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VOLTAGE REGULATOR SYSTEM FOR HIGH AND LOW VOLTAGE REGULATION

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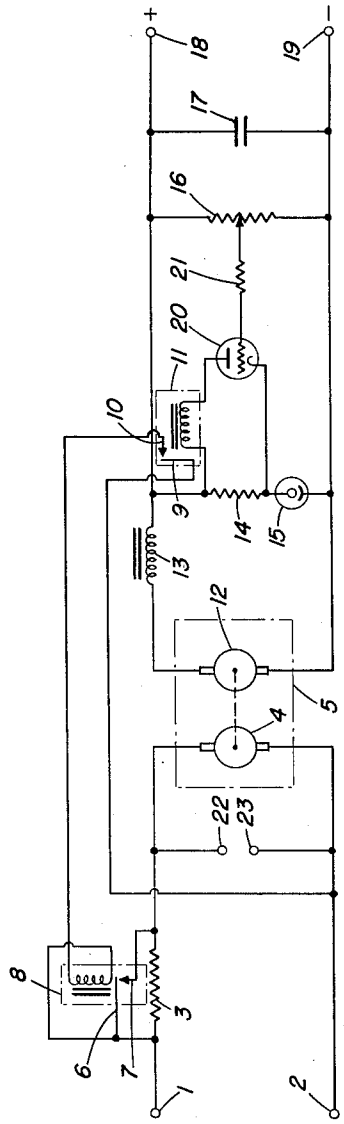

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VOLTAGE REGULATOR SYSTEM FOR HIGH AND LOW VOLTAGE REGULATION

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This invention relates to voltage-regulator systems, and more particularly to systems for regulating the output voltages of power supplies capable of furnishing both low-voltage and high-voltage outputs. Such arrangements, for example, are commonly employed to energize electronic equipments from a low-voltage source, the equipments requiring regulated low voltages to energize the filaments of the vacuum tubes and regulated high voltages for supplying their plates. A common form of such a device is a dynamotor, which comprises a single rotating armature provided with low-voltage and high-voltage commutators. When such a device is used, it is common practice to energize the filaments of the associated electronic equipments from the same source which is used to drive the low-voltage or motor portion of the dynamotor. The high-voltage or generator portion of the dynamotor in turn furnishes power suitable for the plate circuits of the vacuum tubes in the electronic equipments.

In accordance with the present invention, it is proposed to regulate the low voltage which is supplied to such a dynamotor in response to fluctuations in the high-voltage output of the dynamotor. By means of a simple electronic circuit, relatively small fluctuations in this output voltage may be utilized to provide an extremely effective correction to the low voltage. This amplification of the control arrangement, in combination with the large inertia of the rotating armature of the dynamotor, provides a very satisfactory degree of voltage regulation.

As an additional feature of the invention, the regulated low voltage appearing at the terminals of the motor portion of the dynamotor may also be utilized to energize the filaments of the vacuum tubes of associated electronic equipments. Thus a system which is primarily adapted for providing a regulated high-voltage supply additionally provides a very useful regulated low-voltage supply.

For a better understanding of the invention, reference is made to the accompanying drawing, which is a circuit diagram of a voltage-regulator system in accordance with the present invention capable of providing both high-voltage and low-voltage regulation.

Referring to the drawing, input terminals 1 and 2 are connected to the primary low-voltage source of power, not shown. Resistor 3 and motor portion 4 of dynamotor 5 are connected in series between terminals 1 and 2. Resistor 3 is shunted by normally closed contacts 6 and 7 of relay 8. The winding of this relay is in turn connected,

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in series with normally open contacts 9 and 10 of relay 11, across terminals 1 and 2.

Generator portion 12 of dynamotor 5 supplies, through series choke coil 13, a network comprising resistor 14 and voltage-regulator tube 15 in series. The latter network is shunted by potentiometer 16 and by capacitor 17, and its terminals are connected to output terminals 18 and 19, as indicated. The winding of relay 11 is connected, in series with vacuum tube 20, across resistor 14. The grid of vacuum tube 20 is connected through series resistor 21 to the movable arm of potentiometer 16.

The direct-current source of power connected to input terminals 1 and 2 drives dynamotor 5, producing a high direct-current voltage between terminals 18 and 19. Due to the operation of voltage-regulator tube 15, the cathode of vacuum tube 20 is maintained at a substantially fixed potential with respect to terminal 19. Potentiometer 16 permits the grid potential of vacuum tube 20 with respect to that of its cathode to be adjusted to a desired value. A change in the high voltage at terminals 18 and 19 will, however, produce a change in the grid-cathode potential applied to vacuum tube 20, and hence in its plate current.

