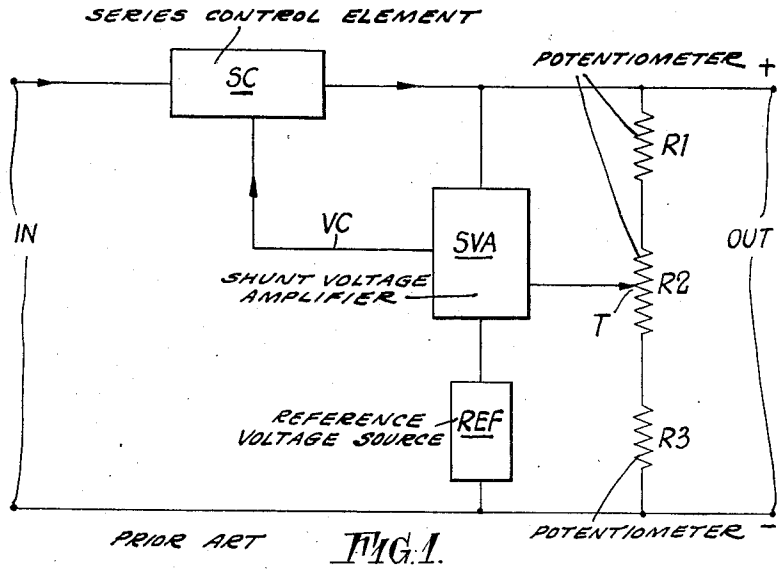
July 1, 1958 P. M. WRIGHT ET AL 2,841,758

VOLTAGE STABILIZING CIRCUIT ARRANGEMENTS

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PRIOR ART FIG. 1.

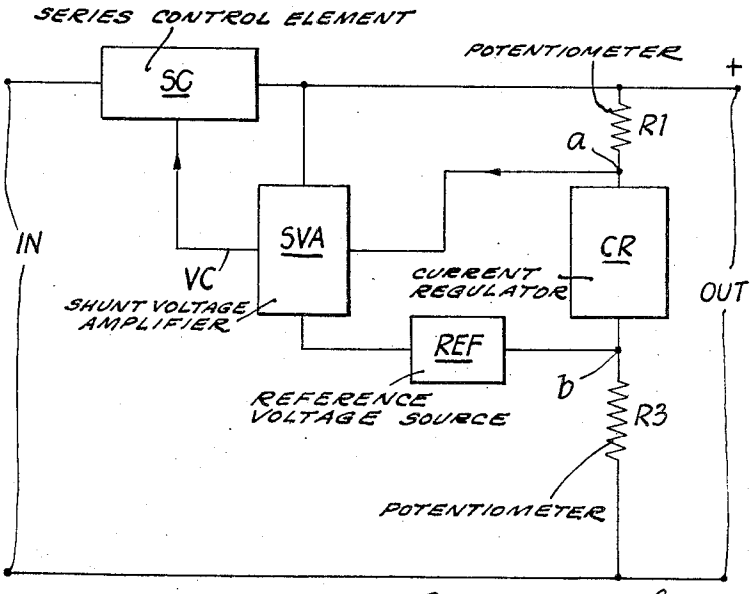



FIG. 2.

