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D. A. DEISINGER ET AL

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ELECTRONIC VALVE

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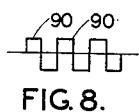
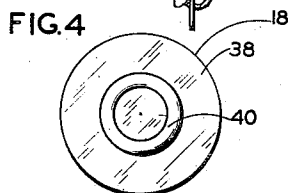
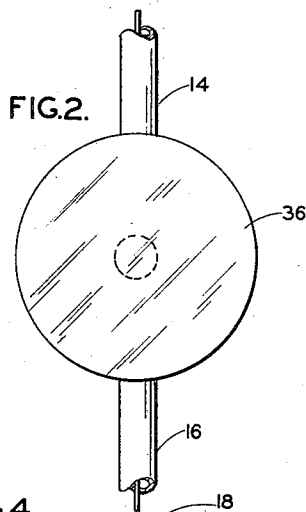
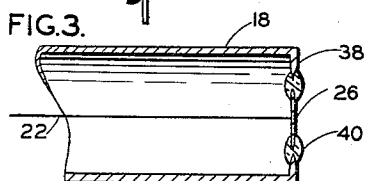
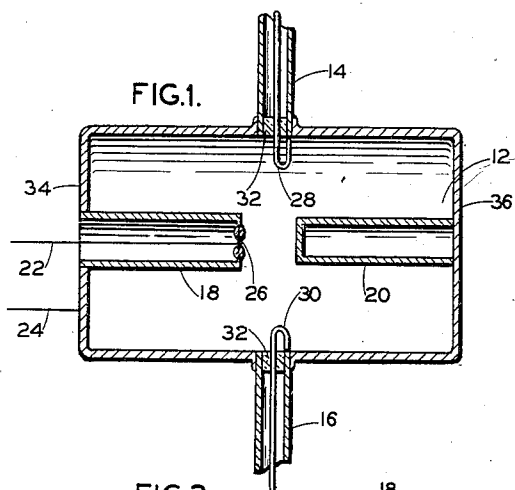
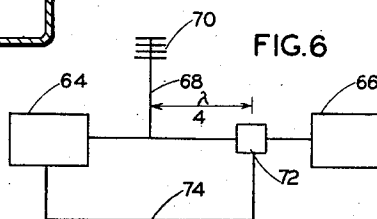
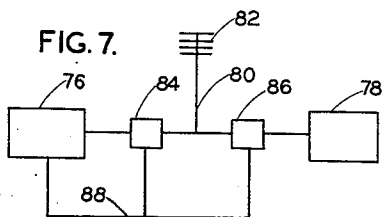
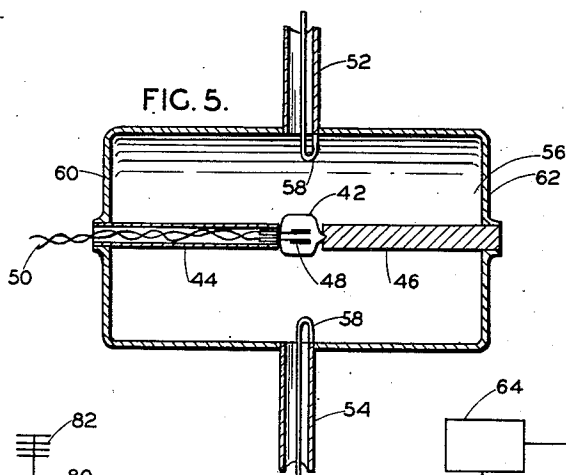


FIG. 8.



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ELECTRONIC VALVE

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1

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

This invention relates to electronic valves, and more especially to valves which control the passage of ultrahigh frequency energy.

The primary object of our invention is to generally improve ultra high frequency circuits, particularly for controlling the flow of radio frequency power. To this end we provide a normally resonant cavity resonator through which energy is efficiently conveyed from an input circuit to an output circuit when the resonator is resonant, and we provide said resonator with electrodes and an ionizable gas, the arrangement being such that ionization of the gas makes the electrode gap conductive, thereby detuning the resonator and interrupting the transfer of power between the input and output circuits.

A more specific object of the invention is to make it possible to control the operation of the valve by means of a relatively small control voltage, and with this object in view we provide the resonator with one or more auxiliary electrodes exposed to the ionizable gas, said electrodes being so spaced that the gap therebetween is readily broken down by the comparatively small control voltage. Still another object is to eliminate the necessity for sealing the entire resonator in order to confine the ionizable gas, and for this purpose a small sealed glass envelope containing the ionizable gas and the auxiliary electrodes is disposed directly between the main electrodes of the cavity. An ordinary neon lamp may be used, for example, thereby greatly simplifying the structure of the remainder of the electronic valve.

