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PROTECTING DEVICE FOR GAS OR VAPOR-FILLED, CONTROLLED DISCHARGE TUBES

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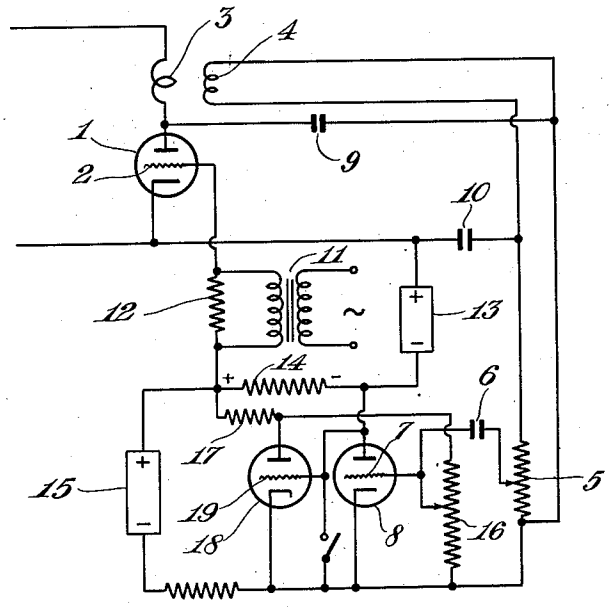


Fig. 1.

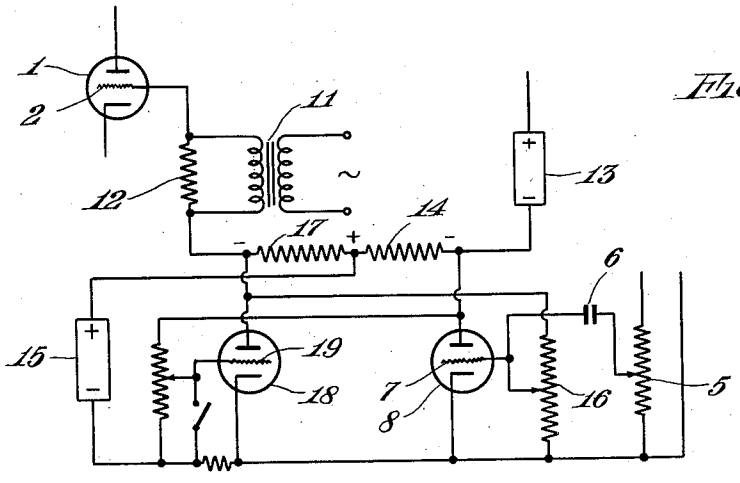
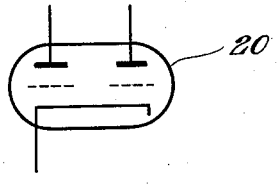


Fig. 2

Fig. 3.



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PROTECTING DEVICE FOR GAS- OR VAPOR-FILLED CONTROLLED DISCHARGE TUBES

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7 Claims. (Cl. 315—291)

1

This invention relates to a protecting device for gas- or vapour-filled, controlled discharge tubes which are cut off by the control means in the case of excessively high currents and backfires in the tube, and is characterized in that, in order to provide additional protection against defects of the protecting device, the latter comprises, at least two controlled high-vacuum tubes which are included in the control-circuit of the discharge tube in such arrangement that, in a normal conductive state of one high-vacuum tube (I), the discharge tube is allowed to operate by the control-voltage, whereas in the case of excessively high currents and backfiring in the discharge tube, the control-member of the high-vacuum tube (I) is given a pulse by which this tube is cut off, or at least the anode current is limited to a lower value, this anode current limitation resulting not only in the supply of a cut-off voltage to the discharge tube by way of its control-member but also in making the other high-vacuum tube (II) conductive in such manner that the cut-off voltage across the discharge tube is maintained.

Since use is made of a high-vacuum tube which only in its normal conductive state allows operation of the discharge tube which may be included in a rectifier circuit, the advantage is secured that in the case of failure of the high-vacuum tube, due to which this tube is put out of action, the discharge tube also is cut off.

