarity, corresponding respectively to the leading and trailing edges of each pulse from said pulse generator, for firing the gas tube at the leading edge and extinguishing the gas tube at the trailing edge of each pulse from said pulse generator.

2. A control circuit comprising a two-element gas discharge tube, a source of direct potential of a value at least sufficient to fire said gas discharge tube, an electron discharge device having at least a grid, a cathode, and an anode, said electron discharge device being normally cut off, said source of direct potential being connected intermediate said anode and one element of said gas discharge tube and said cathode being connected to the other element of said gas discharge tube, a generator of substantially square wave

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pulses, and differentiating means connected to said pulse generator for deriving from each square wave pulse a positive-going differentiated pulse and a negative-going differentiated pulse, each of sufficient amplitude to respectively render conductive and cut off said electron discharge device, and means connecting said differentiating means to said grid for supplying thereto said differentiated pulses, thereby rendering said gas tube conductive at the leading edge of said square wave pulse and non-conductive at the trailing edge of said square wave pulse.

3. A control circuit comprising a two-element gas discharge tube, a source of direct potential of a value at least sufficient to fire said gas discharge tube, an electron discharge device having at least a grid, a cathode and an anode, said electron discharge device being normally cut off, said source of direct potential being connected intermediate said anode and one element of said gas discharge tube, a radio frequency choke connecting said cathode to the other element of said gas discharge tube, a generator of substantially square wave pulses, and differentiating means connected intermediate said pulse generator and said grid for deriving a positive-going differentiated pulse of sufficient amplitude to render said electron discharge device conductive from the leading edge of said square wave pulse and a negative-going differentiated pulse of sufficient amplitude to cut off said electron discharge device from the trailing edge of said square wave pulse.

4. A control circuit comprising a vacuum tube, a gas tube, said tubes being connected with their space current paths in series, the series circuit of said tubes being connected between a source of direct potential having a value sufficient to fire said gas tube and a source of reference potential, a square wave pulse generator, a differentiating circuit connected to the output of said pulse generator for deriving from a square wave pulse a first pulse coincident with the leading edge thereof of sufficient amplitude to render said vacuum tube conductive, and a second pulse coincident with the trailing edge thereof of sufficient amplitude to cut off said vacuum tube, and means connecting the output of said differentiating circuit to the input of said vacuum tube.

5. The control circuit of claim 4, in which said vacuum tube includes at least a cathode, anode and control element and the output of said differentiating circuit is connected between said control element and said cathode.

6. A radio frequency switching system comprising a coaxial transmission line, a half wavelength coaxial stub line having its outer conductor at one end thereof connected to the outer conductor of said transmission line at ground potential and having its inner conductor at said one end thereof connected to the inner conductor of said transmission line, the point of junction of said stub line and said transmission line being one quarter of a wavelength from the input of said transmission line; a gas tube having a first electrode connected to the grounded outer conductor of said stub line at the other end thereof and having a second electrode connected to the inner conductor of said stub line at said other end thereof; a blocking condenser positioned along said inner conductor of said stub line between said gas tube and said transmission line, whereby direct current appearing across said gas tube may be isolated from said transmission line; a source of plate voltage of a value at least

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sufficient to fire said gas tube; a quarter wavelength coaxial stub line having one end of its outer conductor connected to the outer conductor of said half wavelength stub line intermediate said ends thereof; an electron discharge device having its cathode connected to the second-named electrode of said gas tube through the inner conductor of said quarter wavelength stub line, and having its plate connected to the grounded electrode of said gas tube through said source of plate voltage, and having a grid resistor connecting said grid and said cathode; a condenser; a pulse generator connected to the grid of said electron discharge device through said condenser; said condenser and resistor constituting a differentiating means for applying to the grid of said electron discharge device pulses of opposite polarity corresponding respectively to the leading

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and trailing edges of each pulse from said pulse generator.

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References Cited in the file of this patent

UNITED STATES PATENTS

	Number	Name	Date
	1,933,976	Hanson	Nov. 7, 1933
	1,966,216	Philpott	July 10, 1934
5	2,140,003	Engl	Dec. 13, 1938
	2,189,549	Hershberger	Feb. 6, 1940
	2,203,882	Shore	June 11, 1940
10	2,284,101	Robins	May 26, 1942
	2,405,843	Moe	Aug. 13, 1946
15	2,408,425	Jenks	Oct. 1, 1946
	2,412,161	Patterson	Dec. 3, 1946
	2,442,304	Mayle	May 25, 1948
	2,505,534	Fiske	Apr. 25, 1950