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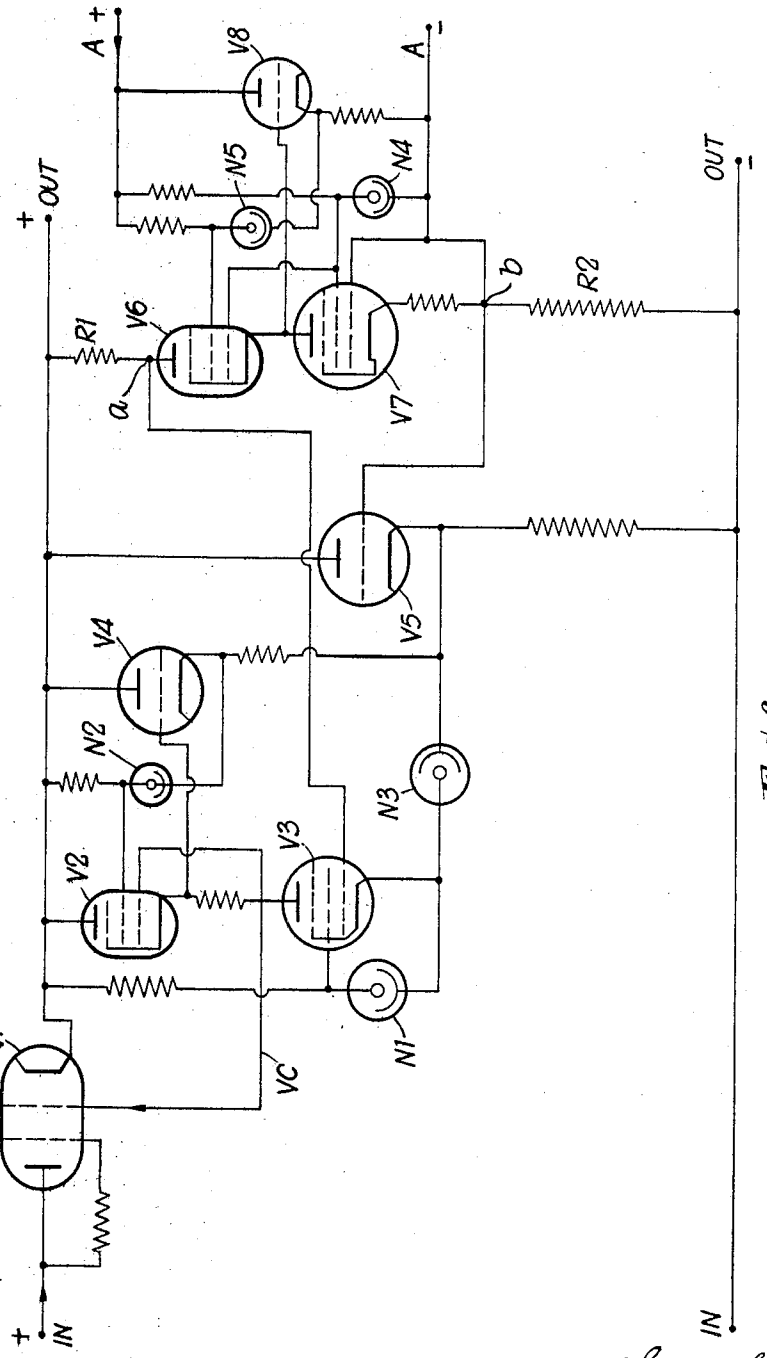



FIG. 3.

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# VOLTAGE STABILIZING CIRCUIT ARRANGEMENTS

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Claims priority, application Great Britain April 21, 1953

2 Claims. (Cl. 323—22)

This invention relates to voltage stabilizing circuit arrangements suitable for use for the supply of extra high tension (E. H. T.) in television apparatus, high tension (H. T.) for thermionic valves, and for like purposes such arrangements being used to supply, at output terminals, a substantially constant predetermined (and, if desired, adjustable) voltage which is derived from a voltage source the value of which is not constant. More specifically the invention relates to voltage stabilizing circuit arrangements of the kind in which voltage taken from a potentiometer across the output terminals is compared with a reference voltage and the resultant used to control a series control element in the feed to one terminal to maintain the output voltage substantially constant.

The invention is illustrated in and explained in connection with the accompanying drawings in which Fig. 1 is a block diagram of a typical known voltage stabilizer of the kind to which the invention relates, Fig. 2, is a block diagram of one embodiment of this invention; and Fig. 3 is a simplified circuit diagram of one embodiment of the invention.

The typical known stabilizer shown in Fig. 1 is fed with input voltage at terminals IN and supplies substantially constant output voltage at terminals OUT, the necessary control to obtain constancy of output being obtained by varying the value of a series control element or circuit SC inserted in the positive rail, which is marked + in Fig. 1, the negative rail being marked —. The control of the elements SC is effected in any suitable well known manner by voltage fed over the lead VC from a shunt voltage amplifier SVA which compares two voltages fed thereto and provides over lead VC, a controlling output dependent on their differences. One of these two voltages is derived from a reference voltage source REF such as a battery or a neon discharge tube and the other is derived from a tap T on a potentiometer R1, R2, R3 connected across the output terminals. The arrangement is such that if the voltage at the tap T departs from the reference voltage the controlling voltage VC varies the element SC in the direction to restore equality.