In the event of excessively high currents or back-firing in the discharge tube a pulse is transmitted to the operative high-vacuum tube (I) with the result that it is put out of action or carries a lower anode current such that also in this event the discharge tube is cut off. Since the said pulse is only of short duration, the high-vacuum tube and consequently, also the discharge tube, would again become operative upon termination of the pulse. As long as the defect in the latter is not remedied, the cycle is repeated. In order to avoid this, the second high-vacuum tube (II) is made conductive upon anode-current limitation or complete cutting off of the high-vacuum tube (I), with the result that the cut-off voltage across the discharge tube is maintained. This may, for example, be effected by providing that the second high-vacuum tube produces a cut-off voltage across the discharge tube, by which voltage this tube is maintained cut-off, even when the first high-vacuum tube (I) again becomes normally operative upon termination of the interference pulse, thus avoiding "swinging."

2

In the event of defects in the second high-vacuum tube (II), due to which it cannot be made conductive by the first high-vacuum tube (I), "swinging" may be made perceptible by a signally device.
signalling device.

However, the two high-vacuum tubes (I and II) are preferably combined to form a single high-vacuum tube having separate anodes, separate control-members, but a common cathode and filament. Since defects in high-vacuum tubes practically always originate from the cathode and the filament, both of the high-vacuum tubes are then out of action, so that the discharge tube is also cut off.

In order that the invention may be more clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying drawing, given by way of example, in which a few embodiments of the invention are represented diagrammatically.

Referring to Fig. 1, the reference numeral 1 designates a gas- or vapour-filled discharge tube which is included in a rectifier circuit and is controllable by means of a grid 2. The anode lead comprises a current transformer 3 of which the secondary winding 4 transmits pulses, through a resistance 5 and a condenser 6, to a grid 7 of a first high-vacuum tube 8 in the event of currents exceeding the normal anode current of the discharge tube 1.

In the event of backfire in the discharge tube 1, the resistance 5, the condenser 6 and the grid 7 likewise receive pulses through a condenser 9 connected to the anode-lead, the resistance 5 and a condenser 10 and back to the cathode of the discharge tube 1.

During normal operation the discharge tube 1 is periodically made operative by a suitable alternating control-voltage from a control-transformer 11 through a resistance 12, since the source 13 of negative cut-off voltage is adequately compensated by the voltage drop across the anode resistance 14 of the high-vacuum tube 8 which is conductive during normal operation and of which the source of anode voltage is designated 15. Through resistance 16 and anode resistance 17 of a second high-vacuum tube 18 and through the source 15 of anode voltage, this high-vacuum tube has such a grid voltage that it is conductive, and in this event the tube 18 may also be conductive to a certain degree. The tube 18 is connected with its grid 19 to the anode of tube 8.

If, in the event of excessively high currents or of backfires occurring in the discharge tube 1, the high-vacuum tube 8 is cut off or its anode current is adequately reduced, the compensating voltage drop across the anode resistance 14 decreases to such a degree that, owing to the then predominating negative grid voltage of the supply 13, the ignition voltage across the resistance 12 cannot become sufficiently positive to ignite the discharge tube 1. Consequently, this tube is then cut off. However, upon termination of the interference pulse across transformer 3, the high-vacuum tube 8 would again ignite, thus enabling also ignition of the discharge tube 1. To avoid this at least temporarily, the grid 19 of the second high-vacuum tube 18 is connected to the anode of tube 8 (or to a suitable tapping of the anode resistance 14) owing to which the aforesaid decrease in voltage drop across the anode resistance 14 and the consequent increase in positive potential of the anode of tube 8, results in that the grid of tube 18 becomes positive to such a degree that this tube either becomes conductive, from the non-conductive state, or transmits a higher anode current than before. Consequently, the anode voltage of tube 18 drops to such a degree that the voltage across resistance 18 and hence across grid 7 decreases sufficiently to prevent tube 8 from conveying the normal current which would be required to ignite again the discharge tube 1. As long as the tube 18 carries the high anode current, tube 8 consequently conveys a reduced current or no current at all.

