

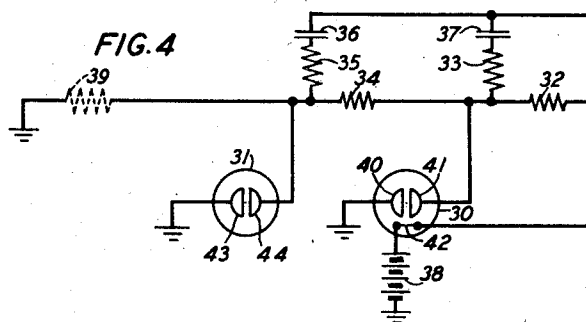
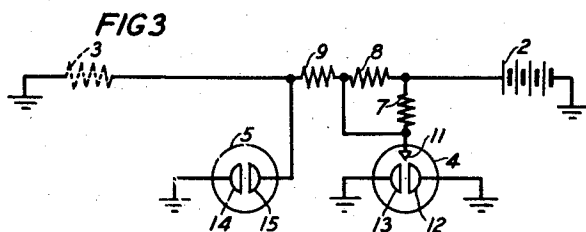
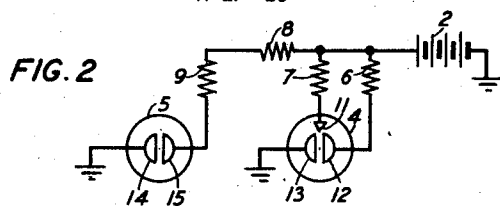
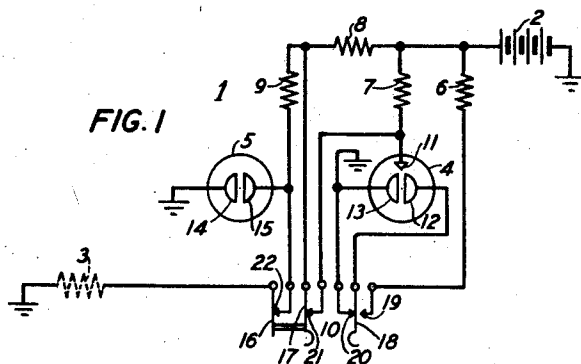
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VOLTAGE REGULATOR

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VOLTAGE REGULATOR

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This invention relates to voltage regulators and particularly to voltage regulators employing gas-filled space discharge devices.

One object of the invention is to provide a voltage regulator between a supply circuit and a load circuit that shall employ gas-filled space discharge devices in an improved manner to effect first an approximate adjustment and then an accurate adjustment of the voltage supplied to the load circuit.

Another object of the invention is to provide a voltage regulator employing gas-filled tubes and resistance elements between a supply circuit and a load circuit that shall ignite the gas-filled tubes in parallel circuits connected to the supply circuit and that shall maintain constant voltage on the load circuit by connecting the tubes in tandem between the supply circuit and the load circuit.

A further object of the invention is to provide a voltage regulator of the above-indicated type that shall connect each tube in series with a resistance element and the tubes with associated resistance elements in parallel to the supply circuit to ignite the tubes and that shall connect one tube in series with a resistance element across the supply circuit, the second tube in series with a resistance element across the first tube and the load circuit across the second tube to maintain the load voltage substantially constant.

Vacuum tubes of many types are used in electric circuits and in many cases it is essential to maintain the voltage of the plate supply for the tubes substantially constant. It is desirable in many instances to provide a voltage regulator for the plate supply of the tubes that shall be free of any moving parts and that shall have a low maintenance cost.

According to the present invention a voltage regulator is provided for the plate supply of tubes in a measuring circuit of a telegraph line that shall be free from moving parts and that shall have a low first cost and a low maintenance cost. The regulator consists essentially of two gas-filled tubes, a number of resistance elements and a switch which controls the ignition of the tubes and the connection of the tubes in operative position.

