

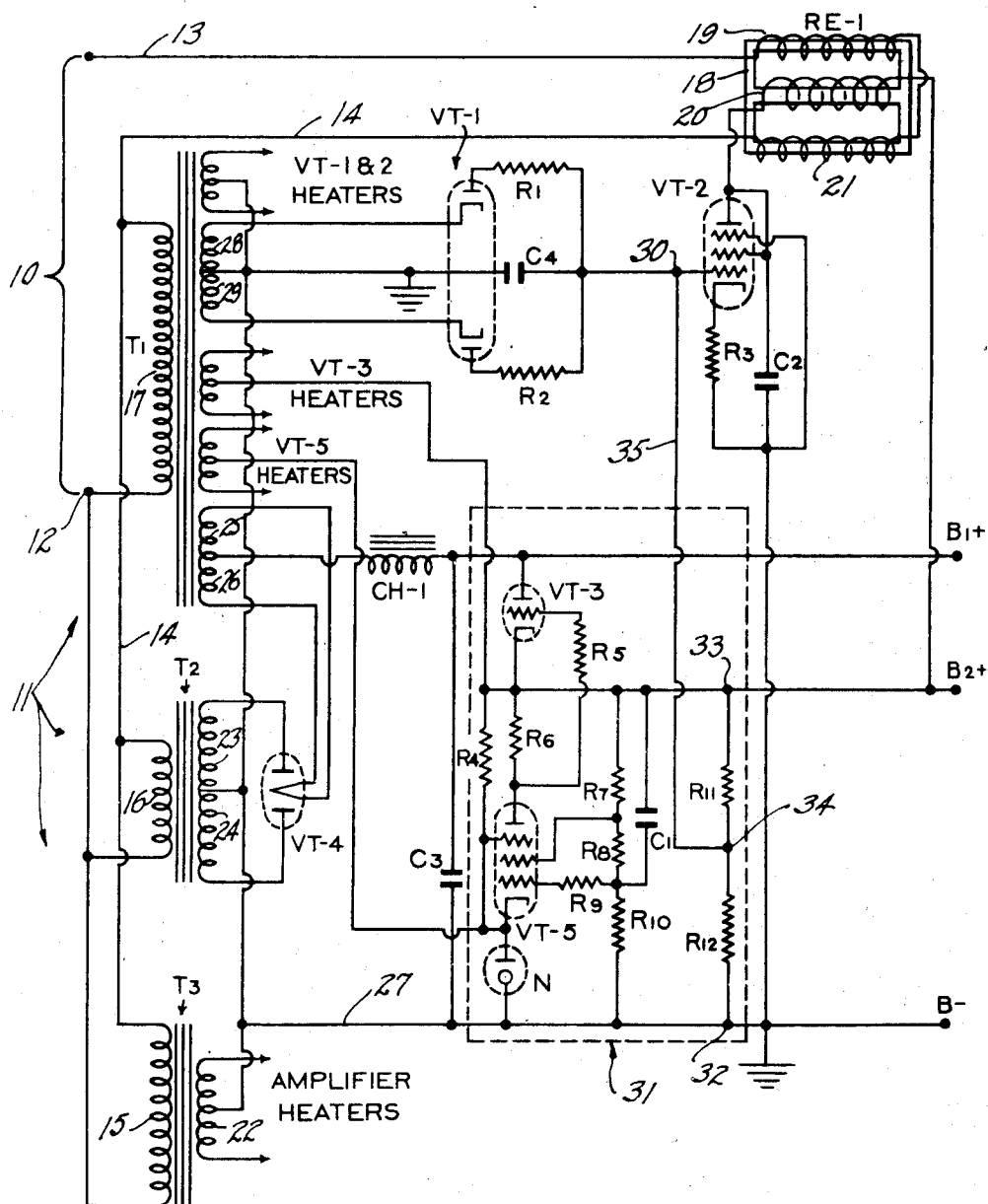
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W. C. ANDERSON

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VOLTAGE CONTROL APPARATUS

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INVENTOR
Wilmer C. Anderson

BY

August, Henry & Campbell
ATTORNEYS

UNITED STATES PATENT OFFICE

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VOLTAGE CONTROL APPARATUS

Wilmer C. Anderson, Douglaston, N. Y., assignor
to Arma Corporation, Brooklyn, N. Y., a corporation of New York

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This invention relates to voltage control apparatus, and has particular reference to automatic means for effecting accurate regulation of a plurality of voltage supplies from a single source, such as all of the tube filament, grid and plate supply outputs of a power-pack for electronic-mechanical servo-systems.

In electronic servo-systems utilizing the characteristics of vacuum tubes in accurate mathematical calculations, it is important that the voltage supply to many points be accurate and uniform. Electronic systems of voltage control are known to the art which are accurate and reliable, but the power which they can handle is decidedly limited. Saturated core reactors, on the other hand, are capable of handling great power, but are not reliable, by themselves.