This known stabilizer has practical defects which are particularly serious where the output voltage at OUT is required to be of high value, of the order of several kilovolts, for example. Owing to the nature of the reference voltage source—a neon tube or a battery—it cannot in practice conveniently be of high voltage, and a reference source of 100 volts, or at most of a few hundred volts, is all that is conveniently obtainable. Accordingly, if the required output voltage is high the tap T on the potentiometer R1, R2, R3 must be near the negative rail and the potentiometer must step down the output voltage by a large ratio to produce the voltage for comparison with the reference voltage. This, of course, inherently involves that changes in the output voltage—what may be termed the error voltage—are stepped down by the same ratio and the gain of the feed back loop through the amplifier SVA and lead VC and therefore the sensitivity of the stabilizer are correspondingly reduced. This difficulty cannot be avoided, as might be thought at first sight, by interchanging the positions of the amplifier SVA and the reference source REF or by connecting the latter directly to the positive rail and dropping the remainder of the voltage in a series resistance to the negative lead. The reason for this is that the amplifier must have a large resistance either in its anode or its cathode lead to drop most of the high potential. In the former case the error voltage must be derived at a standing potential close to that of the negative rail while in the latter there must either be a great amount of negative feedback on the amplifier or there must be great loss in gain therein due to dividing down its output voltage.



The present invention seeks to overcome the foregoing effects and difficulties.

According to this invention a voltage stabilizing circuit arrangement of the kind in which voltage taken from a potentiometer across the output terminals is compared with a reference voltage and the resultant used to control a series control element in the feed to one terminal to maintain the output voltage substantially constant, comprises a current regulator included in said potentiometer whereby the current therethrough is maintained substantially constant at a predetermined value.

The predetermined value may be made adjustable for the purpose of adjusting the stabilized output voltage.

Fig. 2 is a block diagram of an embodiment of this invention, like references denoting like parts in Figs. 1 and 2. The essential difference between Figs. 1 and 2 is that, in Fig. 2 a current regulator CR is included in the potentiometer across the output terminals to maintain the current through the said potentiometer constant whatever the output voltage, and the connections to the amplifier SVA and to the reference source REF are taken from the opposite sides of this regulator as shown. Since the current through the potentiometer is constant the voltage drops in the resistive elements R1 and R3 thereof will also be constant and any error voltage fluctuations will appear across the regulator CR. Since current regulators of low static voltage drop—of the order of a few hundred volts—combined with very high dynamic impedance are readily available, a current regulator of appropriately chosen design can be inserted anywhere that may be required in the potentiometer and hence the full error voltage can be developed across a small static voltage drop at a mean potential of which there is great freedom of choice. It is possible therefore to insert the current regulator in the potentiometer at a point of a few hundred volts below the potential of the positive rail and drop the rest of the voltage in a high resistance on the negative side of the regulator. In other words, in Fig. 2, R1 can be quite small and R3 large. The negative side of the current regulator is at constant potential relative to the negative rail and therefore by connecting the reference source REF as shown to the said negative side and comparing its voltage with that of the positive side of the regulator (also as shown), the full error voltage is made available between the input terminals of the amplifier SVA.

Any current regulator of reasonably low static voltage drop and high dynamic impedance can be used. Fig. 3, however, shows a preferred arrangement.

In Fig. 3 the series control element (SC of Fig. 2) is constituted by a valve V1 and the valves V2, V3, V4 in conjunction with the neon discharge tubes N1 and N2 constitute the shunt voltage amplifier SVA of Fig. 2. The neon discharge tube N3 constitutes the reference voltage source REF of Fig. 2. The valves V6, V7 and V8 in conjunction with the neon discharge tubes N4 and N5 constitute the current regulator CR of Fig. 2, the valve V5 being a cathode follower valve the purpose of

which is to transform the high impedance of the potentiometer to the low impedance required for the shunt voltage amplifier. As will be seen the curent regulator of Fig. 3 is essentially a cathode follower constituted by the valve V6 with the valve V7 as its cathode load. The valve V8, in conjunction with the neon discharge tubes N4 and N5 supplies screen grid voltages to the valves V6 and V7 an auxiliary supply being connected at A+ and A—.