In one form of the invention a three-element cold cathode tube, a two-element cold cathode tube, a number of resistance elements and a switch are employed in a regulator between the supply circuit and the load circuit. In one position of the switch the ignition circuit of the

three-element tube is connected in series with a resistance element across a supply circuit to ignite the tube and the two-element tube is connected in series with a resistance element across the supply circuit to effect ignition of the two element tube. Upon ignition of the three-element tube a holding circuit is established through another resistance element across the supply circuit. In the second position of the switch the operating circuit of the three-element cold cathode tube is connected through two parallelly arranged resistance elements across the supply circuit. The two-element tube is connected in series with a resistance element across the three-element tube and the load circuit is connected across the two-element tube. In the first position of the switch the two cold cathode tubes are connected across the supply circuit in parallel and ignited and in the second position of the switch the two cold cathode tubes are operated in tandem for supplying a substantially constant voltage to a load circuit.

A gas-filled tube, as for example, a cold cathode tube may be employed as a voltage regulator if connected across a source in series with a resistance element. The current flow through the cold cathode tube will vary in accordance with voltage variations of the source but the potential across the tube will not vary with the voltage variations of this source. The voltage variations of the source are absorbed by the resistance in series with the cold cathode tube. In experiments which have been performed, it is found that if the source has a 10 per cent variation, the voltage drop across the first tube will have a voltage variation of the order of 1 per cent and the voltage variations across the second tube will be of the order of .1 per cent. Resistance elements of different value are employed in the ignition and operation of the cold cathode tubes in order to insure that the current flow through either of the cold cathode tubes is limited to a safe value.

In the accompanying drawing, Fig. 1 is a diagrammatic view of a voltage regulator constructed in accordance with the invention;

Fig. 2 is a diagrammatic view of the ignition circuits for the tubes in the voltage regulator shown in Fig. 1;

Fig. 3 is a diagrammatic view of the operating circuits for the voltage regulator shown in Fig. 1; and,

Fig. 4 is a diagrammatic view of a modification of the regulator shown in Fig. 1.

Referring to Fig. 1 of the drawing, a voltage regulator 1 is shown connected between a direct current source comprising a battery 2 and a load shown as a resistance 3. The regulator comprises a three-element cold cathode tube 4, a two-element cold cathode tube 5, four resistance elements 6, 7, 8 and 9 and a switch 10. The tube 4 is provided with three electrodes 11, 12 and 13 and the tube 5 is provided with two electrodes 14 and 15. The switch 10 is provided with three switch members 16, 17 and 18 and four contact members 19, 20, 21 and 22. The two tubes 4 and 5 are illustrated as gas-filled cold cathode tubes.

The switch 10 is shown in Fig. 1 in the operating position. In such position the switch members 16, 17 and 18 respectively engage the contact members 22, 21 and 20. In the starting position of the switch the switch member 18 engages the contact member 19 and the switch members 16 and 17 are disengaged from the contact members 22 and 21. In one regulator circuit the resistance 8 was made 6,000 ohms, the resistance 7 was made 8,600 ohms, the resistance 9 was made 2,500 ohms, the resistance 6 was made .1 megohm and the load was made 20,000 ohms.

Assuming the switch 10 to be in the starting position, a circuit is completed from the battery 2 for breaking down the tube 4 across the electrodes 12 and 13. This circuit may be traced from ground through the battery 2, resistance element 6, contact member 19, switch member 18 and electrodes 12 and 13 to ground. This tube breaks down when 70 volts are impressed across it. At the same time the tube 5 breaks down by means of a circuit which may be traced from ground through the battery 2, resistance elements 8 and 9 and the electrodes 15 and 14 to ground. The tube 5 breaks down when approximately 70 volts are impressed across it. A diagrammatic view of the circuit completed by the switch 10 for igniting two tubes 4 and 5 is shown in Fig. 2 of the drawing. In Fig. 2 it will be noted that the two tubes 4 and 5 are connected in parallel to the battery 2. Upon breakdown or ignition of the tube 4, a sustaining circuit is completed through the electrodes 11 and 13. This circuit may be traced from ground through the battery 2, resistance element 7 and the electrodes 11 and 13 to ground.