To accomplish the foregoing and other more specific objects which will hereinafter appear, our invention resides in the electronic valve elements and their relation one to another as hereinafter are more particularly described in the specification, and sought to be defined in the claims. The specification is accompanied by a drawing in which

Figure 1 is a longitudinal section through an electronic valve embodying features of our invention;

Figure 2 is an end elevation thereof;

Figure 3 is an enlarged section showing a detail of one of the electrodes;

Figure 4 is an end view of the same;

Figure 5 is a longitudinal section through a modified form of our invention;

2

Figure 6 is a block diagram schematically showing one use of our electronic valve;

Figure 7 is a block diagram illustrating a modification; and

Figure 8 is explanatory of the modification of Figure 7.

Referring to the drawing and more particularly to Figure 1, the electronic valve comprises a cavity resonator 12 having input and output circuits 14 and 16, these preferably being alike so that the valve is reversible. Spaced electrodes 18 and 20 are provided in the resonator, and the gap therebetween is filled with an ionizable gas. Resonator 12 with electrodes 18 and 20 is so designed as to be resonant to the particular frequency of the energy being controlled, so that the valve efficiently transmits said energy between the circuits 14 and 16 when the gas is not ionized. However, when the gas is ionized, a conductive path is established across the gap between the electrodes, and the resonator is thereupon detuned and consequently made non-conductive between the circuits 14 and 16.

In accordance with our invention, the operation of the electronic valve is controlled by means of an external control circuit here indicated by conductors 22 and 24. Conductor 22 is connected to an auxiliary electrode 26, which is insulatedly fixed in position and which makes it possible to ionize the gas with a relatively low voltage.

Considering the structure of Figures 1 through 4 in greater detail, the cavity 12 is a cylindrical cavity resonator, and the circuits 14 and 16 are coaxial lines which terminate in loops 28 and 30 respectively, passing through the cylindrical wall of the resonator. The resonator is sealed at the coaxial lines by means of insulation plugs 32. The electrodes 18 and 20 project coaxially into the cavity resonator from the opposite end walls 34 and 36. Both electrodes are shown hollow, but the electrode 20 may, if desired, be made solid. The auxiliary electrode 26 (see Figure 3 and 4) is preferably inserted in the inner end 38 of electrode 18. In the present case, the auxiliary electrode 26 is a small metal disk, the edge of which is embedded in a ring of insulation 40. The periphery of annulus 40 is sealed to the edge of the aperture in inner end 38 of electrode 18. Conductor 22 extends from auxiliary electrode 26 through the hollow main electrode 18.

Figure 5 illustrates a modification of the invention which has the advantage that it is not necessary to seal the main cavity. Instead, the ionizable gas is contained within a sealed glass envelope 42, and the envelope 42 is disposed be-

tween the main electrodes 44 and 46. The ionizable gas is exposed to a pair of auxiliary electrodes 48, and the external control circuit 50 is connected to auxiliary electrodes 48. The operation of this valve is substantially the same as that previously described, that is, the application of a control voltage to the external circuit 50 will ionize the gas, thereby breaking down the gap between the main electrodes 44 and 46 and so detuning the resonator. This makes the cavity non-conductive between the circuits 52 and 54.

Considering the illustrated valve in greater detail, the cavity resonator 56 is cylindrical, and the circuits 52 and 54 are coaxial lines terminating in loops 58 at the cylindrical wall of the resonator. The main electrodes 44 and 46 project coaxially into the cavity from the circular end walls 60 and 62. The glass envelope with its auxiliary electrodes may be an ordinary neon lamp of appropriate size. The electrode 44 is left hollow and thereby provides a convenient passage for the external control wires 50. Electrode 44 may have an end wall, but this has been omitted in the drawing in order to more clearly show the wires leading to the lamp. It is evident that because of the sealed nature of the neon lamp, it is unnecessary to seal the main portion of the resonator.

The electronic valve may be used in many connections for the control of ultra high frequency power. One example is illustrated in Figure 6, in which we diagrammatically illustrate a pulse-echo system comprising a transmitter 64 and a receiver 66, connected in common to a transmission line 68 and a directive antenna system 70. In such an arrangement it is important to protect the receiver 66 from the impact of the powerful pulses transmitted from the transmitter 64. In accordance with the present invention, an electronic switch or valve 72 is connected in the transmission line between the receiver and the common line 68, this valve being of the type herein disclosed. A control wave is fed from the transmitter to the electronic valve, this being schematically illustrated by the dotted-line connection 74. This control wave is synchronous with the transmitted pulses, thereby blocking the line to the receiver when the transmitter is operating, yet opening the said line during the interval between pulses. The valve 72 is preferably located approximately one quarter-wave length from the common line 68 (or any odd number of quarter-wave lengths), thereby presenting infinite impedance across the common line 68 in order not to reduce the efficiency of the transmission line circuit between the transmitter 64 and the antenna 70.