In accordance with the present invention, an automatic voltage control apparatus is provided, which supplies uniform and accurate voltages to many points and affords great power with utmost reliability at all times, so that the control apparatus of this invention is safely adaptable for use in making mathematical calculations for purposes requiring great accuracy.

The invention combines in a novel way the advantage of accuracy of an electronic voltage control system with the great power capacity of a saturated core reactor, so that both accuracy and a multiplicity of voltage outputs result. In a preferred embodiment of the invention, a suitable electronic voltage regulator provides a relatively low power constant voltage as a standard, which is compared with the input voltage applied to series windings on two legs of a saturable core reactor, whose third leg winding is supplied with any difference between the input and standard voltage to thereby vary the output of the reactor. The reactor is used to vary the output voltage of the entire control system, preferably by application of the regulated voltage therefrom to the primary windings of the input transformers supplying the various loads, such as vacuum tubes and the like.

It will be seen that the voltage control system of this invention affords large power output while maintaining the accuracy and constancy of a conventional low power electronic voltage regulator, and that these desirable results are obtained by a simple arrangement involving the use of relatively few parts additional to the usual electronic regulator.

A more complete understanding of the invention may be had upon reference to the accompanying drawing, which is a diagram of a pre-

ferred form of the invention, the parts thereof being represented by conventional electrical symbols.

Referring to the drawing, numeral 10 indicates a service connection to a 115 volt, single-phase alternating supply which is subject to the variation of supply voltage common to a commercial outlet. This supply is fed to the assembly of transformers shown at 11, the service lead 12 feeding one side of each of the primary windings 15, 16 and 17 of transformers T₁, T₂ and T₃ and the other service lead 13 feeding through the series windings 19 and 21 of the saturable core reactor RE—1, which is of conventional construction comprising a core 18 having three interconnected legs bearing windings 19, 20 and 21. The return lead 14 is connected to the other side of primary windings 15, 16, 17 of transformers T₁, T₂, T₃.

The secondary winding 22 of the step-down transformer T₃ may be connected to a pair of amplifier tube heater leads, not shown, and to the usual pair of high-voltage secondary windings 23 and 24 of step-up transformer T₂. These are to supply the double-wave electronic rectifier VT—4, the positive side of which is connected to the pair of secondary windings 25, 26 of transformer T₁ whose common lead is connected through the choke CH—1 to the terminal B₁+. The negative terminal of rectifier VT—4 is connected by the grounded lead 27 to the B-terminal as shown.

In similar well-known manner, the primary winding 17 of transformer T₁ induces in the various other secondary windings suitable heater voltages for the vacuum tubes used, as indicated in the drawing. In addition to the heater voltage secondary winding of transformer T₁, another pair of secondary windings 28, 29 is provided for transformer T₁, in conformity with this invention. These windings feed relatively high voltages through the duplex rectifier tube VT—1 and resistors R—1, R—2 and condenser C—4 to provide a direct current voltage at the point 30 for an indication of the relative value of all output voltages of the composite load of transformers T₁, T₂, and T₃ for a purpose to be explained.

The final unit of the voltage-control apparatus of this invention is designated 31 and is adapted for producing across the terminals B₂+ and B— an accurately regulated standard voltage of low power, to which the voltage produced at point 30 is to be continuously conformed. The unit 31 is of known construction comprising the

parts shown and operating in such a way as to cause the output voltage across 32—33 to be substantially independent of the load impedance connected across 32—33 or of the unregulated filtered direct current voltage input to the unit 31. This is because any fluctuation in the output voltage across 32—33 will vary the potential applied to the grid of type 6J7 tube VT—5, and hence the grid-cathode potential, since the regulating action of two-watt neon tube N keeps the cathode potential of tube VT—5 constant. Any variation in output voltage is accordingly applied to tube VT—5 and, after amplification thereby, affects the grid potential of 2A3 type tube VT—3 so as to produce a change in voltage drop therein which opposes the change in output voltage across 32—33. The foregoing description of voltage regulator unit 31 is sufficient for an understanding of its function in connection with the present invention, further details being obtainable upon reference to page 615 and Fig. 19 of Terman's "Radio Engineers' Handbook," published 1943 by McGraw Hill Co.

Across the output terminals 32—33 of voltage regulator unit 31 are bridged in series the resistances R11 and R11 and from their junction point 34 a lead 35 is connected to the point 30 on the grid of the tube VT—2, which controls the flow of current through the winding 20 on the center leg of the reactor RE—1 in accordance with the voltage on its grid, and causes regulation of the input voltage from source 10 to primary windings 15, 16 and 17 of transformers T1, T2, T3, in a well known manner.

