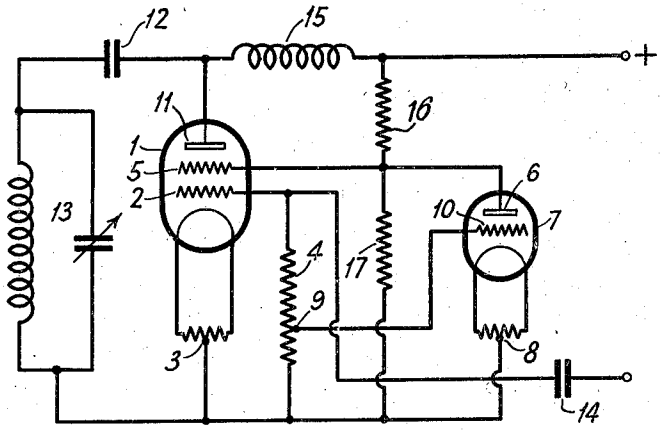
Sept. 6, 1938. D. F. GEORGE 2,129,088

THERMIONIC VALVE CIRCUIT ARRANGEMENT

Filed May 23, 1936



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Patented Sept. 6, 1938 2,129,088

UNITED STATES PATENT OFFICE

2,129,088

THERMIONIC VALVE CIRCUIT ARRANGEMENT

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Application May 23, 1936, Serial No. 81,361
In Great Britain May 24, 1935

4 Claims. (Cl. 250—27)

This invention relates to thermionic valve circuit arrangements and has for its object to provide an improved safety circuit arrangement whereby the chances of damage to a valve due to flow therethrough of excessive current caused by a failure in an associated circuit is substantially reduced or eliminated.

The invention though not exclusively limited thereto is particularly applicable to radio transmitter and like high frequency oscillator valve circuit arrangements.

If, in a radio transmitter or like apparatus, a thermionic valve be connected in a high frequency circuit—either as a high frequency oscillator or as a high frequency amplifier "driven" by a preceding oscillator—of usual convention arrangement, substantial grid current will flow under normal oscillator conditions. If, in the case of a high frequency amplifier valve the oscillatory "drive" fails, or in the case of a high frequency oscillator valve some high frequency component in the circuit breaks down, the valve will no longer present its normal back electro-motive force, and in consequence, will take an abnormally heavy anode current which will in time damage the valve, e. g. will cause it to become "soft" or lose its cathode emission. As a further consequence, the normally substantial grid current will cease to flow. The present invention utilizes this latter effect to provide an automatic safety action preventing the continued flow of abnormally high anode current due to a breakdown.

In carrying out this invention, the valve to be protected is provided with a screen grid (i. e. it is a valve having a grid between the control grid and the anode, e. g. a so-called screen grid valve, pentode or other multi-grid valve) and means operated automatically in dependence upon the grid current of the said valve is provided for substantially lowering the screen grid potential of the valve below normal if the said valve ceases to pass normal grid current. It has been found that if the screen grid potential of a valve having a screen grid be considerably reduced in value from its normal high positive potential, the internal anode-cathode resistance of the valve increases to a high value which, at zero screen grid potential, approaches infinity. Accordingly the effect of automatically reducing the screen grid potential is substantially to reduce the anode current which can flow through the valve.

Preferably the automatic reduction of the screen grid potential is obtained by connecting in the screen grid circuit a gas filled electric discharge device of the trigger-action type, or a tube otherwise known under the registered trade mark "Thyratron". Such a tube is normally prevented from being conductive by bias potential applied to its grid and derived from the grid circuit of the valve to be protected, the arrangement being such that when the grid current of the valve to be protected drops substantially the grid potential of the Thyratron device changes to an extent, and in a direction, sufficient to cause the said device to become conductive, and thus bring down the potential of the screen grid of the valve to be protected.

The invention is illustrated in the accompanying drawing which shows diagrammatically one embodiment thereof.

Referring to the drawing, a high frequency amplifier—for example in a radio transmitter—comprises a screen grid valve 1 the control grid 2 of which is connected to the cathode point 3 through a grid resistance 4. The screen grid 5 of the valve is connected to the anode 6 of a gas filled grid controlled discharge device 7 whose cathode point 8 is connected to the cathode point 3 of the screen grid valve 1. A suitably chosen tapping 9 upon the grid resistance 4 is connected to the grid 10 of the grid controlled discharge device 7. The anode 11 of the valve 1 is connected through a coupling condenser 12 to one end of the usual parallel tuned output circuit 13 the other end of this circuit being connected to the common cathode point. High frequency oscillations from a suitable master or other "drive" source (not shown) are applied, through a suitable coupling condenser 14 to the control grid 2 of the valve 1 and anode potential from a source (not shown) is applied to the anode 11 of the valve 1 through a choke 15. Normal relatively high screen grid potential is applied to the screen grid 5 of the valve 1 from the anode potential source by means of a high resistance potentiometer consisting of two series resistances 16, 17, one (16) of which is connected between the potential source and the screen grid 5 and the other (17) of which is connected between the screen grid 5 and the common cathode point.

