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CONSTANT VOLTAGE POSITIVE BIAS SUPPLY

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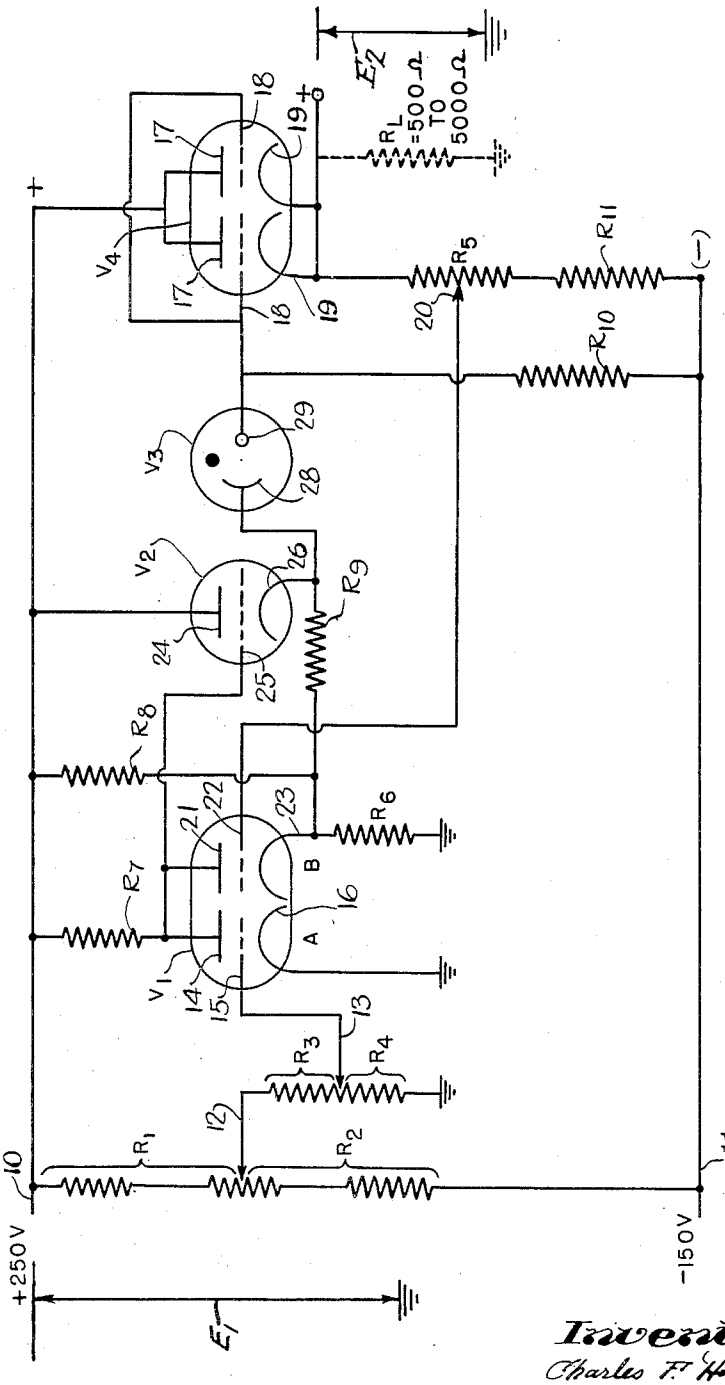

Inventors
Charles F. Hobbs
Norman B. Saunders
By William D. Hall
Attorney

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CONSTANT VOLTAGE POSITIVE BIAS SUPPLY

Charles F. Hobbs, Watertown, and Norman B. Saunders, Cambridge, Mass., assignors to the United States of America as represented by the Executive Secretary of the Office of Scientific Research and Development

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5 Claims. (Cl. 323—22)

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This invention relates to an improved circuit arrangement and more particularly to circuit means for providing a constant voltage positive bias supply.

In the design of the signal strength control circuits for certain types of pulse generators, there is a requirement of a constant voltage low potential supply for application to the cathodes of the first pulse amplifier stage in each pick-up oscilloscope. One suggestion has been to attempt to supply controlled bias to the tubes in the first pulse amplifier stage by means of a voltage divider circuit. However, due to the peculiar connection of the potentiometers in this type of circuit, changing any one potentiometer changes the resistance of the circuit and hence the bias voltage to all amplifiers. This interrelation is unsatisfactory.

An object of the invention therefore is to overcome the difficulty noted and to devise a circuit capable of producing proper bias without undesirable inter-action between potentiometers.

We have found that one suitable means of attaining this objective consists in the combination with a voltage divider of a circuit of a cathode follower type which includes a glow discharge type regulator adapted to be attached to the cathode follower so that its bias is automatically changed by changes in the cathode voltage.