When tube 8 is made inoperative due to a defect, the compensating voltage across the anode resistance 14 likewise disappears and the discharge tube 1 is cut off by 13 or caused to pass a permissible low current. This may be effected by means of circuit-arrangements known per se for this purpose.

Fig. 2 represents a circuit-arrangement, in which the anode resistance 17 shown in Fig. 1 is likewise included in the grid-circuit of discharge tube 1. This results in that, in the aforesaid event of an increase in anode current in tube 18 owing to an interference pulse at the grid of tube 8, the voltage drop across resistance 17 is increased, so that the negative grid bias of discharge 1 is likewise increased. The polarity of the voltage across resistance 17 is, in effect, such that the negative voltage of 13 is supported. This yields more security in preventing the discharge tube 1 from becoming again operative.

According to the invention, a practical guarantee against breakdown of the protecting device itself, without the use of the aforesaid signalling device, is obtained by combining the two high-vacuum tubes 8 and 18 to form a single tube having separate anodes and control-members, but a common cathode. This is shown in Fig. 3. In this case a defect in tube 20, which practically always originates from the cathode and the filament, results in that neither of the anodes conveys current, so that the compensation voltage across the resistances 14 and 17 respectively fails and the cut-off voltage 13 predominates.

The arrangement of the secondary winding 4 of the transformer 3 is chosen to be such that at least at the beginning of each current period during normal operation of the discharge tube 1, a pulse is transmitted to the grid 7 of tube 8, the intensity of the pulse being chosen to be such

that the tube is not cut-off, whereas the tube is cut off in the event of an excessively high current which, consequently, considerably exceeds the normal current.

As stated, backfiring is avoided by providing a condenser 9 which is connected in such manner that a negative pulse is applied to the grid in the event of backfire occurring in the discharge tube. In the case referred to the negative pulse is already produced at a voltage variation of sufficient speed and value, so that cutting off of the discharge tube is initiated even before backfiring occurs.

In the diagrams described the reliability of the protecting device practically entirely depends upon freedom from interference of the source 13 of negative grid voltage. However, with the use, for example, of accumulator batteries its operation may be made steady so that disturbances are practically excluded. Additional protection may be provided by using the voltage of supply 13 as a control-voltage for a main switch by which the primary of the supply transformer for the discharge tube 1 is switched off when the voltage of 13 becomes too low.

What I claim is:

1. In a rectifying circuit-arrangement provided with a gaseous discharge device having a cathode, an ignition electrode and a plate, said device being interposed in an alternating-current circuit to effect rectification, and means to apply an alternating voltage to said ignition electrode periodically to ignite said device, a protective system preventing excessive current flow and backfire in said device comprising first and second electron discharge tubes each having a cathode, a grid and an anode, first and second resistances connected respectively to the anodes of said first and second tubes, means coupled to said alternating-current circuit to derive control pulses therefrom having an intensity depending on the current flow through said device, means to apply said control pulses to the grid of said first tube to render said tube non-conductive when the current flow in said device exceeds a predetermined safety value thereby to develop a control potential across said first resistance, means to apply said control potential to said ignition electrode in a direction extinguishing said device, means to apply said control potential to the grid of said second tube in a direction increasing the conductivity of said second tube thereby developing a biasing potential across said second resistance, and means to apply said biasing potential to the grid of said first tube to maintain same non-conductive.