The whole arrangement is such that in normal operation the voltage applied to the grid 10 of the grid controlled gas filled discharge device 7 is sufficient to prevent said device from becoming conductive, but if—for example owing to the faiure of the high frequency "driving source"—the grid current of the screen grid valve drops much below normal, the negative bias voltage on the grid of the gas filled discharge device is no longer maintained at a sufficient value to prevent

said device from becoming conductive, and accordingly the said device becomes conductive thereby bringing down the voltage of the screen grid **5** to much below normal value. Accordingly the internal resistance of the valve **1** rises to an extent amply sufficient to prevent it from damage due to excessive anode current flow.

By suitably choosing the gas filled discharge device—such devices giving an anode to filament voltage drop of only about 15 volts when current is being passed, are available on the market at the present time—it is possible to cause the screen grid potential to be reduced almost to that of the cathode, thus reducing the anode feed current of the screen grid valve practically to zero. By virtue of the fact that the resistances **16**, **17** are high, the high tension current flow through the gas filled discharge device, when the said device is conductive, will be vary low.

The invention is not limited to the use of a gas filled discharge device or other purely electrical relay, since obviously a suitable electromechanical relay could be employed and operated under grid current control, but the illustrated embodiment with its purely electrical action is preferred. Again, as will be obvious, the invention can be employed to protect a bank of valves just as well as a single valve.

An important practical advantage of the present invention lies in its extreme simplicity and cheapness of construction.

The following statement of components (this statement is given purely by way of example) relates to a circuit as illustrated and which has been successfully employed in actual experimental practice.

Valve **1**: Valve as now commercially known under the trade designation Marconi A. C./S. 2.
Anode voltage: 3,500 volts.
Resistance **16**: 45,000 ohms.
Resistance **17**: 12,000 ohms.
Resistance **4**: 12,000 ohms between grid **2** and point **9**.
1,800 ohms between point **9** and point **3**.
Device **7**: Gas filled relay as now commercially known under the trade designation G. T. 1.

In this embodiment, under normal oscillatory conditions the anode feed was 250 milli-amperes, and the total anode power was 875 watts with the grid **2** at 200 volts negative, 750 volts (maximum) on grid **5**, 26 volts negative on grid **10**, and 750 volts on anode **6**, there being, of course, no discharge current through the device **7**.

On the occurrence of a failure (e. g. a failure of carrier frequency drive to the valve **1**) the anode feed, the total anode power, the voltages on the grids **2**, **5** and **10**, all dropped practically to zero and the voltage on anode **6** became approximately 15 volts. Without the safety circuit, a similar fault would have destroyed the valve **1** by anode "dead loss" wattage.

What is claimed is:

1. A protective system for a circuit of the type which includes an electron discharge tube for the generation of oscillations, said tube having a cathode, an anode, a control grid and at least one other grid, said protective system comprising a gaseous discharge tube of the "trigger-action" type, a control grid in the last said tube, means inter-connecting the control grids of the two said tubes for causing the gaseous discharge tube to be triggered off in response to a cessation of oscillations in the first said tube, and means acting in dependence upon the conductivity of the gaseous discharge tube for rendering the first said tube substantially non-conductive.

2. A system in accordance with claim 1 and further characterized in that the first said discharge tube possesses a screen grid electrode and said gaseous discharge tube possesses an anode electrode, these two electrodes being inter-connected.

3. A protective system for a multi-grid electron discharge tube on the input circuit of which oscillations are normally impressed, said system comprising a grid-controlled gaseous discharge tube having a space path of relatively low impedance when "triggered off", means including a resistive impedance in said input circuit of the first said tube and a connection therefrom to the control grid of said gaseous tube for triggering off the latter in response to a marked diminution of amplitude of said oscillations in said input circuit, and means acting in dependence upon a flow of space current in said gaseous tube for rendering the first said tube substantially non-conductive.

4. A system in accordance with claim 3 and having an output circuit for said gaseous tube which connects with a screen grid in said multi-grid discharge tube.

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