The operation of the voltage control apparatus of this invention is readily understood from the foregoing description and may be summarized as follows: The voltage regulator unit 31, regardless of variation of voltage of the power source 10, produces a standard direct current voltage which is predetermined by the ratio of resistances R10, R7 and R8, and applies that standard voltage to the point 30, i. e. the grid of the tube VT—2. At the same time tube VT—1 provides a sample direct current voltage proportional to the alternating current voltage of the power source 10 and applies it also to point 30 but in opposite sense to the voltage supplied from unit 31. When, therefore, the sample voltage of the system applied at 30 from VT—1 agrees with the standard voltage from unit 31, also applied at 30, a predetermined current flows in the regulating winding 20 of reactor RE—1. However, when the sample voltage from tube VT—1 disagrees with the standard voltage from unit 31, appropriate change in correction current will be passed by tube VT—2 through regulating winding 20 of reactor RE—1 to vary the portion of the full voltage source 10 which is applied to the primary windings 15, 16 and 17 of transformers T1, T2, T3. In this way, continuous and accurate control of a heavy load is automatically accomplished by means of a regulator of a very light load, without requiring attention for indefinitely long periods.

Although a preferred embodiment of the invention has been illustrated and described herein, it is to be understood that the invention is not limited thereby, but is susceptible of changes in form and detail within the scope of the appended claims.

I claim:

1. In voltage control apparatus wherein a relatively high-power composite load is applied to an alternating current source in series with a

voltage input control means for said load, the combination of a delivery voltage measuring device, a relatively low-power constant voltage standard comprising an electronic voltage regulator, comparing means responsive to any difference in magnitude and sense between the voltage output of said voltage measuring device and the constant voltage of said voltage standard, and means energized by the difference output of said comparing means and interposed between said source and load, whereby said control apparatus is caused to operate in accordance with said voltage comparison to regulate the voltage applied to said relatively high-power load.

2. In a voltage control apparatus wherein a relatively high-power composite load is applied to an alternating current source in series with a voltage input control means, the combination of a voltage regulator connected to said source for producing a relatively low power constant voltage, a winding interposed between said source and said load, a rectifier connected to said source, comparing means responsive to any difference in magnitude and sense between the output voltages of said regulator and rectifier, and a second winding in electrical relation to said first winding and connected to said responsive means, whereby said control apparatus is caused to operate in accordance with said voltage comparison to regulate the voltage applied to said relatively high power loads.

3. In voltage control apparatus wherein a relatively high-power composite load is applied to an alternating current source in series with a voltage input control means, the combination of a voltage regulator connected to said source for producing a relatively low power constant voltage, a saturable core having a winding interposed between said source and said load, a rectifier connected to said source, comparing means responsive to any difference in magnitude and sense between the output voltages of said regulator and rectifier, and a second winding on said core and connected to said responsive means, whereby said control apparatus is caused to operate in accordance with said voltage comparison to regulate the voltage applied to said relatively high power load.

4. In a voltage control apparatus wherein a relatively high-power composite load is applied to an alternating current source in series with a voltage input control means, the combination of a voltage regulator connected to said source for producing a relatively low power constant voltage, an input transformer having a primary winding connected to said source and a secondary winding, a winding interposed between said source and said primary winding, a rectifier connected to said secondary winding, comparing means responsive to any difference in magnitude and sense between the output voltages of said regulator and rectifier, and a second winding in electrical relation to said first winding and connected to said responsive means, whereby said control apparatus is caused to operate in accordance with said voltage comparison to regulate the voltage applied to said relatively high power loads.

5. In a voltage control apparatus wherein a relatively high-power composite load is applied to an alternating current source in series with a voltage input control means, the combination of a voltage regulator connected to said source for producing a relatively low power constant voltage, a winding interposed between said source

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between said resistances and responsive to any difference in magnitude and sense between the output voltages of said regulator and rectifier, a second winding on said core and connected to said responsive means, whereby said control apparatus is caused to operate in accordance with said voltage comparison to regulate the voltage applied to said relatively high power loads.

13. In combination with a direct current voltage regulator for an alternating current source, an input transformer having a primary winding connected to said source and a secondary winding, a saturable core reactor having a winding interposed between said source and the primary winding of said input transformer, a rectifier connected to the secondary winding of said input transformer, means responsive to any difference in magnitude and sense between the output voltages of said regulator and rectifier, a second winding for said reactor, and connections between said means and said second reactor winding, whereby the voltage impressed on said primary winding is increased or decreased in accordance with the correction voltage impressed by said second reactor winding.

14. In combination with a direct current voltage regulator for an alternating current source, an input transformer having a primary winding

8

connected to said source and a secondary winding, a saturable core reactor having a winding interposed between said source and the primary winding of said input transformer, a rectifier connected to the secondary winding of said input transformer, a pair of series resistances bridged across the output of said regulator, means interposed between the output of said rectifier and a point between said resistances and responsive to any difference in magnitude and sense between the output voltages of said regulator and rectifier, a second winding for said reactor, and connections between said means and said second reactor winding, whereby the voltage impressed on said primary winding is increased or decreased in accordance with the correction voltage impressed by said second reactor winding.

WILMER C. ANDERSON.

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