The operation will be better understood by considering three conditions, two of which are hypothetical. The first condition is that in which the voltage applied to terminals 1 and 2 is below the normal operating range. Under this condition, the potential of the grid of vacuum tube 20 with respect to its cathode is sufficiently negative that the plate current of this tube is not large enough to energize relay 11. Since relay 11 is normally open, relay 8 remains in its normally closed state, and resistor 3 is bypassed. Under this condition, the full voltage which is applied to terminals 1 and 2 appears at the terminals of the motor portion 4 of dynamotor 5.

The second hypothetical condition of operation occurs when the voltage applied to terminals 1 and 2 exceeds the normal operating range. Under this condition, the potential of the grid of vacuum tube 20 with respect to its cathode is such that an appreciable plate current flows, closing relay 11 and opening relay 8. This chain of events introduces into the input circuit resistor 3, thus lowering the voltage which appears at the terminals of motor portion 4 of dynamotor 5.

The third and only condition realized in practice is when the voltage applied to terminals 1 and 2 falls within the operating range. Under this condition of operation, there is a continuous shift back and forth between the first and sec-

ond conditions mentioned above, so that relay 8 alternately opens and closes, the length of time it remains in each position depending upon whether the applied voltage is near the low end or the high end of the operating range. It will be understood that generator portion 12 of dynamotor 5 continues to generate a high-voltage output even when motor portion 4 is not being fully energized, since the dynamotor armature continues to rotate without substantial loss of speed for some time after the input voltage is decreased. This inertia of the dynamotor armature, in combination with the effective amplification of control realized by the use of vacuum tube 20 and its associated relays, provides a very close regulation of the high output voltage in spite of wide variations, within the operating range, of the applied input voltage.

If the voltage-regulator system is used in conjunction with electronic equipments which employ vacuum tubes, the regulated low voltage which appears at the motor terminals of dynamotor 5 may advantageously be also utilized to energize the filaments of such vacuum tubes. Terminals 22 and 23 are provided for this purpose. It will be apparent that, when the system is operating with relay 8 open and hence with resistor 3 in circuit with the source of input power, motor portion 4 of dynamotor 5 will tend to function as a generator. Because of this, the voltage appearing between terminals 22 and 23 will tend to remain substantially constant regardless of whether or not resistor 3 is in the circuit. Such provision of a closely regulated low voltage, in addition to the provision of regulated high voltage, is one of the features of the present invention.

The circuit constants and tube types may be varied and it is understood that various obvious elements may be substituted without departing from the scope of the invention as claimed.

What is claimed is:

1. In a system for delivering regulated D.-C. voltage from an unstable, D.-C. voltage source comprising the combination of a D.-C. motor and a resistor connected in series for connection across said source, an intermittent shunt across said resistor, voltage generating means driven by said motor, and comparing means for operating said shunt variably according to the deviation of the generated voltage from a reference voltage standard, whereby regulated D.-C. voltage may be obtained at the motor terminals.

2. In a system for delivering regulated low voltage direct current and high voltage direct current from an unstable low voltage direct current source, the combination of a resistor and a direct-current motor in series for connection to said source, means driven by said direct-current motor for generating direct current at high voltage, a bridge including a fixed-voltage arm connected as a load on said high voltage generator, and means, including an amplifier vacuum tube energized by the unbalance voltage of said bridge, for intermittently shunting said resistor, the generator action of said motor subsequent to a shunted-resistor interval acting to maintain regulated direct-current voltage across the motor terminals and to regulate the high voltage delivered.

3. In a system for delivering regulated low voltage direct current and high voltage direct current from an unstable low voltage direct current source, the combination of a first resistor and a direct current motor in series for connection to said source, a first relay having normally closed contacts connected across said first resistor, generator means driven by said direct current motor for generating direct current at high voltage, a potentiometer having a movable arm and connected across said generator means, a second resistor and voltage regulator tube connected in series across said generator means, an electron discharge tube having an anode, control grid, and cathode, said cathode being operatively connected to the junction between said second resistor and voltage regulator tube, said grid being operatively connected to the arm of said potentiometer, a second relay having a winding and normally open contacts, said winding being operatively connected between said anode and the high voltage terminal of said generator means, circuit means connecting the contacts of said second relay to control the energization of the first relay thereby providing an arrangement whereby, when the high voltage output of the generator means attains at least a predetermined value, the contacts of the first relay are opened and the first resistor effectively connected in series with the motor.

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