In the operating position of the switch 10 which is shown in Fig. 1 of the drawing, the two tubes 4 and 5 are connected in tandem between the source comprising the battery 2 and the load comprising the resistance 3. The operating circuit for the tube 4 may be traced from ground through the battery 2, resistance elements 7 and 8 in parallel, electrode 11 and the electrodes 12 and 13 in parallel to ground. The operating voltage across the tube 4 is in the neighborhood of 75 volts. The operating circuit for the tube 5 may be traced from the conductor between the resistance element 7 and the electrode 11 of the tube 4 through contact member 21, switch member 17, resistance element 9 and the electrodes 14 and 15 to ground. The sustaining voltage across the electrodes of the tube 5 which is applied to the load 3 is in the neighborhood of 60 volts.

The tandem connection of the tubes 4 and 5 between the source 2 and the load 3 is diagrammatically illustrated in Fig. 3 of the drawing. Tube 4 is shown connected in circuit with the resistance elements 7 and 8 across the battery 2. The tube 5 is shown connected in circuit with the resistance element 9 across the tube 4 and

the resistance element 3 is connected across the tube 5. The voltage across the electrodes of the tube 4 is maintained approximately constant and the voltage across the electrodes of the tube 5 is maintained substantially constant. In the operating circuit shown in Fig. 3 of the drawing, the voltage variations of the source with respect to the tube 4 are absorbed by the resistance elements 7 and 8 and the voltage variations supplied to the tube 5 are absorbed by the resistance element 9.

Referring to Fig. 4 of the drawing, a regulator circuit similar to the regulator circuit shown in Fig. 1 is provided wherein the operating switch is eliminated. The regulator shown in Fig. 4 comprises two cold cathode tubes 30 and 31, four resistance elements 32, 33, 34 and 35 and two condensers 36 and 37. The two tubes 30 and 31 are energized from a battery 38 for supplying constant voltage to a load 39. The tube 30 comprises two electrodes 40 and 41 and a strap 42 included in the base of the tube. The strap 42 prevents excess current in tube 31 in case tube 30 is removed from its socket. The tube 30 may be an RCA-874. The tube 31 is provided with two electrodes 43 and 44.

The two tubes 30 and 31 are ignited by means of two parallel circuits connected to battery 38. The ignition circuit for the tube 30 may be traced from ground through the battery 38, condenser 37, resistance 33 and the electrodes 41 and 40 to ground. The ignition circuit for the tube 31 may be traced from ground through the battery 38, condenser 36, resistance 35 and the electrodes 44 and 43 to ground. Upon ignition the tubes 30 and 31 are operated in tandem between the source and the load. The operating circuit for the tube 30 may be traced from ground through the battery 38, resistance element 32 and electrodes 41 and 40 to ground. The operating circuit for the tube 31 may be traced from the conductor between the resistance 32 and electrode 41 through the resistance element 34 and the electrodes 44 and 43 to ground. The load 39 is connected across the tube 31. The tube 30 breaks down when 125 volts are impressed across it and is operated when 90 volts are impressed on it. The tube 31 breaks down when 70 volts are impressed across it and is operated when 60 volts are impressed on it. In the regulator shown in Fig. 4 of the drawing it will be noted that the two tubes 30 and 31 are ignited in parallel circuit relation and are operated in tandem relation.

Modifications in the circuits and in the arrangement and location of parts may be made within the spirit and scope of the invention and such modifications are intended to be covered by the appended claims.

What is claimed is:

1. In a voltage regulator connected between a load circuit and a current supply circuit, two cold cathode tubes, a plurality of resistance elements, means for igniting a first one of said tubes from said supply circuit through a first one of said resistance elements and the second of said tubes through a second and a third ones of said resistance elements in series and means for establishing an operating circuit for said first one of said tubes from said supply circuit through a fourth one and said second one of said resistance elements in parallel, for establishing an operating circuit for the second tube from across said first tube through said third resistance element and for energizing the load circuit by the potential drop across said second tube.