The figure in the accompanying drawing is a schematic diagram of the circuit of the invention.

A source of potential, not shown, having an intermediate point grounded, has its positive terminal connected to wire 10 and its negative terminal connected to wire 11. A voltage divider represented by resistances R_1 and R_2 is bridged across wires 10 and 11. The slider 12 is connected to ground through a second voltage divider having resistances R_3 and R_4. The slider 13 on resistances R_3 and R_4 is connected to grid 15 of the A element of double triode V_1. The plate potential for this tube is supplied between wire 10 and ground and is indicated by E_1. The negative potential applied between terminal 11 and ground provides bias potential and excitation for voltage regulator tube V_3.

The load whose voltage is to be regulated is represented schematically by the resistance R_L, which, as an example, may have a value varying from 500 to 5000 ohms. This load resistance is connected between the cathodes 19 of double triode V_4 and ground. The potential to be regulated is indicated at E_2.

A voltage divider, represented by resistances R_5 and R_{11}, is connected from cathode 19 of tube

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V_4 to the source of negative potential 11. The slider 20 on resistance R_5 is connected to grid 22 of element B of double triode V_1. Anodes 14 and 21 are connected together and supplied through a common anode resistor R_7. Anodes 14 and 21 are connected to grid 25 of triode V_2. Cathode 23 is connected to ground through cathode resistor R_6.

Tube V_2 is a cathode follower, well known in the art. Its anode 24 is connected directly to the source of positive potential 10 while its cathode 26 has a cathode resistor R_9 connected indirectly to ground through cathode resistor R_6 of tube V_{1B}. This connection provides a regenerative feed back, which adds to the sensitivity and is an important feature of the invention.

The output of the cathode follower V_2 may be applied to the grid of the load current tube V_4 by connecting the cathode 26 directly to grids 18 of V_4, connected in parallel. In the preferred arrangement, a voltage regulator tube V_3, of the glow discharge type, is interposed, the cathode of V_2 being connected to the anode 28 of the glow discharge tube V_3 while cathode 29 is connected to grids 18. A high resistance R_{10} is connected from cathode 29 of V_3 to the source of negative potential 11. This provides the normal excitation required for the operation of the glow discharge tube. A high resistance R_8 is connected from wire 10 to cathode 23 of V_{1B} to provide the desired positive bias.

The circuit operates in the following manner:

Any change in output voltage E_2 causes a corresponding change in the potential of grid 22 of tube V_{1B}. The change in grid voltage may be slightly smaller than the change in E_2 (for setting of R_5 toward the R_{11} end) but will always be proportional thereto. The change in grid voltage on V_{1B} is amplified and applied to the grids 18 of the output tubes V_4 in the opposite phase to the original change in E_2. The reversal of phase is accomplished by connecting anode 21 of V_{1B} directly to grid 25 of tube V_2. This effect is then transmitted to V_4 without further reversal of phase by cathode follower action of V_2, from cathode 26 through gas tube V_3 to grids 18. Gas tube V_3 is a constant voltage device.

The amplified reversed phase voltage applied to the control grids 18 of the output tube V_4 opposes the voltage change on the cathode load resistance R_L by cathode follower action of V_2. A portion of the cathode voltage of V_2 is applied to the cathode of V_{1B} as a regenerative voltage to increase the gain of that stage. The amount of regenerative feedback should be adjusted to

the critical amount required to cause the stage to be unstable with the negative feedback path disconnected at X.

The purpose of tube V_{1A} is to provide compensation for fluctuations in supply voltage. This is accomplished by applying a fraction of the supply voltage derived from voltage divider R_3, R_4 to control grid 15 of V_{1A}. Anodes 14 and 21 have a common anode resistor R_7; consequently the output voltages of both tubes, V_{1A} and V_{1B}, are combined and applied to grid 25 of cathode follower V_2 and thence to grids 18 of output tube V_4. It will be seen that a reduction in supply voltage E_1 causes a reduction in grid voltage of V_{1A}, an increase in the plate potential of V_{1A}, an increase in grid voltage of V_2, an increase in grid voltage of V_4, an increase in load current through R_L, and consequently a compensation for the initial drop in supply voltage E_1.

If the adjustment of R_5 is changed the voltage between the output and the grid of V_{1B} is changed. This results in a change in the operating point of that tube with a corresponding change in the output voltage from V_4. For example; suppose the grid of V_{1B} is made more negative by moving the slider of R_5 toward the negative end. This results in a decreased flow of plate current through V_{1B} with a resultant increase in its plate voltage. This increased plate voltage increases the grid voltage on V_4 and consequently increases the output voltage appearing across the load resistance R_L since V_4 is a cathode follower.

This circuit may be applied to test equipment where a very constant low voltage supply capable of delivering any desired amount of current is needed. The load current may be increased indefinitely by increasing the number of triodes in parallel in the final cathode follower stage V_4.