The negative side of the regulator, point *b* of Fig. 3 (this point is also marked in Fig. 2) is at constant potential relative to the negative rail as also will be, therefore, the grid of the valve V5 and the cathode thereof. Point *a* (also repeated in Fig. 2) is at constant potential in relation to the positive rail e. g. a few hundred volts below it. Full error voltage will therefore appear between point *a* and the cathode of valve V5. The reference neon discharge tube N3 source has one terminal connected to the cathode of valve V3 and the valve V3 compares the potential at *a* with the potential across the tube N3 since the control grid of said valve is connected to *a* and the cathode thereof to the remaining terminal of tube N3. The anode load of valve V3 is constituted by valve V2 which is connected as a cathode follower and is a pentode of very high dynamic impedance so that the full amplification factor of valve V3 can be realized.

Another reason for making the anode load of valve V3 dynamically as high as possible is that neon discharge tubes have, in practice, small regions of negative resistance in their characteristics and it may be shown that the stability of such a voltage amplifier with such a negative resistance in its cathode circuit depends upon the positive value of the anode load being at least $\mu$ times the value of the negative resistance exhibited, where $\mu$ is the amplification factor. The high dynamic load provided by valve V2 therefore also makes for stability as well as for utilization of high gain from the valve V3.

The valve V4 in conjunction with the neon discharge tube N2 supplies the screen grid voltage for the valve V2.

It will now be seen that the arrangement of Figs. 2 and 3 can readily be made of very high sensitivity even where a high output voltage is required and only a relatively low reference source is available. In practice it is possible, with an arrangement as described and illustrated in Figs. 2 and 3 to provide an output E. H. T. voltage of the order of 10 kv. stabilized to a few hundreds of millivolts.

While we have described our invention in certain preferred embodiments, we realize that modifications may be made and we desire that it be understood that no limitations upon our invention are intended other than may be imposed by the scope of the appended claims.

We claim:

1. A voltage stabilizing circuit arrangement of the kind of which voltage taken from a potentiometer across the output terminals is compared with a reference voltage and the resultant is used to control a series control element in the feed to one terminal to maintain the output voltage substantially constant, the circuit arrangement comprising a first part of the potentiometer of relatively low resistive value connected between said one terminal and a current regulator included in said potentiometer and a second part of the potentiometer of relatively high resistive value connected between the current regulator and the other output terminal, the voltage being taken from the potentiometer a the junction of the first part and the current regulator and wherein the comparing is effected by comparing means, and the reference voltage is derived from a reference source, one side of the source being connected to the comparing means and the other side of the source being connected to the junction between the regulator and said second part wherein the comparing means comprises a thermionic voltage amplifier, and wherein said other side is connected to the last-mentioned junction through a cathode follower valve, and wherein the amplifier comprises a valve including at least an anode, a cathode, and a grid, said cathode being connected to said one side of the source and said grid being connected to the junction between said first part and the regulator, an anode load for said amplifier valve constituted by a pentode connected thereto as a cathode follower, said pentode including an anode connected to said first mentioned terminal.

2. A voltage stabilizing circuit arrangement of the kind in which voltage taken from a potentiometer across the output terminals is compared with a reference voltage and the resultant is used to control a series control element in the feed to one terminal to maintain the output voltage substantially constant, the circuit arrangement comprising a comparing means, a first part of the potentiometer of relatively low resistive value connected between said one terminal and a current regulator included in said potentiometer, a second part of the potentiometer of relatively high resistive value connected between the current regulator and the other output terminal, the voltage being taken from the potentiometer at the junction of the first part of the potentiometer and the current regulator and the junction of the second part of the potentiometer and the current regulator and wherein the comparing is effected by said comparing means, and the reference voltage is derived from a reference source, one side of said source being connected to the comparing means and the other side of said source being connected to the junction between the regulator and said second part of the potentiometer and wherein the current regulator comprises a cathode follower valve including at least an anode, a cathode and a grid, said anode being connected through a part of the potentiometer to said first mentioned terminal, an additional valve including at least a cathode, an anode and a grid, and wherein said cathode of said follower valve is connected to the anode of said additional valve, said additional valve serving as a cathode load for said cathode follower valve, the cathode of said additional valve being connected through another part of the potentiometer to the other output terminal.

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