A modified arrangement for the same purpose is illustrated in Figure 7, in which transmitter 76 and receiver 78 are connected to a common transmission line 80 and a directive antenna 82. In this case we provide electronic valves 84 and 86 for both the transmitter and the receiver, the said valves being controlled in synchronism with the transmitter, as indicated by the dotted-line connection 88. The valves may be controlled by a square wave, such as that illustrated in Figure 8, and the auxiliary electrodes are preferably normally biased by means of a suitable direct current potential, which is connected with reversed polarity at one valve compared to the other. In such case, the positive peaks 90 of the square wave will add to the bias and render one of the valves conductive, while the negative peaks will buck the bias and render the said valve

non-conductive. Conversely, the negative half cycles will add to the bias of the other valve and make it conductive, while the positive half cycles 90 will buck the bias and make the latter valve nonconductive. The valves 84 and 86 will therefore be made conductive in alternation, thus disconnecting the receiver from the antenna when the transmitter is connected thereto, and vice versa.

It is believed that the construction, operation, and method of using our improved electronic valve, as well as the advantages thereof, will be apparent from the foregoing detailed description. The cavity resonators illustrated in Figures 1 and 5 are hybrid cavity resonators, which have the advantage of being more compact than pure resonators for the same frequency. However, the invention may, if desired, be applied to a pure cavity resonator by using parallel grids disposed inside the cavity and so arranged that the potential applied across the grids will ionize the space therebetween. When not energized, such grids if of sufficiently open construction, will not change the mode of vibration in the cavity resonator to the hybrid type which is produced by large electrodes, for unlike the latter they do not add lumped inductance and capacitance to the cavity resonator structure.

It will be apparent that while we have shown and described our invention in several preferred forms, many changes and modifications may be made in the structures disclosed without departing from the spirit of the invention as sought to be defined in the following claims.

We claim:

1. An electronic valve for high frequency energy comprising a cavity resonator having input and output circuit coupling means therein, a pair of spaced electrodes in said resonator, said resonator being sealed and filled with an ionizable gas, said resonator being resonant to said energy and the valve being conductive between said circuits when said gas is not ionized, an auxiliary electrode insulatedly secured on the internal exposed surface of one of said electrodes, and means connected to said auxiliary electrode to apply an external control voltage to said auxiliary electrode to ionize the gas and break down the gap between the electrodes, thereby detuning the resonator and making the valve non-conductive between the input and output circuits.

2. An electronic valve for high frequency energy comprising a cylindrical cavity resonator having input and output loops at the cylindrical wall thereof, a pair of spaced electrodes projecting axially in said resonator from opposite ends thereof, said resonator being sealed and filled with an ionizable gas, said resonator being resonant to said energy and the valve being conductive between said loops when said gas is not ionized, an auxiliary electrode insulatedly secured on the internal exposed surface of one of said electrodes, and means connected to said auxiliary electrode to apply an external control voltage to said auxiliary electrode to ionize the gas and break down the gap between the electrodes, thereby detuning the resonator and making the valve non-conductive between the input and output loops.

3. An electronic valve for high frequency energy comprising a cavity resonator having input and output circuit coupling means, a pair of spaced electrodes in said resonator, said resonator being sealed and filled with an ionizable gas, said resonator being resonant to said energy and the valve being conductive between said

5

coupling means when said gas is not ionized, one of said electrodes being a hollow metal body the inner end of which includes a metal insert insulatedly sealed in position by a ring of insulation, and means connected to said auxiliary electrode to apply an external control voltage to said insert to ionize the gas and break down the gap between the electrodes.

4. An electronic valve for high frequency energy comprising a cylindrical cavity resonator having input and output loops at the cylindrical wall thereof, a pair of spaced electrodes projecting axially in said resonator from opposite ends thereof, said resonator being sealed and filled with an ionizable gas, said resonator being resonant to said energy and the valve being conductive between said loops when said gas is not ionized, one of said electrodes being a hollow metal cylinder the inner end of which includes a metal disk insulatedly sealed in position by a ring of insulation, and means connected to said auxiliary electrode to apply an external control

6

voltage to said insert to ionize the gas and break down the gap between the electrodes, thereby detuning the resonator and making the valve non-conductive between the input and output loops.

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