While we have shown a preferred embodiment of our invention, it should be understood that various changes and modifications may be resorted to, in keeping with the spirit of the invention as defined by the appended claims.

We claim:

1. A system for regulating voltage comprising, a source of direct current potential supply having an intermediate point grounded, a first tube, a second tube and an output tube each having at least an anode, cathode and control grid, an output circuit connected from the output tube cathode to said ground, a voltage divider connected from the cathode of said output tube to the negative source of supply, a connection from the voltage divider to the first grid, a connection from the first tube anode to the second tube grid, negative bias means for the output tube including a gas discharge tube connecting the cathode of the second tube to the grid of the output tube and a resistor connecting said output grid to the negative source of supply, an anode resistor for the first tube, and a regenerative feed back connection including a cathode resistor for the first tube connected to said ground and a cathode resistor for the second tube connected to the first cathode.

2. A system for regulating voltage comprising a source of direct current potential supply having an intermediate point grounded, a first tube, a second tube and an output tube each having at least an anode, cathode and grid, an output circuit connected from the cathode of the output tube to said ground, a voltage divider connected from the cathode of said output tube to the negative source of supply, a connection from the voltage divider to the first grid, a direct connection from the first tube anode to the second tube grid, a gas discharge tube connecting the cathode of the second tube to the grid of the output tube and a resistor connected from said output grid to the negative source of supply, an anode and a cathode resistor for the first tube, and a regenerative feed back connection including a cathode resistor for the second tube connected to the first tube cathode.

3. A system for regulating voltage comprising a source of direct current potential supply having an intermediate point grounded, a load impedance and a load current vacuum tube having at least an anode, cathode and grid, connected in series from the positive source to ground, and vacuum tube means responsive to the potential variations across the load resistance for controlling the grid of the load current tube, said vaccum tube means including a first tube having an anode and cathode and an anode and cathode resistor respectively in series bridged from ground to the positive source of potential supply, a cathode follower tube having its cathode resistor connected to the cathode of the first tube, a potential divider bridged from the cathode of said load tube to the negative source of supply, and a connection from the voltage divider to the grid of the first tube, and negative bias means interposed between the second tube and the output tube including a gas discharge tube connecting the second tube cathode to the grid of the output tube and a resistor connected from the output tube grid to the negative source of supply.

4. A system for regulating voltage comprising a source of direct current potential supply having an intermediate point grounded, a first tube, a second tube, and an output tube each having at least an anode, cathode and grid, an output circuit connected from the output tube cathode to ground, a voltage divider connected from the output cathode to the negative source of supply, a connection from the voltage divider to the first tube grid, an anode resistor for the first anode, a connection from the first anode to the second grid, a regenerative connection for the first tube including a cathode resistor for the first tube connected to ground and a cathode resistor for the second tube connected to the cathode of the first tube, and negative bias means interposed between the second tube and the output tube including a glow discharge voltage regulator tube having an anode and a cathode connected respectively to the second tube cathode and the grid of the output tube and a high resistance connecting the cathode of the regulator tube to the negative potential source.

5. A system for regulating voltage comprising, a source of direct current potential supply having an intermediate point grounded, a load resistance one end of which is grounded and a vacuum tube in series with the potential source and load resistance for controlling the current, vacuum tube means responsive to the load voltage for controlling the load current tube, and vacuum tube means responsive to the supply voltage for controlling first mentioned means, said first mentioned means including a triode having an anode and cathode resistor, a cathode follower tube, a glow discharge voltage regulator tube and a voltage divider connected from the positive load terminal to the negative source of supply, a connection from the voltage divider to the grid of the triode, a connection from the plate of the triode to the grid of the cathode follower tube, a re-

generative connection for the triode including a cathode resistor for the cathode follower tube connected to the cathode of the triode, a connection from the cathode of the cathode follower tube to the anode of the voltage regulator tube, a connection from the cathode of the voltage regulator tube to the grid of the load current tube, and a high resistance connected from the cathode of the voltage regulator tube to the negative source of supply, said supply voltage responsive means including a second voltage divider bridged across the source of supply voltage and a second triode having its cathode connected to ground, its anode connected to the anode of said first triode and its grid connected to said second voltage divider.

CHARLES F. HOBBS.
NORMAN B. SAUNDERS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,120,884	Brown	June 14, 1938
2,127,822	Koch	Aug. 23, 1938
2,252,613	Bingley	Aug. 12, 1941
2,268,790	White	Jan. 6, 1942
2,330,638	Stratton	Sept. 28, 1943
2,383,492	Klemperer	Aug. 28, 1945
2,434,069	Goldberg	Jan. 6, 1948
2,475,050	Purington	July 5, 1949
2,484,724	Paradise	Oct. 11, 1949