2. In a rectifying circuit-arrangement provided with a gaseous discharge device having a cathode, an ignition electrode and a plate, said device being interposed in an alternating-current circuit to effect rectification, and means to apply an alternating voltage to said ignition electrode periodically to ignite said device, a protective system preventing excessive current flow and backfire in said device comprising first and second electron discharge tubes each having a cathode, a grid and an anode, first and second resistances, means to apply an anode potential through said first and second resistances to the anodes of said first and second tubes respectively, a cut-off bias voltage source connected between the ignition electrode and the cathode of said device through said first resistance, said first resistance having a value at which the voltage drop developed thereacross during the

conduction of said first tube has a magnitude counteracting the cut-off bias on said device, means coupled to said alternating-current circuit to derive control pulses therefrom having an intensity depending on the current flow through said device, means to apply said control pulses to the grid of said first tube to render said tube non-conductive when the current flow in said device exceeds a predetermined safety value whereby the voltage drop across said first resistance is reduced to a level at which said device is rendered non-conductive, means connecting the anode of said first tube to the grid of said second tube whereby when said first tube is rendered non-conductive the conductivity of said second tube is increased thereby to develop a bias potential across said second resistance, and means to apply said bias potential to the grid of said first tube to maintain same non-conductive.

3. An arrangement, as set forth in claim 2, wherein said means to derive control pulses includes a transformer having a primary connected in series with said gaseous discharge device and a secondary connected to a resistance element, a point on said element being coupled to the grid of said first tube.

4. An arrangement, as set forth in claim 3, further including a coupling capacitor connected between the plate of said gaseous device and one end of the secondary of said transformer, whereby control pulses are applied to said element when said device backfires.

5. In a rectifying circuit-arrangement provided with a gaseous discharge device having a cathode, an ignition electrode and a plate, said device being interposed in an alternating-current circuit to effect rectification, and means to apply an alternating voltage to said ignition electrode periodically to ignite said device, a protective system preventing excessive current flow and backfire in said device comprising first and second electron discharge tubes each having a cathode, a grid and an anode, first and second resistances, a source of anode potential having its negative terminal connected to the cathodes of said tubes and its positive terminal connected through said first and second resistances respectively to the anodes of said tubes, a cut-off bias voltage source connected between the cathode and grid of said device through said first resistance, said first resistance having a value at which the voltage drop thereacross during the conduction of said first tube has a magnitude counteracting the cut-off bias on said device, means coupled to said alternating-current circuit to derive control pulses therefrom having an intensity depending on the current flow through said device, means to apply said control pulses to the grid of said first tube to render said tube non-conductive when the current flow in said device exceeds a predetermined safety value whereby the resultant voltage drop across said first resistance effects extinction of said device, means connecting the anode of said first tube to the grid of said second tube whereby the voltage developed at the anode of said first tube during the non-conduction thereof increases the conductivity of said second tube, means connecting the anode of said second tube to the grid of said first tube whereby the potential developed at the anode of said second tube during the increased conductivity thereof maintains said first tube non-conductive.

6. An arrangement, as set forth in claim 5, wherein said first and second tubes are contained in a single envelope and possess a common cathode.

7. In a rectifying circuit-arrangement provided with a gaseous discharge device having a cathode, an ignition electrode and a plate, said device being interposed in an alternating-current circuit to effect rectification, and means to apply an alternating voltage to said ignition electrode periodically to ignite said device, a protective system preventing excessive current flow and backfire in said device comprising first and second electron discharge tubes each having a cathode, a grid and an anode, first and second resistances, a source of anode potential having its negative terminal connected to the cathodes of said tubes and its positive terminal connected through said first and second resistances respectively to the anodes of said tubes, a cut-off bias voltage source connected between the cathode and grid of said device through said first and second resistances, said first and second resistances having values at which the combined voltage drop thereacross during the conduction of said first tube has a magnitude counteracting the cut-off bias on said device, means coupled to said alternating-current circuit to derive control pulses therefrom having an intensity depending on the current flow through said device, means to apply said control pulses to the grid of said first tube to render said tube non-conductive when the current flow in said device exceeds a predetermined safety value whereby the resultant voltage drop across said first resistance effects extinction of said device, means connecting the anode of said first tube to the grid of said second tube whereby the voltage developed at the anode of said first tube during the non-conduction thereof increases the conductivity of said second tube, means connecting the anode of said second tube to the grid of said first tube whereby the potential developed at the anode of said second tube during the increased conductivity thereof maintains said first tube non-conductive.

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