2. In a voltage regulator connected between a load circuit and a direct current supply circuit, two cold cathode tubes, a plurality of resistance elements, means for igniting each of said tubes from said supply circuit through selected ones of said resistance elements and for holding the tubes ignited and means including different selected ones of said resistance elements for establishing an operating circuit for a first one of said tubes from said supply circuit, for establishing an operating circuit for the second tube from across said first tube, whereby the voltage across said first tube is that supplied to the operating circuit of said second tube, and for energizing the load circuit by the potential drop across the second tube, said second means rendering ineffective the ignition paths for said tubes when said operating circuits are established.

3. In a voltage regulator connected between a supply circuit and a load circuit, two gas-filled tubes, a plurality of resistance elements, means for connecting each of said tubes in series with a resistance element and for connecting the two tubes with the associated resistance elements in parallel circuits across said supply circuit to effect ignition of the tubes, and means connecting the supply circuit across one tube and for connecting the last-mentioned tube in series with a resistance element across the other tube.

4. In a voltage regulator connected between a load circuit and a direct current supply circuit, a first cold cathode tube, a second two element cold cathode tube, a plurality of resistance elements, and means comprising a switch in one position for igniting each of said tubes from said supply circuit and in a second position for igniting the first tube in series with one of said resistance elements for said supply circuit, for operating the second tube in series with another of said resistance by the potential drop across said first tube and for energizing the load circuit by the potential drop across said second tube.

5. In a voltage regulator connected between a load circuit and a direct current supply circuit, a first three-element cold cathode tube, a second two-element cold cathode tube, a plurality of resistance elements, means for igniting the three-element tube in series with one of said resistance elements from said supply circuit and for completing a holding circuit for the tube through a second one of said resistance elements, means for igniting said two-element tube in circuit with two of said resistance elements from said supply circuit, and means for establishing an operating circuit for the first tube from the supply circuit through two of said resistance elements in parallel, for establishing an operating circuit for the second tube across said first tube through one of said resistance elements and for energizing the load circuit by the potential drop across said second tube.

6. In a voltage regulator circuit two cold cathode tubes having different ignition and operating voltages, a variable source of direct current, a load circuit, and means comprising a switch

in one position for disconnecting the load from said second tube and for igniting each of said tubes from said source and in a second position for connecting the first tube in series with resistance across said source, for connecting the second tube in series with resistance across said first tube and for connecting the load across the second tube to maintain the voltage on the load substantially constant.

7. In a voltage regulator connected between a direct current supply circuit and a load circuit, four resistance elements, a first three-element cold cathode tube having ignition and operating circuits, a second cold cathode tube, and means comprising a switch in one position for connecting the igniting circuit of the first tube in series with one of said resistance elements to said source to ignite the tube, for establishing a holding circuit from the supply circuit through a second one of said resistance elements and for igniting the second tube in series with two of said resistance elements from said supply circuit and in a second switch position for connecting the operating circuit of the first tube through two of said resistance elements in parallel to the source, for connecting the second tube in series with one of said resistance elements across said first tube and for connecting the load circuit across said second tube.

8. In a voltage regulator connected between a direct current supply circuit and a load circuit, two gas-filled tubes, a plurality of resistance elements, two capacity elements, means for connecting each of said tubes in series with one of said resistance elements and one of said capacity elements and for connecting the two tubes with the associated resistance and capacity elements across said supply circuit to effect ignition of the tubes and means for connecting a first one of said tubes in series with a resistance element across the supply circuit, for connecting the second tube in series with a resistance element across the first tube and for connecting the load circuit across the second tube.

9. In a voltage regulator connected between a load circuit and a direct current source of supply, two gas-filled tubes, two resistance means, means for connecting said source, said load and said two resistance means in series relation, means for connecting one of said tubes in shunt between one terminal of said source and a point between said two resistance means and the other of said tubes in shunt between one terminal of said source and a point between said resistance means and said load, whereby the potential difference across said one tube is greater than that across said other tube, and means for temporarily impressing across each of said tubes a potential difference derived from said source greater than said first-mentioned potential difference thereacross to start said tubes into operation, said last-mentioned means effectively placing both said tubes temporarily in parallel with each other with respect to said source.

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